TITLE: Big Nasty Connectors (BNC)

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So there you sit, $5k worth of Kingko Loudenboomer MK-50 radio in your panel, $1000 worth of Davey Booze ANR headsets on your heads, and you can't talk to the ground because somebody hamhanded the $2 BNC antenna connector during the installation. Sigh.

Well, cheer up, bucko, because you are about to learn the right way to assemble a BNC connector and eliminate one possible source of failure in your radio system. Tha's right, two pages of words and pictures that will let you be the resident expert on one of the most common causes of radio failure -- the antenna connector.

Just a step backwards for a minute…back to WWII. At the time, there were literally dozens of connector standards. However, just like resistors, capacitors, and inductors had no real standards at the time, we all became aware that if we were going to be able to chug out hundreds of thousands of military radios, we were going to have to set some standards. The resistors and such were standardized with the RMA (Radio Manufacturer's Association, later RETMA - Radio, Electronic, and TV Manufacturer's Association) standard codes and values, and a group of the RF types got together and standardized the connectors. One of the connectors, which was to become by far the most popular RF connector ever designed, was the Bayonet, Normal impedance, type C, or BNC.

So here we sit with a cellophane package of connector parts in one hand, a 50 ohm RG-58 coaxial cable in the other hand, and the desire to terminate the cable with the connector. What to do?

In my opinion, what to do is to make sure that those connector parts are a regular old solder-on clamp type connector. Yes, I am aware that there are BNC crimp-on connectors, but I thought you said right up front that you wanted a reliable connector? Isn't that why we are doing this little song and dance? I'm here to tell you that I've seen the crimp style fail, they are NOT as weatherproof as the solder-on style, and in 40+ years of playing this avionics game, I have yet to have my first solder-on failure.

In reality, I've used BNC connectors from a dozen different manufacturers, from the most expensive to the economy class, and I find practically no difference in the performance or the reliability. The reliability comes from the *assembly* and not from the components. The mil-spec variety and the bottom end commercial variety are, in my opinion, equally suited for light aircraft use at VHF up to and including transponder.

One thing we need to consider right up front is sex. And, as Chuck Berry so aptly noted back in the '70s, sex isn't a problem so long as you know how to handle it. And how we handle it with BNC connectors is to figure out which is the male connector and which is the female. No, the gaskets don't come color coded pink and blue, so we will have to look at the *center conductor* of the connector to make this determination. Unlike power connectors, where the *body* of the connector determines the sex, in RF connectors, the center pin is the determining factor. The male BNC comes with a pointed center pin and the female BNC comes with a flared and open center pin. Now comes the first secret of this little rigamarole -- the *male* cable connector is almost always referred to as a **UG-88** type connector (even if it isn't a milspec connector, the mil-spec number is the common reference). The *female* connector is referred to as a **UG-89** type.

Having said all that, it's probably time to get on with the assembly, don'cha think? The first step is to get yourself a small container, like a sandwich keeper or other seamless small box. Don't use a cardboard box with folded seams or I guarantee you will lose one of the tiny parts. And, heaven forbid, should you lose a washer or

a gasket, please throw the rest of the parts away and write the connector off as a loss. Don't try and salvage the situation by leaving out one of these "nonessential" parts or I guarandamntee you that the connector reliability will be in the dumper.

So, let's inventory the parts (see the exploded view drawing). The large cylinder is the body. Inside the body there is a machined nylon or Teflon insulator that will accept the center pin and (invisible to you) there is an indentation in the insulator that will capture a corresponding ridge on the center pin and hold it firmly.

Then there is a tapered thick metal "washer" called a clamp. Next to the clamp there is a rubber washer, then a thin metal washer, then a thick metal "gland" nut. Finally, there is (generally gold or nickel plated) the center pin.

Putting it all together (by the numbers)

1. My personal secret for success is in this first step. Cut the coaxial cable (RG-58, or just "coax") off square where you are going to install the connector. Slip over the coax (in this order) the gland nut (threads towards the coax cut end), the thin metal washer, and the rubber washer~~, and the clamp. The clamp should be oriented so that the thick part of the clamp is next to the rubber washer and the thin neck is towards the cut end of the coax.~~ Slide all these parts back onto the coax jacket out of the way and use a rubber band, piece of tape, or other mechanism to keep the parts back and out of the way.

2. Using a very sharp exactly-knife (hobby knife), carefully cut the black outer plastic sheath jacket of the coax (RG-58) back " (10mm). Try and not nick too many wires from the braided shield just under the black plastic outer sheath. My rule of thumb is that if I accidentally cut more than 25% of the braid, or 100% of the braid in any one location, I start over.

3. Unravel or flay the braid so that you have mostly individual braid wires instead of the mesh braid that the coax was manufactured with. Fold these braid wires back over the black plastic sheath.

4. Cut the center conductor insulation back to half of what is now exposed. Try not to score or cut the solid center conductor at all. If you feel you have weakened the center conductor, cut the cable back and try again. More than anything else, a broken center conductor is the cause of connector failure. It takes a steady hand and a bit of practice, but it is possible to remove the insulation with little, if any, contact with the center conductor.

5. Second assembly secret -- put the coax in a small bench vise with the center conductor pointing vertical. Lightly tin the center conductor with a thin coating of solder. Now put the center pin onto the center conductor…it should fit almost all the way down to the center conductor insulation. Wipe your soldering iron on a sponge to get all the loose solder off and get a nice shiny solder surface on the iron tip. Put the iron tip onto the center pin just below where the pin takes a diameter cut to neck down to the tip. Touch some solder to the area at the base of the pin where the pin joins the center conductor. In about 5 seconds this solder will melt. After the solder melts, count aloud "A thousand one, a thousand two, a thousand three" and then remove the iron from the pin. Leave things alone for about ten seconds.

6. Use a pair of longnose pliers and try to pull the pin (gently, now) off the coax. You should feel a nice rock-solid joint between the pin and the center conductor, with a fillet of solder all the way around the pin base and the center conductor. If the pin passes this test, you've gotten 95% of the reliability of the connector assured.

7. Now for the hard part and secret #3. Pull the braid back down over the center pin. Install the clamp over the braid with the thick part of the clamp towards the gland nut and the thin part towards the center pin. Let the clamp bottom out against the black sheath jacket. Spread the braid out so that it stands at 90° to

the coax and the clamp all the way around the cable. ~~Remove the rubber band (or whatever locking mechanism you used to keep the small parts out of the way on the coax). Slide the clamp down until it touches the braid.~~ Now using your thumbnail, wrap the braid around and over the clamp until the braid touches the black sheath jacket. Keep the clamp pressed hard against the junction of the braid and the jacket. Use wirecutters to trim the braid so that when you fold the braid up and over the thick part of the clamp that the braid just touches the black insulation. This, too, is a trick that takes some practice. More better you trim a bit, fold up and check, trim a bit more, fold up and check until you get it just right. About the third or fourth one of these connectors you assemble and you won't even have to measure. The old famous "TLAR" test (That Looks About Right).

8. Insert the center pin and coax into the connector body. You should be able to push the center pin into the body and feel a "click" or snap when the center pin seats itself into the body's insulator. Sometimes it is necessary to *gently* pull on the center pin with longnose pliers to get it to seat properly. When it is seated properly, the tip of the pin will be flush with the outer diameter of the body insulator. (Note that the outer diameter of the body insulator, the thin shim metal sheath, and the body locking ring are almost all flush with one another.)

9. Push the gland nut down into the body and begin to thread the nut into the body. Do NOT let the body rotate relative to the coax. The nut should be rotating, but the body and coax should remain steady. It is relatively easy to cross-thread this nut into the body, so before wrenching on this last part of the assembly, make sure you can get a thread or two finger-tight before using tools.

10. And the last secret for the day. There is a "flat" on the connector body just between the bayonet ring and the body itself. A " ignition wrench will just barely squeeze onto this flat, and is the tool of choice to hold the body while you tighten the nut. Yes, in a pinch I've used gas pliers to hold the body, but it isn't really the "right" way to do things. At any rate, hold the body with wrench or pliers and use a regular " open-end wrench to tighten the gland nut into the body. There should be half a thread to a thread showing between the nut and the body when the assembly is properly tightened.

That's it, folks. You are now a fully qualified BNC connector assembler. And, of course, the question becomes, "Where do I get BNC connectors?" Unfortunately, as much as I enjoy sending you to The Shack for your parts, I do not consider The Shack's BNC connectors to be aviation quality. They are all crimp or twist-on style and that just doesn't cut it with me. Mouser has the 171-9313 for about two bucks a pop, Digi-Key has its A24424 for about the same, and the usual gang of avionics suspects (RST, Spruce, Chief) are all in the same ballpark. Just be sure you get the *clamp* type and not the *crimp* type.

The weather here as I write this in March has gone from a very balmy 70°+ back into the low 'teens at night, so perhaps I'll be able to get some data in the next few days for the engine preheat warmer for the next article. Then we'll take a trip into the world of carb temp gauges, back to the engine warmer for an auto-on control, and then we'll wander aimlessly for a while. See you next month.

Author's Note: Jim Weir is the chief avioniker at RST Engineering. He will be glad to answer avionics questions for this article or on any avionics subject in the Internet newsgroup rec.aviation.homebuilt. If you are having trouble with newsgroups, go to www.rst-engr.com and click on the "How To Use The Net" link.

PHOTO LOG

Photo 1 -- All the parts in exploded view. Note that the clamp has been installed at the junction of the braid and the sheath and that the braid wires have been wrapped up and around the thick part of the clamp. Take exceptional pains to see that ALL the braid wires are wrapped up and around and that none of them will be able to short out against the center pin when installed.

Photo 2 -- Soldering the center pin on. Note that the solder is being fed in from the bottom and that the iron is halfway up the pin. This shot was taken just after the solder melted and the pin is now firmly attached to the center conductor of the coax.

Photo 3 -- Fastening it all together. Note the thin "ignition style" wrench on the body and the regular open end wrench on the gland nut

KP0206 jpg & pdf An assembly drawing showing the components to be assembled on the connector.