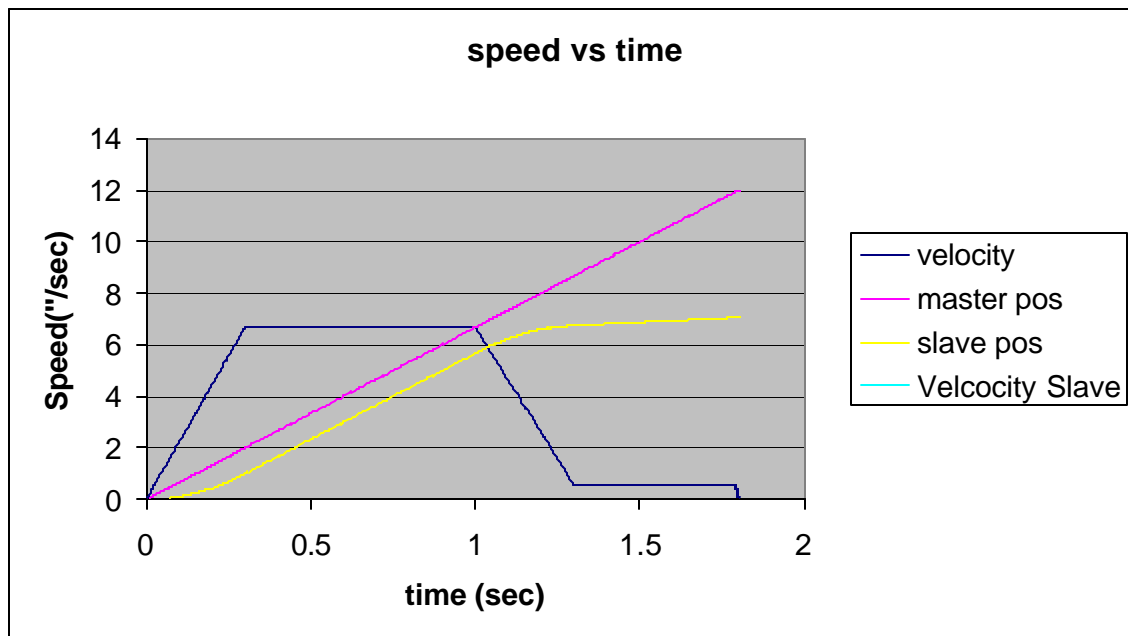


Rapid Feed Cycle Profile Using PCAM

PURPOSE OF THIS DOCUMENT: This application note is to be used to assist machinery builders that need to implement a Rapid to Feed type profile for ControlLogix Motion. This note is for advanced users and assumes you have knowledge of ControlLogix Sercos and some previous experience in programming motion.

APPLICATION DESCRIPTION: Multiple station machines where a single part is worked on by multiple cells at different times. A close industry term would be “Dial Table” common to the automotive industry. The part would have to be drilled, tapped, or worked on by the particular cell then the dial would transfer to the next cell until the part is completed.

This note looks at the rapid / feed portion of that application, so keeping the cycle time you would feed the part forward, at some predefined position decelerate to a fixed position, work on the part, retract to start position. The transfer would occur to put a different part in for you to work on.



SYSTEM DESCRIPTION:

- ControlLogix
- RSLogix 5000 software v11.11 or higher
- Kinetix integrated motion

CHALLENGES:

This note looks at the rapid / feed portion of that application, so keeping the cycle time you would feed the part forward, at some predefined position decelerate to a fixed position, work on the part, retract to start position. The transfer would occur to put a different part in for you to work on.

SOLUTIONS:

A common application requires that we perform the above cycle, that is:

1. Rapid acceleration
2. Rapid constant
3. Rapid deceleration
4. Feed at a constant rate
5. Feed deceleration
6. Possibly dwell (using a timer instruction when the cycle is completed)
7. Return to start (using a move instruction – MAM) specifying the speed accel and decel rates

There are key values that we require to develop this profile. These values are (the values in grey below are the values chosen to enter. There are 2 key periods in the cycle, the Rapid (which looking at the profile above is segment's 1-3) and the Feed (which is segment 4-5)

Rapid Cycle

Start Speed – The starting speed of the rapid cycle – typically 0

Rapid Speed – The speed the rapid cycle will achieve during constant – segment 2 (units/sec)

Rapid Accel – The rate of acceleration for segment 1 (units/sec²)

Rapid Decel - The rate of deceleration for segment 1 (units/sec²)

Accel Time – The time of the cycle it takes to accelerate (sec)

Decel Time -- The time of the cycle it takes to decelerate (sec)

Requested Rapid Time – The desired time for the rapid cycle (Segment1+Segment2+Segment3)

Start Position – The absolute position of the axis when the cycle will start (typically 0)

Feed Cycle

Feed Position – The position shown in the cycle profile above

Feed Speed – The speed of the Feed Cycle (Segment 4)

Feed Decel – The rate of deceleration for Segment 5 (units/sec²)

Decel Time – The time for deceleration in Segment 5 (sec)

Requested Feed Time – The desired time for the feed cycle (Segment 4+ Segment5)

Max Depth(End Position) – The max absolute position that the axis can move linearly to complete the cycle

Number of Points – Using a PCAM instruction, how many total points would be used to perform the cycle

Number of Acc/Dec Segments – the number of segments, this case has 5

There are a few ways to make this work the easiest is to increase the speed of the axis over the 'Rapid Speed' and to use a MCD (Motion Change Dynamics) to change the speed before the Feed Position this will be simpler in terms of programming, while maintaining the cycle time. Another method that we have chosen is to use a PCAM to accomplish this, a PCAM is going to give you the exact profile that will respond within 1 coarse update period. We basically 'break' the profile up into segments and calculate the profile's velocity and position using formulas.

We have simplified the process by doing the following:

The values in grey above are values you will enter, the others will be calculated automatically. We have developed 2 tools that should help in deriving the pcam table:

Excel Spreadsheet:

- The spreadsheet has 2 worksheets, The first workbook will accept the values to work with (worksheet named Formulas)
- The second worksheet is named points, where we will derive the points using formulas and each segment is separated by lines, so if you want to add more cam points (>400 points) you will have to manually add or remove the cells – this worksheet also contains a graph that will show the profile in terms of speed vs. time

You can take the values from the spreadsheet (master and slave positions) and paste them into the cam profile editor.

RSLogix program:

- In opening the diagram , this program is designed to have a virtual axis to act as a master to drive the slaves (which are actually performing the PCAM profile). The virtual is set at a fixed speed, typically the rapid speed and should be set up to continuously jog (MAJ).
- Each axis is contained as a program, Rapid0, Rapid1, Rapid2, and transfer. The Rapid axes are identical in terms of coding and use UDT's to contain all the information for each axis
- There are 5 subroutines in each program:
 - R01_MainRoutine – controls enabling/disabling, resetting faults, and general control for the program
 - R02_Motion – controls all the motion for the profile
 - R03_PCAM_Calculate – calculates all the parameters for the table
 - R04_General_Motion_Calculate – calculates the general values for the profile

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R05_Fill_Cam_Table – is structured text that contains looping that will fill the values for the PCAM table using the formulas derived from R03 and R04

P00 is the Main Program, it is used for overall machine control. It handles things of this nature:

- Enable/Disable ALL Axes
- Reset ALL Axes
- Cycle Start
- Calculate Profile

P01-P06 are the Programs that are associated with each axis

- R01_Main_Routine
 - Controls Axis Functions (Enable this particular Axis)
 - Calls all the appropriate Functions (JSR's)
 - Axis Enable/Disable
- R02_Motion Routine
 - Performs Motion Instructions and Handle Motion Routines
- R03_PCAM_Calculate
 - Calculates the PCAM increments and other parameters such as Feed Position and Max Depth
- R04_General_Motion_Calculate
 - Calculates the Accel/Decel rate for the rapid and feed cycles
- R05_Fill_Cam_Table
 - Nested Structured Text that calculates the points for the PCAM table

FOR MORE INFORMATION

See the program attached (.ACD file) and the file Profile.XLS contains all the formulas used

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**Headquarters for Allen-Bradley
and Rockwell Software**

Americas – Rockwell Automation, 1201 South Second Street, Milwaukee, WI 53204-2496 USA, Tel: (1) 414.382.2000, Fax: (1) 414.382.4444

Europe – Rockwell Automation SA/NV, Boulevard du Souverain 36, 1170 Brussels, Belgium, Tel: (32) 2 663 0600, Fax: (32) 2 663 0640

Asia Pacific – Rockwell Automation, 27/F Citicorp Centre, 18 Whitfield Road, Causeway Bay, Hong Kong, Tel: (852) 2887 4788, Fax: (852) 2508 1846

**Headquarters for Dodge
and Reliance Electric**

Americas – Rockwell Automation, 6040 Ponders Court, Greenville, SC 29615-4617 USA, Tel: (1) 864.297.4800, Fax: (1) 864.281.2433

Europe – Rockwell Automation, Brühlstraße 22, D-74832 Elztal-Dallau, Germany, Tel: (49) 6261 941 110, Fax: (49) 6261 941 122

Asia Pacific – Rockwell Automation, 55 Newton Road, #11-01/02 Revenue House, Singapore 307987, Tel: (65) 351 6723, Fax: (65) 355 1733