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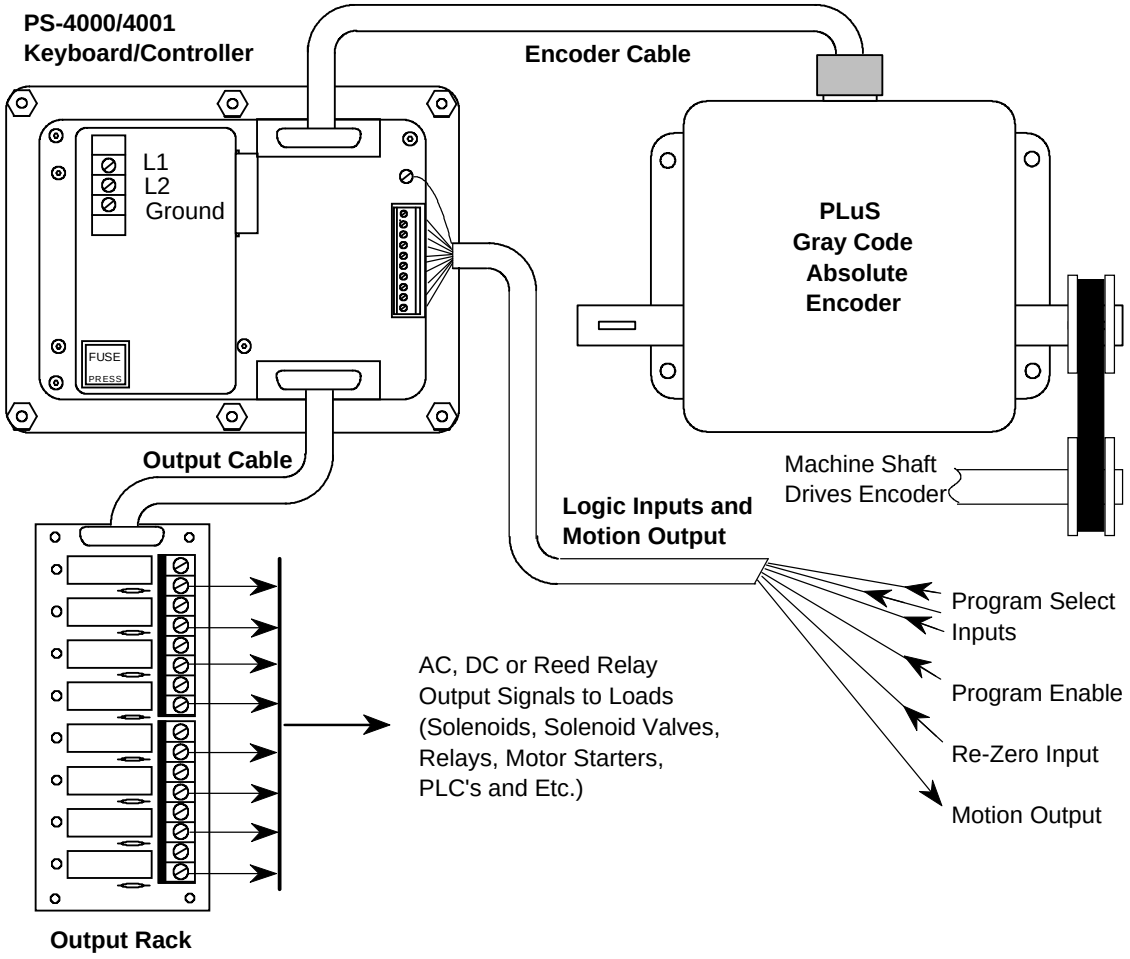
6 Error Codes

7 Logic Input/Output Terminal Block

Appendix

Wiring diagrams that appeared in some previously printed manuals are available upon request from Electro Cam Corp.

PS-4000/4001 System



PS-4011 System

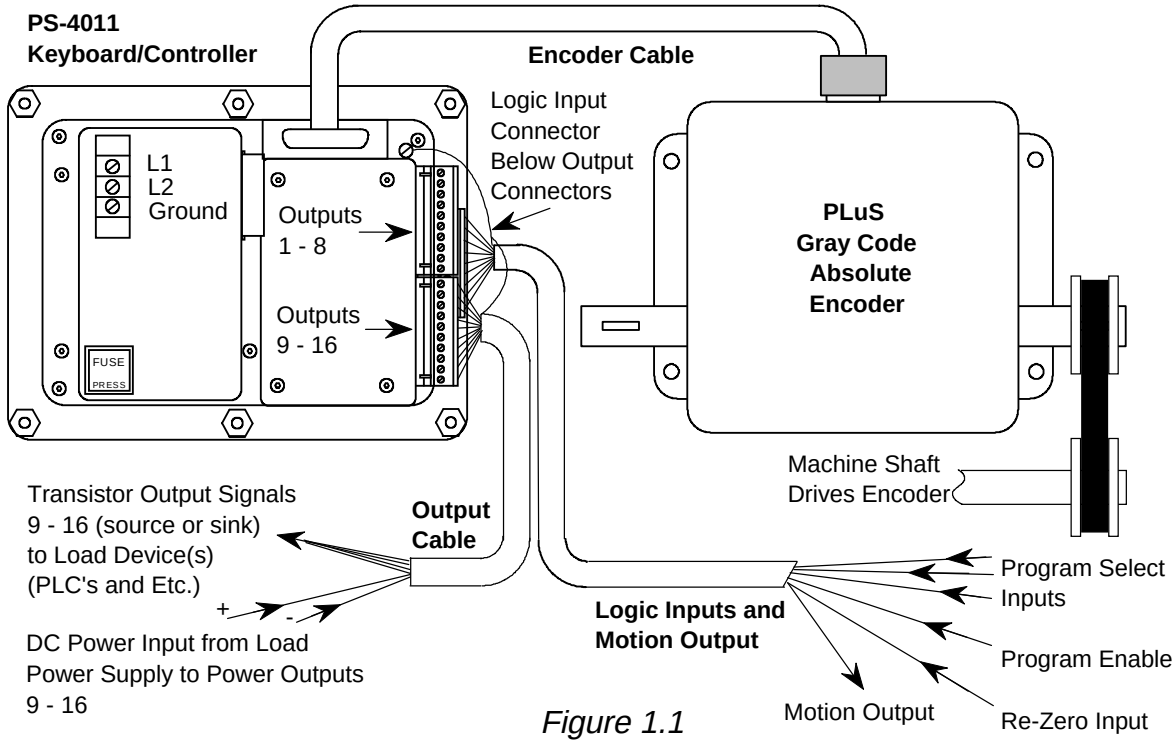


Figure 1.1

1
Product Description

Machine control functions must often be synchronized to a rotating shaft. This has been traditionally done by positioning mechanical switches on brackets that surround cams which ride on the shaft. Rotary Cam Limit Switches are a significant improvement; they provide the same function with a simple connection to the input shaft (and at a reduced cost). Programmable Limit Switches (PLS's) provide this same function while allowing remote programming of "ON" and "OFF" setpoints. PLS's also provide users with other advanced features, such as adjustment in motion, programmable offset, RPM and position monitoring, and motion detection.

STANDARD FEATURES

The PLuS controllers are enhanced, multiple program, multiple channel Programmable Limit Switches which accept shaft position input from an absolute Gray code encoder and turn channel outputs on and off according to the position of the encoder shaft. On/off setpoints are programmed through the PLuS Keyboard/Controller, based on 0 to 359 degree shaft rotation. Each output channel has 256 on/off setpoints per revolution of the encoder shaft. The PS-4000/4001 controllers are available with 8, 16, 24 or 48 outputs and the PS-4011 is available with 8 or 16 outputs. The 8, 16 and 24 channel versions have 8 programs, and the 48 channel versions have 5 programs.

NOTE:
All on/off setpoint references in this manual are in **degrees**.

Each separate program contains a complete set of on/off setpoint data for each channel and is stored in non-volatile EEPROM memory. The "active program" (program currently controlling the outputs) is selected through inputs on the back of the PLuS Keyboard/Controller (and/or through the keyboard on PS-4001/4011 model controllers). A new active program may be selected while the unit is in motion. The on/off channel setpoint data for the active program is transferred to the outputs when the encoder input changes.

DEFINITION: ACTIVE PROGRAM

The active program is the program whose channel on/off setpoints are currently being used to update the outputs. When displaying position or RPM, the active program number appears in the LED display above the PGM key. There are up to 8 programs on the PLuS; only one program may be active at a time. When a new program is selected to be active, the on/off setpoint data for all channels is updated to correspond to the data in the newly selected program. Programs which are "not active" may be viewed or changed while the machine is operating. The outputs will continue to be controlled by the "Active" Program.

The output modules used in the PS-4000/4001 systems are optically isolated, and can drive loads (up to 3 Amps) directly. They can also be used to interface with programmable logic controllers or other logic devices. The output transistors used in the PS-4011 are also optically isolated and can drive loads up to 30 VDC, 50 mA. The primary purpose of the model PS-4011 is to interface directly to logic devices (PLC's, etc.) without the use of output racks and modules.

Output channels are programmed through the PLuS Keyboard/Controller and each may have up to 256 on/off setpoints per revolution of the encoder shaft. Pulses are initially programmed while the unit is stopped (RPM = 0) and may extend through 0 (example: “on” at 270 degrees and “off” at 90 degrees). While in motion, the end points of pulses may be moved incrementally by pressing the “INC”(increment) and “DEC” (decrement) keys on the PLuS Keyboard/Controller.

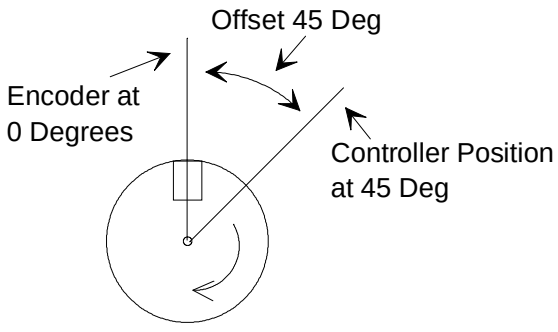
DEFINITION: PULSE

A pulse is the duration of the ON period between an “on” and an “off” setpoint pair. A pulse is programmed by using the “ON” and “OFF” keys in conjunction with numeric entry. A pulse is not entered until both the “on” and “off” setpoints defining it have been entered. Each channel may contain up to 128 pulses (256 on/off setpoints).

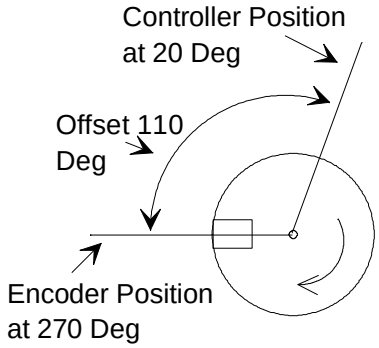
The PLuS controllers incorporate an “offset” which allows “Machine Zero” to be established quickly and easily (Fig 1.2). The amount of offset may be set through the numeric keypad on the PLuS Keyboard/Controllers while the unit is stopped (RPM = 0), and may be incrementally changed while in motion through the “INC” and “DEC” keys. In addition, a “Re-Zero” input on the back of the Keyboard/Controller allows you to **temporarily** set “Machine Zero” at any time. Offset values created by the Re-zero input are not stored in the controller's permanent memory and will be lost when power is removed.

DEFINITION: OFFSET

Offset is the angular difference (in degrees) between the Encoder's actual position and the controller’s position value. This allows the controller’s position value to lead or lag the encoder's actual position by a specified number of degrees. (See figure 1.2). When the offset is 0, the indicated controller position will correspond exactly with the encoder shaft position (when the encoder keyway is straight up the PLuS controller will read a position of 0).



Example 1



Example 2

Figure 1.2 Offset Examples

OFFSET ADJUSTMENT: OFFSET ABSOLUTE (FCN #3)

The “Offset Absolute” function monitors and adjusts the amount of offset in degrees. A different Offset value can be entered numerically when the encoder is not turning or the existing value can be incremented or decremented any time that programming is enabled. The Absolute Offset value should be recorded after the machine is set up and running properly so that it can quickly be re-enter if the offset value is inadvertently changed.

OFFSET ADJUSTMENT: OFFSET RELATIVE (FCN #4)

The “Offset Relative” function monitors and adjusts the current controller position in relation to the Encoder position. A different controller position value (Relative Offset) can be entered numerically when the encoder is not turning or the existing value can be incremented or decremented any time that programming is enabled. This allows the desired controller position to be changed to correspond to the current machine position. Stop the machine in a “known position” and adjust FCN #4 to set the controller position to correspond to that known machine position.

Motion detection is provided through an optically isolated “sourcing” output (5 VDC, 50 mA maximum) on the back of the Keyboard/Controller and through an LED on the keyboard face. High and Low RPM setpoints are provided to establish a “range” of RPM in which the motion detection output (and the LED) will be on.

A “Program Enable” input on the back of the Keyboard/Controller must be energized before programming changes can be made. This input can be used to prevent unauthorized program changes.

The large, easy to read LED display on the face of the Keyboard/Controller may display either RPM (cycles per minute) or controller position in degrees (includes offset).

PS-4001 AND 4011 MODEL ENHANCEMENTS

The PS-4001/4011 model controllers have the same features and physical dimensions as the PS-4000 controllers plus two additional features: 1) Selection of the “Active Program” from the keyboard (Function #5), and 2) Automatic speed compensation on selected output channels (The number of compensated channels and the amount of compensation is selected through functions #6 and #7).

DESCRIPTION OF SYSTEM COMPONENTS

System components, and their relationship to each other, are illustrated on page 1.1, Figure 1.1.

A complete PLuS PS-4000/4001 system consists of:

1) PS-4256 series Encoder (NEMA 12 or NEMA 4X housing and 0 to 1000 or 0 to 2000 RPM must be specified)
2) PS-400X series Keyboard/Controller (8, 16, 24, or 48 outputs)
3) 8, 16 or 24 point Output Rack (2- 24 output racks needed for 48 output system)
4) Encoder Cable (connects the Controller to the encoder)
5) Output Rack Cable (connects the Controller to the output rack - 2 cables needed for 48 output system)
6) Plug-in AC, DC, or Reed Relay Output Modules

All six components must be specified and ordered to have a complete, operating PS-4000/4001 system (ref. Fig. 1.1).

Controller / Output Rack Compatibility:

8 Output Controller: An 8 output rack is best suited to an 8 output controller. A 16 output rack can be used, but only the first 8 output positions will operate.

16 Output Controller: A 16 output rack is best suited to a 16 output controller. An 8 output rack can be used, but only 8 of the controllers 16 outputs can be utilized. Two 8 output racks can NOT be connected to a single controller.

24 Output Controller: A 24 output rack must be used. 8 and 16 output racks will NOT function with a 24 output controller.

48 Output Controller: Two 24 output racks must be used if more that 24 outputs are required. A single 24 output rack can be used if 24 or less outputs are needed (the outputs used can be addressed as 1-24 or 25-48). A second 24 output rack can be added at any time without affecting the wiring of the first output rack.

A complete PLuS PS-4011 system consists of:

1) PS-4256 series Encoder (NEMA 12 or NEMA 4X housing and 0 to 1000 or 0 to 2000 RPM must be specified)
2) PS-4011 series Keyboard/Controller (8 or 16 outputs)
3) Encoder Cable (connects the Controller to the encoder)
4) Output Cable (connects transistor outputs directly to load inputs - Electro Cam PS-4300-04-XXX shielded cable is recommended, 2 cables needed for 16 output system)

KEYBOARD/CONTROLLER

The PLuS Keyboard/Controller is microprocessor based and interrupt driven. Changes in the encoder shaft position generate a hardware interrupt which causes the CPU to suspend its current task (monitoring the keyboard and updating position or RPM display) and immediately update the on/off status of the channel outputs.

A terminal block on the back of the Keyboard/Controller provides logic inputs and motion detection output. Logic inputs are used to select the active program, enable programming, re-zero the indicated shaft position, and determine which direction of encoder shaft rotation causes the indicated position display to increase in value. The re-zero input generates a hardware interrupt for immediate response.

Polarized, screw down DB25 connectors are provided on the back of the PLuS Keyboard/ Controllers to connect the encoder cable. On the PS-4000/4001 controllers, another DB25 connector is used to connect the output rack cable. Encoder and output rack connectors are of different gender so that it is not possible to incorrectly attach cables.

The face of the Keyboard/Controller is constructed of UV hard coated mylar, and is impervious to most environments. Keys provide tactile feedback for keypress verification, and large, easy to read seven segment LED's provide a clear indication of position, RPM, or programming status. Keyboard/Controller units are stud mounted and seal to the mounting surface with the gasket supplied with each unit.

GRAY CODE ENCODER

The PLuS system is designed to use PLuS Encoders which are rugged, sealed, absolute eight bit Gray code encoders. They feature 3/4" double ended shafts supported at both ends by sealed ball bearings. They are available with either Nema 12 or Nema 4X (stainless steel) enclosures and come in two speed ranges. The PS-4256/4456 units are rated at 0 to 1000 RPM. The PS-4257/4457 units are rated at 0 to 2000 RPM. The encoder discs are made of stainless steel. Gray code is output to the Keyboard/Controller via noise immune RS422 differential drivers for reliable operation in harsh industrial environments.

OUTPUT RACKS

8, 16 and 24 point output racks are available for use with the PLuS Keyboard/Controller. The 24 point output racks are "addressable", and two are daisy chained together in 48 output systems.

All output racks provide for individually fused, socketed, optically isolated output modules. The racks are constructed of rugged, .090" thick circuit board material. Connections to the output modules are made through screw down terminal blocks. Bright LED indicators are provided for each module to indicate on/off status (Modules must be in place for Led's to operate).

OUTPUT MODULES (PS-4000/4001)

Output modules must be ordered separately from output racks and are available in AC, DC and reed relay configurations. Both “zero crossing” and “random turn on” AC output modules are available. DC output modules may be wired in either “sinking” or “sourcing” mode, and are available with either 0 to 60 VDC or 0 to 200 VDC ratings.

Output modules can drive loads directly, and may interface directly to programmable logic controllers or other control devices. They can be intermixed in any combination and placed in any position on output racks: up to 8 modules on an 8 Output Rack; up to 16 modules on a 16 Output Rack; and up to 24 modules on a 24 Output Rack.

OUTPUT TRANSISTORS (PS-4011 only)

Sinking or Sourcing transistor outputs must be specified on PS-4011 controllers. The outputs are capable of switching up to 30 VDC, 50 mA maximum. The 18 pin transistor array chips used for each group of 8 outputs are socketed and can be replaced in the field should the need arise. A 1 Amp plug-in fuse is provided for each group of 8 outputs and is also field replaceable. Connection to the transistor outputs is made through keyed, pluggable 10 terminal connectors on the back of the controller.

CABLES

Encoder and Output Rack cables used with the PLuS controllers are pre-assembled at the factory in a variety of standard lengths and shipped ready to install (custom lengths are available). These cables are shielded and are provided with DB25 screw down connectors installed. PS-4011 output cables are cut, stripped and tinned with a spade connector attached to the shield drain wire at the controller end. Program Select and Program Enable cables are shielded, and all wires are cut, stripped, and tinned, and ready to install. All connectors are polarized to insure proper installation, and all discrete wires are clearly labeled. All cables must be ordered separately to customer specified length requirements.

GRAY CODE OUTPUT OPTION

The Models PS-4001/4011 are available with a Gray Code Output option (G Option). The last 8 outputs (16 outputs required minimum) will output an 8 bit Gray Code pattern which is identical to that of the Encoders. The bit pattern output will be the one which corresponds to the controller position, not the encoder position. In other words, the Gray Code output takes into account the Offset. This Gray Code signal can be connected to a PLC or other logic device to provide it with position information.

NOTE: Output Channel 9 is the least significant bit (LSB) and Output Channel 16 is the most significant bit (MSB) of the Gray Code Output.

2
Installation

GROUNDING

PLuS units come equipped with shielded cables that are ready to plug in. In order for that shielding to be effective, care must be taken to insure that a solid ground path exists between system components. Please observe the following recommended procedures:

1) Securely fasten the Keyboard/Controller to the control cabinet with the #10 nuts and star washers provided with the unit. The use of star washers will insure a good electrical connection between the Keyboard/Controller and the control cabinet.

2) If the control cabinet is not mounted directly to the machine, take care to insure a solid connection between the cabinet and the machine. A braided grounding strap or 12 gauge stranded wire is recommended.

3) Securely fasten the encoder to the machine frame using star or split washers. Check to insure that continuity exists between the encoder enclosure and machine ground. Insure that the encoder cable shield wire is attached to the NON-TERMINATED spade connector on the encoder printed circuit board (PCB) if the encoder enclosure is securely attached to machine ground.

4) If the encoder enclosure cannot be securely grounded, insure that the encoder cable shield wire is attached to the TERMINATED spade connector on the encoder PCB.

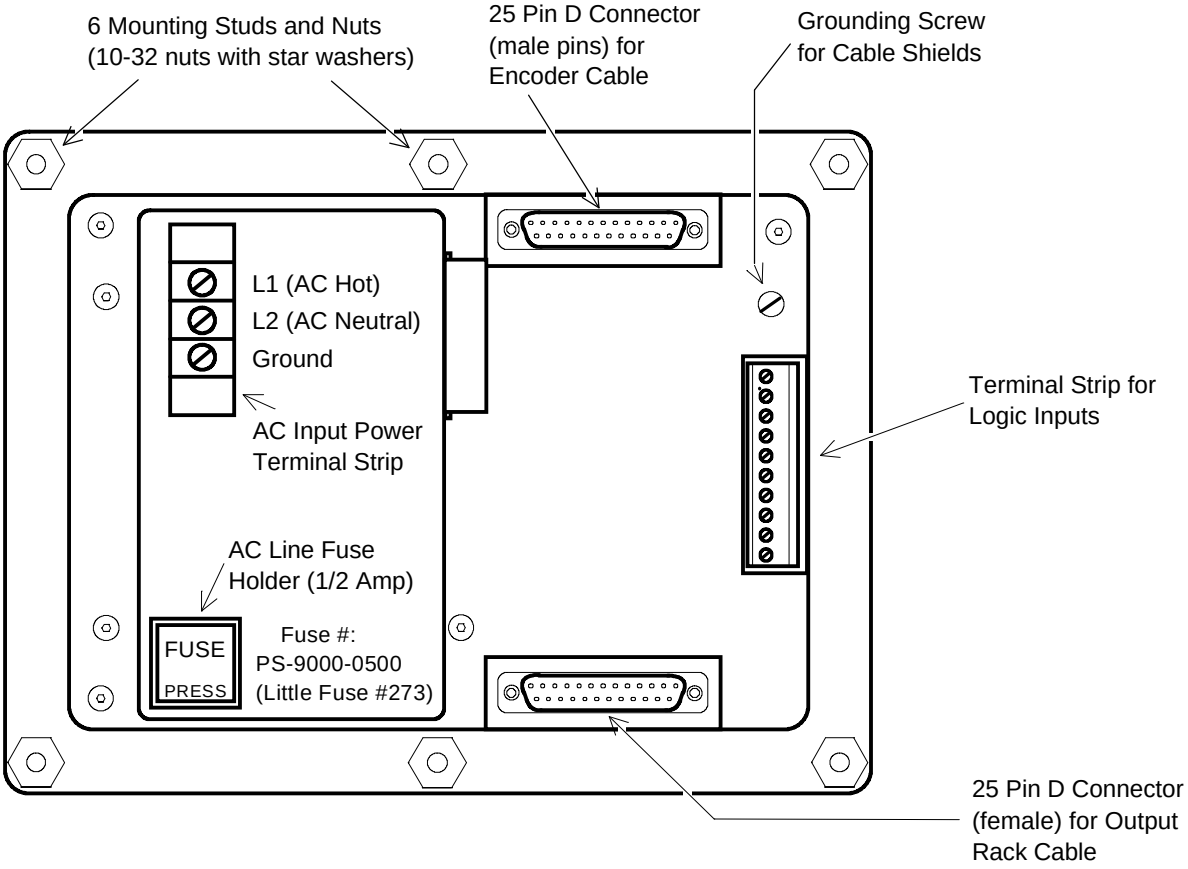
5) Be sure to tighten the screws that hold the encoder and output rack cables in place. These screws are part of the shield connection.

6) If you are using a Program Select Switch, or a Program Enable Switch, be sure to attach the shield wire to the Keyboard/Controller grounding lug located next to the Logic Input terminal block.

7) Make sure that proper grounding procedures are followed when wiring AC power to the machine. Always make sure that the machine frame is not “floating” with respect to ground.

PS-4000/4001 Rear Panel Layout

Back View



Right Side View (as viewed from back)

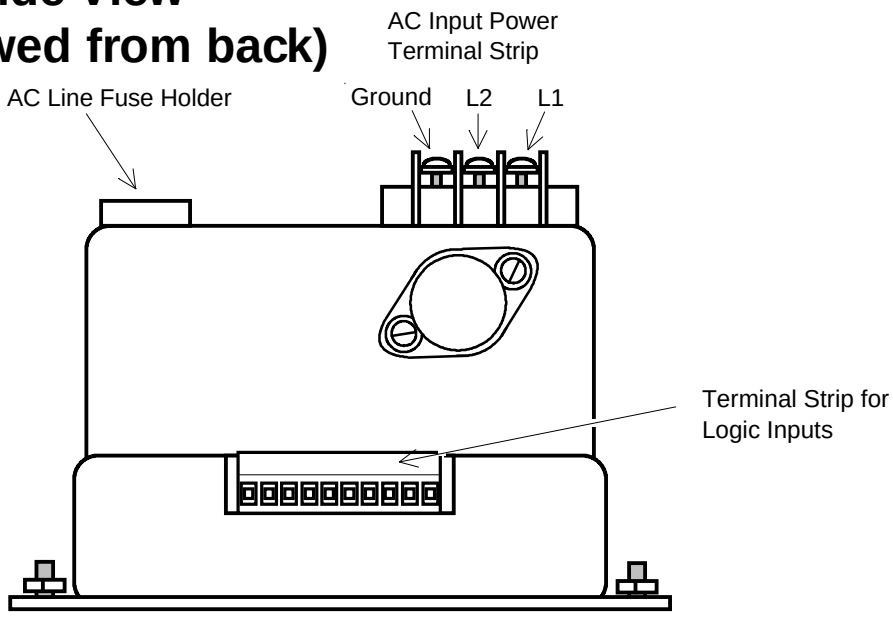
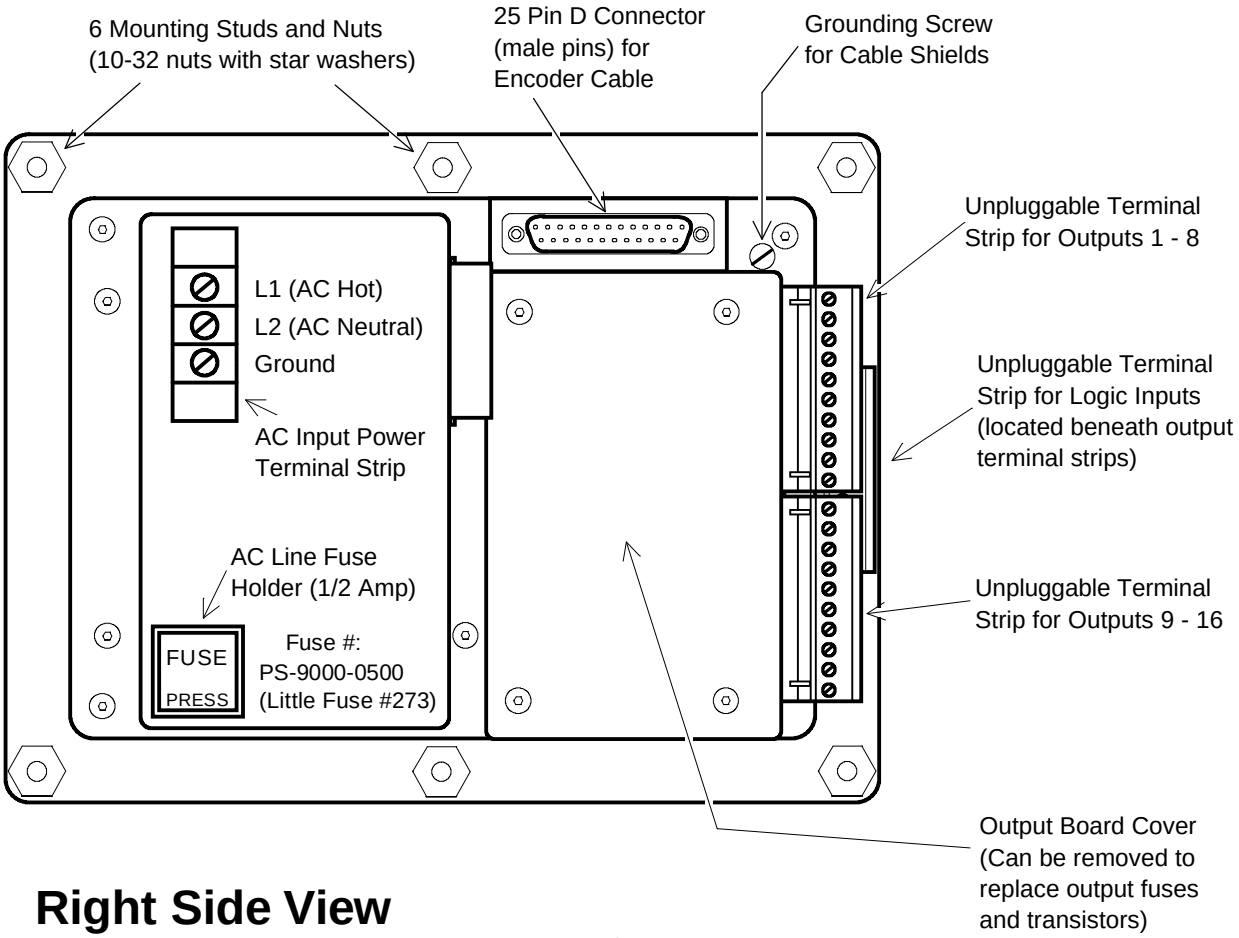


Figure 2.1 PS-4000/4001 Rear Panel Drawing

PS-4011 Rear Panel Layout

Back View



Right Side View (as viewed from back)

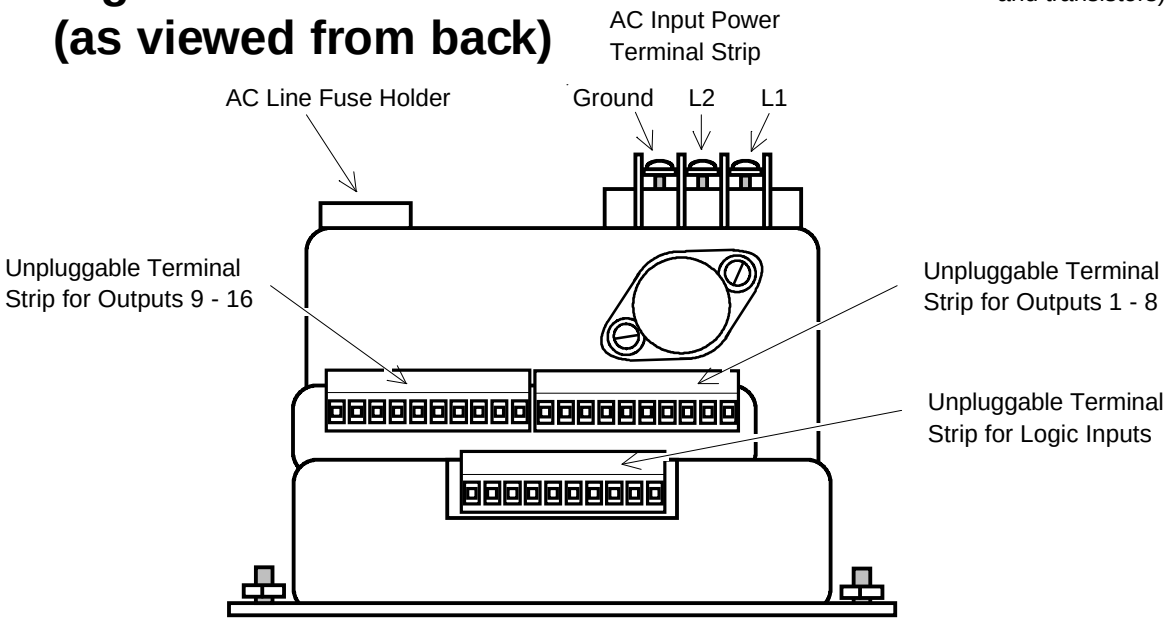


Figure 2.2 PS-4011 Rear Panel Drawing

KEYBOARD/CONTROLLER MOUNTING

The PLuS Keyboard/Controller is mounted to the electrical enclosure with six (6) #10-32 nuts and star washers. Cut a hole in the enclosure to the dimensions as shown in “Mounting Dimensions” (Fig 2.3). Drill six (6) 5/16" holes around the cutout as shown. Remove the #10-32 nuts and star washers from the Keyboard/Controller. Leaving the gasket in place, slide the Keyboard/Controller into the cutout and fasten the unit securely in place with the nuts and star washers. NOTE: The gasket is designed to be sandwiched in between the Keyboard/Controller and the electrical enclosure.

AC power is supplied through a three position terminal block mounted on the back of the Keyboard/Controller. Wire L1, L2, and Ground as shown on the unit label.

Check that the fuse cap on the fuse holder is securely in place, and that there is a fuse (.5 Amp) inside the holder.

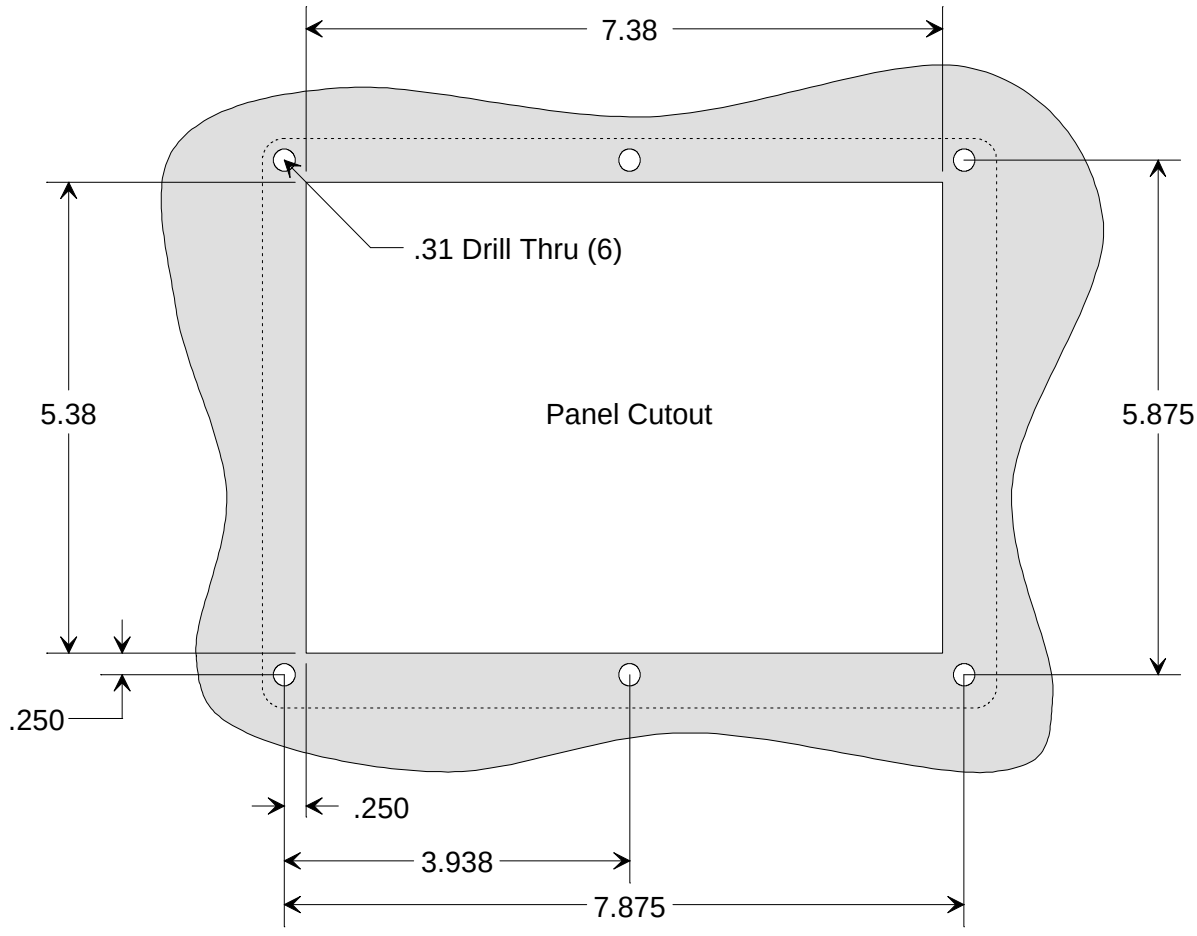


Figure 2.3 Panel Cutout

DIRECTION OF INCREASING ROTATION:
Keyboard/Controller units are shipped with a jumper wire in place between terminals 9 and 10 on the Logic Input/Output terminal block. This jumper causes the controller to show INCREASING indicated encoder shaft position with CCW rotation viewed from the left hand shaft extension. Remove this jumper with power off if you wish to indicate increasing position with CW rotation.

ENCODER MOUNTING

WARNING: Do not attempt to adjust the metal encoder disks. These are preset at the factory to tight tolerances. Moving the encoder disks will cause malfunction and will void your warranty.

Mount the encoder to the machine frame using four 1/4" bolts with locking washers. Insure that the unit is mounted to a flat surface, and that tightening the bolts does not distort the encoder enclosure in any way.

The 3/4" encoder shaft may be coupled to the machine using timing belts, chains, gears, or couplings. A 3/16" woodruff keyway (#606) is supplied on the shaft for securing timing belt pulleys, sprockets, gears, or flexible couplings.

DO NOT OVERTIGHTEN THE DRIVING BELT OR CHAIN! Although the 3/4" shaft is supported on both ends with rugged ball bearings, it is not indestructible.

NOTE: Always keep the cover in place after cable installation. Failure to keep cover in place may cause malfunction and will void your warranty.

ENCODER CABLE

NOTE:
The following encoder cable installation is for the standard supplied fitting. If you desire to run the cable in 3/4" flexible conduit, the standard fitting can be removed and a sealed 3/4" conduit fitting put in its place.

1) Slide the threaded conduit endcap, split plastic reinforcing endcap, and split rubber grommet on to the encoder cable.

2) Gently push the socket connector and shield wire through the conduit fitting.

3) Spread the locking/eject clips apart on the encoder PCB board header and insert the the cable connector. The socket connector and header are polarized, so that it is not possible to install this connector backwards. Push gently down on the socket connector until the locking/eject clips snap back into a vertical position. The connector is now locked in place.

4) Attach the shield wire to one of the spade connectors on the encoder PCB as described in “GROUNDING”, above.

5) Gently slide the rubber grommet up to the conduit fitting. Leave enough cable inside the encoder so that there is no strain on the 26 pin locking header. Make sure that the split plastic endcap is in place and screw the threaded conduit cap securely onto the conduit fitting. Make sure that the cable does not become twisted during tightening.

5) Screw the encoder cover securely back in place after making sure that 1) the cable is not twisted or under strain, 2) the shield wire is properly terminated, and 3) that there is no debris in the encoder enclosure, especially not metal shavings.

NOTE: Always keep the cover in place after cable installation. Failure to keep cover in place may cause malfunction and will void your warranty.

6) Connect the other end of the cable to the Keyboard/Controller using the two screws attached to the connector hood. This connector is “gender compatible” with only one of the DB25 connectors on the Keyboard/Controller, so that it is not possible to install this cable incorrectly.

OUTPUT RACK MOUNTING (PS-4000/4001)

Output racks are mounted to the electrical enclosure panel with #6 x 1" self tapping screws (or equivalent). Four screws are required for 8 and 16 point I/O racks.

Install output modules in the sockets provided on the rack. Output modules may be placed anywhere on the rack, it is not necessary to have a contiguous block of output modules. Output racks will accept AC, DC, and reed relay output modules in any position. It is recommended, of course, that AC and DC wiring be physically separated for the most effective elimination of any electrical noise that may be transmitted through the wiring to other control devices.

Refer to figures 2.4 and 2.5 for general output module wiring information. Specific output module wiring examples are found in the “Wiring and Application Notes” section of this manual.

OUTPUT RACK CABLE

Secure the output rack cable to both the output rack and the Keyboard/Controller using the screws attached to the hoods. These connectors are also “gender compatible” with only one of the DB25 connectors on the Keyboard/Controller, so that it is not possible to install these cables incorrectly.

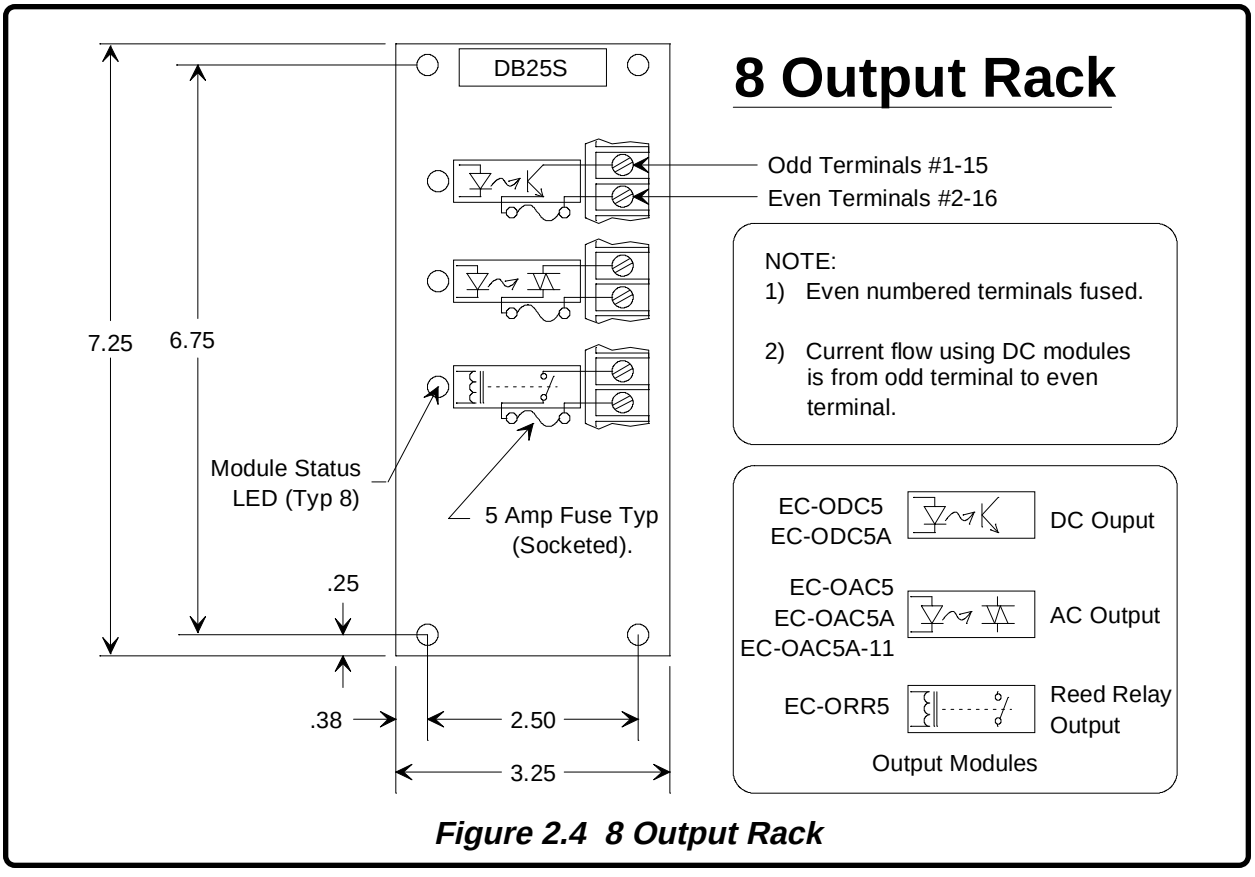


Figure 2.4 8 Output Rack

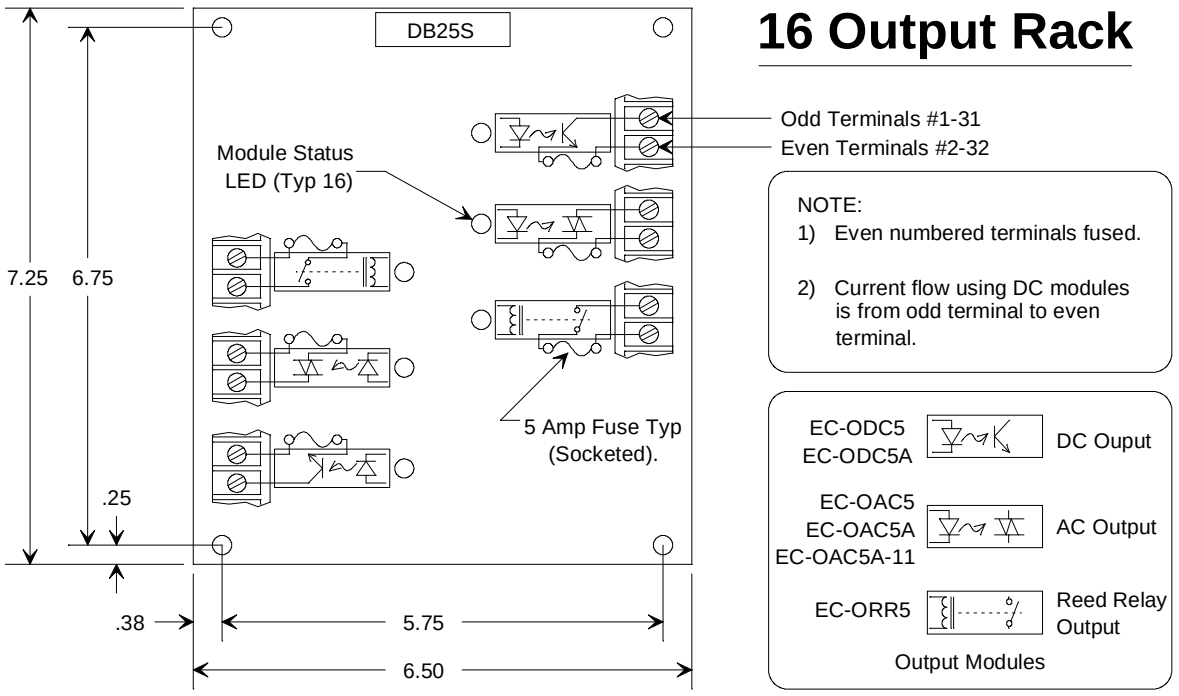


Figure 2.5 16 Output Rack

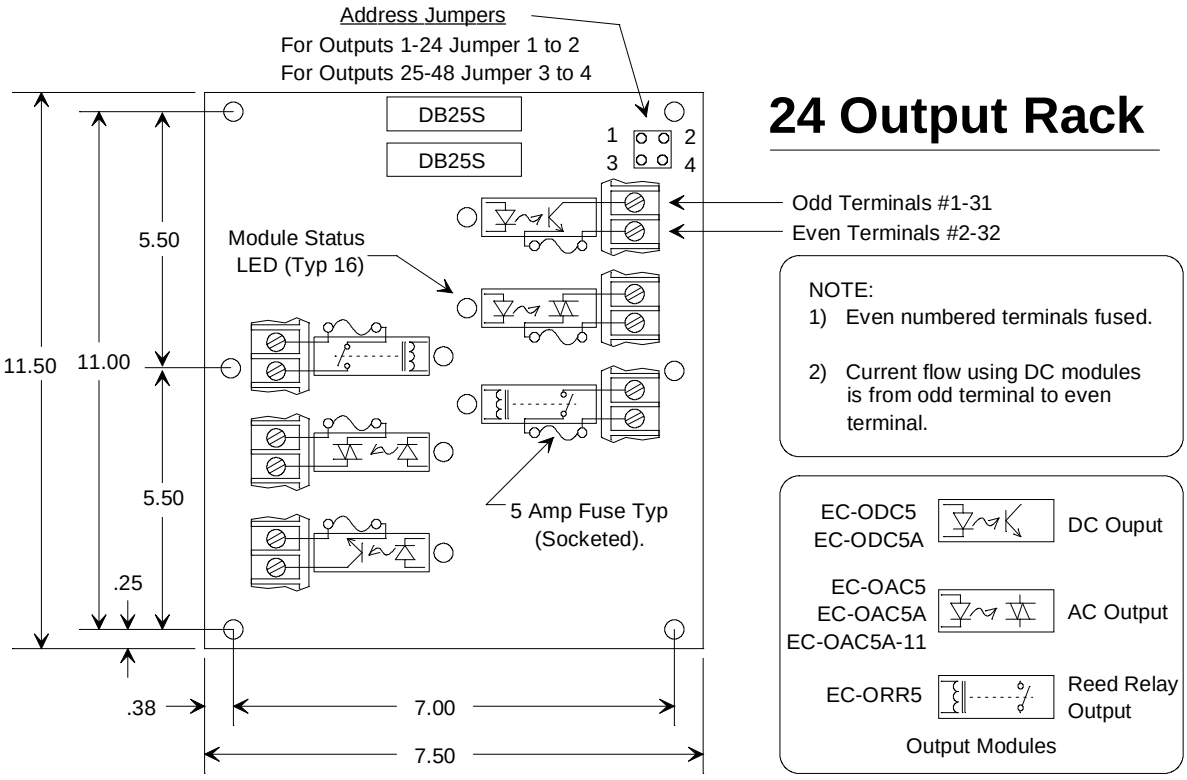


Figure 2.6 24 Output Rack

PS-4011 OUTPUT BOARDS

The Output Board which contains the output transistor array chips and the fuses is located under the output board cover shown in Figure 2.2. The unpluggable output terminal strips plug into receptacles that are mounted to the output board. The only time it will be necessary to remove the output board cover is when an output fuse is blown or a transistor array chip is damaged.

Output Transistor Array Chip(s)

Each group of 8 output transistors is contained in a single 18 pin transistor array chip. If one or more of these transistors becomes damaged the chip can simply be unplugged from the socket and replaced with an equivalent chip. Note in Figure 2.7 that the Sinking and Sourcing output boards do NOT use the same transistor array chip.

Output Fuse(s)

Each group of 8 outputs (1 transistor array chip) is protected by a 1 Amp plug in fuse. This fuse will blow if the DC power polarity is incorrectly wired to the "+" and "-" terminals on the output terminal strip. On the sourcing output versions this fuse will also blow if the total amount of current being conducted by that group of 8 outputs exceeds 1 Amp. If a fuse does blow, all 8 of the outputs in that group will be inoperative until the fuse is replaced.

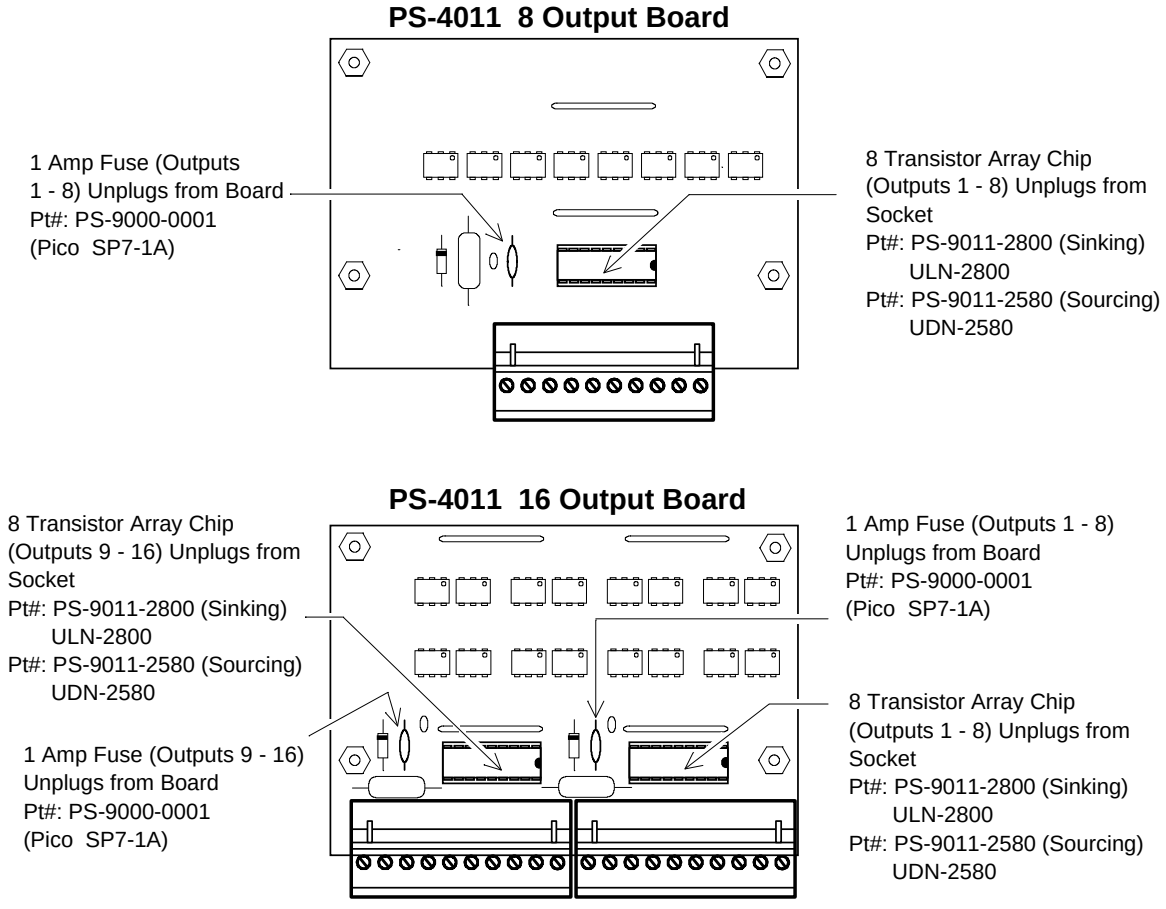


Figure 2.7 PS-4011 Output Boards

PS-4011 OUTPUT CABLE(S)

The PS-4011 uses unpluggable screw terminal strips to connect the transistor outputs to the load device. Therefore, no special connectors are needed for output wiring. However, shielded cable is recommended (Electro Cam Pt#: PS-4300-04-XXX, 2 cables required for system with more than 8 outputs) to maximize the system's immunity to electrical noise. The shield should be connected to the Grounding screw located on the back paned just above the output terminal strips (see Figure 2.2). The shield should be left unconnected at the load end of the cable. Also, the cable should be kept away from other electrical wiring, especially control wiring involving solenoids, relays, contactors and motors.

Wiring diagrams which show how to connect the PS-4011 outputs to load devices are located in section 8 of this manual, Figures 8.25 and 8.26.

Keyboard Layout of Plus Controllers

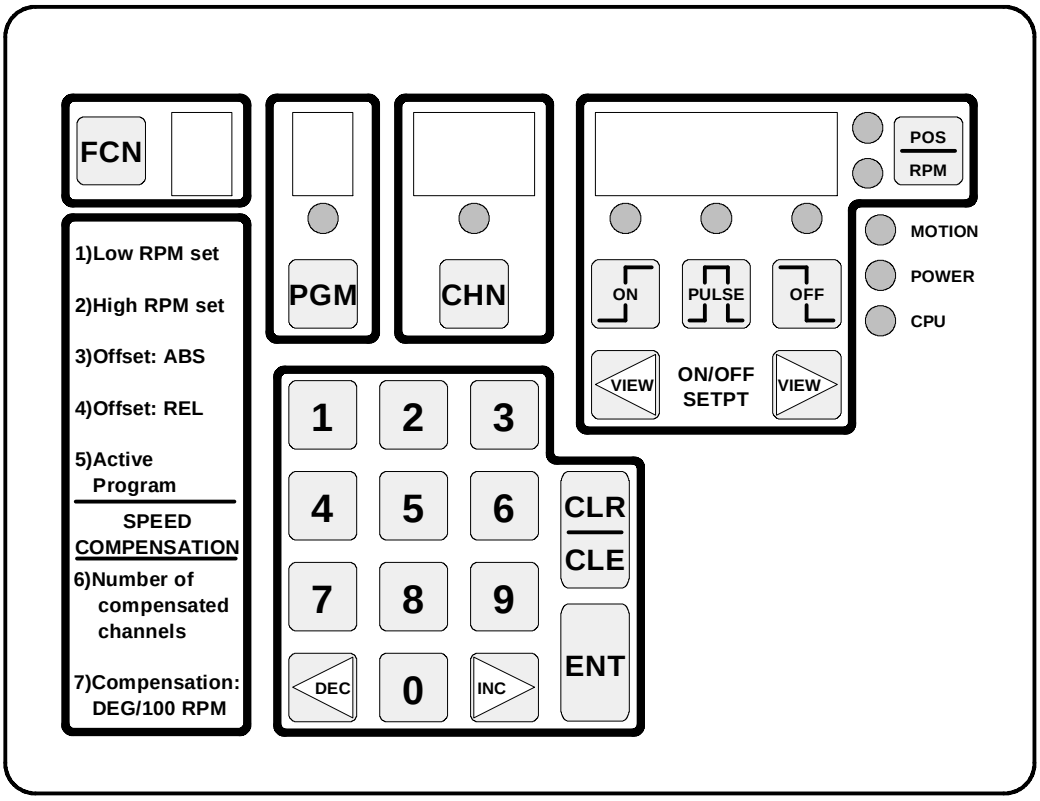


Figure 3.1 PLuS Controller Keyboard

The keyboard pictured above in Figure 3.1 corresponds to the PS-4001 and PS-4011 models. The PS-4000 is identical except that the Function label (items 1-7 beneath the FCN key) does NOT include items 5-7. (The PS-4000 does not allow the active program to be selected from the keyboard and does not have Speed Compensation)

3
Keyboard Overview

NOTE: "Numeric Entry" is the entering of a new setpoint value using the numeric keypad. ALL NUMERIC ENTRY MUST BE CONCLUDED BY PRESSING THE ENTER KEY. If an error is made during entry, the CLEAR key may be pressed to clear the display.

FUNCTION 

Initiates selection of a programming function. Numeric entry is used after pressing this key to enter the desired function number.

PROGRAM 

Initiates selection of a program for viewing or editing. Numeric entry is used after pressing this key to enter the desired program number.

CHANNEL 

Initiates selection of a particular channel within a program for viewing or editing. Numeric entry is used after pressing this key to enter the desired channel number. If this key is pressed without first selecting a program, the currently active program is automatically selected for editing.

ON 

Initiates the entering of a new on/off setpoint pair ("pulse"). Numeric entry is used after pressing this key to enter the "ON" setpoint. Channel setpoints are not affected until the "OFF" setpoint for the pulse has been entered.

OFF 

Initiates the entering of a new "OFF" setpoint. A new "ON" setpoint must have previously been entered. Numeric entry is used after pressing this key to enter the "OFF" setpoint.

PULSE 

When viewing pulses, pressing this key will put the PLuS in “pulse mode”. In this mode, incrementally moving one pulse setpoint automatically moves the other pulse setpoint by the same amount, keeping the total “ON” duration constant (See error code “E6” in Section 6). Successive presses of this key will toggle the unit between standard pulse mode and “multi-pulse mode”. The “multi-pulse” mode is characterized by a flashing LED above the pulse key. In “multi-pulse mode”, moving any pulse setpoint automatically moves ALL channel setpoints. Movement of a setpoint in pulse mode can ONLY be done with the INC and DEC keys. This can be done while the unit is in motion.

VIEW INCREASING 

Moves to the next on/off setpoint in an increasing numerical direction. The LED’s above the ON and OFF keys indicate whether the setpoint reached is an “ON” or OFF” setpoint. The display above the ON and OFF keys will contain the setpoint value. If no setpoints are programmed, no LED’s will be illuminated, and “0” will be displayed. A channel must be selected before using this key, or an “E3 ordr” error message will be displayed.

VIEW DECREASING 

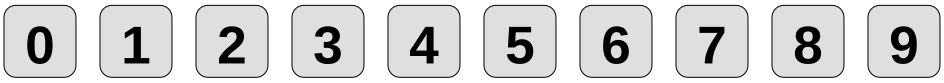
Moves to the next on/off setpoint in an decreasing numerical direction. The LED’s above the ON and OFF keys indicate whether the setpoint reached is an “ON” or "OFF” setpoint. The display above the ON and OFF keys will contain the setpoint value. If no setpoints are programmed, no LED’s will be illuminated, and “0” will be displayed. A channel must be selected before using this key, or an “E3 ordr” error message will be displayed.

POS/RPM 

Toggles setpoint display between showing position and RPM when not in programming mode. When viewing channel setpoints, pressing this key will cause the PLuS to return to displaying indicated encoder shaft position and channel on/off activity. IN ANY OTHER MODE, THIS KEY WILL CAUSE THE PLuS TO ABANDON PROGRAMMING AND RETURN TO NORMAL OPERATING MODE.

In normal operating mode, successive presses of the POS/RPM key wil toggle the display between the controller position and RPM.

0 - 9



Numeric Entry keys. Pressing these keys will cause numbers to be entered into the appropriate display. The ENTER key must be pressed to conclude Numeric Entry.

DECREMENT

Used to decrease a setpoint by 1 (see note “E6” on page 6-2). Only active while viewing channel setpoints, changing the offset, or changing the amount of speed compensation.

INCREMENT

Used to increase a setpoint by 1 (see note “E6” on page 6-2). Only active while viewing channel setpoints, changing the offset, or changing the amount of speed compensation.

CLEAR
CLR ENTRY

Clears a display or flashing error condition. Used while viewing setpoints to initiate changing the currently viewed setpoint through Numeric Entry. Numeric entry is used after pressing this key to enter a new setpoint value. Used during numeric entry to clear display. Numeric Entry may NOT be used to change setpoint values (except high and low motion detection values) while the PLuS is in motion.

ENTER

Concludes Numeric Entry. After pressing this key,the entire display will blank momentarily if the desired operation was successful.

NOTE:

Setpoint changes done through Numeric Entry will affect output channel operation immediately because outputs are updated out of fast RAM memory. Permanent memory (EEPROM) backup of the changes may take several seconds. DO NOT POWER DOWN OR DISABLE PROGRAMMING IMMEDIATELY AFTER “ENTERING” A SETPOINT OR IT MAY NOT BE COMPLETELY STORED INTO EEPROM MEMORY.

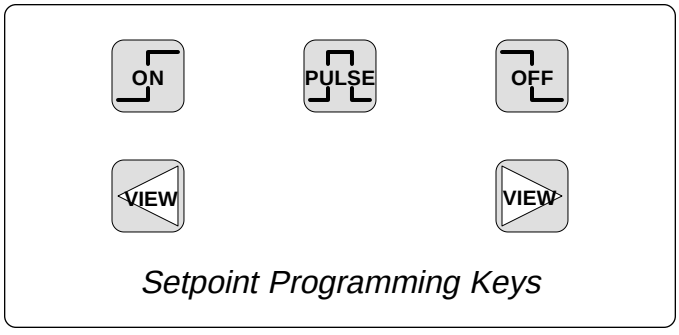
4
Output Channel Programming

SETPOINTS AND PULSES

NOTE:
The Program Enable Input (Logic Terminal Strip) Must be Energized to Allow Output Programming.

An output channel is programmed by entering ON and OFF setpoints. The ON duration between an ON setpoint and an OFF setpoint is referred to as a "pulse". Each pulse requires both an ON and an OFF setpoint. The ON setpoint must always be entered before setting an OFF setpoint or an "E3-ordr" error will be displayed. Each channel may have up to 128 pulses (256 ON/OFF setpoints). Pulses may be programmed to go through zero.

The PLuS Programmable Limit Switch keyboard has five keys that directly refer to pulses: the ON key, the PULSE key, the OFF key, the VIEW DECREASING key, and the VIEW INCREASING key:



Setpoint Programming Keys

When you have selected a channel to view or edit, pressing the VIEW keys will move successively through all the ON and OFF setpoints programmed into that channel. The VIEW INCREASING key will traverse setpoints in an increasing numerical direction, and the VIEW DECREASING key will traverse setpoints in a decreasing numerical direction.

Above the ON and OFF keys are LED indicators. When viewing setpoints, the ON LED, when illuminated, indicates that the displayed position is the FIRST "ON" POSITION of a pulse. You then know that at least one position is ON (the present one), and that it is the start of a pulse that extends in the INCREASING NUMERICAL DIRECTION, and may extend through 0 (example: ON at 270 and OFF at 90).

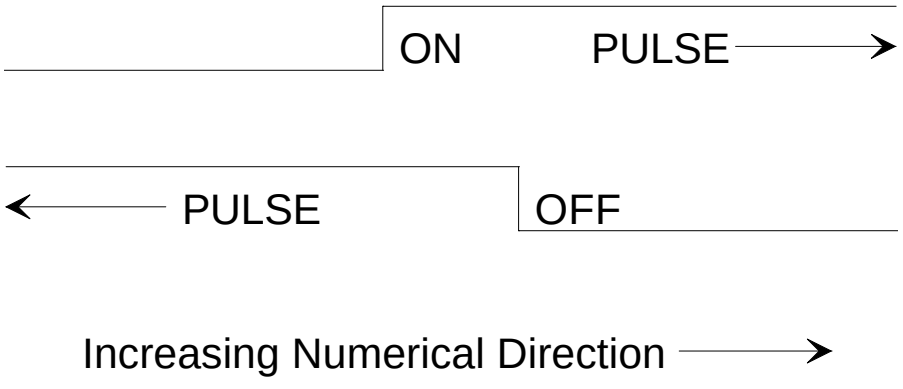


Figure 4.1

When the OFF LED is illuminated, the display is indicating the FIRST “OFF” POSITION FOLLOWING a pulse. You then know that at least one position is ON (the next position in a DECREASING NUMERICAL DIRECTION), and that the indicated position is the end of a pulse that extends in the DECREASING NUMERICAL DIRECTION, and may go through 0 (e.g. ON at 270 and OFF at 90).

During programming, the ON and OFF keys are only used to enter a NEW pulse, and the LEDs above them are used to indicate whether you are entering a new ON or a new OFF setpoint.

The PULSE key is only used during programming. When pressed, it places the PLuS in “pulse mode”. In this mode, both setpoints of a pulse are moved simultaneously using the INCREMENT and DECREMENT keys. The PULSE key may also initiate “Multi-Pulse” mode, in which ALL setpoints of a channel are moved simultaneously. A pulse must already have been entered before using this key or an error code will appear.

NOTE:
In the following examples, the current active program will be used unless otherwise specified. The examples apply to all programs. To specify an action on a program different than the current active program you must specify the program number first. Once a program has been specified, it is not necessary to re-enter it if you wish to move to a different channel within the same program.

PROGRAM/CHANNEL SELECTION (VIEWING CHANNEL ACTIVITY)

Before viewing or programming setpoints, you must first select the channel. If you select a channel without first selecting a program, the current active program is automatically selected. If you wish to view or edit a program other than the current active program, you must first select a program. Once a channel has been selected, the display will show the indicated encoder shaft position and channel activity in real time. The indicated encoder shaft position displayed is based on the offset associated with the channel being viewed.

NOTE:

1) When illuminated, the discrete PGM LED indicates that the program selected for editing is the current active program.

2) When illuminated, the discrete CHN LED indicates that the channel is ON at the position indicated. If you are viewing the current active program, the CHN LED will reflect the status of the output for that channel.

3) CHANGES MADE TO THE CURRENT ACTIVE PROGRAM WILL BE REFLECTED IMMEDIATELY BY THE OUTPUTS.

EXAMPLE:
Select channel 7 on current active program for viewing.

Select channel 7 (Current active program is automatically selected).

EXAMPLE:
Select channel 7 on program 3 for viewing.

Select program 3.

Select channel 7.

VIEWING CHANNEL SETPOINTS

You may view the pulses in a channel at any time by selecting a channel and pressing either VIEW INCREASING or VIEW DECREASING to step through the setpoints. If there are no pulses programmed into the channel, both ON and OFF LEDs will be off and the display will show "0". If the channel is always ON, both ON and OFF LEDs will be illuminated, and the display will show "1".

EXAMPLE:
Assume that channel 7 of the current active program contains two pulses, 30 to 60 and 100 to 130. View these pulses.

Select channel 7 of current active program.

[CHN] [7] [ENT]

Press VIEW INCREASING to step through pulses in increasing numerical direction.

[VIEW] (30) [VIEW] (60) [VIEW] (100) [VIEW] (130) [VIEW] (30)

OR

Press VIEW DECREASING to step through pulses in decreasing numerical direction.

[VIEW] (130) [VIEW] (100) [VIEW] (60) [VIEW] (30) [VIEW] (130)

ENTERING A NEW PULSE

A new pulse may be entered through numeric entry. This operation may NOT be done while the encoder is turning.

EXAMPLE:
Enter a new pulse in channel 7 of the current active program to be ON at 30 and OFF at 60.

Select channel 7 of current active program.

[CHN] [7] [ENT]

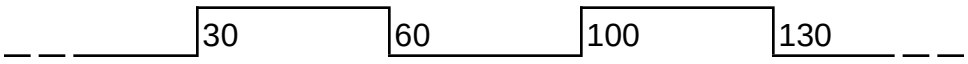
Enter new pulse.

[ON] [3] [0] [ENT] [OFF] [6] [0] [ENT]

CLEARING A PULSE

A specific pulse may be cleared by making one of the setpoints equal to the other (ON = OFF or OFF = ON). This operation may NOT be done while the encoder is turning.

EXAMPLE:
Assume that channel 7 of the current active program contains two pulses, 30 to 60 and 100 to 130. Clear the pulse from 100 to 130.



Select channel 7 of the current active program.

CHN 7 ENT

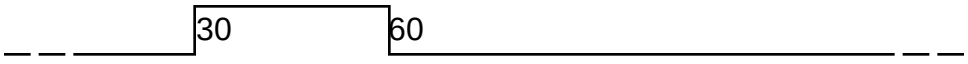
Press VIEW INCREASING until 130 appears in display.

VIEW (30) VIEW (60) VIEW (100) VIEW (130)

Clear the OFF setpoint (130) and enter the ON setpoint (100).

CLR 1 0 0 ENT

The channel will now be programmed:



NOTE:
In the above example, you could have stopped viewing at the ON setpoint of 100 and made it equal to the OFF setpoint of 130.

CLEARING A CHANNEL

All pulses in a channel will be cleared if a pulse is entered with both ON and OFF equal to 0. When this operation is complete, both ON and OFF LEDs will be off and the display will show “0”. This operation may NOT be done while in motion.

EXAMPLE:
Clear all pulses in channel 7 of current active program.

Select channel 7 of current active program.

CHN 7 ENT

Clear all pulses in channel 7.

ON 0 ENT OFF 0 ENT

ENTERING A 360 DEGREE PULSE (Date Codes 8903 and Later)

A 360 degree pulse (channel always ON) may be programmed by entering a pulse with both ON and OFF setpoints equal to “1”. When this operation is complete, both ON and OFF LEDs will be illuminated and the display will show “1”. This operation may NOT be done while the encoder is turning. A channel that is always ON can be used to signal other machine devices that the PLuS system is powered up and not in an error condition.

EXAMPLE:
Set channel 7 of current active program to always be “ON”.

Select channel 7 of current active program.

CHN 7 ENT

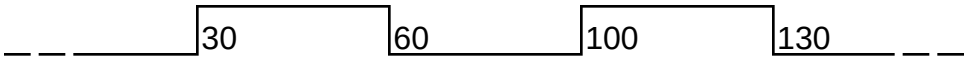
Set channel 7 to be "ON" for 360 degrees.

ON 1 ENT OFF 1 ENT

MODIFYING A PULSE WITH NUMERIC ENTRY

An ON or OFF setpoint of a pulse may be modified with numeric entry. While viewing channel setpoints, you may CLEAR a setpoint and ENTER another value. This operation may NOT be done while the encoder is turning.

EXAMPLE:
Assume that channel 7 of the current active program contains two pulses, 30 - 60 and 100 - 130. Change the second pulse to be ON at 100 and OFF at 115.



Select channel 7 of the current active program.

CHN 7 ENT

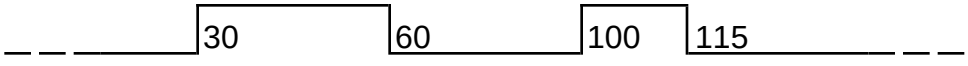
Press VIEW INCREASING until 130 appears in display.

VIEW VIEW VIEW VIEW

Clear the OFF setpoint (130) and enter 115.

CLR 1 1 5 ENT

The channel will now be programmed:



MODIFYING A PULSE USING THE INCREMENT/DECREMENT KEYS

An ON or OFF setpoint of a pulse may be modified with the INCREMENT or DECREMENT keys. While viewing channel setpoints, press either the INCREMENT or DECREMENT keys. This operation may be done while in motion.

EXAMPLE:
Assume that channel 7 of the current active program contains two pulses, 30 to 60 and 100 to 130. Change the second pulse to be ON at 100 and OFF at 125.

Select channel 7 of the current active program.

CHN 7 ENT

Press VIEW INCREASING until 130 appears in display.

VIEW (30) VIEW (60) VIEW (100) VIEW (130)

Press the DECREMENT key until display reads 125. Notice that you skip over 129 and 127.

DEC (128) DEC (126) DEC (125)

The channel will now be programmed:

PULSE MODE

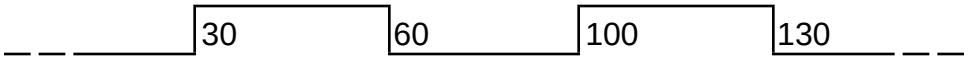
Individual pulses can be moved, or an entire channel "rotated" through the pulse mode. The first press of the PULSE key while viewing channel setpoints will place the unit in "pulse mode". Successive presses of the PULSE key will toggle the unit between standard pulse mode and "multi-pulse" mode. When in multi-pulse mode, the LED above the PULSE key will flash, indicating that if ANY setpoint is moved ALL setpoints will be moved.

STANDARD PULSE MODE

The ON and OFF setpoints of a pulse may be modified simultaneously in pulse mode with the INCREMENT or DECREMENT keys. While viewing channel setpoints, place the PLuS in pulse mode by pressing the PULSE key, and then press either the INCREMENT or DECREMENT keys. This operation may be done while the encoder is turning. Pulses can only be moved using the INCREMENT and DECREMENT keys.

NOTE:
When any key other than INC or DEC is pressed, you will immediately exit pulse mode. You must again press the PULSE key to return to pulse mode.

EXAMPLE:
Assume that channel 7 of the current active program contains two pulses, 30 to 60 and 100 to 130. Change the second pulse to be ON at 95 and OFF at 125.



Select channel 7 of the current active program.

CHN 7 ENT

Press VIEW INCREASING until 130 appears in display.

VIEW (30) VIEW (60) VIEW (100) VIEW (130)

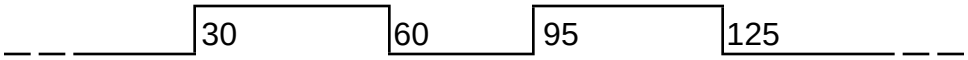
Press the PULSE key to place the PLuS in pulse mode.

PULSE

Press the DECREMENT key until display reads 125. Notice that you skip over 129 and 127. (See “E6” error in Section 6)

DEC (128) DEC (126) DEC (125)

The channel will now be programmed:



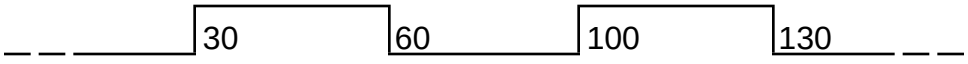
NOTE:
The duration of the pulse will remain constant even if the difference between the resulting ON and OFF setpoints appears to change.

MULTI-PULSE MODE

The ON and OFF setpoints of a ALL pulses in a channel may be modified simultaneously in multi-pulse mode with the INCREMENT or DECREMENT keys. While viewing channel setpoints, place the PLuS in multi-pulse mode by pressing the PULSE key until the LED above the PULSE key begins flashing. Then press either the INCREMENT or DECREMENT keys to "rotate" the entire channel. This operation may be done while the encoder is turning. Channels can only be "rotated" using the INCREMENT and DECREMENT keys.

NOTE:
When any key other than INC or DEC is pressed, you will immediately exit pulse mode. You must again press the PULSE key twice to return to multi-pulse mode.

EXAMPLE:
Assume that channel 7 of the current active program contains two pulses, 30 to 60 and 100 to 130. Advance both pulses 5 degrees.



Select channel 7 of the current active program.

CHN 7 ENT

Press VIEW INCREASING until 30 appears in display.

VIEW (30)

Press the PULSE key twice to place the PLuS in multi-pulse mode. Note that the LED above the PULSE key flashes on and off in multi-pulse mode.

PULSE PULSE

Press the DECREMENT key until display reads 25. Notice that you skip over 29 and 27. (See "E6" error in Section 6)

DEC (128) DEC (126) DEC (125)

The channel will now be programmed:

NOTE:
The duration of the pulses will remain constant even if the difference between the resulting ON and OFF setpoints appears to change.

5
Function Programming

Function programming on the PLuS controllers allows access to the extra features that rotary cam limit switches do not include. These features include: Motion dection output, position offset, program selection and speed compensation. This section includes detailed descriptions of these features and how they are accessed from the keyboard. (There is a programming “quick referrence” page in the appendix which is helpful once the concepts of these features are understood)

MOTION DETECTION

A motion detection output and LED indication is provided on the PLuS controller. The user may set both high and low motion detection setpoints. When the rpm of the PLuS is equal to or greater than the low motion setpoint, and less than or equal to the high motion setpoint, the motion output on the back terminal strip will turn on and the motion LED on the keyboard will be illuminated .

The rpm display on the front panel is updated once every second. The motion detection output on the back panel terminal strip and the Motion LED on the front panel are updated ten times every second. The numeric display provides an easy to read, stable indication of rpm; the motion detection output reacts more quickly.

Program the motion detection setpoints as follows:

LOW MOTION SETPOINT (FCN #1)

The low motion setpoint may be programmed whenever the program enable input is energized (encoder turning or stationary).

EXAMPLE:
Set the low motion setpoint to 100 rpm.

To display the present Low Motion setpoint press:

To clear the display and enter 100 press:

HIGH MOTION SETPOINT (FCN #2)

The high motion setpoint may be programmed whenever the program enable input is energized (encoder turning or stationary).

EXAMPLE:
Set the high motion setpoint to 200 rpm.

To display the present High Motion setpoint press:

FCN 2 ENT

To clear the display and enter 200 press:

CLR 2 0 0 ENT

OFFSET PROGRAMMING

The PLuS controllers provide a straightforward and flexible means to adjust the offset. Two functions (methods) are provided for this purpose: 1) Offset: Absolute (FCN #3), and 2) Offset: Relative (FCN #4).

NOTE:
The Absolute offset programming method (FCN #3) displays the actual value of the offset. The Relative offset programming method (FCN #4) displays the current controller position in real time.

ABSOLUTE OFFSET (FCN #3)

The Absolute Offset function is used to directly change the offset value. The offset should be recorded when the machine is running properly. If the offset is then ever programmed incorrectly, simply reloading the known “good” value will restore the machine to its previous state.

EXAMPLE: Assume that in the process of changing tooling, the indicated position has been incorrectly adjusted through FCN #4. Previously, the offset value had been recorded at 94. The present offset value is indicated at 245. Change the offset back to the known correct value.

To display the present absolute offset value press:.

FCN 3 ENT

To clear the value of 245 and enter a new value of 94 press:.

CLR 9 4 ENT

Numeric Entry of the Absolute Offset value can only be done when the encoder is NOT turning. However, increment and decrement adjustments of the offset value can be made while the encoder turning or stationary (“fine tuning”).

RELATIVE OFFSET (FCN #4)

The Relative Offset function indirectly changes the offset value. It is used to set the controller position to a known value with respect to the current encoder position (machine position). This function would be used during setup when the controller position does not correspond to the known machine position. Changes made to the controller position using FCN #4 will automatically adjust the offset value.

Assume the controller has been installed on a machine and that the machine is at rest with the "tooling" in a position that corresponds with a "known" degree reading on the machine timing diagram. It is unlikely that the PLuS encoder shaft has been adjusted so that the indicated position corresponds exactly with the machine position. Use function #4 to set the indicated position to agree with the machine position.

EXAMPLE:
Assume the machine has been brought to a position that is "known" to be 38 degrees. The controller position is displayed as 145 degrees. Change the indicated encoder shaft position to correspond to the known machine position.

To display the present controller position press:

FCN 4 ENT

To clear value of 145 and enter the new position of 38 press:.

CLR 3 8 ENT

Numeric Entry of the Relative Offset value can only be done when the encoder is NOT turning. However, increment and decrement adjustments of the Relative Offset value can be made while the encoder turning or stationary ("fine tuning"). To increment or decrement the offset value while the encoder is turning with a stable display, use the Absolute Offset function (FCN #3).

ACTIVE PROGRAM (FCN #5) (Models PS-4001/4011)

This function allows the "active" program to be selected from the keyboard as well as from the logic inputs on the back of the controller. The "Active Program" select function is available on all PS-4001/4011 model controllers.

The value programmed into FCN #5 is the program number that will be active when there are NO Program select inputs active. Program select inputs will OVERRIDE the value programmed into FCN #5. This allows the active program to be selected through the keyboard without using an external Program Select Switch.

NOTE:
If the program select inputs are being used, FCN #5 must be set equal to 1 to allow program #1 to be selected from the select inputs. Because program #1 requires all program select inputs to be de-energized, the controller selects the program specified by FCN #5. Therefore, if FCN #5 is not set equal to 1, it is impossible to select program #1 from the program select inputs.

EXAMPLE:
Select program #4 to be the active program.

To display the program number presently selected to be active press:

FCN **5** **ENT**

The currently active program will appear in the display above the PGM key. To clear the display and enter 4 press:

CLR **4** **ENT**

SPEED COMPENSATION (Models PS-4001/4011)

Speed compensation is available on all PLuS PS-4001/4011 model controllers. This function allows the controller to automatically advance channel setpoints as the encoder RPM increases. This automatic compensation for speed is similar to the "centrifugal advance" on an automobile engine; it "advances" channel pulses in time proportional to the encoder RPM.

This feature may be used to compensate for valve turn-on or turn-off time, cylinder actuation speed, mechanical relay delays, etc. It will allow you to set your machine up at a low speed, and then have the controller automatically advance channel setpoints to take care of those delays at higher speeds.

Speed compensation is LINEAR and AUTOMATIC. Program (through FCN #6) the number of channels that are to be compensated. Program (through FCN #7) the amount of "advance" desired (in DEGREES PER 100 RPM). The PLuS controller then automatically applies the correct advance for any encoder speed (up to the controller's specified maximum RPM).

EXAMPLE:
Assume that a PLuS controller has been set up as follows:
FCN #7: 10 (Degrees / 100 RPM)
Channel 1: ON at 60 degrees, OFF at 120 degrees

The following illustration shows how the pulse is shifted at various RPM readings. The PLuS controller automatically takes into account "+" RPM (encoder rotation that causes controller position to increase) and "-" RPM (encoder rotation that causes controller position to decrease). In both cases, the controller advances the pulse in TIME.

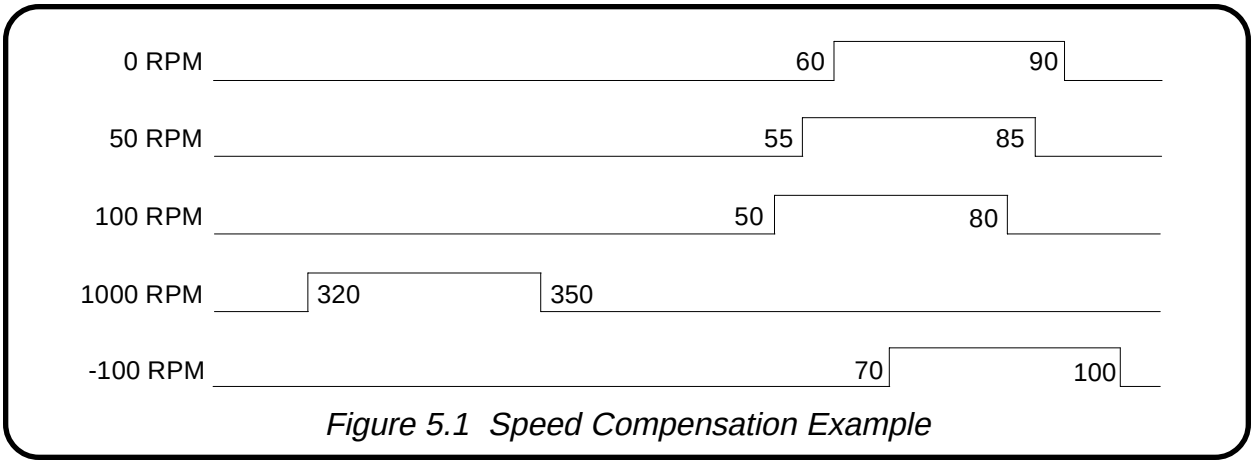


Figure 5.1 Speed Compensation Example

There are three functions that control automatic speed compensation: FCN #6 - Number of Compensated Channels, FCN #7 - Compensation Value (Degrees/100RPM), and FCN #8 - RPM Ramp Limit. The first (FCN #6) specifies how many channels are to be compensated. The second (FCN #7) specifies how much "advance" is to be applied to the compensated channels. The third (FCN #8) determines how large of a speed change is needed to cause an immediate update of the speed compensated set points (Speed compensated setpoints are normally updated every 1 second).

NUMBER OF COMPENSATED CHANNELS (FCN #6) (MODELS PS-4001/4011)

The number of compensated channels may be programmed to be any number between 0 and the number of channels available on the unit. Compensated channels start with channel #1 and continue with consecutive channel numbers. Therefore, if 3 channels are specified to be speed compensated, channels 1,2 and 3 would be affected.

This function may only be programmed when the encoder is NOT turning.

EXAMPLE:
Set channels 1,2,3 and 4 to be compensated.

To display the number of channels currently compensated press:

FCN 6 ENT

The number of compensated channels will appear in the display area above the CHN key. To clear the display and enter 4 press:

CLR 4 ENT

COMPENSATION: DEGREES / 100 RPM (FCN #7) (Models PS-4001/4011)

The compensation value may be programmed to any value. The value entered will be the number of degrees the compensated channels will be advanced at 100 RPM. At other RPM values the amount of advance will be directly proportional.

EXAMPLE:
Set the compensation value to 10 degrees / 100 RPM.

To display the present compensation value press:

FCN 7 ENT

The present compensation value will appear in the rightmost display. To clear the displayed value and enter 10 press:

CLR 1 0 ENT

The amount of Speed Compensation may be changed while the encoder is turning through the increment/decrement keys.

EXAMPLE: Increase the compensation value 3 degrees / 100 RPM using INC/DEC mode.

To display the present compensation value press:

The present compensation value will appear in the right most display. Use the INC key to increase the compensation value by 3.

NOTE:
At low compensation values, it may take 2 seconds for the controller to complete its calculations when a new value is entered or an existing value incremented or decremented.

RPM RAMP LIMIT (FCN #8) (PS-4001 Model Controllers Date Codes 8808 and Later, All PS-4011's)

(Note: FCN #8 is not called out on the face of the keyboard because it is a function that is set only once for a particular type machine.)

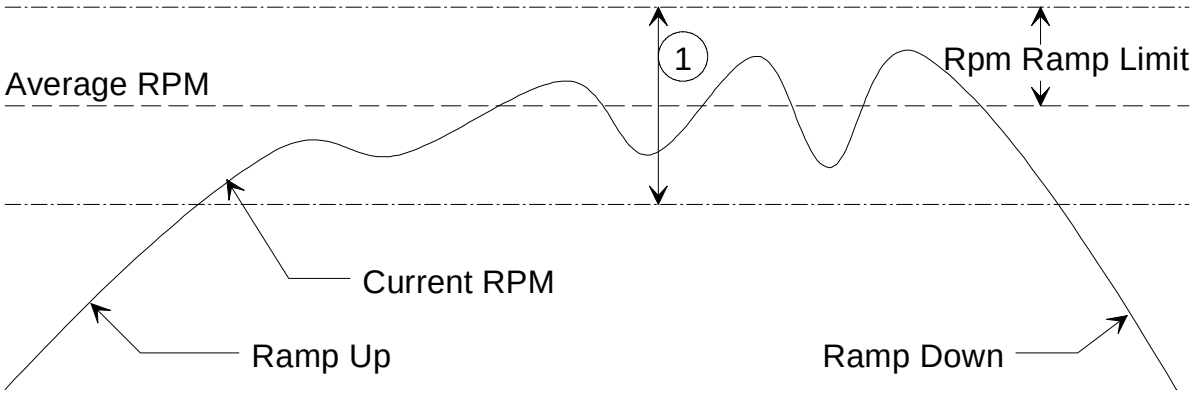
During normal operation, most machines will show some variation in RPM during each "machine cycle". Though the RPM display will vary by only 1 or 2, the instantaneous RPM may vary 5 or more, depending on the pattern of loading.

PLuS controllers calculate the CURRENT RPM every 100 milliseconds (.1 Sec). The displayed value of RPM is updated every second, and shows the AVERAGE of 10 consecutive CURRENT RPM calculations. The amount (degrees) of compensation advance depends on the RPM and the value programmed through FCN #7 (Degrees/100 RPM). In order to avoid "jitter" on the compensated outputs, the amount of advance is normally calculated using the AVERAGE RPM (displayed RPM).

When a machine is being ramped up or down, it is necessary to update the speed compensation more often. This keeps compensated outputs synchronized with other machine functions as the machine makes large changes in RPM.

The "RPM Ramp Limit" allows you to establish a "normal" variation in RPM, within which the amount of compensation advance is based on the AVERAGE RPM. When the RPM of the machine changes by more than the specified "RPM Ramp Limit", the amount of compensation is immediately updated based on the CURRENT RPM.

As the machine ramps up or down, the AVERAGE RPM will change every second, but probably will not be close to the CURRENT RPM. As long as the CURRENT RPM differs from the AVERAGE RPM by more than the RPM Ramp Limit, the amount of compensation advance will be based on the CURRENT RPM.



(1) When current RPM is within this range, speed compensation is updated on a one second interval.

When current RPM is outside of this range, speed compensation is updated each .1 sec.

Figure 5.2 RPM Ramp Limit

The above illustrates that the amount of compensation advance during the “Ramp Up” and “Ramp Down” phases of machine operation is based on the CURRENT RPM. The amount of compensation advance is based on the AVERAGE RPM when the CURRENT RPM is within “RPM Ramp Limit” of the AVERAGE RPM.

EXAMPLE:
Set the RPM Ramp Limit to be +/- 10 RPM.

To display the present RPM Ramp Limit press:

FCN **8** **ENT**

The present RPM Ramp Limit will appear in the rightmost display. Use numeric entry to set the RPM Ramp Limit to 10 RPM by pressing:

CLR **1** **0** **ENT**

NOTE:
Only numeric entry may be used to set the RPM Ramp Limit. The RPM Ramp Limit may be changed while the encoder is turning.

6
Error Codes

PROGRAMMING ERROR CODES (NON-FATAL)

Error code messages have been incorporated into the keyboard controller to enable the user to better understand the nature of errors as they occur during programming. If an error occurs during operation or programming, the display will flash on and off while displaying an error code number and a four “character” reminder. **A flashing error display may be cleared by pressing the CLEAR key.**

“E0 EErr” EEPROM PROGRAMMING ERROR

Indicates that an error has occurred while trying to program the EEPROM memory. Press the CLEAR key once to clear the error.

Possible cause: Program enable input on back of PLuS was switched off while EEPROM programming was in process.

> **NOTE:**
> Channel outputs will reflect program changes immediately as they are entered, whether or not the EEPROM was able to be programmed. Channel outputs are updated out of RAM; this area of channel setpoint storage is immediately updated when program changes are made. The EEPROM memory is much slower (it is programmed during a separate interrupt routine), and large changes may require several seconds to complete.

Solution: Make sure that the program enable input on back of PLuS is turned ON and reprogram setpoint. It may take up to 3 seconds to complete EEPROM programming after changes are made. If the program enable input is turned off during this time, an “E0” error will result. If this error occurs while programming the current active program, the output patterns will reflect the new setpoints immediately because outputs are updated from RAM storage and are unaffected by the ability or inability to program the EEPROM.

"E1 OLAP" PULSE OVERLAP

An attempt was made to 1) wipe out a pulse using the INCREMENT or DECREMENT key, 2) merge two pulses using the INCREMENT or DECREMENT keys, 3) form a new pulse that would have enclosed other pulses, 4) form a new pulse that would have extended another pulse, or 5) change an "ON" or "OFF" setpoint in such a way that the resulting pulse would have enclosed (or merged with) other pulses. Press the CLEAR key once to clear the error, and again to clear an illegal value if one was entered.

"E2 -run" NOT ALLOWED WHILE RUNNING

An attempt was made to alter a setpoint or offset value using numeric entry while in motion. While the encoder is turning, channel setpoints, offset value, and indicated encoder shaft position may only be changed incrementally using the INCREMENT and DECREMENT keys. Press the CLEAR key once to clear the error.

"E3 ordr" KEYSTROKE OUT OF ORDER

A key was pressed out of sequence. This would occur, for example, if you started to enter a channel but didn't conclude numeric entry by pressing the ENTER key. Pressing the VIEW keys would result in an "E3" error because a channel really hasn't been entered. This error generally means that a previous operation has not been completed, or that pressing that key didn't make sense (example: pressing VIEW INCREASING while programming a low rpm setpoint). Press the CLEAR key once to clear the error.

"E4 -Pro" PROGRAMMING NOT ENABLED

An attempt was made to alter a setpoint (or any value stored in EEPROM memory) when the Program Enable Input on the back of the PLuS was NOT On. It is necessary that the program enable input be ON in order for the EEPROM to be programmed. Press the CLEAR key once to clear the error.

"E5 8888" NUMBER OUT OF RANGE

A number was entered that exceeded limits. For example, trying to program channel 17 in a sixteen channel PLuS will result in "E5". Press the CLEAR key twice and enter a new value.

"E6 -379" ILLEGAL SETPOINT VALUE

A setpoint value that ended in three (3), seven (7), or nine (9 - other than 89, 179, 269, 359) was entered. Although one revolution of the shaft is represented as a position between 0 and 359, when 256 actual positions are converted to read out in

degrees (360), certain numbers must be skipped. The numbers that are skipped have a least significant digit of three, seven, and nine, except those around the quadrants (89, 179, 269, 359). Press the CLEAR key twice and enter a new value.

NOTE:
The converting of encoder values between 0 and 255 into displayed values between 0 and 359 will result in the display "skipping" numbers when the INC and DEC keys are pressed (Example: the display would change from 30 to 28 when the DEC key was pressed only once because 29 is not a "legal" value).

When moving pulses in "Pulse Mode", the duration of certain pulses may appear to change for this same reason. Remember, however, that ALL pulses consist of an integral number of "256ths of a circle" and that the true duration of a pulse will remain constant regardless of what "degree" values are used to represent its on/off setpoints.

As an example, assume you have a pulse that is ON at 76 and OFF at 88. The difference between the ON and OFF setpoints is 12. If the OFF setpoint is moved to 90 in pulse mode, the ON setpoint will move to 80, giving a difference between setpoints of 10. The actual duration of the pulse (in "256ths of a circle") will remain constant.

"SYSTEM ERROR CODES (FATAL)

NOTE:
In the event of a major system fault, the PLuS will display a three digit code in the setpoint window and HALT OPERATION. It will be necessary to remove AC power to the unit in order to restore service. Unless the controller has suffered permanent physical damage, a power-down/power-up sequence will restore the unit to service.

In any case, these fault conditions are a sign that something is SERIOUSLY wrong: either a system component has failed, or too much electrical noise is present. If your unit exhibits any of these fault conditions, contact the factory for assistance at (800) 228-5487.

"FE0" MEMORY FAULT

Indicates that the PLuS has detected a fault in its random access memory. It is not possible to function without this memory. The unit has probably suffered some damage to its hardware, and should be returned for repair.

"FE1" PROGRAM COUNTER FAULT

Indicates that the Program Counter in the CPU has become corrupted, and that reliable operation is no longer possible until the system has been completely reset.

This error may either be caused by hardware failure or by electrical noise.

"FE2" WATCHDOG TIMER FAULT

Indicates that the watchdog timer has timed out. The operating system of the PLuS controller must activate an internal signal at regular intervals; failure to do so means that the program is no longer operating correctly, and that the unit must be shut down.

This error may either be caused by hardware failure or by electrical noise.

"FE3" OVERSPEED FAULT

This error occurs if the encoder exceeds the maximum RPM rating of the PLuS controller (2000 RPM).

7
Logic Terminals

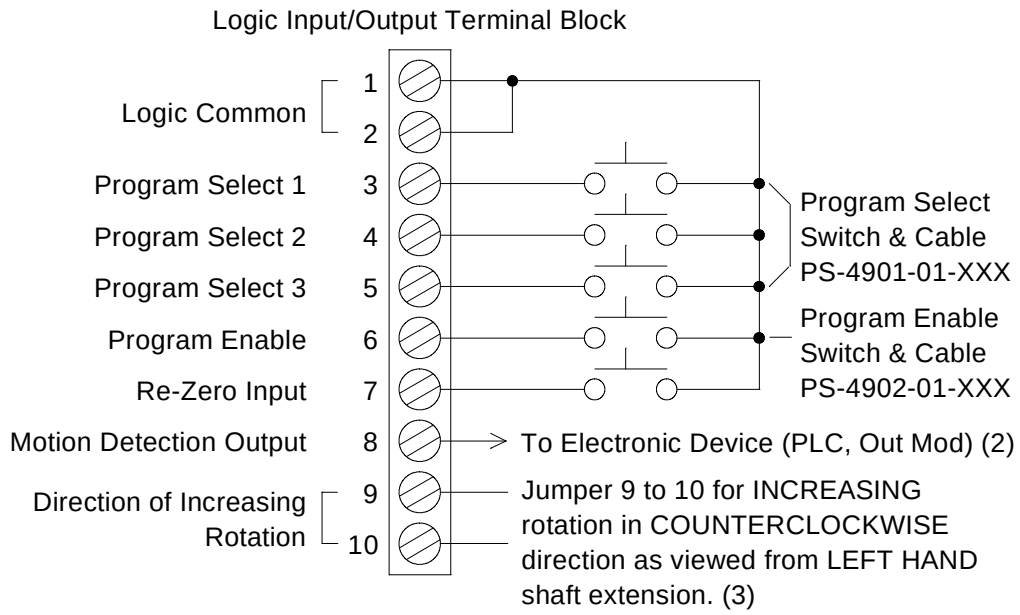


Figure 7.1 Logic Terminal Connections

NOTE:

1) Logic inputs (terminals 3 - 7) are "ON" when connected to logic ground and "OFF" when their circuit to logic ground is open. Logic inputs may be connected to logic ground through switches, relays, or open collector transistor outputs (PLC's or other electronic devices).

2) Motion detection output is capable of SOURCING 5 Volts (6 mA max) to LOGIC GROUND (Terminals 1 & 2) through the output of an opto-coupler.

3) Do not connect terminals 9 & 10 to anything but each other.

PROGRAM SELECT INPUTS (GRAY CODE)

The three program select inputs specify which program is currently active. Only one program is active at a time. The active program may be changed at any time by changing the status of the program select inputs. The active program may be changed while the unit is in motion. Programs are selected as follows:

Program Number	SEL3	SEL2	SEL1
1	OFF	OFF	OFF
2	OFF	OFF	ON
3	OFF	ON	ON
4	OFF	ON	OFF
5	ON	ON	OFF
6	ON	ON	ON
7	ON	OFF	ON
8	ON	OFF	OFF

Figure 7.2 Program Select Gray Code Chart

The program select inputs may be wired to switches, relays, open collector outputs of programmable logic controllers, or other control devices.

A Program Select Switch with Cable (part number PS-4901-01-XXX) is available which provides the Gray Code output to directly interface with the program select inputs. It comes ready to install with a shielded cable cut to any desired length.

When used with a programmable logic controller, these inputs provide the ability to change programs in real-time through a simple four wire connection (three program select inputs and logic ground).

PROGRAM ENABLE INPUT

The Program Enable Input must be ON to allow program changes to be made to output channel set points or Function Programming. If programming changes are attempted when this input is OFF, the flashing “E3 -Pro” (Programming Not Enabled) error message will be displayed.

NOTE:
This input MUST be ON before ANY programming changes can be made to the PLuS controller. This includes output channel setpoints, motion set points, offset value, active program, and speed compensation values.

Units are supplied with a factory installed jumper between terminals 2 and 6 to enable programming. Typically, these terminals would be connected to a key switch or to the open collector output of a programmable logic controller to restrict programming.

A Program Enable Switch with Cable (part number PS-4902-01-XXX) is available. It is a lockswitch which comes ready to install with a shielded cable cut to any desired length.

RE-ZERO INPUT

When the Re-Zero input is energized the controller position is immediately set to 0 whether the encoder is turning or stationary. The controller will begin incrementing or decrementing position from the 0 position even if the Re-Zero input is held ON. The re-zero function is edge triggered and the input is a one-shot. The input must be turned OFF and back ON before another Re-Zero function will occur.

NOTE:
Changes made to the Offset value by the Re-Zero input are not stored in the EEPROM memory of the controller. If Power is removed and restored, the Offset will be set according to the last values programmed by Functions #3 or #4. Therefore the Re-Zero input can NOT be used to permanently synchronize the controller position to the machine. Functions #3 or #4 must be used for this purpose.

The Re-Zero input may be wired to switches, relays, photo detectors or any electronic device which provides a current Sinking signal (typically an open collector output).

MOTION DETECTION OUTPUT

The motion detection output turns ON (sourcing) when the encoder shaft rpm is between (or equal to) the low and high motion detection setpoints (See functions 5 & 6). If the shaft rpm is below the low setpoint or above the high setpoint this output is OFF. The output is updated on a .1Sec interval. Internal logic ignores small variations in shaft positions so that this output will not turn ON due to shaft oscillation.

If the low motion setpoint is set to be greater than the high motion setpoint, the motion detection output will NEVER turn ON.

If the low motion setpoint is set to zero, the motion detection output will ALWAYS be ON.

DIRECTION OF INCREASING ROTATION

With terminals 9 & 10 jumpered, the controller position will increase with counterclockwise shaft rotation (as viewed from the left hand shaft extension). The controller is shipped with this these terminals jumpered. To indicate DECREASING position with counterclockwise rotation, remove this jumper.

NOTE:
These terminals are only sampled when the controller powers up. If terminals 9 & 10 are connected or unconnected after power is applied, the corresponding direction change will not take affect until the controller is powered down and powered up again.

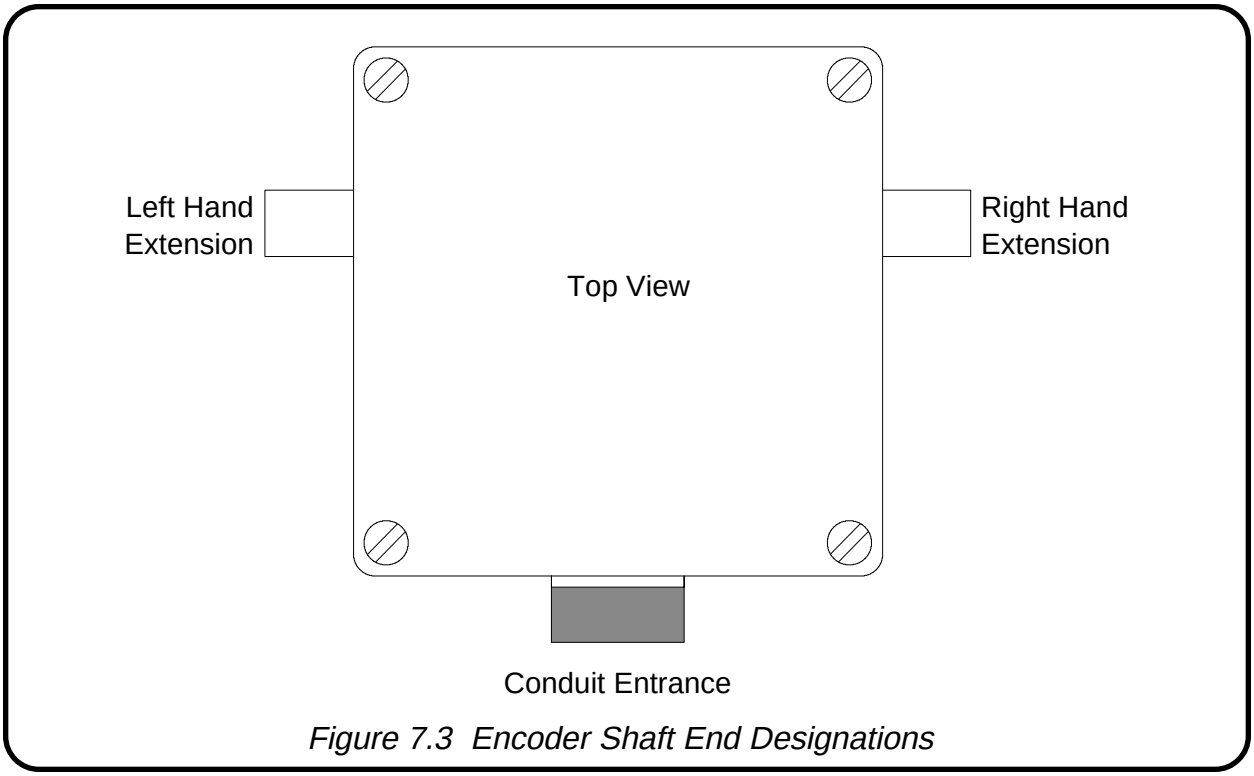
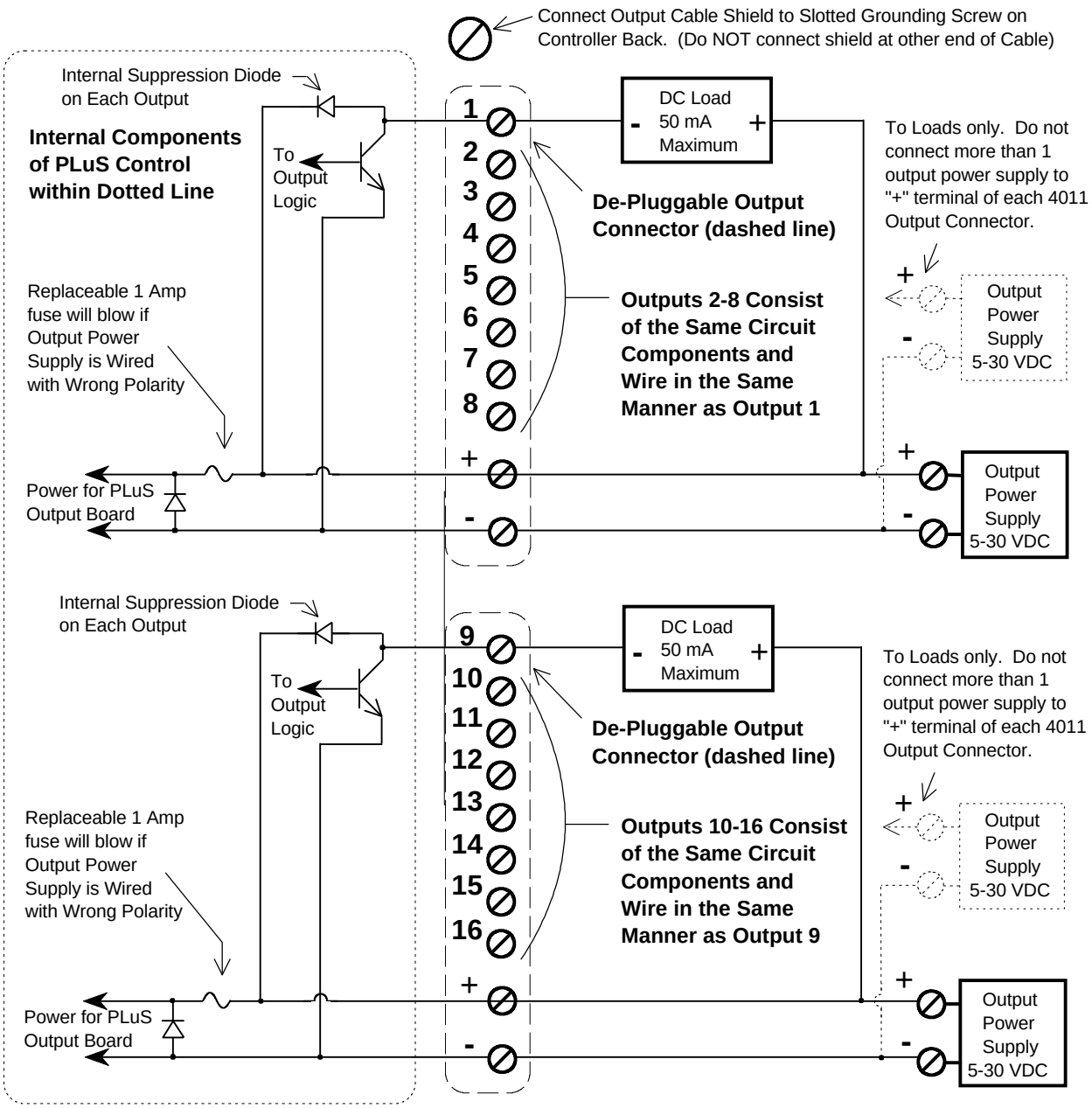


Figure 7.3 Encoder Shaft End Designations

PS-4011 Sinking Output Wiring



The Output Power Supplies shown can be internal to the load device being driven. This will normally be the case when connecting to PLC's.

More than 1 power supply can be used to power loads within each group of 8 outputs. Only one of the power supplies used within the group can have its positive side connected to the "+" terminal of the corresponding 4011 output terminal strip. The common of each power supply used within a group of 8 outputs must be connected to the "-" terminal of the output terminal strip.

The same power supply can be used to power all 16 outputs by paralleling the wiring between the "+" and "-" terminals on the 4011 output terminal strips.

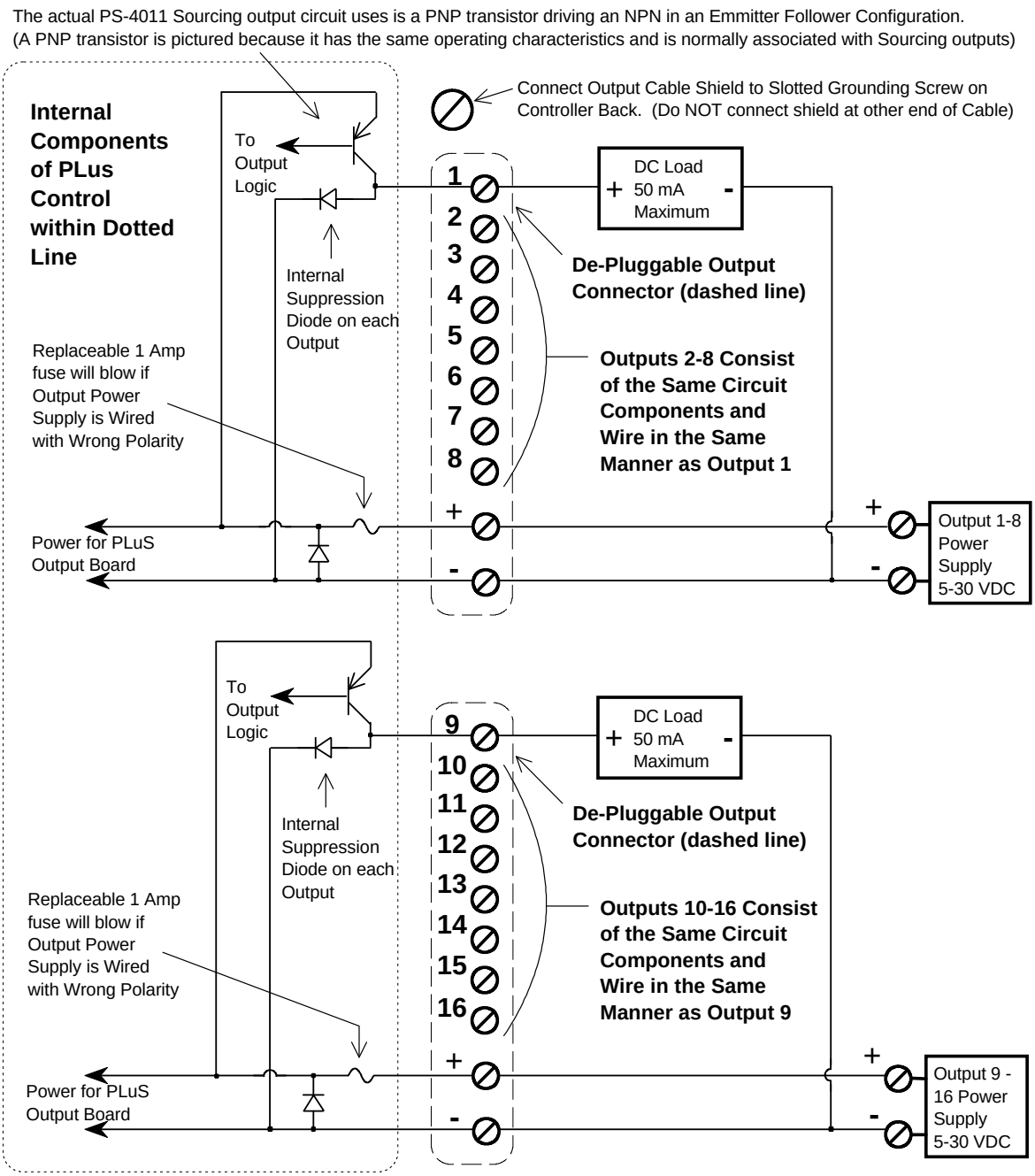
Both the "+" and "-" terminals on the output terminal strip(s) must be connected to a load power supply.

The unpluggable output terminal strips are keyed so they can only be plugged into the correct receptacle. Do not use force when plugging them in.

Use Shielded Cable(s) for output wiring. Electro Cam 10 conductor cable Pt# PS-4300-XXX (XXX = length in feet) is recommended. Two cables required for 16 output units.

Figure 8.25 PS-4011 Sinking Output Wiring

PS-4011 Sourcing Output Wiring



The Output Power Supplies shown can be internal to the load device being driven. This will normally be the case when connecting to PLC's.

The loads connected to outputs 1-8 must all be powered from the same power supply.

The loads connected to outputs 9-16 must all be powered from the same power supply.

The same power supply can be used to power all 16 outputs by paralleling the wiring between the "+" and "-" terminals on the PLuS output terminal strips.

The load power supply must be connected to both the "+" and "-" terminals on the output terminal strip(s).

The unpluggable output terminal strips are keyed so they can only be plugged into the correct receptacle.

Use Shielded Cable(s) for output wiring. Electro Cam 10 conductor cable Pt# PS-4300-XXX (XXX = length in feet) is recommended. Two cables required for 16 output units.

Figure 8.26 PS-4011 Sourcing Output Wiring

Connecting PS-4011's to PLC's

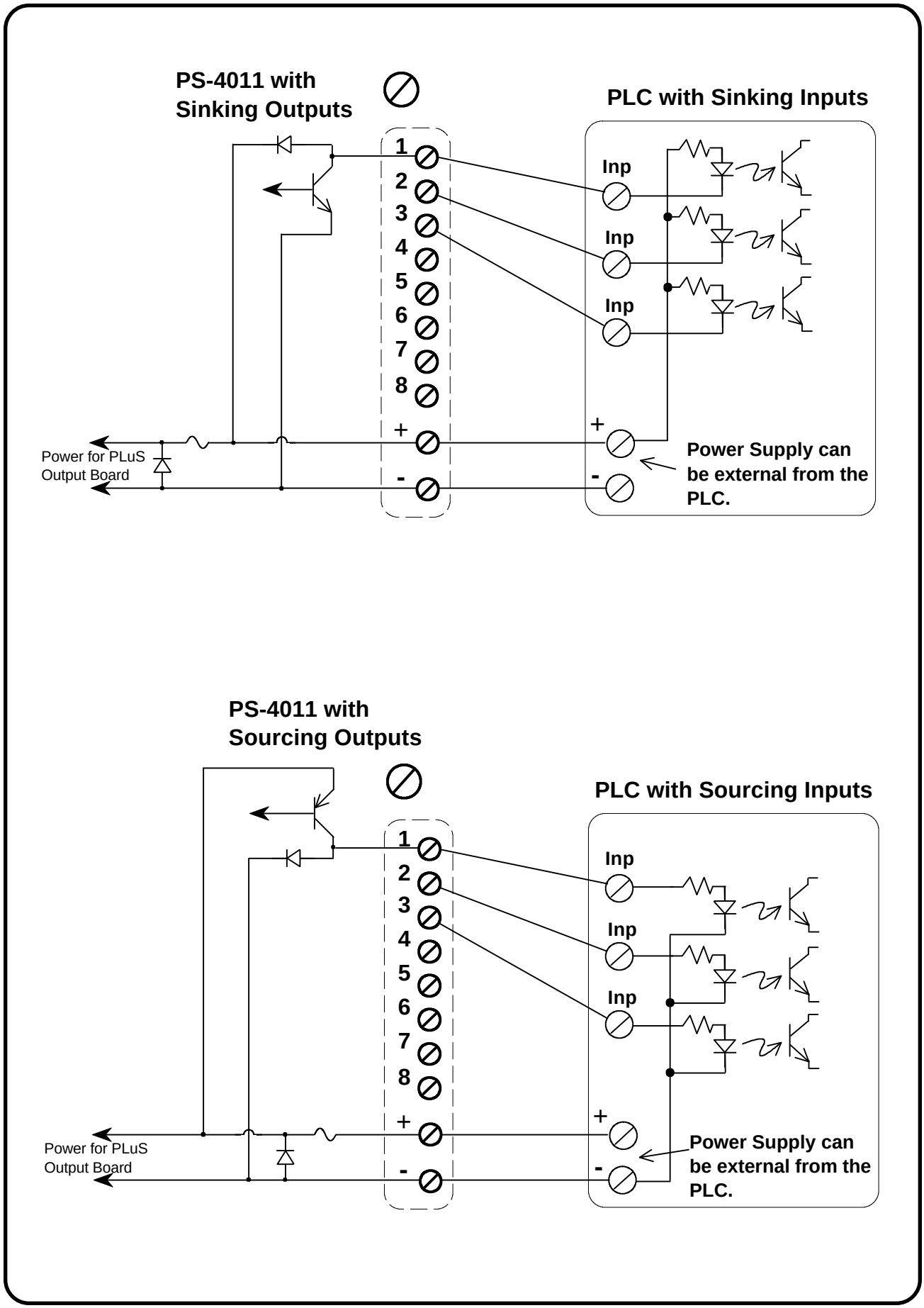


Figure 8.27 Connecting PS-4011's to PLC's

Described below is a list of all of the programming operations. All of these operations can be performed while the encoder is NOT turning. Those items that are marked with an asterisk (*) can also be performed while the encoder is turning. Inactive programs, those programs which are not currently selected, can be modified while the active program is controlling the outputs (only one of the 8 programs is selected at any given time). Remember, only those programming functions marked with an asterisk (*) can be performed while the encoder is turning.

- *SELECT ACTIVE PROGRAM - This can be done through the use of Function 5 or the hardware program select inputs (4000 inputs only). The active program can be changed on the fly at any point in the cycle.

- *SELECT OUTPUT CHANNEL TO BE PROGRAMMED / MONITORED - Numerically enter the desired output channel.

- CREATE OUTPUT PULSES FOR SELECTED OUTPUT CHANNEL - Numerically enter the On and Off edges of each pulse. (The On edge is the degree position where the output turns on, the Off edge is the degree position where the output turns off. Up to 128 pulses can be programmed for each output.)

- MOVE EXISTING OUTPUT PULSE EDGES NUMERICALLY - Numerically enter the new position for the selected On or Off Pulse edge (other edge unaffected).

- *INCREMENT / DECREMENT OUTPUT PULSES
  - *A. Edge - Move leading or trailing edge of an output pulse
  - *B. Pulse - Move an entire output pulse (leading and trailing edge) without affecting duration. (Pulse LED on steady)
  - *C. Multi-pulse - Move ALL of the output pulses in a given channel. (Pulse LED blinking)

- *SET LOW AND HIGH MOTION OUTPUT PRESETS (RPM) - Numerically enter the Low RPM setpoint (FCN 1) and the High RPM setpoint (FCN 2).

- *SET THE AMOUNT OF OFFSET (Offset = PLuS position value when the encoder is at Zero position - keyway in straight up position)
  - A. Absolute (ABS) Numeric Entry - Numerically enter the desired position value that the PLuS should display when the encoder is at zero (FCN 3).
  - *B. Absolute (ABS) Inc / Dec - Increment and Decrement the Offset value (FCN 3).
  - C. Relative (REL) Numeric Entry - Numerically enter the desired position value that PLuS should display when the encoder is in its present postion (FCN 4).
  - *D. Relative (REL) Inc / Dec - Increment and Decrement the Offset value (FCN 4). (The relative Offset feature is most useful when the encoder is stopped in a known machine position)

- NUMBER OF SPEED COMPENSATED OUTPUT CHANNELS (Not PS-4000) - Numerically enter the number of output channels affected by speed compensation (FCN 6).

- *SET AMOUNT OF SPEED COMPENSATION (Degrees of advance per 100 RPM) (Not PS-4000)
  - A. Numerically enter the number of degrees / 100 RPM desired (FCN 7).
  - *B. Increment and Decrement the number of degrees / 100 RPM (FCN 7).

  NOTE - The Response time (in mSec) of a device can be converted to degrees/100RPM as follows:

  mSec x .6 = # degrees / 100 RPM

  Example: The speed compensation needed for a solenoid with a 20 mSec response is:

  20 x .6 = 12 degrees / 100 RPM

- *SET COMPENSATION RPM RAMP LIMIT (Not PS-4000) - Numerically enter the amount of RPM change (FCN 8), up or down, that will cause an immediate update to speed compensation (speed compensation is normally updated every second).

Keyboard Controller

Power Input:

115 VAC 50/60 Hz:	90 - 135 VAC
230 VAC 50/60 Hz:	180 - 270 VAC
Power Consumption:	25 VA

Environment:

Operating Temp:	32 - 130 Degrees F.
Storage Temp:	-40 - 160 Degrees F.
Operating Humidity:	95% Relative non-cond.
NEMA Rating:	NEMA 4

Physical:

Overall Dimensions:	8.5" W x 6.5" H x 4.5" D
Panel Cutout Size:	7.38" W x 5.38" H
Weight:	4 Lbs

Functional:

Output Response:	40 uSec after position reached (plus module response)
Prog. Select Response:	40 mSec
Re-Zero Input Resp:	20 mSec
Motion Output Resp:	.1 Sec
Motion Output Signal:	5 VDC, 6 mA (max)
Maximum RPM:	2000

PS-4011 Output Transistors (Sink or Source)

Voltage:	30 VDC (max)
Current:	50 mA (max)

Encoder

Environment:

Operating Temp:	32 - 130 Degrees F
Storage Temp:	-40 - 160 Degrees F
Operating Humidity:	95% Relative non-cond.
NEMA Rating:	NEMA 12 - (PS-425x) NEMA 4 - (PS-445x)

Physical:

Enclosure Size:	6" W x 6" L x 4.25" H
Mounting Holes (4)	5/16 Diameter
Weight:	7 Lbs.
Shaft Diameter:	.750" (double ended) with 3/16" woodruff keyway #606
Maximum RPM:	1000 (4x56) 2000 (4x57)
Radial Load (max):	

Output Module Specification Chart

Output Modules	Voltage	Current	Response
EC-OAC5A	24 -280 VAC	.01 - 3 Amps	Zero Cross Turn ON
EC-OAC5A-11	24 - 280 VAC	.01 - 3 Amps	Random Turn ON
EC-ODC5	0-60 VDC	0 - 3 Amps	100 uSec
EC-ODC5A	0 - 200 VDC	0 - 1 Amp	100 uSec
EC-ORR5 (Reed Relay)	24 VDC 115 VAC	100 mA 50 mA (resistive loads only)	400 uSec

Accessories

PS-4901-01-XXX	Program Select Switch and Cable Assembly. This is an 8 position switch (outputs Gray Code) to be used for remote program selection.
PS-4902-01-XXX	Program Enable Switch and Cable Assembly. This locking key switch can be used to prevent unauthorized program changes.
PS-4903-01-001	Sealed Conduit Enterance. This fitting can be used to provide sealing and strain relief where the encoder cable exits the control cabinet.
EC-9002-0001	Remote Digital Tachometer. Can be used to provide a display of the encoder RPM away from the control keyboard. One of the PLuS channels must be programmed ot provide the tachometer with 60 pulses / revolution. The tachometer has a 4 digit display and is battery operated.
EC-9002-0002	Replacement batteries for the remote tachometer.

Spare Parts and Suppressors

PS-9000-0500	Fuse: 1/2 Amp Line Fuse for keyboard controller. (Little Fuse #273)
PS-9000-0005	Fuse: 5 Amp Plug-in Output Module Fuse. Each module has a dedicated plug-in fuse next to it on the rack. (Pico SP7-5A)
PS-9000-0001	Fuse: 1 Amp Plug-in fuse for output rack logic power and PS-4011 Transistor Output boards. (Pico SP7-1A)
EC-9001-1010	MOV: 115 VAC Spike Suppressor for AC inductive loads.
EC-9001-2020	MOV: 230 VAC Spike Suppressor for AC inductive loads.
EC-9001-2000	R-C Spike Suppressor for AC or DC inductive loads up to 230 V.
EC-9001-4004	Diode: 1N4004 Spike Suppressor for DC loads.
EC-9001-5369	Zener Diode (50 VDC): 1N5369 Spike Suppressor for DC loads.
EC-9001-5388	Zener Diode (200 VDC): 1N5388 Spike Suppressor for DC loads.
EC-9001-5010	Load Resistor, 10K Ohm, 5 Watt (Pkg. of 4)

ATTENTION

Wiring diagrams that appeared in some previously printed manuals are available from Electro Cam Corp. upon request.