Instruction Manual

TEC-8300
Self-Tune Fuzzy / PID Process Temperature Controller

Agency Approvals

TEMPCO Electric Heater Corporation
607 N. Central Avenue • Wood Dale, IL 60191-1452 USA
Tel: 630-350-2252 • Toll Free: 800-323-6859
Fax: 630-350-0232 • E-mail: info@tempco.com
Web: www.tempco.com

Serving Industry Since 1972

Manual TEC-8300 Revision 11/2013

NOTES

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 or damage to or destruction of 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

- Installers. . . . . Read Chapters 1, 2
- Basic Function User. . . . . Read Chapters 1, 3, 5
- Enhanced Function User . . . . Read Chapters 1, 3, 4, 5
- System Designer . . . . Read All Chapters
- Expert User. . . . . Read Page 10

NOTE:

It is strongly recommended that a process should incorporate a LIMIT CONTROL like TEC-910 which will shut down the equipment at a preset process condition in order to preclude possible damage to products or system.

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

Contents

NOTES

1–1 Features

** Unique * Valuable

** High accuracy 18-bit input A–D

** High accuracy 15-bit output D–A

** Fast input sample rate (5 times/second)

** Two function complexity levels

** User menu configurable

** Pump control

* Fuzzy plus PID microprocessor-based control

* Automatic programming

* Differential control

* Auto-tune function

* Self-tune function

* Sleep mode function

* “Soft-start” ramp and dwell timer

* Programmable inputs(thermocouple, RTD, mA, VDC)

* Analog input for remote set point and CT

* Event input for changing function and set point

* Programmable digital filter

* Hardware lockout and remote lockout protection

* Loop break alarm

* Heater break alarm

* Sensor break alarm and bumpless transfer

* RS-485, RS-232 communication

* Analog retransmission

* Signal conditioner DC power supply

* A wide variety of output modules available

* Safety UL/CSA/IEC1010–1

* EMC/CE EN61326

TEC-8300 Fuzzy Logic plus PID microprocessor-based controller incorporates a bright, easy to read, 4-digit LED display which indicates the process value. Fuzzy Logic technology enables a process to reach a predetermined set point in the shortest time, with the minimum of overshoot during power-up or external load disturbance. The units are housed in a 1/8 DIN case, measuring 48mm x 96mm with 65mm behind-panel depth. The units feature three touch keys to select the various control and input parameters. Using a unique function, you can put up to five parameters at the front of the user menu by using SEL1 to SEL5 found in the setup menu. This is particularly useful to OEM’s as it is easy to configure the menu to suit the specific application.

TEC-8300 is powered by 11–26VAC/VDC or 90–264VAC supply, incorporating dual 2 amp. control relays output and dual 2 amp. alarm relays output as standard. Alternative output options include SSR drive, triac, 4–20mA and 0–10 volts. TEC-8300 is fully programmable for PT100, thermocouple types J, K, T, E, B, R, S, N, L, 0–20mA, 4–20mA, and voltage signal input, with no need to modify the unit. The input signals are digitized by using an 18-bit A to D converter. Its fast sampling rate allows the TEC-8300 to control fast processes such as pressure and flow. Self-tuning is incorporated. Self-tuning can be used to optimize the control parameters as soon as undesired control results are observed. Unlike auto-tuning, self-tuning will produce less disturbance to the process during tuning, and can be used at any time.

Digital communications formats RS-485, RS-232 or 4–20mA retransmission are available as an additional option. These options allow the TEC-8300 to be integrated with supervisory control systems and software, or alternatively to drive remote displays, chart recorders, or data loggers.

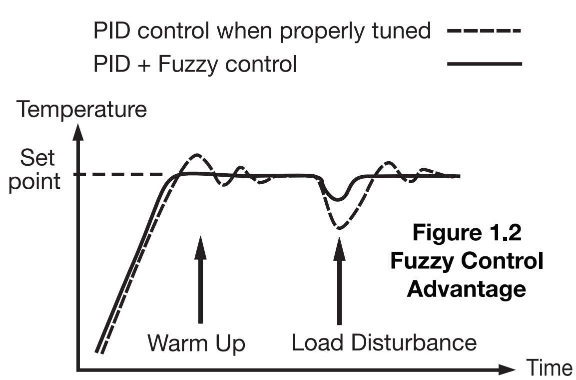


Figure 1.2
Fuzzy Control Advantage

Two different methods can be used to program the TEC-8300. 1. Use the keys on the front panel to program the unit manually; 2. use a PC with setup software to program the unit via the RS-485 or RS-232 COMM port.

For nearly a hundred years, PID control has been used and has proven to be an efficient controlling method by many industries, yet PID has difficulty dealing with some sophisticated systems such as second and higher order systems, long time-lag systems, during set point change and/or load disturbance circumstances, etc. The PID principle is based on a mathematical model which is obtained by tuning the process. Unfortunately, many systems are too complex to describe precisely in numerical terms. In addition, these systems may be variable from time to time. In order to overcome the imperfections of PID control, Fuzzy Technology was introduced. What is Fuzzy Control? It works like a good driver. Under different speeds and circumstances, he can control a car well based on previous experience, and does not require knowledge of the kinetic theory of motion. Fuzzy Logic is a linguistic control which is different from the numerical PID control. It controls the system by experience and does not need to simulate the system precisely as a PID controller would.

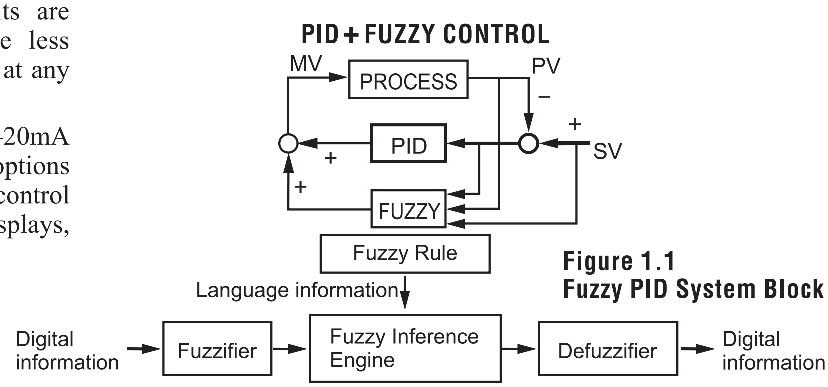


Figure 1.1
Fuzzy PID System Block

The function of Fuzzy Logic is to adjust PID parameters internally in order to make manipulation of output value MV more flexible and adaptive to various processes.

The Fuzzy Rule may work like this:

- If the temperature difference is large, and the temperature rate is large, then ΔMV is large.
- If the temperature difference is large, and the temperature rate is small, then ΔMV is small.

PID+Fuzzy Control has been proven to be an efficient method to improve the control stability as shown by the comparison curves at left:

1–2 Ordering Code

TEC-8300- ☐ ☐ ☐ ☐ ☐ ☐ ☐
1 2 3 4 5 6 7

Power Input — 1

4: 90 - 264 VAC, 50/60 HZ
5: 11 - 26 VAC or VDC
9: Special Order

Signal Input — 2

1: Standard Input
Input 1 - Universal Input
Thermocouple: J, K, T, E, B, R, S, N, L
RTD: PT100 DIN, PT100 JIS
Current: 4 - 20mA, 0 - 20 mA.
Voltage: 0 - 1V, 0 - 5V, 1 - 5V, 0 - 10V
Input 2 - CT and Analog Input **
CT: 0 - 50 Amp. AC Current Transformer
Analog Input: 4 - 20 mA, 0 - 20mA, 0 - 1V, 0 - 5V, 1 - 5V, 0 - 10V.
Input 3 - Event Input (EI)
9: Special Order

Output 1 — 3

0: None
1: Relay 2A/240VAC
2: Pulsed voltage to drive SSR, 5V/30mA
3: Isolated 4 - 20mA / 0 - 20mA*
4: Isolated 1 - 5V / 0 - 5V *
5: Isolated 0 - 10V
6: Triac Output 1A / 240VAC,SSR
9: Special order

Output 2 — 4

0: None
1: Relay 2A/240VAC
2: Pulsed voltage to drive SSR, 5V / 30mA
3: Isolated 4 - 20mA / 0 - 20mA *
4: Isolated 1 - 5V / 0 - 5V*
5: Isolated 0 - 10V
6: Triac Output, 1A / 240VAC, SSR
7: Isolated 20V / 25mA DC Output Power Supply
8: Isolated 12V / 40 mA DC Output Power Supply
9: Isolated 5V / 80mA DC Output Power Supply
A: Special order

Alarm 1 — 5

0: None
1: Form C Relay 2A / 240VAC
9: Special order

Alarm 2 — 6

0: None
1: Relay 2A / 240VAC
9: Special order

Communications — 7

0: None
1: RS-485
2: RS-232
3: Retransmit 4-20mA /0-20mA *
4: Retransmit 1 - 5V / 0 - 5V *
5: Retransmit 0 - 10V
9: Special order

* Range set by front keyboard
** Need to order accessory TEC99999 if Heater Break detection is required.

Example

TEC-8300-4111101

- 90 - 264 operating voltage
- Input: Standard Input
- Output 1: Relay
- Output 2: Relay
- Alarm 1: Form C Relay
- RS- 485 Communication Interface

Accessories

TEC99014— RS-232 interface cable (2M)
TEC99999— 0–50amp AC current transformer
TEC-101-101— Isolated 4–20mA/0–20mA analog output module
TEC-101-114— Isolated 1–5V/0–5V analog output module
TEC-101-115— Isolated 0–10V analog output module
TEC-101-109— Isolated 1A/240VAC triac output module (SSR)
TEC-101-111— Isolated 20V/25mA DC output power supply
TEC-101-112— Isolated 12V/40mA DC output power supply
TEC-101-113— Isolated 5V/80mA DC output power supply
TEC-102-101— Isolated RS-485 interface module
TEC-102-103— Isolated RS-232 interface module
TEC-102-104— Isolated 4–20mA/0–20mA retransmission module
TEC-102-105— Isolated 1–5V/0–5V retransmission module
TEC-102-106— Isolated 0–10V retransmission module

Related Products

TEC99001— Smart network adapter for third party software; converts 255 channels of RS-485 or RS-422 to RS-232 network
TEC99002— Smart network adapter for DAQ software; converts 255 channels of RS-485 or RS-422 to RS-232 network

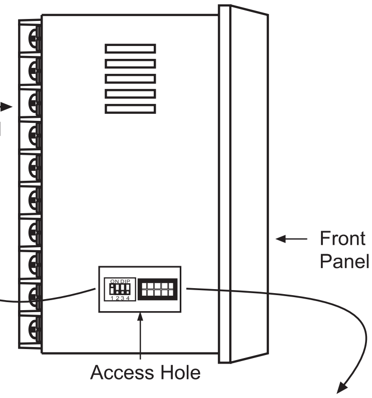
1–3 Programming Port and DIP Switch

Table 1.1
DIP Switch Configuration

DIP Switch: ■ :ON □ :OFF

		1	2	3	4
Input 1 Select	TC, RTD, mV	■	□		
	0-1V, 0-5V, 1-5V, 0-10V	□	■		
	0-20 mA, 4-20 mA	■	■		
Lockout	All parameters are Unlocked			□	□
	Only SP1, SEL1-SEL5* are unlocked			■	□
	Only SP1 is unlocked			□	■
	All Parameters are locked			■	■
Factory Default Setting		■	□	□	□

Figure 1.3
Access Hole Overview



The programming port is used to connect to TEC99003 for automatic programming (TEC99013 programming cable also required).

The programming port is used for off-line automatic setup and testing procedures only. Do not attempt to make any connection to these pins when the unit is being used for normal control purposes.

When the unit leaves the factory, the DIP switch is set so that TC and RTD are selected for input 1 and all parameters are unlocked.

Lockout function is used to disable the adjustment of parameters as well as operation of calibration mode. However, the menu can still be viewed even under lockout condition.

*SEL1-SEL5 represent those parameters which are selected by using SEL1, SEL2,… SEL5 parameters contained in the setup menu. The parameters that have been selected are then allocated at the beginning of the user menu.

1–4 Keys and Displays

The unit is programmed by using the three keys on the front panel. The available key functions are listed in the following table.

Table 1.2 Keypad Operation

TOUCHKEYS	FUNCTION	DESCRIPTION
▲	Up Key	Press and release quickly to increase the value of parameter. Press and hold to accelerate increment speed.
▼	Down Key	Press and release quickly to decrease the value of parameter. Press and hold to accelerate decrement speed.
⟲	Scroll Key	Scrolls through the parameters in order.
Press ⟲ for at least 3 seconds	Enter Key	Allows access to more parameters on user menu, also used to enter manual mode, auto-tune mode, default setting mode, and to save calibration data during calibration procedure.
Press ⟲ for at least 6 seconds	Start Record Key	Resets historical values of PVHI and PVLO and start to record the peak process value.
Press ⟲ ▲	Reverse Scroll Key	Scrolls through the parameters in reverse order during menu scrolling.
Press ⟲ ▼	Mode Key	Selects the operation mode in sequence.
Press ▲ ▼	Reset Key	Resets the front panel display to normal display mode, also used to leave the specific mode execution, to end auto-tune and manual control execution, and to quit sleep mode.
Press ▲ ▼ for at least 3 seconds	Sleep Key	The controller enters sleep mode if the sleep function (SLEP) is enabled (select YES).

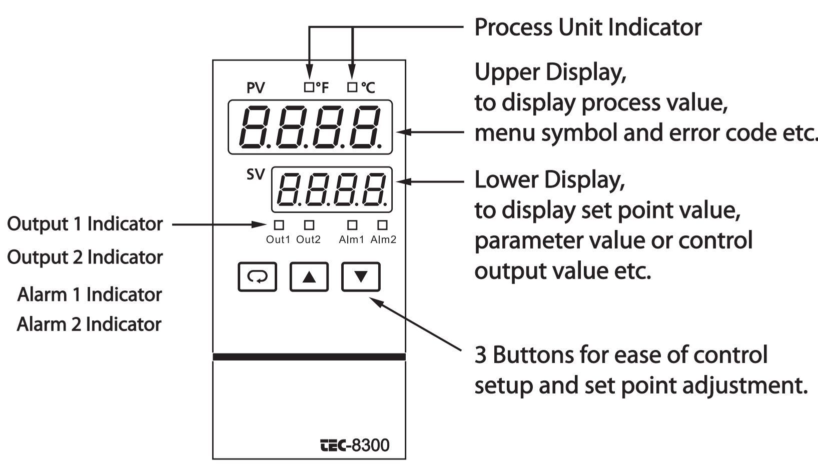


Figure 1.4 Front Panel Description

How to display a 5-digit number

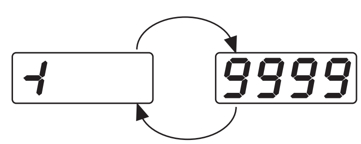
For a number with decimal point the display will be shifted one digit right:

-199.99 will be displayed by -199.9

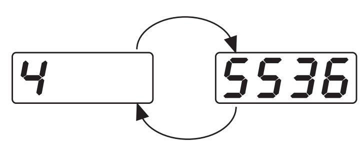
4553.6 will be displayed by 4553

For a number without decimal point the display will be divided into two alternating phases:

-19999 will be displayed by:



45536 will be displayed by:



-9999 will be displayed by:

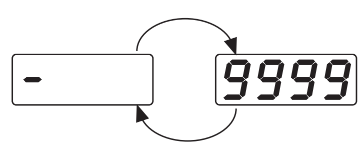
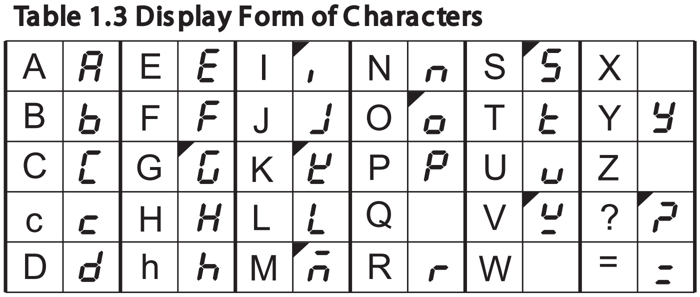
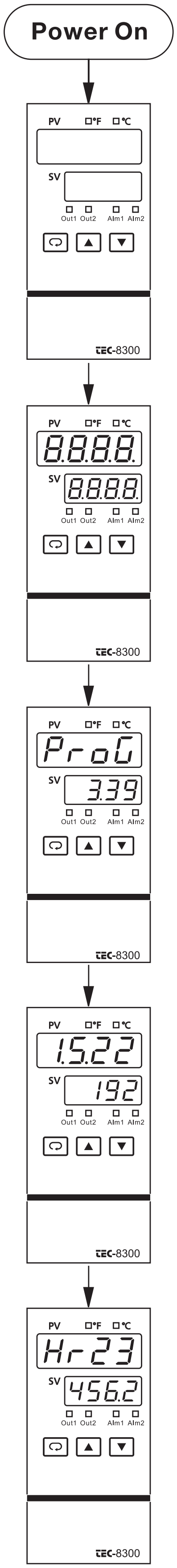


Table 1.3 Display Form of Characters



◤: Indicates Abstract Characters

Figure 1.5 Display Sequence of Initial Message



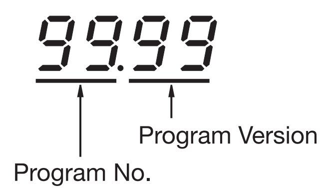
All segments of display and indicators are left off for 0.5 second.

All segments of display and indicators are lit for 2 seconds.

Display program code of the product for 2.5 seconds.

The left diagram shows program no. 3 (for TEC-8300) with version 39.

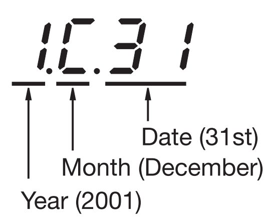
Program Code



Display Date Code and Serial number for 2.5 seconds.

The left diagram shows Year 2001, Month May (5), Date 22nd and Serial number 192. This means that the product is the 192nd unit produced on May 22nd, 2001. Note that the month code **A** stands for **October**, **B** stands for **November** and **C** stands for **December**.

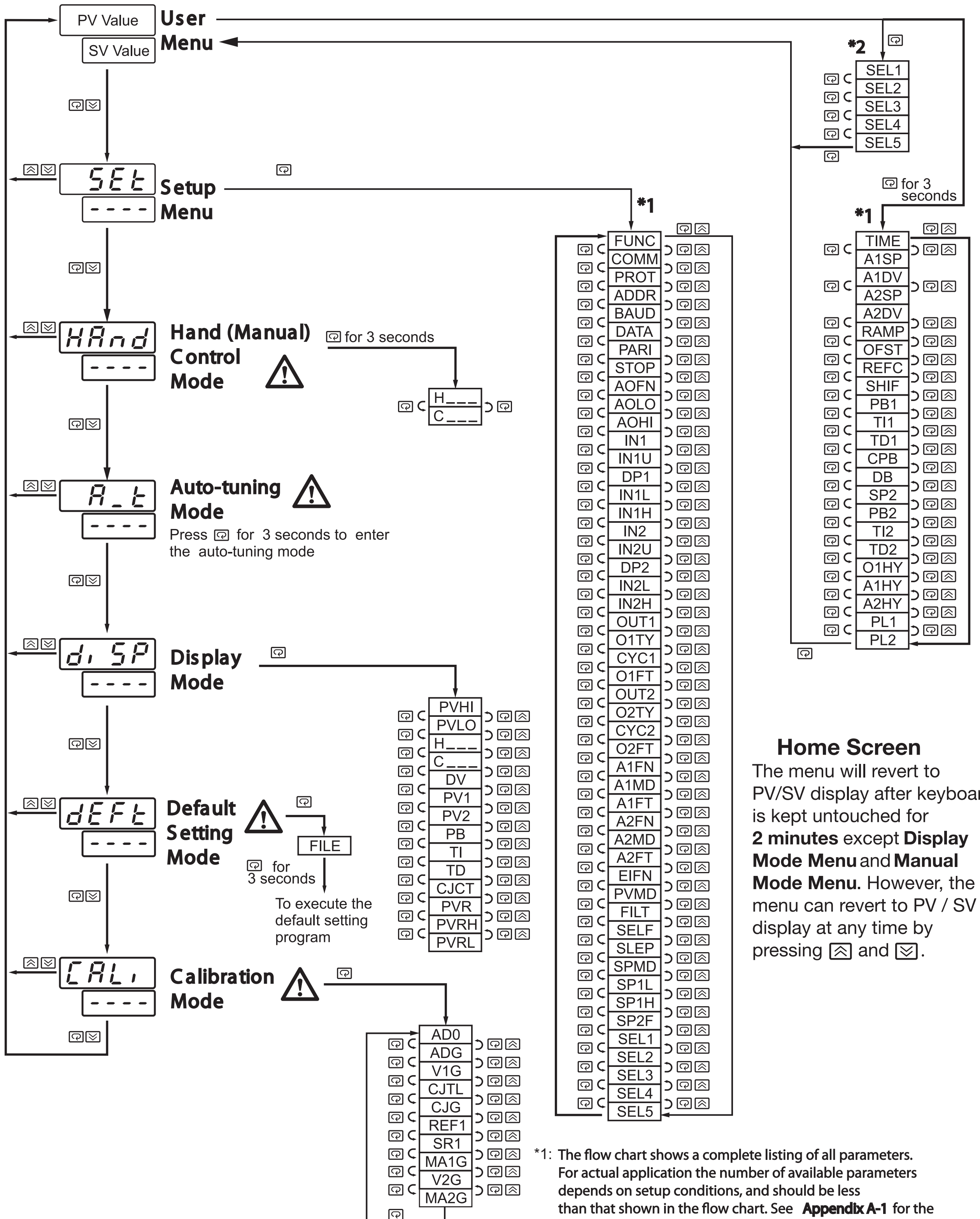
Date Code



Display the used hours for 2.5 seconds.

The left diagram shows that the unit has been used for 23456.2 hours since production.

1–5 Menu Overview



Home Screen

The menu will revert to PV/SV display after keyboard is kept untouched for **2 minutes** except **Display Mode Menu** and **Manual Mode Menu.** However, the menu can revert to PV / SV display at any time by pressing [▲] and [▼].

⚠ Apply these modes will break the control loop and change some of the previous setting data. Make sure that if the system is allowable to use these modes.

*1: The flow chart shows a complete listing of all parameters. For actual application the number of available parameters depends on setup conditions, and should be less than that shown in the flow chart. See **Appendix A-1** for the existence conditions of each parameter.

*2: You can select at most 5 parameters put in front of the user menu by using SEL1 to SEL5 contained at the bottom of setup menu.

1–6 System Modes

The controller performs closed loop control in its normal control mode condition. The controller will maintain its normal control mode when you are operating the user menu, setup menu, or display mode, reloading default values, or applying event input signals. Under certain conditions, the normal control mode will transfer to an exception mode. The exception modes include: sleep mode, manual mode, failure mode, calibration mode, and auto-tuning mode. All of these modes perform in an open loop control except auto-tuning mode which performs ON-OFF plus PID closed loop control. The mode transfer is governed by the priority conditions. A lower priority mode can not alter a higher priority mode, as shown in figure 1.6.

System Modes

Sleep mode:
See section 4-11.

Manual mode:
See section 3-23.

Failure mode:
See section 3-17.

Calibration mode:
See chapter 6.

Auto-tuning mode:
See section 3-20.

Normal control mode:
See section 3-24, 3-26, 4-1

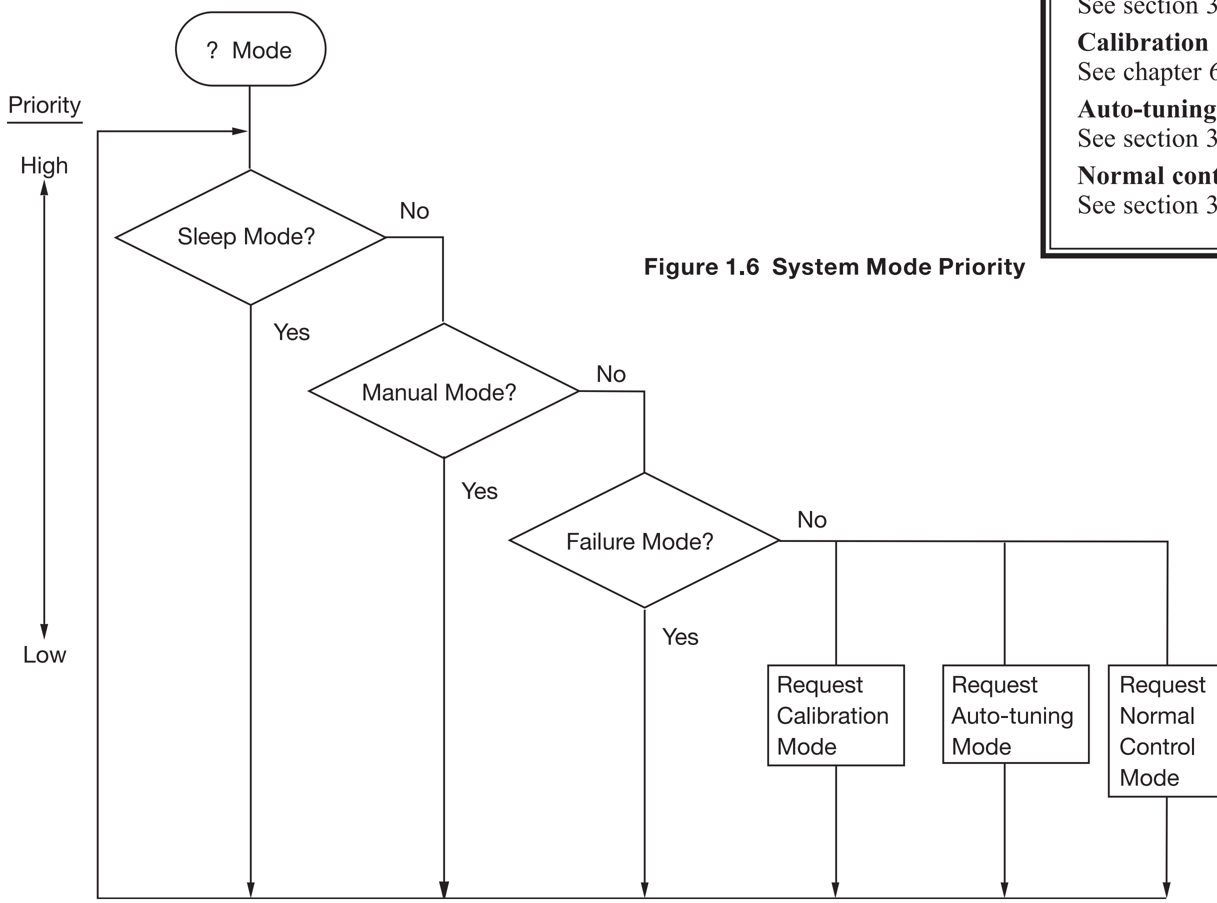


Figure 1.6 System Mode Priority

Calibration mode, auto-tuning mode, and normal control mode are in the same priority level. Sleep mode is in the highest priority level.

1–7 Parameter Description

Table 1.4 Parameter Description (page 1 of 7)

Contained in	Basic Function	Parameter Notation	Display Format	Parameter Description	Range	Default Value
User Menu	✓	SP1		Set point 1	Low: SP1L High: SP1H	100.0°C (212.0°F)
	✓	TIME	timE	Dwell Time	Low: 0 High: 6553.5 minutes	0.0
	✓	A1SP	A1SP	Alarm 1 Set point	See Table 1.5, 1.6	100.0°C (212.0°F)
	✓	A1DV	A1dv	Alarm 1 Deviation Value	Low: -200.0°C (-360.0°F) High: 200.0°C (360.0°F)	10.0°C (18.0°F)
	✓	A2SP	A2SP	Alarm 2 Set point	See Table 1.5, 1.7	100.0°C (212.0°F)
	✓	A2DV	A2dv	Alarm 2 Deviation Value	Low: -200.0°C (-360.0°F) High: 200.0°C (360.0°F)	10.0°C (18.0°F)
		RAMP	rAmP	Ramp Rate	Low: 0 High: 500.0°C (900.0°F)	0.0
	✓	OFST	oFSt	Offset Value for P control	Low: 0 High: 100.0 %	25.0
		REFC	rEFC	Reference Constant for Specific Function	Low: 0 High: 60	2
	✓	SHIF	SHiF	PV1 Shift (offset) Value	Low: -200.0°C (-360.0°F) High: 200.0°C (360.0°F)	0.0
	✓	PB1	Pb1	Proportional Band 1 Value	Low: 0 High: 500.0°C (900.0°F)	10.0°C (18.0°F)
	✓	TI1	ti1	Integral Time 1 Value	Low: 0 High: 1000 sec	100
	✓	TD1	td1	Derivative Time 1 Value	Low: 0 High: 360.0 sec	25.0
	✓	CPB	CPb	Cooling Proportional Band Value	Low: 1 High: 255 %	100
	✓	DB	db	Heating-Cooling Dead Band Negative Value= Overlap	Low: -36.0 High: 36.0%	0
		SP2	SP2	Set point 2	See Table 1.5, 1.8	37.8°C (100.0°F)
		PB2	Pb2	Proportional Band 2 Value	Low: 0 High: 500.0°C (900.0°F)	10.0°C (18.0°F)
		TI2	ti2	Integral Time 2 Value	Low: 0 High: 1000 sec	100
		TD2	td2	Derivative Time 2 Value	Low: 0 High: 360.0 sec	25.0
	✓	O1HY	o1HY	Output 1 ON-OFF Control Hysteresis	Low: 0.1 High: 55.6°C (100.0°F)	0.1
	✓	A1HY	A1HY	Hysteresis Control of Alarm 1	Low: 0.1 High: 10.0°C (18.0°F)	0.1
	✓	A2HY	A2HY	Hysteresis Control of Alarm 2	Low: 0.1 High: 10.0°C (18.0°F)	0.1
		PL1	PL1	Output 1 Power Limit	Low: 0 High: 100 %	100
		PL2	PL2	Output 2 Power Limit	Low: 0 High: 100 %	100
Setup Menu	✓	FUNC	FunC	Function Complexity Level	0 bASC : Basic Function Mode 1 FuLL : Full Function Mode	1
		COMM	Comm	Communication Interface Type	0 nonE : No communication function 1 485 : RS-485 interface 2 232 : RS-232 interface 3 4-20 : 4 - 20 mA analog retransmission output 4 0-20 : 0 - 20 mA analog retransmission output 5 0-1V : 0 - 1V analog retransmission output 6 0-5V : 0 - 5V analog retransmission output 7 1-5V : 1 - 5V analog retransmission output 8 0-10 : 0 - 10V analog retransmission output	0
		PROT	Prot	COMM Protocol Selection	0 rtu : Modbus protocol RTU mode	0

Table 1.4 Parameter Description (page 2 of 7)

Contained in	Basic Function	Parameter Notation	Display Format	Parameter Description	Range	Default Value
		ADDR	Addr	Address Assignment of Digital COMM	Low: 1 High: 255	—
		BAUD	bAud	Baud Rate of Digital COMM	0 0.3 : 0.3 Kbits/s baud rate 1 0.6 : 0.6 Kbits/s baud rate 2 1.2 : 1.2 Kbits/s baud rate 3 2.4 : 2.4 Kbits/s baud rate 4 4.8 : 4.8 Kbits/s baud rate 5 9.6 : 9.6 Kbits/s baud rate 6 14.4 : 14.4 Kbits/s baud rate 7 19.2 : 19.2 Kbits/s baud rate 8 28.8 : 28.8 Kbits/s baud rate 9 38.4 : 38.4 Kbits/s baud rate	5
		DATA	dAtA	Data Bit count of Digital COMM	0 7bit : 7 data bits 1 8bit : 8 data bits	1
		PARI	PAri	Parity Bit of Digital COMM	0 EVEn : Even parity 1 odd : Odd parity 2 nonE : No parity bit	0
Setup Menu		STOP	StoP	Stop Bit Count of Digital COMM	0 1bit : One stop bit 1 2bit : Two stop bits	0
		AOFN	Ao.Fn	Analog Output Function	0 PV1 : Retransmit IN1 process value 1 PV2 : Retransmit IN2 process value 2 P1-2 : Retransmit IN1 −IN2 difference process value 3 P2-1 : Retransmit IN2 −IN1 difference process value 4 SV : Retransmit set point value 5 MV1 : Retransmit output 1 manipulation value 6 MV2 : Retransmit output 2 manipulation value 7 dV : Retransmit deviation(PV-SV) Value	0
		AOLO	Ao.Lo	Analog Output Low Scale Value	Low: -19999 High: 45536	0°C (32.0°F)
		AOHI	Ao.Hi	Analog Output High Scale Value	Low: -19999 High: 45536	100.0°C (212.0°F)
	✓	IN1	in1	IN1 Sensor Type Selection	0 J_tC : J type thermocouple 1 K_tC : K type thermocouple 2 T_tC : T type thermocouple 3 E_tC : E type thermocouple 4 B_tC : B type thermocouple 5 R_tC : R type thermocouple 6 S-tC : S type thermocouple	1 (0)

Table 1.4 Parameter Description (page 3 of 7)

Contained in	Basic Function	Parameter Notation	Display Format	Parameter Description	Range	Default Value
Setup Menu	✓	IN1	in1	IN1 Sensor Type Selection	7 n_tC : N type thermocouple 8 L-tC : L type thermocouple 9 Pt.dn : PT 100 ohms DIN curve 10 Pt.JS : PT 100 ohms JIS curve 11 4-20 : 4 - 20 mA linear current input 12 0-20 : 0 - 20 mA linear current input 13 0-1V : 0 - 1V linear Voltage input 14 0-5V : 0 - 5V linear Voltage input 15 1-5V : 1 - 5V linear Voltage input 16 0-10 : 0 - 10V linear Voltage input 17 SPEC : Special defined sensor curve	1 (0)
	✓	IN1U	in1u	IN1 Unit Selection	0 oC : Degree C unit 1 oF : Degree F unit 2 Pu : Process unit	0 (1)
	✓	DP1	dP1	IN1 Decimal Point Selection	0 no.dP : No decimal point 1 1-dP : 1 decimal digit 2 2-dP : 2 decimal digits 3 3-dP : 3 decimal digits	1
	✓	IN1L	in1L	IN1 Low Scale Value	Low: -19999 High: 45536	0
	✓	IN1H	in1H	IN1 High Scale Value	Low: -19999 High: 45536	1000
		IN2	in2	IN2 Signal Type Selection	0 nonE : IN2 no function 1 Ct : Current transformer input 2 4-20 : 4 - 20 mA linear current input 3 0-20 : 0 - 20 mA linear current input 4 0-1V : 0 - 1V linear voltage input 5 0-5V : 0 - 5V linear voltage input 6 1-5V : 1 - 5V linear voltage input 7 0-10 : 0 - 10V linear voltage input	1
		IN2U	in2u	IN2 Unit Selection	Same as IN1U	2
		DP2	dP2	IN2 Decimal Point Selection	Same as DP1	1
		IN2L	in2L	IN2 Low Scale Value	Low: -19999 High: 45536	0
		IN2H	in2H	IN2 High Scale Value	Low: -19999 High: 45536	1000
	✓	OUT1	out1	Output 1 Function	0 rEVr : Reverse (heating) control action 1 dirt : Direct (cooling) control action	0
	✓	O1TY	o1tY	Output 1 Signal Type	0 rELY : Relay output 1 SSrd : Solid state relay drive output 2 SSr : Solid state relay output 3 4-20 : 4 - 20 mA current module	0

Table 1.4 Parameter Description (page 4 of 7)

Contained in	Basic Function	Parameter Notation	Display Format	Parameter Description	Range	Default Value
Setup Menu	✓	O1TY	o1tY	Output 1 Signal Type	4 0-20 : 0 - 20 mA current module 5 0-1V : 0 - 1V voltage module 6 0-5V : 0 - 5V voltage module 7 1-5V : 1 - 5V voltage module 8 0-10 : 0 - 10V voltage module	0
	✓	CYC1	CYC1	Output 1 Cycle Time	Low: 0.1 High: 100.0 sec	18.0
	✓	O1FT	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, power starts or manual mode starts.	0.0
	✓	OUT2	out2	Output 2 Function	0 nonE : Output 2 no function 1 CooL : PID cooling control 3 dCPS : DC power supply module installed	0
	✓	O2TY	o2tY	Output 2 Signal Type	Same as O1TY	0
	✓	CYC2	CYC2	Output 2 Cycle Time	Low: 0.1 High: 100.0 sec	18.0
	✓	O2FT	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, power starts or manual mode starts.	BPLS
	✓	A1FN	A1Fn	Alarm 1 Function	0 nonE : No alarm function 1 timr : Dwell timer action 2 dE.Hi : Deviation high alarm 3 dE.Lo : Deviation low alarm 4 db.Hi : Deviation band out of band alarm 5 db.Lo : Deviation band in band alarm 6 PV1.H : IN1 process value high alarm 7 PV1.L : IN1 process value low alarm 8 PV2.H : IN2 process value high alarm 9 PV2.L : IN2 process value low alarm 10 P1.2.H : IN1 or IN2 process value high alarm 11 P1.2.L : IN1 or IN2 process value low alarm 12 d1.2.H : IN1– IN2 difference process value high alarm 13 d1.2.L : IN1– IN2 difference process value low alarm 14 Lb : Loop break alarm 15 SEn.b : Sensor break or A-D fails	2
	✓	A1MD	A1md	Alarm 1 Operation Mode	0 norm : Normal alarm action 1 LtCh : Latching alarm action 2 HoLd : Hold alarm action 3 Lt.Ho : Latching & Hold action	0

Table 1.4 Parameter Description (page 5 of 7)

Contained in	Basic Function	Parameter Notation	Display Format	Parameter Description	Range	Default Value
	✓	A1FT	A1Ft	Alarm 1 Failure Transfer Mode	0 oFF : Alarm output OFF if sensor fails 1 on : Alarm output ON if sensor fails	1
	✓	A2FN	A2Fn	Alarm 2 Function	Same as A1FN	2
	✓	A2MD	A2md	Alarm 2 Operation Mode	Same as A1MD	0
	✓	A2FT	A2Ft	Alarm 2 Failure Transfer Mode	Same as A1FT	1
		EIFN	Ei.Fn	Event Input Function	0 nonE : Event input no function 1 SP2 : SP2 activated to replace SP1 2 Pid2 : PB2, TI2, TD2 activated to replace PB1, TI1, TD1 3 SP.P2 : SP2, PB2, TI2, TD2 activated to replace SP1, PB1, TI1, TD1 4 r5.A1 : Reset alarm 1 output 5 r5.A2 : Reset alarm 2 output 6 r.A12 : Reset alarm 1 & alarm 2 7 d.o1 : Disable Output 1 8 d.o2 : Disable Output 2 9 d.o12 : Disable Output 1 & Output 2 10 LocK : Lock All Parameters	1
Setup Menu		PVMD	PV.md	PV Mode Selection	0 PV1 : Use PV1 as process value 1 PV2 : Use PV2 as process value 2 P1-2 : Use PV1_ PV2 (difference) as process value 3 P2-1 : Use PV2_ PV1 (difference) as process value	0
		FILT	FiLt	Filter Damping Time Constant of PV	0 0 : 0 second time constant 1 0.2 : 0.2 second time constant 2 0.5 : 0.5 second time constant 3 1 : 1 second time constant 4 2 : 2 seconds time constant 5 5 : 5 seconds time constant 6 10 : 10 seconds time constant 7 20 : 20 seconds time constant 8 30 : 30 seconds time constant 9 60 : 60 seconds time constant	2
	✓	SELF	SELF	Self Tuning Function Selection	0 nonE : Self tune function disabled 1 YES : Self tune function enabled	0
		SLEP	SLEP	Sleep mode Function Selection	0 nonE : Sleep mode function disabled 1 YES : Sleep mode function enabled	0

Table 1.4 Parameter Description (page 6 of 7)

Contained in	Basic Function	Parameter Notation	Display Format	Parameter Description	Range	Default Value
Setup Menu		SPMD	SP.md	Set point Mode Selection	0 SP1.2 : Use SP1 or SP2 (depends on EIFN) as set point 1 minr : Use minute ramp rate as set point 2 Hr.r : Use hour ramp rate as set point 3 PV1 : Use IN1 process value as set point 4 PV2 : Use IN2 process value as set point 5 PuMP : Selected for pump control	0
	✓	SP1L	SP1.L	SP1 Low Scale Value	Low: -19999 High: 45536	0°C (32.0°F)
	✓	SP1H	SP1.H	SP1 High Scale Value	Low: -19999 High: 45536	1000.0°C (1832.0°F)
		SP2F	SP2F	Format of set point 2 Value	0 ACtu : set point 2 (SP2) is an actual value 1 dEVi : set point 2 (SP2) is a deviation value	0
	✓	SEL1	SEL1	Select 1st Parameter	0 nonE : No parameter put ahead 1 timE : Parameter TIME put ahead 2 A1SP : Parameter A1SP put ahead 3 A1dV : Parameter A1DV put ahead 4 A2SP : Parameter A2SP put ahead 5 A2dV : Parameter A2DV put ahead 6 rAmP : Parameter RAMP put ahead 7 oFSt : Parameter OFST put ahead 8 rEFC : Parameter REFC put ahead 9 SHiF : Parameter SHIF put ahead 10 Pb1 : Parameter PB1 put ahead 11 ti1 : Parameter TI1 put ahead 12 td1 : Parameter TD1 put ahead 13 CPb : Parameter CPB put ahead 14 db : Parameter DB put ahead 15 SP2 : Parameter SP2 put ahead 16 Pb2 : Parameter PB2 put ahead 17 ti2 : Parameter TI2 put ahead 18 td2 : Parameter TD2 put ahead	0
	✓	SEL2	SEL2	Select 2nd Parameter	Same as SEL1	0
	✓	SEL3	SEL3	Select 3rd Parameter	Same as SEL1	0
	✓	SEL4	SEL4	Select 4th Parameter	Same as SEL1	0
	✓	SEL5	SEL5	Select 5th Parameter	Same as SEL1	0
Calibration Mode Menu	✓	AD0	Ad0	A to D Zero Calibration Coefficient	Low: -360 High: 360	—
	✓	ADG	AdG	A to D Gain Calibration Coefficient	Low: -199.9 High: 199.9	—
	✓	V1G	V1G	Voltage Input 1 Gain Calibration Coefficient	Low: -199.9 High: 199.9	—
	✓	CJTL	CJt.L	Cold Junction Low Temperature Calibration Coefficient	Low: -5.00°C High: 40.00°C	—

Table 1.4 Parameter Description (page 7 of 7)

Contained in	Basic Function	Parameter Notation	Display Format	Parameter Description	Range	Default Value
Calibration Mode Menu	✓	CJG	C JG	Cold Junction Gain Calibration Coefficient	Low: -199.9 High: 199.9	—
	✓	REF1	rEF. 1	Reference Voltage 1 Calibration Coefficient for RTD 1	Low: -199.9 High: 199.9	—
	✓	SR1	Sr. 1	Serial Resistance 1 Calibration Coefficient for RTD 1	Low: -199.9 High: 199.9	—
	✓	MA1G	nA 1.G	mA Input 1 Gain Calibration Coefficient	Low: -199.9 High: 199.9	—
	✓	V2G	V2.G	Voltage Input 2 Gain Calibration Coefficient	Low: -199.9 High: 199.9	—
	✓	MA2G	nA2.G	mA Input 2 Gain Calibration Coefficient	Low: -199.9 High: 199.9	—
Display Mode Menu	✓	PVHI	PV.Hi	Historical Maximum Value of PV	Low: -19999 High: 45536	—
	✓	PVLO	PV.Lo	Historical Minimum Value of PV	Low: -19999 High: 45536	—
	✓	MV1	H_ _ _	Current Output 1 Value	Low: 0 High: 100.00 %	—
	✓	MV2	C_ _ _	Current Output 2 Value	Low: 0 High: 100.00 %	—
	✓	DV	dV	Current Deviation (PV-SV) Value	Low: -12600 High: 12600	—
	✓	PV1	PV 1	IN1 Process Value	Low: -19999 High: 45536	—
	✓	PV2	PV2	IN2 Process Value	Low: -19999 High: 45536	—
	✓	PB	Pb	Current Proportional Band Value	Low: 0 High: 500.0°C (900.0°F)	—
	✓	TI	ti	Current Integral Time Value	Low: 0 High: 4000 sec	—
	✓	TD	td	Current Derivative Time Value	Low: 0 High: 1440 sec	—
	✓	CJCT	CJCt	Cold Junction Compensation Temperature	Low: (-40.00°C) High: (90.00°C)	—
	✓	PVR	PVr	Current Process Rate Value	Low: -16383 High: 16383	—
	✓	PVRH	PVr.H	Maximum Process Rate Value	Low: -16383 High: 16383	—
	✓	PVRL	PVr.L	Minimum Process Rate Value	Low: -16383 High: 16383	—

Table 1.5 Input (IN1 or IN2) Range

Input Type	J_TC	K_TC	T_TC	E_TC	B_TC	R_TC	S_TC
Range Low	-120°C (-184°F)	-200°C (-328°F)	-250°C (-418°F)	-100°C (-148°F)	0°C (32°F)	0°C (32°F)	0°C (32°F)
Range High	1000°C (1832°F)	1370°C (2498°F)	400°C (752°F)	900°C (1652°F)	1820°C (3308°F)	1767.8°C (3214°F)	1767.8°C (3214°F)

Input Type	N_TC	L_TC	PT.DN	PT.JS	CT	Linear (V, mA) or SPEC
Range Low	-250°C (-418°F)	-200°C (-328°F)	-210°C (-346°F)	-200°C (-328°F)	0 Amp	-19999
Range High	1300°C (2372°F)	900°C (1652°F)	700°C (1292°F)	600°C (1112°F)	90 Amp	45536

Table 1.6 Range Determination for A1SP

If A1FN =	PV1.H, PV1.L	PV2.H,PV2.L	P1.2.H, P1.2.L D1.2.H, D1.2.L
Range of A1SP same as range of	IN1	IN2	IN1, IN2

Table 1.7 Range Determination for A2SP

If A2FN =	PV1.H, PV1.L	PV2.H,PV2.L	P1.2.H, P1.2.L D1.2.H, D1.2.L
Range of A2SP same as range of	IN1	IN2	IN1, IN2

Table 1.8 Range Determination for SP2

If PVMD =	PV1	PV2	P1−2, P2−1
Range of SP2 same as range of	IN1	IN2	IN1, IN2

Exception: If any of A1SP, A2SP or SP2 is configured with respect to CT input, its adjustment range is unlimited.

⚠ Dangerous voltage capable of causing death can be present in this instrument. Before installation or beginning any 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.

⚠ 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 122°F.

2–1 Unpacking

Upon receipt of the shipment, remove the unit from the carton and inspect the unit for shipping damage.

If there is any damage due to transit, report the damage and file a claim with the carrier.

Write down the model number and serial number for future reference when corresponding with our service center. The serial number (S/N) is labeled on the box and the housing of the controller.

2–2 Mounting

Make the panel cutout to fit the dimensions shown in figure 2.1.

Remove both mounting clamps and insert the controller into the panel cutout. Reinstall the mounting clamps. Gently tighten the screws in the clamp until the controller front panel fits snugly in the cutout.

2–3 Wiring Precautions

- Before wiring, check the label to verify the correct model number and options. Switch off the power while checking.
- Care must be taken to ensure that the maximum voltage ratings specified on the label are not exceeded.
- It is recommended that the power source for these units be protected by fuses or circuit breakers rated at the minimum value possible.
- All units should be installed inside a suitably grounded metal enclosure to prevent live parts from being accessible to human hands and metal tools.
- All wiring must conform to the appropriate standards of good practice and local codes and regulations. Wiring must be suitable for the voltage, current, and temperature ratings of the system.
- Beware not to over-tighten the terminal screws.
- 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 8 are not exceeded.
- Electrical power in industrial environments contains a certain amount of noise in the form of transient voltage and spikes. This electrical noise can adversely affect the operation of microprocessor-based controls. For this reason we strongly recommend the use of shielded thermocouple extension wire which connects the sensor to the controller. This wire is a twisted-pair construction with foil wrap and drain wire. The drain wire is to be attached to ground at one end only.

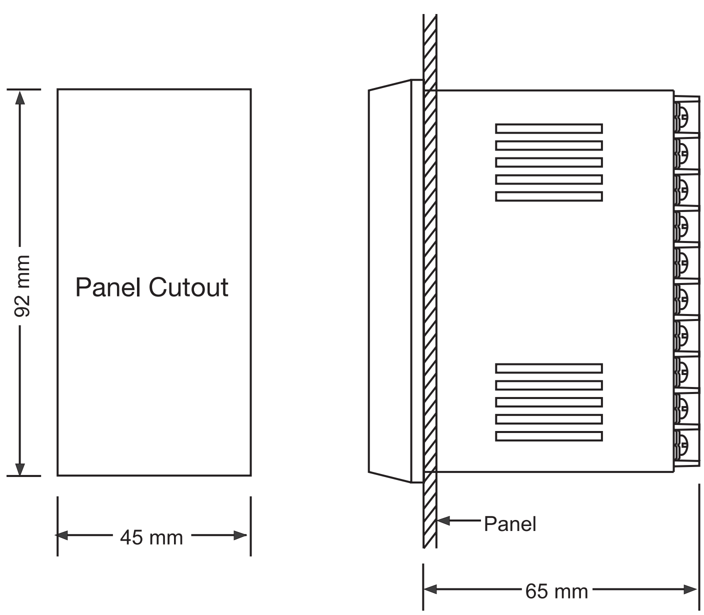


Figure 2.1 Mounting Dimensions

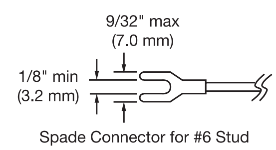
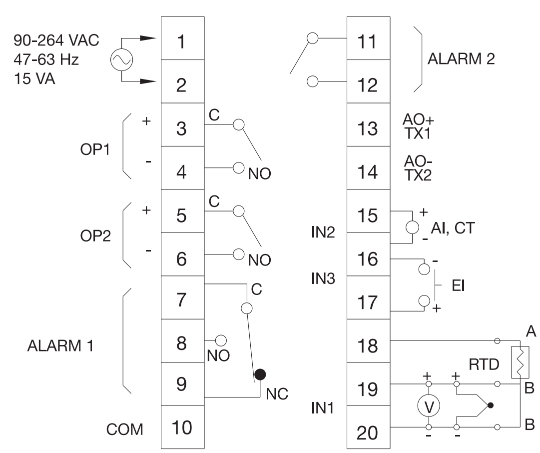


Figure 2.2
Lead Termination

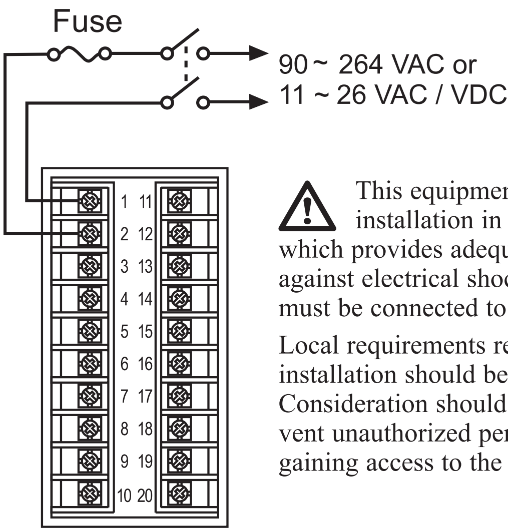


All relay contacts Resistive 2A/240VAC

Figure 2–3
Rear Terminal Connections

2–4 Power Wiring

The controller is supplied to operate at 11–26VAC/VDC or 90–264VAC. Check that the installation voltage corresponds to the power rating indicated on the product label before connecting power to the controller.



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

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

Figure 2.4 Power Supply Connections

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 close to the work area. Some experiments with probe location are often required to find the optimum position.

In a liquid process, the addition of a stirrer will help eliminate thermal lag. Since a 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.

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

Standard sensor limits of error are ±4°F (±2°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 Thermocouple Input Wiring

The thermocouple input connections are shown in figure 2.5. The correct type of thermocouple extension lead-wire or compensating cable must be used for the entire distance between the controller and the thermocouple, ensuring that the correct polarity is maintained throughout. Joints in the cable should be avoided, if possible.

If the length of the thermocouple plus the extension wire is too long, it may affect the temperature measurement. A 400 ohms K type or a 500 ohms J type thermocouple lead resistance will produce approximately 1°C temperature error.

The color codes used on the thermocouple extension leads are shown in table 2.1.

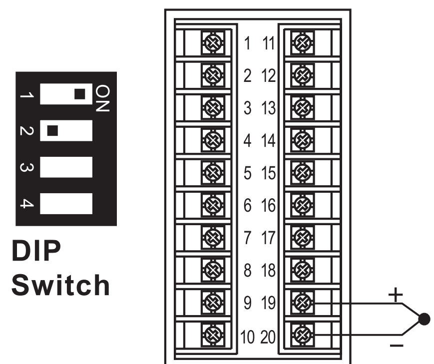


Figure 2.5 Thermocouple Input Wiring

Table 2.1 Thermocouple Cable Color Codes

Thermocouple Type	Cable Material	British BS	American ASTM	German DIN	French NFE
T	Copper (Cu) Constantan (Cu-Ni)	+ white blue * blue	+ blue red * blue	+ red brown * brown	+ yellow blue * blue
J	Iron (Fe) Constantan (Cu- Ni)	+ yellow blue * black	+ white red * black	+ red blue * blue	+ yellow black * black
K	Nickel-Chromium (Ni-Cr) Nickel-Aluminum (Ni-Al)	+ brown blue * red	+ yellow red * yellow	+ red green green	+ yellow purple * yellow
R S	Pt-13%Rh,Pt Pt-10%Rh,Pt	+ white blue * green	+ black red * green	+ red white * white	+ yellow green * green
B	Pt-30%Rh Pt-6%Rh	Use Copper Wire	+grey red * grey	+red grey * grey	Use Copper Wire

* Color of Overall Sheath

2–7 RTD Input Wiring

The RTD connections are shown in figure 2.6, with the compensating lead connected to terminal 19. For two-wire RTD inputs, terminals 19 and 20 should be linked. A three-wire RTD offers the capability of lead resistance compensation, provided that the three leads are the same gauge and equal in length.

For the purpose of accuracy, a two-wire RTD should be avoided if possible. A 0.4ohm lead resistance in a two-wire RTD will produce 1°C temperature error.

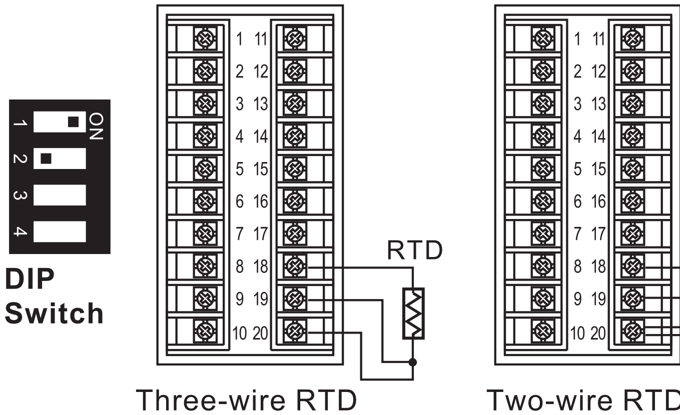


Figure 2.6 RTD Input Wiring

2–8 Linear DC Input Wiring

DC linear voltage and linear current connections for input 1 are shown in figure 2.7 and figure 2.8.

DC linear voltage and linear current connections for input 2 are shown in figure 2.9 and figure 2.10.

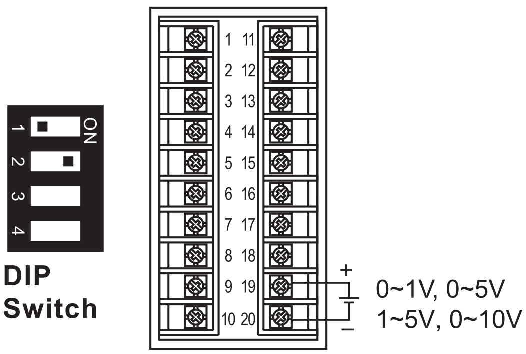


Figure 2.7
Input 1 Linear Voltage Wiring

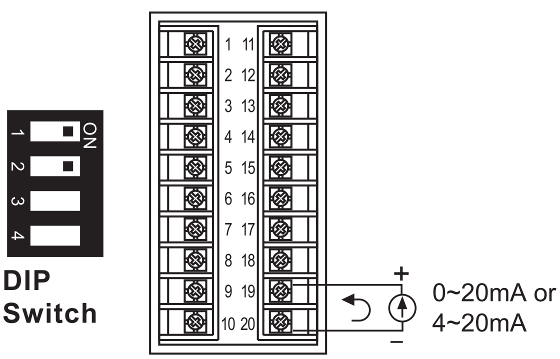


Figure 2.8
Input 1 Linear Current Wiring

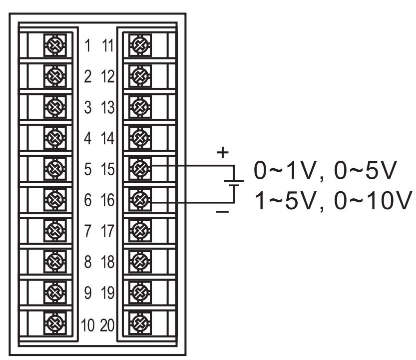


Figure 2.9
Input 2 Linear Voltage Wiring

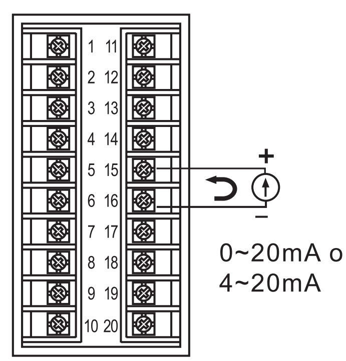


Figure 2.10
Input 2 Linear Current Wiring

2–9 CT/Heater Current Input Wiring

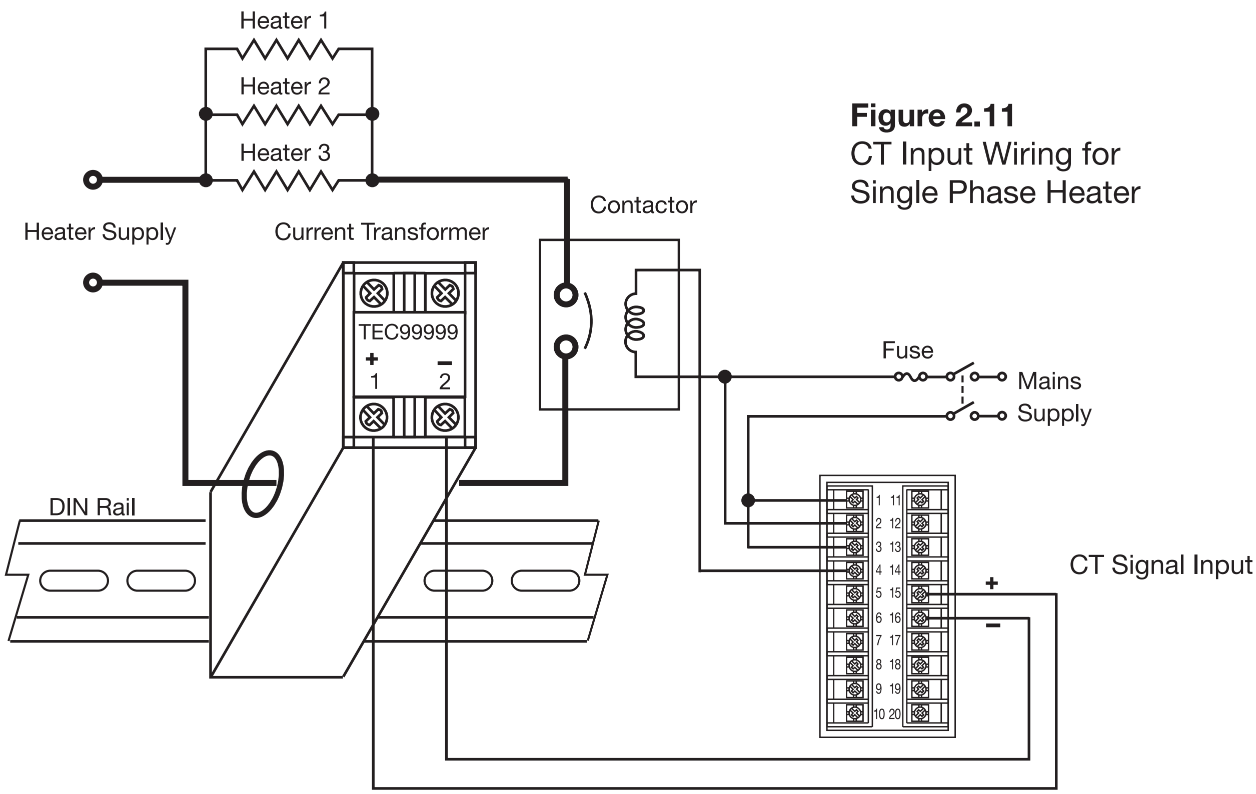


Figure 2.11
CT Input Wiring for
Single Phase Heater

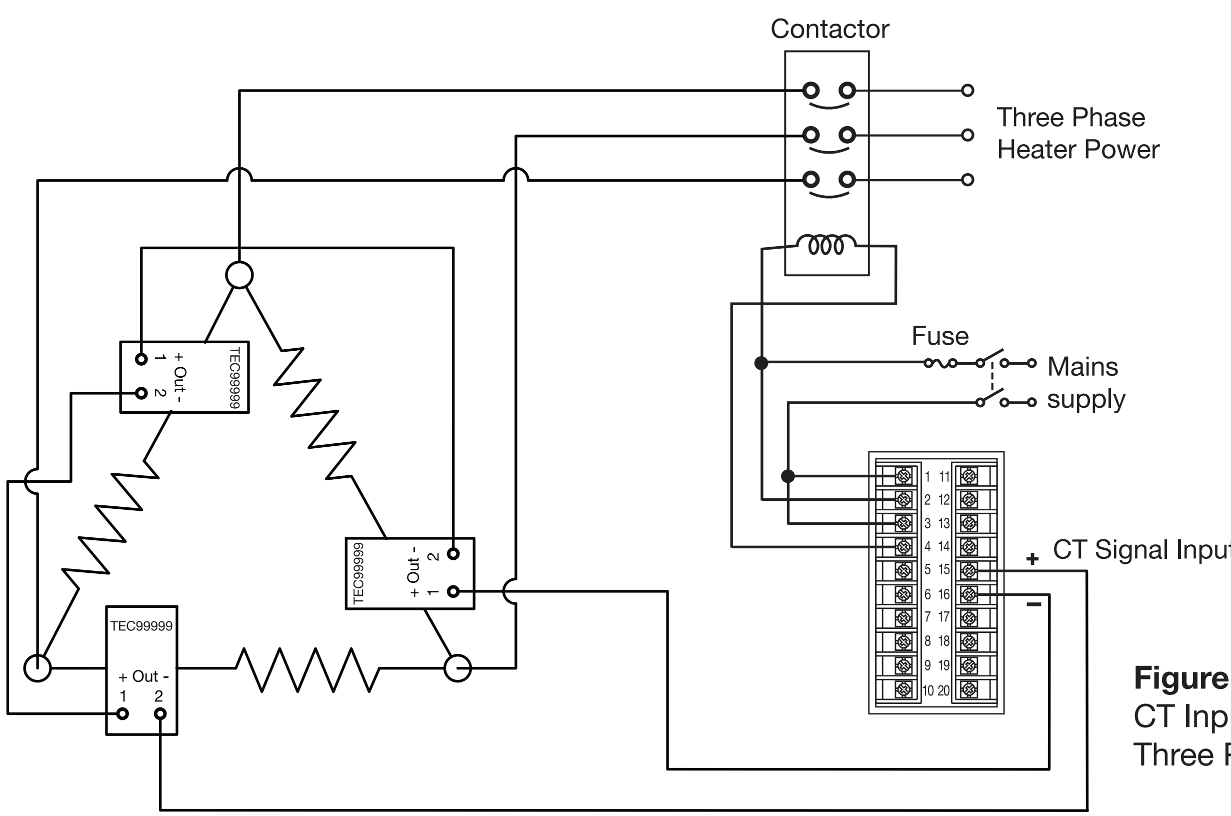


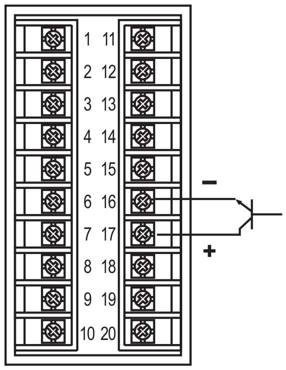
Figure 2.12
CT Input Wiring for
Three Phase Heater

Make sure that the total current through TEC99999 does not exceed 100A rms.

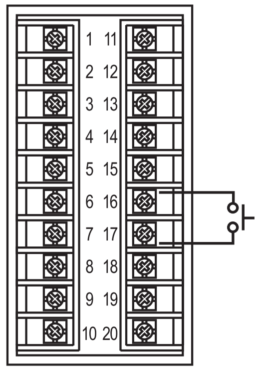
2–10 Event Input wiring

The event input can accept a switch signal as well as an open collector signal. The event input function (EIFN) is activated when the switch is closed or an open collector (or a logic signal) is pulled down.

Also refer to section 4-1 for event input functions.



Open Collector Input

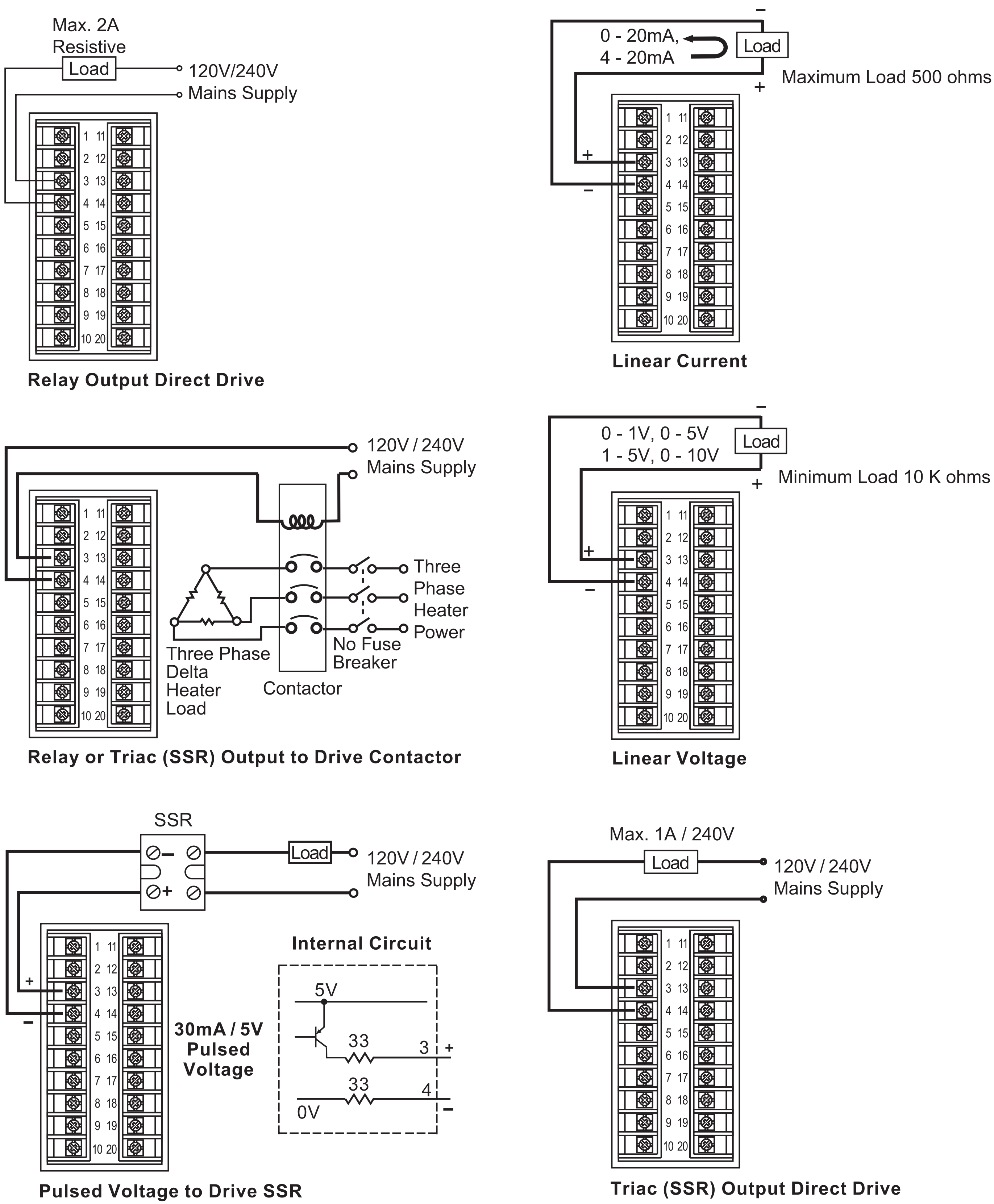


Switch Input

Figure 2.13 Event Input Wiring

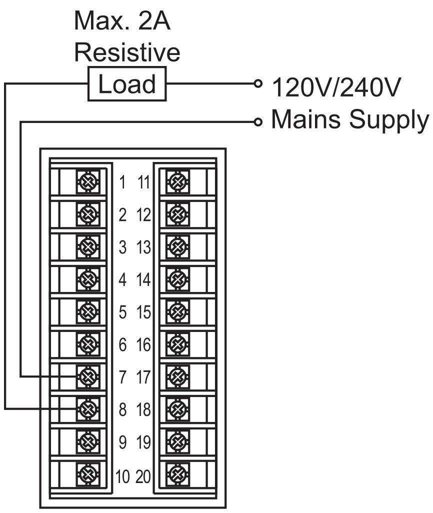
2–11 Output 1 Wiring

Figure 2.14 Output 1 Wiring

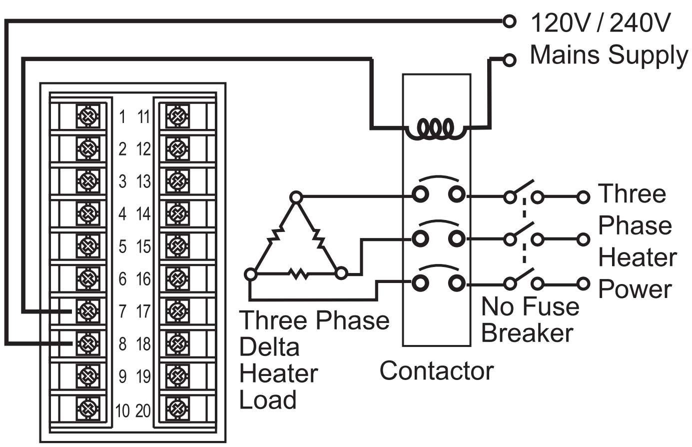


2–12 Output 2 Wiring

Figure 2.16 Alarm 1 Wiring

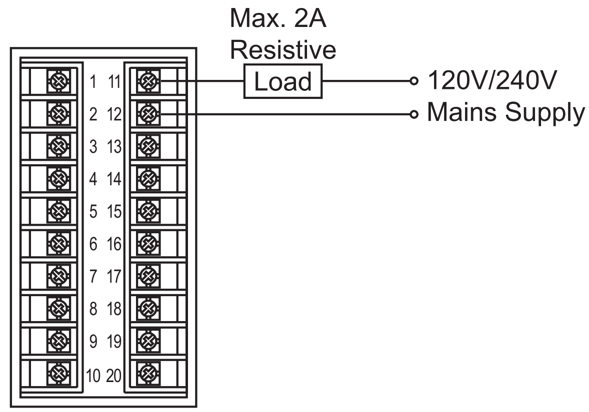


Relay Output Direct Drive

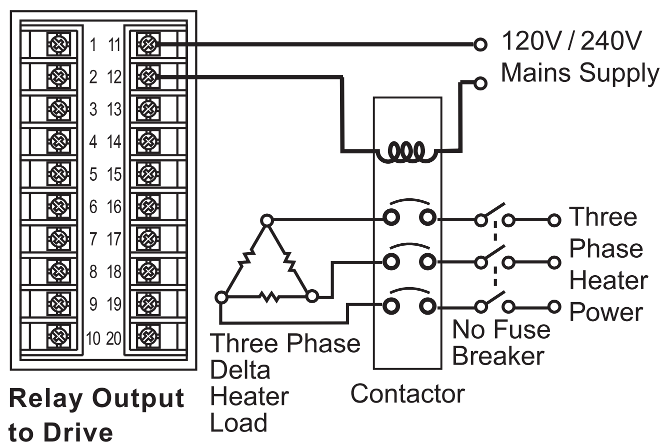


Relay Output to Drive Contactor

Figure 2.17 Alarm 2 Wiring



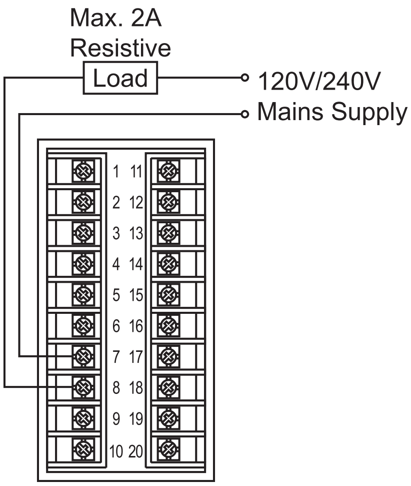
Relay Output Direct Drive



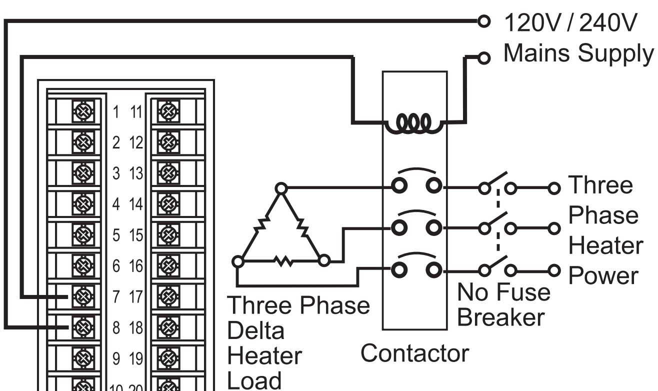
Relay Output to Drive Contactor

2–13 Alarm 1 Wiring

Figure 2.16 Alarm 1 Wiring



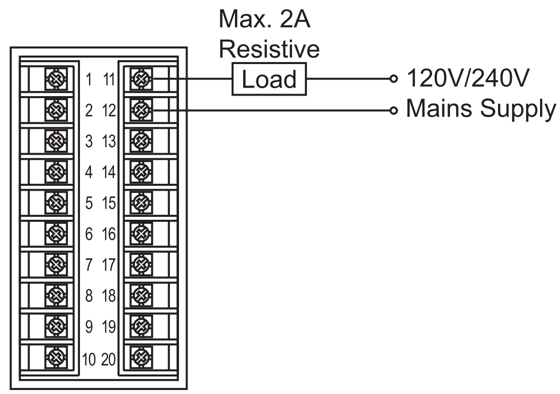
Relay Output Direct Drive



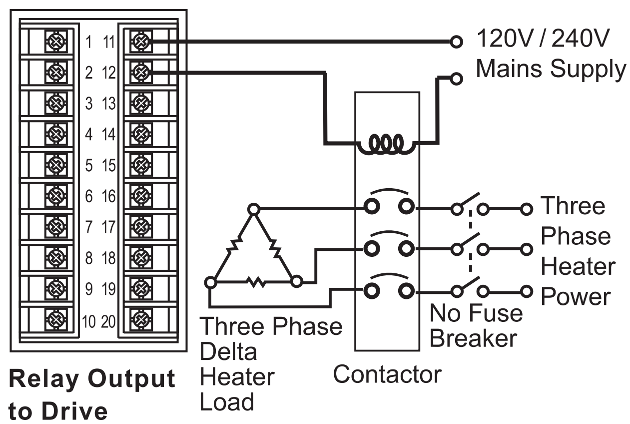
Relay Output to Drive Contactor

2–14 Alarm 2 Wiring

Figure 2.17 Alarm 2 Wiring



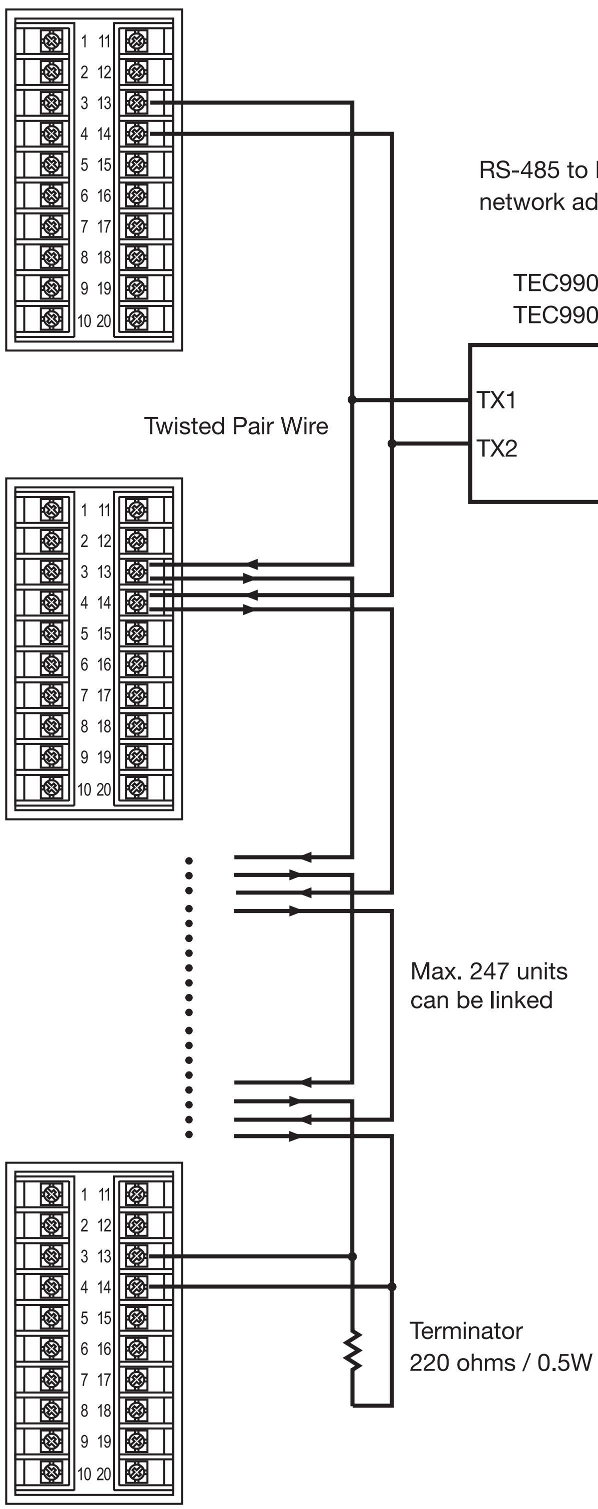
Relay Output Direct Drive



Relay Output to Drive Contactor

2–15 RS-485

Figure 2.18 RS-485 Wiring



2–16 RS-232

Figure 2.19 RS-232 Wiring

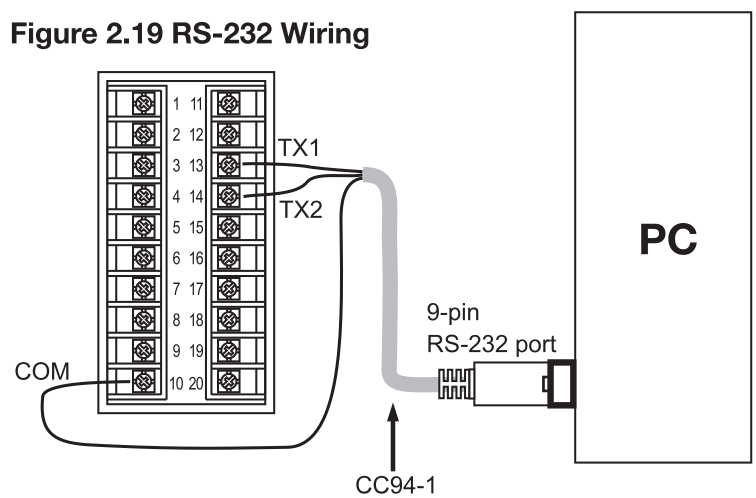
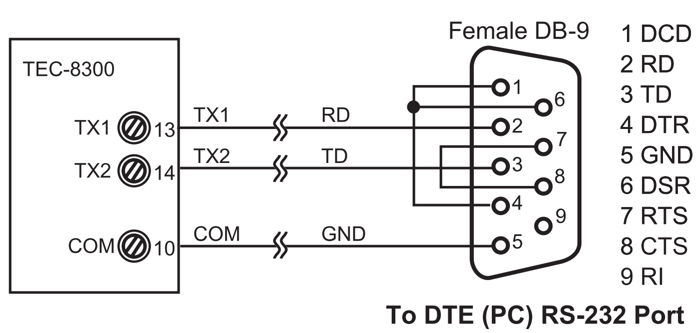
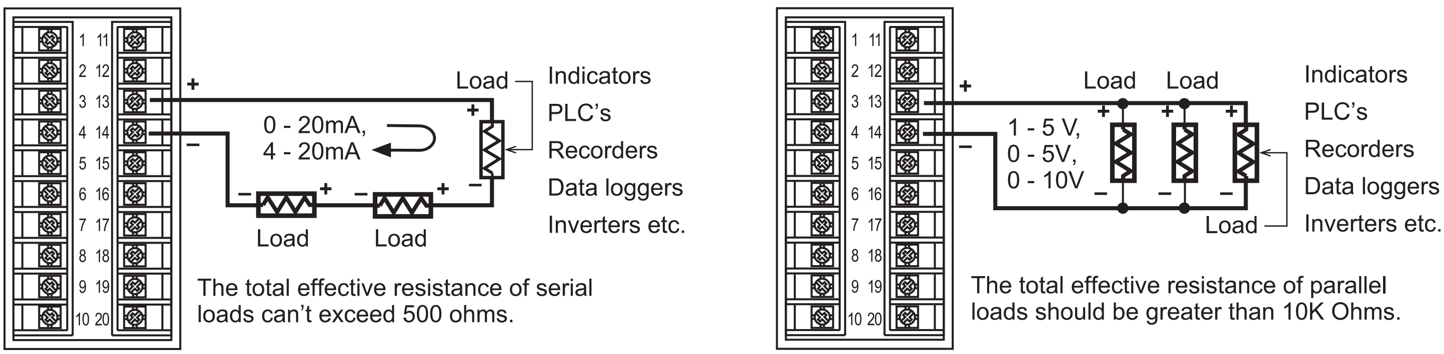


Figure 2.21 Configuration of RS-232 Cable



2–17 Analog Retransmission

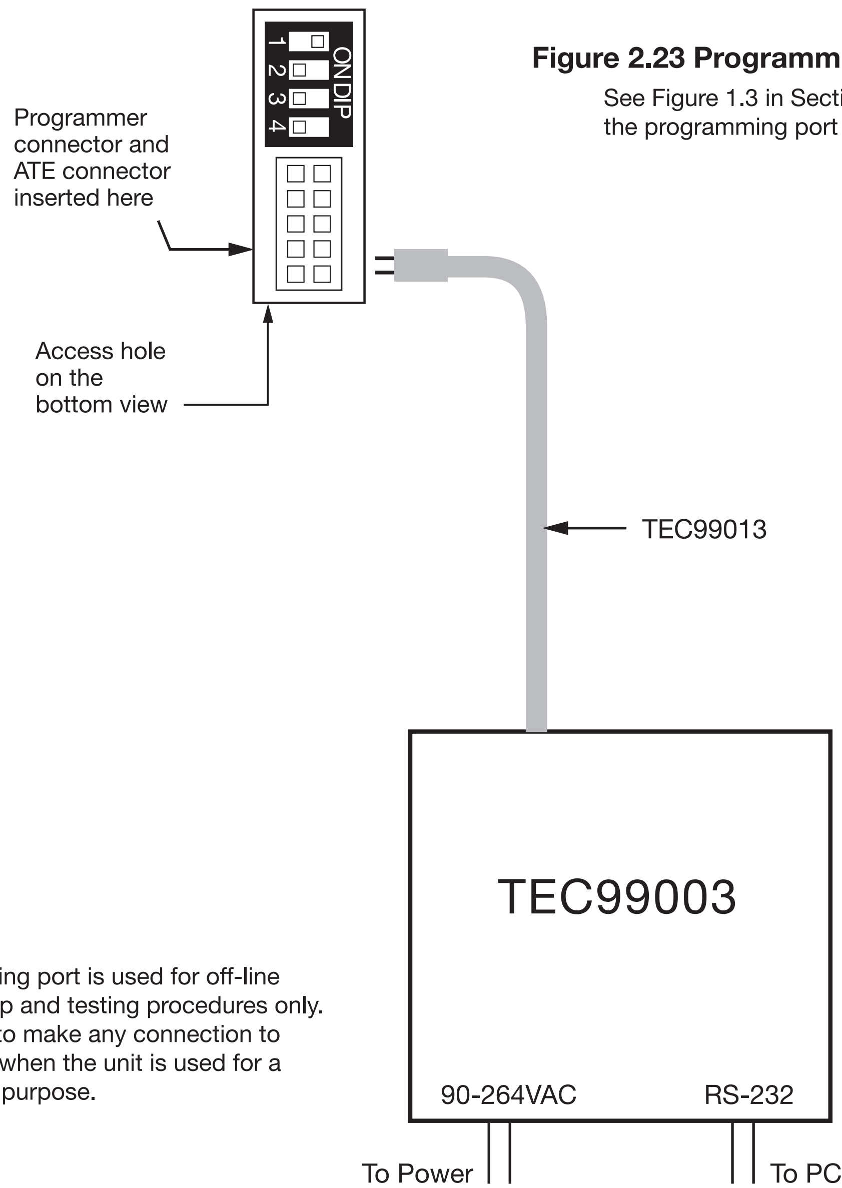
Figure 2.22 Analog Retransmission Wiring



Retransmit Current **Retransmit Voltage**

Figure 2.23 Programming Port Wiring

See Figure 1.3 in Section 1-3 to find the programming port location.



NOTE:
The programming port is used for off-line automatic setup and testing procedures only. Don't attempt to make any connection to these jumpers when the unit is used for a normal control purpose.

This unit provides a useful parameter "FUNC" which can be used to select the function complexity level before setup. If Basic Mode (FUNC=BASC) is selected for a simple application, then the following functions are ignored and deleted from the full function menu:

RAMP, SP2, PB2, TI2, TD2, PL1, PL2, COMM, PROT, ADDR, BAUD, DATA, PARI, STOP, AOFN, AOLO, AOHI, IN2, IN2U, DP2, IN2L, IN2H, EIFN, PVMD, FILT, SLEP, SPMD, and SP2F.

Basic Mode capabilities:

1. Input 1: thermocouple, RTD, volt, mA
2. Input 2: CT for heater break detection
3. Output 1: heating or cooling (relay, SSR, SSRD, volt, mA)
4. Output 2: cooling (relay, SSR, SSRD, volt, mA), DC power supply
5. Alarm 1: relay for deviation, deviation band, process, heater break, loop break, sensor break, latch, hold, or normal alarm.
6. Alarm 2: relay for deviation, deviation band, process, heater break, loop break, sensor break, latch, hold, or normal alarm.
7. Dwell timer
8. Heater break alarm
9. Loop break alarm
10. Sensor break alarm
11. Failure transfer
12. Bumpless transfer
13. PV1 shift
14. Programmable SP1 range
15. Heat-cool control
16. Hardware lockout
17. Self-tune
18. Auto-tune
19. ON-OFF, P, PD, PI, PID control
20. User-defined menu (SEL)
21. Manual control
22. Display mode
23. Reload default values
24. Isolated DC Power supply

If you don't need:

1. Second setpoint
2. Second PID
3. Event input
4. Soft start (RAMP)
5. Remote set point
6. Complex process value
7. Output power limit
8. Digital communication
9. Analog retransmission
10. Power shut off (sleep mode)
11. Digital filter
12. Pump control
13. Remote lockout

…then you can use basic mode.

3–1 Input 1

Press [⟲] [▼] to enter setup mode. Press [⟲] to select the desired parameter. The upper display indicates the parameter symbol, and the lower display indicates the selection or the value of the parameter.

IN1: Selects the sensor type and signal type for Input 1.
Range: (Thermocouple) J_TC, K_TC, T_TC, E_TC, B_TC, R_ TC, S_TC, N_TC, L_TC
(RTD) PT.DN, PT.JS
(Linear) 4–20, 0–20, 0–1V, 0–5V, 1–5V, 0–10
Default: J_TC if °F is selected, K_TC if °C is selected.

IN1

IN1U: Selects the process unit for Input 1.
Range: °C, °F, PU (process unit).
If the unit is neither °C nor °F, then PU is selected.
Default: °C or °F

IN1U

DP1: Selects the location of the decimal point for most (not all) process-related parameters.
Range: (T/C and RTD) NO.DP, 1-DP
(Linear) NO.DP, 1-DP, 2-DP, 3-DP
Default: 1-DP

DP1

IN1L: Selects the low scale value for Linear type input 1.
Hidden if: T/C or RTD type is selected for IN1.

IN1L

IN1H: Selects the high scale value for Linear type input 1.
Hidden if: T/C or RTD type is selected for IN1.

IN1H

How to use IN1L and IN1H:

If 4–20mA is selected for IN1, SL specifies the input signal low (i.e., 4mA), SH specifies the input signal high (i.e., 20mA), S specifies the current input signal value, and the conversion curve of the process value is shown as follows:

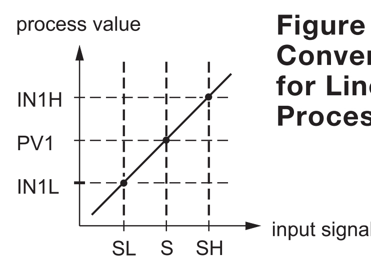


Figure 3.1 Conversion Curve for Linear Type Process Value

Formula : $PV1 = IN1L + (IN1H - IN1L)\dfrac{S - SL}{SH - SL}$

Example: If a 4–20mA current loop pressure transducer with range 0–15 kg/cm2 is connected to input 1, then perform the following setup:

IN1 = 4–20 IN1L = 0.0

IN1U = PU IN1H = 15.0

DP1 = 1 − DP

Of course, you may select another value for DP1 to alter the resolution.

3–2 OUT1 and OUT2 Types

O1TY: Selects the signal type for Output 1. The selection should be consistent with the output 1 module installed.

O1TY `o1tY`

The available output 1 signal types are:

RELY: Mechanical relay

SSRD: Pulsed voltage output to drive SSR

SSR: Isolated zero-switching solid-state relay

4–20: 4–20mA linear current output

0–20: 0–20mA linear current output

0–1V: 0–1V linear voltage output

0–5V: 0–5V linear voltage output

1–5V: 1–5V linear voltage output

0–10V: 0–10V linear voltage output

O2TY: Selects the signal type for Output 2. The selection should be consistent with the output 2 module installed.

O2TY `o2tY`

The available output 2 signal types are the same as for O1TY.

The range for linear current or voltage may not be very accurate. For 0% output, the value for 4–20mA may be 3.8–4mA; while for 100% output, the value for 4–20mA may be 20–21mA. However, this deviation will not degrade the control performance at all.

3–3 Configuring User Menu

Most conventional controllers are designed with a fixed order in which the parameters scroll. The TEC-8300 has the flexibility to allow you to select those parameters which are most significant to you and put these parameters at the front of the display sequence.

SEL1: Selects the most significant parameter for view and change. **SEL1** `SEL 1`

SEL2: Selects the 2nd most significant parameter for view and change. **SEL2** `SEL2`

SEL3: Selects the 3rd most significant parameter for view and change. **SEL3** `SEL3`

SEL4: Selects the 4th most significant parameter for view and change. **SEL4** `SEL4`

SEL5: Selects the 5th most significant parameter for view and change. **SEL5** `SEL5`

Range: NONE, TIME, A1.SP, A1.DV, A2.SP, A2.DV, RAMP, OFST, REFC, SHIF, PB1, TI1, TD1, C.PB, DB, SP2, PB2, TI2, TD2

When using the up and down keys to select the parameters, you may not see all of the above parameters. The number of visible parameters is dependent on the setup condition. The hidden parameters for the specific application are also deleted from the SEL selection.

Example:

A1FN selects TIMR

A2FN selects DE.HI

PB1=10

TI1=0

SEL1 selects TIME

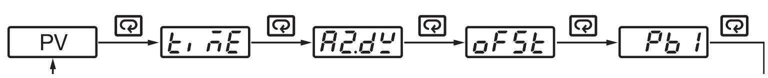
SEL2 selects A2.DV

SEL3 selects OFST

SEL4 selects PB1

SEL5 selects NONE

Now, the upper display scrolling becomes:



3–4 Heat Only Control

Heat Only ON-OFF Control: Select REVR for OUT1, set PB1 to 0, SP1 is used to adjust set point value, O1HY is used to adjust dead band for ON-OFF control, TIME is used to adjust the dwell timer (enabled by selecting TIMR for A1FN or A2FN). Output 1 hysteresis (O1HY) is enabled in the case of PB1=0. The heat only on-off control function is shown in the diagram at right.

Setup ON-OFF:

OUT1 = `rEVr`

PB1 = 0

Adjust: SP1, O1HY, TIME (if enabled)

The ON-OFF control may introduce excessive process oscillation even if hysteresis is minimized to the smallest. If ON-OFF control is set (i.e., PB1=0), TI1, TD1, CYC1, OFST, CPB and PL1 will be hidden and have no function to the system. The manual mode, auto-tuning, self-tuning and bumpless transfer will be disabled too.

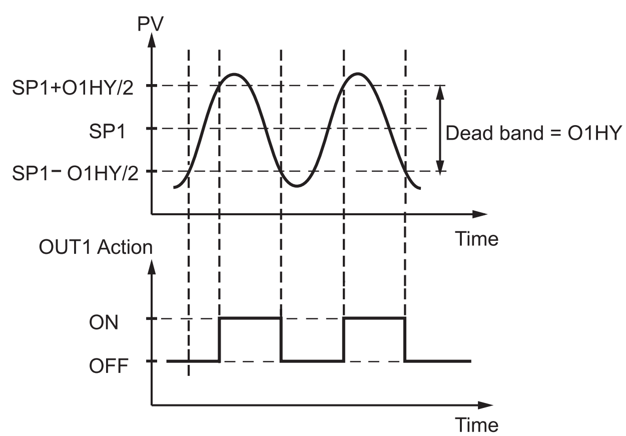


Figure 3.2 Heat Only ON-OFF Control

3–4 Heat Only Control continued next page…

Heat only P (or PD) control: Select REVR for OUT1, set TI1 to 0, SP1 is used to adjust set point value, TIME is used to adjust the dwell timer (enabled by selecting TIMR for A1FN or A2FN). OFST been enabled in case of TI1=0 is used to adjust the control offset (manual reset). Adjust CYC1 according to the output 1 type (O1TY). Generally, CYC1=0.5~2 seconds for SSRD and SSR, CYC1=10~20 seconds for relay output. CYC1 is ignored if linear output is selected for O1TY.

O1HY is hidden if PB1 is not equal to 0.

OFST Function: OFST is measured by % with range 0–100.0%. In the steady state (i.e., 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 PB1, that is lower 25%, then increase OFST 25%, and vice versa. After adjusting OFST value, the process value will be varied and eventually coincide with set point. Using the P control (TI1 set to 0), the auto-tuning and self-tuning are disabled. Refer to section 3-21 "manual tuning" for the adjustment of PB1 and TD1. Manual reset (adjust OFST) is not practical because the load may change from time to time and often need to adjust OFST repeatedly. The PID control can avoid this situation.

Setup P:

OUT1 = rEVr

TI1 = 0

CYC1 (if RELAY, SSRD or SSR is selected for O1TY)

Adjust:

SP1, OFST, TIME (if enabled), PB1(≠0), TD1

Heat only PID control: Selecting REVR for OUT1, SP1 is used to adjust set point value. TIME is used to adjust the dwell timer (enabled by selecting TIMR for A1FN or A2FN). PB1 and TI1 should not be zero. Adjust CYC1 according to the output 1 type (O1TY). Generally, CYC1=0.5~2 seconds for SSRD and SSR, CYC1=10~20 seconds for relay output. CYC1 is ignored if linear output is selected for O1TY. In most cases, self-tuning can be used to substitute for auto-tuning. See section 3-19. If self-tuning is not used (select NONE for SELF), then use auto-tuning for the new process, or set PB1, TI1, and TD1 with historical values. See section 3-20 for auto-tuning operation. If the control result is still unsatisfactory, then use manual tuning to improve control. See section 3-21 for manual tuning. TEC-8300 contains a very clever PID and Fuzzy algorithm to achieve a very small overshoot and very quick response to the process if it is properly tuned.

Setup PID:

OUT1 = rEVr

O1TY

CYC1 if RELAY, SSRD or SSR is selected for O1TY)

SELF=NONE or YES

Adjust:

SP1, TIME (if enabled), PB1(≠0), TI1(≠0), Td1

Auto-tuning:

Used for new process during initial tuning

Self-tuning:

Used for a process any time.

Manual Tuning:

May be used if self-tuning and auto-tuning are inadequate.

3–5 Cool Only Control

ON-OFF control, P (PD) control, and PID control can be used for cool 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 in section 3-5 for heat only control except that the output variable (and action) for the cool control is inverse to the heat control, such as the following diagram shows:

Setup Cool Control:

OUT1 = dirt

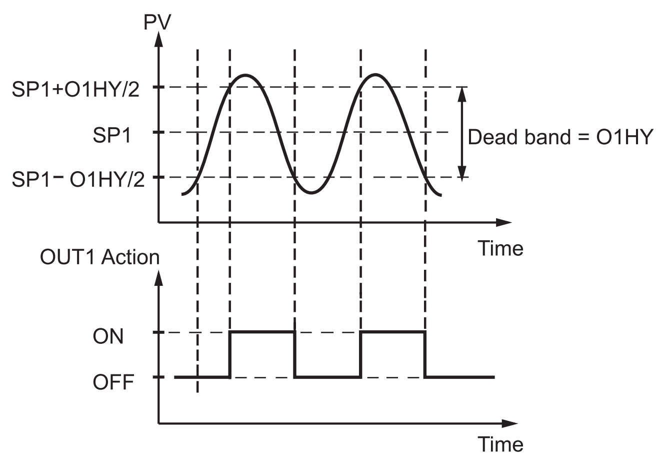


Figure 3.3 Cool Only ON-OFF Control

Refer to section 3-5, in which similar descriptions for heat only control can be applied to cool only control.

3–6 Heat-Cool Control

The heat-cool control can use one of six combinations of control modes. Setup of parameters for each control mode are shown in the following table.

Table 3.1 Heat-Cool Control Setup

Control Modes	Heat Uses	Cool Uses	Setup Values											
			OUT1	OUT2	O1HY	OFST	PB1	TI1	TD1	CPB	DB	A1FN or A2FN	A1MD or A2MD	A1HY or A2HY
Heat : ON-OFF Cool : ON-OFF	OUT1	ALM1 or ALM2	REVR	NONE	☆	×	=0	×	×	×	×	DE.HI or PV1.H	NORM	☆
Heat : ON-OFF Cool : P (PD)	ALM1 or ALM2	OUT1	DIRT	NONE	×	☆	≠0	=0	☆	×	×	DE.LO or PV1.L	NORM	☆
Heat : ON-OFF Cool : PID	ALM1 or ALM2	OUT1	DIRT	NONE	×	×	≠0	≠0	☆	×	×	DE.LO or PV1.L	NORM	☆
Heat : P (PD) Cool : ON-OFF	OUT1	ALM1 or ALM2	REVR	NONE	×	☆	≠0	=0	☆	×	×	DE.HI or PV1.H	NORM	☆
Heat : PID Cool : ON-OFF	OUT1	ALM1 or ALM2	REVR	NONE	×	×	≠0	≠0	☆	×	×	DE.HI or PV1.H	NORM	☆
Heat : PID Cool : PID	OUT1	OUT2	REVR	COOL	×	×	≠0	≠0	☆	☆	☆	×	×	×

× : Not Applicable ☆ : Adjust to meet process requirements

NOTE: The ON-OFF control may result in excessive overshoot and undershoot problems in the process. The P (or PD) control will result in a deviation 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: O1TY, CYC1, O2TY, CYC2, A2SP, A2DV, O1TY and O2TY are set in accordance with the types of OUT1 and OUT2 installed. CYC1 and CYC2 are selected according to the output 1 type (O1TY) and output 2 type (O2TY). Generally, select 0.5~2 seconds for CYC1 if SSRD or SSR is used for O1TY. Select 10~20 seconds if relay is used for O1TY. CYC1 is ignored if linear output is used. Similar conditions are applied to CYC2 selection.

Examples:

Heat PID+Cool ON-OFF: Set OUT1=REVR, A1FN or A2FN=PV1.H, A1FN or A2MD=NORM, A1HY or A2HY=0.1, PB1≠0, TI1≠0,TD1≠0, and set appropriate values for O1TY and CYC1.

Heat PID+Cool PID: set OUT1=REVR, OUT2=COOL, CPB=100, DB=-4.0, PB1≠0, TI1≠0, TD1≠0, and set appropriate values for O1TY, CYC1, O2TY, CYC2.

If you have no idea about a new process, then use the self-tuning program to optimize the PID values by selecting YES for SELF to enable the self-tuning program. See section 3-18 for a description of the self-tuning program. You can use the auto-tuning program for the new process or directly set the appropriate values for PB1, TI1, and TD1 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 3-20 for more information on manual tuning.

CPB Programming: The cooling proportional band is measured by % of PB with a range of 1~255. Initially set 100% for CPB and examine the cooling effect. If the cooling action should be enhanced then decrease CPB, if the cooling action is too strong then increase CPB. The value of CPB is related to PB and its value remains unchanged throughout the self-tuning and auto-tuning procedures.

Adjustment of CPB is related to the cooling media used. If air is used as the cooling medium, set CPB at 100(%). If oil is used as the cooling medium, set CPB at 125(%). If water is used as the cooling medium, set CPB at 250(%).

DB Programming: Adjustment of DB is dependent on the system requirements. If a higher positive value of DB (greater dead band) is used, unwanted cooling action can be avoided, but an excessive overshoot over the set point will occur. If a lower 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 PB1 (or PB2 if PB2 is selected). 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.

3–7 Dwell Timer

Alarm 1 or alarm 2 can be configured as dwell timer by selecting TIMR for A1FN or A2FN, but not both, otherwise **Er07** will appear. As the dwell timer is configured, the parameter TIME is used for dwell time adjustment. The dwell time is measured in minute ranging from 0 to 6553.5 minutes. Once the process reaches the set point the dwell timer starts to count from zero until time out.The timer relay will remain unchanged until time out. The dwell timer operation is shown as following diagram.

If alarm 1 is configured as dwell timer, A1SP, A1DV, A1HY and A1MD are hidden.

The case is the same for alarm 2.

Example:

Set A1FN=TIMR or A2FN=TIMR, but not both.

Adjust TIME in minutes

A1MD (if A1FN=TIMR) or A2MD (if A2FN=TIMR) is ignored in this case.

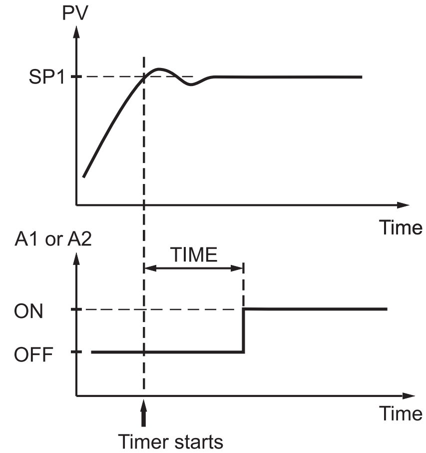


Figure 3.4 Dwell Timer Function

3–8 Process Alarms

A process alarm sets an absolute trigger level (or temperature). When the process (could be PV1, PV 2, or PV1-PV2) exceeds that absolute trigger level, an alarm occurs. A process alarm is independent from the set point. Adjust A1FN (Alarm 1 function) in the setup menu. One of eight functions can be selected for process alarm. These are: PV1.H, PV1.L, PV2.H, PV2.L, P1.2.H, P1.2.L, D1.2.H, D1.2.L.

When PV1.H or PV1.L is selected, the alarm examines the PV1 value. When PV2.H or PV2.L is selected, the alarm examines the PV2 value. When P1.2.H or P1.2.L is selected, the alarm occurs if the PV1 or PV2 value exceeds the trigger level. When D1.2.H or D1.2.L is selected, the alarm occurs if the PV1-PV2 (difference) value exceeds the trigger level. The trigger level is determined by A1SP (Alarm 1 set point) and A1HY (Alarm 1 hysteresis value) in User Menu for alarm 1. The hysteresis value is introduced to avoid interference action of alarm in a noisy environment. Normally A1HY can be set with a minimum (0.1) value. A1DV and/or A2DV are hidden if alarm 1 and/or alarm 2 are set for process alarm.

Normal Alarm: A1MD=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: A1MD=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 alarms are disabled when the power is shut off or if event input is applied with proper selection of EIFN.

Holding Alarm: A1MD=HOLD

A holding alarm prevents an alarm from powering up. The alarm is enabled only when the process reaches the set point value (may be SP1 or SP2, see section 4-1 event input). Afterwards, the alarm performs the same function as a normal alarm.

Latching/Holding Alarm: A1MD=LT.HO

A latching/holding alarm performs both holding and latching function.

8 Types of Process Alarms:

PV1.H, PV1.L, PV2.H, PV2.L, P1.2.H, P1.2.L, D1.2.H, D1.2.L

Process Alarm 1

Setup: A1FN, A1MD

Adjust: A1SP, A1HY

Trigger level=A1SP±A1HY

Process Alarm 2

Setup: OUT2, A2FN, A2MD

Adjust: A2SP, A2HY

Trigger level=A2SP±A2HY

Reset Latching alarm

1. Power off
2. Apply event input in accordance with proper selection of EIFN

Although the descriptions in the examples below are based on alarm 1, the same conditions can be applied to alarm 2.

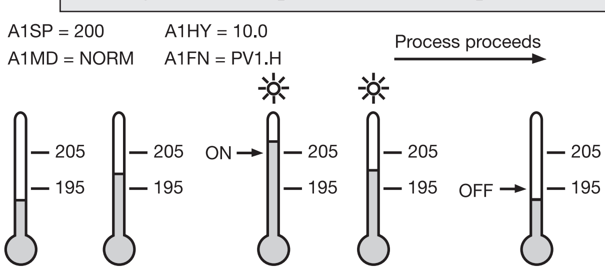


Figure 3.5 Normal Process Alarm

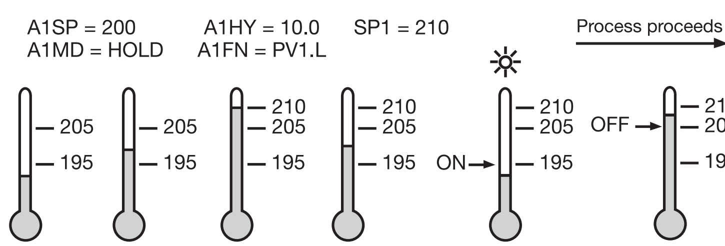


Figure 3.7 Holding Process Alarm

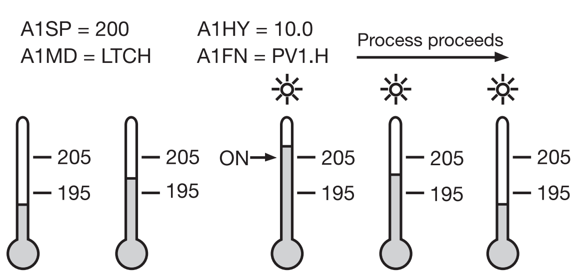


Figure 3.6 Latching Process Alarm

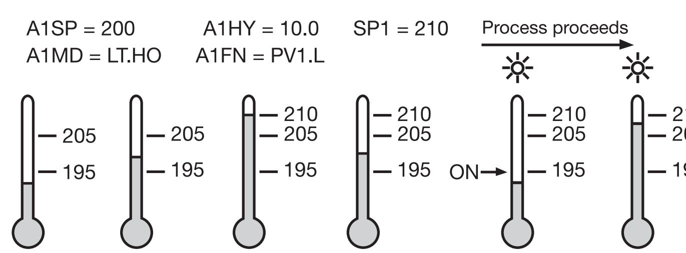


Figure 3.8 Latching/Holding Process Alarm

3–9 Deviation Alarm

A deviation alarm alerts the user when the process deviates too far from the set point. The user can enter a positive or negative deviation value (A1DV, A2DV) for alarm 1 and alarm 2. A hysteresis value (A1HY or A2HY) can be selected to avoid interference problems in a noisy environment. Normally, A1HY and A2HY can be set with a minimum (0.1) value. The trigger level of the alarm moves with the set point.

For alarm 1,
trigger level=SP1+A1DV±A1HY.

For alarm 2,
trigger level=SP1+A2DV±A2HY.

A1SP and/or A2SP are hidden if alarm 1 and/or alarm 2 are set for deviation alarm. One of four alarm modes can be selected for alarm 1 and alarm 2. These are: normal alarm, latching alarm, holding alarm and latching/holding alarm. See section 3-8 for descriptions of these alarm modes.

2 Types of deviation alarms:
DE.HI, DE.LO

Deviation alarm 1:
Setup: A1FN, A1MD
Adjust: SP1, A1DV, A1HY
Trigger levels:
SP1+A1DV±A1HY

Deviation alarm 2:
Setup: OUT2, A2FN, A2MD
Adjust: SP1, A2DV, A2HY
Trigger levels:
SP1+A2DV±A2HY

Examples:

A1FN = DE.HI, A1MD = NORM, SP1 = 100, A1DV=10, A1HY=4

Indicates an Alarm Condition

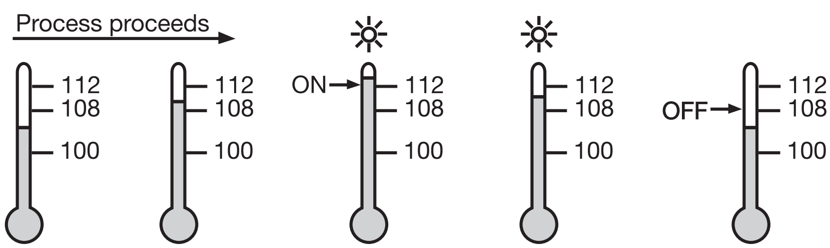


Figure 3.9
Normal Deviation Alarm

A1FN = DE.HI, A1MD = LTCH, SP1 = 100, A1DV=10, A1HY=4

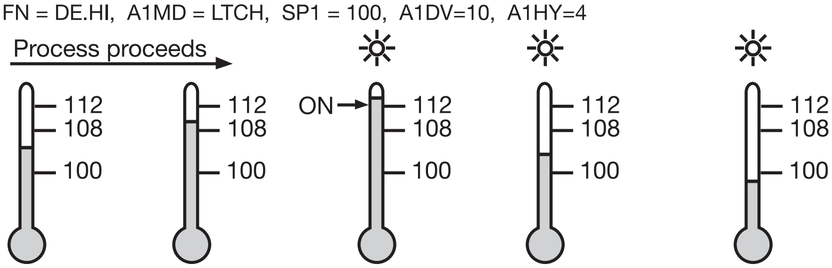


Figure 3.10
Latching Deviation Alarm

A1HY = DE.LO, A1MD = HOLD, SP1 = 100, A1DV= -10, A1HY=4

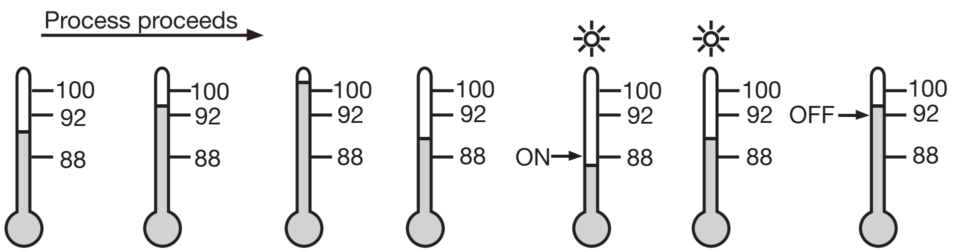


Figure 3.11
Holding Deviation Alarm

A1HY= DE.LO, A1MD = LT.HO, SP1 = 100, A1DV= -10, A1HY=4

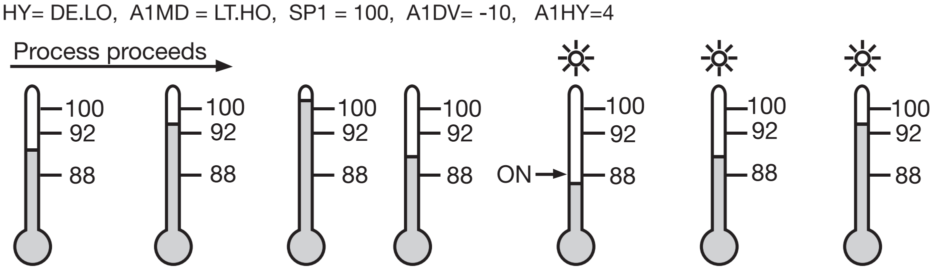


Figure 3.12
Latching/Holding
Deviation Alarm

3–10 Deviation Band Alarm

A deviation band alarm presets two reference levels relative to set point. Two types of deviation band alarm can be configured for alarm 1 and alarm 2. These are deviation band high alarm (A1FN or A2FN select DB.HI) and deviation band low alarm (A1FN or A2FN select DB.LO). A1SP and A1HY are hidden if alarm 1 is selected as a deviation band alarm. Similarly, A2SP and A2HY are hidden if alarm 2 is selected as a deviation band alarm.

The trigger level for deviation band alarm moves with the set point. For alarm 1, the trigger level=SP1±A1DV. For alarm 2, the trigger level=SP1±A2DV. One of four alarm modes can be selected for alarm 1 and alarm 2. These are: normal alarm, latching alarm, holding alarm and latching/holding alarm. See section 3-8 for descriptions of these alarm modes.

2 types of deviation band alarms:
DB.HI, DB.LO

Deviation band alarm 1:
Setup: A1FN, A1MD
Adjust: SP1, A1DV
Trigger level: SP1±A1DV

Deviation band alarm 2:
Setup: OUT2, A2FN, A2MD
Adjust: SP1, A2DV
Trigger levels: SP1±A2DV

Indicates an Alarm Condition

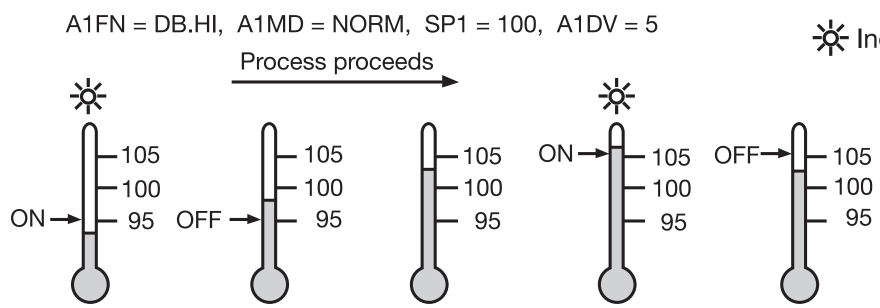


Figure 3.13 Normal Deviation Band Alarm

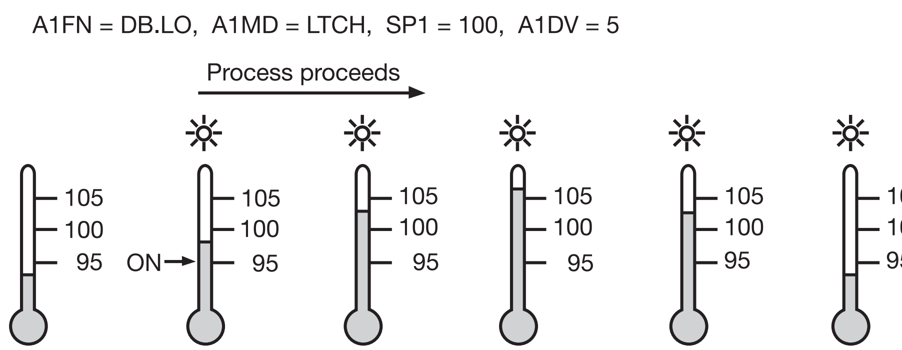


Figure 3.14 Latching Deviation Band Alarm

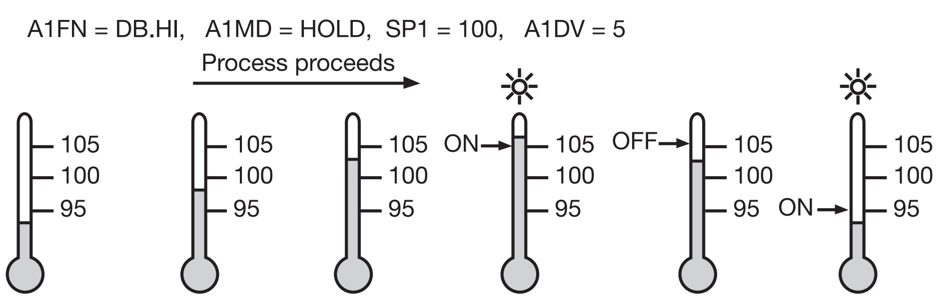


Figure 3.15 Holding Deviation Band Alarm

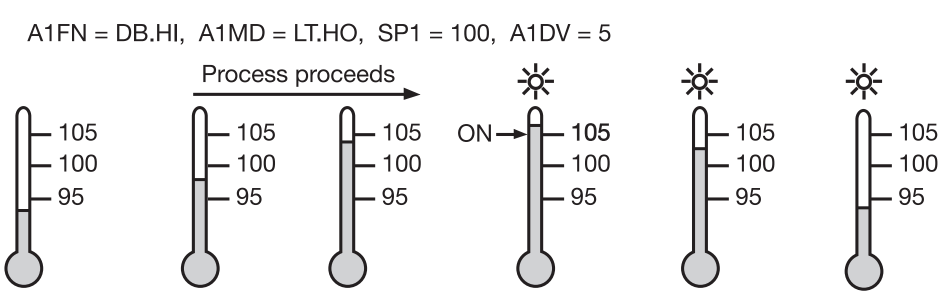


Figure 3.16 Latching/Holding Deviation Band Alarm

3–11 Heater Break Alarm

A current transformer (Part No. TEC99999) should be installed to detect the heater current if a heater break alarm is required. The CT signal is sent to input 2, and the PV2 will indicate the heater current in 0.1amp resolution. The range of the current transformer is 0 to 50.0amp. For more detailed descriptions about heater current monitoring, please see section 3-24.

Heater break alarm 1

Setup: IN2=CT
A1FN=PV2.L
A1MD=NORM
A1HY=0.1
Adjust: A1SP
Trigger level: A1SP±A1HY

Heater break alarm 2

Setup: IN2=CT
A2FN=PV2.L
A2MD=NORM
A2HY=0.1
Adjust: A2SP
Trigger level: A2SP±A2HY

Limitations:

1. Linear output can't use heater break alarm.
2. CYC1 should use 1 second or longer to detect heater current reliably.

Example:

A furnace uses two 2KW heaters connected in parallel to warm up the process. The line voltage is 220V and the rating current for each heater is 9.09A. If we want to detect any one heater break, set A1SP=13.0A, A1HY=0.1, A1FN=PV2.L, A1MD=NORM, then:

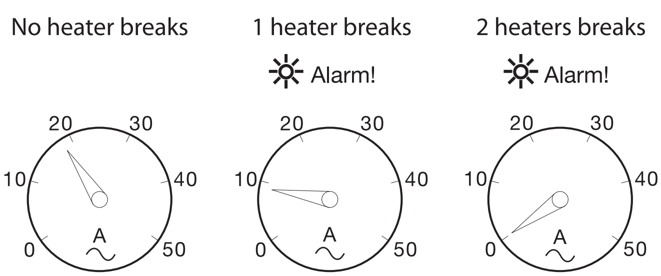


Figure 3.17 Heater Break Alarm

3–12 Loop Break Alarm

Select LB for A1FN if alarm 1 is required to act as a loop break alarm. Similarly, if alarm 2 is required to act as a loop break alarm, then set OUT2 to AL2 and A2FN to LB. TIME, A1SP, A1DV, and A1HY are hidden if alarm 1 is configured as a loop break alarm. Similarly, TIME, A2SP, A2DV, and A2HY are hidden if alarm 2 is configured as a loop break alarm.

Loop break alarm 1

Setup: **A1FN** = LB
A1MD = NORM, LTCH

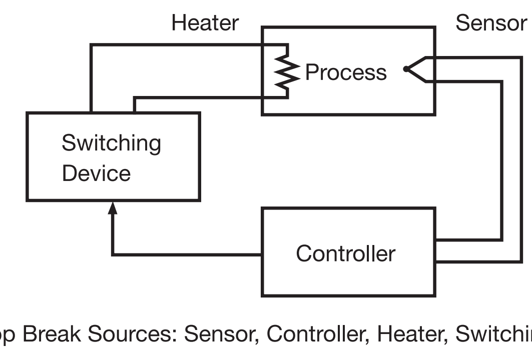
Loop break alarm 2

Setup: **OUT2** = AL2
A2FN = LB
A2MD = NORM, LTCH

One of four kinds of alarm modes can be selected for alarm 1 and alarm 2. These are: normal alarm, latching alarm, holding alarm and latching/holding alarm. However, the holding mode and latching/holding mode are not recommended for loop break alarm since loop break alarm will not perform the holding function even if it is set for holding or latching/holding mode. See section 3-8 for descriptions of these alarm modes.

Loop break conditions are detected during a time interval of 2TI1 (double the integral time, but 120 seconds maximum). Hence the loop break alarm doesn't respond as quickly as it occurs. If the process value doesn't increase (or decrease) while the control variable MV1 has reached its maximum (or minimum) value within the detecting time interval, a loop break alarm (if configured) will be activated.

Figure 3.18 Loop Break Sources



Loop break alarm (if configured) occurs when any following conditions happen:

1. Input sensor is disconnected (or broken).
2. Input sensor is shorted.
3. Input sensor is defective.
4. Input sensor is installed outside (isolated from) the process.
5. Controller fails (A-D converter damaged).
6. Heater (or chiller, valve, pump, motor etc.) breaks or fails or is uninstalled.
7. Switching device (used to drive heater) is open or shorted.

3–13 Sensor Break Alarm

Alarm 1 or alarm 2 can be configured as a sensor break alarm by selecting SENB SEnb for A1FN or A2FN. The sensor break alarm is activated as soon as failure mode occurs. Refer to section 3-16 for failure mode conditions. Note that A-D failure also creates a sensor break alarm. TIME, A1SP, A1DV, and A1HY are hidden if alarm 1 is configured as a sensor break alarm. Similarly, TIME, A2SP, A2DV and A2HY are hidden if alarm 2 is configured as a sensor break alarm.

One of four kinds of alarm modes can be selected for sensor break alarm. These are: normal alarm, latching alarm, holding alarm and latching/holding alarm. However, the holding alarm and latching/holding alarm are not recommended for sensor break alarm since sensor break alarm will not perform the holding function even if it is set for holding or latching/holding mode. See section 3-8 for the descriptions of these alarm modes.

Sensor Break Alarm 1

Setup: A1FN=SENB
A1MD=NORM, LTCH

Hidden: TIME, A1SP, A1DV, A1HY

Sensor Break Alarm 2

Setup: OUT2=AL2
A2FN=SENB
A2MD=NORM, LTCH

Hidden: TIME, A2SP, A2DV, A2HY

3–14 SP1 Range

SP1L (SP1 low limit value) and SP1H (SP1 high limit value) in the setup menu are used to confine the adjustment range of SP1.

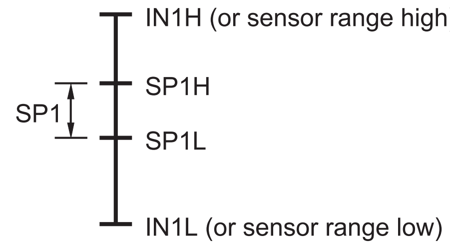
Example: A freezer is working in its normal temperature range -10°C to -15°C. In order to avoid an abnormal set point, SP1L and SP1H are set with the following values:

SP1L=-15°C   SP1H=-10°C

Now SP1 can only be adjusted within the range of -10°C to -15°C.

Setup: SP1L, SP1H

Figure 3.19 SP1 Range



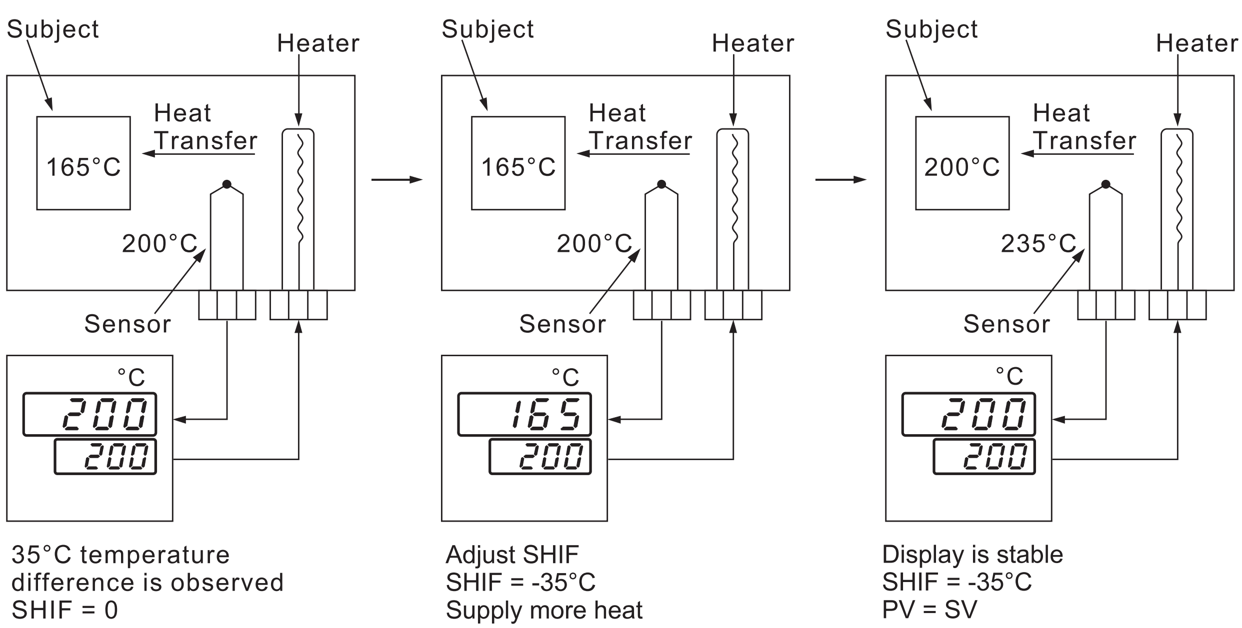
3–15 PV1 Shift

In certain applications it is desirable to shift the controller display value from its actual value. This can easily be accomplished by using the PV1 shift function.

Press the “scroll” key to bring up the parameter SHIF. The value you adjust here, either positive or negative, will be added to the actual value. The SHIF function will alter PV1 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 (different temperature) is common and necessary to an extent in any thermal system for heat to be 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 so 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 3.20 PV1 Shift Application



3–16 Failure Transfer

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

1. **SB1E** occurs (due to input 1 sensor break or input 1 current below 1mA if 4–20mA is selected or input 1 voltage below 0.25V if 1–5V is selected) if PV1, P1-2, or P2-1 is selected for PVMD or PV1 is selected for SPMD.
2. **SB2E** occurs (due to input 2 sensor break or input 2 current below 1mA if 4–20mA is selected or input 2 voltage below 0.25V if 1–5V is selected) if PV2, P1-2, or P2-1 is selected for PVMD or PV2 is selected for SPMD.
3. **ADER** occurs if the A-D converter of the controller fails.

Output 1 and output 2 will perform the failure transfer function as one of the following conditions occurs:

1.During power starts (within 2.5 seconds).

2.The controller enters failure mode.

3.The controller enters manual mode.

4.The controller enters calibration mode.

Failure mode occurs as:

1. SB1E
2. SB2E
3. ADER

Failure Transfer of output 1 and output 2 occur as:

1. Power start (within 2.5 seconds)
2. Failure mode is activated
3. Manual mode is activated
4. Calibration mode is activated

Failure Transfer of alarm 1 and alarm 2 occur as:

Failure mode is activated

Failure Transfer Setup:

1. O1FT
2. O2FT
3. A1FT
4. A2FT

Output 1 failure transfer, if activated, will perform:

1. If output 1 is configured as proportional control (PB1=0), and BPLS is selected for O1FT, then output 1 will perform bumpless transfer. Thereafter, the previous averaging value of MV1 will be used for controlling output 1.
2. If output 1 is configured as proportional control (PB1=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 (PB1=0), then output 1 will be driven OFF if O1FN selects REVR and be driven ON if O1FN selects DIRT.

Output 2 failure transfer, if activated, will perform:

1. If OUT2 selects COOL, and BPLS is selected for O1FT, then output 2 will perform bumpless transfer. Thereafter, the previous averaging value of MV2 will be used for controlling output 2.
2. If OUT2 selects COOL, and a value of 0 to 100.0 % is set for O2FT, then output 2 will perform failure transfer. Thereafter, the value of O1FT will be used for controlling output 2.

Alarm 1 failure transfer is activated as the controller enters failure mode. Thereafter, alarm 1 will transfer to the ON or OFF state preset by A1FT.

Alarm 2 failure transfer is activated as the controller enters failure mode. Thereafter, alarm 2 will transfer to the ON or OFF state preset by A2FT.

Exception: If A1FN or A2FN are configured for loop break (LB) alarm or sensor break (SENB) alarm, alarm 1 or alarm 2 will be switched to ON state independent of the setting of A1FT. If A1FN or A2FN are configured for dwell timer (TIMR), the alarm will not perform failure transfer.

3–17 Bumpless Transfer

The bumpless transfer function is available for output 1 and output 2 (provided that OUT2 is configured as COOL).

Bumpless transfer is enabled by selecting BPLS for O1FT and/or O2FT and activated as one of the following cases occurs:

1. Power starts (within 2.5 seconds).
2. The controller enters failure mode. See section 3-16 for failure mode descriptions.
3. The controller enters manual mode. See section 3-22 for manual mode descriptions.
4. The controller enters calibration mode. See chapter 6 for calibration mode descriptions.

As bumpless transfer is activated, the controller will transfer to open-loop control and uses the previous averaging value of MV1 and MV2 to continue control.

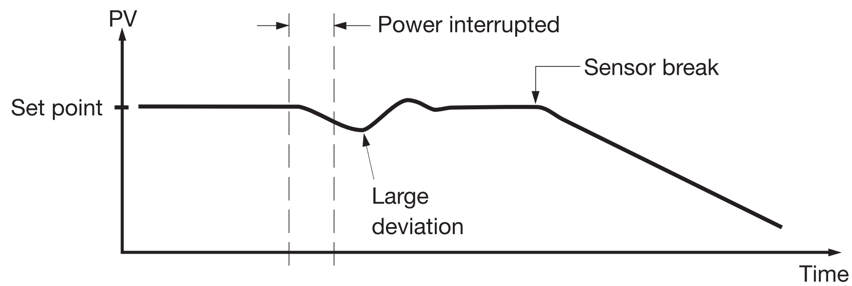
Bumpless transfer setup:

1. O1FT=BPLS
2. O2FT=BPLS

Bumpless transfer occurs as:

1. Power starts (within 2.5 seconds)
2. Failure mode is activated
3. Manual mode is activated
4. Calibration mode is activated

Without Bumpless Transfer



Since the hardware and software need time to be initialized, the control is abnormal as the power is recovered and results in a large disturbance to the process. During the sensor breaks, the process loses power.

With Bumpless Transfer

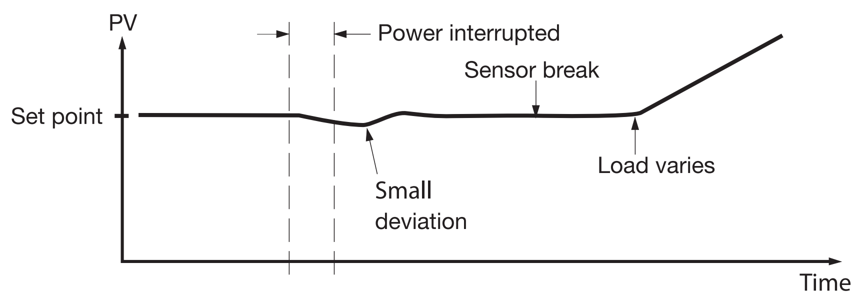


Figure 3.21 Benefits of Bumpless Transfer

When bumpless transfer is configured, the correct control variable is applied immediately as power is recovered, and the disturbance is small. During sensor breaks, the controller continues to control by using its previous value. If the load doesn't change, the process will remain stable. If the load changes, the process may run away. Therefore, you should not rely on bumpless transfer for extended periods of time. For fail safe reasons, an additional alarm should be used to announce to the operator when the system fails. For example, a sensor break alarm, if configured, will switch to failure state and tell the operator to use manual control or take proper security action when the system enters failure mode.

***WARNING*: After the system fails, never depend on bumpless transfer for a long time, or it might cause the system to run away.**

3–18 Self tuning

Self-tuning provides an alternate option for tuning the controller. It is activated when YES is selected for SELF. When self-tuning is used, the controller will change its working PID values and compare the process behavior to previous cycles. If the new PID values achieve better control, then it changes the next PID values in the same direction. Otherwise, it changes the next PID values in the reverse direction. When an optimal condition is obtained, the PID values will be stored in PB1, TI1, and TD1, or PB2, TI2, and TD2, as determined by the event input conditions. See section 4-1. When self-tuning is completed, the value of SELF will change from YES to NONE to disable the self-tuning function.

When self-tuning is enabled, the control variables are tuned slowly so that the disturbance to the process is less than auto-tuning. Usually, self-tuning will perform successfully with no need to apply additional auto-tuning.

Exceptions: Self-tuning will be disabled as soon as one of the following conditions occurs:

1. NONE is selected for SELF.
2. The controller is used for on-off control (PB=0).
3. The controller is used for manual reset (TI=0).
4. The controller is in a loop break condition.
5. The controller is in failure mode (e.g., sensor break).
6. The controller is in manual control mode.
7. The controller is in sleep mode.
8. The controller is being calibrated.

If self-tuning is enabled, auto-tuning can still be used any time. Self-tuning will use the auto-tuning results for its initial values.

Benefits of Self-tuning:

1. Unlike auto-tuning, self-tuning will produce less disturbance to the process.
2. Unlike auto-tuning, self-tuning doesn't change the control mode during the tuning period. It always performs PID control.
3. Changing the set point during self-tuning is allowable. Therefore, self-tuning can be used for ramping set point control as well as remote set point control where the set point is changed from time to time.

Self-tune Menu

SELF

Selects

nonE Disable Self-tuning

or

YES Enable Self-tuning

Default

SELF=NONE

Operation:

The parameter SELF is contained in the setup menu. Refer to section 1-5 to find SELF for initiating self-tuning.

3–19 Auto tuning

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

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

Applicable conditions:
PB1≠0, TI1≠0 if PB1,TI1,TD1 assigned
PB2≠0, TI2≠0, if PB2, TI2, TD2 assigned

Operation:

1. The system has been installed normally.
2. Use the default values for PID before tuning.
   The default values are: PB1=PB2=18.0°F
   TI1=TI2=100 seconds, TD1=TD2=25.0 seconds.
   Of course, you can use other reasonable values for PID before tuning according to your previous experiences. But don't use a zero value for PB1 and TI1 or PB2 and TI2, otherwise, the auto-tuning program will be disabled.
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 [⟲] [▼] until [A_t] [----] appears on the display.
5. Press [⟲] for at least 3 seconds. The upper display will begin to flash and the auto-tuning procedure is beginning.

NOTE:

Ramping function, remote set point, or pump function, if used, will be disabled once auto-tuning is proceeding.

Procedures:

Auto-tune function advantage:
Consistent tuning results can be obtained

Auto-tuning can be applied either as the process is warming up (cold start) or when the process has been in a steady state (warm start). See figure 3.22.

As the process reaches the set point value, the unit enters a waiting cycle. The waiting cycle elapses for a double integral time (TI1 or TI2, dependent on the selection, see section 4.1), then it enters a learning cycle. The double integral time is introduced to allow the process to reach a stable state. Before the learning cycle, the unit performs a pre-tune function with PID control. While in the learning cycle, the unit performs a post-tune function with an ON-OFF control. The learning cycle is used to test the characteristics of the process. The data is measured and used to determine the optimal PID values. At the end of the two successive ON-OFF cycles, the PID values are obtained and automatically stored in the nonvolatile memory. Once the auto-tuning procedures are completed, the process display will cease to flash and the unit will revert to PID control using its new PID values.

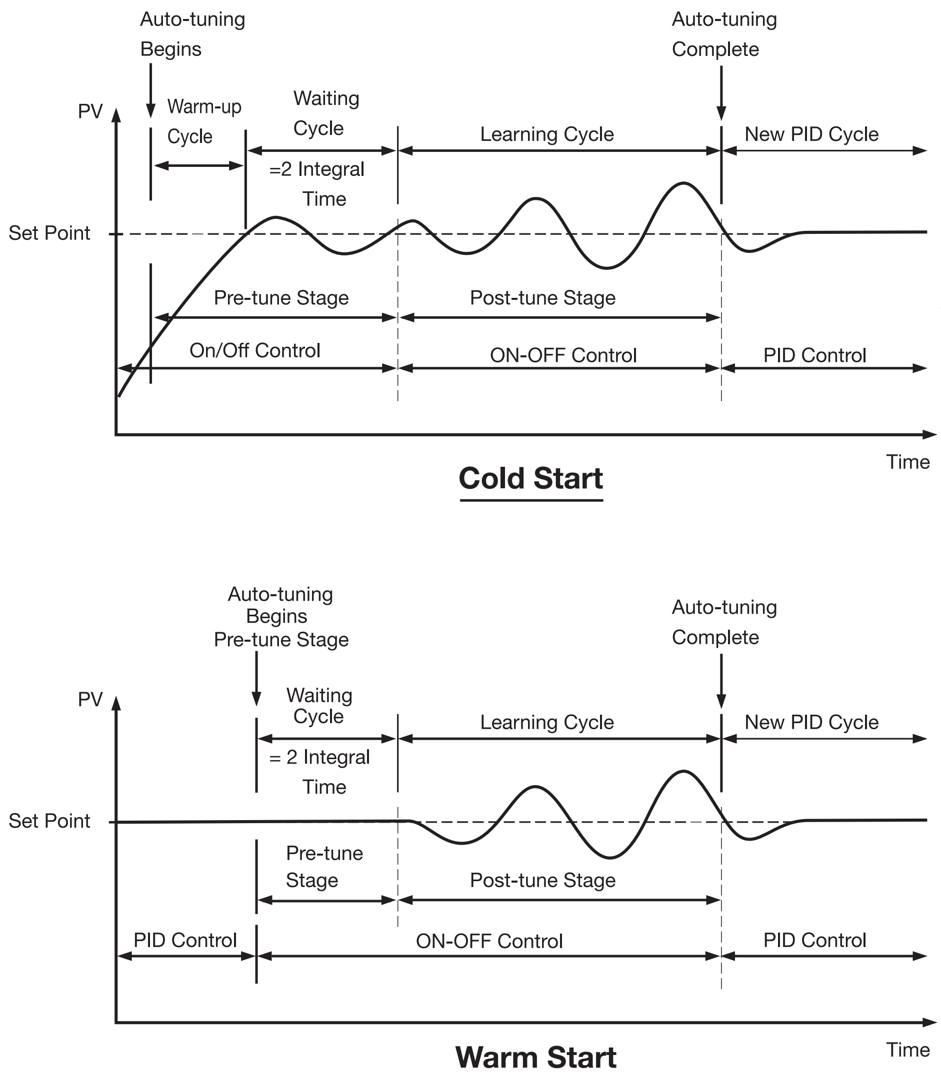


Figure 3.22
Auto-Tuning Procedure

If auto-tuning begins near the set point (warm start), the unit skips the warm-up cycle and enters the waiting cycle. Afterward, the procedures are the same as described for cold start.

AtEr Auto-Tuning Error

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

- If PB exceeds 9000 (9000 PU, 900.0°F or 500.0°C);
- if TI exceeds 1000 seconds;
- if the set point is changed during the auto-tuning procedure;
- or if the event input state is changed so that the set point value is changed.

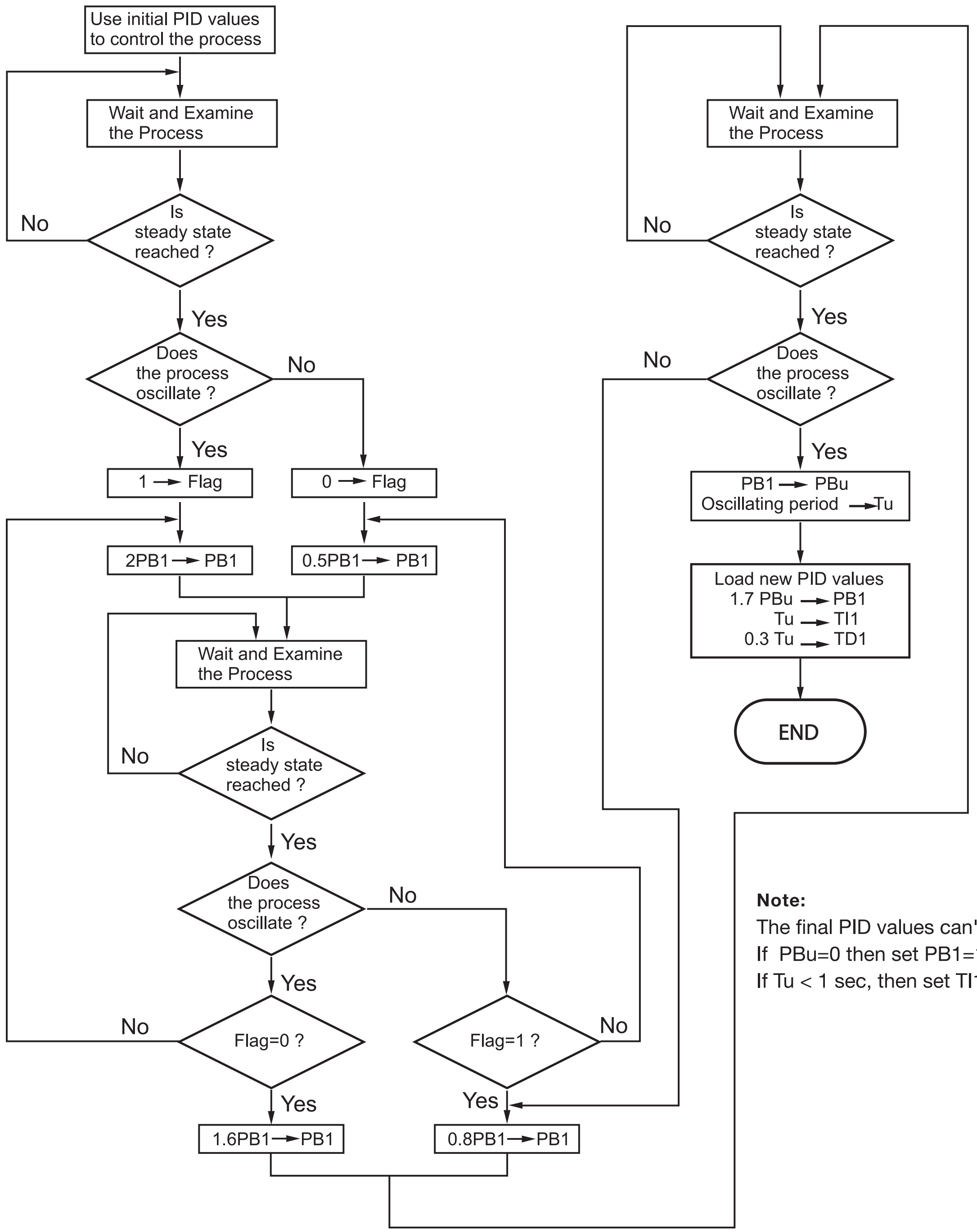
Solutions to AtEr

1. Try auto-tuning again.
2. Don't change the set point value during the auto-tuning procedure.
3. Don't change the event input state during the auto-tuning procedure.
4. Use manual tuning instead of auto-tuning. (See section 3-20)
5. Touch any key to reset AtEr message.

3–20 Manual Tuning

In certain applications (very few), when using both self-tuning and auto-tuning to tune a process proves inadequate for the control requirements, you can try manual tuning. Connect the controller to the process and perform the procedures according to the flow chart shown in the following diagram.

Figure 3.23 Manual Tuning Procedure



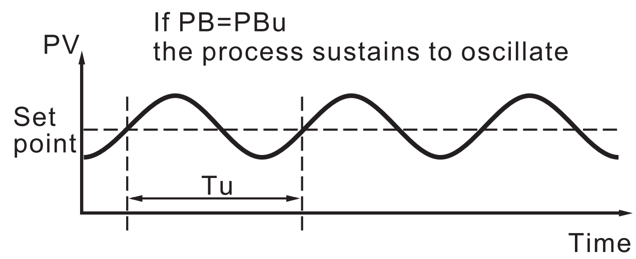
Note:
The final PID values can't be zero.
If PBu=0 then set PB1=1.
If Tu < 1 sec, then set TI1=1 sec.

The above procedure may take a long time before reaching a new steady state since the P band was changed. This is particularly true for a slow process. As a result, the above manual tuning procedures will take from minutes to hours to obtain optimal PID values.

3–20 Manual Tuning, continued…

The PBu is called the ultimate P band, and the period of oscillation Tu is called the ultimate period in the flow chart in figure 3.23. When this occurs, the process is said to be in a critical steady state. figure 3.24 shows an example of a critical steady state.

Figure 3.24 Critical Steady State



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

ADJUSTMENT SEQUENCE	SYMPTOM	SOLUTION
(1) Proportional Band (P) PB1 and/or PB2	Slow Response	Decrease PB1 or PB2
	High overshoot or Oscillations	Increase PB1 or PB2
(2) Integral Time (I) TI1 and/or TI2	Slow Response	Decrease TI1 or TI2
	Instability or Oscillations	Increase TI1 or TI2
(3) Derivative Time (D) TD1 and/or TD2	Slow Response or Oscillations	Decrease TD1 or TD2
	High Overshoot	Increase TD1 or TD2

Table 3.2 PID Adjustment Guide

Figure 3.25 shows the effects of PID adjustment on process response.

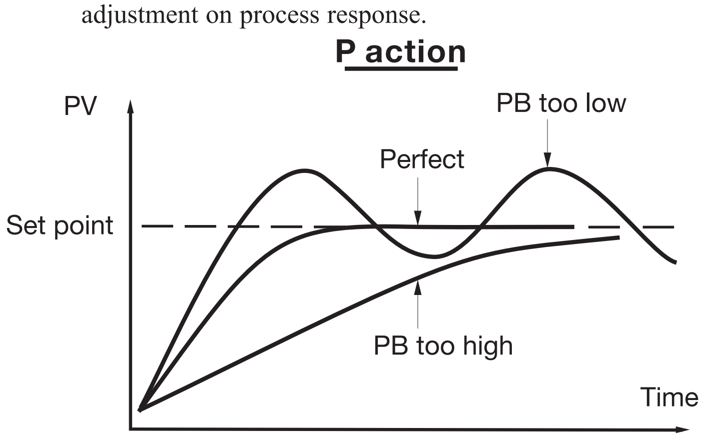
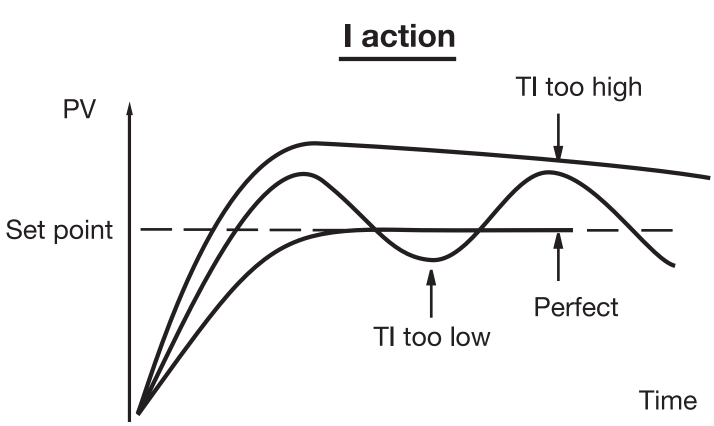
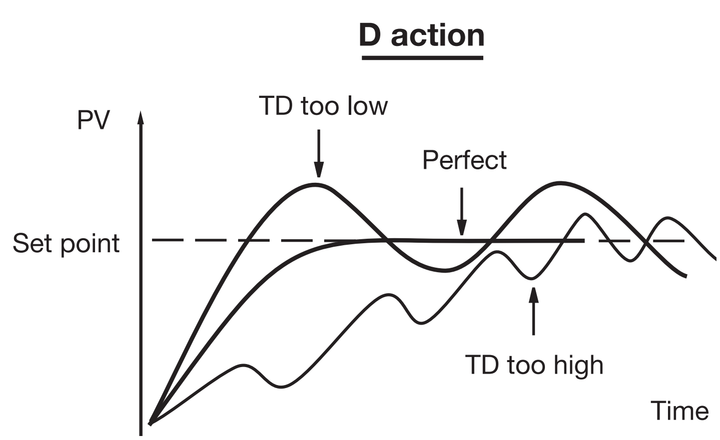


Figure 3.25 Effects of PID Adjustment

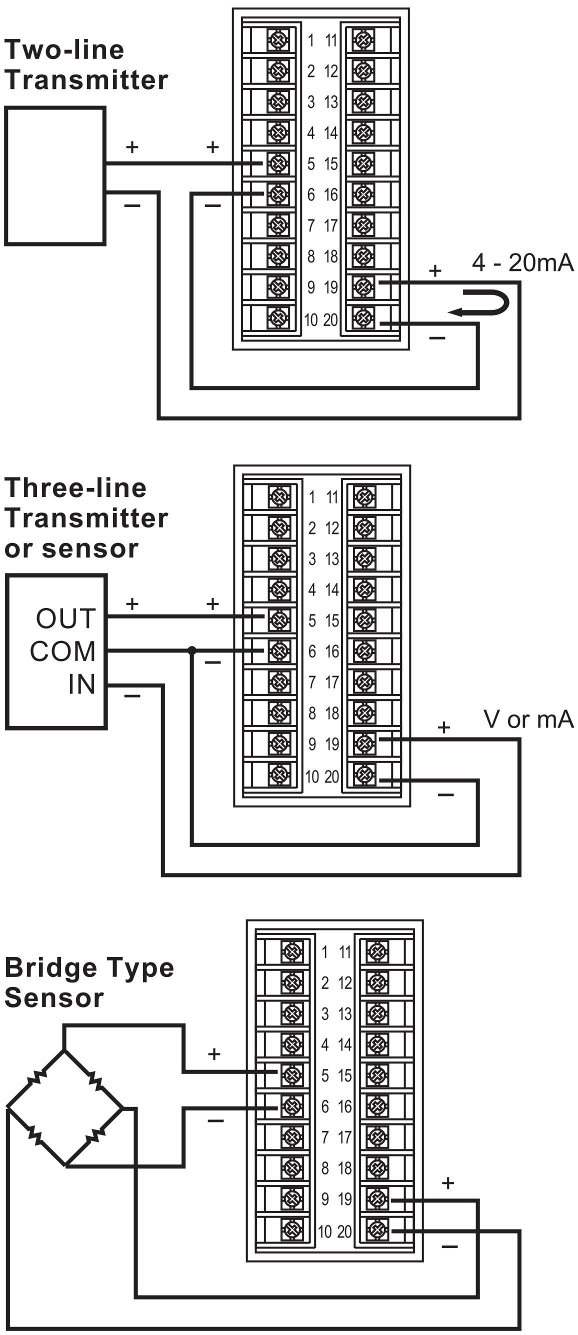




3–21 Signal Conditioner DC Power Supply

Three types of isolated DC power supplies are available to supply an external transmitter or sensor. These are 20V rated at 25mA, 12V rated at 40mA and 5V rated at 80mA. The DC voltage is delivered to the output 2 terminals.

Figure 3.26 DC Power Supply Applications



Set

OUT2 = dCPS DC Power Supply

Caution:

To avoid damage, don't use a DC power supply beyond its current rating. Purchase one with the correct voltage to suit your external devices. See the ordering code in section 1-2.

3–22 Manual Control

Manual control may be used for the following purposes:

1. To test the process characteristics to obtain a step response as well as an impulse response and use these data for tuning a controller.
2. To use manual control instead of a closed-loop control if the sensor fails or the controller's A-D converter fails. **NOTE** that bumpless transfer can not be used for an extended time. See section 3-17.
3. In certain applications, it is desirable to supply a process with a constant demand.

Operation:

Press and release ⟲ ▼ until HAnd ---- (hand control) appears on the display. Press ⟲ for 3 seconds. The upper display will begin to flash and the lower display will show H___ . The controller is now in manual control mode.

Pressing ⟲ will cause the lower display to show C___ and H___ alternately where H___ indicates output 1 on-time % and C___ indicates output 2 on-time %. Now you can use the up and down keys to adjust the percentage values for H or C.

H38.4 **Means** MV1=38.4% for OUT1 (or heating)

C7.63 **Means** MV2=7.63% for OUT2 (or cooling)

The controller performs open loop control as long as it stays in manual control mode. The H value is exported to output 1 (OUT1) and C value is exported to output 2 provided that OUT2 is performing cooling function (i.e., OUT2 selects COOL).

Exception

If OUT1 is configured as ON-OFF control (i.e., PB1=0 if PB1 is assigned or PB2=0 if PB2 is assigned by event input), the controller will not perform manual control mode.

Exiting Manual Control

Press ▲ ▼ keys the and the controller will revert to its previous operating mode (may be a failure mode or normal control mode).

3–23 Display Mode

Operation

Press [↻] [▼] several times until [dISP] [----] (display) appears on the display. Then press [↻] to enter display mode. You can select more parameters to view by pressing [↻] or pressing [↻] [▲] to reverse sequence. The system mode of the controller and its operation will remain unchanged. When the controller enters display mode, the upper display will show the parameter value and the lower display will show the parameter symbol except [H___] and [C___]. [H___] shows the percentage value for output 1 and [C___] shows the percentage value for output 2 on the lower display while the upper display shows the current process value.

PVHI/PVLO show the historical extreme (maximum or minimum) values of the process on the upper display. The historical extreme values are saved in a nonvolatile memory even when it is unpowered. Press [↻] for at least 6 seconds to reset both the historical values PVHI and PVLO and begin to record new peak process values.

MV1/MV2 show the process value on the upper display and [H___] shows the percentage control value for output 1, while [C___] shows the percentage control value for output 2.

DV shows the difference value between process and set point (i.e., PV-SV). This value is used to control output 1 and output 2.

PV1 shows the process value of input 1 on the upper display.

PV2 shows the process value of input 2 on the upper display.

PB shows the current proportional band value used for control.

TI shows the current integral time used for control.

TD shows the current derivative time used for control. Since the controller is performing FUZZY control, the values of PB, TI, and TD may change from time to time.

CJCT shows the temperature at the cold junction, measured in °C independent of the unit used.

PVR Shows the changing rate of the process in °C (or °F or PU) per minute. It may be negative if the process is going down.

PVRH/PVRL The maximum and minimum changing rate of the process since power up, as measured in °C (or °F or PU) per minute. PVRH is a positive value while PVRL is a negative value.

PVHI	PVHi
PVLO	PVLo
MV1	H___
MV2	C___
DV	dV
PV1	PV1
PV2	PV2
PB	Pb
TI	ti
TD	td
CJCT	CJCt
PVR	PVr
PVRH	PVr.H
PVRL	PVr.L

NOTE

The controller will not revert to its PV/SV display from display mode unless you press the [▲] [▼] keys.

3–24 Heater Current Monitoring

TEC99999, a current transformer, should be equipped to measure the heater current. Select CT for IN2. The input 2 signal conditioner measures the heater current while the heater is powered and the current value will remain unchanged while the heater is unpowered. The PV2 will indicate the heater current. For information on how to read PV2 value, please refer to section 3-24.

Accessory installed:

TEC99999

Setup

IN2=CT

O1TY or O2TY=RELY, SSRD or SSR

CYC1 or CYC2≥1 second

Limitations

1. Linear output type can't be used.
2. CYC1 (or CYC2) should be set for 1 second or longer to detect heater current reliably.
3. Only full-wave AC current can be detected.

NOTES

If the heater to be measured is controlled by output 1, then CYC1 should be set for 1 second or longer and O1TY should use RELY, SSRD, or SSR. Similarly, if the heater to be measured is controlled by output 2, then CYC2 should be set for 1 second or longer and O2TY should use RELY, SSRD, or SSR to provide an adequate time for the A to D converter to measure the signal. Since CT94-1 can detect a full-wave AC current only, a DC or half-wave AC current can't be measured.

3–25 Reload Default Values

The default values listed in table 1.4 are stored in the memory when the product leaves the factory. On certain occasions, it is desirable to retain these values after the parameter values have been changed. Here is a convenient way to reload the default values.

Operation

Press [↻] [▼] several times until [dEFt] [----] appears. Then press [↻]. The upper display will show [FiLE].Use the up and down keys to select 0 or 1. If °C units are required, select 0 for FILE and if °F units are required, select 1 for FILE. Then press [↻] for at least 3 seconds. The display will flash for a moment while the default values are reloaded.

FILE 0

°C default file

FILE 1

°F default file

CAUTION

The procedure mentioned above will change the previous setup data. Before performing it, take note of any parameters (PID values, alarm setpoints, ect.

NOTES

Chapter 4 Full Function Programming

4–1 Event Input

Refer to section 2-10 for wiring an event input.

The event input accepts a digital type signal. Three types of signal, relay or switch contacts, open collector pull low, and TTL logic level can be used to switch the event input.

One of ten functions can be chosen by using Ei.Fn (EIFN) in the setup menu.

Terminals:

(17) Event input +

(16) Event input –

NONE: Event input no function

If chosen, the event input function is disabled. The controller will use PB1, TI1, and TD1 for PID control and SP1 (or other values determined by SPMD) for the set point.

SP2: If chosen, the SP2 will replace the role of SP1 for control.

PID2: If chosen, the second PID set PB2, TI2, and TD2 will be used to replace PB1, TI1, and TD1 for control.

SP.P2: If chosen, SP2, PB2, TI2, and TD2 will replace SP1, PB1, TI1, and TD1 for control.

NOTE: If the second PID set is chosen during auto-tuning and/or self-tuning procedures, the new PID values will be stored in PB2, TI2, and TD2.

RS.A1: Resets alarm 1 as the event input is activated. However, if the alarm 1 condition is still existent, alarm 1 will be retriggered when the event input is released.

RS.A2: Resets alarm 2 as the event input is activated. However, if the alarm 2 condition is still existent, alarm 2 will be retriggered when the event input is released.

R.A1.2: Resets both alarm 1 and alarm 2 as the event input is activated. However, if alarm 1 and/or alarm 2 are still existent, alarm 1 and/or alarm 2 will be triggered again when the event input is released.

RS.A1, RS.A2, and R.A1.2 are particularly suitable to be used for latching and/or latching/holding alarms.

D.O1: Disables output 1 as the event input is activated.

D.O2: Disables output 2 as the event input is activated.

D.O1.2: Disables both output 1 and output 2 as soon as the event input is activated.

EIFN

0	NONE
1	SP2
2	PID2
3	SP.P2
4	RS.A1
5	RS.A2
6	R.A1.2
7	D.O1
8	D.O2
9	D.O1.2
10	LOCK

When any of D.O1, D.O2, or D.O1.2 are selected for EIFN, output 1 and/or output 2 will revert to their normal conditions as soon as the event input is released.

LOCK: All parameters are locked to prevent them from being changed. See section 4-13 for more details.

SP2F Function: Defines the format of SP2 value. If ACTU is selected for SP2F in the setup menu, the event input function will use the SP2 value for its second set point. If DEVI is selected for SP2F, the SP1 value will be added to SP2. The sum of SP1 and SP2 (SP1+SP2) will be used by the event input function for the second set point value. In certain applications, it is desirable to move the second set point value with respect to the value of set point 1. The DEVI function for SP2 provides a convenient way to do this.

SP2F = Format of SP2 value

ACTU: SP2 is an actual value

DEVI: SP2 is a deviation value

4–2 Second Set Point

In certain applications it is desirable to have the set point change automatically, without the need to adjust it. You can apply a signal to the event input terminals (pin 17 and pin 16). The signal applied to the event input may come from a timer, a PLC, an alarm relay, a manual switch or other device. Select SP2 for EIFN, which is in the setup menu. This is available only when SP1.2, MIN.R, or HR.R is used for SPMD.

Application 1: A process is required to be heated to a higher temperature as soon as its pressure exceeds a certain limit. Set SPMD=SP1.2, EIFN=SP2 (or SP.P2 if the second PID is required for the higher temperature too). The pressure gauge is switched ON as it senses a higher pressure. Connect the output contacts of the pressure gauge to the event input. SP1 is set for a normal temperature and SP2 is set for a higher temperature. Choose ACTU for SP2F.

Application 2: An oven is required to be heated to 300°C from 8:00AM to 6:00PM. After 6:00PM it should be maintained at 80°C. Use a programmable 24 hour cycle timer for this purpose. The timer output is used to control the event input. Set SPMD=SP1.2, and EIFN=SP2 (or SP.P2 if the second PID is required to be used for the second set point). SP1 is set at 300°C and SP2 is set at 80°C. Choose ACTU for SP2F. After 6:00PM the timer output is closed. The event input function will then select SP2 (=80°C) to control the process.

Refer to section 4-1 for more descriptions about SP2F function.

Apply Signal To

(17) Event input +

(16) Event input –

Setup

EIFN choose SP2 or SP.P2

Availability

SPMD choose

SP1.2

or Mi n.r

or Hr.r

Format of SP2 Value

SP2F choose

ACtU Actual Value

or dEVi Deviation Value

4–3 Second PID Set

In certain applications the characteristics of a process are strongly related to its process value. The TEC-4300 provides two sets of PID values. When the process is changed to a different set point, the PID values can be switched to another set to achieve optimum conditions.

Apply signal to

(17) Event input +
(16) Event input –

Auto-tuning second PID

The optimal PID values for a process may vary with its process value and set point. Hence if a process is used for a wide range of set points, dual PID values are necessary to optimize control performance. If the first PID set is selected (event input is not applied) during auto-tuning procedure, the PID values will be stored in PB1, TI1, and TD1. Similarly, if the second PID set is selected (event input is applied while PID2 or SP.P2 is selected for EIFN) during auto-tuning, the PID values will be stored in PB2, TI2, and TD2 as soon as auto-tuning is completed.

Setup

EIFN choose PID2 or SP.P2

Application 1: programmed by the set point

EIFN=SP.P2

Choose SP.P2 for EIFN. Both set point and PID values will be switched to another set simultaneously. The signal applied to the event input may come from a timer, a PLC, an alarm relay, a manual switch or other devices.

Application 2: programmed by the process value

EIFN=PID2

If the process value exceeds a certain limit, 500°C for example, it is desirable to use another set of PID values to optimize control performance. You can use a process high alarm to detect the limit of the process value. Choose PV1H for A1FN, NORM for A1MD, adjust A1SP to be equal to 500°C, and choose PID2 for EIFN. If the temperature is higher than 500°C, then alarm 1 is activated. The alarm 1 output is connected to the event input, so the PID values will change from PB1, TI1, and TD1 to PB2, TI2, and TD2.

Alarm output controls the event input

Refer to section 5-9 for more details.

4–4 Ramp and Dwell

Ramp

The ramping function is performed during power up as well as any time the set point is changed. Choose MINR or HRR for SPMD, and the unit will perform the ramping function. The ramp rate is programmed by using RAMP, which is found in the user menu.

SPMD Choose

Unit / minute
or Unit / hour

Adjust

RAMP

Example without dwell timer

Select MINR for SPMD, °C for IN1U and set RAMP=10.0. SP1 is set to 200°C initially, then changed to 100°C 30 minutes after power up. The starting temperature is 30°C. After power up, the process runs like the curve shown below, ramping up or down by 10°C/minute.

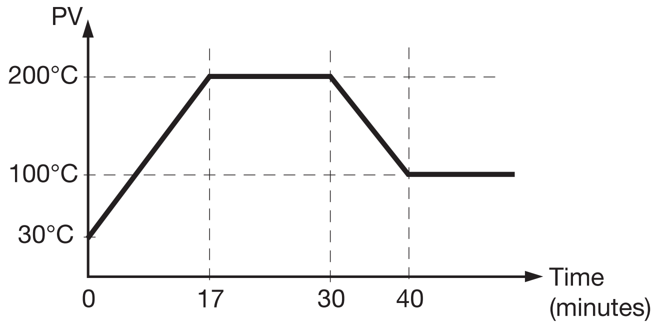


Figure 4.1 RAMP Function

Note: When the ramp function is used, the lower 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 pressed for adjustment. The ramping value is initiated as the process value either at power up or when RAMP and/or the set point are changed. Setting RAMP to zero means no ramp function at all.

Dwell

The dwell timer can be used separately or in conjunction with a ramp. If A1FN is set for TIMR, alarm 1 will act as a dwell timer. Similarly, alarm 2 will act as a dwell timer if A2FN is set for TIMR. The timer is programmed by using TIME which is in the user menu. The timer starts to count as soon as the process reaches its set point, and triggers an alarm when it times out. Here is an example.

A1FN or A2FN Choose

TIMER

Adjust

TIME

Example without ramp

Select TIMR for A1FN, °F for IN1U and set TIME=30.0. SP1 is set to 400°F initially, and corrected to 200°F before the process reaches 200°F. As the process reaches the set point (i.e., 200°F), the timer starts to count. The TIME value can still be corrected without disturbing the timer before time out. TIME is changed to 40.0, 28 minutes after the process has reached its set point. The behavior of the process value and alarm 1 are shown below.

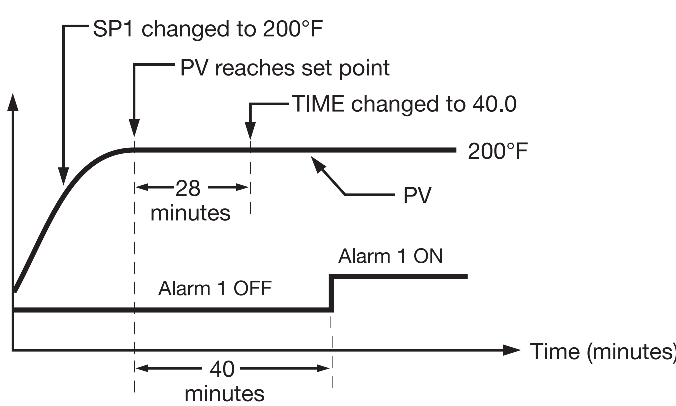


Figure 4.2 Dwell Timer

4–4 Ramp and Dwell, continued

Once the timer output is energized, it will remain unchanged until power down or an event input programmed for resetting the alarm is applied.

Note: TIMR can't be chosen for A1FN and A2FN simultaneously, or an Er07 error code will result.

Er07
Error code

Ramp and dwell

A ramp may be accompanied with a dwell timer to control the process. Here is an example.

Example with ramp and dwell

Select HRR for SPMD, PU for IN1U, and set RAMP=60. Select TIMR for A2FN and set TIME=20.0. When power is applied, the process value starts at 0, SP1=30, and SP2=40. The timer output is used to control event input.

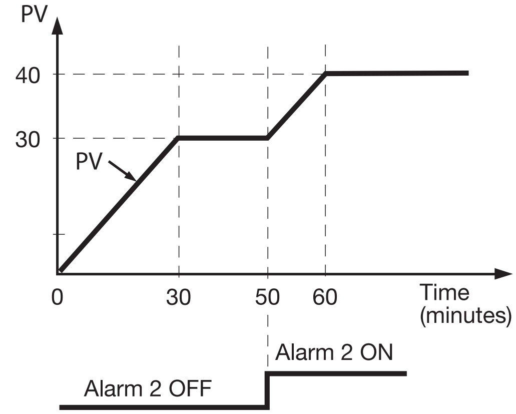


Figure 4.3 Ramp Accompanied with a Dwell Timer

4–5 Remote Set Point

Selecting PV1 or PV2 for SPMD will enable the TEC-4300 to accept a remote set point signal. If PV1 is selected for SPMD, the remote set point signal is sent to input 1, and input 2 is used for the process signal input. If PV2 is selected for SPMD, the remote set point signal is sent to input 2, and input 1 is used for the process signal. To achieve this, set the following parameters in the setup menu.

Setup
FUNC=FULL
SPMD=PV2, PVMD=PV1
or
SPMD=PV1, PVMD=PV2

Case 1: Use Input 2 to accept remote set point

FUNC=FULL

IN2, IN2U, DP2, IN2L, IN2H, are set according to remote signal.

PVMD=PV1

IN1, IN1U, DP1, are set according to the process signal

IN1L, IN1H if available, are set according to the process signal

SPMD=PV2

Case 2: Use Input 1 to accept remote set point

FUNC=FULL

IN1, IN1U, DP1, IN1L, IN1H, are set according to remote signal.

PVMD=PV2

IN2, IN2U, DP2, are set according to the process signal

IN2L, IN2H if available, are set according to the process signal

SPMD=PV1

Note 1: If PV1 is chosen for both SPMD and PVMD, an Er01 error code will appear. If PV2 is chosen for both SPMD and PVMD, an Er02 error code will appear. In either case, the TEC-4300 will not control properly.

Error message
Er01
Er02

Note 2: If PV1/PV2 is selected for SPMD, a signal loss will result in the controller reverting to manual mode with 0% output.

4–6 Differential Control

In certain applications it is desirable to control a second process such that its process value always deviates from the first process by a constant value. To achieve this, set the following parameters in the setup menu.

Setup
PVMD=P1-2
or PVMD=P2-1
SPMD=SP1.2

FUNC=FULL

IN1, IN1L, IN1H are set according to input 1 signal

IN2, IN2L, IN2H are set according to input 2 signal

IN1U, DP1, IN2U, DP2, are set according to input 1 and input 2 signal

PVMD=P1-2 or P2-1

SPMD=SP1.2

The response of PV2 will be parallel to PV1 as shown in the following diagram:

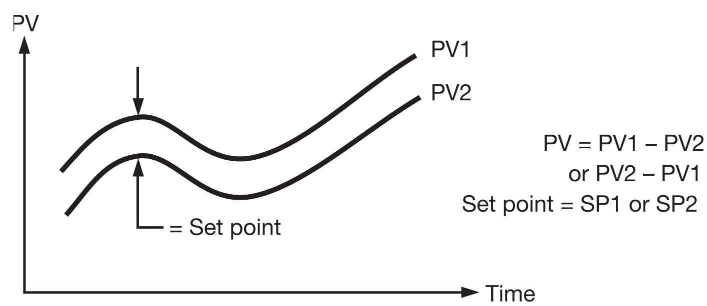


Figure 4.4 Relation between PV1 and PV2 for a Differential Control

The PV display will indicate PV1-PV2 value if P1-2 is chosen for PVMD, or PV2-PV1 value if P2-1 is chosen for PVMD. If you need PV1 or PV2 to be displayed instead of PV, you can use the display mode to select PV1 or PV2 to be viewed. See section 3-23.

Error messages

If P1-2 or P2-1 is selected for PVMD, while PV1 or PV2 is selected for SPMD, an Er03 error code will appear.

In this case the signals used for input 1 and input 2 should be the same unit and the same decimal point, that is, IN1U=IN2U, DP1=DP2, otherwise an Er05 error code will appear.

Error message
Er03
Er05

4–7 Output Power Limits

In certain systems the heater (or cooler) is over powered such that the process is too heavily heated or cooled. To avoid an excessive overshoot and/or undershoot you can use the power limit function. Output 1 power limit PL1 is contained in the user menu. If output 2 is not used for cooling (that is, COOL is not selected for OUT2), then PL2 is hidden. If the controller is used for ON-OFF control, then both PL1 and PL2 are hidden.

Menu
PL1
PL2

Operation:

Press for 3 seconds, then press several times to reach PL1 and PL2. PL1 and PL2 are adjusted by using the up and down keys with range of 0–100%.

Example:

OUT2=COOL, PB1=10.0°C, CPB=50, PL1=50, PL2=80%

Output 1 and output 2 will act as the following curves:

NOTE:

The adjustment range of MV1 (H) and MV2 (C) for manual control and/or failure transfer are not limited by PL1 and PL2.

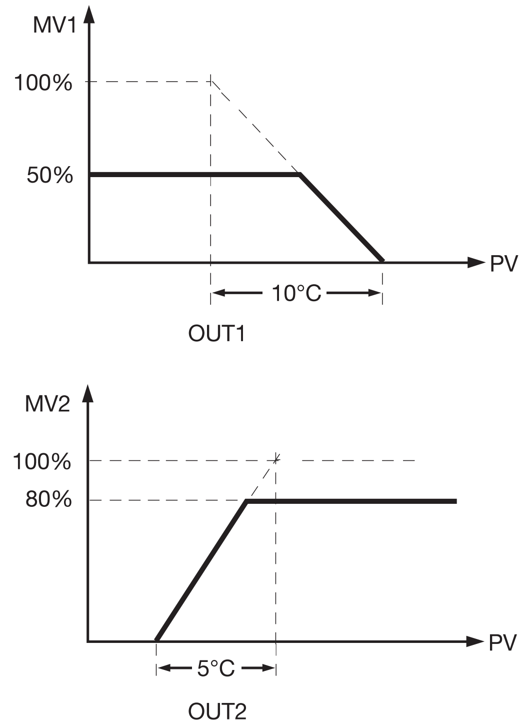


Figure 4.5 Power Limit Function

4–8 Data Communication

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

Using a PC for data communication is the most economical method. The signal is transmitted and received through the PC communication port (generally RS-232). Since a standard PC can't support an RS-485 port, a network adapter (such as TEC99001 or TEC99927) must be used to convert RS-485 to RS-232 for a PC if RS-485 is required for data communication. Up to 247 RS-485 units can be connected to one RS-232 port; therefore a PC with four comm ports can communicate with 988 units.

Setup

Enter the setup menu.

Select FULL (full function) for FUNC.

Select 485 for COMM if RS-485 is required, or 232 if RS-232 is required. Select RTU (i.e., Modbus protocol RTU mode) for PROT. Set individual addresses for any units that are connected to the same port. Set the baud rate (BAUD), data bit (DATA), parity bit (PARI) and stop bit (STOP) so that these values are accordant with the PC setup conditions.

If you use a conventional 9-pin RS-232 cable instead of TEC99014, the cable should be modified for the proper operation of RS-232 communications according to section 2-16.

RS-485 Benefits:
Long distance
Multiple units

RS-232 Benefits:
Direct connection to a PC

RS-485 Setup
FUNC=FULL
COMM=485
PROT=RTU
ADDR=Address
BAUD=Baud Rate
DATA=Data Bit Count
PARI=Parity Bit
STOP=Stop Bit Count

RS-485 Terminals
13 TX1
14 TX2

RS-232 Setup
FUNC=FULL
COMM=232
PROT=RTU
ADDR=Address
BAUD=Baud Rate
DATA=Data Bit Count
PARI=Parity Bit
STOP=Stop Bit Count

RS-232 Terminals
13 TX1
14 TX2
10 COM

4–9 Analog Retransmission

Analog retransmission is available for model number TEC-8300-XXXXXXN where N=3, 4 or 5. See ordering code in section 1-2.

Setup Menu

FunC FUNC

Conn COMM

AoFn AOFN

AoLo AOLO

AoHi AOHI

Terminals

(13) AO+

(14) AO–

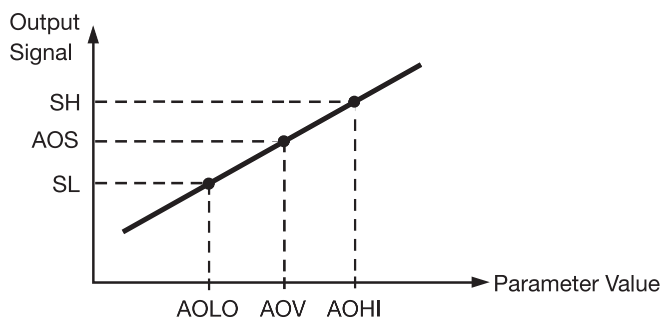
Setup

Select FULL for FUNC in the setup menu.

Select a correct output signal for COMM which should be accordant with the retransmission option used. Five types of retransmission output are available. These are: 4–20mA, 0–20mA, 0–5V, 1–5V and 0–10V. There are eight types of parameters that can be retransmitted according to the analog function (AOFN) selected. These are: PV1, PV2, PV1–PV2, PV2–PV1, SV, MV1, MV2 and PV–SV. Refer to table 1.4 for a complete description. Select a value for AOLO corresponding to output zero and select a value for AOHI corresponding to output SPAN.

How to determine output signal:

AOLO and AOHI are set to map to output signal low SL (e.g., 4mA) and output signal high SH (e.g., 20mA) respectively. The analog output signal AOS, corresponding to an arbitrary value of parameter AOV, is determined by the following curve.



Formula: $$AOS = SL + (AOV - AOLO)\,\frac{SH - SL}{AOHI - AOLO}$$

$$AOV = AOLO + (AOS - SL)\,\frac{AOHI - AOLO}{SH - SL}$$

Figure 4.6 Conversion Curve for Retransmission

Notes:

The setup values used for AOHI and AOLO must not be equal, otherwise, incorrect values will occur. However, AOHI can be set either higher or lower than AOLO. If AOHI is set higher than AOLO it could result in a direct conversion. If AOHI is set lower than AOLO it could result in a reverse conversion.

NOTES

AOHI ≠ AOLO

AOHI > AOLO: Direct conversion

AOHI < AOLO: Reverse conversion

Example

A control uses a 4–20mA analog output to retransmit the difference value between input 1 and input 2 (PV1–PV2). It is required that if the difference value is -100, 4mA will be exported, and if the difference value is 100, 20mA will be exported. Make the following setup for TEC-8300:

IN1U=PU, DP1=NODP, IN2U=PU, DP2=NODP, FUNC=FULL, COMM=4-20, AOFN=P1-2, AOLO=-100, AOHI=100

4–10 Digital Filter

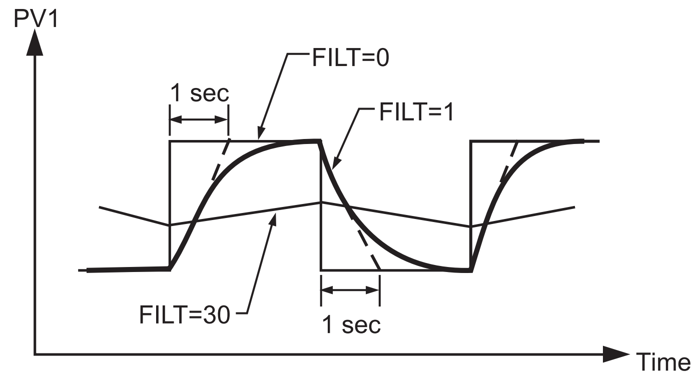
Menu

FiLt FILT

Filter is used to stabilize the process display.

In certain applications the process value is too unstable to be read. A programmable low-pass filter incorporated in the TEC-8300 can be used to improve this. This is a first order filter with the time constant specified by the FILT parameter which is in the setup menu. The default value of FILT is set at 0.5 seconds before shipping. Adjust FILT to change the time constant from 0 to 60 seconds. 0 seconds means no filter is applied to the input signal. The filter is characterized by the following diagram.

Figure 4.7 Filter Characteristics



Note

The filter is available only for PV1, and is performed for the displayed value only. The controller is designed to use an unfiltered signal for control even if the filter is applied. A lagged (filtered) signal, if used for control, may produce an unstable process.

4–11 Sleep Mode

To enter sleep mode:

Set FUNC for FULL to provide full function.

Select YES for SLEP to enable sleep mode.

Press ▲ ▼ for 3 seconds; the unit will now enter sleep mode.

Sleep mode features:

Shut off display

Shut off outputs

Green power

Replaces power switch

Setup menu

FUNC = FULL

SLEP = YES

During sleep mode:

1. All displays are shut off except a decimal point which is lit periodically.
2. All outputs and alarms are shut off.

To exit sleep mode:

1. Press ▲ ▼ to leave the sleep mode.
2. Disconnect the power.

the sleep function can be used in place of a power switch to reduce the system cost.

Default: SLEP = NONE, sleep mode is disabled.

Note: If sleep mode is not required by your system, NONE should be selected for SLEP to disable sleep mode.

4–12 Pump Control

PUMP:

A cost effective solution

Pump control function is one of the unique features of the TEC-8300. Using this function, the pressure in a process can be excellently controlled. The pressure in a process is commonly generated by a pump driven by a variable speed motor. The complete system has the following characteristics which affect control behavior.

1. The system is very noisy.
2. The pressure changes very rapidly.
3. The pump characteristics are ultra nonlinear with respect to its speed.
4. The pump can't generate any more pressure if its speed is lower than half of its rating speed.
5. An ordinary pump may slowly lose pressure even if the valves are completely closed.

Obviously, a conventional controller can't fulfill the conditions mentioned above. Only the superior noise rejection capability in addition to the fast sampling rate possessed by the TEC-8300 can handle such an application. To achieve this, set the following parameters in the setup menu:

FUNC = FULL
EIFN = NONE
PVMD = PV1
FILT = 0.5
SELF = NONE
SPMD = PUMP
SP2F = DEVI

Key menu

SPMD
SP2F
REFC
SP2

and program the following parameters in the user menu:

REFC = reference constant

SP2 = a negative value added to SP1 to obtain the set point for the idle state

Pump control features:

1. Minimum oscillation of pressure
2. Rapidly stabilized
3. Guaranteed pump stop
4. Programmable pump stopping interval

Since the pump can't produce any more pressure at lower speeds, the pump may not stop running even if the pressure has reached the set point. If this happens, the pump will be overly worn and waste additional power. To avoid this, the TEC-8300 provides a reference constant REFC in the user menu. If PUMP is selected for SPMD, the controller will periodically test the process by using this reference constant after the pressure has reached its set point. If the test shows that the pressure is still consumed by the process, the controller will continue to supply appropriate power to the pump. If the test shows that the pressure is not consumed by the process, the controller will gradually decrease the power to the pump until the pump stops running. When this happens, the controller enters an idle state. The idle state will use a lower set point which is obtained by adding SP2 to SP1 until the pressure falls below this set point. The idle state is provided for the purpose of preventing the pump from been restarted too frequently. The value of SP2 should be negative to ensure that the controller functions correctly.

The pump functions are summarized as follows:

1. If the process is demanding material (i.e., loses pressure), the controller will precisely control the pressure at the set point.
2. If the process no longer consumes material, the controller will shut off the pump for as long as possible.
3. The controller will restart the pump to control the pressure at the set point as soon as the material is demanded again while the pressure falls below a predetermined value (i.e., SP1+SP2).

Programming guide:

1. Perform auto-tuning to the system under such conditions that the material (i.e., pressure) is exhausted at typical rate. A typical value for PB1 is about 10Kg/cm≈, TI1 is about 1 second, TD1 is about 0.2 seconds.
2. If the process oscillates around the set point after auto-tuning, then increase PB1 until the process can be stabilized at the set point. The typical value of PB1 is about half to two times the range of the pressure sensor.
3. Increasing FILT (filter) can further reduce the oscillation amplitude. But a value of FILT higher than 5 (seconds) is not recommended. A typical value for FILT is 0.5 or 1.
4. Close the valves and observe whether the controller can shut off the pump each time. The value of REFC should be adjusted as little as possible so that the controller can shut off the pump each time when all the valves are closed. A typical value for REFC is between 3 and 5.
5. An ordinary pump may slowly lose pressure even if the valves are completely closed. Adjust SP2 according to the rule that a more negative value of SP2 will allow the pump to be shut off for a longer time when the valves are closed. A typical value for SP2 is about -0.50Kg/cm≈.

An example for pump control is given in section 5-1.

4–13 Remote Lockout

Remote Lockout:

1. Connect external switch to terminal 17 and 16.
2. Set **LOCK** for **EIFN**
3. Lock all parameters

The parameters can be locked to prevent them from being changed by using either hardware lockout (see section 1-3), remote lockout, or both. If you need the parameters to be locked by using an external switch (remote lockout function), then connect a switch to terminals 17 and 16 (see section 2-10), and choose LOCK for EIFN (see section 4-1).

If remote lockout is configured, all parameters will be locked when the external switch is closed. When the switch is left open, the lockout condition is determined by internal DIP switch (hardware lockout, see section 1-3).

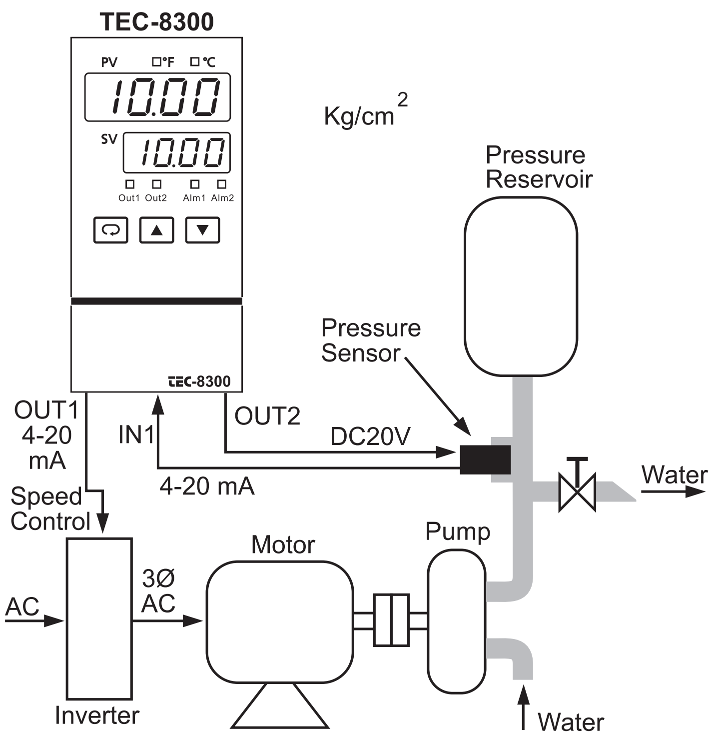
Hardware lockout: Can be used only during initial setup.

Remote lockout: Can be used any time.

5–1 Pump/Pressure Control

Regulated water supply systems are widely used in residential areas, water plants, chemical plants, electrical plants, semiconductor plants, etc. By taking advantage of its PUMP function, the TEC-8300 can be used to create an economical yet versatile solution for these applications. Here is an example:

Figure 5.1 A Water Supply System



The water pressure in this example must be controlled at 10Kg/cm≈. To achieve this, the following devices are used for this example:

Inverter: To supply a variable frequency AC voltage to the motor.

Motor: A 3-Ø induction motor.

Pump: Any appropriate economical type of pump.

Pressure Sensor: A three-wire or two-wire type of pressure transducer with a 0–20Kg/cm≈ range.

Pressure Reservoir: Provides smoother pressure for the system.

TEC-8300: Order a TEC-8300 with standard input, 4–20mA output 1, 20V DC output 2 for sensor power.

Set the following parameters in the setup menu:

FUNC = FULL	OUT1 = REVR	SELF = NONE
COMM: optional	O1TY = 4-20	SLEP = NONE
IN1 = 4-20	O1FT = 0	**SPMD = PUMP**
IN1U = PU	OUT2 = DCPS	SP1L = 5.00
DP1 = 2-DP	A1FN: optional	SP1H = 15.00
IN1L = 0	EIFN = NONE	**SP2F = DEVI**
IN1H = 20.00	PVMD = PV1	
IN2 = NONE	FILT = 1	

Key menu:
SPMD
SP2F
REFC
SP2

Adjust the following parameters in the user menu:

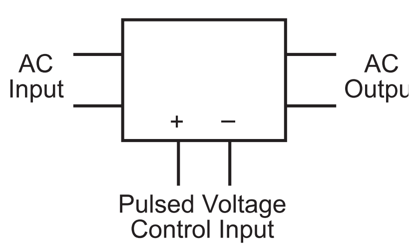
A1SP: optional	TI1 = 1
REFC = 3	TD1 = 0.2
PB1 = 10.00	**SP2 = -0.50**
	PL1 = 100

Refer to section 4-12 for more details.

5–2 Variable Period Full Wave SSR (VPFW SSR)

VPFW SSR is a variable period full wave solid-state relay. It can provide a zero cross output with superior controllability compared to a conventional SSR with a fixed time base. The block diagram of VPFW SSR is shown as follows:

Figure 5.2
Block Diagram of VPFW SSR

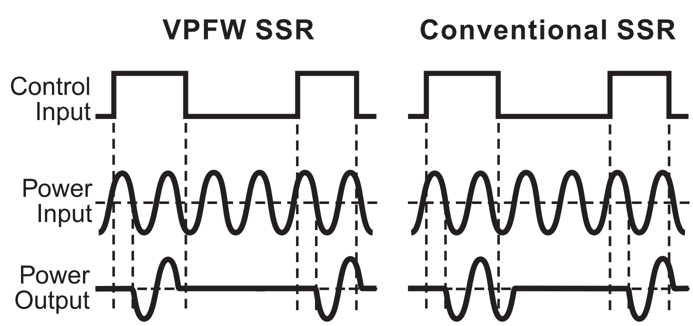


NOTES:

1. The VPFW SSR can be used to drive resistant load and some types of inductance load such as relay, contactor, magnetic switch, solenoid valve, etc. However, it **can not drive motor and capacitance load**.
2. Only **AC power** can supply VPFW SSR, otherwise it will not operate properly.

Unlike a conventional SSR, the VPFW SSR always gives the output an even number of half cycles (full wave) as shown in the following diagram.

Figure 5.3 VPFW SSR vs. Conventional SSR



The VPFW switches the load without DC current, minimizing the harmonic current and stress on the load. This prolongs the load life.

Since the duty cycle (i.e., output power level) of the control input is small, the off-period will be extended to keep the output resolution such that the conversion error is minimized. As low as 0.1% timing error can be achieved. Hence, VPFW SSR is particularly suitable for smoother control.

5–2 Variable Period Full Wave SSR, continued next page…

5–2 Variable Period Full Wave SSR, continued…

The advantages of VPFW SSR over conventional SSR are summarized in the following table:

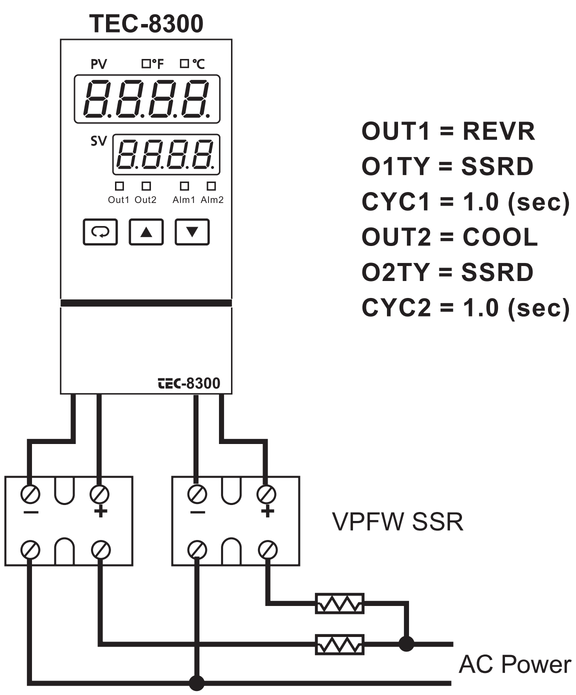
Table 5.1
Function Comparison between Conventional SSR and VPFW SSR

Functions	VPFW SSR	Conventional SSR
Zero Cross Switching	Yes	Yes
Time Base	Variable	Fixed
Proportional Timing Error	± .1%	± 1% (for 1 sec. cycle time)
Control Achievement	Excellent	Good
Half on Cycles	Even	Even and Odd
DC Load Current	Zero	Nonzero
Harmonic Current	Low	Higher
Stress on the Load	Low	Higher
Load (Heater) Life	Longer	Shorter

Output 1 and output 2 of the TEC-8300 can be connected to the VPFW SSR directly provided that a pulsed voltage drive output is ordered.

Here is an example:

Figure 5.4 VPFW SSR Application Example

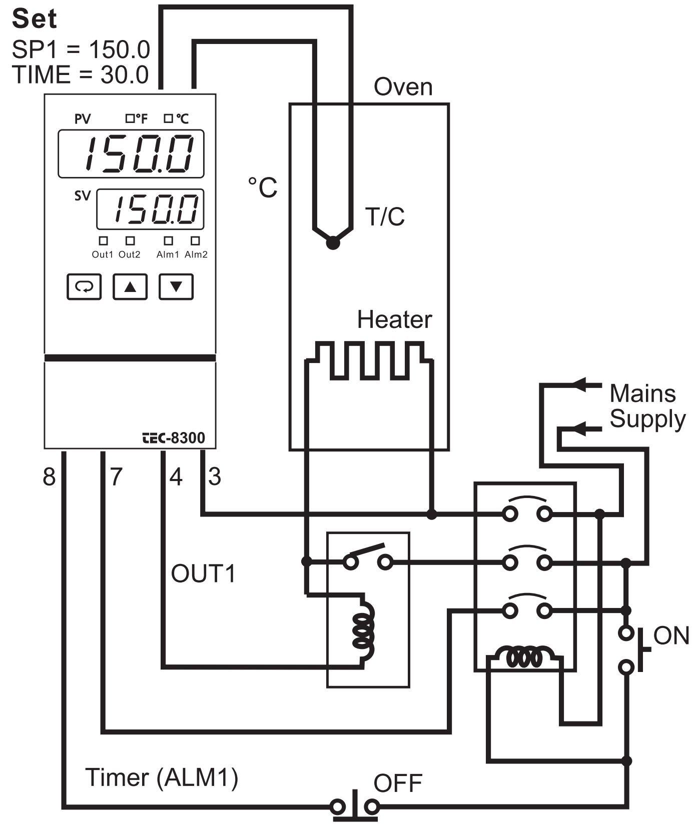


Three phase VPFW SSR's are also available upon request.

5–3 Heat Only Control

An oven is designed to dry the products at 150°C for 30 minutes and then stay unpowered for another batch. A TEC-8300 equipped with dwell timer is used for this purpose. The system diagram is shown as follows:

Figure 5.5 Heat Control Example



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

FUNC = BASC (basic function)
IN1 = K_TC
IN1U = °C
DP1 = 1_DP
OUT1 = REVR
O1TY = RELY
CYC1 = 18.0
O1FT = 0.0
A1FN = TIMR
A1FT = ON
SELF = NONE

Auto-tuning is performed at 150°C for a new oven.

5–4 Cool Only Control

A TEC-8300 is used to control a refrigerator with the temperature below 0°C. To avoid set point adjustment beyond the desired range, SP1L is set at -10°C and SP1H is set at 0°C. Because the temperature is lower than the ambient, a cooling action is required, so select DIRT for OUT1. Since output 1 is used to drive a magnetic contactor, select RELY for O1TY. Because a small temperature oscillation is tolerable, use ON-OFF control to reduce the over-all cost. To achieve ON-OFF control, PB1 is set to zero and O1HY is set at 0.1°C.

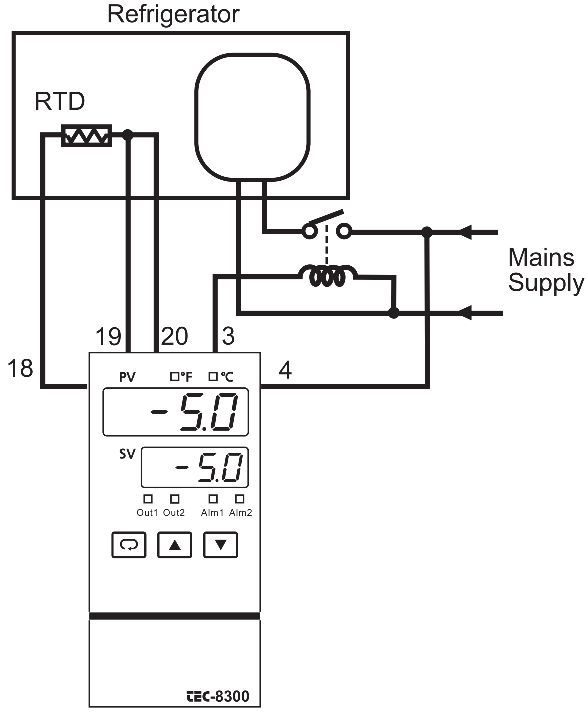
Figure 5.6 Cooling Control Example

Setup Summary:

FUNC = BASC
IN1 = PT.DN
IN1U = °C
DP1 = 1-DP
OUT1 = DIRT
O1TY = RELY
SP1L = -10°C
SP1H = 0°C

User Menu:

PB1 = 0 (°C)
O1HY = 0.1 (°C)



5–5 Heat-Cool Control

An injection mold is 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 a higher temperature (e.g., 250°C), the circulation oil needs to be cooled as its temperature rises. Here is an example at right:

PID heat-cool is used for the example at right.

To achieve this, set the following parameters in the setup menu:

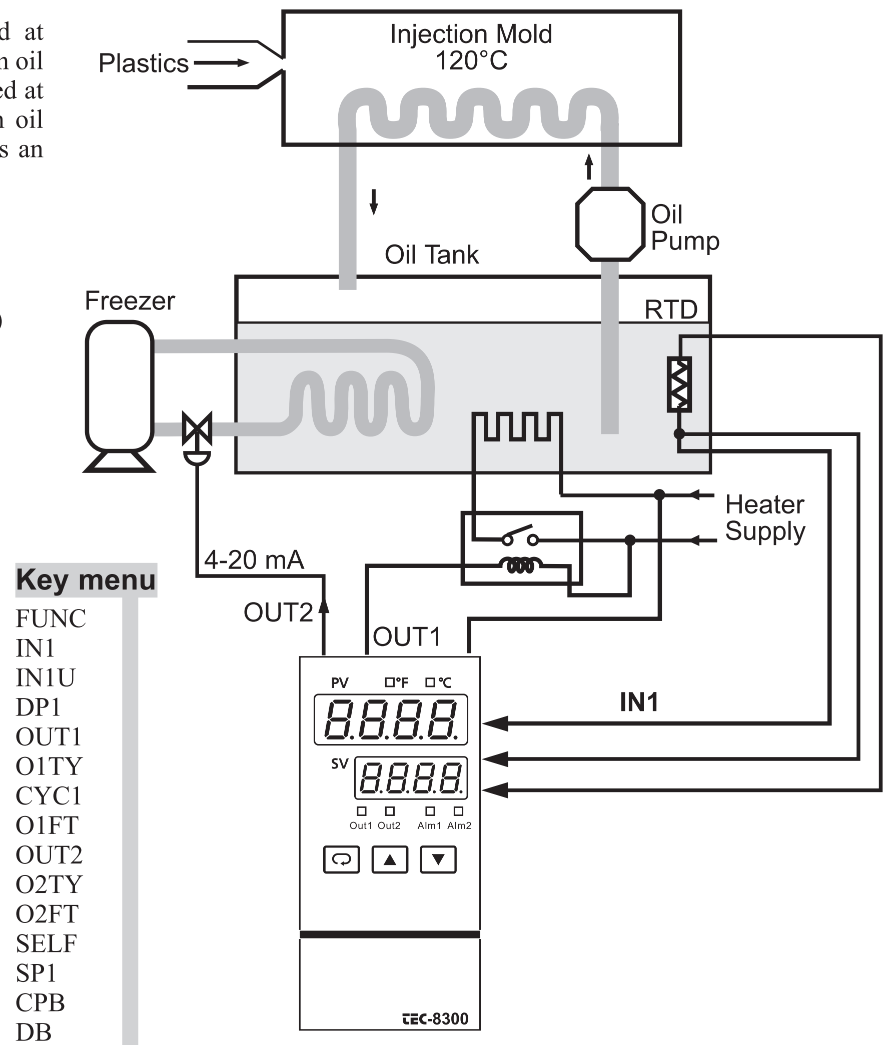
FUNC = BASC	CYC1 = 18.0 (seconds)
IN1 = PT.DN	O1FT = 0.0
IN1U = °C	OUT2 = COOL
DP1 = 1-DP	O2TY = 4–20
OUT1 = REVR	O2FT = BPLS
O1TY = RELY	SELF = STAR

Adjust SP1 to 120.0°C, CPB to 125(%) and DB to -4.0(%).

Apply auto-tuning at 120°C for a new system to get optimal PID values. See section 3-19.

Adjustment of CPB is related to the cooling medium used. If water is used as the cooling medium instead of oil, the CPB should be set at 250(%). If air is used as the cooling medium instead of oil, the CPB should be set at 100(%). Adjustment of DB is dependent on the system requirements. A more positive value of DB will prevent unwanted cooling action, but will increase the temperature overshoot, while a more negative value of DB will achieve less temperature overshoot, but will increase unwanted cooling action.

Figure 5.7 Heat-Cool Control Example



5–6 Ramp and Dwell

Example 1: Temperature cycling chamber

A chamber is used to test the temperature cycling effect on personal computers. An external cycle timer is used to control the event input for switching the set point. The products under test are required to stay at 60°C for 1 hour and -10°C for 30 minutes. The transition interval between the high and low temperatures is required to be 5 minutes. Make the following setup:

EIFN = SP.P2
A1FN = TIMR
OUT1 = REVR, relay output
OUT2 = COOL, 4–20mA output
SPMD = MINR
IN1U = °C
DP1 = 1-DP

The circuit diagram and its temperature profile are shown below:

Figure 5.8 A Temperature Cycling Chamber

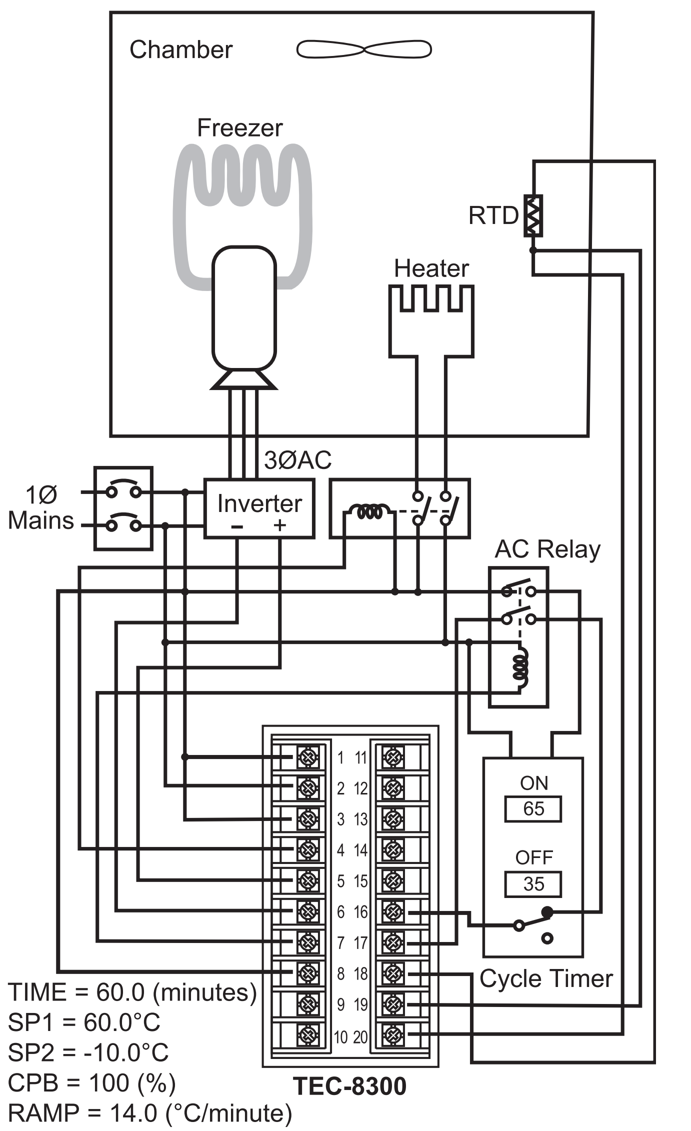
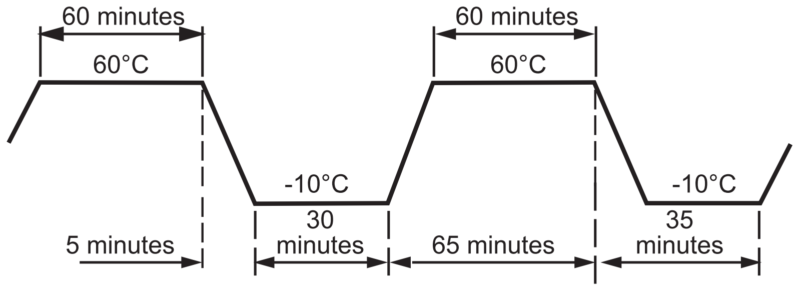


Figure 5.9 Temperature Profile of Chamber

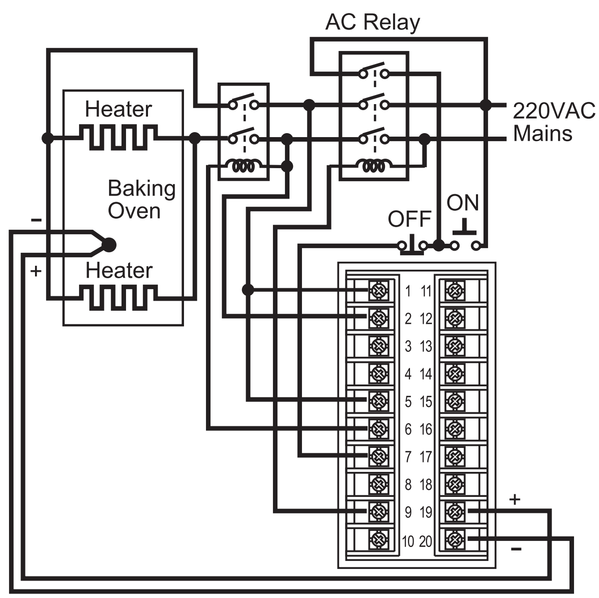


The TEC-8300 provides a 4–20mA signal to control the speed of the inverter. SP.P2 is chosen for EIFN in order to create a dual PID control. You can perform auto-tuning twice at SP1 and SP2 for the initial setup for the dual PID values. Refer to sections 3-19 and 4-3.

Example 2: Programmable bread baking oven

Bread is baked in batches. A ramp is incorporated to control the thermal gradient to suit for making the bread. A dwell timer is used to shut off the oven power and announce this to the baker. The system is configured as shown in the following diagram.

Figure 5.10 A Bread Baking Oven



Push the ON switch to start a batch. The temperature will rise with a ramp rate determined by the RAMP value. The bread is baked with the set point temperature for a predetermined amount of time which is set in the TIME value, and then the power is shut off. The temperature profile is shown in the following figure.

A1FN = TIMR Time = 40.0 (minutes)
SPMD = MINR RAMP = 30.0 (°C/min)

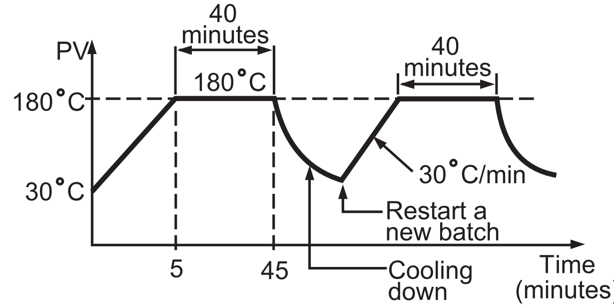
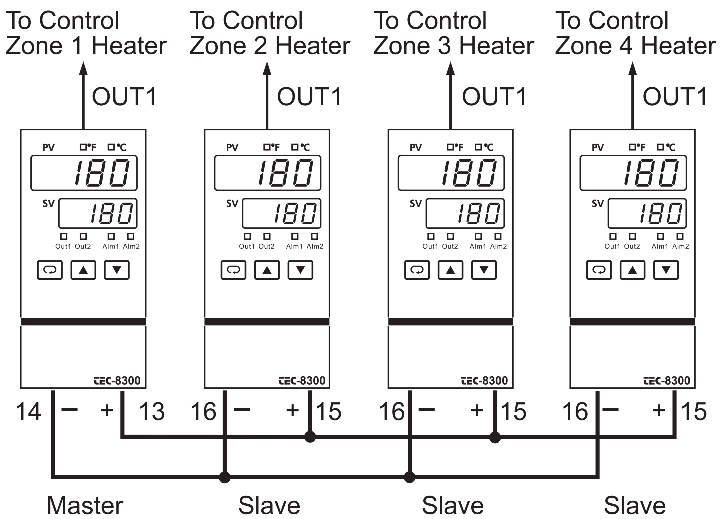


Figure 5.11 Temperature Profile of Baking Oven

5–7 Remote Set Point

An on-line multiple zone oven is used to dry paint. Since heat demand varies at different positions in the production line, multiple zones with individual controls should be used to ensure a consistent temperature profile. If you order a TEC-8300 with a retransmission unit for the master controller, and retransmit its set point to input 2 on the rest of the slave controllers, each zone will be synchronized with the same temperature. Here is an example:

Figure 5.12 Remote Set Point Application



Set the following parameters in the setup menu:

For the master unit	For the slave units
FUNC = FULL	FUNC = FULL
COMM = 1–5V	IN2 = 1–5V
AOLO = 0°C	IN2L = 0°C
AOHI = 300°C	IN2H = 300°C
PVMD = PV1	PVMD = PV1
SPMD = SP1.2	SPMD = PV2

If a voltage signal (such as in the above example) is sent to slave units, the slave inputs should be connected in parallel. If a current signal (e.g., 4–20mA) is sent to slave units, the slave inputs should be connected in series. Current retransmission is widely used because it can transmit over a longer distance without voltage drop.

Note: AOHI and IN2H should be set with values higher than the set point range used.

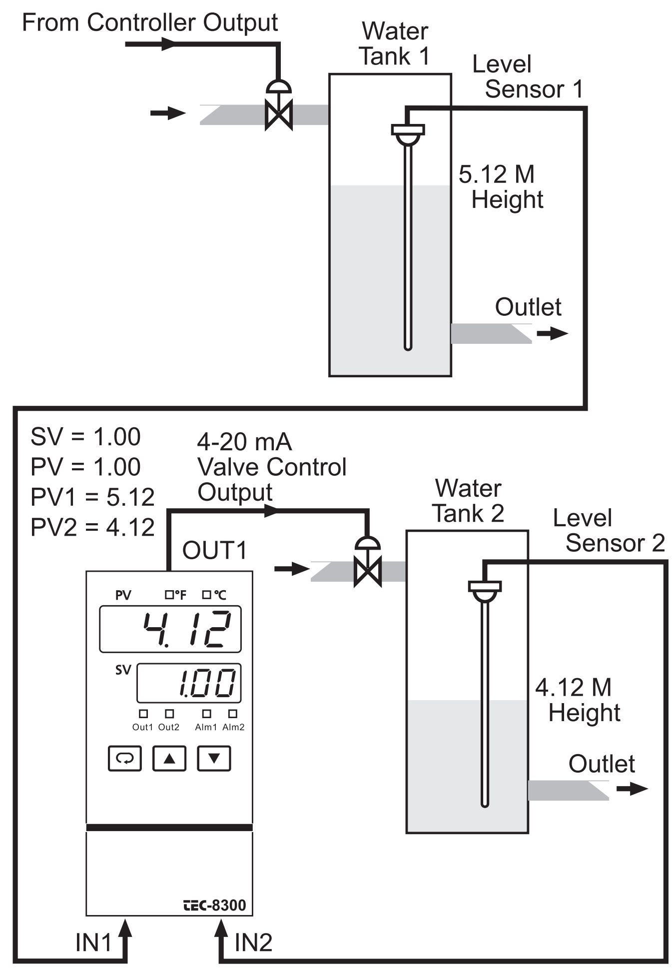
5–8 Differential Control

In certain applications it is desirable to control a second process so that its process value always deviates from the first process value by a constant amount. Water tank 1 is 5.12 meters in height, and the level in water tank 2 needs to be maintained at 1 meter lower than the tank 1 level.

Set the following parameters in the setup menu:

FUNC = FULL
IN1, IN1L, IN1H: According to sensor 1 signal
IN1U = PU
DP1 = 2-DP
IN2, IN2L, IN2H: According to sensor 2 signal
IN2U = PU
DP2 = 2-DP
OUT1 = REVR
O1TY = 4–20
PVMD = P1-2
SPMD = SP1.2

Figure 5.13 Differential Control Example



Adjust SP (here it is 1.00) to control the difference between PV1 and PV2. Choose P1-2 for PVMD; the PV display will show the difference value (PV1-PV2) between PV1 and PV2, and this value will be stabilized to the set point (here it is 1.00). If you need PV1 or PV2 instead of PV, you can use the display mode to select PV1 or PV2 for display. See section 3-23. The above diagram indicates PV2 instead of PV.

5–9 Dual Set Point/PID

The TEC-8300 will switch between the two PID sets based on the process value, the set point, or either of the event inputs. As the control ramps up to the higher process value, the process characteristics change. When this happens, the original PID values are no longer valid. To achieve optimal control over the entire range, a second PID set is used.

Example 1: Single set point/dual PID

A heat treating furnace is used over the range of 400°C to 1200°C.

1. Set the following parameters in the setup menu:
   FUNC = FULL
   A1FN = PV1H
   A1MD = NORM
   EIFN = PID2
   PVMD = PV1
   SPMD = MINR
2. Adjust the following parameters in the user menu:
   A1SP = 800°C
   A1HY = 1.0°C
   PL1 = 100(%)
   RAMP: According to the process requirement
   SP1: According to the process requirement
3. Tune the first PID set at SP1 = 50°C and tune the second PID set at SP1 = 1100°C, or set the proper values for PB1, TI1, TD1, PB2, TI2, and TD2 directly according to previous records to eliminate the auto-tuning sequence.

The circuit diagram and its temperature profile are shown as follows:

Figure 5.14 Dual PID Furnace

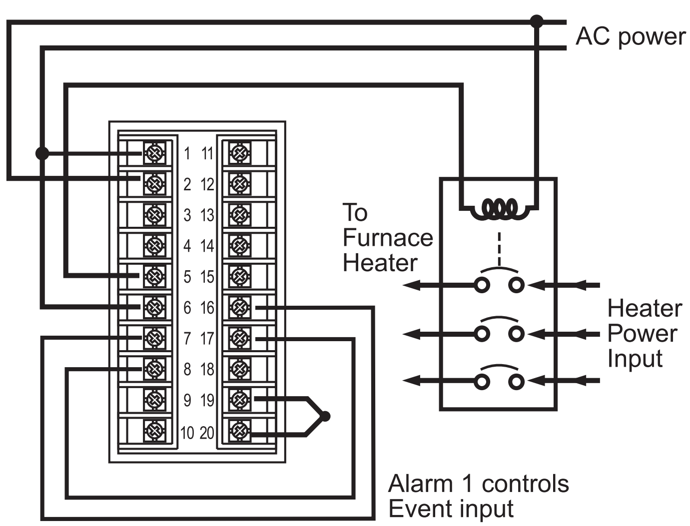
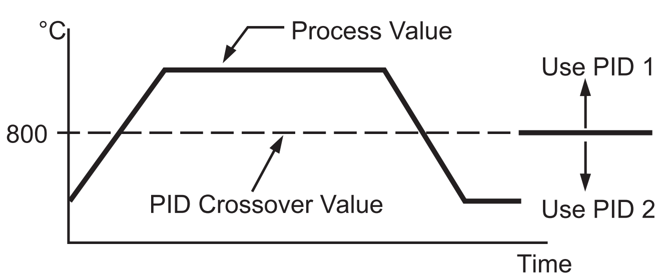


Figure 5.15 Dual PID Crossover



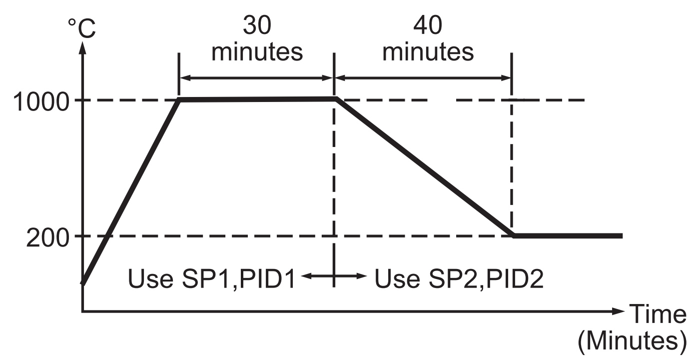
Example 2: Dual set point/PID

A heat treating furnace is required to harden the mold at a high temperature (1000°C) for 30 minutes, then the mold is cooled down with a programmable ramp (20°C/minute) to a lower set point (200°C). Use the dual set point/PID and ramp/dwell functions for this application.

1. Set the following parameters in the setup menu:
   FUNC = FULL
   A1FN = TIMR
   EIFN = SP.P2
   PVMD = PV1
   SPMD = MINR
2. Adjust the following parameters in the user menu:
   TIME = 30.0 (minutes)
   RAMP = 20.0 (°C/minute)
   SP1 = 1000°C
   SP2 = 200°C
   PL1 = 100(%)
3. Set the proper values for PB1, TI1, TD1, PB2, TI2, and TD2 directly according to previous records. For a new system, tune the first PID set at SP1 = 800°C and tune the second PID set at SP2 = 400°C.

The circuit diagram is the same as shown in figure 5.14. The temperature profile is shown below:

Figure 5.16 Dual Set Point /PID Profile



5–10 RS-485

A tile making plant has five production lines. Each production line is equipped with 16 TEC-8300 units to control the temperature for the kiln. They want to program the controllers and monitor the process from the control room to improve quality and productivity. A cost-effective solution for the above application would be to use 80 TEC-8300 units plus a TEC99002 smart network adapter and DAQ PC-based software for this purpose.

The system is installed as shown in the following diagram.

Setup

Enter setup mode to configure each TEC-8300. Choose FULL for FUNC, 485 for COMM, RTU for PROT, and select a different address (ADDR) for each unit. Use the same values of BAUD, DATA, PARI, and STOP for the TEC-8300's, TEC99002 and DAQ-Software. Also refer to section 2-15 and section 4-8.

Taking advantage of DAQ software, the operator can monitor the process on the PC screen, program the set point as well as other control parameters such as PID values, download the ramp and soak profile to the controllers, execute the manual control or trigger auto-tuning, etc., and print out reports as required. The historical data can be saved in the floppy drive, hard drive, or on a CD for permanent storage.

Setup menu

- FUNC
- COMM
- PROT
- ADDR
- BAUD
- DATA
- PARI
- STOP

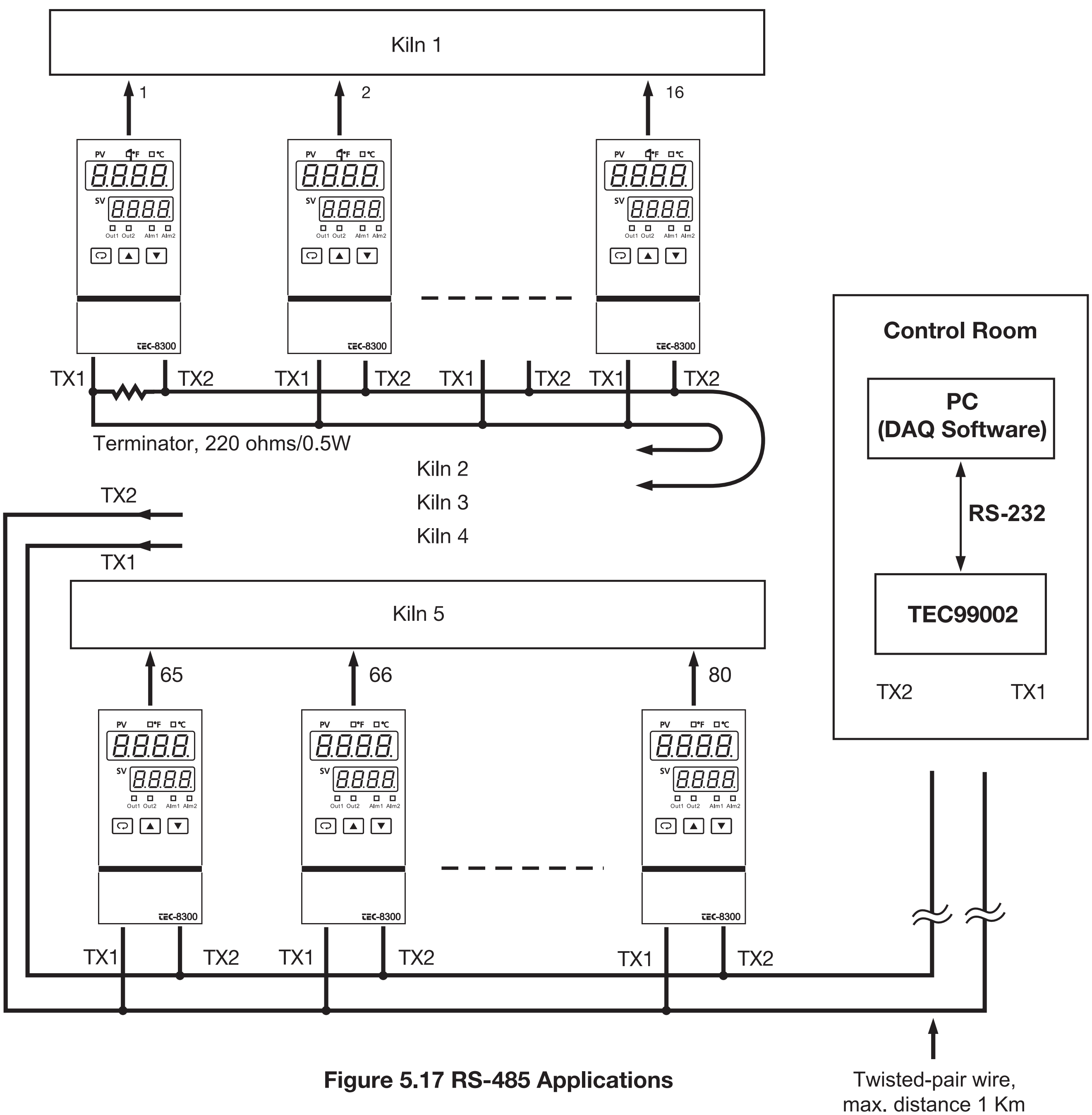


Figure 5.17 RS-485 Applications

5–11 RS-232

Suppose a chemical experiment is performed in a laboratory. and an engineer wants to find the relationship between the chemical reaction and temperature. He uses a TEC-8300 to control the temperature of the solution being tested. He is particularly interested in generating a test report containing the relationship between the concentration and temperature.

For a single unit application, it is adequate to order a TEC-8300 with RS-232 communication and DAQ software. Using the BC-Net software, the temperature data can be viewed and stored in a file. The user can program the temperature as well as other control parameters such as PID values. He can set up the controller, download a ramp and soak profile, execute manual control or auto-tuning procedure, etc. The results can be printed out or stored in a file for future reference.

Refer to section 2-16 for installation and section 4-8 for setup procedure.

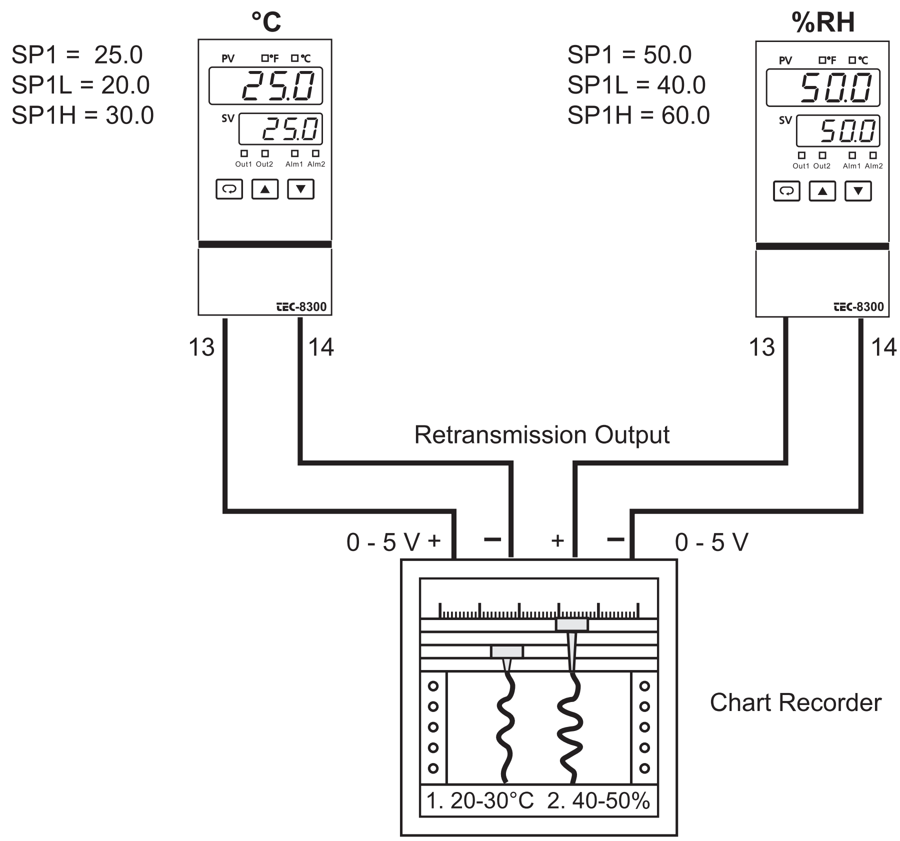
5–12 Retransmit

An air-conditioned room uses two TEC-8300 units to control the temperature and humidity. The temperature and humidity must be recorded on a chart recorder. The preferred ranges for these two parameters are: 20°C to 30°C and 40% RH to 60% RH. The recorder inputs accept a 0–5V signal.

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

UNIT 1:	**UNIT 2:**
FUNC=FULL	FUNC=FULL
COM=0–5V	COMM=0–5V
AOFN=PV1	AOFN=PV1
AOLO=20.0(°C)	AOLO=40.0(%)
AOHI=30.0(°C)	AOHI=60.0(%)
IN1=PTDN	IN1=0–1V (according to humidity sensor)
IN1U=°C	IN1U=PU
DP1=1-DP	DP1=1-DP

Figure 5.18 Retransmission Application



SP1L and SP1H are used to limit the adjustment range of the set point.

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

⚠ Entering calibration mode will break the control loop. Make sure that the system is ready to enter calibration mode.

Equipment needed for calibration:

1. A high-accuracy calibrator (Fluke 5520A calibrator recommended) with the following functions:
   0–100mV millivolt source with ±0.005% accuracy
   0–10V voltage source with ±0.005% accuracy
   0–20mA 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

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

Manual calibration procedures

• Perform step 1 to enter calibration mode.

Step 1

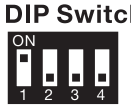
Set the lockout DIP switch to the unlocked condition (both switches 3 and 4 are off).

Press both scroll and down keys and release them quickly. The operation mode menu will appear on the display. Repeat this operation several times until CAL1 ---- appears on the display. Press the scroll key for at least 3 seconds. The display will show AdO and the unit will enter calibration mode. Output 1 and output 2 use their failure transfer values to control.

• Perform step 2 to calibrate zero for the A to D converter and step 3 to calibrate the gain for the A to D converter. The DIP switch should be set for T/C input.

Step 2

DIP Switch Position



T/C Input

Short terminals 19 and 20, then press the scroll key for at least 3 seconds. The display will blink for a moment until a new value is obtained. If the display didn't blink or if the obtained value is equal to -360 or 360, then calibration failed.

Step 3

Press the scroll key until the display shows AdG. Send a 60mV signal to terminals 19 and 20 with the correct polarity. Press the scroll key for at least 3 seconds. The display will blink for a moment until a new value is obtained. If the display didn't blink or if the obtained value is equal to -199.9 or 199.9, then calibration failed.

• Perform step 4 to calibrate the voltage function (if required) for input 1.

Step 4.

DIP Switch Position

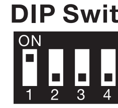
0-10V Input

Set the DIP switch for voltage input. Press the scroll key until the display shows V1G. Send a 10V signal to terminals 19 and 20 with the correct polarity. Press the scroll key for at least 3 seconds. The display will blink for a moment until a new value is obtained. If the display didn't blink or if the obtained value is equal to -199.9 or 199.9, then calibration failed.

• Perform both steps 5 and 6 to calibrate RTD function (if required) for input 1.

Step 5.

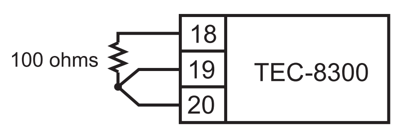
DIP Switch Position



RTD Input

Set the DIP switch for RTD input. Press the scroll key until the display shows rEF.1. Send a 100 ohms signal to terminals 18, 19, and 20 using to the connection shown below:

Figure 6.1 RTD Calibration



Press the scroll key for at least 3 seconds. The display will blink for a moment; if it does not, calibration failed.

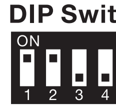
Step 6.

Press the scroll key and the display will show Sr.1. Change the ohm's value to 300 ohms. Press the scroll key for at least 3 seconds. The display will blink for a moment while values are obtained for SR1 and REF1 (last step). If the display didn't blink or if any value obtained for SR1 or REF1 is equal to -199.9 or 199.9, then calibration failed.

• Perform step 7 to calibrate mA function (if required) for input 1.

Step 7.

DIP Switch Position



mA Input

Set the DIP switch for mA input. Press the scroll key until the display shows mA1G. Send a 20mA signal to terminals 19 and 20 with the correct polarity. Press the scroll key for at least 3 seconds. The display will blink for a moment until a new value is obtained. If the display didn't blink or if the obtained value is equal to -199.9 or 199.9, then calibration failed.

• Perform step 8 to calibrate voltage as well as CT function (if required) for input 2.

Manual calibration procedures, continued next page…

Step 8.

Press the scroll key until the display shows V2G. Send a 10V signal to terminals 15 and 16 with the correct polarity. Press the scroll key for at least 3 seconds. The display will blink for a moment until a new value is obtained. If the display didn't blink or if the obtained value is equal to -199.9 or 199.9, then calibration failed.

• Perform step 9 to calibrate mA function (if required) for input 2.

Step 9.

Press the scroll key until the display shows mA2G. Send a 20mA signal to terminals 15 and 16 with the correct polarity. Press the scroll key for at least 3 seconds. The display will blink for a moment until a new value is obtained. If the display didn't blink or if the obtained value is equal to -199.9 or 199.9, then calibration failed.

• Perform step 10 to calibrate offset of cold junction compensation, if required. Set the DIP switch for T/C input.

Step 10.

Set up the equipment according to the following diagram to calibrate the cold junction compensation. Note that a K type thermocouple must be used.

DIP Switch Position

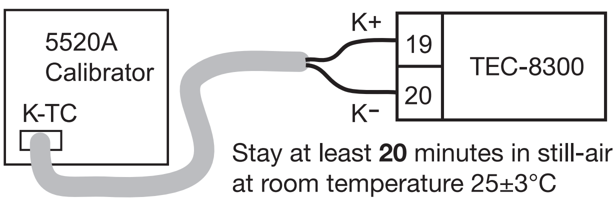


Figure 6.2 Cold Junction Calibration Setup

The 5520A calibrator is configured for 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 a temperature of 25±3°C. Allow at least 20 minutes to warm up. The DIP switch is located at the TC input. Perform step 1 as stated above, then press the scroll key until the display shows CJtL. Press the up and down keys until a value of 0.00 is obtained. Press the scroll key at least 3 seconds. The display will blink for a moment until a new value is obtained. If the display didn't blink or if the obtained value is equal to -5.00 or 40.00, then calibration failed.

• Perform step 11 to calibrate the gain of cold junction compensation if required. If a test chamber for calibration is not available, perform step 11N to use a nominal value for the cold junction gain.

Step 11.

Set up the equipment the same as in step 10. The unit under calibration is powered in a still-air room with a temperature of 50±3°C. Allow at least 20 minutes to warm up. The calibrator source is set at 0.00°C with internal compensation mode.

Perform step 1 as stated on the previous page, then press the scroll key until the display shows CJtL. Press the up or down keys until a value of 0.0 is obtained. Press the scroll key for at least 3 seconds. The display will blink for a moment until a new value is obtained. If the display didn't blink or if the obtained value is equal to -199.9 or 199.9, then calibration failed. This setup is performed in a high temperature chamber, therefore it is recommended to use a computer to perform the procedures.

Step 11N.

Perform step 1 as stated on the previous page, then press the scroll key until the display shows CJtL. Press the up and down keys until a value of 0.1 is obtained. Press the scroll key for at least 3 seconds. The display will blink for a moment until the new value 0.0 is obtained. Otherwise, calibration failed.

Caution: It is **not recommended** to use step 11N, since the cold junction gain is not able to achieve the rated accuracy using this step.

• Final step

Step 12.

Set the DIP switch to your desired position (refer to section 1-3).

Automatic calibration procedures

The programming port (see section 2-18) of the TEC-8300 can be used for automatic calibration.

The equipment required for automatic calibration is available upon request.

This procedure requires access to the circuitry of a unit under live power. Accidental contact with line voltage is possible. Only qualified personnel should perform these procedures. Potentially lethal voltages are present.

Troubleshooting procedures:

1. If an error message is displayed, refer to table 7.1 to see what caused it and what action to take to correct the problem.
2. Check each point listed below. Experience has proven that many control problems are caused by a defective instrument.
   - Line wires are improperly connected
   - No voltage between line terminals
   - Incorrect voltage between line terminals
   - Connections to terminals are open, missing, or loose
   - Thermocouple is open at tip
   - Thermocouple lead is broken
   - Shorted thermocouple leads
   - Short across terminals
   - Open or shorted heater circuit
   - Open coil in external contactor
   - Burned out line fuses
   - Burned out relay inside control
   - Defective solid-state relays
   - Defective line switches
   - Burned out contactor
   - Defective circuit breakers
3. If the points listed on the above chart have been checked and the controller still does not function properly, it is recommended that the instrument be returned to the factory for inspection. Do not attempt to make repairs without a qualified engineer and proper technical information, as damage may result. It is also recommended to use adequate packing materials to prevent damage during transportation.
4. Refer to table 7.2 for some probable causes and actions.

Table 7.1 Error Codes and Corrective Actions

Error Code	Display Symbol	Error Description	Corrective Action
1	Er01	Illegal setup values been used: PV1 is used for both PVMD and SPMD.	Check and correct setup values of PVMD and SPMD. PV and SV can't use the same value for normal control
2	Er02	Illegal setup values been used: PV2 is used for both PVMD and SPMD.	Same as error code 1
3	Er03	Illegal setup values used: P1-2 or P2-1 is used for PVMD while PV1 or PV2 is used for SPMD. Dependent values used for PV and SV will create incorrect result of control	Check and correct setup values of PVMD and SPMD. Difference of PV1 and PV2 can't be used for PV while PV1 or PV2 is used for SV
4	Er04	Illegal setup values 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 PB1 or PB2 = 0, and TI1 or TI2 = 0)	Check and correct setup values of OUT2, PB1, PB2, TI1, TI2 and OUT1. IF OUT2 is required for cooling control, the control should use PID mode (PB = $\not{0}$, TI = $\not{0}$) and OUT1 should use reverse mode (heating action), otherwise, don't use OUT2 for cooling control
5	Er05	Illegal setup values been used: unequal IN1U and IN2U or unequal DP1 and DP2 while P1-2 or P2-1 is used for PVMD or, PV1 or PV2 is used for SPMD or, P1.2.H, P1.2.L, D1.2.H or D1.2.L are used for A1FN or A2FN.	Check and correct setup values of IN1U, IN2U, DP1, DP2, PVMD, SPMD, A1FN or A2FN. Same unit and decimal point should be used if both PV1 and PV2 are used for PV, SV, alarm 1 or alarm 2.
6	Er06	Illegal setup values used: OUT2 select =AL2 but A2FN select NONE	Check and correct setup values of OUT2 and A2FN. OUT2 will not perform alarm function if A2FN select NONE.
7	Er07	Illegal setup values used: Dwell timer (TIMR) is selected for both A1FN and A2FN.	Check and correct setup values of A1FN and A2FN. Dwell timer can only be properly used for single alarm output.
10	Er 10	Communication error: bad function code	Correct the communication software to meet the protocol requirements.
11	Er 11	Communication error: register address out of range	Don't issue an over-range register address to the slave.
12	Er 12	Communication error: access a non-existent parameter	Don't issue a non-existent parameter to the slave.
14	Er 14	Communication error: attempt to write a read-only data	Don't write a read-only data or a protected data to the slave.
15	Er 15	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	AtEr	Fail to perform auto-tuning function	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.Don't change Event input state during auto-tuning procedure. 4.Use manual tuning instead of auto-tuning.
29	EEPE	EEPROM can't be written correctly	Return to factory for repair.
38	Sb2E	Input 2 (IN2) sensor break, or input 2 current below 1 mA if 4-20 mA is selected, or input 2 voltage below 0.25V if 1 - 5V is selected	Replace input 2 sensor.
39	Sb1E	Input 1 (IN1) sensor break, or input 1 current below 1 mA if 4-20 mA is selected, or input 1 voltage below 0.25V if 1 - 5V is selected	Replace input 1 sensor.
40	AdEr	A to D converter or related component(s) malfunction	Return to factory for repair.

Table 7.2 Common Failure Causes and Corrective Actions

Symptom	Probable Causes	Corrective Actions
1) LED's will not light	- No power to instrument - Power supply defective	- Check power line connections - Replace power supply board
2) Some segments of the display or LED lamps not lit or lit erroneously.	- LED display or LED lamp defective - Related LED driver defective	- Replace LED display or LED lamp - Replace the related transistor or IC chip
3) Display Unstable	- Analog portion or A-D converter defective - Thermocouple, RTD or sensor defective - Intermittent connection of sensor wiring	- Replace related components or board - Check thermocouple, RTD or sensor - Check sensor wiring connections
4) Considerable error in temperature indication	- Wrong sensor or thermocouple type, wrong input mode selected. - Analog portion of A-D converter defective	- Check sensor or thermocouple type and if proper input mode was selected - Replace related components or board
5) Display goes in reverse direction (counts down scale as process warms)	- Reversed input wiring of sensor	- Check and correct
6) No heat or output	- No heater power (output), incorrect output device used - Output device defective - Open fuse outside of the instrument	- Check output wiring and output device - Replace output device - Replace output fuse
7) Heat or output stays on but indicator reads normal	- Output device shorted, or power service shorted	- Check and replace
8) Control abnormal or operation incorrect	- CPU or EEPROM (non-volatile memory) defective. Key switch defective - Incorrect setup values	- Check and replace - Read the setup procedure carefully
9) Display blinks; entered values change by themselves	- Electromagnetic interference (EMI), or Radio Frequency interference (RFI) - EEPROM defective	- Suppress arcing contacts in system to eliminate high voltage spike sources. Separate sensor and controller wiring from " dirty " power lines, ground heaters - Replace EEPROM

NOTES

Power

90–264VAC, 47–63Hz, 15VA, 7W maximum

11–26 VAC/VDC, 15VA, 7W maximum

Input 1 resolution: 18 bits

Sampling rate: 5x/second

Maximum rating: -2VDC minimum, 12VDC maximum (1 minute for mA input)

Temperature effect: ±1.5uV/°C for all inputs except mA input ±3.0uV/°C for mA input

Sensor lead resistance effect:

T/C: 0.2uV/ohm

3-wire RTD: 2.6°C/ohm of resistance difference of two leads

2-wire RTD: 2.6°C/ohm of resistance sum of two leads

Common mode rejection ratio (CMRR): 120dB

Normal mode rejection ratio (NMRR): 55dB

Sensor break detection:

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

Sensor break responding time:

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

Characteristics:

Type	Range	Accuracy @ 25°C	Input Impedance
J	-120°C to 1000°C (-184°F to 1832°F)	±2°C	2.2 MΩ
K	-200°C to 1370°C (-328°F to 2498°F)	±2°C	2.2 MΩ
T	-250°C to 400°C (-418°F to 752°F)	±2°C	2.2 MΩ
E	-100°C to 900°C (-148°F to 1652°F)	±2°C	2.2 MΩ
B	0°C to 1820°C (32°F to 3308°F)	±2°C (200°C to 1820°C)	2.2 MΩ
R	0°C to 1767.8°C (32°F to 3214°F)	±2°C	2.2 MΩ
S	0°C to 1767.8°C (32°F to 3214°F)	±2°C	2.2 MΩ
N	-250°C to 1300°C (-418°F to 2372°F)	±2°C	2.2 MΩ
L	-200°C to 900°C (-328°F to 1652°F)	± 2°C	2.2 MΩ
PT100 (DIN)	-210°C to 700°C (-346°F to 1292°F)	± 0.4°C	1.3 KΩ
PT100 (JIS)	-200°C to 600°C (-328°F to 1112°F)	± 0.4°C	1.3 KΩ
mV	-8mV to 70mV	± 0.05%	2.2 MΩ
mA	-3mA to 27mA	± 0.05%	70.5 Ω
V	-1.3V to 11.5V	± 0.05%	302 KΩ

Input 2

Resolution: 18 bits

Sampling rate: 1.66x/second

Maximum rating: -2VDC minimum, 12VDC maximum

Temperature effect: ±3.0uV/°C for mA input ±1.5uV/°C for all other inputs

Common mode rejection ratio (CMRR): 120dB

Sensor break detection: Below 1mA for 4–20mA input, below 0.25V for 1–5V input, unavailable for other inputs.

Sensor break responding time: 0.5 seconds

Characteristics:

Type	Range	Accuracy @25°C	Input Impedance
TEC99999	0 – 50.0 A	±2% of Reading ±0.2 A	302 KΩ
mA	-3mA – 27mA	±0.05%	$70.5\Omega + \frac{0.8V}{\text{input current}}$
V	-1.3V – 11.5V	±0.05%	302 KΩ

Input 3 (event input)

Logic low: -10V minimum, 0.8V maximum.

Logic high: 2V minimum, 10V maximum

External pull-down resistance: 400KW maximum

External pull-up resistance: 1.5MW minimum

Functions: select second set point and/or PID, reset alarm 1 and/or alarm 2, disable output 1 and/or output 2, remote lockout.

Output 1/Output 2

Relay rating: 2A/240 VAC, life cycles 200,000 for resistive load

Pulsed voltage: source voltage 5V, current limiting resistance 66W.

Linear output characteristics:

Type	Zero Tolerance	Span Tolerance	Load Capacity
4-20mA	3.8-4mA	20-21mA	500Ω max.
0-20mA	0 mA	20-21mA	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: 0.01% for full load change

Output settling time: 0.1 second (stable to 99.9%)

Isolation breakdown voltage: 1000VAC

Temperature effect: ±0.0025% of SPAN/°C

Triac (SSR) Output

Rating: 1A/240VAC
Inrush Current: 20A for 1 cycle
Min. Load Current: 50mA rms
Max. Off-state Leakage: 3mA rms
Max. On-state Voltage: 1.5V rms
Insulation Resistance: 1000Mohms min. at 500VDC
Dielectric Strength: 2500VAC for 1 minute

DC voltage supply characteristics *(installed at output 2)*

Type	Tolerance	Max. Output Current	Ripple Voltage	Isolation Barrier
20 V	± .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

Alarm 1/Alarm 2

Alarm 1 relay: Form C rating 2A/240VAC, 200,000 life cycles for resistive load.
Alarm 2 relay: Form A, max. rating 2A/240VAC, 200,000 life cycles for resistive load.
Alarm functions: •Dwell timer, •Deviation high/low alarm, •Deviation band high/low alarm, •PV1 high/low alarm, •PV2 high/low alarm, •PV1 or PV2 high/low alarm, •PV1-PV2 high/low alarm, •Loop break alarm, •Sensor break alarm.
Alarm mode: Normal, latching, hold, latching/hold.
Dwell timer: 0–6553.5 minutes

Data Communication

Interface: RS-232 (1 unit), RS-485 (up to 247 units)
Protocol: Modbus protocol RTU mode
Address: 1–247
Baud Rate: 0.3~38.4Kbits/sec
Data Bits: 7 or 8 bits
Parity Bit: None, even or odd
Stop Bit: 1 or 2 bits
Communication Buffer: 50 bytes

Analog Retransmission

Functions: PV1, PV2, PV1-PV2, PV2-PV1, set point, MV1, MV2, PV-SV deviation value
Output Signal: 4–20mA, 0–20mA, 0–1V, 0–5V, 1–5V, 0–10V
Resolution: 15 bits
Accuracy: ±0.05% of span ±0.0025%/°C
Load Resistance: 0–500ohms (for current output)
10Kohms minimum (for voltage output)
Output Regulation: 0.01% for full load change
Output Settling Time: 0.1 sec. (stable to 99.9%)
Isolation Breakdown Voltage: 1000VAC min.
Integral linearity error: ±0.005% of span
Temperature effect: ±0.0025% of span/°C
Saturation low: 0mA (or 0V)
Saturation high: 22.2mA (or 5.55V, 11.1V min.)
Linear output range: 0–22.2mA(0–20mA or 4–20mA), 0–5.55V (0–5V, 1–5V), 0–11.1V (0–10V)

User Interface

Dual 4-digit LED displays: Upper 0.4" (10mm), lower 0.3" (8mm)
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 1~255% of PB
ON-OFF: 0.1–100.0(°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: 0.1–100.0 seconds
Manual control: Heat (MV1) and cool (MV2)
Auto-tuning: Cold start and warm start
Self-tuning: Select NONE or YES
Failure mode: Auto-transfer to manual mode while sensor break or A-D converter damage
Sleep mode: Enable or disable
Ramping control: 0–900.0°F/minute or 0–900.0°F/hour ramp rate
Power limit: 0–100% output 1 and output 2
Pump/pressure control: Sophisticated functions provided
Remote set point: Programmable range for voltage or current input
Differential control: Control PV1-PV2 at set point

Digital Filter

Function: First order
Time constant: 0, 0.2, 0.5, 1, 2, 5, 10, 20, 30, 60 seconds programmable

Environmental and Physical

Operating temperature: -10°C to 50°C
Storage temperature: -40°C to 60°C
Humidity: 0 to 90% RH (non-condensing)
Insulation resistance: 20Mohms min. (at 500VDC)
Dielectric strength: 2000VAC, 50/60Hz for 1 minute
Vibration resistance: 10–55Hz, 10m/s for 2 hours
Shock resistance: 200m/s (20g)
Moldings: Flame retardant polycarbonate
Dimensions: 48mm(W)X96mm(H)X80mm(D), 65mm depth behind panel
Weight: 220 grams

Approval Standards

Safety: UL873 (11th edition, 1994), CSA C22.2 No. 24-93, EN61010-1 (IEC1010-1)
Protective class: IP 20 housing and terminals with protective covers
EMC: EN61326

A–1 Menu Existence Conditions

Menu Existence Conditions Table (Page 1 of 3)

Menu	Parameter Notation	Existence Conditions
User Menu	SP1	Exists unconditionally
	TIME	Exists if A1FN selects TIMR or A2FN selects TIMR
	A1SP	Exists if A1FN selects PV1H, PV1L, PV2H, PV2L, P12H, P12L, D12H or D12L
	A1DV	Exists if A1FN selects DEHI, DELO, DBHI, or DBLO
	A2SP	Exists if A2FN selects PV1H, PV1L, PV2H, PV2L, P12H, P12L, D12H or D12L
	A2DV	Exists if A2FN selects DEHI, DELO, DBHI, or DBLO
	RAMP	Exists if SPMD selects MINR or HRR
	OFST	Exists if TI1 is used for control (depends on Event input and EIFN selection) but TI1= 0 and PB1≠0 or if TI2 is used for control (depends on Event input and EIFN selection) but TI2= 0 and PB2≠0
	REFC	Exists if SPMD selects PUMP
	SHIF PB1	Exists unconditionally
	TI1 TD1	Exists if PB1≠0
	CPB, DB	Exists if OUT2 select COOL
	SP2	Exists if EIFN selects SP2 or SPP2, or if SPMD selects PUMP
	PB2	Exists if EIFN selects PID2 or SPP2
	TI2 TD2	Exists if EIFN selects PID2 or SPP2 provided that PB2≠0
	O1HY	If PID2 or SPP2 is selected for EIFN, then O1HY exists if PB1= 0 or PB2 = 0. If PID2 or SPP2 is not selected for EIFN, then O1HY exists if PB1= 0
	A1HY	Exists if A1FN selects DEHI, DELO, PV1H, PV1L, PV2H, PV2L, P12H, P12L, D12H, or D12L
	A2HY	Exists if A2FN selects DEHI, DELO, PV1H, PV1L, PV2H, PV2L, P12H, P12L, D12H, or D12L
	PL1	If PID2 or SPP2 is selected for EIFN, then PL1 exists if PB1≠0 or PB2≠0. If PID2 or SPP2 is not selected for EIFN, then PL1 exists if PB1≠0
	PL2	Exists if OUT2 selects COOL

Menu Existence Conditions Table (Page 2 of 3)

Menu	Parameter Notation	Existence Conditions
Setup Menu	FUNC	Exists unconditionally
	COMM	Exists if FUNC selects FULL
	PROT ADDR BAUD DATA PARI STOP	Exists if COMM selects 485 or 232
	AOFN	Exists if COMM selects 4-20, 0-20, 0-1V, 0-5V, 1-5V, or 0-10
	AOLO AOHI	Exists if COMM selects 4-20, 0-20, 0-1V, 0-5V, 1-5V, or 0-10 and AOFN is not MV1 and MV2
	IN1 IN1U DP1	Exists unconditionally
	IN1L IN1H	Exists if IN1selects 4-20, 0-20, 0-1V, 0-5V, 1-5V, or 0-10
	IN2	Exists if FUNC selects FULL
	IN2U DP2 IN2L IN2H	Exists if IN2 selects 4-20, 0-20, 0-1V, 0-5V, 1-5V, or 0-10
	OUT1 O1TY CYC1 O1FT OUT2	Exists unconditionally
	O2TY CYC2 O2FT	Exists if OUT2 selects COOL

Menu Existence Conditions Table (Page 3 of 3)

Menu	Parameter Notation	Existence Conditions
Setup Menu	A1FN	Exists unconditionally
	A1MD	Exists if A1FN selects DEHI, DELO, DBHI, DBLO, PV1H, PV1L, PV2H, PV2L, P12H, P12L, D12H, D12L, LB or SENB
	A1FT	Exists if A1FN is not NONE
	A2FN	Exists unconditionally
	A2MD	Exists if A2FN selects DEHI, DELO, DBHI, DBLO, PV1H, PV1L, PV2H, PV2L, P12H, P12L, D12H, D12L, LB or SENB
	A2FT	Exists if A2FN is not NONE
	EIFN PVMD FILT	Exists if FUNC selects FULL
	SELF	Exists unconditionally
	SLEP SPMD	Exists if FUNC selects FULL
	SP1L SP1H	Exists unconditionally
	SP2F	Exists if EIFN selects SP2 or SPP2, or if SPMD selects PUMP
	SEL1 SEL2 SEL3 SEL4 SEL5	Exists unconditionally

A–2 Factory Menu Description

Parameter Notation	Display Format	Parameter Description	Range		Default Value
EROR	Eror	Current Error Code	Low: 0	High: 40	—
PROG	ProG	Program Identification Code Contains Program Number and Version Number	Low: 0	High: 15.99	—
MODE	modE	Contains Lockout Status Code and Current System Mode	Low: 0	High: 3.5	—
CMND	Cmnd	Command Password	Low: 0	High: 65535	—
JOB	Job	Job Password	Low: 0	High: 65535	—
DRIF	d _ _ _	Warm-up Drift Calibration Factor	Low: -5.0°C	High: 5.0°C	—
AD0	Ad0	A to D Zero Calibration Coefficient	Low: -360	High: 360	—
ADG	AdG	A to D Gain Calibration Coefficient	Low: -199.9	High: 199.9	—
V1G	V 1.G	Voltage Input 1 Gain Calibration Coefficient	Low: -199.9	High: 199.9	—
CJTL	CJt.L	Cold Junction Low Temperature Calibration Coefficient	Low: -5.00°C	High: 40.00°C	—
CJG	CJ.G	Cold Junction Gain Calibration Coefficient	Low: -199.9	High: 199.9	—
REF1	rEF. 1	Reference Voltage 1 Calibration Coefficient for RTD 1	Low: -199.9	High: 199.9	—
SR1	Sr. 1	Serial Resistance 1 Calibration Coefficient for RTD 1	Low: -199.9	High: 199.9	—
MA1G	mA 1.G	mA Input 1 Gain Calibration Coefficient	Low: -199.9	High: 199.9	—
V2G	V2.G	Voltage Input 2 Gain Calibration Coefficient	Low: -199.9	High: 199.9	—
SIG1 *	Si G 1	Point 1 Signal Value of Special Sensor	Low: -19999	High: 45536	—
IND1 *	ind 1	Point 1 Indication Value of Special Sensor	Low: -19999	High: 45536	—
SIG2 *	Si G2	Point 2 Signal Value of Special Sensor	Low: -19999	High: 45536	—
IND2 *	ind2	Point 2 Indication Value of Special Sensor	Low: -19999	High: 45536	—
SIG3 *	Si G3	Point 3 Signal Value of Special Sensor	Low: -19999	High: 45536	—
IND3 *	ind3	Point 3 Indication Value of Special Sensor	Low: -19999	High: 45536	—
SIG4 *	Si G4	Point 4 Signal Value of Special Sensor	Low: -19999	High: 45536	—
IND4 *	ind4	Point 4 Indication Value of Special Sensor	Low: -19999	High: 45536	—
SIG5 *	Si G5	Point 5 Signal Value of Special Sensor	Low: -19999	High: 45536	—
IND5 *	ind5	Point 5 Indication Value of Special Sensor	Low: -19999	High: 45536	—
SIG6 *	Si G6	Point 6 Signal Value of Special Sensor	Low: -19999	High: 45536	—
IND6 *	ind6	Point 6 Indication Value of Special Sensor	Low: -19999	High: 45536	—
SIG7 *	Si G7	Point 7 Signal Value of Special Sensor	Low: -19999	High: 45536	—
IND7 *	ind7	Point 7 Indication Value of Special Sensor	Low: -19999	High: 45536	—
SIG8 *	Si G8	Point 8 Signal Value of Special Sensor	Low: -19999	High: 45536	—
IND8 *	ind8	Point 8 Indication Value of Special Sensor	Low: -19999	High: 45536	—
SIG9 *	Si G9	Point 9 Signal Value of Special Sensor	Low: -19999	High: 45536	—
IND9 *	ind9	Point 9 Indication Value of Special Sensor	Low: -19999	High: 45536	—
TYPE*	tYPE	Signal Type of Special Sensor	Low: 0	High: 3	—
DATE	dAtE	Manufacturing Date of Product	Low: 0	High: 3719	—
NO	no	Serial Number of Product	Low: 1	High: 999	—

* These parameters are available only if SPEC is selected for IN1.

Parameter Notation	Display Format	Parameter Description	Range				Default Value
HOUR	Hour	Working Hour Value	Low:	0	High:	65535 Hours	—
HRLO	Hr.Lo	Fractional Hour Value	Low:	0	High:	0.9 Hour	—
ERR1	Err 1	Historical Error Record 1	Low:	0	High:	FFFF	0
ERR2	Err2	Historical Error Record 2	Low:	0	High:	FFFF	0
DELI	dELi	ASCII Input Delimiter	Low:	0000	High:	007F	000A
BPL1	bPL. 1	OUT1 Bumpless Transfer Value	Low:	0	High:	100.00 %	—
BPL2	bPL.2	OUT2 Bumpless Transfer Value	Low:	0	High:	100.00 %	—
CJCL	CJC.L	Sense Voltage of Cold Junction Calibration Low	Low:	31.680	High:	40.320 mV	—

A–5 Memo

Use the following table as a master copy for your settings.

Use the following table as a master copy for your settings (page 1 of 2).

Contained in	Parameter Notation	Display Format	Your setting
User Menu	SP1		
	TIME	timE	
	A1SP	A1.SP	
	A1DV	A1.dv	
	A2SP	A2.SP	
	A2DV	A2.dv	
	RAMP	rAmP	
	OFST	oFSt	
	REFC	rEFC	
	SHIF	SHiF	
	PB1	Pb1	
	TI1	ti1	
	TD1	td1	
	CPB	C.Pb	
	DB	db	
	SP2	SP2	
	PB2	Pb2	
	TI2	ti2	
	TD2	td2	
	O1HY	o1.HY	
	A1HY	A1.HY	
	A2HY	A2.HY	
	PL1	PL1	
	PL2	PL2	
Setup Menu	FUNC	FunC	

Contained in	Parameter Notation	Display Format	Your setting
Setup Menu	COMM	Comm	
	PROT	Prot	
	ADDR	Addr	
	BAUD	bAud	
	DATA	dAtA	
	PARI	PAri	
	STOP	StoP	
	AOFN	Ao.Fn	
	AOLO	Ao.Lo	
	AOHI	Ao.Hi	
	IN1	in1	
	IN1U	in1.u	
	DP1	dP1	
	IN1L	in1.L	
	IN1H	in1.H	
	IN2	in2	
	IN2U	in2.u	
	DP2	dP2	
	IN2L	in2.L	
	IN2H	in2.H	
	OUT1	out1	
	O1TY	o1.tY	
	CYC1	CYC1	
	O1FT	o1.Ft	

Use the following table as a master copy for your settings (page 2 of 2).

Contained in	Parameter Notation	Display Format	Your setting
Setup Menu	OUT2	out2	
	O2TY	o2.tY	
	CYC2	CYC2	
	O2FT	o2.Ft	
	A1FN	A1.Fn	
	A1MD	A1.nd	
	A1FT	A1.Ft	
	A2FN	A2.Fn	
	A2MD	A2.nd	
	A2FT	A2.Ft	
	EIFN	Ei.Fn	
	PVMD	PV.nd	
	FILT	FiLt	
	SELF	SELF	
	SLEP	SLEP	
	SPMD	SP.nd	
	SP1L	SP1.L	
	SP1H	SP1.H	
	SP2F	SP2F	
	DISF	diSF	
	SEL1	SEL1	
	SEL2	SEL2	
	SEL3	SEL3	
	SEL4	SEL4	
	SEL5	SEL5	

Contained in	Parameter Notation	Display Format	Your setting
Calibration Mode Menu	AD0	Ad0	
	ADG	AdG	
	V1G	V1.G	
	CJTL	CJt.L	
	CJG	CJ.G	
	REF1	rEF.1	
	SR1	Sr.1	
	MA1G	nA1.G	
	V2G	V2.G	
	MA2G	nA2.G	
Display Mode Menu	PVHI	PV.Hi	
	PVLO	PV.Lo	
	MV1	H___	
	MV2	C___	
	DV	dV	
	PV1	PV1	
	PV2	PV2	
	PB	Pb	
	TI	ti	
	TD	td	
	CJCT	CJCt	
	PVR	PVr	
	PVRH	PVr.H	
	PVRL	PVr.L	

WARRANTY

Tempco Electric Heater Corporation is pleased to offer suggestions on the use of its products. However, Tempco makes no warranties or representations of any sort regarding the fitness for use, or the application of its products by the Purchaser. The selection, application, or use of Tempco products is the Purchaser's responsibility. No claims will be allowed for any damages or losses, whether direct, indirect, incidental, special, or consequential. Specifications are subject to change without notice. In addition, Tempco reserves the right to make changes–without notification to the Purchaser–to materials or processing that do not affect compliance with any applicable specification. TEC Temperature Controllers are warranted to be free from defects in material and workmanship for two (2) years after delivery to the first purchaser for use. Tempco's sole responsibility under this warranty, at Tempco's option, is limited to replacement or repair, free of charge, or refund of purchase price within the warranty period specified. This warranty does not apply to damage resulting from transportation, alteration, misuse, or abuse.

RETURNS

No product returns can be accepted without a completed Return Material Authorization (RMA) form.

TECHNICAL SUPPORT

Technical questions and troubleshooting help is available from Tempco. When calling or writing please give as much background information on the application or process as possible.

E-mail: techsupport@tempco.com
Phone: 630-350-2252
800-323-6859

TEMPCO ELECTRIC HEATER CORPORATION ®
Committed to Excellence

TEMPCO Electric Heater Corporation
607 N. Central Avenue • Wood Dale, IL 60191-1452 USA
Tel: 630-350-2252 • Toll Free: 800-323-6859
Fax: 630-350-0232 • E-mail: info@tempco.com
Web: www.tempco.com