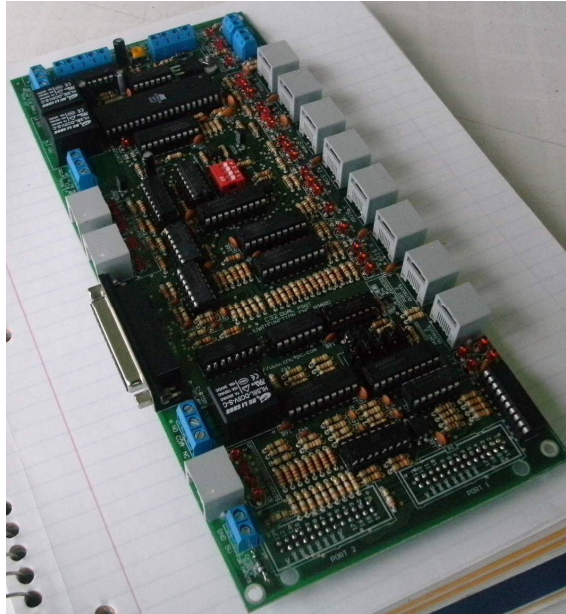


C32- DUAL PORT MULTIFUNCTION CNC BOARD Rev. 1.1

User manual Rev. 1.2



1. Overview

This card has been designed to provide a flexible and easy connections using (RJ45 and Networks Cables) interface to drivers and function boards. This board comes with sockets that allow direct connection of a Smooth Steeper Board (from Warp9 Tech Design Inc) or DB25 headers. It also serves as an interface board for the pendants provided by CNC4PC (MPG2, MPG4, and MPG8).

This board provides a fast, easy, clean and safe installation.

Features

- **Connects directly to the Smooth Stepper (from Warp9).**

The board is provided with sockets that allow the Smooth Stepper Board

to be plugged directly into this board. No ribbon cables required.

- **IEEE 1284 Standard compatible.**

Includes the circuitry recommended by the IEEE 1284 Level 1 standards for bidirectional parallel communications between personal computers and peripherals.

- ***RJ45 connectors for all I/Os.***
You only have to use standard networks cable to make all connections.
- ***Easy connections with CNC4PC relay boards and speed control boards.***
- ***Connects 4 and 6 axis pendants (MPG2, MPG4, and MPG8)***
- ***Has a relay that reflects the status of the e-stop button.***
- ***Optoisolated inputs.***
- ***Works with regular parallel ports.***
Board C24 (from CNC4PC) or Ribbon cables can be used to connect regular parallel ports.
- ***Monitors E-Stop, Safety Charge Pump, and Drivers (it only monitors G320/340, G203, G210/201, Dugong, and Viper Servomotor drives at this time).***
 - ***Enables and disables the drivers.***
- ***Microcontroller based SCHKP.***

This board comes with a microcontroller that allows the

implementation of a complex algorithm for sampling and analyzing the SCHKP signal.

- ***All TTL 5VDC signals.***
Interface directly with parallel port interface products and other CNC4PC cards. 5VDC (TTL) cards are very common among automation devices.
- ***Buffered outputs.***
All outputs are buffered through the use of high speed and high current buffers, with the result that your devices receive all the power they need.
- ***Status LEDs on all inputs and output connections.***
No more guessing. You can SEE all your signals. Save valuable time and brainpower for CNCing. To avoid remaining current to the main load (driver or other device), all the indicator outputs LEDs are driven by independent buffers of the ones that drive de output.
- ***Built-in Variable Speed Control.***
It has an optoisolated analog 0-10VDC output that will convert a step signal into an analog signal that can be used to command a commercial VFD. This analog can be adjusted using on-board potentiometer, so this board can be adjusted to other voltages.
- ***Two Built-in Electromechanical Relays with NO and NC positions.***

- **34 inputs and outputs on 2 ports.**

PINS	LPT1	LPT2	TOTAL
INPUT	5	13	18
OUTPUT	12	4	16
TOTAL	17	17	34

- **Inputs and outputs with close 5V and ground connections.**

Forget about grounding problems. Easily connect your pin by using your close by ground connection. No need

to be an electronics expert to ground all your stuff.

- **Works directly with popular CNC hardware and software.**

That goes for GeckoDrive, DeskCNC or Rutex and parallel port control software such as mach3, Linux EMC2, and TurboCNC.

2. Specifications.

DIGITAL OPTOISOLATED INPUT SPECIFICATIONS	
Numbers of inputs	18
On-state voltage range	2 to 5V DC
Maximum off-state voltage	0.8V
Typical signal delay	2.8uS

DIGITAL OUTPUT SPECIFICATIONS	
Number of outputs	16
Maximum output voltage	(5V power supply voltage) + 0.5V
Typical output current	24mA
Maximum off-state voltage	0.44 V
Maximum supported frequency	4M
Typical signal delay	10 nS
Time of transition to high impedance state	120mS*

*Time passed since a fault in the SChP signal is detected and the outputs are disabled.

3. Powering the Board.

3.1. Main Power Supply: The board requires a main power supply. This should be a +5vdc@2amp power supply. This goes on the terminals located in the upper right hand position.

3.2. Optoisolated Inputs: In the upper left hand position, there is another power terminal for powering the optos for the inputs. If optoisolation is not required, the same power supply can be used to power the circuit. To preserve optoisolation, this power supply and its ground must be kept isolated from the circuits you want to keep isolated.

3.3 Optoisolated Outputs: This goes in the terminals located in the bottom. It is for powering the circuit that interacts with the drivers. If the drivers are optoisolated, then the main power supply can be used here. If optoisolation is required, then an external power supply is required. Note that while G320/340 has optoisolated step and direction signals, the ERR/RES is not, so an external power supply is required to preserve optoisolation. To preserve optoisolation, this power supply and its ground must be kept isolated from the circuits you want to keep isolated.

3.4 Optoisolated Analog Output: If optoisolation is required, an external power supply must be used. To preserve optoisolation, this power supply and its ground must be kept isolated from the circuits you want to keep isolated. This is a must when using speed controllers that make the ground of the analog circuit common with the ground of the motors.

4. Functional Block Diagrams

4.1 Outputs 2-9 simplified functional block diagram

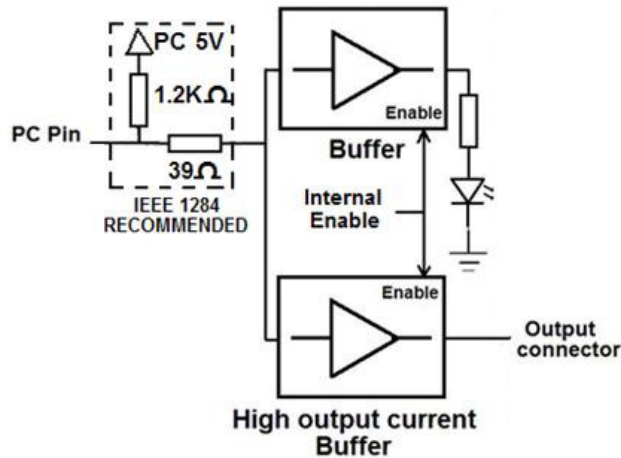


Fig. 1 Simplified functional block diagram for the outputs 2-9.

Parallel Port coupling is done following IEEE 1284 standard recommendation. The indicator led is driven by a different buffer.

4.2 Outputs 1, 14, 16 and 17 simplified functional block diagram

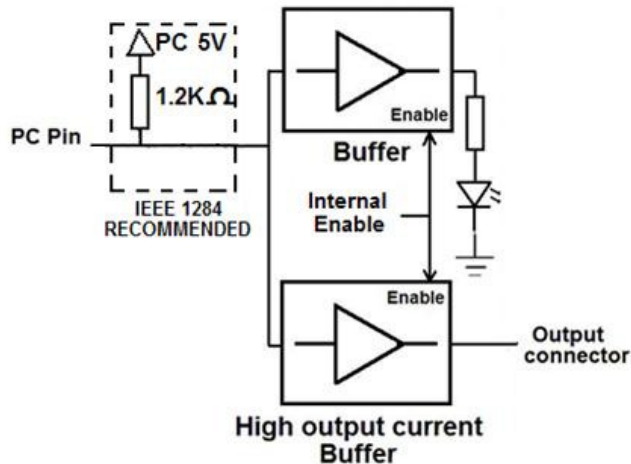


Fig. 2 Simplified functional block diagram for the outputs 1, 14, 16 and 17.

Note: "Internal Enable" = "E-Stop Pin" AND ("SCHP" OR "Bypassed SCHP") AND Port 1 connection.

The "Internal Enable" is the result of an AND Operation among the "E-Stop Pin", the SCHP operation mode selected by the user and the port 1 connection to the PC parallel port or the Smooth Stepper.

4.3 Inputs simplified block diagram

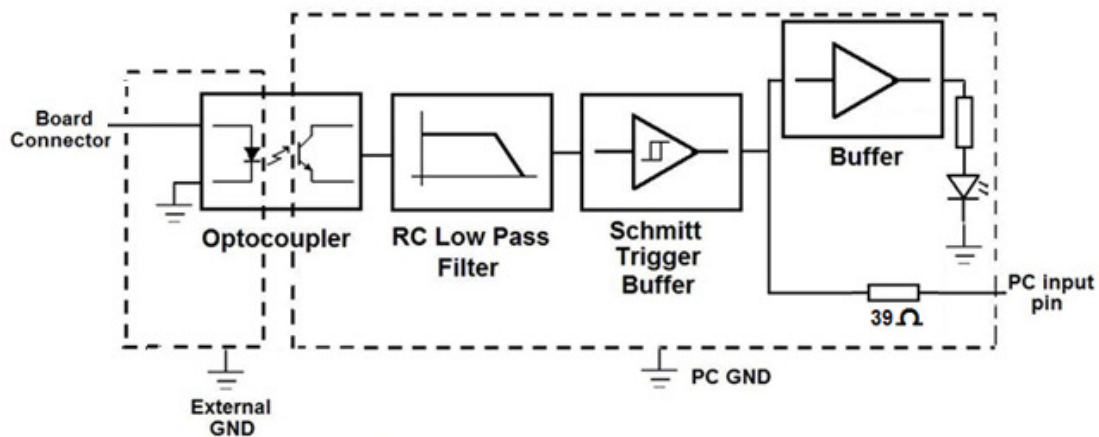


Fig. 3 Simplified functional block diagram for the Port 1 inputs.

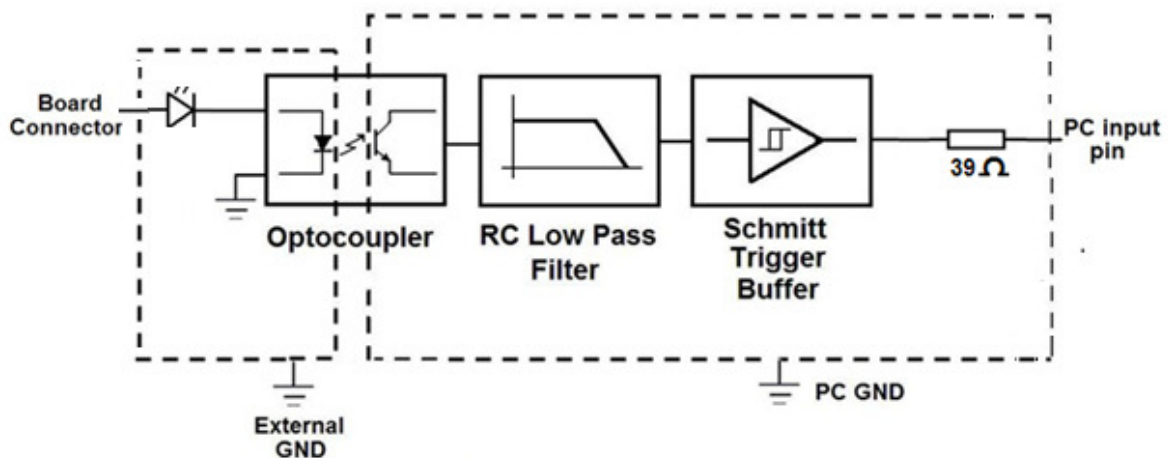


Fig. 4 Simplified functional block diagram for the Port 2 inputs.

WARNING: CONNECTING RJ45 CABLES SPECIFIED FOR INPUT TO DEVICES THAT PRODUCE OUTPUTS CAN CAUSE DAMAGE TO THE BOARD.

5. Special Functions

5.1 Safety Charge Pump “SCHP”. (Pin 17 “Port 2”)

This board takes advantage of Mach ability to send a specific frequency through one of the pins of the parallel port when the program is in control of the system. CNC machinery can be very dangerous, and you could have a risk of the machine doing something different than what you intend the machine to do if the program loses control of your system. Mach can be programmed in a way, so when it is “in control”, it delivers a 12.5 KHz signal through one of the pins. This card lets you use this signal to work as an On/Off switch for your system, enabling a powerful safety system for your equipment. If you ever had windows crash on you, then this card is for you. The port can also do weird things while the system is coming up, or down.

For Configuring the Charge Pump in Mach X: Use the dialog *Config / Ports and pins / Output Signals*. Enable the *Charge Pump* output and configure it as is shown in the Fig. 12. Next, press the *apply* button.

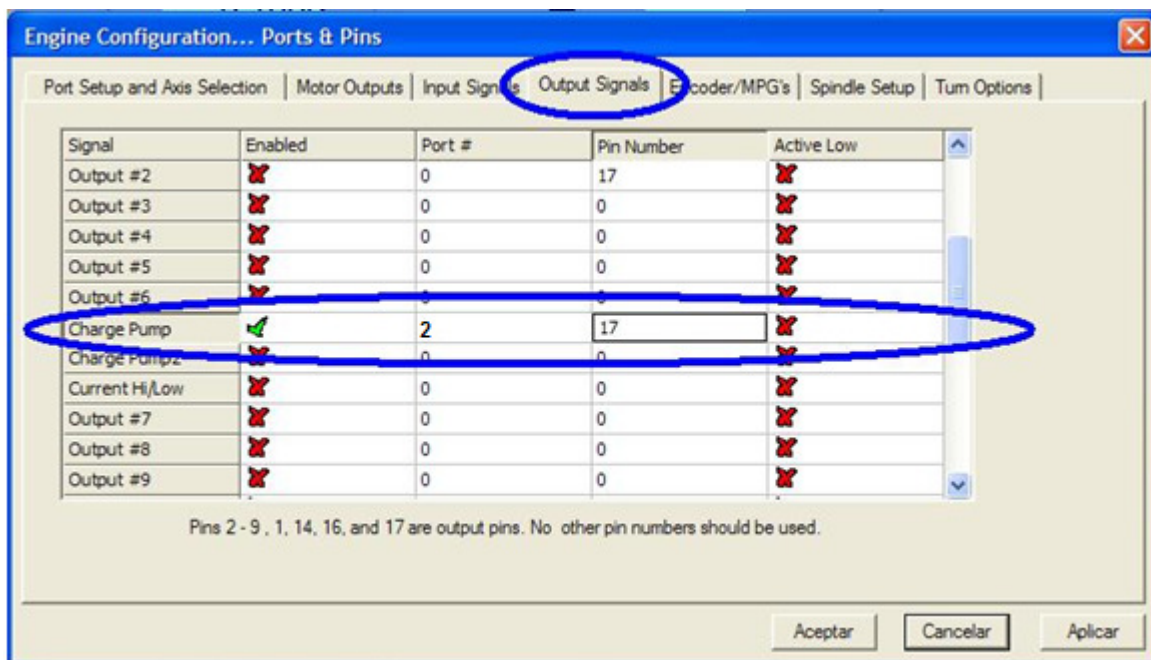
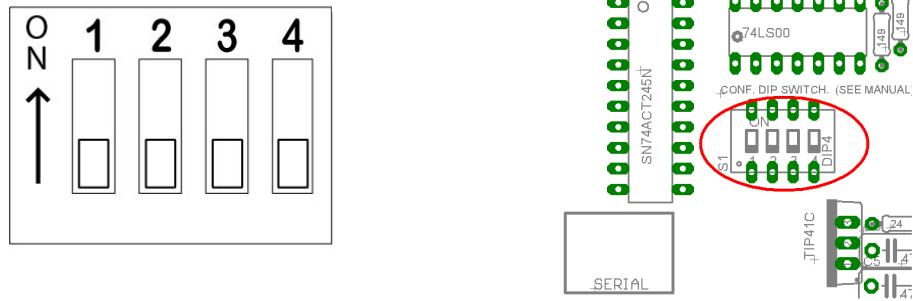


Fig. 5. Charge Pump configuration

Selecting the SCHK operation mode

The onboard DIPSWITCH allows activating or deactivating the SCHK detection function.



SWITCH 2 ON: Activate the SCHP detection function.

SWITCH 2 OFF: Deactivate the SCHP detection function.

Note: When the Safety Charge Pump is activated, 5V in the E-Stop terminal and a valid SCHP signal is present, Port 2 Pin 17 will go high. This high signal can be used to enable other external devices, such as enabling other Breakout Boards, or relays that would enable servos, VFDs, contactors, etc....

5.2 Variable Speed Control. (pin 14 “Port 1”)

This function lets you control your spindle with step and direction signals, as if it was an axis motor. It converts the step signal into an analog (0-10VDC).

A Variable Frequency Drive or Inverter works by modifying the frequency for AC motors. You can control most of these devices with an external analog signal (0-10VDC). That is, if there is 5VDC coming into through the control signal, the motor will run at 50% of full speed, if there was 10VDC, the motor will run at 100% of full speed. If there is no signal coming out, then the motor will stop.

This function can also be used on many DC motor controllers by replacing the potentiometer that controls the speed.

Requirements:

It requires a +12VDC@20mA power supply to operate.



WARNING: To keep the output signals optoisolated, these must not have common ground or connections to current with other circuits you are using.

You will require a voltmeter to fine tune your system.

Wiring:

Before connecting anything, please be sure to read your VFD's manual and make sure you understand all the safety issues.

Please check the wiring guide and wiring samples here:

<http://cnc4pc.com/Tech Docs/C6R5 WG.pdf> and

<http://cnc4pc.com/Tech Docs/C6R5 WS.pdf>

Configuring the Control Software:

It is strongly recommend you read your control software's manual. You need to configure your control software to control the spindle as if it was an angular axis. This card requires a 25 KHz input signal in the Port 1 pin 14 to deliver 10VDC. So you have to set the speed of the motor (spindle) at maximum. For acceleration values adjust them to where you feel comfortable. Keep in mind the acceleration of the motor must also be set in your VFD.

For configuring Mach follow these steps:

1. Go to Config / Ports&Pins / Motor Outputs. Enable the spindle and select the port and pins you wired for step and direction.

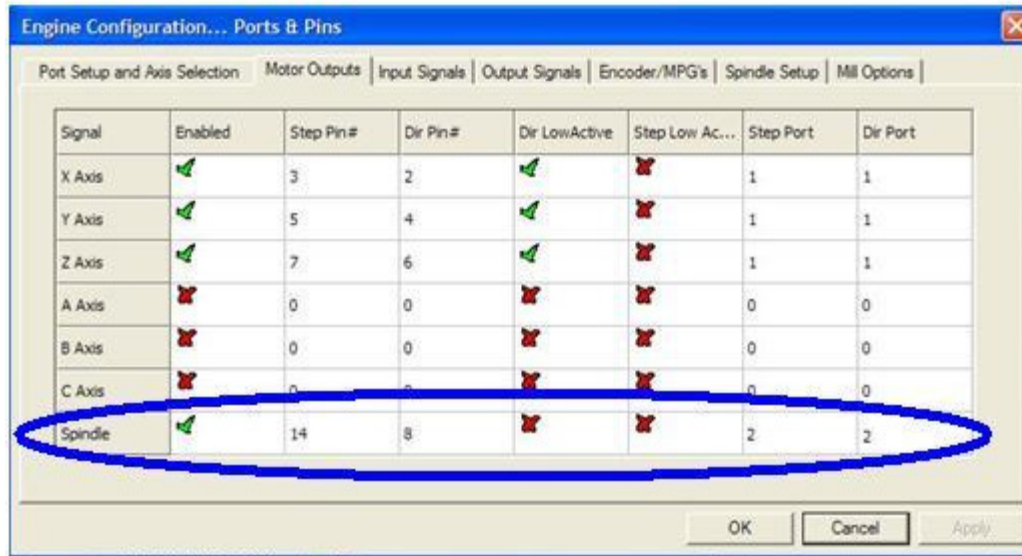


Fig. 6. *Ports&Pins* configuration screenshot

- Go to Config / Ports&Pins / Spindle Setup. In the motor control box, check Use Spindle Motor Output and Step /Dir Motor. Under Pulley Ratios set the pulley ratios of the machine.

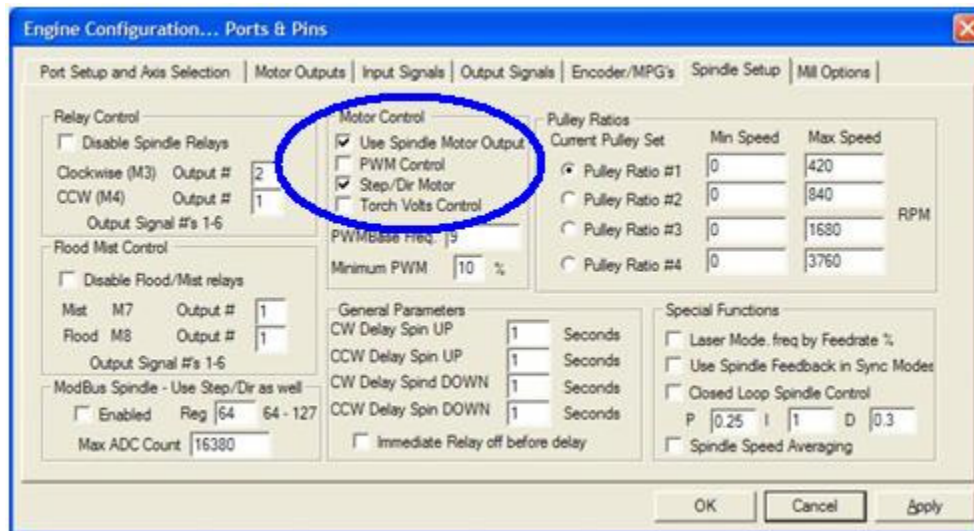


Fig. 7. *Spindle Setup* screenshot.

- Go to Config / Motor Tuning / Spindle. On Steps per unit put 1,000, set velocity to maximum. For Acceleration, choose the acceleration that you feel comfortable with. Start slow, increase acceleration as you test your system. Under Step Pulse length, use a number from 2 to 5, but start with 2. This number is directly

proportional to the final voltage you will get in the analog output. Use this number and the fine tuning pot to adjust the voltage you want to get at max speed.

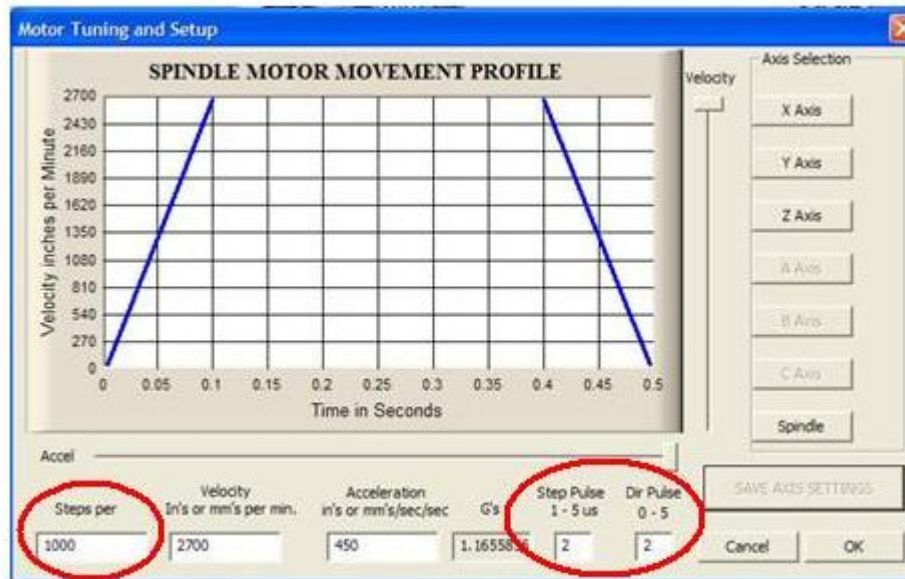


Fig. 8. *Motor Tuning and Setup* screenshot.

After configuring the Mach, these steps should be followed.

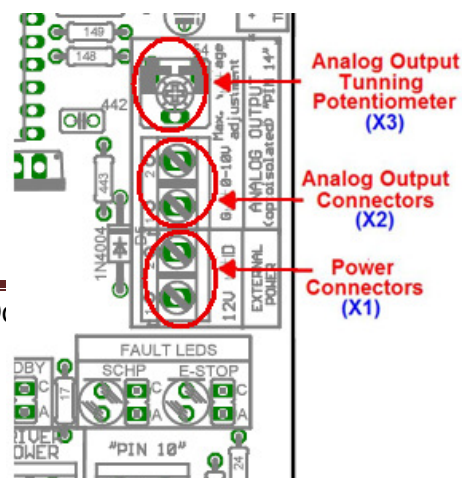
Step 1. Ensure that all external power sources are set to **OFF**.

Step 2. Connect the power supply to the Power Inputs Connectors (X1).

Step 3. Turn on the external supplies

Step 4. Connect a multimeter in the analog outputs connectors (X2) and make and fine tune this output:

Make sure that when you reach the max speed in the control software you get 10VDC out (X2). This voltage can vary depending on many things, including the electrical



properties of parallel port or breakout board you are using, the length of the step pulse your software is delivering, and the normal hi or low status of your step pin. Play with the pot, hi/low status of the pin, and pulse length to fine tune the output voltage.

5.3 Electromechanical relays. (Pins 1 and 16 “Port 1”)

Mechanical relays are very flexible because they can be used for AC or DC and come with NO and NC (Normally Open and Normally Closed) positions. Relay are independents, one reacts to Pin 1 and the other one to Pin16 and that both can be used at the same time. The relay specification are showed in the below table.

ELECTROMECHANICAL RELAYS SPECIFICACTIONS	
Maximun Current (AC)	7A@240VAC; 10A@125VAC
Maximun Current (DC)	15A@524VDC; 10A@28VDC

Table 2. Electromechanical Relays Specifications.

5.4 Microcontroller based driver monitoring system.

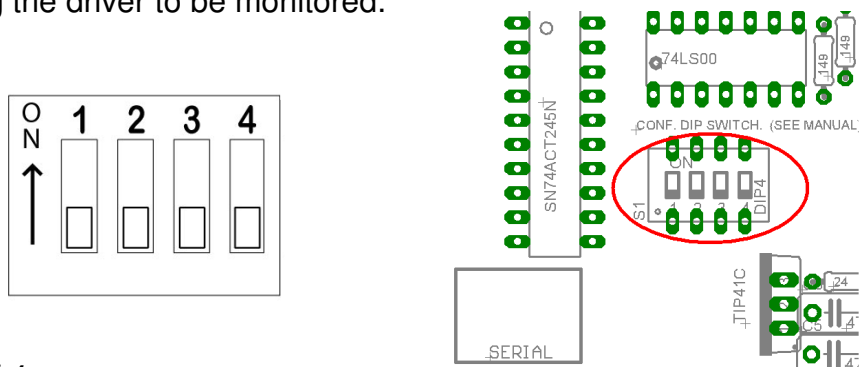
This board incorporates a microcontroller that runs programs that monitor the drivers, e-stop and perform other functions.

Functions:

- Enables and disables the drivers.
- Monitors E-Stop.
- Monitors Safety Charge Pump,
- Monitors the Drivers errors pins. (it only monitors G320/340, G203, G210/201 and Viper Servomotor drives at this time).
- Indicates the fault source.
- Indicates the system Status.

5.4.1 Configuration DIPSWITCH

The DIPSWITCH allows activating or deactivating the SCHP detection function, and selecting the driver to be monitored.



- **SWITCH 1**

SWITCH 1 OFF: Delayed enable output (Port 2 Pin 17).

SWITCH 1 ON: Non Delayed enable output (Port 2 Pin 17).

The enable output will be activated when start the drivers enable process. A delay in the signal activation time could be added by selecting the OFF position in the DIPSWITCH 1. The table below shows the delay time for every supported driver.

DRIVER	DELAY (Sec.)
G320/340	5
G203	2
G210/201	2

Viper Servodriver	5
-------------------	---

- **SWITCH 2**

SWITCH 2 ON: Activate the SCHK detection function

SWITCH 2 OFF: Deactivate the SCHK detection function

- **SWITCH 3 and 4**

Select the driver you will use according to the below table.

DRIVER	DIP 3	DIP 4
G320/G340	0	0
G203	1	0
G210/201	0	1
Viper /Dugong	1	1

5.4.2 Program description

In order to start the driver monitoring function it is necessary connecting the driver ERR/RES (servo drivers) or EN (stepper driver) terminal to the RJ45 driver connector pin 4.

ERR/RES (servo drivers) or EN (stepper driver) descriptions

Operation Mode 1 (G320/G340)

When the system starts, the board's error/reset pins go to a low state (0V), making sure the driver remains disabled. When SCHK and E-Stop function are checked and validated and there is no fault signal coming from a driver, the system send a high (5V) to the driver's error/reset pins for about 5 seconds to enable the drivers. After that the system monitors the driver's err/res pins. If a fault occurs on any driver (0V in driver ERR/RES pin) or an external fault occurs (E-Stop or SCHK fault), the system stops and sends an e-stop signal to the controller. All outputs on the board are disabled and the drivers will be disabled by sending a LOW (0V) to the drivers ERR/RES pin. The system will remain that way until the conditions to restart are present again.

Operation Mode 2 (G203).

When the system starts, the board's enable pin go to a HIGH state (5V). When SCHK and E-Stop function are checked and validated, the system send a LOW (0V) to the driver's EN pin for about 2 Sec, enabling the drivers. If an external error occurs, the system stops, resets the CNC software and sends a HIGH (5V) to the drivers EN pin. The system will remain that way until the conditions to restart are present again.

Operation Mode 3 (G210/201).

When the system starts, the board's enable pin go to a LOW state (0V). When SCHK and E-Stop function are checked and validated, the system send a HIGH (5V) to the Drivers EN pin for about 2 Sec, enabling the Drivers. If an external error occurs, the system stops, resets the CNC software and sends a LOW (0V) to the drivers EN pin. The system will remain that way until the conditions to restart are present again.

Operation Mode 4 (Viper & Dugong).

When the system starts, the board's enable pin go to a low state (0V). This will disable the drives. When SCHK and E-Stop function are checked and validated and there is no fault signal coming from a driver, the system sends a high (5V) to the driver's Fault Output pin, enabling the drivers. After that the system monitors the driver's Fault Output pin. If an error is generated in any driver (0V in driver Fault Output pin) or an external error occurs, the system stops, resets the CNC software and sends a LOW (0V) to the drivers to ensure they remain disabled.

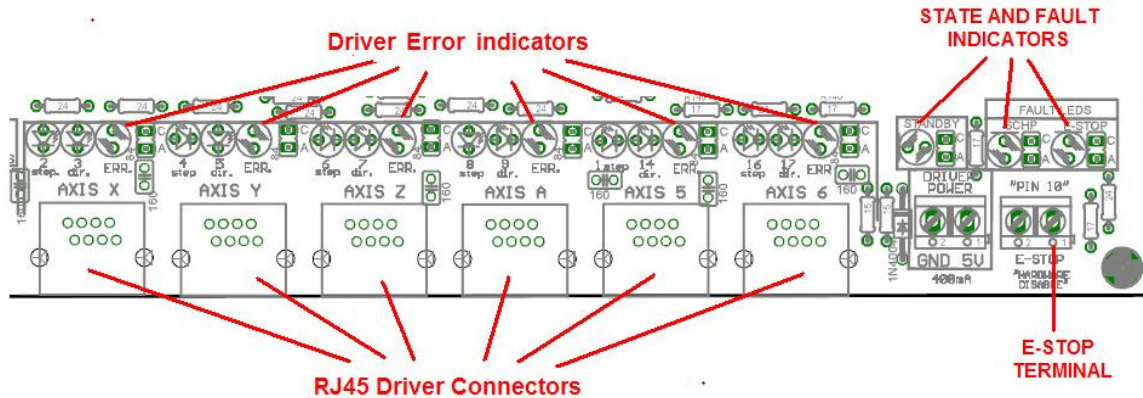
LEDs indicator Operation

For example, when the GECKO DRIVE is first powered up, it will be necessary to push the momentary switch to START for 5 seconds. This will clear the power-on reset condition and extinguish the FAULT LED. The motor will then be enabled and the drive will begin to operate. This START function is automatically done by the built in microcontroller based circuit when the SCHK is validated, or when the board is power up if the SCHK function is disabled by the user.

The **standby LED** will light to indicate that the system is ready but disabled.

There are 3 possible error sources, a driver fault, an E-STOP error and a SCHK error.

If at any time after that a condition occurs that causes the GECKO SERVO DRIVE to “fault out”, such as not being able to complete a step command, the ERR/RES terminal will be activated, signaling the microcontroller an error has occurred. In this case the **Standby LED** indicator and the respective **driver error LED** indicator will light up in order to indicate to the user that an error has occurred in an specific driver.



If the E-STOP button is pressed the **Standby LED** indicator and the **E-STOP error LED** indicator will light up.

If the SCHP detection function is activated, and the system is ready (STANDBY LED OFF), and an error has occurred with the SCHP signal, the **Standby LED** indicator and the **SCHP error LED** indicator will light up.

6. Pinouts

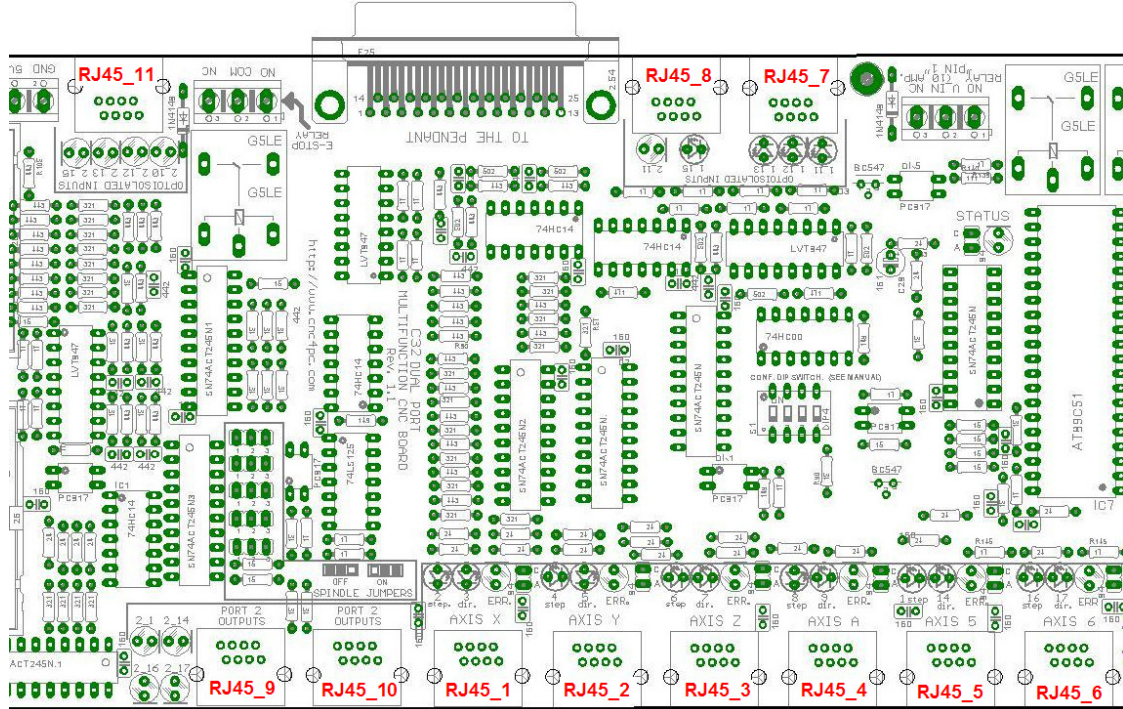


Fig. 9. RJ45 Distribution

RJ45_1		RJ45_2		RJ45_3		RJ45_4		RJ45_5		RJ45_6	
RJ45 PIN	P.P. PIN	RJ45 PIN	P.P. PIN	RJ45 PIN	P.P. PIN	RJ45 PIN	P.P. PIN	RJ45 PIN	P.P. PIN	RJ45 PIN	P.P. PIN
1	5V	1	5V	1	5V	1	5V	1	5V	1	5V
2	NC	2	NC	2	NC	2	NC	2	NC	2	NC
3	1_3	3	1_5	3	1_7	3	1_9	3	1_14	3	1_17
4	Err/res X	4	Err/res Y	4	Err/res Z	4	Err/res A	4	Err/res 5	4	Err/res 6
5	GND	5	GND	5	GND	5	GND	5	GND	5	GND
6	NC	6	NC	6	NC	6	NC	6	NC	6	NC
7	1_2	7	1_4	7	1_6	7	1_8	7	1_1	7	1_16
8	NC	8	NC	8	NC	8	NC	8	NC	8	NC
Supported connection		Supported connection		Supported connection		Supported connection		Supported connection		Supported connection	
G320/340		G320/340		G320/340		G320/340		G320/340		G320/340	
G203		G203		G203		G203		G203		G203	
G210/201		G210/201		G210/201		G210/201		G210/201		G210/201	
Viper Servomotor		Viper Servomotor		Viper Servomotor		Viper Servomotor		Viper Servomotor		Viper Servomotor	

RJ45_7		RJ45_8		RJ45_9		RJ45_10		RJ45_11	
RJ45 PIN	P.P. PIN	RJ45 PIN	P.P. PIN	RJ45 PIN	P.P. PIN	RJ45 PIN	P.P. PIN	RJ45 PIN	P.P. PIN
1	2_16	1	NC	1	NC	1	NC	1	NC
2	5V_EXT	2	5V_EXT	2	5V	2	5V	2	5V_EXT
3	NC	3	NC	3	NC	3	NC	3	NC
4	NC	4	1_15	4	2_14	4	2_17	4	2_10
5	1_11	5	2_11	5	2_1	5	2_16	5	2_12
6	1_12	6	NC	6	2_16	6	NC	6	2_13
7	1_13	7	NC	7	2_17	7	NC	7	2_15
8	GND_EXT	8	GND_EXT	8	GND	8	GND	8	GND_EXT
Supported connection		Supported connection		Supported connection		Supported connection		Supported connection	
C16		C3		C19, C15, C5, C8 or C9		C15, C8 or C9		General Use	

NC: Not Connected

M_N: Parallel port or Smooth Stepper pin, where M is the port number and N is the pin number.

7. Using the Pendant ON/OFF selection jumper for input pins.

In this board the Port 2 input pins 10, 11, 12, 13 and 15 are able to be used with the pendant (DB25 connector) or as general use input pin (RJ45 connector). This configuration can be selected by using the Pendant ON/OFF selection jumper how is shown in the below image.

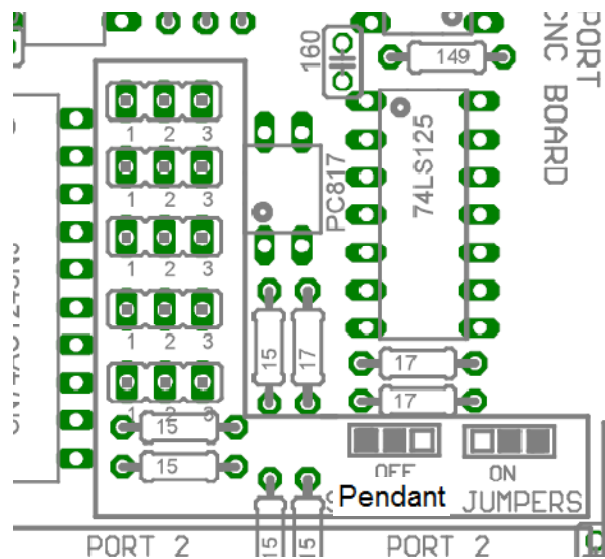


Fig. 9 Pendant ON/OFF selection jumper.

Port 2 pins (2-9) are configured as inputs and are only accessible through the pendant on the DB25 connector.

8. Wiring diagrams

While this board supports only TTL +5VDC signals, different kind of sensors, switches using different voltages can be connected using the diagrams that follow:

Note: The below wiring diagrams are an example, any input can be used for the connections.

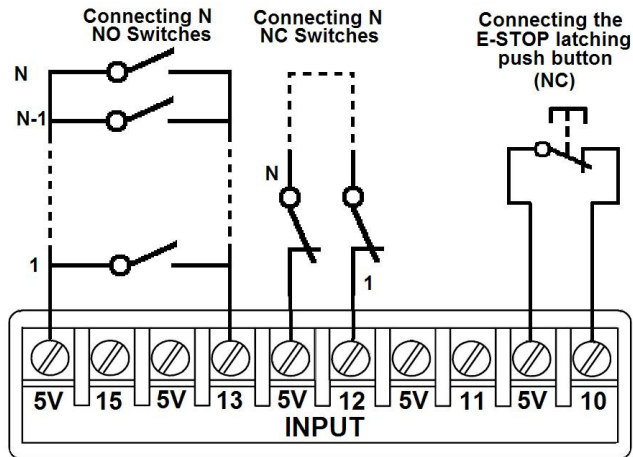


Fig. 10 Wiring diagram to connect switches.

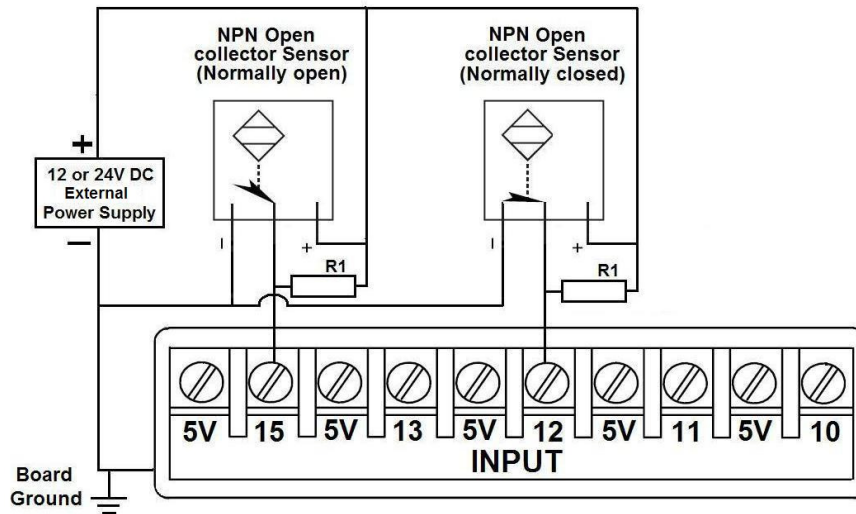


Fig. 11 Wiring diagram to connect NPN open collector proximity sensors.

For a 24V or 12V sensor, the recommended value for the external resistor R1 is 4.7K Ohm.

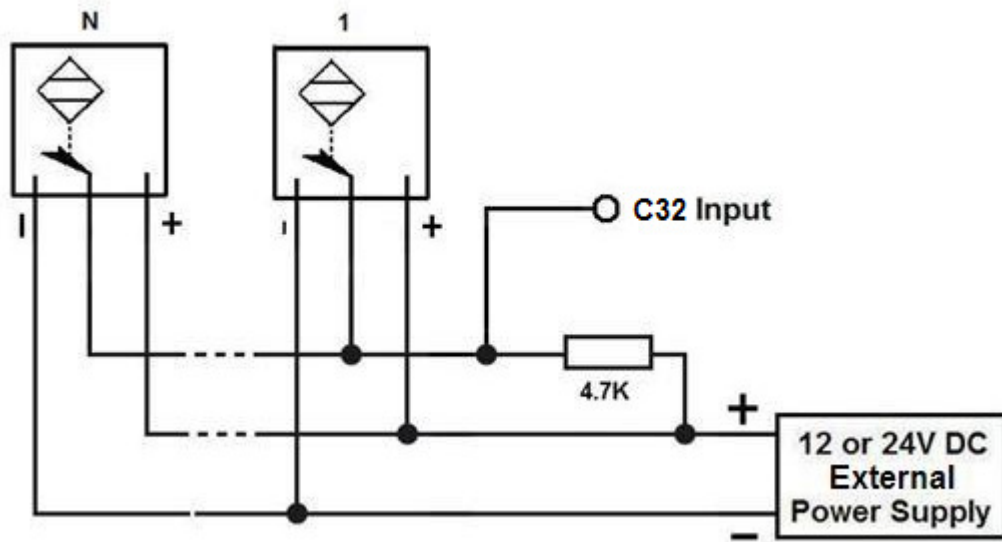


Fig. 12 Wiring diagram to connect in parallel NPN open collector proximity sensors.

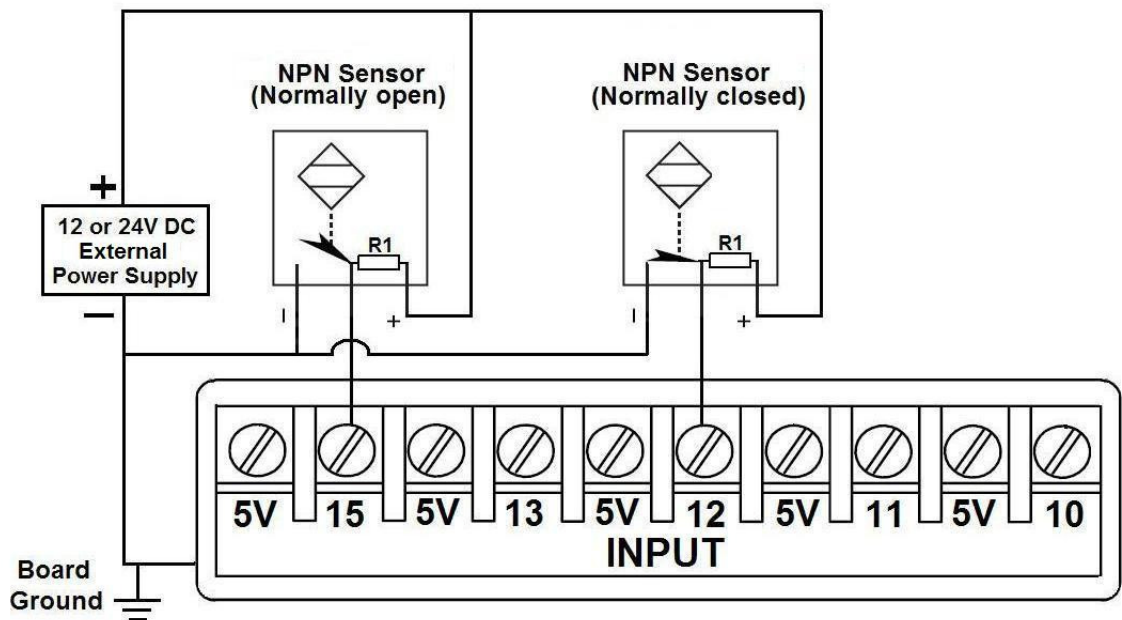


Fig. 13 Wiring diagram to connect NPN proximity sensors with internal pull up resistor.

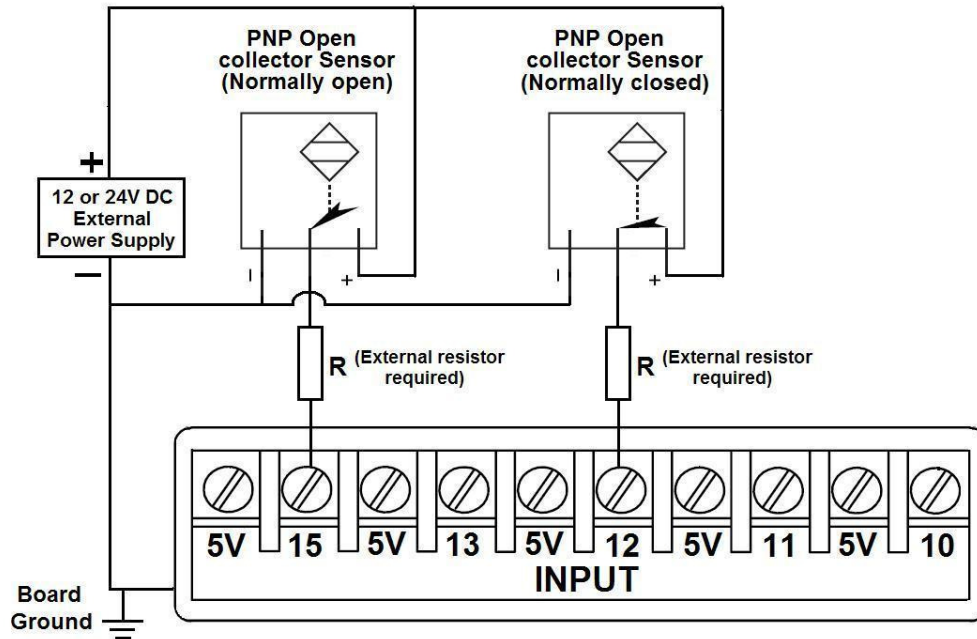


Fig. 14 Wiring diagram to connect PNP open collector proximity sensors

Connecting PNP open collector proximity sensor with the C32 Rev.1.1		
Board	R Value (12V)	R Value (24V)
C11 Rev. 8	470Ω	1KΩ

Table 15. R value to Connect PNP open collector proximity sensor with the C33.

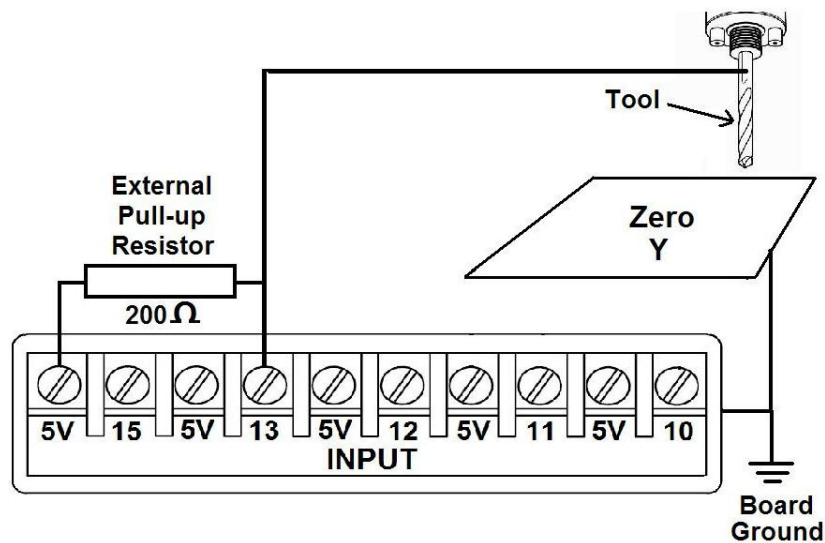


Fig. 16 Wiring diagram to do an “Auto Tool Zero”

9. Troubleshooting.

SYMPTOM 1: THE BOARD DOES NOT RELAY THE SIGNALS.

POSSIBLE CAUSE	POSSIBLE SOLUTIONS
<ul style="list-style-type: none"> - Pin conflict or mach3 configuration. It is possible that the port address used for the pin is not right, or that there is a pin conflict with the. That is that you are using that same pin twice. (it could be assigned to a different function). 	<ul style="list-style-type: none"> - Go to the device manager in windows, and check the memory address used for the parallel port you are using. Usually it will be 378 for LPT1. Check also that the port does not have a conflict. Then in mach3, go to Ports & Pins / Port Setup and Axis Selection. Check the memory address is correct. - Check that the pin you are using is not been used anywhere else in your setup. Got to motor output and output signals, and check all the entries.
<ul style="list-style-type: none"> - The board does not like the waveform it is getting. Some breakout boards could invert the signals or modify the pulse width. Changing the active low status of the pin used also inverts the waveform. 	<ul style="list-style-type: none"> - Play with the active low status of the pin used for the frequency.
<ul style="list-style-type: none"> - The signal or frequencies are not getting to the board. It could be the cable or that you are passing the signal through the same breakout board that you are enabling/disabling, so the outputs could be disabled, so they will not get to the breakout board. 	<ul style="list-style-type: none"> - Try a different cable. - Test the pins in the cable (before they reach the breakout board) with a multimeter.
<ul style="list-style-type: none"> - Problems with Mach3 Pulse Generation. Mach3 could have installation problems (you did not restart immediately after installation), or there could be something creating a conflict. Some dongle devices might cause this, other software, like QuickTime or drivers for touch screen. 	<ul style="list-style-type: none"> - Test this in a different PC. - Follow Art's suggestions for optimizing up WinXP: http://www.machsupport.com/downloads/XP_Optimization.txt.

SYMPTOM 2: THE ANALOG OUTPUT DOES NOT REACH THE 10VDC.

POSSIBLE CAUSE	POSSIBLE SOLUTIONS
- Insufficient pulse width. It is possible that the signal pulse width is not enough to activate the optocouplers.	- In Mach X, go to Config / Motor Tuning / Spindle. Under Step Pulse length increase this value, use a number from 3 to 5, but start with 3.
- The signal is set active low or the breakout board could be inverting the signals.	- In Mach X, go to Config / Ports&Pins / Motor Outputs. Change the active low status of the pin used for step.

SYMPTOM 3: THE OUTPUTS DO NOT GET ENABLED / NO SIGNALS ARE COMING OUT.

POSSIBLE CAUSE	POSSIBLE SOLUTIONS
- The EN terminal (Enable Outputs) is not enabled. The board requires to be externally enabled.	- Make sure you are providing +5vdc to the EN terminal. This +5vdc can be taken from the terminal next to it.
- The Safety Charge Pump is not configured. The Safety Charge Pump can either be configured in the control software or disabled by moving the jumper to the disable position.	- Start by disabling the SCHP. Enable it and configure it once your system is setup.
- The parallel cable is not well connected to the PC parallel port.	- Check if the parallel port is well connected to the PC.

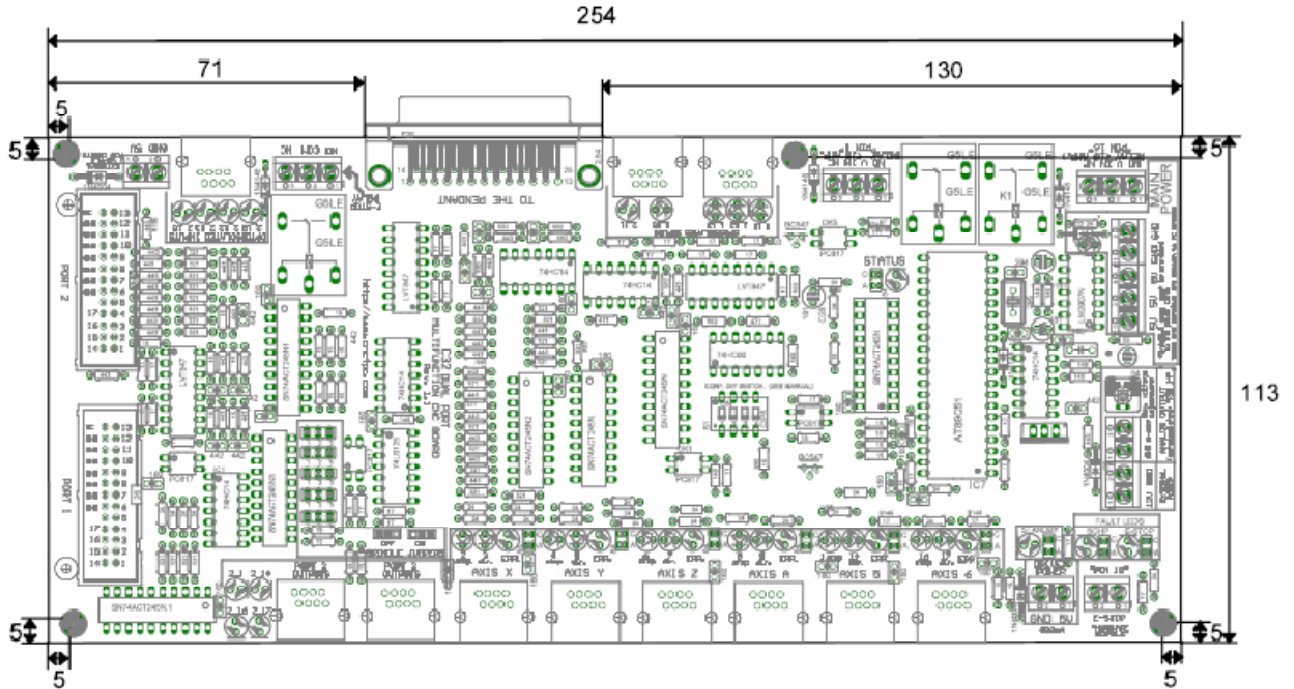
SYMPTOM 4: THERE IS NOISE IN THE SYSTEM, OR THE MOTORS DO NOT MOVE SMOOTHLY.

POSSIBLE CAUSE	POSSIBLE SOLUTIONS
- The board could be underpowered.	- Make sure you are using a +5vdc 1.5amp power supply.
- There could be a short that could be draining the power to the board.	- Check that there are no hot spots in the board or it's connections. - Measure the board's power consumption, it should be less than 1200mA (depending on the features used).

SYMPTOM 5: A I/O PIN MIGHT NOT BE WORKING.

POSSIBLE CAUSE	POSSIBLE SOLUTIONS
<ul style="list-style-type: none">- A chip may have gone bad. These buffers could act as fuses for the signals, and they can go bad because of noise spikes or even strong static.	<ul style="list-style-type: none">- These chips are inexpensive and readily available. You can order them here: http://www.cnc4pc.com/Store/osc/index.php?cPath=38_43.- Carefully moving chips around and checking if the problem moves around could be a way of figuring out if this is the case.
<ul style="list-style-type: none">- There could be a problem with the parallel cable or parallel port.	<ul style="list-style-type: none">- Test this with a different PC or parallel port.

10. Dimensions.



All dimensions are in Millimeters.

Disclaimer:

Use caution. CNC machines could be dangerous machines. DUNCAN USA, LLC or Arturo Duncan are not liable for any accidents resulting from the improper use of these devices. The C32 is not fail-safe device, and it should not be used in life support systems or in other devices where its failure or possible erratic operation could cause property damage, bodily injury or loss of life.