



SUPER X3 CNC MILL

Manual

Revision 1B

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Initial Setup

Tools needed:

- Tin snips, or tool suitable for cutting straps
- Philips Screwdriver
- 17 mm end wrench or socket
- Hoist, lift, or friends with big muscles

When you receive your Super X3, it is preferred to place it in an area that is clear around the crate. Once you remove the straps, the crate can be disassembled. Start from the top by unscrewing all the screws. After the top is removed and placed away from your working area, the sides can be removed by unscrewing the rest of the sides.

Underneath the lower skid, there are 4 retainer bolts that hold the mill down. You will need your 17mm end wrench or socket to loosen and remove these bolts.

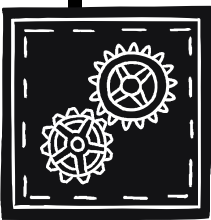
The power supplies, drivers, fan, and PCB boards are located in the black casing to the side. All connections have been made at the factory except two. However, with jarring of transportation, it is possible to loosen other connections. Visually check all connectors in the case and make sure there are not loose. The two remaining connectors are the “Emergency Stop” and power. Emergency stop connection is made on the PCB board labeled “E-Stop”. Only one power connection is required. It is a white four pin connector that connects inside the rear housing. If you do not easily see the mating power connector, it will make it easier to remove the upper inspection plate. This is located at the top of the body.

After connecting power and E-Stop, you can mount the component casing onto the back of the mill. Re-use the 6 screws removed from the lower case plate.

The unit is **heavy**. An engine hoist (cherry picker), if available, is the easiest way of moving these. If not, 2 of your biggest friends will suffice. The working platform of the Super X3 needs to be stout. The heavier the construction the happier you will be with the performance. Noise, smoothness, and safety are all enhanced by a working structure that is sturdy.

****Note on electrical connections:** The unit has a 1300 watt motor and 600 watts of available power for it's driver/stepper system. Make sure your breaker that the Super X3 CNC mill is connected to has at least 15 amps available.*

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Syil CNC Conversion

Introduction

We at Syil have a passion for seeing something come from nothing. We also share of love of manufacturing. We wanted to share this love with the rest of the world.

Historically, manufacturing in the U.S. was associated with 15,000lb machines that required lifts to move and trained operators monitoring 24/7. These colossal machines, outfitted with high grade ball screws, G-code controlled spindles, and huge motors, run 24/7 because of the need to pay for themselves. Moving these machines not only presents a problem, but the power requirements for such a beast can hinder many shops capacity. These machines cost as much as a house, and demand about the same in maintenance.

Where does that leave the rest of us? A characteristic, small production shop is filled with manual machines dating back to when my great grandfather first ate solid foods. Granted, these machines are true American legends, worthy of much praise. They still fall short on keeping up with competition. To compound the problem even more: U.S. politics and what have you, has “blessed” us with all the protections conceivable. We are well protected, even from ourselves. While this may seem brilliant on the surface, it comes at a price. Labor is costly. What is the byproduct? You have a shop with 4 people running all the machinery with what used to have 16.

Computer numerical control is a godsend to manufacturing. It is part of the answer. However, it is out of reach for most shops. It would also be somewhat unwise to indenture the business, just to pay for the “Zeus” sized VMCs. Some people have kindled that creative spirit and converted their manual machines over to CNC. Some work well. Some, not so much. So we at Syil have tried to come up with a balance. Giving all those great advantages of the more expensive CNC mills to the rest of us. Using some of the best components and some ingenuity, we are proud to offer the first product of our venture together, the **Super X3 CNC machine**.

Finally: consistency in quality, and affordability for the rest of us.

A note on accuracy:

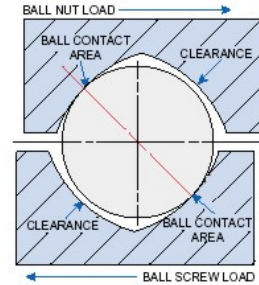
We have extensively tested our machines with the following results. Although there may be some variation between machines, we try for consistency in every product.

These are some of our findings:

Spindle run out:	.0002” ±.0005”
*Locking the spindle on the front panel will give you the best rigidity while cutting hard steels	
X Travel	15.5”±.04”
Y Travel	6.3”±.08”
Z Travel	8.1”±.07
Backlash	<.004”
Repeatability	±.0004”

Ballscrews:

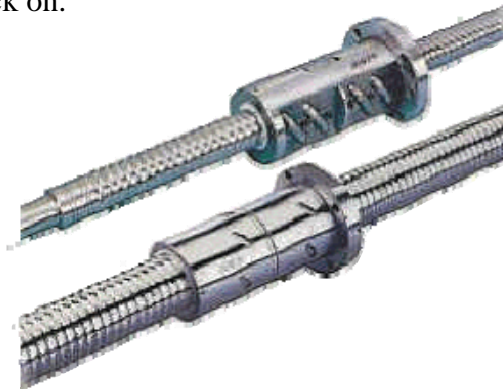
- 5.08 T.P.I.
- 420 MC Stainless steel
- Rolled type
- Double nut



The ballscrews included on the Syil products are made from high quality Italian stainless steel. They will provide a lifetime of precision with very light maintenance.

Maintenance:

- Every year or 100 hours of operation:
 - Spray a light film of light weight #2 oil (WD-40, etc.) on the screws and run them from throw to throw.
 - Each axis is easily accessible except for the Z axis. For it, you must remove the four socket screws that hold the back on.



Access to the ball screws can be viewed as a challenge, but is really quite easy. It can be done by the average person. If for some reason you wish to remove them, here are the steps you would need to do:

Z axis:

- Remove the controller assembly
- Remove the black casing cover from the back of the mill
- Unbolt bearing blocks and de-couple stepper

X axis

- Remove left end plate
- Remove motor dust cover
- Remove bolts from right end plate
- Slide table off from the left
- Unbolt from bearing blocks and de-couple

Y axis

- Remove saddle
- Remove rear y axis dust cover
- Unbolt from bearing blocks and de-couple

**Note: Do not run the screw completely out of the nut. If you do, you will have the experience of a 120 ball bearings running about. Then the fun task of re-inserting them.*

Parallel Interface PCB:

- 4 Axis support
- 4 Axis limit / home support
- Direct support for all common PC controller software (Mach, KCAM, Etc.)
- Support for spindle control (DC power, AC power, frequency conversion)
- Photocoupled input/output protection
- Emergency stop
- 2 Aux inputs/outputs (Coolant, Probe, Tool height, etc.)

Technical:

Power: DC 13-18V, AC 12-16V (50-60Hz)

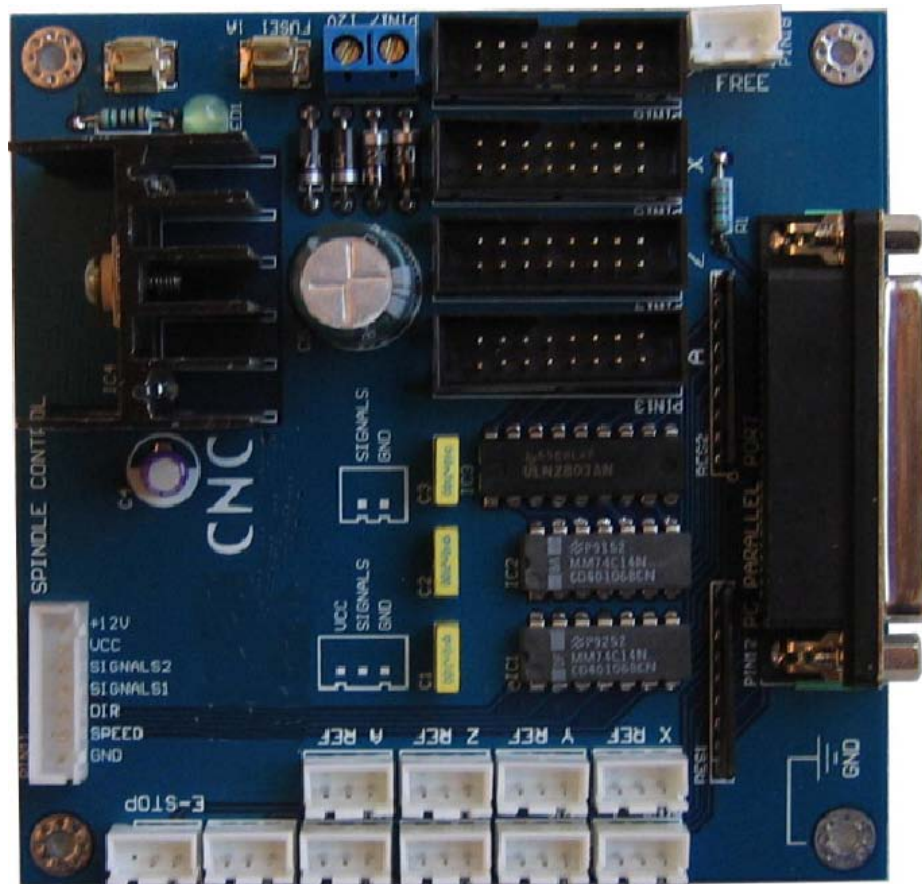
Current at idle: 9mA

Current at full: 100mA

Output drive voltage: 5V

Output current: ~2mA

Input signals: Pull-up resistors



Pin Name	Input/Output	Parallel inter- face pin number	Description
X axis direc- tion	OUT	2	X axis stepper direction control
X axis pulse	OUT	16	X axis stepper drive
X axis limit	IN	15	X axis origin point detection
Y axis direc- tion	OUT	14	Y axis stepper direction control
Y axis pulse	OUT	5	Y axis stepper drive
Y axis limit	IN	13	Y axis origin detection
Z axis direc- tion	OUT	17	Z axis stepper direction control
Z axis pulse	OUT	6	Z axis stepper drive
Z axis limit	OUT	12	Z axis origin point detection
A axis direc- tion	IN	4	A axis stepper direction control
A axis pulse	OUT	3	A axis stepper drive
A axis limit	IN	11	A axis origin point detection
Spindle direc- tion	OUT	8	Spindle direction control
Spindle pulse	OUT	9	Spindle speed control
Aux 1	OUT	7	Configure software to assign usage
Aux 2	OUT	1	Configure software to assign usage
E Stop	IN	10	Emergency stop switch
Digitizing Probe	IN	11	②correct configure this pin if you are using a tool adjuster, digitizing probe

Stepper Driver:

Syil™



Features

- Power supply from DC 32V to 60V.
- Auto half-current function—that means the output current of the driver will automatically decline to half if the stepper pulse pause over than 0.3s.
- Forced shut down of output current by the E-Stop.
- Driving current can be adjusted from 1.0A to 4.3A.
- Phase origin and malfunction protection indicator.
- All input / output are isolated by photocouplers.
- **2, 4, 5, 10, 20, 25, 50, 100 microstep subdivisions are selectable.**
- Over-heat protection is integrated. When the driver over-heats, it will shut down the output current. And when the temperature returns to normal level, it will reset automatically.
- H bridge structure driver circuits just like a servo system are applied in the driver. This creates performance of this stepper drive system very close to servo systems.
- Protection functions----When the power supply is lower than 30V, or the temperature of the shell is over than 80°C, the driver will shut down automatically and the **fault LED** will light.

Each case is capable of housing 4 drivers. They are powered by a 600 watt power supply.

Auto Half Current Set :

This driver contains an auto half current function. The output current of the driver will automatically decline to half, if the stepper pulse pause goes over 0.3s. When the next pulse comes, the current will recover to the original value. This function can depress the thermal value both of the driver and stepper motor. When the drive current is in half state, the moment of force will come down. If this situation is not wanted, it can be disabled.

Auto Half Current Function	s1
Enable	OFF
Disable	ON

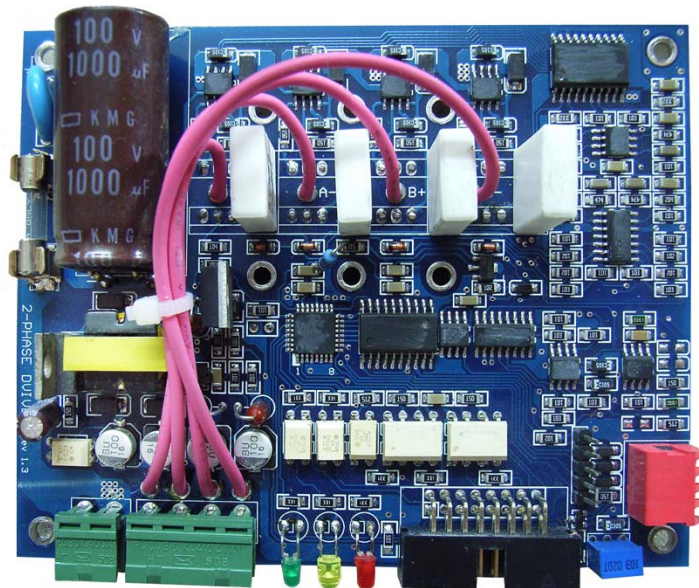
NOTE: The auto half current function is a real-time function. So user can set it while the driver is working.

Drive Current Adjustment:

The driving current can be adjusted from 1.0A to 4.3A. The current will go down with clockwise rotation of the pots resistor; and the current will go up when rotated counter-clockwise. Half of the total movement on the pot = 2.6A. Adjustment is done by inserting an amp meter in series with one of the phases. Since this is been done at the factory, and re-checked at the warehouse, there is no need to adjust your steppers. Steppers will generate more heat while they are not moving due to the holding torque. If your stepper is extremely hot (160 degrees or more) after 5 minutes, Then reduce the current could be too high.

ATTENTION:

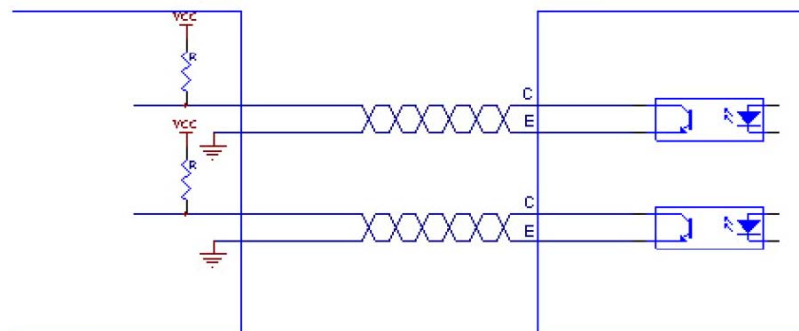
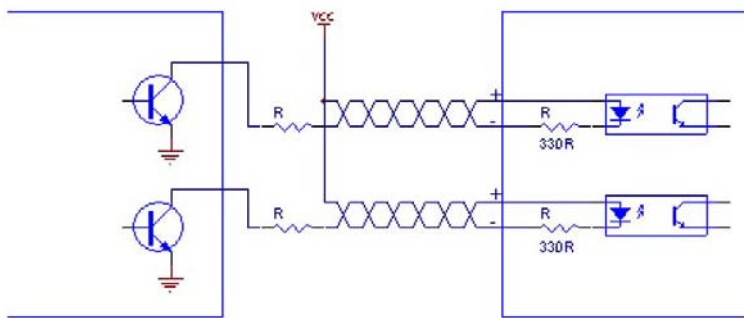
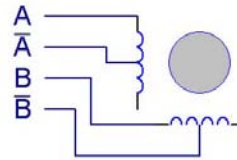
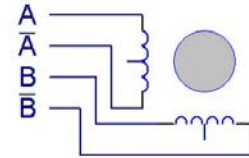
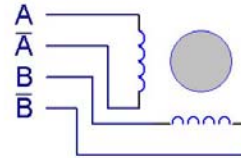
Do not adjust the current value too high. High current will increase the holding torque of the stepper motor, but it will bring increase the stepper temperature. Possibly causing a thermal problem. Please adjust the drive current to the stepper motor's specifications. (3Amps)



Stepper connections:

The following illustrations show various ways that you can connect up a stepper to our drivers.

There are advantages and disadvantages to various connection methods. Some provide higher torque while others provide higher rapid and traverse speeds. Know what you are doing before you attempt to rewire anything that has been done at the factory.





Stepper motors:

Our X and Y axis stepper motors are a NEMA 23. They have a holding torque of 260 oz/in. And consumes 3 amps per phase.

Our Z-axis stepper motor is a NEMA 34. They have a holding torque of 460 ounces per inch. And consumes 3 amps per phase.

With a default setting of 25 micro-steps, and a reasonably fast computer, rapid traverse speeds are approximately 80 to 100 inches per minute.

电机型号 Model	接法 The Connect method	最大静 扭 矩Holding Torque (N • m±10%)	额定电流 / 相 Current /Phase (A)	相阻抗 Resistance /Phase (ohms± 10%)	相感抗 Inductance /Phase (mH±20%)	额定扭矩 Rated Torque (N • m)	转子 惯量 Rotor Inertia (g-cm2)	长度 Length (mm)	重量 Weight (Kg)
86HS2A65-408		3.5	4.0	0.7	3.9	3.2	1000	65	1.7
86HS2A80-404		5.0	4.0	0.8	6.6	4.5	1400	80	2.3
86HS2A80-308	(串联)	5.0	3.0	1.6	14	4.5	1400	80	2.3
86HS2A80-608	(并联)	5.0	6.0	0.4	3.5	4.5	1400	80	2.3
86HS2A118-404		9.7	4.0	1.2	11.5	8.5	2700	118	3.8
86HS2A118-308	(串联)	9.7	3.0	1.9	22.4	8.5	2700	118	3.8
86HS2A118-608	(并联)	9.7	6.0	0.47	5.6	8.5	2700	118	3.8
86HS2A156-358	(串联)	13	3	2.23	25.8	12	4000	156	5.4
86HS2A156-658	(并联)	13	6.1	0.56	6.4	12	4000	156	5.4

Steps and Resolution

Ball Screw Calculations

Ball Screw is Metric	5.08	TPI						
Stepper per rev	200							
<i>Micro Steps</i>					Default			
2	4	5	10	20	25	50	100	
2032	4064	5080	10160	20320	25400	50800	101600	Steps per Inch
<i>Maximum Traverse Speed at</i>			25000	Hz				
738	369	295	148	74	59	30	15	Inches Per Minute
<i>Maximum Traverse Speed at</i>			35000	Hz				
1033	517	413	207	103	83	41	21	Inches Per Minute
<i>Maximum Traverse Speed at</i>			45000	Hz				
1329	664	531	266	133	106	53	27	Inches Per Minute
<i>Resolution</i>								
0.0025	0.00125	0.001	0.0005	0.00025	0.0002	0.0001	0.00005	

From the above chart, you will be able to determine your maximum traverse speeds based on computer output frequency. From the default setting of 25 micro-steps (which is hardware selectable on our drivers) and a computer less than 1 GHz you will have 59 inches as a rapid traverse. With a computer of around 2 GHz you will be able to achieve 106 inches per minute. You will also notice, at 25 micro-steps, the resolution is .0002" per step. This means the smallest movement you can make with each step is .0002". This chart truly demonstrates the ability of our drivers. In most competitors, your micro-steps are divided up into one quarter steps. At four micro-divisions, your highest resolution is .00125". It is also possible to select 100 micro steps. This brings your resolution to .00005". Incredible resolution, but at a cost of your rapid traverse speeds.

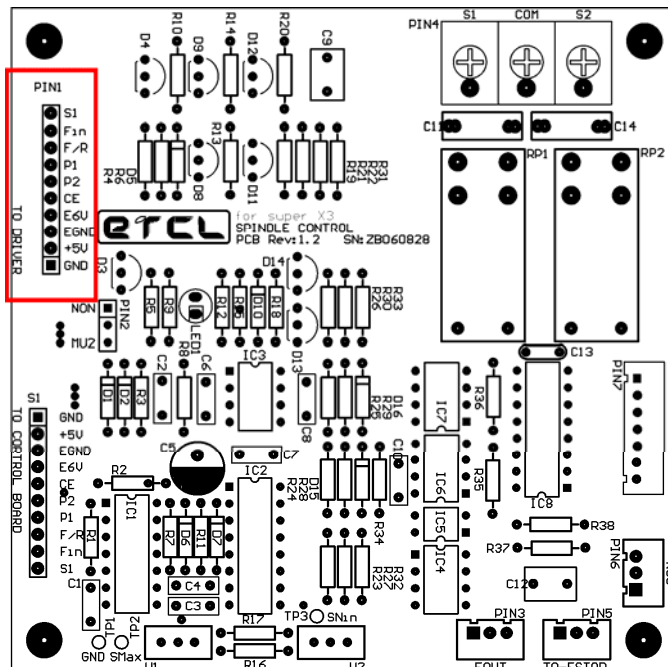
SUPER X3 spindle control board operating instructions

Function synopsis:

- ⇒ With the installation of this control panel realizes following functions:
- ⇒ Spindle rotational speed by the computer input (MACH Software).
- ⇒ Through the change-over switch, CNC control or retain your manual control.
- ⇒ May control two groups electric appliances, coolant pump, lights, etc.
- ⇒ Through jumps the line to brave, may cause the engine bed kneading board the rotational speed value, demonstrates original two times.
- ⇒ Adds and additional safety feature by stopping the spindle during and E-STOP.
- ⇒ Panel readout and software readout of spindle RPM.
- ⇒ Spindle low and high rpm can be adjusted via pots adjustments.

Connection explanation

The main spindle board connection
Position on the following diagram:

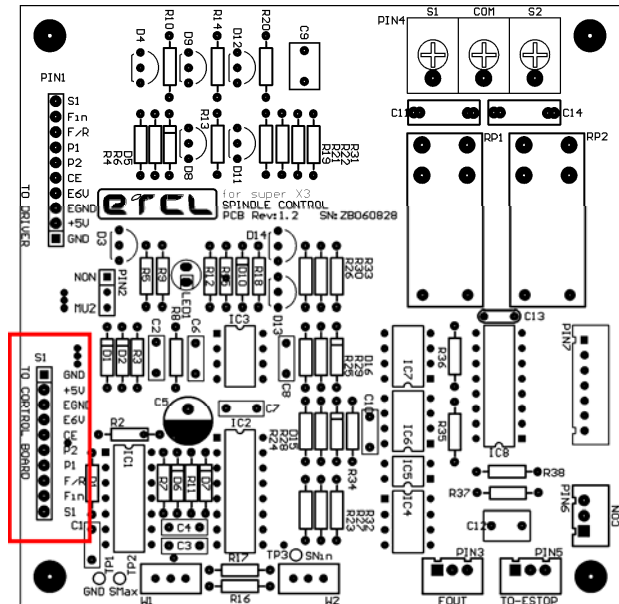


Main control panel connection

Position following chart:

Function and connection:

The plug panel inserts onto this plug receptacle. Signal arrangement and original machine configuration are the same.



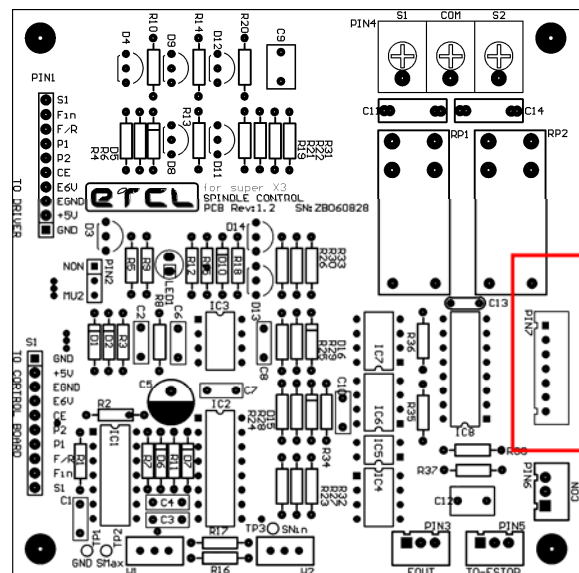
Control signal connection:

Position following chart:

Function and connection:

Control signal input

Through the breakout board it receives four signals for the spindle control. MACH software controls the pulse-duration modulation, The frequency for must be higher than 500hz. Too low of PWM, and the frequency can cause the main spindle rotation to have noise. When PWM duty factor is 0%. When, the main spindle rotational speed is on the control panel potentiometer W2 Establishes rotational speed. When the duty factor is 100%. The main spindle rotational speed is a potentiometer W1 Establishes the rotational



Electric appliance control connection

The connection position distributes the chart:

Function and connection:

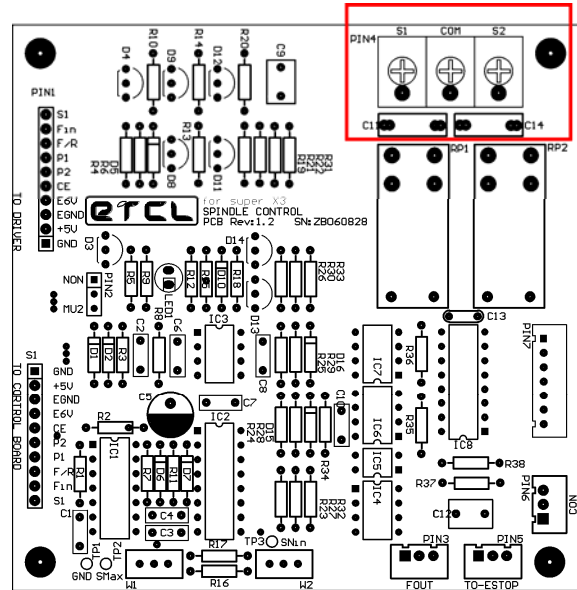
Two groups of relays, use in controlling exterior electric appliances. coolant pump, lights, etc.

COM = Common Power Input

Relay RP1 COM End = Common

S2 Relay principle is the same.

Current capacity is **5A**.



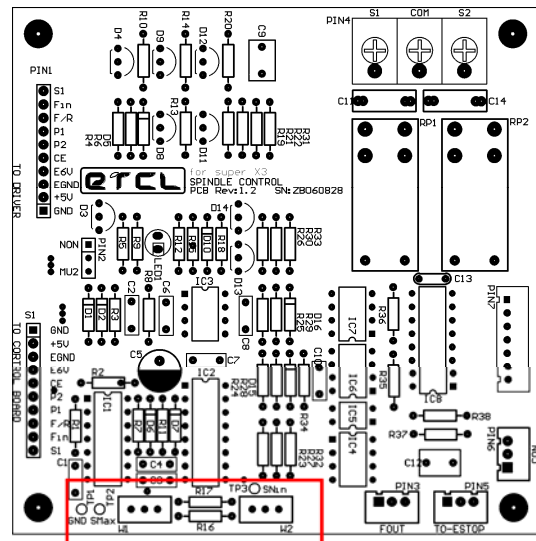
Rotational speed hypothesis potentiometer

Position following chart:

The function and the adjustment consists of two pots, W1 & W2.

W1 corresponds to the spindle control pulse 100% duty factor. While at rotational speed, you may sample the test point TP2 using TP1 (GND). You will be measuring DC voltage. The higher the voltage, the faster the corresponding RPM.

W2 corresponds is the spindle control pulse 0% duty factor. While at rotational speed you may sample the test point TP3 using TP1 (GND). You will be measuring DC voltage. The higher the voltage, the faster the corresponding RPM.

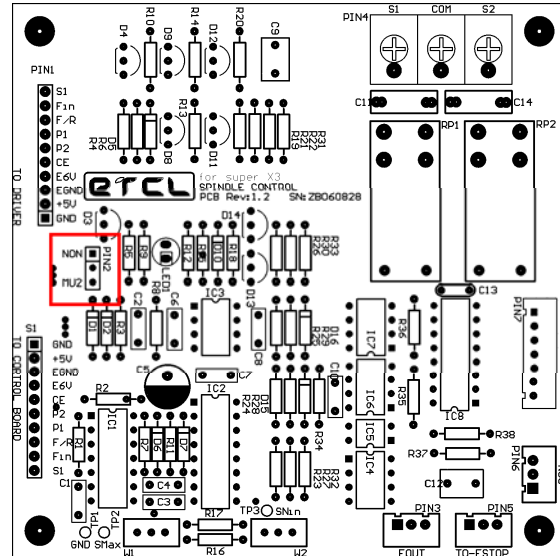


Rotational speed display jumper

Position following chart:

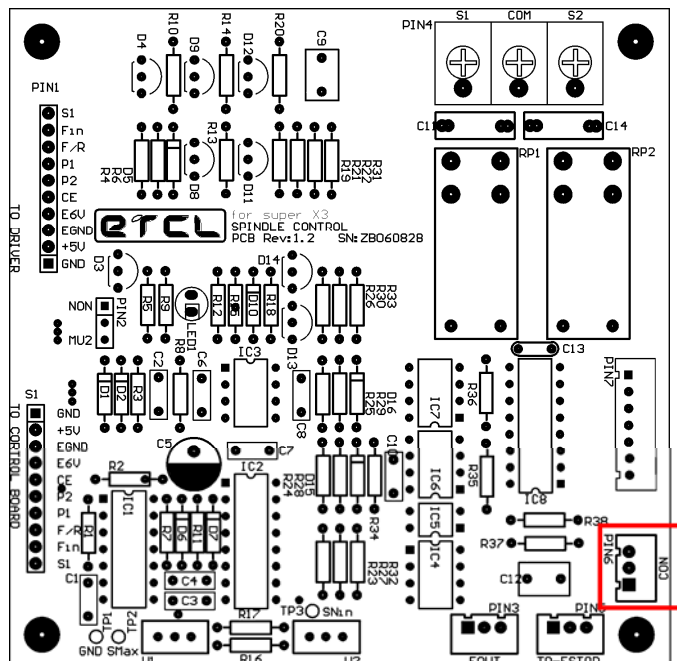
Function and operating instructions:

After adding a high speed spindle gear, in order to display the correct RPM on your head display you will need to change a jumper. For stock speed gears NON will have to be jumpered. For high speed gears, MU2 will be covered.



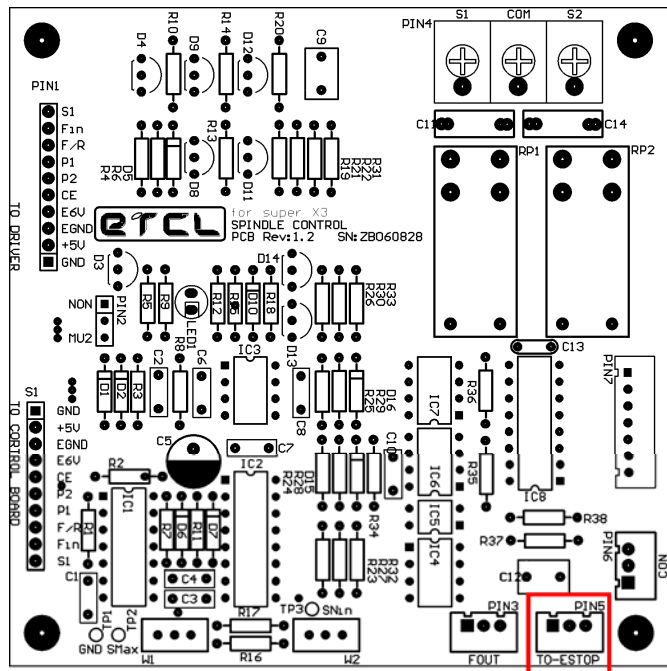
Function and connection:

This port is used for switching control between the front panel and your controller software. Open is panel control. When pin 1 & 2 are closed spindle is under control of your controller.



Function and connection:

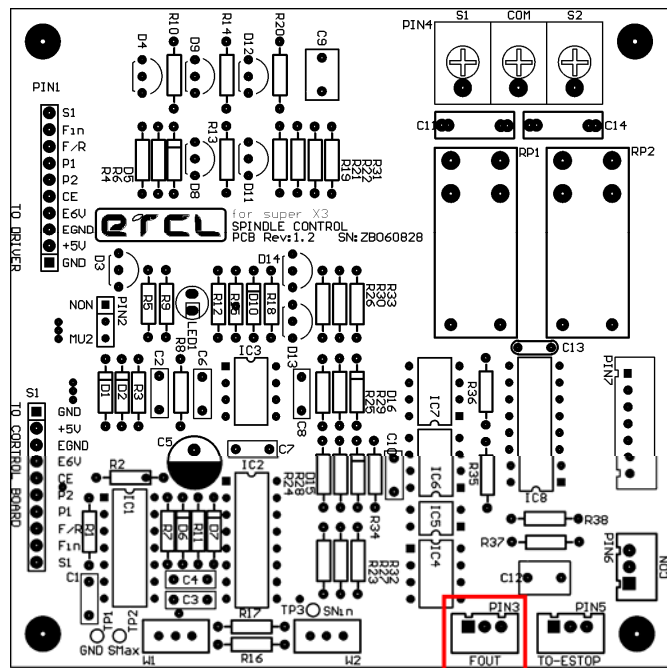
This connection needs to be connected to your breakout board. This is your E-Stop function feedback for MACH.



Function and connection:

This connection outputs spindle RPM pulse signal. This may be reported back to your controller software to confirm actual RPM.

Feature has not been implemented yet.



The black magic of G-Codes spindle

Controlling the spindle with a controller is one of the most fundamental and convenient differences that separate our product from the competition. Not only does it allow you to select the RPM of your spindle but also the direction and on / off. This gives you the convenience of allowing the machine to finish its cycle and turning itself completely off.

Whenever you are operating in the area of the spindle is appropriate to lock the spindle to insure that no spindle operation is possible. That is why we have incorporated a spindle lock into every spindle controlled machine. You can unlock and lock the spindle from the touchpad on the face of the machine. The only buttons used are the stop and start buttons. Before beginning any operations make sure that your controller is on, the machine is then switched on, and the controller reset. If you look at your display on the face of the mill you'll notice a reading of "0000 forward stop" is illuminated on the LCD. This represents a locked spindle. To unlock the spindle simply press the "start" button on the face of the mill. You'll notice that the spindle does not turn. In the LCD display however, you will notice that the display now reads "0080 forward". This represents the spindle is unlocked and ready for G-Codes control. You should not have your hands on or around the spindle while the spindle is unlocked. It is always possible for a PC, with as complex as it is, to produce a rogue pulse that may turn on your spindle. Making it a very frightening and possibly unpleasant day for yourself. At any time you're ready for a tool change, it is suggested that you press the stop button on the face of the mill after the spindle has stopped motion to re-lock the spindle.



Pulley speed set up in your Mach 3 controller

The daughter board that controls your spindle motor is controlled via pulse width modulation or PWM. Since there is no active indexed feedback into the controller the speed is an educated guess. At the factory we tune the spindle to plus or minus 100 of the desired RPM. So, it is possible to input 1000 RPM and display 1100. Although this makes very little difference in the machining capability of the machine it is somewhat confusing. To ensure your Mach 3 controller knows the range of speed so I can divide up the pulse width modulation correctly you need to tell at the range of speeds. Under the config tab of your controller you will find pulleys. If you are running a small pulley your range of speed is from 80 RPM to 1750. If this were the case, in Pulley 1 enter for a minimum 80 and a maximum 1750. If you're running a larger gear your minimum speed will be 200 and your maximum speed 3500. If you are switching between smaller and larger pulleys you may want to set up pulley 1 for low speed and pulley 2 for high speed. We are working on an index feedback addition to the machines that will enable full rigid tapping capability once the Mach 3 controller supports it. Look for this in the near future.