S-CURVE

DOCUMENTATION AND TUTORIAL FOR THE S-CURVE ON THE COOL MUSCLE

1. INTRODUCTION

The s-curve function allows the user to define a smooth response yet still maintain a high acceleration. In many applications the ideal step response is not one where the maximum speed is reached instantaneously. The jarring effect of high acceleration and deceleration can damage the application, yet a slow acceleration can slow down production dramatically. In these applications the ideal step response is to have a slow initial acceleration, leading into a high acceleration to a low deceleration to the required speed. The resultant speed curve is what is known as an s-curve.

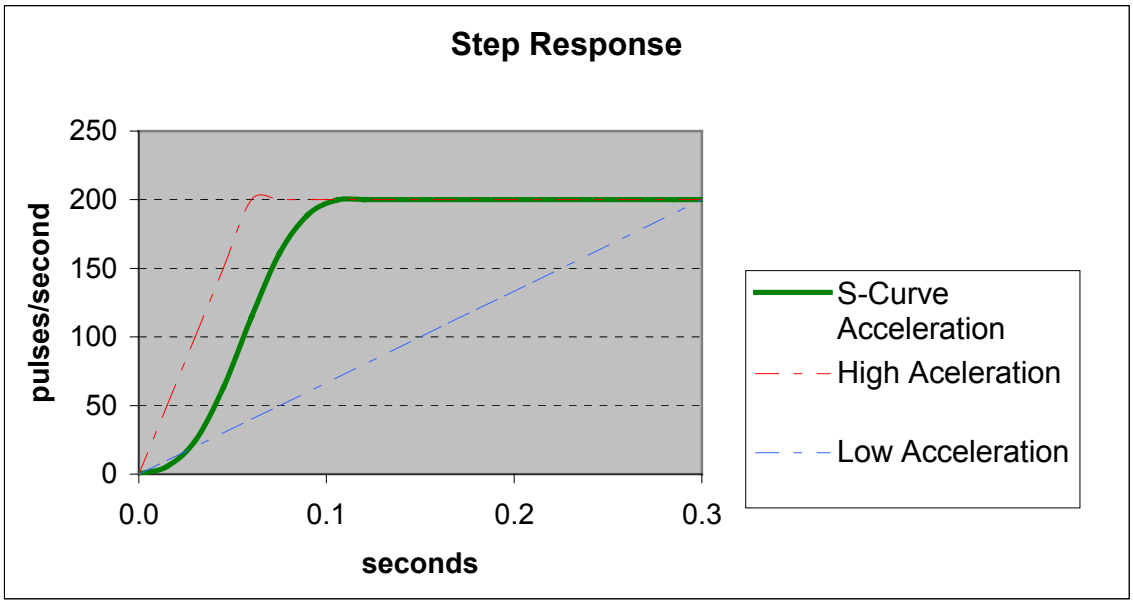

Figure 1: Step response of an S-Curve function.

Figure 1 shows how the s-curve can maintain advantages of both a high and low acceleration. High overall acceleration is maintained yet jarring effects are minimised.

2. K69: S-CURVE K-PARAMETER

The K69 parameter is the most significant parameter when dealing with the s-curve function. K69 is unit-less and acts as the gain of the function ranging from 0 to 1024. When it is set to 0 the s-curve function is turned off, i.e. the standard response for the given speed and acceleration is output. When set to 1024 the response is the most defined s-curve function.

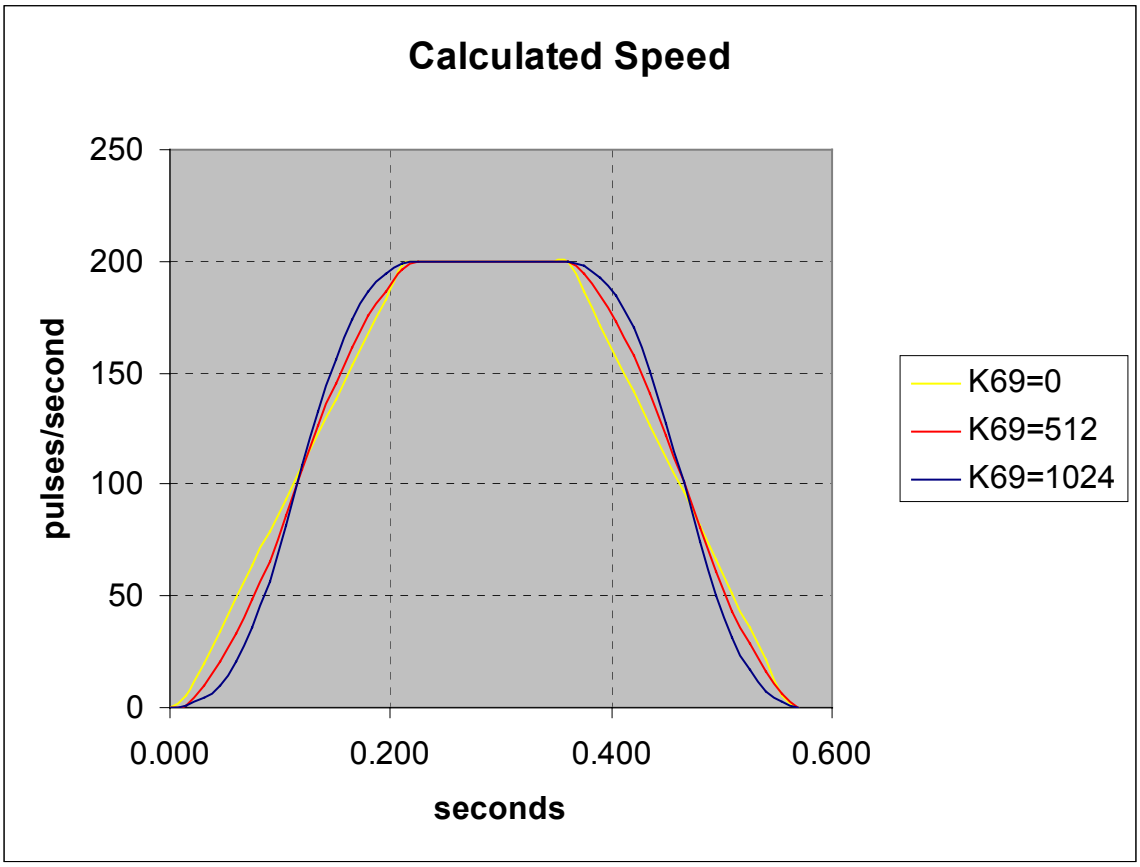

Figure 2: Calculated s-curve speed response by the Cool Muscle.

Figure 2 shows the response calculated by the Cool Muscle (how to capture this response will be described in the tutorial following). As can bee seen in the diagram by adjusting the K69 value from 0 to 1024 the s-curve becomes more pronounced.

3. S-CURVE TUTORIAL

3.1. Objectives and requirements

The objective of this tutorial is to familiarize the user with the s-curve function in the Cool Muscle. K69 is the main parameter, however, creeping speed (K51) and acceleration both play important roles in the forming of a curve. Some prior knowledge of the Cool Muscle may be required. Firmware versions 1.14 and above have the s-curve function implemented. A copy of Cool Works Lite should be installed on the PC attached to a single Cool Muscle through the RS232 port. Microsoft Excel, Matlab or an equivalent graphing program should be available to plot the outputs. Follow the steps in order to ensure full understanding of the function.

3.2. Tutorial steps

3.2.1. Step 1: ensure correct firmware version

Only firmware versions 1.14 and above have the s-curve implemented. Open Cool Works Lite (CW Lite) and query "%100". If version 1.14 or above is loaded this will return some hardware and software information. The line "SV=x.xx" is the current software version loaded.

3.2.2. Step 2: set the automatic poll and timer

The automatic poll and timer sets the Cool Muscle to constantly return information. There are a number or modes available, which can be read about in the manual. This tutorial is going to deal with the calculated speed and the real speed. Set the following to program the Cool Muscle to return the calculated speed at an interval of 15 ms.

- K66=1
- K67=15

Though in theory the more points the more accurate the curve generated we don't want to overload the Cool Muscle with communication. Communication has the highest interrupt priority and can disrupt motion if used to frequently.

3.2.3. Step 3: set the dynamic values and resolution

Set the dynamic speed, acceleration and position to the following:

- a=100
- s=200
- p=7000

The resolution should be 1000 pulses/rev i.e. K37=3.

3.2.4. Step 4: set the creeping speed (K51)

K51, the creeping speed is important to the look of an s-curve. If high initial accelerations are a problem, the creeping speed should be set as low as possible. The creeping speed is defined as the speed from which the motor will start its acceleration. I.e. if the creeping speed is set to 10 it will accelerate as fast as possible to 10 pps (pulses per second) and then accelerate with the required acceleration from there. By default K51 is 10 pps but can be set down to 1pps. Set K51=1.

3.2.5. Step 5: graph the calculated speed

K69 is the s-curve parameter and sets the gain of the s-curve. Starting with K69=0, execute the dynamic run command (^). The terminal window of CW Lite should return the speed values at an interval of 15ms. If it does not, return to step 2 and verify the K66 and K67 settings. Copy and paste the values into a graphing program such as Excel or Matlab at intervals of 15ms. Due to calculations in the Cool Muscle the values are calculated with respect to 50000/10 and the maximum speed is 1000. By dividing the returned number by 5 it can be normalized to the maximum real speed. Repeat this step for K69=512 and K69=1024. Remember, the dynamic values are absolute so set the current position back to the origin (|2) before executing the dynamic command (^).

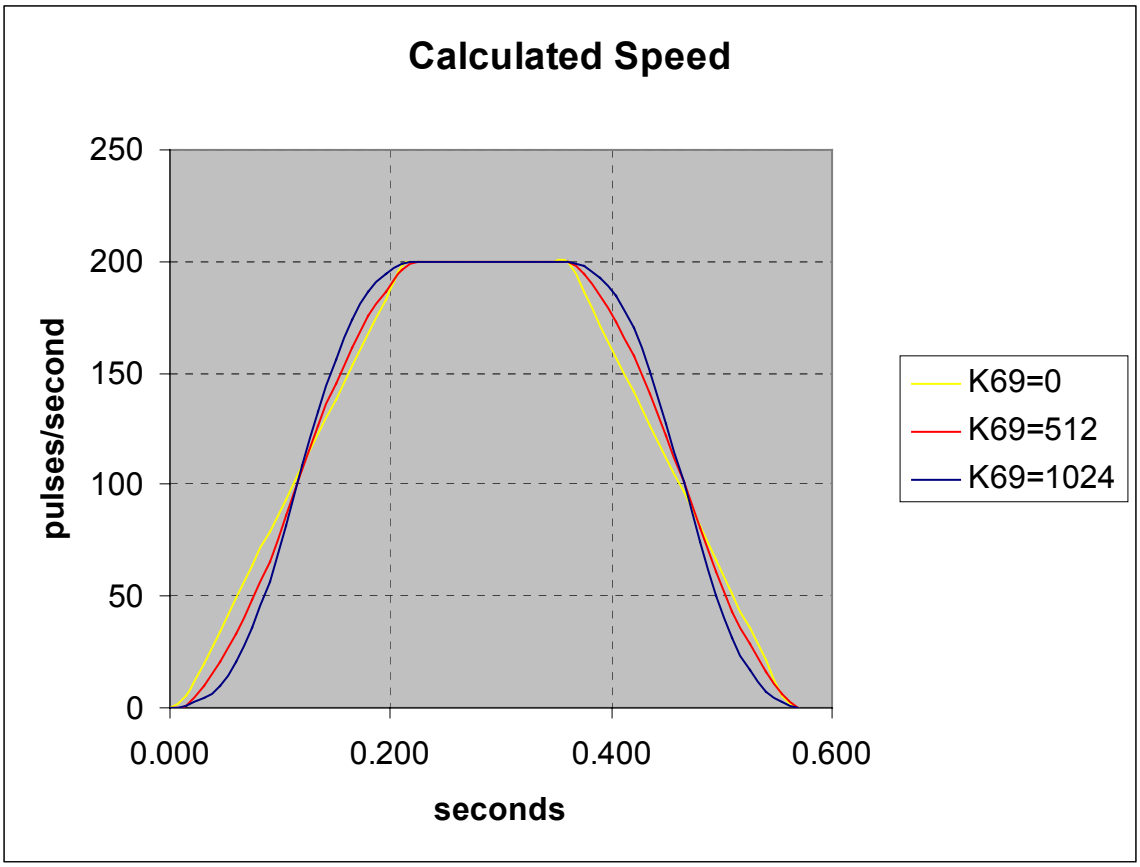

Figure 3: Calculated speed curve by the Cool Muscle

3.2.6. Step 6: graph the real speed

Repeat step 5 but with K66=3 to graph the real speed of the Cool Muscle. It is not necessary to divide by 5 as the Cool Muscle is outputs the real speed and no longer the calculated speed. The graph should look like the following Figure 4.

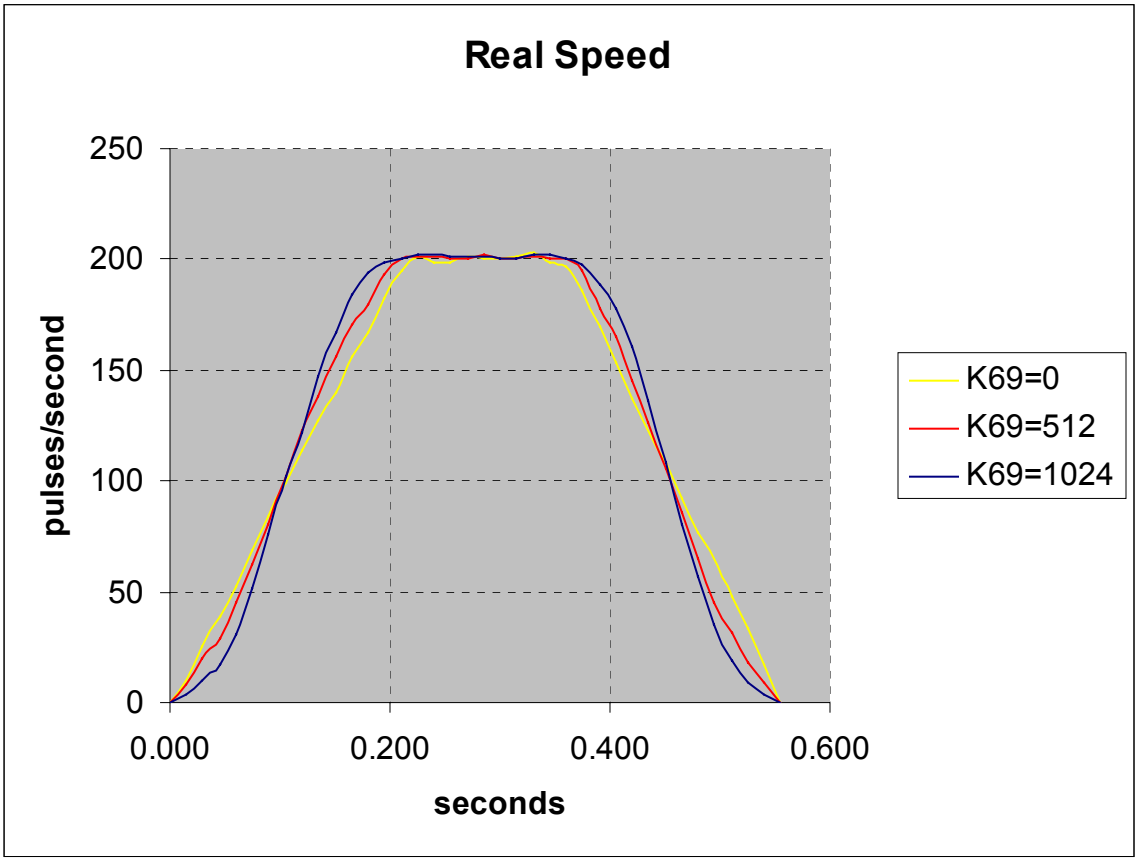

Figure 4: Real speed of the Cool Muscle