User's Manual

P41 / P91
Auto-Tune Fuzzy / PID
Profiling Controller

UL LISTED

RoHS

FUTUREDESIGN CONTROLS

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.

Use the Manual

• Installers	Read Chapter 1, 2
• System Designer	Read All Chapters
• User	Read Chapters 3, 4

NOTE:

It is strongly recommended that an independent LIMIT CONTROL like the FDC L91 be incorporated into the process to shut down the equipment at a preset process condition in order to prevent possible damage to product and/or the system.

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

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Chapter 1 Overview

1-1 General

The Fuzzy Logic plus PID microprocessor-based profiling controller series, incorporate two bright, easy to read 4-digit LED displays indicating process value and set point value. The Fuzzy Logic technology enables a process to reach a predetermined set point in the shortest time, with minimum overshoot during power-up or external load disturbance.

The P91 is a 1/16 DIN size panel mount profiling controller. It can also be used for rail mount by adding a rail mount kit. The P41 is a 1/4 DIN size panel mount profiling controller. These units are powered by standard 90-250Vac or optional 11-26Vdc supply, incorporating a 2 amp. control relay output as standard. The second output can be used as a cooling control output, an event output or an alarm. Both outputs can support triac, logic output, linear current or linear voltage.

Both units are fully programmable for PT100 and thermocouple types J, K, T, E, B, R, S, N, L, C, P as standard. MA and VDC inputs are optional and must be specified at time of order. The fast input sampling rate and high accuracy 18-bit A to D converter, allow these units to respond quickly in order to control fast processes.

The controller outputs can also be configured as more than just basic heating and/or cooling outputs, these include: up to three alarm outputs, up to three event outputs and up to two analog retransmission outputs.

Digital communications, RS-485 or RS-232, are available as an additional option. These options allow the units to be integrated with a supervisory control system and software.

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

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

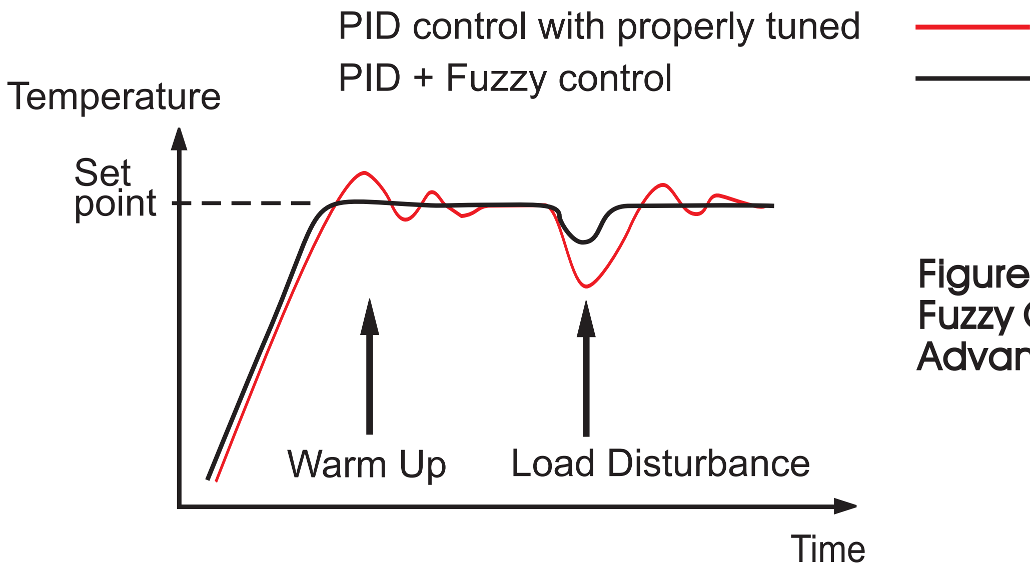


Figure 1.1
Fuzzy Control Advantage

The “P” series can be configured as a single set point controller (static mode) or a ramp and dwell profiling controller (profile mode). The profile mode feature allows the user to program up to 9 profiles of up to 64 free-format (ramp, dwell, jump or end) segments each. The total segments available for the product is 288 segments.
NOTE: Profiles can NOT be linked together.

The profiling controllers contain the following features:

Flexible Program Configuration

Up to 64 segments can be programmed for a single profile. Each segment can be configured as a ramp or a dwell (soak) segment, or a jump step defining a repeat number of cycles within the profile and finally terminated by an end segment. During operation, the user can edit segments of the running profile ro make in process changes.

Maximum Program Capacity

There are a total of 9 profiles can be defined. Profiles are divided into three different lengths: profiles 1-4 can be a maximum of 16 segments, profiles 5-7 can be a maximum of 32 segments and profiles 7-9 are 64 segments maximum. All profiles begin with segment 0, i.e., profile 1 allows for programming of segments 0-15 (for a total of 16 segments) while profile 7 allows programming of segments 0-63 (64 total).

Event Input

The event input feature allows the user to select one of eight functions: enter profile run mode, enter profile hold mode, abort profile mode, enter manual mode, perform failure transfer, enter off mode, advance to the next segment and select second set of PID values.

Programmable Event Outputs

Up to three relays are configurable for event outputs and the state of each output can be defined for each segment and end of profile.

Analog Retransmission

Output 5 and output 4 (P41 only) of the products can be equipped with an analog output module. The output can be configured for transmitting the process value as well as set point value.

High Accuracy

The "P" series are manufactured with custom designed ASIC (Application Specific Integrated Circuit) technology which contains an 18-bit A to D converter for high resolution measurement (true 0.1 F resolution for thermocouple and PT100) and a 15-bit D to A converter for linear current or voltage control outputs. The ASIC technology provides improved operating performance, low cost, enhanced reliability and higher density.

Fast Sampling Rate

The sampling rate of the input A to D converter is 5 time/second (5Hz). The fast sampling rate allows the "P" series to control fast processes.

Fuzzy Control

The function of fuzzy control is to fine tune and adjust PID parameters based on the previous response of the process to the controller output and allow the controller to adapt to various processes. The result is to enable the process to reach a predetermined set point in the shortest time, with minimum overshoot and undershoot during power-up or external load disturbance.

Digital Communication

The units can be equipped with an RS-485 or RS-232 interface card to provide digital communications. When using the RS-485 interface, up to 247 units can be connected together to a host computer.

Programming Port

A programming port is used to connect the unit to a PC for quick configuration.
See Related Products Pg 10

Auto-tune

The auto-tune function allows the user to simplify initial setup for a new system. The internal algorithm is provided to obtain an optimal set of control parameters for the process which can be applied when the process is warming up (cold start) or after the process has been operating at steady state (warm start) conditions.

Lockout Protection

A password can be entered to prevent parameters from being changed. If a password is activated, the password must successfully be set to allow any changes to the unit.

Bumpless Transfer

Bumpless transfer allows the controller to continue to control by using its previous output value if the sensor breaks. As a result, the process can maintain control temporarily as if the sensor was operating normally.

Digital Filter

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

SEL Function

The units provide the ability for user to select parameters which are more important and place these parameters in the home page for quick access. There are 8 parameters to choose from which allow the user to build their own custom display sequence.

1-2 Ordering Code

P41- □ □ □ □ □ □ □ □
P91- □ □ □ □ □ 0 □ □

Power Input

4: 90 - 250 VAC, 47-63 Hz
5: 11 - 26 VAC or VDC, SELV, Limited Energy

Signal Input

1: Standard Input
Thermocouple:
J, K, T, E, B, R, S, N, L, C, P
RTD: PT100 DIN, PT100 JIS
Voltage: 0-60mV
5: 0-10V, 0-1V, 0-5V, 1-5V *
6: 0-20/4-20 mA *
9: Special Order

Output 1

0: None
1: Relay rated 2A/240VAC
2: SSR Driver 5 VDC @ 30 Ma
3: 4 - 20mA / 0 - 20mA Isolated
4: 1 - 5V / 0 - 5V/0 - 10V Isolated
6: Triac output 1A / 240VAC,SSR
C: SSR Driver 14 VDC @ 40 Ma
9: Special order

Output 2

0: None
1: Relay rated 2A/240VAC
2: SSR Driver 5 VDC @ 30 ma
3: 4 - 20mA / 0 - 20mA Isolated
4: 1 - 5V / 0 - 5V/0 - 10V Isolated
6: Triac output 1A / 240VAC,SSR
7: Trans power supply 20 VDC/ 25 ma Isolated
8: Trans power supply 12 VDC/40 ma Isolated
A: Trans power supply 5 VDC/80 ma Isolated
C: SSR Driver 14 VDC @ 40 Ma
9: Special order

Output 3

0: None
1: Relay rated 2A/240VAC
2: SSR Driver 5 VDC @ 30 Ma
6: Triac output 1A / 240VAC,SSR
7: Trans power supply 20 VDC/25 ma Isolated
8: Trans power supply 12VDC/40 ma Isolated
A: trans power supply 5VDC/80 ma Isolated
C: SSR Driver 14 VDC @ 40 Ma
9: Special order

Output 4 (P41 ONLY)

0: None
1: Relay rated 2A/240VAC
2: SSR Driver 5 VDC @ 30 Ma
3: 4 - 20mA / 0 - 20mA Retrans Isolated
4: 1 - 5V / 0 - 5V/0 - 10V Retrans Isolated
6: Triac output 1A / 240VAC,SSR
7: Trans power supply 20 VDC/25 Ma Isolated
8: Trans power supply 12 VDC/40Ma Isoalted
A: Trans power supply 5 VDC/80 Ma Isolated
C: SSR Driver 14 VDC @ 40 Ma
9: Special order

Output 5

0: None
3: 4 - 20mA / 0 - 20mA Retrans Isolated
4: 1 - 5V / 0 - 5V/0 - 10V Retrans Isolated
7: Trans power supply 20 VDC/25ma Isolated
8: Trans power supply 12 VDC/40 Ma Isolated
A: Trans power supply 5 VDC/80 Ma Isolated
D: RS-485 interface Isolated
E: RS-232 interface Isolated

Options

0: Panel mount IP50 standard
1: Panel mount IP65 water resistant rubber installed
2: DIN rail mount with IP50 (for P91 only)
3: DIN rail mount with IP65 (for P91 only)

* NOTE: Reference ONLY Input solder bridges select type of input allowed. These are set as ordered from factory.
Input option 1 = T/C, RTD, MV G1-shorted, G2-Open
Input option 5 = VDC-G1-opened, G2-Open
Input option 6 = Ma - G1 Don't Care, G2-Short
If an input field change is required CONSULT FACTORY.

Accessories

OM94-6 = Isolated 1A / 240VAC Triac Output Module (SSR)
OM94-7 = 14V / 40mA SSR Drive Module
OM98-3 = 4 - 20 mA / 0 - 20 mA Analog Output Module Isolated
OM98-5 = 0 -10V Analog Output Module Isolated
CM94-1 = RS-485 Interface Module for P41 Output 5 Isolated
CM94-2 = RS-232 Interface Module for P41 Output 5 Isolated
CM94-3 = 4-20mA/0-20mA Retrans Module for P41 Output 5 Isolated
CM94-5 = 0-10V Retrans Module for P41 Output 5 Isolated
CM97-1 = RS-485 Interface Module for P91 Output 5 Isolated
CM97-2 = RS-232 Interface Module for P91 Output 5 Isolated
CM97-3 = 4-20mA/0-20mA Retrans Module for P91 Output 5 Isolated
CM97-5 = 0-10V Retrans Module for P91 Output 5 Isolated
DC94-1 = 20V/25mA DC Output Power Supply Isolated
DC94-2 = 12V/40mA DC Output Power Supply Isolated
DC94-3 = 5V/80mA DC Output Power Supply Isolated
DC97-1 = 20V/25mA DC Output Power Supply for P91 Output 5 Isolated
DC97-2 = 12V/40mA DC Output Power Supply for P91 Output 5Isolated
DC97-3 = 5V/80mA DC Output Power Supply for P91 Output 5 Isolated
CC94-1 = RS-232 Interface Cable (2M)
CC91-1 = Programming Port Cable
RK91-1 = Rail Mount kit for P91
DC21-1 = 20V/25mA DC Output Power Supply for P41 Output 5 Isolated
DC21-2 = 12V/40mA DC Output Power Supply for P41 Output 5 Isolated
DC21-3 = 5V/80mA DC Output Power Supply for P41 Output 5Isolated

Related Products

SNA-10A - This is an RS232/RS485 converter used for 3rd party software supporting multi-loop RS-485 serial communications.

SNA-12A This is an RS232/RS485 converter used with the FDC-Set Configuration software.
P/n CC91-1 This is a Configuration cable and must also be used with SNA-12A when using FDC -Set.

1-3 Programming Port

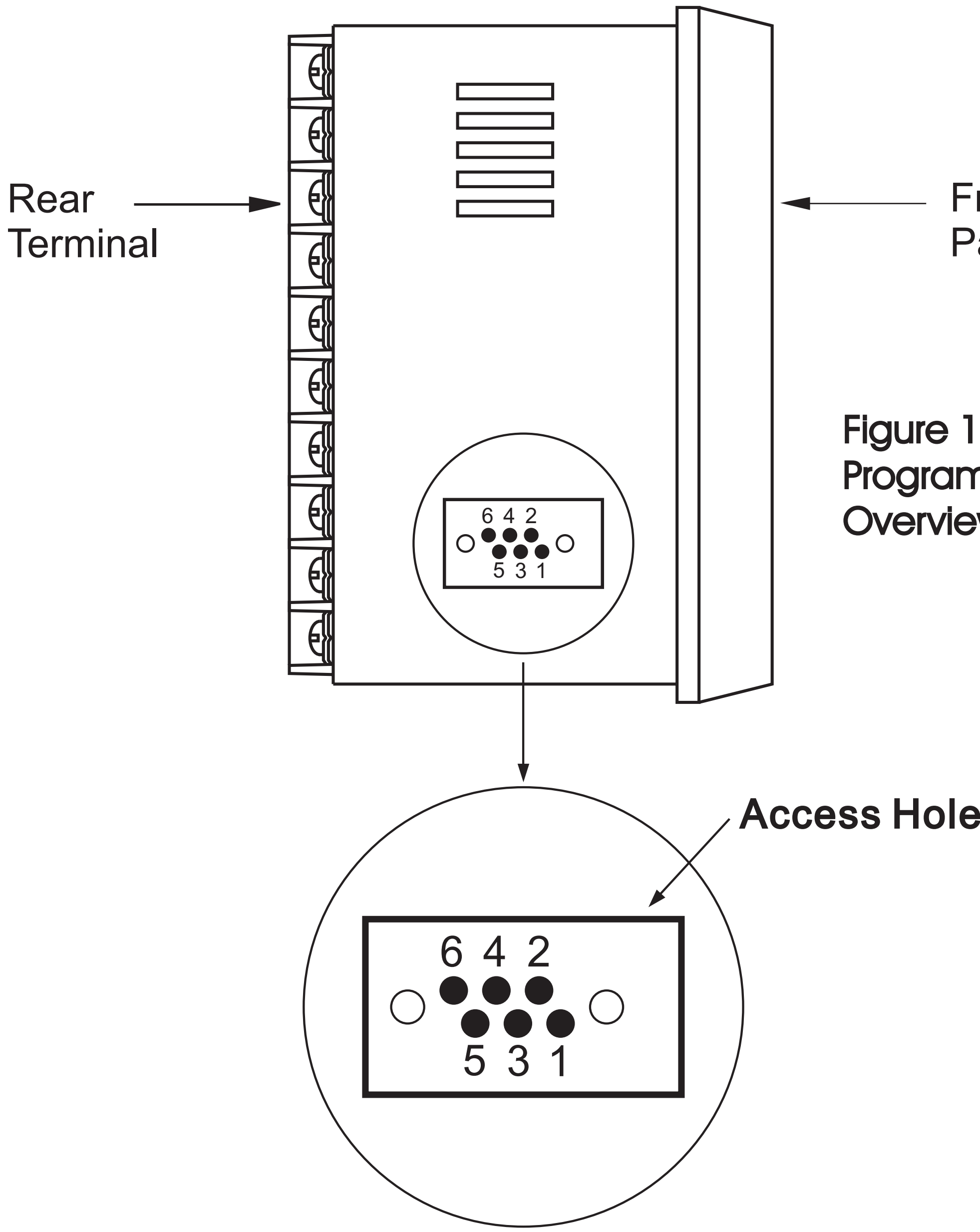


Figure 1.2
Programming Port
Overview

A special connector (CC91-1) is used to connect the programming port to a PC for automatic configuration. The PC must have FDC-Set installed to use the configuration feature via PC.

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 "On-Line" in a running application.

See page 10 for parts needed for using configurator port.

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 selected parameter.

DOWN KEY : [▼]

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

PAGE KEY: [🗋]

This key is used to select desired page of parameters.

REVERSE SCROLL : [⟲] [▲]

Press both [⟲] and [▲] keys to jump to the previous parameter.

RESET KEY : [▲] [▼]

Press both [▲] and [▼] keys to :

1. Revert the display to display the process value.
2. Reset the latching alarm, once the alarm condition is removed.
3. Stop the manual control mode , auto-tuning mode and off mode, then enters the static mode.
4. Clear the message of communication error, holdback time out error and auto-tuning error.

ENTER KEY : Press [🗋] for 5 seconds to :

1. Enter the selected mode to run.
2. Enter the CONF settings
3. Execute calibration procedure for the low point and high point calibration.

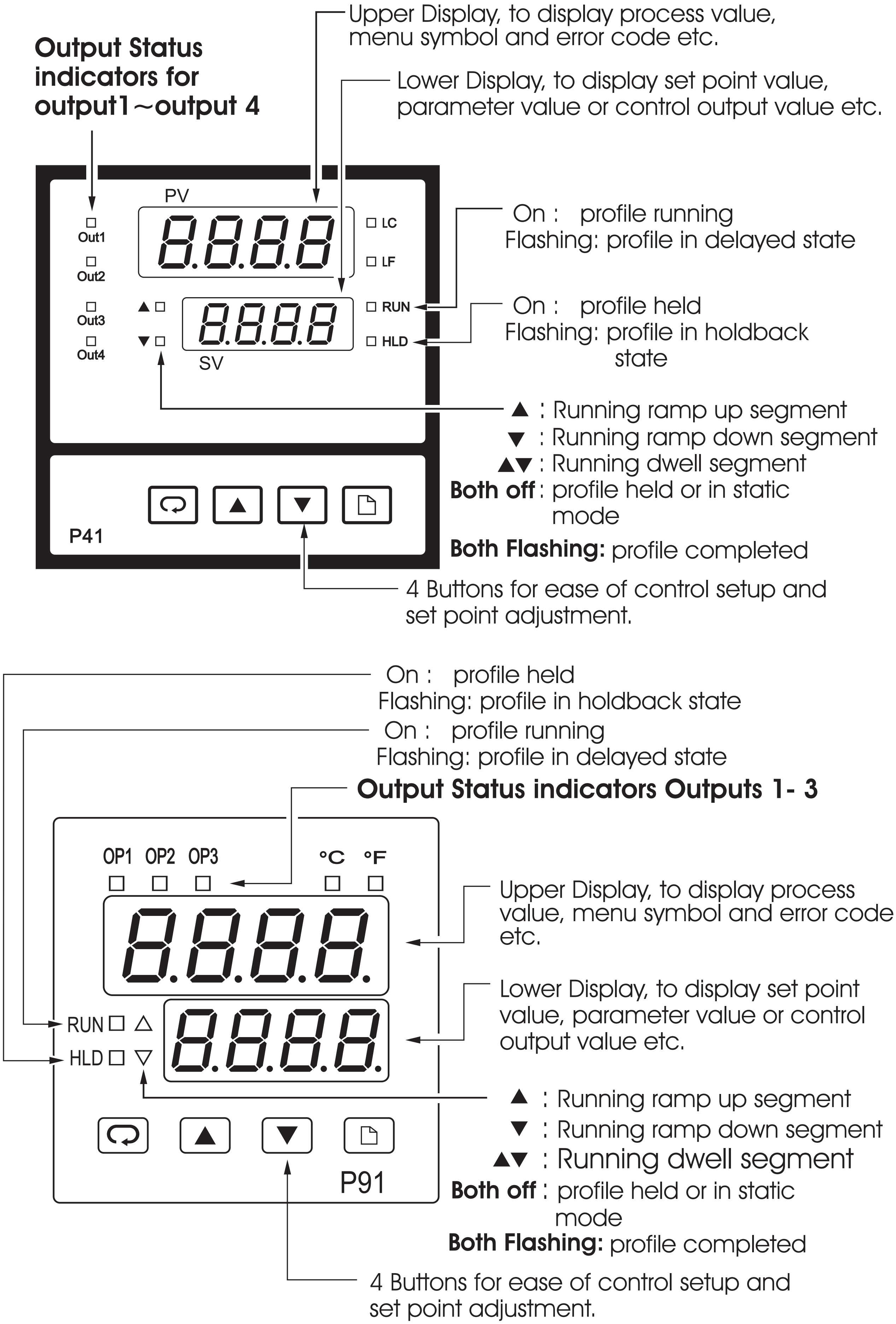


Figure 1.3 Front Panel Description

The unit will display the program code for 2.5 seconds during power up. The code is the program number followed by the version number. For the P41, the program number is 37. The program number for the P91 is 38. In the example figure below, the version number is 12.

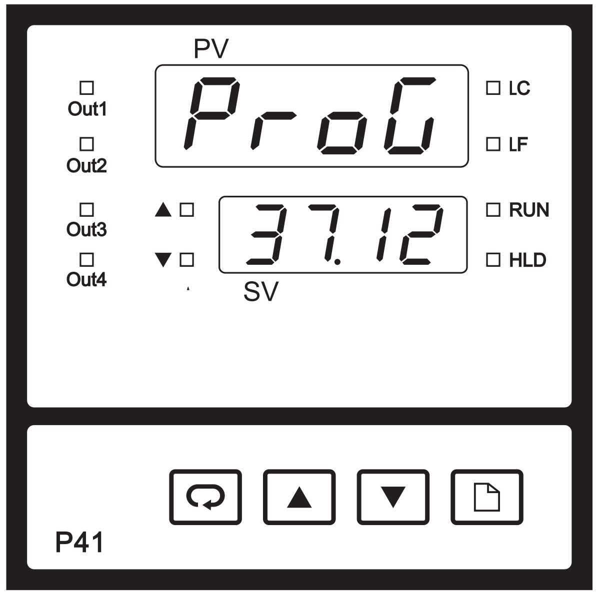
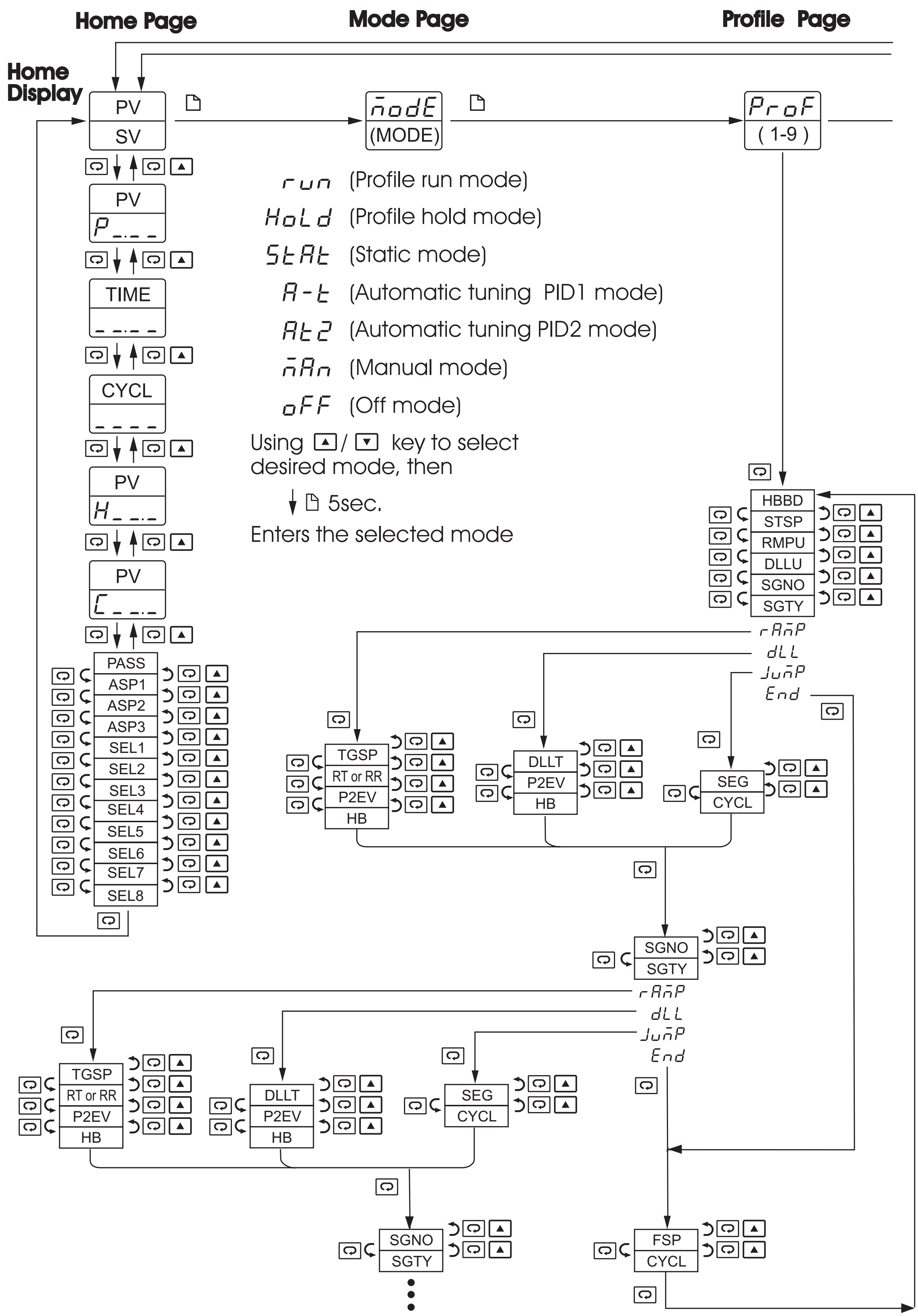
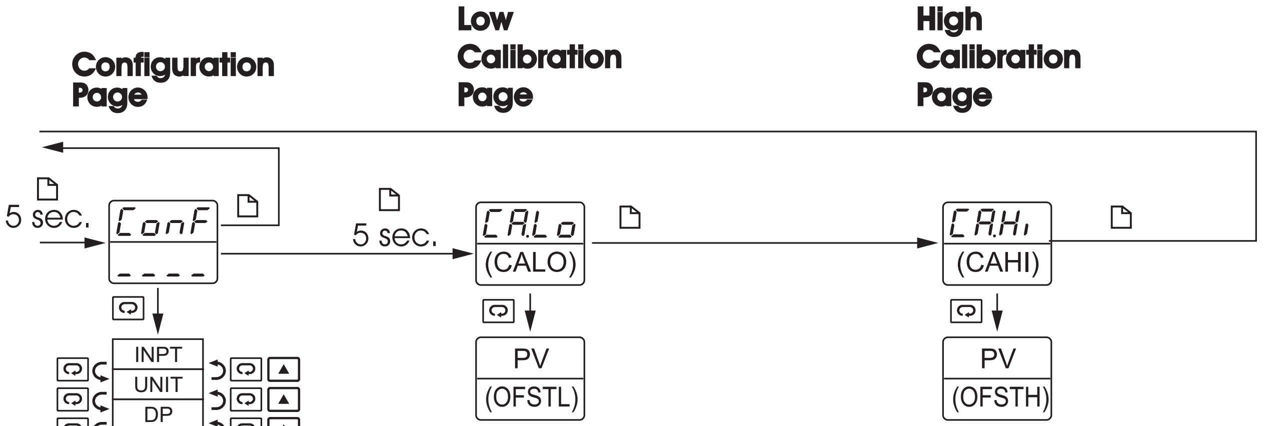


Figure 1.4 Program code display

1-5 Key Operation Flowchart





Using ▲ or ▼ key to adjust the offset low value (lower display) until the process value (higher display) is equal to the required value, then

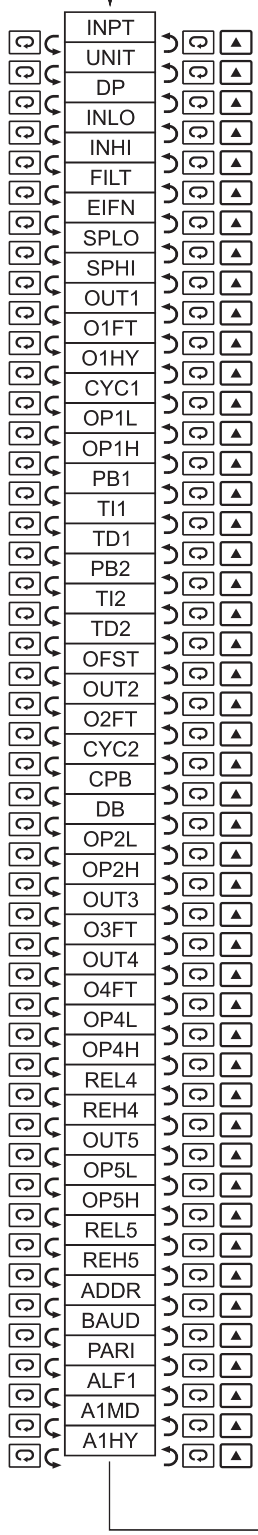
↓ 5 sec.

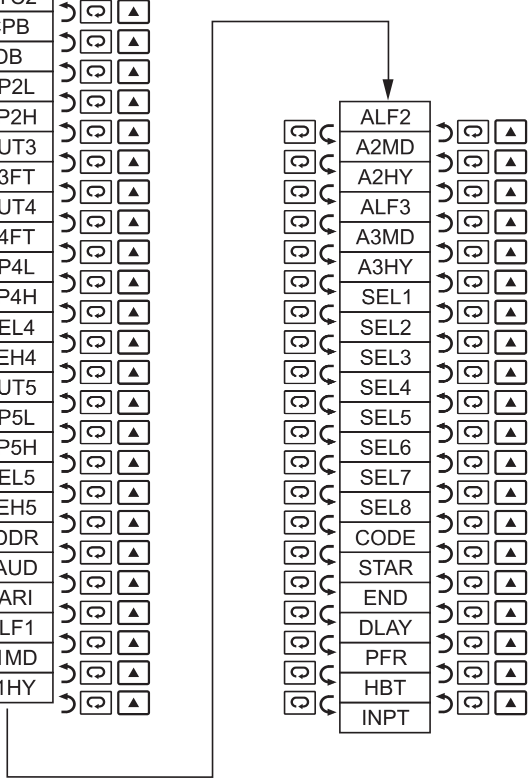
Complete calibration procedure for the low point calibration.

Using ▲ or ▼ key to adjust the offset high value (lower display) until the process value (higher display) is equal to the required value, then

↓ 5 sec.

Complete calibration procedure for the high point calibration.





⚠ **Once the unit has been configured under a specific decimal point selection, changing the decimal point setting (DP) will require the entire unit to be reconfigured to maintain previous control settings.**

Profiles, alarm set points, set point limits, etc., DO NOT automatically scale, i.e., 100.0 becomes 1000 (not 100), and must be set up again manually.

1-6 Parameter Descriptions

Register Address	Parameter Notation	Parameter Description	Range	Default Value	Data type
0	SP1	Controller (Static mode) Set point value **See Note *1**	Low: SPLO High: SPHI	25.0 C (77.0 F)	R/W
1	PFSG P-.- -	Indicate the current Profile/Segment number	Low: 1.00 High: 9.63 Profile number (9) Segment number (63)	1.00	R/W
2	TIME ti nE	Time remaining for the current segment	Low: 00.00 High: 99.59	—	R/W
3	CYCL CYCL	cycle remaining for the current profile	Low: 1 High: 9999 10000=infinite	—	R
4	PASS PASS	Password entry	Low: 0 High: 9999	1	R/W
5	ASP1 ASP 1	Set point for alarm 1	Low: -32768 High: 32767	10.0 C (18.0 F)	R/W
6	ASP2 ASP2	Set point for alarm 2	Low: -32768 High: 32767	10.0 C (18.0 F)	R/W
7	ASP3 ASP3	Set point for alarm 3	Low: -32768 High: 32767	10.0 C (18.0 F)	R/W
8	INPT i nPt	Input sensor selection	(T/C = thermocouple) 0 J_tC : J type T/C 1 K_tC : K type T/C 2 t_tC : T type T/C 3 E_tC : E type T/C 4 b_tC : B type T/C 5 r_tC : R type T/C 6 S_tC : S type T/C 7 n_tC : N type T/C 8 L_tC : L type T/C 9 C_tC : C type T/C 10 P_tC : P type T/C 11 Pt.dn : PT 100 ohms DIN curve 12 Pt.JS : PT 100 ohms JIS curve	1 (0)	R/W

Register Address	Parameter Notation	Parameter Description	Range	Default Value	Data type
8	INPT inPt	Input sensor selection **NOTE:** Linear Inputs selections13-19 MUST be ORDERED to use properly See order matrix Page 9	13 4-20 : 4 - 20 mA linear current input 14 0-20 : 0 - 20 mA linear current input 15 0-60 : 0 - 60 mV linear millivolt input 16 0- 1V : 0 - 1V linear voltage input 17 0-5V : 0 - 5V linear voltage input 18 1-5V : 1 - 5V linear voltage input 19 0- 10 : 0 - 10V linear voltage input	1 (0)	R/W
9	UNIT unit	Input unit selection	0 °C : Degree C unit 1 °F : Degree F unit 2 Pu : Process unit	0 (1)	R/W
10	DP dP	Decimal point selection **See Note *2 on PG 31**	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	R/W
11	MODE mode	Operation mode	0 run :Profile run mode 1 HoLd :Profile hold mode 2 StAt :Static mode 3 A-t :Automatic tuning PID1 mode 4 At2 : Automatic tuning PID2 mode 5 mAn :Manual mode 6 oFF :Off mode	0	R/W
12	INLO inLo	Input low scale value	Low: -32768 High: INHI-50	-17.8 C (0 F)	R/W
13	INHI inHi	Input high scale value	Low: INLO+50 High: 32767	93.3 C (200.0 F)	R/W

Register Address	Parameter Notation	Parameter Description	Range	Default Value	Data type
14	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	R/W
15	EIFN EiFn	Event input function	0 nonE : No function 1 run : Program run mode 2 HoLd : Program hold mode 3 Abot : Abort profile mode 4 mAn : Manual mode 5 F.trA : Failure Transfer 6 oFF : Off mode 7 PASS : Pass to the next segment 8 Pid2 : Select PB2 TI2 & TD2 for control	0	R/W
16	SPLO SP.Lo	Low limit of set point value	Low: -32768 High: SPHI	-17.8 C (0 F)	R/W
17	SPHI SP.Hi	High limit of set point value	Low: SPLO High: 32767	537.8 C (1000 F)	R/W
18	OUT1 out1	Output 1 function	0 nonE : No function 1 H.on.F : Heating on-off control 2 H.tPC : Heating time proportioning control 3 H.Lin : Heating linear control 4 C.on.F : Cooling on-off control 5 C.tPC : Cooling time proportioning control 6 C.Lin : Cooling linear control	3	R/W

Register Address	Parameter Notation	Parameter Description	Range	Default Value	Data type
19	O1FT o1Ft	Output 1 failure transfer status	Select BPLS (bumpless transfer) or 0.0 ~ 100.0 % to continue output 1 control function as the unit fails, or select OFF (0) or ON (1) for ON-OFF control.	0	R/W
20	O1HY o1.HY	Output 1 ON-OFF control hysteresis	Low: 0.1 High:50.0 BC(90.0F)	0.1C (0.2 F)	R/W
21	CYC1 CYC1	Output 1 cycle time	Low: 0.1 High: 90.0 sec.	18.0	R/W
22	OP1L oP1L	Low limit value for output 1	Low: 0 High: 100.0 %	0	R/W
23	OP1H oP1H	High limit value for output 1	Low: 0 High: 120.0 %	100.0	R/W
24	PB1 Pb1	Proportional band value 1	Low: 0 High: 500.0 C (900.0 F)	10.0 C (18.0 F)	R/W
25	TI1 ti1	Integral time value 1	Low: 0 High: 3600 sec	100	R/W
26	TD1 td1	Derivative time value 1	Low: 0 High: 900.0 sec	25.0	R/W
27	PB2 Pb2	Proportional band value 2	Low: 0 High: 500.0 C (900.0 F)	10.0 C (18.0 F)	R/W
28	TI2 ti2	Integral time value 2	Low: 0 High: 3600 sec	100	R/W
29	TD2 td2	Derivative time value 2	Low: 0 High: 900.0 sec	25.0	R/W
30	OFST oFSt	Offset value for P control (TI=0)	Low : 0.0 High : 100.0%	25.0	R/W
31		Reserved			
32		Reserved			
33	OUT2 out2	Output 2 function	0 nonE: No function 1 C.tPC : Cooling time proportioning control 2 C.Lin : Cooling linear control 3 ALm1: Alarm 1 output 4 r.AL1: Reverse alarm 1 Output 5 EVn1: Event 1 output 6 dC.PS : DC power supply output	3	R/W

Register Address	Parameter Notation	Parameter Description	Range	Default Value	Data type
34	O2FT o2Ft	Output 2 failure transfer status	Select BPLS (bumpless transfer) or 0.0 ~ 100.0 % to continue output 2 control function as the unit fails, or select OFF (0) or ON (1) for alarm or event output.	0	R/W
35	CYC2 CYC2	Output 2 cycle time	Low: 0.1 High: 90.0 sec.	18.0	R/W
36	CPB C.Pb	Cooling proportional band value	Low: 50 High: 300 %	100	R/W
37	DB d.b	Heating-cooling dead band (negative value= overlap)	Low: -36.0 High: 36.0 %	0	R/W
38	OP2L oP2L	Low limit value for output 2	Low: 0 High: 100.0 %	0	R/W
39	OP2H oP2H	High limit value for output 2	Low: 0 High: 120.0 %	100.0	R/W
40		Reserved			
41		Reserved			
42	OUT3 out3	Output 3 function	0 nonE : No function 1 ALm2 : Alarm 2 output 2 r.AL2 : Reverse alarm 2 output 3 Evn2 : Event 2 output 4 dC.PS : DC power supply output	3	R/W
43	O3FT o3Ft	Output 3 failure transfer status	0 oFF : Output 3 OFF as unit fails 1 on : Output 3 ON as unit fails	0	R/W
44	OUT4 out4	Output 4 function (for P41 only)	0 nonE : No function 1 ALm3 : Alarm 3 output 2 r.AL3 : Reverse alarm 3 output 3 Evn3 : Event 3 output 4 rE.Pv : Retransmit process value 5 rE.SP : Retransmit set point value 6 dC.PS : DC power supply output	3	R/W

Register Address	Parameter Notation	Parameter Description	Range	Default Value	Data type
45	O4FT oYFt	Output 4 failure transfer status (for P41 only)	0 oFF : Output 4 OFF as unit fails 1 on : Output 4 ON as unit fails	0	R/W
46	OP4L oP4L	Low limit value for output 4 (for P41 only)	Low: 0 High: 100.0 %	0	R/W
47	OP4H oP4H	High limit value for output 4 (for P41 only)	Low: 0 High: 120.0 %	100.0	R/W
48	REL4 rEL4	Retransmission low scale value for output4 (for P41 only)	Low: -32768 High:32767	0.0 C (32.0F)	R/W
49	REH4 rEH4	Retransmission high scale value for output4 (for P41 only)	Low: -32768 High:32767	10 0.0 C (212.0F)	R/W
50		Reserved			
51	OUT5 out5	Output 5 function	0 nonE : No function 1 Comm : Communication port 2 rE.PV : Retransmit process value 3 rE.SP : Retransmit set point value 4 dC.PS : DC power supply output	0	R/W
52	OP5L oP5L	Low limit value for output 5	Low: 0 High: 100.0 %	0	R/W
53	OP5H oP5H	High limit value for output 5	Low: 0 High: 120.0 %	100.0	R/W
54	REL5 rEL5	Retransmission low scale value for output 5	Low: -32768 High:32767	0.0 C (32.0F)	R/W
55	REH5 rEH5	Retransmission high scale value for output 5	Low: -32768 High:32767	10 0.0 C (212.0F)	R/W
56	ADDR Addr	Address assignment of digital communication	Low: 1 High: 255	—	R/W

Register Address	Parameter Notation	Parameter Description	Range	Default Value	Data type
57	BAUD bAud	Baud rate of digital communication	0 2.4 : 2.4 Kbits/s baud rate 1 4.8 : 4.8 Kbits/s baud rate 2 9.6 : 9.6 Kbits/s baud rate 3 14.4 : 14.4 Kbits/s baud rate 4 19.2 : 19.2 Kbits/s baud rate 5 28.8 : 28.8 Kbits/s baud rate 6 38.4 : 38.4 Kbits/s baud rate	2	R/W
58	PARI PAri	Parity bit of digital communication	0 EVEn : Even parity 1 odd : Odd parity 2 nonE : No parity bit	0	R/W
59	ALF1 ALF1	Alarm 1 function	0 PV.HI : Process high alarm 1 PV.Lo : Process low alarm 2 dE.HI : Deviation high alarm 3 dE.Lo : Deviation low alarm 4 db.HL : Deviation band high/low alarm 5 End.P : End of profile alarm 6 HoLd : Hold mode alarm 7 StAt : Static mode alarm	2	R/W
60	A1MD A1.md	Alarm 1 operation mode	0 nor m : Normal alarm action 1 LtcH : Latching alarm action 2 HoLd : Hold alarm action 3 Lt.Ho : Latching & hold alarm action	0	R/W
61	A1HY A1.HY	Hysteresis control for alarm 1	Low: 0.1 High: 50.0 LC (90.0 LF)	0.1 C (0.2 F)	R/W

Register Address	Parameter Notation	Parameter Description	Range	Default Value	Data type
62	ALF2 ALF2	Alarm 2 function	0 PV.Hi : Process high alarm 1 PV.Lo : Process low alarm 2 dE.Hi : Deviation high alarm 3 dE.Lo : Deviation low alarm 4 db.HL : Deviation band high/low alarm 5 End.P : End of profile alarm 6 HoLd : Hold mode alarm 7 StAt : Static mode alarm	2	R/W
63	A2MD A2.md	Alarm 2 operation mode	0 norm: Normal alarm action 1 Ltch: Latching alarm action 2 HoLd: Hold alarm action 3 Lt.Ho: Latching & hold alarm action	0	R/W
64	A2HY A2.HY	Hysteresis control for alarm 2	Low: 0.1 High: 50.0 C (90.0 F)	0.1 C (0.2 F)	R/W
65		Reserved			
66	ALF3 ALF3	Alarm 3 function (for P41 only)	0 PV.Hi : Process high alarm 1 PV.Lo : Process low alarm 2 dE.Hi : Deviation high alarm 3 dE.Lo : Deviation low alarm 4 db.HL : Deviation band high/low alarm 5 End.P : End of profile alarm 6 HoLd : Hold mode alarm 7 StAt : Static mode alarm	2	R/W
67	A3MD A3.md	Alarm 3 operation mode (for P41 only)	0 norm: Normal alarm action 1 Ltch: Latching alarm action 2 HoLd: Hold alarm action 3 Lt.Ho: Latching & hold alarm action	0	R/W

Register Address	Parameter Notation	Parameter Description	Range	Default Value	Data type
68	A3HY A3.HY	Hysteresis control for alarm 3 (for P41 only)	Low: 0.1 High: 50.0 C (90.0 F)	0.1 C (0.2 F)	R/W
69		Reserved			
70	SEL1 SEL 1	Select 1'st parameter for home page	0 nonE : No parameter selected 1 inPt : INPT selected for home page 2 unit : UNIT selected for home page 3 dP : DP selected for home page 4 Pb 1 : PB1 selected for home page 5 ti 1 : TI1 selected for home page 6 td 1 : TD1 selected for home page 7 Pb2 : PB2 selected for home page 8 ti 2 : TI2 selected for home page 9 td2 : TD2 selected for home page 10 oFSt : OFST selected for home page 11 o 1.HY : O1HY selected for home page 12 CYC 1 : CYC1 selected for home page 13 CYC2 : CYC2 selected for home page 14 C.Pb : CPB selected for home page 15 d.b : DB selected for home page 16 A 1.HY : A1HY selected for home page 17 A2.HY : A2HY selected for home page 18 A3.HY : A3HY selected for home page 19 Addr : ADDR selected for home page	1	R/W
71	SEL2 SEL2	Select 2'nd parameter for home page	Same as SEL1	2	R/W
72	SEL3 SEL 3	Select 3'rd parameter for home page	Same as SEL1	3	R/W

Register Address	Parameter Notation	Parameter Description	Range	Default Value	Data type
73	SEL4 SEL4	Select 4'th parameter for home page	Same as SEL1	4	R/W
74	SEL5 SEL5	Select 5'th parameter for home page	Same as SEL1	5	R/W
75	SEL6 SEL6	Select 6'th parameter for home page	Same as SEL1	6	R/W
76	SEL7 SEL7	Select 7'th parameter for home page	Same as SEL1	12	R/W
77	SEL8 SEL8	Select 8'th parameter for home page	Same as SEL1	19	R/W
78	CODE CodE	Security code for parameter protection	Low: 0 High: 9999 0=unprotected 1000= home page unprotected	0	R/W
79		Reserved			
80	STAR StAr	Set point value at start of each profile	0 PV : Current process value PV 1 SP1 : Controller set point value SP1 2 St.SP : Start set point value STSP	0	R/W
81	END End	Set point value at end of each profile	0 F.SP : Final set point value for each program 1 SP1 : Controller set point value 2 oFF : All outputs go to off execpt end of profile relay	0	R/W
82	DLAY dLAY	Delay time (hours /minutes) between profile initiation and profile start	Low : 0.00 High : 99.59	0	R/W

Register Address	Parameter Notation	Parameter Description	Range	Default Value	Data type
83	PFR P.F.r	Power fail recovery	0 cont : Continue profile from the last setpoint value 1 PV : Continue Profile from current PV 2 SP1 : Static mode, SP1 3 oFF : OFF mode	2	R/W
84	HBT Hb.t	Holdback wait time	Low : 0.00 High : 99.59 (hour.minute) 0.00= inFi : infinite	1.00	R/W
85		Reserved			
86	PROF ProF	Profile number selected for view	Low: 1 High: 9	1	R/W
87	HBBD Hb.bd	Holdback band	Low: 1 High: 555 C (999F)	—	R/W
88	STSP St.SP	Start set point value	Low : SPLO High : SPHI	—	R/W
89	RMPU rmP.u	Unit for ramp segment	0 HH.mm : Hours. Minutes 1 mm.SS : Minutes. Seconds 2 1min : units per minute 3 1Hr : units per hour	—	R/W
90	DLLU dLL.u	Unit for dwell segment	0 HH.mm : Hours. Minutes 1 mm.SS : Minutes. Seconds	—	R/W
91	SGNO SG.no	Segment number	Low : 0 High:15(PROF=1~4) 31(PROF=5~7) 63(PROF=8,9)	—	R/W
92	SGTY SG.ty	Segment type for the selected segment number	0 rAmP : Ramp 1 dLL : Dwell 2 JumP : Jump 3 End : End	3	R/W
93	TGSP tG.SP	Target set point for ramp segment	Low : SPLO High : SPHI	—	R/W

Register Address	Parameter Notation	Parameter Description	Range	Default Value	Data type
94	RTRR rt.rr	Time duration or Ramp rate for ramp segment	Low: 0 High: 5999	—	R/W
95	P2EV P2.EV	States assignment of PID selection and event outputs for ramp, and dwell segment.	Four-bit binary number (0=inactive 1=active) 0000 (4th digit) Event 1 (3rd digit) Event 2 (2nd digit) Event 3 (1st digit) PID 2	—	R/W
96	HBTY Hbty	Holdback type	0. oFF : Holdback disabled 1. Lo : Deviation low holdback 2. Hi : Deviation high holdback 3. bAnd : Deviation band holdback	—	R/W
97	DLLT dLL.t	Duration time for dwell segment	Low: 0 High: 99.59	—	R/W
98	SEG SEG	Target segment number for the jump segment	Low : 0 High:15(PROF=1~4) 31(PROF=5~7) 63(PROF=8,9)	—	R/W
99	CYCL CYCL	Repeat number of cycles for the jump and end segment	Low: 1 High: 9999 10000 = infinite (inFi)	—	R/W
100	FSP F.SP	Final set point for the end segment	Low: SPLO High: SPHI	—	R/W
101	OFSTL	Offset value for low point calibration	Low: -1999 high: 1999	0	R/W
102	OFSTH	Offset value for high point calibration	Low: -1999 high: 1999	0	R/W
103	ADLO	mV calibration low coefficient	Low: -1999 high: 1999	—	R/W
104	ADHI	mV calibration high coefficient	Low: -1999 high: 1999	—	R/W

Register Address	Parameter Notation	Parameter Description	Range	Default Value	Data type
105	RTDL	RTD calibration low coefficient	Low: -1999 high: 1999	—	R/W
106	RTDH	RTD calibration high coefficient	Low: -1999 high: 1999	—	R/W
107	CJLO	Cold junction calibration low coefficient	Low: -5.00 high: 40.00	—	R/W
108	CJHI	Cold junction calibration high coefficient	Low: -1999 high: 1999	—	R/W
109	DATE	Date code	Low: 0 High: 3719 (9C31)	—	R/W
110	SRNO	Serial number	Low: 0 High: 9999	—	R/W
111		Reserved			
112	BPL1	Bumpless transfer value of MV1	Low: 0 High: 100.00	—	R
113	BPL2	Bumpless transfer value of MV2	Low: 0 High: 100.00	—	R
114	CJCL	Sense voltage durig cold junction calibration low	Low: 0 High: 7552	—	R
115	CALO CALo	Input signal value during low point calibration	Low: -32768 High: 32767	0	R
116	CAHI CAHi	Input signal value during high point calibration	Low: -32768 High: 32767	1000	R
117	CAIN	Input sensor calibrated	Low: 0 High: 20	20	R
118		Reserved			
119		Reserved			
120		Reserved			
121		Reserved			
122		Reserved			

Register Address	Parameter Notation	Parameter Description	Range	Default Value	Data type
123		Reserved			
124		Reserved			
125		Reserved			
126		Reserved			
127		Reserved			
128	PV	Process value	Low: -32768 High: 32767	—	R
129	SV	Set point value for control	Low: SPLO High: SPHI	—	R
130	MV1 H- -.-	Output 1 percentage value (Heating)	Low: 0.00 High: 100.00	—	*3
131	MV2 C- -.-	Output 2 percentage value (Cooling)	Low: 0.00 High: 100.00	—	*3
132	STAT	Mode and operation status word	Bit 0 = Profile run mode Bit 1 = Profile hold mode Bit 2 = Static mode Bit 3 = Automatic tuning mode Bit 4 = Manual mode Bit 5 = Off mode Bit 6 = Failure mode Bit 7 = Profile running up Bit 8 = Profile runing down Bit 9 = Profile soaking Bit 10 = Alarm 1 active Bit 11 = Alarm 2 active Bit 12 = Alarm 3 active Bit 13 = Event 1 on Bit 14 = Event 2 on Bit 15 = Event 3 on	—	R
133	EROR	Error Code	Low: 0 High: 40	—	R
134	PFSG	Current profile and segment runing	Low: 1.00 High: 9.63	—	R
135	TNSG	Total number of segments	Low: 1 High: 64	—	R
136	TTSG	Total time for segment runing	Low: 0 High: 99.59	—	R

Register Address	Parameter Notation	Parameter Description	Range	Default Value	Data type
137	SPSG	Set point for current segment	Low:SPLO High: SPHI	—	R
138	TIME	Time remaining for the current segment	Low:00.00 High: 99.59	—	R
139**	CYCL	Cycle remaining for the current loop	Low:1 High: 9999 10000=infinite	—	R
140	PROG	Program and version code of the product	Low: -32768 High: 32767	—	R
141	HBTR	Holdback time remaning for the current segment	Low: 0 High: 99.59	—	R
142	CMND	Command code	Low: -32768 High: 32767	—	R/W
143	JOB	Job code	Low: -32768 High: 32767	—	R/W

** NOTE Cycles rregister indicates "current cycles remaining" for last jump segment (outer jump) and NOT inner jump segments.

NOTES

***1** Controller memory has a maximum life of one million (1,000,000) write cycles. If the controller is operated by a supervisory control system, avoid excessive set point writes to the controller or premature failure of the controller may result. Units with version number V.19 and later have been updated to write the set point (when sent via communications) to memory once every 6 minutes allowing unlimited set point writes to the controller for a life span of greater than 10 years.

***2** Once the unit has been configured under a specific decimal point selection, changing the decimal point setting (DP) will require the entire unit to be reconfigured to maintain previous control settings. Profiles, alarm set points, set point limits, etc., DO NOT automatically scale, i.e., 100.0 becomes 1000 (not 100), and must be set up again manually.

***3** Read only unless in manual control mode.

Chapter 2 Installation

⚠ Dangerous voltages capable of causing serious injury or death may be present in this instrument. Before installation or prior to beginning any cleaning or troubleshooting procedures, turn off power to all equipment and follow proper lockout-tagout procedures. Units suspected of being faulty should be disconnected and removed to a properly equipped workshop for testing and repair. Component replacement and internal adjustments must be made by a qualified maintenance person only.

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

⧈ CAT. II

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

⚠ The front panel of the instrument may be cleaned using a soft, cloth and a mild detergent. Do not use harsh chemicals or volatile solvents like paint thinners to clean the instrument or discoloration and deformation of the unit case may result.

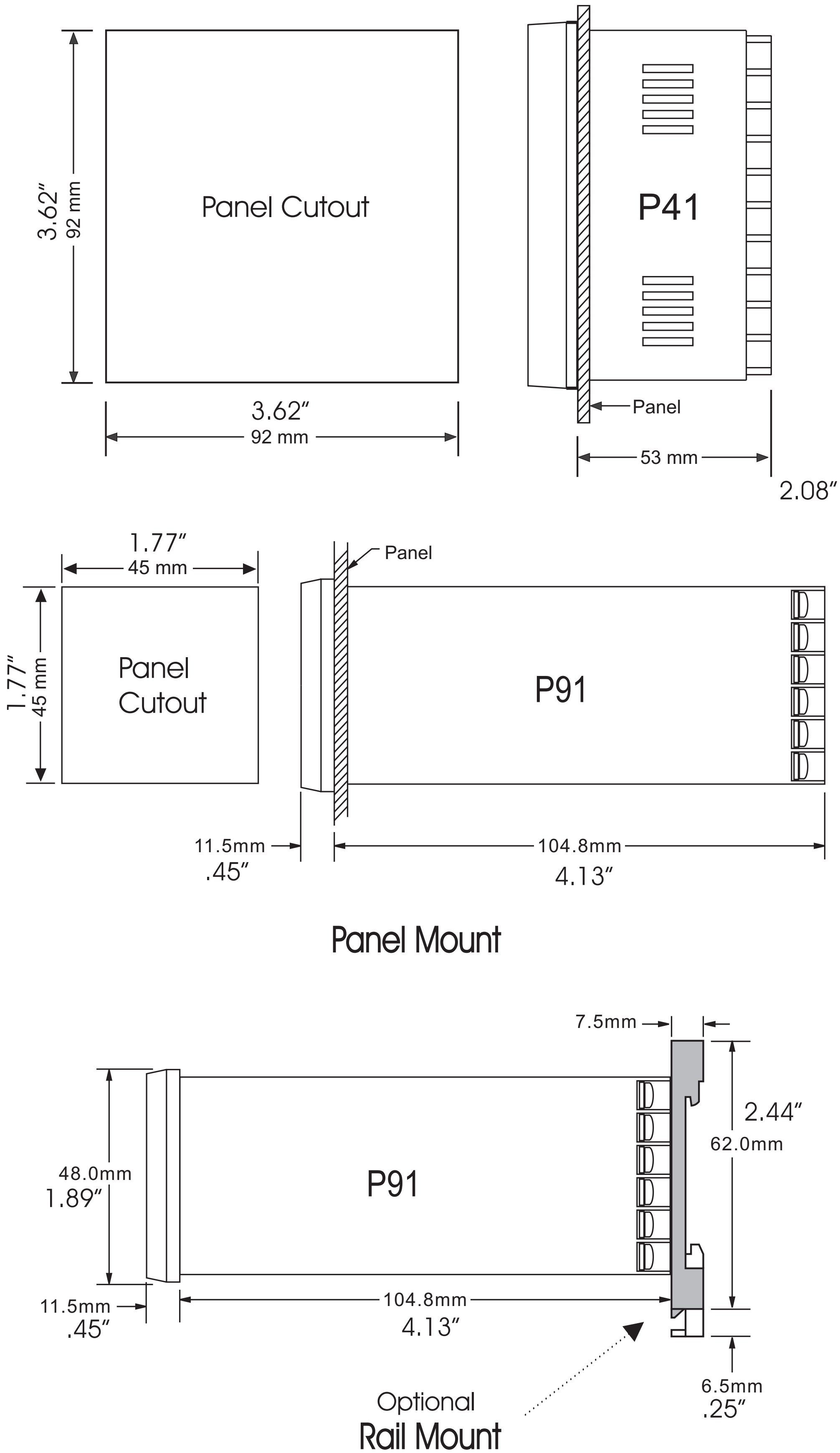
2-1 Unpacking

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

2-2 Mounting

Make the appropriate panel cutout to the dimensions shown in Figure 2.1 Remove both mounting clamps from the unit and insert the controller into the panel cutout. Snap the mounting clamps back in place and slide them towards the front of the unit until the controller is secured in the cutout.

Figure 2.1 Mounting Dimensions



2 - 3 Wiring Precautions

* Before wiring, check the label for the correct model number, voltage rating and options.

* Care must be taken to ensure that the maximum voltage rating specified on the label is not exceeded.

* It is recommended that power wiring of the unit be protected by fuses or circuit breakers rated at the minimum value possible.

* The unit should be installed inside a suitably grounded metal enclosure to prevent live parts from being accessed by human hands or metal tools.

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

* Do not over-tighten the terminal screws. The torque should not exceed 1 N-m (8.9 Lb-in or 10.2KgF-cm).

* Unused control terminals should not be used as jumper points for other wiring as they may be internally connected, causing damage to the unit.

* Verify that the ratings of the input and output devices connected to the controller do not exceed those specified in Chapter 6.

* Except for thermocouple wiring, all wiring should use stranded copper conductors with a maximum of 18 AWG.

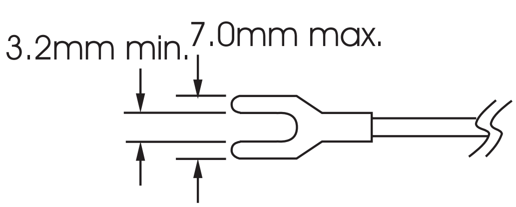


Figure 2.2 Lead Termination for P41

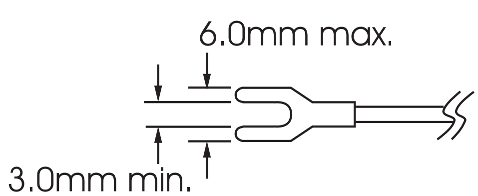


Figure 2.3 Lead Termination for P91

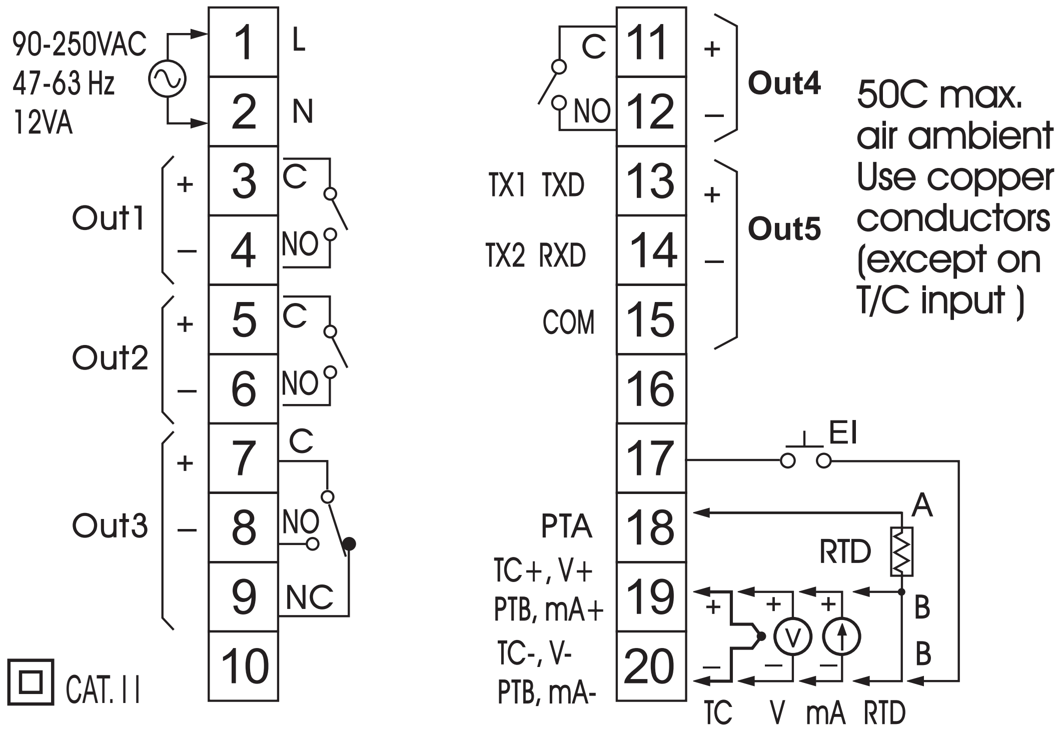


Figure 2.4 Rear Terminal Connection for P41

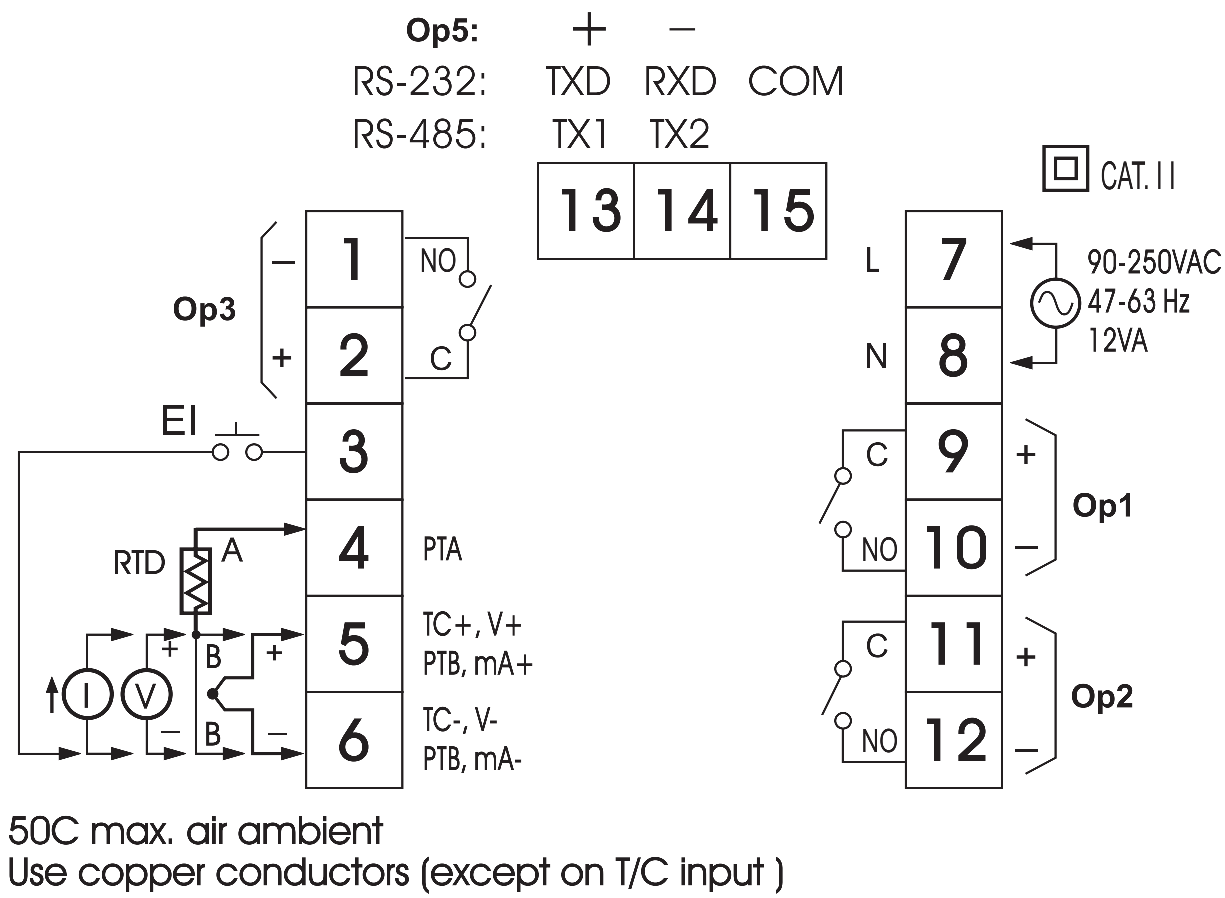


Figure 2.5 Rear Terminal Connection for P91

2-4 Power Wiring

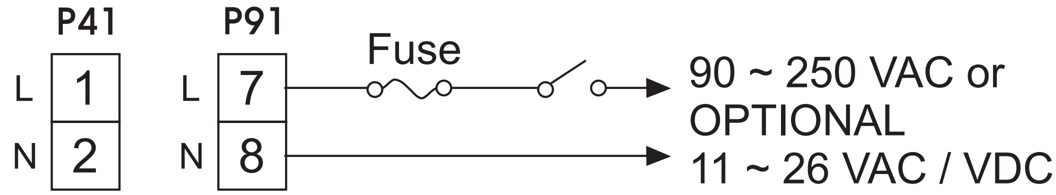


Figure 2.6 Power Supply Connections

2-5 Sensor Input Wiring

Proper sensor type selection and installation are very important factors to obtain precise measurements. Many problems in a control system can be attributed to improper sensor selection or poor installation. The sensor must have the correct range to meet the process requirements. The sensor should also be placed so that it can detect any process changes with minimal lag so that the controller can respond quickly.

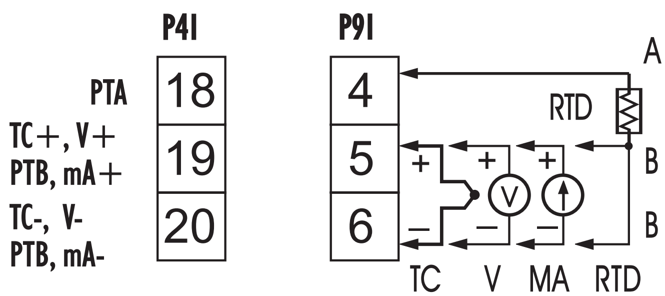


Figure 2.7 Sensor Input Wiring

For thermocouple inputs, the correct type of thermocouple extension wire must be used for the entire distance between the controller and the thermocouple, ensuring that the correct polarity is observed throughout. Splices 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 ohm K type or a 500 ohm J type thermocouple lead resistance will produce 1degree C error.

For two-wire RTD inputs, terminals 19 and 20 on the P41, or terminals 5 and 6 on the P91 must be connected together. Three-wire RTD's offer inherent lead resistance compensation provided that the three leads are of same gauge and equal length. Two-wire RTD's should be avoided if possible, for the purpose of accuracy. A 0.4 ohm lead resistance of a two-wire RTD will produce 1 degree C error.

2-6 Control Output Wiring

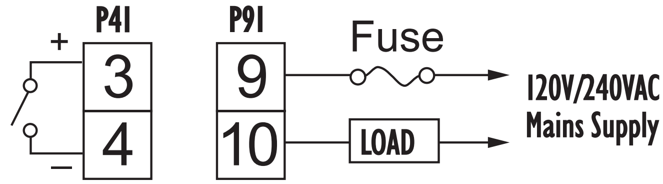


Figure 2.8 Output 1 Relay or Triac (SSR) to Drive Load

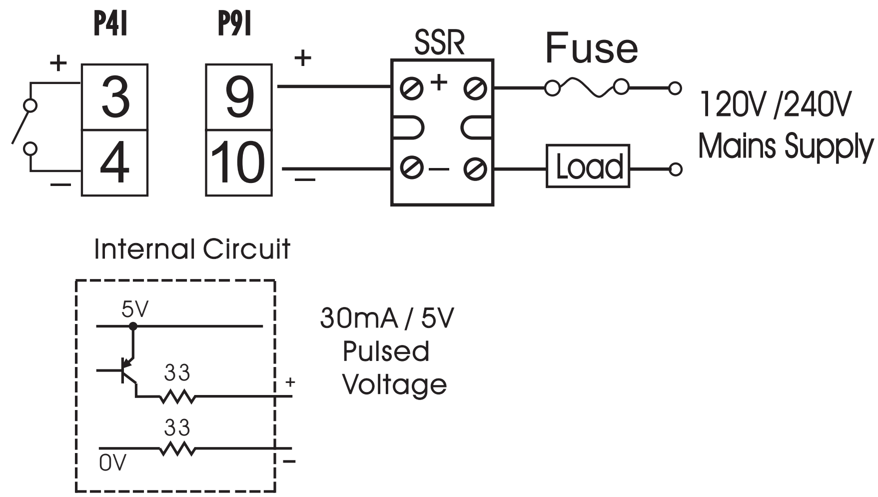


Figure 2.9 Output 1 Pulsed Voltage to Drive SSR

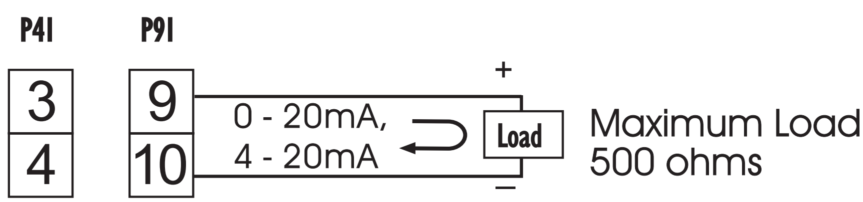


Figure 2.10 Output 1 Linear Current

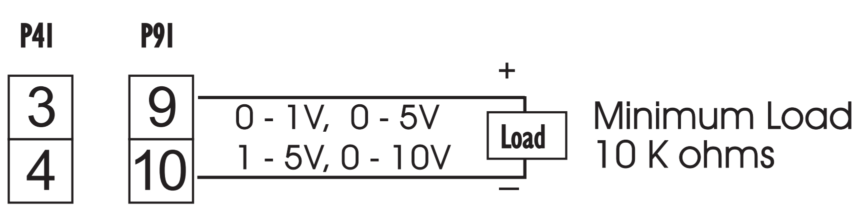


Figure 2.11 Output 1 Linear Voltage

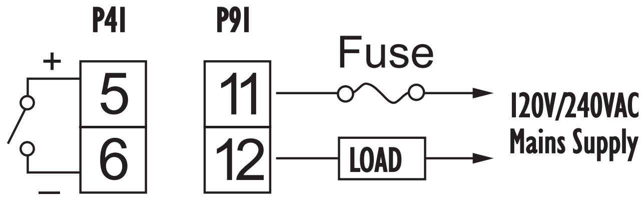


Figure 2.12 Output 2 Relay or Triac (SSR) to Drive Load

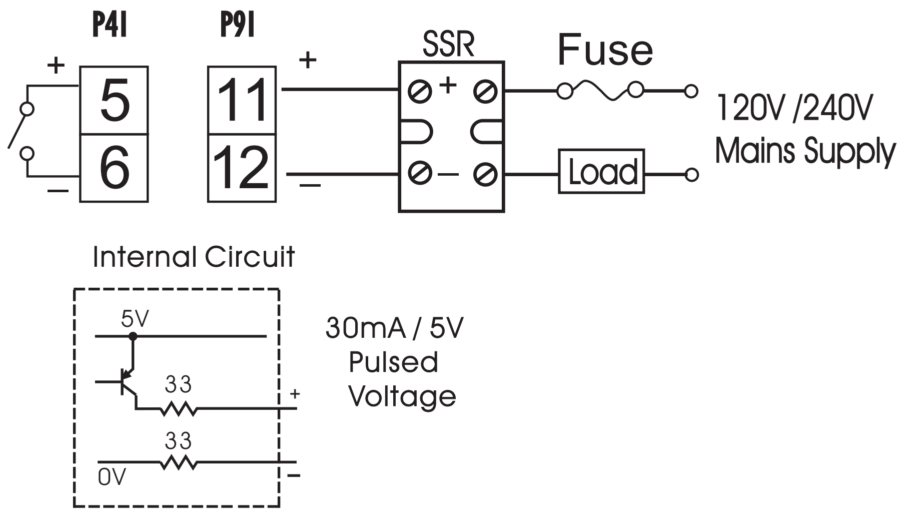


Figure 2.13 Output 2 Pulsed Voltage to Drive SSR

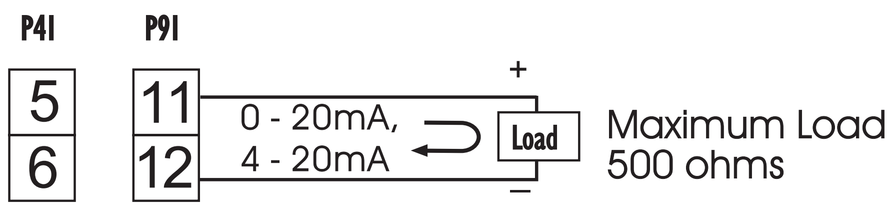


Figure 2.14 Output 2 Linear Current

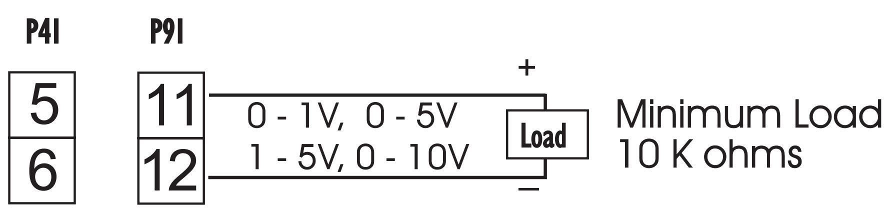


Figure 2.15 Output 2 Linear Voltage

2-7 Alarm / Event Output Wiring

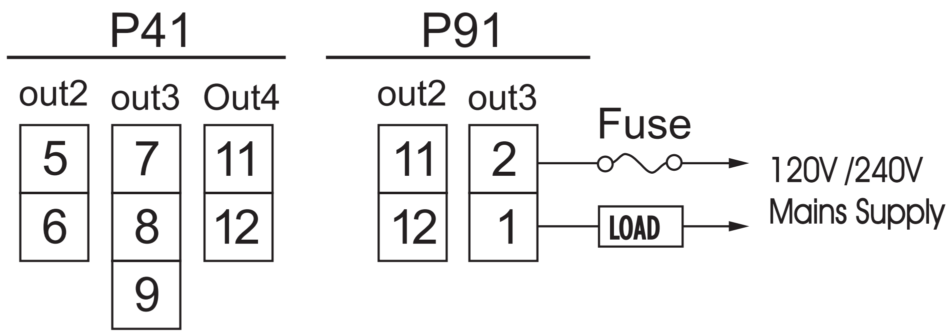


Figure 2.16 Alarm/Event Output Wiring

Note: Form C relay contacts are provided for alarm/event 2 (out3) on the P41 only. Alarm/event 3 (out4) is not available on the P91.

2-8 Event Input Wiring

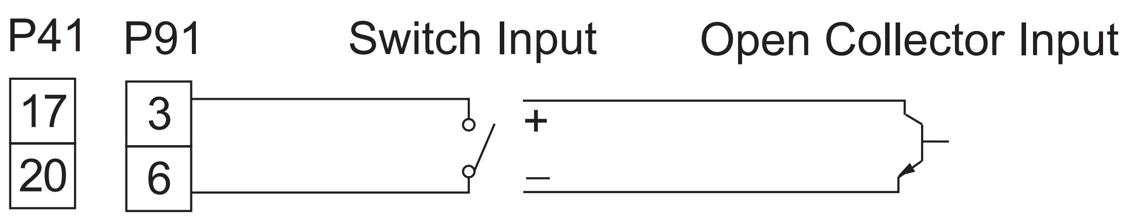


Figure 2.17 Event Input wiring

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

2-9 Retransmission Output Wiring

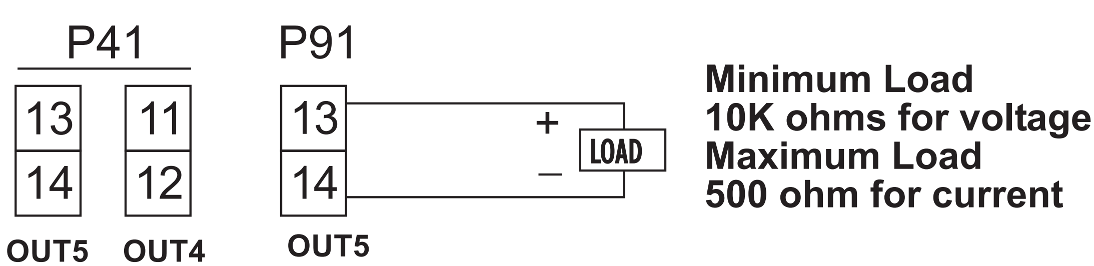


Figure 2.18 Retransmit 4-20 / 0-20 mA Wiring

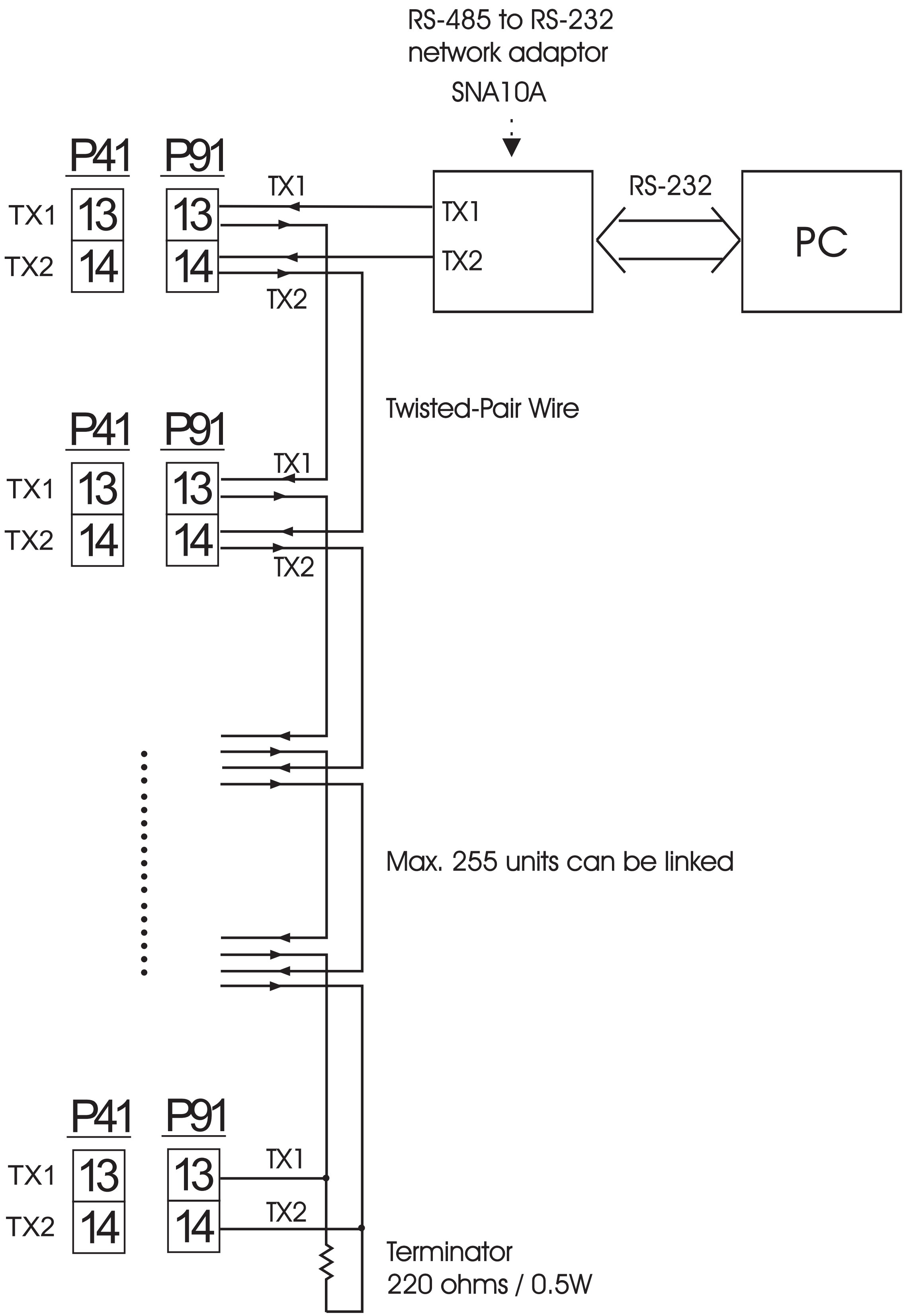


Figure 2.19 RS-485 Wiring

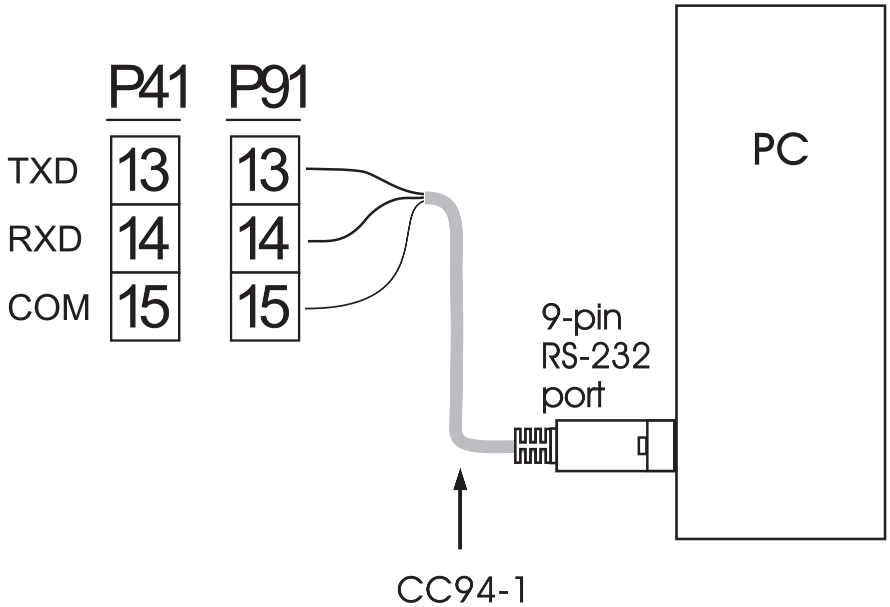


Figure 2.20 RS-232 Wiring

NOTE: If you use a conventional 9-pin RS-232 cable instead of CC94-1, the cable must be modified according to the following circuit diagram.

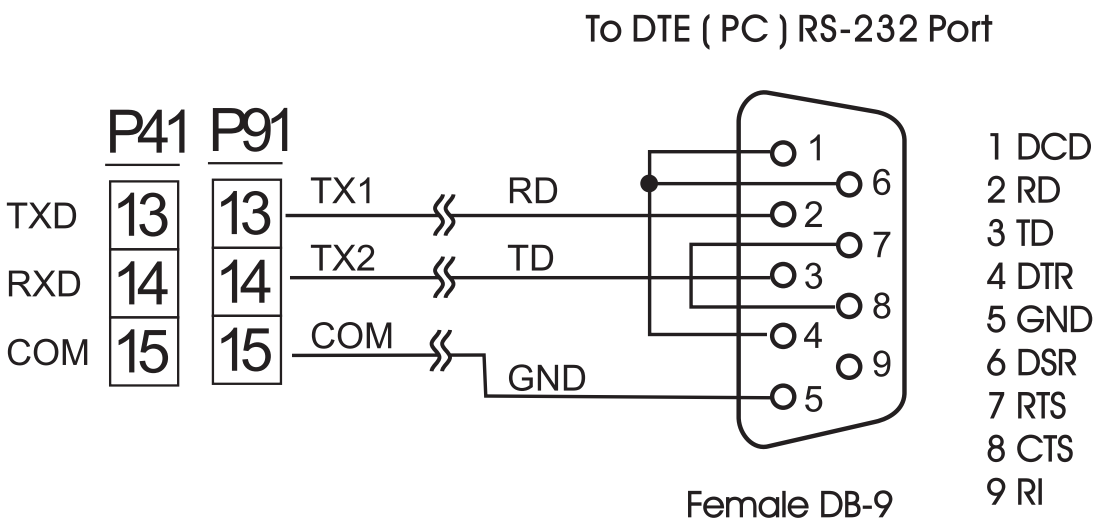


Figure 2.21 Configuration of RS-232 Cable

Chapter 3 Configuration

The parameters stored in Home page can be obtained by pressing the scroll key . The parameters in the Configuration page are obtained by pressing the page key 2 times to show ProF - the Profile page, then press and hold the page key for 5 seconds to enter the Configuration page.

3-1 Password

There are two parameters which specify the data security function, these are PASS (password) and CODE (security code).

Value of CODE	Value of PASS	Results
0	Any value	All parameters are changeable
1000	=1000	All parameters are changeable
	≠1000	Only Home page parameters are changeable
Others	=CODE	All parameters are changeable
	≠CODE	All parameters are not changeable

Table 3.1 Password operation

3-2 Signal Input

INPT: Selects 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, C_TC, P_TC.
(RTD) PT.DN, PT.JS
(linear) 4-20, 0-20, 0-60, 0-1V, 0-5V, 1-5V, 0-10

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

DP: Selects the resolution of process value.
Range: (for T/C and RTD) NO.DP, 1-DP
(for linear) NO.DP, 1-DP, 2-DP, 3-DP

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

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

How to use INLO and INHI :

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

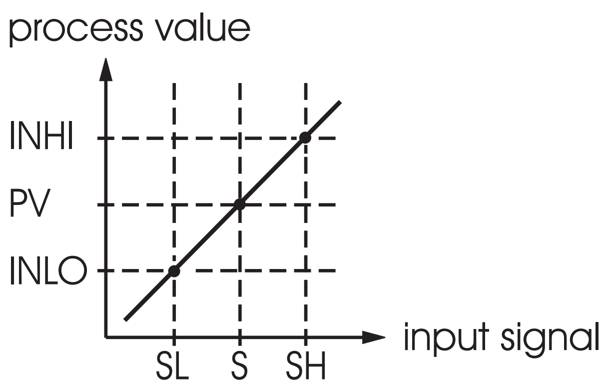


Figure 3.1
Conversion Curve for Linear Type Process Value

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

Example : A 4-20 mA current loop pressure transducer with range 0 - 15 kg/cm^2 is connected to input, then perform the following setup:

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

Other decimal point selections may be used to vary the resolution of the input. Two decimal points were merely used for this example.

3-3 Event Input

The Event input accepts a (1) relay or switch contact, (2) open collector or (3) TTL logic level input to activate the event input. One of 8 functions can be chosen by using the (E, Fn) setting in the Configuration page.

0 NONE: Event input function disabled.
1 RUN: When selected, unit enters RUN mode in the selected profile.
2 HOLD: When selected, unit enters HOLD mode if profile is active.
3 ABOT: When selected, unit quits a running profile and enter STATIC mode.
4 MAN: When selected, unit enters MANUAL mode.
5 FTRA: When selected, unit will perform failure transfer.
6 OFF: When selected, unit enters OFF mode.
7 PASS: When selected, unit advances to next segment of a running profile.
8 PID2: When selected, PB2, TI2 and TD2 replaces PB1, TI1 and TD1.

3-4 Control Outputs

There are five control mode types that can be configured for the P series as shown in Table 3.2.

Control Modes	OUT1	OUT2	O1HY	A1HY	CPB	DB
Heat only	H.on.F H.tPC H.Lin	×	☆	×	×	×
Cool only	C.on.F C.tPC C.Lin	×	☆	×	×	×
Heat: ON-OFF Cool: ON-OFF	H.on.F	ALm1	○	○	×	×
Heat: PID Cool: ON-OFF	H.tPC H.Lin	ALm1	×	○	×	×
Heat: PID Cool: PID	H.tPC H.Lin	C.tPC C.Lin	×	×	○	○

☆:Required to adjust if ON-OFF control is configured.

○ :Adjust to meet process requirements   × : Don't care

Table 3.2 Heat-Cool Control Configuration Value

Heat Only ON-OFF Control: Select H.on.F for OUT1 and use O1HY to adjust the dead band for ON-OFF control. The heat only on-off control function is shown in the following diagram.

NOTE: The ON-OFF control mode may introduce excessive process oscillation even if the hysteresis is minimized to the smallest possible value. When ON-OFF control is selected, PB1, TI1, TD1, PB2, TI2, TD2, CYC1, CYC2, OFST, CPB and DB will be hidden and have no function in the control. The auto-tuning mode and bumpless transfer are also disabled.

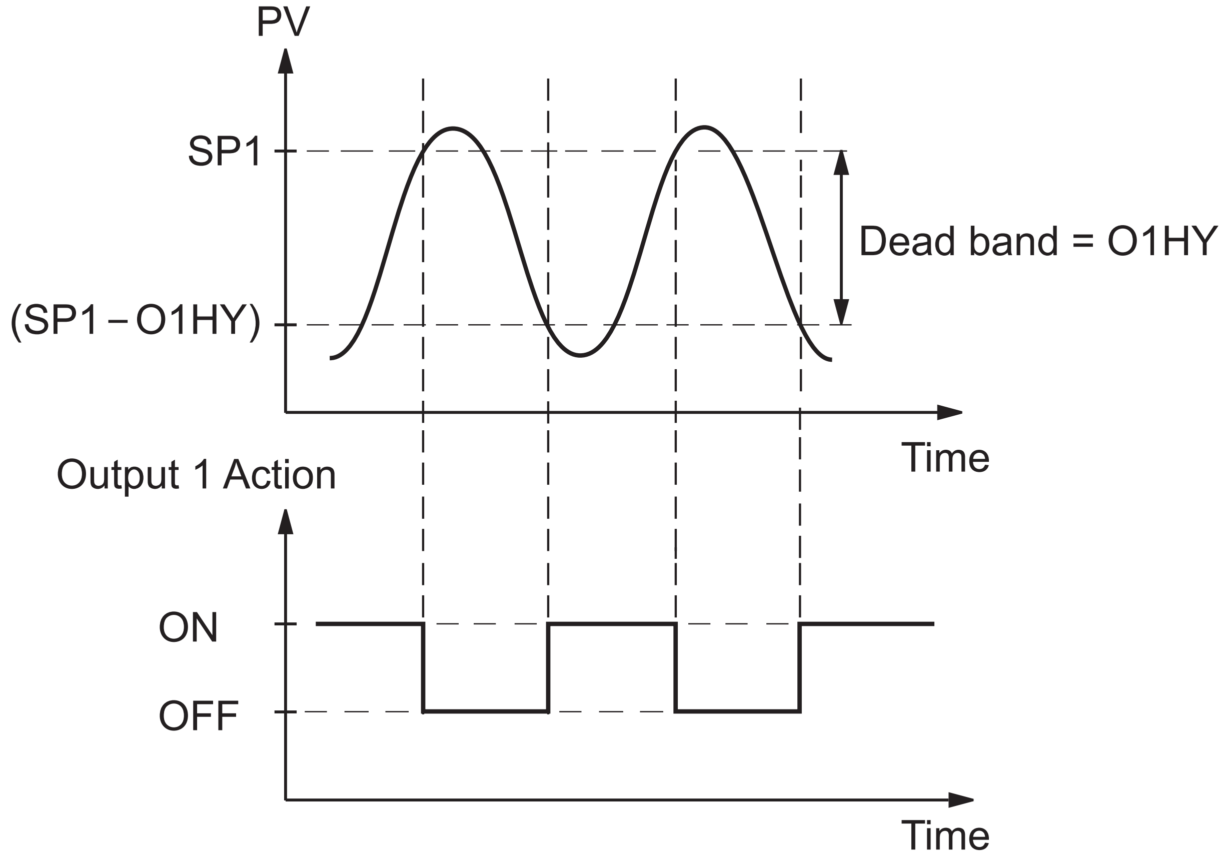


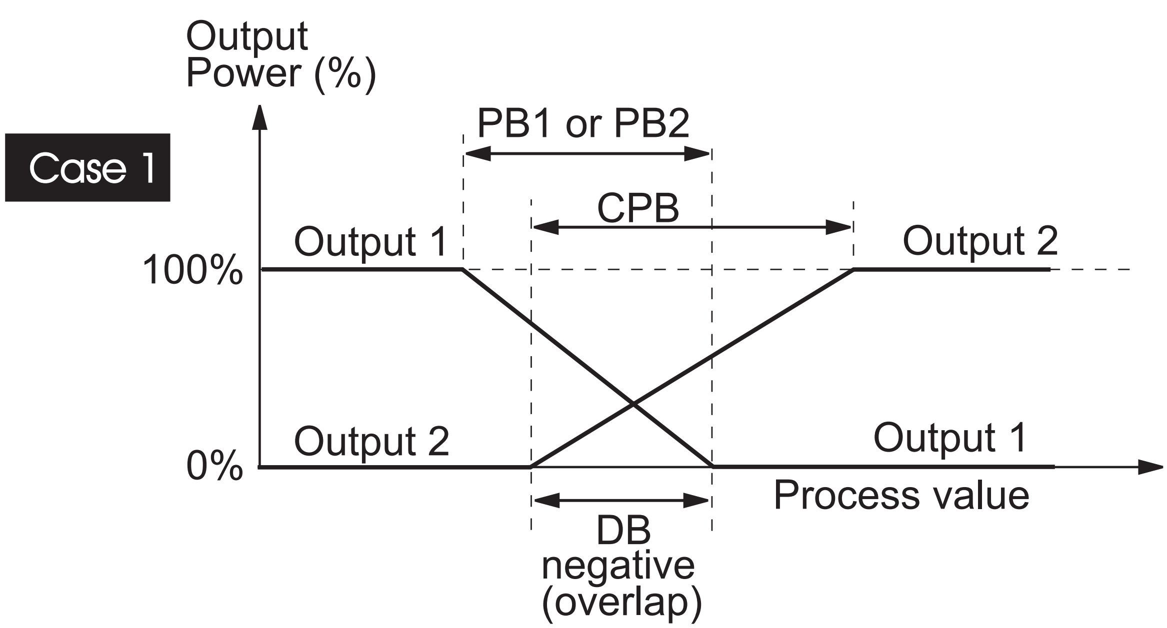
Figure 3.2 Heat Only ON-OFF Control

Heat only P (or PD) control: Select H.tPC or H.Lin for OUT1 and set TI1 and TI2 to ZERO. OFST is then used to adjust the control offset (manual reset) and O1HY is hidden. OFST is measured in % with a range of 0-100.0%. Under steady state operation (i.e. the process has stabilized), if the process value is lower than the set point by 5°C for example, and 20°C is used for the proportional band, that equals an offset of 25%. Thus, increase the OFST value by 25% and it will compensate for set point offset in the process. After adjusting OFST to a new value, the process value will move to coincide with set point. The auto-tuning mode is disabled for P or PD control. Refer to section 3-11 for manual tuning. P or PD control is not precise for processes with changing load conditions and will require frequent adjustments to the OFST. The PID control mode should thus be used because it automatically does this for you.

Heat only PID control: Set H.tPC or H.Lin for OUT1 and non-zero values for the proportional band and integral time. Perform an auto tune to obtain the proper tuning parameter values or set appropriate values for PB1, TI1 and TD1. If the control result is still unsatisfactory, it may be necessary to perform manual tuning to improve the control. See section 3-11 for manual tuning. The unit contains an intelligent PID and fuzzy control algorithm to achieve a very small overshoot and very quick response to the process if tuned properly.

Cool only control: ON-OFF control, P (or PD) control and PID control can be selected for cool only control through output 1. Set OUT1 to C.onF, C.tPC or C.Lin . The operation of cool only ON-OFF control, cool only P (or PD) control and cool only PID control are same as the descriptions for heat only control except that the output variable (and action) for cooling control is the opposite of heating control.

Heat - Cool control: Three types of bimodal (heat/cool) control modes are available as shown in Table 3.1. Case 1 through Case 3 in Figure 3.3 below, depict the various combinations for heat/cool PID operation. Case 4 shows depicts an alternate control mode in which heating is done using proportional control (PID) and cooling is provided though ON-OFF operation.



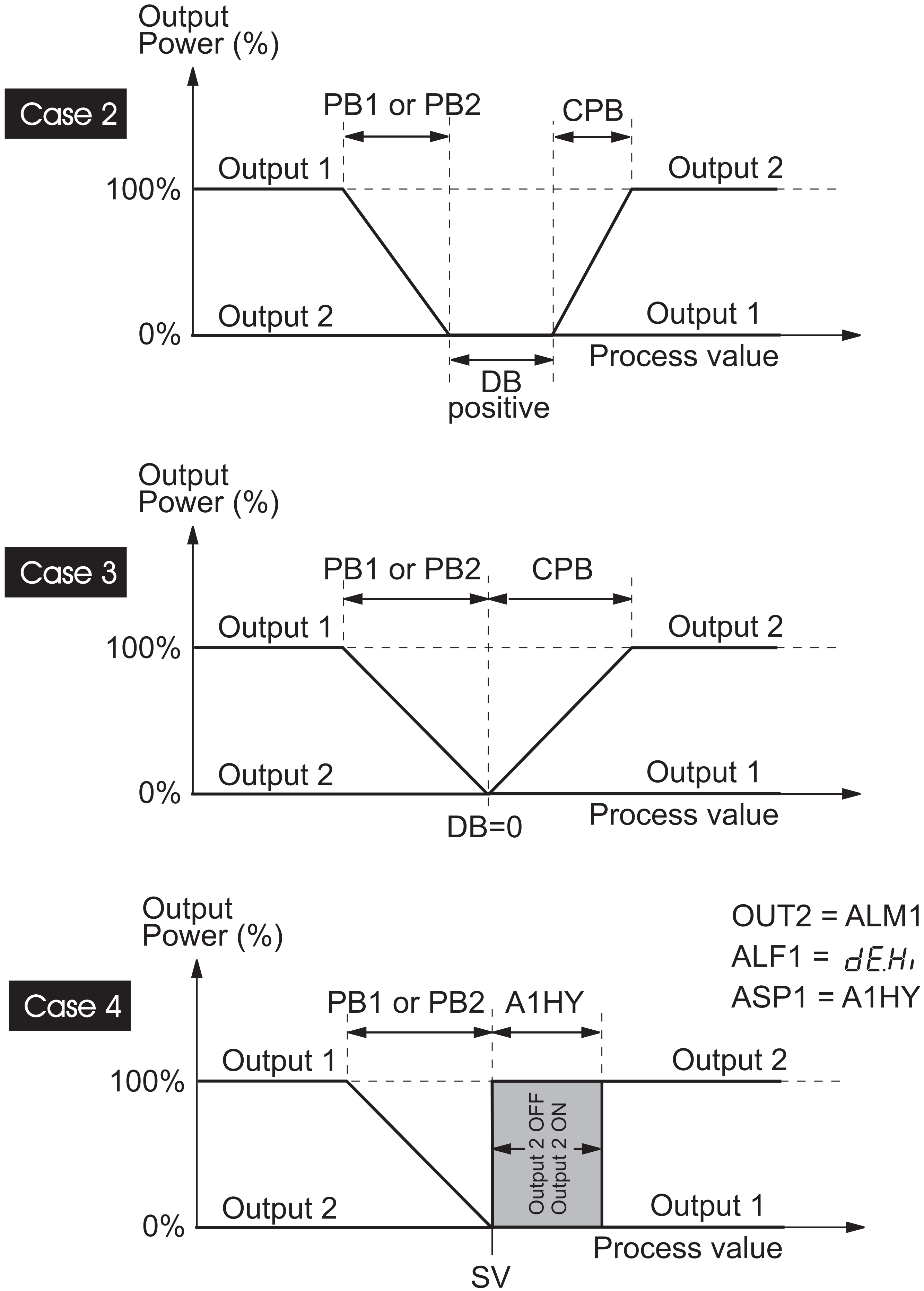


Figure 3.3 Heat - cool Control

CPB Configuration: The cooling proportional band is measured in % of The proportional band (PB) with a range 50-300. Set CPB to 100% to begin and examine the cooling effect. If cooling action should be enhanced then decrease CPB. If cooling action is too strong then increase CPB. The value of CPB is related to PB and its value remains unchanged throughout any auto-tuning procedures.

NOTE: The adjustment of CPB is also related to the cooling media used. When air is used as the cooling media, it is recommended that CPB be set to 100%. For oil, a typical setting to use for CPB is 125%. If water is used as the cooling media, adjust CPB to 250%.

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

NOTE : For bimodal (heat/cool) operation, ON-OFF control may result in excessive overshoot and undershoot problems in the process. The P (or PID) control will result in the process value constantly deviating from set point. It is recommended to use PID control for the heat/cool operation to produce a stable and zero offset process value.

CYC1, CYC2, O1FT and O2FT Configuration: The output cycle times, CYC1 and CYC2 should be adjusted according to the type of output device. Generally, a 0.5~2 sec. can be used if a solid state relay drive or solid relay (triac) is installed for the output. If a relay is installed for the output, a 10~20 sec. cycle time is used. If a linear output (voltage or current) is used, the cycle time can be ignored.

See **Section 3-9** for O1FT and O2FT adjustment.

3-5 Alarms

The unit can be configured with up to three alarm outputs on the P41 at OUT2, OUT3 and OUT4 and up to two alarm outputs on the P91 at OUT2 and OUT3. There are 8 alarm functions and 4 alarm modes available for each alarm output.

PV.Hi : A process high alarm is independent of set point. When the process is higher than the alarm set point, a process high alarm occurs. When the process value is lower than the alarm set point minus the alarm hysteresis, the alarm is off.

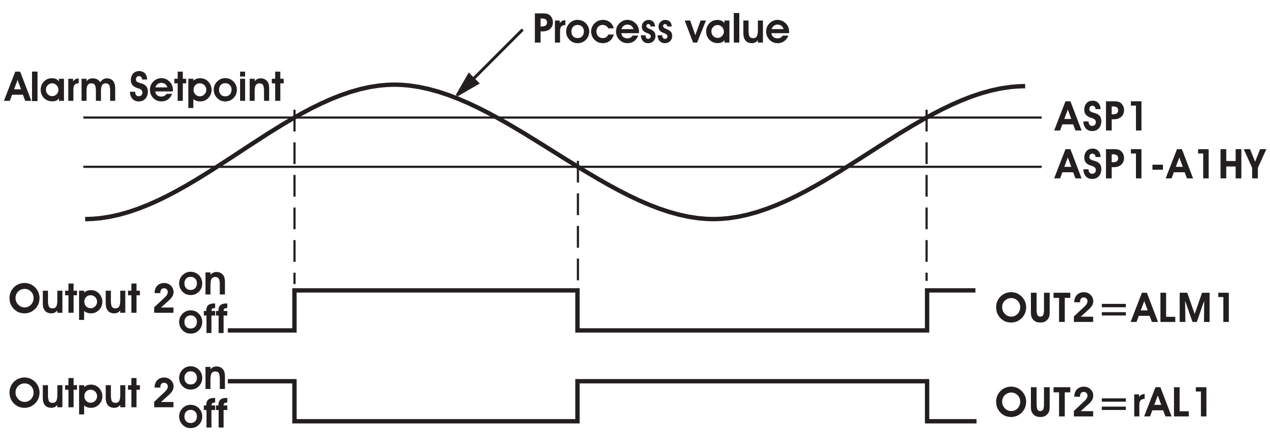


Figure 3.4 Process High Alarm 1 Operation

PV.Lo : A process low alarm is independent of set point. When the process is lower than the alarm set point, a process low alarm occurs. When the process value is above the alarm set point plus the alarm hysteresis, the alarm is off.

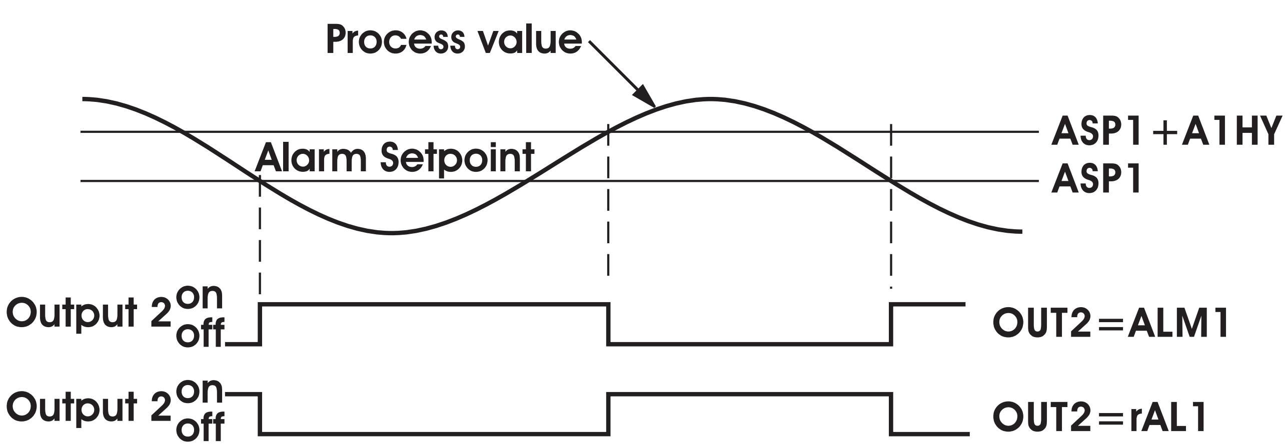


Figure 3.5 Process Low Alarm 1 Operation

dE.Hi : A deviation high alarm is dependant upon the control set point and alerts the operator when the process deviates too high over the set point value. When the process is higher than SV+ASP1 (NOTE: ASP1 must be entered as a positive value), a deviation high alarm occurs. When the process falls below SV+ASP1-A1HY, the alarm is off.

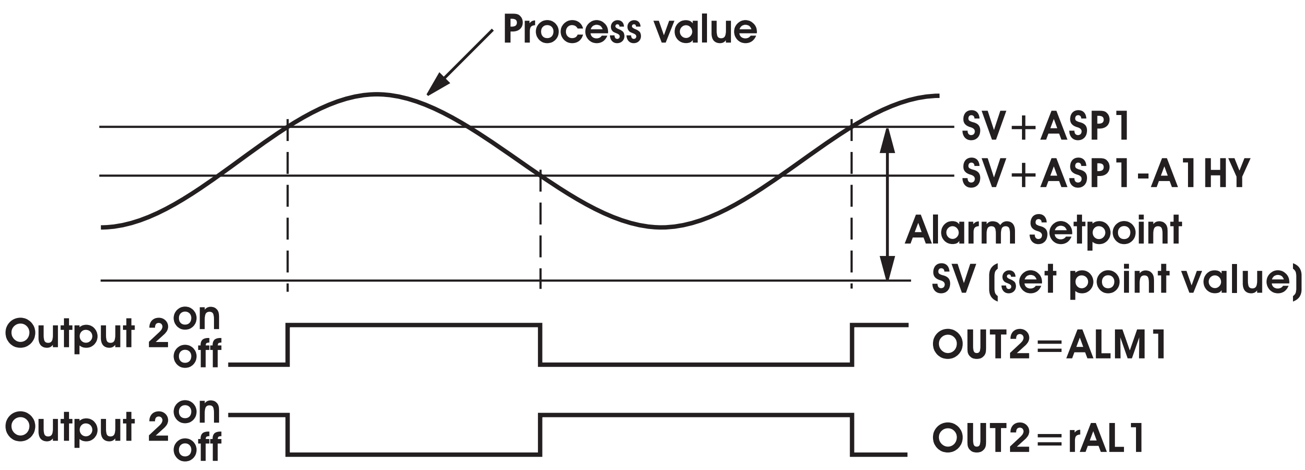


Figure 3.6 Deviation High Alarm 1 Operation

dE.Lo : A deviation low alarm is dependant upon the control set point and alerts the operator when the process deviates too low below the set point value. When the process is lower than SV+ASP1 (NOTE: ASP1 must be entered as a negative value), a deviation low alarm occurs. When the process is higher than SV+ASP1+ A1HY, the alarm is off.

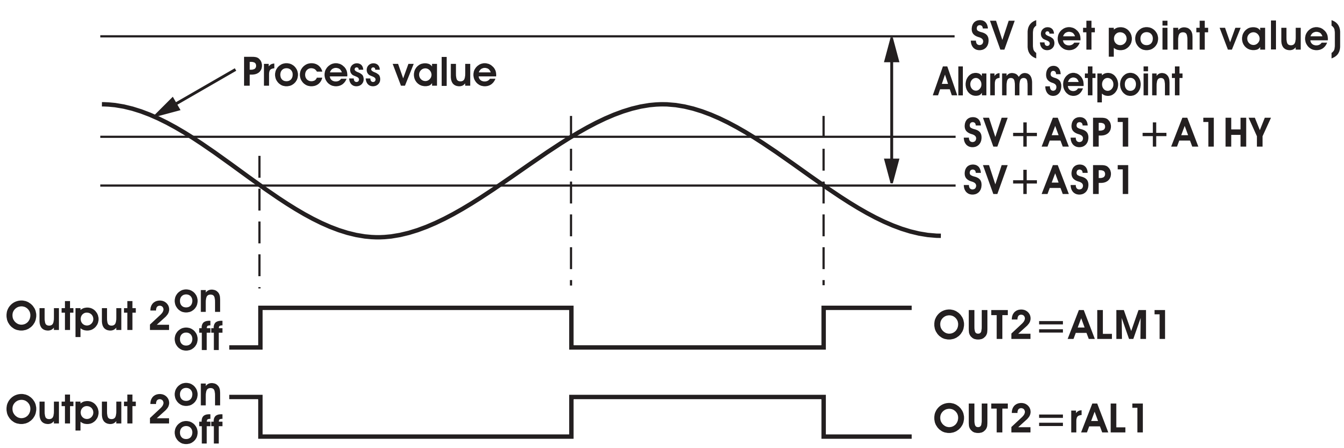


Figure 3.7 Deviation Low Alarm 1 Operation

dbHL : A deviation band high/low alarm presets two trigger levels relative to the control set point value. The two trigger levels are SV+ASP1 and SV-ASP1 for the high and low alarm values. When the process is higher than SV+ASP1 or lower than SV-ASP1, a deviation band alarm occurs. When the process is within the trigger levels, SV+ASP1-A1HY and SV-ASP1+ A1HY, the deviation band alarm is off.

NOTE: ASP1 must be entered as a positive value.

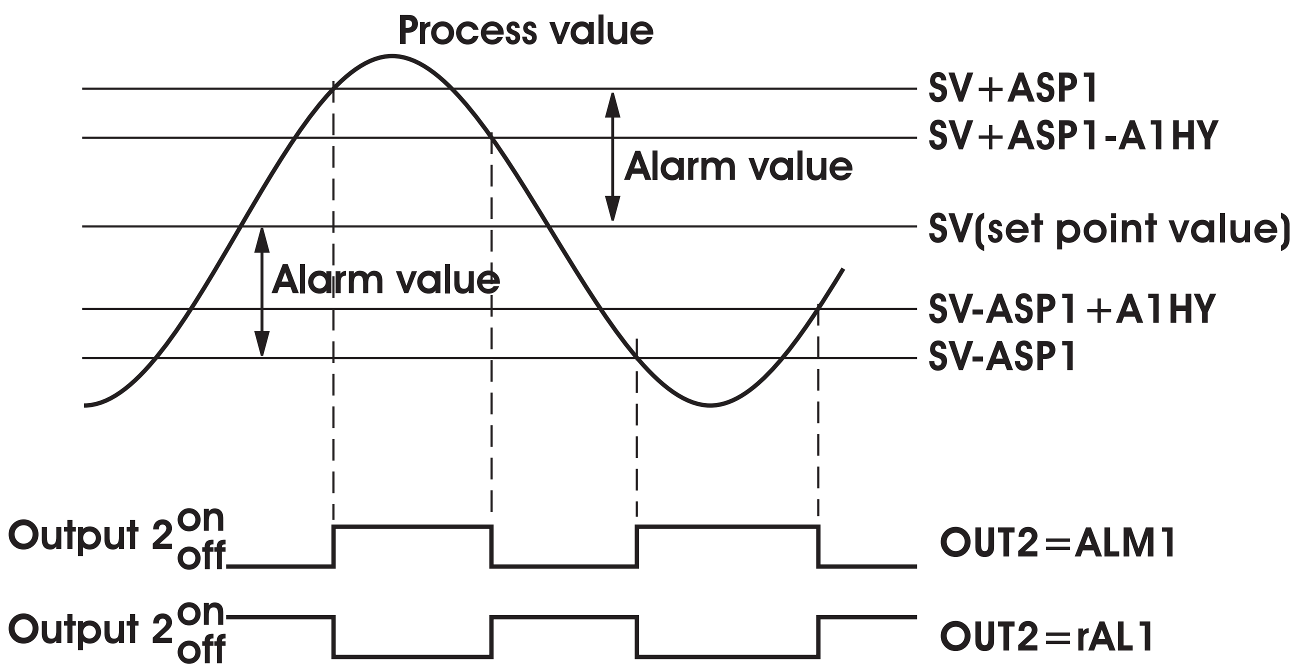


Figure 3.8 Deviation Band Alarm 1 Operation

NOTE: The settings and operation of alarm 2 and alarm 3 are the same as those described for alarm 1. In the above descriptions, SV denotes the current set point value for control which is different from SP1 when in the profile mode of operation.

The alarm modes (A1MD, A2MD and A3MD) are set by using a three bit binary number.

alarm mode value	Description
norm	A direct acting normal alarm output is off as the non-alarm condition and on as an alarm condition. The output state is inverted as a reverse alarm output is selected for OUT2, OUT3 or OUT4.
LtcH	A direct acting latching alarm output is on as an alarm condition and it will remain unchanged even if the alarm condition is cleared. The output state is inverted as a reverse alarm output is selected for OUT2, OUT3 or OUT4.
HoLd	A direct acting holding alarm output is off even if an alarm condition may occur on power up. This will prevail until the alarm condition returns to the "inactive" condition, thereafter the alarm will operate normally. The output state is inverted as a reverse alarm output is selected for OUT2, OUT3 or OUT4.
Lt.Ho	A direct acting **latching** and **holding** alarm performs both holding and latching alarm functions. The output state is inverted as a reverse alarm output is selected for OUT2, OUT3 or OUT4.

Table 3.3 Alarm mode description

The latching alarm output is reset when both ▲ and ▼ keys are pressed at the same time and the alarm condition is no longer present.

3-6 Configure Home Page

Conventional controllers are designed with fixed parameter scrolling. The "P" Series has the flexibility for you to select the parameters which are most useful to you and put these parameters in the home page. Hence, you can have a custom home page.

There are up to eight parameters can be displayed on the home page. These are the SEL1~SEL8 parameters in the configuration page. Each parameter can be configured to display one of 19 parameters: INPT, UNIT, DP, PB1, TI1, TD1, PB2, TI2, TD2, OFST, O1HY, CYC1, CYC2, CPB, DB, A1HY, A2HY, A3HY and ADDR. Note that not all of the 19 parameters may be available as some of the selections or only visible based on the configuration of the controller.

3-7 User Calibration

Each unit is calibrated at the factory before shipment; however, the unit can be re-calibrated in the field with the use of proper calibration equipment.

Purpose of User Calibration

The basic calibration of the unit is highly stable and set for life. User calibration allows you to offset the permanent factory calibration to either:

1. Calibrate the unit to meet your reference standard.
2. Match the calibration of the unit to that of a particular transducer or sensor input.
3. Calibrate the unit to suit the characteristics of a particular installation.
4. Remove long term drift in the factory set calibration.

There are two parameters: offset low value (OFSTL) and offset high value (OFSTH) which can be adjusted to correct the error in the process value reading. See Section 1-5 for the key operation flowchart; press the  key until the low calibration page is obtained.

Send the low signal to the input of unit, then press the key. If the process value (the upper display) is different from the input signal, you can then use the ▲ and ▼ keys to change the OFSTL value (the lower display) until the process value is equal to the correct value you input to the unit. Then press and hold key for 5 seconds. The low point calibration is complete. The same steps can then be used to adjust the high point calibration.

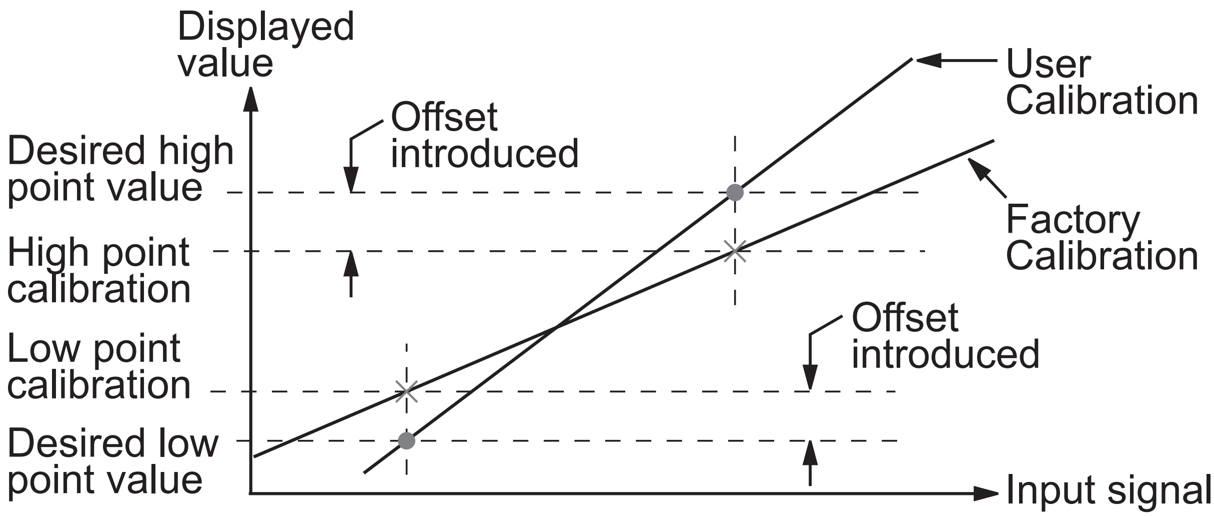


Figure 3.9 Two Point User Calibration

The two point offset constructs a straight line (linear calibration) between the two points. To insure greatest accuracy, it is best to calibrate with the two points at the minimum and maximum operating ranges of the system. After 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- 8 Digital Filter

In certain application 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. The default value of FILT is 0.5 sec. FILT can be adjusted To a time constant from 0 to 60 seconds. Zero seconds represents no filtering is applied to the input signal. The filter is characterized by the following diagram.

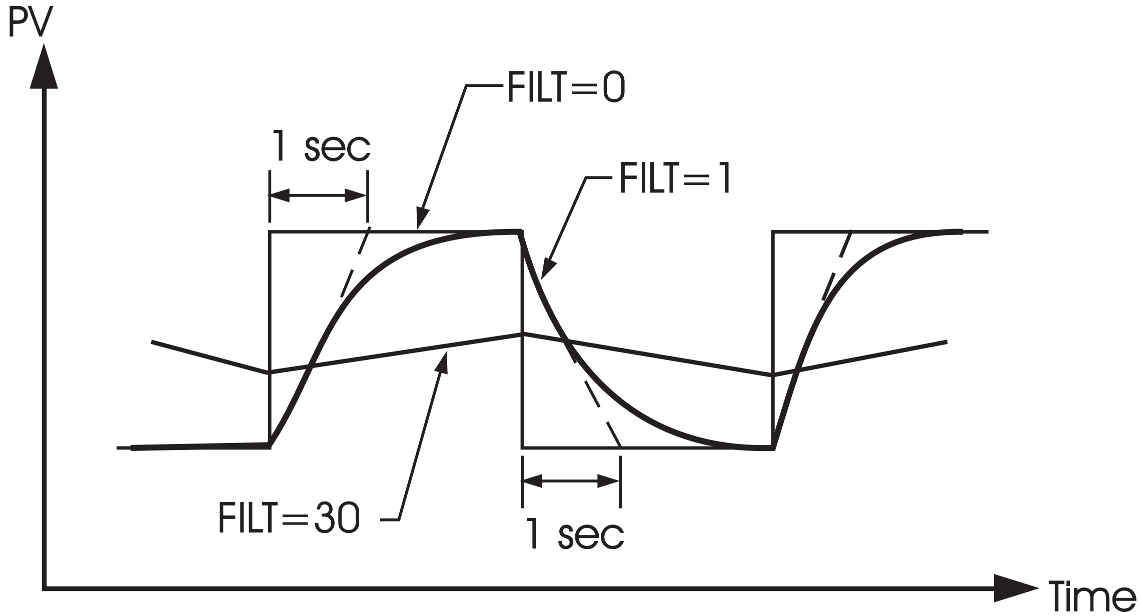


Figure 3.10 Filter Characteristics

Note

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

3 -9 Failure Transfer

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

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

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

Output 1 Failure Transfer, if activated, will perform:

1. If output 1 is configured as proportional control (i.e,. HTPC, CTPC, HLIN, or CLIN selected for OUT1), and BPLS is selected for O1FT, then output 1 will perform bumpless transfer. Thereafter the previous averaging value of MV1 will be used for output 1.
2. If output 1 is configured as proportional control, 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 (i.e., HONF or CONF is selected for OUT1), then output 1 will transfer to off state if OFF is set for O1FT and transfer to on state if ON is set for O1FT.

Output 2 Failure Transfer, if activated, will perform:

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

OUT3 and OUT4 Failure Transfer is activated as the controller enters failure mode. Thereafter the alarm will transfer to the ON or OFF state which is determined by the set value of O3FT or O4FT..

3 -10 Auto-tuning

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

Auto-tuning is applied in cases of:

* Initial setup for a new process.
* The process has changed substantially from the previous auto-tuning values.
* The control result is unsatisfactory.

Operation:

1. Set the correct values on the configuration page. Nonzero values for PB and TI should be set.
2. Set **EIFN** = PID2 if a second set of PID's is required to be tuned.
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 and then enter the A-T mode. The upper display will begin to flash and the auto-tuning procedure for PID1 will begin.
4. If the system needs to use a second set of PID values, then after the first auto-tuning is complete, close the event input of the unit and repeat step 3 for the second set of PID values.

NOTE :

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

Procedures:

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

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

AtEr Auto-Tuning Error

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

- If PB exceeds 9000 (9000 PU, 900.0 F or 500.0 C).
- or if TI exceeds 3600 seconds.
- or if set point is changed during auto-tuning procedure.

Solutions to AtEr

1. Try auto-tuning once again.
2. Don't change set point value during auto-tuning procedure.
3. Don't set zero value for PB and TI.
4. Use manual tuning instead of auto-tuning (See section 3-12).
5. Touch ▲ and ▼ key to reset AtEr message.

3 - 11 Manual Tuning

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

If the control performance by using auto-tuning is unsatisfactory, use the following rules for further adjustment (manual tuning) of PID values:

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

Table 3.4 PID Adjustment Guide

Figure 3.11 shows the effects of PID adjustment on process response.

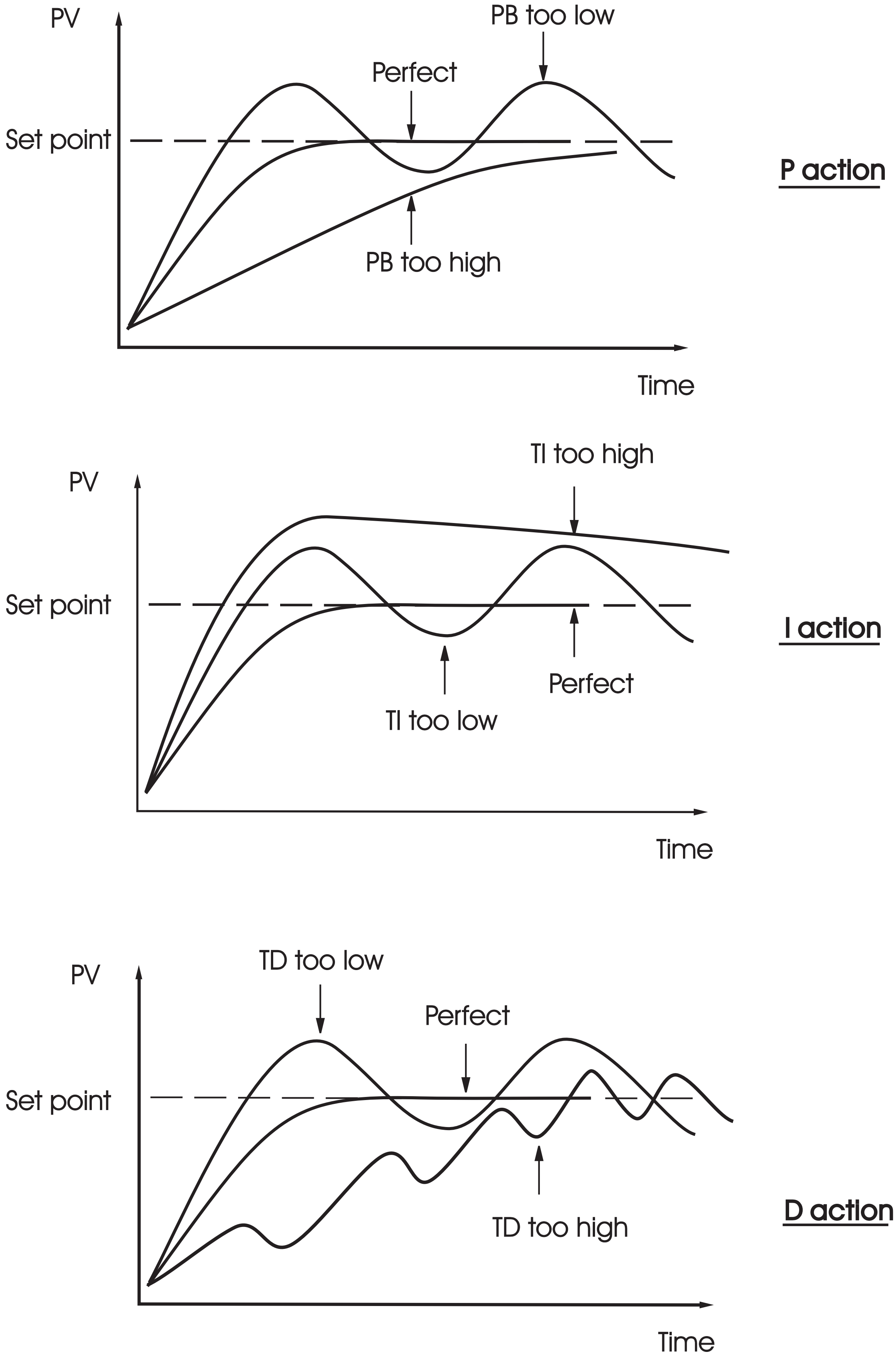


Figure 3.11 Effects of PID Adjustment

3 -12 Manual Mode

Operation:

To enable manual control, the password PASS should be set with a value equal to CODE (except CODE=0).

Press [key] key to get nodE (mode select), then use ▲ and ▼ keys to obtain nAn (Man). Then press [key] key for 5 seconds and the unit will enter manual mode. The upper display will begin to flash and the lower display will show H___ or C___ . H___ indicates control percentage value for heating output and C___ indicates control percentage value for cooling output. The up and down keys can be used to adjust the percentage values for the heating or cooling output. The controller performs open loop control as long as it stays in manual mode.

Exit Manual Mode

To press both ▲ and ▼ keys , the controller will revert to static mode and show home display.

3 - 13 Data Communication

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

Two types of interfaces are available for serial communications. These are 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 is used for RS-232, RS-485 is less sensitive to noise and suitable for a longer distance. RS-485 can communicate without error over distances of up to 1 km while RS-232 is not recommended for distances over 20 meters.

Since a standard PC does not provide an RS-485 port, a network adaptor (such as the SNA10A) has to be used to convert the RS-485 signal to RS-232 for the PC's serial port. Using RS-485 allows multiple units (up to 247) to be connected a single port while RS-232 allows only a single device to be connected.

Data Communications Setup

Enter the configuration page and select COMM for OUT4 (P41 only) or OUT5. Set the desired address (ADDR) for the unit, and set the baud rate (BAUD) and parity (PARI) to match the values used for the PC's port. When using RS-485, each unit on the link must have its own unique address. If more than one unit is set to the same address, the communications will not work properly.

NOTE: If you use a conventional 9-pin RS-232 cable instead of the CC94-1, the cable should be modified for proper operation according to **Section 2-10.**

3 - 14 Retransmission

The unit can output (retransmit) the process value or set point value via its retransmission terminals RE+ and RE- provided that the retransmission option is ordered. To enable retransmission, select rE.P.v for the PV or rE.SP for the SP in the configuration page for OUT4 (P41 only) or OUT5. The following parameters will then shave to be configured for the selected output:

OP4L: Low limit value for output 4
OP4H: High limit value for output 4
REL4: Retransmission low scale value for output 4
REH4: Retransmission high scale value for output 4
OP5L: Low limit value for output 5
OP5H: High limit value for output 5
REL5: Retransmission low scale value for output 5
REH5: Retransmission high scale value for output 5

Example: If you want to output 4mA for PV at 0°C and 20mA for PV at 1000°C via output 5, then set the following parameters:

OUT5 = rE.Pv
OP5L = 20.0(%), since 20% of a 0-20mA output module will output 4mA (20% of 20mA span).
OP5H = 100.0(%)
REL5 = 0°C
REH5 = 1000°C

3 - 15 Output Scaling

Output scaling can be applied to the control outputs when a linear output is used (Case 1 in Fig. 3.12) and to the retransmission output (Case 2 in Fig. 3.12). The Out.L value in Fig. 3.12 may be 0 mA, 0V, 1V or 4mA, and the Out.H value may be 20mA, 5V or 10V according the output module installed.

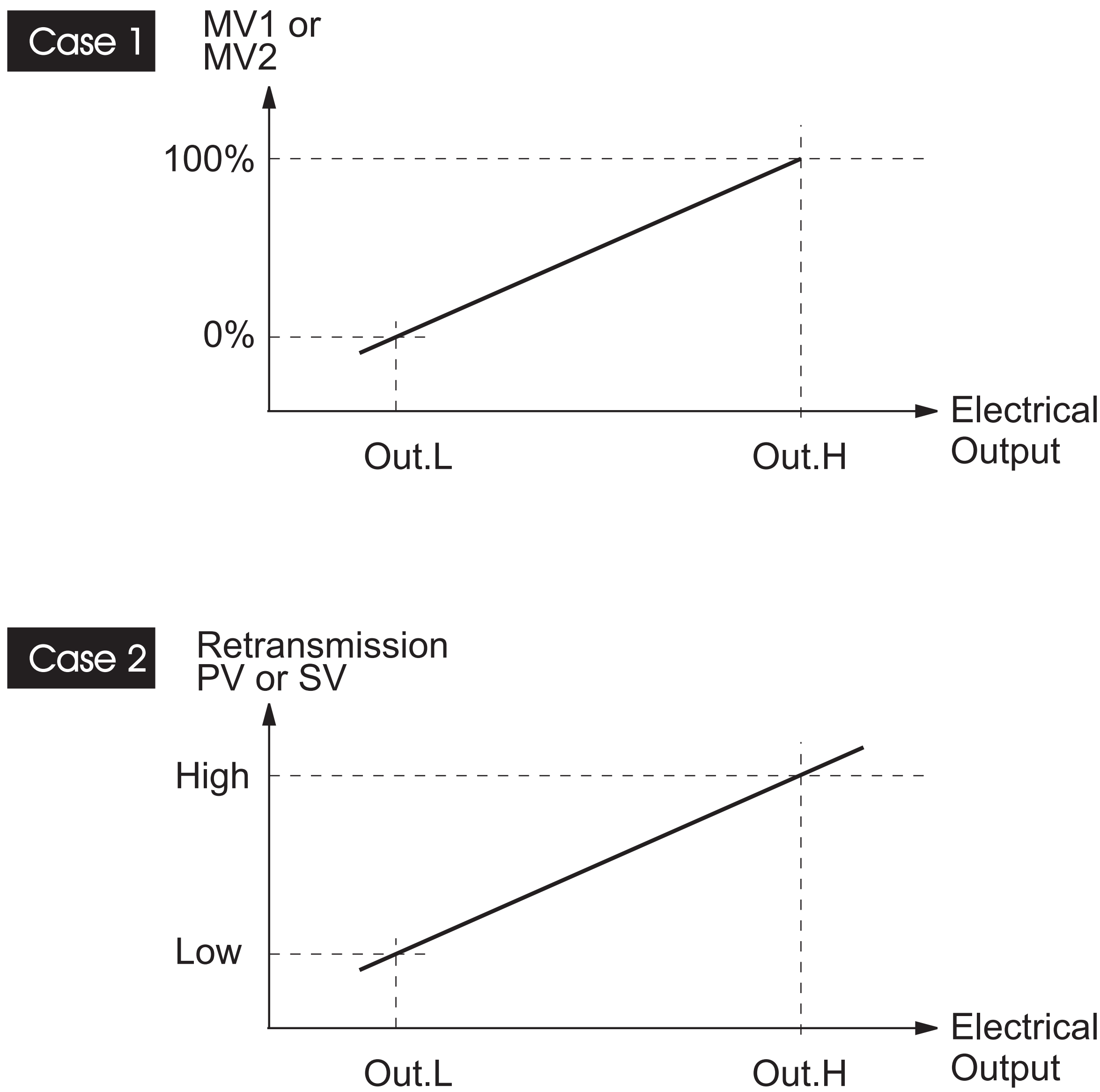


Figure 3.12 Output Scaling Function

Chapter 4 Profiler Operation

4-1 What is a Set Point Profiler

Many applications need to vary temperature or process value with time. Such applications need a controller which varies set point as a function of time. The P41 and P91 controllers can do this. The set point is varied by using a set point profiler. Profiles are stored as a series of "ramp" and "dwell" segments, as shown below.

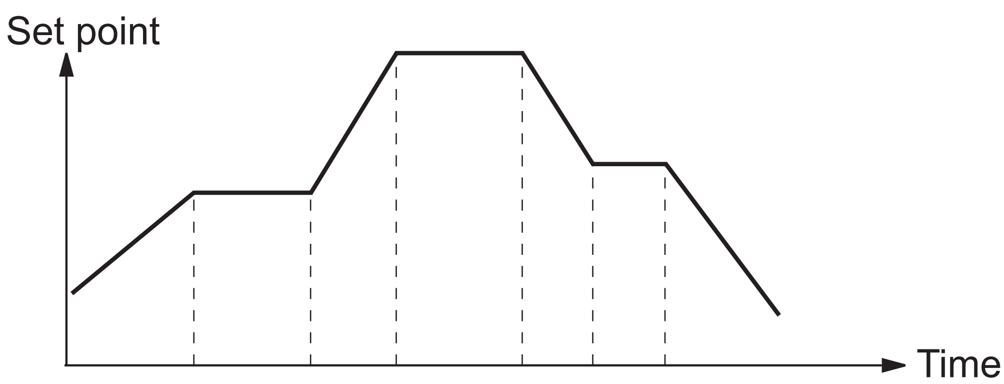


Figure 4.1 Set Point Profile

In each segment, you can also define the state of up to 3 event outputs which can drive either relay, logic or triac outputs depending on the modules installed in the controller.

A profile can be executed once, or repeated a set number of times or even repeated continuously. If repeated a set number of times, the number of cycles must be specified as part of the profile.

There are four types of segment:

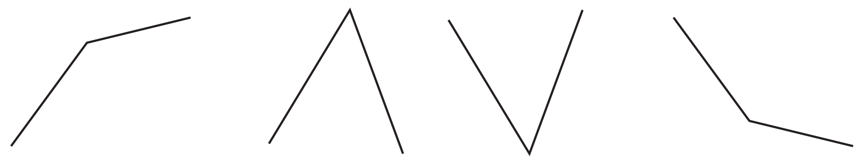
Ramp	/ \	The set point ramp (linear), from its current value to a new value, can be at a set rate (ramp rate), or in a set period of time (ramp time). The ramp rate or the ramp time and the target set point are specified for each segment when creating or modifying a profile.
Dwell	—	The set point remains constant for a specified period.
Jump		It is often necessary to jump backward and run the loop a set number of cycles.
End		The profile either ends in this segment or repeats a set number of cycles. The profile stops after the repeated cycles are finished.

Table 4.1 Segment Types

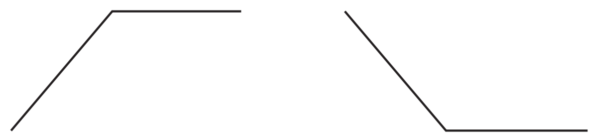
4-2 Segment Connection

Four kinds of combinations are allowable for connecting segments, These are:

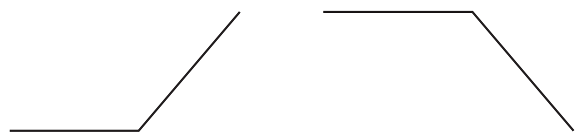
Ramp-Ramp:



Ramp-Dwell:



Dwell-Ramp:



Dwell-Dwell:

4-3 Profiler (Control) Modes

The "P" Series controllers have eight operating modes:

Mode	Description	Indication
Run	In run mode, the profiler varies the set point according to the stored profile values.	RUN light on
Hold	In hold mode, the profile is "frozen" at its current point. In this state you 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, when they will be overwritten by the stored profile values.	HLD light on

Mode	Descrition	Indication
Holdback	Holdback indicates that the process value is lagging the set point by more than a preset amount (holdback band, HBBD) and that the profile is in HOLD, waiting for the process to catch up.	HLD light flashes.
Static	In static mode, the profiler is inactive and the controller acts as a standard controller, with the set point determined by the value set in the lower display.	Both RUN and HLD light are off.
A-T	In automatic tuning mode, the profiler is inactive and the controller executes the automatic tuning function at its static mode set point.	Both RUN and HLD light are off. Upper display flashes.
MAN	In manual mode, the profiler is inactive and the heating and cooling output values can be adjusted at the lower display by the up-down keys.	Both RUN and HLD light are off. Upper display flashes. Lower display shows H___ or C___ .
OFF	In off mode, the profiler is inactive and all the outputs are disabled. This includes all the control outputs as well as all alarm and event outputs.	Both RUN and HLD light are off. Upper display shows OFF and flashes.
End	The profile is complete.	Both RUN and HLD lights flash.

Table 4.2 Profiler Modes

4-4 Running, Holding and Aborting a Profile

To change the operating mode of the controller, press the page key until the mode page is obtained. The upper display will show modE and the lower display indicates the mode selection value. To start a profile, press the up/down keys repeatedly until run is obtained, then press and hold the page key for 5 seconds to switch the profiler into RUN mode.

Once a profile is running, the user can put the profiler in HOLD mode, which "freezes" the profile at its current state. The set point, event outputs and time remaining in the segment will maintain their values unless changed by the user or the profiler is put back into RUN mode. To place the profiler in HOLD, select HoLd from the mode page, and press and hold the page key for 5 seconds. The profiler will then enter HOLD mode.

The operator may also abort (i.e., terminate) the profile by selecting StAt (static mode) from the mode page. When the program is aborted, the profiler is inactive and enters static mode. At the same time both the RUN light and HLD light are off.

4-5 Viewing and Modifying Profile Operation

Three parameters: PFSG, TIME and CYCL indicate the status of profile progress. The operator can easily view these parameters, the current profile and segment number, the time remaining for the current segment and the cycles remaining for the current profile, on the home page by pressing the scroll key and cycling through the values.

By changing the value of P_._ _ (profile and segment number) using the up/down keys, the user can select a desired profile/segment entry point to start or jump the current segment to the next segment when in HOLD mode. When in HOLD mode, the user can also change the value of TIME to shorten or prolong the time remaining of the current segment. If it is determined that additional cycles are required of the current profile, the CYCL parameter can be changed to increase or decrease the number of jumps remaining.

4-6 Profile Start Options

When a profile is started, the set point can start from either the current process value, the last control set point or from a predefined starting set point. The **STAR** parameter is used to specify this starting set point value.

PV: selects the process value (default value)
SP1: selects the current controller set point value
STSP: selects the start set point value

The normal method is to start from the process value, because this will produce a smooth and bumpless start to the process. However, if the time period of the first segment must be defined, using SP1or STSP for the starting point will insure that the first segment time duration is maintained.

4-7 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, should this occur. The action of Holdback is similar to a deviation alarm and can be enabled or disabled on a per segment basis. Holdback uses three parameters: **HBT** - holdback wait time, **HBBD** - holdback band and **HBTY** - holdback type.

If the deviation from the set point exceeds the holdback band (HBBD), then the holdback feature, if enabled, will automatically freeze the profile at its current point and the HLD light will flash to indicate holdback is active. At the same time, the holdback timer begins to count. When the value of the holdback timer exceeds the value of holdback wait time **HBT**, the profiler will automatically terminate the holdback and jump to the next segment. When this occurs, an error code HbEr will be displayed on the controller to indicate that the holdback wait time had been exceeded.

If the process value returns to within the holdback band setting before the holdback timer is exceeded, the profile will resume operation as normal. There are four different Holdback types:

oFF - Disables Holdback - no action is taken.

Lo - Deviation Low Holdback holds the profile back when the process value deviates below the set point by more then the holdback band (HBBD).

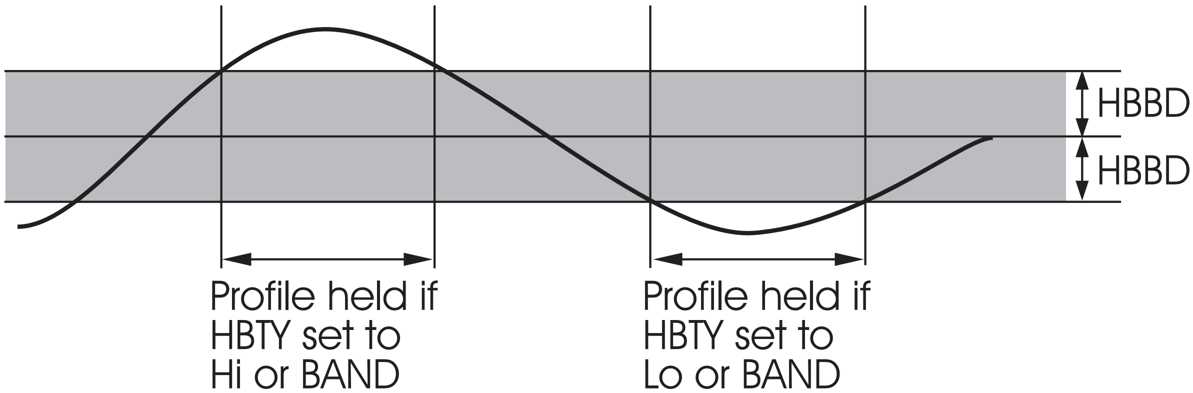
Hi - Deviation High Holdback holds the profile back when the process value deviates above the set point by more than the holdback band (HBBD).

bAnd - Deviation Band Holdback is a combination of the two. It holds the profile back when the process value deviates either above or below the set point by more than the holdback band (HBBD).

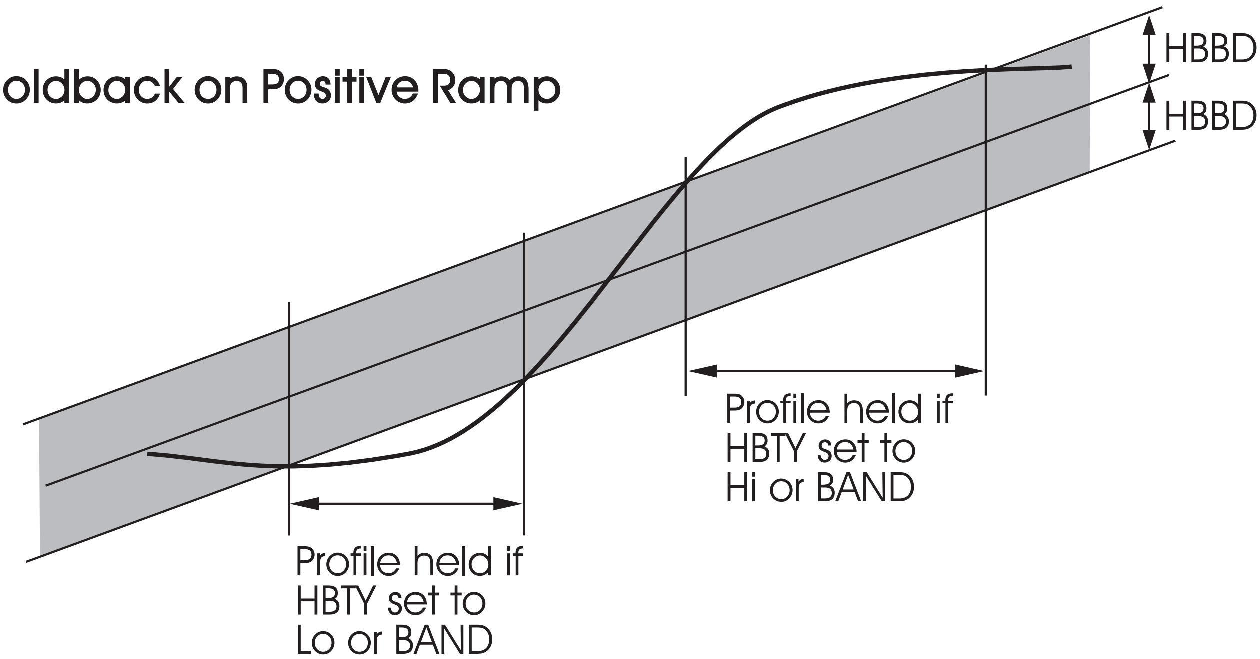
NOTE

HBT is a global parameter which is common to all profiles.
HBBD is a parameter which applies to a specific profile.
HBTY is a parameter which applies to a segment in a specific profile.

Holdback on Dwell



Holdback on Positive Ramp



Holdback on Negative Ramp

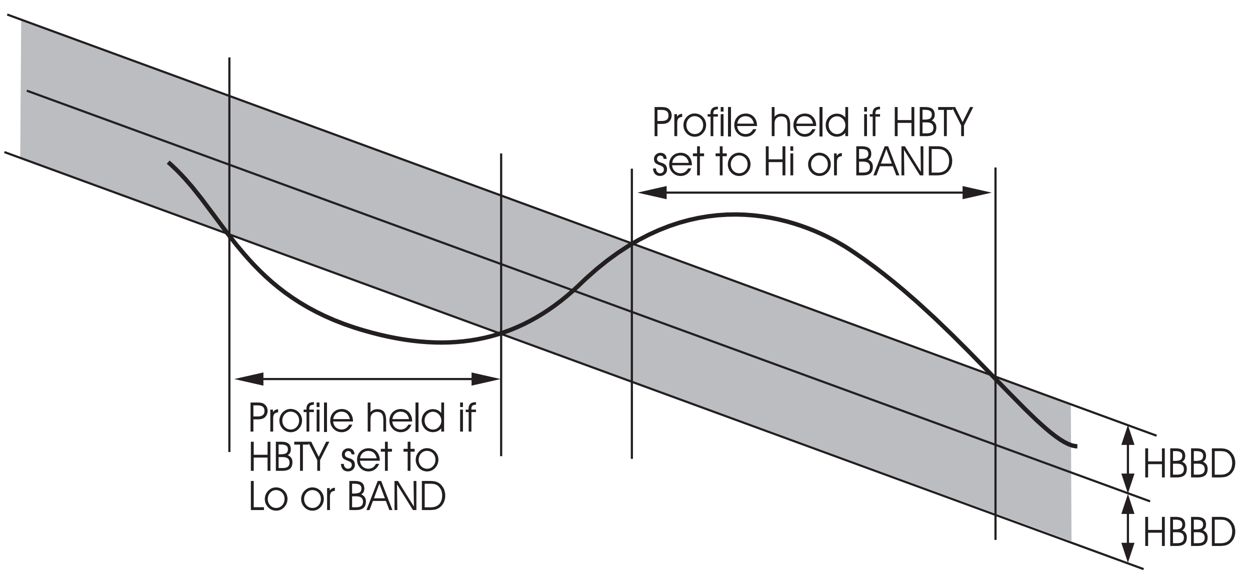


Figure 4.2 Holdback Operation

4-8 Power Failure

If power is lost to the controller and then restored while a profile is running, the behavior of the profile is determined by the setting of the power failure recovery parameter "PFR" in the profile configuration. There are 4 available settings - cont, Py, SP1 and oFF.

If cont is selected, then when power is restored, the profile continues from where it was interrupted when power was lost. The set point value (SV), time remaining (TIME) and cycles remaining (CYCL) will be restored to their power-down values. This selection provides the fastest process recovery. The following figures (4.3 and 4.4) show the recovery action when continue is selected.

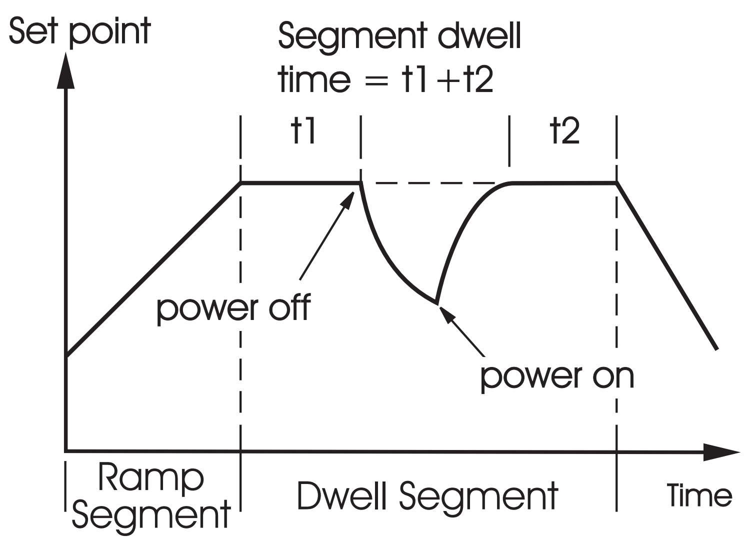


Figure 4.3 Recovery from Profile at Dwell Segment

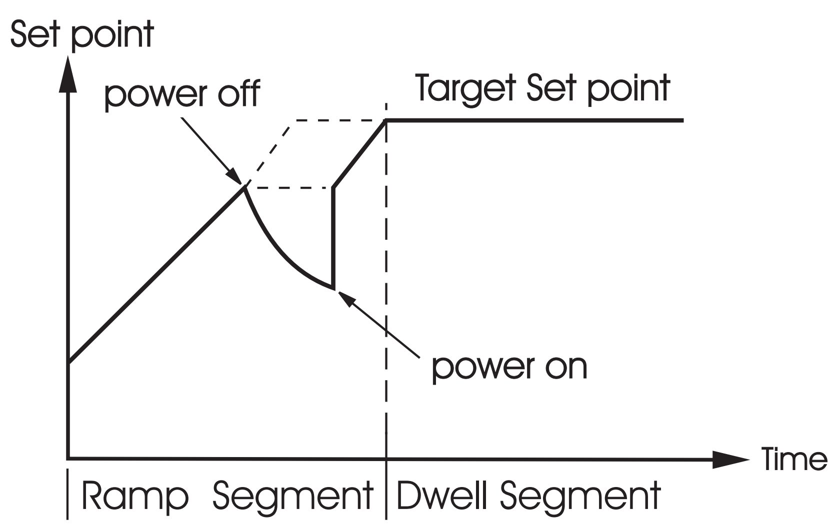


Figure 4.4 Recovery from Profile at Ramp Segment

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

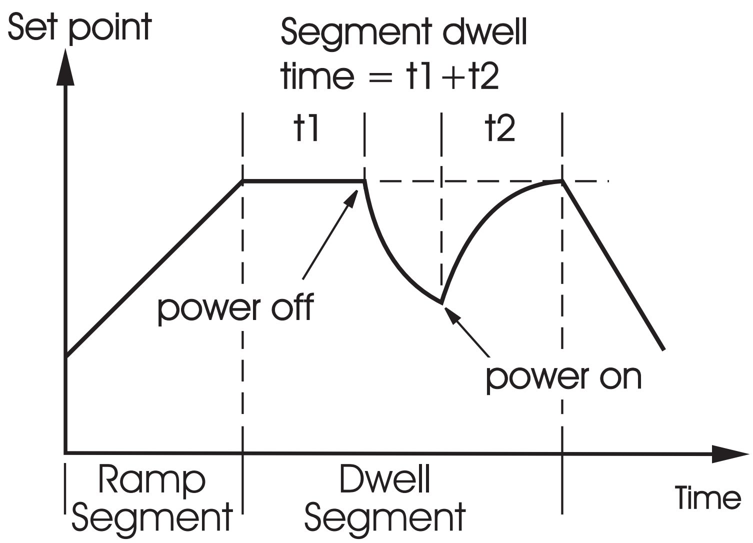


Figure 4.5 Recovery from PV at Dwell Segment

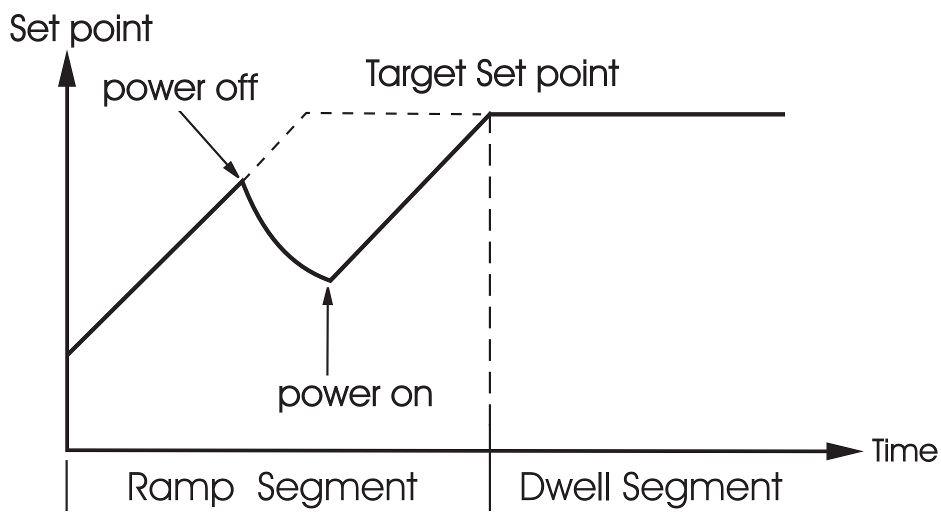


Figure 4.6 Recovery from PV at Ramp Segment

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

If oFF is selected, when power is restored, the profiler is disabled and the controller enters OFF mode. All the control outputs as well as alarm and event outputs are turned off.

4-9 Configuring the Profiler

Prior to creating a profile or using the controller for the first time, you should familiarize yourself with all of the profile parameters and settings, and insure that the controller is configured properly for your application.

The following parameters are common to all profiles (configuration):

Global Data

STAR: set point value at start of profile
END: set point value at end of profile
DLAY: delay time before profile start
PFR: power fail recovery
HBT: holdback wait time

The following parameters apply to a specific profile:

Profile Data

PROF: profile number selected for view
HBBD: holdback band
STSP: start set point value
RMPU: unit for ramp segment
DLLU: unit for dwell segment

The following parameters apply to each segment of a specific profile:

Segment Data

SGNO: segment number
SGTY: segment type
TGSP: target set point
RTRR: ramp time or ramp rate
P2EV: PID selection and event output states
HBTY: holdback type
DLLT: dwell time
SEG: target segment number for jump segment
CYCL: repeat number of cycle
FSP: final set point for the end segment

4-10 Viewing and Creating a Profile

To create or view a profile stored in the unit, press the page key repeatedly in order to get to the profile page. The profile page will be indicated by ProF in the upper display, and the lower display will indicate the number of the currently selected profile (1-9).

Using the up/down keys, enter the number of the profile to be viewed or edited. Once the selection is made, pressing the scroll key will then cycle through the profile data and segment parameter values (see **Section 1-5**, **Key Operation Flowchart**).

The profile data values include the holdback band (Hb.bd), the start set point (St.SP), the ramp units (rmP.u) and the dwell units (dLL.u). If holdback is going to be required for the profile, set the holdback band to the allowed maximum deviation that will be allowed from set point during profile operation. Note that the holdbank band is entered in whole numbers only, regardless of the decimal point selection made for the input configuration of the control.

If the profile start set point has been selected in the configuration as the start set point for profiles, set the start set point to the required value for the profile. Next, set the ramp and dwell units to the desired setting for the profile. Note that these settings apply to all ramp and dwell segments of the profile. The available selections are:

Ramp Segments

- HH.mm = hours : minutes
- mm.SS = minutes : seconds
- 1min = ramp rate in units per minute
- 1Hr = ramp rate in units per hour

Dwell Sgements

- HH.mm = hours : minutes
- mm.SS = minutes : seconds

The next parameter after the profile data values is the segment number (SG.no). This is the first of the segment parameters and is used to select which segment of the profile is to be viewed/edited. The value can be changed using the up/down arrow keys from 0 (first step of the profile) to the last step of the selected profile.

Pressing the scroll key repeatedly will cycle through the available segment parameters. The display will then automatically return to the segment number parameter once all other parameters have been set for a segment, in order to speed profile entry. This allows the user to simply set the next segment number of the profile and then scroll through and edit its associated values.

The first parameter of a segment is the segment type (SG.tY). The type of segment defines the other parameters that are visible and required to be set for the segment. The four segment types are:

rAnP : ramp to a new target set point at a set rate or in a set time
dLL : dwell for a set time
JunP : jump to a specified segment in the same profile
End : last segment (end of the profile)

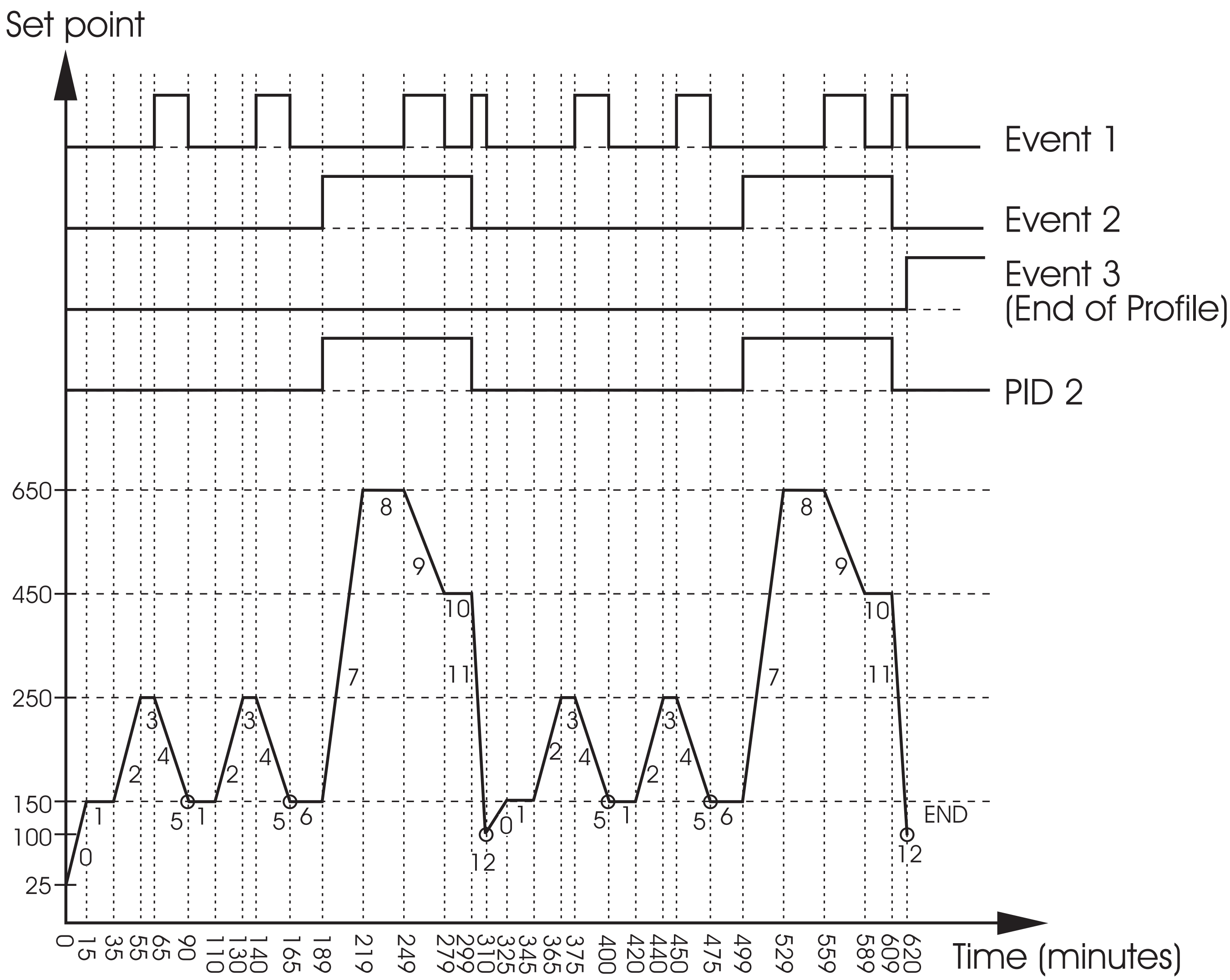
Once the segment type is defined, pressing the scroll key will cycle through the remaining parameters for the segment as shown in the following chart.

Parameter	Segment type (SGTY) selected			
	0 RAMP	1 DWELL	2 JUMP	3 END
TGSP	✓			
RTRR	✓			
P2EV	✓	✓		
HBTY	✓	✓		
DLLT		✓		
SEG			✓	
CYCL			✓	✓
FSP				✓

Table 4.3 Parameters Associated with Segment Type

Note that there can be more than one end step in a profile if not al segments are used. In these cases, the first end step will be used as the last segment of the profile. One the profile entry is complete, pressing both the up and down keys at the same time, or pressing the page key, will return to the home page.

Figure 4.7 Profile Example



A heat treatment oven needs to vary temperature as a function of time according to the process graph depicted above. Output 1 of the control is used as the heating output, but due to the high rate of heating required, an additional heater is turned on at elevated temperatures using event 1 (output 2) to act as a boost. When the boost heater is activated, a second PID set is also required in order to maintain proper temperature control of the oven.

In order to accelerate cooling, a fan is turned on through event 2 (output 3) during the cooling sequences. In order to alert operators that the profile has completed, an alarm is connected to output 4 (event 3) of the P41 controller. This is turned on for the last segment of the profile to indicate that the process is complete.

Global Data

STAR = STSP
END = OFF
DLAY = 0
PFR = PV
HBT = 1.00

Profile Data

PROF = 1
HBBD = 50
STSP = 25.0
RMPU = HH.MM
DLLU = HH.MM

Segment Data

Segment 0
SGNO = 0
SGTY = RAMP
TGSP = 150.0
RTRR = 00.15
P2EV = 0000
HBTY = Lo

Segment 1
SGNO = 1
SGTY = DLL
P2EV = 0000
HBTY = band
DLLT = 00.20

Segment 2
SGNO = 2
SGTY = RAMP
TGSP = 250.0
RTRR = 00.20
P2EV = 0000
HBTY = Lo

Segment 3
SGNO = 3
SGTY = DLL
P2EV = 0000
HBTY = band
DLLT = 00.10

Segment 4
SGNO = 4
SGTY = RAMP
TGSP = 150.0
RTRR = 00.25
P2EV = 0001
HBTY = Hi

Segment 5
SGNO = 5
SGTY = JUMP
SEG = 1
CYCL = 2

Segment 6
SGNO = 6
SGTY = DLL
P2EV = 0000
HBTY = band
DLLT = 00.24

Segment 7
SGNO = 7
SGTY = RAMP
TGSP = 650.0
RTRR = 00.30
P2EV = 1010
HBTY = Lo

Segment 8
SGNO = 8
SGTY = DLL
P2EV = 1010
HBTY = band
DLLT = 00.30

Segment 9
SGNO = 9
SGTY = RAMP
TGSP = 450.0
RTRR = 00.30
P2EV = 1011
HBTY = Hi

SGNO = 10
SGTY = DLL
P2EV = 1010
HBTY = band
DLLT = 00.20

Segment 10

SGNO = 11
SGTY = RAMP
TGSP = 100.0
RTRR = 00.11
P2EV = 0001
HBTY = Hi

Segment 11

SGNO = 12
SGTY = END
CYCL = 2
FSP = 100.0

Segment 12

4-11 Event Outputs and PID Selection

The event outputs and PID selection are defined by parameter P2EV. There are up to 3 event outputs that can be configured, which utilize OUT2, OUT3 and OUT4 (P41 only). Register 95, shown in Section 1-6 describes how to define event status and select PID values.

The controller can store two sets of PID parameters in memory. If the unit is in RUN or HOLD mode, the PID sets are selected by the most significant bit of parameter P2EV. If the unit is in static mode (STAT), the PID sets are selected by event input function EIFN. If the unit is in A-T mode, then tuning is performed on PB1, TI1 and TD1. If the unit is in AT2 mode, then PB2, TI2 and TD2 are selected for the tuning parameters.

Chapter 5 Specifications

Power

90-250 Vac, 47-63 Hz, 12VA, 5W maximum
11-26 Vac/Vdc, 12VA, 5W maximum (optional)

Event Input

Logic Low: -10V minimum, 0.8V maximum.
Logic High: 2V minimum, 10V maximum
External pull-down Resistance: 400KΩ maximum
External pull-up Resistance: 1.5MΩ minimum

Control Input

Resolution: 18 bits
Sample Rate: 5Hz
Digital Filter: 0, 0.2, 0.5, 1, 2, 5, 10, 20, 30, 60 second programmable
Maximum Rating: -2 Vdc min., 12 Vdc max. (1 minute for mA input)
Temperature Effect: 1.5uV/°C (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

Burn-out Current: 200nA
Common Mode Rejection Ratio (CMRR): 120dB
Normal Mode Rejection Ratio (NMRR): 55dB
Sensor Break Detection:
- Sensor open for TC, RTD and mV inputs
- Sensor short for RTD input
- below 1 mA for 4-20 mA input
- below 0.25V for 1 - 5 V input
- unavailable for other inputs

Sensor Break Response Time:
- Within 4 seconds for TC, RTD and mV inputs
- 0.1 seconds for 4-20mA and 1-5V inputs

Characteristics:

Type	Range	Accuracy @ 25 °C	Input Impedance
J	-120°C - 1000°C (-184°F - 1832°F)	2°C	2.2 MΩ
K	-200°C - 1370°C (-328°F - 2498°F)	2°C	2.2 MΩ
T	-250°C - 400°C (-418°F - 752°F)	2°C	2.2 MΩ
E	-100°C - 900°C (-148°F - 1652°F)	2°C	2.2 MΩ
B	0°C - 1800°C (32°F - 3272°F)	2°C (200°C - 1800°C)	2.2 MΩ
R	0°C - 1767.8°C (32°F - 3214°F)	2°C	2.2 MΩ
S	0°C - 1767.8°C (32°F - 3214°F)	2°C	2.2 MΩ
N	-250°C - 1300°C (-418°F - 2372°F)	2°C	2.2 MΩ
L	-200°C - 900°C (-328°F - 1652°F)	2°C	2.2 MΩ
C	0°C - 2315°C (32°F - 4199°F)	2°C	2.2 MΩ
P	0°C - 1395°C (32°F - 2543°F)	2°C	2.2 MΩ
PT100 (DIN)	-210°C - 700°C (-346°F - 1292°F)	0.4°C	1.3 KΩ
PT100 (JIS)	-200°C - 600°C (-328°F - 1112°F)	0.4°C	1.3 KΩ
mV	-8mV - 70mV	0.05%	2.2 MΩ
mA	-3mA - 27mA	0.05%	70.5Ω
V	-1.3V - 11.5V	0.05%	650 KΩ

Output Types

Relay Rating: 2A/240 Vac, resistive load (200,000 cycles)

Pulsed Voltage: 5Vdc source, 30mA max.
14Vdc source, 40mA max. (optional)

Triac (SSR) Output:

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

Linear Output:

- Resolution: 15 bits
- Output Regulation: 0.02% for full load change
- Output Settling Time: 0.1 sec. (stable to 99.9%)
- Isolation Breakdown Voltage: 1000 Vac
- Temperature Effect: 0.01% of Span/°C

Linear Output Characteristics

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

DC Voltage Supply Characteristics

Type	Tolerance	Max. Output Current	Ripple Voltage	Isolation Barrier
20 V	A1 V	25 mA	0.2 Vp-p	500 VAC
12 V	A0.6 V	40 mA	0.1 Vp-p	500 VAC
5 V	A0.25 V	80 mA	0.05 Vp-p	500 VAC

Analog Retransmission

Output Signal: 4-20mA, 0-20mA, 0-5V, 1-5V, 0-10V
Resolution: 15 bits
Accuracy: 0.05% of span
Load Resistance:
    0 - 500 ohms (for current output)
    10 K ohms minimum (for voltage output)
Isolation Breakdown Voltage: 1000 VAC min.
Output Regulation: 0.01% for full load change
Output Settling Time: 0.1 sec. (stable to 99.9%)
Integral Linearity Error: 0.005% of span
Temperature Effect: 0.0025% of span/°C
Saturation Low: 0mA (or 0V)
Saturation High: 22.2 mA (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)

Data Communication

Interface: RS-232 (1 unit), RS-485 (up to 247 units)
Protocol: Modbus RTU
Address: 1-247
Baud Rate: 2.4 ~ 38.4 Kbits/sec
Parity: None, Even or Odd
Communication Buffer: 256 bytes

Profiler

Number of Profiles: 9
Number of Segments per Profile:
    Profile 1 ~ 4: 16
    Profile 5 ~ 7: 32
    Profile 8, 9: 64
Event Outputs: 3 maximum (2 for P91)

User Interface

Dual 4-digit LED Displays
Keypad: 4 keys
Programming Port: automatic setup, calibration and testing
Communication Port: RS-232 or RS-485 (Modbus RTU protocol)

Control Mode

Output 1: Reverse (heating) or direct (cooling) action
Output 2: Event 1or alarm 1, PID cooling control; cooling P band 50~300% of PB, dead band -36.0 ~ 36.0% of PB
Output 3: Event 2 or alarm 2
Output 4: Event 3 or alarm 3 (P41 only)
ON-OFF: 0.1-90.0 (°F) hysteresis control (P band = 0)
P or PD: 0-100.0% offset adjustment
PID: Fuzzy logic modified
    Proportional band 0.1 ~ 900.0°F.
    Integral time 0-1000 seconds
    Derivative time 0-360.0 seconds
Cycle Time: 0.1-90.0 seconds
Manual Control: Heat (MV1) and Cool (MV2)
Auto-tuning: Cold start and warm start
Failure Mode: Auto-transfer to manual mode for sensor break or A-D converter failure
Ramping Control: 0-900.0 °F/minute or 0-900.0°F/hour ramp rate

Alarm

Alarm Functions: Dwell timer, deviation high/low, deviation band, PV high/low alarm
Alarm Mode: Normal, latching, hold, latching/hold
Dwell Timer: 0.1-4553.6 seconds

Environmental & Physical

Operating Temperature: -10°C to 50°C
Storage Temperature: -40°C to 60°C
Humidity: 0 to 90% RH (non-condensing)
Altitude: 2000m maximum
Pollution: Degree 2
Insulation Resistance: 20 Mohms min. (at 500 VDC)
Dielectric Strength: 2000 VAC, 50/60 Hz for 1 minute
Vibration Resistance: 10 - 55 Hz, 10 m/s^2 for 2 hours
Shock Resistance: 200 m/s^2 (20g)
Moldings: Flame retardant polycarbonate
Dimensions:

P41 ----- 96mm(W) X 96mm(H) X 65mm(D),
53 mm depth behind panel
P91 ----- 48mm(W) X 48mm(H) X 116mm(D),
105 mm depth behind panel

Weight:

P41 ----- 250 grams
P91 ----- 150 grams

Approval Standards

UL Listed File E197216
CSA File 209463
CE EN61010-1 (IEC1010-1)
RoHS
EMC En61326

Protective Class :

IP65 for panel with additional option
IP50 for panel without additional option
IP20 for terminals and housing with protective cover.
All indoor use only.

EMC: En61326

Table A.1 Error Codes and Corrective Actions

Error Code	Display Symbol	Error Description	Corrective Action
4	Er04	**Illegal setup values been used: Before COOL is used for OUT2, DIRT (cooling action) has already been used for OUT1, or PID mode is not used for OUT1 (that is PB = 0, and/or TI = 0)**	**Check and correct setup values of OUT2, PB, TI and OUT1. If OUT2 is required for cooling control, the control should use PID mode (PB ≠ 0, TI ≠ 0) and OUT1 should use reverse mode (heat action), otherwise, don't use OUT2 for cooling control.**
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.**
14	Er 14	**Communication error: attempt to write a read-only data or a protected data**	**Don't write a read-only data or a protected data to the slave.**
15	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.**
25	HbEr	**Holdback time out**	**Evaluate validity of the PID values**
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. Use manual tuning instead of auto-tuning. 4. Don't set a zero value for PB. 5. Don't set a zero value for TI. 6. Touch RESET key**
27	CAEr	**You have selected an input type which was not calibrated**	**Calibrate the new input type or change input type to the calibrated one.**
29	EEPE	**EEPROM can't be written correctly**	**Return to factory for repair.**
30	CJEr	**Cold junction compensation for thermocouple malfunction**	**Return to factory for repair.**
39	SbEr	**Input sensor break, or input current below 1 mA if 4-20 mA is selected, or input voltage below 0.25V if 1 - 5V is selected**	**Replace input sensor.**
40	AdEr	**A to D converter or related component(s) malfunction**	**Return to factory for repair.**

Warranty

Future Design Controls products shown below are warrantied 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 the delivery to the first purchaser for use.

300 Series: FDC-2500, 9300, 8300, 4300
100/C/L/B Series: FDC-9100, 8100, 4100, C91, C21, L91, L41 and B41
P Series: FDC -P91 and P41
90 & 200 Series: FDC-9090, 8120, 8130, 4120, 2220, 9200

Future Design Controls provides no warranty or representations of any sorts regarding the fitness of use or application of its product by the purchaser. Users are responsible for the selection, suitability of the products for their application or use of Future Design Controls products.

Future Design Controls shall not be liable for any damages or losses, whether direct, indirect, incidental, special, consequential or any other damages, costs or expenses excepting only the cost or expense of repair or replacement of the Future Design Control products as described below.

Future Design Controls sole responsibility under warranty, at Future Design Controls 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 t damage resulting from transportation, alteration, misuse or abuse.

Future Design Controls reserves the right to make changes without notification to purchaser to materials or processing that do not affect compliance with any applicable specifications.

RETURN MATERIAL AUTHORIZATION:

Please contact Future Design Controls for Return Material Authorization Number prior to returning to factory.

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