ACCELERATION

Acceleration is a change in velocity with respect to time.

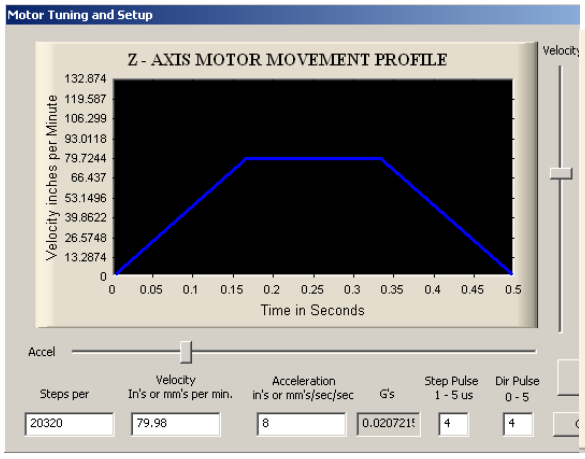
The term, in context of the above definition, is best described by Newton's Law F=MA (Force is equal to Mass times Acceleration), since all motion can be derived or evaluated from the law. The value just provides a quantity one can relate to and is relative to motion since there are different motions ie; linear, circular, gravity and the related acceleration value can be none, instantaneous, average, etc. The value can be expressed in many different ways depending on the motion which is being defined or investigated.

In practical applications one defines an acceleration desired and finds what is required to achieve it ….or ….. accepts the value based on some other parameters. One could say that they are either designing a system to achieve the task or they accept their system " as is " and the acceleration is defined by what they have.

Should one desire a general understanding of motion and the affect of acceleration they should study Physics or specifics like Kinematics.

MACH3

Mach3 software controls the axis / moving parts of the machine which have motion. Motion is composed of other parameters such as time and velocity. So acceleration is just one required value the software must know in order to control the motion. The description of a machines axis motion is defined to Mach in Motor Tuning and Setup. Figure 1 below shows a Trapizoidal motion profile which is used in Mach. (Note: There are other motion profiles but the information here is restricted to the movement profile found in Mach).



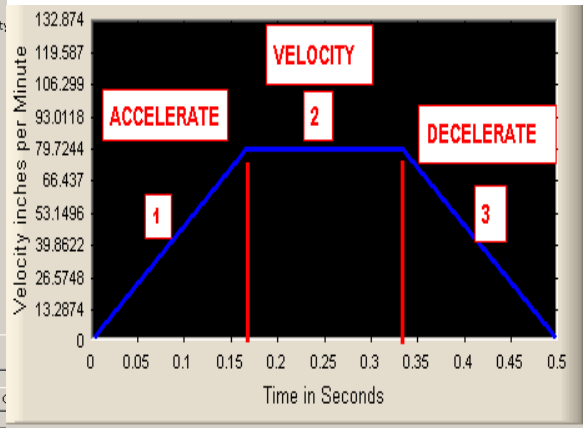


FIGURE 1 – MOVEMENT PROFILE FIGURE 2

The motion shown in Figure 2 is composed of three parts and related to time. The axis will accelerate at a constant change rate until it reaches a velocity, then the axis will maintain that velocity, and then decelerate.

Figure 3 shows acceleration from a lower constant velocity to a higher constant velocity. (The figure is provided for understanding and is not part of motor tuning)

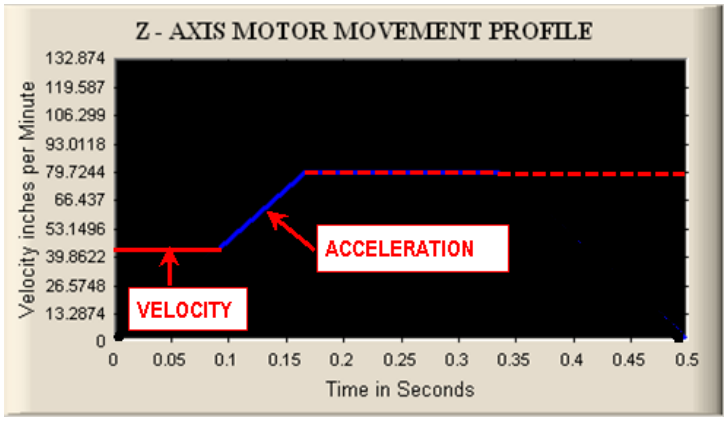


FIGURE 3

KERNEL SPEED

The graph shown in Figure 2 was based on a Kernel Speed of 25000 Hz. The selected Kernel Speed defines how many pulses you want the computer to output when using Mach3 and is defined as shown in Figure 3. The Driver Test, when run, will confirm that the selected Kernel Speed can be used in harmony with Windows since Mach is sharing time with the operating system. Changing the Kernel Speed will change the graph in Figure 2 increasing or decreasing the max allowable velocity the software will use. There is no advantage to using a higher Kernel speed than necessary.

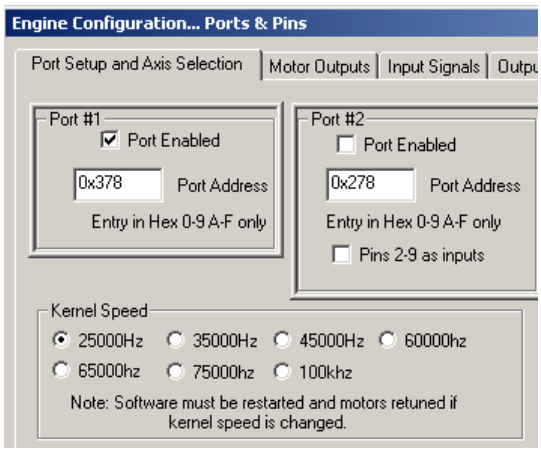


FIGURE 3

The computer output (number of available pulse instructions to the drive) can restrict

the velocity, the steps per unit input is calculated and is composed of the axis components, the drive may be limited to how many pulses it can send to the motors, how fast something can accelerate to a velocity is dependant on the axis systems ability to provide adequate torque at some rate to address the systems inertia. All this is inter-related, so keep in mind the above comments and hopefully what was noted before is taking on some meaning, namely.

In practical applications one defines an acceleration desired and finds what is required to achieve it …or … accepts the value based on some other parameters.

Figure 4A & 4B shows the affect of changing the Kernel Speed (KS) and the result for the same given acceleration, velocity and steps per unit value.

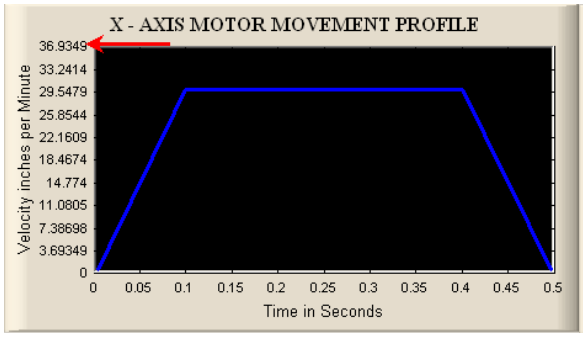


FIGURE 4A KS=25000

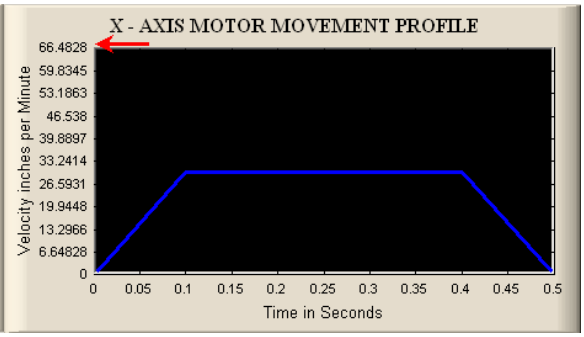
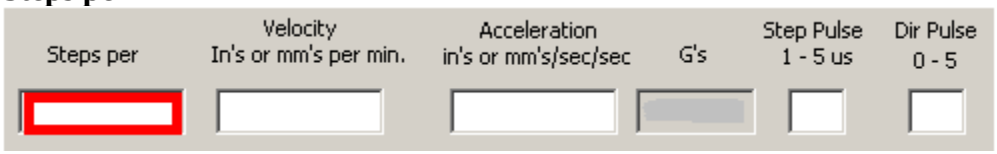


FIGURE 4B KS=45000

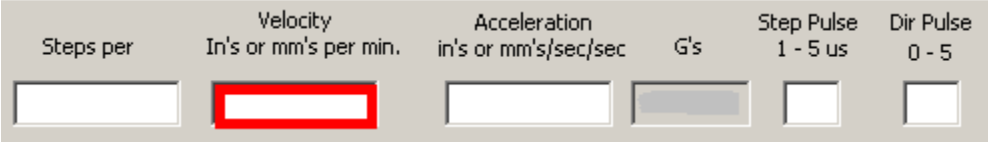
The velocity which is shown in terms of IPM (inches per min) was almost doubled. That does not mean your machine has the capability to achieve the higher velocity that the software is using. IPM terms are used in CNC and one can convert to inches per minute, feet per second, miles per hour, etc if they can't relate to IPM.

Steps per



This value is calculated based on the components of an axis. It is how many steps are required to move the axis a distance. A better wording would be steps per unit, but, the units are defined elsewhere in Mach. Even better would be "Pulses" per unit since that is what is actually input.
The calculated value is normally used for input. The calculated value may require refinement since the components are built to some tolerance. The steps per unit provides an absolute value relating a unit of distance to electronic control of the movement.

Velocity



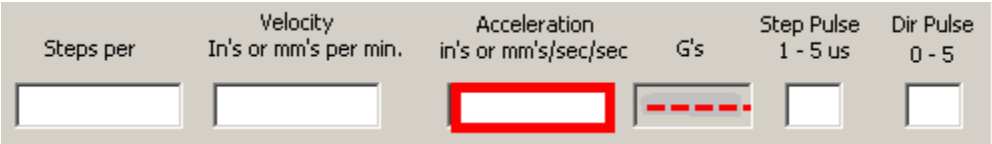
A constant rate of speed in time with motion in a direction.
Speed is motion without direction. The velocity is constant if it does not change.

A stepper motor can only be pulsed to some max rpm or rotation. The Kernel Speed (pulses the motor can receive via the computer and driver) when divided by the Pulses per unit provides the Velocity (inches per minute) available in motor tuning.
The Kernel Speed , Steps per, velocity and acceleration are interrelated from a control point of view.

KERNEL SPEED	STEPS PER	Max Velocity (software)
25000	10000	250
35000	10000	350
60000	10000	600

ACCELERATION

The unit value is mm/sec/sec or inches /sec/sec when used in defining the motion profile for an axis in CNC. G's is a reference value calculated by the software since acceleration can be expressed in terms of gravitation pull.



Acceleration

Acceleration is how fast an axis can go from no movement to some velocity in a time period. It is linear since it's distance in a sec. It is also how fast it can increase from a current velocity to a higher velocity. The acceleration is determined by the ability of the motor to overcome the inertia of the axis. The axis usually changes circular motion to linear motion and as such it is made up of couplings, gears, belts, pulleys, a screw (or rack and pinion), and the motor itself.
So to accelerate the motor it must have enough torque to overcome all the resistances which are trying to keep it from rotating. A measure of that resistance is called inertia and all rotating components have it in motion and is based on their mass. Additionally other forces exist which add to the total force the motor must overcome ie; friction, efficiency of the components. You can increase the end user torque by gearing up or down, providing more energy to the system, or changing the system makeup (different screws or pitch), etc.

The longer the time to accelerate to some velocity the flatter the angle will be in motor tuning. It takes a lot of Force to move a big mass from standstill to a high velocity in a short time period. The amount of torque / force available from the motor is not infinite within the motors capability. It takes energy to rotate the motors shaft.