

Assembling the Patch-Feed



Hello.

My name is Hans. You might know me from the 3D-Printed portable Antennarotor or the Rants i sometimes have on Twitter... Im a Metallworker from Austria and fascinated with HamRadio and Satellites in special.

Today i will give you a Step by Step Instrucion on how to assemble the Patch AntennaFeed for QC100 the HamRadio Tansponder on the Es'Hailsat2 Satellite.



Introduction

The Dual AntennaFeed we are going to assemble today is the Brainchild from Dr Mike Willis and UHF-Satcom. They did a great Job in designing this Feed and they also made it OpenSource so everyone can rebuild one for himself. Remco den Besten wrote a great Manual that describes the Feed in Detail. It is found here: https://uhf-satcom.com/blog/patch_antenna

This Feed allows to send over the 2.4Ghz Uplink Frequency. On the back of the Feed is the LNB attached so you can Tx and Rx with the same Feed.

This manual is for People who already have cut the Reflector, the Patch and the waveguide. It is hard to write a Guide for manufacturing these Parts because of the many many tools one could have access to. You can basically build this Feed with just a Metallfile and you can make the Parts with sub one Million Dollar Hightech CNC Machines. Maybe if there is some Interest i can make a Guide for manufacturing the Parts with basic common tools...

(Here it is: <http://www.oe8hsr.at/blog/wp-content/uploads/Manuals/BuildingThePlates.pdf>)

Disclaimer and Safety Issues

In this Guide i describe how i would assemble the Feed. If you have other Ideas and Methods that are more effective or accurate please let me know, but don't yell at me saying „this is sh%%, why didnt you use this and do that instead...” A lot of ways lead to Rome...

Everyone is capable of assembling this Feed with basic tools that should be in every home Workshop. No special knowledge is needed. BUT be adviced that working with Metall and Fire always can hurt you and your Belongings. Be aware that some tools and Materials used in this Manual can be Dangerous for your health and Safety.

- Don't touch hot Parts, even if they don't look hot.
- Don't touch not deburred Edges of Metallparts.
- Don't set something on Fire when working with Blowtorches.
- Don't put Solder in your Mouth and always wash your Hands after using Solder.

I, nor the Designers of this Feed are responsible for any Damage you do to yourself, your Belongings, Others or any technical Equipment you connect to this Feed

A word of Advice before we start the Action: Take yourself as much time as you need to assemble this Feed. The key in a good working Antenna is Accuracy. Have your tools prepared and in good usable Condition.

Quote: „Slow is Smooth and Smooth is Fast.“ Phil Dunphy

Tools and Parts needed:

- The 2 Plates, for Reflector (round one) and Patch (funny looking square one)
- The Waveguide (tube)
- A Antennaconnector of your choice (capable for the Frequency, i used an N Type)
- The 4 pcs mounting Screws (in my case M3, the lengh will be cut later)
- Some Scotchbrite or Steelwool
- Some Solder and if possible Flux (you really really want to use Flux, believe me)
- Some sort of Distance holder with 3mm in Height.
- A drill or if you tend to break Stuff easily a few more (for M3 we use D2.5mm)
- Other drills with 1mm and 5mm and maybe 3mm
- A Threadcutter (M3 in my case)
- A file
- A Screwdriver (Flathead for manipulating the hot Stuff and adjusting the Feed)
- A Handdrill
- A Blowtorch (or if you have very much time a Hotair-Solderingstation)
- An Anglegrinder (not neccecery but nice to have)



- A small Ruler with an accurate angle or a small right angle
- A Caliper
- A Holepunch and a Hammer.
- A vice will come in Handy...
- A SWR-Analyser for measuring the Feed would be recommended
- A deburring tool of some kind like a Countersink or a bigger Drill

We also need some common Material like Brakecleaner or Soapwater for cleaning and a bit of Wood or Cardbord. A big Wrench would be good but you can improvise...



Lets begin:

The first Thing we have to do is take the Patch and lay it on a flat, stable Surface. Align it that the cut Corners are on the left-upper Side and on the right bottom Side. If you make a Mistake here the Feed will have the wrong Polarisation... Mark the hole for the Center connector of your Antennaconnector. The Location from the Center is 8mm in the X-Axis (Left to Right) and 28mm in the Y-Axis (Top to Bottom).

Its easier when you measure 24.75mm from the Right Side of the Patch in the Left Direction and when you measure 4.75mm from the Top in the Direction of the Bottom.

You do Best when you adjust the Measure on a caliper and slide one Arm of the Caliper on the Right Side and the other Arm on the Surface of the Plate. Then it makes a Scratch with the exact Measure on the plate. (Thats an old Metallworker Lifhack. You're welcome.)

Do this for both Measures and mark the point where both Lines cross with a Dot. (see Picture)



Now take your Centerpunch and put the Tip of it on the Point we marked.

A good Technique is that you hold the Punch in an angle at first (see Picture), so you can see the Tip and align it. Then hold the Punch upright and hit it with the Hammer but gently at first. You can check now if you have hit the desired Spot.

If you missed, give it another try on the right Position. Do this as often as you need to finally hit the right point. ;)

When you have created a small Mark you can put the Centerpunch in that Mark and hit it harder so that you get a nice Dip in the Plate.

Quote: „Good centered is half drilled...” Aaron Whiffelingpin



Now lets drill this Thing...

Put a small Drill (1 - 2.5mm, i used the 2.5mm but smaller might be better because this Hole is going to be soldered later...) into your Powerdrill and switch the speed all up to eleven or the highest gear-setting you have.

As a rule of Thumb for your next Projects: When the Drill gets smaller the RPM go up. When the Material gets harder the RPM go down. This is a 2.5mm drill in Brass so you can go full speed...

(The Formula for the exact RPM is: $RPM = (Cuttingspeed * 1000) / Diameter * \pi$ Cuttingspeed in m/min Diameter in mm)

Put the Tip of your Drill into the Punch we made earlier and try to drill as Vertical as possible through the Plate. Please note that the Drill will come out to the other End so you might want to put some Sood or a Spacer under it so you don't drill into the new Kitchentable. ;)

Don't apply too much Force on the Drill. Its very small and it breaks very easily. The Drill Parts tend to fly around at high speeds seeking the shortest Way to the part of your body where it hurts the most, so be warned...



Use a Countersink or a larger Drill to deburr the Hole on both Sides.

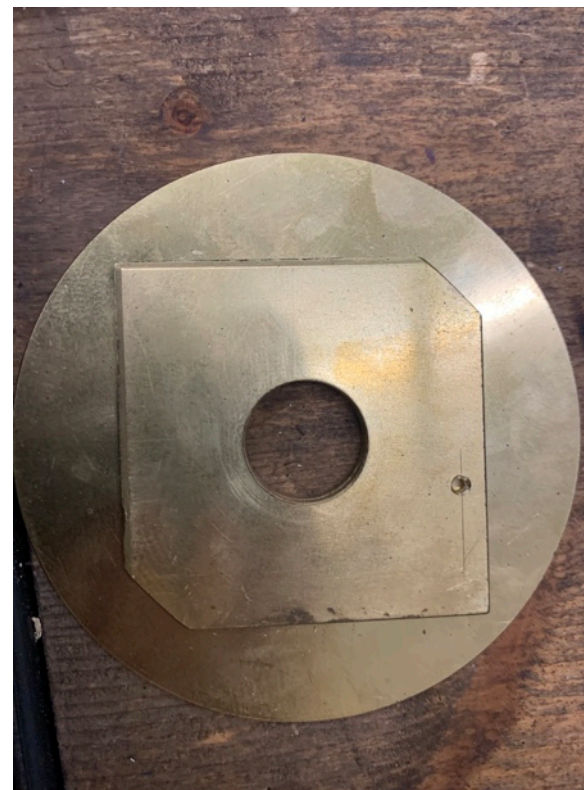
This is best Practice for every Hole you drill in the Future from now on.
It looks clean and is safe to touch...

When using a Countersink you go very slow at the RPM so you get a clean Finish and don't mess up the Countersink.

Now align the Patch and the Reflector as exact as possible over the 22mm hole in the middle. It doesn't hurt when you put the Copper tube into both parts for 100% accuracy.

Use the same Drill as before to make a Dip in the Reflector.

This will be the Position where we drill next.



Now we need to drill a bigger Hole in the Dip we made earlier.

I used a 5mm Drill because the Teflon Insulator on my Antennaconnector has a Diameter of 4mm but you might go a bit bigger or smaller. Just make sure you don't short out the center Connection of the Antennaconnector on the Reflector...

Also deburr the Hole on both Sides.



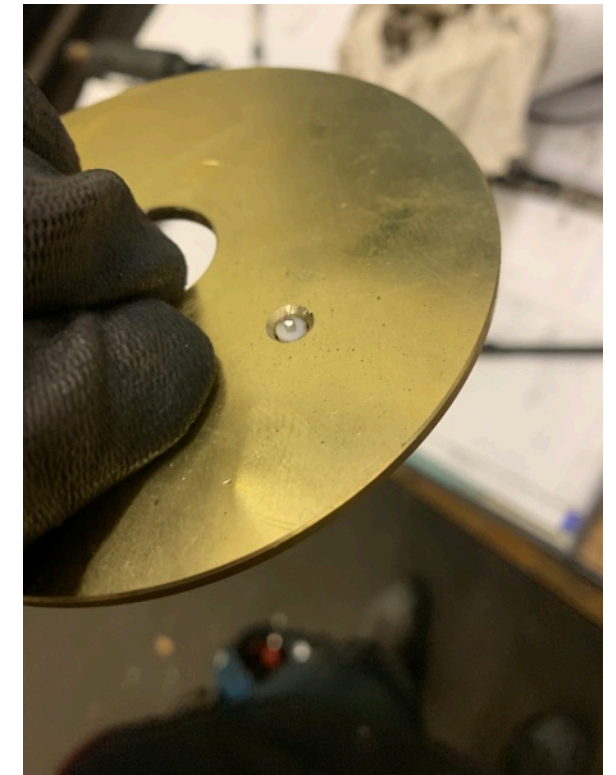
Now take the Antennaconnector and put it through the Hole we drilled. Make sure the Connector is centered as good as possible and try to align the Connector with the Reflector that will be put on later... (so that the Sides are parallel)

Use a small Marker-Pen and mark the Positions of the Holes through the Holes in the Connector. Make sure you don't slide around with the Connector while marking the Holes. Its important to work accurate here, else some Screws wont fit in the Holes...

Use the Centerpunch and mark at the Dots as described earlier. You might want to put on the Connector again and check the Dips you made if they allign with the Holes in the connector.

Take your time for this.

Use the Powerdrill and drill all 4 Holes with a 2.5mm drill. De-burr it with the Countersink properly.



Put the M3 Threadcutter into the Powerdrill and switch the speed as Low as possible.

Place the Threadcutter onto the Hole as straight as possible and let it spin (right round right round) slowly.

Don't cut into the Table, you might break the Cutter and we don't want that to happen.

When you finished the Thread, reverse the Direction of the Cutter and put it out again.

Repeat this step for all 4 Threads.

Don't be afraid of cutting the Threads. If you are nervous you can also cut the Threads by hand but it works very well with the Powerdrill...

Now put in the connector and screw all Screws in.

If one or two Screws wont go in then shame on you!!

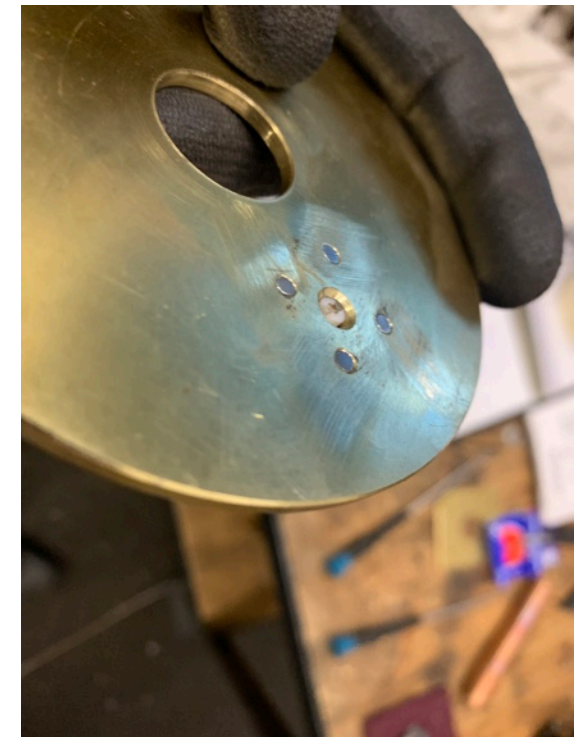
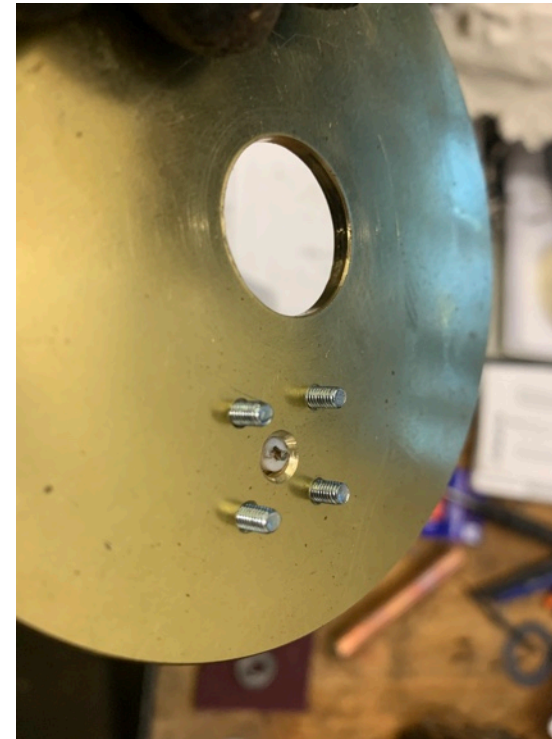
Just joking. This happened to me too. (very very often on different Projects...) Take a 3.5mm drill and drill up the Holes in the Antennaconnector. (Not the Reflector!!!)



Depending on the Length of your Screws they will stick out of the other Side more or less. This is not wanted because it messes with the RF. (someone told me, i have no idea...)

Use a Anglegrinder or a Handsaw to cut the Screws about 0.5 to 1mm from the Reflector. Don't cut into the Reflector.

Use a File and file the remaining Screw until its flat of the Reflector. Polish the Area with some Scotchbrite and for Gods sake, don't cut of the Middlepin of the Antennaconnector...



Now we are preparing for soldering.

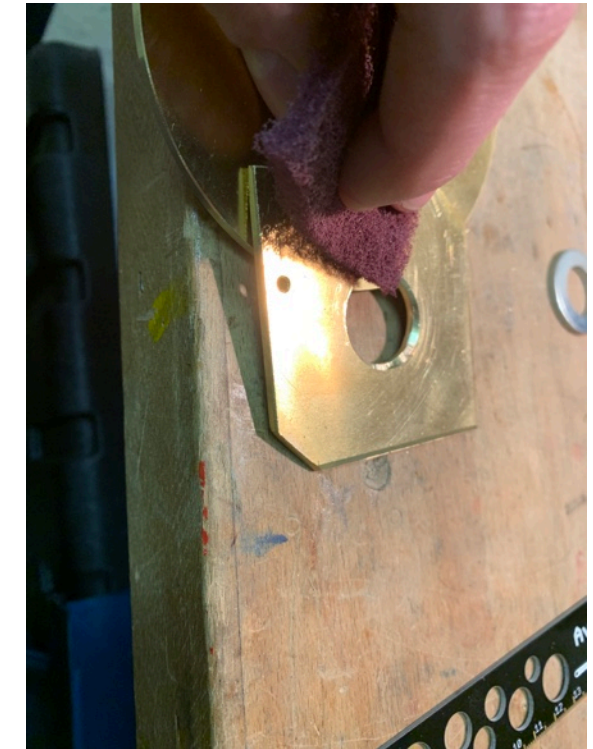
Deburr the 22mm Hole where we will solder. That means the Topside of the Reflector and the Topside of the Patch so the Solder can flow.

Use some Scotchbrite and polish the inside of the 22mm Hole and the Area around the Hole. Also polish the tube in the Area where we will Solder.

If your tube is Oxidated a bit on the Inside you can roll the Scotchbrite around a long Drill and polish the inside...

Use hot Soapwater or Brakecleaner to degrease the Solderingarea, the inside of the 22mm Holes and the Tube.

After cleaning avoid to touch it with your filthy filthy Fingers. ;)



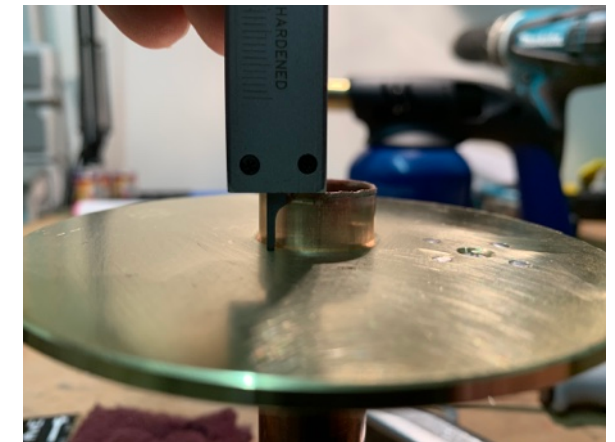
Now we will put the Parts together and prepare for soldering.

If the Plate goes hard onto the Tube you can file out the Hole a bit. (use a round, or a halfround File for this) Make sure you clean it after filing. Make sure you have a tight Fit between the Hole and the Tube, it makes everything easier.

If it goes on too hard don't use a hammer. Use a tool with a hole in it (bigger than 22mm) and put it in a Vice as shown on the Picture. Use some thick Cardboard or the folded Scotchbrite between Tube and Vicejaw.

Now close the Vice and press the Plate onto the Tube.

The Tube should protrude about 5mm from the Patch and the Distance between the Patch and Reflector is 3mm. My Plates are 3mm thick so the Tube must protrude 11mm from the Top-side of the Reflector. Use your Calipers and set the 11mm (or in your Case maybe 10mm or less.) and check if you have pressed the Plate onto the Tube enough.



Use a Tool with a right Angle like a Ruler and lay one Side FLAT onto the Plate. Now you can see if the Tube is aligned to the Plate in a 90° angle.

The Angle is right when there is no Lightgab between the Tube and the Tool when the Tool lays flat on the Reflector.

Adjust the Tube until the Angle is ok.



Wrap some Aardboard or thick Paper around the Tube and put it into the vice as shown on the Picture. Its recommended that you lay the Reflector onto the Jaws of the Vice so everything keeps in Place even when the Reflector gets bigger due to the Heat.

Apply some Flux to the Area we will solder.

Funfact: In Austria Flux for Metallwork is called „Witchgrease“

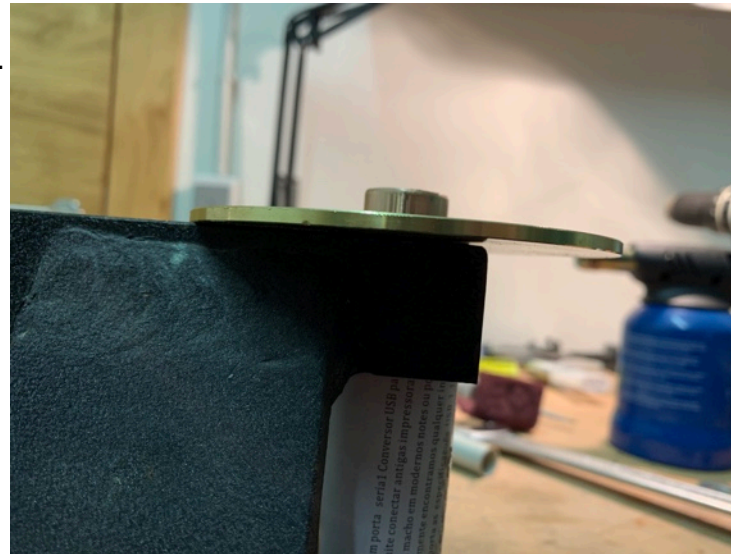
Prepare the Solder an Light up that Blowtorch.

Try to heat the whole Plate evenly and also heat the Tube in the Middle. Let it get really Hot and when you think its Hot enough heat it up a bit more. Copper melts at 1085°C don't be shy. ;)

Put away the Flame and touch the Area where the two Parts touch with the Solder. If it melts you are on Temperature. The Solder should flow nicely and adhere on both, the Plate and the Tube. If it doesn't, try to heat the Part where it doesn't adhere a bit more.

Let the Solder flow all around and reheat it from Time to Time.

Use as less Solder as possible. If you have used too much you can wipe it away with an old Cotton cloth. Don't use Polyester... Seriously...



Make sure you soldered all around the Joint.

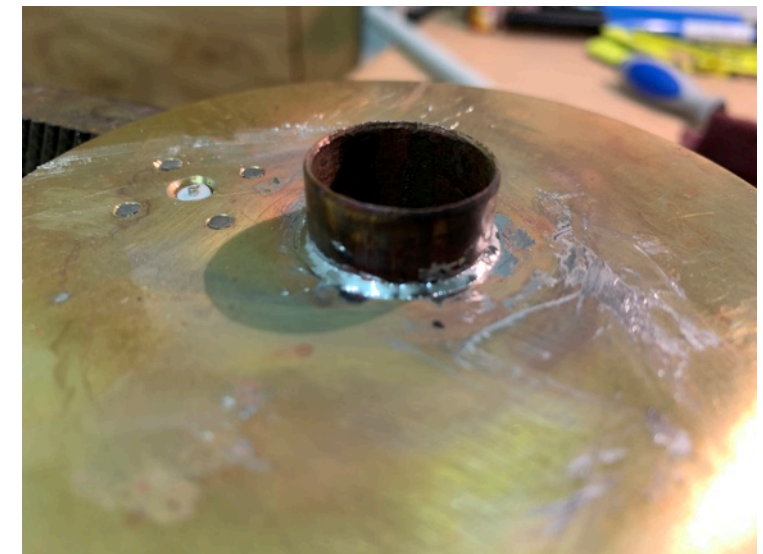
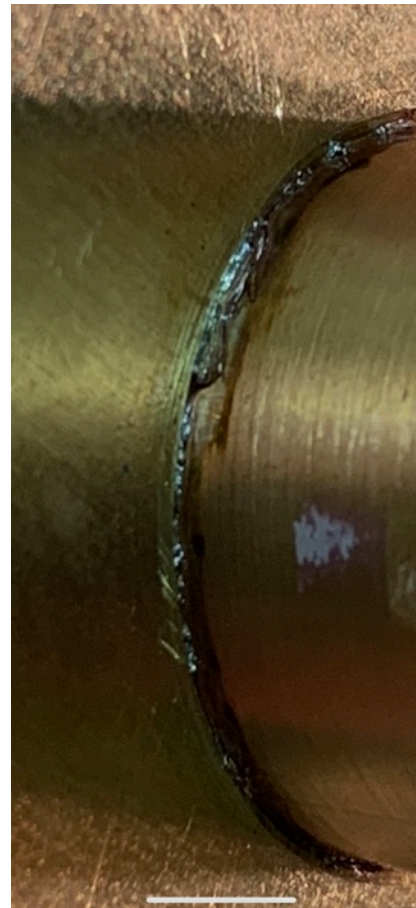
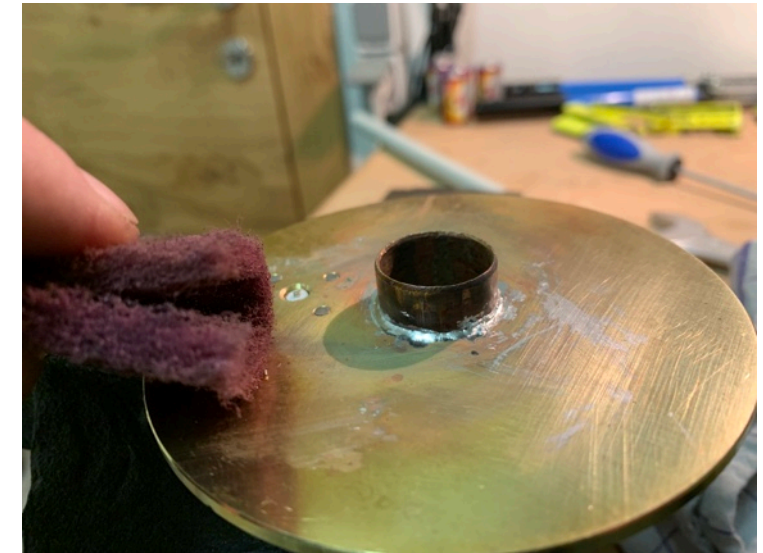
After you are happy with the Solderjoint let it cool down.

Give yourself a Break and admire the Part you made. You mastered Metall and Fire and are half Way to finish something other People Pay 90Euros for...

If you have used too much Solder you can file it away but don't scratch the Plate nor the Tube too much.

Clean everything with some Scotchbrite.

The Solderjoint is good when the Solder comes out on the Bottomside of the Reflector. If it doesn't you maybe didn't get Hot enough.



Align the Patch onto the Tube so that the Hole we drilled is over the Middle-connection of the Antennaconnector.

(Make sure the Teflon around the Middle-connector is cut away before you mount the Patch.)

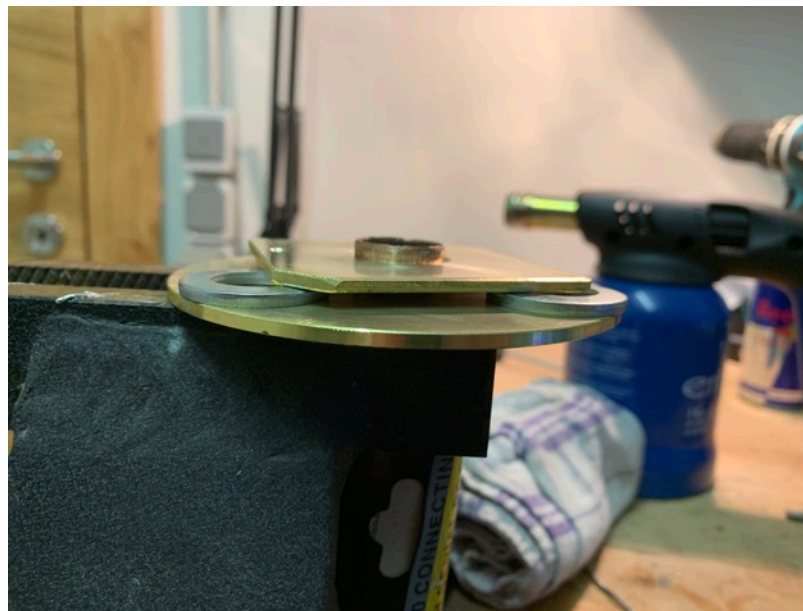
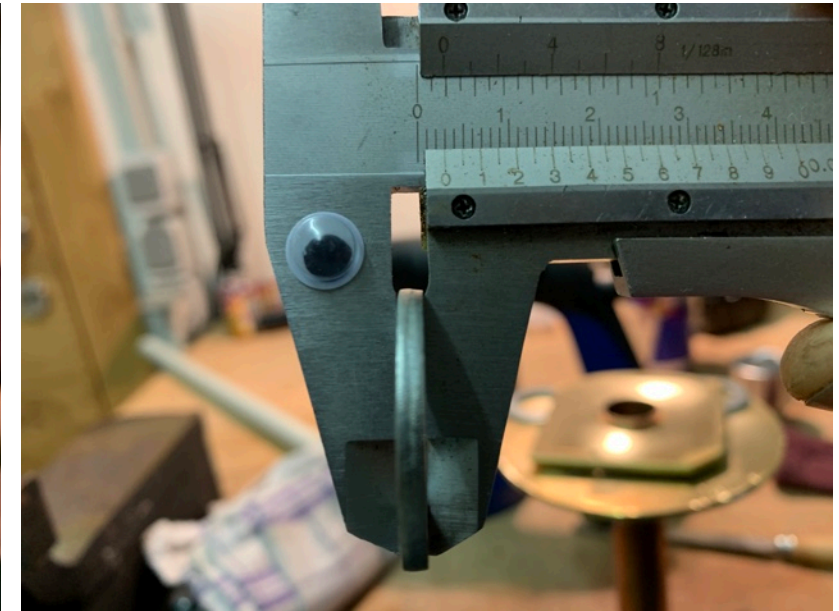
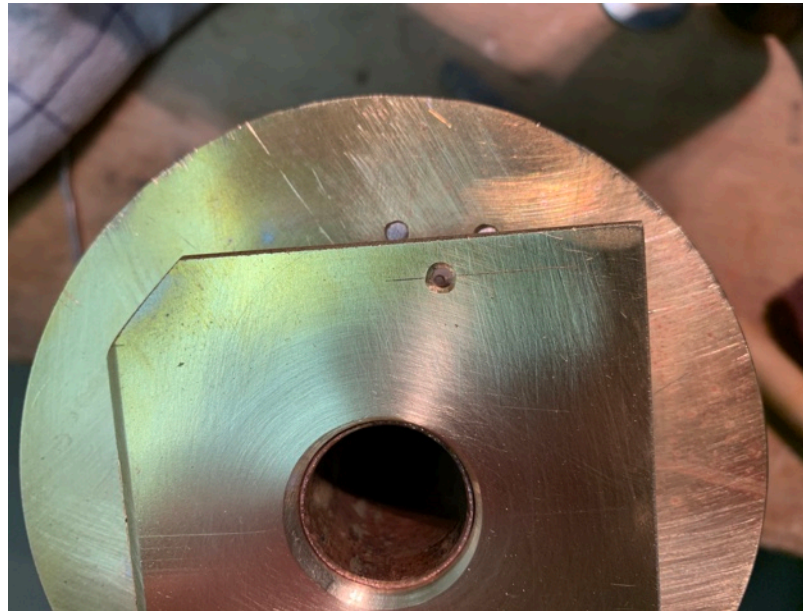
Prepare the 3mm Distances (I noticed that with my Material 2.8mm is more suitable but the Manual says 3mm)

Press the Patch onto the Tube as described earlier and put the distances between the Patch and the Reflector.

Put the Feed in the Vice again (don't forget the Cardboard or the Paper for Protection.)

Use your Caliper to check the Distance between Topside of the Patch and Topside of the Reflector ($3\text{mm} + \text{Materialthickness}$) on all Corners and in the Middle. adjust as necessary.

Keep in Mind that the Patch will get bigger when getting hot so prepare something to press the Patch against the Distances while the Solder is hot.



Apply some Flux on the Solderarea.

Heat everything up and apply Solder.
Clean excessive Solder if needed with
Cottoncloth.

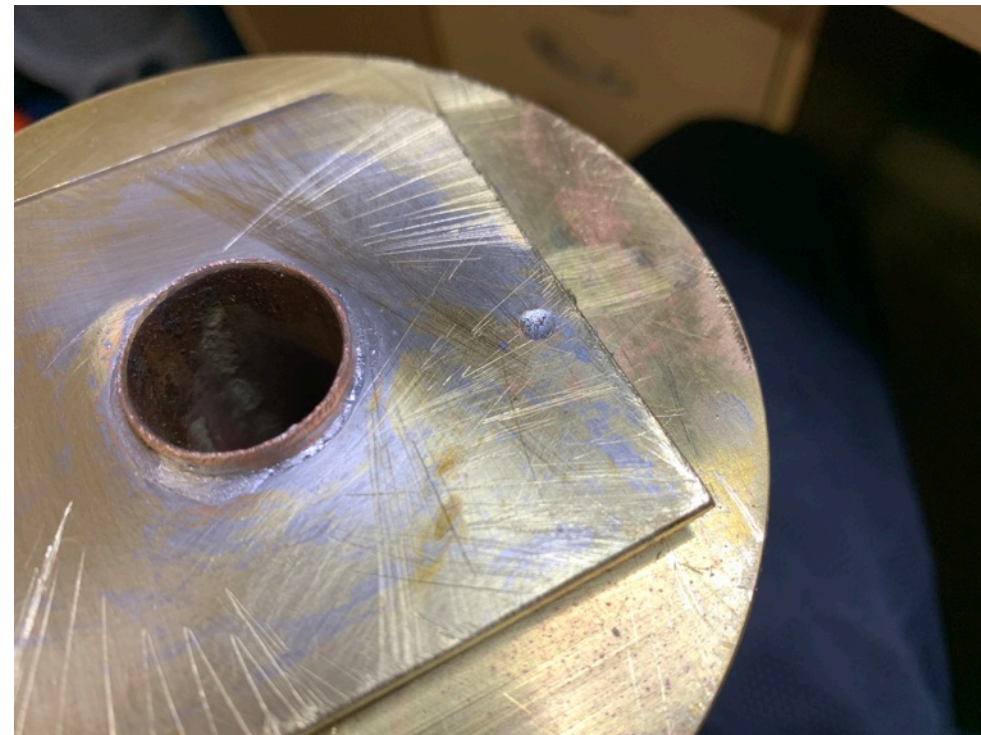
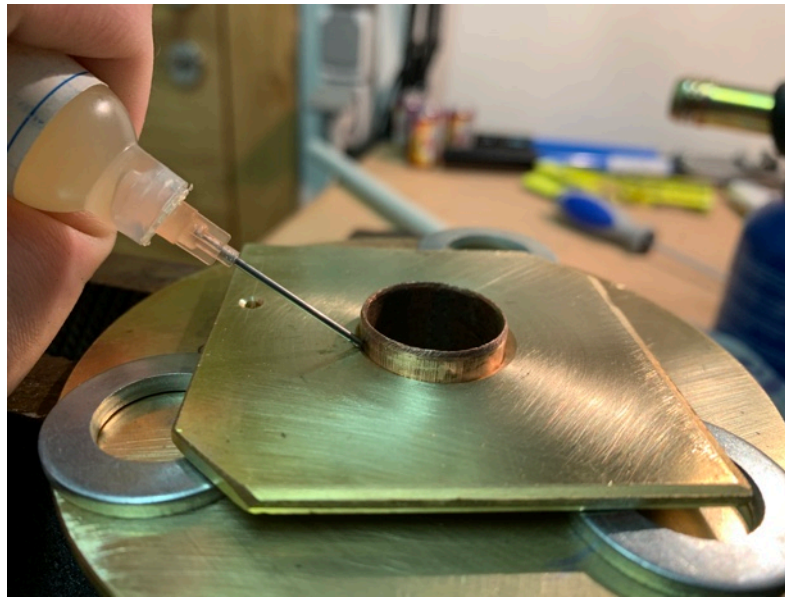
While the Patch is hot you can Solder the
Middleconnector of the Antennaconnec-
tor to the Patch through the Hole.

When you are happy with your Solderjob
use something (in my case a big Wrench)
to press the Patch against the Distances
and hold a bit until the Solder is solid.

Clean and polish everything after it got
cold.

Congratulations. We are finished now.

Press the Dielectric lens into the Front
and mount the LNB in the Rear, we hear
us on the Air. =)



Measuring the Feed:

Make sure your SWR Analyser is calibrated properly.

Mount the Feed onto the Feedholder of the Dish and connect the Feed to the Analyser.

Switch on the Analyser and check the Reading.

Our Goal is to get a SWR of 1 (or as close as possible). The R Value is a Indicator of how well the Feed is matched. 50 Ohms is the Goal.

To my Experience, when your R value is too Low the Plates are too far appart. When the R Value is too high the Plates are too close.



You can finetune the Feed.

When you press the cut Corners and the Reflector together the R Value goes up (always press both Corners at the same Time. It works best with 2 Tongs.)

When you want the R value to go down use two Flathead Screwdrivers and bend the Plates away from each other by twisting the Screwdrivers

When you press the cut Corners and the Reflector further away R Value goes down.

You should be able to finetune the Feed very accurately.

When you print a curve you should see two Dips. (in the Picture on the right you can see a small Dip on the right Side.) The Dip should be around 20db apart. (starting at -18db and going to -40db in the Picture)

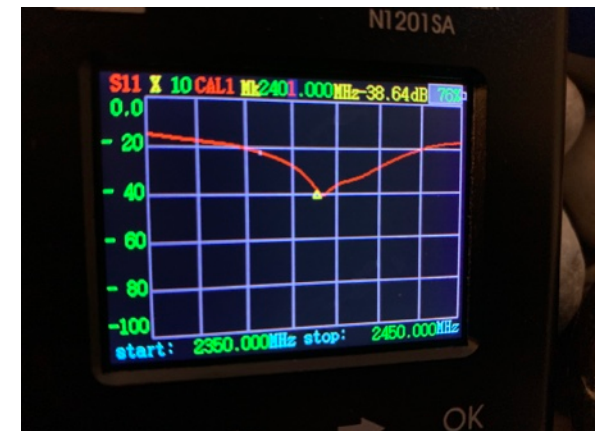
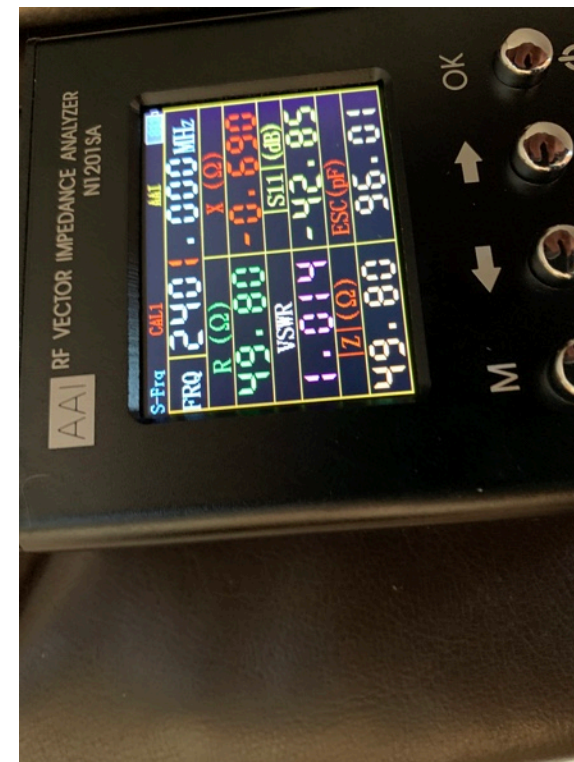
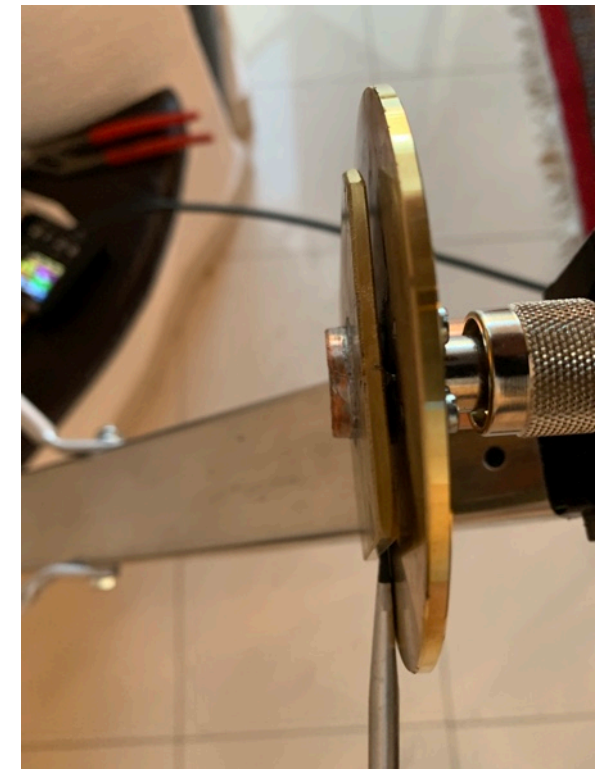
When using thick Material like the 3mm Plates i used it is possible that the Solderjoint of the Patch breaks while bending.

If this is the case don't get worried, you can resolder it. You may want to adjust the Distances between the Plates.

For example when the R value was 40 Ohms you may want to test a Distance of 2.7-2.8mm between the Plates.

After a bit of bending the Patch should be matched.

Have Fun while building the Patch and be proud of your Work.



I want to thank Dr Mike Willis and UHF-Satcom for their Work and their Help everytime when i had a Question. I am a complete newcomer to Ultra High Frequency Applications and they helped me alot.

I also want to thank Remco den Besten for his great Guide.

Special Thanks go out to AMSAT-DL for their Work and Ef-

fort to give us this Opportunity to work with a Geostationary Satellite.

I hope you found this Manual helpfull. If you have Feedback write me a mail to oe8hsr@oe8hsr.at or a DirectMessage on Twitter under the Username @MeltdownCore

Have a lot of Fun on the Airwaves.

