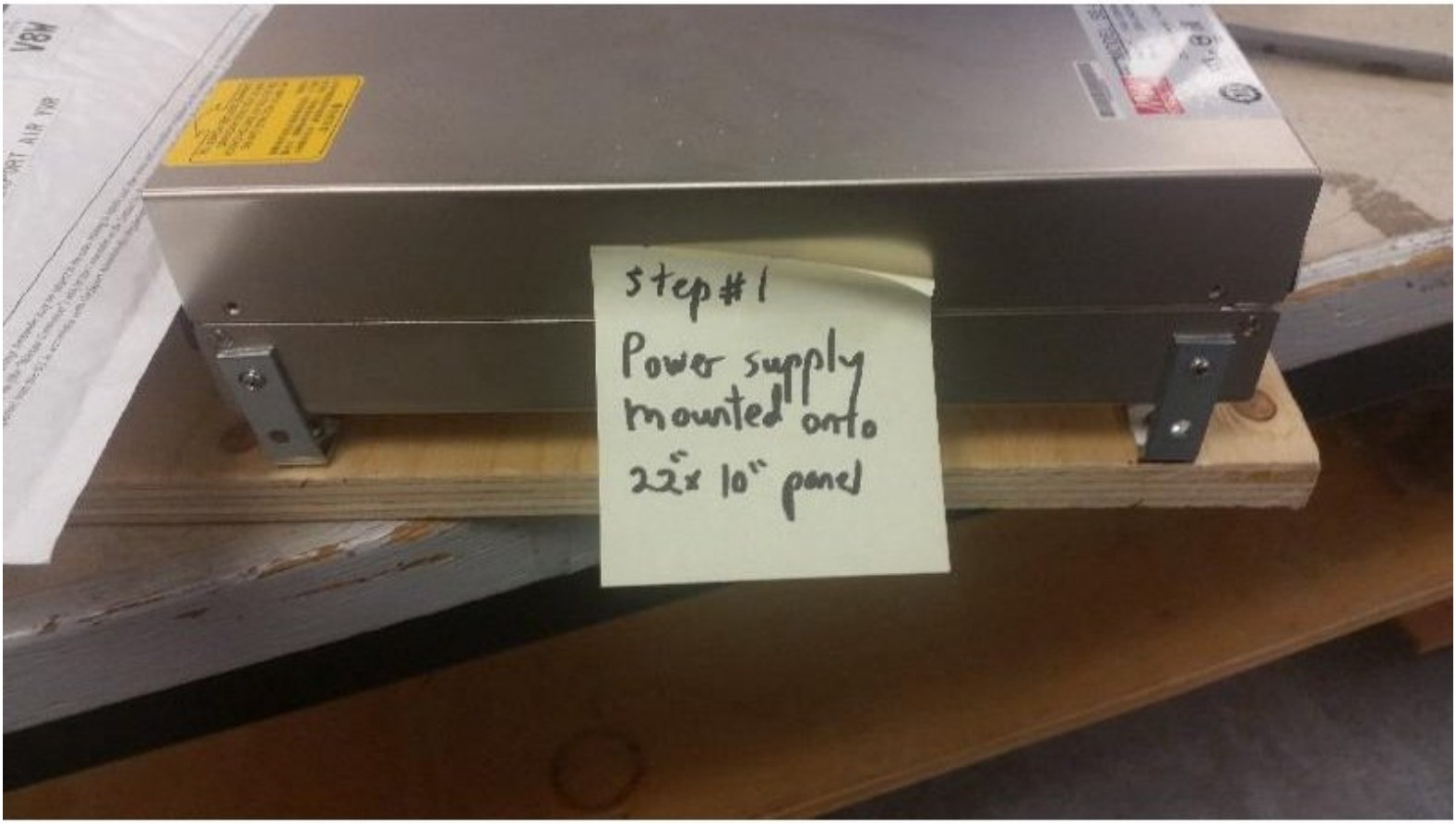
24 VDC power supply upgrade for BOXZY

Eliminate brownouts to the control board of the BOXZY that can ruin 3D prints by upgrading the power supply to 24VDC with a minimum of 14A (350-500W)

Written By: Michael Chernoff



INTRODUCTION

During 3D printing, the BOXZY can sometimes experience glitches that can ruin 3D prints.

This happens because when the X, Y, Z motors, the fans, the extruder and the heater are operating at the same time this can suck in more current that the 19VDC 10.4A power supply can provide. The power supply will brownout, and this will glitch the control board. The result of this glitch is that the 3D print will suddenly shift several mm in the X or Y direction and ruin the 3D print.

I could not find a 19VDC 14A power supply, so we are upgrading the supply to 24VDC & 14A (between 350 - 500Watt). I initially upgraded the power supply to 24VDC 25A (a 600W power supply), but this was overkill.

This upgrade should safely provide a 24VDC power supply with a safety stop button and a power bar on the side that can be used to power the router and the heater.

We will also upgrade the heater to a 24VDC heater, add a more efficient 12VDC regulator for the board, and we will also add a 12VDC regulator to the canister cooling fan power supply to regulate the fan voltage to 12 VDC instead of 19 VDC.

Guide steps include:

a) Building/wiring the 24 VDC power supply (with STOP button)

b) modifying the ultimaker v1.5.7 control board to use a more efficient DC-DC regulator

c) Replacing the 12 VDC fan in the printer canister with a 24 vdc fan

d) replacing the A4988 stepper motor drivers with DRV8255 stepper drivers, and setting the limit current. (I assume 1.75A for X/Y/Z motors and 1A for extruder motors)

e) replacing the 12 VDC heater cartridge in the extruder with a 24 VDC heater cartridge.

DISCLAIMER: THIS IS A PROJECT INVOLVING WORKING WITH AC CURRENT AND VOLTAGES.

TRY IT AT YOUR OWN RISK. I TAKE NO RESPONSIBILITY FOR YOUR WORK.

TOOLS:

- Soldering Iron (1)
- wire cutter/wire stripper (1)
- solder tip cleaner (brass shaving version) (1)
- Solder tip tinner (1)

PARTS:

- a) 9Ft long 14 Gauge (rated at 15A) replacement appliance cord (1)
- b) 1/2" Thomas & Betts PVC strain relief connector (2)
- c) 3/4" Thomas and Betts PVC strain

- Hand drill (1)
- 3/16" drill bit (1)
- #2 Robertson screwdriver bit (1)
- Copper braid for desoldering (Solder wick) (1)

https://www.digikey.ca/product-detail/en/chemtronics/80-6-5/80-6-5-ND/306985?utm_adgroup=Desoldering+Braid%2C+Wick%2C+Pumps&mkwid=sSohTKyd6&pcrid=249862389973&pkw=&pmt=&pdv=c&productid=306985&slid=&gclid=Cj0KCQjw5MLrBRCIARIsAPG0WGzqJIUT7aoEWQT_b0uXQGkm3hZ8Xeg2qrjGZodF679C-n7DN0yvbp8aAkXmEALw_wcB

- flat head screwdriver (1)
- #2 Robertson screwdriver (1)
- M2.5 allan key (1)
- 1 x small tip philips head screwdriver. (1)
- 1 x Digital multimeter (used as voltmeter) (1)

- c) 3/4" Thomas and Betts PVC strain relief connector (2)
- d) 2NC emergency stop switch rated at 10A @ 600VAC (1)

Either a 2NC push/pull switch or a 2NC push/pull twist to reset switch.

- e) 6-outlet power bar rated at 15A with surge suppressor and off switch (1)
- f) 5.5mm to 2.5mm barrel connector cable rated at 16 AWG, with exposed wire leads (1)

I measured the OD of this cable and it is 7mm. https://www.digikey.ca/product-detail/en/globtek-inc/LCP6186FSILI-SR-R/1939-1879-ND/10057505

- g) 12VDC regulator RECOM R-78C12 DC-DC switching regulator (1)

I got this tip from this youtube video here https://www.youtube.com/watch?time_continue=1&v=EDALnUeGb_g

- h) 24 VDC 40 Watt E3D V6 heater cartridge (for extruder) (1)
- i) heat shrink tubing (1)

I ordered something like this from amazon https://www.amazon.com/270-pcs-Adhesive-Assortment-MILAPEAK/dp/B0771K1Z7Q/ref=sr_1_3?keywords=heat+shrink+tubing+with+heat+activated+adhesive&qid=1567638158&s=gateway&sr=8-3

- j) #11 Wire terminal screw connector to connect three (3) 14 Gauge wires together (3)

Ideal brand #11 (Get a 4-pack)
https://www.homedepot.ca/product/ideal--11-set-screw-4-pack-/1000663839

- k) 24 VDC electric fan 40mm (square) x28mm (depth) with a decibel level under 40 db (I used a digikey 1688-1128-ND) (1)

digikey 1688-1128-ND
For the canister fan on the 3D printer canister. https://www.digikey.ca/products/en?keywords=1688-1128-nd

- l) Thomas Betts Outdoor Weatherproof PVC Double Gang Device Box Grey. Make sure you get the one with threaded

connections. (1)
for holding in the terminal wires. Make sure you get the device box with threaded connections.

- m) Outdoor Weatherproof PVC Double Gang Blank Cover Thomas Betts Outdoor Weatherproof PVC Double Gang Blank Cover (1)
- n) 22" x 10" plywood (1 2" thick) (to mount power supply components) (1)
- o) Four (4) 4-40 x 1/4" long screws (1)
- p) twelve (12) #10 robertson wood screws (1/2" lg) (1)
- q) four (qty = 4) 1-1/2" corner brace (4)
- r) 24VDC power supply rated between 350 Watt (supplies 14.6A) to 500 watt (supplies 21 A) (1)
Go to digikey and type AC-DC voltage convertor rated between 350 to 500 Watt. Here is an example of the minimum that you want https://www.digikey.ca/product-detail/en/mean-well-usa-inc/LRS-350-24/1866-3346-ND/7705034
- s) Several zip ties long enough to secure the power bar to the panel through holes drilled in the wood panel. (6)
6" to 8" zip ties
Take some from the bag here https://www.amazon.ca/DTOL-Plastic-Cable-100-Pack-Black/dp/B002C0SKBW
- t) DRV8255 stepper motor drivers. Upgrading from the A4988 stepper motor drivers to the DRV8255 stepper motor drivers makes them more voltage tolerant, and allows them to handle higher current. https://www.pololu.com/product/2133 (4)
Pololu DRV8255 stepper motor drivers
Look at the pololu website for details here https://www.pololu.com/product/2133
- u) hinged ferrite core for 9mm thick cable (digikey 240-2066-ND) (2)
(I measured my power cable, it was 9mm thick, so I used a 9.07mm inner diameter hinged digikey 240-2066-ND
Measure your power cable, it might have a different OD. The digikey link is here

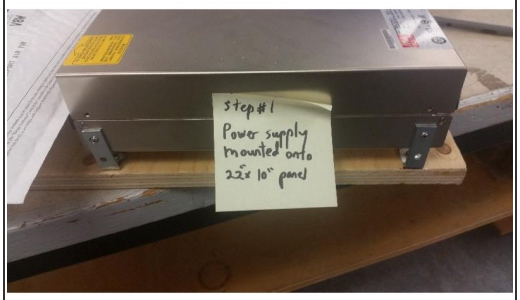
https://www.digikey.ca/products/en?keywords=240-2066-nd

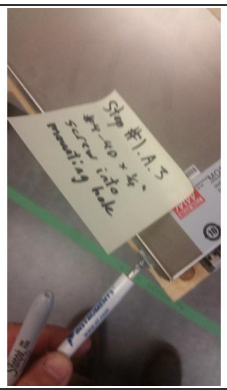
- v) Hinged ferrite core for 7mm thick cable (digikey 240-2075-ND) (2)

Hinged ferrite core for 7mm thick cable

We used two (2) of these on the 24 VDC barrel jack cable. The digikey site is here https://www.digikey.ca/products/en?keywords=240-2075-nd)

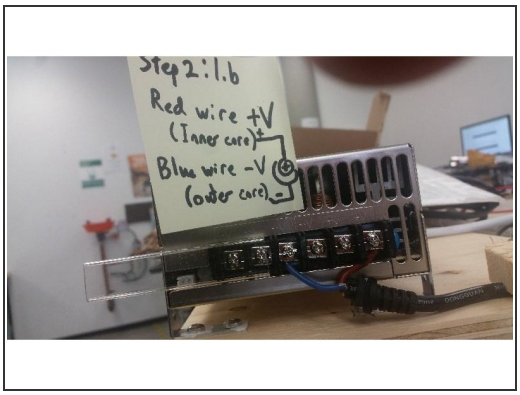
Step 1 — 1.Building the power supply. (a) screw the 24 VDC power supply to the wooden board.





- The 24 VDC power supply is heavy. Securing it to the 22" x 10" plywood board with the 1-1/2" angle brackets is the easiest way to keep it in place.
- Step #1: Measure the dimensions of the power supply, locate the mounting holes on the power supply and figure out how best to lay out the angle brackets so they line up with the mounting holes on the 24 VDC power supply)
- Step #2: Screw the angle brackets into the wood using eight (8) #10 Robertson cap screws (1/2" long)
- Step #3: Screw in the 4-40 x 1/4" screws through the angle brackets into the 24 VDC power supply to secure it to the panel.
- *NOTE: Steps #2 & #3 can be reversed if needed). The picture also shows the angle brackets mounted inwards

Step 2 — 1.Building the power supply. (b) screw barrel connector cable to the power supply



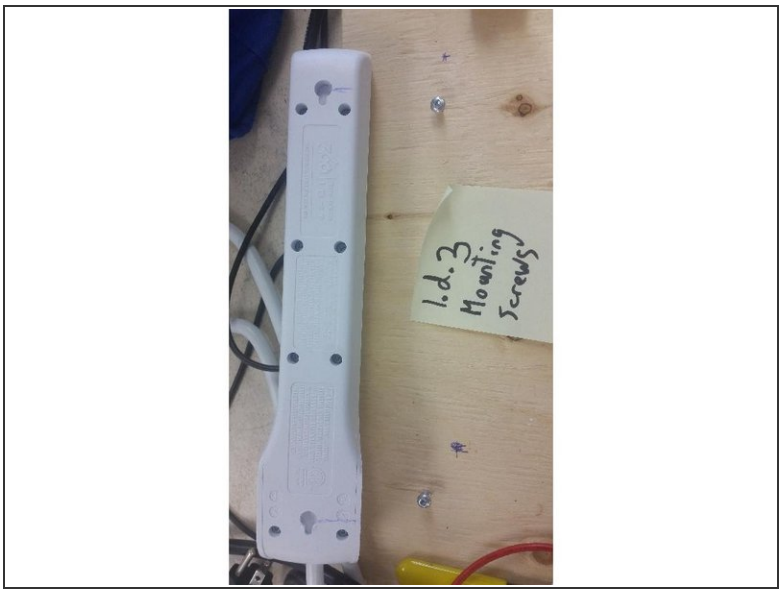
- The BOXZY accepts a 5.5mm OD / 2.5mm ID barrel plug for the power supply. This is how we connect the barrel jack cable to the 24 VDC power supply.
- Step #1: The barrel connector used in the BOXZY has a HOT (+POSITIVE) inner core, and the (-NEGATIVE) outer core. For this cable the red wire is the inner (+POSITIVE), but the blue wire is the (-NEGATIVE) outer core.
- Step #2: Wire the inner core wire (RED/+POSITIVE) to the +V of the DC output of the DC power supply.
- Step #3: Wire the outer core wire (BLUE/-NEGATIVE) to the -V of the DC output of the DC power supply
- Step #4: Strain relief is necessary to prevent the cable from being ripped out.
- Step #5: Measure the cable diameter, and find a drill bit the same diameter as the cable.
- Step #6: Drill a hole in a wood block using the drill bit, then cut the wooden block in half. Pre-drill some 1/8" holes to serve as guides for #8 screws (ensure they do not cross where the cable will go). Now we screw the wood block down over the barrel cable to serve as strain relief to keep the cable from pulling loose.

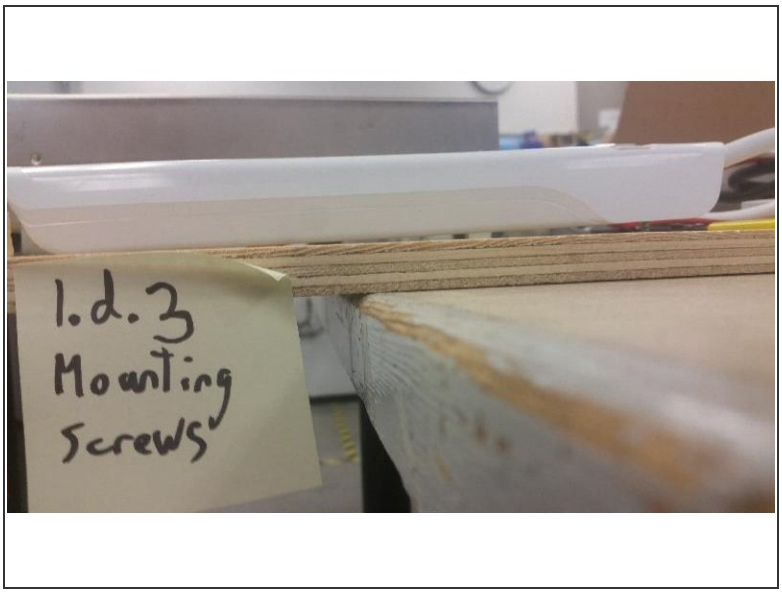
Step 3 — 1.Building the power supply (c) Connect the 24 VDC supply to the dual ganged enclosure

- Now we connect the 24VDC power supply to the PVC Outdoor Weatherproof Double Gang Device Box. Look at the first 12 seconds of the video to see the process. Note in my setup I did not buy enough 3/4" connectors and used a 1/2" connector instead. This was sub-optimal because I had to feed both the power bar wire & the 24VDC AC supply in same hole
- Step #1: Get the PVC outdoor weatherproof device box, And a 3/4" threaded strain relief connector, and the 9ft long replacement appliance power cable.
- Step #2: Make sure the cord is UNPLUGGED. Cut 9" off the end of the replacement cord (the end with the exposed wires. DO NOT CUT NEAR THE THREE PRONG CORD). Strip the outer insulation of the last 3" of each side of the cut off wire. Do not strip any of the insulation off of the ends of the green/white/black wires.
- Step #3: Knock out three (3) of the 3/4" diameter holes in the device box. They are initially sealed, but can be knocked out easily enough by stabbing in with a screwdriver.
- Step #4: Feed the wire through the 3/4" diameter strain relief connector (remember the wire feeds through Cap/Gland/connector/ gasket.). Do not tighten the connector yet onto the wire. (Note: in my picture I have both the power bar wire & 3-wires going through a single 1/2" connector. This is suboptimal & the other way with two 3/4" is better)
- Step #5: Feed the green/black/white wires though one of the 3/4" holes, and thread the 3/4" connector into the 3/4" hole. Tighten the connector (with the gasket) onto the PVC outdoor device box. It should now be snug, but the cable can move freely though the connector.
- Step #6: Strip 1/4" of insulation off of the green/black/white wires near the DC power supply. On the DC power supply, connect BLACK to L (Live). Connect WHITE to N (Neutral). Connect GREEN to ground.

- Step #7: Pull the rest of the wire into the device box (this shortens the amount of wire outside the device box). Leave enough length of wire outside the box to be able to locate the box near the DC power supply. Now tighten the cap on the connector to keep it from pulling loose.

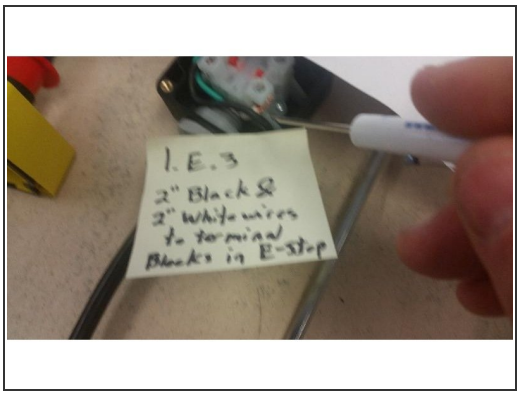
Step 4 — 1.Building the power supply (d) Connect the power bar into the dual ganged enclosure

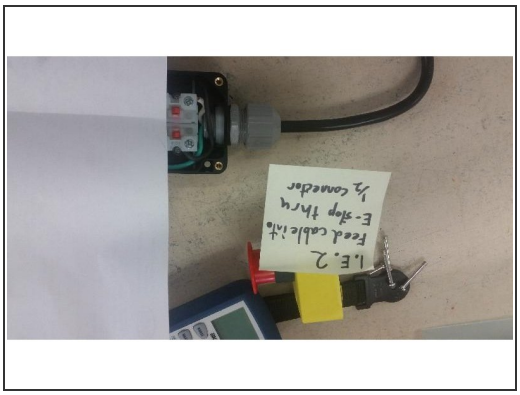




- A power bar connected to this power supply can be used to power external devices for the BOXZY. At our lab we use this to powerthe router, when CNC milling, and both the heated bed & the active cooling line for our E3D V6 hotend, when 3D printing. We are wiring the power bar so it will also be shut down by hitting the emergency stop.
- Step #1: Figure out the best location for the power bar on the wood panel next to the 24VDC supply & mark the cable where it would be inside the device box & mark the power bar cable with a marker. Now cut off the 3-prong connector near head, & strip the outer insulation down to the marker line. DO NOT CUT THE 3-WIRES OR STRIP THEIR INSULATION)
- Step #2: Attach an appropriate gland to the 3/4" connector to hold the cable in place. Feed the power-bar-cable through the 3/4" connector (and gasket) and then through the 3/4" hole in the enclosure. Tighten the 3/4" connector against the device box. Do not tighten the connector cap against the cable.
- Step #3: Move the power bar to the best location and secure it to the board. We used two #8 cap screws as mounting screws, drilled them into the wooden panel, then fitted the power bar onto the screws, and we drilled some holes into the panel in order to zip-tie the cables in place. Now the power bar is fixed in place.
- Step #4: Now make any adjustments to the power bar cable the power bar cable inside the device box until the cable is properly set, and tighten the cap on the connector. Now the power bar is properly fixed in place (but not connected to AC power.)

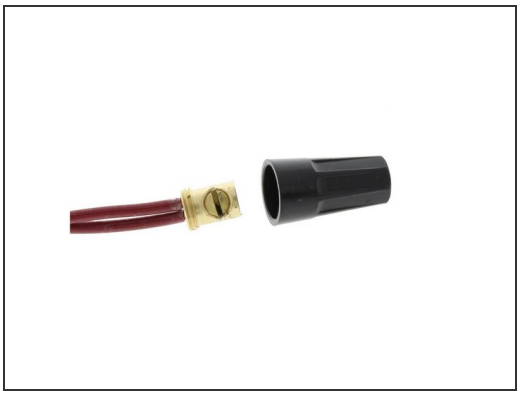
Step 5 — 1.Building the power supply (e) Connect the ESTOP emergency button

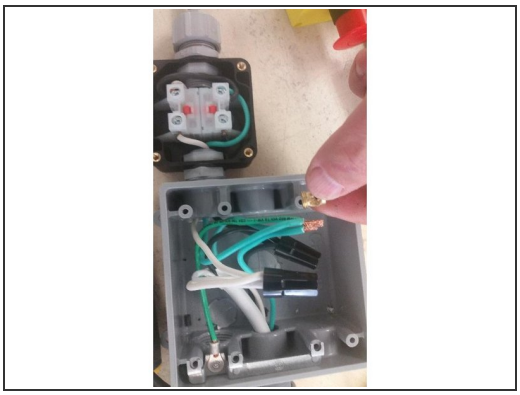




- Now we show how to connect the E-Stop to the dual gang box. Get the two (2) 1/2" strain relief connectors, and the E-Stop button, and the rest of the 14 Gauge appliance replacement cable. Make sure that the appliance replacement plug IS UNPLUGGED FROM THE WALL.
- Step #1: Take the remainder of the 9ft long replacement extension cord, and cut off 11" of the outer jacket of the appliance cable. Leave the insulation on the BLACK (Live) / WHITE (Neutral)/ GREEN (GND). DO NOT CUT OFF THE BLACK/WHITE/GREEN WIRES. (yet)
- Step #2: Take E-STOP button, & use a screwdriver to pop out both the 1/2" holes. Unscrew the screws from the E-STOP and open the E-STOP so you can see the terminal blocks. Feed extension cord through the 1/2" Strain relief connector (& gasket), and into the E-STOP (hole labelled TOP).
- Step #3: Screw the 1/2" connector tightly into the E-Stop using the plastic nut in E-STOP. Remove cap & gland from the other 1/2" strain relief connector. Connect other end of connector to one of the 3/4" connection holes on the dual gang box. Screw them together tightly so E-Stop is connected tightly to dual gang box & lies flat on panel
- Step #4: Now take the 10" of Black & White wires. DO NOT CUT THE GREEN WIRE. measure 8" of black and white wire sticking out from replacement appliance cable & cut them off. Set the 8" cutoff black & white wires aside. Strip 1/4" insulation from end of of the black&white wires remaining on cable, and screw them into TOP of E-Stop terminals.
- Step #5: Now strip 1/4" of insulation off of on end of the 8" black and white wires, and wire them into the bottom terminals of the E-Stop. Now feed the 8" black/white/wires and 10" uncut green wire through the strain relief connector into the dual gang box.
- Step #6: Fit the top of the E-stop back into place on the E-Stop. Now screw it in place.

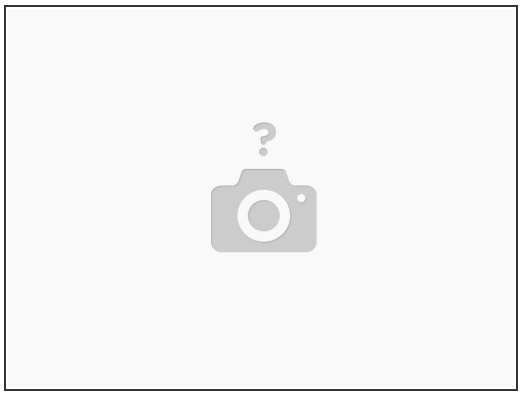
Step 6 — 1.Building the power supply (f) Wiring the BLACK/WHITE/GREEN wires together





- The wires were all fed into the dual gang box. Now we need to wire all three (3) Black (Live) wires together, all three (3) White (Neutral) wires together, and all three (3) (maybe 4) green GND wires together. Remember to feed wires into each brass fitting one-at-a-time.
- Step #1: Take all three BLACK (Live) wires inside the dual gang box, and strip enough insulation off of the three (3) black wires to fit inside the brass fitting of a #11 set screw wire connector. Tighten setscrew with flat end screwdriver until tight against all three wires. Give all 3 wires a tug to ensure connection. Screw on black cap.
- Step #2: Take all three WHITE (neutral) wires inside the dual gang box, and strip enough insulation off of the three (3) white wires to fit inside the brass fitting of a #11 set screw wire connector. Tighten setscrew with flat end screwdriver until tight against all three wires. Give all 3 wires a tug to ensure connection. Screw on black cap.
- Step #3: Take all three GREEN (GND) wires inside dual gang box. There may be a 4th case GND wire. Strip enough insulation off of the (3 or 4) GND wires to fit inside the brass fitting of a #11 set screw wire connector. Tighten setscrew with screwdriver until tight against all three wires. Give all 3 wires a tug to ensure connection. attach cap.
- Step #4: Screw on the lid of the dual gang box.
- Step #5: Screw the dual gang box to the wooden panel to secure it in place.

Step 7 — 1.Building the power supply (g) TESTING



- DO NOT PLUG POWER INTO THE BOXZY YET. Test the power supply. See if the 24VDC power supply provides 24 VDC. See if the power bar supplies 110 VAC. See if pressing the E-STOP button kills power to the 24 VDC power supply and the power bar. See if resetting the E-Stop turns power back on. (Basic testing).
- Step #1: Make sure the 24VDC is NOT plugged into the BOXZY
- Step #2: Plug in the power supply. Use a digital multimeter to test if the barrel connector provides 24 VDC. Set the multimeter to measure AC voltage. Now see if the power bar supplies power (see if the switch on the power bar is powered on).
- Step #3: Hit the E-stop to see if the power is still on. It should still be off
- Step #4: reset the E-Stop and see if power is still on.

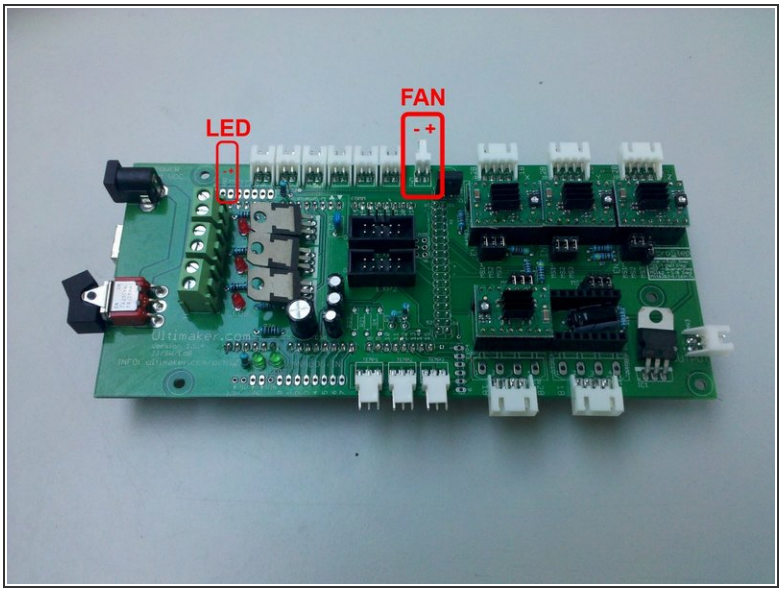
Step 8 — 2.Upgrading the control board. (a) removing the case and the board

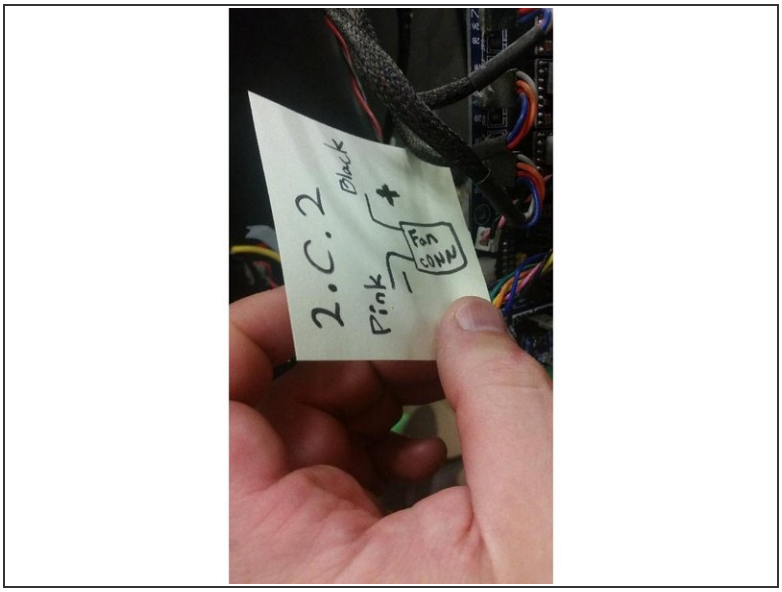
- The power supply has been built. Control board must be modified to avoid blowing out the 3D printer canister cooling fan, and to avoid overheating the board by replacing the 12 VDC regulator with a cooler running 12 VDC regulator that can more easily handle converting 24 VDC to 12 VDC. Special thanks to NEATHERBOT for the info in this section.
- This is the link to Neatherbot's tutorial for upgrading the 12 VDC regulator on the control board to a more efficient 12 VDC switching regulator. https://www.youtube.com/watch?time_conti...
- Step #1: Go to the BOXZY, loosen the screws holding on the control board cover (use an m2.5 metric Allan key)
- Step #2: Slip the case off screws and now use the same m2.5mm allan key to remove the three (3) screws holding the board onto the BOXZY. SAVE THE SCREWS and the plastic offsets.
- Now you can reach the 12 VDC regulator

Step 9 — 2.Upgrading the control board. (b)Desolder the old 12 VDC regulator, and solder on the new one.

- We will now use a soldering iron, a solder braid/solder wick and a solder sucker to desolder and remove the old 12 VDC regulator from the board, and replace it
- Step #1: Preheat the soldering iron. make sure the tip is clean and use the solder wick to remove the solder from around the 7812 regulator. Do not pull hard (avoid damaging the traces on the board). Use flat cutters to cut the 7812 off the board, then use the soldering iron to heat the remaining pin pieces and pull them out of the board.
- Step #2: Clean the holes using the soldering iron and the solder sucker, and the solder braid.
- Step #3: Now insert the RECOM R-78C12 DC-DC 12 VDC switching regulator to the board (orient it the same way the 7812 was oriented.). Solder the leads to the board.

Step 10 — 2.Upgrading the control board. (C)Identifying the wires to splice

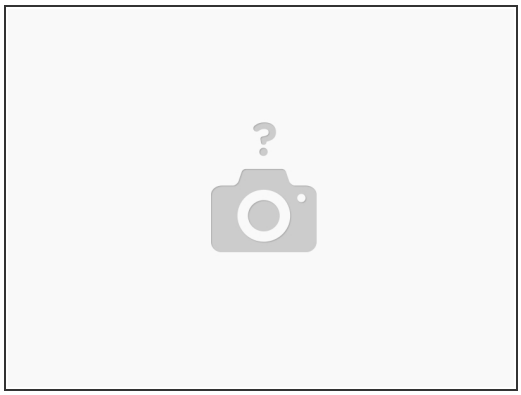




- The cooling fan used in the 3D printer canister is a 12V cooling fan that is run overpowered at 19V. If we upgrade the power supply to 24V we will burn it out. To solve this we will replace the 12 VDC fan (dimensions 40mm x 28mm) with a 24 VDC fan (dim 40mm x 28mm).
- P.S: Initially I tried wiring a 24 to 12 VDC step-down regulator between the fan power output on the board and the wires feeding power and signals to the BOXZY 3D print head, but this is a better solution).
- Step #1: Locate the 3D printer canister. Unscrew the six (6) screws from the top (including the ones in the handle) so that the red disc on the top can be removed.
- Step #2: locate the black and red wires coming from the fan, and see which wires they were spliced to. In my case (FAN:RED -> BOXZY:BLACK) & (FAN:BLACK -> BOXZY:PINK).
- Step #3: Make sure the power is OFF to the BOXZY. Strip off the heat- shrink insulation used by BOXZY to connect the 12 VDC fan to the canister. Unscrew the 12VDC fan from the red disc and put it aside.
- Step #4: Now screw on the new 24 VDC fan. The side of the 24 VDC fan with the label should be VISIBLE. (IF YOU CANNOT SEE THE LABEL WHEN YOU PUT IT IN, YOU SCREWED THE FAN ON BACKWARDS). Slip some heat shrink tubing onto both the red and black wires from the 24 VDC fan.

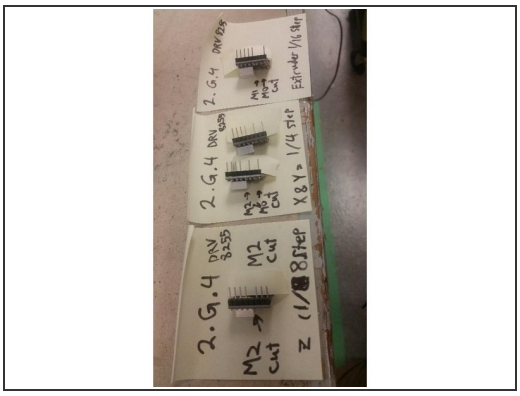
- Step #5: Connect the wires from the fan to the wires from the BOXZY canister header (FAN:RED -> BOXZY:BLACK) & (FAN:BLACK -> BOXZY:PINK). Solder them together, then after the solder has cooled, slip the heat shrink tubing over the solder joints and heat the tubing until the joints are properly covered.
- Step #6: Now fit the red disc back onto the canister and screw all six (6) screws (and the handle) back onto the printer head canister.

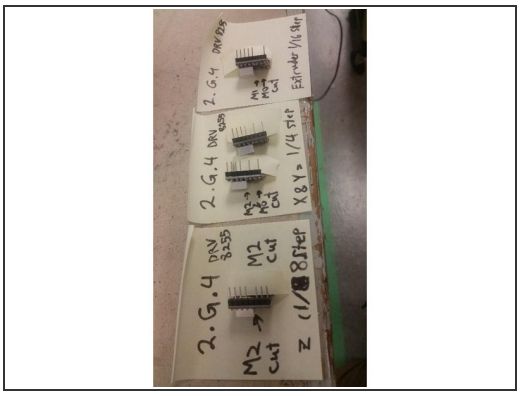
Step 11 — 2.Upgrading the control board (F) reattach board



- Reattach the control board, to the BOXZY. Also decide if we want to upgrade the stepper motor drivers (I RECOMMEND UPGRADING THE STEPPER MOTOR DRIVERS)
- Step #1: Screw control board back onto BOXZY (DO NOT FORGET TO INCLUDE THE NYLON SPACERS). Afterwards verify if we want to upgrade the motor controllers (BOXZY initially used A4988 stepper drivers). I recommend upgrading to the DRV8255 motor drivers instead of A4988 because they handle higher voltages better).
- Step #2: Verify that all the wires are still properly fitted into their sockets, and that they did not detach while the board was off of the BOXZY.
- Step #3: Decide whether to upgrade the stepper motor drivers on the control board. The BOXZY initially used A4988 stepper motor drivers (see the link here https://www.pololu.com/product/1182). If one of them burns out they will need replacement. I suggest using the DRV8255 stepper motor drivers shown here https://www.pololu.com/product/2133
- Step #4: If you do decide to upgrade the stepper motor drivers, then follow the optional steps 2.G & 2.H on the next two pages.

Step 12 — 2.Upgrading the control board. (G-OPTIONAL) install new motor drivers and set STEP MODE for the stepper motor drivers





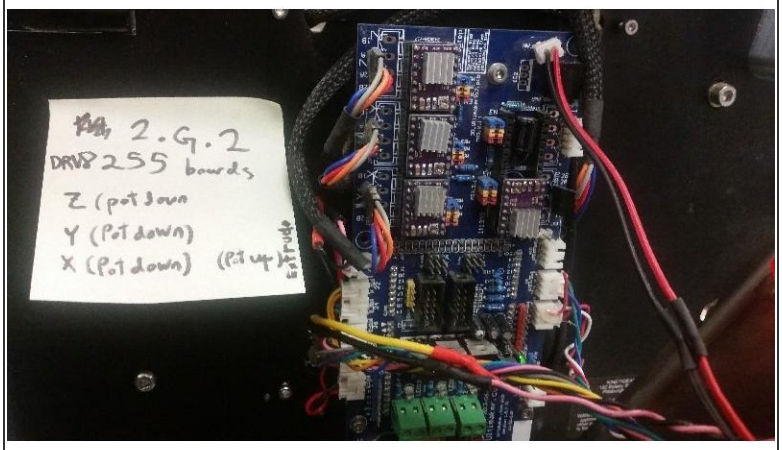
- Replace the four (4) BOXZY stepper motor drivers with DRV8255 stepper drivers (OPTIONAL BUT RECOMMENDED), Set the step mode of each X, Y, Z & Extruder stepper motor driver by cutting pins on stepper motor driver board to ground them. BOXZY uses 1/4 step for X & Y motors, 1/8 step for Z motor, and 1/16 step for extruder.
- Step #1: UNPLUG THE USB CABLE AND THE 24 VDC POWER SUPPLY FROM THE BOXZY. Stepper motors operate in different step modes, & use different current settings. For BOXZY, X & Y motors go at 1/4 step@1.75A. Z motor goes in 1/8 step@1.75A. & extruder goes in 1/16 step@1A. The ultimaker 1.5.7 control board clearly labels X , Y, Z & EXTRUDER.
- Step #2: Note the location and orientation of the X/Y/Z and Extruder motor drivers plugged into the BOXZY control board. Note the heat sinks are attached to the main chip on the control board. Take SPECIAL NOTE of the location of the potentiometers on each stepper motor driver. Now PULL OUT THE OLDER STEPPER MOTOR DRIVERS.
- if using DRV8255, the stepper motor drivers are oriented so that the potentiometers are located on the BOTTOM of the X, Y, and Z stepper motor drivers, and on the TOP of the extruder driver. In this tutorial I ASSUME WE ARE USING DRV8255 DRIVER BOARDS. Remember, if the drivers are PLUGGED IN THE WRONG ORIENTATION, they will FRY.
- Step #3A (A4988 ONLY): If replacing the motor driver with A4988 driver boards, set X & Y to 1/4 step by clipping pin MS1& MS3. Set Z to 1/8 step by clipping pin MS3 only, and set the EXTRUDER to 1/16 step, by leaving all pins alone. Pololu ref https://www.pololu.com/product/1182. Plug A 4988 boards back in to BOXZY, Potentiometer down for XYZ,

- Step 3B (A4988 ONLY): When plugging A4988 boards back into the BOXZY control board, pay attention to the orientation of the potentiometers of the X, Y, Z, and Extruders. When using the A4988, X/Y/Z have potentiometers oriented UP, & the potnetiometer on extruder orients DOWN. *Remember: DRIVERS WILL FRY IF PLUGGED IN INCORRECT ORIENTATION.

- Step #4 (DRV8255 ONLY): If replacing the motor driver with a DRV8255, driver boards, set X & Y to 1/4 step by clipping pin MODE0& MODE2. Set Z to 1/8 step by clipping pin MODE2 only, and set the EXTRUDER to 1/16 step, by clipping MODE0 & MODE1. Pololu ref https://www.pololu.com/product/2133

- Step 4B (DRV8255 ONLY): When plugging 8255 boards back into the BOXZY control board, pay attention to the orientation of the potentiometers of the X, Y, Z, and Extruders. When using the 8255, X/Y/Z have potentiometers oriented DOWN, & EXTRUDER has potentiometer oriented UP. *Remember: DRIVERS WILL FRY IF PLUGGED INTO INCORRECT ORIENTATION.

Step 13 — 2.Upgrading the control board. (H-OPTIONAL) Plug motor drivers into the contro board, and set current limit.



- We are still committing to changing the stepper driver boards. Now we adjust the potentiometer to set the maximum current that each stepper motor will receive. This protects the steppers from burnout. The motor drivers will have had their stepper mode set up. Also remember, the X/Y/Z motors use 1.75A, and the extruder motor uses 1A.

- Use following references for setting stepper mode & current limit/voltage levels of the boards a) For A4988 see Pololu datasheet https://www.pololu.com/product/1182 b) For DRV8255 use the pololu datasheet https://www.pololu.com/product/2133 c)tutorial on A4988 go here https://www.makerguides.com/a4988-steppe...

- Current limits are set by adjusting the potentiometer on the A4988, or the DRV8255. The Boxzy has a tutorial on replacing A4988 drive boards located here Replacing a Stepper Motor Driver Different boards (including different versions of A4988, as well as DRV8255 use different formula to set limit current)

- Know where to measure the voltages. Use a digital multimeter, set it to measure voltage, and use it to measure the voltage setting. Use the multimeter to measure the voltage between the metal potentiometer on the board and the ground pin on the board. Note: In this tutorial, all pictures show DRV8255 control boards.

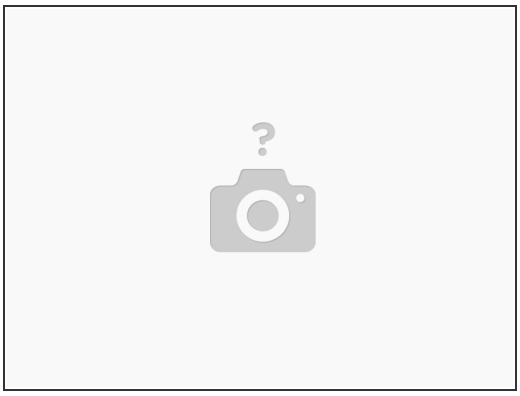
- Step #1: Make sure the BOXZY is UNPLUGGED from 24 VDC. Now PLUG IN USB CABLE ONLY TO THE PC. This will provide the reference 5VDC voltage needed by the control board required for our adjustments. NOTE*** SKIP THESE STEPS IF YOU ARE USING THE ORIGINAL A4988 DRIVERS PROVIDED BY BOXZY WITHOUT MAKING ADJUSTMENTS, AND JUST RE-ATTACH THE COVER).

- Step #2 (BOXZY ORIGINAL A4988 ONLY): If using original A4988 motor drivers that came with BOXZY, or A4988 motor drivers from before 2017, use formula VREF=8·IMAX·RCS, where RCS = 0.05Ohm. So for limit current =1.75A for X/Y& Z motors), set VRef =0.05*8*1.75 = 0.7V = Vref. For the extruder, with limit current 1A, Vref = 1*0.8*0.05=0.4V.

- Step #3 (A4988 FROM 2017 OR LATER): If replacing the motor driver with A4988 from 2017 or later, use formula VREF=8·IMAX·RCS, where RCS = 0.068Ohm. So for a limit current of 1.75A for the X/Y/Z motors), set VRef =0.068*8*1.75 = 0.952V. For the extruder that operates at 1A, set VRef = 0.068*8*1 = 0.544V

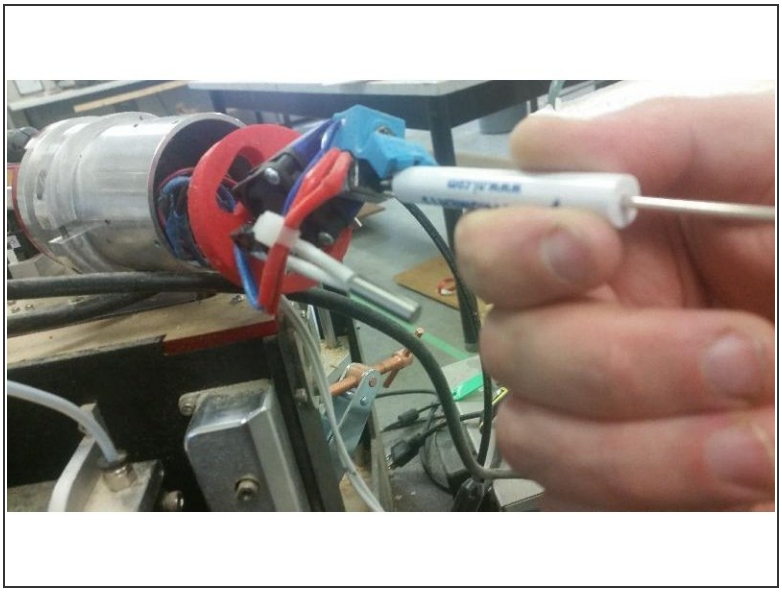
- Step #4 (DRV8255 ONLY): If replacing the motor driver with a DRV8255, use formula VREF=0.5*IMax. So for a limit current of 1.75A for the X/Y/Z motors, set the VRef =0.5*1.75 = 0.875V. For the extruder that operates at 1A, set VRef = 0.5*1 = 0.5 = Vref.

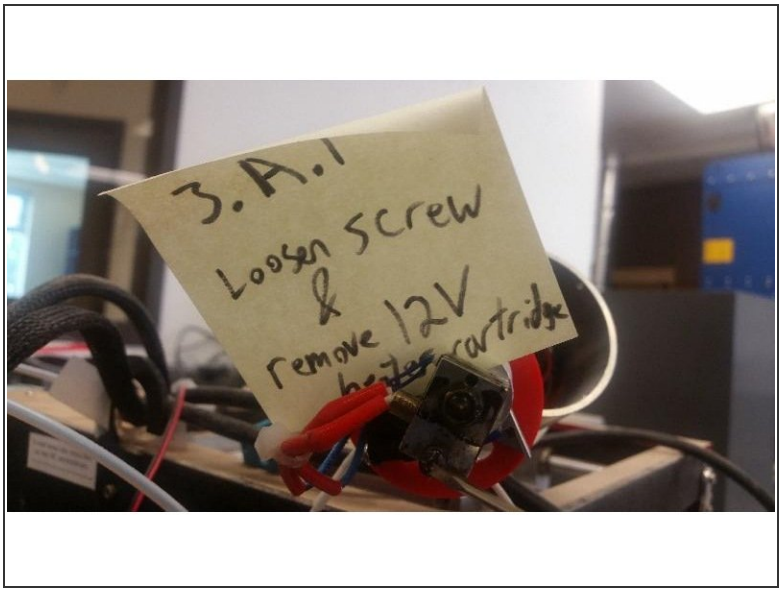
Step 14 — 2.Upgrading the control board. (I) reattach board, verify the voltage on the motor drivers, and attach cover



- Now we reattach the cover over the control board, and tighten it back on using a 2.5mm allan key. Make sure that the wires are not pinched by the cover when reattaching it.

Step 15 — 3.Upgrading the heater cartridge on the 3D printer canister

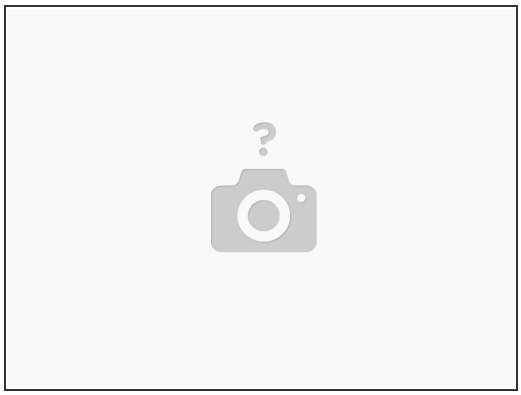




- The BOXZY uses a 12 VDC heater cartridge for the 3D printer and runs it at 19 VDC. With this upgrade, the heater cartridge is upgraded to a 24 VDC heater cartridge operating at 24 VDC.
- Step #1: Take the hot end, and loosen the screw that keeps the 12 VDC heater cartridge attached. Pull out the old 12 VDC heater cartridge and insert the new 24 VDC heater cartridge.

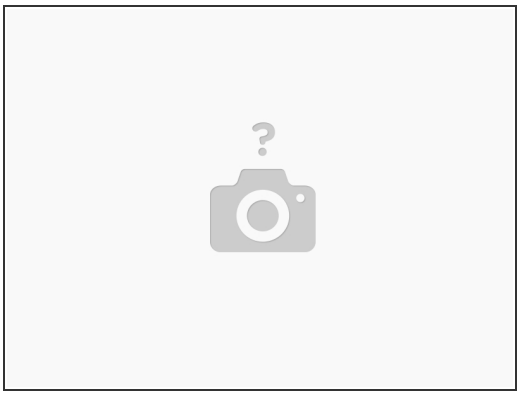
- Step #2: unscrew the plate that holds the hot end inside the canister, and pull out the hotend. Locate the point where the two (2) wires for the 24 VDC hotend are 4" (or more) from the hotend, and cut the wires that were feeding power to the 12 VDC cartridge. Strip 1/4" of insulation from the ends of the wires to be soldered.
- Step #3: Slip 1" of heat shrink tubing over the wires for the 24 VDC heater. move the shrink wrap away from the exposed leads. so heat from soldering iron will not prematurely shrink the tubing. Now measure the length of wires needed for the 24 VDC heater, and cut the wires to length, and strip off an additional 1/4" of insulation from the wires
- Now solder the wires together (order does not matter) so that the 24 VDC heater is connected to the canister heater power lines. Let the wires cool, then slip the heat shrink tubing over the exposed solder joints. Use a heat source to shrink the tubing over the exposed solder joints.
- Now coil the wire back into the 3D printer canister, re-insert the hotend head, and tighten the screws to reattach it. Make sure that there are no wires getting pinched or excessively strained.
- Do not forget to reattach the insulating silicone sleeve cover on the hotend of the 3D printer extruder.

Step 16 — Add ferrite beads to the 24 VDC power supply



- I am not sure how well these work, but adding ferrite beads to both the 110 VAC line and the 24 VDC power supply cables of the 24 VDC power supply to filter out noise in the lines that can cause electrical glitches.
- Step #1: Use a vernier caliper and measure the diameter of the 110 VAC power cable attached to the 24 VDC power supply. In our case, the 110 VAC power supply In our case, we measured the cable diameter to be 9.04mm
- Step #2: Use a vernier caliper and measure the 24 VDC cable on the power supply. In the case of the 24 VDC power cable, we measured the cable diameter to be 6.7mm
- Go to digikey, and search for ferrite cores cable and wiring, and look for snap-on ferrite beads. Get on bead for the 110 VAC cable, and another snap-on ferrite bead for the 24 VDC cable.
- In this case order one https://www.digikey.ca/product-detail/en... for the 6.7mm OD 24 VDC cable, and
- In this case order a https://www.digikey.ca/product-detail/en..., ferrite bead for the 110 VAC cable with OD 9.04mm.
- Now snap the ferrite beads onto the correct cables. This should help filter out any electrical noise generated by the power supply that could potentially glitch the power supply.

Step 17 — 4.Test the 3D printer hotend



- Before you print, test the hotend to ensure that it is properly connected

These should be all of the parts needed to get you started. Here is the electrical schematic showing the design of the power supply with E-stop

