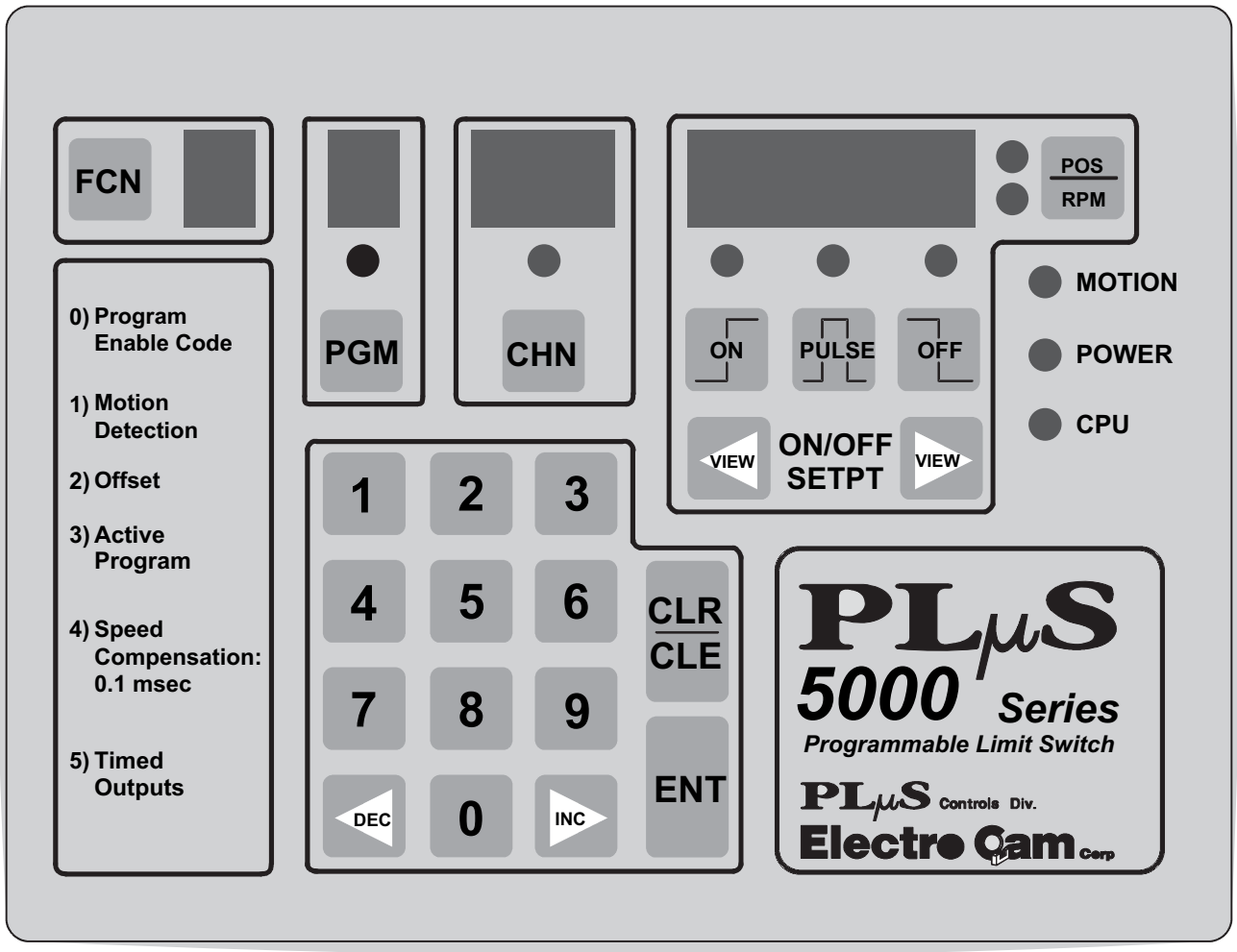
PLµS® PS-5144 Series
Programmable Limit Switch



Programming & Installation Manual

February 2005

Electro Cam Corp.
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1. Electro Cam Corp. warrants that for a period of twelve (12) months from the date of shipment to the original purchaser, its new product to be free from defects in material and workmanship and that the product conforms to applicable drawings and specifications approved by the Manufacturer. This warranty period will be extended on Distributor or OEM orders to a maximum of eighteen months to take into consideration Distributor or OEM shelf time.

2. The remedy obligations of Electro Cam Corp. under this warranty are exclusive and are limited to the repair, or at its option, the replacement or refund of the original purchase price of any new apparatus which proves defective or not in conformity with the drawings and specifications. Shipment of the claimed defective product to Electro Cam Corp. shall be at the cost of the consumer. Shipment of the repaired or replacement product to the consumer shall be at the cost of Electro Cam Corp. All claims must be made in writing to Electro Cam Corp., 13647 Metric Road, Roscoe, IL 61073 USA.

3. In no event, and under no circumstances, shall Electro Cam Corp. be liable for:

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   b. Product failure or damages due to misuse abuse, improper installation or abnormal conditions of temperature, dirt or other contaminants as determined at the sole discretion of Electro Cam Corp.

   c. Product failures due to operation, intentional or otherwise, above rated capacities as determined at the sole discretion of Electro Cam Corp.

   d. Non-authorized expenses for removal, inspection, transportation, repair or rework. Nor shall the manufacturer ever be liable for consequential and incidental damages, or in any amount greater than the purchase price of the equipment.

4. There are no warranties which extend beyond the description on the face hereof. This warranty is in LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED INCLUDING (BUT NOT LIMITED TO) ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, ALL OF WHICH ARE EXPRESSLY DISCLAIMED. Any legal proceeding arising out of the sale or use of this apparatus must be commenced within (18) months of the date of shipment from the manufacturer.

PS-5144 Quick Start Guide

Basic program settings required for operation of the PS-5144 controller.

1) **Scale Factor**
Determines the number of counts per revolution of the resolver. The factory default is 360. To change:
- Press "**FCN**" Key, then numerically enter "**101**", then press "**ENT**" Key.
- Press "**CHN**" key until "**SF**" is displayed above "**CHN** key.
- Enter the new scale factor numerically and press "**ENT**".
- Press "**POS/RPM**" key to exit this function.

2) **Direction of Increasing Rotation**
Turn the resolver and verify that the position counts in an increasing direction. If not, change the direction of rotation:
- Press "**FCN**" Key, then enter "**101**", then "**ENT**" Key". "**dr**" is displayed above "**CHN**" key.
- Press "**PULSE**" key to change direction of rotation.
- Press "**POS/RPM**" key to exit this function.

3) **Set the Displayed Position to Match the Actual Machine Position**
With your machine stopped at zero or a known position, make sure the PS-5144 display matches the position. If not, you need to set the Shaft Position setting.
- Press "**FCN**" Key, then numerically enter "**101**", then press "**ENT**" Key.
- Press "**CHN**" key until "**SP**" is displayed above "**CHN** key.
- Enter the correct position numerically then press "**ENT**".
- Press "**POS/RPM**" key to exit this function.

4) **Set the ON/OFF Setpoints for Each Output Channel**
- Press "**CHN**" key, select the output to be programmed by pressing number keys and then press "**ENT**" key.
- Press "**ON**" key, enter position that you want the output to turn on, press "**ENT**".
- Press "**OFF**" key, enter position that you want the output to turn off, press "**ENT**".

Note:
- Repeat step 4 to add additional ON/OFF settings.
- You can enter multiple ON/OFF setpoints in a channel, but they can not overlap.
- To clear a channel of all setpoints, set both the ON and OFF setpoints to "0".

5) **To View or Check the ON/OFF Setpoints for an Output Channel.**
- Press "**CHN**" key, select the output to be viewed and then press "**ENT**" key.
- Press the right "**view**" key. The ON setpoint will be displayed.
- Press the "**view**" key again. The OFF setpoint will be displayed.
- If you have multiple ON/OFF points in the same channel, keep pressing the "**view**" key to cycle through all setpoints in a channel.

The PS-5144 is now set up to turn outputs ON and OFF at the specified positions.

If you wish to apply additional features to your outputs such as Speed Compensation, Timed Outputs, Motion Anding or product sensing, refer to the appropriate section of this manual for details.

About This Manual

This manual is organized in a manner that minimizes the amount of material that has to be read to perform specific tasks. A detailed table of contents and an index by topic (at the end of the manual) simplify the job of locating needed information. The top of each page in the manual is labelled with the topic(s) covered on that page. Section and page number information is on the bottom of each page. An appendix section is used to house detailed / optional information in a place where it doesn't get in the way when it isn't needed.

The "Product Introduction" and "Getting Started" sections will be especially helpful to people who do not have previous experience with Electro Cam programmable limit switches. It is recommended that all technical personnel read the product introduction section, since it does overview all of the standard and optional features available in the PS-5144 control.

This PS-5144 Installation/Operation manual is organized into the following sections:

Section I - Product Introduction
Most people find it helpful to have an overall understanding of the system and its capabilities before jumping into the details of wiring and programming. This section gives an overview of cam switch operation, the components which make up a programmable limit switch system and the features/advantages of the PS-5144 system and specifications.

Section 2 - Getting Started
This section describes the basic tasks which must be accomplished to get the system installed. These tasks include controller and resolver mounting. Dimensioned drawings of the controller and three common Electro Cam resolvers are also contained in this section.

Section 3 - Wiring
Technical personnel responsible for wiring need to refer to this section. It gives detailed wiring illustrations for resolver cables, inputs, output modules, analog outputs, transistor outputs, and communication wiring.

Section 4 - Programming Introduction
The information given on keyboard / display operation in this section is important for anyone that must program or adjust the control. This section describes the operation of the keyboard and displays, shows how to interpret information displayed, explains the three different levels of programming access, and shows how to program / adjust the outputs.

Section 5 - Operation Function Programming
Personnel with programming responsibilities that go beyond simple output position adjustment will need some or all of the information covered in this section. It explains all of the standard functions and illustrates how to program them. Examples of functions in this section are: Motion settings, speed compensation, analog settings, and others.

Section 6 - Configuration Programming
Technical personnel responsible for the initial setup and programming need to examine each of the functions described in this section. Once the Configuration Functions are correctly set, it is unlikely they will ever need to be changed. However, it is good to review them after the machine is up and running to insure that all of the features available have been utilized to their full advantage. Examples of Configuration Functions are: Direction of Rotation, Scale Factor, Display Default, and others.

Section 7 - Troubleshooting and Utility Functions
This section provides a list of common problems and causes as well as a list of flashing error messages and what to do when they occur. Utility functions which can assist in troubleshooting are covered as well as instructions for troubleshooting and replacing the transistor outputs.

Section 8 - Communications
This section covers PLμSNET II, serial communications using Electro Cam Corp. Protocol, and error codes.

Appendix
Technical personnel responsible for initial installation and maintenance may need to refer to specific topics in this section. Many of the topics and details included in the Appendix are not needed in most applications. Topics in the Appendix include: detailed information on output grouping and modes, program select input formats, system parts list, Gray Code output, and others.

Index
An alphabetical index is provided at the end of the manual to assist with finding specific information.

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Basic Cam Switch Operation

The PS-5144 control's main purpose is to operate up to 25 outputs in a manner that simulates cam switches.The drawing to the right illustrates the operation of a cam switch. Its function is to switch the load on and off at the same rotary positions of the cam shaft during each revolution of that cam shaft. The rotating cam shaft is driven by a machine at a 1:1 ratio, so that the on / off positions of the cam switch always match specific positions in the machine cycle. However, cam limit switches have the following disadvantages: unreliable (wear), hard to adjust (machine must be stopped during adjustment), and they cannot run at high speeds because of contact bounce and excessive mechanical wear.

PLuS controls overcome these basic cam switch problems: reliable (no moving wear parts), easy to adjust from keyboard while machine is running or stopped, and they can operate at speeds up to 3000 RPM. They also add many other capabilities which go way beyond simple cam switch logic. However, keep in mind that their basic operation does simulate cam switch logic.

Resolver Replaces Cam Shaft

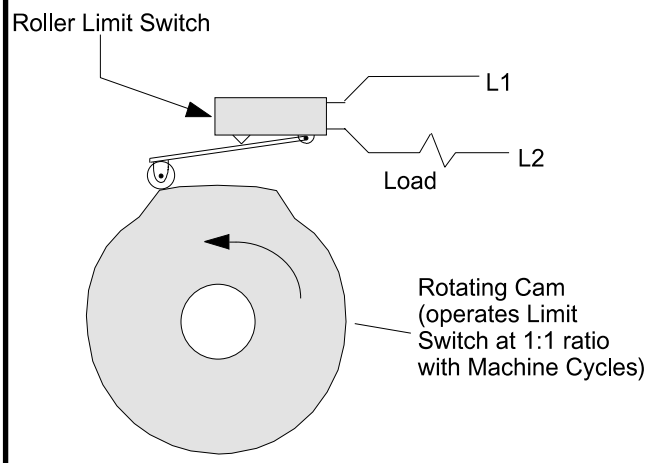
The PS-5144 system uses a resolver to monitor the rotary position of the machine being controlled. It will normally be coupled to the machine at a 1:1 ratio, so that the position signal it outputs always represents the rotary position of the machine cycle.

The resolver itself is a reliable device because it does not have any frictional moving parts involved with its signal generation. The output signal is generated by fixed and rotating coils of wire and always represents the actual position of the resolver shaft. Therefore, it is an "Absolute" position signal.The Electro Cam resolvers are very rugged because of the heavy duty housing, shaft and bearings used to isolate the internal resolver mechanism from mechanical shock and loads. As an example, Electro Cam's foot mount resolver is pictured to the right.

Resolver Theory

The illustration to the right pictures the coils used in a brushless resolver to generate the position signals. A fixed frequency and voltage (VR) is supplied to the resolver to excite it. This frequency is induced into a coil that supplies the frequency to the rotating armature. The rotating armature in turn induces signals into the stationary Sin and Cos coils that vary in magnitude according to the rotary position of the armature. The ratio of the signal levels of the Sin and Cos coils represent the shaft position. Standard PLuS controls can interpret this signal to 10 bit resolution (1024 steps per rev) and "H" option controls to 12 bit resolution (4096 steps per rev).

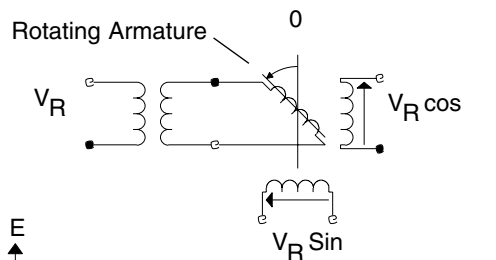
Basic Cam Switch Operation



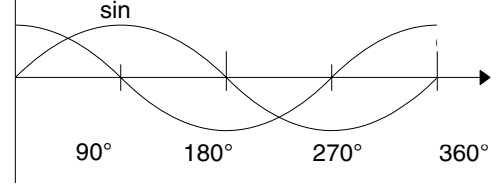
Foot Mount Resolver

Side/top connector shown; end connector version also available.

Resolver Coils



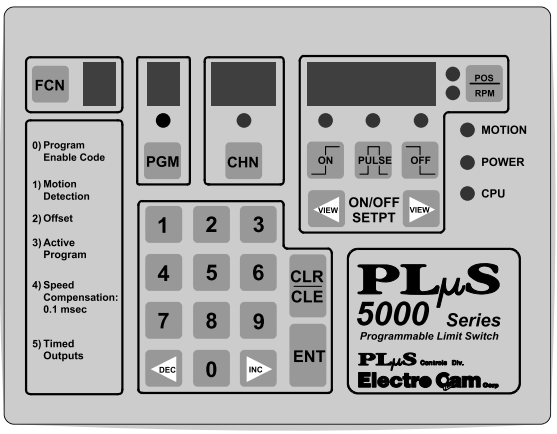
Resolver Output Signals



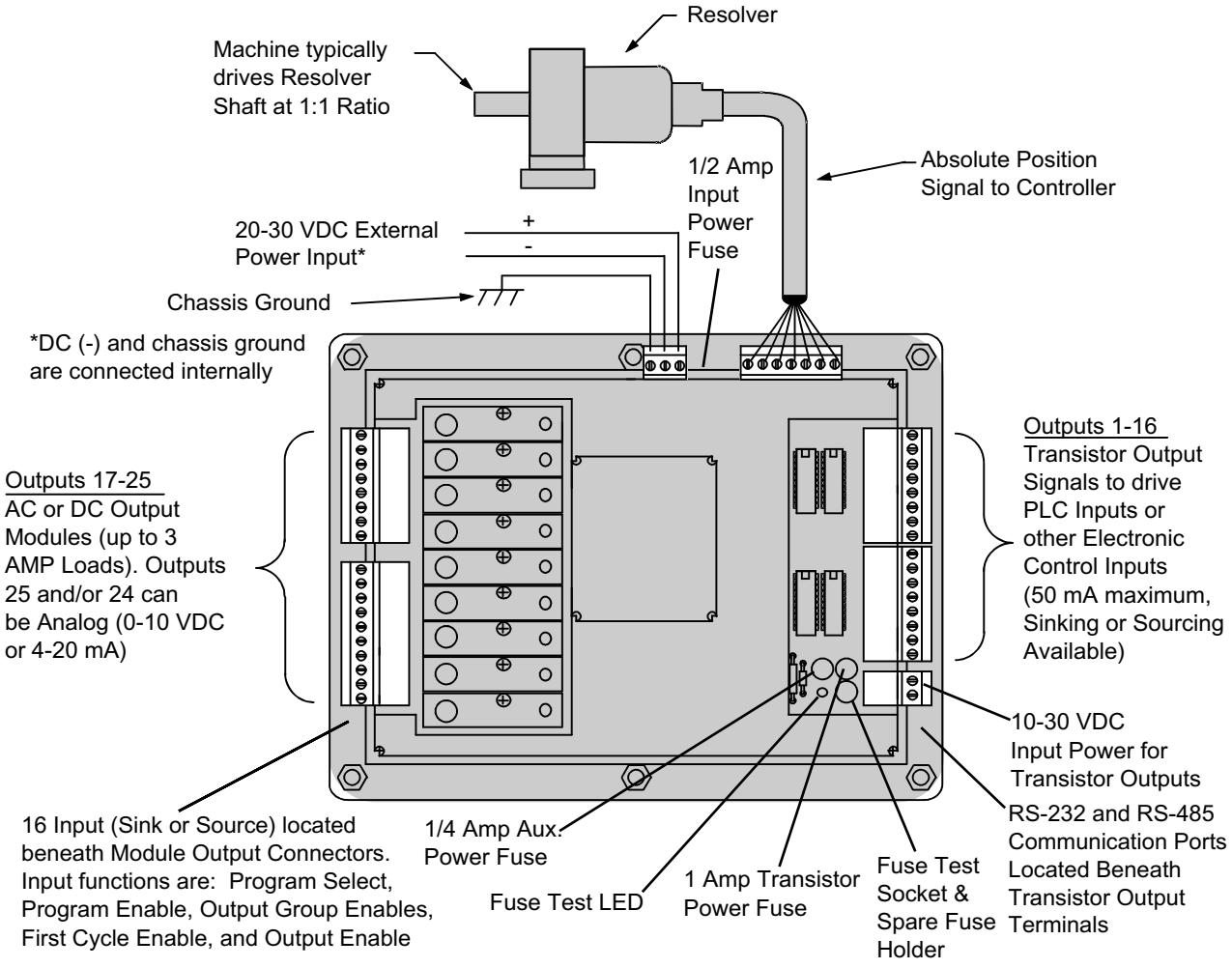
Keyboard/Controller

The keyboard controller is the main component of the PS-5144 system. In addition to housing the microprocessor and associated circuitry, all of the I/O circuits required are either self contained or plug onto the back of the controller. This eliminates the need for external I/O racks and associated cables. The front keypad and displays provide a complete user interface from which every aspect of the control's operation can be monitored and programmed. When properly mounted with the gasket provided, the keyboard meets NEMA 4 standards. A clear silicon rubber boot assembly is available to provide NEMA 4X protection for installations where harsh washdown chemicals are used.

PS-5144 Controller

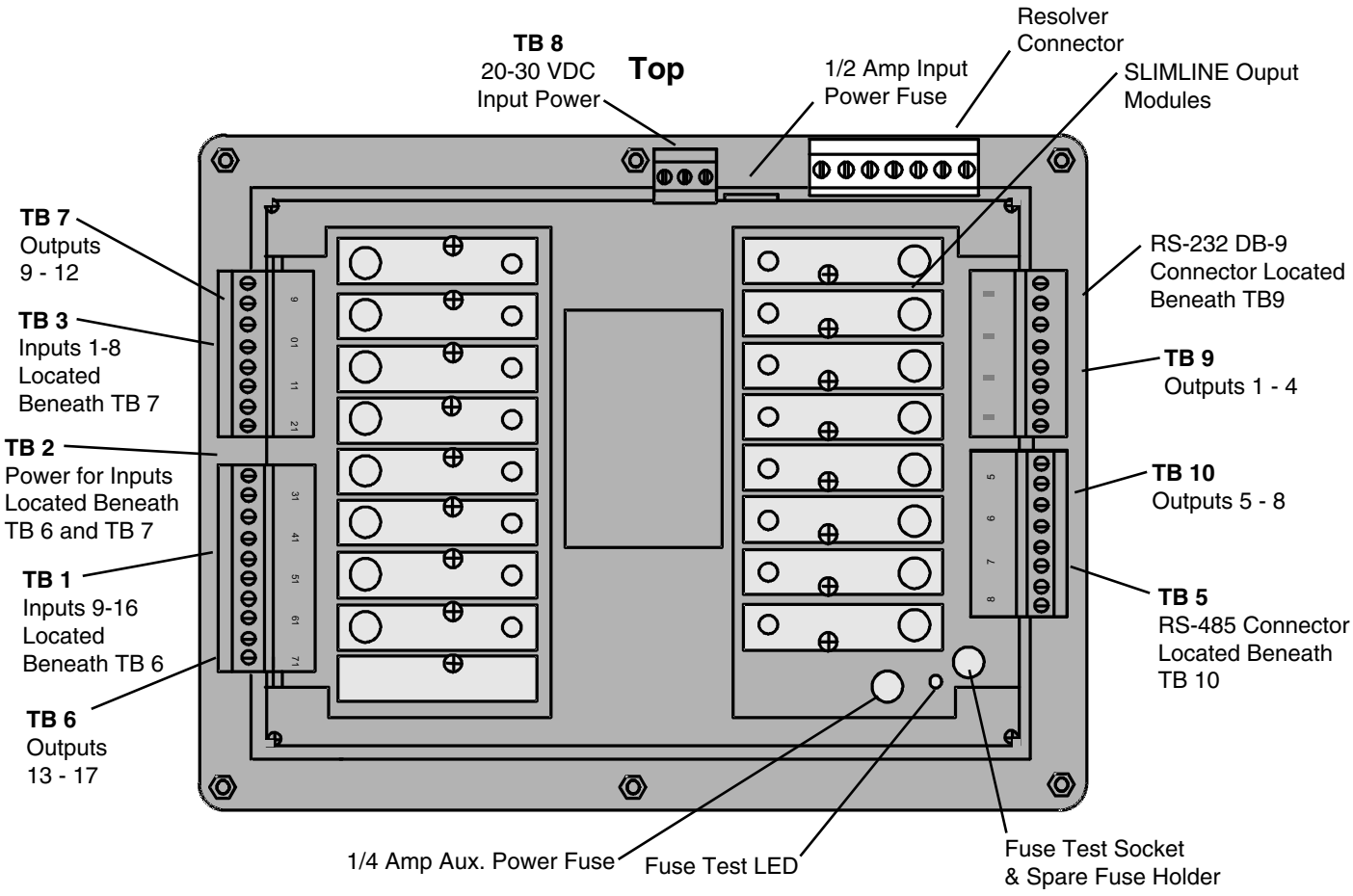


PS-5144-24-X16M09 System Overview



Back View of Controller

PS-5144-24-M17 System Overview



Back View of Controller

Ease of Setup

All output position setpoint values are simply entered through the numeric keypad. These setpoints can be adjusted while the machine is running or stopped by using the increment, decrement, or numeric keys. The keyboard is also used to synchronize the control's position to the machine, eliminating the need to mechanically adjust the resolver's shaft position.

Multiple Programs

Up to 48 different programs (job recipes) can be stored in the control's memory. This minimizes downtime for job changeover because simply changing program numbers makes all of the output setting changes required. Program numbers can be changed by mechanical switches; PLC's (using the hardware program select inputs); the keypad; or serial communication messages.

Output Speed Compensation

Speed compensation allows outputs to compensate for the response time of the output devices by turning on earlier as machine speeds increase. This eliminates the need to adjust output settings whenever machine speeds are changed. Utilizing speed compensation often allows higher production speeds and eliminates the need for output adjustments. Any 16 of the 25 outputs can be speed compensated, each by a unique amount as required. Speed compensation is programmed in .1 ms units.

Motion ANDing

Two motion speed ranges can be defined through programming. Combinations of outputs can then be ANDed with either speed range so that they will be disabled unless the machine speed is within the speed range specified. This can be used to turn off outputs if the machine stops, disable outputs until the machine reaches a minimum speed, or disable outputs if the machine goes above a specified maximum speed. A common use for this feature is disabling outputs to glue valves so the flow of glue turns off if the machine stops where glue is being applied.

Timed Outputs

Any 4 of the outputs can be timed if desired. Timed outputs will turn on at the programmed "on" position and turn off when the specified time elapses, rather than staying on until an "off" position is reached. The result is a constant output duration, regardless of machine speed. (The output will turn off when the "off" position is reached if it hasn't already timed out.) Time delays are programmed in 1 ms units up to a maximum of 9999 ms (9.999 sec).

Analog Output(s)

Up to 2 analog signals can be output from the control. A 0-10 VDC or a 4-20 mA analog output module is required for each analog signal. The analog signals will be linearly proportional to RPM (machine speed), but each can have a unique offset (analog signal at 0 RPM), and high RPM (RPM where maximum signal occurs) These values are programmed numerically through the keyboard—no measuring equipment is required for initial setup and calibration is not needed. Typical uses for the analog output are control of glue pressure as machine speeds change and speed matching of other equipment to the machine being controlled.

Scalable Position Resolution

The number of increments per revolution (Scale Factor) is programmed by the user. Standard controls have a maximum of 1024 increments per revolution and "H" option (high resolution) controls have a maximum of 4096 increments per revolution. To make the control operate and program in degrees, a Scale Factor of 360 is used. In some applications it is desirable to use a Scale Factor that defines each increment as a specific distance in engineering units (ex: 1 inc = .1" of travel).

Output Grouping and Modes of Operation

Outputs can be subdivided into groups and each group can be associated with an input device. There are five different modes of operation that can be selected for each group. For example, some modes allow the group to become active only when the corresponding input has signaled that product is present. Glue control is a typical place where outputs are disabled until product is sensed as being present. If grouping and modes seem appropriate for your application, you will have to review the detailed explanations of modes to determine which of the five modes is most appropriate. See Mode information in Appendix.

Serial Communication

The control has both an RS-232 and an RS-485 communication port. There is a PLuSNET software package available, for IBM compatible computers, which allows the control's entire program to be saved from the control to a disk file or loaded from a disk file to the control. The program can be printed or edited using the computer. It is also possible to send individual communication commands to the control, while running, to change settings in the program. The individual user must write appropriate software to communicate at the individual command level. A remote display, which connects to the RS-485 port, is also available. This allows Position and RPM information to be displayed up to 1000 feet away from the control. See Appendix page A-15.

Outputs

Transistor Outputs: There are 16 on the PS-5144-24-X16-M09. Sinking or sourcing outputs (determined by model ordered), up to 30 VDC 50 mA. Typically the transistor outputs are used to drive other electronic control device inputs such as PLC's and other control circuits with low level inputs.

Power Output Modules: There are 9 on the PS-5144-24-X16-M09 and 17 on the PS-5144-24M17. AC and/or DC modules can be used. A mix of AC and DC modules can be installed on the same control as needed. The AC and DC modules are normally used to directly drive electro-mechanical load devices such as solenoids, solenoid valves, relays, etc. It is desirable to directly drive devices that must operate very accurately (ex: glue valves, clutch/brakes, etc.) to avoid control delay and inconsistency caused by PLC scan times.

Analog Output Modules: Two types of analog output modules are available, 0-10 VDC and 4-20 mA output. Each analog module takes up one output module space. Additional information on analog outputs was presented in the analog output description on the previous page.

Inputs

The 16 dedicated inputs can be wired to operate from sinking or sourcing signals in the range of 10-30 VDC. Input functions are: program number select, programming enables, output group enables, 1st cycle enable and output enable. Detailed descriptions of each input are given in the getting started section.

Note: Please understand and utilize the two program enable inputs, **Master Enable** and **Operator Enable**, before putting the control into production. Using them properly can avert downtime caused by unauthorized personnel changing aspects of the program that should not be changed. The programming access level scheme built into the PS-5144 will minimize the risk of invalid programming changes. Review the detailed explanation of programming access levels (page 4-5 of this manual) and determine how to best use them regarding your machine application and personnel.

High Resolution

Controls with the “H” (high resolution) option can divide the resolver shaft rotation into as many as 4096 steps (increments). The number of increments per revolution that the control programs (Scale Factor) can be set for any value in the range of 2-4096. It is common to use a scale factor of 3600, which means that positions are being programmed in .1 degree increments. In some applications the rotation of the resolver shaft represents linear motion on the machine. It is often possible to use a Scale Factor that allows each step to be equivalent to a unit of linear travel. For example, if one revolution equaled 24" of travel, a Scale Factor of 2400 would result in each increment being equal to .01".

Leading / Trailing Edge Speed Comp ation

Controls with the “L” (leading/trailing edge speed compensation) option allow outputs to speed compensate the “on” and “off” edges of output pulses by different amounts. If a device with very critical control tolerances has on and off response times that are different, it is necessary to compensate the “on” edge by a different amount than the “off” edge. This will insure that the device stays properly synchronized to the machine over a wide range of speeds. High speed gluing is a common application where the “on” and “off” edges of the output signal have to be compensated by different amounts.

Gray Code Position Output

Controls with the “G” (Gray Code output) option provide 8 bits of position information on outputs 1-8. These 8 bits can drive eight standard DC inputs on a PLC (or other electronic control device) so it will know the current machine position. This position information is easily decoded by a PLC without the use of expensive PLC accessory cards. The PLC can then make position control decisions that do not demand a fast response while other PLuS outputs directly control devices that must operate quickly and consistently. See Appendix page A-14.

Large Program Memory

Controls with the “F” (large memory) option can store more job setup (recipe) information. Standard controls can store 48 programs consisting of not more than 1258 output pulses total. “F” units increase this capacity by storing up to 256 programs consisting of not more than 4589 output pulses total. This additional recipe storage capability is useful for applications where multiple complex recipes (multiple pulses in one or more outputs) or more than 48 recipes are stored.

Keyboard Boot - NEMA 4X

Controls with the “W” (washdown) option are shipped with a clear silicon rubber boot fitted over and around the keyboard area. The back of this boot provides a good seal between the back of the keyboard and the panel that the control is mounted in. The boot is transparent and pliable, allowing the keyboard to be viewed and operated through it. In addition to preventing contamination from harsh chemicals, the boot also protects the keyboard from grease, oil, dirt, and normal wear that could shorten the life of the keyboard. These clear silicon rubber boots can be ordered separately and installed on existing controls in the field. The boot part number is PS-4904-99-001.

Getting Started Introduction

The purpose of this section of the manual is to make the user aware of the tasks that are involved to install, wire and program the PS-5144 system. Some insight into these tasks will be provided, but it will be necessary to refer to other sections of the manual to get the detailed information required, especially in the area of programming.

Mounting the Control

This control is intended to be panel mounted using the six mounting studs protruding from the back of the keyboard (see Panel Cutout drawing to right). Enclosures are available from Electro Cam if an appropriate mounting location does not exist in an existing control cabinet. The following must be considered:

1. Allow space at both sides and the top of control for terminal connectors to be unplugged (remove all connectors when installing control in panel).
2. Temperatures in cabinet must be between 32° and 130° F (0° to 55°C)
3. Locate control away from devices that generate electrical noise (contactors, drives, etc.)
4. Use the gasket provided to prevent contaminants from getting into the PLuS control and cabinet.

Wiring Guidelines

Normal wiring practices associated with the installation of electronic controls, in accordance with local codes, should be followed. Some guidelines are:

1. Route I/O wiring away from high voltage, motor drive, and other high level control signals.
2. Use shielded cables for resolver, input, transistor output, and communication circuits. Also shield module output circuits that are driving low current electronic input circuits.
3. Ground shielded cables at PLuS control end only (except for resolver cable). Any of the screws on the controller back can be used for grounding.
4. Use appropriate suppression devices where module outputs are directly driving inductive loads.

Assigning Outputs

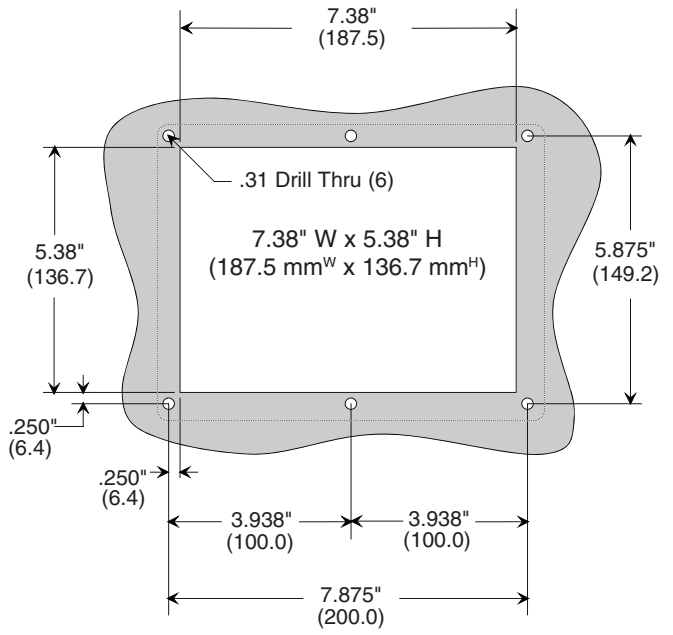
Outputs available depend on the PS-5144 model:

	Model -24-M17	**Model -24-X16M09**
Transistor:	None	Outputs 1-16
DC/RR:	Outputs 1-15	Outputs 17-23
DC/RR or Analog:	Outputs 16 & 17	Outputs 24 & 25

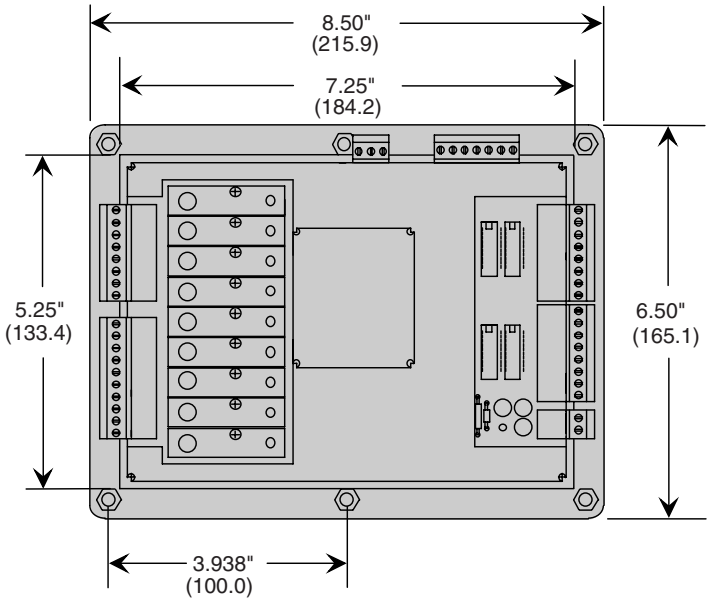
Therefore, output assignments cannot be random. The load device to be driven must be matched to the appropriate output type.

Applications which use output grouping and mode capabilities must take grouping and mode assignments into account when assigning outputs. Information on grouping and modes is available in the Appendix.

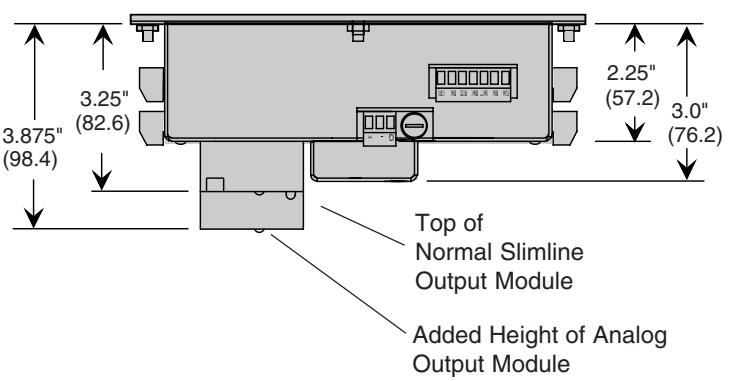
Panel Cutout



Dimensioned Back View



Dimensioned Top View



General Resolver Installation Information

Choose a mounting location for the resolver that allows convenient mechanical connection of the resolver shaft to the machine. The resolver is normally driven at a 1:1 ratio to machine cycles, but this is not true in all applications. The shaft can be coupled to the machine using a chain and sprocket, timing pulley and belt, or a direct shaft-to-shaft coupling. If a shaft-to-shaft coupling is used, Electro Cam Corp. recommends the use of a FLEXIBLE coupling. Flexible couplings are included on the Electro Cam Corp. price list.

CAUTION: Turn power to the machine OFF prior to installation!

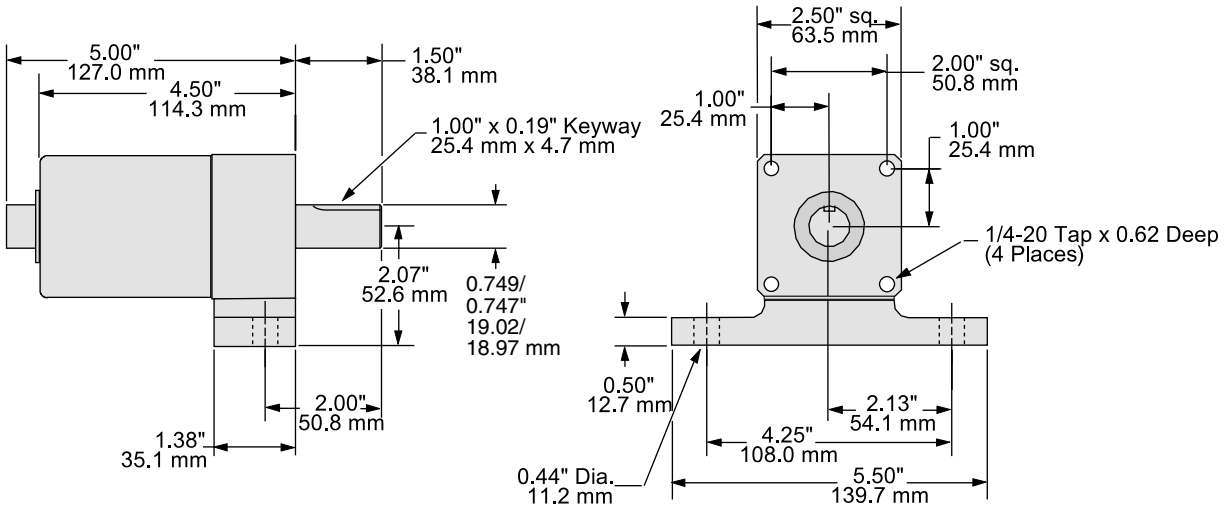
If possible, select a location that shelters the resolver from accidental mechanical abuse, lubricants, washdown chemicals, or any other liquids that may be present. Most Electro Cam resolvers have a NEMA 4 rating or better, but avoiding contaminants will maximize their reliability. Resolvers can operate in a wide range of temperatures, -40 to 257° F (-40 to 125° C).

The following are drawings and descriptions of the three most commonly used Electro Cam resolvers (other resolvers are available).

Foot Mount Resolver - (NEMA 4)

The foot mount resolver is convenient to mount because it is simply held in place by two bolts through the holes in the foot. This resolver is very rugged because of its external 3/4" diameter shaft size and internal 17 mm shaft size supported by two 17 mm (ID) ball bearings. It is available with an **end connector (pictured) or a side / top connector** and uses the standard resolver cable (PT# PS-5300-01-XXX).

Foot Mount Resolver - 3/4" Shaft

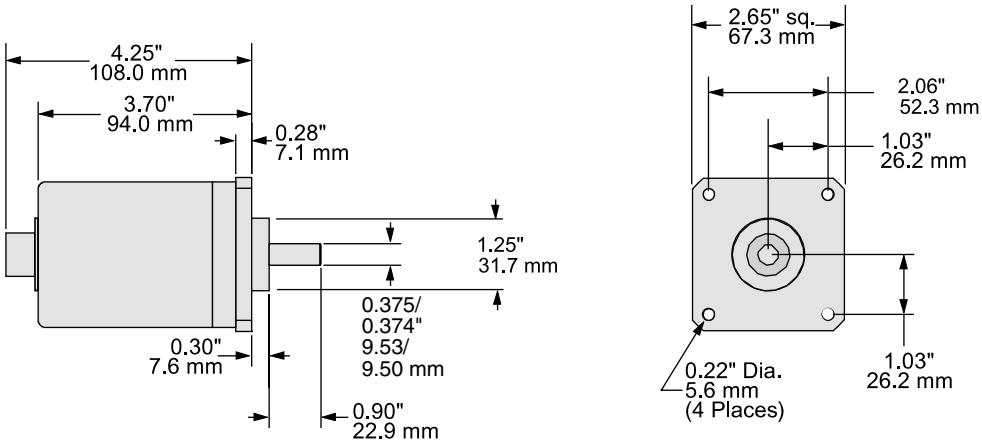


Resolver Dimensions and Mounting

Flange Mount Resolver - (NEMA 4)

The flange mount used on this resolver is a standard type and size that is also used by other industrial devices. The 1.25" pilot bushing can be used as a centering guide to exactly locate the resolver shaft when mounted. The resolver is held in place with bolts through the four mounting holes at the corners of the flange. The external shaft size is 3/8" diameter (standard size for this flange mount), but the shaft diameter within the resolver is 17 mm and two 17 mm (ID) ball bearings support it. It is available with an **end connector (pictured) or a side / top connector** and uses the standard resolver cable (PT# PS-5300-01-XXX).

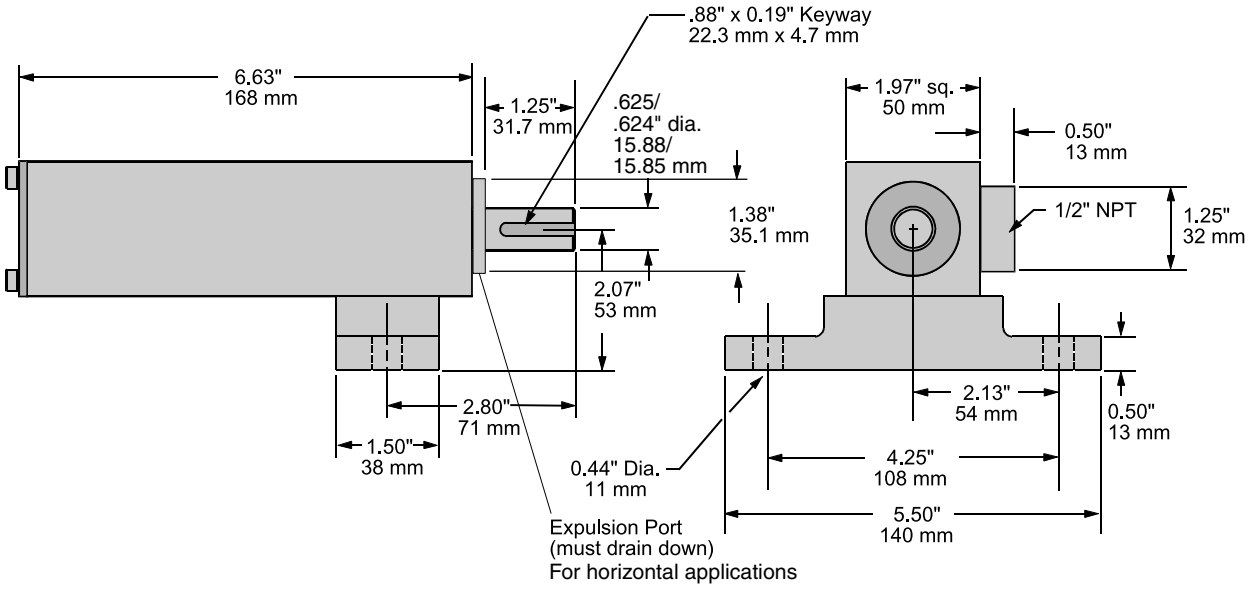
Flange Mount Resolver - 3/8" Shaft



Stainless Steel Foot Mount - (NEMA 4X)

This resolver is designed to operate in severe environments, such as the food and beverage industries, where harsh cleaning chemicals are often used. All exposed parts (body, shaft, cap screws, etc.) are stainless steel. The 5/8" shaft is supported by two 5/8" (ID) stainless steel, double sealed ball bearings and a special stainless shaft seal is also used. Electrical connections are made on an internal terminal strip so that no connectors are exposed to the environment. **This resolver can be ordered with left or right side conduit entrance (right shown)** and uses resolver cable PT# PS-5300-02-XXX.

Stainless Steel Foot Mount Resolver - 5/8" Shaft



The drawing below shows the relative position of the outputs, inputs, terminal connectors, and fuses on the back of the PS-5144-24-X16M09 controller. It is important that electrical personnel are familiar with the location, function, and features of these components.

Unpluggable Screw Terminal Connectors

All of the screw terminals used for field wiring can be unplugged from the controller. It is necessary to have all connectors unplugged when mounting the control in the panel cutout. Each connector is uniquely keyed so it can not be plugged into the wrong position. All terminals are appropriately labelled on each connector. In most situations it is easier to have the connectors unplugged while the wires are being connected.

Fuses and Fuse Tester

There are 3 fuses used on the controller itself, and there is 1 fuse built into each of the power output modules. The 1/2 amp Slo Blo input power fuse is a glass tube type. The other fuses are a plug-in type and can be tested in the fuse test socket provided at the bottom of the transistor output board (control must be powered up when using the test socket). These plug- in fuses are not all the same value, so they can not be used interchangeably. The transistor output fuse is 1 amp, the auxiliary power fuse is 1/4 amp and the output module fuses are 4 amps.

Controls are shipped from the factory with a spare 4 amp fuse in the test socket. When a good fuse is plugged into the test socket, the test LED will be lit.

Transistor Output Array Chips

The transistor output array chips are socketed to allow replacement in the field should one become damaged. There is a difference in chip placement between sourcing and sinking output units (sinking units use a dip jumper block where sourcing units use a transistor array chip). Details on transistor output troubleshooting are given on page 7-9.

Slimline Power Output Modules

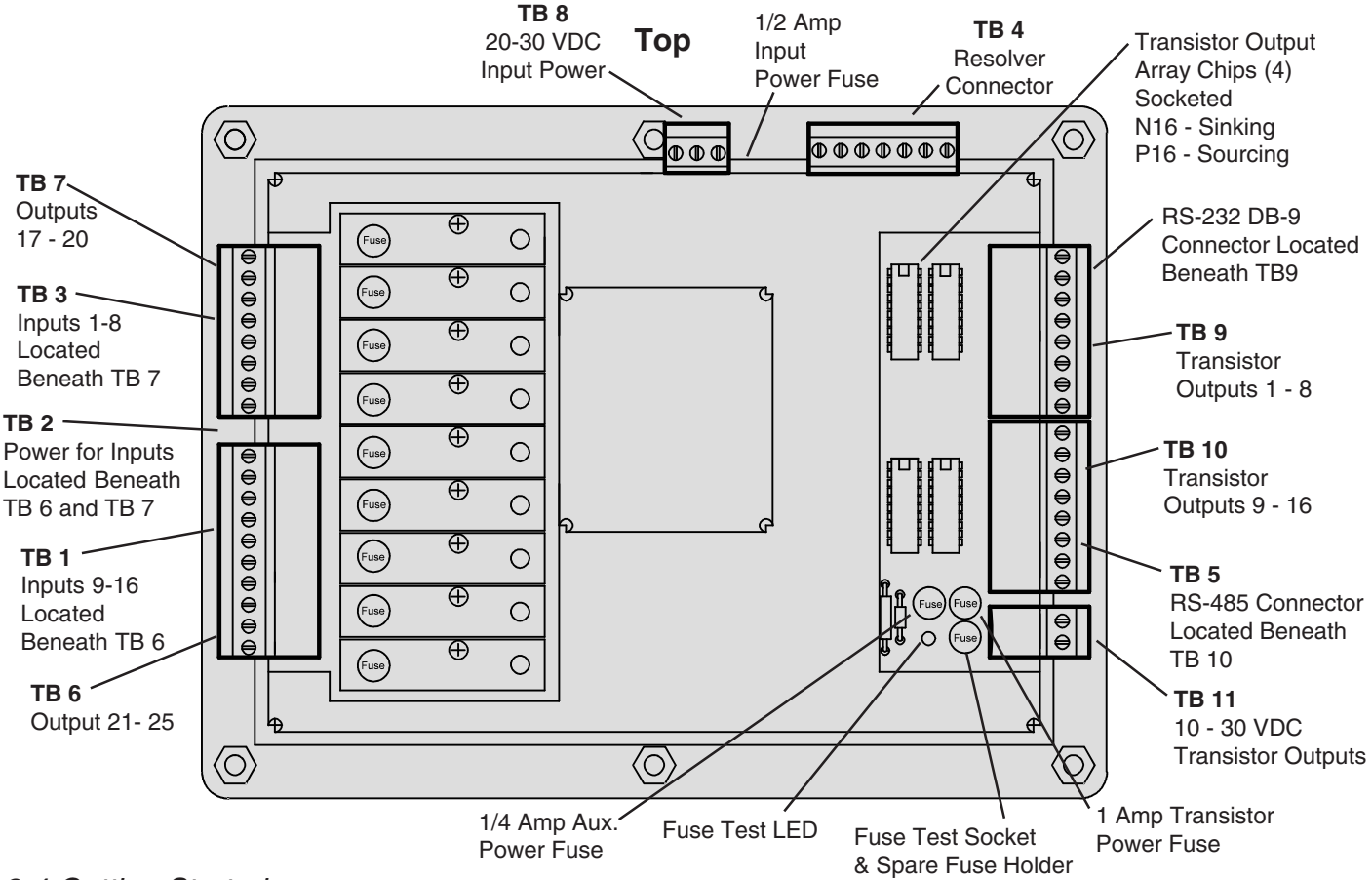
The power output modules are available with AC or DC outputs and can be mixed on the same control as needed. A phillips head screw holds each module in place and individual modules can be removed and installed without affecting the other modules on the unit. Each module contains a fuse, which is in series with the load, and an LED, which indicates when the logic side of the module is on.

Note: Analog output modules do not have fuses or LEDs.

Component Parts List

A complete listing of the component parts used on the PS-5144 control system is located on page A-16.

Back View of PS-5144-24-X16M09 Controller - Terminal and Component Identification



PS-5144-24-M17 Terminal and Component Information

The drawing below shows the relative position of the outputs, inputs, terminal connectors, and fuses on the back of the PS-5144-24-M17 controller. It is important that electrical personnel are familiar with the location, function, and features of these components.

Unpluggable Screw Terminal Connectors

All of the screw terminals used for field wiring can be unplugged from the controller. It is necessary to have all connectors unplugged when mounting the control in the panel cutout. Each connector is uniquely keyed so it can not be plugged into the wrong position. All terminals are appropriately labelled on each connector. In most situations it is easier to have the connectors unplugged while the wires are being connected.

Fuses and Fuse Tester

There are 2 fuses used on the controller itself, and there is 1 fuse built into each of the power output modules. The 1/2 amp Slo Blo input power fuse is a glass tube type. The other fuses are a plug-in type and can be tested in the fuse test socket provided at the bottom of the power output module board (control must be powered up when using the test socket). These plug- in fuses are not all the same value, so they can not be used interchangeably. The auxiliary power fuse is 1/4 amp and the output module fuses are 4 amps.

Controls are shipped from the factory with a spare 4 amp fuse in the test socket. When a good fuse is plugged into the test socket, the test LED will be lit.

Slimline Power Output Modules

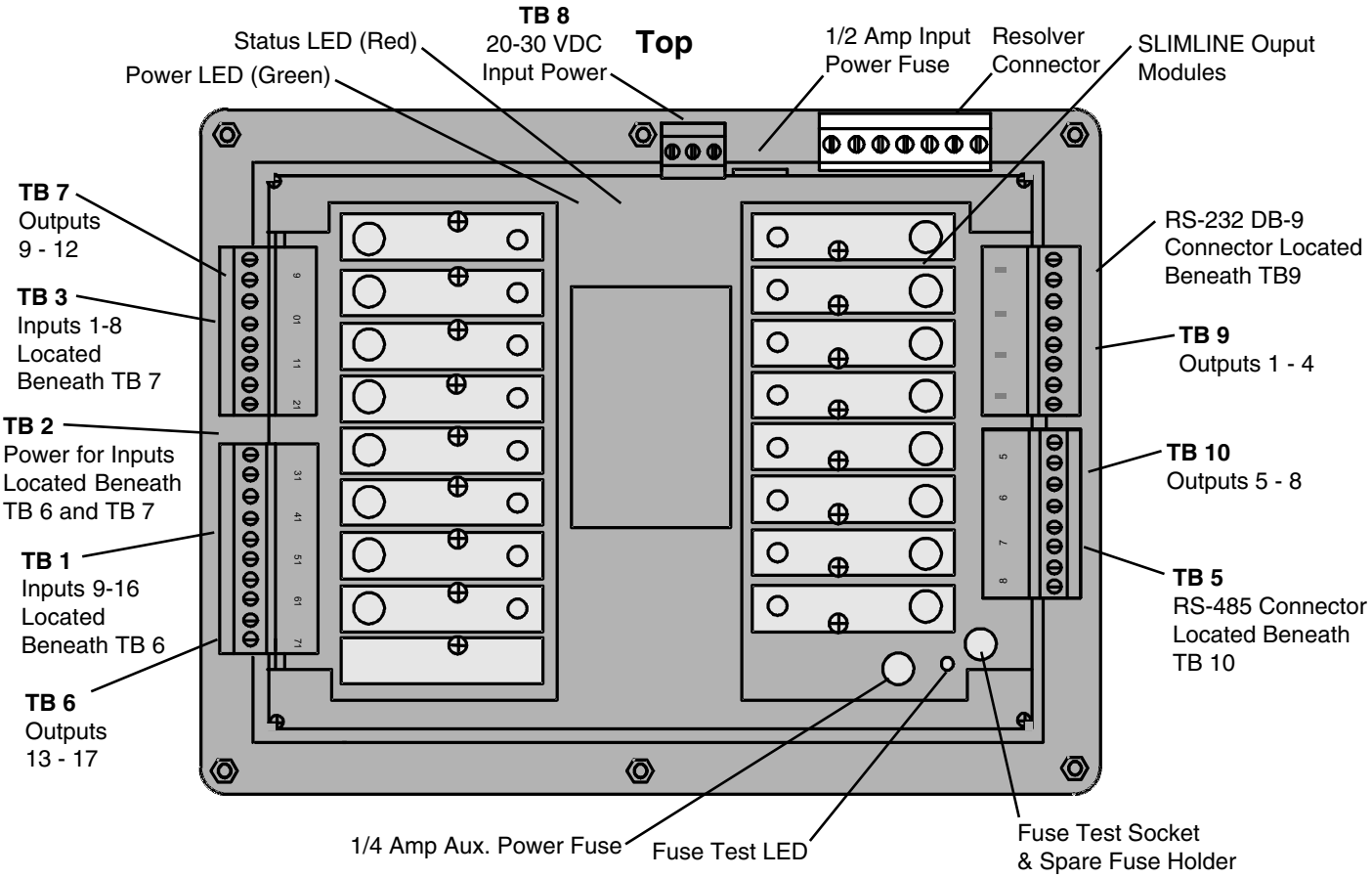
The power output modules are available with AC or DC outputs and can be mixed on the same control as needed. A phillips head screw holds each module in place and individual modules can be removed and installed without affecting the other modules on the unit. Each module contains a fuse, which is in series with the load, and an LED, which indicates when the logic side of the module is on.

Note: Analog output modules do not have fuses or LEDs.

Component Parts List

A complete listing of the component parts used on the PS-5144 control system is located on page A-16.

Back View of PS-5144-24-M17 Controller - Terminal and Component Identification



PS-5144-24-X16M09 Terminal Block Details

Terminal Block	Function	ECC Part #[1]
TB 1	Inputs 9–16 Input 9 - Group 1 Enable Input 10 - Group 2 Enable Input 11 - Group 3 Enable Input 12 - Group 4 Enable Input 13 - Group 5 Enable Input 14 - Group 6 Enable Input 15 - First Cycle Enable Input 16 - Output Enable	PS-9006-0024
TB 2	Power for inputs	PS-9006-0018
TB 3	Inputs 1–8 Inputs 1 thru 6 - Program Select Input 7 - Master Program Enable Input 8 - Operator Program Enable	PS-9006-0023
TB 4	Resolver connector	PS-5300-01-TER
TB 5	RS-485 connector	PS-9006-0025
TB 6	Module outputs 21–25	PS-9006-0028
TB 7	Module outputs 17–20	PS-9006-0027
TB 8	Power for controller	PS-9006-0026
TB 9	Transistor outputs 1–8, sinking Transistor outputs 1–8, sourcing	PS-9006-0019 PS-9006-0021
TB 10	Transistor outputs 9–16, sinking Transistor outputs 9–16, sourcing	PS-9006-0020 PS-9006-0022
TB 11	Power for transistor outputs	PS-9006-0017

[1] Keyed to prevent accidental insertion into wrong sockets.

PS-5144-24-M17 Terminal Block Details

Terminal Block	Function	ECC Part #[1]
TB 1	Inputs 9–16 Input 9 - Group 1 Enable Input 10 - Group 2 Enable Input 11 - Group 3 Enable Input 12 - Group 4 Enable Input 13 - Group 5 Enable Input 14 - Group 6 Enable Input 15 - First Cycle Enable Input 16 - Output Enable	PS-9006-0024
TB 2	Power for inputs	PS-9006-0018
TB 3	Inputs 1–8 Inputs 1 thru 6 - Program Select Input 7 - Master Program Enable Input 8 - Operator Program Enable	PS-9006-0023
TB 4	Resolver connector	PS-5300-01-TER
TB 5	RS-485 connector	PS-9006-0025
TB 6	Module outputs 13-17	PS-9006-0031
TB 7	Module outputs 9-12	PS-9006-0030
TB 8	Power for controller	PS-9006-0026
TB 9	Module outputs 1-4	PS-9006-0033
TB 10	Module outputs 5-8	PS-9006-0034

[1] Keyed to prevent accidental insertion into wrong sockets.

Input Power and Resolver Wiring

Input Power Wiring

20 to 30 VDC input power must be supplied to the controller on the DC power input connector (TB 8) shown in the drawing below. 1/2 Amp is the maximum amount of current the control can draw before the Slo Blo fuse will blow. The DC input power will be used to power the control and supply up to 1/4 Amp for input circuits and accessories connected to the Auxiliary Power Output terminals located between the input terminal strips.

The connector polarity must be wired as shown. Wiring the polarity backward will cause the 1/2 Amp power input fuse to blow as soon as power is applied. The control will not be damaged, but it will be necessary to correct the polarity and replace the fuse before the control can be operated.

To insure proper electrical noise immunity, it is important that a good electrical ground be connected to the ground terminal on the DC power input connector.

Note: If the control is powered up without a resolver properly connected, **an "E10-rES" error message will result.** Pressing any key will clear the error message and allow programming to be done. However, when a resolver is not properly connected, all of the outputs will be disabled. Properly connecting a resolver will restore output operation. See page 7-2 for details.

Pages 7-2 through 7-5 list all of the flashing error messages used by the PS-5144 controller and what corrective action should be taken when they occur. Take the time to look up error messages if they occur to insure reliable operation of the controller.

Resolver Wiring

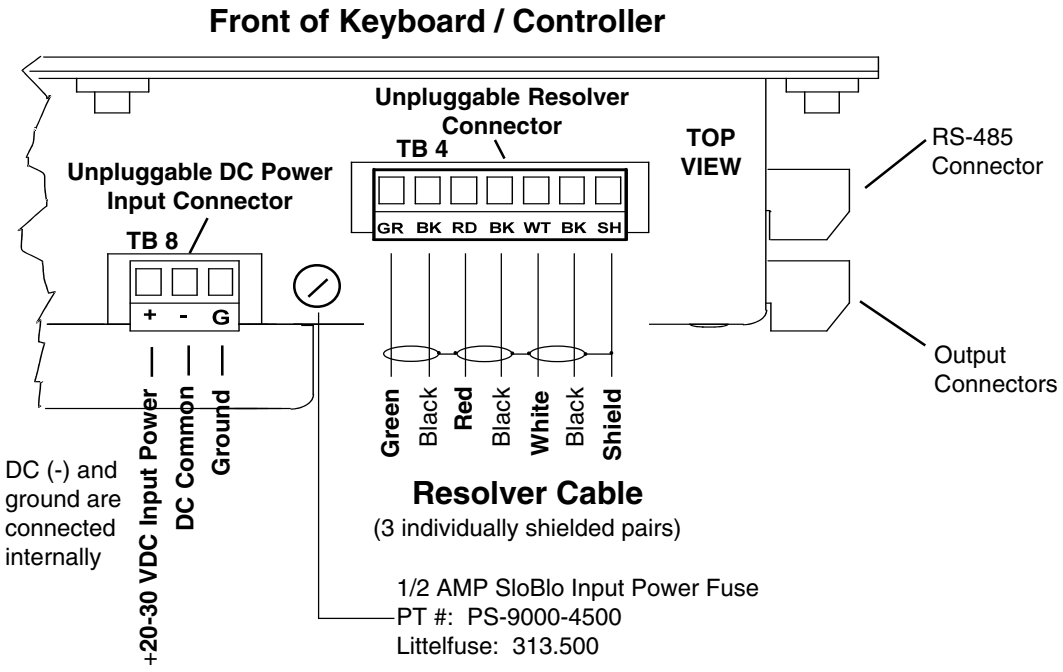
The standard Electro Cam resolver cables (PT# PS-5300-01-XXX) are shipped pre-wired to the resolver connector (soldered) and the controller connector (TB4 screw terminals). Remove the controller connector if it becomes necessary to route the cable through areas where the connectors won't fit. Start at the resolver end and run the cable back to the control.

The shield is connected at both ends of the cable to prevent damage due to electrostatic discharge. If electrical noise problems are suspected when the control is in operation, call the Electro Cam factory for advise regarding shielding.

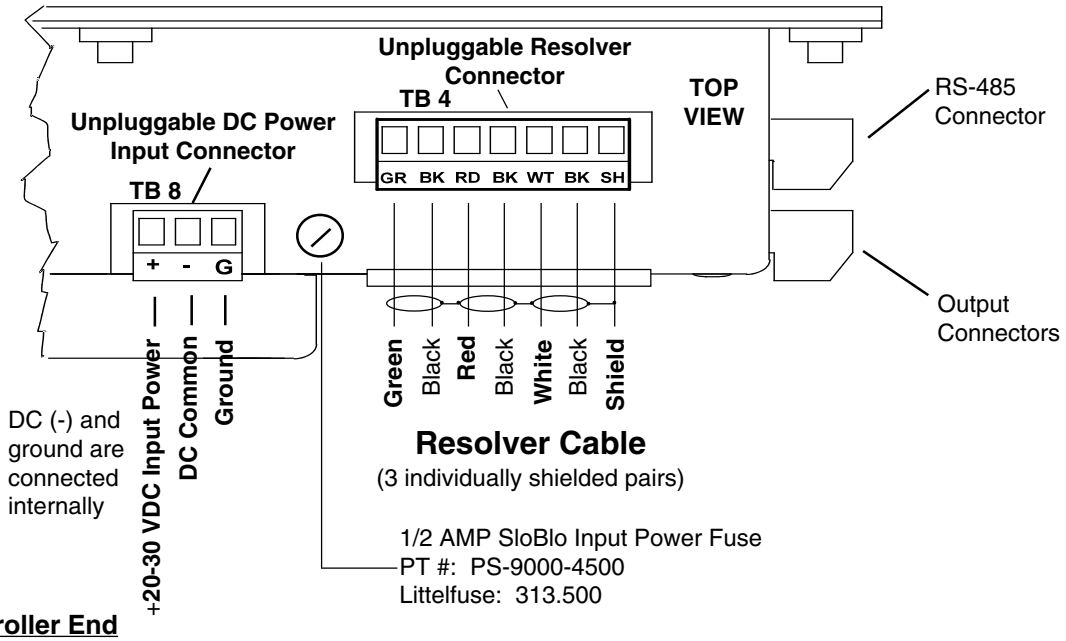
The resolver cable used with the stainless steel resolvers (PT# PS-5300-02-XXX) does not have a connector at the resolver end because screw terminals are used inside that resolver. When routing this cable, start at the controller end and run the plain end of the cable to the resolver. When properly connected, both ends of the cable shield will be connected. If electrical noise problems are suspected when the control is in operation, call the Electro Cam factory for advise regarding shielding.

Resolver cables supplied by Electro Cam are a special type consisting of three individually twisted/shielded pairs with a common braid shield. This insures that reliable position information is being received by controller. The use of other cable types could degrade the accuracy of the position signals and make them more susceptible to electrical noise. For these reasons, it is recommended that customers do not make their own resolver cables. Electro Cam will make resolver cables any length up to 1000 feet and can expedite shipment as required.

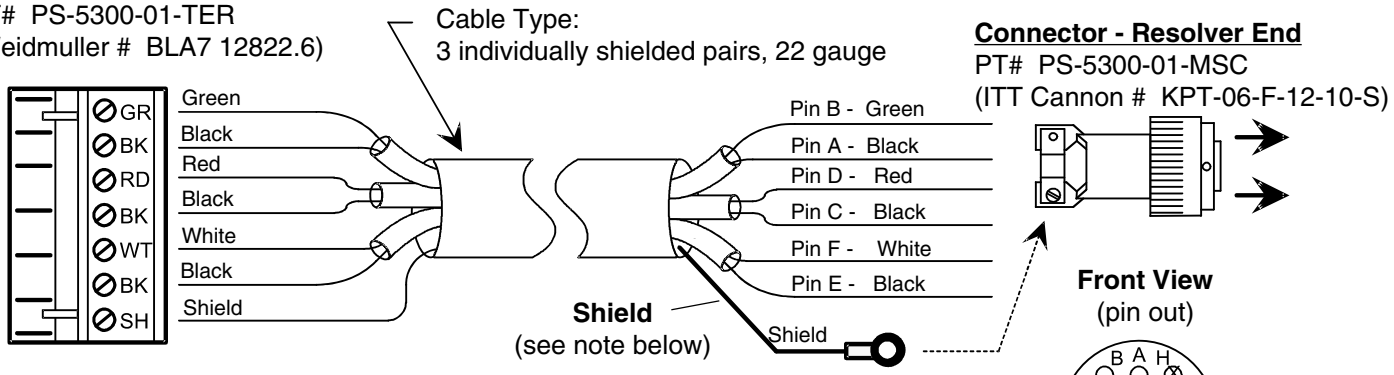
Top View of Controller - Input Power and Resolver Connectors



Top View of Controller - Input Power and Resolver Connectors

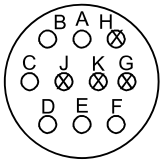


Connector - Controller End
PT# PS-5300-01-TER
(Weidmuller # BLA7 12822.6)



Connector - Resolver End
PT# PS-5300-01-MSC
(ITT Cannon # KPT-06-F-12-10-S)

Front View
(pin out)



⊗ = Not Used

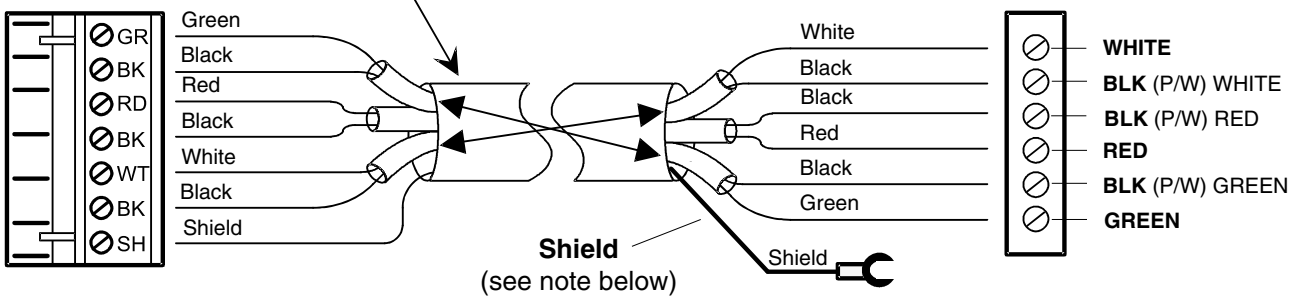
Shielding Note: Resolver cables made after 3-2-93 have a ring lug on a black shield wire at the resolver end. The ring lug should be attached to one of the resolver connector strain relief screws to protect against static discharge through the resolver cable. In some installations, it may be advisable to disconnect the ring lug to prevent ground loops through the cable shield. Consult Electro Cam if electrical noise problems are suspected.

Cable for Resolver with Terminal Strip Connections

PT# PS-5300-02-XXX (XXX = Length in Feet)

Connector - Controller End
PT# PS-5300-01-TER
(Weidmuller # BLA7 12822.6)

Connector Inside Resolver
(cable is stripped and tinned at both ends)



Shielding Note: This type of resolver cable will have a spade lug connected to the shield at the resolver end. The lug should be attached to the grounding stud on the cover plate of the resolver. In some installations, it may be advisable to disconnect the lug to prevent ground loops through the cable shield. Consult Electro Cam if electrical noise problems are suspected.

Output Wiring

Output Types

The outputs available depend on the PS-5144 Model:

Output Type	Model 5144-24-M17	Model 5144-24-X16M09
Transistor	None	Outputs 1-16
AC/DC/RR Modules Only	Outputs 1-15	Outputs 17-23
AC/DC/RR or Analog Modules	Outputs 16 & 17	Outputs 24 & 25

The load device to be driven must match the output type.

Power Output Modules

Output modules can directly switch inductive loads and resistive loads that require more current or voltage than the transistor outputs can supply. **The modules do not supply the power for the load; they simply switch it.** Each output module has two dedicated terminals and therefore does not share any common signal with the other modules. This allows AC and DC modules to be mixed on the same control. DC modules can be wired to sink or source as shown on the next page.

Analog Output Modules

Analog output modules generate signals that are proportional to the resolver RPM. They can be used only in the output positions shown above. Either a 0-10 VDC or 4-20 mA analog module can be used in either module position. ANALOG QTY must be programmed for the number of analog modules installed. An external power supply is not needed because the analog modules get the power they source from the controller. The analog output signal is completely isolated.

Transistor Outputs

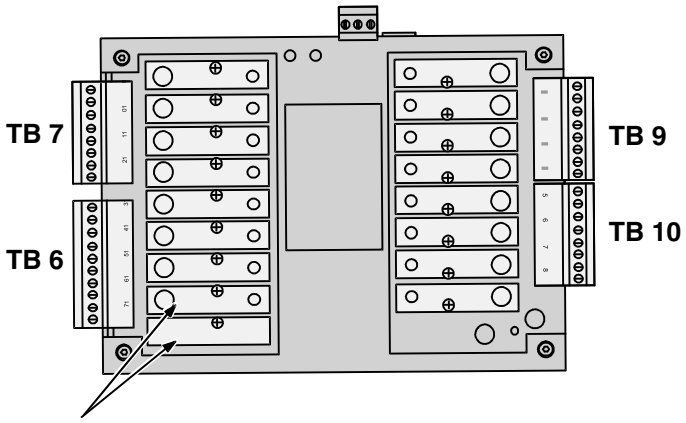
PS-5144-24-X16M09 models include 16 transistor outputs to drive the electronic input circuits of other control devices. The outputs are limited to 30 VDC, 50 mA each and should not be used to control inductive devices such as solenoids, solenoid valves or relays.

The control can be ordered with either sinking or sourcing transistor outputs. Both types require a 10-30 VDC power supply connected to TB 11 to drive the transistor output circuitry. The transistor output fuse will blow if the power supply polarity is incorrect, but the circuitry will not be damaged.

Sinking transistor outputs (N16 controls) conduct to the negative terminal of TB 11. Therefore the common for TB 11 and the load must be electrically the same. This may require connecting commons together if the power supplied to TB 11 is not also the load power supply. Electronic counters/ratemeters often fall into this category. The power supply that powers the load does not have to be the same voltage as the transistor power supplied to TB 11.

Sourcing transistor outputs (P16 controls) conduct to the positive power terminal of TB 11. The load is therefore powered from the same supply that is providing the transistor power.

PS-5144-24-M17



Outputs 16 & 17
Analog or AC/DC

TB 10
Outputs #5–8

8		7		6		5	
A	B	A	B	A	B	A	B

TB 9
Outputs #1–4

4		3		2		1	
A	B	A	B	A	B	A	B

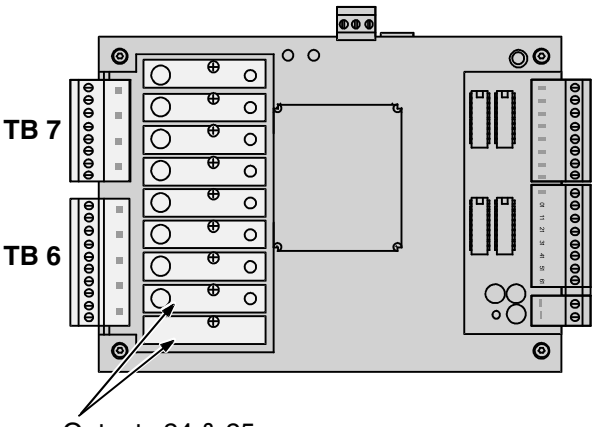
TB 7
Outputs #9–12

9		10		11		12	
A	B	A	B	A	B	A	B

TB 6
Outputs #13–17

13		14		15		16		17	
A	B	A	B	A	B	A	B	A	B

PS-5144-24-X16M09



Outputs 24 & 25
Analog or AC/DC

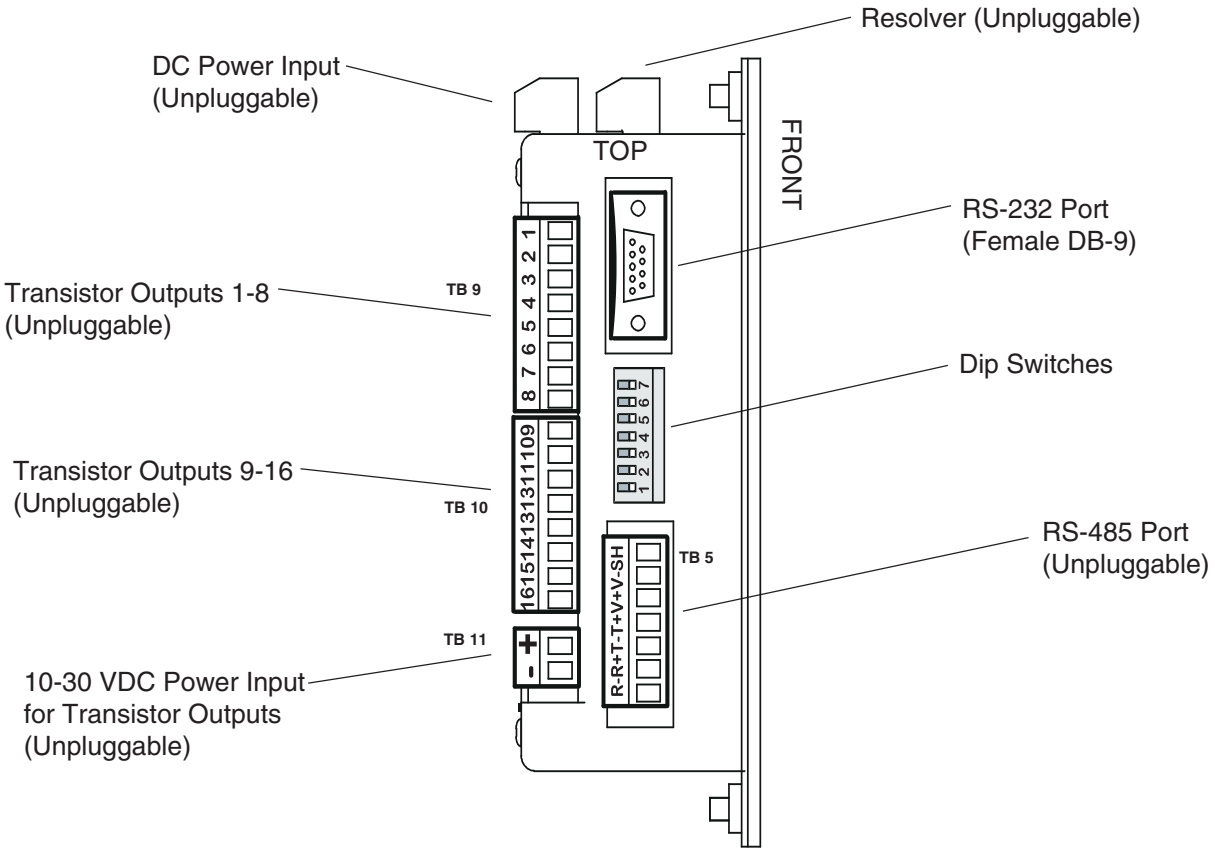
TB 7
Outputs #17–20

17		18		19		20	
A	B	A	B	A	B	A	B

TB 6
Outputs #21–25

21		22		23		24		25	
A	B	A	B	A	B	A	B	A	B

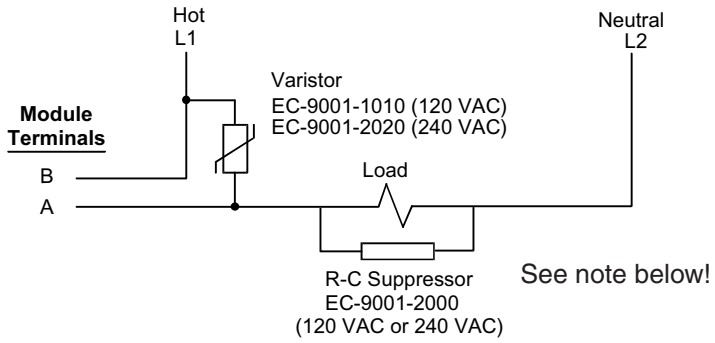
Transistor Outputs - Right Side View



Power Output Module Wiring

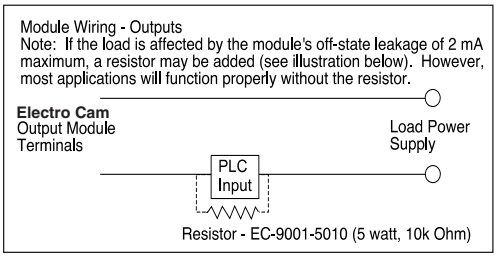
An output module is required for each output being used. AC and DC output modules can be mixed as needed. Any module position can accommodate either an AC or a DC module.

AC Output



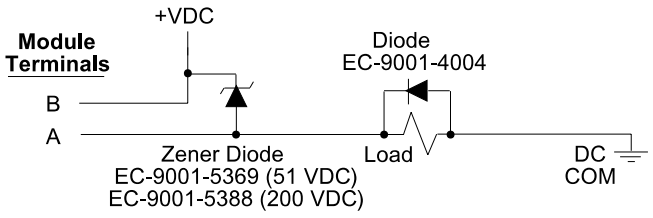
Note—Most applications will not need the varistor or R-C suppressor shown above. However, when other switching devices are in series or parallel with the AC module, voltage spikes may damage the module. Use one of the following two methods to suppress voltage spikes.

- For infrequent switching, connect a varistor (MOV) across the terminals.
- For continuous switching, wire an R-C suppressor in parallel with the load.



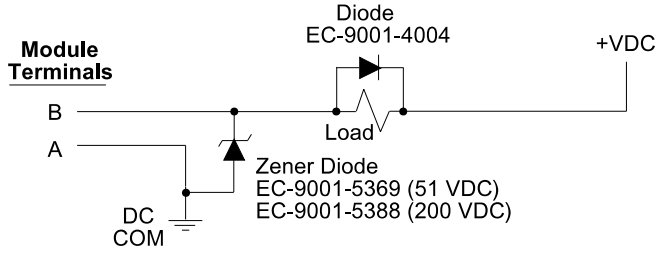
DC Output

Sourcing



Sourcing - Connect VDC directly to the "B" terminal of output module. Connect the "A" terminal to one side of the load devices. Connect the other side of the load to DC common.

Sinking



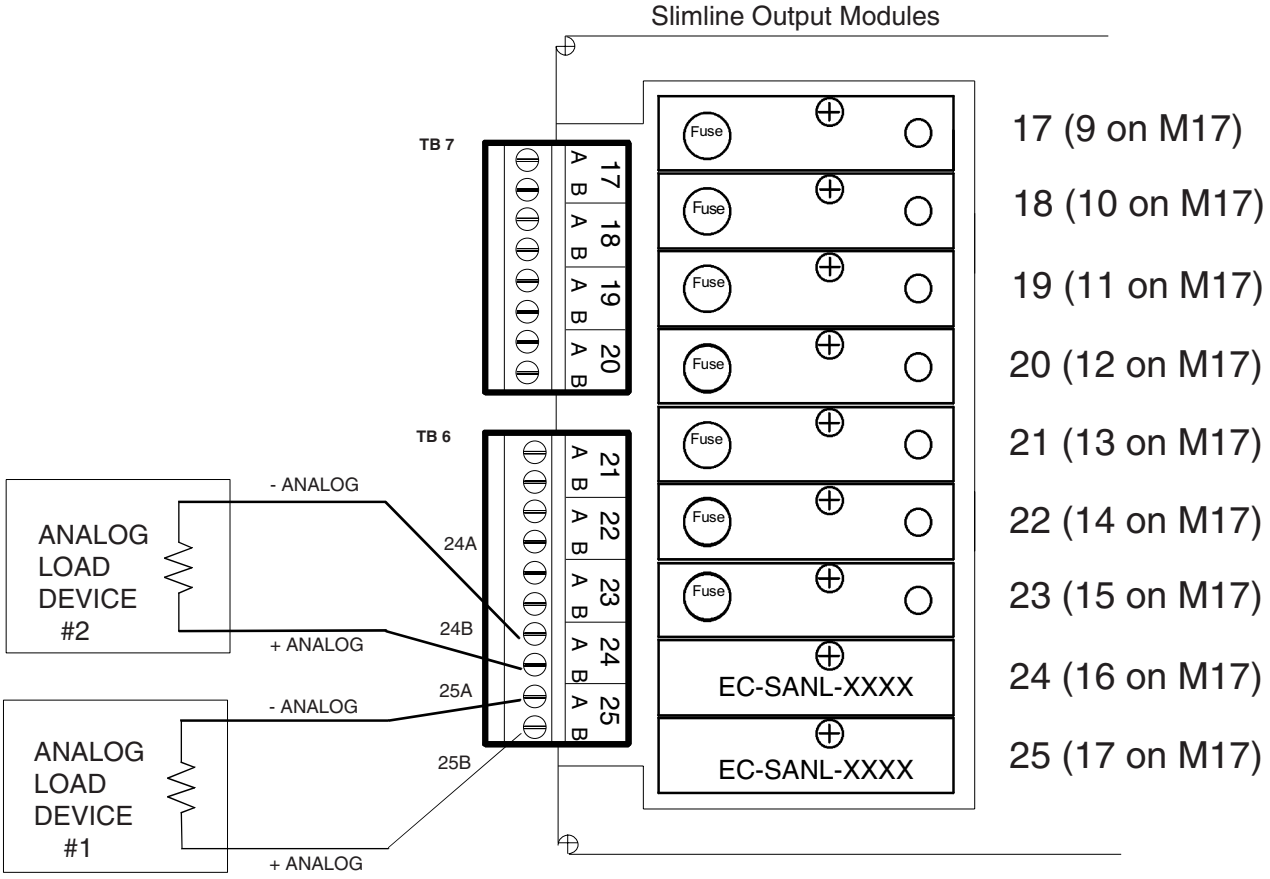
Sinking - Connect positive VDC directly to one side of the load device. Connect other side of the load to the "B" terminal of the output module. Connect the "A" terminal to DC common.

Note—Most applications will not need the diodes shown above. However, highly inductive DC loads may damage modules by generating voltage spikes when switched off. Suppress these loads using one of these two methods:

- Connect a Zener diode across the terminals. This will not significantly increase the load turn off time. Voltage rating of the diode must be greater than the normal circuit voltage.
- Connect a reverse-biased diode across the load. This may increase the load turn off time.

Reed relay output modules are available. They should only be used in applications where the solid state AC or DC modules will not work. Consult factory.

Wiring for Analog Outputs X16M09 or M17



The programming of FCN 101 "nA" determines how many analog outputs can be used as follows:

nA = 0 no analog outputs - modules 24 and 25 are normal outputs (or 16 and 17 on M17)
nA = 1 1 analog output - module 25 is analog, module 24 normal (or 17 analog, 16 normal on M17)
nA = 2 2 analog outputs - modules 24 and 25 are both analog (or 16 and 17 on M17)

A 0-10 VDC (EC-SANL-010V) or a 4-20 mA (EC-SANL-420M) analog output module can be used in either module position.

ANALOG MODULE INFORMATION

PT #	TYPE	CURRENT OUTPUT	LOAD RESISTANCE
EC-SANL-010V	0-10VDC	5 mA MAX	2K OHM MIN
EC-SANL-420M	4-20 mA	20 mA MAX	275 OHM MAX

NOTE: Both analog output modules source the analog signal. An external analog power supply is not used. The analog output signals are isolated.

CAUTION: Do not apply external voltage to an analog module or you will damage it.

Transistor Output Wiring

Sinking or Sourcing (as pertaining to Electro Cam Corp. products)

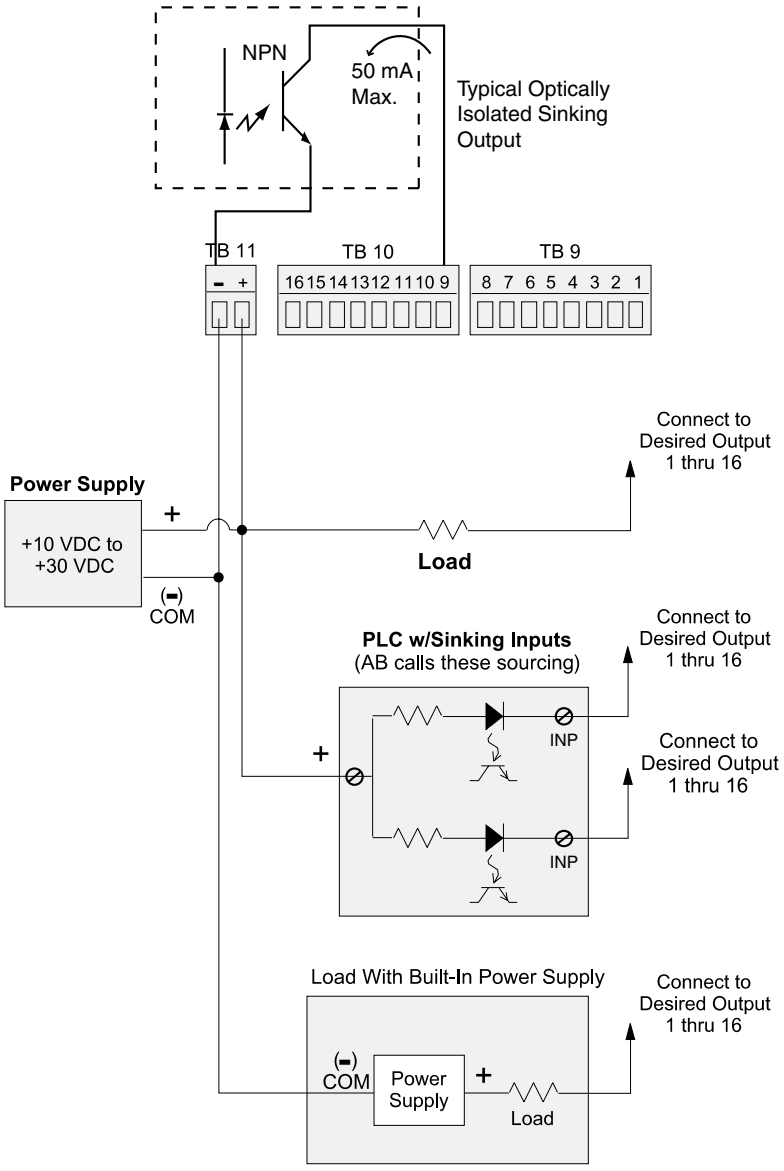
Sinking means that when the logic is true and the output (or input device) is ON, the output (or input device) is providing a DC common or ground to the connected device.

Sourcing means that when the logic is true and the output (or input device) is ON, the output (or input device) is providing a +DC voltage to the connected device.

This information is important when interfacing an Electro Cam Corp. product with another electronic device. If you are using an Electro Cam Corp. product input to an Allen-Bradley 1746-IN16 "sinking" input card* or similar A-B device, you have to supply a +DC voltage (Electro Cam Corp. ***Sourcing*** output) to this card, NOT a DC common or ground. In these cases, ***Sinking*** is what the card does with the input voltage; sinks it to common or ground.

*Other manufacturers include, but not limited to: Koyo (formerly GE Series 1, Texas Instruments, or Siemens SIMATIC PLS's) that use descriptions similar to Allen-Bradley.

Wiring for Sinking Transistor Outputs (N16)
Model PS-5144-24-N16M09



Please Note:

- Outputs are rated at 30 VDC, 50 mA.
- Transistor outputs should not be used to switch inductive devices such as solenoids or relays.
- Sinking outputs conduct to the negative terminal of TB 11 when "on."
- The power supply shown in "Load with Built-In Power Supply" does not have to be the same voltage as the power supply connected to TB 11.

Transistor Output Wiring

Sinking or Sourcing (as pertaining to Electro Cam Corp. products)

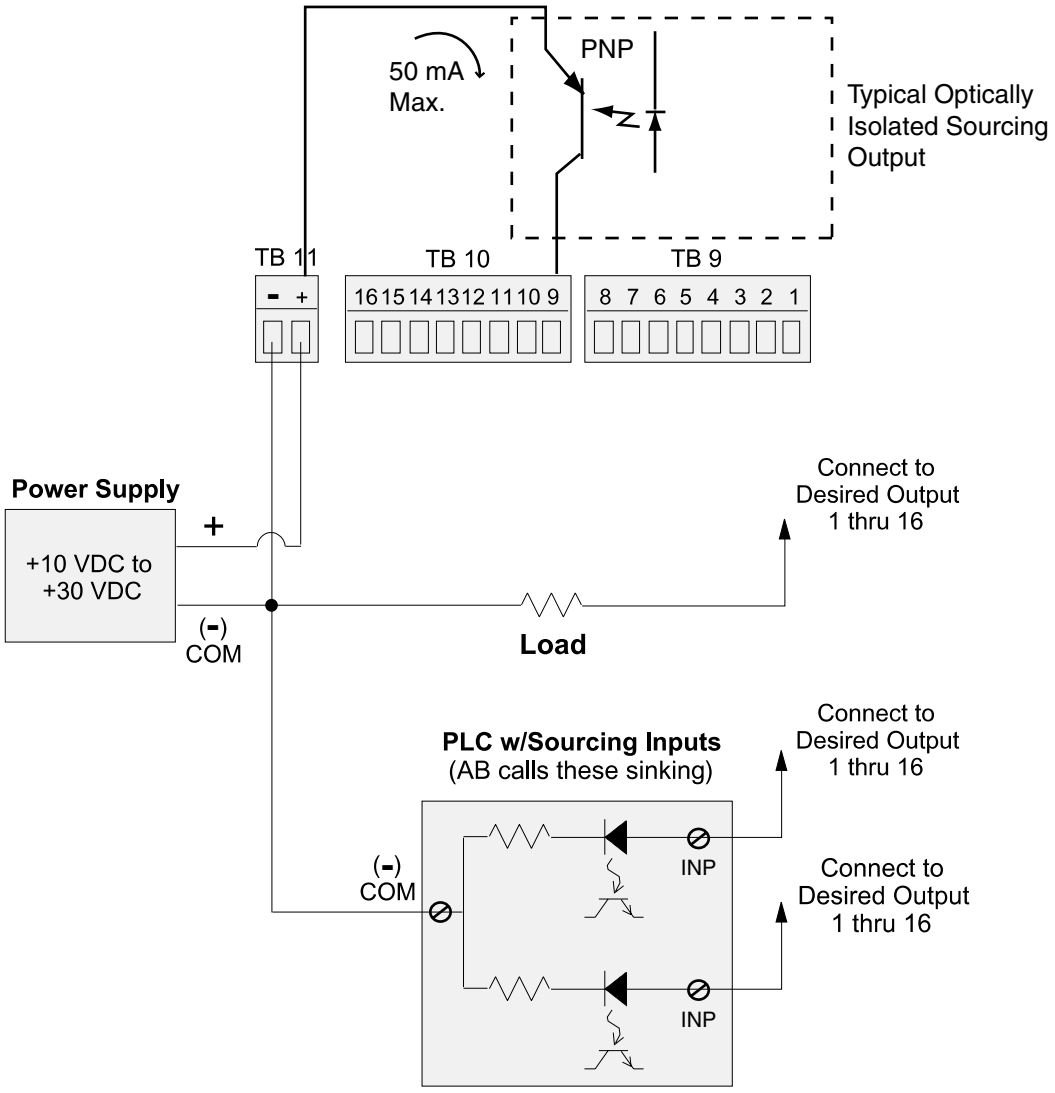
Sinking means that when the logic is true and the output (or input device) is ON, the output (or input device) is providing a DC common or ground to the connected device.

Sourcing means that when the logic is true and the output (or input device) is ON, the output (or input device) is providing a +DC voltage to the connected device.

This information is important when interfacing an Electro Cam Corp. product with another electronic device. If you are using an Electro Cam Corp. product input to an Allen-Bradley 1746-IN16 "sinking" input card* or similar A-B device, you have to supply a +DC voltage (Electro Cam Corp. ***Sourcing*** output) to this card, NOT a DC common or ground. In these cases, ***Sinking*** is what the card does with the input voltage; sinks it to common or ground.

*Other manufacturers include, but not limited to: Koyo (formerly GE Series 1, Texas Instruments, or Siemens SIMATIC PLS's) that use descriptions similar to Allen-Bradley.

Wiring for Sourcing Transistor Outputs (P16)
Model PS-5144-24-P16M09



Please Note:

- Outputs are rated at 30 VDC, 50 mA.
- Transistor outputs should not be used to switch inductive devices such as solenoids or relays.
- Sourcing outputs conduct to the positive terminal of TB 11 when "on."

Input Wiring

The 16 control inputs on the PS-5144 are arranged on two terminal strips, each containing eight inputs. Either terminal strip can be wired to accept sinking or sourcing input signals, but all eight inputs on that strip will require the same type of signal. Each input is optically isolated and can be powered from an external DC power source or the auxiliary power terminals located between the two input strips.

Many different types of devices can be used to drive the inputs. Typical devices used include: mechanical switches, relay contacts, DC 3 wire sensors, solid state DC output modules, and PLC DC outputs. Two wire DC sensors can also be used, but it may be necessary to connect a load resistor in parallel with the input.

The wiring diagrams to the right show how to wire inputs for sinking and sourcing devices. Notice that the "C" (common) terminal is connected to +VDC for sinking input devices, or to -VDC for sourcing input devices. Since each terminal strip has its own common, it is possible to wire the first eight inputs for one type of signal while the second eight are wired for the other. For example, assume a PLC with sourcing outputs is going to control the Program Select inputs, and photo eyes with sinking outputs are going to control the Group Enable inputs. Connect the "C" terminal on the top input strip to -VDC (sourcing) and connect the "C" terminal on the bottom input strip to +VDC (sinking).

Input Function Descriptions

Program Select (1-6) - The on/off status of the six program select inputs determines which program is controlling the outputs. Binary, BCD, or Gray Code can be selected as the program select format. When all program select inputs are off the program number selected in FCN 3 will become active. See page 3-13.

Master Enable (7) - All programming functions can be accessed when this input is on. To avoid inadvertent program changes, do NOT leave this input energized when the machine is in production.

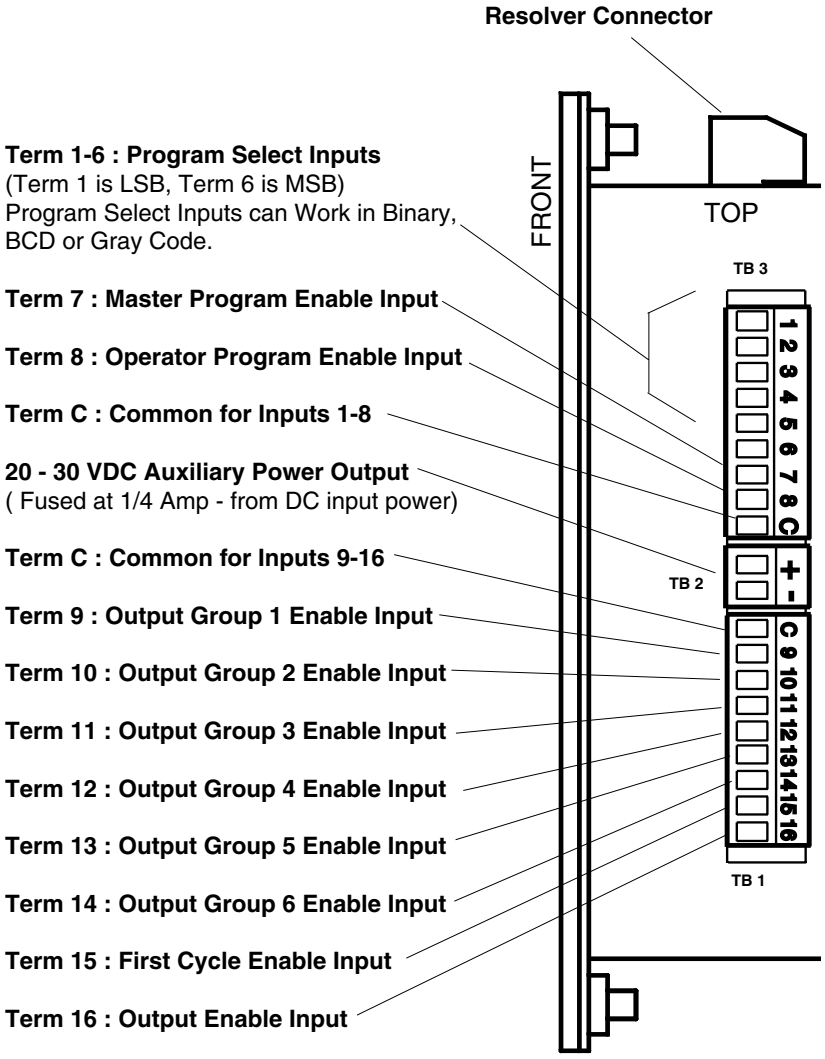
Operator Enable (8) - Operator level programming is enabled when this input is on (function 106 determines which outputs and items operators have access to).

Group Enable (9-14) - These inputs work in conjunction with the corresponding output group numbers (1-6) to re-zero position and/or enable the outputs within that group. Typically photo eyes and other sensors will operate these inputs. See FCN 108 and 109 programming on pages 6-8 & 6-9, and the Appendix for details.

First Cycle Enable (15) - Mode 5 only uses this input to allow the 1st machine cycle to operate the corresponding outputs (see page 6-9 and the Appendix for details).

Output Enable (16) - Any one or combination of the 25 outputs (except analog) can be ANDed with this input by programming FCN 110. Outputs that are ANDed will only operate when this input is on. This can be used in conjunction with Motion ANDing and output modes.

Left Side View
Terminal Identification



Input Wiring Information

The Auxiliary DC Power Output can be used to power the inputs, or an external supply can be used. Each input draws approximately 11 mA @ 24 VDC.

Each input terminal block can be wired for sinking or sourcing signals as follows:

Sinking - Connect positive side of power supply to the input common terminal and switch DC common to the individual input terminals.

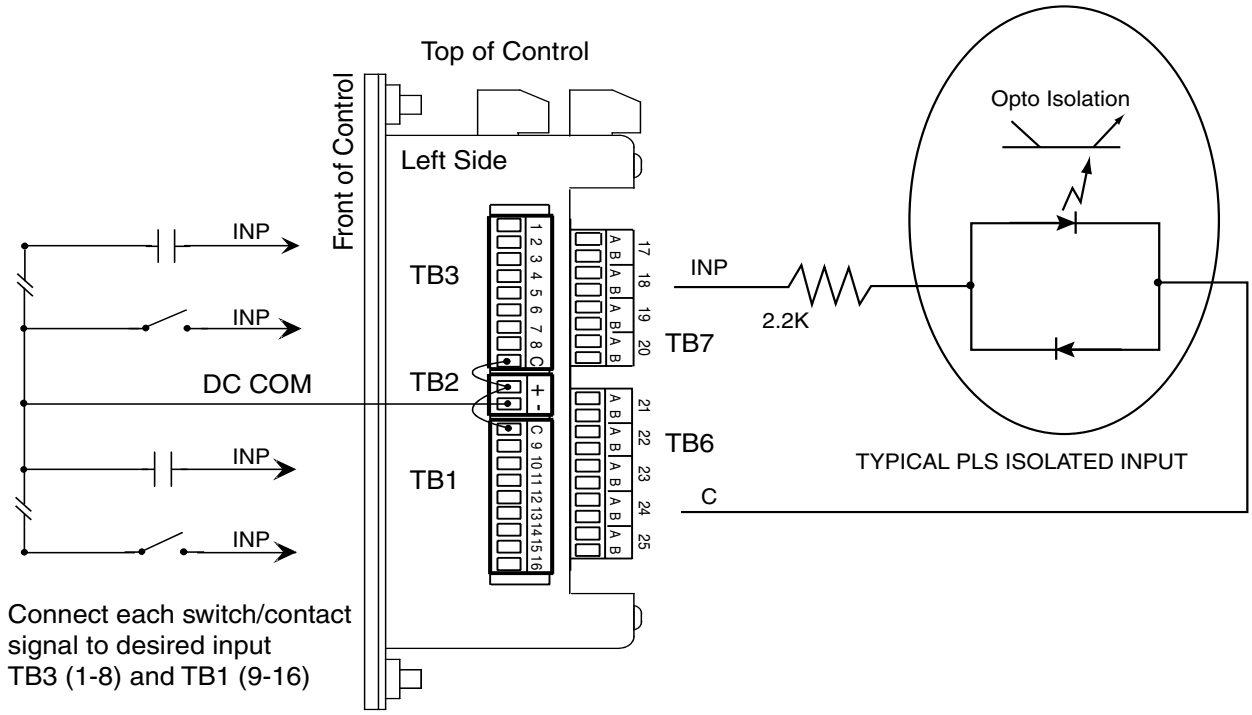
Sourcing - Connect common of power supply to the input common terminal and switch positive DC voltage to the individual input terminals.

The inputs can be operated in the voltage range of 10-30 VDC.

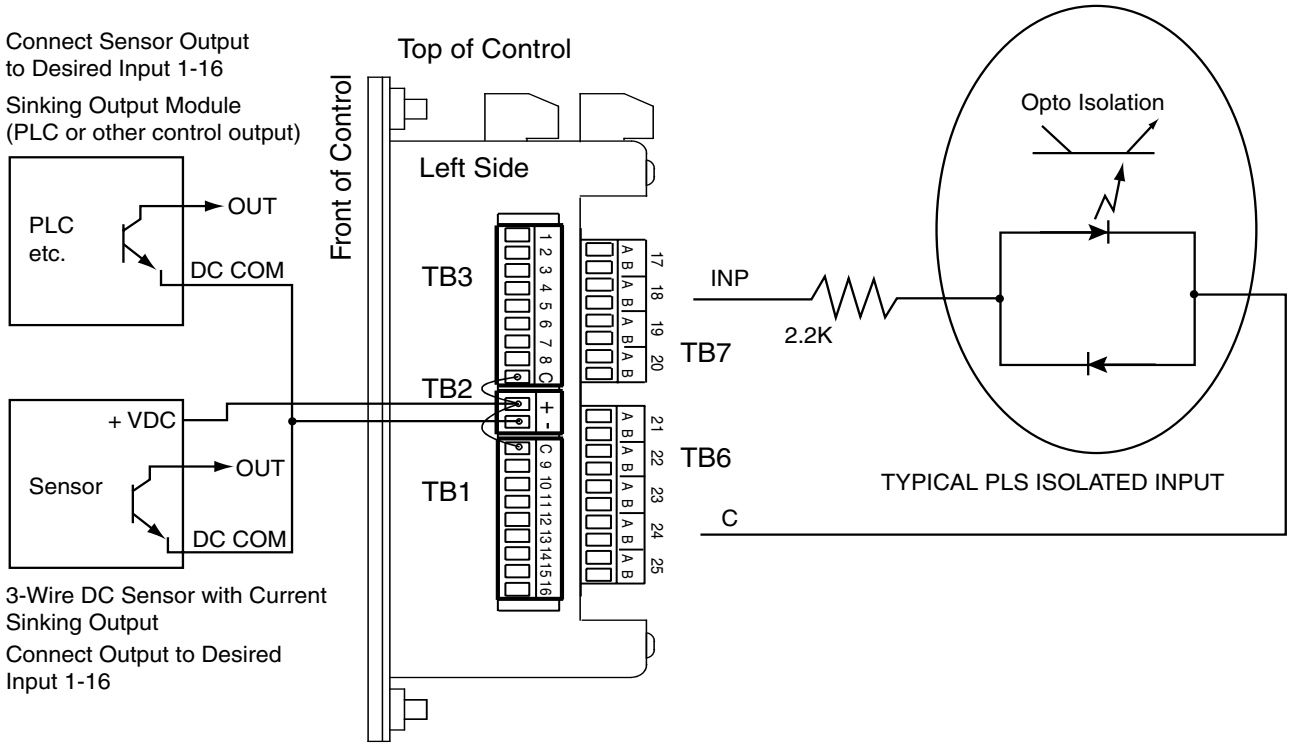
Current Sinking Input Wiring

(DC Common is Being Switched)

Mechanical Contacts
(Switches / Relays)



Solid State Devices



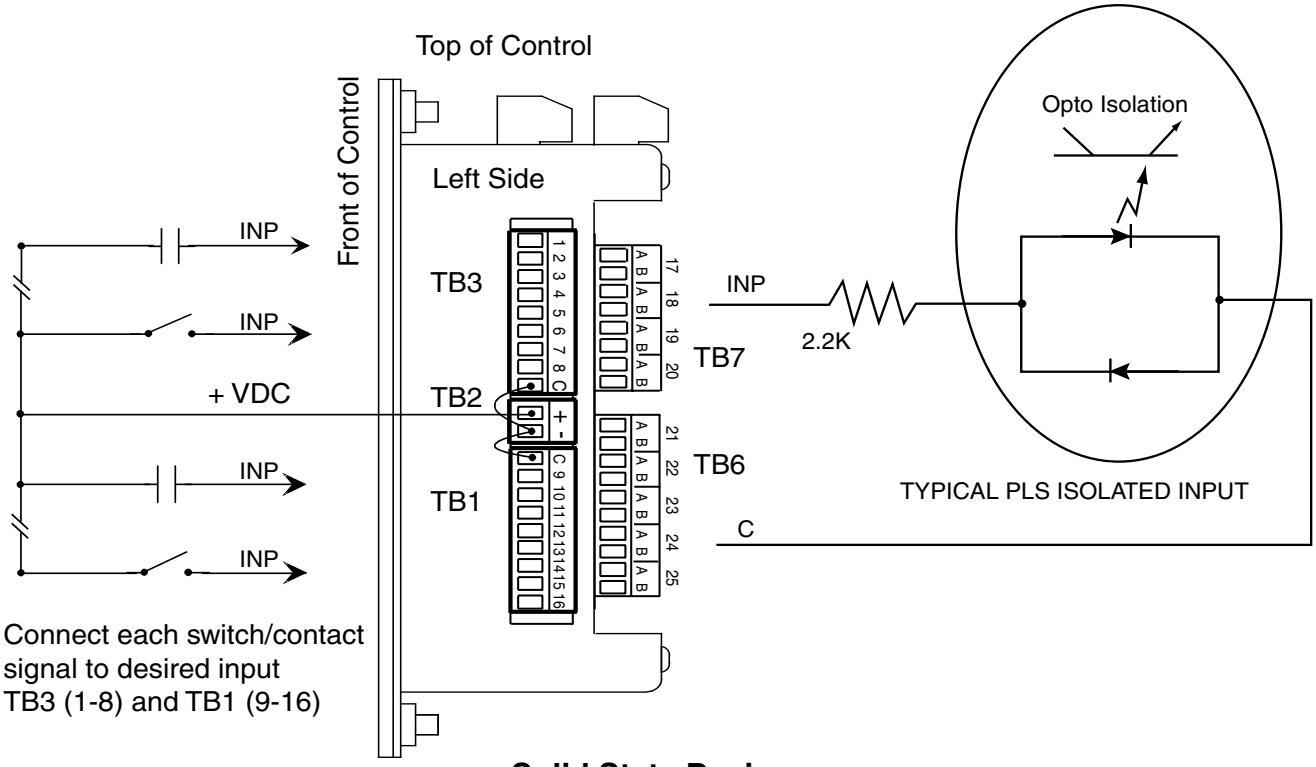
Note: An external DC power supply can be used instead of the control's Auxiliary DC power output terminals as shown. The Auxiliary DC supply is fused at 1/4 amp and will be the same voltage as the DC Input power to the controller. The inputs will operate from 10-30 VDC and draw approximately 11 mA each at 24 VDC. A combination of mechanical contacts and solid state devices can be used.

Current Sourcing Input Wiring

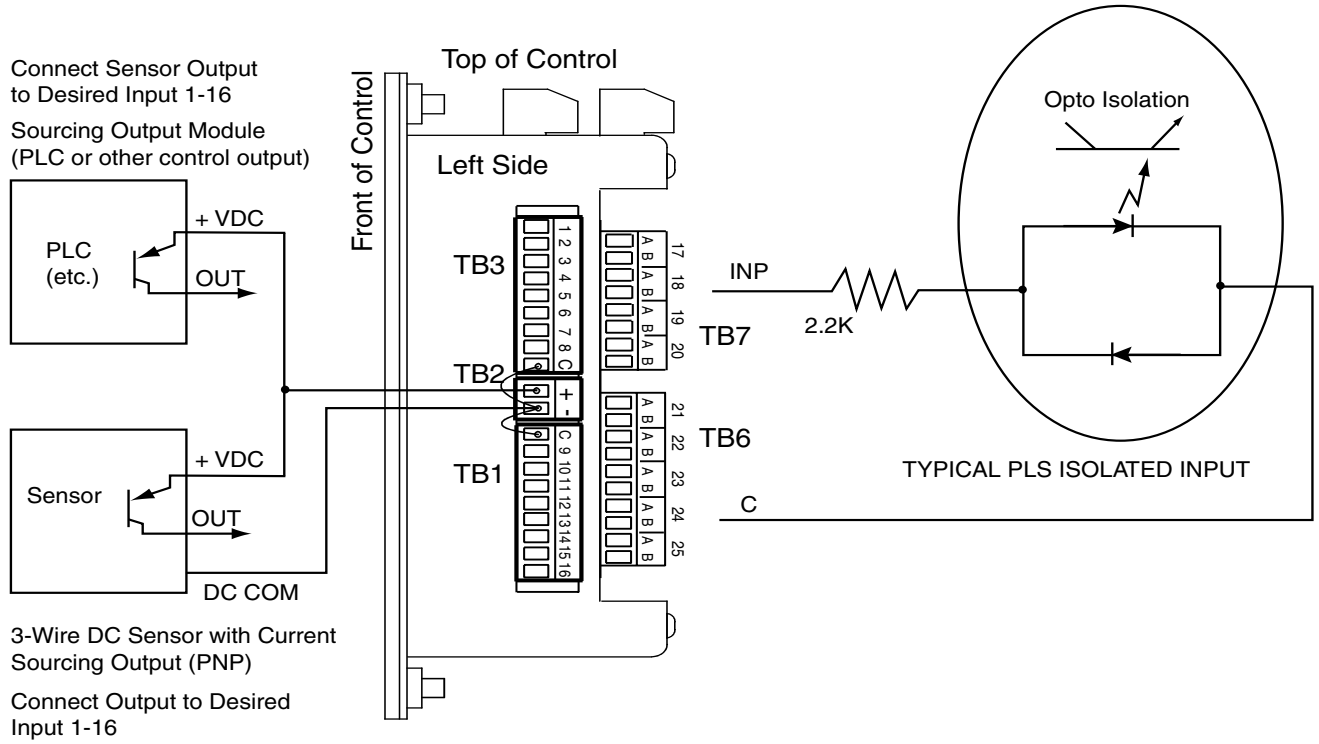
(+ VDC is Being Switched)

Mechanical Contacts

(Switches / Relays)



Solid State Devices



Note: An external DC power supply can be used instead of the control's Auxiliary DC power output terminals as shown. The Auxiliary DC supply is fused at 1/4 amp and will be the same voltage as the DC Input power to the controller. The inputs will operate from 10-30 VDC and draw approximately 11 mA each at 24 VDC. A combination of mechanical contacts and solid state devices can be used.

Program Select Information Wiring

General Program Select Information

Three formats are available for the program select inputs: BCD (Binary Coded Decimal), Binary, and Gray Code. **The desired format is chosen in FCN 101 - "PS".** Any time one or more of the program select inputs is on, the corresponding program number will become active.

The tables to the right list all of the valid input combinations for each of the formats. When all of the hardware program select inputs are off, the program number specified by Function 3 (Active Program) will become active. This allows the active program number to be selected from the keyboard when the hardware select inputs are not being used.

BCD Format

The BCD format allows standard 1 or 2 digit BCD switches to be interfaced to the program select inputs. PLCs can also output values in BCD.

The program number selected can be calculated by adding up the values associated with each of the inputs that are on. For example, if inputs 5, 3, and 1 are on, program number 15 would be active (10 + 4 + 1).

Remember, **the only valid values for the 10's digit are 0, 1, 2, or 3.** Trying to output a larger value to the 10's digit will cause the wrong program number to be selected. **9 is the largest valid value for the units digit.** A units digit combination larger than 9 will set the units digit to 9.

Binary Format

The binary format is convenient for PLC program select output signals. The program number selected can be calculated by adding up the values associated with each of the inputs that are on. For example, if inputs 5, 3, and 1 are on, program number 21 would be active (16 + 4 + 1).

Because the standard PS-5144 has 48 programs available, **a binary program select value larger than 48 selects program number 48.**

Gray Code

Electro Cam has 8 position Gray Code selector switches available as standard accessories for PS-5144 and other PLuS controls.

Because the standard PS-5144 has 48 programs available, **a Gray Code program select value larger than 48 selects program number 48.**

BCD Program Select Table

	10'S		UNITS			
Inp #:	**6**	**5**	**4**	**3**	**2**	**1**
Value:	20	10	8	4	2	1
PGM #						
FCN 3	0	0	0	0	0	0
1	0	0	0	0	0	1
2	0	0	0	0	1	0
3	0	0	0	0	1	1
4	0	0	0	1	0	0
5	0	0	0	1	0	1
6	0	0	0	1	1	0
7	0	0	0	1	1	1
8	0	0	1	0	0	0
9	0	0	1	0	0	1
10	0	1	0	0	0	0
11	0	1	0	0	0	1
12	0	1	0	0	1	0
13	0	1	0	0	1	1
14	0	1	0	1	0	0
15	0	1	0	1	0	1
16	0	1	0	1	1	0
17	0	1	0	1	1	1
18	0	1	1	0	0	0
19	0	1	1	0	0	1
20	1	0	0	0	0	0
21	1	0	0	0	0	1
22	1	0	0	0	1	0
23	1	0	0	0	1	1
24	1	0	0	1	0	0
25	1	0	0	1	0	1
26	1	0	0	1	1	0
27	1	0	0	1	1	1
28	1	0	1	0	0	0
29	1	0	1	0	0	1
30	1	1	0	0	0	0
31	1	1	0	0	0	1
32	1	1	0	0	1	0
33	1	1	0	0	1	1
34	1	1	0	1	0	0
35	1	1	0	1	0	1
36	1	1	0	1	1	0
37	1	1	0	1	1	1
38	1	1	1	0	0	0
39	1	1	1	0	0	1

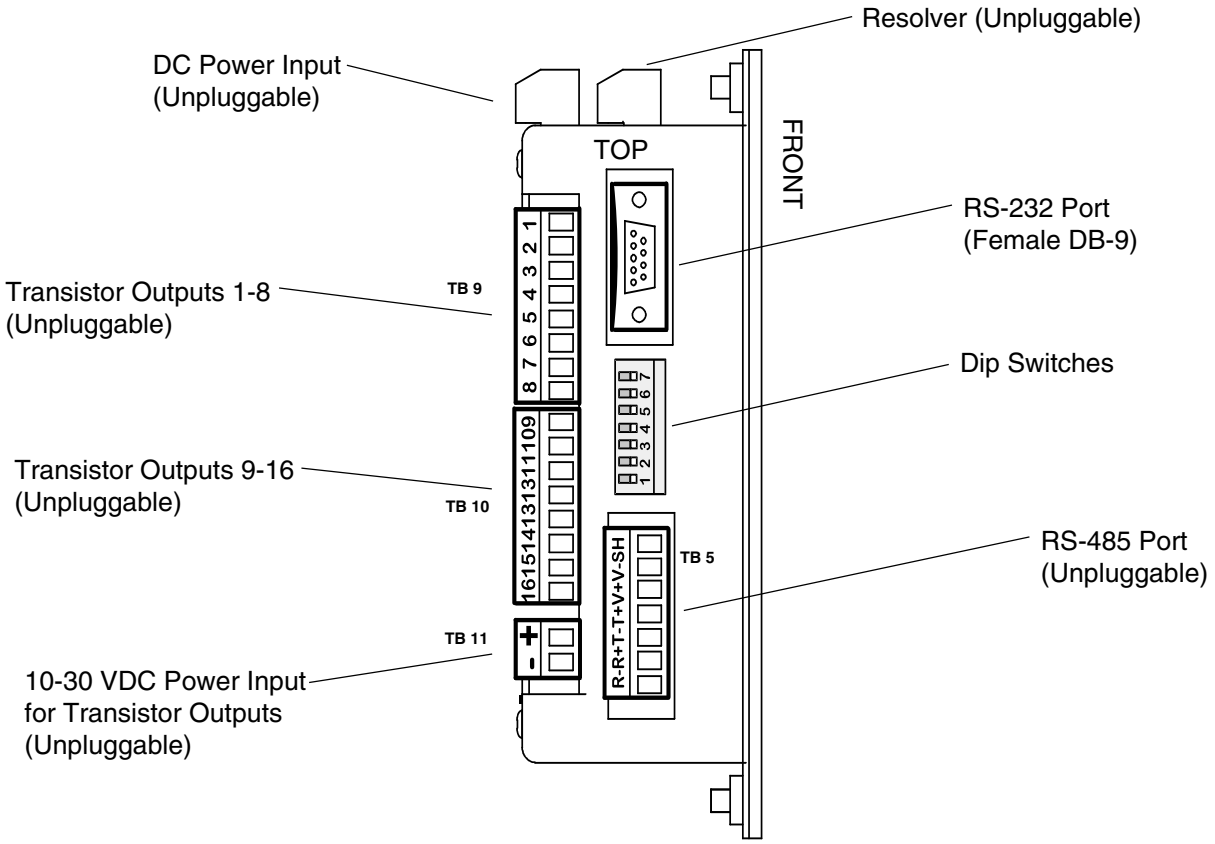
Binary Program Select Table

Inp #:	**6**	**5**	**4**	**3**	**2**	**1**
Value:	32	16	8	4	2	1
PGM #						
FCN 3	0	0	0	0	0	0
1	0	0	0	0	0	1
2	0	0	0	0	1	0
3	0	0	0	0	1	1
4	0	0	0	1	0	0
5	0	0	0	1	0	1
6	0	0	0	1	1	0
7	0	0	0	1	1	1
8	0	0	1	0	0	0
9	0	0	1	0	0	1
10	0	0	1	0	1	0
11	0	0	1	0	1	1
12	0	0	1	1	0	0
13	0	0	1	1	0	1
14	0	0	1	1	1	0
15	0	0	1	1	1	1
16	0	1	0	0	0	0
17	0	1	0	0	0	1
18	0	1	0	0	1	0
19	0	1	0	0	1	1
20	0	1	0	1	0	0
21	0	1	0	1	0	1
22	0	1	0	1	1	0
23	0	1	0	1	1	1
24	0	1	1	0	0	0
25	0	1	1	0	0	1
26	0	1	1	0	1	0
27	0	1	1	0	1	1
28	0	1	1	1	0	0
29	0	1	1	1	0	1
30	0	1	1	1	1	0
31	0	1	1	1	1	1
32	1	0	0	0	0	0
33	1	0	0	0	0	1
34	1	0	0	0	1	0
35	1	0	0	0	1	1
36	1	0	0	1	0	0
37	1	0	0	1	0	1
38	1	0	0	1	1	0
39	1	0	0	1	1	1
40	1	0	1	0	0	0
41	1	0	1	0	0	1
42	1	0	1	0	1	0
43	1	0	1	0	1	1
44	1	0	1	1	0	0
45	1	0	1	1	0	1
46	1	0	1	1	1	0
47	1	0	1	1	1	1
48	1	1	0	0	0	0

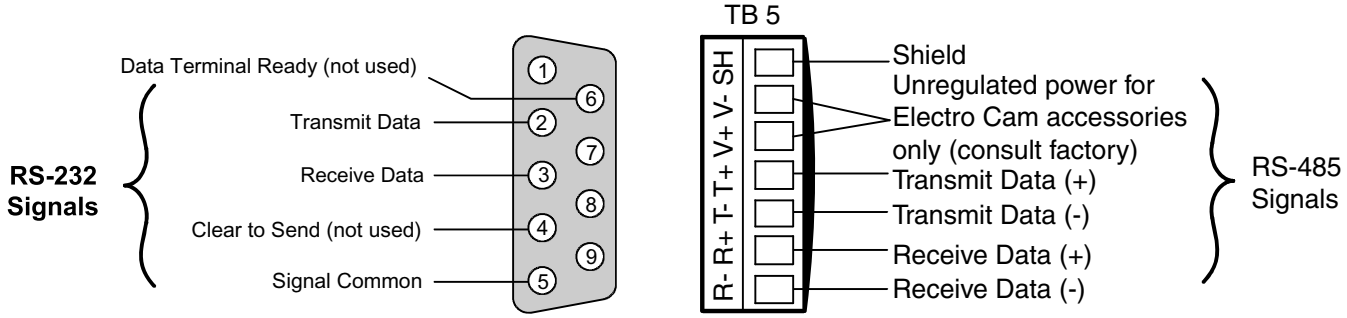
Gray Code Program Select Table

Inp #:	**6**	**5**	**4**	**3**	**2**	**1**
	MSB					LSB
PGM #						
FCN 3	0	0	0	0	0	0
1	0	0	0	0	0	1
2	0	0	0	0	1	1
3	0	0	0	0	1	0
4	0	0	0	1	1	0
5	0	0	0	1	1	1
6	0	0	0	1	0	1
7	0	0	0	1	0	0
8	0	0	1	1	0	0
9	0	0	1	1	0	1
10	0	0	1	1	1	1
11	0	0	1	1	1	0
12	0	0	1	0	1	0
13	0	0	1	0	1	1
14	0	0	1	0	0	1
15	0	0	1	0	0	0
16	0	1	1	0	0	0
17	0	1	1	0	0	1
18	0	1	1	0	1	1
19	0	1	1	0	1	0
20	0	1	1	1	1	0
21	0	1	1	1	1	1
22	0	1	1	1	0	1
23	0	1	1	1	0	0
24	0	1	0	1	0	0
25	0	1	0	1	0	1
26	0	1	0	1	1	1
27	0	1	0	1	1	0
28	0	1	0	0	1	0
29	0	1	0	0	1	1
30	0	1	0	0	0	1
31	0	1	0	0	0	0
32	1	1	0	0	0	0
33	1	1	0	0	0	1
34	1	1	0	0	1	1
35	1	1	0	0	1	0
36	1	1	0	1	1	0
37	1	1	0	1	1	1
38	1	1	0	1	0	1
39	1	1	0	1	0	0
40	1	1	1	1	0	0
41	1	1	1	1	0	1
42	1	1	1	1	1	1
43	1	1	1	1	1	0
44	1	1	1	0	1	0
45	1	1	1	0	1	1
46	1	1	1	0	0	1
47	1	1	1	0	0	0
48	1	0	1	0	0	0

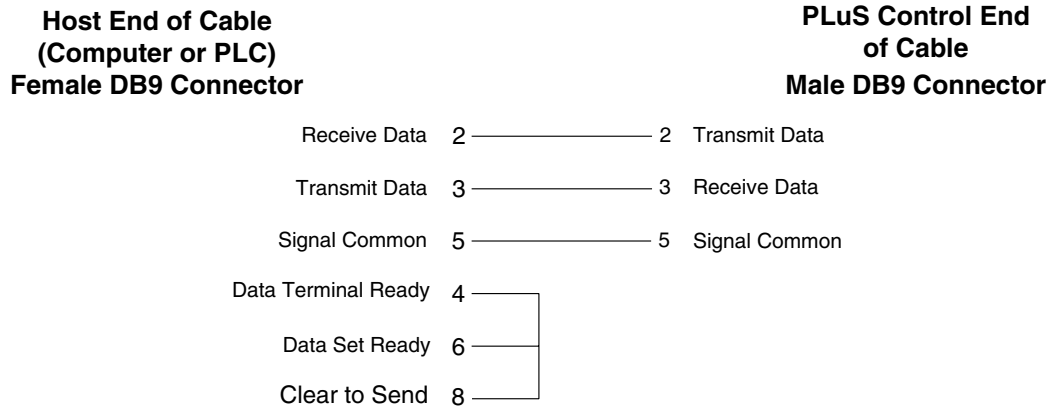
Right Side View



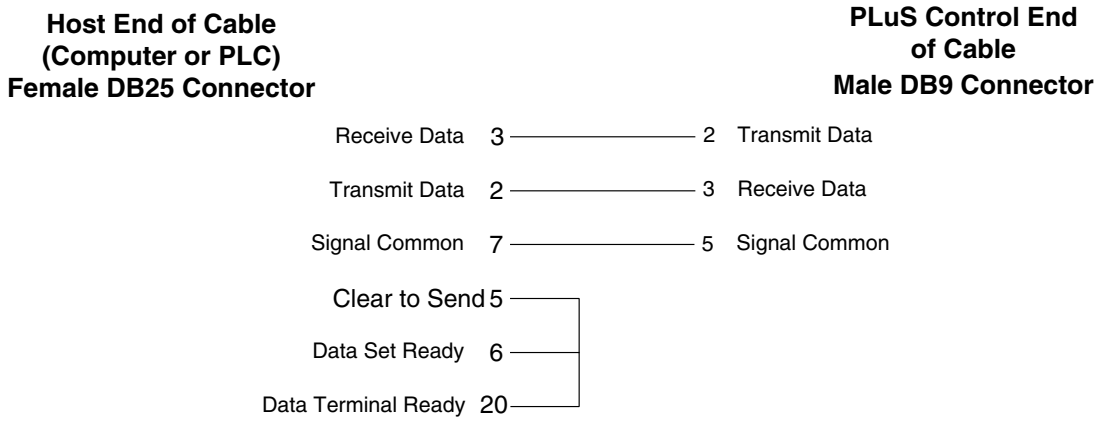
Communication Pins / Terminals



RS-232 Cable Wiring for Host with DB9 Connector

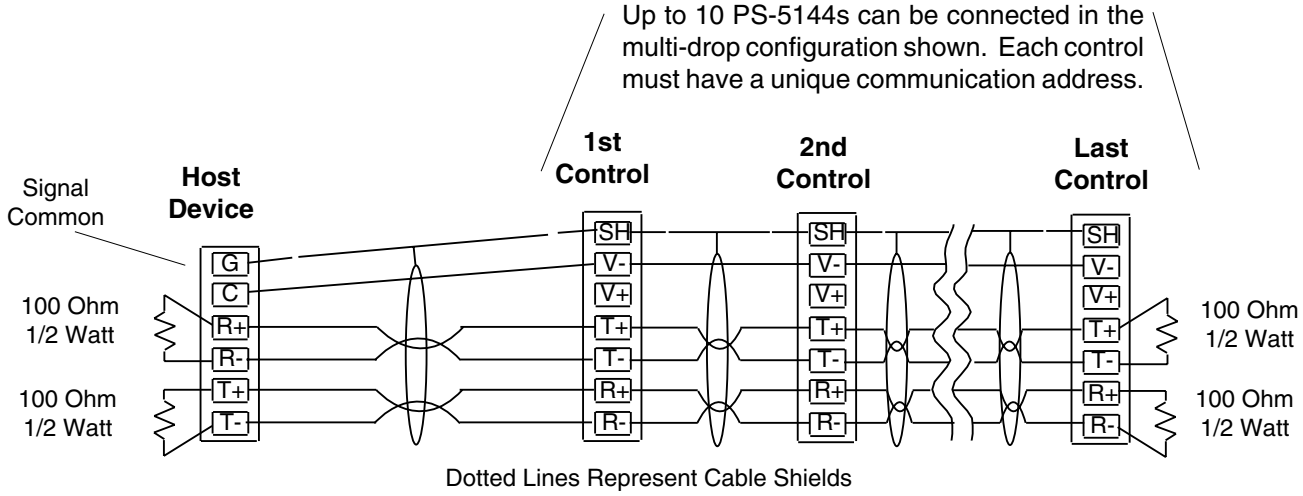


RS-232 Cable Wiring for Host with DB25 Connector



Note: RS-485 must be used for "Multi-Drop" communication (more than one controller connected simultaneously). RS-232 can only be connected to one control at a time.

PS-5144 RS-485 Communication Wiring



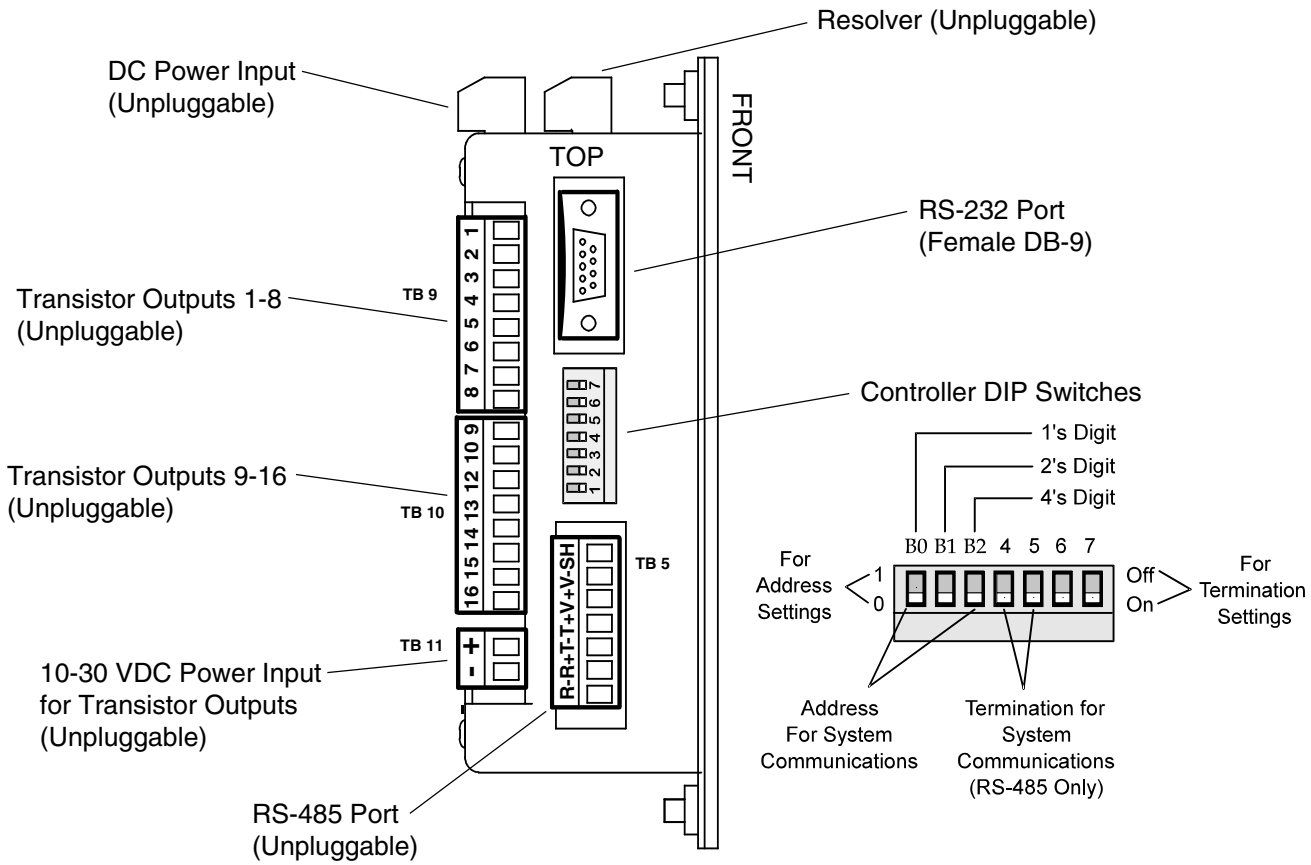
Dotted Lines Represent Cable Shields

Notes: Terminating resistors are recommended at both ends of the communication network (may be built into host device). Only connect shields at one end of each cable to avoid ground loops. If only one control is being connected to the host device, wire with terminating resistors as illustrated for the last control.

Controllers Equipped With Dip Switches

Pages 3-16 and 3-17 contain information that applies to all controllers equipped with DIP switches (shipped approximately 6/17/96 or later). The DIP switches allow for termination of RS-485 communications and system communications address selection.

Controller - Right Side View



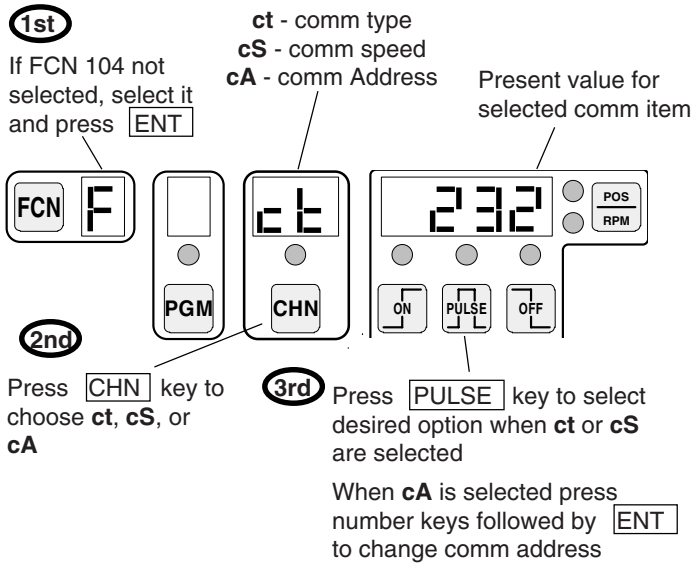
FCN 104: Communication Parameters

(Master Programming MUST be Enabled)

ct - communication type: Specifies which communication port is being used by the PLuS control. It contains both an RS-232 and an RS-485 port. The type of port being used on the PLuS must match the type of port being used by the device communicating with the PLuS.

cS - communication Speed: Specifies the baud rate (bits per second) that the PLuS communication port will operate at. It must be set for the same baud rate as the device communicating with the PLuS control. The choices are: 4800, 9600, 19200, and 38400 baud.

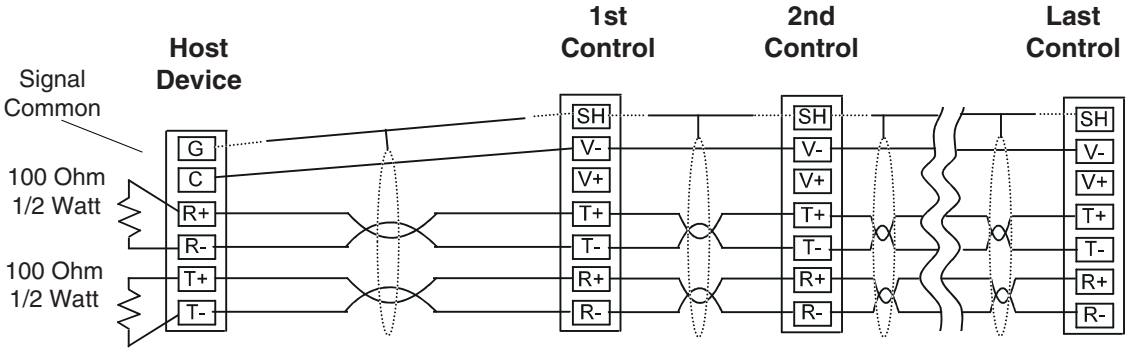
cA - communication Address: Each control can have a unique communication address (0-255) because multiple controls can be wired to the same host device in an RS-485 network. This allows the host to send information to a specific control while the other controls will ignore the information. A PLuS control will ignore incoming information if the address that information specifies does not match the communication address of the control. *The controller DIP switch must be set to zero for the programmed communications parameters to take affect.*



Comm Item	Choices
ct (port type)	RS-232, RS-485
cS (baud)	4800, 9600, 19200, 38400
cA (comm add)	0-255

PS-5144 RS-485 Communication Wiring

Up to 10 PS-5144s can be connected in the multi-drop configuration shown. Each control must have a unique communication address.



Controller DIP switches 4 and 5 are used to establish termination on the control end. See Controller - Right Side View illustration on page 3-16.

Dotted Lines Represent Cable Shields

Terminating resistors are recommended on the host end (may be built-in) of the communication network to establish termination. Only connect shields at one end of each cable to avoid ground loops.

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Initial Programming Overview
There are several basic programming steps that need to be done initially. These steps are necessary for controls that are installed on machines, and to a lesser extent apply to controls that are being tested "on the bench". Initial programming of the following items, in the order they are presented, will avoid problems later.

If you are not already familiar with PLuS control programming, it is recommended that pages 4-2 and 4-3 (Programming Introduction) of this manual be reviewed before proceeding. If you simply want to see outputs operate "on the bench", connect DC input power, connect the resolver, plug in some output modules, and go to Step 8 on the next page.

Note: Flashing error messages will be displayed in response to programming errors and hardware problems. Pages 7-2 and 7-3 list all of the flashing error messages used by the PS-5144 controller and what corrective action should be taken when they occur.

Step 1 - Direction of Rotation
FCN 101 "dr" allows the control to be set for Clockwise (CL) or Counter Clockwise (CCL) rotation of the resolver (as viewed from front of resolver). In most applications it is desirable to have the position value increasing as the machine moves in a forward direction. The factory set choice is Counter Clockwise.

If the resolver is installed, simply monitor position (press POS/RPM key until POS LED on) and move the machine in the forward direction. If the position value increases, a programming change is NOT needed. If the value decreases, go into FCN 101 "dr" and select the opposite direction of rotation (see page 6-1).

Note: If an Electro Cam resolver is not being used, it may be necessary to program the resolver type chosen (FCN 101 "rt"). See page 6-3 for details.

Step 2 - Scale Factor
The Scale Factor (FCN 101 "SF") is the number of position increments per resolver revolution. For most applications it is desirable to program and monitor position in degrees, so a Scale Factor of 360 is used (360 is the factory set value). Sometimes greater position accuracy is needed, so a larger Scale Factor is used. Page 6-1 details and illustrates how to program the Scale Factor.

Step 3 - Shaft Position
The PS-5144 stores and tracks the actual machine position and calls it "Shaft Position". Once correctly set, the Shaft Position will always represent the actual position of the machine when running or stopped. To set Shaft Position, stop the machine in a known position and set FCN 101 "SP" equal to that position value. Shaft Position will serve as the position reference for FCN 6 offset values programmed later. Page 6-2 illustrates how to program Shaft Position.

Step 4 - Number of Analog Outputs
If analog outputs are going to be used, the number desired (0, 1, or 2) should be specified now in FCN 101 "nA". It is not necessary to establish the analog offset(s) and full scale RPM values at this point, just the number of analog outputs needed. If no analog outputs are needed, insure that "nA" is set to 0 (0 is the factory setting). Page 6-2 illustrates how to program the Number of Analog Outputs.

Step 5 - Number of Output Groups
The PS-5144 can be subdivided into as many as six different groups of outputs. Each group can have a unique phase relationship to the machine and can interact with an input signal in operating Modes 1-5. If you are sure that your application will not use output grouping or modes, verify that FCN 108 is set for only 1 group of outputs (page 6-8) and that FCN 109 is set for Mode 0 (page 6-9), both factory settings. This will configure the control to perform standard cam output logic on all outputs, all outputs will be in phase with each other. Go to step 7 if output grouping and modes will not be used for your machine application.

If output grouping will be used, the next programming step is to establish the number of groups and the number of outputs in each of these groups. This is done by programming FCN 108 accordingly, which is illustrated on page 6-8. Also, detailed information on output grouping can be found on page A-2. When FCN 108 programming is complete, go on to step 6 below.

Step 6 - Modes of Operation for Output Groups
Each of the output groups established in step 5 above can be programmed to operate in any one of the six modes available (Modes 0-5). Mode selection programming is done using FCN 109, page 6-9. Additional information, which details the operation of each mode, is located in the Appendix. If you are not already familiar with the logic and programming of these modes, you should review these pages so your application can most effectively utilize the output logic that modes offer.

Step 7 - Offsetting Position(s)
Output group position(s) can be offset from the "Shaft Position" by programming either FCN 2 or FCN 6. Any output group(s) that are operating in Mode 1 or 2 will require FCN 6 to be set as a preset value. Output groups that are in modes 0, 3, 4, or 5 can be offset by programming FCN 2 equal to their desired position(s) when the machine is stopped, or by programming an amount of offset advance from "Shaft Position" using FCN 6. In these non-resetting modes, FCN 2 and FCN 6 will interact with each other - changing one will affect the value programmed in the other. Programming information for FCN 2 and FCN 6 are on pages 5-3 and 5-7, respectively.

In applications where all of the output groups have the same position relationship to the machine, setting the "Number of Group Offsets" to one will simplify programming and operation. FCN 101 "nO" (number of offsets) sets the number of group offsets as shown on page 6-2.

Initial Programming - Function Summary

Step 8 - Program Output On/Off Setpoints
At this point, the only essential programming step remaining is output setpoints. Determine the position values where each output should cycle "on" and "off" and program those values accordingly. If multiple programs (job recipes) are going to be used, pay attention to which program number the output setpoints are being programmed into. Information on programming output setpoints is located on page 4-4.

When all of the output setpoint programming is complete, the control system can be tested. The outputs should cycle on and off at the programmed position locations as the resolver turns through the cycle. If modes 2, 3, 4, or 5 are being used, outputs will be disabled unless the corresponding input conditions are met. Input windows must also be programmed for Modes 2, 4, and 5. Review page 6-9 and the Modes information in the Appendix if the input/window requirements are not clear at this time.

Step 9 - Take Advantage of All Features Available
The programming steps to this point have included only those steps that were necessary to get the machine basically running. There are many other control features that may be very beneficial to your application. For example, Speed Compensation (FCN 4), Timed Outputs (FCN 5) or Motion ANDing (FCN 107) may be appropriate for this application.

It will be necessary to review each controller function to determine which features should be utilized. Below is a summary of all of the PS-5144 functions. **"Operation Functions"** can be made accessible to operators and are programmed/adjusted periodically as needed. **"Configuration Functions"** are normally programmed during the initial setup and then left alone after they are set to best match the control's features to the application requirements.

Operation Functions

FCN 0: Program Enable Code (Programming Access)

FCN 1: Motion Detection
- Lo - Low RPM Value for Speed Range
- Hi - High RPM Value for Speed Range
- Ao - Analog Offset
- AH - Analog High RPM Value

FCN 2: Offset (Position)

FCN 3: Active Program

FCN 4: Speed Compensation

FCN 5: Timed Outputs

FCN 6: Absolute Offset

FCN 7: Program Copy
- SP - Source Program
- dP - Destination Program

FCN 8: Pulse Generation
- Pn - Program Number
- CH - Channel Number
- on - Start Position of Pulse Train
- oF - End Position of Pulse Train
- ct - Count (number of pulses)
- du - On Duration of Each Pulse

Configuration Functions

FCN 101: Unit Configuration #1
- dr - Direction of Rotation
- SF - Scale Factor
- SP - Shaft Position
- nA - Number of Analog Outputs
- nO - Number of Group Offsets
- rt - Resolver Type
- PS - Program Select Format (Input)

FCN 102: Unit Configuration #2
- Sc - Speed Compensation Type
- tb - Time Base
- gL - Gray Code Logic Type

FCN 103: Display Configuration
- dd - Display Default
- tr - Toggle RPM
- ru - RPM Update (Rate)

FCN 104: Communication Parameters
- ct - Communication type
- cS - Communication Speed
- cA - Communication Address

FCN 105: Setup and Operator Enable Codes
- SE - Setup Enable Code
- OE - Operator Enable Code

FCN 106: Operator Functions and Outputs
- SP - Setpoints (Outputs)
- Sd - Speed Detection (FCN 1)
- oF - Offset (FCN 2)
- AP - Active Program (FCN 3)
- Sc - Speed Compensation (FCN 4)
- to - Timed Outputs (FCN 5)

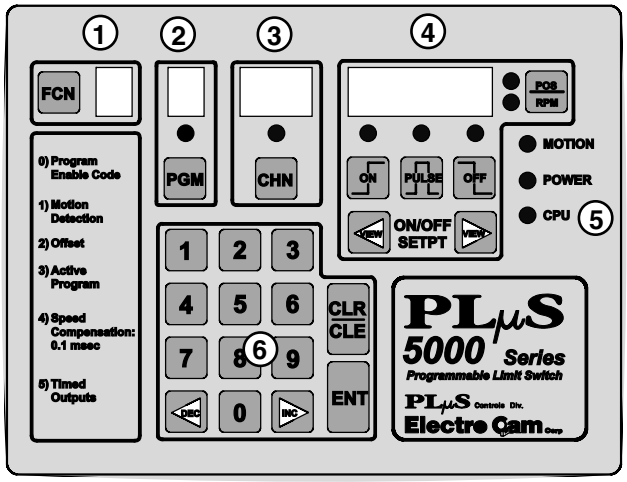
FCN 107: Motion ANDing

FCN 108: Subdividing Outputs into Groups

FCN 109: Output Enable Modes

FCN 110: Outputs ANDed with Enable Input

FCN 111: Channel Setpoint Memory (monitor)



①- Function Key and Display

The **FCN Key** is used to access the control's functions. An "F" will be displayed during function programming. During normal operation, when Position or RPM are indicated, a "P" will be displayed as the first letter of the abbreviation "Pn" which represents program number.

②- Program Key, LED and Display

The **PGM key** is ONLY used to view or edit inactive programs. During normal operation, when Position or RPM are indicated, an "n" will be displayed as the second letter of the abbreviation "Pn" which represents program number. **When "Pn" is displayed, the number shown in the CHN display is the current active program.** When an inactive program is selected for viewing/editing, a "-" (dash) will be shown in the PGM display.

③- Channel Key, LED and Display

The **CHN key** allows the desired output channel to be selected for setpoint viewing/programming. The selected channel number is shown in the display directly above the CHN key (decimal points will be lit if channel has more than 1 pulse). When the CHN LED is lit, the channel currently selected is in the ON state. During normal operation, when Position or RPM are indicated, the current active program number will be shown in CHN display following the "Pn" abbreviation. The CHN key is also used to select channel numbers during Function programming. Details are given in the programming sections.

④- Value Display, Position/RPM Key and LEDs, ON Key and LED, PULSE Key and LED, OFF Key and LED, and View Keys

The **POS/RPM key** selects between Position and RPM being shown in the value display immediately to the left of the key. The corresponding POS or RPM LED will be lit when either item is displayed. **Pressing the POS/RPM key allows programming functions to be exited/aborted and returns the control to displaying Position or RPM.**

The **ON** and **OFF keys** are ONLY used to specify the ON and OFF pulse edges during setpoint creation (not adjustment). The corresponding ON and OFF LEDs will be lit during these setpoint programming operations. (The ON and OFF keys and LEDs are also used when programming the optional leading and trailing edge speed compensation feature).

The **VIEW keys** allow the current "on" and "off" setpoints of the currently selected channel to be displayed in sequence, one at a time (for monitoring and/or **adjustment**). The corresponding ON or OFF LED will be lit to indicate whether an ON or OFF edge is currently displayed. The >VIEW key displays the setpoints in increasing numeric order, the <VIEW key displays them in decreasing numeric order.

The **PULSE key** allows setpoint pairs (pulses) to be incremented and decremented simultaneously. When the PULSE LED is lit steady, the pulse (both edges) whose edge is currently displayed will increment and decrement when the INC and DEC keys are pressed. Pressing the PULSE key a second time will cause the LED to blink. This indicates that the multi-pulse mode is activated and all of the pulses in the currently selected output channel will increment and decrement when the INC and DEC keys are pressed.

⑤- MOTION, POWER and CPU LEDs

The **Motion LED** is lit whenever the machine speed is within the current "Motion Level 1" setpoints (FCN 1).

The **Power LED** is lit whenever the control is powered up.

The **CPU LED** only lights when a Fatal error condition is detected by the controller. Power cycle the control to clear the error condition. Call Electro Cam if the error condition reoccurs.

⑥- Numeric, CLR/CLE, ENT, INC and DEC Keys

The **number keys** are used to input all numeric values needed during setpoint and function programming.

The **CLR/CLE key** is used to clear numeric values during programming operations.

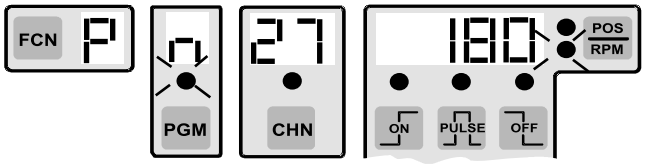
The **ENT key** is used to enter numeric values into the controller after they have been keyed in. Failing to press ENT when programming numeric values will result in the old value remaining in the controls memory. Numeric value changes must be "Entered" by pressing the ENT key before they are accepted by the controller.

The **INC and DEC keys** cause numeric values that are displayed in the controls POS display to be incremented and/or decremented each time the corresponding key is pressed. Output setpoints, speed compensation and timed output values are examples of items that can be incremented and decremented using the INC and DEC keys.

Examples of Common Displays

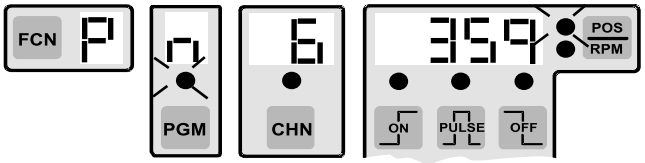
RPM Display

The display to the right shows that the current active program number is 27 and the current RPM is 180. The RPM LED is lit to indicate that the number shown is the RPM value.



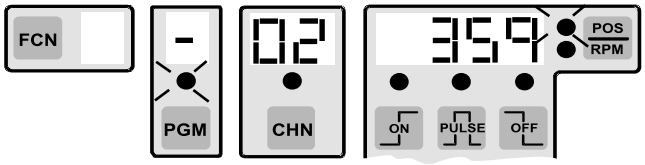
Position Display (1 Offset)

The display to the right shows that the current active program number is 6 and the current Position is 359. The POS LED is lit to indicate that the number shown is the Position value.



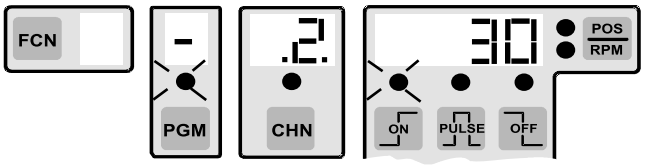
Position Display (Multiple Offsets)

The display to the right shows that the current Position of Output Group 2 is 359. The POS LED is lit to indicate that the number shown is the position value. When there is more than one offset value possible, the controller will step through each Output Group's position as the POS/RPM key is pressed before returning to the RPM display.



Output Setpoint Monitoring/Programming Display

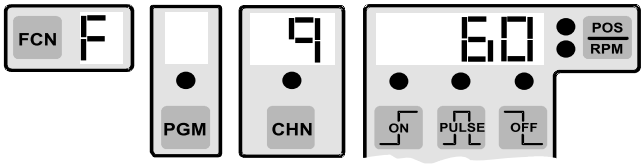
The display to the right shows that output 2 is programmed to turn on at 30. The decimal points in the channel display indicate that output 2 presently has more than one pulse programmed in it. When the decimal points are not on, the corresponding output does NOT contain multiple pulses. While the output setpoints are displayed, the CHN LED will be on when the corresponding output is on.



Function Programming Display

The display to the right shows that Function programming is being accessed ("F" in FCN display). The information shown in the other displays will vary according to the specific function being programmed.

Press the POS/RPM key to exit or abort function programming and return to a Position or RPM display mode.



Levels of Programming Access

The 5000 Series of controls have three levels of programming access. This protects the programmed contents in the controls by allowing personnel with different degrees of program responsibility to access those features they need to adjust, while restricting them from others. Entry into these levels of programming is accomplished through dedicated hardware inputs and/or programmable enable codes entered through the keyboard. Brief descriptions of these programming access levels are as follows:

Master Level - Accesses all programmable features. In addition to all control related setpoints and functions, the "Master" level allows the keyboard entry codes for the "Setup" and "Operator" access levels to be established/ changed. Master level programming also establishes which Functions and outputs are accessible to the operator (FCN 106).

Setup Level - Accesses all output setpoints and the Functions listed on the keyboard front panel. These are control aspects that may need occasional adjustment, but go beyond normal "Operator" responsibilities.

Operator Level - Accesses the Functions and output numbers, including setpoint programming, specified by "Master" level programming (see FCN 106 for details). Any combination of the "Setup Level" functions and output numbers can be made available to operators.

The table below details which functions and set points can be changed at the 3 levels of programming access. It also indicates if the programming access levels can be accessed by hardware input and/or keyboard enable code.

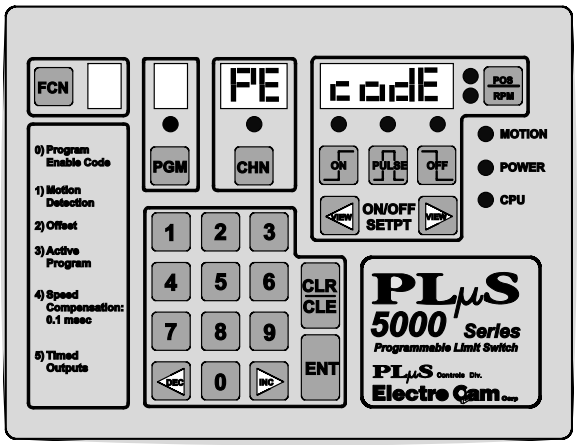
FEATURE	MASTER	SET UP	OPERATOR
Enable Method	hardware	code	hardware / code
Output Set Points	All Outputs	All Outputs	FCN 106
Output Time Out Values	All Outputs	All Outputs	FCN 106
Motion Set Points	Yes	Yes	FCN 106
Analog Setup	Yes	Yes	FCN 106
Offset	Yes	Yes	FCN 106
Active Program	Yes	Yes	FCN 106
Speed Compensation	Yes	Yes	FCN 106
FCN 106 (oper. access)	Yes	No	No
Direction of Rotation	Yes	No	No
Scale Factor	Yes	No	No
Shaft Position	Yes	No	No
Number of Analog Outs	Yes	No	No
Number of Offsets	Yes	No	No
Resolver Type	Yes	No	No
Program Select Format	Yes	No	No
Display Mode	Yes	No	No
Program Enable Codes	Yes	No	No
Motion ANDed Outputs	Yes	No	No
Output Grouping/Modes	Yes	No	No
Output Enable ANDing	Yes	No	No
Communication Setup	Yes	No	No

Hardware Program Enable Inputs

Master Programming is enabled when terminal 7 on the input terminal strip (located on left side of controller) is energized. The Master level can only be accessed by energizing this input. Operator programming is enabled when terminal 8 is energized. The Operator level can also be accessed through a keyboard enable code.

Keyboard Enable Codes for Setup and Operator Access

(See FCN 105 on page 6-6 to enter the setup and operator enable code numbers)



Either the Setup or Operator programming levels can be accessed by entering the corresponding program enable code through the keyboard. These codes can be 1, 2, 3, or 4 digit numbers and are established during Master level programming. See page 5-1.

To Enter a program enable code number press:

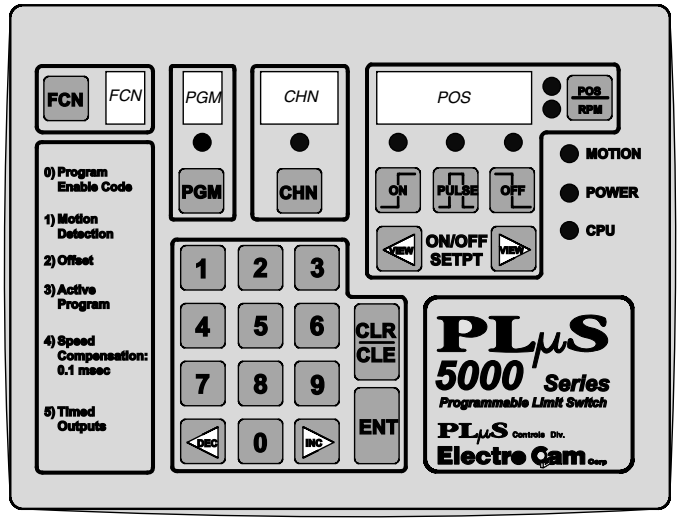
FCN | 0 | ENT | 1st digit | 2nd digit | 3rd digit | 4th digit | ENT

The PE codE message will disappear when a valid enable code is entered. The level of access gained depends upon which code number is entered.

Programming access will time-out approximately 5 minutes after the last keystroke. To cancel access before the 5 minute time-out press:

FCN | 0 | ENT | CLR/CLE | ENT

Output Setpoint Programming



Programming Error Messages

Flashing error messages indicate programming mistakes as they occur. See itemized list below.

Simply press **CLR** to cancel flashing error message.

Programming Error Messages

E1 OLAP: Output pulse just created/adjusted overlapped an existing output pulse in the same channel.
E2 -run: Attempted programming can NOT be done while ma chine is running (resolver is turning).
E4 -Pro: Program enable Off when programming was attempted.
E5 8888: Value entered NOT valid for item being programmed.
E7 -dEF: More than 25 outputs allocated in FCN 108.
E9-tdE: Attempted to program too many timed outputs (4 max).
E11-ScE: Attempted to program more than 16 speed compen sated outputs.

Programming and system errors are described on pages 7-2 and 7-3.

Output Setpoint Programming

Desired output channel MUST be selected before its setpoints can be created, viewed, adjusted, or cleared.

SELECT OUTPUT CHANNEL

If POS or RPM led NOT lit press:

POS/RPM	CHN	1	6
POS or RPM led now lit	CHN and POS displays blank	1st Digit shown in CHN display	2 Digit value in CHN display

Channel 16 used as example.

VIEW SETPOINTS

View setpoints of output channel presently selected.

VIEW VIEW — ON/OFF setpoints shown in position display in increasing order with ON and OFF LEDs. 0 is shown and both LEDs off if no setpoints exist.

VIEW VIEW — ON/OFF setpoints shown in position display in decreasing order with ON and OFF LEDs. 0 is shown and both LEDs off if no setpoints exist.

Note: A maximum of 512 pulses can exist in any one program. Additional pulses beyond 512 (in one program) will not be accepted by the controller.

CREATE SETPOINTS

To create setpoints in output channel presently selected.

ON	3	0
On led lit, POS blank	1st Digit shown in POS display	2 Digits shown in POS display

On at 30 degrees used as example.

OFF	6	0	ENT
OFF led lit, POS blank	1st Digit shown in POS display	2 Digits shown in POS display	POS display blinks once to confirm setpoint entry.

Off at 60 degrees used as example.

Note: When entering multiple pulses, press **ENT** after each pulse.

CHANGE SETPOINTS

To change setpoints in output channel presently selected.

INC/DEC

INC — Displayed ON/OFF setpoint increases 1 increment each time INC key is pressed.

INC DEC — Displayed ON/OFF setpoint decreases 1 increment each time DEC key is pressed.

NUMERIC ENTRY

5	0	ENT
1st Digit shown in POS display	2 Digits shown in POS display	POS display blinks once to confirm setpoint change.

Changing setpoint to 50 degrees used as example.

PULSE MODE

To change both setpoints of a pulse simultaneously.

PULSE — Pulse led lit

INC OR DEC — ON and OFF setpoints of ALL pulses increase/decrease 1 increment each time INC/DEC key is pressed.

MULTI-PULSE MODE

To change all setpoints in the output channel simultaneously.

PULSE — Pulse led lit

PULSE — Pulse led blinking

INC OR DEC — ON and OFF setpoints of ALL pulses increase/decrease 1 increment each time INC/DEC key is pressed.

CLEAR SETPOINTS

CLEAR 1 PULSE

To clear 1 pulse (1 pair of setpoints) on selected output channel.

Use numeric entry method (shown in CHANGE SETPOINTS above) to set OFF setpoint equal to ON setpoint value. Both setpoints will be erased.

CLEAR EXISTING SETPOINTS

To clear all setpoints on selected output channel.

ON	0	OFF	0	ENT
ON Led lit, POS blanks	0 shown in POS display	OFF Led lit, POS blanks	0 shown in POS display	POS display blinks and shows 0, ON and OFF leds are off.

Program Enable and Motion Detection

FCN 0: Program Enable Code

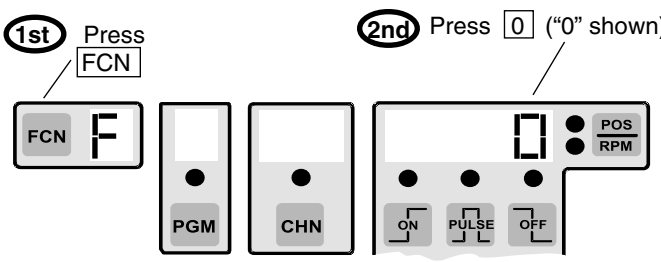
Keyboard entry of a 4 digit code number allows personnel to gain access to programming operations that would otherwise be locked out. This can be used in lieu of energizing the "Operator Program Enable Input" (key switches, toggle switches, etc).

Personnel should use the keystroke sequence shown in the illustrations to the right to enter either the "Operator" or "Set-up" enable code number.

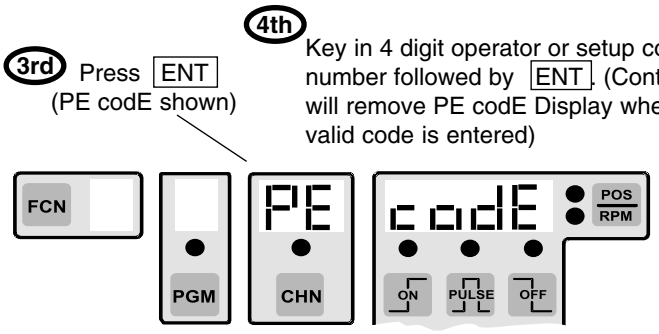
When programming operations are completed, the keystroke sequence shown at the bottom of the illustration should be entered to cancel programming access. Programming access will time-out approximately 5 minutes after the last keystroke if it is not cancelled.

Note: FCN 105 is used to create or change the enable code numbers. FCN 106 determines which programming functions and output numbers are accessible to operators.

Selecting Function 0



Programming Enable Codes



To cancel Programming Access press:

FCN | 0 | ENT | CLR | ENT

FCN 1: Motion Detection/Analog Output

(Programming MUST be Enabled)

Motion detection allows specified outputs to be disabled when the machine speed is not within a programmed range. Two motion levels (speed ranges) can be specified by programming the corresponding Lo and Hi RPM values as shown to the right. These two ranges operate completely independent of each other.

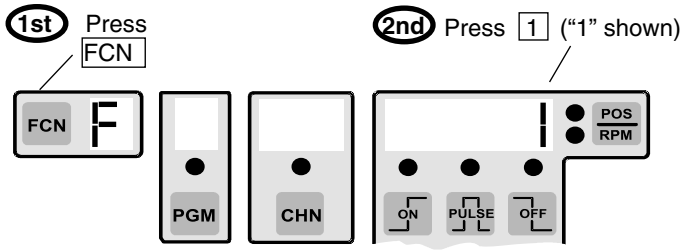
Each controller output can be ANDed with motion level 1, motion level 2, or not be ANDed with either motion level (see FCN 107). This allows individual outputs, or groups of outputs, to respond to either motion level. ANDed outputs will only be active when the machine speed is within the specified speed range. Outputs that are not ANDed will be on whenever the machine position is within their programmed on/off positions, regardless of machine speed.

This feature can be used as a motion detector to insure that specific outputs will turn off if the machine stops at an unusual position (jam or E-stop condition).

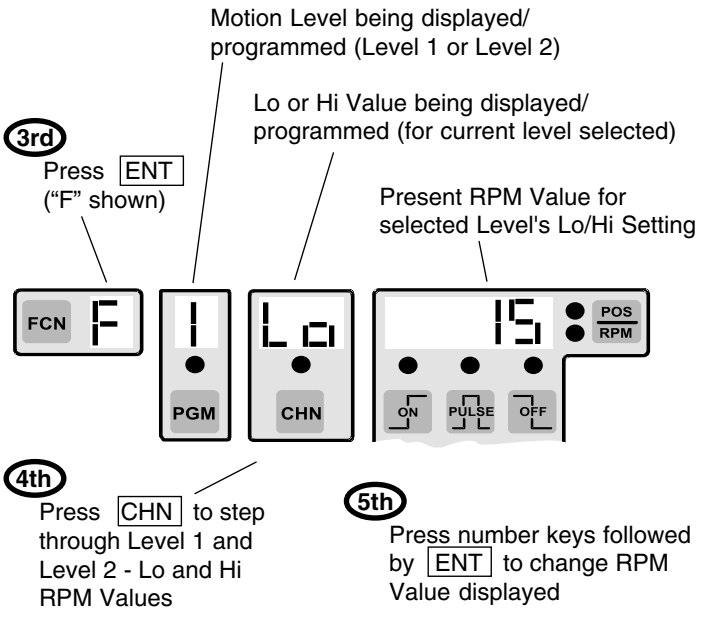
Any output channel can be turned into a hardware motion level signal by programming it to be On @ 1, Off @ 1 and then ANDing it with the desired motion level.

Note: FCN 1 also includes analog output programming (Ao and AH) if analog output(s) are being used. See next page.

Selecting Function 1



Programming Motion Detection



FCN 1: Analog Output Signal Levels

(Programming MUST be Enabled)

The PS-5144 control can be programmed to have 0, 1, or 2 analog outputs (FCN 101 - nA) . FCN 1 will handle the analog offset and analog high RPM values in accordance with how many analog outputs are selected. If 0 analog outputs are selected, no analog parameters will be shown in FCN 1 - only motion setpoints.

An analog output signal will be linearly proportional to the current resolver RPM. Two types of analog output modules are available: 0-10 VDC or 4-20 mA. The appropriate analog module must be installed in the corresponding output module position. On the X16-M09 controller the first analog channel is always module position 25, and the second is module position 24. On the M17 controller the first analog channel is always module position 17, and the second is module position 16.

There are two programmable values for each analog output - "analog offset" and "analog high RPM". When two analog outputs are being used, the two outputs can have different values for offset and high RPM. FCN 1 will show analog output 1 offset and high RPM values first and then advance to analog output 2 values.

Ao - Analog offset: Analog offset is the analog signal level that will be output when the resolver is at 0 RPM. This allows the minimum analog signal to be greater than 0 volts or 4 mA, which is required in many applications. Because the analog output module has 4096 increments (12 bits) of signal level available, the offset is specified as the number of increments of signal that should be output at 0 RPM. Calculate analog offset values as follows:

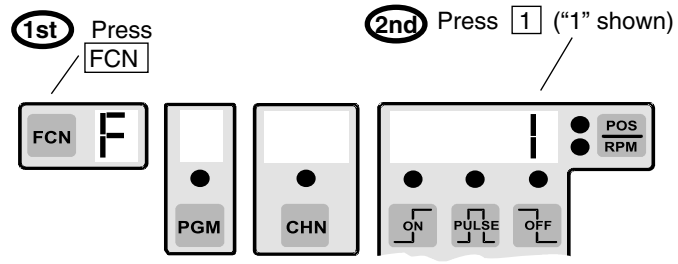
For 0-10 VDC: (Min Sig/10) x 4096
EX: to have 2 VDC Min Sig, Ao = (2/10) x 4096 = 819

For 4-20 mA: ((Min Sig-4)/(16)) x 4096
EX: to have 5 mA Min Sig, Ao = ((5-4)/(16)) x 4096=256

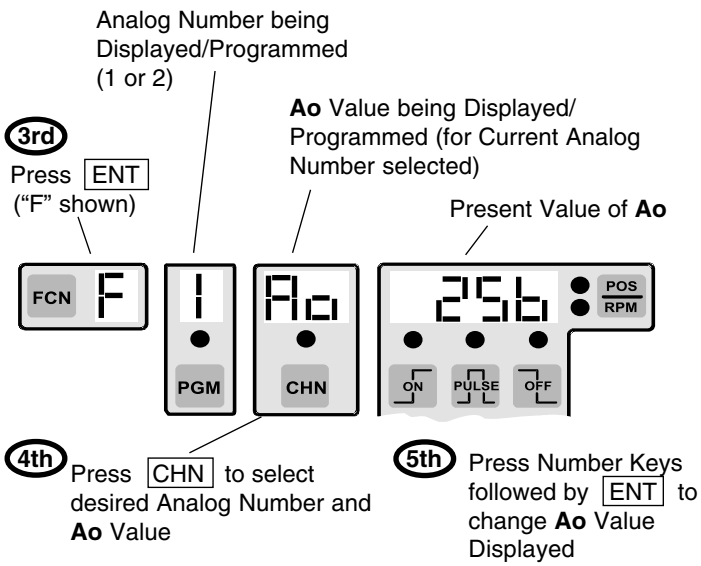
AH - Analog High RPM: Analog high RPM is the lowest resolver speed at which full scale analog output will occur. It is programmed in whole RPM. When this speed is reached, the analog output signal level will be at full scale (10 VDC or 20 mA). Increasing speed beyond Analog high RPM will NOT increase the analog output beyond full scale.

Complete Example
To have 6 mA @ 0 RPM and 20 mA @ 1500 RPM, set Ao and AH as follows:
Ao = ((6-4)/(16)) x 4096 = 512
AH = 1500

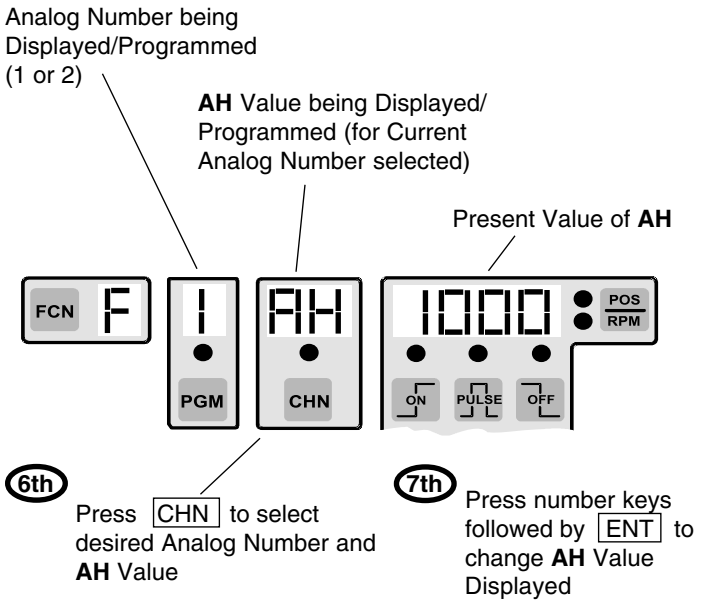
Selecting Function 1



Programming Analog Offset (Ao)



Programming Analog High RPM (AH)



Offset and Active Program

FCN 2: Offset (Position)

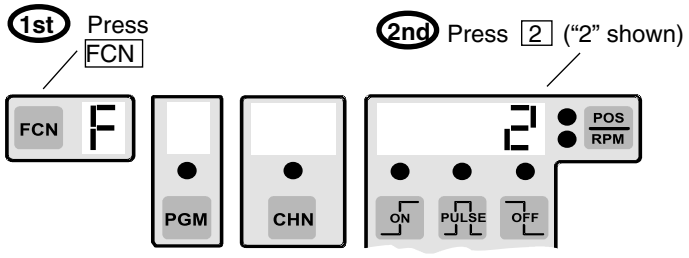
(Programming MUST be Enabled)

The Offset function allows the controller position to be set to match the position of the machine. This eliminates the need to mechanically adjust the position of the resolver shaft to match the machine position.

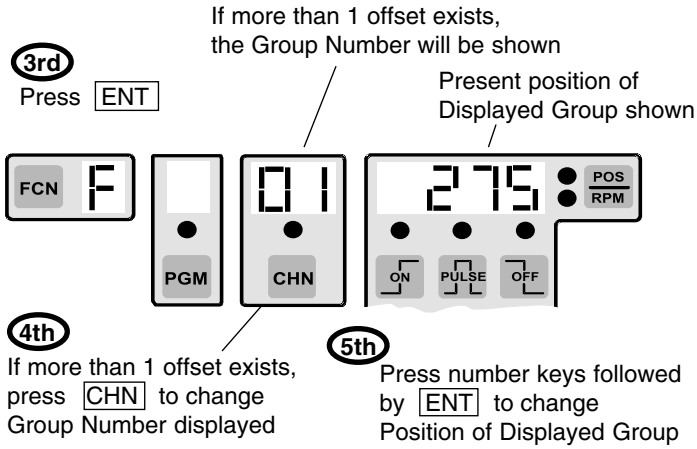
To set the Offset, simply stop the machine in a known position and enter that position value into FCN 2 as shown to the right (typically the machine 0 position is used). While in FCN 2, the value shown in the POS/RPM display is the current position value. The position display on the control will match the machine position at all times when the Offset is correctly set.

If a value is shown in the CHN display, the outputs are divided into more than one group and each group can have a unique offset (FCN 101: nO = EACH), the offset of each group can be set/monitored by pressing the CHN key to sequence through the group offsets. If all groups should have the same position value, the "one" mode should be selected to eliminate the need to individually set the offset of each group (FCN 101: nO = onE).

Selecting Function 2



Programming Offset



FCN 3: Active Program

(Programming MUST be Enabled)

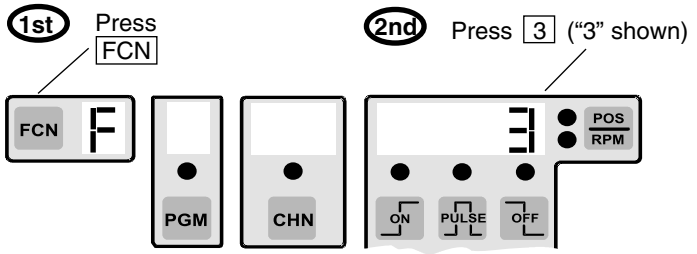
The PS-5144 control can store up to 48 programs in its memory. The "Active Program" is the program number that is currently controlling the output channels. The Active Program can be selected through the keyboard by numeric entry, or through the hardware program select inputs.

To select the Active Program number through the keyboard, follow the FCN 3 programming steps shown to the right.

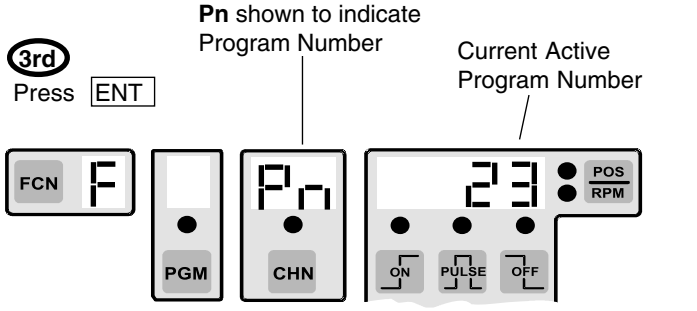
Do NOT use the PGM (program) key to attempt to change the active program. Pressing the PGM key allows inactive programs to be viewed/edited. Unless it is necessary, avoid viewing/editing inactive programs.The LED above the PGM key is on whenever the current Active Program is being viewed/edited.

Note: If any hardware program select input is energized, the control will make the program number selected by hardware the Active Program. The program number selected by FCN 3 will only become active when all of the hardware inputs are off. Serial communication can also be used to change the value of FCN 3.

Selecting Function 3



Changing Active Program



4th Press number keys followed by ENT to change Active Program Number

FCN 4: Speed Compensation (Standard)

(Programming MUST be Enabled)

If the control has the "L" option (Leading/Trailing Edge speed comp) and FCN 102 has "SC" set to "botH", go to the next page which describes Leading/Trailing Edge speed compensation. The "L" option would be shown at the end of the part number on the back label of the control (ex: PS-5144-24-P16M09-L).

The purpose of speed compensation is to maintain proper synchronization between the machine and device(s) energized by the controller, over the entire range of machine speeds. To do this, the controller automatically advances the "on"/"off" setpoints of the corresponding output(s) as the machine speeds up. This will compensate for the response lag of the devices being controlled, thus maintaining proper synchronization between them and the rest of the machine.

Speed comp is programmed by entering the response time of the output device in XXX.X msec (1 ms = .001 Sec). The output will always turn on this number of ms before the programmed "on" position is reached, and turn off this number of ms before the programmed "off" position is reached. As speed increases, the number of degrees of advance will automatically increase to maintain the number of msec of advance programmed.

Standard compensation ("onE" mode on "L" units) advances both the "on" edge and "off" edge of the output pulse by the same amount. This assumes that the device being controlled has "turn on" and "turn off" times that are approximately equal or that the exact timing of one edge isn't as critical as the other (Leading/Trailing edge speed comp can adjust the "on" and "off" edges by different amounts).

The controller samples machine speed and updates compensation approximately 10 times per second. Therefore, output devices maintain proper synchronization while machine speeds are changing. This is especially beneficial on machines where speeds ramp up and down quickly.

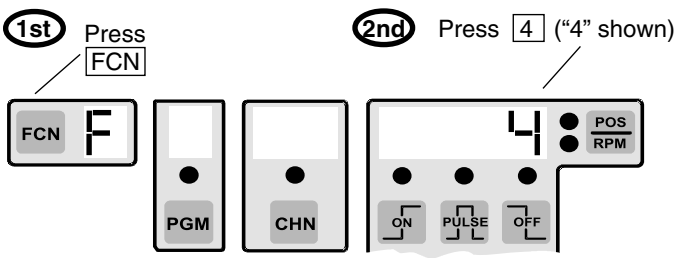
Each compensated output channel can be programmed for a unique amount of compensation. Devices that respond quickly (glue systems, clutch/brakes, etc) require less compensation than slower responding devices (air cylinders, dump mechanisms, etc). Enter the response time needed for each compensated output (XXX.X ms) and the control will automatically compensate for each device. **A maximum of 16 outputs can be speed compensated, but these can be any 16 of the 25 available.**

Note: PS-4000 and most PS-5000 Series PLuS controls specify speed comp in terms of how many degrees per 100 or 1000 RPM the setpoints will be advanced. Convert between Deg/100 or Deg/1000 and ms as follows:

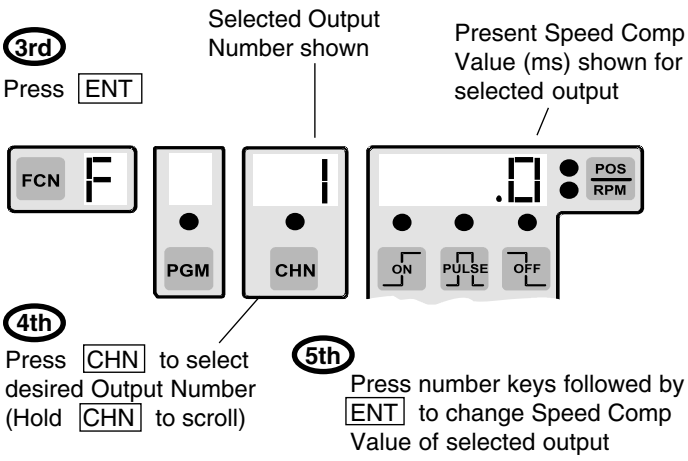
ms = (Deg/1000 RPM)/6 **ms** = (Deg/100 RPM)/.6

Deg/1000 RPM = ms x 6 **Deg/100 RPM** = ms x .6

Selecting Function 4



Programming Standard Speed Comp



Setup Procedure

1st Accurately determine the 0 speed machine position values where the device should turn on and off (jog or hand crank machine and record the positions from the controller display). Program the output channel to turn on and off at these 0 speed values.

2nd Go to FCN 4 and select the channel number being compensated. Enter the response time of the device being controlled in XXX.X ms (1 ms = .001 Sec). If the response it not known, estimate it. Ensure that the number is entered as XXX.X ms (LSD - .1 ms)

3rd Run the machine and adjust the speed compensation value until the output is properly synchronized with the machine. If the output is energizing too soon, decrease the speed comp—too late, increase the speed comp.

Suggestion: Speed comp can be adjusted most accurately at high speeds. Make coarse initial adjustments at mid-range speed and fine tune the speed comp value at high speed.

Once this procedure is completed, the control will correctly compensate for the corresponding output device over the entire range of machine speeds.

Note: Controls with Gray Code option ("G") will start FCN 4 with "Cc" (Code comp) and then step through channels starting with 9. See page A-14 for details.

FCN 4: Speed Comp (Leading/Trailing)

If the control does not have the "L" option (Leading/Trailing Edge speed comp) or FCN 102 does not have "SC" set to "botH", go to the previous page which describes standard speed compensation. The "L" option would be shown at the end of the part number on the back label of the control (ex: PS-5144-24-P16M09-L).

The purpose of speed compensation is to maintain proper synchronization between the machine and device(s) energized by the controller, over the entire range of machine speeds. To do this, the controller automatically advances the "on"/"off" setpoints of the corresponding output(s) as the machine speeds up. This will compensate for the response lag of the devices being controlled, thus maintaining proper synchronization between them and the rest of the machine.

Leading/Trailing speed comp is programmed by entering the "on" and "off" response times of the output device in ms (XXX.X 1 ms = .001 Sec). The output will always turn on the "on" number of ms before the programmed "on" position is reached, and turn off the "off" number of ms before the programmed "off" position is reached. As speed increases, the number of degrees of advance for both edges will automatically increase to maintain the number of ms of advance programmed.

Leading/Trailing edge speed compensation ("botH" mode on "L" units) can advance the "on" edge and "off" edge of the output pulse by different amounts as required. This allows the control to accurately compensate load devices that have "on" and "off" response times that are not equal (high speed glue systems are common applications requiring Leading/Trailing speed comp).

The "L" option controller samples machine speed 10 times per second and updates compensation typically 5 times per second. Therefore, output devices maintain proper synchronization while machine speeds are changing. This is especially beneficial on machines where speeds ramp up and down quickly.

Each compensated output channel can be programmed for unique amounts of compensation. Devices that respond quickly (glue systems, clutch/brakes, etc) require less compensation than slower responding devices (air cylinders, dump mechanisms, etc). Enter the "on" and "off" response time needed for each compensated output (XXX.X ms) and the control will automatically compensate for each device. **A maximum of 16 outputs can be speed compensated, but these can be any 16 of the 25 available.**

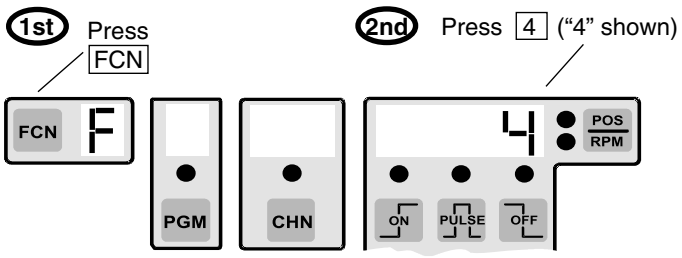
Setup Procedure

Note: PS-4000 and most PS-5000 Series PLuS controls specify speed comp in terms of how many degrees per 100 or 1000 RPM the setpoints will be advanced. Convert between Deg/100 or Deg/1000 and ms as follows:

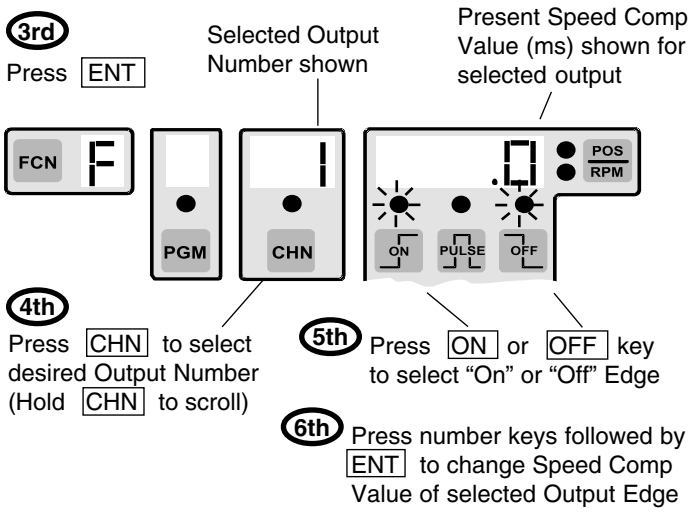
ms = (Deg/1000 RPM)/6 **ms** = (Deg/100 RPM)/.6

Deg/1000 RPM = ms x 6 **Deg/100 RPM** = ms x .6

Selecting Function 4



Programming Leading/Trailing Speed Comp



1st Accurately determine the 0 speed machine position values where the device should turn on and off (jog or hand crank machine and record the positions from the controller display). Program the output channel to turn on and off at these 0 speed values.

2nd Go to FCN 4 and select the channel number being compensated. Enter the "on" and "off" response time of the device being controlled in ms (XXX.X 1 ms = .001 Sec). If the response it not known, estimate it.

3rd Run the machine and adjust the speed compensation values until the output is properly synchronized with the machine. If the output is energizing too soon, decrease the on speed comp—too late, increase the on speed comp. If the output is de-energizing too soon, decrease the off speed comp—too late, increase the off speed comp.

Suggestion: Speed comp can be adjusted most accurately at high speeds. Make coarse initial adjustments at mid-range speed and fine tune speed comp values at high speed.

Once this procedure is completed, the control will correctly compensate for the corresponding output device over the entire range of machine speeds.

FCN 4: Negative Speed Compensation (Input Gating) (Programming MUST be Enabled)

All PS-5144 controls have the Negative Speed Comp feature.

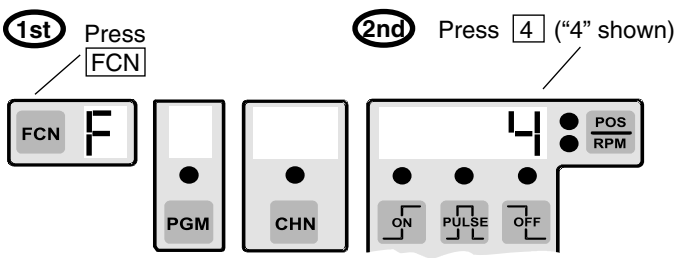
Negative Speed Comp causes the output channel to lag its programmed machine position by the specified number of msec. It is used when an input sensor is being gated, by the corresponding output channel, into another control system (PLC, registration control, etc). Since most sensors have very fast response times, negative speed comp is only needed in situations where the sensor is slow to respond or the machine speeds are high and sensor timing is critical.

Sensor lag can cause an object that is present at the correct position in the cycle to appear late. Negative speed comp can retard the gate signal (by the sensor response time) so the sensor and gate signals are in sync when the object is in the correct position.

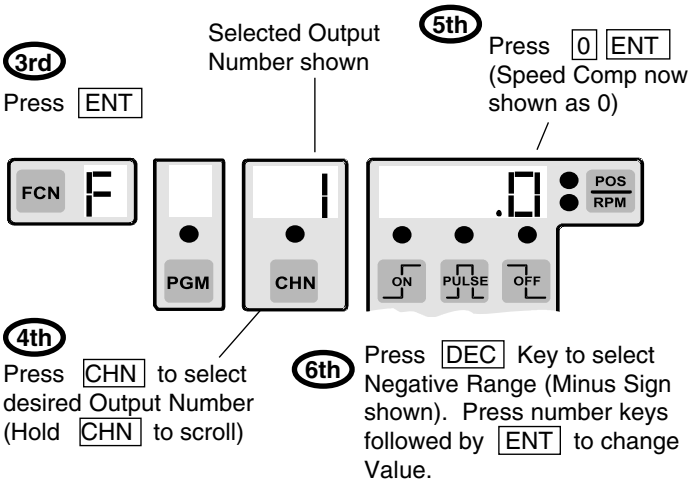
Example: Assume a product sensor requires 5 ms to respond and a PS-5144 output channel provides a reference window. At 200 RPM, the sensor signal would turn on 6 degrees (5 ms) after the start of the registration mark. If the reference window isn't delayed by 6 degrees also, it will have a 6 degree head start and the product will appear to be 6 degrees later than it actually was.

Note: Set Speed Comp = 0 to restore positive values.

Selecting Function 4



Programming Negative Speed Comp



FCN 5: Timed Outputs

(Programming MUST be Enabled)

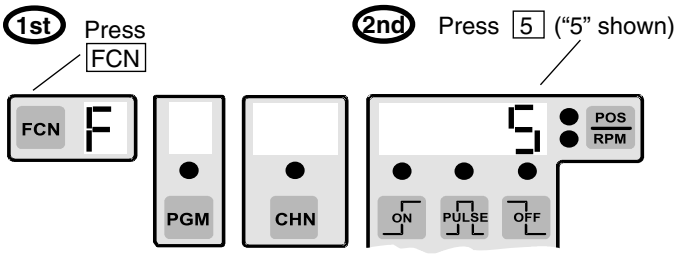
Any 4 of the 25 total outputs can be programmed to time out rather than remaining on until an "off" position its reached. This allows the output duration to be held constant regardless of machine speed. Outputs are timed in 1 ms increments up to a maximum of 9999 ms (9.999 Sec). Once an output times out it will not come back on until the next output pulse is reached. Each timed output channel can specify a unique amount of time delay.

A timed output must be programmed with "on" and "off" position setpoints in the same manner that all outputs are programmed. A timed output will turn on when the beginning of the pulse is reached and turn off the specified number of msec later. If the output pulse "off" position is reached before the specified time has elapsed, the timing will be aborted and the output will turn off immediately.

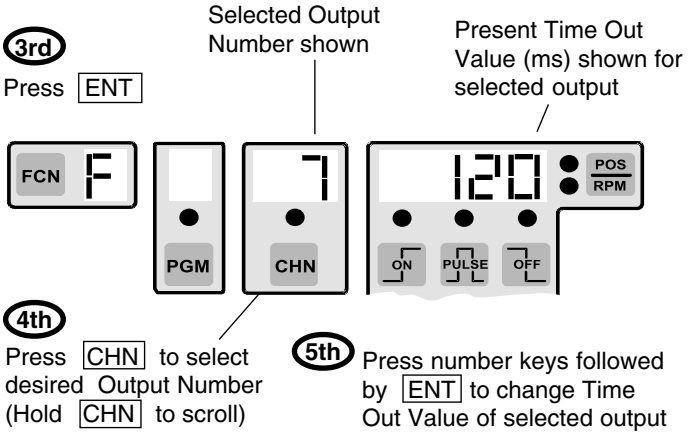
If more than 4 timed outputs are attempted an "E9 tdE" error message will flash (too many timed outputs).

Note: If the machine is rotating in the reverse direction, timed outputs will energize when the "off" edge of the pulse occurs, just as non-timed outputs do.

Selecting Function 5



Programming Timed Outputs



Absolute Offset and Program Copy

FCN 6: Absolute Offset

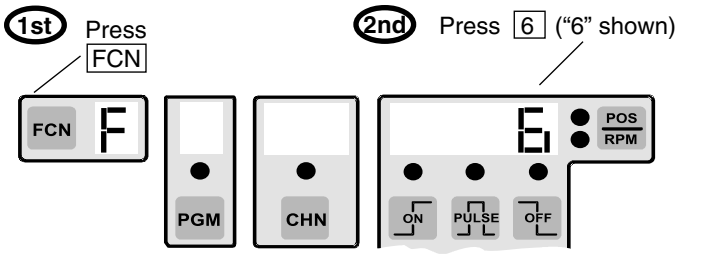
(Programming MUST be Enabled)

The Absolute Offset function will work in one of two ways, depending on the mode of operation selected (FCN 109) for the output group(s). Each group can have a unique Absolute Offset value if the Number of Group Offsets (FCN 101, nO) is NOT set to "onE".

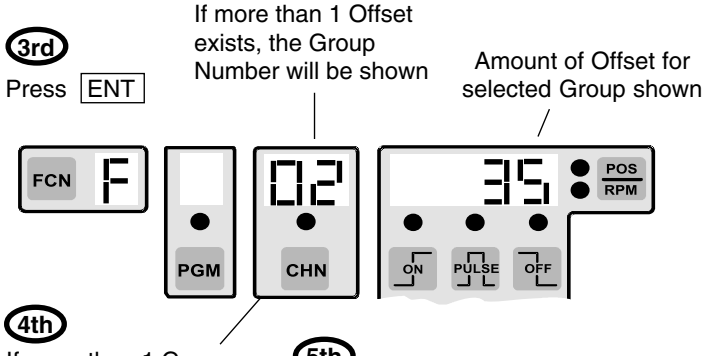
Modes 0, 3, 4 & 5 (offset from Shaft Position)
Corresponding group position is equal to the Shaft Position (FCN 101, SP) plus the Absolute Offset (FCN 6) value. Absolute Offset allows the lead or lag between machine position (when SP = machine position) and the corresponding group position to be specified directly. For example, assume a scale factor of 360. If FCN 6 = 10, then group position always leads SP by 10 degrees. If FCN 6 = 350, then group position always leads SP by 350 degrees (lags it by 10).

Modes 1 & 2 (reset to preset when input occurs)
Corresponding group position becomes set equal to the Absolute Offset Value (FCN 6) when the input signal occurs. This allows the group position adjustment from the keyboard, rather than having to adjust the sensor position. For example, if the signal from a sensor is resetting the group position 5 degrees too late, set the Absolute Offset equal to 5 so the sensor signal causes it to reset to 5 degrees rather than 0.

Selecting Function 6



Programming Absolute Offset(s)



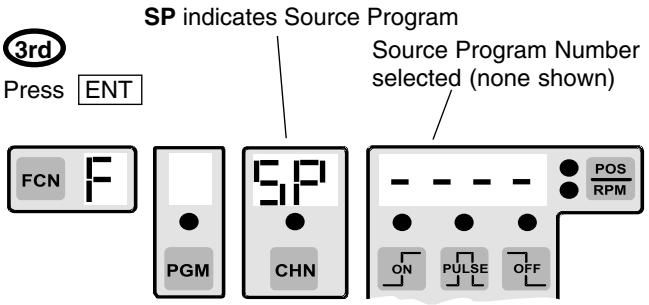
FCN 7: Program Copy

(Programming MUST be Enabled)

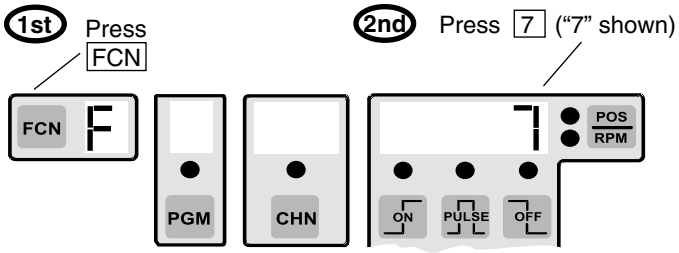
The Program Copy feature allows all of the channel setpoints to be copied from any program ("Source Program") to any other program ("destination Program"). If a program already exists at the destination, it will be completely overwritten by the source program. On many machines, different job set-ups require changes to only a few of the channels. Use the copy feature to transfer all of the channel setpoints to a new program, then manually edit those program channels that need different values. This is easier than manually entering all of the channel setpoints.

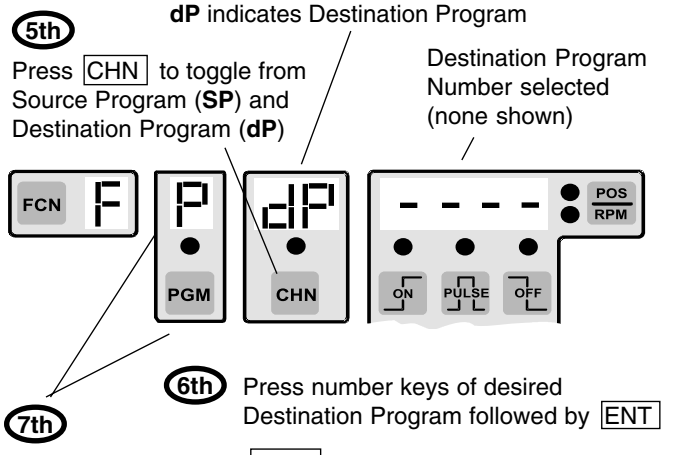
An existing program can be deleted by copying an empty program to it.

Copying Programs



Selecting Function 7





Pulse Copy (Automatic Multiple Pulse Generation)

FCN 8: Pulse Copy

(Programming MUST be Enabled)

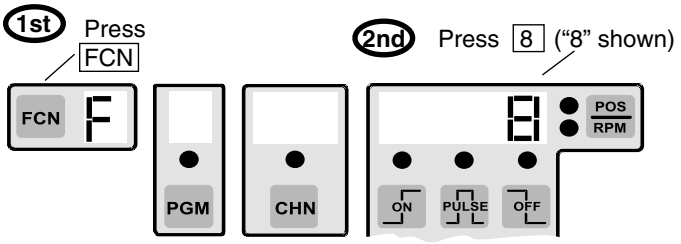
The Pulse Copy feature can create a burst, or whole revolution, of pulses in any program and output channel. It is not necessary to manually enter the on and off positions for each pulse individually. The program number, channel number, starting position, ending position, number of pulses and duration define the pulse train that will be created. The pulse spacing will be as uniform as possible given the specified space, duration and number of pulses.

All of the following parameters must be entered before the desired pulse train can be generated:

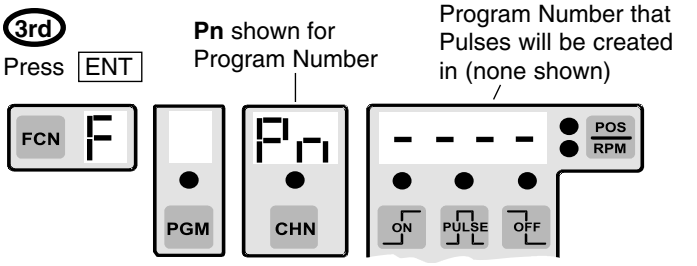
- Pn - Program number
- CH - Channel number
- on - on position of 1st pulse
- oF - oFF position of last pulse
- ct - number of pulses (count)
- du - on duration (# of scale factor increments)

Note: A standard PS-5144 can store approximately 1200 output pulses total among all programs used. The "F" option increases storage to approximately 4500 pulses total. Creating large pulse trains will limit the total number of programs available.

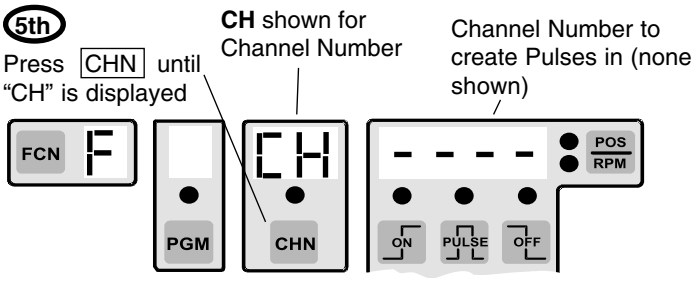
Selecting Function 8



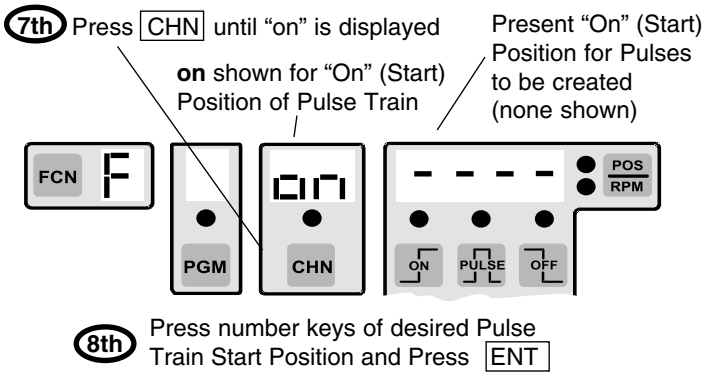
Generating a Pulse Train



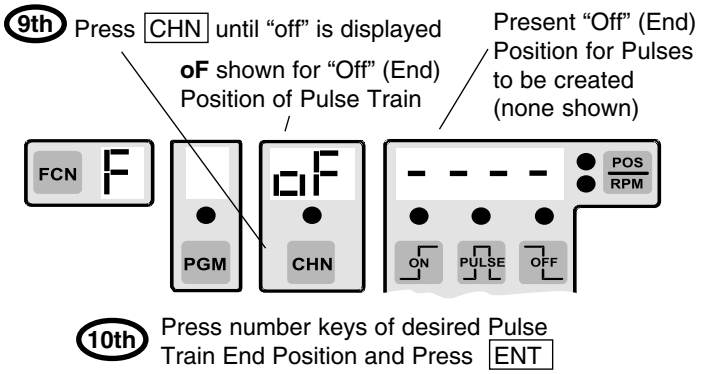
4th Press number keys of desired Program Number followed by ENT



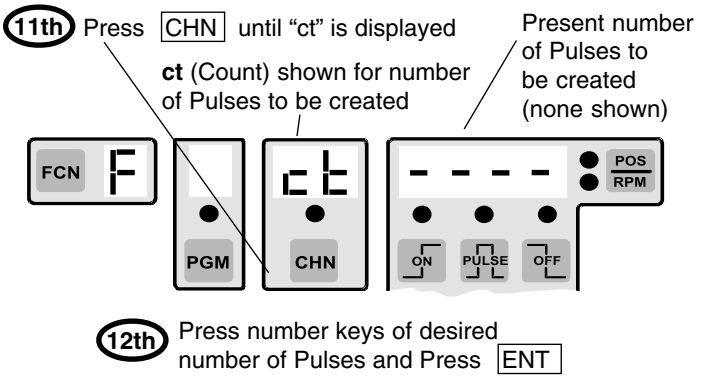
6th Press number keys of desired Channel (Output) Number and press ENT



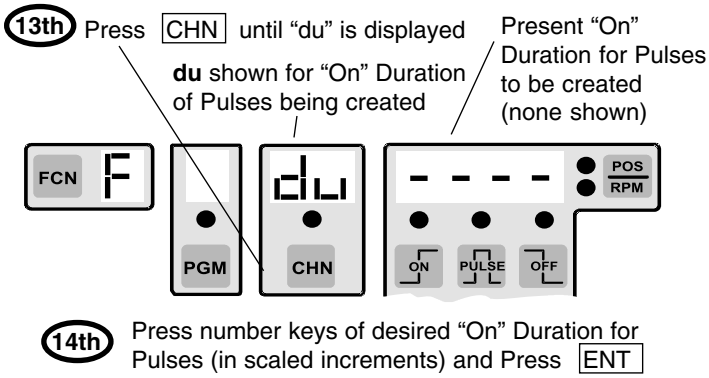
8th Press number keys of desired Pulse Train Start Position and Press ENT



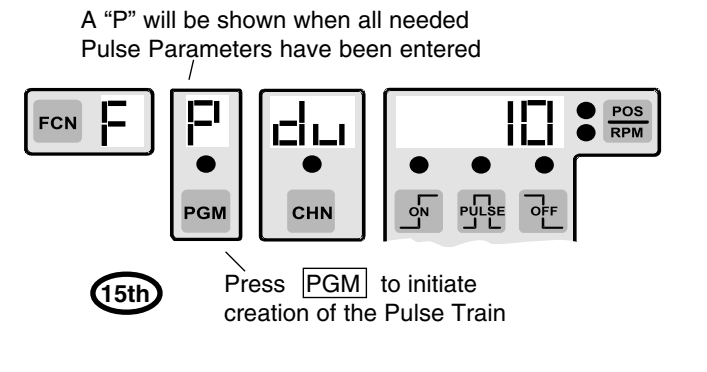
10th Press number keys of desired Pulse Train End Position and Press ENT



12th Press number keys of desired number of Pulses and Press ENT



14th Press number keys of desired "On" Duration for Pulses (in scaled increments) and Press ENT



15th Press PGM to initiate creation of the Pulse Train

Direction of Rotation and Scale Factor

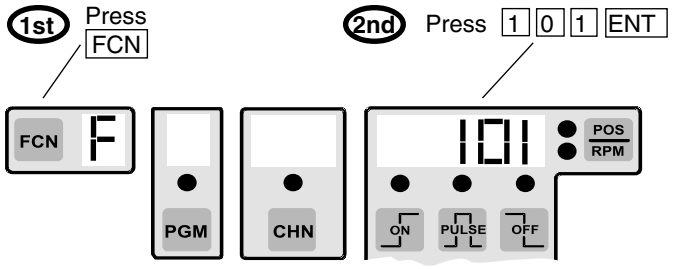
FCN 101: Unit Configuration #1

(Master Programming MUST be Enabled)

Function 101 accesses hardware / software set-up options that are application specific. Once the appropriate selections are made for these items, they will not normally need changing.

Access FCN 101 as shown in the illustration to the right and then press the CHN key to select the desired parameter for programming.

Selecting Function 101



dr - Direction of Rotation

(Master Programming MUST be Enabled)

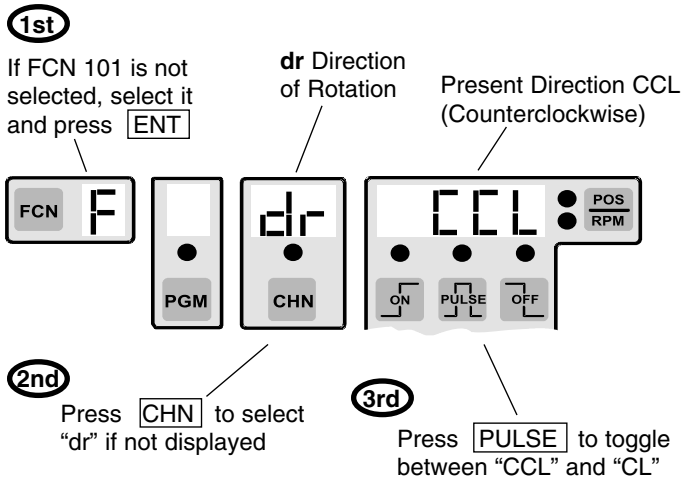
The Direction of Rotation determines which direction of resolver rotation (clockwise or counterclockwise) will cause the position values on the controller to increase. This is normally set so the position value increases as the machine turns in its forward direction.

The clockwise / counterclockwise designation refers to the rotation of the resolver shaft as viewed from the front (shaft end) of the resolver.

CL - Clockwise

CCL - Counterclockwise

Program Direction of Rotation



SF - Scale Factor

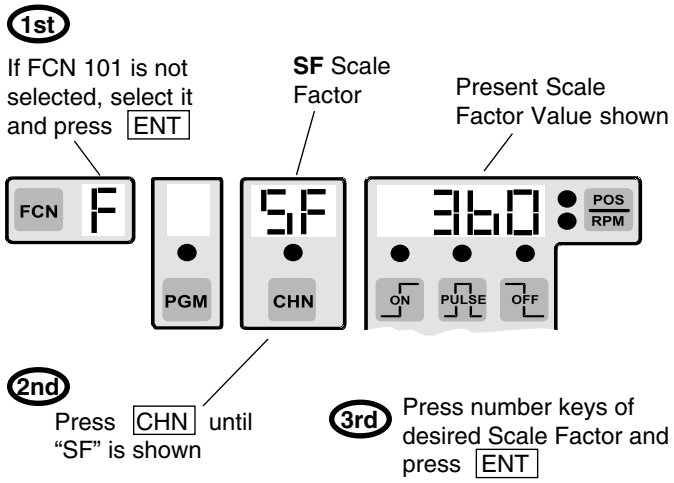
(Master Programming MUST be Enabled)

The Scale Factor is the number of increments each revolution will be broken into. A Scale Factor of 360 (0-359) allows the control to operate in degrees. A Scale Factor of 1024 (0-1023) allows positions to be programmed more accurately (.35 degree increments). In some applications, the Scale Factor can be set so each increment equals a unit of linear travel (Ex: 1 Rev = 10" travel, if SF=1000 then each increment = .01").

Scale Factors range from 2-1024 on standard PS-5144s. Scale Factors range from 2-4095 in "H" option units.

Note: When the Scale Factor is changed, all programmed setpoints are recalculated to convert them to the new Scale Factor. The keyboard will be inoperative until the calculations are done (the Scale Factor value will blink once when done).

Program Scale Factor



Shaft Position, Number of Analog Outputs, Number of Offsets

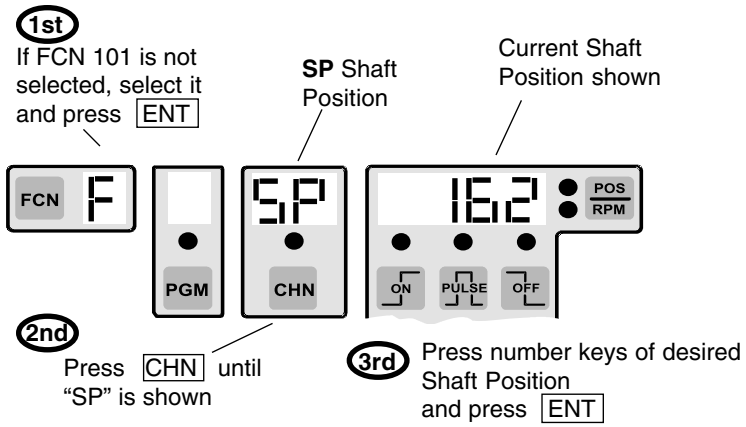
SP - Shaft Position

(Master Programming MUST be Enabled)

The Shaft Position should be set to match the actual position of the machine. Once this is done, Shaft Position and machine position will always be the same.

The Absolute Offset function (FCN 6) uses Shaft Position as the reference for output groups operating in Modes 0, 3, 4, or 5 (modes which do not reference position to input signals). This makes it very simple to set and monitor the phase relationship between output groups and machine position.

Program Shaft Position



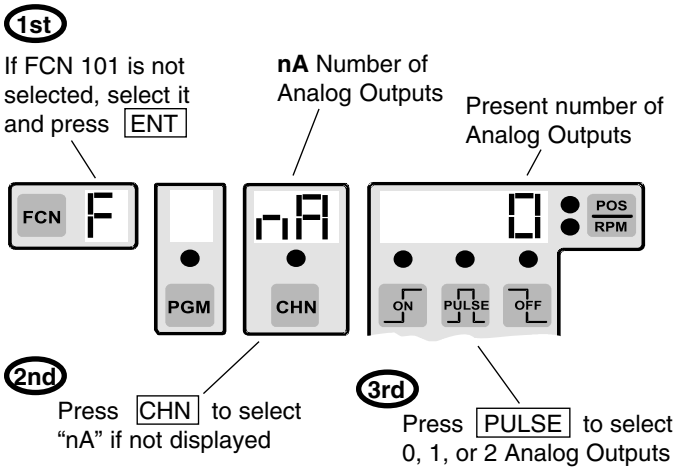
nA - Number of Analog Outputs

(Master Programming MUST be Enabled)

The PS-5144 control can have up to 2 analog outputs, each can be offset and scaled by different values. If no analog outputs are needed, all 25 output channels are available as normal position outputs. Select 0, 1, or 2 analog channels (nA = 0, 1 or 2) as shown in the illustration to the right. FCN 1 is where the analog offset and analog high RPM values are programmed. An analog output module is required for each analog output (0-10 VDC or 4-20 mA modules are available).

nA = 0 All 25 outputs are normal outputs.
nA = 1 Output 25 is analog, 1-24 normal outputs.
nA = 2 Outputs 24 & 25 are analog, 1-23 normal. (Output 25 is analog 1, 24 is analog 2)

Program Number of Analog Outputs



nO - Number of Group Offsets

(Master Programming MUST be Enabled)

The PS-5144 can be subdivided into as many as 6 output groups (FCN 108). Each group can have a unique offset (phase relationship to the machine) and can operate in any of the 6 modes available (FCN 109).

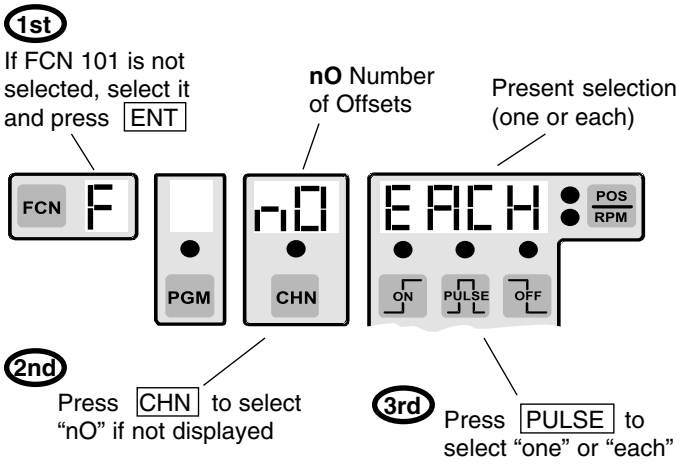
Most applications do not require unique offsets for the groups, so "nO = onE" can be programmed. This ensures that all groups are at the same phase relationship to the machine. Only one position value needs to be displayed when the "onE" mode is chosen. Therefore, the POS/RPM key toggles between position and RPM each time it is pressed.

Note: "onE" can NOT be specified if any of the groups must operate in Mode 1 or 2.

If output groups must have unique offsets or Mode 1 or 2 operation is needed, "EACH" must be selected. The control will sequence through the position value for each group as the POS/RPM key is pressed (group number displayed in CHN window).

onE = One offset for all output groups.
EACH = Each output group can have unique offset.

Program Number of Group Offsets



Resolver Type and Program Select Format

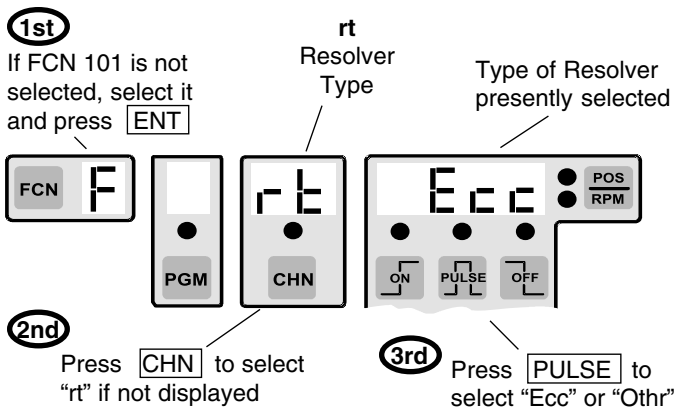
rt - Resolver Type

(Master Programming MUST be Enabled)

The PS-5144 can operate with resolvers that have a transformation ratio of .454 or 1. Standard Electro Cam resolvers have a ratio of .454. Some resolvers made by other manufacturers have a ratio of 1. Program the "rt" selection of the PS-5144 to match the transformation ratio of the resolver being used.

Ecc = Electro Cam Resolver (transformation ratio .454)
othr = Other Resolver (transformation ratio 1)

Program Resolver Type



PS - Program Select Format

(Master Programming MUST be Enabled)

The hardware program select inputs can be programmed to operate in any 1 of 3 formats:

bin = Binary (6 bits - max program number 48)
Note: Program 48 will be selected if the binary input value exceeds 48

grAy = Gray Code (6 bits - max program number 48)
Note: Program 48 will be selected if the Gray Code input value exceeds 48

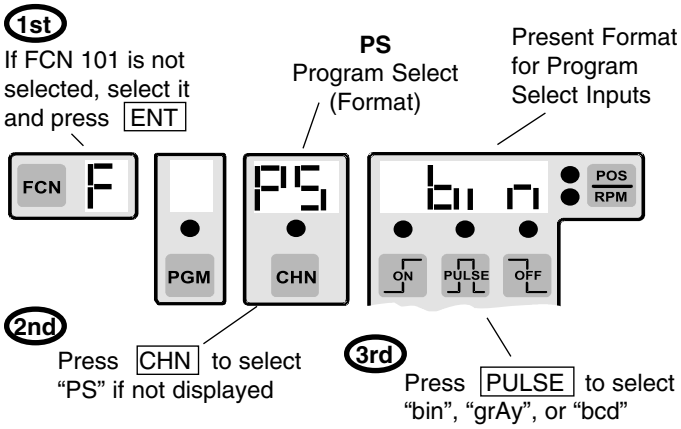
bcd = Binary Coded Decimal (6 bits-max program number 39)
Note: Units digit will be set to 9 if binary value of inputs 1, 2, 3 & 4 exceeds 9.

Input terminals 1-6 are the program select inputs. Terminal 1 is the LSB and terminal 6 is the MSB.

The FCN 3 keyboard selected program number will only be active when all program select hardware inputs are off. It is recommended that FCN 3 be set to 48 when Binary or Gray Code is used and 39 if BCD is used. Leave program 48 (or 39) empty or program it with settings that can not harm the machine or personnel. If a malfunction occurs in the program select circuits, potential harm may be avoided.

Detailed information on the program select formats is given on page A-13.

Select Format for Program Select Inputs



Speed Comp Type, Time Base, Gray Code Logic

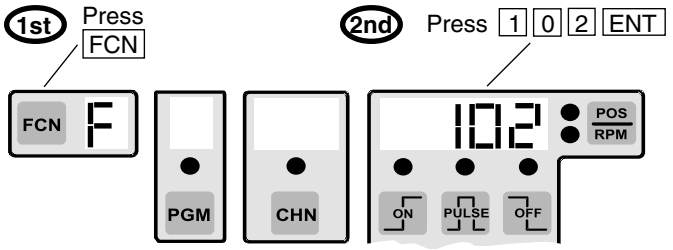
FCN 102: Unit Configuration #2

(Master Programming MUST be Enabled)

Function 102 accesses the type of speed compensation being used ("L" option units only), the time base for timed outputs and the type of logic being used for Gray Code ("G" option units only). Controls that do not contain the "L" or "G" options will NOT display the "SC" or "gL" items.

If the control does NOT have special output timing features, the time base ("Tb") will be set to 1 ms and cannot be changed.

Selecting Function 102



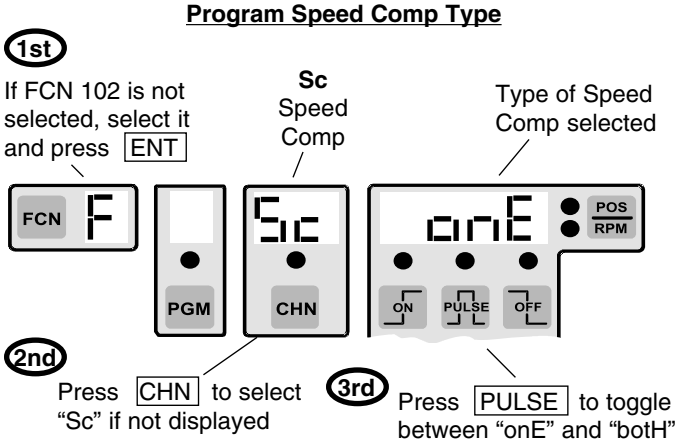
Sc - Speed Comp Type (only Controls with "L" Option)

Controls which have the "L" option can have speed comp set to operate in the "onE" (standard) mode or the "botH" (leading / trailing edge) mode. In the "onE" mode, the same value of speed comp is used by both the on and off edges of a compensated output channel. In the "botH" mode, different amounts of speed comp can be applied to the on and off edges of an output channel. This allows accurate compensation for devices which have on and off response times that are different.

one = Standard speed comp (one value for both edges)

botH = Leading / trailing speed comp (different amounts for each edge)

Program Speed Comp Type

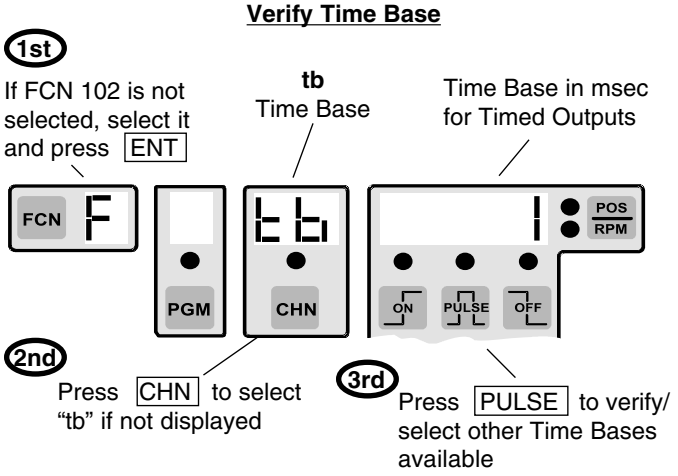


tb - Time Base

Standard PS-5144 controls have a fixed 1 msec time base for timed outputs. The time base can be monitored, but not changed, as shown to the right. Pressing the PULSE key will not cause the "1" value displayed to change.

Special version of the PS-5144, with a different time base, will display a number other than 1 for "tb". If more than one time base is available, pressing the PULSE key will step through the choices.

Verify Time Base



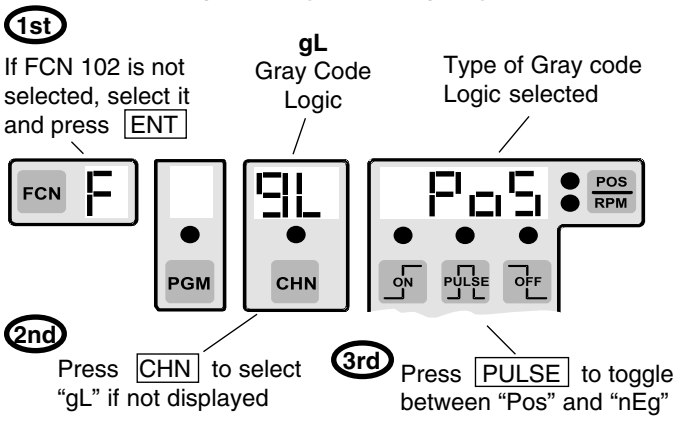
gL - Gray Code Logic Type (only Controls with "G" Option)

The Gray Code output channels 1-8 can be configured to operate with positive logic or negative logic. This eliminates the need for external logic conversion when interfacing to controls which need negative logic as described below.

PoS - Outputs are ON for Gray Code "1" values

nEg - Outputs are ON for Gray Code "0" values (inverted)

Program Gray Code Logic Type



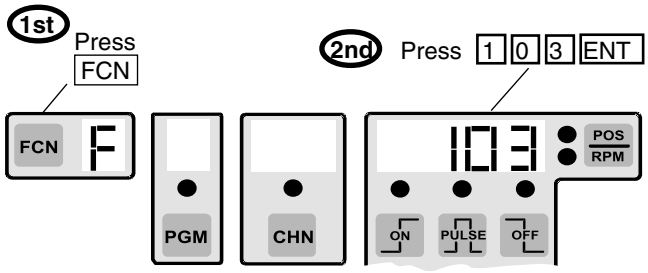
FCN 103: Display Configuration

(Master Programming MUST be Enabled)

Function 103 selects display options. In the manual mode, the control requires the POS/RPM key to be pressed to switch the display from position to RPM. An automatic mode can also be selected which switches between position and RPM displays based on machine speed.

The rate at which the RPM display updates can be set to 1, 2, or 10 updates per second in FCN 103 also.

Selecting Function 103



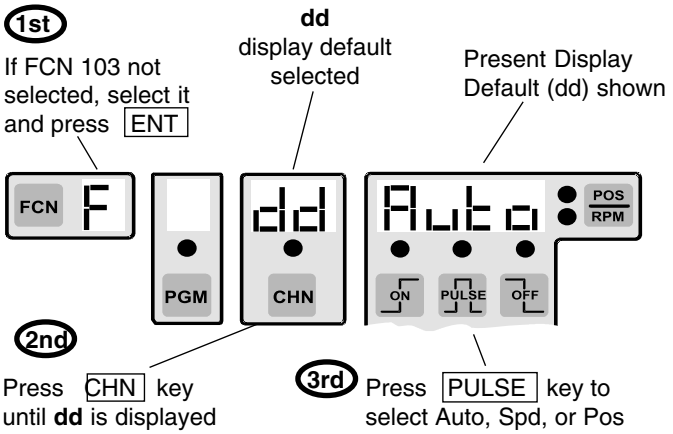
dd - Display Fault

Display default selects whether the display will switch manually or automatically between position and RPM as follows:

SPd - (Speed) Control powers up with RPM displayed and the POS/RPM key must be pressed to switch between POS and RPM.

PoS - (Position) Control powers up with POS displayed and the POS/RPM key must be pressed to switch between POS and RPM.

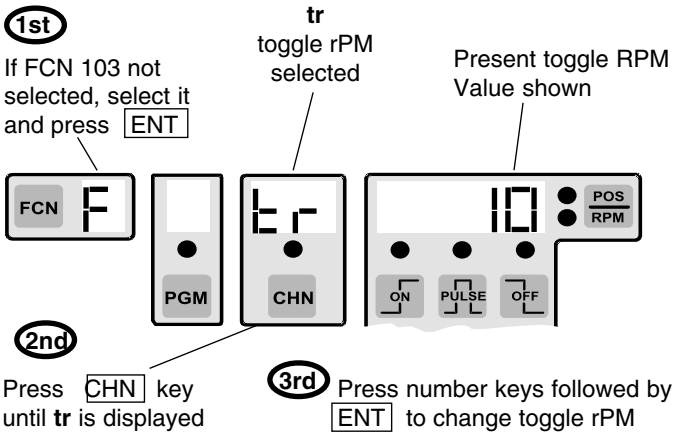
Auto - (Automatic) Display will show POS when machine speed is below toggle RPM (tr) and RPM when speed is above. Pressing POS/RPM key will cause display to switch manually, but next speed change through "tr" will automatically select displayed item again.



tr - Toggle RPM

The Toggle RPM ("tr") is the machine speed at which the controller's display switches between showing position and RPM if "dd" is set for the Auto mode.

When a remote display is used, it will always switch between position (P) and RPM (r) at the toggle RPM. The display default ("dd") selected (SPd, PoS or Auto) does not affect the operation of the remote display.

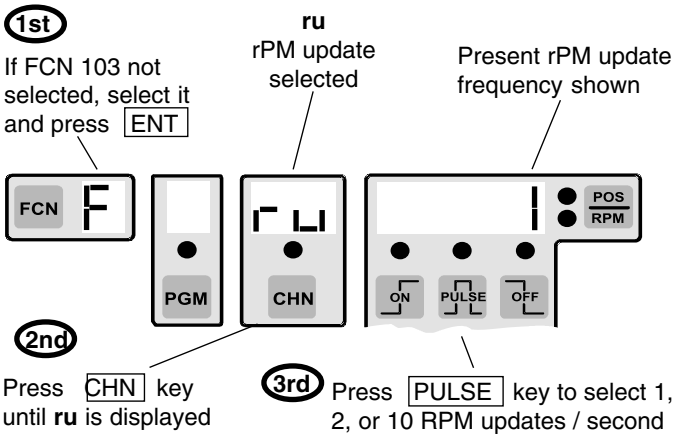


ru - RPM Update (Rate)

The number of times per second that the RPM updates on the controller's display (and a remote display if used) is selected by "ru" as follows:

1 - 1 RPM display update per second
2 - 2 RPM display updates per second
10 - 10 RPM display updates per second

Note: RPM is always calculated 10 times per second. "ru" only affects how often the RPM display is updated. 1 update per second is typically best because it averages out insignificant speed changes and is comfortable to read. Use a faster update rate to view quick speed changes.



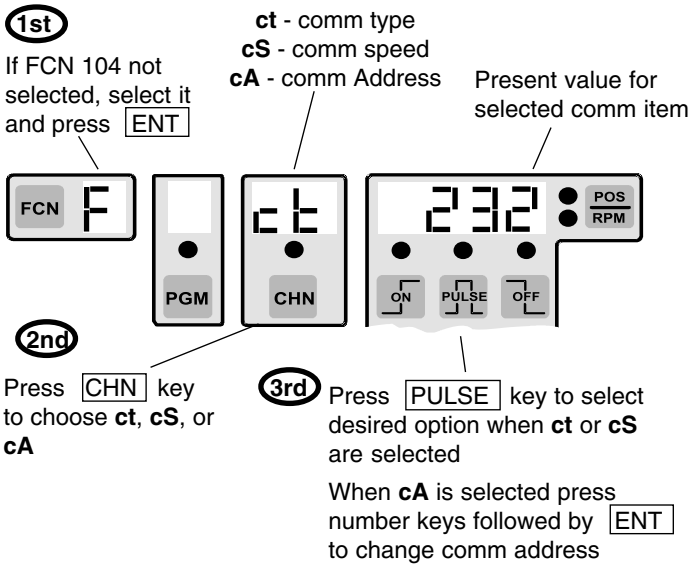
FCN 104: Communication Parameters

(Master Programming MUST be Enabled)

ct - communication type: Specifies which communication port is being used by the PLuS control. It contains both an RS-232 and an RS-485 port. The type of port being used on the PLuS must match the type of port being used by the device communicating with the PLuS.

cS - communication Speed: Specifies the baud rate (bits per second) that the PLuS communication port will operate at. It must be set for the same baud rate as the device communicating with the PLuS control. The choices are: 4800, 9600, 19200, and 38400 baud.

cA - communication Address: Each control can have a unique communication address (0-255) because multiple controls can be wired to the same host device in an RS-485 network. This allows the host to send information to a specific control while the other controls will ignore the information. A PLuS control will ignore incoming information if the address that information specifies does not match the communication address of the control. *The controller DIP switch must be set to zero for the programmed communications parameters to take effect.*



Comm Item	Choices
ct (port type)	RS-232, RS-485
cS (baud)	4800, 9600, 19200, 38400
cA (comm add)	0-255

FCN 105: Setup and Operator Enable Codes

(Master Programming MUST be Enabled)

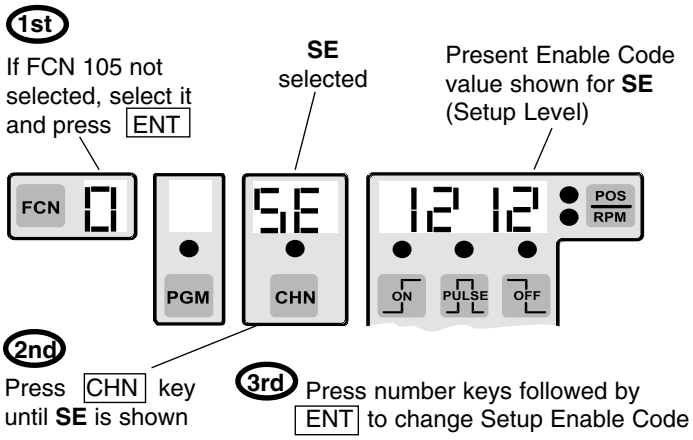
Enable codes allow personnel to gain access to programming operations without energizing hardware inputs. FCN 105 establishes the 4 digit numbers that "Setup" and "Operator" level personnel will use. These numbers can be changed at any time, but the "Master" level program enable input must be energized to do so.

SE - Setup Enable Code: This is the 4 digit enable code number that technical personnel will use to gain programming access. They will have access to all output channel setpoints and the programming functions listed on the control's front label (FCNs 1-5).

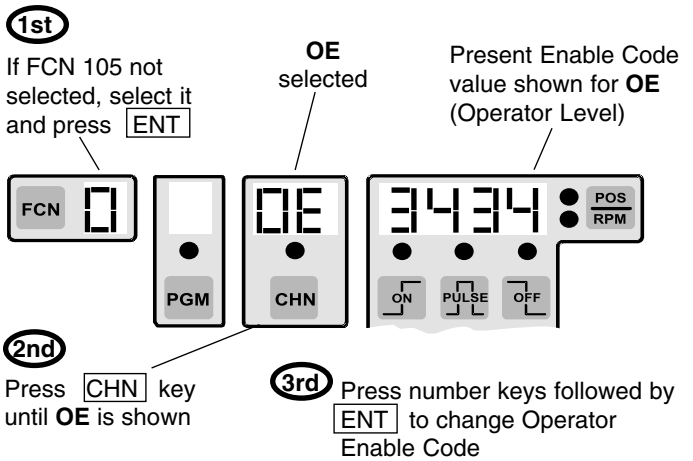
OE - Operator Enable Code: This is the 4 digit enable code number that operator personnel will use to gain programming access. The output channel numbers and programming functions they will have access to are determined by FCN 106 programming (FCN 106 is accessible at "Master" level only).

Note: Operator programming access can also be activated by energizing input terminal 8. Setup level programming can only be accessed through the setup keyboard enable code.

Program Setup Enable Code



Program Operator Enable Code



FCN 106: Output Channels and Functions Accessible at Operator Level

(Master Program Enable MUST be on)

To Select Operator Accessible Channels:
Step through the channels and select On or Off according to whether or not the operator should be able to adjust them.

on - Operator CAN adjust this output channel.
oFF - Operator can NOT adjust this output channel.

Note: Operators cannot be given access to channels 91-96 (the input windows for groups 1-6).

Other programming functions (those shown on the control's front panel label) can be enabled for operators as described below. Operators can adjust speed comp and/or output time-out on the channels that were set to “on” in the above step (selected channels), if “Sc” and/or “to” are set to “on” as described below.

SP - Setpoints (output ON/OFF position settings)
on - Output setpoints can be adjusted by Operators (selected channels)
oFF - Output setpoints can NOT be adjusted by Operators

Sd - Speed Detection (FCN 1 - Motion Setpoints and Analog parameters)
on - FCN 1 values can be adjusted by Operators
oFF - FCN 1 values can NOT be adjusted by Operators

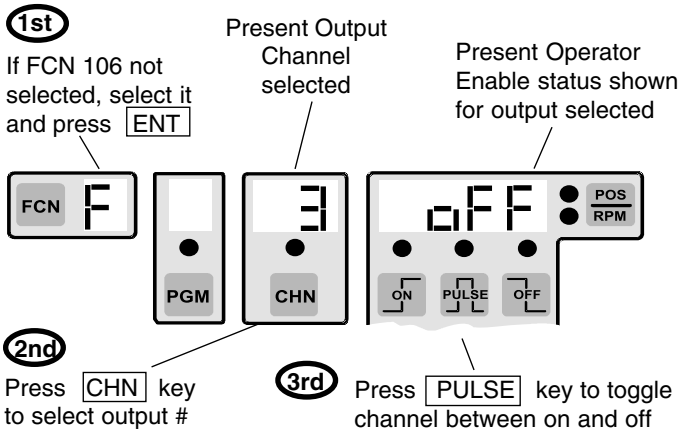
oF - Offset (FCN 2)
on - Offset values can be adjusted by Operators
oFF - Offset values can NOT be adjusted by Operators

AP - Active Program (FCN 3)
on - Operators can change the Program Number
oFF - Operators can NOT change the Program Number

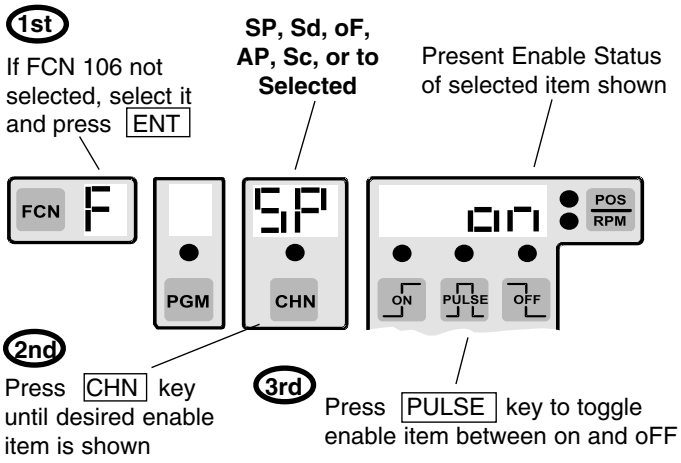
Sc - Speed Compensation (FCN 4)
on - Operators can change speed comp (selected channels)
oFF - Operators can NOT change speed comp values

to - Timed Outputs (FCN 5)
on - Operators can change output times (selected channels)
oFF - Operators can NOT change output times

Selecting Operator Accessible Channels



Selecting Operator Accessible Functions



In the programming illustration above, output setpoints (“SP”) have been enabled for adjustment at the operator programming level. Output setpoints can now be adjusted, by operators, on those channels that are enabled in the channel portion or FCN 106. Enabling speed comp (“Sc”) and/or timed output (“to”) adjustment would also only apply to those channels that are enabled for operator adjustment.

FCN 107: Motion ANDing

(Master Program Enable MUST be on)

The PS-5144 has 2 motion levels (speed ranges) which are programmed in FCN 1. Any output(s) can be ANDed with either motion level. When an output is ANDed with a motion level, it will only operate when the machine speed is within the Lo and Hi RPM values programmed for that motion level. Outputs that must always operate, regardless of machine speed, should NOT be ANDed with either motion level.

Program Motion ANDing, for each output, as follows:

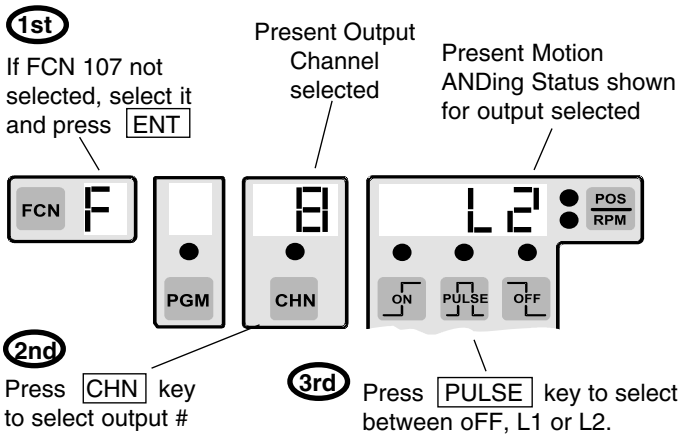
oFF - Selected output is NOT ANDed with either motion level and will be active at all times.

L1 - Selected output is ANDed with motion level 1.

L2 - Selected output is ANDed with motion level 2.

Note: It is not possible to AND any output(s) with both L1 and L2 simultaneously.

Programming Motion ANDing



FCN 108: Subdividing Outputs into Groups

(Master Program Enable MUST be on)

The outputs can be subdivided into as many as 6 output groups. The number of output groups and the number of outputs in each group is determined by FCN 108.

If FCN 101 "nO" is set to "EACH", each output group can be at a unique degree position which is adjustable through FCN 2 or FCN 6 (CHN key selects Output group #). The POS/RPM key will individually display each group's position by showing the group number above the CHN key while showing the current position next to the POS/RPM key.

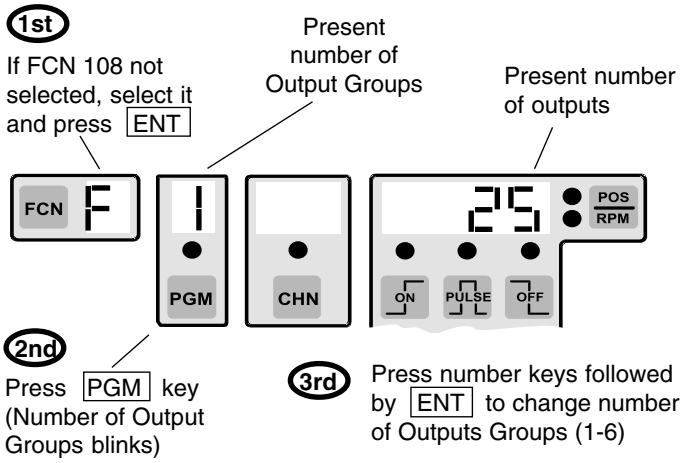
When the number of outputs in each group is being assigned, all of the outputs must be accounted for. The last output group will automatically contain the outputs remaining after the number of outputs in the other groups is defined. The number of outputs in the last group automatically changes if the total number of outputs in the other groups is changed.

Outputs are assigned sequentially, starting with the first output going into the first group. For example, if three groups are created with 9 outputs in group 1 and 7 outputs in group 2, the outputs would be assigned as follows: Group 1 would contain outputs 1-9, group 2 would contain outputs 10-16, and group 3 would contain outputs 17-25 (remaining outputs).

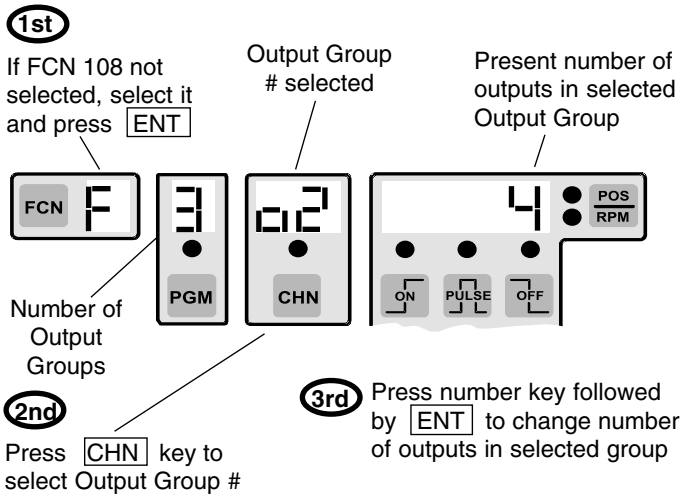
Each output group has a dedicated enable input and can be assigned to operate in any one of the Output Enable Modes. See FCN 109 (next page) for programming of Enable Modes.

See Output Grouping (page A-1) in the appendix of this manual for further information.

Programming the Number of Output Groups



Programming the Number of Outputs in Each Group



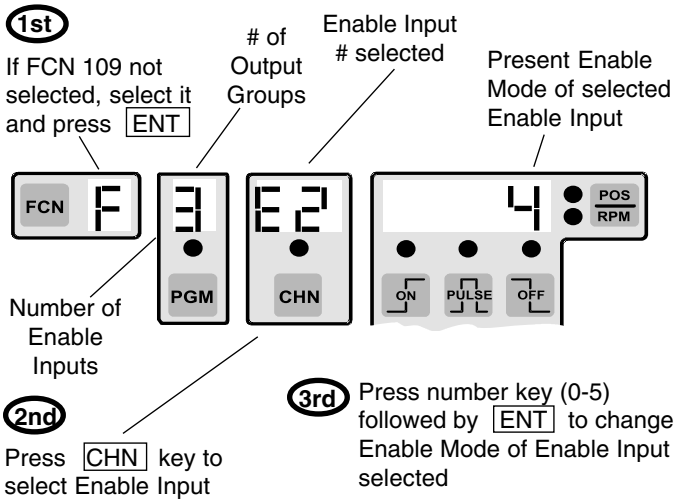
FCN 109: Output Group Enable Modes

(Master Program Enable MUST be on)

Each output group that is created in FCN 108 can be programmed to operate in any one of the 6 modes (0-5) available. Modes allow outputs to be disabled if input requirements are not met and/or change the position reference (offset) of the group based on the leading edge of an input signal. **The ability to run different modes simultaneously greatly increases application versatility.** 6 output group enable inputs are located on the logic terminal strip (term 9-15) -each group has a dedicated hardware input. All outputs in a group operate in the same mode and are affected by the same input signal.

Modes 1, 2, 4, and 5 also require the programming of input windows. An input window either specifies where the input becomes rearmed (modes 1 & 2) or the position in the cycle where the input signal must occur (modes 4 & 5). These windows are programmed in channels 91 - 96 in the same fashion that output channels are programmed. **Channel 91 is the window for group 1, channel 92 for group 2 and etc.**

Programming Output Enable Modes



Mode 0 - Normal Cam Operation

Enable Input: Ignored completely.

Outputs: Active at all times (on whenever group position is within programmed ON/OFF setpoints).

Enable Window: Not needed.

Mode 1 - Reset Position to Preset Value

Enable Input: Leading edge of input signal causes group position to become the Absolute Offset (FCN 6) value (reset to preset), if the input is armed.

Outputs: Active at all times (on whenever group position is within programmed ON/Off setpoints).

Enable Window: Rearms input so another reset to preset can occur. Window can be reached from either direction. Once the input is rearmed, the next input signal can occur at any position. It does NOT have to be within the window.

Mode 2 - Reset Position to Preset & Enable Outputs

Enable Input: Leading edge of input signal activates the outputs and causes group position to become the Absolute Offset value (FCN 6), if the input is armed.

Outputs: Active only after an input signal occurs. Remain active until the beginning of the next enable window. Will then be disabled until next input signal occurs.

Enable Window: Rearms input so another reset to preset and output activation can occur. Window can be reached from either direction. Once the input is rearmed, the next input signal can occur at any position. It does NOT have to be within the window.

Mode 3 - AND Outputs with Input Signal

Enable Input: Presence of input signal activates the outputs. Outputs are inactive when input is off.

Outputs: Only active when Enable Input signal on.

Enable Window: Not needed.

Mode 4 - Activate Outputs if Input Occurs in Window

Enable Input: Leading edge of input signal must occur within Enable Window to activate outputs. Group position (offset) is not changed. Position where input turns off does NOT affect the output cycle.

Outputs: Active if start of input signal occurred within Enable Window. Outputs become inactive at the start of the next enable window and remain inactive until next input signal starts within window.

Enable Window: Must be positioned so that leading (on) edge of the input signal occurs within the window.

Mode 5 - Activate Outputs if Input On During Window

(Includes “First Cycle” and Stop/Unlatch features)

Mode 5 operates in a manner very similar to Mode 4 with some minor differences and added features as follows: **Enable Input:** Input must be on during a portion, or all, of the Enable Input Window to activate outputs. Group position (offset) is not changed. The position of the leading and trailing edges of the input signal are not critical as long as the input is on during some portion of the Enable Window.

Outputs: Active if input was on during any portion of Enable Window. Can also become active from First Cycle Enable Input signal if machine is stopped and Enable Input is on. Will become inactive at the start of next window and remain inactive until Enable Input requirements are again met.

Enable Window: Must be positioned so that some portion of input signal occurs within the window.

Stop/Unlatch Logic: If the machine stops while the output logic is activated, it will become deactivated. The outputs will turn off and will not cycle when motion resumes (unless the First Cycle Enable Input feature is used).

First Cycle Enable Input: Energizing this input activates the outputs to start cycling from the current position if the machine is stopped and the Enable Input is on. If needed, use motion ANDing to prevent outputs from coming on while machine is still stopped.

FCN 110: Outputs ANDed with Output Enable Input

(Master Program Enable MUST be on)

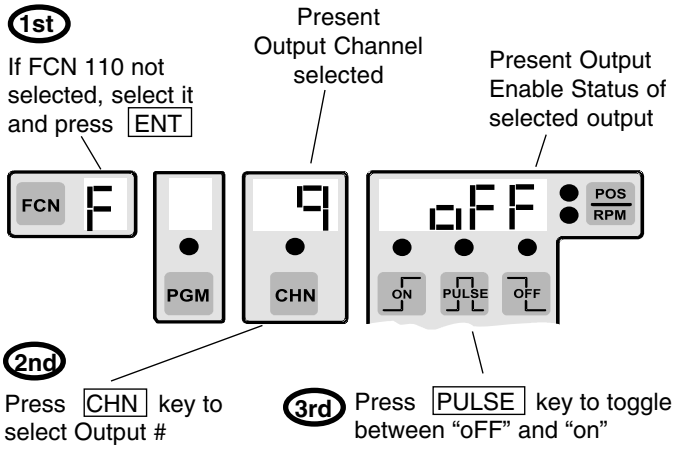
The PS-5144 has a dedicated Output Enable input located on the input terminal strip (term 16). Any output(s) can be ANDed with this Output Enable input. An output that is ANDed with it will only operate when the Input is on. Outputs that must always operate, regardless of the Output Enable input status, must be set to the OFF mode.

oFF - Selected output # is NOT ANDed with Enable Input

ON - Selected output # is ANDed with Enable Input

Note: The Output Enable feature allows any combination of outputs (regardless of grouping) to be disabled by turning off the hardware Output Enable input. This can simplify the implementation of safety circuits and other system logic required. Analog outputs cannot be ANDed with the Output Enable input.

Programming Output Enable Channels



FCN 111: Channel Setpoint Memory (Monitor Only)

(Programming Access does NOT have to be on)

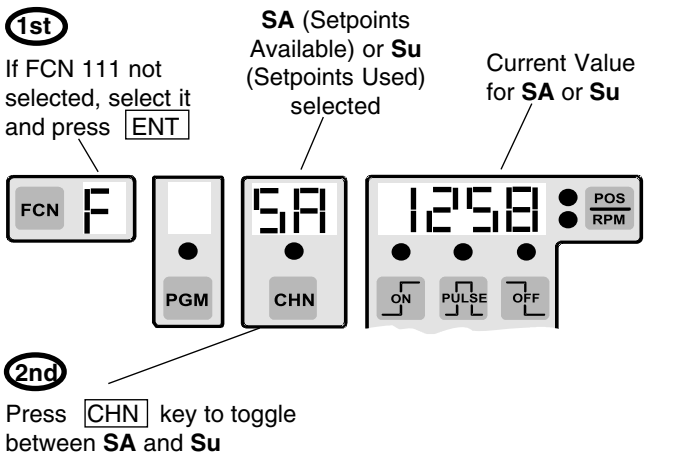
The PS-5144 with standard size memory can store approximately 1200 output setpoint pairs (1200 pulses). A PS-5144 with the “F” option (large memory) can store approximately 4500 output setpoint pairs. Function 111 allows the total setpoint pair memory and the amount presently used to be monitored as follows:

SA - Total number of Setpoint Pairs Available

Su - Number of Setpoint Pairs Presently being Used.

Note: The control can store up to 48 different programs provided the total number of output setpoint pairs used (Su) is less than the total number available (SA). Applications which have more than 25 setpoints in each program will be restricted to less than 48 programs if the control has the standard size memory.

Monitoring Output Setpoint Memory



Number of Setpoint Pairs remaining is equal to: **SA - Su**

General Troubleshooting

Troubleshooting Introduction

This section of the manual contains information which covers both programming and hardware troubleshooting. The controller does identify common programming errors and hardware problems with flashing error messages. Lists of these error messages are found on the next two pages (pages 7-2 & 7-3). If the controller is displaying a flashing error message, look it up in the error message lists and take the recommended steps to correct it.

The troubleshooting section also contains information on special programming functions that can be used to force outputs on manually, monitor input status, monitor actual resolver position, and test the keyboard hardware. Also, alternate functions are described, which allow all of the control's programming, or all of the output setpoints, to be erased. Be careful when using these functions.

The last page (page 7-9) of the troubleshooting section shows how the transistor output array chips can be replaced in the field should one or more of them become damaged.

Common Troubleshooting Problems

The remainder of this page describes some commonly encountered problems along with likely causes. In many cases, the likely causes are programming errors. Wiring, blown fuses and other causes are also covered where applicable. If you are unable to solve a problem after going through this section, call the Electro Cam factory for assistance.

A. Control Position Value(s) go in Wrong Direction Relative to Machine Direction.

1. Check FCN 101 "dr" for the correct direction of rotation.
2. Check resolver wiring (page 3-1).

B. Controller Position Value(s) do not Match Machine Position.

1. Verify that Shaft Position is correct (FCN 101-"SP").
2. Program FCN 2 or FCN 6 to correct controller position.

C. Controller Completely Dead - No LEDs Lit on Keyboard.

1. Check input power fuse.
2. Check 20-30 Vdc input power present.

D. Outputs not Cycling at Correct Machine Positions

1. Check that correct program number is active.
2. Check the setpoints of the output(s) in question.
3. Verify that control position matches machine position.

E. All Transistor Outputs Not Operating.

1. Check that correct program number is active.
2. Use FCN 200 (page 7-5) to manually force on one of the transistor outputs. Determine if the output is on (check load device status or use a meter). If it is on, there is probably a programming problem (if not on go to step 3). Verify that the output setpoints are correctly programmed. Other possible programming causes are timed outputs (FCN 5), motion ANDing (FCN 107), output modes (FCN 109), and enable input ANDing (FCN 110).
3. Check the transistor output fuse.
4. Check transistor 10-30 Vdc input power present.

F. Some Transistor Outputs Not Working.

1. Check that correct program number is active.
2. Use FCN 200 (page 7-5) to manually force on one of the transistor outputs that is not working. Determine if the output is on (check load device status or use a meter). If it is on, there is probably a programming problem (if not on go to step 3). Verify that the output setpoints are correctly programmed. Other possible programming causes are timed outputs (FCN 5), motion ANDing (FCN 107), output modes (FCN 109), and enable input ANDing (FCN 110).
3. Check the transistor array chips of the outputs that are not functioning (details on page 7-9).

G. Some Module Output(s) Not Working.

1. Check that correct program number is active.
2. Use FCN 200 (page 7-5) to manually force on one of the module outputs in question. Observe the LED built into the module to determine if it is on. If it is on, there is probably a programming problem (if not on go to step 3). Verify that the output setpoints are correctly programmed. Other possible programming causes are timed outputs (FCN 5), motion ANDing (FCN 107), output modes (FCN 109) and enable input ANDing (FCN 110).
3. If the LED was not on when the output was forced on, using FCN 200, try another module before proceeding to step 4.
4. Check output module fuses of modules where the LED is cycling but the load device is not energizing.
5. Check that load power is present in the circuit and correctly wired.

H. Analog Output Not Working.

1. Check that FCN 101 "nA" (number of analog outputs) is programmed for the correct number of analog outputs.
2. Check that analog output module is located in the correct module position according to FCN 101 "nA".
3. Check that FCN 1 "Ao" (analog offset) and "AH" (analog high RPM) are correctly programmed.
4. Check correct wiring of analog output.
5. Verify that analog load device is within specifications for the analog module.
6. Try a different analog output module.

I. Serial Communication Not Working.

1. Check FCN 104 programming regarding "ct" (comm type), "cS" (comm speed) and "cA" (comm address). Host device and controller must use matching values for these items.
2. Check communication cable wiring (pages 3-14 and 3-15).

Resolver Troubleshooting

Mechanical Problems

If the resolver is generating erratic RPM or position readings, or the position appears to be shifting periodically with respect to the machine cycle, check the mechanical coupling between the resolver and the machine.

If the coupling is not slipping, loosen the coupling and rotate the resolver shaft in both directions with sudden, jerky motions. If the controller displays unusual position or RPM readings, the resolver may need to be replaced.

Resolvers cannot be repaired in the field. If a unit fails, do not disassemble it. Return it to the factory for replacement.

Electrical Problems

Page 3-2 shows the wiring diagrams for Electro Cam Corp. resolvers and cables. If any wire in one of the three individually shielded pairs becomes disconnected, the following error message will appear on the keypad/display:

"E10 -rES" Resolver Fault
The output channels will immediately be disabled until the resolver is reconnected. Press ECS to clear the error message.

Note that ESC will clear the message and restore access to keypad programming even if the resolver has not been reconnected.

The following procedure should be conducted when the resolver is not functioning and/or the controller is indicating an "E10-rES" error message.

1. Verify that all electrical connections at each end of the resolver cable are secure.
2. Disconnect the cable at the controller. Measure the resistance between all wires on the connector. The paired wires should each have the resistance shown in the figure below, while the resistance between every other combination of wire should be infinite. If the resistance values are correct, the contoller may need to be replaced.
3. If the resistance values in step 2 are incorrect, the problem may be in the cable or in the resolver. Disconnect the cable at the resolver and measure the resistance at the resolver pins. The paired wires should each have the resistance shown in the figure below, while the resistance between every other combination of wire should be infinite. If the resistance values are correct, the cable is bad. If the resistance values are wrong, the resolver should be replaced.

Wire Pair	Resistance	or	Resistance
White/Black	15 to 25 ohms		60 to 85 ohms
Red/Black	20 to 40 ohms		135 to 185 ohms
Green/Black	20 to 40 ohms		135 to 185 ohms

Programming Error Messages

Introduction to Programming Error Messages

Programming error messages indicate that an attempted programming step was invalid. The exact message flashing defines why the programming attempted was not acceptable. Except for the first error message shown, “E0 EErr”, the control will continue to operate the outputs normally while flashing programming error messages are present.

These Programming Error Messages do not indicate that there is something wrong with the control. They indicate that invalid programming is being attempted. The flashing System Error Messages described on the next page indicate electrical hardware problems not related to programming.

Programming Error Message Descriptions

“E0 EErr” EEPROM Programming Error
The Checksum associated with the Function programming (controller’s global configuration) was found to be incorrect when the control powered up. This problem is usually caused by the control powering down within four seconds after a programming change is made (non-volatile memory was being updated when power was lost). Outputs will be disabled until the error condition is cleared.

SOLUTION: Press any key to clear the flashing error message. All configuration programming (Functions) will be returned to the Factory Defaults, but setpoint information will remain unchanged. It will be necessary to reprogram all functions that were altered from the Factory Defaults. (See page 7-7, Alt FCN 7000, for a listing of Factory Defaults.)

“E1 OLAP” Pulse Overlap
The output pulse that was just created or incremented/decremented overlaps or touches another pulse that already exists on the same output channel. Therefore, it was not entered. Also, if one edge of a pulse is incremented/decremented until it becomes equal to the other edge, an “E1 OLAP” error will occur.

SOLUTION: Press any key to clear the flashing error message. Use VIEW keys to review the setpoints that are already programmed on this channel to determine the cause of the overlap condition.

“E2 run” Item Can Not be Programmed While Running
While the resolver was turning, an attempt was made to change a programmed item that cannot be changed unless the resolver is stationary. Example - Items which cannot be changed while in motion are: Direction of Rotation (FCN 101 - dr), Scale Factor (FCN 101 - SF), Output Grouping (FCN 108), and Enable Input Modes (FCN 109).

SOLUTION: Press any key to clear the flashing error message. Stop the machine (resolver) while making the program change.

“E4 -Pro” Programming Not Enabled
A programming change was attempted when the corresponding level of programming access was not enabled. There are three levels of programming access - see page 4-5 of this manual for details.

SOLUTION: Press any key to clear the flashing error message. Enable the appropriate level of programming access and make the necessary changes.

“E5 8888” Number Out of Range
An attempt was made to enter a number that exceeds allowable limits for the item being programmed. Some examples are: a setpoint value that exceeds the scale factor, a channel number that exceeds 25, the number of output groups exceeding 6 (FCN 108), etc.

SOLUTION: Press any key to clear the flashing error message. Enter a valid value for the item being programmed.

“E7-dEF” Too Many Outputs Allocated
An attempt was made to allocate more than 25 outputs in FCN 108.

SOLUTION: Press any key to clear the flashing error message. Review Function 108 to find the cause of the problem.

“E9 tdE” Too Many Timed Outputs
An attempt was made to program more than 4 Timed Outputs.

SOLUTION: Press any key to clear the flashing error message.

"E10-rES" Resolver Fault
See page 7-2 for detailed information.

“E11-ScE” Too Many Speed Compensated Channels
An attempt was made to program more that 16 speed compensated outputs.

SOLUTION: Press any key to clear the flashing error message.

System Error Messages

Introduction to System Error Messages

System errors occur when conditions are detected within the controller that can cause unreliable operation. Rather than allowing the control to continue operating, **all outputs will be disabled and an error message displayed whenever system error conditions occur.**

The cause of a system error must be determined and corrected before reliable controller operation can be guaranteed. Contact the Electro Cam factory for assistance whenever system error messages repeat.

System Error Message Descriptions

"E0 FAtL" Memory Fault
A problem with random access memory has been detected and the unit cannot function properly. Memory circuitry in the controller is not functioning properly.

SOLUTION: The control must be returned to factory for repair. Call Electro Cam for further information.

"E1 CHEC" Checksum Error (Checked on Power-up)
The stored checksum value did not match the memory contents when checked on power-up. All outputs will be disabled while this error condition exists. This problem can be caused by severe electrical noise during power-up or hardware failure within the control.

SOLUTION: Remove and restore input power to the controller. If the control repeats the "E1 CHEC" error condition each time it is powered up, hardware within the control is damaged. Call Electro Cam for further information.

"E10 -rES" Resolver Fault
See Page 7-2 for more detailed information.

"E12 -oFd"
This message indicates that the offset mode has been changed to **onE** instead of **EACH**, when the controller is in Mode 1 or 2. See page 6-2, **"nO"**.

SOLUTION: When using Mode 1 or 2, the offset mode should remain on **EACH**.

"CrASH" Watchdog Timer Fault
The Watchdog Timer has timed out, indicating that the controller is not properly executing its program. All outputs will be disabled during this error condition. This problem can be caused by severe electrical noise or hardware failure within the control.

SOLUTION: Remove and restore input power to the controller. If the control repeats the "CrASH" error condition each time it is powered up, hardware within the control is damaged. Call Electro Cam for further information.

If "CrASH" errors occur at intermittent intervals, they are apparently being caused by excessive electrical noise. Check wiring for proper shielding and grounding.

"FATL_AnA" Analog Chip Error
This message indicates that the controller's analog chip has malfunctioned.

SOLUTION: Call Electro Cam for further information.

Note: A bad analog module will not cause this error message.

"FATL_INTN" or "FATL_INT2" Internal Run Errors
These messages indicate that there is a hardware problem with the internal circuitry. All outputs will be disabled.

SOLUTION: Call Electro Cam for further information.

"LinEFAiL" Input Power Voltage Low
The DC input power operating the controller dropped below normal operating voltage, causing the controller to stop functioning.

SOLUTION: Control will come out of "LinEFAiL" condition when input voltage rises to normal range.

"Pb Stuc" Push Button Stuck
If one of the keyboard keys is on when the unit powers up, this message will be displayed. It can indicate that a key is shorted and always on.

SOLUTION: If "Pb Stuc" error message remains or occurs frequently on power up, call Electro Cam for further information.

"StoP" Controller in Stop Mode
When serial communication command 6 (COM_STOP) is sent to the control, it goes into an idle mode and displays the message "StoP". The Stop mode allows serial information to be written directly into the control's EEPROM memory, thus allowing rapid loading of program information. The PLuSNET DLOAD (download) program first puts the control in the Stop mode before sending information. When the loading process is complete, it returns the control to the run mode. The control can be left in the Stop mode if the loading process is interrupted before it finishes.

SOLUTION: Power cycle the control to restore normal operation.

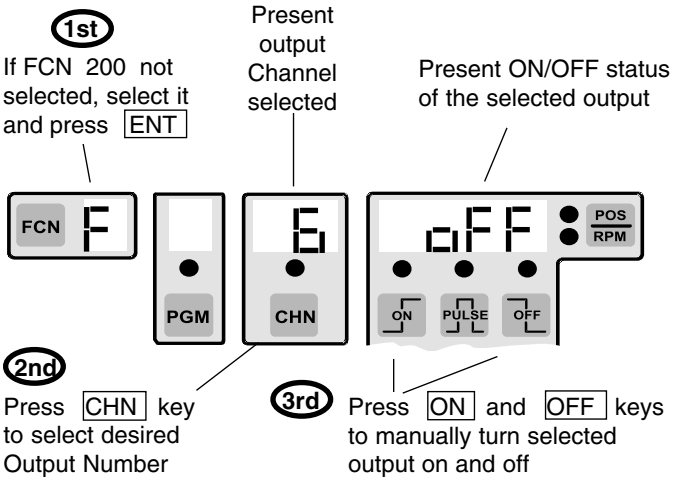
FCN 200: Manually Turn on Individual Outputs

(Master Programming MUST be Enabled)

FCN 200 allows individual outputs to be turned on manually, one at a time. **All other control operations are disabled when FCN 200 is accessed.** This capability can be used to manually test the wiring and output devices connected.

The CHN key is used to select which output will be manually operated, and the ON and OFF keys will turn the selected output on and off. Advancing to another output number or exiting FCN 200 will automatically turn off any output that was manually energized.

Press POS/RPM key to exit FCN 200.



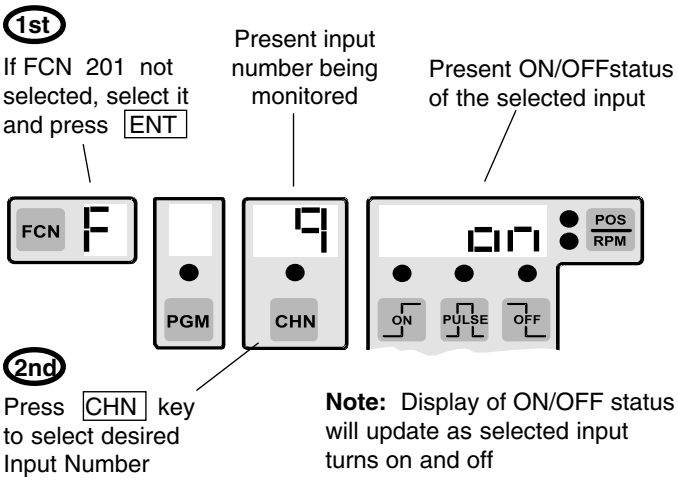
FCN 201: Monitor Status of Inputs

(Master Programming MUST be Enabled)

FCN 201 allows each individual input to be monitored, one at a time. **All other control operations are disabled when FCN 201 is accessed.** This can be used to manually check input wiring and the connected input devices.

The CHN key is used to select which input is being monitored. The status displayed is continuously updated to show the current status of the input.

Press POS/RPM key to exit FCN 201.



Input Numbers / Functions

1-6	Program Select (1 is LSB)
7	Master Program Enable
8	Operator Program Enable
9	Group 1 Enable
10	Group 2 Enable
11	Group 3 Enable
12	Group 4 Enable
13	Group 5 Enable
14	Group 6 Enable
15	First Cycle Enable
16	Output Enable

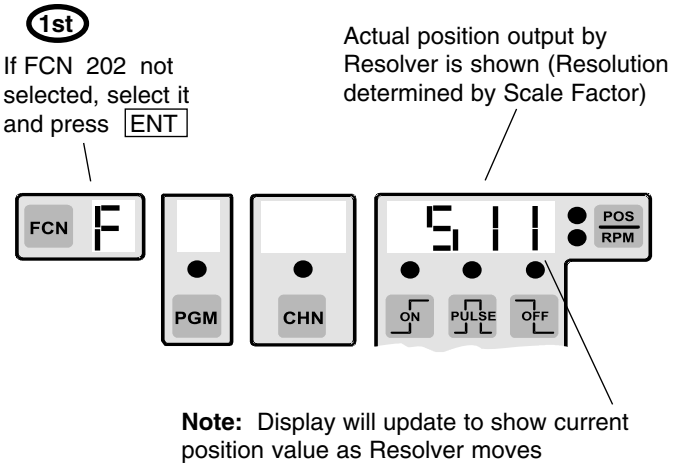
FCN 202: Monitor Actual Resolver Position

(Master Programming MUST be Enabled)

FCN 202 displays the actual resolver position value being output by the resolver. The displayed value does not take into consideration Offset or Direction of Rotation. The resolution of the displayed resolver position is determined by the current Scale Factor as follows:

S.F. Value	Position Resolution
2 - 512	512 (9 bits)
513 - 1024	1024 (10 bits)
1025 - 2048	2048 (11 bits - "H" Option Only)
2049 - 4096	4096 (12 bits - "H" Option Only)

Press POS/RPM key to exit FCN 202.



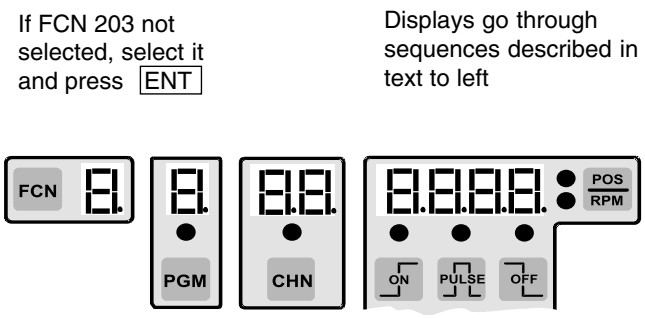
FCN 203: Test All Keyboard LEDs

(Master Programming MUST be Enabled)

FCN 203 lights up all of the keypad LEDs, including the 7 segment displays and their decimal points. This operation can be used to verify that each hardware LED element is operational. The display will go through the following sequence of operation:

1. All 7 segment LED elements light up.
2. Each 7 segment LED lights up in sequence.
3. All indicator LEDs light up (except CPU).
4. CPU indicator LED lights up.
5. LED indicators light up in sequence. (test returns to step 1)

Hold any key to exit FCN 203.



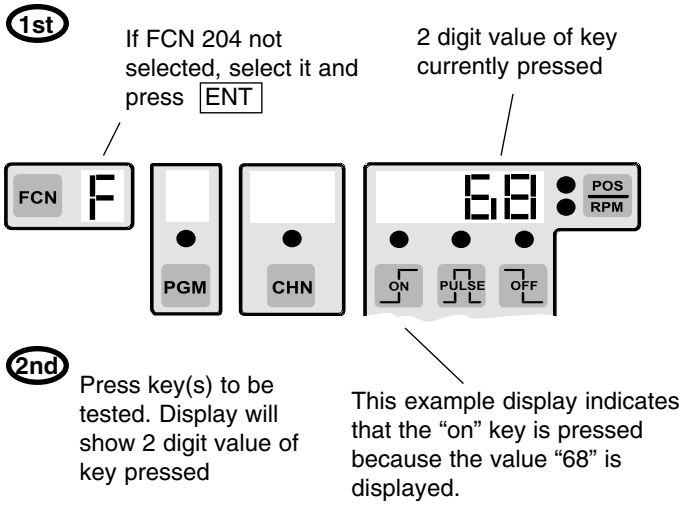
FCN 204: Test Individual Keyboard Keys

(Master Programming MUST be Enabled)

FCN 204 allows individual testing of each key on the keyboard. A 2 digit number is displayed for each key pressed, which confirms that the pressed key is being recognized by the controller. The 2 digit key values are as follows:

Value		Key	Value		Key
99	-	No Key or Multiple Keys	65	-	FCN
			66	-	PGM
48	-	0	67	-	CHN
49	-	1	68	-	ON
50	-	2	69	-	PULSE
51	-	3	70	-	OFF
52	-	4	71	-	<VIEW
53	-	5	72	-	VIEW>
54	-	6	73	-	<DEC
55	-	7	74	-	INC>
56	-	8	75	-	ENT
57	-	9	76	-	CLR

Power cycle the control to exit FCN 204.



Alternate Functions

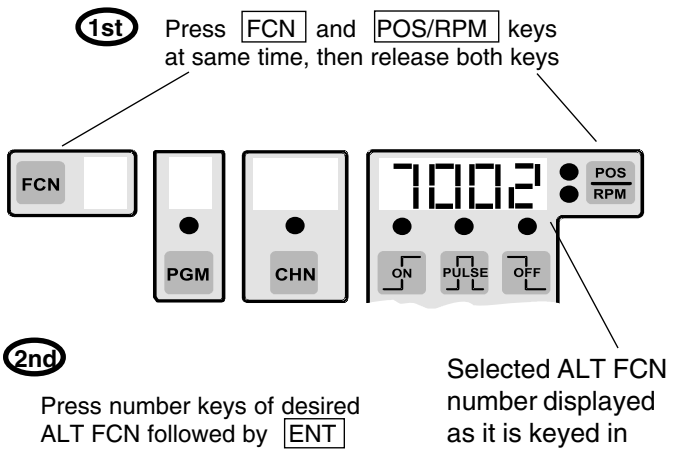
The Alternate Functions (ALT FCNs) allow the control's output setpoint programming to be erased completely and restore all of the function programming to the Factory Default settings if desired. Also, the operation of the control's Watchdog Timer and non-volatile EEPROM circuit and can be tested.

Warning: Output setpoint and function programming can be erased when Alternate Functions are activated.

Ensure that all programmed information is documented or saved to a disk file (units with serial communication) so it can be restored later if needed.

Alternate Functions are activated by using the key stroke sequence illustrated to the right.

Accessing Alternate Functions



ALT FCN 7000: Restore Factory Defaults and Clear All Output Channel Setpoints
The control will scroll through memory locations shown in position display for approximately 30 seconds. "E0 EErr" display will be flashing when the operation has completed. Press any key to restore normal operation. All Function programming will be reset to Factory Default settings and all "on"/"off" setpoints will be cleared. (Factory Defaults listed to right.)

ALT FCN 7001: Clear all Output Channel Setpoints
The control will scroll through memory locations shown in position display for approximately 30 seconds. A normal display of program number and Position or RPM will be restored when all setpoints have been cleared.

ALT FCN 7002: Watchdog Timer Test
The control will display "rSEt" followed by "CrASH" if the watchdog timer functions are operating properly. Press any key to restore normal operation.

If "CrASH" is not displayed when ALT FCN 7002 is activated, call Electro Cam for assistance.

ALT FCN 7999: Extensive EEPROM Test
This function Restores Defaults and Clears All Channel Setpoints. The control will scroll through memory locations shown in the position display for approximately 6-1/2 minutes. "CrASH" will be displayed when the test has completed if no problems were found in EEPROM. Press any key to clear the "CrASH" display, an "E0 EErr" message will then be displayed. Press any key to restore normal operation.

If a problem is found with the EEPROM circuitry, the display will latch up, during the test, with the bad memory location address shown. Call Electro Cam for further information if this happens.

Factory Default Settings

FCN 1 - 1 Lo = 10
1 Hi = 3000
2 LO = 10
2 Hi = 3000

FCN 2 - Position Value (no offset)

FCN 3 - PN = 1

FCN 4 - All CHN 0

FCN 5 - All CHN 0

FCN 6 - Position Value (no offset)

FCN 101 - dr = CCL
SF = 360
S = Position Value (no offset)
nA = 0
nO = EACH
rt = Ecc
PS = bin

FCN 102 - Sc = onE
tb = 1

FCN 103 - dd = SPd
tr = 0
ru = 1

FCN 104 - ct = 485
cS = 9600
cA = 1

FCN 105 - SE = 1
OE = 2

FCN 106 - CHN 1-25 oFF
SP = oFF
Sd = oFF
oF = oFF
AP = oFF
Sc = oFF
to = oFF

FCN 107 - CHN 1-25 oFF

FCN 108 - 1 (grp) 25 (outs)

FCN 109 - 1 (grp) 0 (Mode)

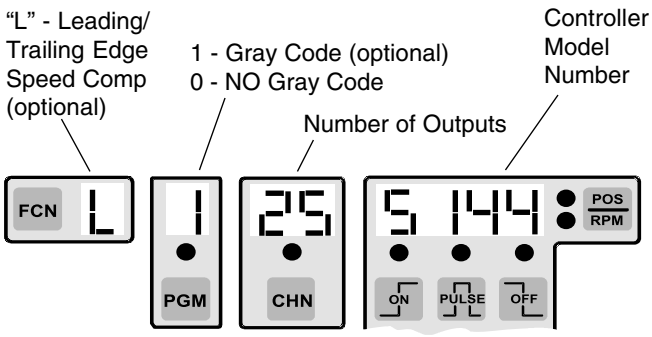
Retrieving Control's Features Information

Detailed information about the control model and specific features it contains can be retrieved from the keyboard. The functions listed below provide a fool proof way to determine which features are included in the control. Programming access in not required to view these functions since they cannot affect the operation of the control.

FCN 300: "L" & "G" Options, Outputs & Model

The illustration to the right describes the information presented by FCN 300. The "L" option (leading/trailing edge speed comp) and "G" option are optional features on PS-5144 controls, and therefore, do not exist in all units. A given control may have both, one, or neither of these features.

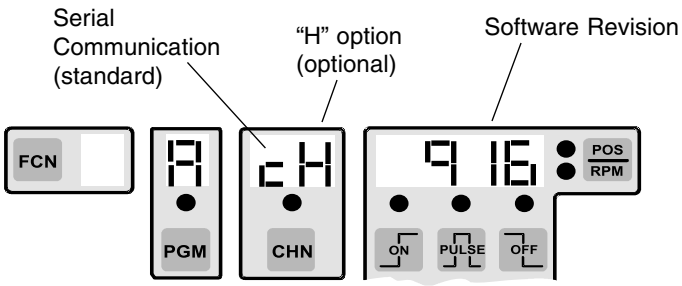
Press FCN 3 0 0 ENT



FCN 301: "C" & "H" Options, Software Rev.

The illustration to the right describes the information presented by FCN 301. The "C" option (serial communication) is a standard feature of all PS-5144 controls. The "H" option (high resolution—12 bits) is an optional feature, and therefore, does not exist in all PS-5144 units. The software revision number indicates which version of PS-5144 firm ware is in the control.

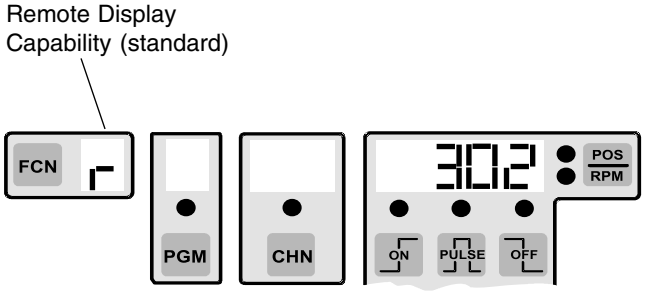
Press FCN 3 0 1 ENT



FCN 302: Remote Display and Output Update

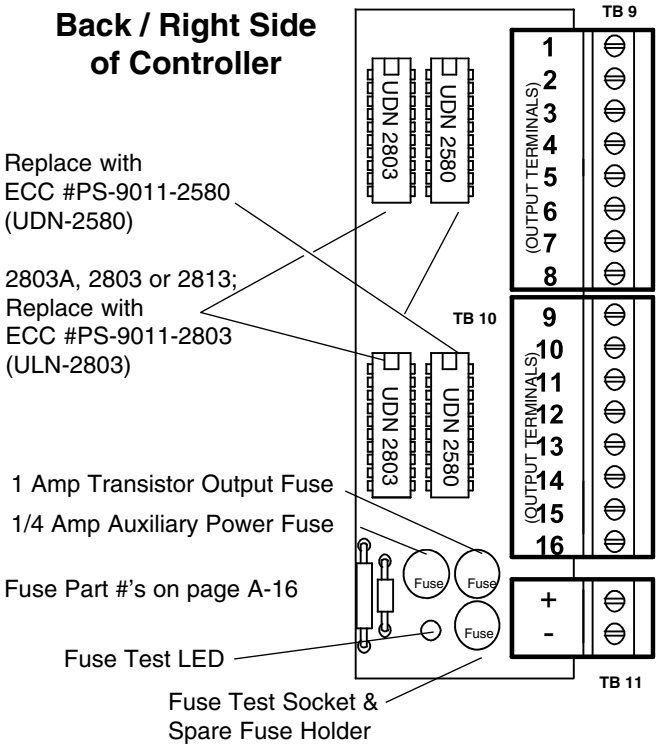
The illustration to the right describes the information presented by FCN 302. The "r" indicates that an Electro Cam remote display device can be operated from the RS-485 serial port (standard on all PS-5144 controls).

Press FCN 3 0 2 ENT



Troubleshooting Transistor Outputs

Sourcing Transistor Outputs: Model# PS-5144-24-P16M09

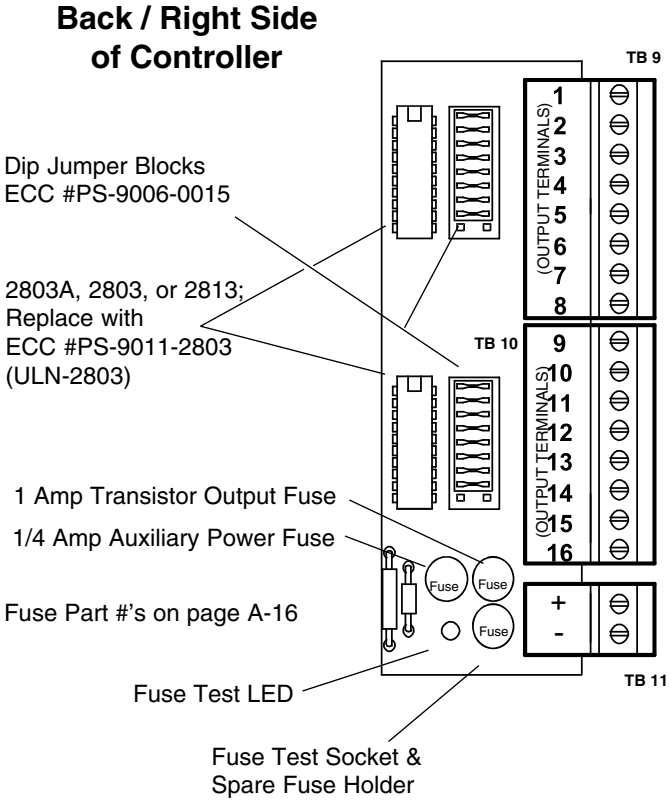


The transistor output circuits are powered by a 10-30 VDC supply connected below the transistor output terminals (page 2-4). **If all of the transistor outputs are not functioning, ensure that 10-30 VDC is applied and that the "1 Amp Transistor Output Fuse" is good**. It can be checked by plugging it into the "Fuse Test Socket" and observing the "Fuse Test LED".

The transistor array chips are socketed for field replacement. In the event of a wiring error or accidental short circuit, it is possible to damage one or more of the array chips. In these situations, replacing the UDN 2580 chip(s) will usually correct the problem. **Ensure that a short circuit doesn't exist before replacing the chip—be careful not to bend the pins when plugging the chip in.** Each chip operates the 8 transistor outputs immediately to the right of it. **The orientation of the notched end of the chip is critical—ensure that the chip is inserted as shown to the left.**

If replacing the UDN 2580 does not solve the problem, try replacing the ULN 2803A, 2803, or 2813 chip next to it.

Sinking Transistor Outputs: Model# PS-5144-24-N16M09



The transistor output circuits are powered by a 10-30 VDC supply connected below the transistor output terminals (page 2-4). **If all of the transistor outputs are not functioning, ensure that 10-30 VDC is applied and that the "1 Amp Transistor Output Fuse" is good.** It can be checked by plugging it into the "Fuse Test Socket" and observing the "Fuse Test LED".

The transistor array chips and jumper blocks are socketed for field replacement. In the event of a wiring error or accidental short circuit, it is possible to damage one or more of the array chips. In these situations, replacing the ULN 2803A/2813 chip(s) will usually correct the problem. **Ensure that a short circuit doesn't exist before replacing the chip - be careful not to bend the pins when plugging the chip in.** Each chip operates the 8 transistor outputs immediately to the right of it. **The orientation of the notched end of the chip is critical—ensure that the chip is inserted in the direction shown in the illustration to the left.**

Do NOT remove the jumper blocks shown next to the transistor array chips. **If one is removed and needs to be reinserted, ensure that the unjumpered holes in the dip socket are at the bottom, as shown in the illustration.** The jumper block only connects the top eight sets of holes. Connecting the bottom two holes will short out the "10-30 VDC Transistor Input Power" and cause the "1 Amp Transistor Output Fuse" to blow.

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PLμsNet II Upload/Download Program

Description

PLμSNet II is a DOS program that will run on most IBM-PC compatible computers. When the serial port of the PC is connected to a PLμS Programmable Limit Switch, PLμSNet II can transfer programming values between the computer and the controller in either direction. PLμSNet II includes its own communications software with selection of baud rate, PLμS controller address, and the computer's COM port. No other communication software is needed.

Functions

PLμSNet II provides two main functions: **Uploading** a controller's complete set of programming values from the controller to an ASCII file on the PC; and **downloading** the contents of an ASCII from a computer to the PLμS controller. PLμSNet II also provides a text editor to view and change the contents of an ASCII file.

Applications

Hard Copy Reference—Using PLμSNet II, a PLμS controller's programming can be saved as an ASCII file and printed out for reference. The printout can be used to study line operation or to program other PLμS controllers in the plant.

Archival Storage—The ASCII file containing a PLμS controller's programming can be stored on a hard drive or floppy disk. In the event of accidental alteration or erasure of the controller's programming, PLμSNet II can be used to download the ASCII file to the controller to restore normal operation.

Programming Multiple Units—If several PLμS controllers will have the same values, one controller can be programmed correctly and its setpoints uploaded to a PC using PLμSNet II. The programming can then be downloaded to the other PLμS controllers, eliminating the need to manually reenter setpoints for each controller.

Modify Programming—Once a program has been saved as an ASCII file, it can be studied and edited to create other versions of the program.

Contents

The PLμSNet II Communications Software Program includes these materials:

(1) Introduction sheet.

(1) One disk containing the PLUSNET.EXE file.

Cable

To use PLμSNet II, a serial communications cable is required to connect the PLμS controller to an IBM compatible personal computer. This cable can be purchased from Electro Cam Corp., or it can be built by the customer using the wiring information shown in the PLμS Programming and Installation Manual.

Installation

Copy the PLUSNET.EXE file to the desired directory on the PC.

Operation

Connect the PC and the PLμS controller with a communications cable and turn both units ON.

Start PLUSNET.EXE from the DOS command line, or from a DOS window within Microsoft Windows. The menus in the program are self-explanatory.

Sample ASCII Program Copied from PS-5144 Using PLμSNET II

```
2: 5144                 ;Model
3: 316                  ;Firmware revision
4: 17                   ;Output quantity
5: 5,1                  ;Option: -H; High resolution
5: 6,1                  ;Option: -L; Leading/trailing speed comp
5: 7,1                  ;Option: -A; Analog output
6: 1                    ;Default Program
9: 1,0                  ;Offset: group#, offset
9: 2,0                  ;Offset: group#, offset
10: 1,0,2000            ;Analog output: Analog chn#, offset, high rpm
11: 1,10,3000           ;Motion detection: level#, low rpm, high rpm
11: 2,10,3000           ;Motion detection: level#, low rpm, high rpm
14: 0                   ;Map limit
17: 0                   ;Direction of increasing rotation: 0=CCW, 1=CW
18: 360                 ;Scale factor
19: 0                   ;Shaft offset
20: 1                   ;Analog quantity
21: 0                   ;Resolver type: 0=ECC, 1=Other
22: 0                   ;Program select mode: 0=bin, 1=BCD, 2=Gray
25: 1,1                 ;Termination resistors: grp1 on/off, grp2 on/off
27: 1,1,0,0             ;Rate setup: mpx, div, dec pt, units
28: 20                  ;Toggle rpm
29: 0                   ;Rpm update rate: 0=1/Sec, 1=2/Sec, 2=10/Sec
30: 1                   ;Speed comp mode: 0=Single, 1=L/T
31: 0                   ;Group pos display mode: 0=Each, 1=One
32: 1                   ;Operator ID number
33: 2                   ;Setup ID number
34: 3                   ;Master ID number
35: 1;1,1,1,1,1,1,1,1   ;Per chn enable: chns 1-8; chn on/off
35: 2;1,1,1,1,1,1,1,1   ;Per chn enable: chns 9-16; chn on/off
35: 3;0,0,0,0,0,0,0,0   ;Per chn enable: chns 17-24; chn on/off
36: 1                   ;Operator enable: Setpoints
37: 1                   ;Operator enable: Default program
38: 1                   ;Operator enable: Speed comp
39: 1                   ;Operator enable: Timed outputs
40: 1                   ;Operator enable: Offsets
41: 1                   ;Operator enable: Motion Detection
42: 1                   ;Operator enable: Analog values
43: 2;0,0,0,0,0,0,0,0   ;Motion ANDing: chns 9-16; chn levels (o=none)
43: 3;0,0,0,0,0,0,0,0   ;Motion ANDing: chns 17-24; chn levels (o=none)
44: 1;0,0,0,0,0,0,0,0   ;Output enable ANDing: chns 1-8; chn on/off
44: 2;0,0,0,0,0,0,0,0   ;Output enable ANDing: chns 9-16; chn on/off
44: 3;0,0,0,0,0,0,0,0   ;Output enable ANDing: chns 17-24; chn on/off
45: 2                   ;Output group quantity
46: 1,10,0              ;Output group config: group, #chns, mode
46: 2,6,4               ;Output group config: group, #chns, mode
49: 1,1,0,90            ;Pulse: pgm, chn, on, off
49: 1,1,180,270         ;Pulse: pgm, chn, on, off
49: 1,2,0,180           ;Pulse: pgm, chn, on, off
49: 1,3, 45,270         ;Pulse: pgm, chn, on, off
```

Background

PS-5144 controllers include programming that allows them to accept and respond to a set of serial commands issued by a system host such as a PLC or other computer. The commands can interrogate the PS-5144 for operating and control data, and they can also change programming values within the PS-5144.

Serial communications are initiated when the system host sends a command to the PS-5144. The PS-5144 processes the command and sends a reply to the host. Modbus ASCII protocol is available (see page 8-13).

Syntax

All commands are sent and received as ASCII character strings in the following syntax. **Do not include spaces between fields.**

Command from Host: STX ADR CMD <DTA> CSM ETX

Reply from PLuS: ACK or NAK <DTA> CSM ETX

Field	No. of Characters	Description
STX	1	Start of text. The PLuS uses "!" for this character.
ADR	2 hex	Address of PLuS controller on network (0-255)
CMD	2 hex	Command number. Commands are listed later on in this chapter.
DTA	n hex	The number and type of data elements is determined by the command, reply, or the error. **All data is sent and received in hex.**
CSM	2 hex	Checksum. The method by which the PS-5144 calculates the checksum is described later in this chapter. When the host sends a command, it must include a checksum calculated in the same way so that the PS-5144 can check the command for communication errors. The host should also use this calculation method to analyze the reply from the PS-5144 for possible communication errors.
ETX	1	End of text. The PLuS uses a carriage return, or <CR>, for this character
ACK	1	Positive acknowledge. The PLuS uses the letter "A" for ACK.
NAK	1	Negative acknowledge, or error condition. The PLuS uses the letter "N" for NAK. A list of error replies are included later in this section.

The specified number of ASCII characters must be sent for each field. Include leading zeroes if the data in a field is less than the field length. The control will also include leading zeroes in its replies.

Set the host's communication parameters to 8N1: eight data bits, no parity, one stop bit.

Description

The PS-5144 controller recognizes a set of 95 commands. Some of these commands involve testing and diagnostic functions performed at the factory. Because these commands are of little use in field installations, they are not included in the following pages. For information on the complete command set, contact the factory.

The commands are grouped by general function. In the syntax shown for each command and reply, the characters used for STX, ETX, ACK, and NAK are substituted, as listed on the previous page.

The commands are listed in hex.

Supervisory Commands

CMD (hex)	Name		Function
04	Hello		Are you there?
		Cmd:	! ADR **04** CSM <CR>
		Reply:	A <CR>
06	Com Stop		Stop operation & idle; changes will be written directly to EEPROM with no other action taken.
		Cmd:	! ADR **06** CSM <CR>
		Reply:	A <CR>
07	Checksum		Sets new checksums in EEPROM.
		Cmd:	! ADR **07** CSM <CR>
		Reply:	A <CR>
08	Start		Resume operation.
		Cmd:	! ADR **08** CSM <CR>
		Reply:	A <CR>
09	Reset		Create hard reset through watchdog.
		Cmd:	! ADR **09** CSM <CR>
		Reply:	A <CR>

Status Commands

0A	RPM		Current RPM.
		Cmd:	! ADR **0A** CSM <CR>
		Reply:	A XXXX CSM <CR>
			where “XXXX” = current RPM in hex.
38	Shaft Pos		Shaft position.
		Put:	! ADR **38** P XXXX CSM <CR>
		Reply:	A <CR>
		Get:	! ADR **38** G CSM <CR>
		Reply:	A XXXX CSM <CR>
			where “XXXX” is the shaft position in hex.
0B	Grp Pos		Current position.
		Cmd:	! ADR **0B** XX CSM <CR>
		Reply:	A YYYY CSM <CR>
			where “XX” is the group number minus one. “YYYY” is that group’s position in hex.

Configuration Commands

CMD (hex)	Name		Function
56	Kbd Qty		Number of keypads connected.
		Put:	! ADR **56** P XX CSM <CR>
		Reply:	A <CR>
		Get:	! ADR **56** G CSM <CR>
		Reply:	A XX CSM <CR>
			where "XX" = number of keypads connected.
0D	Setup ID		Setup ID code.
		Put:	! ADR **0D** P XXXX CSM <CR>
		Reply:	A <CR>
		Get:	! ADR **0D** G CSM <CR>
		Reply:	A XXXX CSM <CR>
			where "XXXX" = Setup Enable Code in hex.
0E	Operator ID		Operator ID code.
		Put:	! ADR **0E** P XXXX CSM <CR>
		Reply:	A <CR>
		Get:	! ADR **0E** G CSM <CR>
		Reply:	A XXXX CSM <CR>
			where "XXXX" = Operator Enable Code in hex.
58	Master ID		Master ID code.
		Put:	! ADR **58** P XXXX CSM <CR>
		Reply:	A <CR>
		Get:	! ADR **58** G CSM <CR>
		Reply:	A XXXX CSM <CR>
			where "XXXX" = Master Enable Code in hex.
0F	User Pgm		User programming enable/disable.
		Put:	! ADR **0F** P XX <00 or 01> CSM <CR>
		Reply:	A <CR>
		Get:	! ADR **0F** G XX CSM <CR>
		Reply:	A <00 or 01> CSM <CR>
			where "XX" is the channel number minus 1, in hex. "00" = disable, and "01" = enable.
10	Motion Enab		Motion detection on/off for a specified output channel.
		Put:	! ADR **10** P XX <00, 01, or 02> CSM <CR>
		Reply:	A <CR>
		Get:	! ADR **10** G XX CSM <CR>
		Reply:	A <00, 01, or 02> CSM <CR>
			where "XX" is the channel number minus 1, in hex. "00" = L1 & L2 off; "01" = L1 on; "02" = L2 on.

Configuration Commands (cont'd)

CMD (hex)	Name		Function
12	Inc Direction		Direction of increasing rotation.
		Put:	! ADR **12** P <00 or 01> CSM <CR>
		Reply:	A <CR>
		Get:	! ADR **12** G CSM <CR>
		Reply:	A <00 or 01> CSM <CR>
			where "00" = CCW, and "01" = CW
13	Scale Factor		Scale factor.
		Put:	! ADR **13** P XXXX CSM <CR>
		Reply:	A <CR>
		Get:	! ADR **13** G CSM <CR>
		Reply:	A XXXX CSM <CR>
			where "XXXX" = scale factor in hex.
48	Lo Limit		Motion detection low limit.
		Put:	! ADR **48** P <00 or 01> YYYY CSM <CR>
		Reply:	A <CR>
		Get:	! ADR **48** G <00 or 01> CSM <CR>
		Reply:	A YYYY CSM <CR>
			where "YYYY" = low limit RPM in hex. "00" = Level 1, "01" = Level 2.
49	Hi Limit		Motion detection high limit.
		Put:	! ADR **49** P <00 or 01> YYYY CSM <CR>
		Reply:	A <CR>
		Get:	! ADR **49** G <00 or 01> CSM <CR>
		Reply:	A YYYY CSM <CR>
			where "YYYY" = high limit RPM in hex. "00" = Level 1, "01" = Level 2.
17	Time Delay		Delay value for Timed Output channels.
		Put:	! ADR **17** P XX YYYY CSM <CR>
		Reply:	A <CR>
		Get:	! ADR **17** G XX CSM <CR>
		Reply:	A YYYY CSM <CR>
			where "XX" is the channel minus 1, in hex, and "YYYY" is the delay in msec, in hex.
18	Default Pgm		Default program.
		Put:	! ADR **18** P XXXX CSM <CR>
		Reply:	A <CR>
		Get:	! ADR **18** G CSM <CR>
		Reply:	A XXXX CSM <CR>
			where "XXXX" is the Default Program minus 1, in hex.

Configuration Commands (cont'd)

CMD (hex)	Name		Function
1A	Spd Cmp Mode		Standard or Leading/Trailing mode.
		Put:	! ADR **1A** P <00 or 01> CSM <CR>
		Reply:	A <CR>
		Get:	! ADR **1A** G CSM <CR>
		Reply:	A <00 or 01> CSM <CR>
			where "00" = Standard, "01" = Leading/Trailing
1B	Spd Cmp Val		Speed comp value.
		Put:	! ADR **1B** P XX YYYY ZZZZ CSM <CR>
		Reply:	A <CR>
		Get:	! ADR **1B** G XX CSM <CR>
		Reply:	A YYYY ZZZZ CSM <CR>
			where "XX" is the channel minus 1, in hex. "YYYY" is the value in tenths of a msec for the leading edge, and "ZZZZ" is the value for the trailing edge. For standard speed comp, "YYYY" = "ZZZZ". "Y" and "Z" values are hex.
4B	Analog Qty		Number of analog outputs used.
		Put:	! ADR **4B** P XX CSM <CR>
		Reply:	A <CR>
		Get:	! ADR **4B** G CSM <CR>
		Reply:	A XX CSM <CR>
			where "XX" is the number of analog outputs used. "XX" can be 00, 01, or 02.
1C	Analog		Analog values.
		Put:	! ADR **1C** P XX YYYY ZZZZ CSM <CR>
		Reply:	A <CR>
		Get:	! ADR **1C** G XX CSM <CR>
		Reply:	A YYYY ZZZZ CSM <CR>
			where "XX" is the channel minus one, in hex. "YYYY" is the Offset from 0 to 4095, converted to hex. "ZZZZ" is the High RPM in hex.
1D	Grp Qty		Output group quantity.
		Put:	! ADR **1D** P XX CSM <CR>
		Reply:	A <CR>
		Get:	! ADR **1D** G CSM <CR>
		Reply:	A XX CSM <CR>
			where "XX" is the number of output groups, from one to six.
4A	Offset Mode		One offset for all groups, or individual offset for each group.
		Put:	! ADR **4A** P <00 or 01> CSM <CR>
		Reply:	A <CR>
		Get:	ADR **4A** G CSM <CR>
		Reply:	A <00 or 01> CSM <CR>
			"00" = Each; "01" = One.

Configuration Commands (cont'd)

CMD (hex)	Name		Function
1E	Grp Offset		Output group offset value.
		Put:	! ADR **1E** P XX YYYY CSM <CR>
		Reply:	A <CR>
		Get:	ADR **1E** G XX CSM <CR>
		Reply:	A YYYY CSM <CR>
			where "XX" is the group number minus 1. "YYYY" is the offset value for that group, in hex.
3C	Shaft Offset		Shaft position offset.
		Put:	! ADR **3C** P XXXX CSM <CR>
		Reply:	A <CR>
		Get:	! ADR **3C** G CSM <CR>
		Reply:	A XXXX CSM <CR>
			where "XXXX" is the shaft offset in hex.
1F	Grp Chn Qty		Number of channels in a specified output group.
		Put:	! ADR **1F** P XX YY CSM <CR>
		Reply:	A <CR>
		Get:	! ADR **1F** G XX CSM <CR>
		Reply:	A YY CSM <CR>
			where "XX" is the group number minus one. "YY" is the number of output channels in that group, in hex.
21	Mode		Mode for the specified output group.
		Put:	! ADR **21** P XX YY CSM <CR>
		Reply:	A <CR>
		Get:	! ADR **21** G XX CSM <CR>
		Reply:	A YY CSM <CR>
			where "XX" is the group number minus one. "YY" is the operating mode, from zero to five.
47	Output Enab		Output Enable ANDing on or off for specified channel.
		Put:	! ADR **47** P XX <00 or 01> CSM <CR>
		Reply:	A <CR>
		Get:	! ADR **47** G XX CSM <CR>
		Reply:	A <00 or 01> CSM <CR>
			where "XX" is the channel number minus one, in hex. "00" = ANDing "off"; "01" = ANDing "on".
4D	Pgm Sel Mode		Program select terminals use Binary, Gray Code, or BCD format.
		Put:	! ADR **47** P <00, 01, or 02> CSM <CR>
		Reply:	A <CR>
		Get:	! ADR **47** G CSM <CR>
		Reply:	A <00, 01, or 02> CSM <CR>
			"00" = Binary; "01" = Gray Code; "02" = BCD.

Setpoint Commands

CMD (hex)	Name		Function
22	Spt Count		Return number of pulses.
		Cmd:	! ADR **22** CSM <CR>
		Reply:	A XXXX CSM <CR>
			where "XXXX" is the total number of pulses in hex. Includes all pulses in all channels and programs in the controller.
23	Wipe Spt		Deletes all pulses from EEPROM.
		Cmd:	! ADR **23** CSM <CR>
		Reply:	A <CR>
24	Get Spt		Return program, channel, and on/off points for the specified pulse.
		Cmd:	! ADR **24** XXXX CSM <CR>
		Reply:	A XX YY ZZZZ TTTT CSM <CR>
			where "XXXX" is the number of the pulse in hex. Pulses are numbered starting at Channel 1, Program 1, Position 0. As the transducer rotates through a complete cycle, each pulse encountered is numbered sequentially. After one cycle, the pulses in Channel 2 are numbered, and so on.
			In the reply, "XX" is the program number of the specified pulse, minus one. "YY" is the channel number, minus one. "ZZZZ" and "TTTT" are the "on" and "off" points of the pulse, respectively. All values are in hex.
25	Add Spt		Adds a setpoint.
		Cmd:	! ADR **25** XX YY ZZZZ TTTT CSM <CR>
		Reply:	A <CR>
			where "XX" is the program number minus one, and "YY" is the channel number minus one. "ZZZZ" and "TTTT" are the "on" and "off" points of the pulse, respectively. All values are in hex.
26	Del Spt		Deletes a setpoint.
		Cmd:	! ADR **26** XX YY ZZZZ TTTT CSM <CR>
		Reply:	A <CR>
			where "XX" is the program number minus one, and "YY" is the channel number minus one. "ZZZZ" and "TTTT" are the "on" and "off" points of the pulse, respectively. All values are in hex.
27	Mod Spt		Modifies one edge of a setpoint.
		Cmd:	! ADR **27** XX YY ZZZZ TTTT MM NNNN CSM <CR>
		Reply:	A <CR>
			where "XX" is the program number minus one and "YY" is the channel number minus one.
			"ZZZZ" and "TTTT" are the **current** "on" and "off" points of the pulse, respectively.
			"MM" is the edge to be modified: "00" is the "off" edge, "01" is the "on" edge.
			"NNNN" is the new value for the specified edge. All values are in hex.

	CMD (hex)	Name		Function
Setpoint Commands (cont'd)	**28**	Inc Spt		Advances one edge of a pulse, both edges, or all pulses in a channel, by one scale factor increment.
			Cmd:	! ADR **28** XX YY ZZZZ TTTT MM CSM <CR>
			Reply:	A <CR>
				where "XX" is the program number minus one, and "YY" is the channel number minus one.
				"ZZZZ" and "TTTT" are the **current** "on" and "off" points of the pulse, respectively.
				"MM" specifies the scope of the change: "00" is the "off" edge; "01" is the "on" edge; "02" is both edges of the pulse; and "03" is all edges of all pulses in the channel. All values are in hex.
	29	Dec Spt		Retards one edge of a pulse, both edges, or all pulses in a channel, by one scale factor increment.
			Cmd:	! ADR **29** XX YY ZZZZ TTTT MM CSM <CR>
			Reply:	A <CR>
				where "XX" is the program number minus one, and "YY" is the channel number minus one.
				"ZZZZ" and "TTTT" are the **current** "on" and "off" points of the pulse, respectively.
				"MM" specifies the scope of the change: "00" is the "off" edge; "01" is the "on" edge; "02" is both edges of the pulse; and "03" is all edges of all pulses in the channel. All values are in hex.
Display Commands	**30**	Def Disp		Default display on start-up.
			Put:	! ADR **30** P XX CSM <CR>
			Reply:	A <CR>
			Get:	! ADR **30** G CSM <CR>
			Reply:	A XX CSM <CR>
				where "XX" is the display mode: "00" is Speed, "01" is Position, and "02" is Auto.
	31	Tog RPM		Toggle RPM speed.
			Put:	! ADR **31** P XXXX CSM <CR>
			Reply:	A <CR>
			Get:	! ADR **31** G CSM <CR>
			Reply:	A XXXX CSM <CR>
				where "XXXX" is the toggle RPM speed in hex.
	57	Rate Setup		Multiplier and units for RPM display.
			Put:	! ADR **57** P XX YY CSM <CR>
			Reply:	A <CR>
			Get:	! ADR **57** G CSM <CR>
			Reply:	A XX YY CSM <CR>
				"XX" is the multiplier: "01" = 1X; "02" = 2X; "03" = 3X; "04" = .5X.
				"YY" = units: "00" = RPM; "01" = BPM; "02" = CPM

Special Commands

CMD (hex)	Name	Function
2A	Key Press	Adds a value to the keyboard buffer; just like pressing a key. Cmd: ! ADR **2A** XX CSM <CR> Reply: A <CR> where "XX" is the key number in hex. See "Keypad Diagnostics" in Section 7 for a method to determine the key number for each key on the keypad.
2B	En Mot Spt	Enable "Motion ANDing" programming at operator level. Put: ! ADR **2B** P <00 or 01> CSM <CR> Reply: A <CR> Get: ! ADR **2B** G CSM <CR> Reply: A <00 or 01> CSM <CR> where "00" = disabled, "01" = enabled.
2C	En Offset	Enable "Offset" programming at operator level. Put: ! ADR **2C** P <00 or 01> CSM <CR> Reply: A <CR> Get: ! ADR **2C** G CSM <CR> Reply: A <00 or 01> CSM <CR> where "00" = disabled, "01" = enabled.
2D	En Act Pgm	"Active Program" enable at operator level. Put: ! ADR **2D** P <00 or 01> CSM <CR> Reply: A <CR> Get: ! ADR **2D** G CSM <CR> Reply: A <00 or 01> CSM <CR> where "00" = disabled, "01" = enabled.
2E	En Spd Cmp	Enable "Speed Comp" programming at operator level. Put: ADR **2E** P XX <00 or 01> CSM <CR> Reply: A <CR> Get: ! ADR **2E** G XX CSM <CR> Reply: A <00 or 01> CSM <CR> where "XX" is the channel number minus 1, in hex. "00" = disabled, "01" = enabled.
2F	En Timed Out	Enable "Timed Output" programming at operator level. Put: ! ADR **2F** P XX <00 or 01> CSM <CR> Reply: A <CR> Get: ! ADR **2F** G XX CSM <CR> Reply: A <00 or 01> CSM <CR> where "XX" is the channel number minus 1, in hex. "00" = disabled, "01" = enabled.

Error Codes

Error Replies

If a command sent to the PS-5144 cannot be processed for any reason, the controller sends a reply in the following format:

N <error code> CSM <CR>

The error codes are listed below.

Code	Name	Meaning
00	OK	Processed ok.
01	BAD BUFFER	Buffer not correct.
02	NOT OUR ADDRESS	To someone else.
03	BAD COMMAND	Illegal command.
04	BAD DATA	Illegal data.
05	NOT IN MOTION	Can't do while running.
06	TOO MANY TIMERS	Too many timers for time base.
07	NOT AN OPTION	Option not on unit.
08	NOT STOPPED	Can't do this unless STOPPED.
09	BAD FORMAT	Bad input or output format string.
0A	TIMEOUT	Timeout error.
0B	BAD KEY	Illegal key value.
0C	FLASH ERROR	Flash programming error.
0D	BAD PROGRAM#	Illegal program number.
0E	BAD CHANNEL#	Illegal channel number.
0F	KEYBOARD CONFLICT	Conflict with keyboard activity.

Checksum

Calculating Checksum

The PS-5144 calculates checksums in four steps:

1. Add the ASCII values of the command string, not including STX (!) or ETX (<CR>).
2. Make the decimal value from Step 1 negative.
3. Convert the value from Step 2 to hex.
4. Use the two least significant digits from Step 3.

The following examples will clarify how Checksums are calculated:

Example 1—Command 0A: **Request RPM from Controller #1**

Command: !010A<CSM><CR>

Checksum Calculation:

```
   0  1  0  A
   |  |  |  |
  48+49+48+72 = 217(decimal)
```

–217 decimal = FF27 hex; therefore: Checksum = 27

String sent to controller = !010A27<CR>

Example 2—Command 25: Add Pulse to Control #2

Pulse Values: Program 15, Output Channel 9, "On" at 25, "Off" at 290

Command: !02250E0800190122<CSM><CR>

Checksum Calculation:

```
0  2  2  5  0  E  0  8  0  0  1  9  0  1  2  2
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
48+50+50+53+48+69+48+56+48+48+49+57+48+49+50+50 = 821(decimal)

–821 decimal = FCCB hex; therefore: Checksum = CB
String sent to controller = !02250E0800190122CB<CR>
```

Data Organization

This section describes the internal data structure of PLuS controllers, and how this data may be accessed via serial communications. The data has been organized as a series of "Coils" and "Registers" compatible with PLC programming techniques. You access and/or change the data within a PLuS controller by forcing coils ON or OFF, and by reading and writing register data.

A PLuS Controller can be completely programmed via the serial interface. All controller data, such as pulses, speed compensation, timed output values, etc., are available as registers. Configuration data, such as the direction of rotation, number of keyboards, number of analog outputs, etc., is also available as register data. The controller is programmed by writing to these registers. Data is monitored within the controller by reading from these registers.

Note: The ability of the EEPROM to retain data is reduced after 100,000 write cycles. Do not set up routines that constantly write data to the EEPROM's.

Mapping

In addition to accessing controller data via dedicated registers, specific indexed data items can be accessed through the 240 data display registers. This is done by "mapping" a specific indexed data element to a data display register; a data display register is assigned to represent a pulse, speed comp value, etc. Once an indexed data element is mapped it can be accessed either through the data display register or through the dedicated register.

Mapping is useful when displaying more than one instance of an indexed data element at once. For instance, speed compensation is accessed via three registers; 1) a channel index, 2) a leading edge value, and 3) a trailing edge value. This means that the values of speed compensation for all channels can be accessed, but only one at a time. To display more than one value of speed compensation at once, simply map the values to a series of data display registers.

You must define how many mappings are available through the Map Limit register.

Modbus

Modbus ASCII protocol is used for serial communications.

Set host controller communication parameters to 7 data bits, 2 stop bits, no parity.

Limit the number of consecutive registers or coils read to 32.

Discrete Elements

Inputs

10001 - 10016	DC Inputs

Outputs

00001 - 00100	Channel Outputs

ORing and NOT ANDing

00101 - 00200	Channel ORing
00201 - 00300	Channel NOT ANDing

Special Purpose

00301 - 00400	Special Purpose

00301	Global Unforce
00302	Pulse Register Enable
00303	Create New Pulse
00304	Move Both Edges of Pulse
00305	Move All Pulses in Channel
00314	NAK Bad Address Reads
00315	Execute Special Function
00316	Auto Increment

Registers

Special Purpose & Data Display

40001	Message and Special Function (16 registers)
40017	Data Display (240 registers)

RPM

40257	RPM

Position

40258	Position Mapping
40259	Position Index
40260	Position

Pulse Programming

40261	Pulse Mapping
40262	Total Pulse Count
40263	Channel Pulse Count

Pulse Programming (Cont.)

40264	Program Index
40265	Channel Index
40266	Pulse Index
40267	Pulse On
40268	Pulse Off
40269	New On
40270	New Off

Default Program

40271	Default Program

Speed Compensation

40272	Speed Comp Mapping
40273	Channel Index
40274	Leading Edge Comp
40275	Trailing Edge Comp

Timed Outputs

40276	Timed Output Mapping
40277	Channel Index
40278	Time Delay

Offset

40279	Offset Mapping
40280	Group Index
40281	Group Offset

Motion Detection

40282	Motion Detection Mapping
40283	Channel Index
40284	Low Motion Detection RPM
40285	High Motion Detection RPM

Analog Output

40286	Analog Output Mapping
40287	Channel Index
40288	Analog Offset
40289	Analog High RPM

Gray Code Speed Compensation

40290	Gray Code Speed Comp

Mapping Registers

40296	Map Limit
40297	Map Quantity
40298	Map Store
40299	Map Recall

Model Information

40300	Model
40301	Revision
40302	Output Quantity
40303	Option Index
40304	Option

Hardware Configuration

40306	Increasing Direction
40307	Scale Factor
40308	Shaft Position
40309	Shaft Offset
40310	Analog Quantity
40311	Resolver Type
40312	Program Select Mode
40313	Gray Level
40314	Time Base
40315	Termination Resistor One
40316	Termination Resistor Two

Display Configuration

40317	Default Display
40318	Rate Multiplier
40319	Rate Divisor
40320	Rate Decimal Point Position
40321	Rate Units
40322	Toggle RPM
40323	RPM Update Rate
40324	Speed Comp Display Mode
40325	Group Position Display Mode

Password ID Numbers

40326	Operator ID
40327	Setup ID
40328	Master ID

Per Channel Enable

40329	Per Channel Enable Index
40330	Per Channel Enable

Operator Function Enable

40331	Operator Function Enable Bitmask

Motion ANDing

40332	Channel Index
40333	Motion Enable Level

Output Enable ANDing

40334	Output Enable Index
40335	Output Enable

Group Programming

40336	Group Quantity
40337	Group Index
40338	Channel Quantity
40339	Group Mode

Run Time Control

40340	Stop Control
40341	EEPROM Checksum
40342	EEPROM Changed

The following registers are not supported by early versions of Modbus Controllers.

Active Program

40343	Active Program

I/O Control

40350 - 40359	Input Status
40360 - 40369	Output Status
40370 - 40379	ORing Bits
40380 - 40389	ANDing Bits

Communications

40390	Type (RS485/RS232)
40391	Baud Rate
40392	Address

Discrete I/O

Inputs

10001 - 10016 **DC Inputs**
These points represent the status of the DC inputs.

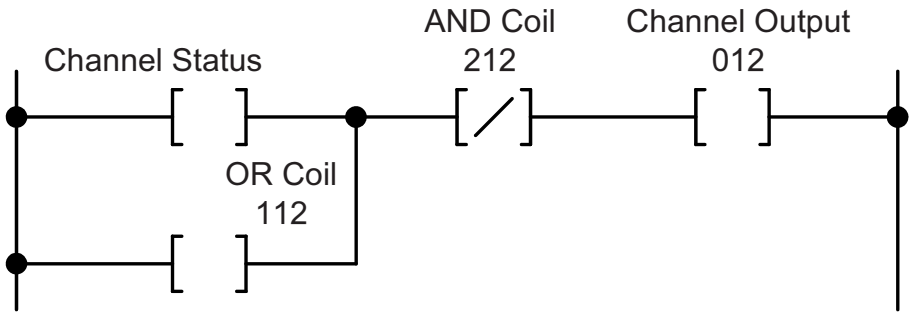
Outputs

00001 - 00100 **Channel Outputs**
These coils represent the status of the channel outputs. Forcing these coils directly will set/clear the appropriate ORing and ANDing coils as required.
The Channel Output Coil status before OR/ANDing is determined by setpoints, group modes, speed compensation, motion ANDing, enable input ANDing, timed outputs, and resolver fault status.

ORing and NOT ANDing

00101 - 00200 **Channel ORing**
Setting these coils to '1' will force the corresponding Channel Output Coil ON.

00201 - 00300 **Channel NOT ANDing**
Setting these coils to '1' will force the corresponding Channel Output Coil OFF.



Ladder Diagram Example of ORing/ANDing Coils

Special Purpose

00301 - 00400 Special Purpose

301 **Global Unforce**
Clears all OR and NOT AND coils when set from '0' to '1' (edge active).

302 **Pulse Register Enable**
When '1', this coil enables the creation of new pulses through writes to the New Off Register. When this coil is '0', writes to New Off Register do not create a new pulse.

303 **Create New Pulse**
Creates a new pulse defined by the New On and New Off registers when set from '0' to '1' (edge active). This coil is ignored if coil 302 is '1'.

304 **Move Both Edges of Pulse**
When '1', this coil will cause both edges of a pulse to move when either the leading or trailing edge is changed by '1' (incremented or decremented).

305 **Move All Pulses in Channel**
When '1', this coil will cause all edges of all pulses in a channel to move when either the leading or trailing edge is changed by '1' (incremented or decremented).

314 **NAK Bad Address Reads**
When '1', this coil will cause the controller to NAK attempted reads to non-existent registers. When this coil is '0', reads to non-existent registers return a value of zero.

315 **Execute Special Function**
Executes the special function defined by the contents of the Special Purpose Registers (40001-40017) when set from '0' to '1'.

316 **Auto Increment**
When '1', this coil enables the auto increment feature on index registers. This feature allows sequential reading of indexed values without changing the index register.

Note: The "Pulse Register Enable" coil (#302) is intended for mass downloads.
When a pulse is created using this mode, the new pulse does not appear in the channel until the unit is power cycled. This enables pulses to be added faster in a batch type situation.
When pulses need to be created and take effect immediately, "Create New Pulse" coil (#303) should be used instead.
"Pulse Register Enable" coil (#302) should be set to 0.
A pulse created with "Create New Pulse" coil will take effect immediately and not require the unit to be power cycled.

Special Purpose & Data Display

40001 **Special Function (16 registers)**
The first 16 registers (001 - 016) are used for entering data used by the special functions.

40017 **Data Display (240 registers)**
These registers (017 - 256) are used by the Mapping functions to display individual instances of indexed data.

RPM

40257 **RPM**
Read only
Returns the current RPM.

Position

40258 **Position Mapping**
Read/write
Values: 17 - 256
Specifies the general purpose register used to display the position for the output group specified by the Group Index Register.

40259 **Position Index**
Read/write
Values: 1 - 6
Specifies the output group whose position is displayed in the Position Register.

40260 **Position**
Read only
Values: 0 - (Scale Factor - 1)
returns the current position for the output group specified by the Group Index Register.

Pulse Programming

40261 **Pulse Mapping**
Read/write
Values: 17 - 255
General Purpose register used for mapping the On and Off values for the pulse specified by the index registers. Two registers will be used; the first will contain the On value, the second will contain the Off value.

40262 **Total Pulse Count**
Read/write
Values: 0 - n
Returns the total number of pulses for all channels. Writing a value of '0' to this register will erase all pulses. You can only write to this register when the Stop register is '1'.

40263 **Channel Pulse Count**
Read only
Values: 0 - n
Returns the number of pulses in the channel defined by the index registers below.

40264 **Program Index**
Read/write
Values: 0 - Max Program Number
Contains the current program number for pulse access. Writing to this register resets the Channel Index Register and the Pulse Index Register to '1'. When this register is '0', the current active program is used for setpoint access and for mapping (setpoints mapped with a program index of '0' will automatically change when the active program changes).

Pulse Programming (Con'td)

40265 **Channel Index**
Read/write
Values: 1 - Max Channel Number
Contains the current channel number for pulse access. Writing to this register resets the Pulse Index Register to '1'. This register is reset to '1' when the Program Index Register is changed.

40266 **Pulse Index**
Read/write
Values: 1 - n
Contains the current pulse number for pulse access.
This register is reset to '1' when the Program Index Register or Channel Index Registers are changed.

40267 **Pulse On**
Read/write
Values: 0 - (Scale Factor - 1)
Pulse On Value.

40268 **Pulse Off**
Read/write
Values: 0 - (Scale Factor - 1)
Pulse Off Value.

40269 **New On**
Read/write
Values: 0 - (Scale Factor - 1)
New Pulse On Value.
Writing to this register loads the On setpoint of a new pulse for the program and channel specified by the index registers above.

40270 **New Off**
Read/write
Values: 0 - (Scale Factor - 1)
New Pulse Off Value.
Writing to this register loads the Off setpoint of a new pulse for the program and channel specified by the index registers above. The pulse is stored when the Off value is written if the Pulse Register Enable Coil is set to '1'; otherwise the pulse is stored when the Create New Pulse Coil is changed form '0' to '1' (edge active).

Default Program

40271 **Default Program**
Read/Write.
Values: 1 - Max program number
Defines the program that will be active if no hardware program select inputs are active.

Speed Compensation

40272 **Speed Comp Mapping**
Read/Write
Values: 17 - 255
General purpose register used for mapping speed compensation values. Two registers will be used; the first will contain the leading edge value, the second will contain the trailing edge value.

40273 **Channel Index**
Read/Write
Values: 1 - Max Channel Number
Channel index for speed comp values.

Speed Compensatin (Cont'd)

40274 **Leading Edge Comp**
Read/Write
Values: 0 - n (.1mS)
Specifies the leading edge speed comp value.

40275 **Trailing Edge Comp**
Read/Write
Values: 0 - n (.1mS)
Specifies the trailing edge speed comp value.

Timed Outputs

40276 **Timed Output Mapping**
Read/write
Values: 17 - 255
General purpose register used for mapping timed output values.

40277 **Channel Index**
Read/Write
Values: 1 - Max Channel Number
Channel index for time delay values.

40278 **Time Delay**
Read/write
Values: 0 - n (1mS)
Specifies the maximum time in milliseconds that a channel may stay on after it has bee turned on.

Offset

40279 **Offset Mapping**
Read/write
Values: 17 - 256
General purpose register used for mapping Group Offset values.

40280 **Group Index**
Read/write
Values: 1 - 6
Group index for offset values.

40281 **Group Offset**
Read/write
Values: 0 - (Scale Factor - 1)
Offset value for the specified group.
Note that this value is a PRESET value for groups in modes 1 or 2.

Motion Detection

40282 **Motion Detection Mapping**
Read/write
Values: 17 - 255
General purpose register used for mapping low and high motion detection values. Two registers will be used; the first will contain the low motion detection rpm value, the second will contain the high motion detection rpm value.

40283 **Channel Index**
Read/write
Values: 1, 2
Motion detection level index for high and low motion detection values.

Motion Detection (Cont.)

40284 **Low Motion Detection RPM**
Read/write
Values: 0 - n
Motion detection low limit for the level specified by the index register.

40285 **High Motion Detection RPM**
Read/write
Values: 0 - n
Motion detection high limit for the level specified by the index register.

Analog Output

40286 **Analog Output Mapping**
Read/write
Values: 17 - 255
General purpose register used for mapping analog offset and high RPM values. Two registers will be used; the first will contain the analog offset value, the second will contain the high RPM value.

40287 **Channel Index**
Read/write
Values: 1, 2
Analog channel index for analog offset and high RPM values.

40288 **Analog Offset**
Read/write
Values: 0 - 4095
Analog output at 0 RPM.

40289 **Analog High RPM**
Read/write
Values: 0 - 3000
RPM at which analog output is 4095.

Gray Code Speed Compensation

40290 **Gray Code Speed Comp**
Read/write
Values: 0 - n (.1mS)
In controllers equipped with the "-G" option, the Gray code bit pattern is speed compensated by this amount.

Mapping Registers

40296 **Map Limit**
Read/write
Values: 0 - 256
Sets the maximum number of data mappings.

40297 **Map Quantity**
Read/write
Values: 0 - 256
Returns the number of data mappings active in the controller.
NOTE: Writing a '0' to this register will delete all data mappings!

40298 **Map Store**
This register is only for use by utility programs.

40299 **Map Recall**
This register is only for use by utility programs.

Model Information

40300 **Model**
Read only
Returns the PLuS model number (5144, 6144, etc.).

40301 **Revision**
Read only
Returns the major software revision.

40302 **Output Quantity**
Read only
Returns the number of output channels (8, 9, 16, 17, 25, etc).

40303 **Option Index**
Read/write
Values: 1 - n
Used as index for reading installed controller options through the Option Register.

40304 **Option**
Read only
Values: 0 - n
Returns installed controller options as specified through the Option Index Register. A value of '0' at index '1' means no options are installed.

Hardware Configuration

40306 **Increasing Direction**
Read/write
Values: 0 = CCW, 1 = CW
Specifies the direction of rotation of the resolver (viewed from the shaft end) that will result in an increasing numerical display of position.

40307 **Scale Factor**
Read/write
Values: 2 - 1024 (4096 with "-H" Option)
Scale factor used for pulse, position, and offset programming.

40308 **Shaft Position**
Read only
Values: 0 - (Scale Factor - 1)
Returns the current resolver shaft position, including the shaft offset.

40309 **Shaft Offset**
Read/write
Values: 0 - (Scale Factor - 1)
Offset that is added to raw resolver position to make Shaft Position.

40310 **Analog Quantity**
Read/write
Values: 0, 1, 2
Specifies the number of analog modules active.

40311 **Resolver Type**
Read/write
Values: 0 = Electro Cam, 1 = Other
Specifies type of resolver attached to controller.

40312 **Program Select Mode**
Read/write
Values: 0 = Binary, 2 = BCD, 1 = Gray code
Specifies how the program select inputs determine the active program.

Hardware Configuration (Cont'd)

40313 **Gray Level**
Read/write
Values: 0 = Positive True, 1 = Negative True
On controllers equipped with the "-G" Option, this register specifies the logic level of the Gray code bit pattern.

40314 **Time Base**
Read only
Values: 0 = 1mS, 1 = .5mS, 2 = .2mS
Returns the timer interrupt rate.

40315 **Termination Resistor One**
Read/write
Values: 0 = Off, 1 = On
Termination resistor On/Off RS485 port; keyboard port for 6000's, RS485 Communication port for 5144's.

40316 **Termination Resistor Two**
Read/write
Values: 0 = Off, 1 = On
Termination resistor On/Off for RS232/RS485 port; communication port for 6000's with 5144A Input Board.

Display Configuration

40317 **Default Display**
Read/write
Values: 0 = RPM, 1 = Position, 2 = Auto Select
Specifies Pos/Rpm display mode; only applicable on 5XXX controllers.

40318 **Rate Multiplier**
Read/write
Values: 1 - 1091
RPM rate multiplier; 6000 controllers only.

40319 **Rate Divisor**
Read/write
Values: 1 - 63
RPM rate divisor, 6000 controllers only.

40320 **Rate Decimal Point Position**
Read/write
Values: 0 - 3
RPM decimal point position; 6000 controllers only.

40321 **Rate Units**
Read/write
Values: 0 = RPM, 1 = BPM, 2 = CPM, 3 = IPM
RPM display units; 6000 controllers only.

40322 **Toggle RPM**
Read/write
Values: 0 - n
Specifies RPM which will cause position display to blank (6000 series) or to change from Position to RPM (5000 series).

40323 **RPM Update Rate**
Read/write
Values: 0 = 1/Sec, 1 = 2/Sec, 2 = 10/Sec
Rate at which the RPM display is updated.

Display Configuration

40324 **Speed Comp Display Mode**
Read/write
Values: 0 = One, 1 = L/T
Specifies whether speed comp values are displayed as one value for both leading and trailing edges, or as a value for each.

40325 **Group Position Display Mode**
Read/write
Values: 0 = Each, 1 = One
Specifies whether the positions for output groups are individually displayed, or if they are displayed as one value for all groups. Output group positions can only be displayed as one if none are in mode 1 or mode 2 (rezero modes).

Password ID Numbers

40326 **Operator ID**
Read/write
Values: 0 - n
Specifies the Operator ID number used to enable the Operator access level for programming.

40327 **Setup ID**
Read/write
Values: 0 - n
Specifies the Setup ID number used to enable the Setup access level for programming.

40328 **Master ID**
Read/write
Values: 0 - n
Specifies the Master ID number used to enable the Master access level for programming.

Per Channel Enable

40329 **Per Channel Enable Index**
Read/write
Values: 1 - Max Channel Number
Channel index for the Per Channel Enable register.

40330 **Per Channel Enable**
Read/write
Values: 0=No Operator access, 1=Operator access enabled
Specifies whether channel data can be modified under the Operator access level (0=no, 1=yes).
Channel data such as speed comp and timed output values can be individually enabled per channel for operator access through this register.

Operator Function Enable

40331 **Operator Function Enable Bitmask**
Read/write
Values: 0 - 0FFFFH
Bit mask which specifies which programming functions the operator may perform.
Bit 0: Pulse on/off values.
Bit 1: Default program.
Bit 2: Speed compensation.
Bit 3: Timed outputs.
Bit 4: Offsets.
Bit 5: Motion detection.
Bit 6: Analog offset & high rpm.

Motion ANDing

40332 **Channel Index**
Read/write
Values: 1 - Max Channel Number
Channel index for the Motion Enable Level Register.

40333 **Motion Enable Level**
Read/write
Values: 0 = Off, n = Motion Detection Level
Specifies the motion detection level used for a channel.

Output Enable ANDing

40334 **Output Enable Index**
Read/write
Values: 1 - Max Channel Number
Channel index for the Output Enable register.

40335 **Output Enable**
Read/write
Values: 0=Channel not ANDed, 1=Channel ANDed
Specifies whether a channel is ANDed with the Enable Input.

Group Programming

40336 **Group Quantity**
Read/write
Values: 1 - 6
Specifies the number of output groups.

40337 **Group Index**
Read/write
Values: 1 - 6
Group index for Channel Quantity and Group Mode Registers.

40338 **Channel Quantity**
Read/write
Values: 0 - n
Defines the number of channels in the output group specified by the Group Index Register.

40339 **Group Mode**
Read/write
Values: 0 - 5
Defines the operating mode for the output group specified by the Group Index Register. Note that groups in mode '0' do not need (or have) an enable input.

Run Time Control

40340 **Stop Control**
Read/write
Values: 0 = Running, 1 = Stopped
When PLuS is STOPPED, changes written to registers do not update the checksum in EEPROM memory. Changes are faster when unit is stopped, but you must read from the Checksum Register when changes are complete to establish a valid checksum. Writing a '1' value to this register will place the PLuS in STOPPED mode. Writing a '0' to this register will restart the PLuS via a watchdog timer reset.

40341 **EEPROM Checksum**
Read only
Returns the current checksum of EEPROM memory. If computed checksum of EEPROM memory does not match the current value (i.e. if changes were made while unit STOPPED), a new value will be written to EEPROM memory.

Run Time Control (Cont'd)

40342 **EEPROM Changed**
Read only
Values: 0 = no change, 1 = changed.
A value of '1' in this register means that the EEPROM has been changed (through the keyboard) since the last time this register was read. Reading this register sets it to '0'.

Active Program

40343 **Active Program**
Read/Write.
Values: 1 - Max program number
Returns to program currently active; determined either by hardware inputs or by the value of the default program. If hardware inputs are active, writes to this register will change the default program, but the active program will not change.

I/O Control

40350 - 40359 Input Status
Read Only.
Values: 0 - 65535
Each register represents the status of 16 inputs.

40360 - 40369 Output Status
Read/Write.
Values: 0 - 65535
Each register represents the status of 16 outputs. The least significant bit of the register corresponds to the lowest numbered output. Writing to one of these registers will force 16 outputs. The ORing and ANDing registers (and coils) will reflect the forced conditions.

40370 - 40379 ORing Bits
Read/Write.
Values: 0 - 65535
Each register represents the status of 16 ORing bits. The least significant bit of the register corresponds to the lowest numbered output. When a '1' is present in an outputs' bit position, the output will be forced ON. The OUTPUT STATUS register will reflect the forced condition.

40380 - 40389 ANDing Bits
Read/Write.
Values: 0 - 65535
Each register represents the status of 16 ANDing bits. The least significant bit of the register corresponds to the lowest numbered output. When a '1' is present in an outputs' bit position, the output will be forced OFF. The OUTPUT STATUS register will reflect the forced condition.

Host Communications Setup

40390 **Communication Type (RS485/RS232)**
Read/Write.
Values: 0/1 (0=RS485, 1=RS232)
Determines the communication type used by the controller. This register may only be written to when the controller is stopped (via the STOP CONTROL register).

40391 **Communication Baud Rate**
Read/Write.
Values: 2/3/4/5 (2=4800, 3=9600, 4=19200, 5=38400)
Determines the baud rate used by the controller. This register may only be written to when the controller is stopped (via the STOP CONTROL register).

Host Communications Setup (Cont'd)

40392 **Communication Address**
Read/Write.
Values: 1-255
Determines the address used by the controller. This register may only be written to when the controller is stopped (via the STOP CONTROL register).

NOTE: If the three address switches on the input board are all UP (address 7), the controller will be automatically configured to be RS232, 9600 baud, address 1. Use this feature to enable communications with a controller if no keyboard is available or if you are unsure of the communication parameters currently in use.

Special Functions

Overview

Special functions are used to implement features not directly defined by the standard registers. Special functions are executed by loading the special purpose registers (40001-40016) with data, and then bringing the Execute Special Function Coil (00315) from '0' to '1'.

The data loaded into the special purpose registers is dictated by the special function being performed; each different special function will define the number and use of the special purpose registers.

Register 40001 will define the special function to be performed; registers 40002-40016 will hold the data needed for the special function.

Pulse Copy

This function will add a series of pulses to a specific program and channel.

Register Use:

40001: 1 (Pulse Copy)
40002: Program number.
40003: Channel number.
40004: Beginning on value of pulse envelope.
40005: Ending off value of pulse envelope
40006: Number of pulses within envelope.
40007: Duration (width) of each pulse within envelope.

Registers 40004 and 40005 define the on and off values of the envelope pulse that will be divided into a series of smaller pulses.

Register 40006 contains the number of pulses that the envelope pulse will be divided into.

Register 40007 contains the duration of each of the smaller pulses.

This function will not be completed if the envelope pulse would overlap any other pulse in the specified program and channel, or if the count and duration values would result in overlapping pulses within the envelope pulse.

Once the registers have been loaded, bring the special purpose coil number 315 from '0' to '1'. The command will be acknowledged when pulse programming is complete. Special purpose coil number 315 must be made '0' before this function can be used again.

EEPROM Clearing

This function will clear various areas of EEPROM memory.

Register Use:

40001: -3 (EEPROM Clearing)
40002: EEPROM Clearing Function Number:
- 7000: Clear all EERPOM memory.
- 7001: Clear configuration memory.
- 7002: Clear setpoint memory.

Output Grouping (PS-5144-24-X16M09 Example)

Advantages of Grouping Outputs

The PS-5144 outputs can be subdivided into as many as six different groups, each has a dedicated enable input. There are two primary reasons to group outputs:

1. The outputs grouped together should all be enabled if a specific input condition is met, and disabled if that input condition is not met.

   A typical example of this situation is gluing. Usually a photo eye or other device senses the presence of product immediately before gluing should occur. If the product is not present, the corresponding glue outputs should not cycle. The controller can accomplish this type of logic in modes 2, 4, or 5, if these glue outputs are grouped together and the sensor is connected to the input which controls this group of outputs.

2. The outputs are grouped together because they must maintain a constant phase relationship with each other while being able to vary their group phase relationship to the other outputs.

   A typical example of this situation is a web converting process where individual items are being made from a web of material. Often times the phase relationship between different sections of the machine changes due to stretch and other variables. The outputs at each section must stay in phase with that section, not the resolver. If the outputs for a given section are grouped, the phase of the group can be adjusted, instead of individually adjusting each of the outputs in the group. The adjustments can be made manually from the keyboard or automatically by an external signal from a sensor or other control device.

A comprehensive understanding of the operating modes is required to realize the potential advantages of output grouping (see Appendix for detailed explanations of each of the 6 modes). The fact that each group can be in any of the 6 modes and operates independent of the other groups makes grouping a powerful tool in many applications.

How to Group Outputs

The programming of FCN 108 determines how many output groups are created and how many outputs will be in each group. Outputs are assigned to the groups in sequential order. Therefore, group 1 will start with output 1 and include the specified number of outputs. Group 2 will begin on the next output and run sequentially until its specified number of outputs is reached. This process continues for up to 6 groups. However, the last group will automatically include all of the outputs that are left over from the previous groups.

Example #1: Establish 3 groups of outputs with 10 outputs in group 1, 8 outputs in group 2, and the remaining outputs in group 3. Program FCN 108 as follows:

PGM	CHN	POS	(controller displays)
3	01	10	(group 1 = 10 outputs)
3	02	8	(group 2 = 8 outputs)
3	03	7	(group 3 = remaining outputs)

The example above shows how the programmed information would be shown on the display. The 3 in the PGM display represents the number of groups, the number in the CHN display is the group number, and the number in the POS display is the number of outputs in that group (page 6-8 illustrates FCN 108 programming).

The resulting output grouping would be as follows:

Group 1:	Outputs	1	-	10	(first 10 outputs)
Group 2:	Outputs	11	-	18	(next 8 outputs)
Group 3:	Outputs	19	-	25	(remaining outputs)

Output Group Enable Inputs 1, 2, and 3 would be used to control these output groups. The remaining Output Group enable Inputs would be inactive. FCN 109 programming determines which mode each of the 3 groups operates in.

Example #2: Establish 6 groups of outputs with 4 outputs in group 1, 3 outputs in group 2, 5 outputs in group 3, 6 outputs in group 4, 2 outputs in group 5, and the remaining outputs in group 6. Program FCN 108 as follows:

PGM	CHN	POS	(controller displays)
6	01	4	(group 1 = 4 outputs)
6	02	3	(group 2 = 3 outputs)
6	03	5	(group 3 = 5 outputs)
6	04	6	(group 4 = 6 outputs)
6	05	2	(group 5 = 2 outputs)
6	06	5	(group 6 = 5 outputs)

The resulting output grouping would be as follows:

Group 1:	Outputs	1	-	4	(first 4 outputs)
Group 2:	Outputs	5	-	7	(next 3 outputs)
Group 3:	Outputs	8	-	12	(next 5 outputs)
Group 4:	Outputs	13	-	18	(next 6 outputs)
Group 5:	Outputs	19	-	20	(next 2 outputs)
Group 6:	Outputs	21	-	25	(remaining outputs)

Output Group Enable Inputs 1-6 would all be used to control these output groups. FCN 109 programming will determine which mode each of the 6 groups operates in.

Mode Introduction - Mode 0 Operation

Introduction to Modes

The use of modes allows the PS-5144 to perform output logic which goes beyond simple cam outputs. There are six different modes (Modes 0-5) which can be assigned to output groups. Each mode has unique operating characteristics which can be matched to the logic requirements of the corresponding groups. In many situations, utilizing mode logic can eliminate the need for external logic (PLC or discrete circuits) in series with the PS-5144 outputs.

Each output group can be operated in the most appropriate mode, regardless of which mode(s) other groups are operating in. In many applications, more than 1 mode will be used to satisfy the control requirements of different machine sections. The following are brief descriptions of the modes:

Mode 0 - Outputs always enabled, like a simple cam switch, and the group position can only be adjusted manually through the keyboard. This mode is appropriate for output signals which must occur at the exact same position in every machine cycle.

Mode 1 - Resets group position to a preset value when the group enable input signal occurs. Outputs are always active. This mode is appropriate for phasing output groups from sensors or other devices which signal a mechanical reference position. Mode 1 can also be used in applications where some machine sections run multiple cycles per resolver revolution.

Mode 2 - Disables group outputs until the group enable input signal occurs. When the input occurs, the group position immediately resets to the preset value and the outputs are allowed to cycle during the next machine cycle. This mode is useful for applications where products may not be evenly spaced and the group outputs must only cycle when a product has been sensed.

Mode 3 - Only enables outputs to cycle when group enable input is on. If the input is off, all of the outputs in the corresponding group will be off, regardless of position. Use this mode where the presence of a maintained signal indicates that it is OK for the group outputs to be active.

Mode 4 - Enables outputs to cycle if the group enable input signal turned on during a designated portion (window) of the cycle. Outputs will be disabled at the end of the cycle until the input signal turns on again during the window portion of another cycle. Use this mode to check presence and correct position of a product before enabling the output group for this machine cycle.

Mode 5 - Same logic as Mode 4 with added features that disable output logic if machine stops in mid-cycle and allow a cycle to be manually initiated after the normal input portion of the cycle. This mode is used to check the presence and correct position of a product before enabling the output group like Mode 4. In addition, it will cancel the output enable logic if the machine stops after it was enabled and, it will allow it to be manually enabled whenever the input signal is still on.

Example Applications that Utilize Modes

Web Converting Machines - Disposable diapers, medical pads, office folders, etc. Phase relationships between machine sections can be adjusted manually in Mode 0 or automatically in Mode 1.

Cartoners / Case Packers - Vacuum, material handling, loading and other functions are usually controlled in Mode 0. Gluing functions are typically controlled in Modes 4 or 5 to prevent glue from being dispensed when containers are not present.

Vertical Form/Fill/Seal Machines - Package material handling output functions are controlled in Mode 0, while pump or fill functions are handled in Mode 1 to automatically correct for mechanical phase changes made between these two sections of the machine (this allows 1 resolver to do a job that would otherwise require 2 resolvers).

Machines with Multiple Cycle Ratios - Some machines have different sections that run at different cycle ratios per overall machine cycle. For example, one portion of a machine may complete several cycles while another section cycles only once. By using Mode 1 or 2 it is possible to have some output groups cycling multiple times while other groups cycle only once.

Details of Mode 0 - Standard Cam Operation

An output group operating in Mode 0 will turn on the outputs every time the group position is within the programmed position setpoints. The outputs are always enabled. No input logic is used with Mode 0 - the corresponding input is ignored. The position of the output group can only be adjusted through the keyboard using FCN 2 or FCN 6. The group position information will be stored in permanent memory and proper group position will be restored each time the control is powered on.

Use Mode 0 whenever the corresponding outputs are required to operate during every cycle of the machine.

How to Program Mode 0 Operation

1. Program FCN 108 and 109 to correctly establish the output grouping and modes required for this machine application (insure that Mode 0 is selected for this group).
2. Check that this group has the desired position relationship to the machine position. Program FCN 2 or FCN 6 to adjust it.
3. Program output setpoints to cycle the outputs on and off at the desired output group positions.

No other programming is required for Mode 0.

Note: Mode 0 logic never disables the outputs, however, Motion ANDing (FCN 107) and the Output Enable Input (input 16 and FCN 110) can disable outputs that are operating in Mode 0.

Details of Mode 1 - Alter Position from Input Signal

An output group operating in Mode 1 will have its outputs enabled at all times. What makes it different from simple cam logic is its ability to alter its position relationship to the machine based on an external input signal. The start (leading edge) of an input signal will instantly cause the group's position to be set to the preset value (FCN 6). The outputs will immediately update in accordance with the new position and continue cycling from that point.

The input signal acts in a momentary manner, therefore, it doesn't matter how long the input remains energized. The "reset to preset" operation will occur when the leading edge of the input signal occurs. However, once the reset to preset operation occurs, the control disarms the input and ignores it until it becomes rearmed. A programmed window determines where the input will become rearmed (rearming the input is similar to cocking a gun, once it is rearmed it can fire at any position).

The input window is programmed in the same manner that output pulses are programmed and is referenced to the corresponding group position. Channel 91 is the window for group 1, channel 92 for group 2, and so on up to 96. The position where the window is programmed determines if the input is re-armed right away or ignored until a specified number of degrees of travel occur. The window can be reached from either direction of travel. Therefore, the "on" edge of the window determines how much forward travel is needed to reach the window and the "off" edge determines how much reverse travel is needed.

The position reference that is established by input signals does not get stored in the control's permanent memory. Therefore, when the control powers up a mode 1 group will assume Shaft Position (FCN 101 "SP") as its initial position value. On power up, the input is armed and the first signal received will cause the position to immediately change to the preset value (FCN 6).

Example Application: Control sections of a machine that vary in phase relationship

This illustration shows a single PLuS control and resolver controlling 3 "Adjustable Phase" sections of a converting machine. The rotary position of the electrical output signals can be manually set/ adjusted from the keyboard or automatically adjusted by sensors. This keeps the electrical control signals properly synchronized to the mechanical devices in each section when phase adjustments are made. One resolver provides the position information needed for all sections of the machine, regardless of their phase relationship.

Note: All gear drives are 1:1 ratio.

How to Program Mode 1 Operation

1. Program FCN 108 and FCN 109 to correctly establish the output grouping and modes required for this machine application (insure that Mode 1 is selected for this group).

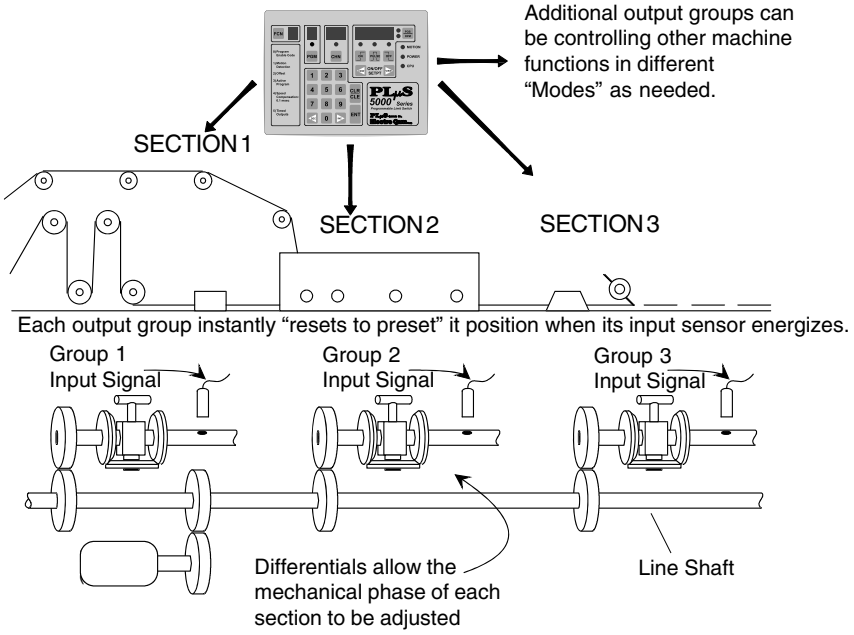
2. Program FCN 6 for the desired reset to preset position for this output group (normally 0 is used).

3. Program the input window (CHN 9X) to start where the group enable input should be rearmed when the machine is moving in a forward direction and to end where the input should be rearmed if the machine is moving in reverse. If the input should always be armed, program CHN 9X to start 1 increment after the preset value and end one increment before 0.

Note: The group input window (CHN 9X) and the group output position setpoints must be programmed individually for each of the controller programs used (up to 48). Different programs can have different values as required.

If the output group position fails to preset when input signals occur, insure that an input window (CHN 9X) is programmed and that the input is wired to the control correctly. FCN 201 (page 7-5) allows input status to be monitored on keyboard display (9-14 are group enable inputs).

Mode 1 Example Application



Mode 1 Logic Flow Chart

The flow chart to the right details how Mode 1 operates. The control's response to any set of conditions can be determined by stepping through the flow chart blocks using those conditions when decision blocks are encountered. The flow chart shows when the group enable input is armed and disarmed. Mode 1 logic never disables the outputs, however, Motion ANDing (FCN 107) and the Output Enable Input (input 16 and FCN 110) can disable outputs that are operating in Mode 1.

How to Use the Flow Chart

To use the block diagram assume that the control is continuously processing the blocks at a very fast rate and is never stopped on any one block. The control will get stuck processing the same path of blocks repeatedly (loop) until a condition changes within one of the decision blocks in that loop which alters the path. Response to a condition change is almost instantaneous so the new conditions established in the next loop take affect quickly. Note that the logic path can only flow in the direction of the arrows, never against them.

Rectangle Block

Output enable/disable status or a logic memory flag is altered.

Diamond Block

A yes/no decision is made based on the condition stated within the block.

Mode 1 Flow Chart Blocks

1. Control powers up and assumes Shaft Position (FCN 101 "SP") as the initial group position.

2. Group enable input is armed. Enable the outputs to cycle at their programmed "on"/"off" setpoints.

3. Check for leading edge of group enable input signal. If it occurred go to step 4, if not loop back to step 2.

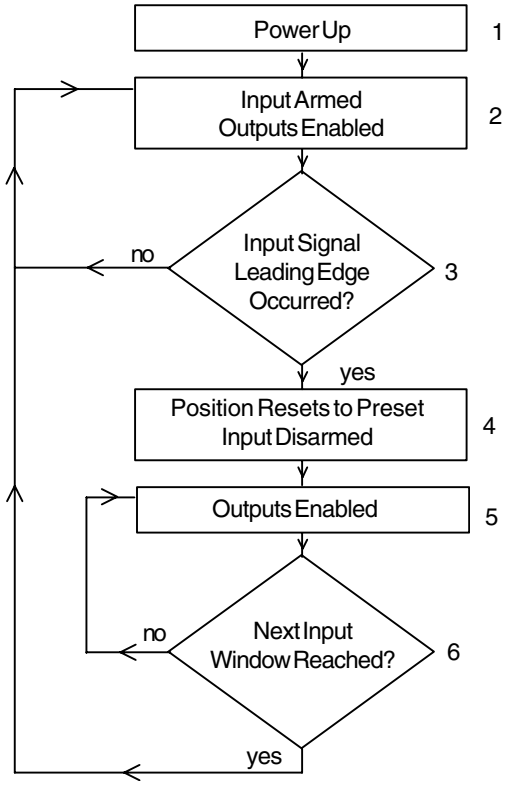
4. Reset group position to preset value (FCN 6). Disarm group enable input.

5. Enable the outputs to cycle at their programmed "on"/"off" setpoints. Go to step 6.

6. Check if group position has reached next input window (CHN 9X). If yes go to step 2, if no loop back to step 5.

   Note: Position can reach input window from forward or reverse direction.

Mode 1 Logic Flow Chart



Details of Mode 2 - Alter Position and Enable Outputs

An output group operating in Mode 2 only has its outputs enabled after an input signal has occurred. The start (leading edge) of an input signal instantly causes the group's position to be set to the preset value (FCN 6). The outputs will immediately be enabled to cycle, and will stay enabled until the next input window is reached.

The input signal acts in a momentary manner, therefore, it doesn't matter how long the input remains energized. The "reset to preset" operation will occur when the leading edge of the input signal occurs. However, once the reset to preset operation occurs, the control disarms the input and ignores it until it becomes rearmed. A programmed window determines where the input will become rearmed (rearming the input is similar to cocking a gun, once it is rearmed it can fire at any position). The outputs are disabled when the next input window is reached.

The input window is programmed in the same manner as output pulses and is referenced to the corresponding group position. Channel 91 is the window for group 1, channel 92 for group 2, and so on up to channel 96. The position of the window determines where the outputs become disabled and where the control starts looking for the next input signal so the process can repeat.

The position reference that is established by input signals does not get stored in the control's permanent memory. However, it is not important in Mode 2 since the outputs will be disabled until an input signal occurs. On power up, the input is armed, the outputs are disabled and the first input signal received will cause the position to immediately change to the preset value (FCN 6).

How to Program Mode 2 Operation

1. Program FCN 108 and FCN 109 to correctly establish the output grouping and modes required for this machine application (insure that Mode 2 is selected for this group).
2. Program FCN 6 for the desired reset to preset position for this output group (normally 0 is used).
3. Program the input window (CHN 9X) to start at 355 and end at 359 as initial values.
4. Manually crank or jog the machine through a cycle with a product present. After the reset to preset occurs (sensor detects start of product), record the group position values where each of the group outputs needs to cycle on or off. Program these values into the corresponding outputs.
5. Program the input window (CHN 9X) to start before the next valid input signal leading edge will occur. The start of the input window must be after the latest output "off" position recorded in step 4 (the start of the window disables the outputs) and before the next input signal leading edge. Set the end of the input window to a position that is ahead of the earliest position where group outputs start cycling on.

Note: The group input window (CHN 9X) and the group output position setpoints must be programmed individually for each of the controller programs used (up to 48). Different programs can have different values as required.

If the output group fails to operate when the machine is run with product present, insure that the group input leading edge occurs after the first programmed window (CHN 9X) and that the input is wired to the control correctly. FCN 201 (page 7-5) allows input status to be monitored on keyboard display (9-14 are group enable inputs).

The flow chart to the right details how Mode 2 operates. The

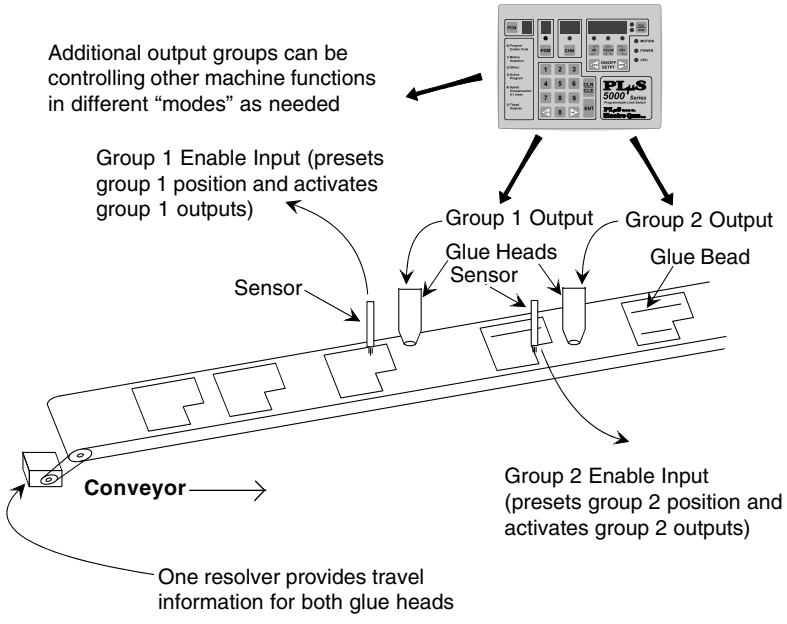
Mode 2 Example Application

Example Application: Control different machine functions asynchronously, on demand

This illustration shows a PLuS control and one resolver "independently" controlling two glue heads at different locations on a conveyor. The spacing between parts being glued is **random**.

Each output group instantly "presets" its control position when its enable input energizes. The outputs in the group then become active for up to 359 degrees.

Random spacing between parts is automatically handled because each sensor causes the position of its output group to preset. This references the output signals to the leading edge of the part being glued. When parts are not present the outputs will be inactive.



control's response to any set of conditions can be determined by stepping through the flow chart blocks using those conditions when decision blocks are encountered. The flow chart determines when the outputs are enabled and disabled by Mode 2 logic.

Note: Motion ANDing (FCN 107) and the Output Enable Input (input 16 and FCN 110) can also disable outputs.

How to Use the Flow Chart

To use the block diagram assume that the control is continuously processing the blocks at a very fast rate and is never stopped on any one block. The control will get stuck processing the same path of blocks repeatedly (loop) until a condition changes within one of the decision blocks in that loop which alters the path. Response to a condition change is almost instantaneous so the new conditions established in the next loop take affect quickly. Note that the logic path can only flow in the direction of the arrows, never against them.

Rectangle Block

Output enable/disable status or a logic memory flag is altered.

Diamond Block

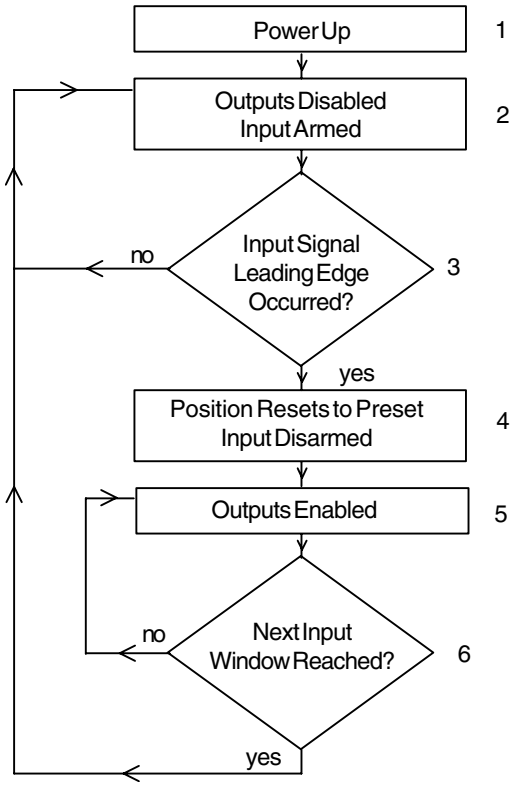
A yes/no decision is made based on the condition stated within the block.

Mode 2 Flow Chart Blocks

1. Control powers up and assumes Shaft Position (FCN 101 "SP") as the initial group position.
2. Outputs are disabled. Group enable input is armed.
3. Check for leading edge of group enable input signal. If it occurred go to step 4, if not loop back to step 2.
4. Reset group position to preset value (FCN 6). Disarm group enable input.
5. Enable the outputs to cycle at their programmed "on"/"off" setpoints. Go to step 6.
6. Check if group position has reached next input window (CHN 9X). If yes go to step 2, if no loop back to step 5.

   Note: Position can reach input window from forward or reverse direction.

Mode 2 Logic Flow Chart



Details of Mode 3 - AND Outputs with Input Signal

An output group operating in Mode 3 will have the same characteristics as a group operating in Mode 0, except that the corresponding enable input must be on to enable the outputs in this group (acts like the input is in series with each output). When the input is on the outputs will be enabled, but as soon as the input turns off they will be disabled. When the group position is within an outputs setpoints, that output would turn on as soon as the input turned on, and would turn off as soon as the input turned off. Therefore, if the input changes state during the pulse, it is possible to only get a partial output pulse. As in Mode 0, position changes can only be made through FCN 2 or FCN 6, and position information in maintained in the control's permanent memory.

Use Mode 3 if the group outputs can only be allowed to cycle when a maintained enable signal is present.

How to Program Mode 3 Operation

1. Program FCN 108 and 109 to correctly establish the output grouping and modes required for this machine application (insure that Mode 3 is selected for this group).
2. Check that this group has the desired position relationship to the machine position. Program FCN 2 or FCN 6 to adjust it.
3. Program output setpoints to cycle the outputs on and off at the desired output group positions.

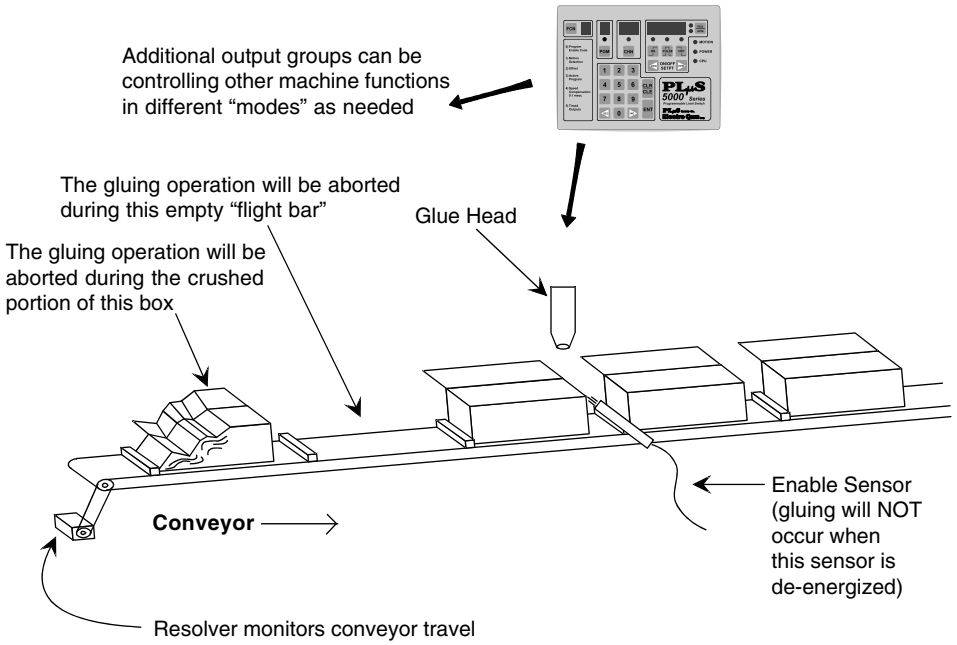
No other programming is required for Mode 3 to operate. If an output group operating in Mode 3 fails to cycle its outputs, insure that the input signal is on and wired to the control correctly. FCN 201 (page 7-5) allows input status to be monitored from the keyboard display (9-14 are group enable inputs).

Mode 3 Example Application

Example Application: Operate a machine function only while a related input signal is maintained

In this illustration the glue head will only be allowed to operate while the photo eye sees the top edge of a box. Boxes that are crushed or not properly erected will cause the glue function to be aborted when the eye loses sight of the top edge.

Mode 3 operation eliminates the need to hard wire photo eyes and other sensors in series with the corresponding controller outputs. Instead, the sensor input is “ANDed” with the selected output(s) through Mode 3 programming.



Mode 3 Logic Flow Chart

The flow chart to the right details how Mode 3 operates. The control's response to any set of conditions can be determined by stepping through the flow chart blocks using those conditions when decision blocks are encountered. The flow chart determines when the outputs are enabled and disabled by Mode 3 logic.

Note: Motion ANDing (FCN 107) and the Output Enable Input (input 16 and FCN 110) can also disable outputs.

How to Use the Flow Chart

To use the block diagram assume that the control is continuously processing the blocks at a very fast rate and is never stopped on any one block. The control will get stuck processing the same path of blocks repeatedly (loop) until a condition changes within one of the decision blocks in that loop which alters the path. Response to a condition change is almost instantaneous so the new conditions established in the next loop take affect quickly. Note that the logic path can only flow in the direction of the arrows, never against them.

Rectangle Block

Output enable/disable status or a logic memory flag is altered.

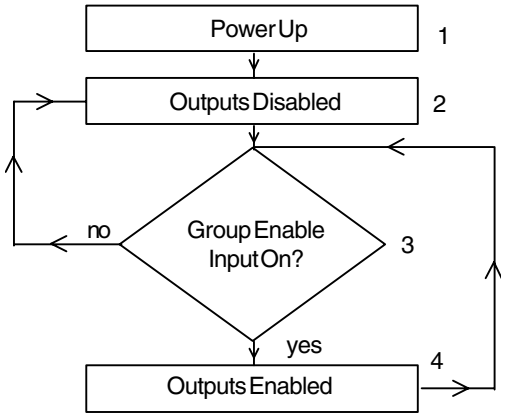
Diamond Block

A yes/no decision is made based on the condition stated within the block.

Mode 3 Flow Chart Blocks

1. Control powers up based on the last group position reference that was programmed into FCN 2 or FCN 6.
2. Disable outputs (do not allow them to cycle at their programmed position setpoints).
3. Check if group enable input on. Go to step 4 if it is, loop back to step 2 if it is not.
4. Enable outputs to cycle on and off at their programmed position setpoints. Loop back to step 3.

Mode 3 Logic Flow Chart



Details of Mode 4 - Input Signal Required for Output Cycle

An output group operating in Mode 4 only has its outputs enabled after an input signal has occurred within a specified window of the machine cycle. The start (leading edge) of the input signal will cause the group's outputs to be enabled to cycle, and they will stay enabled until the next input window is reached. The group position is not altered by the input signal.

The input signal acts in a momentary manner, therefore, it doesn't matter how long the input remains energized. However, the leading edge of the input must occur within the programmed input window. The outputs will then become enabled and will remain enabled until the start of the next input window is reached.

The input window is programmed in the same manner as output pulses and is referenced to the corresponding group position. Channel 91 is the window for group 1, channel 92 for group 2, and so on up to channel 96. The starting position of the window determines where the outputs become disabled and where the control starts looking for the next input signal so the process can repeat.

The position reference for the group is not affected by the input signal. Therefore, the group position maintains a constant relationship with the machine position. On power up, the group position will be based on the last position reference that was determined by FCN 2 or FCN 6 programming. This reference can only be altered through FCN 2 or FCN 6 programming from the keyboard.

Example Application: Operate machine function(s) only if sensor detects part in correct position

In this illustration the punch will operate if the enable sensor detects the leading edge of the part at the correct position in the machine cycle. The presence and correct position of parts is verified by the enable sensor before the group output(s) are activated. The control position remains in sync with the machine position.

The output(s) in the group become active for the remainder of the machine cycle if the enable sensor signal occurs within a specified position in the machine cycle. Sensor signals that occur outside of the programmed "enable input window" will be ignored.

This mode of operation is appropriate for flight bar conveyors, rotary index tables, and similar types of machinery.

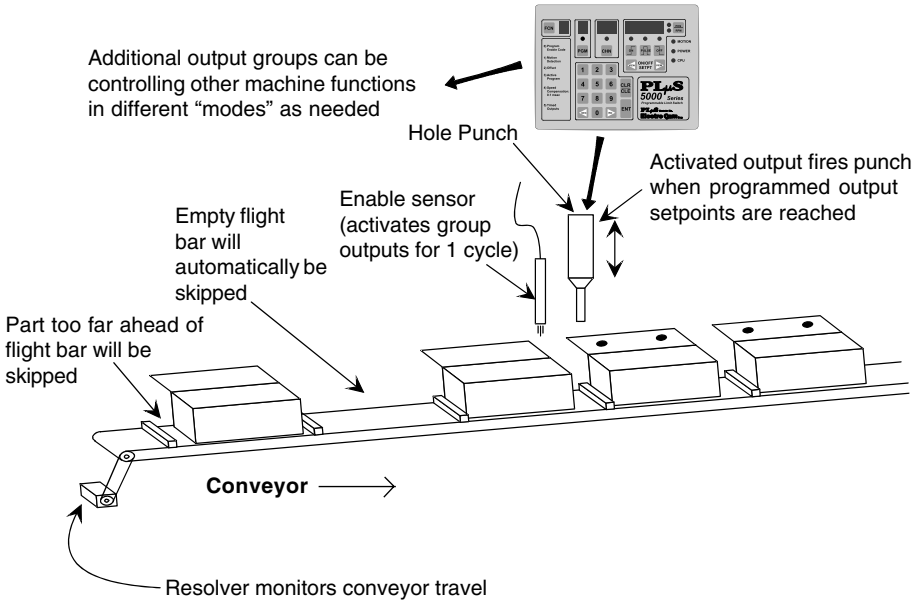
How to Program Mode 4 Operation

1. Program FCN 108 and FCN 109 to correctly establish the output grouping and modes required for this machine application (insure that Mode 4 is selected for this group).
2. Check that this group has the desired position relationship to the machine position. Program FCN 2 or FCN 6 to adjust it.
3. Record the starting position value where the sensor first detects the product as it passes by (leading edge of input).
4. Record the earliest and latest positions where one or more outputs in this group must be on.
5. Program the input window (CHN 9X) to start before the leading edge position of the input signal (recorded in step 3) and end after the leading edge position. The start of the input window must be after the latest output position recorded in step 4 (the start of window disables the outputs) and before the leading edge of the input signal occurs. Set the end of the input window to the latest position in the cycle that a valid input signal leading edge could occur.

Note: The group input window (CHN 9X) and the group output position setpoints must be programmed individually for each of the controller programs used (up to 48). Different programs can have different values as required.

If the output group fails to operate when the machine is run with product present, insure that the group input leading edge occurs within the programmed window (CHN 9X) and that the input is wired to the control correctly. FCN 201 (page 7-5) allows input status to be monitored on keyboard display (9-14 are group enable inputs).

Mode 4 Example Application



Mode 4 Logic Flow Chart

The flow chart to the right details how Mode 4 operates. The control's response to any set of conditions can be determined by stepping through the flow chart blocks using those conditions when decision blocks are encountered. The flow chart determines when the outputs are enabled and disabled by Mode 4 logic.

Note: Motion ANDing (FCN 107) and the Output Enable Input (input 16 and FCN 110) can also disable outputs.

How to Use the Flow Chart

To use the block diagram assume that the control is continuously processing the blocks at a very fast rate and is never stopped on any one block. The control will get stuck processing the same path of blocks repeatedly (loop) until a condition changes within one of the decision blocks in that loop which alters the path. Response to a condition change is almost instantaneous so the new conditions established in the next loop take affect quickly. Note that the logic path can only flow in the direction of the arrows, never against them.

Rectangle Block

TASK

Output enable/disable status or a logic memory flag is altered.

Diamond Block

DECISION

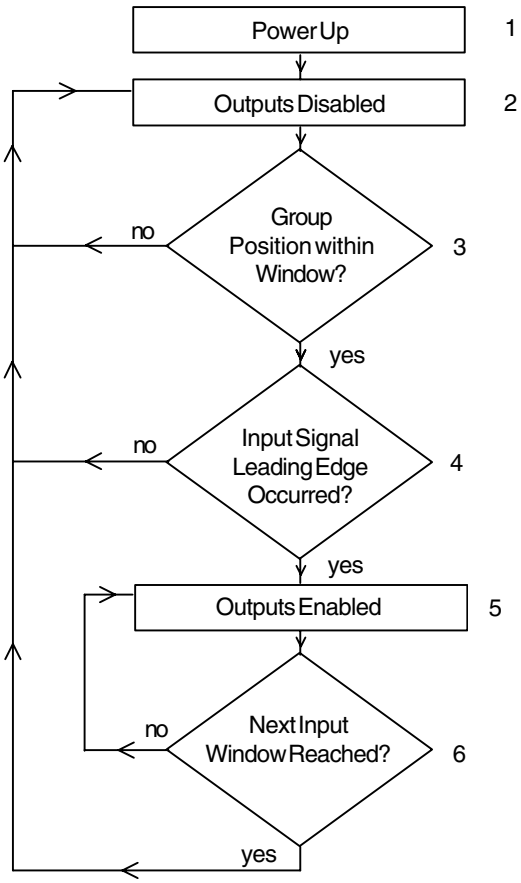
A yes/no decision is made based on the condition stated within the block.

Mode 4 Flow Chart Blocks

1. Control powers up based on the last group position reference that was programmed into FCN 2 or FCN 6.
2. Outputs are disabled.
3. Check group position within the group input window. Go to step 4 if it is, loop back to step 2 if it is not.
4. Check for leading edge of group enable input signal. If it occurred go to step 5, if not loop back to step 2.
5. Enable the outputs to cycle at their programmed "on"/"off" setpoints. Go to step 6.
6. Check if group position has reached next input window (CHN 9X). If yes go to step 2, if no loop back to step 5.

   Note: position can reach input window from forward or reverse direction.

Mode 4 Logic Flow Chart



Details of Mode 5

Mode 5 has the same basic operating characteristics as Mode 4 with some added features. An output group operating in Mode 4 only has its outputs enabled after the leading edge of an input signal has occurred within the specified window of the machine cycle. Unlike Mode 4, Mode 5 does not require that the leading edge of the input signal must occur within the window. The outputs will be enabled as long as the input is on during any portion of the input window.

Note: The window ends at the start of the first programmed output pulse in the group that occurs after the start of the window, even though channel 9X may be programmed to a later Off position.

Mode 5 also includes logic which disables the outputs if the machine stops while they are enabled. This feature is useful in gluing applications. Often the product that was in process when the machine stopped is ruined and may have to be removed before the machine is started again. If the outputs are not disabled after the machine stop situation, glue would be applied to an empty machine station when it starts up again. Mode 5 automatically prevents this from happening.

The "1st Cycle Enable" feature gives Mode 5 additional flexibility. The group outputs will be enabled when the 1st cycle enable input is energized if the machine is stopped (or within the 1st cycle since being stopped) and the corresponding group enable input signal is on. This allows output operations to be continued on a product that was in process when the machine stopped. It also allows outputs to be manually enabled after the product window has been passed, if the machine is stopped or within the 1st cycle. Use motion ANDing (FCN 107) if the group outputs must be prevented from turning on while the machine is stopped. Each time the machine stops, output logic is disabled and it is necessary to energize the 1st cycle enable input to have the outputs continue this machine cycle.

Note: If you stop at any point beyond the 1st leading edge of any channel in that group, the 1st cycle enable input will be disregarded.

How to Program Mode 5 Operation

1. Program FCN 108 and FCN 109 to correctly establish the output grouping and modes required for this machine application (insure that Mode 5 is selected for this group).
2. Check that this group has the desired position relationship to the machine position. Program FCN 2 or FCN 6 to adjust it.
3. Record the starting and ending position values where the sensor detects the product as it passes by.
4. Record the "on" and "off" positions for each of the outputs in this group.
5. Program the input window (CHN 9X) to be on between the latest off and the earliest on positions recorded in step 4, in an area where the input signal will be on. The window does not have to be wide. Therefore, in most applications it does not have be to right next to the latest off or earliest on positions. Insure that the input signal is on during some portion of the window (input on positions recorded in step 3). Remember, the window ends if the 1st programmed output pulse in the group occurs after the start of the window, but before the window off point.

Note: The group input window (CHN 9X) and the group output position setpoints must be programmed individually for each of the controller programs used (up to 48). Different programs can have different values as required.

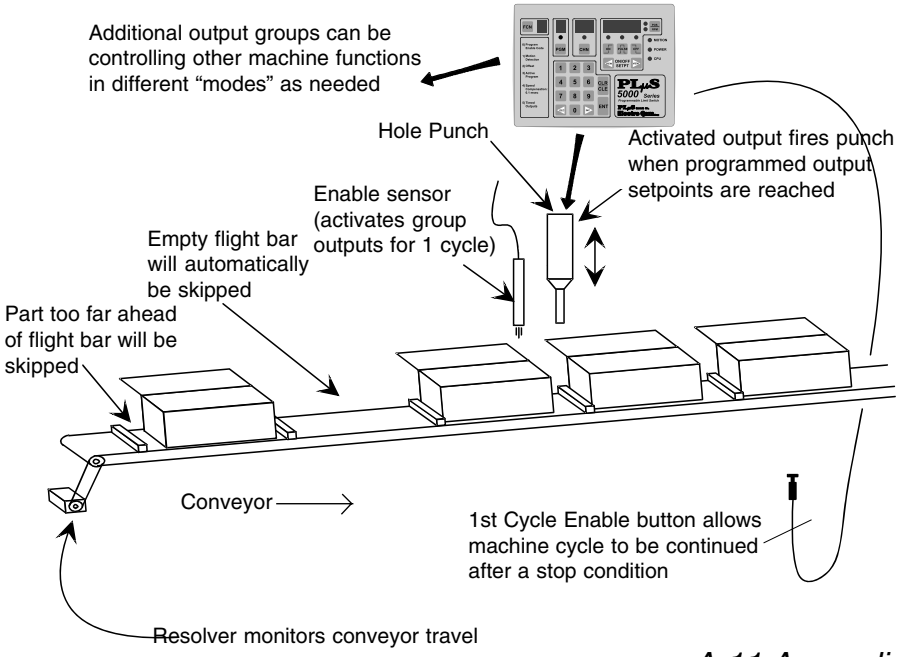
If the output group fails to operate when the machine is run with product present, insure that the group input is on during the programmed window (CHN 9X) and that the input is correctly wired. FCN 201 (page 7-5) allows input status to be monitored on keyboard display (9-14 are group enable inputs).

Mode 5 Example Application

Example Application: Operate machine function only if sensor detects part in correct position

In this illustration the punch will operate if the enable sensor detects the leading edge of the part at the correct position in the machine cycle just as in the Mode 4 illustration on page A-9. The difference is that Mode 5 has the 1st cycle enable input and the motion logic.

The motion logic discontinues output cycles that are in progress when the machine stops. The 1st cycle enable button allows them to be continued when the machine starts up if the button has been pressed. This allows machine operators to control whether or not the part in process is continued when the machine starts up again.



Mode 5 Logic Flow Chart

The flow chart to the right details how Mode 5 operates. The control's response to any set of conditions can be determined by stepping through the flow chart blocks using those conditions when decision blocks are encountered. The flow chart determines when the outputs are enabled and disabled by Mode 5 logic.

Note: Motion ANDing (FCN 107) and the Output Enable Input (input 16 and FCN 110) can also disable outputs.

How to Use the Flow Chart

To use the block diagram, assume that the control is continuously processing the blocks at a very fast rate and is never stopped on any one block. The control will get stuck processing the same path of blocks repeatedly (loop) until a condition changes within one of the decision blocks in that loop. Response to a condition change is almost instantaneous, so the new conditions established in the next loop take affect quickly. Note that the logic path can only flow in the direction of the arrows, never against them.

Rectangle Block

Output enable/disable status or a logic memory flag is altered.

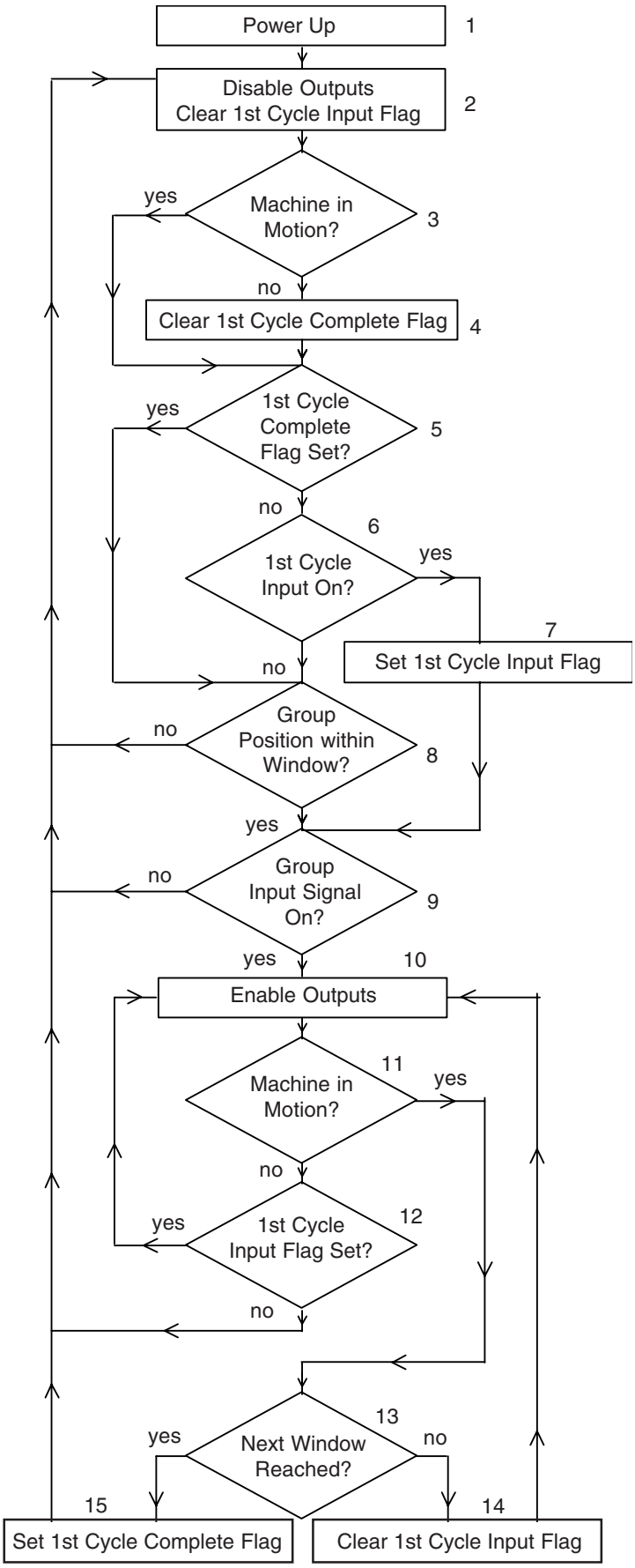
Diamond Block

A yes/no decision is made based on the condition stated within the block.

Mode 5 Flow Chart Blocks

1. Control powers up based on the last group position reference that was programmed into FCN 2 or FCN 6.
2. Outputs are disabled. Flag which indicates 1st cycle enable has been activated is unlatched.
3. Check machine in motion. If machine is moving go to step 5, if not got to step 4.
4. Clear 1st Cycle Complete Flag because machine is not moving.
5. Check if 1st Cycle Complete Flag is set. If it is go to step 8, if not go to step 6.
6. Check if 1st Cycle Input is on. If it is go to step 7, if not go to step 8.
7. Set 1st Cycle Input Flag. Go to step 9.
8. Check group position within the group input window. Go to step 9 if it is, loop back to step 2 if it is not.
9. Check group enable input signal on. If it is go to step 10, if not loop back to step 2.
10. Enable the outputs to cycle at their programmed on/off setpoints. Go to step 11.
11. Check machine in motion. If machine is moving go to step 13, if not go to step 12.
12. Check 1st Cycle Input Flag set. If it is loop back to step 10, if it is not go to step 2.
13. Check if group position has reached next input window (CHN 9X). If yes go to step 15, if no go to step 14.
14. Clear 1st Cycle Input Flag because machine is moving. Loop back to step 10.
15. Set 1st Cycle Complete Flag because next window has been reached. Go to step 2 (start of next cycle).

Mode 5 Logic Flow Chart



Program Select Information

General Program Select Information

Three formats are available for the program select inputs: BCD (Binary Coded Decimal), Binary, and Gray Code. **The desired format is chosen in FCN 101 - "PS".** Any time one or more of the program select inputs is on, the corresponding program number will become active.

The tables to the right list all of the valid input combinations for each of the formats. When all of the hardware program select inputs are off, the program number specified by Function 3 (Active Program) will become active. This allows the active program number to be selected from the keyboard when the hardware select inputs are not being used.

BCD Format

The BCD format allows standard 1 or 2 digit BCD switches to be interfaced to the program select inputs. PLCs can also output values in BCD.

The program number selected can be calculated by adding up the values associated with each of the inputs that are on. For example, if inputs 5, 3, and 1 are on, program number 15 would be active (10 + 4 + 1).

Remember, **the only valid values for the 10's digit are 0, 1, 2, or 3.** Trying to output a larger value to the 10's digit will cause the wrong program number to be selected. **9 is the largest valid value for the units digit.** A units digit combination larger than 9 will set the units digit to 9.

Binary Format

The binary format is convenient for PLC program select output signals. The program number selected can be calculated by adding up the values associated with each of the inputs that are on. For example, if inputs 5, 3, and 1 are on, program number 21 would be active (16 + 4 + 1).

Because the standard PS-5144 has 48 programs available, **a binary program select value larger than 48 selects program number 48.**

Gray Code

Electro Cam has 8 position Gray Code selector switches available as standard accessories for PS-5144 and other PLuS controls.

Because the standard PS-5144 has 48 programs available, **a Gray Code program select value larger than 48 selects program number 48.**

BCD Program Select Table

	10'S		UNITS			
Inp #:	**6**	**5**	**4**	**3**	**2**	**1**
Value:	20	10	8	4	2	1
PGM #						
FCN 3	0	0	0	0	0	0
1	0	0	0	0	0	1
2	0	0	0	0	1	0
3	0	0	0	0	1	1
4	0	0	0	1	0	0
5	0	0	0	1	0	1
6	0	0	0	1	1	0
7	0	0	0	1	1	1
8	0	0	1	0	0	0
9	0	0	1	0	0	1
10	0	1	0	0	0	0
11	0	1	0	0	0	1
12	0	1	0	0	1	0
13	0	1	0	0	1	1
14	0	1	0	1	0	0
15	0	1	0	1	0	1
16	0	1	0	1	1	0
17	0	1	0	1	1	1
18	0	1	1	0	0	0
19	0	1	1	0	0	1
20	1	0	0	0	0	0
21	1	0	0	0	0	1
22	1	0	0	0	1	0
23	1	0	0	0	1	1
24	1	0	0	1	0	0
25	1	0	0	1	0	1
26	1	0	0	1	1	0
27	1	0	0	1	1	1
28	1	0	1	0	0	0
29	1	0	1	0	0	1
30	1	1	0	0	0	0
31	1	1	0	0	0	1
32	1	1	0	0	1	0
33	1	1	0	0	1	1
34	1	1	0	1	0	0
35	1	1	0	1	0	1
36	1	1	0	1	1	0
37	1	1	0	1	1	1
38	1	1	1	0	0	0
39	1	1	1	0	0	1

Binary Program Select Table

Inp #:	**6**	**5**	**4**	**3**	**2**	**1**
Value:	32	16	8	4	2	1
PGM #						
FCN 3	0	0	0	0	0	0
1	0	0	0	0	0	1
2	0	0	0	0	1	0
3	0	0	0	0	1	1
4	0	0	0	1	0	0
5	0	0	0	1	0	1
6	0	0	0	1	1	0
7	0	0	0	1	1	1
8	0	0	1	0	0	0
9	0	0	1	0	0	1
10	0	0	1	0	1	0
11	0	0	1	0	1	1
12	0	0	1	1	0	0
13	0	0	1	1	0	1
14	0	0	1	1	1	0
15	0	0	1	1	1	1
16	0	1	0	0	0	0
17	0	1	0	0	0	1
18	0	1	0	0	1	0
19	0	1	0	0	1	1
20	0	1	0	1	0	0
21	0	1	0	1	0	1
22	0	1	0	1	1	0
23	0	1	0	1	1	1
24	0	1	1	0	0	0
25	0	1	1	0	0	1
26	0	1	1	0	1	0
27	0	1	1	0	1	1
28	0	1	1	1	0	0
29	0	1	1	1	0	1
30	0	1	1	1	1	0
31	0	1	1	1	1	1
32	1	0	0	0	0	0
33	1	0	0	0	0	1
34	1	0	0	0	1	0
35	1	0	0	0	1	1
36	1	0	0	1	0	0
37	1	0	0	1	0	1
38	1	0	0	1	1	0
39	1	0	0	1	1	1
40	1	0	1	0	0	0
41	1	0	1	0	0	1
42	1	0	1	0	1	0
43	1	0	1	0	1	1
44	1	0	1	1	0	0
45	1	0	1	1	0	1
46	1	0	1	1	1	0
47	1	0	1	1	1	1
48	1	1	0	0	0	0

Gray Code Program Select Table

Inp #:	**6**	**5**	**4**	**3**	**2**	**1**
	MSB					LSB
PGM #						
FCN 3	0	0	0	0	0	0
1	0	0	0	0	0	1
2	0	0	0	0	1	1
3	0	0	0	0	1	0
4	0	0	0	1	1	0
5	0	0	0	1	1	1
6	0	0	0	1	0	1
7	0	0	0	1	0	0
8	0	0	1	1	0	0
9	0	0	1	1	0	1
10	0	0	1	1	1	1
11	0	0	1	1	1	0
12	0	0	1	0	1	0
13	0	0	1	0	1	1
14	0	0	1	0	0	1
15	0	0	1	0	0	0
16	0	1	1	0	0	0
17	0	1	1	0	0	1
18	0	1	1	0	1	1
19	0	1	1	0	1	0
20	0	1	1	1	1	0
21	0	1	1	1	1	1
22	0	1	1	1	0	1
23	0	1	1	1	0	0
24	0	1	0	1	0	0
25	0	1	0	1	0	1
26	0	1	0	1	1	1
27	0	1	0	1	1	0
28	0	1	0	0	1	0
29	0	1	0	0	1	1
30	0	1	0	0	0	1
31	0	1	0	0	0	0
32	1	1	0	0	0	0
33	1	1	0	0	0	1
34	1	1	0	0	1	1
35	1	1	0	0	1	0
36	1	1	0	1	1	0
37	1	1	0	1	1	1
38	1	1	0	1	0	1
39	1	1	0	1	0	0
40	1	1	1	1	0	0
41	1	1	1	1	0	1
42	1	1	1	1	1	1
43	1	1	1	1	1	0
44	1	1	1	0	1	0
45	1	1	1	0	1	1
46	1	1	1	0	0	1
47	1	1	1	0	0	0
48	1	0	1	0	0	0

"G" Option - Gray Code Output

Gray Code Position Output -

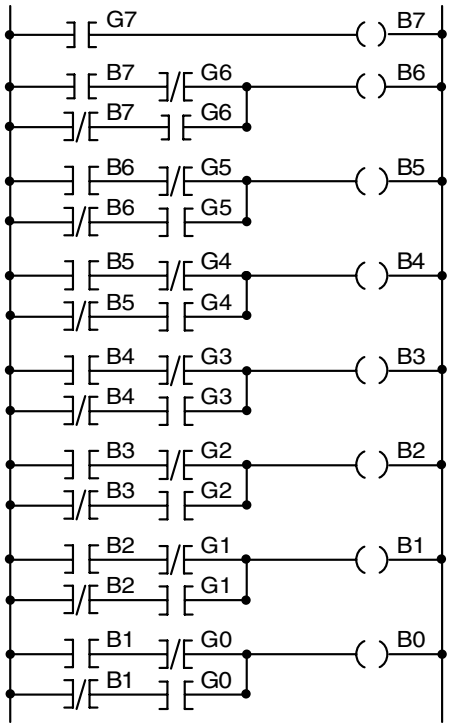
(Only units with the "G" Option)

Plus Controls with the Gray Code output option provide 8 Bit Gray Code position information on outputs 1-8 (output 1 is LSB, 8 is MSB). The position output represents the control's current "Shaft Position" value. Therefore the Gray Code position matches the Shaft Position (FCN 101 "SP") at all times. The Gray Code position outputs can be Speed Compensated, as a group, as shown below.

The Ladder Diagram shown on the right will convert the 8 Bit Gray Code output signal (G0-G7) from the PLuS control to a binary number (B0-B7) during each scan of the PLC. Because only one bit changes states per Gray Code increment, the decoding process is error free and does not require the use of latching or handshaking circuitry. The value of the Binary result will always be in the range of 0 - 255 because the 8 bit Gray Code divides each revolution into 256 uniform increments. Ladder rungs which follow the conversion can compare the rotary position value to known positions for control of machine devices that must operate at specific positions within the overall machine cycle. The rotary position of the machine cycle can also be used to gate input sensors and shift register functions.

Converting Gray Code to Binary involves a sequence of "Exclusive OR" operations. It is simple to program this same conversion logic in other programming languages besides ladder logic. In addition to decoding the rotary position of the encoder, controls with arithmetic capability can be programmed to perform direction reversal, position offset, and re-zero functions as well as convert the position value to degrees for easier monitoring and setup.

Gray Code Conversion Ladder



G0 - G7 = Gray Code Input Bits from PLuS control to PLC. G0 is output #1 (LSB) and G7 is output #8 (MSB).

B0 - B7 = Binary Equivalent of Gray Code Position after Decoding.

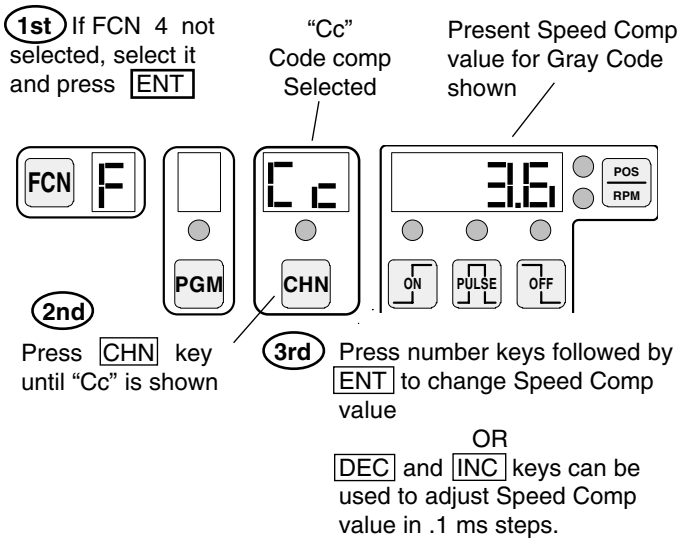
FCN 4: Gray Code Speed Compensation

(Programming Must be Enabled)

Speed Compensation is the ability of the control to automatically advance an output's setpoints as the machine speeds up. The Gray Code position output can be Speed Compensated by entering a speed comp value when the "Cc" (Code comp) symbol is shown in the CHN display. All of the Gray Code output channels will be compensated by this same amount.

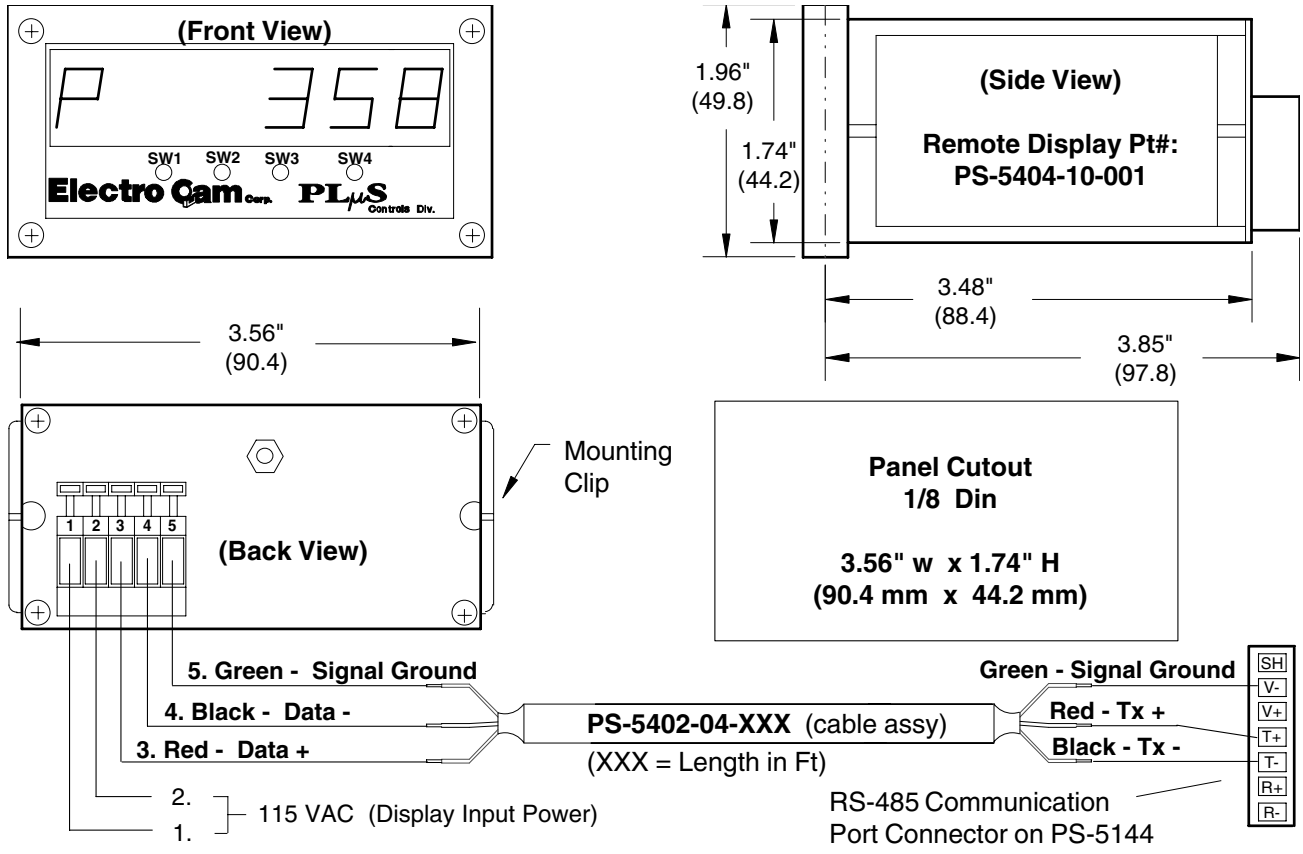
Speed compensation is set in .1 ms units. If the response of the system using the Gray Code information is known, set "Cc" equal to that amount of time in .1 ms units. If the response it not known, estimate it and then make adjustments by trial and error as needed. Steps 2 and 3 of the setup procedure given on page 5-4 for standard speed compensation also apply to Gray Code speed compensation.

Note: The Gray Code always uses standard speed compensation, regardless of whether or not the other outputs are set to operate in the leading/trailing speed comp mode ("L" option units only).



Remote Display Installation, Wiring and Setup

Dimensioned / Wiring Drawing



Display Operation

The remote display receives data from the PLuS control via RS-485 serial communication. The display will show either the controller's present rotary position or RPM as follows:

P 3 5 9 (example of position 359 shown by remote display)
r 2 5 0 (example of 250 RPM shown by remote display)

The toggle RPM (FCN 103 “tr”) value programmed determines the speed at which the display switches from showing position to RPM. At speeds below the toggle RPM value, position will be shown. At speeds equal to or above toggle RPM, the current RPM value will be displayed. It is NOT necessary for the control's display default (FCN 103 “dd”) to be set to auto; the display will automatically switch between position and RPM at the toggle RPM value, regardless of what the control's display is showing. The value of RPM update (FCN 103 “ru”) will determine how many times per second the display updates RPM.

To display position at all times set the toggle RPM to a number that is higher than the maximum speed of the machine. To display RPM at all times set the toggle RPM to 0.

Controller / Display Setup

Controller

Setup these FCN 104 items in the PLuS control as follows:

ct = 232 When ct is set to 232, the controller is automatically set-up to transmit position and rpm data out the 7-pin terminal to the remote display. Normal communication is then available on the DB9 connector.

tr = ? (select the RPM value where display should switch from showing position to RPM)

Display

All of the programmable items in the display will be correctly set at Electro Cam before the display is shipped. Below is a summary of the correct settings required to interface to the PS-5144 control. This information is stored in a permanent memory in the display and should never have to be programmed. However, if the display does not operate when connected to the control, check for correct display settings.

Display Settings

Baud Rate:	9600
Echo:	Off
Justification:	None
Terminators:	Two
Unit address:	1
Comm. Type:	RS485

PS-5144 Parts and Accessories

Fuses

PS-9000-4500	1/2 Amp Slo Blo - DC Power Input (mfg: Little Fuse, Pt#313.500)
PS-9005-0001	1 Amp - Transistor Power Fuse (mfg: Wickman, Pt# 19370-048)
PS-9005-0250	1/4 Amp - Auxiliary Power Fuse (mfg: Wickman, Pt# 19374-035)
PS-9005-0004	4 Amp - SLIMLINE Output Module Fuse (mfg: Wickman, Pt# 19370-062)

Output Modules (SLIMLINE)

EC-ODC060-3	0-60 VDC Output Module
EC-ODC200-1	0-200 VDC Output Module
EC-OAC240-3	24-280 VAC Output Module
EC-ORR000-0	Reed Relay Module (resistive loads only)
EC-SANL-010V	0-10 VDC Analog Output Module
EC-SANL-420M	4-20 mA Analog Output Module

Transistor Array Output Chips

PS-9011-2580	Sourcing Transistor Array Chip (generic Pt#: UDN-2580)
PS-9011-2803	Sinking Transistor Array Chip (generic Pt#: ULN-2803)
PS-9006-0015	DIP Jumper Block (16 Pin)

Resolvers

See price list for wide range of mounting styles, shaft sizes, housings, and connectors available. Resolver types include foot mount, flange mount, stainless steel, and geared.

Resolver Cables

PS-5300-01-XXX	Cable for Resolvers with Pin Connectors
PS-5300-02-XXX	Cable for Resolvers with Screw Terminals
PS-5903-01-001	NEMA 4X-1/2 NPT Cable Clamp used w/PS-5262 Resolvers

Connectors

PS-5003-01-TER	Resolver (control end - 7 terminals)
PS-9006-0017	Transistor Input Power (2 terminals)
PS-9006-0018	Auxiliary Power Output (2 terminals)
PS-9006-0019	Sinking Transistor Outputs 1-8 (8 terminals)
PS-9006-0020	Sinking Transistor Outputs 9-16 (8 terminals)
PS-9006-0021	Sourcing Transistor Outputs 1-8 (8 terminals)
PS-9006-0022	Sourcing Transistor Outputs 9-16 (8 terms)
PS-9006-0023	Inputs 1-8 (9 terminals)
PS-9006-0024	Inputs 9-16 (9 terminals)
PS-9006-0025	RS-485 Connector (7 terminals)
PS-9006-0026	20-30 VDC Power Input (3 terminals)

Communication Cables and Programs

PS-5402-01-012	RS-232 Cable (DB-9 connector both ends)
PS-5402-04-XXX	RS-485 Cable (Tinned both ends)
PS-5401-01-010	PLuSNET Communication Software Package

Switches

PS-4902-01-XXX	Program Enable Key Switch and Cable
PS-4901-01-XXX	8 Position Program Select Switch and Cable

Accessories

PS-4904-99-001	Clear Silicon Rubber Keyboard Boot (NEMA 4X)
PS-5404-10-001	Remote Display for Position / RPM (NEMA 1)
PS-5404-10-002	Remote Display for Position / RPM (NEMA 4)

Controller and Resolver Specifications

CONTROLLER

Electrical

Input Power	20 - 30 VDC
Input Current	500 mA max. (includes current drawn by accessory power output)
Perm. Memory:	EEPROM (no battery required)
Accessory Power Output:	Voltage 20-30 VDC, current fused @ 250mA
Terminal Torque:	4.5 inch-lbs.(use copper 60/75-C wire)

Environment

Operating Temp:	32 - 131 Deg F (0 - 55 Deg C)
Storage Temp:	-40 - 160 Deg F (-40 - 70 Deg C)
Operating Humidity:	95% Relative non-condensing
NEMA Rating	1, 4, 4X, or 12 w/proper enclosure

Physical

Overall Dimensions:	8.5"W x 6.5"H x 4.25"D 216mm x 165mm x 108mm
Panel Cutout Size:	7.38"W x 5.38"H 187.5mm x 135.7mm
Weight:	3.5 Lbs (1.6 Kg)

Outputs

PS-5144-24-(P16 or N16)M09

Real World Outputs:	Up to nine SLIMLINE modules may be mounted on controller. Modules may be any mix of AC, DC, reed relay, and up to two analog. All modules optically isolated.
DC (Transistor) Outputs:	16 sinking (N16) or sourcing (P16), optically isolated. Type must be specified on order.

PS-5144-24-M17

Real World Outputs:	Up to 17 SLIMLINE modules may be mounted on controller. Modules may be any mix of AC, DC, reed relay, and up to two analog. AI optically isolated.
Output Isolation:	All Outputs Optically Isolated

Inputs

Number of Inputs:	16
Input Isolation:	All Inputs Optically Isolated
Input On State Voltage:	10-30 VDC
Input Current:	11 mA @ 24 VDC
Prog. Select Response:	100 ms (Hardware response + processing time)
Other Inputs Response:	1 ms

Operation

Scan Time:	100-250 µs (exact time determined by programming)
Position Resolution:	10 bits (1024 increments) 12 bits (4096 increments "H" option)
Speed Compensation:	Programmed in .1 ms steps for each output individually (16 compensated outputs max) Updated 10 times per second Leading/trailing edge option (up-date time typically 5 times per Sec)
Output Timeout:	1.0 ms time base (accuracy: +1,-0 ms)
Number of Timed Outs:	4 timed outputs
Multiple Programs:	48 Programs (256 - "F" Option)
Total Pulse Memory:	1258 Pulses (4589 - "F" Option)
Pulses per Program:	512 Max (512 - "F" Option)
Pulses per Output:	512 Max (512 - "F" Option)
Maximum Speed:	Up to 2500 RPM Speeds in excess of 3000 RPM available

Serial Communication

Port Types: 1 RS-232 and 1 RS-422/485
Baud Rates: 4800, 9600, 19.2K, 38.4K
Note: RS-485 can be configured as a "Multi-Drop" network

Analog Output

Number of Analogs:	2 Max (0, 1, or 2 - programmable)
Output Types:	4-20 mA or 0-10 VDC
Resolution:	12 Bit Analog Hardware (Speed is calculated in 1/6 of an RPM steps, which limits the number of analog steps available in applications running under 680 RPM)
Update Frequency:	100 ms
Linearity:	+/-.2% full scale @ 25°C (77°F)

RESOLVER(S)

Operating Temp:	-40° to 125°C (-40° to 257°F)
Storage Temp:	-40° to 125°C (-40° to 257°F)
Operating Humidity:	95% Relative non-condensing
NEMA Rating:	NEMA 4 NEMA 4X
Maximum RPM:	3000 RPM
Max Cable Length:	1000 Ft.
Type:	Single Turn - Brushless
Resolution (all resv's):	12 Bits (4096 increments)
Linearity (standard):	+/-20 arc minutes (resolver only) (+/-30 arc minutes combined with R/D converter in controller)
Linearity (specials):	+/-3 to +/-10 arc minutes (resolver only) +/-7 to +/-14 arc minutes combined with R/D converter in controller)

Note: A resolver's linearity errors are repeatable at all positions of its 360 degree rotation. Therefore, once appropriate setpoints are established, machine performance is consistent every cycle.

SAFETY RATINGS

Controllers and keypads are UL and C-UL listed Industrial Control Equipment, File E151636. The C-UL indicates "Certified for Canada" and is similar to CSA certification.

OUTPUT MODULES

AC Outputs: EC-OAC240-3 (SLIMLINE)

Load Voltage:	24 V rms minimum 280 V rms maximum
Load Current:	30 mA rms minimum 3 A rms max. @/below 35°C (95°F) Above 35°C derate 50 mA/°C (27.8 mA/°F)
Input Voltage:	5 VDC nominal 8 VDC maximum
Turn On Time:	100 μs maximum @ 60 Hz
Turn Off Time:	8.3 ms maximum @ 60 Hz
Off State Leakage:	2 mA AC rms @ 120 VAC rms, 60 Hz
Frequency:	65 Hz maximum
On State Volt. Drop:	1.6 V peak maximum
Dropout Voltage:	1 VDC maximum
Pickup Voltage:	2.5 VDC minimum
Operating Temp:	-30 to +70°C (-22° to +158°F)

DC Outputs: EC-ODC060-3 (SLIMLINE)

Output Voltage:	0 to 60 VDC
Output Current:	3 A @/below 35°C (95°F) Derate 35.7 mA/°C above 35°C (19.8 mA/°F above 95°F)
Input Voltage:	5 VDC nominal 8 VDC maximum
Turn On Time:	50 μs maximum
Turn Off Time:	50 μs maximum
Off State Leakage:	1 μA DC maximum @ 24 VDC
Output Voltage Drop:	1.6 V peak maximum
Dropout Voltage:	1 VDC maximum
Pickup Voltage:	2.5 VDC minimum
Operating Temp:	-30 to +70°C (-22° to +158°F)

DC Outputs: EC-ODC200-1 (SLIMLINE)

Output Voltage:	0 to 200 VDC
Output Current:	1 A @/below 45°C (113°F) Derate 18 mA/°C above 45°C (10 mA/°F above 113°F)
Input Voltage:	5 VDC nominal 8 VDC maximum
Turn On:	50 μs maximum
Turn Off:	50 μs maximum
Off State Leakage:	1 μA DC maximum @ 24 VDC
Output Voltage Drop:	1.75 VDC maximum
Dropout Voltage:	1 VDC maximum
Pickup Voltage:	2.5 VDC minimum
Operating Temp:	-30 to +70°C (-22° to +158°F)

Reed Relays: EC-ORR000-0 (SLIMLINE)

Output Type:	N/O Reed Relay Contacts
Contact Rating:	10 VA maximum
Switching Voltage:	100 VDC or 130 VAC maximum
Switching Current:	0.5 A maximum
Carry Current:	1.5 A maximum
Turn On Time:	500 μs
Turn Off Time:	500 μs
Mechanical Life:	5 x 10^6 cycles
Operating Temp:	-30 to +70°C (-22° to +158°F)

ANALOG OUTPUT MODULES

0-10 VDC: EC-SANL-010V (SLIMLINE)

Resolution:	12 Bits (4096 increments)
Output Voltage:	0 - 10 VDC
Output Current:	140 mA DC maximum
Accuracy:	+/- 0.3% full scale @ 25°C (77°F)

4-20 mA: EC-SANL-420M (SLIMLINE)

Resolution:	12 Bits (4096 increments)
Output Current:	4 mA DC to 20 mA DC
Load Resistance:	450 Ohms maximum
Accuracy:	+/- 0.3% full scale @ 25°C (77°F)

TRANSISTOR OUTPUTS

Sinking Transistor Outputs (N16MO9)

Output Type:	Current Sinking (NPN)
Output Voltage:	5 - 30 VDC
Output Current:	50 mA cont. maximum
Input Voltage:	5 - 30 VDC

Sourcing Transistor Outputs (P16MO9)

Output Type:	Current Sourcing (PNP)
Output Voltage:	5 - 30 VDC
Output Current:	50 mA cont. maximum
Input Voltage:	5 - 30 VDC

Programming References

Proper documentation will minimize downtime and frustration. Once the control system is properly installed, wired, and programmed, the need to refer to the manual will be minimal. There are several pages in the manual which will make good references for programming and output adjustments. Electro Cam suggests that page 4-6 (output setpoint programming instructions) be copied and kept available to personnel that need to make periodic adjustments.

Documentation of Individual Programs

It is also important that the basic application programming be documented in a manner that is easy to understand. Since up to 48 programs can be used, it is advisable to document each program individually. The form shown on the next page was developed for this purpose. It is suggested that each program be documented in this manner.

Many of the items on this form will be the same for each program. Therefore, the amount of writing can be minimized by filling in one form with the information that is the same for each program, running copies of this version, and then filling in only those items which vary from program to program.

The following sequence of steps details this process:

1. Make a copy of page A-20.
2. Fill in the fields that will be the same in each program:

   Name / Description
   Operator Access (mark the outputs that operators can adjust)
   Group # (if groups are being used)
   Mode (if modes are being used)
3. Make enough copies of the partially filled in form to provide one for each program (recipe) that will be used
4. Fill in the output and window setpoint fields for each program individually (be sure to indicate the program number on each sheet)

Proper recording of program information will maximize machine performance and help personnel to understand when and how to make necessary adjustments.

Note: An IBM compatible software package (PLuSNET) is available to save, print, edit, and load the control's programming.

PROGRAM # _____

Output CHN #	Name / Description	Output Setpoints	Operator Access	Group#	Mode
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					

Input CHN #	Name / Description	Window Setpoints	Group#	Mode
91			1	
92			2	
93			3	
94			4	
95			5	
96			6	

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