Fabricating a chassis from clad PCB board material

How many times have you started a project and the finished appearance is based on what box you had laying around, rather than what you would like to have? It may even have extra holes or cutouts that aren't used, and it is apparent to everyone what took place.

With some effort, project boxes or chassis can be constructed using copper clad pc board material for your electronics projects using common hand tools. More expensive tools can be used to save time, but the same quality end product can be obtained with readily available hand tools that you probably already have. The methods described in this document will use the most basic tools and techniques. You may, of course, use any tools at your disposal to streamline the project, but the end result, after painting, will be strong and the exterior will be indistinguishable from a press brake formed sheet metal chassis. With the addition of custom decals, you can produce cases with professional looking results. I use this process, to check for form and fit on all my chassis designs before sending them out to sheet metal shops for production fabrication.

Fiberglass printed circuit board material is a very desirable material to work with. It is strong, easily obtainable, easy to cut using various methods, and being copper clad, it solders easily and therefore has excellent electrical shielding. I have yet to attend a hamfest where there isn't someone selling pieces of pc board stock. It is available on eBay, mail order outlets, and also McMaster Carr. Given the amount you are going to use and the time spent in fabrication, I would suggest a better quality as opposed to a lesser quality. Single side board can be used, except for supports and gussets where you may want to solder on both sides. I use double sided board on all my chassis. The extra layer of copper makes the final product more rigid.

The last time I checked McMaster Carr, they had:

Part #8521K46

Grade G-10/FR4 Copper-Clad Garolite Sheet Clad on Both Sides, 1/16" Thick, 24" X 36"

In stock at $43.37 Each.

This will make a lot of small chassis. There are many suppliers selling smaller pieces, so look through the surplus catalogs.

I will direct this exercise around using 1/16” thick, double sided copper, G10, using simple tools, and incorporating some methods for illustrating what can be done using this material, that may or may not, apply to your specific application, but are shown here for reference. I basically fabricate the enclosure, add holes, finish paint and apply decals.

The items you want to address for your basic design are size, how you are going to attach internal boards, or assemblies, what edges you want exposed, and how you would like the cover to fit, or even if you have to have a cover at all. Simple projects can be an “open frame” concept.

Required tools

- Something to cut the pcb material. I use a heavy pair of tin snips, but it can also be cut with a hacksaw. Those that are fortunate to have a shear, can use that.
- Scribe
- A scale to measure and scribe cut lines and hole locations.
- An inexpensive dial or digital caliper is extremely helpful.
- Small square is required to check that the finished pieces are square, and later to check for soldered joint squareness.
- Piece of 2” angle iron about 6” long, can be aluminum angle as well.
- A few spring loaded clamps.
- Sheet of 120 grit emery paper
- Soldering iron (40 watt should do), and rosin core solder
- Solder Wick®, for repair, if needed
- Scotchbrite® pad
- Any flat surface to place the emery paper on for finish sizing of the individual pieces. A cut piece of mounted Formica would be ideal.
- Smooth file, for radiusing edges, and de-burring.
- 4-40 brass nuts, and stainless steel 4-40 screws for holding nuts in place while soldering.
- Assorted drills and files for holes and cutouts.

It is assumed that the builder knows how to safely use hand tools and will apply the appropriate safety equipment, and practices.

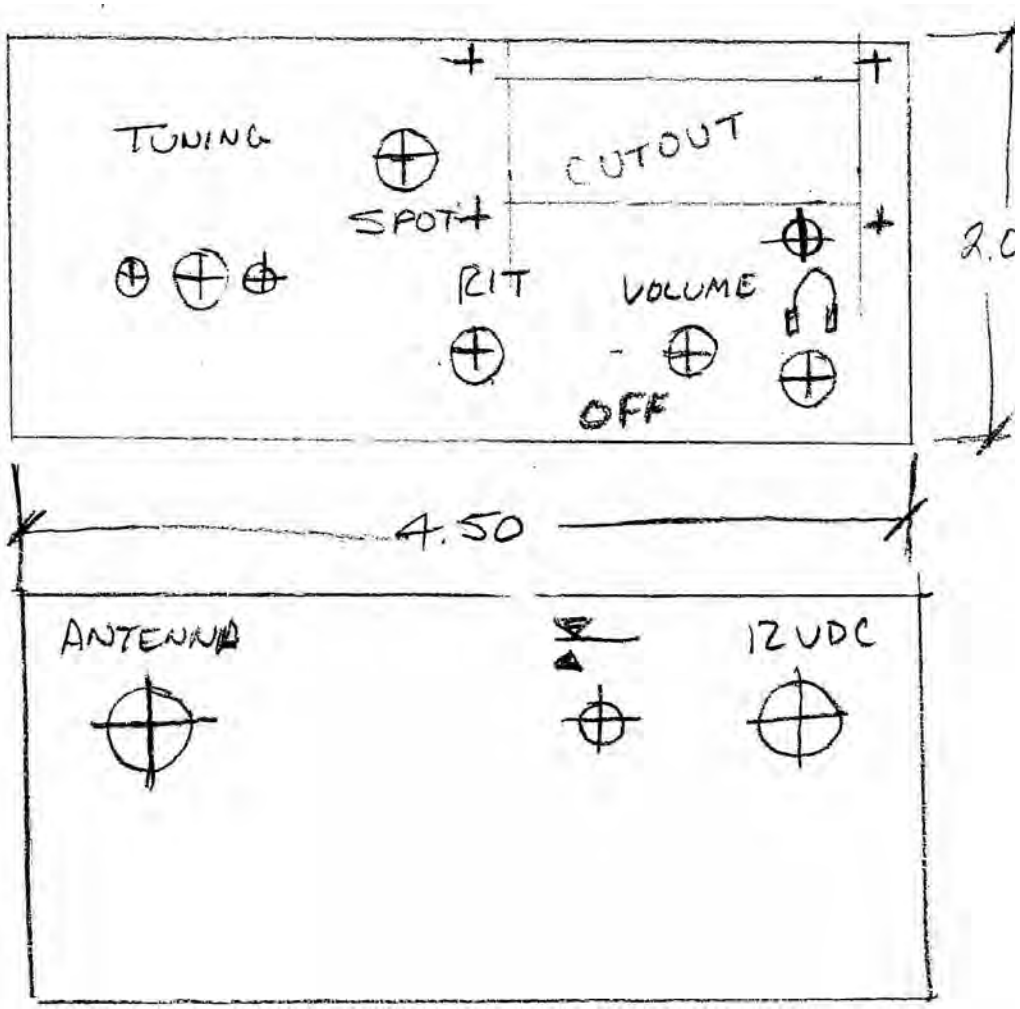
Know what you want

The more time that you spend planning, will be time well spent. Ideally, you have your project completed and working, and just need to have a chassis. Will this be something you want to look at on top of you desk while you are operating, or a piece of functional test equipment that rarely sees the light of day?

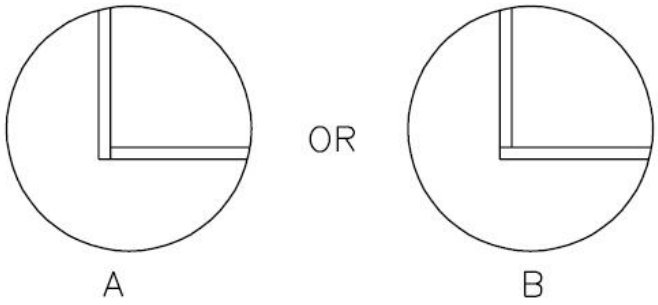
We will assume the former and this will be our project. Having said that, if you are early in the project and have the ability to decide where to place any board mounted components that will need access through the enclosure of your final design, now is a good time to think ahead of how these components will interact each other. For instance, will the knobs I'm using be too close to one another, do you really want that phone jack on the front, as opposed to the rear. These types of considerations need attention, and we will assume you have resolved all these issues.

Starting out

It is a good idea to make a rough sketch of what you would like the chassis to look like. Pencil, paper, ruler and eraser are my preferred method. I use a CAD program later on, as I do my designs, but they all start out on paper first. This chassis will have a painted base and cover.

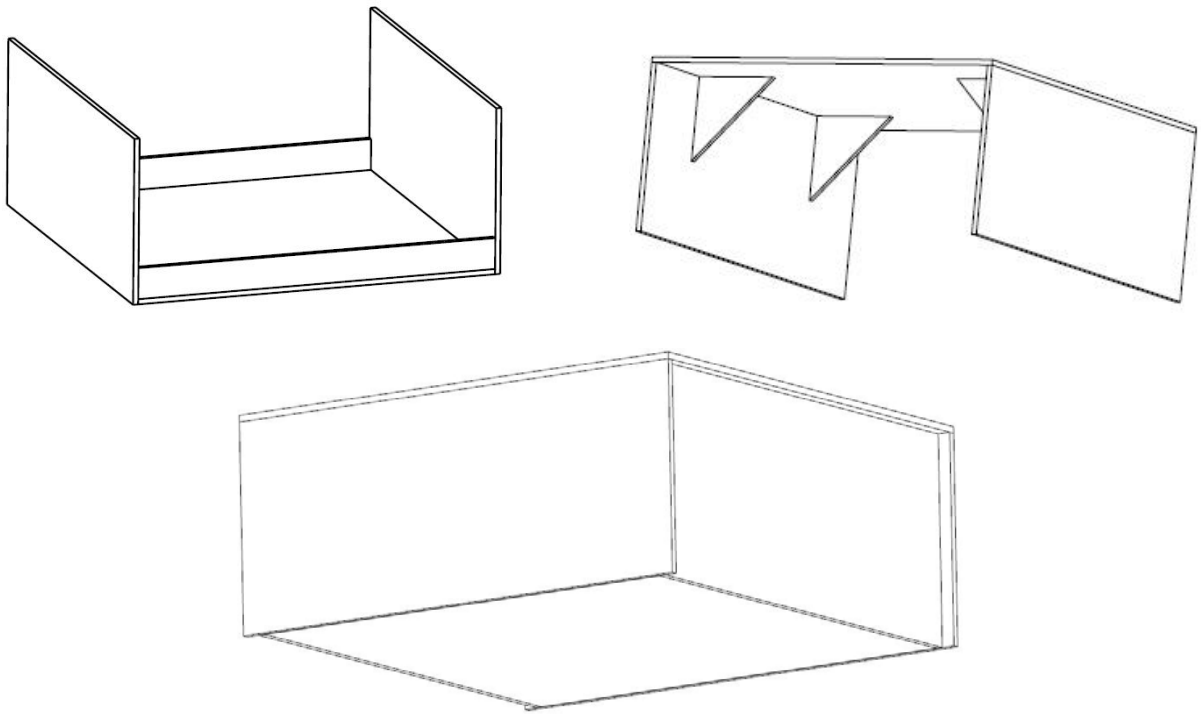


Once you decide on the overall size and basic location of any holes, you need to decide how you want the corners to fit. Below is a diagram of what I mean.



Suppose you are looking at the two illustrations from the left and it is the front panel. A is preferable to B, because the chances of seeing a crack at the bottom of the front panel is eliminated. Of more importance, is the fact that you have to allow for material thickness in your overall size of the individual pieces, depending on how you want the edges to fit with together. Think ahead, as these pieces can be difficult to replace in the middle of soldering it together, and it is easy to fabricate the cover and find you are one or two material thicknesses off, and now it won't fit the base.

<u>Our exercise project</u>



This is the basic chassis bottom and cover we are going to build. It's going to be about 4 1/2" wide, 4 1/2" deep, and 2" high. The cover will overhang 1/8" to the front and rear. We will make the cover .01" wider to allow for a non-interference fit.

The bottom chassis will have two narrow sides connecting the front and back panels. On these strips, I will solder a brass nuts to the inside, so the cover has something to attach to. These strips also act as corner supports for the joint between the front and rear panels to the bottom. It is not a good idea to depend only on the soft solder joint to provide all the strength for a 90° unsupported panel. As we proceed you will see that these are not continuously soldered joints, only stitches. We will use gussets on the cover to support the sides.

Make a materials list of all the bit and pieces that will make up your chassis.

This chassis will be:

Bottom chassis:

Front and rear panel	2ea. 4.500 x 2.000
Bottom	1ea. 4.375 x 4.500
Sides	2ea. 4.375 x .375

Cover:

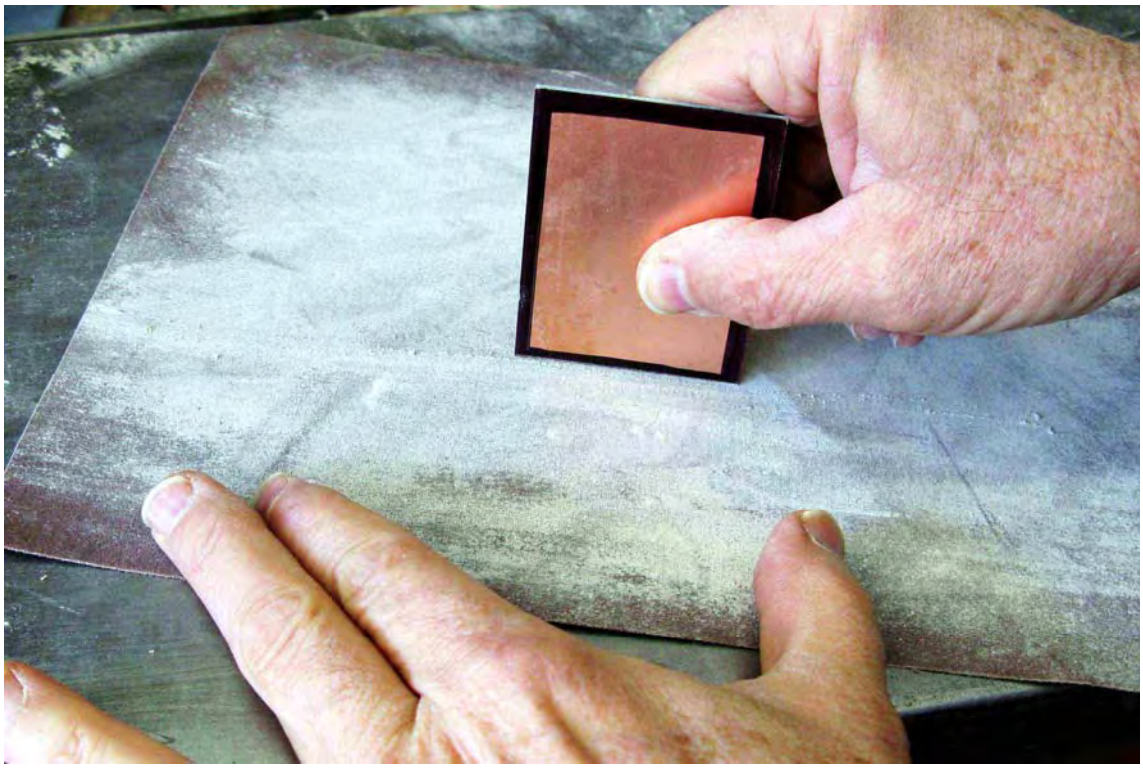
Top	1ea. 4.510 x 4.750
Sides	2ea. 4.750 x 2.000
Gussets	4ea. 1.00 x1.00 x 45°

I start by adding about 1/32”-1/16” to the overall length and width of each piece needed. I then use the Magic Marker to mark approximately where the scribed line is going to be made, and scribe over the marker band. This gives contrast to your scribed line, and also prevents cutting to a previous scribed line you may have made incorrectly. Scribe the pcb material. Be clever, and measure twice and cut once.

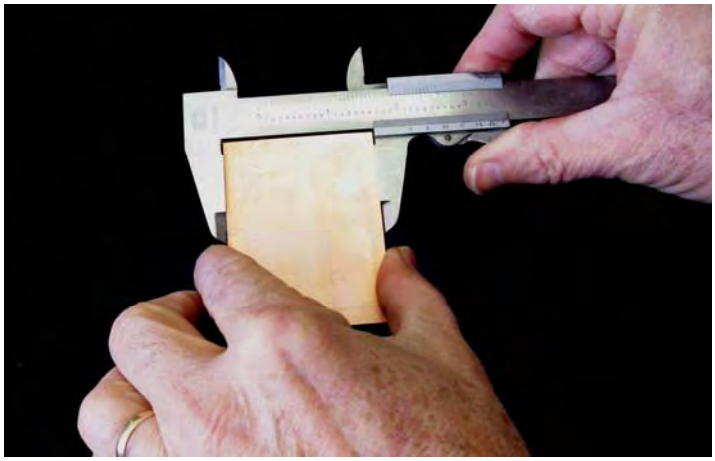
When working fiberglass or any material that produces dust, use the appropriate face and breathing protection to keep from inhaling dust.

Shearing leaves the thickness a little ragged, and de-laminates it slightly. Once you have all the pieces cut, you want to have nice square corners to the finished size and a square corner at the thickness, on all four edges. To do that, you rub all four edges on the 120 grit emery paper, laying on a flat surface. Start out slow, as the size can change very quickly, and it is easy to get undersize, or out of square. Check the four corners for squareness frequently during the process, and adjust accordingly. The end result should be to your list of finished sizes, four square corners, and all four edges cleaned up and smooth.

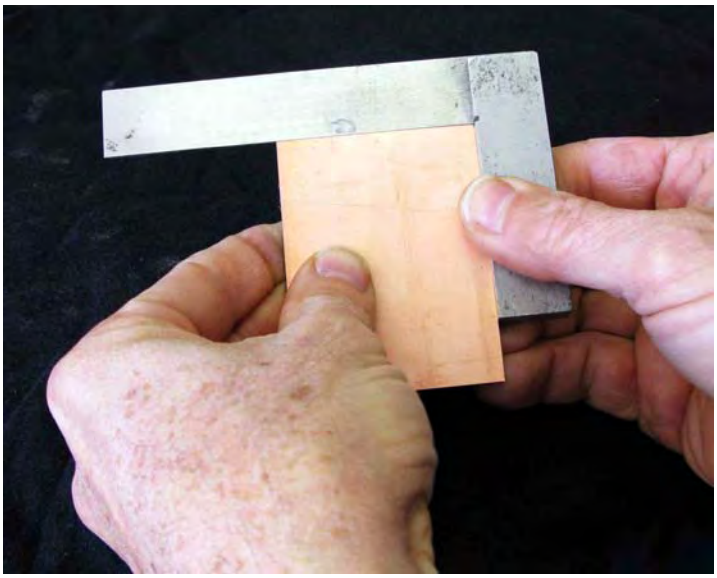
Cut oversize



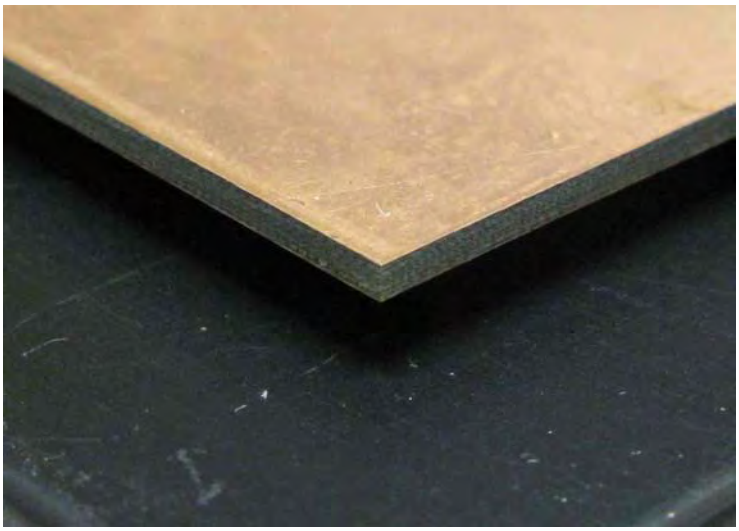
Sand edges



Check size frequently



Check corner squareness frequently

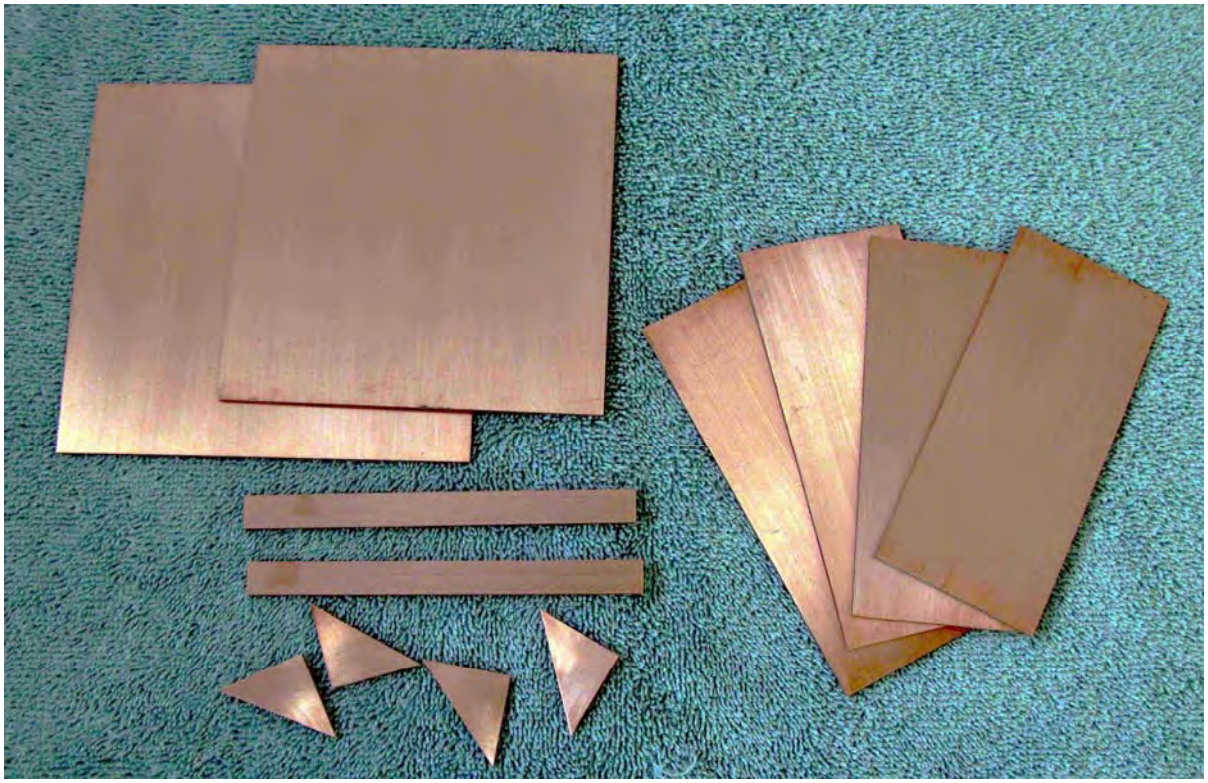


Edge squareness and edge clean-up

Repeat this for all the pieces required. The more time you take getting the stock to the correct size and square, will be time well spent.

Test fit the chassis together

Now is a good time to double check that you did your math correctly. Butt the pieces together to see if you have the correct basic fit. If you are off a material thickness somewhere, it will show up, and you can make a replacement part, with the correct dimensions. After you have assured yourself that all is correct, take all your pieces to the sink and scrub them with some Scotchbrite to prepare the surface for soldering. Remove any surface corrosion, oils, and traces of the marker so that the copper is shiny and will solder easily.



Here are the parts sized, squared, and cleaned up for soldering.

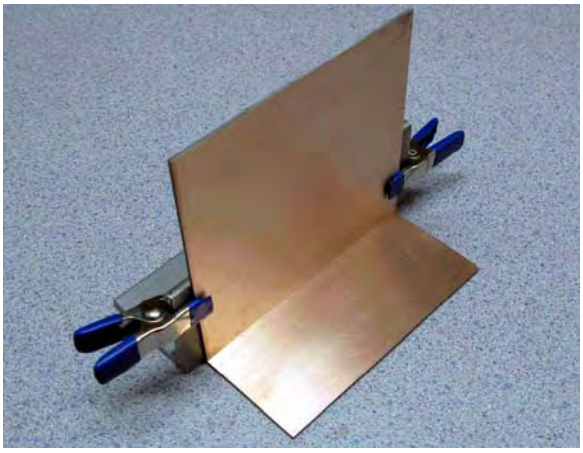
Soldering the chassis together

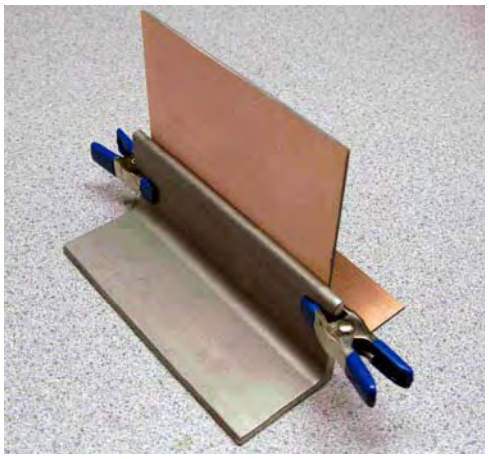
There are some physical characteristics of the solder that must be understood to make this all work like it's supposed to. First, and most important, you must understand that the solder contracts when it cools off. Knowing this, we can allow for it. When two pieces of the pcb material are clamped 90° apart, and you apply solder at the joint, the joint will close about 1°-2°, no matter how well you clamp it, and you will end up with an 88° corner. That doesn't sound like a lot, but it will make your project turn out poorly. There are a couple of ways to allow for this change. You could start out with the joint positioned at 92°, and then it would draw back to 90°. However, not everybody has the ability to machine the angle iron to that angle.

So what we are going to do is clamp it to the 90° angle, as best we can, and reflow the solder one node at a time to get our desired 90°. It sounds difficult , but really is easy.

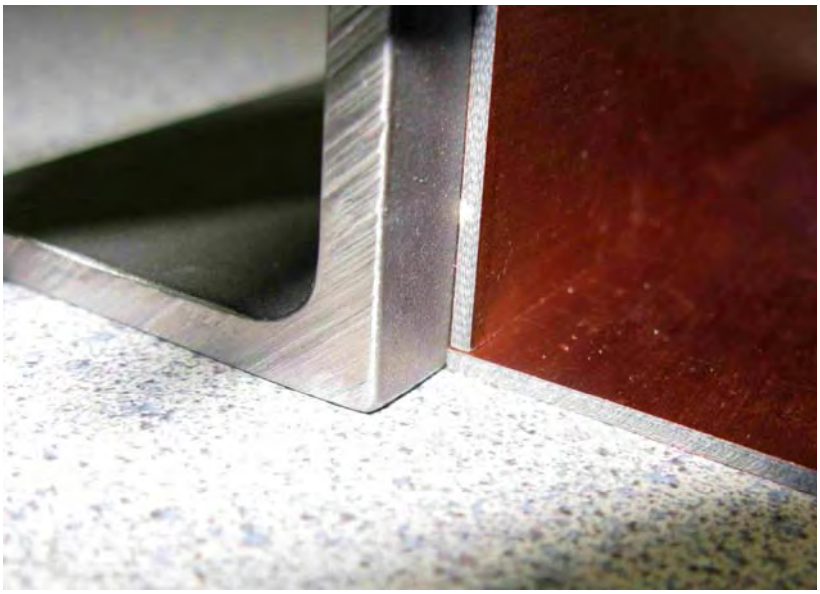
This brings up a point I mentioned earlier. The solder joints we make are not continuous joints the length of the interface. We are going to do a stitched joint, a 1/8” long stitch or node, every 5/8” - 3/4” of desired length. With the addition of corner braces and gussets, you will have a strong chassis without the warping caused by a continuous solder joint.

We now use the piece of angle iron and the spring loaded clamps to position two mating pieces.





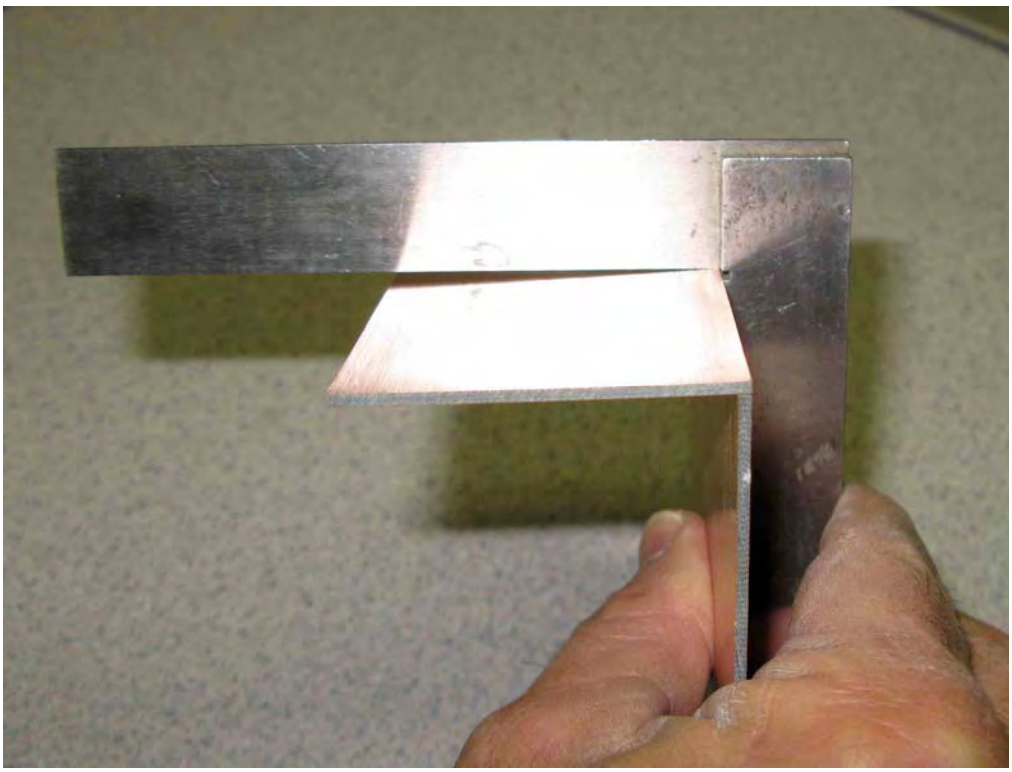
Here the bottom is against angle iron, and the front panel is flat on the table.



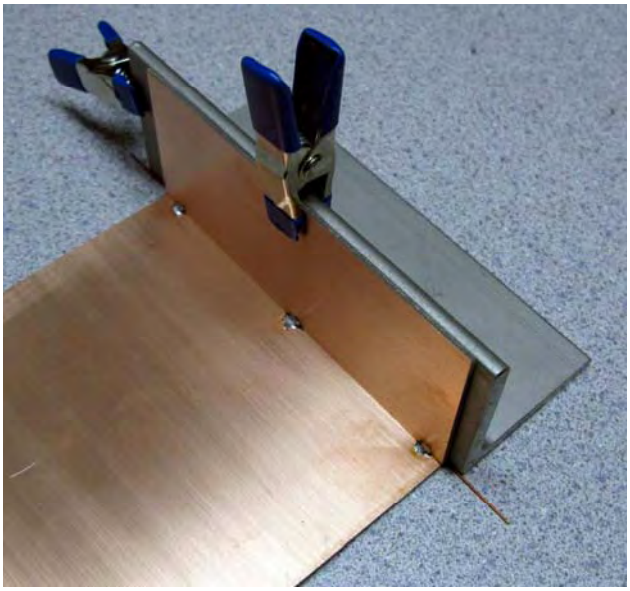
Note the corner orientation.

Now is an excellent time to refer to the diagram A & B mentioned earlier. It is very easy to get the first corner joint in the wrong orientation !

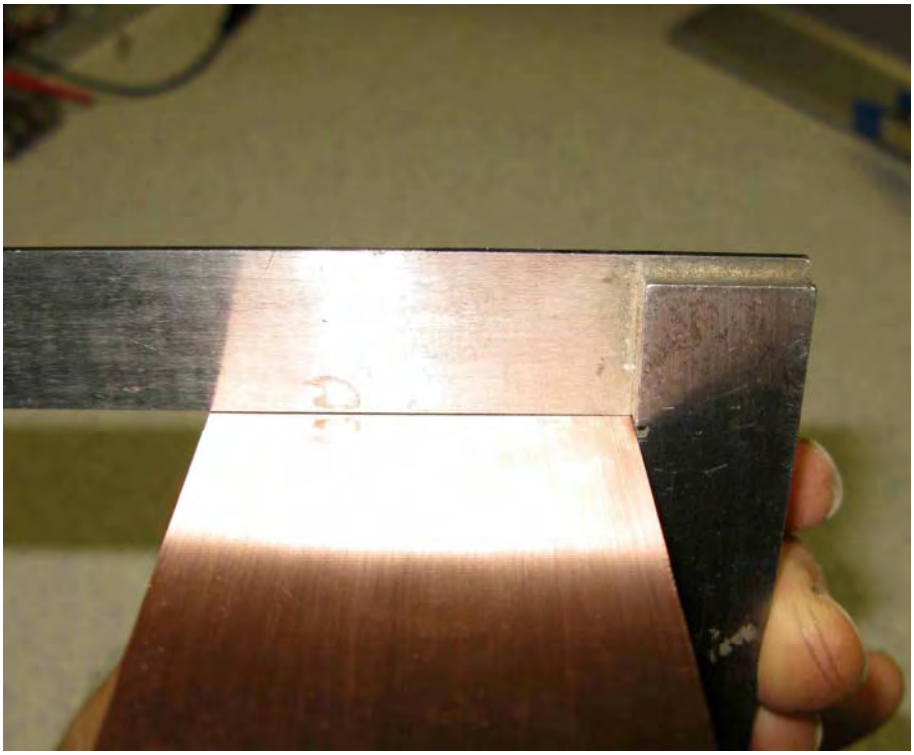
We will start soldering now that the two pieces are positioned properly by putting a short 1/8” long bead in the center and one at each end, about 1/4” in from the edge.



Remove the joined two pieces from the angle iron and check it with the square, you can see how much the cooling solder makes the side draw in.

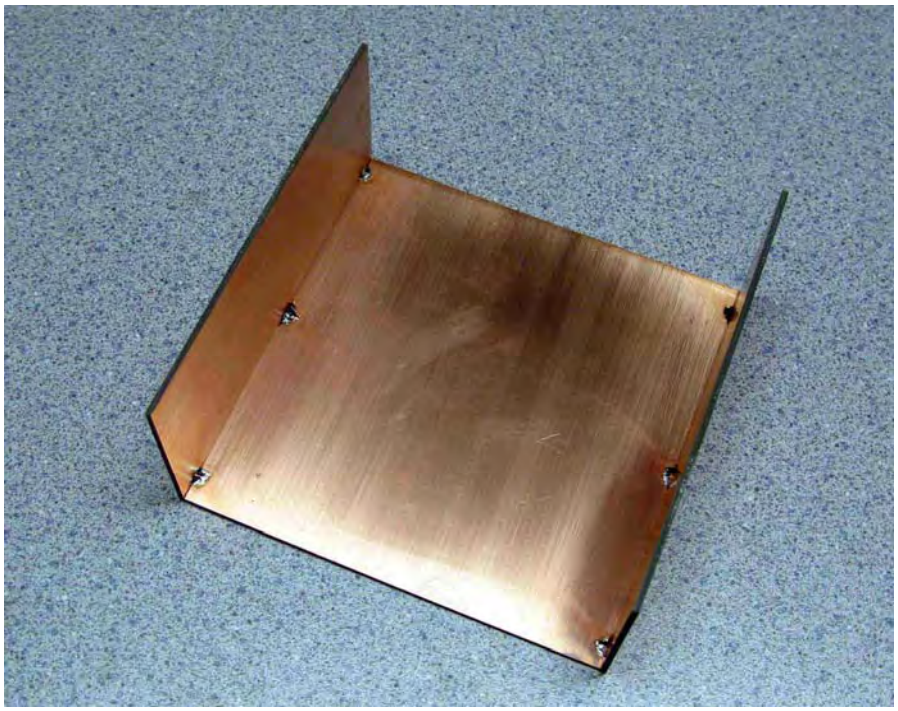


We will correct this situation by placing a piece of 20awg wire at the bottom, between the angle iron and the part and re-clamping at the top. Touch the soldering iron to each of the three stitches, and press down on the board when the solder becomes fluid, and hold in place as the solder cools. It only takes a second or two. You may have to use a larger wire diameter, but you get the idea, and can see how this will approximate a larger than 90° angle.

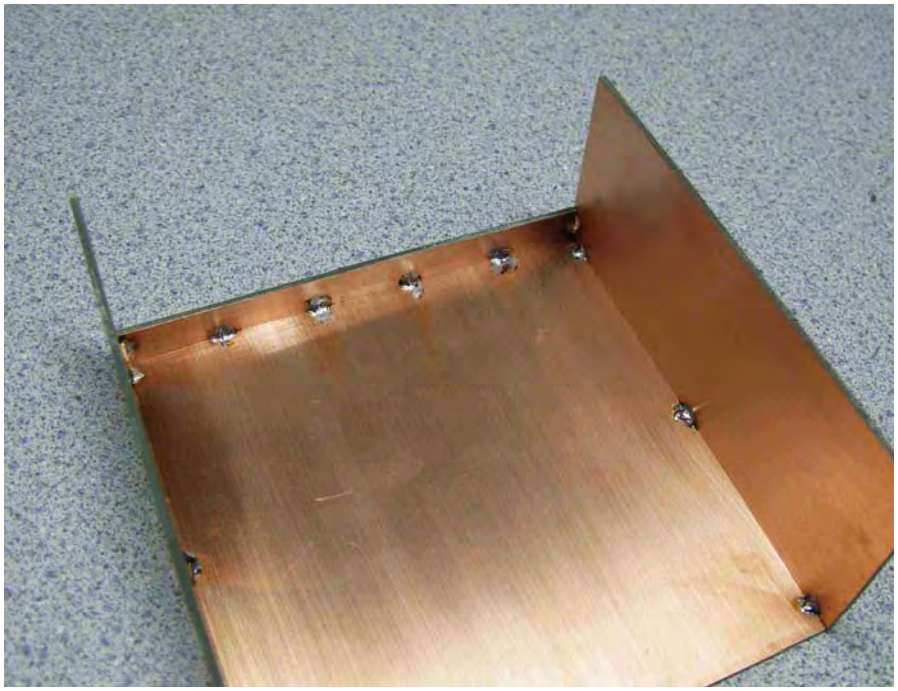


As you can see for the above picture, the results can be dramatically improved. Take your time, and you can get each union very close to 90°.

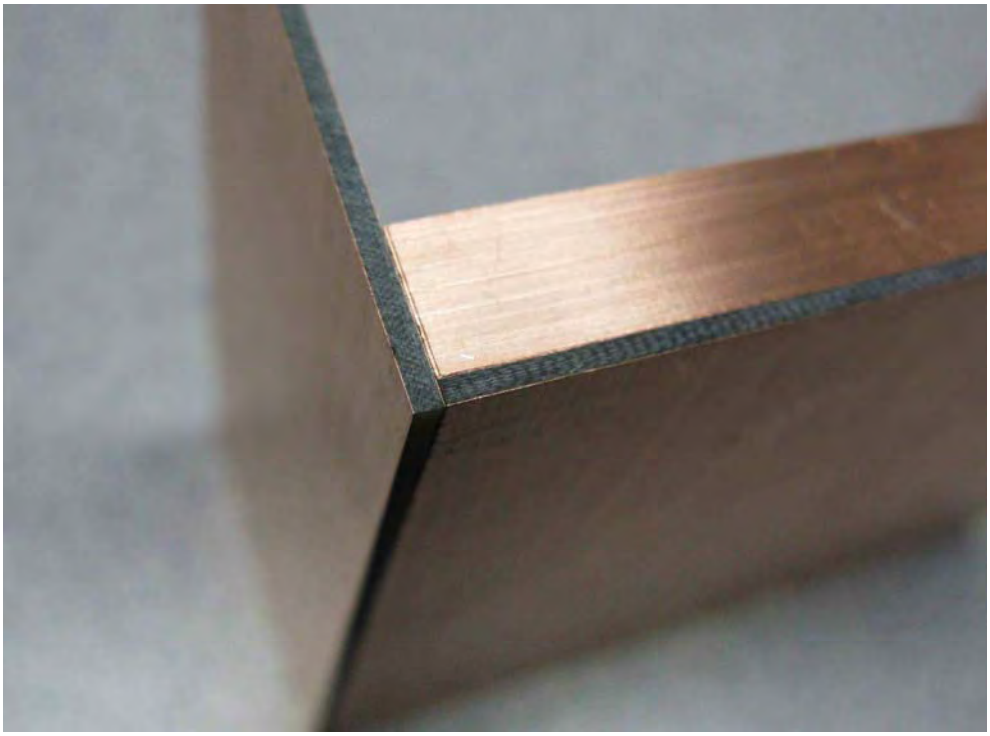
Do not try to bend or straighten the angle, without applying heat to the stitch. If you try to force the joint you will lift the copper off the board, and the union at that point is useless.



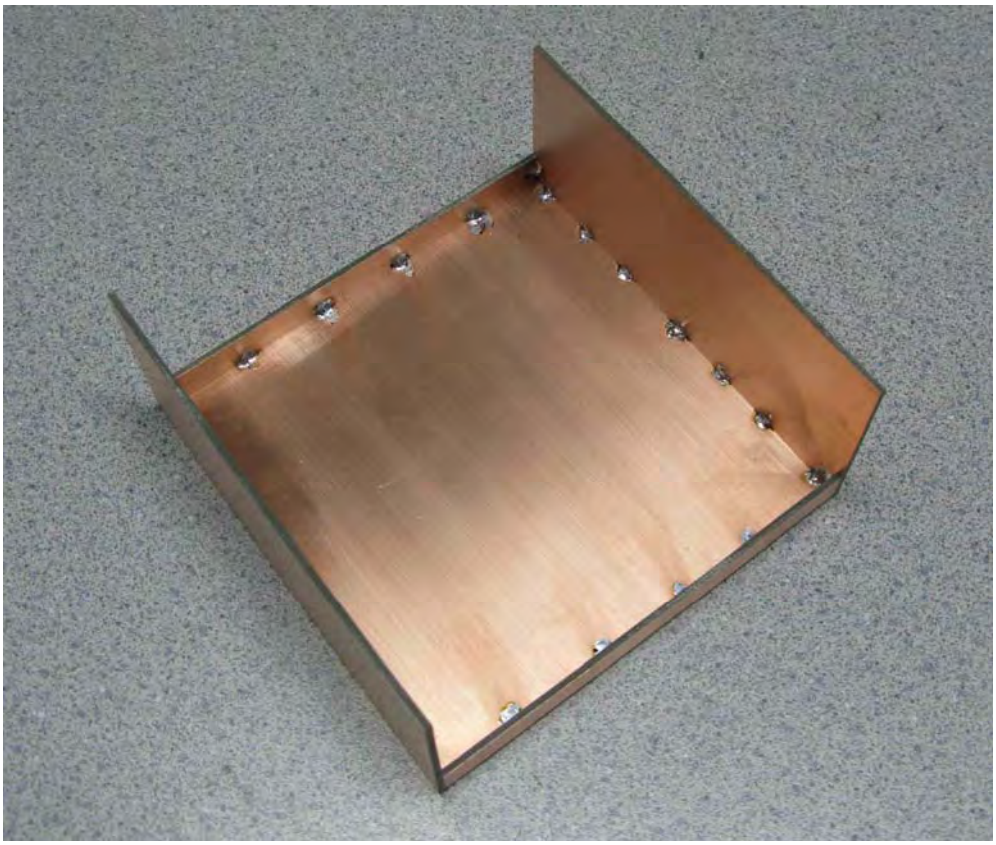
Use the same technique for the other side of the chassis. At this point there are only three stitches for each side. Whenever stitches are added , you will need to check for squareness and re-melt and correct.



Proceed to soldering the two side pieces, they should be flush with the sides.



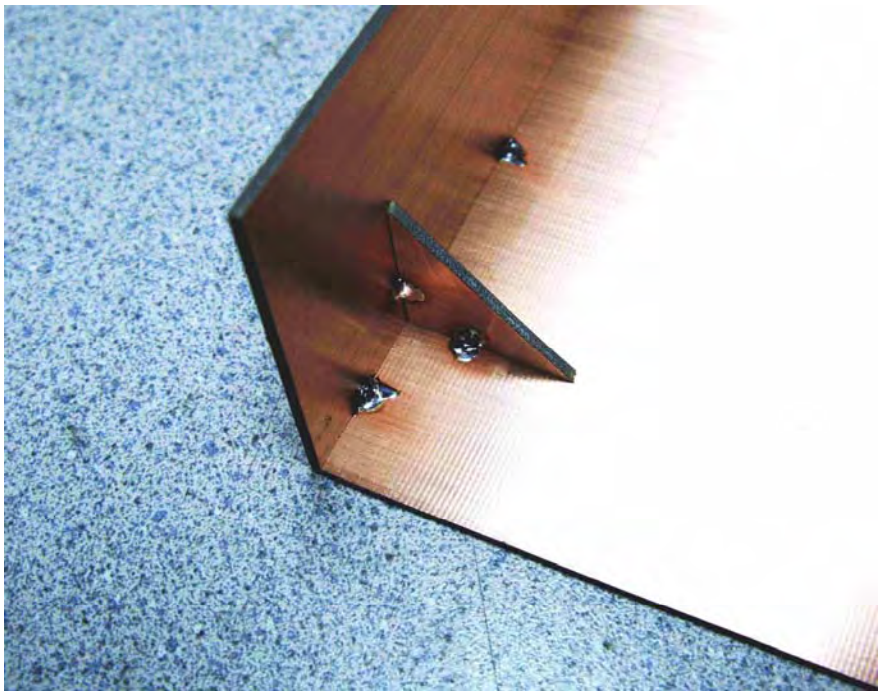
Here you see the importance of having the edges sanded square. It allows the sides pieces to be flush with the outside surfaces.



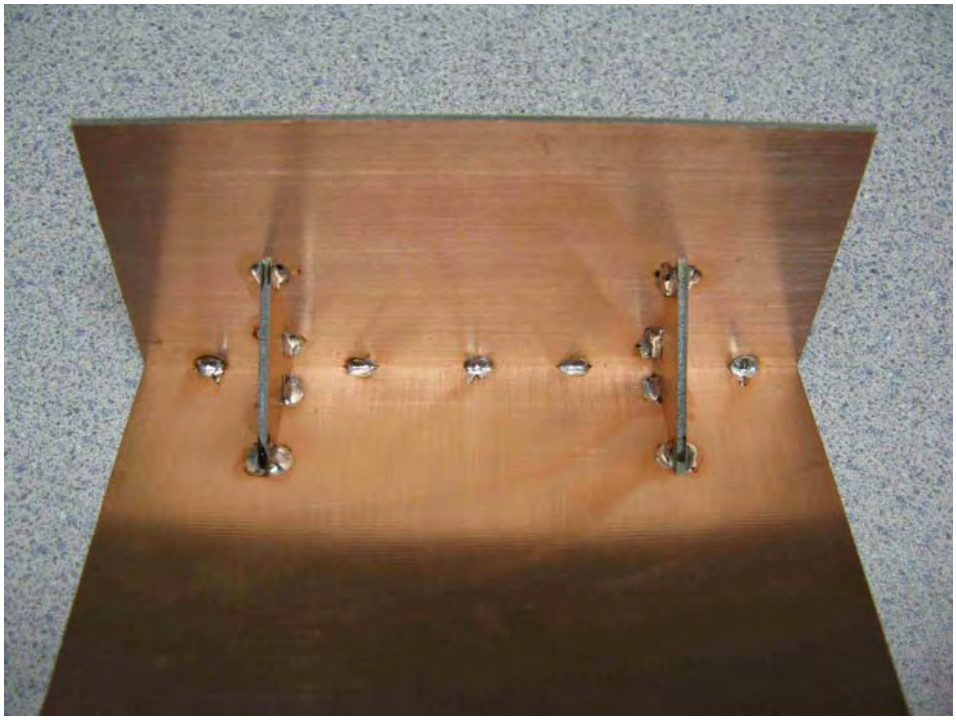
With the two sides attached, you can now fill in the stitches at about every 3/4”. When you are finished, re-check for squareness. You will probably have re-melt the new stitches to bring it back to square.

For the cover, attach the two sides, as you did for the bottom chassis. The sides will need to be squared up, using the earlier technique with the wire. Do not depend on the gussets to square the sides, they are only for mechanical support, and to give strength to the side joints.

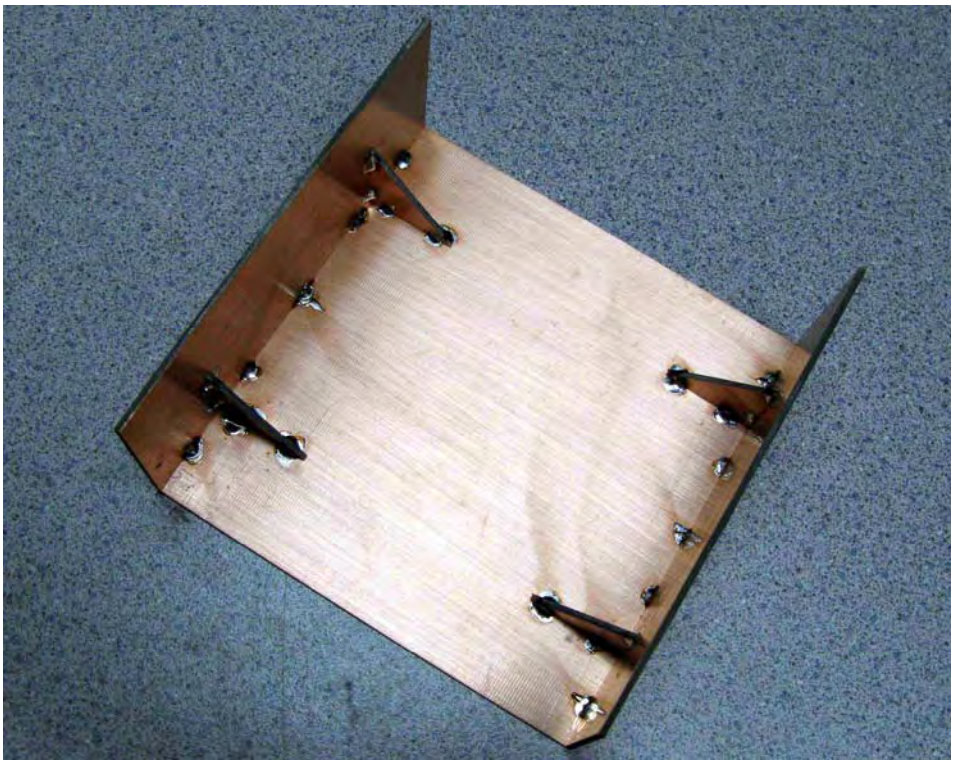
Using one of the spring clamps position a cover gusset at the dimension you desire. Be sure the gusset will not interfere with any internal components.



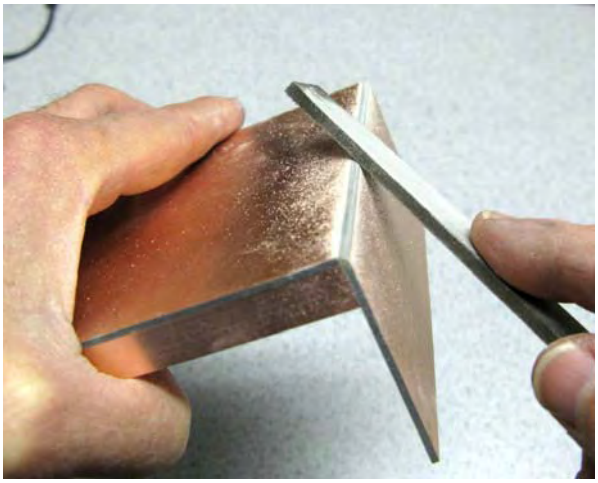
Tack solder it in a couple of places and check the outside for squareness.

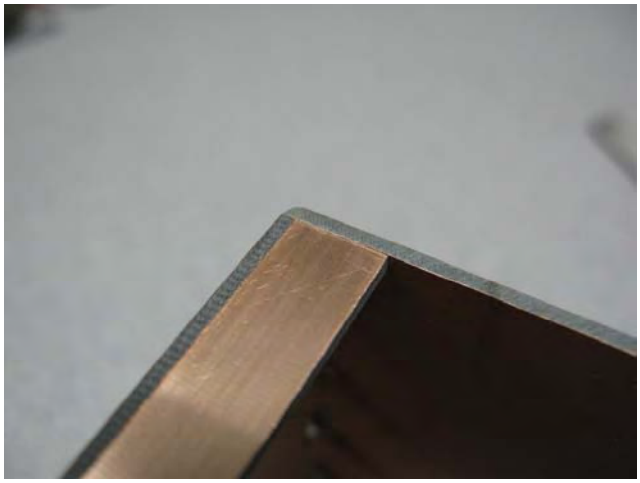


Proceed to the other gussets, and finish solder on both sides. You will notice the end stitches for the cover are farther in. This is to allow for the 1/8” overhang, to keep the bottom chassis edge from contacting the solder stitch of the cover, when assembled.



The finished cover should look like this now. Check the fit with the mating bottom chassis. If it is too tight for assembly, you can carefully sand the offending stock off the bottom chassis using the 120 grit emery paper and a flat surface.

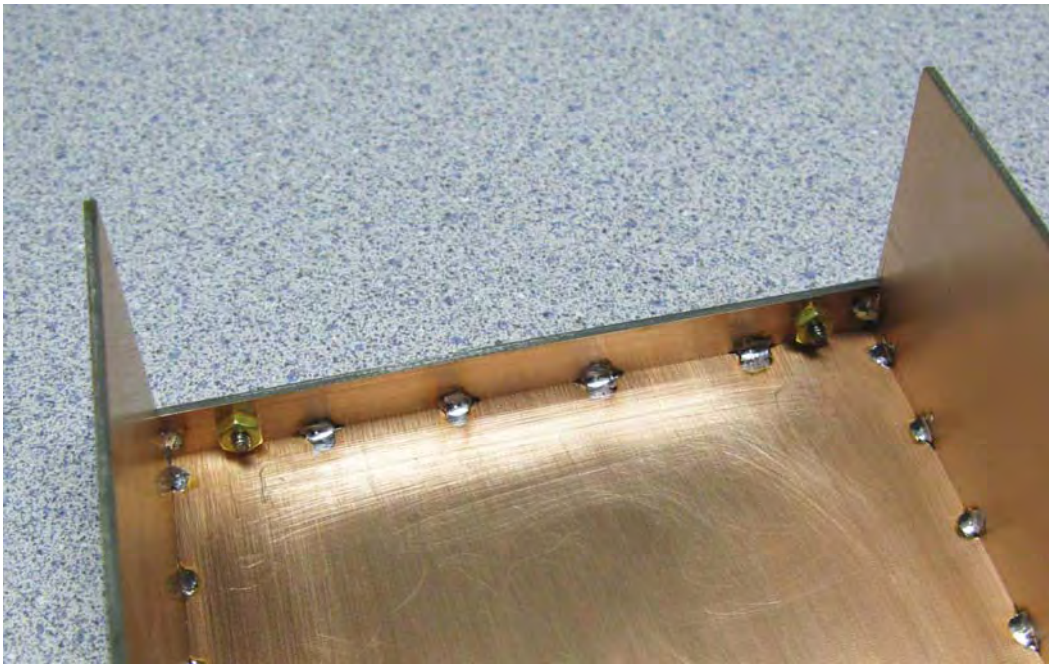




I choose to round the edges that would normally be radiused, if this was a sheet metal chassis. This operation is not needed, and does not lend any value, other than appearance.

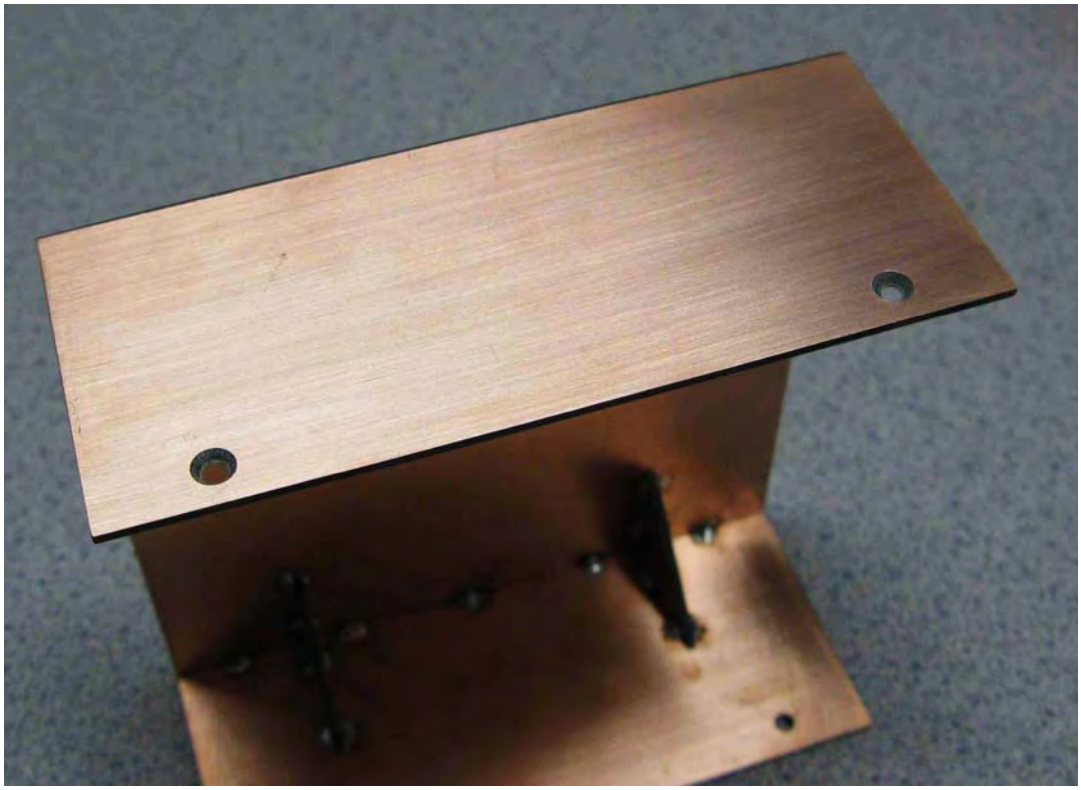
At this point your chassis should look like the picture above. You may now clean off any objectionable flux, buff lightly with the Scotchbrite pad to smooth any sharp edges or burrs.

Decide how many and where you want your cover mounting holes. Carefully scribe, center punch the locations, and drill a clearance hole for the screws you want to use. In this case we are using 4-40 hardware, so a clearance hole of .113” or #33 drill is used. In this case I chose to use four screws at the corners.

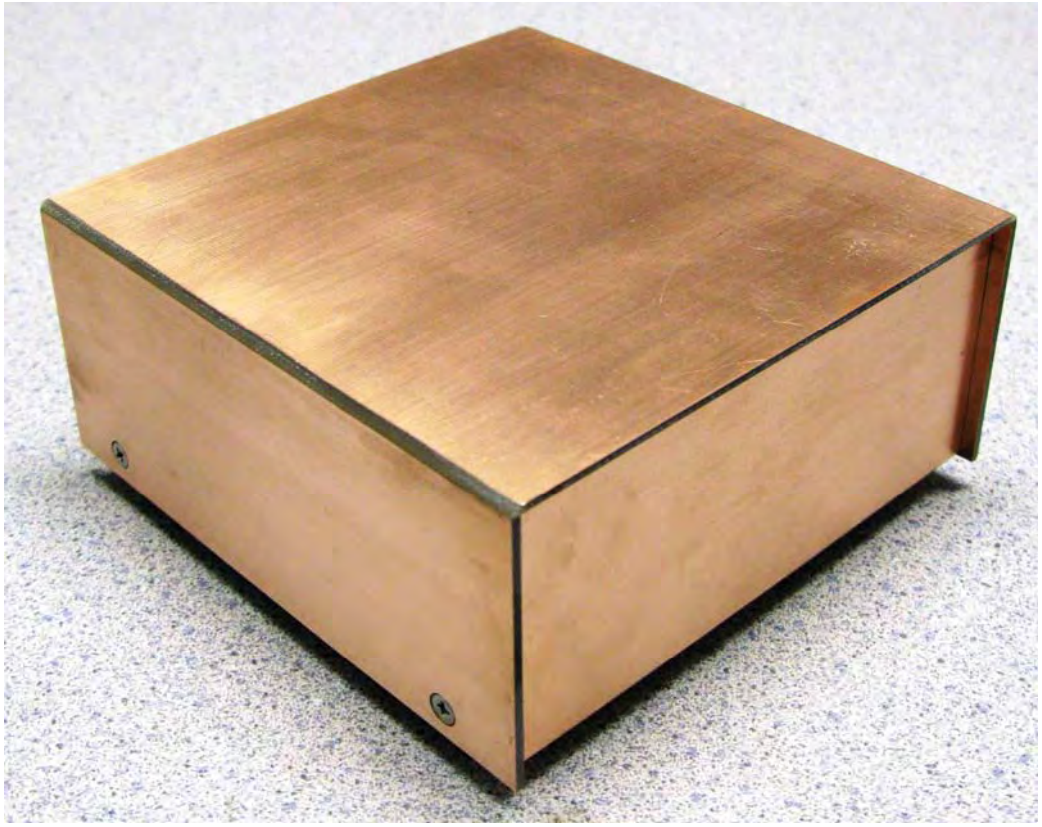


Use stainless steel screws to temporarily hold the brass nuts in place, so they can be soldered to the inside. Do not use any temporary screws that the solder may stick to, as you may solder the screw to the nut.

Solder the nuts to the inside foil.



Drill the cover, and countersink the holes if you are using flat head screws.



Here's our completed chassis, with four stick on rubber feet, and flat head hardware. It is now ready for any holes. With the time and effort you have invested, you want to measure and drill carefully. Mistakes can be repaired, but it's nice to do it right the first time. Good luck with your project.

Ken – wa4mnt
www.qrpbuilder.com