

PCC-IV Controller

Instruction Manual

Revision 0.2



Preferred Instruments

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WARNING

The PCC-IV is commonly used to control potentially dangerous combustion and chemical processes.

Only qualified instrument engineers or senior technicians that have read this entire manual, and are familiar with all aspects of the process being controlled should attempt to re-configure the blockware control logic contained in the memory of a PCC-IV Controller.

VERIFY THAT THE PROCESS BEING CONTROLLED HAS BEEN SAFELY SECURED, ISOLATED, OR BYPASSED (AS REQUIRED BY THE SITE CONDITIONS) BEFORE MODIFYING ANY OF THE BLOCKWARE DATA IN ANY BLOCK IN THE PCC-IV MEMORY.

FAILURE TO DO SO CAN RESULT IN EQUIPMENT DAMAGE, INJURY, OR DEATH.

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Revision History:

Revision 0.1 – 10/20/2017

- Added PUMC logo to each page
- Minor grammar/format changes throughout
- Corrected error in description of alarm annunciator screen

Revision 0.2 – 01/22/2018

- Updated Section 5 to latest PC4_Draw
- Stated that 24 Vdc power supply wiring should be shielded twisted pair.

INTRODUCTION

The PCC-IV represents the next generation of digital controllers. As a programmable logic relay, it maintains all the advantages of single or multiple loop controllers while addressing many of the features of PLCs and DCS I/O modules.

The mounting depth (will fit in 8" deep panels); NEMA 13 splash proof front panel; standard RS-485 communications facility (Modbus protocol); Ethernet Modbus protocol; and USB/laptop and front panel configuration capabilities are clear differences between itself and its competitors. The PCC-IV has retained and enhanced many of the features that customers have come to appreciate about our digital controllers... "Service Manual", "Learn" function, "Boiler Efficiency" function, Oxygen Sensor/Temperature Controller, O2 signal conversion option card, and many others.

It is the flexibility of the PCC-IV, not simply as measured by its ability to function without its front panel, but more importantly its I/O expansion capabilities and the significant number of choices available for expansion, that render the PCC-IV an unparalleled choice for most control applications. Consider that each PCC-IV CPU board has two expansion board slots that accept any of the available option cards (Note: a third slot is available but is dedicated for use with only one type of option card). Consider further that there are option cards which can perform the following:

- Control the temperature of oxygen sensors and convert their millivolt outputs to signals useful for control and/or monitoring applications
- Accept both analog and digital signals as inputs and outputs in many combinations
- Accept up to 6 isolated analog inputs, control up to 5 triac device pairs, or control up to 6 relay outputs

As noted, the ability to install the PCC-IV CPU board alone (i.e. less front panel), with or without any of the combination boards mentioned above, further enhance data acquisition and control capabilities.

The PCC-IV is designed with all new modern components, including a color touchscreen interface, faster processor, more (and longer-lasting) memory, more block capacity, and modern Ethernet networking capabilities. The new PC4_Draw programming software is .NET based and is Windows 10 compatible and does not use the obsolete Visio program.

Replacing a PCC-III with a PCC-IV is easy. The new loop controller fits in the same cutout as the PCC-III, and it uses the same expansion boards. Terminal blocks are the same, no field wiring changes are required. You can use PC3_Edit to extract a program from an existing PCC-III. Then open the PC3_Edit file in PC4_Draw to convert the program and download the new program into the PCC-IV. The PCC-IV runs off external 24VDC power but still has the same PCC-III 120Vac I/O.

So, as you read this manual, be sure that you are clear about the vast capabilities of the PCC-IV. It is simply not just another digital controller.

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Product Description

This section overviews the many PCC-IV features which address the requirements of both data acquisition and control applications. The PCC-IV is designed to address the needs of most process control applications, and that design has been further optimized to meet the exacting needs of combustion control systems.

Features

Benefits

Multiple Loops	Allows cost effective control of more than one process loop in a single controller.
Service Manual	Allows manual control in the event of memory, CPU, or digital circuitry failure.
Redundant Memories	Allows for self-recovery in the event of a primary memory error.
Optically Isolated Data Highway	Safe/reliable communication that prevents a single controller failure from disrupting an entire network. Redundant RS-485 communications are available as an option.
Engineering Units Display Flexibility	Allows the operator to view up to 10 process variables each with process (tag) descriptions.
Local Parameter Configuration	Allows front panel parameter configuration without the need for a special configurator or laptop computer. Note: two, standard micro-USB ports allows laptop blockware configuration.
Ten-point ("first in-first out") Alarming	Allows the operator to view the order of alarms and acknowledge each separately.
"Learn" Function	Allows for easy entry of complex function curves without prerequisite data collection.
Industry standard communications	Allows the controller to be used in any system and/or with others hardware/software which communicate via Modbus protocol (RS-485 and/or Ethernet).
Optional I/O Cards	Allows significant Discrete and Analog I/O expansion capabilities within a single controller.
Self-supporting CPU Board	The controller's CPU board is fully functional without the front panel, allowing for further I/O expansion alternatives.
Easy PCC-III Upgrade	With the addition of an external 24 VDC power supply, the PCC-IV can be installed in the same location as a PCC-III. The PCC-IV field wiring terminals are physically and electrically identical to the PCC-III. CPU board analog input 250 ohm jumpers are in the same locations as in the PCC-III. The same Option Boards are used. The PCC-IV can use the same program with a simple PC4_Draw automatic conversion.

Distributed Control System Concepts

The PCC-IV represents the fourth generation of process controllers from Preferred Instruments. This controller is designed to provide a true distributed approach to control applications. The PCC-IV provides automation features that are self-sufficient and will operate independently from the remainder of the control system. The PCC-IV can be configured as a data collection I/O module (DCS-IV) for a data acquisition system, as a multi-loop controller, or as a traditional single loop controller. In all cases the PCC-IV will communicate on a network with a central operator's station using the industry standard Modbus protocol.

Because the PCC-IV is self-sufficient, control will be maintained even if for any reason, the operator's station(s) or network are completely disabled. Unlike a PLC, a single PCC-IV or DCS-IV failure affects a relatively small percentage of the overall system's I/O. Considering all the above, the need for redundant power supplies, microprocessor cards, or I/O cards is greatly reduced.

The backbone of the system is the network. The network used between controllers is based upon the industry-standard Modbus protocol, using the controller's integral RS-485 and Ethernet communications ability. This network communication is optically isolated.

Analog and Discrete Control Functions

The PCC-IV includes all the control functions needed for your application. The controller includes not only traditional analog functions but also many discrete (logical) and timing functions. The controller can handle many tasks that would normally require the use of a PLC, and the use of option cards permits expansion of those discrete I/O capabilities (up to 13 DI and 10 RO/DO). Discrete functions can also be readily integrated with analog functions which has been traditionally difficult to accomplish with a PLC, due to its purely logical basis. The combination of integral analog, discrete, and timing functions renders the PCC-IV a very powerful control solution.

Configuration Concepts

In many applications, the PCC-IV is shipped with a standard factory configuration, but it is designed to permit easy modification or development of control strategies in the field. The PCC-IV can modify parameters using front panel touchscreen display. Any Windows computer can configure the logic graphically with the PC4_Draw software. The PCC-IV USB port allows PC4_Draw to monitor live data, change any parameter, and read/write entire function block configurations and provides full documentation capabilities.

Com-Link Data Highway Concepts

The PCC-IV can be networked together over an industry standard Modbus network (RS485, or Ethernet Modbus TCP/IP). Modbus is an open architecture format to allow flexibility for future system expansion and/or modification. The RS485 and Ethernet networks are electrically isolated controller-controller, and controllers-SCADA. The RS485 network allows controllers to be located up to 4000 feet apart, and up to 31 controllers (plus the Master) can be networked. The use of Modbus as a communications protocol allows the PCC-IV to be integrated with other's equipment and on networks supplied by ourselves or others.

Blockware Concepts

The PCC-IV makes use of Blockware (aka Function Blocks) which makes control strategy configuration easy. In **Section 5**, we will discuss Blockware and configuration in greater detail, but the basic elements that make up Blockware are as follows:

Blocks

The PCC IV memory is made up of blocks. Each block is a container into which a Blockware Function is placed. Think of a block as a “cell” in an Excel spreadsheet, you put a formula or a function into a cell, and the formula uses the values from other cells as inputs for the formulas. The controller includes sufficient memory to handle 256 blocks.

Library of Functions

The PCC-IV has an extensive library of Functions to handle any type of control task. These Functions are identified and described in detail in **Section 6** of this manual. The library includes Functions for the conversion of inputs to engineering values, mathematical operations, logical operations, timing operations, the traditional PID algorithm, and other types of special **PID** Functions. Additional special Functions such as “Learn”, “Boiler Efficiency”, etc. are included and are described in **Section 6**.

Any-Function-Any-Block

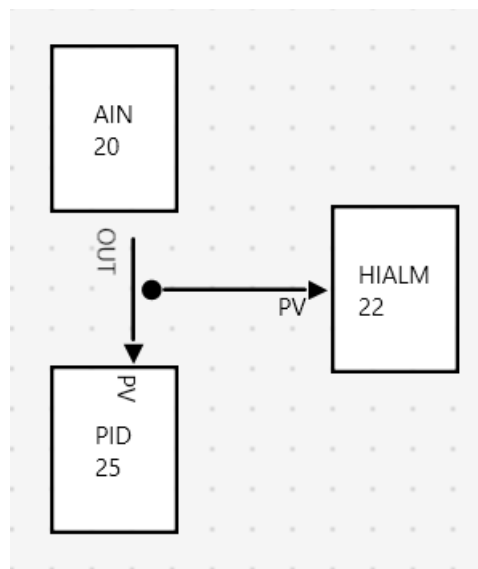
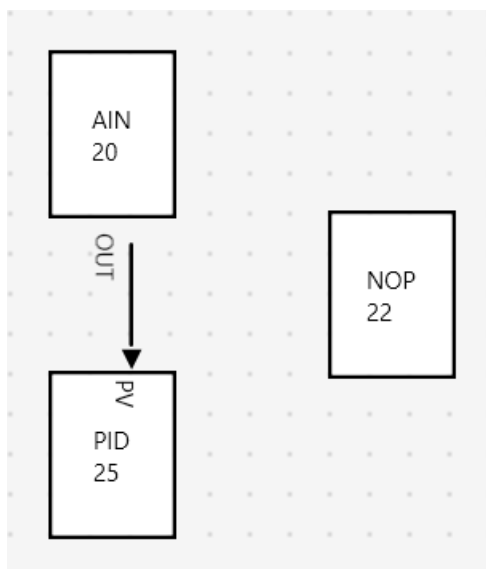
Each block is assigned a Function-type during configuration. Any Function-type can be used in any block number. The block number only determines the order in which the blocks are calculated. In the example below at left, Block number 22 is not being used, so it has the default **NOP**, or “No **OP**eration” Function in it. At right, Block 22 was changed from a **NOP** to a **HIALM** (high alarm) Function type.

Reusable Functions

Almost all PCC IV Function-types can be used as many times as required, within the 256-block limit. There are some Functions that are directly linked to the hardware that can only be used as many times as there is mating hardware. For example, only one **PANEL** Function (Front Panel Display Interface) can be used because there is only one front panel. While those related to **PID** Functions, curve fitting Functions, etc. can be used as many times as is deemed necessary for the application.

Softwiring

Most Function-types, like **HIALM**, need information from other sources (i.e., blocks) to calculate a result. Softwiring is the term used to describe how the blocks are interconnected within the software. Softwiring allows the input of a block to monitor the output of any other block. At right below, the PV (Process Variable) input of Block 22 (**HIALM**) is monitoring the output of Block 20 (**AIN**), via a softwiring connection.



Special Option Card and Special Function Block Capabilities

The following are applications features of the PCC-IV which extend its capabilities considerably:

Multiple F(x)

The F(x) function-type allows for “characterizing” or “curve fitting” of a relationship when that relationship is non-linear. In combustion control applications, as an example, it is desirable to have the fuel input to a burner follow a linear relation with firing rate demand. Even with a properly selected valve trim, the relationship will not be perfectly linear, but with the application of an F(x) block, this objective can be realized. The PCC-IV has the capacity to use as many F(x) functions as are required by the application.

Learn Mode

The learn mode allows for easy commissioning of applications involving single or multiple non-linear functions. This capability is best described with an example. In combustion control applications, as the firing rate is increased, the best combustion air damper position will likely not be a linear function. An F(x) block can be used to effectively linearize the combustion air flow vs. firing rate relationship. F(x) blocks will likely be required for the fuel-valve-degree-of-opening demand signal and the oxygen setpoint (if O₂ Trim is provided). The clear benefit of the learn mode is that at each of the F(x) block data points, after optimum conditions are set by the technician, he/she simply presses the “Learn” button for the PCC-IV to remember (learn) the current firing rate vs. valve and damper positions and oxygen setpoint relationships simultaneously. The technician then proceeds in a similar fashion up to full firing rate, repeating this procedure at each point. This results in a considerable savings in commissioning time and an optimally characterized process.

Boiler Efficiency

The boiler efficiency function allows the controller to calculate, in real time, the boiler’s efficiency and display that result on the controller’s front panel (and/or a recorder or a Data Acquisition terminal). Boiler efficiency is calculated using the ASME “by losses” method. This function requires inputs of flue gas temperature, combustion (ambient) air temperature, percent oxygen in the flue gas, and percent firing rate (for radiation loss determination) to evaluate the efficiency. This function is not only useful for establishing on-line fired equipment efficiency, but also allows determination of changes in that efficiency and therefore the potential for maintenance.

Triac Output for Electric Actuators (option cards)

Many systems utilize electric actuators where a bi-directional on-off voltage signal is used to drive the actuator open or closed. The PCC-IV has the optional interface electronics to accomplish this control action. Additionally, the Triac Output option card(s) include position feedback input provisions for optimizing control of actuator position.

Service Manual and Block Forcing

In Service Manual mode, controller 4-20mA outputs and/or servo Triac Outputs can be manually controlled from the faceplate, and the associated logic is overridden. Individual outputs, or all outputs can be placed in Service Manual mode. Service Manual is useful for initial process or burner setup and to manually operate a unit in the event a critical sensor, transmitter, or wiring fault occurs.

With a password, any block output can be forced to any value. This is useful for technician-level debugging and operation until a transmitter is repaired/replaced.

Steam Flow Pressure Compensation

Accurate steam flow measurements are very important to the control and monitoring of process systems. Even though most control systems are designed to assure a constant pressure, variations and/or upsets can occur, which, if unaccounted for, can render records erroneous and produce unacceptable instabilities in all control loops upon which this measurement depends.

Gas Flow Pressure/Temperature Compensation

Most gas flow measurements require some level of pressure and/or temperature compensation. This becomes important when the flow measurement is a significant process control variable as it is in a “fully metered” combustion control strategy.

High-Temperature Hot-Water (HTHW) BTU/Hr Computation

An important characteristic of any high-temperature, hot-water generator is the quantity of BTU’s produced per interval of time. With inputs of the generator’s inlet and outlet water temperatures and the water’s flow rate, this value can be easily calculated. The resultant value is typically compared to that from the boiler efficiency calculation to determine if possible problems have arisen.

Drum Level Pressure Vs. Density Compensation

In applications where there are large swings in steam demand, the steam generator's drum level can be subjected to significant shrink and swell. Density compensation is an important tool in assuring optimum drum level control despite these conditions.

Oxygen Sensor Control/Signal Conversion (option card)

Zirconium oxide "in situ" oxygen analyzers include a basic electronics package that maintains sensor temperatures at exacting levels and converts the millivolt output of the sensor into a linear "O₂ vs. milliamp" function (4-20 mA dc). When equipped with the appropriate option card, the PCC-IV performs the same function as the manufacture's electronics package, while coincidentally allowing for the automatic integration of that variable into any planned control or monitoring strategy.

Relay Output Channels

The PCC-IV can be equipped with up to 6 relay outputs. The relay contacts are rated for up to 8A inductive loads and include integral surge suppressors for extended contact life. These outputs can be directly wired into most burner limit circuits without external "helper" relays.

Flow Totalization

The PCC-IV is equipped with a pulse counter function-type to permit output and subsequent totalization of flow rates on digital displays. This can eliminate the need for local counters on flow meters in those instances when they already transmit an analog flow signal to the PCC-IV.

PCC IV Loop Controller Model Number

PCC IV - a b c 0

Option Card Slot Number 1

0	none
A	AIN 5 ch. 4-20 mA / 0-5 VDC
B	IAIN 3 ch. Isolated 4-20 mA / 0-5 VDC
F	AIN 3 ch. 4-20 mA / 0-5 VDC AOUT 2 ch. 4-20 mA Combination Board
G	TOUT 2 pair Triac Outputs, 2A 24-120 VAC AIN 2 ch. Pot / 0-5 VDC / 4-20 mA Combination Board
J	DIN 4 ch. 120 VAC, Optically-Isolated ROUT 2 ch. Relay Contact, 8A Inductive Combination Board
Z	ZrO2 Oxygen Analyzer Amplifier and Temperature Controller
R	Redundant RS-485 Communications, Optically isolated (Slot 1 only)

Option Card Slot Number 2

	Select card type from the "Slot 1" list above
--	---

Option Card Slot Number 3

0	none
S	TOUT 1 pair Triac Outputs, 2A, 24-120 VAC

Option Board Input / Output Expansion Examples:

PCC IV Model Number	4-20 mA 0-5 VDC AIN	4-20 mA AOUT	120 VAC DIN	8A (relay) ROUT	2A (Triac pairs) TOUT	200 mA (sinking) DOUT	Total I/O
PCC-IV- 0 0 0 0	5	2	5	2	0	4	18
PCC-IV- A A 0 0	15	2	5	2	0	4	28
PCC-IV- F F 0 0	11	6	5	2	0	4	28
PCC-IV- J J 0 0	5	2	13	6	0	4	30
PCC-IV- G G S 0	9	2	5	2	5	4	27
PCC-IV- F G S 0	10	4	5	2	3	4	28
PCC-IV- A J 0 0	10	2	9	4	0	4	29

Note: The examples given in no way reflect the number of possible option card possibilities. The PCC-IV has a total of three (3) option card slots, of which one is designated for use by the "S" card only. The remaining two slots can house any of the remaining option cards in any desired combination. Please refer to Section 2 to establish the total 24 VDC power supply requirements.

Preferred Instruments

PCC-IV Controller Spare Parts List

Part Number	Description	Recommended spares per 10 PCC-IVs
PCC-IV-0000	Complete PCC IV controller, with case & mounting brackets	0.5
92703	Main power fuse, 1.6A slow-blow	2.0
92705	Cable, 6.5 ft., USB-A to Micro USB-B	
92443	24Vdc/2.5A DIN rail mounted power supply	
99663	Micro-SDHC Memory Card, 8 GB with Case and Adapter	
99659	USB programmer for SD cards	
190801-PANEL	Front Panel, complete, includes: Bezel w/ gasket, touchscreen, USB cable, screw, nameplate	0.5
90137	Front Panel screw with integral O-ring	
90415	Bezel w/ Gasket (Set)	
90416	Touch Screen Retaining Plate	
94309	TFT LCD	
19708F	Preferred Instruments nameplate for Front Panel, Alum	
92492	Cable, 1.6 ft., USB-A to Micro USB-B	
	Available Spare Parts:	
190800	CPU board	
92491	2 pt. 24 Vdc power connector	
92204	8 pt. field wiring connector	
92223	14 pt. field wiring connector	
92076	Slide-on jumper (250 ohm & R/W)	
2759-006A-08C	CPU to case retainer screw, 6-32 x 1/2	
92707	Cable, 9.8 ft., USB Extension Cable, A-Male to A-Female	
190348	Case for panel mounting with rear cover (190347 panel mounting brackets not included)	
90134	Case to panel gasket	
190347	Panel Mounting Bracket Kit (2 brackets/kit)	
190319	1 pair Triac output option board (slot 3 only)	
92245	5 pt. field wiring connector	
92247	fuse, 3 A, fast acting	
190361	5 ch. 4-20 mA / 0-5 VDC AIN option board	
92243	12 pt. field wiring connector	
190362	3 ch. 4-20 mA / 0-5 VDC isolated AIN option board	
92251	6 pt. field wiring connector	
190366	3 ch. 4-20 mA / 0-5 VDC AIN, 2 ch. 4-20 mA AOUT combination option board	
92243	12 pt. field wiring connector	
190367	2 ch. 0-5 VDC / pot AIN, 2 pair 3A 24-120 VAC TOUT (Triac) combination option board	
92243	12 pt. field wiring connector	
190370	4 ch. 120 VAC opto-isolated DIN, 2 ch. 8 A ROUT (Relay) combination option board	
92243	12 pt. field wiring connector	
25250-0B25-3/4MF	250.0 Ohm Precision Resistor	
PC4_Draw	Windows PC-based Blockware design and maintenance software	

PCC-IV Specifications

Mechanical:

Case Size: Height: 7.38"; Width: 3.00"; Depth: 7.75"
Enclosure Type: Flush panel mounted
Front Panel Size: 8.00" H X 3.75" W
Panel Cutout: 7.50" H X 3.13" W (+/- .062)
Weight: 6 lbs. (excluding option boards)

Environmental:

Operating Temp: 32 to 122°F (0 to 50°C)
Storage Temp: -20 to 150°F (-28 to 65°C)
Humidity Limits: 15 to 95% (non-condensing)
Front Panel: NEMA 13, IP65

Performance:

Accuracy: 0.025% Analog Inputs and Outputs, 70 F
Resolution: 16-bit input / 16-bit output
Execution Cycle: Ten per second
Retentive Memory Life: 40-50 yrs., MRAM, no batteries, non-EEPROM

Operator Control Panel:

Display: Backlit TFT LCD display showing current display loop and variable
Bar graphs: Process Variable, Setpoint, and Output displayed
Touchscreen-based Pushbuttons: Display Select, Alarm acknowledge, Setpoint adjustment, 4 user-defined, configurable buttons
Faceplate: Splash proof
Alarm Annunciator: 10 Point, First out, Time/Date Stamped
Status Indicators: 8 (6 Configurable)
Real-time Clock: Powered by super-cap, no batteries, keeps time for 8+ days after being powered down

Electrical:

Input Power Requirements: 24 Vdc (+/- 15%), 450mA, 10.5 VA (CPU board with faceplate, no option boards or field loads). See Section 2 to calculate additional 24Vdc load due to option boards and field device loads.
1.6A/24Vdc Input fuse, 1.1A max total load (recommended)

Input/output (Standard – no option cards):

Analog Inputs: Quantity: 5
Type: 4-20 ma DC; 0-5 VDC

Analog Outputs: Quantity: 2
Type: 4-20 ma DC, 800-ohm load

Discrete Inputs: Quantity: 5
Type: 120 VAC opto-isolated

Discrete Outputs: Quantity: 6
Type: (2) SPDT relay contact, 8A, 120V; ½ HP @ 120 VAC
(4) Open Collector (sinking), 24 VDC, 200Ma

I/O Expansion: See Table Above

Communications

Network: Protocol: Modbus (ASCII, RTU, or TCP/IP mode)
Speed: 4800-115,200 baud
Type: RS-485 (optically isolated) or Ethernet
Configuration: Type: Micro-USB connector

Specifications subject to change without notice.

Section 2: Installation

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Option Board Descriptions

Option Board Slot 1 or Slot 2

A	AIN	5 ch.	4-20 mA / 0-5 Vdc	
B	IAIN	3 ch.	Isolated 4-20 mA / 0-5 Vdc	
F	AIN	3 ch.	4-20 mA / 0-5 Vdc	
	AOUT	2 ch.	4-20 mA	Combination Board
G	TOUT	2 pair	Triac Outputs, 2A 24-120 Vac	
	AIN	2 ch.	Pot / 0-5 Vdc / 4-20 mA	Combination Board
J	DIN	4 ch.	120 Vac, Optically-Isolated	
	ROUT	2 ch.	Relay Contact, 8A Inductive	Combination Board
Z	AIN	3 ch.	mV, Optically-Isolated	ZP Oxygen Analyzer
	TOUT	1 ch.	Triac Outputs, 2A, 120 Vac	Combination Board

Note: The 'Z' Option Board is described in the ZP Oxygen Analyzer Manual, it is NOT covered by this Manual.

Option Board Slot 3

S	TOUT	1 pair	Triac Outputs, 2A, 24-120 Vac
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Mounting Overview

PCC-IV is designed for flush mounting in an enclosure in a NEMA 13 (IP65) indoor environment. Continuous operation is guaranteed over the 32-125 F (0-52 C) ambient temperature range without derating. The controller should not be subjected to excessive vibration. The PCC-IV is UL508 recognized for NEMA 1 dry indoor applications. The NEMA 13 rating is based on Preferred Instruments testing and is not third party UL508 recognized.

NEMA 13 / IP65 Environment

A NEMA 13 environment is generally defined as: Intended for indoor use primarily to provide a degree of protection against dust, and splashed or sprayed water, oil, or non-corrosive coolant. NEMA 13 is generally equivalent to the European IEC standard IP65.

The PCC-IV front panel and case gasket will provide NEMA 13 protection if the enclosure to which the PCC-IV is mounted itself is designed for NEMA 13 (minimum) protection.

PCC-IV can be installed in more severe environments if the user provides additional protection that is consistent with and/or required for the area's rating.

Ambient Temperature

PCC-IV is rated for continuous operation over the 32-125 F (0-52 C) ambient temperature range without derating. A typical PCC-IV installation (in a control cabinet mounted next to an industrial packaged boiler) would not require cabinet cooling. However, each installation should be evaluated individually to determine if the PCC-IV ambient temperature (i.e., the control cabinet internal temperature) will exceed 125 F.

The control cabinet internal temperature is a function of the outside air temperature, the surface area of the control cabinet, and the amount of heat released by other components inside the cabinet. A PCC-IV consumes 12 VA worst case, therefore, it releases a maximum of 75 Btu/hr. The major control cabinet manufacturers (Hoffman, Hammond, ...) include information in their catalogs to help calculate cabinet internal temperature rise (with and without various cooling methods).

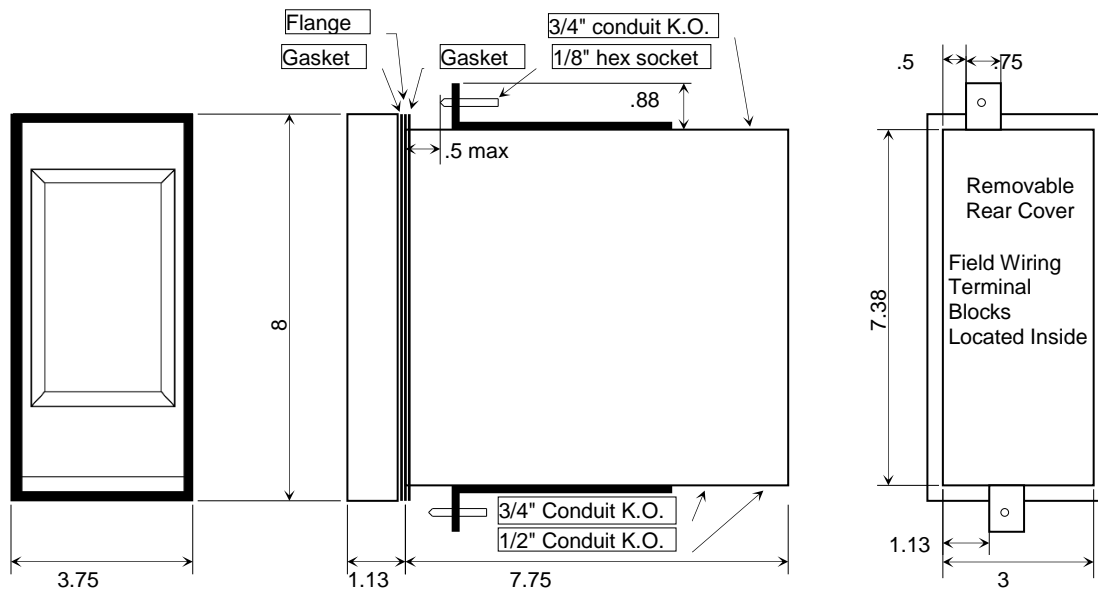
Rear Access

The PCC-IV case is 7 ¾" deep behind the mounting flange; therefore, PCC-IV can be mounted in 8" or deeper control cabinets. All field wiring connections are located behind a cover plate in the rear of the controller. Rear access is required for installation, calibration, and troubleshooting. Routine operation is accomplished from the front of the controller. Control strategy Blockware downloading/uploading is accomplished from either the front or the back of the controller, as desired, based on the position of the USB programming port select jumpers, JP2 (Pins 1-3 & 2-4 for the front jack – Pins 3-5 & 4-6 for the rear jack).

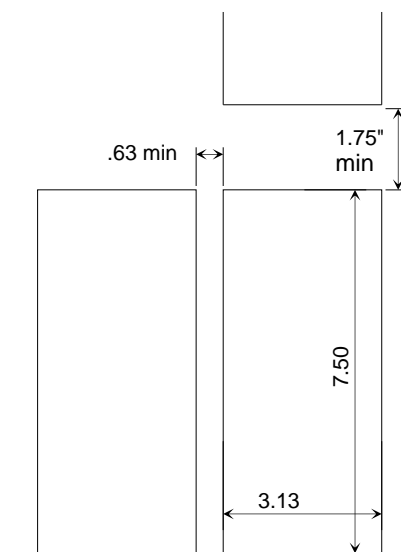
Mounting

Refer to the PCC-IV Mounting and Panel Cutout Dimension drawings that follow. Cut the hole in the enclosure. Remove any burrs and loose metal chips. Remove the Panel Mounting Brackets from the PCC-IV case. Slide the PCC-IV into the hole. From the rear of the PCC-IV, slide the Mounting Brackets tabs into the slots in the PCC-IV case. Using a 1/8" Allen wrench, tighten each mounting bracket screw against the enclosure.

Additional Mounting Brackets can be ordered as part number 190347, if the mounting brackets supplied with the PCC-IV are lost or damaged.



**PCC-IV Dimensions
(inches)**



**Panel Cutout Dimensions
and Minimum Spacing (inches)**

Wiring Overview



WARNING

The PCC-IV is commonly used to control potentially dangerous combustion and chemical processes. **VERIFY THAT THE PROCESS BEING CONTROLLED HAS BEEN SAFELY SECURED, ISOLATED, OR BYPASSED (AS REQUIRED BY THE SITE CONDITIONS) BEFORE REMOVING POWER FROM THE PCC-IV CONTROLLER. FAILURE TO DO SO CAN RESULT IN EQUIPMENT DAMAGE, INJURY, OR DEATH.**



WARNING

It is very common to have multiple sources of power among the wires connected to a PCC-IV. **VERIFY THAT ALL SOURCES OF POWER HAVE BEEN DISCONNECTED BEFORE WORKING ON WIRING. FAILURE TO DO SO CAN RESULT IN INJURY OR DEATH.**

All Panel and Field wiring should conform to National and Local Electrical Codes. Typically, NEC (National Electric Code) applies to field wiring; while NFPA 79 and UL508 applies to Industrial Control Panel wiring.

120 Vac Ground

Connect the incoming AC Power Ground (i.e. "Green Wire" Ground) to the screw and lug marked "GROUND" inside the rear of the case near the bottom of the terminal strips. AC Ground is not connected to DC Common. See "DC Commons and AC Neutrals" on page 2-20.

Terminal Blocks

(See Field Wiring Label below)

All field wiring terminals are separable and plug-in to the PC board. This allows rapid board-level replacement without disconnecting individual field wires. Verify that terminals are inserted properly before applying power.

The AC terminals on the CPU board are numbered 1L to 8L and 1U to 8U. The terminals are arranged in two rows of eight. "L" refers to the lower row, while "U" refers to the upper row.

Terminals 1L to 8L, 1U to 8U, and 29 to 33 accept 24-12 ga. wire and should be tightened to 4.5 in-lb. Terminals 1 to 28, and 40 to 51 accept 22-14 ga. wire and should be tightened to 2.2 in-lb.

Wire Type

All wiring (AC, DC, and shielded cable) should be copper, stranded, 150 V min., and 60° C minimum.

Shielded Cable

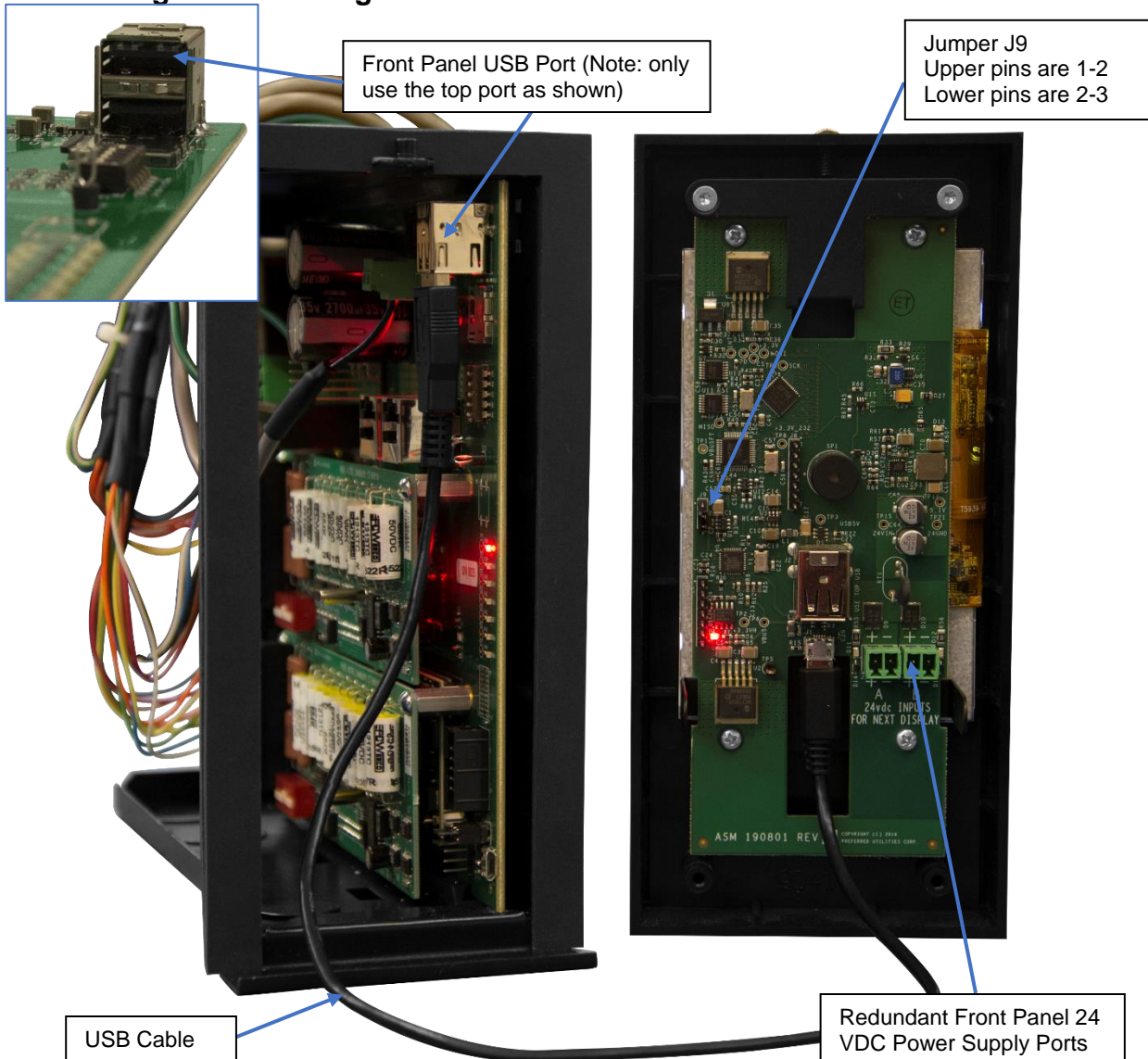
All 4-20 mA / 0-5 Vdc input and output wiring and 24 Vdc power supply wiring should be 22-gauge minimum, 85% shield (min.) and have twisted pairs (Belden 8737 or equal). 100% foil shielding is preferable, if available.

The shields of all 4-20 mA / 0-5 Vdc cables should be connected at one end only, as shown on the drawings that follow. Generally, the shield is connected to the DC common of the Power Supply that is powering the signal. All shield foils, and shield wires should be insulated (taped or heat shrink) to prevent accidental connection to earth or power ground. Shields connected at both ends, or unintentional second grounds can add extra noise to a signal instead of reducing noise. To prevent noise pick-up, shielded cables should never be run in conduits or trays with AC wiring (any voltage). Ignition transformer and variable frequency drive AC wiring is particularly noisy and should be kept separated from all DC signal wiring.

24 Vdc Redundant Power Input Terminals

An external 24 Vdc power supply powers the PCC-IV. The PCC-IV CPU board has dual, diode isolated, 24 Vdc power input terminals. 24 Vdc only needs to be connected to one of the inputs. A second, redundant 24 Vdc power supply can be connected to the other 24 Vdc input terminals, if desired, but it is not required. The shield of the 24 Vdc power supply should be connected to the power supply negative terminal; tape off the shield at the PCC-IV.

Connecting and Powering the Front Panel



Connect the front panel to the CPU board via a USB-A to micro-USB-B cable. Only use the top USB port (farther away from the circuit board) on the CPU board to connect the front panel to the CPU board. For most installations, the front panel will receive the power required for operation via the CPU board's front panel USB Port.

If the USB cable connecting the CPU to the front panel is incapable of supplying the required current, a separate 24 VDC power supply connection will be required to power the front panel. This may be possible if the USB cable is longer than 3.5 meters (~11.3 ft) (i.e. a DCS-IV with remote front panel). Like the CPU board, the front panel has redundant power supply ports. If a separate power supply connection is necessary, move the jumper J9, on the back of the front panel, from pins 2-3, to pins 1-2. If, in the future, a separate power supply is no longer necessary, move the jumper J9, on the back of the front panel, from pins 1-2, back to pins 2-3. The power supply connection may come from the same power supply used for the PCC-IV.

24 Vdc & 5 Vdc Power Supply Load Calculations

The PCC-IV CPU board is powered by an external 24 Vdc power supply that must be rated as a minimum for (450 mA + field loads + option board loads). 450 mA is the load for the CPU Board + the face plate + a 25% safety factor. Additional load is added by option boards, 4-20 outputs, and field devices. The PCC-IV is only limited by the rating of the external power supply and/or the PCC-IV 1.6A fuse F1. Below is a worksheet to calculate precise 24 Vdc current load, if necessary.

Item	mA each	Qty.	Total
2-wire 4-20 mA Transmitters that are powered by PCC-IV	20		
4-20 mA Outputs (CPU + "F" board(s))	20		
Relays (CPU + "J" board(s))	25		
"B" Isolated Input board(s)	55		
"G" Triac Board, 24V powers +5Vdc Field wiring load dependent	50 max.		
"S" Triac Board	0		
"Z" Oxygen Analyzer Interface Board	45		
Total mA Load:			

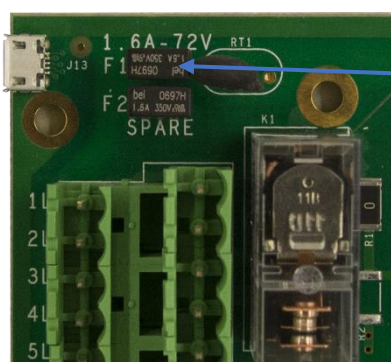
Notes:

- 1) Only count 4-20 mA outputs and relays that are being used.
- 2) Each "B" board draws 55 mA regardless of how many input channels are being used.
- 3) Example: a PCC-IV-BF00 that is configured to use: (3) 4-20 mA outputs, (6) 4-20 transmitter inputs, 2 relay outputs, plus "B" board 55 mA internal load adds a 285 mA load. Therefore, a 735 mA (minimum) power supply is required.
A safe rule of thumb is >1A for a PCC-IV with 3 Option Boards with all 24Vdc field loads in use.
- 4) An external 300 mA fast-acting fuse for field +24 Vdc loads is recommended.
- 5) The CPU has a 5 Vdc / 50 mA power supply for field devices (feedback pots, etc.). Each "G" option board also has a separate 5 Vdc / 50 mA power supply. Note the "G" board 5Vdc current usage adds to the 24 Vdc current requirement.
- 6) Verify that the power supply used is rated for the required mA load at the highest expected ambient temperature. Some power supply mA ratings must be de-rated significantly above 40C (104F).

Fuses

Every PC board in the PCC-IV that uses a fuse is shipped with one spare fuse attached to the PC board (see drawings on pages 2-9 thru 2-10 for fuse locations). Fuses used in the PCC-IV include:

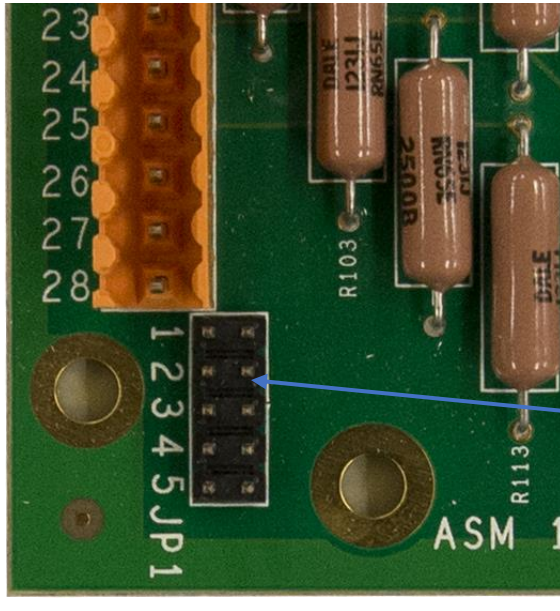
Board	Service	Amps	Type	Preferred Part Number
CPU	+24 Vdc power input	1.6 A	Slo-Blo, Radial, 0.2" pitch Littlefuse 39611600440 or equal	92703
"G" and "S" Triac option boards	24-120 Vac power to Triacs	3.0 A	Normal Blow 250 V, 5x20 mm	92247



F1 = CPU Fuse
F2 = Spare Fuse

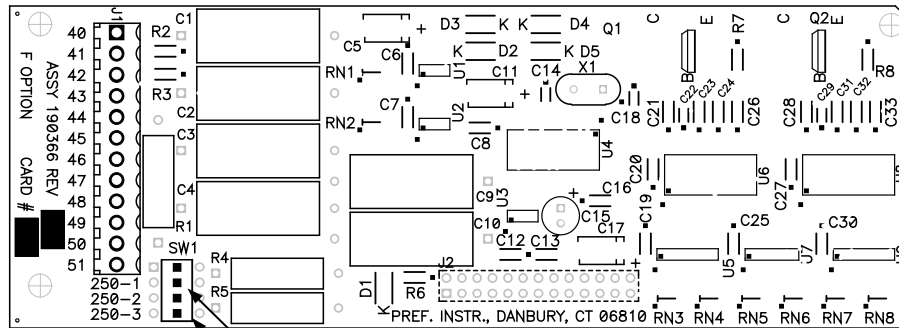
250-ohm Resistors for 4-20 mA Inputs

Except for the “G” Option Board, every PCC-IV Analog Input channel has an internal 250.0-ohm precision resistor that the user can connect to the input. If connected, the 250-ohm resistor converts a 4-20 mA signal into a 1-5 Vdc signal.



CPU Board JP1 jumpers:
Install a jumper to connect the
internal 250.0-ohm resistor for the
applicable analog input channel.

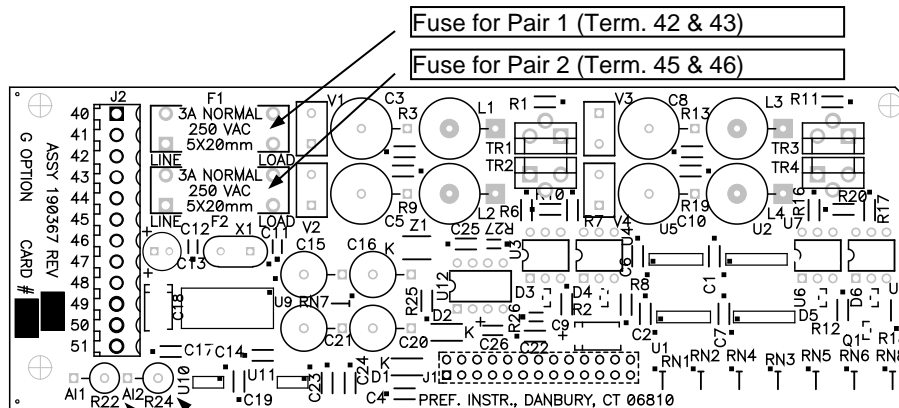
The “G” Option Board is used primarily to drive electric actuators with 0-5 Vdc position feedback potentiometers. If “G” board analog inputs will be connected to a 4-20mA signal, externally mounted 250-ohm resistors are required. Precision 250.0-ohm resistors are available separately as part number 25250-0B25-3/4.



AIN ch. 1
AIN ch. 3

To Connect 250-ohm Resistor:
Turn Switch ON

“F” Option Board 250-ohm Switches
Combination: 4-20 mA / 0-5Vdc Analog Inputs, 3 Channels
4-20 mA Analog Outputs, 2 Channels

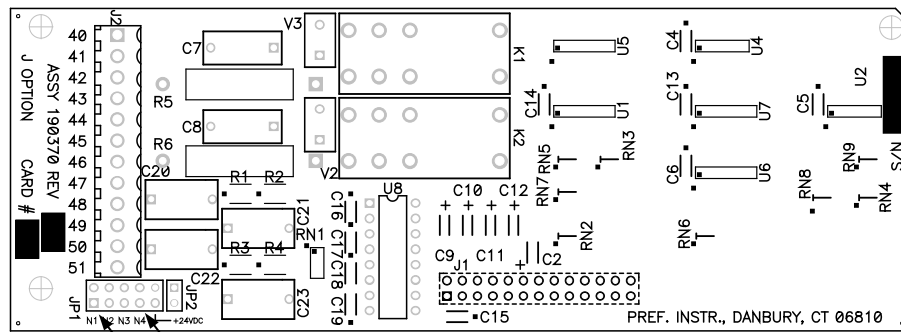


Fuse for Pair 1 (Term. 42 & 43)
Fuse for Pair 2 (Term. 45 & 46)

AIN ch. 2
AIN ch. 1

330k Pull-Up Resistor:
Remove if External Pull-Down Resistor
or External 250-ohm Resistor is in use.

“G” Option Board Fuses and Pull-ups
Combination: 0-5Vdc Analog Input, 2 Channels
Triac Output (AC Solid State Switch), 2 Pairs (4 Triacs)

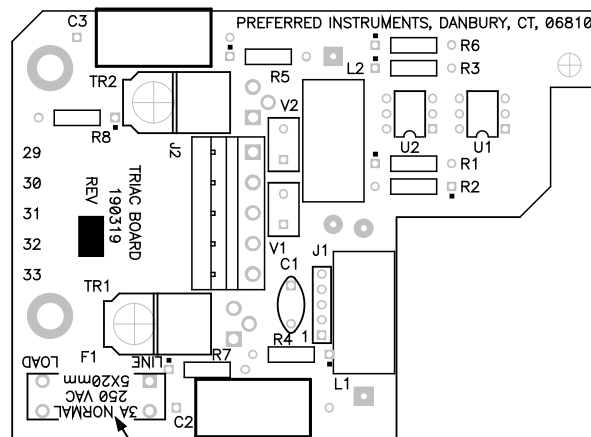


DIN ch. 4 Neutral

DIN ch. 1 Neutral

Neutrals are Isolated ch. to ch.,
Neutrals of Selected Channels can be
Connected by Installing Jumpers.

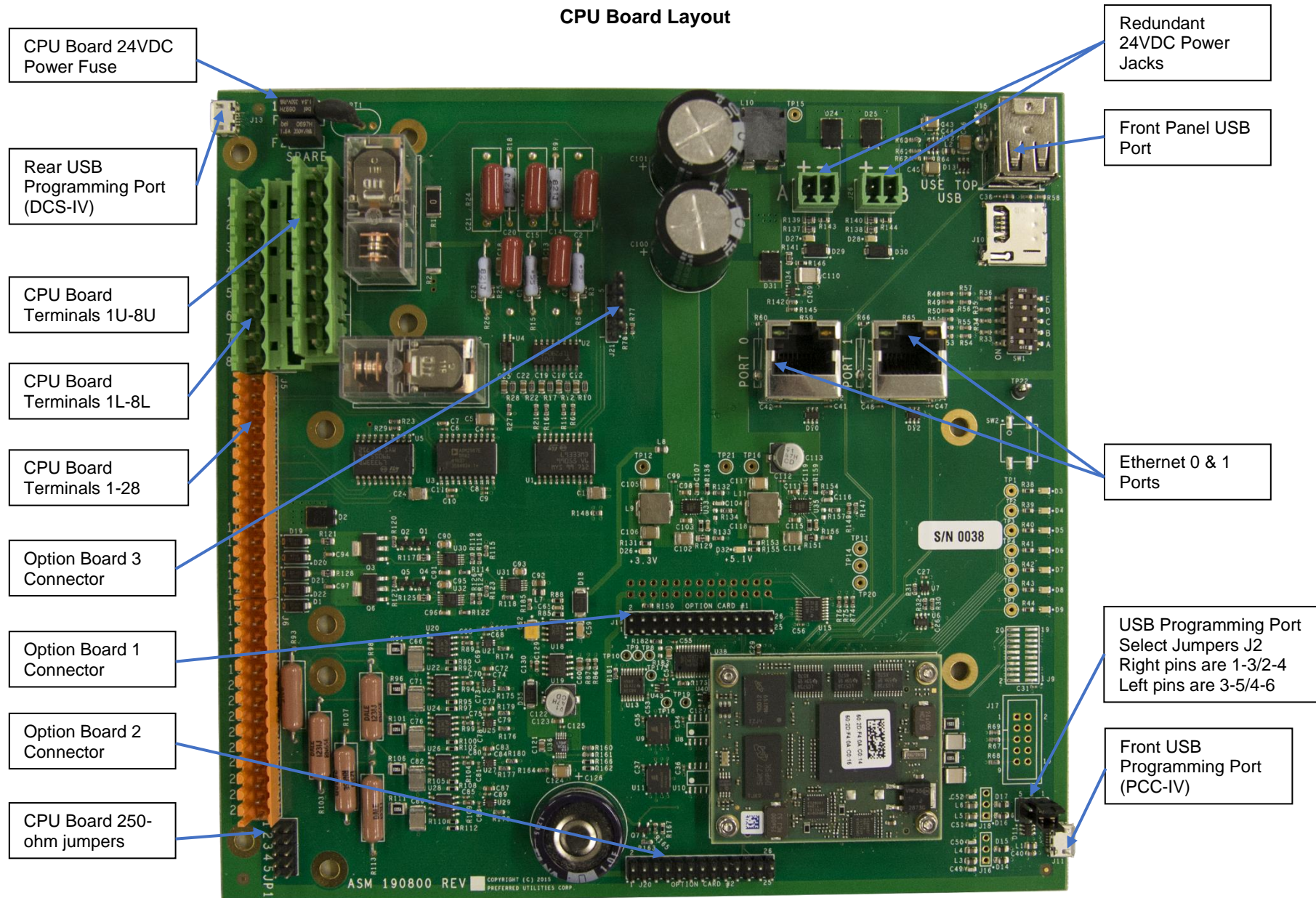
“J” Option Board Isolated Neutral Jumpers
Combination: 120 Vac Isolated Discrete Inputs, 4 Channels
Relay Outputs, 8A, ½ HP, 2 Channels



Fuse for Pair 1 (Term. 30 & 31)

“S” Option Board 120 Vac Fuse
Triac Output (AC Solid State Switch), 1 Pairs (2 Triacs)

CPU Board Layout



Option Board Field Wiring Terminals

PCC-IV Option Board Field Wiring Terminal Numbers (for Option Board Slots 1 or 2)

Model:	A Analog Input	B Isolated Analog Input	F Analog Input Analog Output	G Analog Input Triac Output	J Discrete Input 120 Vac Relay Output																																																																																																																																																																		
	<table><tr><td>40</td><td>+</td><td>AI x-1</td></tr><tr><td>41</td><td>-</td><td></td></tr><tr><td>42</td><td>+</td><td>AI x-2</td></tr><tr><td>43</td><td>-</td><td></td></tr><tr><td>44</td><td>+</td><td>AI x-3</td></tr><tr><td>45</td><td>-</td><td></td></tr><tr><td>46</td><td>+</td><td>AI x-4</td></tr><tr><td>47</td><td>-</td><td></td></tr><tr><td>48</td><td>+</td><td>AI x-5</td></tr><tr><td>49</td><td>-</td><td></td></tr><tr><td>50</td><td>-</td><td>SC</td></tr><tr><td>51</td><td>-</td><td>SC</td></tr></table>	40	+	AI x-1	41	-		42	+	AI x-2	43	-		44	+	AI x-3	45	-		46	+	AI x-4	47	-		48	+	AI x-5	49	-		50	-	SC	51	-	SC	<table><tr><td>40</td><td>+</td><td>IAI x-1</td></tr><tr><td>41</td><td>-</td><td></td></tr><tr><td>42</td><td>+</td><td>IAI x-2</td></tr><tr><td>43</td><td>-</td><td></td></tr><tr><td>44</td><td>+</td><td>IAI x-3</td></tr><tr><td>45</td><td>-</td><td></td></tr></table>	40	+	IAI x-1	41	-		42	+	IAI x-2	43	-		44	+	IAI x-3	45	-		<table><tr><td>40</td><td>+</td><td>AI x-1</td></tr><tr><td>41</td><td>-</td><td></td></tr><tr><td>42</td><td>+</td><td>AI x-2</td></tr><tr><td>43</td><td>-</td><td></td></tr><tr><td>44</td><td>+</td><td>AI x-3</td></tr><tr><td>45</td><td>-</td><td></td></tr><tr><td>46</td><td>-</td><td>SC</td></tr><tr><td>47</td><td>-</td><td>SC</td></tr><tr><td>48</td><td>+</td><td>AO x-1</td></tr><tr><td>49</td><td>-</td><td></td></tr><tr><td>50</td><td>+</td><td>AO x-1</td></tr><tr><td>51</td><td>-</td><td></td></tr></table>	40	+	AI x-1	41	-		42	+	AI x-2	43	-		44	+	AI x-3	45	-		46	-	SC	47	-	SC	48	+	AO x-1	49	-		50	+	AO x-1	51	-		<table><tr><td>40</td><td>HT</td><td>TRIAC HOT</td></tr><tr><td>41</td><td>NT</td><td>NEUTRAL</td></tr><tr><td>42</td><td>I1</td><td>INC 1 TO x-1 (pair 1)</td></tr><tr><td>43</td><td>D1</td><td>DEC 1.</td></tr><tr><td>44</td><td>NT</td><td>NEUTRAL</td></tr><tr><td>45</td><td>I2</td><td>INC 2 TO x-2 (pair 2)</td></tr><tr><td>46</td><td>D2</td><td>DEC 2.</td></tr><tr><td>47</td><td>NT</td><td>NEUTRAL</td></tr><tr><td>48</td><td>+</td><td>+ 5 Vdc</td></tr><tr><td>49</td><td>+</td><td>AI x-1</td></tr><tr><td>50</td><td>+</td><td>AI x-2</td></tr><tr><td>51</td><td>-</td><td>SC</td></tr></table>	40	HT	TRIAC HOT	41	NT	NEUTRAL	42	I1	INC 1 TO x-1 (pair 1)	43	D1	DEC 1.	44	NT	NEUTRAL	45	I2	INC 2 TO x-2 (pair 2)	46	D2	DEC 2.	47	NT	NEUTRAL	48	+	+ 5 Vdc	49	+	AI x-1	50	+	AI x-2	51	-	SC	<table><tr><td>40</td><td>R1</td><td>RO x-1</td></tr><tr><td>41</td><td>R1</td><td></td></tr><tr><td>42</td><td>R2</td><td>RO x-2</td></tr><tr><td>43</td><td>R2</td><td></td></tr><tr><td>44</td><td>H1</td><td>DI x-1</td></tr><tr><td>45</td><td>N1</td><td></td></tr><tr><td>46</td><td>H2</td><td>DI x-2</td></tr><tr><td>47</td><td>N2</td><td></td></tr><tr><td>48</td><td>H3</td><td>DI x-3</td></tr><tr><td>49</td><td>N3</td><td></td></tr><tr><td>50</td><td>H4</td><td>DI x-4</td></tr><tr><td>51</td><td>N4</td><td></td></tr></table>	40	R1	RO x-1	41	R1		42	R2	RO x-2	43	R2		44	H1	DI x-1	45	N1		46	H2	DI x-2	47	N2		48	H3	DI x-3	49	N3		50	H4	DI x-4	51	N4	
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42	I1	INC 1 TO x-1 (pair 1)																																																																																																																																																																					
43	D1	DEC 1.																																																																																																																																																																					
44	NT	NEUTRAL																																																																																																																																																																					
45	I2	INC 2 TO x-2 (pair 2)																																																																																																																																																																					
46	D2	DEC 2.																																																																																																																																																																					
47	NT	NEUTRAL																																																																																																																																																																					
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45	N1																																																																																																																																																																						
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47	N2																																																																																																																																																																						
48	H3	DI x-3																																																																																																																																																																					
49	N3																																																																																																																																																																						
50	H4	DI x-4																																																																																																																																																																					
51	N4																																																																																																																																																																						

Notes:

Any Combination of the above Option Cards can be used in Slots 1 or 2

"x" indicates the PC Board Number in the above channel descriptors
0 = CPU board, 1 = Option Slot 1, 2 = Option Slot 2

All the above Option Cards use the same Terminal Numbers

When wiring schematics are created, label Terminals as term. no."

"x" is the option card slot number. Examples:
1-46 means Option Card 1, terminal number 46
2-46 means Option Card 2, terminal number 46

PCC-IV "S" Option Board Field Wiring Terminal Numbers (Option Board Slot 3 Only)

29	HT	TRIAC HOT
30	I1	INC 1 TO x-1 (pair 1)
31	D1	DEC 1.
32	NT	NEUTRAL (Tie Point)
33	NT	NEUTRAL

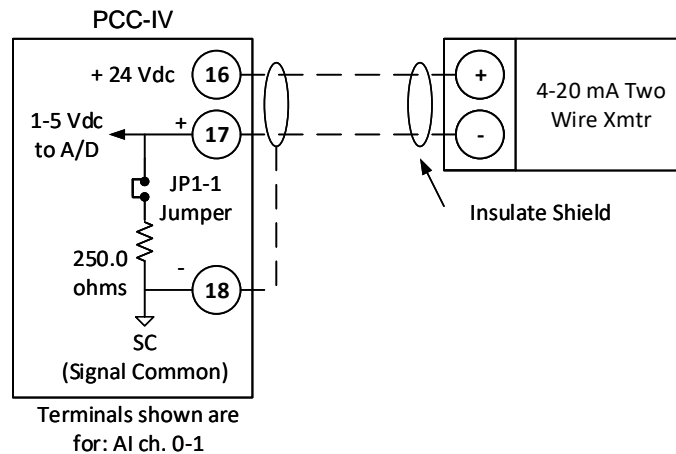
Wiring Examples

Two Wire 4-20 mA Input, Internal 24 Vdc

Typical for: CPU, "A", and "F" boards.

This example shows Analog Input 1 on the CPU Board. Install JP 1-1 to connect the internal 250.0-ohm resistor.

The shield connects to the PCC-IV Signal Common "-".



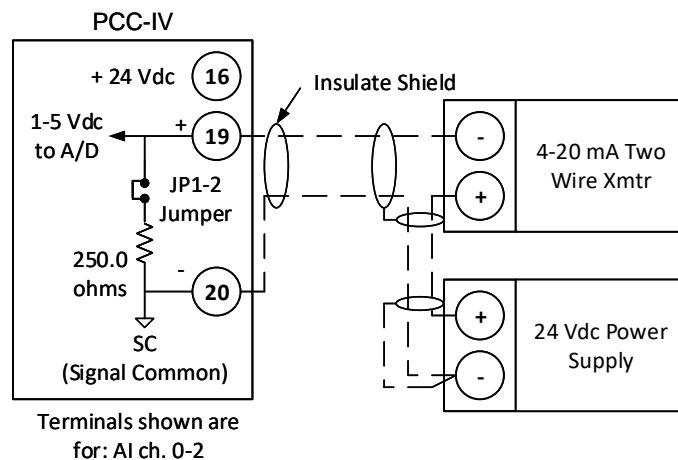
Two Wire 4-20 mA Input, External 24 Vdc

Typical for: CPU, "A", and "F" boards.

This example shows Analog Input 2 on the CPU Board. Install JP 1-2 to connect the internal 250.0-ohm resistor.

The External Power Supply "-" and the PCC-IV Signal Common "-" must be connected.

The shield connects to the External Power Supply "-".



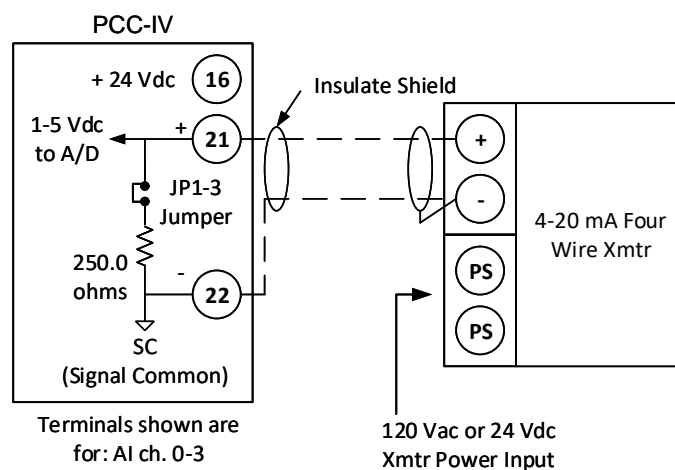
Four Wire 4-20 mA Input

Typical for: CPU, "A", and "F" boards.

This example shows Analog Input 3 on the CPU Board. Install JP 1-3 to connect the internal 250.0-ohm resistor.

The Transmitter "-" and the PCC-IV Signal Common "-" must be connected.

The shield connects to the Transmitter "-".



Isolated 4-20 mA Input

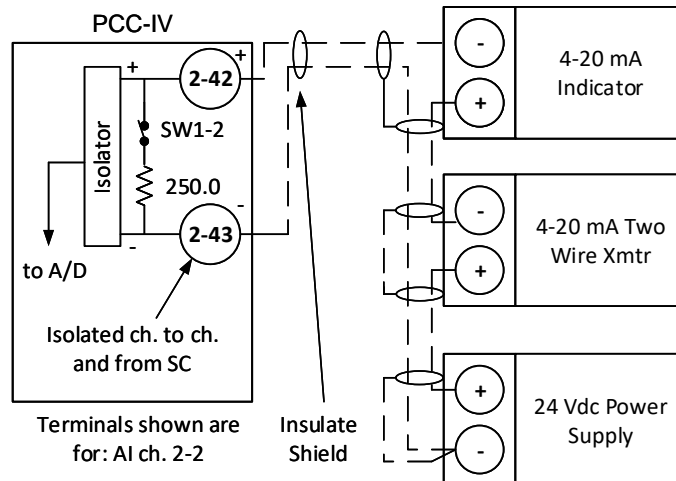
"B" Option Board Only.

This example shows Analog Input 2 on a "B" Option Board that is plugged into Slot 2. Turn ON switch 1-2 to connect the internal 250.0-ohm resistor.

The "-" of each channel is isolated from all other channels and from the CPU Signal Common "-".

The External Power Supply "-" and the "B Board "-" for this channel must be connected.

The shield connects to the External Power Supply "-".



1-5 Vdc Input

Typical for: CPU, "A", and "F" boards.

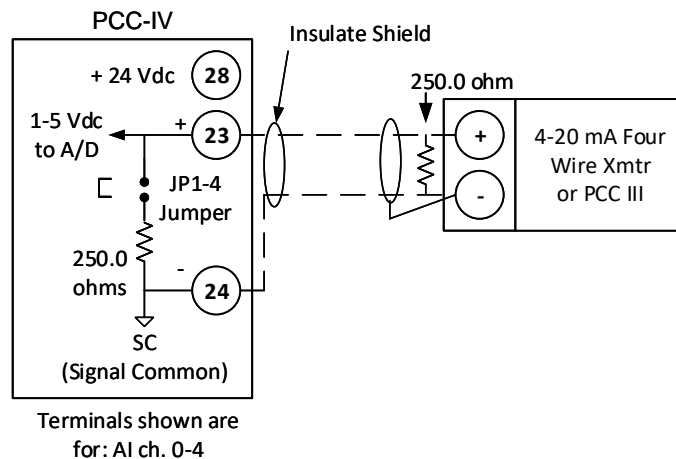
This example shows Analog Input 4 on the CPU Board. Remove JP 1-4 to disconnect the internal 250.0-ohm resistor.

The 5-Mohm input impedance of each channel allows over 15 PCC-IVs to be connected to the same 1-5 V signal.

See "Pull-Up/Down Resistors" in this Section

The External Power Supply "-" and the PCC-IV Signal Common "-" must be connected.

The shield connects to the External Power Supply "-".



0-10 Vdc Input

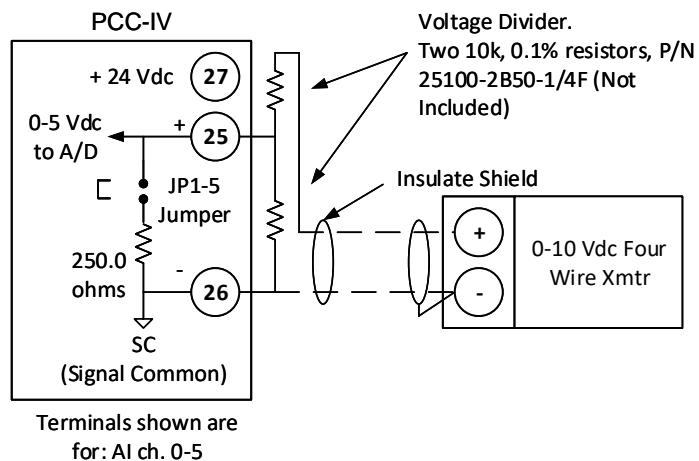
Typical for: CPU, "A", and "F" boards.

This example shows Analog Input 5 on the CPU Board. Remove JP 1-5 to disconnect the internal 250.0-ohm resistor.

The two external precision resistors reduce the signal by exactly 50%. Set the AIN Block for a 0-5V range, instead of the default 1-5V range.

The External Power Supply "-" and the PCC-IV Signal Common "-" must be connected.

The shield connects to the External Power Supply "-".



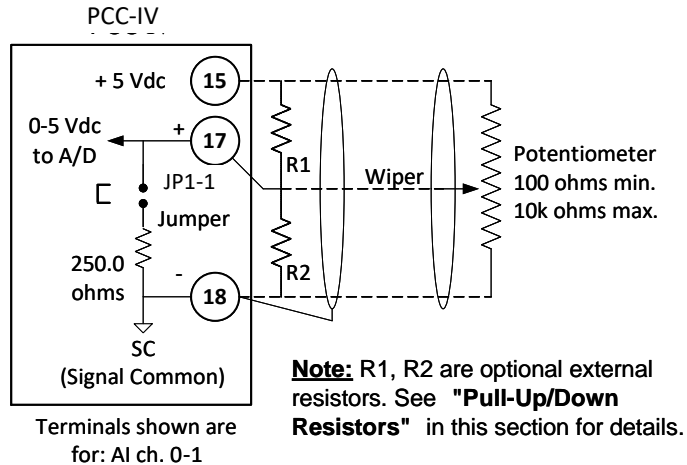
Potentiometer Input

Typical for: CPU, "A", and "F" boards.

This example shows Analog Input 1 on the CPU Board. Remove JP 1-1 to disconnect the internal 250.0-ohm resistor.

The +5 Vdc power supply (term. 15) is rated at 50 mA.

The shield connects to the Signal Common "-".



Note: For Actuator Feedback Pots

See "Pull-Up/Down Resistors" in Section 2 and F83 TOUT in Section 6 for Fault Mode wiring considerations.

Potentiometer Input, "G" Board

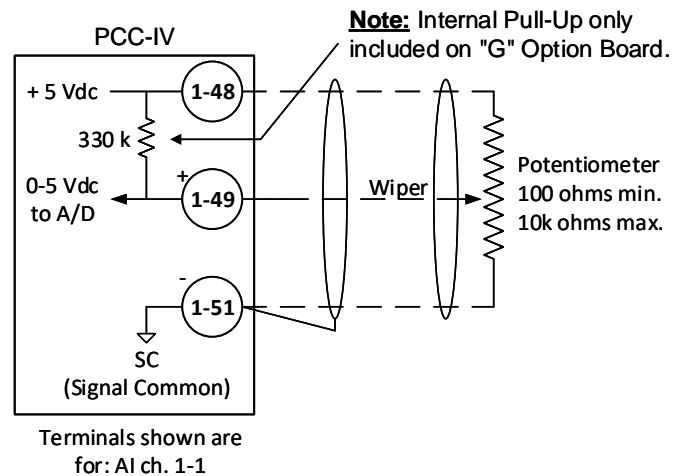
"G" Option Board Only.

This example shows Analog Input 1 on a "G" Option Board that is plugged into Slot 1. There are no 250.0-ohm resistors on the "G" board.

The +5 Vdc power supply (term. 1-48) is rated at 50 mA, total. If two pots are connected to the +5 Vdc, then the smallest value is 200 ohms (each).

The "G" board has a built-in pull-up resistor. It must be removed if an external 250.0-ohm resistor is required.

The shield connects to the Signal Common "-".



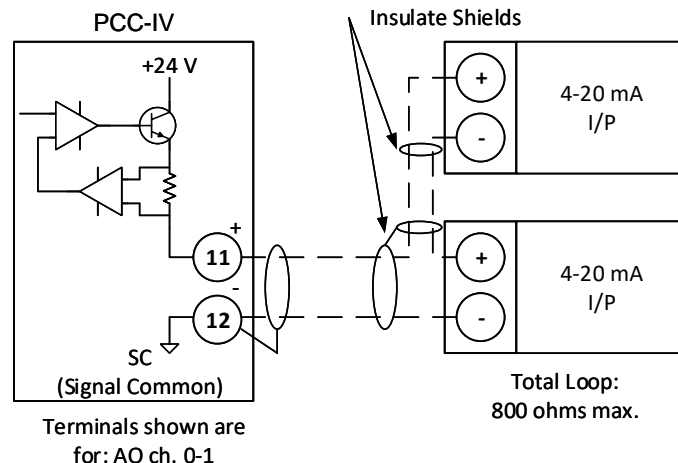
4-20 mA Output

Typical for: CPU, and "F" boards.

This example shows Analog Output 1 on the CPU Board.

The maximum 4-20 mA total loop resistance external to the PCC-IV is 800 ohms.

The shield connects to the Signal Common "-".



120 Vac Discrete Inputs, CPU Board

CPU Board Only.

This example shows Discrete Input 1 on the CPU Board.

The Neutrals for the 5 Discrete Input channels on the CPU board are connected internally.

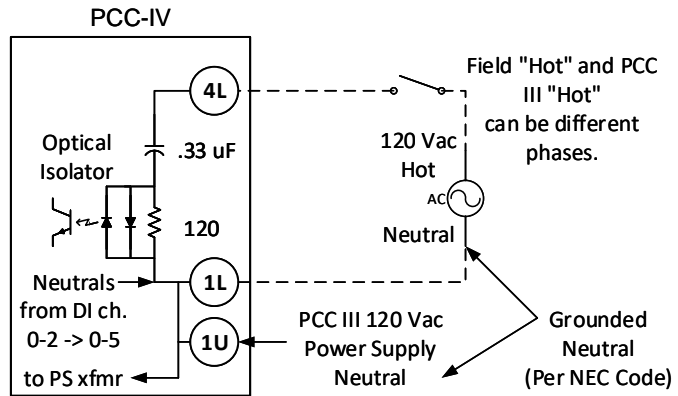
Specifications:

> 90 Vac = ON

< 3 mA = OFF

Input Impedance = 8 k (+/- 20%)

Typical Input Current = 15 mA



Terminals shown are
for: DI ch. 0-1

120 Vac Discrete Inputs, "J" Board Isolated Neutrals

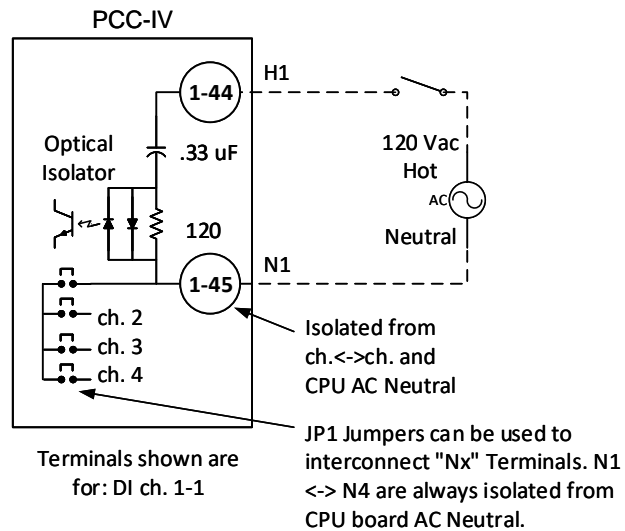
"J" Board Only.

This example shows Discrete Input 1 on a "J" Option Board that is plugged into Slot 1.

Each Discrete Input has a separate isolated Neutral which is isolated from all other channels and from the CPU Neutral.

If Isolation is not desired, jumpers on the JP1 jumper block interconnect the channel Neutrals. Each jumper connects an individual channel Neutral to an isolated inter-channel tie bus. Therefore, two jumpers would have to be installed to connect the Neutrals of two different channels.

The CPU AC Neutral (terminal 1U) does not connect to the "J" board. An external wire must be run if these isolated Neutrals need to be connected.



Terminals shown are
for: DI ch. 1-1

JP1 Jumpers can be used to interconnect "Nx" Terminals. N1 <-> N4 are always isolated from CPU board AC Neutral.

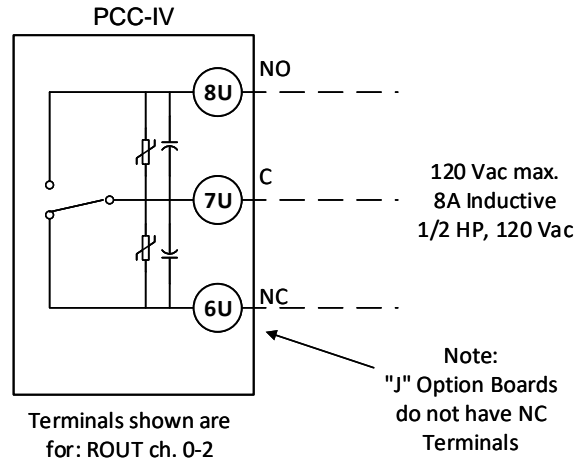
Relay Output

Typical for: CPU, and "J" boards.

This example shows Relay Output 1 on the CPU Board.

The Relay contacts are protected from damage due to inductive loads by a capacitor and a 150 V Varistor. To prevent damaging the Varistor, do not apply voltages greater than 145 Vac across the Relay contacts.

When the Relay Contacts are Open, less than 1.8 mA of leakage current is applied to the load through the snubber cap and Varistor.



Discrete Output, Sinking, Internal 24 Vdc

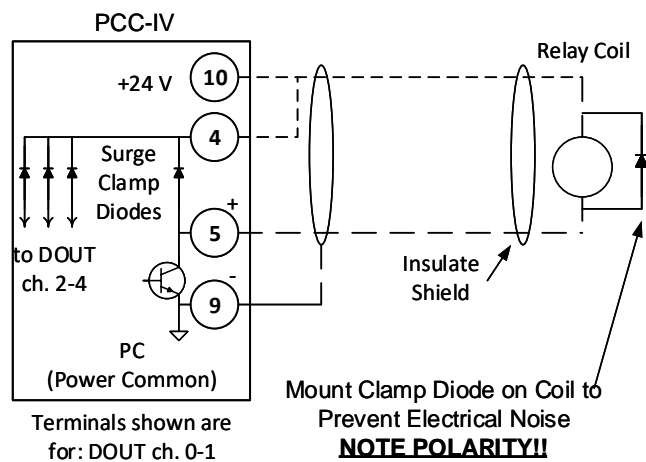
CPU Board Only.

This example shows Discrete Output 1 on the CPU Board.

DOUT channels are Open Collector Transistors (i.e. "Sinking") with internal clamping diodes. When active, the DOUT conducts DC current to Power Common.

Coil loads (relays, solenoids, ...) require an additional field mounted clamp diode on the actual coil to prevent noise induction in adjacent field wiring.

NOTE: Incorrect clamp diode Polarity causes a direct short.



Each DOUT channel is rated 200 mA max. load. See "24 Vdc Power Supply" on page 2-6 to calculate the mA current available from the 24 Vdc Power Supply.

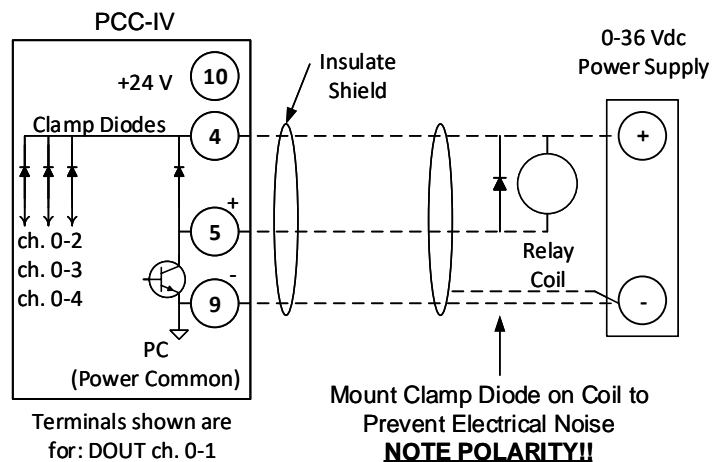
The shield connects to the Power Common "-".

Discrete Output, Sinking, External 24 Vdc

CPU Board Only.

The same comments noted above apply. This example shows an External Power supply being used to power the load.

The shield connects to the External Power Supply "-".



Triac Output, Reversible Actuator

Typical for: "G" and "S" boards.

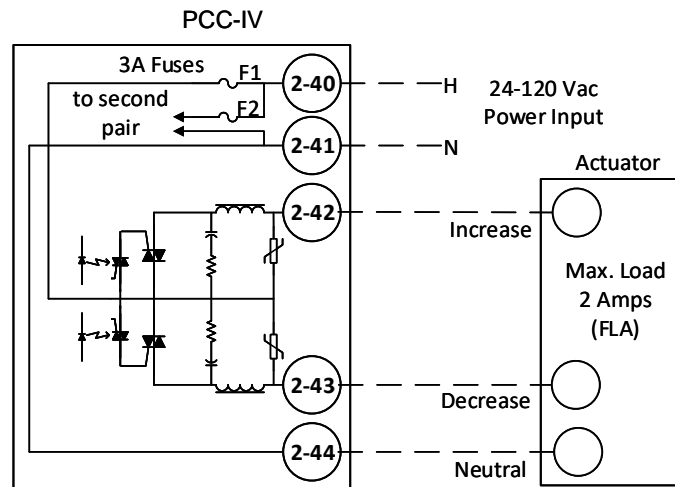
This example shows Pair 1 of a Triac Output on a "G" Option Board in Slot 2.

The Triacs are protected by surge suppressing capacitors, inductors, and varistors (6 mA leakage, type).

The Triac Hot and Neutral supply are isolated from the PCC-IV 120 Vac. Each Triac pair has a separate fuse.

Motors rated 24 – 120 Vac, and 0-2 Amps are acceptable.

The "G" Board also includes two Analog Input channels. If a Position Feedback signal is required by the control strategy, See the potentiometer and 4-20 mA input examples above.



Terminals shown are
for: TOUT ch. 2-1

Triac Output, Other AC Loads

Typical for: "G" and "S" boards.

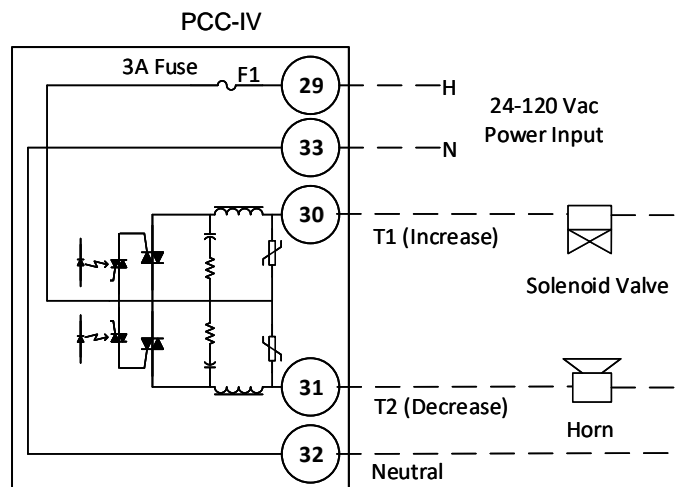
This example shows Pair 1 of a Triac Output on a "S" Option Board in Slot 3.

The TOUT Blockware allows each Triac to be controlled as a separate Solid-State AC Switch.

The Triacs are protected by surge suppressing capacitors, inductors, and varistors (6 mA leakage, type).

The Triac Hot and Neutral supply are isolated from the PCC-IV 120 Vac. Each Triac pair has a separate fuse.

Loads rated 24 – 120 Vac, and 0-2 Amps are acceptable.



Terminals shown are
for: TOUT ch. 3-1

DC Commons and AC Neutrals Isolation

The drawing on the next page shows the relationships between the various grounds and commons within the PCC-IV. A thorough understanding of these relationships will prevent unintended ground loops in the DC and AC field wiring. "Ground loops" is a general term to describe unintended current flows via AC ground or DC common circuits, which generally are not drawn on a schematic as a distinct field wiring connection.

DC ground loops can cause lower than expected 4-20 mA values due to a portion of the current bypassing the intended circuit path and traveling through some unintended parallel path. AC ground loops can cause Ground Fault Interrupter Circuit Breakers to trip if current returns via a neutral that is not protected by the GFCI breaker.

The PCC-IV is not powered by 120Vac. Terminals 2U, 2L, 3L are connected to each other but not to any other internal PCC-IV circuitry. These terminals are provided for compatibility with PCC-III controllers. 120 Vac does NOT need to be connected to these terminals for new PCC-IV installations.

120Vac Neutral DOES need to be connected to 1U or 1L for 120 Vac DIN's 1 thru 5 to operate correctly (terminals 4L – 8L).

The following information is provided to assist installers with a PCC-III to PCC-IV retrofit only.

Green Wire Ground: The incoming AC power ground (the "Green" wire) is only connected to case ground (i.e., the metal enclosure). Case ground is isolated from all neutrals and all DC commons. Case ground should always be connected to the appropriate power supply ground, per NEC.

Line: The CPU AC power line input (Terminal 2U) is internally connected to CPU terminals 2L and 3L. CPU Terminal 2U is not internally connected to any of the option boards. If a connection is desired, external wiring is required.

Hot: The hot power inputs to the "G" and "S" Triac Output option boards are isolated from the CPU line input. Each option board hot is isolated from the hot of the other option boards. If a connection is desired, external wiring is required. The hot input for a Triac option board is a common input that feeds all Triacs on that board.

Neutral: The CPU AC Power neutral input (Terminal 1U) is internally connected to CPU terminal 1L. CPU Terminal 1U is not internally connected to any of the option boards. If a connection is desired, run a field wire from the CPU board to the option board.

CPU Terminal 1U is the return path (or neutral) for all current that enters the CPU 120 Vac discrete input channels (Terminals 4L-8L). The hots and neutrals of all "J" option board 120 Vac discrete input channels are isolated from the CPU board line and neutral. Each "J" board input channel is isolated from other "J" board channels. The "J" board is provided with jumpers to allow connecting the neutrals of the channels together if desired.

DC Common: The DC commons ("-") are isolated from case ground. All signal commons on the CPU board are interconnected and are connected to the signal commons on the "A", "F", and "G" option boards. Specifically, the following terminals are all internally connected to each other:

CPU: 9, 12, 14, 18, 20, 22, 24, 26
 "A": x-41, x-43, x-45, x-47, x-49, x-51
 "F": x-41, x-43, x-45, x-46, x-47, x-49, x-51
 "G": x-51

Power Common (PC): Terminal 9 on the CPU board is reserved for "noisy" electrical loads such as external relay coils, and solenoids.

Signal Common (SC): Except for Terminal 9 (power common), all other DC commons are referred to as signal common and should be connected to low noise 0-5 Vdc and 4-20 mA circuits.

Isolated Signal Commons: The "-" terminal of each channel of a "B" option board is isolated from all other channels on that option board and from the CPU board. The "+" terminals are also isolated channel-to-channel and from the CPU board.

Isolated RS485: Terminal 3 ("COM") is the isolated DC common of the isolated power supply that powers the field wiring portion of the isolated RS485 communications link. The RS485 data "+" and "-" (terminals 1 & 2) are also isolated from the CPU board.

Grounds, Neutrals, and DC Commons Schematic

Pull-Up/Down Resistor for Voltage Inputs

This sub-section does not apply to 4-20 mA inputs; that is, inputs with the 250-ohm resistor connected.

The 250-ohm resistor is never connected for: 1-5 V, 0-5 V, 0-10 V, and Potentiometer Inputs.

Each analog input has a low pass noise filter with high quality, low leakage capacitors for 60 Hz noise rejection. If the field wiring breaks, a pot wiper gets dirty, or is otherwise disconnected, the A/D input voltage will remain at the last value for several hours due to the capacitors in the filter. In many applications, it is desirable for the input to fail to either 0V or 5V after the input becomes disconnected.

A Pull-Up Resistor (R1) will force the Input to 5V after a wire break.

A Pull-Down Resistor (R2) will force the Input to 0V after a wire break.

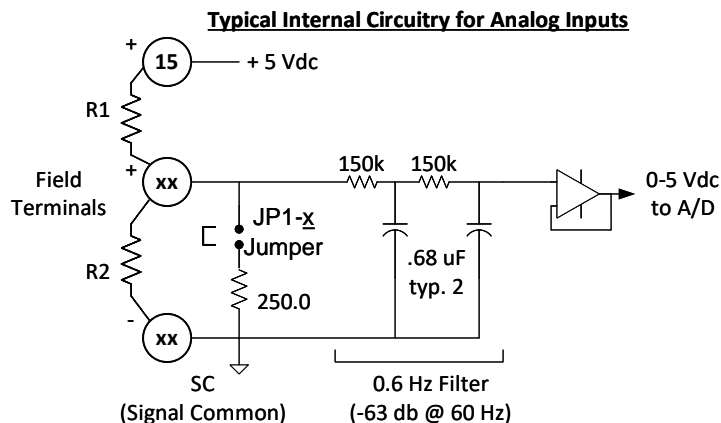
If Required, install only one (1) Resistor, either R1 or R2. Do NOT install BOTH resistors.

The value of R1 or R2 depends on the impedance of the field device, the desired response time, and the acceptable level of error introduced by the resistor. Each application should be analyzed separately.

Example: An input for a 1k position feedback pot on an electric actuator with an "R1" pull-up resistor equal to 330k. This combination adds less than 0.05% error and has a 3-sec. response time. If the pot is wired such that approx. +5 V is 100% open, then TOUT will drive the actuator fully closed if the feedback pot wiper circuit becomes disconnected. If the desired effect is to make the actuator fail open, then reverse the +5 and Common wires to the pot and re-calibrate TOUT.

The CPU, "A", "B", and "F" boards do not include pull-up or pull-down resistors. If desired, the user must mount them externally.

The "G" option board includes an integral 330k Pull-Up Resistor on each Input channel.



RS485 Communications Wiring

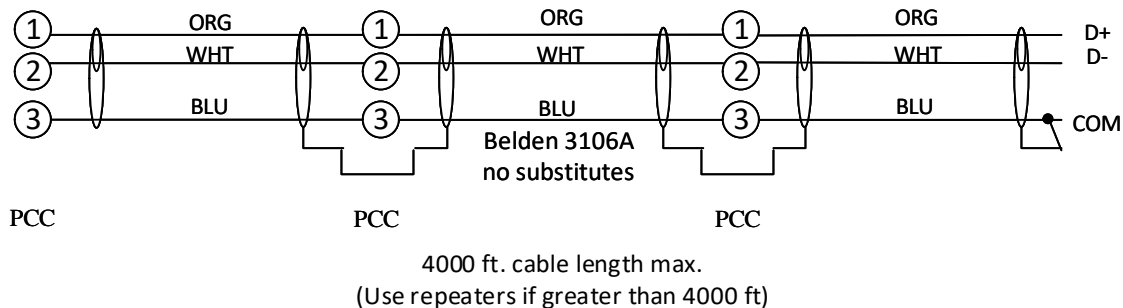
RS-485 communications wiring (terminals 1-3) is optically isolated and is not electrically connected to any other circuits within the PCC-IV. This means that an accidental short to the RS485 cable will not affect the operation of the other controllers (up to 31 units) connected to the cable.

RS-485 cabling may be up to 4000 feet in length. Longer distances can be accommodated by using RS-485 repeaters. RS-485 network cabling should always be arranged in a bus. Do not wire cabling in a star or with stub connections. See the drawings below for examples of bus and stub wiring layouts.

Belden P/N 3106A (Preferred part number 16284) is the recommended shielded cable for all PCC-IV RS-485 communications data highways. Belden 3106A is specifically designed for RS485 applications and is 3-wire shielded cable arranged as: 1 twisted pair with a foil shield, plus a separate single insulated conductor that is not twisted into the main pair. The 3 wires are surrounded by a second braided shield and an overall PVC insulation. Belden 3106A has a characteristic impedance of 120 ohms, has 22 Ga. conductors, and is rated 300V @ 60C.

Shielding and RS-485 Commons: The shield should be connected to the RS-485 common terminal at the master station. At each PCC, PLC, RS-485/232 converter and any other devices on the network, the shields should not be connected to each controller's RS-485 common. The shields of the network cables should be wired together to continue the shield to the next controller. The single wire (i.e., not part of the twisted pair) in the cable should be connected to all the communications DC commons on the RS-485 network. Cut off the foil and braided shields, insulate the bare shield wire and any exposed shield and connect as shown below.

RS232/RS485 Converters: Typical DCS and SCADA workstations have RS232 communications ports, and require an external RS232/RS485 converter. RS232/RS485 converters are available from: Telebyte Technology (516-423-3232) Model 8324. The RS485 cable must have exactly one set of Pull-Up/Pull-Down resistors installed to ensure that the cable is biased to greater than 0.2 Vdc differential in the idle state (i.e., no nodes are transmitting). The Model 8324 has internal Pull-Up/Pull-Down resistors that are activated by setting DIP switches.



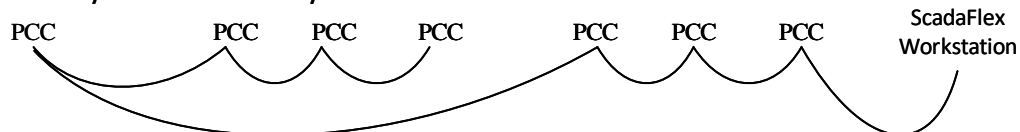
RS-485 Bus Layout



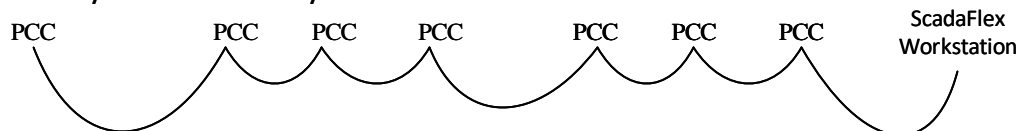
Daisy Chained Bus Layout: OK



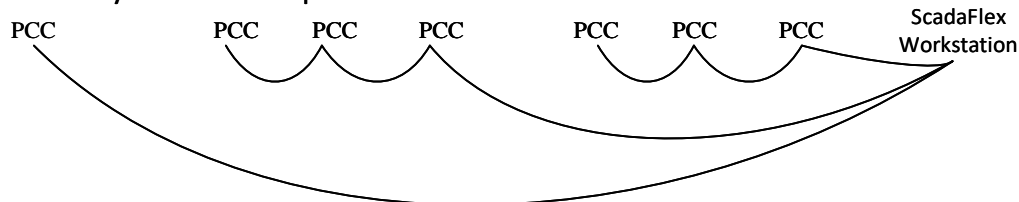
Daisy Chained Bus Layout: OK



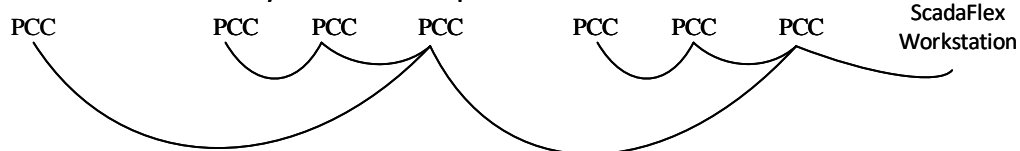
Daisy Chained Bus Layout: OK



Star Layout: Not Acceptable



Bus with Stubs Layout: Not Acceptable

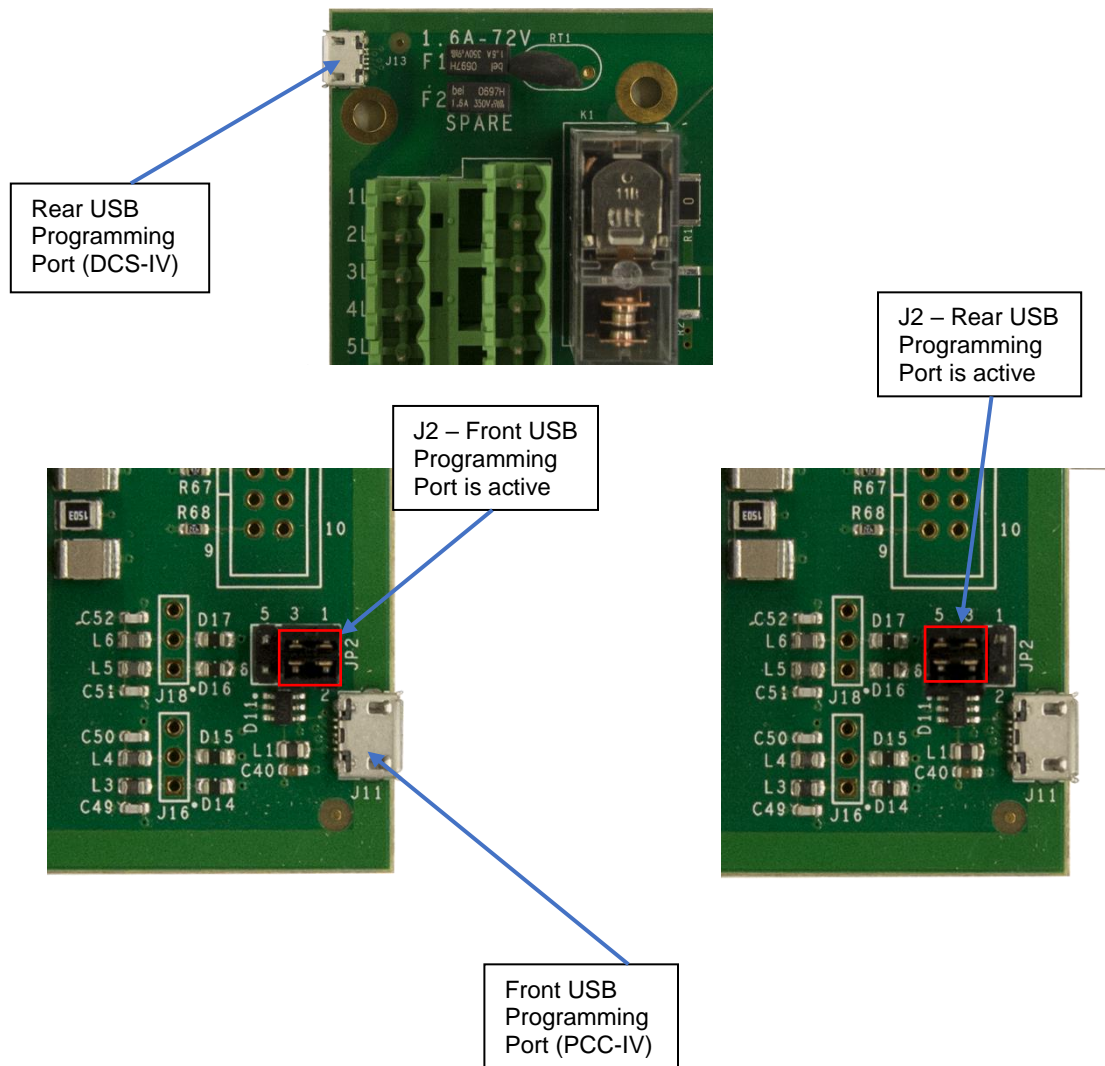


Ethernet Cables

The PCC-IV can communicate with other Modbus devices via one or both Ethernet ports located on the CPU board. This utilizes the Modbus TCP/IP communications protocol via a standard Ethernet (CAT5, CAT5e, CAT6, or similar) cable. See Section 4 for more information.

Micro-USB Download Cable

The PCC/DCS-IV can upload and download blockware configurations and other diagnostic information via the front or back micro-USB jack on the CPU board. The signals are standard USB 2.0 levels and can be directly connected to a standard personal computer USB port. There is (1) USB port, but (2) physical USB jack locations. Jumpers on the CPU board select the front or rear jack. The rear jack is used for PCC-IV applications, and the front jack is used for DCS-IV applications. To make the front jack active, move both jumpers J2, to pins 1-3 & 2-4. To make the rear jack active, move both jumpers J2, to pins 3-5 & 4-6.



Field Installation of Option Boards



WARNING

The PCC-IV is commonly used to control potentially dangerous combustion and chemical processes. **VERIFY THAT THE PROCESS BEING CONTROLLED HAS BEEN SAFELY SECURED, ISOLATED, OR BYPASSED (AS REQUIRED BY THE SITE CONDITIONS) BEFORE REMOVING POWER FROM THE PCC-IV CONTROLLER. FAILURE TO DO SO CAN RESULT IN EQUIPMENT DAMAGE, INJURY, OR DEATH.**

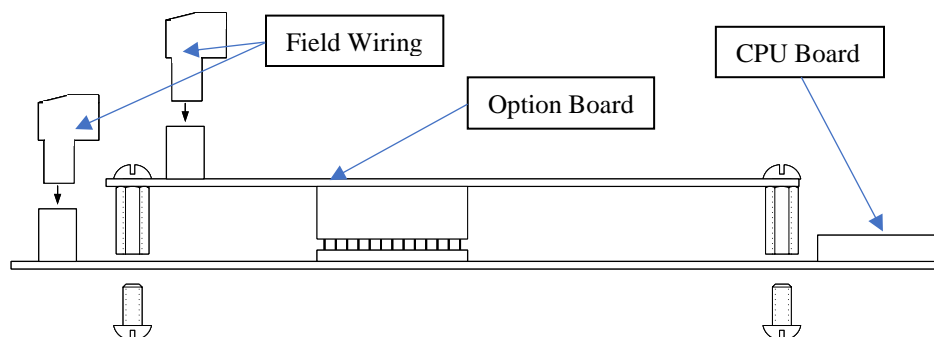


WARNING

It is very common to have multiple sources of power among the wires connected to a PCC-IV. **VERIFY THAT ALL SOURCES OF POWER HAVE BEEN DISCONNECTED BEFORE WORKING ON WIRING. FAILURE TO DO SO CAN RESULT IN INJURY OR DEATH.**

The quantity of PCC-IV input and output channels can be expanded by adding up to three plug-in option boards. These option boards can be field installed by competent instrument technicians. Refer to the procedure below, the drawing below, and the CPU board layout drawing above.

If the PCC-IV is controlling a process, it must be safely taken out of the control loop before attempting to install any option cards.
Remove all power to the instrument. Multiple power sources may be present.
Remove the front panel from the PCC-IV: <ul style="list-style-type: none"> Remove the screw on the top of the front panel. Grasp the top corners of the front panel and move it forward, away from the case, about 1/2". Move the front panel upwards and away from the case about 1/2". The front panel should now be free. Depress the two retainer clips on each side of the ribbon cable connector on the CPU board and remove the ribbon cable connector.
Remove the rear cover from the PCC-IV.
Note where each field wiring terminal strip connector is plugged-in.
Unplug the field wiring terminal strip connectors at the rear of the circuit boards.
Unscrew the board-to-case retainer screw (see CPU board layout). It is in the lower rear area of the CPU board, next to the JP1 250-ohm jumper header.
Prepare a static free work area and protect all circuit boards from a static discharge.
Slide the main PCB out of the PCC-IV and place on a static protected mat.
Install the option cards as shown below.
Reassemble the instrument in reverse order.
Calibration may be required, see Section 4, "Calibrate I/O Submenu".
Wire the new option board(s).



Installation of Option Boards onto CPU Board (Side View)

Section 3 Operation

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Operator Controls and Front Panel Usage

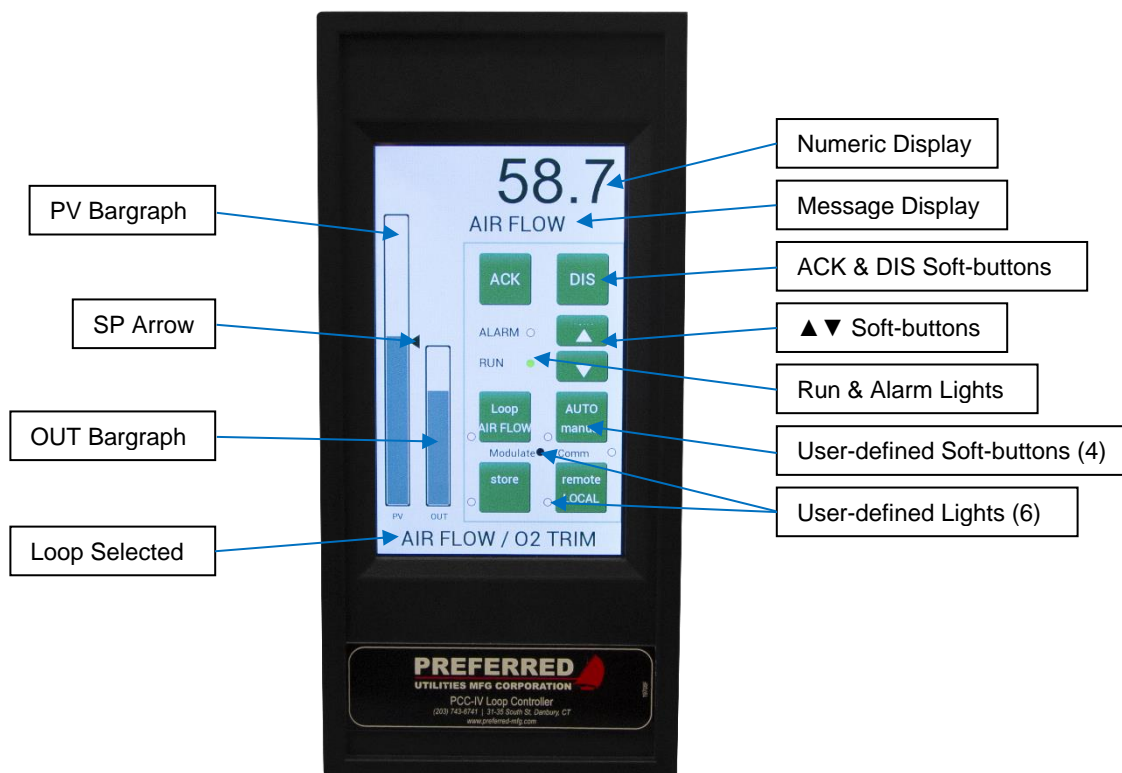


Figure 1

General

This section will explain the front panel displays and the operation of the front panel soft-buttons. This section is intended as an aid to the everyday operator of the PCC-IV controller.

The PCC-IV is a general purpose, software configurable, microprocessor based controller. Typical applications:

- High school heating plant firing rate controller, with time of day clock, start time logic and outside air temperature reset
- Multiple burner, high pressure steam boiler fuel flow and air flow controller
- Boiler furnace pressure (i.e. draft) controller
- Electric generator steam turbine throttle valve controller
- Waste water pH controller
- Pump and Fan variable speed drive flow/pressure controller
- Batch reactor temperature controller
- Paper stock consistency controller
- Chemical additive ratio blending controller
- Heat treating temperature controller

The same physical PCC-IV controller hardware is used in every case. What differentiates one controller from another is the application-specific blockware (i.e., control strategy software) in the memory of the PCC-IV.

By design, the PCC-IV is exceedingly flexible, and very adaptable. For convenience, this section will use specific examples to explain how to operate the PCC-IV. However, the reader should remember that **each PCC-IV will be programmed differently to suit the needs of an application. For this reason, one must consult the documentation for the blockware loaded in the memory of your specific PCC and become familiar with your installation before attempting to operate the PCC-IV controller.**

The operation of the four soft-buttons and six configurable lights, shown in Figure 1, changes depending on the blockware (i.e., control logic) that has been loaded into the memory of the PCC-IV. Throughout this Section, the words: "Typically", "Optionally", "Configurable", and "User defined" will be used to indicate that the operation of a soft-button or display may in fact vary from that described in the examples given in this section.

Front Panel Displays and Soft-buttons

RUN Light

The green **RUN** light indicates the health of the hardware and indicates if the Blockware is being over-ridden (i.e. FORCED or Service Manual (S/M)) or has errors.

The **RUN** light should be ON continuously.

If the RUN light is blinking or off, the PCC-IV blockware is not operating properly. A technician should be called immediately to determine the cause of the problem. It is normal for a technician to purposely put the PCC-IV into either Service Manual (S/M) or FORCE mode during various maintenance procedures. However, the PCC-IV should not be in S/M or FORCE mode during normal operation. See Section 4 for details on S/M and FORCE modes.

The RUN light indicates Normal, Forced, or S/M Mode

Green RUN Light ON / OFF Cycle	Operating Mode
ON Continuous	Normal
Flashing – Blinks OFF once every second	Forced Block(s)
Flashing – Blinks ON twice every second	Service Manual
OFF Continuous	Not Operating

Note: S/M Mode RUN light indication takes priority over FORCED Mode indication when both S/M and FORCED Modes are active.

PV Bargraph

Typically, this bargraph provides a graphical display of the **Process Variable (PV)** over a range of from 0-100%. "Process Variable" is control system slang for: "that specific system condition that the PCC-IV is trying to control."

Put another way, if the PCC-IV is modulating a steam valve to control the burner fuel oil temperature, then the oil temperature is the Process Variable (PV). If the PCC-IV is a boiler feedwater controller, the boiler drum water level is the PV.

However, the blockware designer is free to use this bargraph to display any other variable.

SP Arrow

Typically, the PV bargraph has an arrow that provides a graphical display of the **SetPoint (SP)** over a range of from 0-100%. "Setpoint" is control system slang for: "that specific value at which the PCC-IV should maintain the Process Variable".

Put another way, if the PCC-IV is modulating a steam valve to control the burner fuel oil temperature, then as noted above the oil temperature is the PV (that is, Process Variable). If you want to keep the oil temperature at a constant 220 deg. F, then the Setpoint would be 220 deg. F.

Typically, since the bargraph is setup to display PV and SP simultaneously, both the bargraph and arrow will be at the same height, when the PCC-IV is in AUTO and the controller is maintaining the desired setpoint.

However, the blockware designer is free to use this arrow to display any other variable.

OUT Bargraph

Typically, this bargraph provides a graphical display of the **OUTput** of the PCC-IV over a range of from 0-100%. "Output" is control system slang for: "whatever the PCC-IV is changing to maintain the process at the desired setpoint".

Put another way, if the PCC-IV is modulating a steam valve to control the burner fuel oil temperature, then the 4-20 mA signal being sent to the steam valve positioner is the Output. In this case, the OUT bargraph would indicate 0-100% of the steam control valve's opening demand signal.

However, the blockware designer is free to use this bargraph to display any other variable.

Numeric Display

This display is used to show numbers. Typically, the values shown are shown in engineering units. That is, the numbers are usually not in units of from 0-100%. See **ACK** and **DIS** for more details.

Touching this area of the display will bring up a soft keypad that allows users to change modifiable values. See ▲ and ▼ Soft-buttons for more details.

Message Display

This display is used to show a message that describes the numeric value above it. The message display can show up to 16 characters (using scrolling across the display). See **ACK** and **DIS** for more details.

DIS Soft-button

The PCC-IV can display up to 10 channels of process control information. Pressing and releasing the **DIS** soft-button causes the next display channel to appear on the message and numeric displays. The display channel sequence repeats after the last channel is displayed. Repeatedly pressing the **DIS** soft-button to cycle through the display channels is called "scrolling" through the display channels.

Each display channel consists of a numeric display and a message display working as a matched pair to display one variable. Pressing and releasing **DIS** to scroll through the display channels causes both the numeric and message displays to change to the next display channel at the same time.

A typical display channel example would be boiler drum steam pressure (the variable). After scrolling to this display channel with the **DIS** soft-button, the numeric display might show "149" (for 149 psig) while the message display might simultaneously show "DRUM PSI".

Additionally, the **DIS** button can be held down continuously for 3 seconds to enter the Main Menu (see Section 4).

The operation of the **DIS** soft-button cannot be changed by the blockware designer. In normal operation, the **DIS** soft-button can always be used to scroll through the display channels.

There are only three reasons why depressing the **DIS** soft-button would not cause a change in the display channel:

- If it is held down for 3 seconds to enter the Main Menu screen.
- The Blockware loaded in the PCC-IV memory does not have any display channels.
- If the green RUN light is OFF or blinking indicating that the controller may need to be serviced.

▲ and ▼ Soft-buttons

These soft-buttons are used to increase or decrease the value that is currently being displayed on the numeric display. These soft-buttons can only be used to change values that the blockware designer has configured to be modifiable from the front panel.

Typically, the setpoint, the controller output (when in manual), ratio, bias, and other values can be changed with these soft-buttons.

The blockware designer can also limit the amount of adjustment that is possible. For example, if the setpoint is normally 150 psig, the blockware designer can internally limit the range of adjustment to 125 – 175 psig.

Additionally, for values that can be modified, the user may touch the numeric display and enter any valid value via a soft keypad.

▲ and ▼ Rate of Change

When the operator presses and holds down either the ▲ or ▼ soft-button, the displayed value will initially ramp slowly. However, after every 10 counts, the display ramp speed increases by a factor of ten. Therefore, the longer the ▲ or ▼ soft-button is pressed, the faster the displayed value will change.

Example:

Assume the Numeric display initially shows 0.00

The Operator presses and continuously holds down the ▲ soft-button.

The Numeric display would change as follows:

0.00, 0.01, 0.02, 0.03, 0.04, 0.05, 0.06, 0.07, 0.08, 0.09,
0.10, 0.20, 0.30, 0.40, 0.50, 0.60, 0.70, 0.80, 0.90,
1.00, 2.00, 3.00, 4.00, 5.00, 6.00, 7.00, 8.00, 9.00
...

Note: the ramping sequence does not have to start with the right-hand digit equaling "0" as shown in the above example. If the initial display value had been 0.03, the ramp rate would change after 0.13, 1.03, 10.03, 100.03, ..., that is after every 10 display value changes.

Whenever the ▲ or ▼ soft-button is released, the ramping rate will pause at its current "decade" to allow the user a chance to increase or decrease that digit again. After about 3 seconds, it will automatically move to the next lower digit until it reaches the slowest rate (least significant digit). **Therefore, if you don't want the displayed value to change rapidly, release the ▲ or ▼ soft-button after the displayed value has changed by <= 9 counts.**

Auto/Manual Soft-button and Light

The top, right user-defined button/light can be defined as any function. **However, it would be very unusual for a blockware designer to use this soft-button / light pair for anything besides selecting the automatic or manual mode for the controller's output.**

Typically, when the light is ON, the controller is in manual (MAN). When the light is OFF, the controller is in automatic (AUTO). The soft-button is typically configured as a toggle-type. That is, every time the soft-button is pressed, the status toggles to the opposite status: MAN to AUTO, AUTO to MAN, MAN to AUTO,

Auto-DIS (Automatic Display Channel Selection): Auto-DIS is an optional feature that most blockware designers utilize. Auto-DIS connects the **AUTO/MAN** soft-button to the display channel selection logic as follows:

When **AUTO / MAN** changes from MAN to AUTO, display ch. 2 (typically the PV) is automatically selected.

When **AUTO / MAN** changes from AUTO to MAN, display ch. 1 (typically the OUT) is automatically selected.

However, after Auto-DIS has changed the display channel, the operator can still use **DIS** soft-button to select a different display channel.

Without Auto-DIS, the operator would have to first press the **AUTO / MAN** soft-button and then manually change the display channel with the **DIS** soft-button.

Auto/Manual Example

This example would cover a typical blockware control logic case. However, your blockware may be different. Review the documentation provided with the blockware for your specific controller to determine the purpose of each soft-button.

Assume that the controller has the AUTO/MAN soft-button configured to allow selection of either the automatic or manual mode ... Auto-DIS is in use ... there is NO Blockware that overrides MAN mode ... the Output is currently in AUTO ... and the Output is initially set to 4%.

To put the controller Output into Manual and then set the Output (i.e., the valve, or damper, or ...) to 20 % open:

- Press the AUTO / MAN soft-button.
- The AUTO / MAN light will come ON, indicating that the Output is in Manual mode.
- The Display channel will automatically change to the Output channel (VALVE, or DAMPER, or a similar message will be displayed on the Message Display).
- Use the ▲ and ▼ soft-buttons as described above until the Numeric Display reaches 20.
- If desired, you can now press the **DIS** soft-button to scroll through (i.e., change) the display channels.
- If the AUTO / MAN soft-button remains in Manual (the light will be ON), the Output will remain at 20%, even though a different display channel may be displayed.
- If an alarm occurs, you can press the **ACK** button to silence the alarm horn (if supplied). The Output will remain at 20%. Press **DIS** to return to the display channels.
- No matter which display channel is currently being displayed, when the AUTO / MAN button is pressed again, the Output will return to that corresponding with the Automatic control mode.

ALARM Light

The Alarm Light operates as follows:

Alarm Light	Status
Blinking	One or more alarm messages have NOT been displayed. Press, and hold, ACK to display the alarms screen.
ON	All alarm messages have been displayed. 1 or more alarm inputs are still in the alarm condition.
OFF	All alarm messages have been displayed. No alarm inputs are in the alarm condition.

The operation of the **ALARM** light cannot be changed by the blockware designer. However, alarm(s) can be disabled by blockware. Typically, this is done to prevent nuisance alarms when a process is shutdown.

ACK Soft-button and the Alarm Annunciator

The PCC-IV can monitor up to 10 different alarm conditions. When a new alarm condition occurs, the **ALARM** light will start blinking. Optionally, the blockware designer can cause the PV bargraph and SP arrow to blink, and if supplied, to activate a panel-mounted or remote alarm horn, bell, and/or light.

The first press and release of the **ACK** button silences an optional/external alarm horn or bell. If the **ALARM** light continues to blink, then there are additional alarm messages that have not been silenced.

A long press of the **ACK** button (about 3 seconds) changes the display to the Alarm History screen. This displays up to 10 active and unacknowledged alarms. Press the Back soft-button to return to the previous screen.

The operation of the **ACK** soft-button cannot be changed by the Blockware designer. However, alarm(s) can be disabled by Blockware. Typically, this is done to prevent nuisance alarms when a process is shutdown.

Example:

A feedwater-controller monitors and has alarm channels for: Low Feedwater Supply Pressure, High Drum Level, Low Drum Level, and Low-Low Drum Level. Assume that a boiler modulates up to maximum rate, but the feedwater pump capacity is inadequate, the feedwater pressure drops, the drum level drops and the boiler eventually trips due to low-low water level. After the boiler trips, the feedwater pressure returns to normal pressure. The displays would respond as follows:

User Defined Soft-buttons

These four soft-buttons are configured by the blockware designer. The purpose and operation of each of these soft-buttons is determined by the blockware designer. Review the documentation provided with the blockware for your specific controller to determine the purpose of each soft-button. The blockware designer will label these buttons to indicate the purpose of each soft-button.

User Defined Lights

These six lights are configured by the Blockware designer. The purpose and operation of each of these lights is determined by the blockware designer. Review the documentation provided with your specific controller's blockware to determine the purpose of each light.

The four lights that are located to the lower-left of a soft-button are all controlled by blockware that is independent of the operation of the soft-button itself. While it is very common for these four lights to be used to indicate when the soft-button is ON, it is not unusual for some of these lights to be used as simple indicators that are not affected by the operation of the mating soft-button.

Multiple Loops

PCC-IV can control more than one loop at the same time. The method used to accomplish this is selected by the blockware designer. Review the documentation provided with your specific controller's blockware to determine the requirements specific to your application. Two different loop-select methods are described below. Only one of the two methods will be used.

LOOP Soft-button Loop Select Method: As an example, one PCC-IV can simultaneously control boiler firing rate based on drum pressure (the first loop) and the feedwater control valve based on drum level and steam flow (the

second loop). However, the front panel display will display only one of the two loops at a time. The operator will select which loop is to be displayed by pressing the LOOP soft-button.

In this example, the PSI and LEVEL text at the bottom of the screen would indicate which loop (LEVEL or PSI) is currently being displayed on the bargraphs, and which loop Auto-DIS is using to select a display channel (see pg. 3-5 for Auto-DIS). Pressing the LOOP soft-button causes the selected loop to toggle back and forth: LEVEL to PSI, PSI to LEVEL, LEVEL to PSI, ...

Once a loop is selected, Auto-DIS works as described above for the currently selected loop. If PSI is the selected loop: Auto-DIS would display PSI when the PSI AUTO/MAN button is put into AUTO, and FIRING RATE when put into MAN. If LEVEL was the currently selected loop, Auto-DIS displays DRUM LEVEL in AUTO and FEEDWATER VALVE in MAN.

AUTO/MAN Soft-buttons Loop Select Method: An alternative method for selecting the currently displayed loop is to use one of two AUTO/MAN soft-buttons for each loop as the loop select soft-button. This method is used when there is no Loop soft-button.

If the LEVEL loop is currently being displayed, pressing the PSI AUTO/MAN soft-button would change the displays from the LEVEL loop to the PSI loop, but the PSI AUTO/MAN status would not change. After the PSI loop has been selected for display, pressing the PSI loop AUTO/MAN soft-button would toggle the Auto-Manual status as expected.

When the PSI loop is currently being displayed, pressing the LEVEL AUTO/MAN soft-button would change the displays from the PSI loop to the LEVEL loop, but the LEVEL AUTO/MAN status would not change. After the LEVEL loop has been selected for display, pressing the LEVEL loop AUTO/MAN soft-button would toggle the Auto-Manual status as expected.

The text at the bottom of the screen would display which loop is currently being displayed on the bargraphs.

Section 4: Menu Operations

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Introduction

The PCC-IV Blockware (i.e. the control strategy) is software based and is field configurable. The PCC-IV Blockware, on-line diagnostics, and other controller configuration data can be viewed or modified using either of the methods that follow:

Front Panel: Some examples of what can be accomplished from the front panel menus:

- Change any parameter (with appropriate password)
 - PID tuning
 - Alarm setpoint adjustment
- Blockware Live Value debugging
- Copy Primary Memory to Backup
- Service Manual Mode Control
- Force any Block Output (with appropriate password)
- On-line diagnostics
- Passwords
- Communications and Real Time Clock Setup
- Calibrate analog Inputs and Outputs

This Section will describe the purpose and operation of every menu item.

PC4_Draw: PC4_Draw is a CAD-based, drag-and-drop style program for Windows 7 thru 10 computers. PC4_Draw includes a library with pre-drawn figures for each PCC-IV blockware function types. The user simply drags the desired functions onto the drawing page, and then uses smart connector lines to interconnect the blocks. Double-clicking on any block allows the user to edit data within the block. The resulting drawing can be printed on a printer. PC4_Draw is used to upload or download software to and from the PCC-IV and can be used to do on-line troubleshooting using the real-time block output value display of every lock in the PCC-IV. Some examples of what requires a personal windows-based computer and PC4_Draw to accomplish:

- Assigning Function Types to Blocks
- Softwiring from Block to Block
- Viewing all block outputs simultaneously
- Changing the operator panel

This Section does not cover the operation and use of PC4_Draw.

Entering the Main Menu

From the operator screen, pressing and holding the DIS soft-button for about 3 seconds will bring up the Main Menu. All data entry, editing, and diagnostics are accomplished from this menu and submenus. The menus may be entered at any time, and the PCC-IV blockware will continue to execute normally. However, since the displays are showing menu data; none of the front panel process mode display channels can be displayed or modified (i.e. Setpoint, Controller Manual Output, etc.).

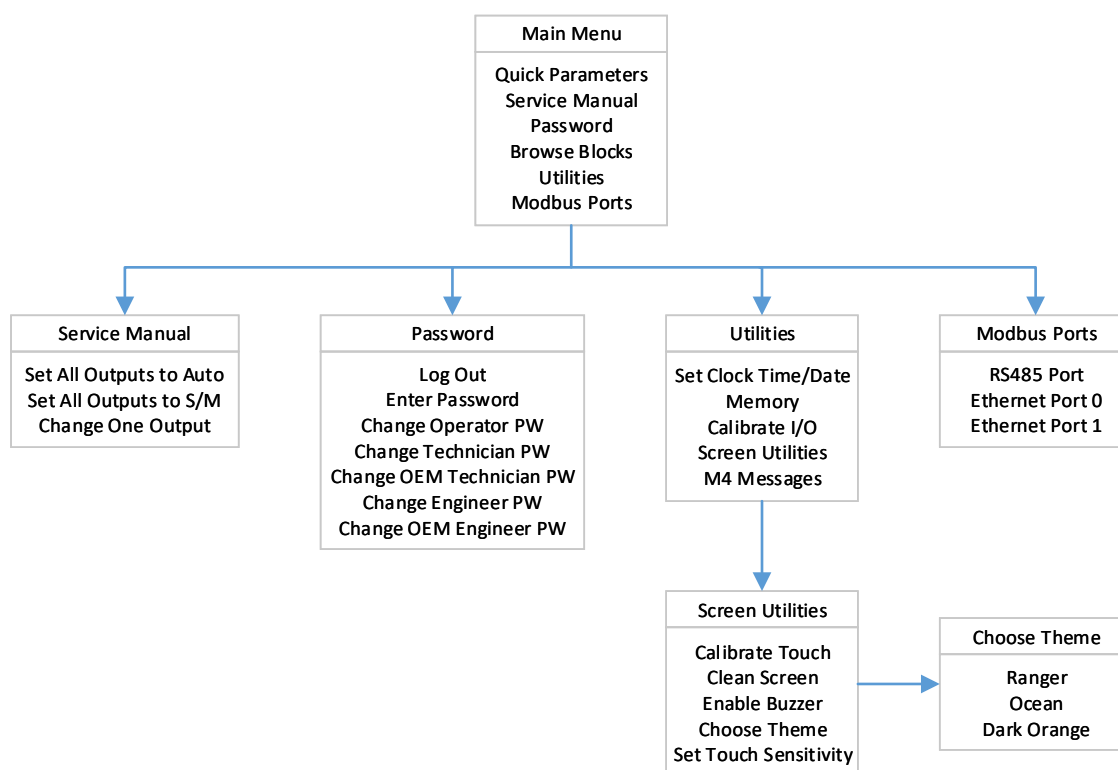
The menus can always be used to display all data in the PCC-IV memory, regardless of the password or S/M status. However, data can only be changed if the password and/or S/M mode restrictions are satisfied, see Sections 4 and 6.

The majority of the blockware parameters (tuning, alarm setpoints, time delays, characterizer breakpoints, ...) can be changed on-line with the blockware continuing to execute. However, PCC-IV must be in service manual (S/M) mode to change parameters that have a drastic effect on the controller outputs (see Section 6).

Press and hold DIS for about 3 seconds



Menu Tree



Main Menu

The Main Menu simply displays the names of all the other Menus contained in the PCC-IV. The Main Menu provides the means to access the other Menus. Press the desired submenu soft-button to access that submenu.

NOTE:

Every menu and sub-menu screen has an ACK button that allows you to silence the alarm and / or jump to the Alarm History screen.

Every menu and sub-menu also has a BACK button to change to the previous screen and finally to exit the menus and return to the operator faceplate screen.

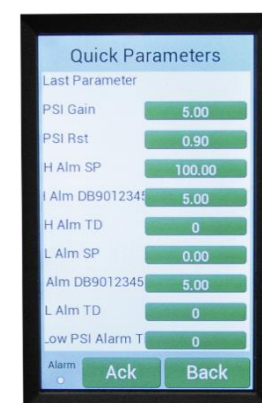


Quick Parameters Menu

The purpose of the Quick Parameters menu is to provide the user with rapid access to frequently used blockware parameters. Examples: PID Gain, High and Low alarm setpoints, equipment startup delay time, and warm-up ramp rate of change. The Quick Menu can have up to 10 lines: "Last Parameter" plus up to 9 Quick selection line items. The Quick menu line item descriptions, Block Numbers, and Parameter numbers are configured by the blockware designer.

To edit a Quick Parameter item, press the soft-button next to the associated item you wish to change. A soft keypad will pop up, and assuming the Password level is correct, the user will be able to enter any valid value for the selected parameter. The new value will be saved after pressing Enter. The Esc key will clear the value, and the Back button will go back without making any changes.

If the current Password is not at the correct level or if S/M mode is required and not set, then the Parameter cannot be edited, and an error message will be displayed.



Last Parameter

The first line in the Quick Parameters menu will be the last parameter edited or viewed from the Browse Blocks menu. This allows the user to quickly edit the last parameter that was changed. The PCC-IV saves the last parameter linkage automatically and retains the link even after leaving the Main menu.

Example: if you are tuning a PID Block and use the Browse Blocks menu to change the PID Gain value, go back to the process display mode, observe the process response, and then re-enter the Quick Parameters Menu. The first parameter in the list will be the PID Gain value that was just changed.

The Last Parameter link is lost when the PCC-IV powers down or re-boots, and the words "Last Parameter" will be displayed with no associated soft-button. The Last Parameter link is established and will again be in the Quick Parameters menu after a Parameter is displayed via the Browse Blocks menu.

Service Manual Menu

What is "Service Manual" (S/M) Mode?

Normal Operation: During normal operation, an **AOUT** (or **TOUT**) Block converts a blockware 0-100% input signal into a proportional 4-20 mA (or Triac) hardware output every scan (1/10 second). Normal operation continues uninterrupted, regardless of the front panel display mode, process mode, or annunciator mode.

Most PCC-IV controller blockware control strategies have an "Auto / Manual" station on the front panel. During normal operation, both Auto and Manual modes rely on the blockware to regulate the 4-20 mA or Triac output channels. Manual mode does not bypass the output channel blockware (i.e., AOUT or TOUT) and does not directly regulate the output hardware.

Service Manual (S/M): During S/M mode, a 4-20 mA (or Triac) output channel is directly controlled using the permanently programmed firmware ROM, instead of the blockware logic. In fact, the blockware memory can be erased or corrupted, and the operator will still be able to manually regulate the PCC-IV 4-20 mA and Triac outputs. The firmware ROM is factory programmed, and cannot be erased or corrupted by the user.



Relay outputs and sinking discrete outputs are always controlled by the blockware. S/M mode has no effect on these.

When an output channel enters S/M mode, the output remains at the last value, unless the operator uses the special Service Manual "Change One Output" submenu to change the output.

The primary reason for using the Service Manual mode is to prevent the 4-20 mA and/or Triac outputs from changing when the user is writing new blockware or for troubleshooting.

S/M mode can be activated from the Service Manual menu. All outputs can be placed in S/M or Auto, and an individual output channel can be changed via the "Change One Output" submenu. The output channels can all be in Auto operation mode, all in S/M mode, or in any combination of modes. However, PCC-IV will automatically put all output channels into the S/M mode if any of the self-diagnostic tests detect a problem.

The PCC-IV will not de-activate S/M mode automatically. The user must manually de-activate S/M mode from the Service Manual menu.

The RUN light indicates Normal, Forced, or S/M Mode

Green RUN Light ON / OFF Cycle	Operating Mode
ON Continuous	Normal
Flashing – Blinks OFF once every second	Forced Block(s)
Flashing – Blinks ON twice every second	Service Manual
OFF Continuous	Not Operating

Note: S/M Mode RUN light indication takes priority over FORCED Mode indication when both S/M and FORCED Modes are active.



WARNING

The PCC-IV is commonly used to control potentially dangerous Combustion and Chemical Processes. **VERIFY THAT THE PROCESS BEING CONTROLLED HAS BEEN SAFELY SECURED, ISOLATED, OR BYPASSED (AS REQUIRED BY THE SITE CONDITIONS) BEFORE PUTTING THE PCC-IV CONTROLLER INTO SERVICE MANUAL MODE.** FAILURE TO DO SO CAN RESULT IN EQUIPMENT DAMAGE, INJURY, OR DEATH.

WHEN A PCC-IV OUTPUT IS IN THE SERVICE MANUAL MODE, THE OPERATOR HAS TOTAL RESPONSIBILITY TO ENSURE THAT ALL EQUIPMENT IS OPERATED SAFELY.

Entering Service Manual (S/M)

From the Main Menu, press Service Manual to enter the submenu. The top of the screen will display the S/M Status of: None in SM, All in SM, or Some in SM. You have three options: Placing all AOUT & TOUT blocks into S/M, placing all AOUT & TOUT blocks into Auto (normal), or placing one output at a time into S/M or Auto.

Set All Outputs to S/M

Pressing the *Set All Outputs to S/M* soft-button puts all the 4-20 mA and Triac output channels into S/M mode. If you go back to the operator screen, the RUN light will start blinking.

Set All Outputs to Auto

Pressing the *Set All Outputs to Auto* soft-button starts the blockware error check routine. If no errors are detected, the controller puts all the 4-20 mA and Triac output channels back under blockware control. If you go back to the operator screen, the RUN light will stop blinking (assuming no blocks are forced).

If the blockware error check detects an error, an error message will indicate the nature of the error and the block that is causing the error. The RUN light will continue to blink.

Change One Output to S/M or Auto

Pressing the *Change one output* soft-button allows the user to change one output at a time from the next submenu. The three soft-buttons at the top determine which output is being manipulated.

- Board determines which board you are changing:
0 = CPU board, 1 = Option Card 1, 2 = Option Card 2, 3 = Option Card 3.
- Channel determines which 4-20mA output channel number or Triac pair you are changing:
1 = Channel 1, 2 = Channel 2, etc....
- Type determines whether you are modifying a 4-20 ma or Triac output:
AOUT = Analog Output (4-20 ma); TOUT = Triac Output

Example: Board = 1, Chanel = 2, Type = AOUT – This means I am currently modifying the 4-20 ma signal of channel 2 on option card 1.



The next two soft-buttons allow the user to place the selected output into S/M or Auto. The SM Flag value tells you the output's status (True = S/M, False = Auto).

Changing an Output Value in S/M Mode

When an output channel enters S/M mode, the output is held at the last value. The output will remain at the last value until the operator changes the output from the *Change one output* submenu.

Select which output to manipulate as described above. Use the Channel Value soft-button to bring up a keypad to enter any value, or use the INC & DEC keys to change the displayed S/M output as follows:

AOUT (i.e. 4-20 mA) channels: The numeric display is 0-100% of 4-20 mA. 0% = 4 mA, 100% = 20 mA. The 4-20 vs. 20-4 Parameter in the AOUT Block does NOT change this scaling, 0% is always 4 mA.

TOUT (i.e. Triac) channels: The INC key turns ON the T1 (i.e. "Increase") Triac of the selected pair. The DEC key turns ON the T2 (i.e. "Decrease") Triac of the selected pair.

If the Triacs are driving an actuator, do not depend on the S/M logic to indicate the actuator's position on the Numeric display. The operator must independently observe the actuator's position and respond accordingly.

The S/M logic will attempt to find a **TOUT** block that is assigned to the Triac channel being displayed, and display that assigned **TOUT** block output on the numeric display. However, the displayed position is blockware based, not S/M firmware based, therefore it can display an incorrect position if there are blockware errors.

Password Menu

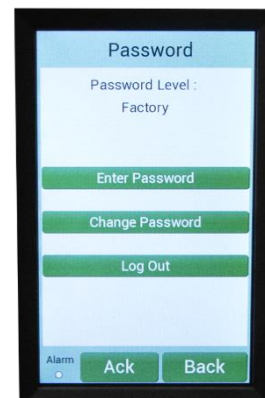
The Browse Blocks screen will display all data, regardless of the Password system status. However, the Browse Blocks menu will not allow the user to modify blockware parameters unless the active Password Level is acceptable.

As shipped from the factory, the PCC-IV password system is disabled; therefore, the user can modify any item in the PCC-IV.

Once a Password Level is activated, it will automatically deactivate after a timeout period of 6 hours.

Password Levels

Level	Active Password	Service Manual (S/M) Mode	Factory Default (Disabled PW)
3	Engineer	required	9997
3	OEM Engineer	required	7
2	Technician	not required	9998
2	OEM Technician	not required	1
1	Operator	not required	9999



Section 6, "Blockware Functions - Technical Reference", specifies the minimum password level required to modify each individual parameter of each function block available in the PCC-IV.

The Password Menu allow the user to perform the following:

- **Enter Password** – allows the user to enter a password – press the *Enter Password* soft-button and a keypad will open. Type in the Engineer, Technician, or Operator password and press Enter. "Engineer", "Technician", or "Operator" will be displayed under Password Level of the Password submenu. The Password Level is now active for 6 hours or until the user selects Log Out.
- **Change Password** – Change one of the passwords or enable/disable the password system (see below)
- **Log Out** – will log out so that no password level is activated – Once a Password Level is activated, it will automatically deactivate after 6 hours. However, the current Password Level can be de-activated before the Timeout by entering the Password submenu and pressing the *Log Out* soft-button.

The Change Password Soft-button

Pressing the *Change Password* soft-button allows the user to select what action is being performed on the Password Submenu. From the Command screen, the user can select from the following:

- Change Operator PW
- Change Technician PW
- Change OEM Technician PW
- Change Engineer PW
- Change OEM Engineer PW

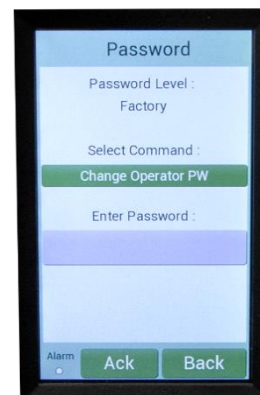
Enabling the Password System

A Password is any number (except 0 or the factory default) between -19999 and +19999. To enable the Password system, an Engineer and Technician Password must be configured; however, the Operator Password is optional. The Technician and Operator Passwords may be the same number.



To enable the Password system for the first time: First change the Engineer/OEM Engineer & Technician/OEM Technician Passwords as described below.

Change a Password: Go to the Password submenu and enter the Engineer, Technician, or Operator password as described above. If the password system is disabled, enter the default password from the table above. You must be logged on at the same or higher password level to change a password. Then, press the *Change Password* soft-button and select *Change Engineer/Technician/Operator PW*. On the next Password submenu, press the *Enter Password* soft-button and a keypad will open. Type in the desired password. Write down the number that is being displayed, then press Enter; "Password Changed" will be displayed.



ATTENTION

It is very important to write down the Engineer (OEM Engineer), Technician (OEM Technician), and Operator Password numbers and keep this record in a convenient location. **DO NOT LOSE THE PASSWORDS. If the passwords are lost or forgotten, you will not be able to modify any of the Blockware data.** If the password has been lost, contact Preferred Instruments during normal East Coast business hours at (203) 743-6741 for a controller specific temporary password. Have the serial number and real-time clock and date of the affected unit(s) available.

Disabling the Password System

Change all passwords to their factory default values as described above, and the password system will be disabled.

Browse Blocks Menu

This menu allows the user to display or modify all the Blockware parameters (i.e., PID Gain, Alarm Setpoint,) or Force Block outputs in all 256 Blocks of the PCC-IV memory.

General

Do not attempt to use the Browse Blocks menu until after you have read the complete Instruction Manual. The concepts in the following Sections are particularly important, and should be fully understood before modifying the blockware:

Section 4	SERVICE MANUAL Menu
Section 4	PASSWORD Menu
Section 4	MEMORY Menu
Section 5	Configuring Blockware Control Strategies (the entire Section)
Section 6	Blockware Functions – Technical Reference (the entire Section)



WARNING

The PCC-IV is commonly used to control potentially dangerous combustion and chemical processes. VERIFY THAT THE PROCESS BEING CONTROLLED HAS BEEN SAFELY SECURED, ISOLATED, OR BYPASSED (AS REQUIRED BY THE SITE CONDITIONS) **BEFORE MODIFYING ANY OF THE BLOCKWARE DATA IN ANY BLOCK IN THE PCC-IV MEMORY.** FAILURE TO DO SO CAN RESULT IN EQUIPMENT DAMAGE, INJURY, OR DEATH.

The user should always refer to a blockware schematic drawing when attempting to modify any aspect of the blockware.

The PCC-IV blockware executes continuously, including when the Browse Blocks menu is being used. Any changes that are made will affect the blockware as soon as the **ENTER** key is pressed.

The parameters in any block can be displayed at any time. However, if the Password system is enabled, values can only be changed if the correct security password has been entered. See Section 6, Blockware Functions – Technical Reference, for the password level required to change each parameter.

The Function Type of a block and the input softwiring of a block cannot be modified from the front panel. This requires a personal computer running the PC4_Draw software.

The number of items (i.e., lines) in the Browse Blocks menu depends on the Function Type in the block that is being displayed. This menu has up to four groups of line items:

- Function Name
 - The first line of text for each block will display the block # and type (I.e. ****B5 FPCON*** would indicate Block 5 which is a Front Panel Constant (FPCON) block).
- A line for each Input (if there is a softwired input)
 - Each Input will first list the Input name.
 - The next line will indicate the value entering the block at that input.
 - These two lines will be repeated for each Input if there are multiple block Inputs.
- A line for each Parameter (if any)
 - Each Parameter will first list the parameter name.
 - The next line will be a soft-button displaying the current value of the parameter. See below for editing parameters.
 - These two lines will be repeated for each parameter if there are multiple block parameters.
- Output
 - Finally, the block output will be displayed. The first line will say "Output."
 - The next line will be a soft-button displaying the current value of the output. See below for forcing outputs.

Section 6, Blockware Functions – Technical Reference, provides a detailed description of each function type.

How to use Browse Blocks

Navigation

The upper left soft-button displays which block is currently at the top of the screen. I.e. B17 means that Block 17 is the uppermost block on the screen. Pressing this soft-button brings up a keyboard that allow the user to type in a number and navigate directly to the desired block number.

The next three soft-buttons are filters used to make navigation easier. By pressing the IN soft-button, the user can remove all Inputs from the list. The OUT soft-button removes all but the first output of each block (auxiliary outputs), and the PAR soft-button removes all Parameters from the list.

Note: Only blocks that are used in the current blockware are displayed in the list. Therefore, some block numbers may be skipped.

The user can also scroll through the list of blocks by pressing the arrows at the top and bottom of the navigation bar on the right of the screen; by touching the navigation bar itself to jump up or down the list; or by sliding their finger up and down the screen to scroll through the list of blocks.

Change a Parameter

To change a parameter, press the soft button beneath the parameter you wish to change. This will bring up a keypad that allows to user to enter any valid value – assuming the correct password level is active. Pressing ENTER makes the change. Press ESC to erase what is displayed and press Back to return to the previous screen without making any changes. See Section 6 for a complete description of Parameters and the password level required to change them.

Forcing Block Outputs

As an aid to trouble-shooting and field wiring check-out, PCC-IV Block Outputs can be temporarily "FORCED" to remain at a user selected, fixed value. When **AOUT**, **TOUT**, **DOUT**, or **ROUT** Block outputs are FORCED, the hardware outputs will be set to the equivalent value (see also "Forcing **TOUT** in Dual Triacs Mode").



WARNING

The PCC-IV is commonly used to control potentially dangerous combustion and chemical processes. **Block outputs should only be FORCED on a short term, temporary basis under the direct, continuous supervision of a qualified technician who is familiar with the operation of the entire control system.** FAILURE TO DO SO CAN RESULT IN EQUIPMENT DAMAGE, INJURY, OR DEATH.

The FORCE data ...i.e., FORCED block number(s) and the output value(s)... is stored in RAM, it is not stored in the Blockware EEPROM memories. **Therefore, after every power interruption, or any other PCC-IV CPU re-start, all FORCED blocks will revert to UN-FORCED.**

The RUN light indicates Normal, Forced, or S/M Mode

Green RUN Light ON / OFF Cycle	Operating Mode
ON Continuous	Normal
Flashing – Blinks OFF once every second	Forced Block(s)
Flashing – Blinks ON twice every second	Service Manual
OFF Continuous	Not Operating

Note: S/M Mode RUN light indication takes priority over FORCED Mode indication when both S/M and FORCED Modes are active.

To force a block output, navigate to the desired block as described above and press the soft-button beneath the output you wish to change. The next submenu displays the selected block's output next to a soft-button that has the status of the block (forced or unforced). Press this button to toggle between forced and unforced. Multiple blocks may be forced simultaneously. The *Unforce All* soft-button will unforce all blocks in the PCC-IV. If any block is forced, the RUN light will blink on the operator display page.

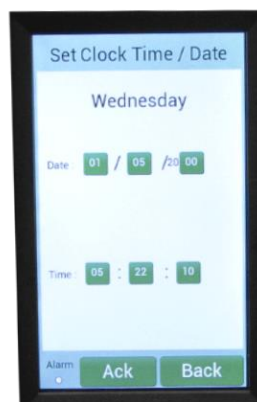
Once forced, press the value button to bring up a keypad that allows to user to enter any valid value – assuming the correct password level is active. Pressing ENTER makes the change. Press ESC to erase what is displayed and press Back to return to the previous screen without making any changes.

Utilities Menu

The Utilities Menu simply displays the names of the other submenus contained in the PCC-IV. The Utilities Menu provides the means to access the other submenus. Press the desired submenu soft-button to access that submenu.

Set Clock Time/Date Menu

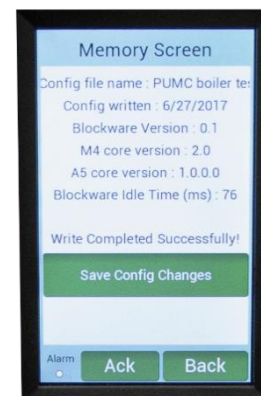
The current time and date is displayed in this sub-menu. If incorrect, press any soft-button to change to the correct date (MM/DD/20YY) and time (HH:MM:SS) (24-hour format). The real-time clock continues to keep time for 8+ days after being powered down.



Memory Menu

This screen displays pertinent information relating to what is currently loaded in the PCC-IV.

- Config file name: This is the name of the file written by the Blockware designer.
- Config Written: The date the config file was written.
- Blockware Version: The Block Function Library version used to create this logic
- M4 core firmware version: The M4 core executes the blockware logic.
- A5 core firmware version: The A5 core executes the screen and communications software.
- Block (average) Idle Time (ms): The PCC-IV executes all its blocks in 100 ms (10 times per second). If it scans every block in the blockware in less than 100 ms (Scan Time), it fills the remaining time with a delay loop. This is the Block Idle Time. In the unlikely event that the scan time is >100 ms, the PCC-IV will always complete the execution of all blocks.



Save Config Changes:

Data changes that are made during the use of the Browse Blocks, Calibrate I/O, and Modbus Ports menus are saved in the non-volatile, redundant, NVRAM. While very unlikely, both NVRAM's could be corrupted. After making any changes, the user SHOULD "Save Config Changes" into the separate EEPROM memory via the Utilities >> Memory Submenu. This creates a third redundant backup of any changes made by the user.

Pressing this soft-button will copy any changes you made to the Parameters via Browse Blocks, to Calibration data via Calibrate I/O, and to Communication data via Modbus Ports from NVRAM to EEPROM memory.

Calibrate I/O Menu

This menu item allows the user to calibrate the Analog Inputs (0-5 Vdc) and the Analog Outputs (4-20 mA). All PCC-IV controller Analog Inputs and Analog Outputs are factory calibrated per the chart below.

Board Type:	Input or Output	Factory Calibration Tolerance
All	Input	+/-0.001 V or 0.025% of 4 V
All	Output	+/-0.003 mA or 0.019% of 16 mA



When is Calibration Required?

Typically, a PCC-IV will not require field calibration for the life of the controller. There are two reasons to field calibrate all or part of the PCC-IV: An Option Board is installed in the field, or the factory calibration data is corrupted.

Option board installed in the field: Because factory calibration data is not in the CPU board EEPROM memory, the PCC-IV uses default calibration data to allow operating the new option board without factory calibration data. The default data reduces the guaranteed accuracy as shown below. If this accuracy is acceptable, the new Option Board does not have to be calibrated.

Board Type:	Input or Output	Worst Case Accuracy when using Default Calibration Data
CPU, A, F, or G	Input	+/-10 mV or 0.25% of 4 V
B	Input	+/-50 mV or 1.25% of 4 V
CPU or F	Output	+/-0.05 mA or 0.3% of 16 mA

NOTE: This chart only applies to field installed Option Boards that have NOT been calibrated. Factory installed Option Boards are calibrated as noted above.

The above chart reflects theoretical, worst case accuracy data. Typically, the default data provides much higher accuracy than the chart shows. Input voltage accuracy can be checked by measuring the input voltage, converting it to a percentage (based on AIN Block scaling), and comparing the result to the AIN Block Output value as shown by the Browse Blocks menu item. Output accuracy can be checked by putting the Output into S/M mode and comparing the measured mA output to the percentage displayed by the Browse Blocks menu item.

Factory calibration data is corrupted: While unlikely, it is possible to corrupt the Blockware or Calibration data. If the calibration data does not pass the validation tests performed at start-up, the PCC-IV will use default calibration data and continue operating with the reduced accuracy as described above.

Analog Input Calibration Procedure



WARNING

The PCC-IV is commonly used to control potentially dangerous combustion and chemical processes. **VERIFY THAT THE PROCESS BEING CONTROLLED HAS BEEN SAFELY SECURED, ISOLATED, OR BYPASSED (AS REQUIRED BY THE SITE CONDITIONS) BEFORE CALIBRATING THE PCC-IV.** FAILURE TO DO SO CAN RESULT IN EQUIPMENT DAMAGE, INJURY, OR DEATH.

This procedure requires a low noise voltage source that can produce 2.500 Vdc and 5.000 Vdc, and a DC Voltmeter to measure the calibration voltages to within +/- 0.4 mV. This means that the DC Voltmeter must display at least "5 ½ digits" (i.e., 19.9999). However, not all 5 ½ digit Voltmeters have +/- 0.4 mV accuracy, depending on the accuracy specification of the meter, a 6 ½ digit meter may be required.

Most portable test meters and voltage calibrators have 4 ½ digits or less of display resolution. "Calibrating" the PCC-IV with a less than 5 ½ digit DC Voltmeter will result in lower PCC-IV accuracy.

This procedure applies to the CPU Board (Board 0), Option Board 1, and Option Board 2.

1. Set All Outputs to SM, using the Service Manual submenu.
2. Remove all field wiring from all the Analog Input channels on the Board to be calibrated. Alternatively, un-plug the field wiring connector, and plug-in a spare field wiring connector.
3. Wire all the "+" terminals of all the channels together, to the Voltage Source, and to the Voltmeter (see Section 2 for terminal numbers).
4. Wire all the "-" terminals of all the channels together, to the Voltage Source, and to the Voltmeter.
5. Disconnect all 250 ohm resistors (i.e., switch OFF or remove the jumpers).
6. Go to the Calibrate I/O submenu.
7. Select which Board is being calibrated (CPU Board = 0; Option Card 1 = 1; Option Card 2 = 2).
8. Set Type to AIN.
9. Press Enter.
 - a. The message "APPLY 2.500 VOLTS SIGNAL TO CHANNELS 1 – x, THEN PRESS ENTER" will be displayed.
 - b. The error message "MUST BE IN S/M TO CALIBRATE" will be displayed if ALL the Outputs are NOT in S/M mode.
10. Set the Voltage Source to 2.5000 Vdc, +/-0.0005 Vdc.
11. Press Enter.
 - a. The error message "CALIBRATION ABORTED, CHANNEL x OUT OF RANGE +/- yyyy" will be displayed if:
 - i. The Voltage Source is not at the correct voltage
 - ii. A 250-ohm resistor is connected to the input
 - iii. The Voltage Source is noisy
 - iv. The A/D has out of tolerance parts
 - b. "yyyy" indicates the magnitude of the error, and is used by factory technicians for diagnostics, values can be 6000 and higher.
 - c. If there was an error, press Escape to return to the menu; the original calibration will still be in effect.
 - d. If the 2.5 V calibration was successful, the message "APPLY 5.000 VOLTS SIGNAL TO CHANNELS 1 – x, THEN PRESS ENTER" will be displayed.
12. Set the Voltage Source to 5.0000 Vdc, +/-0.0005 Vdc.
13. Press Enter.
 - a. The error message "CALIBRATION ABORTED, CHANNEL x OUT OF RANGE +/- yyyy" will be displayed for one of the same reasons described above.
 - b. If there was an error, press Escape to return to the menu; the original calibration will still be in effect.
 - c. If the 5.0 V calibration was successful, the message "Input calibration is complete" will be displayed.

14. If there were no errors, press Escape to return to the menu; the new calibration will be in effect.
15. Repeat the above steps for any other Boards that are going to be calibrated.
16. The user may "Save Config Changes" from the Memory submenu, if additional redundancy is desired.
17. **Important!** Be sure to exit Service Manual from the Service Manual submenu.

Analog Output Calibration Procedure



WARNING

The PCC-IV is commonly used to control potentially dangerous Combustion and Chemical Processes. **VERIFY THAT THE PROCESS BEING CONTROLLED HAS BEEN SAFELY SECURED, ISOLATED, OR BYPASSED (AS REQUIRED BY THE SITE CONDITIONS) BEFORE CALIBRATING THE PCC-IV.** FAILURE TO DO SO CAN RESULT IN EQUIPMENT DAMAGE, INJURY, OR DEATH.

This procedure requires a DC milliamp meter to measure the 4-20 mA output signal to within ± 0.002 mA. This means that the DC milliamp meter must display at least "5 ½ digits" (i.e., 20.001). However, not all 5 ½ digit meters have ± 0.002 mA accuracy, depending on the accuracy specification of the meter, a 6 ½ digit meter may be required.

Most portable test meters and voltage calibrators have 4 ½ digits or less of display resolution. "Calibrating" the PCC-IV with a less than 5 ½ digit DC milliamp meter will result in lower PCC-IV accuracy.

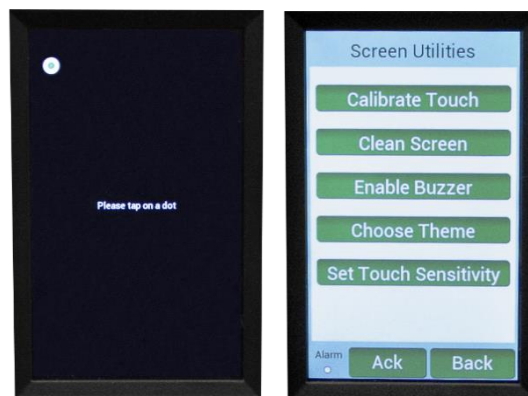
This procedure applies to the CPU Board (Board 0), Option Board 1, and Option Board 2.

1. Set All Outputs to SM, using the Service Manual submenu.
2. Remove all field wiring from the Analog Output channel to be calibrated. Alternatively, un-plug the field wiring connector, and plug-in a spare field wiring connector.
3. Wire the "+" terminal to the milliamp meter (see Section 2 for terminal numbers).
4. Wire the "-" terminal to the milliamp meter.
5. Go to the Calibrate I/O submenu.
6. Select which Board is being calibrated (CPU Board = 0; Option Card 1 = 1; Option Card 2 = 2).
7. Select which Channel is being calibrated.
 - a. While a group of Analog Inputs are calibrated all at the same time, each 4-20 mA Output must be calibrated individually.
8. Set Type to AOUT.
9. Press Enter.
 - a. The message "SET OUTPUT TO 4.00 MILLIAMPS, THEN PRESS ENTER" will be displayed.
 - b. The error message "MUST BE IN S/M TO CALIBRATE" will be displayed if ALL the Outputs are NOT in S/M mode (see above).
 - c. The error message "CALIBRATION ABORTED, DEVICE OUT OF COMPLIANCE" will be displayed if the actual current output is not approximately 4 mA. This can be caused by:
 - i. Milliamp loop is open circuit
 - ii. The test meter is set to Volts instead of Amps
 - iii. There is too much resistance in the loop
 - iv. An external voltage or current source is connected to the field wiring
 - d. If there was an error, press Escape to return to the menu; the original calibration will still be in effect.
10. Using the INC or DEC key, and observing the milliamp meter, set the 4-20 mA Output to 4.000 mAdc, ± 0.003 .
 - a. The Channel Value displayed on the PCC-IV front panel is a percentage of output. 0.000 = 0% = 4 mA.
 - b. As you press INC or DEC, this Channel Value should be ignored. Set the output to 4 mA based on the attached milliamp meter.
11. Press Enter.
 - a. The message "SET OUTPUT TO 20.00 MILLIAMPS, THEN PRESS ENTER" will be displayed.

- b. The error message "CALIBRATION ABORTED, ..." will be displayed for the same reasons described above.
 - c. If there was an error, press Escape to return to the menu; the original calibration will still be in effect.
12. Using the INC or DEC keys, and observing the milliamp meter, set the 4-20 mA Output to 20.000 mAdc, +/-0.003.
 - a. The Channel Value displayed on the PCC-IV front panel is a percentage of output. $100.000 = 100\% = 20 \text{ mA}$.
 - b. As you press INC or DEC, this Channel Value should be ignored. Set the output to 20 mA based on the attached milliamp meter.
13. Press Enter.
 - a. The message "Output calibration complete" will be displayed, if the calibration was successful.
14. If there were no errors, press Escape to return to the menu; the new calibration will be in effect.
15. Repeat the above steps for any other Boards/Channels that are going to be calibrated.
16. The user may "Save Config Changes" from the Memory submenu, if additional redundancy is desired,
17. **Important!** Be sure to exit Service Manual from the Service Manual submenu.

Screen Utilities Menu

The Screen Utilities Menu simply displays the names of the other submenus contained in the PCC-IV. The Screen Utilities Menu provides the means to access the other submenus. Press the desired submenu soft-button to access that submenu.



Calibrate Touch

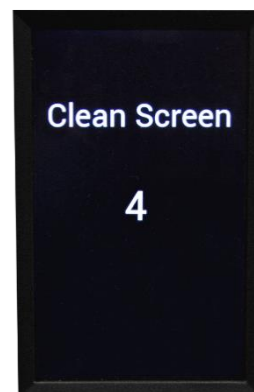
Pressing this soft-button brings up the Calibration Screen. Follow the instructions on that screen to calibrate the touchscreen. A stylus may be used if desired.

Clean Screen

This disabled the touchscreen for 15 seconds to allow the user to clean the screen. A countdown will be displayed showing how much time is left. Use a damp, lint-free cloth without any chemicals to clean the screen.

Enable Buzzer

Determines if the PCC-IV beeps when a soft-button is pressed. Press this soft-button to toggle between the Enable and Disabled modes.



Choose Theme

The color scheme can be changed to the user's preferences. There are three to choose from: Ranger (used in this manual), Ocean, and Dark Orange. Navigate to the *Choose Theme* submenu and press the desired soft-button to select the user-desired theme.



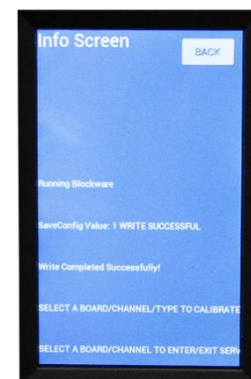
Set Touch Sensitivity

Press the *Touch Sensitivity* soft-button and pick from the list to set the touchscreen sensitivity to the user-desired level.



M4 Messages Menu

This screen displays the last few internal messages of the PCC-IV blockware and is useful in troubleshooting and general info about the last thing to happen. The user will not normally need to view this screen.



Modbus Ports

This menu is used to setup the communications parameters for the RS-485 and Ethernet ports.

Modbus is an ANSI standard communications protocol that is used extensively for DCS, SCADA, and RTU applications. See Section 2 for wiring; and see "Modbus Functions," below, for the supported Modbus functions.



RS485 Port

This is the Isolated RS-485 Modbus communication port which is wired to terminals 1 thru 3 at the back of the PCC-IV CPU card. See Section 2 for wiring. After making all changes described below, press the *Confirm* soft-button to make the changes. Press *Back* to cancel all changes. Be sure to “Save Config Changes” from the Memory submenu after making changes.

Device Address

This menu item determines the Modbus node address for this controller. The address can be any value from 1 to 32. The user must insure that each PCC-IV, or other Modbus devices on the same cable, have their own unique Address.

Press the *Device Address* soft-button and type in a valid address. Press Enter to save the value and return to the RS485 Settings screen. Press *Back* to return without making any changes.



Baud Rate

This menu item determines the Baud rate for Modbus RS-485 communication. Available baud rates are: 4800 (i.e. 4.8k), 9600, 19200, 38400, 57600, and 115200

Press the *Baud Rate* soft-button and press the correct baud rate on the next screen. Press *Back* to return without making any changes.

Parity

This menu item determines the parity for Modbus RS-485 communication. A parity of Even, Odd, or None is available.

Press the *Parity* soft-button and press the correct parity on the next screen. Press *Back* to return without making any changes.

RTU/ASCII

This menu item selects either Modbus RTU protocol or Modbus ASCII protocol.

Press the *RTU/ASCII* soft-button and press the correct protocol on the next screen. Press *Back* to return without making any changes.

+/- Data

This menu item directs the PCC-IV Modbus software to reply with either positive integers only, or signed integers (positive and negative). A few older SCADA and DCS I/O drivers did not support signed integers. PCC-IV Block Outputs can range from -32700 to +32700. Set this parameter to SIGNED unless the SCADA or DCS system specifically has a problem communicating with the PCC-IV.

Press the *+/- Data* soft-button and press the correct format on the next screen. Press *Back* to return without making any changes.

Ethernet Port 0 (or 1)

These are the Modbus TCP/IP (Ethernet) communication ports which are located on the CPU board. After making all changes described below, press the *Confirm* soft-button to make the changes. Press *Back* to cancel all changes.

IPv4 address

This is the IP address used to address this PCC-IV. It must follow the normal TCP/IP rules such as being a unique address and being on the same subnet as other network devices. Contact your network administrator if assistance is needed. IP address is required for Modbus TCP/IP communication.

IPv4 mask

This is the subnet mask of your network. Contact your network administrator if assistance is needed. IP mask is required for Modbus TCP/IP communication.



IPv4 gateway

If needed, this is the gateway used to forward information to other networks. Not every configuration will use the IP gateway. Contact your network administrator if assistance is needed.

Supported Modbus Functions

The PCC-IV includes Modbus TCP/IP, ASCII, and RTU protocols, and supports the following Modbus Functions:

Function	Modbus Description	PCC-IV Description	Notes
01	Read Coil Status	Read Discrete Block Output	
03	Read Holding Registers	Read Analog Block Output	
05	Force Single Coil	Write Single Discrete Block Output	1
06	Preset Single Register	Write Single Analog Block Output	1
08-00	Loopback Diagnostic		2
15	Force Multiple Coils	Write Multiple Discrete Block Output	1
16	Preset Multiple Registers	Write Multiple Analog Block Output	1

Notes:

1. Only Tags set up by the Blockware programmer may be written to (See section 5).
2. Only the Loopback diagnostic sub-function (Code 00) is supported.

Addressing:

Each PCC-IV is field configurable; therefore, the User must have the PCC-IV Blockware Documentation or Drawing for the Controller that is going to be queried to know which Function Types are in which Blocks, and to know the significance of each signal.

The Controller Station Address is within the range 1-32 as described above.

Modbus addresses for Tags are generated by the blockware designer during blockware creation. Using the Export OIT Tags feature, these Tag Names and Modbus addresses can be imported into a Preferred OIT program by the OIT software author. See Section 5 for more information.

Section 5 – CONFIGURING BLOCKWARE

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Blockware Basics

PCC-IV uses blockware to implement the control strategies that are contained in the memory of the PCC-IV. The word blockware is derived from the words Block diagram and software. The use of blockware results in a clearly documented, easy to understand, and easy to configure a system. The basic elements of blockware are as follows:

Blocks

The PCC-IV memory has 256 Blocks (B0 – B255). Each block is a container into which a blockware function is placed. Think of a block as a cell in an Excel or similar spreadsheet; you put a formula or a function into a cell, and the formula uses the values from other cells as inputs for the formulas. Another analogy would be physical relay sockets that have signal processing modules plugged into each socket (i.e., Block). The controller includes sufficient memory to handle 256 Blocks (see below).

Library of Functions

The PCC-IV has an extensive library of functions to handle almost any type of control task. These functions are identified and described in detail in Section 6 of this manual. The library includes functions for the conversion of inputs to engineering values, mathematical operations, logical operations, timing operations, the traditional PID algorithm and other types of special **PID** functions, and many others. Additional special functions such as “Learn”, “Boiler Efficiency”, etc. are included and are described, in depth, in Section 6.

Any-Function-Any-Block

Each block is assigned a function type during configuration. Any function type can be used in any block number. The block number only determines the order in which the blocks are calculated. In the example below at left, block number 22 is not being used, so it has the default **NOP**, or “No Operation” function in it. At right, Block 22 was changed from a **NOP** to a **HIALM** (high alarm) function type.

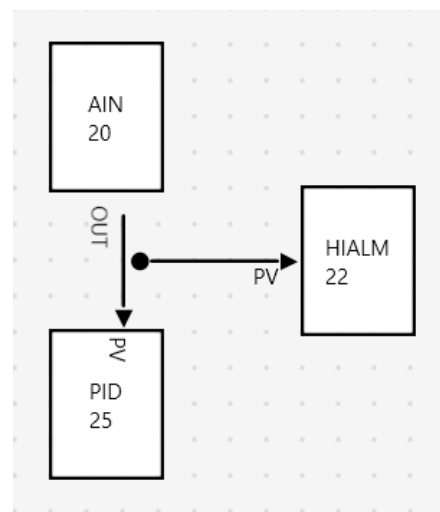
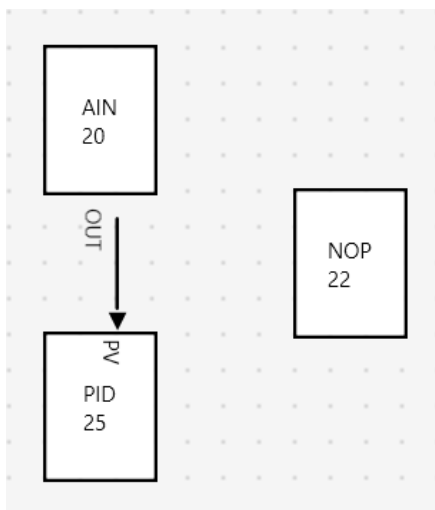
Reusable Functions

Almost all PCC-IV function types can be used as many times as required, within the 265 Block limit. There are some functions that are directly linked to the hardware that can only be used as many times as there is mating hardware. For example, only one **PANEL** function (front panel display interface) can be used because there is only one front panel. While those related to **PID** functions, curve fitting functions, etc. can be used as many times as is deemed necessary for the application.

Softwiring

Most function types, like **HIALM**, need information from other sources (i.e., blocks) to calculate a result. Softwiring is the term used to describe how the blocks are interconnected within the software. Softwiring allows the Input of a Block to monitor the Output of any other block. At right below, the PV (Process Variable) input of block 22 (**HIALM**) is monitoring the output of Block 20 (**AIN**), via a softwiring connection.

Note: If a block input is not softwired to some other signal, a value of 0 is used to calculate the function for that input (for analog inputs: 0 = 0.00%, for discrete inputs: 0 = False).



PCC-IV Blocks

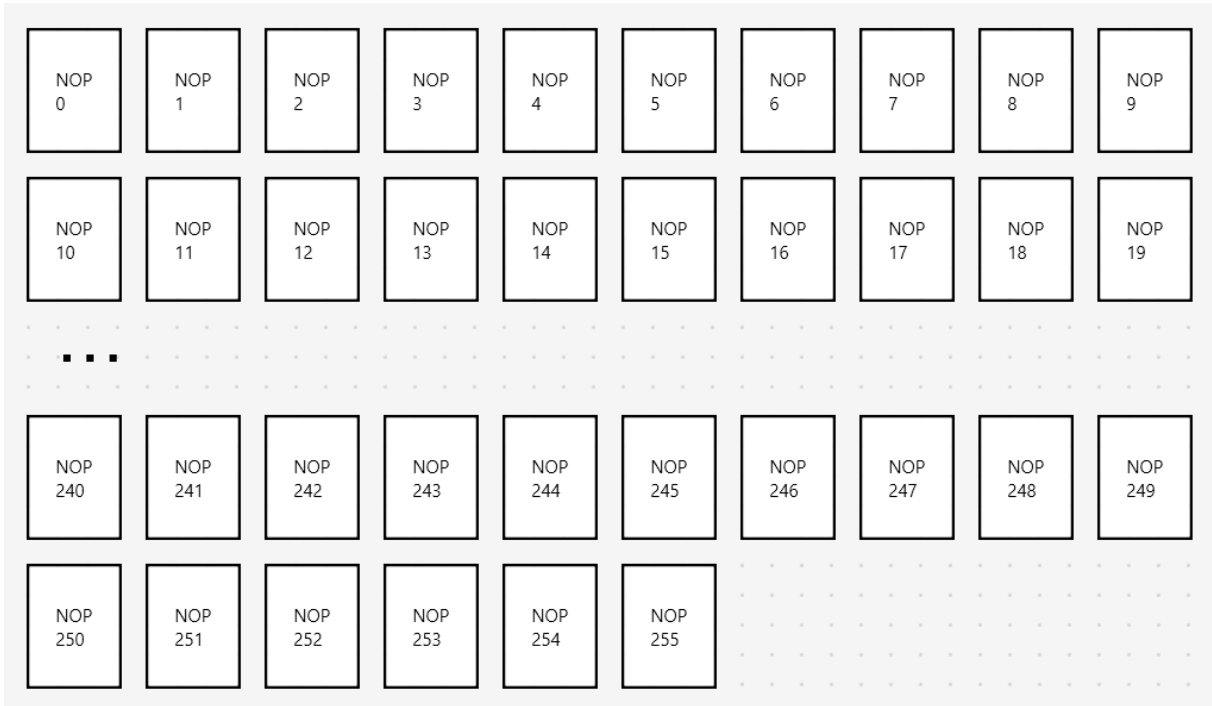


Figure 5.1

PCC-IV Terminology / Glossary

Block

The memory of the PCC-IV is divided into 256 groups. Each group or block can be set-up by the user to perform a specific task, such as: (A*B), (A+B), square root, PID control, etc. The task that a block performs is determined by the function type that we assign to the block. Function type is explained below. NOTE: blocks are often referred to as "B1", "BLK 1", or simply by the block's number.

All blocks are identified by a number (0 thru 255). This number determines the sequence in which the blocks are executed. Every 100ms (i.e., 10 times/sec), the PCC-IV computes each block in sequence from 0 thru 255, and updates all Tags.

Blockware Configuration

This refers to the process of entering information into the blocks; such as: the function type (i.e., the task that each block will perform), the specification of which of the field wiring inputs a block should use, the gain of a PID control function, etc.... A controller's configuration determines how the overall controller will function. Multiple PCC-IVs can be equipped with identical hardware (circuit boards, etc.), but each can be configured to function differently.

Function Type or Function Code Number

The Function Code Number is a number that identifies the type of computation or the type of action that a block will perform. Examples are:

F2	get an analog Input from the field terminal strip
F51	calculate (A*B) / C
F71	calculate a PID controller Output
F118	x seconds after Input turns on, turn on Output

Numbers are hard to remember, so normally we refer to each of the functions by using an abbreviation (or Function Name), such as:

F2	AIN	Analog INput
F51	AB/C	(A*B) / C
F71	PID	PID controller
F118	DAETDR	Delay After Energize Time Delay Relay

All the functions available in the PCC-IV are listed in numerical order in Section 6 (Blockware Technical Reference) of the instruction manual, and the task that each type performs is described in detail. Section 6 provides two Table of Contents: the first is in Function Code Number (numerical) order, the second is in Function Name (alphabetical) order.

Input

There are two types of inputs: electrical signals that are physically wired to the rear terminal strip of the controller and imaginary connections inside the PCC-IV that software a signal from the output of one block to the input of another block. Typically, when we talk about inputs we will be talking about the software connections internal to the PCC-IV.

Every block produces at least one output; some functions have multiple outputs. The function type determines the output value. Some functions do not require any input from any other blocks... for example: the AIN block receives it's 0-5 Vdc input from the PCC-IV's field terminal strip... while other functions require multiple inputs... for example: the AB/C block requires that three values be inputted (A, B, & C).

Inputs can be referred to by a meaningful abbreviation such as "A", or "PV" (Process Variable), or by an Input number (I1, I2, etc.). Section 6 describes the purpose of each input for each function type. Note: The input value for one block is always the output value of some other block.

Parameter

Many functions require setup information to work properly; we call these values parameters. A parameter can be used to make a selection such as: do you want to take the square root of this field? 1 = yes, 0 = no. The reset rate of a PID function would be considered a parameter. The setpoint of a high alarm would be a parameter.

Any value that needs to be established when the controller is first configured or those values that the user will change rarely are parameters. In Section 6, the purpose of each function's parameter will be identified in detail. Parameters are referred to by their name or by "P1", "P2", etc.

Analog

Block outputs within the PCC-IV that can be varied continuously and in small increments are called analog values. Analog values inside the PCC-IV are normally considered to be 0.00%-100.00% values. However, analog block outputs can range from -327.67% to +327.67%, and all computations are carried out to 0.001% internal resolution.

Discrete

Block outputs within the PCC-IV that can only have values of 0 or 1 (i.e. ON / OFF, TRUE / FALSE, HI / LOW) are called discrete values. Discrete and analog values cannot be intermixed. That is, if a function type calls for one of its inputs to be an analog value, then the user cannot assign discrete value to this input.

NAND

NAND flash memory is the permanent memory that stores all the firmware (i.e., non-changeable software) that makes the PCC-IV work (like ROM except that it can be re-flashed). This memory is not lost when the power is turned off. The PCC-IV screen driver firmware, menus, Modbus protocol, version number, Ethernet and RS485 drivers, etc. are stored in NAND flash memory.

RAM

RAM stands for **R**andom **A**ccess **M**emory. RAM can be read from and written to. RAM is volatile, temporary memory that is erased every time power is lost. The advantage is that it is very fast. RAM is where the configuration blockware is processed during normal operation.

EEPROM

EEPROM, or Electrically Erasable/Programmable Read Only Memory, is also flashable. The block function-types, softwiring, parameters, communication setup, calibration data, etc. are stored in this flash memory.

Upon power-up, the PCC-IV copies the contents of the EEPROM to RAM. The controller then operates from this RAM. When a user presses the "Save Config Changes" soft-button via the Utilities >> Memory submenu, the applicable contents of NVRAM (see below) are copied to EEPROM for additional redundancy.

NVRAM Retentive Memory

NVRAM, or Non-Volatile RAM, is used to automatically save and restore specific block parameters and specific block output values at the end of each 100ms "scan". NVRAM retains its data after being powered down for approximately 20 years. NVRAM does not use batteries, or capacitors, to retain its data, and can be written indefinitely without wearing out. PCC-IV has dual redundant NVRAM chips and alternates writes to chip A vs chip B every other scan.

Typically, setpoints, ratios, flow totals, and pushbutton statuses are saved and restored to/from retentive memory. Retentive memory allows a controller to resume controlling in the same state following power up as it was prior to shutdown. The block outputs and block parameters that are saved in retentive memory are specified in Section 6.

Some of the functions that save outputs to and are restored from retentive memory are: FPT/H (Front Panel Track and Hold), F(T) (Function of Time ramp generator), FPON (Front Panel Constant), COUNT (Pulse Counter), RDIN (Remote Discrete Input), PB (Pushbutton), and F/F (Flip/Flop). Most other function type outputs are re-calculated every scan based on the current inputs and are not restored at power up.

A5 Core

This is the core (microprocessor) that controls communication with any external device (Modbus, USB programming, front panel).

M4 Core

This is the core (microprocessor) that controls the Watchdog Timer, Real Time Clock, all internal processes, and I/O that uses the Motherboard and Option Boards (AIN, ZAIN, AOUT, DIN, ROUT, TOUT, DOUT).

Configuring Blockware Control Logic

In some applications, the PCC-IV blockware is pre-configured at the factory. In other cases, it is desirable to modify that configuration in the field because the end user may want to add features due to process changes. Yet in other cases, the customer may prefer configuring their own system from scratch.

The PCC-IV allows for easy modification or complete development of a configuration in the field via a personal computer/laptop, USB-A to Micro-USB-B cable, and the PC4_Draw software.

Using PC4_Draw

The PC4_Draw software runs on any Windows 7 thru 10 based computer/laptop. This manual assumes the user has a basic understanding of how to use personal computers, open/close files, navigate folders, etc.

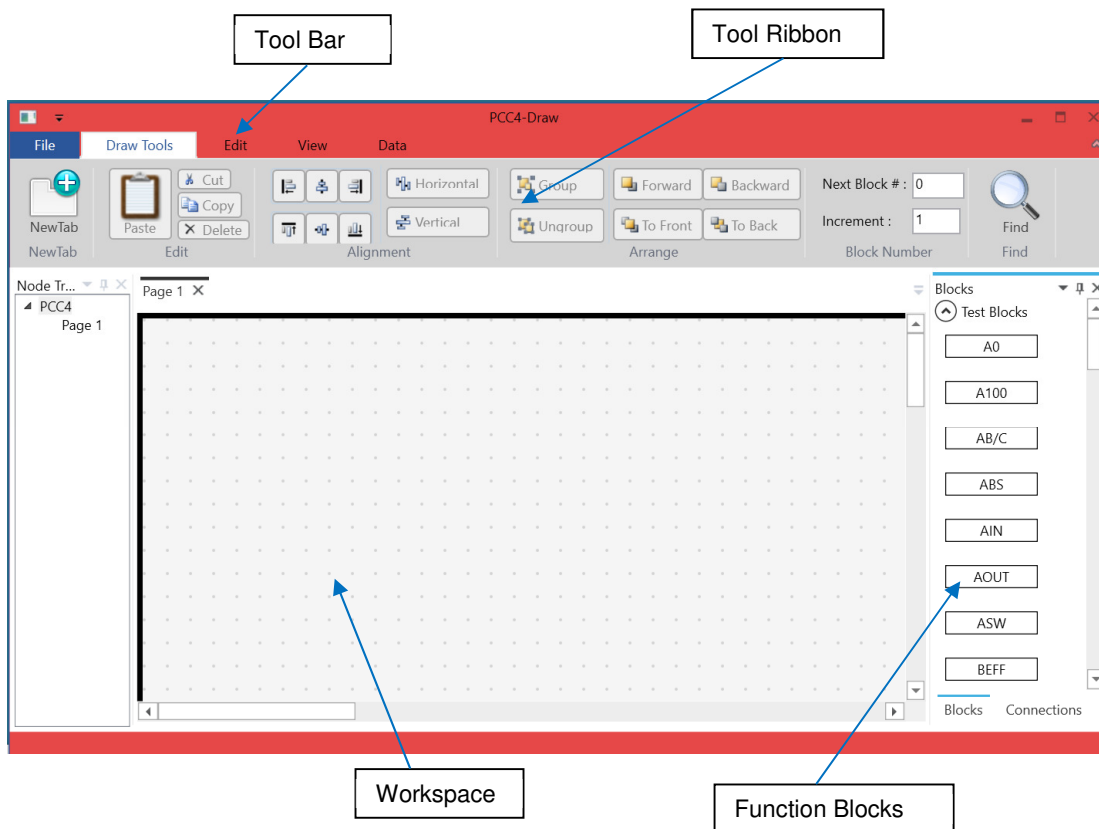
To open PC4_Draw, open the file *PC4_Draw.exe*. Then, click on the File tab to navigate to

New>>New PCC4 Config to create a new file

Open>>Open PCC4 Config to open an existing file

Open>>Open PCC3 Config to open and auto-convert a PCC3 .mdb file

After this, your program will look something like this:



Anatomy of a Block

Blocks can be dragged from the right onto the workspace. Double click on the block to open a block details window which allows you to see its inputs and parameters, set its block number, set parameter values, and see their minimum and maximum ranges. A comments block is available to leave notes. After making changes, click the *Confirm Changes* button. If nothing is connected to a block's input or parameter, it will default to 0% for analog inputs and logic 0 for digital inputs, and Parameters will be what you set them to here (see Connection Points and Softwiring below). See Section 6 for a full description of each block's inputs and parameters.

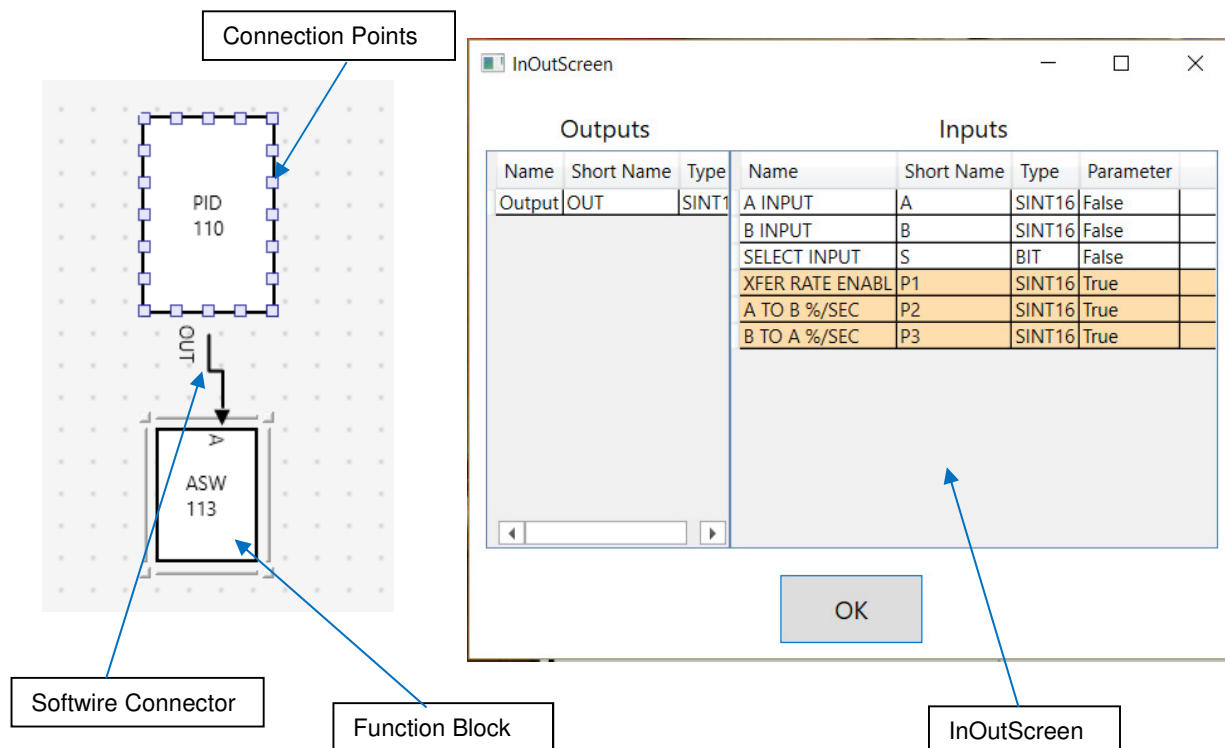
Block Details window showing parameters for block 113. The window includes a 'Block Number' field set to 113, a 'Comments' field, and a 'Confirm Changes' button. Below is a table of parameters:

Name	Value	Minimum	Maximum	Parameter	Description
A INPUT	0.00	-327.68	327.67	False	A INPUT
B INPUT	0.00	-327.68	327.67	False	B INPUT
SELECT INPUT	0	0	1	False	SELECT INPUT
XFER RATE ENABL	0	0	1	True	XFER RATE LIMITING 0=OFF 1=ON
A TO B %/SEC	1.00	0.10	100.00	True	A TO B %/SEC RATE LIMIT
B TO A %/SEC	1.00	0.10	100.00	True	B TO A %/SEC RATE LIMIT

A block can also be resized to make it easier for the programmer to visualize the Blockware or if more connection points are needed.

Connection Points and Softwiring

To connect one block to another, hover the mouse cursor over the edge of a block and connection points will appear. Hold the left mouse button and drag the line that appears (softwire) from the source block to the destination block. An *InOutScreen* pop-up will appear asking you which output and input you are trying to connect. Select the correct points and click OK.

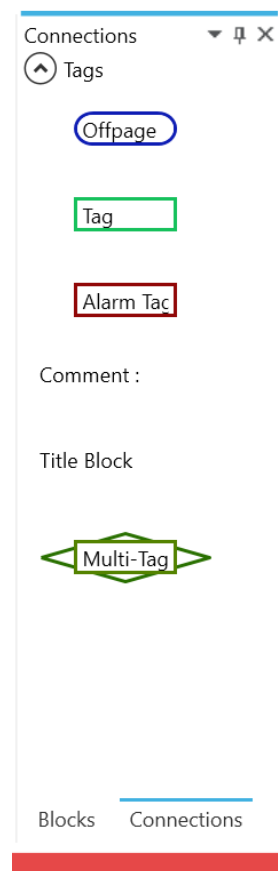


Connectors

At the bottom of the list of Function Blocks is a Tab which allows the programmer to select different connections.

- **Off-page** Connectors allow the programmer to software a block output (the source) on one page to a Block Input (the destination) on a different page. Both Off-page's must have the same name. Off-page connectors can also be used on the same page to avoid a confusing jumble of crisscrossing softwires. A source Off-page can connect to as many destination Off-page's as desired. The source and destination must be the same signal type: analog-to-analog or discrete-to-discrete.
- **Tags** can be connected to an analog, or discrete, Output, Input, or Parameter. A Tag makes a value available on the faceplate, and the Comm ports for display or R/W changes. A Tag can also be the "source" for a "destination" Off-page.
- **Alarm Tags** can only be linked to Discrete Outputs and include extra fields for easy interface to the Preferred touchscreen/OIT alarm logging system.
- **Comments** are simply text boxes that the programmer can use to clarify what is going on, add information about block parameters, etc.
- **Title Block** is editable and holds information common to all pages in the blockware. Clicking on the title block will allow editing and will display a revision history comments section. Each page has a unique Page Description section.
- **Multi-Tag** is a special tag that can only be linked to:
 - F(x) parameters X0 or Y0
 - F(t) parameters T1 or Y0

The designer selects the first Modbus register, and PC4_Draw automatically assigns the next 10 registers to the following X's, Y's, or T's. Multi-Tags can not be used as a "source" for a "destination" Off-Page connector.



Search and Replace

The Find button on the tool bar is a powerful tool to Search for all occurrences of a Block, Tag, Off-Page, comment text, etc on any/all pages of the Blockware.

By right clicking on any Tag or Off-Page, you can search for, and jump to, all "destination" and/or "source" usages.

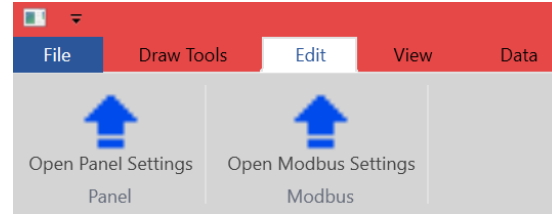
Search and Replace operations can also be done. For example, all Tag Names that contain "Blr 1" can be replaced with "Blr 2".



Modifying the Front Panel Settings

The PANEL function block is used in Blockware by the programmer to control alarm enable, silence, and output signals. See Section 6 for more details.

To change Front Panel Settings, click on the *Edit* tab on the Tool Bar and then click on *Open Panel Settings* on the Ribbon. This will open the Panel Data Screen where the programmer can set up everything related to the Front Panel. This is usually performed after the programmer is finished setting up the rest of the Blockware so that Tags, Push Buttons, and LEDs are already set up.



- **Display Channel** – There are up to 10 Display Channels that the user scrolls through by pressing the DIS soft-button. The programmer sets those up here. Set the following for each Display Channel:
 - Click the cell in the Source Tag column and select the appropriate Tag from the dropdown list.
 - Enter the number of digits to be displayed to the right of the decimal point.
 - Enter the Zero and Span values to be displayed, but without the decimal point. Example: 0.00-100.00% Block Output corresponds to -12.0" to +12.0" Drum Level. Enter: Decimal Point = 1, Zero = -120, Span = +120, Message = DRUM LEVEL. The Span can be less than the Zero (e.g.: Zero = +120 and Span = -120).
 - Enter the message to show in the message display (i.e. Steam PSI or Drum Level).
- **Alarm Channel** – You can set up to 10 alarms which will show on the Front Panel Alarm Annunciator and cause the PANEL Block to output a Common Alarm signal. See Section 6 for more information. Set the following for each Alarm Channel:
 - Click the cell in the Source Tag column and select the appropriate Tag from the dropdown list. These can be any digital Tag or Alarm Tag.
 - Enter the message to be displayed on the Front Panel Alarm Annunciator Screen.
- **Push Button** – There are up to 4 user-configurable pushbuttons that are set up here. The buttons are arranged from left-to-right, top-to-bottom (1 = top-left, 2 = top-right, 3 = bottom-left, 4 = bottom right). Set the following for each Push Button:
 - Click the cell in the Source Tag column and select the appropriate Tag from the dropdown list. These can be any digital Tag or Alarm Tag, but the tag must be connected to a PB (pushbutton) block.
 - Type specifies how the PB will respond to a press. "MOM_HI" or momentary high means the output = 1 for as long as the button is pressed. "MOM_LO" or momentary low means the output = 0 for as long as the button is pressed. "TOGGLE" means the output changes to the opposite of the previous output during the first scan of every button press.
 - There are two lines of text available on each button. The programmer can change these lines of text depending on whether the output = 1 or 0. Upper Message On = the top line when the output is a 1. Lower Message On = the lower line when the output is a 1. Likewise, the programmer would enter text for the Upper and Lower messages when the output is a 0.



- **LED Number** – there are up to 6 user-configurable LEDs that are set up here. The LEDs next to each pushbutton are numbered the same as the pushbuttons (1-4). LEDs 5 & 6 are the two between the upper and lower pushbuttons. Set the following for each LED:
 - Click the cell in the Source Tag column and select the appropriate Tag from the dropdown list. These can be any digital Tag or Alarm Tag.
 - Enter the text to be displayed next to the LED (LEDs 5 & 6).
- **Loop Names** – These specify the text that will be displayed at the bottom of the operator screen depending on which control loop is selected. This ensures the operator knows which control function is currently being

displayed on the bar graphs. The left text box will be displayed when Loop 1 is selected and the right text box will be displayed when Loop 2 is selected.

- Loop Elements – These determine the behavior of the bargraphs and display channels. Set the following for the Loop Elements:
 - Loop 1 PV bargraph – Select which Tag you want to control the PV bargraph when Loop 1 is selected. 0% will be the bottom of the bar, and 100% will be the top of the bar. (I.e. Drum PSI)
 - Loop 1 SP bargraph – Select which Tag you want to control the SP Arrow when Loop 1 is selected. 0% will show the arrow at the bottom of the bar and 100% will show the arrow at the top of the bar. (I.e. Drum PSI Setpoint)
 - Loop 1 OUT bargraph – Select which Tag you want to control the OUT bargraph when Loop 1 is selected. 0% will be the bottom of the bar, and 100% will be the top of the bar. (I.e. Firing Rate)
 - Loop 1 Auto/Manual – Optional: Select which Tag you want to control the Automatic Display Channel Selection (Auto-DIS) feature (0 = Auto, 1 = Manual). When this output changes from a 1 to a 0, the Loop 1 PV display channel will automatically be selected. When this output changes from a 0 to a 1, the Loop 1 OUT display channel will automatically be selected. The **DIS** button will still function normally after the Auto-DIS feature changes what is displayed (see section 3).
 - Loop 2 elements control the bargraphs and display in like manner and behave like Loop 1 elements.
 - Loop Select – Optional: If two control loops are used, select which Tag you want to control the active loop (0 = Loop 1, 1 = Loop 2).
- Bargraph Blinking Enabled – This is a True of False selection that determines whether the bargraph will blink during an alarm condition. When there is an alarm the ALARM LED will start blinking, and if this is set to True, the bargraphs will start flashing.
- Quick Parameters – Up to 9 Quick Parameters can be configured here. This allows users to quickly change commonly used parameters. See section 4 for using the Quick Parameters Menu. Set the following for each Quick Parameter:
 - Click the cell in the Source Tag column and select the appropriate Tag from the dropdown list.
 - Enter the text to be displayed for each Quick Parameter (up to 16 characters long).

Writing a Configuration to the PCC-IV



The PCC-IV is commonly used to control potentially dangerous combustion and chemical processes. **VERIFY THAT THE PROCESS BEING CONTROLLED HAS BEEN SAFELY SECURED, ISOLATED, OR BYPASSED (AS REQUIRED BY THE SITE CONDITIONS) BEFORE WRITING A CONFIGURATION TO THE PCC-IV CONTROLLER.** FAILURE TO DO SO CAN RESULT IN EQUIPMENT DAMAGE, INJURY, OR DEATH.



SERVICE MANUAL BYPASSES THE BLOCKWARE. If the logic designer does not use the AOUT and/or TOUT “S/M” outputs to implement bumpless transfer, these outputs can rapidly make large changes upon exiting Service Manual. **ANYTHING IN RETENTIVE MEMORY (NVRAM) SUCH AS SETPOINTS, FLOWS, TOTALS, PUSHBUTTON STATES, AND BLOCK OUTPUTS WILL BE ERASED BY THE NEW PROGRAM.**

To send the blockware to a PCC-IV, secure, isolate, or bypass the process being controlled, and/or place the controller into Service Manual to hold all outputs at their current value.

Connect a USB cable between the computer and the PCC-IV – see section 2 if assistance is needed.

Click on the *Data* tab on the Tool Bar and then click on *Write* on the Ribbon.

If there are no errors, the Blockware will be written to the PCC-IV.

Reading a Configuration from the PCC-IV

Connect a USB cable between the computer and the PCC-IV – see section 2 if assistance is needed.

Click on the *Data* tab on the Tool Bar and then click on *Read* on the Ribbon.

If there are no errors, the Blockware will be read from the PCC-IV.

Viewing Live Values

Connect a USB cable between the computer and the PCC-IV – see section 2 if assistance is needed.

Click on the *View* tab on the Tool Bar and then click on *Toggle Live Values* on the Ribbon.

If the Blockware in PC4_Draw matches the running Blockware, you will be able to see the output of each block and Tag from within PC4_Draw.

Exporting OIT Tags

If the programmer needs Tag data for a Preferred Touchscreen/OIT, it can be exported in a .csv file format.

Click on the *Data* tab on the Tool Bar and then click on *Export OIT Tags* on the Ribbon.

A window will open asking you to choose a file name and location to save the file. Click OK when ready.

See OIT or SCADA documentation for information on how to import that data.

Good Control Strategy

Development of good control strategy starts with a well-conceived plan. These few steps will help the user to configure the PCC-IV in a timely manner:

- Define the user's requirements
- Check the system Input/output (I/O) count
- Break the configuration down into manageable sections
- Drag the blocks needed for each section to the canvas
- Assign block numbers and "Softwire" the Block Inputs
- Modify Parameters as required
- Add tags necessary for setting up the Panel Data Screen and/or OIT communication
- Configure the front panel displays and alarms
- Test the configuration
- Place controller into operation

The remainder of this Section will be a detailed example of how to enhance a simple Boiler Master Blockware Control Strategy by adding features in small manageable sections.

Flashing/Updating Firmware

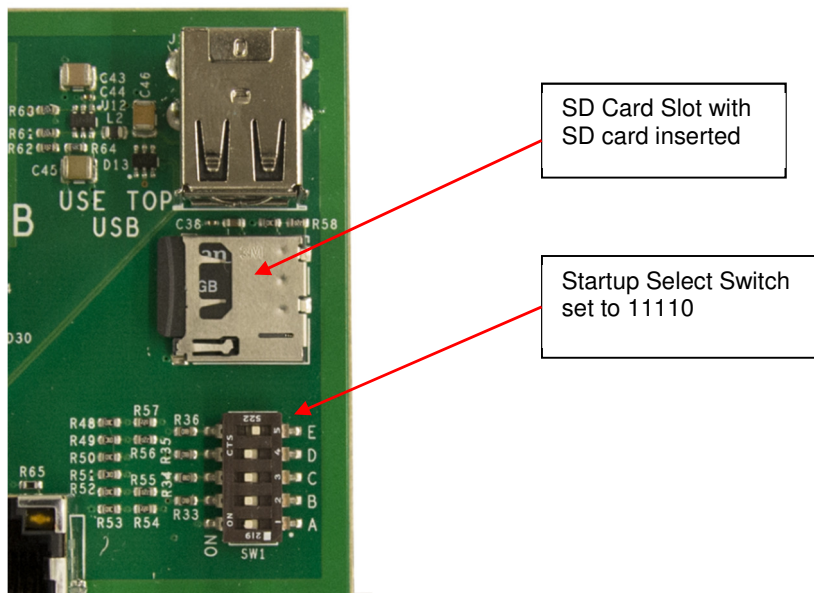
As new features are added to the PCC-IV blockware, faceplate displays, Communications interfaces, PC4_Draw interface, etc... it may be necessary to use a Micro SD card to flash the controller with new firmware. After obtaining an SD card with the new firmware image pre-loaded on it from your distributor, service provider, or Preferred Utilities, follow the directions below.



WARNING

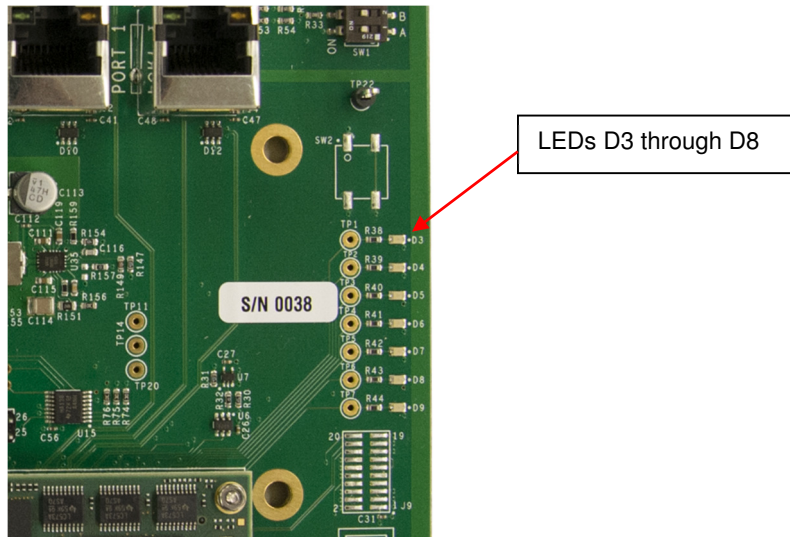
The PCC-IV is commonly used to control potentially dangerous Combustion and Chemical Processes. VERIFY THAT THE PROCESS BEING CONTROLLED HAS BEEN SAFELY SECURED, ISOLATED, OR BYPASSED (AS REQUIRED BY THE SITE CONDITIONS) BEFORE REMOVING POWER FROM THE PCC-IV CONTROLLER. FAILURE TO DO SO CAN RESULT IN EQUIPMENT DAMAGE, INJURY, OR DEATH.

1. Gain access to the PCC-IV CPU board that needs the firmware flashed.
2. If possible, Read the Blockware from the PCC-IV into PC4_Draw per Section 5 of the PCC-IV Technical Manual.
3. Remove power by unplugging the 24 Vdc power supply plug(s).
4. Wait approximately 10-15 seconds for all capacitors to discharge and for all LED's to turn off.
5. On the CPU board, set the startup select switch (SW1) to 11110 (A=ON, B=ON, C=ON, D=ON, E=OFF).
6. Insert SD card into the SD card slot (J10), on the PCC-IV, by sliding it in until it clicks.

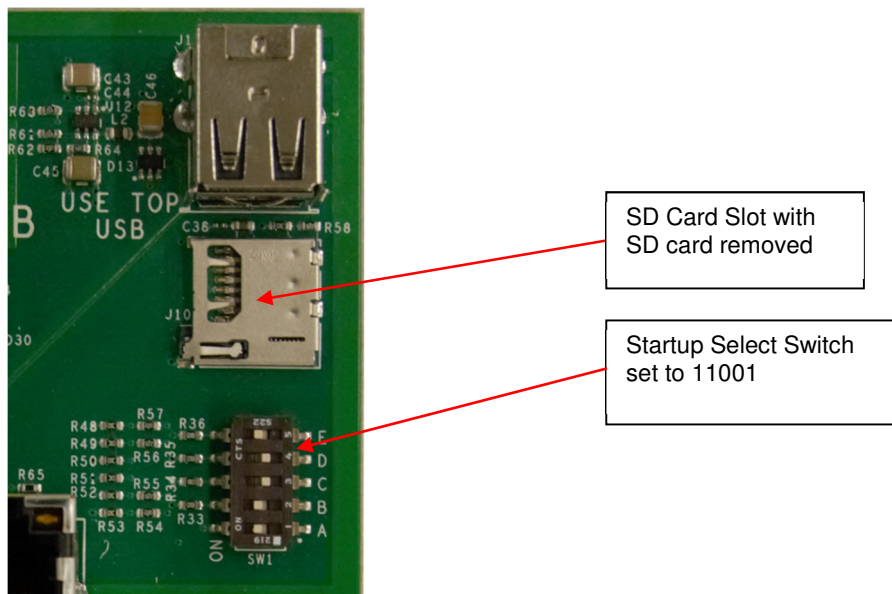


7. Apply power to the CPU board by plugging in one 24 Vdc power plug. This can be from the cabinet or any other approved 24 Vdc source.

8. Wait until LEDs D3 through D8 are flashing in unison. It takes approx. 1 minute to flash the firmware.
9. Remove power by unplugging the 24 Vdc power supply plug.
10. Wait approximately 10 seconds for all capacitors to discharge.



11. Remove the SD card by pressing it in until it clicks. It will then slide out of the SD card slot.
12. On the CPU, set the startup select switch (SW1) to 11001 (A=ON, B=ON, C=OFF, D=OFF, E=ON).
13. Reinstall the PCC-IV back to its correct location and apply power by plugging in the 24 Vdc power supply plug(s).



14. Using PC4 Draw, write the Blockware that was previously saved back into the PCC-IV, in accordance with the PCC-IV Technical Manual. If the Blockware was not able to be saved, write the latest as-delivered/as-left Blockware, and inform the customer that they will need to re-enter alarm setpoints, tuning & calibration data, and any other changes they have made.

Modifying a Blockware Configuration

Let's suppose a customer has developed a simple "Boiler Master" configuration as shown below. The configuration consists of a steam drum pressure transmitter Input, drum pressure setpoint, a PID control loop, a 4-20 ma "firing rate demand" Output wired to a control actuator or valve, logic to send the Output to "low fire" (via a discrete Input from the Flame Safeguard System (FSG) and Auto/Manual control logic. The customer has decided to add an Input from a Plant Master controller and add high and low boiler drum pressure alarms.

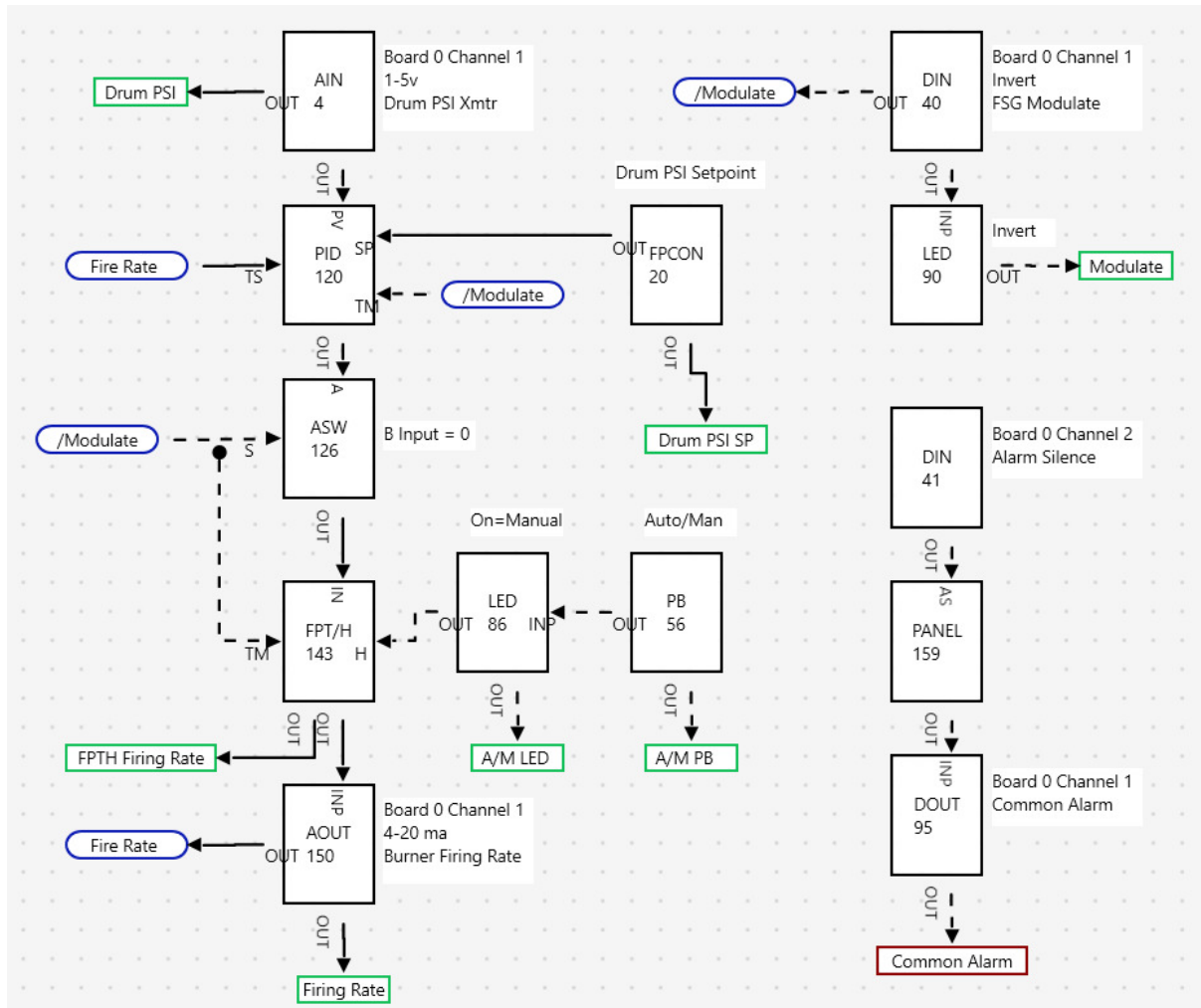


Figure 5.2

Following the recommended approach:

Define the requirements.

We will need to add an input for the Plant Master Demand, a Submaster bias station (to load balance the boilers), a pushbutton to switch between Plant Master or Local PID control, an LED to show the user which of these modes the controller is in, and high and low-pressure alarms. The front panel display must also be modified.

Check the I/O count

The controller has four extra inputs available. If the user wants the Plant Master input to be electrically "isolated", an option card will be required. Isolating the Plant Master is not required, but it is a more robust system design that prevents a single wiring problem from affecting multiple boilers.

Break the configuration down into manageable sections

This is a relatively small change. We will add an alarm section, a Submaster bias section and a control mode section.

Drag the blocks needed for each section to the canvas, assign block numbers, and “Softwire” the Block Inputs

Figure 5.3 (below) highlights each section that is to be added to the original configuration. The Plant Master section will require an input Block (AIN), a Front Panel Constant Block (FPCON) for the Submaster bias, and a weighted sum Block (WSUM) to calculate the bias. The Plant Master / Local PID selector requires a pushbutton Block (PB), an indicator Block (LED) and a switching Block (ASW). The alarm section requires a high alarm Block (HIALM) and a low alarm Block (LOALM). They are softwired as shown.

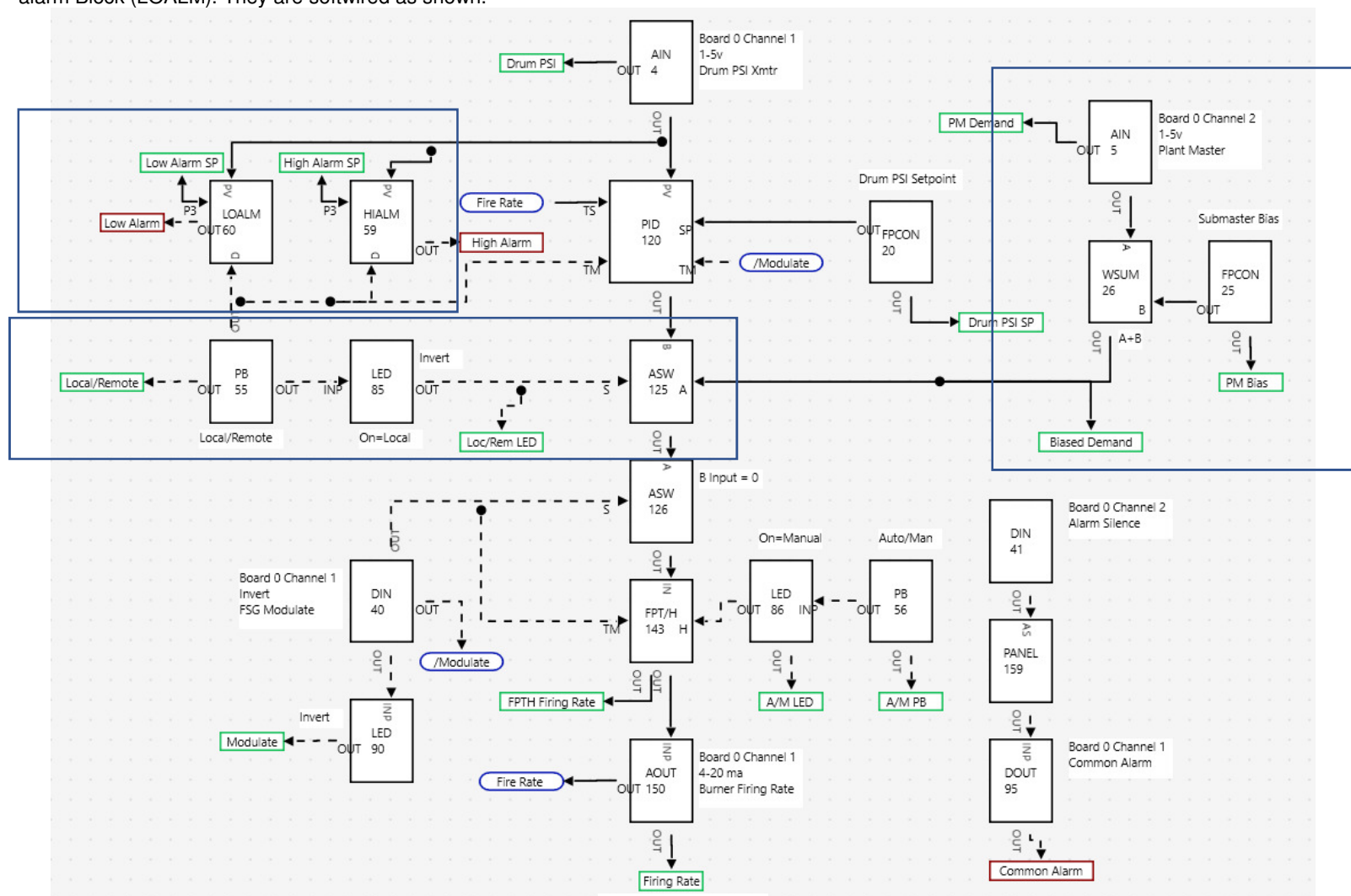


Figure 5.3

Modify Parameters as required

See Section 6 for a complete description of every block parameter

Block 5 AIN:

There are seven parameters that can be configured. In many cases the default value will be used. However, some parameters need to be modified to suit the needs of the desired Control Strategy.

- P1 – Option Board 0 since the CPU board input is being used
- P2 – Input Channel 2 as the second analog input channel is being used
- P3 – Volts for 0% is 1.000 as this will be a 1-5 Vdc signal
- P4 – Volts for 100% is 5.000 as this will be a 1-5 Vdc signal
- P5 – Sq. Root Option is 0 as we do not want to square root the signal
- P6 – Filter Seconds 1.0 as this will eliminate noise or sharp spikes
- P7 – Low Flow Cutoff is 0.00 as this is not required

Block 25 FPCON:

We need a Front Panel Constant to adjust/display our Submaster Bias. We will setup a +/- 50% bias adjustment range.

- P1 – Min Output is -50.00
- P2 – Max Output is 50.00

Block 26 WSUM:

We want to apply the positive or negative Submaster Bias to the Plant Master signal. We will setup the WSUM block as “A + B” with Input A as the Plant Master signal and Input B as the +/- Bias signal.

- P1 – K1 is 1.000 as we are not scaling the input
- P2 – K2 is 1.000 as we are not scaling the input
- P3 – K3 is 1.000, it is not used in this application
- P4 – K4 is 0.00, it is not used in this application

Block 55 PB:

We need to add a pushbutton to select Local PID or Remote Plant Master control.

- P1 – Pwr Up Mode is 3 as we want the button to power up in its last mode of operation

Block 59 HIALM:

We will assume the Plant Master has a high and low header pressure alarm. We want high and low drum pressure alarms only when in Local PID mode.

- P1 – SP Mode is 2 as we want an internal setpoint
- P2 – % Deadband is 1.00 as we want 1% of the Drum Pressure transmitter's full-scale range to be our deadband (i.e. a 0-200 PSI transmitter would have a dead band of 2 PSI).
- P3 – is 70.00 as we want 70% of the Drum Pressure transmitter's full-scale range to give us a high alarm (i.e. a 0-200 PSI transmitter would alarm above 140 PSI).
- P4 – Disable Hi/Lo is 1 so that the alarm is disabled when the PB is high
- P5 – Delay Sec of 60. We want a 60 second delay before the alarm sounds to prevent nuisance alarming.

Block 60 LOALM:

- P1 – SP Mode is 2 as we want an internal setpoint
- P2 – % Deadband is 1.00 as we want 1% of the Drum Pressure transmitter's full-scale range to be our deadband (i.e. a 0-200 PSI transmitter would have a dead band of 2 PSI).
- P3 – is 40.00 as we want 40% of the Drum Pressure transmitter's full-scale range to give us a high alarm (i.e. a 0-200 PSI transmitter would alarm below 80 PSI).
- P4 – Disable Hi/Lo is 1 so that the alarm is disabled when the PB is high
- P5 – Delay Sec of 60. We want a 60 second delay before the alarm sounds to prevent nuisance alarming.

Block 85 LED:

We will use a light to tell us whether we have selected Local PID or Remote Plant Master control

- P1 – Invert Input is 1 as we need to invert the input – when the PB is low (0) the LED is high (1) – this causes the LED to light up when we are in Local PID mode.

Block 125 ASW:

- P1 – Xfer rate Enable is 1 – we want transfer rate limiting to avoid and “bumps” when switching modes
- P2 – A to B %/Sec is 1.00. This gives us a 1% per second transfer rate going from Plant Master to Local PID mode.

- P3 – B to A %/Sec is 1.00. This gives us a 1% per second transfer rate going from Local PID to Plant Master mode.

Add tags necessary for setting up the Panel Data Screen and/or OIT & SCADA communication

We add tags as necessary to enable us to see up the following for the Front Panel:

- Plant Master Demand as a Display Channel
- Change the Plant Master Bias
- Set up a Local/Remote Pushbutton and LED
- Annunciate High and Low Drum Pressure alarms
- Make it easier for the operator to change High and Low Drum Pressure alarm setpoints

Configure the front panel displays and alarms

- Open the Panel Data Screen
- We add two new display channels:
 - For the next Channel, select **PM Demand** as the Source Tag, Dec Pt = 0, Zero = 0, Span = 100, Message = "PM Demand"
 - For the next Channel, select **PM Bias** as the Source Tag, Dec Pt = 0, Zero = 0, Span = 100, Message = "PM Bias"
 - Note that the limits of -50 to 50 are set up in the new FPCON block above. The Zero setting here is what the display will show when the output is at 0%. The Span setting here is what the display will show when the output is at 100% (even if it will never actually get there).
- We add two Alarm Channels:
 - For the first Channel, select **High Alarm** as the Source Tag, Message = "High PSI"
 - For the next Channel, select **Low Alarm** as the Source Tag, Message = "Low PSI"
- We set up the new Pushbutton:
 - For Pushbutton 1, select **Local/Remote** as the Source Tag, Type = Toggle, Upper Message On = "Remote", Upper Message Off = "Local"
 - Note that the LED that is set up next is inverted, so when it is on, we are in Local. When the Pushbutton is on, we are in Remote.
- We set up the new LED:
 - For LED 1, select **Loc/Rem LED** as the Source Tag, Message = "Local"
- For Loop Names, we want to name Loop 1 "Local PID" and name Loop 2 "Plant Master."
- We add the following to Loop Elements:
 - For Loop 2 PV bargraph, select **PM Demand** as the Source Tag.
 - For Loop 2 SP bargraph, select **Biased Demand** as the Source Tag.
 - For Loop 2 OUT bargraph, select **Firing Rate** as the Source Tag.
 - For Loop 2 Auto/Manual, select **A/M PB** as the Source Tag.
 - For Loop Select, select **Local/Remote** as the Source Tag.
 - These settings allow us to automatically switch between the local Drum PSI and Drum SP (Loop 1) and the remote Plant Master demand and biased demand (Loop 2). The Local/Remote Pushbutton determines which Loop is active.
 - This way, when in remote mode, the operator can quickly compare Firing Rate to Plant Master demand and see if there is any Bias. In local mode, the operator can quickly see Drum PSI, Setpoint, and Firing Rate.
 - In both cases, when Firing Rate is placed into manual, the Firing Rate Channel will automatically be displayed, and when Firing Rate is placed into Auto, Either Drum PSI or PM Demand will be displayed. The **DIS** soft-button will still work as normal, see section 3.
- The Bargraph Blinking setting will remain unchanged.
- We will set up Quick Parameters as we want to make it easier for the operator to change alarm setpoints.
 - For Quick Parameter 1, select **High Alarm SP** as the Source Tag, Description = "High PSI SP"
 - For Quick Parameter 2, select **Low Alarm SP** as the Source Tag, Description = "Low PSI SP"

Test the configuration

Read **Section 4** before testing. This section explains how to use the “Force” and “Examine” features of the PCC-IV’s Browse Blocks Menu. **The PCC-IV should not be performing any control Function while being tested. Each Block that was added or was modified should be thoroughly checked prior to returning the PCC-IV to process control.**

To test the configuration:

- Write the new Blockware to the PCC-IV and verify there are no errors. The green RUN LED should be solid green after sending the configuration
- Display “PM Demand.” Compare the numeric display to that of the Plant Master Output. If they do not match, check engineering units in the Panel Data Screen and check parameters of B5 (AIN).
- Display “PM Bias.” Using the ▲ and ▼ soft-buttons run the Bias all the way up and all the way down to verify the display ranges from -50% to +50%. Set the Bias to -10%. Using the PCC-IV’s Browse Blocks Menu, force the Plant Master Input (B5) to 50% or, if possible, base load the Plant Master at 50%. Examine B26. It should read 40%. If not, check the Inputs and parameters of Blocks 5, 25, and 26.
- Press the Local/Remote Pushbutton to toggle the control mode. The LED, PV, and SP bargraphs should toggle accordingly. If not, check the Inputs and/or parameters of Blocks 55 (PB) & 85 (LED). Place in Local PID mode.
- Place the controller in the Local PID mode. Force the Drum Pressure Input (B4) to 0%. A “Low PIS” Alarm should annunciate. Acknowledge the alarm (press “ACK”) and check the verbiage on the annunciator display. Correct if necessary. Note: A 4-20 ma simulator can be used as the Input in lieu of forcing the Block.
- Force the Drum Pressure Input to 100%. A “High PSI” Alarm should annunciate. Acknowledge the alarm and check the verbiage on the display. Correct if necessary.
- Unforce all Blocks
- Force the output of Block 40 to zero to allow adjustment of the Analog Output.
- Place the controller into Auto and select Remote mode.
- Set the Bias to zero.
- Force Block 5 to various settings and verify the output of the controller, B150 (AOUT), follows Plant Master Demand. The PV and SP bargraphs should be equal and follow Plant Master Demand.
- Adjust the Bias and verify the output of the controller, B150 (AOUT), follows Plant Master Demand +/- the Bias accordingly. The SP bargraph should be offset by the Bias value.
- Place the controller into Local mode.
- Adjust the Drum PSI Setpoint to various settings. The SP bargraph should follow accordingly.
- Force the Drum PSI input, Block 4 (AIN), above or below the Drum PSI Setpoint. The output of the controller should react inversely. The PV bargraph should follow the Drum Pressure accordingly.

Place the controller into operation

If all the above tests were successful, you are ready for operation. Once in operation you should check the tuning (Gain, Integral, etc.) of the Drum Pressure PID control loop and adjust if necessary.

Section 6: Blockware Functions – Technical Reference

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Note: See the ZP Oxygen Analyzer Instruction Manual for Function F6 [ZAIN]

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[A100]	Analog Constant, 100.00%	4	[FPCON]	Front Panel Adjustable Constant	22
[AB/C]	(A*B) / C Multiply - Divide.....	20	[FPT/H]	Front Panel Adjustable Track / Hold	11
[ABS]	Absolute Value	24	[H/LLIM]	High / Low Signal Limiter	10
[AIN]	Analog Input	4	[HIALM]	High Alarm	38
[AOUT]	Analog (4-20 mA) Output	28	[HSEL]	High Select	8
[ASW]	Analog Switch	9	[INTTDR]	Interval Time Delay Relay (Non- Retriggerable One Shot).....	47
[BEFF]	Boiler Efficiency.....	7	[INV]	Invert	22
[COMM]	RS485 Communications Link Control	49	[L/L]	Lead – Lag with Gain	19
[CON]	Analog Constant	22	[LED]	LED 37	
[COUNT]	Pulse Counter	23	[LOALM]	Low Alarm	40
[D0]	Discrete 0 Constant	34	[LOGIC]	User Defined Logic	43
[D1]	Discrete 1 Constant	34	[LSEL]	Low Select.....	8
[DADTDR]	Delay After De-energize Time Delay Relay (Off Delay)	46	[MSEL]	Median Selector	9
[DAE/DAD]	Delay After Energize / Delay After De-energize Timer	47	[NOP]	No Operation Dummy Function	50
[DAETDR]	Delay After Energize Time Delay Relay (On Delay)	46	[NOT]	NOT Logic	44
[DCON]	Discrete Constant	35	[PANEL]	Front Panel Display	35
[DEV]	Deviation Calculation (for Bargraph Displays).....	23	[PB]	Pushbutton	37
[DEVALM]	Deviation Alarm	40	[PID]	PID Control (with GAP and ADAPTIVE gain).....	24
[DIN]	Discrete Input	34	[RAIN]	(RS485) Remote Analog Input.....	5
[DOUT]	Discrete Output (Open Collector - Sinking).....	50	[RATE]	Rate of Change Alarm	42
[DSW]	Discrete Switch	45	[RDIN]	(RS485) Remote Discrete Input	36
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[F(T)]	Function of Time Generator.....	13	[RLIM]	Rate Limiter	10
[F(X)]	Function of X Generator with Learn Mode.....	15	[ROUT]	Relay Output	49
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Introduction

Section 6 provides detailed information on each of the blockware functions included in the PCC-IV firmware.

See Section 5 for details on designing and configuring blockware control strategies.

Each function has a Name and a Function Code Number, which are interchangeable. The Function Name is a mnemonic, or abbreviation of the function's description (Function Name "**AIN**" = Analog Input). The Function Code is the number that the PCC-IV internal firmware uses to reference a function (Function Code "F2" = **AIN**). Typically, users refer to functions by Function Name, not Function Code.

Functions are arranged in Function Code order in this Section.

Each function has a verbal description, technical data (Header, Inputs, and Parameters), and when appropriate an application example. A glossary of the terminology used in the technical data area of each function follows:

NAME:	The Function Name (i.e. mnemonic or abbreviation)
SINGLE USE FUNCTION:	"N" = Function can be used in multiple Blocks "Y" = Function can only be used in one Block.
OUTPUT TYPE:	"A" = The Block Output is Analog: a -327.00 to + 327.00 % value. "D" = The Block Output is Discrete: A Logical "0" or Logical "1" value.
Input - Type:	"A" = The Block Output is Analog: a -327.00 to + 327.00 % value. "D" = The Block Output is Discrete: A Logical "0" or Logical "1" value.
Parameter - Default:	The value assigned to this Parameter when a Function is initially assigned to a Block
Parameter - Max:	The maximum value that the Parameter can be changed to.
Parameter - Min:	The minimum value that the Parameter can be changed to.
Parameter - Code:	The minimum password level required to change a Parameter (if Passwords are enabled)

Default Block Inputs:

There are 256 blocks in the PCC-IV (numbered 0 to 255). Think of a block as a receptacle, or socket into which the user inserts a PCC-IV blockware function. Any PCC-IV blockware function can be inserted into any available block.

When a function is initially assigned to a block, the block inputs are automatically defaulted to a value of 0 (that is, 0% for analog inputs, logic "0" for digital inputs).

F0 [A0] Analog Constant, 0.00%

Function **A0** provides a constant Output of 0.00%.

No inputs or parameters are required for **A0**.

```
-----
NAME:      A0                      SINGLE USE FUNCTION:  N      OUTPUT TYPE:  A
-----
No Inputs and No Parameters
```

F1 [A100] Analog Constant, 100.00%

Function **A100** provides a constant Output of 100.00%.

Analog 100.00% is useful as a dummy input to many other functions: **ASW**, **AB/C**, No inputs or parameters are required for **A100**.

```
-----
NAME:      A100                   SINGLE USE FUNCTION:  N      OUTPUT TYPE:  A
-----
No Inputs and No Parameters
```

F2 [AIN] Analog Input

Function **AIN** is the blockware interface to the PCC-IV Analog Inputs A/D converter hardware. **AIN** retrieves the 0.000 - 5.100 Vdc signal from the selected field terminals, applies a digital low pass filter, scales the voltage to a 0-100.00% Block Output, and optionally takes the square root. A jumper selectable 250 ohm, 0.1% resistor on the circuit board is used to convert a 4-20 mA Input to 1-5 Vdc Input. A hardware based low pass filter (-3 dB @ 0.6 Hz, -63 dB @ 60 Hz) is included for each analog Input for noise reduction, and high frequency aliasing prevention.

The AIN function interfaces to Analog Inputs on the CPU board and on option boards. Parameter 1 specifies the board location, the CPU board = board 0. Parameter 2 selects a specific Input on the specified board.

Any portion of the 0 - 5.100 Vdc Input range (0.5 Vdc min. span) may be selected and scaled to the 0-100.00% Block Output using parameters 3 & 4. Voltages outside the configured 0-100.00% range produce proportional Block Outputs, within the limitations of 0-5.100 Vdc measurement range, and +/- 327% Block Output range. Parameters 3 & 4 may be configured for reverse Inputs (0% = 5 Vdc, 100% = 1 Vdc for 20-4 mA transmitters).

Scaling Example: Parameter 3 (0%) = 1.000 Vdc, Parameter 4 (100%) = 5.000 Vdc. Outputs for other voltages: 0.000 Vdc = -25%, 1.000 Vdc (or 4 mA) = 0 %, 4.000 Vdc (or 20 mA) = 75.00%, 5.100 Vdc in = 102.50%

The square root option is scaled for 0-100% Input = 0-100% Output, that is:
Block Output = 10 * [sq. root (Input).]

Square Root Example:

100% Input = 100% Output, 49% Input = 70% Output, 4% Input = 20% Output. Negative Inputs yield a 0% Output.

The Low Flow Cutoff parameter forces the Block Output to 0.00% if the Block Output would be less than (Parameter 7). This feature is bypassed if the Cutout is 0.0%.

NAME: AIN SINGLE USE FUNCTION: N OUTPUT TYPE: A

No Inputs

Parameter	Description	Default	Max	Min	Code	Notes
1	OPTION BOARD (0=CPU BOARD)	0	2	0	3	
2	INPUT CHANNEL	1	5	1	3	1
3	VOLTS INPUT FOR 0% OUTPUT	1.000	5.100	0.000	2	2,3
4	VOLTS INPUT FOR 100% OUTPUT	5.000	5.100	0.000	2	2,3
5	SQ ROOT? 0=NO 1=YES	0	1	0	2	4
6	FILTER SECONDS	1.0	300.0	0.0	1	
7	LOW FLOW CUTOFF (0=OFF)	0.00	30.00	0.00	2	

Notes:

1. The quantity of Inputs available is dependent on the type of option board installed. An error message is displayed when writing the Blockware to the PCC-IV if sufficient Inputs are not available.
2. The difference between Parameters 3 & 4 must be greater or equal to 0.500 Volts.
3. Reverse Input scaling is valid, i.e. 0% Output = 5.000 Volts, 100% Output = 0.000 Volts.
4. Negative Inputs (after 0% and 100% scaling) yield a 0% Output if Square Root mode is selected

F5 [RAIN] (Modbus) Remote Analog Input

When the PCC-IV Modbus communications link (Comm Link) is in "Local Mode", the Comm Link can read all Block Outputs; however, the Comm Link is prevented from writing data to (i.e. changing) all Block Outputs, except for the **RAIN** and **RDIN** Blocks. The Comm Link is always permitted to write data to **RAIN** and **RDIN** Block Outputs.

Signal Conditioning: The value written by the Comm Link first passes through a min/max limiter, followed by a %/sec rate limiter, and then a first order low pass digital smoothing filter. The result of the digital filter becomes the **RAIN** Block Output. By setting parameters 1-4, any of or all these signal conditioners can be turned off.

The Comm Link scaling is: (Block Output*100). That is, when Comm Link writes 5047, PCC-IV interprets the value as 50.47%. A **RAIN** Block Output of 17.01% is reported to the Comm Link as 1701. The limiting and filtering discussed above can cause the value written by Comm Link to be different from the **RAIN** Block Output that is read by Comm Link. **RAIN** will not indicate an error to the Comm Link if Comm Link writes a value outside of the min/max limits.

Timeout: The value written by Comm Link remains in effect until a new value is written, or until a Comm Link time-out. Upon Comm Link time-out (i.e. no new message received within \bar{x} sec., parameter 5), **RAIN** can either remain at the last value or switch to the default value (parameters 6 and 7). If **RAIN** switches to the default, the signal conditioning is applied to smooth the transition.

At power down, the Block Output is saved in the Retentive Memory area of the NVRAM. During the first scan after CPU start-up, the **RAIN** Block Output is set to the value stored in the Retentive Memory. If Retentive Memory is invalid, the Block Output initializes to the Default Output value upon CPU start-up.

NAME: RAIN SINGLE USE FUNCTION: N OUTPUT TYPE: A

No Inputs

Parameter	Description	Default	Max	Min	Code	Notes
1	MIN OUTPUT	0.00	199.99	-199.99	2	1
2	MAX OUTPUT	100.00	199.99	-199.99	2	1
3	%/SEC RATE LIMITER (100=OFF)	100.00	100.00	0.10	2	2
4	FILTER SECONDS	0.00	3.00	0.00	2	x
5	COMM FAIL DELAY SEC.	5	3600	1	2	x
6	FAIL ACTION, 0=LAST, 1=DEFAULT	0	1	0	2	x
7	FAIL DEFAULT	0.00	199.99	-199.99	2	x

Notes:

1. MIN must be less than MAX.
2. 100.00%/sec rate limit turns off Rate Limiting

F11 [DUAL] Dual Range Flow Transmitter Selector-Scaler

Function **DUAL** is used to automatically select and scale one of two flow transmitters in a dual range arrangement. This allows greater measurement accuracy over a wider flow range.

Example: An orifice plate with two differential pressure transmitters piped in parallel. The High range transmitter is calibrated 0-100" WC, the Low range transmitter is calibrated 0-9" WC. The **DUAL** Block should be set to a 9% switch point, with the square root option selected (the transmitters should NOT have internal square root selected).

From 100" – 9" WC, the High Range Input would be selected, square rooted, and sent to the **DUAL** Block Output as a 100-30% signal. Below 9" WC, the Low range would be selected, the transmitter signal would be scaled, square rooted, and sent to the **DUAL** Block Output as a 30-0% signal.

Formula (shown with optional square root being taken):

If High Range Input greater than Switch Point:
Output = 10 * square root [High Range Input]
Else
Output = 10 * square root [(Low Range Input * Switch Point) / 100]

NAME: DUAL SINGLE USE FUNCTION: N OUTPUT TYPE: A

Input	Type	Description	Notes
1	A	HI RANGE INPUT	
2	A	LOW RANGE INPUT	1

Parameter	Description	Default	Max	Min	Code	Notes
1	SWITCHING POINT (% OF HIGH RANGE)	10.00	50.00	1.00	2	2
2	SQUARE ROOT? 0=NO 1=YES	1	1	0	2	

Notes:

1. Low Range Input MUST be scaled to match the Switch Point and the High Range transmitter.
Example: High Range transmitter is 0-120" WC for 4-20 mA, or 0-100% inside the PCC-IV, If the Switch point is 10%, the Low range transmitter MUST be calibrated 0-12.0" wc for 0-100%.
2. Percent of High Range Input.

F22 [BEFF] Boiler Efficiency

Function **BEFF** calculates Boiler or Process Heater Efficiency based upon the ASME Efficiency Test using the Losses Method. For fuels with a known chemical composition (Natural Gas, Oils, ...), this method is a more reliable means of calculating efficiency than Input-Output based calculations. This method also applies to solid fuels (wood, coal, ...), however, more frequent fuel analysis and resultant parameter corrections are required to account for moisture and chemical changes.

BEFF (and ASME) considers boiler casing radiation losses and miscellaneous fixed percentage losses (blowdown, unburned fuel, ...). Most portable combustion analyzers do not account for these losses and will typically indicate combustion efficiency, not boiler efficiency. Therefore, most portable combustion analyzers will indicate a higher efficiency than the **BEFF** (and ASME) method.

Default Fuels: The "Fuel A" default Parameters below are for #6 fuel oil, "Fuel B" defaults are for Natural Gas. Contact Preferred Instruments for Parameter values for other fuels.

NAME:		BEFF	SINGLE USE FUNCTION:		N	OUTPUT TYPE:		A
Input	Type	Description	Notes					
1	A	EXIT TEMPERATURE INPUT	1					
2	A	AMBIENT TEMP INPUT	1,2					
3	A	% OXYGEN INPUT	1					
4	A	PPM CO INPUT	1,3					
5	A	% FIRING RATE INPUT	1					
6	D	FUEL SELECT INPUT (0 = FUEL A, 1 = FUEL B)	4					
Parameter	Description		Default	Max	Min	Code	Notes	
1	% O2 FULL SCALE		10.00	25.00	10.00	2		
2	PPM CO FULL SCALE		1000	5000	1000	2		
3	EXIT TEMPERATURE FULL SCALE		1000	2000	300	2		
4	AMBIENT TEMPERATURE FULL SCALE		100	1000	100	2		
5	% LOSS DUE TO RADIATION AT 100% FIRING RATE		0.75	5.00	0.00	2	5	
6	% LOSS DUE TO MISC FIXED LOSSES		1.00	5.00	0.00	1		
<u>Fuel A Components: Moles/Unit of Fuel Burned</u>			(Default = #6 Oil)				6	
7	FUEL A MOLES OF C		7.377	12.000	0.000	2		
8	FUEL A MOLES OF H2		3.175	6.000	0.000	2		
9	FUEL A MOLES OF S		0.027	6.000	0.000	2		
10	FUEL A MOLES OF N2		0.011	2.000	0.000	2		
11	FUEL A MOLES OF O2		0.022	2.000	0.000	2		
12	FUEL A MOLES OF H2O		0.011	5.000	0.000	1		
13	FUEL A HEATING VALUE MILLIONS OF BTUS/UNIT OF FUEL		1.812	2.500	0.100	2		
<u>Fuel B Components: Moles/Unit of Fuel Burned</u>			(Default = Nat. Gas)				6	
14	FUEL B MOLES OF C		1.050	12.000	0.000	2		
15	FUEL B MOLES OF H2		2.000	6.000	0.000	2		
16	FUEL B MOLES OF S		0.000	6.000	0.000	2		
17	FUEL B MOLES OF N2		0.050	2.000	0.000	2		
18	FUEL B MOLES OF O2		0.000	2.000	0.000	2		
19	FUEL B MOLES OF H2O		0.000	5.000	0.000	1		
20	FUEL B HEATING VALUE MILLIONS OF BTUS/UNIT OF FUEL		0.409	2.500	0.100	2		

Notes:

1. All analog input signals must be "zero" based. 0% Input = 0 deg. F, 0% Oxygen, 0 ppm CO, 0 Btu Input. Non-zero-based signals can be converted with a SCALE (F45) Block.
2. If the CO signal is not available, leave this block at its 0% default value.
3. This Input is 0-100% Fuel Btu Input, NOT 0-100% of operating range. If a burner has an 8:1 turndown, this Input should be 12.5% at low fire. A SCALE (F45) Block can be used to convert a 0-100% operating range to Fuel Input %. This Input only affects the Radiation (i.e. boiler sheathing) losses.
4. 0 = Fuel A = (#2 Oil by default), 1 = Fuel B = (Natural Gas by default)

5. Radiation (boiler sheathing) heat loss is a nearly constant Btu/hr rate (i.e., a fixed quantity, but not a fixed percentage of Btu Input)). Enter as a Percentage of maximum firing rate Btu Input. Radiation Loss = [(Parm 5 * 100) / Input 5]
6. Typical "Units of Fuel" are:

Liquid and Solid Fuels:	Moles/100 lbs. Fuel burned
	Million Btu/100 lbs Fuel burned
Gaseous Fuels:	Moles/Mole of Fuel burned
	Million Btu/Mole of Fuel burned
7. Contact Preferred Instruments for Parameter values for other fuels. Constants for any fuel can be calculated if the chemical analysis of the fuel is known.

F31 [HSEL] High Select

Function **HSEL** selects the greater of the three Inputs and copies that value to its Block Output. If there are only two Inputs, connect either one of the two active Input Block numbers to the third Input.

NAME: HSEL		SINGLE USE FUNCTION: N		OUTPUT TYPE: A
Input	Type	Description	Notes	
1	A	A INPUT		
2	A	B INPUT		
3	A	C INPUT		

No Parameters

F32 [LSEL] Low Select

Function **LSEL** selects the lowest (i.e. smaller) of the three Inputs and copies that value to its Block Output. If there are the only two Inputs, connect either one of the two active Input Block numbers to the third Input.

NAME: LSEL		SINGLE USE FUNCTION: N		OUTPUT TYPE: A
Input	Type	Description	Notes	
1	A	A INPUT		
2	A	B INPUT		
3	A	C INPUT		

No Parameters

F33 [MSEL] Median Selector

Function **MSEL** selects the median (i.e., middle) of the three Inputs and copies that value to its Block Output. Examples:

A Input	B Input	C Input	Block Output
10 %	15%	14%	14%
5 %	- 10%	12 %	5 %
77 %	78 %	78 %	78 %

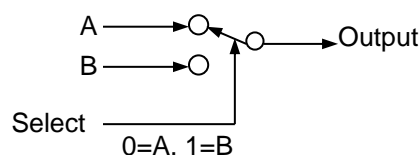
If this function is configured with only two active Inputs, the third Input will be the default Block 0 [A0%]. In this case, the Median selection would compare the two active Inputs to 0%.

NAME: MSEL		SINGLE USE FUNCTION: N		OUTPUT TYPE: A	
Input	Type	Description			Notes
1	A	A INPUT			
2	A	B INPUT			
3	A	C INPUT			

No Parameters

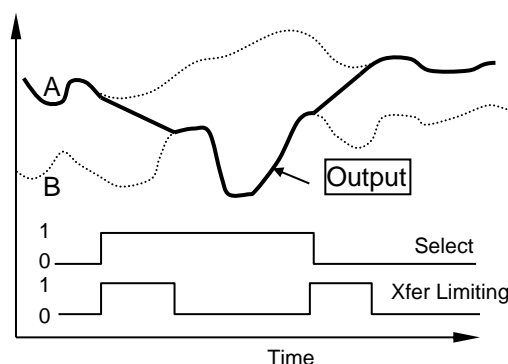
F34 [ASW] Analog Switch

Function **ASW** is used to switch the Block Output between one of two analog Input signals under control of a discrete (on/off) Select signal. The concept is like an SPDT relay or 3 port solenoid valve. When the Select signal is 0 (low) the "A" analog Input is selected and passed to the **ASW** Block Output. When Select = 1 (high), the "B" signal is passed to the Output.



Transfer Rate Limiting: When Parameter 1 = 0 (Transfer Rate Limiting is OFF), the Block Output changes instantaneously when the Select Input changes.

When Parameter 1 = 1 (Transfer Rate Limiting is ON), the rate of change of the Block Output signal is limited for the duration of the transfer. After the Block Output becomes equal to the selected Input, the rate limiting is disabled and the Output will track the selected Input with no rate of change limiting. Independent rate-of-change limits are provided for A to B, and B to A transfers.



The Transfer Rate of Change feature can be used to provide bumpless transfer, and for ramp generators.

NAME:		ASW	SINGLE USE FUNCTION:			N	OUTPUT TYPE:		A
Input	Type	Description						Notes	
1	A	A INPUT							
2	A	B INPUT							
3	D	SELECT INPUT (0 = A Input, 1 = B Input)						1	
Parameter	Description		Default	Max	Min	Code	Notes		
1	XFER RATE LIMITING 0=OFF 1=ON		0	1	0	2	2		
2	A TO B %/SEC RATE LIMIT		1.00	100.00	0.10	2			
3	B TO A %/SEC RATE LIMIT		1.00	100.00	0.10	2			

Notes:

- Output = "A" Input when "Select" = 0, Output = "B" Input when "Select" = 1
- When "Xfer Rate Limiting" = 0, the Output changes instantaneously when "Select" changes.

F35 [H/LLIM] High / Low Signal Limiter

Function **H/LLIM** passes the Input to the Block Output if the value is less than Parameter 1 (Hi Limit), and greater than Parameter 2 (Low Limit). If the Input is outside of these limits, the Block Output is held at the appropriate limit value. The limits can be positive/positive, positive/negative, or negative/negative; however, the Hi Limit must be greater than the Low Limit.

NAME: H/LLIM SINGLE USE FUNCTION: N OUTPUT TYPE: A

Input Type Description Notes

1 A INPUT

Parameter	Description	Default	Max	Min	Code	Notes
1	HI LIMIT	100.00	199.99	-199.98	2	1
2	LOW LIMIT	0.00	199.98	-199.99	2	1

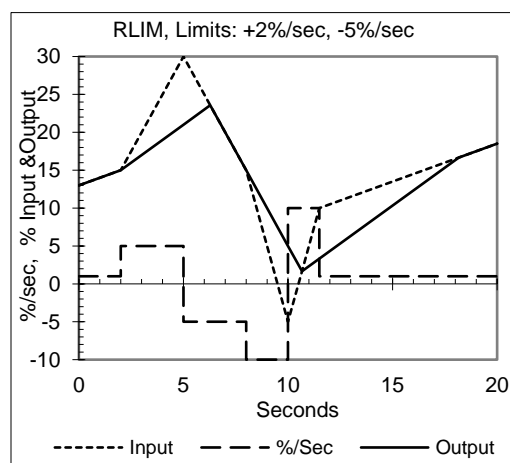
Notes:

1. The Hi Limit MUST be greater than the Low Limit.

F36 [RLIM] Rate Limiter

Function **RLIM** compares the %/sec rate of change of the Input analog signal to Parameter 1 (increasing) & 2 (decreasing) rate of change limits. Whenever the Input rate of change is between the two limits, the Input is passed to the Block Output. If the Input rate of change exceeds either limit, the Output will ramp at the appropriate rate limit until the Output becomes equal to the Input.

The Input rate of change is ignored during the output rate limiting mode. Therefore, if the Input rate of change briefly exceeds one of the limits, and then returns to a moderate rate, the Block Output will lag the Input until the Output becomes equal to the Input again.



NAME: RLIM SINGLE USE FUNCTION: N OUTPUT TYPE: A

Input Type Description Notes

1 A INPUT

Parameter	Description	Default	Max	Min	Code	Notes
1	+ %/SEC LIMIT	10.00	100.00	0.10	2	
2	- %/SEC LIMIT	-10.00	-0.10	-100.00	2	

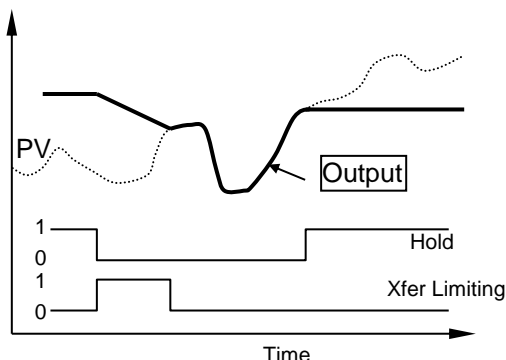
F38 [FPT/H] Front Panel Adjustable Track / Hold

Function **FPT/H** is a Track/Hold that allows the Operator to adjust the Block Output from the Front Panel display when the Block is in Hold mode. Its function is equivalent to an Auto/Manual, or Remote/Local station.

Track Mode: When the Block is in Track mode (like Auto or Remote), the Block Output is set equal to the "Signal" Input. That is, the Block Output "tracks" the Block Input.

Hold Mode: When the Block is in Hold mode (like Manual or Local), the Block Output remains at the last value unless changed by the Operator or the Modbus communications link. In Hold mode, if the Operator selects a **FPT/H** Block for display on the front panel, the Block Output can be changed with the front panel UP-DOWN arrows.

After the Operator completes the change, the Block Output will remain at the last value until the next Operator change or until the Block goes into Track mode. The **FPT/H** Block must have a Tag configured in the Panel Data Screen to allow changes from the front panel. In Hold mode, the Modbus communications link can change the Block output by writing a new value to the Block Output.



Mode Selection: The Track/Hold mode is normally determined by the "Hold Select" Input (0 = Track mode, 1 = Hold mode). However, the optional Track Override Inputs can override the "Hold Select" Input. If either "Track Override" Input is set to a discrete "1", the "Hold Select" Input is ignored and the Block is forced into the Track mode (see below). If no Blocks are connected to these Inputs, the default value of Discrete 0 Inputs disable the override feature.

TRACK OVERRIDE 1	TRACK OVERRIDE 2	HOLD	Track/Hold Mode
0	0	0	Track
0	0	1	Hold
0	1	not used	Track
1	0	not used	Track
1	1	not used	Track

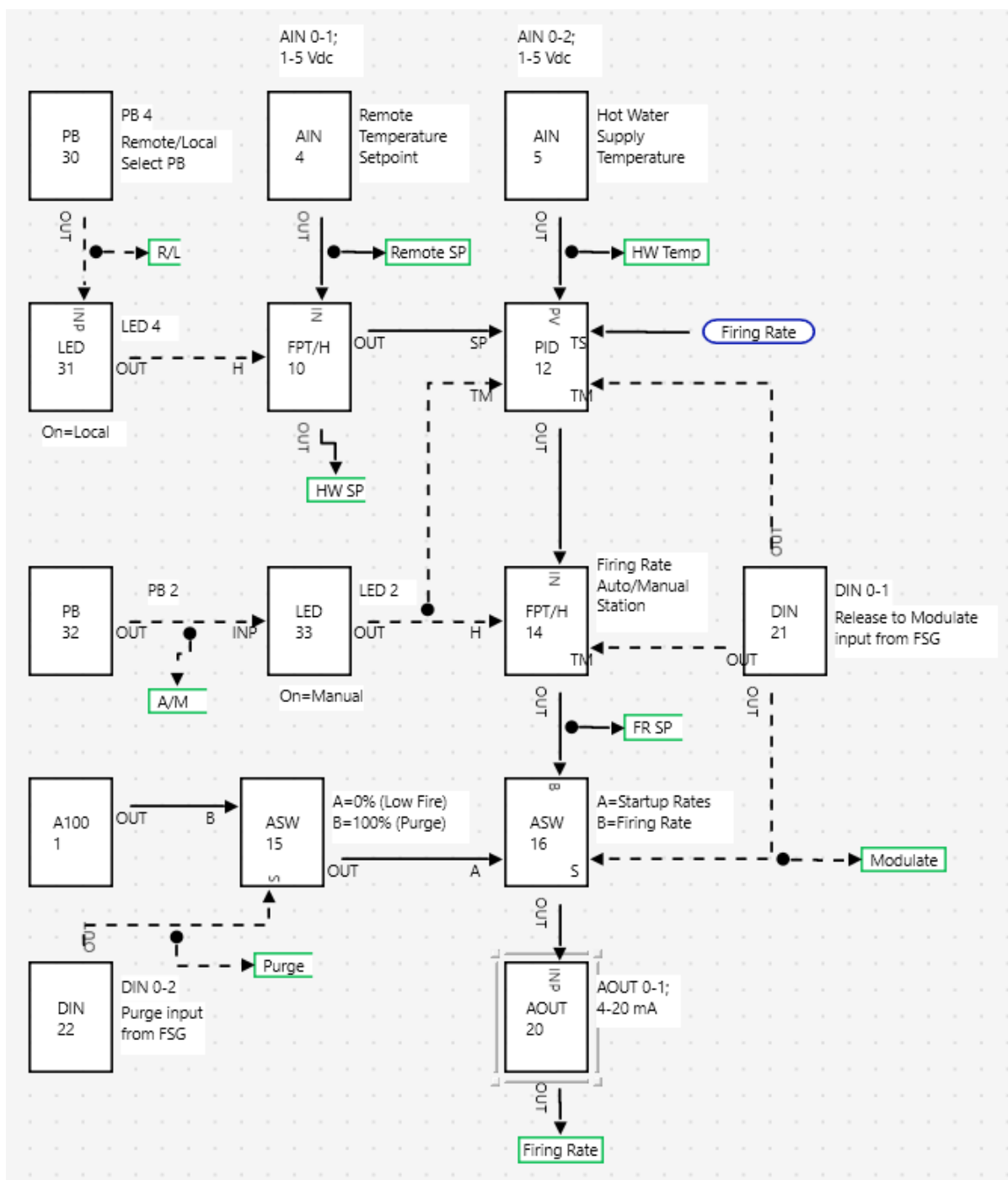
Transfer Rate Limiting is OFF when Parameter 3 (Transfer Rate Limit) equals 100%/sec, and the transfer from Hold mode to Track Mode is instantaneous. That is, the Block Output is set equal to the Signal Input during the first scan of the mode change.

Transfer Rate Limiting is ON when the Transfer Rate Limit is less than 100%/sec. The rate of change of the Block Output signal is limited to (Parameter 3) %/sec for the duration of the transfer from the last Hold Mode Block Output to the current Signal Input. When the Block Output becomes equal to the Signal Input, the rate limiting is disabled and the Output will track the Signal Input with no rate of change limiting. The Transfer Rate of Change feature is used primarily to provide bumpless transfer.

In ALL cases, the Block Output is limited to the Min and Max Output values set in Parameters 1 & 2.

For applications that only require a simple Track/Hold function without any Operator adjustment capability, simply use **FPT/H** without connecting **FPT/H** to a front panel display channel.

At power down, the Block Output is saved in the Retentive Memory area of the NVRAM. During the first scan after CPU start-up, the **FPT/H** Block Output is set to the value stored in the Retentive Memory.



The Blockware Example shows typical applications of the FPT/H function. Block 14 is the **FPT/H** Manual/Auto station for the control loop. Before the burner releases to modulation, the **FPT/H** "TM" Input and the **PID** "TM" Input force both Blocks to Track the Firing Rate Output (Block 20). This insures a bumpless, balance-less transfer from light-off to modulate.

The second **FPT/H**, Block 10, is used to implement a remote setpoint with local manual override strategy. In Remote mode, the **PID** setpoint will be the Remote setpoint. When the Operator presses the pushbutton to put the controller in Local setpoint mode, the setpoint will initially be held at the most recent remote setpoint, and the Operator can then adjust it to any desired value. The Transfer Rate Limiting would be used to prevent a rapid setpoint change when transferring from Local Setpoint mode back to Remote Setpoint mode.

NAME:		FPT/H		SINGLE USE FUNCTION:		N		OUTPUT TYPE:		A	
Input	Type	Description						Notes			
1	A	SIGNAL INPUT									
2	D	HOLD SELECT INPUT		(1 = HOLD)				1			
3	D	TRACK OVERRIDE INPUT		(1 = TRACK)				1			
4	D	TRACK OVERRIDE INPUT		(1 = TRACK)				1			
Parameter		Description				Default	Max	Min	Code	Notes	
1		MIN OUTPUT				0.00	199.99	-199.99	2	2	
2		MAX OUTPUT				100.00	199.99	-199.99	2	2	
3		% / SEC TRANSFER LIMIT (100% = OFF)				100.00	100.00	0.10	2		

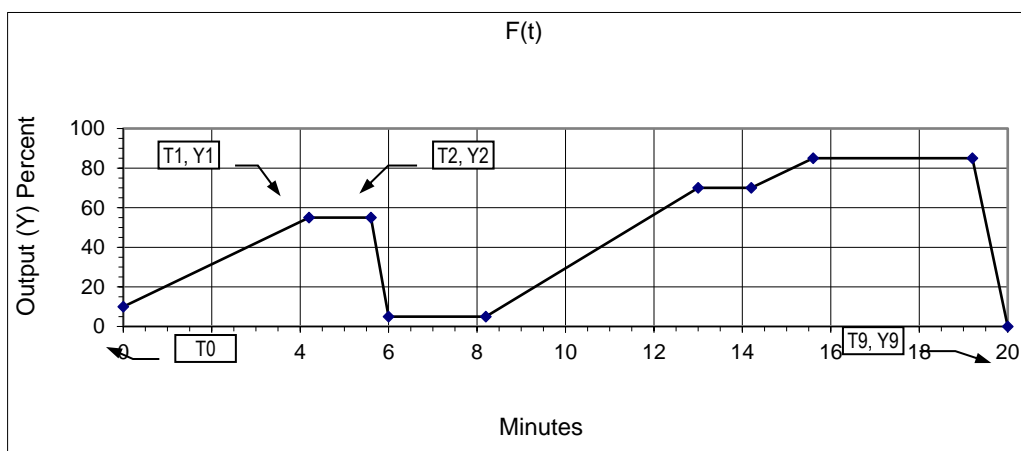
Notes:

1. See Track / Hold truth table above.
2. Max Output MUST be larger than Min Output limit.

F41 [F(T)] Function of Time Generator

Function **F(T)** generates a Block Output based on a user generated output vs time profile. The parameters provide an initial (y_0) Block Output value (at time = 0.0 min), plus 10 additional (y, t) breakpoint pairs. Between each breakpoint pair, the function ramps in a straight-line fashion from breakpoint to breakpoint (see the figure below). Individual segment slopes from 600%/min to 0.01%/min can be generated.

A typical application is temperature setpoint generation for Heating or Cooling Ramp/Soak cycles.



Less than 10 Breakpoints: All ten breakpoints do not have to be used, the **F(T)** function ignores all breakpoints after the first $T_i = 0.0$ is encountered. Breakpoints 4 through 10 (inclusive) would be ignored in this example: $Y_0=10\%$; ($Y_1=20\%$, $T_1=10.0$); ($Y_2=20\%$, $T_2=20.0$); ($Y_3=30\%$, $T_3=30.0$); ($Y_4=0\%$, $T_4=0.0$).

Reset and Hold Inputs: The Reset Input sets and holds the clock at 0.0 minutes whenever the Reset Input is "1". If the Hold Input is "0", the clock will start to run when the Reset Input is "0". Setting the Hold Input to "1" stops the clock, and the time will remain at that value until the Hold Input returns to "0", at that point the clock resumes running from the held value onward (see chart).

Reset Input	Hold Input	Clock
1	not used	0.0 min
0	0	Run / Resume
0	1	Stop and Hold

Auto-Recycle: If Parameter 1 (Auto Recycle) = 0, the Block Output will remain at Y_i , when the clock reaches the last valid T_i . If Parameter 1 (Auto Recycle) = 1, when the clock reaches the last valid T_i , the clock resets to 0.0 min and repeats the ramp sequence.

At power down, the clock run time is saved in the Retentive Memory area of the NVRAM. During the first scan after CPU start-up, the clock run time is set to the value stored in Retentive Memory. This feature can be bypassed by forcing the Block logic to set the Reset Input = 1 at power-up.

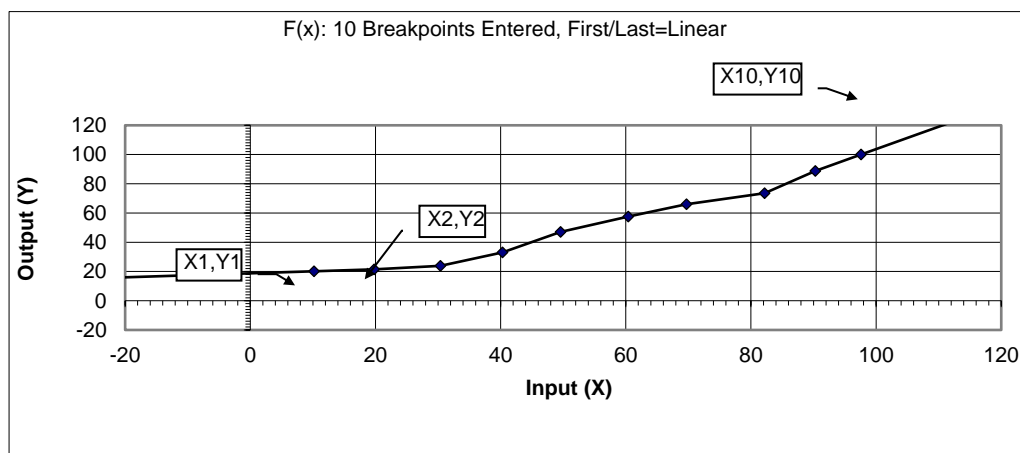
NAME:		F(T)		SINGLE USE FUNCTION:		N		OUTPUT TYPE:		A	
Input	Type	Description				Notes					
1	D	HOLD INPUT (1=HOLD)				1					
2	D	RESET INPUT (1=RESET)				1					
Parameter		Description				Default	Max	Min	Code	Notes	
1	AUTO RECYCLE 0=NO 1=YES				0	1	0	2			
2	Y0 %				0.00	150.00	-150.00	2			
3	T1 MINUTES				0.0	1999.9	0.0	2	2		
4	Y1 %				0.00	150.00	-150.00	2			
5	T2 MINUTES				0.0	1999.9	0.0	2	2		
6	Y2 %				0.00	150.00	-150.00	2			
7	T3 MINUTES				0.0	1999.9	0.0	2	2		
8	Y3 %				0.00	150.00	-150.00	2			
9	T4 MINUTES				0.0	1999.9	0.0	2	2		
10	Y4 %				0.00	150.00	-150.00	2			
11	T5 MINUTES				0.0	1999.9	0.0	2	2		
12	Y5 %				0.00	150.00	-150.00	2			
13	T6 MINUTES				0.0	1999.9	0.0	2	2		
14	Y6 %				0.00	150.00	-150.00	2			
15	T7 MINUTES				0.0	1999.9	0.0	2	2		
16	Y7 %				0.00	150.00	-150.00	2			
17	T8 MINUTES				0.0	1999.9	0.0	2	2		
18	Y8 %				0.00	150.00	-150.00	2			
19	T9 MINUTES				0.0	1999.9	0.0	2	2		
20	Y9 %				0.00	150.00	-150.00	2			
21	T10 MINUTES				0.0	1999.9	0.0	2	2		
22	Y10 %				0.00	150.00	-150.00	2			

Notes:

1. See chart above for REST and HOLD Input operation.
2. Times must be entered in ascending order. Starting from T0 and scanning toward T10, all breakpoints after the first $T_i = 0.0$ will be ignored.

F42 [F(X)] Function of X Generator with Learn Mode

Function **F(X)** generates a Block Output based on a user generated Output vs Input profile (i.e., $y=f(x)$). The parameters provide 11 (X, Y) breakpoint pairs. Between adjacent breakpoints, **F(X)** “draws” a straight line from breakpoint to breakpoint (see the figure below).



Less than 11 breakpoints: All eleven breakpoints do not have to be used. Starting from X_1 , **F(X)** ignores all breakpoints after the first $X_i = -150.00$ is encountered. Example: $Y_1=10\%$, $X_1=0.00\%$; $Y_2=22\%$, $X_2=20.00\%$; $Y_3=29\%$, $X_3=30.0$; $Y_4=0\%$, $X_4=-150.00$. Breakpoints 4 through 11 (inclusive) would be ignored in this example. The X coordinates can be any value; however, the X values must be entered in ascending order (i.e. $X_1 < X_2 < X_3 < X_4 \dots$).

First/Last Segments: For X Inputs below the first or above the last defined breakpoints, the Block Output can be held at the last valid Y value (Hold mode), or the Block Output can vary per the last valid line segment equation (Linear mode). Parameter 1 (First/last Segment) = 0 holds the Output, Parameter 1 = 1 varies the Output linearly. The figure above illustrates Linear mode. At least two points must be entered to activate Linear Mode.

Learn Mode

X and Y coordinates may be entered or modified at any time from the PCC-IV front panel editor, the USB port, or the MODBUS communications port (via PLINK). **F(X)** also has a **Learn** mode for automated entry and editing of characterizing curves. **Learn** mode is particularly useful for setting up the various curves associated with combustion applications: fuel/air ratio, oxygen setpoint, flue gas recirculation curves, furnace draft feedforward, and feedwater valve characterizer curves.

When Input 2 (Learn Enable) = 1 the **Learn** mode is activated and Inputs 3, 4, and 5 determine how **Learn** mode operates. Inputs 3-5 are ignored when Input 2 (Learn Enable) = 0. The Block Output continues to be calculated based on the X input and the current parameters throughout **Learn** mode. See the truth table below:

Learn Enable Input	Learn Input	Clear Input	Action
0	not used	not used	Learn mode is disabled
1	0	not used	No (X, Y) data is stored in the parameters
1	1	not used	No (X, Y) data is stored in the parameters
1	^1	0	The current X and Y Input values are stored in a pair of parameters (see below)
1	^1	1	All X and Y parameters are reset to the default values

NOTE: **^1** means: on the rising edge (i.e., only once during the scan that the Input changes from 0 to 1)

Automated Storing of (X, Y) Data in Learn Mode:

If the Learn Enable Input = 1, and Clear Input = 0, Then: During the first scan that the Learn Input changes from 0 to 1; the current X and Y Inputs are stored in a (X_i, Y_i) parameter pair. The rules for selecting the (X_i, Y_i) parameter pair are as follows:

If less than 11 "active X" Parameters exist (i.e., X_i > -150.00%):

Is the current "X" Input within +/- 2.00% of an existing "X" Parameter?

Yes: Replace the existing (X, Y) parameter values with the "X" and "Y" Inputs.
This allows you to "Edit" an existing "Y" value using Learn Mode.

No: Store the current "X" and "Y" Inputs in a new (X_i, Y_i) parameter pair such that the "X" values remain in ascending order (i.e. X₁ < X₂ < X₃ < X₄ ...).
F(X) automatically moves all (X, Y) parameter pairs above X_i up one position.

If 11 active "X" Parameters exist:

Replace the existing breakpoint (X, Y) parameter pair that is closest to the current "X" value with the current "X" and "Y" Inputs.

The above process only occurs during the first scan that the Learn Input changes from 0 to 1. If Learn = 1 for more than one scan, the subsequent scans do not "Learn" any additional values.

"Clearing" (X, Y) Data

If the Learn Enable Input = 1, and Clear Input = 1, Then: During the first scan that the Learn Input changes from 0 to 1; all eleven "Y" parameters are set equal to Parameter 24, the "Y VALUES AFTER CLEAR" parameter. All eleven "X" Parameters are set equal to -150.00% (i.e., inactive). This allows the Block Output to be set to a defined value until a new curve is entered.

Blockware Example: The Blockware on the next page shows a simplified parallel positioning combustion control application that uses two **F(x)** Blocks. The **F(x)** in Block 55 holds the fuel-to-air characterizing curves for one fuel. The **F(x)** in Block 62 holds the Oxygen Setpoint versus Load (i.e. Firing Rate) characterizing curves for one fuel. A second or third fuel could be accommodated by adding additional **F(x)** Blocks and **ASW** Blocks to select the correct **F(x)** Block based on the fuel currently being fired.



WARNING:

This simplified example does not show all the required safety features that would be included in a real combustion control strategy. Do not use the Blockware example shown for an actual application.

The Blockware is configured to use Learn Mode for simultaneous entry of the fuel/air and Oxygen Setpoint/Load **F(x)** curves. The general procedure a Burner Technician would follow is:

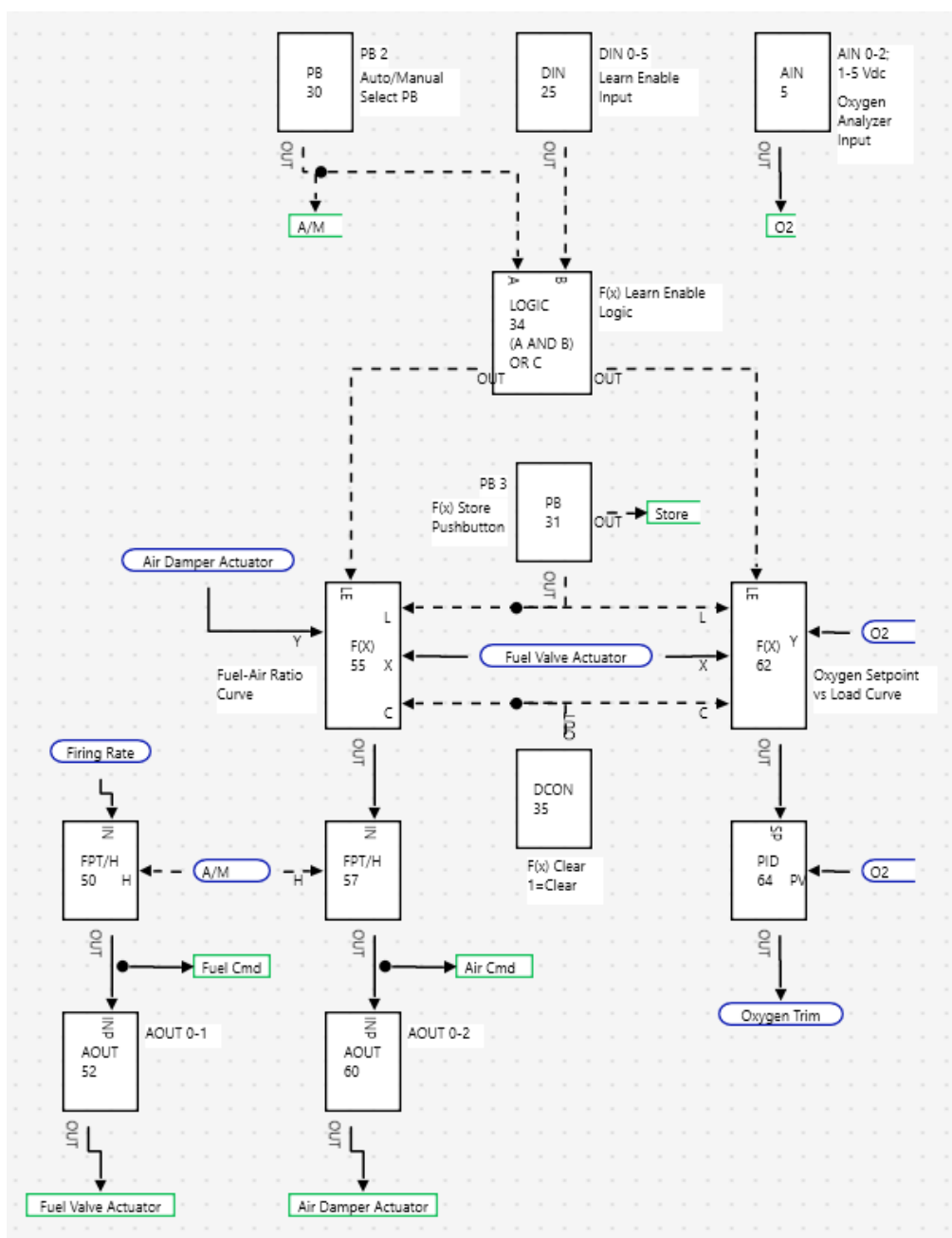
- 1.) Enable Learn Mode
- 2.) Put BOTH the Fuel and Air Actuators in Manual
Manually position the Fuel and Air at Minimum Firing Rate for best combustion
Allow the Oxygen Analyzer signal to stabilize
Press the front panel pushbutton that is configured as the "STORE" button.
Block 55 will add an (X, Y) breakpoint for the current fuel (X) and air (Y) positions.
Block 62 will add an (X, Y) breakpoint for the current fuel (X) and Oxygen (Y) Levels.
- 3.) Repeat the above 4 steps at 10 additional firing rates (less if applicable). Make sure that the Maximum firing rate is "Stored".
- 4.) Disable Learn Mode



WARNING:

In a combustion application, it is not safe to leave the Learn Mode enabled during normal operation. An accidental "Store" operation would instantly change the fuel/air ratio. The Blockware should include sufficient logic and interlocks to prevent unsafe conditions.

The example below requires an external "Learn Enable" input to be a "1" (**DIN** Block 25), and both the fuel and air must be in Manual before "Learn Mode" is enabled. A **DCON** could also be used as a permissive, **DCON** requires a "Technician" level password to enable changing its Parameter.



WARNING: This simplified example does not show all the required safety features that would be included in a real combustion control strategy. Do not use the Blockware example shown for an actual application.

NAME: F(X) SINGLE USE FUNCTION: N OUTPUT TYPE: A

Input	Type	Description	Notes
1	A	X INPUT	
2	D	LEARN ENABLE INPUT (1=ENABLE)	1
3	D	LEARN INPUT (^1=LEARN)	2,3
4	D	CLEAR INPUT (^1=CLEAR)	2,4
5	A	Y INPUT	5

Parameter	Description	Default	Max	Min	Code	Notes
1	FIRST/LAST SEGMENT 0=HOLD 1=LINEAR	0	1	0	2	
2	X1	0.00	150.00	-150.00	2	6
3	Y1	0.00	150.00	-150.00	2	
4	X2	100.00	150.00	-150.00	2	6
5	Y2	100.00	150.00	-150.00	2	
6	X3	-150.00	150.00	-150.00	2	6
7	Y3	50.00	150.00	-150.00	2	
8	X4	-150.00	150.00	-150.00	2	6
9	Y4	50.00	150.00	-150.00	2	
10	X5	-150.00	150.00	-150.00	2	6
11	Y5	50.00	150.00	-150.00	2	
12	X6	-150.00	150.00	-150.00	2	6
13	Y6	50.00	150.00	-150.00	2	
14	X7	-150.00	150.00	-150.00	2	6
15	Y7	50.00	150.00	-150.00	2	
16	X8	-150.00	150.00	-150.00	2	6
17	Y8	50.00	150.00	-150.00	2	
18	X9	-150.00	150.00	-150.00	2	6
19	Y9	50.00	150.00	-150.00	2	
20	X10	-150.00	150.00	-150.00	2	6
21	Y10	50.00	150.00	-150.00	2	
22	X11	-150.00	150.00	-150.00	2	6
23	Y11	50.00	150.00	-150.00	2	
24	Y VALUE AFTER CLEAR	100.00	150.00	-150.00	2	

Notes:

- 1 = Learn Mode enabled, 0 = disabled.
- This Input is ignored if LEARN ENABLE Input = 0.
- The Learn Event is active during the single scan when the LEARN Input changes from 0 to 1, AND (LEARN ENABLE Input equals 1 and CLEAR Input equals 0).
- The Clear Event is active during the single scan when the LEARN Input changes from 0 to 1, AND (LEARN ENABLE Input equals 1 and CLEAR Input equals 1).
- The Y Input value is only used during the single scan of a Learn Event. The Input is limited to +/- 150.00%.
- The X coordinates MUST be in ascending order, that is: X1 < X2 < X3 < X4 ... < X11.
- Xi = -150.00 indicates that the (X, Y) pair is inactive (i.e., not being used). All inactive (X, Y) pairs must be the "upper" X's (i.e. X11, X10, X9, ...). F(x) determines how many of the eleven (X, Y) breakpoints to use by starting at X1, and scanning up looking for the first Xi = -150.00. That pair and all pairs above it are ignored.

F43 [L/L] Lead – Lag with Gain (Dynamic Compensation)

Function **L/L** provides Lag, Lead, and Gain compensation in a single Block. Lag is a digital filter operation and is the first operation performed on the Input. Lead is a Derivative (or Rate) operation, and is performed on the result of the Lag filter. Gain is a simple multiplier that acts on the result of the Lead operation.

Lag and Gain operations can be used alone or in combination with any other operation. Lead requires Lag to be non-zero, and the ratio: (Lead seconds / Lag seconds) must be less than 15.

The Lag seconds is the time it takes for a step Input to drive the Output to 63% of the Input change. A larger value provides more damping.

The Lead Seconds is the derivative gain; that is: {Rate (%/Sec) * Lead (Sec) = %}. A larger value provides a larger response to a signal change.

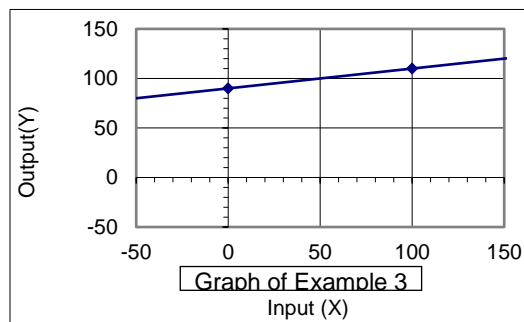
NAME:		L/L	SINGLE USE FUNCTION:			N	OUTPUT TYPE:		A
Input	Type	Description						Notes	
1	A	PV INPUT							
Parameter		Description	Default	Max	Min	Code	Notes		
1		LAG SECONDS	0	1800	0	2	1,2,3		
2		LEAD SECONDS	0	1800	0	2	1,2,3		
3		GAIN	1.00	20.00	0.01	2			

Notes:

- 0 = Off
- Lag seconds must be greater than 0, if Lead is greater than 0
- The ratio: (Lead Seconds / Lag Seconds) must be less than 15

F45 [SCALE] Signal Scaling

Function **SCALE** generates a Block Output based on two (X, Y) scaling points. X is the Block Input, and Y is the Block Output. The straight line defined by scaling points (X₁, Y₁) and (X₂, Y₂) continues beyond the two defined points and generates a Block Output within the +/- 327% limitations of the Input and Output. See examples below:



Example 1		Example 2		Example 3	
Input (X):	X1= 0 X2= 100	X1= 0 X2= 50	X1= 0 X2= 100	X1= 0 X2= 100	
Output (Y):	Y1= 50 Y2= 0	Y1= 0 Y2= 100	Y1= 90 Y2= 110	Y1= 90 Y2= 110	

NAME: SCALE		SINGLE USE FUNCTION: N			OUTPUT TYPE: A		
Input	Type	Description	Notes				
1	A	SIGNAL INPUT					
Parameter	Description		Default	Max	Min	Code	Notes
1	X1		0.00	150.00	-150.00	2	
2	Y1		0.00	150.00	-150.00	2	
3	X2		100.00	150.00	-150.00	2	
4	Y2		100.00	150.00	-150.00	2	

F51 [AB/C] (A*B) / C Multiply - Divide

Function **AB/C** multiplies Input A by Input B, and then divides by Input C. **AB/C** then updates the Block Output with the result. Inputs within +/- 327% are acceptable, the Block Output is limited to +/- 327%.

Divide by Zero: If the C Input equals 0.00%, the Output will be set to 327.00% with the sign determined by the result A times B. For Example:

A	B	C	Output
100	100	100	100
50	100	100	50
100	100	50	200
75	51	50	76.50
-10	20	20	-10
10	1	0	+327
-1	0	0	-327

AB/C can be used for A*B multiplication (without dividing) by connecting Input C to dummy Block 1 (**A100** function, or 100%).

AB/C can be used for A/C division (without multiplying) by connecting Input B to dummy Block 1 (**A100** function, or 100%).

NAME:	AB/C	SINGLE USE FUNCTION:	N OUTPUT TYPE: A

Input	Type	Description	Notes
1	A	A INPUT	
2	A	B INPUT	
3	A	C INPUT	

No Parameters

F52 [WSUM] Weighted Sum

Function **WSUM** computes the following "Weighted Sum" equation:

$$\text{Output} = ((\text{Input A}) * K1) + ((\text{Input B}) * K2) + ((\text{Input C}) * K3) + K4$$

Configured with three Inputs and using the default parameters, **WSUM** adds the three Inputs. **WSUM** does not require three active Inputs, connect un-used Inputs to dummy Block 0 (**A0** function, or 0%). Constants K1 through K4 allow **WSUM** to be used for addition, subtraction, averaging, and scaling.

WSUM Examples:

Application	Desired equation	Actual equation	K1	K2	K3	K4
Addition	A + B	(A*1.000)+(B*1.000)+((0%)*1.000)+0.00	1.000	1.000	n/a	0.00
Addition	A + B + C	(A*1.000)+(B*1.000)+(C*1.000)+0.00	1.000	1.000	1.000	0.00
Subtraction	A - B	(A*1.000)+(B*-1.00)+((0%)*1.000)+0.00	1.000	-1.000	n/a	0.00
Averaging	(A + B) / 2	(A*0.500)+(B*0.500)+((0%)*1.000)+0.00	0.500	0.500	n/a	0.00
Averaging	(A+B+C) / 3	(A*0.333)+(B*0.333)+(C*0.333)+0.00	0.333	0.333	0.333	0.00
Scaling: 0-100% xmtr Input is equivalent to 50-75% setpoint	0.25A + 50	(A*0.25)+(B*1.00)+((0%)*1.00)+50.00	0.250	n/a	n/a	50.00
Addition with Scaling (Weighted Sum) A: 0-100% = 0-50 gpm B: 0-100% = 0- 150 gpm C: 0-100% = 0- 200 gpm Output: 0-100% = 0-400 gpm	0.125A + 0.375B + 0.500C	(A*0.125)+(B*0.375)+(C*0.500)+0.00	0.125	0.375	0.500	0.00

Inputs within +/- 327% are acceptable, and the Block Output is limited to +/- 327%.

NAME:		WSUM		SINGLE USE FUNCTION:		N		OUTPUT TYPE:		A	
Input	Type	Description						Notes			
1	A	A INPUT									
2	A	B INPUT									
3	A	C INPUT									
Parameter		Description				Default	Max	Min	Code	Notes	
1	K1					1.000	10.000	-10.000	2		
2	K2					1.000	10.000	-10.000	2		
3	K3					1.000	10.000	-10.000	2		
4	K4					0.00	199.99	-199.99	2		

F53 [INV] Invert

Function **INV** negates its analog Input; that is: $\text{Output} = \text{Input} * -1$
For example: a +21% Input is converted to a -21% Output.

NAME: INV		SINGLE USE FUNCTION: N		OUTPUT TYPE: A	
<hr/>					
Input	Type	Description			Notes
<hr/>					
1	A	INPUT			

No Parameters

F54 [CON] Analog Constant

Function **CON** Outputs a user defined analog constant. This value can be changed via: the PCC-IV Editor menus (under password protection), via USB Blockware download, or via the MODBUS communications link (using **PLINK** F124). This value cannot be changed from the PCC-IV front panel Operator displays during normal operation.

NAME: CON		SINGLE USE FUNCTION: N		OUTPUT TYPE: A		
No Inputs						
Parameter	Description	Default	Max	Min	Code	Notes
1	ANALOG CONSTANT VALUE	0.00	199.99	-199.99	2	

F55 [FPCON] Front Panel Adjustable Constant

Function **FPCON** outputs a user defined analog constant. This value can be changed via: the PCC-IV front panel Operator displays during normal operation, or via the Modbus communications link. This value cannot be changed from the PCC-IV Editor menus, nor via the USB Blockware download. This function is used for Operator adjustable setpoints, ratios, channel selections, etc. ...

A **FPCON** Block must have a Tag associated with a Display Channel in the Panel Data Screen to allow the Operator to be able to change the value from the front panel Operator displays. The MIN and MAX parameters limit the range of adjustment that can be made.

At power down, the Block Output is saved in the Retentive Memory area of the NVRAM. During the first scan after CPU start-up, the **FPCON** Block Output is set to the value stored in the Retentive Memory.

NAME: FPCON		SINGLE USE FUNCTION: N		OUTPUT TYPE: A		
No Inputs						
Parameter	Description	Default	Max	Min	Code	Notes
1	MIN OUTPUT	0.00	199.99	-199.99	2	
2	MAX OUTPUT	100.00	199.99	-199.99	2	

F56 [DEV] Deviation Calculation (for Bargraph Displays)

Function **DEV** subtracts the two Inputs ... Process Variable (PV) and Setpoint (SP) ..., multiplies the difference by a gain, and then adds a 50% bias to the result. When used with a Tag to control one of the front panel Bargraphs, the bargraph will be at 50% when the two signals are equal, will be > 50% when PV > SP, and will be < 50% when PV < SP.

Parameter 1 is the "Proportional Band", that is the % deviation required to drive the Output from 50% to 100%. The **DEV** formula is:

$$\text{Block Output} = ((\text{PV} - \text{SP}) * (50 / \text{Parameter 1})) + 50\%$$

DEV Examples:

PV	SP	Parm. 1	Output
52	50	2.00	100.00
50	50	2.00	50.00
48	50	2.00	0.00
73	70	5.00	80.00

NAME: DEV		SINGLE USE FUNCTION: N			OUTPUT TYPE: A		
Input	Type	Description	Notes				
1	A	PV INPUT					
2	A	SP INPUT					
Parameter	Description		Default	Max	Min	Code	Notes
1	% OF PV=MAX DEVIATION		2.00	50.00	0.20	2	1

Notes:

1. PV-SP error is limited to +/- 300% internally.

F58 [COUNT] Pulse Counter

Function **COUNT** adds 0.01% to the Block Output during the first scan that the Pulse Input changes from a 0 to a 1 (i.e. on the rising edge), assuming (Parameter 1) the Pulse Divisor = 1. If the Pulse Divisor = 5, then 5 pulse rising edges must be received before the Output is incremented by 0.01.

The Block Output rolls over from 99.99% to 0.00% after 10,000 pulses. The Block output is forced to 0.00% when the Reset Input equals 1.

A typical application would be to count flow totalizer pulses, and then connect the **COUNT** Block Output to a Tag in a Front Panel Display channel. See the **TOT** function.

At power down, the Block Output is saved in the Retentive Memory area of the NVRAM. During the first scan after CPU start-up, the **COUNT** Block Output is set to the value stored in the Retentive Memory.

NAME:		COUNT	SINGLE USE FUNCTION:			N	OUTPUT TYPE:		A
Input	Type	Description					Notes		
1	D	PULSE INPUT	(^1=COUNT)					1	
2	D	RESET INPUT	(1=RESET)						
Parameter		Description			Default	Max	Min	Code	Notes
1	PULSE DIVISOR			1	19999	1	2		

Notes:

1. Increments Output on the rising edge of the Input (i.e., the first scan when Input becomes a 1)

F59 [SQRT] Square Root

Function **SQRT** provides a 0-100% scaled square root of a 0-100% Input signal. Negative Inputs result in a 0.00% Block Output. Inputs up to +327% are acceptable. For positive Inputs, the scaling formula is:

$$\text{Output} = 10 * (\text{square root}(\text{Input}))$$

Examples:

256% in = 160% out, 49% in = 70% out, 16% in = 40% out, 4% in = 20% out, 0% in = 0% out, -1% in = 0% out

NAME: SQRT		SINGLE USE FUNCTION: N		OUTPUT TYPE: A
Input	Type	Description	Notes	
1	A	INPUT BLOCK		

No Parameters

F60 [ABS] Absolute Value

Function **ABS** outputs the absolute value of the Input. That is: for Input > 0, the Output = Input; for Input < 0, the Output = Input * -1.

NAME: ABS		SINGLE USE FUNCTION: N		OUTPUT TYPE: A
Input	Type	Description	Notes	
1	A	INPUT		

No Parameters

F71 [PID] PID Control (with GAP and ADAPTIVE gain)

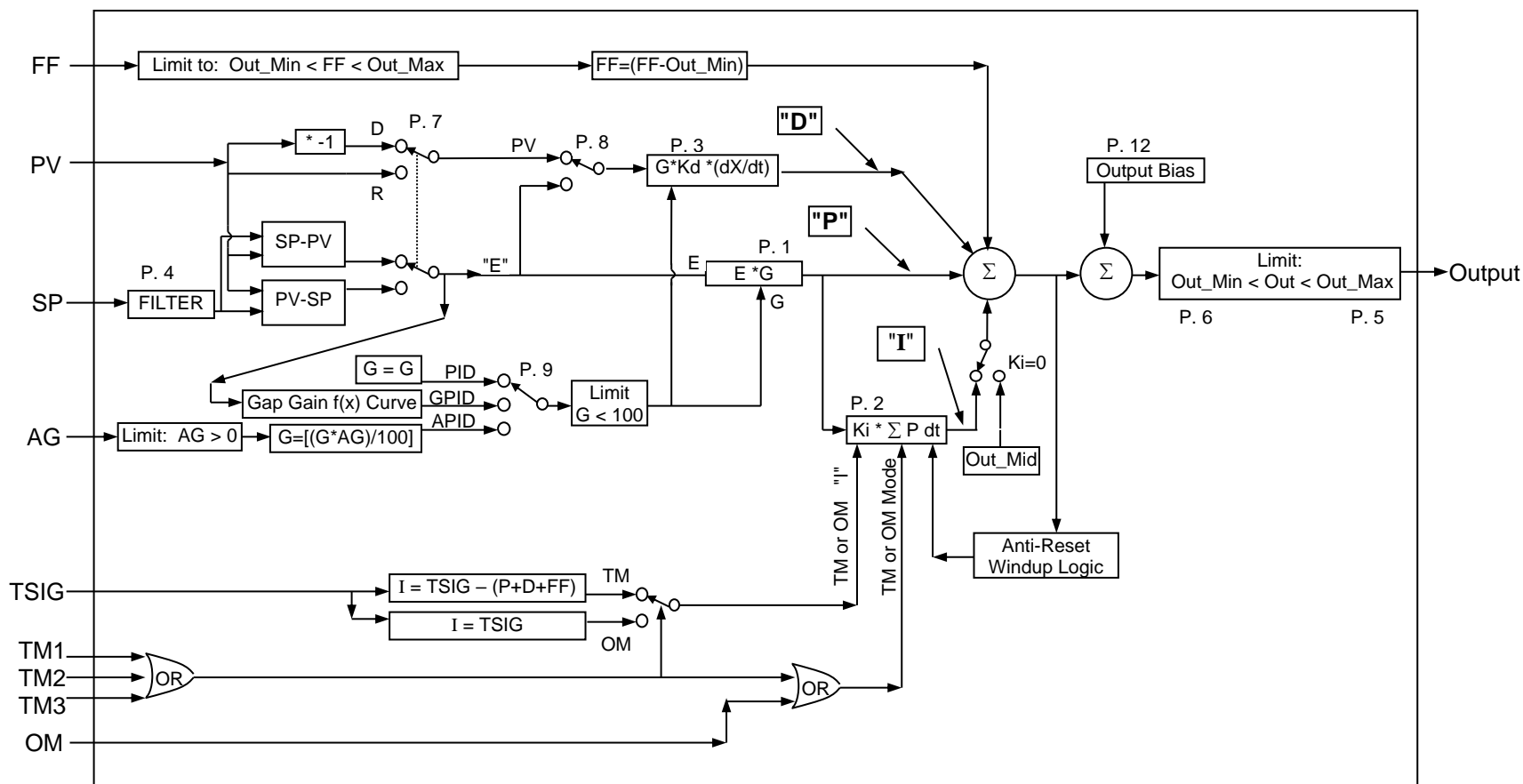
Function **PID** is a Proportional, Integral, Derivative control algorithm. The PID equation used is called the "Parallel" form by the ISA (Instrument Society of America); others have used the terms "Non-Interactive", or "Ideal" form. See figure below for **PID** logic schematic, see Appendix *** for PID tuning suggestions.

The Proportional constant is expressed as Gain, as opposed to "Proportional Band". To convert Proportional Band (i.e. "PB") into Gain: Gain = (100 / PB), or 5% PB is equal to a Gain of 20.00. A numerically larger Gain results in a larger **PID** output change for the same Process Variable (PV) versus Setpoint (SP) difference.

The Integral constant is expressed as "Repeats per Minute". A numerically larger Repeats/min results in a greater **PID** output % per minute ramp change for the same Process Variable (PV) versus Setpoint (SP) difference.

The Derivative constant is expressed as "Rate Minutes". A numerically larger Rate Minutes results in a greater **PID** output step change for the same Process Variable (PV) versus Setpoint (SP) percent per minute rate of change. The Derivative Input is low pass filtered at 1/10 of Rate Minutes to limit the Derivative Kick magnitude.

The optional Setpoint Filter (Parameter 4) can be used to reduce system upsets due to inadvertent rapid Setpoint changes by the Operator (see note 6).



Internal Schematic of PID (F71) Function Block

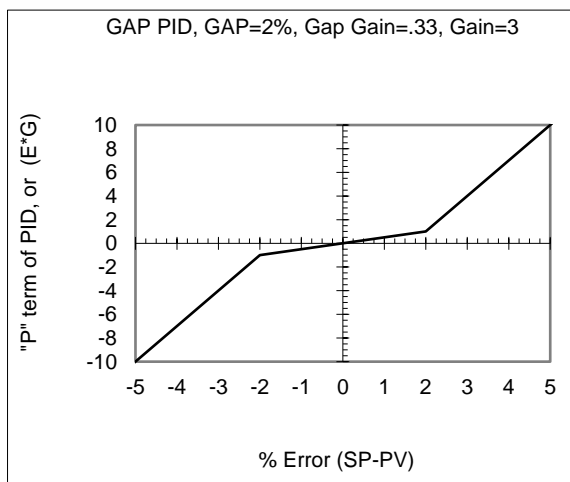
A Feedforward Input is provided which is summed with the P+I+D values prior to the Output Min/Max limiting logic. This prevents Integral Term Reset-Windup when feedforward control strategies are used.

For control logic that does not use Integral action, an Output Bias (Parameter 12) is provided to allow changing the **PID** Output mid-point (i.e. the Output when PV=SP), see notes 8 and 9.

Track Mode: Multiple Track Mode Inputs are provided to allow Blockware based bumpless transfer during: Manual to Auto, and Process Startup to Auto mode changes (see note 4). Track Mode causes the PID Output to be equal to the Track Signal Input by forcing the "I" (Integral) term of P + I + D. See **FPT/H** (F38) for a bumpless transfer Blockware example.

An Override Mode Input is provided to allow automatic Blockware based bumpless transfer in "Constraint" based control strategies (see note 5). Override Mode forces the "I" term to be equal to the Track Signal Input. Override Mode will not be enabled unless Repeats/min is greater than 0. An example of a Constraint based control logic is: One of several boilers on a header is burning a process off-gas ...modulate the burner's firing rate based on Plant Master firing rate, unless the off-gas supply pressure drops, then reduce firing rate to maintain a minimum off-gas supply pressure.

Non-linear systems such as pH, and furnace draft can be controlled more effectively by using the Gap PID or Adaptive gain **PID** modes (Parameter 9). Gap PID provides a simple dual gain strategy (i.e., lower gain near setpoint, higher gain farther away from setpoint). Adaptive gain PID allows the gain to be changed continuously as a function of a secondary variable using an **F(x)** Block (see notes 3 and 12).



NAME:	PID	SINGLE USE FUNCTION:	N	OUTPUT TYPE:	A		
Input	Type	Description			Notes		
1	A	PV INPUT					
2	A	SP INPUT					
3	A	TRACK SIGNAL INPUT			1		
4	A	FEED FORWARD INPUT			2		
5	A	ADAPTIVE GAIN INPUT			3		
6	D	TRACK MODE 1 INPUT (1=TRACK)			4		
7	D	TRACK MODE 2 INPUT (1=TRACK)			4		
8	D	TRACK MODE 3 INPUT (1=TRACK)			4		
9	D	OVERRIDE MODE INPUT (1=OVERRIDE)			4		
Parameter		Description	Default	Max	Min	Code	Notes
1		GAIN	10.00	100.00	0.10	2	
2		INTEGRAL, REPEATS/MIN 0=OFF	1.00	60.00	0.00	2	8
3		DERIVATIVE, MINUTES 0=OFF	0.00	30.00	0.00	2	
4		SETPOINT FILTER 0=OFF, 1.00=MAX	0.00	1.00	0.00	2	6
5		MAX OUTPUT %	100.00	150.00	0.00	2	7,8
6		MIN OUTPUT %	0.00	50.00	-50.00	2	7,8
7		CONTROL ACTION 0=REV 1=DIR	0	1	0	3	10
8		DERIVATIVE ACTION 0=PV 1=ERROR	0	1	0	3	11
9		PID TYPE 1=PID,2=GPID,3=APID	1	3	1	3	3,12
10		GAP BAND (+/- % OF PV)	0.25	50.00	0.05	2	12
11		GAP GAIN MULTIPLIER	0.00	1.00	0.00	2	12
12		OUTPUT BIAS	0.00	100.00	-100.00	2	8,9

NOTES:

1. The Track Input signal is used during Track or Override modes to force the value of the PID Integral term. This Input is used to provide bumpless transfer. See above for details.
2. The Feed Forward Input is added to the result of the PID calculation before the Output Min/Max limiting logic. This prevents Integral Term Reset Windup.
3. The Adaptive Gain Input is ignored for PID types 1 and 2 (see Parameter 10). Negative Input values are set equal to 0.00%, Inputs greater than +327.00% are set equal to +327.00%. The PID Gain (Parameter 1) is multiplied by the Adaptive Gain Input divided by 100.00%.
Example: Gain = 15.0, and the Adaptive Gain Input = 25.00%, the effective PID gain would be 3.75.
4. The three Track Mode Inputs are logically OR'd together. If any one of the three Inputs equals "1", AND Repeats/Min > 0, then the Block Output is forced to equal the Track Signal Input. This is accomplished by forcing the PID Integral term to counteract the Proportional, Derivative, and Feed Forward terms. If all three Track Mode Inputs equal "0", the normal PID calculation determines the Output.
5. When the Override Input = "1", AND the PID is NOT in Track Mode, AND Repeats/Min > 0, the PID Integral term is set equal to the Track Signal Input. This feature is used to provide bumpless transfer when Override (i.e. Constraint) control strategies are utilized. See Example in the Configuration section. Track mode has priority over Override mode.
6. The Setpoint Filter is used to prevent abrupt PID Output changes due to setpoint changes. When the filter = 1.000, the filter time constant (in seconds) is: $(60 / (\text{Integral Repeats/Min}))$, Parameter 2 determines the Repeats/Min. The filtering effect is proportionately less as the Setpoint Filter parameter is reduced. Example: Setpoint Filter = 0.90, Repeats/Min = 0.75; therefore, the filter time constant is 72 seconds.
Note: If Parameter 2 = 0.01 repeats/min, and setpoint filter = 1.00, the filter time constant is 6000 seconds!
Note: When Parameter 2 = 0.00 (i.e. Reset turned OFF), the filter time constant is 60 seconds when the setpoint filter = 1.00. Setpoint filter values less than 1.00 reduce the time constant proportionately.
The Setpoint filter must be turned OFF for full metering combustion fuel and airflow PID loops, and for cascade control inner loops (i.e. three-element feedwater flow loop).
7. The Maximum Output limit must be greater than the Minimum Output limit (Parameters 5 and 6).
8. For P or PD modes (i.e. Repeats/min=0.0, I term is Off), the PID Output equals the mid-point of the Maximum and Minimum Output Parameters when PV=SP. For Example: the mid-point is 50% for 0-100% Output range, 100% for 50-150%, 75% for 50-100%, ... Neither Track Mode nor Override Mode will activate if Repeats/Min = 0.0.
9. In applications when Repeats/min=0.0 (i.e. I term is Off), it is not always desirable for the PID Output to be at the midpoint when PV=SP (see note 8). Examples: some batch processing, level control, and pressure relief valves. Output Bias adds/subtracts to/from the standard PID midpoint Output, but the Output is still limited by the Min/Max Output Parameters. If Output Bias is non-zero when Repeats/min > 0, serious system oscillations can occur due to Reset Windup.
10. Reverse action means that the PID Output decreases when the process variable Input increases above setpoint. Direct action causes the Output to increase when the process variable increases above setpoint.
11. "Derivative Action = PV" (Parameter 10 = 0) avoids abrupt PID Output changes due to setpoint changes, since the derivative only responds to changes of the PV Input. "Derivative Action = Error" (Parameter 10 = 1) is generally only used in the inner loop of cascaded PID loops.
12. Gap PID provides an error zone on either side of the setpoint with reduced (or zero) gain. This feature is useful with noisy signals such as boiler furnace pressure, and with non-linear processes such as pH control loops. Gap Band (Parameter 11) determines setpoint deviation band within which the reduced gain is applied. The Gap Gain Multiplier (Parameter 12) numerically multiplies the normal PID Gain (Parameter 1) within the Gap Band. Gap Gain can be set equal to 0. Outside the Gap band the normal PID Gain remains the same, but the error is automatically biased down for a smooth transition (see figure above). Gap Parameters 11 and 12 are ignored for PID types 1 and 3 (see Parameter 9).

F81 [AOUT] Analog (4-20 mA) Output

Function **AOUT** is the Blockware interface to the PCC-IV 4-20 mA output hardware. **AOUT** converts a 0-100% Input into either a 4-20 mA output (0% = 4 mA), or a 20-4 mA output (0% = 20 mA). The **AOUT** milliamp output is proportional over the entire -25% to 125% Input range (i.e. 0-24 mA), and the D/A converter has 16-bit resolution (i.e. 0.0004 mA).

The **AOUT** Block Output is equal to the **AOUT** Block Input, unless the Block Output is "Forced" or under "Service Manual" (S/M) control (see Section 4).

The **AOUT** Block has an auxiliary digital output called **SM**. This indicates the current Service manual status of this **AOUT** block. This auxiliary output is a 1 if the block is in S/M, and it is a 0 if the block is not in S/M.

When Forced, the **AOUT** Block Output is equal to the percentage that the user entered when the Block was forced. The 4-20 mA output is based on the Force Value and the "Reverse Output" parameter. Example: **AOUT** is forced to 25%, and "Reversed Output" is set to "0" or 4-20 mA; then the actual mA output would be 8 mA. If "Reversed Output" is set to "1" or 20-4 mA; then the actual mA output would be 16 mA when forced to 25%.

During Service Manual (S/M) mode, the Block Input is ignored, and the user sets the hardware mA output directly from the Front Panel (see Section 4). During S/M, the **AOUT** Block output will be the percentage that is equivalent to the mA output. If "Reverse Output" is "1", the percentage will be scaled accordingly. Example: S/M set output to 8 mA, and "Reverse Output" is "0" (4-20); then Block Output will be 25%. If "Reverse Output" was "1" (20-4); then the Block Output would be 75%

The **AOUT** function interfaces to Analog Outputs on the CPU board, and on option boards. Parameter 1 specifies the board location, the CPU board = Board 0. Parameter 2 selects a specific Analog Output on the specified board.

NAME:		AOUT	SINGLE USE FUNCTION:		N	OUTPUT TYPE:		A
Input	Type	Description				Notes		
1	A	INPUT BLOCK						
Aux. Output								
1	D	SERVICE MANUAL MODE (SM)						
Parameter	Description		Default	Max	Min	Code	Notes	
1	OPTION BOARD (0=CPU BOARD)		0	2	0	3	1	
2	SELECT CH 1 OR CH 2		1	2	1	3	1	
3	REVERSE OUTPUT? 0=4-20 1=20-4		0	1	0	3		

Notes:

1. The quantity of Outputs available is dependent on the type of option board installed. An error message is displayed when writing the Blockware to the PCC-IV if sufficient Outputs are not available.

F83 [TOUT] Triac Output

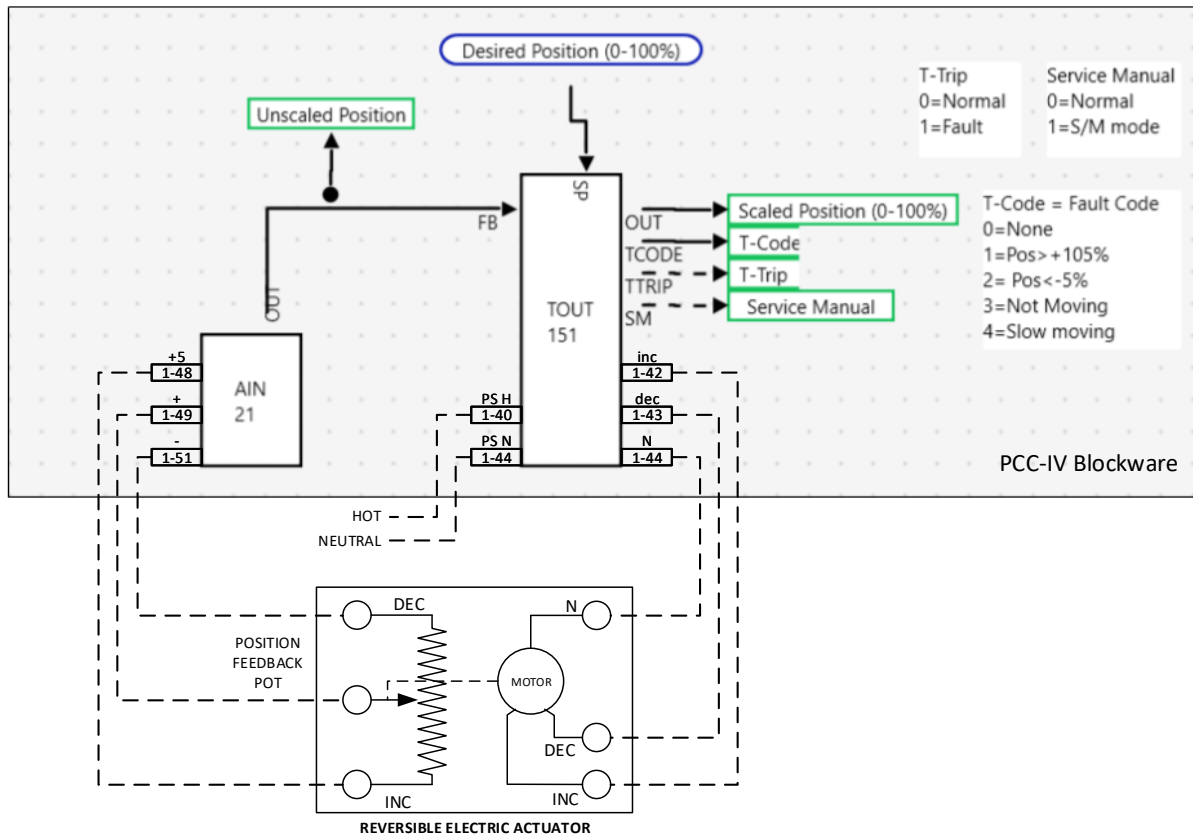
The **TOUT** Block has an auxiliary digital output called **SM**. This indicates the current Service manual status of this **TOUT** block. This auxiliary output is a 1 if the block is in S/M, and it is a 0 if the block is not in S/M.

Additional auxiliary outputs (**TTRIP** and **TCODE**) are described below.

Function **TOUT** is the Blockware interface to the PCC-IV Triac output option board hardware. Triacs are solid state switches for use with 24-120 Vac, 0-2 Amp inductive loads. **TOUT** can be used in one of two modes: **Positioner** mode, OR Dual **Triacs** mode (see Parameter 3).

Dual Triacs Mode allows direct Blockware control of each of the individual Triacs. Triac 1 is turned on when Triac 1 Input equals 1, Triac 2 is turned on when Triac 2 Input equals 1. In Dual Triacs Mode, the Setpoint Input is ignored. The Block Output is equal to the Scaled Position as described below in Positioner mode.

Positioner Mode is used to position a reversible electric actuator that is equipped with a position feedback signal (potentiometer, 0-5 Vdc, or 4-20 mA). **TOUT** compares the Setpoint Input to the Scaled Position, if the difference is outside of the Deadband (Parameter. 7), one of the two Triac outputs is turned ON to drive the actuator toward the Setpoint position. When the actuator position is within the range of: (Setpoint +/- Deadband), both Triacs are turned OFF. In Positioner Mode, the Triac 1 and Triac 2 Inputs are ignored. The Block Output of **TOUT** is the 0-100% Scaled Position of the actuator. See the diagram below for a typical Positioner Mode application.



TYPICAL F83 (TOUT) 'POSITIONER' MODE APPLICATION

Scaled Position (Positioner Mode): The actuator position feedback signal must be connected to a PCC-IV Analog Input channel (typically on a "G" Option Board). The **AIN** Block for this channel is then connected to the **TOUT** Block Feedback Input. For Potentiometer position feedback signals, the **AIN** Block Scaling Parameter values should be 0V = 0 % and 5V=100%. The **AIN FILTER SECONDS** (Parameter 6) **MUST** be set to 0.0 seconds, larger values will cause the actuator to hunt or oscillate.

TOUT Parm. 4 & 5 are used to convert the unscaled **AIN** Feedback Input to a 0-100% **TOUT** Scaled Position.
Example: **AIN** = 25% at minimum position, **AIN** = 75% at maximum position. Set Parameter 4 (0% feedback) = 25%, and Parameter 5 (100% feedback) = 75%. When: Feedback Input = 25%, **TOUT** Block Output = 0%; Feedback = 35%, **TOUT** = 20%; Feedback = 45%, **TOUT** = 40%; ... Feedback = 75%, **TOUT** = 100%. For "fail open" applications P4 (Parameter 4) can be greater than P5, that is: P4 (0% feedback) = 75%, and P5 (100% feedback) = 25%.

Use S/M for Initial Actuator Setup (Positioner Mode): After the actuator electrical installation is completed, put the PCC-IV into S/M mode (Service Manual, see Section 4), and go to the Service Manual submenu for *Change one output*. Select the applicable **TOUT** channel (Triac Output, Board x, Channel y). Press the INC key to open/increase the actuator; press the DEC key to close/decrease the actuator.

Calibrating the Scaled Position (Positioner Mode): Read "Scaled Position", "Initial Actuator Setup", and "Are Bias Resistors Required" sections of **TOUT** before Calibrating. Consult the Blockware to determine the Block Number of the **TOUT** function that drives the actuator being calibrated. Use S/M mode to move the actuator during this

procedure (see 'Actuator Setup' above). The Scaled Position must be calibrated whenever the actuator is initially installed, changed-out, re-stroked, or if the feedback pot is changed.

Using the *Change one output* Service Manual submenu, press and hold the DEC key until the actuator is fully closed (0% position). Use the Browse Blocks menu (see Section 4) to display the unscaled FEEDBACK INPUT (I02) value of this **TOUT** Block. Enter this value into Parameter 4 (Feedback % at 0% Position).

Using the *Change one output* Service Manual submenu, press and hold the INC key until the actuator is fully open (100% position). Use the Browse Blocks menu (see Section 4) to display the un-scaled FEEDBACK INPUT (I02) value of this **TOUT** Block. Enter this value into Parameter 5 (Feedback % at 100% Position).

Deadband %, Parameter 7 (Positioner mode): This value must be adjusted individually for each actuator to minimize hunting (due to the connected load and the effectiveness of the actuator's brake). Use either "Force" mode (see Section 4) or the Blockware's "Manual" mode (if provided) to vary the actuator's position in 5-10% steps (do not use S/M mode). Then observe the actuator response. If the actuator hunts, increase the Deadband. If the actuator doesn't hunt, decrease the deadband in increments until it does hunt after a move, and then increase the deadband until the actuator doesn't hunt. Try to get the Deadband as small as possible WITHOUT hunting occurring.

Stroke Time, Parameter 6 (Positioner mode): **TOUT** uses Parameter 6 in an anticipator calculation to minimize actuator undershoot and overshoot during each move. This parameter should be set to the approximate time (in seconds) that it takes to move the actuator from 0% to 100% (Scaled Position). Typically, 85% of the actuator nameplate stroke time is used. Values above 100% of the actual stroke time can cause overshooting and subsequent hunting. Values below 45% of the actual stroke time can cause false **TTRIP** trips due to "Slow Moving".

After the Deadband has been adjusted, if the actuator continues to overshoot or undershoots excessively, adjusting the Stroke Time can help to reduce this. If the actuator undershoots, increase Stroke Time; if the actuator overshoots, decrease the Stroke Time.



WARNING

The **TOUT** Fault Detection logic may require external Pull-up and Bias resistors for proper operation. Failure to provide these parts and to test the installed system can result in EQUIPMENT DAMAGE, INJURY, OR DEATH.

The Fault Detection logic in **TOUT** is NOT sufficient for ALL applications. Each application must be individually assessed and the control logic and external safety shutdown systems must be individually designed for the application. Many applications require additional independent monitoring (for example: A Low Oxygen burner trip).

Actuator Fault Detection (Positioner Mode): Some Hazardous applications monitor the actuators for "faults" to cause an alarm or safety shutdown. An example is parallel positioning of separate fuel and air actuators for burner fuel-air ratio control. **TOUT** provides internal fault monitoring logic that is made available to other Blocks via the **TTRIP** and **TCODE** auxiliary Outputs.

This logic is designed for actuators with position feedback potentiometers (pots) that are wired directly to a PCC-IV analog input. This logic is NOT designed to work with 4-20 mA or other types of position feedback signals. This logic is designed to detect an open circuit in any of the Pot field wires or the Pot element, stalled or burned out motors that are not moving, and overloaded motors that are moving very slowly.

Typical actuator faults include: blown actuator power fuses, open field wiring, burned out motor windings, dirty feedback pots that cause the wiper to go open circuit, and worn feedback pot resistance elements that break and go open circuit.

The internal **TOUT** Fault Detection logic monitors the actuator. A Fault is indicated by a **TTRIP** Output (0=Normal, 1=Fault), and the type of Fault is indicated by a **TCODE** 0-4% analog Output as shown below.

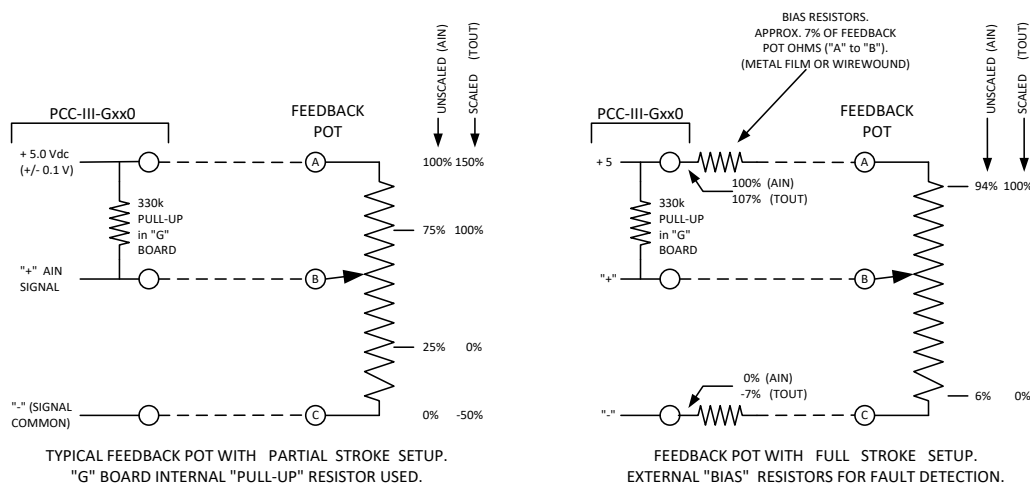
Conditions that cause **TTRIP** to change to a "1" (Fault), and the resulting **TCODE** Output:

TCODE	Condition:	Potential Reason with "Fail Closed Wiring" (+5 V wired to Pot Increase)	Potential Reason with "Fail Open Wiring" (+5 V wired to Pot Decrease)
0 %	PCC-IV Reset or Power-up. No Code in Memory.		
1 %	Scaled Position greater than 105% for more than P9 seconds	Pot wiper wiring is "open circuit". Pot "-" wiring is "open circuit". Pot element is "open circuit".	Pot "+5V" wiring is "open circuit". Pot element is "open circuit".
2 %	Scaled Position less than -5% for more than P9 seconds	Pot "+5V" wiring is "open circuit". Pot element is "open circuit".	Pot wiper wiring is "open circuit". Pot "-" wiring is "open circuit". Pot element is "open circuit".
3 %	Actuator stopped moving for more than P9 seconds (Note 1).	Stalled, torque overload, jammed. Blown fuse. Any motor wire "open circuit". Motor winding burned out. Motor limit switch opened within 5-95% Scaled Position (Note 1). Check Scaled Position calibration.	Same as "Fail Closed"
4 %	Actuator moving Slower than 40% speed for more than P9 seconds (Note 1)	Binding linkage, damper, or valve. Low AC line voltage. Stroke Time (P6) set too low.	Same as "Fail Closed"

Note 1: TTRIP will NOT "Fault" due to "Actuator Stopped" or "Actuator Slow" if any of the following are true:

- The TOUT channel is in S/M mode.
- Scaled Position is less than -5% or greater than 105%.
- The Decrease Triac is ON, and the Scaled Position is less than 5%
- The Increase Triac is ON, and the Scaled Position is greater than 95%
 - The last two exceptions prevent nuisance 'Faults' due to inaccurate travel limit switch operation

All actuators that use Fault Detection require a "pull-up" resistor (330k or less) that is connected from the Feedback Pot wiper to +5V, and it should be located inside the PCC-IV controller. Review "Pull-Up/Down Resistor for Voltage Inputs" in Section 2. If the pot wiper circuit field wiring goes open-circuit, or if the wiper loses contact with the pot element due to wear or dirt, the PCC-IV analog input will ramp to +5V within 3 seconds. The PCC-IV "G" option board includes an internal 330k pull-up resistor for each analog input. The CPU, "A", "B", and "F" board analog inputs do NOT have internal pull-up resistors, and require external resistors.



FEEDBACK POT FAULT DETECTION WITH "PULL-UP" AND "BIAS" RESISTORS

Are Bias Resistors Required for Positioner Mode Fault Detection? If 0V and +5V position feedback pot voltages correspond to a Scaled Position outside the -5% to +105% range, Bias resistors are NOT required. If 0V and +5V correspond to a Scaled Position inside the -5% to +105% range, Bias resistors ARE required. Preferred Instruments model DM-1E-P1 actuators (90 deg stroke) do NOT require Bias resistors, Preferred model R-AL actuators DO require 75-ohm Bias resistors.

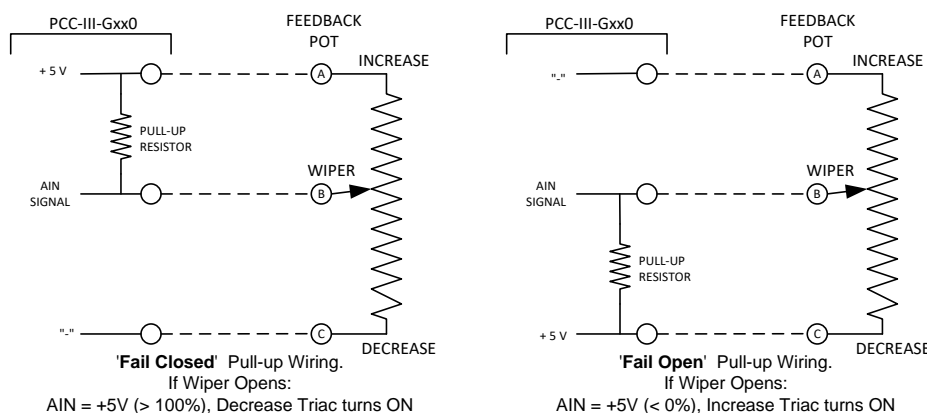
The best way to determine if Bias resistors are required with other actuators is to install the actuator, stroke it, Calibrate the Scaled Position (see above), and then test the actuator for proper Fault Detection (see below for procedure). When in doubt, install Bias Resistors (if Fault Detection is required).

See the schematic above for Bias resistor wiring. Use metal film or wire wound Bias Resistors (for low temperature drift), carbon composition or carbon film resistors should not be used if the ambient temperature changes substantially. The Bias resistance should be approximately 7% (or more) of the feedback pot element's actual resistance (some pots have a +/- 20% tolerance).

Fail Mode: STOP, INC, DEC, DISABLE (Parameter 8): If the Scaled Position is outside the -5% to +105% range for more than P9 seconds, TOUT activates the triacs per the mode selected by P8:

P8	Fail Mode	Triac Response
0	STOP	Both triacs are turned OFF.
1	INC	INCREASE triac is turned ON, DECREASE triac is turned OFF
2	DEC	DECREASE triac is turned ON, INCREASE triac is turned OFF
3	DISABLE	The Fault is ignored. The triacs respond to the normal TOUT PV and SP logic

During the P9 time delay, the triacs respond to the normal **TOUT** PV and SP logic. Wire the Feedback Pot as indicated below to achieve the desired response during the P9 time delay:



"PULL-UP" WIRING FOR "FAIL-CLOSED" AND "FAIL-OPEN" SYSTEMS

Desired Response:	Connect Pot "Increase" end to:	Connect Pot "Decrease" end to:
Fail Close	+5 V	"-" (Signal Common)
Fail Open	"-" (Signal Common)	+5 V

Test Feedback Pot Fault Detection: Install the actuator, stroke it, Calibrate the Scaled Position (see above), and then test the Feedback Pot Fault Detection. The block outputs of TOUT, TTRIP, and TCODE must be monitored during the test. Frequently these are Front Panel Display channels; if not, consult the Blockware drawing to find the block numbers and use the Utilities / Examine menu (see Section 4) to display the values.

Disconnect one feedback pot wire at a time, leaving the other two wires connected. Verify the following:

Open Pot Wire	TOUT for "Fail Closed Wiring" (+5 V = Increase)	TCODE for "Fail Closed Wiring" (+5 V = Increase)	TOUT for "Fail Open Wiring" (+5 V = Decrease)	TCODE for "Fail Open Wiring" (+5 V = Decrease)
Increase	less than -5%	2.00 %	less than -5%	2.00 %
Wiper	greater than +105%	1.00 %	less than -5%	2.00 %

Decrease	greater than +105%	1.00 %	greater than +105%	1.00 %
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"Forcing" **TOUT** Blocks (see Section 4):

Positioner mode: The "Forced" Block Output becomes the Setpoint, and the Setpoint Input signal is ignored. That is, when Forced, triacs activate based on the Scaled Feedback as compared to the Forced Block Output. TOUT uses the normal Positioner logic when "Forced", and therefore requires the Position Feedback Input to be active and Scaling Parameters 4 & 5 to be setup for proper operation.

Dual Triacs mode: +199.99% activates Triac 1, -199.99% activates Triac 2.

S/M Mode, Dual Triacs mode (See Section 4): Using the *Change one output* Service Manual submenu , pressing the INC key will activate Triac 1 (Increase) while the INC key is pressed. The DEC key similarly activates Triac 2 (Decrease).

NAME: TOUT		SINGLE USE FUNCTION: N		OUTPUT TYPE: A
Input	Type	Description	Notes	
1	A	SETPOINT INPUT	1,8	
2	A	FEEDBACK INPUT		
3	D	TRIAC 1 INPUT (INCREASE)	2	
4	D	TRIAC 2 INPUT (DECREASE)	2	

Aux. Output

1	D	SERVICE MANUAL MODE (SM)
2	D	TRIP, SERVO FAULT (TTRIP)
3	A	TRIP CODE (TCODE)

Parameter	Description	Default	Max	Min	Code	Notes
1	OPTION BOARD (1-3)	3	3	1	3	7
2	TRIAC PAIR	1	2	1	3	3,7
3	MODE 0=POSITIONER 1=DUAL TRIACS	0	1	0	3	
4	FEEDBACK % AT 0% POSITION	0.0	150.0	-50.0	3	4,5
5	FEEDBACK % AT 100% POSITION	100.0	250.0	-50.0	3	4,5
6	STROKE TIME (SEC)	15.0	300.0	4.0	3	6
7	DEADBAND %	0.7	15.0	0.1	3	
8	FAIL MODE: 0=STOP 1=INC 2=DEC 3=DISABLE	3	3	0	3	
9	FAIL TRIP DELAY	3.0	90.0	2.0	3	

Notes:

1. Ignored in Dual Triac mode.
2. Ignored in Positioner mode.
3. The "G" option board has two pairs of Triacs.
4. The difference between Parameters 4 & 5 must be greater or equal to 10%.
5. Reverse Input scaling is valid, i.e. 0% POSITION = 100% Feedback, 100% POSITION = 0% Feedback.
6. Stroke time is from 0% to 100% POSITION (i.e. Scaled Feedback, NOT 0-100% Feedback Input).
7. The quantity of Outputs available is dependent on the type of option board installed. An error message is displayed when writing Blockware to the PCC-IV if sufficient Outputs are not available.
8. Internally limited to 0-100% range.

F90 [D0] Discrete 0 Constant

Function **D0** provides a constant Output of a discrete 0 (i.e. logic "Low").

Discrete 0 is the default Input for all discrete Inputs for all functions. No Inputs or parameters are required for **D0**.

```
-----
NAME:      D0                      SINGLE USE FUNCTION:  N      OUTPUT TYPE:  D
-----
No Inputs and No Parameters
```

F91 [D1] Discrete 1 Constant

Function **D1** provides a constant Output of a discrete 1 (i.e. logic "High").

Discrete 1 is useful as a dummy Input to many other functions: **PANEL**, **LOGIC**, No Inputs or parameters are required for **D1**.

```
-----
NAME:      D1                      SINGLE USE FUNCTION:  N      OUTPUT TYPE:  D
-----
No Inputs and No Parameters
```

F92 [DIN] Discrete Input

Function **DIN** is the Blockware interface to the PCC-IV's 120 Vac optically isolated Discrete Inputs hardware. The **DIN** function interfaces to Discrete Inputs on the CPU board, and on option boards. Parameter 1 specifies the board location, the CPU board = board 0. Parameter 2 selects a specific Discrete Input on the specified board.

When 120 Vac is applied to the selected Input, the Block Output equals discrete "1". Optionally, Parameter 3 (Invert Output) can be used to invert the Output (i.e., 120 Vac Input equals discrete "0" Output)

```
-----
NAME:      DIN                      SINGLE USE FUNCTION:  N      OUTPUT TYPE:  D
-----
No Inputs
```

Parameter	Description	Default	Max	Min	Code	Notes
1	OPTION BOARD (0=CPU BOARD)	0	2	0	3	
2	INPUT CHANNEL	1	5	1	3	1
3	INVERT OUTPUT? 0=NO 1=YES	0	1	0	2	

Notes:

1. Maximum quantity depends on type of option board that is currently installed

F93 [DCON] Discrete Constant

Function **CON** outputs a user defined discrete constant. This value can be changed via: the PCC-IV Browse Blocks menus (under password protection), via USB Blockware download, or via the MODBUS communications link. This value cannot be changed from the PCC-IV front panel Operator displays during normal operation.

NAME: DCON		SINGLE USE FUNCTION: N		OUTPUT TYPE: D		
Input	Type	Description	Notes			
NONE						
Parameter	Description		Default	Max	Min	Code Notes
1	DISCRETE CONSTANT VALUE		0	1	0	2

F96 [PANEL] Front Panel Display

The front **PANEL** is the Operator's interface to the PCC-IV Blockware logic. The Blockware designer uses the *Panel Data Screen* to determine the Blockware variables that the Operator can view, the variables the Operator can modify, and the alarms to be annunciated. See Section 5 for more information. The **PANEL** Block Output is controlled by the "Annunciator Logic" (see below).

See Section 3 for normal operation of the Front Panel. See Section 4 for operating the Menu System.

Annunciator Logic: The Alarm Channel Settings in the *Panel Data Screen* determine which Tags will be Annunciated. The first scan that an alarm Input changes from a "0" to a "1" (i.e., on the rising edge), the matching alarm channel message is stored at the end of the sequential memory stack with a time/date stamp. If an alarm clears and re-alarms before the alarm message is viewed (i.e. acknowledged), annunciator will NOT put a second copy of the same message on the stack.

When Input 2 (Annunciator Enable) equals "1", the annunciator functions normally. When the Annunciator Enable Input equal "0" (the default Input), no new alarms are stored in the stack. However, all existing alarms on the stack remain until cleared and acknowledged. Annunciator Enable can be used to prevent nuisance alarms during process startup or shutdown.

When a new alarm occurs, the **PANEL** Block Output changes to a "1", The ALARM LED starts flashing, and optionally (section 5) the bargraphs start flashing. Typically, the **PANEL** Block Output is connected to a **ROUT**, **DOUT**, or **TOUT** Block, and then physically wired to an external audible alarm. Press ACK, or change Input 1 (Remote Alarm Silence) from a "0" to a "1" to silence an alarm, to change **PANEL**'s Block Output back to "0", and to stop the optional bargraph flashing. See Section 3 for further details.

Note: If there are multiple PCC-IV's, all the configured alarm horn outputs can be wired in parallel to a single audible alarm. A single external Alarm Silence pushbutton can then be wired in parallel to a **DIN** on each PCC-IV.

NAME:		PANEL	SINGLE USE FUNCTION:	Y	OUTPUT TYPE:	D
Input	Type	Description	Notes			
1	D	RMT ALM SILENCE BLOCK	1			
2	D	ANNUNCIATOR ENABLE BLOCK	1			

No Parameters

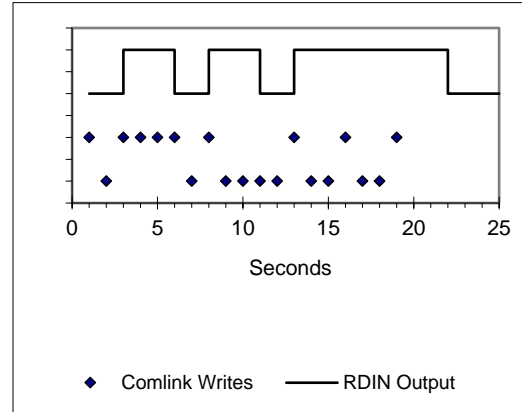
F97 [RDIN] (MODBUS) Remote Discrete Input

When the PCC-IV MODBUS communications link (Comm Link) is in "Local Mode", the Comm Link can read all Block Outputs; however, the Comm Link is prevented from writing data to (i.e. changing) all Block Outputs, except for the **RAIN** and **RDIN** Blocks. The Comm Link is always permitted to write data to **RAIN** and **RDIN** Block Outputs.

Pulse Mode = Off (i.e. Parameter 1 = 3600 sec): The value written by Comm Link remains in effect until a new value is written by Comm Link, or until a Comm Link time-out. Upon Comm Link time-out (i.e. no new Comm Link writes within (Parameter 2) seconds), the Comm Link value can either remain at the last value received or switch to the default value (see parameters 3 & 4).

Pulse Mode = On (i.e. Parameter 1 < 3600 sec): The **RDIN** Block Output becomes a re-triggerable one-shot pulse, with (Parameter 1) seconds minimum duration. If Parameter 1 = 0 seconds, **RDIN** creates a one scan long pulse. Pulse mode is useful as a Comm Link Watchdog timer, or for logic that requires momentary pulses.

A Comm Link write of "0" followed by a Comm Link write of "1" is the "trigger" to change the **RDIN** Output to a "1" and start the Pulse timer. If no additional Comm Link triggers occur, the **RDIN** Output changes to a "0" after the Pulse timer expires. If another Comm Link trigger occurs when **RDIN**'s Output = "1", the timer restarts. If no further Comm Link writes occur, or if Comm Link continuously writes either a "1" or a "0", the Pulse timer will expire, and the **RDIN** output changes back to a "0". See Pulse Mode timing diagram below:



Power Down: The Block Output is saved in the Retentive Memory area of the NVRAM.

CPU start-up: If Pulse Mode=Off: The Block Output and the Comm Link value are set to the value in Retentive Memory during the first scan. If Retentive Memory is invalid, the Block Output initializes to the Default Output upon CPU start-up. If Pulse Mode=On: The Block output is set to "0", and Comm Link must write a "0", followed by a "1" to change the **RDIN** Output to a "1".

NAME: RDIN SINGLE USE FUNCTION: N OUTPUT TYPE: D

No Inputs

Parameter	Description	Default	Max	Min	Code	Notes
1	PULSE SECONDS (3600=CONTINUOUS)	3600	3600	0	2	1
2	COMM FAIL DELAY SEC.	5	3600	1	2	x
3	FAIL ACTION 0=LAST, 1=DEFAULT	0	1	0	2	x
4	FAIL DEFAULT	0	1	0	2	x

Notes:

1. If Pulse Seconds less than 3600, Fail delay must be greater than Pulse seconds.

F98 [PB] Pushbutton

Function **PB** is the Blockware interface to the 4 user configurable pushbuttons on the front panel. Each pushbutton has an LED indicator that is controlled separately via the *Panel Data Screen* (See section 5). A Tag is attached and configured in the *Panel Data Screen* to select which Pushbutton the block controls.

At power down, the **PB** Block Output is saved in the Retentive Memory area of the NVRAM. During the first scan after CPU start-up, the **PB** Block Output is set per Parameter 1. "LAST" means: use the value saved in Retentive Memory.

NAME: PB		SINGLE USE FUNCTION: N			OUTPUT TYPE: D	
Input	Type	Description	Notes			
NONE						
Parameter	Description		Default	Max	Min	Code Notes
1	POWER UP 1=HI 2=LO 3=LAST		3	3	1	2 1

Notes:

1. See the description above.

F99 [LED] LED

Function **LED** is the Blockware interface to the 6 user configurable LED indicators on the front panel. A Tag is attached and configured in the *Panel Data Screen* to select which LED the Tag controls. See Section 5.

Parameter 1 allows the LED and **LED** Block Outputs to be inverted.

NAME:		LED	SINGLE USE FUNCTION:			N	OUTPUT TYPE:		D
Input	Type	Description					Notes		
1	D	INPUT BLOCK					1		
Parameter		Description		Default	Max	Min	Code	Notes	
1	INVERT INPUT? 0=NO 1=YES			0	1	0	2	1	

Notes:

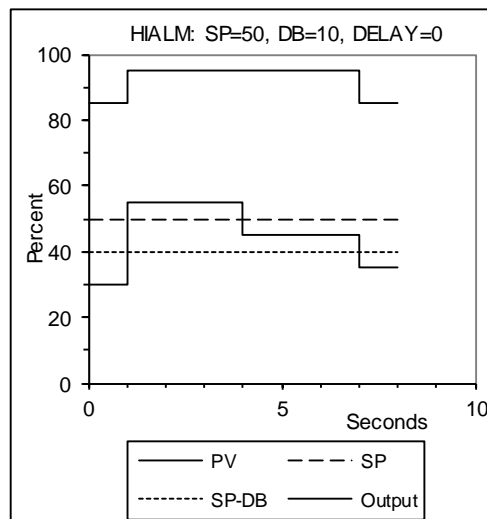
1. If Param. 1 (INVERT INPUT) = 0: When Input = 1, LED is On, Output = 1
If Param. 1 (INVERT INPUT) = 1: When Input = 1, LED is Off, Output = 0

F101 [HIALM] High Alarm

Function **HIALM** compares the PV (Process Variable) Input to the SP (Setpoint) and changes the Block Output to a "1" when PV > SP. If **HIALM** is connected to a Panel Data Screen Tag, or directly to an **ROUT**, **DOUT**, or **TOUT** Block, it can trigger audible/visual alarms. **HIALM** can also be used as a trigger in Blockware to automate a control strategy.

Example: Trigger an **ASW** to select **PID "B"** instead of **PID "A"**, when steam flow exceeds 20%. See top figure at right

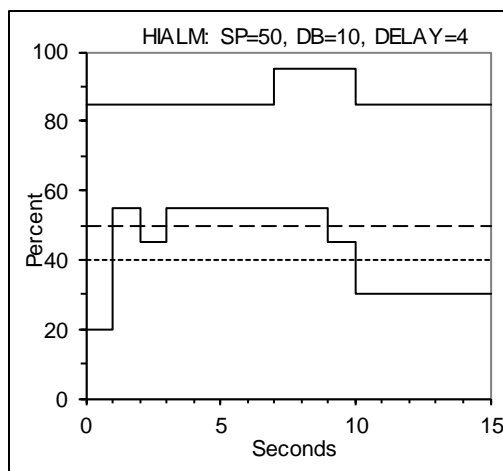
Inputs 2-3, and Parameters 1-5 modify the basic behavior as follows:



Deadband or Hysteresis (Parameter 2): When Deadband (DB)= 0.0: Output = 1, if PV > SP; or Output = 0, if PV ≤ SP. When Deadband > 0: Output = 1, if PV > SP; and once the Output becomes a 1, it remains a 1 until PV < (SP - DB) and then it resets to 0.

Internal vs External Setpoint (Parameters 1 and 3, and Input 2): By default, Parameter 1 = 2, and **HIALM** uses the INTERNAL SETPOINT stored in Parameter 3 as the SP. Changing Parameter 1 to "1", causes **HIALM** to use the EXT SP (External Setpoint) Input (Input 2) as the SP.

In EXT SP mode: A **FPCON** (F55) Input to EXT SP allows the Operator to adjust an alarm setpoint from the front panel Process mode display channels, and **FPCON**'s Min/Max parameters can limit the range of adjustment. If the **PID** setpoint **FPCON** Block feeds a **WSUM** (F52) Block, and **WSUM** connects to the EXT SP, the **HIALM** setpoint can be a constant percentage above the Operator adjusted **PID** setpoint.



Alarm Time Delay (Parameter 5): PV must be continuously greater than SP for (Parameter 5) seconds before the **HIALM** Block Output will change to a "1". See bottom figure at right.

Alarm Disable (Parameter 4, and Input 3): By default, **HIALM** is Enabled and responds to alarms because the defaults are: Input 3 is Block 2 (**DO** or Low), and Alarm Disable is ACTIVE HI (Parameter 4 = 1). However, Blockware can use the Disable Input (Input 3) to selectively Disable individual alarm Blocks, that is force the alarm Block Output to be a "0". Parameter 4 determines if the Disable signal is "Active HI", or "Active LO" as follows:

Parameter 4	Disable Input	Mode
1 (Active HI)	0	Enabled
1 (Active HI)	1	Disabled
0 (Active LO)	0	Disabled
0 (Active LO)	1	Enabled

NAME:		HIALM		SINGLE USE FUNCTION:		N		OUTPUT TYPE:		D	
Input	Type	Description							Notes		
1	A	PV INPUT									
2	A	EXT SP INPUT (Optional)							1		
3	D	DISABLE INPUT							2		
Parameter		Description				Default	Max	Min	Code	Notes	
1		SP MODE 1=EXT 2=INT				2	2	1	2	1	
2		% DEADBAND				0.20	100.00	0.00	1	3	
3		% INTERNAL SETPOINT				50.00	199.99	-199.99	1	1	
4		ALARM DISABLE ACTIVE LO/HI									
		0=LO, 1=HI				1	1	0	2	2	
5		ALARM DELAY SECONDS				0	600	0	1	4	

Notes:

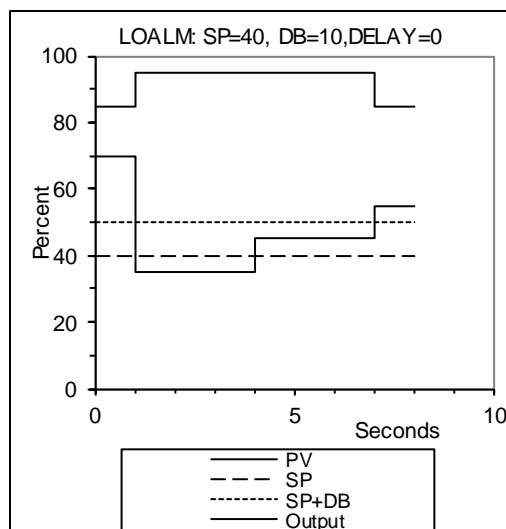
1. See "Internal vs External Setpoint" above.
2. See "Alarm Disable" above.
3. See "Deadband" above.
4. See "Alarm Time Delay" above.

F102 [LOALM] Low Alarm

Function **LOALM** compares the PV (Process Variable) Input to the SP (Setpoint) and changes the Block Output to a "1" when $PV < SP$. If **LOALM** is connected to a Panel Data Screen Tag, or directly to an **ROUT**, **DOUT**, or **TOUT** Block, it can trigger audible/visual alarms for the Operator. **LOALM** can also be used as a trigger in Blockware to automate a control strategy. See figure.

Deadband or Hysteresis (Parameter 2): When Deadband (DB)=0.0: Output = 1, if $PV < SP$; Output = 0, if $PV \geq SP$. When Deadband > 0: Output = 1, if $PV < SP$; and once the Output becomes a 1, it remains a 1 until $PV > (SP + DB)$ and then it resets to 0. See figure at right.

See **HIALM** (F101) above for details on Inputs 2-3, and Parameters 1, and 3-5.



NAME:		LOALM	SINGLE USE FUNCTION:		N	OUTPUT TYPE:		D
Input	Type	Description	Notes					
1	A	PV INPUT						
2	A	EXT SP INPUT	1					
3	D	DISABLE INPUT	1					
Parameter		Description	Default	Max	Min	Code	Notes	
1	SP MODE 1=EXT 2=INT		2	2	1	2	1	
2	% DEADBAND		0.20	100.00	0.00	1	3	
3	% INT SP		50.00	199.99	-199.99	1	1	
4	ALARM DISABLE ACTIVE LO/HI 0=LO, 1=HI		1	1	0	2	2	
5	ALARM DELAY SECONDS		0	600	0	1	4	

Notes:

- See "Internal vs External Setpoint" in **HIALM** (F101) above.
- See "Alarm Disable" in **HIALM** (F101) above.
- See "Deadband" above.
- See "Alarm Time Delay" in **HIALM** (F101) above.

F103 [DEVALM] Deviation Alarm

Function **DEVALM** subtracts the PV (Process Variable) Input from the SP (Setpoint) and changes the Block Output to a "1" if the absolute value of the difference is greater than the allowable Deviation (Parameter 2). Or, in equation form:

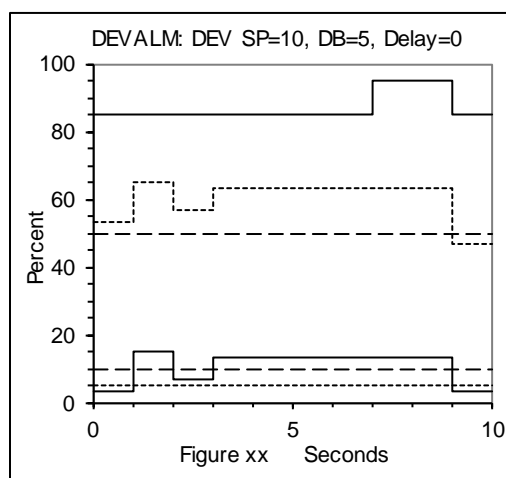
If $|(PV-SP)| > \text{Deviation}$ Then Block Output = "1"

Note: " $|(PV-SP)|$ " means:

If (PV-SP) is negative, multiply by -1

If **DEVALM** is connected to a Panel Data Screen Tag, or directly to an **ROUT**, **DOUT**, or **TOUT** Block, it can trigger audible/visual alarms for the Operator. **DEVALM** can also be used as a trigger in Blockware to automate a control strategy.

Inputs 2-3, and Parameters 1, and 3-7 modify the basic behavior as follows:



Deadband or Hysteresis (Parameter 3): When Deadband (DB)= 0.0: Output = 1, if $|(PV-SP)| > \text{Deviation}$, or Output = 0, if $|(PV-SP)| \leq \text{Deviation}$. When Deadband > 0: Output = 1, if $|(PV-SP)| > \text{Deviation}$, and once the Output becomes a 1, it remains a 1 until $|(PV-SP)| < (\text{Deviation} - \text{DB})$ and then it resets to 0. See figure above.

Internal vs External Setpoint (Parameters 1 and 4, and Input 2): By default, Parameter 1 = 1, and **DEVALM** uses the EXT SP (External Setpoint) Input (Input 2) as the SP. Changing Parameter 1 to "2", causes **DEVALM** to use the INTERNAL SETPOINT stored in Parameter 4 as the SP.

Alarm Time Delay (Parameter 7): $|(PV-SP)|$ must be continuously greater than the % Deviation threshold for (Parameter 7) seconds before the **DEVALM** Block Output will change to a "1".

Alarm Disable (Parameter 5, and Input 3): By default, **DEVALM** is Enabled and responds to alarms because the defaults are: Input 2 is Block 2 (**DO** or Low), and Alarm Disable is ACTIVE HI (Parameter 5 = 1). However, Blockware can use the Disable Input (Input 3) to selectively Disable individual alarm Blocks; that is, force the alarm Block Output to be a "0". Parameter 5 determines if the Disable signal is "Active HI", or "Active LO" as follows:

Parameter 5	Disable Input	Mode
1 (Active HI)	0	Enabled
1 (Active HI)	1	Disabled
0 (Active LO)	0	Disabled
0 (Active LO)	1	Enabled

Inverted Output (Parameter 6): When Parameter 6 = 1, The Block Output is opposite the normal value. Or, when INVERTED = "1", Output = "1" if $|(PV-SP)| < \text{Deviation}$.

NAME:		DEVALM		SINGLE USE FUNCTION:		N	OUTPUT TYPE:		D
Input	Type	Description					Notes		
1	A	PV INPUT							
2	A	EXT SP INPUT					1		
3	D	DISABLE INPUT					2		
Parameter		Description		Default	Max	Min	Code	Notes	
1		SP MODE 1=EXT 2=INT		1	2	1	2	1	
2		% DEVIATION THRESHOLD		2.00	199.99	0.10	1		
3		% DEADBAND		0.10	100.00	0.00	1	3	
4		% INT SP		50.00	199.99	-199.99	1	1	
5		ALARM DISABLE ACTIVE LO/HI 0=LO, 1=HI		1	1	0	2	2	
6		INVERT OUTPUT 0=NO 1=YES		0	1	0	2	5	
7		ALARM DELAY SECONDS		0	600	0	1	4	

Notes:

1. See "Internal vs External Setpoint" above.
2. See "Alarm Disable" above.
3. See "Deadband" above.
4. See "Alarm Time Delay" above.
5. See "Inverted Output" above

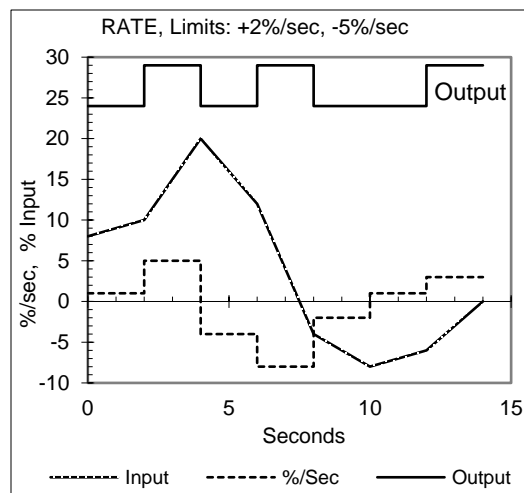
F104 [RATE] Rate of Change Alarm

Function **RATE** calculates the % per second (%/sec) rate of change of the Input signal every scan. **RATE** also saves the %/sec values from the previous 5 scans in memory. **RATE** then computes the average %/sec rate of change over the last 5 scans, and compares the average to the two alarm thresholds in Parameters 1 and 2.

Alarm Time Delay (Parameter 4): If the average %/sec rate exceeds either threshold continuously for more than (Parameter 5) seconds, the **RATE** Output changes to a "1". As soon as the average %/sec rate returns below both thresholds, the **RATE** Output returns to a "0". See Figure.

Alarm Disable (Parameter 3, and Input 2): By default, **RATE** is Enabled and responds to alarms because the defaults are: Input 3 is Block 2 (**D0** or Low), and Alarm Disable is ACTIVE HI (Parameter 3 = 1). However, Blockware can use the Disable Input (Input 2) to selectively Disable individual alarm Blocks; that is, force the alarm Block Output to be a "0". Parameter 3 determines if the Disable signal is "Active HI", or "Active LO" as follows:

Parameter 3	Disable Input	Mode
1 (Active HI)	0	Enabled
1 (Active HI)	1	Disabled
0 (Active LO)	0	Disabled
0 (Active LO)	1	Enabled



NAME: RATE SINGLE USE FUNCTION: N OUTPUT TYPE: D

Input	Type	Description	Notes
1	A	INPUT	
2	D	DISABLE INPUT	1

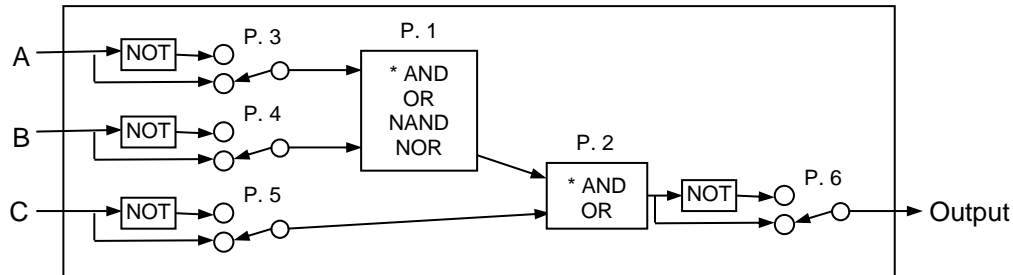
Parameter	Description	Default	Max	Min	Code	Notes
1	+ % /SEC LIMIT	10.0	100.0	0.1	1	
2	- % /SEC LIMIT	-10.0	-0.1	-100.0	1	
3	ALARM DISABLE ACTIVE LO/HI 0=LO, 1=HI	1	1	0	2	1
4	ALARM DELAY SECONDS	0	600	0	1	2

Notes:

- See "Alarm Disable" above.
- See "Alarm Time Delay" above.

F107 [LOGIC] User Defined Logic

Function **LOGIC** provides user configurable binary logic for up to three discrete Inputs. Parameters 3-6 allow negating any Input or the Block Output. Parameter 1 selects the logical function used to combine Inputs A and B. Parameter 2 selects the logical function used to combine Input C with the result of A and B. See figure below.



If only two Inputs are used: Connect Inputs A and B, leave Input C connected to the default Block 2 (D0), and change Parameter 2 to a "2" (OR logic).

Inputs:

A	B
0	0
0	1
1	0
1	1

Result for each logical function:

AND	OR	NAND	NOR
0	0	1	1
0	1	1	0
0	1	1	0
1	1	0	0

NAME:		LOGIC	SINGLE USE FUNCTION:			N	OUTPUT TYPE:	D
Input	Type	Description	Notes					
1	D	A INPUT						
2	D	B INPUT						
3	D	C INPUT						
Parameter	Description		Default	Max	Min	Code	Notes	
1	A-B LOGIC 1=AND 2=OR 3=NAND							
	4=NOR		1	4	1	2		
2	(AB) - C LOGIC 1=AND 2=OR		1	2	1	2		
3	INVERT INPUT A 0=NO 1=YES		0	1	0	2		
4	INVERT INPUT B 0=NO 1=YES		0	1	0	2		
5	INVERT INPUT C 0=NO 1=YES		0	1	0	2		
6	INVERT OUTPUT 0=NO 1=YES		0	1	0	2		

F110 [XOR] Exclusive OR Logic

Function **XOR** calculates the "Exclusive OR" logical function for two discrete Inputs. XOR means If ONLY one Input is True (Exclusively), Then the Output is True. See Truth Table:

Inputs:

A	B
0	0
0	1
1	0
1	1

Result:

XOR
0
1
1
0

NAME:		XOR		SINGLE USE FUNCTION:		N		OUTPUT TYPE:		D	
<hr/>											
Input	Type	Description						Notes			
1	D	A INPUT									
2	D	B INPUT									
<hr/>											
Parameter		Description				Default	Max	Min	Code	Notes	
1	INVERT OUTPUT? 0=NO 1=YES				0	1	0	2			

F111 [NOT] NOT Logic

Function **NOT** logically inverts (i.e. negates) the Block Input.

NAME: NOT		SINGLE USE FUNCTION: N		OUTPUT TYPE: D	
Input	Type	Description	Notes		
1	D	INPUT BLOCK			

No Parameters

F112 [F/F] Flip Flop Logic

Function **F/F** behaves like a Latch relay. The Block Output remains at its last value (1 or 0) unless one of the three Inputs is activated. The Block Output behaves per the table below:

Parameter 1 Inverted Output	Set	Reset	Toggle	Output
0 = No	1	0	X	1
0 = No	0	1	X	0
1 = Yes	1	0	X	0
1 = Yes	0	1	X	1
X	1	1	X	No change, same value from previous scan
X	0	0	^1	Opposite the Output value from the previous scan. 0 becomes 1, 1 becomes 0
X	0	0	0, 1, or 1 -> 0	No change, same value from previous scan

X means: not used, can be any value

^1 means: on the rising edge (i.e., only once during the scan that the Input changes from 0 to 1)

The Set and Reset Inputs have priority over the Toggle Input; that is, the Toggle Input is ignored unless both the Set and Reset Inputs = 0. When Set = Reset = 1, the Block Output does not change, and the Toggle Input is ignored. The Toggle Input is only active for the single scan after the Toggle Input changes from 0 to 1, and Set = Reset = 0.

At power down, the **F/F** Block Output is saved in the Retentive Memory area of the NVRAM. During the first scan after CPU start-up, the **F/F** Block Output is set per Parameter 2. "LAST" means: use the value saved in Retentive Memory.

NAME: F/F		SINGLE USE FUNCTION: N		OUTPUT TYPE: D		
Input	Type	Description	Notes			
1	D	SET INPUT				
2	D	TOGGLE INPUT				
3	D	RESET INPUT				
Parameter		Description	Default	Max	Min	Code Notes
1	INVERT OUTPUT 0=NO 1=YES		0	1	0	2
2	POWER UP 1=HI 2=LO 3=LAST		3	3	1	2

F116 [TOT] Totalizer (Integrator with Pulse Output)

Function **TOT** is a signal integrator with a scaled pulse Output. The primary application of the **TOT** Block is to drive a counter for flow totalization. **TOT** can connect to a **DOUT**, **TOUT**, or **ROUT** Block to drive an external physical counter. **TOT** can also be connected to a **COUNT** Block, and the **COUNT** Block Output can be displayed via a Panel Data Screen Tag.

100% Input Counts/Hr (Parameter 2) determines the **TOT** Output pulse scaling as follows: If the Input is a constant 100%, Then **TOT** produces (Parameter 2) Pulses (or Counts) per hour. The **TOT** Block Output is normally "0", each Block Output pulse is a "1" for exactly one scan. Example: If the **TOT** Input is a 0-100% signal from a steam flow meter that is calibrated for 0-75,000 lb/hr steam flow, set Parameter 2 to "7500" to make every pulse equivalent to 10 lbs of steam.

Input Cutoff % (Parameter 1): The calibration of some flowmeters tends to drift near 4 mA (0%). This can cause false flow totalization when there is no flow. Inputs less than (Parameter 1) are ignored, and no pulse Outputs are generated. Negative Inputs do not generate a pulse Output.

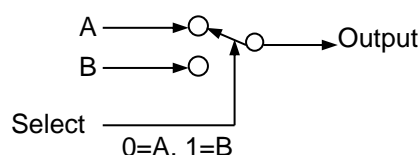
Disable Input (Parameter 3, and Input 2): By default, **TOT** is Enabled and totalizes because the defaults are: Input 2 is Block 2 (**DO** or Low), and Alarm Disable is ACTIVE HI (Parameter 3 = 1). However, Blockware can use the Disable Input (Input 2) to selectively Disable totalization, that is force the **TOT** Block Output to be a "0". Parameter 3 determines if the Disable signal is "Active HI", or "Active LO" as follows:

Parameter 3	Disable Input	Mode
1 (Active HI)	0	Enabled
1 (Active HI)	1	Disabled
0 (Active LO)	0	Disabled
0 (Active LO)	1	Enabled

NAME:		TOT	SINGLE USE FUNCTION:		N	OUTPUT TYPE:		D
Input	Type	Description					Notes	
1	A	INPUT BLOCK						
2	D	DISABLE BLOCK						
Parameter		Description		Default	Max	Min	Code	Notes
1		INPUT CUTOFF %		0.00	100.00	0.00	2	
2		100% INPUT COUNTS/HOUR		1000	18000	60	2	
3		DISABLE INPUT ACTIVE LO/HI:						
		0=LO, 1=HI		1	1	0	2	

F117 [DSW] Discrete Switch

Function **DSW** is used to switch the Block Output between one of two discrete Input signals under control of a discrete Select signal. The concept is like an SPDT relay or 3 port solenoid valve. When the Select signal is "0" the A Input is selected and passed to the **DSW** Block Output. When Select = "1", the "B" signal is passed to the Output. The Block Output changes instantaneously when the Select Input changes.



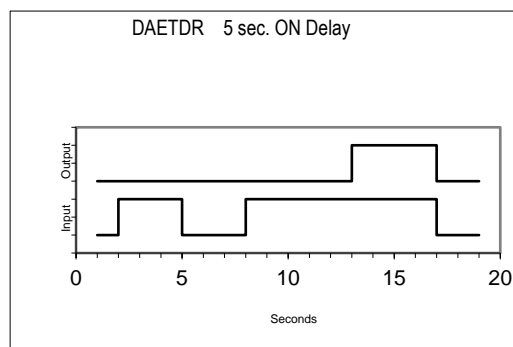
NAME:		DSW	SINGLE USE FUNCTION:		N	OUTPUT TYPE:		D
Input	Type	Description					Notes	
1	D	A INPUT						
2	D	B INPUT						
3	D	SELECT INPUT (0 = A, 1 = B)						

No Parameters

F118 [DAETDR] Delay After Energize Time Delay Relay (On Delay)

Function **DAETDR** simulates a "Delay After Energize" Time Delay Relay, also known as an "ON Delay" function. The Output may be inverted, see Parameter 2. The timing diagram shows the default, non-inverted logic.

For non-Inverted Output: When the Input = "0", the Output is "0", and the timer is reset to (Parameter 1) seconds. When the Input = "1", the timer starts counting down, and the Output changes to "1" when the timer counts down to 0 seconds.

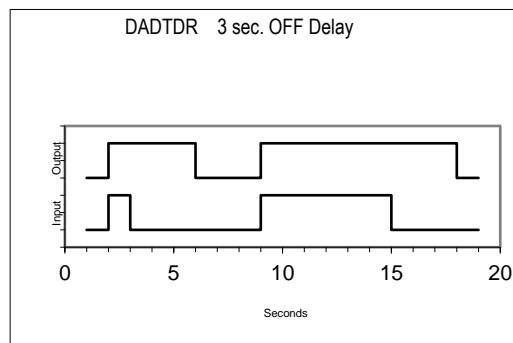


NAME:		DAETDR		SINGLE USE FUNCTION:		N		OUTPUT TYPE:		D		
<hr/>												
Input	Type	Description							Notes			
<hr/>												
1	D	INPUT										
<hr/>												
Parameter		Description			Default		Max		Min		Code	Notes
<hr/>												
1		SECONDS DELAY			1		19999		1		2	
2		INVERT OUTPUT 0=NO 1=YES			0		1		0		2	

F119 [DADTDR] Delay After De-energize Time Delay Relay (Off Delay)

Function **DADTDR** simulates a "Delay After De-energize" Time Delay Relay, also known as an "OFF Delay" function. The Output may be inverted, see Parameter 2. The timing diagram shows the default, non-inverted logic.

For non-Inverted Output: When the Input = "1", the Output is "1", and the timer is reset to (Parameter 1) seconds. When the Input changes from "1" to "0", the timer starts counting down, and the Output changes to "0" when the timer counts down to 0 seconds.

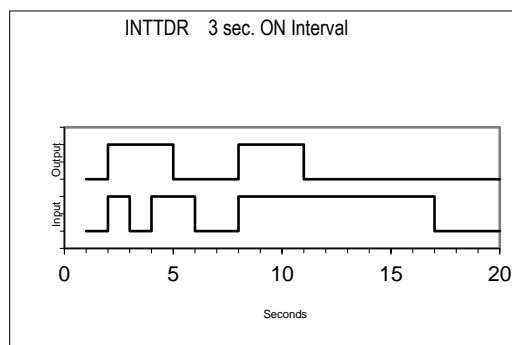


NAME:		DADTDR		SINGLE USE FUNCTION:		N		OUTPUT TYPE:		D		
<hr/>												
Input	Type	Description							Notes			
<hr/>												
1	D	INPUT										
<hr/>												
Parameter		Description			Default		Max		Min		Code	Notes
<hr/>												
1		SECONDS DELAY			1		19999		1		2	
2		INVERT OUTPUT 0=NO 1=YES			0		1		0		2	

F120 [INTTDR] Interval Time Delay Relay (Non-Retriggerable One Shot)

Function **INTTDR** simulates a "Interval" Time Delay Relay, also known as a "Non-Retriggerable One Shot" function. The Output may be inverted (see Parameter 2). The timing diagram shows the default, non-inverted logic.

For non-Inverted Output: When the **INTTDR** Output is "0", the timer is reset to (Parameter 1) seconds. When the **INTTDR** Input changes from a "0" in the previous scan to a "1" in the current scan, the timer starts counting down, and the Output changes to "1". When the Timer counts down to 0, the Output changes to "0". While the timer is counting down, the Input is ignored and has no effect on the timer or Output.



If the Delay Seconds is set to 0 seconds, the **INTTDR** Output will be "1" for exactly one scan.

NAME:		INTTDR		SINGLE USE FUNCTION:		N		OUTPUT TYPE:		D	
Input	Type	Description						Notes			
1	D	INPUT						1			
Parameter		Description				Default	Max	Min	Code	Notes	
1		SECONDS DELAY (0=1 SCAN)				1	19999	0	2	2	
2		INVERT OUTPUT 0=NO 1=YES				0	1	0	2		

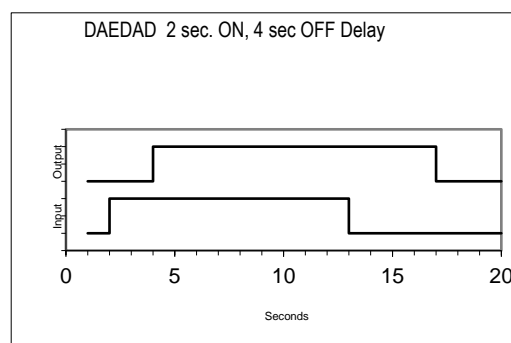
Notes:

1. An Input transition from 0 to 1 starts the timing sequence.
2. Delay Seconds = 0 means the Output will go active for exactly one scan and then return to the inactive Output state.

F121 [DAE/DAD] Delay After Energize / Delay After De-energize Timer

Function **DAE/DAD** combines **DAETDR** (F118) and **DADTDR** (F119) into a single function. **DAE/DAD** behaves as though the Output of a **DAETDR** Block was the Input to a **DADTDR** Block. **DAE/DAD** provides an initial ON Delay, and then provides an OFF Delay when the Input returns to "0". The Output may be inverted, see Parameter 3. The timing diagram shows the default, non-inverted logic.

For non-Inverted Output: When the **DAE/DAD** Output is "0" AND the Input is "0": the ON and OFF timers are reset to (Parameter 1) and (Parameter 2) seconds, respectively. When the Input = "1", the ON Delay timer starts counting down, and the Output changes to "1" when the ON Delay timer counts down to 0 seconds.



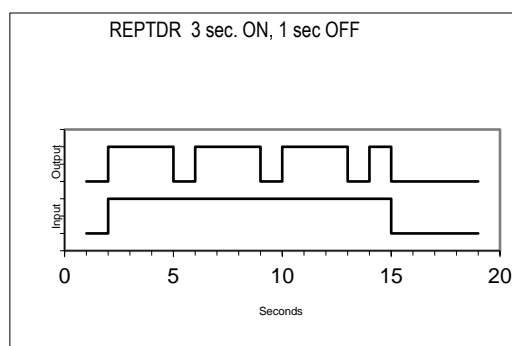
When the **DAE/DAD** Output is "1", and the Input changes from "1" to "0", the OFF Delay timer starts counting down, and the Output changes to "0" when the timer counts down to 0 seconds. If the Input changes back to "1" while the Output is still "1", the OFF Delay timer is reset.

NAME:		DAE/DAD		SINGLE USE FUNCTION:		N		OUTPUT TYPE:		D	
Input	Type	Description						Notes			
1	D	INPUT									
Parameter		Description		Default		Max		Min		Code	Notes
1		ON DELAY SECONDS		1	19999			1		2	
2		OFF DELAY SECONDS		1	19999			1		2	
3		INVERT OUTPUT 0=NO 1=YES		0	1			0		2	

F122 [REPTDR] Repeat Time Delay Relay

Function **REPTDR** provides repetitive Block Output cycling (1, 0, 1, 0, ...) with defined ON and OFF times. The Output may be inverted, see Parameter 2. The timing diagram shows the default, non-inverted logic.

For non-Inverted Output: When the Input is "0", the Output is "0", and both ON and OFF timers reset. When the Input changes from "0" to "1", the Output changes to "1", and the ON timer starts (Parameter 1). If the Input is still "1", and the ON timer times out, the Output changes to "0", the OFF timer starts, and the ON timer resets. If the Input is still "1", the Output changes to "1" and the cycle repeats until the Input changes to "0".



NAME:		REPTDR	SINGLE USE FUNCTION:		N	OUTPUT TYPE:		D
Input	Type	Description					Notes	
1	D	INPUT						
Parameter		Description	Default	Max	Min	Code	Notes	
1		ON TIME SECONDS	1	19999	1	2		
2		OFF TIME SECONDS	1	19999	1	2		
3		INVERT OUTPUT 0=NO 1=YES	0	1	0	2		

F123 [COMM] MODBUS Communications Link Control

Function **COMM** provides Communications Link (Comm Link) status and controls the ability of Modbus to write (modify) PCC-IV Block Outputs and parameters. The Block is not required if the Comm Link does not have to write (modify) to any Block Outputs or parameters (i.e., the Comm Link will be read-only).

The Block Output is "1" if MODBUS communication is enabled.

Remote/Local (R/L) Input: When the R/L Input is "1" (Remote), the Comm Link can write (modify) FPT/H (F38), FPCON (F55), PB (F98), RAIN (F5), and RDIN (F97) Block Outputs.

When the R/L Input is "0" (Local), the Comm Link cannot modify FPT/H, FPCON, or PB Blocks. However, Comm Link can write to RAIN and RDIN Blocks in Local mode.

NAME: COMM		SINGLE USE FUNCTION: Y		OUTPUT TYPE: D	
Input	Type	Description			Notes
1	D	REMOTE\LOCAL BLOCK (1=REMOTE WRITES ENABLED, 0=LOCAL ONLY)			

No Parameters

F125 [ROUT] Relay Output

Function **ROUT** is the Blockware interface to the PCC-IV Relay Output hardware. **ROUT** interfaces to Relay Outputs on the CPU board and on option boards. Parameter 1 specifies the board location (the CPU board = board 0). Parameter 2 selects a specific Relay on the specified board.

Invert Input: By default, a "1" Input energizes the Relay and changes the Output to a "1". If Parameter 3 is changed to a "1", a "0" Input Energizes the Relay and the Block Output.

NAME:	ROUT	SINGLE USE FUNCTION:			N	OUTPUT TYPE:	D

Input	Type	Description	Notes				
1	D	INPUT BLOCK	1				
Parameter	Description		Default	Max	Min	Code	Notes
1	OPTION BOARD (0=CPU BOARD)		0	2	0	3	
2	OUTPUT CHANNEL		1	2	1	3	
3	INVERT INPUT? 0=NO 1=YES		0	1	0	2	1

Notes:

1. See "Invert Input" above. By default, Relay energizes when Input = "1"

F126 [DOUT] Discrete Output (Open Collector - Sinking)

Function **DOUT** is the Blockware interface to the PCC-IV's 24 Vdc Open Collector Discrete Output hardware. **DOUT** interfaces to Discrete Outputs on the CPU board and on option boards. Parameter 1 specifies the board location (the CPU board = board 0). Parameter 2 selects a specific Discrete Output channel on the specified board.

Invert Input: By default, a "1" Input energizes the Discrete Output and changes the Output to a "1". If Parameter 3 is changed to a "1", a "0" Input Energizes the Discrete Output and the Block Output.

NAME:		DOUT		SINGLE USE FUNCTION:		N		OUTPUT TYPE:		D	
Input	Type	Description						Notes			
1	D	INPUT BLOCK						1			
Parameter		Description		Default		Max		Min		Code	Notes
1		OPTION BOARD (0=CPU BOARD)		0		2		0		3	
2		OUTPUT CHANNEL		1		4		1		3	
3		INVERT INPUT? 0=NO 1=YES		0		1		0		2	1

Notes:

1. See "Invert Input" above. By default, Relay energizes when Input = "1"

F127 [NOP] No Operation Dummy Function

Function **NOP** does not do anything. **NOP** is the default function that is placed in all Blocks when memory is erased. A **NOP** Block is not a valid Input to any other Block, and if used as an Input would cause a "Type Mismatch" error that would prevent the programmer from writing Blockware to the PCC-IV.

NAME: NOP		SINGLE USE FUNCTION: N		OUTPUT TYPE: D	
No Inputs and No Parameters					