USB Rechargeable Cordless Soldering Iron

Created by Phillip Burgess

https://learn.adafruit.com/usb-rechargeable-cordless-soldering-iron

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Overview

This project takes an existing tool — the Hakko FX-901 cordless soldering iron — and adds USB charging and a Lithium Ion battery inside a 3D-printed pack.

The FX-901 normally uses four AA cells, either alkaline or NiMH type. I like having this little iron around for cosplay electronics emergencies, and adding USB charging means there's less to pack...it can use the same phone charger and USB cable I'm already traveling with. Less is good.

A fine little backup iron for anyone who does electronics outdoors...RC helicopters, ham radio, Burning Man, things like that.

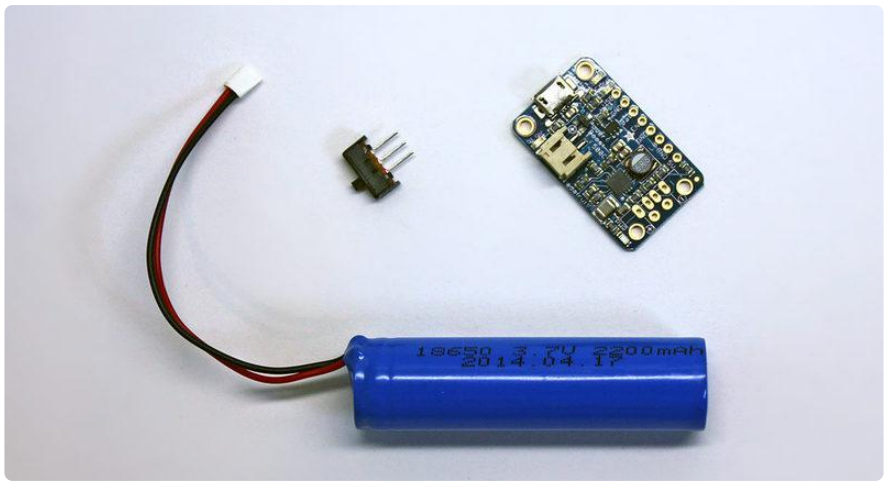
Read through all the instructions before you begin. That way you'll know the plan and won't install anything backwards.

No modifications are made to the iron itself or the original battery pack; it can still be used if needed. What we're building here is a complete swap-out replacement for the pack.

Adafruit Parts:

- 2200 mAh Lithium Ion Cylindrical Battery (http://adafru.it/1781)
- PowerBoost 500C Charger (http://adafru.it/1944)
- Breadboard-Friendly SPDT Slide Switch (http://adafru.it/805)

Use the PowerBoost 500C Charger, not the 500 Basic. We need the former's USB charging feature. And not the PowerBoost 1000C; it's wider and won't fit in the 3D-printed case.



Also Required

- 3D printer. The battery holder is just under 110mm long and will fit in the build volume of most printers. For exceptionally small printers, try rotating the part 45 degrees, so it's pointed corner-to-corner.
- Filament: transparent PLA or ABS is preferred, allowing the PowerBoost status LEDs to show through. White or natural may also work.
- Glue: 5-minute epoxy (preferred) or E6000 craft glue.
- Hakko FX-901 cordless soldering iron (and batteries, if currently using it to build this project). We don't currently stock the FX-901, but it's available through Amazon and elsewhere.
- Wire cutters, solder and related paraphernalia, optionally some heat-shrink tubing
- 2 (two) #4-40 x 3/8" oval- or pan-head machine screws (steel, brass or zinc-plate, not nylon — we're using these as makeshift power terminals)
- 4 (four) #4-40 nuts
- 20 gauge wire (for powering the iron)
- 30 or 28 gauge wire (for the on/off switch)
- USB power adapter and A-to-microB cable for recharging

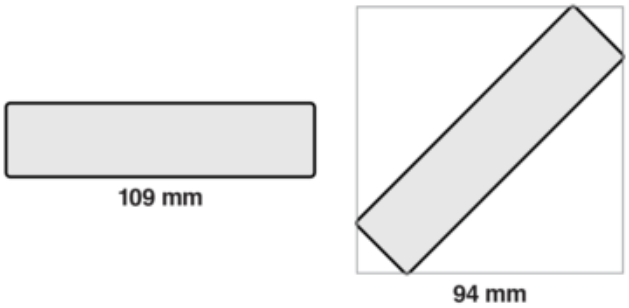
3D Printing

Let's start with the printing first. You can assemble the electronics (on the next page) while the printer runs the job.

Download 3D Files from Thingiverse

There are two parts: a main pack into which all of the electronics fit, and a small latch piece to hold the pack in place in the iron (similar to the original battery holder). Use transparent filament so you can see the PowerBoost status LEDs inside.

The pack has some minor bridging and overhangs, but most printers should be OK without support material. If not, switch that on and give it another go.



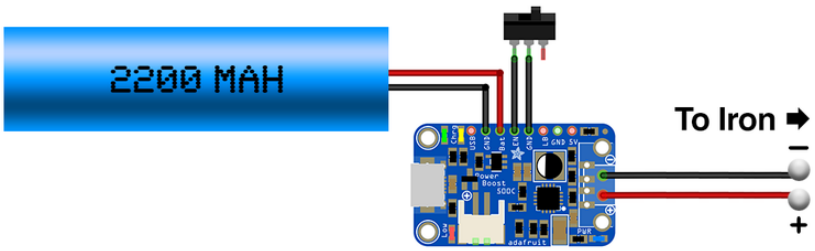
If using a very tiny printer (such as M3D or Printrbot Play), you may need to turn the body 45 degrees to fit corner-to-corner across the bed.

"Normal" quality (0.2mm layer height), 25% infill works well. "Fine" quality (0.1mm) looks amazing but takes hours to print.

The latch piece slots into place at the back of the pack. There's no "click" like the original battery holder, but friction should be sufficient. If needed, you can scale the Z axis to make it a little thicker or thinner, and print that piece again...it only takes a few minutes.

This flat area is where the PowerBoost circuit fits inside. It also turns out to be a good spot for contact info, since I occasionally loan tools at events.

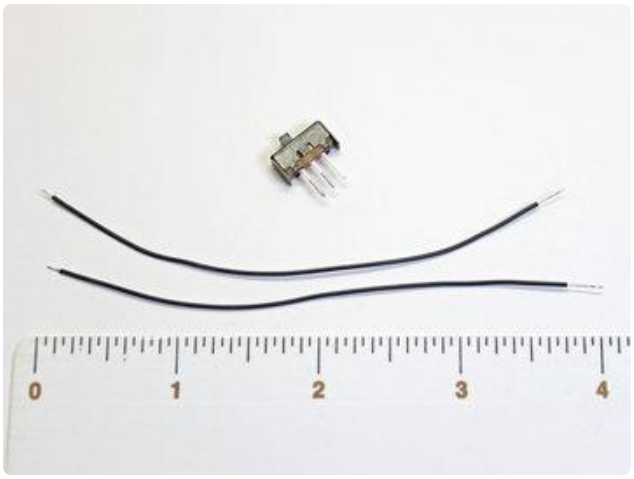
Soldering



This is a simple soldering project with just a few connections required. We know you're eager to get started, but don't rush into it...most importantly, do not install the USB jack on the PowerBoost! We'll be wiring to the PowerBoost directly.

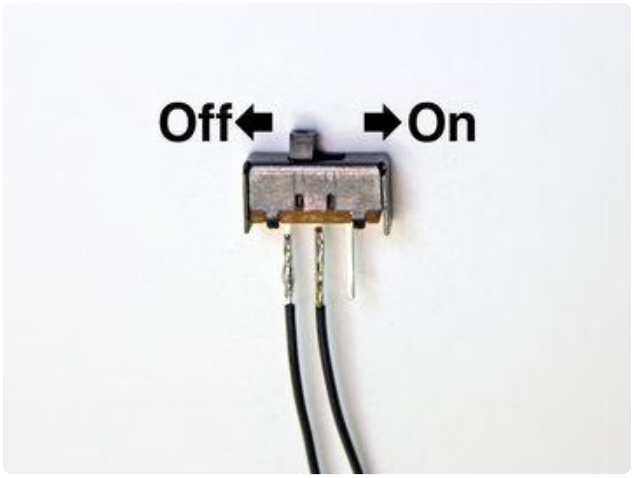
DO NOT install the USB jack on the PowerBoost!

Switch



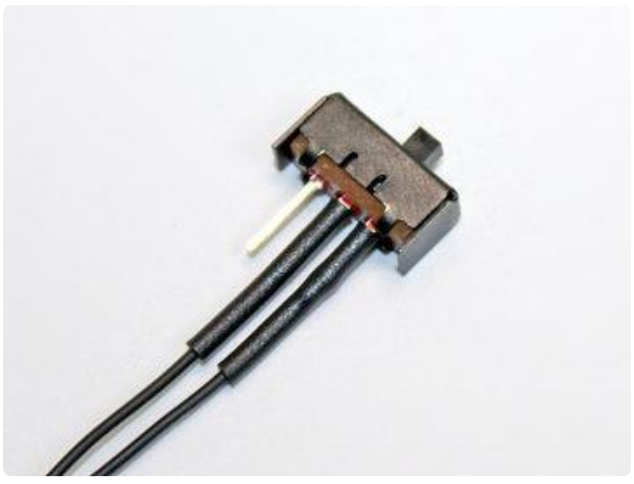
Cut two pieces of wire about 4 inches long. Our 30-gauge silicone stranded wire works well...or use 30-gauge wire-wrap wire or peel a couple conductors off a ribbon cable.

Strip about 1/4" insulation from one end and 1/8" from the other. Tin the ends if using stranded wire.

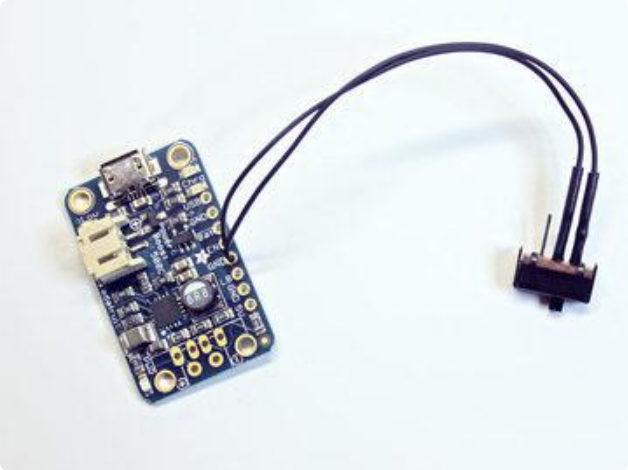


Tin the legs of the switch and solder the wires: one goes to the middle pin, the other goes to either of the two outer pins; the third pin is not connected.

For later reference: the switch is “off” when moved to the two-wires side.



Optional but recommended: heat-shrink tubing reinforces these connections so they won’t break off later. Use it if you got it!

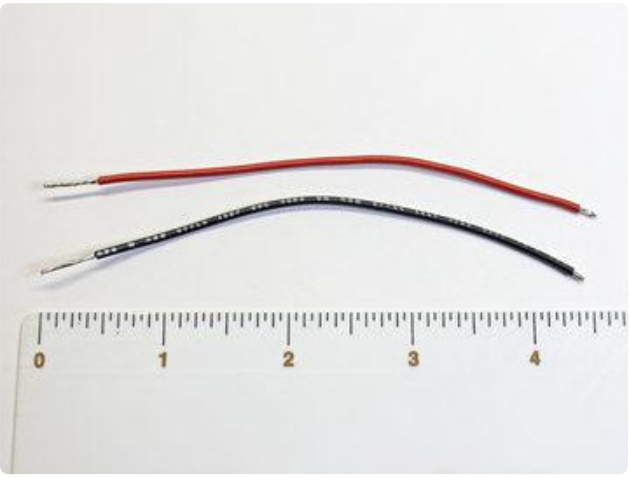


Solder the other end of these two wires to EN and adjacent GND pin on the PowerBoost (near the Adafruit logo).

Polarity doesn't matter here; either wire to either pin.

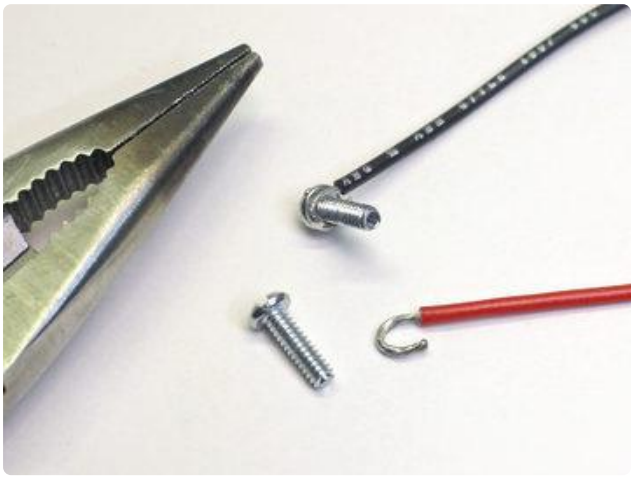
Wires should be above the board; let's keep the underside as flat as possible.

Power Wires



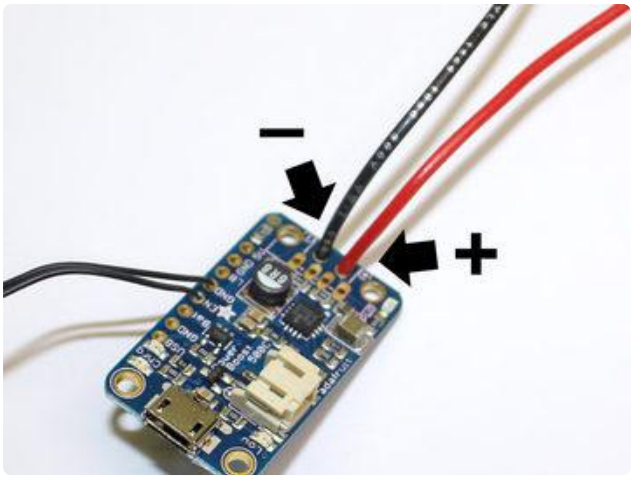
Cut two pieces of thicker wire (20 gauge is ideal, but a little smaller is OK) about 4.5 inches long. Use different colors for + and – if you have it, else keep careful notes.

Strip 1/2" of insulation from one end of the wires, and 1/8" from the other end. Tin the ends if using stranded wire.



Using pliers, wrap the longer exposed end of the wires around two #4-40 x 3/8" metal screws to create little hooks.

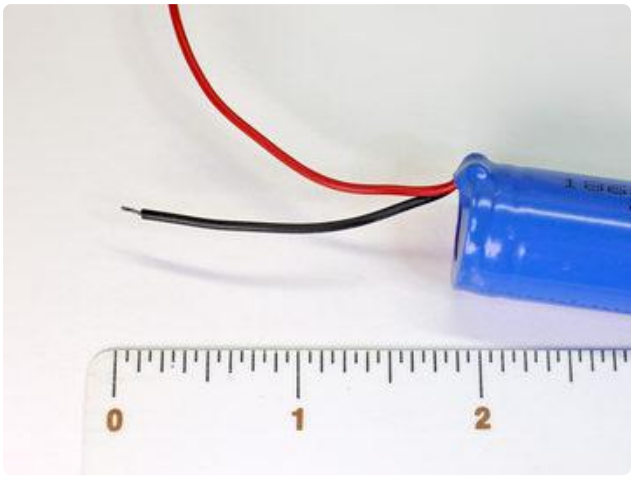
Remove the screws afterward; we'll get back to these later.

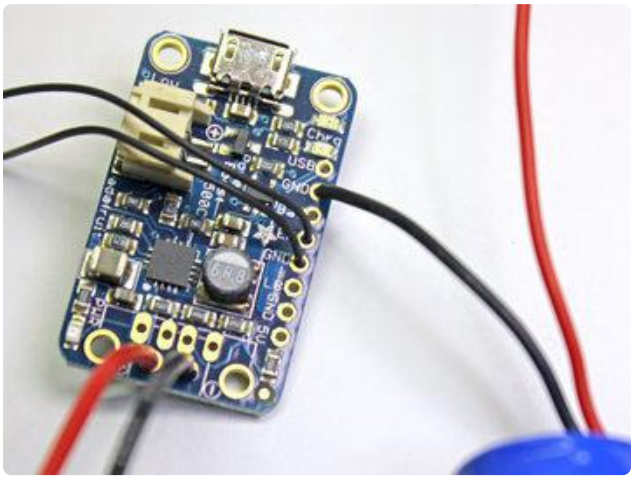


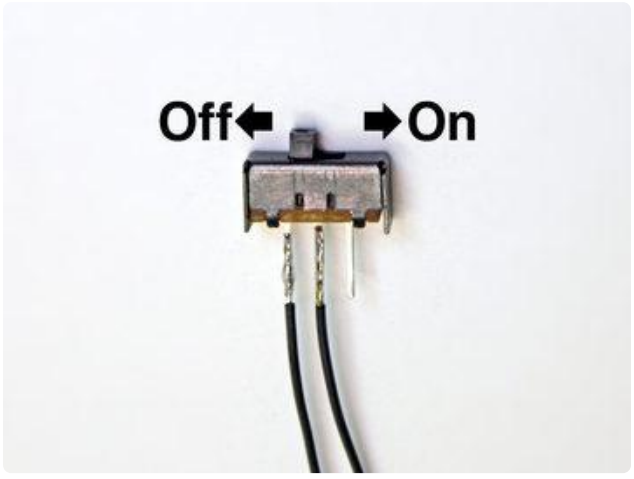
The other end of these wires solder to the + and – terminals near the end of the PowerBoost board. (Not the mounting holes!)

As with the power switch, the wires should run above the board to keep the underside flat.

Battery



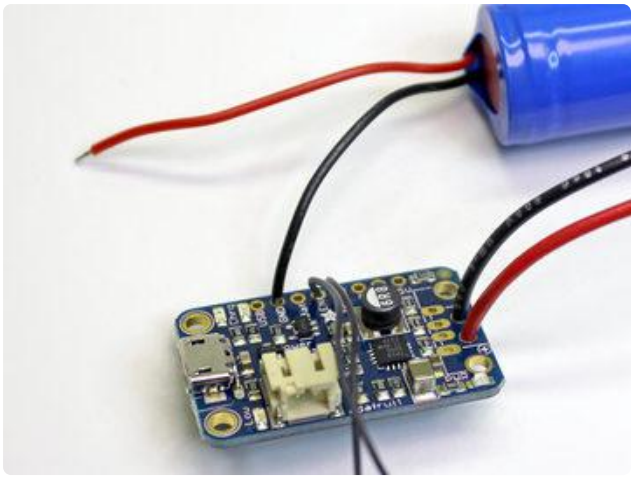


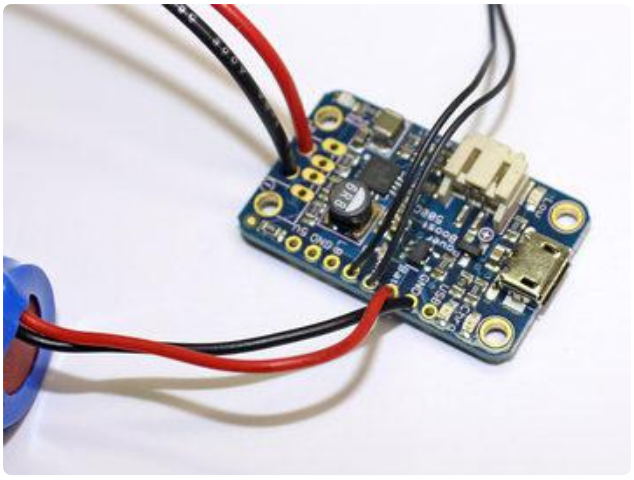


Trim ONLY the minus (black) wire on the Lithium Ion battery, keeping about 2 inches. Strip a little insulation and tin the end of the wire. Solder this to the PowerBoost GND pin that's between "USB" and "Bat."

Make sure the power switch is in the OFF position before continuing.

Cut and solder just ONE BATTERY WIRE AT A TIME, else you risk an electrical short...this battery packs a wallop! One at a time, please.





Now repeat with the plus (red) wire. Cut to 2 inches long, strip, tin end and solder to the PowerBoost BAT pin.

If you accidentally make a solder bridge between GND and BAT, pull the wire out quickly while the solder's still molten! Clean up the solder on the board and try again.

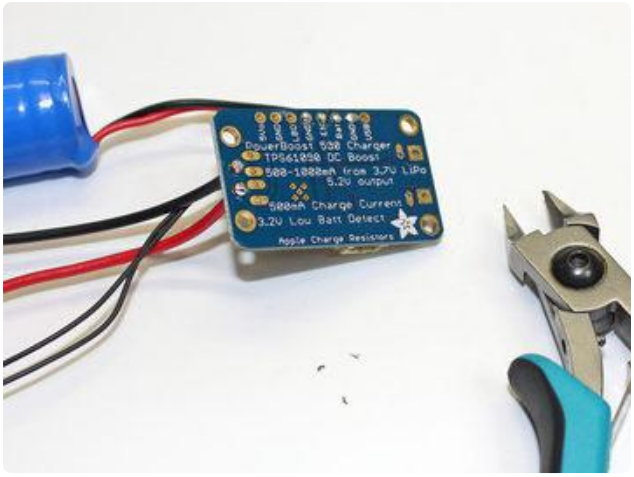
These batteries do feature short circuit protection, but that's no reason to tempt fate. Handle every battery with respect!

Test It!

Cover the ends of the two power wires with some masking tape, or just be super extra careful that they're not touching each other or anything conductive.

Try the power switch. The blue LED should turn on with the switch in one position, off in the other position. This LED indicates that the PowerBoost is providing 5V output. You can test with a multimeter if you like.

Plug in a USB wall charger. You should see a yellow LED indicating the battery is charging, or green if it's fully charged.



If everything looks good, switch it off and you can then optionally clean up any pokey wire bits from the underside of the PowerBoost board.

Be careful not to bridge the BAT and GND connections when you do this. Trim one at a time, and don't contact the other pin.

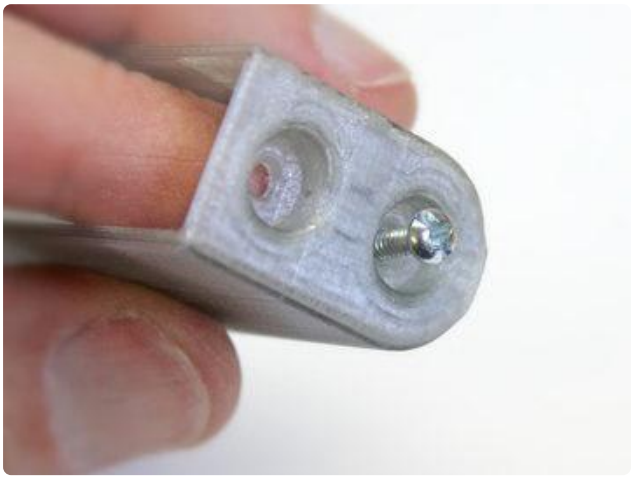
Troubleshooting

If you don't see a blue LED when switched on, it can usually be traced to the following:

- Check your soldering closely. There may be a bridged solder connection, a cold joint, or a clipped bit of wire cruft may have landed on the circuit.
- Try the power switch in both positions.
- The battery may be run down. Try briefy charging it.
- The battery's protection circuit may have triggered during soldering and didn't reset automatically. Plug in a USB charger briefly and see if that revives it...you should see a yellow LED indicating "charging," then try the power switch again and check for the blue LED.

Assembly and Use

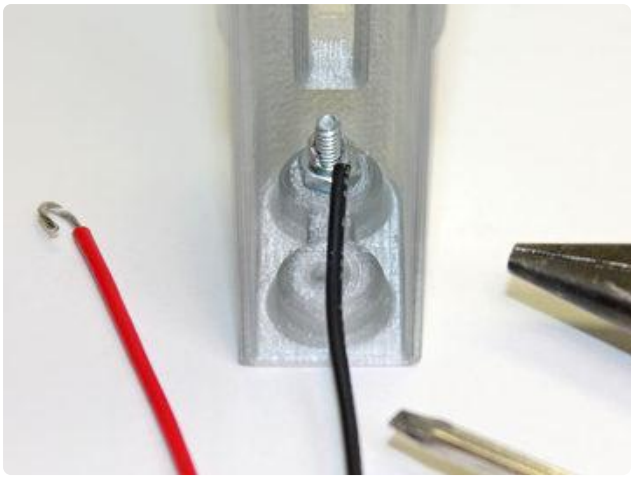
Power Wires



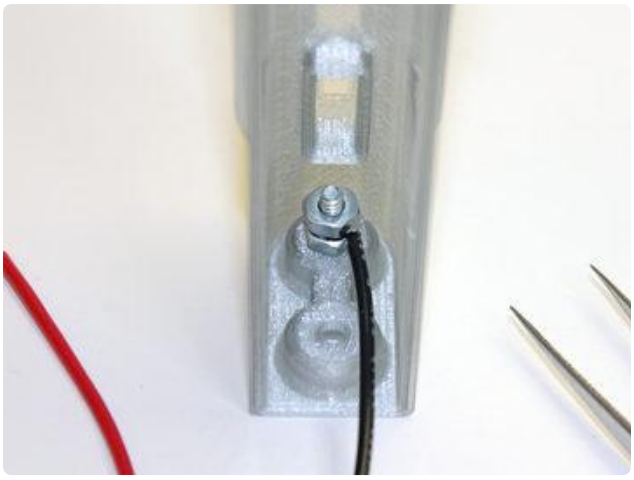
Insert a #4-40 x 3/8" machine screw into the more recessed of two holes on the end of the printed battery case. Add a matching nut on the inside. This may require tweezers and a few tries!

Tighten the screw so it’s snug and doesn’t rattle, but not so tight as to crack the case.

This screw will be the negative terminal to the soldering iron.



Earlier we bent hooks on the ends of the thicker power wires. Wrap the negative (–) wire hook around this first screw, then add a second nut. Cinch it down securely using small pliers.

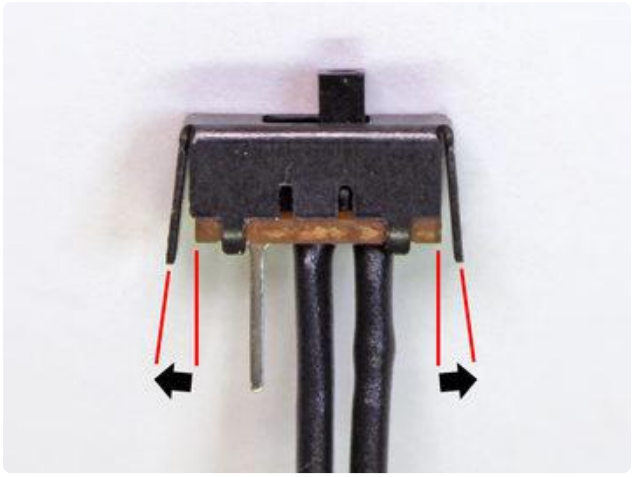


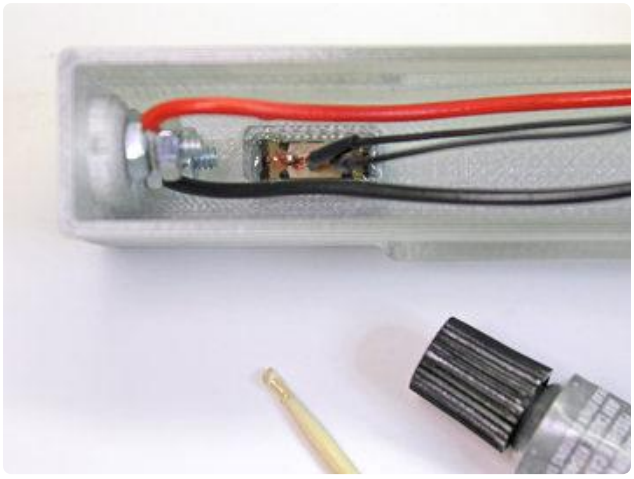
Make sure the nuts are pinching the metal part of the wire, not the insulation. You may need to pull the insulation back a bit to ensure good contact.

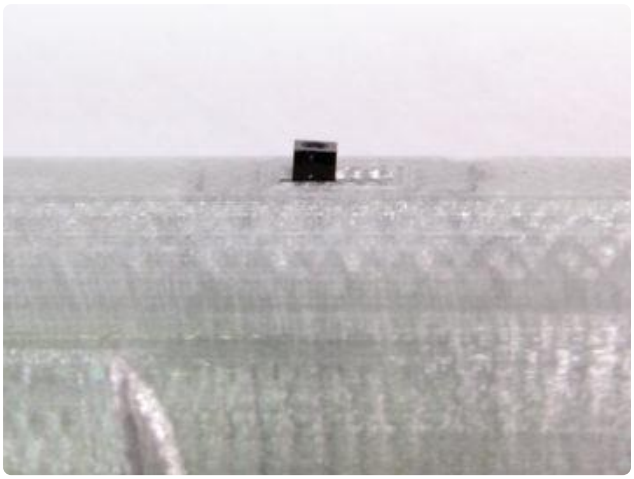
Repeat with the second screw, nuts and positive (+) wire in the other hole. This one's a little easier, since it's closer to the surface.

Both wires should be securely held in place; they shouldn't pivot around. If everything seems solid, secure the nuts with a tiny dot of thread lock, epoxy or E6000 glue.

Power Switch





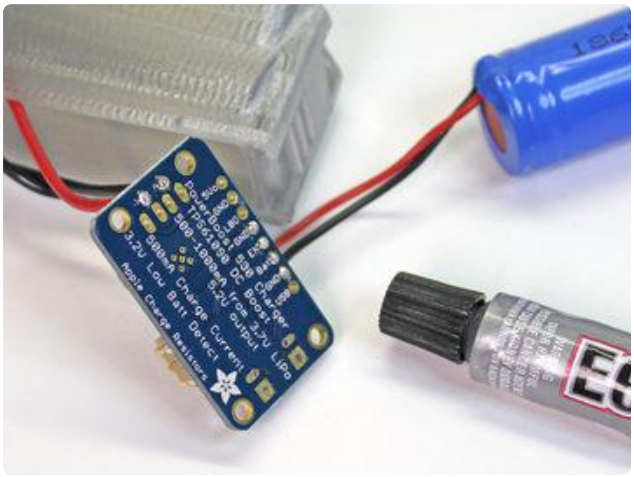


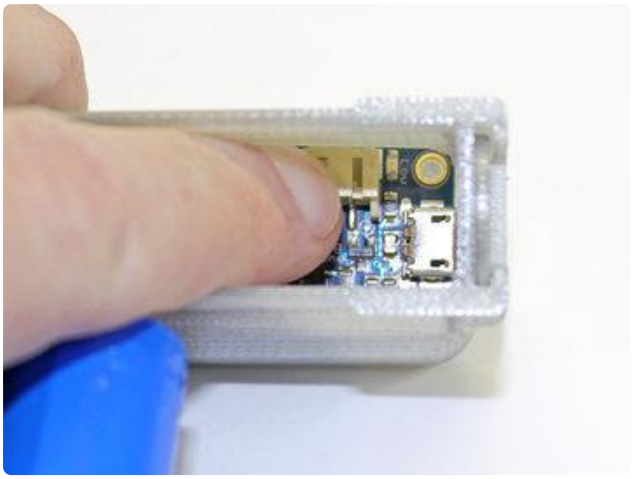
Splay the ends of the power switch ever-so-slightly to provide some spring pressure, then press-fit it into the slot in the enclosure (you may need tweezers or small pliers to reach). The unconnected pin should be nearest the screw terminals...or at least, I felt this made the most sense, so the “on” direction matches the iron’s regular power switch.

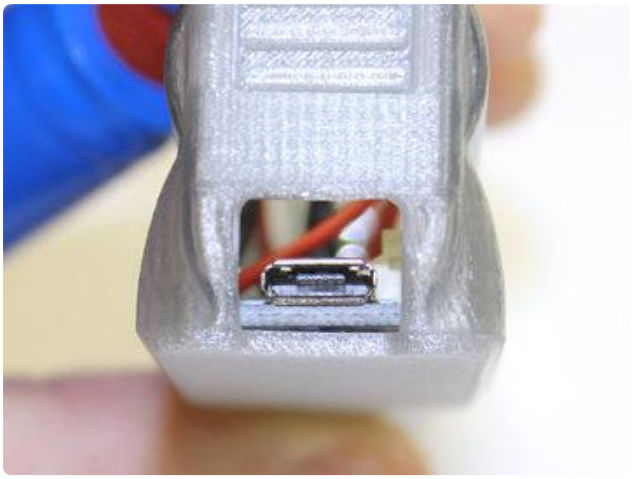
Secure the switch in place from behind with some dabs of 5-minute epoxy. E6000 glue works too, but needs a few hours to reach full strength; the switch will get pushed out if you play with it too soon. DO NOT goober the switch up with tons of glue...if it seeps inside, the switch will no longer work! A bit at the ends should be plenty.

When properly installed, the tip of the switch should protrude just a millimeter or two from the surface. Set this piece ON ITS SIDE while the glue dries, or the switch might get pushed out of its socket (and then gets glued there permanently).

PowerBoost

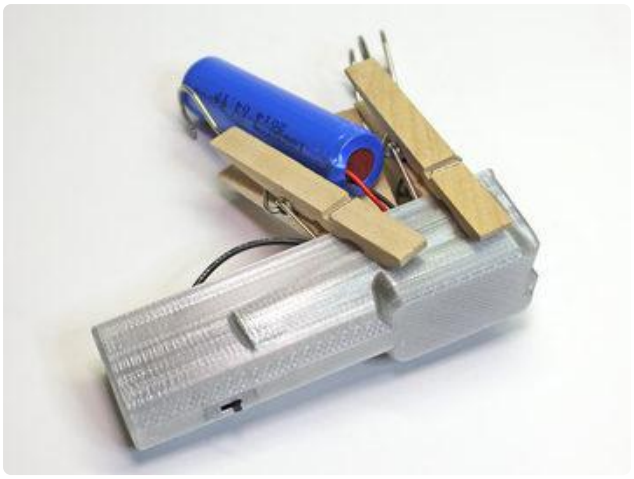






Add a dollop of glue to the flat underside of the PowerBoost 500 board, then angle it into place. The board will not drop straight in...lower it in sideways, catch one edge in the case, then pivot it down like closing a door. (This was to make the overall case a little slimmer.)

Make sure the USB port faces the end opening! Also, keep some pressure on the board while the glue dries, so it sits flat. Finger pressure is fine for fast-setting epoxy, otherwise improvise with whatever non-conductive implements you have around.

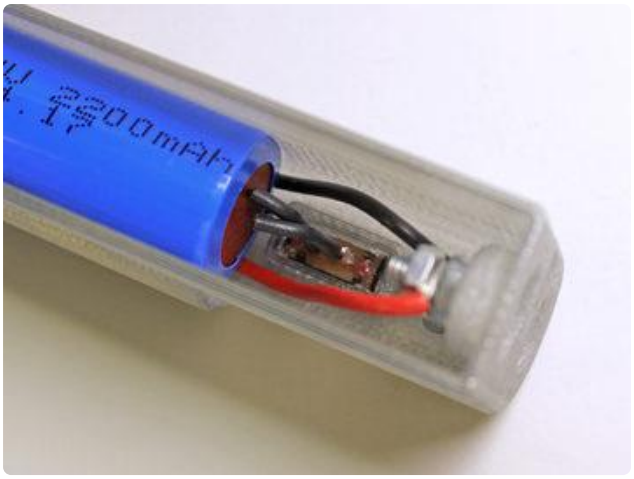


Battery

The last step, getting the battery inserted, is a little tricky. The enclosure is just flexible enough that we can squeeze the battery through the slightly-too-narrow opening.

The battery wires should point toward the USB end of the case. Push that end of the battery into the MIDDLE of the case, then gradually slide it along while pushing in the rest...the tip of the battery should “click” first, then you can pivot the full battery into place.

If the case bulges around the battery, it’s probably interference from the wires. Pivot the end of the battery back out, arrange the wires more carefully using tweezers or a toothpick, then press the battery back into place. It may take a few tries to get it just right.



If using E6000 glue or a slower-setting epoxy, set the battery case aside at least overnight...the glue needs several hours to reach full strength. Place it on its side to dry, and make sure the power switch has not been pushed out of place. If so, press it back in from behind while the glue's still flexy.

Using It

Flick the battery switch toward the tip of the iron to engage the PowerBoost. You should see a blue LED light...if not, check the troubleshooting steps on the prior page.

You need to use both this switch AND the regular iron power switch to turn it on. If either switch is off, the iron will not heat up.

All the same safety precautions of the original iron are in effect. Tip is hot and may burn fingers or ignite things. After switching off, wait until iron has cooled before replacing cap and putting away.

I'm not a fan of soldering irons without a stand, but in desperate times you just have to make due with what's there. Perhaps one could get clever with a coat hanger to design a safe stand that surrounds the tip.

If you see a red LED, that means the battery is very low — below 3.2 Volts.

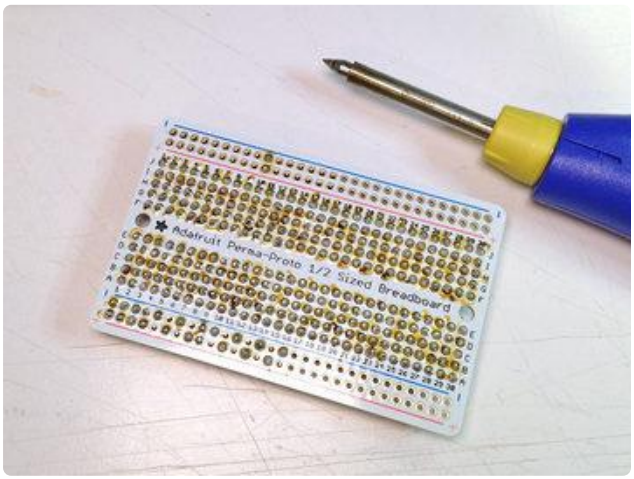
The nice thing about lithium-ion cells is that you can top them off any time, low battery or not. Plug in a USB microB cable to a phone- or tablet-charging wall supply, or a powered USB hub. You'll see a yellow LED while charging, and a green LED when full. A full charge may take a couple hours.

You can use the iron while plugged into USB. There isn't enough current to simultaneously charge the battery while soldering, but it will at least discharge more slowly.

Temper Your Expectations

You cannot change the laws of physics. Even with a mighty lithium ion battery (and the well-regarded Hakko brand), this will always be a 5(-ish) watt soldering iron. The goal here was the convenience of USB charging, and most of the limitations of the original tool are still at play. This is a small emergency back-up iron, the electronics equivalent of those temporary spare tires. As such, some things to keep in mind:

- It takes at least 45 seconds from a cold “off” state before the tip is hot enough for soldering.
- At only 5 watts, thermal recovery is going to be poor. Count to five after each solder connection before starting the next.
- It’s good for component-to-board and small component-to-wire and wire-to-wire connections. Large connections are not practical.
- Probably best with leaded solder. Lead-free requires a higher temperature.
- Both when charging and when running the iron, it’s normal for the PowerBoost to get a little warm, no harm done!



I successfully soldered 300 header pins, provided I allowed a few seconds for thermal recovery after each pin. That’s not bad!

After about 30 minutes of continuous soldering like this, when it came time to fill along the power rails, the battery could not keep up and there was insufficient heat for good connections; I switched it off at that point and plugged it in to recharge. So the iron works fast in this state, but not long.

A fresh set of AA alkaline cells, by comparison...with an initial voltage a bit over 6V, the iron heats quickly (ready in 30 seconds) and the first couple rows went well. But alkaline batteries perform poorly with high current loads...eventually managed about 250 pins, but this took over an hour due to progressively slower thermal recovery! And that’s a couple bucks worth of batteries, gone.

Nickel Metal Hydride (NiMH) cells will almost certainly outperform either in this application...they thrive under heavy loads, and with no boost converter to operate, should run longer into their discharge curve. But the downside of having to bring a

separate charger just for those cells (vs. using a USB cable already on-hand) was the entire motivation for this project.