The Application Note is pertinent to the Mentor II / Quantum III Drive Family

Pseudo- S Accel/Decel Ramps

This application note attempts to illustrate the dramatic positive effects that S-Ramps can have on a drive system versus using standard linear ramps. When one looks over normal industrial applications, there are few that actually need or require the more precise linear accel/decel ramp. We know that sudden changes in speed causes stress on the mechanical drive train (chains, belts, gearbox etc) not to mention an in-rush of line current. These negative effects can be reduced significantly with the application of S-Ramps (even the more simplistic pseudo-S) as described in this article.

Effect of Motor Current without S-Ramp

The waveform shown below illustrates the application of linear accel/decel ramps and the resultant current requirement to achieve that linear ramp. Note that the resultant current demand is the derivative of the linear ramp. (The derivative of velocity is acceleration-acceleration torque requires current)

The most disturbing part of this waveform is the sudden and abrupt demand of current required from the power line/drive in order to satisfy the requested linear ramp. This sudden demand of current is what makes lights go dim, causes isolation transformers to groan and places stress on fusing etc. This sudden surge of current causes a sudden surge in motor shaft torque which results in undue mechanical strain- specifically if the load doesn't need to follow a linear accel/decel time.
Result of Motor Current with PseudoS-Ramp

The waveform below illustrates the use of a pseudo S-Ramp (not quite a pure S but good enough to achieve the desired effects). Note minimal transition disturbance as compared with the linear plot (previous plot) on the resulting current waveform.

(waveforms as captured using Drivecom for Mentor/Quantum & Unidrives)

Conclusion

One can readily see the advantage in using S-Ramp Accel/Decel for general purpose applications. It reduces current in-rush demands, mechanical stresses and may also help tame those high inertia situations as the S ramped reference will be much easier to follow than the corners of the linear reference. Also note that the drive can easily follow the S-Ramp without overshooting (red & blue traces).

The Unidrive has a pure symmetrical S-Ramp function built-in. To use it one needs only to set parameter #2.06=1. The amount of S can be adjusted with parameter #2.07.

Although, the Mentor II nor Quantum III have a built-in S-Ramp, a pseudo S Ramp can easily be implemented. See next page.
Pseudo S-Ramp Generation

It turns out that a pseudo S-ramp can be generated if a Linear Ramp is run through a simple LPF (low-pass filter/integrator). The drive already produces the timed linear ramp we need at location #2.01.

The following are screen-shots from MentorSoft – Drive utility program for Mentor II and Quantum III Drives.

To obtain a copy of free copy of MentorSoft click on the link below: www.emersonct.com/pdProducts/downloads/appNotesPDF/ctan193.pdf

If we take this linear ramp out one of the programmable analog outputs, and run it through a simple RC network (integrator) and back into one of the programmable analog inputs, then we could use this modified signal as the drives speed reference.
Refer to Menu 7 Programmable Analog I/O

DAC #1 was selected because the default for this output is already picking up the output of the Linear Ramped reference, #2.01.

ADC #1 was selected because the default for this input is already being directed to the Hard Speed Reference of the Speed Reference summing junction, #3.18.
**Calculation of Resistor & Capacitor Values**

A suitable RC time constant (like the one illustrated in the pseudo S scope recording) is about 20%-40% of the drives linear Accel/Decel time. In this example, the drives’ accel/decel time was set for 3 seconds. So an RC time constant target was 0.2 x 3 or 0.6 seconds. I selected ½ second. Knowing that the input impedance of the ADC’s are nominally 100K, I wanted to stay below 30% of this impedance. Therefore, the R value that I selected was to be less than 33K.

Therefore, for \( t = RC \) and \( t = 0.5 \) I selected a readily available resistor value for R of 22K and Capacitor of 22uF.

Resulting in a time constant of approximately:

\[
t = RC = (22 \times 10^3) \times (22 \times 10^{-6}) = 484 \times 10^{-3} \text{ or } 0.48 \text{sec}
\]

(really, the R here becomes the parallel combination of 100K and 22K or 18K, so the time constant is more like 0.4sec – but close enough for our purposes.)

**Calibration**

Because the Analog Input has an approximate input impedance of 100K, the series R will result in a voltage division (drop) across the R. For this example, it would be approximately:

![Diagram](image)

So we must use the Analog Input Scaler to recover the voltage lost so that 100% speed from #2.01 will be realized when used as the conditioned speed reference.

**Note:** The capacitor used in this circuit should be a low leakage type (tantalum or similar) 15-25vdc rated. The positive lead should go to the DAC output. The circuit shown would be for Unipolar applications only. For bi-polar situations, you would use two caps in series with negative leads connected together (the value of capacitance would need to be doubled (or resistor doubled) as capacitors in series halve their values if the same).
**Calibration** con't

A more practical way of calibrating the scaler is to simply set the DAC output to a parameter that is set at 1000. I did this by temporarily changing the output assignment of DAC #1 to read the value in the Max Speed Limit register, parameter #1.06, which is almost always 1000—but I still checked!. ( I set #7.08 = 106). This will cause 10v to be generated on the DAC output. Then you would read the Analog Input directly, in this example #7.01. In my circuit, #7.01 read 792 ( due to parts tolerances versus theoretical calculated previously). Therefore, the scaling parameter #7.16 would become:

\[
\frac{1000}{792} = 1.263 \quad \rightarrow \quad \text{set } #7.16 = 1263
\]

in order to bring the 792 reading up to 1000 when directed to #3.18

**Observation**

At this point one could check the resultant S (now #3.18) against the Linear Ramp (#2.01) to see how it behaves before we actually use it. This is always a good practice as mis-wiring or wrong parameter values could result in unexpected results.

Shown below is the observations I made before I actually used it as reference.

Since it looked ok to me, I decided to use it as the drives speed reference. To accomplish this, read on.
Using the Pseudo S-Ramp

Since the pseudo S ramp is already being directed to register #3.18, all we need to do is to close #3.19 and open #3.21 (with the drive not running of course!).

Set #3.21 to 0 to stop linear ramp from becoming the reference

Set #3.19 to 1 to use the pseudo S-ramp as the reference

Run the drive and test it out. Don't forget to perform a Store if you like the results.

Questions ?? Ask the Author:

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