
Internal High-Speed Logic

Programmable limit switches are microprocessor-based controls that convert the rotary motion of a shaft into signals suitable for precise control of machine events and processes.

Electro Cam 6000 and select 5000 Series PL μ S programmable limit switches have the capability to perform machine logic through the ability of using inputs to enable outputs. Electro Cam Corp. refers to this as Internal High Speed Logic (or *output grouping and modes of operation*).

An output group is a user defined number of output channels that need to operate together within the framework of the machine process. Each group of channels maintains a common phase relationship. Modes of operation are pre-programmed logical sequences that are built into the firmware of the PL μ S.

How does the PL μ S emulate the logical sequences of a PLC without the complexity of programming and longer scan times associated with a PLC?

The PL μ S allows the user to assign a number of outputs to a “Group,” which then operates in one of six possible modes. Each of these modes (except Mode 0) is based on the operation of an input terminal. For each mode, the status of this input determines the operation of the outputs within the Group.

A PLC approaches the task differently. It constantly looks down the ladder logic rungs for instructions assigned to each input and output. The process of examining every input, output and the conditions required to operate them introduces a time delay as the PLC scans through the information.

Grouping output circuits and assigning different modes of operation to them reduces the amount of work the PL μ S’s digital processor has to do. Think of modes as “canned” subroutines that require only a single bit to turn them on. Limiting the information being processed keeps the scan times to a minimum.

The logical processes formed from the Groups and Modes operation still give incredible power and flexibility for programming and operation within your application. For high speed control of rotary-based machine functions, the PL μ S operates more efficiently than the PLC.

PL μ S controllers can operate as many as six Groups of outputs, or as few as one. Use of these Groups and Modes can help provide these benefits:

Reduced Waste and Cleanup — By enabling devices such as glue guns to operate only when a product is present, operating modes conserve adhesive and reduce mess and cleanup.

Increased Productivity — When used to compensate for phase adjustments between machine sections, operating modes can improve the high speed accuracy of machine functions. Off-loading these high-speed logic functions from the PLC to the PL μ S helps maintain reasonable scan times in the PLC. This allows higher machine speeds, better product quality, and reduced scrap.

This use of a single input allows the PL μ S to respond to real world machine conditions in one of a couple of ways: allowing conditional operation; controlling operation if and only if a certain condition is met, or for phase adjustment; allowing a marker from the operation to “reset” the processes.

NOTE: All Modes of Operation are not available on all Electro Cam controllers. Please contact factory.

Let’s look at how the modes of operation work to establish logical machine operations without complex programming:

Mode 0

Groups assigned to Mode 0 have their outputs always enabled. They are not affected by the operation of the enable input for the Group. So, when the rotation of the limit switch reaches the programmed setpoint, switching occurs. This is commonly referred to as straight cam logic.

Mode 1

Groups of outputs assigned to Mode 1 are always enabled to turn on at their setpoints. When the Group enable input turns on, the start position for all the outputs in the Group resets, using an offset function. The enable input has no further affect for the outputs until it turns off, and is then re-armed by a pulse programmed for the Group in the “Group Channel.” This will operate straight cam logic until the input is received, then reset.

The “Group Channel” is an enable input channel associated with a Group, whose setpoints are configured to control internal timing for the Group, rather than activating a real-world device. Within all modes of operation, enable input channels are used to establish “windows of opportunity,” or in some cases as a re-arm enable point.

Let’s look at an example that may help clarify how the outputs are affected by operation in Group 1.

Three sections of an adjustable phase converting machine are controlled by a single PL μ S controller and resolver. Groups 1, 2 and 3 all operate in Mode 1. The position of each Group is reset to the “preset” value when the Group’s sensor detects the registration mark on the shaft for the corresponding machine section. 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.

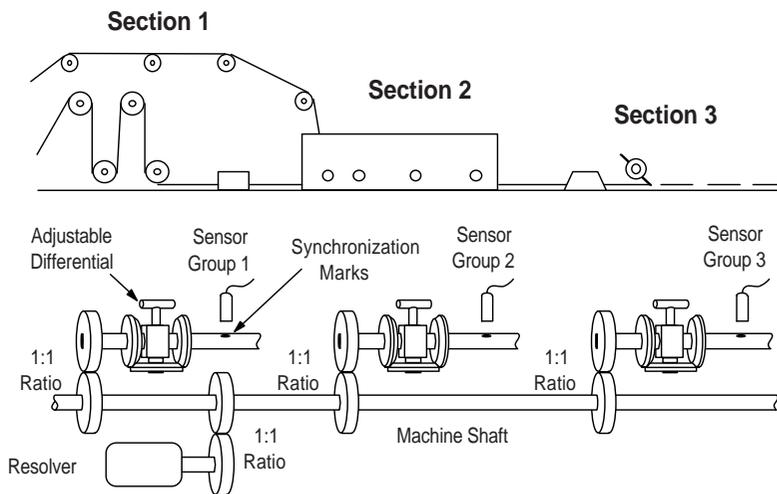


Figure 1

Mode 2

Outputs in a Mode 2 Group are disabled until the Group enable input turns on. Then the outputs are enabled to turn on for one machine cycle only at their programmed setpoints. As in Mode 1, the instant the Group input turns on, the Group start position resets through an offset function.

Two glue heads at different locations on the conveyor are controlled independently by a single PLμS controller and resolver. The spacing between parts being glued is random.

The sensors are connected to the input terminals for the corresponding Groups. When a sensor detects a product, it resets the corresponding Group position to the "preset" values and enables the Group outputs to turn on the glue guns at the correct setpoints.

When parts are not present, the outputs will be inactive.

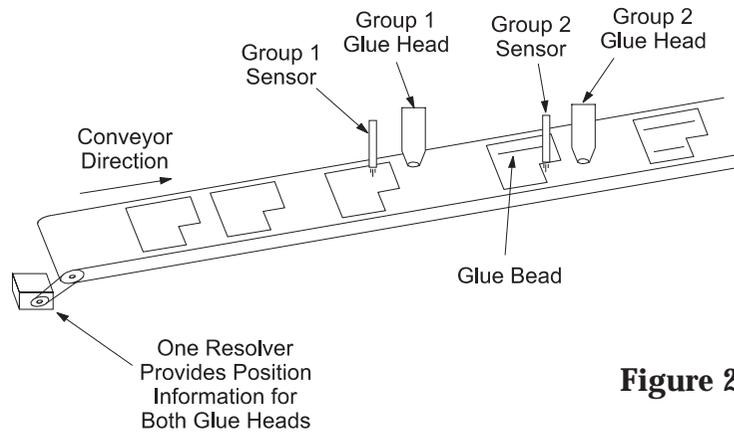


Figure 2

Mode 3

Outputs for a Group in Mode 3 turn on at their programmed setpoints only when the Group enable input is on.

Mode 3 is particularly helpful in a situation where you desire operation of the outputs only when the input sensor "sees" something, like a product on a conveyor, or a machine component placement.

The Group position does not reset, and operates the same as Mode 0 with the addition of the logic function.

In this illustration the glue head will operate only while the photoeye sees the top edge of a carton. Gluing will stop on crushed or improperly erected cartons when the eye loses sight of the top edge.

Mode 3 operation eliminates the need to hard-wire photoeyes and other sensors in series with the corresponding controller outputs. Instead, the sensor is "ANDed" with the output through Mode 3 programming.

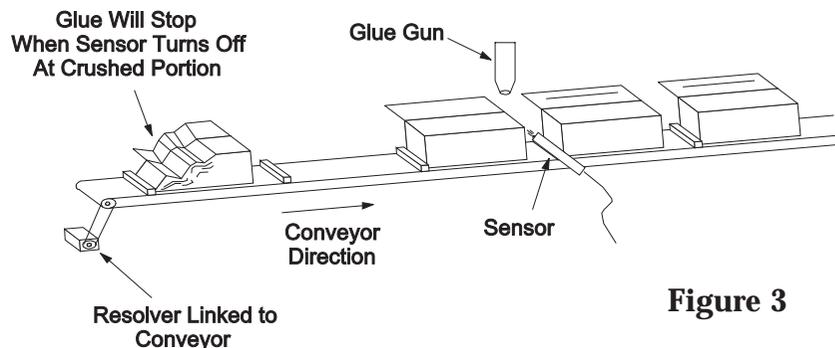


Figure 3

Mode 4

Outputs grouped in Mode 4 will be enabled to turn on at their programmed setpoints for one machine cycle only if the Group enable input switches on within a programmed “window” of the cycle.

The Group position does not reset, and operates the same as Mode 0 with the addition of the logic function. Inputs are edge-triggered in this mode. (See glossary.)

The glue gun will be enabled for one machine cycle only if the sensor detects the leading edge of a carton during the pulse programmed in the group channel. If a carton is missing or incorrectly positioned, the glue gun will not activate.

Mode 4 operation is appropriate for flight bar conveyors, rotary index tables, and similar types of machinery.

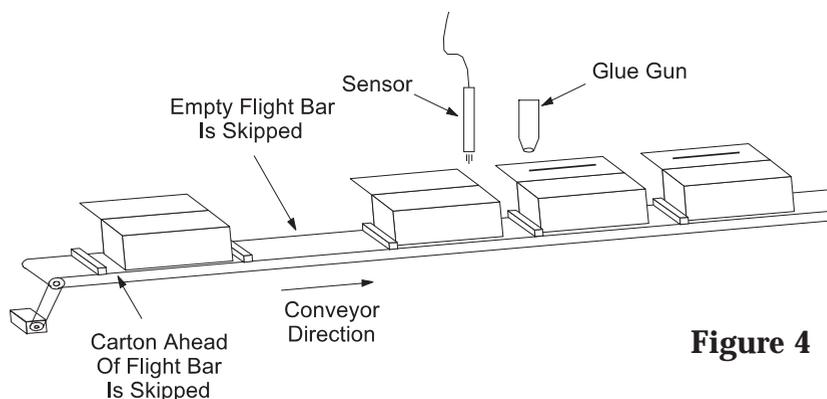


Figure 4

Mode 5

In Mode 5, outputs will be enabled to turn on at their programmed setpoints for one machine cycle only if the Group enable input is on for any portion of a programmed window of the cycle. This sounds identical to Mode 4, but Mode 5 differs from Mode 4 in several ways. First, in Mode 4, the input signal must *start* within the preprogrammed segment of rotation often referred to as “edge-triggered.” In Mode 5, *any* portion of the time the input is on can occur within that window of opportunity, and still make the outputs work, often referred to as “level-triggered.” Once rotation stops in Mode 5, all outputs are immediately disabled. If the input is on when the machine stops, operation can be resumed by energizing the PLμS “first cycle enable” terminal allowing operations to resume that were suspended when the rotation stopped.

The Group position does not reset, and operates the same as Mode 0 with the addition of the logic function.

The glue gun will be enabled for one machine cycle if the sensor sees a carton during the pulse programmed into the group channel. If a carton is missing, the glue gun will not activate.

If the line stops, the glue gun will be disabled immediately. To re-enable the glue gun on the same machine cycle, depress the push-button while the product sensor is “on.”

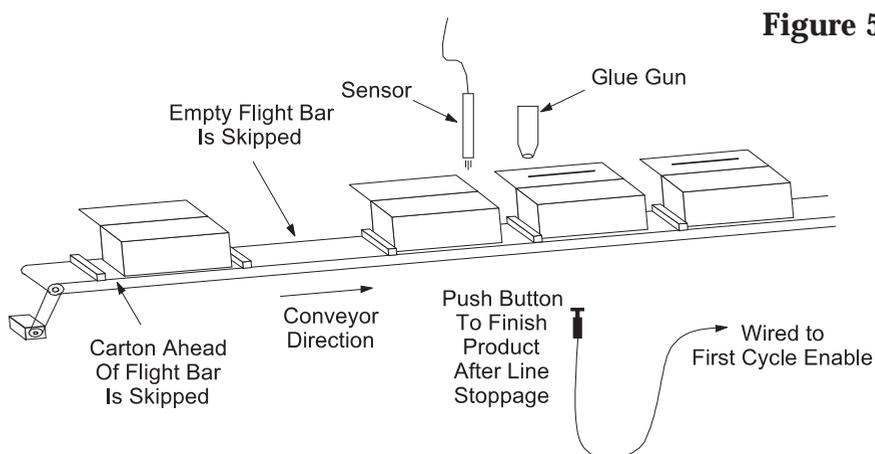


Figure 5

The pre-programmed logical subroutines available through the use of output groups and operating modes give PLμS units exceptional high speed performance. Your PLC or other high-level control method can stick with what it's good at — control of slower-speed elements, and supervisory control of multiple control schemes.

Glossary

- Channels** – Each Channel in the PL μ S controller contains ON and OFF setpoints for one 360° revolution of the resolver/encoder shaft. Channels are one of two types: **Output Channels** are used to control machine functions based on shaft position. The output turns ON when shaft position is within the bounds of a pulse that has been programmed into the channel. **Enable Input Channels** act as enable points or windows for an input received from a sensor or other controlling device.
- Cycle** – One complete sequence of events on an automated machine. Typically, on a rotary motion machine, one revolution of the encoder/resolver shaft equals one cycle.
- Edge-Triggered Input** – Activates an event when the input goes from false to true within a preprogrammed window.
- Encoder** – A position-sensing device that can be grouped into the following categories: incremental/absolute, linear/rotary, or optical/magnetic. Electro Cam products utilize gray code absolute optical encoders or magnetic type resolvers (absolute devices).
- Group Logic Inputs** – Signals from external sensors or switches that are accepted into PL μ S controllers and associated with Groups of outputs as part of the internal high speed logic feature.
- Inputs** – Signals from external sources accepted into the PL μ S controller which can be sent from a position transducer (encoder/resolver) or other external sensor or switch.
- Internal High Speed Logic** – In certain PL μ S controllers, this allows the user to divide outputs into Groups, each of which can be controlled by assigned inputs. Groups can operate in any one of six modes.
- Level-Triggered Input** – Activates an event when the input is true within the preprogrammed window. Input may change from false to true prior to the window, but must remain true in some portion of the window.
- Machine Cycle** – See **Cycle**.
- Mode** – A type of operation in which a group of outputs function.
- Program** – Allows a user to store channel ON/OFF setpoints for specific machine set-ups. By selecting different programs, product changeovers can easily be made without reprogramming individual setpoints.
- Pulses** – A pulse begins at the ON setpoint and ends at the OFF setpoint. The ON setpoint is the leading edge of the pulse, and the OFF setpoint is the trailing edge. When multiple pairs of setpoints are programmed into one channel, the channel is said to have multiple pulses.
- Resolver** – A magnetic type encoder that converts shaft position to an electrical signal that can be read by the controller. All Electro Cam resolver-based PL μ S controllers utilize ratiometric R/D (resolver-to-digital) converters to achieve noise immune data transmission over long distances.
- Scale Factor** – Allows the user to program the number of increments per revolution on resolver-based units. For example, to make the controller display position in degrees, a scale factor of 360 is used.
- Setpoints** – Points within one rotation of the resolver/encoder at which a channel turns ON or OFF. Setpoints can be programmed into a channel through the keypad/display. Any given channel can turn ON and OFF multiple times within one rotation.
- Window** – A user-defined (programmable) pulse within a machine cycle where input signals are accepted.
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Application Assistance

Electro Cam Corp. is highly experienced in analyzing machine control problems and finding economical solutions that provide excellent productivity and product quality. For application assistance, or to request more detailed information on our products, please call our application engineers at **800-228-5487** (USA and Canada).