red lion®

Tel +1 (717) 767-6511
Fax +1 (717) 764-0839
www.redlion.net

MODEL PAX2C – 1/8 DIN TEMPERATURE/PROCESS PID CONTROLLER

- PID CONTROL WITH REDUCED OVERSHOOT
- UNIVERSAL PROCESS, TEMPERATURE, VOLTAGE, CURRENT AND RESISTANCE INPUT
- PROGRAMMABLE DUAL LINE DISPLAY WITH UNITS INDICATION AND BAR GRAPH
- FOUR PROGRAMMABLE UNIVERSAL ANNUNCIATORS
- TRI-COLOR DISPLAY, WITH 7 PROGRAMMABLE COLOR ZONES
- UP TO 16 ALARMS WITH BOOLEAN LOGIC FUNCTIONALITY
- BUILT-IN USB PROGRAMMING PORT ENABLING UNIT CONFIGURATION WITH CRIMSON PROGRAMMING SOFTWARE
- NEMA 4X/IP65 SEALED FRONT BEZEL

C (UL) US LISTED
3RSD
PROCESS CONTROL EQUIPMENT

CE

DESCRIPTION

The PAX2C Temperature/Process Controller offers many features and performance capabilities to suit a wide range of applications. The PAX2C has a universal input to handle various input signals including Temperature, DC Voltage/Current and Resistance. Optional plug-in cards allow the opportunity to configure the controller for present applications, while providing easy upgrades for future needs. The PAX2C employs a tri-color display with seven independently programmable color zones.

The controller has been specifically designed for harsh industrial environments. With NEMA 4X/IP65 sealed bezel, CE compliance and extensive testing of noise effects, the controller provides a tough reliable application solution.

MAIN CONTROL

The controller operates in the PID Control Mode for both heating and cooling, with on-demand auto-tune that establishes the tuning constants. The PID tuning constants may be fine-tuned and then locked out from further modification. The controller employs a unique overshoot suppression feature, that allows the quickest response without excessive overshoot. Switching to Manual Mode provides the operator direct control of the output.

DISPLAY

The PAX2C features a dual line display with units annunciators, dual bar graphs, four universal annunciators and tri-color capability. Each of the seven display zones may be configured independently of the others, providing a visual indication of control and/or alarm status.

ALARMS

The PAX2C has up to sixteen "soft" alarms that may be configured to suit a variety of control and alarm requirements. These alarms may be used to monitor and/or actuate the controller's physical outputs as well as change display colors. Mapped "soft" alarms may be processed independently or logically combined using AND/OR Boolean logic.
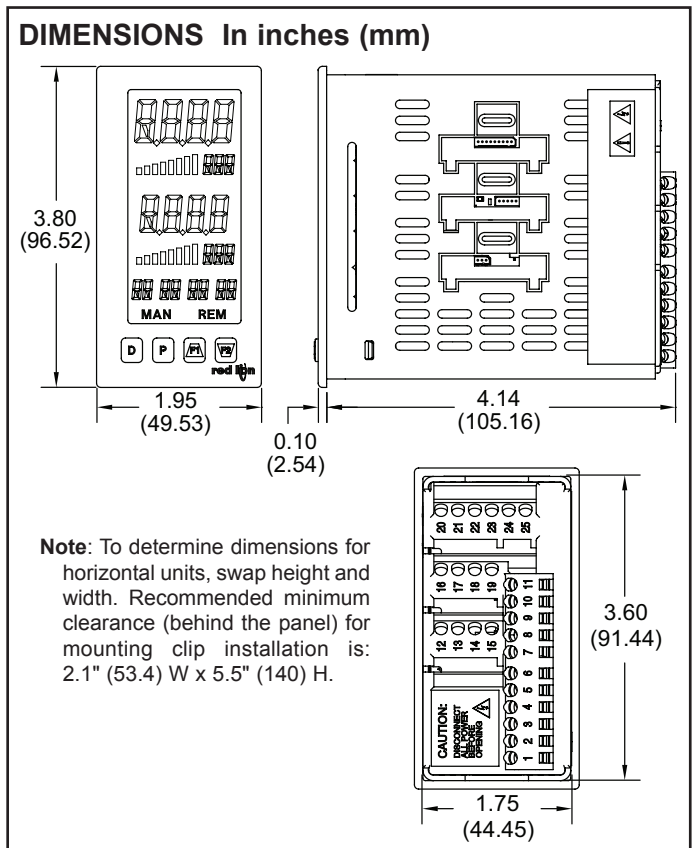
OPTION CARDS

Optional plug-in cards provide dual FORM-C relays, quad FORM-A, quad sinking, or quad sourcing open collector logic outputs. These cards can be used as control outputs or for alarm indication.

A linear DC output signal is available as an optional plug-in card. The card provides either 20 mA or 10 V signals. The output can be scaled independent of the input range and can track the input, max and min readings or for control.

Communication and bus capabilities are also available as option cards. These include RS232, RS485, DeviceNet, and ProfibusDP. The PAX2C can be programmed to utilize Modbus protocol. With Modbus, the user has access to most configuration parameters. Readout values, setpoint, process and alarm values can be controlled through the bus. Additionally, the controller has a feature that allows a remote computer to directly control the outputs of the controller.

With a Windows® based program, made available by Red Lion Controls, configuration data can be downloaded to the PAX2C via a built-in USB programming port.

DIMENSIONS In inches (mm)

3.80 (96.52)
1.95 (49.53)
0.10 (2.54)
4.14 (105.16)

Note: To determine dimensions for horizontal units, swap height and width. Recommended minimum clearance (behind the panel) for mounting clip installation is: 2.1" (53.4) W x 5.5" (140) H.

3.60 (91.44)
1.75 (44.45)

SAFETY SUMMARY

All safety related regulations, local codes and instructions that appear in this literature or on equipment must be observed to ensure personal safety and to prevent damage to either the instrument or equipment connected to it. If equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. Do not use this unit to directly command motors, valves, or other actuators not equipped with safeguards. To do so can be potentially harmful to persons or equipment in the event of a fault to the unit.
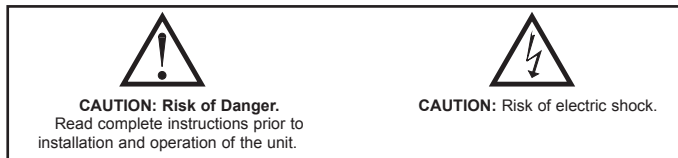
⚠	⚠
CAUTION: Risk of Danger. Read complete instructions prior to installation and operation of the unit.	**CAUTION:** Risk of electric shock.

TABLE OF CONTENTS

ORDERING INFORMATION

Controller Part Numbers

MODEL NO.	DESCRIPTION	PART NUMBER
PAX2C	Universal Input Temperature/Process Controller, Horizontal	PX2C8H00
	Universal Input Temperature/Process Controller, Vertical	PX2C8V00

Option Card and Accessories Part Numbers

TYPE	MODEL NO.	DESCRIPTION	PART NUMBER
Optional Plug-In Cards	PAXCDS	Dual Setpoint Relay Output Card	PAXCDS10
		Quad Setpoint Relay Output Card	PAXCDS20
		Quad Setpoint Sinking Open Collector Output Card	PAXCDS30
		Quad Setpoint Sourcing Open Collector Output Card	PAXCDS40
	PAXCDC	RS485 Serial Communications Card with Terminal Block	PAXCDC10
		Extended RS485 Serial Communications Card with Dual RJ11 Connector	PAXCDC1C
		RS232 Serial Communications Card with Terminal Block	PAXCDC20
		Extended RS232 Serial Communications Card with 9 Pin D Connector	PAXCDC2C
		DeviceNet Communications Card	PAXCDC30
		Profibus-DP Communications Card	PAXCDC50
	PAXCDL	Analog Output Card	PAXCDL10
	CBLUSB	USB Programming Cable Type A-Mini B	CBLUSB01

Note:
[1.] For Modbus communications use RS485 Communications Output Card and configure communication (*type*) parameter for Modbus.

GENERAL CONTROLLER SPECIFICATIONS

1. **DISPLAY**: Negative image LCD with tri-color backlight.
   The display is divided into seven independently programmable color zones:
   Line 1, Line 2, Universal Annunciators (1-4) & Mnemonics
   Line 1 and 2: 4 digits each line
   Display Range: -1999 to 9999
   Units - Programmable 3 digit units annunciator
   Bar Graph - Programmable 8 segment bar graph
   Universal Annunciator 1 thru 4: Programmable 2 digit annunciator
   Status Mnemonics: MAN - Controller is in Manual Mode
   REM – Controller is in Remote Mode
   Vertical Model Digit Size: Line 1 - 0.51" (13 mm), Line 2 - 0.44" (11.2 mm)
   Horizontal Model Digit Size: Line 1 - 0.62" (15.7 mm), Line 2 - 0.47" (12.0 mm)
2. **POWER**:
   AC Power: 40 to 250 VAC, 50/60 Hz, 20 VA
   DC Power: 21.6 to 250 VDC, 8 W
   Isolation: 2300 Vrms for 1 min. to all inputs and outputs.
3. **KEYPAD**: 2 programmable function keys, 4 keys total
4. **A/D CONVERTER**: 24 bit resolution
5. **DISPLAY MESSAGES**:
   "OLOL" - Appears when measurement exceeds + signal range.
   "ULUL" - Appears when measurement exceeds - signal range
   "Shrt" - Appears when shorted sensor is detected. (RTD range only)
   "OPEN" - Appears when open sensor is detected. (TC/RTD range only)
   ". . . ." - Appears when display values exceed + display range.
   "- . . ." - Appears when display values exceed - display range.
6. **INPUT CAPABILITIES**:

Current Input:

INPUT RANGE	ACCURACY * (18 to 28°C)	ACCURACY * (0 to 50°C)	IMPEDANCE	‡ RESOLUTION
± 250 µADC	0.03% of rdg + 0.03µA	0.12% of rdg + 0.04µA	1.11 KΩ	0.1µA
± 2.5 mADC	0.03% of rdg + 0.3µA	0.12% of rdg + 0.4µA	111 Ω	1µA
± 25 mADC	0.03% of rdg + 3µA	0.12% of rdg + 4µA	11.1 Ω	10µA
± 250 mADC	0.05% of rdg + 30µA	0.12% of rdg + 40µA	1.1 Ω	0.1mA
± 2 ADC	0.5% of rdg + 0.3mA	0.7% of rdg + 0.4mA	0.1 Ω	1mA

Voltage Input:

INPUT RANGE	ACCURACY * (18 to 28°C)	ACCURACY * (0 to 50°C)	IMPEDANCE	‡ RESOLUTION
± 250 mVDC	0.03% of rdg + 30µV	0.12% of rdg + 40µV	451 KΩ	0.1mV
± 2.0 VDC	0.03% of rdg + 0.3mV	0.12% of rdg + 0.4mV	451 KΩ	1mV
± 10 VDC	0.03% of rdg + 3mV	0.12% of rdg + 4mV	451 KΩ	1mV
± 25 VDC	0.03% of rdg + 3mV	0.12% of rdg + 4mV	451 KΩ	10mV
± 100 VDC	0.3% of rdg + 30mV	0.12% of rdg + 40mV	451 KΩ	0.1V
± 200 VDC	0.3% of rdg + 30mV	0.12% of rdg + 40mV	451 KΩ	0.1V

Temperature Inputs:
   Scale: °F or °C
   Offset Range: -1999 to 9999 display units.

Thermocouple Inputs:
   Input Impedance: 20MΩ
   Lead Resisitance Effect: 0.03 µV/Ω
   Max Continuous Overvoltage: 30 VDC

INPUT TYPE	RANGE	ACCURACY* (18 to 28 °C)	ACCURACY* (0 to 50 °C)	STANDARD	WIRE COLOR	
					ANSI	BS 1843
T	-200 to 400°C	1.2°C	2.1°C	ITS-90	(+) blue (-) red	(+) white (-) blue
E	-200 to 750°C	1.0°C	2.4°C	ITS-90	(+) purple (-) red	(+) brown (-) blue
J	-200 to 760°C	1.1°C	2.3°C	ITS-90	(+) white (-) red	(+) yellow (-) blue
K	-200 to 1250°C	1.3°C	3.4°C	ITS-90	(+) yellow (-) red	(+) brown (-) blue
R	0 to 1768°C	1.9°C	4.0°C	ITS-90	no standard	(+) white (-) blue
S	0 to 1768°C	1.9°C	4.0°C	ITS-90	no standard	(+) white (-) blue
B	150 to 300°C 300 to 1820°C	3.9°C 2.8°C	5.7°C 4.4°C	ITS-90	no standard	no standard
N	-200 to 1300°C	1.3°C	3.1°C	ITS-90	(+) orange (-) red	(+) orange (-) blue
C (W5/W26)	0 to 2315°C	1.9°C	6.1°C	ASTM E988-90**	no standard	no standard

RTD Inputs:
   Type: 3 or 4 wire, 2 wire can be compensated for lead wire resistance
   Excitation current: 100 ohm range: 136.5 µA ±10%
   10 ohm range: 2.05 mA ±10%
   Lead resistance: 100 ohm range: 10 ohm/lead max.
   10 ohm range: 3 ohms/lead max.
   Max. continuous overload: 30 VDC

INPUT TYPE	RANGE	ACCURACY* (18 to 28 °C)	ACCURACY* (0 to 50 °C)	STANDARD **
100 ohm Pt alpha = .00385	-200 to 850°C	0.4°C	1.6°C	IEC 751
100 ohm Pt alpha = .00392	-200 to 850°C	0.4°C	1.6°C	no official standard
120 ohm Nickel alpha = .00672	-80 to 259°C	0.2°C	0.5°C	no official standard
10 ohm Copper alpha = .00427	-110 to 260°C	0.4°C	0.9°C	no official standard

Resistance Inputs:

INPUT RANGE	ACCURACY * (18 to 28°C)	ACCURACY * (0 to 50°C)	COMPLIANCE	MAX CONT. OVERLOAD	‡ RESOLUTION
100 ohm	0.05% of rdg +0.03 ohm	0.2% of rdg +0.04 ohm	0.175 V	30 V	0.1 ohm
999 ohm	0.05% of rdg +0.3 ohm	0.2% of rdg +0.4 ohm	1.75 V	30 V	1 ohm
9999 ohm	0.05% of rdg +1 ohm	0.2% of rdg +1.5 ohm	17.5 V	30 V	1 ohm

‡ Higher resolution can be achieved via input scaling.

* After 20 min. warm-up, @ 5 samples per second input rate. Accuracy is specified in two ways: Accuracy over an 18 to 28ºC and 15 to 75% RH environment; and Accuracy over a 0 to 50ºC and 0 to 85% RH (non condensing) environment. The specification includes the A/D conversion errors, linearization conformity, and thermocouple ice point compensation. Total system accuracy is the sum of controller and probe errors. Accuracy may be improved by field calibrating the controller readout at the temperature of interest.

**

These curves have been corrected to ITS-90.

7. **EXCITATION POWER**: Jumper selectable
   Transmitter Power: +18 VDC, ± 5% @ 50 mA max.
   Reference Voltage: + 2 VDC, ± 2%
     Compliance: 1KΩ load min (2 mA max)
     Temperature Coefficient: 40 ppm/ºC max.
   Reference Current: 1.05 mADC, ± 2%
     Compliance: 10 KΩ load max.
     Temperature Coefficient: 40 ppm/ºC max.
8. **USER INPUTS**: Two programmable user inputs
   Max. Continuous Input: 30 VDC
   Isolation To Sensor Input Common: Not isolated.
   Logic State: User programmable (*UAC t*) for sink/source (Lo/Hi)

INPUT STATE (*U5r AC t*)	LO/SINK	HI/SOURCE
	20KΩ pull-up to +3.3V	20KΩ pull-down
Active	V_{IN} < 1.1 VDC	V_{IN} > 2.2 VDC
Inactive	V_{IN} > 2.2 VDC	V_{IN} < 1.1 VDC

9. **CUSTOM LINEARIZATION**:
   Data Point Pairs: Selectable from 2 to 16
   Display Range: -1999 to 9999
   Decimal Point: 0 to 0.000
10. **MEMORY**: Nonvolatile FRAM memory retains all programmable parameters and display values.
11. **ENVIRONMENTAL CONDITIONS**:
   Operating Temperature Range: 0 to 50 °C
   Storage Temperature Range: -40 to 60 °C
   Vibration to IEC 68-2-6: Operational 5-150 Hz, 2 g
   Shock to IEC 68-2-27: Operational 25 g (10 g relay)
   Operating and Storage Humidity: 0 to 85% max. RH non-condensing
   Altitude: Up to 2000 meters
12. **CERTIFICATIONS AND COMPLIANCES**:
   CE Approved
     EN 61326-1 Immunity to Industrial Locations
     Emission CISPR 11 Class A
     IEC/EN 61010-1
     RoHS Compliant
   UL Listed: File #E179259
   Type 4X Indoor Enclosure rating (Face only)
   IP65 Enclosure rating (Face only)
   IP20 Enclosure rating (Rear of unit)
   Refer to EMC Installation Guidelines section of the bulletin for additional information.
13. **CONNECTIONS**: High compression cage-clamp terminal block
   Wire Strip Length: 0.3" (7.5 mm)
   Wire Gauge Capacity: One 14 AWG (2.55 mm) solid, two 18 AWG (1.02 mm) or four 20 AWG (0.61 mm)
14. **CONSTRUCTION**: This unit is rated NEMA 4X/IP65 for indoor use only. IP20 Touch safe. Installation Category II, Pollution Degree 2. One piece bezel/ case. Flame resistant. Synthetic rubber keypad. Panel gasket and mounting clip included.
15. **WEIGHT**: 8 oz. (226.8 g)

OPTIONAL PLUG-IN CARDS

⚠ **WARNING: Disconnect all power to the unit before installing plug-in cards.**

Adding Option Cards

The PAX2C controllers can be fitted with up to three optional plug-in cards. The details for each plug-in card can be reviewed in the specification section below. Only one card from each function type can be installed at a time. The function types include Setpoint/Control (PAXCDS), Communications (PAXCDC), and Analog Output (PAXCDL). The plug-in cards can be installed initially or at a later date.

COMMUNICATION CARDS (PAXCDC)

A variety of communication protocols are available for the PAX2C controller. Only one PAXCDC card can be installed at a time. *Note: For Modbus communications use RS485 Communications Output Card and configure communication (tYPE) parameter for Modbus.*

PAXCDC10 - RS485 Serial (Terminal)   PAXCDC30 - DeviceNet

PAXCDC1C - RS485 Serial (Connector)   PAXCDC50 - Profibus-DP

PAXCDC20 - RS232 Serial (Terminal)

PAXCDC2C - RS232 Serial (Connector)

SERIAL COMMUNICATIONS CARD
Type: RS485 or RS232

Communication Type: RLC Protocol (ASCII), Modbus RTU, and Modbus ASCII

Isolation To Sensor & User Input Commons: 500 Vrms for 1 min. Working Voltage: 50 V. Not Isolated from all other commons.

Data: 7/8 bits

Baud: 1200 to 38,400

Parity: no, odd or even

Bus Address: Selectable 0 to 99 (RLC Protocol), or 1 to 247 (Modbus Protocol), Max. 32 controllers per line (RS485)

Transmit Delay: Selectable for 0 to 0.250 sec (+2 msec min)

DEVICENET™ CARD
Compatibility: Group 2 Server Only, not UCMM capable

Baud Rates: 125 Kbaud, 250 Kbaud, and 500 Kbaud

Bus Interface: Phillips 82C250 or equivalent with MIS wiring protection per DeviceNet™ Volume I Section 10.2.2.

Node Isolation: Bus powered, isolated node

Host Isolation: 500 Vrms for 1 minute (50 V working) between DeviceNet™ and controller input common.

PROFIBUS-DP CARD
Fieldbus Type: Profibus-DP as per EN 50170, implemented with Siemens SPC3 ASIC

Conformance: PNO Certified Profibus-DP Slave Device

Baud Rates: Automatic baud rate detection in the range 9.6 Kbaud to 12 Mbaud

Station Address: 0 to 125, set by rotary switches.

Connection: 9-pin Female D-Sub connector

Network Isolation: 500 Vrms for 1 minute (50 V working) between Profibus network and sensor and user input commons. Not isolated from all other commons.

PROGRAMMING SOFTWARE

Crimson® software is a Windows® based program that allows configuration of the PAX® controller from a PC. Crimson offers standard drop-down menu commands, that make it easy to program the controller. The controller's program can then be saved in a PC file for future use. The Crimson installation file is located on the included flash drive, or it can be downloaded at www.redlion.net

CONTROL/OUTPUT CARDS (PAXCDS)

The PAX2C controller has 4 available control/output plug-in cards. Only one PAXCDS card can be installed at a time. (Logic state of the outputs can be reversed in the programming.) These plug-in cards include:

PAXCDS10 - Dual Relay, FORM-C, Normally open & closed

PAXCDS20 - Quad Relay, FORM-A, Normally open only

PAXCDS30 - Isolated quad sinking NPN open collector

PAXCDS40 - Isolated quad sourcing PNP open collector

DUAL RELAY CARD
Type: Two FORM-C relays

Isolation To Sensor & User Input Commons: 2000 Vrms for 1 min. Working Voltage: 240 Vrms

Contact Rating:
One Relay Energized: 5 amps @ 120/240 VAC or 28 VDC (resistive load). Total current with both relays energized not to exceed 5 amps

Life Expectancy: 100 K cycles min. at full load rating. External RC snubber extends relay life for operation with inductive loads

QUAD RELAY CARD
Type: Four FORM-A relays

Isolation To Sensor & User Input Commons: 2300 Vrms for 1 min. Working Voltage: 250 Vrms

Contact Rating:
One Relay Energized: 3 amps @ 240 VAC or 30 VDC (resistive load). Total current with all four relays energized not to exceed 4 amps

Life Expectancy: 100K cycles min. at full load rating. External RC snubber extends relay life for operation with inductive loads

QUAD SINKING OPEN COLLECTOR CARD
Type: Four isolated sinking NPN transistors.

Isolation To Sensor & User Input Commons: 500 Vrms for 1 min. Working Voltage: 50 V. Not Isolated from all other commons.

Rating: 100 mA max @ V_{SAT} = 0.7 V max. V_{MAX} = 30 V

QUAD SOURCING OPEN COLLECTOR CARD
Type: Four isolated sourcing PNP transistors.

Isolation To Sensor & User Input Commons: 500 Vrms for 1 min. Working Voltage: 50 V. Not Isolated from all other commons.

Rating: Internal supply: 18 VDC unregulated, 30 mA max. total
External supply: 30 VDC max., 100 mA max. each output

ALL FOUR SETPOINT CARDS
Response Time: See Update Rates step response specification on page 3; add 6 msec (typical) for relay card

LINEAR DC OUTPUT (PAXCDL)

Either a 0(4)-20 mA or 0-10 V linear DC output is available from the analog output plug-in card. The programmable output low and high scaling can be based on various display values. Reverse slope output is possible by reversing the scaling point positions.

PAXCDL10 - Retransmitted Analog Output Card

ANALOG OUTPUT CARD
Types: 0 to 20 mA, 4 to 20 mA or 0 to 10 VDC

Isolation To Sensor & User Input Commons: 500 Vrms for 1 min. Working Voltage: 50 V. Not Isolated from all other commons.

Accuracy: 0.17% of FS (18 to 28 °C); 0.4% of FS (0 to 50 °C)

Resolution: 1/3500

Compliance: 10 VDC: 10 KΩ load min., 20 mA: 500 Ω load max.
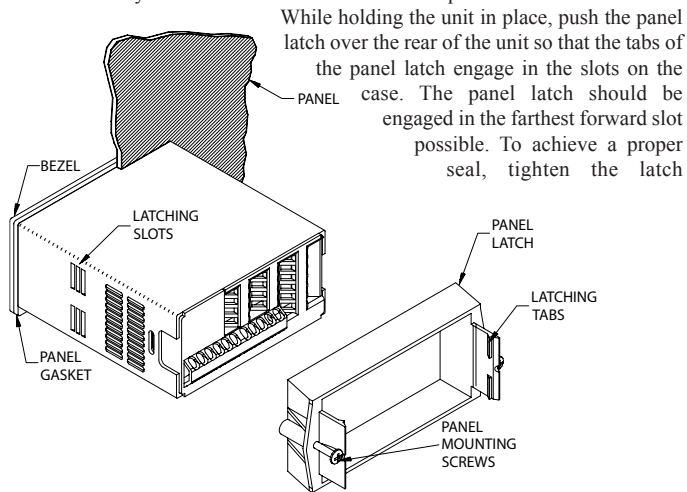
Powered: Self-powered

Step Response: See Update Rates step response specification on page 3.

Update time: See ADC Conversion Rate and Update Time parameter

1.0 INSTALLING THE CONTROLLER

Installation

The PAX2C meets NEMA 4X/IP65 requirements when properly installed. The unit is intended to be mounted into an enclosed panel. Prepare the panel cutout to the dimensions shown. Remove the panel latch from the unit. Slide the panel gasket over the rear of the unit to the back of the bezel. The unit should be installed fully assembled. Insert the unit into the panel cutout.

While holding the unit in place, push the panel latch over the rear of the unit so that the tabs of the panel latch engage in the slots on the case. The panel latch should be engaged in the farthest forward slot possible. To achieve a proper seal, tighten the latch

screws evenly until the unit is snug in the panel (Torque to approximately 7 in-lbs [79N-cm]). Do not over-tighten the screws.

Installation Environment

The unit should be installed in a location that does not exceed the operating temperature and provides good air circulation. Placing the unit near devices that generate excessive heat should be avoided.

The bezel should only be cleaned with a soft cloth and neutral soap product. Do NOT use solvents. Continuous exposure to direct sunlight may accelerate the aging process of the bezel.

Do not use tools of any kind (screwdrivers, pens, pencils, etc.) to operate the keypad of the unit.

HORIZONTAL PANEL CUT-OUT

$3.62 \, ^{+.03}_{-.00}$
$(92 \, ^{+.8}_{-.0})$

$1.77 \, ^{+.02}_{-.00}$
$(45 \, ^{+.5}_{-.0})$
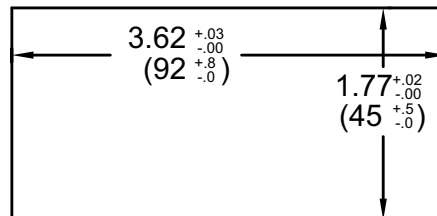
2.0 SETTING THE JUMPERS

The PAX2C controller has four jumpers that must be checked and/or changed prior to applying power. The following Jumper Selection Figures show an enlargement of the jumper area.

To access the jumpers, remove the controller base from the case by firmly squeezing and pulling back on the side rear finger tabs. This should lower the latch below the case slot (which is located just in front of the finger tabs). It is recommended to release the latch on one side, then start the other side latch.

⚠️ **Warning**: Exposed line voltage exists on the circuit boards. Remove all power to the controller and load circuits before accessing inside of the controller.

Current Input

For current input, only one jumper must be configured to select the current range. This jumper is shared with the voltage input range. To avoid overloads, select the jumper position that is high enough to accommodate the maximum signal input level to be applied.

Note: The position of the T/V jumper does not matter when the controller is in the current input mode.
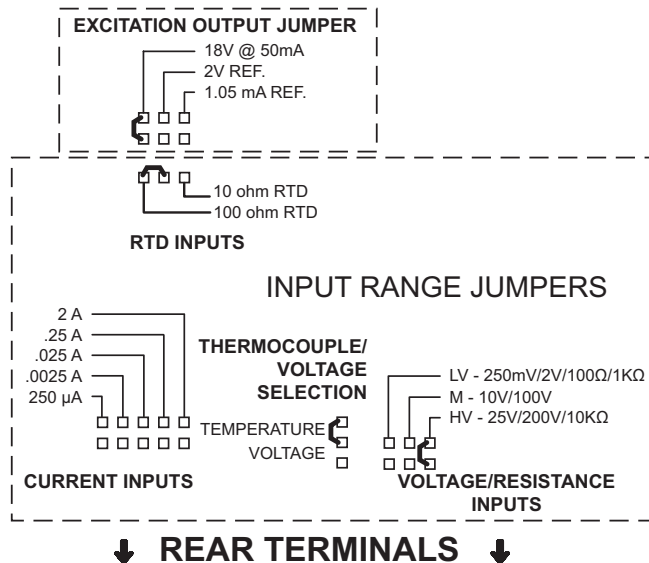
Temperature Input

For temperature measurement the T/V jumper must be in the T (temperature) position. For RTD sensors the RTD jumper must also be set.

Resistance Input

Three jumpers are used to configure the resistance input. The T/V jumper must be in the V (voltage) position, and the excitation jumper must be in the 1.05 mA REF position. The voltage/resistance jumper position is determined by the input range.

Excitation Output Jumper

This jumper is used to select the excitation range for the application. If excitation is not being used, it is not necessary to check or move this jumper.
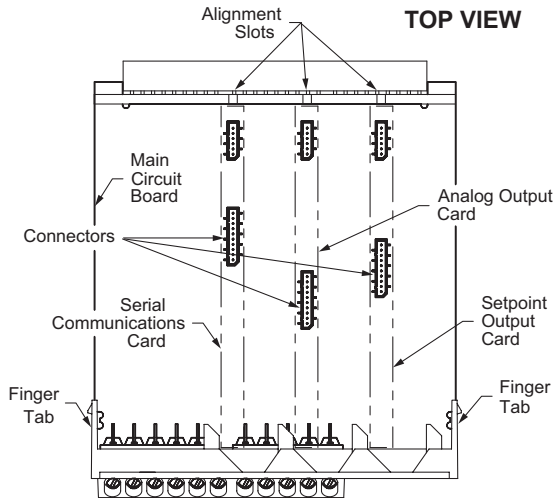
INPUT RANGE JUMPERS

Voltage Input

Two jumpers are used in configuring the controller for voltage/resistance. The first jumper, T/V, must be in the V (voltage) position. The second jumper is used to select the proper voltage input range. (This jumper is also used to select the current input range.) Select a range that is high enough to accommodate the maximum signal input to avoid overloads. For proper operation, the input range selected in programming must match the jumper setting.

3.0 INSTALLING PLUG-IN CARDS

The plug-in cards are separately purchased optional cards that perform specific functions. These cards plug into the main circuit board of the controller. The plug-in cards have many unique functions when used with the PAX2C.

CAUTION: The plug-in card and main circuit board contain static sensitive components. Before handling the cards, discharge static charges from your body by touching a grounded bare metal object. Ideally, handle the cards at a static controlled clean workstation. Also, only handle the cards by the edges. Dirt, oil or other contaminants that may contact the cards can adversely affect circuit operation.

TOP VIEW

Alignment Slots
Main Circuit Board
Connectors
Analog Output Card
Serial Communications Card
Setpoint Output Card
Finger Tab
Finger Tab

To Install:

1. With the controller removed from the case, locate the plug-in card connector for the card type to be installed. The types are keyed by position with different main circuit board connector locations. When installing the card, hold the controller by the rear terminals and not by the front display board.

   If installing the Quad sourcing Plug-in Card (PAXCDS40), set the jumper for internal or external supply operation before continuing.

Internal Supply (18 V unregulated)
External Supply (30 V_{max})
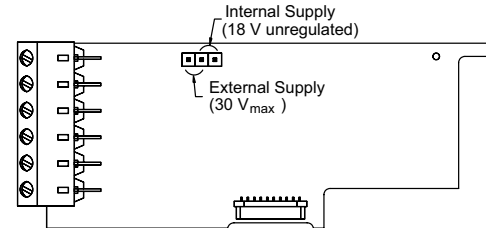
2. Install the plug-in card by aligning the card terminals with the slot bay in the rear cover. Be sure the connector is fully engaged and the tab on the plug-in card rests in the alignment slot on the display board.

3. Slide the controller base back into the case. Be sure the rear cover latches fully into the case.

4. Apply the plug-in card label to the bottom side of the controller in the designated area. Do Not Cover the vents on the top surface of the controller. The surface of the case must be clean for the label to adhere properly.

4.0 WIRING THE CONTROLLER

WIRING OVERVIEW

Electrical connections are made via screw-clamp terminals located on the back of the controller. All conductors should conform to the controller's voltage and current ratings. All cabling should conform to appropriate standards of good installation, local codes and regulations. It is recommended that the power supplied to the controller (DC or AC) be protected by a fuse or circuit breaker.

When wiring the controller, compare the numbers embossed on the back of the controller case against those shown in wiring drawings for proper wire position. Strip the wire, leaving approximately 0.3" (7.5 mm) bare lead exposed (stranded wires should be tinned with solder). Insert the lead under the correct screw-clamp terminal and tighten until the wire is secure (Pull wire to verify tightness). Each terminal can accept up to one #14 AWG (2.55 mm) wire, two #18 AWG (1.02 mm), or four #20 AWG (0.61 mm).

EMC INSTALLATION GUIDELINES

Although Red Lion Controls Products are designed with a high degree of immunity to Electromagnetic Interference (EMI), proper installation and wiring methods must be followed to ensure compatibility in each application. The type of the electrical noise, source or coupling method into a unit may be different for various installations. Cable length, routing, and shield termination are very important and can mean the difference between a successful or troublesome installation. Listed are some EMI guidelines for a successful installation in an industrial environment.

1. A unit should be mounted in a metal enclosure, which is properly connected to protective earth.

2. Use shielded cables for all Signal and Control inputs. The shield connection should be made as short as possible. The connection point for the shield depends somewhat upon the application. Listed below are the recommended methods of connecting the shield, in order of their effectiveness.

   a. Connect the shield to earth ground (protective earth) at one end where the unit is mounted.

   b. Connect the shield to earth ground at both ends of the cable, usually when the noise source frequency is over 1 MHz.

3. Never run Signal or Control cables in the same conduit or raceway with AC power lines, conductors, feeding motors, solenoids, SCR controls, and heaters, etc. The cables should be run through metal conduit that is properly grounded. This is especially useful in applications where cable runs are long

and portable two-way radios are used in close proximity or if the installation is near a commercial radio transmitter. Also, Signal or Control cables within an enclosure should be routed as far away as possible from contactors, control relays, transformers, and other noisy components.

4. Long cable runs are more susceptible to EMI pickup than short cable runs.

5. In extremely high EMI environments, the use of external EMI suppression devices such as Ferrite Suppression Cores for signal and control cables is effective. The following EMI suppression devices (or equivalent) are recommended:

   Fair-Rite part number 0443167251 (RLC part number FCOR0000)
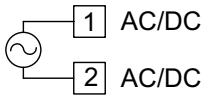   Line Filters for input power cables:
   Schaffner # FN2010-1/07 (Red Lion Controls # LFIL0000)

6. To protect relay contacts that control inductive loads and to minimize radiated and conducted noise (EMI), some type of contact protection network is normally installed across the load, the contacts or both. The most effective location is across the load.

   a. Using a snubber, which is a resistor-capacitor (RC) network or metal oxide varistor (MOV) across an AC inductive load is very effective at reducing EMI and increasing relay contact life.

   b. If a DC inductive load (such as a DC relay coil) is controlled by a transistor switch, care must be taken not to exceed the breakdown voltage of the transistor when the load is switched. One of the most effective ways is to place a diode across the inductive load. Most RLC products with solid state outputs have internal zener diode protection. However external diode protection at the load is always a good design practice to limit EMI. Although the use of a snubber or varistor could be used.

   RLC part numbers: Snubber: SNUB0000
   Varistor: ILS11500 or ILS23000

7. Care should be taken when connecting input and output devices to the instrument. When a separate input and output common is provided, they should not be mixed. Therefore a sensor common should NOT be connected to an output common. This would cause EMI on the sensitive input common, which could affect the instrument's operation.
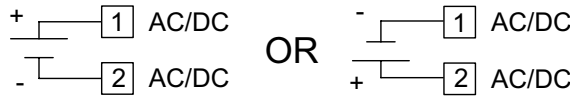
Visit RLC's web site at http://www.redlion.net/Support/InstallationConsiderations.html for more information on EMI guidelines, Safety and CE issues as they relate to Red Lion Controls products.

4.1 POWER WIRING

AC Power

```
AC/DC  1   AC/DC
AC/DC  2   AC/DC
```

DC Power

```
+   1  AC/DC          -   1  AC/DC
         OR
-   2  AC/DC          +   2  AC/DC
```

The power supplied to the meter shall employ a 15 Amp UL approved circuit breaker for AC input and a 1 Amp, 250 V UL approved fuse for DC input. It shall be easily accessible and marked as a disconnecting device to the installed unit. This device is not directly intended for connection to the mains without a reliable means to reduce transient over-voltages to 1500 V.

4.2 VOLTAGE/RESISTANCE/CURRENT INPUT SIGNAL WIRING

IMPORTANT: Before connecting signal wires, the Input Range Jumpers and Excitation Jumper should be verified for proper position.

Voltage Signal

```
I INPUT        V-TC-RTD IN        INP COMM
   6               7                  8
       +              −
200VDC MAX.
```
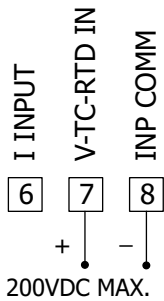
Process/Current Signal (external powered)

```
I INPUT            INP COMM
   6                  8
-          +
   Load
+
2A DC MAX.
```
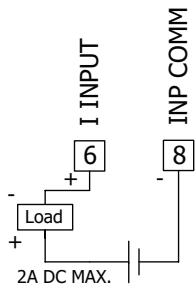
Process/Current Signal (2 wire requiring 18V excitation)

Excitation Jumper: 18 V

```
V EXEC    COMM    RTD EXC    I INPUT
  3        4        5          6
       +   2 WIRE   -
           TRANSMITTER
```
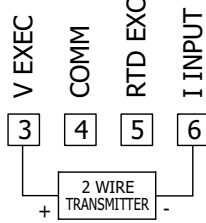
Current Signal (3 wire requiring 18 V excitation)

Terminal 3: +Volt supply
Terminal 6: +ADC (signal)
Terminal 8: -ADC (common)
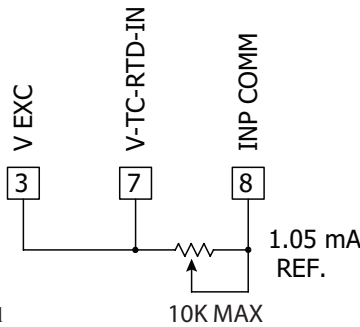Excitation Jumper: 18 V
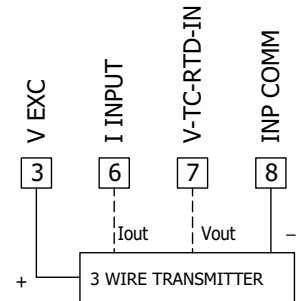
Voltage Signal (3 wire requiring 18 V excitation)

Terminal 3: +Volt supply
Terminal 7: +VDC (signal)
Terminal 8: -VDC (common)
Excitation Jumper: 18 V

```
V EXC    I INPUT    V-TC-RTD-IN    INP COMM
  3        6            7             8
           Iout         Vout
     +   3 WIRE TRANSMITTER          −
```
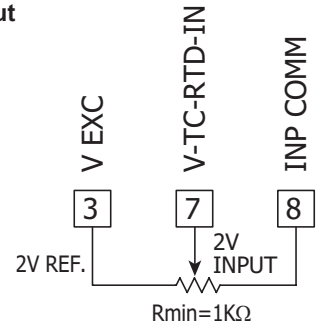
Resistance Signal (2 wire requiring excitation)

Terminal 3: Jumper to terminal 7
Terminal 7: Resistance
Terminal 8: Resistance
Excitation Jumper: 1.05 mA REF.
T/V Jumper: V position
Voltage/Resistance Input Jumper: Set per input signal

```
V EXC    V-TC-RTD-IN    INP COMM
  3          7             8
                    1.05 mA
                    REF.
         10K MAX
```

Potentiometer Signal as Voltage Input (3 wire requiring excitation)

Terminal 3: High end of pot.
Terminal 7: Wiper
Terminal 8: Low end of pot.
Excitation Jumper: 2 V REF.
T/V Jumper: V
Voltage/Resistance Input Jumper: 2 Volt
Module 1 Input Range: 2 Volt
Note: The Apply signal scaling style should be used because the signal will be in volts.

```
V EXC        V-TC-RTD-IN    INP COMM
  3              7             8
                            2V
2V REF.                     INPUT
                 Rmin=1KΩ
```

CAUTION: *Sensor input common is NOT isolated from user input common. In order to preserve the safety of the controller application, the sensor input common must be suitably isolated from hazardous live earth referenced voltages; or input common must be at protective earth ground potential. If not, hazardous live voltage may be present at the User Inputs and User Input Common terminals. Appropriate considerations must then be given to the potential of the user input common with respect to earth common; and the common of the isolated plug-in cards with respect to input common.*
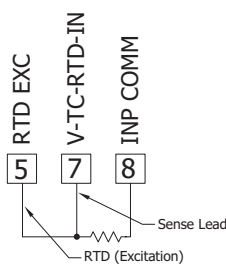
4.3 TEMPERATURE INPUT SIGNAL WIRING

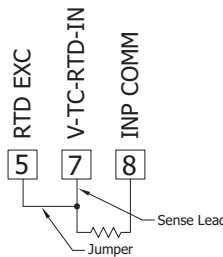**IMPORTANT**: Before connecting signal wires, verify the T/V Jumper is in the T position.

Thermocouple

```
V-TC-RTD-IN    INP COMM
    7              8
+                  −
```

3-Wire RTD

```
RTD EXC    V-TC-RTD-IN    INP COMM
   5           7             8
                          Sense Lead
        RTD (Excitation)
```

2-Wire RTD

```
RTD EXC    V-TC-RTD-IN    INP COMM
   5           7             8
                          Sense Lead
              Jumper
```

CAUTION: *Sensor input common is NOT isolated from user input common. In order to preserve the safety of the controller application, the sensor input common must be suitably isolated from hazardous live earth referenced voltages; or input common must be at protective earth ground potential. If not, hazardous live voltage may be present at the User Inputs and User Input Common terminals. Appropriate considerations must then be given to the potential of the user input common with respect to earth common; and the common of the isolated plug-in cards with respect to input common.*

4.4 USER INPUT WIRING

If not using User Inputs, then skip this section. User Input terminal does not need to be wired in order to remain in the inactive state.

Sinking Logic (⎍⎍⎍ ᴸᵒ)

When the ⎍⎍⎍ parameter is programmed to ᴸᵒ, the user inputs of the controller are internally pulled up to +3.3 V with 20 KΩ resistance. The input is active when it is pulled low (<1.1 V).
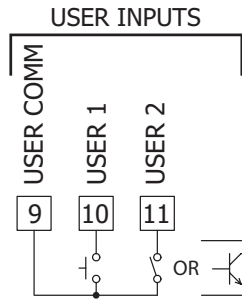
USER INPUTS

USER COMM | USER 1 | USER 2
9 | 10 | 11

OR

Sourcing Logic (⎍⎍⎍ ᴴᵢ)

When the ⎍⎍⎍ parameter is programmed to ᴴᵢ, the user inputs of the controller are internally pulled down to 0 V with 20 KΩ resistance. The input is active when a voltage greater than 2.2 VDC is applied.

USER INPUTS

USER COMM | USER 1 | USER 2
9 | 10 | 11

OR

V SUPPLY (30V max.)
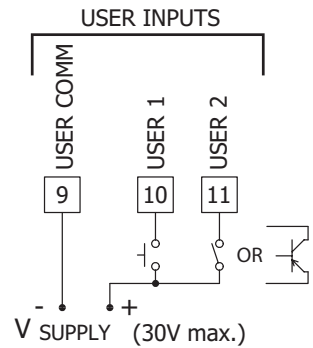
4.5 SETPOINT (ALARMS) WIRING

4.6 SERIAL COMMUNICATION WIRING

4.7 ANALOG OUTPUT WIRING

See appropriate plug-in card bulletin for wiring details.

5.0 REVIEWING THE FRONT BUTTONS AND DISPLAY

Line 1:
Display, Bar Graph and Units
(Color Zone 1)

Line 2:
Display, Bar Graph and Units
(Color Zone 2)

Universal Annunciators
(Color Zones 3 - 6)

MAN   REM

Manual and Remote Mode Mnemonics
(Color Zone 7)

D | P | F1 | F2

KEY	DISPLAY MODE OPERATION
D	Index Line 2 through enabled Line 2 display values
P	Enter full programming mode or access the parameter and hidden display loops; Press and hold to skip parameters and go directly to Code or Programming Menu
F1	User programmable Function key 1; hold for 3 seconds for user programmable second function 1*
F2	User programmable Function key 2; hold for 3 seconds for user programmable second function 2*

Factory setting for F1 and F2 and second function F1/F2 is no mode

KEY	PROGRAMMING MODE OPERATION
D	Return to the previous menu level (momentary press) Quick exit to Display Mode (press and hold)
P	Access the programming parameter menu, store selected parameter and index to next parameter
F1	Increment selected parameter value; Hold F1 and momentarily press F2 key to increment next decade or D key to increment by 1000's
F2	Decrement selected parameter value; Hold F2 and momentarily press F1 key to decrement next decade or D key to decrement by 1000's

DISPLAY LINE 1

Line 1 consists of a large 4-digit top line display, eight segment bar graph and a three digit units mnemonic: Values such as Input, Max(HI) & Min (LO) may be shown on Line 1. The eight segment bar graph may be mapped to values such as Output Power, Deviation or Setpoints. The three digit units mnemonic characters can be used to indicate which Line 1 display value is shown. Line 1 is a tri-colored display and may be configured to change color based on specified alarm/logic configurations.

DISPLAY LINE 2

Line 2 consists of a 4-digit bottom line display, eight segment bar graph and a three digit units mnemonic. Values such as Setpoints, Output Power, Deviation, PID Parameters/Tuning Status, List A/B Status, and Alarm Values may be shown on the Line 2 display. The eight segment bar graph may be mapped to values such as Output Power, Deviation or Setpoints. The three digit units mnemonic characters can be used to indicate which Line 2 display value is shown. Line 2 is a tri-colored display and may be configured to change color based on specified alarm/logic configurations.
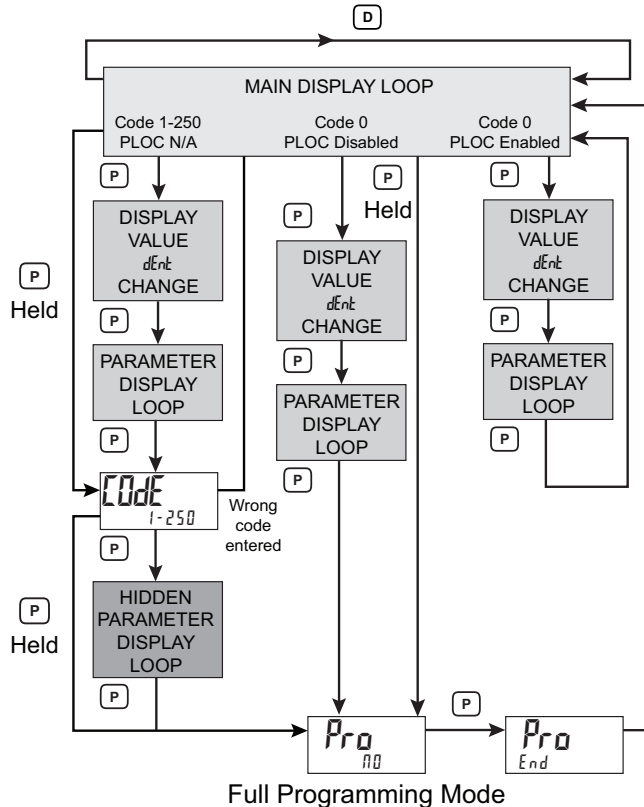
The display loops described in the next section are used to view, reset and modify the selected display values, based on the Line 2 Value Access setting programmed for each available value. See Line 2 parameters in the Display Parameters programming section for configuration details.

Universal Annunciator Zones

The PAX2C has four programmable universal annunciator zones. Each zone has a user-defined two digit annunciator mnemonic to suit a variety of applications. Universal annunciator zones are tri-colored and may be configured to change color based on specified alarm/logic configurations.

Manual Mnemonic

'MAN' - Flashes when the unit is in manual mode

The Mnemonic zone is tri-colored and may be configured to change color based on specified alarm/logic configurations.

LINE 2 DISPLAY LOOPS

The PAX2C offers three display loops to allow users quick access to needed information.

Full Programming Mode

Main Display Loop

In the Main display loop, the D key is pressed to sequence through the selected Line 2 values. The Line 2 units mnemonics are used to indicate which Line 2 value is currently shown. When in the Main display loop, the Function keys □ and □ perform the user functions programmed in the User Input parameter section.

Parameter and Hidden Parameter Display Loops

Display loops provide quick access to selected parameters that can be viewed and modified on Line 2 without having to enter Full Programming mode. These values may include: input, max/min, List A/B selection, output power, PID parameters/control, alarm parameters, setpoint values/selection, and display intensity and contrast settings. To utilize the Parameter or Hidden Parameter display loops, a security code (1-250) must be programmed. (See Programming Security Code in the Display Parameters programming section for details.)

The Parameter display loop is accessed by pressing the **P** key. The selected Parameter display loop values can be viewed and/or changed per the Line 2 Value Access setting programmed for each available value. The Hidden Parameter display loop follows the Parameter display loop, and can only be accessed when the correct security code is entered at the Code prompt. Combining the two parameter loops provides an area for parameters that require general access and/or protected or secure access depending on the application needs.

While in the Parameter and Hidden Parameter loops, pressing the **D** key will return the meter to the Main display loop. To directly access the Code prompt, press and hold the **P** key. This can be done from the Main display loop or at any point during the Parameter display loop. Also, to directly access Full Programming mode while in the Hidden Parameter loop, press and hold the **P** key to bypass any remaining Hidden Parameter loop values.

6.0 PROGRAMMING THE PAX2C

It is recommended that program settings be recorded as programming is performed. A blank Parameter Value Chart is provided at the end of this bulletin.

BASIC/ADVANCED MODE

The PAX2C incorporates two different configuration modes that are user selectable via the Display Configuration Menu:

Basic Mode (b5ıC)

When the PAX2C is configured in this mode, a maximum of four alarms are supported and no mapped backlignt color changes are available. Default backlight colors are still user selectable.

Advanced Mode (AdUC)

A maximum of sixteen alarms are supported and all backlight color configuration menu parameters are enabled. Select this mode when you require more than four alarms or where display color changes are desired.

PROGRAMMING MODE ENTRY

The Programming Mode is entered by pressing the **P** key. Full Programming Mode will be accessible unless the controller is programmed to use the Parameter loop or Hidden Parameter loop on the Line 2 display. In this case, programming access will be limited by a security code and/or a hardware program lock. (Refer to the previous section for details on Line 2 display loops and limited programming access.) Full Programming Mode permits all parameters to be viewed and modified. In this mode, the front panel keys change to Programming Mode Operations and certain user input functions are disabled.

MODULE ENTRY

The Programming Menu is organized into seven modules. These modules group together parameters that are related in function. The □ and □ keys are used to select the desired module. The displayed module is entered by pressing the **P** key.

MODULE MENU

Upon entering a module, a parameter selection sub-menu is provided to choose the specific parameter type for programming. For example, this includes analog and user input under the Input Parameter menu. Use the □ and □ keys to select the desired parameter type, and press the **P** key to enter the parameter menu.

PARAMETER MENU

Upon entering the Parameter Menu, the **P** key is pressed to advance to a specific parameter to be changed. After completing the parameter menu, or upon pressing the **D** key, the display returns to the initial entry point for the parameter menu. For each additional press of the **D** key, the display returns to the previous level within the module until exiting the module entirely.

SELECTION/VALUE ENTRY

For each parameter, the top line display shows the parameter while the bottom line shows the selections/value for that parameter. The □ and □ keys are used to move through the selections/values for the parameter. Pressing the **P** key, stores and activates the displayed selection/value. This also advances the meter to the next parameter.

Numerical Value Entry

If the parameter is programmed for enter (*Entr*), the /F1\ and \F2/ keys are used to change the parameter values in any of the display loops.

The /F1\ and \F2/ keys will increment or decrement the parameter value. When the /F1\ or \F2/ key is pressed and held, the value automatically scrolls. The longer the key is held the faster the value scrolls.

For large value changes, press and hold the /F1\ or \F2/ key. While holding that key, momentarily press the opposite arrow key (\F2/ or /F1\) to shift decades (10's 100's, etc), or momentarily press the **D** key and the value scrolls by 1000's as the arrow key is held. Releasing the arrow key removes the decade or 1000's scroll feature. The arrow keys can then be used to make small value changes as described above.

PROGRAMMING MODE EXIT

To exit the Programming Mode, press and hold the **D** key (from anywhere in the Programming Mode) or press the **P** key with *Pro NO* displayed. This will commit stored parameter changes to memory and return the meter to the Display Mode. If a parameter was just changed, the **P** key must be pressed to store the change before pressing the **D** key. (If power loss occurs before returning to the Display Mode, verify recent parameter changes.)
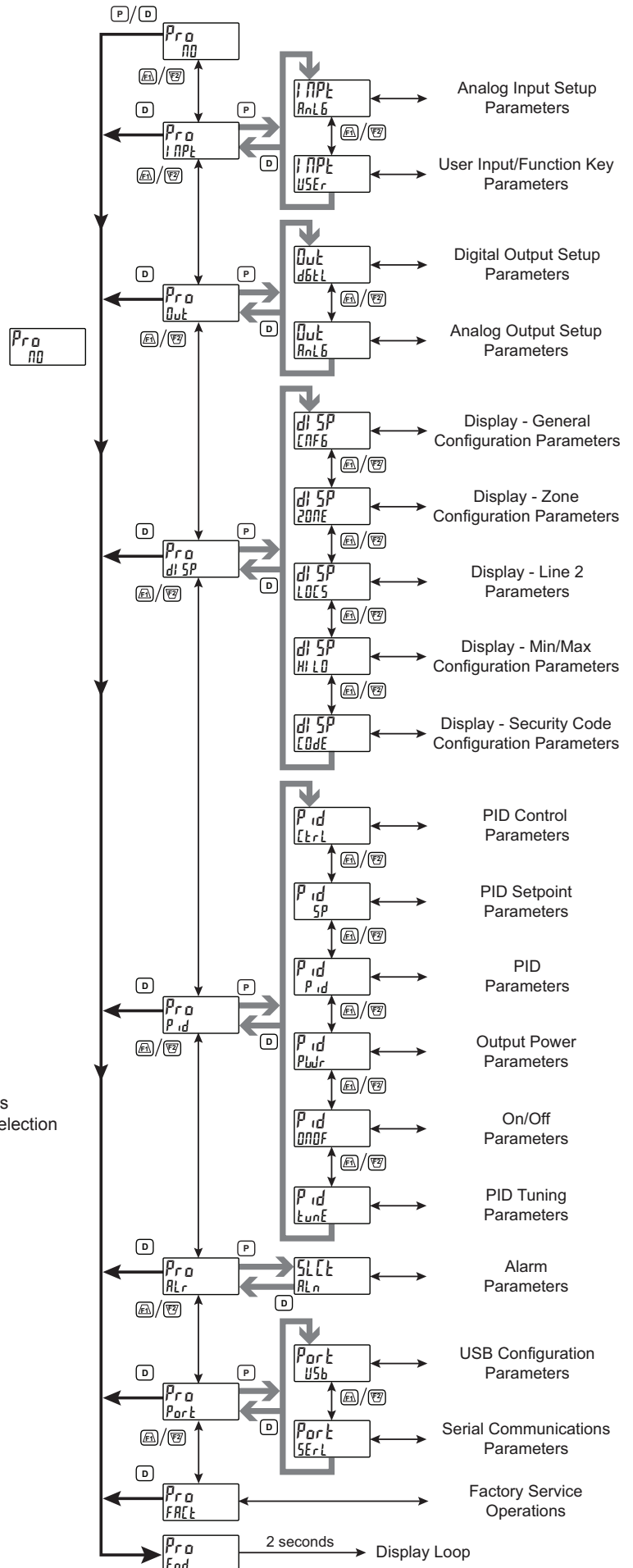
PROGRAMMING TIPS

It is recommended to start with the Input Parameters and proceed through each module in sequence. If lost or confused while programming, press and hold the **D** key to exit programming mode and start over. It is recommended that program settings be recorded as programming is performed. When programming is complete lock out programming with a user input or lock-out code.

Factory Settings may be completely restored in the Factory Service Operations module. This is useful when encountering programming problems.
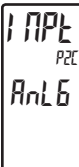
In Programming Menu:
Top line is green to indicate top level programming modules
Top line is orange to indicate module menu or sub-menu selection
Top line is red to indicate a changeable parameter.

Pro NO (P/D)

- **Pro INPT**
  - **INPT AnLG** — Analog Input Setup Parameters
  - **INPT USEr** — User Input/Function Key Parameters
- **Pro Out**
  - **Out dGtL** — Digital Output Setup Parameters
  - **Out AnLG** — Analog Output Setup Parameters
- **Pro dISP**
  - **dISP CNFG** — Display - General Configuration Parameters
  - **dISP ZONE** — Display - Zone Configuration Parameters
  - **dISP LOC5** — Display - Line 2 Parameters
  - **dISP HILO** — Display - Min/Max Configuration Parameters
  - **dISP COdE** — Display - Security Code Configuration Parameters
- **Pro Pid**
  - **Pid CtrL** — PID Control Parameters
  - **Pid SP** — PID Setpoint Parameters
  - **Pid Pid** — PID Parameters
  - **Pid PWr** — Output Power Parameters
  - **Pid ONOF** — On/Off Parameters
  - **Pid tunE** — PID Tuning Parameters
- **Pro ALr**
  - **SLCt ALn** — Alarm Parameters
- **Pro Port**
  - **Port USb** — USB Configuration Parameters
  - **Port SErL** — Serial Communications Parameters
- **Pro FACt** — Factory Service Operations
- **Pro End** — 2 seconds → Display Loop

Pro NO

11

INPUT PARAMETERS ($I\Pi P t$)

INPUT SELECT
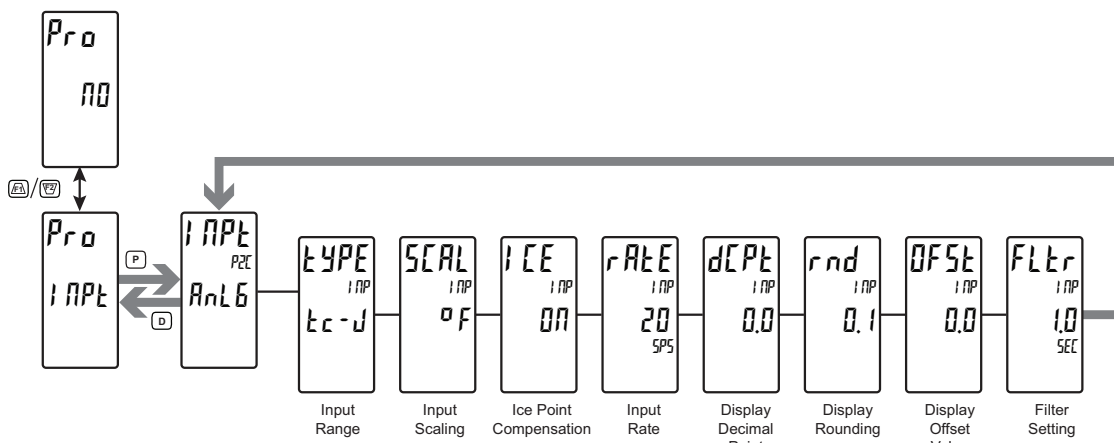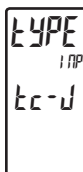
```
I\Pi Pt
    P2C
AnL6
```

AnL6   USEr

Select the Input to be programmed.

ANALOG INPUT PARAMETERS: TEMPERATURE MODE ($AnL6$)

This section details the programming for the analog input.

| Input Range | Input Scaling | Ice Point Compensation | Input Rate | Display Decimal Point | Display Rounding | Display Offset Value | Filter Setting |

TEMPERATURE INPUT TYPE

```
tYPE
   I\Pi P
tc-J
```

250 uA	2 U	1V RES	tc-r	r392
25 mA	10 U	10V RES	tc-5	r672
25 mA	25 U	tc-t	tc-b	r427
250 mA	100 U	tc-E	tc-n	
2 A	200 U	tc-J	tc-C	
250 mV	100 RES	tc-V	r385	

Shaded selections indicate the available temperature input types. Select the desired input type.

TEMPERATURE SCALE

```
SCAL
   I\Pi P
oF
```

oF   oC
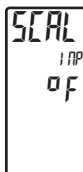
Select the temperature scale. If changed, those parameters that relate to the temperature scale should be checked.

ICE POINT COMPENSATION
For TC Input Range Selection only.

```
ICE
  I\Pi P
O\Pi
```

O\Pi   OFF

This parameter turns the internal ice point compensation on or off. Normally, the ice point compensation is on. If using external compensation, set this parameter to off. In this case, use copper leads from the external compensation point to the meter.

INPUT UPDATE RATE (/SEC)

```
rAtE
   I\Pi P
20
   SPS
```
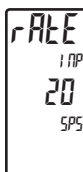
5   10   20

Select the ADC conversion rate (conversions per second). The selection does not affect the display update rate, however it does affect alarm and analog output response time. The default factory setting of 20 is recommended for most applications. Selecting a fast update rate may cause the display to appear very unstable.

DECIMAL RESOLUTION (Display Units)

```
dCPt
   I\Pi P
0.0
```

0 to 0.0   (temp)
0 to 0.000 (curr/volt/ohm)

Select desired display resolution. The available selections are dependent on the Input Type selected ($tYPE$).

ROUNDING INCREMENT

```
rnd
  I\Pi P
0.1
```

1   2   5
10   20   50   100

Rounding selections other than one, cause the Input Display to 'round' to the nearest rounding increment selected (ie. rounding of '5' causes 122 to round to 120 and 123 to round to 125). Rounding starts at the least significant digit of the Input Display. Remaining parameter entries (scaling point values, setpoint values, etc.) are not automatically adjusted to this display rounding selection.

DISPLAY OFFSET

```
OFSt
   I\Pi P
0.0
```

- 1999 to 9999

The display can be corrected with an offset value. This can be used to compensate for probe errors, errors due to variances in probe placement or adjusting the readout to a reference thermometer.

DIGITAL FILTERING
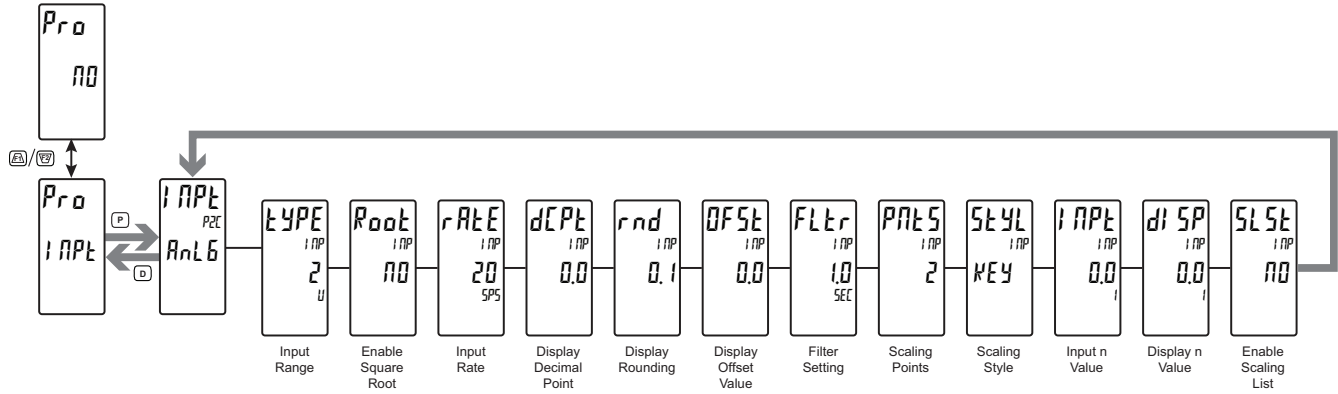
```
FLtr
   I\Pi P
1.0
   SEC
```

0.0 to 25.0   seconds

The input filter setting is a time constant expressed in tenths of a second. The filter settles to 99% of the final display value within approximately 3 time constants. This is an Adaptive Digital Filter which is designed to steady the Input Display reading. A value of '0' disables filtering.

ANALOG INPUT PARAMETERS: PROCESS MODE (AnLG)

This section details the programming for the analog input.

Input Range	Enable Square Root	Input Rate	Display Decimal Point	Display Rounding	Display Offset Value	Filter Setting	Scaling Points	Scaling Style	Input n Value	Display n Value	Enable Scaling List

PROCESS INPUT TYPE

250 uA	2 U	1K RES	tc-r	r392
25 mA	10 U	10K RES	tc-S	r672
25 mA	25 U	tc-t	tc-b	r427
250 mA	100 U	tc-E	tc-n	
2 A	200 U	tc-J	tc-C	
250 mV	100 RES	tc-K	r385	

Shaded selections indicate the available process input types. Select the desired input type.

SQUARE ROOT

YES   NO

This parameter allows the unit to be used in applications in which the measured signal is the square of the PV. This is useful in applications such as the measurement of flow with a differential pressure transducer.

Example: It is necessary to square root linearize the output of a differential pressure transmitter to indicate and control flow. The defining equation is F = 278 $\sqrt{\Delta P}$, where ΔP = 0 - 500 PSI, transmitted linearly by a 4 - 20 mA transducer. At full flow rate (ΔP = 500 PSI), the flow is 6216 ft^3/h. The following scaling information is used with the controller:

dCPt = 0	INPt 1 = 400 mA
Root = YES	di SP2 = 6216 ft^3/hr
di SP 1 = 0 ft^3/hr	INPt2 = 2000 mA

As a result of the scaling and square root linearization, the following represents the readings at various inputs:

Delta P (PSI)	Transmitter (mA)	Flow (ft^3/hr)
0.00	4.00	0
15.63	4.50	1099
31.25	5.00	1554
62.50	6.00	2198
125.00	8.00	3108
187.50	10.00	3807
250.00	12.00	4396
312.50	14.00	4914
375.00	16.00	5383
437.50	18.00	5815
500.00	20.00	6216

INPUT UPDATE RATE (/SEC)
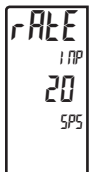
5   10   20   40

Select the ADC conversion rate (conversions per second). The selection does not affect the display update rate, however it does affect alarm and analog output response time. The default factory setting of 5 is recommended for most applications. Selecting a fast update rate may cause the display to appear very unstable.
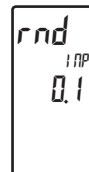
DECIMAL RESOLUTION (Display Units)
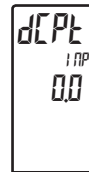
0 to 0.000 (curr/volt/ohm)
0 to 0.0   (temp)

Select desired display resolution. The available selections are dependent on the Input Type selected (tYPE).
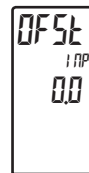
ROUNDING INCREMENT

1   2   5
10   20   50   100

Rounding selections other than one, cause the Input Display to 'round' to the nearest rounding increment selected (ie. rounding of '5' causes 122 to round to 120 and 123 to round to 125). Rounding starts at the least significant digit of the Input Display. Remaining parameter entries (scaling point values, setpoint values, etc.) are not automatically adjusted to this display rounding selection.

DISPLAY OFFSET

- 1999 to 9999

The display can be corrected with an offset value. This can be used to compensate for sensor errors, errors due to variances in sensor placement or adjusting the readout to a reference source. A value of zero will remove the affects of offset.
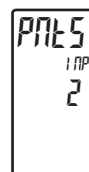
DIGITAL FILTERING

0.0 to 25.0   seconds

The input filter setting is a time constant expressed in tenths of a second. The filter settles to 99% of the final display value within approximately 3 time constants. This is an Adaptive Digital Filter which is designed to steady the Input Display reading. A value of '0' disables filtering.

SCALING POINTS

2 to 16

Linear - Scaling Points (2)

For linear processes, only 2 scaling points are necessary. It is recommended that the 2 scaling points be at opposite ends of the input signal being applied. The points do not have to be the signal limits. Display scaling will be linear between and continue past the entered points up to the limits of the Input Signal Jumper position. Each scaling point has a coordinate-pair consisting of an Input Value (INPt n) and an associated desired Display Value (di SP n).

Nonlinear - Scaling Points (Greater than 2)

For non-linear processes, up to 16 scaling points may be used to provide a piece-wise linear approximation. (The greater the number of scaling points used, the greater the conformity accuracy.) The Input Display will be linear between scaling points that are sequential in program order. Each scaling point has a coordinate-pair consisting of an Input Value (*I NPt n*) and an associated desired Display Value (*dI SP n*). Data from tables or equations, or empirical data could be used to derive the required number of segments and data values for the coordinate pairs. In the Crimson software, several linearization equations are provided to help calculate scaling points.

SCALING STYLE

StYL
I NP
KEY

KEY	key-in data
APLY	apply signal

If Input Values and corresponding Display Values are known, the Key-in (*KEY*) scaling style can be used. This allows scaling without the presence of the input signal. If Input Values have to be derived from the actual input signal source or simulator, the Apply (*APLY*) scaling style must be used.

INPUT VALUE FOR SCALING POINT 1

I NPt
I NP
0.000
1

- *1999* to *9999*

For Key-in (*KEY*), enter the known first Input Value by using the /F1\ or \F2/ arrow keys. (The Input Range selection sets up the decimal location for the Input Value). For Apply (*APLY*), the existing programmed value will appear. If this is acceptable, press the **P** key to save and continue to the next parameter. To update/program this value, apply the input signal that corresponds to Scaling Point 1, press \F2/ key and the actual signal value will be displayed. Then press the **P** key to accept this value and continue to the next parameter.

DISPLAY VALUE FOR SCALING POINT 1

dI SP
I NP
0.0
1

- *1999* to *9999*

Enter the first coordinating Display Value by using the arrow keys. This is the same for *KEY* and *APLY* scaling styles. The decimal point follows the *dCPt* selection.

INPUT VALUE FOR SCALING POINT 2

I NPt
I NP
1.000
2

- *1999* to *9999*

For Key-in (*KEY*), enter the known second Input Value by using the /F1\ or \F2/ arrow keys. For Apply (*APLY*), the existing programmed value will appear. If this is acceptable, press the **P** key to save and continue to the next parameter. To update/program this value, apply the input signal that corresponds to Scaling Point 2, press \F2/ key and the actual signal value will be displayed. Then press the **P** key to accept this value and continue to the next parameter. (Follow the same procedure if using more than 2 scaling points.)

DISPLAY VALUE FOR SCALING POINT 2

dI SP
I NP
100.0
2

- *1999* to *9999*

Enter the second coordinating Display Value by using the /F1\ or \F2/ arrow keys. This is the same for *KEY* and *APLY* scaling styles. (Follow the same procedure if using more than 2 scaling points.)

ENABLE SCALE LIST

SLSt
I NP
NO

NO   *YES*

When enabled, a second list of scaling points is active in the selected parameter list for List A and List B.

USER INPUT/FUNCTION KEY PARAMETERS (USEr)

The two user inputs are individually programmable to perform specific meter control functions. While in the Display Mode or Program Mode, the function is executed the instant the user input transitions to the active state. The front panel function keys, F1 and F2, are also individually programmable to perform specific control functions. While in the Display Mode, the primary function is executed the instant the key is pressed. Holding the function key for three seconds executes a secondary function. It is possible to program a secondary function without a primary function.

In most cases, if more than one user input and/or function key is programmed for the same function, the maintained (level trigger) actions will be performed while at least one of those user inputs or function keys are activated. The momentary (edge trigger) actions will be performed every time any of those user inputs or function keys transition to the active state.

Note: In the following explanations, not all selections are available for both user inputs and front panel function keys. Displays are shown with each selection. Those selections showing both displays are available for both. If a display is not shown, it is not available for that selection. USEr-n will represent both user inputs. Fn will represent both function keys and second function keys.
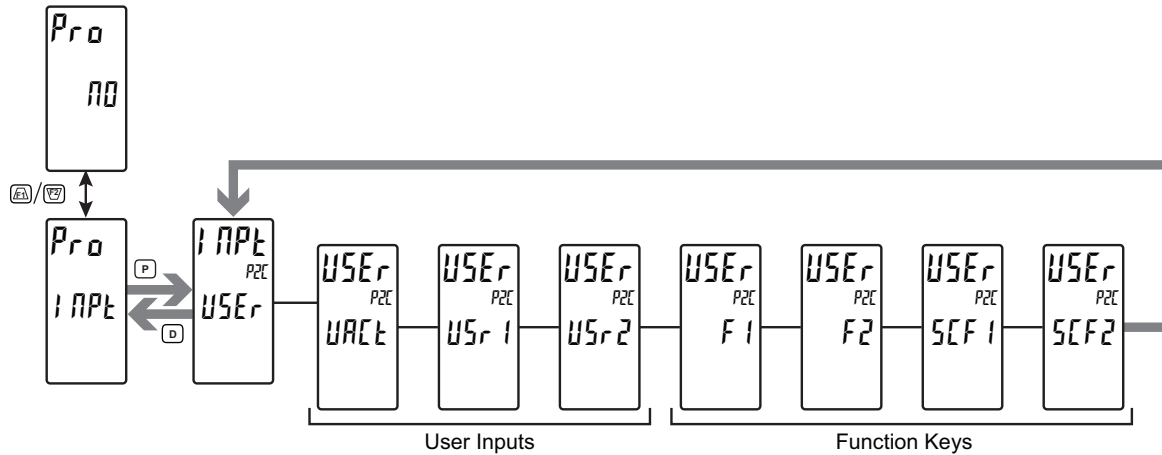
USER INPUT ACTIVE STATE

Lo Hi

Select the desired active state for the User Inputs. Select Lo for sink input, active low. Select Hi for source input, active high.

NO FUNCTION

No function is performed if activated. This is the factory setting for all user inputs and function keys.

PROGRAMMING MODE LOCK-OUT

Programming Mode is locked-out, as long as activated (maintained action). A security code can be configured to allow programming access during lock-out.

INTEGRAL ACTION LOCK

Integral Action of the PID computation is disabled as long as activated (USr = maintained action; Fn = toggle).

AUTO/MANUAL MODE

Places the controller in manual (user) mode as long as activated (USr = maintained action; Fn = toggle). The output is "bumpless" when transferring to/from either operating mode.

SETPOINT SELECTION

When activated (USr = maintained action; Fn = toggle), the controller uses Setpoint 2 (SP2) as the active setpoint value.
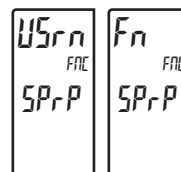
PID PARAMETER SELECTION

When activated (USr = maintained action; Fn = toggle), the controller uses the Alternate P, I, D, and filter values for control. The controller initiates a "bumpless" transfer during each transfer in an effort to minimize any output power fluctuation.
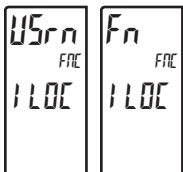
SETPOINT RAMPING DISABLE

When activated (USr = maintained action), setpoint ramping is terminated and unit will operate at the target setpoint. When user input is released, setpoint ramping will resume at the next setpoint change.
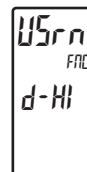
When Function key is pressed (Fn = toggle), setpoint ramping is terminated and unit will operate at the target setpoint. A second press of the function key resumes setpoint ramping at the next setpoint change.

SELECT MAXIMUM DISPLAY

The Maximum display appears on Line 2 as long as activated (maintained). When the user input is released, the previously selected display is returned. The **D** or **P** keys override and disable the active user input. The Maximum continues to function independent of the selected display.

RESET MAXIMUM DISPLAY

```
USrn    Fn
  FNC     FNC
r-HI    r-HI
```

When activated (momentary action), r5Et flashes and the Maximum resets to the present Input Display value. The Maximum function then continues from that value. This selection functions independent of the selected display.
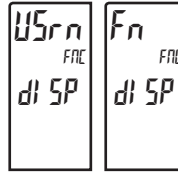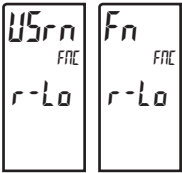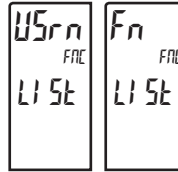
SELECT MINIMUM DISPLAY

```
USrn
  FNC
d-Lo
```

The Minimum display appears on Line 2 as long as activated (maintained). When the user input is released, the previously selected display is returned. The **D** or **P** keys override and disable the active user input. The Minimum continues to function independent of the selected display.

RESET MINIMUM DISPLAY

```
USrn    Fn
  FNC     FNC
r-Lo    r-Lo
```

When activated (momentary action), r5Et flashes and the Minimum resets to the present Input Display value. The Minimum function then continues from that value. This selection functions independent of the selected display.

RESET MAXIMUM AND MINIMUM DISPLAY

```
USrn    Fn
  FNC     FNC
r-HL    r-HL
```

When activated (momentary action), r5Et flashes and the Maximum and Minimum readings are set to the present Input Display value. The Maximum and Minimum function then continues from that value. This selection functions independent of the selected display.

RESET ALARMS

```
USrn    Fn
  FNC     FNC
r-AL    r-AL
```

When activated (momentary action), the controller will reset any active alarms that are selected in the User/Function Alarm Selection Menu (A5EL).

    Basic Mode: 4 Alarms Max
    Advanced Mode: 16 Alarms Max

ALARM MASK SELECTION

```
A5EL
   Un
  NO
   An
```

Selects the alarms that will be reset when the User Input/Function keys are activated. Any alarms configured as "YES" will be reset depending on the alarms configuration. Please see the Alarms section of the manual for more information on the alarm reset operation.

ADJUST DISPLAY INTENSITY

```
USrn    Fn
  FNC     FNC
dLEU    dLEU
```

When activated (momentary action), the display intensity changes to the next intensity level.

DISPLAY SELECT

```
USrn    Fn
  FNC     FNC
di SP   di SP
```

When activated (momentary action), Line 2 advances to the next display that is not locked out from the Display Mode.

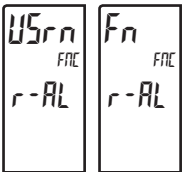## SELECT PARAMETER LIST

```
USrn    Fn
  FNC     FNC
LI St   LI St
```

Two lists of input scaling points and alarm values (including band and deviation) are available. The two lists are named L5tA and L5tb. If a user input is used to select the list then L5tA is selected when the user input is not active and L5tb is selected when the user input is active (maintained action). If a front panel key is used to select the list then the list will toggle for each key press (momentary action). The display will only indicate which list is active when the list is changed. To program the values for List-A and List-B, first complete the programming of all the parameters. Exit programming and switch to the other list. Re-enter programming and enter the desired values for the input scaling points, alarms, band, and deviation if used.

PRINT REQUEST

```
USrn    Fn
  FNC     FNC
Prnt    Prnt
```
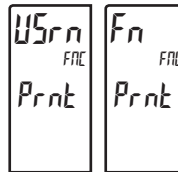
The meter issues a block print through the serial port when activated, and the serial type is set to rLC. The data transmitted during a print request and the serial type is programmed in Module 7. If the user input is still active after the transmission is complete (about 100 msec), an additional transmission occurs. As long as the user input is held active, continuous transmissions occur.

OUTPUT PARAMETERS (Out)

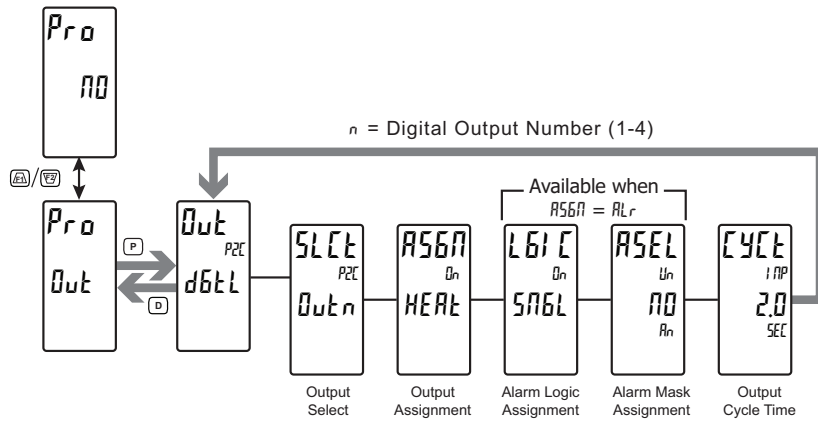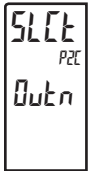### OUTPUT SELECT

```
Out
 INP
d6tL
```

d6tL   AnL6
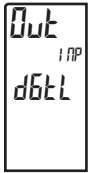
Select the Digital or Analog output to be programmed. The Analog output selection only appears if an analog output and/or digital output plug-in card is installed in the meter. When there is no output card installed, "No Card" will be displayed on the display when trying to enter the Output Configuration.

DIGITAL OUTPUT PARAMETERS (d6tL)

To have digital output capabilities, a digital output Plug-in card needs to be installed into the PAX2C (see Ordering Information). Depending on the output card installed, there will be two or four digital outputs available.

n = Digital Output Number (1-4)

Available when
A56A = ALr

| Output Select | Output Assignment | Alarm Logic Assignment | Alarm Mask Assignment | Output Cycle Time |

DIGITAL OUTPUT SELECTION

```
SLCt
 P2C
Outn
```

Out1 Out2 Out3 Out4

Selects the digital output to be programmed. The "Outn" in the following parameters will reflect the chosen output number. After the chosen output is completely programmed, the display returns to the Output Select menu. Repeat steps for each output to be programmed. The number of outputs available is digital output card (PAXCDS) dependent (2 or 4).

### DIGITAL OUTPUT ASSIGNMENT

```
A56A
 On
HEAt
```

NONE   HEAt   COOL   ALr   MAN

This selection is used to assign the controller's digital outputs to various internal values or conditions. It is possible to assign the same properties to more than one output.

NONE = Digital Output is disabled
HEAt = Heat Output Power
COOL = Cool Output Power
ALr = Alarm
MAN = Manual Control Mode

ALARM LOGIC MODE
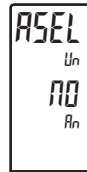
```
L6IC
 On
SN6L
```

SN6L And   Or

The PAX2C supports three different modes when an output is assigned as an alarm:

SN6L = Any single alarm. Selecting YES to any selection will change other alarm selections to NO.
And = Allows multiple alarms to be mapped to an output using AND Boolean logic. For example: If AL1 and AL2 are active, the output will energize.

Or = Allows multiple alarms to be mapped to an output using OR Boolean logic. For example: If AL1 or AL2 are active, the output will energize.

ALARM MASK ASSIGNMENT

```
ASEL
 Un
NO
 An
```

NO   YES

Selects the alarms to be logically combined per the Alarm Logic Mode selection. Any alarms configured as "YES" will be used in the Boolean logic calculation. If the Alarm Logic Mode is assigned as Single (SN6L), only one alarm may be selected at a time.

Basic Mode: 4 Alarms Max
Advanced Mode: 16 Alarms Max

DIGITAL OUTPUT CYCLE TIME

```
CYCt
 INP
2.0
 SEC
```

0.0 to 60.0   seconds

The Cycle Time value is the sum of a time-proportioned output's on and off cycles. With time proportional outputs, the percentage of output power is converted into output on time of the cycle time value eg. if the controller's algorithm calls for 65% power, and has a Cycle Time of 10 seconds, the output will be on for 6.5 seconds and off for 3.5 seconds. A Cycle Time equal to, or less than, one-tenth of the process time constant is recommended.

This parameter is only available when the digital output assignment is configured as HEAt or COOL.

ANALOG OUTPUT PARAMETERS (AnLG)

This section is only accessible with the optional PAXCDL Analog card installed (see Ordering Information).
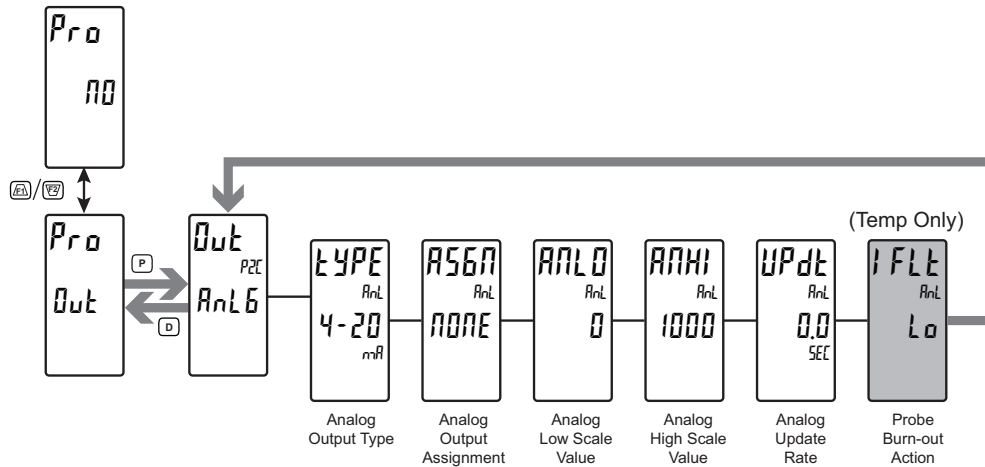
ANALOG OUTPUT TYPE

4-20   0-10   0-20

Enter the analog output type. For 0-20 mA or 4-20 mA use terminals 18 and 19. For 0-10 V use terminals 16 and 17. Only one range can be used at a time.

ANALOG OUTPUT ASSIGNMENT

NONE   INPt   HI   LO   OP
SP   dEu

Enter the source for the analog output to retransmit:

NONE = Manual Mode operation. (See Serial RLC Protocol in the Communications Port module).
INPt = Input Value
HI = Maximum Display Value
LO = Minimum Display Value
OP = Output Power
SP = Active Setpoint Value
dEu = Deviation from the Setpoint value

ANALOG LOW SCALE VALUE

-1999 to 9999

Enter the Display Value that corresponds to 0 mA (0-20 mA), 4 mA (4-20 mA) or 0 VDC (0-10 VDC).

ANALOG HIGH SCALE VALUE

-1999 to 9999

Enter the Display Value that corresponds to 20 mA (0-20 mA) , 20 mA (4-20 mA) or 10 VDC (0-10 VDC).
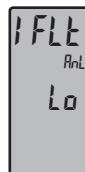
ANALOG UPDATE TIME

0.0 to 10.0   seconds

Enter the analog output update rate in seconds. A value of 0.0 allows the meter to update the analog output at the ADC Conversion Rate.

The following programming step is only available when Input Type in the Input Menu is set for a temperature input (TC/RTD).

PROBE BURN-OUT ACTION

Lo   Hi

Enter the probe burn-out action. In the event of a temperature probe failure, the analog output can be programmed for low or high scale.
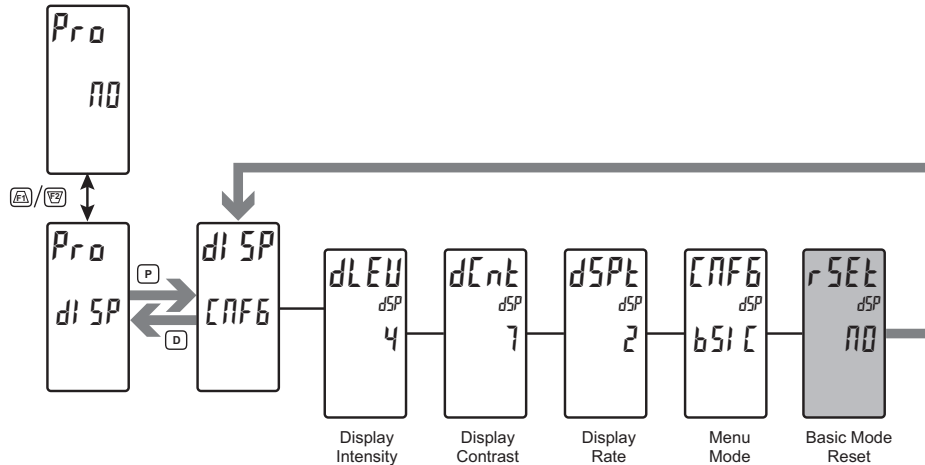
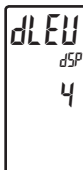# DISPLAY PARAMETERS (dISP)

DISPLAY SELECT

dISP
CNFG

CNFG   ZONE   LOCS   HILO   CODE

Select the display parameters to be programmed.

DISPLAY PARAMETERS: GENERAL CONFIGURATION (CNFG)

| Display Intensity | Display Contrast | Display Rate | Menu Mode | Basic Mode Reset |

DISPLAY INTENSITY LEVEL

dLEU
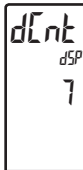dSP
4

0 to 4

Enter the desired Display Intensity Level (0-4) by using the arrow keys. The display will actively dim or brighten as the levels are changed. This parameter can also be accessed in the Display, Parameter or Hidden Loops when enabled.
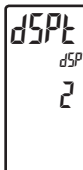
DISPLAY CONTRAST LEVEL

dCnt
dSP
7

0 to 15

Enter the desired Display Contrast Level (0-15) by using the arrow keys. The display contrast / viewing angle will actively adjust up or down as the levels are changed. This parameter can also be accessed in the Display, Parameter or Hidden Loops when enabled.
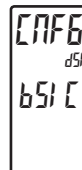
DISPLAY UPDATE RATE (/SEC)

dSPt
dSP
2

1   2   5   10   20

This parameter configures the display update rate. It does not affect the response time of the setpoint output or analog output option cards.

OPERATING MODE

CNFG
dSP
bSIC

bSIC   AdUC

This parameter configures the unit to operate in Basic or Advanced Mode. Basic mode offers a reduced menu structure geared towards simpler applications that may not require the more advanced features of the PAX2C.

Basic Mode (bSIC):
   Maximum of four alarms
   Configuration of Display Color Zones is limited to a default
      color (no dynamic changing of zone colors based on
      mapped parameters)
Advanced Mode(AdUC):
   Maximum of sixteen alarms
   Full configuration on all seven Display Color Zones

The following programming step is only available when switching from Advanced Operating Mode to Basic Operating Mode. The PAX2C Factory default is Basic Operating Mode.
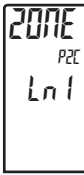
BASIC MODE RESET

rSEt
dSP
NO

NO   YES

Resets the unit back to Basic Operating Mode factory defaults.

Warning: Any Advanced Operating Mode configuration in the unit that is not supported in Basic Operating Mode will be cleared and reset back to factory defaults.
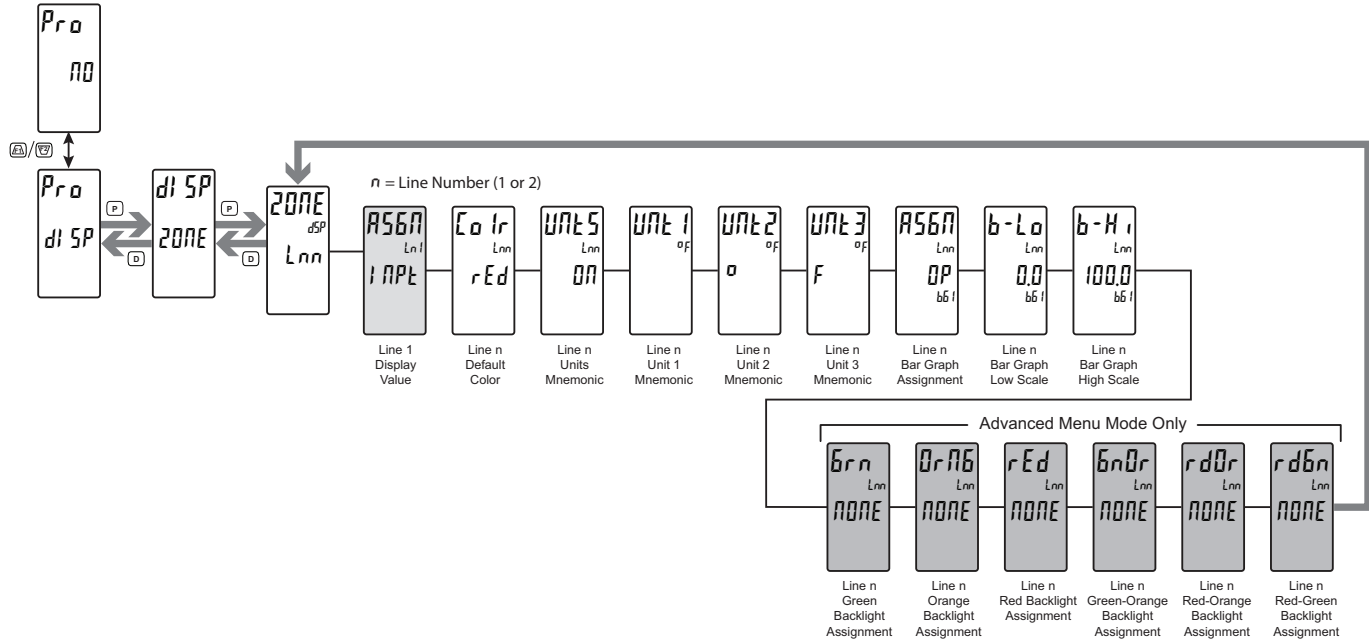
DISPLAY PARAMETERS: ZONE SELECT (ZONE)

ZONE SELECT

| ZONE |
| P2C |
| Ln1 |

| Ln1 | Ln2 | UAn1 | UAn2 |
| UAn3 | UAn4 | Mn |

Select the zone to be programmed.

DISPLAY PARAMETERS: ZONE CONFIGURATION - LINE 1 & LINE 2 (Ln1 & Ln2)

| Pro |
| NO |

↕ [△]/[▽]

| Pro |
| dISP |

[P] →
← [D]

| dISP |
| ZONE |

[P] →
← [D]

| ZONE |
| dSP |
| Lnn |

n = Line Number (1 or 2)

A5Gn	Colr	UntS	Unt1	Unt2	Unt3	A5Gn	b-Lo	b-Hi
Ln1	Lnn	Lnn	oF	oF	oF	Lnn	Lnn	Lnn
INPt	rEd	On	o	F	F	OP	0.0	100.0
						bGn	bGn	bGn

Line 1 Display Value | Line n Default Color | Line n Units Mnemonic | Line n Unit 1 Mnemonic | Line n Unit 2 Mnemonic | Line n Unit 3 Mnemonic | Line n Bar Graph Assignment | Line n Bar Graph Low Scale | Line n Bar Graph High Scale

— Advanced Menu Mode Only —

Grn	OrNG	rEd	GnOr	rdOr	rdGn
Lnn	Lnn	Lnn	Lnn	Lnn	Lnn
NONE	NONE	NONE	NONE	NONE	NONE

Line n Green Backlight Assignment | Line n Orange Backlight Assignment | Line n Red Backlight Assignment | Line n Green-Orange Backlight Assignment | Line n Red-Orange Backlight Assignment | Line n Red-Green Backlight Assignment

LINE 1 ASSIGNMENT
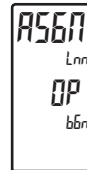
| A5Gn |
| Ln1 |
| INPt |

| NONE | INPt | HI | LO |

Select the value to be assigned to the primary or top line of the controller display.

NONE = Line 1 is Disabled
INPt = Input/Process Value
HI = Maximum Display Value
LO = Minimum Display Value
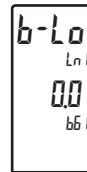
LINE n DISPLAY COLOR

| Colr |
| Lnn |
| rEd |

| Grn | OrNG | rEd |

Enter the desired Display Line, Bar Graph, and Programmable Units Display color.

Grn = Green
OrNG = Orange
rEd = Red

LINE n UNITS MNEMONIC

| UntS |
| F |
| On |

| OFF | On |

This parameter allows programming of the display mnemonics characters. Three individual characters may be selected from a preprogrammed list.

The characters available for the programmable modes include:

A b C d E F G H I J K L **M** N O P Q R S t U V **W** Y 2 O 1
2 3 4 5 6 7 8 9 a c E 9 h i **m** n o 9 r u **w** - : C J r º _ blank
Two character spaces are required to display this character.

LINE n BAR GRAPH ASSIGNMENT

| A5Gn |
| Lnn |
| OP |
| bGn |

| NONE | OP | dEu | SP |

Select the parameter to be assigned to Display Line n bar graph.

NONE = Bar Graph is disabled
OP = Output Power
dEu = Deviation from the Setpoint Value
SP = Active Setpoint

LINE n BAR GRAPH LOW SCALING POINT

| b-Lo |
| Ln1 |
| 0.0 |
| bG1 |

-1999 to 9999

Enter the desired Display Line n Bar Graph Low Scaling Point by using the arrow keys.

LINE n BAR GRAPH HIGH SCALING POINT

| b-Hi |
| Ln1 |
| 100.0 |
| bG1 |

-1999 to 9999

Enter the desired Display Line n Bar Graph High Scaling Point by using the arrow keys.

The following programming steps are only available in the Advanced Operating Mode.

These parameters allow Line n backlights to change color, or alternate between two colors when the mapped parameter is activated. When multiple backlight assignments are programmed for a particular zone, the color priority is defined as follows (from Lowest to Highest): Grn, Org, REd, GnOr, RdOr, RdGn

BACKLIGHT ASSIGNMENT SELECTIONS

NONE = Backlight color change disabled
Out 1 = Output 1
Out2 = Output 2
Out3 = Output 3
Out4 = Output 4
ALr = Alarm
MAN = Manual Control Mode

The following two programming steps are only available when the Backlight Assignment is configured as an Alarm (ALr). These steps apply to each of the six different backlight color assignment parameters.
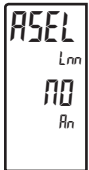
ALARM LOGIC MODE

LGIC Lnn **SNGL**

SNGL   And   Or

The PAX2C supports three different modes when an output is assigned as an alarm:

SNGL = Any single alarm

And = Allows multiple alarms to be mapped to an output using AND Boolean logic. For example: If AL1 **and** AL2 are active, the output will energize.

Or = Allows multiple alarms to be mapped to an output using OR Boolean logic. For example: If AL1 **or** AL2 are active, the output will energize.

ALARM MASK ASSIGNMENT

ASEL Lnn **NO** An

NO   YES

Selects the alarms to be logically combined per the Alarm Logic Mode selection. Any alarms configured as YES will be used in the Boolean logic calculation. If the Alarm Logic Mode is assigned as Single (SNGL), the last alarm selected as YES will be used.

LINE n GREEN BACKLIGHT ASSIGNMENT

Grn Lnn **NONE**

NONE   Out 1   Out2   Out3   Out4   ALr   MAN

Select the parameter to be assigned to Line n Green Backlight.

LINE n ORANGE BACKLIGHT ASSIGNMENT

OrNG Lnn **NONE**

NONE   Out 1   Out2   Out3   Out4   ALr   MAN

Select the parameter to be assigned to Line n Orange Backlight.

LINE n RED BACKLIGHT ASSIGNMENT

rEd Lnn **NONE**

NONE   Out 1   Out2   Out3   Out4   ALr   MAN

Select the parameter to be assigned to Line n Red Backlight.

LINE n GREEN-ORANGE BACKLIGHT ASSIGNMENT

GnOr Lnn **NONE**

NONE   Out 1   Out2   Out3   Out4   ALr   MAN

Select the parameter to be assigned to Line n Green-Orange Backlight.

LINE n RED-ORANGE BACKLIGHT ASSIGNMENT

rdOr Lnn **NONE**

NONE   Out 1   Out2   Out3   Out4   ALr   MAN

Select the parameter to be assigned to Line n Red-Orange Backlight.

LINE n RED-GREEN BACKLIGHT ASSIGNMENT

rdGn Lnn **NONE**

NONE   Out 1   Out2   Out3   Out4   ALr   MAN

Select the parameter to be assigned to Line n Red-Green Backlight.
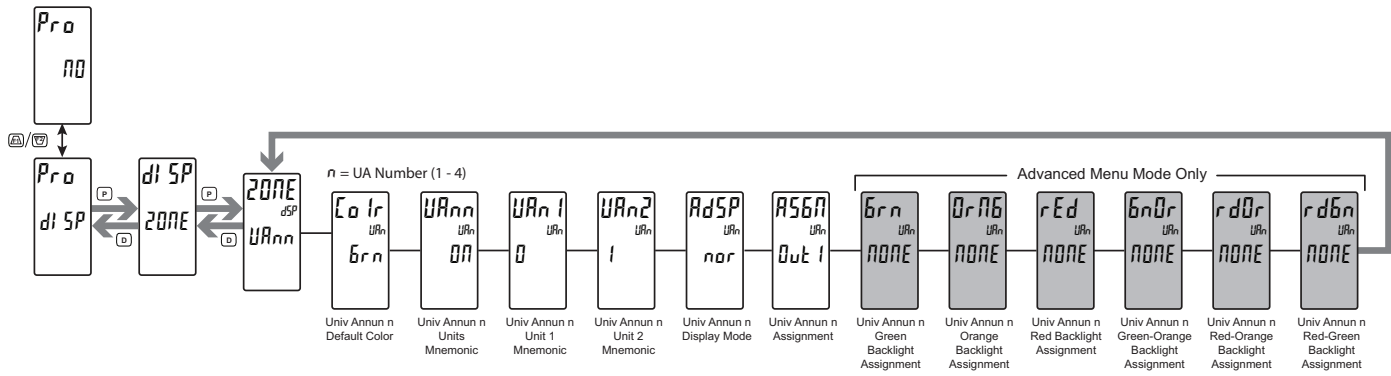
UNIVERSAL ANNUNCIATOR n DISPLAY COLOR

Grn   OrNG   rEd

Enter the desired Universal Annunciator Display color.

Grn = Green
OrNG = Orange
rEd = Red

UNIVERSAL ANNUNCIATOR n UNITS MNEMONIC

OFF   ON

This parameter allows programming of the display mnemonics characters. Two individual characters may be selected from a preprogrammed list.

The characters available for the programmable modes include:

A b C d E F G H I J K L M N O P Q R S t U Y W Y 2 0 1
2 3 4 5 6 7 8 9 a c P g h i m n o q r u w - = [ ] r ° _ blank
Two character spaces are required to display this character.

UNIVERSAL ANNUNCIATOR n DISPLAY MODE

nor   rEu   FLSh

Enter the desired Universal Annunciator Display Mode. This parameter is available when the Universal Annunciator is in List (LISt) Mode.

nor = Displays the configured universal annunciator when the mapped parameter is activated (on).
rEu = Displays the configured universal annunciator when the mapped parameter is deactivated (off).
FLSh = Flashes the configured universal annunciator when the mapped parameter is activated (on).

UNIVERSAL ANNUNCIATOR n ASSIGNMENT

NONE Out1 Out2 Out3 Out4 ALr MAN

Selects the parameter that enables the Universal Annunciator mnemonic to be displayed. If the mapped parameter is active, the mnemonic is displayed. If the mapped parameter is not active, the mnemonic will be disabled (off).

NONE = Universal Annunciator text is disabled
Out1 = Output 1
Out2 = Output 2
Out3 = Output 3
Out4 = Output 4
ALr = Alarm
MAN = Manual Control Mode

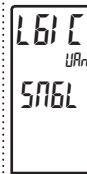The following programming steps are only available in the Advanced Operating Mode.

These parameters allow Universal Annunciator n backlights to change color, or alternate between two colors when the mapped parameter is activated. When multiple backlight assignments are programmed for a particular zone, the color priority is defined as follows (from Lowest to Highest): Grn, OrG, rEd, GnOr, rdOr, rdGn.

BACKLIGHT ASSIGNMENT SELECTIONS

NONE = Backlight color change disabled
Out1 = Output 1
Out2 = Output 2
Out3 = Output 3
Out4 = Output 4
ALr = Alarm
MAN = Manual Control Mode

The following two programming steps are only available when the Backlight Assignment is configured as an Alarm (ALr). These steps apply to each of the six different backlight color assignment parameters.

ALARM LOGIC MODE

SNGL   And   Or

The PAX2C supports three different modes when an output is assigned as an alarm:

SNGL = Any single alarm
And = Allows multiple alarms to be mapped to an output using AND Boolean logic. For example: If AL1 **and** AL2 are active, the output will energize.
Or = Allows multiple alarms to be mapped to an output using OR Boolean logic. For example: If AL1 **or** AL2 are active, the output will energize.

ALARM MASK ASSIGNMENT

NO   YES

Selects the alarms to be logically combined per the Alarm Logic Mode selection. Any alarms configured as YES will be used in the Boolean logic calculation. If the Alarm Logic Mode is assigned as Single (SNGL), the last alarm selected as YES will be used.

UNIVERSAL ANNUNCIATOR n GREEN
BACKLIGHT ASSIGNMENT

`Grn`
UAn
`NONE`

NONE   Out1   Out2   Out3   Out4   ALr   MAN

Select the parameter to be used to activate the Green backlight on Universal Annunciator n.

UNIVERSAL ANNUNCIATOR n ORANGE
BACKLIGHT ASSIGNMENT

`OrNG`
UAn
`NONE`

NONE   Out1   Out2   Out3   Out4   ALr   MAN

Select the parameter to be used to activate the Orange backlight on Universal Annunciator n.

UNIVERSAL ANNUNCIATOR n RED
BACKLIGHT ASSIGNMENT

`rEd`
UAn
`NONE`

NONE   Out1   Out2   Out3   Out4   ALr   MAN

Select the parameter to be used to activate the Red backlight on Universal Annunciator n.

UNIVERSAL ANNUNCIATOR n GREEN-ORANGE
BACKLIGHT ASSIGNMENT

`GnOr`
UAn
`NONE`

NONE   Out1   Out2   Out3   Out4   ALr   MAN

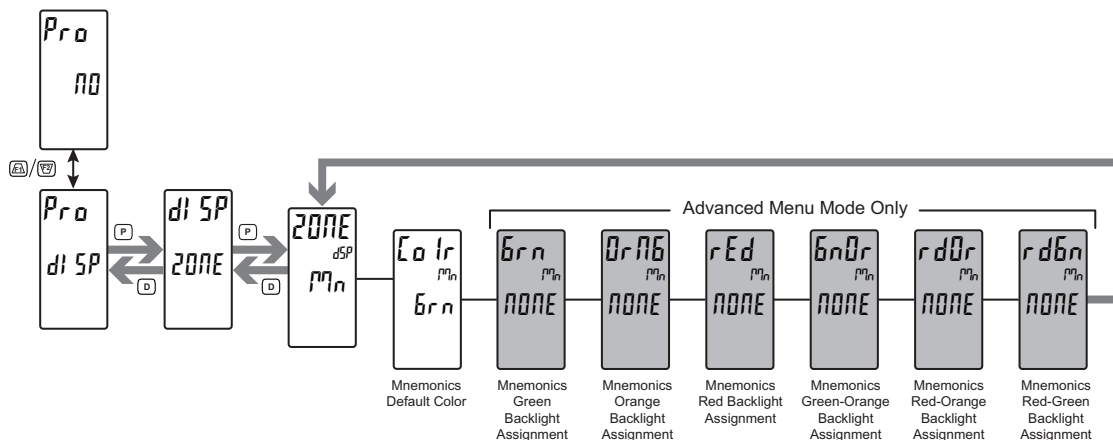Select the parameter to be used to activate the Green-Orange backlight on Universal Annunciator n.

UNIVERSAL ANNUNCIATOR n RED-ORANGE
BACKLIGHT ASSIGNMENT

`rdOr`
UAn
`NONE`

NONE   Out1   Out2   Out3   Out4   ALr   MAN

Select the parameter to be used to activate the Red-Orange backlight on Universal Annunciator n.

UNIVERSAL ANNUNCIATOR n RED-GREEN
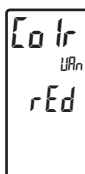### BACKLIGHT ASSIGNMENT

`rdGn`
UAn
`NONE`

NONE   Out1   Out2   Out3   Out4   ALr   MAN

Select the parameter to be used to activate the Red-Green backlight on Universal Annunciator n.

Pro NO

Pro dISP → **dISP ZONE** → **ZONE dSP** → **Colr Mn Grn** → Advanced Menu Mode Only → **Grn Mn NONE** | **OrNG Mn NONE** | **rEd Mn NONE** | **GnOr Mn NONE** | **rdOr Mn NONE** | **rdGn Mn NONE**

Mnemonics Default Color | Mnemonics Green Backlight Assignment | Mnemonics Orange Backlight Assignment | Mnemonics Red Backlight Assignment | Mnemonics Green-Orange Backlight Assignment | Mnemonics Red-Orange Backlight Assignment | Mnemonics Red-Green Backlight Assignment

MNEMONICS DISPLAY COLOR

Colr ᵁᴬⁿ rEd

Grn   OrNG   rEd

Enter the desired Mnemonics Display color.

Grn = Green
OrNG = Orange
rEd = Red

The following programming steps are only available in the Advanced Operating Mode.

These parameters allow the mnemonic backlights to change color, or alternate between two colors when the mapped parameter is activated. When multiple backlight assignments are programmed for a particular zone, the color priority is defined as follows (from Lowest to Highest): Grn, OrG, rEd, GnOr, rdOr, rdGn

BACKLIGHT ASSIGNMENT SELECTIONS

NONE = Backlight color change disabled
Out1 = Output 1
Out2 = Output 2
Out3 = Output 3
Out4 = Output 4
ALr = Alarm
MAN = Manual Control Mode

The following two programming steps are only available when the Backlight Assignment is configured as an Alarm (Alr). These steps apply to each of the six different backlight color assignment parameters.

ALARM LOGIC MODE

LGIC ᵁᴬⁿ SNGL

SNGL   And   Or

The PAX2C supports three different modes when an output is assigned as an alarm:

SNGL = Any single alarm
And = Allows multiple alarms to be mapped to an output using AND Boolean logic. For example: If AL1 **and** AL2 are active, the output will energize.
Or = Allows multiple alarms to be mapped to an output using OR Boolean logic. For example: If AL1 **or** AL2 are active, the output will energize.

ALARM MASK ASSIGNMENT

ASEL ᵁᴬⁿ NO ᴬⁿ

NO   YES

Selects the alarms to be logically combined per the Alarm Logic Mode selection. Any alarms configured as YES will be used in the Boolean logic calculation. If the Alarm Logic Mode is assigned as Single (SNGL), only one alarm may be selected at a time.

MNEMONICS GREEN BACKLIGHT ASSIGNMENT

Grn Mn NONE

NONE Out1 Out2 Out3 Out4 ALr MAN

Select the parameter to be used to activate the mnemonic Green backlight.

MNEMONICS ORANGE BACKLIGHT ASSIGNMENT

OrNG Mn NONE

NONE Out1 Out2 Out3 Out4 ALr MAN

Select the parameter to be used to activate the mnemonic Orange backlight.

MNEMONICS RED BACKLIGHT ASSIGNMENT

rEd Mn NONE

NONE Out1 Out2 Out3 Out4 ALr MAN

Select the parameter to be used to activate the mnemonic Red backlight.

MNEMONICS GREEN-ORANGE BACKLIGHT ASSIGNMENT

GnOr Mn NONE

NONE Out1 Out2 Out3 Out4 ALr MAN

Select the parameter to be used to activate the mnemonic Green-Orange backlight.

MNEMONICS RED-ORANGE BACKLIGHT ASSIGNMENT

rdOr Mn NONE

NONE Out1 Out2 Out3 Out4 ALr MAN

Select the parameter to be used to activate the mnemonic Red-Orange backlight.

MNEMONICS RED-GREEN BACKLIGHT ASSIGNMENT

rdGn ᵁᴬⁿ NONE

NONE Out1 Out2 Out3 Out4 ALr MAN

Select the parameter to be used to activate the mnemonic Red-Green backlight.

This section details programming for the Line 2 (Bottom Line) Display. Various Input, Display, PID, Alarm, and Function Parameters can be shown on the Line 2 display. The display loops described below are used to view, reset and modify the selected display values, based on the Line 2 Value Access setting programmed for each available value.

Main Display Loop

In the Main display loop, the selected values can be consecutively read on Line 2 by pressing the **D** key. The lower 3-character units mnemonic indicates which Line 2 value is currently shown. When in the Main display loop, the Function keys □ and □ perform the User functions programmed in the User Input program section.

Parameter Display Loop and Hidden Parameter Loop

These display loops provide quick access to selected parameters that can be viewed and modified on Line 2 without having to enter Full Programming Mode. To utilize the Hidden Parameter display loop, a security code (1-250) must be programmed. (See Security Code Configuration at the end of this section.)The Parameter display loop is accessed by pressing the **P** key. The selected Parameter display loop values can be viewed and/or changed per the Line 2 Value Access setting programmed for each available value. The Hidden Parameter loop follows the Parameter display loop, and can only be accessed when the correct security code is entered at the Code prompt.

Line 2 Value Access Configuration

Line 2 values can be made accessible in either the Main (**D** key), Parameter (**P** key) or Hidden (**P** key following code entry) display loops. When the List parameter is configured for an *Ent* setting, a List assignment submenu will follow. Refer to Input module, User sub-menu section for a description of the function. Each parameter must be configured for one of the following settings. Not all settings are available for each parameter, as shown in the Parameter Value Access table.

SELECTION	DESCRIPTION
LOC	Not viewed on Line 2 Display (Factory Default Setting).
drEd	View in Main display loop. Cannot change or reset.
dEnt	View and change in Main display loop.
PrEd	View in Parameter display loop. Cannot change or reset.
PEnt	View and change in Parameter display loop.
HrEd	View in Hidden display loop. Cannot change or reset.
HEnt	View and change in Hidden display loop.

LINE 2 PARAMETER VALUE ACCESS

DISPLAY	DESCRIPTION	NOT VIEWED	MENU DISPLAY LOOP (D KEY)		PARAMETER DISPLAY LOOP (P KEY)		HIDDEN LOOP	
		LOC	*drEd*	*dEnt*	*PrEd*	*PEnt*	*HrEd*	*HEnt*
I NPt	Input	x	x		x		x	
HI	Max Value	x	x	x	x	x	x	x
LO	Min Value	x	x	x	x	x	x	x
dLEU	Display Intensity Level	x	x	x	x	x	x	x
dCnt	Display Contrast Level	x	x	x	x	x	x	x
SP	Actual Setpoint Value	x	x	x	x	x	x	x
SP1	Setpoint 1 Value	x	x	x	x	x	x	x
SP2	Setpoint 2 Value	x	x	x	x	x	x	x
OP	Output Power (must be in manual mode to edit)	x	x	x	x	x	x	x
dEu	Deviation	x	x		x		x	
SPrP	Setpoint Ramping	x	x	x	x	x	x	x
P id ACt	Actual PID Values: P, I & D	x	x	x	x	x	x	x
P id Pr i	Primary PID Values: P, I & D	x	x	x	x	x	x	x
P id ALt	Alternate PID Values: P, I & D	x	x	x	x	x	x	x
ALn	Alarm Values: Basic Mode (1-4), Advanced Mode (1-16)	x	x	x	x	x	x	x
bdn	Band/Deviation	x	x	x	x	x	x	x
SPSL	Setpoint Selection	x	x	x	x	x	x	x
SPrP	Setpoint Ramping	x	x	x	x	x	x	x
I LOC	Integral Lock	x	x	x	x	x	x	x
trnF	Manual/Auto Control Mode	x	x	x	x	x	x	x
PSEL	PID Parameter Selection	x	x	x	x	x	x	x
tunE	Tuning Enable	x	x	x	x	x	x	x
r -HI	Reset Maximum Value	x		x		x		x
r -Lo	Reset Minimum Value	x		x		x		x
r -HL	Reset Max and Min Values	x		x		x		x
r -AL	Reset Alarms	x		x		x		x
LI St	Parameter List A/B Access	x	x	x	x	x	x	x
Prnt	Print Request	x		x		x		x

LINE 2 VALUE ACCESS PARAMETER SELECTION

```
LOCS
    Ln2
INPL
```
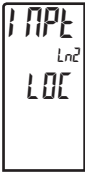
INPL   di5P   Pid   ALr   FNCL

Select the display parameters to be displayed.

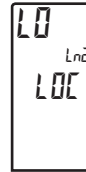## DISPLAY PARAMETERS: LINE 2 PARAMETER VALUE ACCESS - INPUT (INPL)

Line 2 Input Value Access   Line 2 MAX Access   Line 2 MIN Access

---
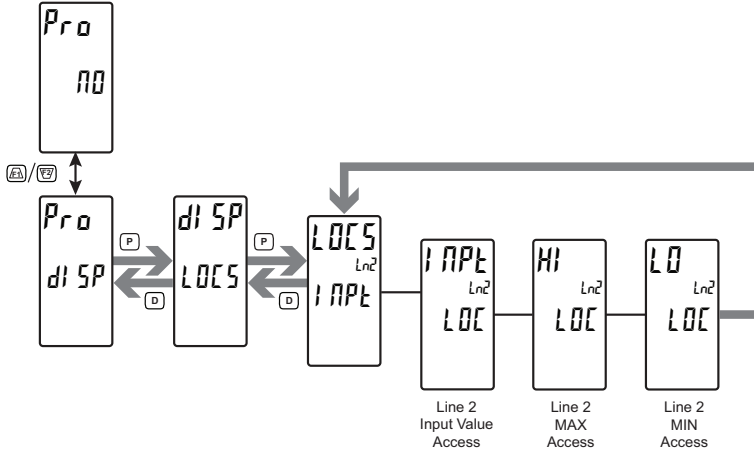
LINE 2 INPUT ACCESS

```
INPL
    Ln2
LOC
```

LOC   drEd   PrEd   HrEd

Displays the controller process input reading on Line 2.

**LINE 2 MAX ACCESS**

```
HI
    Ln2
LOC
```

LOC   drEd   dEnL   PrEd   PEnL   HrEd   HEnL

When configured for dEnL, PEnL or HEnL, the Max Display value can be reset using a front keypad sequence. To reset, push the **P** key while viewing the Hi value on Line 2. The display will show rHI NO. Press the /F1\ key to select YES and then press **P** key. The display will indicate rSEL and then return to the Hi value parameter.

LINE 2 MIN ACCESS

```
LO
    Ln2
LOC
```

LOC   drEd   dEnL   PrEd   PEnL   HrEd   HEnL

When configured for dEnL, PEnL or HEnL, the Min Display value can be reset using a front keypad sequence. To reset, push the **P** key while viewing the Lo value on Line 2. The display will show rLo NO. Press the /F1\ key to select YES and then press **P** key. The display will indicate rSEL and then return to the Lo value parameter.

DISPLAY PARAMETERS: LINE 2 PARAMETER VALUE ACCESS - DISPLAY (dISP)

Line 2 Display Level Access

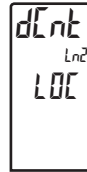Line 2 Display Contrast Access
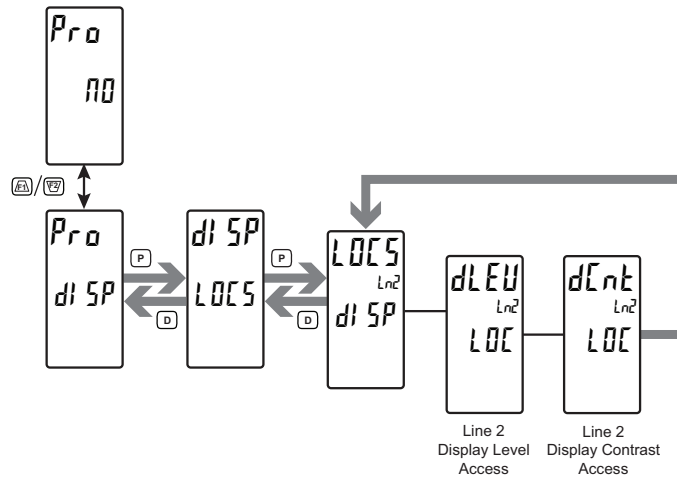
LINE 2 DISPLAY INTENSITY LEVEL
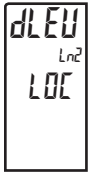
LOC   drEd   dEnt   PrEd   PEnt   HrEd   HEnt

When configured for *dEnt*, *PEnt* or *HEnt*, the display intensity can be adjusted in the selected display loop by using the /F1\ and \F2/ keys while viewing *dLEU*.
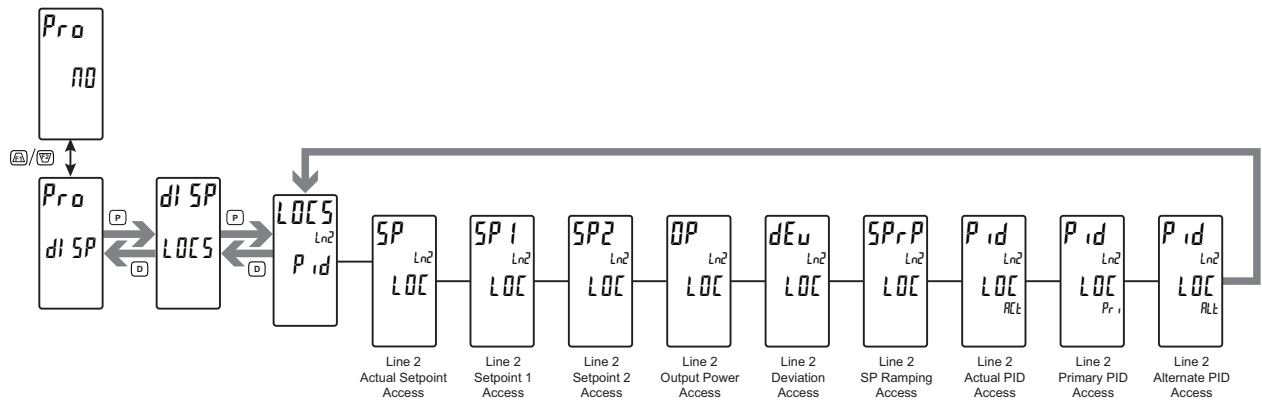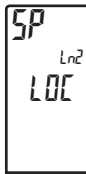
LINE 2 DISPLAY CONTRAST LEVEL

LOC   drEd   dEnt   PrEd   PEnt   HrEd   HEnt

When configured for *dEnt*, *PEnt* or *HEnt*, the display contrast can be adjusted in the selected display loop by using the /F1\ and \F2/ keys while viewing *dEnt*.

Line 2 Actual Setpoint Access | Line 2 Setpoint 1 Access | Line 2 Setpoint 2 Access | Line 2 Output Power Access | Line 2 Deviation Access | Line 2 SP Ramping Access | Line 2 Actual PID Access | Line 2 Primary PID Access | Line 2 Alternate PID Access
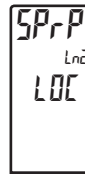
LINE 2 ACTIVE SETPOINT VALUE

LOC drEd dEnt PrEd PEnt HrEd HEnt

When configured for *dEnt*, *PEnt* or *HEnt*, the active setpoint value can be adjusted in the selected display loop by using the [F1] and [F2] keys while viewing SP. When configured for d-ENt, the P key must be pressed to select the item prior to changing the value.
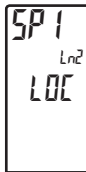
LINE 2 SETPOINT 1 VALUE

LOC drEd dEnt PrEd PEnt HrEd HEnt

When configured for *dEnt*, *PEnt* or *HEnt*, the Setpoint 1 value can be adjusted in the selected display loop by using the [F1] and [F2] keys while viewing *SP1*. When configured for *dEnt*, the **P** key must be pressed to select the item prior to changing the value.

LINE 2 SETPOINT 2 VALUE

LOC drEd dEnt PrEd PEnt HrEd HEnt

When configured for *dEnt*, *PEnt* or *HEnt*, the Setpoint 2 value can be adjusted in the selected display loop by using the [F1] and [F2] keys while viewing *SP2*. When configured for *dEnt*, the **P** key must be pressed to select the item prior to changing the value.

LINE 2 OUTPUT POWER VALUE

LOC drEd dEnt PrEd PEnt HrEd HEnt

Displays the Output Power value on Line 2 in the selected display loop. In manual mode, the value can be adjusted in the selected display loop by using the F1 and F2 keys. When configured for *dEnt*, the **P** key must be pressed to select the item prior to changing the value.

LINE 2 DEVIATION VALUE

LOC drEd PrEd HrEd

Displays the difference between Temp/Process and the Actual Setpoint value on Line 2 in the selected display loop.

LINE 2 SETPOINT RAMPING VALUE

LOC drEd dEnt PrEd PEnt HrEd HEnt

When configured for *dEnt*, *PEnt* or *HEnt*, the Setpoint Ramping value can be adjusted in the selected display loop by using the [F1] and [F2] keys while viewing *SPrP*. When configured for *dEnt*, the **P** key must be pressed to select the item prior to changing the value.
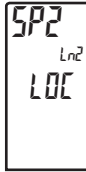
LINE 2 ACTUAL PID VALUES

LOC drEd dEnt PrEd PEnt HrEd HEnt

When configured for *dEnt*, *PEnt* or *HEnt*, the Actual PID values (P, I & D) can be adjusted in the selected display loop by using the [F1] and [F2] keys while viewing the selected parameter. When configured for *dEnt*, the **P** key must be pressed to select the item prior to changing the value.
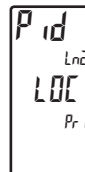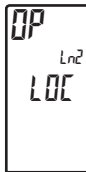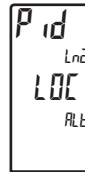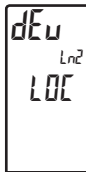
LINE 2 PRIMARY PID VALUES

LOC drEd dEnt PrEd PEnt HrEd HEnt

When configured for *dEnt*, *PEnt* or *HEnt*, the Primary PID values (P, I & D) can be adjusted in the selected display loop by using the [F1] and [F2] keys while viewing the selected parameter. When configured for *dEnt*, the **P** key must be pressed to select the item prior to changing the value.

LINE 2 ALTERNATE PID VALUES

LOC drEd dEnt PrEd PEnt HrEd HEnt

When configured for *dEnt*, *PEnt* or *HEnt*, the Alternate PID values (P, I & D) can be adjusted in the selected display loop by using the [F1] and [F2] keys while viewing the selected parameter. When configured for *dEnt*, the **P** key must be pressed to select the item prior to changing the value.
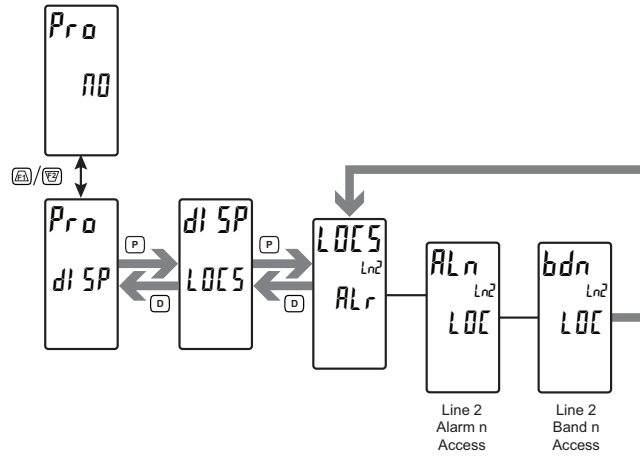
LINE 2 ALARM ACCESS
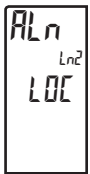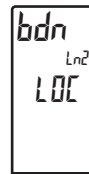
LOC   drEd   dEnt   PrEd   PEnt   HrEd   HEnt

When configured for dEnt, PEnt or HEnt, the Alarm n value can be adjusted in the selected display loop by using the F1 and F2 keys while viewing ALn. When configured for dEnt, the P key must be pressed to select the item prior to changing the value.
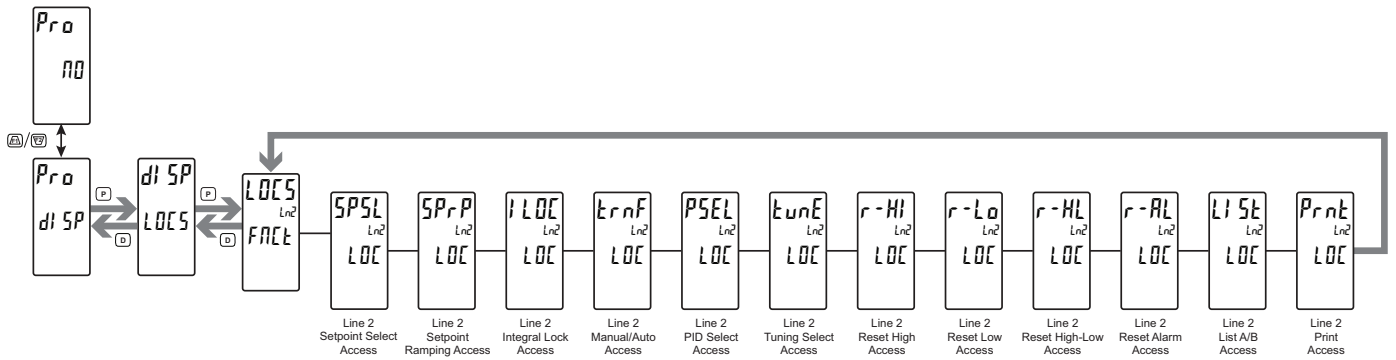
LINE 2 BAND/DEVIATION ACCESS

LOC   drEd   dEnt   PrEd   PEnt   HrEd   HEnt

When configured for dEnt, PEnt or HEnt, the Band/Deviation n value can be adjusted in the selected display loop by using the F1 and F2 keys while viewing bdn. When configured for dEnt, the P key must be pressed to select the item prior to changing the value.

Basic Mode: 4 alarms max
Advanced Mode: 16 alarms max

## LINE 2 USER FUNCTION ACCESSIBLE ITEMS

The following list of User functions can be made available in the Display (dEnt), Parameter (PEnt) or Hidden (HEnt) display loops. The more critical and frequently used Functions should be first assigned to the User Inputs and User Function keys. If more functions are needed than what can be obtained with User Inputs, this feature will provide a means to provide that access. Please refer to the USER INPUT / FUNCTION KEY PARAMETERS (USEr) section for a detailed description of the available functions.

SPSL   ILOC   PSEL   r-HI   r-HL   LISt *
SPrP   trnF   tunE   r-Lo   r-AL   Prnt

* Also available as a read-only item in the Display (drEd), Parameter (PrEd) or Hidden (HrEd) Display loops.

LINE 2 PARAMETER LIST A/B ACCESS
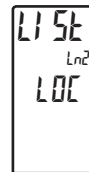
LOC   drEd   dEnt   PrEd   PEnt   HrEd   HEnt

When configured for dEnt, PEnt or HEnt, the Parameter list can be selected using a front keypad sequence. To select, push the P key while viewing LISt x". "x" will begin to flash, press the F1 key to select "A" or "b" and then press P key. The selected Parameter List will become active and the display will advance to the next available item or menu loop. See User Functions "Select Parameter List" for a description of the list function. The Line 2 Parameter List provides a means of setting or viewing the active parameter list.

DISPLAY PARAMETERS: DISPLAY MIN/MAX CONFIGURATION (*HI LO*)

MAX Capture Delay Time   MIN Capture Delay Time
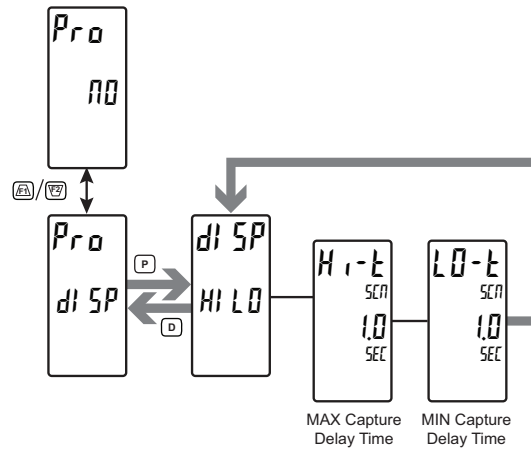
MAX CAPTURE DELAY TIME

0.0 to *25.0* seconds

When the Input Display is above the present MAX value for the entered delay time, the controller will capture that display value as the new MAX reading. A delay time helps to avoid false captures of sudden short spikes.

MIN CAPTURE DELAY TIME

0.0 to *25.0* seconds

When the Input Display is below the present MIN value for the entered delay time, the controller will capture that display value as the new MIN reading. A delay time helps to avoid false captures of sudden short spikes.

DISPLAY PARAMETERS: SECURITY CODE CONFIGURATION (*CODE*)

Programming Security Code
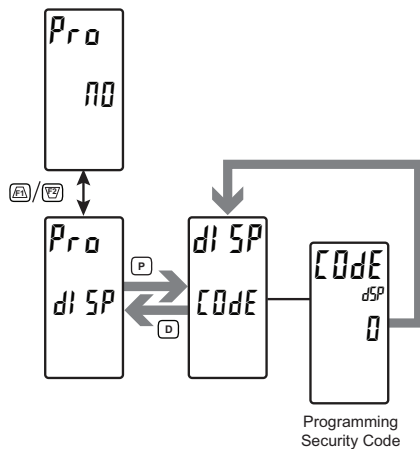
PROGRAMMING SECURITY CODE
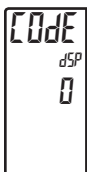
0 to *250*

The Security Code determines the programming mode and the accessibility of programming parameters. This code can be used along with the Program Mode Lock-out (*PLOC*) in the User Input Function parameter (Input [User] module).

To activate the Hidden Parameter display loop, a security code (1-250) must be entered. If a "0" security code is programmed, Full Programming Mode is available following the Parameter Loop. Pressing the **P** key takes you into, and is used to step through the Parameter Loop. Two modes are available. Full Programming mode allows all parameters to be viewed and modified. Parameter display loop mode provides access to those selected parameters that can be viewed and/or modified without entering the Full Programming mode.

The following chart indicates the levels of access based on various *CODE* and User Input *PLOC* settings.

SECURITY CODE	USER INPUT CONFIGURED	USER INPUT STATE	HIDDEN AND FULL PROGRAMMING MODE ACCESS
>0	*PLOC* or Not Active	Any State	After Parameter Display Loop with correct code # at *CODE* prompt.
0	*PLOC*	Active	No Access
0	*PLOC* or Not Active	Not Active	Access after Parameter Display Loop

PID Parameters (*Pid*)

PID PARAMETER MENU SELECTION

```
Pid
   P2C
Ctrl
```
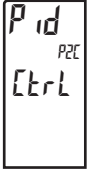
Ctrl   SP   Pid   Pwr   ONOF   tunE

Select the PID parameter menu to be programmed.

PID Parameters: Control Parameters (*Ctrl*)

```
Pro
 NO
```

⬍ 🔺/🔻

```
Pro     Pid    tYPE    trnF    OP
Pid     Ctrl   HEAt    Auto      USr
                                 0.0
```

Control Type   Control Mode   Manual Output Power

PID CONTROL TYPE

```
tYPE
HEAt
```
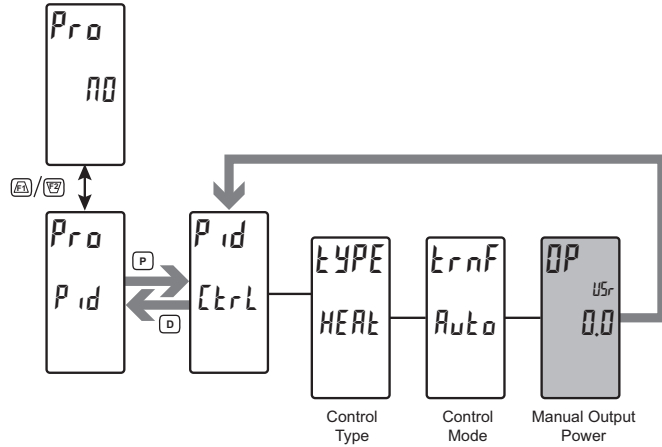
HEAt   COOL   botH

Select the type of PID control desired. When programmed for Heating action (reverse), the output power decreases when the Process Value is above the setpoint value. When programmed for Cooling (direct), the output power will increase if the Process value is above the Setpoint Value.

PID CONTROL MODE

```
trnF
Auto
```

Auto   MAN

Select Automatic or Manual Operation. In Automatic (*Auto*) mode (closed loop; On/Off, or PID Control), the controller calculates the required output to reach and maintain setpoint, and acts accordingly. In manual mode (*MAN*), the calculated PID algorithm heat and cool output percentages are not used to control the controller outputs. The unit is instead placed into an open loop mode where the control does not work from a setpoint or process feedback.

The following programming step is only available when PID Control Mode is set to Manual Mode (*MAN*).

OUTPUT POWER

```
OP
  USr
0.0
```

- 100.0 to 100.0 %

Manual Output Power is the level the PID module will assume in manual mode.

PID Parameters: Setpoint Parameters (5P)

| Setpoint Selection | Setpoint 1 Value | Setpoint 2 Value | Setpoint Low Limit | Setpoint High Limit | Setpoint Ramping Timebase | Setpoint Ramp Rate |

SETPOINT SELECTION

5P 1   5P2

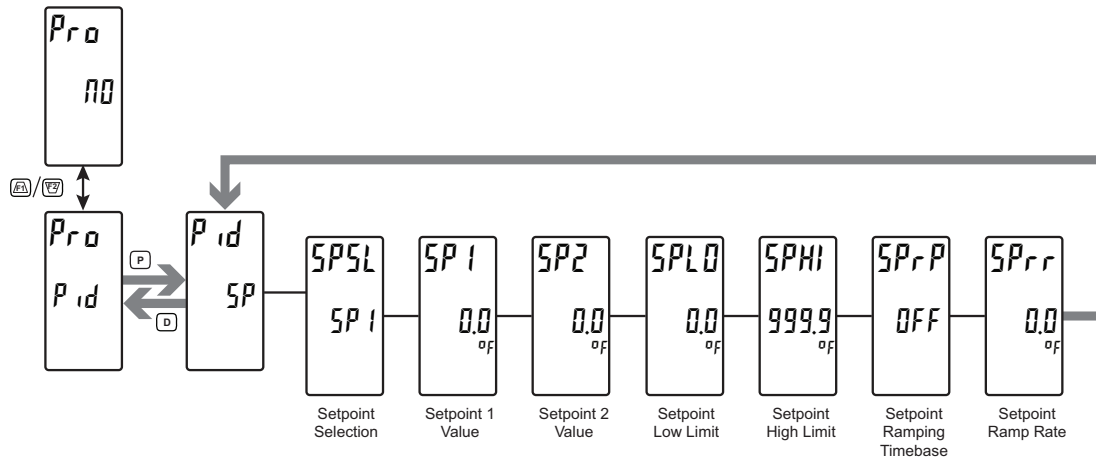Select the desired Setpoint Value (SP1 or SP2) to use as the control point. The SP Select function can also be configured in the Display Parameter LOC5 Menu (P id LOC5) or a User Input or Function Key can be assigned to the Setpoint Select Function.

SETPOINT 1 VALUE

- 1999 to 9999

One of the two values that may be selected as the target setpoint of the process.

SETPOINT 2 VALUE

- 1999 to 9999

One of the two values that may be selected as the target setpoint of the process.

SETPOINT LOW LIMIT

- 1999 to 9999

Select the desired Setpoint Low Limit value. This value should be selected so that the controller setpoint value cannot be set outside the safe operating range of the process.

SETPOINT HIGH LIMIT

- 1999 to 9999

Select the desired Setpoint High Limit value. This value should be selected so that the controller setpoint value cannot be set outside the safe operating range of the process.

SETPOINT RAMPING TIMEBASE

OFF   5EC   MIN   hour

Select the desired unit of time for ramping of the process:

OFF = Off
5EC = Seconds
MIN = Minutes
hour = Hours

SETPOINT RAMP RATE

0 to 9999

The Ramp Rate property is used to reduce sudden shock to a process during setpoint changes and system startup, a setpoint ramp rate can be used to increase or decrease the Target Setpoint at a controlled rate. The value is entered in units/time. A value of 0 disables setpoint ramping. If the Setpoint Ramp Rate is a non-zero value, and the Actual Setpoint is changed or the controller is powered up, the controller sets the Target Setpoint to the current process measurement, and uses that value as its setpoint. It then adjusts the Target Setpoint according to the setpoint Ramp Rate. When the Target Setpoint reaches the Actual Setpoint, the controller resumes use of the Actual Setpoint value. (In a properly designed and functioning system, the process will have followed the Target Setpoint value to the Actual Setpoint value.)
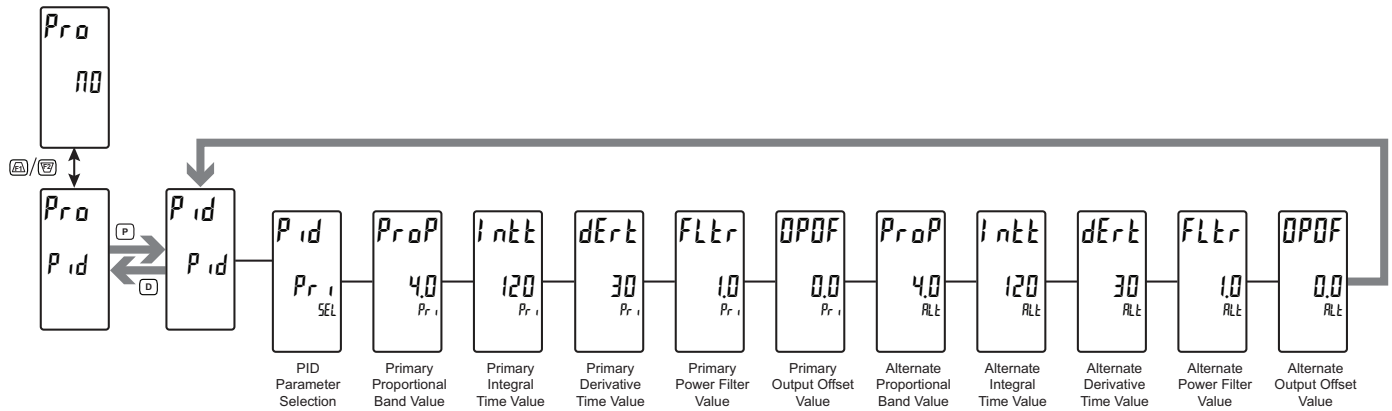
| PID
Parameter
Selection | Primary
Proportional
Band Value | Primary
Integral
Time Value | Primary
Derivative
Time Value | Primary
Power Filter
Value | Primary
Output Offset
Value | Alternate
Proportional
Band Value | Alternate
Integral
Time Value | Alternate
Derivative
Time Value | Alternate
Power Filter
Value | Alternate
Output Offset
Value |

PID PARAMETER SELECTION

Pri   ALt

Select the desired set of PID Values (Primary or Alternate) that will be used in the PID calculation. The PID Parameter Selection function can also be configured in the Display Parameter *LOCS* Menu (*Pid LOCS*) or a User Input or Function Key can be assigned to the PID Parameter Selection Function.

PRIMARY/ALTERNATE PROPORTIONAL BAND

0 to *999.9* %

The Proportional Band property, entered as a percentage of the full input range, is the amount of input change required to vary the output full scale. For temperature inputs, the input range is fixed per the entered thermocouple or RTD type. For process inputs, the input range is the difference between the Process at 0%, and Process at 100% values. The Proportional Band is adjustable from 0.0% to 999.9%, and should be set to a value that provides the best response to a process disturbance while minimizing overshoot. A Proportional Band of 0.0% forces the controller into On/Off Control with its characteristic cycling at setpoint. The optimal value may be established by invoking Auto-tune.

PRIMARY/ALTERNATE INTEGRAL TIME

0 to *65000* seconds

The Integral Time is the time in seconds that it takes the integral action to equal the proportional action, during a constant process error. As long as the error exists, integral action is repeated each Integral Time. The higher the value, the slower the response. The optimal value may be established by invoking autotune.

PRIMARY/ALTERNATE DERIVATIVE TIME

0 to *9999* seconds

The Derivative Time is the seconds per repeat that the controller looks ahead at the ramping error to see what the proportional contribution will be and then matches that value every Derivative Time. As long as the ramping error exists, the derivative contribution is repeated every derivative time. Increasing the value helps to stabilize the response. Too high of a value, coupled with noisy signal processes, may cause the output to fluctuate too greatly, yielding poor control. Setting the time to zero disables derivative action. The optimal Derivative Time may be established by invoking auto-tune.

PRIMARY/ALTERNATE POWER FILTER

0 to *60.0* seconds

The Power Filter is a time constant, entered in seconds, that dampens the calculated output power. Increasing the value increases the dampening effect. Generally, a Power Filter in the range of one-twentieth to one-fiftieth of the controller's integral time (or process time constant) is effective. Values longer than these may cause controller instability due to the added lag effect.

PRIMARY/ALTERNATE OUTPUT OFFSET

- *100.0* to *100.0*

This value effectively shifts the zero output point of the module's output power calculation. This feature is most commonly used in proportional-only applications to remove steady-state error.

PID Parameters: Output Power Parameters (PWr)

```
Pro
  NO
```
↕ ▲/▼

```
Pro          P id
P id   P→    PWr    FLtP      dEAd      Ht6n      HtLo      HtH i      CL6n      CLLo      CLH i
       ←D           50.0      0.0       100.0     0.0       100.0      100.0     0.0       100.0
                     %         %         %         %         %          %         %         %
```

| Fault Condition Power Value | Output Deadband | Output Heat Gain | Heat Power Low Limit | Heat Power High Limit | Output Cool Gain | Cool Power Low Limit | Cool Power High Limit |
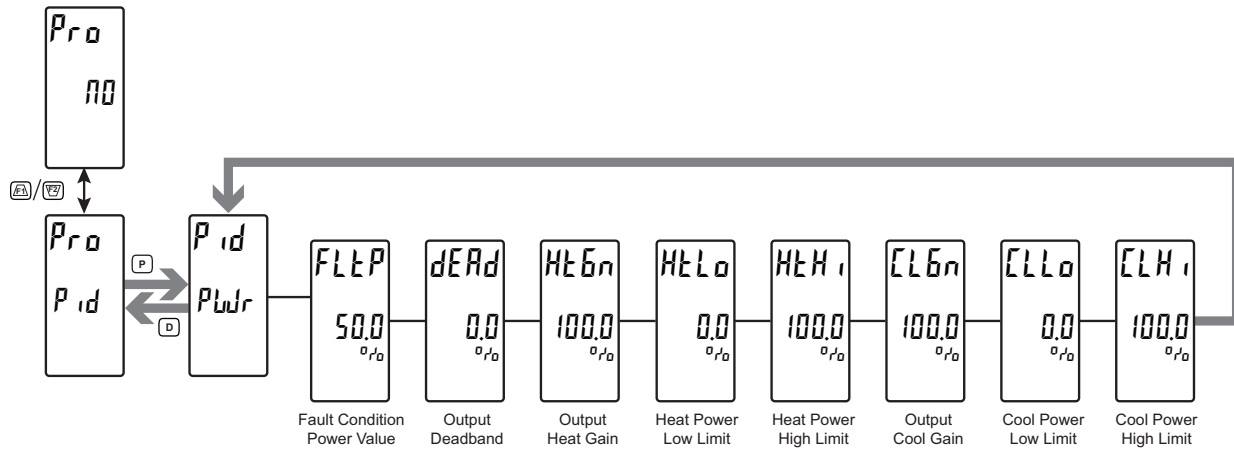
FAULT CONDITION POWER VALUE

```
FLtP
50.0
  %
```

- 199.9 to 200.0 %

Enter the desired control output value for the controller to assume in the event that the input sensor fails. You may enter values in excess of 100% and -100% to overcome limitations caused by Power Transfer Values, such as Gains and Offsets, that would otherwise limit the output to less than their maximums.

OUTPUT DEADBAND

```
dEAd
0.0
  %
```

- 100.0 to 100.0 %

The Output Deadband property defines the area in which both the heating and cooling outputs are inactive, known as deadband, or the area in which they will both be active, known as overlap. A positive value results in a deadband, while a negative value results in an overlap.

OUTPUT HEAT GAIN

```
Ht6n
100.0
  %
```

0 to 500.0 %

The Output Heat Gain defines the gain of the heating output relative to the gain established by the Proportional Band. A value of 100% causes the heat gain to mimic the gain determined by the proportional band. A value less than 100% can be used in applications in which the heater is oversized, while a value greater than 100% can be used when the heater is undersized. For the majority of applications the default value of 100% is adequate, and adjustments should only be made if the process requires it.

HEAT POWER LOW AND HIGH LIMITS

```
HtLo
0.0
  %
```

0 to 200.0 %

The Heat Low Limit and Heat High Limit properties may be used to limit controller power due to process disturbances or setpoint changes. Enter the safe output power limits for the process. You may enter values in excess of 100% to overcome limitations caused by power transfer values, such as gains and offsets, which would otherwise limit the output to less than their maximums.

```
HtH i
100.0
  %
```

OUTPUT COOL GAIN

```
CL6n
100.0
  %
```

0 to 500.0 %

The Output Cool Gain defines the gain of the cooling output relative to the gain established by the Proportional Band. A value of 100% causes the cool gain to mimic the gain determined by the proportional band. A value less than 100% can be used in applications in which the cooling device is oversized, while a value greater than 100% can be used when the cooling device is undersized. For the majority of applications the default value of 100% is adequate, and adjustments should only be made if the process requires it.

COOL POWER LOW AND HIGH LIMITS

```
CLLo
0.0
  %
```

0 to 200.0 %

The Cool Low Limit and Cool High Limit properties may be used to limit controller power due to process disturbances or setpoint changes. Enter the safe output power limits for the process. You may enter values in excess of –100% to overcome limitations caused by power transfer values, such as gains and offsets, which would otherwise limit the output to less than their maximums.

```
CLH i
100.0
  %
```

PID Parameters: On/Off Parameters (*ONOF*)

On/Off
Hysteresis
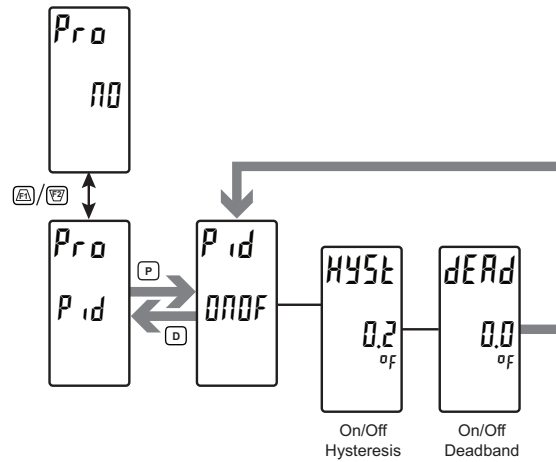
On/Off
Deadband

ON/OFF HYSTERESIS

HYSt

0.2

0 to *50.0* units

The On/Off Hysteresis property is used to eliminate output chatter by separating the on and off points of the output(s) when performing on/off control. The hysteresis value is centered around the setpoint, that is, the transition points of the output will be offset above and below the setpoint by half of the On/Off Hysteresis value. This value effects outputs programmed for Heat or Cool. During auto-tune, the controller cycles the process through 4 on/off cycles, so it is important to set the On-Off Hysteresis to an appropriate value before initializing auto-tune.

ON/OFF DEADBAND

dEAd

0.0

- *199.9* to *999.9* units

The On-Off Deadband property provides a means of offsetting the on-points of heat and cool outputs programmed for on/off operation. This results in a deadband if the value is positive, and overlap if the value is negative. When determining the actual transition points of the outputs, the On/Off Hysteresis value must also be taken into consideration.

PID Parameters: PID Tuning Parameters (`tunE`)

PID Tuning
Code

PID
Initiate Tuning
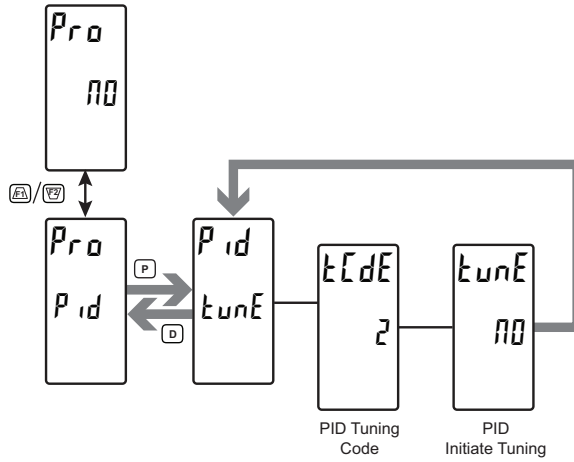
PID TUNING CODE

`tCdE`
`2`

`0` to `4`

The Tune Response property is used to ensure that an auto-tune yields the optimal P, I, and D values for various applications. A setting of Very Aggressive (0) results in a PID set that will reach setpoint as fast as possible, with no concern for overshoot, while a setting of Very Conservative sacrifices speed in order to prevent overshoot. Note: If the Tune Response property is changed, auto-tune needs to be reinitiated for the changes to affect the PID settings. See the PID Tuning Explanations Section for more information.

`0` = Very Aggressive
`1` = Aggressive
`2` = Default
`3` = Conservative
`4` = Very Conservative

PID INITIATE TUNING

`tunE`
`NO`

`NO`   `YES`

The PID Initiate Tuning is used to initiate an auto-tune sequence. Auto-tune may be used to establish the optimal P, I, D, and Power Filter values for a particular process. See the PID Tuning Explanations Section for more information
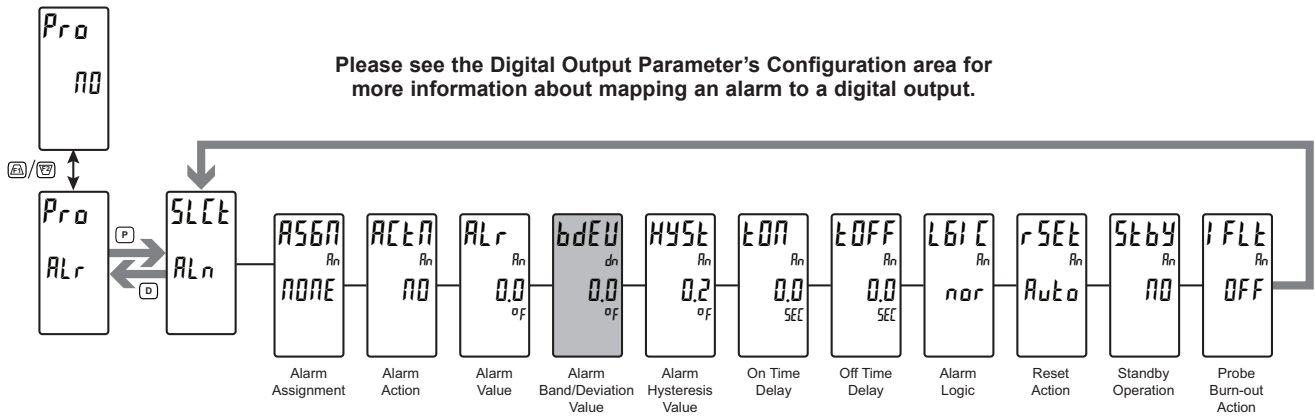
Alarm Parameters (`ALr`)

ALARM PARAMETER MENU SELECTION

`SLCt`
`P2C`
`AL1`

`AL1` `AL2` `AL3` `AL4` } Basic Mode

`AL5`   through   `AL16` } Advanced Mode

Select the Alarm parameter to be programmed.

ALARM PARAMETERS (ALn)

Please see the Digital Output Parameter's Configuration area for more information about mapping an alarm to a digital output.

Pro NO												

Pro ALr ⇄ SLCt ALn → ASGN An NONE | ACtN An NO | ALr An 0.0 °F | bdEU dn 0.0 °F | HYSt An 0.2 °F | tON An 0.0 SEC | tOFF An 0.0 SEC | LGIC An nor | rSEt An Auto | Stby An NO | I FLt An OFF

Alarm Assignment	Alarm Action	Alarm Value	Alarm Band/Deviation Value	Alarm Hysteresis Value	On Time Delay	Off Time Delay	Alarm Logic	Reset Action	Standby Operation	Probe Burn-out Action

ALARM ASSIGNMENT

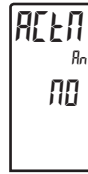| ASGN An NONE |
|---|

NONE   PU

Selects the parameter to be used to trigger the Alarm.

NONE = No Alarm Assignment (alarm disabled)
PU = Input Process Value

ALARM ACTION
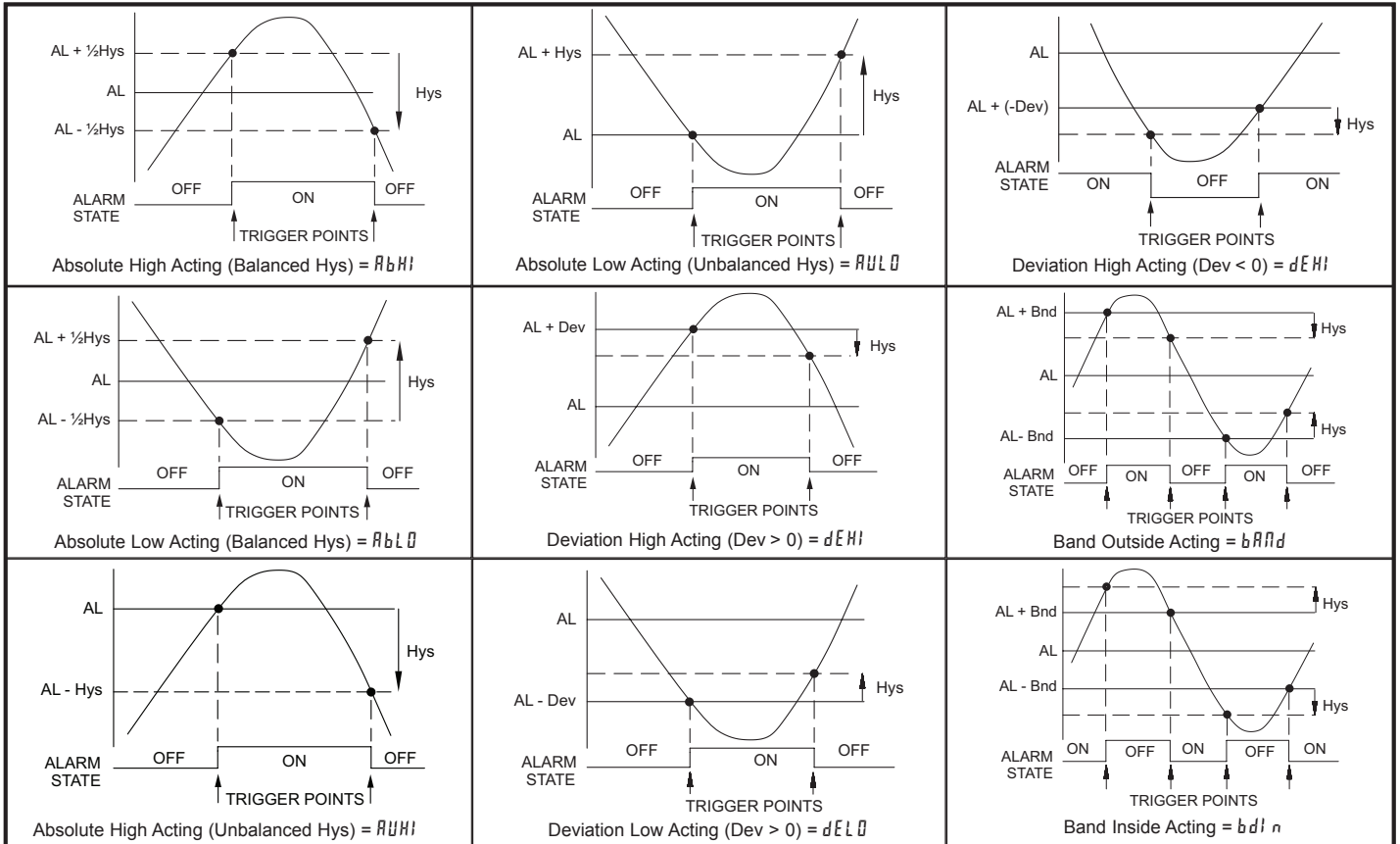
ACtN An NO

NO   AbHI   AbLO   AUHI   AULO
dEHI   dELO   bANd   bdIn

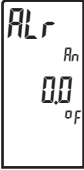Enter the action for the selected alarm. See Alarm Figures for a visual detail of each action.

NO = No Alarm Action
AbHI = Absolute high, with balanced hysteresis
AbLO = Absolute low, with balanced hysteresis
AUHI = Absolute high, with unbalanced hysteresis
AULO = Absolute low, with unbalanced hysteresis
dEHI = deviation high, with unbalanced hysteresis
dELO = deviation low, with unbalanced hysteresis
bANd = Outside band, with unbalanced hysteresis
bdIn = Inside band, with unbalanced hysteresis

Setpoint Alarm Figures

With reverse logic rEu, the below alarm states are opposite.

Absolute High Acting (Balanced Hys) = AbHI

Absolute Low Acting (Unbalanced Hys) = AULO

Deviation High Acting (Dev < 0) = dEHI

Absolute Low Acting (Balanced Hys) = AbLO

Deviation High Acting (Dev > 0) = dEHI

Band Outside Acting = bANd

Absolute High Acting (Unbalanced Hys) = AUHI

Deviation Low Acting (Dev > 0) = dELO

Band Inside Acting = bdIn

ALARM VALUE

`ALr`
An
`0.0`
°F

-1999 to 9999

Enter desired alarm value. Alarm values can also be entered when the alarm is programmed as `dEnt`, `PEnt` or `HEnt`. The decimal point position is determined by the Decimal Resolution setting in the Analog Input Parameter Menu.
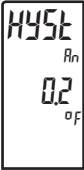
BAND/DEVIATION VALUE

`bdEU`
dn
`0.0`
°F

-1999 to 9999

This parameter is only available in band and deviation alarm actions. Enter desired alarm band or deviation value. When the Alarm Action is programmed for Band, this value can only be a positive value.

HYSTERESIS VALUE

`HYSt`
An
`0.2`
°F

1 to 9999

Enter desired hysteresis value. See Alarm Figures for visual indication or representation of how alarm actions (balanced and unbalanced) are affected by the hysteresis. When the alarm is a control output, usually balanced hysteresis is used. For alarm applications, usually unbalanced hysteresis is used. For unbalanced hysteresis modes, the hysteresis functions on the low side for high acting alarms and functions on the high side for low acting alarms. Note: Hysteresis eliminates output chatter at the switch point, while on/off time delay can be used to prevent false triggering during process transient events.
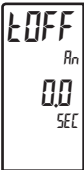
ON TIME DELAY

`tOn`
An
`0.0`
SEC

0 to 9999 seconds

Enter the time value in seconds that the alarm is delayed from turning on after the trigger point is reached. A value of 0.0 allows the controller to update the alarm status per the response time listed in the Specifications. When the output logic is `rEu`, this becomes off time delay. Any time accumulated at power-off resets during power-up.

OFF TIME DELAY

`tOFF`
An
`0.0`
SEC

0 to 9999 seconds

Enter the time value in seconds that the alarm is delayed from turning off after the trigger point is reached. A value of 0.0 allows the controller to update the alarm status per the response time listed in the Specifications. When the output logic is `rEu`, this becomes on time delay. Any time accumulated at power-off resets during power-up.
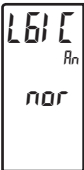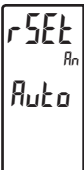
ALARM LOGIC

`LGIC`
An
`nor`

nor   rEu

Enter the logic of the alarm. The `nor` logic leaves the alarm operation as normal. The `rEu` logic reverses the alarm logic. In `rEu`, the alarm states in the Alarm Figures are reversed.
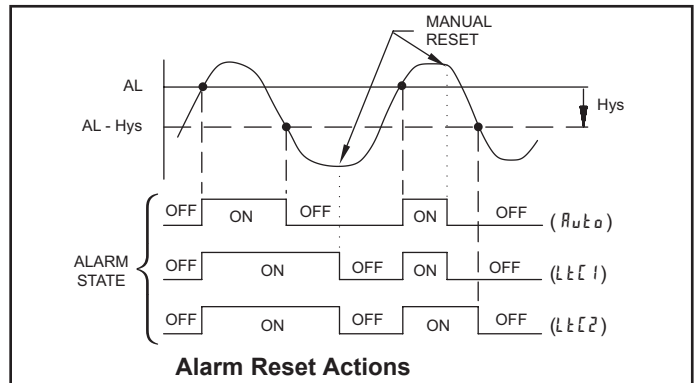
RESET ACTION

`rSEt`
An
`Auto`

Auto   LtC1   LtC2

Enter the reset action of the alarm.

`Auto` = Automatic action; This action allows the alarm to automatically reset off at the trigger points per the Alarm Action shown in Alarm Figures. The "on" alarm may be manually reset (off) immediately by a front panel function key or user input. The alarm remains reset off until the trigger point is crossed again.

`LtC1` = Latch with immediate reset action; This action latches the alarm on at the trigger point per the Alarm Action shown in Alarm Figures. Latch means that the alarm can only be turned off by front panel function key or user input manual reset, serial reset command or controller power cycle. When the user input or function key is activated (momentary or maintained), the corresponding "on" alarm is reset immediately and remains off until the trigger point is crossed again. Any alarms that are latched at power down will be reset.

`LtC2` = Latch with delay reset action; This action latches the alarm on at the trigger point per the Alarm Action shown in Alarm Figures. Latch means that the alarm can only be turned off by front panel function key or user input manual reset, serial reset command or controller power cycle. When the user input or function key is activated (momentary or maintained), the controller delays the event until the corresponding "on" alarm crosses the trigger off point. Any alarms that are latched at power down will be reset.

Alarm Reset Actions

ALARM STANDBY OPERATION

`Stby`
An
`nO`

nO   YES

When `YES`, the alarm is disabled (after a power up) until the trigger point is crossed. After the alarm trigger is reached, the alarm operates normally per the Alarm Action and Reset Mode.

The following programming step is only available when Input Type in the Input Menu is set for a temperature input (TC/RTD).
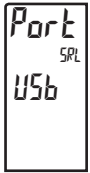
BURN-OUT ACTION

`1FLt`
An
`OFF`

OFF   On

Enter the probe burn-out action. In the event of a temperature probe failure (TC open; RTD open or short), the alarm output can be programmed to be on or off.
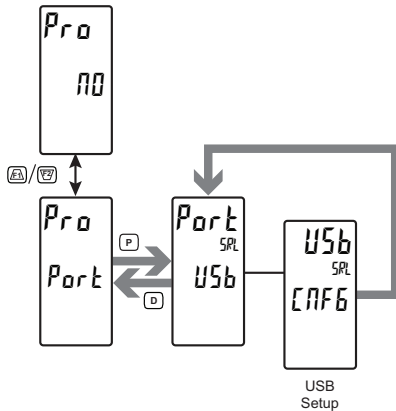
PORT PARAMETERS (Port)

PORT PARAMETER MENU SELECTION

```
Port
    SPL
USb
```

USb   SErL

Select the Communication Port Mode.

USB PORT PARAMETERS (USb)

```
Pro
  NO
```

▲/▼

```
Pro
Port
```

P →
```
Port
    SPL
USb
```
← D

```
USb
    SPL
CNFG
```

USB
Setup

USB SETUP

```
USb
    SPL
CNFG
```

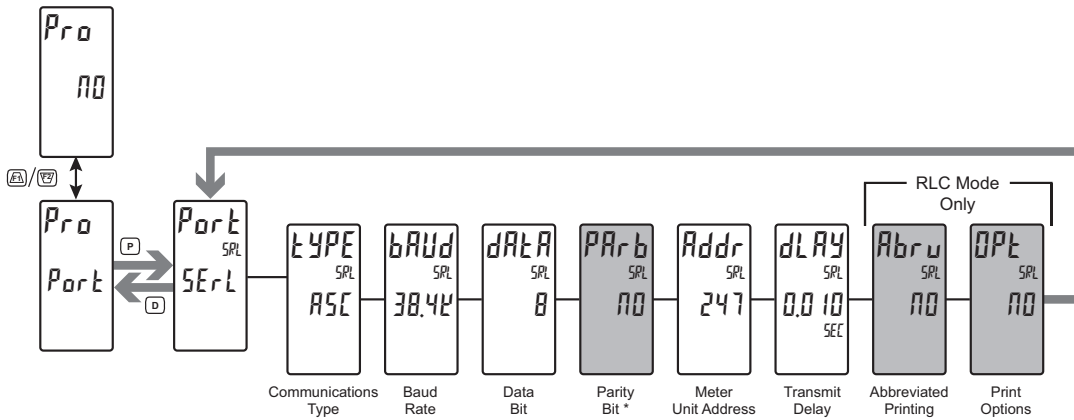CNFG   SErL

CNFG = Configures USB with settings required to operate with Crimson configuration software. This will automatically internally configure the PAX2C USB port to use Modbus RTU protocol, 38400 baud, 8 bits, and unit address of 247. The serial port settings in the Serial Parameters (SErL) will not change, or show this.

SErL = Configures USB to utilize serial settings and protocol as configured in the Serial Parameters.

SERIAL PORT PARAMETERS (SErL)

```
Pro
  NO
```

▲/▼

```
Pro
Port
```

P →
```
Port
    SPL
SErL
```
← D

RLC Mode Only

tYPE SPL ASC	bAUd SPL 38.4K	dAtA SPL 8	PArb SPL NO	Addr SPL 247	dLAY SPL 0.010 SEC	Abrv SPL NO	OPt SPL NO
Communications Type	Baud Rate	Data Bit	Parity Bit *	Meter Unit Address	Transmit Delay	Abbreviated Printing	Print Options

COMMUNICATIONS TYPE

```
tYPE
    SPL
ASC
```

ASC = Modbus ASCII
rLC = RLC Protocol (ASCII)
rtu = Modbus RTU

Select the desired communications protocol. Modbus is preferred as it provides access to all meter values and parameters. Since the Modbus protocol is included within the PAX2C, the PAX Modbus option card, PAXCDC4, should not be used. The PAXCDC1 (RS485), or PAXCDC2 (RS232) card should be used instead.

BAUD RATE

```
bAUd
    SPL
38.4K
```

1200   2400   4800   9600   19.2K   38.4K

Set the baud rate to match the other serial communications equipment on the serial link. Normally, the baud rate is set to the highest value that all the serial equipment are capable of transmitting and receiving.

DATA BIT

```
dAtA
    SPL
8
```
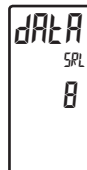
7   8

Select either 7 or 8 bit data word lengths. Set the word length to match the other serial communications equipment on the serial link.

PARITY BIT *

```
PArb
    SPL
NO
```
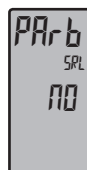
NO   EVEN   Odd
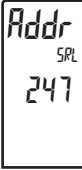
Set the parity bit to match that of the other serial communications equipment on the serial link. The meter ignores the parity when receiving data and sets the parity bit for outgoing data. If no parity is selected with 7 bit word length, an additional stop bit is used to force the frame size to 10 bits.

* Available when Data Bit = 7.

METER UNIT ADDRESS

`Addr`
SPL
`247`

`0` to `99` = RLC Protocol
`1` to `247` = Modbus

Select a Unit Address that does not match an address number of any other equipment on the serial link.

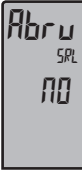## TRANSMIT DELAY

`dLAY`
SPL
`0.010`
SEC

`0.000` to `0.250` seconds

Following a transmit value ("*" terminator) or Modbus command, the PAX2C will wait this minimum amount of time in seconds before issuing a serial response.

The following programming steps are only available when Communications Type(`tYPE`) is programmed for `rLC`.

ABBREVIATED PRINTING

`Abru`
SPL
`NO`

`NO`   `YES`

Select `NO` for full print or Command T transmissions (meter address, mnemonics and parameter data) or `YES` for abbreviated print transmissions (parameter data only). This will affect all the parameters selected in the print options. If the meter address is 00, the address will not be sent during a full transmission.

PRINT OPTIONS

`OPt`
SPL
`NO`

`NO`   `YES`

`YES` - Enters the sub-menu to select the meter parameters to appear during a print request. For each parameter in the sub-menu, select `YES` for that parameter information to be sent during a print request or `NO` for that parameter information not to be sent. A print request is sometimes referred to as a block print because more than one parameter information (meter address, mnemonics and parameter data) can be sent to a printer or computer as a block.

DISPLAY	DESCRIPTION	FACTORY SETTING	MNEMONIC
`INPt`	Signal Input	`YES`	INP
`SP`	*Setpoint	`NO`	SET
`SPrr`	Setpoint Ramp Rate	`NO`	RMP
`OP`	Output Power	`NO`	PWR
`ProP`	*Proportional Band	`NO`	PBD
`Int`	*Integral Time	`NO`	INT
`dEr`	*Derivative Time	`NO`	DER
`ALr`	Alarm Status (1-4)	`NO`	ALR
`AL1`	*Alarm Value 1	`NO`	AL1
`AL2`	*Alarm Value 2	`NO`	AL2
`AL3`	*Alarm Value 3	`NO`	AL3
`AL4`	*Alarm Value 4	`NO`	AL4
`CtrL`	Control Parameters	`NO`	CTL

* Active values

SERIAL COMMUNICATIONS

The PAX2 supports serial communications using the optional serial communication cards or via the USB programming port located on the side of the unit. When USB is being used (connected), the serial communication card is disabled. When using the standard RS232 and RS485 PAX option cards, the PAX2 supports both the RLC protocol and also supports Modbus communications. The PAX Modbus option card should not be used with the PAX2, as the PAX2 internal Modbus protocol supports complete unit configuration, and is much more responsive.

USB

The USB programming port is primarily intended to be used to configure the PAX2 with the Crimson programming software. It can also be used as a virtual serial communications port following installation of the PAX2 USB drivers that are supplied with the Crimson software. When the USB port is being used, i.e. the USB cable is connected between PAX2 and PC, all serial communications with the serial option card (if used) is disabled.

USB Cable type required: USB A to Mini-B (not supplied)

PAX2 CONFIGURATION USING CRIMSON AND USB
1. Install Crimson software.
2. Supply power to PAX2.
3. Insure USB Setup in USB Port Parameters is set to CNFG (factory default setting).
4. Attach USB cable (USB A to Mini-B) between PC and PAX2.
5. Create a new file (File, New) or open an existing PAX2 database within Crimson.
6. Configure Crimson Link options (Link, Options) to the PC port which the USB cable is attached (in Step 4).

SERIAL MODBUS COMMUNICATIONS

Modbus Communications requires that the Serial Communications Type Parameter (tYPE) be set to Modbus RTU (rtu) or Modbus ASCII (ASC).

PAX2 CONFIGURATION USING CRIMSON AND SERIAL COMMUNICATIONS CARD
1. Install Crimson software.
2. Install RS232 or RS485 card and connect communications cable from PAX2 to PC.
3. Supply power to PAX2.
4. Configure serial parameters as Modbus RTU (rtu), 38,400 baud, address 247.
5. Create a new file (File, New) or open an existing PAX2 database within Crimson.
6. Configure Crimson 2 Link options (Link, Options) to the serial port which the communication cable is attached (in step 2).

SUPPORTED FUNCTION CODES

FC03: Read Holding Registers
1. Up to 64 registers can be requested at one time.
2. HEX <8000> is returned for non-used registers.

FC04: Read Input Registers
1. Up to 64 registers can be requested at one time.
2. Block starting point can not exceed register boundaries.
3. HEX <8000> is returned in registers beyond the boundaries.
4. Input registers are a mirror of Holding registers.

FC06: Preset Single Register
1. HEX <8001> is echoed back when attempting to write to a read only register.
2. If the write value exceeds the register limit (see Register Table), then that register value changes to its high or low limit. It is also returned in the response.

FC16: Preset Multiple Registers
1. No response is given with an attempt to write to more than 64 registers at a time.
2. Block starting point cannot exceed the read and write boundaries (40001-41711).
3. If a multiple write includes read only registers, then only the write registers will change.
4. If the write value exceeds the register limit (see Register Table), then that register value changes to its high or low limit.

FC08: Diagnostics
The following is sent upon FC08 request:

Module Address, 08 (FC code), 04 (byte count), "Total Comms" 2 byte count, "Total Good Comms" 2 byte count, checksum of the string

"Total Comms" is the total number of messages received that were addressed to the PAX2. "Total Good Comms" is the total messages received by the PAX2 with good address, parity and checksum. Both counters are reset to 0 upon response to FC08 and at power-up.

FC17: Report Slave ID
The following is sent upon FC17 request:

RLC-PX2C   ab<0100h><40h><40h><10h>
a = SP Card, "0"-No SP, "2" or "4" SP
b = Linear Card "0" = None, "1" = Yes
<0100> Software Version Number (1.00)
<20h>Max Register Reads (64)
<20h>Max Register Writes (64)
<10h> Number Guid/Scratch Pad Regs (16)

SUPPORTED EXCEPTION CODES

01: Illegal Function
Issued whenever the requested function is not implemented in the meter.

02: Illegal Data Address
Issued whenever an attempt is made to access a single register that does not exist (outside the implemented space) or to access a block of registers that falls completely outside the implemented space.

03: Illegal Data Value
Issued when an attempt is made to read or write more registers than the meter can handle in one request.

07: Negative Acknowledge
Issued when a write to a register is attempted with an invalid string length.

PAX2C FREQUENTLY USED MODBUS REGISTERS

Only frequently used registers are shown below. The entire Modbus Register Table can be found at www.redlion.net and on the included flash drive.

Values less than 65,535 will be in (LO word). Values greater than 65,535 will continue into (Hi word). Negative values are represented by two's complement of the combined (Hi word) and (LO word).

Note 1: The PAX2C should not be powered down while parameters are being changed. Doing so may corrupt the non-volatile memory resulting in checksum errors.

REGISTER ADDRESS	REGISTER NAME	LOW LIMIT	HIGH LIMIT	FACTORY SETTING	ACCESS	COMMENTS
	FREQUENTLY USED REGISTERS					
40001	Process Value	N/A	N/A	N/A	Read	1 = 1 Display Unit
40002	Maximum Value	-1999	9999	N/A	Read	1 = 1 Display Unit
40003	Minimum Value	-1999	9999	N/A	Read	1 = 1 Display Unit
40004	Active Setpoint Value	-1999	9999	0	Read/Write	1 = 1 Display Unit
40005	Setpoint 1 Value	-1999	9999	0	Read/Write	1 = 1 Display Unit
40006	Setpoint 2 Value	-1999	9999	0	Read/Write	1 = 1 Display Unit
40007	Setpoint Deviation	N/A	N/A	N/A	Read Only	
40008	Output Power	-1000	1000	N/A	Read/Write	Output Power: Heat/Cool; * writable only in manual mode; 1 = 0.1%
40009	Active Proportional Band	0	9999	40	Read/Write	1 = 0.1 Display Unit
40010	Active Integral Time	0	65000	120	Read/Write	1 = 1 Display Unit
40011	Active Derivative Time	0	9999	30	Read/Write	1 = 0.1 Display Unit
40012	Active Power Filter	0	600	10	Read/Write	1 = 1 Display Unit
40013	Auto-Tune Code	0	4	2	Read/Write	0 = Very Aggressive, 1 = Aggressive, 2 = Default, 3 = Conservative, 4 = Very Conservative
40014	Auto-Tune Request	0	1	0	Read/Write	0 = Off, 1 = Invoke Auto-Tune
40015	Auto-Tune Phase	0	4	0	Read	0 = Off, 4 = Last Phase of Auto-Tune
40016	Auto-Tune Done	0	1	0	Read	1 = Successful Auto-Tune since last power cycle.
40017	Auto-Tune Fail	0	1	0	Read/Write	
40018	Control Mode	0	1	0	Read/Write	0 = Automatic, 1 = Manual Mode
40019	Setpoint Selection	0	1	0	Read/Write	0 = Setpoint 1, 1 = Setpoint 2
40020	Remote/Local Setpoint Selection	0	1	0	Read/Write	0 = Local, 1 = Remote
40021	PID Parameter Selection	0	1	0	Read/Write	0 = Primary PID Values, 1 = Alternate PID Values
40022	Disable Integral Action	0	1	0	Read/Write	0 = Enabled, 1 = Disabled
40023	Disable Setpoint Ramping	0	1	0	Read/Write	0 = Enabled, 1 = Disabled
40024	Setpoint Ramping In Process	0	1	0	Read/Write	0 = Off, 1 = In Process
40025	Setpoint Ramp Rate Value	-1999	9999	0	Read/Write	1 = 1 Display Unit
40026	Alarm (1-16) Status Register	0	65535	0	Read	Bit 15 = A16, Bit 0 = A1
40027	Input Range Alarm	0	1	0	Read	
40028	User Input Status	0	2	0	Read	Bit 1 = User Input 2, Bit 0 = User Input 1
40029	Digital Output Status	0	15	N/A	Read/Write	Status of Digital Outputs. Bit State: 0 = Off, 1 = On Bit 3 = Out1, Bit 2 = Out2, Bit 1 = Out3, Bit 0 = Out4 Outputs can only be activated/reset with this register when the respective bits in the Manual Mode Register (MMR) are set.
40030	Output Manual Mode Register (MMR)	0	31	0	Read/Write	Bit State: 0 = Auto Mode, 1 = Manual Mode Bit 4 = DO1, Bit 3 = DO2, Bit 2 = DO3, Bit 1 = DO4, Bit 0 = Linear Output
40031	Reset Output Register	0	15	0	Read/Write	Bit State: 1 = Reset Output, bit is returned to zero following reset processing; Bit 3 = DO1, Bit 2 = DO2, Bit 1 = DO3, Bit 0 = DO4
40032	Analog Output Register (AOR)	0	4095	0	Read/Write	Functional only if Linear Output is in Manual Mode. (MMR bit 0 = 1) Linear Output Card written to only if Linear Out (MMR bit 0) is set.
40033	Active Alarm 1 Value	-1999	9999	0	Read/Write	Active List (A or B)
40034	Active Alarm 2 Value	-1999	9999	0	Read/Write	Active List (A or B)
40035	Active Alarm 3 Value	-1999	9999	0	Read/Write	Active List (A or B)
40036	Active Alarm 4 Value	-1999	9999	0	Read/Write	Active List (A or B)
40037	Active Alarm 5 Value	-1999	9999	0	Read/Write	Active List (A or B)
40038	Active Alarm 6 Value	-1999	9999	0	Read/Write	Active List (A or B)
40039	Active Alarm 7 Value	-1999	9999	0	Read/Write	Active List (A or B)
40040	Active Alarm 8 Value	-1999	9999	0	Read/Write	Active List (A or B)
40041	Active Alarm 9 Value	-1999	9999	0	Read/Write	Active List (A or B)
40042	Active Alarm 10 Value	-1999	9999	0	Read/Write	Active List (A or B)
40043	Active Alarm 11 Value	-1999	9999	0	Read/Write	Active List (A or B)
40044	Active Alarm 12 Value	-1999	9999	0	Read/Write	Active List (A or B)
40045	Active Alarm 13 Value	-1999	9999	0	Read/Write	Active List (A or B)
40046	Active Alarm 14 Value	-1999	9999	0	Read/Write	Active List (A or B)
40047	Active Alarm 15 Value	-1999	9999	0	Read/Write	Active List (A or B)
40048	Active Alarm 16 Value	-1999	9999	0	Read/Write	Active List (A or B)
40049	Active Alarm 1 Band/Dev. Value	-1999	9999	0	Read/Write	Active List (A or B). Only for Band or Deviation Alarm Action.
40050	Active Alarm 2 Band/Dev. Value	-1999	9999	0	Read/Write	Active List (A or B). Only for Band or Deviation Alarm Action.

REGISTER ADDRESS	REGISTER NAME	LOW LIMIT	HIGH LIMIT	FACTORY SETTING	ACCESS	COMMENTS
40051	Active Alarm 3 Band/Dev. Value	-1999	9999	0	Read/Write	Active List (A or B). Only for Band or Deviation Alarm Action.
40052	Active Alarm 4 Band/Dev. Value	-1999	9999	0	Read/Write	Active List (A or B). Only for Band or Deviation Alarm Action.
40053	Active Alarm 5 Band/Dev. Value	-1999	9999	0	Read/Write	Active List (A or B). Only for Band or Deviation Alarm Action.
40054	Active Alarm 6 Band/Dev. Value	-1999	9999	0	Read/Write	Active List (A or B). Only for Band or Deviation Alarm Action.
40055	Active Alarm 7 Band/Dev. Value	-1999	9999	0	Read/Write	Active List (A or B). Only for Band or Deviation Alarm Action.
40056	Active Alarm 8 Band/Dev. Value	-1999	9999	0	Read/Write	Active List (A or B). Only for Band or Deviation Alarm Action.
40057	Active Alarm 9 Band/Dev. Value	-1999	9999	0	Read/Write	Active List (A or B). Only for Band or Deviation Alarm Action.
40058	Active Alarm 10 Band/Dev. Value	-1999	9999	0	Read/Write	Active List (A or B). Only for Band or Deviation Alarm Action.
40059	Active Alarm 11 Band/Dev. Value	-1999	9999	0	Read/Write	Active List (A or B). Only for Band or Deviation Alarm Action.
40060	Active Alarm 12 Band/Dev. Value	-1999	9999	0	Read/Write	Active List (A or B). Only for Band or Deviation Alarm Action.
40061	Active Alarm 13 Band/Dev. Value	-1999	9999	0	Read/Write	Active List (A or B). Only for Band or Deviation Alarm Action.
40062	Active Alarm 14 Band/Dev. Value	-1999	9999	0	Read/Write	Active List (A or B). Only for Band or Deviation Alarm Action.
40063	Active Alarm 15 Band/Dev. Value	-1999	9999	0	Read/Write	Active List (A or B). Only for Band or Deviation Alarm Action.
40064	Active Alarm 16 Band/Dev. Value	-1999	9999	0	Read/Write	Active List (A or B). Only for Band or Deviation Alarm Action.

SERIAL RLC PROTOCOL COMMUNICATIONS

RLC Communications requires the Serial Communications Type Parameter (type) be set to "rLC".

SENDING SERIAL COMMANDS AND DATA TO THE METER

When sending commands to the meter, a string containing at least one command character must be constructed. A command string consists of a command character, a value identifier, numerical data (if writing data to the meter) followed by a command terminator character * or $.

Command Chart

COMMAND	DESCRIPTION	NOTES
N	Node (Meter) Address Specifier	Address a specific meter. Must be followed by a two digit node address. Not required when address = 00.
T	Transmit Value (read)	Read a register from the meter. Must be followed by register ID character
V	Value Change (write)	Write to register of the meter. Must be followed by register ID character and numeric data.
R	Reset	Reset a register or output. Must be followed by register ID character.
P	Block Print Request	Initiates a block print output. Registers are defined in programming.
*, $	Terminator	Signifies end of transmission

Command String Construction

The command string must be constructed in a specific sequence. The meter does not respond with an error message to invalid commands. The following procedure details construction of a command string:

1. The first characters consist of the Node Address Specifier (N) followed by a 2 character address number. The address number of the meter is programmable. If the node address is 0, this command and the node address itself may be omitted. This is the only command that may be used in conjunction with other commands.
2. After the optional address specifier, the next character is the command character.
3. The next character is the Register ID. This identifies the register that the command affects. The P command does not require a Register ID character. It prints according to the selections made in print options.
4. If constructing a value change command (writing data), the numeric data is sent next.
5. All command strings must be terminated with the string termination characters *, or $. The meter does not begin processing the command string until this character is received. See Timing Diagram figure for differences between terminating characters.

Register Identification Chart

ID	VALUE DESCRIPTION	MNEMONIC	APPLICABLE COMMANDS/COMMENTS
A	Signal Input	INP	T, P
B	Active Setpoint	SET	T, V, P
C	Setpoint Ramp Rate	RMP	T, V, P
D	Output Power	PWR	T, V, P (V only in manual mode)
E	Proportional Band	PBD	T, V, P
F	Integral Time	INT	T, V, P
G	Derivative Time	DER	T, V, P
H	Alarm Status (1-4)	ALR	T, R, P
I	Alarm Value 1	AL1	T, V, R, P (Reset command resets Alarm Outputs)
J	Alarm Value 2	AL2	
K	Alarm Value 3	AL3	
L	Alarm Value 4	AL4	
M	Control Parameters	CTL	T, V, P
O	Auto/Manual Register	MMR	T, V
Q	Analog Output Register	AOR	T, V
S	Digital Output Register	DOR	T, V

Command String Examples:

1. Node address = 17, Write 350 to Alarm 1.
   String: N17VI350$
2. Node address = 5, Read Input value.
   String: N5TA*
3. Node address = 0, Reset Alarm 4 output.
   String: RL*

Sending Numeric Data

Numeric data sent to the controller must be limited to 4 digits (-1999 to 9999). Leading zeros are ignored. Negative numbers must have a minus sign. The controller ignores any decimal point and conforms the number to the scaled resolution. (For example: the meter's scaled decimal point position = 0.0 and 25 is written to a register. The value of the register is now 2.5.

Note: Since the controller does not issue a reply to value change commands, follow with a transmit value command for readback verification.

RECEIVING DATA FROM THE CONTROLLER

Data is transmitted by the controller in response to either a transmit command (T), a print block command (P) or User Function print request. The response from the controller is either a full field transmission or an abbreviated transmission. The controller response mode is selected via the $Abru$ parameter in the Serial Port Parameters.

Full Field Transmission (Address, Mnemonic, Numeric data)

Byte	Description
1, 2	2 byte Node Address field [00-99]
3	\<SP> (Space)
4-6	3 byte Register Mnemonic field
7-18	2 byte data field, 10 bytes for number, one byte for sign, one byte for decimal point
19	\<CR> carriage return
20	\<LF> line feed
21	\<SP>* (Space)
22	\<CR>* carriage return
23	\<LF>* line feed

These characters only appear in the last line of a block print.

The first two characters transmitted are the node address, unless the node address assigned = 0, in which case spaces are substituted. A space follows the node address field. The next three characters are the register mnemonic.

The numeric data is transmitted next. The numeric field is 12 characters long (to accommodate the 10 digit totalizer), with the decimal point position floating within the data field. Negative values have a leading minus sign. The data field is right justified with leading spaces.

The end of the response string is terminated with a carriage return \<CR> and \<LF>. When block print is finished, an extra \<SP>\<CR> \<LF> is used to provide separation between the blocks.

Abbreviated Transmission (Numeric data only)

| Byte	Description
1-12	12 byte data field, 10 bytes for number, one byte for sign, one byte for decimal point
13	\<CR> carriage return
14	\<LF> line feed
15	\<SP>* (Space)
16	\<CR>* carriage return
17	\<LF>* line feed

These characters only appear in the last line of a block print.

Controller Response Examples:

1. Node address = 17, full field response, Input = 875
    17 INP 875 \<CR>\<LF>
2. Node address = 0, full field response, Alarm 2 = -250.5
    SP2 -250.5\<CR>\<LF>
3. Node address = 0, abbreviated response, Alarm 2 = 250, last line of block print
    250\<CR>\<LF>\<SP>\<CR>\<LF>

Auto/Manual Mode Register (MMR) ID: O

This register sets the controlling mode for the outputs. In Auto Mode (0) the controller controls the digital outputs and analog output. In Manual Mode (1) the outputs are defined by the registers DOR and AOR. When transferring from auto mode to manual mode, the controller holds the last output value (until the register is changed by a write). Each output may be independently changed to auto or manual. In a write command string (VO), any character besides 0 or 1 in a field will not change the corresponding output mode.

```
O abcde
     │││││└─e = Analog Output
     ││││└─d = DO4
     │││└─c = DO3
     ││└─b = DO2
     │└──a = DO1
```
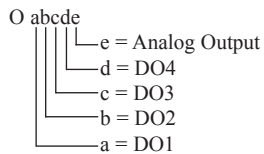
Example: VO00011* places DO4 and Analog in manual.

Analog Output Register (AOR) ID: Q

This register stores the present signal value of the analog output. The range of values of this register is 0 to 4095, which corresponds to the analog output range per the following chart:

| Register Value	Output Signal*		
	0-20 mA	4-20 mA	0-10 V
0	0.00	4.00	0.000
1	0.005	4.004	0.0025
2047	10.000	12.000	5.000
4094	19.995	19.996	9.9975
4095	20.000	20.000	10.000

*Due to the absolute accuracy rating and resolution of the output card, the actual output signal may differ 0.15% FS from the table values. The output signal corresponds to the range selected (0-20 mA, 4-20 mA or 0-10 V).

Writing to this register (VQ) while the analog output is in the Manual Mode causes the output signal level to update immediately to the value sent. While in the Automatic Mode, this register may be written to, but it has no effect until the analog output is placed in the manual mode. When in the Automatic Mode, the controller controls the analog output signal level. Reading from this register (TQ) will show the present value of the analog output signal.
    Example: VQ2047 will result in an output of 10.000 mA, 12.000 mA or 5.000V depending on the range selected.

Digital Output Register (DOR) ID: S

This register stores the states of the setpoint outputs. Reading from this register (TS) will show the present state of all the digital outputs. A "0" in the setpoint location means the output is off and a "1" means the output is on.

```
S abcd
    ││││└─d = DO4
    │││└──c = DO3
    ││└───b = DO2
    │└────a = DO1
```
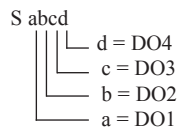
In Automatic Mode, the controller controls the digital output state. In Manual Mode, writing to this register (VS) will change the output state. Sending any character besides 0 or 1 in a field or if the corresponding output was not first in manual mode, the corresponding output value will not change. (It is not necessary to send least significant 0s.)
    Example: VS10* will result in output 1 on and output 2 off.

COMMAND RESPONSE TIME

The controller can only receive data or transmit data at any one time (half-duplex operation). When sending commands and data to the controller, a delay must be imposed before sending another command. This allows enough time for the controller to process the command and prepare for the next command.

At the start of the time interval t_1, the computer program prints or writes the string to the com port, thus initiating a transmission. During t_1, the command characters are under transmission and at the end of this period, the command terminating character (*) is received by the controller. The time duration of t_1 is dependent on the number of characters and baud rate of the channel.

$$t_1 = (10 * \text{\# of characters}) / \text{baud rate}$$

At the start of time interval t_2, the controller starts the interpretation of the command and when complete, performs the command function. This time interval t_2 varies from 2 msec to 15 msec. If no response from the controller is expected, the controller is ready to accept another command.

If the controller is to reply with data, the time interval t_2 is controlled by the use of the command terminating character and the (Serial Transmit Delay parameter (dLAY)). The standard command line terminating character is "*". This terminating character results in a response time window of the Serial Transmit Delay time (dLAY) plus 15 msec. maximum. The dLAY parameter should be programmed to a value that allows sufficient time for the release of the sending driver on the RS485 bus. Terminating the command line with "$" results in a response time window (t_2) of 2 msec minimum and 15 msec maximum. The response time of this terminating character requires that sending drivers release within 2 msec after the terminating character is received.

At the beginning of time interval t_3, the controller responds with the first character of the reply. As with t_1, the time duration of t_3 is dependent on the number of characters and baud rate of the channel.

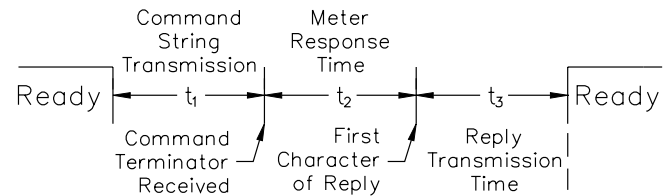$$t_3 = (10 * \text{\# of characters}) / \text{baud rate}.$$

At the end of t_3, the controller is ready to receive the next command. The maximum serial throughput of the controller is limited to the sum of the times t_1, t_2 and t_3.

Timing Diagrams

NO REPLY FROM CONTROLLER
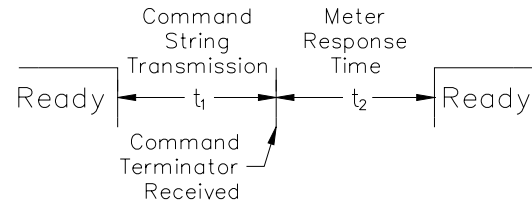
RESPONSE FROM CONTROLLER

COMMUNICATION FORMAT

Data is transferred from the controller through a serial communication channel. In serial communications, the voltage is switched between a high and low level at a predetermined rate (baud rate) using ASCII encoding. The receiving device reads the voltage levels at the same intervals and then translates the switched levels back to a character.

The voltage level conventions depend on the interface standard. The table lists the voltage levels for each standard.

LOGIC	INTERFACE STATE	RS232*	RS485*
1	mark (idle)	TXD,RXD; -3 to -15 V	a-b < -200 mV
0	space (active)	TXD,RXD; +3 to +15 V	a-b > +200 mV
* Voltage levels at the Receiver			

Data is transmitted one byte at a time with a variable idle period between characters (0 to ∞). Each ASCII character is "framed" with a beginning start bit, an optional parity bit and one or more ending stop bits. The data format and baud rate must match that of other equipment in order for communication to take place. The figures list the data formats employed by the controller.

Start bit and Data bits

Data transmission always begins with the start bit. The start bit signals the receiving device to prepare for reception of data. One bit period later, the least significant bit of the ASCII encoded character is transmitted, followed by the remaining data bits. The receiving device then reads each bit position as they are transmitted. Since the sending and receiving devices operate at the same transmission speed (baud rate), the data is read without timing errors.
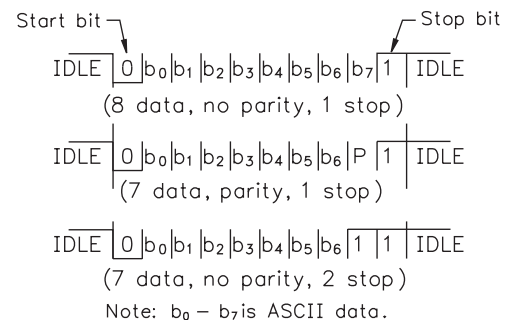

Character Frame Figure

Parity bit

After the data bits, the parity bit is sent. The transmitter sets the parity bit to a zero or a one, so that the total number of ones contained in the transmission (including the parity bit) is either even or odd. This bit is used by the receiver to detect errors that may occur to an odd number of bits in the transmission. However, a single parity cannot detect errors that may occur to an even number of bits. Given this limitation, the parity bit is often ignored by the receiving device. The PAX controller ignores the parity bit of incoming data and sets the parity bit to odd, even or none (mark parity) for outgoing data.

Stop bit

The last character transmitted is the stop bit. The stop bit provides a single bit period pause to allow the receiver to prepare to re-synchronize to the start of a new transmission (start bit of next byte). The receiver then continuously looks for the occurrence of the start bit. If 7 data bits and no parity is selected, then 2 stop bits are sent from the PAX controller.
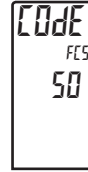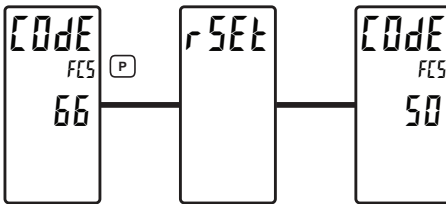
FACTORY SERVICE OPERATIONS (FACT)

```
Pro
  NO
```

⬍ F1/F2

```
Pro        CODE
FACT       FCS
    →P       50
    ←D
```
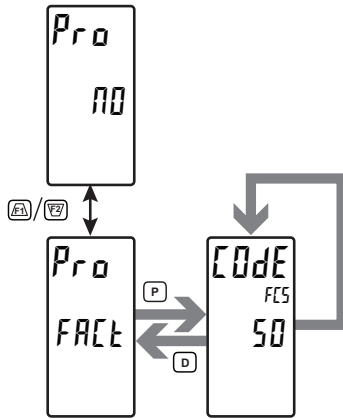
FACTORY SERVICE CODE

```
CODE
FCS
50
```

0 to 250

Enter the Service Code for the desired operation.

RESTORE FACTORY DEFAULTS

```
CODE      rSEt      CODE
FCS              FCS
66    P            50
```

Use the F1 and F2 keys to display CODE 66 and press **P**. The controller will flash rSEt and then return to CODE 50. This will overwrite all user settings with the factory settings.
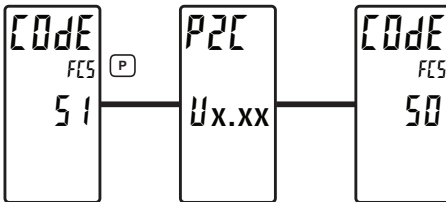
MODEL AND CODE VERSION

```
CODE      P2C       CODE
FCS              FCS
51    P   Ux.xx     50
```

The controller will briefly display the model (P2C) on Line 1, and the current firmware version (UEr x.xx) on Line 2, and then return to CODE 50.

CONTROLLER CALIBRATION

```
CODE      CODE
FCS    P    FCS
48         50
```

NO	Curr	Uolt	rES
tc	ICE	rtd	AnLG

The controller has been fully calibrated at the factory. Scaling to convert the input signal to a desired display value is performed in Input Parameters. If the controller appears to be indicating incorrectly or inaccurately, refer to Troubleshooting before attempting to calibrate the controller. When recalibration is required (generally every 2 years), it should only be performed by qualified technicians using appropriate equipment. Calibration does not change any user programmed parameters. However, it will affect the accuracy of the input signal and the values previously stored using the Apply (APLY) Scaling Style.

Preparation for Current, Volt, and Ohm Input Calibration

⚠ *Warning: Input Calibration of this controller requires a signal source capable of producing a signal greater than or equal to the range being calibrated with an accuracy of 0.01% or better.*

Before starting, verify that the Input Range, T/V, and Excitation Jumper is set for the range to be calibrated. Verify that the precision signal source is connected and ready. Allow a 30 minute warm-up period before calibrating the controller. Selecting NO at any calibration step, will cause the unit to maintain the existing calibration parameters for that step. Selecting YES and pressing the **P** key will cause the unit to store new calibration settings for the range selected. Pressing **D** at any time will exit programming mode, but any range that has been calibrated will maintain the new settings.

Current, Volt and Ohm Calibration Procedure

1. After entering CodE 48, select the input signal type (Curr, Uolt, rES) to be calibrated.
2. Press the **P** key until the desired range along with ZER is displayed in the Line 2 units mnemonic.
3. Apply the zero input limit of the range indicated on Line 1 of the controller.
4. Press F1 to select YES.
5. Press **P**. Display will indicate ---- on Line 2 as the unit reads and stores the new calibration parameter.
6. Display will indicate the desired range along with FUL in the Line 2 units mnemonic
7. Apply the signal level indicated on Line 1 of the controller.
8. Press F1 to select YES.
9. Press **P**. Display will indicate ---- on Line 2 as the unit reads and stores the new calibration parameter.
10. Repeat Preparation and Calibration Procedure for each Input Range to be calibrated.

Preparation for TC calibration

TC calibration parameters will affect RTD calibration. If using an RTD, it is recommended that the RTD calibration be performed after completing the TC calibration.

⚠️ *Warning: TC Input Calibration of this controller requires a signal source capable of producing a 60 mV signal with an accuracy of 0.01% or better.*

Before starting, verify the T/V jumper is in the T position. Verify the precision signal source is connected and ready. Allow a 30 minute warm-up period before calibrating the controller. Selecting ΠΟ at any calibration step, will cause the unit to maintain the existing calibration parameters for that step. Selecting 4E5 and pressing **P** key will cause the unit to store new calibration settings for the range selected. Pressing **D** at any time will exit programming mode, but any range that has been calibrated will maintain the new settings.

TC Calibration Procedure

1. After entering ᒪσdE 4θ, select the Łc.
2. Press the **P** key. Display will indicate 6θmU with ᒄER displayed in the Line 2 units mnemonic.
3. Apply 0 mV to input.
4. Press ⸋F1⸌ to select 4E5.
5. Press **P**. Display will indicate ---- on Line 2 as the unit reads and stores the new calibration parameter.
6. Display will indicate 6θmU with FUL displayed in the Line 2 units mnemonic.
7. Apply 60 mV to input.
8. Press ⸋F1⸌ to select 4E5.
9. Press **P**. Display will indicate ---- on Line 2 as the unit reads and stores the new calibration parameter.
10. TC Calibration complete.

Preparation for RTD Input Calibration

RTD calibration is dependent on TC calibration parameters. Therefore, the TC calibration should be performed prior to attempting the RTD calibration.

⚠️ *Warning: RTD Input Calibration of this controller requires a signal source capable of producing a 300 ohm resistance with an accuracy of 0.01% or better.*

Before starting, verify that the T/V Jumper is in the T position. Verify the RTD jumper is in the proper range. Verify the precision signal source is connected and ready. Allow a 30 minute warm-up period before calibrating the controller. Selecting ΠΟ at any calibration step, will cause the unit to maintain the existing calibration parameters for that step. Selecting 4E5 and pressing **P** key will cause the unit to store new calibration settings for the range selected. Pressing **D** at any time will exit programming mode, but any range that has been calibrated will maintain the new settings.

RTD Calibration Procedure

1. After entering Code 48, select rŁd.
2. Press the **P** key until the desired range along with θ is displayed in the Line 2 units mnemonic.
3. Apply zero ohms to the input of the controller.
4. Press ⸋F1⸌ to select 4E5.
5. Press **P**. Display will indicate ---- on Line 2 as the unit reads and stores the new calibration parameter.
6. Display will indicate the desired range along with a value in the upper right corner, in ohms, to be applied in the next step in the Line 2 units mnemonic of the controller.
7. Apply the signal level, in ohms, as indicated by the Line 2 units mnemonic on the controller.
8. Press ⸋F1⸌ to select 4E5.
9. Press **P**. Display will indicate ---- on Line 2 as the unit reads and stores the new calibration parameter.
10. Repeat Preparation and Calibration Procedure for each Input Range to be calibrated.

Ice Point Calibration Procedure

1. Remove all option cards.
2. Verify ambient temperature of controller environment is between 20°C and 30°C.
3. Set T/V jumper in the T position.
4. Connect a thermocouple with an accuracy of 1°C or better to the controller.
5. In the Analog Input Parameters, verify Input Type (ŁYPE) is set to the type of thermocouple connected in step 4, Temperature Scale (5ᒪAL) is °C, Ice Point Compensation (IᒪE) is turned ON, Decimal Resolution (dᒪPŁ) is 0.0, Rounding Increment (rnd) is 0.1 and Display Offset (θF5Ł) is set to 0.

6. Place the thermocouple in close thermal contact to a reference thermometer probe. (Use a reference thermometer with an accuracy of 0.25% °C or better.) The two probes should be shielded from air movement and allowed sufficient time to equalize in temperature. (A calibration bath could be used in place of the thermometer.)
7. If a difference exits between PAX2C display and reference thermometer, continue calibration.
8. Note the PAX2C display reading as the "Display Mode" reading to be used in Step 12.
9. Enter the Factory Service Operations, select ᒪσdE 4θ and press **P**.
10. Select IᒪE and press **P**.
11. Display will indicate the Existing ICE Point Value.
12. Calculate a new ICE Point Value using: Existing ICE Point Value + (reference temperature – Display Mode reading). All values are in °C.
13. Using ⸋F1⸌ and ⸋F2⸌ change Existing ICE Point Value to indicate the new ICE Point Value calculated in Step 12.
14. Press **P** and return to Display Mode. Verify the Display Mode reading (with 0 Display Offset) matches the reference temperature. If not, repeat steps 8 thru 14.

Preparation for Analog Output Card Calibration

⚠️ *Warning: Calibration of this controller requires an external meter with an accuracy of 0.005% or better.*

Before starting, verify that the precision voltmeter (voltage output) or current meter (current output) is connected and ready. Perform the following procedure.

1. After entering ᒪσdE 4θ, select Anᒪ6.
2. Using the chart below, step through the five selections to be calibrated. At each prompt, use the PAX2C ⸋F1⸌ and ⸋F2⸌ keys to adjust the external meter display to match the selection being calibrated. When the external reading matches, or if the particular range is not in need of calibration, press the **P** key to advance to the next range.

PAX2C DISPLAY	EXTERNAL METER	ACTION
θθ mA	0.00 mA	⸋F1⸌ and ⸋F2⸌ to adjust External Meter
4θ mA	4.00 mA	⸋F1⸌ and ⸋F2⸌ to adjust External Meter
2θθ mA	20.00 mA	⸋F1⸌ and ⸋F2⸌ to adjust External Meter
θθ U	0.00 V	⸋F1⸌ and ⸋F2⸌ to adjust External Meter
1θθ U	10.00 V	⸋F1⸌ and ⸋F2⸌ to adjust External Meter

3. Calibration Complete.

OPERATION OVERVIEW

CONTROLLER POWER-UP

Upon applying power, the controller delays control action and temperature indication for several seconds to perform several self-diagnostic tests and display basic controller information. Initially, the controller illuminates both displays and all annunciators to verify that all display elements are functioning. The controller then displays the unit model type on the top display as well as the current firmware revision number on the bottom display. The controller then checks for correct internal operation and displays an error message (E-XX) if an internal fault is detected (see Troubleshooting for further information). Upon completion of this sequence, the controller begins control action by displaying the temperature/process value and updating the output(s) based on the PID control calculation.

PROCESS START-UP

After starting the process, the controller's PID settings must be initially "tuned" to the process for optimum control. Minimal tuning consists of adjusting the Proportional Band, Integral Time, and Derivative Time parameters to achieve the optimum response to a process disturbance. The controller can be tuned once, but must be re-tuned if the process has been changed significantly. Several options exist for tuning these parameters:

A) Use the controller's built-in Auto-Tune feature (see Auto-Tune).

B) Use a manual tuning technique (see Manual Tuning).

C) Use a third party tuning software package (generally expensive and not always precise).

D) Use values based on control loop experience, calculated values or values from a similar process.

If the controller is a replacement, the PID settings from the unit being replaced may be used as good initial values. Be sure to consider any differences in the units and the PID settings when replacing. The PID settings may be fine tuned by using the techniques outlined in the PID Control section. After tuning the controller to the process, it is important to power the load and the controller at the same time for best start-up response.

CONTROLLER POWER-DOWN

At power down, all parameters and control modes are saved to provide a quick and predictable process response on the next power-up. When powering down the process, it is important to power down the controller at the same time. This prevents the reset action of the controller from shifting the proportional band while the temperature/process value is dropping and prevents excessive overshoot on the next process start-up.

CONTROL MODE EXPLANATIONS

ON/OFF CONTROL

The controller operates in On/Off Control when the Proportional Band is set to 0.0%. In this control mode, the process will constantly oscillate around the setpoint value. The On/Off Control Hysteresis (balanced around the setpoint) can be used to eliminate output chatter. The Output Assignment can be set for heating (reverse - output on when below the setpoint) or for cooling(direct - output on when above the setpoint) applications.

ON/OFF CONTROL - FIGURES

REVERSE ACTING

DIRECT ACTING
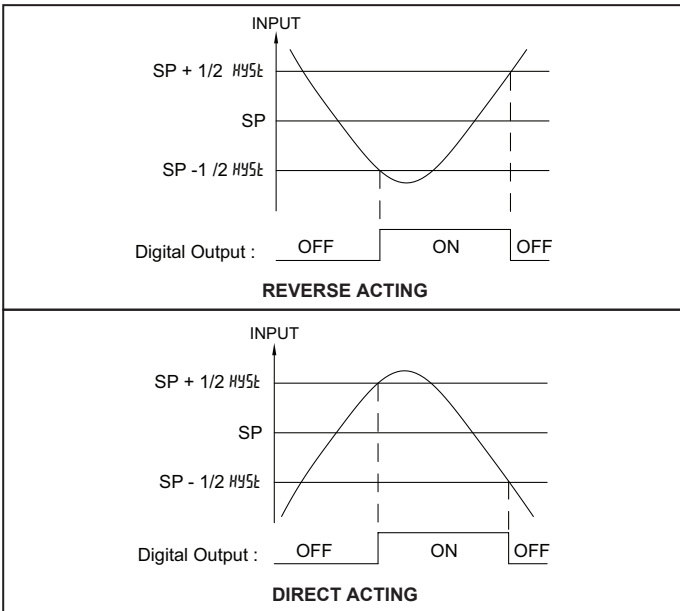
*Note: HYSt in the On/Off Control Figures is a user defined value in the PID Configuration Parameters.*

For heat and cool systems, one Digital Output is assigned as HEAt (reverse) and another Digital Output is assigned as COOL (direct). The Proportional Band is set to 0.0 and the Relative Gain in Cooling to 0.0. The Deadband in Cooling sets the amount of operational deadband or overlap between the outputs. The setpoint and the On/Off Control Hysteresis applies to both O1 and O2 outputs. The hysteresis is balanced in relationship to the setpoint and deadband value.

ON/OFF CONTROL - HEAT/COOL OUTPUT FIGURES

HEAT/COOL DEADBAND VALUE (dEAd) **= 0**

HEAT/COOL DEADBAND VALUE (dEAd) **> 0**

HEAT/COOL DEADBAND VALUE (dEAd) **< 0**
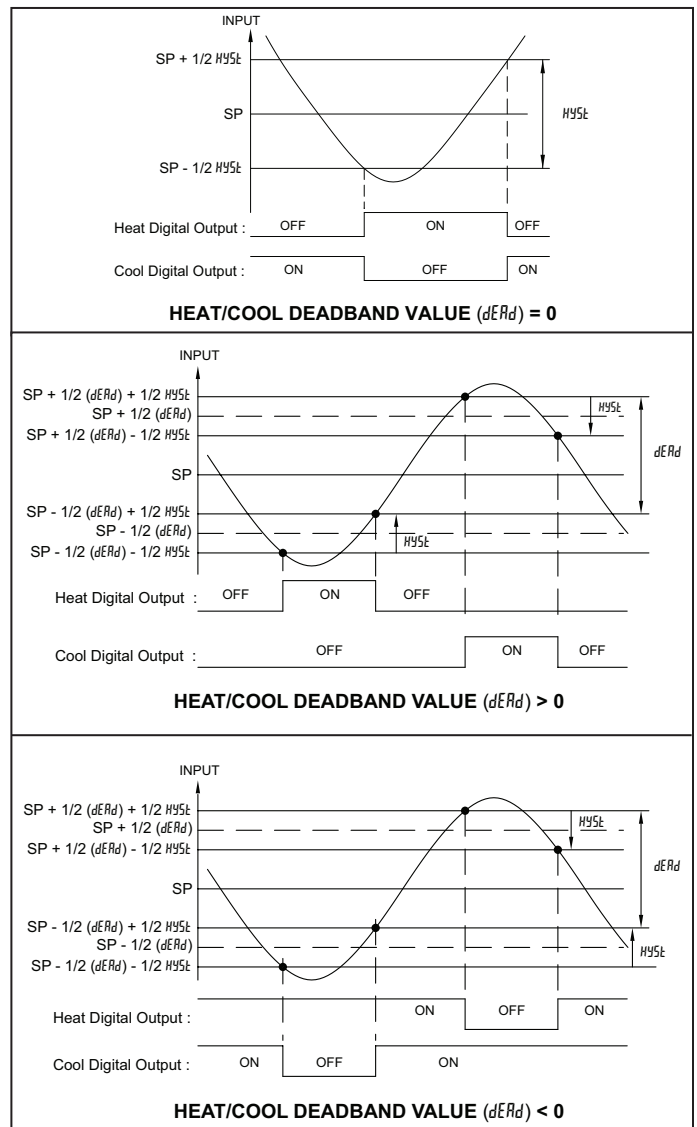
PID CONTROL

In PID Control, the controller processes the input and then calculates a control output power value by use of a specialized Proportional Band, IntegralTime, and Derivative Time control algorithm. The system is controlled with the new output power value to keep the process at the setpoint. The Control Action for PID Control can be set to reverse for heating (output on when below the setpoint) or direct for cooling (output on when above the setpoint) applications.For heat and cool systems, the heat and cool outputs are both used. The PID parameters can be established by using Auto-Tune, or they can be Manually tuned to the process.

TYPICAL PID RESPONSE CURVE
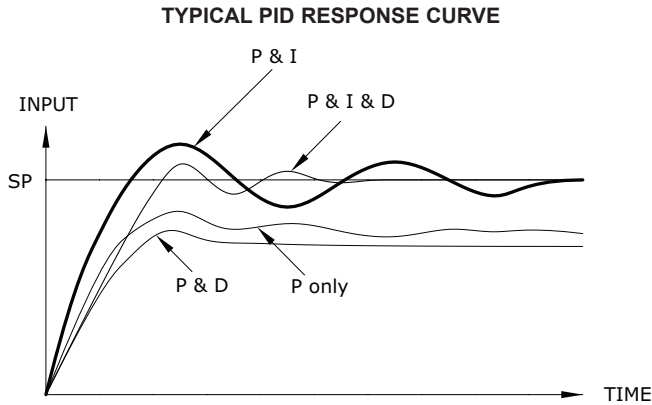
TIME PROPORTIONAL PID CONTROL

In Time Proportional applications, the output power is converted into output On time using the Cycle Time. For example, with a four second cycle time and 75% power, the output will be on for three seconds (4 × 0.75) and off for one second.

The cycle time should be no greater than 1/10 of the natural period of oscillation for the process. The natural period is the time it takes for one complete oscillation when the process is in a continuously oscillating state.

LINEAR PID CONTROL

In Linear PID Control applications, the Analog Output Assignment ᴀⁿᴀˢ is set to % Output Power, ᴏᴾ. The Analog Low Scaling, ᴀⁿˡᴼ , is set to 0.0 and the Analog High Scaling, ᴀⁿᴴᴵ , is set to 100.0. The Analog Output will then be proportional to the PID calculated % output power for Heat or Cooling per the Control Action ᴼᴾᴬᶜ. For example, with 0 VDC to 10 VDC (scaled 0 to 100%) and 75% power, the analog output will be 7.5 VDC.

MANUAL CONTROL MODE

In Manual Control Mode, the controller operates as an open loop system (does not use the setpoint or process feedback). The user adjusts the percentage of power through the % Power display to control the output power. Manual operation provides 0 to 100% power to the ᴴᴱᴬᵗ output and -100 to 0% power to the ᶜᴼᴼˡ output. The Low and High Output Power limits are ignored when the controller is in Manual.

MODE TRANSFER

When transferring the controller mode between Automatic and Manual, the controlling outputs remain constant, exercising true "bumpless" transfer. When transferring from Manual to Automatic, the power initially remains steady, but Integral Action corrects (if necessary) the closed loop power demand at a rate proportional to the Integral Time.

AUTOMATIC CONTROL MODE

In Automatic Control Mode, the percentage of output power is automatically determined by PID or On/Off calculations based on the setpoint and process feedback.

PID CONTROL

PROPORTIONAL BAND

Proportional band is defined as the "band" of temperature the process changes to cause the percent output power to change from 0% to 100%. The band may or may not be centered about the setpoint value depending upon the steady state requirements of the process. The band is shifted by manual offset or integral action (automatic reset) to maintain zero error. Proportional band is expressed as percent of input sensor range.
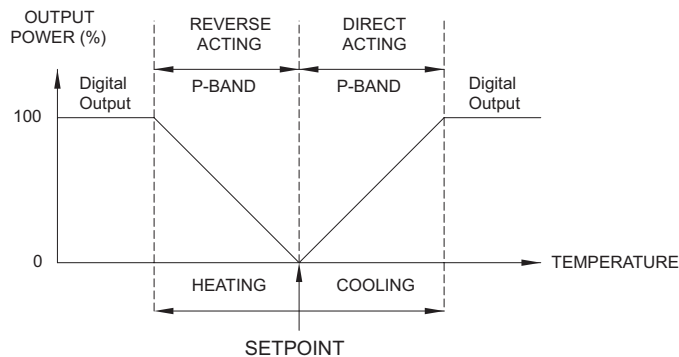
Example: Thermocouple type T with a temperature range of 600°C is used and is indicated in degrees Celsius with a proportional band of 5%. This yields a band of 600°C X 5% = 30°C.

The proportional band should be set to obtain the best response to a disturbance while minimizing overshoot. Low proportional band settings (high gain) result in quick controller response at expense of stability and increased overshoot. Settings that are excessively low produce continuous oscillations at
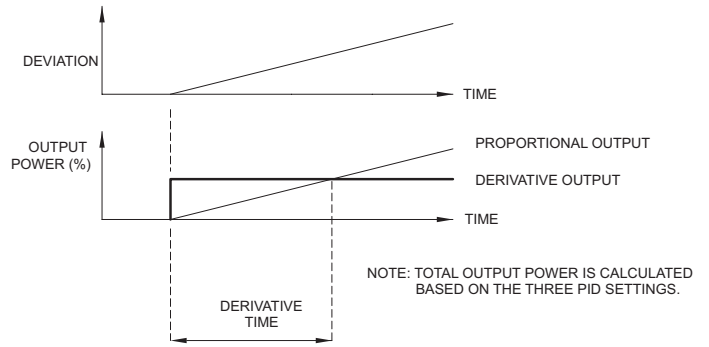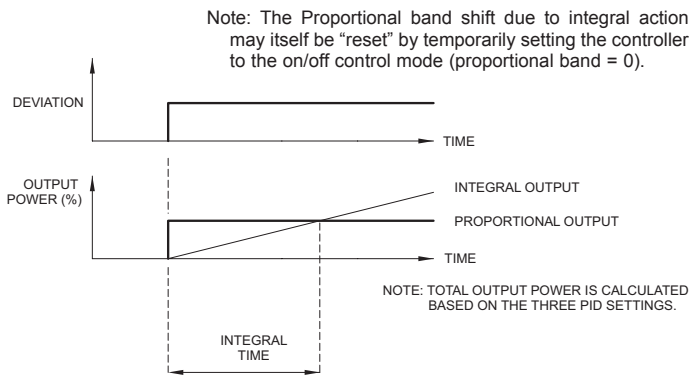
setpoint. High proportional band settings (low gain) result in a sluggish response with long periods of process "droop". A proportional band of 0.0% forces the controller into ON/OFF control mode with its characteristic cycling at setpoint (See ON/OFF Control for more information).

INTEGRAL TIME

Integral time is defined as the time, in seconds, in which the output due to integral action alone equals the output due to proportional action with a constant process error. As long as a constant error exists, integral action repeats the proportional action every integral time. Integral action shifts the center point position of the proportional band to eliminate error in the steady state. The units of integral time are seconds per repeat.

Integral action (also known as "automatic reset") changes the output power to bring the process to setpoint. Integral times that are too fast (small times) do not allow the process to respond to the new output value. This causes over compensation and leads to an unstable process with excessive overshoot. Integral times that are too slow (large times) cause a slow response to steady state errors. Integral action may be disabled by setting the time to zero. If time is set to zero, the previous integral output power value is maintained.

If integral action is disabled, manual reset is available by modifying the output power offset (ᴼᴾᴼꜰ initially set to zero) to eliminate steady state errors. This parameter appears in unprotected parameter mode when integral time is set to zero. The controller has the feature to prevent integral action when operating outside the proportional band. This prevents "reset wind-up".

Note: The Proportional band shift due to integral action may itself be "reset" by temporarily setting the controller to the on/off control mode (proportional band = 0).

NOTE: TOTAL OUTPUT POWER IS CALCULATED BASED ON THE THREE PID SETTINGS.

NOTE: TOTAL OUTPUT POWER IS CALCULATED BASED ON THE THREE PID SETTINGS.

DERIVATIVE TIME

Derivative time is defined as the time, in seconds, in which the output due to proportional action alone equals the output due to derivative action with a ramping process error. As long as a ramping error exists, the derivative action is "repeated" by proportional action every derivative time. The units of derivative time are seconds per repeat.

Derivative action is used to shorten the process response time and helps to stabilize the process by providing an output based on the rate of change of the process. In effect, derivative action anticipates where the process is headed and changes the output before it actually "arrives". Increasing the derivative time helps to stabilize the response, but too much derivative time coupled with noisy signal processes, may cause the output to fluctuate too greatly, yielding poor control. None or too little derivative action usually results in decreased stability with higher overshoots. No derivative action usually requires a wider proportional and slower integral times to maintain the same degree of stability as with derivative action. Derivative action is disabled by setting the time to zero.

PRIMARY/ALTERNATE PID VALUES

The PAX2C incorporates two different groups of PID parameters in memory. These are designated as the Primary (*Pri*) and Alternate (*Alt*) PID values. It is possible to toggle between these values using the PID Selection parameter which is available in the PID configuration menu. This functionality (*PSEL*) is also available via the user inputs, function keys or Line 2 user function.

The Active PID parameters reflect the PID values that are selected via the *PSEL* parameter. If a change is made to an active PID value, such as a user change or after an Auto-tune, the values will automatically be copied into the Primary or Alternate group depending on which group is selected by the *PSEL* parameter.

PID TUNING EXPLANATIONS

AUTO-TUNE

Auto-Tune is a user-initiated function where the controller automatically determines the Proportional Band, Integral Time, Derivative Time, Digital Filter, Control Ouput Dampening Time, and Relative Gain (Heat/Cool) values based upon the process characteristics. The Auto-Tune operation cycles the controlling output(s) at a control point three-quarters of the distance between the present process value and the setpoint. The nature of these oscillations determines the settings for the controller's parameters.

Prior to initiating Auto-Tune, it is important that the controller and system be verified. (This can be accomplished in On/Off Control or Manual Control Mode.) If there is a wiring, system or controller problem, Auto-Tune may give incorrect tuning or may never finish. Auto-Tune may be initiated at start-up, from setpoint or at any other process point. However, insure normal process conditions (example: minimize unusual external load disturbances) as they will have an effect on the PID calculations.

TEMPERATURE

TYPICAL RESPONSE CURVES WITH AUTOTUNE DAMPENING CODES 0 TO 4.

AUTO-TUNING CODE FIGURE

INITIATE AUTO-TUNE

Below are the parameters and factory settings that affect Auto-Tune calculations. If changes are needed, then they must be made before starting Auto-Tune. Please note that it is necessary to configure the input and control outputs prior to initiating auto-tune.

| DISPLAY	PARAMETER	FACTORY SETTING	MENU
FLtr	Digital Filtering	10	INPt
CHYS	On/Off Control Hysteresis	2 (Temperature Mode) 02 (Process Mode)	Pid
tCod	Auto-Tune Code	2	Pid
dEAd	Deadband	00	Pid
tUNE	Auto-Tune Access	LOC	Pid

1. Enter the Setpoint value via the PID Menu or via the Display, Parameter or Hidden Menu Loop Menu (if enabled).
2. Initiate Auto-Tune by changing Auto-Tune *tUNE* to *YES* via the PID Menu or via the Display, Parameter or Hidden Menu Loop Menu (if enabled).
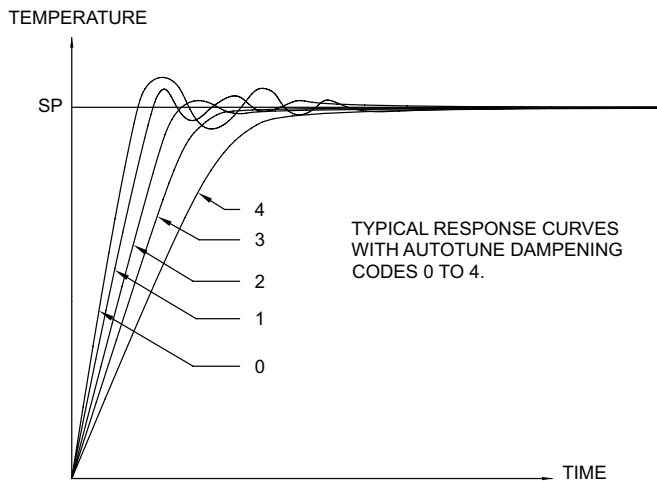
AUTO-TUNE PROGRESS

The controller will oscillate the controlling output(s) for four phases. The bottom display will flash the phase number. Parameter viewing is permitted during Auto-Tune. The time to complete the Auto-Tune cycles is process dependent. The controller should automatically stop Auto-Tune and store the calculated values when the four phases are complete. If the controller remains in Auto-Tune unusually long, there may be a process problem. Auto-Tune may be stopped by entering *no* in Auto-Tune Start *tunE*.

AUTO-TUNE OPERATION (REVERSE ACTING)


* - On/Off Control Hysteresis
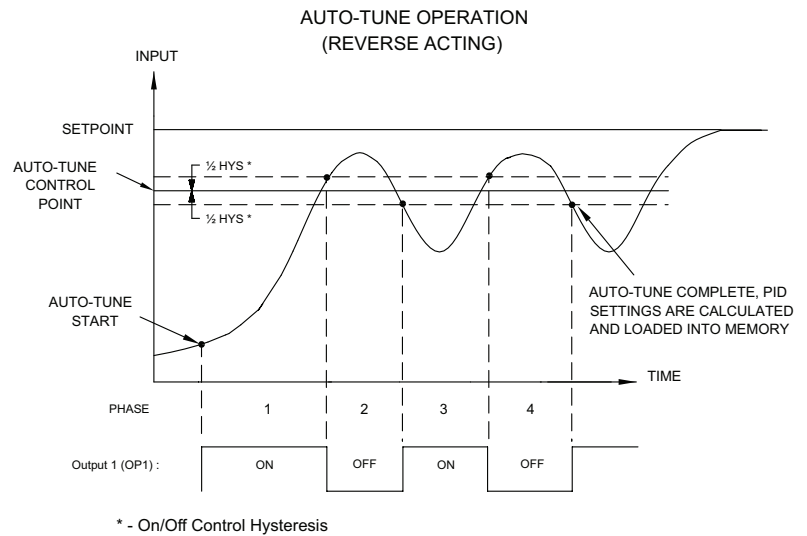
PID ADJUSTMENTS

In some applications, it may be necessary to fine tune the Auto-Tune calculated PID parameters. To do this, a chart recorder or data logging device is needed to provide a visual means of analyzing the process. Compare the actual process response to the PID response figures with a step change to the process. Make changes to the PID parameters in no more than 20% increments from the starting value and allow the process sufficient time to stabilize before evaluating the effects of the new parameter settings.

In some unusual cases, the Auto-Tune function may not yield acceptable control results or induced oscillations may cause system problems. In these applications, Manual Tuning is an alternative.

PROCESS RESPONSE EXTREMES

OVERSHOOT AND OSCILLATIONS
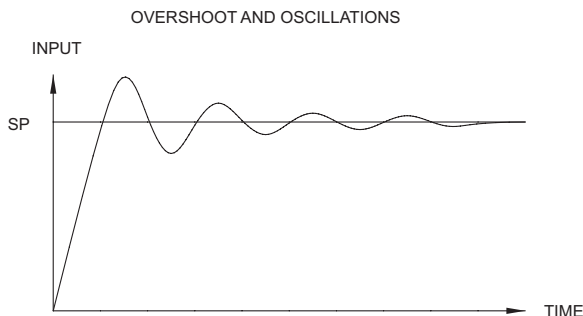
TO DAMPEN RESPONSE:
- INCREASE PROPORTIONAL BAND.
- INCREASE INTEGRAL TIME.
- USE SETPOINT RAMPING.
- USE OUTPUT POWER LIMITS.
- RE-INVOKE AUTO-TUNE WITH A HIGHER AUTO-TUNE CODE.
- INCREASE DERIVATIVE TIME.

SLOW RESPONSE
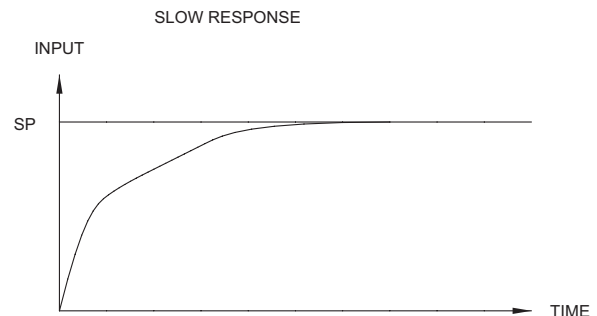
TO QUICKEN RESPONSE:
- DECREASE PROPORTIONAL BAND.
- DECREASE INTEGRAL TIME.
- INCREASE OR DEFEAT SETPOINT RAMPING.
- EXTEND OUTPUT POWER LIMITS.
- RE-INVOKE AUTO-TUNE WITH A LOWER AUTO-TUNE CODE.
- DECREASE DERIVATIVE TIME.

MANUAL TUNING

A chart recorder or data logging device is necessary to measure the time between process cycles. This procedure is an alternative to the controller's Auto-Tune function. It will not provide acceptable results if system problems exist.

1. Set the Proportional Band (*ProP*) to 10.0% for temperature models (Temperature) and 100.0% for process models (Voltage/Current).
2. Set both the Integral Time (*IntL*) and Derivative Time (*dErL*) to 0 seconds.
3. Set the active PID Power Filter (*FLLr*) in the PID Menu to 0 seconds.
4. Set the Output Cycle Time (*CYCL*) in the Digital Output Menu to no higher than one-tenth of the process time constant (when applicable).
5. Place the controller into Manual Control Mode (*MAn*) via the *trnF* parameter in the PID Menu and adjust the % Power to drive the process value to the Setpoint value. Allow the process to stabilize after setting the % Power.

6. Place the controller in Automatic (Auto) Control Mode via the *trnF* parameter in the PID Menu. If the process will not stabilize and starts to oscillate, set the Proportional Band two times higher and go back to Step 5.
7. If the process is stable, decrease Proportional Band setting by two times and change the Setpoint value a small amount to excite the process. Continue with this step until the process oscillates in a continuous nature.
8. Fix the Proportional Band to three times the setting that caused the oscillation in Step 7.
9. Set the Integral Time to two times the period of the oscillation.
10. Set the Derivative Time to 1/8 (0.125) of the Integral Time.
11. Set the Output Dampening Time to 1/40 (0.025) the period of the oscillation.

TROUBLESHOOTING GUIDE

PROBLEM	REMEDIES
No Display At Power-Up	Check power level and power connections
No Display After Power-Up	Check dLEU and dEnt program settings in the Display menu.
Program Locked-Out	Check for Active User Input, programmed for PLOC. Deactivate User Input.
	Enter proper access code at COdE 0 prompt.
No Line 1 Display	Check program settings for Line 1 Display Assignment.
No Line 2 Display	Check program settings for Line 2 Value Access. Confirm at least one Line 2 Parameter Value is enabled in Main Display Loop.
No Programmable Units Display	Check program settings for Line 1/2 Units Mnemonic(s).
Incorrect Process Display Value	Check Input Jumper Setting, Input Level, and Input Connections.
	Verify Input Menu settings.
	Contact factory
Display of OLOL, ULUL, Short, OPEN, or "...."	See General Controller Specifications, Display Messages.
Modules or Parameters Not Accessible	Check for corresponding plug-in option card.
	Verify parameter is valid in regard to previous program settings.
Error Code: EKEY	Keypad is active at power up. Check for depressed or stuck keypad. Press any key to clear Error Code.
Error Code: EPAr Error Code: EdYn	Parameter Data Checksum Error. Press any key to clear Error Code, verify all program settings and cycle power. Contact factory if Error Code returns at next power-up.
Error Code: EPro	Parameter Data Validation Error. Press any key to clear Error Code, verify all program settings and cycle power. Contact factory if Error Code returns at next power-up.
Error Code: ECAL	Calibration Data Validation Error. Contact factory.
Error Code: EL in	Linear Output Card Data Validation Error. Press any key to clear Error Code and cycle power. If Error Code returns at next power-up, replace Linear Option Card or contact factory.

LIMITED WARRANTY

The Company warrants the products it manufactures against defects in materials and workmanship for a period limited to two years from the date of shipment, provided the products have been stored, handled, installed, and used under proper conditions. The Company's liability under this limited warranty shall extend only to the repair or replacement of a defective product, at The Company's option. The Company disclaims all liability for any affirmation, promise or representation with respect to the products.

The customer agrees to hold Red Lion Controls harmless from, defend, and indemnify RLC against damages, claims, and expenses arising out of subsequent sales of RLC products or products containing components manufactured by RLC and based upon personal injuries, deaths, property damage, lost profits, and other matters which Buyer, its employees, or sub-contractors are or may be to any extent liable, including without limitation penalties imposed by the Consumer Product Safety Act (P.L. 92-573) and liability imposed upon any person pursuant to the Magnuson-Moss Warranty Act (P.L. 93-637), as now in effect or as amended hereafter.

No warranties expressed or implied are created with respect to The Company's products except those expressly contained herein. The Customer acknowledges the disclaimers and limitations contained herein and relies on no other warranties or affirmations.