ST-V3 USB Motion Control Card

Dedicated Version for MACH3

V1.0

User manual

Address: 15-4, #799 Hushan Road, Jiangning, Nanjing, China
Tel: 0086-2587156578
Web: www.omc-stepperonline.com
Sales: sales@stepperonline.com
Support: technical@stepperonline.com

Warning:

The mechanical equipment controlled by the motion control card is highly specialized and imposes specific requirements on the knowledge and competence of the operator. If the equipment is improperly designed or used, automated machinery can pose significant risks and potential for damage. Please ensure the safety of the design and usage, and adhere to relevant laws and regulations. If you are uncertain, consult with a qualified technician rather than taking risks.

First-time users or those unfamiliar with the performance of this product or Mach3 software should ensure that the power switch of the mechanical equipment is within easy reach and can be quickly turned off when testing this product. It is strongly recommended that users install an emergency stop button and ensure its proper functionality.

1. Functional Overview

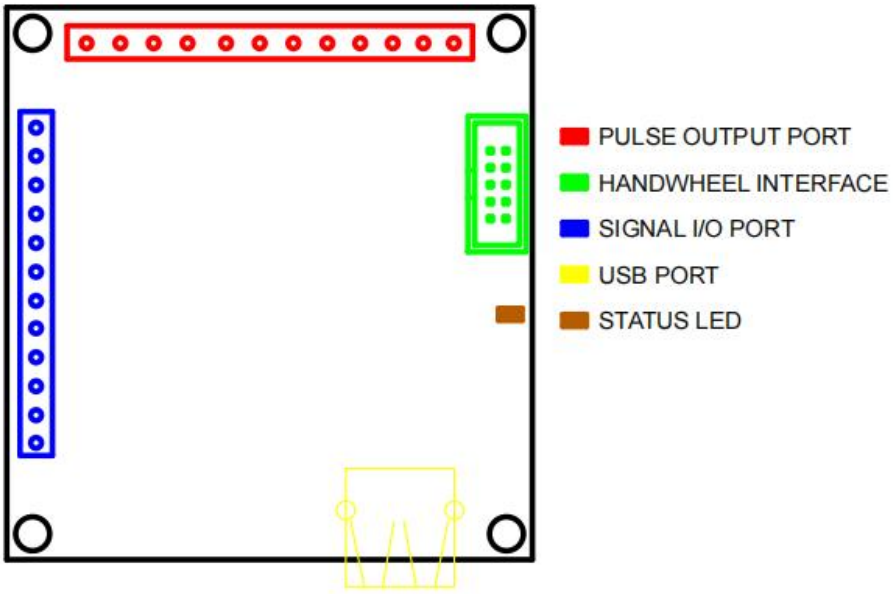
The ST-V3 USB Motion Control Card is specifically designed for Mach3 software.

Features:

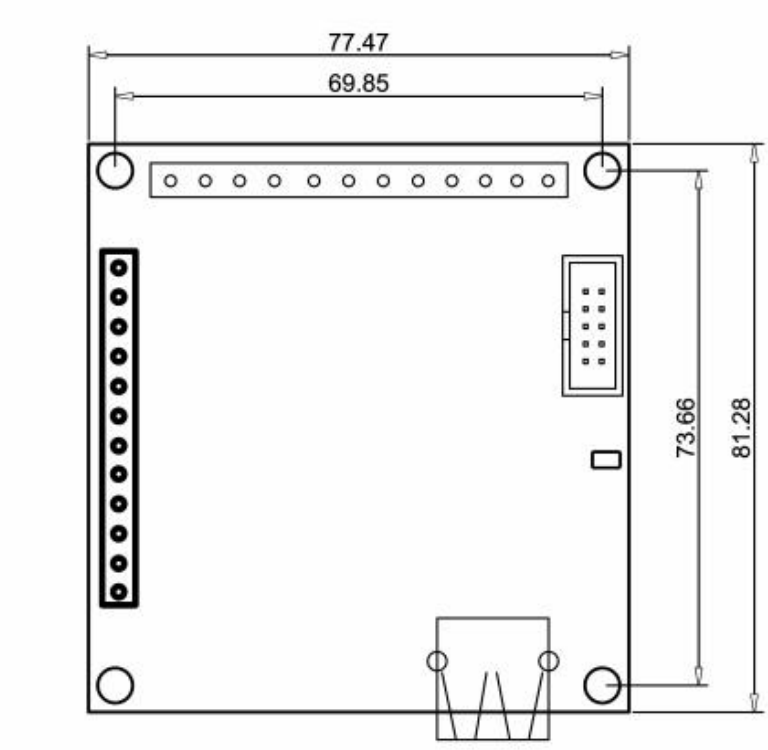
- Supports up to 4-axis linkage control. The 4th axis can be set as a follower axis.
- Output pulse frequency of 100K, using a minimum error interpolation algorithm for high machining accuracy.
- USB interface, compatible with any computer with a USB port. As long as MACH3 can run, the control card can be used.
- Driver-free design, ensuring better compatibility with various hardware and software environments (supports WinXP and Win7 systems).
- Supports automatic homing (return to zero).
- The follower axis automatically levels during homing.
- Supports automatic tool setting.
- Supports emergency stop input.
- Supports limit switch connection.
- Supports spindle control (PWM mode and relay mode).
- Provides 4 opto-isolated digital signal inputs.
- Supports up to 12 digital signal inputs (4 by default).
- Provides 4 opto-isolated relay outputs.
- Supports handwheel interface.
- Anti-interference design with imported industrial-grade components, ensuring high reliability.
- Provides screw-type terminals and 2.54mm pitch pin-header terminals.

2. Appearance and Dimensions

Interface Diagram



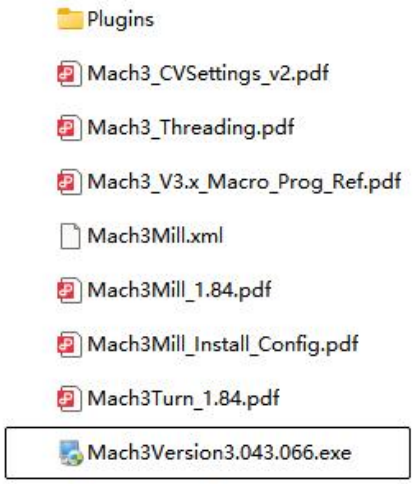
Installation Dimensions



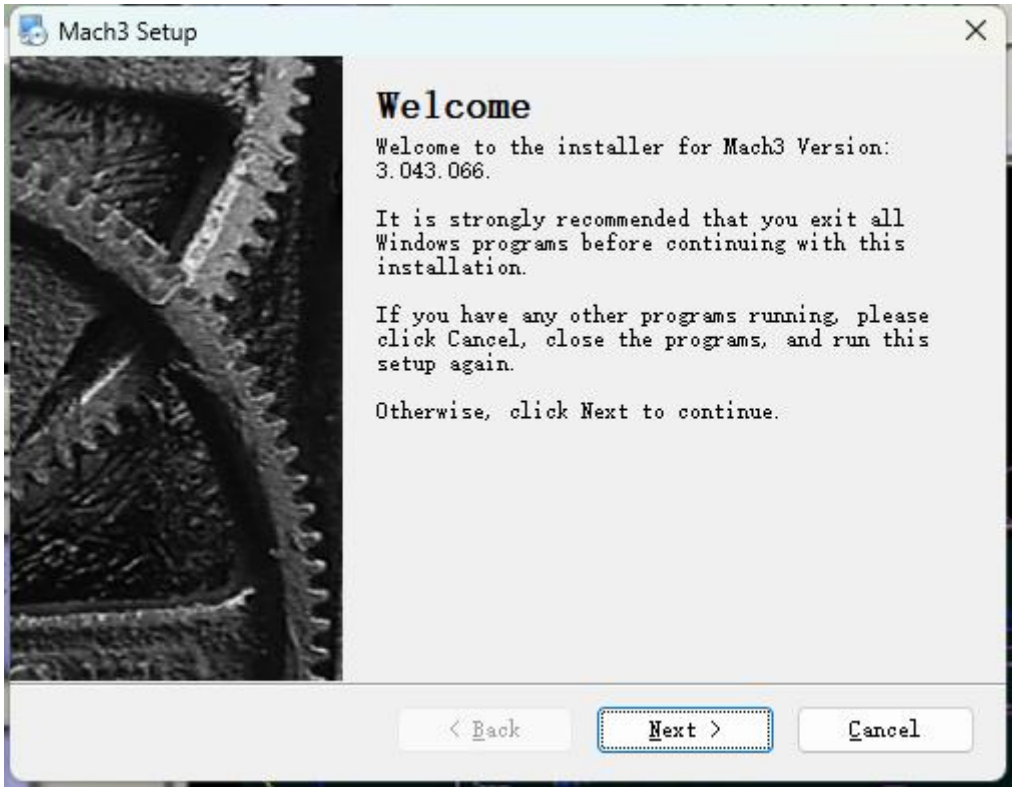
3. Software Installation

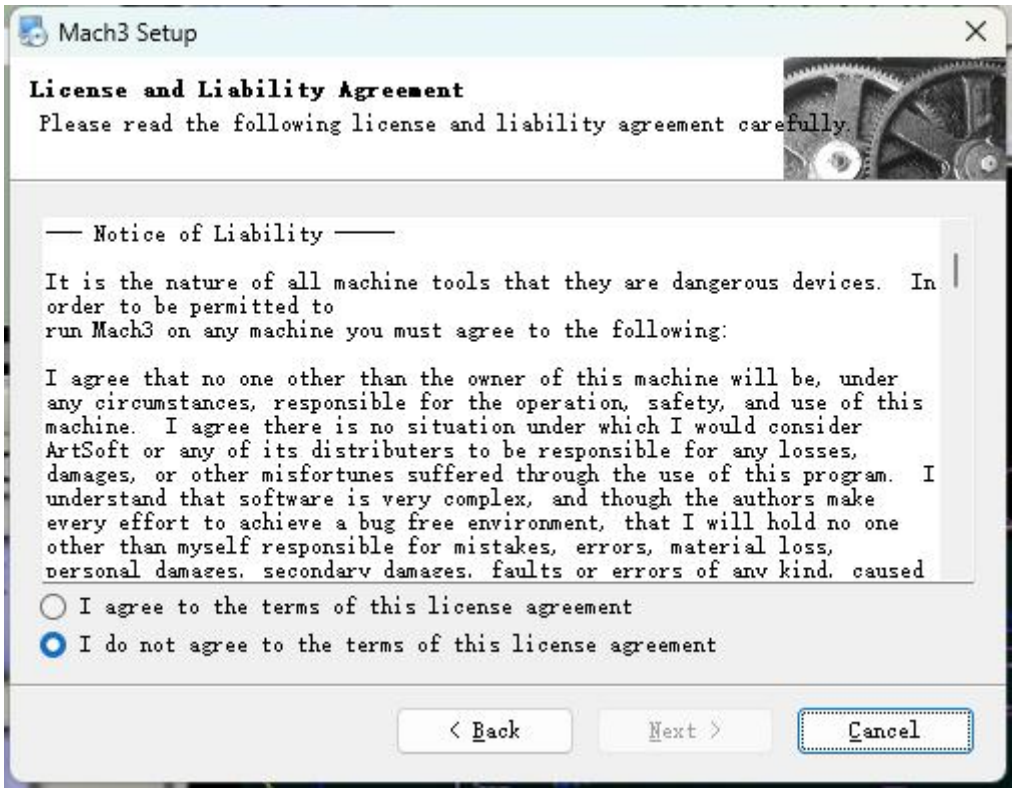
(1) Install Mach3 Software

Download the Mach3 software from the provided resources and run the Mach3Version3.043.066.exe installer.



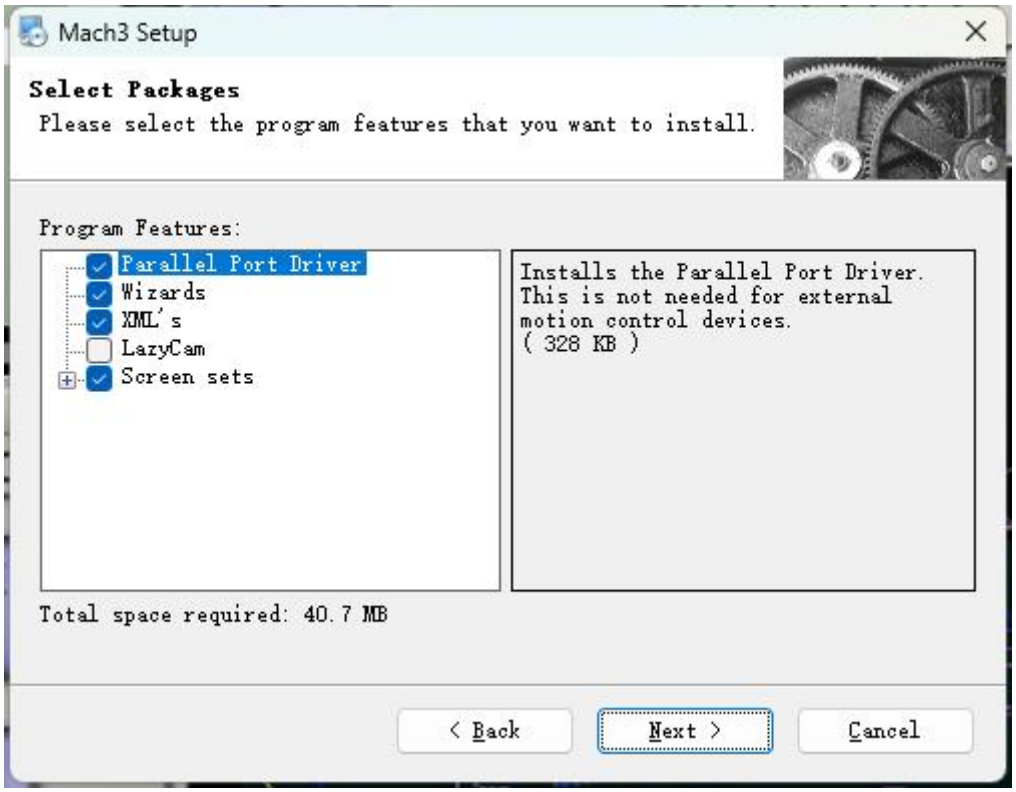
Mach3 installation is straightforward. Simply click Next (or Yes) throughout the process.

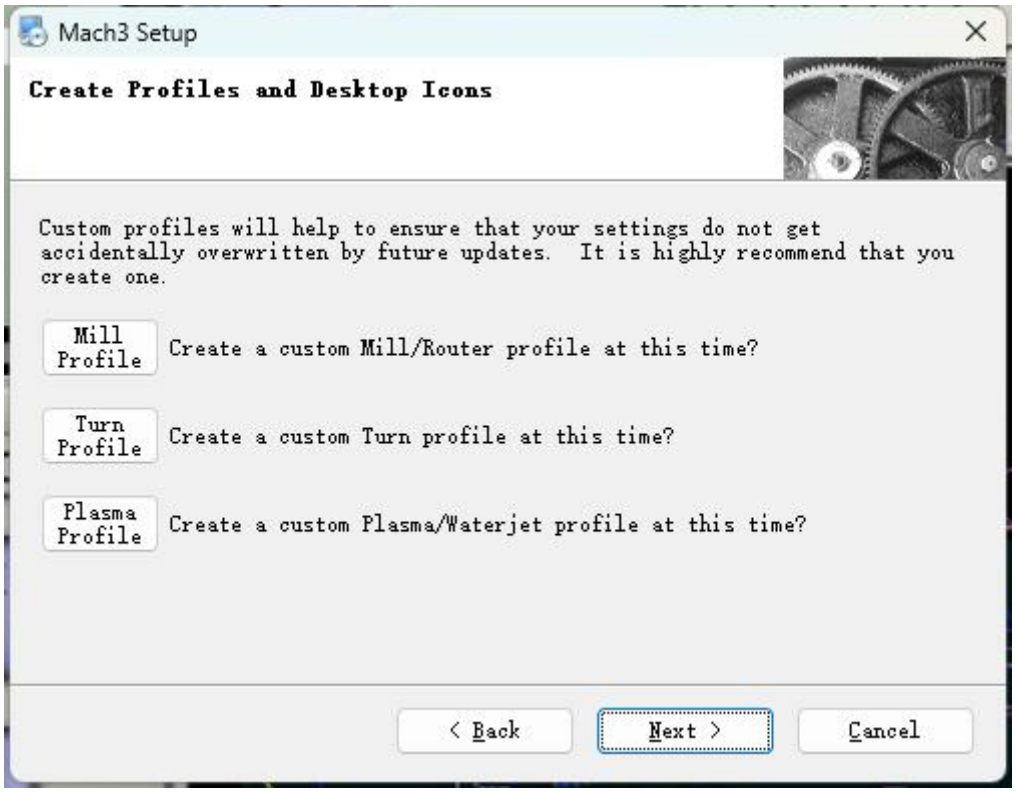


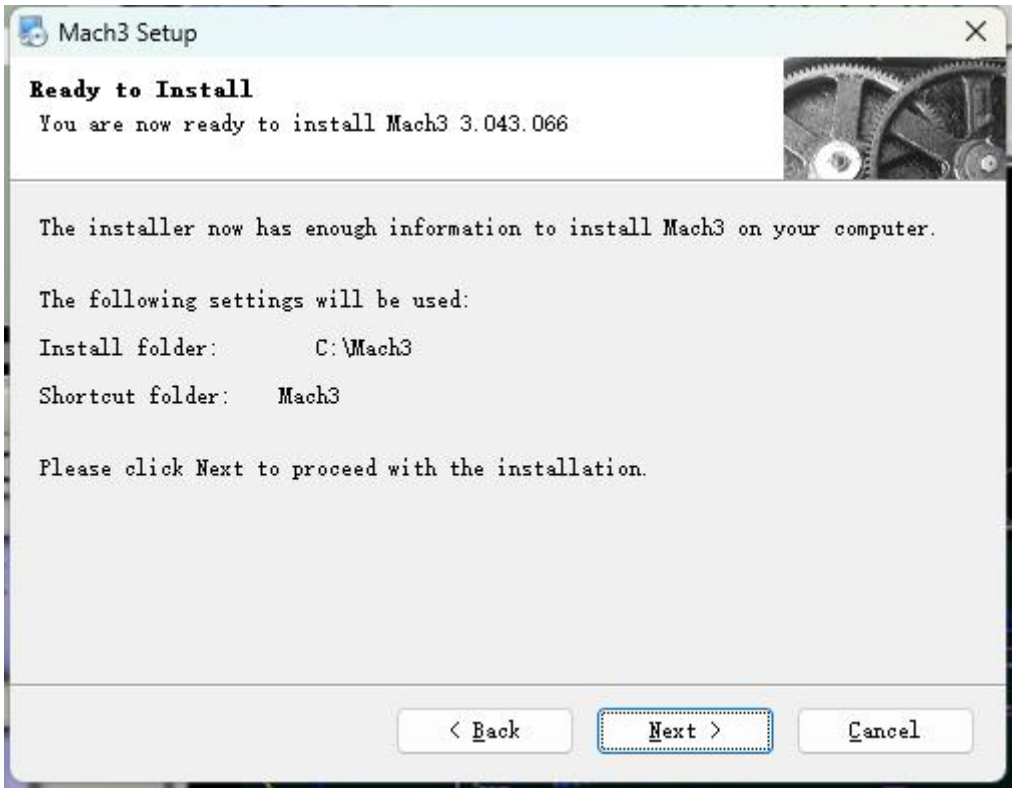


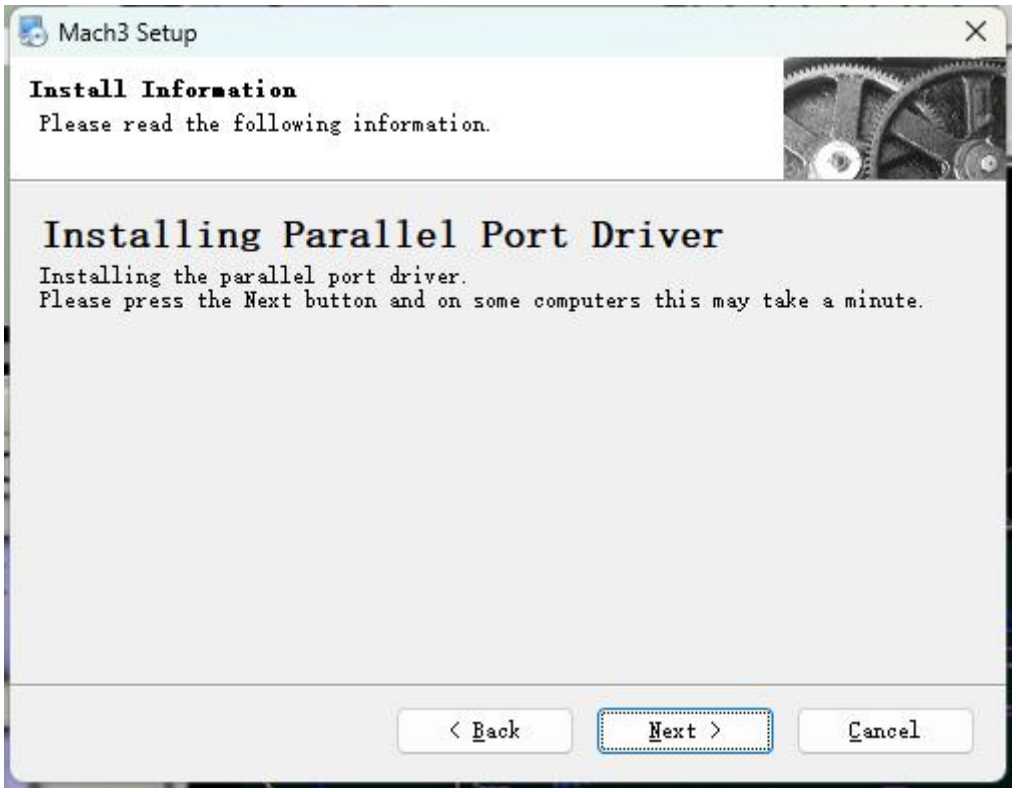
Select Mach3 Installation Location

The default installation location is the Mach3 folder on the C drive.

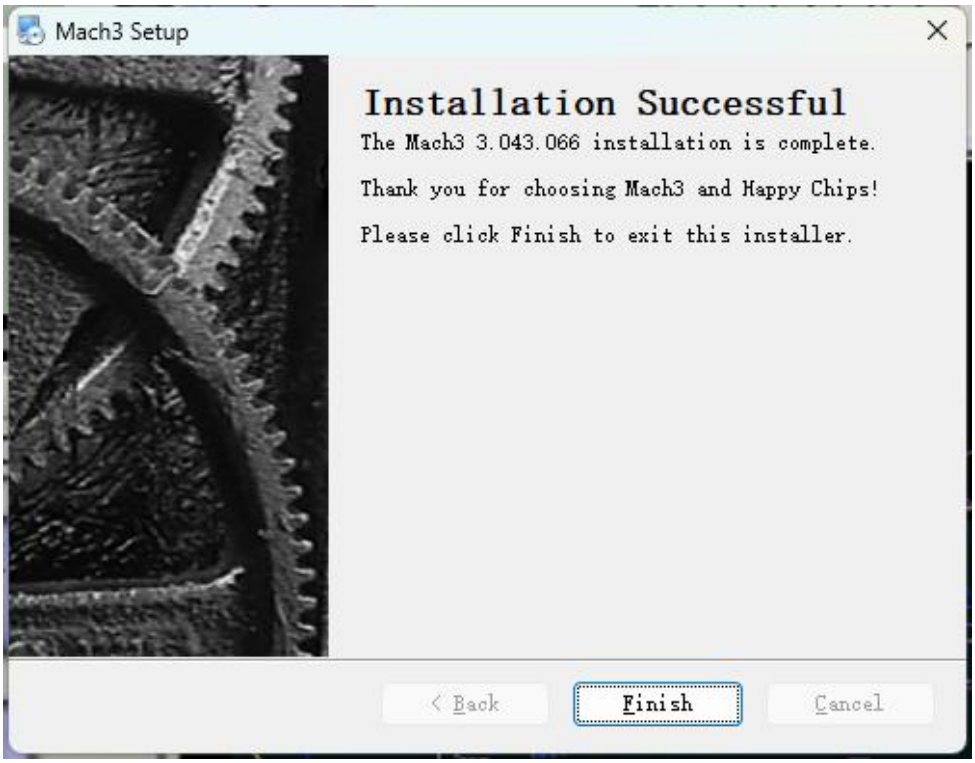

Mach3 Setup
Select Packages
Please select the program features that you want to install.
Program Features:
Parallel Port Driver
Wizards
XML's
LazyCam
Screen sets
Installs the Parallel Port Driver.
This is not needed for external
motion control devices.
(328 KB)
Total space required: 40.7 MB
< Back
Next >
Cancel


Mach3 Setup
Create Profiles and Desktop Icons
Custom profiles will help to ensure that your settings do not get
accidentally overwritten by future updates. It is highly recommend that you
create one.
Mill Profile
Create a custom Mill/Router profile at this time?
Turn Profile
Create a custom Turn profile at this time?
Plasma Profile
Create a custom Plasma/Waterjet profile at this time?
< Back
Next >
Cancel


Mach3 Setup
Ready to Install
You are now ready to install Mach3 3.043.066
The installer now has enough information to install Mach3 on your computer.
The following settings will be used:
Install folder: C:\Mach3
Shortcut folder: Mach3
Please click Next to proceed with the installation.
< Back
Next >
Cancel


Mach3 Setup
Install Information
Please read the following information.
Installing Parallel Port Driver
Installing the parallel port driver.
Please press the Next button and on some computers this may take a minute.
< Back
Next >
Cancel

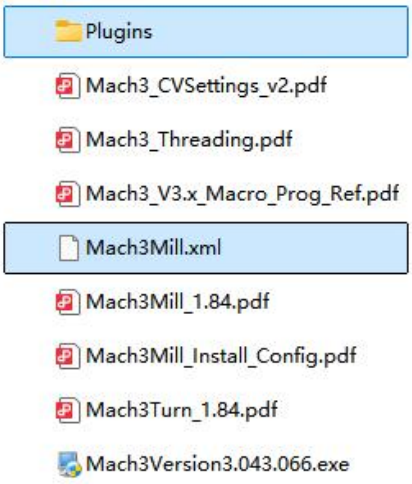
Click "Finish" to complete the Mach3 installation.



(2) Copy Plugins and Configuration Files

The final step is to copy configuration files and plugins. For users new to Mach3 software, configuring Mach3 can be complex. Therefore, we have prepared a typical configuration file, **Mach3Mill.xml**, in the download resources. Simply copy this file to the Mach3 folder, overwriting the existing file, to save time on configuration.

The motion control card requires corresponding plugins to run in Mach3. Copy the **Plugins** folder to the Mach3 installation folder.

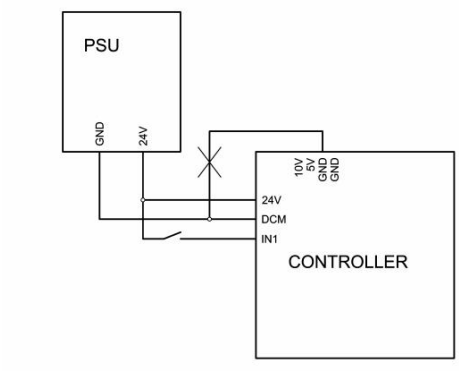


After the installation of Mach3 is completed, several icons will appear on the desktop. The one we will use is “Mach3Mill”, which is for “Mach3 milling machine control”. Additionally, “Plasma” (for plasma cutting machines) can control plasma cutting or laser cutting, and is also commonly used. “Mach3Turn” is for “Mach3 lathe control”, which is not applicable to this series of control cards.

4. Hardware Connection

Connect the computer to the control card via a USB cable, and connect the control card to the motor driver module via signal cables. Refer to the "Typical Wiring Examples for Motion Control Card" and the terminal descriptions of the motor drivers you purchased for specific wiring.

Note: The control card has two rows of terminals. These two rows are completely physically isolated, with no connection between them. Ensure that the signal wires connected to these two rows are not related to each other. Otherwise, external interference signals may enter the control board and the computer's motherboard, reducing the system's anti-interference capability.



Connect one end of the USB cable to the ST-V3 Motion Control Card and the other end to the computer. This product adopts a driver-free design, and the Windows system can automatically detect the ST-V3 Motion Control Card without requiring users to install additional device drivers.

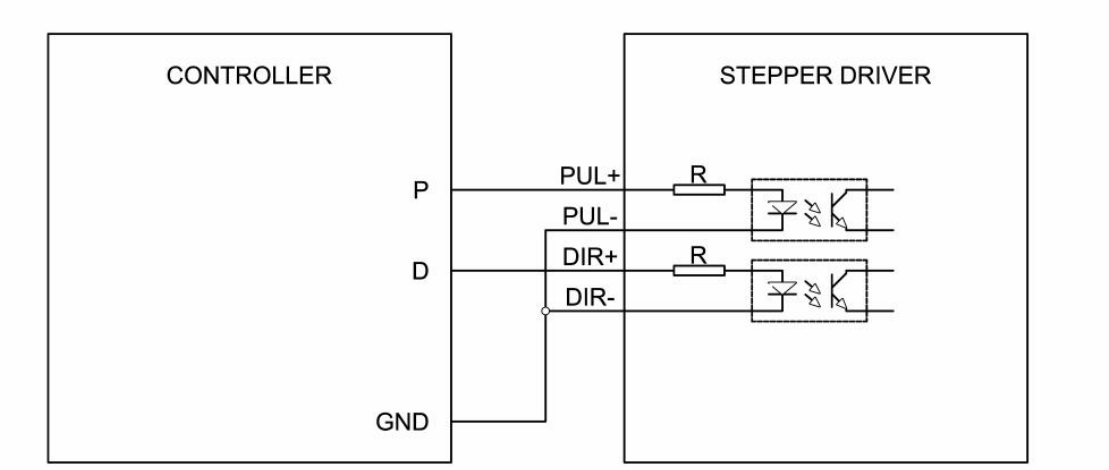
5. Pulse output

1. Connecting Stepper/Servo Motor Drivers

The ST-V3 Motion Control Card can control 4 motors, named X-axis, Y-axis, Z-axis, and A-axis motors. Each motor has two control signals: the command pulse signal P (corresponding to "X P," "Y P," "Z P," "A P") and the direction signal D (corresponding to "X D," "Y D," "Z D," "A D"). Motor drivers typically have two types of signal interfaces: differential and single-ended. The following explains the wiring for these two types of motor drivers.

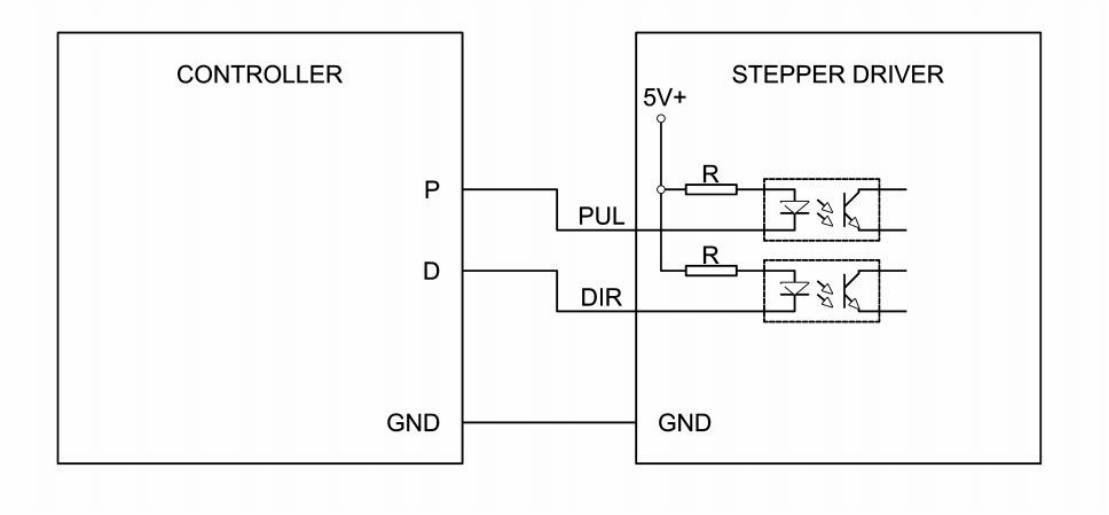
Differential Mode

For motor drivers with differential interfaces, the wiring to the ST-V3 Motion Control Card is as follows:

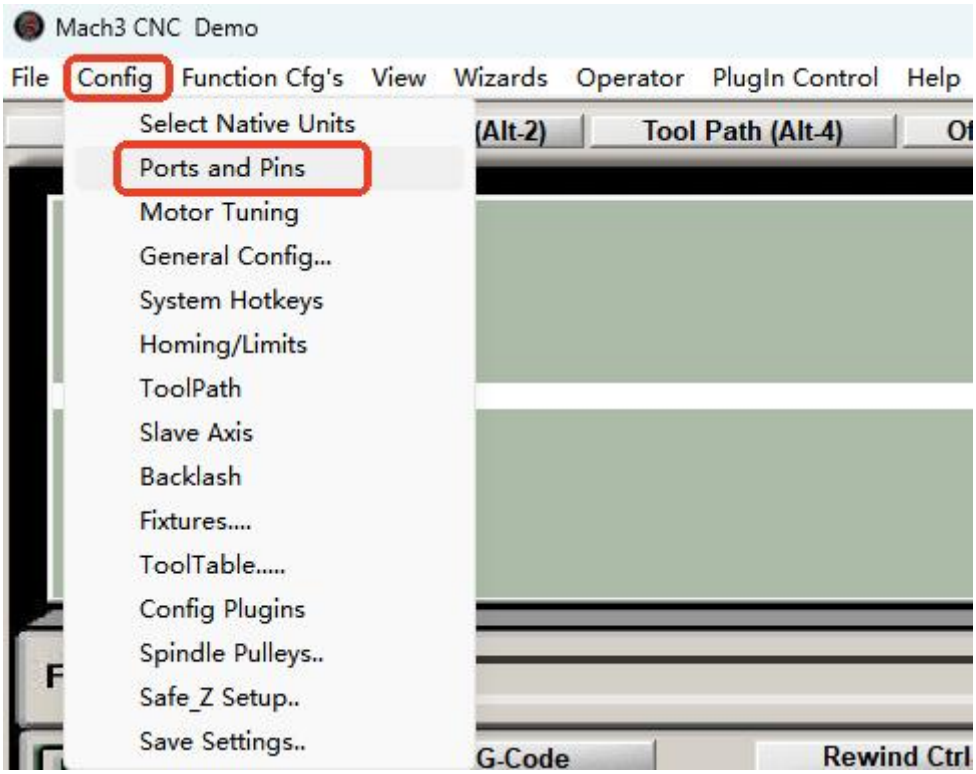


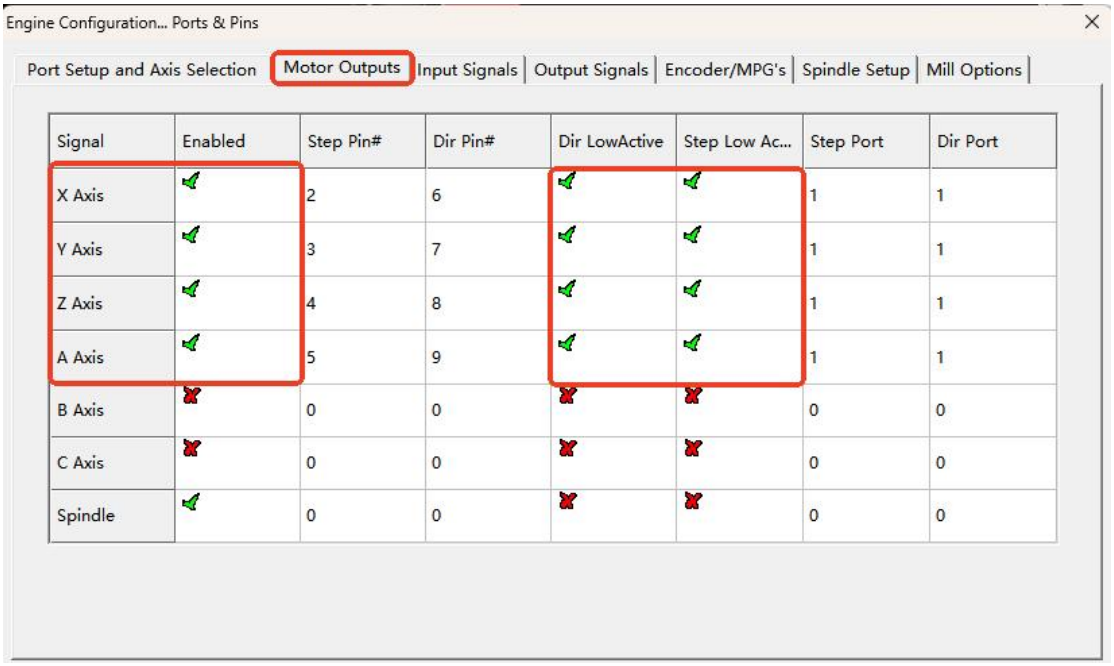
Single-Ended Mode

Motor drivers with single-ended interfaces usually come in two forms. The most common form has the signal isolation optocoupler inside connected to the internal 5V power supply. The wiring diagram for this type of driver's input interface to the ST-V3 Motion Control Card is as follows:



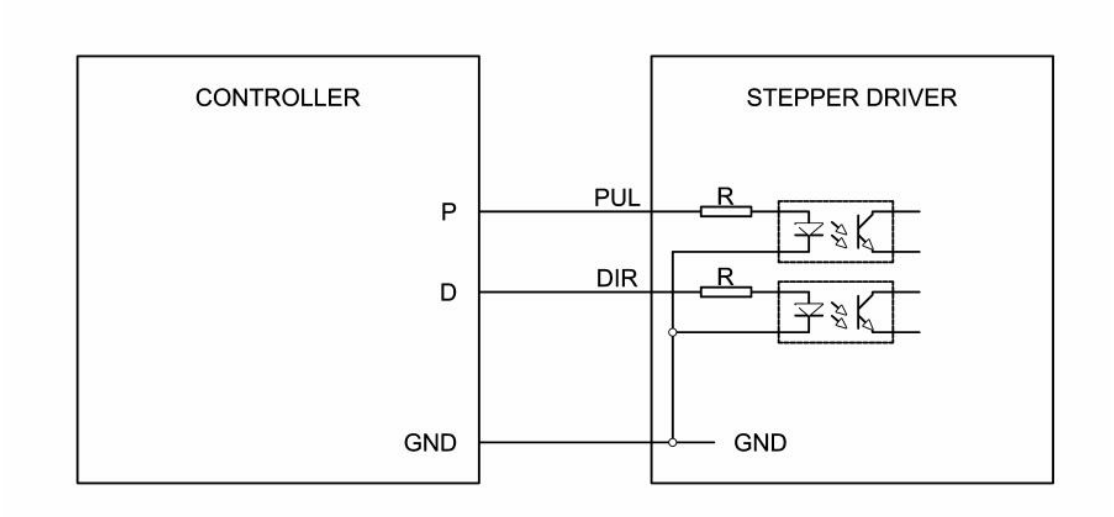
Note: When the ST-V3 motion control card outputs a "1" (high level), the motor driver's optocoupler outputs a "0"; when the ST-V3 motion control card outputs a "0" (low level), the motor driver's optocoupler outputs a "1". Therefore, the [Motor Outputs] in Mach3 must be configured as [Low Active]. The configuration method is: select the menu [Config], choose [Ports and Pins], then select the [Motor Outputs] page, and modify it as follows:





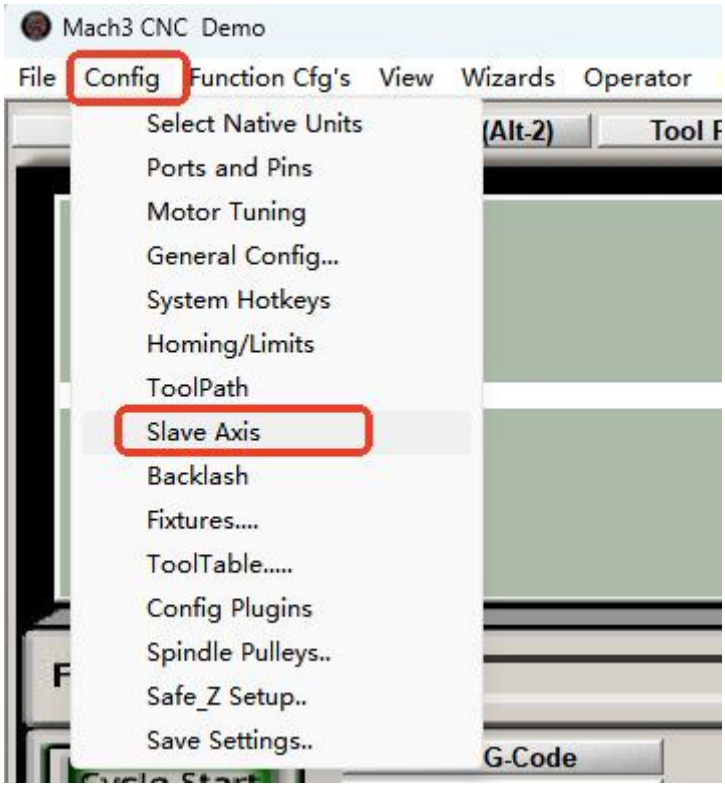
Signal	Enabled	Step Pin#	Dir Pin#	Dir LowActive	Step Low Ac...	Step Port	Dir Port
X Axis	✓	2	6	✓	✓	1	1
Y Axis	✓	3	7	✓	✓	1	1
Z Axis	✓	4	8	✓	✓	1	1
A Axis	✓	5	9	✓	✓	1	1
B Axis	✗	0	0	✗	✗	0	0
C Axis	✗	0	0	✗	✗	0	0
Spindle	✓	0	0	✗	✗	0	0

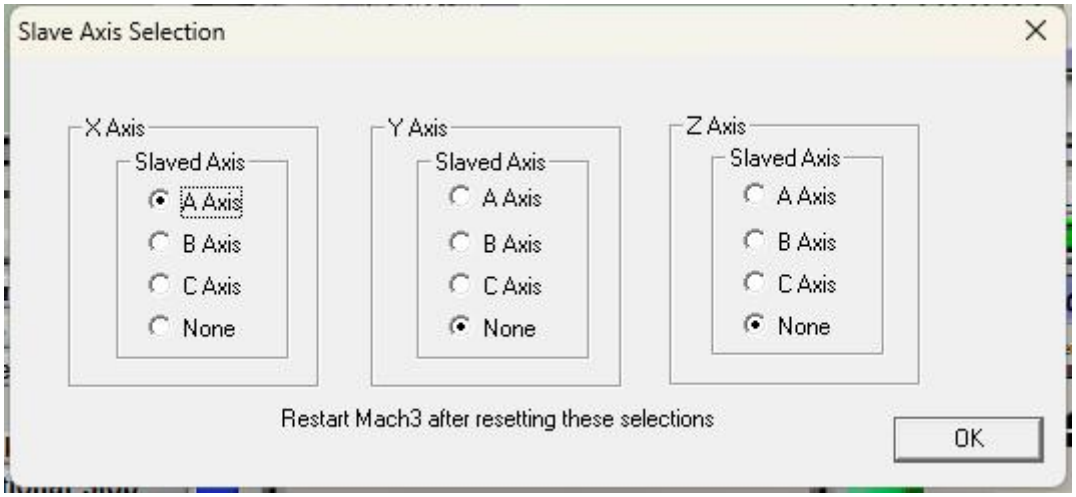
Another form of single-ended motor controllers has one end of the internal signal isolation optocoupler connected to the internal power ground. The wiring diagram for this type of driver's input interface connected to the ST-V3 Motion Control Card is as follows:



2. Slave Axis Setting

Some mechanical devices use a gantry structure, which typically requires dual-motor drive. The A-axis of the ST-V3 Motion Control Card can be set as a slave axis to move the gantry in coordination with the specified master axis. To set the A-axis as a slave axis: in Mach3, select the menu [Config], choose [Slave Axis], and set the slave axis in the [Slave Axis Selection] page.





As shown in the figure above, the A-axis becomes the slave axis of the X-axis. When the X-axis moves, the A-axis moves synchronously with the X-axis. When the X-axis performs a homing operation, the A-axis will automatically balance.

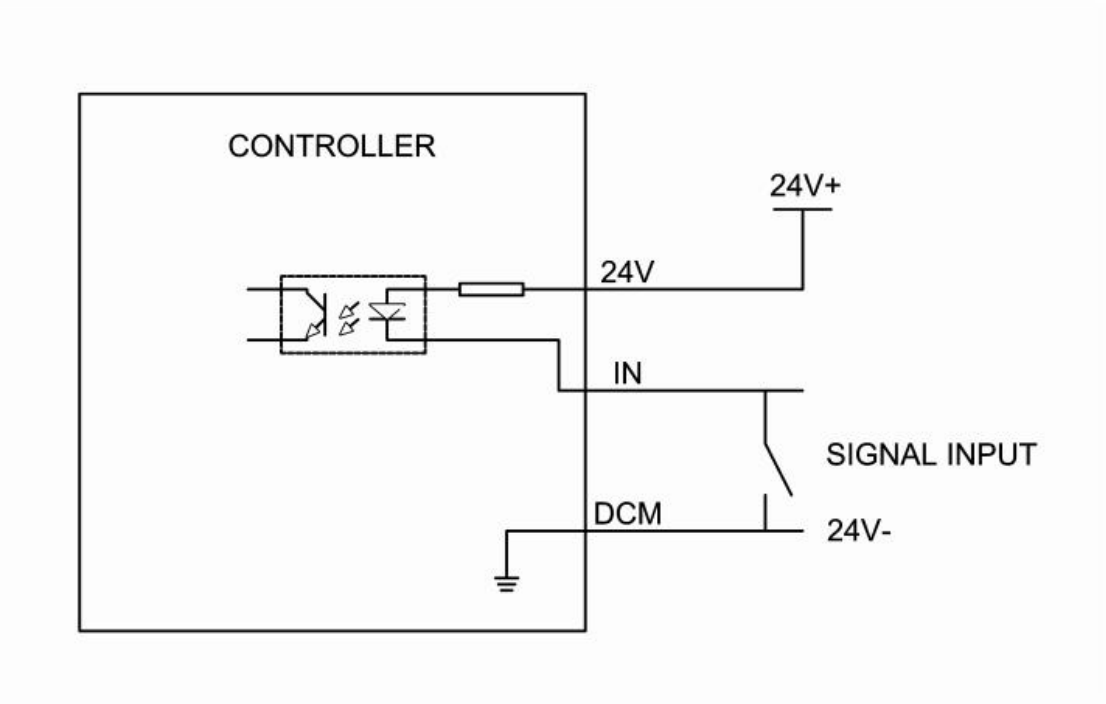
3. Other Notes

The pulse output port of the ST-V3 Motion Control Card includes a pair of 5V power output terminals (5V, GND). This pair of terminals provides a 5V DC power supply for the motor driver's input interface wiring. Avoid introducing other power lines to this interface unless necessary. When debugging the machine, if the movement direction of an axis is opposite

to the expected direction, you can reverse the movement direction by modifying the [Dir Low Active] item in the [Motor Outputs] configuration interface in Mach3. If an axis motor sounds harsh or runs roughly, or if the machining accuracy is abnormal, consider whether the output pulse polarity is opposite to what the motor driver requires. Try modifying the [Pulse Low Active] item in the [Motor Outputs] configuration interface in Mach3 to change the output pulse polarity.

6. Signal Input

The ST-V3 Motion Control Card provides 4 opto-isolated signal inputs. Users can flexibly define these inputs as tool setting signals, homing signals, emergency stop signals, limit input signals, or user-defined switch input signals. The signal input circuit diagram of the ST-V3 Motion Control Card is as follows:

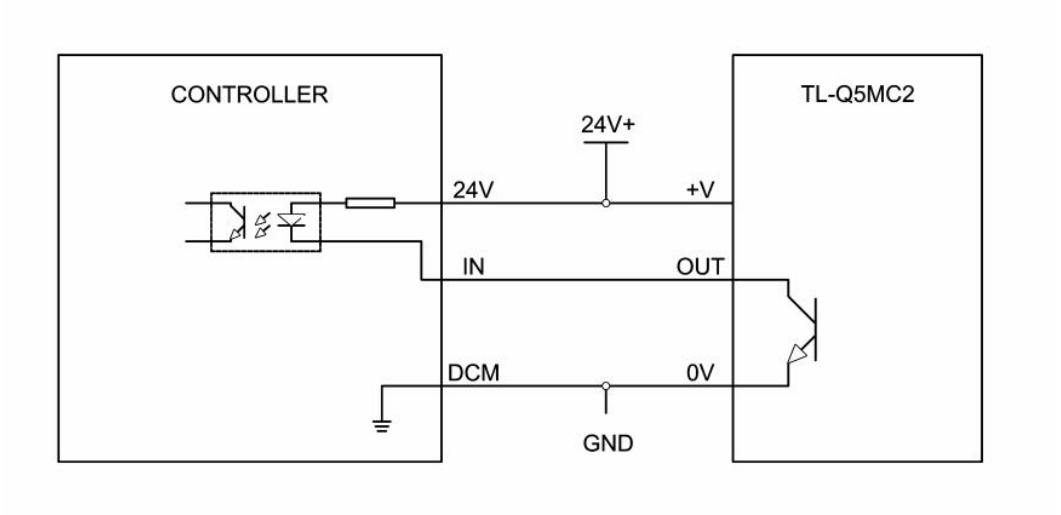


The user should connect the COM+ terminal to the positive pole of the external 24V DC power supply, and the negative pole of the 24V DC power supply should be connected to the COM- terminal. When the IN1..IN4 terminals are shorted to the negative pole of the 24V power supply, the circuit is closed, and the corresponding input signal is logic "1"; when the IN1..IN4 terminals are open, the corresponding input signal is logic "0".

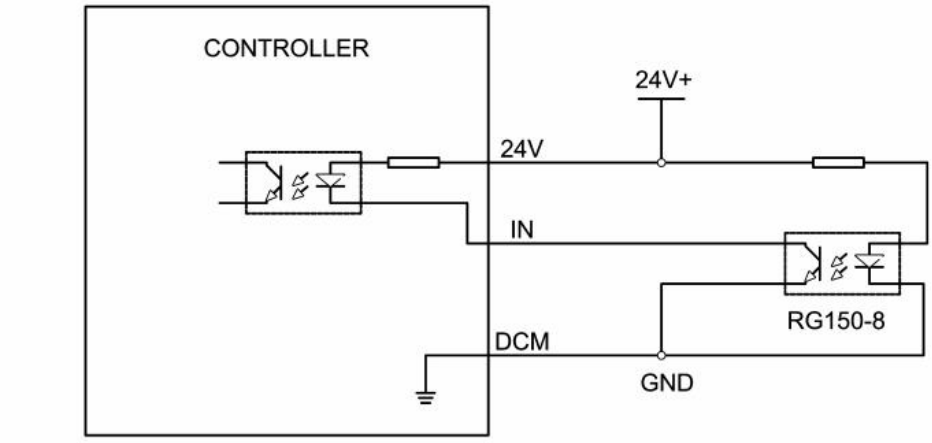
1. Wiring of Input Signals

The signal input terminals are often connected to proximity switches or photoelectric switches by users. Below are examples of these two scenarios.

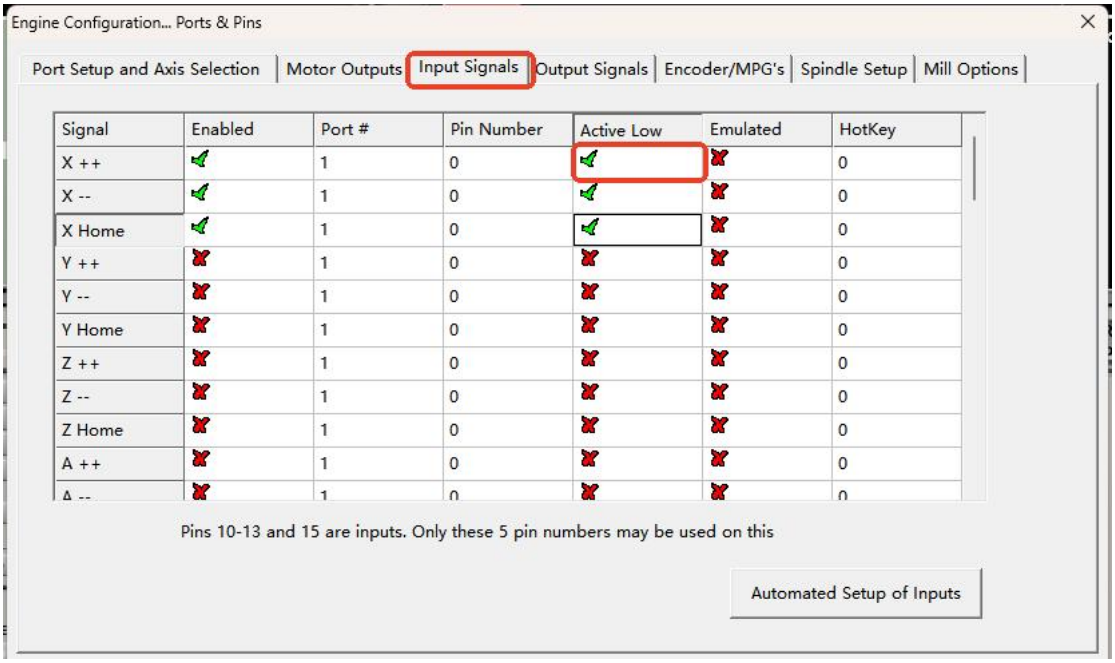
Using the OMRON proximity switch TL-Q5MC2 (TL-Q5MC2 is a DC 3-wire, NPN-type proximity switch with a power supply voltage of DC12-24V and open-collector output) as an example, the wiring diagram is as follows:



Photoelectric switches are often used as limit switches or homing switches. Taking the photoelectric switch RG150-8 (with a maximum LED current of 50mA, NPN type, and open-collector output) as an example, the wiring diagram for the photoelectric switch connected to the ST-V3 Motion Control Card is as follows:



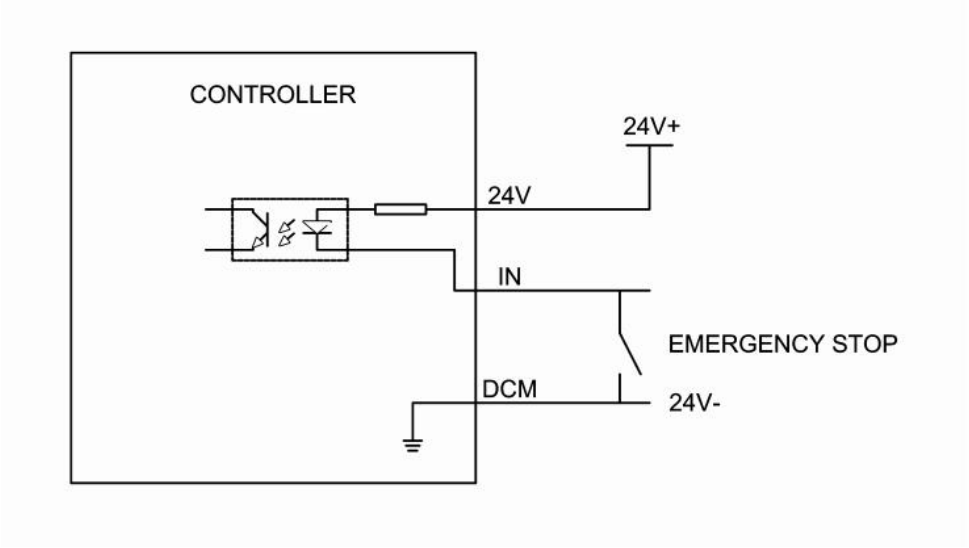
It is worth noting that, under normal circumstances, photoelectric switches are normally open. When the moving part approaches, the light gap of the photoelectric switch is blocked, causing the switch to open. As a result, the signal input terminal is usually at logic "1" and changes to logic "0" when approached. This is the opposite of the previous scenarios. In this case, we must configure the corresponding input terminal as [Active Low] in the Mach3 software. The configuration method is as follows: select the menu [Config], choose [Ports and Pins], and then select the [Input Signals] page, as shown below:



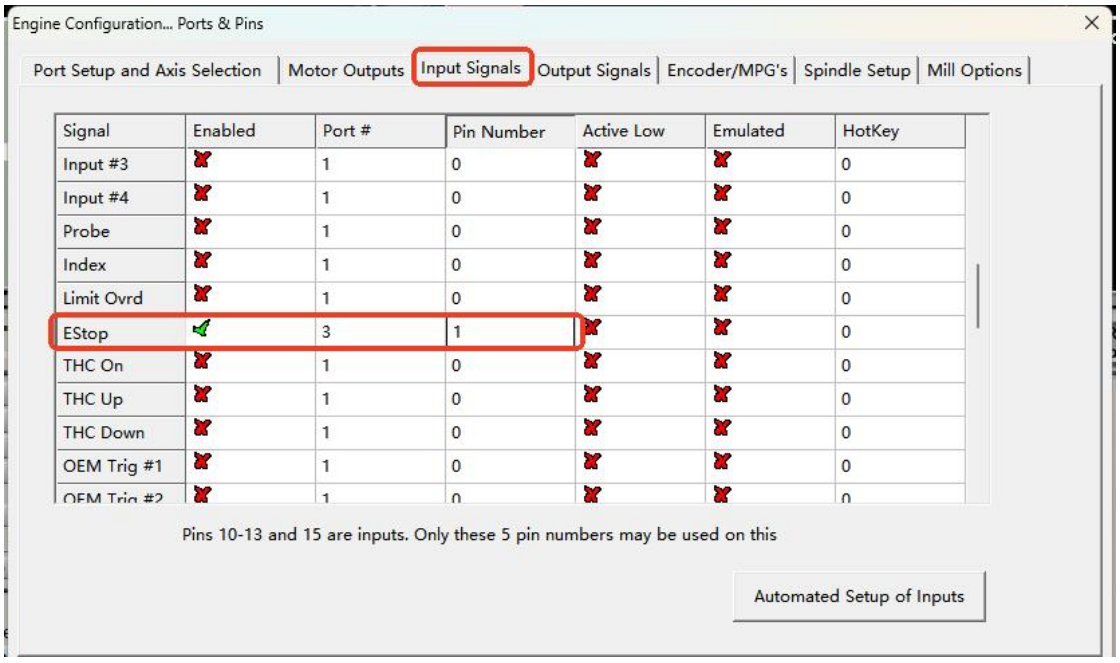
Assuming the user connects the photoelectric switch to the IN1 terminal as the X-axis limit switch, then, as shown in the figure, the [Active Low]*option for “X++” and “X--” should be checked.

2. Emergency Stop Button

When the user presses the [Emergency Stop] button during processing, the process will immediately terminate, eliminating accidents at the first sign of danger. For safety reasons, we strongly recommend connecting an emergency stop button to one of the signal inputs (IN1..IN4). The wiring diagram for the emergency stop button is as follows:



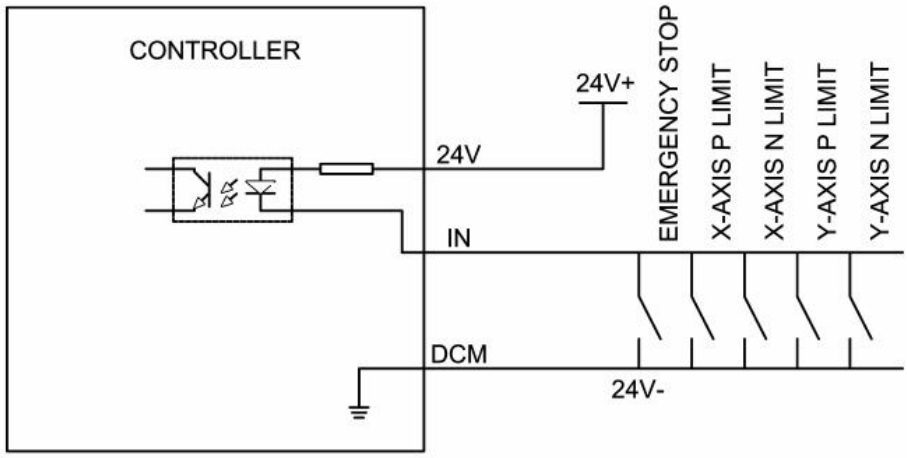
Assuming the user connects the emergency stop button to the IN1 terminal, we need to configure this in the Mach3 software accordingly. The configuration method is as follows: select the menu [Config], choose [Ports and Pins], and then select the [Input Signals] page. Scroll down to find the row with [Signal] named [EStop], check the [Enabled] option for the EStop row, and set [Port #] to 3. Setting the port to 3 means that this signal is processed by the ST-V3 Motion Control Card. Other port numbers indicate that the signal is unrelated to the ST-V3 Motion Control Card. Set [Pin Number] to 1, indicating that this signal is connected to the IN1 terminal of the ST-V3 Motion Control Card. After completing the configuration, click “OK”. The configuration is shown in the figure below:



Run a segment of G-code, then try pressing the emergency stop button connected to the IN1 terminal, and observe whether the device suddenly brakes and stops operating.

3. Limit Switches

When a limit switch is triggered, the machining process will immediately terminate. This effectively prevents the tool from moving outside the working area and causing danger. The effect is the same as pressing the emergency stop button. Therefore, we recommend connecting limit switches. To save signal input terminals, you can connect the positive and negative limit switches of each axis and the emergency stop button in parallel to the same signal input terminal.



Similar to the emergency stop button in the previous section, we need to make corresponding configurations in the Mach3 software. Assuming the limit switch is connected to the IN1 terminal, the configuration method is as follows: select the menu [Config], choose [Ports and Pins], and then select the [Input Signals] page. Scroll down to find the rows with [Signal] named [X++ (X-axis positive limit)], [X-- (X-axis negative limit)], [Y++ (Y-axis positive limit)], [Y-- (Y-axis negative limit)], [Z++ (Z-axis positive limit)], etc. Check the [Enabled] option, set [Port #] to 3, and set [Pin Number] to 1, as shown in the figure below:

Note: If the limit switch used is a photoelectric switch, since photoelectric switches are normally open, you should also refer to the "Input Terminal Wiring" section and check the corresponding [Active Low] option. Additionally, during wiring, the switches should not be connected in parallel but should instead be connected in series.

4. Automatic Homing

The ST-V3 Motion Control Card supports the automatic homing function for each axis. The automatic homing action consists of four consecutive stages:

Stage 1:
The axis moves toward the homing switch at a percentage of the G0 (rapid movement) speed specified by the [Speed%] parameter in Mach3, following the configured direction, until it contacts the homing switch.

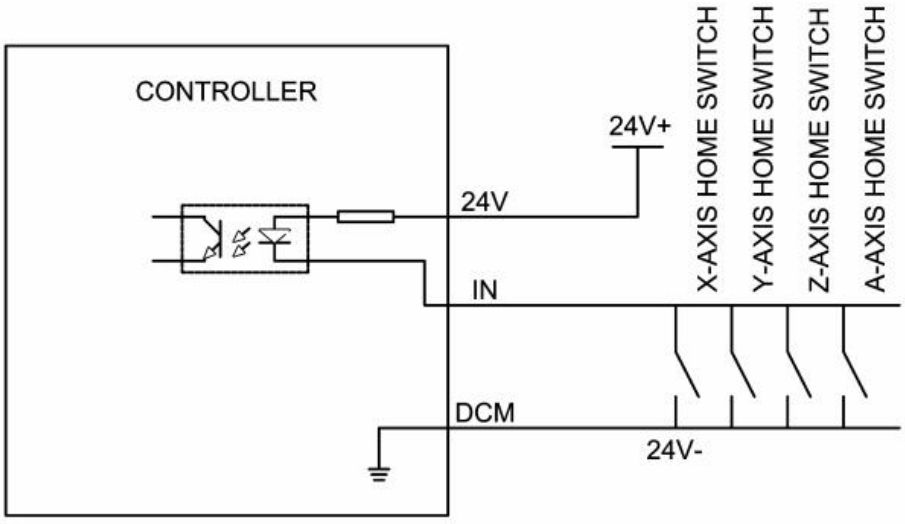
Stage 2:
The axis retracts from the homing switch at the full G0 speed and stops after moving back a preset distance.

Stage 3:
The axis slowly approaches the homing switch again at 1/10 of the Stage 1 speed until it lightly touches the homing switch and stops.

Stage 4: Similar to Stage 2, the axis retracts at G0 speed to the preset distance and stops. The third stage contacts the homing switch at an extremely slow rate to ensure precise homing accuracy. The fourth stage ensures that the axis fully disengages from the homing switch after the homing operation. This step prevents sparking caused by prolonged light contact with the homing switch and ensures the axis disengages completely, allowing multiple axes to share the same signal input terminal (e.g., IN1..IN4) while performing homing operations correctly.

As introduced in the previous section "Limit Switch Setup," to save input terminals, the homing switches of all 4 axes can be connected in parallel and share a single signal input terminal (e.g., IN1..IN4).

The wiring diagram is shown below:



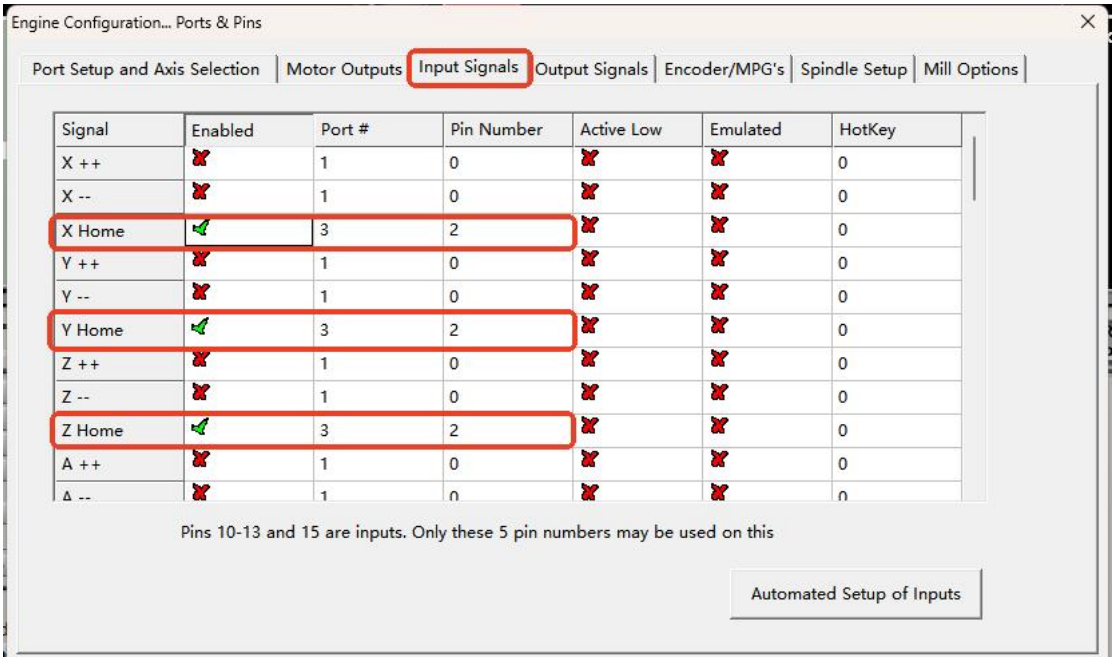
Meanwhile, corresponding configurations need to be made in the Mach3 software. Assuming the homing switch is connected to the IN2 terminal, the configuration method is as follows:
Select the menu [Config],
Choose [Ports and Pins].
Go to the [Input Signals] page.
Scroll down to find the rows with [Signal] named [X Home (X-axis homing switch)], [Y Home (Y-axis homing switch)], [Z Home (Z-axis homing switch)], and [A Home (A-axis homing switch)].

Check the [Enabled] option for each row.

Set [Port #] to "3".

Set [Pin Number] to "2".

The configuration is shown in the figure below:



If the selected homing switch is a photoelectric switch, since photoelectric switches are normally open, you should also refer to the [Input Terminal Wiring] section and check the [Active Low] option. Additionally, the switches should not be connected in parallel but rather in series.

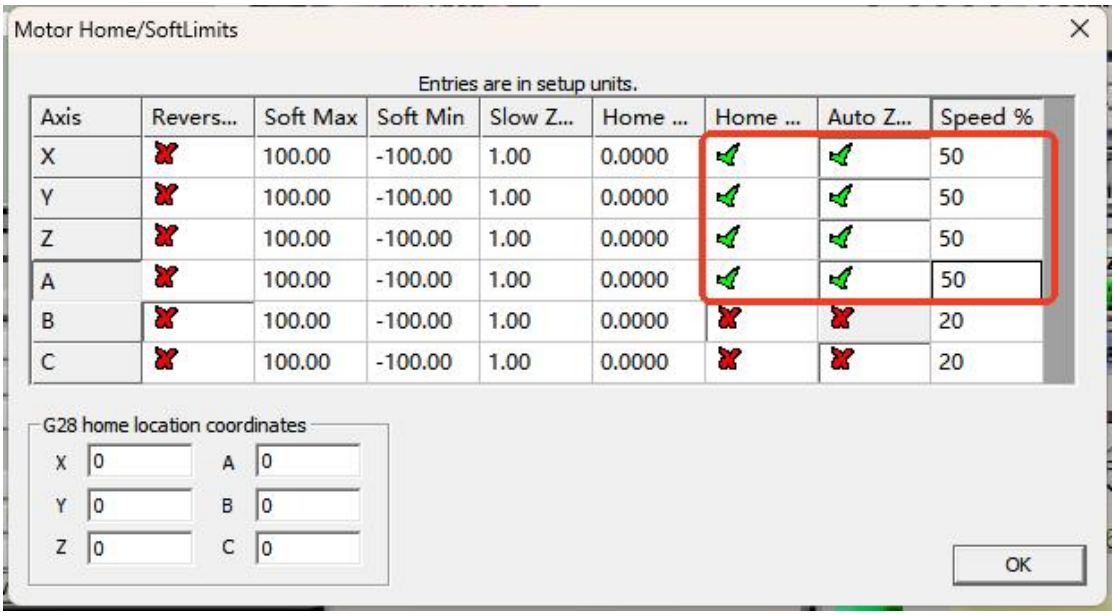
To configure the homing speed:

1. Select the menu [Config].
2. Choose [Homing/Limits].
3. In the [Motor Home/Soft Limits] interface, locate the row corresponding to the desired axis.
4. Modify the [Speed %] value. For example, if you want to perform homing at 50% of the G0 (rapid movement) speed, set [Speed %] to "50".

The direction of axis movement during homing is related to the position of the homing switch.

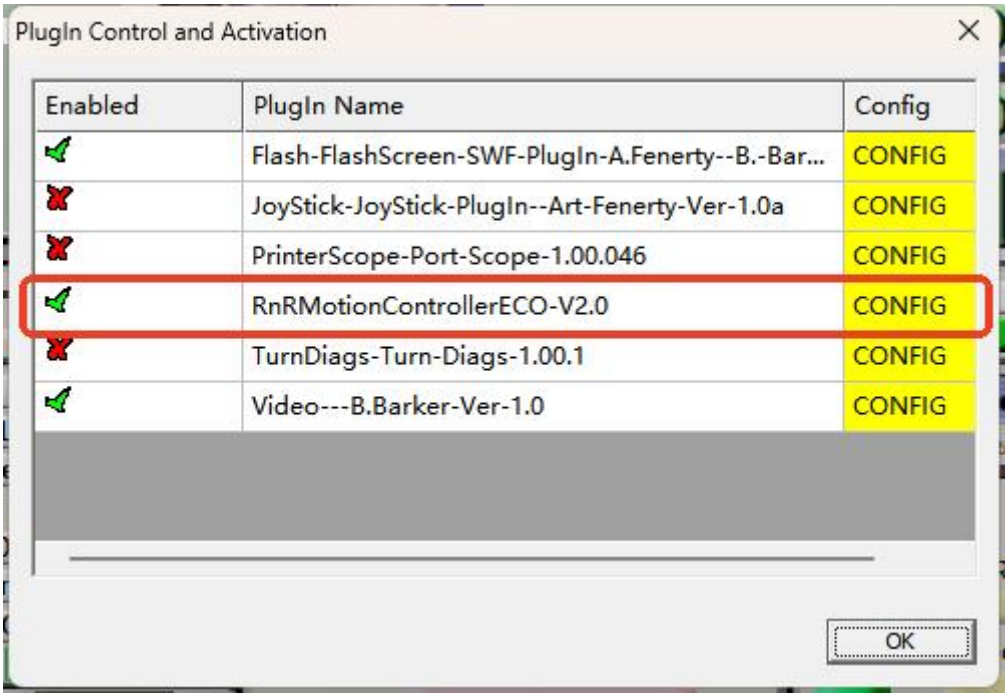
- If the homing switch is installed at the negative coordinate end of the axis, check the [Home Neg] option.
- If the homing switch is installed at the positive coordinate end of the axis, uncheck (or mark with a cross) the [Home Neg] option.

The configuration is shown in the figure below:

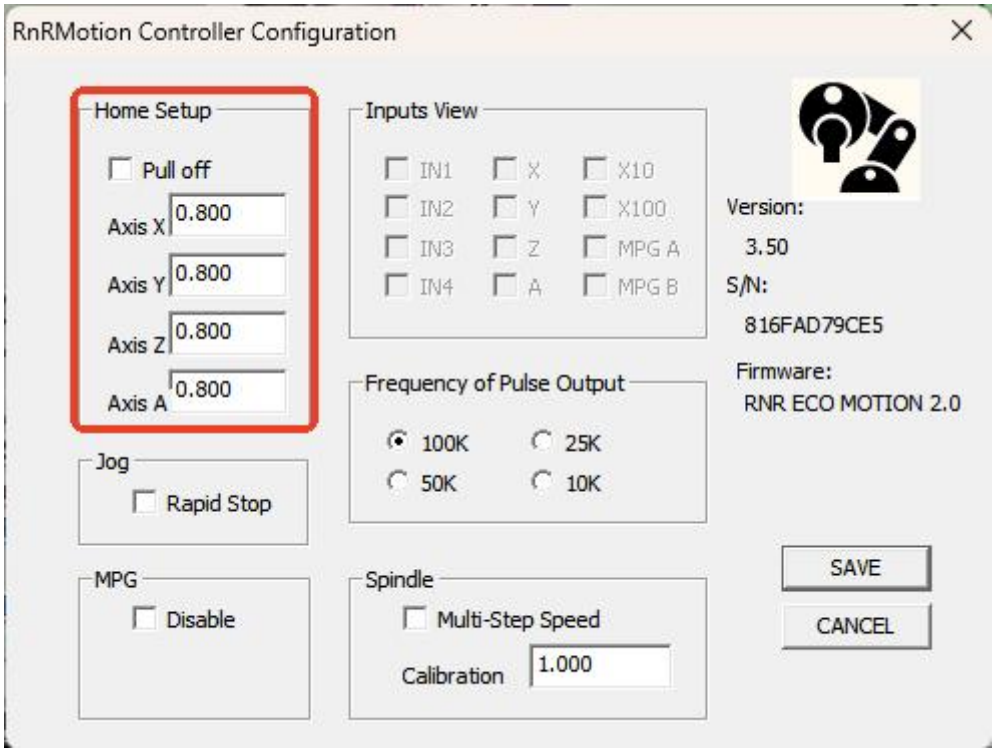


In the automatic homing process, Stage 2 and Stage 4 are the retraction stages after reaching the homing switch. To set the retraction distance:

1. Select the menu [Config].
2. Choose [Config Plugins].
3. A window will pop up as shown below:



In the pop-up window, locate the row for [RnRMotionController-ECO-V2.0] and click [CONFIG] to open the [RNRMotion Controller Configuration] dialog box.



In the homing settings box, modify the retraction distance for each axis. As shown in the figure above, set the retraction distance to "0.8". This way, during the homing operation, the retraction distance will be 0.8 units. After completing the settings, do not forget to click the [SAVE] button.

5. Automatic Homing for Slave Axes

Both the slave axis and its corresponding axis must be equipped with homing switches, and the homing switches for the slave axis and its corresponding axis should be connected to two signal input terminals. Here, assuming the slave axis of the X-axis is the A-axis, then install a homing switch on the X-axis and install a homing switch on the A-axis. When the X-axis performs the homing operation, in the first stage, both the X-axis and the A-axis will move toward the homing switch direction. Then, the axis that first touches the homing switch will stop moving, while the other axis will continue moving until it also touches the homing switch. The subsequent third stage is similar to the first stage. In this way, the two axes are balanced during automatic homing.

6. Automatic Tool Setting

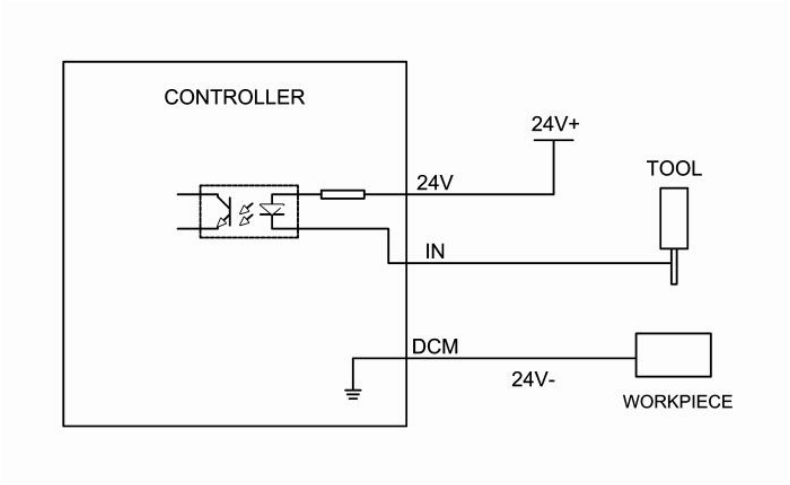
The ST-V3 Motion Control Card supports automatic tool setting functionality. In Mach3, using automatic tool setting, it is possible to achieve automatic measurement and

compensation of tool length, edge finding of workpieces, center finding of cylindrical workpieces, and center point finding of workpiece inner holes.

To use automatic tool setting, connect a signal input terminal (IN1..IN4) of the ST-V3 Motion Control Card to an external tool setter. The tool setter can be a professional tool setter, as shown in the figure:

It can also be a simple homemade tool setter. The tool setter is essentially a micro switch. Therefore, making a homemade tool setter is very simple. Two wires are needed: one connects to the tool or edge finder, and the other connects to a single-sided printed circuit board or the workpiece. When the tool or edge finder touches the copper layer of the circuit board or the metal workpiece, the circuit is completed, and the tool setting signal is input. A simple homemade tool setter is shown in the figure:

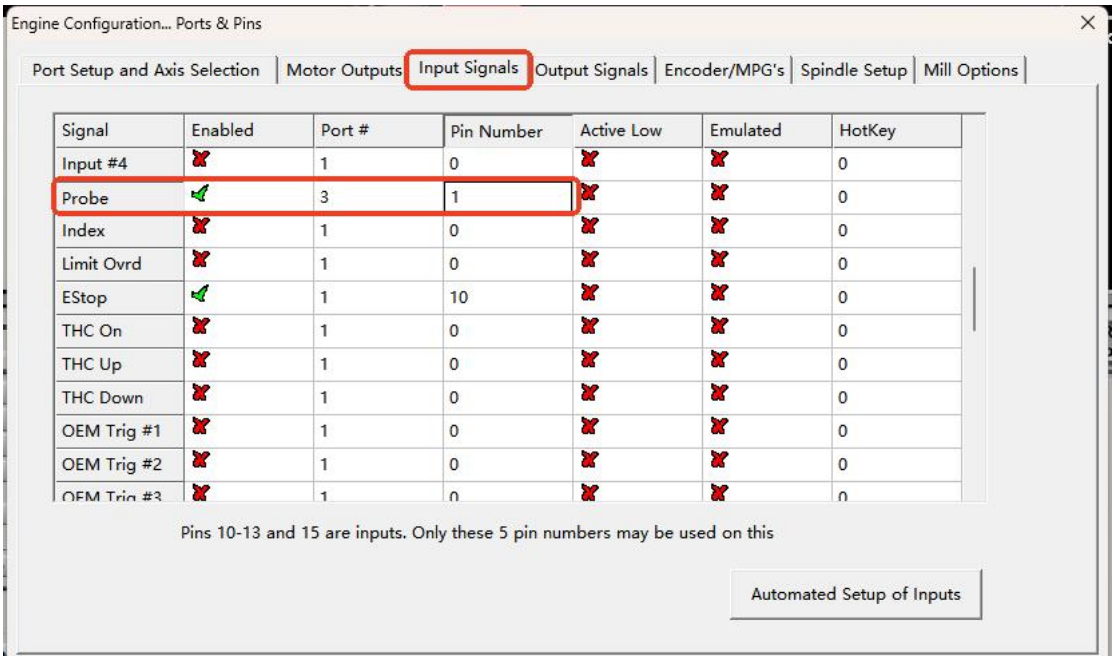
The wiring diagram for tool setting is as follows:



Select one of the input signal terminals IN1..IN4 as the tool setting signal input. Assuming IN1 is selected as the tool setting signal input, the configuration method in Mach3 is as follows:

1. Select the menu [Config].
2. Choose [Ports and Pins].
3. Go to the [Input Signals] page.
4. Locate the row with [Signal] named [Probe (Detection)].
5. Check the [Enabled] option.
6. Set [Port #] to "3".
7. Set [Pin Number] to "1".

The configuration is shown in the figure below:



In Mach3, the specific tool setting process is completed through VBScript code.

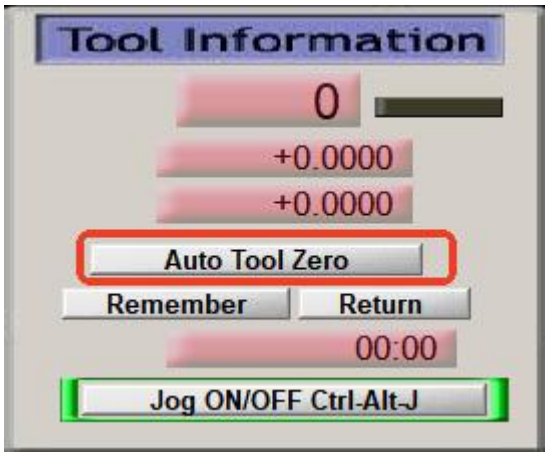
The VBScript code needs to be written by the user according to actual requirements. In the downloaded materials, we have included some common tool setting script codes for your reference and use.

7. Automatic Tool Zeroing

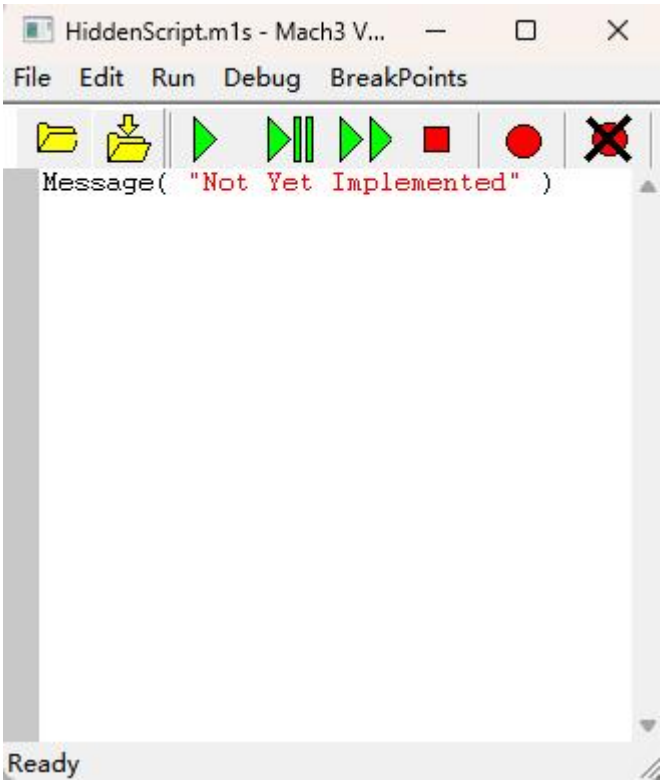
The automatic tool zeroing function helps users eliminate tool length and workpiece thickness, defining the Z-axis zero coordinate at the machining surface of the workpiece. Mach3 does not provide script code for automatic tool zeroing, so we need to program this function.

Programming Steps:

1. Select the menu [Operator].
2. Choose [Edit Button Script].
3. Navigate to the [Program Run] interface in Mach3.
4. Click the [Auto Tool Zero] button, as shown in the figure:



At this point, Mach3 will pop up a script editing window, as shown in the figure:



Delete the original script code in the window. Locate the "Tool Setting Scripts" folder in the downloaded materials and open the "Automatic Tool Zeroing" file., copy the script inside, and paste it into the script editing window in Mach3. Select the window menu [File] and click [Save]. Then close the window.

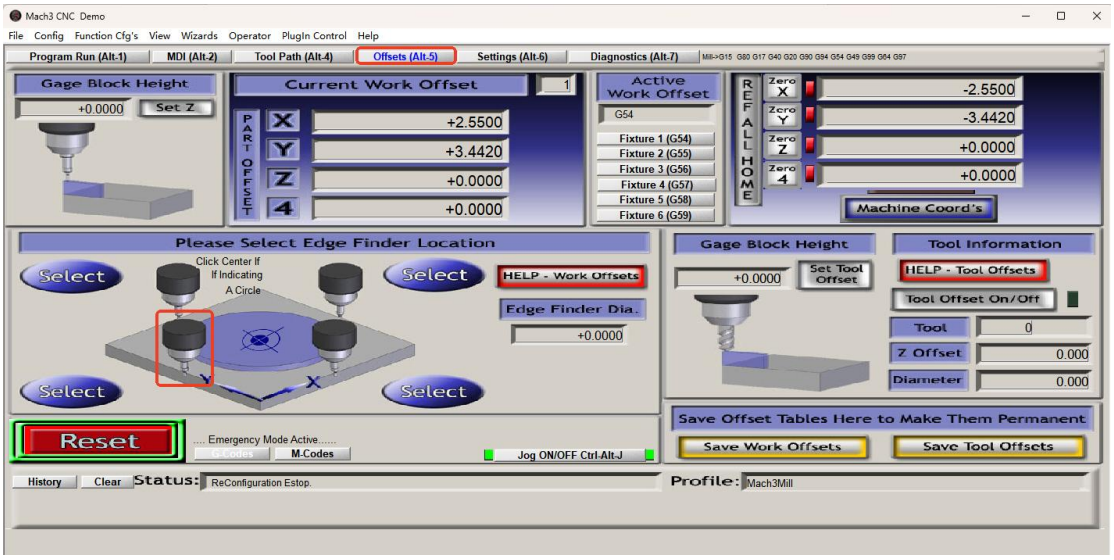
After connecting the tool setter, press the [Auto Tool Zero] button to execute the tool zeroing function.

8. Automatic Edge Finding

The automatic edge finding function helps users set the zero coordinate for a specific edge of the workpiece (left and right edges along the X-axis, top and bottom edges along the Y-axis). There are a total of 4 script codes depending on the edge being found.

Example: To set the X-axis to find the left edge, follow these steps:

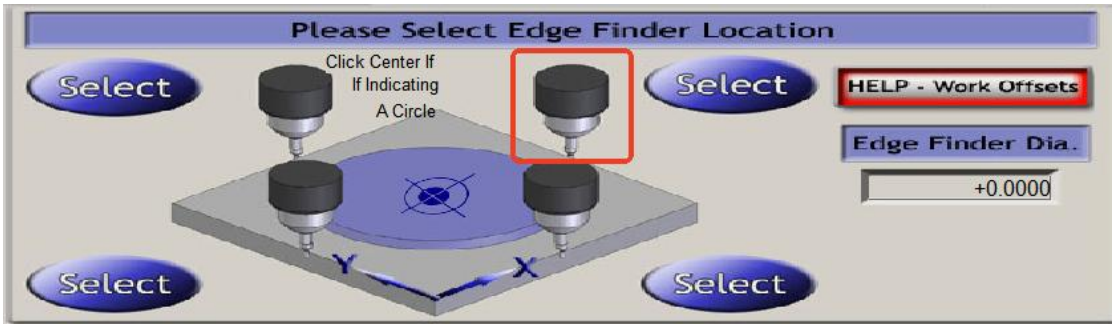
1. Select the menu [Operator].
2. Choose [Edit Button Script].
3. Navigate to the [Offsets] interface in Mach3.
4. Click the part circled in the red box in the figure below:



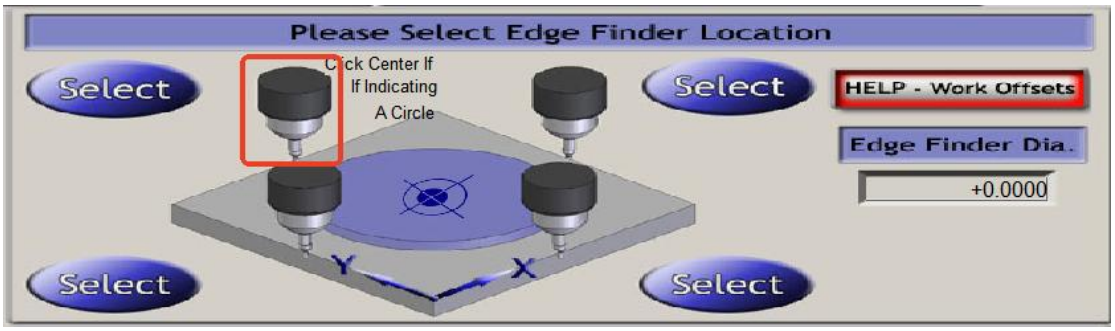
At this point, Mach3 will pop up a script editing window, as shown in the figure:

Delete the original script code in the window. Locate the "Tool Setting Scripts" folder in the downloaded materials., open the "Edge Finding_X Left" file, copy the content, and paste it into the script editing window in Mach3. Select the menu [File] and click [Save]. Then close the window.

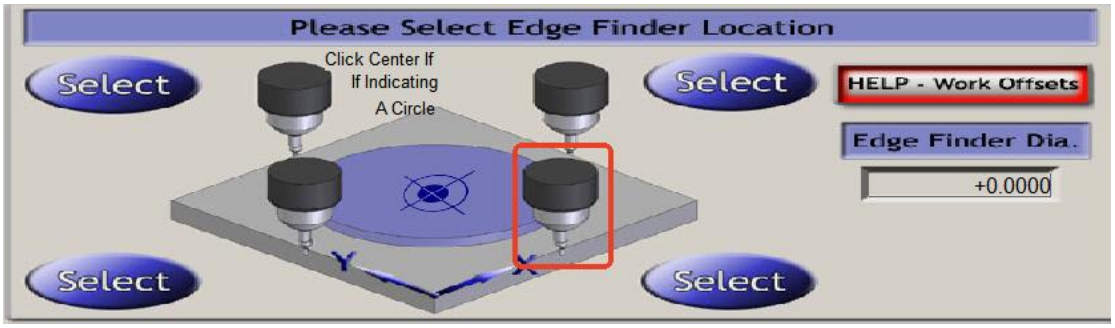
After connecting the tool setter, enter the diameter of the edge finder in the [Edge Finder Dia.] field. When clicking the part circled in the red box in the image above, Mach3 will start the X-axis left edge finding operation. The other 3 edge finding settings are similar.
For X-axis right edge finding:



The script code file for the above button is "Edge Finding_X Right".
For Y-axis top edge finding:



The script code file for the above button is "Edge Finding_Y Top".
For Y-axis bottom edge finding:

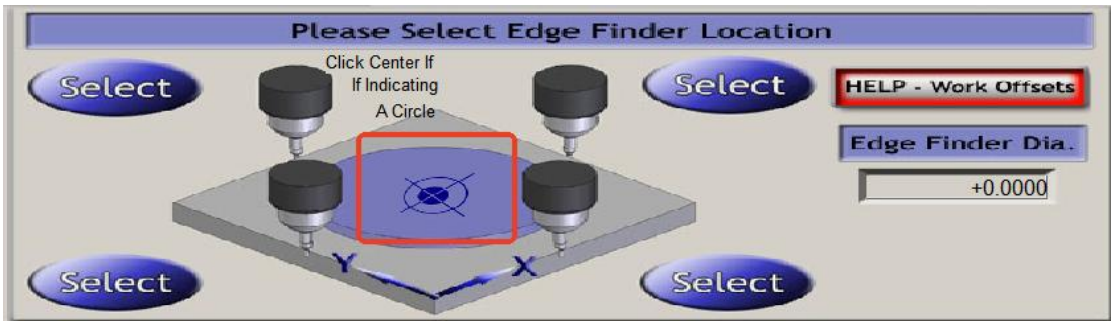


The script code file for the above button is "Edge Finding_Y Bottom".

9. Center Finding

1. Select the menu [Operator].

2. Choose [Edit Button Script].
3. Navigate to the [Offsets] interface in Mach3.
4. Click the part circled in the red box in the figure below:



In the pop-up script editing window, write the code for the center finding function. Locate the "Tool Setting Scripts" folder on the included CD, open the "Center Finding_Cylinder" file, copy the script inside, and paste it into the script editing window in Mach3. Select the menu [File] and click [Save]. Then close the window.

First, use the jog function to move the edge finder to a position approximately 7-8 mm above the (approximate) center of the cylinder. Click the part circled in the red box in the image above, and Mach3 will start the automatic center finding operation for the cylinder.

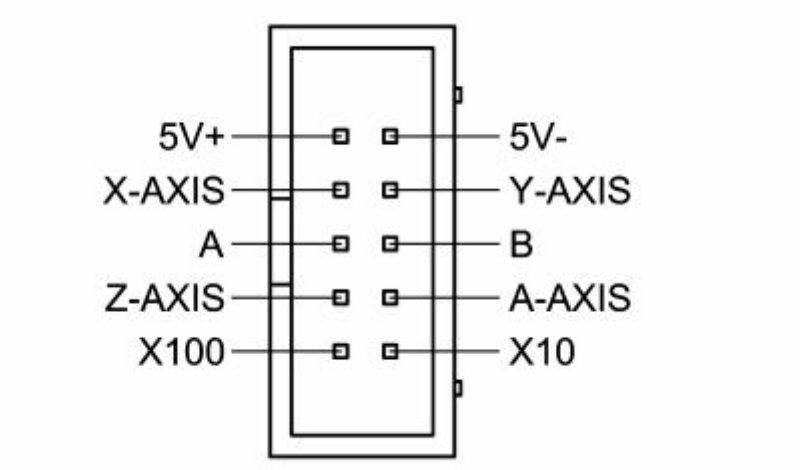
To find the center of a circular hole, please use the script code "Center Finding_Inner Hole" included in the downloaded materials. During operation, first move the edge finder to the (approximate) center of the hole, then click the part circled in the red box in the image above to start the inner hole center finding operation.

7. Handwheel Interface

The ST-V3 Motion Control Card provides a handwheel interface for connecting user-provided handwheels. Note that the handwheel interface has a withstand voltage of 5V, so only handwheels powered by 5V DC can be connected. If the handwheel interface input exceeds 5V, it may damage the ST-V3 Motion Control Card.

1. Handwheel Wiring

The pin definitions for the handwheel interface are shown in the figure below:



Below is an explanation of each pin:

- 5V Positive, 5V Negative: Provides a 5V DC power supply, which can be used to power the handwheel.

- X-axis, Y-axis, Z-axis, A-axis: Connected to the axis selection switch on the handwheel, used to select the axis for jogging.

- A and B: Connected to the encoder outputs A and B of the handwheel.

- X10: Multiplies the handwheel rate by 10.

- X100: Multiplies the handwheel rate by 100.

2. Handwheel Setup in Mach3

After connecting the handwheel, you must configure it in Mach3 to enable the handwheel jogging function. The setup method is as follows:

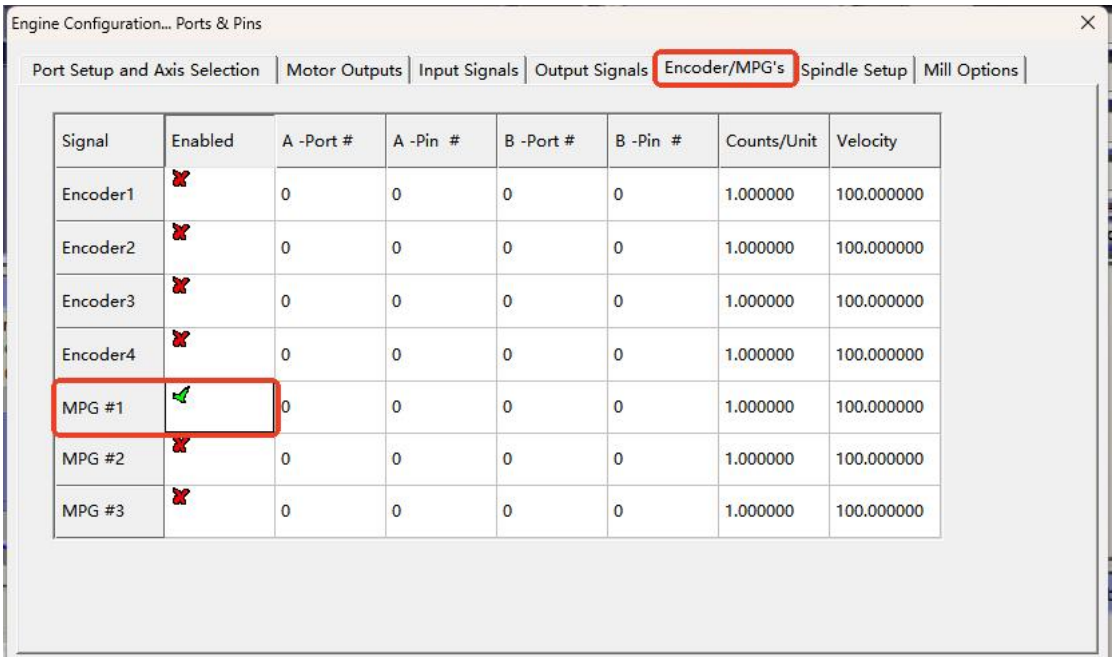
1. Select the menu [Config].

2. Choose [Ports and Pins].

3. Go to the [Encoder/MPG's] page.

4. Check the [Enabled] option for [MPG#1].

The configuration is shown in the figure below:



Signal	Enabled	A -Port #	A -Pin #	B -Port #	B -Pin #	Counts/Unit	Velocity
Encoder1	✗	0	0	0	0	1.000000	100.000000
Encoder2	✗	0	0	0	0	1.000000	100.000000
Encoder3	✗	0	0	0	0	1.000000	100.000000
Encoder4	✗	0	0	0	0	1.000000	100.000000
MPG #1	✓	0	0	0	0	1.000000	100.000000
MPG #2	✗	0	0	0	0	1.000000	100.000000
MPG #3	✗	0	0	0	0	1.000000	100.000000

Click the [OK] button to save the settings. Then press the [Tab] key on the keyboard to bring up the handwheel control interface in Mach3, as shown in the figure:

Click the [Jog Mode] button to switch the jog mode to [MPG] mode. Click [Alt A] to select the X-axis, as shown in the figure above. Try gently rotating the handwheel encoder to see if it can control the movement of the X-axis.

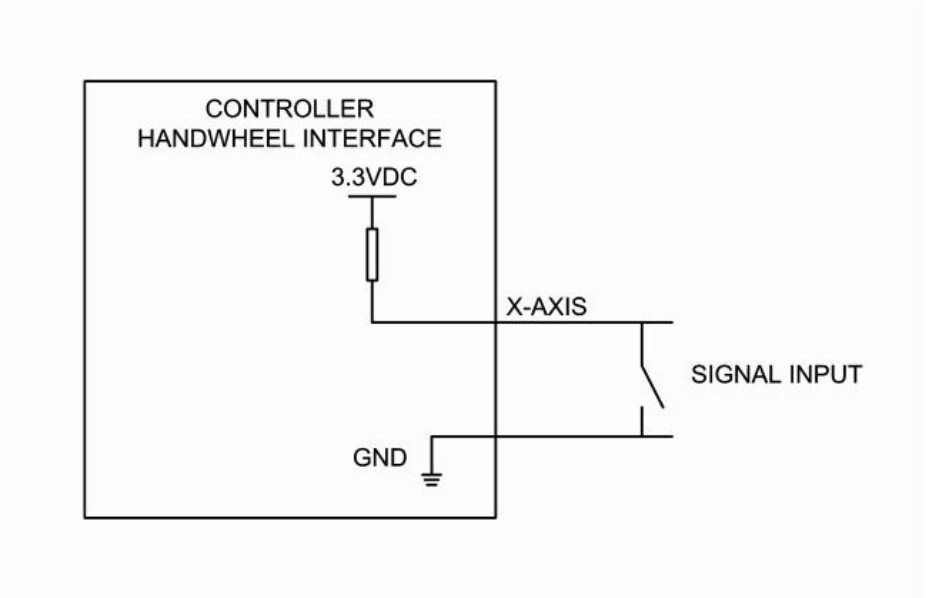
3. Handwheel Interface as Extended Signal Input

If the handwheel is not needed, the handwheel interface can be used as a signal input. This provides an additional 8 input channels, combined with the previous 4 signal input terminals IN1..IN4, resulting in a total of 12 signal input channels. In this case, the handwheel interface pins correspond to the following signal input terminals:

- X-axis: IN5
- Y-axis: IN6
- Z-axis: IN7
- A-axis: IN8
- X10: IN9
- X100: IN10
- A: IN11
- B: IN12

Note: The input terminals IN5..IN12 corresponding to the handwheel interface do not support functions such as homing, limit switches, or tool setting. They can only be used as general-purpose digital signal inputs (typically for connecting control panels).

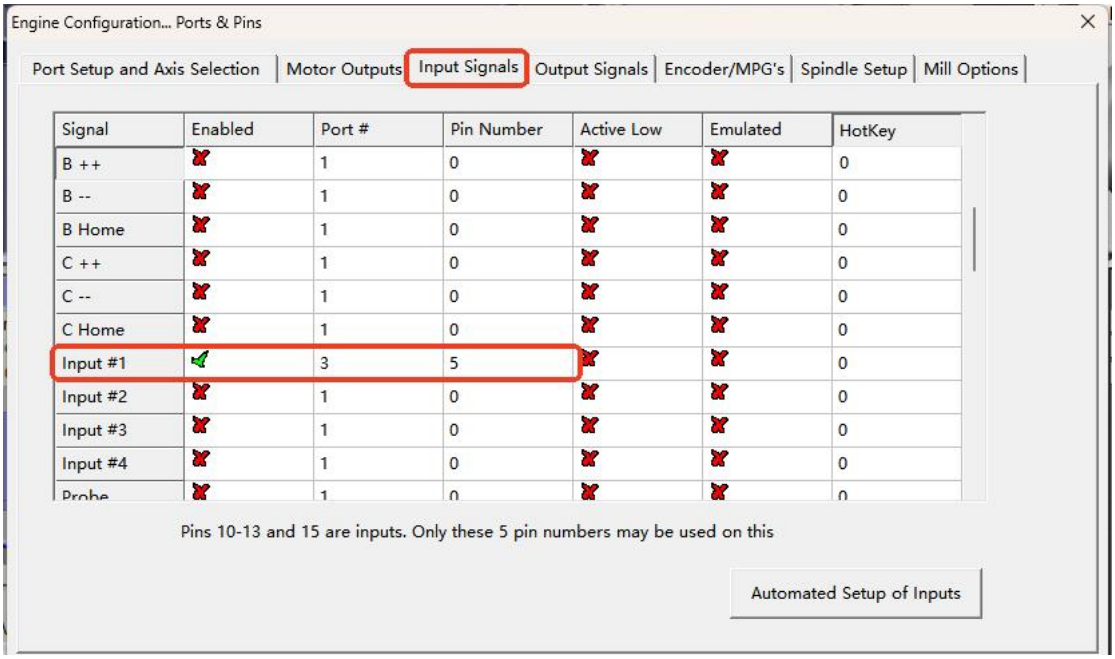
For example, if an input signal needs to be connected to the X-axis, the internal schematic of the handwheel interface is as follows:



When the signal input switch is closed and shorted to ground, the X-axis inputs a logic signal "1". To configure this in Mach3:

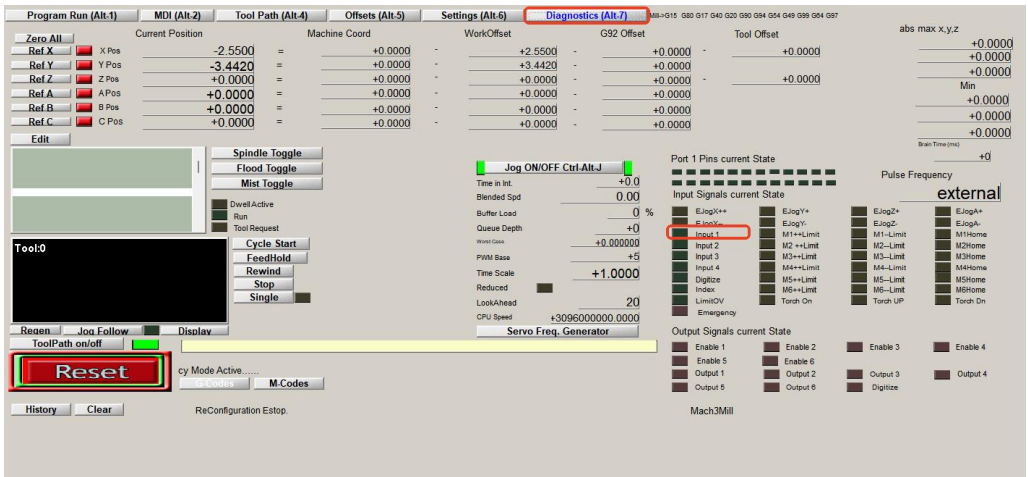
1. Select the menu [Config].
2. Choose [Ports and Pins].
3. Go to the [Input Signals] page.

The configuration is shown in the figure below:



Scroll down to find the row with [Signal] named [Input #1]. Check the [Enabled] option, set [Port#] to "3", and set [Pin Number] to "5". This maps Mach3's input signal [Input #1] to the X-axis input of the handwheel.

Next, navigate to the [Diagnostics] page in Mach3. When the external switch connected to the X-axis is closed, you will see [Input 1] turn green:

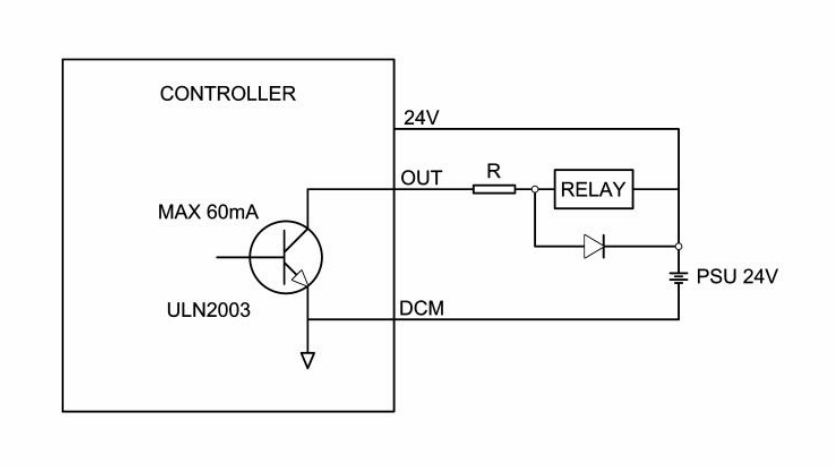


8. Signal Output

The ST-V3 Motion Control Card provides 4 opto-isolated outputs. The outputs use the Darlington transistor ULN2003, which can drive external relays or indicator lights. The driving capability is 60mA.

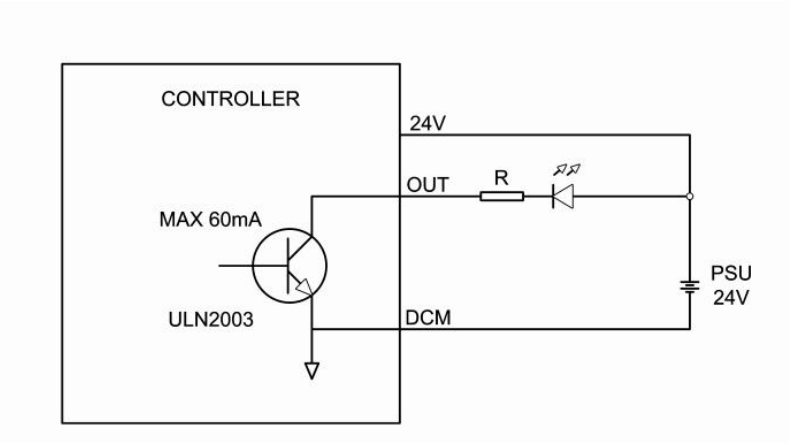
1. Signal Output Wiring

The wiring diagram for driving a relay with signal output is shown below:



The COM+ and COM- terminals of the signal output terminal block are connected to the positive and negative poles of an external 24V DC power supply, respectively. The output terminals OUT1..OUT4 are connected to the relay coil through current-limiting resistors (the other end of the relay coil is connected to the positive pole of the 24V power supply). The resistance value of the current-limiting resistor should be calculated based on the relay's parameters.

The wiring diagram for driving an external indicator light is shown below:



2. Spindle Motor Control

Mach3 supports spindle motor control. Mach3 provides three spindle motor control methods. The first is the relay method. Mach3 outputs control signals for motor forward and reverse through two signal output terminals. The second is the PWM method, where Mach3 outputs a PWM signal with a certain duty cycle through the signal output terminal, enabling speed control of (DC) spindle motors. The third method is the pulse method, mainly used to control servo motors, which the ST-V3 Motion Control Card does not support.

Below is an example to illustrate the setup of the first two spindle control methods in Mach3.

(1) Relay Method

In the relay method, the spindle motor uses two signal output terminals to control the relay's connection or disconnection, enabling the spindle motor's forward and reverse rotation.

Assume we need signal output terminal OUT1 to drive the motor's forward rotation relay and signal output terminal OUT2 to drive the motor's reverse rotation relay.

1. In Mach3, select the menu [Config].

2. Choose [Ports and Pins].

3. In the pop-up dialog, select the [Spindle Setup] page.

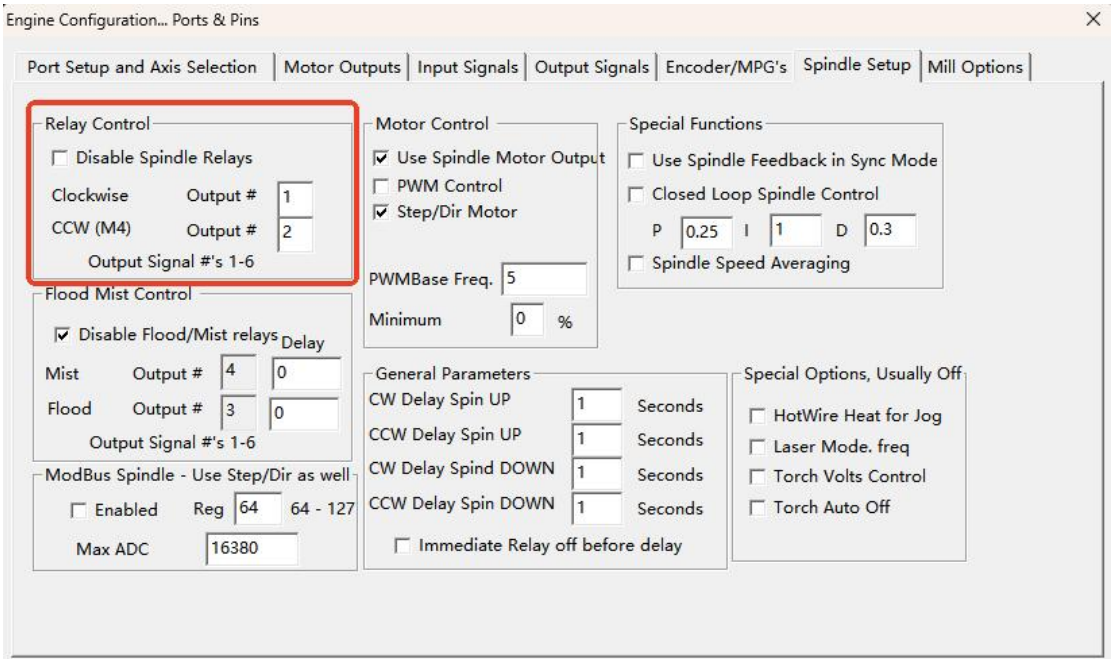
4. In the [Relay Control] box:

   - Ensure [Disable Spindle Relays] is not checked.

   - Enter "1" in the [Clockwise Output #] field.

   - Enter "2" in the [CCW Output #] field.

The configuration is shown in the figure below:



After completing the setup, click the [OK] button to save the settings. Users can connect indicator lights to OUT1 and OUT2 (refer to the previous section) for debugging. When executing the program "M3", you will see OUT1 output a signal; when executing "M4", you will see OUT2 output a signal; and when executing "M5", both OUT1 and OUT2 will turn off. Programs can be entered in the [Input] box within the [Manual Data Input (MDI)] page of Mach3.

(2) PWM Method

Assume we need to output a PWM (Pulse Width Modulation) signal on the OUT3 terminal to drive the spindle motor power relay, enabling motor speed control.

Configuration Steps:

1. In Mach3, select the menu [Config].

2. Choose [Ports and Pins].

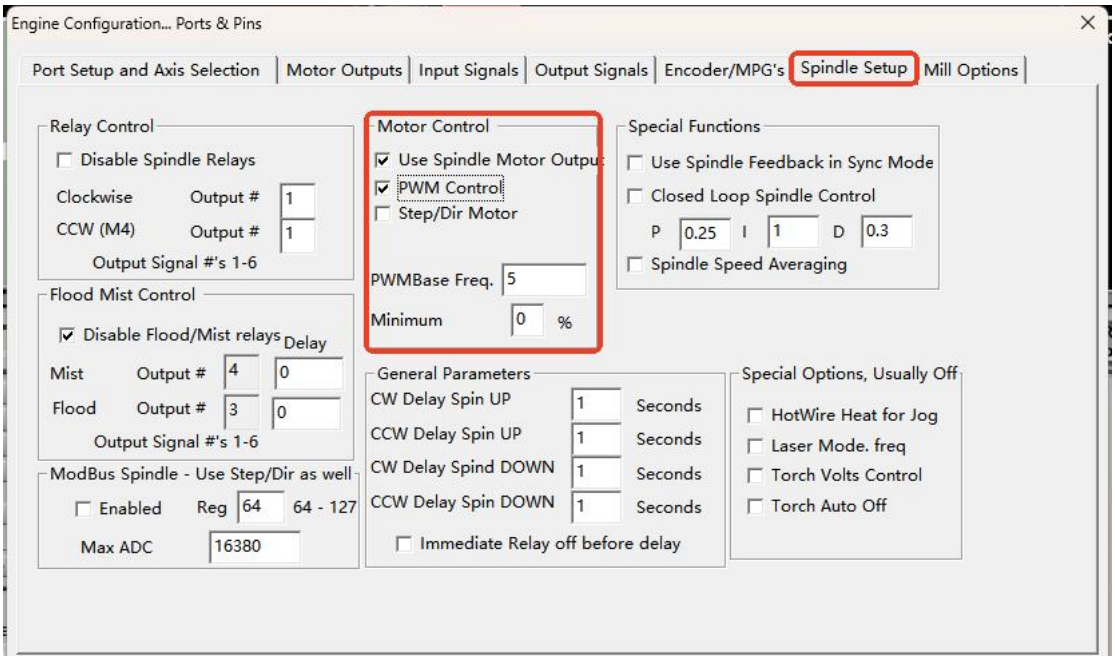
3. In the pop-up dialog, select the [Spindle Setup] page.

4. In the [Motor Control] box:

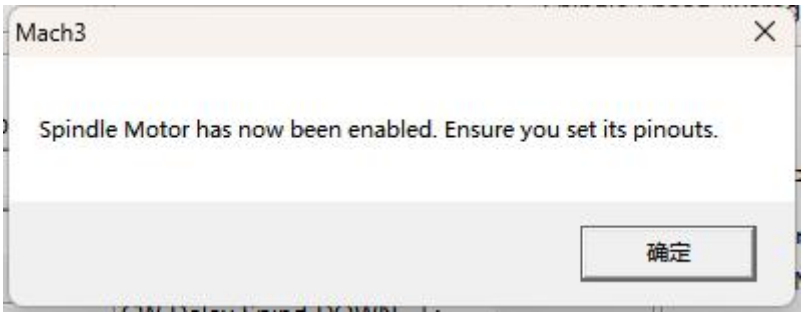
   - Check [Use Spindle Motor Output].

   - Check [PWM Control].

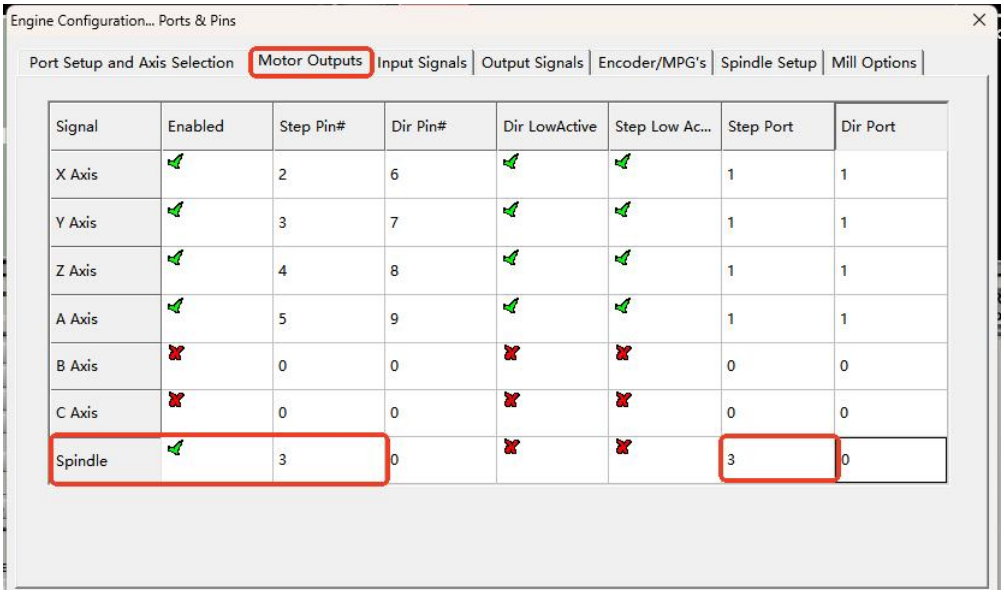
The configuration is shown in the figure below:



When [Use Spindle Motor Output] is checked, Mach3 will automatically enable the spindle motor output pins. At this point, click [OK] in the pop-up prompt box, as shown in the figure:

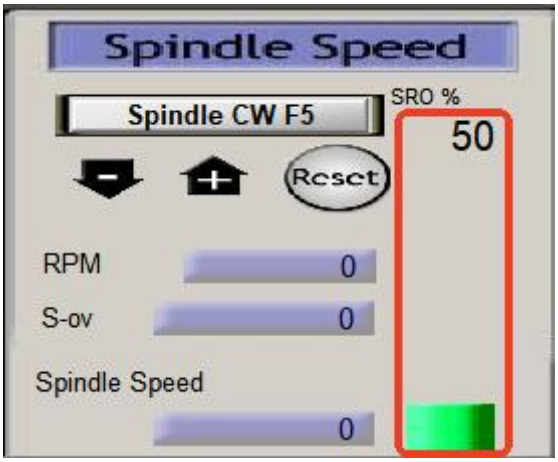


Next, select the [Motor Outputs] page. Scroll down to find the row with [Signal] named [Spindle], check the [Enabled] option, set [Step Port] to "3", and set [Step Pin #] to "3". This designates OUT3 as the PWM output terminal.



After completing the setup, click the [OK] button to save the settings.

Connect an indicator light to OUT3 (refer to the previous section) for debugging. When executing the program "M3", you will see OUT3 output a signal. In the [Program Run] page of Mach3, click the green bar in the [Spindle Speed] section with the mouse and adjust the [SRO%] value to less than 100%, as shown in the figure:

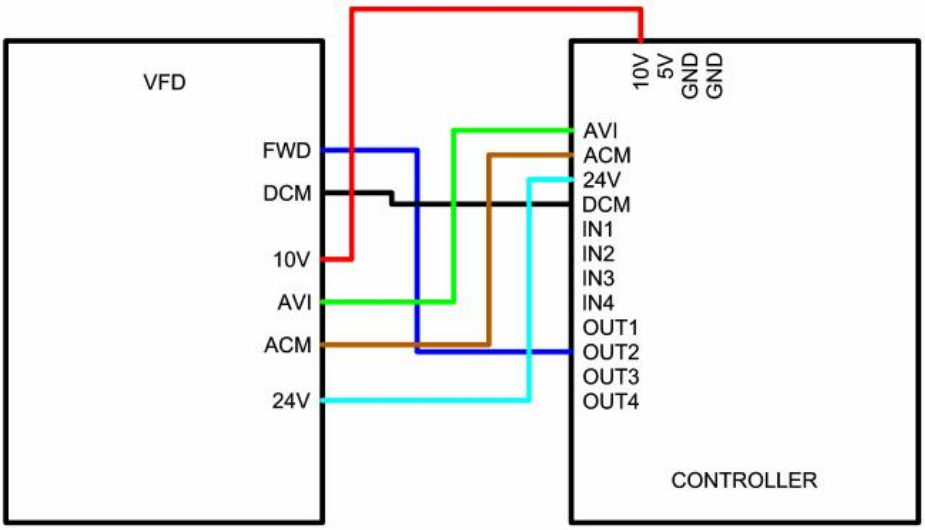


At this point, you can observe the external indicator light connected to OUT3 start to flash (indicating the output of a PWM signal).

3. 0-10V Analog Output

The ST-V3 USB Motion Control Card provides 1 channel of 0-10V analog output and 3 additional output channels, which can be used to control the spindle, water cooling, or other peripheral devices. The 0-10V output can be connected to a frequency converter to control spindle speed.

Steps to Use the 0-10V Output Function:
1. Correctly connect the frequency converter and the ST-V3 USB Motion Control Card terminals. The wiring diagram is shown below:



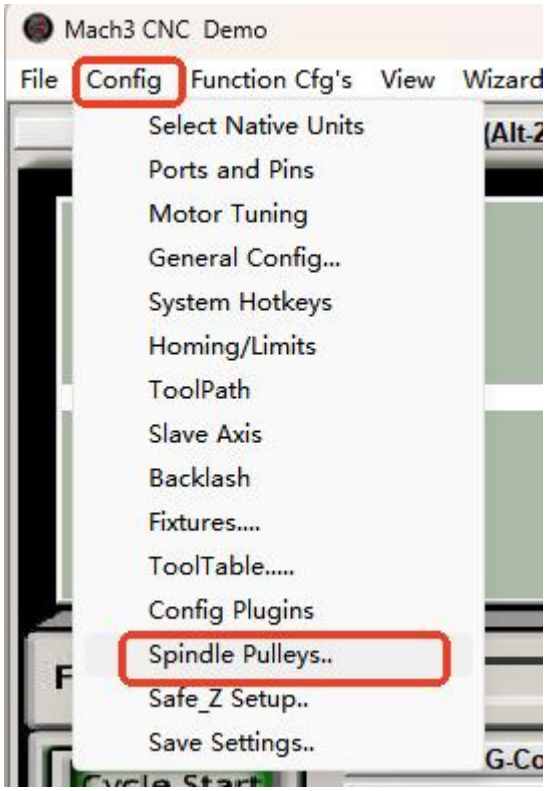
Inverter Terminal Descriptions:

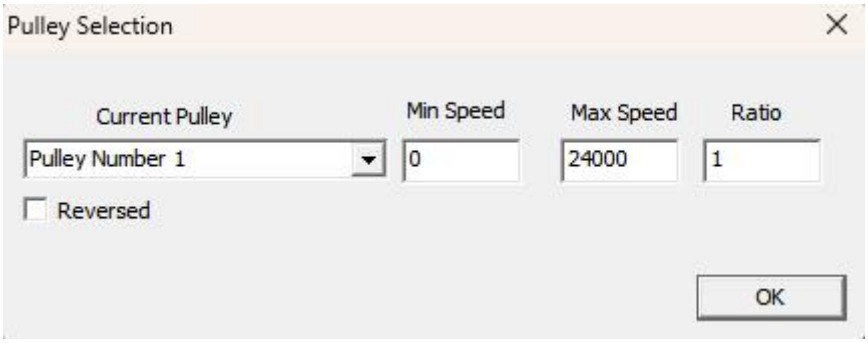
- **FWD**: Forward/Start terminal; on some inverters, it may be a multi-function terminal S1 or X1.
- **DCM**: Digital signal ground; on some inverters, it is called common ground COM.
- **10V**: 10V voltage output; on some inverters, it may be 12V or 5V.
- **AVI**: 0 to 10V analog input.
- **ACM**: 10V analog signal ground; on some inverters, it is called common ground COM.
- **24V**: 24V power output.

Control Card Terminal Descriptions:

- **10V**: 10V voltage input.
- **AVI**: Analog output interface, outputs 0 to 10V analog speed control signal.
- **ACM**: Analog signal ground.
- **24V**: 24V power input; used to power digital signal terminals such as IN and OUT.
- **DCM**: Digital signal ground; the +24V and -24V terminals are connected to the 24V power supply provided by the inverter. If the inverter does not have a 24V power output, an additional 12V to 24V DC power supply must be connected to the +24V and -24V terminals of the control card.
- **IN1~IN4**: Digital signal input terminals; can be used to connect limit switches, emergency stop switches, and other signal inputs.
- **OUT1~OUT4**: Digital signal output terminals; can be used to drive relays or output control signals.

2. Set the maximum spindle speed based on the actual parameters of the frequency converter and spindle (e.g., 24000 RPM). The configuration is shown below:

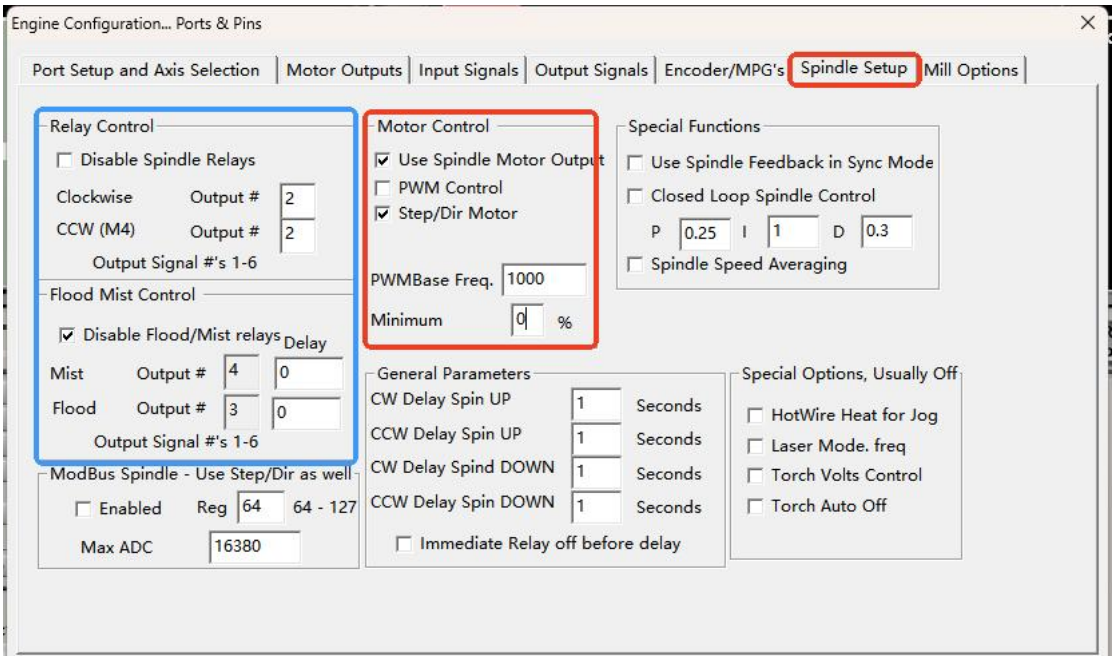




3. Configure spindle output parameters:

- The red box indicates settings that must strictly follow this example.
- The blue box indicates settings that can be adjusted based on actual requirements.
- In this example:
  - The first relay controls the spindle on/off.
  - The second relay controls cooling.
  - The third relay controls misting.

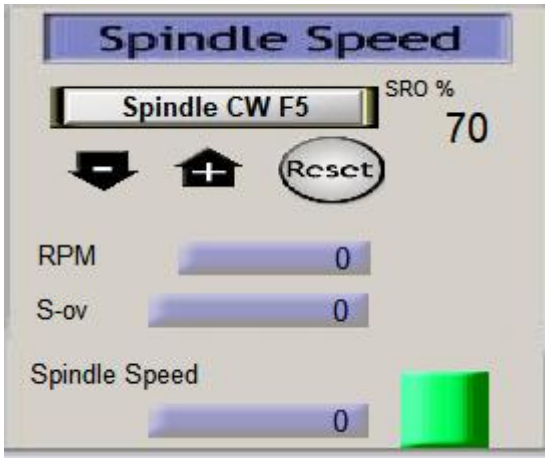
The configuration is shown below:



4. Enable the spindle output terminal. The configuration is shown below:

There are two ways to control the 0-10V output value:

1. Use the S command. For example, S20000 sets the speed to 20000 RPM.
2. Use the Mach3 interface:
   - Enter the Spindle Speed and adjust the SRO% slider.
   - As shown in the figure below:



Click Spindle Forward to start Output 1. The spindle motor will begin running, and the Spindle Forward button will flash. Set a spindle speed (e.g., 12000 RPM). Adjust the SRO% green slider. The control card will output a 0-10V analog signal between the AVI and ACM interfaces, thereby changing the motor speed.

4. Other Signal Outputs

The signal output terminals OUT1..OUT4 can be assigned as Mach3 output pins, allowing them to be controlled by Mach3 scripts. For example, if you need to assign OUT4 to Mach3's [OUTPUT #1], the setup method is: select the menu [Config], choose [Ports and Pins], and in the pop-up dialog, select the [Output Signals] page. Find the row with [Signal] as [Output#1], check [Enabled], modify [Port #] to "3", and modify [Pin Number] to "4". Click [OK] to save.

Appendix: Typical Wiring Diagram of Motion Control Card