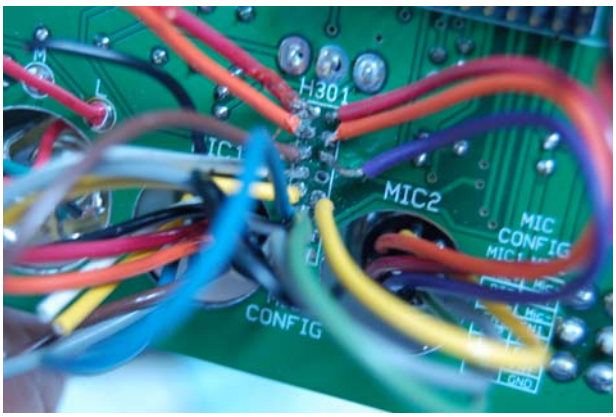
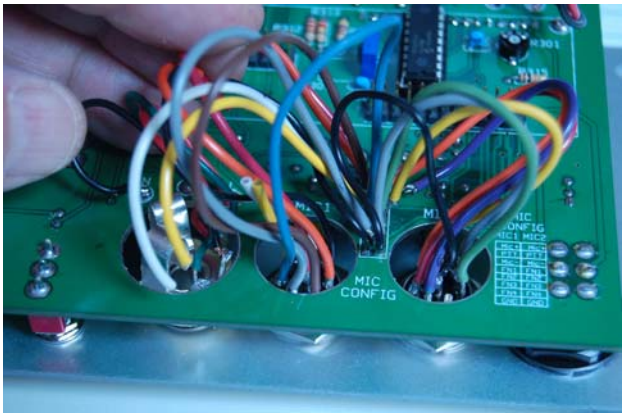
W8ZR ’s Tips for Wiring Circuit Board Jumpers

Most of the StationPro assembly entails soldering components onto circuit boards, but there is a small amount of point-to-point wiring, mostly installing short jumpers from front panel connectors to pads on the adjacent printed circuit board. A few builders have struggled with this part of the assembly, so for these folks here are a few hints I’ve learned over the years.

The first step is to diagnose the problem, and I’ll use the StationPro microphone connectors as an example, since they have the most wires in the smallest space. The two photos below show the wiring of a builder who struggled several hours trying to solder jumpers to the StationPro’s microphone pads.





As you inspect these photos take note the following problems:

(1) The wires are roughly twice as long as necessary. Excessive wire length makes it impossible to route the wire bundle neatly and to keep track of individual leads. Overly long wires tend to get caught on components when they’re stuffed into an enclosure, and the flexing puts stress on solder joints. Furthermore, it’s very hard to avoid touching adjacent wires with your soldering iron when there’s a snarl of wires around every connection. If you look carefully, you can see melted insulation on some of the wires.

Rule No. 1: Jumpers should be no longer than necessary to reach neatly from point A to point B.

(2) The insulation on some wires is stripped too far back from the solder connection (look at the blue wire on the right side of the left photo). Obviously, uninsulated wires in close proximity are prone to short circuits. In this case, the tinned lead was too thick to fit into the hole in the circuit board. One reason it wouldn’t fit is that the wire’s strands weren’t twisted tightly before tinning, and too much solder was used to tin the strands. But the biggest reason is that the builder used hookup wire that was too big for the job – No. 20 AWG in this case, instead of the called-for No. 22 AWG. One can always use smaller wire (within reason) without problems for short jumpers, but it’s impossible to do a good job if the wire is too thick. Note also how the wires seem to crowd the pads, with very little clearance between pads.

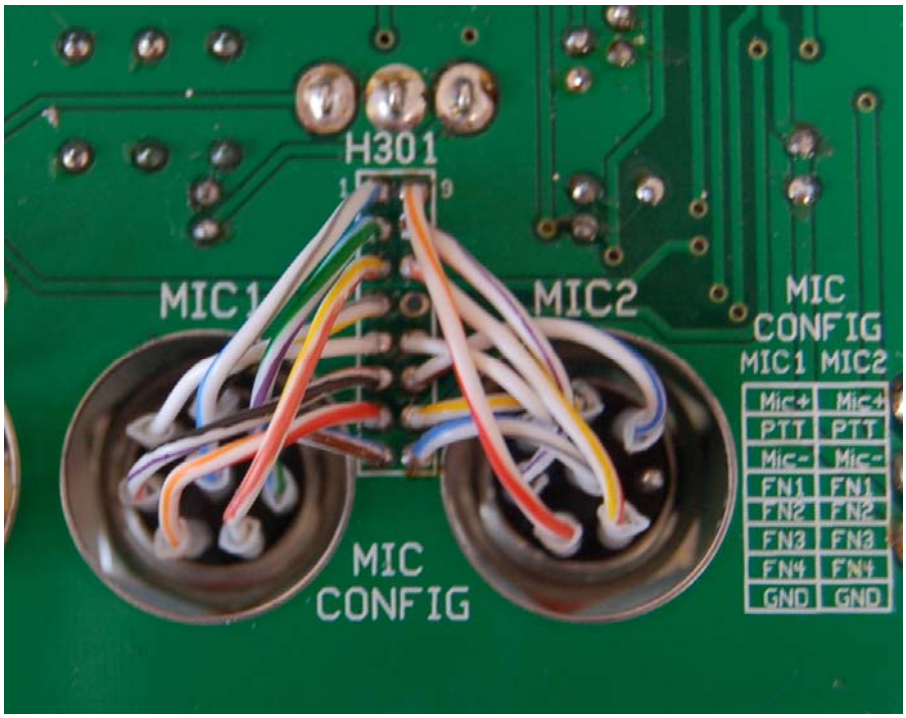
Rule No. 2: Use the correct size hookup wire for the job. Tinned leads should always fit easily into mating circuit board holes. Go smaller if necessary, but never bigger.

Rule No. 3: Tin but don't over-tin stranded hookup wire before connecting it, and be sure you first twist tightly the leads. The purpose of tinning is two-fold: (1) it keeps tiny loose strands from causing short circuits or mushing out the strands as you slip them into the hole; (2) it helps wet the solder bond between the strands and the sides of the circuit board pad.

The final problem isn't visible from the photos but is a frequent source of trouble, and that is wires that extend too far into the circuit board hole and out the other side. In this example, if wires extend below the circuit board too far it's not possible to get wire cutters into the narrow space between the circuit board and the front panel. This situation invites short circuits between adjacent wires.

Rule No. 4: Don't overstrip insulated wires. A rule of thumb is to strip wires that connect to solder lugs 1/4 in., and wires that connect to circuit board pads 1/8". Most printed circuit boards are 1/16 in. thick, so a wire stripped 1/8 in. will only extend through the bottom of the board 1/16 in., which won't cause any problems.

Now let's take a look at the same connectors, wired according to the above rules.



Note how easy it is to follow which connector wire goes to which pad, and how the clutter has been eliminated by merely shortening the wires. Also note that by using proper gauge wire, there is now ample space between pads, thus minimizing the possibility of short circuits. Because these wires were stripped only to 1/8 in, the insulation covers each wire right to the solder blob, and the wire extends only a safe 1/16 in. on the underside of the board. Also note that sleeving was placed over each wire, in

order to cover the microphone pins. This is done partly for cosmetic reasons, but also because installing the sleeving on the wire requires one to tug slightly on the wire, thus revealing quickly any poorly soldered wires on the mic connector.

Here are another few tricks I used to simplify the wiring. First, I used teflon insulated hookup wire (which one can frequently find at hamfests, QTH.com, or eBay. Don't pay retail, because it is very expensive.) Teflon insulation doesn't melt, so there's never a problem with accidentally melting insulation. On the other hand, teflon insulation is tough, which makes it a bit harder to strip. Never try to strip insulation, teflon or otherwise, by gripping it with wire cutters and pulling. I use an Exacto knife, single-edge razor blade, or box cutters (with a fresh blade) to cut carefully the insulation around the wire, and then pull off the end by gripping it with wire cutters. It takes a few seconds longer to strip wire this way, but you end up with a nice clean strip. Also, clamp the wire with needle nose pliers while you're pulling off the insulation, so you don't pull loose the other end. I know not everybody will be able to use teflon-insulated wire. For common plastic-insulated hookup wire, you'll find that the insulation will melt easily and sometimes shrink and pull back from the heated end. In that case, you should tin the wire first and then clip it to 1/8" after tinning.

In wiring the above connectors, I started at the bottom row of pads and worked systematically toward the top row. That way it was easy to get my soldering iron onto the pads without having other wires get in the way. After each wire was soldered, I carefully dressed the wire. It is good wiring practice to have each wire come up vertically from its pad for a short distance, and then veer over gracefully (without sharp bends) toward its destination.

I used different colored wires for each pin because I happened to have many colors on hand. However, as you can see from the photo, that's a minor benefit. If the wires are short and neatly dressed, there shouldn't be any confusion if you use the same color wire. (On long runs, just use an ohmmeter.) It's MUCH more important that you use the right kind of hookup wire than multiple colors, even if you have only one color. Without good hookup wire, you are doomed to failure.

Now a word about soldering irons. When working with small wires (No. 22AWG or smaller), it's essential to use a small-tipped soldering iron with a sharp point on the tip. For the connections in the above photo, I used an Aoyue model 968 soldering station (bought on eBay). The tip was 1/2 in. long and tapered from 1/8 in gradually down to a fine point. A nice feature of this soldering station is that it has a little tube connected to a vacuum pump to draw solder smoke away from the joint, so you can see what you're doing and won't cough all night. But there are many other acceptable soldering irons. (I also use a Weller EC2001 with an EC200C soldering pencil, which has a 3/8 in long tip that is 0.1 in. at the thickest point and tapers gradually to a fine point.) Whatever soldering pencil you use, it HAS to have a fine point. No wedge tips allowed! And variable temperature soldering irons are a big plus. I normally set the temperature at about 730 degrees F, but crank it up higher when soldering to ground planes, since they really soak up the heat. You want to make sure solder flows onto the ground plane and doesn't just ball up on the lead.

And let's not forget solder. For the photo, I used ordinary tin-lead solder (resin flux, naturally) of diameter .031" (1/32"). Don't use anything thicker, because (a) you won't be able to sneak it down next to the pad and (b) it will draw off too much heat from your soldering pencil.

And now I'll finish with a few obvious but important tips.

(1) Esthetics count. If your connection doesn't *look* good it isn't good. Pay attention to every single wire and every single solder joint. Inspect every joint with a magnifying glass, dress every wire as you go along, and if everything doesn't look right, then strip it out and do it over. Believe me, you'll save time in the long run! (It took me about one hour to wire up these two microphone connectors.)

(2) Don't start wiring until you have the right tools. You're headed down the path toward total frustration if you don't have a good soldering pencil, right-sized solder, a sharp knife or box cutter, a magnifying glass, a bright light, small, high quality needle-nosed pliers and flush-cut wire cutters, and sharp pointed tweezers.

(3) Don't rush. Let me repeat that. Don't rush. Think of the tortoise and the hare. You'll get to the finish line faster (and happier) if you take your time, work only when you're rested, and stop as soon as you feel your edge slipping.

And finally, keep in mind that none of this is rocket science. Wiring neatly and carefully doesn't take talent, a high IQ, or even experience. Okay, maybe a little experience. But basically, all it takes is a systematic step-by-step approach, a modicum of patience, and the ability to recognize when something looks good and when it doesn't. Your goal isn't just to complete a StationPro that works when you're done (although that obviously is an important goal). You also want to build a StationPro you can be proud of. End of sermon.