



## *DataChart® 2000* **Velocity Measurements Application Note # 7**

How do I measure the velocity of a hydraulic cylinder using a LVDT signal?

The customer is testing aircraft hydraulic cylinders. He is plotting the throw of the cylinder using an LVDT (Linear Variable Displacement Transformer) which outputs a voltage proportional to the displacement along the cylinders 8" stroke. A velocity measurement is best done through the use of the differential equation:  $V = dS/dT$  or Velocity = a change in distance divided by a change in time.

This technique uses the fact that we can sample at 8 points every second or a sample rate of 125 msec with a very accurate time base. By currently measuring the distance at point 2 and 125 msec later calculating that data point into point 1, we now have a established a delta on the distance curve of where the point is now (Pt 2) and where it was 125 msec ago (Pt1). Upon subtraction of Pt2 – Pt1, we have the required delta distance on the LVDT curve for 1/8 second. Multiplying the delta equation by 8 or K1, scales the reading up to 1 second duration. As a result you have distance for 1 sec or velocity in Inches per second. The Channel 3 curve will be updated every 125 msec.

This will require 3 channels of which two are calculated channels. Program Pt. 1 to be a Calculated Channel and Set Equation to be Pt 2. This will cause Pt.1 to be Pt 2 delayed by 1/8 second or 125 msec. The keystrokes are: Program – Points –Prog point – Point? 1 – Setup pt – Calculated – Equation – Set equation – P2 –Enter –Exit – Keep setup – yes.

Program Pt 2 = the LVDT input signal. Do all the necessary scaling at this time.

Program Pt 3 as a calculated channel. Add constant K1 = 8. Set the calculation to: Pt3 = (Pt2 – Pt1) \* K1. This will cause channel 3 to plot the change in distance every second and update every 125 msec. Thus you will have a plot of the velocity of the cylinder. If the LVDT is scaled to inches, Point 3 will read in Inches/sec.

Set the Record Rate to the fastest sample rate. The key strokes are Prog – Record Setup – Record Rate – All Rates – Secs (lo) > 0<. - This will set the sample rate to 1/8 second. For short tests you will want the record rate set as fast as possible.

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As a handy tip to go along with this application, you could pick a trigger to record if you want to start a recording after some displacement or some velocity has begun. Here are further instructions to set the trigger to record at the beginning of a test.

1. First program your required points and set the alarms for that point at the required level.
2. Under Program – Record Setup – Points (Trigger) – Specify the points numbers that you wish to be a trigger for the recorder start up. Answer Yes or No for each point.
3. Go to Function – Record On/Off – Select Trigger – Trigger On? – Yes. Exit out and the recorder will trigger (start recording) when the alarm or alarms on any point is activated.