TITLE: The Little Radio That Could (Installation, Part II)

ISSUE: Special Feature

By Jim Weir
Humble Tinker, RST

"DAMMIT. The plate doesn't fit." After carefully machining an adapter plate to mount my brand spanking new Microair 760 radio into a 3 ⅛" instrument hole for Snarly Charlie (N73CQ, the company classic 182), the darned thing didn't fit. I mean, after all, I *wrote* the plans to machine adapter plates (Kitplanes Wxyz '01 page $$) and now the first one I make from the plans won't fit my new radio. Rats.

After calming down a bit (and a snort of Old Rammycackle to help that process along) I examined just WHY the radio didn't fit the plate. It's because…ummm…the radio is slightly larger than a standard 2 ¼" instrument. Yup, a "standard" instrument is 2 ⅜" square, but the Microair is just a hair over 2 ½" square, and that extra ⅛" was enough to make an interference fit with the press-nut needed to mount the plate to the instrument hole. Sigh.

Time for the grinding wheel. Once again the old Dremel-tool comes to my rescue. After grinding down one edge of each of the 4 press-nuts to clear the Microair cover, the plate would fit the radio. However, as a result of the grinding, one small edge of the threads on the press-nut were weakened, so during the install, I was especially careful not to overtorque the plate mounting screws. And, you can't have a screw any longer than the thickness of the instrument panel plus the thickness of the press-nut. If you try and put a longer screw in, you will butch up the radio's cover. Depending on what is directly under the cover at the screw's point of contact, you may wind up with a couple of pounds of very expensive fried silicon.

So, general warning, especially if you are going to be mounting your radio in a crowded panel – before you buy the radio cut yourself a piece of cardboard 2 ½" square and poke holes in it where the plans in Kitplanes tell you to put mounting holes in a 2 ¼" instrument mount. Put the cardboard into the instrument panel and see if there is an interference fit. If it looks like you've got enough clearance, go buy the little rascal. You'll find the Microair every bit as good a radio as I said it is (Kitplanes, Dec '99).

If you don't like the grinding wheel on the press-nut process, there is a family of nutplates (PEM® series F or equivalent) that mount flush from both sides of an 0.060" thick sheet of aluminum. Or, you could back off a little from the 8-32 press-nuts I used to a 6-32 and not have to grind as much. Your choice.

So after this little hiccup at the outset of the process, let's keep on with the installation of this little gem. Remembering that the power/audio connector on this radio is a DB-15 computer-style connector (and that they are a crystal witch kitty to install "blind"), and remembering that this whole airplane was wired using the Karmic Connector principles (Kitplanes, Nov & Dec '97 & Feb '98), the electrical installation to install this radio was a snap. Unplugging the (sob, sniffle) obsolete RST-571 360 channel radio from the Karmic plug and making up a cable to go from the DB-15 on the back of the Microair to the Karmic plug took more time to write about than to do. The DB-15 was permanently installed on the back of the Microair, and the long pigtail down to the Karmic connector was plugged in and bingo. No fuss, no muss, and worked the first time. Almost.

For those not familiar with the Karmic connector series, this is a proposed standard for avionics installations using the inexpensive yet reliable Molex® 0.062 series nylon connector. In this installation, a simple 8-wire cable from the DB-15 connector on the back of the radio to the 12-pin nylon Karmic connector was fabricated on the bench, installed onto the radio, and that is the sum total of the "rewiring" needed to change radios. If back-issues of Kitplanes for these months are out of print, we've uploaded them to our web page www.rst-engr.com in the bibliography section for your use. Please enjoy them with our compliments.

See also the photograph that shows the Karmic connectors tied in to a barrier strip system for wiring the aircraft. During this installation, we were also installing the new digital clock (Kitplanes® Nov '01) and we had a fairly major wiring error. (My error from fifteen years ago when I wrote the pinouts from the connectors wrong. You'd be surprised how fast a ten amp breaker pops when it is connected directly to airframe ground.) Had I not used barrier strip construction and been able to get at these strips with a voltmeter, I'd STILL be trying to figure out what happened. Between the Karmic connectors and the barrier strips, this airplane can be worked on fairly effortlessly.

Note that in a prior paragraph I said that it worked the first time…*ALMOST*. There is an undocument hiccup in the installation manual that you really need to know about. Here's the deal. No switch in the aviation world has zero resistance. No wire in the aviation world has zero resistance. Therefore, we decided a long time ago that the voltage on the PTT line at the radio could never be zero volts, but had to be a few millivolts above zero. Further thought along those lines brought us to the conclusion that not only did the PTT switch itself have some resistance, and the wire, but if we were going to allow for such things as switching diodes to keep the pilot's key from activating the copilot's mic (and vice-versa) that we were going to have to allow for some reasonable voltage on the PTT line of the radio and still call it "keyed". There is dissention in the ranks as to whether that voltage is 1.5 or 2 volts (different "standard" specs say different things), but most of us agree that anything below 1.5 volts at the transmitter PTT line is "transmit" and anything above 4 volts is "receive".

Unfortunately, Microair didn't adhere to this convention. The PTT line at the transmitter has to be below 0.4 volts (400 millivolts) for the transmitter to fully key. It's sort of odd, too. With 1.1 volts on the key line (going through an audio panel with switching diodes) the transmitter would key and put out power, but there was no modulation (audio) on the carrier. But when I grounded the key line directly at the barrier strip I had full carrier and modulation. Sigh. A couple of emails to downundah' got me the information that the little rascal wants no more than 0.4 volts to fully transmit. So, two days before Oshkosh I'm inside the audio panel cutting and pasting an extra relay onto the board to do a "hard" ground on the PTT line. Just be aware of this requirement for very low voltage on the key line when you install your Microair.

Oh, and the admonition in the manual to use all shielded wire? Horsefeathers. Use shielded wire on the microphone input and regular old "aircraft quality" unshielded stranded wire on the rest of it.

Now that the rascal is in, I can do something that I've wanted to do to this airplane for an awfully long time and just never got around to doing. When I rebuilt the airplane, I just slapped a couple of commercial fiberglass whip antennas into the standard Cessna antenna holes and fired up the radios. I never got around to seeing exactly how "good" a commercial whip is on a storeboughten airplane. I mean, I've measured dozens of homebuilts with copper tape antennas, but I've never done my own airplane. I guess it is high time to get the old power meter out and see what kind of foolishness I've done to myself.

Let me give you a bit of advice before proceeding on. Having been in the homebuilt antenna business before Rutan had winglets, I've had my share of calls that start out, "Your antenna is no damn good, I measured it with my good buddy's meter and this antenna is a pile of poo." Good buddy is a giveaway. A CB wattmeter? Yup. Guess what? A meter intended for 27 MHz. CB is rarely, if ever, good for 120 MHz. aircraft. So before you start trying to find "the problem", solve part of the problem by using a wattmeter intended for the aircraft band. Usually, any "ham" wattmeter intended for 2-meters will work passably well on an aircraft system, and the MFJ antenna analyzer or Bird bi-directional wattmeter are intended for just this purpose. Moving on…

The prime measure of any antenna's worth is the far-field pattern. That is, at some long distance away from the antenna, what is the strength of a standard transmitter on one end and a standard receiver on the other end relative to some standard antenna. That's a lot of standards, isn't it? For an antenna made of non-lossy material (like a copper strip inside a fiberglass rod) we can generally say that the far-field efficiency will be strongly affected by a parameter called "VSWR" (VIZZ-war). All VSWR measures is the ratio between the power sent to the antenna and the how much of this sent power was reflected back by the antenna. This ratio is then measured at a number of points in the band and a graph is generated showing VSWR versus frequency. Generally, the antenna is measured at the band edges (118.0 and 136.975 MHz.) and every 3 or 4 MHz. in between.

Many thousands of hours and tens of thousands of dollars have been wasted trying for the ultimate in VSWR. Let me paint you a picture. A VSWR of 1:1 means all the power from the transmitter was radiated and none was reflected. This is impossible in the real world, but it is a place to start. What exactly does a 1.5:1, or a 2:1 or even a 3:1 VSWR really mean? Well, let me tell you technically what it means, and then relate it to range. A 1.5:1 VSWR means that 96% of the transmitter power is being radiated by the antenna; a 2:1 VSWR radiates 89% of the transmitter power, and a 3:1 radiates 74% of the power. In range (range being proportional to the square root of the transmitter power), let's presume that a perfect (1:1 VSWR) antenna will work out to 100 miles. If the VSWR is 1.5:1, your range drops to 98 miles. At 2:1 it drops to 94 miles. At 3:1 it drops to 86 miles. All this fussin' and fightin' to get the VSWR down (and, of course, the wild advertising claims) does little more than reduce your range by a drop in the bucket.

Given that picture, let's see what the antennas on a production airplane look like. To do this test, I used a VSWR meter manufactured by a company called MFJ Electronics. The neat thing about this little meter (the actual name is "Antenna Analyzer") is that it is completely self contained with its own battery power supply, RF oscillator, frequency counter, and detector/meter all in one little package. In all honesty, for $250, every EAA chapter in the country ought to have one of these little rascals to loan out to the membership when the antennas are installed in the member's homebuilt. We'd save a lot of time and pain if antennas were measured when installed.

But I digress. Measuring the antennas took far less time than writing about it. Thirty seconds after I connected the analyzer to the antenna lead I had my answers – the 2:1 VSWR bandwidth was from 113 to 140 MHz, and from 118 to 137 MHz. the VSWR never got above 1.5:1. Note that you really want to take the measuring instrument above and below the band edges of the com band to see that the antenna VSWR really *does* start rising rapidly. If it does not, you can be sure that there is something wrong with the installation – somewhere in the system there is a glitch. Antennas are *supposed* to "get bad" rapidly outside their bandwidth. Anything else says that you don't have an antenna, but a rubber resistor somewhere in the system.

Another good way to see if the antenna is really radiating is to watch the VSWR meter and put your hand close (6" or so) to the tip of the antenna. The VSWR ought to go high out of sight.

The final test consists of the old hairdryer test. Tune in a distant signal, one that has a bit of noise on it. I used Sacramento ATIS, about 60 miles distant. Wiggle ALL the wires going to and from the radio and see if there is noise in your headset from the wiggle. Most often, this will be a loose or corroded ground connection. Fix it NOW. Then turn on a cheap hairdryer and hold it somewhere about two feet from the antenna. If all the ground connections are good, and if the noise limiter in the radio is working properly, you ought to be able to *just barely* detect the whine from the brushes on the hairdryer. (Caution…don't use around fuel vents or open fuel caps. Point the hot air away from plastic and painted surfaces.)

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The ultimate test, of course, is a flight test. How about a 4000 mile flight test? Yep, we got this little rascal in just one week before we left for Oshkosh and used it as the primary radio for the trip. It performed flawlessly for the entire trip. I was especially pleased to hear how crisp the audio was. As I said in the prior "bench test" article (Kitplanes® Dec '99 and posted on the RST website and on Bob Nuckoll's website) there is something subtle about audio design that the same tests will show one radio with "soft" audio and another design of radio with "crisp" audio. Phase distortion (difficult to measure) accounts for a lot of it, and this radio is high on the "crisp" list.

There was also some discussion of transmitter power in the prior article. Suffice it to say that we crossed three mountain ranges where ATC coverage is not the best and the little hummer kept right up with the big boys. Those would be the Sierra Nevada (Oakland Center), the Wasatch (Salt Lake Center) and the Rockies (Denver Center). Not one lost communication or "say again, you are weak or garbled" on the whole trip, and I was in no way at the MEA or MRA for instrument flight through any of these mountain ranges.

I guess my bottom line is that I have no reason to say anything differently from the prior article on the radio's performance. It has done everything that you would expect of a radio and more – the radio itself still gets a grade of A in my design class. I still don't have all those memory channel procedures down pat, but I'm sure that with time I'll find my way around them. The nice thing is that if you don't need these extra functions, they don't get in the way of using the basic radio. Nice little radio…comes highly recommended by me.

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 AND DRAWING LOG

DRAWING

InstallPlate.pdf –	Manufacturing the plate to install the Microair radio in a 3⅛" instrument hole.
KPsch.pdf –	Schematic drawing of the installation adapter cable.

PHOTOS

All photos are in format DCP00xxx.jpg, where xxx is the picture number listed below

897 –	The press-nut after being ground down to fit.
898 –	Grinding the press-nut with the Dremel tool.
903 –	The Microair DB-15 to Karmic connector adapter cable (904 is a much better picture). The background is the Microair installation manual (on the left) and the Karmic drawing (on the right).
904 --	A much better picture of the adapter cable.
905 --	Installed into the instrument panel (rough)
906 --	Installed into the instrument panel (rough)
910 --	Barrier terminal blocks for the aircraft wiring. Note the Karmic connector going to the Microair radio on the extreme right of the picture.
911 --	Final installation with instrument panel cover in place.
917 --	Firing it up for the first time (Note the time – 5:40 pm two days before Oshkosh.)
923 --	The MFJ Antenna Analyzer looking at an antenna with a 1.2:1 VSWR at 122.95 MHz.