Control TechNotes

Programmable Limit Switch Function

For the 2600XM, 2700 and MultiPro™ Series Automation Controllers

Technical Note No. 20, March 10, 1998

This is an optional firmware feature in the 2600XM and 2700 controllers. To order a controller with the PLS function, you must add the **-PLS** suffix to the controller part number. The PLS function is a standard feature of the MultiPro family.

The PLS function is supported by:

- Controller Firmware R2.18
- 2206 Stepper Motor Module Firmware R1.3
- 2219 Servo Motor Module Firmware R2.9

The following application describes the PLS function and demonstrates how it is used. The PLS function is transparent to the controller's Quickstep program since it runs in the controller's background routine. It provides uniform and accurate triggering of up to 16 digital outputs.

Features Include

- PLS table controls up to 16 outputs in 2 banks of 8 each
- Individually selectable position reference for each bank
- Up to 127 transition points for each output
- Programmable rollover point for repeating cycles
- Individual output enable/disable
- Data Table holds transition point image and is changeable on-the-fly
- 1 ms resolution on output changes

Contents

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What is a PLS?

PLS is the acronym for Programmable Limit Switch.

Many of the machines in industry, which have moving slides or turntables, use simple limit switches. These switches have a small lever or finger, which activates its contacts when a bump or "switch dog" mounted on the moving portion of the machine touches it. The switch provides an output signal to some other device and indicates a known position or point on this moving portion. If you want to change the point at which the simple limit switch sends its signal, then you must mechanically adjust the "switch dog".

A Programmable Limit Switch uses some type of position sensor to monitor the position of a slide or rotary table. Flexibility is gained by being able to "program" an output to turn on when a pre-defined position is reached. Additional flexibility is gained by the ability to program the point at which this output turns off as well as the ability to program multiple points at which this output cycles.

CTC has expanded on this idea by embedding this functionality in its integrated controllers. Instead of using an additional sensor to monitor position, CTC allows the selection of any 2206 or 2219 axis position within the controller to be used as the PLS reference position. The first sixteen outputs in the controller, which are arranged in two groups of eight each,   are available for use with this PLS function. Each bank has the flexibility to use a different axis position as its position reference. Outputs may be programmed with up to 127 transitions with a PLS repeat cycle. You may also program a rollover position which allows for cycle repetition.

The Soft Programmable Limit Switch (PLS)

How the PLS function works in CTC controllers

The PLS is configured with special purpose registers as well as the Data Table. The special purpose registers provide configuration and control for the PLS. The Data Table contains the image of transition points and output states.

Every millisecond (1000 times per second), the controller's background routine reads the position of the designated motor. It then compares this position with Data Table positions. When a transition point is reached, the controller changes the state of an associated output based on the output state defined in the Data Table. An output may be individually programmed to control a variety of actuators based on cycle positions. The following figure shows how the PLS function works in CTC controllers.
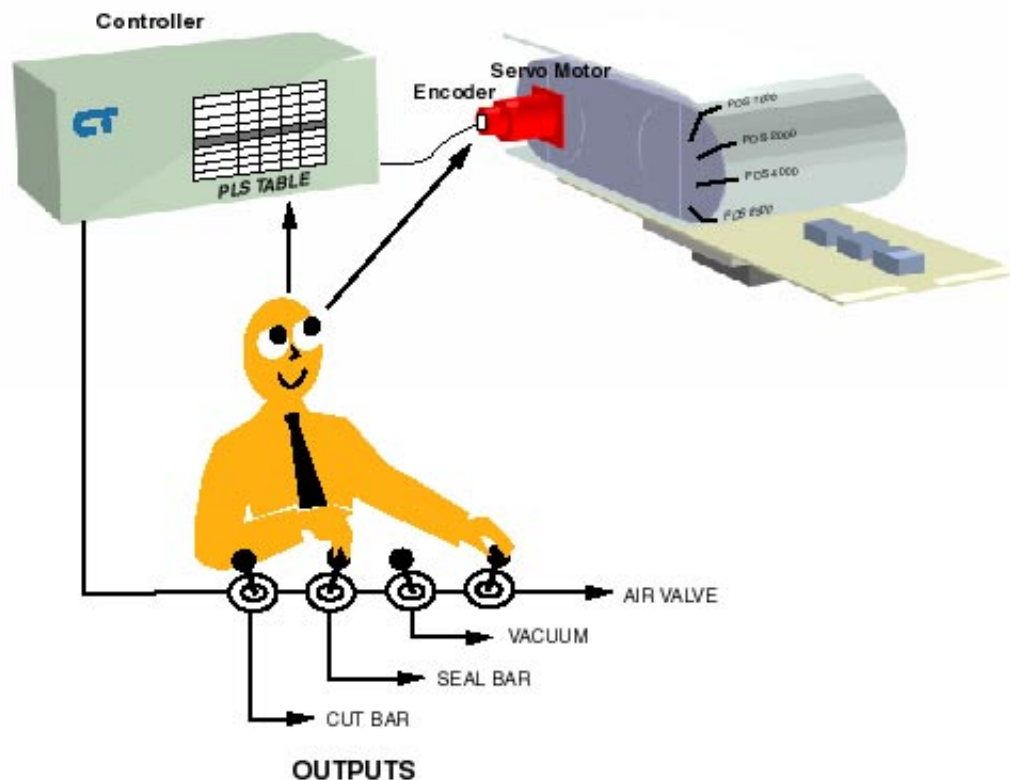
Data Table Configuration

In the following table (Base Row X), Output 1 will turn on at 1000 counts, off at 2000 counts, on again at 8500 counts, and off at 11,250 counts. The user defines the repeat cycle (rollover), which automatically resets the PLS table back to column #1 and starts the cycle again. The maximum allowable position and rollover is 64000. If your Data Table is wider than your PLS data or you have unused outputs, then you should terminate your ending column with a '65535'. In this example, the eighth output is not used, so a 65535 is placed in the first column of Output 8 and the remaining data in this row is set to zero. In addition:

- The Base Row X is the actual Data Table row where the PLS begins. This allows you to have multiple PLS tables in the same application.
- The base row is user-definable for flexibility of placement.
- The PLS uses 16 consecutive rows beginning with the base row.
- The PLS assigns an output to each row beginning with Output 1.
- The PLS area of the Data Table is divided into 2 banks of 8 rows each.
- Two columns are used for each transition point.
- The first of each column pair is the position reference transition point.
- The second of each column pair is the output state desired at the transition point.
- Any outputs not defined may still be used normally in the Quickstep program.

	Output number	Col 1 Transition point	Col 2 Output state	Col 3 Transition point	Col 4 Output state	Col 5 Transition point	Col 6 Output state	Col 7 Transition point	Col 8 Output state	Col 9 Termination
Base Row X	1	1000	1	2000	0	8500	1	11250	0	65535
X + 1	2	#	1	#	0	#	1	#	0	65535
X + 2	3	#	1	#	0	#	1	#	0	65535
X + 3	4	#	1	#	0	#	1	#	0	65535
X + 4	5	#	1	#	0	#	1	#	0	65535
X + 5	6	#	1	#	0	#	1	#	0	65535
X + 6	7	#	1	#	0	#	1	#	0	65535
X + 7	8	65535	0	0	0	0	0	0	0	0
X + 8	9	#	1	#	0	#	1	#	0	65535
X + 9	10	#	1	#	0	#	1	#	0	65535
X + 10	11	#	1	#	0	#	1	#	0	65535
X + 11	12	#	1	#	0	#	1	#	0	65535
X + 12	13	#	1	#	0	#	1	#	0	65535
X + 13	14	#	1	#	0	#	1	#	0	65535
X + 14	15	#	1	#	0	#	1	#	0	65535
X + 15	16	#	1	#	0	#	1	#	0	65535

Bank 1 spans Base Row X through X + 7. Bank 2 spans X + 8 through X + 15.

Special Purpose Registers

Base Row

Register

5910	Base Row/Data Table Row Pointer: R/W*****; specifies the row number where the PLS portion of the Data Table begins.

PLS Bank 1

5911	Axis number, R/W; specifies the servo or stepping motor axis to be used as the PLS reference for Bank 1.
5912	Current PLS Position, R; specifies the current PLS reference value.
5913	Rollover Position, R/W; specifies the rollover value of the PLS table (the point at which the table is reset).
5914	Base Position, R; contains the original position of the reference axis at time of enable.
5951 - 5958	PLS Output Enables, R/W; enables Outputs 1 through 8. 5951 is for output 1, 5952 is for output 2, and so on. 0 = disabled, 1 = enabled. Active only at the beginning of each cycle.
5971 – 5978	Column Pointers, R/W; displays the current active column for each output.

PLS Bank 2

5921	Axis number, R/W; specifies the servo or stepping motor axis to be used as the PLS reference for Bank 2.
5922	Axis number, R/W; specifies the servo or stepping motor axis to be used as the PLS reference for Bank 2.
5923	Rollover Position, R/W; specifies the rollover value of the PLS table (the point at which the table is reset). Based on reference counts.
5924	Base Position, R; the original position of the reference axis at time of enable.
5959 - 5966	PLS Output Enables, R/W; enables Outputs 9 through 16. 5959 is for output 9, 5960 is for output 10, and so on. 0 = disabled, 1 = enabled. Active only at the beginning of each cycle.
5979 – 5986	Column Pointers, R/W; displays the current active column for each output.

NOTES:

1. The PLS begins running when the rollover value is set.
2. The Quickstep program may still control outputs directly.
3. An output can be made to wrap around by leaving it on through the rollover transition.
4. All outputs are initially disabled. The corresponding PLS output enable registers must be set to 1 for the output to function under PLS control. These registers may be changed at any time for output control. If an output is disabled, then the value in the Data Table is 0. It remains in its last state until commanded otherwise. This state could be on or off.

*R = Read only, W = Read only, R/W = Read and Write

Programming Example

```
[1]  Start
     ─────────────────────────────────────────
     <TURN OFF ALL DIGITAL OUTPUTS>
     ─────────────────────────────────────────
     monitor Start_Switch goto Next

[2]  Initialize_PLS
     ;;;
     ;;; Profile the axis used for the PLS position.
     ;;; Point to the first row of where the PLS data is
     ;;; located in the Data Table.
     ;;; Store the axis number to the Axis number register
     ;;; for bank one. Enable the first eight outputs
     ;;; (store 1). Disable = 0
     ─────────────────────────────────────────
     <NO CHANGE IN DIGITAL OUTPUTS>
     ─────────────────────────────────────────
     profile Reference_Axis servo at position maxspeed=Speed
     accel=Accel P=P_Val I=I_Val D=D_Val
     store My_First_Row to PLS_Base_Row_Reg_5910
     store 1 to Bank1_Axis_Number_Reg5911
     store 1 to Bank1_PLS_Output_Enable1_Reg5951
     store 1 to Bank1_PLS_Output_Enable2_Reg5952
     store 1 to Bank1_PLS_Output_Enable3_Reg5953
     store 1 to Bank1_PLS_Output_Enable4_Reg5954
     store 1 to Bank1_PLS_Output_Enable5_Reg5955
     store 1 to Bank1_PLS_Output_Enable6_Reg5956
     store 1 to Bank1_PLS_Output_Enable7_Reg5957
     store 1 to Bank1_PLS_Output_Enable8_Reg5958
     search and zero Reference_Axis
     monitor Reference_Axis:stopped goto Next

[3]  Start_PLS
     ;;;
     ;;; Storing a value to the rollover register activates
     ;;; the PLS function. The time delay is necessary to
     ;;; set up the background routine.
     ─────────────────────────────────────────
     <NO CHANGE IN DIGITAL OUTPUTS>
     ─────────────────────────────────────────
     store 12000 to PLS_Bank1_Rollover_Reg_5913
     delay 10 ms goto Next

[4]  Start_Reference_Axis
     ─────────────────────────────────────────
     <NO CHANGE IN DIGITAL OUTPUTS>
     ─────────────────────────────────────────
     turn Reference_Axis cw
```