MACH3 USB port 4 axis Stepper motor Driver Card USB8727T4 Manual
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Chapter 1. Introduction

1.1 Product Introduction

Novusun CNC has engaged in the Numerical control industry for 7 years, specialized in the research, development and production of various CNC controller systems with high quality and high reliability. We produce the Brushless DC motor, Stepper motor driver, and also 1 to 6 axis CNC motion controllers.

USB8727T4 is the 4 axis motion controller we spend 1 years to design.

USB8727T4 support Mach3 software, through USB port to communicate with computer.

This manual introduces operation, connection and usage schedule of our professional motion controller for engraving machine. Through a lot of the drawing the users can learn quickly how to use this motion controller.

1.2 Products specification

- Support USB;
- 5 ports photoelectric isolated input interface;
- 1 ports photoelectric isolated output interface;
- 1 port 0-10V spindle speed analog output interface(can change to PWM output);
- 2 relay output.
- can support 4 axis stepper systems,200KHz pulse output for every axis;
- ARM motion control chip;
main device is 12V-32VDC power supply input, current should higher than 10A;

1.3 Products Appearance and size

USB8727T4 motion controller is with the sealed open structure, there are 2pcs setting holes at the bottom. We can fix 2pcs 4mm diameter holes at the cabinet, and install the controller into the cabinet. The controller appearance as the Figure 1-1 and Figure 1-2 show:

The products overall size is 150mm*105mm*25mm:

The bottom install size is 142.6mm*96mm.

![USB8727T4 front appearance and size](image-url)
1.4 substantival explanation

When operate the USB8727T4, where will be a lot of English abbreviation, now we list all of them for your kindly references:

FRO: Feeding adjust: During the operating process, the F value already set, and need to adjust the current feeding speed, then we can adjust FRO value to realize it.
SRO: Spindle speed adjust: During the operating process, the S value already set, and need to adjust the current spindle speed, then we can adjust SRO value to realize it:

Current Speed $S' = S \times SRO$.

SRJ: speed adjust manually

During the operating process, as the manual speed already set, and we need to adjust the current speed, and impossible to fix the value during it is working, then we can revise the SRJ value to realize it.

Current manual speed $F_{S'} = \text{Setting manual speed} \times SRJ$.

F: Feedingspeed, the unit is mm/min. For example $F = 200$, means every minute feeding 2000mm.

S: Spindle Speed. Unit is rad/min. For example $S = 20000$, means 20000 revolution/Minute.

X axis Coordinate

Y axis Coordinate

Z axis Coordinate

A axis Coordinate

B axis Coordinate

C axis Coordinate

Ready: Ready Mode. In the mode we can do any operation, include processing or values modification or starting 2nd mode.

Reset: Reset mode. In this mode, it should stop every operation.

“Step”: Manual Step Mode. Every axis can conduct the manual step operation at this mode.

MPG: MPG mode. Every axis can conduct the MPG operation at this mode.
1.5 Noting and Warning

Free from exposure to the electronics without waterproof function. Please environment as dry as possible. This is the icon.

Wiring warning, the IO input terminal of this equipment support the equipment with source switch (such as Inductive proximity switch.) When using such kind of switch, attention please: avoid the +terminal and –terminal of power supply to connect with GND. This equipment’s analogy quantity output terminal of spindlecontrolalos have a certain load capacity. Please avoid this terminal connect with GND in case that the interior components and parts be brokendown.

Operation warning, Please do the security measures well when connecting with the machine tools. The ESTOP, limit and other things must be perfected. When comes across the emergancy, please press the ESTOP key at once or cut off the power directly, thus avoiding the equipment damage and casualty.

High voltage danger, the primary device is 18-32VDC power supply. Voltage equipment. Pls pay attention to the electricity, safety when conducting the operation.
Chapter 2. Connection

2.1 Device Power supply Solution

The power supply solution in the field of the Industrial automation is always very complicated, there is a lot of the GND, now we describe the structure of the power supply as below:

The power supply structure as the Figure 2-1, main power supply input and MPG module and stepper control output module are common GND, Limited and Estop input module and Spindle speed adjust M3/M8/M1 module are common GND, between main power supply and output module there are photoelectric isolation. The inputs of limited switch and Estop and so on are Common anode, inside of the device, there is +12VDC as common+, no need to connect external power supply. Based on the reference of output GND interface, output a 0-10V adjustable voltage to adjust the spindle speed, M3/M8/M10 digital output interface is open-GND. If connect an external relay, need to output GND to refer to, and give the relay an external power supply.

Figure 2-1. Power supply structure of NVUM
2.2 Product connection define and method

Figure 2-2. Product wiring section and interface summary
As the Figure 2-2 showed, the connection of the controller includes power supply interface, USB connection interface, Stepper/Servo control output interface, spindle control output interface, Estop and limited switch and tool setting input interface and so on. Now we descript them in details as below.

### 2.2.1 Main power input

As Figure 2-2 showed, No.1 terminal block is Main power input interface, need input 12-40V/above 200W. There is silkprint "+" and "-", See as figure 2-2, left terminal is "+" and right terminal is "-".

### 2.2.2 Spindle control output

We define the interface from left are: GND1 (Output GND), VSO (0-10V adjustable speed output), M3 (Spindle run or stop).

Take Nowforeuer inverter as the example. Spindle control output and the inverter connection showed as Figure 2-3. If ACM and DCM are closed, only need to connect one port.
Figure 2-3. Spindle control output and inverter connection

VSO real output voltage = 10V * spindle setting speed / max spindle speed. For example, if max spindle speed is 24000, current spindle speed is S = 18000, so the VSO output voltage = 10 * 18000 / 24000 = 7.5V.

Max. spindle speed setting ports as showed sa Figure 2-4, open it from Pulley from Menu config. The current spindle speed can be set by S directive or Mach 3 spindle setting speed module.
2.2.3 12V fan's power port

As the Figure 2-2 showed, the marked No. 3 is Fan's power port. It can supply 12V 100mA. The terminal type is XH2-54-2P, left is "+", right is "-".

2.2.4 MPG port

As the Figure 2-2 showed, the marked No. 4 position interface is MPG port. The pin order see as Figure 2-5.
### Table 2-1. MPG port definition

<table>
<thead>
<tr>
<th>No.</th>
<th>Mark</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>T1OUT</td>
<td>TXD of Serial port</td>
</tr>
<tr>
<td>2</td>
<td>VMPG</td>
<td>Power supply + for MPG(5V)</td>
</tr>
<tr>
<td>3</td>
<td>WHA+</td>
<td>A phase positive of the encoder</td>
</tr>
<tr>
<td>4</td>
<td>WHB+</td>
<td>B phase negative of the encoder</td>
</tr>
<tr>
<td>5</td>
<td>XIN</td>
<td>X axis select input</td>
</tr>
<tr>
<td>6</td>
<td>ZIN</td>
<td>Z axis select input</td>
</tr>
<tr>
<td>7</td>
<td>X100IN</td>
<td>100 rate select input</td>
</tr>
<tr>
<td>8</td>
<td>EP</td>
<td>Estop port</td>
</tr>
<tr>
<td>9</td>
<td>R1IN</td>
<td>RXD of Serial port</td>
</tr>
<tr>
<td>10</td>
<td>GND</td>
<td>Ground and common end</td>
</tr>
<tr>
<td>11</td>
<td>WHA−</td>
<td>A phase positive of the encoder</td>
</tr>
<tr>
<td>12</td>
<td>WHB−</td>
<td>B phase negative of the encoder</td>
</tr>
<tr>
<td>13</td>
<td>YIN</td>
<td>Y axis select input</td>
</tr>
<tr>
<td>14</td>
<td>AIN</td>
<td>A axis select input</td>
</tr>
<tr>
<td>15</td>
<td>X10IN</td>
<td>10 rate select input</td>
</tr>
</tbody>
</table>

#### 2.2.5 USB port

As the Figure 2-2 showed, Marked No. 5 position is the USB port. Mach3 connect to this board through the USB port.

#### 2.2.6 5th axis extend port

As the Figure 2-2 show, The marked No. 6 port is 5th axis extend port. This port is defined as +5V/STEPB/DIRB from top to bottom. Wire method see as Figure 2-10.
2.2.7 Limit/Home input port

As the Figure 2-2 showed, Marked No. 7 position is the limited / home input port. They are the optical isolated Input interface. Reference Table 2-1, The silkprint IN3 IN4 IN5 IN6 on the board connect to PIN3/PIN4/PIN5/PIN6 of the mach3. Internal structure see as Figure2-7. 2 lines Proximity Switch/ordinary fretting switch / drawing see as Figure2-8.
3 lines Proximity Switch connection Figure 2-9, brown cable for Proximity switch connect with 12V, Black cable connect channel, blue cable connect with GND1.

Only support NPN 3 lines proximity switch.

2.2.8 probe port

As the Figure 2-2 showed, Marked No. 8 position is probe port. Probe port is fixed to
5.5mm DC port. It's IN2 in mach3. Setting method see as Figure 2-10. Definition of the port see as Figure 2-11.

![mach3 setting of probe](image1)

![Definition of probe port](image2)

### 2.2.9 2 Relay output

As the Figure 2-2 showed, Marked No. 9 position is 2 relay output port. You can used as
mist and flood control port. The relay support 250V3A electric equipment. If the current or the voltage exceed 250V or 3A. You should use a larger relay. Relay1 and relay2 are controlled by PIN2 and PIN3 of PORT2 in mach3. Wire method see as Figure 2-12

2.2.10 Estop port

As the Figure 2-2 show, The marked No. 10 is estop port. This port type is XH2-54-2P. You can connect this port to emergency stop switch directly. Estop is fixed to IN1 in mach3. Setting of mach3 see as figure 2-13.
2.2.11 Stepper motor port.

As the Figure 2-2 show, The marked No. 11 are 4 axis stepper motor port. They are X/Y/Z/A from top to bottom. Each axis's pin is defined as B-/B+/A-/A+ from top to bottom.

2.2.12 4 axis motor current adjust potentiometer

As the Figure 2-2 show, The marked No. 12 are 4 axis motor current adjust potentiometer. Near by the potentiometer, there are marked "← + →", it means clockwise turning, the current increase, and counterclockwise turning, the current decrease. And the regulating range is 0.6A-4A. See as Figure 2-14.
2.2.12 **Micro step setting switch.**

As the Figure 2-2 show, The marked No. 12 are 4 axis stepper motor micro step setting switch. Each switch is marked M1/M2/M3. micro step setting see as table 2-2.

<table>
<thead>
<tr>
<th>Micro step</th>
<th>M1</th>
<th>M2</th>
<th>M3</th>
<th>step/cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>400</td>
</tr>
<tr>
<td>8</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>1600</td>
</tr>
<tr>
<td>16</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>3200</td>
</tr>
<tr>
<td>32</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
<td>6400</td>
</tr>
<tr>
<td>64</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
<td>12800</td>
</tr>
<tr>
<td>128</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
<td>25600</td>
</tr>
<tr>
<td>10</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
<td>2000</td>
</tr>
<tr>
<td>20</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>4000</td>
</tr>
</tbody>
</table>

Table 2-2. Micro step setting table
Chapter 3. Software Installation

3.1 MACH3 Install

When you purchase our product, we will supply a CD-ROM, which contains the MACH3 installation, registration, and USB plug-ins. See as Figure 3-1.

![Figure 3-1. MACH3 soft installation](Mach1Lic.dat Mach3Version3.043.066.exe readme first.txt)

First run the installation Mach3Version3.043.066 into the first page. See as Figure 3-2.
Click Next and then enter the page shown in Figure 3-3. Select I agree and click Next. See as Figure 3-4.

--- Notice of Liability -----  
It is the nature of all machine tools that they are dangerous devices. In order to be permitted to run Mach3 on any machine you must agree to the following:  
I agree that no one other than the owner of this machine will be, under any circumstances, responsible for the operation, safety, and use of this machine. I agree there is no situation under which I would consider ArtSoft or any of its distributors to be responsible for any losses, damages, or other misfortunes suffered through the use of this program. I understand that software is very complex, and though the authors make every effort to achieve a bug free environment, that I will hold no one other than myself responsible for mistakes, errors, material loss.

I agree to the terms of this license agreement
I do not agree to the terms of this license agreement
Figure 3-4. MACH3 installation process 3

Select the installation path, click Next (it can be installed on any disk, and recommended to install the C drive or the D drive) See as Figure 3-5

Click Next until completion. Then restart the computer.
3.2 Plugin Install

Copy the file NOVUSUN.DLL to X:/mach3/plugin, X is installation disk of mach3.
Chapter 4. Setting of software

4.1 Open software

Double-click the mach3mill. Start mach3 software. We enter plugin select dialog box. See as Figure 4-1. You should copy NOVUSUN.DLL to plugin folder first, then you can see this dialog box.

Choose Novusun-Novusun-Plugin_ver-3.0b, then click "OK". Then we enter main page of mach3. See as Figure 4-2.
4.2 Software Common settings

4.2.1 Motor operating parameters setting

See as Figure 4-2. From submenu “motor tuning” of the menu “config” into the motor
The parameters are defined as follows:

Steps per: Pulse equivalent, it is number of pulses required with axial movement 1mm. This can be calculated by lead screw pitch and motor drive segment. Such as pitch 2.5mm, 2-phase motor 8 segments, Calculation method is $8 \times \frac{200}{2.5} = 640$.

Velocity: The speed is the axial velocity, Units is mm/s, Recommended settings 1500.

Acceleration: Units is mm/s², Recommended settings 200.

Step Pulse: Step Pulse Cannot be set, it’s 2.5us in default.

Dir Pulse: Dir Pulse Cannot be set, it’s 2.5us in default.

Attention: The parameters for each axis is not necessarily the same, To select the axis, and then set parameters. You should click “SAVE AXIS SETTINGS” After setting.

4.2.3 Port Settings
See as Figure 4-5, Click the sub-menu “ports and pins” of menu “Config” into Port Settings dialog box.

The sub-pages you need to set include “Motor Outputs”, “Input Signals”, “Output Signals” and “Spindle Setup”. First Click to enter “Motor Outputs”. This page is to select the stepper motor control pin. Because our usbmach3 interface board stepper motor signals are fixed, So here only need to Select, no need to select the specific pin. See as Figure 4-7
To make the Z axis to the same direction, Z axis’s “Dir low” should be set to “√”. Other axes’s should be set as system need.

Figure 4-7. Stepper motor port settings dialog

Click “Input Signals” into the input signal settings page. See as Figure 4-8.
Here you can configure according to your actual needs the corresponding function. Optional Function include XYZABC6axis’s Upper and lower limit、XYZABC6axis’s HOME point. We set upper limit and home of XYZA to 3456 corresponding IN3IN4IN5IN6 of the board.

ESTOP and probe Setting see as Figure 4-9, estop’s pin number is 1, and probe's is 2.

Click “Spindle Setup” switch to the spindle settings page. See as Figure4-10.
Figure 4-10. Spindle Settings dialog

Here we can configure the spindle rotates CW, Reverse CCW, Mist, Flood pin, See as Figure 4-10. They have been configured as 1, 2, 3, 4. Corresponding to output#1~output#4 in Figure 4-11. output#1~output#6 in Output Signal Setup dialog can be Configured into these 4 signals. Here we only configure CW/MIST/FLOOD. CW is controlled by OUT1. MIST is controlled by OUT2. Flood is controlled by OUT3. Here we note correspondence between 2 page. Please select “use spindle motor output” if required PWM speed spindle. And select “PWM Control”. Our PWM pin fixedly arranged on a special pin on Stepper motor setting dialog.

Figure 4-11. Spindle setting corresponds to the output configuration
Chapter 5. Using of software

5.1 Set Machine Coordinate system

Firstly Open the software, as the drawing 5-1 shows, at this time, the software can operate the machine movements, but before the setting machine coordinate system, there is no connection between the software and machine. So first step is to set the machine coordinate system.

1. Set the machine original position switch

As our request, some machine set the original point at the coordinate positive direction, some machines set the original point at the coordinate negative direction. Mach 3 can search out the machine original point direction by the software setting. As the pic 5-2 shows, open Homing on the config menu. Then as pic 5-3 shows. On this page, Home Neg is for searching for the machine
original point direction, $\times$ means searching original point at negative direction; $\sqrt{\text{ }}$ means searching original points at the positive direction. As the picture 5-3 shows, X axis’s original position is at the negative direction, Y and Z’s original points are at the positive direction.

![Figure 5-2. Click homing of Config](image)

![Figure 5-3. Motor Home and Softlimits dialog](image)

2. Set soft limits
As Figure 5-3 shows, this page also can set machine soft limit points. Soft Max is positive direction soft limited points, soft Min is negative direction soft limited points. The soft limited points values is according the references to the machine coordinate system, so as this example shows, Y and Z axis’s max value is 0, all the effective coordinate data is less than 0. As the Figure shows, according to our current request, we set our XYZ axis soft limited points area as [0, 270] [-390, 0] [-100, 0].

3. Searching for machine original points

As Figure 5-4 shows, press REF ALL HOME at main display page, then XYZ A4 start to search for the original points, if you need more axis’s operation, edit macro command, or press Alt+7 into Diagnostics display page, you can search original point for every axis. Diagnostics

5.2 Set workpiece coordinate system

Because every working material is hold in different position on the machine, we need to set
one or more workpiece coordinate system.

1. Move to current working piece 0 point

Firstly hold down the material, use keyboard or pendant to move tool tip at the 0 point, so this 0 point is the working piece 0 point, it related with the working G code file, so the user must be very familiar to his own working G code. As our example shows, the 0 point is on the center of the working piece surface, so we just move the tool tip to this position.

2. Clear Coordinate

As 5-5 shows, press Zero button on each axis, then clear to 0 for each axis. After operation, the result shows as Figure 5-6.

![Figure 5-5. Press Zero on each axis, all clear to 0](image-url)
5.3 Open G code file and run

As Figure 5-7 shows, press “load G code” button at the main page or open “Load G code” at main menu “File”, open your G code. It displayed as Figure 5-8 showing, then press button “cycle start” then machine start to work.
Chapter 5 Using of Software

Figure 5-7. Press Load G-Code and open your G code

Figure 5-8. After opening G code, press “Cycle Start” and start to work