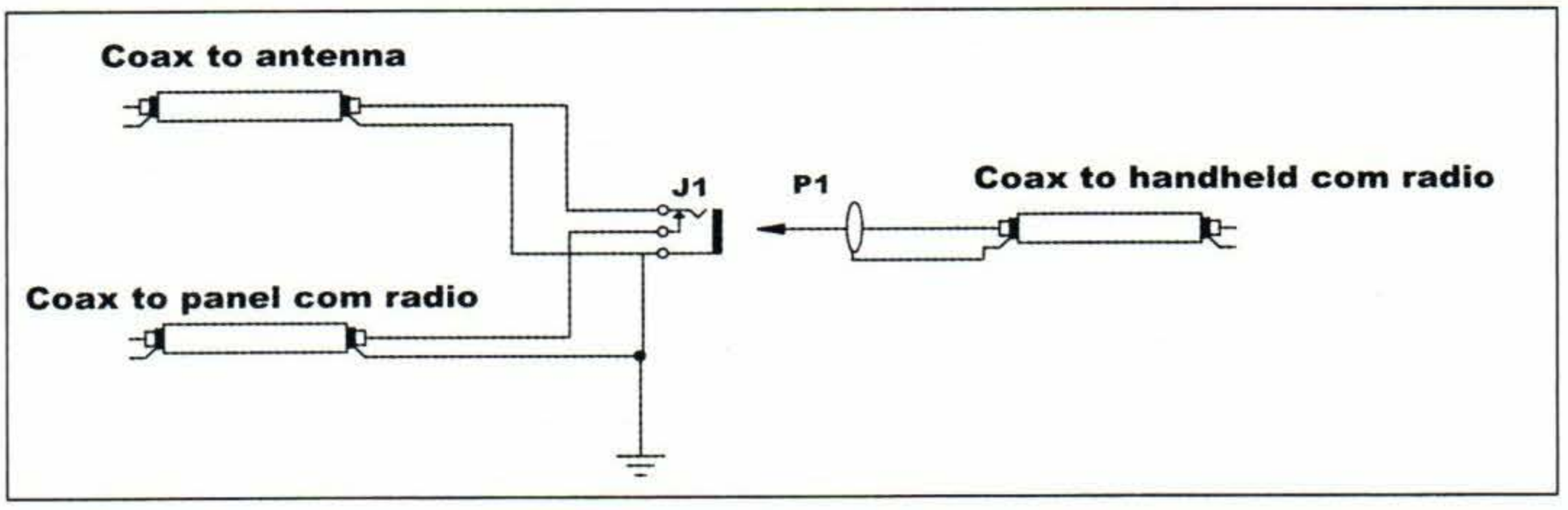
Aero 'Lectrics

By Jim Weir

Build a $2 cockpit antenna diplexer for your handheld.



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 10,000 days, there is a predictable *mean time between failure* (MTBF) for any conglomeration of parts. Some of us will beat the odds and some will fall short. But like death and taxes, failure is inevitable sooner or later.

Most of us take along a handheld transceiver for just such an emergency. However, the little rubber duckie antenna that comes with the radio is an excellent approximation of 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 in a Tupperware tube surrounded by flying wires and other ironmongery, the range of a handheld radio with a rubber duckie is measured less in miles and more in feet. More like a limp-spaghetti antenna inside a copper septic tank.

Solutions

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 during occasional com failures. And because 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 was connected to that inop radio.

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

First thought says to run the output of this panel-mount connector into a remote box, diode-detect the RF from the handheld transmitter, run a couple of latching relays, make a fail-safe and diode-detect the installed com radio, and hook up some circuitry for pilot override of the system. But I've just made myself something that may be less reliable than the com radio itself. No, I want something that is darned near fail-safe and requires an absolute minimum of switching.

Hmmm...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 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 Radio Shack sells them (the plug is 274-288; the jack is 274-248).

Making It Work

First, 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'll use to make this 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 handheld radio to this little plug. The center conductor of the coax goes to the tip terminal and the shield braid goes to shell (ground) terminal.

ILLUSTRATION: JIM WEIR

Some Details

Now it is time to put a couple of caveats on the system. First, the little jack should 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 connections to our jack well insulated with shrink sleeving; I don't want any stray aluminum shavings falling into the works and making our fail-safe project into a fail-now project.

Finally, give the area where the intermediate tab touches the tip contact a tiny amount of contact cleaner or other anticorrosion liquid like WD-40. After all, it may be many months or years before you will need this connector, and during that time, you expect it to be a fail-safe connection from your panel com radio to the antenna. A tiny bit of corrosion protection will go a long way to meet this expectation.

A question remains: How much are we paying in terms of signal loss to the com radio in its normal mode? That's easy to answer. First we connect a regular 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 jack and remeasure the loss. With as sophisticated a piece of equipment as I have on my bench to make measurements like this ($25,000 worth), the loss was down in the noise of the instrument. That is, I can't measure any detectable loss.

So we have ourselves another winner: a low-cost way of making an antenna for our standby handheld radio out of a couple of bucks of Radio Shack parts and an hour's worth of work.

Adding a Wrinkle

The truth is that most of us don't want to cut the coax in the airplane to make modifications like this until we are absolutely sure that this is the way we want things to work. I understand completely. What you can do is remove the cable from the back 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 No. 278-115), you can interconnect the original uncut cable into the new antenna patch jack. If you decide later that you like it, you can remove the patch cable and make a permanent installation.

Questions from the Floor

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

2. "How much of 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. 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 our receivers are designed 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.

How far can you transmit? Examples: From 3000 feet AGL to a ground station, it's 77 miles; from 5000 feet to your lost wingman at the same altitude, it's 141 miles.

Understand that 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). This is getting a bit close to the tested limits most of us design to, so you should be cautious about touching 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 well as a standard horizontal nav antenna. You will 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.

What's Ahead

That does it for this month, so let's take a peek at the next issue. About a year ago, I got a spam e-mail with a blurb about this neat gadget that turns on an electrical device with a beeper signal. Let's see how this might be of some use around the hangar and if we can make one for about 10% of the advertised price. **KP**

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