# PEAK OF FLIGHT NEWSLETTER

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### BASICS OF SOLDERING AND ELECTRICAL WIRING

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PEAK OF FLIGHT

# Basics of Soldering and Electrical Wiring

## By Bobby Potter

Rocketry seems to continually be moving toward electronics. In the early days of rocketry, none of this existed, but as time has gone on electronic equipment like altimeters, flight computers and dual-deployment systems have continued to grow in popularity. If you want to get started learning a new skill, here's the basics.

### *Tools and Supplies*

#### *Wire Strippers*

A good pair of wire strippers can help you remove the insulation from wires without damaging the wires themselves. They work pretty simply, like a pair of scissors. You just slide the wire in to the depth you would like to cut, clamp down, and slide the wire back out. It should cleanly remove the insulation. This is usually required when setting up electronics, but it can be done with any knife or a pair of scissors; it just has to be done much more carefully and with usually worse results.

*FIGURE 1: YOU'LL NEED A CAPABLE PAIR OF WIRE STRIPPERS.*

#### *Diagonal Cutters*

Diagonal cutters, also known as wire cutters, are going to be a necessity. Unlike wire strippers, they do not remove insulation, but rather cut the wire entirely. This is used to cut the proper length wires so that you don't end up with a huge mess of oversized, tangled cables.

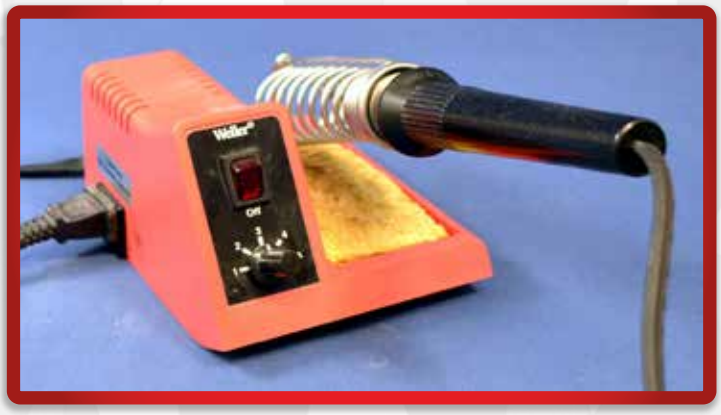


*FIGURE 2: A STANDARD SOLDERING IRON WITH SPONGE.*

#### *Soldering Iron*

Another requirement here, as this is used throughout the entire process. Due to the compact size of most rocketry electronics, we recommend a pencil tip.

#### *Heat-Shrink Tubing*

This allows you to seal soldered joints to avoid shorts.

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**Newsletter Staff**

Writer: Bobby Potter
Layout / Cover Artist: Matthew Martinez
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### *Battery Connectors*

These connect to the battery and are used to transfer power from the battery to the electronics.

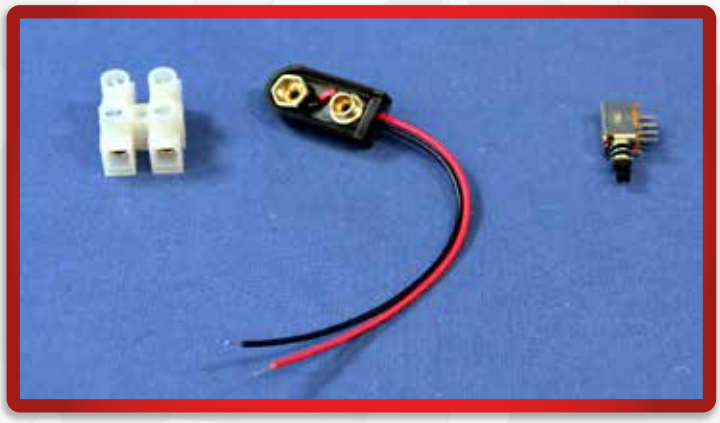

**FIGURE 3: FROM LEFT TO RIGHT, A TERMINAL BLOCK, A 9V BATTERY CONNECTOR AND A SIMPLE PUSH BUTTON SWITCH.**

### *Switch*

A simple switch allows you to easily cut power from the system, allowing you to conserve battery life or easily power the unit on before flight. These are not required in all arrangements, as you can complete the same objective by simply cutting the power.

### *Terminal Block*

These are usually connected to the board itself, and utilize a screw to tighten around the wire and provide a current to the electronics in use.

### *Wire*

Stranded hook-up wire makes a good choice here. Something like this (https://www.apogeerockets.com/Electronics-Payloads/Electronics-Accessories/22ga-Stranded-Wire-Set)

## *Basics of Soldering*

Soldering for the first time can be daunting, but the process is actually much easier than it seems. There are a few tips and tricks here that can help to build your confidence, as well as produce the best results.

First pro-tip: It is not important to touch the solder to the soldering iron. They can touch, but this is a common misconception. The soldering iron should touch and transfer heat to the wires, then the hot wire is what actually melts the solder.

Second pro-tip: First, clean the tip of your soldering iron with the wetted sponge included with your soldering iron. Then, always melt a little bit of solder onto the tip of the soldering iron before you begin. This is called “tending”.

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FIGURE 4: NOTE THE VICE HOLDING THE WIRES IN AN EFFORT TO KEEP THE HANDS FREE.

Third pro-tip: Don't try to hold too much. In one hand you should have your soldering iron, in the other you have the solder. Whatever you are working on should be held or propped up by other means or equipment.

## *How to join wires end-to-end (Splice)*

This is best done through something called the "Western Union Joint". Apparently the Western Union telegraph service had to splice a whole bunch of wires together for their telegraph lines, earning them the namesake, but all we need to know is that it is as simple and efficient of a solder as it gets.

Step 1 - Using the wire strippers, remove ½" of insulation from the wires you are joining.

Step 2 - Cross the tips of the wires halfway down the stripped section. Then twist them around each other so they make a tight bond by themselves.

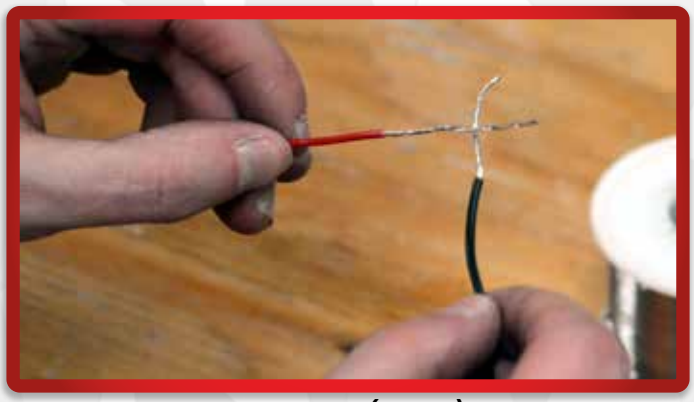

FIGURE 5: CROSSING THE WIRES (STEP 2)

Step 3 - Apply the heat from the soldering iron and melt the solder into the wires. The solder should flow and fill in between all the strands.

Step 4 - Cut a short piece of heat-shrink tubing, slide it over the exposed portion of the joint, and heat with a heat-gun or blow dryer on low settings to shrink onto the wire. This is to prevent shorts and your current from escaping the system.

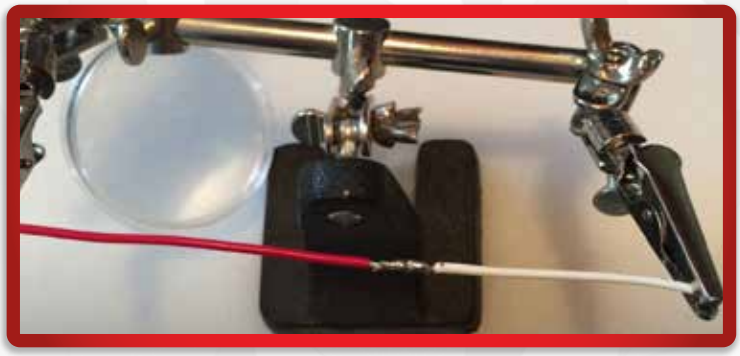

FIGURE 6: JOHN COKER'S NEAT HOLDER AND CLEAN SPLICE.

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### *Soldering to a Switch Terminal*

Step 1 - Strip ½" of insulation from the wires you are connecting to the terminal.

Step 2 - Slide the portion of exposed wire into the soldering lug on the terminal. Then wrap the wire around that lug. This should make a strong connecting itself, and have plenty of surface area connecting to transfer the current.

Step 3 - Start soldering. Remember, clean with the sponge, tend the tip and heat the lug and the wire as opposed to the solder itself.

Step 4 - Slide on your heat-shrink wrap and heat to secure. Be sure that you allow it all to cool before you slide on the wrap.

### *Wire Ends to Screw Terminal Blocks*

While this process isn't really a requirement, it is a really good idea. When attaching a wire to a screwed terminal block, the many strands can separate and deform, potentially damaging the wire as well. This can result in a bad connection, or no connection at all. Finishing the tips of these wires with solder strengthens them, and prevents damage in a screw terminal.

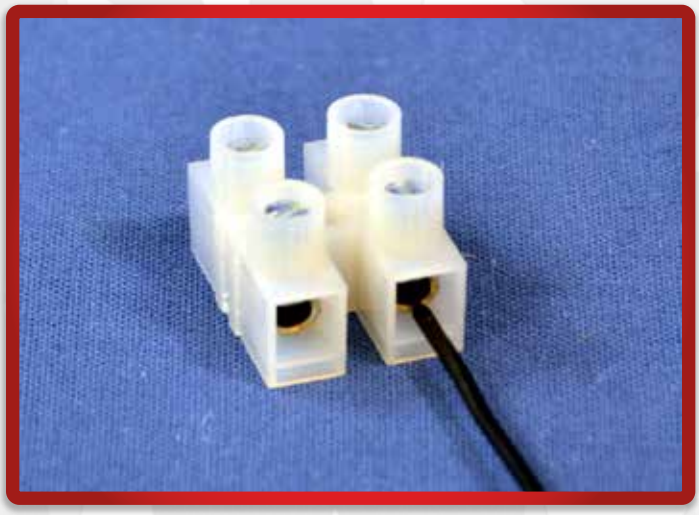

**FIGURE 7: WIRING TO SCREW TERMINAL BLOCKS**

Step 1 - Strip ¼" of insulation of the end of the wire. Twist the strands of the wire together.

Step 2 - Solder as normal - Clean, tend, heat the wire.

Step 3 - Insert into the terminal and screw down as normal. Now that you have a solid tip, there should be little play, and will create a solid connection.

### *What should I use to Power my Unit?*

Traditionally in rocketry, the 9V battery has been the standard. In recent years though, Lithium Polymer (LiPo) batteries have become the preferred choice. They are rechargeable and can put out a large amount of power due to the low levels of internal resistance.

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Battery Output

9V = 9 volts
2 cell LiPo = 7+ volts
3 cell LiPo = 11+ volts

Fortunately, an e-match, like the kind you would be using for electronic parachute deployment, can fire off almost anything. Even the 2 cell LiPo would suffice, assuming you charge it or change it out regularly. If your ebay is utilizing more electronics than just a basic altimeter or flight computer, drawing from the same power source, you should at a minimum be using the 3 cell LiPo or a fresh 9V with every flight. In cases like these, you may want to seriously consider using a separate power source for your ejection system to make sure your parachute deployment will not be prevented. Additional batteries weigh a lot, so there's a trade-off here, but you should never compromise on safety.

## *Do I need Switches?*

Technically, no. A switch is there to prevent your electronics from running and wasting battery while it is waiting to launch. It allows you to easily turn the unit on and off by cutting the power to it entirely.

That said, you could just disconnect the wire, provided you have an easily accessible connection. Some hobbyists will use a hatch in the side of the ebay to allow them access, and just connect the power source right before they are about to fly. Some find it easier to have a switch that they can access from outside the rocket to easily turn their electronics on.

## *Electronic Igniters*

We have a great article on igniters, Peak-of-Flight #527 (https://www.apogeerockets.com/education/downloads/Newsletter527.pdf). That said, there's really only a couple of options here for electronic deployment. You need an e-match or a firewire.

An e-match is easily ignited, and can be triggered with very few volts. It makes it the perfect choice for battered-powered ignition.

## *The Basic Anatomy of an E-Bay*

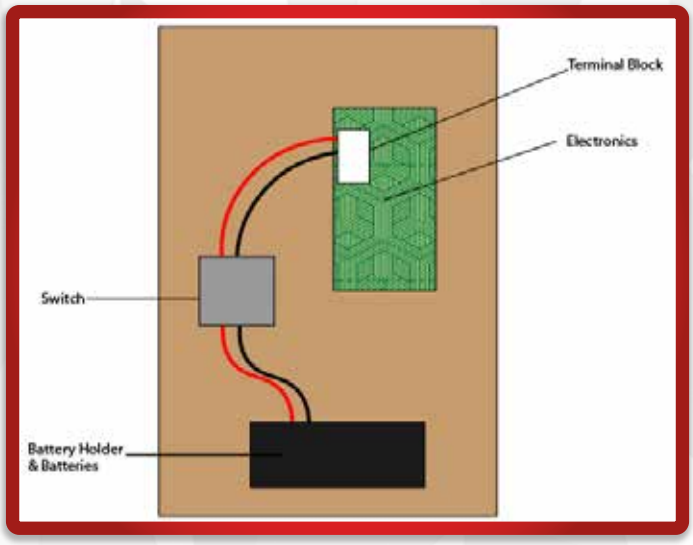


***FIGURE 8: BASIC LAYOUT AND WIRING ROUTE OF AN ELECTRONICS BAY***

A basic e-bay consists of just a few components. This can be used to just record the altitude or velocity of your rocket, but can go much more advanced. It can be used to control anything from cameras to vernier jets, thrust vector control, cameras and a billion other uses. A common use, and the e-bay described here, is for dual-deployment.

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Here are some E-bay kits that might make constructing your ebay much easier: https://www.apogeerockets.com/Electronics_Payloads/Electronic_Bays

### *The Sled*

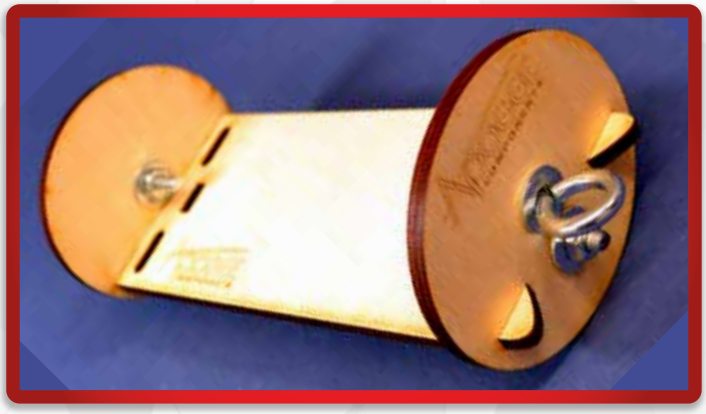

***FIGURE 9: APOGEE'S SLED, AVAILABLE WITH THE FULL E-BAY TO MAKE YOUR WORK EASY*** (https://www.apogeerockets.com/Electronics-Payloads/Electronic-Bays/98mm-Ebay-Kit)

This is where everything will be attached. The sled sits inside the rocket, held in position by a bulkhead both above and below the sled. There are many different e-bay designs, and you may need a different sled depending on your needs. Everything will be mounted on to the sled.

### *The Battery Holder & Battery*

The holder itself doesn't need to be anything special, and often hobbyists will just use a few zip-ties to secure the battery to the sled. The battery is wired to the switch through a battery connector, allowing you to easily switch out the battery as needed.

The Battery Connector (https://www.apogeerockets.com/Electronics-Payloads/Electronics-Accessories/9V-Battery-Connector)

This is a wire that has the appropriate leads to connect to the 9V or LiPo battery of your choice to the switch. With the battery connector, you can quickly and easily switch out your battery.

### *The Switch* (https://www.apogeerockets.com/Electronics-Payloads/Electronics-Accessories/Simple-Switch)

The switch allows you to more easily turn the power on and off, helping you to conserve battery when not in use without requiring you to remove the entire e-bay and disconnect the battery. The battery is wired to the switch, and the switch is in-turn wired to the altimeter.

### *The Altimeter*

This is essentially a basic flight computer, and there are many options available. The altimeter is wired to the switch, and for dual deployment, is also connected to the e-matches.

See all of our altimeter options here: https://www.apogeerockets.com/Electronics_Payloads/Altimeters

### *Conclusion*

I want to express a big thank you to John Coker, founder of thrustcurve.org, for the resources he makes available for rocketeers. To learn the basics of soldering, I watched a video he made available on his personal website. He has also allowed me to adapt that information to the article you see here. He is invaluable to the rocketry community, and if you would like to learn to solder from John himself, check out his video here: http://www.jcrocket.com/basic-wiring.shtml

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