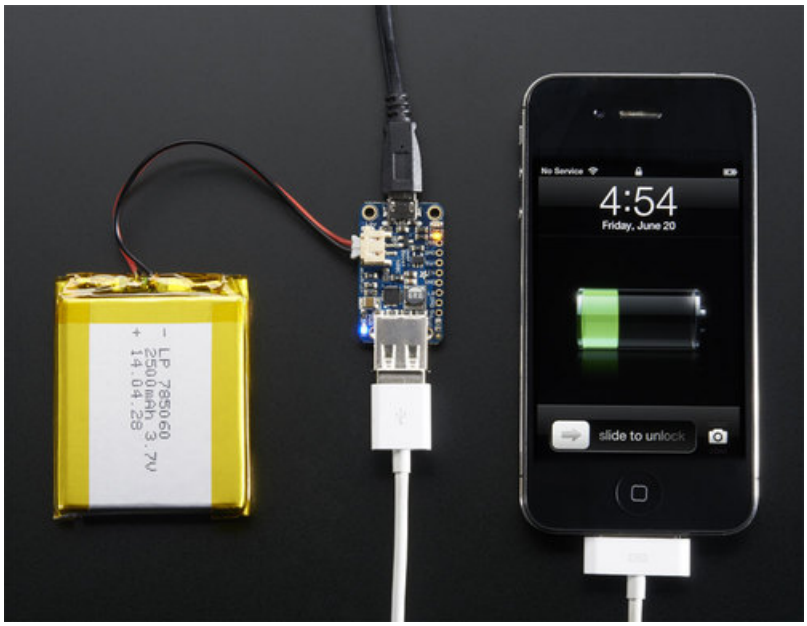
adafruit learning system

Adafruit PowerBoost 500 + Charger

Created by lady ada



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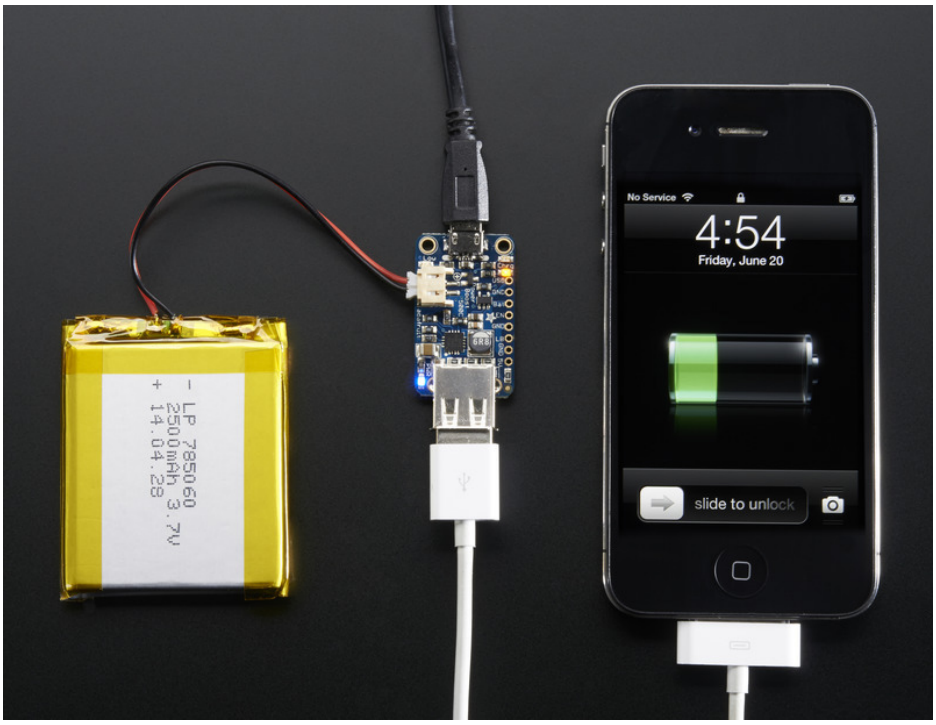
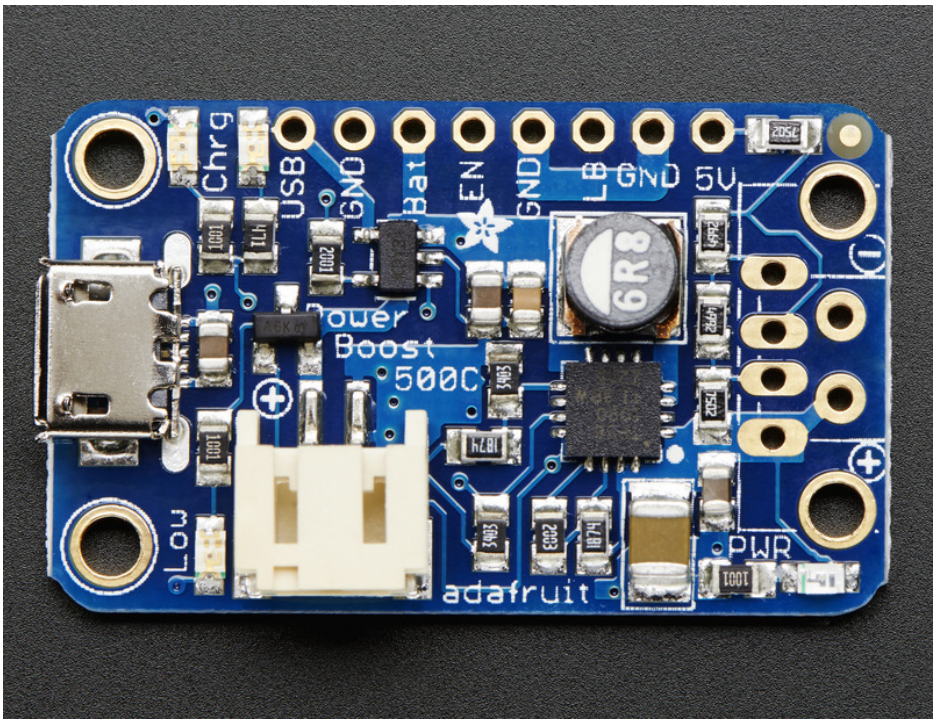
Overview



PowerBoost 500C is the perfect power supply for your portable project! With a built-in battery charger circuit, you'll be able to keep your project running even while recharging the battery! This little DC/DC boost converter module can be powered by any 3.7V LiIon/LiPoly battery, and convert the battery output to 5.2V DC for running your 5V projects.

Like our popular 5V 1A USB wall adapter (https://adafru.it/duP), we tweaked the output to be 5.2V instead of a straight-up 5.0V so that there's a little bit of 'headroom' for long cables, high draw, the addition of a diode on the output if you wish, etc. The 5.2V is safe for all 5V-powered electronics like Arduino, Raspberry Pi, or Beagle Bone while preventing icky brown-outs during high current draw because of USB cable resistance.



The PowerBoost 500C has at the heart a TPS61090 boost converter from TI (https://adafru.it/duQ). This boost converter chip has some really nice extras such as low battery detection, 2A internal switch, synchronous conversion, excellent efficiency, and 700KHz high-frequency operation. Check out these specs!

- Synchronous operation means you can disconnect the output completely by connecting the **EN**able pin to ground. This will completely turn off the output
- 2A internal switch (~2.5A peak limiting) means you can get **500mA**+ from a 3.7V LiPoly/LiIon battery. **We had no problem drawing 1000mA**, just make sure your battery can handle it!
- Low battery indicator LED lights up red when the voltage dips below 3.2V, optimized for LiPo/LiIon battery usage
- Onboard 500mA charge-rate 'iOS' data resistors. Solder in the USB connector and you can plug in any iPhone or iPod for 500mA charge rate. Not suggested for large iPads.
- Full breakout for battery in, control pins and power out
- 90%+ operating efficiency in most cases (see datasheet for efficiency graphs), and low quiescent current: 5mA when enabled and power LED is on, 20uA when disabled (power and low batt LED are off)

(https://adafru.it/dzw)

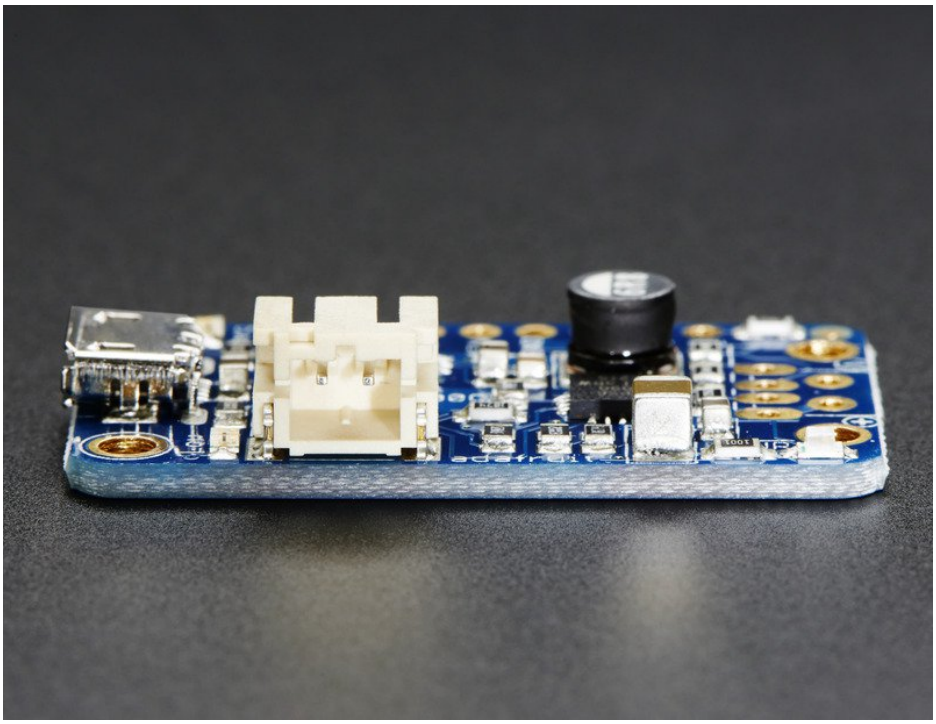
(https://adafru.it/iQf)

To make this even more useful, we stuck a MicroLipo charger on the other side. The charger circuitry is powered from a microUSB jack, and will recharge any 3.7V/4.2V LiIon or LiPoly battery at 500mA max rate. There's two LEDs for monitoring the charge rate, a yellow one tells you its working, a green one lights up when its done. You can charge and boost at the same time no problem, without any interruption on the output so its fine for use as a "UPS" (un-interruptable power supply). Just be aware that the charge rate is 500mA max, so if you're drawing more than ~300mA continuously from the 5V output side, the battery will slowly drain since the charge rate is less than the dis-charge rate.

(https://adafru.it/iQA)

Great for powering your robot, Arduino project, single-board-computer such as Raspberry Pi or BeagleBone! Each order comes with one fully assembled and tested PCB and a loose USB A jack. If you are powering your project from

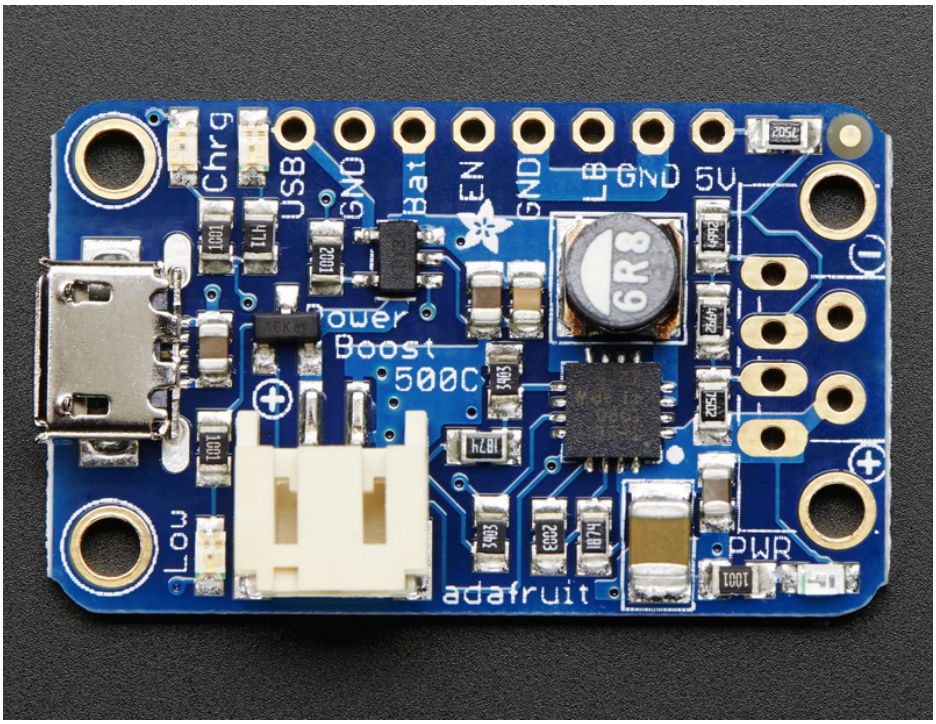
USB, solder the USB A jack in (a 3-minute soldering task). If you would like to use a terminal block, pick up a 3.5mm 2pin block here (https://adafru.it/duR) and solder to the output spot where the USB jack would go. Or dont solder anything in for a more compact power pack.



If you're trying to figure out how much current your project is using, check out the CHARGER DOCTOR! (http://adafru.it/1852)

Pinouts

For many people, the PowerBoost 500C can be used with just the microUSB charge input, battery plug and power outputs. However, we have a couple handy breakouts so lets get started!



Power Pins

There's three power voltages, the USB input for charging the battery (4.75-5.25V whatever is coming out of the USB port), the battery itself (3-4.2V) and the output (5-5.2V)

- **USB** - this is the micro USB 5V power pin. It's the pin that is used to charge the battery, NOT the output power! You can use this if you want to grab power from the microUSB port when it is plugged in
- **GND** - this is the power ground. This boost converter is not 'isolated' - the ground input is the same as the ground output
- **BAT** - this is the battery input, connected directly to the JST connector. For most Lithium batteries, this will range from 3.0V when near-dead to 4.2V when fully-charged. Higher voltages will let you draw more current and in general, are more efficient. Try to keep the wires going to this pin nice and short - 3" or less is best!
- **5V** - this is the boosted output. When the board is running, the voltage will be 5.2V approximately. It may dip down to 5V as the current draw starts to go up (over 500mA). When the board is disabled, this output is 'floating' but you should still try not to apply a voltage to it while the board is disabled. There's a green LED connected to this pin which will let you know when there's power output

Using a bench-top supply or long wires can add too much inductance to the input of the boost converter and destroy it! We really do recommend using Lipoly batteries with short wires

Control Pins

There's two 'control' pins.

- **EN** - this is the 'enable' pin. By default it is pulled 'high' to **VBAT**. To turn off the booster, connect this pin to ground. The switch can be as small as you like, it is just a signal. Contrast this to an inline power switch which would have to be able to handle up to 2A of current! When the chip is disabled the output is completely disconnected from the input.
- **LBO** - not a leveraged buy out! this is the **Low Battery Output**. By default it is pulled high to **BAT** but when the charger detects a low voltage (under 3.2V) the pin will drop down to 0V. You can use this to signal when its time to shut down or alert the user that the battery is low. There is also a red LED connected to this pin.

LEDs

There are **four** onboard LEDs.

- The **Blue** LED sits next to the USB connector socket, and indicates the 5V output power state.
- The **Red** LED is next to the battery JST port and indicates when the battery voltage is below 3.2VDC (Low Battery Output)
- The **Yellow** LED is next to the microUSB connector and indicates when the battery is being charged
- The **Green** LED is also next to the microUSB connector and indicates when the battery is done charging (all full)

Battery and USB connection

You can connect a battery to the breakout strip or to the JST connector. All of Adafruit batteries come with JST cables that will plug in nicely so we strongly suggest that. **Watch the polarity of the cable!** the + and - markings next to the JST will let you know which way is which.

The USB connector can be soldered on to create a portable 'USB power pack'. The two data lines on USB have resistor dividers that match Apple charger values so that you can plug any iOS device in to charge. 99% of other phones, devices and tables are totally cool with these resistors as well. You can always short the D+ and D- lines if you happen to have a phone that wants shorted data lines.

If you don't want a USB connector attached, there are two holes that are designed for a 3.5mm spaced terminal block (not included)

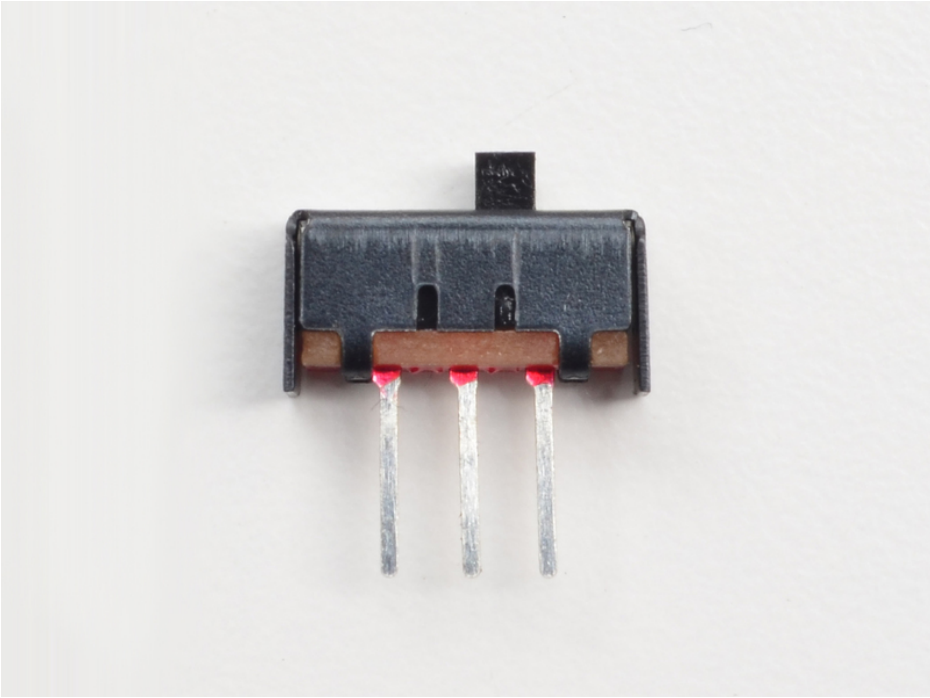
> Some third-party LiPo cells have JST connectors wired opposite from the standard. Connecting these to the PowerBoost will damage your PowerBoost. Double check the polarity before connecting.

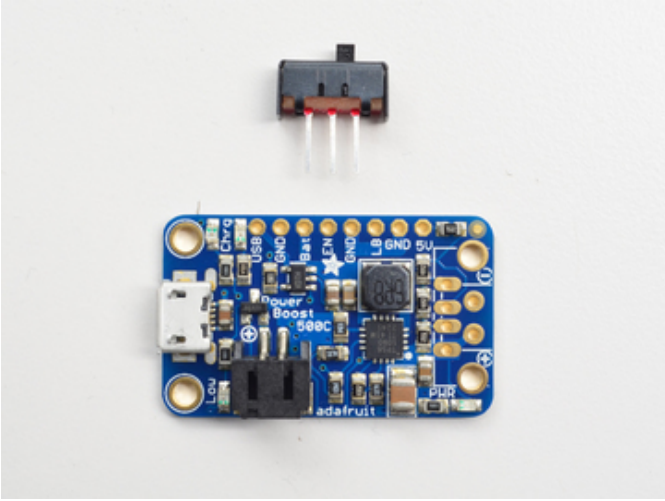
On/Off Switch

The PowerBoost 500C does not come with an on/off switch for the output, but its very easy to add one! Just grab a Breadboard friendly SPDT slide switch from the adafruit shop. (https://adafru.it/drN)

We will be turning the boost on/off via the **ENABLE** pin, so the switch does not have to carry any power, it is only signalling to the boost converter what to do. This means the switch can be small. Use any switch you like, if it is 0.1" spacing thats ideal. If your switch only has two pins instead of three, tie one pin to **GND** and the other pin to **EN** - when the switch is closed, the power will turn off

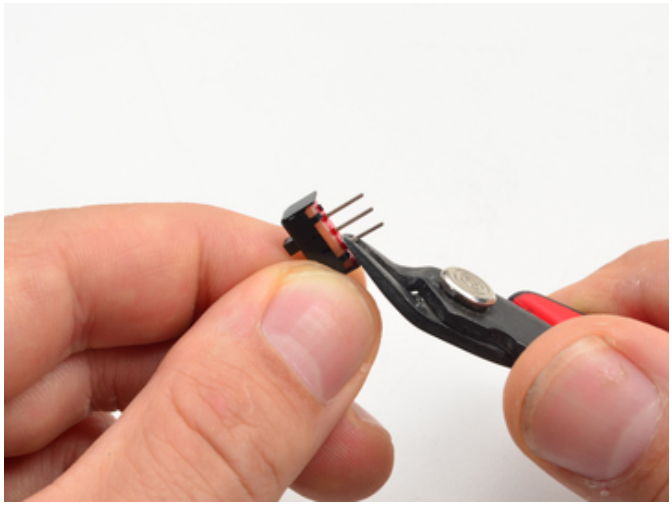
This tutorial assumes you are using a "break-before-make" switch. If you are not sure that your switch is "break-before-make" solder in ONLY the EN and GND pin, skipping the VBAT pin!



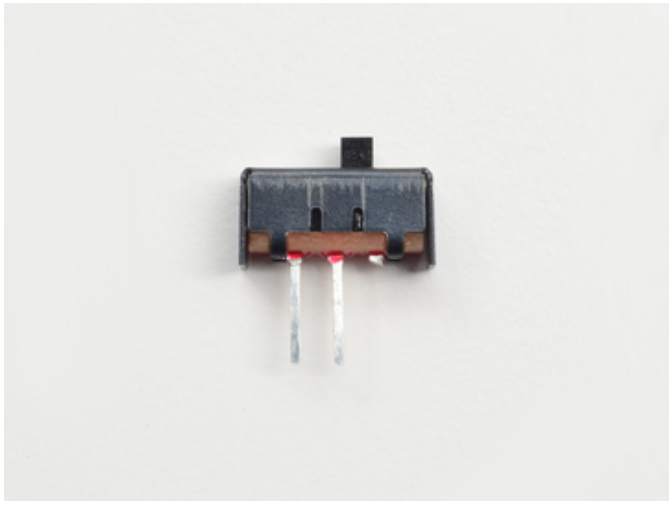


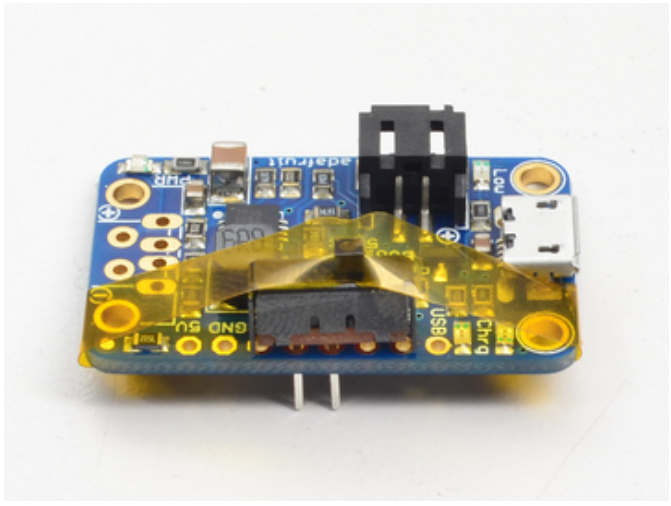
The switch will go into the breakout header, and attach to **VBAT EN** and **GND**
The switch is symmetric so as long as those three pins are attached to the switch you are good to go

For mechanical strength, we soldered in all three pins. However, this only works for "break-before-make" type swtches! **If you are not sure that your switch is "break-before-make" *or* if your switch has only two pins, solder in ONLY the EN and GND pin, skipping the VBAT pin!**

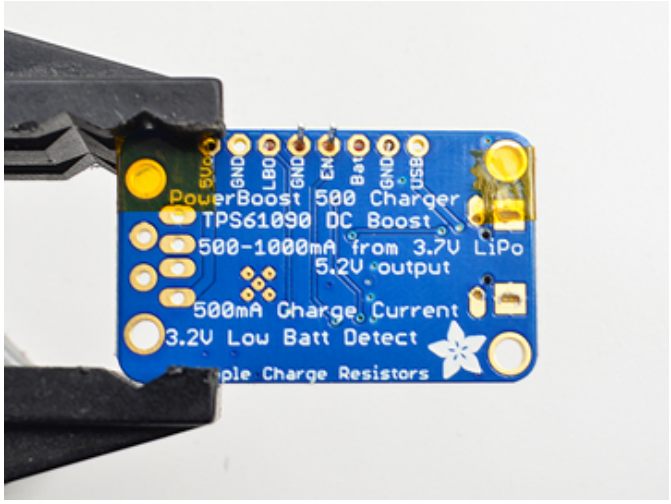


Clip either one of the outside pins with diagonal cutters

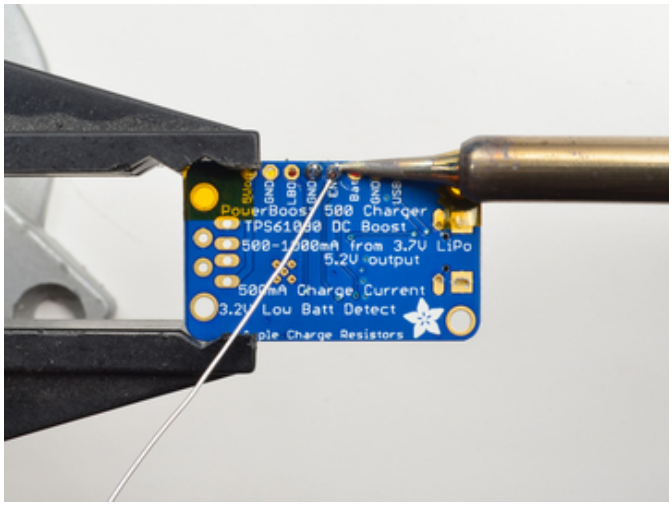




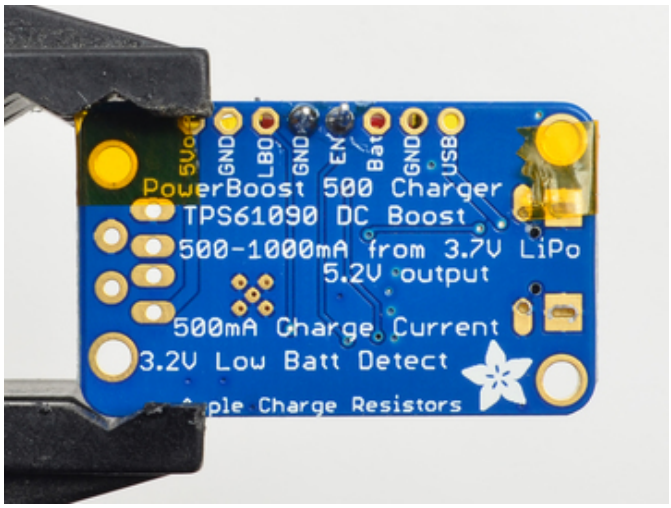
Use kapton tape to keep it in place while you solder



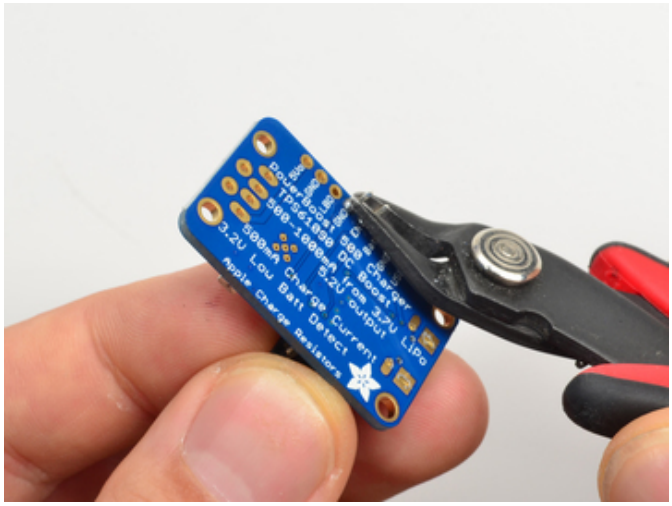
Before soldering, check that you have the right three pins!



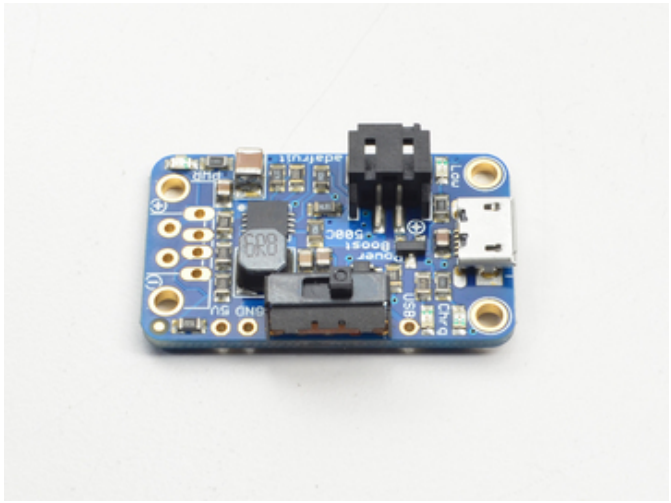
Solder in all three pins with any kind of solder making sure you have a good connection

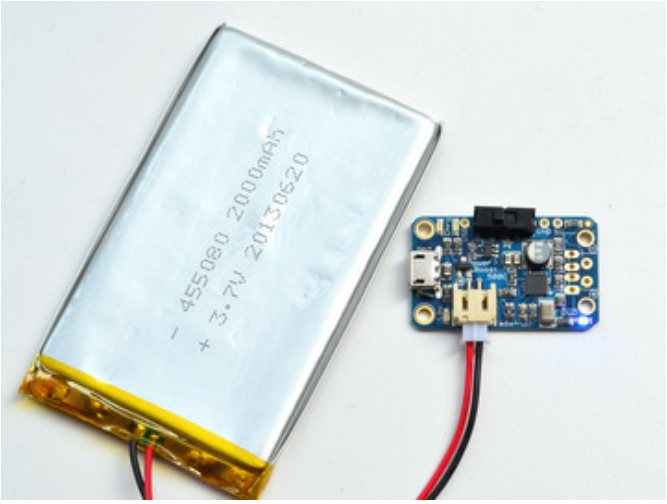


Yay! Check your work...



Clip off the long pins with diagonal cutters





When the switch is to the left, the 5V power will be on, you can tell because the blue LED is lit

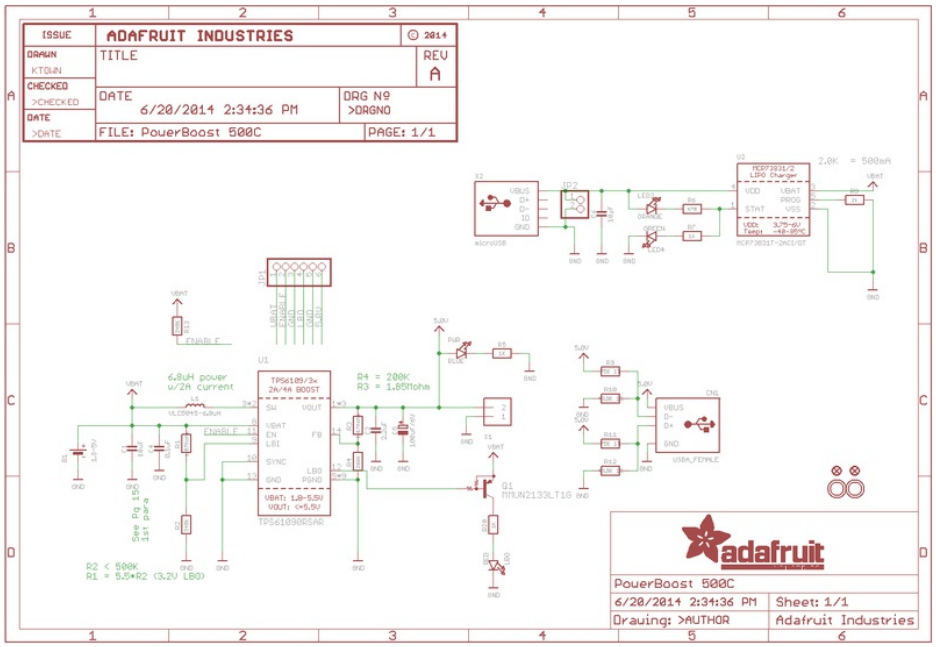
Slide to the right to turn it off.

Downloads

Datasheets & Files

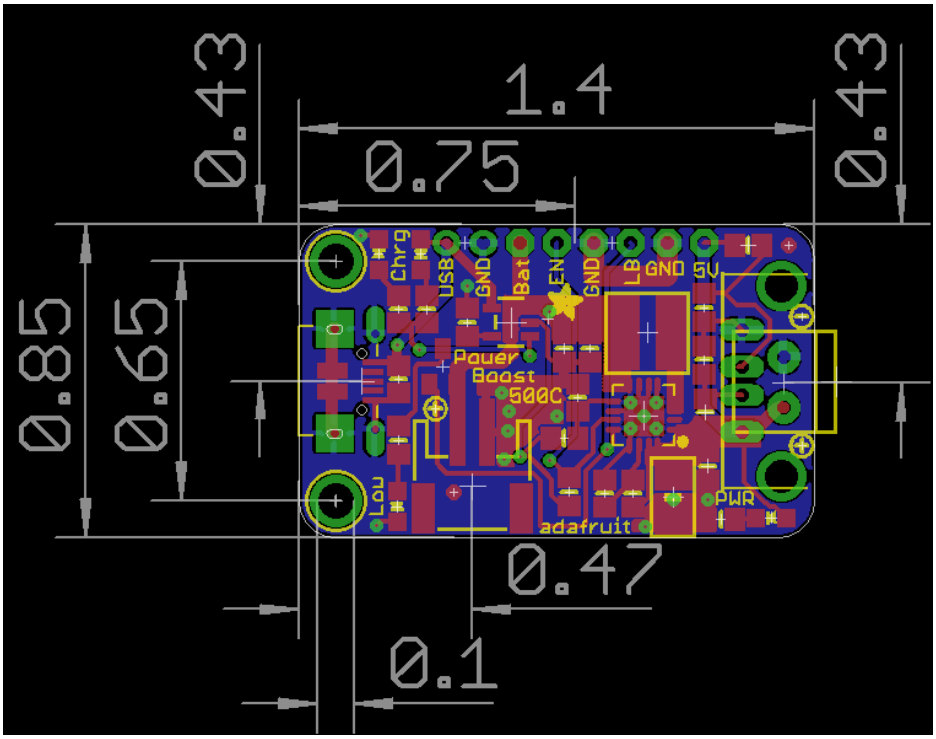
- TPS61090 datasheet (https://adafru.it/duS)(the DC/DC boost control chip used)
- MCP73831 datasheet (https://adafru.it/dvn) (the Lipoly charger chip used)
- EagleCAD PCB files on GitHub (https://adafru.it/pTb)
- Fritzing object in Adafruit Fritzing library (https://adafru.it/aP3)

Schematic



Fabrication Print

Dimensions in Inches


0.43
1.4
0.43
0.75
0.85
0.65
Chrg
USB
GND
Bat
EN
GND
LB
GND
5V
Power
Boost
500C
Lau
PWR
adafruit
0.47
0.1

F.A.Q.

Can I use the PowerBoost without a battery attached?

No. Please note that this board is designed to be used only with a LiPoly attached, it won't work without a battery.

Without the battery installed, both CHG and DONE LEDs are lit!

This is normal, the charger chip dimly lights both LEDs if it cannot detect a battery, this lets you know that it is waiting for a battery to be plugged in!

We don't recommend running the PB500C without a battery, its not going to work very well since there's no 'power path' from USB in to USB!

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