

PPIC1

CNC Parallel Port Interface Card 6 Axis CNC Breakout Board

General Description

PPIC1 is a complete buffered CNC breakout board. It supports up to 6 axes CNC machine control signals (pulse/direction for each axis) with extra two duplicated auxiliary output control signals for X and Y axes.

PPIC1 supports five inputs to define X, Y and Z axes limits using switches or proximity NPN sensors, in addition to two inputs for emergency and probe or any other inputs. External Input signals are optically isolated from the PC parallel port for safety.

One of the most important features of **PPIC1** is embedded switch mode power supply which provides all the required supply voltages eliminating the need for specific external power source.

Output control signals (pulse and direction) should be optically isolated on stepper motor driver.

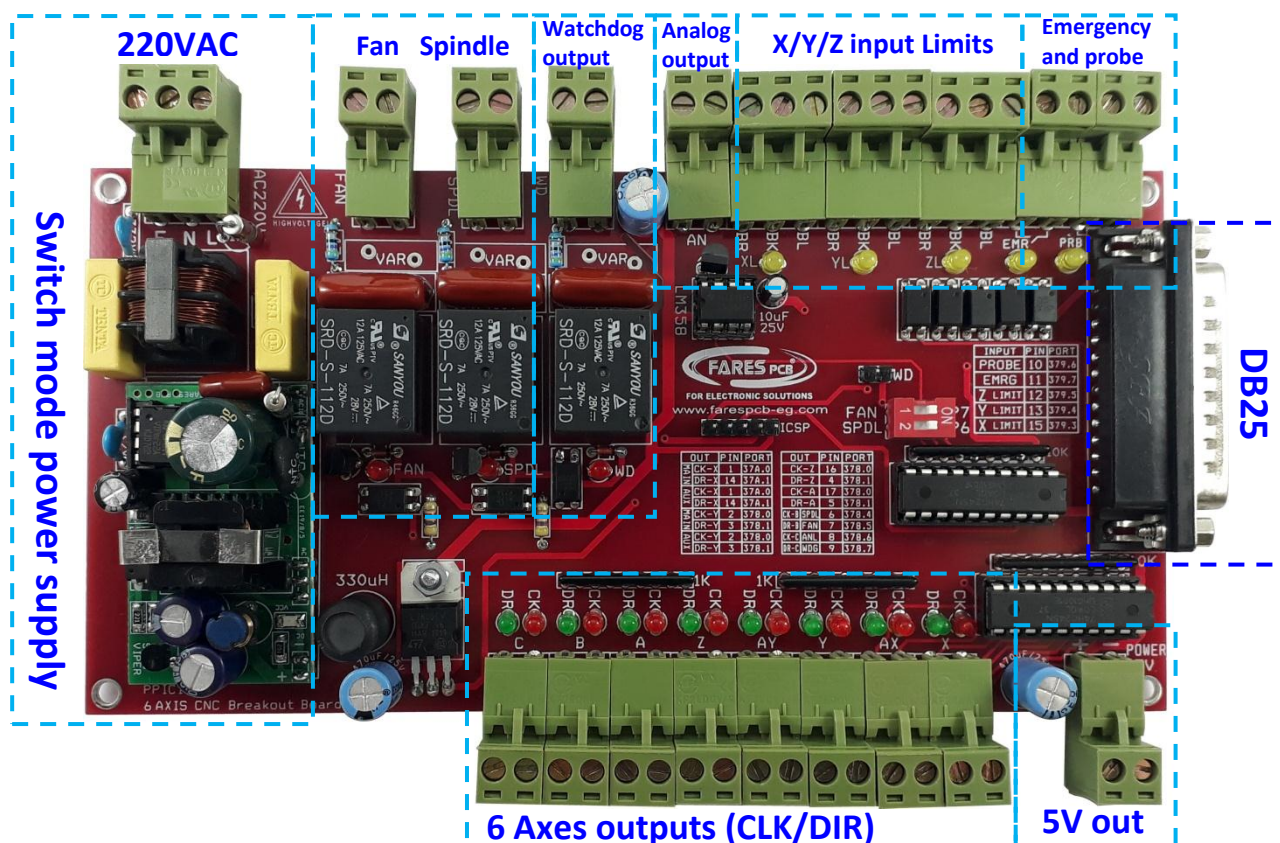
Two output relays are added for spindle and fan control.

PPIC1 includes an analog output (0-10V) for controlling spindle speed.

A very important feature of **PPIC1** is the watchdog facility, which disables all outputs until PC is powered and software starts up (activating this feature requires a software that supports watchdog facility such as MACH3).

Additional relay is included to provide external safety. This relay works in conjunction with watchdog signal to allow control of external devices.

Figure 1. PPIC1 (Power, Input and output units)



PPIC1 Features

- Completely supports MACH3 and any other soft that use LPT port.
- AC 220V input power.
- 6 axes control signals (Pulse" CLK" and Direction "DIR")
 - Main / Auxiliary X axis
 - Main / Auxiliary Y axis
 - Z axis
 - A axis
 - B axis
 - C axis
- Control signals are TTL compatible (10mA). For pin assignment and addressing refer to table1.
- Supports five external inputs. Three inputs for axes limits (NPN Proximity sensors or micro switch inputs) and two inputs for emergency stop and probe inputs (dry contact).
- All inputs are optically isolated for safety.
- Two output relays for spindle and Fan control (3A maximum contact current).
- One analog output (PWM-controlled) for controlling spindle speed.
- Watchdog facility with discrete relay output to ensure that all outputs are disabled during PC starting up and software program loading.
- All outputs and inputs are brought out via pluggable screw clamp connector for flexibility.
- LED indicator for
 - Output pulse signal "CLK" output (RED LED).
 - Output direction signal "DIR" output (Green LED).
 - Output relays "spindle", "fan" and "watchdog" (RED LED).
 - Input signals" XL", " YL", " ZL", " EMR" and" PRB" (Yellow LED).
 - Input power (Green LED).
- Dimension: 180 x 110 x 30 mm.

Figure 2. System Overview

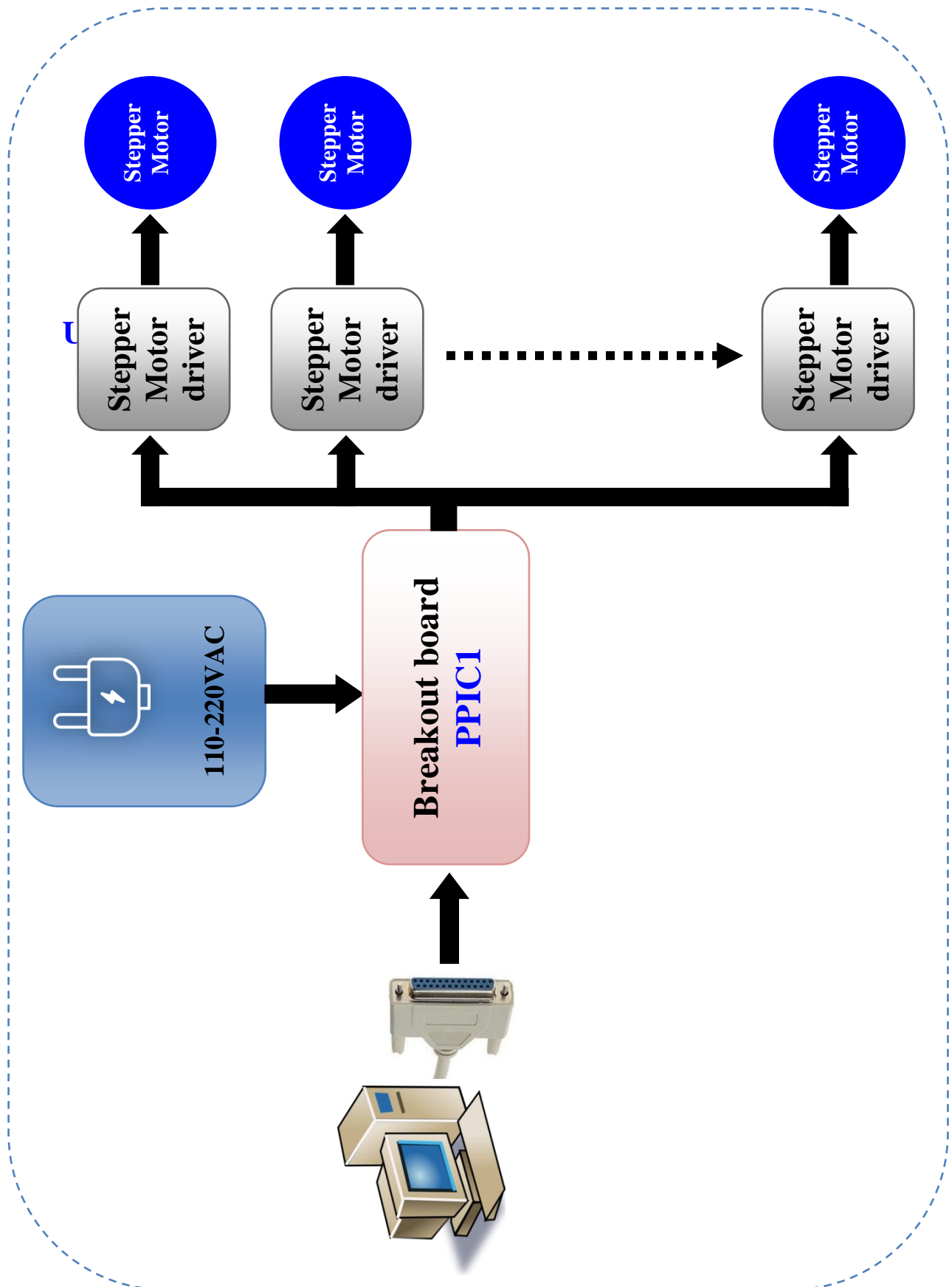


Figure 3. Output connections

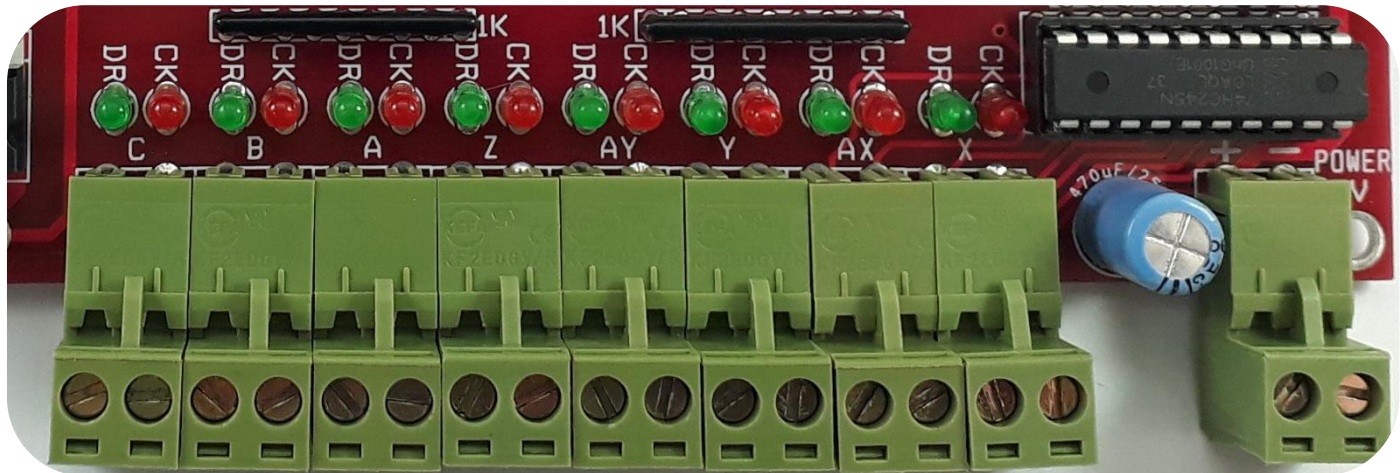
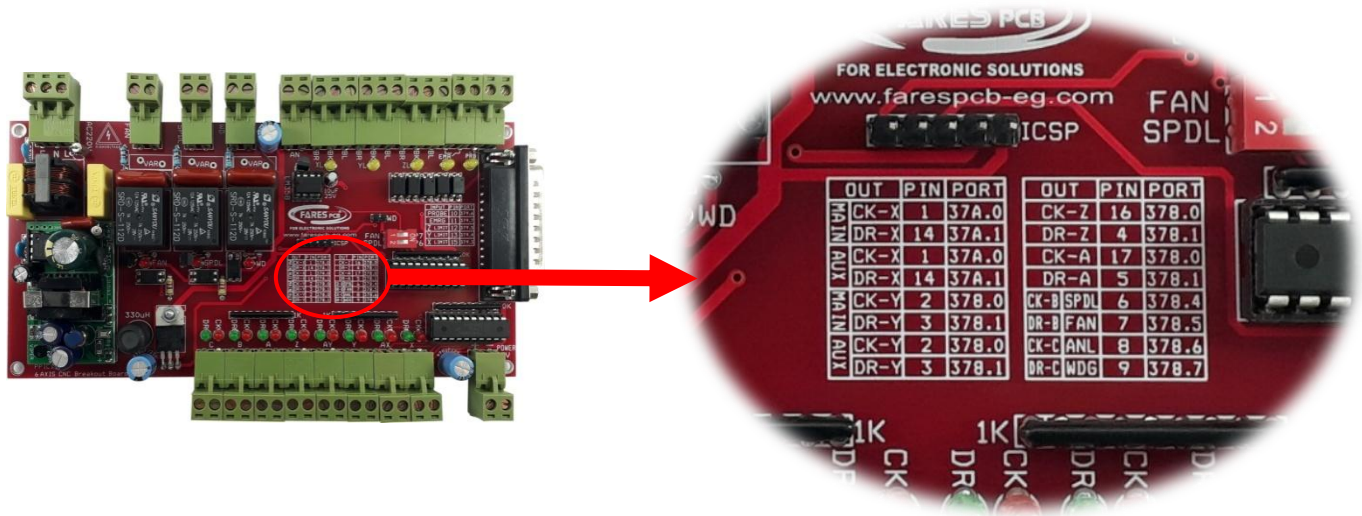


Table1 shows input name, port number, pin number and its function on DB25 socket. Use this table to configure the software that interface to **PPIC1** card.

Table1. Output Ports

Pin Name	Function	Pin#	Port#
CLK_X	X axis step	1	37A.0
CLK_AX	Auxiliary X axis step	1	37A.0
DIR_X	X axis direction	14	37A.1
DIR_AX	Auxiliary X axis direction	14	37A.1
CLK_Y	Y axis step	2	378.0
CLK_AY	Auxiliary Y axis step	2	378.0
DIR_Y	Y axis direction	3	378.1
DIR_AY	Auxiliary Y axis direction	3	378.1
CLK_Z	Z axis step	16	37A.2
DIR_Z	Z axis direction	4	378.2
CLK_A	A axis step	17	37A.3
DIR_A	A axis direction	5	378.3
CLK_B / Spindle	B axis step Or spindle on/off control	6	378.4
DIR_B / Fan	B axis direction Or fan on/off control	7	378.5
CLK_C / Analog output	C axis step Or PWM output to produce analog signal 0-10v	8	378.6
DIR_C / Watchdog	C axis direction Or Watchdog signal (Clock 1-50KHz)	9	378.7

Figure 4. Pinout table for outputs on PPIC1



How to connect axis control signals to stepper driver?

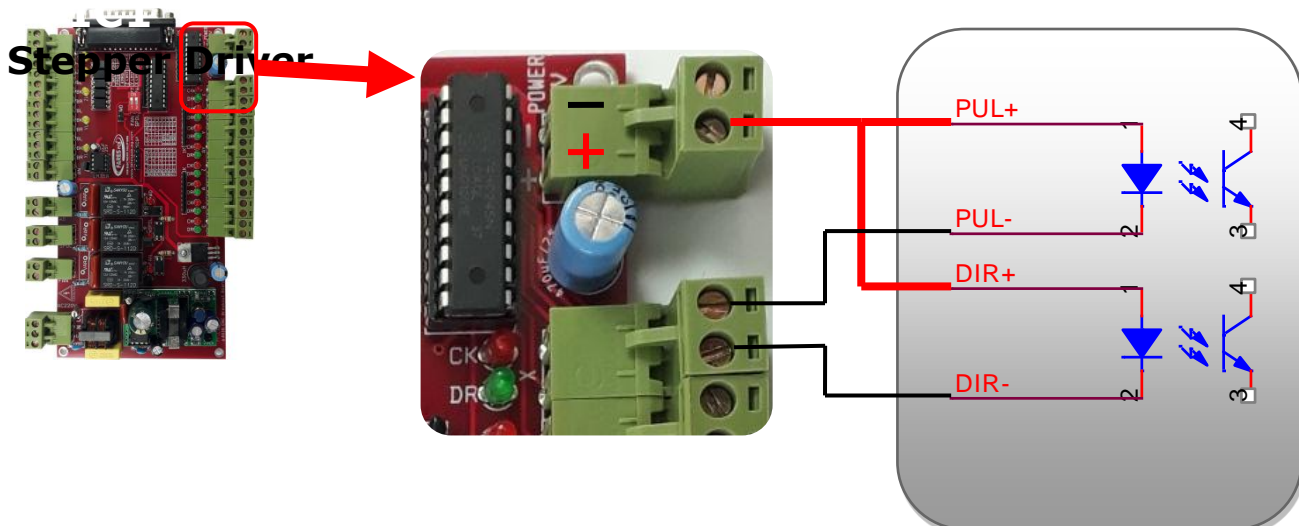
There are two connection techniques to connect control signals to stepper driver. Common anode and Common cathode techniques.

PPIC1 supports both types of connections.

Common Anode connection

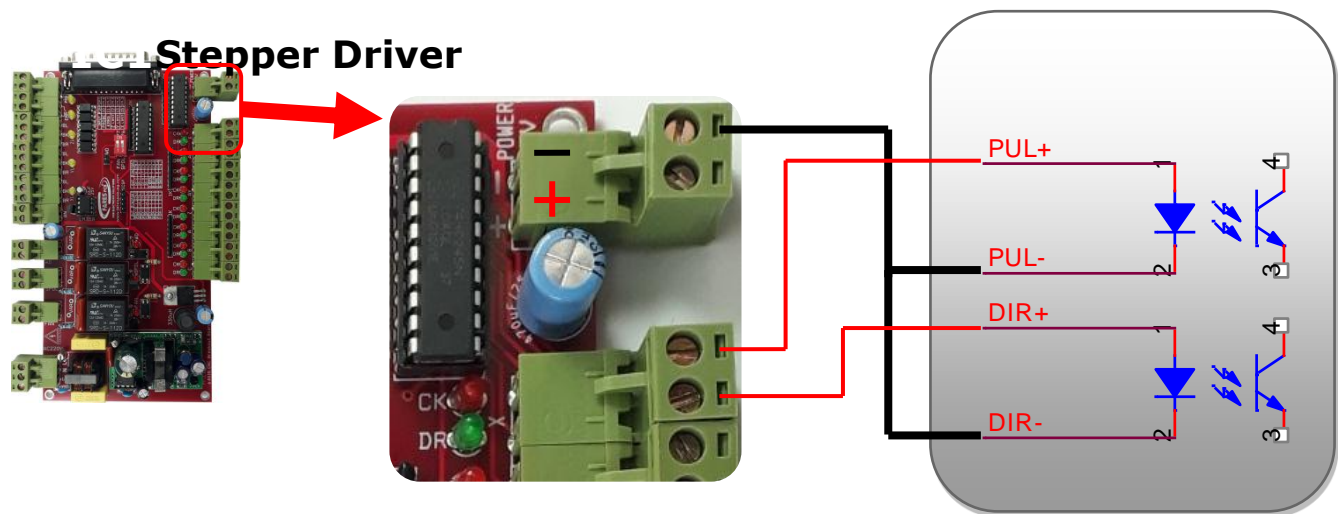
In this type of connection all the +ve signals in step motor driver are tied together and connected to +5V on breakout board, whereas clock output "CLK" is connected to negative terminal of pulse input "PUL-" of stepper driver and in the same way the direction output "DIR" is connected to negative terminal of direction input "DIR-" of stepper driver as seen in figure 5

Figure 5.X axis connection (common anode)



Common Cathode connection

In this type of connection all the -ve signals in step motor driver are tied together and connected to ground on breakout board, whereas clock output "CLK" is connected to positive terminal of pulse input "PUL+" of stepper driver and in the same way the direction output "DIR" is connected to positive terminal of direction input "DIR+" of stepper driver as seen in figure 6

Figure 6.X axis connection (common cathode)**Note:**

Output X axis is the same as output AX axis.

Output Y axis is the same as output AY axis.

Use both main and auxiliary outputs in case of driving the same axis with two motors.

Spindle / FAN outputs

As seen in table axis B outputs (CLK & DIR) are multiplexed with spindle and fan outputs. i.e. to use spindle and fan control output relays you must loss B axis control.

Table2. Spindle/Fan and axis B share the same output ports.

Pin Name	Function	Pin#	Port#
CLK_B / Spindle	B axis step Or spindle on/off control	6	378.4
DIR_B / Fan	B axis direction Or fan on/off control	7	378.5

How to enable spindle and coolant fan?

1. Enable Spindle and/or Fan by setting DIP switch as seen in figure 7.
2. Set the output pin 6 as Spindle and the output pin 7 as fan in software program.
3. The output is dry contact and rated for 3A max. So, if the load needs more current, use external relay or contactor.

Figure 7. Spindle/Fan enabling and Connection of spindle motor and coolant fan to PPIC1

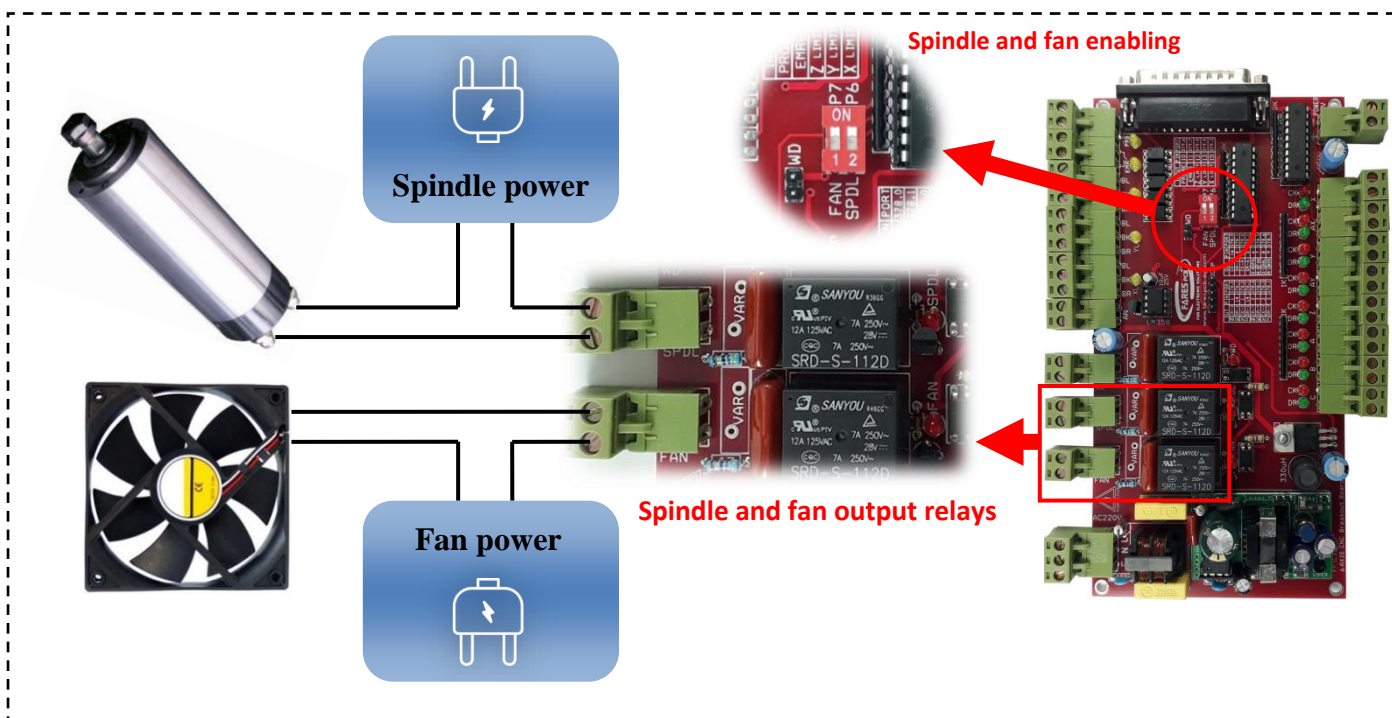


Figure 8. Input connections

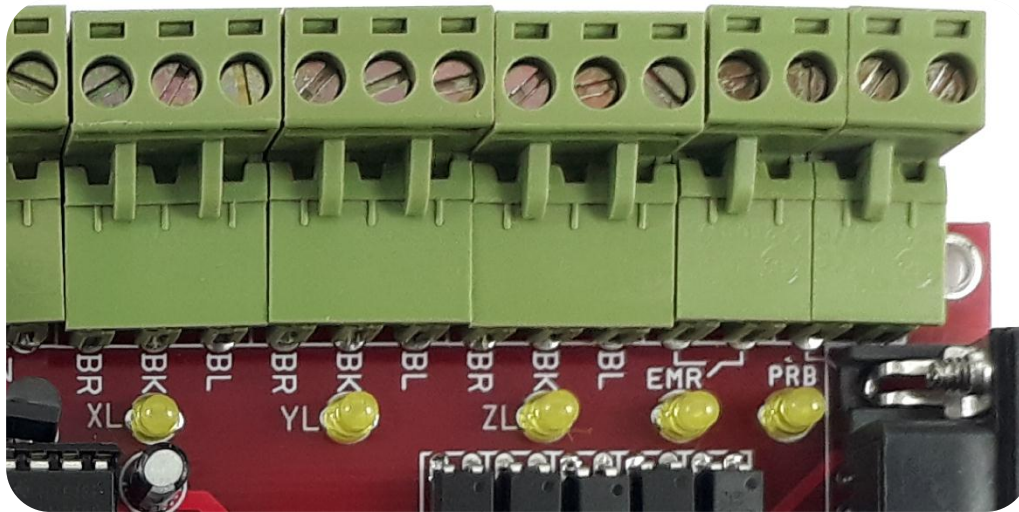
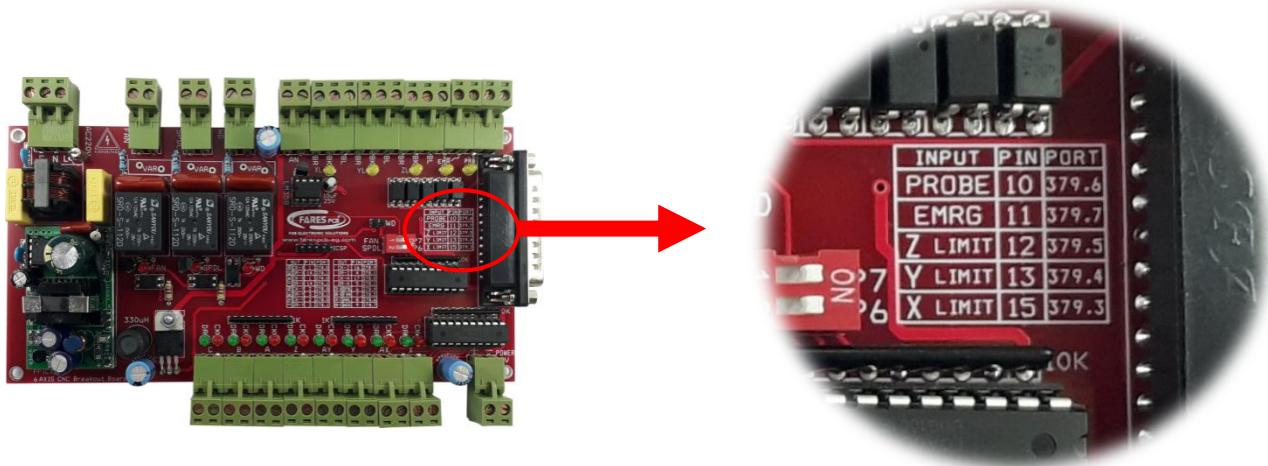


Table3. Input Ports

Pin name	Function	Pin#	Port #
PRB	Touch probe	10	379.6
EMRG	Emergency stop	11	379.7
Z limit	Z axis limit	12	379.5
Y limit	Y axis limit	13	379.4
X limit	X axis limit	15	379.3

Figure 9. Pinout table for inputs on PPIC1



Axis limits

Limit switches serve as the mechanism that tells computer the limits of the CNC machine. When one of the axes moves to an axis limit, the switch is activated and the machine stops. These limit switches are also used to inform the computer of the home position. Typically, 6 of these switches are needed, two per axis. There are different kinds of switches you can use as limit switches. **PPIC1** supports micro switch and proximity sensor (NPN type) as an axis limit switch input.

Figure 10. Micro switch and proximity sensor



Micro switch

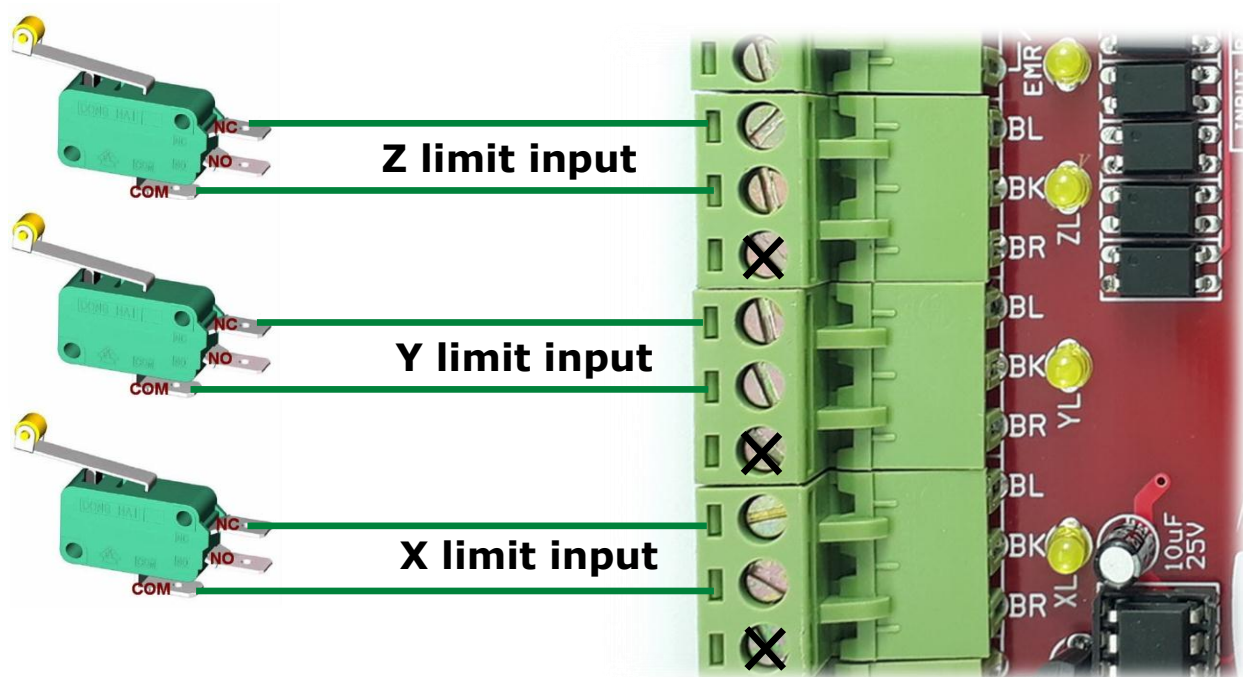


Proximity switch

How to connect micro switches as axes limits?

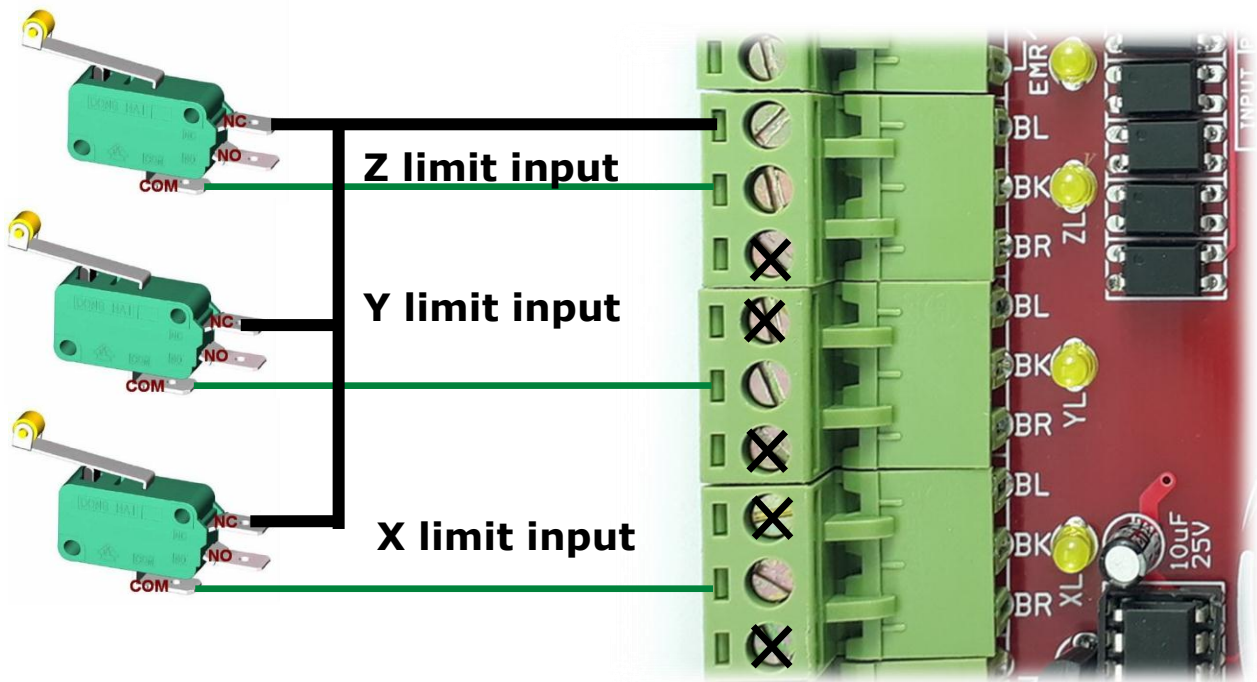
Micro switch can be connected directly to inputs "BL" and "BK". "BR" input is left not connected as seen in figure 11

Figure 11. Micro switch wiring (direct connecting)



There is another way to reduce wiring by connecting one common terminal from any "BL" input to all switches, and the other switches terminals is connected to "BK" inputs as seen in figure 12

Figure 12. Micro switch wiring (reducing connections)



Proximity sensors

Proximity sensor has three terminals. Two for power (10-30V, typically 12V), and one for output signal (GND in case of NPN proximity type). A 3-wire sensor is typically color coded with one brown wire for the +ve supply, blue wire for the common terminal of the power supply and black terminal for output signal. NPN type outputs GND when detecting a target while PNP type outputs +ve when detecting a target.

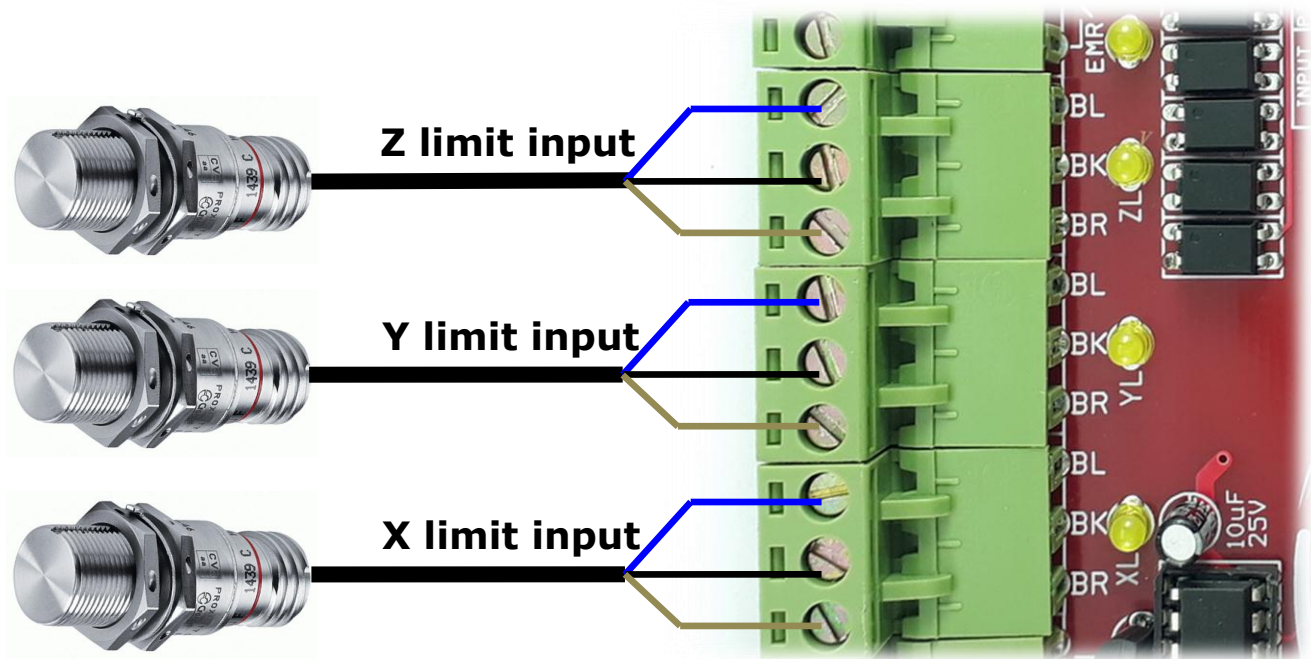
How to connect proximity switches as axes limits?

Proximity switches are simply connected directly according to wire color. As seen in figure 13

Blue terminal is connected to "BL" input.

Black terminal is connected to "BK" input.

Brown terminal is connected to "BR" input.

Figure 13. Proximity sensor wiring**Note:**

- Multiple micro switches can be paralleled to get multiple limit inputs for the same axis.
- Multiple proximity sensors can be paralleled to get multiple limit input for the same axis.

Analog output

Can I control spindle motor speed from PC through **PPIC1**?

The answer is: Of course you can.

PPIC1 provides one analog output can be used as a control signal to any motor speed control device. Your software must support PWM output control.

PPIC1 receives PWM signal from PC (LPT port pin 8) and convert it to analog voltage signal which is directly proportional to PWM duty cycle. The output voltage is ranged from 0 to 10V. The output is scaled linear, so 50% duty cycle PWM signal generates 5V analog output voltage.

The frequency of PWM signal may be start from few hundred hertz up to 50 KHz.

Output analog signal can source current up to 50mA.

Figure 14. Analog output

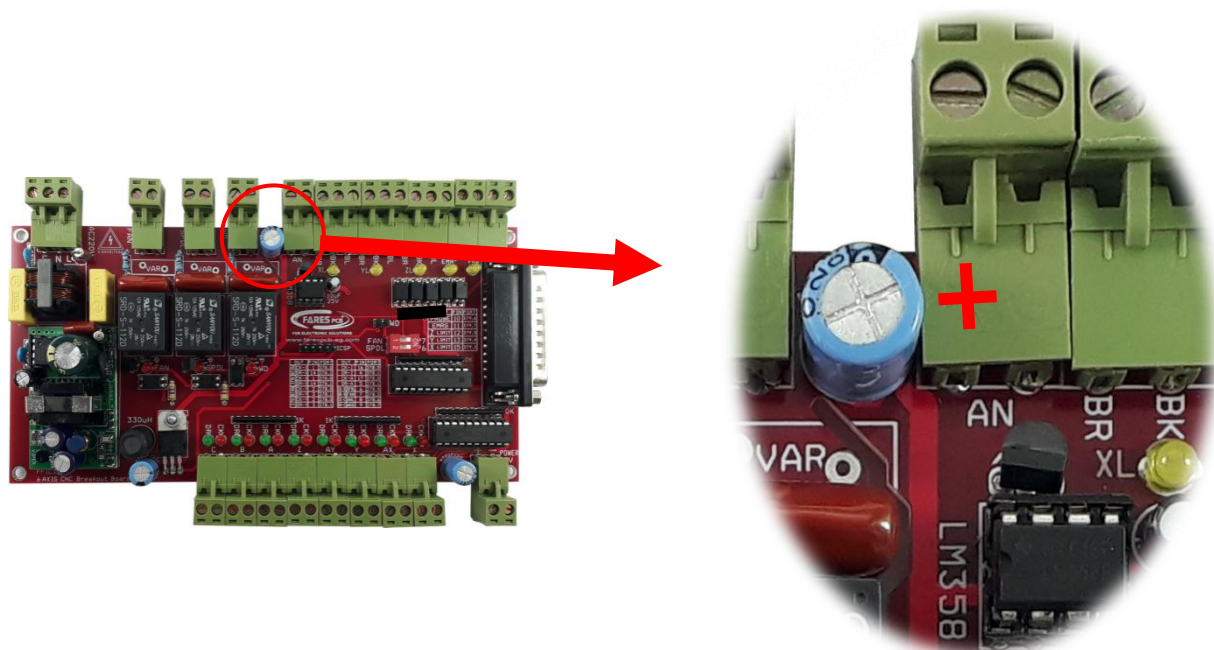


Table3. Analog output pin assignment

Pin Name	Function	Pin#	Port#
CLK_C / Analog output	C axis step Or PWM output to produce analog signal 0-10v	8	378.6

Watchdog facility (charge pump circuit)

Sometimes during turning PC on, random outputs appear on parallel port which may causes random action of system. To overcome this problem you may didn't connect power to system before running your software on PC and when the software starts to control the parallel port then you are able to connect power to other system components such as motor drivers.

Another more efficient solution that didn't need this noisy turning power on sequence is the watchdog function.

Watchdog is simply a safety circuit (charge pump circuit) enables all outputs only when a train of pulses is received from LPT parallel port. So whatever the state of parallel port "0" or "1" all outputs are disabled until PC turn on and software program takes the control of parallel port and outputs pulses to charge pump input.

If a train of pulses is detected then outputs are enabled and WD relay is activated. If the pulses disappeared for 100msec all outputs are disabled and WD relay is turned off.

WD relay can be used to safely disconnect any external device for protection.

WD relay output is dry contact (COM / normally open) and rated for 3A maximum.

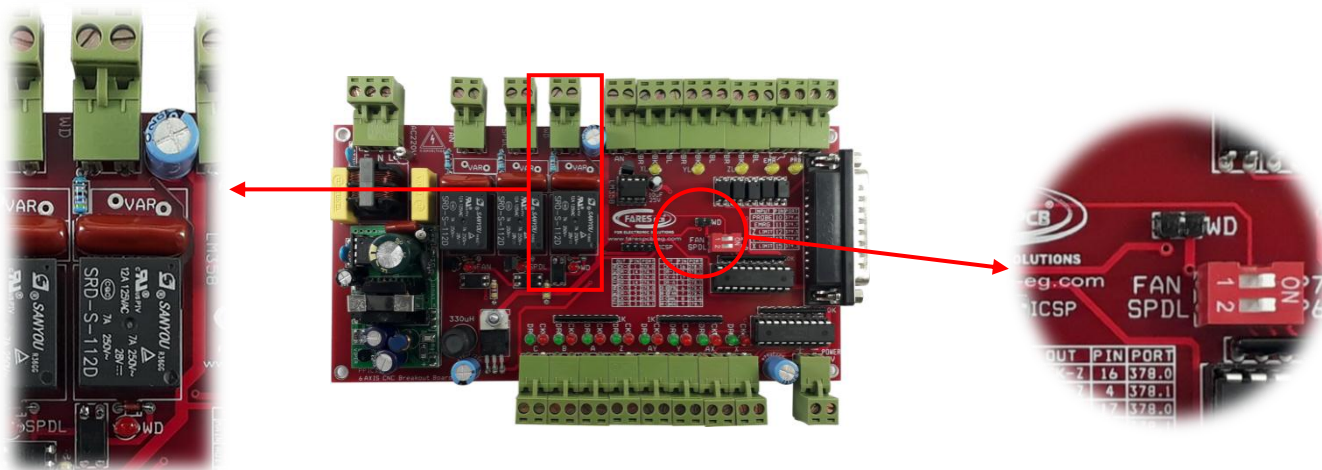
Watchdog circuit can detect signal frequency from 1 KHz up to 50 KHz.

Watchdog function can be selected with putting jumper WD. In this case port pin 9 is dedicated to receive continues pulses from LPT port.

Table4. Watchdog output pin assignment

Pin Name	Function	Pin#	Port#
DIR_C /Watchdog	C axis direction Or Watchdog signal (Clock 1-50KHz)	9	378.7

Figure 15. Watchdog enabling.



PPIC1 configurations

Because of multiplexing of output signals, there several configurations for **PPIC1**.

- Spindle and Clock B outputs share the same port 378.4(Pin 6).
- Fan and Direction B outputs share the same port 378.5(Pin 7).
- Analog and Clock C outputs share the same port 378.6(Pin 8).
- Watchdog and Direction C outputs share the same port 378.7(Pin 9).

Table5.Possible PPIC1 configurations.

Configuration	Axes						Spindle	Fan	Analog	Watchdog
	X	Y	Z	A	B	C				
3 axes	✓	✓	✓	✗	✗	✗	✓	✓	✓	✓
4 axes	✓	✓	✓	✓	✗	✗	✓	✓	✓	✓
5 axes_1	✓	✓	✓	✓	✓	✗	✗	✗	✓	✓
5 axes_2	✓	✓	✓	✓	✗	✓	✓	✓	✗	✗
6 axes	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗

Every configuration needs a different software configuration. Before selecting your configuration, be sure that software supports all requirements.

MACH3 configuration for PPIC1

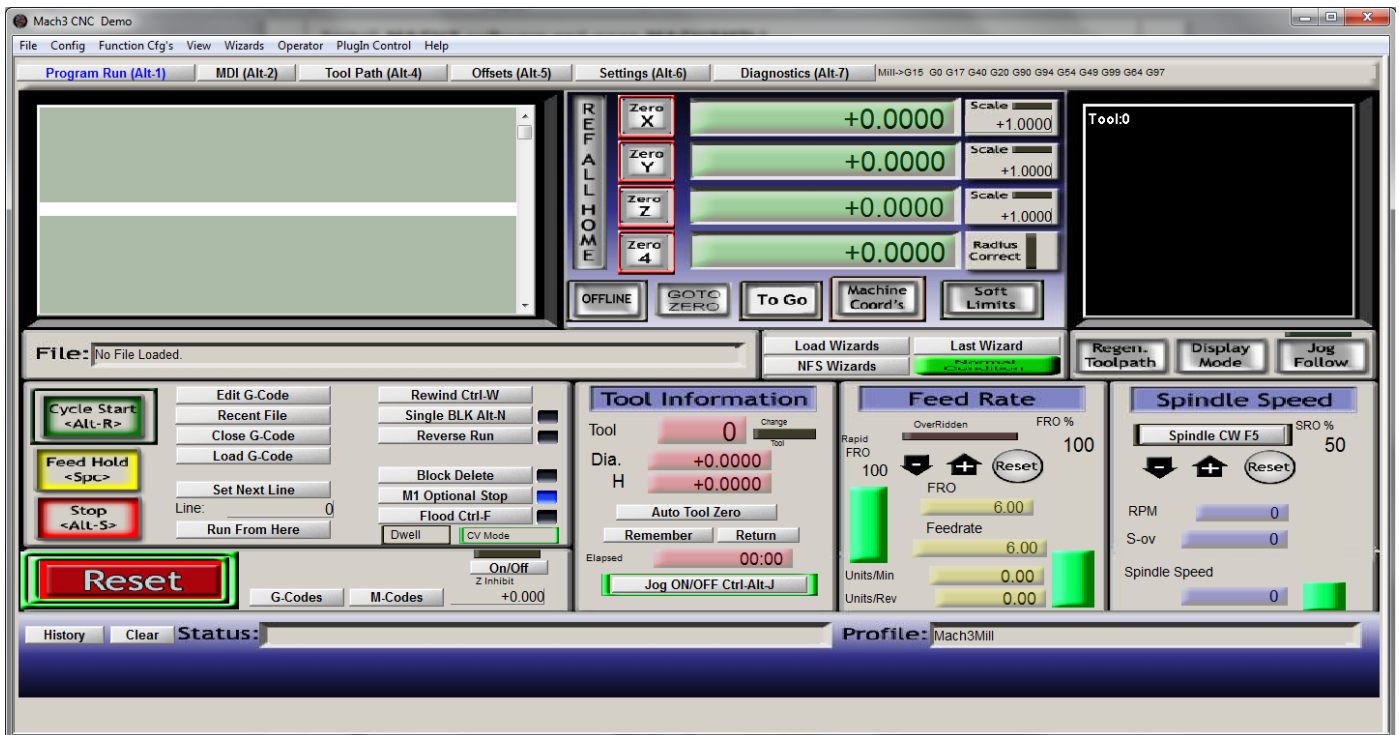
We will demonstrate the configuration of MACH3 for first PPIC1 configuration in table5.

In this configuration: -

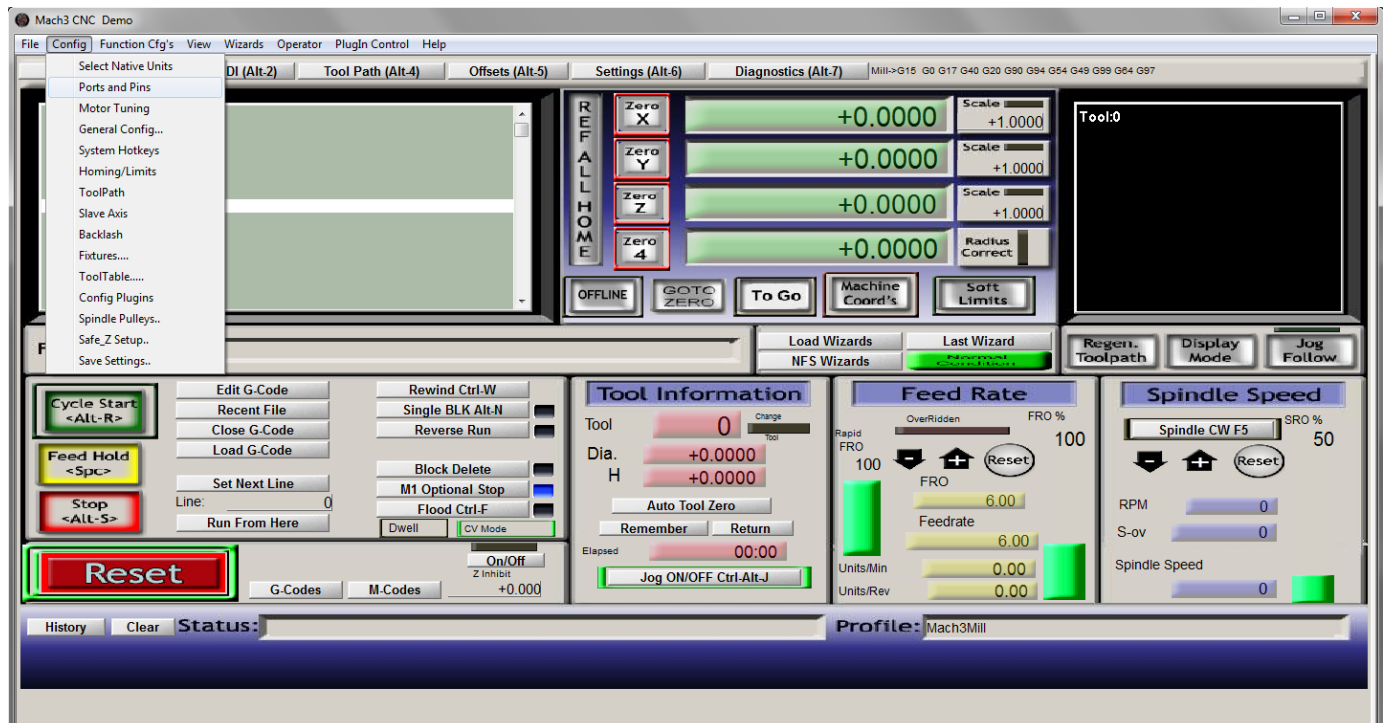
- ✓ X, Y, and Z axes are activated. A, B, C axes are not used.
- ✓ Spindle output is activated.
- ✓ Fan output is activated.
- ✓ Spindle speed control is enabled using analog output.
- ✓ Watchdog facility is activated.

Suppose six proximity sensors are used as a limit inputs. A pair of sensors for each axis. Also let a touch probe is used and an emergency stop switch (normally closed).

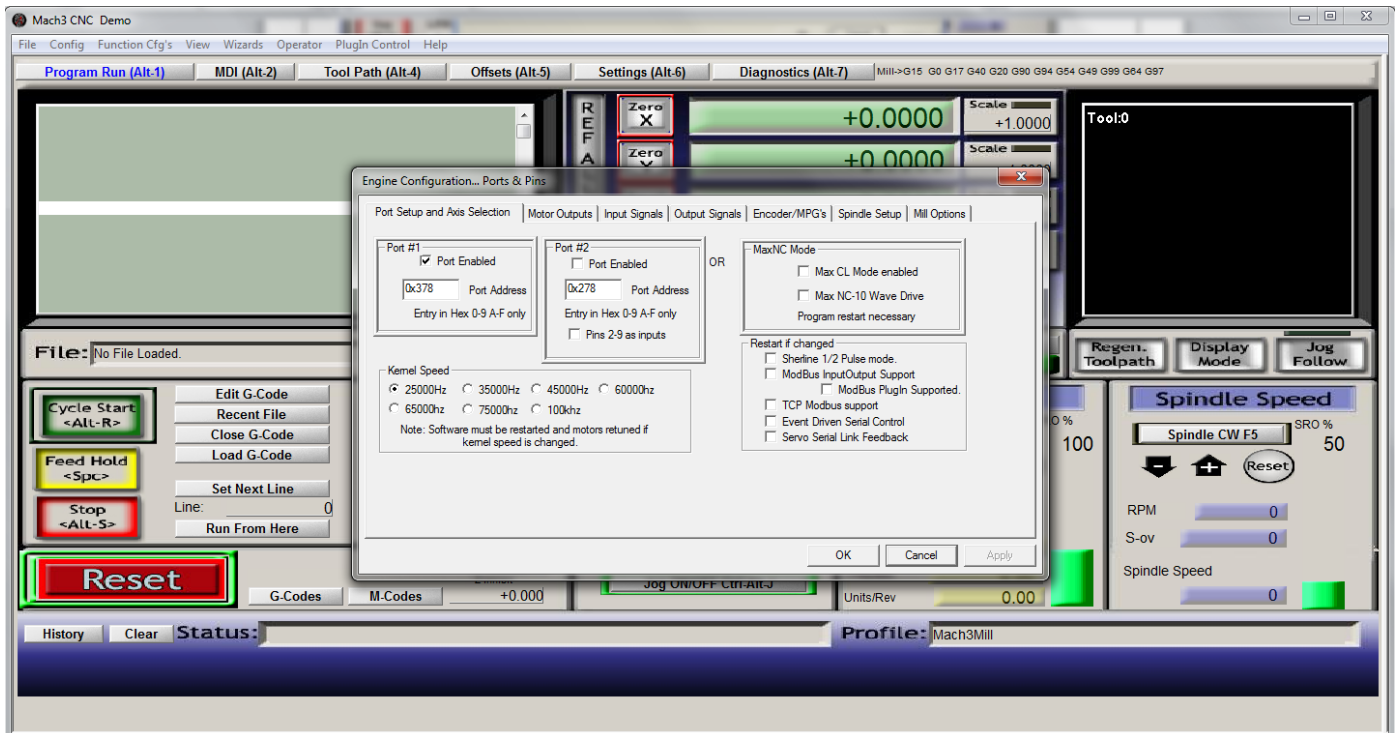
Install **MACH3** software and open **MACH3MILL**



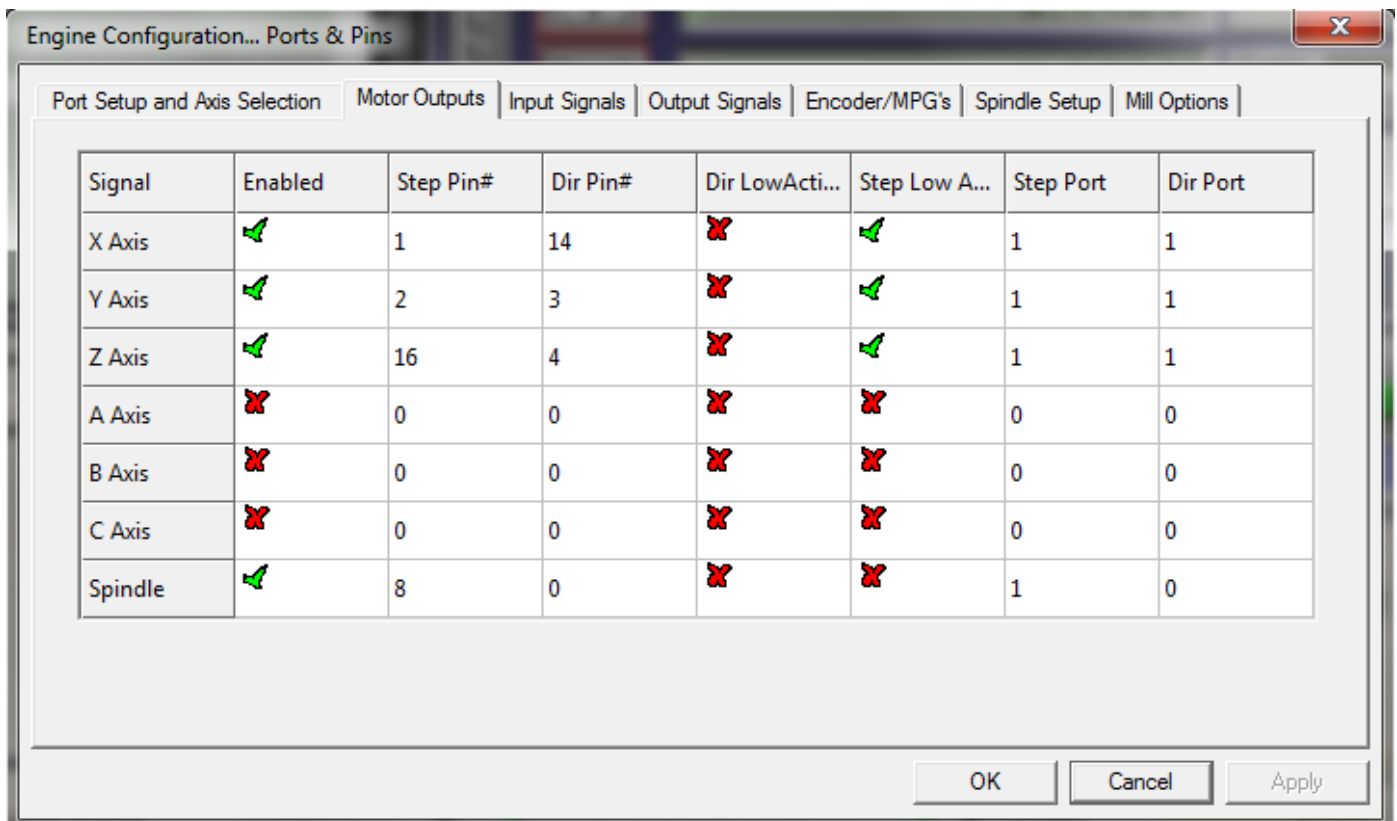
Go to Config menu -> ports and pins as shown in figure



Set the parallel port address (0x378 by default)



Go to motor output tab and enable X, Y, Z axis and spindle and set addresses as shown in figure



Go to input signals tab and set the following,

Enable X axis limits (X++, X--).

Enable Y axis limits (Y++, Y--).

Enable Z axis limits (Z++, Z--).

Set all inputs as active low, and set addresses as shown in figure

Signal	Enabled	Port #	Pin Number	Active Low	Emulated	HotKey
X ++		1	15			0
X --		1	15			0
X Home		1	0			0
Y ++		1	13			0
Y --		1	13			0
Y Home		1	0			0
Z ++		1	12			0
Z --		1	12			0
Z Home		1	0			0

Pins 10-13 and 15 are inputs. Only these 5 pin numbers may be used on this screen

Automated Setup of Inputs

OK Cancel Apply

Enable Probe input (active low) and Estop input and set addresses as shown in figure

Signal	Enabled	Port #	Pin Number	Active Low	Emulated	HotKey
Input #1		1	0			0
Input #2		1	0			0
Input #3		1	0			0
Input #4		1	0			0
Probe		1	10			0
Index		1	0			0
Limit Ovr		1	0			0
EStop		1	11			0
THC On		1	0			0

Pins 10-13 and 15 are inputs. Only these 5 pin numbers may be used on this screen

Automated Setup of Inputs

OK Cancel Apply

Go to Spindle Setup tab and set the following,

Relay Control

- Uncheck Disable Spindle Relays.
- Set Clockwise(M3) to output# 1.
- Set CCW(M4) to output# 1.

Flood/Mist Control

- Uncheck Disable Flood/Mist relays.
- Set Mist M7 to output# 2.

Motor Control

- Check Use Spindle Motor Output.
- Check PWM Control.
- Set PWM Base Freq to 100.
- Set Minimum PWM to 0.

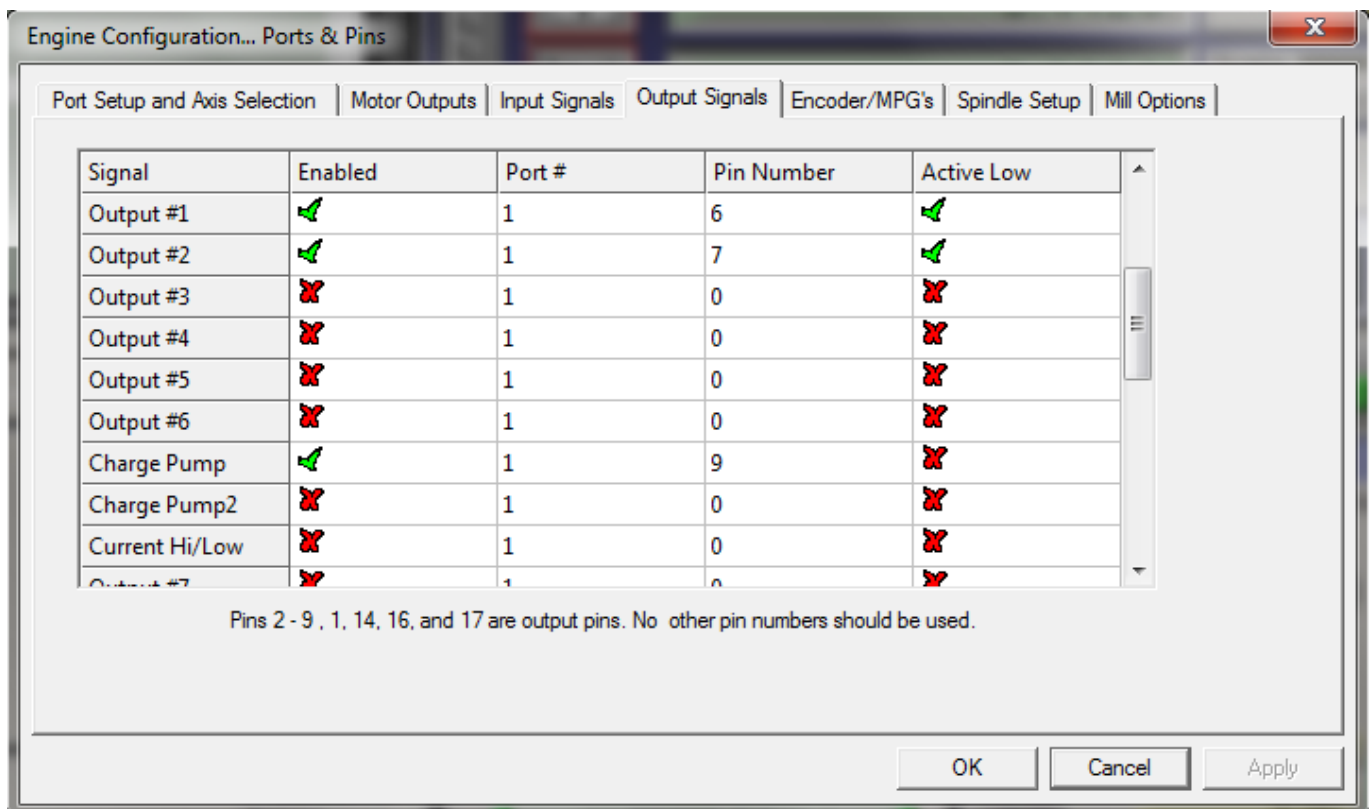
The screenshot shows the 'Engine Configuration... Ports & Pins' dialog box with the 'Spindle Setup' tab selected. The dialog has several tabs: Port Setup and Axis Selection, Motor Outputs, Input Signals, Output Signals, Encoder/MPG's, Spindle Setup, and Mill Options. The 'Spindle Setup' tab contains the following settings:

- Relay Control:**
 - ☐ Disable Spindle Relays
 - Clockwise (M3) Output #
 - CCW (M4) Output #
 - Output Signal #'s 1-6
- Flood Mist Control:**
 - ☐ Disable Flood/Mist relays
 - Mist M7 Output # Delay
 - Flood M8 Output # Delay
 - Output Signal #'s 1-6
- ModBus Spindle - Use Step/Dir as well:**
 - ☐ Enabled Reg 64 - 127
 - Max ADC Count
- Motor Control:**
 - ☒ Use Spindle Motor Output
 - ☒ PWM Control
 - ☐ Step/Dir Motor
 - PWMBase Freq.
 - Minimum PWM %
- General Parameters:**
 - CW Delay Spin UP Seconds
 - CCW Delay Spin UP Seconds
 - CW Delay Spind DOWN Seconds
 - CCW Delay Spin DOWN Seconds
 - ☐ Immediate Relay off before delay
- Special Functions:**
 - ☐ Use Spindle Feedback in Sync Modes
 - ☐ Closed Loop Spindle Control
 - P I D
 - ☐ Spindle Speed Averaging
- Special Options, Usually Off:**
 - ☐ HotWire Heat for Jog
 - ☐ Laser Mode. freq 1
 - ☐ Torch Volts Control
 - ☐ Torch Auto Off

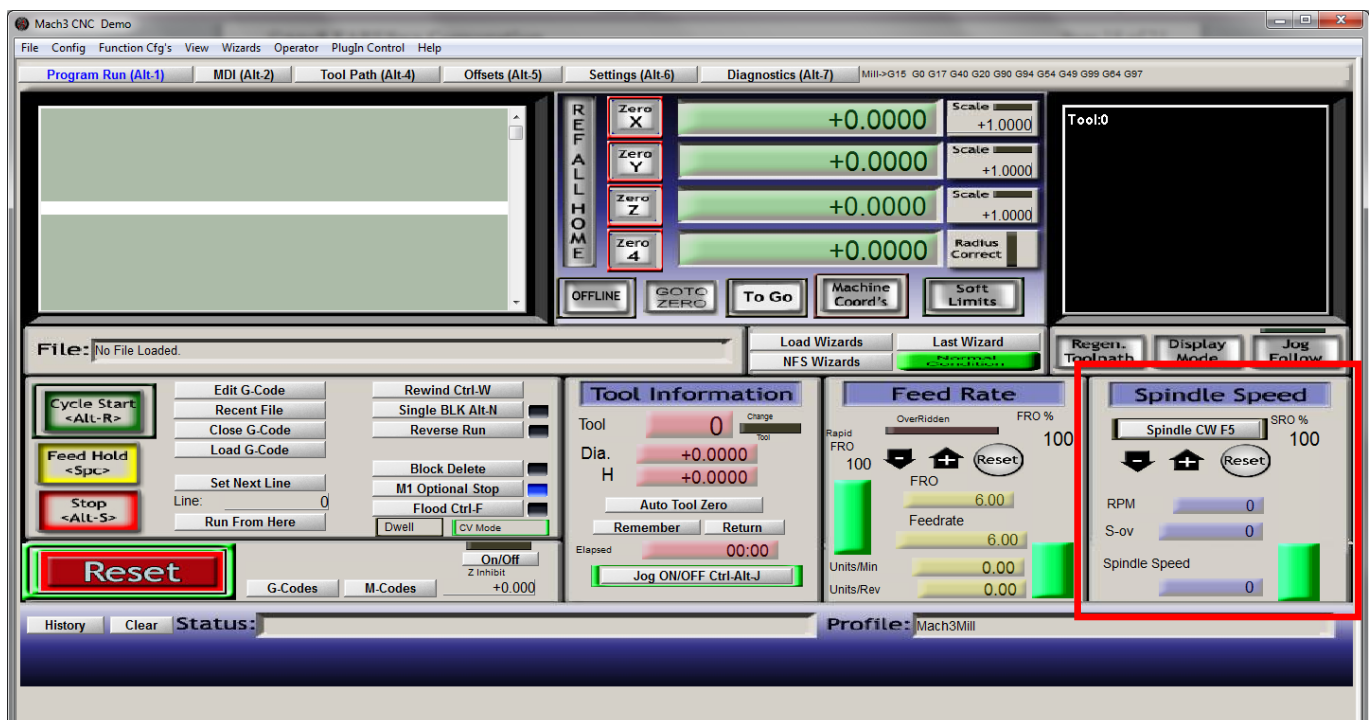
At the bottom right, there are buttons for 'OK', 'Cancel', and 'Apply'.

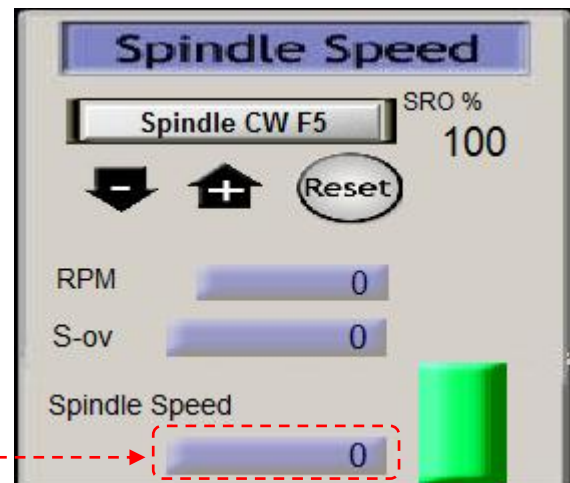
Go to output signals tab and set the following,

- Enable output#1, Output#2 and Charge Pump output
- Set Output#1 and Output#2 as an active low output
- Set charge Pump output as an active high output
- Set addresses as shown in figure.

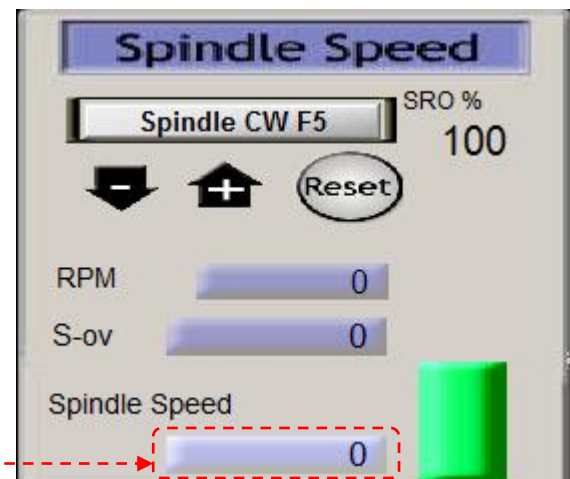


To set spindle speed, go to main screen of MACH3 program and press spindle speed button to edit spindle speed (8000 in our example) and press <Enter>key shown in figures

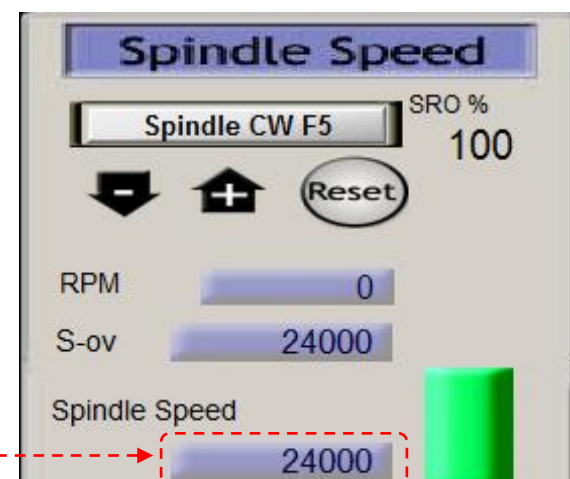




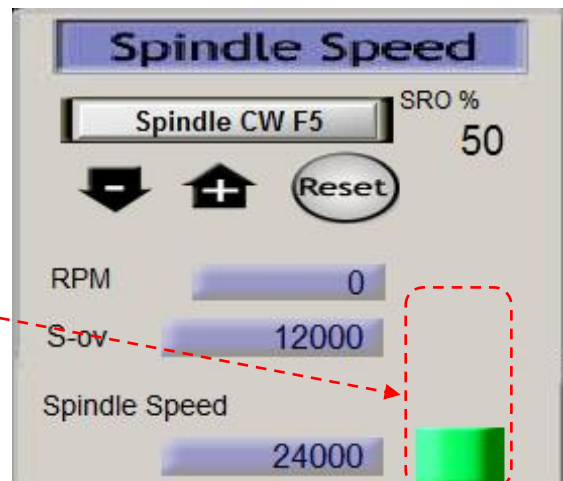
Before button clicking



After button clicking



Entering spindle speed



Use this bar to change spindle speed



Use this button to turn On/Off spindle

Table6. Jog hotkeys.

X		Y		Z		A		B		C	
++	--	++	--	++	--	++	--	++	--	++	--
Right arrow	Left arrow	Up arrow	Down arrow	Page Up	Page Down	+	-	>	<	0	9

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