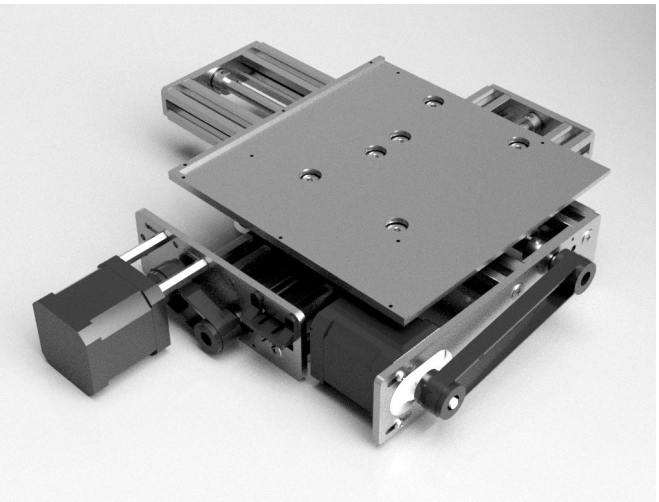
Laser4DIY Low Profile XY Table



- Table Size: 165mm x 165mm
- Overall Size: 368mm x 333mm x 56mm (with pancake motor)
- Based on 2 OpenBuilds NEMA17 V-Slot Actuators with Lead Screw

Files

See https://github.com/Laser4DIY/XY-Table

License

The Laser4DIY XY Table is licensed under the CERN-OHL-P v2.

Parts List

Off-the-shelf parts

Qty	Part Name	Part Link	Comments
2	8mm Metric Acme Lead Screw 290mm	openbuildspartstore.com makersupplies.dk ratrig.com	
2	Anti-Backlash Nut Block for 8mm Metric Acme Lead Screw	openbuildspartstore.com makersupplies.dk ratrig.com	SKU 1055; set includes M5 lock nuts
4	V-Slot 20x20mm 250mm	makersupplies.dk ratrig.com	
8	Xtreme Solid V Wheel Kit	openbuildspartstore.com makersupplies.dk ratrig.com	SKU 465
4	Aluminum Spacers - 6mm	openbuildspartstore.com ratrig.com	SKU 90
4	Eccentric Spacer - 6mm	openbuildspartstore.com ratrig.com	SKU 226
4	Ball Bearing 688Z 8x16x5	openbuildspartstore.com ratrig.com	SKU 780
4	8mm Shim (12x8x1mm)	openbuildspartstore.com ratrig.com	SKU 835
4	Lock Collar - 8mm	openbuildspartstore.com ratrig.com	SKU 840
9	V-Slot T-Nut M5	openbuildspartstore.com ratrig.com	
4	M5 x 20mm Low Profile Screw	openbuildspartstore.com ratrig.com ratrig.com(25pack)	SKU 750-pack
8	M5 x 22mm Low Profile Screw	aliexpress.com	for mounting wheels
8	M5 Nut Low Profile	openbuildspartstore.com ratrig.com	SKU 181; for mounting wheels
5	M5 x 8mm Button Head Screw		
11	M3 x 8mm Button Head Screw		

4	M3 x 5mm Button Head Screw		For screwing SledPlate to BedPlate
10	M3 Nut		
6	M2 x 6mm Screw		for attaching the "ruler"
4	M2 x 10mm Screw		
10	M2 Nut		
2	M2 Washer		
8	Self Tapping Screw #10	openbuildspartstore.com ratrig.com	SKU 720
3	Hex Standoff M3 (female/male) 30mm		For mounting one of the stepper motors
2	NEMA 17 Stepper Motor	openbuildspartstore.com ratrig.com	Use pancake motor to save space (mandatory to fit into Laser4DIY enclosure)
2	GT2 pulley 20 5mm bore	makersupplies.dk ratrig.com	
2	GT2 pulley 20 8mm bore	makersupplies.dk	
1	GT2 timing belt 6 mm closed loop 128 mm	gtech-shop.de	
1	GT2 timing belt 6 mm closed loop 250 mm	gtech-shop.de	
2	Micro Switch		Panasonic AV32143AT or similar

Custom parts

Qty	Part Name	Process	Material	File	
2	StandardEndPlate_BeamBracket	Laser cutting	Aluminium (AlMg3), 2mm	2mm_ALL_with_tabs.dxf	
2	StandardEndPlate_InnerPart	Laser cutting	Aluminium (AlMg3), 2mm	- " -	
2	StandardEndPlate_OuterPart	Laser cutting	Aluminium (AlMg3), 2mm	- " -	
1	EndPlateLower_BeamBracket	Laser cutting	Aluminium (AlMg3), 2mm	- " -	
1	EndPlateLower_InnerPart	Laser cutting	Aluminium (AlMg3), 2mm	- " -	
1	EndPlateLower_OuterPart	Laser cutting	Aluminium (AlMg3), 2mm	- " -	
1	EndPlateUpper_BeamBracket	Laser cutting	Aluminium (AlMg3), 2mm	- " -	
1	EndPlateUpper_InnerPart	Laser cutting	Aluminium (AlMg3), 2mm	- " -	
1	EndPlateUpper_OuterPart	Laser cutting	Aluminium (AlMg3), 2mm	- " -	
1	BedRuler	Laser cutting	Aluminium (AlMg3), 2mm	- " -	
2	SledPlate	Laser cutting	Aluminium (AlMg3), 3mm	3mm_ALL_with_tabs.dxf	
1	BedPlate	Laser cutting	Aluminium (AlMg3), 3mm	- " -	
2	SledSpacer	Laser cutting	MDF, 5mm	5mm_sledspacer.dxf	Could also be aluminium
1	Microswitch Bracket	3d printing	any plastic e.g. PLA	MicroswitchBracket.stl	
1	Microswitch Bracket 2	3d printing	any plastic e.g. PLA	MicroswitchBracket.2stl	

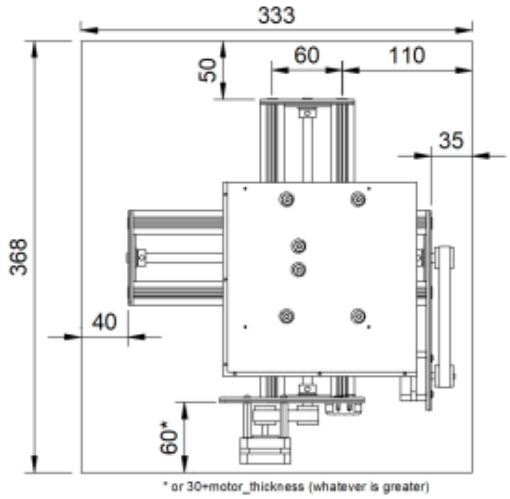
The "end plates" are made of 3 layers of lasercut aluminium, which are aligned and held together by M3 screws. It is also possible to have them CNC milled as one piece, but we chose laser cutting as it is much cheaper to get them produced this way.

Driver Electronics

Qty	Part Name	Part Link	Comment
1	Nucleo STM32F446 (STM32F446RET6)	http://www.st.com/stm32nucleo	Documentation, Manual
1	CNC Shield (for Arduino Uno)	https://blog.protoneer.co.nz /arduino-cnc-shield/	Schematic
2	SilentStepStick TMC2100 stepper driver		other, compatible stepper drivers can be used, too
14	Dupont connector female		You need 2 x 4pin connectors for the stepper motors and 3 x 2pin connectors for the endstops and laser enable signal. We simply used jumper cables and extended/soldered them to the cables coming from the steppers/endstops.

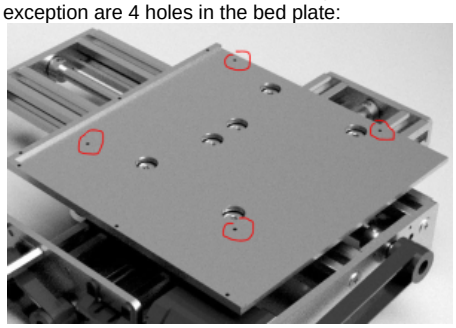
Overall Size

The overall size of the table is larger than its components, as the table moves beyond their extents. The following drawing shows how much space is needed. The aluminum extrusions of the lower rail (vertical in the drawing) are the ones that should be fixed e.g. to a mounting plate using brackets or V-slot T-nuts.

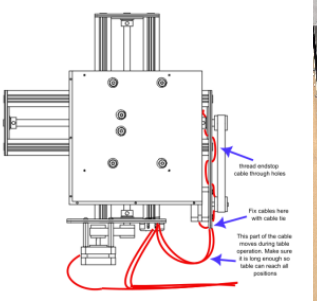


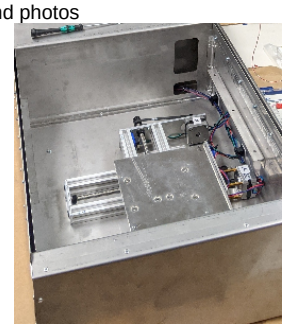
Assembly

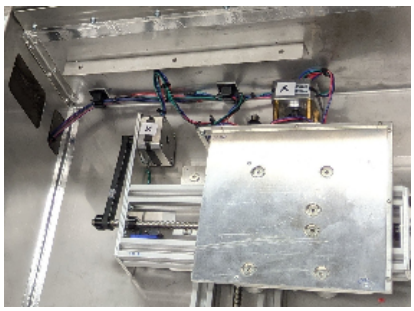
- Please see included STEP file where the individual parts go.
- Start with assembling the "end plates". They are made of 3 layers of lasercut aluminium, which are aligned and held together by M3 screws and M3 on the inside. These screws and nuts are not included in the STEP.
- The wheels (we need 8 for build) consist of 4 parts: The wheel itself, 2 ball bearings and a shim. The shim goes between the 2 ball bearings. The wheel package can contain an addition shim and a lock nut, which are NOT needed for the wheels. Also see wheel build video here: https://openbuildspartstore.com/xtreme-solid-v-wheel-kit/
- The lasercut holes in the aluminium plates are often too small. Drill them out to have the right sizes so that the screws go through. The only exception are 4 holes in the bed plate:

  These holes need an M3 thread to be cut into. Use M3x5 screws to bolt the upper sled plate to the bed plate using these threaded holes.
- There are different types of slot t-nuts: slide-in and drop-in types. The slide-in type can only be inserted from the ends of the profile. If you have these types, make sure you insert the t-nuts at the right places before screwing on the endplates, otherwise they cannot be inserted any more. There are 4 t-nuts in the bottom slots of the assembly, they are used to fix the table in the Laser4DIY device later. Make sure you add these t-nuts now too.
- The wheels are attached with 6mm spacers, with standard spacers on one side and eccentric spacers on the other side of the sled. The eccentric spacers can be used to increase the force the wheels press onto the beams.
- Make sure the motor orientation is correct, i.e. the cable connector is on the right side. See STEP file.
- Wires: see the following diagram and photos



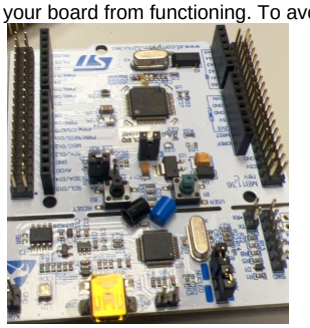




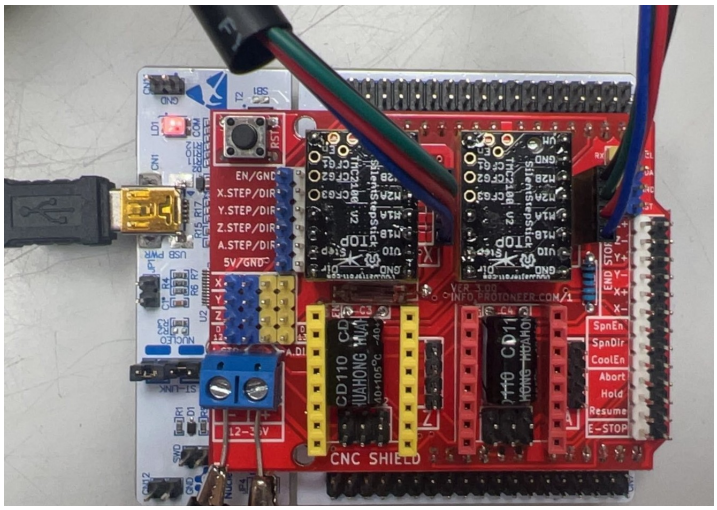
Electronics

The CNC controller consists of a Nucleo STM32F446 board, a CNC shield and 2 TMC2100 SilentStepStick stepper driver boards.

- The CNC shield is inserted into the Arduino connector of the Nucleo board
- Pay attention to the two micro switches on the Nucleo board located under the CNC shield. Some Nucleo boards (all?) have quite tall caps on these switch, which touch the CNC shield and are therefore pressed down all the time! As one of the switches is the reset button this will prevent your board from functioning. To avoid this, remove the caps from the switch:



- There should be no jumpers on the CNC shield
- The SilentStepStick drivers are inserted into the CNC shield (for axis X and Y). Make sure, that the orientation is correct (see image below). A wrong orientation will destroy the driver.



Nucleo board with CNC shield and stepper drivers. In this picture the EN pin of the SilentStepStick drivers is on the top left, the GND pin is on the bottom right

Configuring the TMC2100 stepper drivers

- https://learn.watterott.com/de/silentstepstick/pinconfig/tmc2100/
- 1/16 mcrostepping, 1/256 interpolation, stealthChop CFG1 open + CFG2 open + CFG3 open
- We suggest to simply not solder in the CFG1-3 pins, this way the config is fixed to this setup

Connecting XY table with CNC shield

Function	CNC Shield Label	Wiring
Stepper X	X	4 wires to stepper, ordered of the pins is the same as described in TMC2100 data sheet
Stepper Y	Y	4 wires to stepper, ordered of the pins is the same as described in TMC2100 data sheet
Endstop X	X+	2 wires (signal + ground) to end switched, configured as normally-open
Endstop Y	Y+	2 wires (signal + ground) to end switched, configured as normally-open
Laser Enable	Z+	2 wires (signal + ground) to laser driver electronics

Firmware

We are running an enhanced version of GRBL with the XY table, called GRBL-Advanced. It runs on a STM32F411RE / STM32F446RE Nucleo Board and offers backlash compensation to archive better precision.

You can find the Github repository with our fork here: https://github.com/Laser4DIY/GRBL-Advanced

- Ready to use Binary: https://github.com/Laser4DIY/GRBL-Advanced/tree/software/hex
- Build your own binary:
  - see https://github.com/Schildkroet/GRBL-Advanced
  - on Windows use EmBitz1.1
- Flash firmware onto Nucleo:
  - right click bin/Release/GRBL_Advanced.hex, select EBlink Cortex-M Flash File
    - or via cmd line: eblink -F erase,file=GRBL_Advanced.hex
  - unplug and replug board
  - Test: connect to COM port with 115200 baud

Configuring

To configure GRBL Advanced, please see here: Configuring GRBL Advanced

We are using Lightburn to control the table in the Laser4DIY device. See Configuring Lightburn on how to set it up correctly.

Results

We measured around 0,05mm of backlash for the XY table in both directions. But with the backlash compensation feature, some impressive results are archivable. Here is an example engraving done with our Laser4DIY machine:




Please note that letters are not a single line, the outlines are engraved.

Here is a microscope shot of an engraving with a font ~0.5mm high:



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