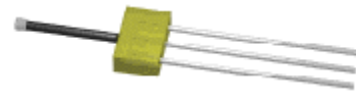


Chapter 10: Probe Assembly

Probes and Probe Values

The essential Probe values can be seen on the left hand side of the Probe information Window. The *Length Box* refers to the length of the prongs from where they exit the epoxy/resin to tip of the prong/rod, including the fringe effect at the end. Thus WinTDR uses the 'electrical length' of the probe rather than the 'physical length'. The *Imped. Box* is the impedance the TDR pulse experiences passing through the cable and rods while immersed in de-ionized water. These values will be constant for the life of the probe. Other values that will remain fairly constant are the cursor and peak position. These will only change when they are added to a multiplexer, or if an extension is added. In either of these cases the impedance will have to be reset also.

Currently there are a wide variety of probes in use. As USU we, for the time, prefer to use three prong probes that run by coax to a TDR. We are constantly looking for the best types of probes for different situations.



Making the Probe Mold Jig

Before we can make probes we need to make the probe mold jig. The jig is fairly simple to make, and reusable. The jig should appear similar to the below. (but it is recommended to make it much longer, with spaces for more than three probes.)

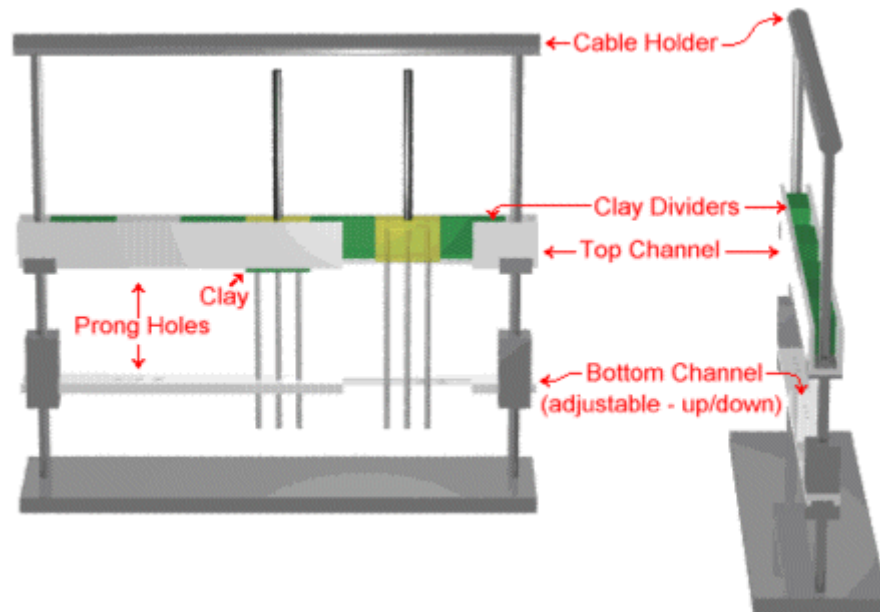


Figure 1: An example of a jig for making probes.

The directions below are sketch and require you to use the picture for directions. The things you need are as follows:

- Top Channel – a U-Channel bar 3cm deep by 1½ cm wide. (As long as you need.)
- Bottom Channel – A flat metal piece, or small U-Channel. (Same length as Top.)
- Cable Holder – Any long metal piece in which you can attach coaxial holders.
- Side Rods – 2 rods (preferably threaded) at least 50 cm long.
 - 8 bolts for the threaded rod to hold channels in place.
 - Tab and dye to screw rods into Cable Holder.
- Bottom Plate or Brace – Anything sturdy to hold the jig up.
- Clay – We use Crayola clay, it seems to work well.

Other items needed:

- A caliper for accurate measurements. (Hole spacing should be fairly accurate.)
- A drill with bits the exact size of your stainless steel rod, and your side rods.

Measure out and drill all holes before assembling. We usually space the center hole for each probe at 8 cm, and 1½ cm off set for each side prong hole. The width we use for clay vs. space is 5 cm for probe width, and 3 cm for clay width. Good luck with the jig.

Making Three Prong Probes

Three prong probes have the center of the coax line attached to the center wire, and the outer mesh attached to the outer two prongs. We have found this to be slightly superior to the two prong probes for various reasons. One reason is that the electromagnetic field is more contained, which gives a more accurate reading in many cases. But in some cases other probe designs may be more suitable.

To construct three prong probes, follow these simple instructions:

1. Precut three times the number of probes desired the rods to length $L+3$ cm to 4 cm to account for the distance lost in the resin, and so you can adjust later.
2. Pre-measure and cut coaxial cable to length $C+5$ cm to allow for attaching the ends.
3. Attach a standard coaxial plug (designed to plug into your TDR unit) to one end of the cable.
4. On the other end strip 1 cm of the black plastic up from the end, and twist the wire mesh into 2, 1 cm strands.

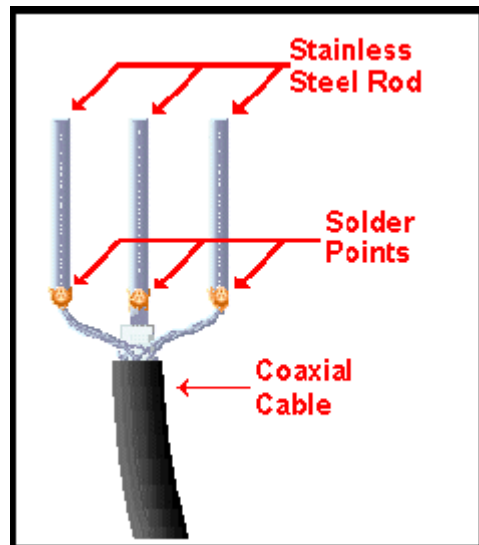
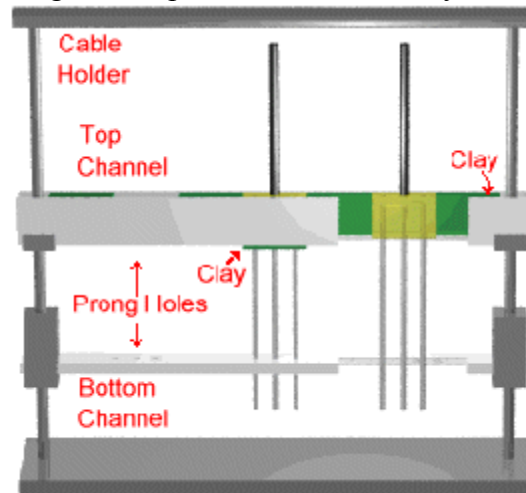


Figure 2: Sample of what the soldered end of the cable should look like.

5. Now clip off approx. $\frac{3}{4}$ cm of the white shielding and approx. $\frac{1}{2}$ cm of the center wire.
6. Solder each of the three wire ends to a distance stainless steel rod, precut earlier.
7. Clean out the TDR probe mold making sure no clay or other residue is in the mold positions to use.
8. Smear Vaseline or another type of lubricant in to the frame with a cotton swab or something similar. Be prepared to be generous with the lubricant and swabs. Make sure the lubricant is uniform because any glob or thick strands will be imprinted in the epoxy.
9. Place the soldered probes into the three holes of a particular mold. The mold should be pre-drilled as shown in the mold diagram to space the rods correctly.
10. While placing the probe, measure each rod and make sure each rod is approximately 1 cm from the top. This should leave 2 cm to 3 cm of probe in the epoxy. It is best that most of the epoxy is around the stainless steel rods because this is where most of the stress will occur during use.
11. After the probes are set in the mold, place clay around the underside of the top channel around the steel rods where the rods pass through the holes. This will prevent epoxy from running down the rods.
12. Mix the epoxy resin with the hardener. We use the System Three Boat Builders Epoxy. Mix two parts resin with one part hardener. Stir, then let stand a couple of minutes, then stir again. Careful no to let the epoxy get too hot.
13. Pour epoxy into the mold positions. Fill each to the very top.
14. Pull cable ends up gently and attach to, or wrap around, cable holder. This is to ensure that the cables are centered straight in each probe.
15. Allow the epoxy to harden overnight.
16. Remove the clay used to prevent spilling from the holes from the underside of the top channel.
17. Clean away any epoxy that has run down the rods. A utility knife works well for this.
18. For each probe, clip the ends of the rods until they are all the same length. We have developed a tool here from a bolt cutter that allows us to cut them exactly to a set length.
19. The epoxy (resin part of the probe) will have rough sharp edges. It is best to sand these down with a belt sander. This will prevent injury, and increase the life of the probe by preventing snagging on sharp edges. It also gives a more professional look.



After this your probes should be ready for use. Remember to calibrate for impedance in de-ionized water before using them to obtain salinity readings.

Other Probes

While we generally use three prong probes, we have extensively used and experimented with various other probe designs. In different situations these other probes may be more appropriate, based on their spatial sensitivity or other design criteria.

For any probe type you make you will have to follow a similar process in making a jig, and creating a probe is described in making a three-prong probe. If you are interested in making round probes we recommend getting a galvanized fence pipe, cutting off 3 ½ cm sections, and attaching them side by side on a long, flat, thin metal plate. (This will take the place of the top U-Channel.) Then drill the holes appropriately in both the top and bottom plates.

This program was written to work specifically with three prong probes. If you attempt to use other types of probes you will have to fiddle with the program a bit, or develop your own method of interpreting the results.