

# Cam Logic and Resolver Information

## 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.

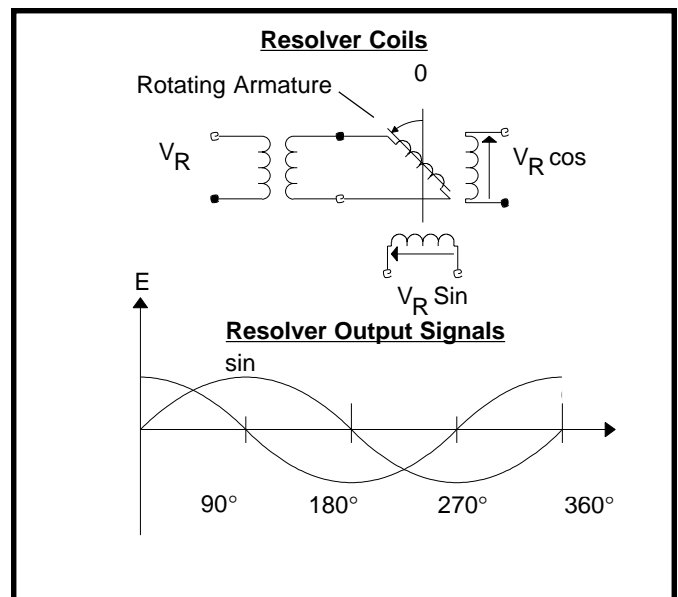
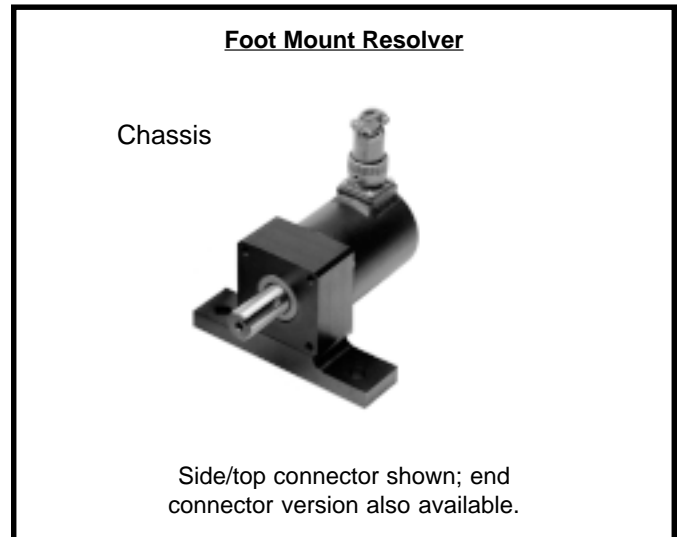
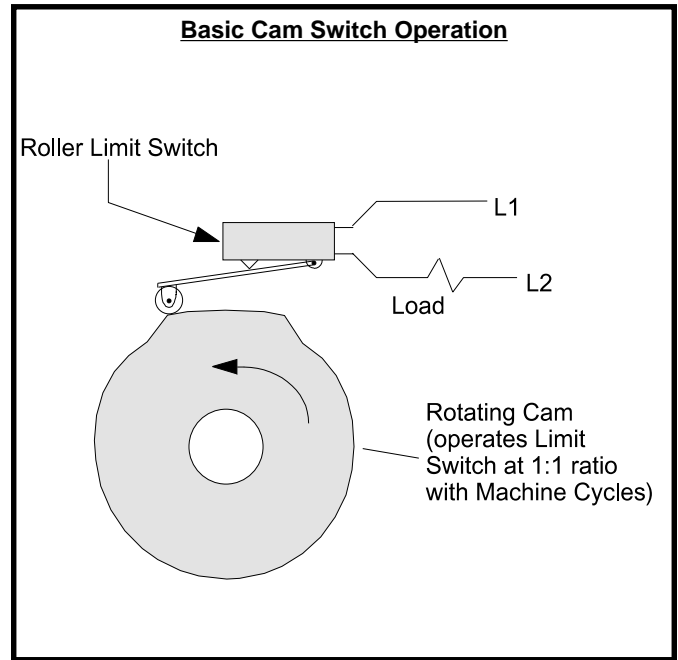
## Resolver Replaces Cam Shaft

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 ( $V_R$ ) 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).

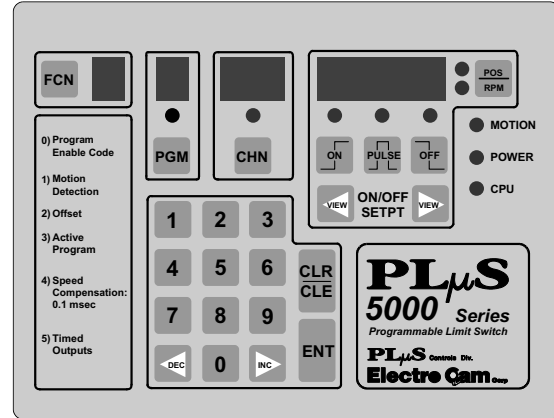


# Keyboard and System Overview

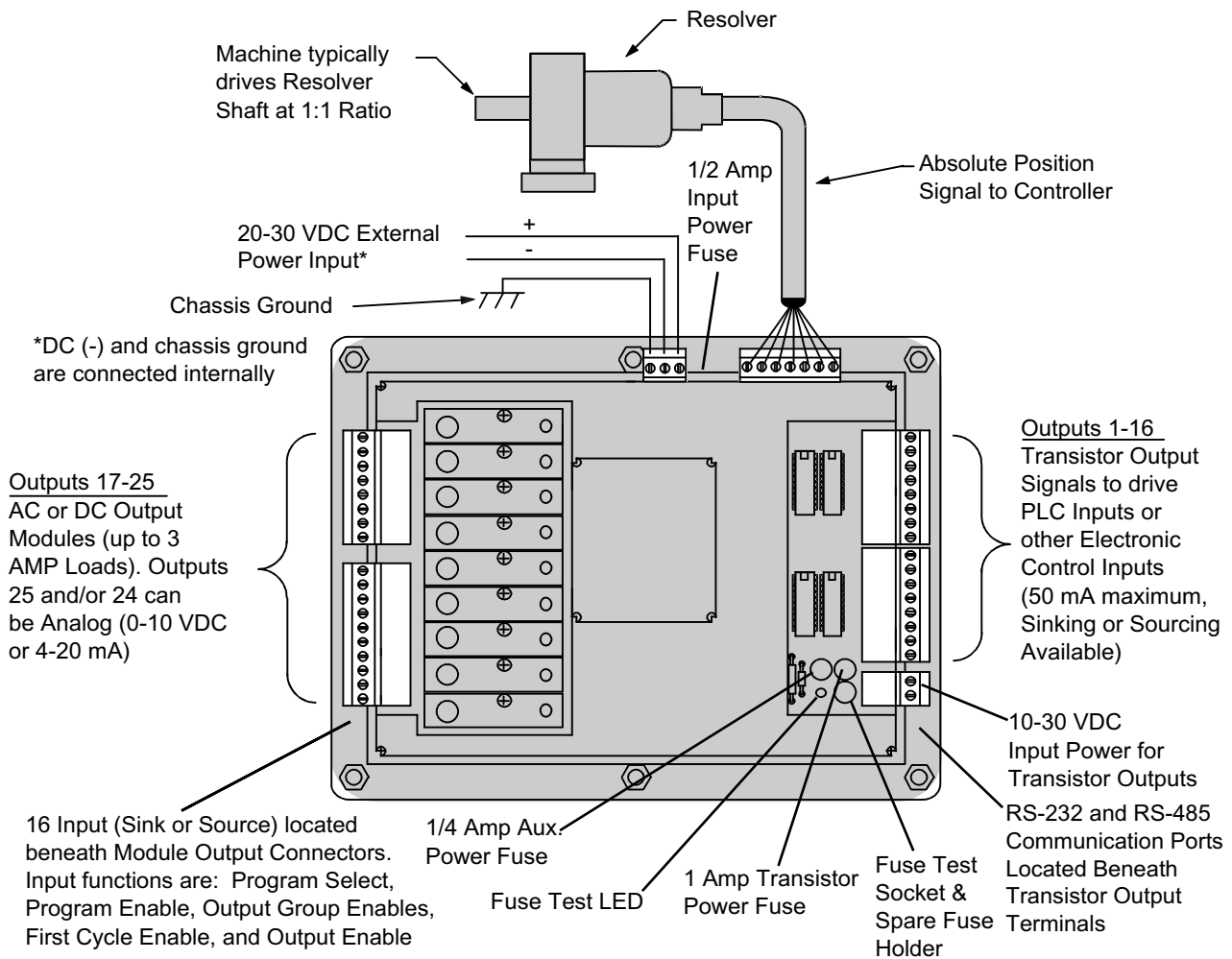
## Keyboard/Controller

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

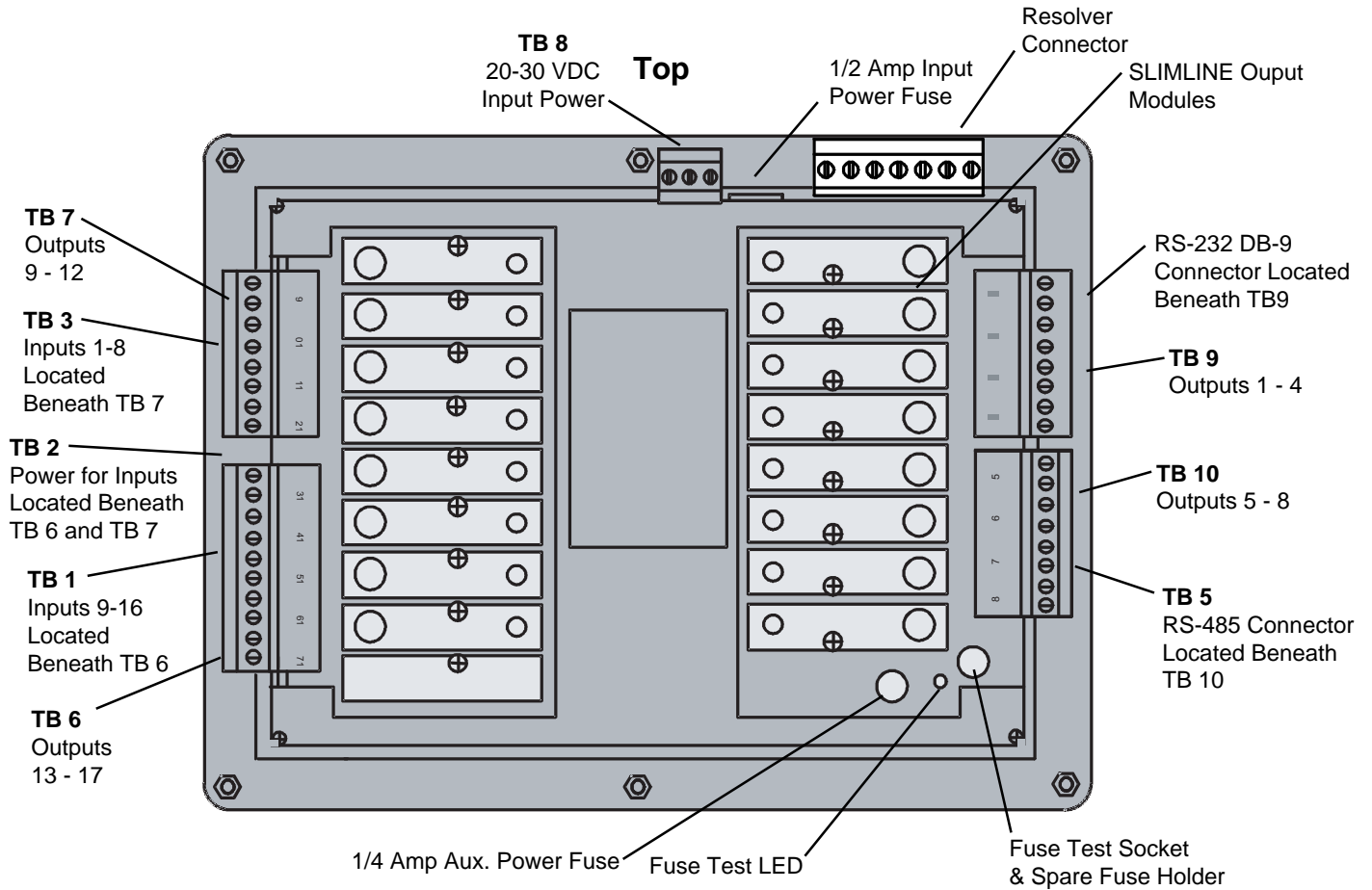


## PS-5144-24-X16M09 System Overview



## 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 PLSNET 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.

## Optional Features

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### 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 Compensation

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 PLS 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.