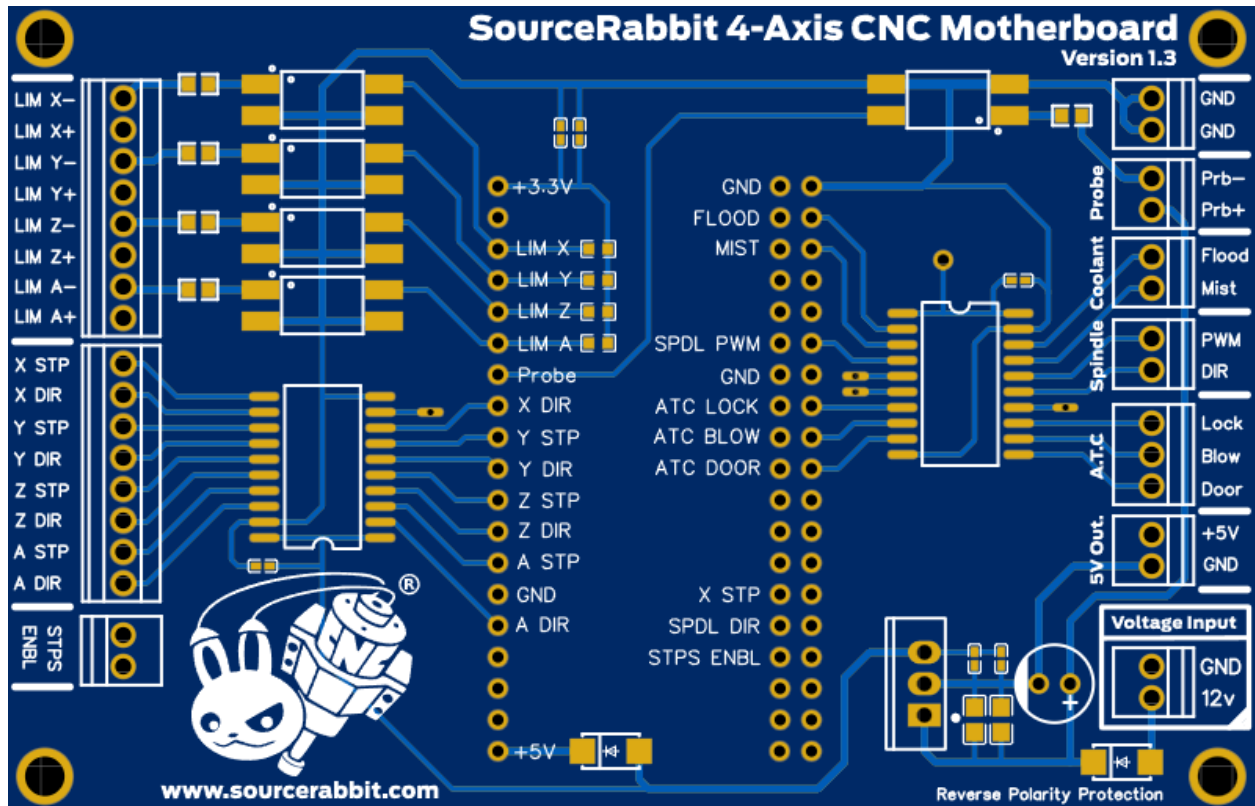


4-Axis CNC Motherboard v1.3

User Manual



Printed Circuit Board for ESP32 DevKitC Microcontroller Hosting

Made in Greece

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Disclaimer

Read and understand the contents of this user manual. Failure to read the manual may result in injury, degraded results or damage to the 4-Axis CNC Motherboard. Always ensure that anyone using the 4-Axis CNC Motherboard knows and understands the contents of the manual.

The conditions or methods used for the assembling, handling, storing, using or disposing of the 4-Axis CNC Motherboard are beyond our control and may be beyond our knowledge. For these and other reasons, we do not take any responsibility and expressly disclaim liability for any losses, injuries, damages or costs arising from or in any way related to the assembly, handling, storage, use or disposal of the product. The information in this document was obtained from sources we believe to be reliable. However, the information is provided without any warranty, express or implied, as to the correctness.

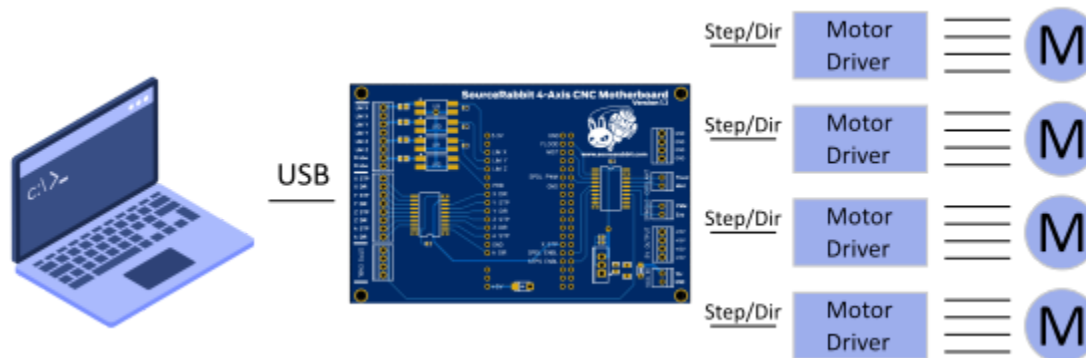
GRBL software is provided to you as is, without warranty. There is no warranty for open source GRBL software. The entire risk for the quality and performance of GRBL is on you.

Intended Purpose

4-Axis CNC Motherboard is designed and manufactured to control Stepper Motors, Servo Motors, Spindles, Mist Pumps and Coolant Pumps of CNC machine tools, through special control software running on PC which is compatible with the GRBL firmware.

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General



The 4-Axis CNC Motherboard is a "small computer" that connects a personal computer with **stepper and servo drivers** operating with **Step/Direction** pulses. It is compatible with all motor controllers on the market, can produce **120,000 pulses per second** and is intended for controlling 3 or 4 Axis CNC machine tools such as Router, Mills, Plasma and Lasers cutters.

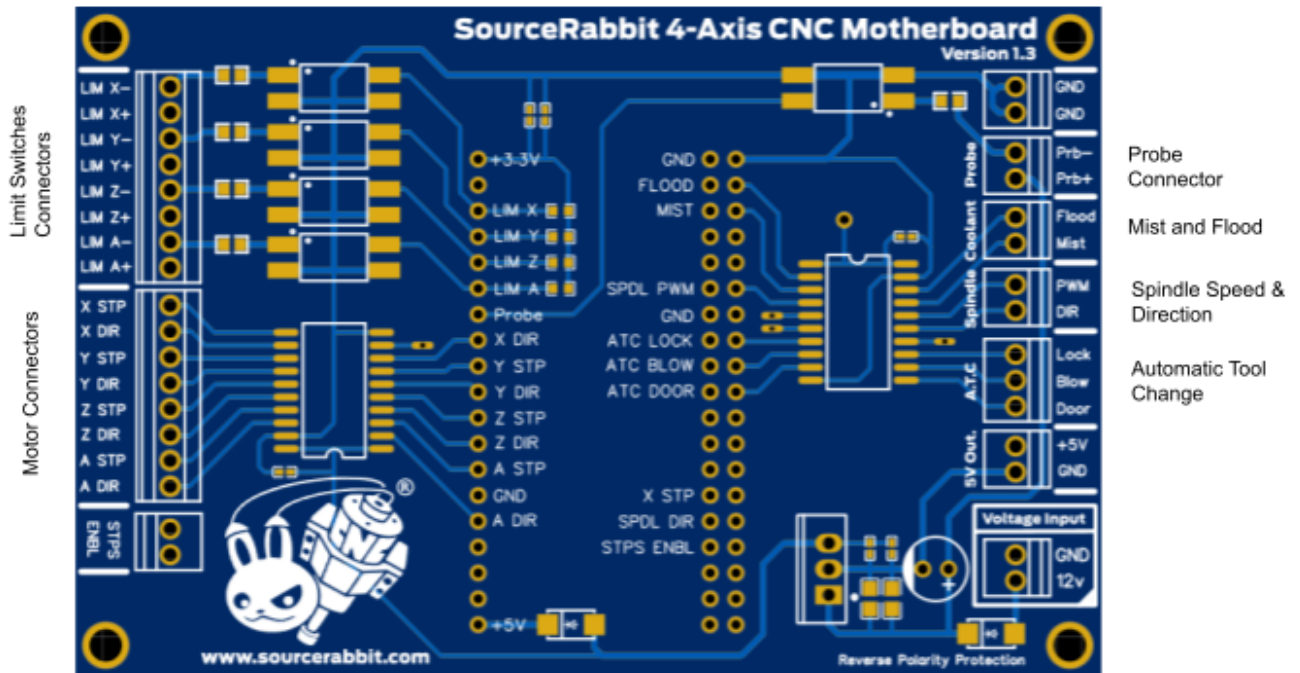
The 4-Axis CNC Motherboard hosts an ESP32-DevKitC-32 microcontroller manufactured by Espressif Systems which is always loaded with the latest 32-bit version of the GRBL firmware. The ESP32-DevKitC-32 microcontroller has a dual core 240mhz, 520Kb ram processor and connects to the USB port of a modern personal computer (PC). The ESP32-DevKitC-32D microcontroller also features bluetooth and WiFi but you need to change the Firmware to enable it. **We recommend that you leave the GRBL firmware as is and use the USB port to communicate with the board from your computer as it is the safest means of communication between PCs and CNC machine tools.**

Features & Specifications

| | |
|---------------------|--|
| Motor Outputs | Up to 4 Stepper or Servo motors |
| Max. Step Frequency | 120khz |
| Limit Switches | 4 opto-isolated limit switch inputs (12VDC) |
| Tool Setter / Probe | Opto-isolated tool setter input (12VDC) |
| Spindle Control | PWM output for Spindle control up to 10Khz (5VDC) |
| Coolant | Mist and Flood coolant outputs (5V DC) |
| MCU | ESP32-WROOM-32 with Dual Core Xtensa 32bit CPU @ 240MHz and 520Kb SRAM |
| Firmware | RabbitGRBL |
| Connectivity | USB |
| Voltage Input | 12V |
| Power Input | 0.75Watt |
| Ambient Temperature | 15°C - 50 °C (59°F - 122°F) |
| Size (W x D x H) | 101.5mm x 66mm x 25mm |
| Net Weight | 50gr |

At a glance

In the image below you can see the top view of the 4-Axis CNC Motherboard. In the rest of the pages of this user manual you will see how to connect to the necessary electronic components to complete your controller.



Basic Wiring

In the following drawings we explain how to connect the necessary components to complete the controller of your machine tool with the 4-Axis CNC Motherboard. If you are not familiar with the connection of electronic and electrical components, **seek the help of a professional electronics or electrician.**

CAUTION: Always use high quality power supplies that meet all CE regulations and have protection against short circuit, overload, overvoltage and overheating.

CAUTION: For your own safety do not make connections or other tasks to the controller if it is connected to the mains. **Always unplug the power supply before carrying out any work and wear protective goggles** approved in accordance with EN 166 and Ansi Z87 +.

CAUTION: For your own safety you should **ensure that your construction has a single grounding point**, i.e. a point where all the GND and EARTH groundings of the electronic and electrical components will connect together. **This point must end at EARTH ground.** This point is usually the "chassis" of the control box, i.e. the body of the metal box that contains the electronic parts of the controller.

Tip: The 4-Axis CNC Motherboard has a Micro USB port. We recommend using a **Panel Mount USB Cable from B Female to Micro-B Male**. With this you will be able to use high quality USB cables from A to B with electromagnetic shielding and ferrite at the ends. In the photo below you will see a Panel Mount USB Cable - B Female to Micro-B Male



1. Electromagnetic Shielded Box

Although many users, for the hosting of their controller, use plastic boxes of electrical installations and in many cases do not cover their controllers at all, **we recommend that you use an electromagnetically shielded box to be sure of the performance of all your electronic components..**

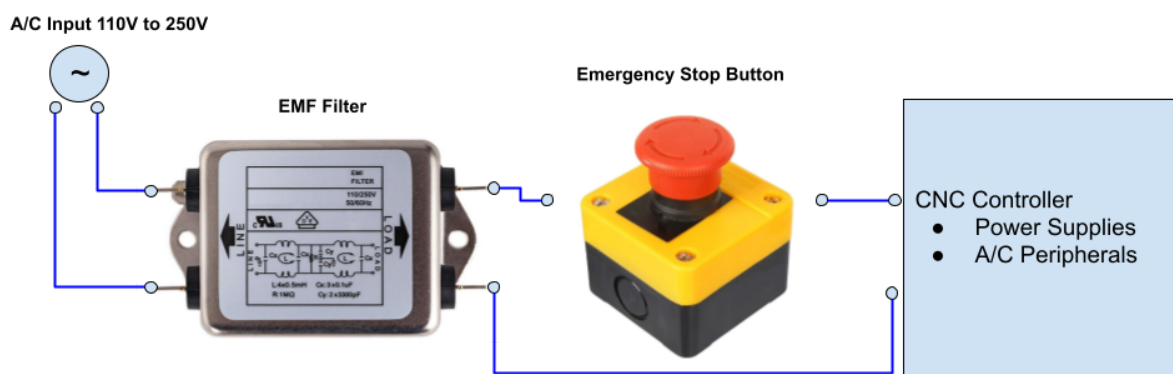
The 4-Axis CNC Motherboard as well as all other components such as Stepper or Servo Drivers, and power supplies **should be placed in an electromagnetically shielded box**, i.e. a **metal box whose body is connected to ground (Earth)**.

The electromagnetically shielded box prevents electromagnetic noise from entering inside your controller. The most common problems from electromagnetic noise arise from **Fluorescent Lamps, transformers of other devices, Plasma Cutters, Inverters and Spindles**.

2. EMF filter and Emergency Stop Button

We recommend you install an **EMF filter at the A/C input of your controller** just before the Emergency Stop Button. The EMF filter will dramatically reduce the "dirty" current in the electricity grid. Dirty electricity is present in the power cords outside your Controller when they contain frequencies other than the standard 60Hz frequency. These "bad" frequencies are generated by devices such as motors, welding machines, inverters and even transformers made of fluorescent lamps.

In the figure below you will see a typical EMF filter installation and Emergency Stop Button

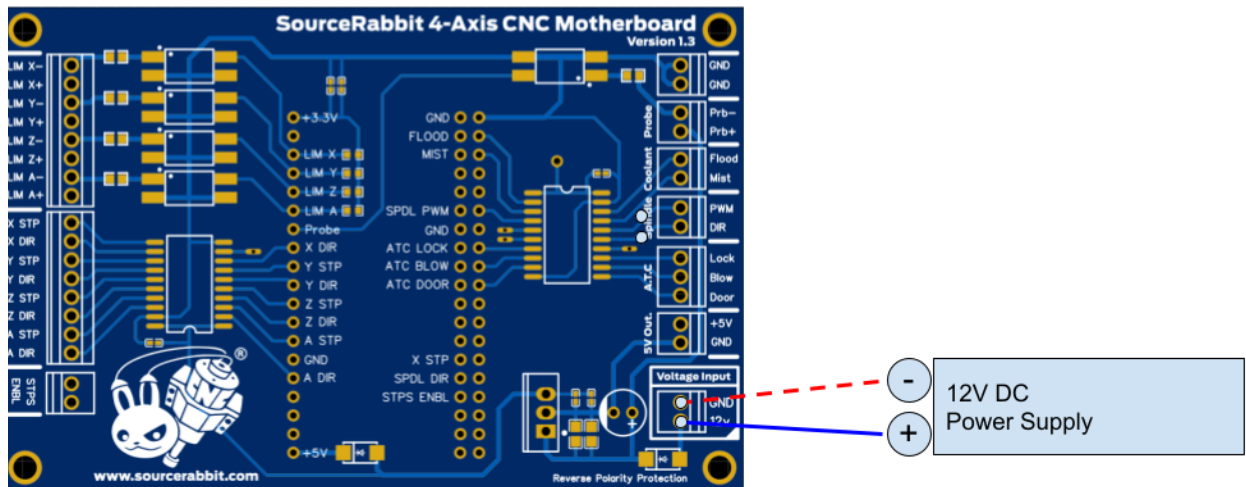


3. Connection to 12V Power Supply

In order for the 4-Axis CNC Motherboard to operate, **a stabilized 12V DC power supply**, of at least 2A, must be connected to the VCC IN input, which must be properly grounded. See the drawing below.

Tip: Always check if the power supply is properly grounded to the Earth with a multimeter before installation..

Tip: Always ensure good ventilation in the power supplies.

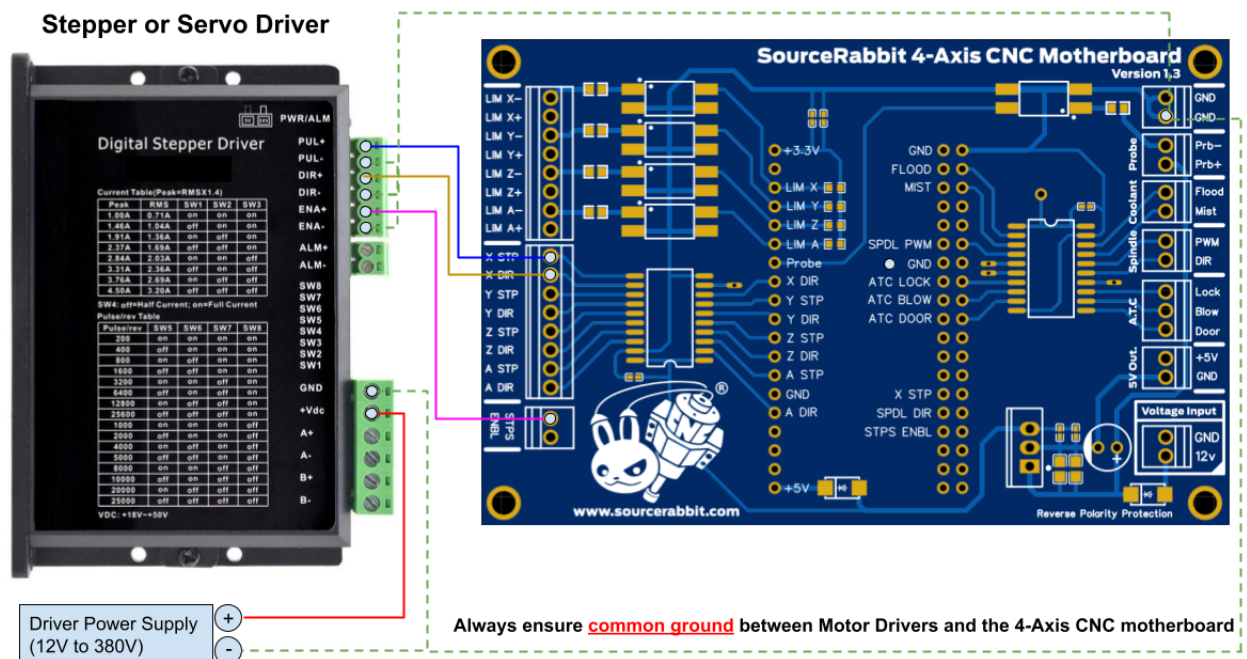


4. Connecting Motor Controllers (Stepper Driver or Servo Driver)

The drawing below explains the connection of a Stepper Driver that uses **STEP (PUL)** and **DIR** ports with the **X-axis** output of the 4-Axis CNC Motherboard. The connection for the other axes (Y, Z & A) is made in exactly the same way.

CAUTION: The motor controller (Stepper Driver) must have **Common Ground** with the 4-Axis CNC Motherboard. This is achieved simply by connecting the **GND** of the power supply to the **GND** of the 4-Axis CNC Motherboard. If the motor controller operates on A/C power then you should refer to the motor controller operating instructions to see how to connect.

Tip: To ensure maximum performance and isolation of electromagnetic noise, it is advisable to use **Twisted Pair Wire** for **STP** and **DIR** connection.



5. Connecting Terminal Switches and Probe / Tool Setter

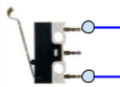
The 4-Axis CNC motherboard has 3 **limit switches sockets** and one socket for **Probe or Tool Setter**. All four sockets supply 12VDC voltage and are isolated with Optocouplers, which ensure isolation of the circuit from electromagnetic noise. In the following drawing you will see the **connection of a terminal switch to the LimX output**, i.e. the connection of a terminal switch for the X axis of the CNC machine tool. The connection for the other axes (Y, Z & A) is made in exactly the same way.

CAUTION: The switches and the Probe / Tool Setter must be in **NC (Normally Closed)** state. In normally closed switches, the contacts that connect the switch are closed, which means that when they are not compressed the circuit is closed.

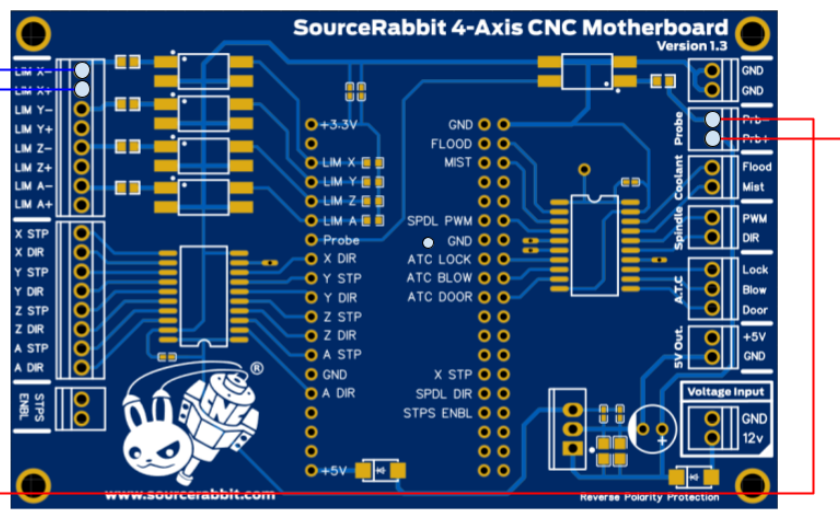
Tip: To ensure maximum performance and isolation of external electromagnetic noise, it is advisable to use **Twisted Pair Wire** or even better **LIYCY signal cables** to connect the terminal switches and the Probe. This ensures maximum accuracy during the Homing Cycle.

Tip: In case you use Coolant Fluids, water or other liquids, we recommend using waterproof terminal switches with IP67 waterproofing index.

**Normally Closed (NC)
Limit Switch**



**Normally Closed (NC)
Tool Setter or Touch
Probe**

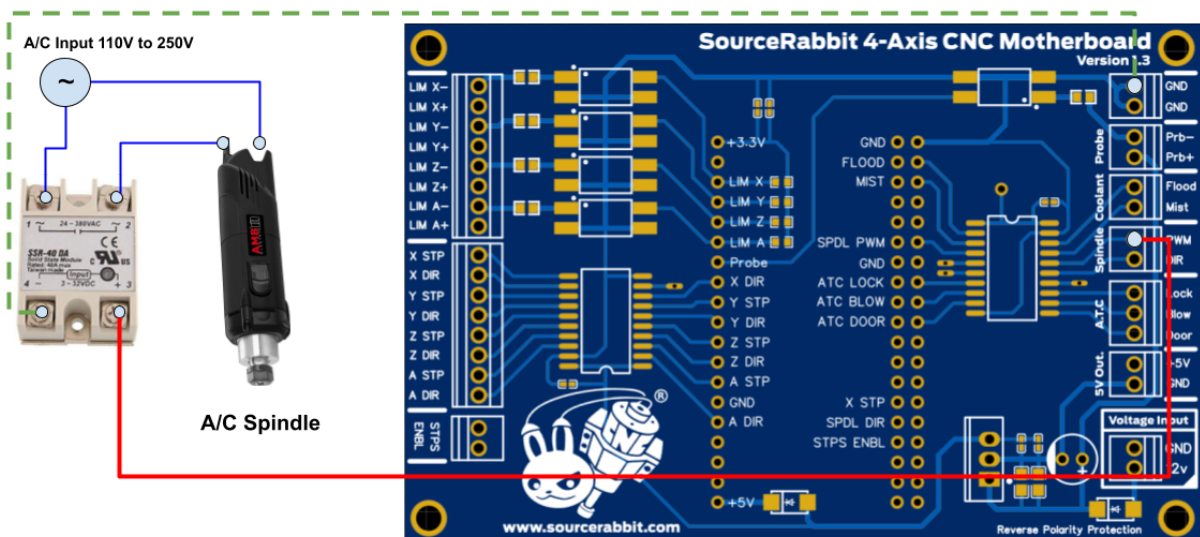


6. Simple Spindle Connection without Speed Control

In the following drawing we explain the connection of a high speed and precision spindle, made by AMB Elektrik, without speed control, using a **Solid State Relay**.

CAUTION: The wiring is typical and may not fit all spindles. In any case you should see the spindle manufacturer's instructions on how to make the correct connection.

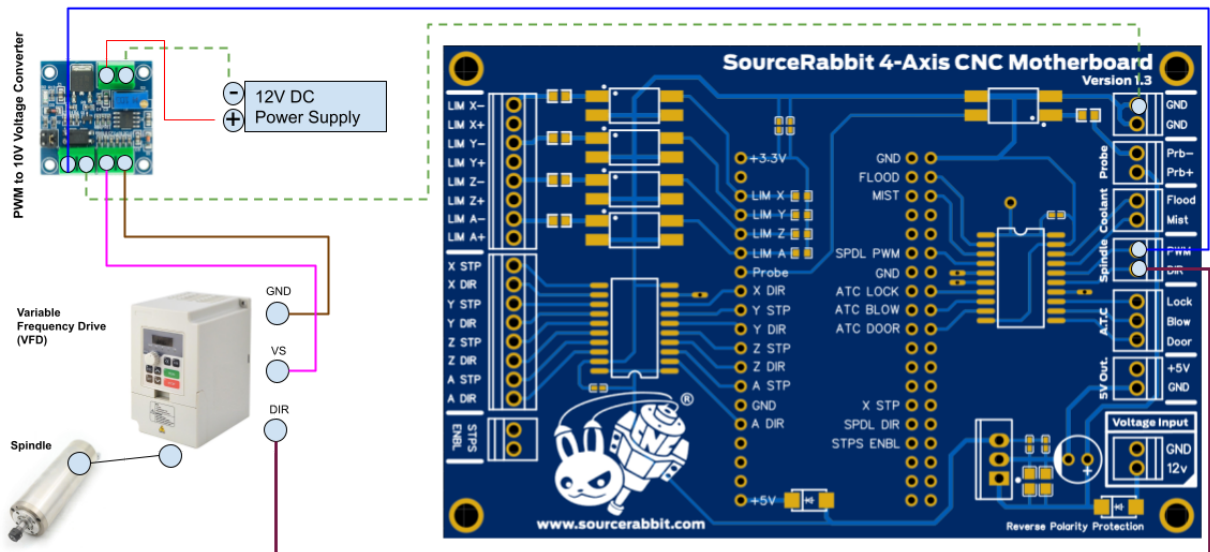
CAUTION: Many low-quality spindles, such as the cheap wood-routers used by the hobby community, produce large amounts of electromagnetic pulses that can damage your health as well as shorten the life of your electronics. **Always make sure to use high quality CE certified spindles that comply with European Community Electromagnetic Compatibility Directives.**



7. Connection for Spindle with VFD (Variable Frequency Drive) Speed Control

In the following drawing you see how to connect the 4-Axis CNC Motherboard to a VFD (Variable Frequency Drive) which receives voltage signals 0V to 10V for speed adjustment. To convert the **PWM signal to 0V to 10V** you have to use a **PWM to Voltage Converter Module 0% -100% to 0-10V**. There are VFDs that do not need to convert PWM to 0V to 10V. In this case the PWM output of the 4-Axis CNC Motherboard is connected directly to the VFD. In either case you should see the VFD manufacturer's instructions on how to make the correct connection.

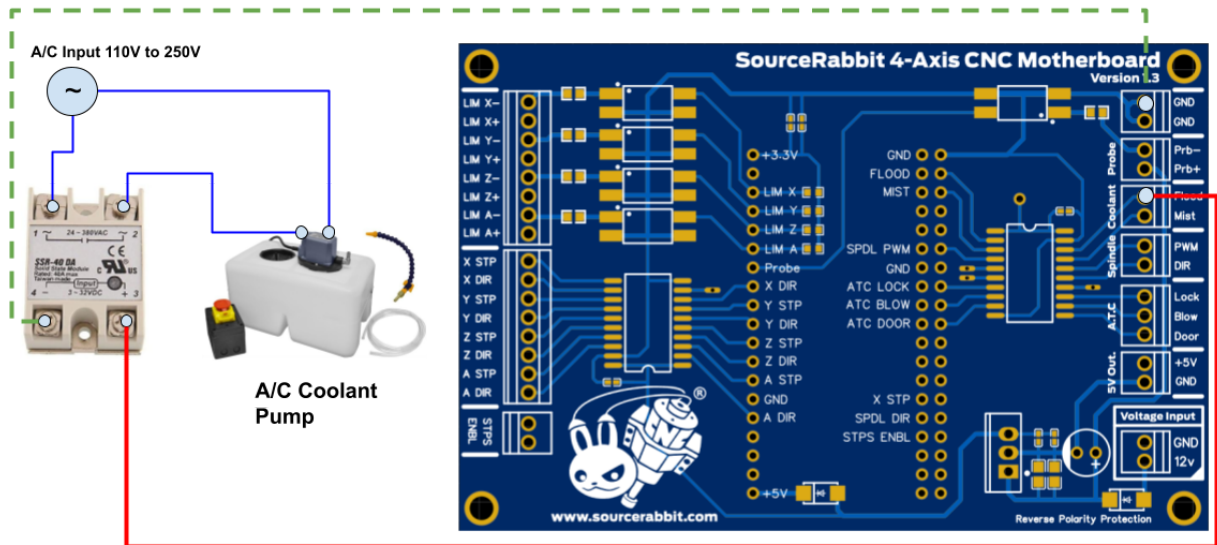
CAUTION: The wiring is typical and may not match all VFDs (Variable Frequency Drives). In either case you should see the VFD manufacturer's instructions on how to make the correct connection.



8. Flood Coolant Pump Connection

In the following drawing you see a typical coolant pump connection using a **Solid State Relay**. The connection for the Mist Coolant system to the Mist pin of the 4-Axis CNC Motherboard is done in exactly the same way.

CAUTION: Always use coolant pumps that meet CE standards



Help & Support

There are some potential problems that you may encounter when using the 4-Axis CNC Motherboard. If you are presented with any of these, you can easily deal with it with the help you will find below.

- **The PC does not "see" the 4-Axis CNC Motherboard**

This problem often occurs in older versions of Microsoft Windows and is due to the lack of Hardware Drivers for USB to UART Bridge used by the 4-Axis CNC Motherboard. In this case you should contact us to direct you or install the Drivers for you on your PC.

- **USB connection drops during operation**

The most common problem faced by CNC machine tool operators is the disconnection of the controller from the PC during operation. This problem is usually caused by **external electromagnetic noises**.

Solutions to the problem:

- Always use a **USB cable with electromagnetic shielding**, no longer than 1.8m and which has ferrite at both ends
- Install an EMF filter at the input of your controller
- Install an EMF filter at the input of the Spindle current (if any)
- Install an EMF filter at the VFD power input (if any)
- Install an EMF filter at the Plasma Cutter power input (if any)
- Install an EMF filter at the input of the power supply of the laser source (if any)
- Install an EMF filter at the inlet of the coolant pump (if any)

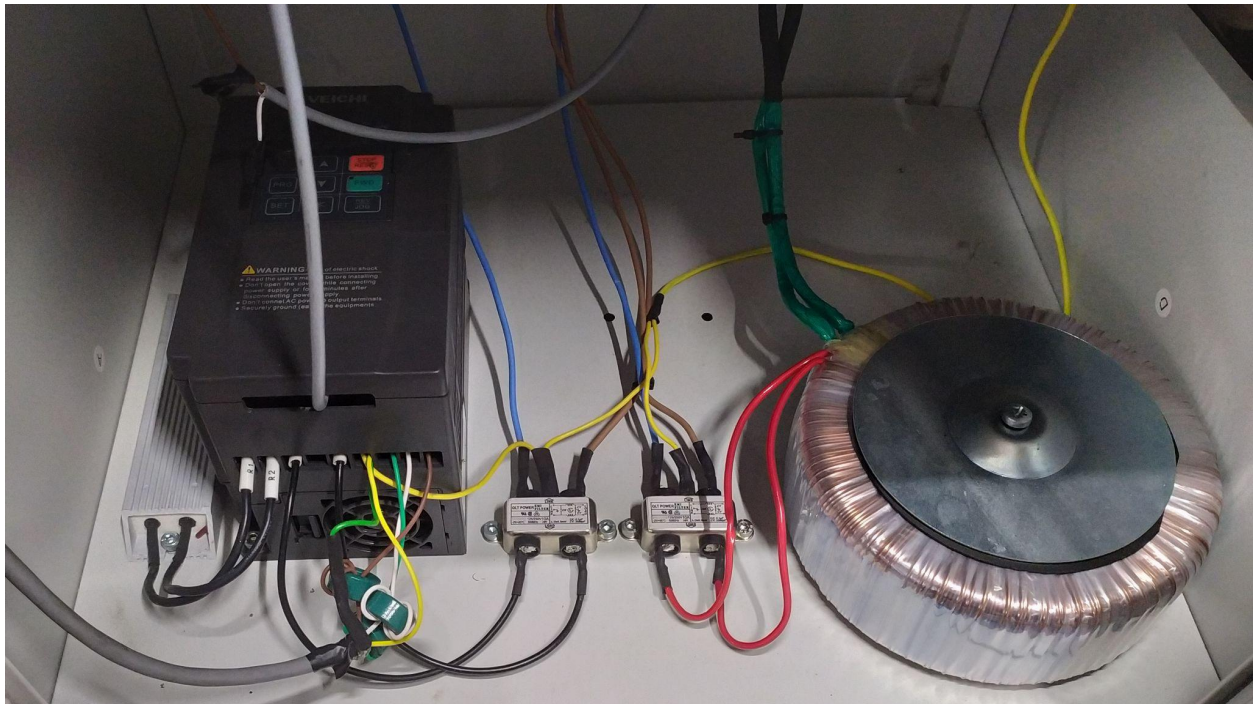
Tip: If you use a laptop to operate your machine tool then you should know that economical Laptops do not have good electromagnetic shielding. Laptop manufacturers, in their attempt to make laptops light and user-friendly, use only plastic to create the computer case. **The plastic offers no electromagnetic shielding.** We recommend that you use a desktop computer to control your machine tool. **The electronics of desktop computers are housed in a metal box (tower) that provides quite satisfactory electromagnetic shielding.**

Tip: If you are using VFD (Variable Frequency Drive) to control motors such as the spindle motor, then the spindle motor with the VFD should be connected with a cable that has electromagnetic shielding and ferrites..

Tip: Keep devices such as Plasma Cutters and VFDs (Variable Frequency Drives) as far away as possible from the 4-Axis CNC Motherboard and the other electronic

components of the controller. **Cheap devices of this type do not have good electromagnetic shielding as their housing is made of plastic**, while in most cases their manufacturers do not integrate an EMF filter. These devices emit large amounts of electromagnetic noise that affects USB devices and can cause problems even on PC hard drives.

In the photo below you will see a typical **VFD** installation (left) for the spindle speed adjustment and a **toroidal type transformer** (right) for the power supply of stepper motors. As you will see, there is a **separate EMF filter** for the VFD and the transformer, while the cable that connects the VFD to the spindle is shielded and has ferrites.



Security & Compliance

- **Electromagnetic Compatibility (EMC)**

The 4-Axis CNC motherboard can cause and receive electromagnetic interference, so the user may need to take appropriate action. In very rare cases the 4-Axis CNC Motherboard may lose its USB connection due to electrostatic discharge (ESD). The USB connection can be fully restored after restarting the PC.

- **Electrical safety**

The 4-Axis CNC Motherboard operates on 12V DC. Therefore the 4-Axis CNC Motherboard is in the scope of the low-voltage directive.

- **General safety information**

The 4-Axis CNC motherboard is not intended for use by persons (including children) with reduced physical and / or mental abilities or lack of experience and knowledge, unless under the supervision or guidance of a person responsible for their safety.

Children must be under constant supervision when using the machine tool.

The above information is believed to be correct, but is not intended to cover all cases and will only be used as a guide.

The conditions or methods used for assembling, handling, storage, use or disposal of the device are beyond our control and may be beyond our knowledge. For this and other reasons, we do not assume responsibility and expressly disclaim liability for loss, injuries, damage, or expense arising out of or in any way connected with the assembly, handling, storage, use or disposal of the product.

Declaration of Conformity EC

ΔΗΛΩΣΗ ΣΥΜΜΟΡΦΩΣΗΣ ΕΚ Declaration of Conformity EC

Όνομα & διεύθυνση κατασκευαστή:
Issuer's name and address:

ΝΙΚΟΛΑΟΣ ΣΙΑΤΡΑΣ
10 Serifou st. , Holargos, 15562,
Attica, Greece

Τύπος Προϊόντος:
Product:

Πλακέτα τυπωμένου κυκλώματος για φιλοξενία Μικροελεγκτή ESP32 DevKitC
Printed Circuit Board for ESP32 DevKitC microcontroller hosting

Ονομασία Προϊόντος:
Type designation:

4-Axis CNC Motherboard v1.3

Η παρούσα δηλώνει, με αποκλειστική μας ευθύνη, ότι το προαναφερθέν προϊόν είναι συμμορφούμενο με τις απαιτήσεις της Ευρωπαϊκής Οδηγίας:

This is to declare, under our sole responsibility, that the designated product is in conformity with the European directives and regulations:

2014/35/EC (LVD)
2014/30/EC (EMC)

Η πλήρης συμμόρφωση με τα Πρότυπα που αναφέρονται παρακάτω αποδεικνύει την εναρμόνιση του προαναφερθέντος προϊόντος με τις απαιτήσεις της προαναφερθείσας Ευρωπαϊκής Οδηγίας:
Full compliance with the Standards listed below proves the conformity of the designated product with the provisions of the above mentioned EC directive:

EN 55014-2: Electromagnetic compatibility. Requirements for household appliances, electric tools and similar apparatus. Immunity. Product family standard

EN 55022:2010: Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement

Έτος Σήμανσης CE / Year of affixing CE Marking: 2023

Holargos, 21 Apr 2023
(Τόπος & Ημερομηνία έκδοσης / Place and date of Issue)

Siatras Nikolaos, CEO
(Ονοματεπώνυμο & Θέση Εργασίας / Name & function)



(Υπογραφή / Signature)