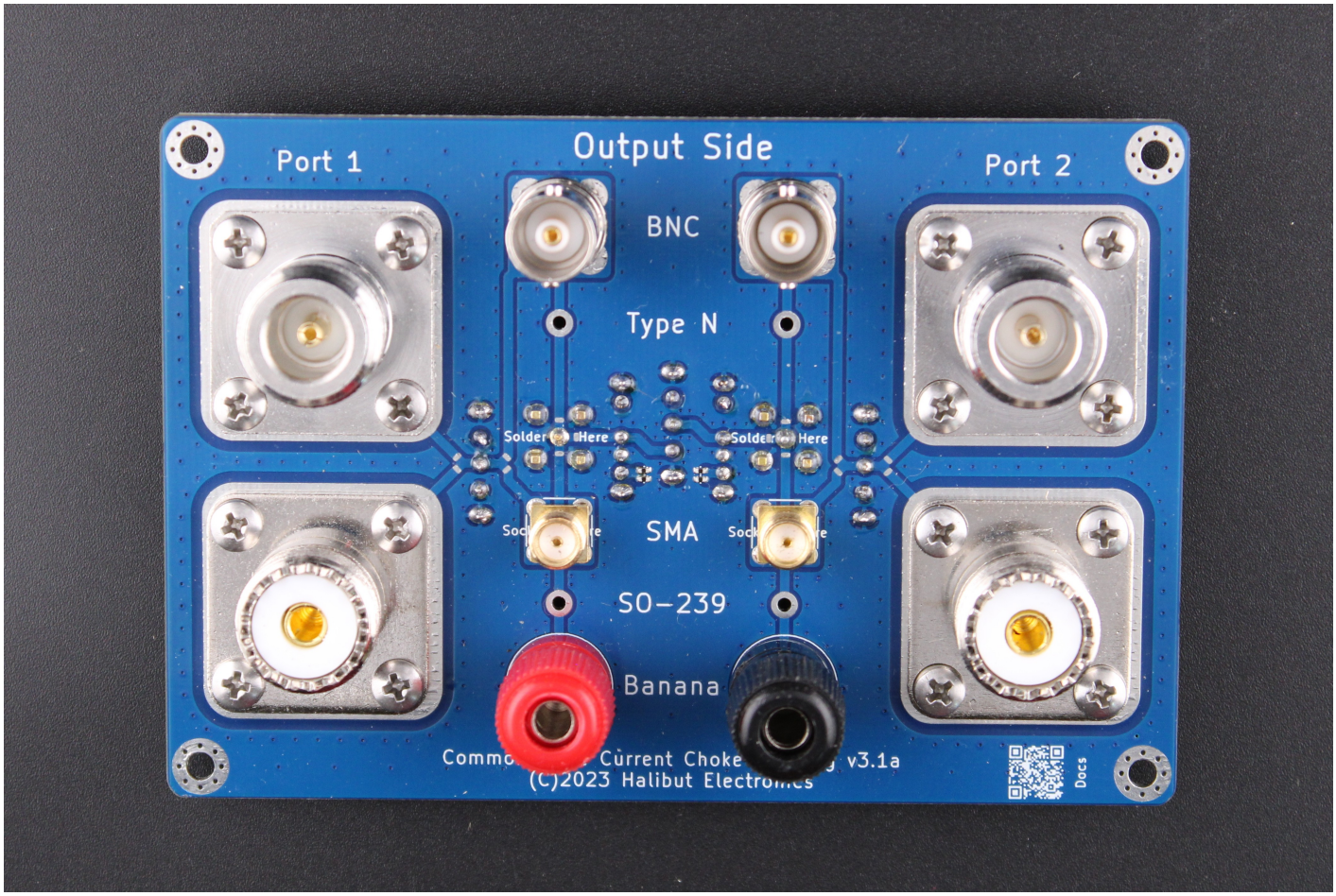
RF CMCC Test Rig Assembly Instructions

Thank you for purchasing the Halibut Electronics RF Common Mode Current Choke Test Rig! That's quite a mouthfull, so I'm just going to call it the RF CMCC Test Rig, or just CMCC, or Rig, etc. ...we're pretty close, on a first name basis. I like to name-drop it a lot. Gives me street cred. ...Anyway...



RF CMCC is a kit, some assembly required. And by "some" I mean "all." But don't worry, it's pretty simple, I'll help you through it.

This version of the documentation covers v3.1 of the **RF** CMCC Test Rig. If your board is marked v3.0, please see the v3.0 Assembly document instead. If your kit has a bunch of digital connectors: RJ45, USB, 3.5mm, etc, then please see the Digital CMCC Assembly document instead.

Special Thanks!

I want to give an extra special thanks to the following Halibut Electronics Patreon members who give at the Barefoot Level or above at the time the v3.1a boards went to fabrication. You help keep the business running, with both your financial and emotional support. Thank you so much.

- AE0PQ Jordan
- WY8V San
- VE3BIC Andre
- W6MDX Tom
- AC7FD Tobias
- AE5X John
- KF5CLZ Dave
- K5IAG David
- VA3MW Mike (Sorry for getting the call sign wrong on the board! But thank you Rod too!)
- KJ7OHF Lionel

Change Log

Date	Description
2022-08-18	First public revision. Assembly of v3.0c boards.
2022-11-30	Updating for v3.0d boards. Electrically identical, new silkscreen to clarify assembly.
2024-01-11	Updating for v3.1a boards. Added on-board calibration standards. Updated images.
2024-04-30	Split v3.0 into its own document: Assembly-v3.0.pdf
2025-06-09	Minor changes for consistency with Digital CMCC Assembly Guide.

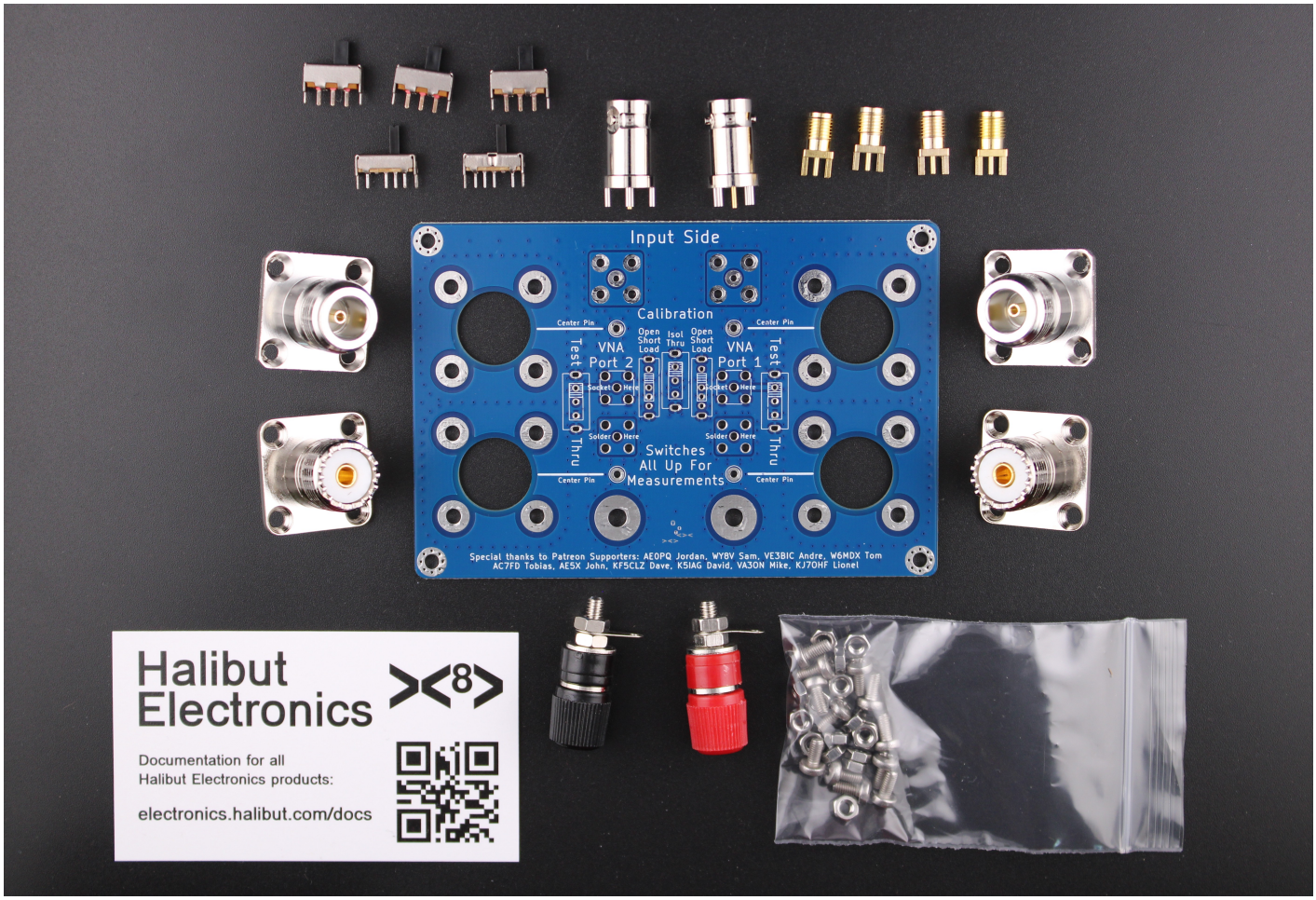
Table Of Contents

1. Parts and Tools

The kit includes all the parts needed to assemble the base kit, but you'll need to provide some tools and consumables.

1.1. Provided in the Kit

First, lets make sure your kit is complete. It should have come with the following items:



Quantity	Description
1	Circuit board
4	SMA female PCB mount connectors
2	BNC female PCB mount connectors
2	UHF/SO-239 female panel mount connectors
2	N female panel mount connectors

Quantity	Description
2	Banana Plug female panel mount connectors. They are probably different colors, likely one red and one black, or they might not be. The color doesn't matter.
3	Single pole, double throw (SPDT) slide switches. They have evenly spaced pins.
2	Single pole, triple throw (SP3T) slide switches. They have a gap in the pins.
16	M3 x 6mm philips head screws
16	M3 nuts
1	Halibut Electronics sticker (In my humble opinion, the most important part)

If any of these parts are missing, please contact us and we'll mail you the missing parts.

1.2. Required: You Provide

You are required to provide the following:

- Soldering iron.
  - I recommend a high wattage iron, something that can deliver a lot of heat. Some of these connectors have a large thermal mass and will take some heat to solder well.
  - A "normal" wattage iron will work, it will just take more time.
- Solder. Either ROHS or leaded, your choice.
- No. 1 Philips screwdriver
- Pliers, or a small crescent wrench, or a small socket/nut driver set for working with the nuts.
  - See below for better options if you have them available.

1.3. Optional Tools

The following tools might make your life a little easier, but aren't strictly required.

- 5.5mm nut driver for M3 nuts.
  - 7/32" will work in a pinch.
  - These are handy to keep around the shack if you work with a lot of M3 screws and nuts, like I do.
  - **Fun Fact:** M3 brass stand-offs (none in this kit) are 3/16" hex. I don't know why they mixed metric (M3) and imperial (3/16"), but 4.7mm nut drivers are impossible to find, so I have to assume they intended it to be 3/16". Ya know, if you're building out your "monotasker tools" kit like I am.
- 7mm nut driver for the nuts on the Banana Plugs.
  - 9/32" will work in a pinch.

1.4. Optional Parts

If you wish to use calibration standards (the "Open, Short, Load" things) with UHF/PL-259 or N connections, instead of the on-board calibration standards, then you can add the ability to calibrate those connectors.

> **Warning** Do NOT perform this optional part if you do not intend to calibrate with UHF/PL-259 or N connectors! Doing this adds more complexity to the signal path, more reflections. It will make it WORSE if you're not going to use the benefit.

- About 1 foot/30cm of small gauge wire.
    - The actual jumpers are about 1 inch/3cm long, plus the stripped ends for soldering. There are at most 4 of them per board.
    - "Small gauge wire" means 18ga or smaller. The hole on the board is 1.5mm diameter, so you might be able to fit 16ga in if that's all you have. But there's no power going through this, so as small as 30ga would be fine. There's no benefit to larger, or smaller, wire. Just use whatever you have.

1.5. All Output Parts are Optional!

If you know you only need to test one type of connector (eg: SMA) and will never need to test another type (eg: Banana), then you can leave off the connectors that you know you'll never use. This could lead to better readings, having less parasitic reactance from those unused connectors. If you change your mind (and haven't lost the parts or used them in some other project), you can always add those sockets later.

Or, just assemble the whole kit as provided so you have the complete tool whenever you might need it. The choice is yours.

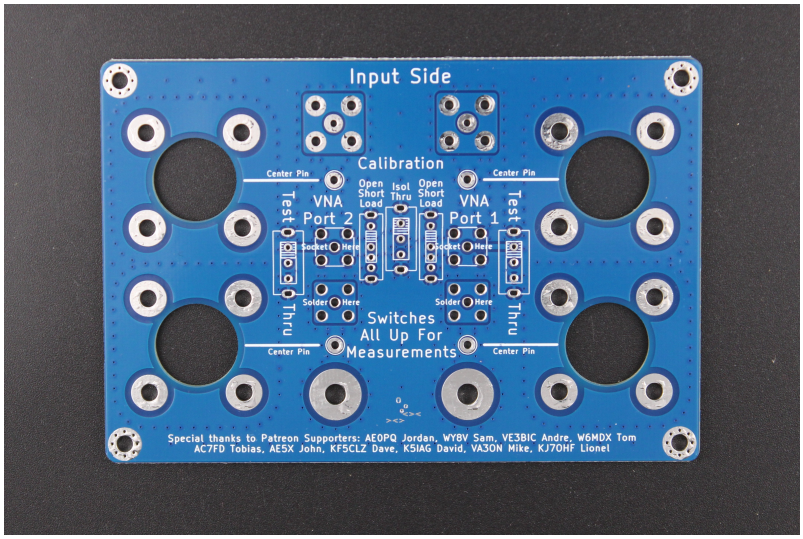
2. Assembly

Ok, you've got all the parts and all the tools. Let's do this thing.

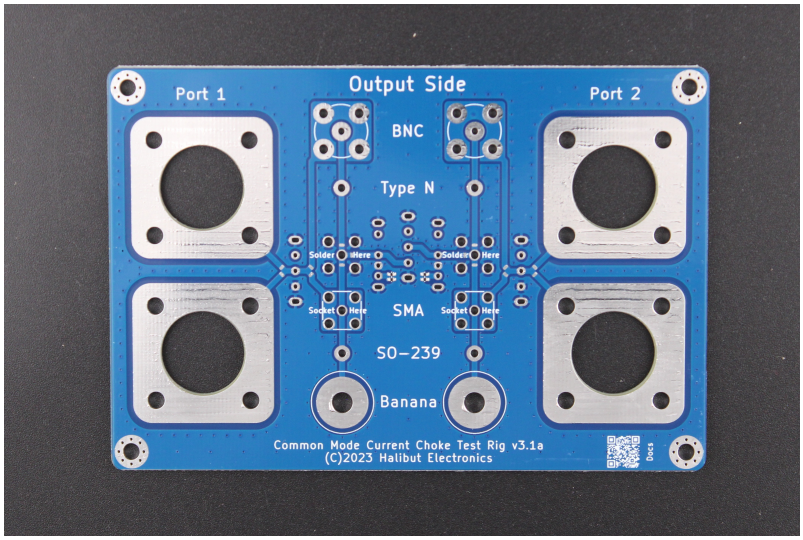
2.1. Inspect the board

The board has labels for the "Input Side" and "Output Side."

- **Input Side** has the "VNA" ports:

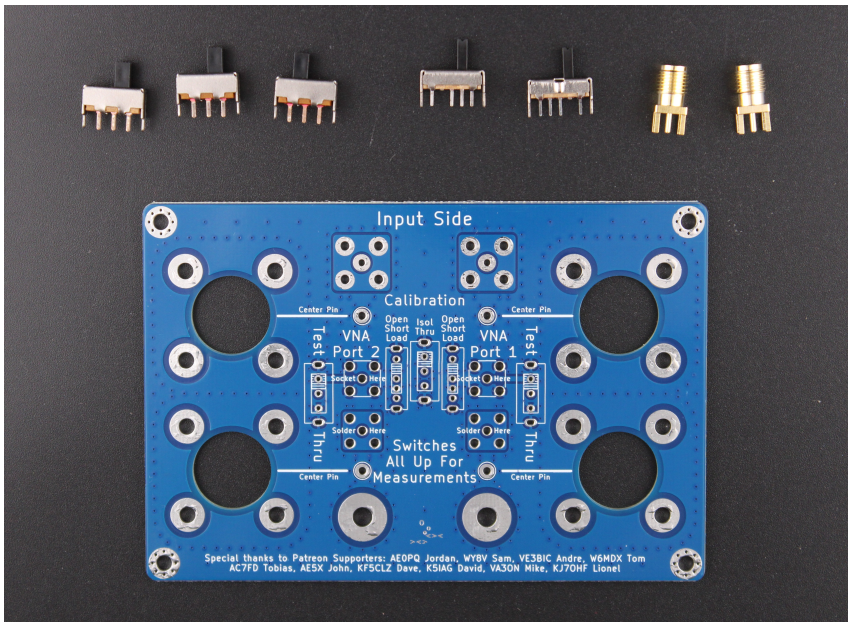


- **Output Side** has the "BNC", "Type N", "SMA", "SO-239", and "Banana" port:



2.2. Soldering the Inputs

Parts Required



- Qty 1: Circuit board.
- Qty 3: SPDT Slide Switches.
- Qty 2: SP3T Slide Switches.
- Qty 2: SMA female PCB mount connectors. (We'll use the other two later.)

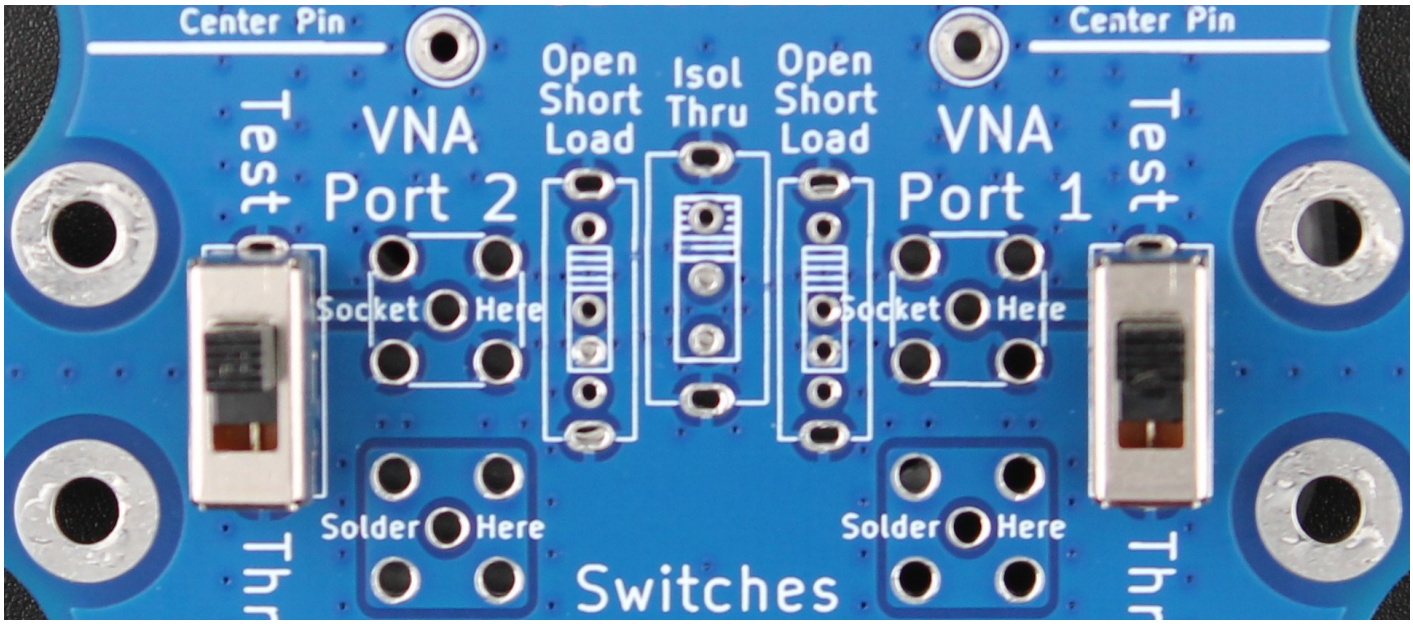
I find it easiest to start with the shortest parts first, then work through the taller parts. To that end, we'll solder the slide switches first, then the SMA sockets. (They're roughly the same size, so the order doesn't matter.)

2.2.1. Slide Switches

These switches are small and low thermal mass, so these will be quick and easy to solder, "like normal." This is as opposed to the SMA ports, which you'll get to next.

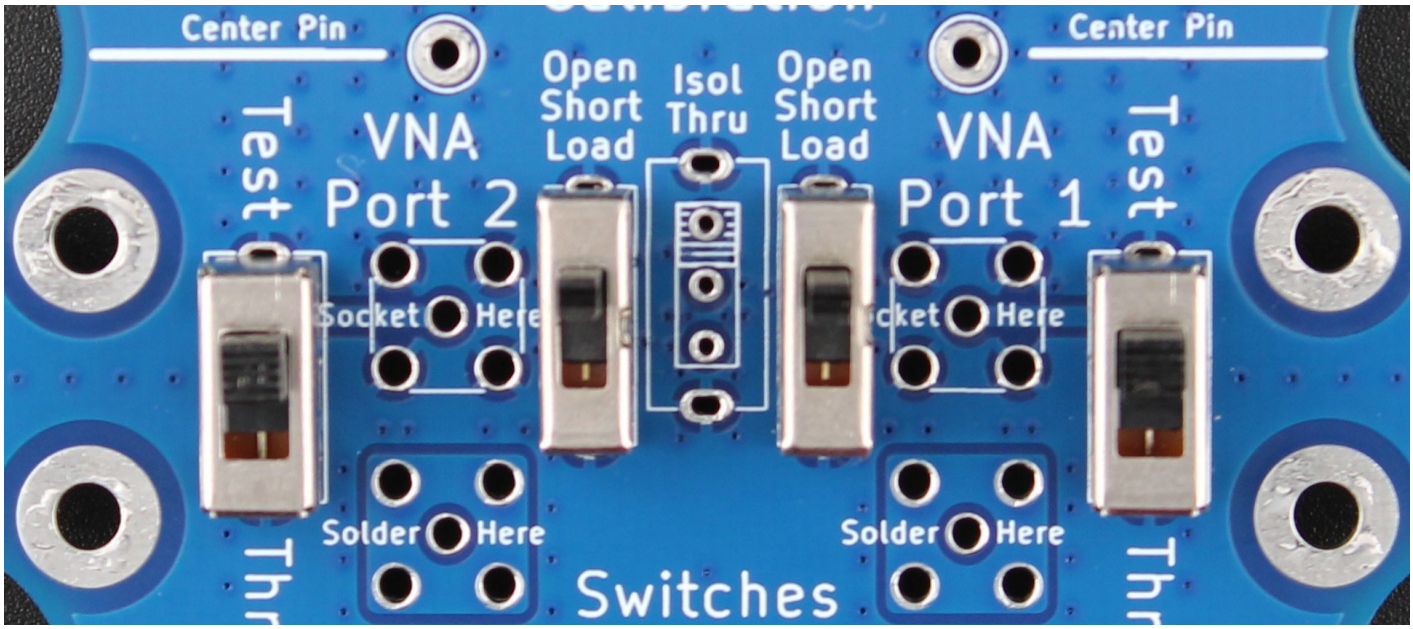
2.2.1.1. Test/Thru Switches

Insert two of the SPDT slide switches into the five pads between the "Test" and "Thru" silkscreens, on the Input side of the board. (We'll use the third SPDT switch later.) These switches have evenly spaced pins. The orientation of the switch doesn't matter. Solder the switches on the Output side of the board.



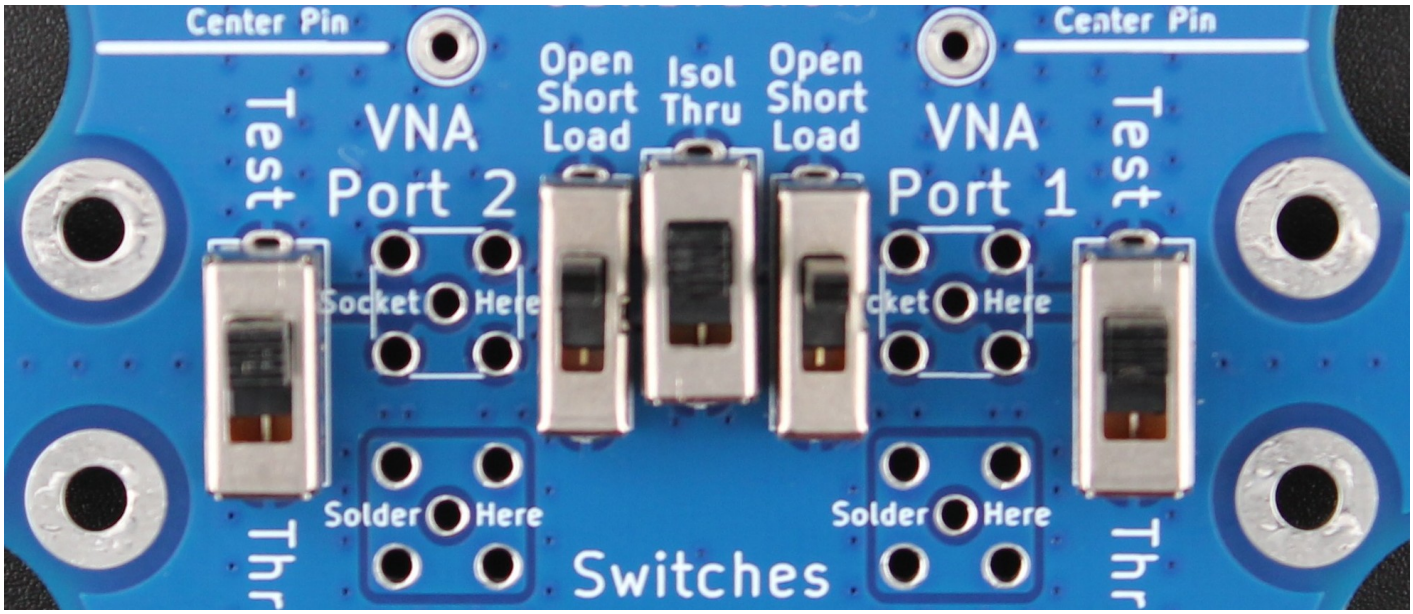
2.2.1.2. Open/Short/Load Switches

Insert the two SP3T slide switches into the six pads below the "Open/Short/Load" silkscreens, on the Input side of the board. These switches have a gap in the pins which only allows them to be inserted in a single orientation. Solder the switches on the Output side of the board.



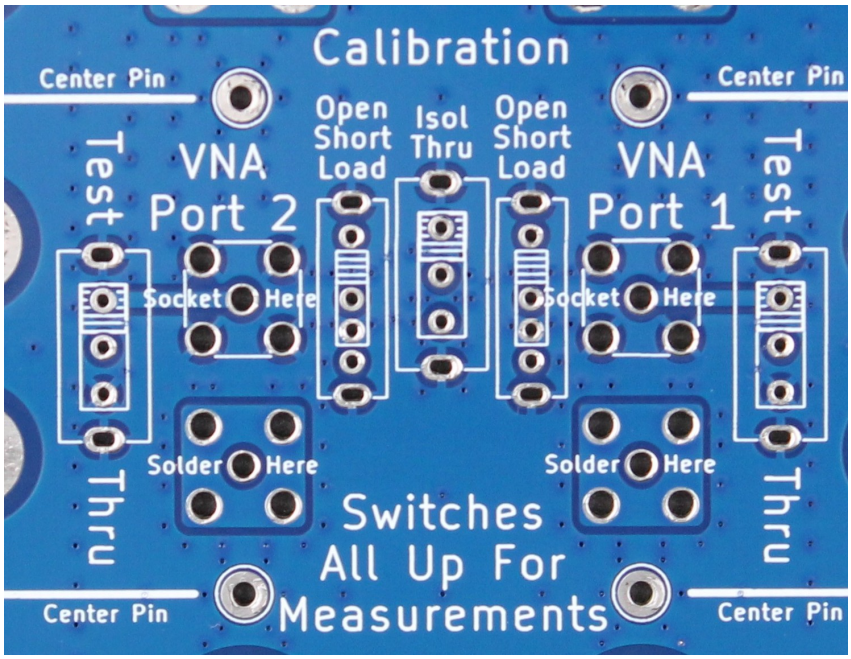
2.2.1.3. Isolation/Through Switch

Insert the third and last SPDT slide switch into the very center of the board, the five pads below "Isol/Thru" silkscreen, on the Input side of the board. This switch is exactly like the "Test/Thru" switches, with evenly spaced pins. The orientation of the switch doesn't matter. Solder the switch on the Output side of the board.



2.2.2. VNA SMA Sockets

There are a total of four SMA sockets on the CMCC Test Rig: two on the Input side, and two on the Output side. The two on the Input side are right below to the "VNA Port X" silkscreen, and have the silk screen outline around them on the Input side, with a "Solder Here" label. Make sure you put the SMAs on the correct side of the board.



SMA sockets have a lot of thermal mass, and will require more heat to solder than most through-hole components. If you have a higher wattage soldering iron, now is the time to break it out.

Insert the SMA sockets in place, then carefully flip the board over so the board is resting on the SMA sockets. The input sockets are well enough centered that it should balance like this. If not, you can solder them one at a time, holding the socket to the board with some tape, or a finger, or whatever.

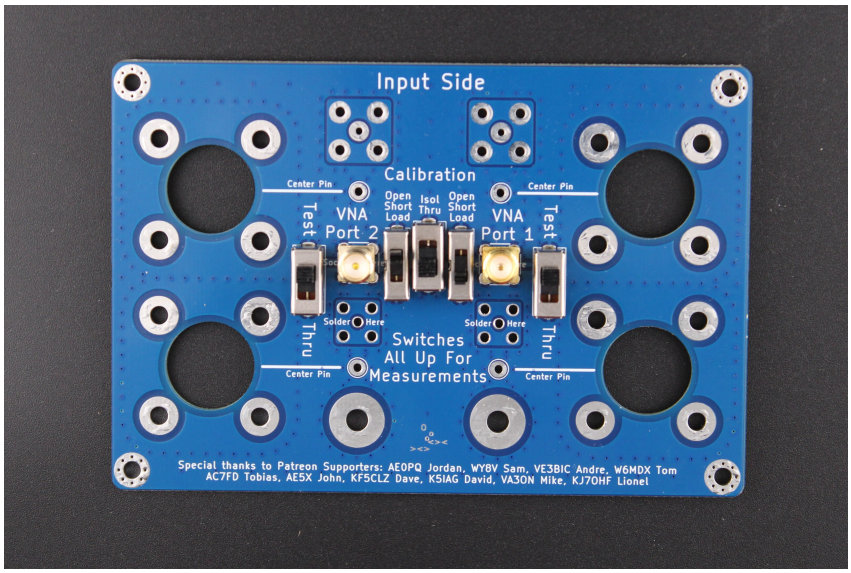
Solder the center pin first. It has the lowest thermal mass on both the socket and the PCB board, and will be the easiest to solder. Also, you can solder the center pin without burning your finger holding the socket against the board. The same is not true when soldering the four outer pins. Once the center pin is soldered, it will hold the sockets in place for you to do the rest.

Make sure the SMA socket is flush against the board before proceeding. Reheat the center pin and adjust the socket until it is flush with the board.

Solder the four outer pins next. Take your time, these will require a lot of heat. Be careful when touching things: both the board and the SMA socket have a lot of thermal mass, and will get very hot while soldering, and stay hot for a long time after.

Maximize surface contact between your soldering iron tip, and the SMA socket pin. Add a (very) little bit of solder to the tip of the iron; the molten solder is a liquid and will have a larger surface area to transfer heat to the SMA socket. Make sure everything is hot enough so the solder flows. You want it to look like a volcano (concave), not a donut (convex).

Do this for both SMA ports on the Input side of the board. It should look like this when you're done:



2.3. Soldering the Outputs

Parts Required

- Qty 2: SMA female PCB mount connectors.
- Qty 2: BNC female PCB mount connectors.

2.3.1. SMA Sockets

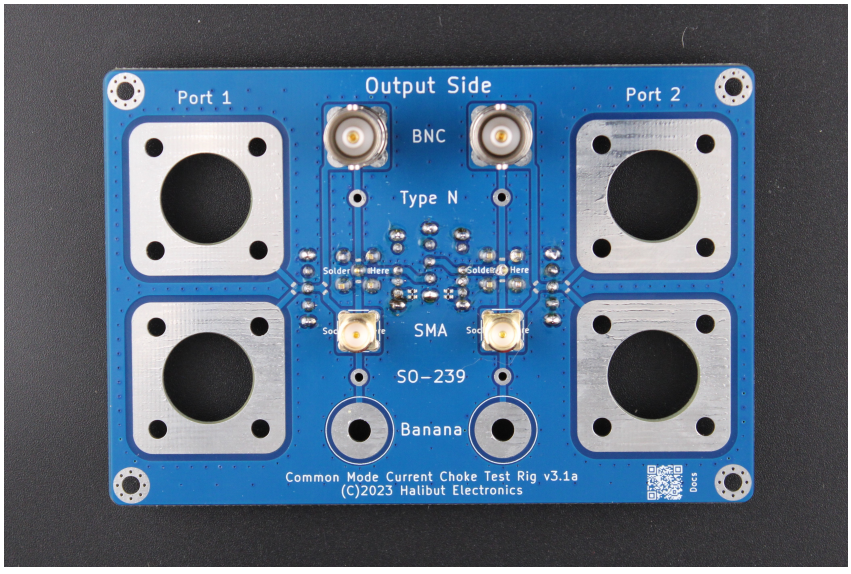
Just like above, but on the other side of the board. Insert the SMA sockets on the Output side of the board, into the sockets next to the "SMA" text, and with the outline on the silkscreen.

Solder them as above: center pin first, then four outer pins. Use lots of heat, and be careful of very hot parts when you're done.

2.3.2. BNC Sockets

The BNC sockets are very similar to the SMA sockets, just larger. Insert them on the Output side of the board, and solder them on the Input side. Solder the center pin first, then the outer four pins. Lots of thermal mass, be careful it's hot, blah blah. Look, you get it by now.

Good news: These BNCs are the last large hot things you need to solder. It will look like this when you're done:



2.4. Screwing in the remaining Outputs

Parts Required

- Qty 2, UHF/SO-239 female panel mount connectors.
- Qty 2, N female panel mount connectors.
- Qty 16, M3 x 6mm philips head screws.
- Qty 16, M3 nuts.
- Qty 2, Banana Plug female panel mount connectors.
    - They are probably different colors, likely one red and one black, or they might not be. The color doesn't matter.

2.4.1. UHF/SO-239 and Type N connectors

Both socket types are attached the same way, so I'm grouping them together.

Note that the Output side of the board has a large rounded square of exposed pad, and the Input side only has exposed pads for the 4 nuts. Make sure you insert the sockets on the Output side, so the large rounded square of exposed pad is in contact with the panel mount connector.

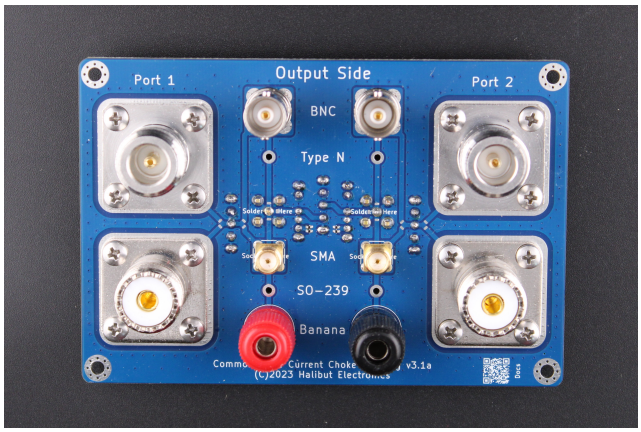
Insert one socket at a time onto the board from the Output side, UHF/SO-239 socket by the "SO-239" marking, and Type N by the "Type N" marking.

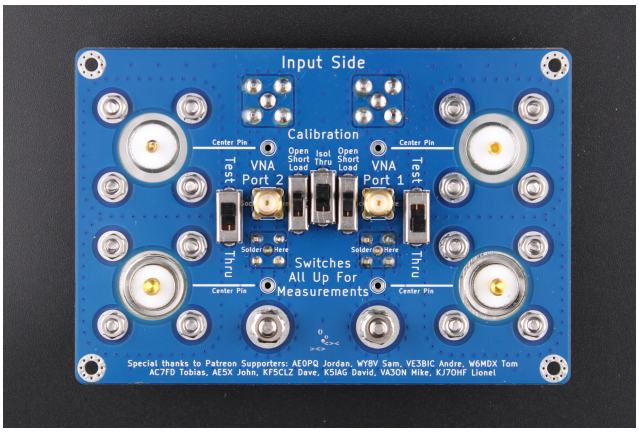
From the Output side, insert an M3 x 6mm screw into one mount hole on the socket, through the board, and attach an M3 nut on the Input side of the board. Attach the nut tight enough that it won't fall off, but leave it loose enough that you can wiggle around the connector for now. There's a lot of play on the board to accommodate for a large range of socket manufacturers, so we need to get all four screws in before tightening them down.

Insert the other three M3 x 6mm screws into the other three mount holes on the socket, through the board, and attach three more M3 nuts on the Input side of the board.

Once you get all four screws and nuts in and finger tight, center the socket on the board so it's entirely on the exposed silver pad, and not overlapping onto the blue solder mask at all. Then tighten down all nuts to hold the socket in place.

Repeat the above for all four UHF/SO-239 and Type N connectors. It'll look like this when you're done (Ignore that the Banana plugs are already inserted; that's the next step):





2.4.2. Banana Plug connectors

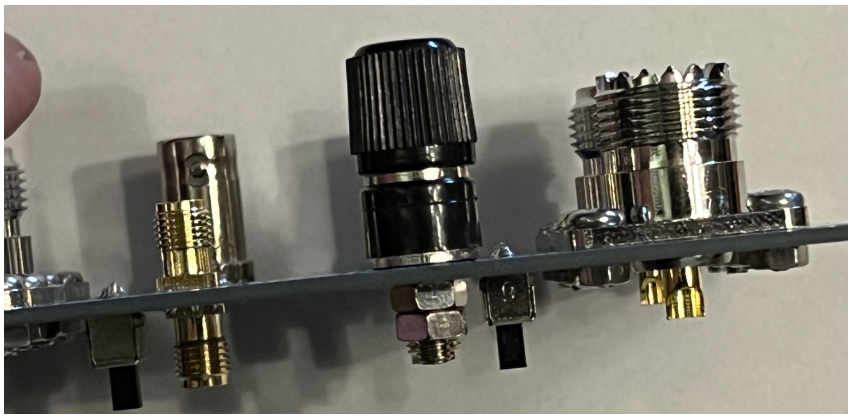
Like all the other sockets, there are two Banana Plug sockets. Unlike the others, the Banana sockets might be different colors. It doesn't matter what color they are, there is no "Positive" or "Negative" here, so you can use which ever color in which ever port you want.

Remove the nut(s) (might be one or two per socket) and solder tab from the bottom of the Banana socket. Be careful, all the other parts of the Banana socket will want to come off at this point. Leave the metal washer, two plastic spacers, and second metal washer, all on the screw post.

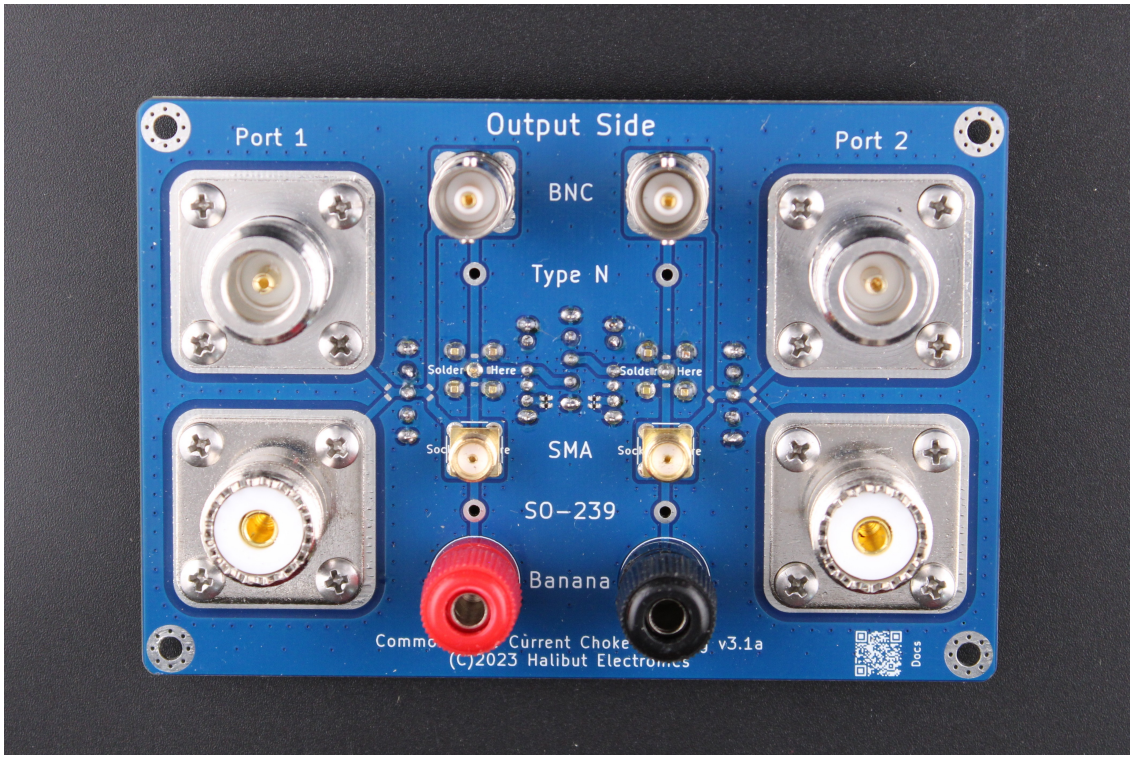
We wont be using the solder tab, so add it to your parts bin, throw it away, or do whatever you want to do with it.

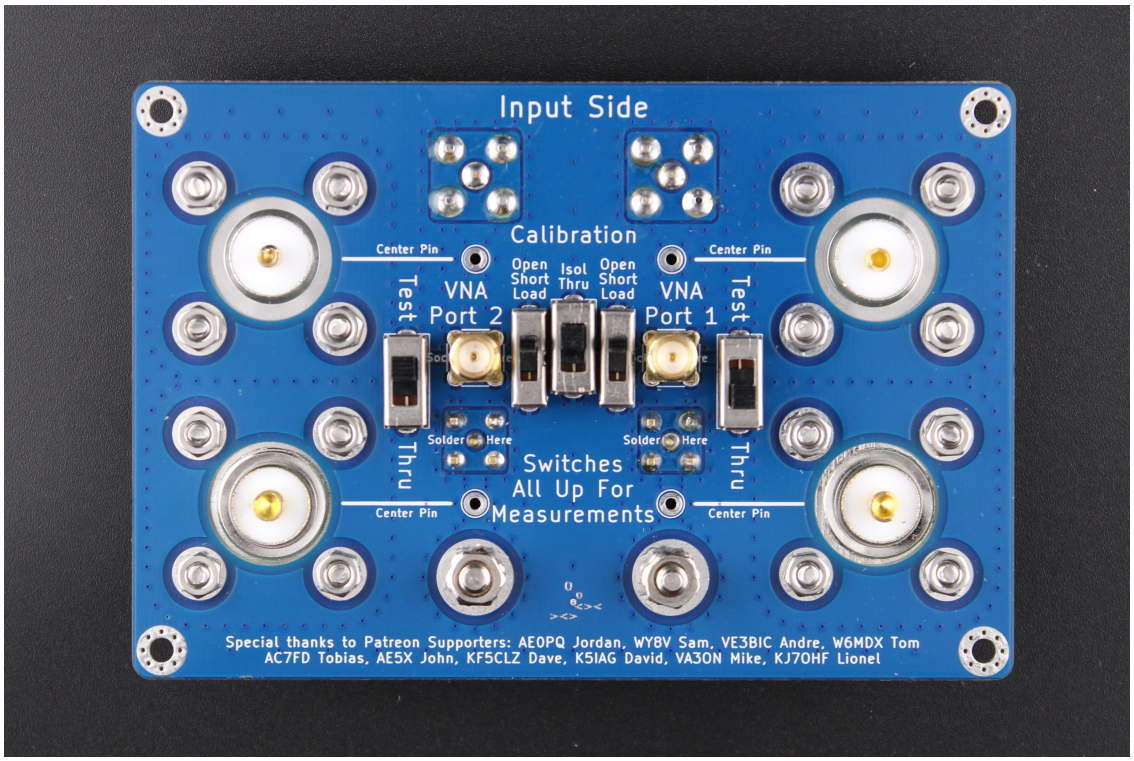
Insert the Banana socket stack-of-parts into the Output side of the board, in the holes labeled "Banana", and thread on at least one nut on the Input side. If your socket came with two nuts, you can put both on and thread the second one tightly down on the first to keep them from coming off. But it's not really necessary. (The second nut is there to hold the solder tab on, which we aren't using.)

The Banana plugs will look like this when done. Note that the two nuts are on the Input side of the board, and the rest of the stack-up is on the Output side:



That's (almost) it! The CMCC Test Rig is completed! (Optional steps below.) It should look like this now:





2.5. **OPTIONAL** UHF/SO-239 and Type N Center Pins

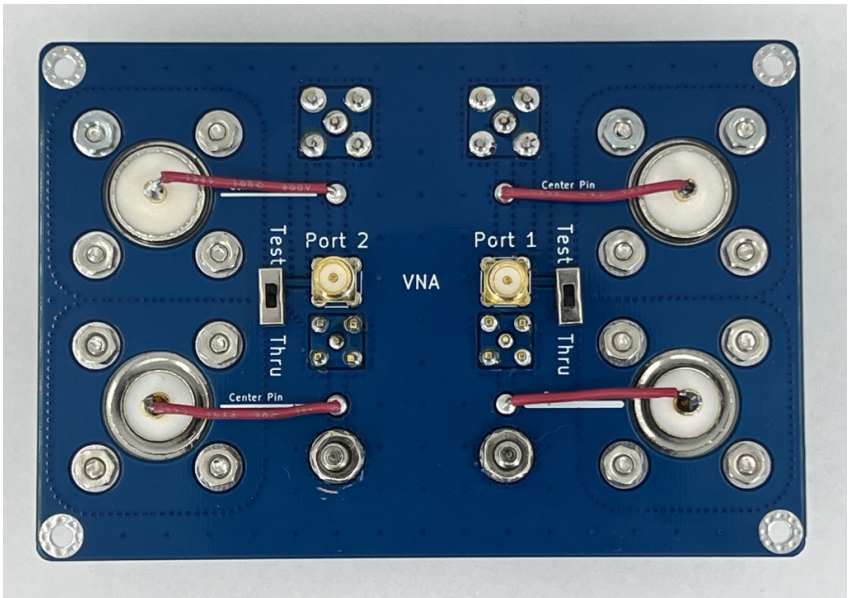
> **IMPORTANT** ONLY install these wires if have UHF/SO-239 or Type N Open, Short, and Load calibration standards. If you don't, leave these wires off. Only install the wires for the calibration standards you have.

Parts Required, You Provide

- Qty 4, about 1"/3cm wire with 1/8"/.5cm stripped of each end.

On the Input side of the board, connect a wire from the center pin of the socket for which you have calibration standards, along the line labeled "Center Pin", to the solder pad on the board at the end of that line.

Keep this wire as short and straight as feasible to minimize parasitic reactance (capacitance to ground on the board below it, or inductance by having more wire than necessary.)



2.6. Sticker (Optional, but Highly Recommended)

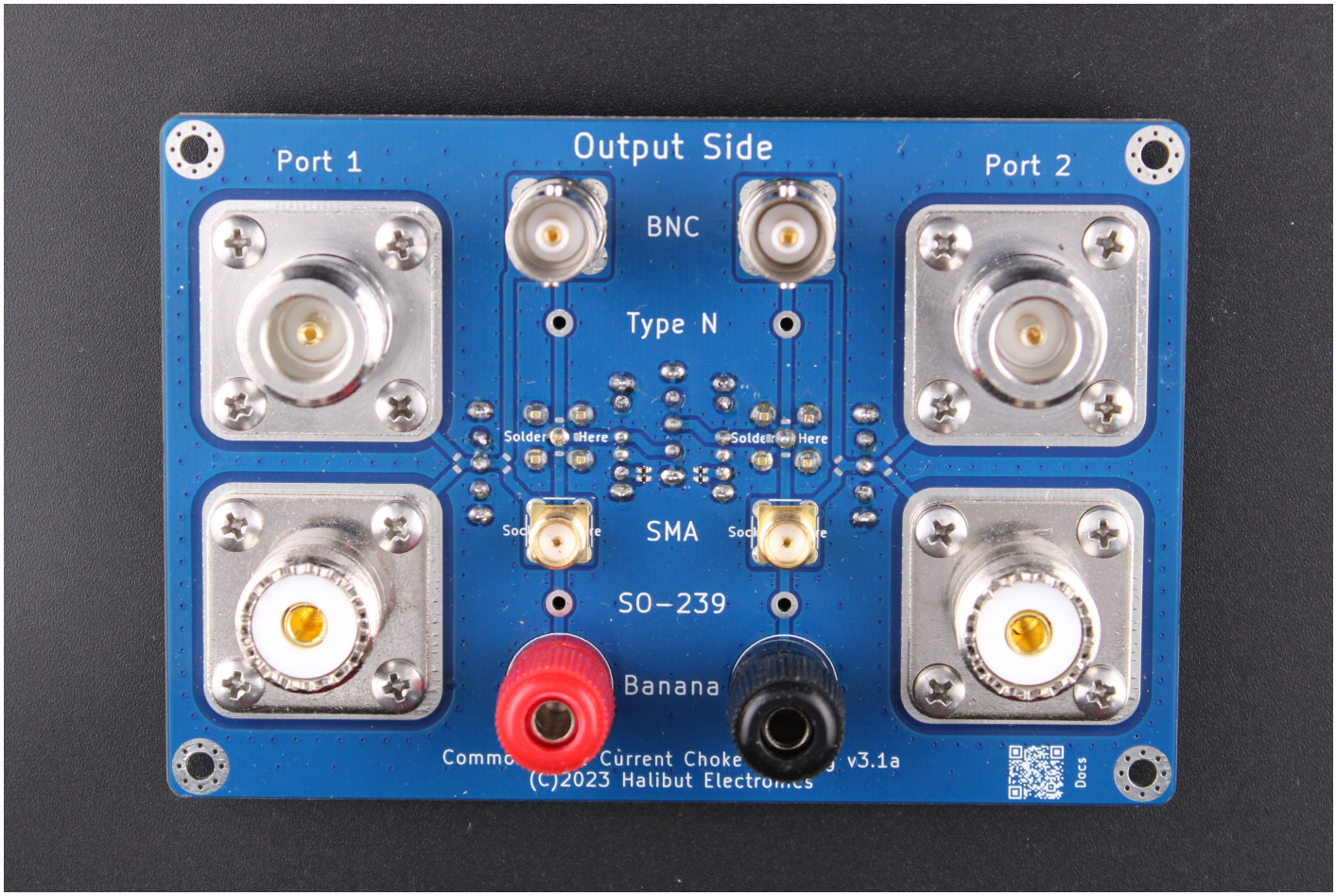
Find a clean, flat, APPROPRIATE surface that needs a sticker and apply the Halibut Electronics sticker ><8> to it. Laptops are a common choice, as are filing cabinets. Also water bottles. Really, the possibilities are endless.

Just, please, no vandalism.

If you post to Mastodon a picture of your Halibut Electronics sticker applied to some appropriate surface, and mention @electronics@halibut.com on Mastodon, you'll probably get a follow and a boost.

3. Conclusion

That's it! Please proceed to the User Guide to learn how to measure the effectiveness of your common mode current chokes.



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- https://halibut-electronics.groups.io/g/general/

And follow us on the Fediverse/Mastodon:

- https://mastodon.halibut.com/@electronics

Thank you, and be good humans. 😀 73 de N6MTS -Mark