Advantages of Grouping Outputs

PS-5XX4 controls can be subdivided into as many as eight different output groups. Each group can have dedicated enable input. There are two primary reasons to group outputs:

1. Outputs may be grouped together so they can 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, 3 or 4, if these glue outputs are grouped together and the corresponding 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 position transducer. If the outputs for a given section are grouped, the phase of the group can be adjusted, rather than having to individually adjust 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 (pages A-3 to A-11 give detailed explanations of each of the five modes). The fact that each group can be in any of the five modes and operates independent of the other groups makes grouping a powerful tool in many applications.

Grouping Outputs and Establishing Modes

The programming of FCN 8 determines how many output groups are created and how many outputs will be in each group. FCN 9 programming determines how many inputs are available and the mode in which each input (and the corresponding group of outputs) will operate. The “Output Group Enable 1” terminal on the logic terminal strip (p. 3-1) is always the input for Group 1. Additional inputs require input modules, located in the initial positions of the I/O rack. These module positions are no longer available for outputs and the number of outputs available is reduced accordingly.

Outputs are assigned to the groups in sequential order. Therefore, Group 1 output(s) will start with the first available output (after the input modules on rack) and include the specified number of outputs. Group 2 will begin with the next output and run sequentially until its specified number of outputs is reached. This process continues for up to eight groups. However, the last group will automatically include all of the outputs that are left. Therefore, the number of outputs in the last group is affected by the number of outputs in the other groups and the number of additional inputs established.

How to Program Output Grouping and Modes

1. Access FCN 8 and program the PGM display for the desired number of output groups. (see p. 4-9)
2. While in FCN 8 assign the desired number of outputs to each group except the last group (it will always contain all of the remaining outputs - this number will change if additional inputs are specified).
3. Access FCN 9 and program the PGM display for the desired number of inputs (see p. 4-9). Only one input per output group is allowed. (Inputs do not have to be allocated for groups operating in Mode 0, if these groups come after the groups that are using other modes.)
4. While in FCN 9 specify the mode of operation for each of the inputs established.
5. Program the appropriate input windows (CHN 91 - Group 1, CHN 92 - Group 2, etc.) for groups that are operating in Modes 1, 2 or 4. These windows must be individually programmed in each program used.

Note: Detailed information on the operating characteristics of modes and the function of the input windows is itemized for each mode on pages A-3 to A-11.

Logic Input Compared to Input Modules

The input for output Group 1 is on the logic terminal strip of the controller. Additional inputs require the use of input modules on the I/O rack. The characteristics of each of these input types is as follows:

Logic Terminal Input - Accepts a sinking signal only. Does not give any indication of input status by the input strip or on the keyboard displays. Response time is approximately 10 msec. Does not consume an output position on the I/O rack.

Module Input (module located on I/O rack) - AC and DC input modules available. Typical DC response is 2-3 msec and DC modules can be wired for sinking or sourcing signals. An LED (in or next to module) shows input status.

Input modules are easier to interface electrically, and provide LED indication of their on/off status. It can be advantageous not to use the logic terminal input by operating Group 1 in Mode 0 to control outputs not associated with input signals.

Note: Once programmed in a channel, this function will be present in that channel in all programs.

Example #1: On a nine I/O 5X24, establish three groups of outputs with four outputs in Group 1, two outputs in Group 2 and the remaining outputs (1) in Group 3. Group 2 and Group 3 both have a photo eye input associated with them and will operate in Mode 4.

Program FCN 8 as follows:

PGM	CHN	POS	
3	01	4	(Group 1 = 4 outputs, modules 3-6)
3	02	2	(Group 2 = 2 outputs, modules 7-8)
3	03	1	(Group 3 = 1 output, module 9)

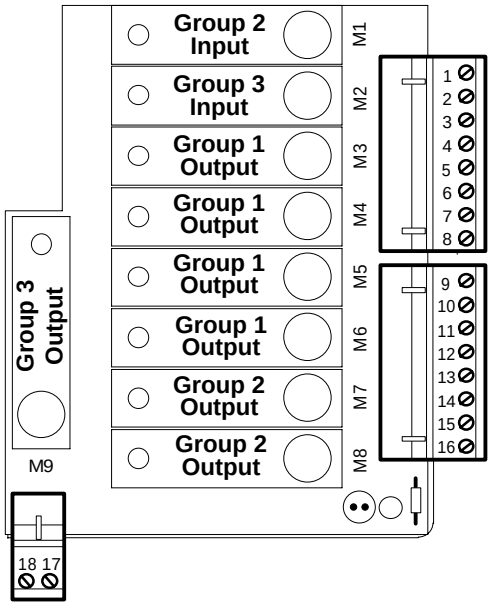
The "3" in the PGM display represents the number of groups, the CHN display is the group number and the POS display shows the number of outputs in the corresponding group. (p. 4-7 illustrates FCN 8 programming).

Program FCN 9 as follows:

PGM	CHN	POS	
3	E1	0	(Group 1 in Mode 0, term strip input)
3	E2	4	(Group 2 in Mode 4, module 1 input)
3	E3	4	(Group 3 in Mode 4, module 2 input)

The "3" in the PGM display represents the number of inputs being allocated, the CHN display shows which Enable input is being programmed, and the POS display shows the mode selected for the corresponding input. (p. 4-7 illustrates FCN 9 programming)

Example #1: I/O Rack Configuration



Note: Group 1 Input on Controller Logic Terminal Strip (not used in this example because Group 1 is in Mode 0)

Example #2: On a 16 I/O 5XX4 controller, establish four groups of outputs with six outputs in Group 1, two outputs in Group 2, three outputs in Group 3, and the remaining outputs (two) in Group 4. Each group requires an input signal and the groups will operate in Modes 1-4, respectively.

Program FCN 8 as follows:

PGM	CHN	POS	
4	01	6	(Group 1=6 outputs, modules 4-9)
4	02	2	(Group 2=2 outputs, modules 10-11)
4	03	3	(Group 3=3 outputs, modules 12-14)
4	04	2	(Group 4=2 outputs, modules 15-16)

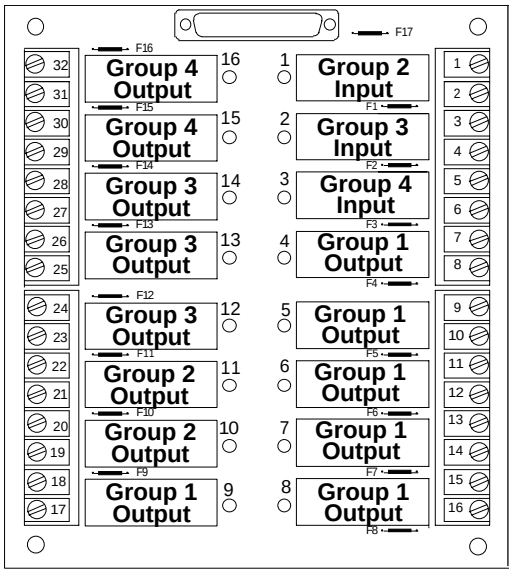
The "4" in the PGM display represents the number of groups, the CHN display is the group number and the POS display shows the number of outputs in the corresponding group. (p. 4-7 illustrates FCN 8 programming)

Program FCN 9 as follows:

PGM	CHN	POS	
4	E1	1	(Group 1 in Mode 1, term strip input)
4	E2	2	(Group 2 in Mode 2, module 1 input)
4	E3	3	(Group 3 in Mode 3, module 2 input)
4	E4	4	(Group 4 in Mode 4, module 3 input)

The "4" in the PGM display represents the number of inputs being allocated, the CHN display shows which Enable input is being programmed, and the POS display shows the mode selected for the corresponding input. (p. 4-7 illustrates FCN 9 programming)

Example #2: I/O Rack Configuration



Note: Group 1 Input on Controller Logic Terminal Strip

Mode Introduction - Mode 0 Operation

Introduction to Modes

The use of modes allows PS-5XX4 controls to perform output logic which goes beyond simple cam outputs. There are five different modes (modes 0-4) which can be assigned to output groups. Each mode has unique operating characteristic which can be matched to the logic requirements of the corresponding groups. In many situations, using mode logic can eliminate the need for external logic (PLC or discrete circuits) in series with the PS-5XX4 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 one mode will be used to satisfy the control requirements of different machine sections. 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 zero 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. 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.

Example Applications that Use Modes

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

Cartoners / Case Packers - Vacuum, material handling, loading, and other functions are usually controlled in Mode 0. Gluing functions are typically controlled in Mode 4 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 one resolver to do a job that would otherwise require two 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 makes only one cycle. 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. 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 8 and 9 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 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 7) 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 reset to zero. The outputs will immediately update in accordance with the zero 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 zero operation will occur when the leading edge of the input signal occurs. However, once the reset occurs, the control disarms the input and ignores it until it becomes re-armed. A programmed window determines where the input will become re-armed (re-arming the input is similar to cocking a gun; once it is re-armed 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 98. 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 the last offset programmed through FCN 2. On power up, the input is armed and the first signal received will cause the position to immediately reset to zero.

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

This illustration shows a single PLuS control and resolver controlling three "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

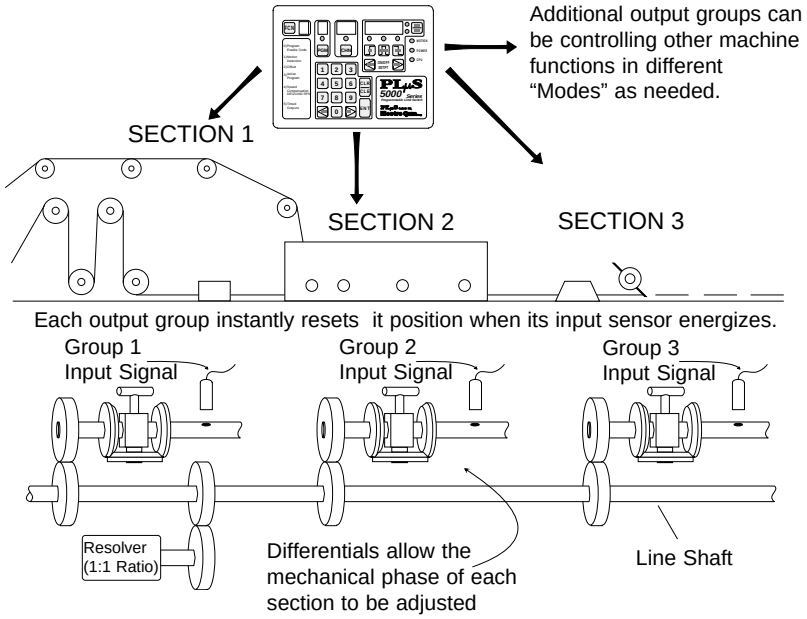
1. Program FCN 8 and FCN 9 to correctly establish the output grouping and modes required for this machine application (insure that Mode 1 is selected for this group).

2. Program the input window (CHN 9X) to start where the group enable input should be re-armed when the machine is moving in a forward direction and to end where the input should be re-armed if the machine is moving in reverse. If the input should always be armed, program CHN 9X to start on 1 and end one increment before zero.

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

If the output group position fails to reset when input signals occur, insure that an input window (CHN 9X) is programmed and that the input is wired to the control correctly.

Mode 1 Example Application



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 7) 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 position determined by last offset programmed from keyboard (FCN 2).

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.

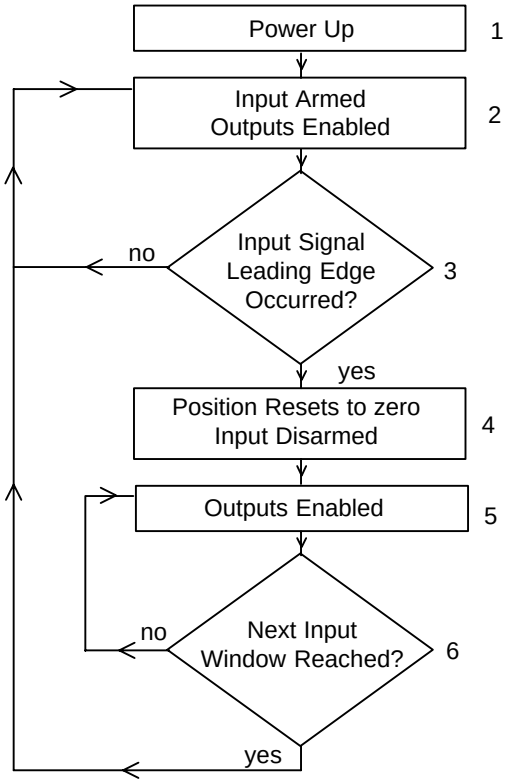
4. Reset group position to zero. Disarm group enable input.

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 reset to zero. 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 operation will occur when the leading edge of the input signal occurs. However, once the reset occurs, the control disarms the input and ignores it until it becomes re-armed. A programmed window determines where the input will become re-armed (re-arming the input is similar to cocking a gun - once it is re-armed 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 98. 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. **Note: If no window is programmed, output will become active if input is activated and will remain active.**

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 reset to zero.

Example Application: Control different machine functions asynchronously, on demand

This illustration shows a PLµS 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 resets 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 reset. This references the output signals to the leading edge of the part being glued. When parts are not present the outputs will be inactive.

How to Program Mode 2 Operation

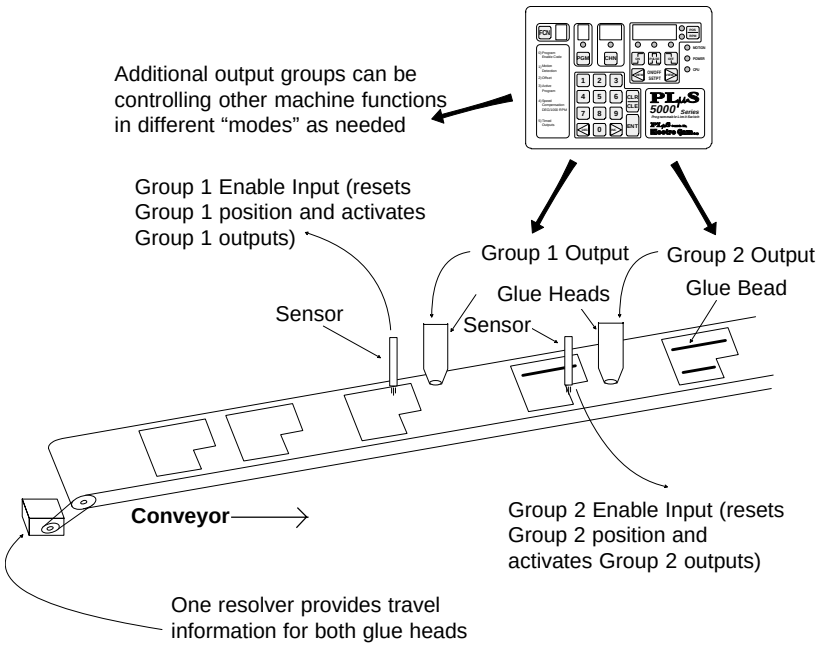
1. Program FCN 8 and FCN 9 to correctly establish the output grouping and modes required for this machine application (insure that Mode 2 is selected for this group).
2. Program the input window (CHN 9X) to start at 355 and end at 359 as initial values.
3. Manually crank or jog the machine through a cycle with a product present. After the reset 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.
4. 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. 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.

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

Mode 2 Example Application



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 2 logic. Note: Motion ANDing (FCN 7) 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

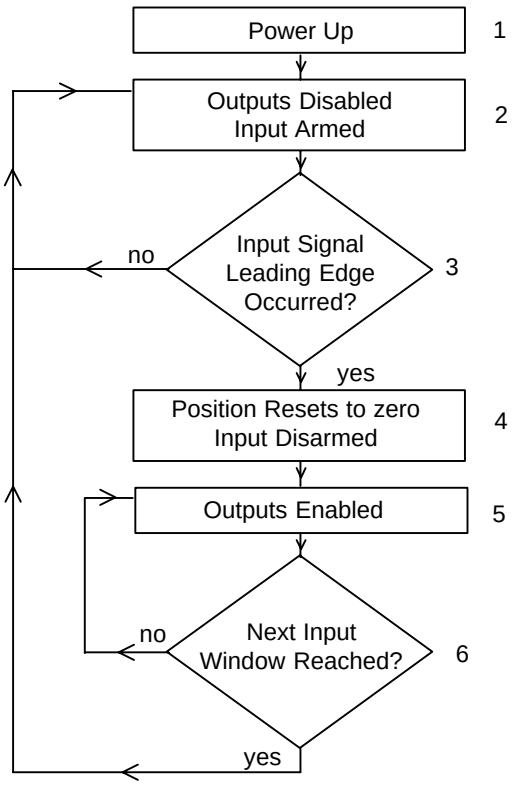
A yes/no decision is made based on the condition stated within the block.

Mode 2 Flow Chart Blocks

1. Control powers up and assumes position determined by last programmed offset.
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 zero. 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 output's 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, 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 8 and 9 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 to adjust it.
3. Program output setpoints to cycle the outputs on and off at the desired output group positions.

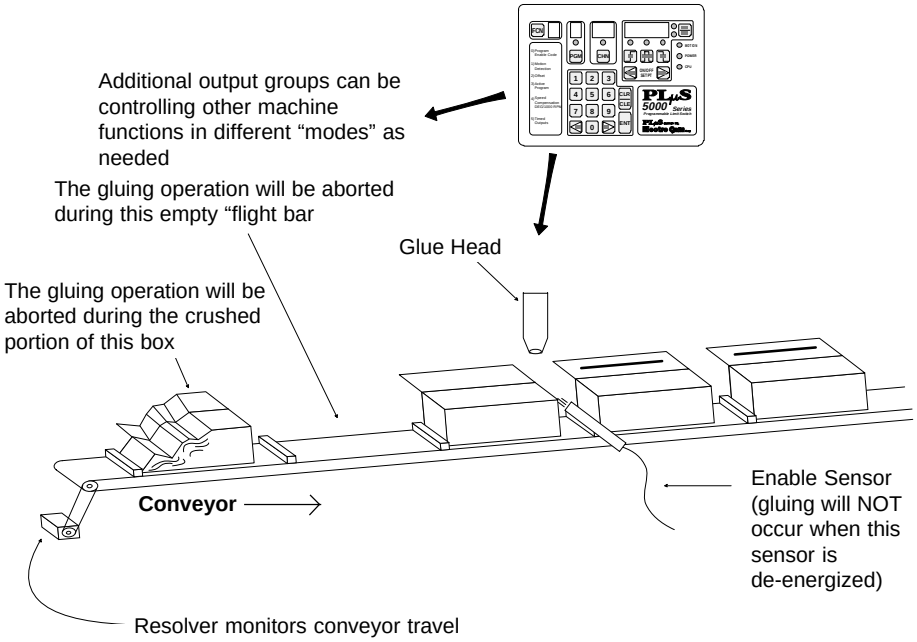
No other programming is required for Mode 3 to operate. If an output group operating in Mode 3 fails to cycle its outputs, insure that the input signal is on and wired to the control correctly. Motion ANDing (FCN 7) can also prevent the outputs from cycling.

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 Example Application



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 7) 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.

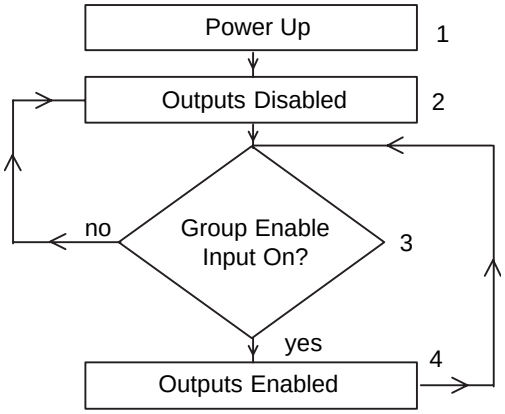
Diamond Block

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.
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 98. 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 programming. This reference can only be altered through FCN 2 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

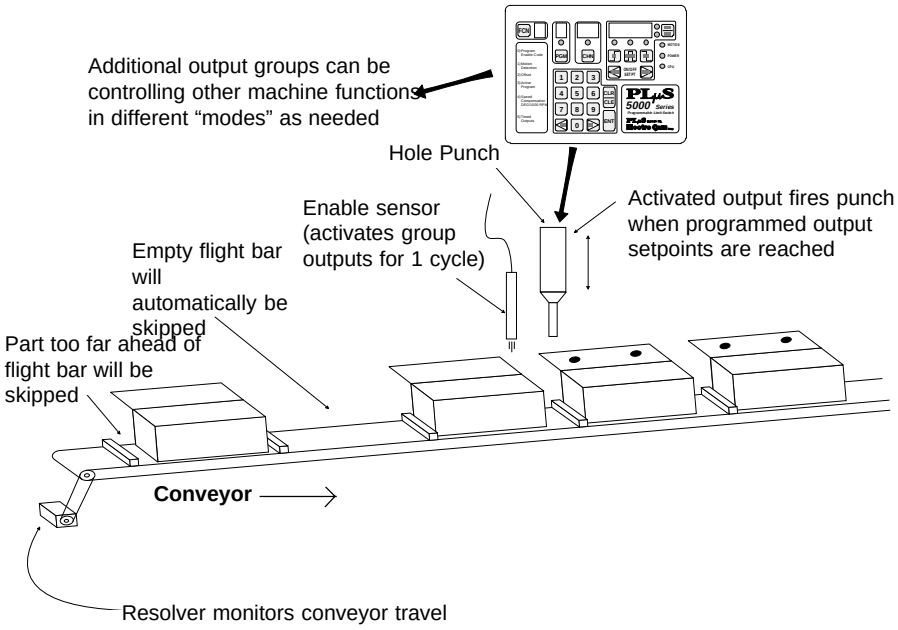
1. Program FCN 8 and FCN 9 to correctly establish the output grouping and modes required for this machine application (insure that Mode 4 is selected for this group).
2. Check that this group has the desired position relationship to the machine position. Program FCN 2 to adjust it.
3. Record the starting 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. 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.

Note: Once programmed in a channel, this function will be present in that channel in all programs.

Mode 4 Example Application



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 7) 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

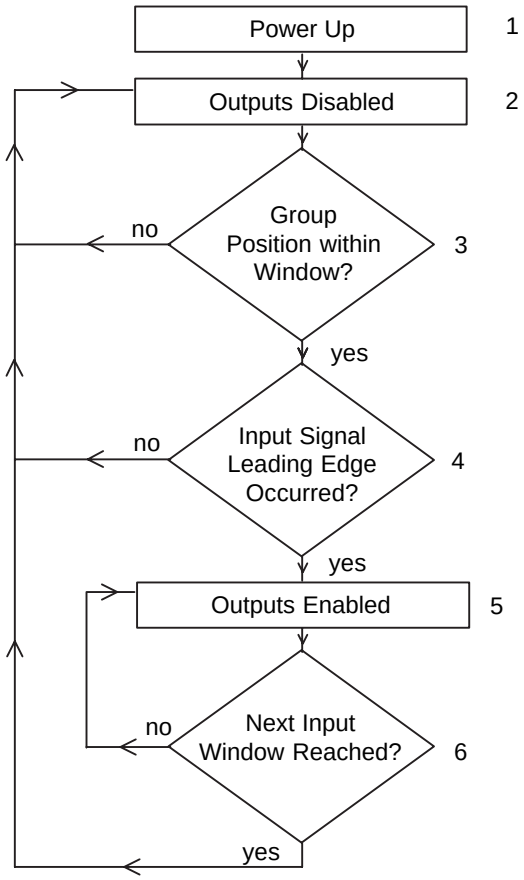
A yes/no decision is made based on the condition stated within the block.

Mode 4 Flow Chart Blocks

1. Control powers up based on the last group position reference that was programmed into FCN 2.
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



Two types of errors may be displayed:

Programming Programming error messages indicate that a programming attempt was invalid. Except for error message "E0 EErr", the control will continue to operate the outputs normally during programming errors. Programming error messages will be flagged in the following list with this symbol: P

System System errors occur when conditions are detected that can cause unreliable operation. **All outputs will be disabled when system error messages 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 errors will be flagged in the following list with this symbol: S

CrASH **Watchdog Timer Fault** S

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 AC input power to the controller. If the control immediately repeats the CrASH error condition each time it is powered up, hardware within the control is damaged. Call Electro Cam for return authorization and further advice.

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

E0EErr **EEPROM Programming Error** P

The Checksum associated with the Function programming (controller's global configuration) was found to be incorrect.

Solution: Press the CLR/CLE 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 re-program all functions that were altered from the factory defaults. (See page A-16, Alt Fcn 7000 for a listing of factory defaults.)

E0FAtL **Memory Fault** S

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: Control must be returned to factory for repair. Call Electro Cam first for return authorization and further information.

E1 CHEC **Checksum Error (Checked on Power-up)** S

The stored checksum value did not match the memory contents when checked on power-up. This problem can be caused by severe electrical noise during power-up or hardware failure within the control.

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

E1 OLAP **Pulse Overlap** P

The output pulse that was just created or adjusted overlaps or touches another pulse that already exists in the same output channel. It was therefore not entered. Also, if one edge of a pulse is moved until it is equal to the other edge, an "E1 OLAP" error will occur.

Solution: Press the CLR/CLE 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.

E2run **Item Can Not be Programmed While Running** P

While the encoder/resolver was turning, an attempt was made to change a programmed item that cannot be changed unless the transducer is stationary. Items which cannot be changed while in motion are: Direction of Rotation (FCN 0 - CL/CCL), Scale Factor (FCN 0 - SF), Output Grouping (FCN 8), and Enable Inputs and Modes (FCN 9).

Solution: Press the CLR/CLE key to clear the flashing error message. Stop the machine (transducer) while making the program change.

E4-Pro **Programming Not Enabled** P

A programming change was attempted when the corresponding level of programming access was not enabled. There are three levels of programming access. See page 4-1 for details.

Solution: Press the CLR/CLE key to clear the flashing error message. Enable the appropriate level of programming access and make the necessary changes.

E58888 **Number Out of Range** P

A number was entered 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 the number of output channels; an active program number that exceeds 8; etc.

Solution: Press the CLR/CLE key to clear the flashing error message. Enter a valid value for the item being programmed.

E6-379 **Illegal Setpoint Value (encoder controls only)** P

A setpoint value with a 3, 7, or 9 in the units digit was entered into a PS-50XX (encoder based) controller. Degree positions with 3, 7, or 9 in the units digit are skipped except for the following positions: 89, 179, 269 and 359.

Solution: Press the CLR/CLE key to clear the flashing error message. Enter a value that does not have 3, 7, or 9 in the units digit.

E7-dEF **Too Many Enable Inputs (5xx4 models only)** P

An attempt was made to program more Enable Inputs (FCN 9) than there are Output Groups (FCN 8).

Solution: Press the CLR/CLE key to clear the flashing error message. Review Functions 8 and 9 to determine the cause of the problem.

E9tdE **Too Many Timed Outputs** P

An attempt was made to program more timed outputs than are allowed. The number of timed outputs depends on the number of outputs and the timing base selected (page 4-5.)

8, 9, and 16 output systems: 8 - 1 mSec timed outputs
4 - .5 mSec timed outputs

24 and 48 output systems: 4 - 1 mSec timed outputs
(No .5 mSec time base)

Solution: Press the CLR/CLE key to clear the flashing error message.

E10-rES **Resolver Fault** S

No resolver is connected to the controller, or one of the connections to the resolver has experienced an intermittent or maintained open circuit condition.

Solution: Press the CLR/CLE key to clear the flashing error message, restore output operation and verify that the control is responding correctly to resolver position changes. It is important to determine the cause of the problem to avoid its occurrence in the future. Check that the resolver cable connector on the back of the control is plugged in all the way and that the seven wires connected to the screw terminals are properly secured. Also check that the resolver connecter is properly secured to the resolver.

The following resistance values can be checked at the control end of the resolver cable when it is unplugged from the controller and plugged into the resolver. Measure the resistance between wire pairs. Measurements will fall into one of two categories depending on age of resolver.

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

E11-ScE **Too Many Speed Compensated Channels (48 output systems only)** P

An attempt was made to program more that 16 speed compensated outputs into a 48 output controller.

Solution: Press the CLR/CLE key to clear the flashing error message.

(Continued next page)

FAtL int **Internal Run Error** S

There is a hardware problem with internal circuitry. All outputs will be disabled.

Solution: Call Electro Cam for return authorization and further information.

LinEFAiL **Input Power Voltage Low** S

The input power to the controller dropped below normal operating voltage, causing the controller to stop functioning. Check that input supply voltage to controller is within specified operating range (pg.A-18).

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

Pb Stuc **Push Button Stuck** S

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.

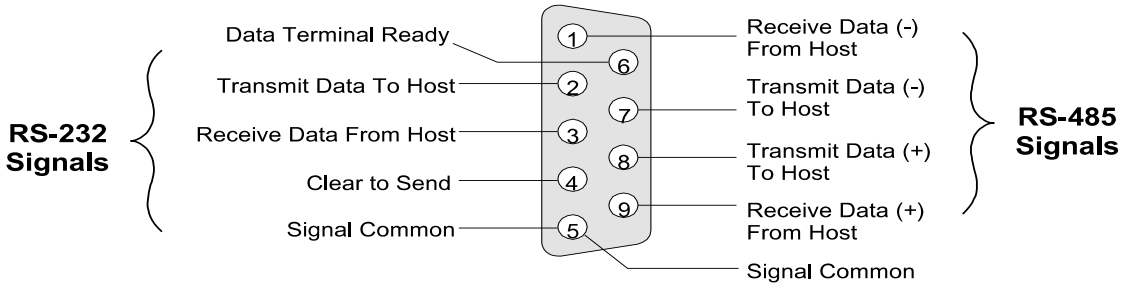
StoP **Controller in Stop Mode** S

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 (down load) 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. If the loading process is interrupted, the control might accidentally be left in the Stop mode.

Solution: Power cycle the control to restore normal operation.

Communication Port Pin Out and RS-232 Cables

PS-5000 Series DB-9 Connector (Female)



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

For standard 485 communications, pin 4 must be connected to pin 6. If pins 4 and 6 are not connected, controller will communicate with remote display, which will interfere with standard 485 communications.

RS-232 Cable Wiring—DB-25 to DB-9*

Computer or PLC with DB-25		PS-5000 Series DB-9
Receive Data 3	———	2 Transmit Data
Transmit Data 2	———	3 Receive Data
Signal Common 7	———	5 Signal Common

RS-232 Cable Wiring—DB-9 to DB-9*

Computer or PLC with DB-9		PS-5000 Series DB-9
Receive Data 2	———	2 Transmit Data
Transmit Data 3	———	3 Receive Data
Signal Common 5	———	5 Signal Common

***Pins 1, 4, 6, 7, and 8 must not be connected!**
Damage may result from using an off-the-shelf RS-232 communications cable.

Encoder Position Chart / 60 Pulse Disc for Encoder Based Controls

This table shows how an encoder based PLuS control scales 256 increments into degrees. Each increment change is equal to exactly 1/256th of a revolution (approximately 1.4 degrees) even though the position displayed sometimes changes by 2 degrees for a 1 increment change in position (control skips 3s, 7s & 9s).

PLuS = Control Position Deg = Actual Degree Postion

PLuS	Deg	PLuS	Deg	PLuS	Deg	PLuS	Deg	PLuS	Deg	PLuS	Deg
0	0.0	60	59.1	120	119.5	180	180.0	240	239.1	300	299.5
1	1.4	61	60.5	121	120.9	181	181.4	241	240.5	301	300.9
2	2.8	62	61.9	122	122.3	182	182.8	242	241.9	302	302.3
4	4.2	64	63.3	124	123.8	184	184.2	244	243.3	304	303.8
5	5.6	65	64.7	125	125.2	185	185.6	245	244.7	305	305.2
6	7.0	66	66.1	126	126.6	186	187.0	246	246.1	306	306.6
8	8.4	68	67.5	128	128.0	188	188.4	248	247.5	308	308.0
10	9.8	70	68.9	130	129.4	190	189.8	250	248.9	310	309.4
11	11.3	71	70.3	131	130.8	191	191.3	251	250.3	311	310.8
12	12.7	72	71.7	132	132.2	192	192.7	252	251.7	312	312.2
14	14.1	74	73.1	134	133.6	194	194.1	254	253.1	314	313.6
15	15.5	75	74.5	135	135.0	195	195.5	255	254.5	315	315.0
16	16.9	76	75.9	136	136.4	196	196.9	256	255.9	316	316.4
18	18.3	78	77.3	138	137.8	198	198.3	258	257.3	318	317.8
20	19.7	80	78.8	140	139.2	200	199.7	260	258.8	320	319.2
21	21.1	81	80.2	141	140.6	201	201.1	261	260.2	321	320.6
22	22.5	82	81.6	142	142.0	202	202.5	262	261.6	322	322.0
24	23.9	84	83.0	144	143.4	204	203.9	264	263.0	324	323.4
25	25.3	85	84.4	145	144.8	205	205.3	265	264.4	325	324.8
26	26.7	86	85.8	156	146.3	206	206.7	266	265.8	326	326.3
28	28.1	88	87.2	148	147.7	208	208.1	268	267.2	328	327.7
		89	88.6					269	268.6		
30	29.5	90	90.0	150	149.1	210	209.5	270	270.0	330	329.1
31	30.9	91	91.4	151	150.5	211	210.9	271	271.4	331	330.5
32	32.3	92	92.8	152	151.9	212	212.3	272	272.8	332	331.9
34	33.8	94	94.2	154	153.3	214	213.8	274	274.2	334	333.3
35	35.2	95	95.6	155	154.7	215	215.2	275	275.6	335	334.7
36	36.6	96	97.0	156	156.1	216	216.6	276	277.0	336	336.1
38	38.0	98	98.4	158	157.5	218	218.0	278	278.4	338	337.5
40	39.4	100	99.8	160	158.9	220	219.4	280	279.8	340	338.9
41	40.8	101	101.3	161	160.3	221	220.8	281	281.3	341	340.3
42	42.2	102	102.7	162	161.7	222	222.2	282	282.7	342	341.7
44	43.6	104	104.1	164	163.1	224	223.6	284	284.1	344	343.1
45	45.0	105	105.5	165	164.5	225	225.0	285	285.5	345	344.5
46	46.4	106	106.9	166	165.9	226	226.4	286	286.9	346	345.9
48	47.8	108	108.3	168	167.3	228	227.8	288	288.3	348	347.3
50	49.2	110	109.7	170	168.8	230	229.2	290	289.7	350	348.8
51	50.6	111	111.1	171	170.2	231	230.6	291	291.1	351	350.2
52	52.0	112	112.5	172	171.6	232	232.0	292	292.5	352	351.6
54	53.4	114	113.9	174	173.0	234	233.4	294	293.9	354	353.0
55	54.8	115	115.3	175	174.4	235	234.8	295	295.3	355	354.4
56	56.3	116	116.7	176	175.8	236	236.3	296	296.7	356	355.8
58	57.7	118	118.1	178	177.2	238	237.7	298	298.1	358	357.2
				179	178.6					359	358.6

60 Pulse Disc Setpoints for Encoder Based Controls

Pulse	ON	OFF	Pulse	ON	OFF	Pulse	ON	OFF	Pulse	ON	OFF
1.	0	2	16.	90	92	31.	179	181	46.	269	271
2.	6	10	17.	96	100	32.	185	188	47.	275	278
3.	12	15	18.	102	105	33.	191	194	48.	281	284
4.	18	21	19.	108	111	34.	196	200	49.	286	290
5.	25	28	20.	115	118	35.	204	206	50.	294	296
6.	31	34	21.	121	124	36.	210	212	51.	300	302
7.	36	40	22.	126	130	37.	215	218	52.	305	308
8.	42	45	23.	132	135	38.	221	224	53.	311	314
9.	50	52	24.	140	142	39.	228	231	54.	318	321
10.	55	58	25.	145	148	40.	234	236	55.	324	326
11.	61	64	26.	151	154	41.	240	242	56.	330	332
12.	66	70	27.	156	160	42.	245	248	57.	335	338
13.	74	76	28.	164	166	43.	252	255	58.	342	345
14.	80	82	29.	168	171	44.	258	261	59.	348	351
15.	85	88	30.	174	176	45.	264	266	60.	354	356

Alternate functions test and/or display the hardware status of the control or perform programming operations. Below is an itemized list of each Alternate Function.

To access Alternate Functions:

1. Press FCN and POS/RPM keys simultaneously.
2. Press numeric keys of Alt Fcn desired.
3. Press ENT key.

Note: Master Program Enable must be On.

Press POS/RPM key to exit Alternate Functions

Alt Fcn 1: Displays Actual Position of Transducer

Resolver: 0-1023 (10 bits) or 0-4095 (12 bits, "H" option)
Encoder: 0-255 (8 bits)

Alt Fcn 2: Displays On (1) Off (0) Status of Logic Inputs

Setpoint Display shows: Program Select Inputs (term 3-5)
Master Program Enable (term 6)
Channel Display shows: Output Group Enable 1 (term 7)
Operator Program Enable (term 9)

Alt Fcn 3: Displays Absolute Value of the Current Offset

This is the number of increments that the control position is leading the transducer position. Example: if Alt Fcn 3 displays a value of 90, the control will be at 90 when the transducer is at its absolute 0 position.

Alt Fcn 4: 60 Pulse Disc

Programs a 60 pulse disc into the last channel of the current active program.

Note: Controls with Analog ("-A") option or Phase Mark Registration ("-P") option do not have this function.

Alt Fcn 1002: Keyboard Test

While each key is pressed a unique number is displayed (99 is displayed if no key is pressed). THE CONTROL MUST BE POWER CYCLED TO EXIT THE KEYBOARD TEST.

Alt Fcn 1003: LED Display Test

All 7 segment Leds will first be turned on, then each Led segment will be lit individually, followed by each of the discrete Leds. The test repeats until a key is pressed.

Alt Fcn 1004: Watchdog Timer Test

Prevents controls internal "Watchdog Timer" circuit from being reset. If Watchdog Timer is functioning properly, the control will go into the "CrASH" mode. Press any key to restart the control.

Alt Fcn 1005: Display Control Model Information

Function display: "L" if control has Leading/Trailing comp
Program display: Graycode output option (0=No, 1=Yes)
Channel display: Number of I/O channels
Setpoint display: Basic model number (5001, 5104, etc)

Alt Fcn 1006: Display Options and Revision #

Function display: "P" if control has Register Mark Phasing
Program display: "A" if control has Analog
Channel display: first digit: "c" if control has Serial Comm
2nd digit: "H" if High Resolution control
Setpoint display: Software Rev # (ex: 507 = Rev 5.07)

Alt Fcn 7000: Restore Factory Defaults and Clear All Output Channel Setpoints

Control will scroll through memory locations shown in position display for approximately 45 seconds. "CrASH" will be displayed when operation is completed. Press CLR/CLE key to restore normal operation.

Factory Defaults are:

FCN 0	dr = CCL		FCN 1	Lo = 10
	SF = 360			Hi = 3000
				Ao = 0
				Ah = 2047
	P1 = 0000		FCN 3	AP = 1 Pb = 1
	P2 = 0000		FCN 4	All Channels 0
	Sc = onE		FCN 5	All Channels 0
	tb = 1		FCN 6	All Channels Off
	ct = 485		FCN 7	All Channels Off
	cS = 9600		FCN 8	1 Group, All Channels
	cA = 1		FCN 9	1 Input, Mode 0
	dd = SPd			
	tr = 20			

Alt Fcn 7001: Clear All Output Channel Setpoints

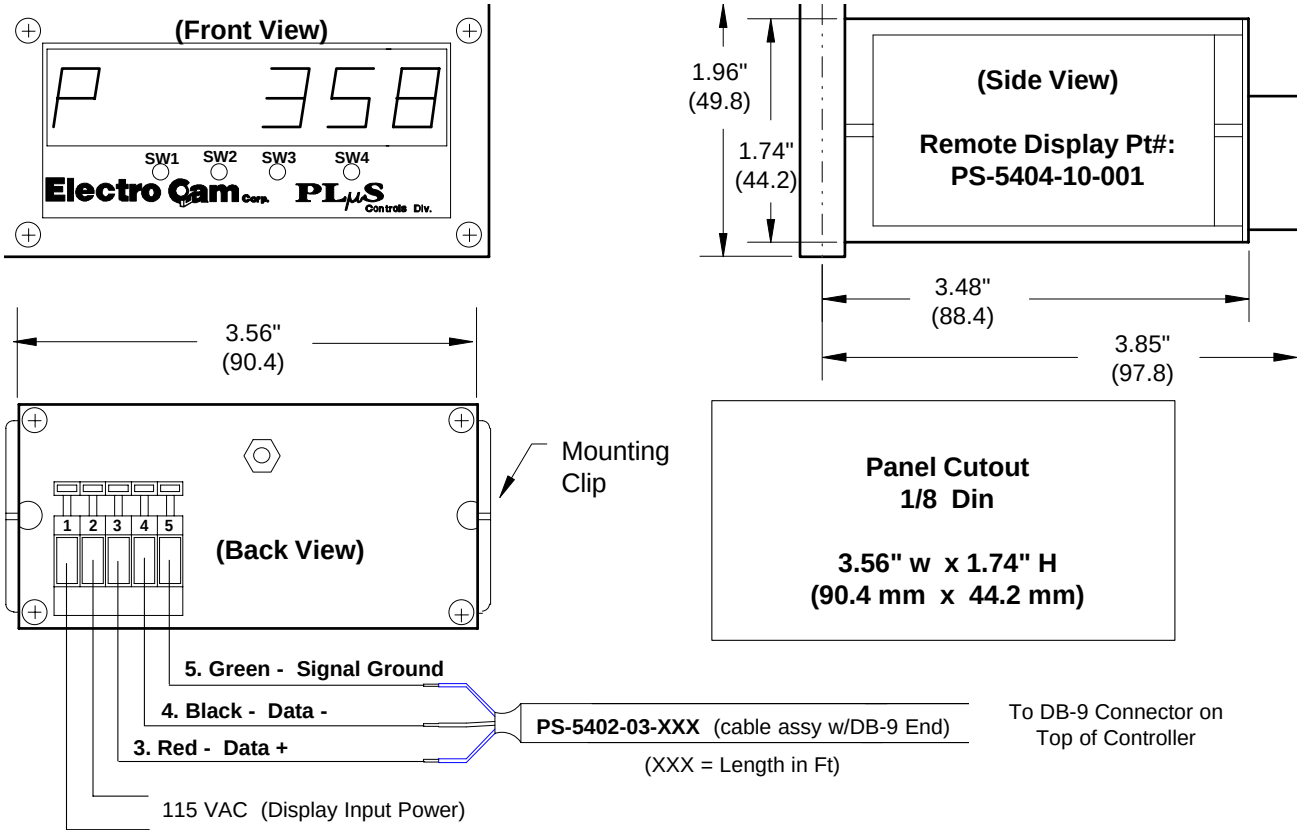
Control will scroll through memory locations shown in position display for approximately 25 seconds. "7001" will be displayed when operation is completed. Press any key to restore normal operation.

Alt Fcn 7999: Extensive EEPROM Test

(Restores Defaults and Clears All Channel Setpoints)
Control will scroll through memory locations shown in position display for approximately 6-1/2 minutes. "EO EErr" will be displayed when operation is completed. This error will show up once at the end of the test, and is not a problem unless it occurs during normal operation. "CRASH" will be displayed on older versions. Press CLR/CLE key to restore normal operation.

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

Dimensioned / Wiring Drawing



Display Operation

The remote display receives data from the PLµS control via RS-485 serial communication. **NOTE: Prior to date code 9740, the "-E" and "-C" options were required for communications.** 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 ("tr") value programmed in FCN 0 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 ("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 ("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 zero.

Note: A jumper between term 4 & 6 on the PLµS comm port will disable display data to allow normal serial communication.

Controller / Display Setup

Controller

Setup these FCN 0 items in the PLµS control as follows:

cS = 9600 9600 baud selected for communication speed. This is the fastest speed at which the display will operate, and is the factory default speed for the controller.

ct = 485 RS-485 format selected for serial port. **Display data will not be transmitted by the controller when in the RS-232 mode.**

tr = ? Select the RPM value where display switches 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. This information is stored in 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 as follows:

1. Press SW1 & SW2 simultaneously until the message "b_rate" is displayed for one second. The current baud rate will appear.
2. If the current baud rate is 9600, go to Step 3. Otherwise, press SW3 until 9600 is displayed.
3. Press SW1 to store the 9600 baud rate and return to normal operation.

Electrical

24 VDC	20-30 VDC
120 VAC 50/60 Hz:	108 - 132 VAC
240 VAC 50/60 Hz:	216 - 264 VAC
Power Consumption:	35 VA
Permanent Memory:	EEPROM (no battery required) min. 100,000 write cycles
Access. Power Out:	12 VDC, 150 mA
Terminal torque:	4.5 inch-lbs.

Use copper 60/75-C wire only

Environment

Operating Temp:	0° to 50°C (32° to 122°F)
Storage Temp:	-40° to 50°C (-40° to 122°F)
Operating Humidity:	95% Relative non-condensing
NEMA Rating:	For use on type 1, 4, 4X or 12 enclosure

Fuses:

20-30 VDC Operation:	1.25A, 250V, SB
120 VAC Operation:	0.5A, 250V, SB
240 VAC Operation:	0.25A, 250V, SB

Physical

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

Operation

Scan Time:	250 µs to 500 µs - Higher speed units available—consult factory
Position Resolution:	10 bits (1024 increments - resolver, standard control) 12 bits (4096 increments - resolver, "-H" option control) 8 bits (256 increments +/- 0.7 Deg - Gray Code encoder)
Speed Compensation:	Programmed in Deg/1000 RPM for each output individually (24 I/O systems and higher: 16 compensated outputs maximum) Updated 10 times per second. Leading/trailing edge option (update time determined by programming, typically 5 to 10 times per sec)
Output Timeout:	0.5 or 1.0 ms time base (accuracy: +1,-0 time increments)
Number of Timed Outputs:	1.0 ms time base: 8 timed outputs 0.5 ms time base: 4 timed outputs (24 and 48 I/O systems have 1.0 ms time base only - up to 4 timed outputs)
Multiple Programs:	64 Prgms. on 8, 9, & 16 I/O units 48 Programs on 24 I/O units 24 Programs on 48 I/O units
Maximum RPM:	Encoder: 2000 RPM Resolver: Up to 3000 RPM Depending on specific model & optional features - Higher speed units available—consult factory

Input Responses

Program Select:	100 ms (Hardware response + processing time)
Output Group Enables:	1 Scan

Serial Communication ("C" Option)

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 ("A" Option - proportional to RPM)

Output Types:	4-20 mA or 0-10 VDC
Resolution:	12 Bit Analog Hardware (Speed is calculated in whole RPM and will determine the actual number of analog steps available in any specific applications.)
Update Time:	100 ms
Linearity:	+/- 0.3% full scale @ 25°C (77°F)

ENCODER(S)

Operating Temp:	0° to 50°C (32° to 122°F)
Storage Temp:	-40° to 50°C (-40° to 122°F)
Operating Humidity:	95% Relative non-condensing
NEMA Rating:	NEMA 12 (PS-4256, 4257) NEMA 4X (PS-4456, 4457)
Max Cable Length:	1000 Ft.
Enclosure Size:	6"W x 6"L x 4.25"H
Mounting Holes (4):	5/16" Diameter
Weight:	9 Lbs.
Shaft Diameter:	.75" (double ended) with Woodruff keyway #606
Maximum RPM:	1000 RPM (PS-4256, 4456) 2000 RPM (PS-4257, 4457)
Resolution:	8 Bits (256 increments)
Accuracy:	+/-0.7°

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):	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.

AC/DC Output Module Specifications

AC Outputs: EC-OAC5A-11 (Standard)
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-ODC5 (Standard)
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-ODC5A (Standard)
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-ORR5 (Standard)

Output Type:	N/O Reed Relay Contacts
Contact Rating:	10VA maximum (DC resistive load)
Switching Volts:	0 V to 200 V, DC or peak AC
Switch Current:	0.5 A maximum, DC or peak AC (resistive loads only)
Carry Current:	1.0 A maximum, DC or peak AC
Turn On Time:	1 ms
Turn Off Time:	500 µs
Mechanical Life:	50 million cycles min at rated load
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 ms
Turn Off Time:	500 µs
Mechanical Life:	5×10^6 cycles
Operating Temp:	-30 to +70°C (-22° to +158°F)

0-10 VDC: **EC-ANLG-010V (Standard)**
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-ANLG-420M (Standard)**
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)

DC Inputs: EC-IDC5 (Standard)
EC-IDC032 (Slimline)

Input Voltage:	10-32 VDC
Input Current:	34 mA maximum (@32 VDC input)
Output Supply Voltage:	4.5 VDC to 6 VDC 5 VDC nominal
Output Supply Current:	18 mA DC maximum @ 5 VDC
Turn On Time:	5 ms maximum
Turn Off Time:	5 ms maximum
Dropout Voltage:	2 VDC maximum
Pickup Voltage:	3 VDC minimum
Operating Temp:	-30 to +70°C (-22° to +158°F)

AC Inputs: EC-IAC5 (Standard)
EC-IAC120 (Slimline)

Input Voltage:	90-140 VAC rms
Input Current:	11 mA AC rms maximum (@140 VAC rms input)
Output Supply Voltage:	4.5 VDC to 6 VDC 5 VDC nominal
Output Supply Current:	16 mA DC maximum @ 5 VDC
Off State Leakage:	100 µA DC maximum @ 30 VDC
Output Voltage Drop:	0.4 VDC @ 50 mA DC
Output Current:	50 mA DC maximum
Turn On Time:	20 ms typical
Turn Off Time:	20 ms typical
Input Allowed for No Output:	45 VAC rms, 3 mA AC rms maximum
Operating Temp:	-30 to +70°C (-22° to +158°F)

AC Inputs: EC-IAC5A (Standard)
EC-IAC240 (Slimline)

Input Voltage:	180-280 VAC rms
Input Current:	5 mA AC rms maximum (@280 VAC rms input)
Output Supply Voltage:	4.5 VDC to 6 VDC 5 VDC nominal
Output Supply Current:	16 mA DC maximum @ 5 VDC
Off State Leakage:	100 µA maximum @ 30 VDC
Output Voltage Drop:	0.4 VDC @ 50 mA DC
Output Current:	50 mA DC maximum
Turn On Time:	20 ms typical
Turn Off Time:	20 ms typical
Input Allowed for No Output:	45 VAC rms, 1 mA AC rms maximum
Operating Temp:	-30 to +70°C (-22° to +158°F)

Sinking Transistor Outputs (PS-5X11, N08 and N16)

Output Type:	Current Sinking (NPN)
Output Voltage:	5 - 30 VDC
Output Current:	50 mA cont. maximum
Input Voltage:	5 - 30 VDC

Sourcing Transistor Outputs (PS-5X11, P08 and P16)

Output Type:	Current Sourcing (PNP)
Output Voltage:	5 - 30 VDC
Output Current:	50 mA cont. maximum
Input Voltage:	5 - 30 VDC