***Title:*** Velocity Feed Forward and Torque Mode Amplifiers
***Products(s):*** DCX-PCI300, DCX-AT300, DCX-VM300, DCX-AT200, DCX-VM200
***Keywords:*** feed forward, velocity gain, following error
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***Summary***
A torque mode amplifier (open loop, no velocity feedback) controlled by a position loop servo controller will satisfy all but the most demanding servo control applications. While these components have historically been used to develop servo systems with high position repeatability, because there is no closure of the velocity loop the following error (difference between where an axis is and where it is supposed to be) will be greater than with servo systems driven by velocity mode amplifiers. By adding a feed forward term to the PID filter the following error of systems using torque mode amplifiers can be significantly reduced.

***More Information***
For each move the servo controller calculates the ideal motion profile based on the target position and trajectory parameters (maximum velocity, acceleration, deceleration). The motion controller then uses a PID (Proportional gain, Integral gain, Derivative gain) filter to close the position loop, adjusting the command output based on the following error. Figure 1 shows a typical response of a servo driven by a torque mode amplifier executing a move of 250,000 encoder counts with an average of 250 counts of following error.

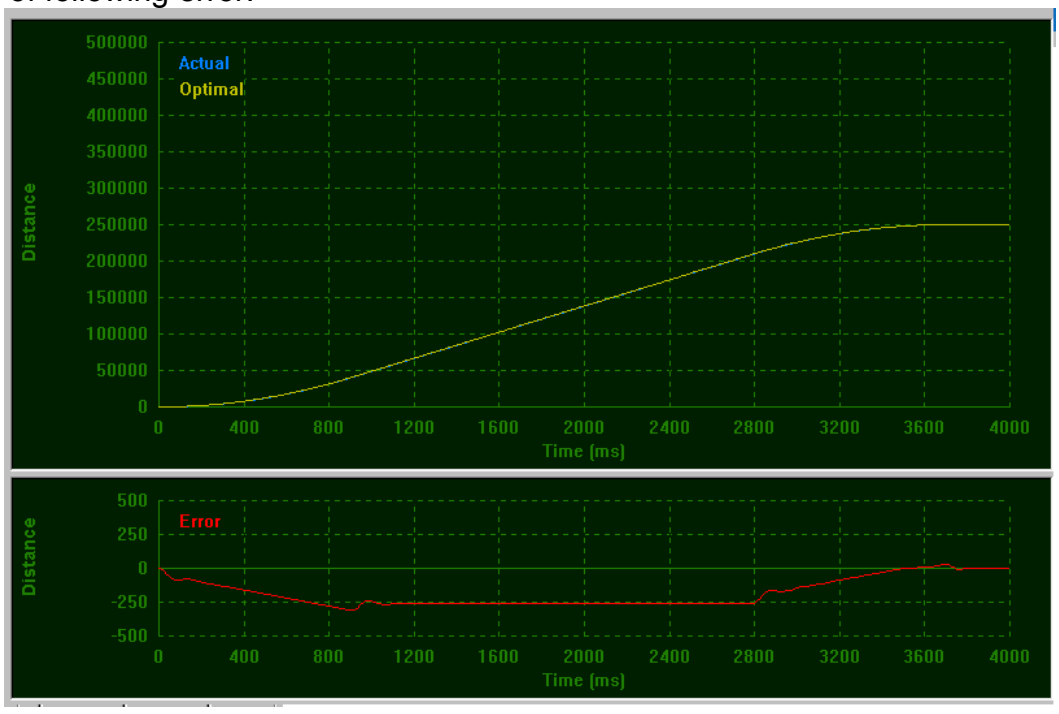


**Figure 1: Typical response of a servo when driven by a torque mode amplifier**

By adding a feed forward term (Velocity Gain) to the position loop of the servo controller the typical following error of a servo is minimized without setting PID gains so high that the axis can become unstable. Figure 2 below depicts the typical reduction of following error when velocity feed forward is added.

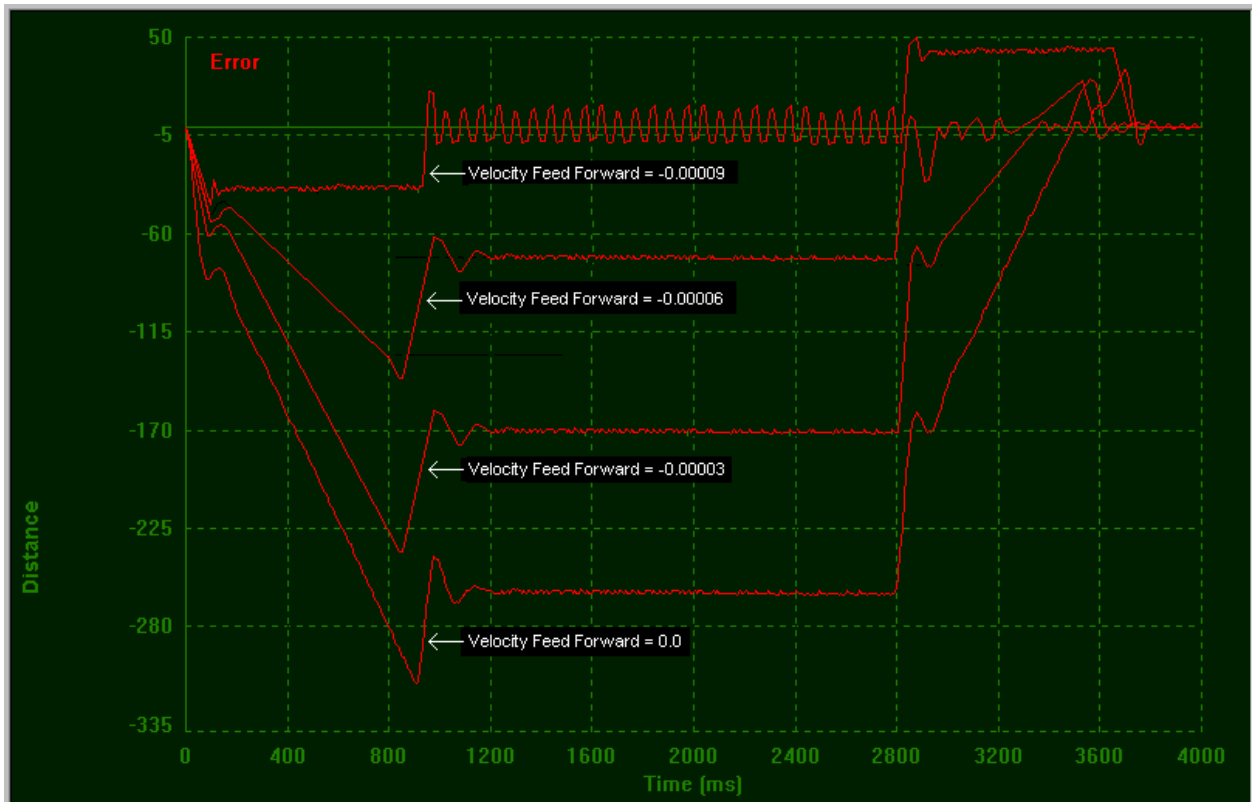


**Figure 2: Typical reduction of following error when velocity feed forward is added. Velocity gain units are expressed as Volts per encoder counts per second.**

The effects of velocity feed forward while an axis is accelerating and decelerating is minimal. With the addition of acceleration feed forward and deceleration feed forward the following error throughout the entire move will be minimized.

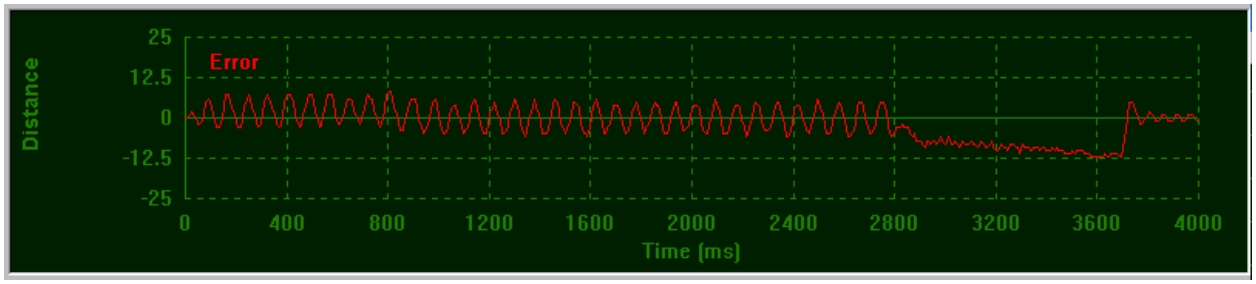


**Figure 3: Typical following error when acceleration (-0.00002) and deceleration (-0.00002) gains are added.**