ANTENNALETS . . . OR . . .

HOW TO KEEP YOUR PRETTY PLASTIC AIRPLANE FROM RESEMBLING AN AGITATED PORCUPINE

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ABOUT THE TIME that someone asked me where he could put the **second** DEM antenna on his VariEze, I started to get the idea that perhaps some enthusiastic plastic airplane builders were instrumenting their ships a little more extravagantly than either Rutan or I expected. In this vein, where the costs of the radios meet or exceed the cost of the airframe, allow me to show you how to do a dual COM, dual NAV, glideslope, marker beacon, plus one DME and one transponder antennas inside a plastic (conductive structure) airplane.

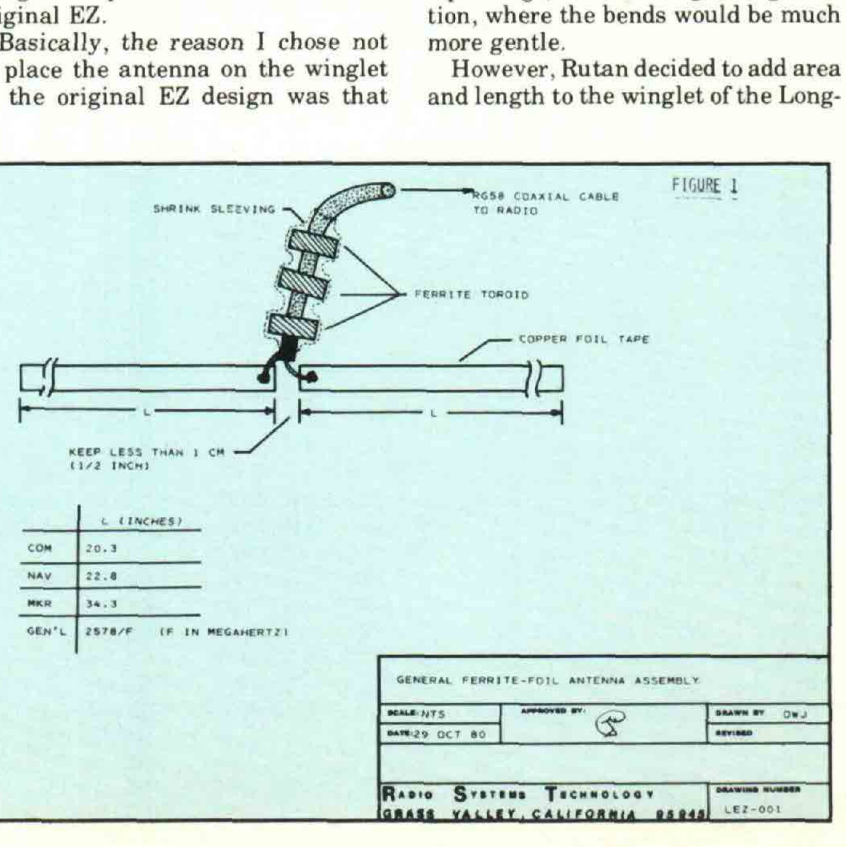
Since my original article on antennas for plastic airplanes came out,[1] there have been a number of new foam-and-glass designs introduced on the market. One of those new designs is a refinement of the ship I used as my example in the original article. Since this refinement, the Long-EZ, is intended for serious cross-country work . . . it is my intention to show how all the antennas described above may be fastened to the airframe of this latest of the Rutan creations. This is not to say that **all** these antennas **must** be mounted on **every** ship. No, each of the antennas are separate unto themselves, and some, all, one or more of them may be installed on your bird. I will, however, point out that it is much cheaper and a whole bunch easier to install a winglet antenna (antennalet) during winglet manufacture than after the aircraft has been flying for 6 months or so. I also hasten to point out that the concepts presented here are not unique to the EZ series of aircraft. Providing that you observe the ground rules about metal structures near the antennas, these antennas should work in any nonconductive ship.

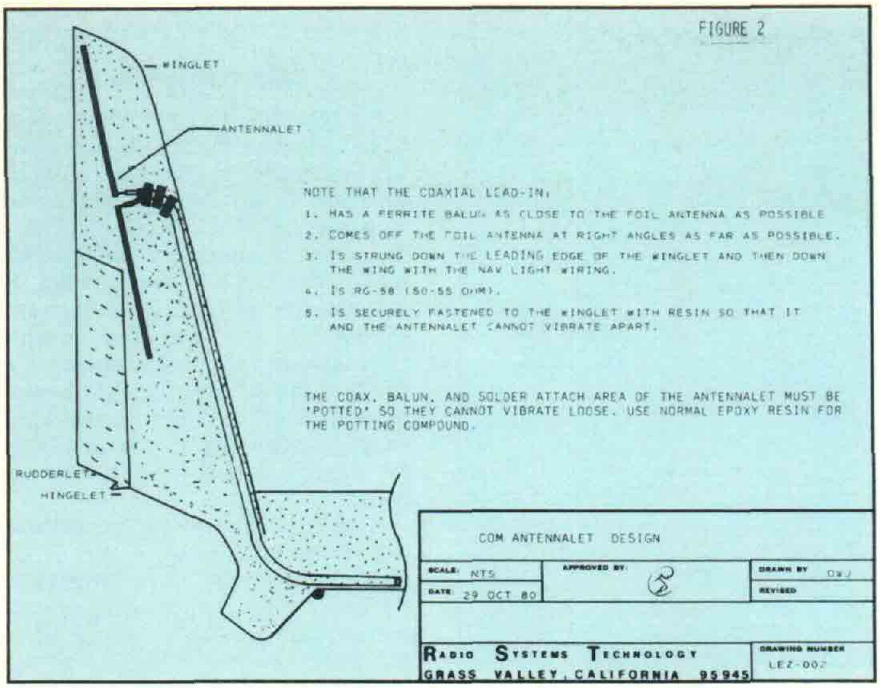
COM Antennas

The original COM antenna as a dipole structure with one dipole ear run down the gear leg and the other dipole ear strung inside the bottom of the fuselage. At the time, I considered this a best compromise between ease of installation and antenna pattern. Although most builders of the straight EZ found this an excellent antenna, the great spirit of antennas decreed that the prototype Long-EZ should have problems with this simple design. Several attempts to locate this elusive problem failed, so I decided that a new approach was in order. Not a totally new design, mind you, but an adaptation of the design that proved so efficient on the original EZ.

Basically, the reason I chose not to place the antenna on the winglet in the original EZ design was that the dipole arms were significantly longer than the winglet, which meant that there would be a sharp bend in the approximate middle of the bottom dipole leg as the foil bent to conform to the winglet-wing interface. Having had poor luck in the past with sharp bends in the middle of dipole legs, I chose the gear-leg location, where the bends would be much more gentle.

However, Rutan decided to add area and length to the winglet of the Long-





EZ, so that now a full-length vertical dipole could be placed on the winglet with only one minor bend. Placing the COM antennalet in the winglet offers several advantages, not the least of which is getting that critical dipole tip area a ways away from metal engines, control cables and salt water sacks (passengers). One further advantage of antennalets is that a dual-COM setup may be easily installed by putting one COM antennalet in each of the two winglets.

Construction techniques for the COM antennalet shown in Figure 2 are basically the same as for the old gear-leg antenna. Once again, the most important detail is to keep the antenna **tips** away from the big pieces of metal. Also, it makes the antennalet work a whole bunch better if you locate the foil dipoles on the trailing edge of the winglet and run the coax and balun at right angles to the dipole as far forward as possible before bending the coax down the leading edge of the winglet, into the wing, and thence into the cabin. The coax may be run down the same path as the NAV light wire. Also, it is permissible to bend the bottom dipole ear slightly in order to miss the rudderlet. Please note further that improved measurement facilities here at RST have shown that the dipole elements should be slightly shorter (see Figure 1) for the dipole arms than presented in my earlier referenced article.

NAV Antennas and Glideslope

The only change that I am going to make on the NAV antenna located in the canard (antennard? cantenna?) is to shorten both dipole arms slightly as listed in Figure 1. The reason for this foreshortening (and likewise for the COM length reduction) is that we have obtained a 12 foot measuring mast at RST which reduces "earth effect" to a negligible quantity. The original work was done using 6' masts, and we had some ground-bounce effects that we could not account for. At any rate, install the NAV antenna into the canard in accordance with the drawings in the original article, but of a length as listed in Figure 1 of this report.

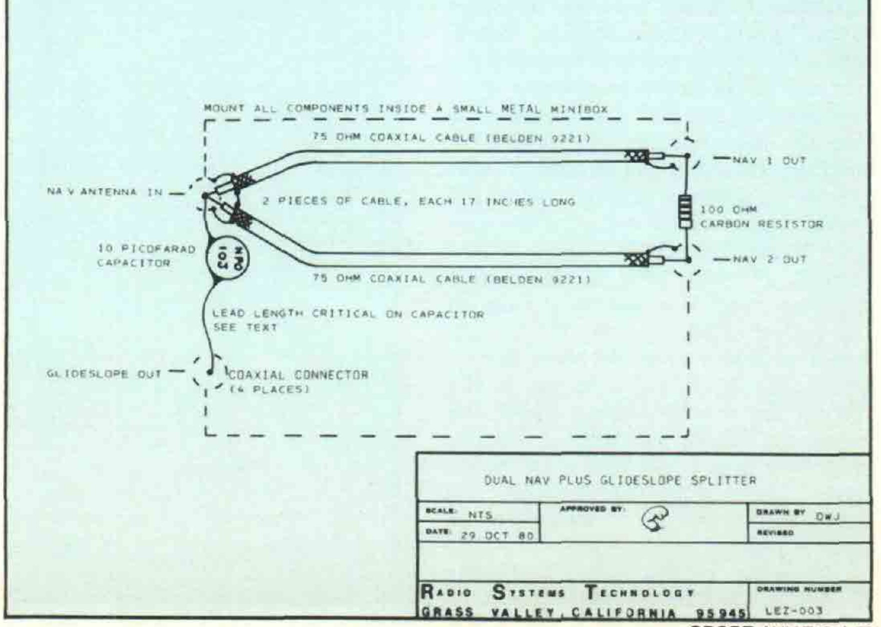
Getting a glideslope output, in addition to getting a second NAV antenna output, is done with what is called a hybrid splitter. The function of the splitter is to take the one signal from the canard NAV antenna, split it into two isolated NAV outputs, plus provide a glideslope output without interfering with the NAV outputs.

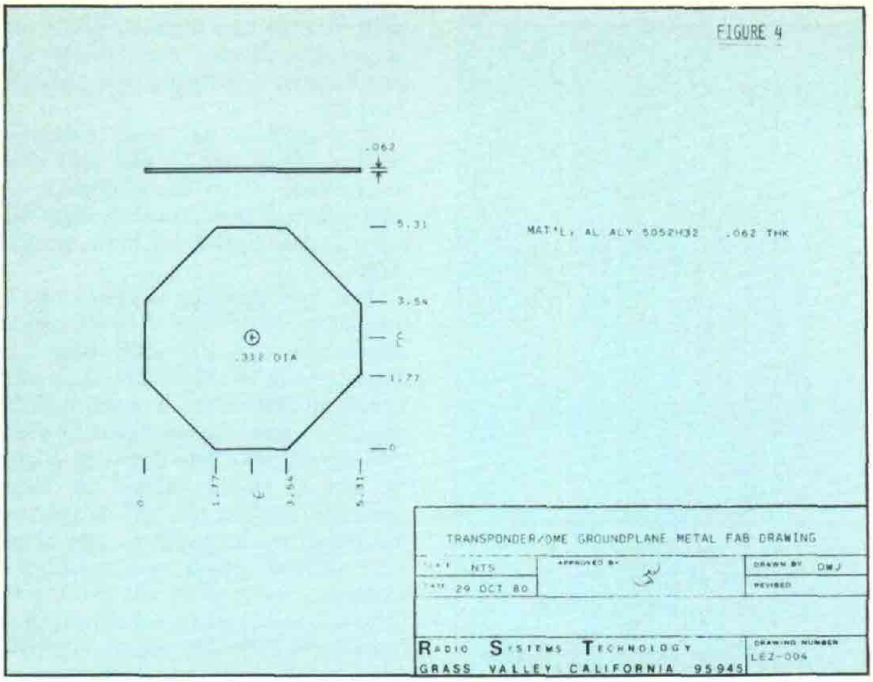
This splitter has been described several years ago in this and other magazines,[2] [3] but the glideslope circuit has not been covered, so I will give a description of both circuits here.

The new splitter consists of two measured lengths of 75 ohM coaxial cable, plus one 100 ohM **carbon** resistor. If the 75 ohM cable has a polyethelyne dielectric (as opposed to teflon), the coax lengths should be about 17" long (each). The drawing, Figure 3, shows these cables as being straight. In fact, the 17" cables may be coiled up as tight as you please and stuffed into a very small box. Also in the drawing you can see the glideslope-coupling capacitor, a 10 picofarad NPO (or mica) capacitor with a total of one inch lead length. In this particular unit, you will notice that one lead of the capacitor is three-quarters of an inch long and the other lead is one quarter of an inch. So long as the total lead length is one inch (±0.2 inch), the glideslope circuit should work just fine.

Marker Beacon

Since I'm just as sure as shootin' that somewhere, someday, someone will get his plastic homebuilt blessed for IFR, we might just as well do the marker beacon design now. In essence, the marker beacon antenna that is placed in one wing instead of the canard (wing of your choice). The nice thing about marker beacon antennas is that you are dealing with high signal strengths and relatively non-critical receiver sensitivities. The





net effect is to make the antenna relatively immune to minor design compromises. If you have to put one antenna tip near the NAV light wiring, it won't really affect the antenna performance that much. If you need to bend the antenna sharply around a curved surface, again, no great problem. Even the cardinal sin of putting one tip near, say, an aluminum fuel tank will not completely destroy the usefulness of this antenna. The only effect you may see by compromising the marker antenna may be a small amount of range reduction or an instrument approach that picks up the marker further out when left of course than when right of course. Big deal.

Auxiliary Antennas

Every now and again, someone comes up with a total off-the-wall requirement for an antenna for their own "special" radio system. Someone will want to put in a 6-meter ham rig, a VHF business band radio or an antenna for the FM music radio. Using the basic design for NAV/COM/marker antenna, you should be able to cut an antenna to be placed in the remaining wing by means of the simple formula L=2578/F, where L= length of each arm of the dipole (inches) and F= the frequency of operation in Magahertz. Where you need to cover a whole band of frequencies, the F value to use is the center for that frequency band. For example, if you wanted an FM antenna for the 88-108 MHz music band, band center would be 98 MHz, and each foil dipole arm would be 26 inches long.

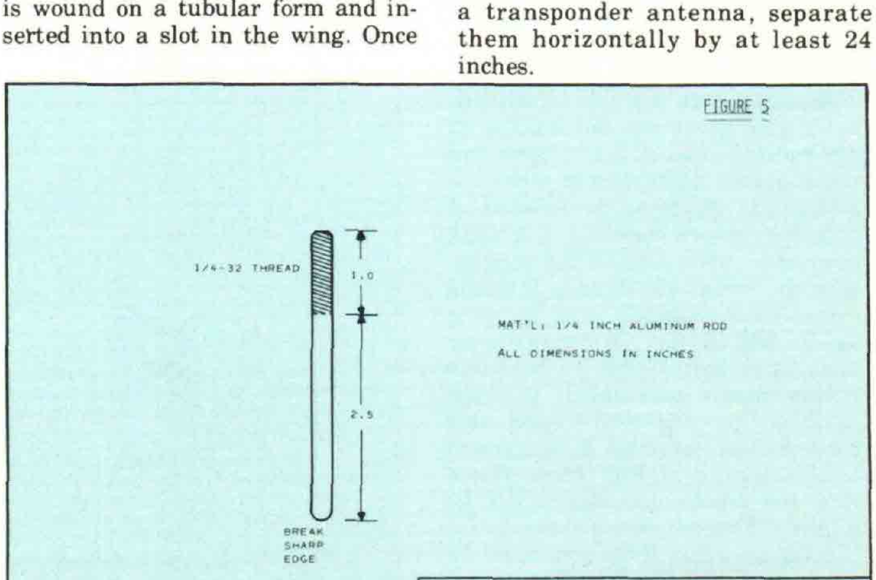
Antennas from an upper frequency of about 400 MHz down to about 45 MHz may be handled in this manner. If your intention is to make a CB antenna for the 27MHz Garbage Band, a simple calculation will show that the dipole will be much longer than a single wing can accommodate. The only out you **may** have, if **you** wish to try it is to calculate the dipole lengths and serpentine the copper foil across the wing. Just think of it as a dipole doing S-turns along your wing and you've got the picture. I freely admit that I haven't tried it, I don't know if it will work or not, so you are pretty much on your own. One ploy that may be worth trying is a "helical" antenna, where the tape (or, actually wire, if you wish) is wound on a tubular form and inserted into a slot in the wing. Once again, I emphasize, you are on your own for any antenna below 45 MHz.

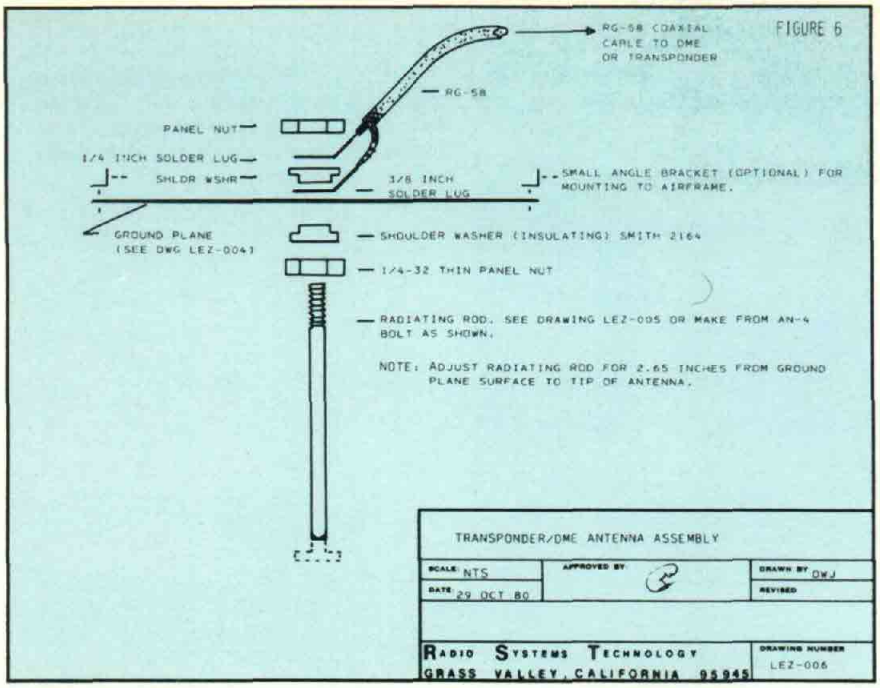
DME/Transponder

For those among us affluent enough to be able to afford pulse equipment (transponder and DME) we offer the ultimate in antenna sophistication and expense — one AN4 bolt and a flat sheet of aluminum for each antenna! The basis of the antenna design is one quarter-wave radiator (AN4 bolt) above a quarter-wave groundplane (aluminum sheet). The whole thing takes up about as much room as a softball and is very lightweight (especially if you substitute an aluminum bolt for the steel AN bolt).

Construction details of the antenna are shown in Figures 4 and 5. The ground plane may be rectangular or circular, your choice, although the rectangular version is preferred for the DME because of bandwidth considerations. Bending the corners of the rectangle up for either mounting or clearance are O.K., as are trimming the sharp corners of the rectangle.

The mounting locations for the antenna on the fuselage are many. Beneath the pilot or co-pilot's seat assembly are excellent choices, as is the cavity adjacent to the landing gear legs. Once again, the only caveat is to keep any and all metal away from the radiating rod tip. However, anything **behind** the ground plane will not affect the rod. Just be sure that you mount the antenna with the rod pointing down. And, for those of you with more money than good sense, if you install both a DME **and** a transponder antenna, separate them horizontally by at least 24 inches.





Sources

Always the question comes up — where can I buy all the bits and pieces to make these fine antennas? The AN bolts and aluminum sheet you shouldn't have much trouble with, as they are standard aircraft hardware. And, although you can certainly purchase copper foil tape at almost any well-stocked office supply house or stained glass window shop, the foil tape, ferrite beads, cable connector, insulating washer and coax cable are all available from Radio Systems Technology, 10985 Grass Valley Ave., Grass Valley, CA 95945. Phone 916/272-2203. A complete NAV or COM foil antenna "kit" consisting of copper foil and ferrites is still only $5, with quick disconnects and longer foil pieces available at additional charge. Write or call RST and ask for a "Plastic-Plane Antenna Price List".

I would like to thank my research assistant Brian Flath (KA6CWO) for his invaluable aid in making the VSWR measurement and the Rutan clan for both installing and testing the prototype antennalets.

References

1) The Plastic Plane $5 Antenna System, *SPORT AVIATION*, Jim Weir, May 1979, PP 45-48.

2) Economy Antennas, *SPORT AVIATION*, Jim Weir, October 1976, PP 71-78.

3) An N-Way Hybrid Power Divider, IRE Trans MTT, Ernest Wilkinson, January 1960, PP 116-118.