
Soigeneris AN-01

Using the G540
VFD Output

V.3





Your Resource for Hi-Tech Hobbies

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A word about safety

We at Soigenetis take pride in providing high quality components for small scale CNC systems. While we make every effort to provide in depth and accurate technical information we cannot make any guarantees about their applicability to your particular application. In reality the only person who can keep you safe is you. We strongly suggest that you avail yourself of all the information available for the components you're putting into your CNC system and understand how they will all interact.

Safety Tips

- Some controls like the STDR-4C will automatically power the spindle when commanded to by your controller (Mach 3). However, it is best to also have a manual interlock switch in-line with your spindle motor to ensure that the spindle cannot accidentally be turned on when you are changing bits.
- Secure all stock to prevent it from becoming a projectile during machining. Nothing can ruin your day faster than having a piece of metal being hurled at you by your machine tool.

Conventions used

-  Indicates a note for parallel port users.

Introduction

One very nice feature to have on your CNC machine is the ability to control the spindle speed from your CNC control program (Mach 3). This requires both a variable speed motor and a matching speed controller for it. While there are many different types of motors and speed controls ranging from three phase AC 'Variable Frequency Drives' (VFD) to a simpler DC motor and SCR speed control for them to be used for our purposes they must accept some form of external command to tell them how fast to go. One of the most common ways to remotely control the motor's speed is by supplying an analog voltage input, the higher the voltage the faster the motor will spin.

The subject of this application note is how to use the 'VFD' output of the Gecko G540 to control the speed of various types of motor speed controllers. We will start with the venerable KBIC SCR type speed control for DC motors and add other types as time goes on.

The Hardware

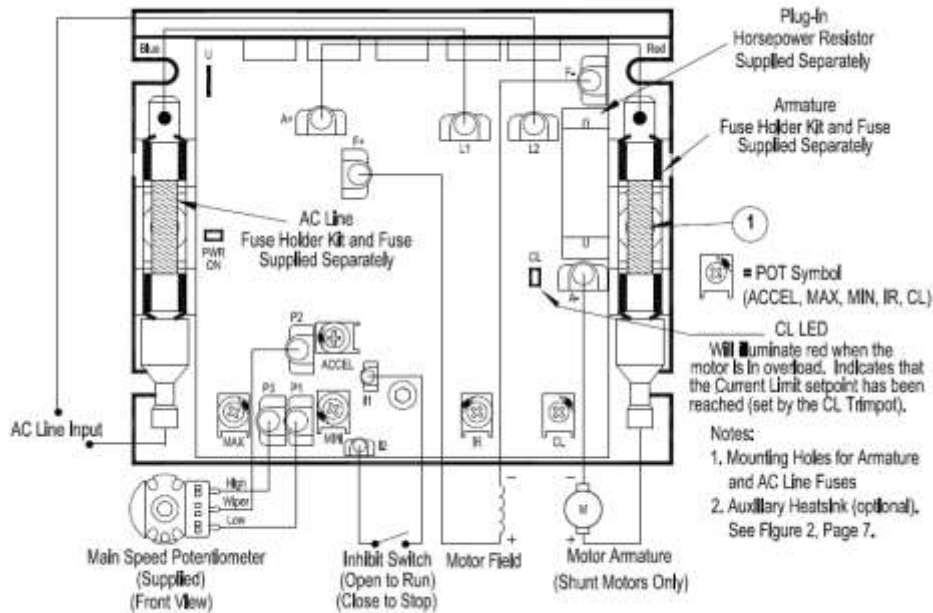
As mentioned before while there are many different types of motors and speed controls one of the most common ways to remotely control the motor speed is to supply an analog voltage input, the higher the voltage the faster the motor will spin. Typically the range of the input voltage is 0-10V (or less).

One VERY important note: The circuitry in many drives, like the KBIC, has no isolation from the mains voltage. This means that anything you hook to it must be completely isolated from the rest of your control circuitry or you'll most likely blow something up.

Fortunately for us the Gecko G640 comes with a 'VFD' output whose ISOLATED internal circuitry converts a Pulse Width Modulated (PWM) signal from Mach 3 to an output voltage. It should be noted that the G540 does not actually output its own voltage, rather you must supply it with up to 10V across pins 7(+) and pin 9(-). The G540 takes this voltage and uses it to generate an output voltage that is in proportion to the PWM duty cycle. For example you input a 10V signal to the G540 and Mach sends a 50% duty cycle signal, the resulting output will be 5V.

KB Electronics KBIC

The first type of speed control we'll cover is the KBIC. This model has been made for many years and is standard equipment on Sherline's machine tools. Please take note that this drive is NOT isolated from the mains voltage so any interfacing down with it must be from an isolated control.



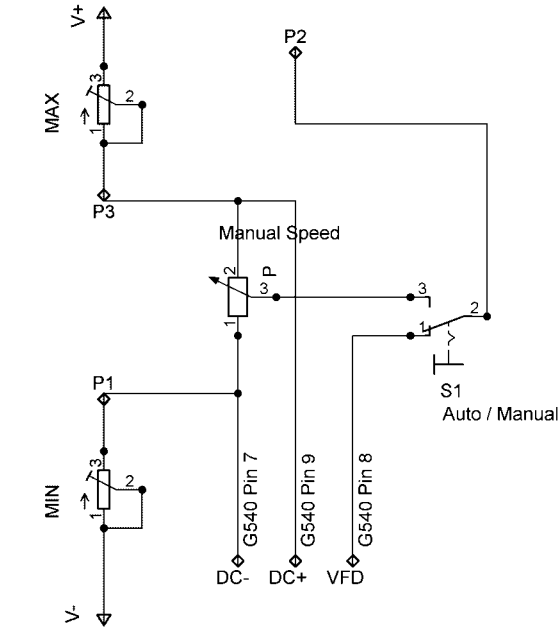
The KBIC speed control is shown at left; the two fuses depicted are optional and may not be on your control.

Notice the location of the P1, P2, P3 terminals and the MIN and MAX adjustments as we will talk about these later.

Many times a speed control is fitted with a simple potentiometer which is hooked to a voltage source (terminals P1 and P3 above) within the drive. The voltage output by the potentiometer feeds the analog input (Terminal P2). You may be able to use the same connection points as the potentiometer (pot) to derive the power source needed for an external control.

The MIN and MAX pot adjusts the range of voltage fed to the main speed spot. An equivalent circuit is shown below. The important thing to note is that the KBIC supplies about 12V between the MAX pot and MIN pot with a bit of clever tuning we can make us of this for the G540's VFD input voltage.

The KBIC manual states that an external speed control voltage of 0-7 VDC can be fed to P2 and F-. The MIN pot is hooked to F-, so if we turn it all the way down (CCW), which is how they are adjusted from the Sherline factory, we will have a convenient F-connection. So our first step is to turn the MIN pot all the way down.



We will be configuring the KBIC to allow switching between manual and automatic control of the speed with a SPDT switch. This provides a bit of convenience for many users and is very simple to do.

With the manual speed control pot hooked up, and turned all the way down so the motor does not turn, measure across terminals P1 and P3 with a voltmeter. Adjust the MAX pot until you get a reading of 8.5V. You'll notice that if you adjust the speed pot now that as the motor starts to spin the voltage between P1 and P3 drops closer to 7V. This is an artifact of how this type of drive works and is normal.

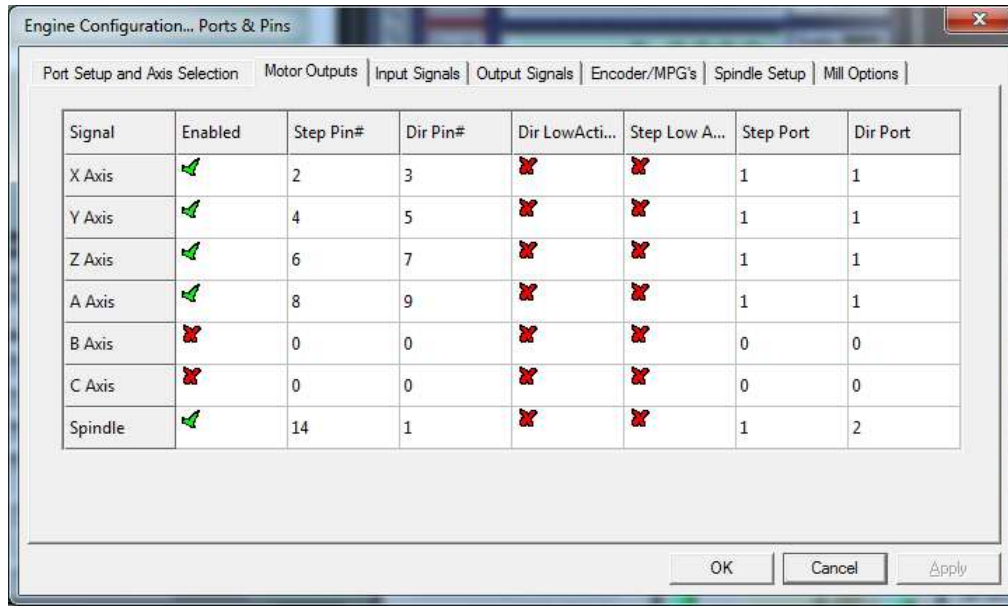
As shown in the diagram above we can tap into the voltage between P1 and P3 and feed this to the G540's VFD input voltage. To be able to switch between automatic and manual operation of the spindle speed we'll add in a small SPDT switch as shown. This switch only changes which source, the G540 or speed pot, is connected to P2.

NOTE: If you have one of our STDR-4C controls the VFD signals for the G540 are brought out to a DB9 connector on the back panel. The pin out of this connector is shown below.

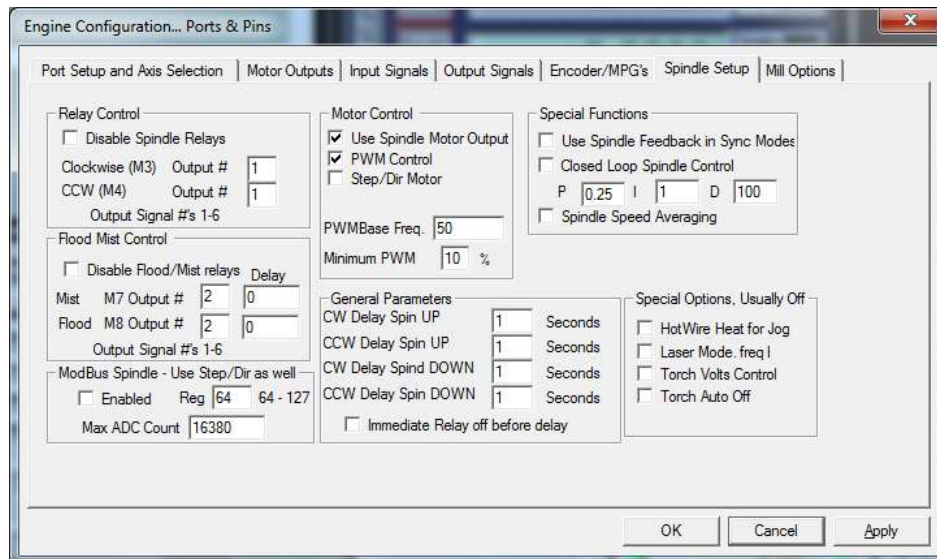
STDR-4C VFD Connector (Female)		
Pin	G540 Pin	Function
1	9	+10VDC
2	8	VFD Out
3	7	DC Common
4-9		open

Configuring Mach 3

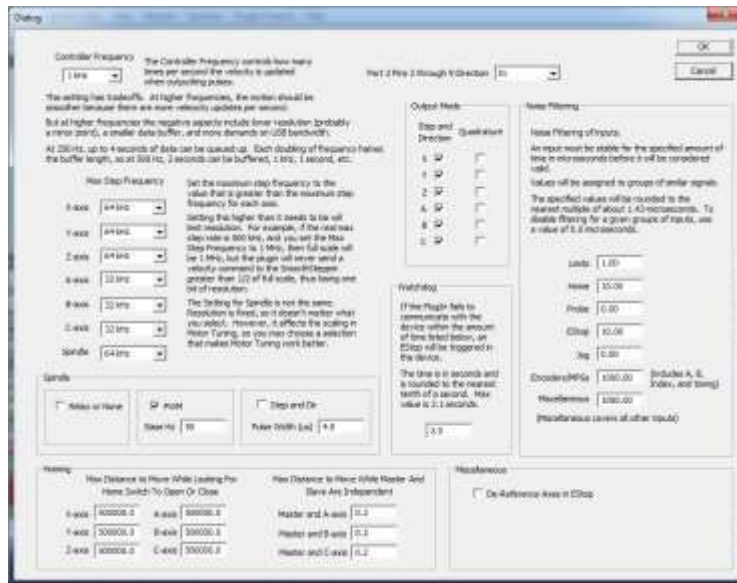
The next step is to configure Mach 3 and then we can calibrate the speed. First make sure that the spindle output is enabled and configured properly for the G540 as shown below. Go to Configuration->Ports & Pins and be sure to click 'Apply' when you are done.



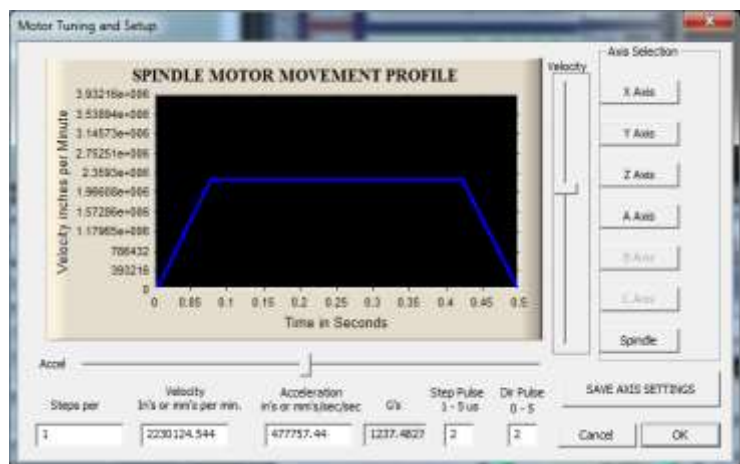
Next, we need to switch to the Spindle Setup tab and turn on the PWM output for the spindle in the 'Motor Control' section as shown below.



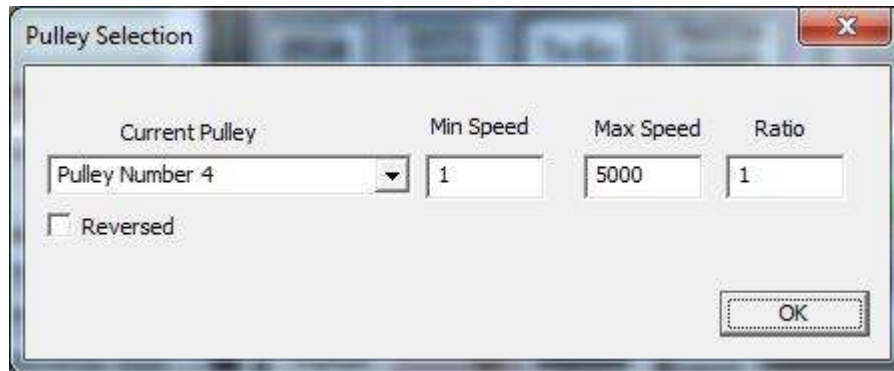
If you're using a SmoothStepper you'll need to set it to use PWM for the spindle in the SmoothStepper configuration screen as shown below. Note both Mach and the SmoothStepper should have their PWM base frequency set to 50hz as this is what the G540 requires.



Next, adjust the spindle in the motor tuning dialog to about 1/2 way for both velocity and acceleration. These settings seem to have no difference for a PWM controlled spindle but they do need to be something other than zero. Make sure to click 'Save Axis Settings' when you're done.



Next go to Configuration->Spindle Pulley and set up a pulley similar to what is shown below, the exact pulley number is not important. We need to calibrate the speed of the spindle motor so we are entering the maximum motor speed under 'Max Speed'. The Sherline motor I was using has a maximum speed of 5000 RPM.



For calibration we want to make the motor go about 1/2 speed, the easiest way to do this is to manually enter a speed command in the MDI line, in the case shown above we would want to enter S2500 on the MDI line.

We also need some way of measuring the motor speed (not the spindle). You could use a hand held tachometer or to have a speed sensor input hooked up in Mach. To turn the spindle on you can press F5 or type m3 in the MDI. Check the readout of the motors speed and adjust the MAX pot on the KBIC to bring it to 2500 RPM.

The actual speed of the motor is not quite linear to the voltage output. The motor will run about 100 RPM faster at both extremes of operation but that is OK as Mach can sync the axis movements to the actual spindle speed for important operations like threading.

The above procedure was written with the presumption that the speed sensor was on the spindle motor. Most spindles have a few choices of pulleys that you can use to get in the speed range you want to be in. To calibrate Mach's spindle speed display to the actual spindle speed you can enter the reduction ratio in the Pulley Selection 'Ratio' box. This only scales the spindle speed DRO in Mach it does not affect the actual motor speed.