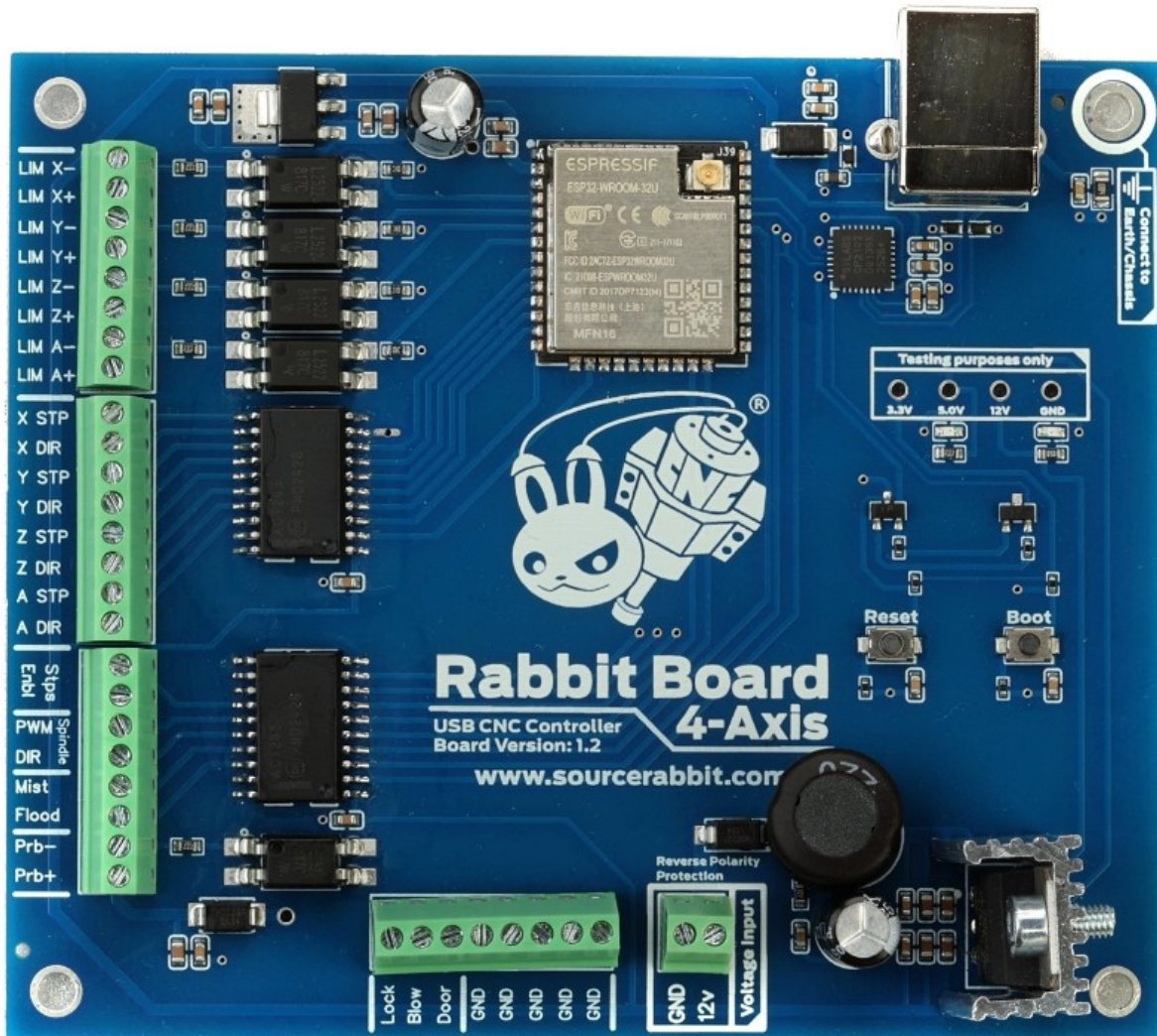


Rabbit Board 4-Axis v1.2

User Manual



Printed Circuit Board (Printed Circuit Board – PCB), intended for use as an electronic motion control subsystem for CNC machine tools, providing wired communication with a computer via a USB (Universal Serial Bus) interface.

Made in Greece

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Disclaimer

Read carefully and fully understand the contents of this user manual before installing or using the Rabbit Board. Failure to read or understand the manual may lead to injury, reduced performance, or damage to the Rabbit Board. Ensure that every person using the Rabbit Board has read and understood the contents of this manual.

The conditions and methods used for assembly, installation, handling, storage, use, or disposal of the Rabbit Board are beyond our control and may exceed our knowledge. For this reason, we accept no responsibility and expressly disclaim any liability for losses, injuries, damages, or expenses arising directly or indirectly from, or related to, the assembly, installation, handling, storage, use, or disposal of the product.

The information contained in this manual is derived from sources considered reliable. However, it is provided without any warranty, express or implied, regarding its completeness, accuracy, or suitability for a specific use.

Rabbit GRBL software is provided as-is without any warranty. No warranty, express or implied, is provided for the Rabbit GRBL software, which is distributed as open-source software. The entire risk regarding the quality, performance, and operation of the GRBL software lies solely with the user.

Intended Use

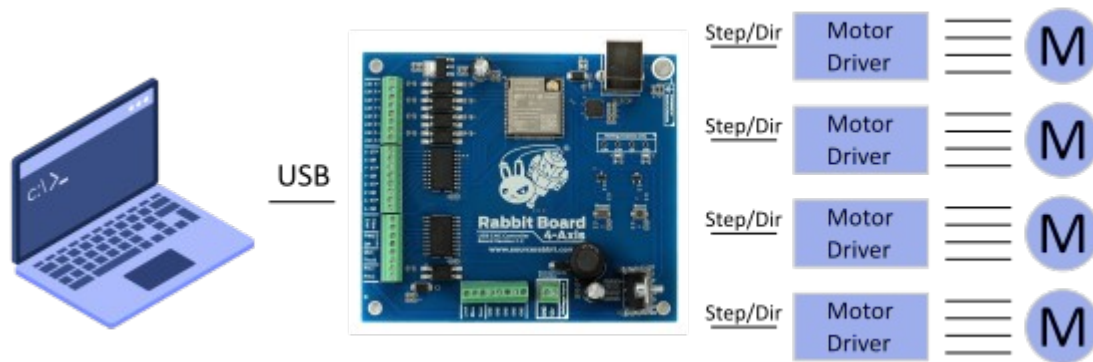
The Rabbit Board was designed and manufactured for use as an electronic control subsystem in CNC machine tools. It is intended to provide control signals to stepper motors, spindle control systems, and auxiliary subsystems, such as air pumps or coolant systems, via suitable external power devices.

Operation of the Rabbit Board is carried out via dedicated control software running on a computer (PC) and compatible with GRBL firmware.

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General Information



The Rabbit Board 4-Axis is a CNC Motion Controller that acts as an intermediate electronic subsystem between a personal computer (PC) and stepper motor drivers that use Step/Direction type signals.

The board is intended for use in 2-, 3-, or 4-axis CNC machine tools such as CNC routers, milling machines, plasma cutters, and laser machines, providing motion control signals to external motor drivers as well as control signals for auxiliary subsystems (e.g., spindle, cooling, air). The Rabbit Board does not directly drive power loads and requires the use of suitable external power devices (drivers, relays, inverter, etc.).

The Rabbit Board is based on an ESP32 microcontroller manufactured by Espressif Systems and operates with 32-bit GRBL firmware, which is pre-installed on the device. Communication with the computer is performed via a wired USB interface, ensuring a stable and reliable connection in CNC environments.

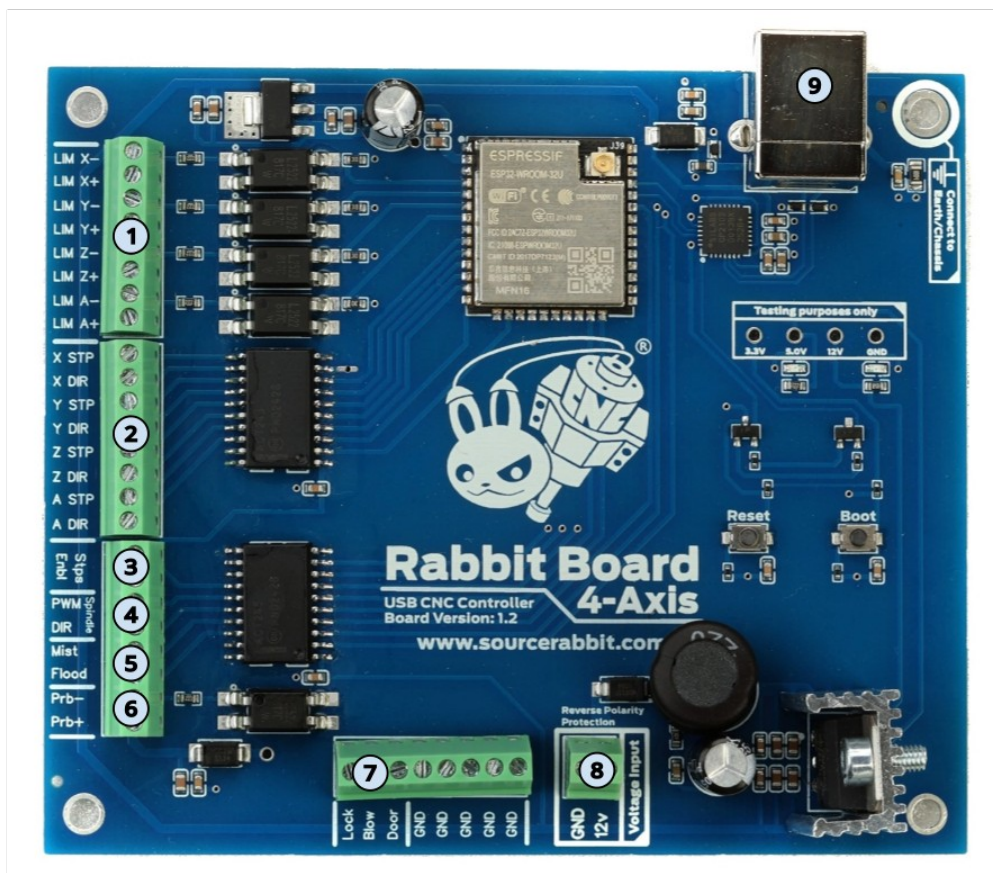
The ESP32 microcontroller includes integrated wireless communication capabilities (Wi-Fi and Bluetooth). However, for reasons of reliability and electromagnetic compatibility in CNC applications, the use of the wired USB connection and keeping the pre-installed GRBL firmware without modifications is recommended.

Any firmware modification and/or activation of wireless functions may affect electromagnetic behavior and the compliance of the final system and is the responsibility of the user/integrator.

Features & Specifications

Motor Outputs	Up to 4 Stepper or Servo motors
Max. Step Rate	120khz
Limit Switches	4 optocoupler-isolated limit switch connectors (12VDC)
Tool Setter / Probe	Optocoupler-isolated connector for Tool Setter or Probe (12VDC)
Spindle Control	PWM for Spindle control up to 10kHz (5VDC)
Coolant	Outputs for Mist and Flood (5V DC)
MCU	ESP32-WROOM-32 with Dual Core Xtensa 32bit CPU @ 240MHz and 520Kb SRAM
Firmware	Rabbit GRBL
Connectivity	USB, Wi-Fi
Input Voltage	12V DC
Max. Power	0.75 Watt
Ambient Temperature	15°C – 50 °C (59°F – 122°F)
Size (L x W x H)	100mm x 95mm x 25mm

At a Glance



In the photo above you can see the top view of the motion controller. In the remaining pages of this user manual you will see how to connect the required electronic components to complete your controller.

#1	Limit switch connection terminals	#6	Input for touch probe or tool setter.
#2	STEP and DIR control outputs for external stepper or servo drivers	#7	Outputs for Automatic Tool Change
#3	Enable (EN) signals for the motor drivers	#8	12V DC power input
#4	Spindle or laser control output via PWM and direction (DIR).	#9	USB port for communication with a computer and sending G-code.
#5	Outputs for controlling the cooling system (coolant) via relay.		

Basic Wiring

In the diagrams below, the recommended method of connecting the basic electrical and electronic components to complete the control box of your machine tool with the motion controller is presented. If you are not familiar with electrical installations or with connecting power and control components, **it is recommended to seek the help of a certified electrician or electronics technician.**

⚠ **WARNING:** Use exclusively high-quality power supplies from a reputable manufacturer, suitable for the specific application, that comply with applicable safety regulations and bear CE marking.

Power supplies must have built-in protection against:

- short circuit (Short Circuit),
- overload (Over Current),
- overvoltage (Over Voltage),
- overheating (Over Temperature).

⚠ **WARNING:** For your safety, do not make connections, disconnections, or perform any work inside the control box while it is connected to the mains. Before any work:

- fully disconnect the power supply,
- make sure there is no residual voltage,
- use approved protective eyewear in accordance with EN 166 and ANSI Z87+.

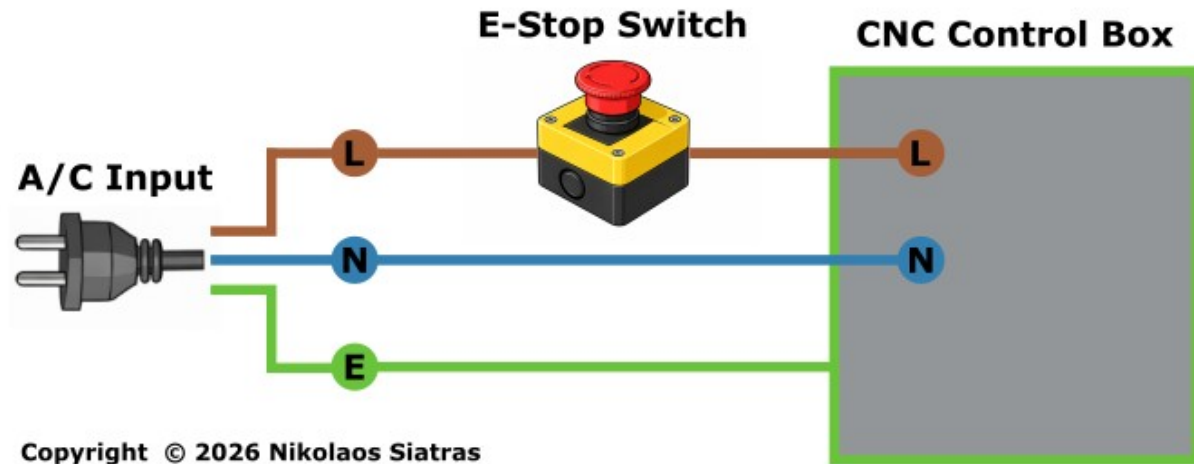
⚠ **WARNING:** Your build must have a central earth (central earth / star ground). All EARTH (PE) grounds of the electrical and electronic components must converge at a common grounding point, which is connected directly to the mains protective earth. This point is usually the metal chassis of the control box, i.e., the metal enclosure that houses the controller electronics.

Proper grounding is critical both for user safety and for the correct operation and electromagnetic compatibility (EMC) of the system.

💡 **Tip:** The motion controller has a USB Type-B (Female) port. We recommend using a high-quality USB A to USB B cable, with electromagnetic shielding and built-in ferrites (ferrite cores) at both ends.

💡 **Tip:** For professional installations, the use of a Panel Mount USB Cable (**USB-B Female to USB-B**) is recommended, so as to avoid directly stressing the controller port and to improve the durability and reliability of the connection.

Electromagnetically Shielded Enclosure and Emergency Stop Switch (E-Stop)



Although many users house their controller in plastic electrical enclosures without apparent problems or, in some cases, do not cover the controller at all, we recommend installing the motion controller and all related electrical and electronic components (power supplies, transformers, motor drivers, etc.) inside an electromagnetically shielded enclosure, i.e., a metal enclosure electrically connected to protective earth (EARTH / PE), together with an Emergency Stop (E-STOP) switch at the AC power input.

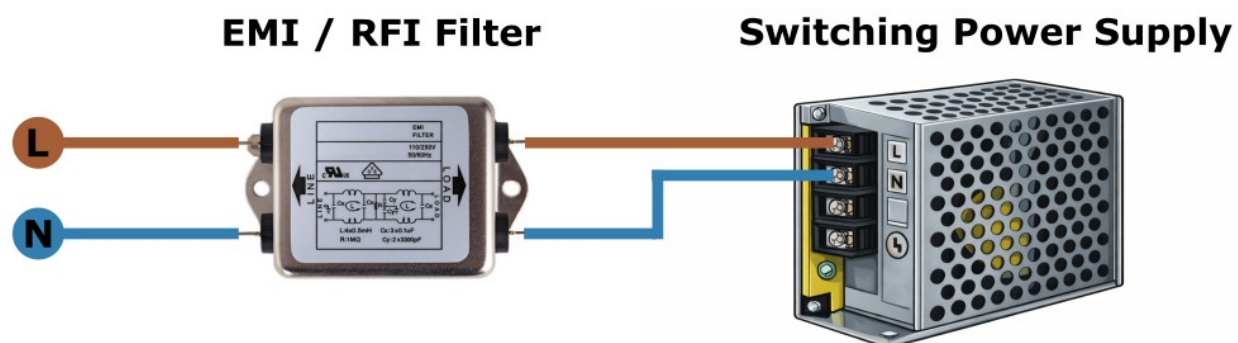
As shown in the schematic diagram, the live conductor (L) of the supply passes in series through the E-STOP switch, so that when it is activated the power supply to the system is immediately interrupted. The neutral (N) is routed directly to the control box power supplies, while the protective earth conductor (EARTH / PE) is connected directly to the metal chassis of the enclosure.

The example above concerns a simple installation in a non-industrial environment. In professional or industrial applications, the requirements of the applicable standards (e.g., EN 60204-1) apply, including the appropriate emergency stop circuit architecture.

⚠ WARNING: The metal body of the control box must be **electrically connected to protective earth (PE)** so that it functions correctly both as shielding and as a common reference point. Proper shielding and grounding of the control box contributes decisively to **stable operation**, the **reduction of communication errors**, and the **improvement of the overall reliability of the CNC system**.

⚠ WARNING: In professional/industrial installations, the use of a suitable two-pole isolator or contactor is required, in accordance with applicable regulations (e.g., EN 60204-1) and the requirements of the installation. The motion controller is not a functional safety device and must not be used as the sole means of emergency stop.

Noise Suppression Filters (EMI/RFI)



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It is recommended to place a mains noise suppression filter (EMI/RFI filter) at the input of each device powered by alternating current (A/C), such as power supplies, transformers, and inverters (VFD). The EMI/RFI filter is installed between the A/C supply and the respective device, with the aim of drastically reducing electromagnetic interference conducted through the electrical network, both into the system and from it to the environment.

This interference originates from unwanted higher-frequency electrical signals that are superimposed on the fundamental mains frequency (50 Hz) and can affect the stability and reliability of electronic circuits. Typical sources of electromagnetic noise in laboratory and industrial environments include electric motors, inverters (VFD), spindles, switching power supplies, as well as lighting fixtures with electronic ballast.

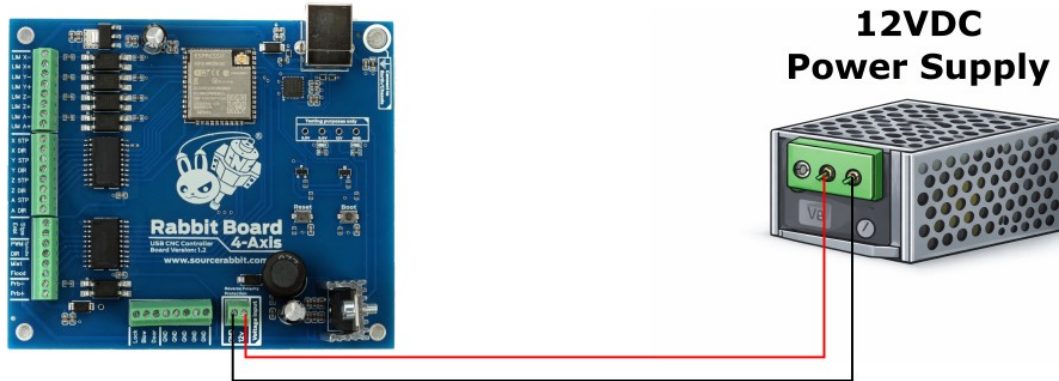
Correct selection, installation, and grounding of EMI/RFI filters, combined with a metal and properly grounded control box, contributes substantially to improving the electromagnetic compatibility (EMC) of the system, reducing communication problems, avoiding false triggering, and ensuring stable and reliable operation.

⚠ WARNING: For electromagnetic shielding to function properly, **the system power supplies must be in mechanical and electrical contact with the metal control box**, which acts as a common reference point and as shielding. The metal control box enclosure must be firmly connected to protective earth (EARTH / PE), ensuring effective discharge of interference and proper operation of the EMI/RFI filters.

💡 Tip: The EMI/RFI filter should be placed as close as possible to the A/C power input of each device.

Power Supply Connection

For the controller to operate, a regulated 12V supply with a current of at least 1.5A must be connected to the Voltage Input, with proper grounding. The supply may come either from a regulated 12V power supply, or from a step-down converter (DC-DC buck converter) that provides a stable 12V output. See the diagram below.



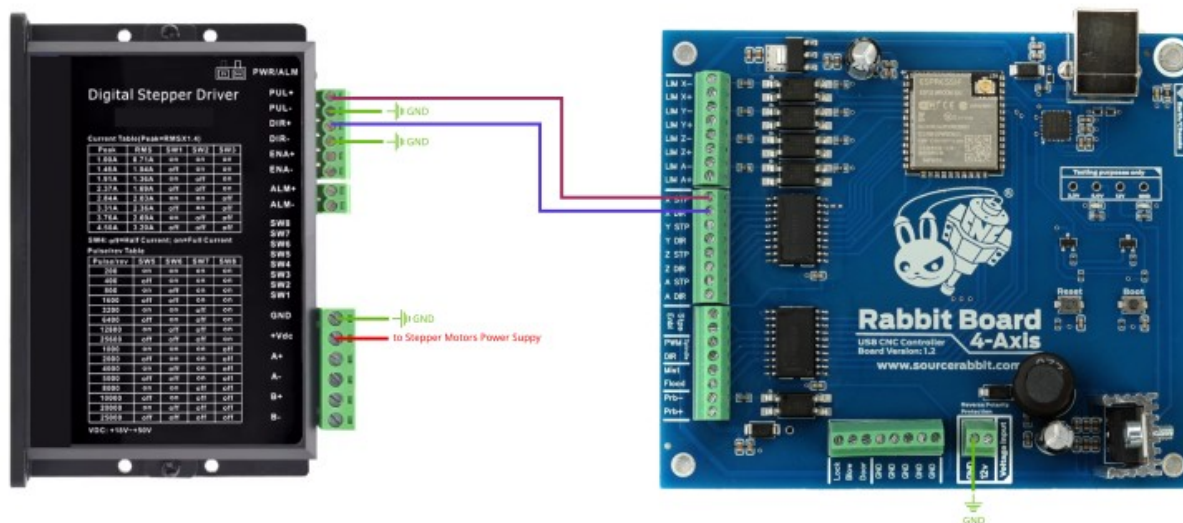
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💡 **Tip:** Always check with a multimeter the continuity/presence of protective earth of the power supplies before installation.

💡 **Tip:** Always ensure good ventilation for the power supplies.

Motor Driver Connection (Stepper Driver or Servo Driver)

In the diagram below you will see the connection of a Stepper Driver that uses STEP (PUL) and DIR ports to the output of the X axis of the motion controller. In exactly the same way, the connection is made for the remaining axes (Y, Z & A).

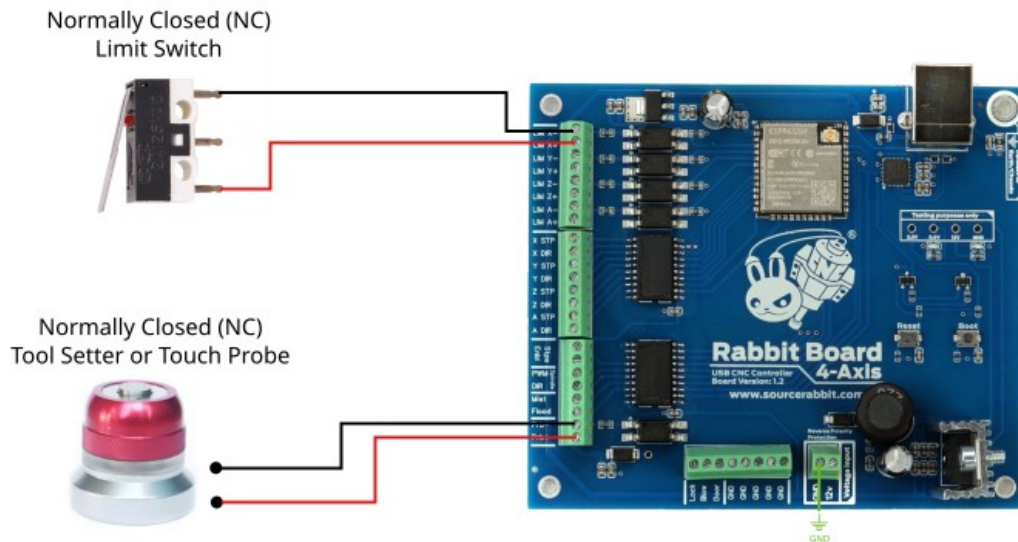


⚠ **WARNING:** The motor driver (Stepper Driver) must share a common ground (Common Ground) with the 4-Axis CNC Motherboard. This is ensured by connecting the GND of the power supply that powers the motor drivers to the GND of the motion controller. In the case where the motor driver operates with A/C current, you should refer to the motor driver manual for the wiring method.

⚠ **WARNING:** The best way to ensure a common ground reference (Common Ground) is a star-type connection (Star Ground). In a star connection, all ground points (GND) converge to a central reference point, avoiding ground loops and reducing electrical noise.

💡 **Tip:** To ensure maximum performance and isolation from electromagnetic noise, it is a good idea to use Twisted Pair Wire for the STEP and DIR connections.

Limit Switch and Probe/Tool Setter Connection



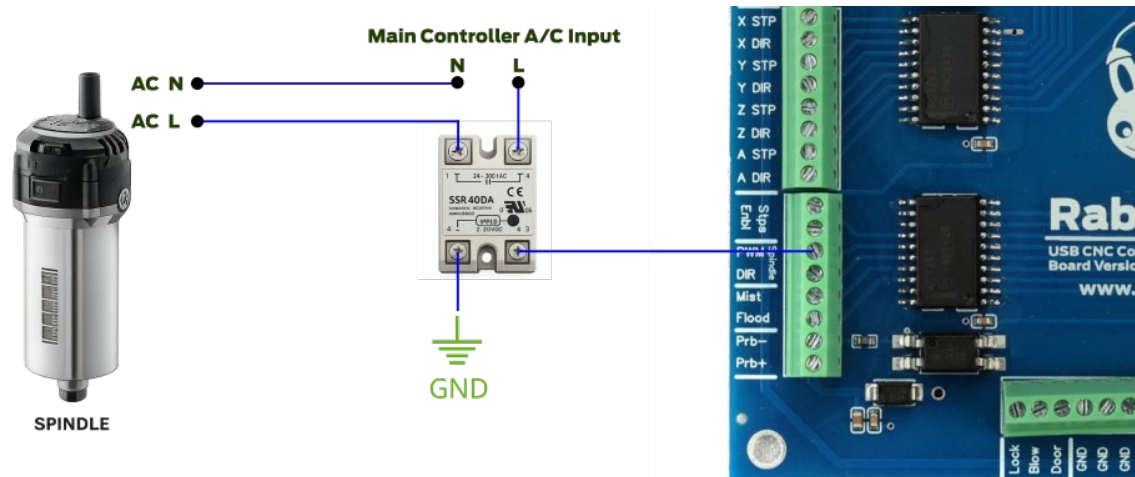
⚠ **WARNING:** The switches and the Probe/Tool Setter must be NC (Normally Closed), i.e., normally closed. In normally closed switches, the contacts that connect the switch are closed, which means that when they are not pressed the circuit is closed.

💡 **Tip:** To ensure maximum performance and isolation from external electromagnetic noise, it is a good idea to use Twisted Pair Wire for connecting the limit switches and the Probe, or even better LIYCY-type signal cables. In this way maximum accuracy during axis referencing (Homing Sequence) is ensured.

💡 **Tip:** If you will use coolant fluids, water, or other liquids, we recommend using waterproof limit switches with an IP67 ingress protection rating.

Simple Spindle Connection (Spindle) without speed control

In the diagram below you will see typical spindle wiring without speed control, using a Solid State Relay.

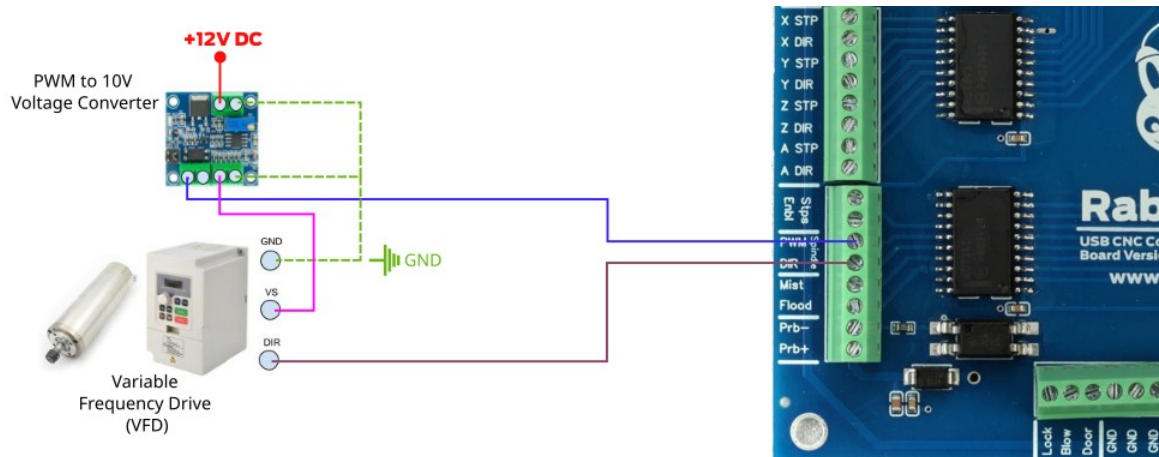


⚠ **WARNING:** The wiring shown is typical and may not match all spindles. In any case, you should consult the spindle manufacturer's instructions for how the correct connection should be made.

⚠ **WARNING:** Many low-quality spindles, such as cheap wood routers used by the hobby community, generate large amounts of electromagnetic pulses that can damage or reduce the lifespan of your electronics. Always make sure to use high-quality spindles from a reputable manufacturer, with CE marking, suitable for industrial use.

Spindle Connection with speed control via VFD (Variable Frequency Drive)

In the diagram below you will see typical spindle wiring with speed control via a VFD that accepts a 0V to 10V voltage signal for speed control. To convert the PWM signal to 0V to 10V we used a PWM to Voltage Converter Module 0%–100% to 0–10V. There are VFDs that do not need conversion of PWM to 0V to 10V. In this case, the PWM output of the 4-Axis CNC Motherboard is connected directly to the VFD. In any case, you should consult the VFD manufacturer's instructions for how the correct connection should be made.



⚠ WARNING: The wiring shown is typical and may not match all VFDs (Variable Frequency Drive). In any case, you should consult the VFD manufacturer's instructions for how the correct connection should be made.

⚠ WARNING: Always install a Filter (EMI/RFI) at the AC input of the VFD

Help & Support

There are some possible problems you may encounter while using the motion controller. If you experience any of these, you can easily address it with the help provided below.

The PC does not “see” the Motion Controller

If the computer does not recognize the motion controller, the problem is usually due to the absence of the necessary system drivers (Hardware Drivers) for the USB to UART bridge used by the device.

The motion controller has a CP210x chipset (Silicon Labs); installation of the corresponding VCP (Virtual COM Port) Drivers is required. Without installing the driver, a virtual COM port is not created and the device cannot communicate with the CNC control software.

USB Disconnection During Operation (USB Connection Dropped)

The most common problem encountered by CNC machine tool operators is the controller disconnecting from the PC during operation. This problem is usually caused by external electromagnetic noise.

Solutions for the disconnection problem:

- Always use a USB cable with electromagnetic shielding, not longer than 1.8m, and with ferrites at both ends.
- Install a Filter (EMI/RFI) at the AC input of each power supply inside the control box
- Install a Filter (EMI/RFI) at the AC input of the Spindle (if present)
- Install a Filter (EMI/RFI) at the AC input of the VFD (if present)
- Install a Filter (EMI/RFI) at the AC input of the Plasma Cutter (if present)
- Install a Filter (EMI/RFI) at the AC input of the laser source power supply (if present)
- Install a Filter (EMI/RFI) at the AC input of the coolant pump power supply (if present)

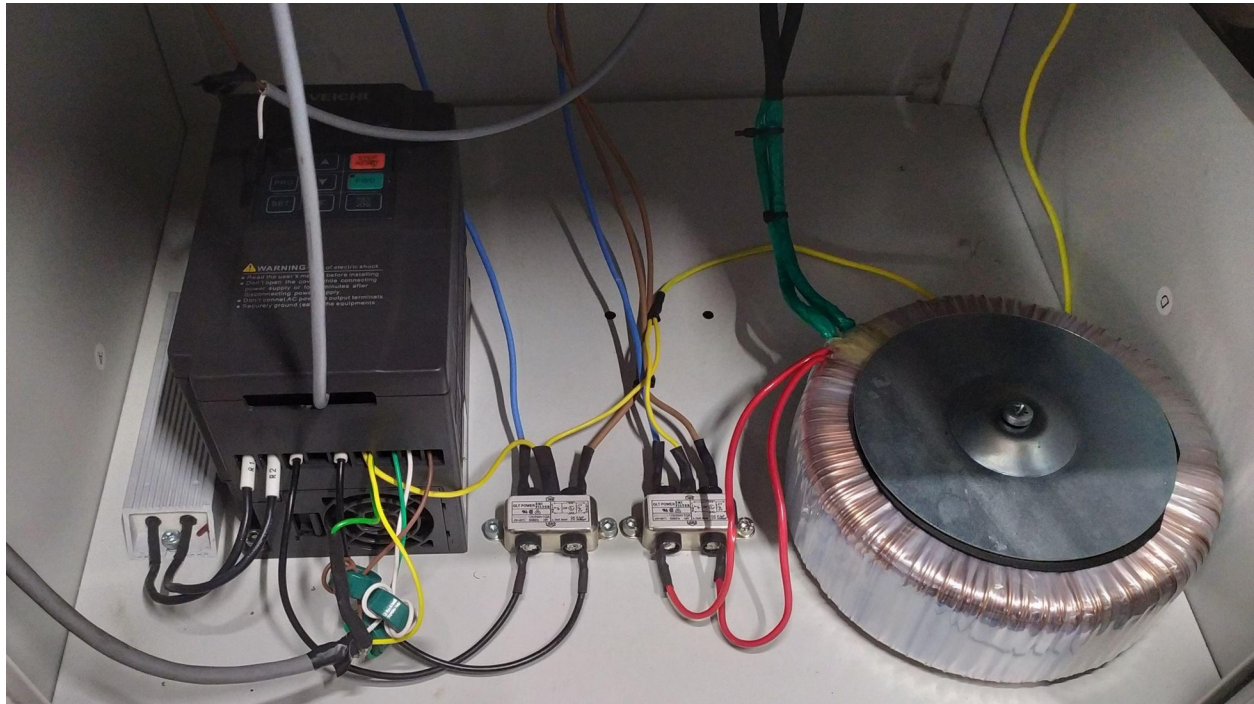
💡 **Tip:** If you use a laptop to operate your machine tool, you should know that budget laptops do not have good electromagnetic shielding. Laptop manufacturers, in an effort to make laptops light and user-friendly, use only plastic to create the computer enclosure. Plastic provides no electromagnetic shielding. We recommend using a desktop PC to control your machine tool. The electronics of desktop PCs are housed in a metal case (tower) that provides fairly satisfactory electromagnetic shielding.

💡 **Tip:** Keep devices such as Plasma Cutters and VFDs (Variable Frequency Drives) as far away as possible. **Cheap devices of this type do not have good electromagnetic shielding** because their enclosure is plastic, and in most cases manufacturers do not fit them with an EMI/RFI filter. These devices emit large amounts of electromagnetic noise that

affects USB devices and can cause problems even with PC hard drives.

In the photo below, a typical VFD installation (left) for spindle speed control and a toroidal transformer (right) for powering stepper motors is shown.

As shown, there is a separate EMI filter for the VFD and a separate filter for the transformer. In addition, the cable that connects the VFD to the spindle has ferrites and internally includes a shielding braid (shield braid).



Safety & Compliance

- **Electromagnetic Compatibility (EMC)**

The product has been designed according to the principles of electromagnetic compatibility (EMC) and is intended to comply with Directive 2014/30/EU, provided it is installed and used in accordance with these instructions (e.g., in a shielded and grounded metal enclosure, with proper wiring and appropriate grounding). Final electromagnetic behavior depends on the overall configuration and installation of the system.

- **General safety information**

Installation of the motion controller in an enclosure/panel connected to the mains (230V A/C) must be carried out by a licensed electrician, in accordance with applicable regulations and relevant standards (e.g., EN 60204-1 where applicable).

Before any wiring/maintenance work, fully disconnect the power supply and ensure that no residual voltage is present.

The motion controller is an electronic control subsystem and is not a functional safety device. It must not be used as the sole means of emergency stop (E-STOP) or protection.

Safe operation of the final system depends on correct integration (grounding, wiring, shielding, appropriate protections) and on the connected power subsystems (power supplies, drivers, VFD, etc.) and is the responsibility of the manufacturer/integrator of the final machine or installation.

The CNC machine tool must be used only by trained individuals. Children must be under continuous supervision and must not have access to the system.

EC Declaration of Conformity

ΔΗΛΩΣΗ ΣΥΜΜΟΡΦΩΣΗΣ ΕΚ Declaration of Conformity EC	
Όνομα και Διεύθυνση Κατασκευαστή: Issuer's Name and Address:	NIKOLAOS SIATRAS 5 Kitiou , Papagos, 15669, Attica, Greece
Τύπος Προϊόντος: Type Designation:	USB CNC Controller
Μοντέλο: Model:	Rabbit Board 4-Axis v1.2
Περιγραφή Προϊόντος: Product Description:	Πλακέτα τυπωμένου κυκλώματος (Printed Circuit Board – PCB), προοριζόμενη για χρήση ως ηλεκτρονικό υποσύστημα ελέγχου κίνησης εργαλειομηχανής CNC, η οποία παρέχει ενσύρματη επικοινωνία με υπολογιστή μέσω διεπαφής USB (Universal Serial Bus). Printed Circuit Board (PCB) intended for use as an electronic motion control subsystem for a CNC machine tool, providing wired communication with a computer via a USB (Universal Serial Bus) interface.
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:	
2014/30/EU 2011/65/EU (EU) 2015/863	– Electromagnetic Compatibility (EMC) Directive – RoHS Directive – Amendment to RoHS
Εφαρμοζόμενα Εναρμονισμένα Πρότυπα / Applied Harmonised Standards:	
EN 61000-6-2:2019 EN 61000-6-4:2019 EN IEC 63000:2018	– Immunity for industrial environments – Emission standard for industrial environments – Technical documentation for RoHS compliance
 Nikolaos Siatras, CEO 02 Jan 2026	