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SERVO TRENDS

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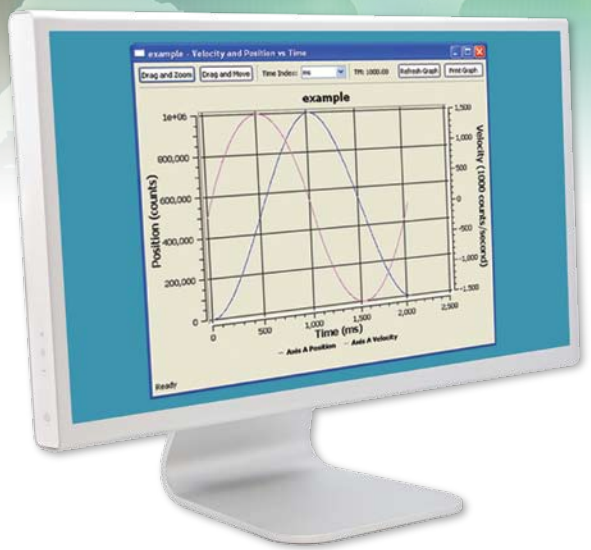


Position and Velocity Profile Generated from GalilPVT

"The mission of Galil's experienced Applications Department is to provide prompt and accurate technical assistance to help OEMs successfully deliver their products to market."

GALIL SUPPORT TEAM

New GalilPVT Software Aids in Programming PVT Mode of Motion

Galil's newest mode of motion is PVT (Position, Velocity, Time). This mode allows arbitrary motion profiles to be defined by position, velocity and time individually on all axes. This motion is designed for systems where the load must traverse a series of coordinates within time constraints and with no discontinuities in velocity. Taking advantage of the built in buffering, the user can create virtually any profile including those with infinite path lengths.

GalilPVT is a developer's tool for using the PVT mode of motion on the DMC-40x0 series motion controller. PVT is one of Galil's more sophisticated modes of motion, and the GalilPVT software tool allows the user to visualize the planned trajectory prior to sending the data to the controller. GalilPVT is offered as a free trial, with saving data disabled. The full version allows the user to save the output data of the software.

GalilPVT aides PVT motion design with the following features:

- Open PVT data in CSV and DMC formats
- Open Contour data in CSV and DMC formats
- Convert Contour data to PVT data
- "Segment View" display of each PVT point as it would be commanded by the user including elapsed time, total distance, incremental position, velocity, and incremental time. Segment data can be edited.
- "Kinematics View" display of controller internal calculations on a profile-by-profile basis including distance, velocity, acceleration, and jerk.
- Graphing capability
  - Multi-axis graphing of Position, Velocity, Acceleration, and Jerk vs. time
  - Single axis graphing of up to two data sets, e.g. Position and Velocity vs. time
  - Two axis position vs. position graphing for coordinated motion planning
- "Motion Summary" providing timing, and maximum velocity, acceleration and jerk throughout the move.
- Stream capability to connect to a controller and stream an arbitrarily long segment list to a DMC-40x0.

➤(cont. pg 2)

To highlight some of the features of PVT and GalilPVT, a simple example will suffice. Suppose the motion requirements of an application are the following:

1. Start from rest and move in 1 second to a position of 1000000 counts.
2. Return to the origin in 1 second.
3. Smoothness in motion is paramount.

We can do this in many ways, three methods are outlined below.

1. Position Relative

The Position Relative (PR) mode of motion is excellent for specifying position targets. The inputs to this mode of motion are speed (SP), acceleration (AC), deceleration (DC), and relative position (PR). A trapezoidal or triangular velocity profile is used to attain the target position. By maintaining a triangular profile, we minimize the magnitude of acceleration. PR mode is not designed, however, to provide a motion within a given time, so some calculations are necessary to guarantee our 2 second round trip.

From the kinematic equations for constant acceleration:

$$a(t) = a \qquad v(t) = at + v_0 \qquad x(t) = \frac{1}{2}at^2 + v_o t + x_0$$

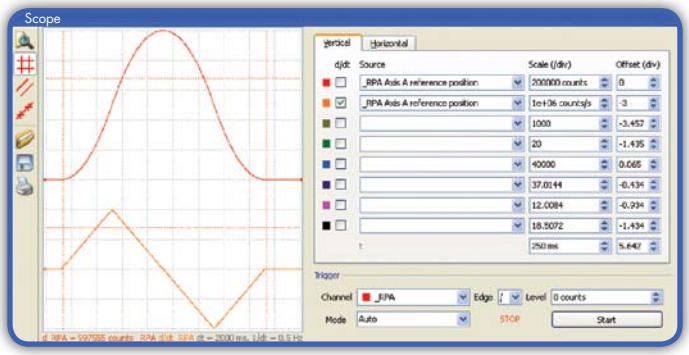
Table 1: Program for Position Relative Mode

```
ACX=4000000
DCX=4000000
SPX=2000000
PRX=1000000
BGX
AMX
PRX=-1000000
BGX
AMX
EN
```

With initial velocity and acceleration zero, we can find that the first acceleration phase, which must traverse 500,000 counts in 0.5 seconds, yields an acceleration of 4,000,000 counts/s/s. Symmetry yields a deceleration of the same value. We calculate the speed from the velocity function as 2,000,000 counts/s.

The code in ***Table 1*** demonstrates this triangular profile. ***Figure 1*** shows a plot of the profile. Notice that the velocity profile (yellow) has a discontinuity (sharp point) at the position curve inflection points. This can cause roughness and vibration in the motion profile.

Figure 1: Graph of Triangular Velocity Profile for Position Relative Mode



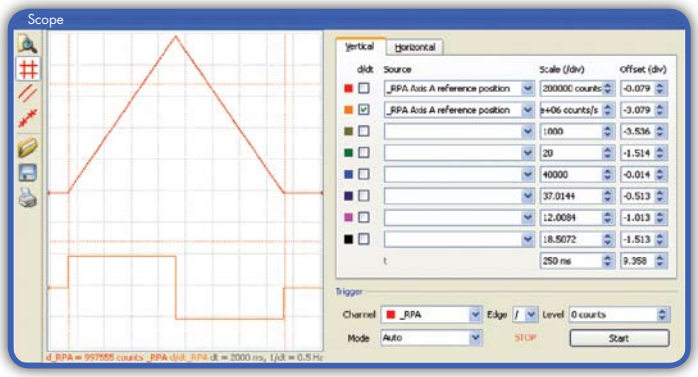
2. Contour Mode

A mode of motion that is better suited to time-based position targets is the contour mode. In this mode, position targets are specified for a particular time interval and the controller linearly interpolates position between these target points. No external calculations are required by the user to ensure the time interval. The code in ***Table 2*** shows a Contour Mode program and ***Figure 2*** shows a graph of the velocity profile. Notice that the position waveform is triangular, and the velocity waveform is square. Acceleration and deceleration are infinite between changes in velocity. In this instance, the contour mode is worse than the position relative mode with respect to velocity smoothness.

Table 2: Program for Contour Mode

```
CMX
DT5;' take a new segment every 2^5 = 32 samples.
' 32 segments yields 32*32=1024=1 second
i=0
#fwd
CD31250;' Contour's max segment size is 32762
' so 1000000 must be piecewise, 31250*32
i=i+1
JP#fwd,i<32
i=0
#rvs
CD-31250
i=i+1
JP#rvs,i<32
CD 0=0;' terminate the buffer
EN
```

Figure 2: Graph of Square Velocity Profile for Contour Mode



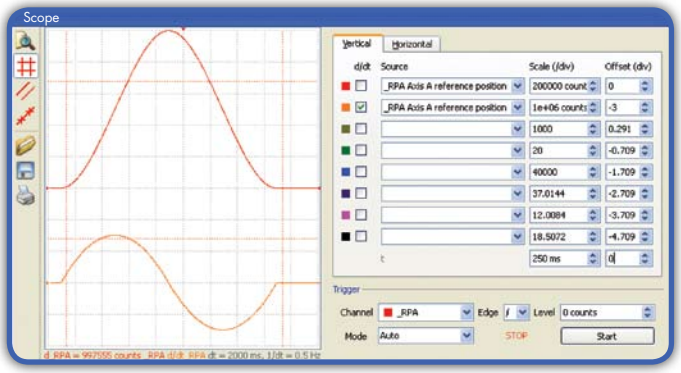
3. PVT Mode

PVT mode is quite easy to specify in this example, and maintains smooth velocity. ***Table 3*** shows the program and ***Figure 3*** shows the resulting velocity profile. Notice that both position and velocity are smooth curves, leading to the smoothest possible motion.

Table 3: Program for PVT Mode

```
PVA=1000000,0,1024;' Move 1M counts, ending with a velocity of 0
'                   Do this in 1024 samples=1 sec.
PVA=-1000000,0,1024;' Return likewise
PVA=0,0,0;' terminate the buffer
BTA;' begin mode
EN
```

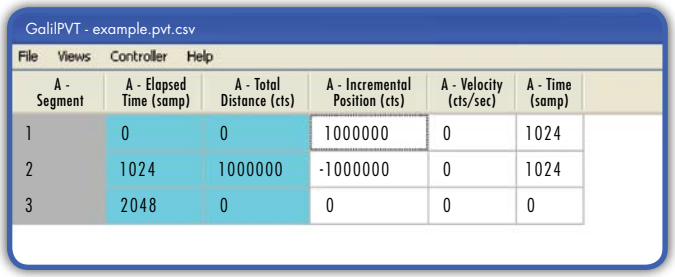
Figure 3: Sinusoidal Velocity Profile of PVT Mode



GalilPVT Software helps with this example by providing visualization of the motion prior to actually profiling it, and provides helpful motion statistics. Example Screen shots of the GalilPVT software are show in ***Figures 4, 5, and 6***. ■

For more information about Galil's new GalilPVT software please visit http://www.galilmc.com/products/galilpvt.php.

Figure 4: Tabular PVT data in GalilPVT



A - Segment	A - Elapsed Time (samp)	A - Total Distance (cts)	A - Incremental Position (cts)	A - Velocity (cts/sec)	A - Time (samp)
1	0	0	1000000	0	1024
2	1024	1000000	-1000000	0	1024
3	2048	0	0	0	0

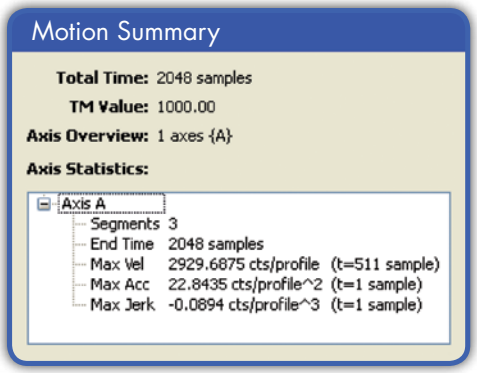
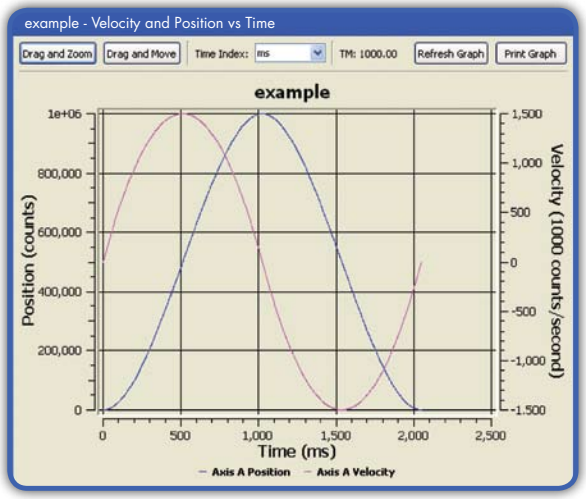


Figure 5: Motion Summary from GalilPVT

Figure 6: Position and Velocity Profile Generated from GalilPVT



New, 2-Minute Video: "Establishing Communication with a Galil Controller"

Galil recently added a 2-minute video to its new library of technical "how-to" videos. The latest video details how to establish communication with Galil controllers using GalilTools software. The system components used in the video are Galil's DMC-40x0 Accelera motion controller connected to a PC running GalilTools software with TCP/IP connection through an Ethernet Switch.

The video demonstrates each step in establishing communication including (1.) Connecting cables from the Ethernet switch to the controller and the PC; (2.) Verifying network settings on a PC and choosing a static IP address for the controller; and (3.) Executing GalilTools software, entering the static IP address and establishing communication with the controller. An example of sending Galil commands and downloading an application program is also presented. ■

Galil's library of informative videos present solutions to common motion and I/O problems. Perfect for busy engineers, these technical tutorials are two minutes each. The tutorials can be accessed at no charge 24/7 at: *http://www.galilmc.com/learning/two-minute-videos.php*

Current Videos

"Establishing Communication with a Galil Controller using GalilTools Software"

"Achieving Precise Temperature Control of a Liquid using RIO Pocket PLC"

"Smooth Multi-Axis Motion through Arbitrary Points using PVT Mode"

"Introduction to the Accelera Motion Controller Series"

"Introduction to the RIO Pocket PLC"

Galil. We Move the World.

With over 500,000 controllers installed worldwide, Galil is the leading supplier of motion controllers. Galil's legacy of innovation began in 1983 with the introduction of the first microprocessor-based servo motion controller. Today, Galil continues its leadership by offering the most powerful, cost-effective and easy-to-use controllers to accommodate all your motion and I/O needs.

Galil offers a broad array of motion controllers in a variety of formats: single and multi-axis, card-level and box-level, bus-based and stand-alone. Galil's Ethernet/RS232 and PCI controllers are available in an Econo version for lowest cost and Accelera version for ultra high-speed performance. Plug-in, multi-axis drives for steppers and servos save space, cost and wiring. For intelligent I/O control, the RIO Pocket PLC is compact, low-cost and packed with analog and digital I/O.

At Galil, we share our expertise with our customers. You will find a wealth of information on our website at http://www.galilmc.com. Here you can view any of Galil's free web-tutorials, read an application note or white paper, post a question on our bulletin board, or download the latest software and manuals.

Exceptional application support is a top priority at Galil. Call Galil today at 800-377-6329 to discuss your project with one of our highly-trained applications engineers. ■

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ACCELERA CONTROLLERS AND DRIVES

DMC-40x0	Ethernet/RS232
DMC-18x6	PCI

ECONO CONTROLLERS AND DRIVES

DMC-21x3	Ethernet/RS232
DMC-18x2	PCI

SINGLE-AXIS CONTROLLERS AND DRIVES

DMC-1415	Ethernet/RS232
CDS-3310	Ethernet/RS232

POCKET PLC I/O CONTROLLER

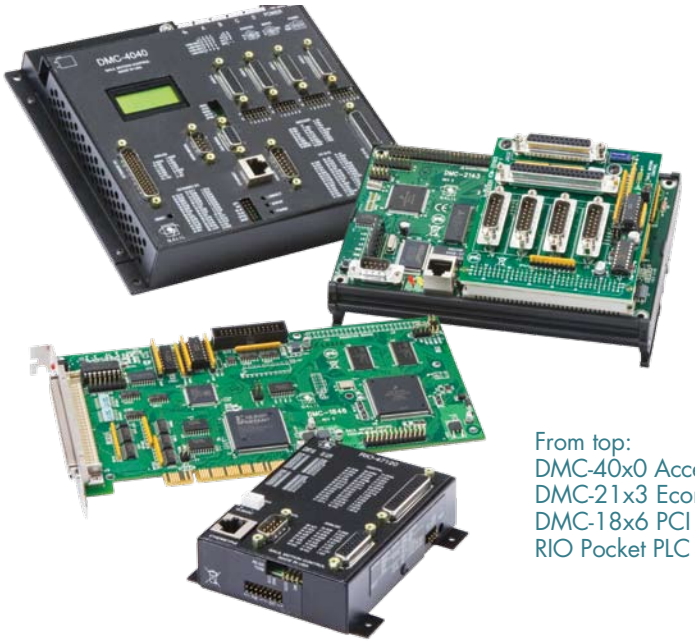
RIO-47xxx	Ethernet/RS232

SOFTWARE TOOLS

GalilTools. Servo Tuning and analysis software

Ladder Interface. Converts Ladder program into DMC code for RIO Pocket PLC.

Galil PVT. Software tool for PVT mode of motion.



From top:
DMC-40x0 Accelera Controller
DMC-21x3 Econo Controller
DMC-18x6 PCI Controller
RIO Pocket PLC

FREE	Online Support Tools
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