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DigiSpeed-SD™ DC-06

Isolated Control Voltage Generator

User's Guide

DigiSpeed-SD™ PCB Ver:3.0
Mach3 Ver: 2.+

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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-SD™ *Isolated Voltage interface unit*. The DigiSpeed-SD™ 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-SD™*. The document contains information on how to use and integrate the board into your own systems.

1.1 Contents

The package received when ordering the DigiSpeed-SD™ contains the following:

- DigiSpeed-SD™ isolated voltage interface unit.
- 2 x 0.1" jumpers.
- 4 x 4mm plastic PCB stand-offs.

1.2 Overview

The DigiSpeed-SD™ Isolated Voltage Interface Unit is designed to allow devices such as the SmoothStepper motion controller and computer CNC programs such as Mach3, to control devices that require an isolated DC control voltage.

DigiSpeed-SD™ 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-SD™ will work with other types of DC motor controllers such as those found in the Asian imported mini lathes and Mills.

The DigiSpeed-SD™ 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-SD™ 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-SD™ is a versatile unit. The board is designed to be installed into existing motor speed controller housings, external CNC housings or other enclosures.

2.1 *Isolated DC-DC Converter.*

Depending on the installation, the device being controlled by the DigiSpeed-SD™ may not be able to provide the 10Vdc supply required by the isolated analog circuitry. In such situations, an optional On-board 5Vdc - 12/15Vdc isolated DC-DC converter may be used to provide the required supply.

3 Features

The main features of the DigiSpeed-SD™ controller are;

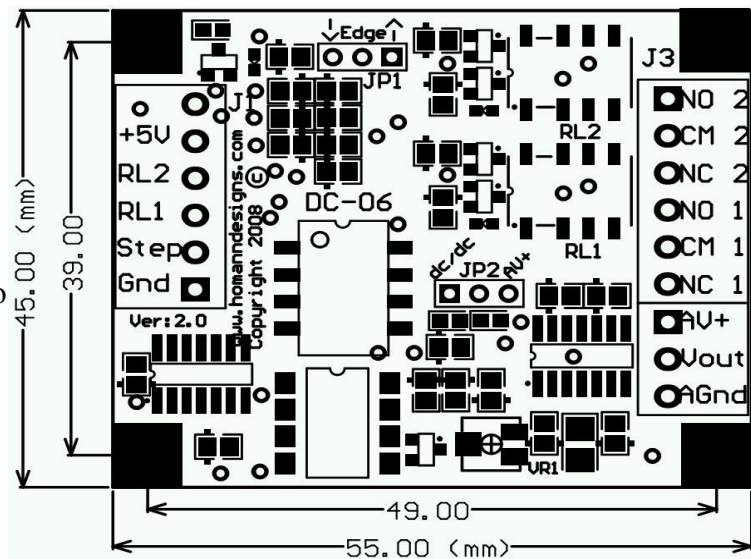
- Controlled by a RISC Microchip micro-controller.
- PCB
 - FR4 Material
 - Double Sided, Plated through holes
 - Silk-Screened on Component Side
 - Solder Mask on Both Sides
- Small PCB footprint 5.5cm(L) x 4.5cm(W)
- Four 4mm mounting holes (supplied with matching stand-offs)
- Single 5V dc power requirements.
- Reverse polarity protection on 5V supply.
- 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
- Step/dir control signal. (0KHz – 25KHz)
- Active high/active low inputs are Jumper selectable
- Output Control Voltage Attenuator.
- 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-SD™ controller provides the capability to control a device such as the the spindle speed of a DC or AC motor via computer control

May of the devices that the DigiSpeed-SD™ 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-SD™ 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-SD™ 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-SD™ 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-SD™ circuit and your PC will occur.

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



The DigiSpeed-SD™ 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.

4.2 Input Signal Polarity Jumper JP1

The DigiSpeed-SD™ has a jumper JP1 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 Output Voltage Selection JP2

Note: This jumper is only fitted when the optional DC-DC isolated voltage generator is fitted.

The DigiSpeed-SD™ controller contains an Output voltage selection jumper, JP2. 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.

5 Quick Start Guide

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

The DigiSpeed-SD™ circuitry is essentially in two parts. One part contains low voltage logic level circuitry that includes the relay driver circuitry 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-SD™ 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 logic side of the DigiSpeed-SD™ controller.

5.1 What you need

To get started, you need:

- DigiSpeed-SD™ controller.
- Breakout board or other mechanism for connecting the DigiSpeed-SD™ 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-SD™ unit sitting on the bench and NOT connected to your Motor controller. Mach3 controls the DigiSpeed-SD™ in Step/Dir mode only.

5.2 Mach3 Configuration Setup

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

For this example, printer port 2 is being used with the port pins connected as shown in Table 1 below.

Notes:

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

<i>Signal</i>	<i>Printer Port Pin Number</i>	<i>PC Input/ Output</i>	<i>DigiSpeed-DC-06 J1 Pins</i>
PC Parallel Port GND (0V)	18-25	-	GND
Spindle Step	17	Out	Step
Relay 1 (Spindle Dir)	1	Out	Relay 1
Relay 2 (CW/CCW Enable)	16	Out	Relay 2
5Vdc with respect to Pin 1	-	-	+5V

Table 1: DigiSpeed-SD™ - Breakout board Connections

5.2.1 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-SD™ Setup.

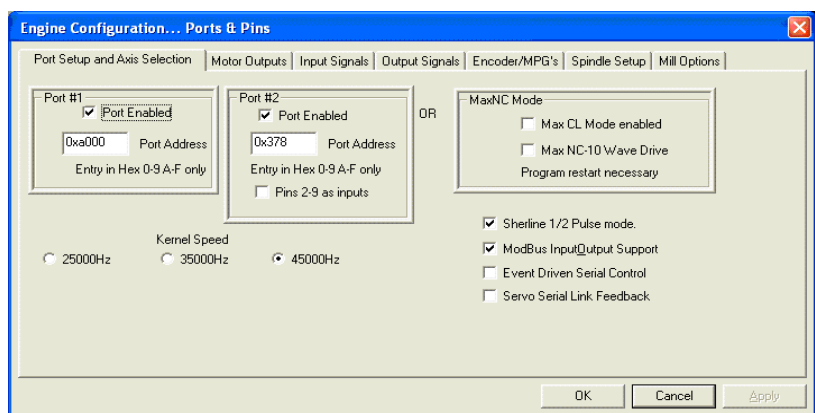


Illustration 1: Mach3 Port Setup

5.2.2 Spindle Setup Tab

The Spindle setup tab is used to configure various options regarding the Spindle operation.

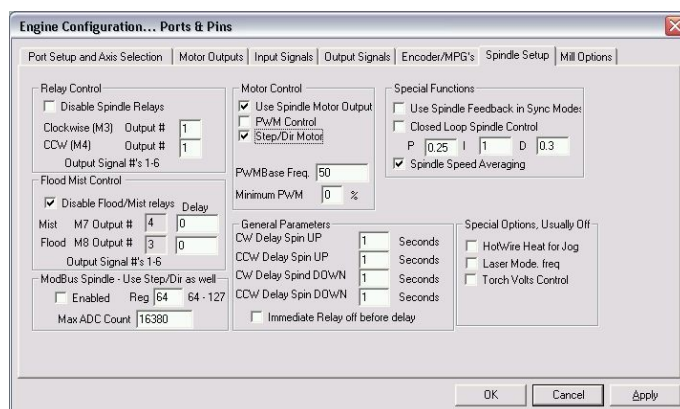


Illustration 2: Spindle Ports and Pins Setup

As shown in Illustration 2 above, 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 'Step/Dir Motor' check box is ticked.
- Pulley ratios – The maximum spindle speeds for the pulley ratios you have are set up to allow Mach3 to calculate the required spindle step frequency

5.2.3 Motor Ports and Pins Setup

Select the *Motor Outputs* tab and enable the *Spindle* Axis. Set the Port and Pin numbers that will be used for the DigiSpeed-SD™ Step and Dir lines. As can be seen in Illustration 3 below, The Step signal pin has been set to 17, 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.

Active Low signals are not selected for both of these pins, as the DigiSpeed-SD™ is configured via JP1 to operate with Active Hi Logic. It is possible to use JP1 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.

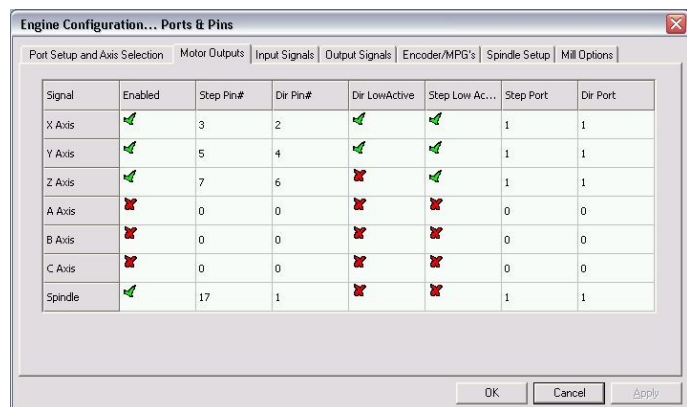


Illustration 3: Motor Outputs Setup Tab

5.2.4 Spindle Motor Tuning Setup

Select the *Config->Motor Tuning* tab and select the *Spindle* Axis. Set the Steps per unit to 20,000. Set the Velocity to its maximum value, and the acceleration to a value that is compatible with your controller and motor.

Illustration 4 above Depicts such a setup. Also, you may need to adjust the Step Pulse value if you find the voltage output is not sufficient. It

should be noted that the velocity may be adjusted to change the maximum output voltage. There is also an attenuation potentiometer on the board that can be used for fine adjustment of the output voltage.

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

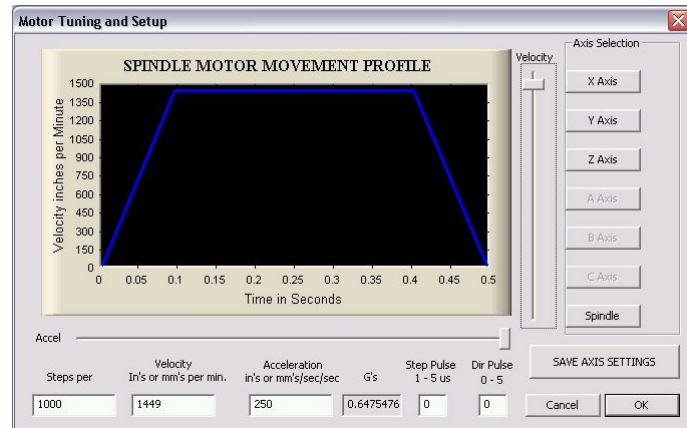


Illustration 4: Spindle Motor Tuning

5.3 Power to the DigiSpeed-SD

The first step in the installation is to provide 5V power to the DigiSpeed-SD™ controller. Wire DigiSpeed-SD™ 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-SD™ 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-SD™. Verify this is the case, by checking that the power Indicator LED is lit. If not, turn off the CNC controller and check the wiring.

5.4 Connect the Step and Relay Signals

Wire DigiSpeed-SD™ J1-Step to pin 17 of the printer port via your CNC controller's breakout board.

If you plan to use the relays on the DigiSpeed-SD™ 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-SD™ J1-Relay 1 to pin 1 of the printer port via your CNC controller's

breakout board.

Wire DigiSpeed-SD™ J1-Relay 2 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-SD™. Set the spindle speed to a non-zero value by typing it into the speed DRO, or entering the command 'S 1000' into the MDI window .

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 JP1.

5.5 Conclusion

You should now have your DigiSpeed-SD™ 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 and Set to Work

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.

The DigiSpeed-SD™ may be mounted into an existing motor controller enclosure or external enclosures. The hardware installation is dependent on what you are installing the DigiSpeed-SD™ 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-SD™ is to be installed into an existing Motor speed controller housing, ensure that there is sufficient space to safely install the DigiSpeed-SD™.

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-SD™ controller is installed into a housing the following wiring is required.

6.2.1 Motor Controller Connection

The DigiSpeed-SD™ 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. *(If you are using the on-board DC/DC converter, then this connection is not necessary)*
- 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 Digital 5V Power Supply.

The DigiSpeed-SD™ circuitry connected to your breakout board requires a 5V supply referenced to you breakout board's Gnd (0V)

To test the DigiSpeed-SD™ 5V Digital supply:

1. Turn on the CNC controller powering up the DigiSpeed-SD™ .
2. Ensure that there is 5Vdc power applied to the DigiSpeed-SD™. You can verify this by the power LED that should be illuminated on the DigiSpeed-SD™.

6.2.2.2 Isolated Analog Power Supply.

The first test is to ensure that the isolated analog circuitry of the DigiSpeed-SD™ is being supplied with the correct and sufficient voltage. This voltage may come from the optional DC/DC converter or from the DC motor controller itself.

If using the DC/DC converter, there is no need to power up your Motor controller. Check that jumper JP2 is in the “dc/dc” position.

If you do not have the converter installed or if you wish to use the motor controllers supply, ensure that jumper JP2 is in the “AV+” position.

The leads connected to the motor speed controller may be 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.

To test the AV+ power supply use a voltmeter and measure the voltage between the J2 terminals labeled “Agnd” and “AV+”. This voltage needs to be greater or equal to the maximum control voltage required by your speed controller (usually 10V).

When using the DigiSpeed-SD™ in place of a manual speed potentiometer, there is the possibility that the Speed controller cannot supply sufficient current for the DigiSpeed-SD™, resulting in the AV+ voltage supply drooping or collapsing. In this situation the optional dc/dc converter is required.

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

6.3 Output Voltage Attenuator VR1

The output voltage attenuator VR1 is used to trim the output voltage. If your board has the on-board DC/DC converter, it has the potential to produce an output voltage of up to 15Vdc. The output voltage generated is dependent on the step frequency, the step pulse width and the parameters in the spindle tuning setup tab.

To set the trimpot to the correct position follow the following steps, noting that if you have the optional DC/DC converter installed, you do not need to power on the DC motor controller to do the following adjustment;

1. Turn the trimpot fully Counter Clockwise (Minimum voltage output)
2. Using Mach3, set the spindle speed to the maximum value for the selected pulley.
3. Using Mach3, enable the spindle.
4. While measuring the voltage between AOut and AGnd, slowly turn the trimpot VR1 clockwise until the voltage reached the required maximum control voltage for your motor speed controller.

7 Operation

7.1 Step/Dir Input

The DigiSpeed-SD™ controller accepts a frequency step signal similar to a stepper motor. The frequency of this signal represents 0 to 100% of maximum spindle speed.

The signal frequency can be in the range of 0KHz to 25KHz. This will provide speed increments from 0 to 100% of maximum spindle speed, dependant on the frequency.

8 Board Dimensions

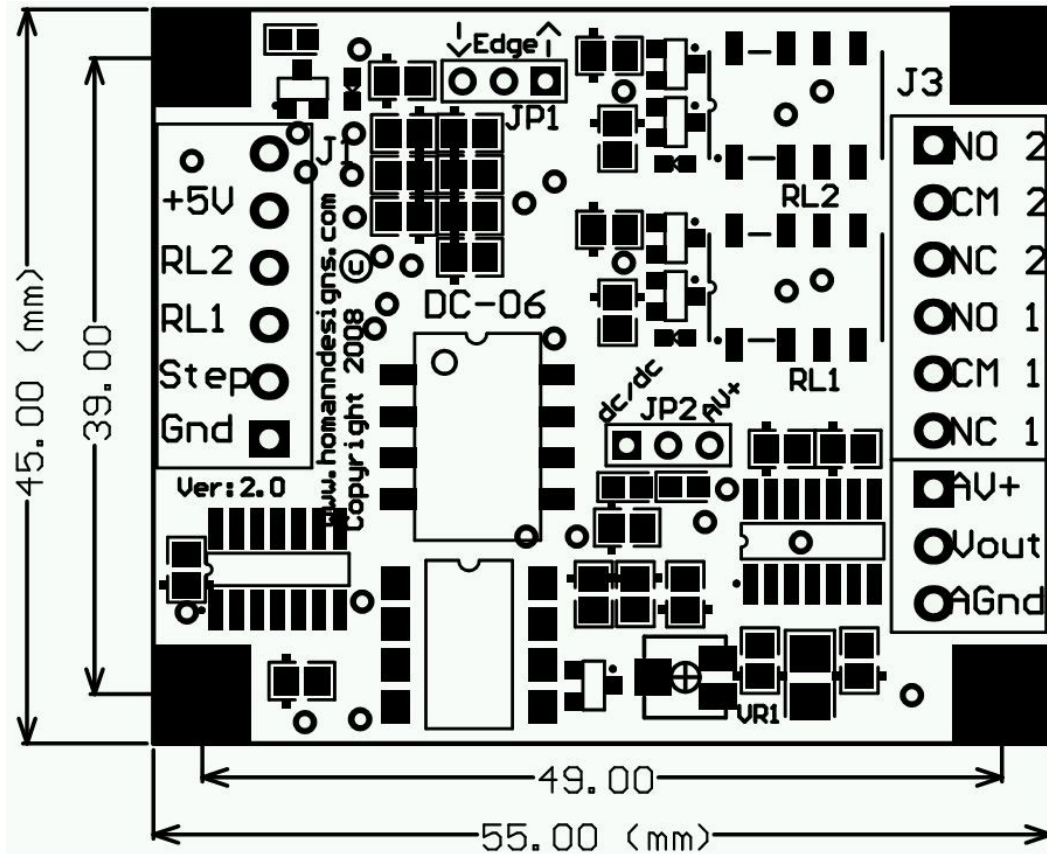


Illustration 5: PCB Dimensions and Layout