Double Capacity MintyBoost with 4-AA Battery Holder Modification

by RoysterBot on February 18, 2010

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Intro: Double Capacity MintyBoost with 4-AA Battery Holder Modification

Need a highly portable USB power source that can be replenished with readily available, common batteries?

The MintyBoost from adafruit Industries is an awesome little kit that nets you a USB charger that runs on 2 AA batteries. This is a great thing because AA batteries are available anywhere and together with the MintyBoost can be used to power most USB devices when you find yourself in a situation with no other source of power. As a volunteer providing emergency communications for organizations that are deployed to disaster stricken areas I have been in this situation before. Keeping critical communications links operational in the field is a major mission success factor. Having a highly portable source of USB power to keep cell phones working is a valuable tool for the first responder. There are, of course, many other uses for portable USB power. One of my favorites is extending the play time of graphic intense iPhone games while traveling.

This charger does more then just provide the 5 volts required to charge USB powered devices. The circuit incorporates a DC to DC boost converter that is able to draw power from batteries that may otherwise be considered "dead". Also known as a "Joule thief" this means you get more output from your battery power investment.

After building my first MintyBoost kit I immediately looked for a way to increase the charging capacity of the device. I noticed that a commonly available 4 AA cell battery holder will fit perfectly into a regular (pack of cards) sized Altoids tin with the MintyBoost. And the tight fit made for a very sturdy device with easy access to the batteries; which is important since the batteries are constantly being replaced.

Since the cells in a 4 AA battery holder are connected in series this results in an output voltage that can vary from about 4.8 volts to about 6.75 volts (for fresh batteries) depending on the type of AA cells used. The input voltage range of the MintyBoost is about 2-5 volts. So modifying the 4 AA cell battery holder to connect the output of 2 serially connected AA batteries together in parallel would result in about 3 volts for the MintyBoost input voltage but at twice the power capacity. The extra power capacity comes in handle with the power-hungry USB devices of today.

This battery holder modification is the primary subject matter of this instructable. I will also show how the modified battery holder and the MintyBoost are installed into the Altoids tin. Actual construction of the MintyBoost kit is not covered.

Thank you for all the great comments and feedback!

If you're interested in buying one of these completed kits they are now available here...
bit.ly/dh15cJ

step 1: Tools and Materials

1 - Minty Boost (Available here: bit.ly/bHPSKI)

2 - 1N5817 diodes (Available here: bit.ly/c56Ymv)

1 - Altoids mint tin (about 3.75” x 2.5” x .8”) – any flavor

1 - 4 AA cell battery holder
There are a number of sources for 4 AA battery holders. I used one from Jameco Electronics and it's shown in the images below. It costs about a dollar and includes a square of foam tape that comes in handy when mounting the holder in the Altoids tin. (Available here: bit.ly/9eOZlI)

22 Gauge stranded hookup wire (red & black)

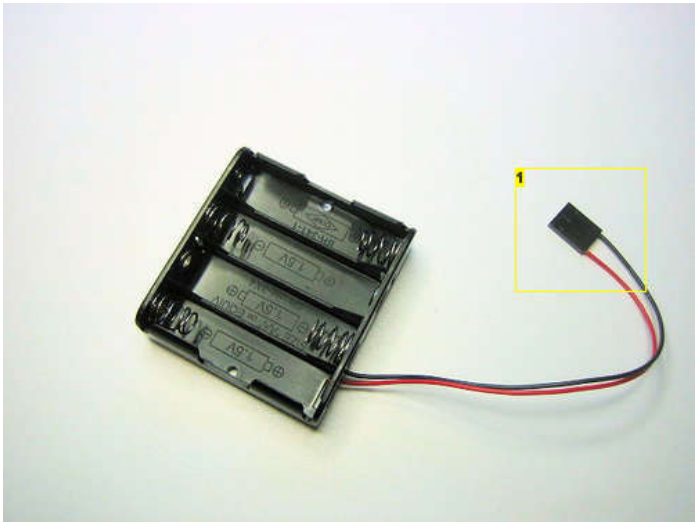
Solder and related tools

Fairly hefty diagonal cutters

Stuff to insulate wires (Heat shrink tubing and related tools / Electrical tape)

1” wide double sided foam tape

Tools to cut thin, soft metal (Rotary tool and bit, small metal files)



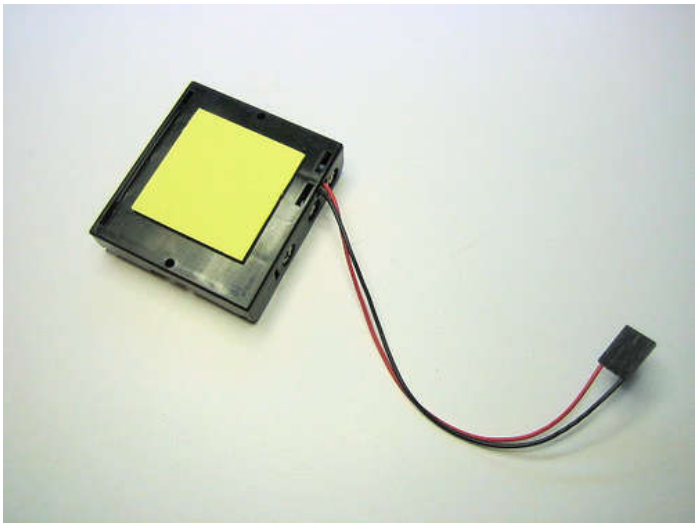
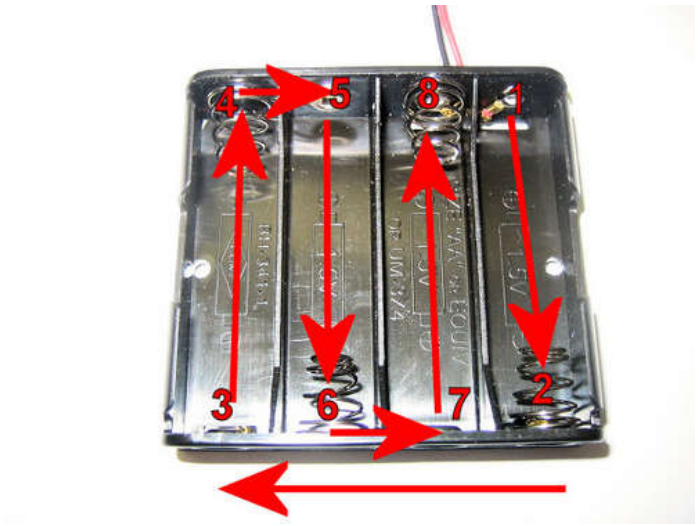


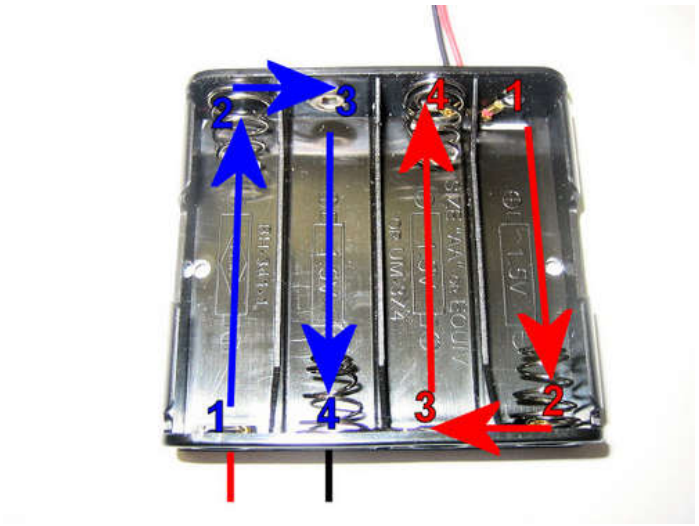
Image Notes
1. Remove this connector.

step 2: Analysis of the modification

The battery holder that we are modifying is configured to deliver 6 volts via the red and black power leads by connecting the batteries serially as shown in the image below. The red power lead is connected at point #1 which makes contact with the positive side of the first battery that completes the connection to point #2. From there the battery holder has a wire running along its back side that connects point #2 to point #3. The second battery completes the connection between point #3 and #4. Point #4 and #5 are actually one physical connection made up of a spring (#4) and rivet (#5) wired together. Points #5 and #6 are connected via the third battery. Point #6 and #7 are another spring/rivet pair. And finally the last battery makes the connection between point #7 and #8. The black power lead is connected to point #8. This serial connection of 4 AA cells results in the 6 volt output.

The modification we are performing is reflected in the next image and will result in 2 pairs of serially connected AA cells. The first pair (red arrows) will use the existing power leads. We will add new power leads to the second pair (blue arrows). Once we have 2 pairs of power leads they will be connected in parallel with diodes added to prevent current flow from one set of batteries to the other.

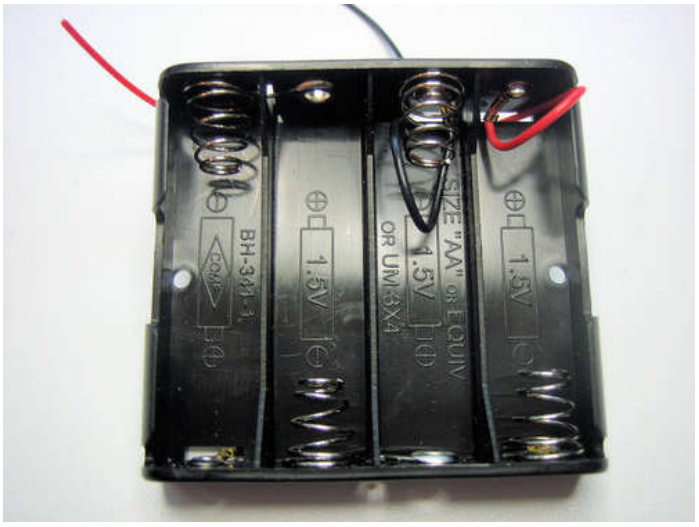




step 3: Re-route power leads

The battery holder will be installed into the Altoids tin so that the side of the holder with the included power leads will be adjacent to the side of the tin that includes the hinges for the tin top. This is a really tight fit; almost like it was planned. But in order for the battery holder to fit nicely into the tin the power leads must be routed out of the bottom of the holder.

The red and black power leads extend from the battery compartments to the outside of the holder via a couple of round holes. Pull the leads into the battery compartment. Then re-route them to the outside via the rectangular holes in the bottom of the holder which are very close to the original exit holes you just pulled them through. See the images below.



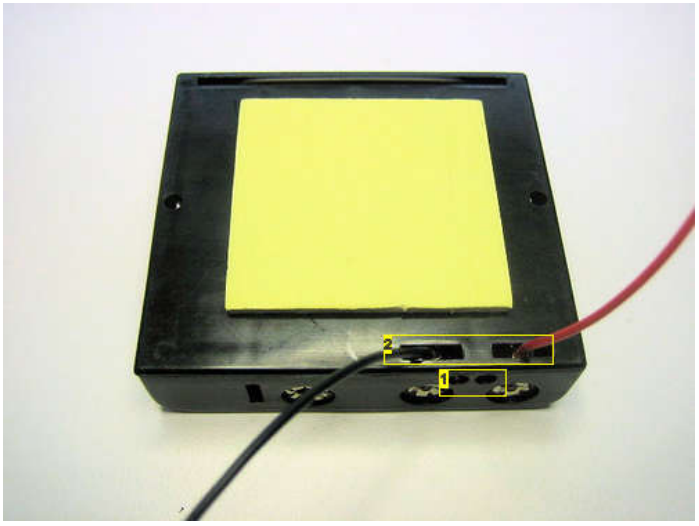
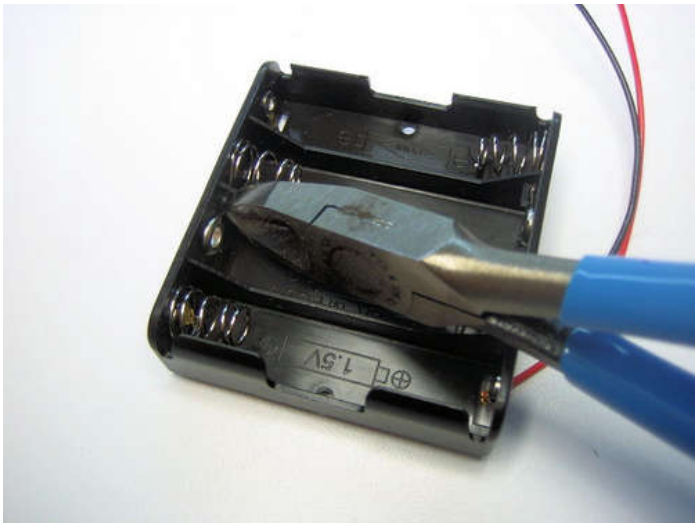


Image Notes
1. Pull leads in from here.
2. Re-route the leads out here.

step 4: Sever the spring

In order to break the battery holder connection paths into 2 isolated sets of 2 batteries we must break the connection between the spring/rivet pair that is in the middle of the holder. The first image below indicates the point where the cut should be made.

The metal that you are going to cut is very hard. I do not suggest using light-weight cutters like those used to trim electronic component leads. I used fairly heavy duty diagonal cutters like in the second photo below. It's a tight fit but I was able to get a bite on the metal wire with the very tip of the cutters and while applying grip pressure and a gentle wrist-twisting motion the spring was extricated. Save the spring as it will be used in step 6.



step 5: Battery bank 1 connections

Now that weve broken the battery connection path in half we can get the first half (lets call it bank 1) functioning by making one connection. On the bottom on the holder there is a wire connecting point #2 and #3 (as referenced in the first image of step 2) that we cut exactly in half as indicated in the first image below.

Notice that the wire we just cut in half is lying in a little channel. Cut a little notch so that the wire running from point #2 can be routed along the existing channel then into the notch you create and then to the rivet at point #7 (as referenced in the first image from step 2). We do this so that we can route the wire to the rivet without adding significantly to the width of the battery holder. Remember that the battery holder will be a tight fit and even the width of the wire added to that side of the holder will make it much harder to squeeze into the Altoids tin.

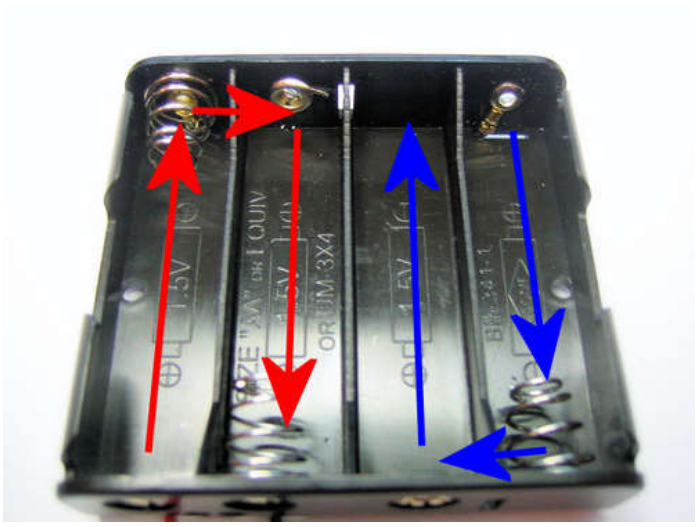
Once the wire has been routed to the rivet solder it there as show in the last image below. When soldering the wire to the rivet, take care not to melt the plastic surrounding the rivet to much. I used a pair of forceps clamped to the top half of the rivet and battery holder to act as a heat sink and to keep the rivet in place. The plastic around the rivet will melt but it hardens quickly so having the rivet clamped in place during the soldering operation is highly recommended.

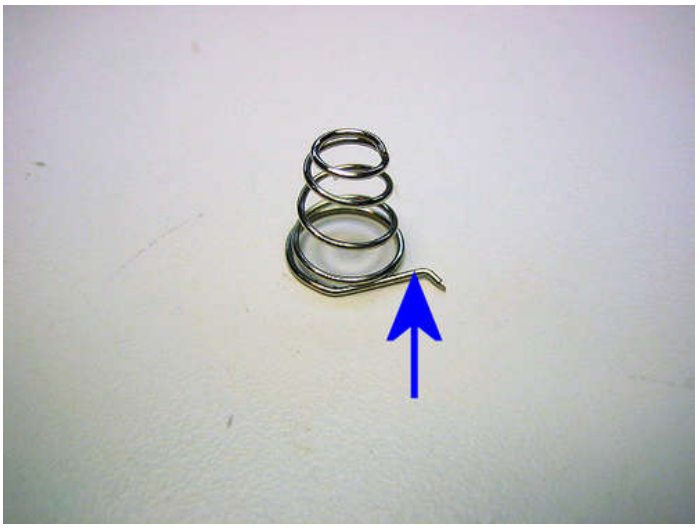
step 6: Battery bank 2 negative terminal

The left side of the first image below shows the fruits of our labor so far; battery bank 1. As we can see by the red arrows we have a connection from the red power lead through one battery to the connection path we created in the previous step then through the other battery to the black power lead.

Now we need to complete battery bank 2. The connection path for this bank is shown in the image below by the blue arrows and will start at the remaining half of the black wire we cut in the previous step. It will then flow through one battery which is connected to the other battery via an existing spring/rivet connection. That second battery will then connect to a spring connection that we are about to add.

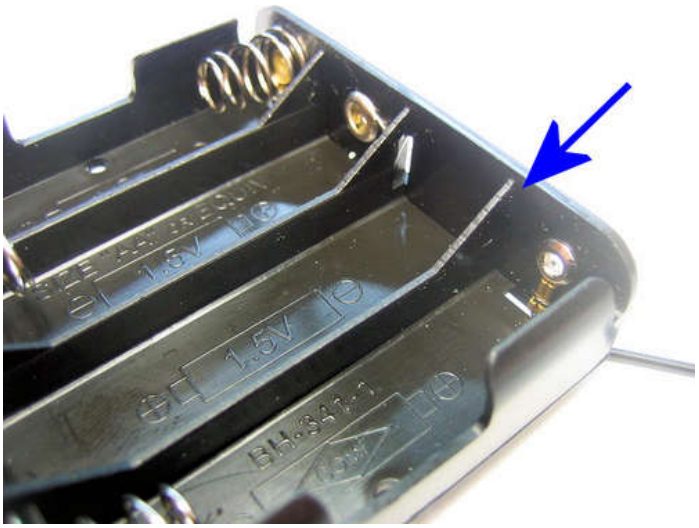
Take the spring that we extricated earlier and remove the bent end by clipping the wire at the point indicated in the second image below. Next solder a 22 gauge stranded piece of hookup wire about 3.5” inches long to the spring as shown in the last image. It is recommended that you use wire with black insulation here since this will be the negative (-) power lead for battery bank two. We will use this spring and wire in a later step.





step 7: Create battery terminal mounting point

Take a look at the image below and note the point indicated by the blue arrow. In order to mount the negative battery terminal that we created in the previous step we need to cut a slit in the battery compartment separator at that point. The slit needs to be slightly narrower than the diameter of the wire we connected to the spring in the previous step (see the second image below). This is so we can wedge the wire into the slit so it is held in place. I used a Dremel cutting wheel to make the perfectly sized slit. But you could use any number of tools to make the cut since the plastic is not very hard.



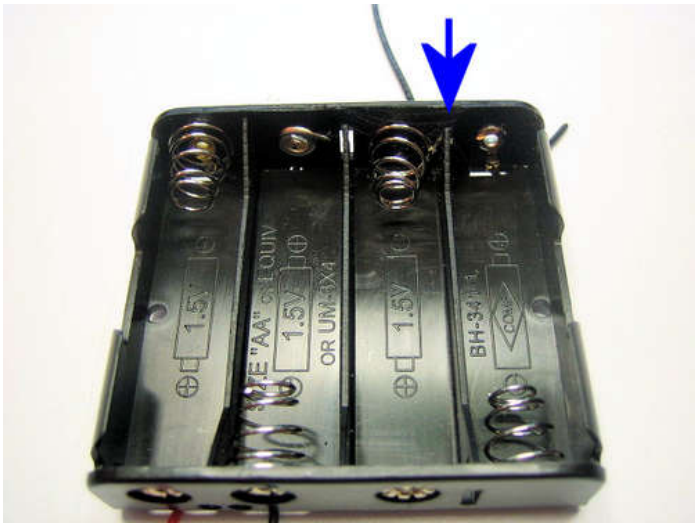
step 8: Mount the negative terminal

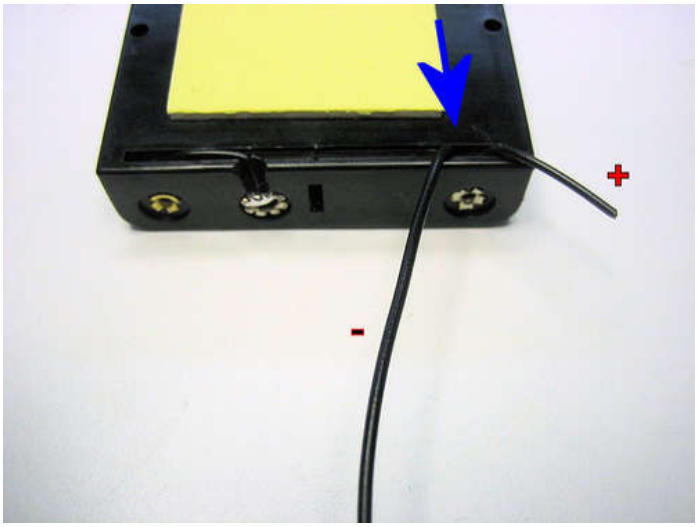
Take the negative spring terminal that you created in step 6 and route the wire through the rectangular hole in the bottom of the battery holder in the outer battery compartment next to the slit you just cut. The wire will be routed next to the existing wire connected to the rivet as show in the first image below.

As you feed the wire through the hole lower the spring into its original position. While sliding the spring into its original position wedge the wire connected to the spring into the slit that you cut. This should hold the spring in place fairly well. Make sure the spring is sitting very close to its' original position so that it will make proper contact when the battery is installed.

You should add a dab of epoxy, JB Weld/JB Kwik or similar hard drying adhesive into the slit at the point indicated by the blue arrow in the second image below to lock the wire and spring in place.

Once this step is completed turn the battery holder over like in the last image below and you will see the long black wire you just added (battery bank 2 negative lead) and the remaining half of the wire you cut earlier (battery band 2 positive lead).



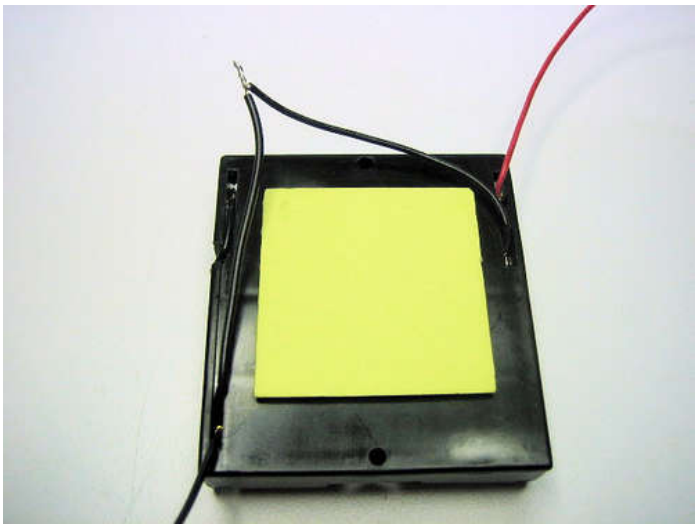


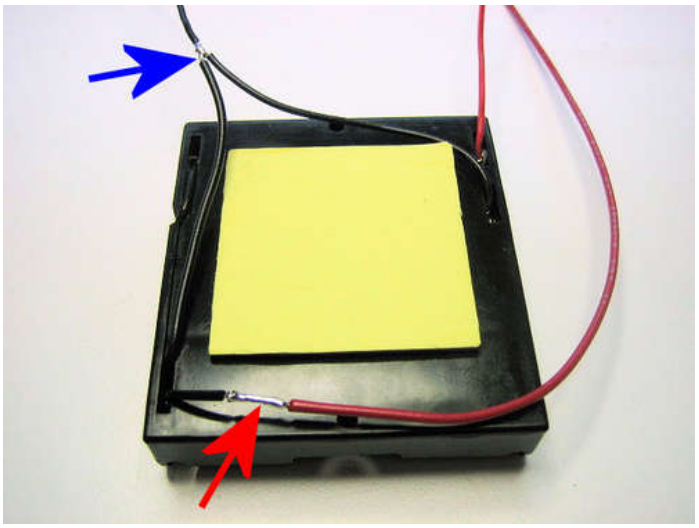
step 9: Extend the battery power leads

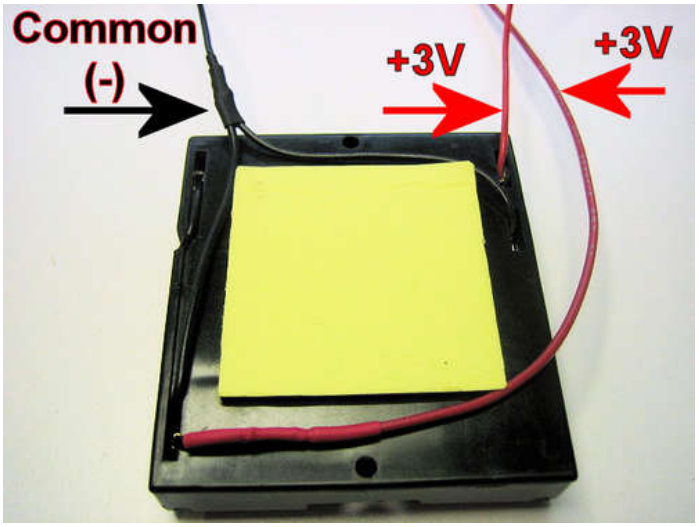
With the bottom of the battery holder facing up as in the first image below route the negative leads of both battery banks as shown. Don't route the wires over the foam tape. Or if you don't have foam tape on your holder (yet) leave room to add it. Don't plan on placing form tape on top of the wires that you are routing now. The combined thickness of the foam tape and wires will make the battery holder sit up too high to fit into the Altoids tin. You'll see why later. Strip and twist the ends of the two negative leads together but don't solder yet.

Next add a length of (black) hook up wire to the joined negative battery leads and solder the connection as shown in the second image below. Then connect some red hook up wire to the positive lead of battery bank 2 and solder as shown. Make sure this wire is routed around the foam tape area and is long enough to meet up with the red lead for battery bank 1.

Finish this step by insulating the two solder connections indicated by the red and blue arrows in the second image. I used heat shrink tubing. Now as you can see in the third image below we have a battery holder with one common negative connection and two 3 volt positive connections.







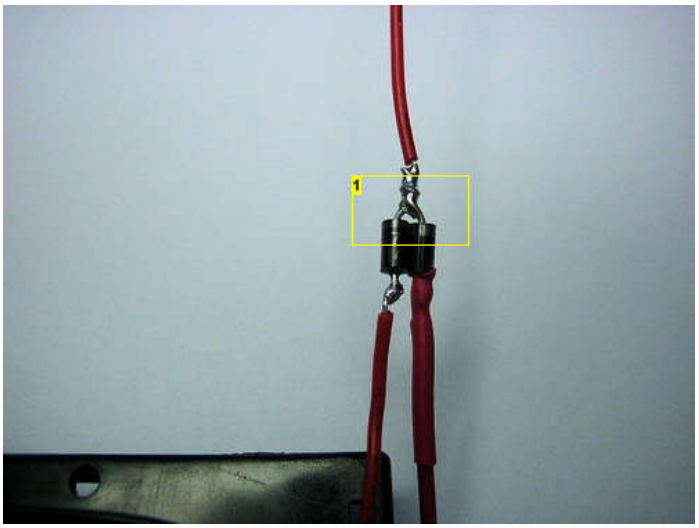
step 10: Connecting battery banks in parallel

If we connect the positive power leads from both battery banks together at this point we will have connected the two battery banks together in parallel. This would give us 3 volts output with the combined power rating of the two battery banks. But then we would have to be very careful that we don't mix battery types or batteries that have different charge states. If we were to put fresh batteries in one bank and weak batteries in the other bank then we might get some undesirable results. The fresh batteries would try to charge the weak ones and they could dangerously overheat. We can prevent this by installing appropriate diodes on each positive lead before they are connected together. This will prevent current from flowing out of one battery bank and then into the other but allow current from both battery banks to reach the MintyBoost.

Refer to the first image below. Cut both positive battery leads relatively close to the edge of the battery case as shown. This will help conserve the limited amount of space in the Altoids tin that we'll be working with after the MintyBoost has been installed.

Next install diodes on the ends of each positive leads keeping the diode leads as short as possible to conserve space. Make sure that the ends of the diodes without the little silver stripe (the anode ends) are connected to the positive battery leads; this is critical. The leads on the end of the diodes with the silver stripe indicate the cathodes and these will be twisted together and connected to the MintyBoost positive input voltage connection.

Make sure these connections are insulated from each other. You can see in the first image below that I used a bit of heat shrink tubing on one lead to accomplish this. Then, as shown in the second image, the entire diode bundle was insulated with more heat shrink tubing.



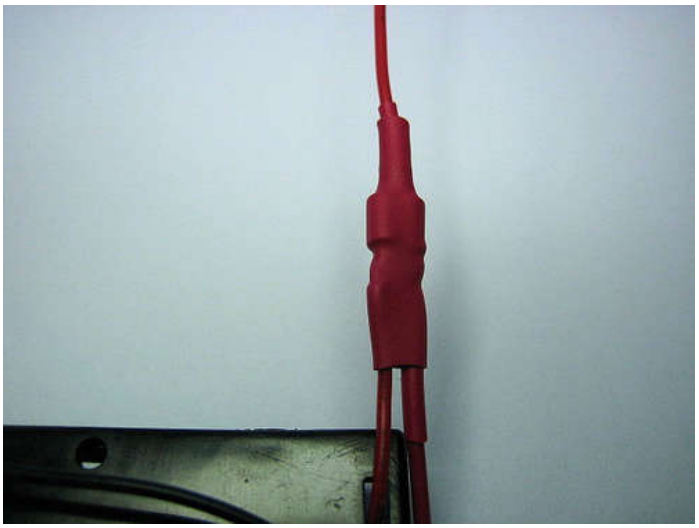
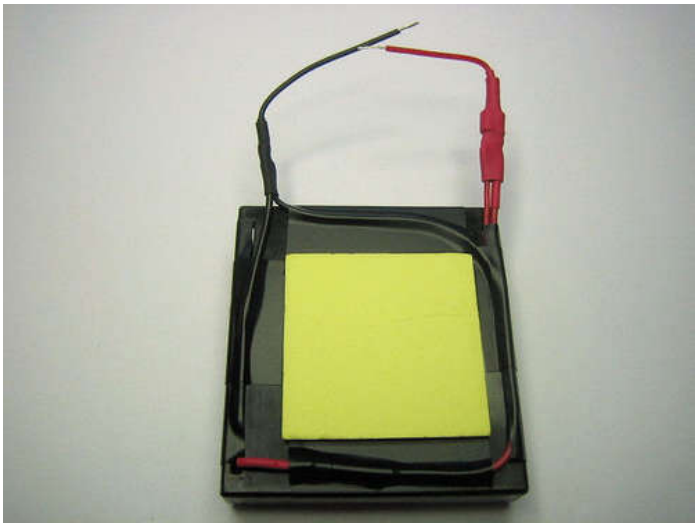


Image Notes
1. Cathode ends with silver stripes.

step 11: Add some Insulation

Since the sides of the battery holder with the exposed metal connections will be very close to the sides of the Altoids tin add some electrical tape to both sides for insulation purposes as shown in the first image. You can also add some tape to the bottom of the holder to help keep the wires in place as shown in the second image.

This completes the battery holder modification. Now we are ready to connect the battery holder to the MintyBoost, prepare the Altoids tin and do the final assembly.

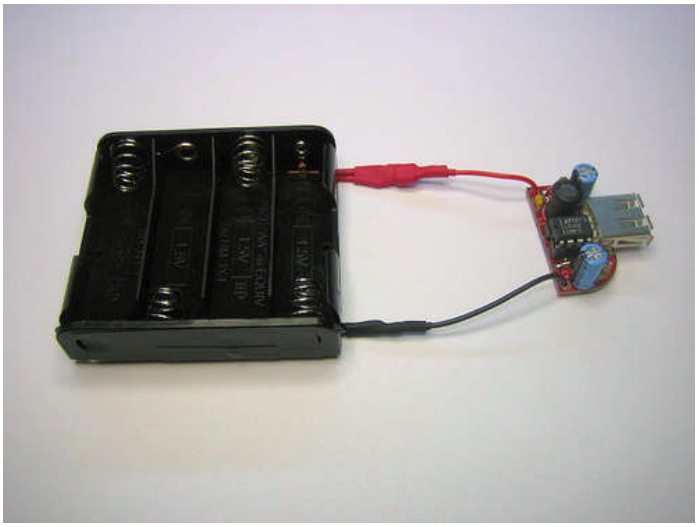


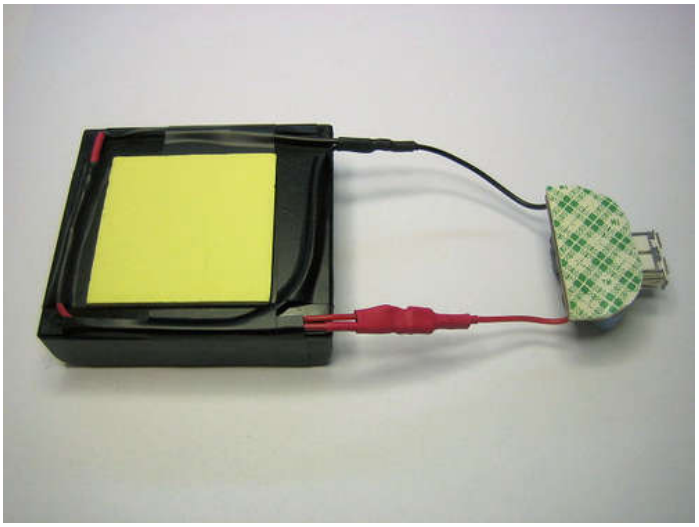
step 12: Connect the MintyBoost

Install batteries into the battery holder and test the output voltage before connecting it to the MintyBoost. Fully charged rechargeable AA cells should give you about 2.5 volts while fresh alkaline cell should give you a bit over 3 volts. Once you are sure you have a properly functioning battery holder remove the batteries and make the connection to the MintyBoost.

Solder the power leads from your newly modified battery holder to the MintyBoost being careful to observe input voltage polarity.

Apply double stick foam tape to the solder side of the MintyBoost and trim to the shape of the circuit board.





step 13: Prepare the Altoids Tin

Cut a hole in the Altoids tin to accommodate the MintyBoost USB connector. The bottom of the hole should be even with the bottom of the USB connector after you apply the foam tape. Here is how I accomplished this...

I measured the USB connector and then created a template out of thin cardboard. This allowed me to check the size of the hole for fit with the USB connector before attempting to cut the tin case. Once the template was made I used it to trace the outline of the hole at the desired location on the tin. Once I marked the outline of the hole where I wanted it I used a Dremel drill bit to make an initial hole and then a Dremel soft metal cutting bit to rough out the hole. Then I used some small hand files, one flat and one square, to finish out the hole. The images below show the progression of this process along with the tools used for each step.

I would like to find a rectangular hole punch to make this step easier in the future.

One of the benefits of making the hole this way instead of using tin shears is that the case is more sturdy and we can use it to sink off some of the heat generated by the MintyBoost as shown later.

step 14: Final assembly

Install the MintyBoost into the Altoids tin as shown. Depending on how tight the USB connector fits through the hole it might be a good idea not to expose the adhesive on the double stick tape until you have the MintyBoost in place. With the USB connector sticking through the hole you can tilt up the circuit board and remove the adhesive protector by grabbing it with needle nose pliers, tweezers or similar tool since there won't be much clearance and then stick it in place.

Now you can add a line of solder along the top of the USB connector joining it to the tin case (second image). This will help to hold the MintyBoost in place while allowing some of the heat it generates to dissipate through the case.

Now expose the adhesive on the battery holder's foam tape. Begin installing the battery holder by inserting the end connected to the MintyBoost (third image) . This will require some gentle prying pressure to get the battery holder started into the case. Continue to slide the battery holder into the case while managing the lay of the power leads (forth image). You want to get the power lead side of the battery case right up against the MintyBoost circuit board. It will require more gentle prying pressure to get the other end of the battery holder into the case. When you do it should snap into place as the curled tin rim of the case snaps over the top of the adjacent battery holder sides (fifth image).

Apply downward pressure to make good contact between the foam tape and the bottom of the case. Squeeze the sides of the Altoids tin to counteract and outward bending that may have resulted from the prying you did to install the battery case.

step 15: Final inspection

As you can see in the first two images below the battery holder fits tightly under the inside rim of the Altoids tin. This helps hold the battery holder in place. You can also see in the second image an example of using JB Weld to hold the modified terminal (from step 8) in place.

The last image below shows the completed project. Since we are using a battery case very similar to those encountered in many consumer electronics the double capacity MintyBoost has a familiar feel to non-technical users. This was an important design consideration since most of the people I have made these for are not technical. After installing batteries and closing the tin case the device has a very sturdy feel. You might even say that it's "Curiously Strong".

I'm not sure what it is about Altoids tins. But when people see something useful made out of one they seem to get a real kick out of it. And I get a kick out of making them. I made a bunch of these for Christmas gifts and have given some to fellow volunteers who rely on portable power sources.

Thanks for taking the time to read my instructable. Your comments are welcome and an honest rating would be appreciated.

Special thanks to Lady Ada (www.ladyada.net) and adafruit Industries (www.adafruit.com).

Thank you for all the great comments and feedback!

If you're interested in buying one of these completed kits they are now available here...
bit.ly/dh15cJ

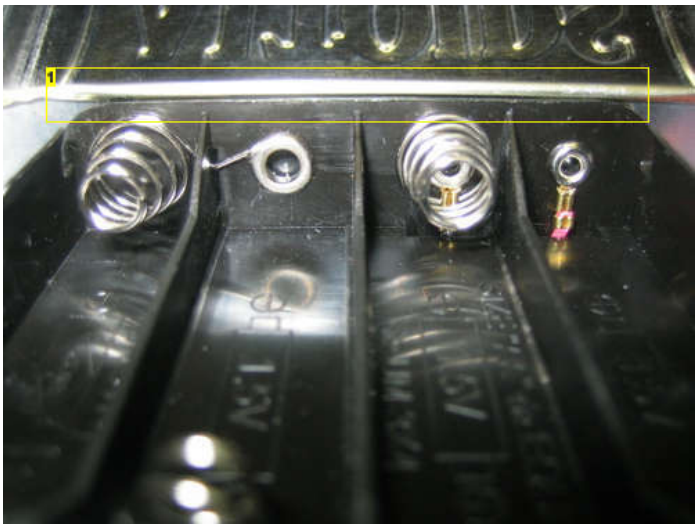


Image Notes
1. The battery holder snaps in place under the curled inside lip of the tin case.

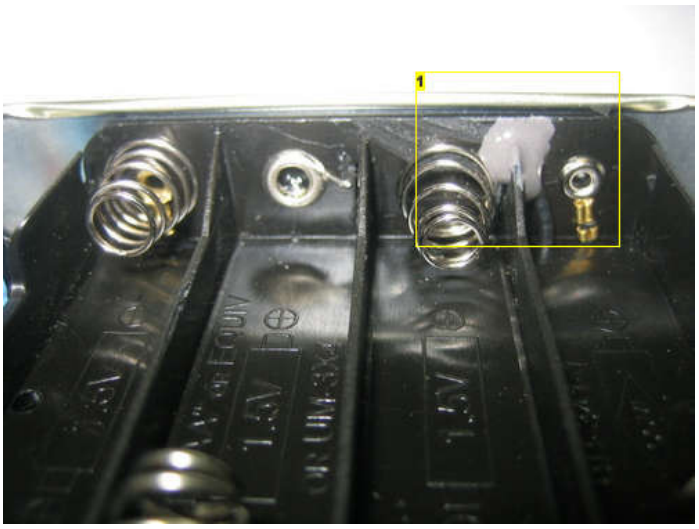


Image Notes
1. Gotta love JB Weld! It's holding the modified spring terminal in place by securing the wire that was wedged into the slit we cut.