Features:

✧ Supports all Mach3 versions, including the Mach3 R3.042.040 version.
✧ No need to install any USB drivers, it can be used after plugging in the computer.
✧ Full support for USB hot-swappable, the card is monitoring USB connection status at any time.
✧ Supports Mach3 software limitation and backlash functions.
✧ Maximum step-pulse frequency is 200KHz, which is suitable for the servo or stepping motor.
✧ Status indicator LED can be useful to show the USB connection, and working status by flashing.
✧ 16 general-purpose inputs, with indicators.
✧ Feed rate, spindle speed rate, or jog rate can be controlled by the adjustment-knob.
✧ With on-board isolated power supply, external power supply is not needed. External power can also be supplied to reduce USB load.
✧ 10 high-speed optocouplers with 10MHz, 24 general optocouplers for isolating all of the input/output signals, this high-cost design can be provided high performance and stable system.
✧ Real-time speed chart and spindle speed changes can be observed.
Contents

Revisions List

Basic connection diagram (an Overview)

Mechanical dimensions diagram

1. Prepare
2. Setup for Mach3
3. Setup motion card Hardware
4. Motion card connection Table
5. Motion card connection Diagram
6. Adjustment-knob
7. Spindle speed PWM output
8. Measure the rotating speed of the spindle
9. Auto tool zero
10. MPG Setup
11. Read-ahead buffer setting
Basic connection diagram (an Overview)

[8 Output Channels]
Can control the Spindle rotation, Mist/Flood coolant, Tool Change, User-defined M-code, etc...

[3/4 Axes control]

[16 general-purpose input]
E-stop, Limit-switch, Jog, Cycle Start, etc.

PC that Running MACH3

Spindle

USB Connection

Spindle Controller

Spindle speed output (PWM)

Steppers /Servos

Adjustment-knob
1. Prepare

1.1 Prepare Mach3 software

The latest version of Mach3 official website:


Mach3 download: as shown below:

![Mach3 Download Page](https://www.machsupport.com/downloads.php)

---

Mach3 is the flagship of the ArtSoft products. It is released in two versions: a Lockdown version, and a Development version. The Lockdown is a stable, static release recommended for new users, or people trialing the software. The Development version contains developing features and is released quite often so people can obtain new (but untested) features and capabilities. Both releases are limited to 500 lines of Gcode until licensed. Mach3 has a limit of 10,000,000 lines of Gcode even after licensing.

*You must use a Desktop PC running a 32-bit version of Windows if you are using the Mach3 Parallel Port Driver. Laptops are not supported because the power saving features of the chipsets disrupt the pulse stream. Mach3 will only be supported on laptops running an external motion controller, such as one of those found on the Plugins page.*

**Lockdown:**

**Mach3 R3.042.040**

**Mach3 Changelog**
Install Mach3:
This card does not require the parallel port driver.
1.2 USB cable Prepare

Magnet ring installed in the USB cable at both ends

![USB cable with magnet rings](image)

**Attention**

Use of acceptable quality USB cable

1.3 Installation the software of the USB motion card

This USB motion card does not need install any USB driver, Windows2000/Xp/Vista/Windows7 can directly identify.

1.3.1 Connecting the USB cable to the PC and the motion card.

1.  ![Mach3 USB Motion Card](image)
2.  ![USB](image)

When the status indicator (LED) lights on the card, USB connection is successful.
1.3.2 Unzip the usbmove.zip, copy or drag usbmove.dll into your Mach3\PlugIns folder. 

Note: Download the latest version of plug-in(usbmove.zip) in

1.3.3 Start the Mach3 software, a dialogue of “Motion Control Hardware PlugIn sensed!!” is shown. Please select the “Mach3-USB-Motion-Card”, you can also check “Don’t ask me this again”.

When the Mach3 is connecting with the card, the Status indicator (LED on the card) is flashing.
2. Setup for Mach3

2.1 Mach3 X, Y, Z, A Axis config as shown below: (Config => Ports and Pins)

2.2 Motor tuning setup as shown below: (Config => Motor Tuning)

Mach3 steps per unit:
Mach3 steps per unit = Mach3 steps per rev * Motor revs per unit
2.3 The Mach3 Menu => Config => Homing/Limits dialog
Axes direction, depends on the “Reversed”.

Axes direction:
Depends on “√” or “X”
2.4 Setup the input singles.
There are 16 general-purpose input channels. The channels number is from 0 to 15 at J4.
Suggest Active Low = "X" (Set High signal Level for Inputs)

2.5 Setup the Output signals.
There are 8 general-purpose (open-drain) output channels.
The channels number is from 0 to 7 at J5.
Suggest Active Low = "√" (Set Low signal Level for outputs)
3. Setup motion card Hardware

The board is used USB power source, with isolated power source module, external power supply is not requested.

All outputs, including 4 axes pulse/DIR/8 output controls/Spindle-speed PWM output, are set to be high-impedance state (Hi-Z) when USB is connected. When running Mach3, Level is controlled by Mach3.

Suggest: All output signals in Mach3 can be set to be Active Low.

3.1 4 axis output signals, please refer to J3signals indicating.

---

4-axes and Spindle PWM outputs

**Schematic**

- **J3**: OC (open-drain output)
- **XS/XD/YS/YD/ZS/ZD/AS/AD**
- **GND**
3.2 16 general-inputs, input voltage 5V (current: 7mA). Wired on J4.
3.3 8 general-outputs, wiring of the 0, 1, 2, 3, 4, 5, 6, 7 on J5.

Maximum Load voltage=24V / current=500mA, When output Low (turn on), otherwise the output is high-impedance state (Hi-Z).
### 4 Motion card connection Table

#### 4.1 4-axes

**J3**

<table>
<thead>
<tr>
<th>Pin Name</th>
<th>Function</th>
<th>Electrical</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GND</td>
<td>GND</td>
<td>GND</td>
<td>Signal Ground</td>
</tr>
<tr>
<td>DC5V</td>
<td>5V DC Output</td>
<td>Max=120mA</td>
<td>On-board isolated power module output</td>
</tr>
<tr>
<td>AD</td>
<td>A Direction</td>
<td>OC, 12V/13mA</td>
<td>A axis Direction Signal</td>
</tr>
<tr>
<td>AS</td>
<td>A Stepping</td>
<td>OC, 12V/13mA</td>
<td>A axis Stepping (Pulse) Signal</td>
</tr>
<tr>
<td>ZD</td>
<td>Z Direction</td>
<td>OC, 12V/13mA</td>
<td>Z axis Direction Signal</td>
</tr>
<tr>
<td>ZS</td>
<td>Z Stepping</td>
<td>OC, 12V/13mA</td>
<td>Z axis Stepping (Pulse) Signal</td>
</tr>
<tr>
<td>YD</td>
<td>Y Direction</td>
<td>OC, 12V/13mA</td>
<td>Y axis Direction Signal</td>
</tr>
<tr>
<td>YS</td>
<td>Y Stepping</td>
<td>OC, 12V/13mA</td>
<td>Y axis Stepping (Pulse) Signal</td>
</tr>
<tr>
<td>XD</td>
<td>X Direction</td>
<td>OC, 12V/13mA</td>
<td>X axis Direction Signal</td>
</tr>
<tr>
<td>XS</td>
<td>X Stepping</td>
<td>OC, 12V/13mA</td>
<td>X axis Stepping (Pulse) Signal</td>
</tr>
</tbody>
</table>

#### 4.2 16-Inputs

**J4**

<table>
<thead>
<tr>
<th>Pin number</th>
<th>Function</th>
<th>Electrical</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>General-purpose Input / MPG Input</td>
<td>5V Max:7mA</td>
<td>general-purpose “0”, “1” Input / or Manual Pulse Generator (AB) Input</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td>Functions are set by Mach3 “Config” =&gt; &quot;Ports and Pins&quot; =&gt; “Input Signals”</td>
</tr>
</tbody>
</table>
### 4.4 Output

<table>
<thead>
<tr>
<th>Pin Name</th>
<th>Function</th>
<th>Electrical</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GND</td>
<td>GND</td>
<td>GND</td>
<td>Signal Ground</td>
</tr>
<tr>
<td>GND</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DC5V</td>
<td>5V DC output</td>
<td>Max=120mA</td>
<td>On-board isolated power module output</td>
</tr>
<tr>
<td>DC5V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PWM</td>
<td>Pulse-Width Modulation</td>
<td>OC, 12V/13mA</td>
<td>Spindle speed Control (Output)</td>
</tr>
<tr>
<td>S+</td>
<td>LED Positive input</td>
<td>6mA</td>
<td>Spindle speed Measure (Input)</td>
</tr>
<tr>
<td>S-</td>
<td>LED Negative input</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>8 general-purpose (open-drain) output channels</td>
<td>Max=24V /500mA OC (open-drain)</td>
<td>Functions are set by Mach3 &quot;Config&quot;=&gt;&quot;Ports and Pins&quot; =&gt; “Output Signals”</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:**
1. “DC5V” is on-board isolated power module output. Voltage:5V, max current **120mA**.
2. “OC”: open-drain output
5  Motion card connection Diagram

5.1  X, Y, Z, A axes output. Optical power supply: Internal (on board) or External.

5.1.1  Using Internal (on board) power supply to drive.

Please install suitable resistance according to your stepping/servo driver need.
5.1.2 Using External power supply to drive.
Please install suitable resistance according to your stepping/servo driver need.
5.2 Input Channels:

There are two methods of voltage power supply: Internal or External

5.2.1 Internal voltage power supply

5V / 7mA per each input channel
5.2.2 External voltage power supply for input.

⚠️ If external power voltage is over 5V, a resistor must be installed.

5V / 7mA per each input channel

ATTENTION:

If the external power voltage is over 5V, a resistor must be installed between the power source and each input channel!

For the external power voltage is 24V, 3KΩ resistor must be used,
And for the external power voltage is 12V, 1.5KΩ resistor must be used,
5.3 Sensor’s wiring and setting

5.3.1 PNP sensor

⚠️ Use the external power supply for the sensor!

Mach3 Input Signals Setting

<table>
<thead>
<tr>
<th>Encoder/MPG</th>
<th>Spindle SETUP</th>
<th>Will Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Setup and Axis Selection</td>
<td>Motor Outputs</td>
<td>Input Signals</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Enabled</th>
<th>Port #</th>
<th>Pin Number</th>
<th>Active Lev</th>
<th>Enulated</th>
<th>HotKey</th>
</tr>
</thead>
<tbody>
<tr>
<td>☑️</td>
<td>1</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

GND: Signal Ground

A resistor:
- Input Max=7mA
  - 24V: 3.3KΩ
  - 12V: 1.5KΩ
  - 5V: 0 Ω

LED lights up when the sensor signal

Input # “0”~“15”

Pick ticks “√”

From 0 to 15 according to the wiring

⚠️ Suggest pick a cross “X” when using a PNP sensor.
5.3.2 NPN sensor

⚠️ Use the external power supply for the sensor!

A resistor:
- Input Max=7mA
  - 24V: 3.3KΩ
  - 12V: 1.5KΩ
  - 5V: 330Ω

the LED does not light when the sensor signal

Input #
- “0”: “15”

GND: Signal Ground

---

Mach3 Input Signals Setting

<table>
<thead>
<tr>
<th>Encoder/TPG’s Setup and Axis Selection</th>
<th>Spindle Setup</th>
<th>Motor Outputs</th>
<th>Input Signals</th>
<th>Output Signals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enabled</td>
<td>Port #</td>
<td>Pin Number</td>
<td>Active Low</td>
<td>Emulated</td>
</tr>
<tr>
<td>1</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Pick ticks “√”

From 0 to 15 according to the wiring

⚠️ Suggest to put tick “√” when using a NPN sensor
5.4 output: 8-general-outputs,
Maximum Load voltage=24V / current=500mA, When output Low (turn on), otherwise the output is high-impedance state (Hi-Z).

5.4.1 Drive LED with Internal(On-board) power

When drive tiny current loads like LED, driver enable signal etc, internal (on-board) power supply can be used directly.
5.4.2 Drive 500mA relay by 5-24V external power supply

Driver high loading devices, must use external power supply

---

Diode: 1N4007

8 – outputs
Form 0 to 7

Relay
Maximum
24V/500mA

Diode must be installed for protection the electronic device. (1N4007 / 1N4148 / etc)
6 Adjustment-knob

6.1 Please complete the step in Chapter 1 (Prepare).

6.2 Connecting the adjustment-knob with the EXT0(J16) of USB Motion Card.

6.3 Go to “Config Plugins” under “Config” to go into “PlugIn Control and Activation”.

---

**PlugIn Control and Activation**

<table>
<thead>
<tr>
<th>Enabled</th>
<th>Plugin Name</th>
<th>Config</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Flash:FlashScreen-SWF-PlugIn-A. Penety--3. -E...</td>
<td>CONFIG</td>
</tr>
<tr>
<td></td>
<td>JoyStick-JoyStick-PlugIn--Art-Penety-Ver-1.0a</td>
<td>CONFIG</td>
</tr>
<tr>
<td></td>
<td>PrinterScope-Port-Scope-1.00.045</td>
<td>CONFIG</td>
</tr>
<tr>
<td></td>
<td>ShuttlePro-Contour-Shuttle-Pendents---A.Peney...</td>
<td>CONFIG</td>
</tr>
<tr>
<td></td>
<td>TurnDiags-Turn-Diags-1.00.1</td>
<td>CONFIG</td>
</tr>
<tr>
<td></td>
<td>auifang-Mach3-USB-Motion-Card</td>
<td>CONFIG</td>
</tr>
<tr>
<td></td>
<td>Video---B Barker---Ver-1.0</td>
<td>CONFIG</td>
</tr>
</tbody>
</table>

After connecting the USB Motion Card, the tick "✓", must be shown, otherwise, please check the connection between the Card and computer.
6.4 After check the “Config”, USB Motion Card setting will be shown. You can select one of the functions which is able to controlled by the external knob. Please select “External 0” in your particular setting. Then, click “OK” to exit.

6.5 Now, you can try to turn the knob to adjust your selected function.
7.1

7.1.1 Spindle Setup

![Spindle Setup Diagram]

- **PWM Hz**: The PWM frequency is set from 1 to 20 Hz.
- **Output Signals**: M3: "Output #1" and M4: "Output #2".
- **Output #1—Output #20**: The diagram shows the connection between the relay control and the output signals.

![Output Signals Diagram]

- **Output #1** and **Output #2**
- **Output Signals**: The output signals are connected to the relay control.
7.1.3 PWM

![PWM Configuration]

7.1.4 Mach3

"Config=>Spindle Pulleys.."  "Pulley Selection"

![Pulley Selection]

<table>
<thead>
<tr>
<th>Current Pulley</th>
<th>Min Speed</th>
<th>Max Speed</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulley Number 4</td>
<td>0</td>
<td>0000</td>
<td>1</td>
</tr>
</tbody>
</table>

[Image: Pulley Selection]
7.2

M3
S10000
M5

7.3

**Schematic**

![Schematic Diagram]

USB

USB  "OC"  PWM

USB  GND

6N137
7.4 USB

DC5V

PWM:

[GND]

0-5V

1K

[0—5V] PWM
Mach3 USB Motion Card AKZ250 Installation Manual

![Diagram of Mach3 USB Motion Card AKZ250 Installation Manual]

- PWM
- GND
- COM
- VI
- [10V]
- FWD/REV
- Spindle
8 Measure the rotating speed of the spindle

8.1 USB Motion Card Configuration dialog

Go to “Config Plugins” under “Config” to go into “PlugIn Control and Activation”.

![Plugin Control and Activation](image)

Check the “Config” to entry the “USB Motion Card”

![USB Motion Card](image)

After connecting the USB Motion Card, the tick √ must be shown, otherwise, please check the connection between the Card and computer.

Input pulse number per each rotation of spindle rotor. Range: 1-4
8.2 Show Spindle Speed

Measured speed will be displayed in the Mach3 as shown below

In addition, you can open the spindle speed real-time waveform display

Wave form always on top
Start/Stop waveform

Right click the mouse
8.3 Hall sensor test circuit

Hall sensor Model "44E", open-drain output (OC).

When the magnet is close to the hall sensor, the LED will light.

8.4 Hall sensor /Rotation plate install

Note: Be carefully about the direction of the magnetic poles of the magnet.

Hall sensor "44E"
Rotation plate, connected with the spindle
8.5 Diagram of the spindle speed sensor part of the USB Motion Card

USB Card: S+
- Positive input
- Resistor 330 Ω + LED

USB Card: S+
- Negative input
- high-speed optocoupler

8.6 Connection Diagram of the hall sensor

When the magnet is close to the hall sensor, the LED (D16) will light.

Connecting the “S+” with “DC5V”

Connecting the “S−” with the output of the hall sensor.
9 Auto tool zero

9.1 Tool touch sensor wires

9.1.1 “one wire” simple tool touch sensor:

Setup Probe input signal, as shown below: (Config => Ports and Pins)

<table>
<thead>
<tr>
<th>Signal</th>
<th>Enabled</th>
<th>Port #</th>
<th>Pin Number</th>
<th>Active Low</th>
<th>Evaluated</th>
<th>Mode External</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input #2</td>
<td></td>
<td>1</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input #3</td>
<td></td>
<td>1</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input #4</td>
<td></td>
<td>1</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Probe</td>
<td></td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Index</td>
<td></td>
<td>1</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Limit +</td>
<td></td>
<td>1</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

"one wire" tool sensor

Resistor:
- 5V: 330 Ω
- 12V: 1.5K Ω
- 24V: 3.3K Ω
- 48V: 6.8K Ω

Input Max=7mA

The Tool, and the machine can also be connected to the GROUND.

The Probe Input Pin Number “0”—“15”.

The LED turn off when touch

Pick tick √ "Turn on Probe"

"0"—“15” Depend on wires

Pick tick “√”
9.1.2 “two-wire” Tool touch sensor:

The Probe Input Pin Number “0”—“15”

on-board isolated power supply. “DC5V”

Setup Probe input signal, as shown below: (Config => Ports and Pins)

*Pick ticks* √  
*Turn on Probe*  
*0”—“15”*  
*Depend on wires*  
*Pick a cross “X”*
9.2 Loading the VB Script to the Auto Tool Zero Button

That Mach3 provides for customizable, user-defined button macros on some of the existing screen buttons is what makes this possible without having to do Mach3 screen designs to add new buttons. The Auto Tool Zero button on the Programs Run screen is the one used for this purpose.

9.2.1 From the Mach3 Program Run screen, click “Operator” on the Menu bar then click “Edit Button Script”. The buttons that are editable will start flashing.

9.2.2 click the flashing Auto Tool Zero button. The Mach3 VB Script Editor window will open. By default this file will always be named “HiddenScript.mls” and at first there is one line of code in the edit window that may have a “Not Implemented” message in it.
9.2.4 Click any where in the edit window’s white space. Highlight any lines by typing Ctrl+A and press the Delete key or click Edit > Select All > press Delete key.

10.2

10.2.1 Mach3  (Config => Ports and Pins)

<table>
<thead>
<tr>
<th>Signal</th>
<th>Enabled</th>
<th>A-Port</th>
<th>A-Pin</th>
<th>B-Port</th>
<th>B-Pin</th>
<th>Counts...</th>
<th>Velocity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Encoder1</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1.000000</td>
<td>100.00...</td>
</tr>
<tr>
<td>Encoder2</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1.000000</td>
<td>100.00...</td>
</tr>
<tr>
<td>Encoder3</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1.000000</td>
<td>100.00...</td>
</tr>
<tr>
<td>Encoder4</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1.000000</td>
<td>100.00...</td>
</tr>
<tr>
<td>MPG #1</td>
<td>✔️</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>4.000000</td>
<td>1000.00...</td>
</tr>
<tr>
<td>MPG #2</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1.000000</td>
<td>100.00...</td>
</tr>
<tr>
<td>MPG #3</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1.000000</td>
<td>100.00...</td>
</tr>
</tbody>
</table>

10.2.2 "TAB" 

- MPG Mode = Multi-Step
- Cycle Jog Step = 0.01
- Jog Mode = MPG
- MPG Axis = X/Y/Z/A
11 Read-ahead buffer setting

11.1 Go to “Config Plugins” under “Config” to go into “PlugIn Control and Activation”.

```
<table>
<thead>
<tr>
<th>Enabled</th>
<th>PlugIn Name</th>
<th>Config</th>
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<td>JoyStick-JoyStick-PlugIn-Art- Fenerty-Ver-1.0a</td>
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<td>TurnDiags-Turn-Diags-1.00.1</td>
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<td>X lifeng-Mach3-USB-Motion-Card</td>
<td>CONFIG</td>
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<td></td>
<td>Video---B Barker-Ver-1.0</td>
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```

After connecting the USB Motion Card, the tick "√", must be shown, otherwise, please check the connection between the Card and computer.

11.2 In accordance with the performance of a PC, set the read-ahead buffer. Adjust the buffer time to run smoothly.