

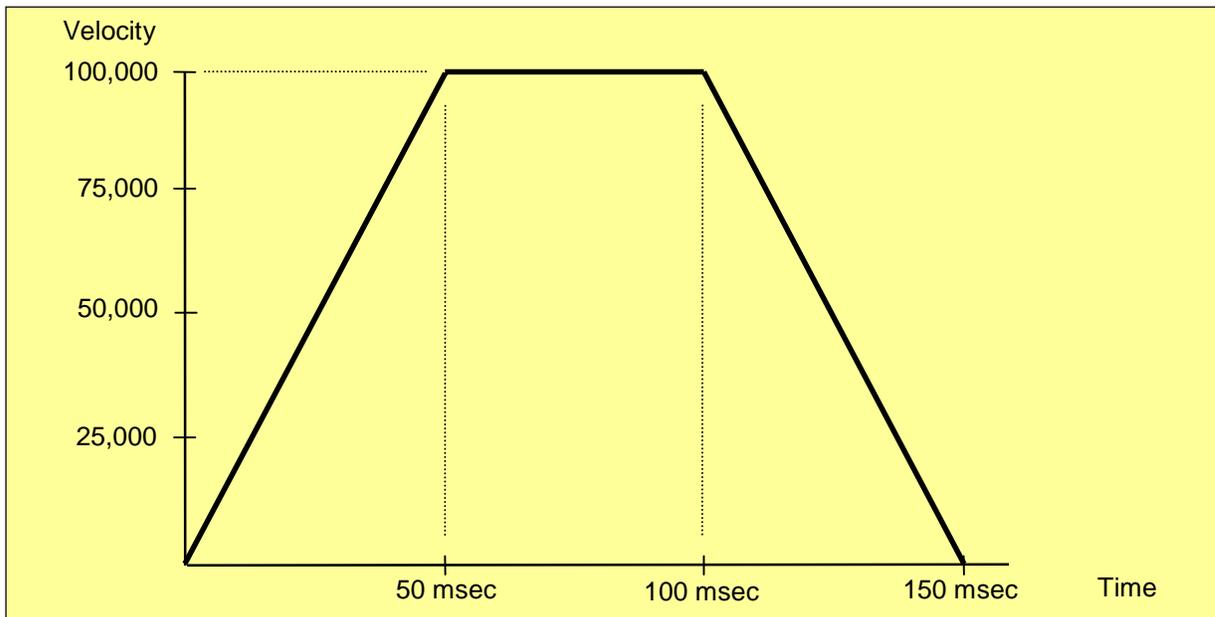
**Title:** Programming a Trajectory Profile for the DC2-PC Motion Controller  
**Products(s):** DC2-PC1XX  
**Keywords:** Trajectory, Velocity, Acceleration, and Deceleration  
**ID#:** TN1026  
**Date:** April 15, 1999

### Summary

Upon commanding a Position Mode move, the DC2-PC1XX motion control card will calculate a Trapezoidal Velocity Profile based on four user defined parameters; Target, Maximum Velocity, Acceleration, and Deceleration.

### Defining the Trajectory Profile

For the purposes of this example, the move target is 10,000 encoder counts and the move is to be completed in 150 msec's. The maximum velocity is 100,000 encoder counts per second. During the move the axis will accelerate for 50 msec's, move at maximum velocity for 50 msec's, and decelerate for 50 msec's.



### Programming the Velocity

To define the maximum velocity of the move, use the MCCL command Set Velocity (*aSVn*). The parameter *n* of the Set Velocity command is expressed in units of encoder counts per 1 msec. This value is then multiplied by a constant (65536).

```
1SV6553600 ;100,000 X .001 = 100 counts per msec.
;Next calculate parameter n by
;multiplying 100 X 65536 = 6553600
```

## Programming the Rate of change of Velocity

Use the MCCL commands Set Acceleration ( $aSA_n$ ) and Set Deceleration ( $aDS_n$ ) to program the rate of change. Parameter  $n$  is expressed in units of encoder counts per msec per msec. For example, to calculate the increase in velocity per msec that will result in the required slope:

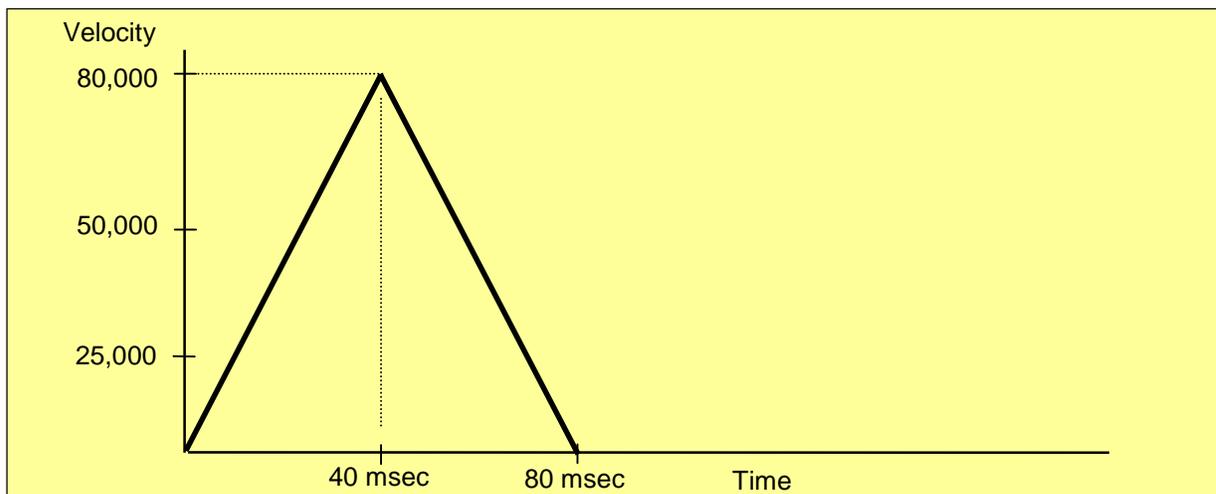
$$\begin{aligned} \text{Increase per msec} &= (\text{Maximum velocity} / \text{slope time}) * \text{sample time}^2 \\ \text{Increase per msec} &= (100,000 / 50 \text{ msec}) * 1 \text{ msec}^2 \\ \text{Increase per msec} &= (100,000 / .05) * .001^2 \\ \text{Increase per msec} &= 2,000,000 * .001^2 \\ \text{Increase per msec} &= 2 \end{aligned}$$

Increasing the velocity of the axis by 2 encoder counts per msec. will cause the axis to reach a velocity 100,000 encoder counts per second after 50 msec's. To define this rate of change, multiply parameter  $n$  by the constant 65536.

$$1SA131072,1DS131072 \quad ;2 \text{ counts} / \text{msec} / \text{msec} * 65536 = 131072$$

## Moves that Never Reach the Maximum Velocity

The DC2-PC1XX calculates a Trapezoidal Velocity Profile for every move, but all moves will not necessarily reach the programmed maximum velocity. Short moves, or moves where a slow rate of change is defined, may reach the deceleration point prior to achieving maximum velocity. This scenario is depicted in the graph below. A 3,200 count move is executed using the trajectory parameters from the previous example. The deceleration point is reached prior to the axis achieving maximum velocity.



To calculate the distance traveled at any time during a rate change:

$$\begin{aligned} d &= \frac{1}{2} a * t^2 && \text{where } d = \text{distance, } a = \text{rate of change,} \\ & && t = \text{elapsed time in msec's} \\ 1600 &= \frac{1}{2} * 2 * 40^2 \end{aligned}$$