TITLE: The $2 Com Antenna Diplexer

ISSUE: Mar '02

By Jim Weir
Humble Tinker, RST

Every now and again, a com radio fails. I don't care if it was made by Marconi his-self in a surgical clean room with gold-filled solder, your com radio is going to fail. Whether in a day or ten thousand days, there is a very predictable MTBF (Mean Time Between Failure) for any conglomeration of parts. Some of us will beat the odds and some will fall short. But just like death and taxes, failure is inevitable sooner or later.

Most of us carry along a little handheld for just such an emergency. However, the little rubber duckie antenna that comes with the radio is an excellent approximation to a dummy antenna -- in practice it is more like a rubber resistor than a rubber antenna. Inside a metal cabin, or a steel tube fuselage, or even a Tupperware® tube surrounded by flying wires, salt water pilot sacks, and other ironmongery, the range of a handheld with a rubber duckie is measured less in miles and more in feet. More like a limp spaghetti antenna inside a copper septic tank.

So what to do? I certainly don't want to hang ANOTHER antenna on that beautiful streamlined skin, especially if the only time I'm going to use it is once in a while during com failure. And, since the antenna is generally one of the more reliable pieces of equipment on the airplane, there is no reason not to disconnect the busted radio and fire that handheld up into the good antenna that had been connected to that inop radio.

There are dozens of schemes to make this happen…most of them involving the pilot playing contortionist with hidden coax connectors while the poor airplane is left to wander aimlessly about the heavens. Wouldn't it be nice if we could just plug our handheld into a panel-mount connector and automatically disconnect the inop radio and connect the handheld directly to the antenna? That seems to be the clever way to do it.

First thought says -- run the output of this panel-mount connector into a remote box, diode detect the RF from the hand-held transmitter, run a couple of latching relays, make a failsafe and diode detect the installed com radio, hook up some circuitry for pilot override of the system…heck, I've just made myself something that may or may not be less reliable than the com radio itself. No, I want something that is darned near failsafe and requires an absolute minimum of switching.

Hmm…what do I have in the inventory that will switch automatically when I plug into it…hey, how about one of those little audio connectors that will cut out the internal radio speaker when I plug in an earpiece? You've used them, those little miniature 3.5 mm phone plugs that have an extra connection to break the speaker line and connect the earphone into the system? Y'know, that just might work. And, I'll bet Rat Shack sells them (plug #274-288, jack #274-248).

First thing to do when you get your hands on the parts is to connect the plug to the jack. As you do so, can you see how the tip of the plug disconnects the little intermediate contact from the jack tip contact? That's the trick we are going to use to make this all work. In normal operation, the aircraft antenna is connected to the jack tip contact terminal. The com radio is connected to the intermediate contact terminal, and both coax shield braids are connected to the shell (ground) terminal. In normal operation, the RF energy passes through the intermediate contact to the tip contact directly to the antenna. When you connect the plug, the plug tip now goes to the antenna, breaks the connection between the intermediate contact and the antenna, and the plug shell goes to the common ground.

All that remains is to run coax cable from a connector that fits your radio to this little plug -- center conductor of the coax to the tip terminal and shield braid to shell (ground) terminal.

Now it is time to put a couple of caveats on the system. First of all, I prefer that little jack to be bolted to a metal plate that is bolted to the same part of the instrument panel that the com radio is fastened to. Second, I want all the connections to our little jack insulated with shrink sleeving to a fare-thee-well. I don't want any stray aluminum shavings falling into the works and making our fail-safe project into a fail-now project. Finally, were it me I'd give the area where that little intermediate tab touches the tip contact a very small amount of contact cleaner or other anticorrosion liquid like WD-40. After all, it may be many months to a few years before you will ever need this connector, and during that time, you expect it to be a failsafe connection from your panel com radio to the antenna. A *tiny bit* of goose grease will go a long ways to meet this expectation.

The question that remains…how much are we paying for this fancydance in terms of loss of signal to the com radio in the normal mode? Heck, that's a pretty easy answer to get. First we connect a regular old piece of coax from our generator to our spectrum analyzer and get a reference level. Then we cut that coax in half and solder it to our little jack and remeasure the loss. With as sophisticated a piece of ($25,000) equipment as I have on my bench to make measurements like this, the loss was down in the noise of the instrument -- that is, I can't measure any detectable loss.

We've got ourselves another winner…a low-cost way of making an antenna for our standby handheld radio out of a couple of bucks of Shack parts and an hour's worth of work.

The bare truth of the matter is that most of us don't really care to cut up the coax in the airplane to make little modifications like this until we are absolutely sure that this is the way we want things to work. I understand that syndrome completely. What you can do, if you wish, is to remove the cable from the backside of the radio (generally a male BNC connector on the end) and make a patch cable with male BNC connectors. Then by using what is called a "female barrel" (or gender bender, RS #278-115) you can interconnect the original uncut cable into our new antenna patch jack. If you decide in a year you like it, you can remove the patch cable and make a permanent installation out of it.

Questions from the floor --

1. "I don't like that flimsy little offshore connector. Can I use a big old 'Murrican moosy connector instead?" Sure, and your moosy loss will go up like a skyrocket. The reason I chose this little jack was that it is small compared to a wavelength. When you start talking about regular old phone plugs and jacks, you are now getting into the range where I'd expect some very measurable radiation losses from the sheer size of the connector parts.

2. "How mucha my handheld transmitter is frying the front end of my inop com receiver?" The measured isolation of the connector is about 27 dB across the com band, worst case. In layman's terms, this means that your 2 watt handheld is putting about 4 MILLIwatts into your dead com's front end. In the 50 ohm impedance we are working with, this is 500 millivolts (½ volt) into the receiver and most of us design our receivers to take a couple of volts before anything serious occurs.

3. "What's my range going to be with your contraption?" Assuming a 2 watt transmitter on one end of the link and a 2 microvolt receiver on the receive end, the *theoretical* range of this link will be on the order of 600 miles. This will never happen in practice because of the "horizon rule". That is, once the station you are communicating with drops below your optical horizon, communications are abruptly terminated. The horizon equation goes something like this: $R = \sqrt{2 * h}$, where range is in statute miles and h is the altitude of the aircraft (the other station is presumed to be on the ground.) If both stations are aircraft stations, h is the combined altitudes of the two aircraft. Example -- How far can you talk with Podunk

Unicom when you are at 3000' agl? 77 miles. Example -- How far an you talk to your wingmate when you are both at 5000' agl? 141 miles.

Understand, these are THEORETICAL numbers without factoring in the deep nulls and enhanced lobes you generally find in a typical aircraft antenna installation. If you reduce each of these range distances by half, you will be generally in the ballpark of reliable communications range.

4. "What happens if I accidentally hit the transmit button on my bad com radio?". Again, the 27 dB isolation is reciprocal, so divide your transmit output power by a factor of 500 to see how much of that power you will be firing directly into the front end of your handheld. The typical 8 watt transmitter? 16 milliwatts, or 900 millivolts (0.9 volts). Now this is getting a bit close to the tested limits most of us design to, so you might want to be a bit cautious about diddling around with that ptt switch when you are in the emergency transmit mode.

5. "Will this scheme work for VOR reception on the handheld too?" Yes, but nowhere near as good as a standard horizontal nav antenna. You will most probably get rather reduced VOR/LOC range as well as some needle wander and inaccuracies. However, it is better than nothing, and the closer you get to the nav station the better this lashup will work.

That about does it for me for the month, so let's take a peek ahead to the next issue. About a year ago, I got a spam email with a blurb about this neat little device that would turn on an electrical device with a beeper signal. Let's see how this might be of some use around the old hangar and if we might be able to make one for about a tenth of the advertised price…

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:

Picture 1 -- The rear of the panel showing the contacts in the normally-closed position.

Picture 2 -- The rear of the panel showing the contacts in the open position, plug inserted

Picture 3 -- The plug inserted from the frontside and showing the goesinta and goesouta connectors on the coax.