FUTUREDESIGN
CONTROLS

PID+ Fuzzy Logic Process Controller
C22/C62/C82/C83/C72/C42/R22

Quick User Manual

High Performance Process &
Temperature Controllers

Warning Symbol

This document contains notices that you should observe to ensure your own personal safety, as well as to protect the product and connected equipment. These notices are highlighted in the manual by a warning triangle and are marked as follows.

⚠ The danger symbol indicates that death or severe personal injury may result if proper precautions are not taken. Do not proceed beyond a warning symbol until the indicated conditions are fully understood and met.

Preface

Original equipment manufacturer reserves the right to change information available in this document without notice. Manufacturer is not liable for any damages incurred to equipment/personal during installation or use of equipment as explained in this document. User must acquire sufficient knowledge & skills prior to using equipment in the application and follow all the local standards & regulations to meet safety requirements.

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Note

It is strongly recommended that a process should incorporate a separate limit control such as the Future Design Controls L91 which can be used to shut down the equipment at a preset process condition in order to avoid possible damage to product and/or equipment.

Technical Assistance

If you encounter a problem with your C-Series controller review all of your configuration information to verify that your selections are consistent with your application: i.e. inputs, outputs, alarms, etc.

If after checking the above the problem persists, you can contact technical support to review your application, configuration, etc. Monday thru Friday, 8:00 a.m. to 5:00 p.m. Eastern Standard Time
- Phone: 866-342-5332
- Fax: 866-332-8014
- Email: support@futuredesigncontrols.com.

Please have the following information available:

• Complete Model #'s and/or Serial #'s for Component(s) in Question
• All Configuration Information
• All User Manuals

UMQSC621C / August 2018

State of California Proposition 65 Warning

⚠️**WARNING Cancer and Reproductive Harm:** This warning is intended to address certain Prop 65 chemicals that may be found in Future Design Controls products. These products can expose you to chemicals including lead and lead compounds which are known to the State of California to cause cancer, birth defects or other reproductive harm.

What is the state of California Proposition 65?
Proposition 65 requires businesses to provide warnings to Californians about significant exposures to chemicals that cause cancer, birth defects or other reproductive harm. These chemicals can be in the products that Californians purchase, in their homes or workplaces, or that are released into the environment. By requiring that this information be provided, Proposition 65 enables Californians to make informed decisions about their exposures to these chemicals. For more information go to: *www.P65Warnings.ca.gov*

The most recent list of chemicals known to the State of California can be seen at:
https://oehha.ca.gov/media/downloads/proposition-65//p65list102618.pdf

⚠️ **Proposition 65 Warning: Affected Future Design Control Products:** This Warning applies to all existing and all future products offered by Future Design Controls.

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1.1   Introduction

The new generation low-cost PID microprocessor-based Fuzzy logic controller series incorporate two bright easy to read LCD Displays which indicate Process Value (PV) and Set point(SP). The Fuzzy Logic technology incorporated on these series controllers enables a process to reach a predetermined set point in the shortest time with minimum of overshoot during start up (Power ON) or external load disturbances (example: an oven door being opened).

The below are the different controller models of this series.

Model No	Mounting Type	DIN Size	Dimensions LxWxD (mm)	Depth Behind Panel (mm)
C22	Panel Mount	1/32 DIN	24x48x85	76
C62	Panel Mount	1/16DIN	48x48x59	50
C82/C83	Panel Mount	1/8 DIN	48x96x59	50
C72	Panel Mount	1/7 DIN	72x72x59	50
C42	Panel Mount	1/4 DIN	96x96x59	50
R22	DIN RAIL		22.5x96x80	

These controllers are powered by an 11-26 or 90-250 VDC /VAC supply, incorporating a 2 Amp control relay output as a standard. The second output can be used as a cooling control or an alarm. Both outputs can be selected as a 5VDC or 14VDC logic output, linear current or linear voltage to drive an external device. There are six types of alarms and a dwell timer that can be configured for the third output. The controllers are fully programmable for Linear current, Linear Voltage,PT100 and thermocouple types J, K, T, E, B, R, S, N, L, U, P, C, and D. The input signal is digitized by using an 18-bit A to D converter. Its fast sampling rate allows the controller to control fast processes.

1.2   Features

The new generation of low cost PID controllers has a lot of unique features. The unique features are listed below.

- ❖ LCD Display
- ❖ High Accuracy 18 Bit A-D Conversion and 15 Bit D-A Conversion
- ❖ Fastest Sampling Rate 200 msec
- ❖ Universal Input
- ❖ Fuzzy Logic +PID Technology
- ❖ Possibility of both RS-485 and analog retransmission
- ❖ 16 Segments of Ramp & Soak
- ❖ Current Transformer (CT) Inputs for heater break detection
- ❖ Up to 6 Event Inputs
- ❖ Remote Setpoint
- ❖ Auto-Tuning
- ❖ Bumpless Transfer
- ❖ Lockout Protection
- ❖ Bidirectional Menu Navigation
- ❖ Soft Start function

1.3 Specifications

Specification	C22	C62	C82	C83	C72	C42	R22
Power Supply	90 to 250VAC, 47 to63Hz , 20 to 28 VAC,47-63Hz / 11 to 40 VDC						
Power Consumption	C22/R22: 8VA, 4W Maximum., C62: 10VA, 5W Maximum., C72/C82/C83/C42: 12VA,6W Maximum						
Signal Input							
Type	Thermocouple(J,K,T,E,B,R,S,N,L,U,P,C,D), RTD(PT100(DIN), PT100(JIS)), Current(mA),Voltage(Volts)						
Resolution	18 Bits						
Sampling Rate	5 Times / Second (200msec)						
Maximum Rating	-2VDC minimum, 12VDC maximum						

Input 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 1800°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
	U	-200°C to 600°C (-328°F to 1112°F)	±2°C	2.2 MΩ
	P	0°C to 1395°C(32°F to 2543°F)	±2°C	2.2 MΩ
	C	0°C to 2300°C(32°F to 4172°F)	±2°C	2.2 MΩ
	D	0°C to 2300°C(32°F to 4172°F)	±2°C	2.2 MΩ
	PT100(DIN)	-200°C to 850°C(-328°F to 1562°F)	±0.4°C	1.3KΩ
	PT100(JIS)	-200°C to 600°C(-328°F to 1112°F)	±0.4°C	1.3KΩ
	mA	-3mA to 27mA	±0.05%	2.5Ω
	VDC	-1.3VDC to 11.5VDC	±0.05%	1.5MΩ

Temperature Effect	1.5µV /°C for all inputs except mA input, 3.0µV /°C for mA
Sensor Lead Resistance Effect	Thermocouple: 0.2 µV /°Ω; 3-wire RTD: 2.6°C /Ω of Difference of Resistance of two leads 2-wire RTD: 2.6°C /Ω of Sum of Resistance of two leads
Burn-out Current	200nA
Common Mode Rejection Ratio(CMRR)	120 dB
Normal Mode Rejection Ratio (NMRR)	55dB
Sensor Break Detection	Sensor open for Thermocouple, RTD and mV inputs, Sensor short for RTD input , Below 1mA for 4-20mA input, Below 0.25VDC for 1 - 5VDC input, Not available for other inputs.
Sensor Break Response Time	Within 4 seconds for Thermocouple, RTD and mV inputs, 0.1 second for 4-20mA and 1 - 5VDC inputs.

Remote Set Point Input							
Type	Linear Current, Linear Voltage						
Range	-3mA to 27mA, -1.3VDC to 11.5VDC						
Accuracy	±0.05 %						
Remote Set Point Option	Not Available	Not Available	Available	Available	Available	Available	Not Available
Input Impedance	Current: 2.5Ω, Voltage:1.5MΩ						
Resolution	18 Bits						
Sampling Rate	1.66 Times/Second						
Maximum Rating	280mA maximum for Current Input, 12VDC Maximum for Voltage Input						
Temperature Effect	±1.5µV/°C for Voltage Input , ±3.0µV/°C for Current Input						
Sensor Break Detection	Below 1mA for 4-20mA input, Below 0.25VDC for 1 - 5VDC input, Not available for other inputs.						
Sensor Break Responding Time	0.1 Second						
Event Input							
Number of Event Inputs	1	2	6	6	2	6	1
Logic Low	-10VDC minimum, 0.8VDC maximum.						
Logic High	2VDC minimum, 10VDC maximum						
Functions	See availability table						
CT Input							
CT Type	CT98-1						
Accuracy	±2%of Full scale Reading,±0.2A						
Input Impedance	294Ω						
Measurement Range	0 to 50AAC						
Output of CT	0 to 5VDC						
CT Mounting	Wall (Screw) Mount						
Sampling Rate	1 Time/Second						
Output 1 /Output 2							
Type	Relay, Pulsed Voltage, Linear Voltage or Linear Current						
Relay Rating	2A,240V AC,200000 Life Cycles for Resistive Load						
Pulsed Voltage	Source Voltage 5VDC,Current Limiting Resistance 66Ω						
Linear Output Resolution	15 Bits						
Linear Output Regulation	0.02% for full load change						

Specification	C22	C62	C82	C83	C72	C42	R22
Linear Output Settling Time	0.1 Sec (Stable to 99.9%)						
Isolation Breakdown Voltage	1000 VAC						
Temperature Effect	±0.01% of Span/ °C						
Load Capacity of Linear Output	Linear Current: 500Ω max., Linear Voltage: 10KΩ min						
Alarm							
Relay Type	Form A						
Maximum Rating	2A,240VAC,200000 Life Cycles for Resistive Load						
Alarm Functions	Dwell Timer, Deviation Low, Deviation High, Deviation Band Low, Deviation Band High, Process High, Process Low						
Alarm Mode	Latching, Hold, Normal, Latching/Hold						
Dwell Timer	0.1 to 4553.6 Minutes						
Data Communication							
Interface	RS-485						
Protocol	Modbus RTU (Slave Mode)						
Address	1 to 247						
Baud Rate	2.8KBPS to 115.2KBPS						
Parity Bit	None, Even or Odd						
Stop Bit	1 or 2 Bits						
Data Length	7 or 8 Bits						
Communication Buffer	160 Bytes						
Analog Retransmission							
Output Signal	4-20mA, 0-20 mA,0 - 10VDC						
Resolution	15 Bits						
Accuracy	±0.05% of Span ± 0.0025% / °C						
Load Resistance	0 to 500Ω for current output , 10KΩ minimum for Voltage Output						
Output Regulation	0.01% for full load change						
Output Setting Time	0.1Second (stable to 99.9%)						
Isolation Breakdown	1000VAC min						
Integral Linearity Error	±0.005% of span						
Temperature Effect	±0.0025% of span /°C						
Saturation Low	0mA or 0VDC						
Saturation High	22.2mA or 5.55V,11.1V min						
Linear Output Ranges	0 - 22.2mA (0 - 20mA/4 - 20mA), 0 - 5.55VDC (0 - 5VDC, 1 - 5VDC),0 - 11.1VDC (0 - 10VDC)						
User Interface							
Keypad	4 Keys						
Display Type	4 Digit LCD Display						
No of Display	2	2	3	3	3	3	2
Upper Display Size	0.4"(10mm)	0.58"(15mm)	0.7"(17.7mm)	0.7"(17.7mm)	0.58"(15mm)	0.98"(25mm)	0.31"(8mm)
Lower Display Size	0.19"(4.8mm)	0.3"(7.8mm)	0.4"(11.2mm)	0.4"(11.2mm)	0.32"(8.3mm)	0.55"(14mm)	0.25"(6.5mm)
Programming Port							
Interface	Micro USB						
PC Communication Function	Automatic Setup, Calibration and Firmware upgrade						
Control Mode							
Output 1	Reverse (Heating) or Direct (Cooling) Action						
Output 2	PID cooling control, Cooling P band 50~300% of PB, Dead band -36.0 ~ 36.0 % of PB						
ON-OFF	0.1~50.0°C (0.1~90.0°F) hysteresis control (P band = 0)						
P or PD	0 - 100.0 % offset adjustment						
PID	Fuzzy logic modified Proportional band 0.1 ~ 500.0°C(0.1~900.0°F), Integral time 0 – 3600 Secs, Derivative Time 0 - 360.0 Secs						
Cycle Time	0.1 to 90.0 Seconds						
Manual Control	Heat(MV1) and Cool(MV2)						
Auto-tuning	Cold Start and Warm Start						
Failure Mode	Auto transfer to manual mode while sensor break or A-D Converter damage						
Ramping Control	0 to 500.0°C (0 to 900.0°F)/Minute or 0 to 500.0°C (0 to 900.0°F)/Hour Ramp Rate						
Digital Filter							
Function	First Order						
Time Constant	0,0.2, 0.5, 1, 2, 5, 10, 20, 30, 60 Seconds, Programmable						
Profiler							
Availability	No	No	Option	Option	Option	Option	No
No of Programs	NA	NA	1Program with 16 Segments or 2Programs with each 8 Segments or 4Programs with each 4 Segments				NA
Environmental and Physical Specifications							
Operating Temperature	-10°C to 50°C						
Storage Temperature	-40°C to 60°C						
Humidity	0 to 90 % RH (Non-Condensing)						
Altitude	2000 Meters Maximum						
Pollution	Degree II						
Insulation Resistance	20MΩ Minimum(@500V DC)						
Dielectric Strength	2000VAC,50/60 Hz for 1 Minute						
Vibration Resistance	10 to 55 Hz , 10m/s^2 for 2 Hours						

Specification	C22	C62	C82	C83	C72	C42	R22
Shock Resistance	200 m/s^2(20g)						
Housing	Flame Retardant Polycarbonate						
Mounting	Panel	Panel	Panel	Panel	Panel	Panel	DIN Rail
Dimensions (W*H*D) (mm)	48*24*92	48*48*59	48*96*59	96*48*59	72*72*59	96*96*59	22.5*96*83
Depth Behind Panel (mm)	84	50	50	50	50	50	
Cut Out Dimensions (mm)	45*22.2	45*45	45*92	92*45	68*68	92*92	
Weight (grams)	120	160	220	220	190	290	160
Approval Standards							
Safety	UL61010-1, CSA 22.2 No.61010-1-12, EN61010-1 (IEC1010-1)						
Protective Class	IP66 for Panel (In process), IP20 for terminals and housing. All indoor use.						
EMC	EN61326						

1.4 Keys and Displays

KEYPAD OPERATION

SCROLL KEY: ▣

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

UP KEY: ▲

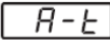This key is used to increase the value of the selected parameter.

DOWN KEY: ▼

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

RESET KEY: R

This key is used to:

1. Revert the display to the home screen.
2. Reset a latching alarm once the alarm condition is removed.
3. Stop manual control mode, auto-tuning mode or calibration mode.
4. Clear an auto-tuning or communication error message.
5. Restart the dwell timer when the dwell timer has timed out.
6. Enter the manual control menu if failure mode occurs.

ENTER KEY: Press ▣ and hold for 5 seconds or longer to:

1. Enter the setup menu. The display will show [SEt] .
2. Enter manual control mode. The display will show [HAnd].
3. Enter auto-tuning mode. The display will show [A-t] .
4. Perform calibration of a selected parameter during the calibration procedure.

Press and hold ▣ for 6.2 seconds, then let go, to select manual control mode.
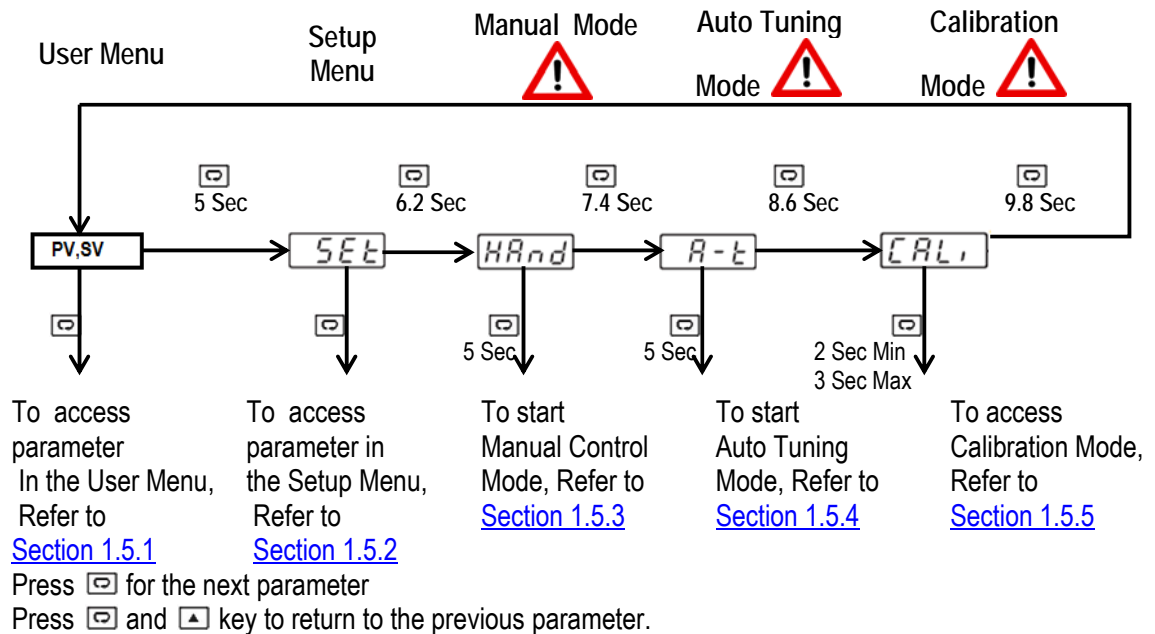Press and hold ▣ for 7.4 seconds, then let go to select auto-tuning mode.
Press and hold ▣ for 8.6 seconds, then let go to select calibration mode.

During power-up, the upper display will show PROG and the lower display will show the Firmware version for 6 seconds.

1.5 Menu Flowchart

The Menu has been divided in to 5 groups. They are as follows:

1. User Menu
2. Setup Menu
3. Manual Mode Menu
4. Auto Tuning Mode Menu
5. Calibration Mode Menu

User Menu	Setup Menu	Manual Mode ⚠️	Auto Tuning Mode ⚠️	Calibration Mode ⚠️
	5 Sec	6.2 Sec	7.4 Sec	8.6 Sec	9.8 Sec
PV,SV	5Et	HAnd	A-t	CALi
		5 Sec	5 Sec	2 Sec Min / 3 Sec Max

To access parameter In the User Menu, Refer to Section 1.5.1

To access parameter in the Setup Menu, Refer to Section 1.5.2

To start Manual Control Mode, Refer to Section 1.5.3

To start Auto Tuning Mode, Refer to Section 1.5.4

To access Calibration Mode, Refer to Section 1.5.5

Press ⌷ for the next parameter
Press ⌷ and ▲ key to return to the previous parameter.

1.5.1 User Menu

The below user menu parameters are available depends on their selection in the event input function.
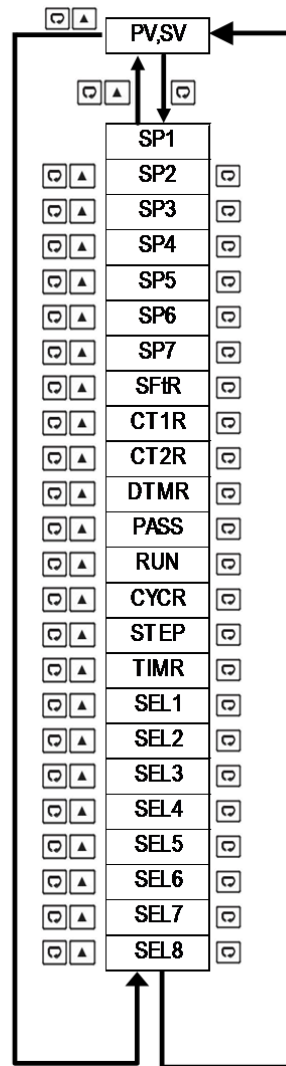
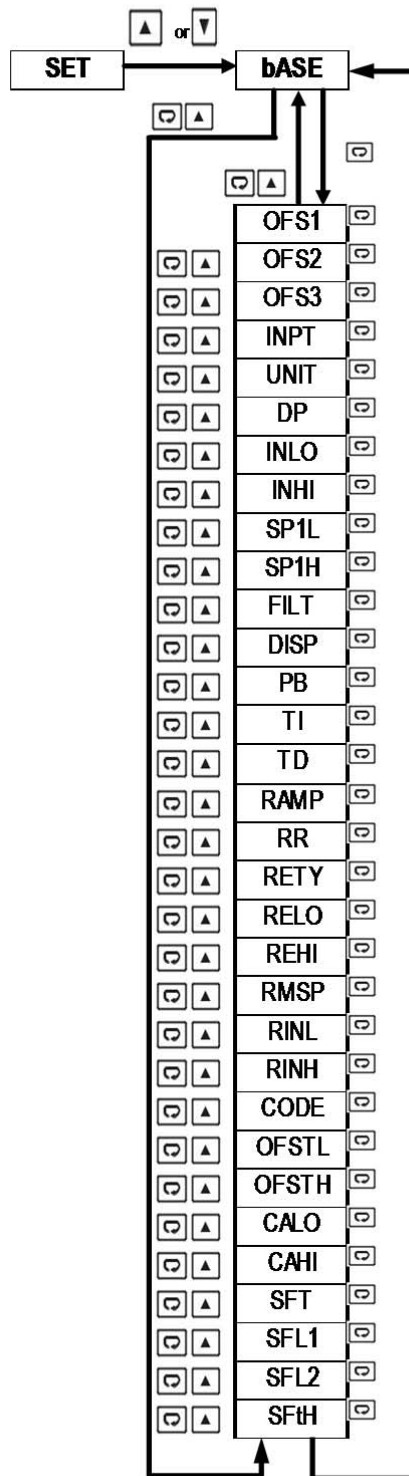## 1.5.2 Setup Menu

The setup menu has been categorized in to eight categories. They are listed as below.

1. Basic Menu
2. Output Menu
3. Alarm Menu
4. Event Input Menu
5. SEL Menu
6. Communication Menu
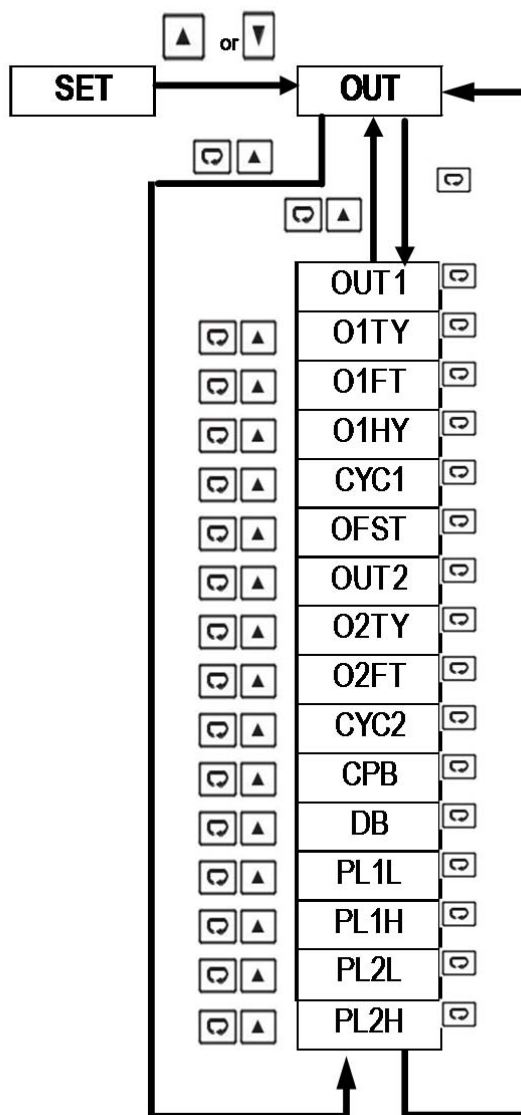7. Current Transformer Input Menu
8. Profile Menu

1.5.2.1 Basic Menu (bASE)

Use ▼ or ▲ key to get bASE in the lower display then use ▣ key to enter to basic menu parameters.

```
                    ▲  or ▼
        ┌─────────┐      ┌─────────┐
        │   SET   │─────▶│  bASE   │◀────────┐
        └─────────┘      └─────────┘         │
           ▣ ▲                 │             │
                              ▣ ▲            ▣
                          ┌─────────┐
                          │  OFS1   │ ▣
                          ├─────────┤
                     ▣ ▲  │  OFS2   │ ▣
                          ├─────────┤
                     ▣ ▲  │  OFS3   │ ▣
                          ├─────────┤
                     ▣ ▲  │  INPT   │ ▣
                          ├─────────┤
                     ▣ ▲  │  UNIT   │ ▣
                          ├─────────┤
                     ▣ ▲  │   DP    │ ▣
                          ├─────────┤
                     ▣ ▲  │  INLO   │ ▣
                          ├─────────┤
                     ▣ ▲  │  INHI   │ ▣
                          ├─────────┤
                     ▣ ▲  │  SP1L   │ ▣
                          ├─────────┤
                     ▣ ▲  │  SP1H   │ ▣
                          ├─────────┤
                     ▣ ▲  │  FILT   │ ▣
                          ├─────────┤
                     ▣ ▲  │  DISP   │ ▣
                          ├─────────┤
                     ▣ ▲  │   PB    │ ▣
                          ├─────────┤
                     ▣ ▲  │   TI    │ ▣
                          ├─────────┤
                     ▣ ▲  │   TD    │ ▣
                          ├─────────┤
                     ▣ ▲  │  RAMP   │ ▣
                          ├─────────┤
                     ▣ ▲  │   RR    │ ▣
                          ├─────────┤
                     ▣ ▲  │  RETY   │ ▣
                          ├─────────┤
                     ▣ ▲  │  RELO   │ ▣
                          ├─────────┤
                     ▣ ▲  │  REHI   │ ▣
                          ├─────────┤
                     ▣ ▲  │  RMSP   │ ▣
                          ├─────────┤
                     ▣ ▲  │  RINL   │ ▣
                          ├─────────┤
                     ▣ ▲  │  RINH   │ ▣
                          ├─────────┤
                     ▣ ▲  │  CODE   │ ▣
                          ├─────────┤
                     ▣ ▲  │  OFSTL  │ ▣
                          ├─────────┤
                     ▣ ▲  │  OFSTH  │ ▣
                          ├─────────┤
                     ▣ ▲  │  CALO   │ ▣
                          ├─────────┤
                     ▣ ▲  │  CAHI   │ ▣
                          ├─────────┤
                     ▣ ▲  │   SFT   │ ▣
                          ├─────────┤
                     ▣ ▲  │  SFL1   │ ▣
                          ├─────────┤
                     ▣ ▲  │  SFL2   │ ▣
                          ├─────────┤
                     ▣ ▲  │  SFtH   │ ▣
                          └─────────┘
```
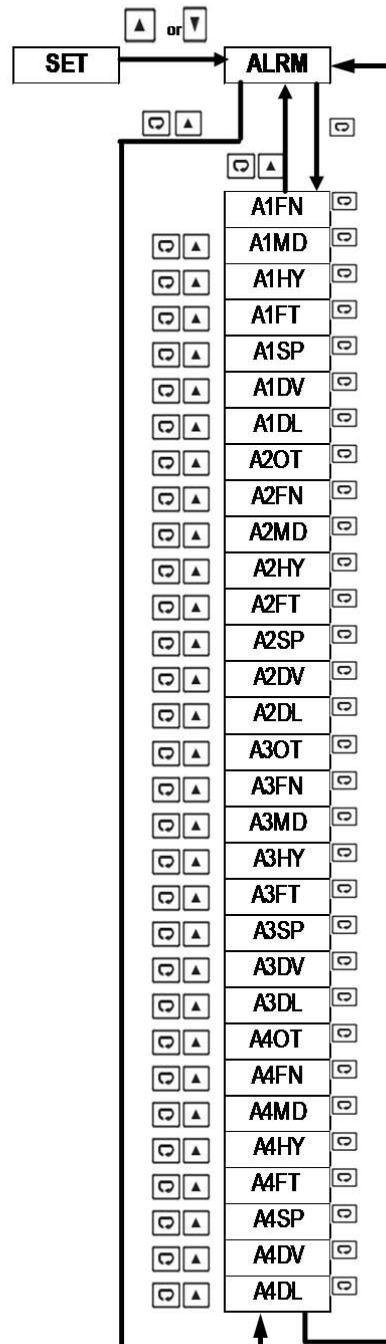
1.5.2.2 Output Menu (oUT)

Use ▼ or ▲ key to get oUT in the lower display then use ▣ key to enter to output menu parameters.
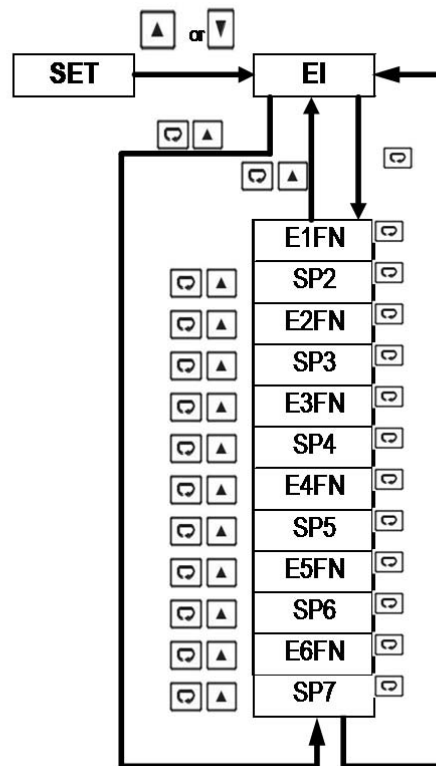
1.5.2.3   Alarm Menu (ALRM)

Use ▽ or △ key to get ALRM in the lower display then use ▭ key to enter to alarm menu parameters.
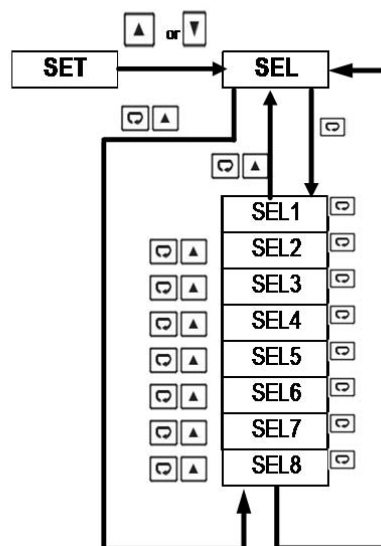
1.5.2.4   Event Input Menu (EI)

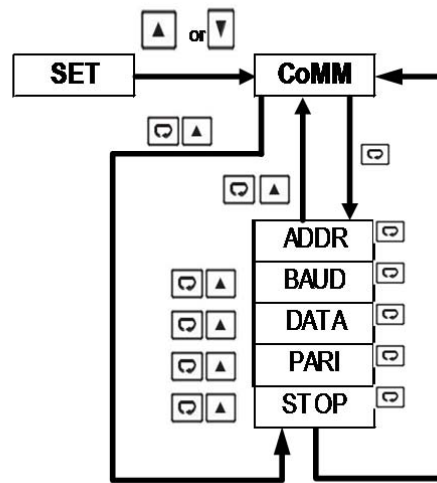Use ▼ or ▲ key to get EI in the lower display then use 回 key to enter to event input menu parameters.

```
              ▲ or ▼
  ┌───────┐        ┌───────┐
  │  SET  │───────▶│  EI   │◀────────┐
  └───────┘        └───────┘         │
                                     │
        ┌──────────────────────────┐ │
        │                          │ │
                   ┌──────┐        │
                   │ E1FN │ 回     │
                   ├──────┤        │
                   │ SP2  │ 回     │
                   ├──────┤        │
                   │ E2FN │ 回     │
                   ├──────┤        │
                   │ SP3  │ 回     │
                   ├──────┤        │
                   │ E3FN │ 回     │
                   ├──────┤        │
                   │ SP4  │ 回     │
                   ├──────┤        │
                   │ E4FN │ 回     │
                   ├──────┤        │
                   │ SP5  │ 回     │
                   ├──────┤        │
                   │ E5FN │ 回     │
                   ├──────┤        │
                   │ SP6  │ 回     │
                   ├──────┤        │
                   │ E6FN │ 回     │
                   ├──────┤        │
                   │ SP7  │ 回     │
                   └──────┘        │
```

1.5.2.5   SEL Menu (SEL)

Use ▼ or ▲ key to get SEL in the lower display then use 回 key to enter to select the user menu parameters.

```
              ▲ or ▼
  ┌───────┐        ┌───────┐
  │  SET  │───────▶│  SEL  │◀────────┐
  └───────┘        └───────┘         │
                                     │
                   ┌──────┐          │
                   │ SEL1 │ 回       │
                   ├──────┤          │
                   │ SEL2 │ 回       │
                   ├──────┤          │
                   │ SEL3 │ 回       │
                   ├──────┤          │
                   │ SEL4 │ 回       │
                   ├──────┤          │
                   │ SEL5 │ 回       │
                   ├──────┤          │
                   │ SEL6 │ 回       │
                   ├──────┤          │
                   │ SEL7 │ 回       │
                   ├──────┤          │
                   │ SEL8 │ 回       │
                   └──────┘          │
```
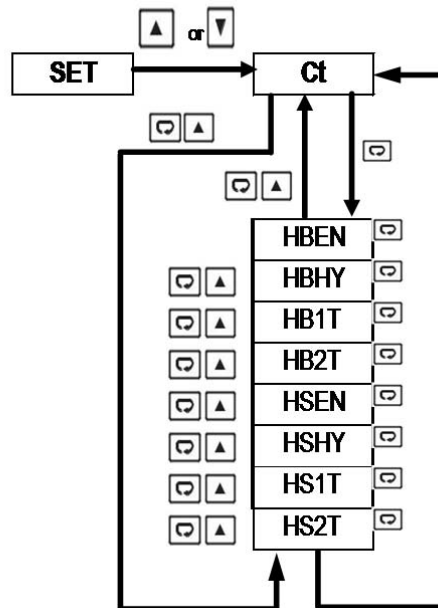
1.5.2.6 Communication Menu (CoMM)

Use ▼ or ▲ key to get CoMM in the lower display then use ⊡ key to enter in to communication menu parameters.
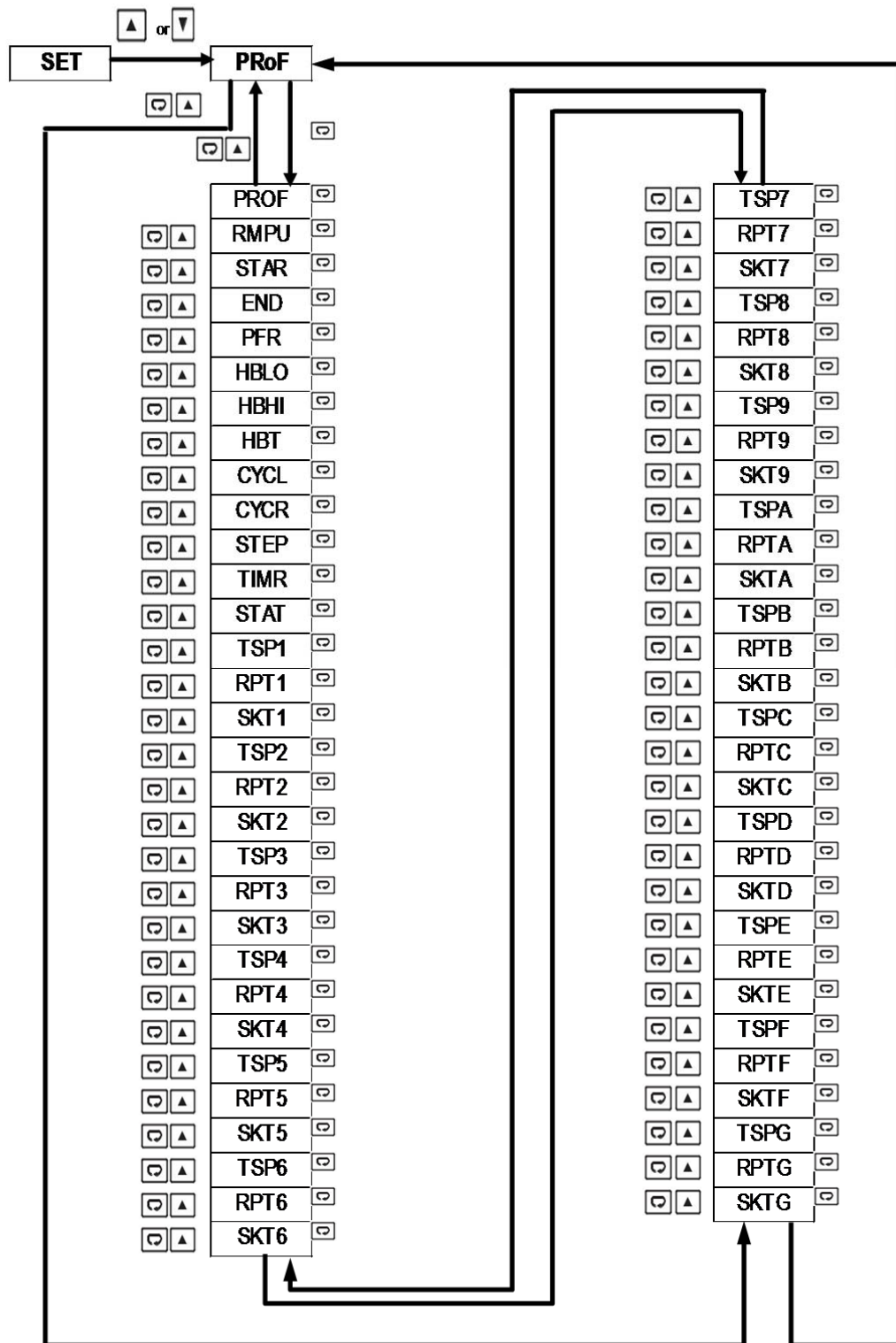

1.5.2.7 Current Transformer Input Menu (Ct)

Use ▼ or ▲ key to get Ct in the lower display then use ⊡ key to enter in to Current transformer(CT) input menu parameters.
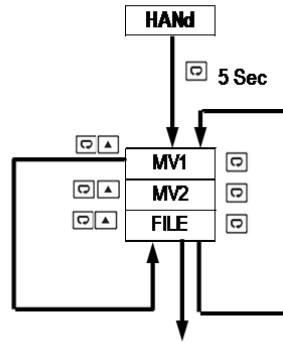
1.5.2.8 Profile Menu (PRoF)

Use ▼ or ▲ key to get PRoF in the lower display then use ⊡ key to enter in to Profile menu parameters.

PROF			TSP7
RMPU			RPT7
STAR			SKT7
END			TSP8
PFR			RPT8
HBLO			SKT8
HBHI			TSP9
HBT			RPT9
CYCL			SKT9
CYCR			TSPA
STEP			RPTA
TIMR			SKTA
STAT			TSPB
TSP1			RPTB
RPT1			SKTB
SKT1			TSPC
TSP2			RPTC
RPT2			SKTC
SKT2			TSPD
TSP3			RPTD
RPT3			SKTD
SKT3			TSPE
TSP4			RPTE
RPT4			SKTE
SKT4			TSPF
TSP5			RPTF
RPT5			SKTF
SKT5			TSPG
TSP6			RPTG
RPT6			SKTG
SKT6			

1.5.3 Manual Mode Menu

Press ⊡ key 5 Sec To execute the selected default program

1.5.4 Auto Tuning Mode

Press ⊡ key 5 seconds to activate Auto tuning Mode

1.5.5 Calibration Mode
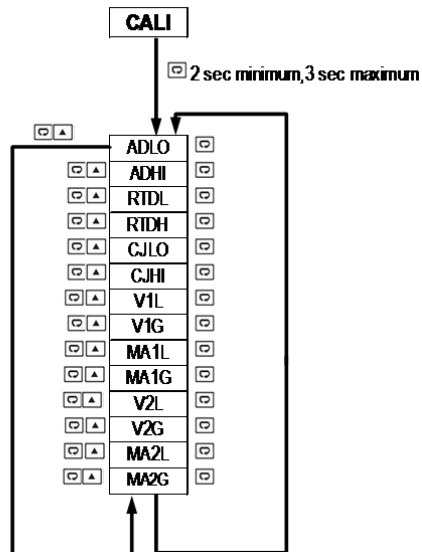
Press ⊡ key for 2 seconds or longer (not more than 3 seconds) then release it to enter calibration Mode.
Press ⊡ Key for 5 seconds to perform calibration.

Note:

- Using Manual, Auto tuning, Calibration modes will break the control loop and change some of the previous setting data. Make sure that the system is allowable to apply these modes.
- The flow chart shows a complete list of all parameters. For actual application, the number of available parameters will vary depending on the setup and model of controller, and will be less than that shown in the flow chart.
- The user can select up to 8 parameters to put in the user menu by using the SEL1~SEL8 parameters in the setup menu

2   Installation and Wiring

⚠️Sometimes dangerous voltages capable of causing death are present in this instrument. Before doing installation or any troubleshooting procedures, the power to the 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 area should not exceed the maximum rating specified in the specification

⚠️Remove stains from this equipment using a soft, dry cloth. Do not use harsh chemicals, volatile solvents such as thinner or strong detergents to clean the equipment in order to avoid deformation.

2.1   Unpacking

Upon receipt of the shipment, remove the controller from the carton and inspect the unit for shipping damage. If any damage is found, contact your local representative immediately. Note 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.
The controller is designed for indoor use only, and is not intended for use in any hazardous area. It should be kept away from shock, vibration, and electromagnetic fields (such as variable frequency drives), motors and transformers. It is intended to operate under the following environmental conditions.

Environmental Parameter	Specification
Operating Temperature	-10°C to 50 °C
Humidity	0% to 90% RH(Non-condensing)
Altitude	2000 M Maximum

2-1. Environmental Specification

2.2   Mounting

Make the panel cut out as per the dimensions required by the controller. The dimensions of the different sizes of this series controller series are given in the following section. Remove the mounting clamps from the controller and insert the controller into the panel cut out. After inserting the controller into the panel cut out, re-install the mounting clamps. Gently tighten the clamp screws until the controller is properly secured into the cutout.

2.3 Wiring

⚠️Sometimes dangerous voltages capable of causing death are present in this instrument. Before doing installation or any troubleshooting procedures, the power to the 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.

The utmost care must be taken to ensure that the maximum voltage rating specified on the label is not exceeded.

It is recommended that the supply power of these units be protected by fuses or circuit breakers rated at the lowest value possible

All units should be installed inside a suitably grounded metal enclosure to prevent live parts being accessible to human hands and metal tools.

All wiring must conform to appropriate standards of good practice and local codes and regulations. Wiring must be suitable for the voltage, current, and temperature rating of the system.

The tightening torque on the Screw terminals should not exceed 1 N-m (8.9 Lb-in or 10.2 Kg F-cm). Except Thermocouple Wiring, all other wires used are to be standard copper conductors with the maximum Gauge not exceeding 18AWG. Before power on the controller, the equipment ground must be connected with minimum of 1.6mm diameter conductor for protective grounding.

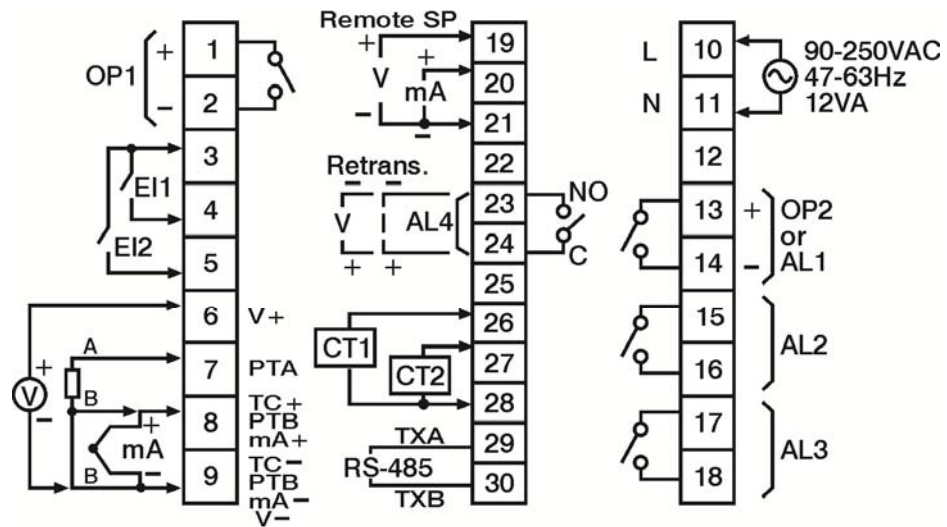### 2.3.1 C22 Terminal Connection
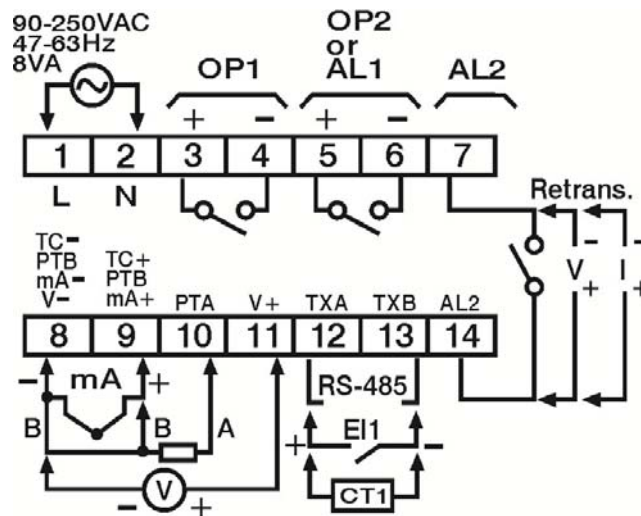
2.3.2 C62 Terminal Connection
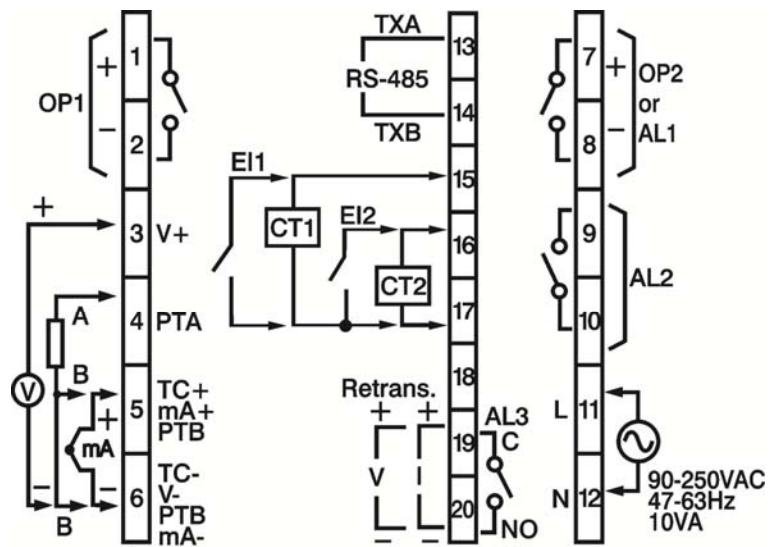
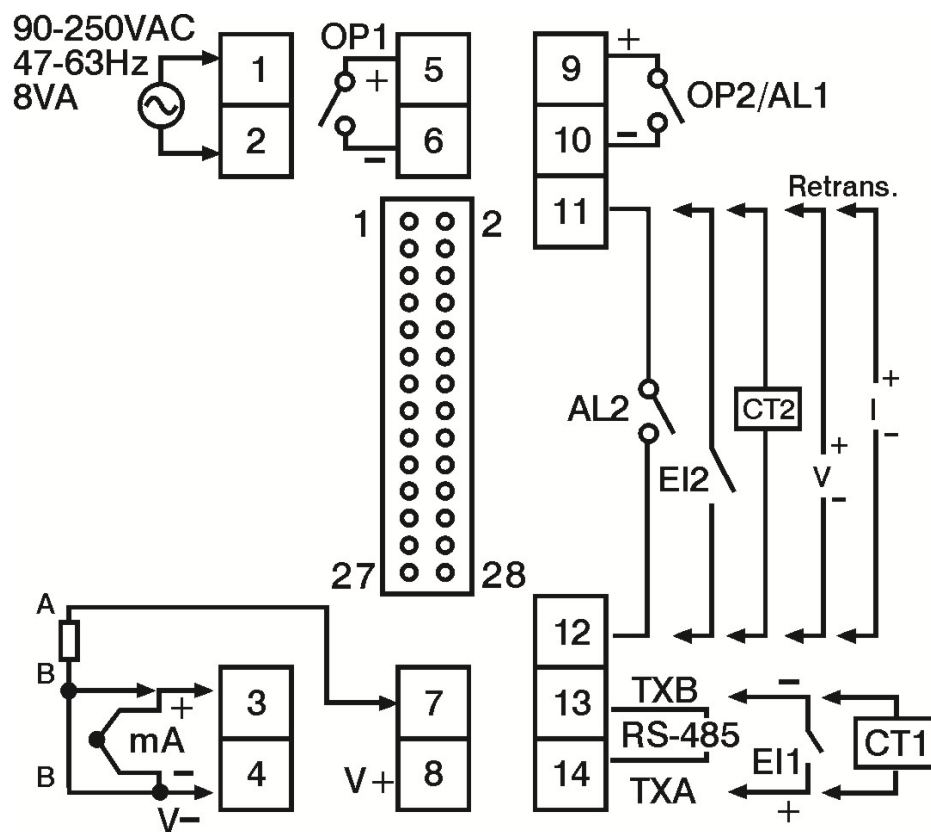### 2.3.3 C82 & C42 Terminal Connection
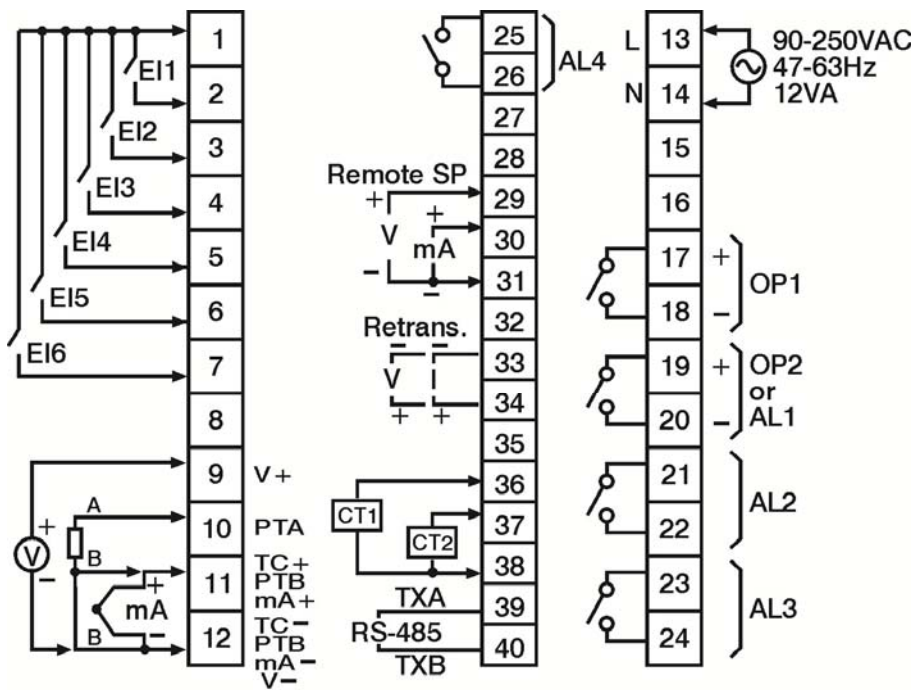
2.3.4 C83 Terminal Connection
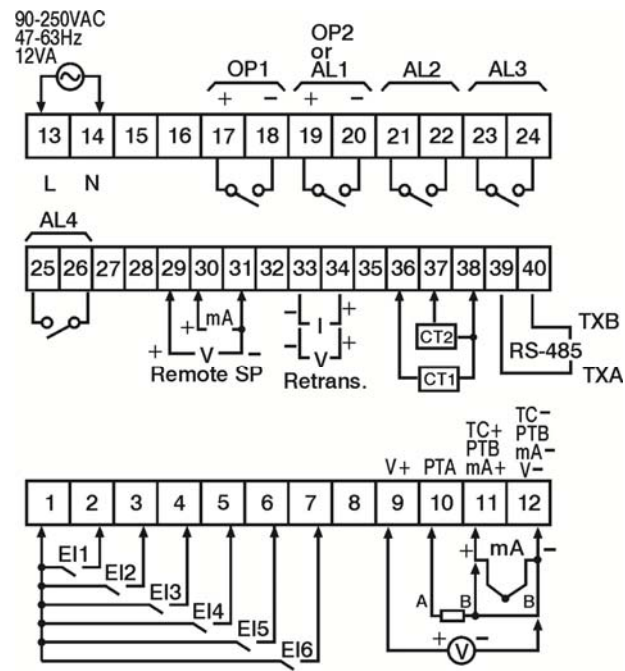
2.3.5 C72 Terminal Connection

2.3.6 R22 Terminal Connection

3   Programming

Press [⟳] for 5 seconds and release to enter the setup menu. Press and release [⟳] to select the desired parameter. The upper display indicates the parameter symbol, and the lower display indicates the value of the selected parameter.

3.1   User Security

There are two parameters PASS (password) and CODE (security code) which will control the data security function.

CODE Value	PASS Value	Access Rights
0	Any Value	All parameters are changeable
1000	=1000	All parameters are changeable
	≠1000	Only user menu parameters changeable
9999	=9999	All parameters are changeable
	≠9999	Only SP1 to SP7 are changeable
Others	=CODE	All parameters are changeable
	≠CODE	No parameters can be changed

3.2   Signal Input

INPT: Select the sensor type or signal type for signal input
> 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, 0-60, 0-1V, 0-5V, 1-5V, 0-10

UNIT: Select the process unit
> Range: °C, °F, PU (Process unit). If the unit is neither °C nor °F, then selects PU.

DP: Select the resolution of process value.
> Range: For Thermocouple and RTD Signal NO.DP, 1-DP and For Linear Signal NO.DP, 1- DP, 2-DP, 3-DP

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

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

How to use INLO and INHI:

If 4-20mA is selected for INPT, let SL represent the low scale of the input signal (i.e. 4 mA), let SH represent the high scale of the input signal (i.e. 20 mA). S represents the current input signal value; the conversion curve of the process value is shown as follows:
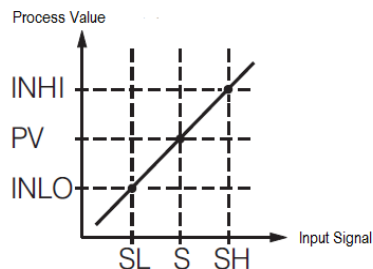
Formula: PV = INLO + (INHI-INLO) ((S – SL)/ (SH-SL))

Example: A 4 -20mA current loop pressure transducer with range of 0-15 kg/cm is connected to the input. The following parameters should be set as follows:

INPT = 4–20, INLO = 0.00, INHI = 15.00, DP = 2-DP

Of course, the user may select a different value for DP to alter the resolution.

3.3 Control Output

There are 4 kinds of control modes can be configured as shown below.

Control Mode	OUT 1	OUT 2	O1HY	O2HY	CPB	DB
Heat Only	REVR	X	Δ	X	X	X
Cool Only	DIRT	X	Δ	X	X	X
Heat PID Cool ON-OFF	REVR	DE.HI	X	O	X	X
Heat PID Cool PID	REVR	COOL	X	X	O	O

X: Not applicable
O: Adjust to meet process Requirements
Δ: Required if ON-OFF Control is configured

3.3.1 Heat Only ON-OFF Control

Select REVR for OUT1, Set PB to 0. O1HY is used to adjust the dead band for ON-OFF control. The output 1 hysteresis (O1HY) setting becomes available when PB = 0. The heat only ON-OFF control function is shown below.
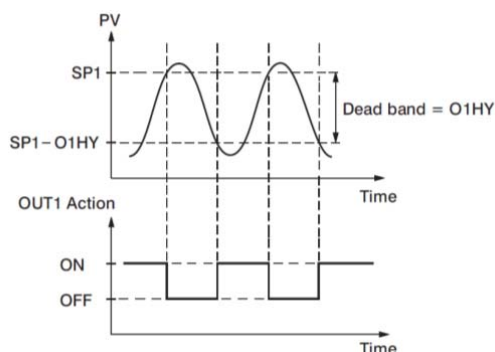
ON-OFF control may cause excessive process oscillations even if the hysteresis is set to the smallest value. If ON-OFF control is set (i.e. PB = 0), TI, TD, CYC1, OFST, CYC2, CPB, DB will no longer be applicable and will be hidden. Auto-tuning mode and bumpless transfer will also be unavailable.

3.3.2 Heat only P or PD Control

Select REVR for OUT1, set TI = 0, OFST is used to adjust the control offset (manual reset).If PB ≠0 then O1HY will be hidden.

OFST Function: OFST is measured in % with a range of 0 - 100.0 %. When the process is stable, let's say the process value is lower than the set point by 5°C. Let's also say that 20 is used for the PB setting. In this example, 5°C is 25% of the proportional band (PB).

By increasing the OFST value by 25%, the control output will adjust itself, and the process value will eventually coincide with the set point.

When using Proportional (P) control (TI = 0), auto-tuning will be unavailable. Refer to "manual tuning " section for the adjustment of PB and TD. Manual reset (OFST) is usually not practical because the load may change from time to time; meaning the OFST setting would need to be constantly adjusted. PID control can avoid this problem.

3.3.3 Heat only PID Control

Select REVR for OUT1. PB and TI should not be zero. Perform auto-tuning for initial startup, or set PB, TI and TD using historical values. If the control result is not satisfactory, use manual or auto-tuning to improve the control performance. The unit contains a very clever PID and Fuzzy algorithm to achieve the set point with a very small overshoot and very quick response to the process if it is properly tuned.

3.3.4 Cool only Control

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

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

3.3.5 Other Setup Required

O1TY, CYC1, O2TY, CYC2, O1FT, O2FT O1TY & O2TY are set in accordance with the type of outputs installed (OUT1 & OUT2) installed. CYC1 & CYC2 are set according to the output 1 type (O1TY) & output 2 type (O2TY). Generally, if SSRD or SSR is used for O1TY, CYC1 is set to a value of 0.5 - 2 seconds. If a Relay is used for O1TY, CYC1 is set to a value of 10 - 20 seconds .If a linear output is used, CYC1 is not applicable. The similar conditions are applied for CYC2 selection.

The user can use auto-tuning program for initial start-up, or they can directly set the appropriate values for PB, TI & TD using the historical records for repeat systems. If the control behavior is still inadequate, then manual tuning may be required to improve control.

3.3.6 CPB Programming

The cooling proportional band is measured by % of PB with a range of 50~300. Initially, set 100% for CPB and examine the cooling effect. If the cooling action should be enhanced, decrease the CPB value. If the cooling action is too strong, increase the CPB value. The value of CPB is directly proportional to the PB setting. Its value remains unchanged throughout the auto-tuning process.

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

3.3.7 DB Programming

Adjustment of DB (Dead band) is dependent on system requirements. If greater dead band is used, then an unwanted cooling action can be avoided, but an excessive overshoot of the set point will occur. If a smaller dead band (DB) is used, then an excessive overshoot can be minimized, but an overlapping of the heating and cooling action will occur. The DB setting is adjustable in the range of -36.0% to 36.0 % of PB.
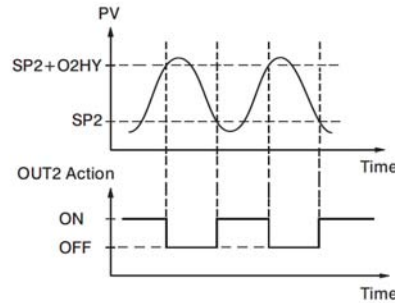
A negative DB value will have an overlap where both outputs are active. A positive DB value has a dead band area where neither output is active.

3.3.8 Output 2 ON-OFF Control (Alarm function)

Output 2 can also be configured as an alarm output. There are 8 kinds of alarm functions and a Dwell timer (dtMR) that can be selected for output 2. They are dtMR (Dwell Timer), dE.HI (deviation high alarm), dE.Lo (deviation low alarm), dB.Hi (Out of band alarm),dB.Lo(In band Alarm), PV.HI (process value high alarm) and PV.LO (process value low alarm), H.bK (Heater Break Alarm), H.St (Heater Short Alarm).
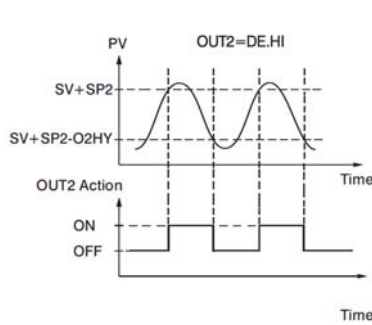
Output 2 Deviation High Alarm   *Output 2 Process Low Alarm*

3.4 Soft-Start

The controller has soft start function to limit the control output on out1 and out2   for a programmable time SFT or up to a programmed threshold value SFTH. The first of two will terminate soft start function and the normal PID control begins. This function is useful for effects such as suppressing the heater output during equipment startup, or lightening the load.

Note: In Profile Version controllers If PFR is set to other than SP1 then the profile function will continue with the set parameter during power recovery. If PFR is set to SP1 then the profile will continue to run with soft start parameters during power recovery.

There are 5 parameters available for soft start function. They are as below.

1. **SFt**: Soft start time. If the   SFt ≠0 then the Soft start function will be enabled. The SFt can be set in the form of Hour: Minute. The range can be set is 00.00 to 99:59.
2. **SFL1**: Soft Start output limit for output 1. It can be set from PL1L to PL1H.
3. **SFL2**: Soft Start output limit for output 2. It can be set from PL2L to PL2H.
4. **SFtH**: Soft start threshold value. The Soft start will be aborted when the process value is greater than or equal to   SFtH.
5. **SFtR**: Soft start time. It will show the remaining time of soft start when it is running.
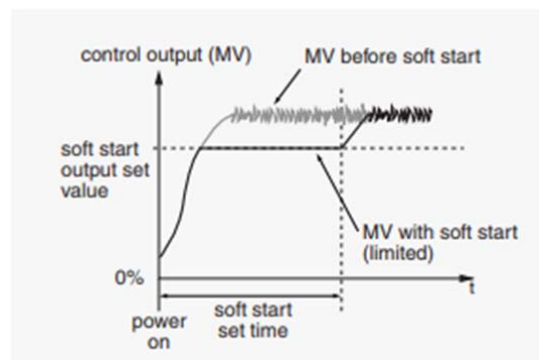
3.5   Alarm

The controller has up to four alarm outputs depending on the controller model. There are 11 types of alarm functions and one dwell timer that can be selected. There are 4 kinds of alarm modes (A1MD, A2MD, A3MD, and A4MD) available for each alarm function (A1FN, A2FN, A3FN, and A4FN). In addition to the alarm output, output 2 can also be configured as an alarm. But output 2 has only provides 8 different alarm functions or dwell timer available.

3.5.1   Alarm Types

There are 11 different types of alarms as listed below that the user can assign to different alarm outputs.

1. **dtMR**: Dwell timer
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. **PV.HI**: Process value high alarm
7. **PV.Lo**: Process value low alarm
8. **H.bK**: Heater break alarm
9. **H.St**: Heater short alarm
10. **E1**.C.o:Event Input 1 Control Alarm Output
11. **E2**.C.o:Event Input 2 Control Alarm Output

The **Dwell timer** can be used separately or accompanied with a Ramp. Alarm outputs can be configured as dwell timers by selecting dtMR for A1FN. If A1FN is set to DTMR, Alarm 1 will act as a dwell timer. Similarly, Alarm 2, Alarm3 or Alarm4 will act as dwell timers if A2FN, A3FN, or A4FN is set to dtMR. When the dwell timer is configured, the parameter DTMR is used for dwell time adjustment.

A deviation alarm alerts the user when the process value deviates too far from the set point. When the process value is higher than SV+A1DV, a **deviation high alarm (dE.HI)** occurs. The alarm is off when the process value is lower than SV+A1DV-A1HY. When the process value is lower thanSV+A1DV, a **deviation low alarm (dE.Lo)** occurs. The alarm is off when the process value is higher than SV+A1DV+A1HY. The trigger level of a deviation alarm is moves with the set point.

A deviation band alarm presets two trigger levels centered on the set point. The two trigger levels are SV+A1DV and SV–A1DV. When the process value is higher than (SV+A1DV) or lower than (SV – A1DV), a **deviation band high alarm (dB.HI)** occurs. When the process value is within the trigger levels, a **deviation band low alarm (dB.Lo)** occurs.

In the above descriptions, SV denotes the current set point value for control. This is different from SP1 when the ramp function is used.

A process alarm can set two absolute trigger levels. When the process value is higher than A1SP, a **process high alarm (PV.HI)** occurs. The alarm is off when the process value is lower than A1SP-A1HY. When the process value is lower than A1SP, a **process low alarm (PV.Lo)** occurs. The alarm is off when the process is higher than A1SP+A1HY. A process alarm is independent of the set point.

In the above description A1SP and A1HY denote Alarm1 Setpoint and Alarm1 Hysteresis. The respective Setpoint and Hysteresis parameters need to be set for other Alarm outputs.

Heater break detection is enabled by setting A1FN to HBEN. A Heater break alarm (H.bK) alerts the user when the current measured by CT1 in CT1R is lower than HB1T-HBHY, or CT2 in CT2R is lower than HB2T-HBHY. When the current measured by CT1 in CT1R is higher than HB1T-HBHY and CT2 in CT2R is lower than HB2T-HBHY, the heater break alarm will be off. The Heater break alarm will be off when both CT values are in normal range. This Alarm will function when output1 is in ON condition only.

The Heater short detection is enabled by setting A1FN to HSEN. A Heater short alarm (H.St) alerts the user when the current measured by CT1 in CT1R is higher than HS1T+HSHY, or CT2 in CT2R is higher than HS2T+HSHY. When the current measured by CT1 in CT1R is lower than HS1T+HSHY and CT2 in CT2R is lower than HS2T+HSHY, the heater short alarm will be off. The Heater short alarm will be off when both CT values are in normal range. . This Alarm will function when output1 is in OFF condition only.

The Heater break and Heater short alarms will work only with Relay and SSR outputs in output1.

The Alarm outputs can be controlled by Event input1 and Event input 2 by selecting **Event Input 1 Control Alarm Output (E1.C.o.) and Event Input 2 Control Alarm Output (E2.C.o.)** for alarm function A2FN and A3FN .The output will be ON as long as the event input is ON. The output will goes OFF when the input is OFF.

3.5.2 Alarm Modes

There are four types of alarm modes available for each alarm function.

1. Normal alarm
2. Latching alarm
3. Holding alarm
4. Latching/ Holding alarm
5. Setpoint Holding Alarm

3.5.2.1 *Normal Alarm: ALMD = NORM*

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

3.5.2.2 *Latching Alarm: ALMD = LTCH*

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

3.5.2.3 *Holding Alarm: ALMD = HOLD*

A holding alarm prevents an alarm condition during power up. This will ignore the alarm condition at first time after power on. Afterwards, the alarm performs the same function as normal alarm.

3.5.2.4 *Latching / Holding Alarm: ALMD = LT.HO*

A latching / holding alarm performs both holding and latching functions. The latching alarm is reset when the RESET key is pressed after the alarm condition is removed.

3.5.2.5 *Set Point Holding Alarm: ALMD = SP.HO*

A set point holding alarm prevents an alarm from power up and / or changing set point. The alarm output is de-energized whenever the set point is changed even if it is in an alarm condition. The alarm reverts to a normal alarm once the alarm condition is removed.

3.5.3 Alarm Delay

In certain applications during startup, nuisance alarms will be generated before the process value reaches the set point. To avoid these kinds of nuisance alarms, a time delay for alarms is available. To enable the time delay for alarms, set the delay time using the A1DL, A2DL, A3DL, and A4DL parameters. These parameters will avoid the nuisance alarm during the process value reaches set point.

For example the process set point set to 100. When the process approaching 100 it will go to 103 and 97. During this time the Hi Alarm will be activated and deactivated continuously. To avoid these kind of nuisance alarms the alarm delay function can be used. It will generate the alarm after the PV is in alarm condition continuously at least for the period of time configured in alarm delay parameters. The alarm delay can be configured in minutes and seconds.

3.5.4 Alarm Failure Transfer

Alarm Failure transfer is activated as the unit enters failure mode. The respective Alarm will go on if ON is set for A1FT, A2FT,A3FT or A4FT and will go off if OFF is set for A1FT,A2FT, A3FT, or A4FT. The unit will enter failure mode if a sensor break occurs or if the A-D converter fails.

3.6   User Menu Configuration

        Conventional controllers are designed with parameters in a fixed order.
If the user needs a friendlier menu operation to suit their application, most conventional controllers do not offer a solution. The C series controllers have the flexibility for the user to select those parameters which are most significant, and put these parameters in an easy access USER menu.

        There are eight user friendly parameters from the below list that can be set for user menu configuration using the SEL1-SEL8 parameters.

1. SP2
2. DTMR
3. DISP
4. Pb
5. Td
6. TI
7. o1HY
8. CPb
9. dB
10. A1HY
11. A1SP
12. A1dV
13. A2HY
14. A2SP
15. A2dV
16. A3HY
17. A3SP
18. A3dV
19. A4HY
20. A4SP
21. A4dV
22. PL1L
23. PL1H
24. PL2L
25. PL2H
26. OFTL
27. OFTH
28. CALO
29. CAHI
30. A1DL
31. A2DL
32. A3DL
33. A4DL

        When using the up-down key to select parameters, all of the above parameters may not be available. The number of visible parameters is dependent on the setup configuration.

Example:
OUT2 is set to DE.LO, PB = 100.0, SEL1 is set to INPT, SEL2 is set to UNIT, SEL3 is set to PB   ,
SEL4 is set to TI, SEL5~SEL8 is set to NONE. Now, the USER menu display appears as below.
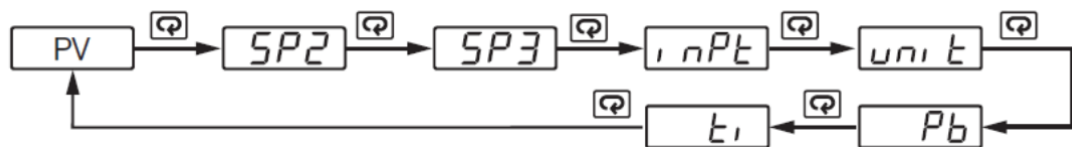
3.7 Ramp

The ramping function is performed during power up as well as any time the set point is changed. Choose MINR or HRR for the RAMP setting, and the controller will perform the ramping function. The ramp rate is programmed by adjusting the RR setting. The ramping function is disabled as soon as the Failure mode, the Manual control mode, the Auto-tuning mode or the Calibration mode occur.

3.7.1 Example without Dwell Timer

Select MINR for RAMP, set °C for UNIT, set 1-DP for DP, Set RR= 10.0, SV is set to 200°C initially, and changed to 100°C after 30 minutes from power up. The starting temperature is 30°C. After power up the process is running like the curve shown below.
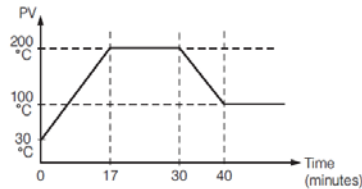
Note: When the ramp function is used, the lower display will show the current ramping value. However it will revert to show the set point value as soon as the up or down key is touched for adjustment. The ramp rate is initiated at power on and/or when the Setpoint is changed. Setting the RR setting to zero means no ramping function at all.

3.8 Dwell Timer

The Dwell timer can be with or without a Ramp. Alarm outputs can be configured as dwell timers by selecting dtMR for A1FN. If A1FN is set to dtMR, Alarm 1 will act as a dwell timer. Similarly, Alarm 2, Alarm3 and Alarm4 will act as dwell timers if A2FN, A3FN, or A4FN is set to dtMR. When the dwell timer is configured, the parameter DTMR is used for dwell time adjustment. The dwell time is measured in minutes ranging from 0.0 to 4553.6 minutes. The Timer starts to count as soon as the Process Value (PV) reaches its set point (SV), and triggers an alarm output once the time has elapsed. The dwell timer operation is shown in the following diagram.
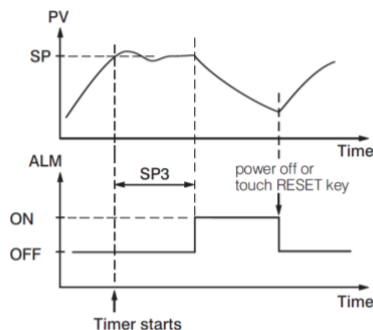
After the timer has finished, the dwell timer can be restarted by pressing the RESET key.

The timer stops counting during manual control mode, failure mode, calibration and auto-tuning.

If alarm1 is configured as a dwell timer, A1HY and A1MD are hidden. It is similar for other alarms as well.

3.9 User Calibration

Each unit is calibrated in the factory before shipment. The user can still modify the calibration in the field.

The basic calibration of the controller is highly stable and set for life. User calibration allows the user to offset the permanent factory calibration in order to:

- ❖ Calibrate the controller to meet a user reference standard.
- ❖ Match the calibration of the controller to that of a particular transducer or sensor input.
- ❖ Calibrate the controller to suit the characteristics of a particular installation.
- ❖ Remove long term drift in the factory set calibration.

There are two parameters: Offset Low (OFTL) and Offset High (OFTH) for adjustment to correct an error in the process value.

There are two parameters for the sensor input. These two signal values are CALO and CAHI. The input signal low and high values are to be entered in the CALO and CAHI parameters respectively.

Refer to <u>section 1.6</u> for key operation and <u>section 1.7</u> for the operation flowchart. Press and hold the ▣ key until the setup Menu page is obtained. Then, press and release the ▣ key to navigate to the calibration low parameter OFTL. Send your low signal to the sensor input of the controller, then press and release the ▣ key. If the process value (the upper display) is different from the input signal, the user can use ▲ and ▼ keys to change the OFTL value (the lower display) until the process value is equal to the value the user needs. Press and hold the ▣ key for 5 seconds to complete the low point calibration. A similar procedure is applied for high scale calibration.

As shown below, the two points OFTL and OFTH construct a straight line. For the purpose of accuracy, it is best to calibrate with the two points as far apart as possible. After the user calibration is complete, the input type will be stored in the memory. If the input type is changed, a calibration error will occur and an error code $CAEr$ is displayed.
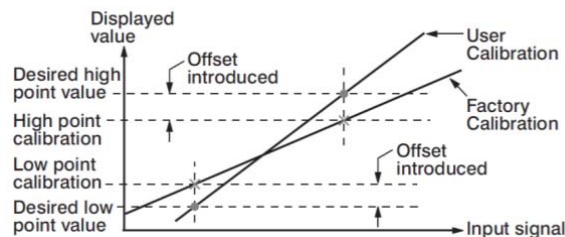

3.10 Digital Filter

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

Note

The Filter is available only for the process value (PV), and is performed for the displayed value only. The controller is designed to use an unfiltered signal for control even when a filter is applied. If a lagged (filtered) signal is used for control; it may produce an unstable process.
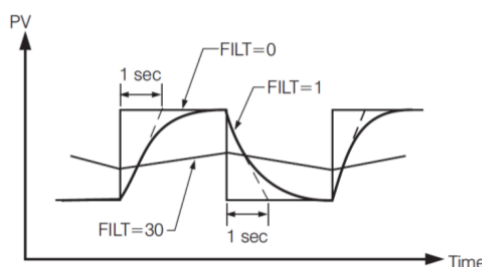
3.11 Failure Transfer

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

1. An SBER error occurs due to an input sensor break, an input current below 1mA for 4-20mA, or an input voltage below 0.25V for 1-5 V.
2. An ADER error occurs due to the A-D converter of the controller fails.

Output 1 and Output 2 will perform the failure transfer (O1.ft & O2.ft) function as the controller enters failure mode.

3.11.1 Output 1 Failure Transfer

If Output 1 Failure Transfer is activated, it will perform as follows:

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

3.11.2 Output 2 Failure Transfer

If Output 2 Failure Transfer is activated, it will perform as follows:

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

3.11.3 Alarm Failure Transfer

An alarm failure transfer is activated as the controller enters failure mode. After that, the alarm output will transfer to the ON or OFF state which is determined by the set value of A1FT, A2FT, A3FT, and A4FT.

3.12 Auto-Tuning

⚠️The auto-tuning process will be performed at the set point (SP1). The process will oscillate around the set point during the tuning process. Set a set point to a lower value if overshooting beyond the normal process value will cause damage. It is usually best to perform auto-tuning at the Setpoint the machine is expected to be operated at, with the process running normally (i.e. material in the oven, etc.)

Auto-Tuning is generally applied in the following cases:

❖ Initial setup for a new process
❖ The set point is changed substantially from the previous Setpoint when auto-tuning was performed.
❖ The control result is unsatisfactory

3.12.1 Auto-Tuning Operation Steps

1. The system has been installed normally.
2. Do not use a zero value for PB or TI; otherwise, the auto-tuning program will be disabled. The LOCK parameter should be set to NONE.
3. Set the set point to a normal operating value or a lower value if overshooting beyond the normal process value will cause damage.
4. Press and hold the [key] key until $\boxed{A\text{-}t}$ appears on the upper display, then let go.
5. Press and hold the [key] key for at least 5 seconds. The TUNE indicator will begin to flash, and the auto-tuning process has begun.

NOTE:

If the ramping function is used, it will be disabled once auto-tuning is started. The auto-tuning mode is disabled if either a failure mode or manual control mode occurs.

Procedures:
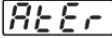
Auto-tuning can be applied either as the process is warming up (Cold Start) or as the process has been in steady state (Warm Start). After the auto-tuning process is completed, the TUNE indicator will stop flashing and the unit will revert to PID control by using its new PID values. The PID values obtained are stored in nonvolatile memory.

3.12.2 Auto Tuning Error

If auto-tuning fails, an ATER $\boxed{AtEr}$ message will appear on the upper display in any of 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 process

3.12.3 Solution for Auto Tuning Error

1. Try auto-tuning once again.
2. Do not change the set point value during the auto-tuning process.
3. Do not set zero value for PB and TI.
4. Use manual tuning
5. Touch RESET $\boxed{R}$ key to reset the $\boxed{AtEr}$ message.

3.13 Manual Tuning

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

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

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

3.14 Manual Control

To enable manual control, ensure the LOCK parameter is set to NONE. Press and hold ⟳ for 6.2 seconds or until $\boxed{HAnd}$ $\boxed{----}$ (Hand Control) appears on the display. Press and hold ⟳ for 5 seconds or until the MAN indicator begins to flash. The lower display will show $\boxed{H\_\_\_}$. The controller has now entered manual control mode. $\boxed{H\_\_\_}$ Indicates the output control variable for output 1, and $\boxed{C\_\_\_}$ indicates the control variable for output 2. The user can use the up-down keys to adjust the percentage values for the heating or cooling output. This % value is based on the CYC1 and CYC2 settings, where the associated output will stay on for the % of time the CYC1 & CYC2 values are set for.

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

The manual mode menu can be reached by pressing ▼ ⟳ keys also

3.14.1 Exit Manual Control

Pressing the $\boxed{R}$ key will revert the controller to its normal display mode.
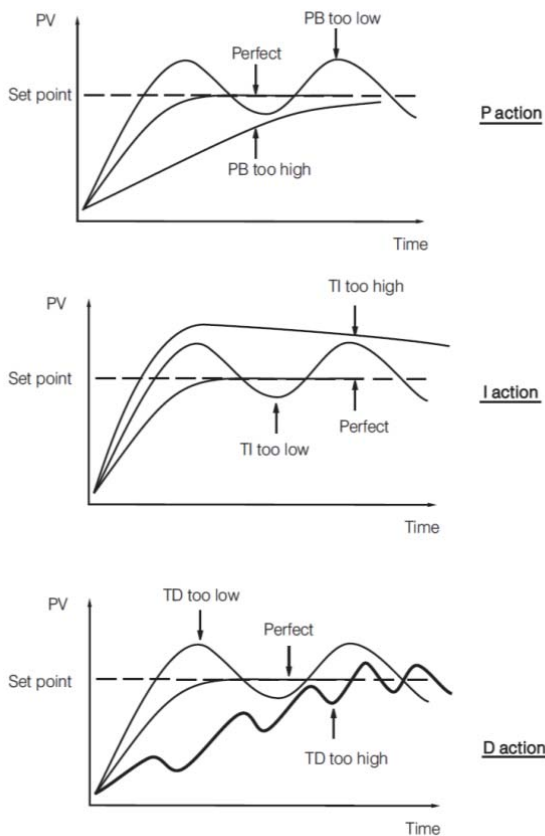
Effects of PID Adjustment

3.15 Factory Default

The controller parameters can be loaded with default values listed in the parameter description table. In certain situation it is desirable to retain these values after the parameters values have been changed. The below procedure to be followed to reload the default values.

1. Ensure the LOCK parameter is set to NONE.
2. Press and hold ⟳ for 6.2 seconds or until $\boxed{HAnd}$ $\boxed{----}$ (Hand Control) appears on the display.
3. Press ⟳ key to navigate the manual mode menu to reach FILE.
4. Press and hold ⟳ for 5 seconds or until the upper display FILE flash for a moment. The default values of all parameters are loaded now.

3.16 Data Communication

The controllers support RS-485 Modbus RTU protocol for data communication. Using a PC for data communication is the most economical way. The signal is transmitted and received through the PC communication Port .Since a standard PC can't support an RS-485 port, a network adaptor such as an RS232 to RS485 Converter or USB to Serial Converter must be used to convert RS-485 to RS-232 or USB for a PC.. Many RS-485 units (up to 247 units) can be connected to one RS-232 port or USB Port .Therefore a PC with 4 comm. ports can communicate with up to 988 units. It is quite economical.

3.16.1 RS-485 Setup

- ❖ Enters the setup menu.
- ❖ Set individual addresses for units connected to the same port.
- ❖ Set the Baud Rate (BAUD), Data Bit (DATA), Parity Bit (PARI) and Stop Bit (STOP) such that these values are accordant with PC setup conditions.

3.17 Retransmission

The controller can output (retransmit) PV or SP via its retransmission terminals RE+ and RE- provided that the retransmission option is ordered. A correct signal type should be selected for option board to meet the retransmission option installed. RELO and REHI are adjusted to specify the low scale and high scale values of retransmission.

3.18 Heater Current Monitoring

A current transformer (CT98-1) is required to measure the heater current. The CT input signal conditioner measures the heater current when the heater is powered (output 1 is on), and the current value will remain unchanged the heater is unpowered (output 1 is off). There are 1 or 2 CT inputs that can be connected to the controllers depending on the model. The CT1R &CT2R will indicate the heater current.

Heater break detection is enabled by enabling heater break detection setting HBEN. A **Heater break alarm (H.bK)** alerts the user when the current measured by CT1 in CT1R is lower than HB1T or CT2 in CT2R is lower than HB2T. When the current measured by CT1 in CT1R is higher than HB1T+HBHY and CT2 in CT2R is higher than HB2T+HBHY, the heater break alarm will be off. The Heater break alarm will be off when both CT values are in normal range. The Heater break alarm function will be enabled when OUT1 is in on condition.

Heater short detection is enabled by enabling heater short detection setting HSEN. A **Heater short alarm (H.St)** alerts the user when the current measured by CT1 in CT1R is higher than HS1T or CT2 in CT2R is higher than HS2T. When the current measured by CT1 in CT1R is lower than HS1T-HSHY and CT2 in CT2R is lower than HS2T-HSHY, the heater short alarm will be off. The Heater short alarm will be off when both CT values are in normal range. The Heater short alarm function will be enabled when OUT1 is in off condition.

Accessory Installed

CT98-1
Required Setup Parameters
Heater Break

1. HBEN
2. HBHY
3. HB1T
4. HB2T

Heater Short

1. HSEN
2. HSHY
3. HS1T
4. HS2T

3.19 Event Input

There are 6 or 2 Event Inputs that are available in this series of controllers depending on the size of the controller. Refer section 2.8 for wiring an event input. The Event input accepts a digital (on/off) type signal. Types of signals that can be used to switch the event input as below.
- ❖ Relay
- ❖ Switch contacts
- ❖ Open collector Pull Low
- ❖ TTL logic level

One of the below functions can be chosen by using **EIFN1 through EIFN6** contained in the setup menu. The same function cannot be set to more than one event input.

3.19.1 Event Input Functions

1. NONE
2. SP2
3. RS.A1
4. RS.A2
5. RS.A3
6. RS.AO
7. CA.LH
8. D.O1
9. D.O2
10. D.O1.2
11. LOCK
12. AU.MA
13. F.tra
14. AL.oN
15. StAR: Run profile as RUN=STAR
16. CoNt: Run profile as RUN=CONT
17. PV: Run profile as RUN=PV
18. Hold: Run profile as RUN=HOLD
19. StoP: Run profile as RUN=STOP

NONE: No Event input 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.
RS.A1: Reset Alarm 1 as the event input is activated. However, if the alarm 1 condition still exists, alarm 1 will be triggered again when the event input is released.
RS.A2: Reset Alarm 2 as the event input is activated. However, if the alarm 2 condition still exists, alarm 2 will be triggered again when the event input is released.
RS.A3: Reset Alarm 3 as the event input is activated. However, if the alarm 3 condition still exists, alarm 3 will be triggered again when the event input is released.

RS.AO: Reset all Alarms as the event input is activated. However, if the alarm condition still exists, the alarm will be triggered again when the event input is released.

CA.LH: Cancel the latched alarm as the event input is activated.

D.O1: Disable Output 1 as the event input is activated.

D.O2: Disable Output 2 as the event input is activated.

D.O1.2: Disable both Output 1 and Output 2.

> **Note:** When any of D.O1, D.O2 or D.O1.2 is 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 and unable to be changed (Read only) in communication.

AU.MA: Switch between auto tuning and manual tuning control mode.

F.tra: Switch to Failure Transfer Mode

AL.oN: If Alarm 2 or Alarm 3 set to E1.c.o or E2.c.o then EI1 or EI2 will activate Alarm Output Alarm 2 or Alarm 3.

StAR: Run profile as RUN=STAR

CoNt: Run profile as RUN=CONT

PV: Run profile as RUN=PV

Hold: Run profile as RUN=HOLD

StoP: Run profile as RUN=STOP

3.20 Remote Set Point

The Setpoint will change proportionally with respect to the input given in the remote Setpoint input terminals. The remote Setpoint function needs the below parameters to be set properly.

1. RMSP
2. RINL
3. RINH

3.21 Ramp and Soak Program

The new C Series controller with profile option can be used in the application where the set point should be changed automatically with the time. It provides 1 program with 16 segment or 2 programs with each 8 segments or 4 programs with each 4 segments. Each segment has both ramp and soak function.

The following parameters are used to configure the controller for ramp and soak programs.

1. PROF
2. RUN
3. RMPU
4. STAR
5. END
6. PFR
7. HBLO
8. HBHI
9. HBT
10. CYC

3.21.1 PROF

Select the required segments to run. There are 8 options available for the user to select the profile segments.

1. **NoNE**: Not used
2. **1--4**: Uses steps 1 to 4
3. **5--8**: Uses steps 5 to 8
4. **1--8**: Uses steps 1 to 8
5. **9-12**: Uses steps 9 to 12
6. **1316**: Uses steps 13 to 16
7. **9-16**: Uses steps 9 to 16
8. **1-16**: Uses steps 1 to 16

3.21.2 RUN

Select the profile rune mode. There are 5 modes available in the controller.

1. **StAR**: Start to run profile
2. **CoNt**: Continue run profile
3. **PV**: Continue run profile from current PV
4. **Hold:** Hold profile
5. **SToP**: Stop profile

3.21.2.1 StAR

The Profile starts to run from the first segment in the selected profile. In run mode, the profiler varies the set point according to the stored profile values.

3.21.2.2 CoNt

The Profile starts to run from the segment where it stopped.

3.21.2.3 PV

The Profile starts to run from the segment where it stopped with current process value.

3.21.2.4 Hold

In hold mode, the profile is frozen at its current point. In this state the user can make temporary changes to any profile parameter (for example, a target set point, a dwell time or the time remaining in the current segment). Such changes will only remain effective until the profile is reset and run again and when they will be overwritten by the stored profile values.

3.21.2.5 StoP

In stop mode the Profile is stopped.

3.21.3 RMPU

Select the Ramp and Soak time units to be used. The options available for selection are Hour Minutes (HH:MM) and Minute Seconds (MM:SS)

3.21.4 STAR

The Set point value of the profile start. The options available for selection is Process value (PV) and controller Setpoint (SP1).

The normal method is to start the profile from the process value, because this will produce a smooth and bumpless start to the process. However, to guarantee the time period of the first segment, the STAR set to SP1 for the start point

3.21.5 END

The Set point value at the end of profile. The options available for end Setpoint is Controller Setpoint (SP1).

3.21.5.1 SP1

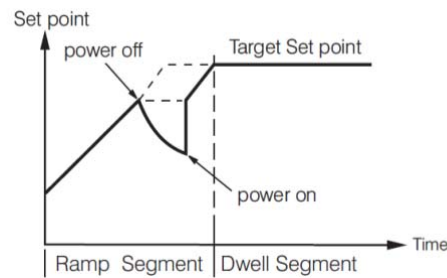The Profile ends with controller Setpoint SP1.

3.21.6 PFR

If power is lost and then restored, while a profile is running, the behaviour of the profile is determined by the setting of the parameter "PFR "power fail recovery in profile configuration. The options available for PFR are CONT, PV, SP1 and OFF.

3.21.6.1 CONT

If CONT is selected, then when power is restored the profile continues from where it was interrupted when power was lost. The parameters such as set point value (SV), time remaining (DTMR) and cycle remaining (CYCR) will be restored to their power-down values. For applications that need to bring the process value to the set point value as soon as possible, this is the best choice. The two diagrams below illustrate the respective responses.
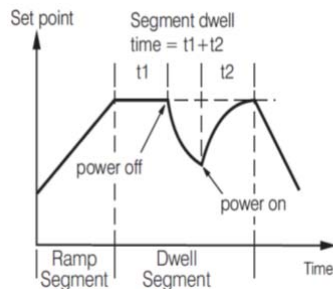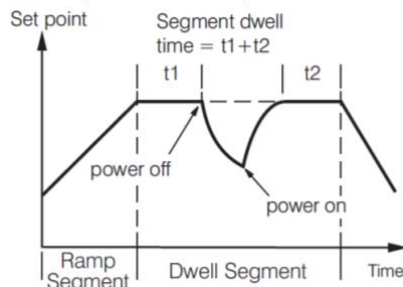

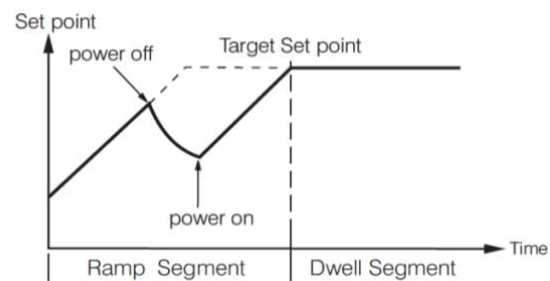*Power failure recovery from profile at Dwell segment*   *Power failure recovery from profile at Ramp segment*

3.21.6.2 PV

If PV is selected then when power is restored the set point starts at the current process value, and then runs to the target set point of the active segment. This choice provides a smoother recovery. The two diagrams below illustrate the respective responses

Power failure recovery from PV at Dwell segment   *Power failure recovery from PV at Ramp Segment*

3.21.6.3 SP1

If SP1 If is selected, then when power is restored the profiler is disabled and it enters static mode, and SP1 is selected for control set point.

3.21.6.4 OFF

If OFF is selected, then when power is restored the profiler is disabled and it enters OFF mode, all the control outputs as well as alarms and events are off.

3.21.7 Holdback

As the set point ramps up or down (or dwells), the measured value may lag behind or deviate from the set point by an undesirable amount. "Holdback" is available to freeze the profile at its current state. The action of Holdback is the same as a deviation alarm. Holdback has three parameters.

1. HBLO: Holdback low band
2. HBHI: Holdback high band
3. HBT: Holdback wait time

If the error from the set point exceeds the set **holdback high band (HBHI)** or lags than the set **holdback low band (HBLO)**, then the holdback will automatically freeze the profile at its current point and the holdback timer begins to count. When the value of holdback timer exceeds the value of **holdback wait time (HBT)**, Holdback indicator HdbK will flash and an error code **HBER** will be displayed.

3.21.8 CYC

The number of cycles to be repeated for the selected profile to be configured by this parameter

3.21.9 Running, Holding and Stopping a Profile

The profile has been start by selecting STAR in the lower display by using ▲▼ keys. After selecting **STAR** press ▣▲▼ keys simultaneously for 1 second to start the profile. The same procedure is applied for Holding and stopping profile. To holding the profile select **HOLD** and stop the profile select **STOP** in the lower display

3.21.10 Viewing and Modifying the Profile Progress

The Profile in progress can be monitored and modified by using the four parameters as below.

1. CYCR: The remaining cycles of the profile
2. STEP: The running step of the profile
3. TIMR: The time remaining to complete the current step of the profile
4. STAT: The current state of the profile.

3.21.11 Configuring the Profile

The profile has been configured by using the following parameters. There are 16 segments available for the user for the configuration. The 16 segments can be used as a single profile or two profiles with each 8 segments or four profiles with each 4 profiles. This selection can be done by **PROF** parameter selection.

3.21.11.1 Profile Segment Parameters

Each profile segments have the following parameters.

1. Target Set Point(TSP)
2. Ramp Time(RPT)
3. Soak Time(SKT)

3.21.11.1.1 Target Setpoint

The target Setpoint of the segment can be configured by the parameters TSP1, TSP2, TSP3, TSP4, TSP5, TSP6, TSP7, TSP8, TSP9, TSP10, TSP11, TSP12, TSP13, TSP14, TSP15, and TSP16.

3.21.11.1.2 Ramp Time

The Ramp time of the segment can be configured by the parameters RPT1, RPT2, RPT3, RPT4, RPT5, RPT6, RPT7, RPT8, RPT9, RPT10, RPT11, RPT12, RPT13, RPT14, RPT15, and RPT16.

3.21.11.1.3 Soak Time

The Soak time of the segment can be configured by the parameters SKT1, SKT2, SKT3, SKT4, SKT5, SKT6, SKT7, SKT8, SKT9, SKT10, SKT11, SKT12, SKT13, SKT14, SKT15, and SKT16.

Warranty

Future Design Controls C-Series products are warranted to be free from functional defects in materials and workmanship at the time the products leave Future Design Controls facilities and to conform at that time to the specifications set forth in the relevant Future Design Controls manual, sheet or sheets for a period of **three years** after delivery to the first purchaser for use.

There are no expressed or implied Warranties extending beyond the Warranties herein and above set forth.

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Return Material Authorization

Contact Future Design Controls for Return Material Authorization number prior to returning any product to our facility.

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