

AnyCubic Photon

External Stepper Driver Installation

Special Thanks to:

Photonsters Facebook Group

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Caution/Disclaimer

- This will likely void your warranty. Do not attempt if you aren't comfortable with a soldering iron, multi-meter, and possibly breaking your Photon
- Read everything first
- Don't blame me or anyone else if you break your printer.

Why?

- Internal stepper driver is limited in function
- External stepper driver can:
 - Lower noise of stepper motor
 - Increase reliability and repeatability
 - Increase mechanical smoothness of Z-axis
- External stepper will not:
 - Increase physical vertical resolution
 - This is function of the leadscrew and stepper motor
 - Mechanical limits vertical resolution to multiples of 0.01mm
 - Eliminate Z-wobble
 - Make prints stick to your bed

Parts list

- Materials
 - Stepper driver of your choice
 - Selection is outside of scope of this document, I used BigtreeTech TMC2208 DIY
 - Stepper driver breakout board
 - 0.1" (2.54mm) header pins (male-male)
 - 3 female-female jumper wires for header pins
 - 1 female to male jumper wire
 - 2 male to bare wire jumper wires
 - Some way to mount the breakout board
 - I used 3mm screw, nut, and 3d printed spacer.
- Tools
 - Soldering iron with good tip for precision work
 - Not required if using press-fit header pins
 - Tools that came with your Photon
 - Precision Jewelers screwdriver set

Parts list

Parts I used and links:

Header pins (10 pack of 40) - [AliExpress](#) [eBay](#)

Stepper Driver (BigTreeTech TMC2208 – Select the DIY one) – [AliExpress](#) [eBay](#)

Stepper Breakout board – [AliExpress](#) [eBay](#)

Jumper wires (select the one that comes with F-F, F-M, and M-M) – [AliExpress](#) [eBay](#)

Screw Set (3mm screws + nuts) – [AliExpress](#) [eBay](#)

Spacer – Printed (3.5mm id, 8mm OD, 6.35mm tall) – [Thingiverse](#)

Jewelers Screwdriver set – [AliExpress](#) [eBay](#)

Procedure:

1. Remove motherboard
2. Install new pin headers on motherboard
3. Wire stepper driver breakout board
4. Install stepper driver and setup
5. Test & change direction if required
6. Set V_{ref} on new driver
7. Reinstall everything

Step 1: Remove motherboard

- See official AnyCubic YouTube video

<https://www.youtube.com/watch?v=Denj5z8BtLg>

- When disassembling machine, position build platform support near the middle.
- Notes:
 - Newer photons may be slightly different than video
 - Be very careful when removing ribbon cables for screen and front touch screen
 - You may need to remove some hot glue from the green screw terminal connectors and double sided tape from the LCD mask connector.

Step 2: Install headers on motherboard

- Will be installing two sets of pins – one to pull the signal from the motherboard, and another to give the breakout board 5V
- Additionally, will be running 12V and GND from the main power connector to the breakout board
- Pins can be solder or pop-in type – pictured are solder type

Step 2: Install headers on motherboard

- Male standard header pins, 0.1" (2.54mm) spacing
- One set of 3 (or 4) and one single pin
 - Set of 4 required if you pull GND connection from the stepper mirror header, 3 if you pull GND from the power connector
 - Recommended to pull GND from the power connector directly



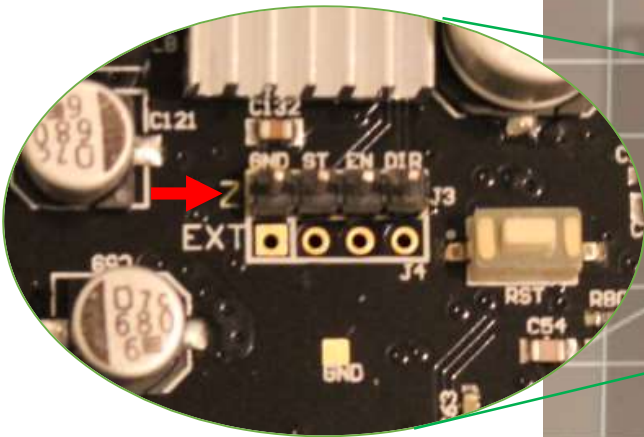
Solder style
header pins



Push in style
header pins

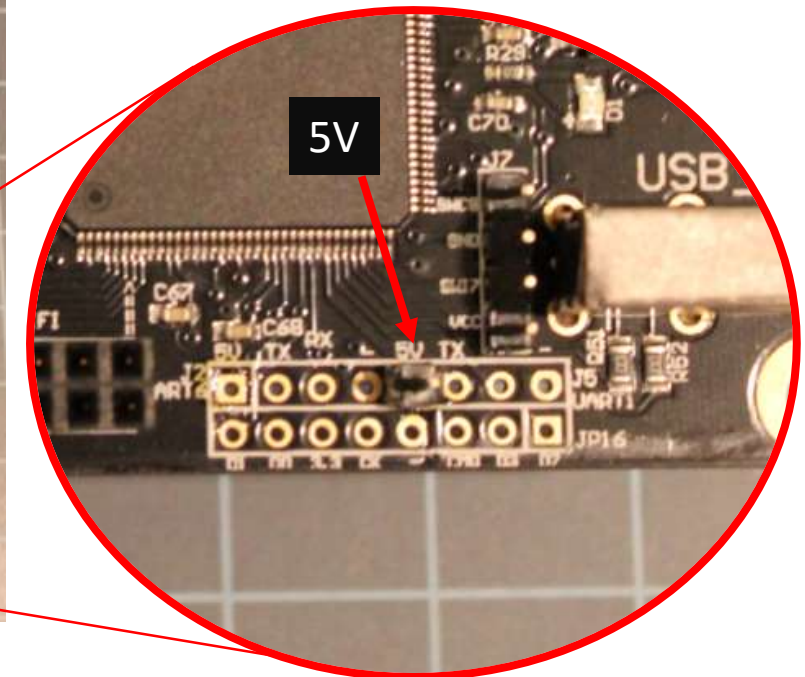
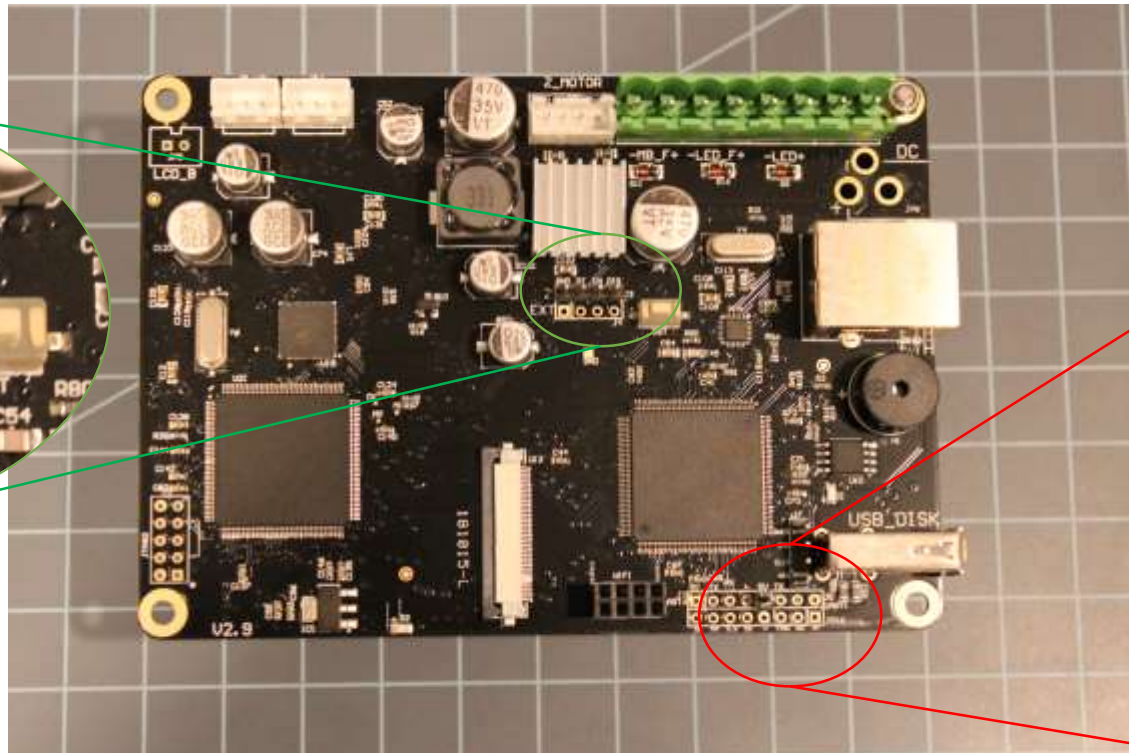
Step 2: Install headers on motherboard

- Install 3 (or 4) set into holes labeled 'Z' on motherboard
- Install 1 additional pin in 5V connection in UART ports near USB slot
- Solder in place from back of board if required



4 pins – installed on 'Z' mirror header

GND pin shown installed



Step 3: Wire stepper driver breakout board

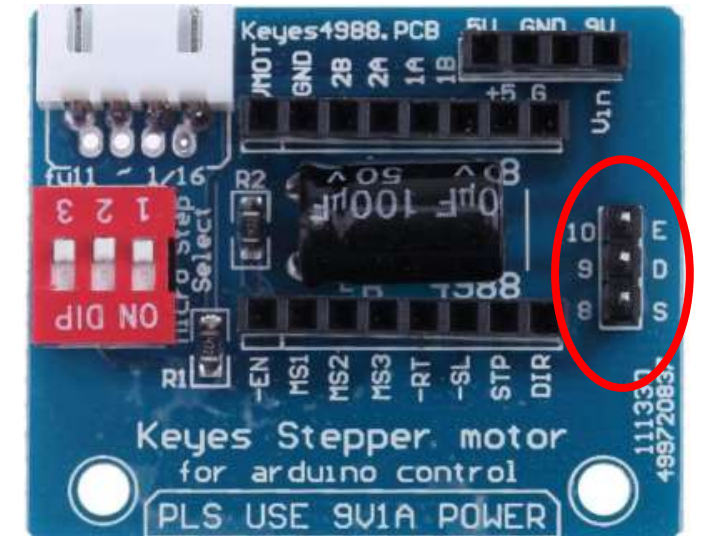
- For ease it is suggested to use breakout board built for stepper drivers
- 6 wire connections total
- If using breakout board you will need:
 - 3 female to female jumper wires
 - 1 (or 2) female to male jumper wire
 - 1 (or 2) male to bare wires
 - Depends on where you want to get ground

Step 3: Wire stepper driver breakout board

- There are 6 wire connections to make on the stepper driver board
 - 3 are to the Z-mirror pin headers installed in step 2 to control the stepper driver – these are labeled as:

Function	Motherboard	Breakout Board
Enable	EN	E
Step	ST	S
Direction	DIR	D

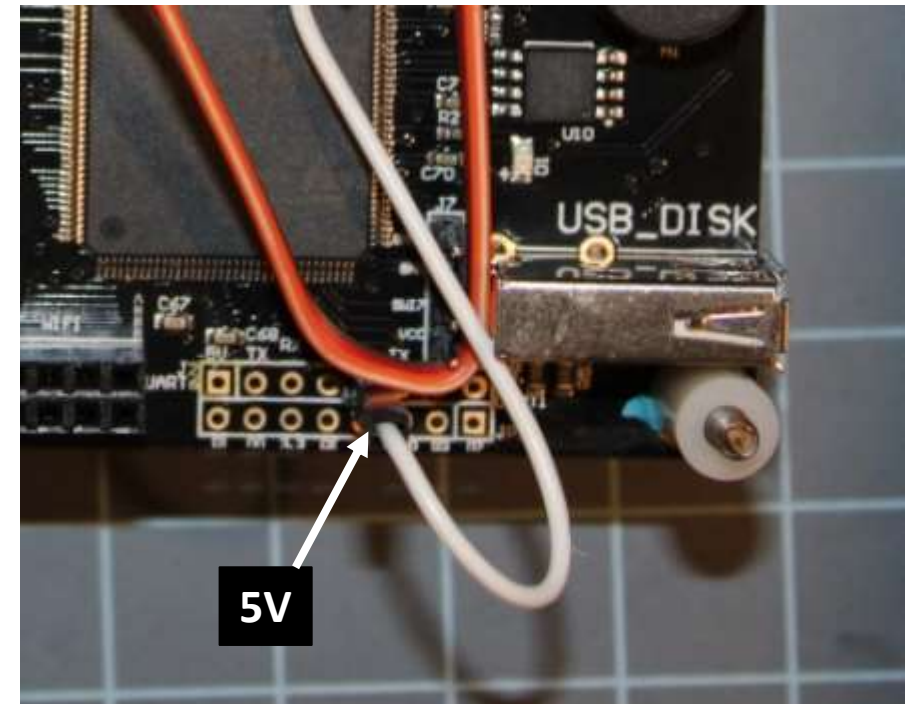
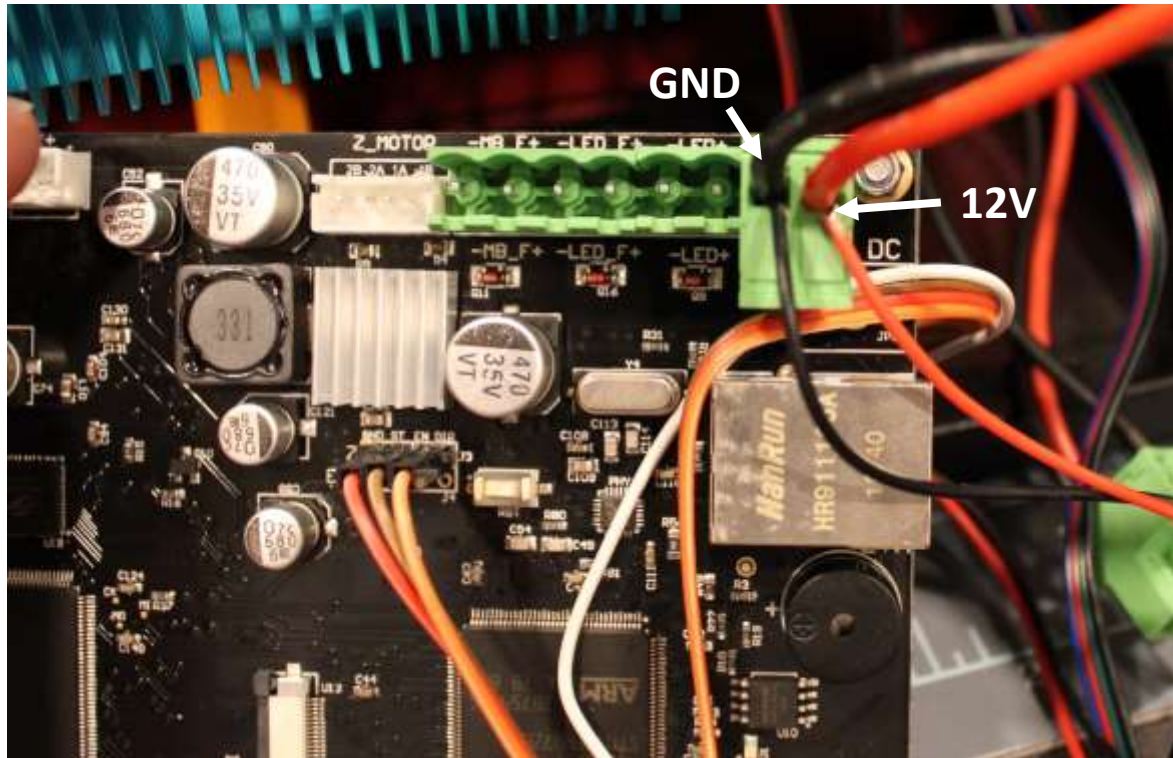
- Using female to female jumper wires, make the following connections:
 - EN pin to the E pin
 - ST pin to the S pin
 - DIR pin to the D pin.



Step 3: Wire stepper driver breakout board

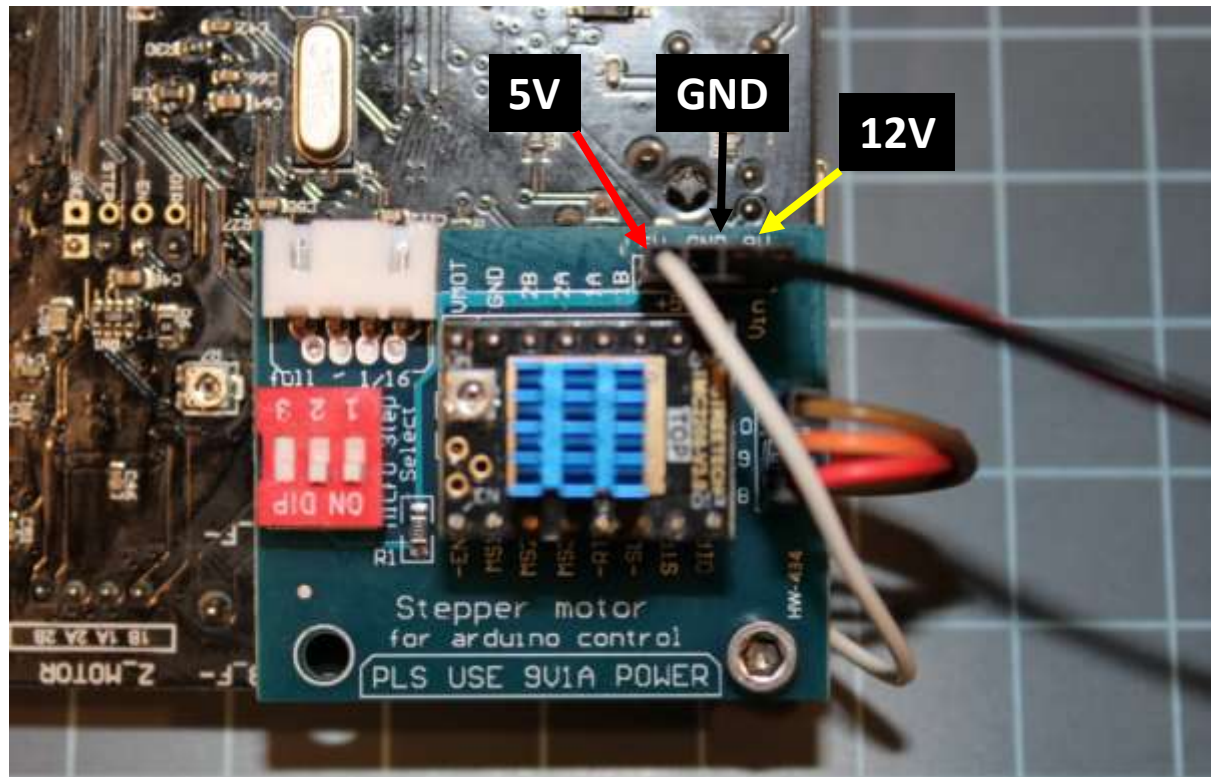
- To give the power to breakout board – 3 more connections are needed
 - 12V, 5V, and GND
- For the GND connection, you have two options:
 - Option 1 – connect directly to screw terminal from power source using male to wire jumper wire
 - This is what is shown
 - Option 2 – connect to the Z-mirror pin header labelled GND
 - Option 1 is recommended
- Connect wire end of male jumper wire to 12V screw terminal with red wire coming from the switch. Connect this to the 9V pin on the breakout board
- Connect one male to female jumper to the 5v line on the breakout board and wire to the 5V pin on the motherboard

Step 3: Wire stepper driver breakout board



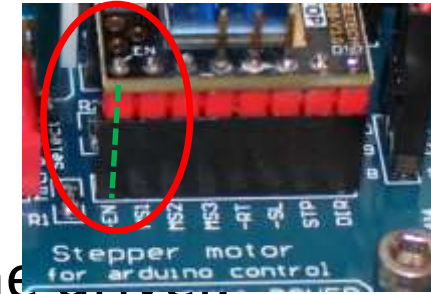
Step 3: Wire stepper driver breakout board

- 12V, 5V, and GND wires connected to breakout board.
 - Either Pin labeled GND is okay
- Engage, Direction, and Step wires connected



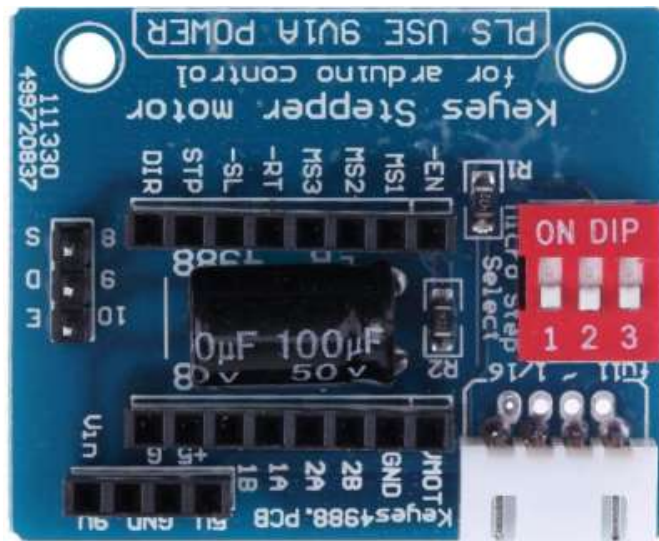
Step 4: Install stepper driver & setup

- Install the stepper driver into the breakout board
 - Ensure proper orientation. Your driver should have pins labeled – plug into matching pin on the breakout board
 - Example - EN driver pin to EN breakout board pin
- The switches on the breakout board are for setup for the driver.
 - Follow the manual/spec sheet for your driver to set MS1, MS2, and MS3 to the correct settings
 - Example settings on next slide – confirm yours in spec sheet for your stepper driver.
- Install heatsink if provided with stepper driver



Step 4: Install stepper driver & setup

- DIP Switch Setup
 - Low is off
 - High is on
- Want setting for 1/16 step
- For my TMC2208 – 1 and 2 on

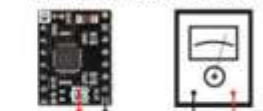


A4988 motor drive pin description, subdivision description and current description



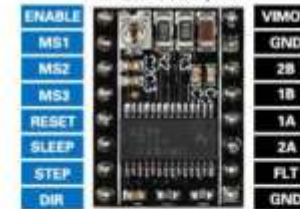
Microstep	MS1	MS2	MS3
Full Step	Low	Low	Low
1/2 Step	High	Low	Low
1/4 Step	Low	High	Low
1/8 Step	High	High	Low
1/16 Step	High	High	High

Factory default current : 1.17A
Maximum drive current : 2.0A



The current setting reference voltage measurement diagram is shown as above
 $I_{Tripmax} = V_{ref}/0.4$

DRV8825 motor drive pin description, subdivision description and current description



Microstep	MS1	MS2	MS3
Full Step	Low	Low	Low
1/2 Step	High	Low	Low
1/4 Step	Low	High	Low
1/8 Step	High	High	Low
1/16 Step	Low	Low	High
1/32 Step	High	Low	High
1/64 Step	Low	High	High
1/128 Step	High	High	High

Factory default current : 2.5A
Maximum drive current : 2.5A



The current setting reference voltage measurement diagram is shown as above
 $I_{Tripmax} = V_{ref} * 2.0$

LV8729 motor drive pin description, subdivision description and current description



Microstep	MS1	MS2	MS3
Full Step	Low	Low	Low
1/2 Step	High	Low	Low
1/4 Step	Low	High	Low
1/8 Step	High	High	Low
1/16 Step	Low	Low	High
1/32 Step	High	Low	High
1/64 Step	Low	High	High
1/128 Step	High	High	High

Factory default current : 1.65A
Maximum drive current : 2.0A



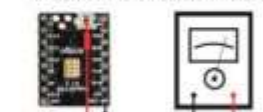
The current setting reference voltage measurement diagram is shown as above
 $I_{Tripmax} = V_{ref} * 2.0$

TMC2100 motor drive pin description, subdivision description and current description



The TMC2100 driver chip uses a differential algorithm to extend the 16 subdivision to 256 subdivisions, and the step value is calculated as 16 subdivided.

Factory default current : 1.0A
Maximum drive current : 1.2A



The current setting reference voltage measurement diagram is shown as above
 $I_{Tripmax} = V_{ref} * 1.9$

Step 5: Test & change direction if required

- Reconnect power to motherboard (leave machine unplugged for now)
- Reconnect touch-screen LCD
- Connect motor to the breakout board (not back to the motherboard)
- Ensure all connections to breakout board and motherboard are correct
 - Only connections required are 6 wires to breakout board, power to motherboard, and LCD touchscreen ribbon cable
- Plug in and turn machine on
 - Try not to touch anything other than power switch and touchscreen LCD when the machine power is on.
- Using the 'Tools' menu – attempt to move the Z-axis up and down to check direction.

Step 5: Test & change direction if required

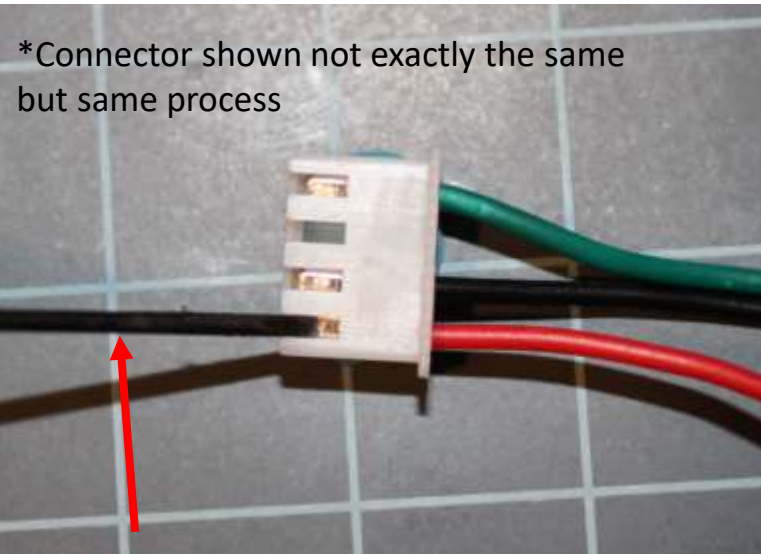
- If direction is correct (e.g. up moves the platform up) – congrats!
 - Proceed to Step 6 to set the V_{ref}
- If direction was backwards (pushing up arrow moved the platform down) we have to change direction of the stepper – Go to Step 5b.

Step 5b: Changing stepper direction

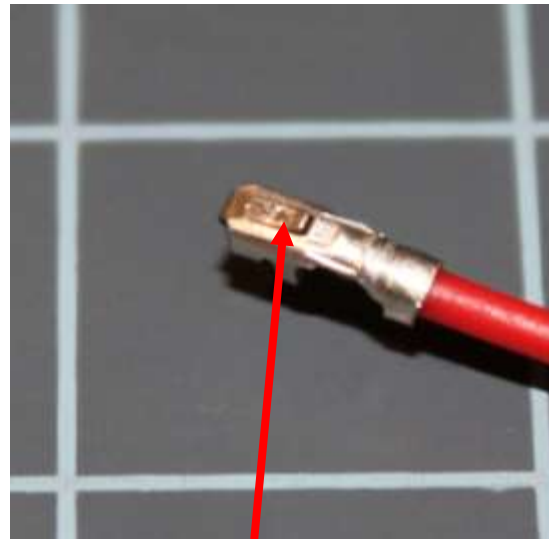
- This method will cover changing the wiring for the stepper motor to switch direction
 - This can also be done in the gcode - see advanced section
- Involves de-pinning the connector, swapping two wires, and putting them back in.
- Turn off and unplug printer
- Unplug connector running from breakout board to the stepper motor

Step 5b: Changing stepper direction

- Take 1.4mm wide screwdriver and gently push down on tab on pin in the stepper motor connector while pulling on wire at same time
 - Remove two wires that are next to each other
 - I removed red and blue
 - Switch the pins, reinstall into connector, and reconnect to stepper breakout board

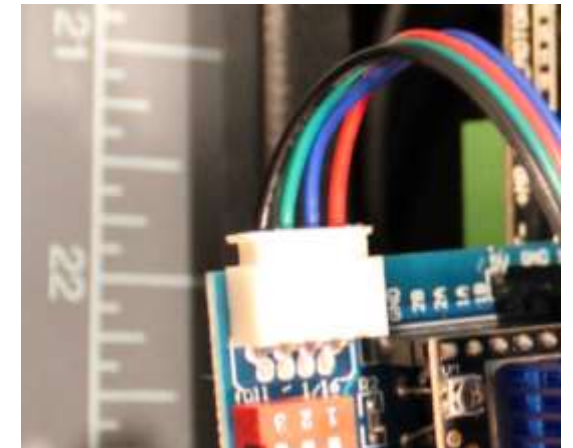


1.4mm wide screwdriver



Tab to push

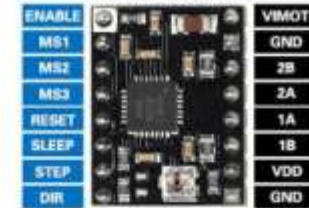
Red and blue wires switched and reconnected



Step 6: Set V_{ref} on stepper driver

- V_{ref} is set by small screw potentiometer on stepper driver
- Correct voltage and procedure varies based on stepper driver
 - See driver spec sheet for instructions and voltage requirements
- Stepper motor is 1.5amp max current (1.06amp RMS current)
 - Use this value to set max voltage on the stepper driver
 - Go low and test – lower current keeps stepper motor cooler and will last longer
 - For my TMC2208 driver – V_{ref} was set to 1.15V (max V_{ref} of 1.4)
 - Examples of some common steppers drivers shown on the right

A4988 motor drive pin description, subdivision description and current description



DRV8825 motor drive pin description, subdivision description and current description



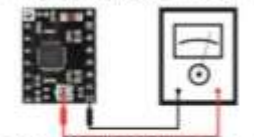
LV8729 motor drive pin description, subdivision description and current description



TMC2100 motor drive pin description, subdivision description and current description

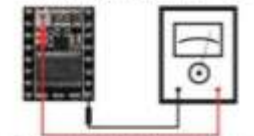


Factory default current : 1.17A
Maximum drive current : 2.0A



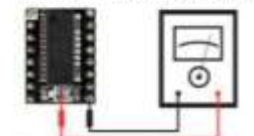
The current setting reference voltage measurement diagram is shown as above
 $I_{trigmax} = V_{ref}/0.4$

Factory default current : 2.5A
Maximum drive current : 2.5A



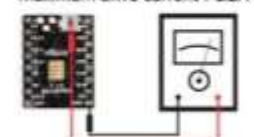
The current setting reference voltage measurement diagram is shown as above
 $I_{trigmax} = V_{ref}*2.0$

Factory default current : 1.65A
Maximum drive current : 2.0A



The current setting reference voltage measurement diagram is shown as above
 $I_{trigmax} = V_{ref}*2.0$

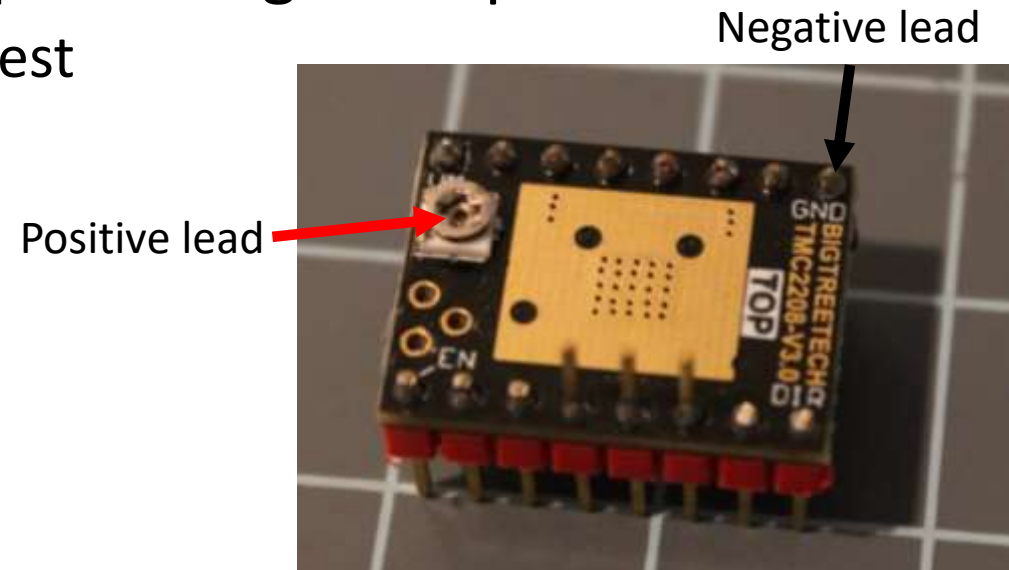
Factory default current : 1.0A
Maximum drive current : 1.2A



The current setting reference voltage measurement diagram is shown as above
 $I_{trigmax} = V_{ref}*1.9$

Step 6: Set V_{ref} on stepper driver

- With machine plugged in and power on- use multi-meter to check voltage at points indicated by your stepper driver spec sheet
 - On TMC2208 – I used GND pin and the top of the potentiometer to check voltage
- Adjust voltage using potentiometer as required to get to spec.
 - Turn off and unplug machine between each test

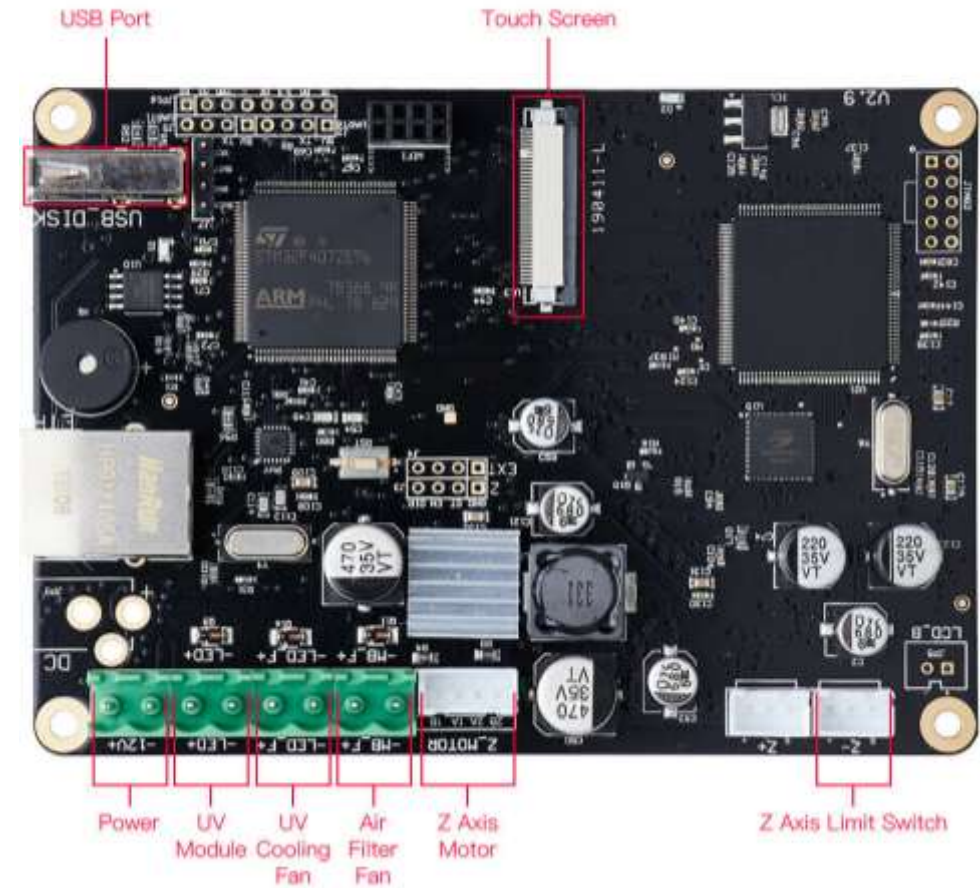


TMC2208 Stepper Driver

Step 7: Reinstall everything

- Find good mounting location for your breakout board
 - Be careful to not let the back touch any metal components or the motherboard
 - I used a spare hole in the motherboard and a 6mm spacer for mounting
- Reinstall motherboard and reconnect wiring
 - Reference AnyCubic video
- Test again
- Complete reassembly

CONNECTOR ILLUSTRATION



Advanced Settings

- Stepper reversal

- Stepper motor direction can be switched by g-code, rather than flipping polarity on a coil. To do this, you will need to make a new gcode file and print on your printer.
- Make a new file, and include the two lines below, exactly as the are.

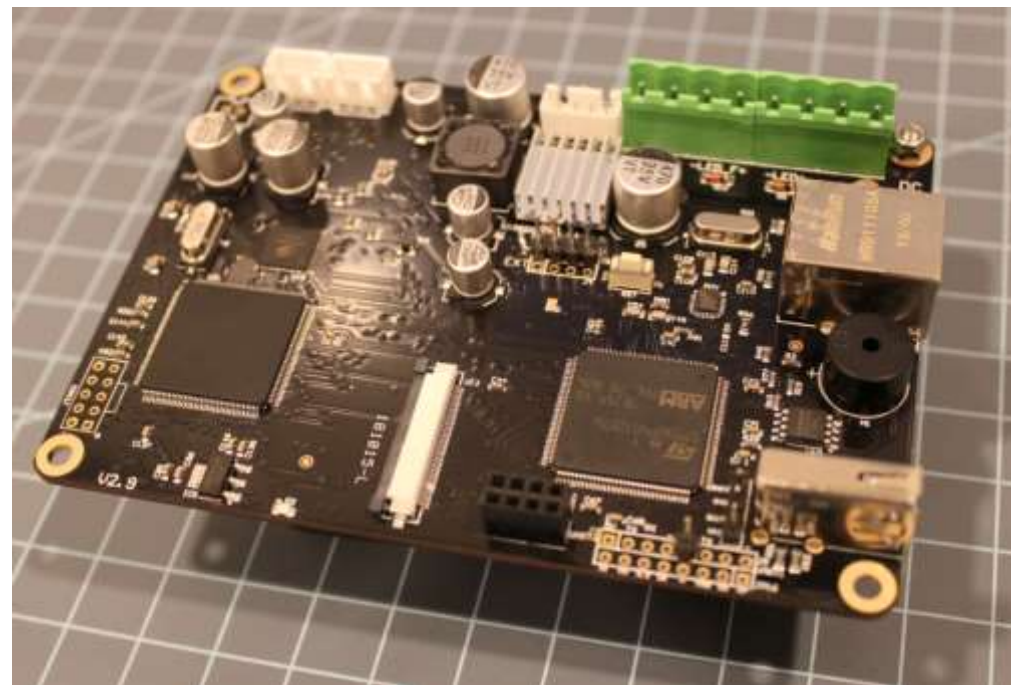
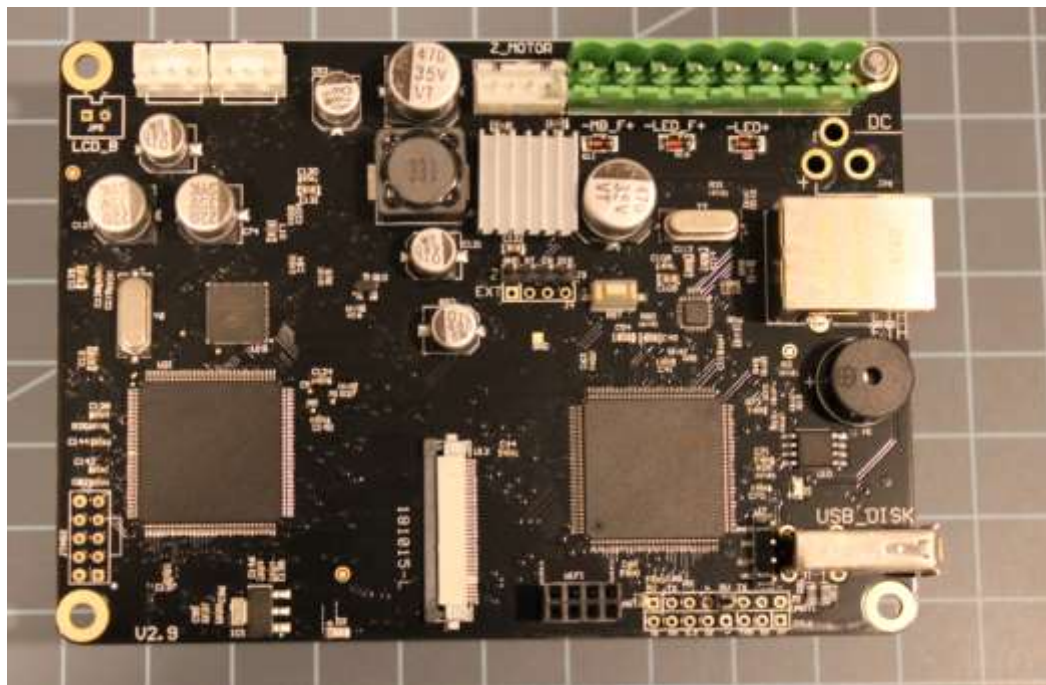
```
M8004 I1  
M8500
```

- Save as a new file with the extension .gcode
- Put this file on a USB and print on your printer.
- Check to ensure Z-direction switched
- To change it back, simply change the file to say the following:

```
M8004 I-1  
M8500
```

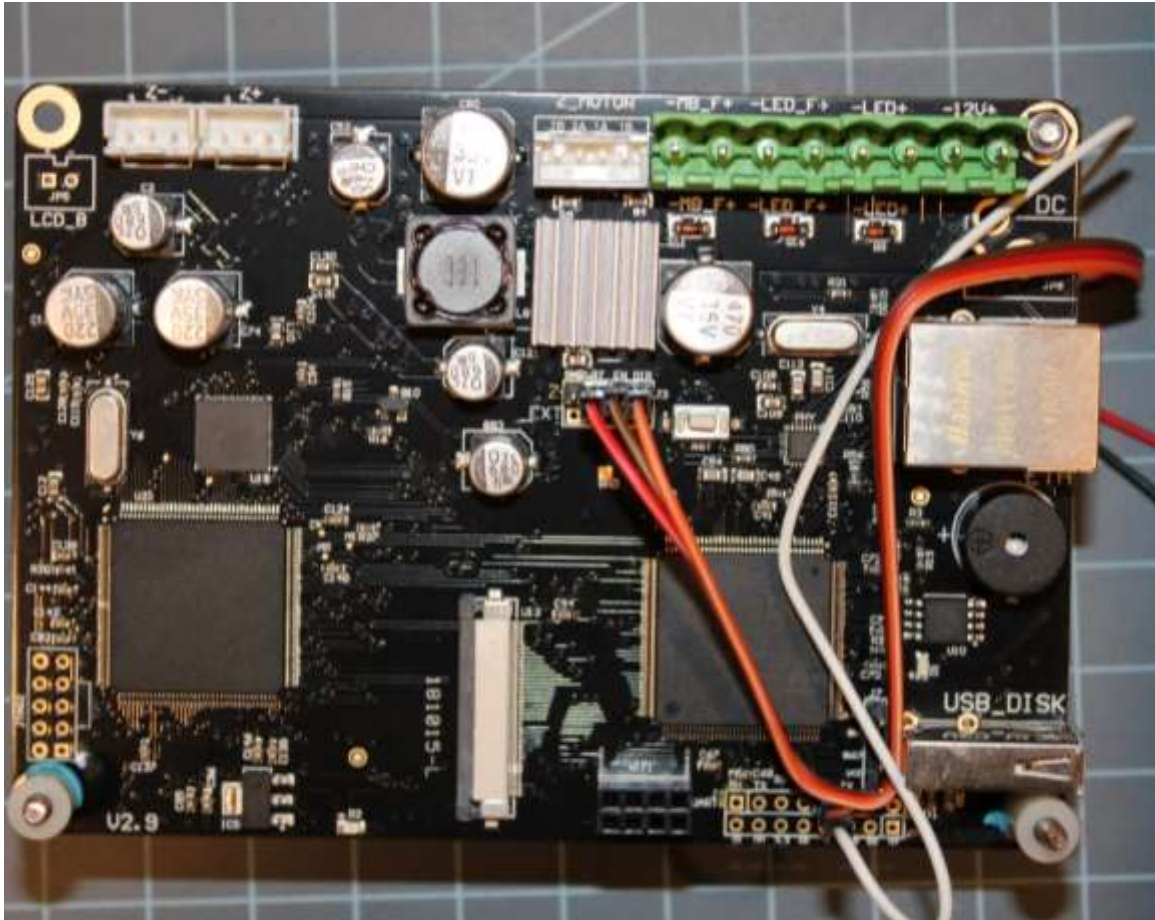
- For more details on the gcode – check the [Photonsters GitHub](#)
 - Direct Link to the factory defaults g-code w/ translations – [HERE](#)
- If you flash your firmware – this value will reset back to default

Appendix: Various pictures of installation

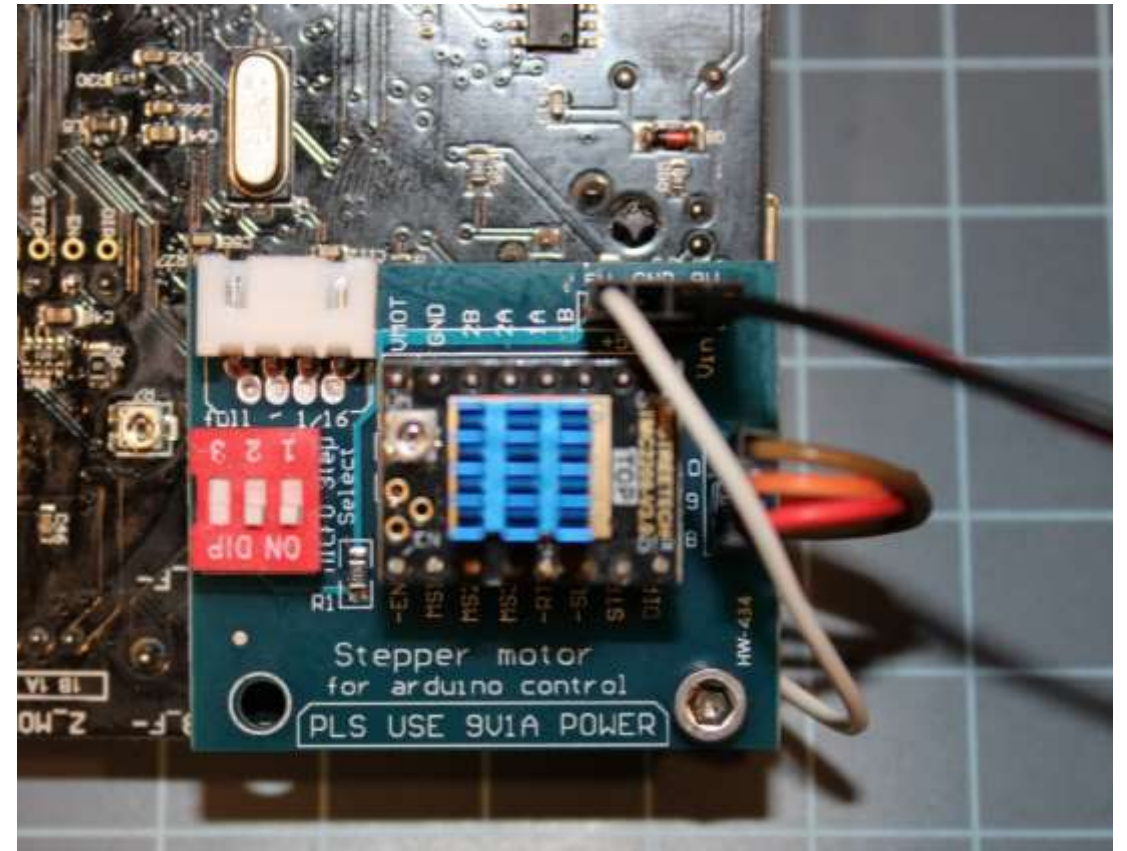


Photon motherboard with headers installed

Appendix: Various pictures of installation

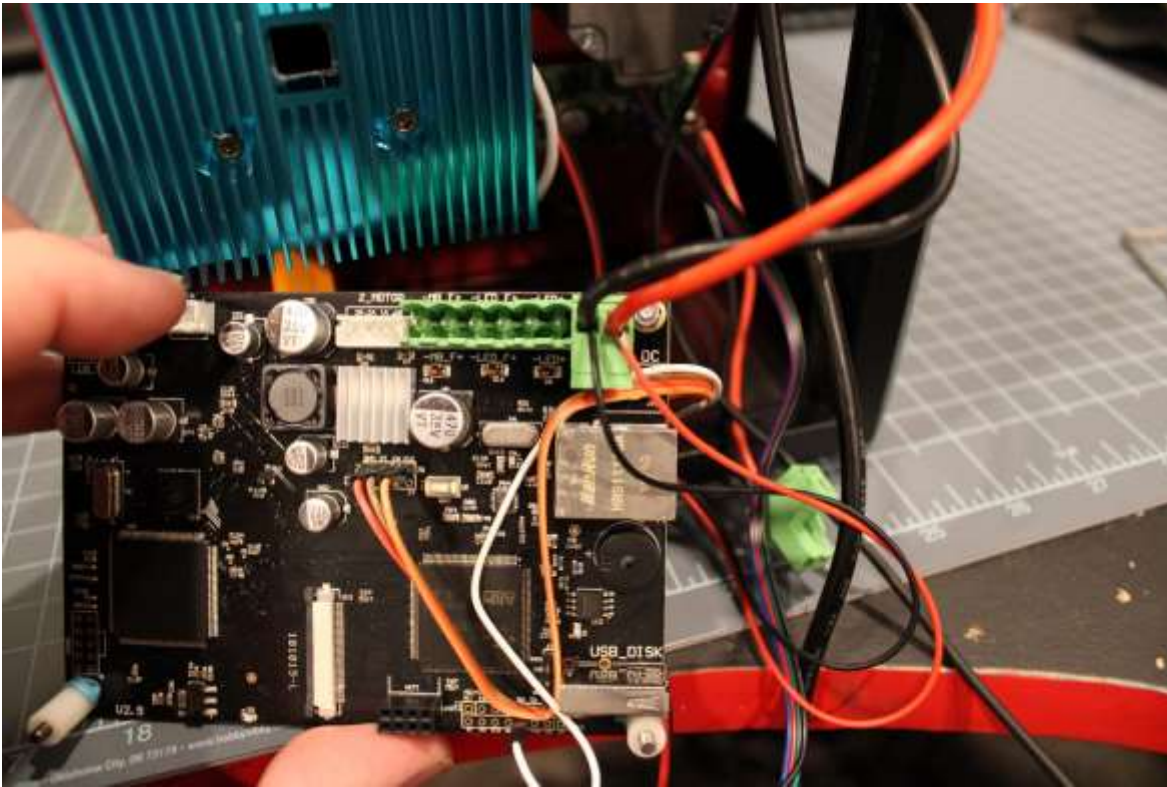


Jumper wires connected. Red and black wires on the right run to power connector screw terminals for 12V and GND



Breakout board wired with driver installed

Appendix: Various pictures of installation



Power wires connected to screw terminals



Motherboard reinstalled -
fans not yet connected

Appendix: Various pictures of installation



Reassembled – view from rear