INSTRUCTION MANUAL – GRBL CNC CONTROLLER

Version: 1.2

CONTENTS

GENERAL

OVERVIEW

This breakout board is designed to work with the popular GRBL open source firmware for controlling CNC and laser machines. We have been very involved in the evolution of GRBL and this shield/breakout board is a simple and effective way to control a machine with GRBL. It offers easy to connect pinout for all signals and JST connectors for the more well used signals.

The board has these features:

- 4 Standard stepper board pinout carriers.
- Ability to select clone axis for multiple motor use.
- Noise suppression limit switch connections.
- Screw terminal and JST connectors for easy hookup.
- Reset select for either GRBL reset or Arduino Reset.
- Works with GRBL 1.1f and Laser Mode

The board has 4 slots for stepper drivers. It comes included with DRV8825 stepper drivers using the Texas Instruments DRV8825 motor driver chip.

Stepper Driver Features:

- 45 V maximum supply voltage
- Six different step resolutions: full-step, half-step, 1/4-step, 1/8-step, 1/16-step, and 1/32-step
- Adjustable current limit setting with potentiometer
- Over-temperature thermal shutdown, over-current shutdown, and under-voltage lockout
- Short-to-ground and shorted-load protection

SPECIFICATIONS

Specification	
Minimum Operating Voltage	8.2V
Maximum Operating Voltage	45V
Continuous Current Per Phase	1.5 amps
Maximum Current Per Phase	2.2 amps
Current Limit Adjustment	Analog Trim Pot
Microstep Resolutions	Full, 1/2, 1/4, 1/8, 1/16, and 1/32
Connectors:	Screw Terminal and JST PH Connectors
Operating Temperature:	0 to 40 °C
Storage Temperature:	-40 to 70 °C
Dimensions:	3.25” x 2.25”

SAFETY

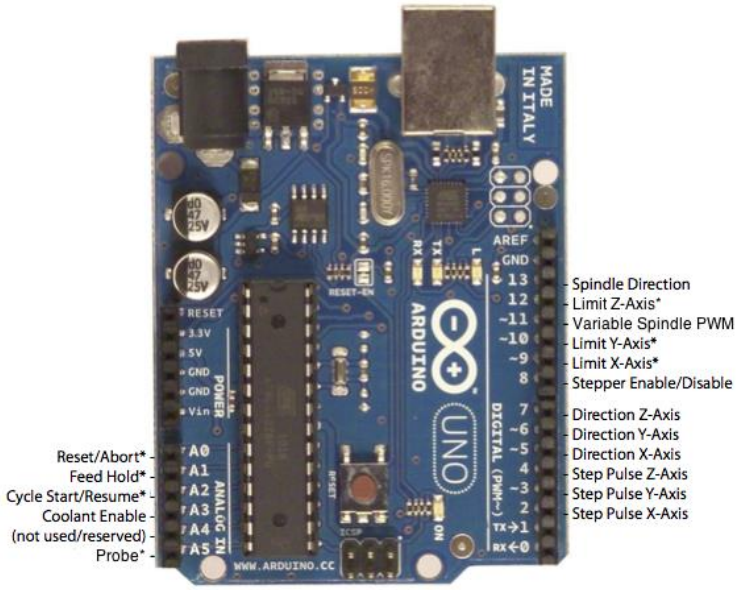
- Operate the GRBL Shield - Breakout Board in an explosion free area.
- The GRBL Shield - Breakout Board may reach high temperatures under operation. Make sure there is adequate airflow to the Driver Board. Also, make sure there is adequate protection around the Driver Board and that it is not in contact with other materials.

DISCLAIMER

- The GRBL Shield - Breakout Board is designed as an OEM product to be integrated into a final solution.
- All statements of safety are only applied when the driver board is used in its intended purpose.
- You are legally responsible for any injury to anybody resulting from the use of or assembly of the GRBL Shield - Breakout Board or their finished products.
- You Accept this driver board as a COMPONENT for integration in a system of YOUR OWN design and will be legally responsible from any and all LIABILITIES.

CONNECTIONS

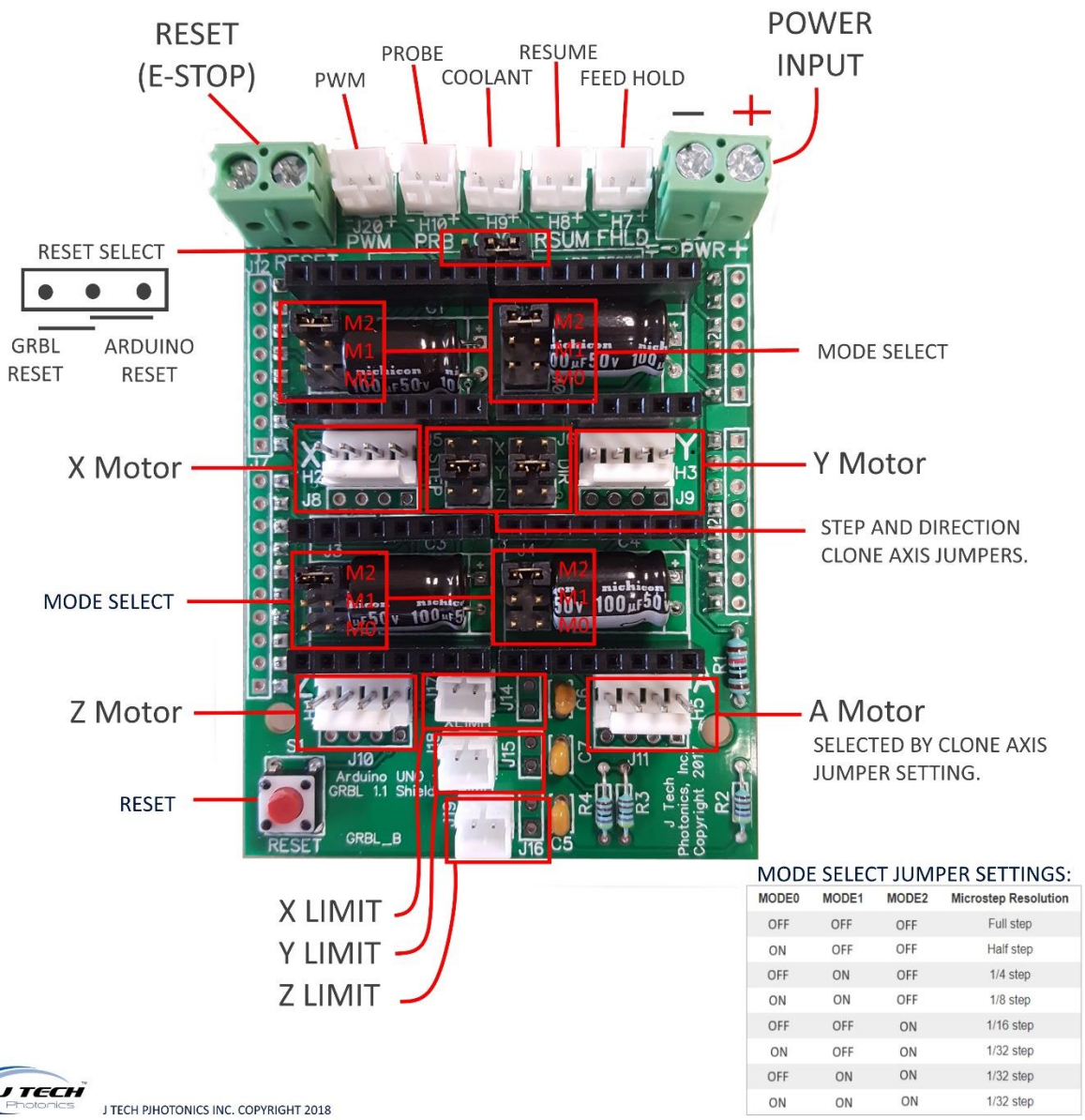
GRBL 1.1 PINOUTS



GRBL 1.1 has all of the following output provided for operating the CNC machine or Laser machine. All of these signals are routed through the GRBL shield to the proper places for the stepper drivers and output connectors.

The GRBL Shield goes on top of the Arduino Uno. It is designed to work with GRBL 0.9 to 1.1f. Full kits came pre-installed with version 1.1f on them.

You can see the outputs on the GRBL board in the following diagram.



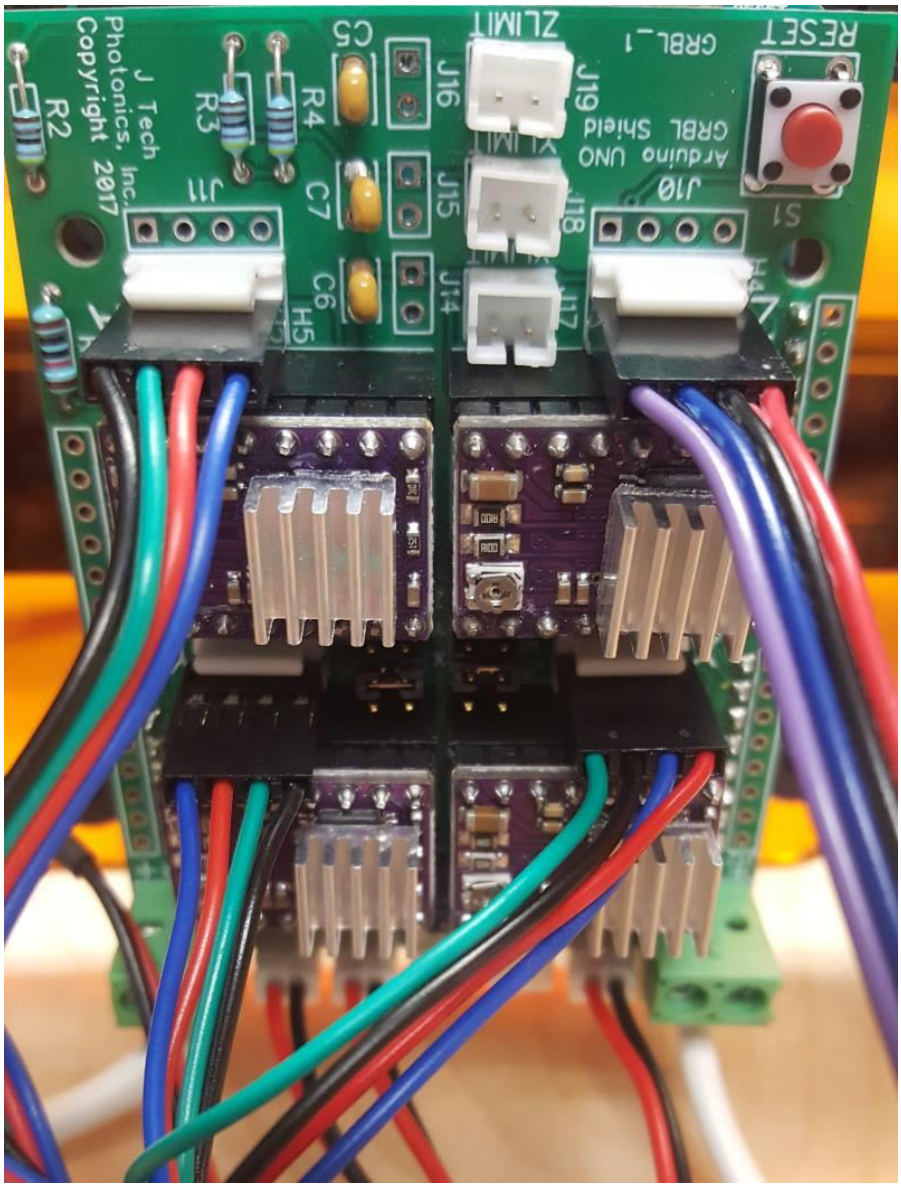
MODE SELECT JUMPER SETTINGS:

MODE0	MODE1	MODE2	Microstep Resolution
OFF	OFF	OFF	Full step
ON	OFF	OFF	Half step
OFF	ON	OFF	1/4 step
ON	ON	OFF	1/8 step
OFF	OFF	ON	1/16 step
ON	OFF	ON	1/32 step
OFF	ON	ON	1/32 step
ON	ON	ON	1/32 step

- Motor Connections: These are standard 4 pin Dupont Connectors that typical stepper motors come with.
- Reset: There is a screw terminal connection for an external reset switch as well as a red button on the board. Both do the same thing. Select using the Reset jumper select to either reset the Arduino (recommended) or just reset GRBL.
- Step and Direction Clone jumpers: These set the A Motor to follow either X, Y, or Z for step and direction. Make sure both Step and Direction are THE SAME axis you clone. For example, make both Y to clone the Y axis.
- Limit Switches: Connect them according to the section “wiring limit switches”.

SETUP WITH KIT PURCHASE

If you bought J Tech stepper motors or a full machine kit, then your machine will be set up correctly with all of the switches, driver current, and settings out of the box. You will just need to connect the motor cables to the correct motor axis on the control board.



Connecting the motors in this way will make the zero position of your machine be in the front left corner of your machine.

MODE SELECT JUMPERS

The GRBL Shield – Breakout Board will have jumpers for the stepping mode for the stepper drivers. Use the following table to configure based on your machine requirements.

MODE0	MODE1	MODE2	Microstep Resolution
OFF	OFF	OFF	Full step
ON	OFF	OFF	Half step
OFF	ON	OFF	1/4 step
ON	ON	OFF	1/8 step
OFF	OFF	ON	1/16 step
ON	OFF	ON	1/32 step
OFF	ON	ON	1/32 step
ON	ON	ON	1/32 step

WIRING LIMIT SWITCHES

The limit switches are used to detect the physical limits of the working area and to position the head in initial position during the homing process. Properly connected limit switches can significantly increase the reliability of the GRBL - the microcontroller pins connected to the switches are very vulnerable to any noise.

Before starting, make sure your coordinate frame is setup properly on your CNC machine and satisfies the right-hand rule. If you're not sure, its explained in the quick setup guide here. Otherwise, you will likely encounter problems with the homing cycle, where it behaves strangely. If you are having issues with the homing cycle, read this FAQ.

There are two types of end switches wiring:

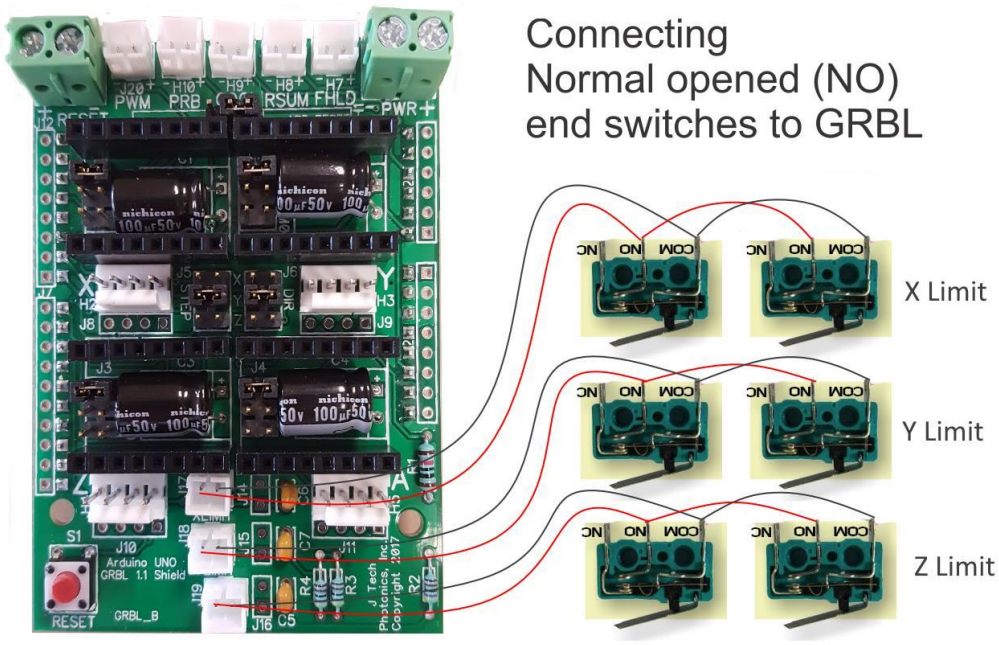
- Normally Opened end switches (NO) - switches are connected in parallel, if the head hits one of the switches the resistance becomes low (<10 Ohm). The wiring is simple but there is no indication if one of the switches is disconnected (broken wire).

- Normally Closed end switches (NC) - switches are connected in serial, if the head hits one of the switches the resistance become high (> 1 MOhm). The wiring is more complicated but if any of the switches is disconnected (broken wire) this will be immediately detected. This is the way how all professional CNC machines end switches were wired.

You can use only one limit switch to do the homing sequence if you want. We prefer to do this with our machines. However, if you would like to connect multiple switches together, here is how. NOTE- If you want hard limits, then you will need two per axis (one on each side).

Homing also needs all three axis. If you do not have a Z axis, then you will need to make a dummy switch to press in the homing cycle, or re-compile GRBL with Z axis limits disabled.

ONLY use Normally OPEN limit switches. If you use Normally Closed, there is too much noise in the signals for GRBL to work.



SETTING MOTOR CURRENT LIMIT

If you purchased this board as a kit with motors included, then you can skip this as they are already set correctly.

If you have purchased just the GRBL shield board, then you need to adjust the current limit to match your specific motors. First thing you need to do is see what the current rating of your motors are. The DRV8825 can provide up to 1.5amps, but never go over this. We recommend using motors that are less than the maximum current level of the driver chip.

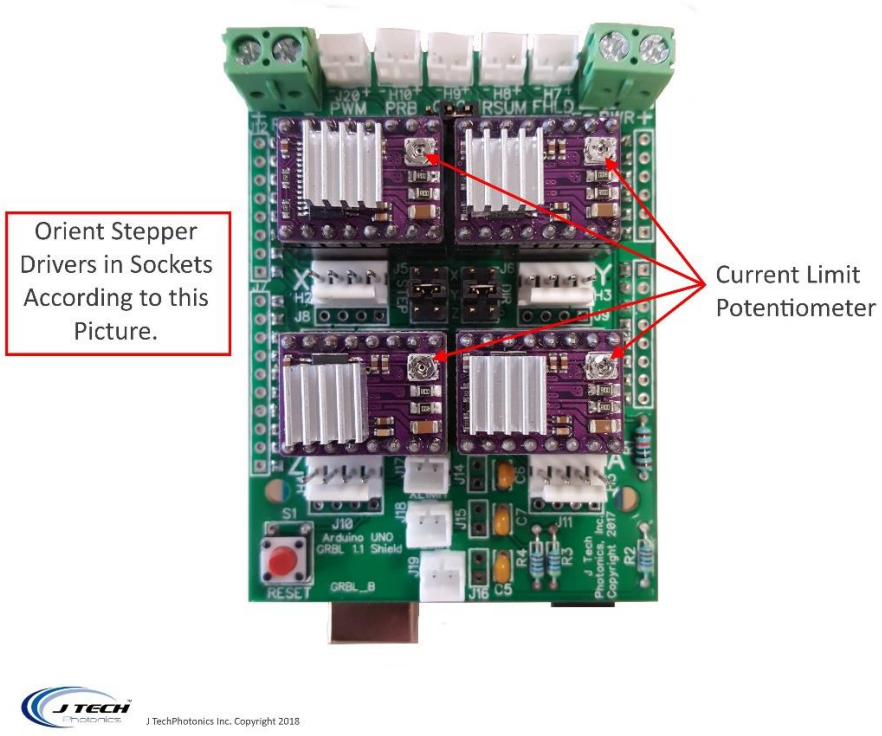
There is a very good video on how to set the current limit here: https://youtu.be/89BHS9hfSUk

The video shows a way to set the current limit by measuring the voltage on the “ref” pin and to calculate the resulting current limit (the current sense resistors are 0.100Ω). The ref pin voltage is accessible on a via that is circled on the bottom silkscreen of the circuit board. The current limit relates to the reference voltage as follows:

Current Limit = VREF × 2

So, for example, if you have a stepper motor rated for 1 A, you can set the current limit to 1 A by setting the reference voltage to 0.5 V.

Note: The coil current can be very different from the power supply current, so you should not use the current measured at the power supply to set the current limit. The appropriate place to put your current meter is in series with one of your stepper motor coils.



GRBL CONFIGURATION

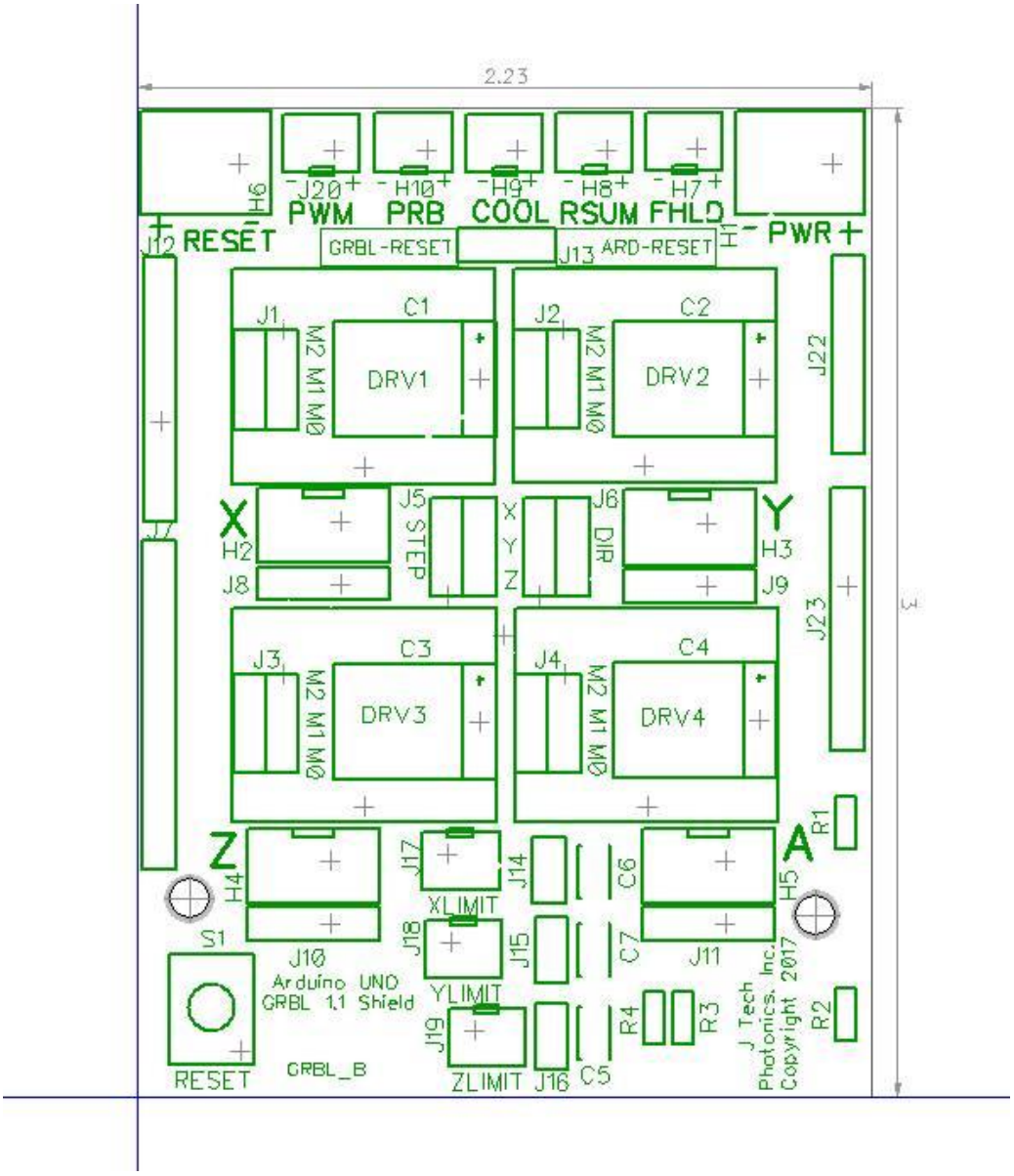
GRBL has settings for different parameters of the machine. You can find the details on the website here: https://github.com/gnea/grbl/wiki/Grbl-v1.1-Configuration

Below is the list of the configuration that is on the board by default from us.

$0=10	Step pulse, microseconds
$1=25	Step idle delay, milliseconds
$2=0	Step port invert, mask

$3=0	Direction port invert, mask
$4=0	Step enable invert, Boolean
$5=1	Limit pins invert, boolean
$6=0	Probe pin invert, boolean
$10=1	Status report, mask
$11=0.010	Junction deviation, mm
$12=0.002	Arc tolerance, mm
$13=0	Report inches, boolean
$20=0	Soft limits, boolean
$21=0	Hard limits, boolean
$22=0	Homing cycle, boolean
$23=0	Homing dir invert, mask
$24=25.000	Homing feed, mm/min
$25=500.000	Homing seek, mm/min
$26=250	Homing debounce, milliseconds
$27=1.000	Homing pull-off, mm
$30=255	Max spindle speed, RPM
$31=0	Min spindle speed, RPM
$32=1	Laser mode, boolean
$100=250.000	X steps/mm
$101=250.000	Y steps/mm
$102=250.000	Z steps/mm
$110=8000.000	X Max rate, mm/min
$111=8000.000	Y Max rate, mm/min
$112=500.000	Z Max rate, mm/min
$120=400.000	X Acceleration, mm/sec^2
$121=400.000	Y Acceleration, mm/sec^2
$122=10.000	Z Acceleration, mm/sec^2
$130=200.000	X Max travel, mm
$131=200.000	Y Max travel, mm
$132=200.000	Z Max travel, mm

DIMENSIONS


2.23
3
J20
H10
H9
H8
H7
H6
PWM
PRB
COOL
RSUM
FHLD
H1
PWR
J12
RESET
GRBL-RESET
J13
ARD-RESET
J1
C1
DRV1
M2 M1 M0
J2
C2
DRV2
J22
X
H2
J5
STEP
X
Y
Z
J6
DIR
Y
H3
J8
J9
J3
C3
DRV3
J4
C4
DRV4
J23
R1
Z
H4
J17
XLIMIT
J14
C6
A
H5
S1
J10
Arduino UNO
GRBL 1.1 Shield
J18
YLIMIT
J15
C7
J11
J19
ZLIMIT
J16
C5
R4
R3
R2
RESET
GRBL_B
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