MICROVA electronics & automation

Motor Control Acceleration and Deceleration

Introduction

Motor controllers such as the Microva MB310 stepper motor controller are able to accelerate from a stopped postion, move to a position prior to the final set point, and then decelerate before stopping at the final set point position. For open loop stepper motors this acceleration and deceleration is needed to prevent the motor shaft position from becoming out of sync with the motor step position in the software due to the rotor inertia.

The MB310 controller includes a motor control script language interpreter which makes it easy to control the motor for almost any application. One of the script commands is "RampSpeed" which is used to ramp the motor speed from the minimum speed to the maximum speed for acceleration or from the maximum speed to the minimum speed for deceleration. The speed transition time is called the ramp time.

Figure 1 shows a typical motor acceleration and deceleration graph. The motor speed is the rate that the motor is stepped when the motor run mode is changed from STOP to MOVE. So the motor may be stopped even though the motor speed variable is not zero as shown in the graph.

How to Calculate the Deceleration Point

When the motor is stopped and the motor set point is changed, either within the motor control script or over the Modbus by the Modbus master, the motor will begin to accelerate as shown by the pink triangle in the graph. The motor will then run at maximum speed until the deceleration point is reached, then the motor will decelerate in order to stop at the new set point. In this example the acceleration and deceleration rates are the same but that is not always the case.

For a given deceleration rate, defined by the min speed, max speed and ramp time, the motor control script program must calculate the deceleration point. The deceleration point is equal to the set point minus the number of steps which occur during the deceleration ramp (or the acceleration ramp since they are the same in this example). Since the Y axis is the speed in pulses/second and the X axis is time, then the number of steps during deceleration (or acceleration) is just the area under the curve during the ramp time (the definite integral). The area under the curve, i.e. the number of steps, during the ramp can be calculated with simple geometry. The pink area is a right triangle with base equal ramp time and height equal (max speed - min speed). And the green area is just the ramp time multiplied by the min speed. So the equation for the number of steps during deceleration is:

$$\text{decel steps} = \frac{\text{ramp time} \times (\text{max speed} - \text{min speed})}{2} + \text{ramp time} \times \text{min speed}$$

$$= \frac{\text{ramp time} \times (\text{max speed} + \text{min speed})}{2}$$

Figure 1: Motor Acceleration/Deceleration