ApeX

PPI
The Perfection Experts

Universal Self-Tune PID Temperature Controller with Ramp / Soak Profile

User Manual

CONTENTS

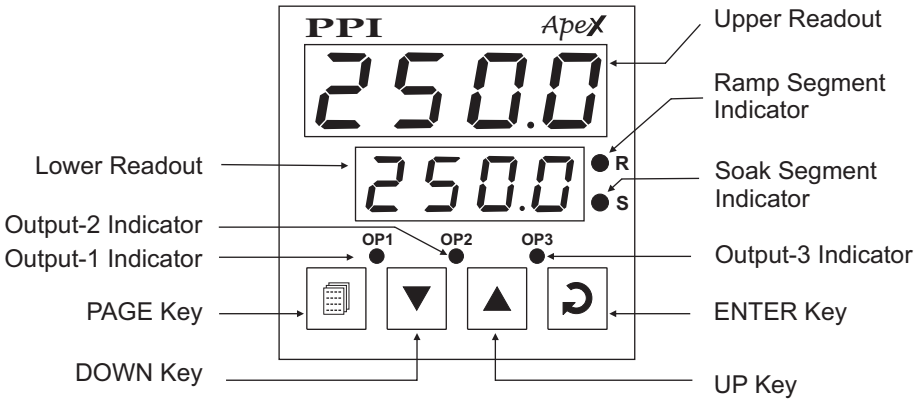
For Size 48X48

For Size 96X96

Section 1

FRONT PANEL LAYOUT

Figure 1.1



The front panel contains digital readouts, LED indicators and keys.

READOUTS

The Upper Readout is a 4 digit, 7-segment bright red LED display and usually displays the PV (Process Value). In Program Mode, the Upper Readout displays parameter values/options.

The Lower Readout is a 4 digit, 7-segment bright green LED display and usually displays SP (Control Setpoint) value. In Program Mode, the Lower Readout displays parameter names (prompts).

INDICATORS

The Table 1.1 lists each front panel LED indicator (identified by the legend) and the associated status it indicates.

Table 1.1

Indicator	Status
OP1	• Indicates Output-1 ON / OFF status if the Control Output is Relay or SSR drive. • Remains OFF if the Control Output is DC Linear.
OP2	• Indicates Output-2 status if OP2 function is Auxiliary / Blower Control. • Flashes Alarm-1 status if OP2 function is Alarm.
OP3	• Indicates Output-3 status if OP3 function is Auxiliary Control. • Flashes Alarm-2 status if OP3 function is Alarm.
R	• Flashes when profile ramp segment is running. • Glows continuously if, ramp segment is in Hold state.
S	• Flashes when profile soak segment is running. • Glows continuously if, soak segment is in Hold state.

KEYS

The Table 1.2 lists the four front panel keys and the associated function.

Table 1.2

Symbol	Key	Function
	PAGE	Press to enter or exit set-up mode.
	DOWN	Press to decrease the parameter value. Pressing once decreases the value by one count; keeping pressed speeds up the change.
	UP	Press to increase the parameter value. Pressing once increases the value by one count;keeping pressed speeds up the change.
	ENTER	Press to store the set parameter value and to scroll to the next parameter on the PAGE.

Section 2

BASIC OPERATIONS

POWER-UP

Upon power-up all displays and indicators are lit on for approximately 3 seconds. This is followed by the indication of the controller model name APE on the Upper Readout and the firmware version 02.01 on the Lower Readout, for approximately 1 second.

MAIN DISPLAY MODE

After the Power-up display sequence, the Upper Readout starts showing the measured PV (Process Value) and the Lower Readout displays the SP (Control Setpoint). This is the MAIN Display Mode that shall be used most often.

% Output Power Indication

For PID Control, the Lower Readout can be toggled using ENTER key to indicate either % Output Power or Control Setpoint SP. The Output Power (0 to 100%) is indicated with the left most digit showing 'P'.

Adjusting SP (Control Setpoint)

If permitted at Supervisory Level, the SP value can be directly adjusted on the Lower Readout in the MAIN Display Mode. Step through the following sequence for adjusting the SP value :

1. If required, press ENTER key to display SP on Lower Readout.
2. Press and release UP or DOWN key once. The Lower Readout starts flashing.
3. Use UP/ DOWN keys to adjust the SP value.
4. Press and release ENTER key. The Lower Readout stops flashing and the new set value is registered and stored.

Tune Mode Indication

The Lower Readout flashes tUnE while the controller is Tuning. Do not disturb the process or alter any parameter values while Tuning is in progress. The "Tune" message automatically disappears upon completion of Tuning procedure.

Profile Mode Indications

While a Profile Cycle is in progress, the front panel indicators 'R' and 'S' indicate (flash / glow) the execution of a Ramp or Soak Segment, respectively.

The Lower Readout shows either Ramping Setpoint or Balance Soak Time depending upon whether a Ramp or a Soak Segment is in progress. The % Output Power (if PID Control) can be viewed by toggling the Lower Readout using ENTER key.

Note
While Profile Cycle is in progress, the Control Setpoint SP can neither be viewed nor be adjusted on Lower Readout. Use Operator Page (described later) for SP adjustment, if required.

The segment type (Ramp/Soak) and the segment number (1 to 4) can be viewed on Lower Readout by keeping the UP key pressed. The Ramp segments are shown as r1, r2, r3 and r4 whereas the Soak segments are shown as S1, S2, S3 and S4.

PV Error Indications

The PV Error type is indicated (flashing) on the Upper Readout. For different errors and the causes refer Table 2.1 below.

Table 2.1

Message	Error Type	Cause
Or	Over-range	PV above Max. Range
Ur	Under-range	PV below Min. Range
OPEn	Sensor Open	Thermocouple / RTD broken

CONTROL/ALARM STATUS UNDER PV ERROR CONDITIONS

a) The tuning, if in progress, is aborted.

b) The Profile Cycle, if in progress, enters in Pause (halt) state.

c) All the control outputs are switched off.

d) For Alarm activation, the under-range condition is treated as minimum PV, whereas the over-range and open conditions are treated as maximum PV. Thus, Process High, positive Deviation Band and Window Band alarms activate under *Over-range/Open error*. Similarly, Process Low, negative Deviation Band and Window Band alarms activate under *Under-range error*.

OPERATOR PAGE AND PARAMETERS

The controller provides a separate page that contains parameters that require frequent settings by the operator. The page is called Operator Page and the parameters are called Operator Parameters. The availability of operator parameters is controlled at supervisory level and these parameters are not affected by the master lock status.

Accessing Operator Page & Adjusting Parameters

Step through the following sequence to open the operator page and to adjust the operator parameter values.

1. Press and release PAGE key. The Lower Readout shows PAGE (PAGE) and Upper Readout shows 0 (0).
2. Press ENTER key. The Lower Readout shows prompt for the first available operator parameter and the Upper Readout shows value for the parameter.
3. Use UP / DOWN keys to adjust the value and then press ENTER key to store the set value and scroll to next parameter.

The controller automatically reverts to MAIN Display Mode upon scrolling through the last operator parameter. Alternatively, use PAGE key to return to MAIN Display Mode.

The operator parameters are described in Table 2.2 Note that the parameters presented on operator page depend upon the functions selected/enabled.

The operator parameter list mainly includes :

a) Profile Start / Abort Command, if Profile feature is enabled.

b) The Control Setpoint (SP).

c) Alarm-1 Setpoint or Blower Setpoint or Auxiliary Control Setpoint for OP2 depending upon the function selected.

d) Alarm-2 Setpoint or Auxiliary Control Setpoint for OP3 depending upon the function selected.

e) Locking for Setpoint Editing on Lower Readout.

Table 2.2

Parameter Description	Settings
PROFILE START COMMAND Strt Set to Yes to start a new profile cycle. Not available if profile cycle in progress.	no No YES Yes
PROFILE ABORT COMMAND Abrt Set to Yes to abort a running profile cycle.	no No YES Yes
CONTROL SETPOINT (SP) SP Control setpoint for OP1.	Setpoint Low to Setpoint High

OP2 Function : Alarm-1

ALARM-1 SETPOINT A1.SP Process High / Process Low Alarm-1 Setpoint.	Min. to Max. Range for the selected Input Type
ALARM-1 DEVIATION BAND A1.dE Positive (+) or Negative (-) Alarm-1 deviation band.	-1999 to 9999 or -199.9 to 999.9
ALARM-1 WINDOW BAND A1.bA Symmetrical Alarm-1 window band.	3 to 999 or 0.3 to 99.9

OP2 Function : Auxiliary Control

AUXILIARY CONTROL SETPOINT SP2 Positive (+) or Negative (-) offset to Control Setpoint (SP) for defining Auxiliary Setpoint.	(Min. Range - **SP**) to (Max. Range - **SP**) for selected Input

OP2 Function : Blower / Compressor Control

BLOWER / COMPRESSOR SETPOINT bL.SP Positive (+) offset to Control Setpoint (SP) for defining Blower / Compressor Setpoint.	0 to 250 or 0.0 to 25.0

OP3 Function : Alarm-2

ALARM-2 SETPOINT A2.SP Process High / Process Low Alarm-2 Setpoint.	Min. to Max. Range for the Input Type

Parameter Description	Settings
ALARM-2 DEVIATION BAND A2.dE Positive (+) or Negative (-) Alarm-2 deviation band.	-1999 to 9999 or -199.9 to 999.9
ALARM-2 WINDOW BAND A2.bA Symmetrical Alarm-2 window band.	3 to 999 or 0.3 to 99.9

OP3 Function : Auxiliary Control

AUXILIARY CONTROL SETPOINT SP3 Positive (+) or Negative (-) offset to Control Setpoint (SP) for defining Auxiliary Setpoint.	(Min. Range - **SP**) to (Max. Range - **SP**) for selected Input

Control Setpoint (SP) Locking

SETPOINT LOCKING SLOC Set to Yes to lock the SP editing on the Lower Readout.	no No YES Yes

Section 3

SET-UP MODE : ACCESS AND OPERATION

The various parameters are arranged in different groups, called PAGES, depending upon the functions they represent. Each group is assigned a unique numeric value, called PAGE NUMBER, for its access.

The parameters are always presented in a fixed format: The Lower Readout displays the parameter prompt (Identification Name) and the Upper Readout displays the set value. The parameters appear in the same sequence as listed in their respective sections.

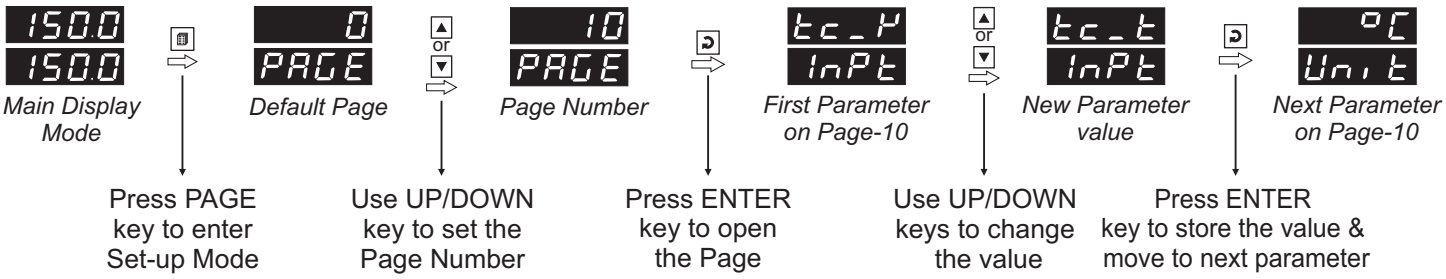
SET-UP MODE

The Set-up Mode allows the user to view and modify the parameter values. Follow the steps below for setting the parameter values:

1. Press and release PAGE key. The Lower Readout shows PAGE and the Upper Readout shows page number 0. Refer Figure 3.1.
2. Use UP / DOWN keys to set the desired PAGE NUMBER.
3. Press and release ENTER key. The Lower Readout shows the prompt for the first parameter listed in the set PAGE and the Upper Readout shows its current value. (If the entered PAGE NUMBER is invalid (contains no parameter list or any associated function), the controller reverts to the MAIN Display Mode.
4. Press and release the ENTER key until the prompt for the required parameter appears on the Lower Readout. (The last parameter in the list rolls back to the first parameter).
5. Use UP/DOWN keys to adjust the parameter value. (The display flashes if UP key is pressed after reaching the maximum value or DOWN key is pressed after reaching the minimum value).
6. Press and release the ENTER key. The new value gets stored in the controller's non-volatile memory and the next parameter in the list is displayed.

The Figure 3.1 illustrates the example of altering the value for the parameter 'Input Type'.

Figure 3.1



Notes

1. To exit the Program Mode and return to the MAIN Display Mode, press and release PAGE key.
2. If no key is pressed for approximately 30 seconds, the set-up mode times out and reverts to the MAIN Display Mode.

MASTER LOCKING

The controller facilitates locking all the PAGES (except Operator PAGE) by applying Master Lock Code. Under Locking, the parameters are available for *view only* and cannot be adjusted. The Master Lock, however does not lock the operator parameters. This feature allows protecting the rather less frequently used parameters against any inadvertent changes while making the frequently used operator parameters still available for any editing.

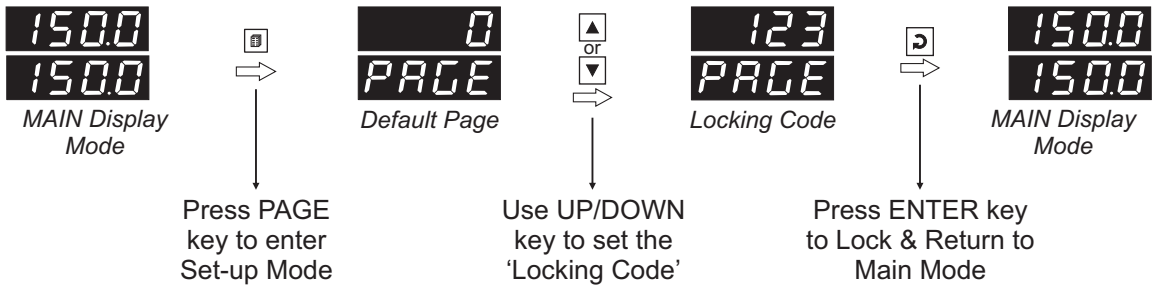
For enabling / disabling the Lock, step through the following sequence:

Locking

1. Press and release PAGE key while the controller is in the MAIN Display Mode. The Lower Readout shows PAGE and the Upper Readout shows 0.
2. Use UP / DOWN keys to set the Page Number to 123 on the Upper Readout.
3. Press and release ENTER key. The controller returns to the MAIN Display Mode with the Lock enabled.

The Figure 3.2 below illustrates the Locking procedure.

Figure 3.2



UnLocking

Repeat the Locking procedure twice for unlocking.

Section 4

I / O CONFIGURATION PARAMETERS

Table 4.1

Parameter Description	Settings (Default Values)
INPUT TYPE `InPt` Refer Table 4.2 for various available 'Input Types' along with their respective Ranges and Resolutions.	Refer Table 4.2 (Default : Type K)
TEMPERATURE DISPLAY UNITS `Unit` Select as '°C' (Centigrade) or '°F' (Fahrenheit).	`°C` °C `°F` °F (Default : °C)
TEMPERATURE RANGE `rAnG` This parameter value must be set in accordance with the Maximum Temperature Range for which the equipment / machine is designed. Set this parameter value appropriately as the same is used by the controller to determine whether or not to Self-Tune / Optimize the controller upon detecting the "Tune at Setpoint Change" condition.	Min. to Max. specified for the selected Input Type (Refer Table 4.2) (Default : 1375)
CONTROL OUTPUT TYPE `C_OP` Refer Table 4.3 for the available options.	Refer Table 4.3 (Default : Relay)
CONTROL MODE `CtrL` *On-Off* The control algorithm tends to maintain the PV at SP by either switching the output (say, Heater) fully OFF or fully ON. The On and Off switching is differentiated by the user settable 'Hysteresis Band'. *PID* The control algorithm uses a 2nd order equation to compute the '% Output Power' required to maintain the PV at SP. The constants P, I, D are automatically set by the controller.	`On.OF` On-Off `PId` PID (Default : PID)
CONTROL LOGIC `C.LOG` *Direct* Cooling Control (Output Power increases with increase in PV). *Reverse* Heating Control (Output Power decreases with increase in PV).	`dir` Direct `rEv` Reverse (Default : Reverse)
HYSTERESIS `HYSt` (For On-Off Control only) Sets a differential (dead) band between the ON and OFF states. Keep it large enough to avoid frequent switching of the load without losing the desired control accuracy.	1 to 999°C or 0.1 to 99.9°C (Default : 2 or 0.2)

Parameter Description	Settings (Default Values)
SETPOINT LOW LIMIT SP.LO Use these limits to prevent accidental over or under settings for the PV control. The SP is settable within these two limits.	Min. Range to Setpoint High for the selected Input Type (Default : -200)
SETPOINT HIGH LIMIT SP.H I Use these limits to prevent accidental over or under settings for the PV control. The SP is settable within these two limits.	Setpoint Low to Max. Range for the selected Input Type (Default : 1375)

Table 4.2

Option	What it means	Range (Min. to Max.)	Resolution (Fixed or settable)
tC_J	Type J Thermocouple	0 to +960°C / +32 to +1760°F	Fixed 1°C / 1°F
tC_K	Type K Thermocouple	-200 to +1375°C / -328 to +2508°F	
tC_t	Type T Thermocouple	-200 to +385°C / -328 to +725°F	
tC_r	Type R Thermocouple	0 to +1770°C / +32 to +3218°F	
tC_S	Type S Thermocouple	0 to +1765°C / +32 to +3209°F	
tC_b	Type B Thermocouple	0 to +1825°C / +32 to +3092°F	
tC_n	Type N Thermocouple	0 to +1300°C / +32 to +2372°F	
rtd	3-wire, RTD Pt100	-199 to +600°C / -328 to +1112°F	
rtd.1	3-wire, RTD Pt100	-199.9 to 600.0°C / -199.9 to 999.9°F	0.1°C / 0.1°F

Table 4.3

Option	What it means	Remarks
rLY SSr	Relay SSR (Solid State Relay)	Applicable for OP1 as Relay / SSR
0-20 4-20	0 to 20 mA current 4 to 20 mA current	Applicable for OP1 as DC Linear Current
0-5 0-10	0 to 5 Volts 0 to 10 Volts	Applicable for OP1 as DC Linear Voltage

Section 5

OP2 FUNCTION PARAMETERS

Table 5.1

Parameter Description	Settings (Default Values)
OUTPUT-2 FUNCTION SELECTION OP2F *None* OP2 module not installed or function not used. *Alarm* OP2 relay activates as Alarm status. *Auxiliary Control* OP2 relay activates as Auxiliary control status. *Blower* OP2 relay activates as Blower / Compressor control status.	nonE None ALrn Alarm CtrL Control bLOr Blower (Default : None)
OP2 Function : Alarm-1	
TYPE AL_1 *Process Low* The alarm activates for PV less than or equal to Alarm Setpoint. *Process High* The alarm activates for PV greater than or equal to Alarm Setpoint. *Deviation Band* The alarm activates if the PV deviation from SP is greater than the set positive or negative 'Deviation Band' value. *Window Band* The alarm activates if the PV deviation from SP is greater than the set 'Window Band' value in either direction. *End Of Profile* The OP2 Relay / SSR is switched ON for the time duration set for the parameter 'Alarm Timer'.	P_Lo Process Low P_Hi Process High dEu Deviation Band bAnd Window Band EoP End of Profile (Default : Process Low)
SETPOINT A1.SP Available for 'Process High' or 'Process Low' Alarms. Sets the Upper (Process High) or Lower (Process Low) Alarm Limit.	Min. to Max. Range for the selected Input type (Default : 0)
DEVIATION BAND A1.dE Available for 'Deviation Band' Alarm. Sets a deviation band above (Positive value) or below (Negative value) the SP for alarm activation.	-1999 to 9999 **or** -199.9 to 999.9 (Default : 0)
WINDOW BAND A1.bA Available for 'Window Band' Alarm. Sets a symmetrical band above and below the SP for alarm activation.	3 to 999 **or** 0.3 to 99.9 (Default : 3)
LOGIC A1.LG *Normal* The Alarm output (Relay/SSR) remains ON under alarm condition; OFF otherwise. Useful for Audio / Visual Alarm. *Reverse* The Alarm output (Relay / SSR) remains OFF under alarm condition; ON otherwise. Useful for Tripping the system under control.	norn Normal rEu Reverse (Default : Normal)

Parameter Description	Settings (Default Values)
INHIBIT A1.i h *No* Alarm is not suppressed for start-up condition. *Yes* The Alarm activation is inhibited (suppressed) until the PV is found within alarm limits from the time the controller is switched ON.	YES Yes no No (Default : Yes)
ALARM TIMER A1.tn Available for End of Profile Alarm. Sets time duration in seconds for which the alarm shall activate upon end of profile cycle.	5 to 250 Seconds (Default : 10)

OP2 Function : Auxiliary Control

OFFSET VALUE SP2 Offset value for the Auxiliary Control Setpoint. Can be set as positive value or negative value. Auxiliary Control Setpoint = Control Setpoint (SP) + Offset Value	(Min. Range - **SP**) to (Max. Range - **SP**) specified for the selected Input Type (Default : 0)
HYSTERESIS HYS.2 Sets a differential (dead) band between the ON and OFF control states.	1 to 999 or 0.1 to 99.9 (Default : 2 or 0.2)
CONTROL LOGIC LOG.2 *Normal* The Output remains ON for PV *below* SP and OFF otherwise. *Reverse* The Output remains ON for PV *above* SP and OFF otherwise.	norn Normal rEu Reverse (Default : Normal)

OP2 Function : Blower / Compressor Control

OFFSET VALUE bL.SP Sets a positive (+) offset to the SP to define the 'Blower / Compressor Setpoint'. Blower / Compressor Setpoint = Control Setpoint (SP) + Offset Value	0 to 250 or 0.0 to 25.0 (Default : 0)
HYSTERESIS bL.HY Differential (dead) band between the blower ON and OFF states.	1 to 250 or 0.1 to 25.0 (Default : 2 or 0.2)
TIME DELAY t.dLY This parameter is mainly used for Compressor Load. The set time delay is elapsed each time before the compressor is switched ON. Set the value to 0 if no Time Delay is required.	00.00 to 10.00 Min. Sec (in steps of 5 Seconds) (Default : 00.00)

Section 6

OP3 FUNCTION PARAMETERS

Table 6.1

Parameter Description	Settings (Default Values)
OUTPUT-3 FUNCTION SELECTION OP3F *None* OP3 module not installed or function not used. *Alarm* OP3 relay activates as Alarm status. *Auxiliary Control* OP3 relay activates as Auxiliary control status.	none None ALrn Alarm CtrL Control (Default : None)

OP3 Function : Alarm-2

TYPE AL_2 *Process Low* The alarm activates for PV less than or equal to Alarm Setpoint. *Process High* The alarm activates for PV greater than or equal to Alarm Setpoint. *Deviation Band* The alarm activates if the PV deviation from SP is greater than the set positive or negative 'Deviation Band' value. *Window Band* The alarm activates if the PV deviation from SP is greater than the set 'Window Band' value in either direction. *End Of Profile* The OP3 Relay / SSR is switched ON for the time duration set for the parameter 'Alarm Timer'.	P_Lo Process Low P_Hi Process High dEu Deviation Band bAnd Window Band EoP End of Profile (Default : Process Low)
SETPOINT A2.SP Available for 'Process High' or 'Process Low' Alarms. Sets the Upper (Process High) or Lower (Process Low) Alarm Limit.	Min. to Max. Range for the selected Input type (Default : 0)
DEVIATION BAND A2.dE Available for 'Deviation Band' Alarm. Sets a deviation band above (Positive value) or below (Negative value) the SP for alarm activation.	-1999 to 9999 **or** -199.9 to 999.9 (Default : 0)
WINDOW BAND A2.bA Available for 'Window Band' Alarm. Sets a symmetrical band above and below the SP for alarm activation.	3 to 999 **or** 0.3 to 99.9 (Default : 3)
LOGIC A2.LG *Normal* The Alarm output (Relay/SSR) remains ON under alarm condition; OFF otherwise. Useful for Audio / Visual Alarm. *Reverse* The Alarm output (Relay / SSR) remains OFF under alarm condition; ON otherwise. Useful for Tripping the system under control.	norn Normal rEu Reverse (Default : Normal)

Parameter Description	Settings (Default Values)
INHIBIT A2.1 h *No* Alarm is not suppressed for start-up condition. *Yes* The Alarm activation is inhibited (suppressed) until the PV is found within alarm limits from the time the controller is switched ON.	YES Yes no No (Default : Yes)
ALARM TIMER A2.tn Available for End of Profile Alarm. Sets time duration in seconds for which the alarm shall activate upon end of profile cycle.	5 to 250 Seconds (Default : 10)

OP3 Function : Auxiliary Control

OFFSET VALUE SP3 Offset value for the Auxiliary Control Setpoint. Can be set as positive value or negative value. Auxiliary Control Setpoint = Control Setpoint (SP) + Offset Value	(Min. Range - **SP**) to (Max. Range - **SP**) specified for the selected Input Type (Default : 0)
HYSTERESIS HYS.3 Sets a differential (dead) band between the ON and OFF control states.	1 to 999 or 0.1 to 99.9 (Default : 2 or 0.2)
CONTROL LOGIC LOG.3 *Normal* The Output remains ON for PV below SP and OFF otherwise. Reverse The Output remains ON for PV *above* SP and OFF otherwise.	norn Normal rEv Reverse (Default : Normal)

Section 7

PID CONTROL PARAMETERS

Table 7.1

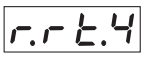
Parameter Description	Settings (Default Values)
CYCLE TIME  (For 'PID' Control) For time-proportionating PID control, the output power is implemented by adjusting the ratio of ON : OFF to a fixed time interval, called 'Cycle Time'. The larger the power the larger the ON time and vice-a-versa. Larger Cycle time ensures longer Relay/SSR life but may result in poor control accuracy and vice-a-versa. *The recommended Cycle Time values are; 20 sec. for Relay and 1 sec. for SSR.*	0.5 to 120.0 Seconds (in steps of 0.5 secs.) (Default : 0.5)
PROPORTIONAL BAND  (For 'PID' Control) The Proportional band is defined in terms of process value deviation from the setpoint (also known as process error). Within the band the output power is varied from maximum (100%) at maximum deviation to minimum (0%) at minimum deviation. The process value thus tends to stabilize at a point within the band where the power input equal losses. Larger Band results in better stability but larger deviation. The Proportional Band value is automatically calculated by controller's Self-Tune feature and seldom requires any manual adjustment.	0.1 to 999.9 (Default : 10.0)
INTEGRAL TIME  (For 'PID' Control) The application of proportional band alone results in process value stability within the band but away from the setpoint. This called steady state Offset Error. The integral action is incorporated for automatic removal of offset error with minimum oscillations. The Integral Time value is automatically calculated by controller's Self-Tune feature and seldom requires any manual adjustments.	0 to 1000 Seconds (Default : 100)
DERIVATIVE TIME  (For 'PID' Control) It is desired that the controller should respond to any dynamic changes in the process conditions (like variations in load, power supply fluctuations, etc.) fast enough so as retain the process value near the setpoint. The derivative time determines how strong the output power will change in response to the rate of change of measured PV. The Derivative Time value is automatically calculated by controller's Self-Tune feature and seldom requires any manual adjustments.	0 to 250 Seconds (Default : 25)

Section 8

PROFILE PARAMETERS

Table 8.1

Parameter Description	Settings (Default Values)
PROFILE FEATURE PrOF *Enable* Activates profile operation. *Disable* De-activates profile operation. The Profile Configuration parameters are then not presented for setting.	EnbL Enable dSbL Disable (Default : Disable)
RAMP BAND r.bnd Refer Setpoint Profile description later in the section.	0 to 250 (Default : 0)
SOAK BAND S.bnd Refer Setpoint Profile description later in the section.	0 to 250 min (Default : 0)
RAMP RATE FOR SEGMENT-1 r.rt.1 The rate at which the setpoint ramps to the first Target Setpoint from the PV at the start of a new Profile Cycle.	00.00 to 99.99 Units / Min (Default : 00.00)
TARGET SETPOINT FOR SEGMENT-1 tSP.1 The target level for the first ramp segment.	Min.Range to Setpoint High (Default : 0)
SOAK TIME FOR SEGMENT-1 SOt.1 The time duration for holding the setpoint at Target Setpoint-1.	0 to 9999 Minutes (Default : 0)
RAMP RATE FOR SEGMENT-2 r.rt.2 The Definitions same as Segment-1	Same as **Ramp Rate**, **Target Setpoint** and **Soak Time** for segment-1
TARGET SETPOINT FOR SEGMENT-2 tSP.2 The Definitions same as Segment-1	
SOAK TIME FOR SEGMENT-2 SOt.2 The Definitions same as Segment-1	
RAMP RATE FOR SEGMENT-3 r.rt.3 The Definitions same as Segment-1	
TARGET SETPOINT FOR SEGMENT-3 tSP.3 The Definitions same as Segment-1	

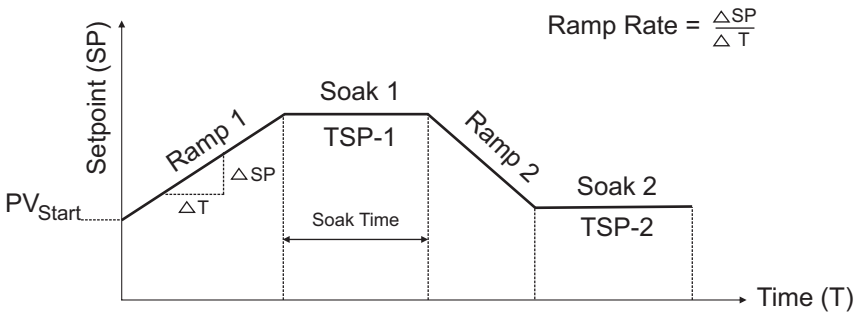
Parameter Description	Settings (Default Values)
SOAK TIME FOR SEGMENT-3  The Definitions same as Segment-1	Same as **Ramp Rate**, **Target Setpoint** and **Soak Time** for segment-1
RAMP RATE FOR SEGMENT-4  The Definitions same as Segment-1	
TARGET SETPOINT FOR SEGMENT-4  The Definitions same as Segment-1	
SOAK TIME FOR SEGMENT-4  The Definitions same as Segment-1	
OUTPUT OFF  *Yes* The Control Output is forced OFF *after* the Profile is over / aborted. *No* The controller maintains the PV at the control setpoint (SP) *after* the Profile is over/aborted.	 Yes  No (Default : Yes)

PROFILE OPERATION

The setpoint profile is a series of straight line segments, called either 'Ramp' or 'Soak' segments. For a Ramp segment, the setpoint changes linearly with respect to time, whereas for a soak segment the setpoint rests over a period of time. The ramp segments thus have a target setpoint to achieve at a pre-determined rate called 'Ramp Rate'. The soak segments maintain the setpoint at the target setpoint for a pre-determined time interval called 'Soak Time'.

Refer Figure 8.1 below that illustrates a profile comprising 2 ramp and 2 soak segments

Figure 8.1



The controller provides a fixed-format, 8-segment Profile: 4 Ramp + 4 Soak; each Ramp followed by a Soak. The control algorithm continuously attempts to make PV equals SP and thereby the PV too follows the setpoint profile.

Profile Execution

In the above figure, the setpoint ramps up from the PV start upto Target Setpoint-1 (TSP-1) with a user defined Ramp Rate-1. The setpoint then holds at TSP-1 for a duration Soak Time-1. Similarly, the setpoint ramps from TSP-1 to TSP-2 with Ramp Rate-2 and then holds at TSP-2 for Soak Time-2.

As shown in the figure, each Ramp segment (except Ramp-1) has a start point which is also the target setpoint for the previous Ramp / Soak segment. For example, the start point for Ramp-2 segment is TSP-1 which is the target setpoint for Ramp-1 and Soak-1 segment. The Start point for the first Ramp segment (Ramp-1), is the PV at the instant of issuing profile start command (PV start in figure 8.1).

If the Ramp Rate for any ramp segment is set to 0, then the Ramping setpoint is immediately raised to the Target setpoint for that segment. That is, the Ramp segment is effectively skipped.

If the Soak Time for any soak segment is set to 0, then that soak segment is skipped. That is, the immediate next Ramp segment is taken for execution.

Holdback Bands

The controller also facilitates a feature, called Holdback, through two parameters namely Ramp Band and Soak Band.

The *Ramp Band* sets up a PV deviation limit with respect to the Ramping Setpoint while a ramp segment is in progress. If the PV lags (or leads) the ramping SP by more than the Ramp Band value then the setpoint ramping holds until the PV catches up again within the ramp band limit. This ensures that the PV approximately maintains the same rate of change as set by the ramp rate in achieving the target setpoint.

The *Soak Band* sets up a PV deviation limit with respect to the Target Setpoint while a soak segment is in progress. If the PV deviates from the Target Setpoint by more than the Soak Band value then the duration for which PV remains out of band is not counted for soak time. This ensures that the PV is maintained at the target setpoint for a guaranteed soak time value.

The ramp or soak band can be independently disabled by setting the band value to 0.

Power-fail Recovery

The resumption of the Profile after a power-failure depends on whether a ramp or a soak was in progress at the time of power-failure.

(a) Ramp Segment in progress

The profile resumes with the same ramp segment that was being executed prior to the power-failure. The ramping, however, begins with the power-on measured PV (servo-start).

(b) Soak Segment in progress

The PV is first ramped (servo-start) to the 'Target Setpoint' with the corresponding 'Ramp Rate' (for e.g., 'Ramp Rate-1' for 'TSP-1') and then the balance 'Soak Time' is executed.

Profile End Events

The OP2/OP3, if configured as End-of-Profile Alarm, the output energizes for the set alarm duration upon profile completion.

The controller also provides 'Output-Off' strategy that can be enabled to force the control output OP1 off upon End-of-Profile.

The output becomes active again after issuance of Start Command for the execution of a new Profile Time Cycle.

If the Output Off strategy is disabled then the controller attempts to maintain the PV at the control setpoint (SP) defined for output-1.

Section 9

SUPERVISORY PARAMETERS

Table 9.1

Parameter Description	Settings (Default Values)
TUNE COMMAND tUnE (For PID Control Mode only) Set to 'Yes' for initiating Tune operation.	YES Yes no No (Default : No)
TUNE ABORT COMMAND Abrt (For PID Control Mode only) Set to 'Yes' for terminating Tune operation in progress.	YES Yes no No (Default : No)
OVERSHOOT INHIBIT oS.i h Set this parameter to 'Enable' if the process exhibits unacceptable overshoot upon start-up or a step change in SP. If enabled, the controller controls the rate of change of PV to minimize overshoot.	EnbL Enable dSbL Disable (Default : Disable)
OVERSHOOT INHIBIT FACTOR Oi h.F This parameter adjusts the effectiveness of the Overshoot Inhibit feature. Increase the value if the overshoot is curbed but the PV takes longer to reach the SP. Decreases the value if the overshoot persists.	1.0 to 2.0 (Default : 1.2)
SELF-TUNE ON SETPOINT CHANGE tn.SP *Enable* Re-tune the controller if there is a substantial (large) change in the SP value. The P, I, D values are optimized. *Disable* Ignore any change in SP value and continue with the existing P, I, D values.	EnbL Enable dSbL Disable (Default : Disable)
OFFSET FOR PV OFSt This parameter adds positive or negative offset to the measured PV for removal of thermal gradient or known sensor error.	-1999 to 9999 or -199.9 to 999.9 (Default : 0)
DIGITAL FILTER FOR PV FLtr This value determines the averaging rate of measured PV and thus helps removing undesired rapid changes in the measured PV. The higher the filter value the better the averaging but the slower the response to actual changes.	0.5 to 25.0 Seconds in steps of 0.5 Seconds (Default : 1.0)
PERMISSION FOR OP2/OP3 SETPOINT EDITING ON OPERATOR PAGE SP.OP This parameter allows the user to enable (permit) or disable (restrict) the adjustment of the Setpoint for OP2 / OP3 functions.	EnbL Enable dSbL Disable (Default : Enable)

Parameter Description	Settings (Default Values)
UTILITY OPTION OPtn *None* No optional utility module is fitted / functional. *Serial Communication* The optional utility module is RS485/RS232 serial communication port. *Profile Start* The optional utility module is Digital Input (potential-free contact closure) for Profile Start Command. An open to close contact will initiate a new Profile Cycle.	nonE None SrL.C Serial Comm. Strt Profile Start (Default : None)
SLAVE ID Id The controller's communication ID for the Master Device to address.	1 to 127 (Default : 1)
BAUD RATE bAUd Communication speed in "Bits per second".	1200, 2400, 4800, 9600 (Default : 9600)
COMMUNICATION WRITE ENABLE CoM.E *Yes* Editing of parameters via communication is permitted. *No* Editing of parameters via communication is denied.	YES Yes no No (Default : Yes)

Section 10
HARDWARE ASSEMBLY AND CONFIGURATIONS

The Figure 10.1 below shows the controller outer-case viewed with front label upright.

ELECTRONIC ASSEMBLY

The basic electronics assembly (without any plug-in modules), comprises of 3 Printed Circuit Boards (PCB). When viewed from the front; the CPU PCB is to the right, Power-supply PCB is to the left and the Display PCB is behind the bezel.

The electronic assembly can be removed from the plastic enclosure and placed back as described and illustrated in Figure 10.2

Figure 10.1

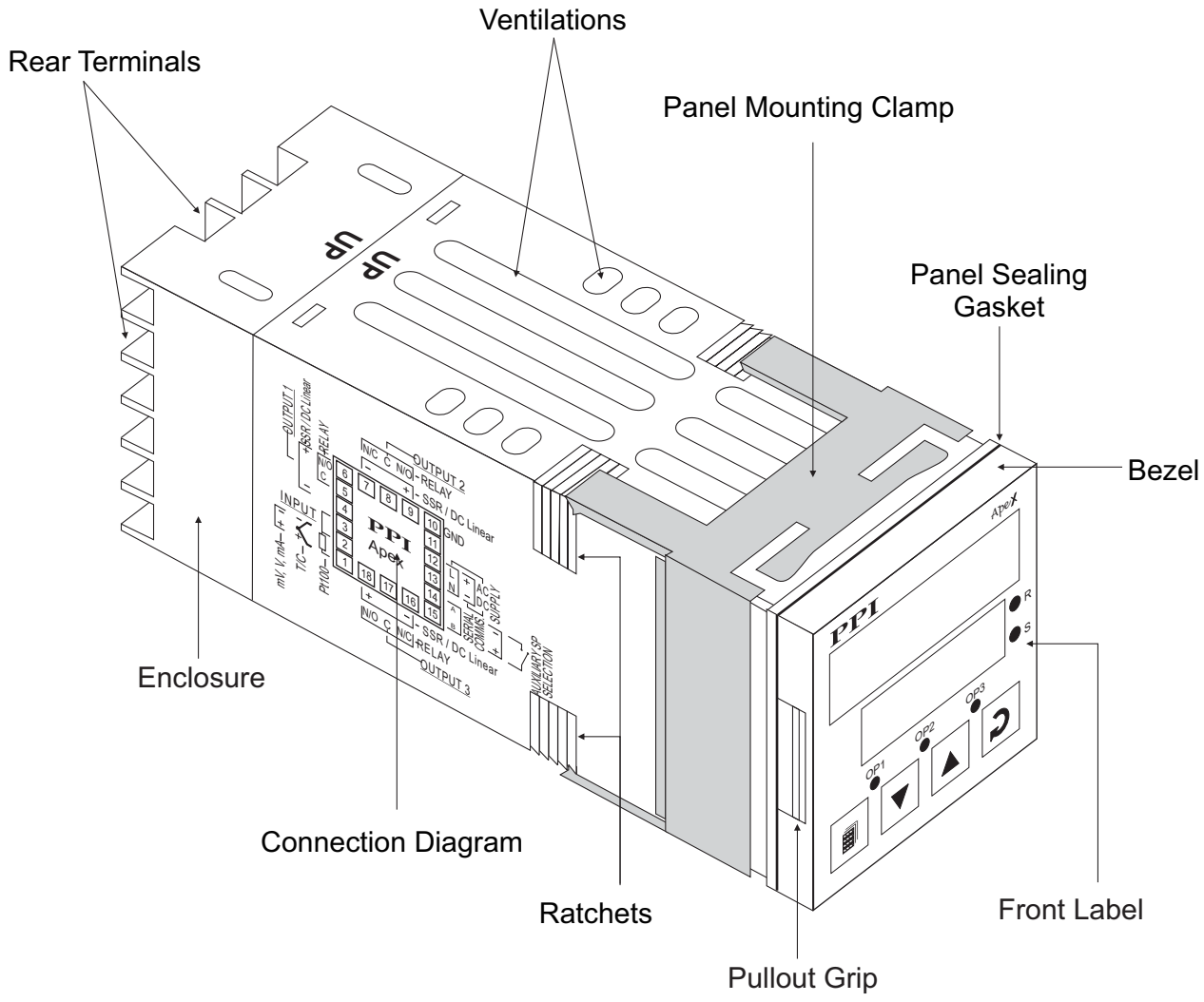
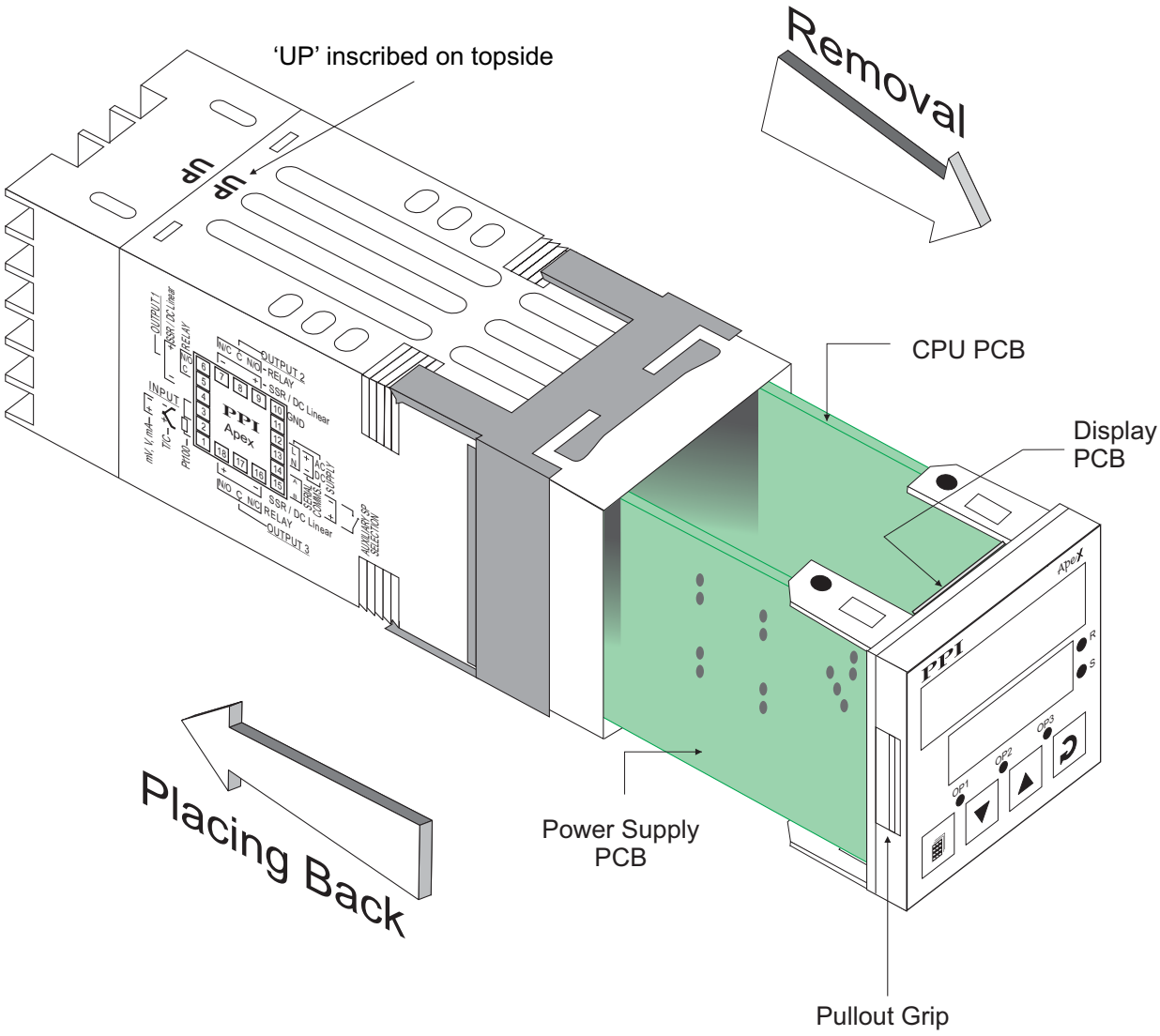


Figure 10.2



Removing Assembly from Enclosure

With the controller upright, hold the Bezel with the fingers on the pullout grips provided on the left and right sides of the bezel. Pull the bezel outward. The assembly comes out with the bezel.

Placing Assembly Back into Enclosure

With the controller upright (the UP inscribed on the Enclosure is on the topside), insert the bezel gently with the boards on either side sliding into the guides provided inside of the Enclosure. Ensure that the bezel fits in tight on the Enclosure-front to secure the panel-sealing gasket.

MOUNTING PLUG-IN MODULES

The controller supports up to 3 plug-in modules, viz. *Output-2 Module* (Relay / SSR or DC Linear), *Output-3 Module* (Relay / SSR or DC Linear) and *Option Module* (RS485 Serial Port or Digital Input for Auxiliary Setpoint selection). These modules are either pre-fitted while the controller is shipped from the factory or can be fitted by the user later.

All 3 plug-in modules are provided with female socket that directly fits into the corresponding male plug provided on either Power-supply PCB or CPU PCB. The *Output-2* and *Option* Modules fit into plugs provided on Power-supply PCB whereas the *Output-3* Module fits into plug provided on the CPU PCB.

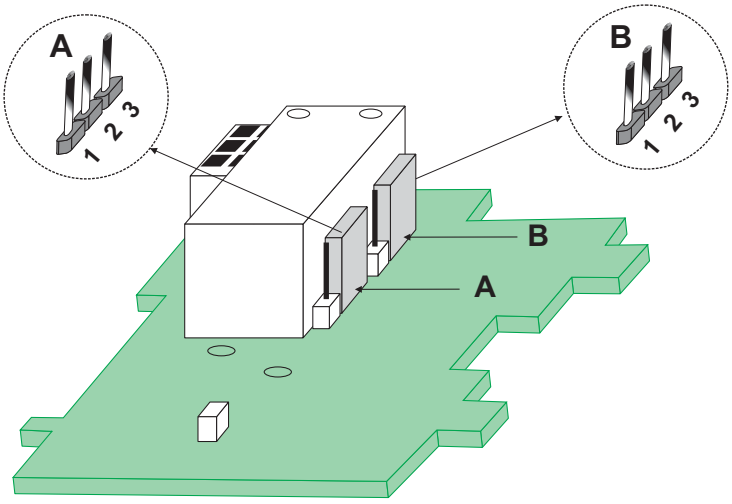
OUTPUT -2 & OUTPUT-3 : Modules and Jumper Settings

The *Output-2* and *Output-3* Modules come in three versions, viz., Relay / SSR, DC Linear Voltage and DC Linear Current. The two modules are identical and, thus, can be fitted interchangeably in Output-2 or Output-3 positions.

Relay / SSR Module

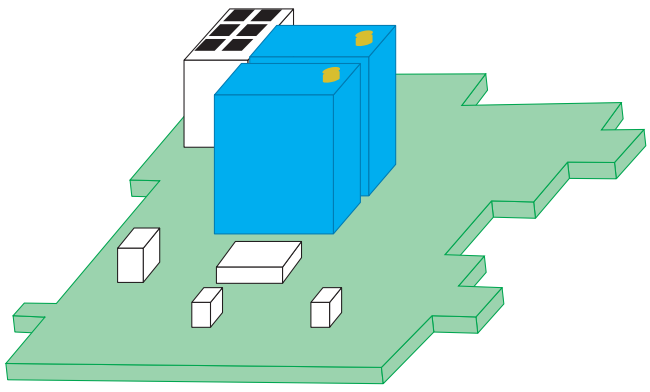
This module can be configured for either Relay or SSR output through proper jumper selection. Two jumper settings A and B, as shown in Figure 10.3 and Table 10.1, are required for Relay or SSR selection.

Figure 10.3



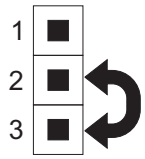
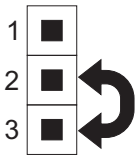
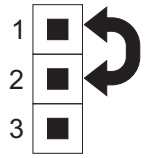
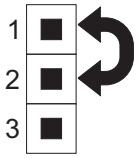
Relay/SSR Module

Figure 10.4



DC Voltage/Current Module

Table 10.1

Output Type	Jumper Setting - A	Jumper Setting - B
Relay		
SSR		

DC Linear Voltage / Current Module

The DC Linear Module is factory configured for either Current or Voltage output. The current output can be configured for 0-20 mA or 4-20 mA and similarly the voltage output can be configured for 0-5 V or 0-10 V through parameter settings.

MOUNTING / UN-MOUNTING OF MODULES

The Figures 10.5 & 10.6 illustrates how to mount the plug-in Output-2 & Output-3 module, respectively. Notice the orientation of the controller and a few identifying components shown in figures to help locate the plugs for the modules. Ensure that the socket snap-fits into the plug and the 2 projected parts on the module fit into the 2 slots provided on the Power-Supply / CPU PCB for proper electrical contacts and secured fitting.

For plugging out the module(s), follow the steps below:

1. Gently pull apart the Power-supply board and the CPU board until the projections of the module board come out of the slots.
2. Pull the module outward to unlock the socket from the plug.

Figure 10.5

Mounting Output-2 Module

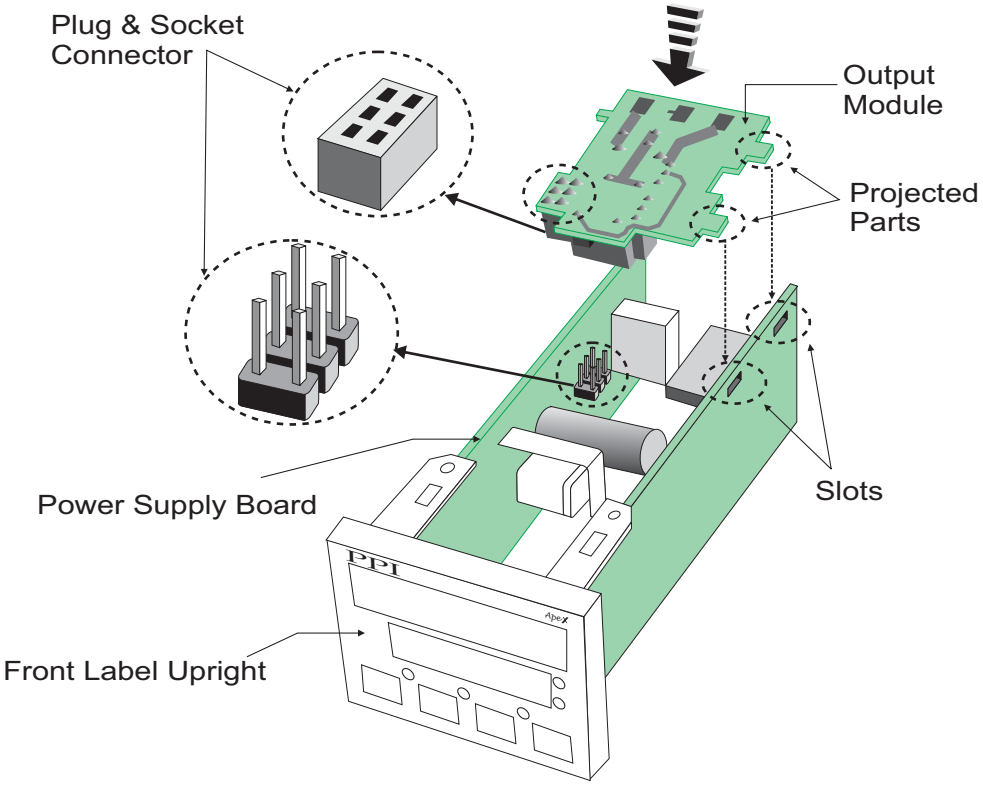
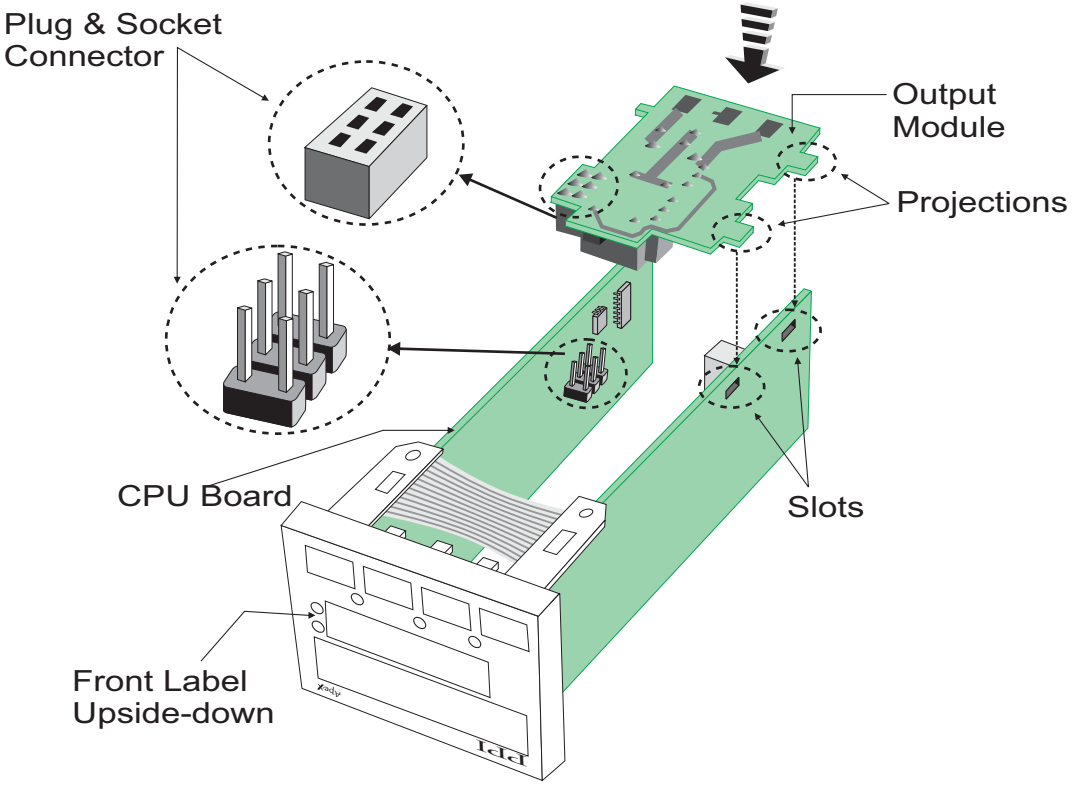


Figure 10.6

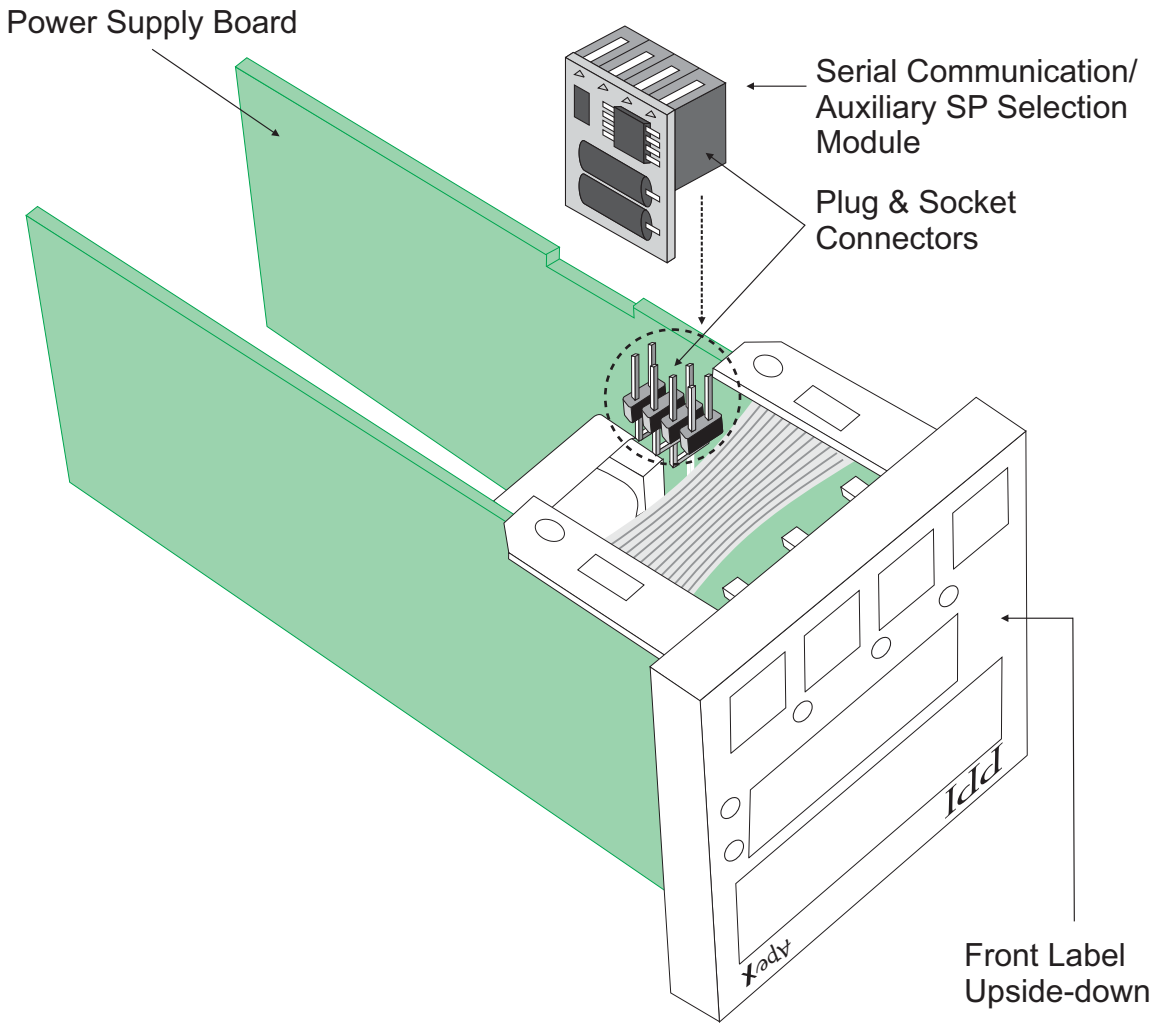
Mounting Output-3 Module



The plug for the Serial Communication or Auxiliary SP Selection module is located on the Power-supply PCB. The Figure 10.7 below illustrates how to plug-in the Serial Communication/Auxiliary SP module. To plug (or unplug) the module simply insert (or remove) the socket into (or from) the plug.

Figure 10.7

Mounting Serial Communication/Auxiliary SP Selection Module

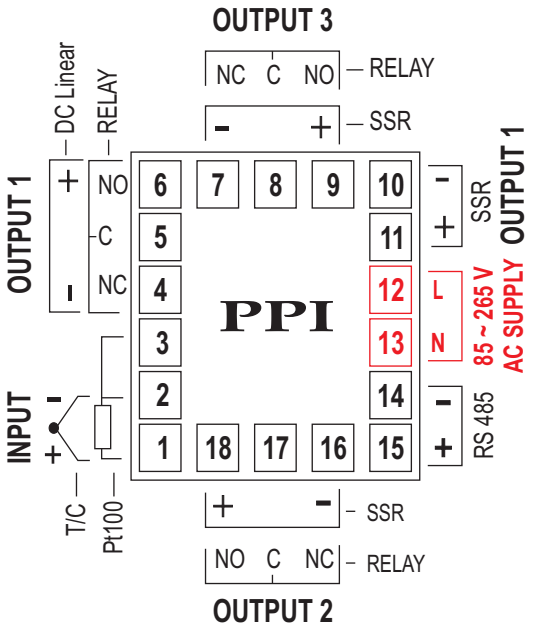


Section 11

ELECTRICAL CONNECTIONS

Refer connection diagram shown on the left side of the enclosure. The diagram shows the terminals viewed from the REAR SIDE with the controller label upright.

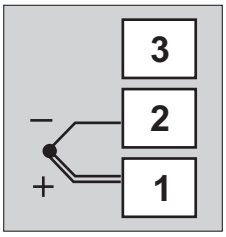
Figure 11.1



TEMPERATURE SENSOR INPUT

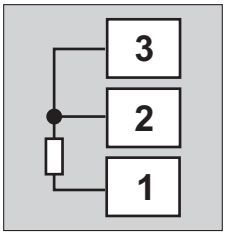
Connect Thermocouple or 3-wire RTD Pt100 sensor as shown below.

Figure 11.2 (a)



Thermocouple

Figure 11.2 (b)



RTD

Thermocouple

Connect Thermocouple Positive (+) to terminal 1 and Negative (-) to terminal 2 as shown in Figure 11.2 (a). Use correct type of extension lead wires or compensating cable. Avoid joints in the cable.

RTD Pt100, 3-wire

Connect single leaded end of RTD bulb to terminal 1 and the double leaded ends to terminal 2 and 3 (interchangeable) as shown in Figure 11.2 (b). Use low resistance copper conductor leads of the same gauge and length. Avoid joints in the cable.

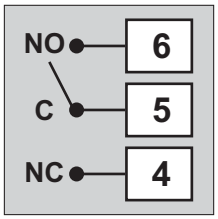
OUTPUT-1 (Control Output)

The Output-1 is factory configured as either Relay / SSR Drive or DC Linear mA / V.

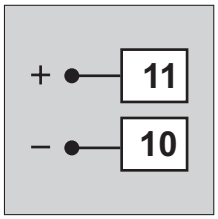
Note that Relay / SSR outputs are simultaneously provided on separate terminals. Refer Figure 11.3 (a).

For DC Linear mA/V, use terminals 4 & 6 as shown in Figure 11.3 (b).

Figure 11.3 (a)

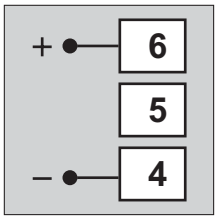


Relay Output



SSR Output

Figure 11.3 (b)



mA/V Output

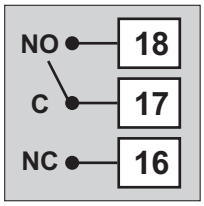
Relay Output
Potential-free Relay changeover contacts NO (Normally Open) and C (Common) rated 10A/240 VAC (resistive load).

SSR Output
Connect (+) and (-) terminals of SSR to terminals 11 & 10, respectively. Use Zero-Crossover, 3 to 30 VDC operated SSR.

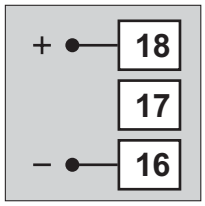
mA / V Output
The Positive (+) of mA / V is available at Terminal 6 & the Negative (-) at Terminal 4.

OUTPUT- 2 (Alarm / Blower / Auxiliary Control)
OUTPUT- 3 (Alarm / Auxiliary Control)

Figure 11.4 (a)

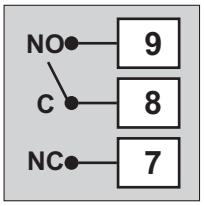


Relay Output

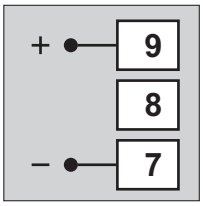


SSR Output

Figure 11.4 (b)



Relay Output

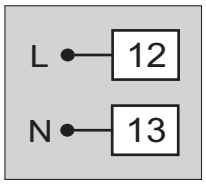


SSR Output

Refer Figure 11.4(a) for Output-2 & Figure 11.4(b) for Output-3 connections.

POWER SUPPLY

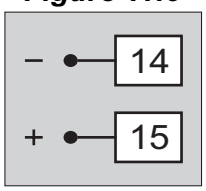
Figure 11.5



The controller accepts single phase, 50/60 Hz Line Voltage ranging from 85 VAC to 264 VAC. Use well-insulated copper conductor wire of the size not smaller than 0.5mm^2 for power supply connections. Connect Line Voltage as shown in Figure 11.5

SERIAL COMMUNICATION PORT

Figure 11.6



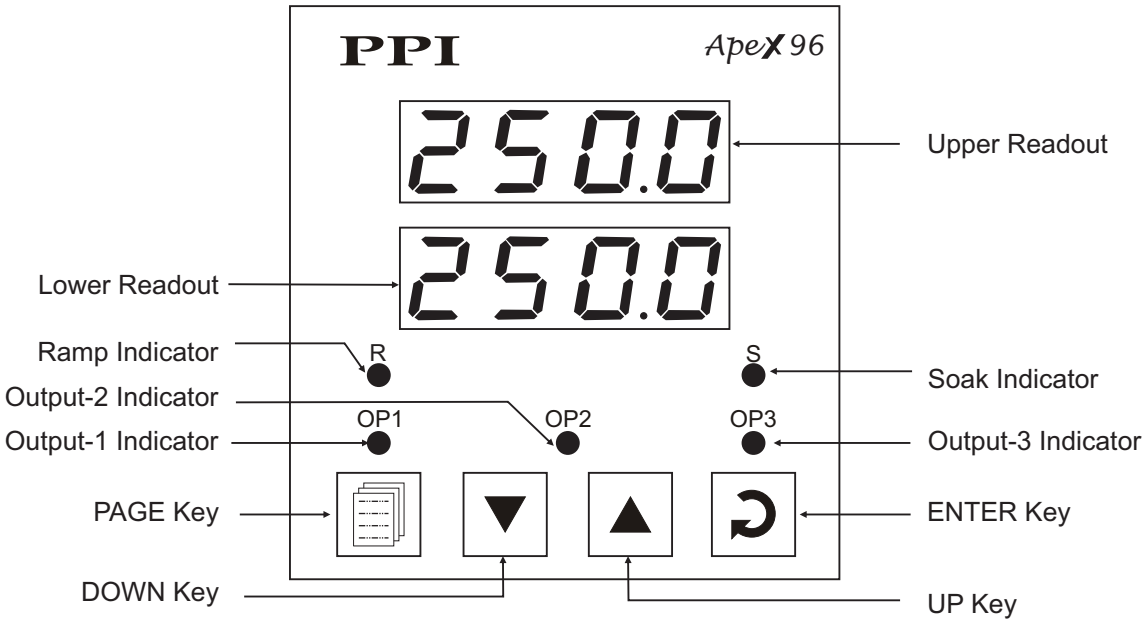
Connect terminal 15 and 14 of the controller to the positive (+) and negative (-) terminals of the master device.
Note that, PC as a master device cannot be connected (wired) directly to the instrument as PC is equipped with RS232C serial port which is not directly compatible with RS485 port on instrument side. In such cases use RS232/RS485 converter as a bridge.

APEX 96X96

Section 1

FRONT PANEL LAYOUT

Figure 1.1



The front panel contains digital readouts, LED indicators and keys.

READOUTS

The Upper Readout is a 4 digit, 7-segment bright red LED display and usually displays the PV (Process Value). In Program Mode, the Upper Readout displays parameter values/options.

The Lower Readout is a 4 digit, 7-segment bright green LED display and usually displays SP (Control Setpoint) value. In Program Mode, the Lower Readout displays parameter names (prompts).

INDICATORS

The Table 1.1 lists each front panel LED indicator (identified by the legend) and the associated status it indicates.

Table 1.1

Indicator	Status
OP1	• Indicates Output-1 ON / OFF status if the Control Output is Relay or SSR drive. • Remains OFF if the Control Output is DC Linear.
OP2	• Indicates Output-2 status if OP2 function is Auxiliary / Blower Control. • Flashes Alarm-1 status if OP2 function is Alarm.
OP3	• Indicates Output-3 status if OP3 function is Auxiliary Control. • Flashes Alarm-2 status if OP3 function is Alarm.
R	• Flashes when profile ramp segment is running. • Glows continuously if, ramp segment is in Hold state.
S	• Flashes when profile soak segment is running. • Glows continuously if, soak segment is in Hold state.

KEYS

The Table 1.2 lists the four front panel keys and the associated function.

Table 1.2

Symbol	Key	Function
	PAGE	Press to enter or exit set-up mode.
	DOWN	Press to decrease the parameter value. Pressing once decreases the value by one count; keeping pressed speeds up the change.
	UP	Press to increase the parameter value. Pressing once increases the value by one count;keeping pressed speeds up the change.
	ENTER	Press to store the set parameter value and to scroll to the next parameter on the PAGE.

Section 2
HARDWARE ASSEMBLY AND CONFIGURATIONS

The Figure 2.1 below shows the controller outer-case viewed with front label upright.

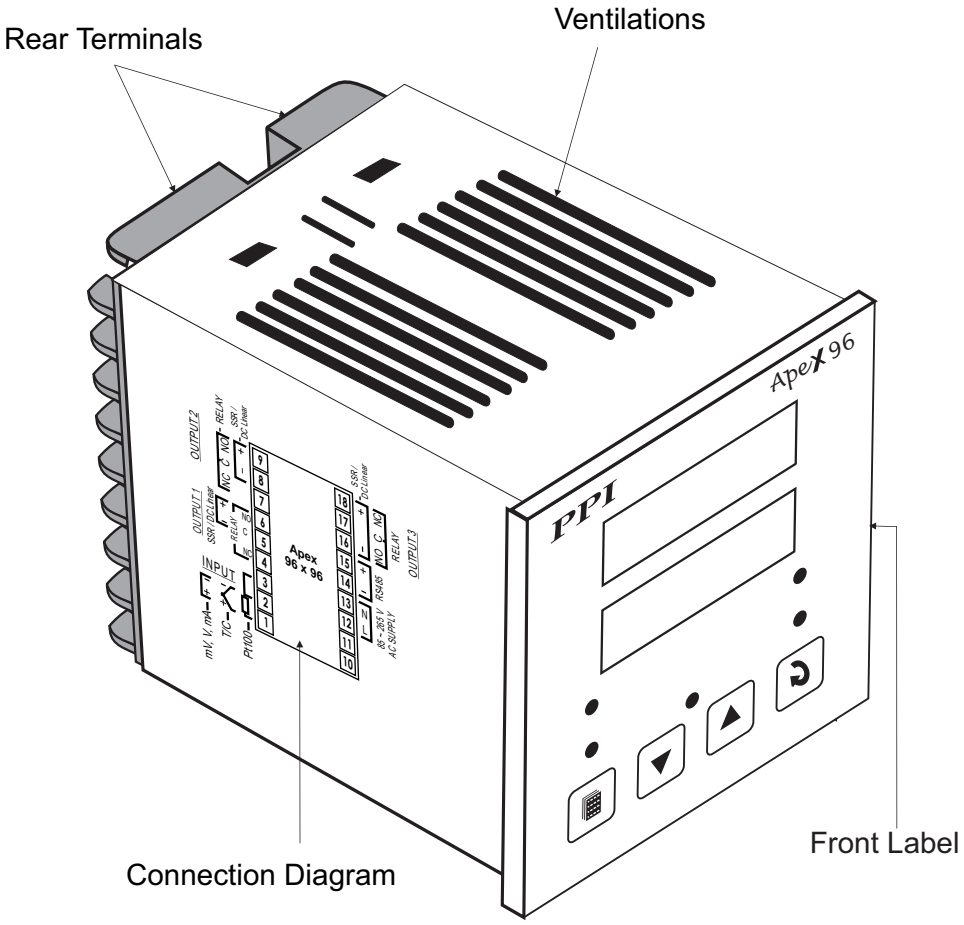
ELECTRONIC ASSEMBLY

The basic electronics assembly (without any plug-in modules), comprises of 3 Printed Circuit Boards (PCB). The CPU PCB, Power-supply PCB and the Display PCB is behind the bezel.

The electronic assembly can be removed from the plastic enclosure and placed back as described and illustrated in Figure 2.1.

Figure 2.1

Enclosure Assembly



OUTPUT-2 & 3 : Jumper Settings

Besides the parameter settings, the Output-2 & 3 configuration requires jumper settings selections as shown in the Table 2.2 below.
Figure 2.2 illustrates mounting of Output Modules.

Table 2.2 **Output-2 & 3 Jumper Settings**

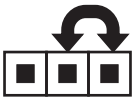
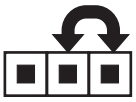
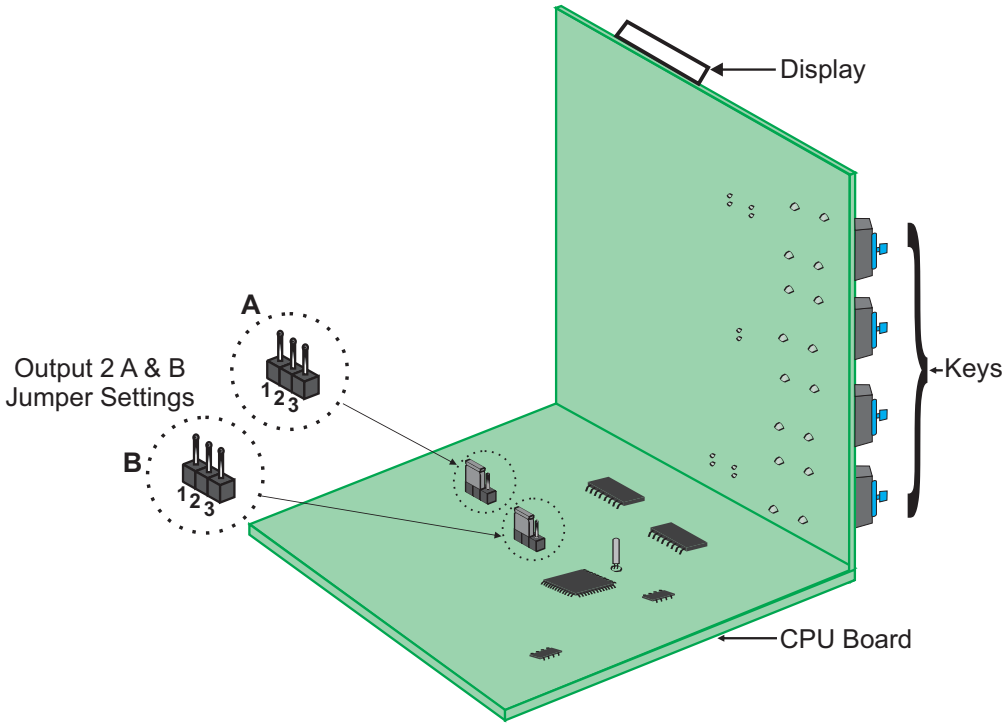
Output Type	Jumper Setting - A	Jumper Setting - B
Relay		
SSR		

Figure 2.2

Mounting Output Modules



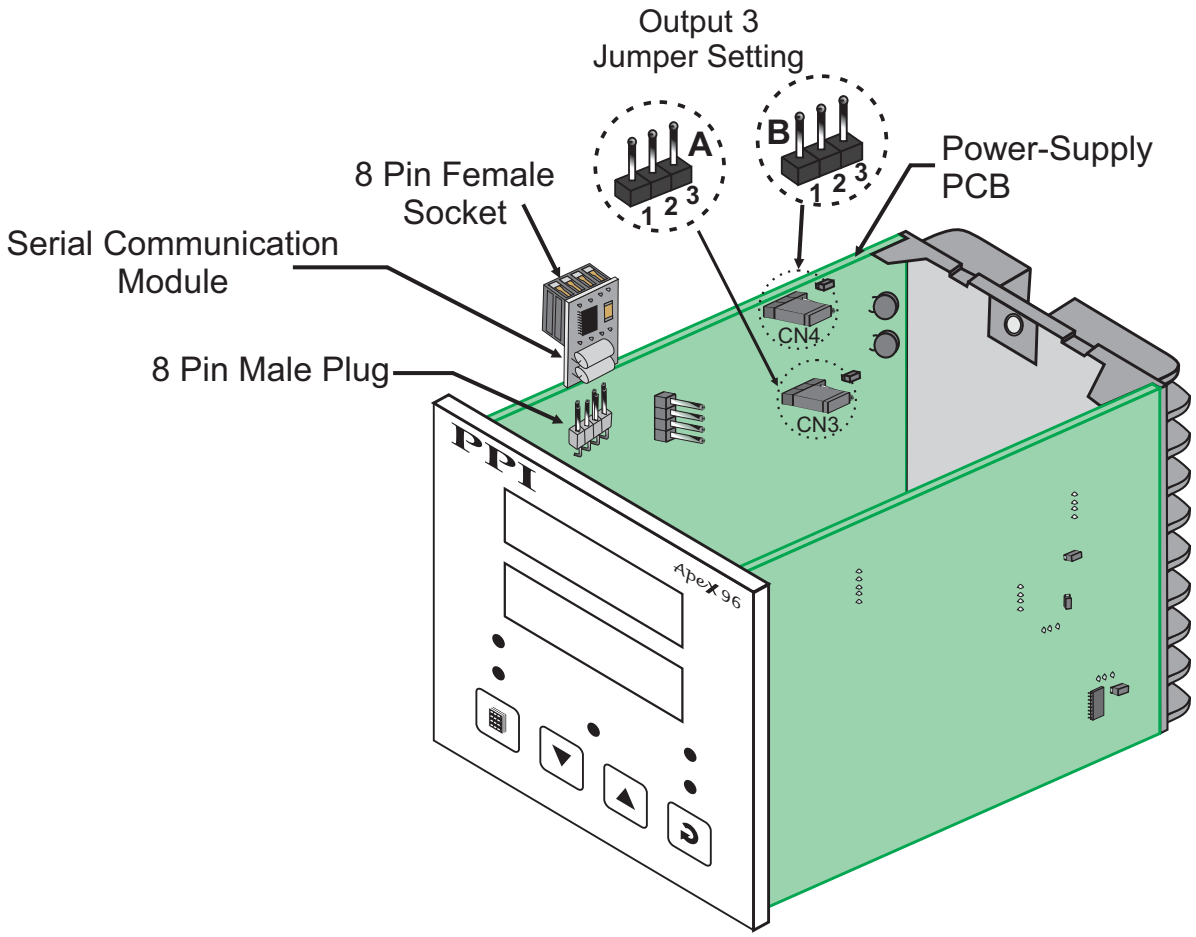
Mounting / Un-Mountion of Modules

The Figure 2.2 Illustrates how to mount output-2 module, respectively. Notice the orientation of the controller & a few identifying components shown in figure to help locate the plugs for the modules.

The plug for the Serial Communication or Auxiliary SP Selection module is located on the Power-supply PCB. The Figure 2.3 below illustrates how to plug-in the Serial Communication/Auxiliary SP module. To plug (or unplug) the module simply insert (or remove) the socket into (or from) the plug.

Figure 2.3

Mounting Serial Communication/Auxiliary SP Selection Module

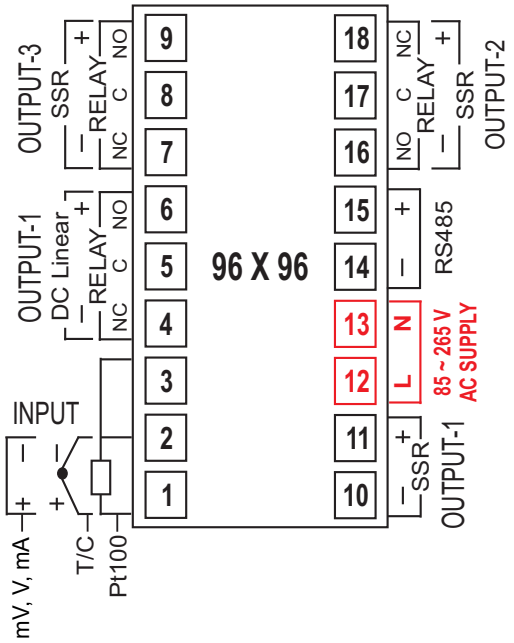


Section 3

ELECTRICAL CONNECTIONS

Refer connection diagram shown on the left side of the enclosure. The diagram shows the terminals viewed from the REAR SIDE with the controller label upright.

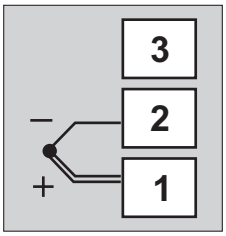
Figure 3.1



TEMPERATURE SENSOR INPUT

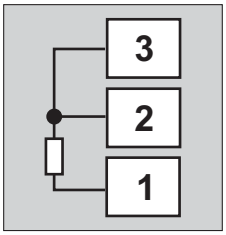
Connect Thermocouple or 3-wire RTD Pt100 sensor as shown below.

Figure 3.2 (a)



Thermocouple

Figure 3.2 (b)



RTD

Thermocouple

Connect Thermocouple Positive (+) to terminal 1 and Negative (-) to terminal 2 as shown in Figure 3.2 (a). Use correct type of extension lead wires or compensating cable. Avoid joints in the cable.

RTD Pt100, 3-wire

Connect single leaded end of RTD bulb to terminal 1 and the double leaded ends to terminal 2 and 3 (interchangeable) as shown in Figure 3.2 (b). Use low resistance copper conductor leads of the same gauge and length. Avoid joints in the cable.

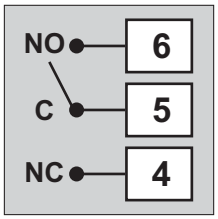
OUTPUT-1 (Control Output)

The Output-1 is factory configured as either Relay / SSR Drive or DC Linear mA / V.

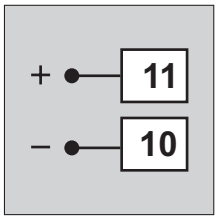
Note that Relay / SSR outputs are simultaneously provided on separate terminals. Refer Figure 3.3 (a).

For DC Linear mA/V, use terminals 4 & 6 as shown in Figure 3.3 (b).

Figure 3.3 (a)

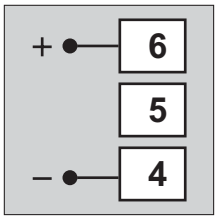


Relay Output



SSR Output

Figure 3.3 (b)



mA/V Output

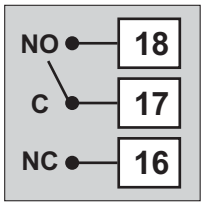
Relay Output
Potential-free Relay changeover contacts NO (Normally Open) and C (Common) rated 10A/240 VAC (resistive load).

SSR Output
Connect (+) and (-) terminals of SSR to terminals 11 & 10, respectively. Use Zero-Crossover, 3 to 30 VDC operated SSR.

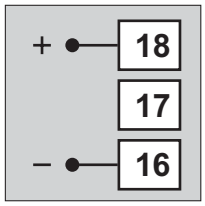
mA / V Output
The Positive (+) of mA / V is available at Terminal 6 & the Negative (-) at Terminal 4.

OUTPUT- 2 (Alarm / Blower / Auxiliary Control)
OUTPUT- 3 (Alarm / Auxiliary Control)

Figure 3.4 (a)

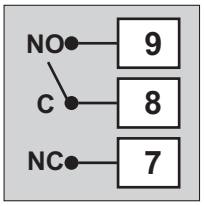


Relay Output

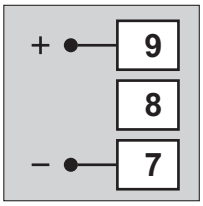


SSR Output

Figure 3.4 (b)



Relay Output

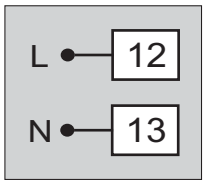


SSR Output

Refer Figure 3.4(a) for Output-2 & Figure 3.4(b) for Output-3 connections.

POWER SUPPLY

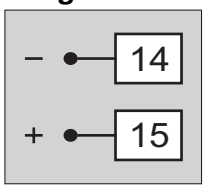
Figure 3.5



The controller accepts single phase, 50/60 Hz Line Voltage ranging from 85 to 264 VAC. Use well-insulated copper conductor wire of the size not smaller than 0.5mm^2 for power supply connections. Connect Line Voltage as shown in Figure 3.5

SERIAL COMMUNICATION PORT

Figure 3.6



Connect terminal 15 and 14 of the controller to the positive (+) and negative (-) terminals of the master device.
Note that, PC as a master device cannot be connected (wired) directly to the instrument as PC is equipped with RS232C serial port which is not directly compatible with RS485 port on instrument side. In such cases use RS232/RS485 converter as a bridge.

PPI
The Perfection Experts

Process Precision Instruments

101, Diamond Industrial Estate, Navghar, Vasai Road (E),
Dist. Palghar - 401 210.Maharashtra, India
Sales : 8208199048 / 8208141446
Support : 07498799226 / 08767395333
sales@ppiindia.net, support@ppiindia.net

Jan 2022