neuro 105

PPI
The Perfection Experts

Programmable Profile Controller

User Manual

CONTENTS

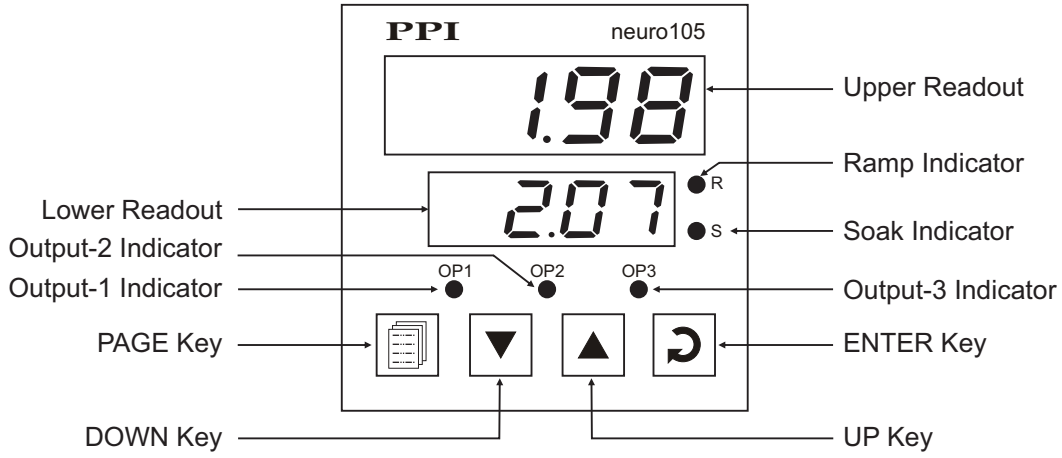
For Size 48X48

For Size 96X96

Section 1
FRONT PANEL LAYOUT

The controller front panel comprises of digital readouts, LED indicators and membrane keys as shown in figure 1.1 below.

Figure 1.1



READOUTS

The upper readout is a 4 digit, 7-segment bright red LED display and usually displays the PV (Process Value). In parameter set-up mode, the upper readout displays parameter values.

The lower readout is a 4 digit, 7-segment bright green LED display and while running a PROFILE program displays either the 'ramping setpoint' / balance 'soak time' or % Output Power. If the controller is operating in fixed setpoint control mode (that is while not running a profile); the lower readout displays the control Setpoint or % Output Power. In parameter set-up mode, the lower readout displays prompts for the parameters.

The indications on the upper and lower readouts, in general, depend on the mode of operation and configuration parameters. Refer respective sections for more details.

INDICATORS

There are five front panel red LED indicators. These indicators 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	Function
R	While a profile program is in progress; flashes if a RAMP segment is in progress and glows steadily if the ramp is in HOLD state.
S	While a profile program is in progress; flashes if a SOAK segment is in progress and glows steadily if the soak timer is in HOLD state.
OP1	Indicates Output-1 ON/OFF status.
OP2	Indicates Output-2 ON/OFF status.
OP3	Indicates Output-3 ON/OFF status.

KEYS

There are four tactile keys provided on the front panel for configuring the controller, setting-up the parameter values and selecting operation modes. The Table 1.2 below details the key functions.

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.

The keys are also assigned various other functions while the controller is in MAIN mode display. The key-functions depend on the mode of operation (Automatic, Hand or Profile) and are described under the respective operation mode in the next Chapter.

Section 2
BASIC OPERATION

POWER-UP

Upon switching on the power to the controller, all displays and indicators are lit on for approximately 3 seconds during which time the controller runs through a self-test sequence. This is followed by the indication of the controller model name on the upper readout and the firmware version on the lower readout, for approximately 1 second.

The upper readout now displays the measured PV (Process Value) and the lower readout displays the ramp setpoint / balance soak time if running a profile program or control setpoint if operating in fixed setpoint mode. If in Hand (Manual) mode; the lower readout displays the last output power set by the user. This is the MAIN display. It is the one that shall be used most often.

MAIN DISPLAY MODES

The controller can be programmed to operate in one of the three modes of operation, viz., Automatic (fixed setpoint), Hand (Manual) and Profile mode. The modes and the corresponding MAIN displays are described below:

1. **Automatic Mode**

   In this mode, the controller automatically adjusts the % (percentage) output power necessary to maintain the process value at the control setpoint. The upper readout displays the Process Value. The lower readout can be toggled to display either the control setpoint or the % output power by pressing ENTER key. That is, if the lower readout is indicating control setpoint, press ENTER key to select % output power indication and vice-a-versa. The % output power is displayed with the leftmost digit indicating the following alphabet to distinguish between the control setpoint and the % output power indications.

Left Most Digit Alphabet While Showing % Power	What it Means
P	The alphabet P stands for Power and is indicated if the controller is operating in Unidirectional control mode, that is, single control output.
H or C	The alphabet H stands for heat and C stands for cool. This is applicable if the controller is configured to operate in Bidirectional control mode, that is, dual control outputs.

   The setpoint value on the lower readout can be adjusted directly (if quick adjustment of setpoint is enabled in PAGE- 12) as explained later.

2. **Hand (Manual) Mode**

   In this mode of operation, the % output power is manually adjustable by the user. The controller maintains the output power set by the user, regardless of the control setpoint.

   Activating Hand Mode and Adjusting Power

   The Hand mode can be activated only if it is enabled in PAGE-12 parameter list. If enabled, step through the following sequence for activating the Hand Mode and adjusting the power.

1. Hold ENTER key depressed for approximately 2 seconds until the lower readout displays % power with the leftmost digit indicating one of the alphabets P, H or C with a flashing decimal point.
2. Release Enter key. The controller is now placed in Hand mode. The upper readout displays the PV and the lower readout displays the % output power with the leftmost digit indicating P (Unidirectional control) or H / C (Bidirectional control) with a flashing decimal point.

Remember that the flashing decimal point on the leftmost digit of the lower readout is an indication of the controller being operated in Hand (Manual) Mode.

3. Adjust the output power using the UP and DOWN keys. Note that the power adjustment is allowed only within the set Power Low and Power High limits. For Bidirectional (heat-cool) control, the Power Low and Power High limits are fixed to -100% (full cooling) and +100% (full heating), respectively.

De-activating Hand Mode Operation

Once the Hand mode is activated, it remains in Hand mode until de-activated. To de-activate the Hand mode and return to the original mode of operation.

1. Hold the ENTER key depressed for approximately 2 seconds until the flashing decimal point on the leftmost digit turns off.
2. Release Enter key. The Hand mode is now de-activated and the controller resumes its original mode of operation.

Note :
If the Hand mode is active and it is Disabled (in PAGE-12 parameter list), the controller gets locked in Hand Mode with the last set value of the output power. That is, the Hand mode can not be de-activated (using ENTER key as described above) and also the output power value can not be altered (using UP/DOWN keys). To de-activate the Hand mode or to alter the output power value, the Hand mode must be Enabled in the PAGE-12 parameter list.

Effect of Activating Hand Mode While Running A Profile-Program

If the Hand mode is activated while running a profile-program, the controller puts the running profile segment in HOLD state, that is, the execution of the current segment is suspended until the controller returns back to the Automatic mode upon de-activating the Hand mode.

Power-Failure in Hand Mode

If the power to the controller is switched-off or a power-failure occurs while the controller is operating in Hand mode; upon resumption of power, the controller continues to operate in Hand mode with the last user set power value.

Bumpless Transfer

The transfer from Automatic mode to Hand mode or vice-a-versa is Bumpless. That is:

- While transferring from Automatic mode to Hand mode, the controller maintains its output to the last computed value in the Automatic mode until adjusted by the user.
- While transferring from Hand mode to Automatic mode, the controller starts adjusting the output power from the value last adjusted by the user in the Hand mode.

This bumpless (smooth) transfer prevents any sudden and large changes in output power that can result in process disturbances.

Note :
The Bumpless transfer is not strictly applied while transferring to and from Hand mode if the controller is running a Profile-program.

3. Profile Mode

The profile mode can be enabled in PAGE-18 parameter list. If enabled, the controller executes the user selected Profile-Program upon issuing start command. The profiles and profile-programs can be configured / set using the parameters listed in PAGE-15 through PAGE-18. In the Profile Mode, the controller behavior is same as that in Automatic mode except for the setpoint that the controller respects for regulating the PV.

If no profile-program is in progress (usually the case, prior to start of a profile-program or after the end of a running profile-program), the controller maintains the PV at the Control setpoint. If, however, the parameter Output Off (OP.OF) in PAGE-18 is set to “Yes”, the controller keeps the control output(s) OFF (0% power) and thus the PV is allowed to attain the ambient temperature.

If a profile-program is being executed, the controller respects the ramp setpoint and attempts to maintain the PV at the ramp setpoint. The Ramp Set point value is determined by the profile segment (ramp segment or soak segment) that is in progress.

Profile-Program Status Indications

While the controller is running a profile-program, the following display indications are available.

1. The front panel indicator R and S indicate whether a Ramp or Soak segment is in progress.

   If the RAMP segment is in progress; the indicator R flashes or glows steadily depending upon the setpoint is ramping or is in HOLD state, respectively. The indicator S remains off.

   If the SOAK segment is in progress; the indicator S flashes or glows steadily depending upon the soak timer is running or is in HOLD state, respectively. The indicator S remains off.

2. The Upper Readout displays the measured PV.

   The Lower Readout displays either ramping setpoint value (if a ramp segment is in progress) or balance soak-time (if a soak segment is in progress). Depressing ENTER key toggles the lower readout to % output power indication.

3. Upon holding the DOWN key depressed, the Lower Readout indicates the profile number (as PF.01, PF.02, etc.) and the Upper Readout indicates the profile-program number (as Pr.01, Pr.02, etc.) that is currently being executed.

   Upon holding the UP key depressed, the Lower Readout indicates the current segment number (as rP.1, rP.2, etc. for a Ramp Segment and SK.1, SK.2, etc. for Soak Segment) of the current profile that is being executed. The Upper Readout indicates the measured PV.

4. The controller provides the facility to cycle a program for a predetermined numbers of times or indefinitely. The current cycle number in progress can be viewed in PAGE-0 (if not programmed for indefinite cycling). The lower readout displays the prompt CYCL while the upper readout shows the current cycle number in progress. This is a view only parameter and thus can not be altered.

Upon completion of the running profile-program, the upper readout continues to indicate the PV. The lower readout indicates control setpoint or % output power. Until the next start command is issued, the controller continues to maintain the PV at the control setpoint. If, however, the parameter Output Off (OP.OF) is set to “Yes”, the controller keeps the control output(s) OFF (0% power) upon completion of a running profile-program until the next start command is issued.

Selecting a New Profile-Program & Issuing Start Command

A new profile-program can be started after the completion or manual abortion of a running program. If the controller is already not running a profile-program, step through the following sequence to select and start a new profile-program.

1. Enter PAGE-0 from the MAIN display mode.
2. The lower readout shows PrG.n (Program Number). Use UP/DOWN keys to select the desired profile-program number and press ENTER key.
3. The lower readout now shows Strt (Start) and the upper readout shows no (No). Use UP key to select YES (Yes) and press ENTER key to return to the MAIN display. The controller starts executing the selected program.

Skipping the Running Segment / Holding the Program / Aborting A Running Program

The controller allows the user to skip a running profile segment (ramp or soak) and advance to the next segment or forcing the program into indefinite HOLD start or to abort the execution of a running program.

Step through the following sequence for skipping a segment, forcing the program in hold state or to abort a program execution.

1. While the controller is executing a profile-program; enter PAGE-0 from the MAIN display mode.

2. The desired operation can be selected on the lower readout by pressing ENTER key. The available operations are Advn (Advance), HoLd (Hold) and Abrt (Abort).

Skip
While the controller displays Advn (Advance) on the lower readout and no (No) on the upper readout; press UP key to select YES (Yes) and then press ENTER key. The controller immediately terminals the execution of the running profile segment and advances to the next segment.

Hold
While the controller display HoLd (Hold) on the lower readout, the upper readout indicates either YES (Yes) or no (No) depending on whether the profile-program is already forced into hold state or not. Thus, this command allows the user to force the program into hold state or to release from the hold state. Select no for releasing and YES for entering the hold state and press ENTER key.

Note that the HOLD state enforced by user is automatically released if the power to the controller is switched off and on. That is, the HOLD state, if enabled, is not stored in the controller memory and upon power-up the controller assumes the default RUN state.

Abort
While the controller displays Abrt (Abort) on the lower readout and no (No) on the upper readout; press UP key to select YES (Yes) and then press ENTER key. The controller immediately terminates the execution of the running profile-program.

3. Press PAGE key to return to the MAIN display mode after completing the desired operation(s).

(For more details on the profile programs and the associated operating terms, refer Section 13 : Setpoint Profiles & Profile-Programs of this manual)

PV ERROR INDICATIONS

In case of PV exceeding the minimum or maximum range specified for the selected input type or in case of input sensor (thermocouple / RTD) open / broken; the upper readout flashes the error messages as listed in Table 2.1

Table 2.1

Error Message (Upper Readout)	**Error Condition**	**Cause**
Or	Over-range	Process Value exceeds maximum input range.
Ur	Under-range	Process Value exceeds minimum input range.
Open	Open	The input sensor is open or broken.

Notes :

1. Under PV Error condition, the control signal is held at the minimum level, that is, OFF.
2. For DC Linear inputs, under the input open condition, the upper readout displays value corresponding to 0 (Zero) level signal. For example, consider 4-20mA input signal scaled to display 0.0 to 100.0. The upper readout then shows approximately -25.0 (corresponding to 0 mA) upon input open.
3. In case of 3-wire RTD sensor input, if the compensating lead (connected at rear panel terminal number 3) is not connected or gets open, the controller does not indicate PV error but the measured value is not compensated for the lead resistance.

QUICK ADJUSTMENT OF THE CONTROL SETPOINT

Except in the case of Hand mode or Profile mode operation; the control setpoint is quickly adjustable in the lower readout if the quick setting mode is enabled in PAGE-12 parameter list. If enabled, step through the following sequence to adjust the control setpoint:

1. If the lower readout is indicating % output power, depress ENTER key to select the control setpoint indication.
2. Press and release UP and DOWN key once. The lower readout starts flashing.
3. Press UP/DOWN keys to adjust the setpoint value. Pressing UP and DOWN key once changes the value by one count; holding the key pressed speeds up the rate of change. The lower readout stops flashing as long as the UP or DOWN key is pressed for adjustment to avoid any obstructions in viewing.
4. Press ENTER key once to register and store the altered value. The lower readout stops flashing.
5. Repeat steps 1 through 4 each time the setpoint value is to be modified.

Note :
The control setpoint is also available in PAGE-10 parameter list for adjustment. If the control setpoint needs to be adjusted while operating in Profile mode or when the quick adjustment mode is disabled, access to PAGE-10 for the adjustment of the control setpoint.

Section 3
PAGES AND PARAMETERS

The controller requires various user settings that determine how the controller will function or operate. These settings are called Parameters.

The PPI *neuro* series controllers are packed with various advanced features and as such require many user settable parameters to activate the features. For the convenience and ease of operation, the various parameters have been grouped separately depending upon the functions they define. Each such group is called a PAGE that is assigned a unique PAGE NUMBER for its access. Each PAGE presents a specified list of parameters, in a fixed sequence, to the user for setting. The user can access to a desired PAGE by entering its PAGE NUMBER and can select and set the desired parameter values.

PARAMETER PROMPTS

Each parameter has an identifying tag, called the parameter Prompt. While setting parameter values in a PAGE, the parameter prompt is always displayed in the lower readout and its current value is displayed in the upper readout.

ACCESSING A PAGE

Each PAGE is accessible only from the MAIN display. That is, from the current PAGE, you must return to the Base display before the other PAGE can be accessed.

To have an access to a PAGE from MAIN display, depress PAGE key. The lower readout shows PAGE and the upper readout shows 0. Adjust the upper readout to the desired PAGE NUMBER using the UP/DOWN keys. Pressing the UP and DOWN key once, changes the value by one count. Holding the key pressed speeds up the rate of change.

Upon adjusting the upper readout to the desired PAGE NUMBER, press ENTER key. The lower readout shows the prompt for the first parameter listed in that PAGE and the upper readout shows its current value.

Note :
If the entered PAGE NUMBER is invalid (contains no parameter list or any associated function), the controller opens PAGE-10 as default but without the facility of adjustments. That is, the PAGE-10 parameter list is presented for view only.

LOCKING/UNLOCKING PARAMETER ADJUSTMENTS

Though access to any PAGE is always permitted, the adjustments of the parameter values, however, can be locked at the supervisory level. If the lock is enabled, the parameter values in each PAGE (except PAGE-0) can only be viewed but can not be adjusted. That is, the UP / DOWN key operation is inhibited. This feature facilitates the supervisory level to protect the parameter values from unauthorized tampering or accidental alterations by the operator.

The controller is shipped from the factory in Unlocked (Lock disabled) condition. The user can enable the lock once the initial configuration and installation is done. For enabling the lock, step through the following sequence:

1. Depress PAGE key from the MAIN display.
2. The lower readout shows PAGE and the upper readout shows 0. Adjust the upper readout to PAGE NUMBER 123 and press ENTER key.
3. The controller returns to the MAIN display with the LOCK enabled.

Note :
Since there is no front panel indication for the 'Lock Enabled' condition, ensure that the lock is enabled by trying to adjust the parameters in any valid PAGE.

For disabling the LOCK (Unlocking), step through the following sequence:

1. Depress PAGE key from the MAIN display.
2. The lower readout shows PAGE and the upper readout shows 0. Adjust the upper readout to PAGE NUMBER 123 and press ENTER key.

3. The controller returns to the MAIN display.
4. Repeat steps 1 and 2. This time the controller returns to the MAIN display with the LOCK disabled (open).

Notes :

1. If the quick adjustment mode for the control setpoint is enabled in PAGE-12 parameter list, the setpoint can be adjusted in the lower readout even under LOCK condition. The supervisory level, thus, can allow or disallow the setpoint adjustment to the operator by enabling or disabling the quick adjustment mode prior to locking
2. If Profile mode is enabled, the PAGE-0 (Profile / Program 'Operating Commands') are available even under LOCK condition.
3. If the Hand mode is enabled in PAGE-12 parameter list, the Hand mode activation and subsequent adjustment of the output power in the lower readout is available even under LOCK condition. The supervisory level, thus, can allow or disallow the Hand mode operation to the operator by enabling or disabling the Hand mode prior to Locking.
4. The 'return to the default factory set values' facility by accessing PAGE-99 is also inhibited (locked) when the LOCK is enabled. Accessing PAGE-7 shall be treated as an invalid PAGE NUMBER.
5. Remember, it requires entering PAGE NUMBER 123 once for LOCKING but twice for UNLOCKING. Also, for UNLOCKING, the PAGE NUMBER 123 must be entered twice during the same duration for which the controller is powered. That is entering the PAGE NUMBER 123 once prior to power loss and once after resumption of power shall not UNLOCK.
6. Do not forget to enable the LOCK again if it was UNLOCKED for some parameter value alteration.

ADJUSTING PARAMETER VALUES

Once a PAGE is accessed, step through the following sequence to adjust the values of the desired parameter(s):

1. Press and release the ENTER key until the prompt for the required parameter appears in the lower readout. The last parameter in the list rolls back to the first parameter.
2. Use UP and DOWN keys to adjust the parameter value.

   Note that some parameters (examples; Alarm Setpoint, Proportional Band, etc.) have numeric values while others (examples; Alarm Logic, Control Mode, etc.) have a series of options. If adjusting a numeric value; depressing the UP / DOWN key once, increases/decreases the parameter value by one digit. For parameters having a series of options, depressing the UP/DOWN key once takes you to the next/previous option. In each case, keeping the UP/DOWN key pressed speeds up the rate. If the value reaches the maximum / minimum settable value/option, the upper readout flashes and the UP (if maximum value is reached) or DOWN (if minimum value is reached) key has no effect.
3. Press ENTER key. The new value gets stored in the controller's non-volatile memory and the next parameter in the list is displayed.
4. For returning to the MAIN display, press PAGE key.

Note :
It is a must to press the ENTER key after altering the value of a parameter else the new value will not be registered / stored. That is, a return to the MAIN display (by depressing PAGE key) without pressing the ENTER key will not store the altered value in the controller memory and the previous set value will be retained.

TIME-OUT REVERT TO MAIN DISPLAY

While the controller is in set-up mode; If there are no key operations (that is, if none of the 4 front panel keys is pressed) for 60 seconds, the controller automatically reverts to the MAIN display mode.

CONDITIONAL PARAMETERS

As discussed above the various parameters (user set values) are grouped and listed in separate PAGES. For convenience, each PAGE contains a list of parameters that relate to some specific functions or operations.

Note, however, that not all parameters are always presented to the user. Some parameters are presented only if the corresponding function or operation mode is selected. Such parameters are called the Conditional parameters, as their availability is dependent on the options selected for some other parameters (in the same or other PAGE). For example, consider the parameter Hysteresis (dead band) contained in PAGE-10 parameter list. This parameter is presented only if the controller is set to operate in On-Off control by setting the Proportional Band parameter value to 0.

Suppressing the conditional parameters (if the conditions are not met) avoids ambiguity and makes the parameter list more comprehensive. Refer the notes below each parameter table (listed in the following 6 sections) for the conditional parameters. Also note that the parameters appear in the same sequence as shown in the table for each PAGE.

Section 4

CONTROL PARAMETERS

PAGE-10 presents the list of parameters that define the constants required by a particular control algorithm for the purpose of computing and outputting the control signals. The Table 4.1 below lists these parameters followed by the definitions for each parameter.

Table 4.1

Parameter Description	Settings (Default Value)
CONTROL SETPOINT SP This is the Setpoint value that the controller respects for the control purpose while it is not running a profile or not in standby / tuning mode.	Setpoint Low to Setpoint High (Default : 0)
PROPORTIONAL BAND Pb Sets proportional gain (% power per unit error). Defined in same units and resolution as that for PV.	0 to 9999 (Default : 50)
HYSTERESIS HYSt Sets differential (dead) band between On-Off switching for OP1.	1 to 250 (Default : 2)
INTEGRAL TIME It Sets integral time constant in seconds. Setting the value to 0, cuts-off the integral action.	0 to 1000 (Default : 100)
DERIVATIVE TIME dt Sets derivative time constant in seconds. Setting the value to 0, cuts-off the derivative action.	0 to 250 (Default : 25)
CYCLE TIME Ct Sets the total 'On + Off' time in seconds for time proportional power output through OP1 Relay / SSR.	0.5 to 120.0 (Default : 20.0)
RELATIVE COOL GAIN rELG Sets the ratio of cooling power to the heating power.	0.1 to 10.0 (Default : 1.0)

Parameter Description	Settings (Default Value)
COOL CYCLE TIME C.CT Sets the On + Off cycle time in seconds for time proportional power output through OP2 Relay / SSR.	0.5 to 120.0 (Default : 20.0)
POWER LOW LIMIT PL This parameter, expressed in %, defines the minimum output power that the controller will always maintain no matter what the control algorithm demands. This parameter is mainly used to limit the minimum closing of the actuators like valves. For most applications this value is set to 0% (default value). This parameter value must be less than the Power High Limit.	0 to less than Power High (Default : 0)
POWER HIGH LIMIT PH This parameter, expressed in %, defines the maximum output power that will not be exceeded no matter what the control algorithm demands. This parameter is mainly used to limit the maximum opening of the actuators like valves. For most applications this value is set to 100% (default value). This parameter value must be greater than the Power Low Limit.	Greater than Power Low to 100 (Default : 100)

Notes :

1. This parameter could also be adjusted on lower readout if quick adjustment is enabled in PAGE-12 parameter list.
2. Available only if the Proportional Band value is set to 0 for On-Off control. Not Applicable for heat-cool PID control.
3. Available only if the proportional Band value is non-zero (PID control).
4. Available only if the control output (OP1) is Relay or SSR (refer PAGE-12 parameter list). In case of On-Off control, this parameter is not functional but provided for Hand mode operation.
5. Available only if output-2 (OP2) is configured as Cool Control output in PAGE-15 parameter list.
6. Available only if output-2 (OP2) is configured as Cool Control output and the output type is configured for Relay or SSR drive in PAGE-15 parameter list.
7. These parameter values are not applicable for On-Off control with relay/SSR as control output or if the controller is configured for heat-cool PID (refer PAGE-12 and PAGE-15 parameter lists).
8. Default values are the factory set values. Also, all the parameters can be set to their factory set values by accessing PAGE-99 and pressing ENTER key. The controller resets and restarts with factory set values.
9. Refer PAGE-12 parameter list for definitions of Setpoint Low and Setpoint High parameters.

Cycle Time Note :

Even though very large Cycle Time values affect the control accuracy by inducing oscillations of the measured PV around control setpoint, in many applications it is unavoidable. In case, higher value for Cycle Time must be used (when switching very high current loads), it is recommended to decrease the Proportional Band value in small steps until satisfactory control accuracy is obtained. Allow enough time between each step change of the Proportional Band for the control loop to stabilize.

Reducing Proportional Band value reduces the amplitude of the PV oscillations but marginally increases the frequency of oscillations. Thus, do not reduce the Proportional Band too much. A reduction up to half the self-tuned value is suggested.

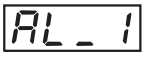
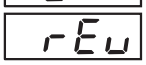
Section 5
ALARM PARAMETERS

PAGE-11 presents the Alarm related parameter list. The controller is provided with 2 independent “Soft” alarms, that is, the alarms can be set and generated even if the corresponding output modules are not fitted or assigned to other function. The alarm statuses are also available via digital communication, if the communication module is fitted.

If output modules (OP-2 for Alarm-1 and OP-3 for Alarm-2) are fitted and assigned to alarm functions, the relay (or SSR) energizes / de-energizes based on the set values for the alarm parameters.

The Table 5.1 lists the various alarm-related parameters followed by the definitions for each parameter.

Table 5.1

Parameter Description	Settings (Default Value)
ALARM-1 TYPE  Select the Alarm-1 activation type. Selecting ‘None’ will disable the alarm and suppress all the related parameters for Alarm-1.	 None  Process low  Process high  Deviation Band  Window Band  End of Profile (Default : None)
ALARM-1 SETPOINT  Sets Alarm limit independent of control setpoint.	Throughout the range for the selected input type (Default : 0)
ALARM-1 DEVIATION BAND  Sets positive or negative deviation (offset) limit from control setpoint for High or Low Alarm-1 activation, respectively.	-999 to 999 (Default : 0)
ALARM-1 WINDOW BAND  Sets symmetrical positive and negative deviation (offset) limits from control setpoint for both High and Low Alarm-1 activation.	3 to 999 (Default : 3)
ALARM-1 HYSTERESIS  Sets differential (dead) band between Alarm-1 switching ON and OFF states.	1 to 999 (Default : 2)
ALARM-1 LOGIC  Set to Yes to suppress Alarm-1 activation upon power-up or process start-up.	 Direct  Reverse (Default : Direct)

Parameter Description	Settings (Default Value)
ALARM-1 INHIBIT A1.i h Set to Yes to suppress Alarm-1 activation upon power-up or process start-up.	no No YES Yes (Default : No)
ALARM-2 TYPE AL_2 **ALARM-2 SETPOINT** A2.SP **ALARM-2 DEVIATION BAND** A2.dE **ALARM-2 WINDOW BAND** A2.bA **ALARM-2 HYSTERESIS** A2.HY **ALARM-2 LOGIC** A2.L **ALARM-2 INHIBIT** A2.i h The Parameter description & settings are the same as that for Alarm-1.	

Table 5.2

Setting option (Upper Readout)	Alarm Type	Alarm Function
nonE	None	Disables Alarm.
P_Lo	Process low	The alarm is activated when the PV equals or falls below the 'Alarm Setpoint' value. The alarm is de-activated when the PV returns above the set value.
P_Hi	Process high	The alarm is activated when the PV equals or exceeds the 'Alarm Setpoint' value. The alarm is de-activated when the PV falls below the set value.
dE	Deviation Band	This alarm type is applied with respect to the control setpoint. The deviation limit can be set above (positive value) or below (negative value) the control setpoint. The alarm is activated when the PV deviation from the control setpoint exceeds the set deviation limit.
bAnd	Window Band	This alarm type is applied with respect to the control setpoint. The band is centered at the control setpoint, defining both positive and negative limits. The alarm is activated when the PV falls outside the band.
EOP	End of Profile	The alarm is activated for 10 seconds after the last segment of the profile is executed indicating the end of the current profile cycle.

ABSOLUTE AND RELATIVE ALARM

The Process Low and the Process High alarms are known as Absolute alarms as these have set values (Alarm Setpoint) that are independent of the control setpoint. On the other hand, the Deviation and the Window Band alarms are known as Relative alarms as these are always referenced to the control setpoint. This means that the absolute alarms may need re-setting as the control setpoint is altered. However, the relative alarms may not require re-setting if the desired deviation limits are the same regardless of the actual value of the control setpoint.

ALARM STATUS UNDER PV ERROR CONDITIONS

The alarm status under PV error conditions depend upon the type of the PV error and the alarm type, as described below :

- **Under-range**

  Since this error occurs when the PV falls below the minimum range specified for an input type, the alarm signals are generated by comparing the set alarm limits with the minimum range value. This means that the alarm gets activated if the set alarm type is either Process Low or Negative Deviation or Band.

- **Over-range**

  Since this error occurs when the PV exceeds the maximum range specified for an input type, the alarm signals are generated by comparing the set alarm limits with the maximum range value. This means that the alarm gets activated if the set alarm type is either Process High or Positive Deviation or Band.

- **Open (Input Sensor Open or Broken)**

  For thermocouple and RTD Pt100, the input sensor open error is treated as Over-range. However, for DC Linear inputs (mV/V/mA), the input sensor open error is treated as Under-range (as the measured PV under input open condition corresponds to the 0 level signal).

The Table 5.3 below summarizes the alarm status under various PV error conditions. The alarm ON status means the alarm is activated and OFF means the alarm is not activated.

Table 5.3

PV ERROR TYPE	ALARM TYPE	ALARM STATUS
Under-range **or** Open (DC Linear input)	Process Low	ON
	Process High	OFF
	Negative Deviation	ON
	Positive Deviation	OFF
	Band	ON
Over-range **or** Open (Thermocouple or RTD Pt100 input)	Process Low	OFF
	Process High	ON
	Negative Deviation	OFF
	Positive Deviation	ON
	Band	ON

Notes :

1. Available only if the Alarm type is Process-Low or Process-High.
2. Available only if the Alarm type is Deviation.
3. Available only if the Alarm type is Band.
4. Not available if Alarm type is End of Profile (EOP).
5. Default values are the factory set values. Also, all the parameters can be set to their factory set values by accessing page 99 and pressing ENTER key. The controller resets and restarts with factory set values.

Section 6
CONFIGURATION PARAMETERS

PAGE-12 parameter list allows the user to configure the controller to match with the available input sensor and the load drive. It also presents the parameters for conditioning the input sensor signal and to exercise the supervisory control over the operator level.

The Table 6.1 below lists the Input / Output parameters.

Table 6.1

Parameter Description	Settings (Default Value)
HAND (MANUAL) MODE ENABLE/DISABLE HAnd This parameter allows the user to enable (permit) or disable (restrict) the activation of the Hand mode operation from the Base display. This is a supervisory control parameter.	EnbL Enable dSbL Disable (Default : Disable)
QUICK ADJUSTMENT OF SETPOINT ENABLE/DISABLE SP This parameter allows the user to enable (permit) or disable (restrict) the adjustment of the control setpoint on the lower readout in MAIN display. This parameter facilitates supervisory control over the operator level.	EnbL Enable dSbL Disable (Default : Enable)
CONTROL OUTPUT (OP1) TYPE C_OP Select the output type in accordance with the hardware configuration for Output-1 (OP1).	Refer Table 6.2 (Default : Relay)
INPUT TYPE InPt Select Input type in accordance with the type of Thermocouple or RTD, sensor or transducer output connected for process value measurement. Ensure proper hardware jumper settings, if required.	Refer Table 6.3 (Default : Type K)
RESOLUTION FOR PV rSLn *(Not Available for Thermocouple Inputs)* Sets the process value indication resolution (decimal point). All the resolution based parameters (control setpoint, hysteresis, alarm setpoints etc.) then follow this resolution setting.	Refer Table 6.3 for the available max/min Ranges & Resolution for each input type. (Default : 1)
RANGE LOW FOR PV rLo Sets process value corresponding to minimum DC Linear signal input (e.g., 0V, 0mA, 4mA, etc.)	Same as above (Default : 0)

Parameter Description	Settings (Default Value)
PV RANGE HIGH r.Hi Sets process value corresponding to maximum DC Linear signal input (e.g., 5V, 10V, 20mA, etc.)	Refer Table 6.3 for the available max/min Ranges & Resolution for each input type. (Default : 1000)
SETPOINT LOW SPLo Sets minimum permissible control setpoint value.	Same as above (Default : -200)
SETPOINT HIGH SPHi Sets maximum permissible control setpoint value.	Same as above (Default : 1300)
OFFSET FOR PV OFSt This value is algebraically added to the measured PV to derive the final PV that is displayed and compared for alarm / control. Final PV = Measured PV + Offset	-1999 to 9999 (Default : 0)
DIGITAL FILTER FOR PV FiLt Sets the time constant, in seconds, for the low-pass digital filter applied to the measured PV. The filter helps smoothing/averaging the signal input and removing the undesired noise.	0.5 to 25.0 (Default : 1.0)

Control Output Type - Table6.2 shows below.

Table 6.2

Option	What it Means
rLY	Electromechanical Relay contacts
SSr	DC Voltage pulses for driving external Solid State Relay (SSR)
0-20	0 to 20 mA DC Current
4-20	4 to 20 mA DC Current

Sensor Input Type - Table6.3 shows below.

Table 6.3

Option	What it means	Range (Minimum to Maximum)	Resolution (Fixed or Settable)
tC_J	Type J Thermocouple	0 to +760ºC	Fixed 1ºC
tC_K	Type K Thermocouple	-200 to +13000ºC	
tC_t	Type T Thermocouple	-200 to +350ºC	
tC_r	Type R Thermocouple	0 to +1700ºC	
tC_S	Type S Thermocouple	0 to +1700ºC	
tC_b	Type B Thermocouple	+200 to +1700ºC	
tC_n	Type N Thermocouple	0 to +1300ºC	
rESu (Default type J)	Reserved for customer specific Thermocouple type not listed above. The type shall be specified in accordance with the ordered (optional on request) thermocouple type.		
rtd	3-wire, RTD Pt100	-199 to +600ºC	User Settable 1ºC or 0.1ºC
0-20	0 to 20mA DC Current	-1999 to +9999units	User Settable 1,0.1 or 0.01units
4-20	4 to 20mA DC Current		
0.050	0 to 50mV DC Voltage		
0.200	0 to 200mV DC Voltage		
1.25	0 to 1.25V DC Voltage		
5.0	0 to 5.0V DC Voltage		
10.0	0 to 10.0V DC Voltage		

Notes:

1. Not available if the controller is configured for heat-cool PID.
2. Available only if the input type is other than thermocouple. For thermocouples (J, K, T, R, S, B, N), the resolution is 1ºC fixed.
3. Applicable only if the input type is DC Linear (mV, V or mA).
4. Default values are the factory set values. Also, all the parameters can be set to their factory set values by accessing page 99 and pressing ENTER key. The controller resets and restarts with factory set values.

Section 7
UTILITY PARAMETERS

PAGE-13 presents the list of parameters that pertain to the controller's utility features. The utilities include Self-tune, start-up Overshoot Inhibit function and Digital Communication (RS485, 2-wire, half-duplex, serial).

The Self-tune and Overshoot Inhibit utilities are software modules that are supplied as standard features. The Digital Communication, however, is a firmware (software plus hardware) and thus requires optional hardware module to be fitted in the controller for its operation.

The Table 7.1 below lists the parameters required for the operations of the utility features.

Table 7.1

Parameter Description	Settings (Default Value)
SELF-TUNE COMMAND tUnE Set to 'Yes' to initiate a new tuning cycle or set to 'No' to abort a tuning operation in progress.	no No YES Yes (Default : No)
OVERSHOOT INHIBIT oS.i h Enabling this feature controls the PV rise or fall upon process start-up in order to reach the control setpoint with as minimum overshoot as possible.	EnbL Enable dSbL Disable (Default : Disable)
BAUD RATE bAUd Communication speed in 'Bits per Second'. Set the value to match with the host baud rate.	1200, 2400, 4800, 9600 (Default : 9600)
CONTROLLER ID NUMBER Id Unique numeric code assigned to the controller for identification by the host. Set the value as required by the host.	1 to 31 (Default : 1)
COMMUNICATION WRITE ENABLE CoM.E Setting to 'No' disallows the host to set or modify any parameter value. The value however can be read by the host.	no No YES Yes (Default : No)

Notes :
1. Applicable only if the Serial Communication module is fitted.
2. Default values are the factory set values. Also, all the parameters can be set to their factory set values by accessing page 99 and pressing ENTER key. The controller resets and restarts with factory set values.

Section 8

OP2 & OP3 FUNCTION PARAMETERS

PAGE-14 presents the list of parameters that allow the user configure the controller for

- Bidirectional Control (Heat - Cool Control)
- Retransmission (recorder) Output
- Assignment of OP2 or OP3 modules to Alarms
- Assignment of OP2 or OP3 modules to Profile Event Outputs.

The Table 8.1 below lists the parameters.

Table 8.1

Parameter Description	Settings (Default Value)
OUTPUT-2 FUNCTION SELECTION OP2F *(Applicable for OP2 hardware module, if fitted)* Select the function / feature to which the OP2 module is to be logically attached for activation.	ALrn Alarm CCon Cool control PFEu Profile Event (Default : Alarm)
OUTPUT-2 TYPE OP2t *(Available if OP2 function is Cool Control)* Select type for Output-2 (OP2) in accordance with the hardware module fitted and / or the jumper settings.	rLY Relay SSr SSR 0-20 0-20mA 4-20 4-20mA (Default : Relay)
OUTPUT-3 FUNCTION SELECTION OP3F *(Applicable for OP3 hardware module, if fitted)* Select the function / feature to which the OP3 module is to be logically attached for activation.	ALrn Alarm rEC Recorder PFEu Profile Event (Default : Alarm)
RECORDER OUTPUT TYPE rECo *(Available if OP3 function is recorder)* Select type for Output-3 (OP3) in accordance with the hardware module fitted.	0-20 0-20mA 4-20 4-20mA (Default : 0-20mA)
RECORDER LOW rECL *(Available if OP3 function is recorder)* Set the minimum parameter value (SP or PV) that shall correspond to the minimum recorder output signal level (0mA or 4 mA or 0V).	Range Low to Range High (Default : 0)

Parameter Description	Settings (Default Value)
RECORDER HIGH r EC.H *(Available if OP3 function is recorder)* Set the maximum parameter value (SP or PV) that shall correspond to the maximum recorder output signal level (20mA or 10 V or 5V).	Range Low to Range High (Default : 0)

Notes :
1. Not available if the output-2 function is selected as Alarm or Profile Event Output.
2. Not available if the output-3 function is selected as Alarm or Profile Event Output.
3. Default values are the factory set values. Also, all the parameters can be set to their factory set values by accessing page 99 and pressing ENTER key. The controller resets and restarts with factory set values.

Section 9
PROFILE : SEGMENT PARAMETERS

The profile segment parameters are contained in PAGE-15. These parameters allow the user to build profiles SET by SET. As detailed in Section 13 of this manual, each SET of a profile comprises a ramp segment and a soak segment. The configuration of ramp and soak segments required 3 parameters, viz., the Ramp Rate, the Target Setpoint and the Soak Time. In PAGE-15, the user can first select the desired Profile Number and then set the parameter values to build the profile.

(Refer Section 13 : Setpoint Profiles & Profile-Programs of this manual for more details).

The Table 9.1 below lists the Profile Segment parameters.

Table 9.1

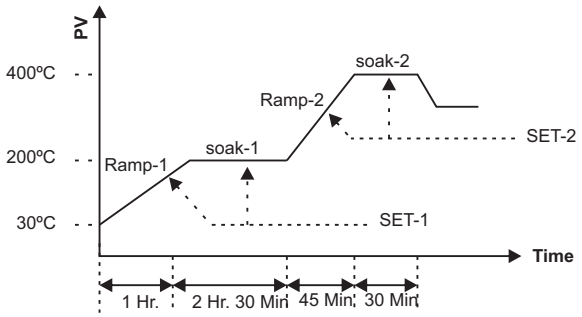
Parameter Description	Settings (Default Value)
SELECT PROFILE NUMBER PrFn This parameter allows the user to select the desired profile that is to be built or altered. The value can be set from 1 to the maximum numbers of profiles pre-configured in PAGE-18 parameter list.	1 to Max. configured
SELECT SET NUMBER SEt.n Each profile is made up of a series of SETS. These SETS are numbered from 1 to maximum 8 (the exact numbers depend upon the pre-configuration in PAGE-18 parameter list). Each SET defines a ramp segment followed by a soak segment. That is, SET-1 defines ramp segment-1 followed by soak segment-1, SET-2 defines ramp segment-2 followed by soak segment-2, and so on. The user can select the desired SET number and then set the parameters that define the ramp and soak segments for the selected SET number. Upon setting the parameters for the last SET of the selected profile, the controller allows selecting the next profile number.	1 to Max. configured
RAMP RATE rAtE This parameter sets the rate at which the setpoint ramps to the set value for the Target Setpoint. The ramp rate value is set as “Units per Minute”. For e.g., a ramp rate of 1.25, for temperature input, means the setpoint shall ramp to the target setpoint at a rate of 1.25ºC per Minute. The setting resolution of this parameter is independent of the displayed PV resolution. If set to 0, the ramp setpoint immediately equals the Target Setpoint. In many cases, rather than ramp rate, the time duration from one Target Setpoint (say, TSP1) to the next Target Setpoint (say, TSP2) is known. The user is then required to compute the ramp rate as: $\text{Ramp Rate} = \frac{\text{Target Setpoint 2 - Target Setpoint 1}}{\text{Time Duration in Minute}}$ Use the computed value (correct to 2 places of decimal) as the parameter value.	0.00 to 99.99 (Default : 0.00)
TARGET SETPOINT tSP Set the Target (End) value for the selected profile segment number.	Range Low to Range High (Default : 0)

Parameter Description	Settings (Default Value)
SOAK TIME SOAP This parameter sets the time duration in Minutes for which the setpoint is maintained at the Target Setpoint. This segment is skipped if set to 0, that is, the setpoint immediately starts ramping to the next Target Setpoint.	0 to 9999 (Default : 0)

AN EXAMPLE PROFILE

The profile building can be best explained using an example. Consider a profile comprising of 2 ramps and 2 soak segments (2 SETS) is to be built. The desired Target Setpoint, ramping duration and soak durations are as illustrated in the following Figure 9.1. It is assumed that the profile start command is issued at the process start-up condition of ambient temperature, say,30ºC.

Figure 9.1



The profile-building requires parameter settings for 2 SETS (SET-1 and SET-2). Now, as stated earlier, each SET requires 3 parameters to be set that define the ramp segment and the soak segment. For the above example profile, the parameter settings should be as under.

SET - 1

(a) Ramp Rate
It is required to raise temperature from 30°C (approximate ambient) to 200 °C in 1 hour (60 Minutes). The ramp rate, thus, should be computed and set as under.
Ramp Rate = (200°C - 30°C) / (60 Min) = (170°C) / (60 Min) = 2.83°C/Min

(b) Target Setpoint
Since the temperature from start-up is to raise to 200°C, set this parameter as 200.

(c) Soak Time
The temperature is to be maintained at the Target Setpoint of 200°C for 2 Hours and 30 Minutes. Thus set this parameter in Minutes as 150.

SET - 2

(a) Ramp Rate
It is required to raise temperature from 200°C to 400°C in 45 Minutes. The ramp rate, thus, should be computed and set as under:
Ramp Rate = (400°C - 200°C) / (45 Min) = (200°C) / (45 Min) = 4.44°C/Min

(b) Target Setpoint
Since the temperature is to raise to 400°C, set this parameter as 400.

(c) Soak Time
The temperature is to be maintained at the Target Setpoint of 400°C for 30 Minutes. Thus set this parameter in Minutes as 30.

Section 10
PROFILE : BAND / EVENT PARAMETERS

The PAGE-16 parameter list allows :

- Setting up ramp and soak Holdback Bands for each profile.
- Programming Event Outputs (if fitted) for every ramp and soak segment of each profile.

(Refer Section 13 : Setpoint Profiles & Profile-Programs for more details).

The Table 10.1 below lists the Profile Band/Event parameters.

Table 10.1

Parameter Description	Settings (Default Value)
SELECT PROFILE NUMBER PrFn This parameter allows the user to first select the desired profile for setting / altering the ramp band, soak band and event outputs. The value can be set from 1 to the maximum numbers of profiles pre-configured in PAGE-18 parameter list.	1 to Max. configured
RAMP HOLD BAND rbnd This parameter sets the allowable deviation between the PV and the ramping setpoint while running a ramp segment. Should the PV fall outside this band, the setpoint ramping holds until the PV re-enters the band. This parameter can be used to ensure that the PV follows the set ramp rate within allowable limits as far as possible. Set this value to 0 if ramp hold back function is not required. Note that, though the ramp band value is independently settable for each profile; the band is not independently settable for each ramp segment of the profile.	0 to 250 (Default : 0)
SOAK HOLD BAND Sbnd This parameter sets the allowable deviation of PV from the Target Setpoint while executing a soak segment. Should the PV fall outside this band, the controller suspends execution of the soak time until the PV enters the band again. Set this value to 0 if soak hold back function is not required. Note that, though the soak band value is independently settable for each profile; the band is not independently settable for each soak segment of the profile.	0 to 250 (Default : 0)
SELECT SEGMENT NUMBER SEGn This parameter allows selecting a ramp segment (segments with ODD numbers like 1, 3, 5 etc.) or a soak segment (segments with EVEN numbers like 2, 4, 6 etc.) of the selected profile and is available only if at least one of OP-2 or OP-3 is programmed as profile Event Output. The controller then presents parameters for Event Output for the selected segment. Upon setting the parameters for the last segment of the selected profile, the controller allows selecting the next profile number.	1 to twice the Max. configured Sets

Parameter Description	Settings (Default Value)
OUTPUT-2 EVENT TIME  This parameter defines the time duration in Minutes from the beginning of the execution of the selected segment. The OP-2 status set by the parameter 'Output 2 Event Status' is maintained for the time period set by this parameter value. Once the set time period is elapsed, the status is reversed.	0 to 9999 (Default : 0)
OUTPUT-2 EVENT STATUS  This parameter defines the ON or OFF status for Output-2 relay / SSR. This status is maintained for the time period set by the parameter 'Output 2 Event Time'. The status is reversed for the balance time of the selected segment.	ON OFF (Default : ON)
OUTPUT-3 EVENT TIME  This parameter is same as 'Output 2 Event Time' parameter but applied to OP-3 relay/SSR module.	0 to 9999 (Default : 0)
OUTPUT-3 EVENT STATUS  This parameter is same as 'Output 2 Event Status' parameter but applied to OP-3 relay/SSR module.	ON OFF (Default : ON)

EVENT OUTPUT EXAMPLE

The Event Output function provided in neuro 105 can be best explained using an example. Refer Figure 10.1 that illustrates the application example. The output relay OP-3 is to be used as an Event Output. The requirements and the corresponding settings are as under.

1. The output should switch ON after 10 Minutes from the time the profile is started. That is during the total execution time of 45 Minutes for Segment-1 (ramp-1), the output should remain OFF for first 10 Minutes. At the end of 10 Minutes, the output should switch ON.

   Set the parameters for SEGMENT-1 as below:

   - OP 3 Event Time : 10 Minutes
   - OP 3 Event Status : OFF

2. The output should remain ON throughout the soak -1 (segment -2) duration of 70 Minutes.

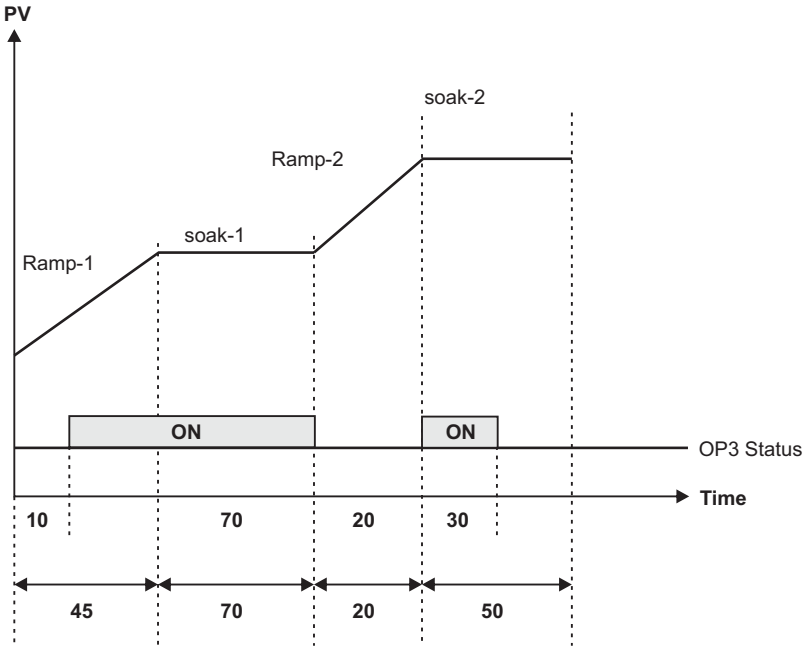
   Set the parameters for SEGMENT-2 as below:

   - OP 3 Event Time : 70 Minutes (or 0 Minutes)
   - OP 3 Event Status : ON (or OFF)

   The same result can also be achieved by setting the parameters as under:

   - OP 3 Event Time : 0 Minutes
   - OP 3 Event Status : OFF

Figure 10.1



3. The output should remain OFF throughout the ramp-2 (segment-3) duration of 20 Minutes.

   Set the parameters for SEGMENT - 3 as below :

   - OP 3 Event Time : 20 Minutes
   - OP 3 Event Status : OFF

   The same result can also be achieved by setting the parameters as under :

   - OP 3 Event Time : 0 Minutes
   - OP 3 Event Status : ON

4. The output should switch ON at the beginning of soak-2 (segment-4) and switch OFF after 30 Minutes. That is during the total execution time of 50 Minutes for Segment-4 (soak-2), the output should remain ON for the first 30 Minutes. At the end of 30 Minutes, the output should switch OFF.

   Set the parameters for SEGMENT-4 as below :

   - OP 3 Event Time : 30 Minutes
   - OP 3 Event Status : ON

Notes :

1. Not available if none of output - 2 function or output - 3 function is selected as Profile Event Output.
2. Available only if the output-2 function is selected as Profile Event Output.
3. Available only if the output-3 function is selected as Profile Event Output.
4. Default value are the factory set values. Also, all the parameters can be set their factory set values by accessing page 99 and pressing ENTER key. The controller resets and restarts with factory set values.

Section 11
BUILDING PROFILE-PROGRAMS

PAGE-17 allows the user to build Profile-Programs by Sequentially Joining (linking) multiple profiles. Also, the numbers of repeat cycles can be set.

Note that the PAGE-17 parameter values can not be altered while the controller is executing a profile-program.

(Refer Section 13 : Setpoint Profiles & Profile-Programs of this manual for more details on profiles and profile-programs).

HOW TO BUILD A PROFILE-PROGRAM

Follow the steps outlined below for building (setting up) a profile-program.

1. Select the desired Program Number (using UP/DOWN key) on the upper readout while the lower readout displays (PrG.n) Press ENTER key.
2. The lower readout now displays the selected program number and the element number in the format (PP.EE), where PP denotes the selected Program Number and EE denotes the Element Number. The value for EE begins as 01 indicating the first element. The desired Profile Number can be selected on the upper readout (using UP/DOWN key) and entered using ENTER key. The selected Profile Number then fits as the Element Number shown on the lower readout.

   With each entry of the Profile Number as element, the value for EE increments by 1, showing the next element number for the selected Program Number. The maximum value for EE is 30.
3. The element entries can be terminated by entering the Profile Number as 0 on the upper readout. Or, the element entries automatically terminate upon pressing the ENTER key for the 30th element.
4. Upon terminating the element entries, the lower readout shows CYCL (Cycle Counter). The upper readout can be adjusted to any desired value from 0 to 99. The value 0 (zero) signifies that the program is to be looped indefinitely until aborted by the user.

EXAMPLE PROGRAM

Consider, a profile-Program is to be built using the profile numbers 2, 1, 2, 4 (in the same sequence) and the same is to be cycled (looped) 5 times. The program itself is to be stored as Program Number 3. Proceed as under.

1. From the MAIN display, enter PAGE-17. The lower readout shows (PrG.n). Adjust upper display to 3 (Program Number) using UP/DOWN key and press ENTER key.
2. The lower readout now shows 3.01 (Program Number 3, Element Number 1). Adjust upper readout to 2 (the profile number as 1st element) using UP/DOWN key and then press ENTER key.
3. The lower readout now shows 3.02 (Program Number 3, Element Number 2). Adjust upper readout to 1 (the profile number as 2nd element) and then press ENTER key.
4. The lower readout now shows 3.03 (Program Number 3, Element Number 3). Adjust upper readout to 2 (the profile number as 3rd element) and then press ENTER key.
5. The lower readout now shows 3.04 (Program Number 3, Element Number 4). Adjust upper readout to 4 (the profile number as 4th element) and then press ENTER key.
6. The lower readout now shows 3.05 (Program Number 3, Element Number 5). Adjust upper readout to 0 (as entry terminator) and then press ENTER key.
7. The lower readout shoes CYCL (Cycle Counter). Adjust upper readout to 5 (since the program is to be looped 5 times) and then press ENTER key.
8. The lower readout now shows PrG.n for the next profile - program to be set-up. Enter the Program Number if required, else press PAGE key to revert to MAIN display.

Section 12

PROFILE : CONFIGURATION PARAMETERS

The Profile and Profile-Programs can be configured using parameters presented in PAGE-18 Configuration involves setting-up the controller for the desired numbers of profiles, the numbers of sets (ramp + soak segment) per profile, the numbers of programs to be built, the output status at the end of profile-program,etc.

(Refer Section 13 : Setpoint Profile & Profile-Programs of this manual for more details on profiles and profile-programs). The Table 12.1 below lists the Profile Configuration parameters.

Table 12.1

Parameter Description	Settings (Default Value)
PROFILE ENABLE / DISABLE PrOF The user can activate (enable) or de-activate (disable) controller's operation in profile mode by setting this parameter value to EnbL or dSbL, respectively. If disabled, the controller behaves as a single loop controller and the PAGE-0 parameters (used for operating a profile-program, like start/abort program, skip segment, etc.) are suppressed.	EnbL Enable dSbL Disable (Default : Enable)
OUTPUT(S) OFF OPOF Set to 'Yes' if after the end of profile, all the control outputs are to be *forced Off* till the issuance of next profile Start command.	no No YES Yes (Default : No)
NUMBERS OF PROFILES nPrF The controller is supplied with a maximum of 2 Profiles of 16 segments (8 Ramp + 8 Soak) each. The actual numbers of profiles, however, vary from application to application. This parameter allows the user to select the numbers of profiles required for a specific application. This facilitates suppressing the relevant parameters for the unused profiles. This parameter value can not be altered while the controller is executing a profile-program.	1 to 2
SELECT PROFILE NUMBER PrFn Refer parameter 'Numbers of Sets for the Profile' below	1 to Max. Configured

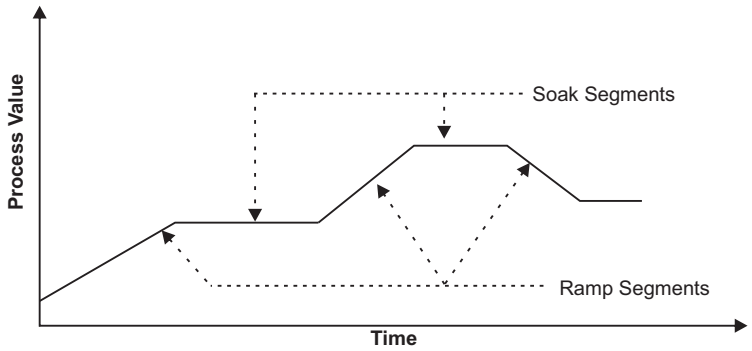
Parameter Description	Settings (Default Value)
NUMBERS OF SETS FOR THE SELECTED PROFILE n.SEt This parameter in conjunction with the parameter 'Select Profile Number' allows the user to configure each profile for the numbers of ramp + soak sets. A maximum of 8 sets (8 Ramp + 8 Soak) can be set for each profile. First select the profile number and then set the value for this parameter. These two parameters rotate in a loop until the numbers of sets for the last of the set numbers of profile are entered. Not necessarily all profiles need all 16 segments and thus this parameter facilitates the user to define each profile for only as many numbers of segments as required for the application and skip the reset for settings. The above two parameter values can not be altered while the controller is executing a profile-program.	1 to 8
NUMBERS OF PROGRAMS n.Pr-G The controller allows the user to build various profile-programs comprising one or several of the profiles in a program. Depending upon the applications, the user can select up to 16 such different programs and store the same in memory. This parameter value can not be altered while the controller is executing a profile-program.	1 to 16
RESET PROGRAM SET-UP r5t.P This parameter facilitates user reset by setting the parameter to YES, each of the previously built programs to their default states. Upon resetting, the controller builds 16 programs of one profile each in the fashion: Program-1 comprising Profile-1, Program-2 comprising Profile-2 and so on. This is equivalent to running (executing) each profile as an independent program. This parameter is not available while the controller is executing a profile-program.	no No YES Yes (Default : No)

Section 13
SETPOINT PROFILES & PROFILE-PROGRAMS

SETPOINT PROFILE

There are a host of applications that require the PV to follow a series of straight-line segments, called PROFILE. A typical profile is illustrated in the following Figure 13.1.

Figure 13.1



PROFILE SEGMENTS

The straight-line segments that form a profile are called Profile Segments. In the figure above it can be seen that the profile segment either has a slope (increases or decreases linearly) or is flat (remain steady) with respect to time. The segment that has a slope is called RAMP and the flat segment is called SOAK. Each profile segment is nothing but a 'series of setpoint' that the controller generates.

RAMP RATE & TARGET SETPOINT

Each ramp segment has an associated slope, called the RAMP RATE, and is defined as the ratio of change in PV per unit time. The end point of a ramp segment is specified in terms of the PV and is called TARGET SETPOINT. That is, the ramp segment ramps up to the Target Setpoint with the specified Ramp Rate. The ramping could be positive or negative and is determined by the relative position of the Target Setpoint with respect to the start setpoint.

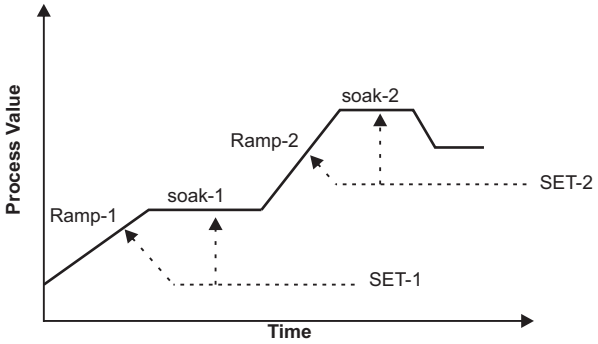
SOAK TIME

Each soak segment has an associated time duration for which the setpoint holds or resets at the Target Setpoint and is called SOAK TIME. The next ramp segment begins at the end of the Soak Time.

SET

A pair of ramp and soak segment is defined as a SET. Thus, a Profile can be thought of as made up of a series of SETS. The SETS are assigned sequential numbers starting from 1. The associated ramp and soak segments are then assigned the same number as the number assigned to the SET. That is, SET-1 comprises Ramp-1 & Soak-1, SET-2 comprises Ramp-2 & Soak-2, and so on. The situation is illustrated in the following Figure 13.2.

Figure 13.2

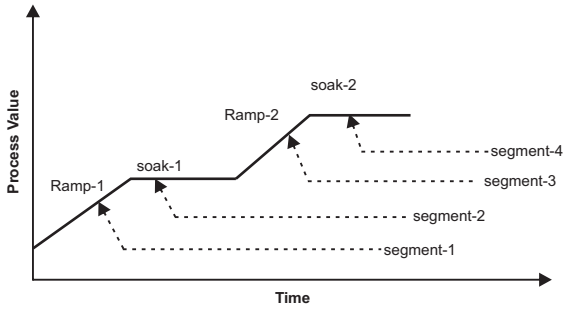


It is abvious from the above definitions that it requires RAMP RATE, TARGET SETPOINT and SOAK TIME to define a specific SET.

SEGMENT NUMBERS

As defined above a profile is made up of series of sets and each set comprises a ramp and a soak segment. That is the total numbers of segments in a profile are twice the numbers of sets. These segments are also numbered sequentially with segment number 1 assigned to Ramp-1, segment number 2 assigned to Soak-1, segment number 3 assigned to Ramp-2, and so on. Refer Figure 13.3 below for illustration.

Figure 13.3



PROFILE - PROGRAM

A profile-program is different from a profile.

As defined earlier, a Profile is built by sequentially joining (linking) ramp and soak segments. In a profile, the end of execution of a segment is followed by the execution of the next segment until the last segment in the profile is executed.

The Profile-Program, on the other hand, is built by sequentially joining (linking) the profiles. In a profile-program, the end of execution of an entire Profile is followed by the execution of the next profile until the last profile in the program is executed.

Note that the neuro 105 controller executes profile-programs rather than stand-alone profiles. This feature allows the user to make the optimum use of the total number of profile segments provided in the controller. Although a single profile accommodates a maximum of 16 segments, the profile-program feature allows the user to run far more than 16 segments (maximum 256 different segments) as a single profile.

How to Build Profiles & Profile-Programs

To build a profile-program requires two simple steps :

1. Build profiles by setting ramp rate, target setpoint and soak time for each set of the profile using PAGE-15 parameter list.

2. Join (link) profiles, in the desired order, using PAGE-17 parameter list.

The neuro 150 controller provides as many as 16 different profiles each of maximum 8 sets (16 segments, 8 Ramp + 8 Soak). The available 16 profiles are numbered from 1 to 16. Likewise, the available sets per profile are numbered from 1 to 8. The exact numbers of profiles and the numbers of sets for individual profile can be pre-configured in PAGE-18 parameter list. Pre-configuring the numbers of profiles and the numbers of sets per profile has two-fold benefits; it avoids ambiguity by suppressing all the relevant parameters for unused profiles/sets and it prevents any inadvertent mistakes while building profiles or profile-programs.

The PAGE-15 parameters allow the user to build all the selected numbers of profiles by selecting the desired profile number at a time. Upon entering the desired profile number, the user can set the parameters for each of the selected numbers of sets by selecting the desired set number at a time. The procedure is outlined below (for definitions of each parameter, refer Section 9 - Profile: Segment Parameters).

1. Enter Page 15 from the MAIN display mode.

2. Set the desired Profile number on the upper readout while the lower readout shows PrFL. The available numbers are from 1

to maximum configured in PAGE-18 parameter list.

3. Now select the Set number on the upper readout while the lower readout shows Set. The available numbers are from 1 to maximum configured for the selected number of profile in PAGE-18 parameter list.

The parameters Ramp Rate, Target Set point and Soak Time for the selected set number can now be set in succession :

4. Repeat step 3 for any other set numbers until all the desired sets are defined. Upon pressing the ENTER key for the Soak Time parameter for the last set number, the controller allows selecting the next desired profile number.

5. Repeat steps 1 to 4 for any other desired profile numbers until all the desired profiles have been built.

Note that selecting the Profile Numbers and the Set Numbers rather than presenting the same sequentially, provide quick access to any specific set of a specific program for altering the parameter values. The Set Number automatically increments to the next number upon setting the parameter values for the previous set, thus, avoiding the need to memorize the set number sequence.

Once the profiles are built, all that is required to build profile-programs is to join (link) the profiles in the desired order. A profile-program may be built using 1 to 30 different profiles. Each profile of a program is referred as ELEMENT of the program. These elements are numbered from 1 to 30. That is, a program comprises of 1 to max. 30 sequentially joined (linked) elements. While a program is run (executed), the controller first runs Element Number 1 followed by Element number 2 and so on until the last element in the program is executed. Note that there is no restriction, Whatsoever, on which Profile Number will fit in which Element Number and also repetitive use of any profile numbers is also permitted. The neuro 105 controller allows a maximum of 16 different programs to be built and stored in the memory. Like profiles, the profile-programs are also numbered from 1 to 16 and the exact numbers of different programs for an application can be pre-configured in PAGE-18 parameter list.

The PAGE-17 parameters allow the user to build all the selected numbers of profile-programs by selecting the desired program number at a time. Upon entering the desired program number, the user can set the desired number of profile for each element of the program. A program can be terminated at any element number by entering the profile number as 0. That is, if a program required only 3 elements, the profile number for the 4th element should be entered as 0. For detailed set-up procedure for building profile-programs refer Section 11 - PROFILE : “PROFILE-PROGRAM” PARAMETERS).

Application Example

Consider the following example for a better explanation of the Profile-Program concept.

An application requires 6 profile-programs using 7 profiles. The profile requirements are as under :

Profile-1 : 6 sets (12 segments, 6 Ramp + 6 Soak)
Profile-2 : 5 sets (10 segments, 5 Ramp + 5 Soak)
Profile-3 : 2 sets (4 segments, 2 Ramp + 2 Soak)
Profile-4 : 2 sets (4 segments, 2 Ramp + 2 Soak)
Profile-5 : 3 sets (6 segments, 3 Ramp + 3 Soak)
Profile-6 : 3 sets (6 segments, 3 Ramp + 3 Soak)
Profile-7 : 4 sets (8 segments, 4 Ramp + 4 Soak)

The Program requirements are as under :

Program-1
This program is required to run Profile-2 preceded by Profile-3. Build the program as under :

Element Number	Profile Number
1	3
2	2
3	0

Program-2
This program is required to run Profile-2 preceded by Profile-4. Build the program as under :

Element Number	Profile Number
1	4
2	2
3	0

Program-3
This program is required to run Profile-2 followed by Profile-5. Build the program as under :

Element Number	Profile Number
1	2
2	5
3	0

Program-4
This program is required to run Profile-2 followed by Profile-6. Build the program as under :

Element Number	Profile Number
1	2
2	6
3	0

Program-5
This program is required to run Profile-1as stand-alone. Build the program as under :

Element Number	Profile Number
1	1
2	0

Program-6
This program is required to run Profile-1followed by Profile-7 and then Profile-1 again. Build the program as under :

Element Number	Profile Number
1	1
2	7
3	1
4	0

Stand-alone Profiles

It is important to notice that even if it is desired to run any Profile as stand-alone, it has to be programmed as an element of the program. Such programs shall, obviously, contain only two elements : 1st element for the desired Profile Number to be run as stand-alone and the 2nd element as terminator (Profile Number 0).

The neuro 105 controller provided an easy way of initializing all selected profiles as stand-alone through parameter rSt.P (Reset Program Set-up) in PAGE-18. When applied, the controller clears all the previous program set-ups and assigns each profile number as a stand-alone element to the corresponding program number. That is, program-1 is set-up to run profile-1 as the only element, program-2 is set-up run profile-2 as the only element, and so on.

PROGRAM CYCLES

Many applications require that a Profile-Program be executed multiple times in a cyclic manner. Cycling a program means re-running a program from its first element after the completion of the last element. For this purpose, the controller provides an independent Cycle Counter for each program in the form of parameter CYCL (Cycle) in PAGE-17. This parameter values is settable from 0 (indefinite loop, that is, the program keeps re-running until manually aborted by the user) to 99. This parameter value must be set to 1 if cycling is not required.

RUNNING (EXECUTING) A PROFILE-PROGRAM

For running any profile-programs, the Profile mode must be enabled in PAGE-18. Only upon enabling the Profile mode, the operating commands are presented in PAGE-0.

(Also refer Section 2 : BASIC OPERATION for usage of Operating Commands).

The available operating commands in PAGE-0 depend upon whether the controller is running a program or it has completed running a program. If the controller is not already running a program, a new program can be started by first selecting the

desired program number and then issuing the start command.

Immediately upon issuing the start command, the controller starts executing the program with its first element (as started earlier, each element of a program is a profile number). The start of execution of a new program or the resumption of a program after power-failure follows what is called as SERVO-START. That is, the program begins with the first measured PV as the beginning point of a ramp segment.

The profile is executed in a fixed sequence : ramp-1, soak-1, ramp-2, soak-2, and so on until the last soak is executed. The completion of the first element (profile) is immediately followed by the 2nd element if it is not terminating 0. This sequence of execution is continued until a terminating element is encountered or the last (30th) element is executed. This further execution (re-run) of the program depends upon the value for the parameter 'Cycle Counter'.

Once the controller starts executing a program, the available operating commands in PAGE-0 are : HOLD, ADVANCE and ABORT. Note that the commands for starting a new program are suppressed since the controller is already executing a program.

The HOLD command allows the user to force / release a running program into / from a hold state. If forced in hold, the execution of the current ramp or soak segment is suspended (refer HOLDBACK feature included later in this section) until the hold state is released.

The ADVANCE command allows the user to immediately terminate the current ramp or soak segment that the controller is executing and start execution of the next segment.

The ABORT command allows the user to immediately terminate the program that the controller is executing. This has the same effect of completion of a program.

PROFILE / PROGRAM STATUS INDICATIONS

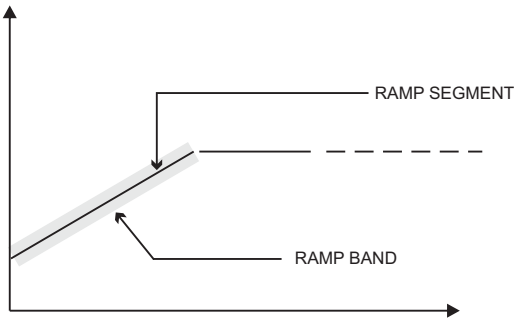
While the controller is running a program, various profile/program statuses are available on the readouts and indicators. Refer Section 2 : BASIC OPERATION for details.

HOLD BACK

The neuro 105 controller provides a feature called the Holdback. While a ramp or a soak segment is being executed, the controller can be forced to enter a HOLD state following the failure to meet certain user-specified conditions. During hold state, depending upon the segment type, ramp or soak, the setpoint generator module suspends setpoint ramping or the timer module stops counting the time pulses, respectively. The setpoint generator and the timer modules automatically resume their respective operations upon removal of the conditions that caused the holdback.

During the execution of the ramp segment, due to various reasons (initial inertia of the process, insufficient load capacity at higher setpoint values to co-op with the set ramp rate, etc.), the PV may not respect the ramping setpoint as closely as desired. Under such conditions, it may be desired to put the setpoint generator in holdback should the PV deviate from the current ramp setpoint value beyond acceptable limits. That is, a band is required to be generated around the ramp segment that will force the setpoint generator to holdback if the PV falls outside this band, as depicted in the Figure 13.4 below.

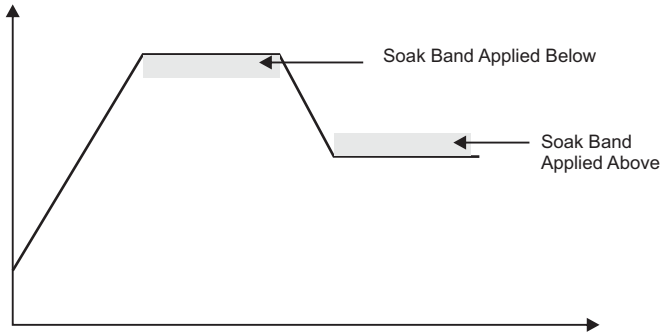
Figure 13.4



The neuro 105 controller allows specifying this band by setting the value of the parameter r.bnd (Ramp Band) in PAGE-16. Note that this parameter value is settable independently for each profile and is applied to all the ramp segments of the profile. That is, each profile can have an independent ramp band that is applied to all its ramp segments. Whenever, the absolute difference between the ramping setpoint and the measured PV exceeds this band value, the controller stops ramping of the setpoint until the PV enters the band. This allows the PV a chance to catch-up to the ramp setpoint.

During the execution of the soak segment, it may be desired that the soaking time should be counted only while the measured PV is within a specified limit, either below or above the Target Setpoint, called the SOAK BAND. That is, whenever the measured PV falls outside soak band, the timer module stops counting time pulses. Note that, whereas the ramp band is centered around the ramp segment; the soak band is applied only above or below the Target Setpoint. If the Target Setpoint is attained following a positive (rising) ramp, the soak band is applied below the Target Setpoint. If, however, the Target Setpoint is attained following a negative (falling) ramp, the soak band is applied above the Target Setpoint. The two cases are depicted in the Figure 13.5 below.

Figure 13.5



The neuro 105 allows specifying this band by setting the value of the parameter S.bnd (Soak Band) in PAGE-16. Note that, like ramp band, this parameter value too is settable independently for each profile and is applied to all the soak segments of the profile. That is, each profile can have an independent soak band that is applied to all its soak segments. One typical application of the soak band is implementing guaranteed soak, that is, to start counting the time pulses only when the measured PV enters the set band limit and keep counting as long as it dose not fall outside the limit. Besides guaranteed soak, it is also useful in many heat treatment applications to ensure that the soak timer dose not start until the PV reaches the Target Setpoint within the band limit.

RELATIVE ALARMS DURING A PROFILE

As already mentioned (in section 5: Alarm parameters) that the Deviation and Window band alarms are the relative alarms. While Profile is running, these alarms are relative to the Ramping and Target Setpoints.

Deviation Alarm

As already mentioned, this alarm sets the upper or lower deviation limit with the respective setpoint. In Profile mode, while RAMP, the Deviation Alarm is application for Ramping Setpoint and while SOAK, the Deviation Alarm is applicable for Target Setpoint.

For example; if the set value for Deviation Band is 3ºC, then, during RAMP, the alarm activates whenever the measured PV exceeds the Ramping Setpoint by 3ºC or more while following the ramping setpoints and during SOAK, the alarm activates whenever the measured PV exceeds the Target Setpoint by 3ºC or more while maintaining the PV at Target Setpoint.

Similarly, if the set value is - 3ºC, then, during RAMP, the alarm activates whenever the measured PV is less than the Ramping Setpoint by 3ºC or more while following the ramping setpoints and during SOAK, the alarm activates whenever the measured PV falls below the Target Setpoint by 3ºC or more while maintaining the PV at Target Setpoint.

Window Alarm

As already mentioned, this alarm sets a symmetrical band around the respective setpoint. It defines both upper and lower deviation limits. In Profie mode, while RAMP, the Window Alarm is applicable for Ramping Setpoint and while SOAK, the Window Alarm is applicable for Target Setpoint.

For example; band value of 3ºC sets a +/- 3ºC band symmetrical to Ramping Setpoint and Target Setpoint. That is, during RAMP, the alarm is activated if the PV deviation from the Ramping Setpoint is greater than or equal to 3ºC in either direction while following the ramping setpoint and during SOAK, the alarm is activated if the PV deviation from the Target Setpoint is greater than or equal to 3ºC in either direction while maintaining the PV at Target Setpoint.

Note :

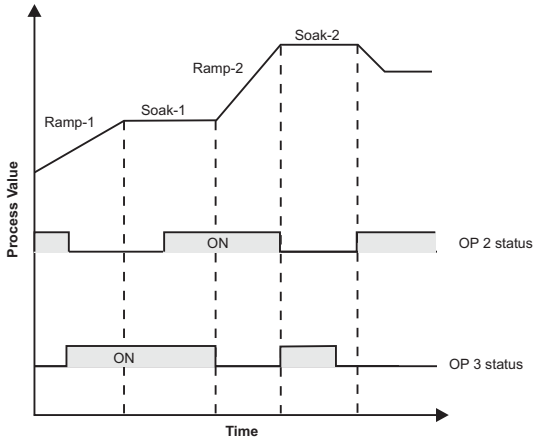
1. The Deviation and Window Alarms are applicable only when they are selected for the Alarm type and the Alarm activation depends on the respective band setting in PAGE-11 (Alarm Parameters).
2. The Deviation and Window Alarms have no relationship with the HOLD BACK band.

EVENT OUTPUTS

An Event Output is an ON-OFF digital output signal in the form of potential-free relay changeover contact or SSR drive pulse that can be independently programmed for each segment of a profile. The Relay / SSR drive output modules OP2 and OP3 (if fitted) can be configured to operate as Profile Event outputs. If configured as Event output, each of OP2 and OP3 can be programmed to remain ON (or OFF) for a pre-settable time from the beginning of a segment and OFF (or ON) for the balance time. This ON or OFF duration is independently programmable for each segment of every profile. Refer Figure 13.6 for illustration of event output.

The 2 parameters required to program the events are : Time Period (in Minutes) and Output Status (ON or OFF). The programmed ON or OFF status defines the output status for the set time period : For the balance time of the segment the output status is reverse of the programmed status. For example, If the set time period is 30 Minutes and the set status is OFF for a ramp segment duration of 80 Minutes, the output remains OFF for 30 Minutes from the beginning of the segment execution and ON for the balance 50 Minutes.

Figure 13.6



POWER-FAILURE RECOVERY

The resumption of the execution of a ramp or soak profile segment upon restoration of power after a failure depends on the segment type, that is, ramp or soak.

Ramp Segment

If a ramp segment was in progress prior to power-failure, the program resumes with the execution of the same ramp segment. The ramping of the setpoint begins with the power-on measured PV (servo-start).

Soak Segment

If a soak segment was in progress prior to power-failure, the program resumes with ramping the measured PV (servo-start) to the target setpoint with the corresponding ramp rate (for e.g., Ramp Rate -1 for Target Setpoint -1) and then the balance soak time is executed. The controller stores in its non-volatile memory, the soak time that was already elapsed prior to the power-failure.

STATE OF CONTROLLER AFTER THE END OF THE PROFILE-PROGRAM

What the controller shall do after the end of a profile-program depends upon the setting of the parameter “output off” (OP.OF) available in PAGE-18.

If the parameter is set to “YES”, the controller keeps the control output(s) Off (0% power) as soon as the execution of running program ends and does so until a new program is initiated or the profile utility is disabled.

If, however, the parameter is set to “NO”, the controller begins the control loop with respect to the control setpoint. This feature, along with the profile parameters, allows the user to freely configure the controller’s operation that best suits his application.

CHANGING PROFILE PARAMETER VALUES WHILE RUNNING A PROGRAM

There are certain profile/program related parameters that can not be altered / modified while the controller is executing a program. These parameters are listed below.

- Pre-configuration of Numbers of Profiles (PAGE-18)
- Pre-configuration of Numbers of Sets (Ramp+Soak) per profile (PAGE-18)
- Pre-configuration of Numbers of Profile-Programs (PAGE-18)
- Building Profile-Programs by joining (linking) profile numbers (PAGE-17)
- Repeat Cycle Counter (PAGE-17)

The user can, however, alter the values for ramp rate, target setpoint and soak time of any set of any profile. The effects of altering these segment values while running a program depends upon whether the pertaining segment is already executed, yet to be executed or in progress at the time of alterations. The effects are as under.

1. If the parameter values pertaining to segments that are already executed are altered, there is no immediate effect. The altered values are effective only when the segments are executes next time.
2. If the parameter values pertaining to segments that are yet to be executed are altered, the altered values become effective from the current execution of the program. That is, the segments will be executed with the altered values.
3. If a ramp segment is in progress and its ramp rate is altered it will be immediately effective. That is, the balance segment will be executed with the altered ramp rate.

   If the target setpoint of the running ramp segment is altered, the ramp set point starts heading to the altered target setpoint.
4. If a soak segment is in progress and its soak time is altered, the already elapsed time is ignored and the altered value is immediately loaded for execution. That is, the timer starts executing the altered soak time value a fresh.

   If the target setpoint of the running soak segment is altered, the soak time execution continues uninterrupted but the control algorithm attempts to maintain the PV at the altered value of target setpoint and the balance soak time is executed with respect to the altered target setpoint value.

Section 14
TUNING

SELF-TUNING

The PPI model neuro 105 incorporates, as a standard feature, the tune-on-demand tuning, called the Self-Tuning. (The '++' version of the neuro 105 controller also includes dynamic or recursive tuning, called the Adaptive Tuning).

Self-tuning is a one-time tuning (or tune-on-demand) that is usually required at the time of initial installation of the controller. If there are no significant changes in the process setpoint or load conditions, re-tuning the controller is seldom required. If, however, the control subsequently becomes unstable (due to changes in process characteristics), the user must re-tune the controller for the new conditions.

Though, the tuning can be initiated anytime, it is recommended (and not mandatory) to start self-tuning from the start-up (usually ambient) condition to achieve the best results. This is recommended for the processes that start-up with full load conditions because the controller can then make accurate measurements of the process's initial parameters that are used to control overshoots/undershoots. In many other applications (specifically those requiring pre-heating), however, it is desirable to tune the controller at or near the control setpoint (that is, at the point when the actual load is introduced in the process) rather than tune from the ambient. For this, the usual procedure is :

(a) Raise the process value to near control setpoint using Manual (hand) mode control.

(b) Switch on the load and try to maintain the PV near control setpoint by adjusting the power manually. Note down the output power value *U* at which the PV is fairly stable around the control setpoint.

(c) Set Power Low and Power High limits to approximately 0.5 U and 1.5 U, respectively. This is done to minimize the PV undershoot/overshoot during tuning procedure and yet ensuring PV oscillations around the setpoint as required by the tuning algorithm.

(d) Transfer control to Auto-mode and immediately issue tune command.

The controller then performs the tuning near control setpoint with full load conditions to ensure optimum settings for the P, I, D parameters. Once the tuning is over, the Power Low and Power High Limits can be removed or re-adjusted, if required.

TUNING THE CONTROLLER FOR HEAT-COOL PID

If the controller is configured to operate in Heat-Cool PID, the self-tune algorithm also computes the value for the parameter Relative Cool Gain (besides P, I and D parameters).

It is important to note that for heat-cool operation, the tune command must be issued at appropriate instant. Observe the following rules :

1. Perform tuning at the setpoint which is fairly above or below the normal ambient temperature. That is, avoid tuning the controller near ambient temperature.
2. If the desired control setpoint fall in heat predominant zone (above ambient) then issue tune command only when the PV is fairly below the setpoint.
3. If the desired control set point falls in cool predominant zone (below ambient) then issue tune command only when the PV is fairly above the setpoint.

General Procedure for Self-Tuning

Whether tuning the controller near the setpoint or from the ambient, the general steps to follow are described below. It is assumed that the controller has been properly configured and installed.

1. Set the control setpoint to the value at which the process will be maintained most of the time.
2. Set required values for the Power High and Power Low Limit parameters. If the control output is Relay or SSR, set

appropriate value for the Cycle Time parameter.

3. Access to PAGE-13. Set the Tune parameter (tUnE) to YES and press ENTER key.

4. The controller now returns to the MAIN display. The upper readout shows the PV and the lower readout continuously flashes tUnE. Do not make any changes to the controller parameters while the tuning is in progress.

5. Upon successful completion of the tuning, the "tUnE" message on the lower readout disappears and the controller starts operating in the set mode of operation (Automatic, Hand or Profile).

Notes :

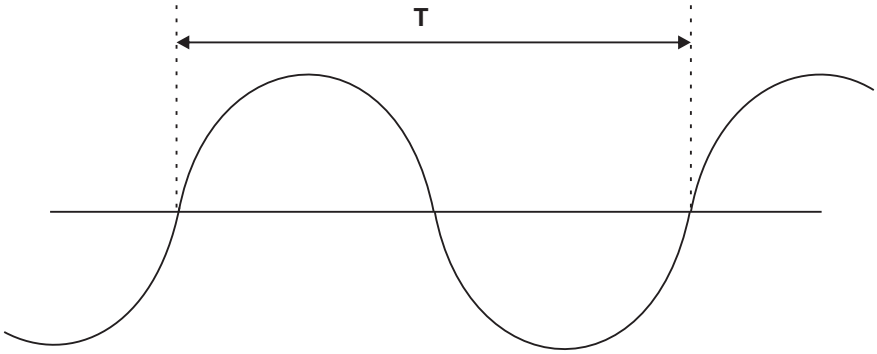
1. The tuning can be initiated from any mode of operation (Automatic, Hand or Profile)
2. If the self-tuning is initiated while the controller is running a Profile cycle; the execution of the current segment is suspended and the controller enters holdback. Upon completion of tuning, the Profile cycle is resumed from where it was left off.
3. If the controller was set to operate as an On-Off controller (by setting Proportional Band value to 0) prior to tuning; the controller will resume its operation with PID control action after completion of tuning.
4. In case of power-failure while tuning is in progress, the tuning automatically resumes from the appropriate step upon resumption of power. If there are possibilities of frequent and long power failures, the tuning might take considerable time for completion.
5. The 'Relay-Amplitude' tuning method implemented in *neuro 102* requires oscillations of PV around a predetermined level (calculated based on the control setpoint value). For the controller to be able to compute the values for P, I, D terms, these oscillations are must. If the PV remains above or below the set level for tuning for extended time (may be due to some external influences like excessive heating in the adjoining chamber, etc.), the controller may not tune properly. If the controller is taking too long for tuning, it is recommended to abort tuning and resort to Manual Tuning described below.

MANUAL TUNING

If for any reason the manual tuning is desired, there are several standard techniques available. The one described below is the simplest and the most popular 'Zeigler Nichols Closed-loop Cycling' method.

The closed-loop cycling method requires forcing the process to oscillate by placing the controller in proportional-only mode (that is cutting-off Integral and Derivation actions) by setting a very small value for the Proportional Band. The control loop cycles with a characteristic frequency, as shown in the Figure 14.1 below. This is a very accurate representation of the process's time responsiveness and is used to calculate the Integral and Derivation time constants of the controller.

Figure 14.1



Follow the steps below for tuning the controller manually.

1. Cut-off Integral and Derivative actions by setting the parameter values to 0. Set the value of the control setpoint at which the tuning is desired or slightly below if the overshoots caused by the oscillations near the operating value are damaging.
2. Reduce Proportional Band value until the PV oscillates. Since the controller is operating in proportion-only mode, the PV oscillations shall occur with an offset error. Ignore this error and measure the period of oscillation as T, as shown in the Figure 14.1 above.
3. Keep increasing the Proportional Band value in small steps until the PV just stabilizes. Allow enough time between the steps for the process to response to the changes made. Note the value of the Proportional Band at which the oscillations just cease (stop), as P.
4. Compute the Proportional Band, Integral Time and Derivative Time from the measured values of P and T as follows :

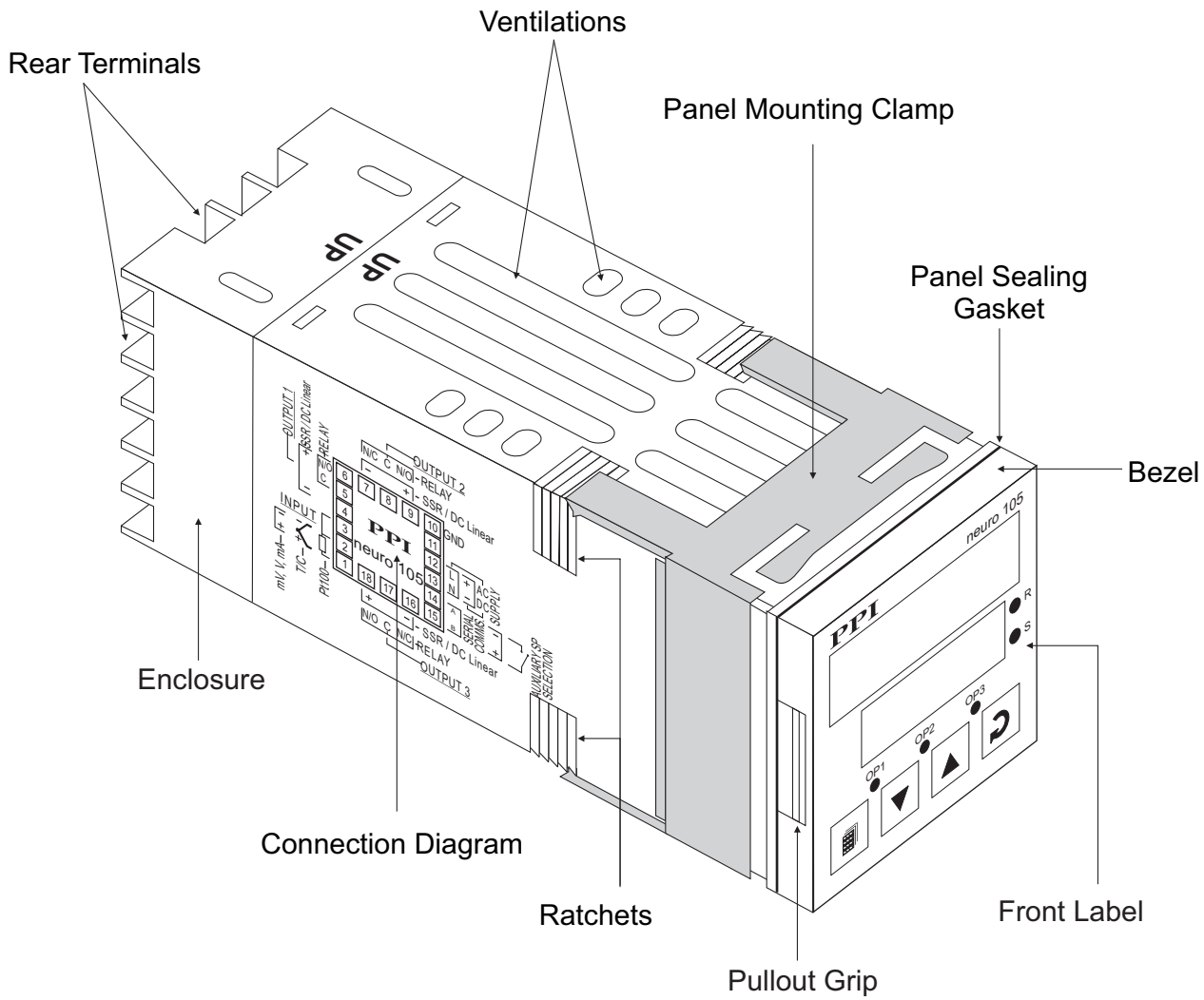
Proportional Band	=	1.67 X P
Integral Time	=	0.5 X T
Derivative Time	=	0.125 X T

5. Set these values for the controller parameters Proportional Band, Integral Time and Derivative Time in PAGE-10 parameter list.

Section 15
HARDWARE ASSEMBLY AND CONFIGURATIONS

The Figure 15.1 below shows the controller outer-case viewed with front label upright.

Figure 15.1

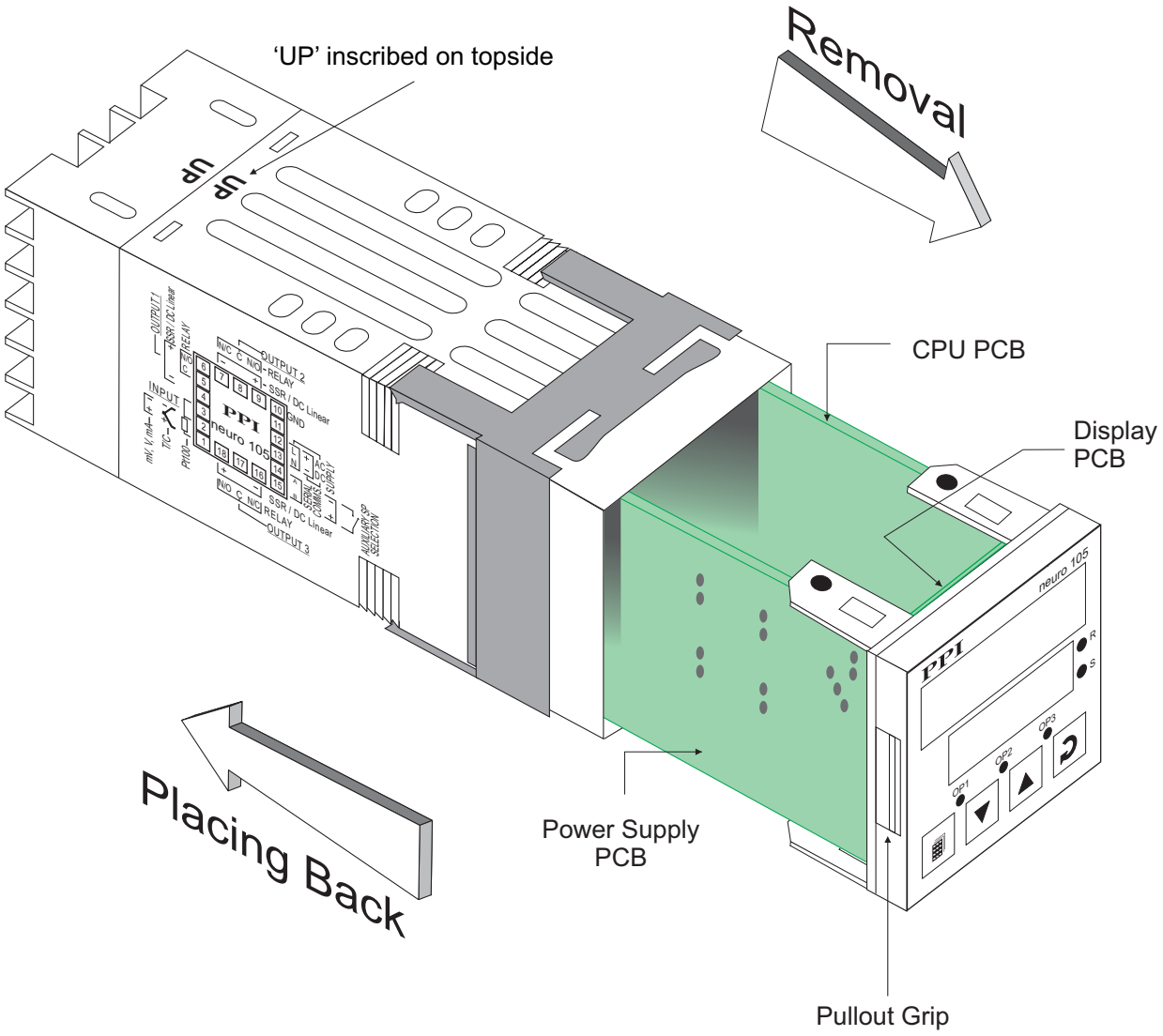


ELECTRONIC ASSEMBLY

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 15.2.

Figure 15.2



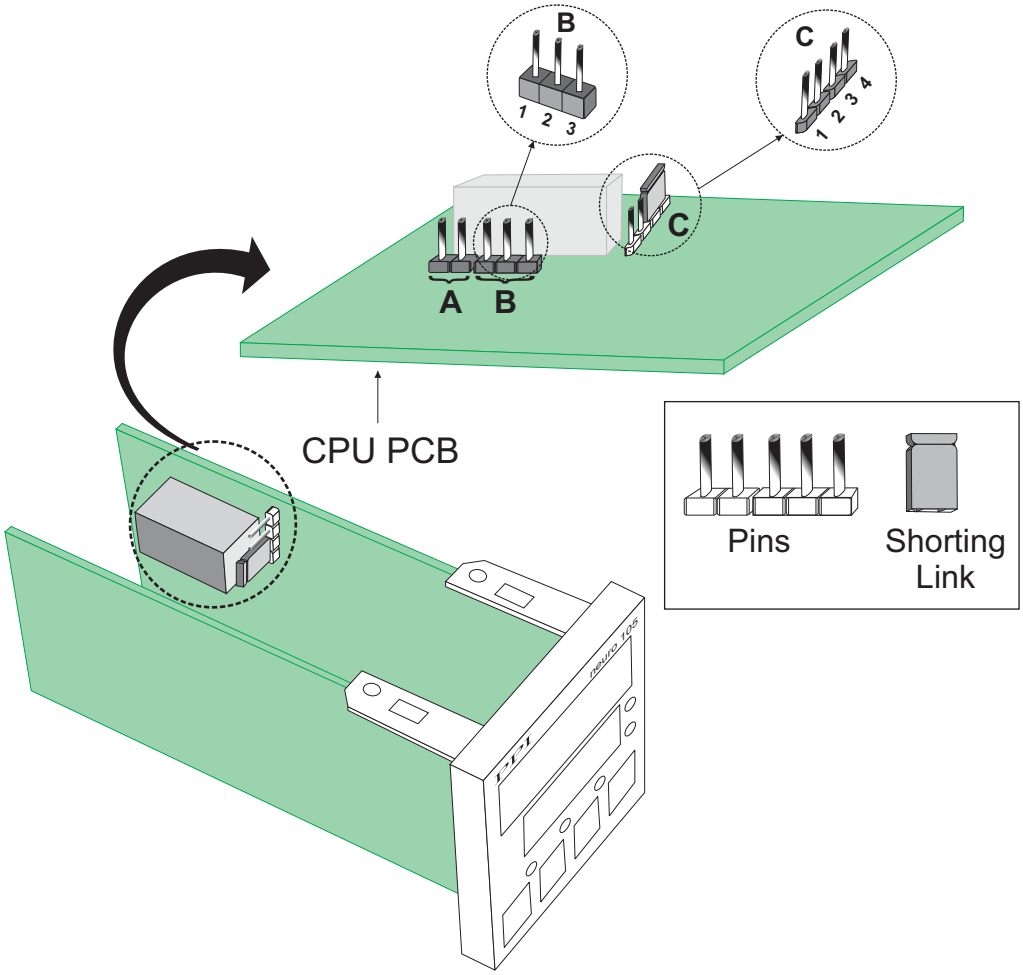
Removing Assembly from Enclosure

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.

Figure 15.3



The Input type and the Output-1 type are user configurable and thus require, besides parameter selections, proper jumper-settings prior to electrical connections. The jumper settings are provided in the form of Pins & Shorting-Link arrangements on the CPU PCB towards the rear end as shown in Figure 15.3. The Jumper setting marked A is for Input configuration whereas those marked B & C are for Output-1 configuration.

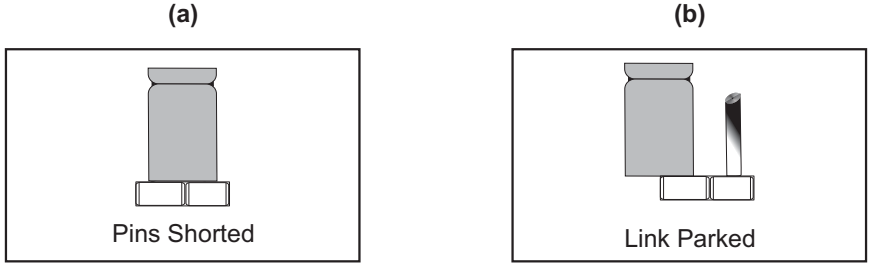
INPUT : Jumper Settings

For DC Linear Current Inputs (0-20mA or 4-20mA), short the Pins using Shorting-Link as shown in Figure 15.4 (a). For all other Input types, keep the Shorting-Link parked leaving the Pins open, as shown in Figure 15.4 (b).

OUTPUT-1 : Jumper Settings

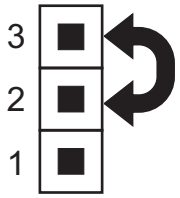
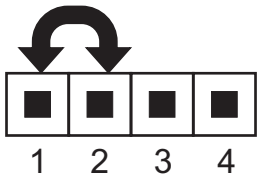
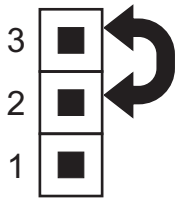
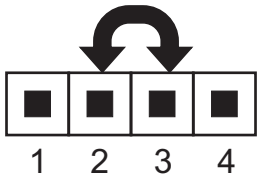
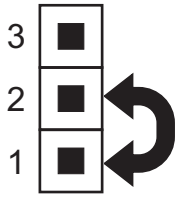
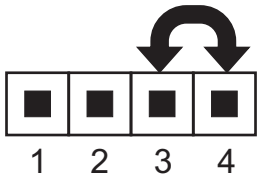
Besides the parameter settings, the Output-1 configuration requires jumper settings marked B & C for different output type selections as shown in the Table 15.1 below.

Figure 15.4 : Input Jumper Settings



DC Linear Current (mA) **All Other Input Types**

Table 15.1 : Output-1 Jumper Settings

Output Type	Jumper Setting - B	Jumper Setting - C
Relay		
SSR Drive		
DC Linear Current (or Voltage)		

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.

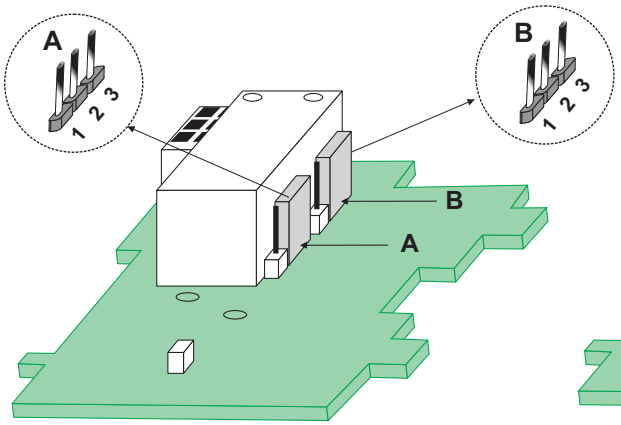
OUTPUT -2 & OUTPUT-3 : Modules and Jumper Settings

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

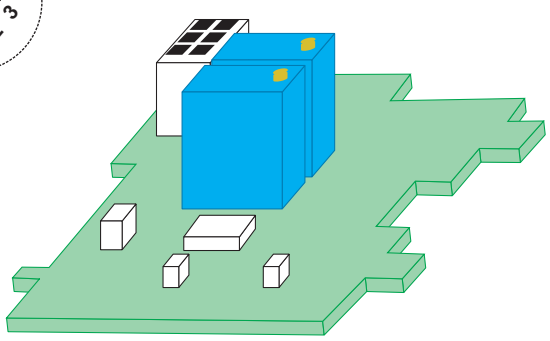
This module can be configured for either Relay or SSR output through proper jumper selection. Two jumper settings A and B, as shown in Figure 15.5 and Table 15.2, are required for Relay or SSR selection.

Figure 15.5



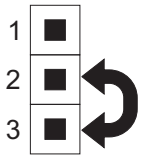
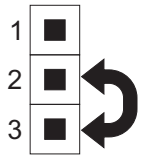
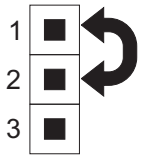
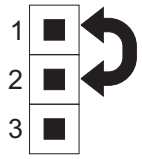
Relay/SSR Module

Figure 15.6



DC Voltage/Current Module

Table 15.2

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 15.7 & 15.8 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 15.7

Mounting Output-2 Module

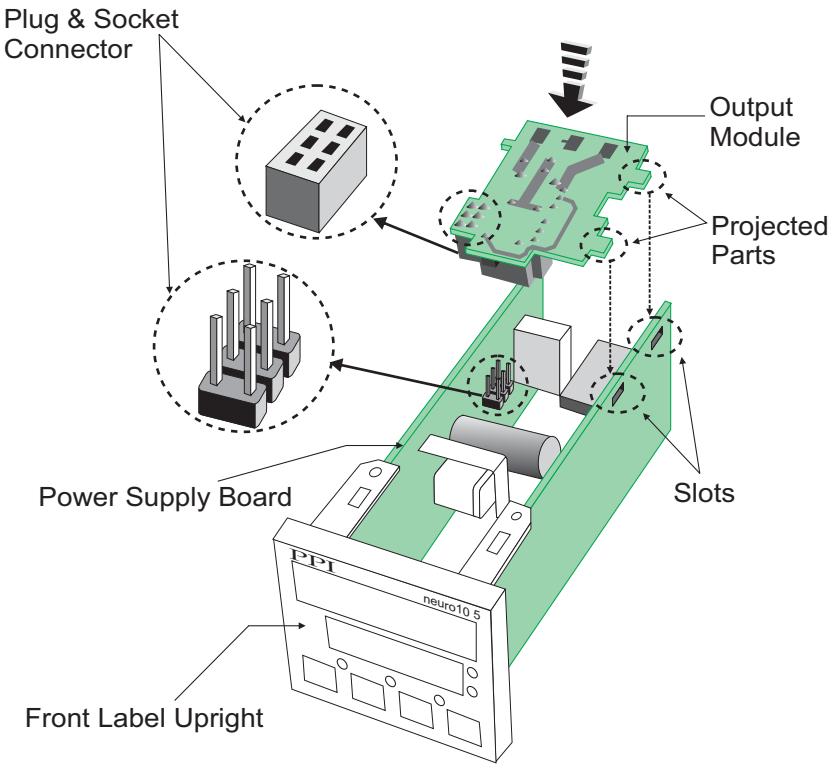
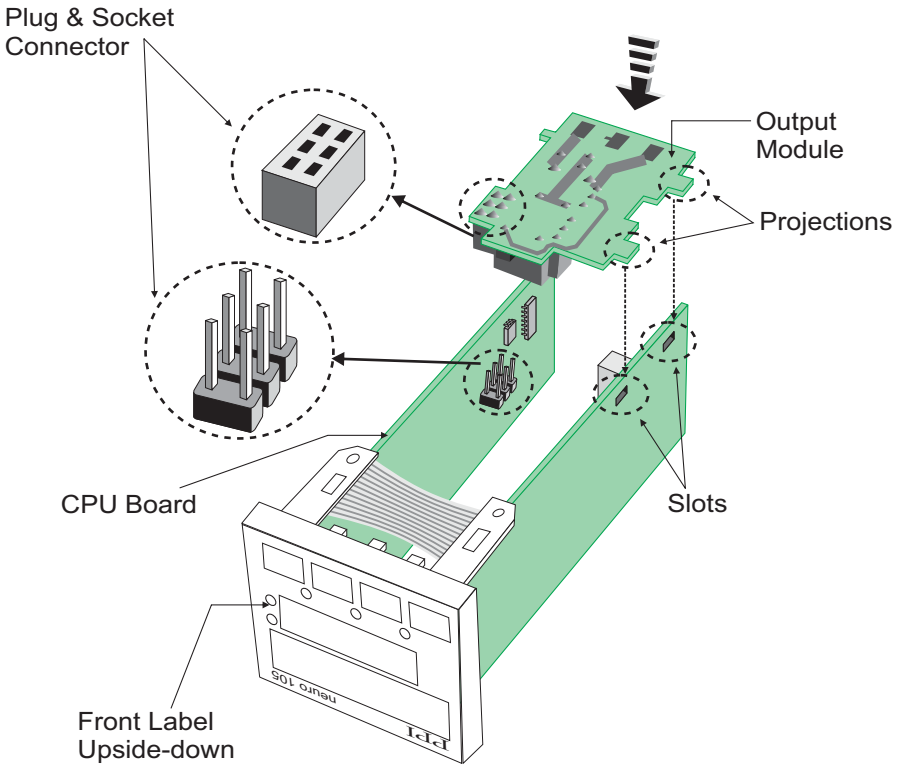


Figure 15.8

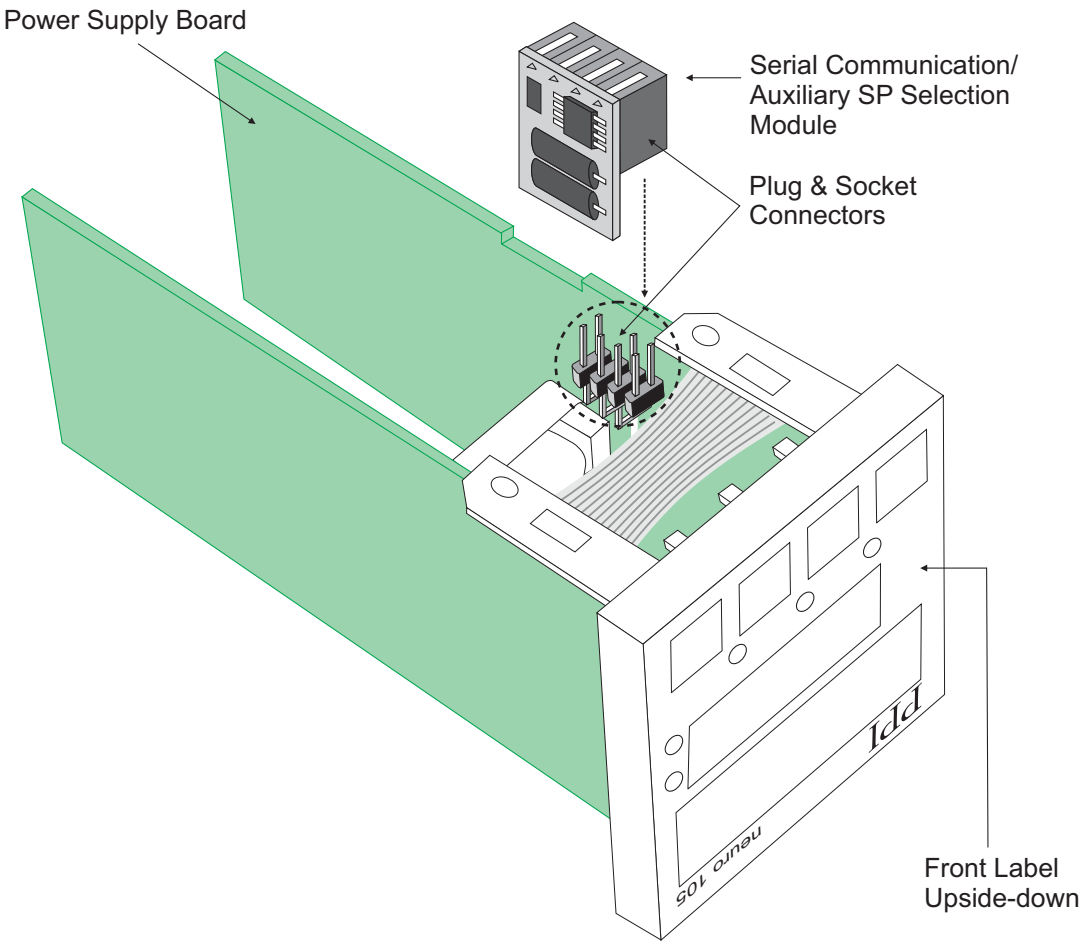
Mounting Output-3 Module



The plug for the Serial Communication or Auxiliary SP Selection module is located on the Power-supply PCB. The Figure 15.9 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 15.9

Mounting Serial Communication/Auxiliary SP Selection Module



Section 16
MECHANICAL INSTALLATION

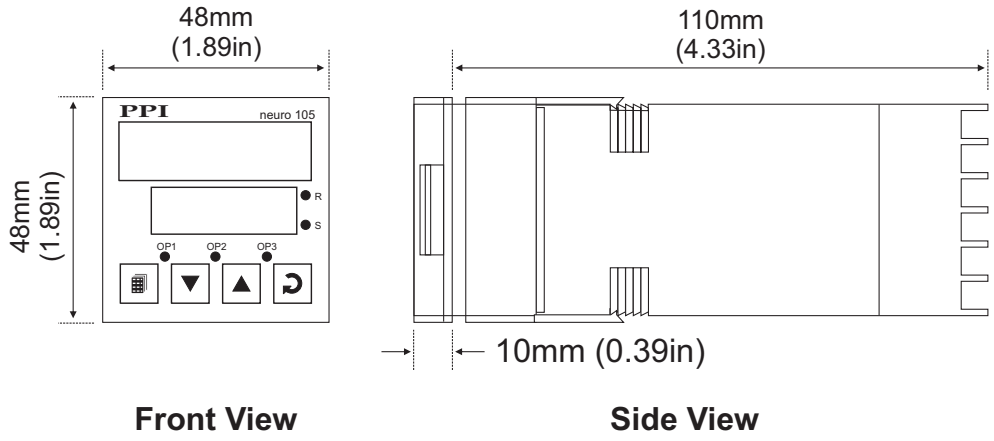
The following precautions should be strictly observed while installing the controller:

1. The place of installation should be free of corrosive/combustible gases and electrically conductive pollution.
2. Ensure that the place of installation is not subject to rapid ambient changes that can cause condensation. Also the Ambient Temperature and Relative Humidity surrounding the controller should not exceed the maximum specified for the proper operation of the controller.
3. The place of installation should be adequately protected against excessive electrostatic or electromagnetic interference.
4. The controller should not be subject to direct vibration or shock.
5. The controller should not be exposed to dust, salt air, direct sunlight or radiant heat.

OUTER DIMENSIONS

The Figure 16.1 shows the outer dimensions of the controller.

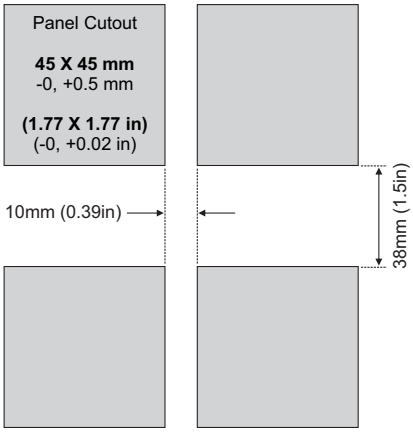
Figure 16.1



PANEL CUTOUT AND RECOMMENDED MINIMUM SPACING

The Figure 16.2 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 16.2

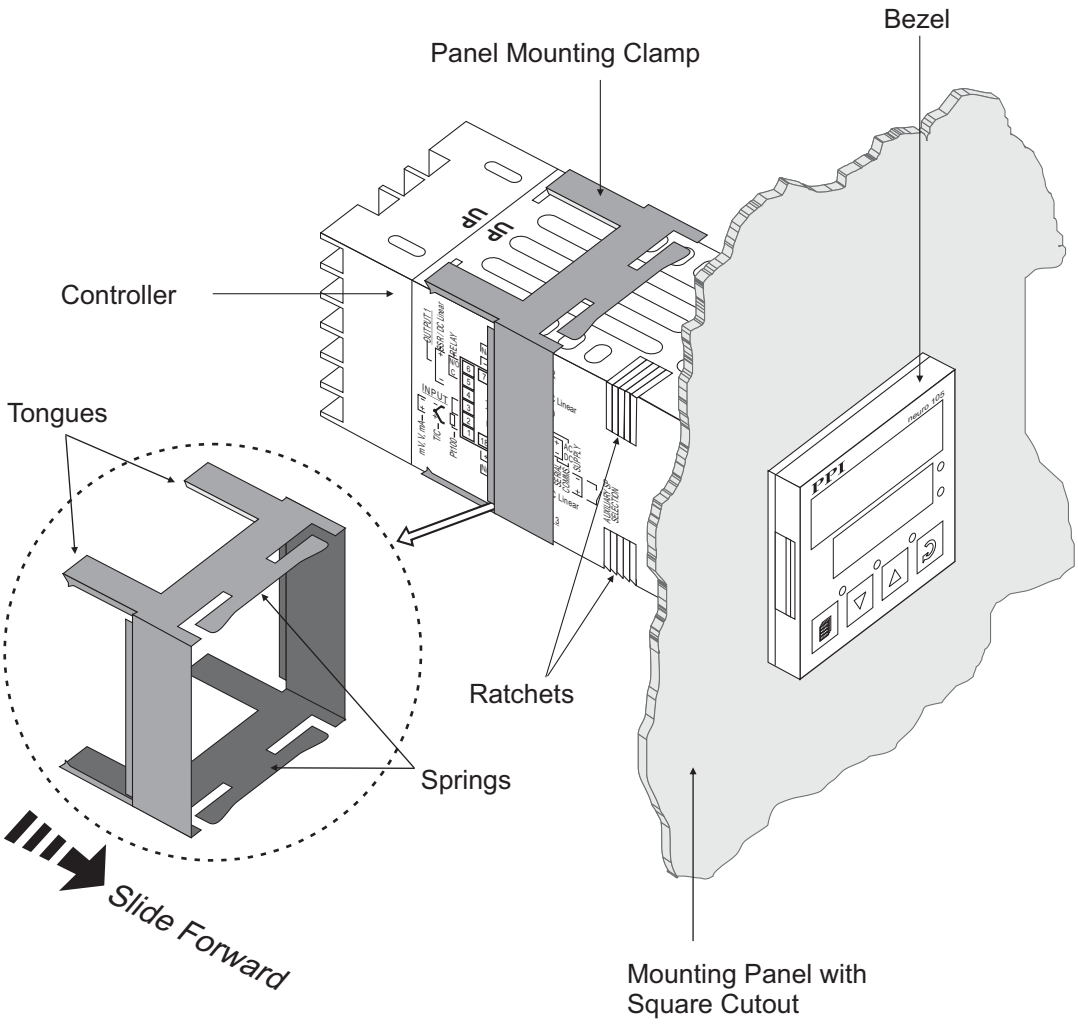


PANEL MOUNTING

Follow the steps below for mounting the controller on panel:

1. Prepare a square cutout to the size shown in Figure 16.2.
2. Remove the Panel Mounting Clamp from the controller Enclosure.
3. Insert the rear of the controller housing through the panel cutout from the front of the mounting panel.
4. Hold the controller gently against the mounting panel such that it positions squarely against the panel wall, see Figure 16.3. Apply pressure only on the bezel and not on the front label.
5. Slide the mounting clamp forward until it is firmly in contact with the rear face of the mounting panel and the tongues of the clamp engage in the ratchets on the controller enclosure, as shown in Figure 16.3. Ensure that the springs of the clamp push firmly against the rear face of the mounting panel for secured mounting.

Figure 16.3



Section 17
ELECTRICAL CONNECTIONS

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

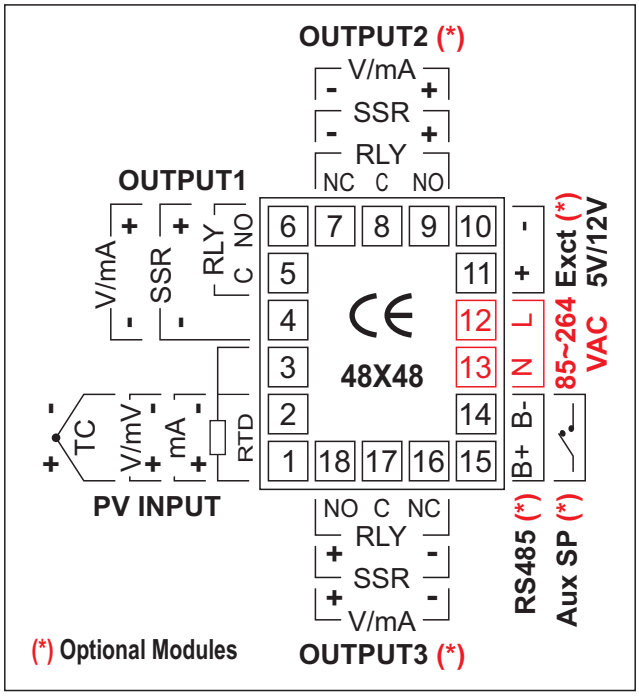
1. The user must rigidly observe the Local Electrical Regulations.
2. Do not make any connections to the unused terminals for making a tie-point for other wires (or for any other reasons) as they may have some internal connections. Failing to observe this may result in permanent damage to the controller.
3. Run power supply cables separated from the low-level signal cables (like Thermocouple, RTD, DC Linear Current/Voltage, 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 Electrical Connection Diagram is shown on the left side of the controller enclosure. The diagram shows the terminals viewed from the REAR SIDE with the controller label upright. Refer the label provided on the Rear Side for terminal numbers. Note that the OUTPUT-2, OUTPUT-3 and the Serial Comm./Auxiliary SP connections are applicable only if the respective plug-in modules are fitted. Also the DC SUPPLY is applicable only if the controller is supplied with 20 to 50 VDC supply voltage option.

The rear panel electrical wiring connection diagram is shown in Figure17.1 below.

Figure 17.1



DESCRIPTIONS

The back panel connections are described as under:

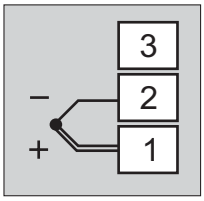
INPUT (Terminals : 1, 2, 3)

The controller accepts Thermocouples (J, K, T, R, S, B, N & Reserved), 3-wire RTD Pt100 and DC Linear Current / Voltage (mV/V/mA) as input.

Thermocouple

Connect Thermocouple Positive (+) to terminal 1 and Negative (-) to terminal 2 as shown in Figure 17.2 (a). Use the correct type of Thermocouple extension lead wires or compensating cable for the entire distance ensuring the correct polarity throughout. Avoid joints in the cable.

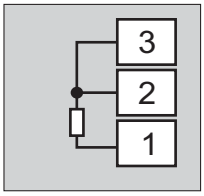
Figure 17.2 (a)



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 17.2 (b). Use copper conductor leads of very low resistance ensuring that all 3 leads are of the same gauge and length. Avoid joints in the cable.

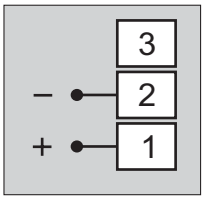
Figure 17.2 (b)



DC Linear Voltage (mV / V)

Use a shielded twisted pair with the shield grounded at the signal source for connecting mV / V source. Connect common (-) to terminal 2 and the signal (+) to terminal 1, as shown in Figure 17.2 (c).

Figure 17.2 (c)

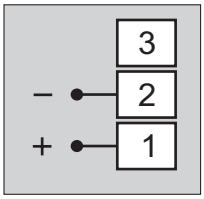


DC Linear Current (mA)

Use a shielded twisted pair with the shield grounded at the signal source for connecting mA source. Connect common (-) to terminal 2 and the signal (+) to terminal 1, as shown in Figure 17.2 (d).

Make sure that the Jumper Pins for Input selection are shorted using the Shorting-Link (Refer S*ection 11 Hardware Assembly and Configurations, Input-Jumper Settings).*

Figure 17.2 (d)



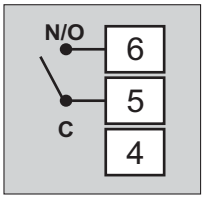
OUTPUT-1 (Relay Terminals : 5, 6; SSR / DC Linear Terminals : 4, 6)

The Output-1 can be configured (through jumper settings) as either Relay, SSR Drive or DC Linear Current (or Voltage).

Relay

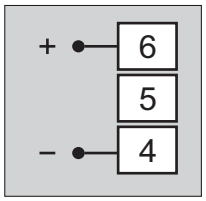
Potential-free Relay changeover contacts N/O (Normally Open) and C (Common) rated 2A/240 VAC (resistive load) are provided as Relay output. Use external auxiliary device like contactor with appropriate contact rating for driving the actual load.

Figure 17.3 (a)



Drive for SSR

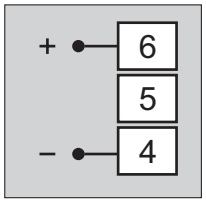
Figure 17.3 (b)



DC Voltage level is generated for switching the external SSR (Solid State Relay). Connect (+) and (-) terminals of SSR to controller terminals 6 and 4, respectively. Use Zero-Crossover, 3 to 30 VDC operated SSR, rated approximately 1.5 times the actual load rating. Use appropriate Heat Sink for load rating exceeding 10A.

DC Linear Current / Voltage Output

Figure 17.3 (c)

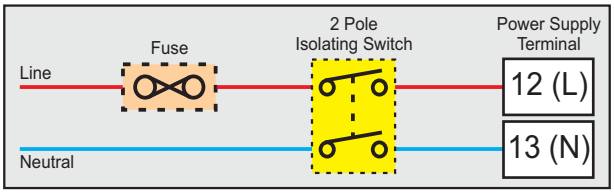


The DC Linear (0/4-20 mA) Current or (0-5/10V) Voltage output is also available at Terminal 6 (+) and Terminal 4 (-) if the Output-1 is configured for DC Linear.

OUTPUT- 2 (Terminals : 7, 8, 9)
OUTPUT- 3 (Terminals : 16, 17, 18)
The Output-2 and Output-3 are available through plug-in modules. The modules are factory configured for either Relay / SSR or DC Linear Voltage or DC Linear Current. The connection descriptions are the same as those described for Output-1.

POWER SUPPLY (Terminals : 12, 13)

Figure 17.4



Caution

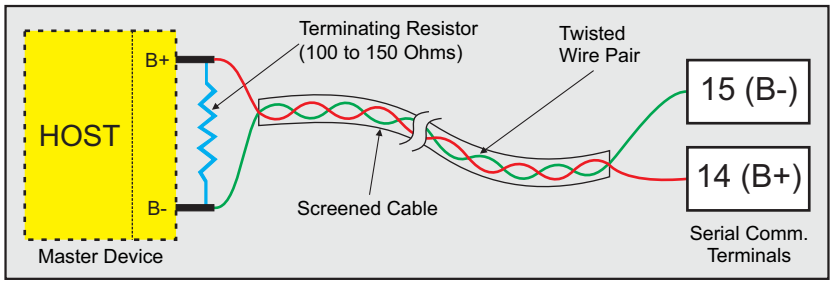
The controller is designed for installation in an enclosure which provides adequate protection against electric shock. Local regulations regarding electrical installation should be rigidly observed. Consideration should be given to prevention of access to the Power Supply terminals by unauthorized personnel.

As standard, 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 12 and the Neutral (Return) supply line to terminal 13 as shown in Figure 17.4. The controller is not provided with fuse and power switch. If necessary, mount them separately. Use a time lag fuse rated 1A @ 240 VAC.

For DC Supply, connect Signal (+) & Common (-) to controller terminals 12 & 13, respectively.

SERIAL COMMUNICATION PORT (Terminals : 14 , 15)

Figure 17.5

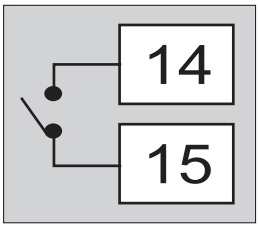


(The Option plug-in module is supplied as either RS485 Serial Port or Digital Input for Auxiliary SP Selection).

If the Optional plug-in communication board is fitted, connect terminal 15 and 14 of the controller to (+) and (-) terminals of the Master device.

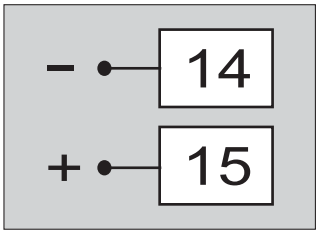
For reliable noise free communication, use a pair of twisted wires inside screened cable as shown in Figure 17.5. The wire should have less than 100 ohms / km nominal DC resistance (Typically 24 AWG or thicker). Connect the terminating resistor (Typically 100 to 150 ohm) at one end to improve noise immunity.

Figure 17.6 (a)



Potential-free Contact closure

Figure 17.6 (b)



TTL-Compatible Voltage Level

DIGITAL INPUT FOR AUXILIARY SP SELECTION (Terminals : 14, 15)

(The Option plug-in module is supplied as either RS485 Serial Port or Digital Input for Auxiliary SP Selection).

The plug-in Option module for selecting Auxiliary SP is factory configured for either potential-free contact closure or TTL-compatible voltage input.

The Setpoint selection is as under :

a) Potential-Free Contacts : OPEN :- Main SP selected
CLOSE :- Auxiliary SP selected

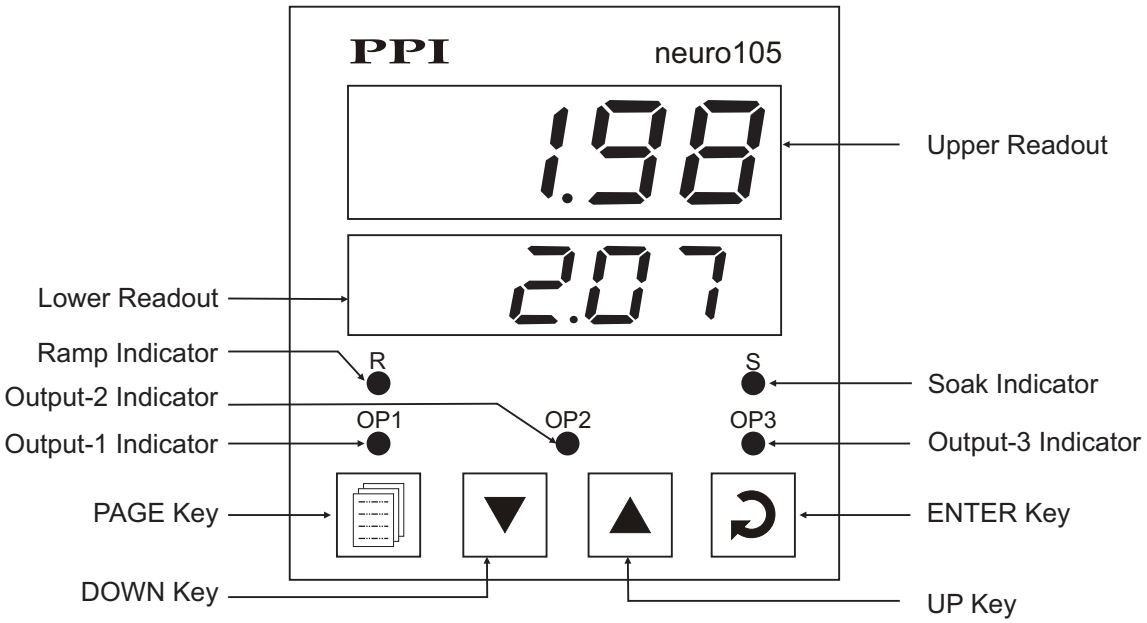
b) TTL-compatible Voltage : > 0.6 V :- Main SP selected
< 0.5 V :- Auxiliary SP selected

neuro 105 96X96

Section 1
FRONT PANEL LAYOUT

The controller front panel comprises of digital readouts, LED indicators and membrane keys as shown in figure 1.1 below.

Figure 1.1



READOUTS

The upper readout is a 4 digit, 7-segment bright red LED display and usually displays the PV (Process Value). In parameter set-up mode, the upper readout displays parameter values.

The lower readout is a 4 digit, 7-segment bright green LED display and while running a PROFILE program displays either the 'ramping setpoint' / balance 'soak time' or % Output Power. If the controller is operating in fixed setpoint control mode (that is while not running a profile); the lower readout displays the control Setpoint or % Output Power. In parameter set-up mode, the lower readout displays prompts for the parameters.

The indications on the upper and lower readouts, in general, depend on the mode of operation and configuration parameters. Refer respective sections for more details.

INDICATORS

There are five front panel red LED indicators. These indicators 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	Function
R	While a profile program is in progress; flashes if a RAMP segment is in progress and glows steadily if the ramp is in HOLD state.
S	While a profile program is in progress; flashes if a SOAK segment is in progress and glows steadily if the soak timer is in HOLD state.
OP1	Indicates Output-1 ON/OFF status.
OP2	Indicates Output-2 ON/OFF status.
OP3	Indicates Output-3 ON/OFF status.

KEYS

There are four tactile keys provided on the front panel for configuring the controller, setting-up the parameter values and selecting operation modes. The Table 1.2 below details the key functions.

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.

The keys are also assigned various other functions while the controller is in MAIN mode display. The key-functions depend on the mode of operation (Automatic, Hand or Profile) and are described under the respective operation mode in the next Chapter.

Section 2
HARDWARE ASSEMBLY AND CONFIGURATIONS

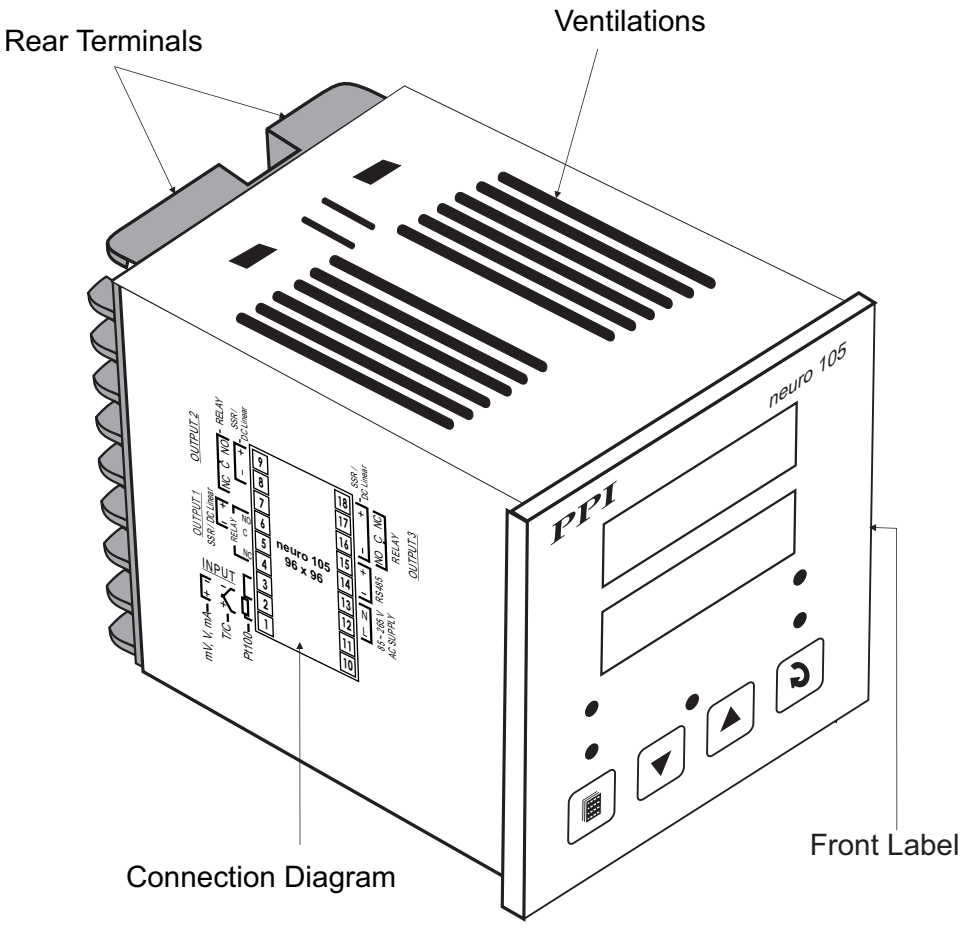
The Figure 2.1 below shows the controller outer-case viewed with front label upright.

ELECTRONIC ASSEMBLY

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

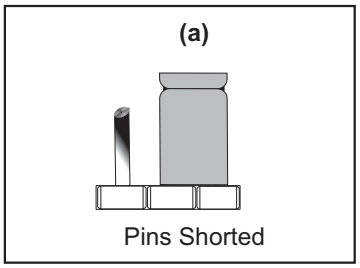
Figure 2.1



Input Jumper Setting

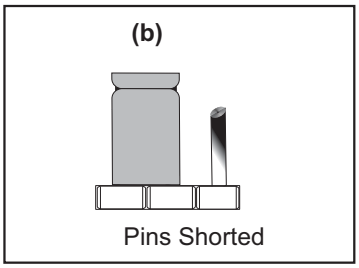
For DC Linear Current Inputs (0-20mA or 4-20mA), short the Pins using Shorting-Link as shown in Figure 2.2 (a). For all other Input types, keep the Shorting-Link parked leaving the Pins open, as shown in Figure 2.2 (b).

Figure 2.2 (a)



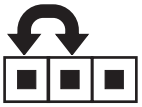
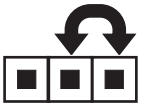
DC Linear Current (mA)

Figure 2.2 (b)



All other Input Types

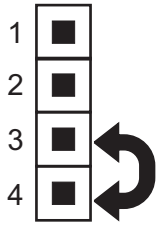
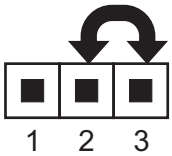
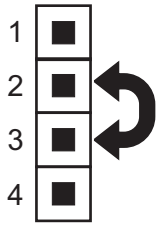
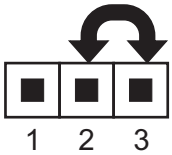
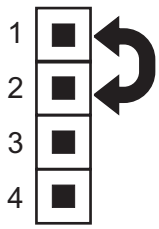
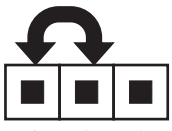
Table 2.1 **Input Jumper Settings**

Input Type	Jumper 'A' Setting
Thermocouple, RTD Pt100, mV & V	
DC Linear Current (mA)	

OUTPUT-1 : Jumper Settings

Besides the parameter settings, the Output-1 configuration requires jumper settings marked B & C for different output type selections as shown in the Table 2.2 below.

Table 2.2 **Output-1 Jumper Settings**

Output Type	Jumper Setting - B	Jumper Setting - C
Relay		
SSR Drive		
DC Linear Current (or Voltage)		

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

The *Output-2* and *Output-3* Modules are identical and, thus, can be fitted interchangeably in Output-2 or Output-3 positions. These modules can be configured for either Relay or SSR output through proper jumper selection. Two jumper settings A and B, as shown in Figure 2.3, are required for Relay or SSR selection. Refer Table 2.3 for appropriate jumper setting positions.

Figure 2.3

Relay/SSR Module

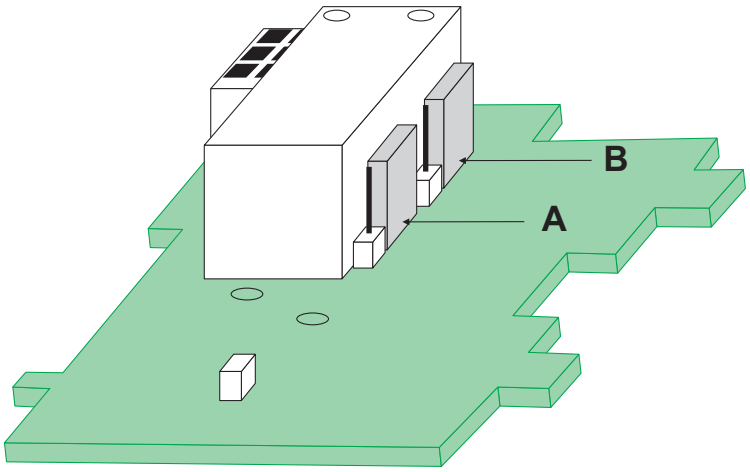


Table 2.3 **Output-2 Jumper Settings**

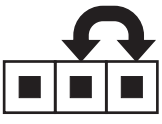
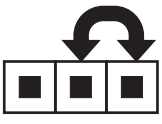
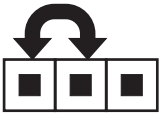
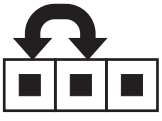
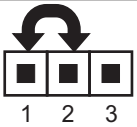
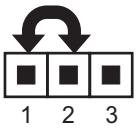
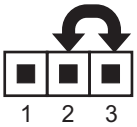
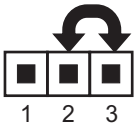
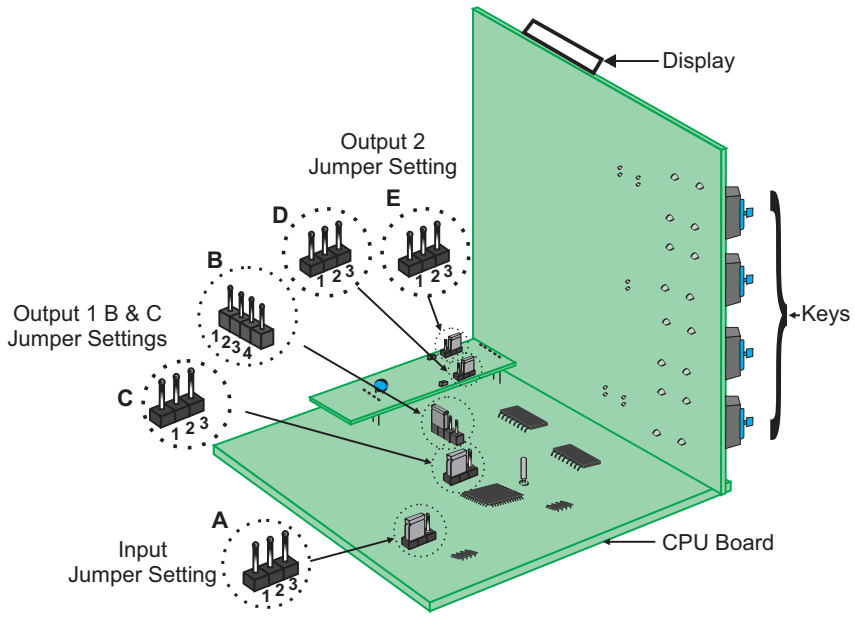
Output Type	Jumper Setting - D	Jumper Setting - E
Relay		
SSR		

Table 2.4 **Output-3 Jumper Settings**

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

Mounting Output Modules

Figure 2.4



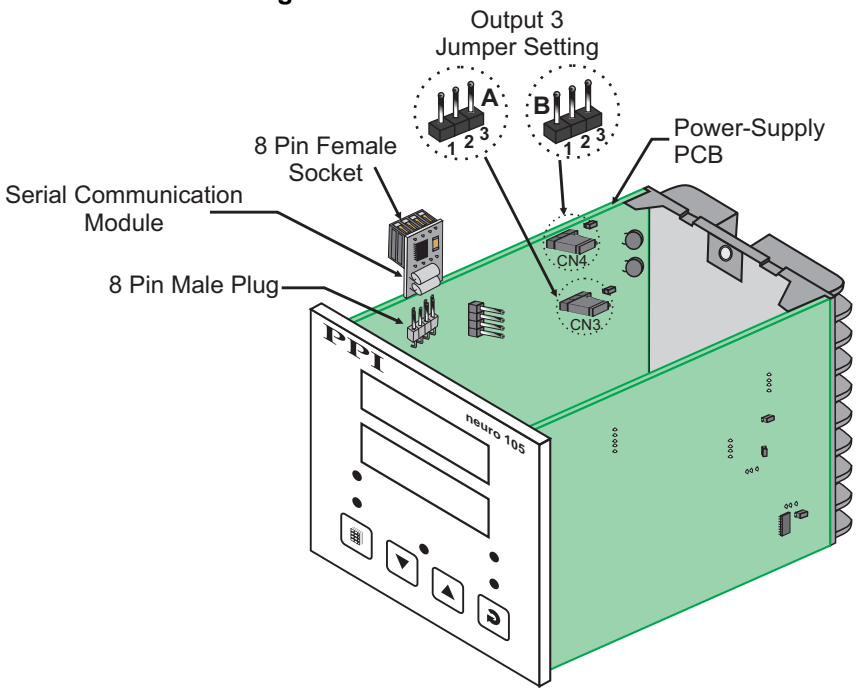
Mounting / Un-Mountion of Modules

The Figure 2.4 Illustrates how to mount output-2 & output-3 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 Remote Alarm Acknowledgment module is located on the Power-supply PCB. The Figure 2.5 below illustrates how to plug-in the Serial Communication/Remote Alarm Acknowledgment module. To plug (or unplug) the module simply insert (or remove) the socket into (or from) the plug.

Figure 2.5

Mounting Serial Communication Module



Section 3

ELECTRICAL CONNECTIONS

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

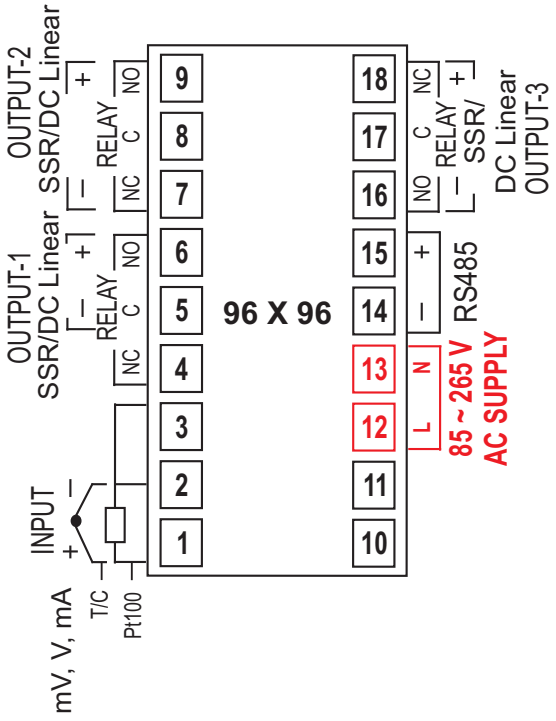
1. The user must rigidly observe the Local Electrical Regulations.
2. Do not make any connections to the unused terminals for making a tie-point for other wires (or for any other reasons) as they may have some internal connections. Failing to observe this may result in permanent damage to the controller.
3. Run power supply cables separated from the low-level signal cables (like Thermocouple, RTD, DC Linear Current/Voltage, 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 Electrical Connection Diagram is shown on the left side of the controller enclosure. The diagram shows the terminals viewed from the REAR SIDE with the controller label upright. Refer the label provided on the Rear Side for terminal numbers. Note that the OUTPUT-2, OUTPUT-3 and the Serial Comm./Auxiliary SP connections are applicable only if the respective plug-in modules are fitted. Also the DC SUPPLY is applicable only if the controller is supplied with 20 to 50 VDC supply voltage option.

The rear panel electrical wiring connection diagram is shown in Figure 3.1 below.

Figure 3.1



DESCRIPTIONS

The back panel connections are described as under:

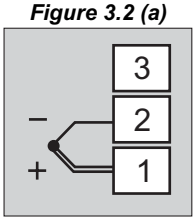
INPUT (Terminals : 1, 2, 3)

The controller accepts Thermocouples (J, K, T, R, S, B, N & Reserved), 3-wire RTD Pt100 and DC Linear Current / Voltage (mV/V/mA) as input.

Thermocouple

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

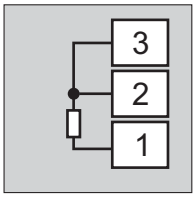
Figure 3.2 (a)



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 copper conductor leads of very low resistance ensuring that all 3 leads are of the same gauge and length. Avoid joints in the cable.

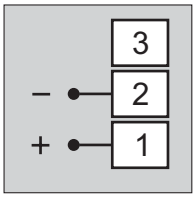
Figure 3.2 (b)



DC Linear Voltage (mV / V)

Use a shielded twisted pair with the shield grounded at the signal source for connecting mV / V source. Connect common (-) to terminal 2 and the signal (+) to terminal 1, as shown in Figure 3.2 (c).

Figure 3.2 (c)

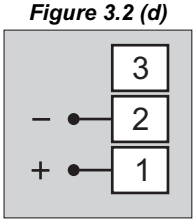


DC Linear Current (mA)

Use a shielded twisted pair with the shield grounded at the signal source for connecting mA source. Connect common (-) to terminal 2 and the signal (+) to terminal 1, as shown in Figure 3.2 (d).

Make sure that the Jumper Pins for Input selection are shorted using the Shorting-Link (Refer *Section 9 Hardware Assembly and Configurations, Input-Jumper Settings).*

Figure 3.2 (d)

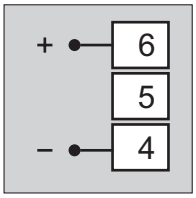


OUTPUT-1 (Terminals : 4, 6)

DC Linear Current / Voltage Output

The DC Linear (0/4-20 mA) Current or (0-5/10V) Voltage output is also available at Terminal 6 (+) and Terminal 4 (-) for Retransmission (Recorder) output. Refer Figure 3.3

Figure 3.3



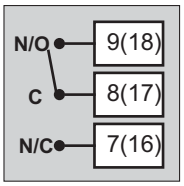
OUTPUT- 2 (Terminals : 7, 8, 9)
OUTPUT- 3 (Terminals : 16, 17, 18)

The Output-2 and Output-3 are available through plug-in modules that can be configured as Relay or SSR through appropriate Jumper Settings. The connection descriptions are shown in figures 3.4(a) and 3.4(b).

Relay

Potential-free Relay changeover contacts N/O (Normally Open) and C (Common) rated 2A/240 VAC (resistive load) are provided as Relay output. Use external auxiliary device like contactor with appropriate contact rating for driving the actual load.

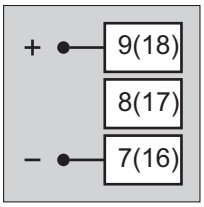
Figure 3.4 (a)



Drive for SSR

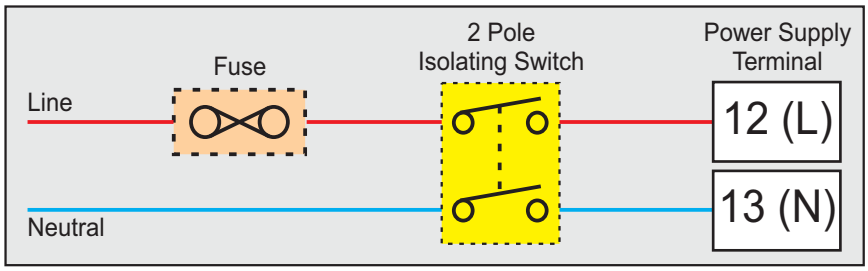
DC Voltage level is generated for switching the external SSR (Solid State Relay). Connect (+) and (-) terminals of SSR to indicator terminals 9(18) and 7(16), respectively. Use Zero-Crossover, 3 to 30 VDC operated SSR, rated approximately 1.5 times the actual load rating. Use appropriate Heat Sink for load rating exceeding 10A.

Figure 3.4 (b)



POWER SUPPLY (Terminals : 12, 13)

Figure 3.5



Caution

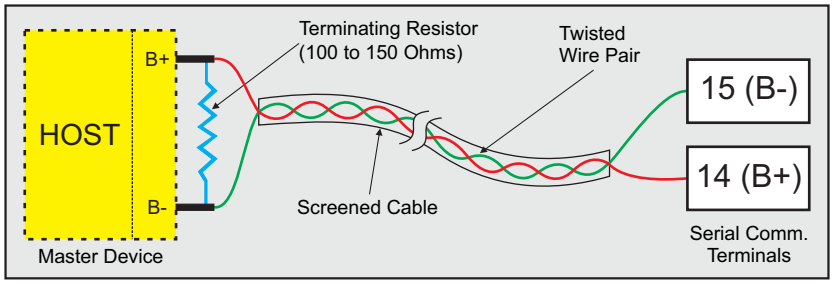
The indicator is designed for installation in an enclosure which provides adequate protection against electric shock. Local regulations regarding electrical installation should be rigidly observed. Consideration should be given to prevention of access to the Power Supply terminals by unauthorized personnel.

As standard, the indicator is supplied with power connections suited for 85 to 264 VAC. Use well-insulated copper conductor wire of the size not smaller than 0.5mm^2 for connections. Connect Line (Phase) to terminal 12 and the Neutral (Return) to terminal 13 as shown in Figure 3.5. The indicator is not provided with fuse and power switch. If necessary, mount them separately. Use a time lag fuse rated 1A @ 240 VAC.

For DC Supply, connect Signal (+) & Common (-) to indicator terminals 12 & 13, respectively.

SERIAL COMMUNICATION PORT (Terminals : 14 , 15)

Figure 3.5

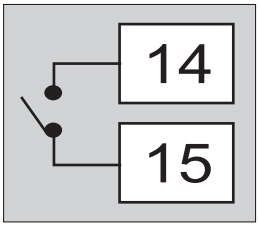


(The Option plug-in module is supplied as either RS485 Serial Port or Digital Input for Auxiliary SP Selection).

If the Optional plug-in communication board is fitted, connect terminal 15 and 14 of the controller to (+) and (-) terminals of the Master device.

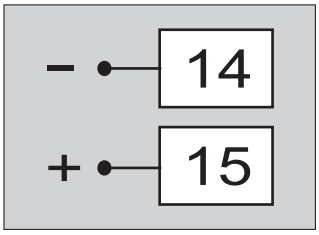
For reliable noise free communication, use a pair of twisted wires inside screened cable as shown in Figure 3.5. The wire should have less than 100 ohms / km nominal DC resistance (Typically 24 AWG or thicker). Connect the terminating resistor (Typically 100 to 150 ohm) at one end to improve noise immunity.

Figure 3.6 (a)



Potential-free Contact closure

Figure 3.6 (b)



TTL-Compatible Voltage Level

DIGITAL INPUT FOR AUXILIARY SP SELECTION (Terminals : 14, 15)

(The Option plug-in module is supplied as either RS485 Serial Port or Digital Input for Auxiliary SP Selection).

The plug-in Option module for selecting Auxiliary SP is factory configured for either potential-free contact closure or TTL-compatible voltage input.

The Setpoint selection is as under :

a) Potential-Free Contacts : OPEN :- Main SP selected
CLOSE :- Auxiliary SP selected

b) TTL-compatible Voltage : > 0.6 V :- Main SP selected
< 0.5 V :- Auxiliary SP selected

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