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DigiSpeed DC-03

Isolated Control Voltage Generator

User's Guide

PCB: DC-03 V3.0
Firmware: Ver: 3.0
Mach3: Ver: 1.84

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***** WARNING *****

The KB Electronics DC speed controller circuit, and other similar speed controllers as found in Asian imported mini lathes and mini mills are at mains voltage potential. This voltage is lethal. Do not attempt to do this conversion if you are not qualified to do so. Confidence is no replacement for qualification!

If you feel that this project is beyond your abilities to SAFELY complete, we can install the unit for you. Please contact us for details

Please ensure you read the complete manual before attempting to install or use this device.

1 Introduction

Thank you for purchasing Homann Designs' DigiSpeed DC-03 *Isolated Voltage interface unit*. The DigiSpeed DC-03 provides a way for controlling DC motor speed controllers and other devices that accept a 0-5Vdc, 0-10Vdc, 0-15Vdc voltage signal

This document is a User's Guide that describes the operation of the *DigiSpeed DC-03*. The document contains information on how to use and integrate the board into your own systems.

1.1 Contents

The box received when ordering the DigiSpeed DC-03 contains the following:

- DigiSpeed DC-03 isolated voltage interface unit.
- 4 x 0.1" jumpers.
- 4 x 4mm plastic PCB stand-offs.

1.2 Overview

The DigiSpeed DC-03 Isolated Voltage Interface Unit is designed to allow devices such as the Gecko G-100 motion controller and computer CNC programs such as Mach2, TurboCNC and other CNC programs to control devices that require an isolated DC control voltage.

DigiSpeed DC-03 is designed primarily for use with KB Electronics style DC motor controllers, such as the KBIC-120. This is the type of controller found in the Sherline Mills and Lathes. DigiSpeed DC-03 will work with other types of DC motor controllers such as those found in the Asian imported mini lathes and Mills.

The DigiSpeed DC-03 is also well suited for use with VFDs such as the Automation Direct GS2 series and other motor speed controllers which accept a 0-5Vdc, 0-10Vdc speed control voltage.

The form factor of the DigiSpeed DC-03 PCB has been designed for easy installation. Due to its compact size, it can also be installed unobtrusively into many of the existing speed controller or CNC controller enclosures.

2 Options

The DigiSpeed DC-03 is a versatile unit. It has an on-board LED indicator, mode select jumpers, and an attenuation multi-turn trim-pot. The board is designed to be installed into existing motor speed controller housings, external CNC housings or other enclosures.

2.1 5Vdc – 15Vdc isolated DC-DC Converter.

Depending on the installation, the device being controlled by the DigiSpeed DC-03 may not be able to provide the 10Vdc supply required by the isolated analog circuitry. In such situations, the optional On-board 5Vdc - 15Vdc isolated DC-DC converter may be used to provide the required supply.

Note: *The DigiSpeed DC-03 Attenuation trimpot may be used to scale the output voltage to 0-10Vdc, or to a voltage that is required by the device being controlled by the DigiSpeed DC-03.*

3 Features

The main features of the DigiSpeed DC-03 controller are;

- Controlled by a RISC Microchip micro-controller.
- PCB
 - FR4 Material
 - Double Sided, Plated through holes
 - Silk-Screened on Component Side
 - Solder Mask on Both Sides
- Small PCB footprint 5.5cm(L) x 4.5cm(W)
- Four 4mm mounting holes (supplied with matching stand-offs)
- Single 5V dc power requirements.
- Reverse polarity protection on 5V supply.
- Multi-Function status indicator LED
- Opto-isolation between the computer logic Voltages and the analog output control voltages.
- Maximum DC Speed controller output voltage for the control supply of 15Vdc
- 10 bit resolution providing more than 1000 steps from 0 to Max Output voltage.
- Three methods to control motor speed.
 - 0-5V analog Voltage
 - PWM - A low frequency PWM signal. (2Hz – 100Hz)
 - On-Board multi-turn trimpot
- Output Control Voltage Attenuator.
- SMT LED indicating the mode and state of the DigiSpeed DC-03 controller.
- 2 on board relays with leds for direction and enable/brake use.
- Jumper selectable Logic Hi or Logic low signals .
- Pluggable 3.5mm terminal block connectors for easy installation and maintenance.

4 Board Description

4.1 Introduction

The DigiSpeed DC-03 controller provides the capability to control a device such as the the spindle speed of a DC or AC motor via computer control

Many of the devices that the DigiSpeed DC-03 is designed to work with such as the KBIC-120 controller supplied by KB Electronics, use a "Hot Ground" circuitry. That is, the reference voltages for setting the speed are at MAINS POTENTIAL voltage. This voltage is dangerous and can be lethal.

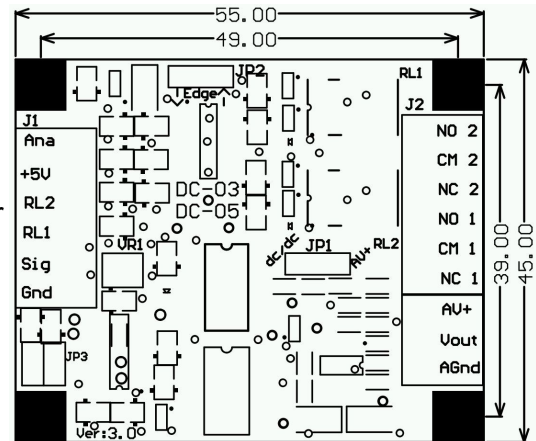
This style of controller uses a control voltage, usually in the 0 –10Vdc range to control the motor speed from 0 – max speed. In reality, this voltage can be anywhere in the range of 5Vdc to 15vdc. The maximum output voltage of the DigiSpeed DC-03 and thus the speed of the motor can be limited by an attenuation trim-pot that reduces this control voltage supply.

AC motor controllers are usually Variable Frequency Drives (VFD) and have terminals for the connection of an external manual control potentiometer, or a 0-5Vdc, 0-10Vdc control voltage.

The DigiSpeed DC-03 circuitry is essentially in two parts. One part contains low voltage logic level circuitry that includes a micro controller and interfaces to the PC or controlling device. It is supplied by 5Vdc that is referenced to the controlling devices ground. The other part of the DigiSpeed DC-03 circuitry is connected to the DC Speed controller control circuitry. This part is at **MAINS POTENTIAL**.

The two parts of the circuitry are separated by opto-isolation. This ensures that the dangerous MAINS POTENTIAL voltages are kept away from the low level logic circuitry. The two parts of circuitry must never be connected together. If it happens, a catastrophic failure of the DigiSpeed DC-03 circuit and your PC will occur.

The DC-03 also contains 2 small signal switching relays. These may be used for direction control, braking control or as an enable control for your motor speed controller.



*****YOU HAVE BEEN WARNED*****
DO NOT GROUND THE MAINS POTENTIAL SIDE OF THE CIRCUITRY



The DigiSpeed DC-03 controller provides a control voltage in place of the control voltage provided by the manual speed control potentiometer. This voltage can be varied from 0V to 100% of the maximum control voltage by computer software.

There are 1023 steps from 0 to the maximum control voltage. If your maximum spindle speed is 6000 rpm, this effectively provides for a 6-rpm resolution in controlling spindle speed.

4.2 Input Signal Polarity Jumper JP2

The DigiSpeed DC-03 has a jumper JP2 that allows you to select Logic Hi or Logic Lo inputs for the DigiSpeed-SD™.

Logic Lo signals are where 0V on the input will turn on the relay. Logic Hi input require 5V to turn on the Relays.

The jumper has two positions marked “^” (Logic Hi) and “v” (Logic Lo).

4.3 Mode Indication LED

The DigiSpeed DC-03 controller contains a SMT LED that is used to indicate the input mode that has been selected and when activity on the input is present.

4.3.1 Mode Indication

The DigiSpeed DC-03 controller used the status indicator LED to show which input mode is selected. It does this by flashing the LED on power up as described below;

- **LED Off** – This indicates that there is no 5Vdc power supplied to the DigiSpeed DC-03 .
- **Single Flash** – Indicates that the DigiSpeed DC-03 is powered in Analog input Mode.
- **Double Flash** – Indicates that the DigiSpeed DC-03 is powered in PWM input Mode.
- **Triple Flash** – Indicates that the DigiSpeed DC-03 is powered in Multi-turn Trimpot input Mode.

4.3.2 Input Activity Indication

The DigiSpeed DC-03 controller uses the status indicator LED to indicate when there is activity on the input. This activity is as described below;

- **LED Off** – This indicates that there is no 5Vdc power supplied to the DigiSpeed DC-03 .
- **Lazy RED Double Flash** – Indicates that the DigiSpeed DC-03 is powered on, and there is no activity on the input source.
- **Fast RED Flash** – Indicates that the DigiSpeed DC-03 is powered, and there is activity on the input source.

4.4 Output Attenuation Trimpot

The DigiSpeed DC-03 controller contains an Output Attenuation Trimpot. The purpose of this is to attenuate or reduce the full scale output voltage of the controller. This may be used to reduce the maximum speed of a spindle.

By turning the screw in the multi-turn trimpot VR1, in a Counter-Clockwise direction, the output voltage will be reduced, or attenuated.

Some VFDs and motor controllers require a 0 – 5Vdc voltage to control spindle speed, yet provide a 10Vdc voltage supply. In this instance, the attenuator may be used to reduce the 10V control voltage to 5V as required by the controller.

4.5 Output Voltage Selection JP1

The DigiSpeed DC-03 controller contains an Output voltage selection jumper, JP1. The purpose of this is to select the source of the isolated voltage that is generated.

If the jumper is fitted between pins 1-2 (towards the DC-DC generator) then the Generators 15Vdc voltage will be used. In this instance there is no need to connect the motor controller to pin AV+ on connector J2

If the jumper is fitted between pins 2-3 (away from the DC-DC generator) then the voltage supplied by the DC motor controller via connector J2, pin AV+ will be used.

4.6 Mode Selection Jumper Block JP3

The DigiSpeed DC-03 can operate in a number of modes, depending on the type of control signal that is provided by your CNC software and or controller. The mode is selected via the mode selection jumpers as shown in the picture below;

Jumper JP3 consists of a two jumpers . If you orient the board so that the Blue input terminal block J1 is on the left, and the blue output terminal block J2 is on the right. Jumper block JP3 should be on the bottom left hand corner. MS1 and MS2 of JP3 are both oriented vertically. MS1 is to the left, MS2 to the right.

<i>Jumper</i>	<i>Function</i>	<i>Position</i>
MS1	Mode Select	Left
MS2	Mode Select	Right

Table 1: Mode Select Jumper Block

5 Quick Start Guide – PWM Mode

This section is intended to allow you to quickly setup and verify the operation of your DigiSpeed DC-03 controller with Mach3 for use in PWM mode. Initially, this will be done with the DigiSpeed DC-03 unit being connected to computer but not your Motor Drive. Once you are familiar with the operation of the DigiSpeedDC-03's operation, it can then be connected to the motor drive.

The DigiSpeed DC-03 circuitry is essentially in two parts. One part contains low voltage logic level circuitry that includes a micro controller and interfaces to the PC via the parallel port. It is supplied by 5Vdc that is referenced to the PC parallel port ground. The other part of the DigiSpeed DC-03 circuitry is connected to the DC Speed controller control circuitry. This part is at **MAINS POTENTIAL**.

The quick start setup will verify the connection to the Microprocessor and logic side of the DigiSpeed DC-03 controller.

5.1 What you need

To get started, you need:

- DigiSpeed DC-03 controller.
- Breakout board or other mechanism for connecting the DigiSpeed DC-03 control lines to the Computer Printer port.
- A PC with a printer port and Mach3 installed and running.

This quick start setup is done with the DigiSpeed DC-03 unit sitting on the bench and NOT connected to your Motor controller.

5.2 DigiSpeed DC-03 Setup

Mach3 controls the DigiSpeed DC-03 in PWM mode only. Therefore you need to place jumper MS1 into the mode selection jumper block JP3

JP1 controls where the voltage source for the analog output voltage comes from and is selectable between an on-board DC/DC converter (recommended) or Sourced externally via J2.

5.3 Mach3 Configuration Setup

The example setup describes how Mach3 is configured for the DigiSpeed DC-03. Your configuration may differ depending on what Printer Port number you are using, and what pins in the port are connected to which DigiSpeed DC-03 pins.

For this example, printer port 2 is being used with the port pins connected as shown in .

Notes:

1. *It is advisable to use a breakout board between the Printer port and the DigiSpeed DC-03.*
2. *The 5V supply for the DigiSpeed DC-03 must be obtained from the breakout board, as it cannot be supplied from the printer port.*

<i>Signal</i>	<i>Printer Port Pin Number</i>	<i>PC Input/Output</i>	<i>DigiSpeed-DC-03 J1 Pins</i>
PC Parallel Port GND (0V)	18-25	-	GND
PWM	1	Out	PWM
Relay 1 (Spindle Dir)	17	Out	Relay 1
Relay 2 (CW/CCW Enable)	16	Out	Relay 2
5Vdc power	-	-	+5V
Analog Input.	-	-	Ana

Table 2: DigiSpeed-DC-03™ - Breakout board Connections

5.3.1 Port Setup

From the *Options* menu in Mach3, select the *Ports & Pins Setup* item. As shown in Illustration 1 below, Port 2 is enabled and is set to the default printer port address 0X378. The other items on this page are not concerned with the DigiSpeed DC-03 Setup.

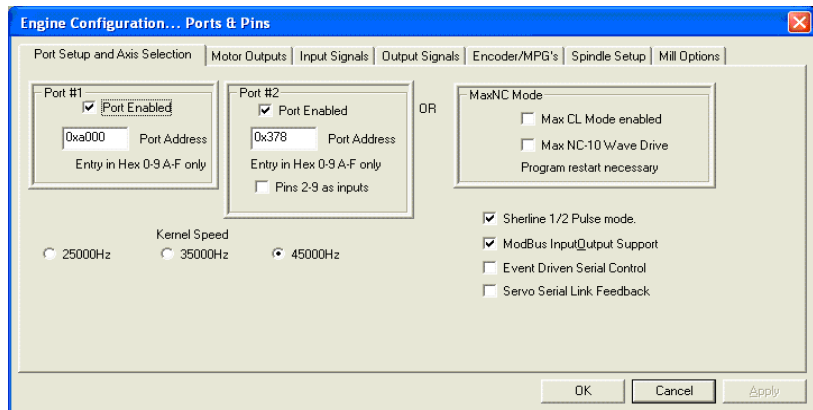


Illustration 1: Mach3 Port Setup

5.3.2 Spindle Setup Tab

The Spindle setup tab is used to configure various option regarding the Spindle operation. As shown in Illustration 2 below, the following items are configured:

- Motor Control – As shown below, the following items are setup:
 - The Use 'Spindle Motor Output' check box is ticked.
 - The 'PWM Control' check box is ticked.
 - The PWM base frequency is set to 50.
 - The minimum PWM % is set to 0
- Pulley ratios – The maximum spindle speeds for the pulley ratios you have are set up to allow Mach3 to calculate the required PWM percentage.

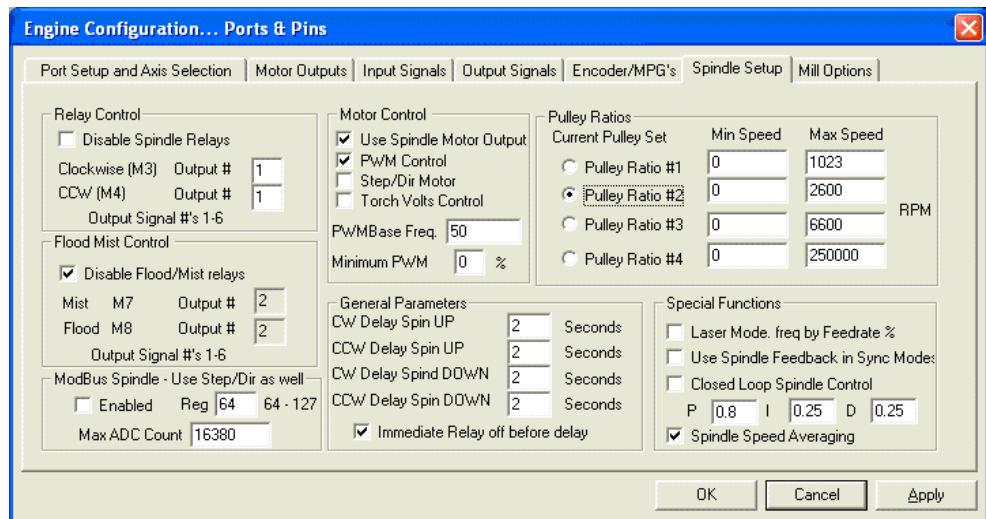


Illustration 2: Mach3 Spindle Setup Tab

This now concludes the configuration of the Mach3 software for the DigiSpeed DC-03. The next step is to hook up the unit to your breakout board for testing.

5.3.3 Motor Outputs Setup

Select the *Motor Outputs* tab and enable the *Spindle Axis*. Set the Port and Pin numbers that will be used for the DigiSpeed-03 Step and Dir lines. As can be seen in Illustration 3, The DC-03 **Sig** input is set to the spindle step pin has been set to 17, with the DC-03 **RL1** input connected to the Dir signal set to 1. The port number for both of these pins has been set to Port 1 in line with the previous port setup.

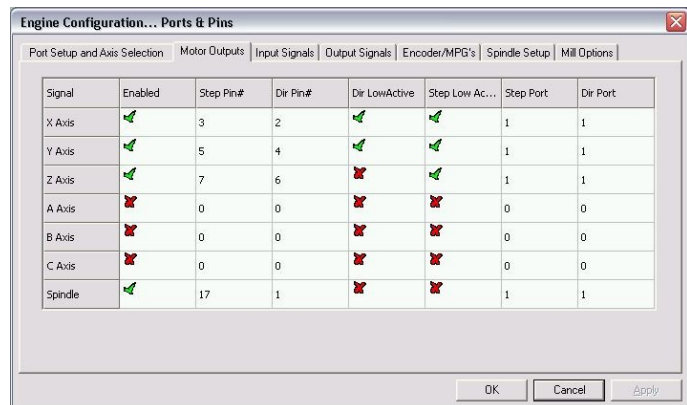


Illustration 3: Motor Outputs Setup Tab

Active Low signals are not selected for both of these pins, as the DigiSpeed-03 is configured via JP1 to operate with Active Hi Logic. It is possible to use JP2 to select Active Lo logic if desired..

Note: If you are not planning to run the spindle in reverse (Most installations) you do not need to connect the Spindle Dir pin. Just set the pin number to 0. This uses one less printer port pin that may be used for other functions.

5.3.4 Output Signals Setup

Select the *Signal Outputs* tab and enable the *Enable1* output. Set the Port and Pin numbers that will be used for the DigiSpeed-03 Step and Dir lines. As can be seen in below, the DC-03 **RL2** input signal is set to the Enable1 pin has been set to 16, the Dir signal set to 1. The port number for both of these pins has been set to Port 1 in line with the previous port setup.

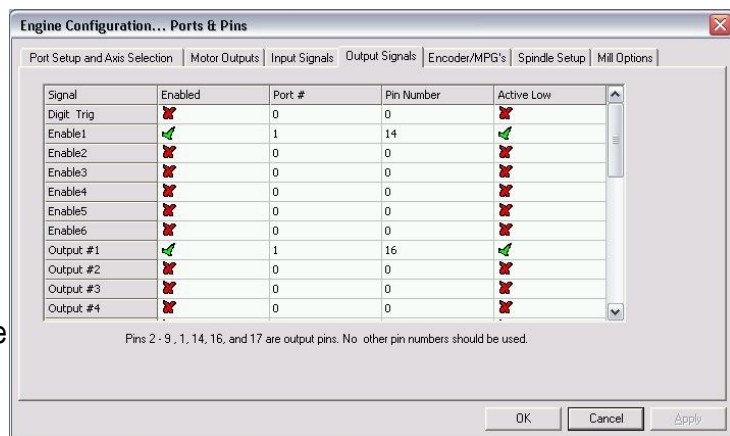


Illustration 4: Output Signals Setup Tab

Active Low signals are not selected for both of these pins, as the DigiSpeed-03 is configured via JP1 to operate with Active Hi Logic. It is possible to use JP2 to select Active Lo logic if desired.

Note: If you are not planning to run the spindle in reverse (Most installations) you do not need to connect the Spindle Dir pin. Just set the pin number to 0. This uses one less printer port pin that may be used for other functions.

5.4 Power to the DigiSpeed-DC-03

The first step in the installation is to provide 5V power to the DigiSpeed DC-03 controller. Wire DigiSpeed DC-03 J1- GND pin to a logic ground terminal on your CNC controller breakout board. This logic ground is the same as the PC printer port 0V potential, found on pins 18 to 25 of your printer port.

Wire DigiSpeed DC-03 J1-+5V to a 5Vdc supply on your CNC controller's breakout board. This needs to be 5Vdc with respect to the PC printer port ground.

Turn on your CNC controller. This should provide the 5Vdc supply to the DigiSpeed DC-03. Verify this is the case, by checking that the Mode Indicator LED is flash a slow double flash. If not, turn off the CNC controller and check the wiring.

5.5 Connect the PWM and Relay Signals

Wire DigiSpeed-03 J1-**Sig** to pin 17 of the printer port via your CNC controller's breakout board.

If you plan to use the relays on the DigiSpeed-03 board then they will need to be wired to your breakout board. If you are not using them, they do not need to be connected.

Wire DigiSpeed-03 J1-**RL1** (Dir) to pin 1 of the printer port via your CNC controller's breakout board.

Wire DigiSpeed-03 J1-**RL2** (CW/CCW Enable) to pin 16 of the printer port via your CNC controller's breakout board.

If you have wired up the relay control signals you can now test that the signals are being received by the DigiSpeed-03. Set the spindle speed to zero typing it into the speed DRO, or entering the command 'S 0' into the MDI window .

Now enter a spindle speed of 1000 into the DRO and enable the spindle. You should now observe the DigiSpeed DC-03 Mode Indicator LED perform a continuous Red fast flash. This indicates that the DigiSpeed DC-03 is enabled and is generating an analog control voltage on the output.

Now using the MDI window, enter 'M3' (Enable spindle CW) . Relay 1 should stay off, and Relay 2 (enable) should turn on.

Now type in 'M4' (Enable Spindle CCW) , Relay 2 (Enable) should go off, then Relay 1 should turn on (CCW) and Relay 2 (Enable) should turn back on.

Now type in 'M5' (Spindle Stop), Relay 2 should turn off.

If the relays appear to work in reverse, it may be that the Logic direction jumper is incorrect. You can change the sense of the logic inputs, Step, Relay 1, and Relay 2 by changing the position of jumper JP2.

5.6 Conclusion

You should now have your DigiSpeed DC-03 operating correctly with Mach3. You are now ready to install the unit into your Motor Speed controller's enclosure, your CNC controller or a separate enclosure.

6 Installation

Before attempting the installation please read the entire manual. If you are unsure of anything, do not do the installation. Get help from someone who is qualified for this type of work. I am not responsible for damage or injury resulting from the installation or use of this device.

It is advisable to integrate the The DigiSpeed DC-03 with your control software before installing and connecting it to your Motor Controller. The unit is powered from a breakout board. Therefore it is possible to test and become familiar with it's operation prior to connecting it to a motor controller.

The board has indicator LEDs that provide status of what is occurring. These can be used to assist in the integration.

The DigiSpeed DC-03 may be mounted into an existing motor controller enclosure or external enclosures. The hardware installation is dependent on what you are installing the DigiSpeed DC-03 into. The physical installation is first covered in the section below, followed by the electrical installation.

6.1 DC Motor Speed Controller housing

If the DigiSpeed DC-03 is to be installed into an existing Motor speed controller housing, ensure that there is sufficient space to safely install the DigiSpeed DC-03.

Refer to the PCB layout and dimensions diagram in determining the positions of holes for mounting. The unit may be mounted using the 4 stand-offs provided.

6.2 Wiring installation

Once the DigiSpeed DC-03 controller is installed into a housing the following wiring is required.

6.2.1 Motor Controller Connection

The DigiSpeed DC-03 is connected to the motor controller via the three terminal pluggable connector J2.

- The terminal labeled **AV+** connects to the potentiometer positive voltage connector on the speed controller.
- The terminal labeled **Vout** connects to the potentiometer connector on the speed controller.
- The terminal labeled **AGnd** connects to the potentiometer control voltage on the speed controller.

These three connections plug into your speed controller in place of your existing manual speed potentiometer. Unless you are using a voltage isolation board these leads are at *****MAINS VOLTAGE POTENTIAL *****. They can cause serious injury or death. Do not connect any earthed test equipment to this terminal block as it is at mains potential.

6.2.2 Initial Testing

6.2.2.1 Attenuation Trimpot Speed Control.

To test the DigiSpeed DC-03 control manually via the attenuation trimpot VR1:

1. Turn off the Motor Speed controller and the CNC controller .
2. Set the DigiSpeed DC-03 mode to Attenuation Trimpot by inserting jumpers MS1 and MS2.
3. Turn the attenuation trimpot Anti-Clockwise eleven complete turns.
4. Power up the DigiSpeed DC-03 .
5. Turn on the Motor Speed controller. Ensure that there is 5Vdc power applied to the DigiSpeed DC-03. You can verify this by the Lazy Double Flash of the LED illuminated on the DigiSpeed DC-03.
6. Slowly turn the trimpot Clockwise until the required maximum spindle speed is reached.

6.2.2.2 Computer Speed Control.

To test the DigiSpeed DC-03 control from Mach3:

1. Turn off the Motor Speed controller and the CNC controller .
2. Set the DigiSpeed DC-03 mode to :PWM by inserting jumpers MS1 only.
3. Power up the DigiSpeed DC-03 .
4. Turn on the Motor Speed controller. Ensure that there is 5Vdc power applied to the DigiSpeed DC-03. You can verify this by the Lazy Double Flash of the LED illuminated on the DigiSpeed DC-03.

Run through the tests detailed in the Quick Start Guide section with the understanding that the spindle is not powered and operational.

7 Operation

7.1 Operation Modes

The DigiSpeed DC-03 has three operational modes, selected by jumpers MS1, MS2 in jumper block JP2. The selection of the modes is described below.

Mode	MS1	MS2
ANALOG	Removed	Don't Care
PWM	Installed	Removed
Attenuation Trimpot	Installed	Installed

Table 3: Mode Selection Jumpers

The selection of the mode is done at power up initialization.

Note: If the mode selection jumpers are modified after the unit is powered up, the new mode will not take effect until the power is cycled.

Each of the modes is discussed in detail below.

7.1.1 Analog Input Mode

In this mode the DigiSpeed DC-03 controller accepts an analog 0-5Vdc signal. 0Vdc represents 0%, varying to 5Vdc which represents 100% of maximum spindle speed.

This will provide 1023 speed increments from 0 to 100% of maximum spindle speed.

With the DigiSpeed DC-03 module supplied with power, and no analog signal is present, the LED will be a Red slow double flash. This indicates that the spindle is active but the speed is set to 0 %. Then, when an analog voltage signal is present, the LED will be a fast continuous flash, indicating that the spindle is active and the speed is set to a value greater than 0 %.

7.1.2 PWM Input Mode

In this mode the DigiSpeed DC-03 controller accepts an “**Active Low**” Pulse Width Modulation signal. The duty cycle of this signal represents 0 to 100% of maximum spindle speed.

The PWM signal period can be in the range of 2Hz to 50Hz. The optimum period is 50Hz. This will provide 1023 speed increments from 0 to 100% of maximum spindle speed.

With +5V is supplied to the DigiSpeed DC-03 module, and no PWM signal is present, the LED will be a Red slow double flash. This indicates that the spindle is active but the speed is set to 0 %. Then, when a PWM signal is present, the LED will be a fast continuous flash, indicating that the spindle is active and the speed is set to a value greater than 0 %.

7.1.3 Attenuation Trimpot

In this mode the DigiSpeed DC-03 controller uses the attenuation trimpot to generate the output voltage. It assumes there is a fullscale analog voltage input and then attenuates it to produce 0% to 100% of the output voltage.

With +5V is supplied to the DigiSpeed DC-03 module, the LED will be a slow double flash when the trimpot is set to maximum attenuation by turning the screw fully counter-clockwise..

When the attenuation is not set at maximum, the LED will flash at a fast rate, with the output voltage generated as a percentage of the full scale voltage.

8 Board Dimensions

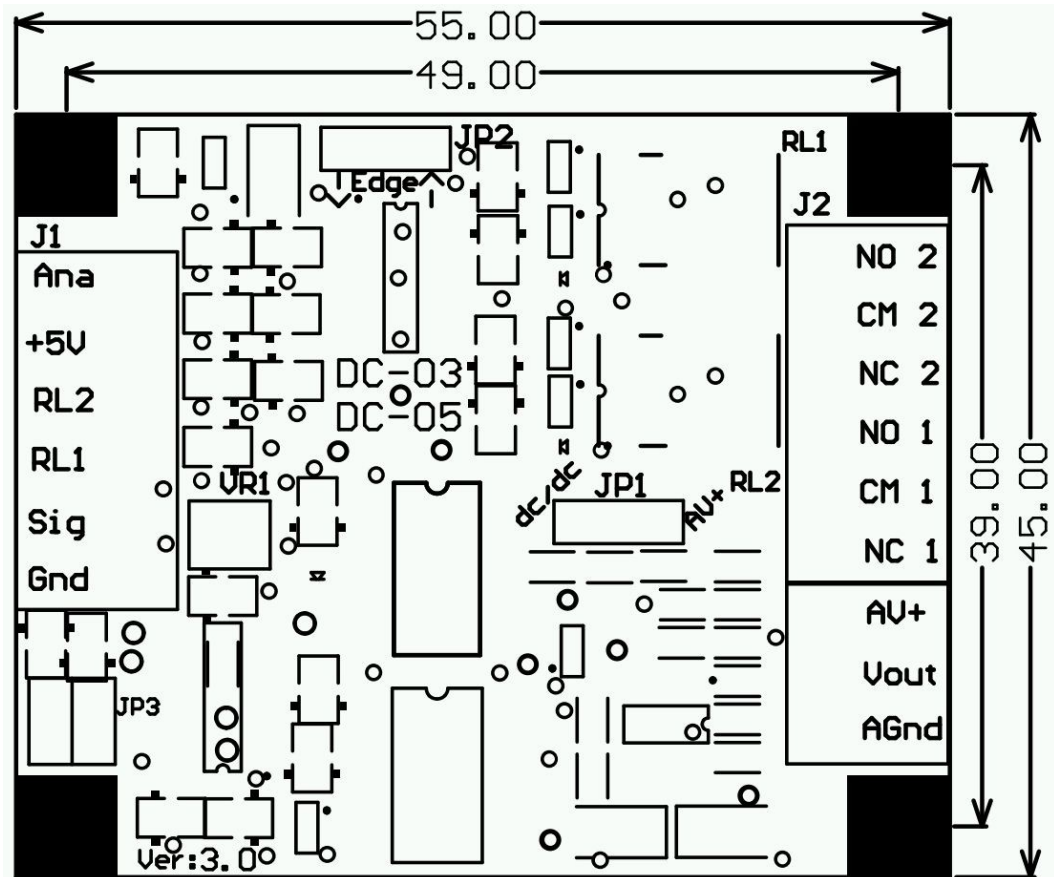


Illustration 5: PCB Dimensions and Layout