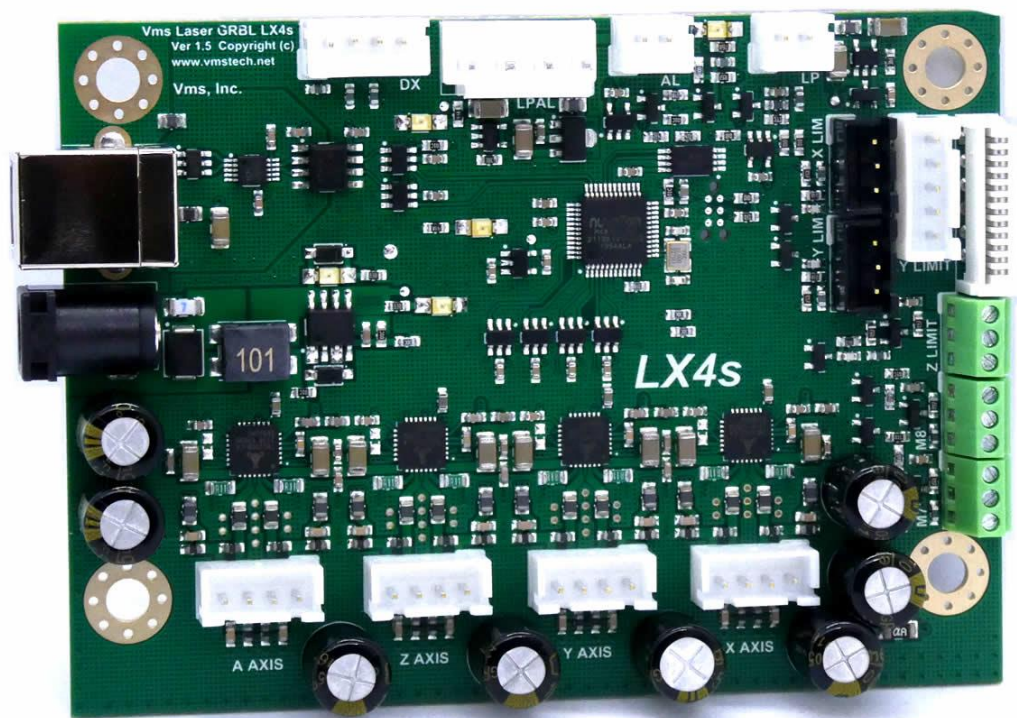


Laser GRBL LX4s Controller

User Manual

For use with LightBurn Software



Copyright information

(c) Copyright 2022 Velocitronics Motion Systems, Inc. (Vms)

The information contained herein is subject to change without notice. The warranties for Vms products and services are set forth in the express warranty statements accompanying such products and services. Nothing herein should be construed as constituting an additional warranty.

Trademark credits

Not available at this time

Safety and precautionary information

WARNING: Laser Engravers emit deadly high voltage (20-30kV) and laser radiation capable of causing instant blindness and tissue damage. Lasers are a fire hazard and a fire extinguisher must be kept close to the machine at ALL times. Never leave a laser engraver unattended while in operation!!

The lasing process can emit dangerous toxic fumes which can be deadly. Always operate a laser engraver in a well-ventilated area or use a fume extractor.

Always wear eye protection that is approved for laser operation for your specific laser while it is powered on.

When you are ready to install the Laser GRBL LX4s board, disconnect the power cord from the back of the unit and wait at least 30 minutes before opening or attempting any work on the laser engraver.

Table of Contents

User Manual	1
Copyright information.....	2
Trademark credits	2
Safety and precautionary information	2
1. About this document	6
Intended audience	6
2. System and Software requirements	6
Minimum System Requirements	6
Software Requirements.....	6
3. Overview of the Hardware	7
Board Features	7
Base Board diagram and connector functions.....	8
Connector definitions and pinout information	9
Base Board diagram and LED locations	10
LED definitions and functions.....	11
4. Hardware Installation	12
5. Hardware Settings and Software Installation	18
Install the USB driver	18
LX4s Board power up and Initialization	19
LightBurn Device Setup	20
Connecting to the LX4s Board	24
Machine Jog X & Y Direction Setup	25
X & Y Limit Switch Testing.....	28
Homing Direction Setup and Homing	30
Workspace Offset Setup	32
Steps per mm calibration for X and Y axes	34
Laser Power Calibration Procedure	35
Rotary Setup and Use.....	37
Z-Bed Setup and Use	38
Going further	39
Troubleshooting LX4 Board and LightBurn	40
M7 & M8 Solid State Relay Control Outputs.....	41
Laser Power Control Output.....	43
Laser Power Supply and Laser PWM Control Output	43
X, Y & Z Limit Inputs	44
JST XHP Connectors and Part Numbers.....	45
JST VHR Connector and Part Number	46
GRBL Settings and Definitions.....	47
Revision History	50

1. About this document

Intended audience

This document is intended to be used by individuals who own a K40 or other similar laser engraver and who have purchased the Laser GRBL LX4s board. This document will guide the user on how to safely install the Laser GRBL LX4s board into their K40 or similar laser engraver and to help the user get better acquainted with the features and functions as well as setting up the software and dialing in settings for first time use.

2. System and Software requirements

Minimum System Requirements

- Windows® 7 or later, MAC OS or Linux, 32 or 64 bit
- 8GB or more memory
- Available USB 2.0 or later port

Software Requirements

- LightBurn software (latest Gcode version): Please follow the link for more information, download a 30-day free trial or purchase for \$60 USD (recently updated from \$40 USD):

<https://lightburnsoftware.com/collections/frontpage/products/lightburn-gcode>

Link to their GitHub software releases page:

<https://github.com/LightBurnSoftware/deployment/releases>

LightBurn has tutorials on how to run your first job and many other videos on YouTube as well as a software support forum here:

<https://forum.lightburnsoftware.com/>

3. Overview of the Hardware

Board Features

- 192 MHz ARM Cortex M4 processor with hardware floating point support
- Simple and small board design
- Four axes integrated TMC2208 drivers with access to driver parameters through a grbl setting
- Dual axis Y slave support for Y slave on Z or A axis configurable through a grbl setting
- Z Limit 24V support for industrial sensors such as the Cloudray Z-Axis Focus Sensor
- M7 and M8 24V active low outputs for air assist or external auxiliary control and compatible with most AC or DC solid state relays
- Electrically isolated full speed USB circuitry for computer to board ground loop isolation
- Custom GRBL firmware loaded with features such as faster step and direction interface, gcode planner engine, larger serial and planner buffers to handle the high-speed data, 16-bit 1000 step grayscale variable laser PWM output with custom configurable PWM options, Z-enable homing, all axis freewheel or axis locking ability and laser power maximum control.
- Custom protected free firmware updates. The firmware is field upgradeable through custom software. The firmware for the processor on the board is proprietary and is not freeware. Please contact Vms for more information.

Power protection

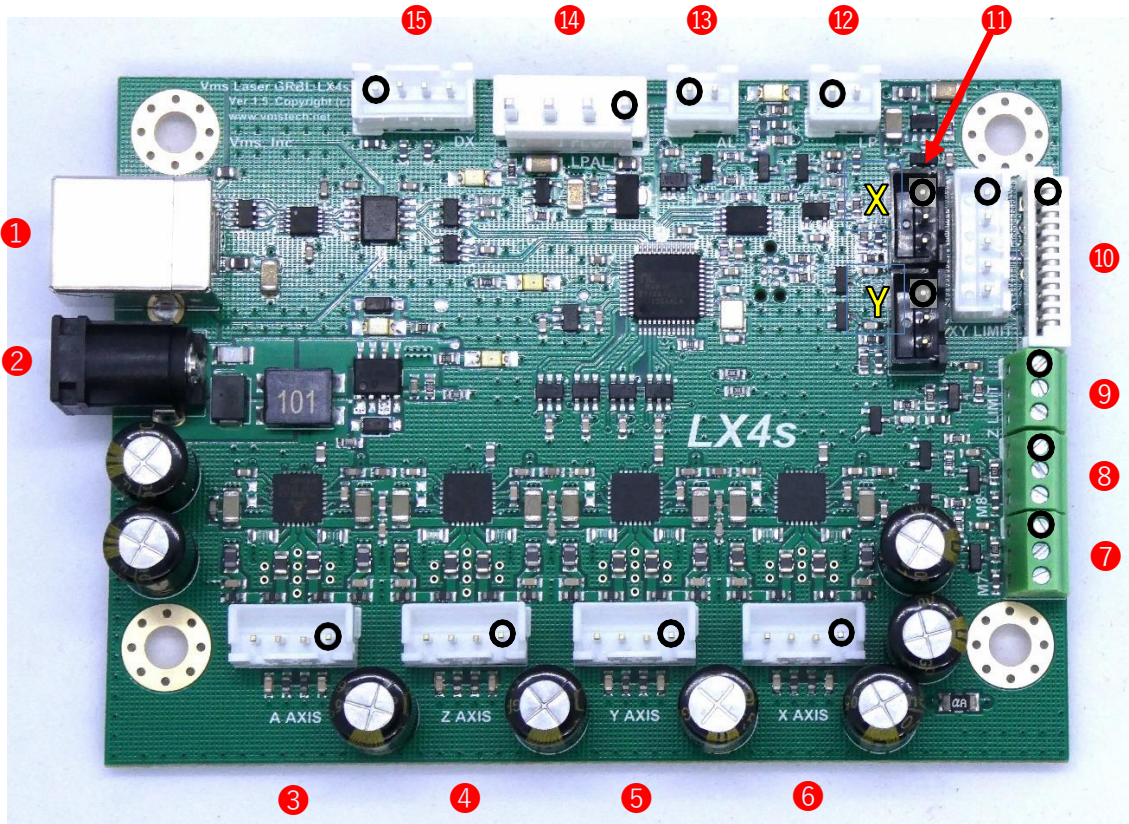
- 24V power input reverse polarity and surge protection

Low voltage signal protection and filtering

- ALL inputs are ESD protected and low pass filtered. All outputs are ESD protected.

Base Board diagram and connector functions

Note: Pin 1 is marked with an 



Connector definitions and pinout information

Each connector with a μ marker on the board denotes pin 1

1. USB B connector

Pin 1 - +5V power
 Pin 2 - Data-
 Pin 3 - Data+
 Pin 4 - USB Ground
 Pin 5 - USB Shield

2. 24V DC power jack

24V @ 6 amps maximum input



3. A-Driver connector

Pin 1 - A-Driver Coil B (B2)
 Pin 2 - A-Driver Coil B (B1)
 Pin 3 - A-Driver Coil A (A1)
 Pin 4 - A-Driver Coil A (A2)

4. Z-Driver connector

Pin 1 - Z-Driver Coil B (B2)
 Pin 2 - Z-Driver Coil B (B1)
 Pin 3 - Z-Driver Coil A (A1)
 Pin 4 - Z-Driver Coil A (A2)

5. Y-Driver connector

Pin 1 - Y-Driver Coil B (B2)
 Pin 2 - Y-Driver Coil B (B1)
 Pin 3 - Y-Driver Coil A (A1)
 Pin 4 - Y-Driver Coil A (A2)

6. X-Driver connector

Pin 1 - Y-Driver Coil B (B2)
 Pin 2 - Y-Driver Coil B (B1)
 Pin 3 - Y-Driver Coil A (A1)
 Pin 4 - Y-Driver Coil A (A2)

7. M7 connector

Pin 1 - +24V
 Pin 2 - Output
 Pin 3 - Ground

8. M8 connector

Pin 1 - +24V
 Pin 2 - Output
 Pin 3 - Ground

9. Z Limit connector

Pin 1 - +24V Power
 Pin 2 - ZL Input
 Pin 3 - Ground

10. X-Driver & XY Limit

Pin 1 - Y-Limit Input	Pin 1 - N/C
Pin 2 - N/C	Pin 2 - Ground
Pin 3 - +5V power	Pin 3 - X-Limit Input
Pin 4 - Y-Limit Input	Pin 4 - Y-Limit Input
Pin 5 - X-Limit Input	Pin 5 - Ground
Pin 6 - Ground	
Pin 7 - Ground	
Pin 8 - N/C	
Pin 9 - X-Driver Coil A (A2)	
Pin 10 - X-Driver Coil A (A1)	
Pin 11 - X-Driver Coil B (B1)	
Pin 12 - X-Driver Coil B (B2)	

11. X & Y 3-Pin Limit

<u>X Limit</u>	<u>Y Limit</u>
Pin 1 - 5V	Pin 1 - 5V
Pin 2 - Ground	Pin 2 - Ground
Pin 3 - X Limit	Pin 3 - Y Limit

12. LP Laser Power Adjust

*0-5V variable buffered analog voltage output

Pin 1 - Laser Power Output
 Pin 2 - Ground

13. AL Laser Output

*Buffered Laser Output is AL (Active-Low) signal

Pin 1 - AL Buffered PWM Output
 Pin 2 - Ground

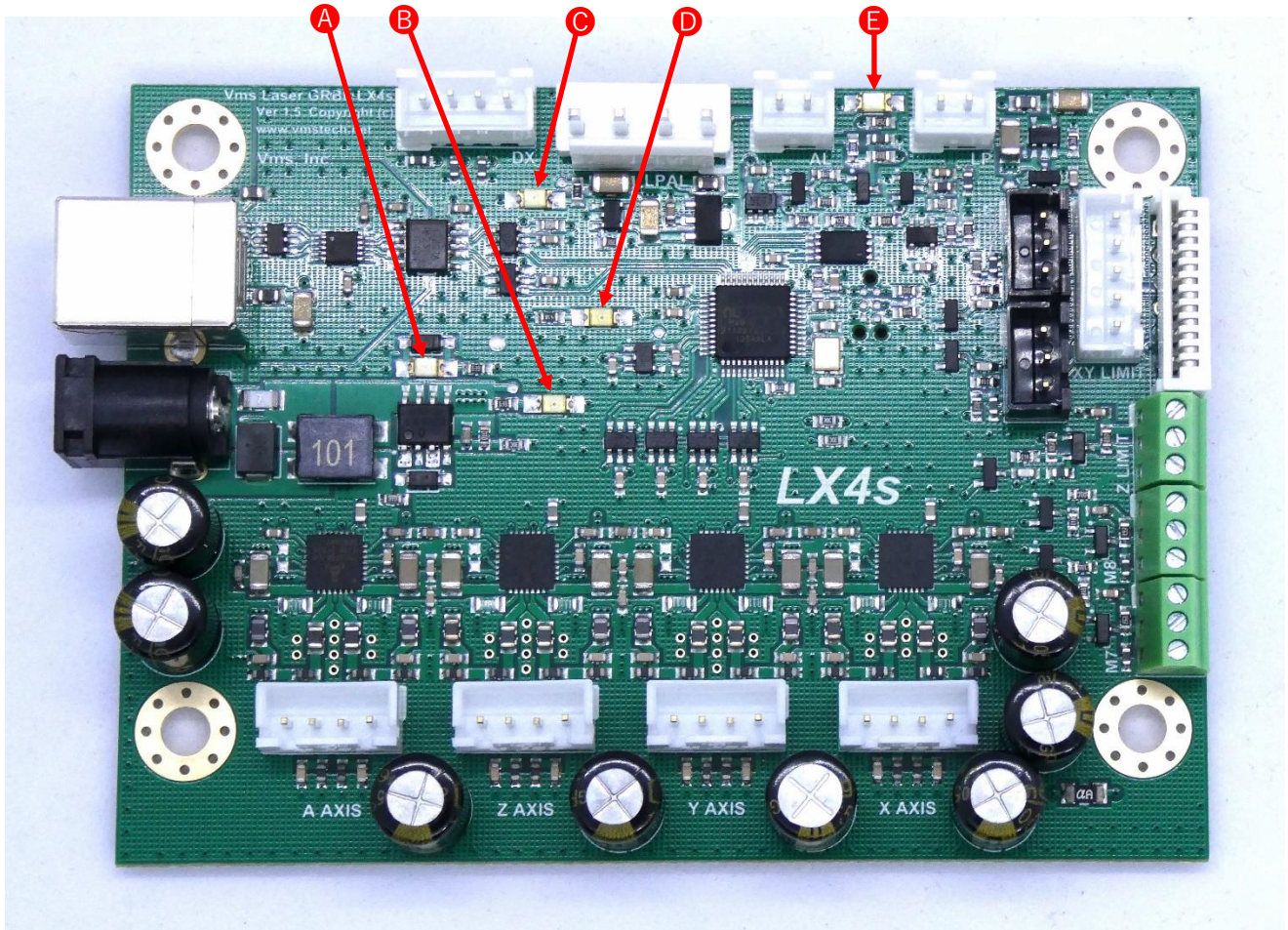
14. LPAL Laser Power & PWM connector

Pin 1 - Laser Output
 Pin 2 - Laser +5V Power (used for laser output pull up)
 Pin 3 - Ground
 Pin 4 - Laser +24V Power (not connected)

15. DX Panel Serial Interface

Pin 1 - DX RX Serial Line
 Pin 2 - DX Enable
 Pin 3 - DX TX Serial Line
 Pin 4 - Ground

Base Board diagram and LED locations



LED definitions and functions

A. Reverse Polarity LED

If the voltage is reversed the red led will illuminate and prevent the board from powering up

B 24V Power LED

If illuminated the 24V power is ON and the drivers are powered

C 3.3V Power LED

If illuminated the 3.3V regulator and protection switch is working correctly

D Done/Active LED

This led indicates GRBL is running and also turns off and on when settings are updated

E 5V Power LED

If illuminated the 5V regulator and protection switch is working correctly

4. Hardware Installation

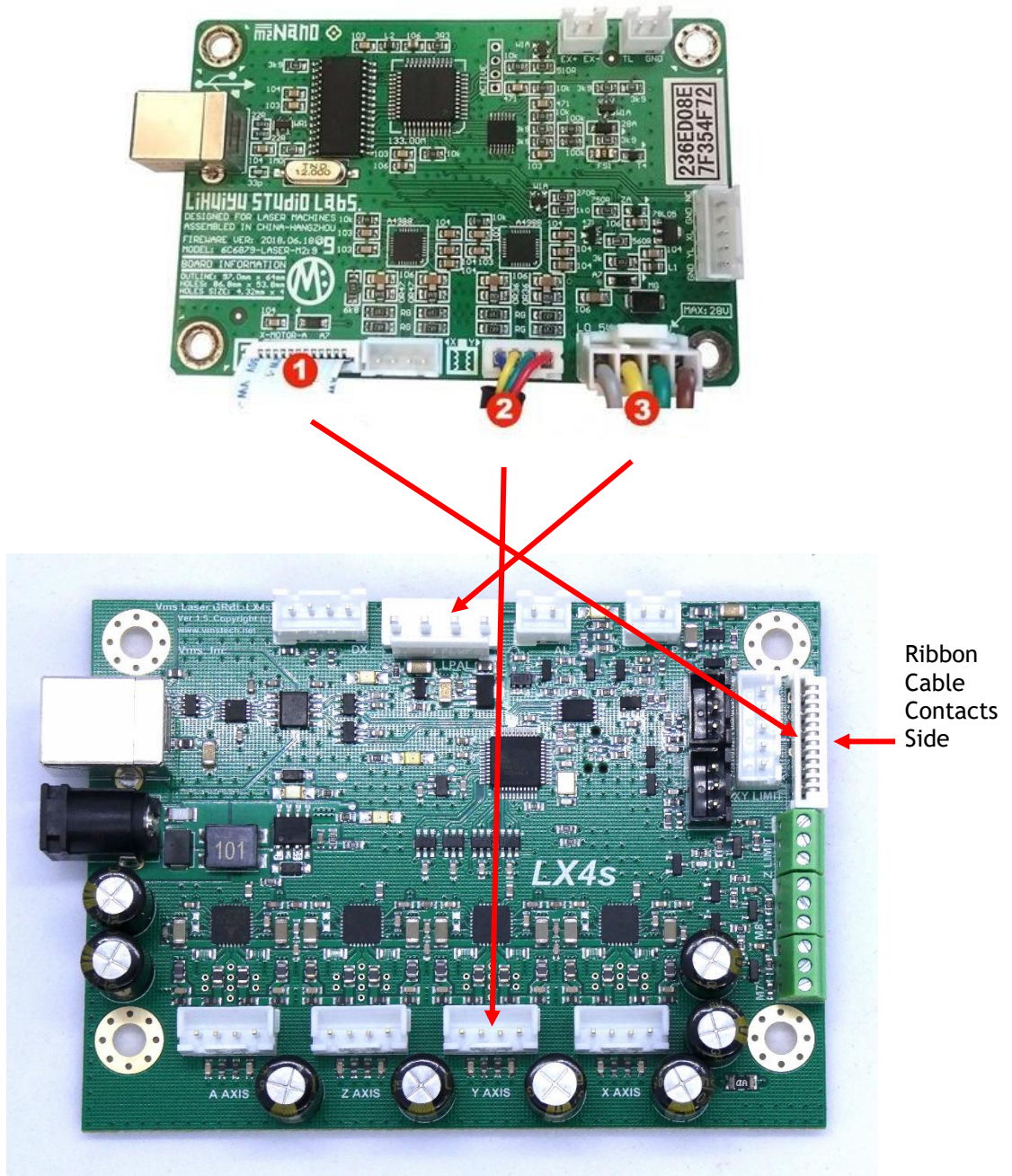
This procedure is for an M2 Nano controller board replacement in a K40 or other laser engraver. Since there are many variations of wiring schemes used in different laser engravers this procedure will only cover how to swap out the M2 Nano board and replace it with the Laser GBRL LX4s board.

1. Disconnect the power cable from the back of the laser engraver. Allow at least thirty minutes for the power supply capacitors to discharge.

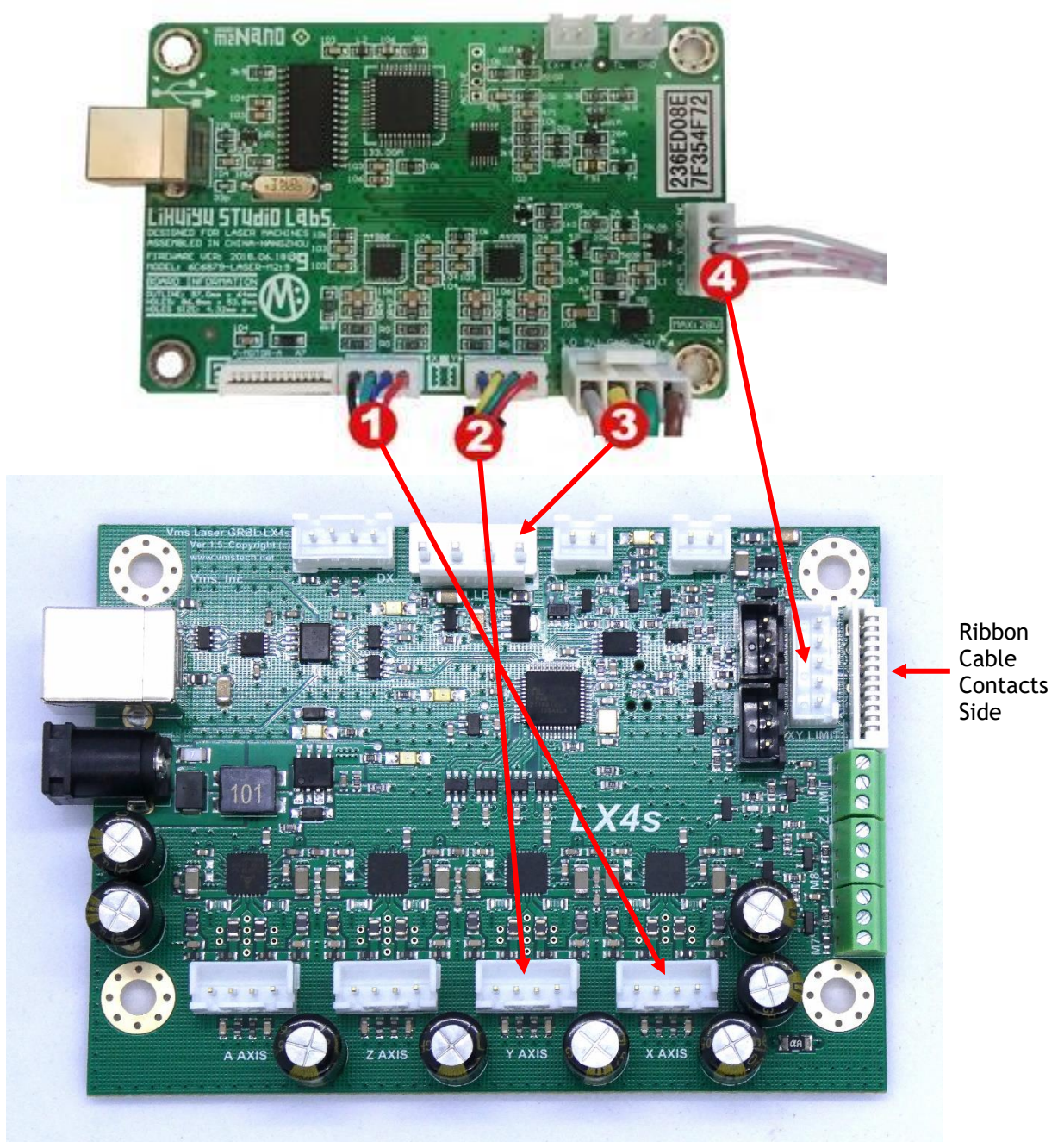
WARNING: Failure to unplug the laser engraver is very dangerous. The laser power supply operates at 20-30kV and can injure or even cause death. Observe ALL precautions while working near high voltage electronics.

2. Locate the electronics compartment. For a K40 engraver the electronics compartment is to the right of the general work area and below the control panel. For other laser engravers consult the user manual to locate the electronics compartment and open it.
3. Depending on the manufacturer, K40's generally come in two different formats "ribbon" and "discrete" cable configurations. The color of the wires is for reference only. As shown on the next page I break up the three wiring configurations

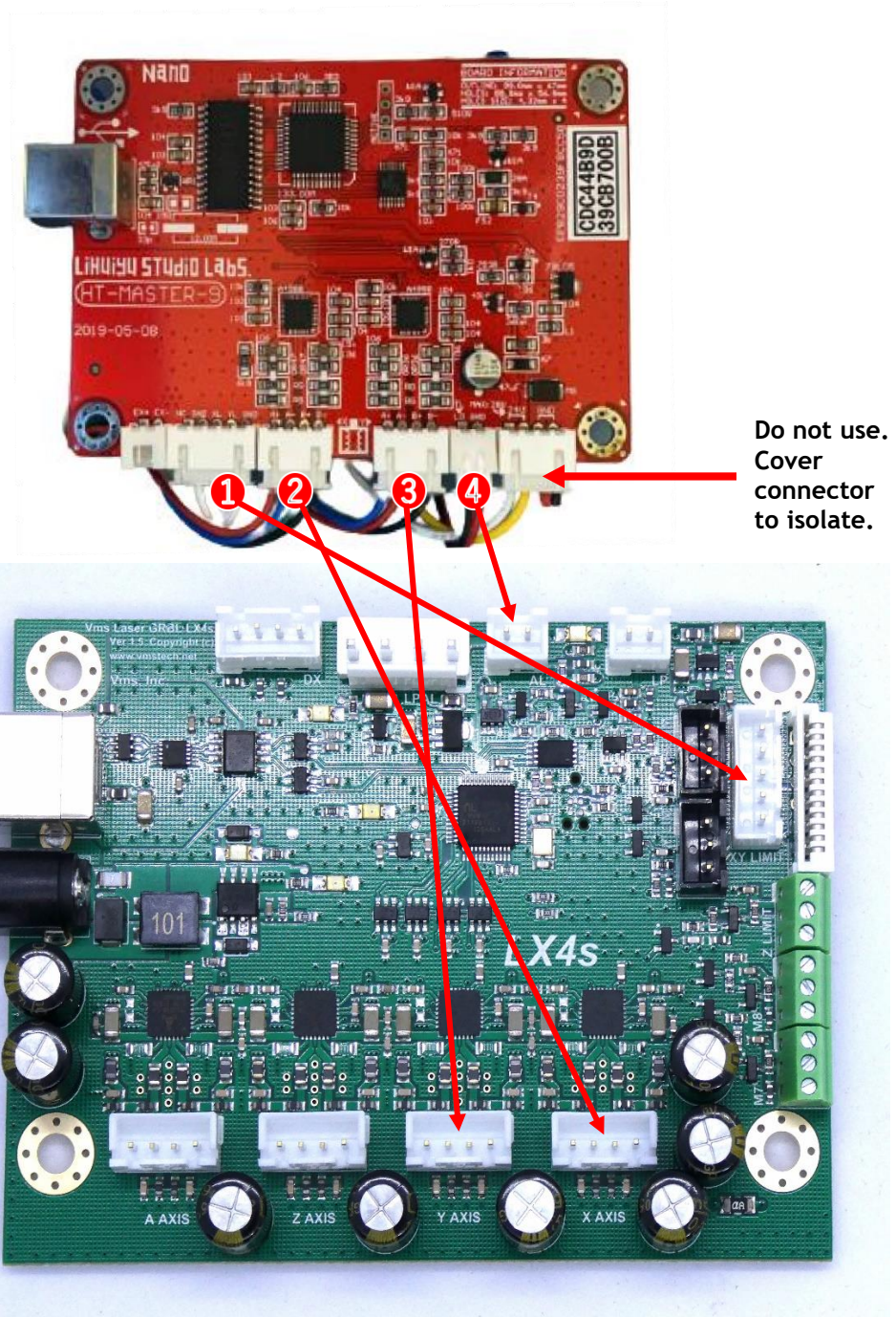
“Ribbon cable” configuration 1:



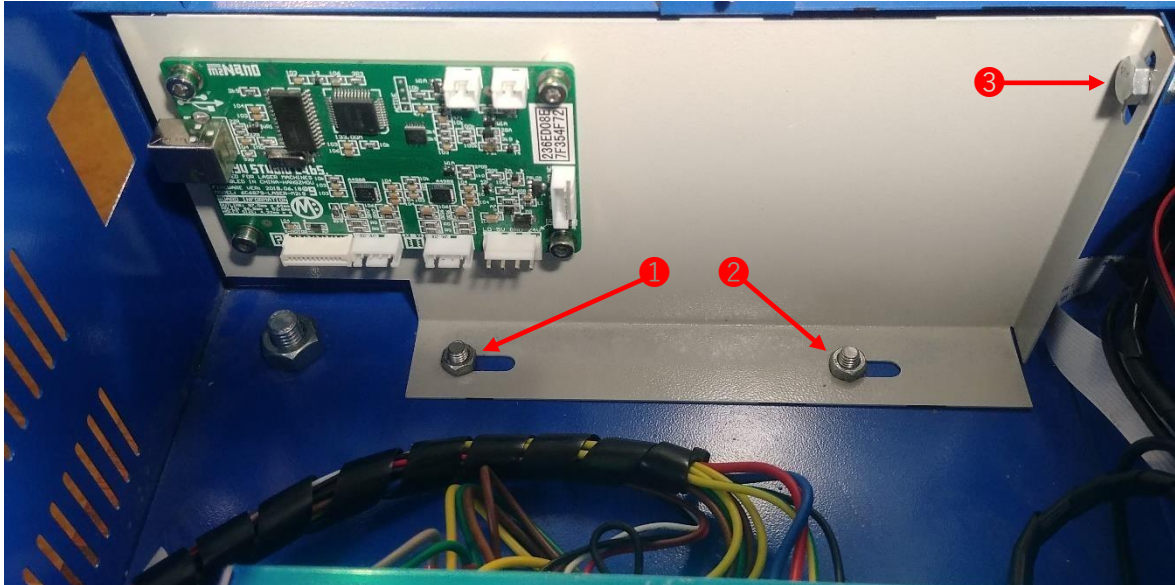
“Discreet wire” configuration 2:



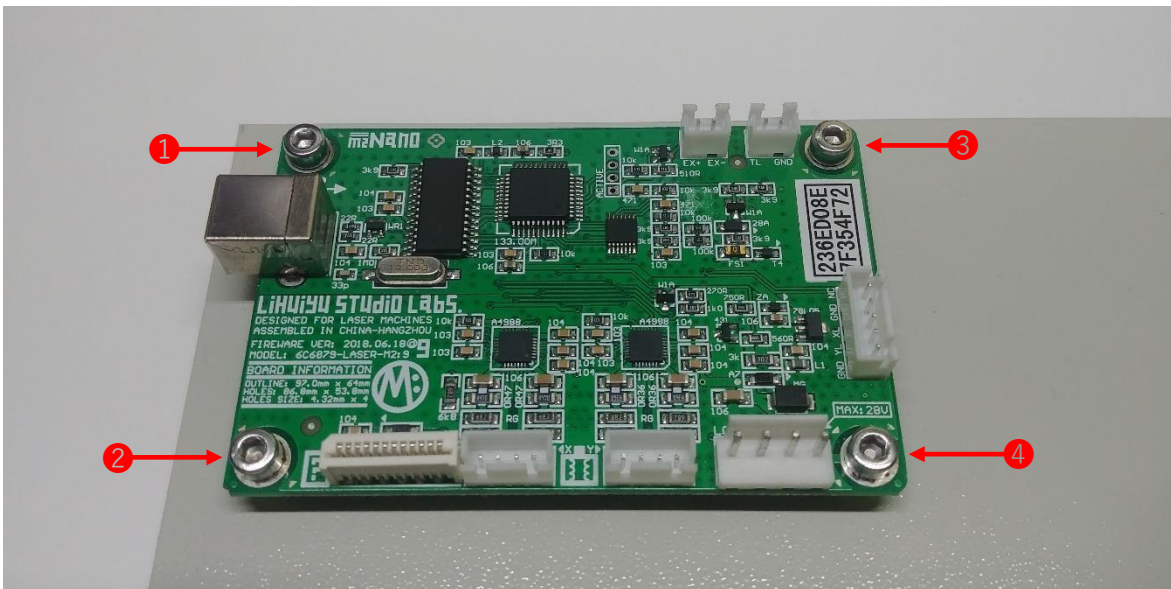
“Discrete wire” configuration 3:



- Take note of which configuration you have above and begin by removing the cables from the board. When the cables are removed you are now ready to remove the M2 Nano frame from the laser engraver. Pictured here is a K40. If your setup differs from a K40 consult your manual for details on how to remove your board from your laser engraver. To remove the M2 Nano frame, remove the three screws as shown:

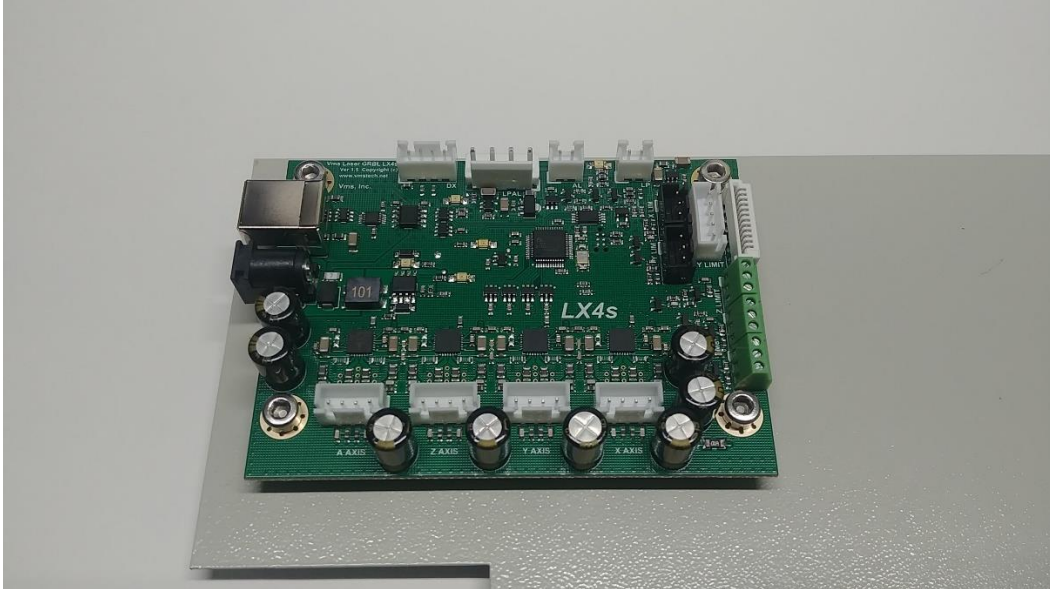


- Once the M2 Nano board frame is removed, you will need to remove four M4 screws, spacers and nuts securing the board in place as shown:



6. Once you have removed the M2 Nano board from the frame or other panel, get your new Laser GRBL LX4s board and fasten it to the same frame or other panel in your laser engraver using the hardware (M4 screws, spacers and nuts) that was previously used to fasten the M2 Nano board. Orientate the board so that the USB port is facing in the same direction as the M2 Nano board.

The finished assembly for a K40 or other laser engraver should look similar to this:



7. Install your board frame or other panel into your K40 or other laser engraver in reverse order.
8. Once the mechanical assembly is complete it is now time to install the cables. To install the cables, follow the “Ribbon cable” or “Discrete wire” configurations previously mentioned in step 3 of this instruction. Ensure all connectors are securely seated in their respective locations.

Congratulations the hardware installation is now complete!!

If you did not complete the installation and need further assistance or have questions regarding the installation, please contact Vms for support.

5. Hardware Settings and Software Installation

Install the USB driver

1. When you are ready, connect the provided USB cable “A” plug into an available USB 2.0 or USB 3.0 port on your PC and the cable “B” plug into the Laser GBRL LX4s board. DO NOT connect the power cable into the board at this time. Below are examples of what an USB “A” plug and “B” plug look like:

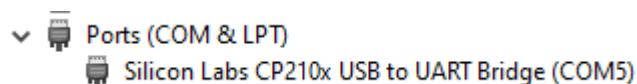


2. Once the USB cable is connected you will need to install the CP2102 Driver. Follow the link below to install the driver. The SiLabs CP2102 works for WINDOWS and MAC.

<https://www.silabs.com/products/development-tools/software/usb-to-uart-bridge-vcu-drivers>

Download the one that pertains to your operating system. Follow the instructions on how to install the driver.

WINDOWS: Once the driver has been installed go to: Device Manager -> expand Ports (COM & LPT) - The SiLabs com port should show up as shown below. Write down the com port number (for example: COM5). You will need this later when connecting to LightBurn.



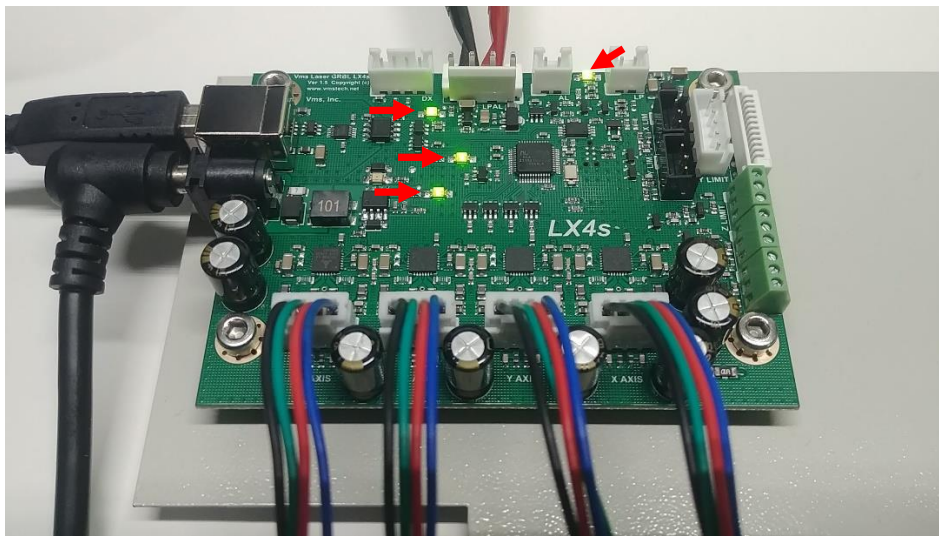
You have now completed the USB driver installation and configuration

LX4s Board power up and Initialization

1. Make sure all connections have been made in section 4. When you are ready, connect the 24V power supply DC connector to the DC jack on the board **FIRST**, then connect the AC power cord and then plug the power cord into the wall outlet. Turn on your laser. The board gets 5V power from the laser power supply.

NOTE: Depending on the country, the power cord may or may not come with the included power supply. Please contact Vms for your options if outside the United States.

2. Now observe the led's. The led's marked with an arrow should be ON as shown. The board is out of the enclosure for illustration purposes only. The board is mounted to a K40 panel:

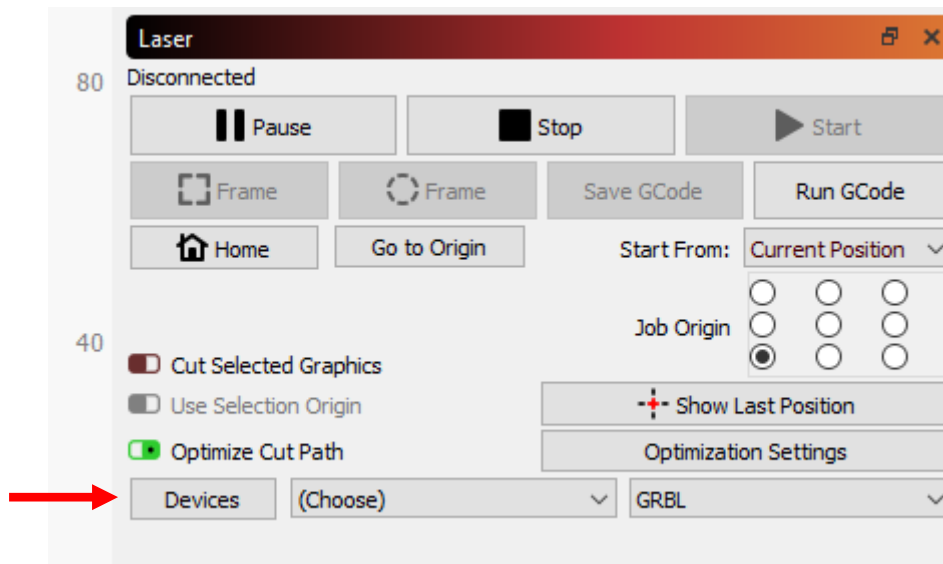


In this example all led's should be illuminated. If your Laser GBRL LX4s board does not have the led's illuminated as shown disconnect power and contact Vms for further assistance.

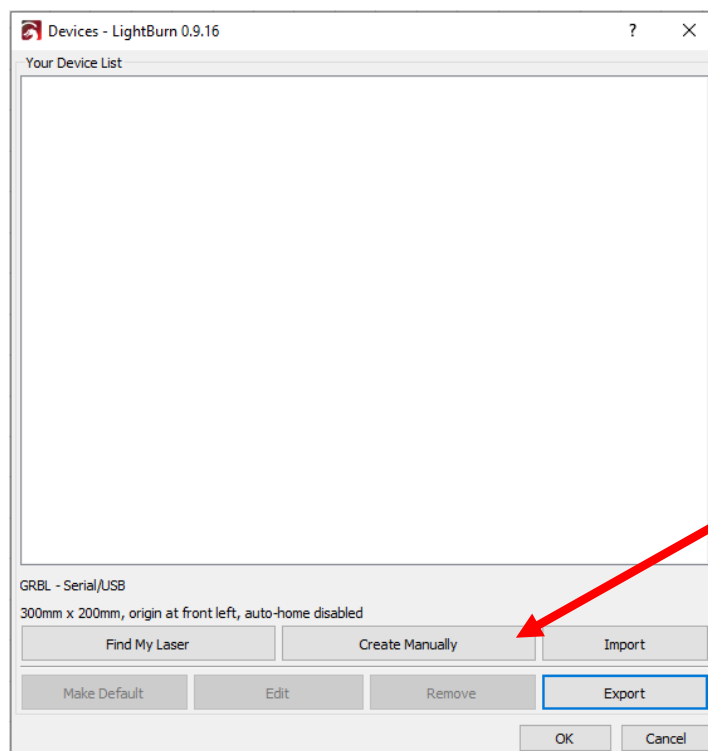
If steps 1 and 2 are completed successfully you can now move on to the next section.

LightBurn Device Setup

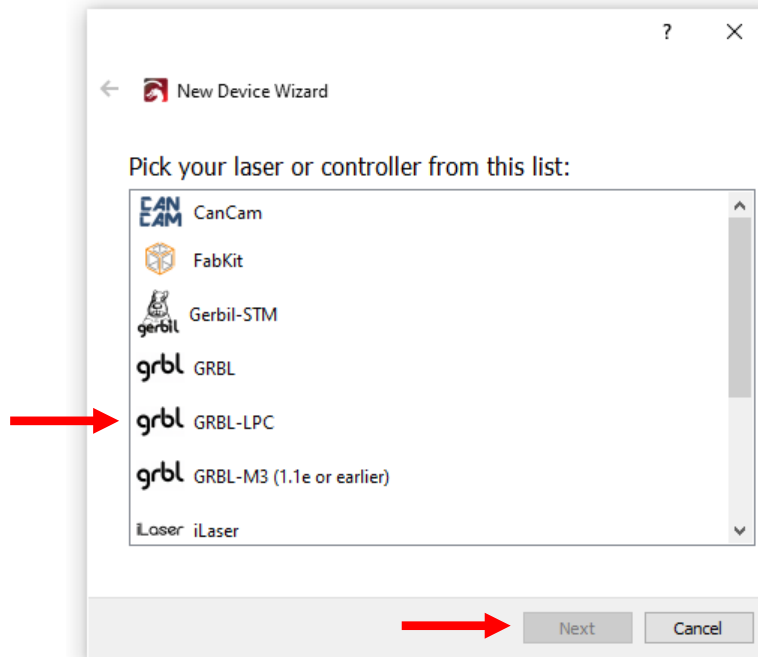
1. Find and run LightBurn software by double clicking the icon on the desktop or find it in the start menu. Once open click on Devices button:



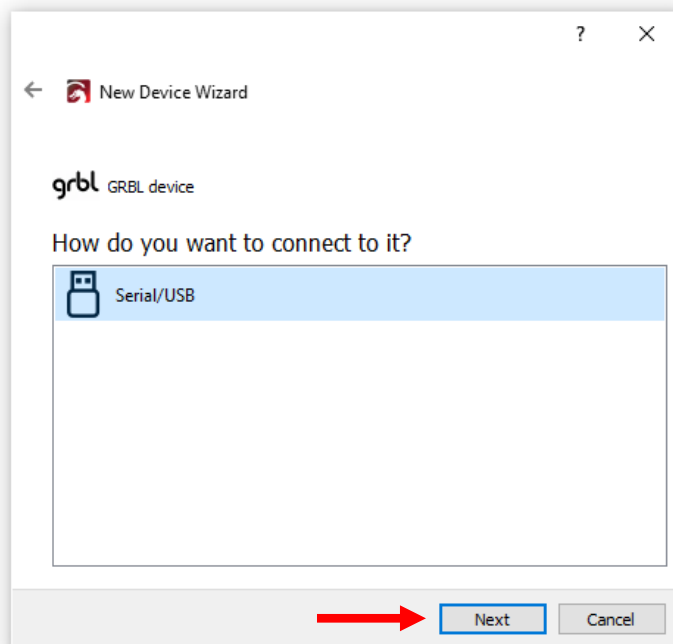
2. Once you click on the Devices button you will see a Devices window appear. Since this is a new installation and there are no devices in the Device List you will need to click on the Create Manually button as shown:



3. Once you have clicked on Create Manually button another window will appear. Choose GRBL-LPC and then Next as shown:

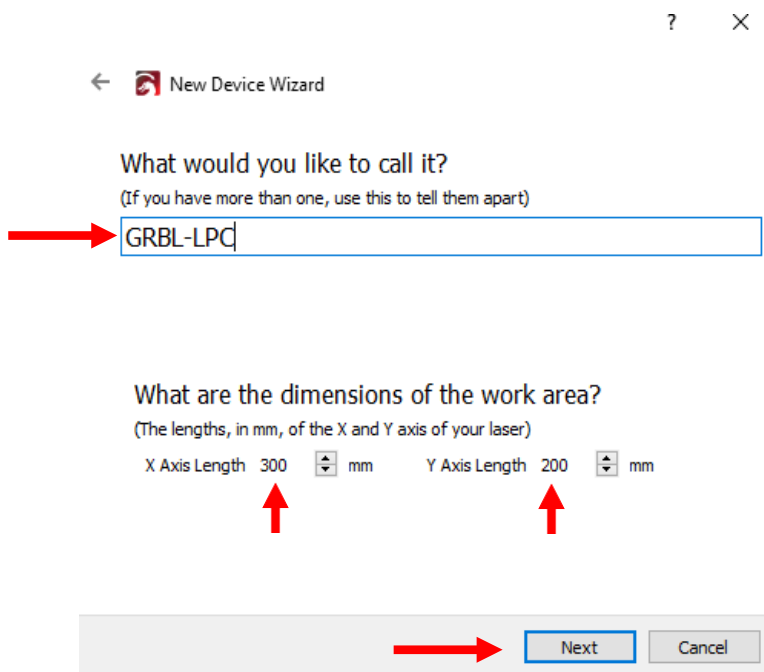


4. Next another window will appear. Click Next as shown:

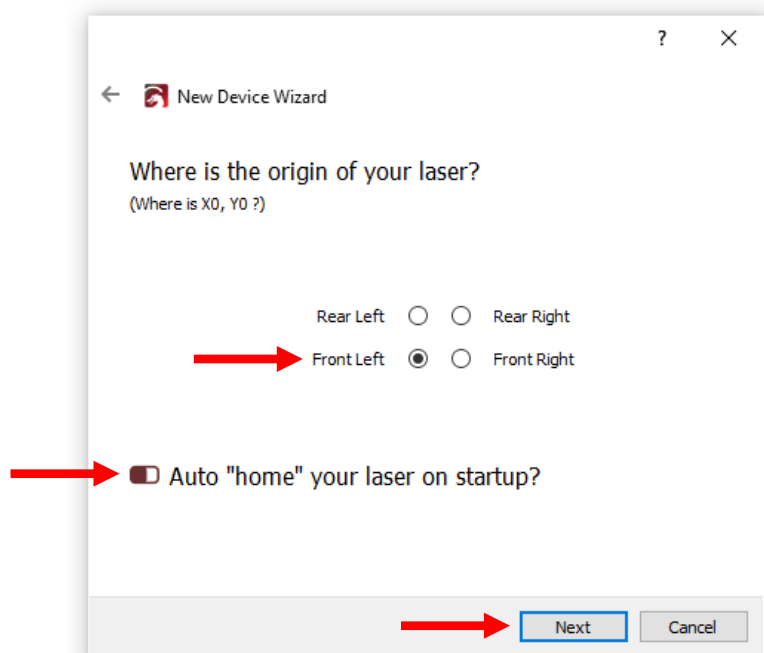


- The next window that appears will ask what you would like to call this connection (you can leave it as "GRBL-LPC" or you can change it if you choose) and the dimension of the work area in MM. For a standard K40, enter X = 300mm and Y = 200mm then click Next.

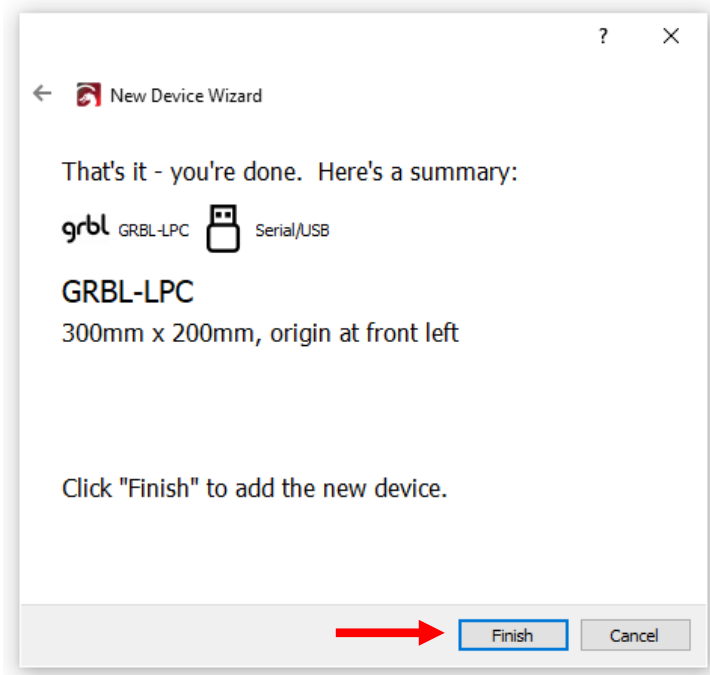
NOTE: If your laser has a bed size that differs from 300mm x 200mm you will need to change \$130 (X-Axis) and \$131 (Y-Axis) to suit your bed size. Please see page 47 for more information.



- The next window that appears will ask for the origin of the laser (the origin **MUST** be Front Left as shown below. Any other option will not work. LightBurn is a positive only coordinate system). Next turn off Auto "home" your laser on startup for now so we can setup the jog direction, homing direction and home the machine. This can be turned back on in the future if you require it. Make the changes as shown below and click Next:



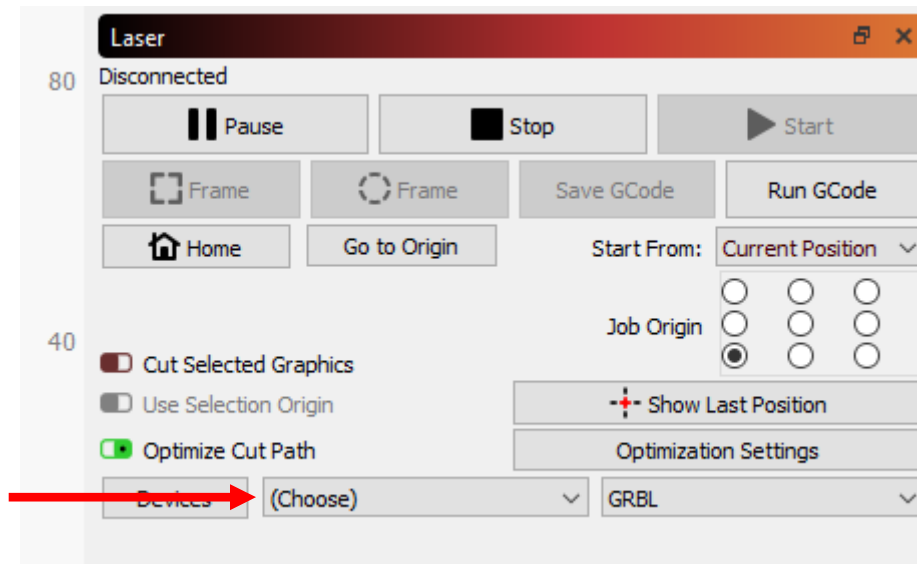
7. Finally, we should see this window when the device has been configured. Click Finish to complete the Device Setup:



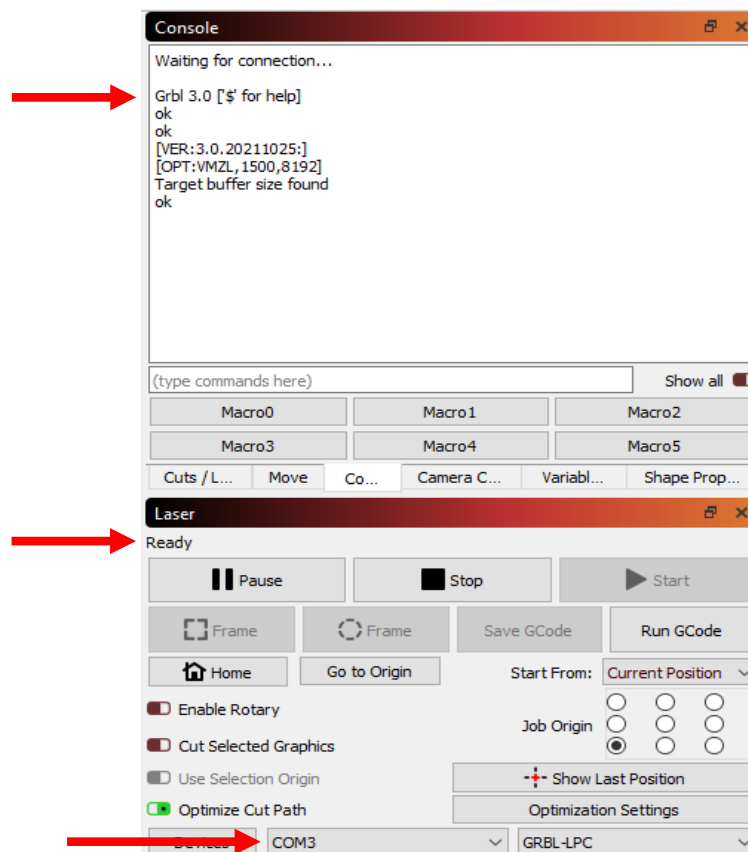
This concludes the Device Setup. If this has been completed successfully proceed to the next section. If the device setup has not completed successfully or if you have questions, please contact Vms for further assistance.

Connecting to the LX4s Board

1. To connect to the LX4s board click the “Choose” dropdown as shown below and select the com port the LX4s board is connected to. If the drivers were installed correctly the dropdown will automatically populate the com port numbers when LightBurn loads.



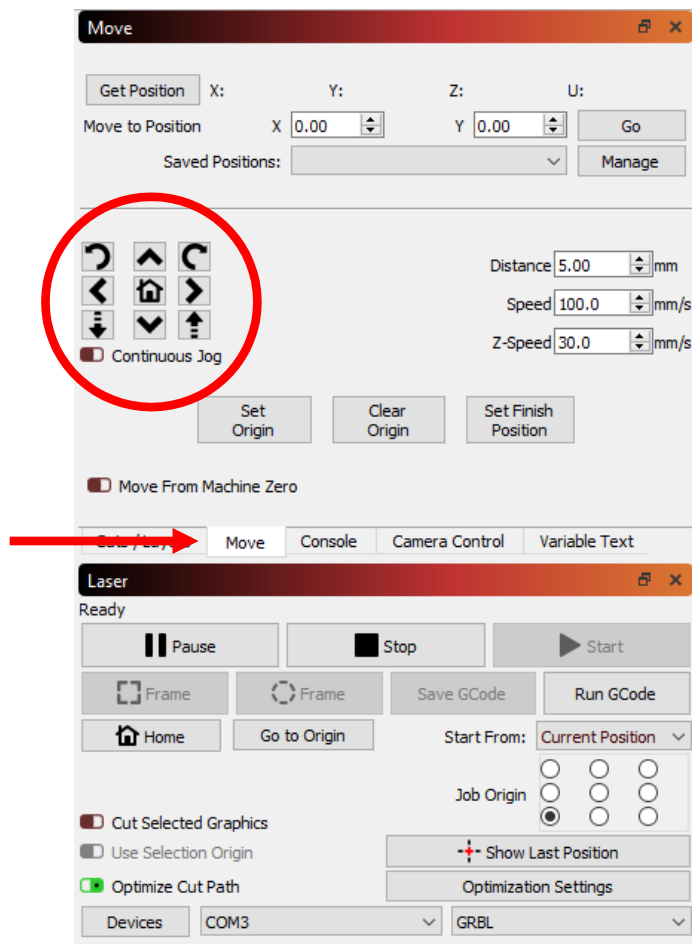
2. Once the correct com port is selected the LX4s board will automatically connect and the “Ready” status will appear as shown below. The Grbl version may vary. In this example the com port is COM3:



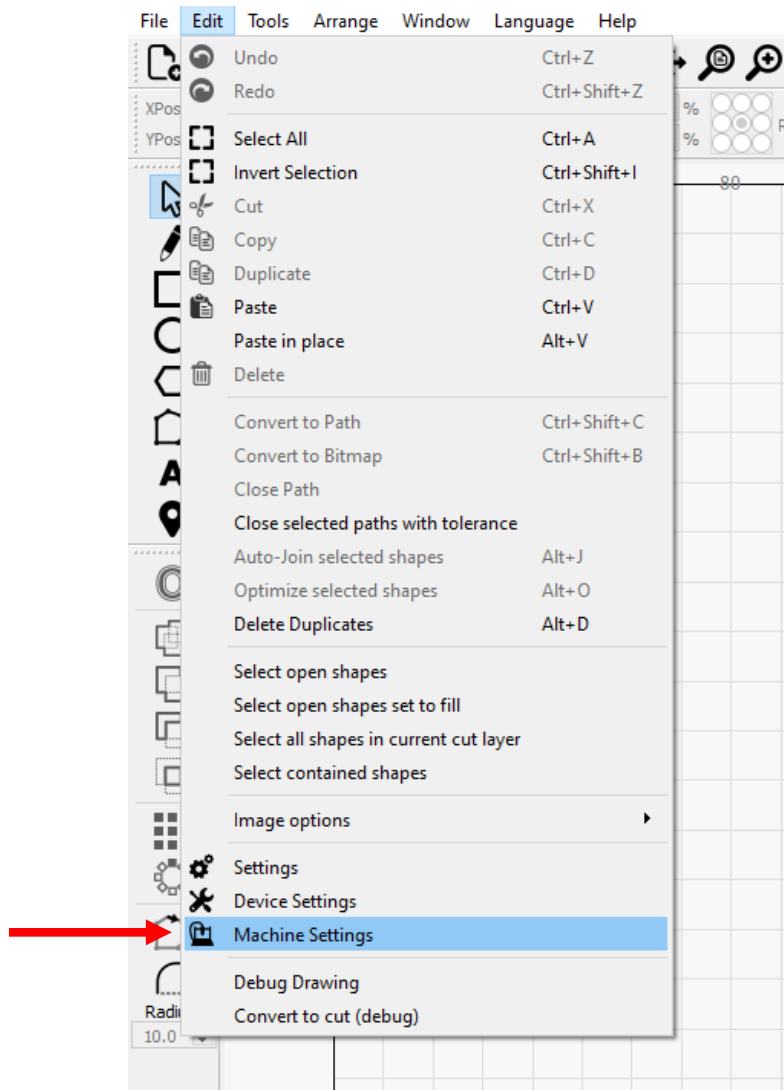
Machine Jog X & Y Direction Setup

Every board that ships have default machine settings for the jog direction. Depending on the motor wiring these may need to be adjusted. To adjust the jog direction, follow the steps below:

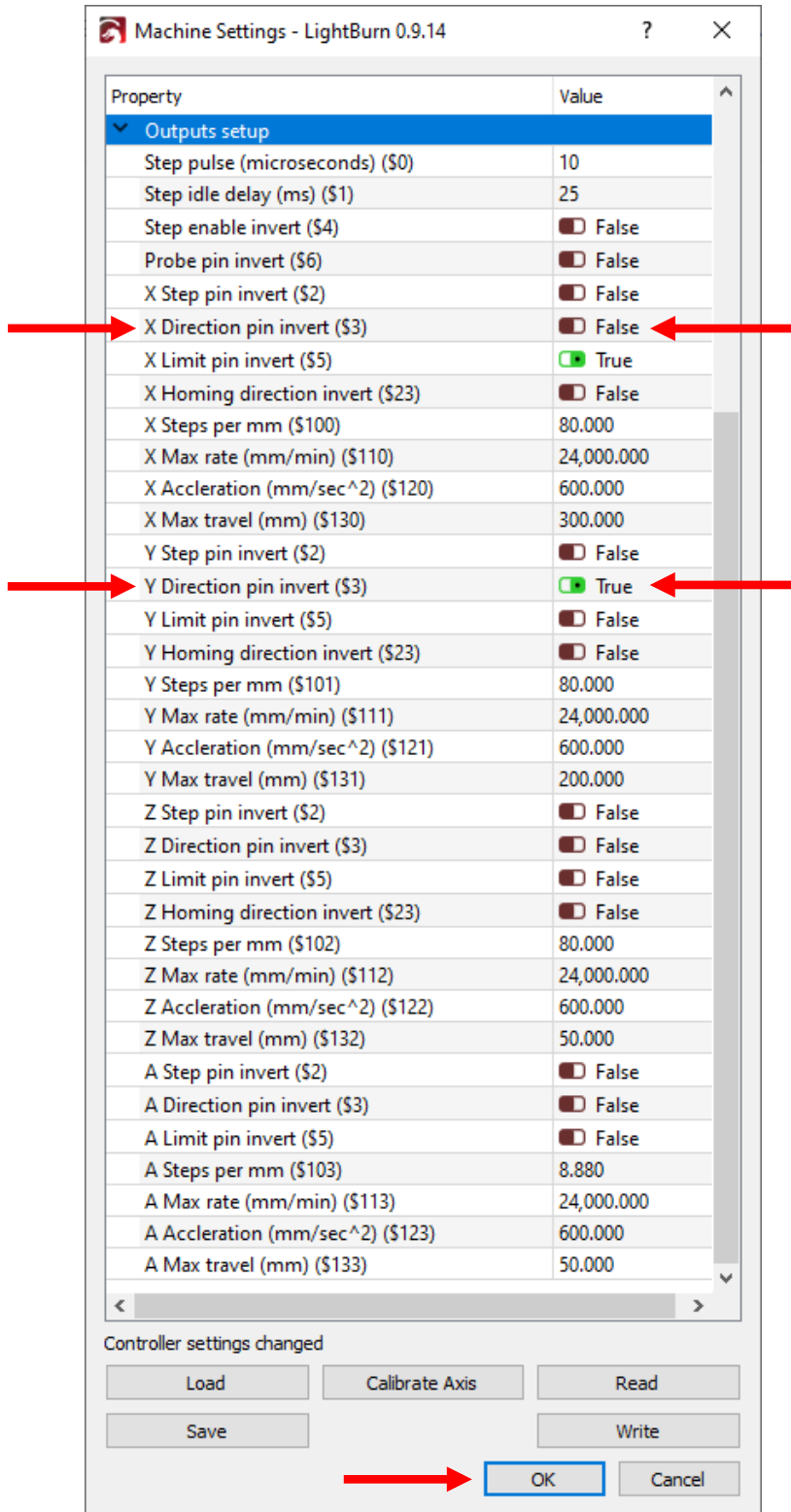
1. First locate the Move tab marked with the red arrow. Then jog the machine using the Left, Right, Up and Down direction buttons circled below. DO NOT jog the laser head in rapid succession or you may lock up the board. Wait for the laser head to complete each “jog” movement before pressing jog again. If the machine jogs in the wrong direction you will need to adjust the axis direction in the machine settings. The X-Axis is Left and Right jog. The Y-Axis is Up and Down jog.



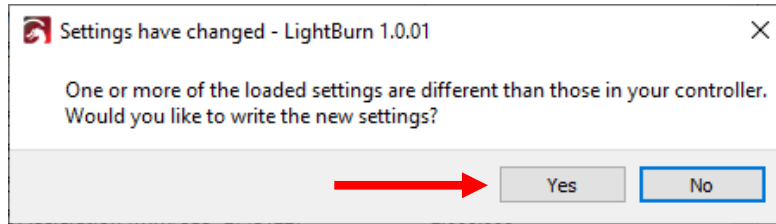
- If the X or Y axis direction is wrong you will need to change the settings for that axis. To change the machine settings, go to Edit and then Machine Settings as shown below:



- Once you click on Machine Settings a properties window will appear. Expand “Outputs setup” by double clicking on it. You will see the X Direction pin invert and Y Direction pin invert as shown below. To change the direction, click on the True or False switch. When you are finished making changes click OK:



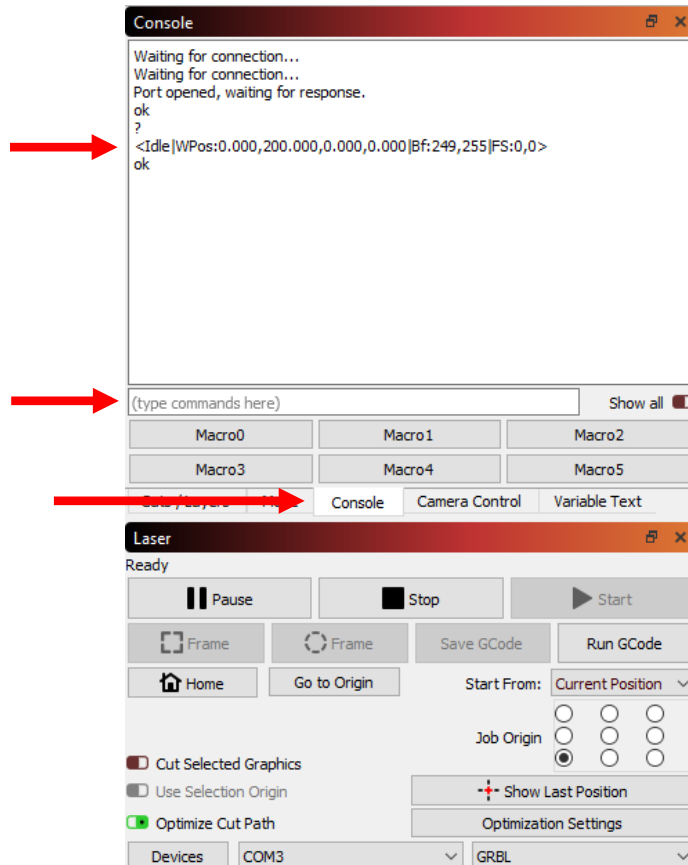
- Once you click OK you will see the Settings Changed window. Click Yes to write the new settings:



- Now go to the Move tab and jog the machine and see if the settings have corrected the jog direction. If the changes have fixed the jog direction you can now proceed to the next section. If the changes have not fixed the jog direction you may need to go back into the Machine Settings to make further changes. If you are having difficulty making these changes, please contact Vms for further assistance.

X & Y Limit Switch Testing

- In order for the laser engraver to home properly you need to ensure the limit switches are working properly. To get a status of the limit pins go to the Console tab and type "?" then press Enter as shown. If the limits are working properly, you should NOT see "Pn: X, Y or Z."



2. To test the X and Y limits you need to trip the photo sensor (commonly found in K40's with the white flat flex cable) with an opaque object in the slot OR press the mechanical micro switch (commonly found in some K40's and other laser engravers) for that axis one at a time ensuring the limit switch stays triggered then type "?" and press Enter. Run this test for the X and Y axis.

NOTE: If you have optical K40 limit sensors OR Normally Closed (NC) mechanical limit switches, the grbl setting \$5 should be 0. If you are using Normally Open (NO) mechanical limit switches, the grbl setting \$5 should be 1.

If you test the X-Axis Limit you should see this in the Console screen:

```
<Idle|WPos:0.000,200.000,0.000,0.000|Bf:249,255|FS:0|Pn:X>  
ok
```

If you test the Y-Axis limit you should see this in the Console screen:

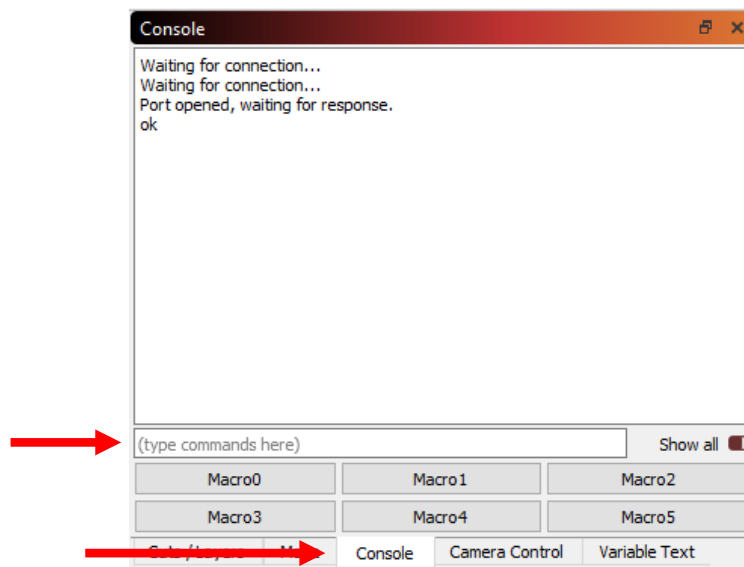
```
<Idle|WPos:0.000,200.000,0.000,0.000|Bf:249,255|FS:0|Pn:Y>  
ok
```

If both limits work proceed to the next section. If they do not work, contact Vms for further assistance.

Homing Direction Setup and Homing

To properly home the laser engraver we need to setup the homing direction. Since we have tested the limit switches in the last section, we can now check the homing direction and make changes if necessary. The way the homing sequence works for the LX4s board is the Z-Axis seeks and then feeds (if z-homing is enabled). If z homing is NOT enabled, X-Axis seeks then feeds first, then the Y-Axis seeks then feeds second.

1. We will setup the homing direction through the Console since LightBurn at this present time is having issues with their software. I will update this section once they release a version with the machine settings fixed. Here is the Console screen as shown below:



In order to adjust the homing direction, you will need to know where the home location is. For most laser engravers the homing location is in the Rear Left or the Rear Right. For custom laser engravers the homing location can also be located in the Front Left or even the Front Right. Below is a list of the different locations and the settings for those locations:

Rear Right \$23=0
 Rear Left \$23=1 (K40's uses this location)
 Front Right \$23=2
 Front Left \$23=3

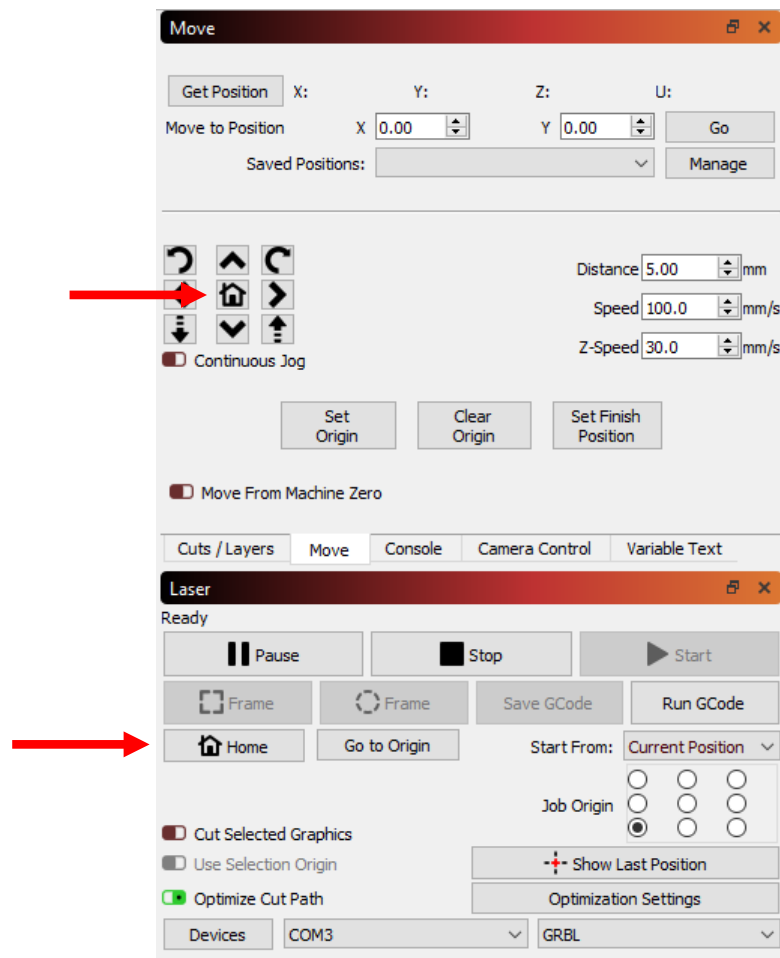
You will need to type for example: \$23=1 in the command field and press Enter. This will save the new homing location.

2. The homing feed and seek speed is intentionally set low so the machine can get an accurate zero point for the X and Y axis every time it homes. If you feel the homing seek speed is too slow this can be changed by:

Homing Feed Rate \$24=200.000 Default is set at 200mm/min = 3.34mm/sec
 Homing Seek Rate \$25=2000.000 Default is set at 2000mm/min = 33.34mm/sec

Note: Keep the homing feed speed at its default. If this value changes this could throw off the home position. If you need to increase the homing seek speed the recommended maximum would be 5000mm/min.

- Next, we need to home the laser engraver. There are two button locations one in the Move tab and one in the Laser section as shown below:



Click either button and observe the homing axis directions carefully. If the machine moves correctly and completes the homing cycle you can go to the next section.

If the X or Y axis go in the wrong direction shut down the laser immediately. Wait for about ten seconds and then turn the laser back on, check the settings and re-home.

If you are having trouble homing the machine and it stops midway either on the X or Y axis or just does not engage the limit switches as it is supposed to, adjust the Homing Cycle Interrupt Delay setting \$28 on page 46. By default, the Homing Cycle Interrupt Delay is set to 5. The Homing Cycle Interrupt Delay is a debounce time for the limit switches. This removes unwanted noise from the limit switch inputs if you have mechanical or optical limits.

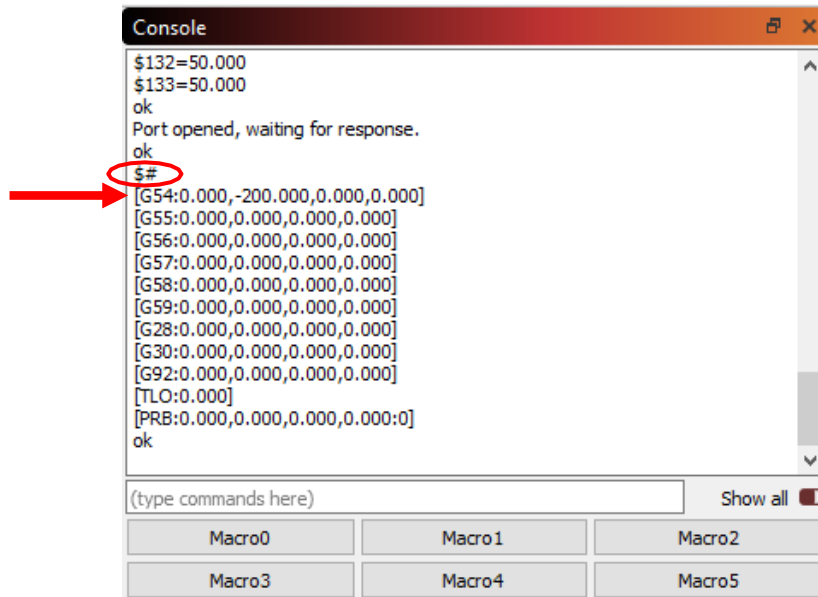
Another important setting is Homing Debounce setting \$26 on page 46. This is set by default to 250 milliseconds. If the homing cycle is too fast and does not complete properly you can increase this value to give the mechanical system time to engage the limit switch and pull off.

If you are still having difficulties homing your machine contact Vms for further assistance.

Workspace Offset Setup

In order for the LX4s board to work well with LightBurn the offsets have to be applied correctly. The LX4s board works like most CNC controllers and uses the positive and negative coordinate system. LightBurn uses positive workspace coordinates only. To get around this we need to apply offsets.

1. To view the current offsets, you need to go to the Console tab and type “\$#” then press Enter. You will see a list of offsets that look something like this:



In this particular instance we only want to use offset G54 from the list of offsets. Above is just an example. When the offsets have been cleared or if you are now setting up the offset for the first time the string should look like this:

```
[G54:0.000,0.000,0.000,0.000]
```

2. In order to enter the offset correctly it is important to note the homing location. The homing location affects where machine position and workspace position start / zero from. To give an example of how this affects the offset let's look at the different homing locations with a bed size of X=300mm Y=200mm:

Home Location:

Rear Right	X=300	Y=200
Rear Left	X=0	Y=200
Front Right	X=300	Y=0
Front Left	X=0	Y=0

As you can see when we setup the origin to the Front Left when we created the device in previous steps this affects the offset that needs to be applied.

- To apply the offsets, we will use the same example above. Find your home location (on the left) Rear Right, Rear Left, Front Right and Front Left. Pick ONLY ONE location and then enter the string to the right under Offset Command in the LightBurn Console command field then press Enter:

<u>Home Location:</u>		<u>Offset Command:</u>
Rear Right	→	G10 L2 P1 X-300 Y-200
Rear Left	→	G10 L2 P1 X0 Y-200
Front Right	→	G10 L2 P1 X-300 Y0
Front Left	→	No offset required

For the offset example above this can be applied to any bed size. For example:

X-Value = Total X travel value

Y-Value = Total Y travel value

G10 L2 P1 XX-Value YY-Value

Hint: *The bed size X and Y values were entered during Device Setup*

- Once the offset has been entered you will need to confirm it. To confirm the offset has been applied correctly, type “\$#” and press Enter. If for example you entered:

G10 L2 P1 X0 Y-200

You should see:

[G54:0.000,-200.000,0.000,0.000]

- If you make a mistake entering the offset values you can clear them. DO NOT re-write the value. It will ADD to the offset that has already been applied. To clear the offset, type this string in the command field:

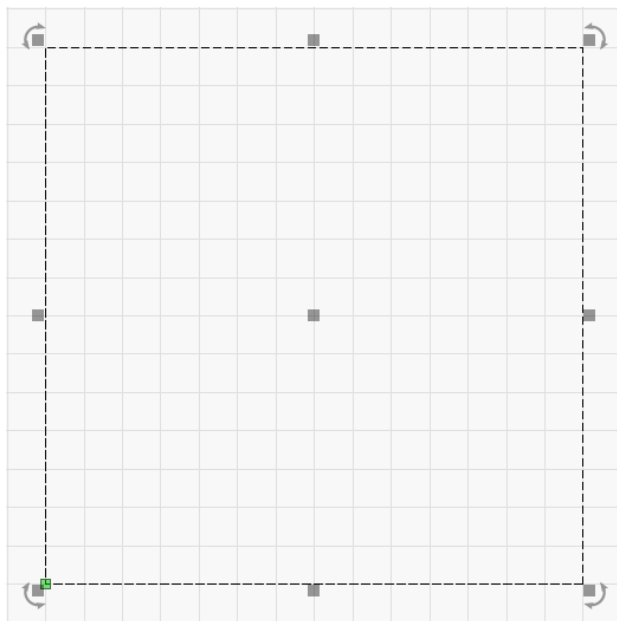
\$RST=# and press Enter

This will clear the offset. To confirm the offset has been cleared type “\$#” and press Enter.

Note: *If you're having trouble with the offsets or have questions contact Vms for further assistance.*

Steps per mm calibration for X and Y axes

The board is loaded with default values of 80.000 steps per mm for the X and Y axes. Most lasers use the 0.9° motors. If your motors are 1.8° then the default value needs to change to 40.000 steps per mm for the X and Y axes. You will have to calibrate your axes and to do this you will have to draw a large 140mm x 140mm square as shown in LightBurn:



Next lase the square and measure it in millimeters. Use this calculator to calibrate X and Y steps per mm:

<https://www.maxzprint.com.au/stepps-per-mm-calculator/>

Scroll to “STEPS PER MM CALIBRATOR” and enter the values. Then once you have the new steps per mm the new value may look something like this as an *example*:

EXAMPLE ONLY 78.9041095890411

You will need to truncate the result to 78.90 which is two digits after the decimal. If the digit count past the decimal is larger than two digits this will lead to unexpected results. Next go to Machine Settings or the console to update \$100 (X) and \$101 (Y).

Note: *If you're having trouble calibrating the axes or have questions contact Vms for further assistance.*

Laser Power Calibration Procedure

To calibrate the laser power properly there are several steps and settings that need to be adjusted. If you do NOT have a mA meter installed STOP! Do not continue this procedure until you install the mA meter in your laser. Pictured below is one mA meter that I suggest:



*This particular meter has an accuracy of 2.5 and can be purchased from Amazon.

Once you have purchased and installed the mA meter in your laser you can now continue on with the laser power calibration. The first thing that needs to be done is to set the laser power maximum so that laser power NEVER exceeds the laser tubes rated maximum power. Various tube wattages (W) are listed below with the current (mA):

40W	=	12mA
60W	=	15mA
80W	=	20mA
100W	=	22mA

The above current (mA) values are suggested values. ALWAYS check the laser tube label or speak to the laser tube manufacturer to get the maximum current (mA). Once the maximum laser tube current (mA) value has been determined, adjust the laser's digital panel, trim pot or \$37 (Laser Power Control) LX4 board setting and then press the test fire button on the laser's digital panel or directly on the laser power supply. Continue to adjust until the installed mA meter shows the maximum value you have determined above. Once this has been set this should not be changed unless it has drifted. You will need to periodically check the laser power to make sure it has not drifted over time. If it has drifted over time then you must re-adjust the maximum set value. The laser tube is a consumable product which means the gas inside the tube depletes and therefore the laser power may change over time.

\$35 and \$36 are set to default values and need to be adjusted to your laser tube current (ma) that was set above. \$35 is the laser PWM minimum value and this value is increased/decreased to close gaps in vector lines such as corners or other gaps where the laser comes to a stop and then transitions to the next line. The \$35 value is typically low for example 1 or maybe 5. This depends on your laser and needs to be adjusted so that the gaps are closed but does not create over burn during the transition. \$35 will affect the results of the test card and laser power calibration so set this value as low as possible.

The \$36 laser PWM maximum is adjusted based on the maximum laser tube current (mA) set above. You will need the Vms Test Card to adjust the \$36 value. Currently there are four test cards 40W, 60W, 80W and 100W. Please contact Vms if you have a laser tube wattage (W) not shown. To calibrate the laser power, \$36 must be increased/decreased so that ALL of the values to the right in (mA) line up as shown in the red box below (Example 1B). For example, if you have a K40 and the laser tube is 40W then the range in current is 12mA - 0.24mA. Keep in mind the mA meter itself has a tolerance of 2.5 so the values may be a little off but within the mA meter's tolerance. Adjust \$36 so that ALL values get as close as possible as shown on the test card (Example 1B). You may need to run the test card job several times to find the best values. To save on material keep lasing over the same area. You are not looking for the best quality engraving just the mA meter results. By decreasing the \$36 value you will start to see the values come into range.

Keep adjusting \$36 down until ALL mA values mostly line up. Some laser power supplies will not fire below 10 - 20%. The best way to run the calibration is to write down the values as the laser progresses through the lines. Shown below is an example (Example 1A) of what I have done. \$36 was set to 21 and \$35 was set to 1 on my K40:

Example 1A:

<u>PWR%</u>	<u>mA Target</u>	<u>mA Actual</u>
100	12	10
90	10.8	9.5
80	9.6	9
70	8.4	8.5
60	7.2	8
50	6	7
40	4.8	6
30	3.6	4
20	2.4	3
10	1.2	1.5
8	0.96	1
6	0.72	Did not lase
4	0.48	Did not lase
2	0.24	Did not lase

Your results will differ from mine but at least you will have an idea of what I have done to set \$35 and \$36 values to achieve the results shown above. Note: Your results will differ and may or may not be as accurate as my values above. This is ok. The mA meter has a tolerance of 2.5 and it is OK if the values are a little off. As long as all the values scale within the range it will be fine. Shown below is the 40W test card example with the mA range in the red box:

Example 1B:

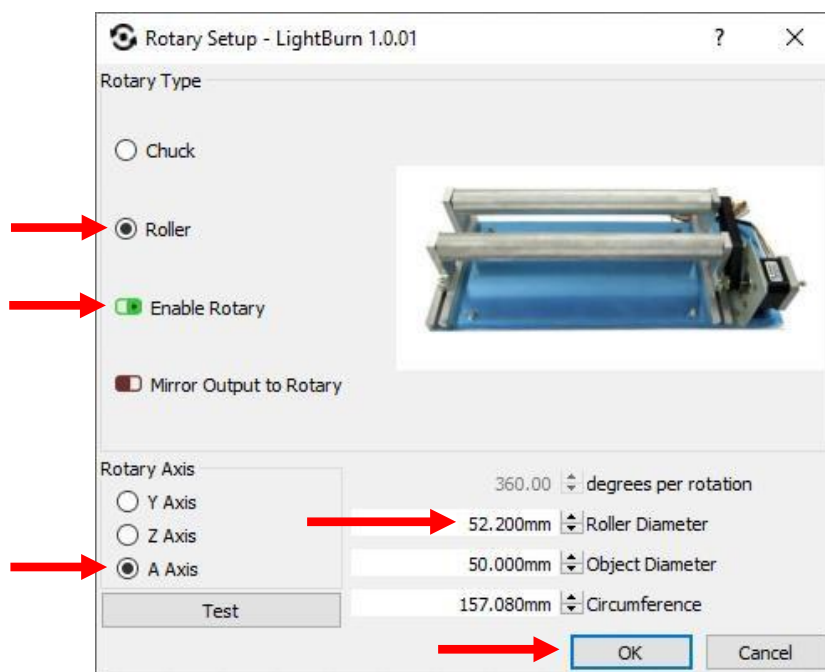


Note: If you're having trouble calibrating laser power or have questions contact Vms for further assistance.

Rotary Setup and Use

1. If the rotary is NOT connected to the LX4s board, turn off the 24V power supply by switching off the power strip or removing power from the AC connector side only. DO NOT disconnect the power supply from the DC jack on the LX4s board if the 24V power supply is on.
2. Connect the rotary to the A-axis as mentioned in the Hardware Installation section of this manual.
3. Turn on the 24V power supply by switching on the power strip or connecting the AC power cord to the power supply. The DC plug should be connected before applying power to the 24V power supply.
4. Open LightBurn if not already open.
5. Go to Tools and then Rotary Setup. Select Roller, Enable Rotary, select the A-axis and then enter the Roller Diameter which should be 52.200mm for V1, V2 or V3 rotaries from HM Laser Accessories (Randy Smith) and then click OK.

Hint: Draw a long rectangle 100mm x 10mm, lase it and measure it with a flexible fabric ruler. Then adjust the roller diameter until the length of the rectangle is 100mm. Adjust in small increments.



6. Go to Edit and then Machine Settings to change (\$103) A-Axis Steps per mm to either of the underlined values below:

8.88, 1.8° 200 Steps per rotation motor or 17.78, 0.9° 400 Steps per rotation motor

Note: If you have a custom rotary, having trouble setting up the rotary or have questions contact Vms for further assistance.

Z-Bed Setup and Use

The Z-Bed is custom and requires building or purchasing one. There are quite a few designs on the internet for the K40 and can be scaled up or down to suit your particular bed size. One z-bed that I recommend is:

https://gitlab.com/armoredblood/lazr_bed

This design is very well documented and has a bill of material to order parts.

The LX4s board Z-axis default is $5102 = 400.000$ steps per mm. This default is for the above referenced z-bed.

If you have a different z-bed you will need to calculate and calibrate the steps per mm. Use the calculator found here:

<https://www.maxzprint.com.au/stepps-per-mm-calculator/>

To calculate steps per mm scroll to the bottom of the page to “STEPS PER MM CALCULATOR FOR LEAD SCREWS”

To calibrate steps per mm scroll to “STEPS PER MM CALIBRATOR”

Note: If you have a custom z-bed, having trouble setting up the z-bed or have questions contact Vms for further assistance.

Going further

Congratulations you have successfully setup the LX4s Board with LightBurn! You are now ready to explore the LX4s board's capabilities.

If you have technical related questions or issues regarding the use of LightBurn there is a technical support forum which can be found here:

<https://forum.lightburnsoftware.com>

Or you can learn more about how to use LightBurn through videos on YouTube!!

<https://youtube.com>

Troubleshooting LX4 Board and LightBurn

1. Board does not connect to LightBurn

- Ensure the USB cable is fully plugged into the computers USB port and the board.
- Ensure the power supply is plugged in and powered. Check and make sure the DC connector is fully plugged into the board.
- Check that the com port is set correctly.

2. Com port numbers change when the computer starts up or restarts.

- Unplug and then plug in the USB cable to reset the connection. This can be done on either end of the cable. Currently working on a program to write registry values to make the com ports “static”. Contact Vms for further details if you have this issue.

3. Laser Engraver moves too fast in between cuts, engraving sections or start and end of a job

- Lower the X and Y Axis Max rate by 5 to 10% increments until the speed is satisfactory.
- Lower the X and Y Acceleration by 5 to 10% increments until the speed is satisfactory.

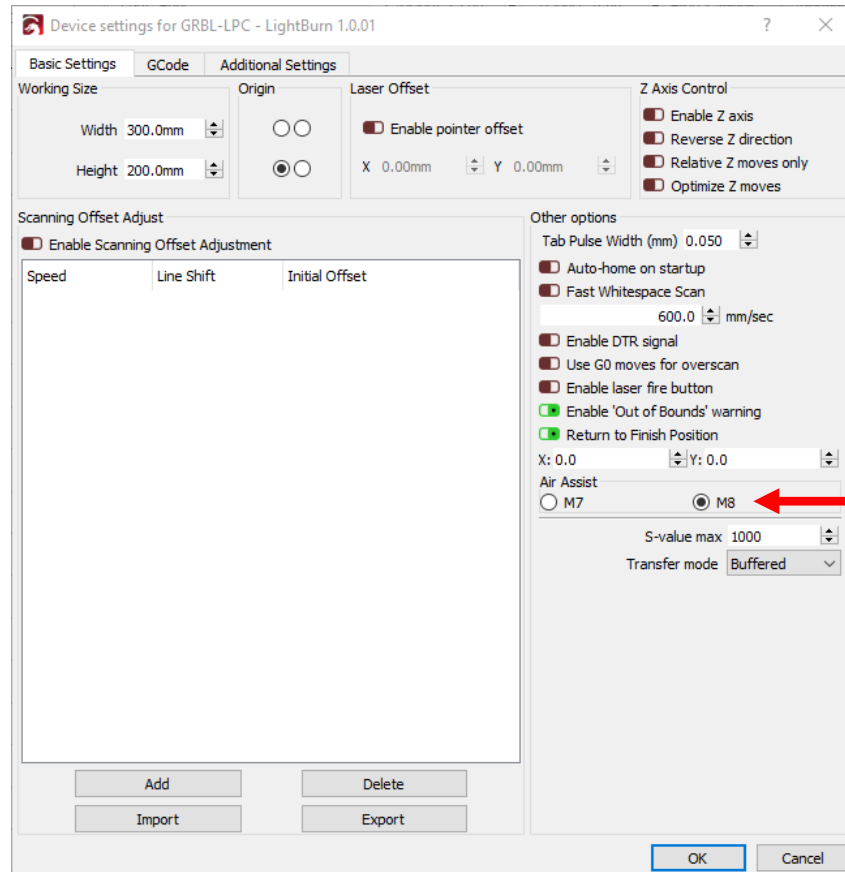
4. LX4 board is unresponsive and status bar is green with “Busy”

- Right click on “Devices” button in the Laser section to do a soft reset of the LX4 board or press the reset button located next to the power connector on the board.

The above list is actively updated. In most cases doing a soft reset or doing a complete power cycle fixes most issues. If you do not see the issue you are having above contact Vms for further assistance.

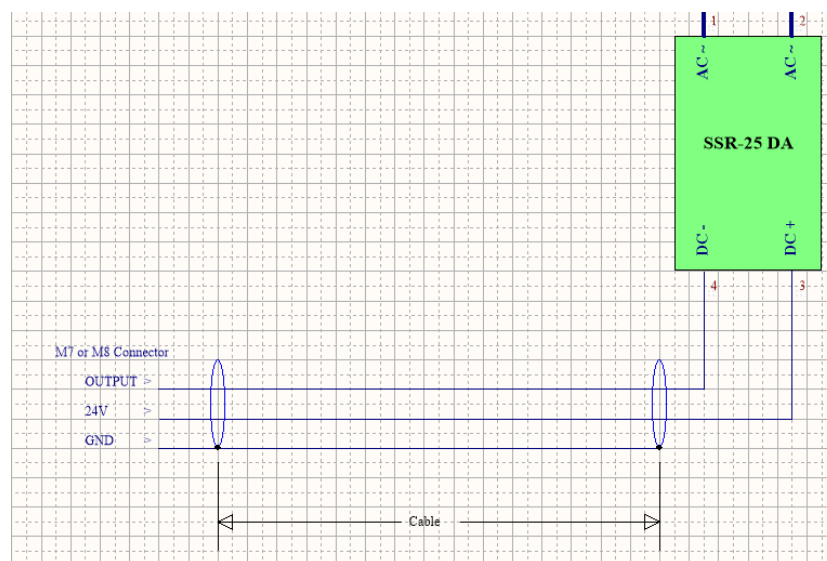
M7 & M8 Solid State Relay Control Outputs

The LX4s board has two solid state relay outputs to control air assist, exhaust fan, auxiliary device or function. You can control M7 or M8 through LightBurn for automatic air assist. To set M7 or M8 go to LightBurn Device Settings and choose which one you would like to use:



NOTE: You can also test M7 and M8 through the LightBurn console. M7 or M8 turns on (switches the mosfet to a low level) and M9 turns both M7 and M8 off (switches the mosfets to a high level)

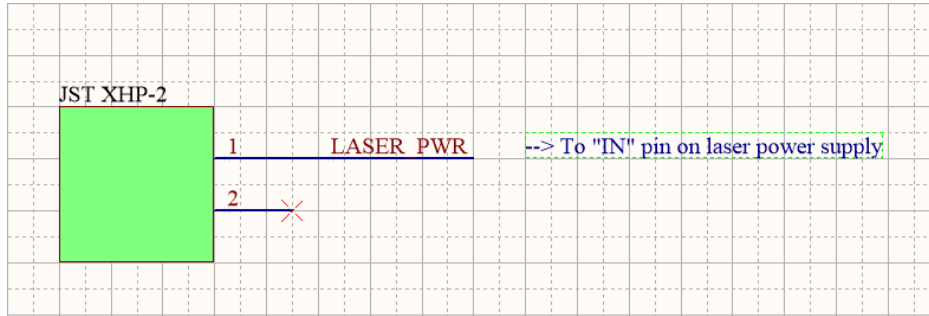
Below is a sample connection to these two connectors and to the solid-state relay:



The solid-state relay used in the diagram is the Fotek SSR-25 DA. Another similar solid-state relay that can be used is the TWTADE SSR-25DA. Both of these solid-state relays can control AC loads. If you need to control a DC load, use the TWTADE SSR-25DD. Both TWTADE SSR-25DA and TWTADE SSR-25DD come with a heatsink. The Fotek SSR-25 DA requires a heatsink. All of these solid-state relays can be found on Amazon.

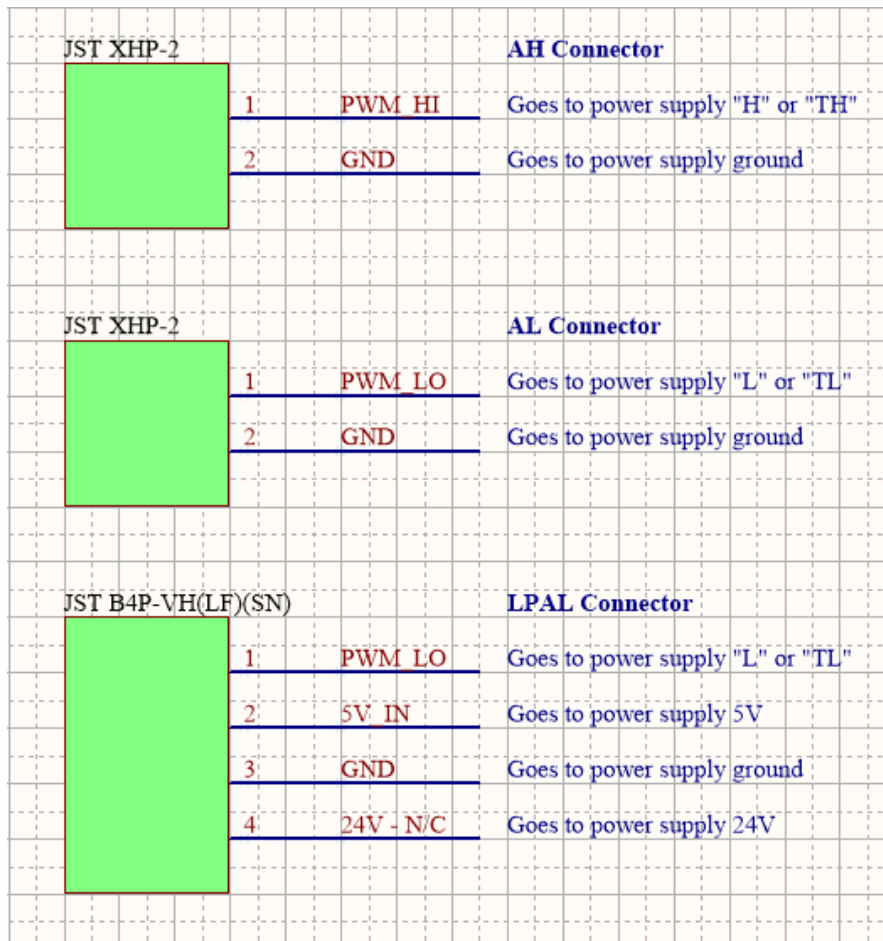
Laser Power Control Output

The laser control output connector LP is controlled by a grbl setting \$37 and can be accessed through the LightBurn console. Each board comes with a red cable assembly PN: 120096. Refer to *** \$37 Laser Power Control below for more information.



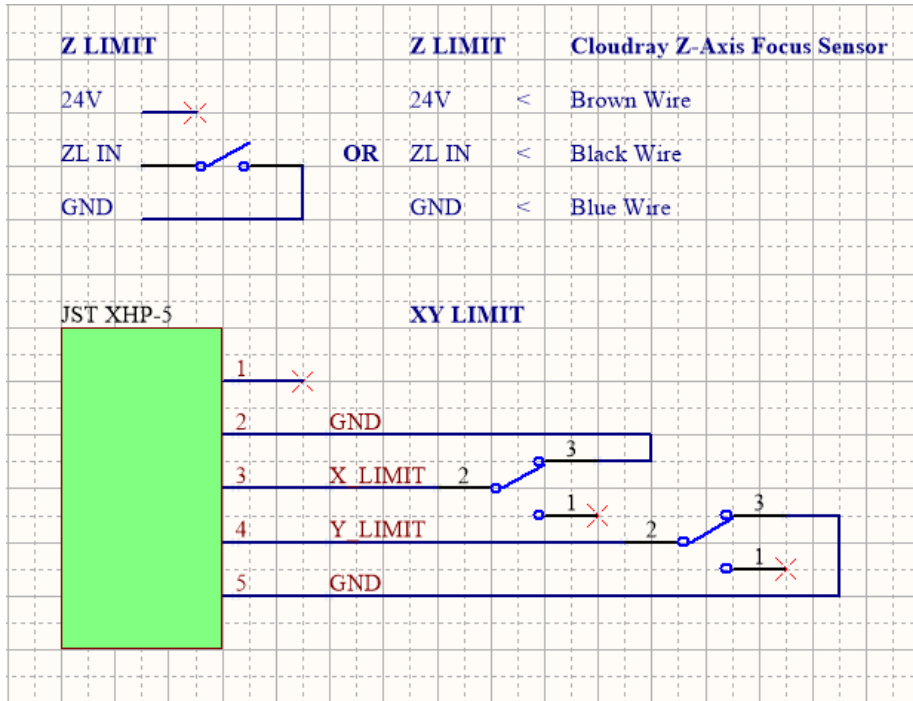
Laser Power Supply and Laser PWM Control Output

The laser power supply and pwm control output connectors LPAL, AL and AH provide the pwm signals and the power input to the LX4s board. Depending on the laser connection type in the hardware setup some of these connectors are not used. The connections are shown below:



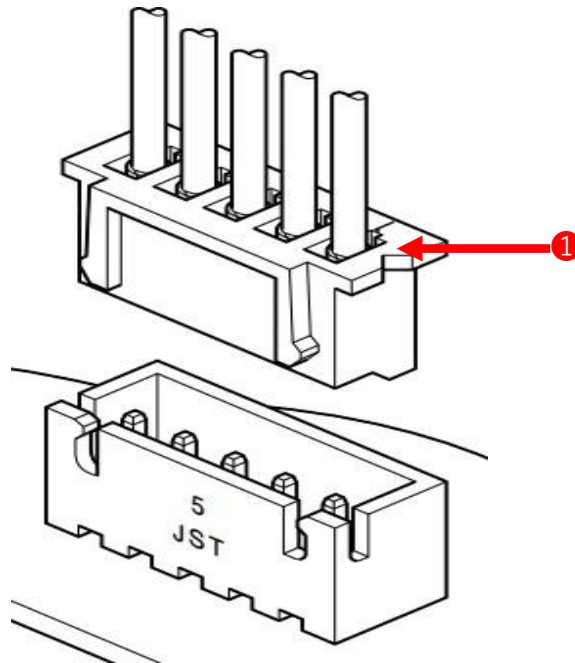
X, Y & Z Limit Inputs

The LX4s Board has X, Y and Z limit inputs and they are on connectors XY LIMIT and Z LIMIT. The connections are wired as shown below:



JST XHP Connectors and Part Numbers

The LX4 Board uses the JST type XHP style connectors for its interconnect standard. There are other Chinese brands that can be purchased from Amazon if desired to terminate your own cables. Below is an example of the XHP connector and the pin #1 mark. The pin #1 mark is the same for the 2, 3, 4, 5, and 6 pin housings:



The housings used on the LX4 board are 2, 3, 4, 5 and 6 positions. The following JST part numbers are below:

2 position - XHP-2	Digi-Key Part #: 455-2266-ND
3 position - XHP-3	Digi-Key Part #: 455-2219-ND
4 position - XHP-4	Digi-Key Part #: 455-2267-ND
5 position - XHP-5	Digi-Key Part #: 455-2268-ND
6 position - XHP-6	Digi-Key Part #: 455-2218-ND

Recommended crimp contacts: SXH-001T-P0.6N

Digi-Key Part #: 455-4220-1-ND

Or you can buy a connector kit from Amazon:

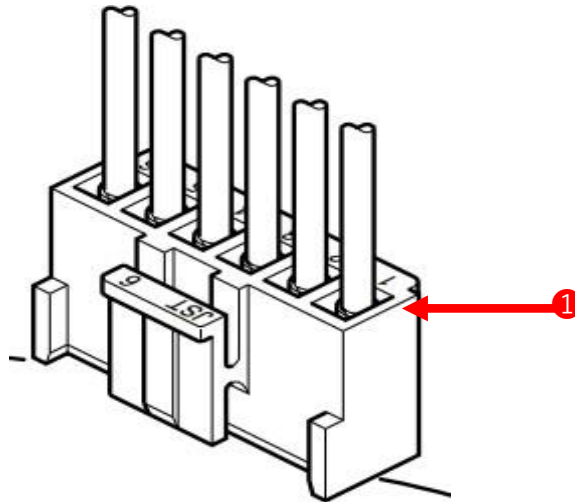
[GeeBat 460pcs 2.54mm JST-XH Female Pin Header 2/3/4/5/6 Pin Housing](#)

You will also need a crimper which can be purchased from Amazon as well:

[Engineers Precision Crimping Pliers PA-09](#)

JST VHR Connector and Part Number

The LX4 Board uses the JST type VHR style connector for the four-pin power and PWM signal. There are other Chinese brands that can be purchased from Amazon if desired to terminate your own cables. Below is an example of the VHR connector and the pin #1 mark:



The housing used on the LX4 board is the 4-position version. The following JST part numbers are below:

4 position - VHR-4N Digi-Key Part #: 455-1185-ND

Recommended crimp contacts: BVH-21T-P1.1 Digi-Key #: BVH-21T-P1.1-ND

You will also need a crimper which can be purchased from Amazon:

[IWISS SN-28B Crimping Tool](#)

NOTE: Since this housing and the crimp contacts usually come with the laser and the power supply wiring is already terminated this is mostly not required but in rare cases this is needed to use the LX4 board.

GRBL Settings and Definitions

The LX4s Board has a custom version of GRBL. Always make changes to the grbl settings from this list only and not from another source off the internet. To access the settings, go to the LightBurn console and type: `$S` then press enter. To reset settings to default: `$RST=$` then press enter.

\$3=0	Direction Invert	0 = X (NO) Y (NO) Z (NO) A (NO) 1 = X (YES) Y (NO) Z (NO) A (NO) 2 = X (NO) Y (YES) Z (NO) A (NO) 3 = X (YES) Y (YES) Z (NO) A (NO) 4 = X (NO) Y (NO) Z (YES) A (NO) 5 = X (YES) Y (NO) Z (YES) A (NO) 6 = X (NO) Y (YES) Z (YES) A (NO) 7 = X (YES) Y (YES) Z (YES) A (NO) 8 = X (NO) Y (NO) Z (NO) A (YES) 9 = X (YES) Y (NO) Z (NO) A (YES) 10 = X (NO) Y (YES) Z (NO) A (YES) 11 = X (YES) Y (YES) Z (NO) A (YES) 12 = X (NO) Y (NO) Z (YES) A (YES) 13 = X (YES) Y (NO) Z (YES) A (YES) 14 = X (NO) Y (YES) Z (YES) A (YES) 15 = X (YES) Y (YES) Z (YES) A (YES)
\$5=0	Limit Pins Invert	Default 0. 1 = Enable XY invert, 0 = Disable XY invert
\$6=0	Probe Pin Invert	DO NOT CHANGE. Not applicable in this version
\$10=2	Status Report	1 = Machine Position 2 = Work Position 4 = Planner Buffer 8 = RX Buffer 16 = Limit Pins
\$11=0.010	Junction Deviation (mm)	DO NOT CHANGE. Default 0.010
\$12=0.002	Arc Tolerance (mm)	DO NOT CHANGE. Default 0.002
\$13=0	Feedback Units	DO NOT CHANGE. 1 = Inches, 0 = Millimeters
\$20=0	Soft Limits	DO NOT CHANGE. 1 = Enable, 0 = Disable
\$21=0	Hard Limits	DO NOT CHANGE. 1 = Enable, 0 = Disable
\$22=1	Homing Cycle	DO NOT CHANGE. 1 = Enable, 0 = Disable
\$23=1	Homing Cycle Direction	0 = Rear Right 1 = Rear Left 2 = Front Right 3 = Front Left
\$24=200.000	Homing XY Feed (mm/min)	Default 200.000, Maximum 800.000
\$25=2000.000	Homing XY Seek (mm/min)	Default 2000.000, Maximum 2250.000
\$26=250	Homing Debounce (msec)	DO NOT CHANGE. Default 250msec
\$27=5.000	Homing XY Pull-off (mm)	Default 4mm, Maximum 255mm
\$28=5	Homing Cycle Interrupt Delay	0 = 1 Clock Cycle (100 µS) 1 = 2 Clock Cycles (200 µS) 2 = 4 Clock Cycles (400 µS) 3 = 8 Clock Cycles (800 µS) 4 = 16 Clock Cycles (1.6 mS) 5 = 32 Clock Cycles (3.2 mS) 6 = 64 Clock Cycles (6.4 mS) 7 = 128 Clock Cycles (12.8 mS) 8 = 256 Clock Cycles (25.6 mS) 9 = 512 Clock Cycles (51.2 mS) 10 = 1024 Clock Cycles (102.4 mS)
\$30=1000	Laser PWM Maximum	DO NOT CHANGE. Default 1000
\$31=1	Laser PWM Minimum	DO NOT CHANGE. Default 1
\$32=1	Laser Mode	DO NOT CHANGE. 1 Enable, 0 = Disabled
\$33=20000	Laser PWM Frequency	Change to suit your laser power supply frequency
\$34=0.0	Laser PWM off value	DO NOT CHANGE. Default 0
\$35=0.0	Laser PWM minimum value	*Default 0.0. See notes below
\$36=100.0	Laser PWM maximum value	**Default 100.0. See notes below
\$37=0.0	Laser Power Control	***Default 0.0. See notes below

\$38=100.0	Laser PWM Override/Shift	****Default 100.0. See notes below
\$39=0	Y Slave Enable	Default 0 Normal, 1 = Y Slave Z, 2 = Y Slave A
\$40=0	Axis Lock/Freewheel	****Default 0. 1 = Axis Lock, 0 = Freewheel
\$41=0	Homing Z-Axis Enable	Default 0. 1 = Enable, 0 = Disable
\$42=5.000	Homing Z Pull-off (mm)	Default 4mm, Maximum 255mm
\$43=200.000	Homing Z Feed (mm/min)	Default 200.000, Maximum 800.000
\$44=2000.000	Homing Z Seek (mm/min)	Default 2000.000, Maximum 2250.000
\$50=16	X-Driver IRUN Current	Default 16, Maximum 32
\$51=16	Y-Driver IRUN Current	Default 16, Maximum 32
\$52=16	Z-Driver IRUN Current	Default 16, Maximum 32
\$53=16	A-Driver IRUN Current	Default 16, Maximum 32
\$54=8	X-Driver IHOLD Current	Default 8, Maximum 32
\$55=8	Y-Driver IHOLD Current	Default 8, Maximum 32
\$56=8	Z-Driver IHOLD Current	Default 8, Maximum 32
\$57=8	A-Driver IHOLD Current	Default 8, Maximum 32
\$58=2	X-Driver IHOLD Delay	Default 2, Maximum 15
\$59=2	Y-Driver IHOLD Delay	Default 2, Maximum 15
\$60=2	Z-Driver IHOLD Delay	Default 2, Maximum 15
\$61=2	A-Driver IHOLD Delay	Default 2, Maximum 15
\$100=80.000	X-Axis (steps/mm)	80.000, 0.9° 400 SPR 40.000, 1.8° 200 SPR
\$101=80.000	Y-Axis (steps/mm)	80.000, 0.9° 400 SPR 40.000, 1.8° 200 SPR
\$102=400.000	Z-Axis (steps/mm)	400.000, 0.9° 400 SPR 200.000, 1.8° 200 SPR
\$103=8.88	A-Axis (steps/mm)	17.78, 0.9° 400 SPD 8.88, 1.8° 200 SPD
\$110=24000.000	X-Axis Max Rate (mm/min)	*****Default 60000. See notes below
\$111=24000.000	Y-Axis Max Rate (mm/min)	*****Default 60000. See notes below
\$112=24000.000	Z-Axis Max Rate (mm/min)	*****Default 60000. See notes below
\$113=24000.000	A-Axis Max Rate (mm/min)	*****Default 60000. See notes below
\$120=2000.000	X-Axis Max Accel (mm/sec ²)	*****Default 2000. See notes below
\$121=2000.000	Y-Axis Max Accel (mm/sec ²)	*****Default 2000. See notes below
\$122=2000.000	Z-Axis Max Accel (mm/sec ²)	*****Default 2000. See notes below
\$123=2000.000	A-Axis Max Accel (mm/sec ²)	*****Default 2000. See notes below
\$130=300.000	X-Axis Max Travel (mm)	Default: 300.000. Adjust this value to your bed size
\$131=200.000	Y-Axis Max Travel (mm)	Default: 200.000. Adjust this value to your bed size
\$132=50.000	Z-Axis Max Travel (mm)	Default: 50.000. Adjust this value to your z bed size
\$133=360.000	A-Axis Max Travel (Degree)	Default: 360.000 degrees. DO NOT CHANGE

** \$35 Laser PWM minimum value

This sets the laser PWM minimum value in a percentage between 0 to 100%. If this value is set to zero then the laser PWM turns off prematurely leaving gaps in corners or in text. This setting is beneficial for vector engraving or cutting. Since the laser power supply is different for every machine this value needs to be adjusted to suit your requirements. Start at a low value like 2.0 and increase this value until you see the gaps close. Once the gap closes adjust a bit higher but not too high where you see it over burning in the corners. See the “Laser Power Calibration Procedure” section for more information. This value supports fractional percentages. For example: 4.2, 5.7 etc.

*** \$36 Laser PWM maximum value

This sets the laser PWM maximum value in a percentage between 0 to 100%. This value is adjusted based on the Vms Test Card created to calibrate laser power. The Test Card comes in different power levels and must be specified at the time of order. See the “Laser Power Calibration Procedure” section for more information. This value supports fractional percentages. For example: 4.2, 5.7 etc.

**** \$37 Laser Power Control

This sets the laser power control in a percentage between 0 to 100%. For example, if the laser power is set to 0% = 0V, 50% = 2.5V and 100% = 5V. The laser power is adjustable to any range in between 0 and 100% with fractional percentages supported which means you can write for example 42.6% laser power. **WARNING:** This function must be set properly and it is recommended to check this value often to ensure the laser power is at the optimal level. The laser power is a MAXIMUM setting and the laser power must never go beyond 16mA or the tube life will be shortened. It is recommended to get an analog milliamp meter to check the power output from the tube.

***** \$38 Laser PWM Override/Shift

This sets the laser PWM override or shift in an integer range between 0 to 255. This feature should only be used when going beyond 300mm/sec. This value shifts the laser PWM value higher or lower to compensate for the throttling effect as you go faster or slower in speed. Typically, GRBL will make the burn lighter at higher speeds and this compensates for that.

***** \$40 Axis Lock / Freewheel

This turns **ON (1)** axis locking which leaves the stepper drivers enabled ignoring GRBL to “lock” the axes when idle or turns **OFF (0)** to allow GRBL to control the stepper drivers enable. If the axis lock is **OFF** the axes are not locked while idle. DEFAULT is 0 which is **OFF**.

***** \$110, \$111, \$112, \$113 - [X, Y, Z & A Axis] Max Rate Explanation

ATTENTION: The DEFAULT is set to the MAXIMUM the board can go. You will need to adjust this to your stepper motors and mechanics of your laser.

This sets the maximum rate each axis can move. Whenever GRBL plans a move, it checks whether or not the move causes any one of these individual axes to exceed their max rate. If so, it'll slow down the motion to ensure none of the axes exceed their max rate limits. This means that each axis has its own independent speed, which is extremely useful for limiting the typically slower Z-axis.

The simplest way to determine these values is to test each axis one at a time by slowly increasing max rate settings and moving it. For example, to test the X-axis, send GRBL something like G0 X50 with enough travel distance so that the axis accelerates to its max speed. You'll know you've hit the max rate threshold when your steppers stall. It'll make a bit of noise, but shouldn't hurt your motors. Enter a setting a 10-20% below this value, so you can account for wear, friction, and the mass of your workpiece/tool. Then, repeat for your other axes.

NOTE: This max rate setting also sets the G0 seek rates.

***** \$120, \$121, \$122, \$123 - [X, Y, Z & A Axis] Max Acceleration Explanation

ATTENTION: The DEFAULT is set to the 2000 for each axis. You will need to adjust this to your stepper motors and mechanics of your laser.

This sets the axes acceleration parameters in mm/second/second. Simplistically, a lower value makes GRBL ease slower into motion, while a higher value yields tighter moves and reaches the desired feed rates much quicker. Much like the max rate setting, each axis has its own acceleration value and are independent of each other. This means that a multi-axis motion will only accelerate as quickly as the lowest contributing axis can.

Again, like the max rate setting, the simplest way to determine the values for this setting is to individually test each axis with slowly increasing values until the motor stalls. Then finalize your acceleration setting with a value 10-20% below this absolute max value. This should account for wear, friction, and mass inertia. We highly recommend that you dry test some G-code programs with your new settings before committing to them. Sometimes the loading on your machine is different when moving in all axes together.

Revision History

Revision	Description of Change
1a	Initial Release
1b	Changed \$120, \$121, \$122, \$123 acceleration values to 2000.000
1c	Updated the GRBL settings and added a new menu command "\$S". Added Laser Power Calibration section. Changed the order of the XY calibration and laser power calibration sections so it flows with the rest of the manual.
1d	Changed the wording for homing location, changed 80W mA to 20 and made some other small textual changes.
1e	Added Homing Cycle Interrupt Delay and updated other parameters. Made some other small textual changes.
1f	Changed CH340 driver setup to CP2102. Adjusted the MAX RATE speed to 24000 from 60000 in the grbl settings list.