Advanced Self-tune PID Temperature Controller with Timer

zenex Pro & zenex Pro 96

Self-tune PID & On-Off Control
Heat (Reverse) & Cool (Direct) Control Mode
Auxiliary Control : Blower/Alarm/Compressor with Time Delay

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User Manual

48x48

96x96

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Section 1

FRONT PANEL LAYOUT

The controller front panel comprises of digital readouts, LED indicators and tactile keys as shown in Figure 1.1(a) : 48 x 48 & Figure 1.1(b) : 96 x 96 below.

Figure 1.1(a) : 48 x 48

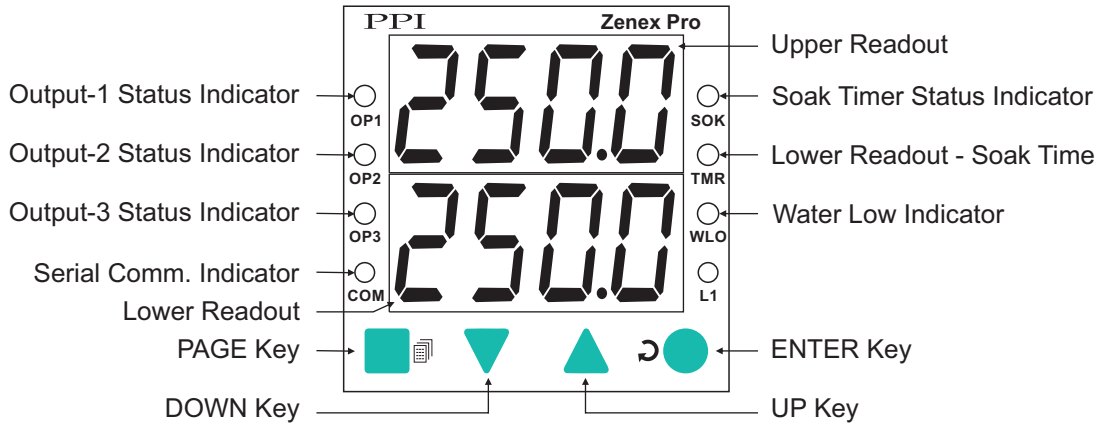
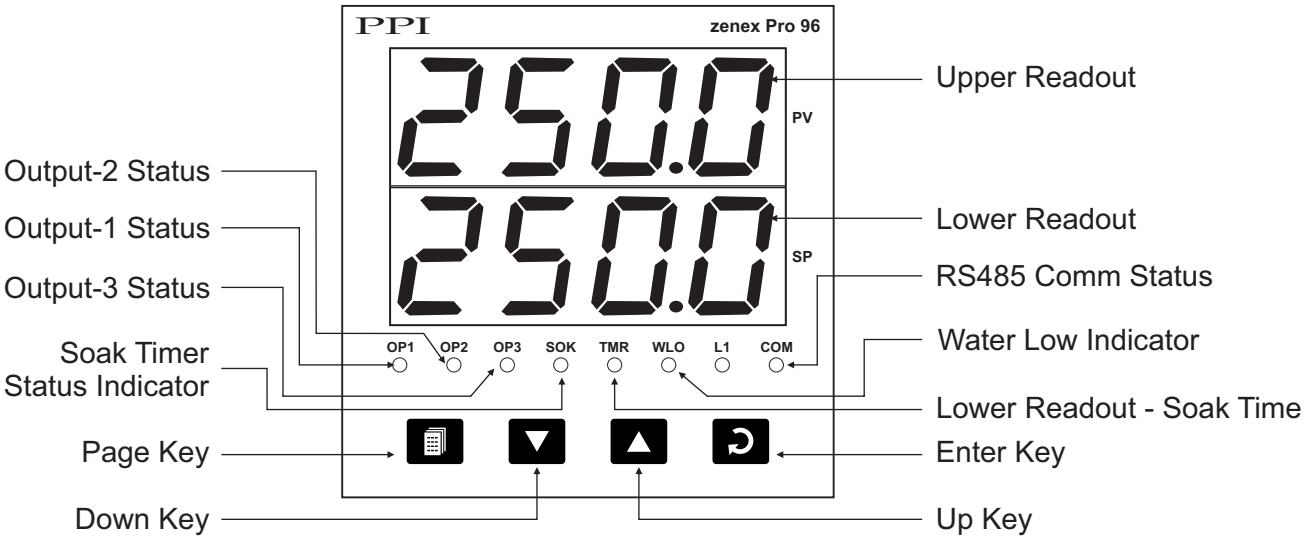


Figure 1.1(b) : 96 x 96



READOUTS

The Upper Readout is a 4 digit, 7-segment bright green LED display and usually displays the Measured Temperature 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

There are 8 front panel red LED indicators. These indicator show various statuses. The Table 1.1 below lists each LED indicator (identified by the front panel 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.
SOK	Flashes while the Soak Timer is counting down. Glows steadily while the Soak Timer is outside the Timer Start Band or Hold Band.
TMR	Glows while the Lower Readout shows the Balance Soak Time.
WLO	Water Level Status. Flashes if water level is LOW.
L1	Unused.
COM	Serial Communication Status. Flashes when data is being exchanged with Master Device.

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 the controller executes the following sequence of operations.

- All displays and indicators are lit on for approximately 3 seconds to check any display segment failure.
- Displays controller model name on the Upper Readout and the firmware version on the Lower Readout, for approximately 1 second. This helps user to verify features and refer to the correct document versions.

MAIN DISPLAY MODE

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

If the controller is configured to operate in PID Control Mode; the Lower Readout can be toggled to indicate either SP or % Output Power using the ENTER Key. The default Lower Readout upon Power-up is SP. While indicating % Power, the left most digit indicates P and remaining digits indicate power value.

Adjusting SP (Control Setpoint)

The SP value can be directly adjusted on the Lower Readout while the controller is in the MAIN Display Mode and the Lower readout is showing SP value. If permitted at Supervisory Level, step through the following sequence for adjusting the SP value:

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

Tune / Optimize Indication

The controller self detects the events such as new installation, significant change in SP, etc. for auto tuning itself to the process under control. Also, the controller can be issued ‘Optimize’ command by the user for optimization of the PID constant values.

While the controller is Tuning/Optimizing, the Lower Readout flashes the message (Busy). The user is advised not to disturb the process or alter any parameter values while the “Busy” message is being flashed. The “Busy” message automatically disappears upon completion of Tuning/Optimization.

Timer (Soak) Mode Indication

While Soak Timer is in progress, the front panel indicator ‘SOK’ flashes or glows steadily depending upon whether the timer is counting down or it is in wait / hold state.

The Lower Readout can be toggled to display either Control Setpoint (SP) or Balance / Elapsed Soak Time or % Output Power, using ENTER key. While the Lower Readout shows balance / elapsed soak time, the indicator ‘TMR’ glows.

The balance / elapsed Soak time is in either ‘Minutes : Seconds’ or ‘Hours : Minutes’ or ‘Hours’, depending upon the time units selected for the Soak Timer. If the selected time units are ‘Hours’, then (a) If the balance/elapsed time is greater than 100 Hours, the time is shown in ‘Hours’. (b) If the balance/elapsed time is less than 100 Hours, the time is shown in ‘Hours : Minutes’.

PV Error Indications

The process value is said to be in error if it exceeds the minimum / maximum range specified for the selected Input sensor type or if the sensor is disconnected (Open or Broken).

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

CONTROL/ALARM STATUS UNDER PV ERROR CONDITIONS

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

b) The Soak Timer, 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 and Upper Readout shows 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) Soak Start / Abort Command, if Soak Time 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) Lock for Setpoint Editing on Lower Readout.

PAGE 0 : OPERATOR PAGE

Table 2.2

Parameter Description	Settings
TIMER START COMMAND Strt Set to Yes to start Soak Timer. Not available if timer already running.	no No YES Yes
TIMER ABORT COMMAND Abrt Set to Yes to abort a running timer.	no No YES Yes
TIME DURATION SoH.t The set time value for the soak timer in the selected time units.	00.05 to 60.00 M:S or 00.05 to 99.55 H:M or 1 to 999 Hours

OP2 Function : Alarm-1

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

OP2 Function : Auxiliary Control

Parameter Description	Settings
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

Parameter Description	Settings
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

Parameter Description	Settings
ALARM-2 SETPOINT A2.SP Process High / Process Low Alarm-2 Setpoint.	Min. to Max. Range for the Input Type
ALARM-2 DEVIATION BAND A2.dE Positive (+) or Negative (-) Alarm-2 deviation band.	-199 to 999 **or** -199.9 to 999.9
ALARM-2 WINDOW BAND A2.bA Symmetrical Alarm-2 window band.	3 to 999 **or** 0.3 to 999.9

OP3 Function : Auxiliary Control

Parameter Description	Settings
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

Parameter Description	Settings
SETPOINT LOCKING S.LOC 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.

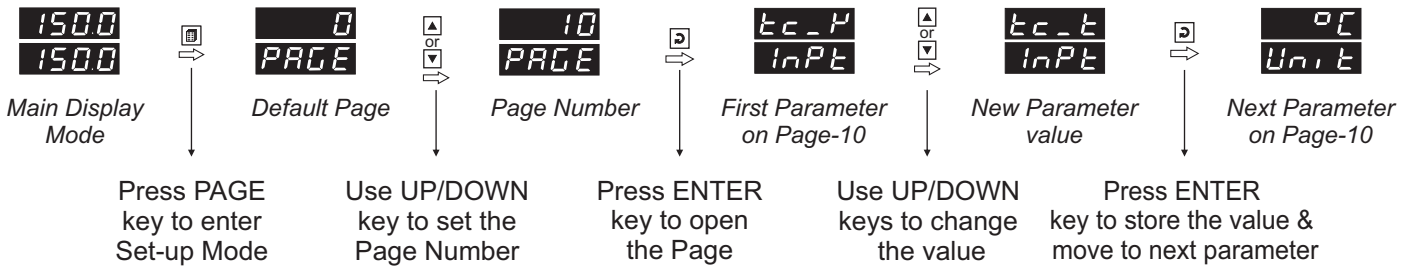
SET-UP MODE

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. *Each page contains a fixed list of parameters that are presented in a pre-determined sequence. Note however that availability of a few parameters, called Conditional Parameters, depend upon the settings for some other parameters. For example, the parameter 'Control Hysteresis' for Output-1 is available only if, the set value for the parameter 'Control Action' is 'On-Off'.*
2. *To exit the set-up mode and return to the MAIN Display Mode, press and release PAGE key.*
3. *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.

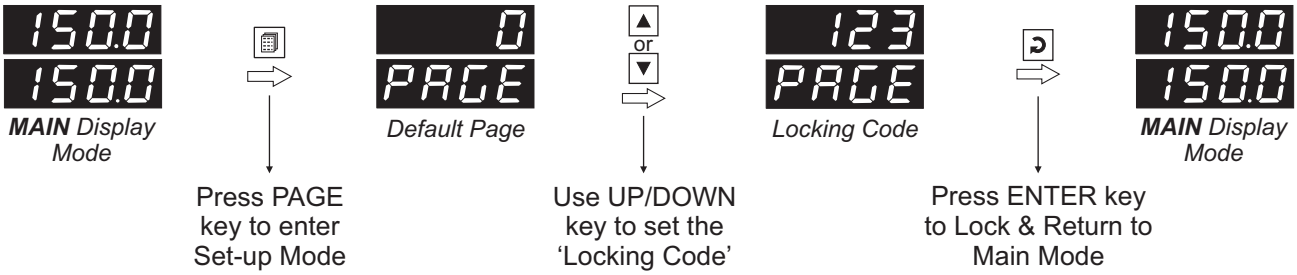
For enabling / disabling the Lock, step through the following sequence:

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

PAGE 10 : I / O CONFIGURATION PARAMETERS

Table 4.1

Parameter Description	Settings Default Value
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 °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 : 1376)
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 rEu 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 Value
SETPOINT LOW LIMIT SP.Lo This parameter sets the minimum limit on the Control Setpoint value.	Min. Range to Setpoint High for the selected Input Type (Default : -200)
SETPOINT HIGH LIMIT SP.Hi This parameter sets the maximum limit on the Control Setpoint value.	Setpoint Low to Max. Range for the selected Input Type (Default : 1376)

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 +1376°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 +3317°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

PAGE 12 : OP2 FUNCTION PARAMETERS

Table 5.1

Parameter Description	Settings Default Value
OUTPUT-2 FUNCTION SELECTION OP2.F *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 ALrm Alarm CtrL Control bLOr Blower (Default : None)

OP2 Function : Alarm-1

Parameter Description	Settings Default Value
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 Soak* 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 dE Deviation Band bAnd Window Band EoS End of Soak (Default : Process Low)
SETPOINT A 1.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 A 1.dE Available for 'Deviation Band' Alarm. Sets a deviation band above (Positive value) or below (Negative value) the SP for alarm activation.	-199 to 999 **or** -199.9 to 999.9 (Default : 0)
WINDOW BAND A 1.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 999.9 (Default : 3)

Parameter Description	Settings Default Value
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.	norm Normal rEv Reverse (Default : Normal)
INHIBIT (A1.Ih) *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.tm) Available for End of Soak Alarm. Sets time duration in seconds for which the alarm shall activate upon end of soak timer.	5 to 250 Seconds (Default : 10)

OP2 Function : Auxiliary Control

Parameter Description	Settings Default Value
OFFSET VALUE (SP.2) 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 999.9 (Default : 2 **or** 0.2)
CONTROL LOGIC (LOG.2) *Normal* The Output remains ON for PV *below* Setpoint and OFF otherwise. *Reverse* The Output remains ON for PV *above* Setpoint and OFF otherwise.	norm Normal rEv Reverse (Default : Normal)

OP2 Function : Blower / Compressor Control

Parameter Description	Settings Default Value
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 250.0 (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

PAGE 13 : OP3 FUNCTION PARAMETERS

Table 6.1

Parameter Description	Settings Default Value
OUTPUT-3 FUNCTION SELECTION OP3.F *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. Water Level Low Alarm OP3 relay activates if water level is Low.	nonE None ALrm Alarm CtrL Control L.LOY Water Level Low Alarm (Default : None)

OP3 Function : Alarm-2

Parameter Description	Settings Default Value
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 Soak* 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 dE Deviation Band bAnd Window Band EoS End of Soak (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.	-199 to 999 **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 999.9 (Default : 3)

Parameter Description	Settings Default Value
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.	norm Normal rEv Reverse (Default : Normal)
INHIBIT A2.Ih *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.tm Available for End of Soak Alarm. Sets time duration in seconds for which the alarm shall activate upon end of soak timer.	5 to 250 Seconds (Default : 10)

OP3 Function : Auxiliary Control

Parameter Description	Settings Default Value
OFFSET VALUE SP.3 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 999.9 (Default : 2 **or** 0.2)
CONTROL LOGIC LOG.3 *Normal* The Output remains ON for PV *below* Setpoint and OFF otherwise. *Reverse* The Output remains ON for PV *above* Setpoint and OFF otherwise.	norm Normal rEv Reverse (Default : Normal)

Section 7

PAGE 14 : PID CONTROL PARAMETERS

Table 7.1

Parameter Description	Settings Default Value
% OUTPUT POWER OUt.P This is a view only parameter that facilitates the indication of '% Output Power' computed by the controller PID algorithm. The computed value lies between Min. power (0.0%) and Max. power (100.0%).	Not Applicable
CYCLE TIME Ct (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 Pb (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 It (For 'PID' Control) The application of proportional band alone results in process value stability within the band but away from the setpoint. This is called steady state Offset Error. The integral action is incorporated for automatic removal of offset error with minimum ocillations. 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)

Parameter Description	Settings Default Value
DERIVATIVE TIME dt (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

PAGE 15 : SOAK TIMER PARAMETERS

(Refer end of this section for detailed Soak Timer Operation)

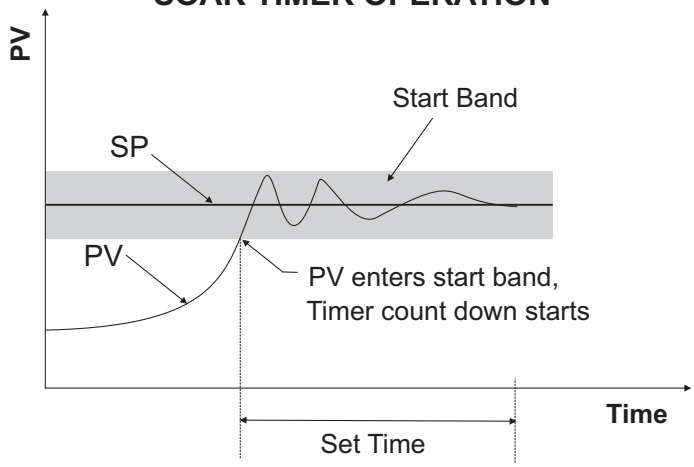
Table 8.1

Parameter Description	Settings Default Value
TIMER ENABLE S.Enb *Yes* Soak Timer function and Start / Abort commands are enabled. *No* Soak Timer function and Start / Abort commands are disabled.	no No YES Yes (Default : No)
TIME UNITS Unit Select the time units depending on the minimum and/or maximum time value required.	mm.SS Min:Sec HH.mm Hours:Min HoUr Hours (Default : Min: Sec)
TIME DURATION SoP.t The preset time value in selected units for the Soak Timer.	00.05 to 60:00 Min:Sec 00.05 to 99:55 Hrs:Min 1 to 9999 Hours (Default : 00.10 Min:Sec)
TIMER VIEW t.uiY Balance : The Lower Readout shows the balance soak time. Elapsed : The Lower Readout shows the elapsed soak time.	bALC Balance ELPS Elapsed (Default : Balance)
TIMER-START BAND S.bnd After issuance of start command, the timer starts counting down once the PV enters the process band around SP defined by this parameter value.	0 to 9999 or 0.0 to 999.9 (Default : 5 **or** 0.5)
HOLDBACK STRATEGY HOLd *None* PV based timer pause is not required. *Up* Timer is paused if PV is outside holdband *above* SP. *Down* Timer is paused if PV is outside holdband *below* SP. *Both* Timer is paused if PV is outside holdband both *above* and *below* SP.	nonE None UP Up dn Down both Both (Default : None)
HOLD BAND H.bnd Sets the temperature limit(s) with respect to the SP for the timer to pause. The timer holds on counting should the PV cross the limit(s).	1 to 9999 **or** 0.1 to 999.9 (Default : 5 **or** 0.5)

Parameter Description	Settings Default Value
SWITCH-OFF CONTROL OUTPUT AT TIMER END OP.OF *Yes* The control output (OP1) is forced off upon completion of timer. *No* The control output state is not forced.	no No YES Yes (Default : No)
POWER-FAIL RECOVERY METHOD Pr.FL *Abort* The timer operation is suspended until a new start command is issued. *Start* The timer re-runs the complete soak time. *Continue* The Soak Timer resumes operation for the balance time.	Abrt Abort Strt (Re)Start Cont Continue (Default : Continue)

Figure 8.1

SOAK TIMER OPERATION



Basic Operation

The Soak Timer is essentially a *preset timer* that can be configured to run as :

(a) A Free Running Timer by setting timer 'Start Band' to 0. That is, the timer starts counting down immediately upon issuance of Start Command by the user and continues until set time is elapsed.

(b) A Setpoint Dependent Timer. That is, after issuance of Start Command, the count down starts only after the PV reaches within timer 'Start Band'. The timer start band is a symmetrical band centered around the SP. For example, for a start band of 2°C and SP value of 100°C, the count down begins once the PV reaches a value within 98°C (SP - Start Band) to102°C (SP + Start Band). Note that, once the PV enters 'Start Band', the timer continues to run regardless of whether the PV remains within or outside the 'Start Band'.

Hold Band Operation

The timer is also provided with a 'Hold Band' that can be enabled to make sure that the timer counts down *only while* the PV is within the 'Hold Band'. That is, the timer pauses (holds counting down) whenever the PV is outside the 'Hold Band'. The 'Hold Band' is set with respect to the SP and can be set above or below or above and below the SP. For example, a 5 °C Hold Band below the SP (say,100°C) will force the timer in pause state whenever the PV is equal or less than 95°C (SP - Hold Band).

Power-fail Recovery Modes

The timer facilitates 3 different power-fail recovery modes, viz., *Continue*, *Re-start* and *Abort*. In *Continue* mode, the timer resumes to execute the balance soak time once the PV is detected within Hold Band. In *Re-start* mode, the timer executes the complete set time all over again. In *Abort* mode, the timer stops execution until a start command is issued.

End-of-Soak Events

The output Relay/SSR modules, OP2 and/or OP3, can be configured as End-of-Soak Alarm with a settable alarm duration. That is, upon completion of Soak Time execution, the Relay energizes (say, to activate a buzzer) for the set alarm duration.

Additionally, the controller provides 'Output-Off' strategy that can be enabled to force the control output OP1 off upon End-of-Soak. The output becomes active again after issuance of Start Command for the execution of a new Soak Time Cycle.

Section 9

PAGE 11 : SUPERVISORY PARAMETERS

Table 9.1

Parameter Description	Settings Default Value
TUNE / OPTIMIZE COMMAND OPt (For PID Control Mode only) Set to 'Yes' for initiating Tune / Optimize operation.	no No YES Yes (Default : No)
TUNE / OPTIMIZE ABORT COMMAND Abrt (For PID Control Mode only) Set to 'Yes' for terminating Tune / Optimize operation in progress.	no No YES Yes (Default : No)
OVERSHOOT INHIBIT OS.Ih (For PID Control Mode only) 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.	dSbL Disable EnbL Enable (Default : Disable)
OVERSHOOT INHIBIT FACTOR O.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.	dSbL Disable EnbL Enable (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)

Parameter Description	Settings Default Value
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.	dSbL Disable EnbL Enable (Default : Enable)
SOAK ABORT COMMAND ON OPERATOR PAGE SOH.A This parameter allows the user to enable (permit) or disable (restrict) the issuance of 'Abort' command from operator page to Abort (Stop) the running Soak Timer.	dSbL Disable EnbL Enable (Default : Enable)
SOAK TIME ADJUSTMENT ON OPERATOR PAGE SOH.t This parameter allows the user to enable (permit) or disable (restrict) the adjustment of the 'Soak Time Duration' on Operator Page.	dSbL Disable EnbL Enable (Default : Enable)
UTILITY OPTION OPtn This parameter assigns one of the following functions to the Digital Input. *General Purpose DI* Useful for remote monitoring the contact closure (switch) status using MODBUS address. *Soak Start* Digital Input is used for issuing Soak Timer Start Command. An open to close contact will initiate the Soak Timer. Water Level Low Digital Input is used for detecting Low Water Level.	GPd1 General Purpose Strt Soak Start Command LEvL Water Level Low Detection (Default : None)
WATER LEVEL-LOW DETECTION LOGIC LLG This parameter is available if Digital Input is used for Low Water Level Detection. Set to 'Open' or 'Close' depending upon whether *contact-open* or *contact-close* means *water low* detection.	OPEn Open CLOS Close (Default : Open)
SLAVE ID Id This parameter assigns a unique identification number that the Master Device can use to address the instrument for any communication data transactions. The settable values are from 1 to 127.	1 to 127 (Default : 1)
BAUD RATE bAUd This parameter defines the communication speed expressed in "Bits per second". The Baud Rate must be set to match the Baud Rate set for the Master Device.	4.8 4800 9.6 9600 19.2 19200 (Default : 9600)

Parameter Description	Settings Default Value
PARITY PAr1 Parity setting for serial communication protocol	nonE None EuEn Even Odd Odd (Default : Even)
COMMUNICATION WRITE ENABLE Con.E *Yes* The Read/Write parameters can be accessed for both reading and writing. *No* The Read/Write parameters can only be accessed for reading. That is, the parameter values cannot be altered through serial communication.	no No YES Yes (Default : Yes)

Section 10

MECHANICAL INSTALLATION

OUTER DIMENSIONS

The Figure 10.1(a) : 48 x 48 & Figure 10.1(b) : 96 x 96 shows the controller outer dimensions.

Figure 10.1(a)
48 x 48

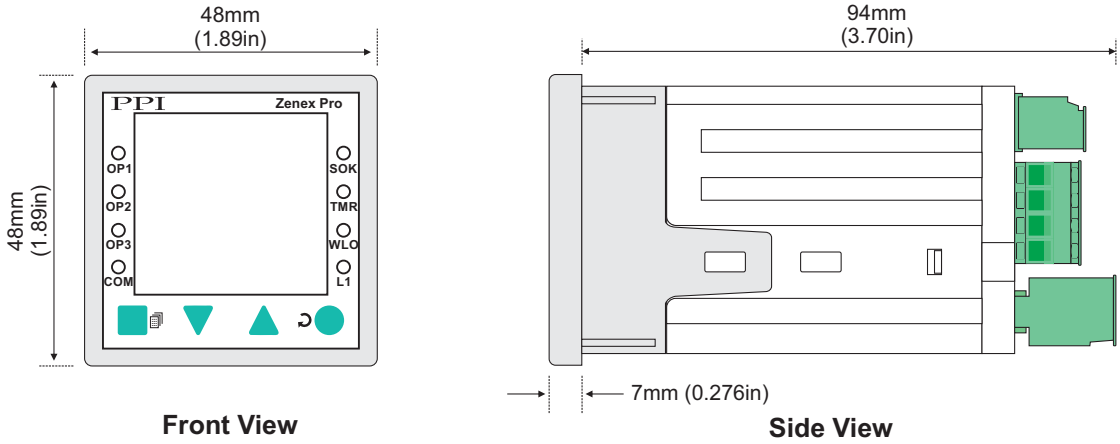
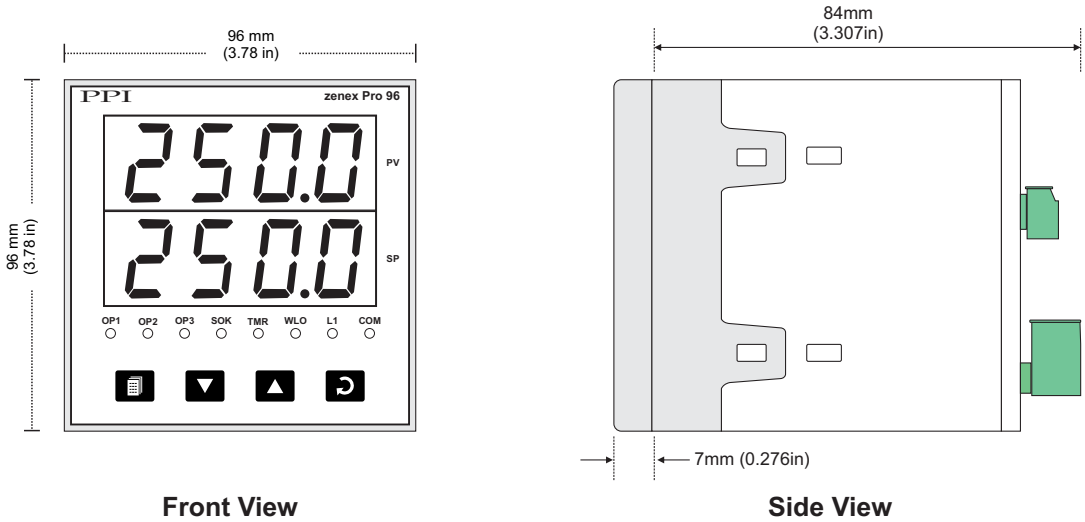


Figure 10.1(b)
96 x 96



PANEL CUTOUT AND RECOMMENDED MINIMUM SPACING

The Figure 10.2(a) : 48 x 48 & Figure 10.2(b) : 96 x 96 shows the panel cutout requirements for a single controller and also the minimum spacing recommended if several controllers are required to be mounted on a single panel.

Figure 10.2(a) : 48 x 48

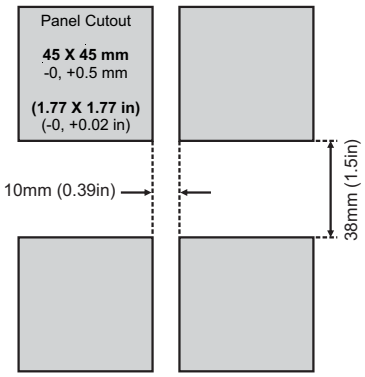
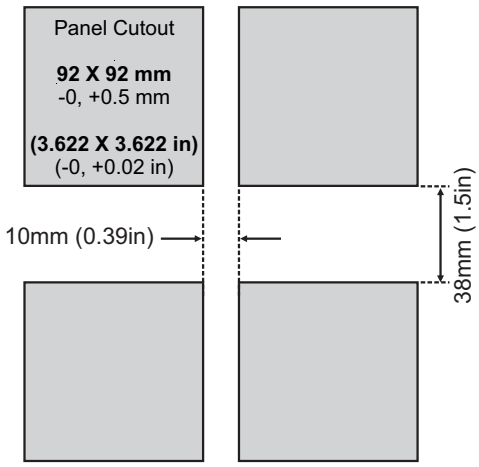


Figure 10.2(b) : 96 x 96

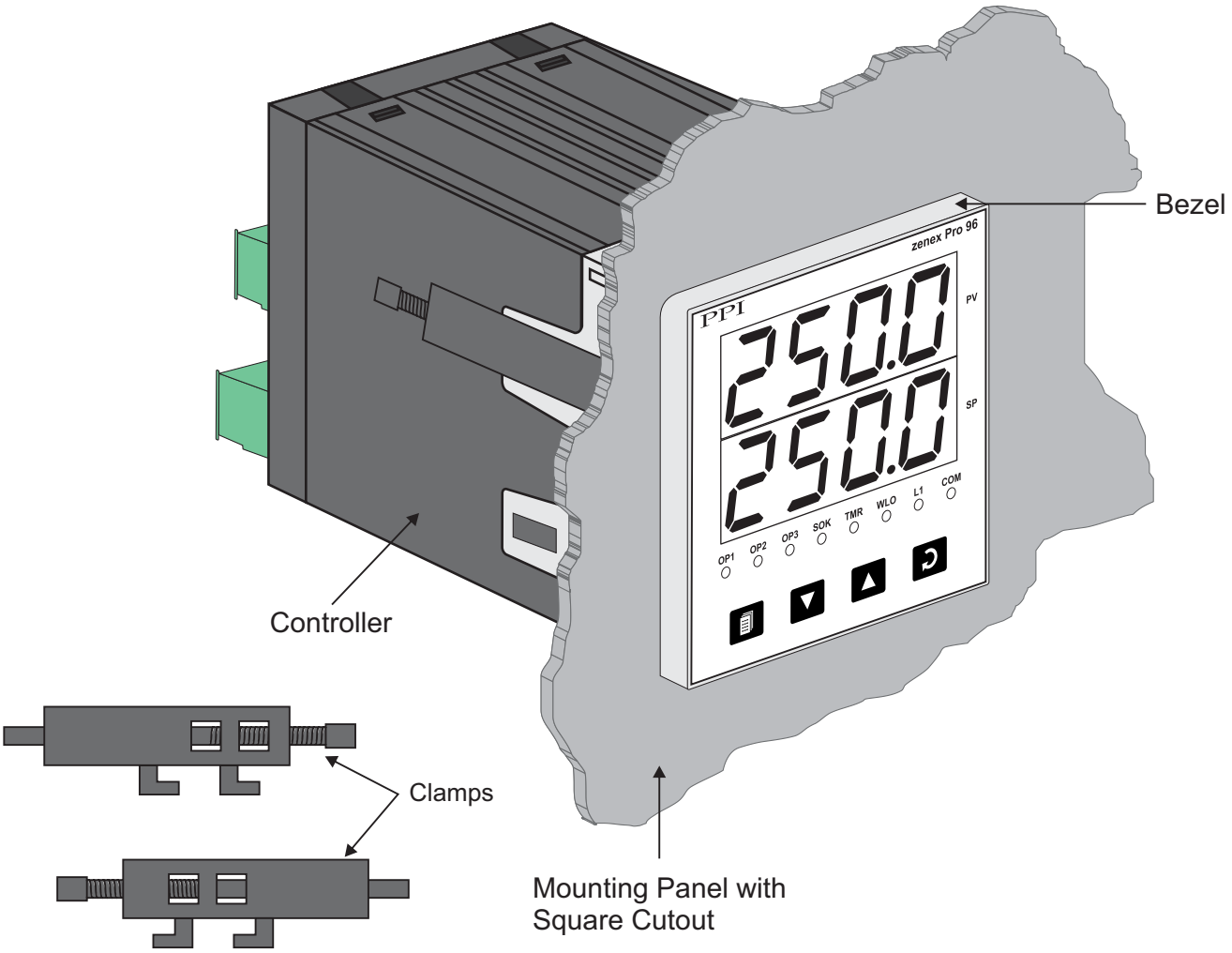


PANEL MOUNTING

Follow the steps below for mounting the controller on panel:

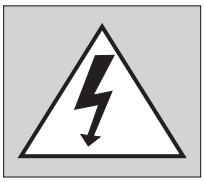
1. Prepare a square cutout to the size shown in Figure 10.2.
2. Remove the Panel Mounting Clamp from the controller Enclosure and insert the rear of the controller housing through the panel cutout from the front of the mounting panel.
3. Hold the controller gently against the mounting panel such that it positions squarely against the panel wall, see Figure 10.3. Apply pressure only on the bezel and not on the front label.
4. Insert the mounting clamps on either side of the controller in the slots provided for the purpose. Rotate the screws clockwise so that they move forward until they push firmly against the rear face of the mounting panel for secured mounting.

Figure 10.3



Section 11

ELECTRICAL CONNECTIONS



WARNING
MISHANDLING / NEGLIGENCE CAN RESULT IN PERSONAL DEATH OR SERIOUS INJURY.

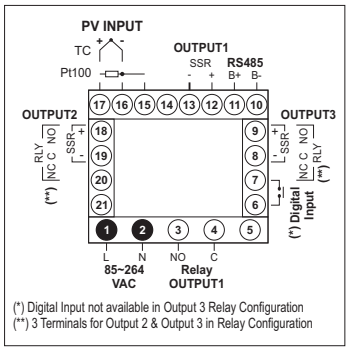
1. The user must rigidly observe the Local Electrical Regulations.
2. Do not make any connections to the unused terminals for making a tie-point for other wires (or for any other reasons) as they may have some internal connections. Failing to observe this may result in permanent damage to the controller.
3. Run power supply cables separated from the low-level signal cables (like RTD, DC Linear (Voltage) signals, etc.). If the cables are run through conduits, use separate conduits for power supply cable and low-level signal cables.
4. Use appropriate fuses and switches, wherever necessary, for driving the high voltage loads to protect the controller from any possible damage due to high voltage surges of extended duration or short-circuits on loads.
5. Take care not to over-tighten the terminal screws while making connections.
6. Make sure that the controller supply is switched-off while making/removing any connections or removing the controller from its enclosure.

CONNECTION DIAGRAM

The connecters provided for wiring are pluggable male-female type. The female parts are soldered on the controller PCBs while the male parts are with screws and removable. The rear panel electrical wiring connection diagram is shown in Figure 11.1(a) : 48 x 48 & Figure 11.1(b) : 96 x 96.

Relay / SSR Control Output Version

Figure 11.1(a) : 48 x 48



DC mA/V Control Output Version

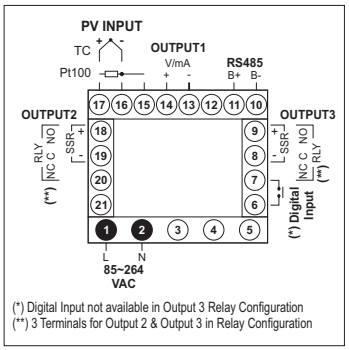
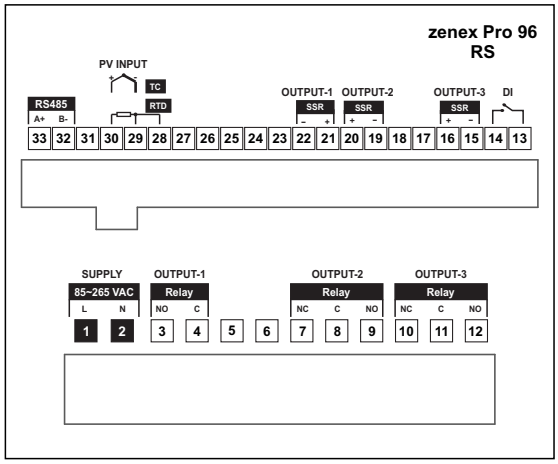
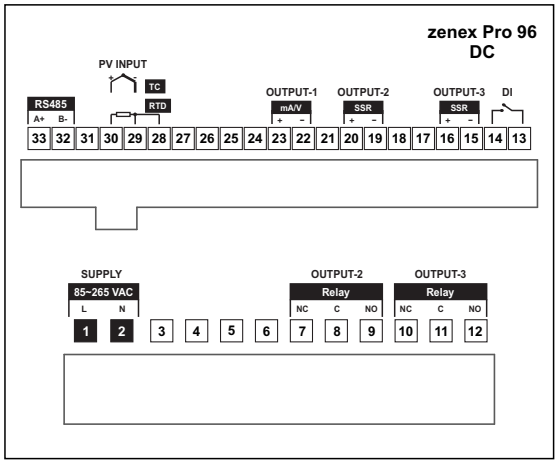


Figure 11.1(b) : 96 x 96





DESCRIPTIONS

The back panel connections are described as under:

PV INPUT : RTD Pt100, 3-wire / Thermocouple

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

Figure 11.2 (a)
RTD Input

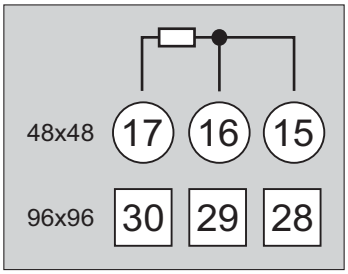
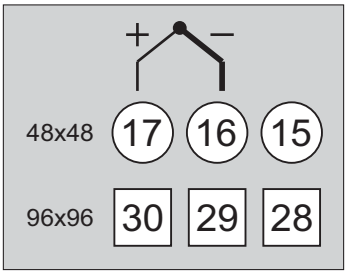


Figure 11.2 (b)
Thermocouple Input



RTD Pt100, 3-wire

Connect single leaded end of RTD bulb to terminal 17 / 30 and the double leaded ends to terminal 16 / 29 and 15 / 28 (interchangeable) as shown in Figure 11.2 (a). Use low resistance copper conductor leads of the same gauge and length. Avoid joints in the cable.

Thermocouple

Connect Thermocouple Positive (+) to terminal 17 / 30 and Negative (-) to terminal 16 / 29 as shown in Figure 11.2 (b). Use correct type of extension lead wires or compensating cable. Avoid joints in the cable.

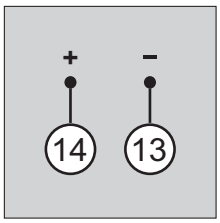
OUTPUT1 : Control Output - Relay
Control Output - SSR
Control Output - V/mA

OUTPUT2 : Alarm / Control - Relay
Alarm / Control - SSR

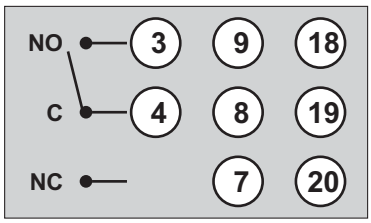
OUTPUT3 : Alarm / Control - Relay
Alarm / Control - SSR

Relay & SSR Control Outputs are available as standard. V / mA Control Output is available on request.

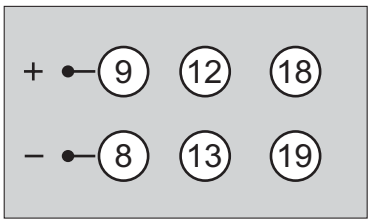
Figure 11.3(a) :
48 x 48



Ouput1
V/mA

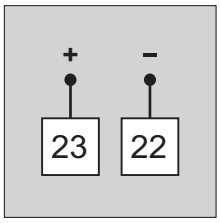


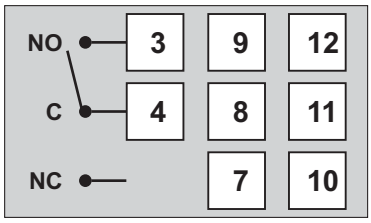
Output1/ Output2 / Output3
Relay

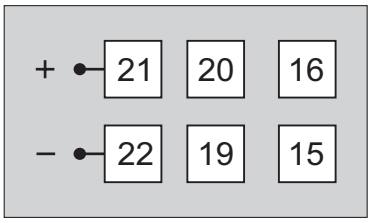


Output1/ Output2 / Output3
SSR

Figure 11.3(b) :
96 x 96







mA / V Output
The Positive (+) of mA / V is available at Terminal 14 / 23 & the Negative (-) at Terminal 13 / 22.

Relay Output
Potential-free Relay changeover contacts NO (Normally Open) and C (Common) rated 5A/240 VAC (resistive load).

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

Digital Input : Low Water-Level Detection or Timer Start Command Digital Input

Potential-free contact closure input terminals are provided as digital input. This input can either be used for low water level detection or for issuance of timer start command. When used as water level detection, an user programmable 'Open' or 'Close' switch position is detected as water level low. When used as timer start command, an Open to Close transition issues start command.

Figure 11.4(a) : 48 x 48

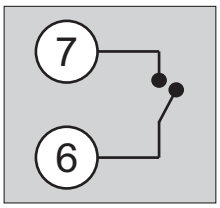
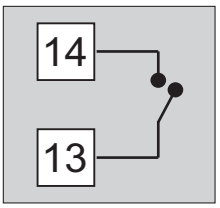


Figure 11.4(b) : 96 x 96

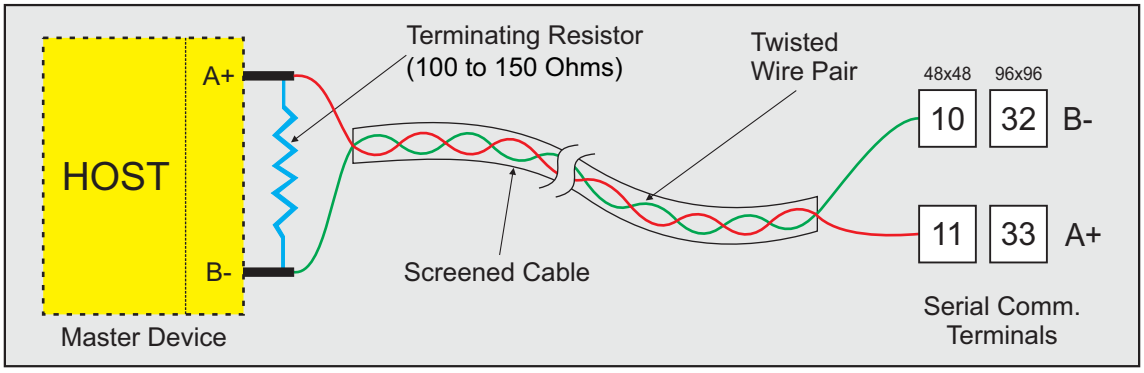


RS485 : Serial Communication Port

Connect terminal 11 / 33 and 10 / 32 of the controller to (A+) and (B-) RS485 terminals of the Master device.

To ensure reliable operation of the Serial Communication Link (without data corruption due to line noise or reflections), use a pair of twisted wires inside screened cable with the terminating resistor (100 to 150 Ohms) at one end, as shown in Figure 11.5 below.

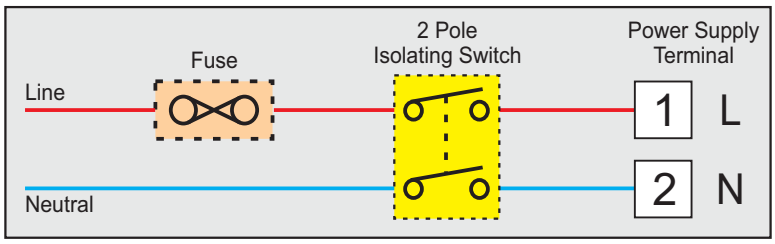
Figure 11.5



85~264 VAC : Power Supply

The controller is supplied with power connections suited for 85 to 264 VAC line supply. Use well-insulated copper conductor wire of the size not smaller than 0.5mm^2 for power supply connections. Connect Line (Phase) supply line to terminal 1 and the Neutral (Return) supply line to terminal 2 as shown in Figure 11.6 below. The controller is not provided with fuse and power switch. If necessary, mount them separately. Use a time lag fuse rated 1A @ 240 VAC.

Figure 11.6



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