How to Power a Project a learn.sparkfun.com tutorial

Contents

Overview

This skill guide will cover the basics of the various ways you can power your electronic project. It will go into some detail about voltage and current considerations you may want to make. It will also go into the extra considerations you have to make if your project is mobile/remote or in other words, not going to be sitting next to a wall power outlet.

If this is truly your first electronic project, you have the option of reading through this skill guide or sticking with the recommended supply for the project or development board of your choice. The SparkFun Inventor's Kitcontains the USB cable you need for power and works fine for all the projects in the kit as well as many more advanced projects. If you're feeling overwhelmed, that kit is the best place to start.

Here are related tutorials you may want to check out:

- Voltage, Current, Resistance, and Ohm's Law
- Battery Technologies
- Connector Basics
- How to Use a Digital Multimeter
- Voltage Regulators
- Parallel vs Series Circuits

Ways to Power a Project

- AC to DC power supplies (like a computer or laptop would use)
- Variable DC bench power supply
- Batteries
- Via a USB cable

The four common ways to supply power to your project

Which option should I pick to power my project?

The answer to this question largely depends on your project specific requirements.

If you're starting off with the SparkFun Inventor's Kit or another basic development board, you will likely just need a USB cable. The Arduino Uno is an example that requires only a USB A to B cable to have the power to run the example circuits in the kit.

If you're in the business of building projects and testing circuits regularly, acquiring a variable DC bench power supply is highly recommended. This will allow you to set the voltage to a specific value depending on what you need for your project. It also buys you some protection as you can set a maximum current allowed. Then, if there is a short circuit in your project, the bench supply will shut down hopefully preventing harm to some components in your project.

A specific AC to DC power supply is often used after a circuit is proven. This option is also great if you often use the same development board again and again in your projects. You know ahead of time that you'll have power covered for building your next project and it's probably already plugged in.

If you want your project to be mobile or based in a remote location away from where you can gather AC wall power from the grid, batteries are the answer you're looking for. Batteries come in a huge variety so be sure to check out the later parts of this tutorial so you can figure out precisely what to choose. Common choices include rechargeable NiMH AA's and lithium polymer ion.

Voltage/Current Considerations

How much voltage do I need for project X?

This depends largely on the circuit so there is no easy answer to this question. However, most microprocessor development boards like the Arduino Uno have a voltage regulator on board. This allows us to supply a voltage in a specified range above the regulated voltage. A lot of microprocessors and IC's on development boards run at 3.3 or 5 Volts.

The power comes from a power supply and then is regulated closely by a voltage regulator so that each chip is powered by a consistent voltage even when the current draw may fluctuate at different times. Supplying these boards with any voltage between 6 and 20 volts should work. Here at SparkFun, we use 9V power supplies for many of our products. However, to verify what voltages are safe, it is recommended that you check the datasheet for the voltage regulator on the development board to see what voltage range is recommended by the manufacturer.

How much current do I need for project X?

This question also depends on the development board and microprocessor you're using as well as what circuits you plan on connecting to it. If your power supply cannot give you the amount of juice the project needs, the circuit may start acting in a strange, unpredictable way. This is also known as a brown-out.

As with voltage, it's recommended to check the datasheets and estimate what the different bits and pieces of the circuit might need. It's also better practice to round up and assume your circuit will need more current than to not have enough. If your circuit includes elements that require massive amounts of current, like motors or servos, you may need a large supply or even separate supplies for the microprocessor and the extra motors. It's also best to get a power supply rated for a higher current and not use the extra than vice-versa.

Have no idea how much current your project draws?

Once you’ve been playing with circuits for a while, it will be easier to estimate the amount of current your project requires. However, the common ways to figure it out experimentally are to either use a variable DC power supply that has a readout for current, or to use a Digital Multi-Meter to measure the current going to your circuit while it’s running.

Digital Multimeter

We highly recommend having a DMM in your electronics toolbox. It’s great for measuring current or voltage.

Connections

How do I connect my battery or power supply to my circuit?

Variable bench power supplies commonly connect to circuits using banana jacks or wires directly. Many power supplies often use a barrel jack connector. Batteries are generally held in a case that holds the batteries and connects the the circuit via wires or a barrel jack. Some batteries like Lithium Polymer Ion batteries often use a JST connector. Read more about connectors on our connector basics tutorial.

Common ways to connect a power to your circuit

Remote/Mobile Power

Going mobile, so what battery should I use?

When you're powering a remote circuit, the same issues of finding a battery that delivers the proper voltage and current still apply, however you also have to consider battery life, size and shape. Battery life, or capacity, is a measure of total charge the battery contains and is commonly measured in Amp hours, or Ah. Battery size, shape and weight is also something to consider when making your project mobile, especially if it's going to be on something that flies like a small quad-copter. You can get a rough idea of the variety by visiting this wikipedia list. Learn more about batteries in our battery technology tutorial.

How much battery capacity do I need for my project?

This question is easier to answer once you have determined the amount of current that your circuit normally draws. In the following example, we will use estimation however it is encouraged to measure current draw of your circuit using a Digital Multimeter.

As an example, let's start with a circuit, estimate its current output, then select a battery and calculate how long it the circuit will run on battery power. Let's choose a barebonesATmega 328 microcontroller setup to be our brains for the circuit. It draws about 20mA in a barebones setup. Let's now connect threered LED'sand the standard 330 ohm current limiting resistors to digital I/O pins of the microcontroller. In that configuration, each LED added makes the circuit draw about 10mA more current. Now let's connect twoMicro Metal motors to the microcontroller as well. Each one of these uses approximately 25mA when turned on. Our total possible current draw is now:

$$20mA + (3 * 10mA) + (2 * 25mA) = 100mA$$

Let's choose a standard alkaline AA battery for this because it has more than enough current capability (up to 1A), has a decent battery capacity, 2Ah, and is very common. The only downside is it only has a 1.5V output and since the rest of our components will run on 5V, we need to step up the voltage. We can use this 5V step-up breakout to get the voltage we need or we can use three AA batteries in series to get us close enough. Three AA's in series gives us a voltage of 4.5 V (3 times 1.5V), plus we will now have 3 times the battery capacity. Consider taking a look at the parallel/series tutorial.

To calculate how long the circuit will last on battery power, we use the following equation:

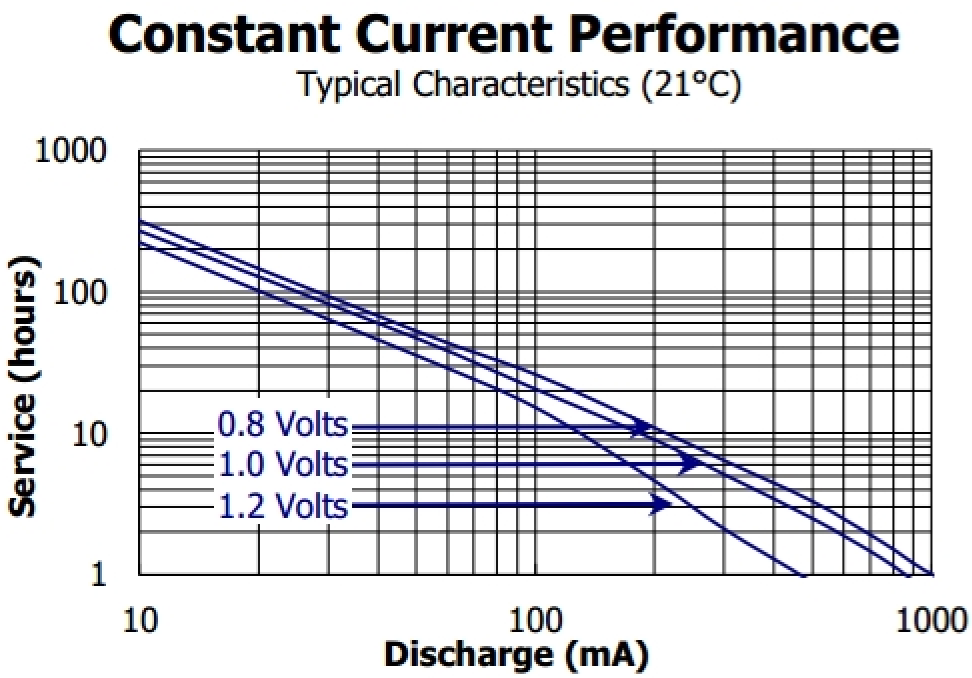
$$\frac{BatteryCapacity(Amphours)}{CurrentDraw(Amps)} = BatteryLife(Hours)$$

For our circuit example, that translates to:

$$\frac{(3 * 2Ah)}{100mA} = 60h$$

We would ideally get 60 hours of battery life out of these three alkaline AA's in this configuration. It's best practice however to 'derate' batteries meaning to assume you're going to get less than ideal battery life. Let's conservatively say that we'll get 75% of the ideal battery life, and therefore about 45 hours of battery life for our project.

Battery life can also vary based on the actual current draw amount. Here's a graph from an Energizer AA battery showing its expected battery life based on constant current draw.



Energizer AA, Current vs Battery Life

If you needed even more battery life, you can add more batteries in parallel. Consider taking a look at the [parallel/series tutorial].

Going Further

So now you know the most common ways to power your circuit and how to figure out which way is best for you depending on your your project's specific requirements. You can make a better judgment now based on current, voltage, connector, and mobility considerations for your project.

Once you have successfully powered your project, it's time to get working on either connecting circuits to it or programming. If you want to learn more before moving on, consider checking out the tutorial on voltage, current, and resitance and the tutorial on how to use a multimeter to to learn how measure these.
