MachDrive Manual

Ver1.4

Overview

The MachDrive is CPLD-based, using LMD18245 proven reliable driver chip, 4 axis bipolar microstepping motor driver, able to drive up 3Amp 48 Vdc. All in one design including opto-isolated parallel port interface, charge pump, idle current reduction, high output current for driving external relays, all are packed inside small footprint of red anodized aluminum heat sink housing with convenience pluggable screw terminal. Works with Stepper and Direction controller software such as Mach2, Mach3, TurboCNC, KCam and EMC

Symbol Used

Warnings are provided to prevent injury to operating personnel or serious damage to MachDrive and your devices

Note Notes indicate special features or characteristics.

Safety Concerns and Disclaimers

- Take static discharge precautions; ground yourself by wearing a grounding strap or touching the metal chassis of earthed computer before touching electronic components.
- Hazardous voltages and current levels may exist on the MachDrive board. Disconnect all power cables to the MachDrive before touching any part of MachDrive. Disconnect all power before configuring jumpers, plug-in resistor or adjusting trimpot.
- The voltages applied to MachDrive power connections **must not exceed ratings**.
- Motor power supply must be **turned off and wait** a few minutes for capacitors to fully discharge before connecting or disconnecting stepper motors.
- All examples and diagrams in this manual are intended to assist understanding. The user is responsible for applying them correctly. CncRoom will not accept any responsibility for the actual use of this product based on these examples. It is the user's responsibility to assess the suitability of this product for his applications.
- Under no circumstances can CncRoom be held responsible for damage resulting from installation or use of this equipment.
- CNC machines are dangerous and can cause injury or even death. CncRoom controller cannot be held responsible for any injuries or damage caused through the use or misuse of the MachDrive controller.

- Machinery driven with this device can and will start without warning and may cause injury or even death. The builder of this device assumes sole responsibility for its use.

Features

- 4 axis bipolar microstepping motor driver.
- LMD18245 proven and reliable based, delivering 3A per phase at 48V max.
- Chopper current control –no big resisters needed, no heat generated.
- Equipped with transient voltage suppressor for each output to ground to protect voltage spikes from motor start, stop and changing speed.
- Over current and over temperature protected by LMD18245.
- Drives 4, 6, or 8 wire bipolar and unipolar stepper motors.
- Hi speed drive with CPLD based with internal bug fixed for LMD18245.
- Torque compensation.
- Full Stepper, 1/2, 1/4, 1/8, 1/16 selectable with jumper and fixed for 1/10, 1/12 model.
- Accurate drive current setting by plug-in resistor, or vary setting from 330 mA to 3 Amp with on board trimpot.
- Accurate Idle current setting with plug-in resistor.
- Selectable charge-pump frequency detection from front panel switch button, 1 kHz, 4 kHz up and 10-15 kHz and always on.
- Selectable idle time from front panel switch button, range from 1-120 minutes, never idle and always idle.
- On board parallel port interface with opto-isolated for all Inputs and Outputs – hi speed 10Mbd for stepper and dir pulse signals.
- Output pins can sink up 350 mA, allow to connect to external relays directly.
- Maximum Stepper rate up to 100 kHz.
- All inputs are active low allows most parallel ports, including notebook to sink current in.
- Elegant red anodized aluminum heat sink housing
- Over voltage and wrong polarity protection with help of external fuse on motor power supply.
- LEDs for Motor, Logic, Optoisolator power supply, Charge Pump, Idle, Status.
- Pluggable Terminal.
- Parallel DB25 Female interface.
- Works with Stepper and Direction software such as Mach2, Mach3, TurboCNC, KCam and DeskNC, EMC.
- Tested with USB SmoothStepper from Warp9 Tech Design.

Preparations for electrical connection

Below is the list of additional items needed to make the MachDrive up and running with your machines.

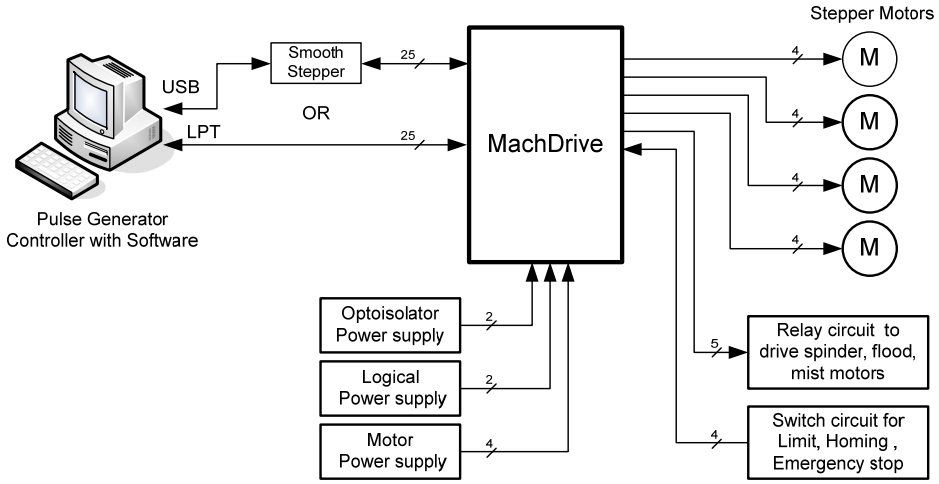
Parallel cable: DB25 male-male straight-through cable
Optoisolator Power Supply: 5Vdc, 100mA
Logic Power Supply: 5Vdc, 200mA
Motor Power Supply: 12-48Vdc with adequate current capacity
Stepper Motors: 4, 6, 8 wire stepper motors
Cooling Fan: (optional, to make temperature below 50 ℃)
Input Circuit components: limit/home switches, sensors
Output Circuit components: relays, spindle motor, flood/ mist pumps etc
Wiring cables: power cable with adequate current carry
Tools: wire cutter, pliers, screwdriver, jeweler's screwdriver

Setup and Operation sequence

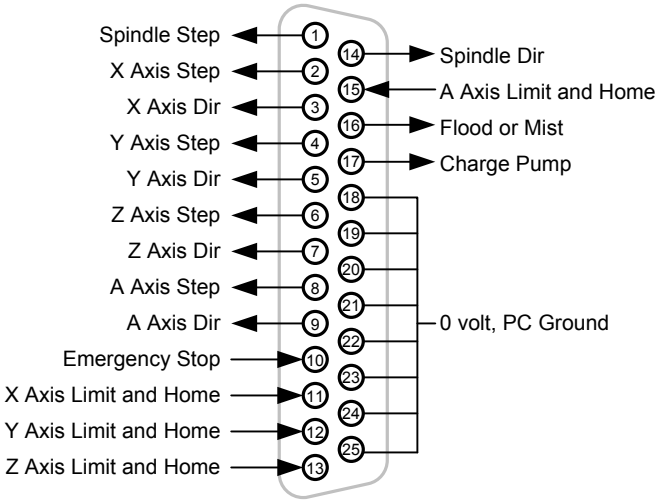
- Take static discharge precautions
- Make output circuit and connect to MachDrive
- Make input circuit and connect to MachDrive
- Setup microstep resolution on MachDrive board
- Setup drive current on MachDrive board
- Setup drive idle current on MachDrive board
- Connect the stepper motors to MachDrive
- Connect all power sources to the MachDrive
- Recheck all wiring again
- Power on the Logical power supply
- Check LOG LED
- Power on the Optoisolator power supply
- Check ISO LED
- Power on the Motor power supply
- Check MOT LED
- Power off all power supplies.
- Connect parallel cable from PC printer port or SmoothStepper to MachDrive
- Power on the logical power supply
- Power on the optoisolator power supply
- Power on the motor power supply
- Configure Pulse generator controller software, Mach3, TurboCNC etc
- Finally! Enjoy your drive.

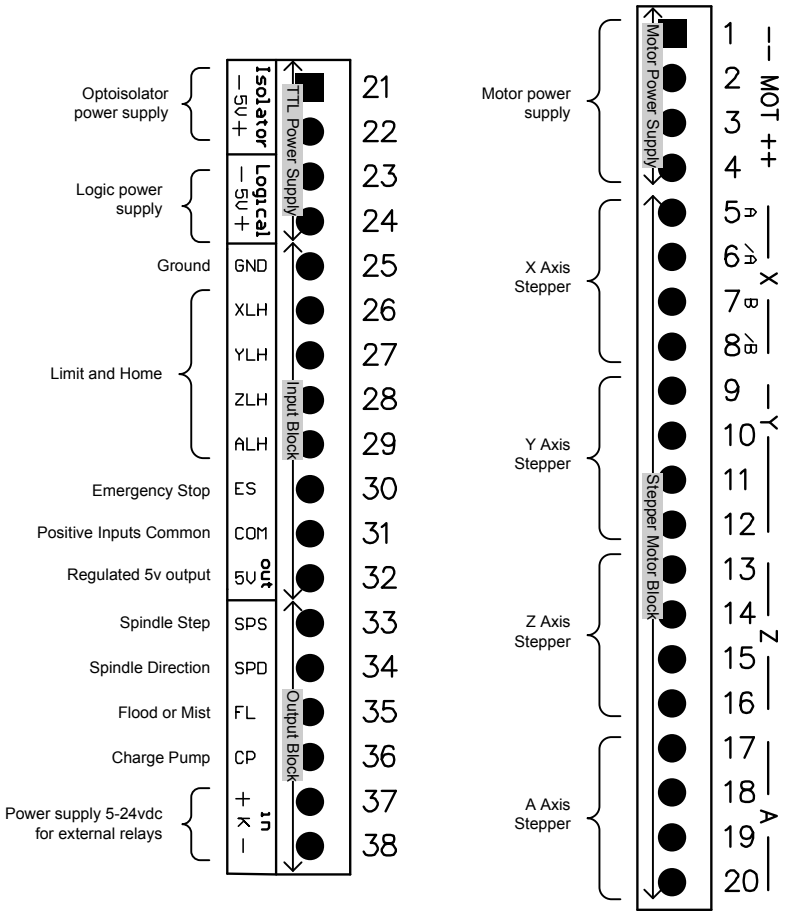
Electrical connection

Connection Block Diagram



Connector and terminal pin assignments



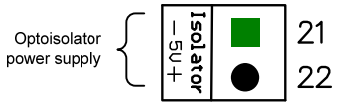


Overview of connector and terminal number

Power Supply Block

Optoisolator Power Supply

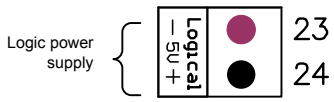
Term.21-22 are inputs for optoisolator power supply, regulated 5 Vdc, 100 mA. Term21 is negative or 0 volt provides the common “ground” reference for the optoisolator inputs and outputs. This pin is connected to the PC ground directly through parallel cable. Term.22 is positive or 5Vdc.



Logic Power Supply

Term.23-24 are inputs for logic power supply 5 Vdc, 200 mA.

Term 23 is for negative logic power supply input and Term 24 is for positive logic power supply input.

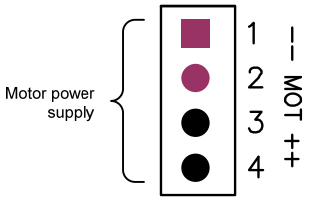


Motor Power Supply

Term.1-4 are inputs for stepper motor power supply 12-48 Vdc with adequate current capacity to power your stepper motors. Term1-2 are for negative motor power supply input and Term3-4 are for positive motor power supply input.

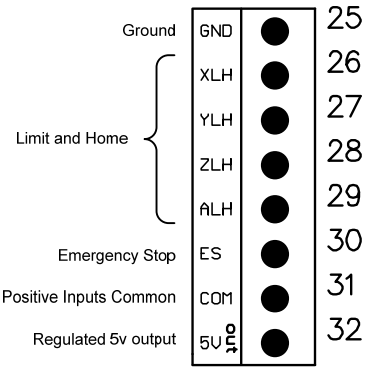
> **Note.** There is voltage spike, over voltage and wrong polarity protection for this connection with help of external fuse.

Warning! Appropriate rated external fuse needed to series with power supply source for Term3-4



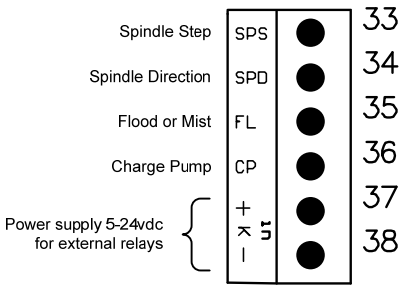
Inputs Block

Term.26-30 are optoisolator inputs and share the same positive common onTerm.31 as shown below. GND and 5 Vdc are provided through Term.25 and Term.32 respectively, all in one single block.



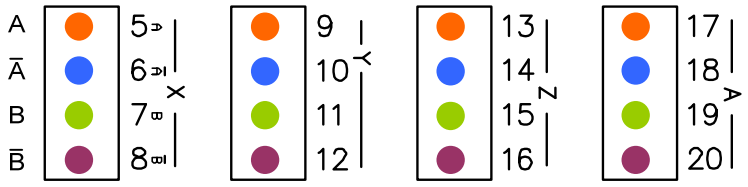
Output Block

Term.33-36 are NPN sink outputs able to sink in current up to 350mA each.
Term.37-38 are positive and negative inputs power supply for external loads, such relays.



Stepper Motor Block

Term.5-8, 9-12, 13-16, 17-20 are outputs for driving bipolar stepper motors. First motor winding connects to Term.5 (A) and Term.6 (/A), while the second winding connects to Term.7 (B) and Term8 (/B). Follow the same way for the rest of stepper motors and connections.



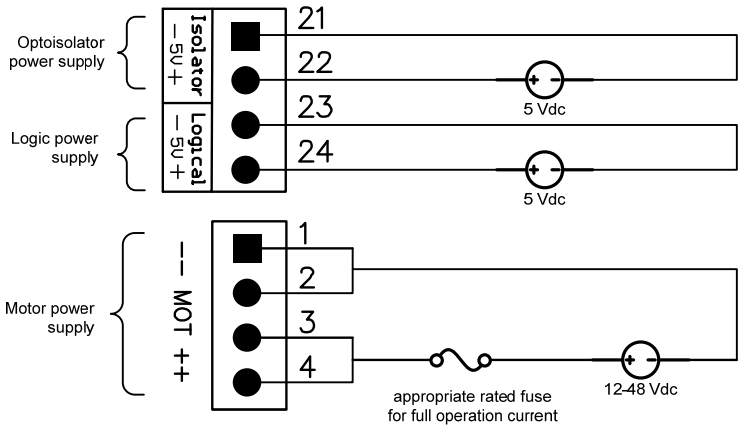
LEDs and Switch button

MOT: when this LED is lit indicates motor power supply at Term.1-4 is present.
LOG: when this LED is lit indicates logical power supply at Term.23-24 is present.
ISO: when this LED is lit indicates isolated power supply at Term.21-22 is present.
Idle: when this LED is lit indicates motor driving in Idle mode.
C-Pump: when this LED is lit indicates charge-pump signal is present.
Status: when this LED flashes in 1 second timing indicates MachDrive is in running mode. This LED is also used to show incoming stepper inputs signal frequency. When this LED is off indicates MachDrive is in setup mode.
Set: setup push button switch for setting Idle and Charge-pump value.

Making electrical connection

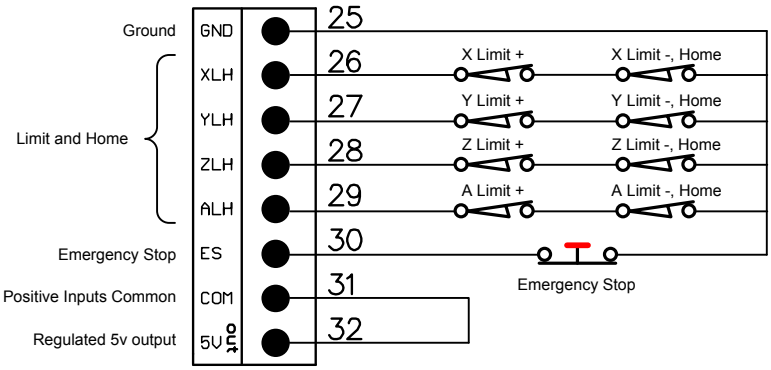
Power Supplies

Following shows an each power supply circuit. When connect and turn on power supply, make sure that each LED is lit accordingly; keep the ripple voltage to 1% for 5Vdc and 10% for Motor power supply or less for best results.

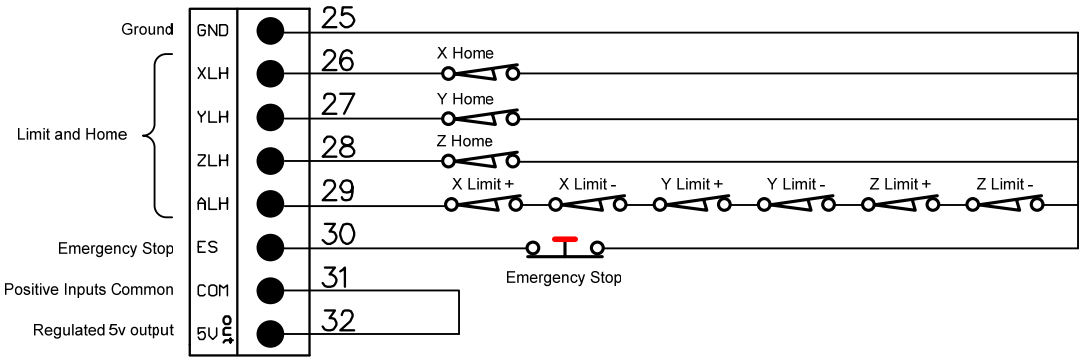


Inputting Limit, Homing and Emergency Stop Switches

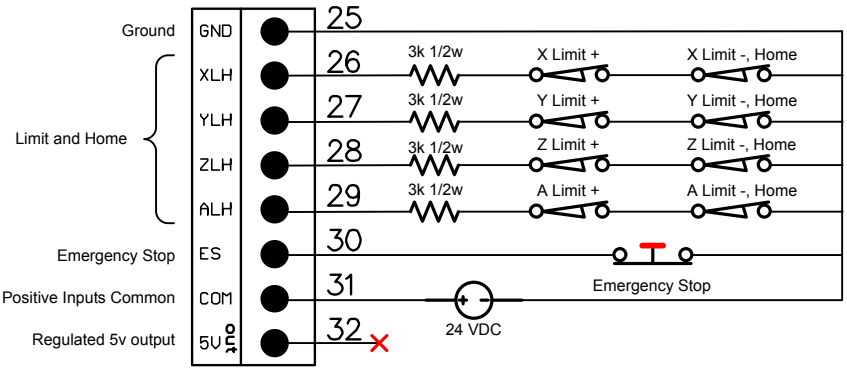
Following shows a simple circuit for one pluggable terminal block, single terminal contains all necessary signals, including 5v and GND, inputs for limit and homing switches.



Another connection style is to separate homing apart from limiting, these home switches can be replaced by NPN output type, slot sensors to get more accuracy.

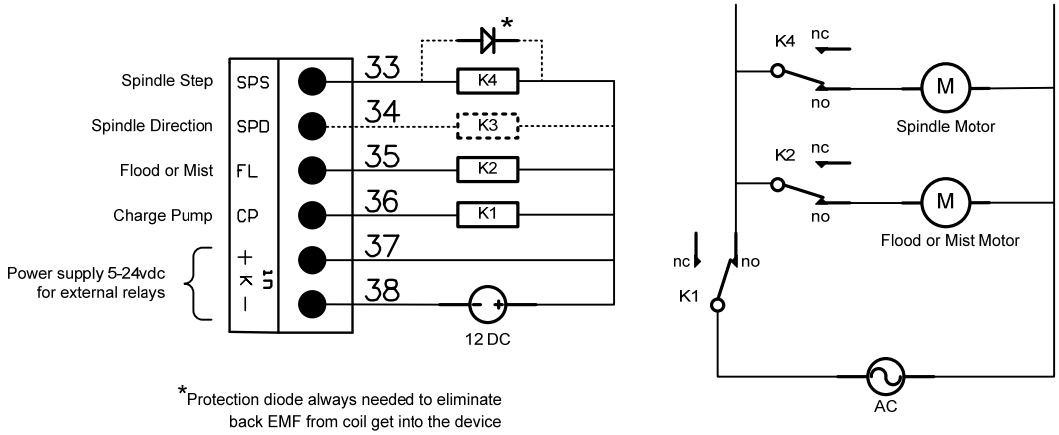


Following shows how to connect external 24Vdc power supply to the Inputs block. Resisters, 3k, are connected in series for each input to limit the current flow through optocoupler.



Driving Spindle, Flood and Mist motors

Circuit below shows a simple external relays connection for spindle, flooding motor control with safety charge pump featured.



*Protection diode always needed to eliminate back EMF from coil get into the device

Driving Stepper motors

MachDrive supports 4, 6, 8 wires stepper motors. Following shows possibility of motor connections

4 Wire Motor Connection
Connect first set of windings to the A, /A terminals. Connect the second set of windings to the B, /B terminals. If the set of windings is uncertain then use an ohmmeter to check for continuity of winding set. When you find the first two wires that have continuity, connect them to the A, /A terminals and connect the other two to the B, /B terminals.

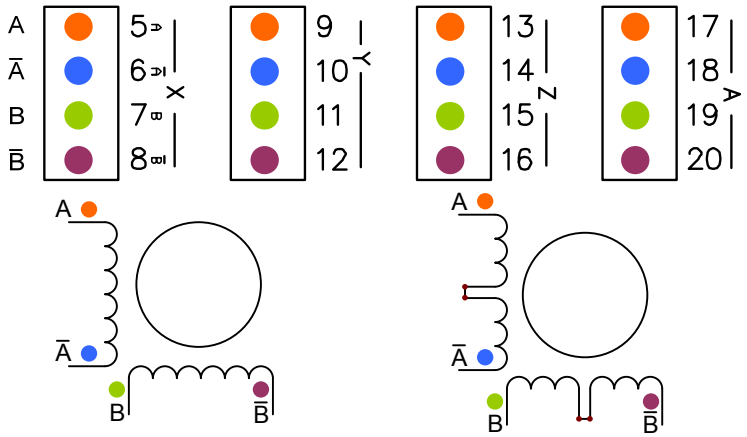
6 Wire Motor Connection
Six wire motors can be connected in two ways: Series Wired (b) and Half Wired (c). Six wire motors contain a center tap on each of the two windings. If the set of windings is uncertain then use an ohmmeter to check for resistance value of half winding or central trap, the resistance value is 1/2 of full winding.

8 Wire Motor Connection
Eight wire motors can be connected in two ways: Series Wired (d) and Parallel Wired (e).

Warning! For the series wired of unipolar stepper as shown in figure (b) (d) need only 50% of the rated current which is stated on the motor's nameplate

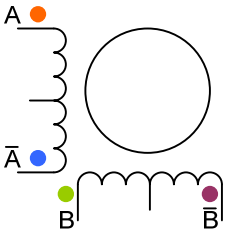
Warning! Motor power must be turned off before connecting or disconnecting stepper motors.

Note. If the motor turns in the wrong direction, reverse any pair of winding leads.

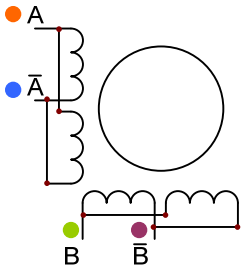


(a) 4 wire motor

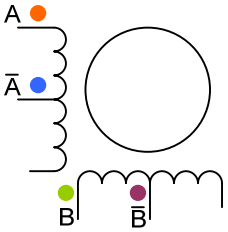
(d) 8 wire motor series wired



(b) 6 wire motor series wired



(e) 8 wire motor parallel wired



(c) 6 wire motor half wired

Hardware Configuration

Set microstep resolution

Microstep resolution is set individually for each axis by J9, J11, J14, J16 refer to components overlay. The Microstep resolution table shows value of jumpers, microstep and number of steps per revolution.

Note. These microstep select jumpers are not used for MD201-10 and MD201-12, since the microstep value is specified in the CPLD chips

Microstep Resolution Table				
Value	**1 2 4**	**Microstep**	**Steps/Rev (1.8 deg motor)**	**Model number**
0	0 0 0	full	200	MD201-x16
1	1 0 0	1/2	400	MD201-x16
2	0 1 0	1/4	800	MD201-x16
***3**	**1 1 0**	**1/8**	**1600**	MD201-x16
4	0 0 1	1/16	3200	MD201-x16
-	-	1/10	2000	MD201-x10
-	-	1/12	2400	MD201-x12
	1 = jumper installed			

*Default

Set drive current

Drive current can be set either one of two ways

1. Fixed plug-in 6.57k resistors are provided in the position of R36, R39, R42, R43, R46, R49, R52, R53, refer to components overlay, for high driving current, 2.85 amps, and reduce drive current to expected level by adjusting trimpot with jeweler's screwdriver and measure resistant value between following test points.

TP2-GND and TP3-GND for axis Y
TP5-GND and TP6-GND for axis Z
TP8-GND and TP9-GND for axis X
TP11-GND and TP12-GND for axis A

2. Turn the trimpot to 0 ohm by using fingertip turns screwdriver clockwise gently until you feel hard to turn, that is 0 ohm and the rest of value relies on only plug-in resistors in the position of R36, R39, R42, R43, R46, R49, R52, R53. This way, you can gain accuracy from 1% or 5% tolerance of the resistors.

Resistor value and Drive current	
Resistor (k)	**Drive Current (Amps)**
75.00	0.25
37.50	0.50
***25.00**	**0.75**
18.75	1.00
15.00	1.25
12.50	1.50
10.71	1.75
9.38	2.00
8.33	2.25
7.50	2.50
6.82	2.75
6.57	2.85
6.25	3.00

*Default

Set idle current reduction

Idle current can be set by plug-in resistor R54, R55, R56, R57 , refer to components overlay, on PCB board. by default the idle current is set to 50% from normal driving to reduce unnecessary heating. Table below shows the resistor value and percentage of reduction.

Idle current reduction feature also can be disabled individually for each axis by jumper xIDLE, yIDLE, zIDLE, aIDLE.

Resistor value and Reduction %	
Resistor (ohm)	**Reduction%**
jumper not installed	0.00%
9000.00	10.00%
4000.00	20.00%
2333.33	30.00%
1500.00	40.00%
***1000.00**	**50.00%**
666.67	60.00%
428.57	70.00%
250.00	80.00%
111.11	90.00%

*Default

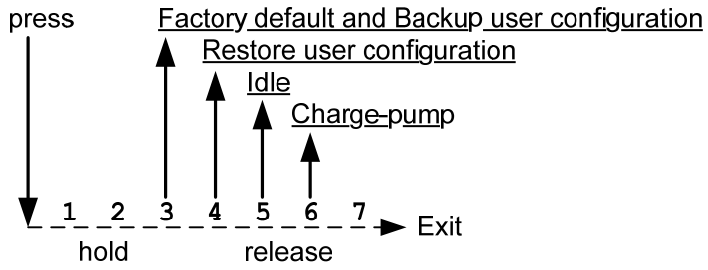
Idler inputs

There are 4 diodes to lead step pulse signal from X, Y, Z and A to Idler, refer to Appendix III, the components overlay. If there is no step pulse comes to idler more than setup time, the idler will output idle single to drive circuit to reduce drive current. These 4 diodes allow user to choose which signal would influence the idler.

Warning! In idle state, all step inputs must be high. Idler watches only this condition and generates idle output signal when idle time exceed setup time. However, in busy state the Status-LED **flashes in fast rate**, this tells us all step inputs are in correct condition for idler to work with. This is mentioned because some software have problem with initialize the step inputs state, if this happened, you can disable this feature from SET button panel or take out all diodes and leave only one diode to monitor prefer axis, such as X axis.

Using the SET button

There is one little black knob named Set, located below LEDs. We use this button to setup Idle time and Charge pump. Simply steps, Press/Hold/Release to enter into setting mode, Press/Release as normal to increase value during setup mode. Status-LED reports in the number of flashes to indicate its current value.



Entry to setup mode

- Press and hold the button, observe and count the number of flashes of Status-LED and release button immediately when you count to flash number 5 or 6 for Idle and Charge Pump respectively.
- Status-LED reports you its current value of that mode.

Change setting

- Press and release as normal to increase value.
- Status-LED shows you its current setting value.

Save and Exit from setup mode

- Press and Hold more than 7 seconds

Cancel Setting

- Turn the power off during setup mode

Note that, when you are making change to the value, no need to wait until the flash sequences finish. The trick to get things done quickly is, right after you release the button, just count number of flashes to know current value, then adding up the value by pressing the button as normal by number of times. The value is rolled over back to 1 if it reaches a maximum value.

For example, you want to set Idle time to 120 minutes, Firstly, press and hold the button, when you count to the fifth flash and release the button immediately.

Now you are in Idle setup mode, Status-LED flashes again, for examples, it flashes for 7 times, to indicate current value is 7, then just press the button 3 times, the new value will be 10, that is 120 minutes, according to Idle Table below.

Finally press and hold the button for more than 7 seconds for saving and exit the setup

The total number of flashes in Idle setup mode reported by the Status-LED represents the following:

Idle Table	
flash#	**idle time in minutes**
***1**	**1**
2	2
3	3
4	4
5	5
6	10
7	20
8	30
9	60
10	120
11	never idle
12	always idle

*Default

The total number of flashes in Charge Pump setup mode reported by the Status-LED represents the following:

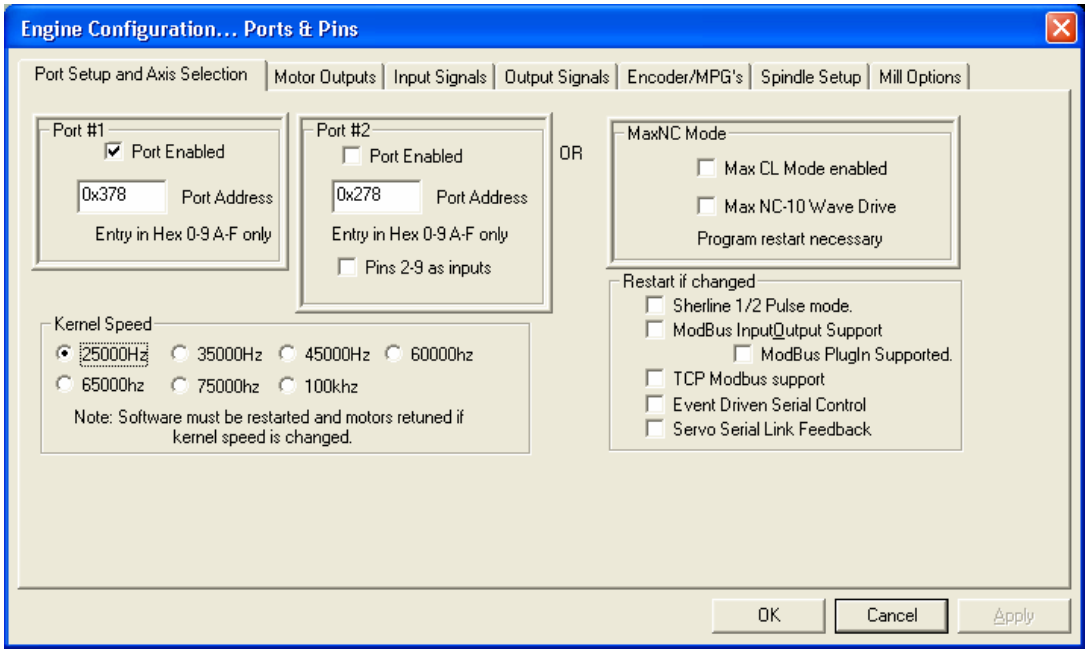
Charge Pump Table	
flash#	**mode**
1	same input logic
2	1 kHz up
***3**	**4 kHz up**
4	10-15 kHz
5	always on

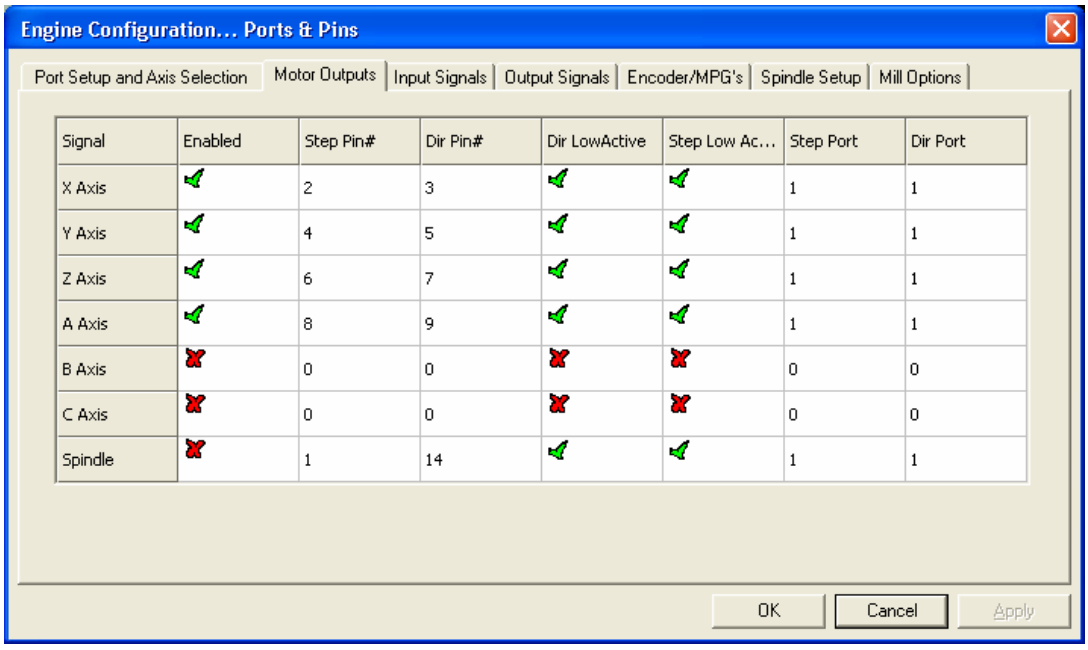
*Default

Software Configuration

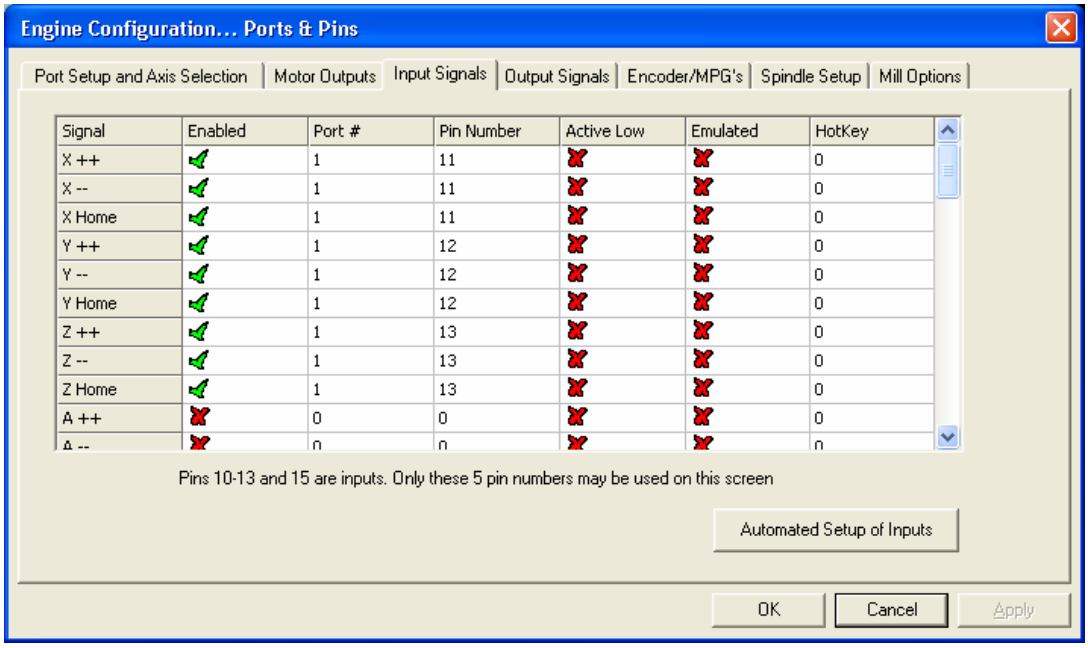
Mach3 Configuration

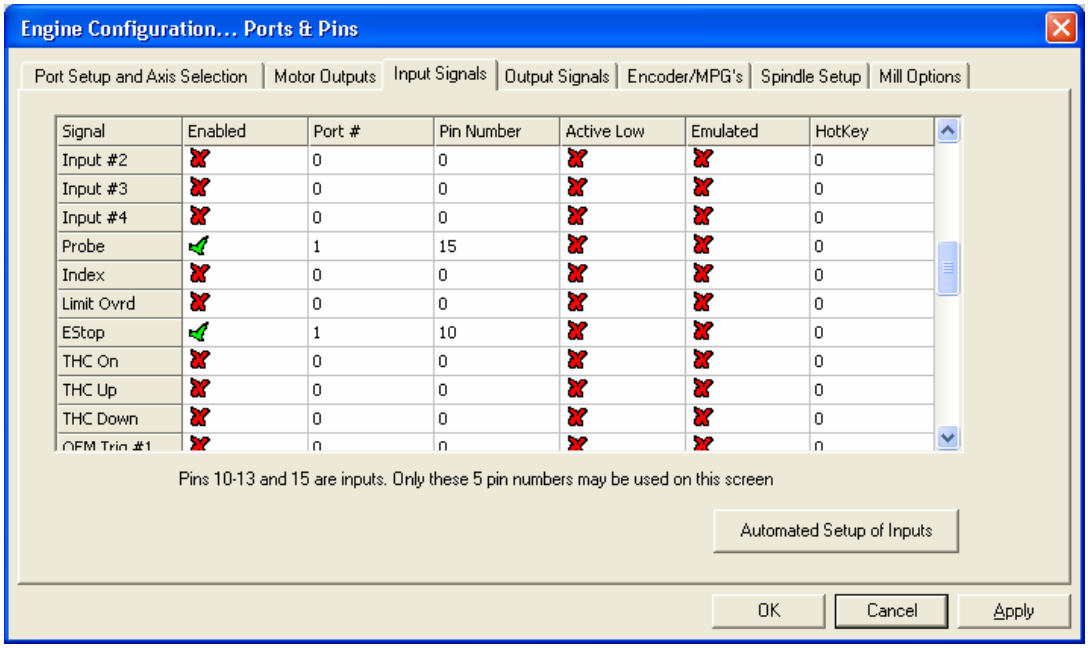
Ports & Pins

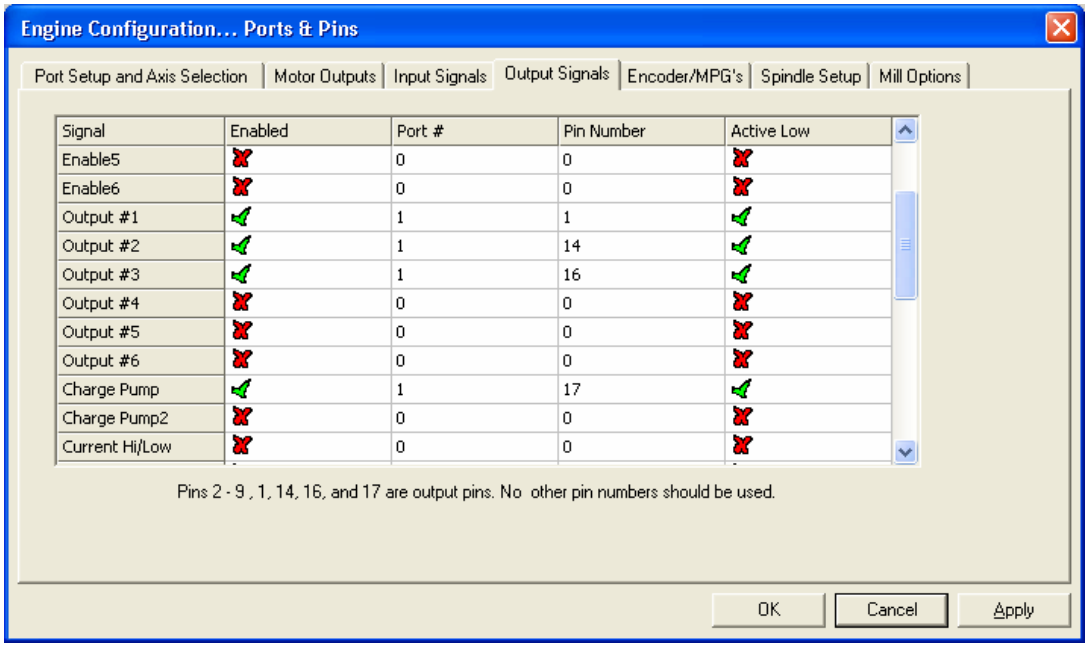


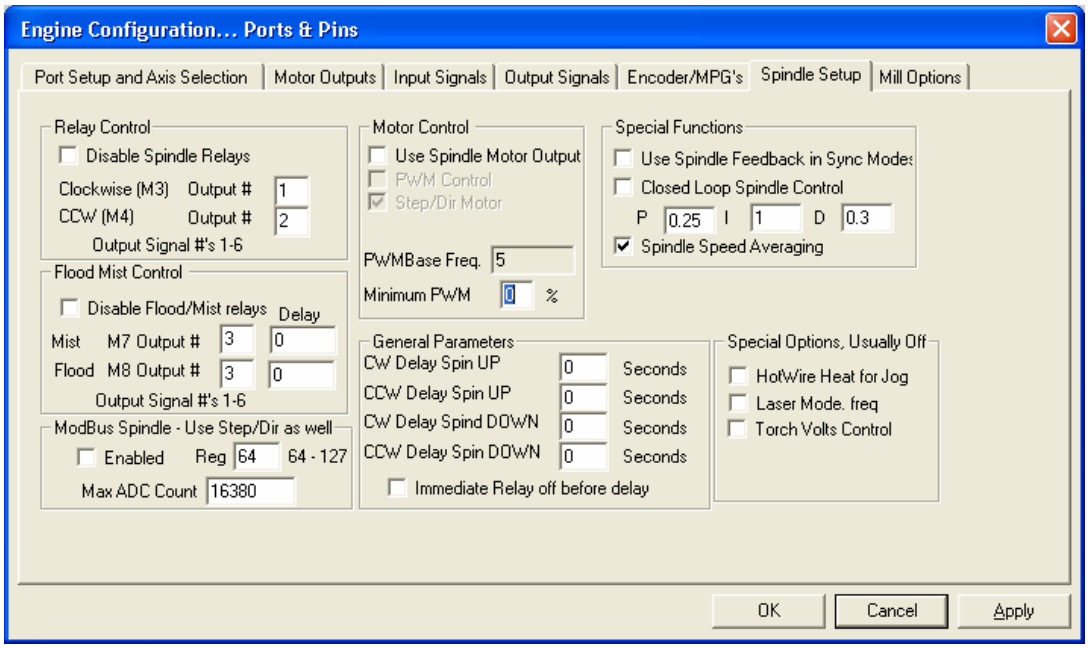


From picture above, Step and Direction signals for spindle control are disabled; meanwhile Clockwise and Counter Clockwise signals in Spindle Setup tab are enabled instead.
However, if you want to use Step and Direction signals to control motor then tick this Spindle to Enabled and tick Disable Spindle Relays in Spindle Setup tab.


Engine Configuration... Ports & Pins
Port Setup and Axis Selection
Motor Outputs
Input Signals
Output Signals
Encoder/MPG's
Spindle Setup
Mill Options
Signal | Enabled | Port # | Pin Number | Active Low | Emulated | HotKey
X ++ | 1 | 11 | 0
X -- | 1 | 11 | 0
X Home | 1 | 11 | 0
Y ++ | 1 | 12 | 0
Y -- | 1 | 12 | 0
Y Home | 1 | 12 | 0
Z ++ | 1 | 13 | 0
Z -- | 1 | 13 | 0
Z Home | 1 | 13 | 0
A ++ | 0 | 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


Engine Configuration... Ports & Pins
Port Setup and Axis Selection
Motor Outputs
Input Signals
Output Signals
Encoder/MPG's
Spindle Setup
Mill Options
Signal | Enabled | Port # | Pin Number | Active Low | Emulated | HotKey
Input #2 | 0 | 0 | 0
Input #3 | 0 | 0 | 0
Input #4 | 0 | 0 | 0
Probe | 1 | 15 | 0
Index | 0 | 0 | 0
Limit Ovrd | 0 | 0 | 0
EStop | 1 | 10 | 0
THC On | 0 | 0 | 0
THC Up | 0 | 0 | 0
THC Down | 0 | 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





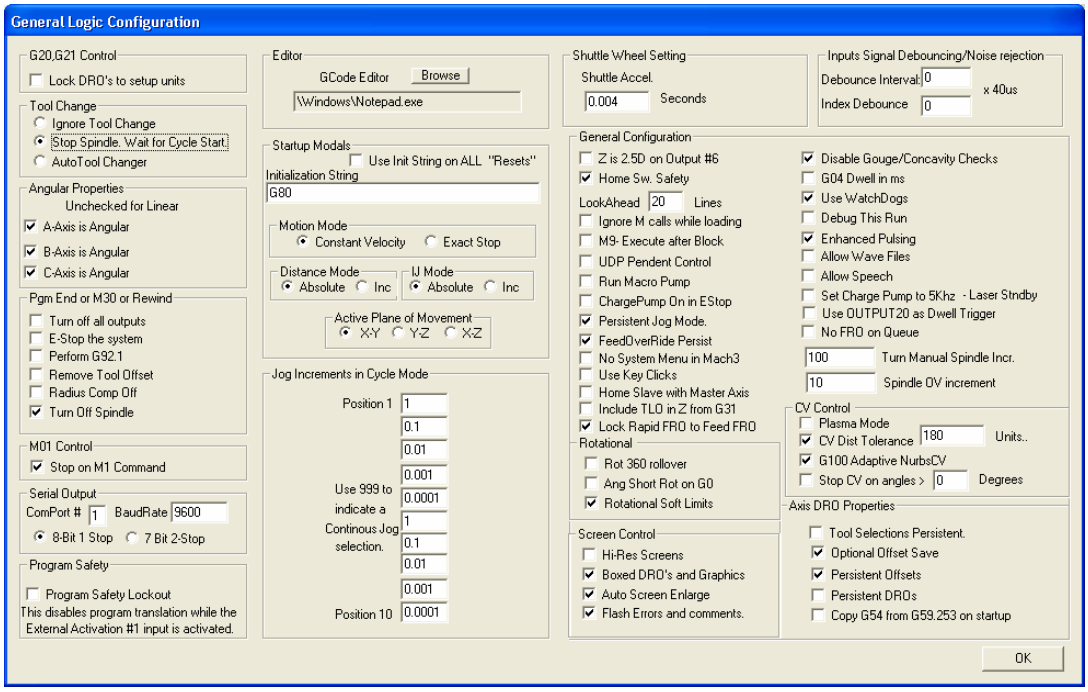
From picture above, Relay Control is used to control spindle

spindle clockwise(M3)	output1 (port1, pin1)
spindle CCW(M4)	output2 (port1, pin14)
turn off spindle (M5)	

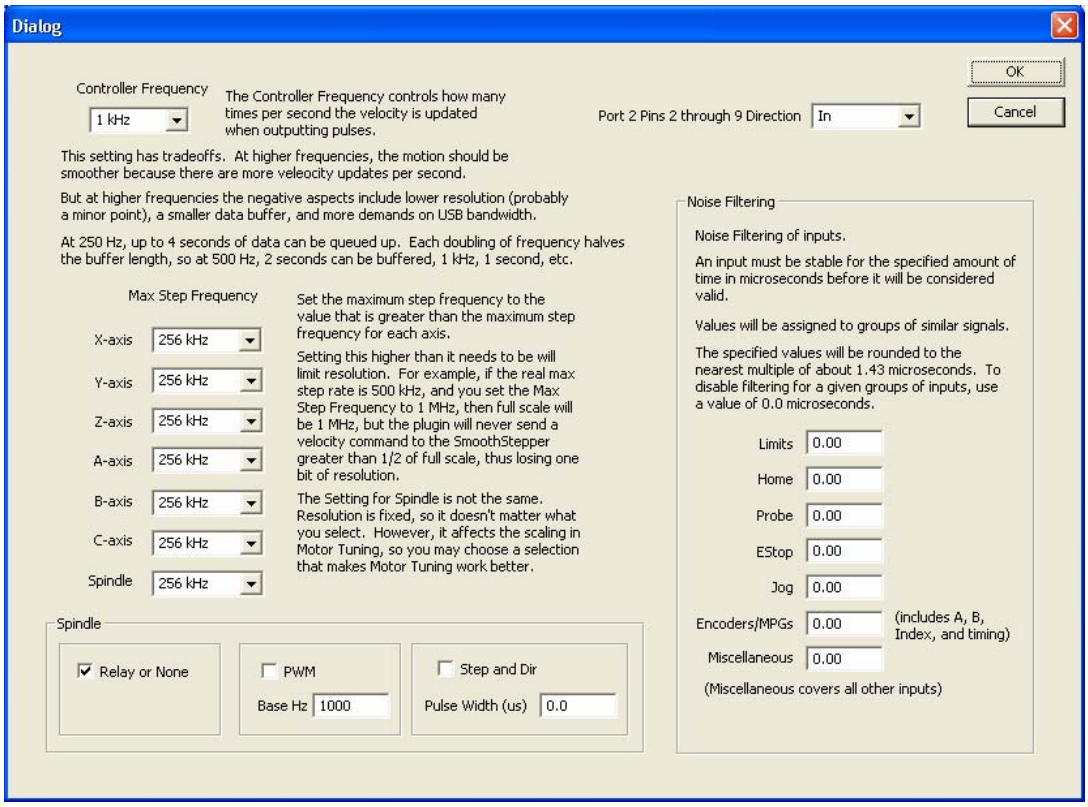
And Flood/Mist Control share the same output

Mist (M7)	output3 (port1, pin16)
Flood (M8)	output3 (port1, pin16)
turn off coolant (M9)	

General Logic Configuration



SmoothStepper



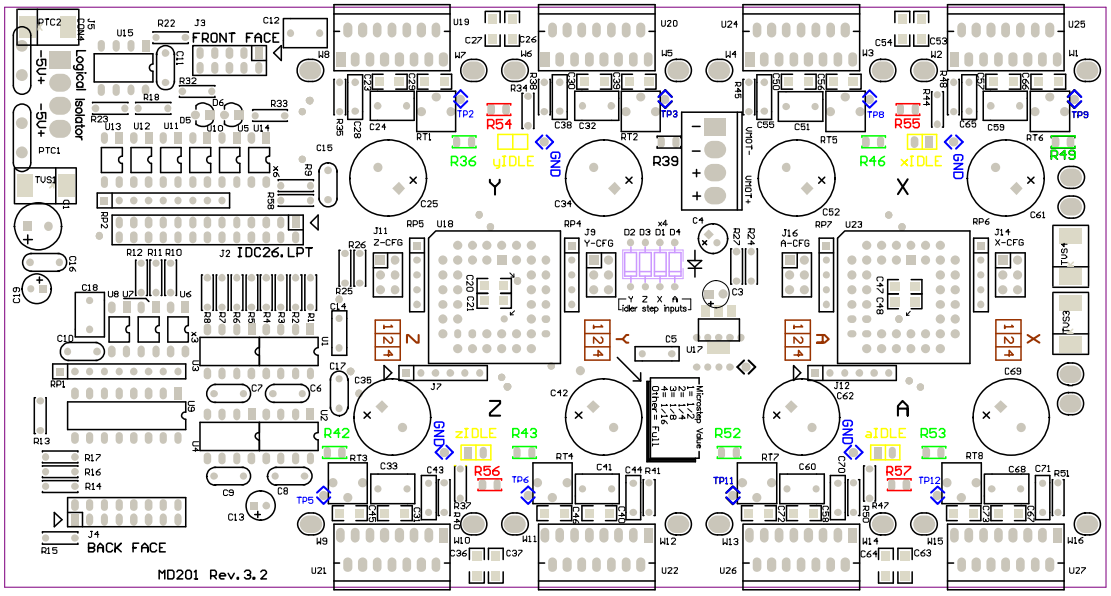
Technical Data

	MD201-316	MD201-416	MD201-312	MD201-412	MD201-310	MD201-410
Number of Axis	3	4	3	4	3	4
Microsteps per full step	1, 2, 4, 8, 16	1, 2, 4, 8, 16	12	12	10	10
Motor power supply	12-48 Vdc , ≤ 10% Vpp ripple					
Logic power supply	5 Vdc, 200 mA, ≤ 1% Vpp ripple					
Isolated power supply	5 Vdc, 100 mA, ≤ 1% Vpp ripple					
Phase Current	330 mA to 3 Amp					
Idle Current Reduction (changeable)	50%					
Step/Direct[1], Logic input signal[1]	5 mA, 10 mA					
Inputs[2]	10 mA, 5 Vdc					
Outputs [3]	-350 mA, 0-50 Vdc					
Step pulse rising/falling edge (min)	2 uS/ 1 uS					
Direction pulse before/after step pulse (min)	200 ns/ 200 ns					
Ambient Temperature	0 ℃ to 50 ℃					
Operating Temperature (max)	70 °C					
Humidity	40%RH － 90%RH					
Weight Approx.	1000 gram					
Dimensions L x W x H	240 x 125.31 x 43.23 mm					

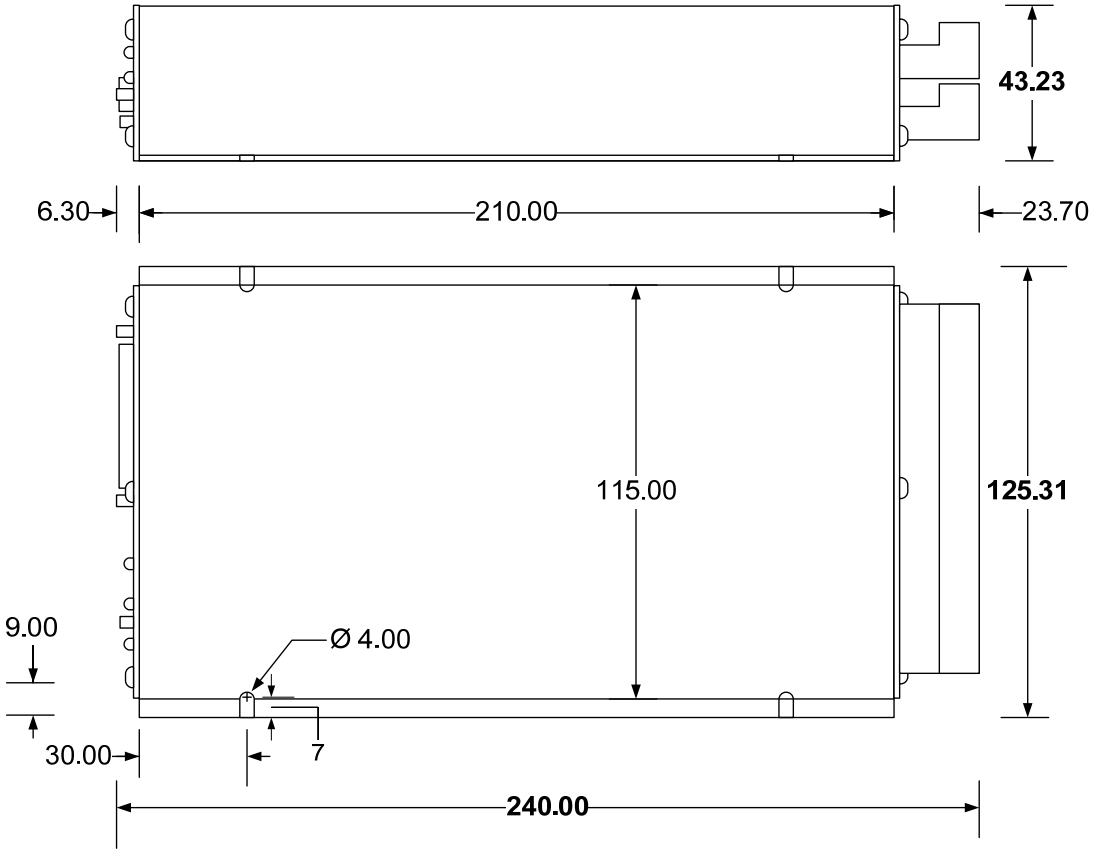
1. Up to 100kHz for Step/Direction (use 10Mbd optoisolotor chip), up to 20 kHz for other logic inputs
2. Input from external devices, such as limit/home switches or sensors output and opto-isolated from the signal generator or PC
3. Transistor NPN output to external devices, such as relays and opto-isolated from the signal generator or PC

MachDrive Components Layout

Red color is location of plug-in resistors for idle current reduction.
Green color is location of plug-in resistors and trimpot for driving current.
Blue color is location for resistance measurement points of each chip.
Brown color is location of microstepping jumpers.
Yellow color is location of jumpers to disable/enable idle current reduction function for each axis.
Violet color is location of idler input diodes



Mechanical Drawings



Measurement unit is mm