

TENNA TIP # 1

COM ANTENNAS FOR COMPOSITE AIRCRAFT

by Bob Archer of Sportcraft Antennas

The art of installing antennas internally into composite aircraft has left many people confused and perplexed so I have decided to try to give some tips and information on the subject. Some people have tried to install monopole antennas internally with a ground plane installed for the antenna to work against and this is just totally bad. There is even a Major manufacturer that installs monopole antennas that should have a ground plane without one. To work properly a ground plane should be at least a half wavelength in diameter and at VHF frequencies this is about four feet. Needless to say there is no place this large to put a ground plane on a small composite aircraft.

First of all I believe that only dipole type antennas should be used in composite (non-conductive) aircraft and that the best location for COM antennas is in the vertical stabilizer while the second best is in the fuselage tailcone. The reason being that COM antennas are vertically polarized and therefore require a vertical space of about 46" for a half wave dipole. The larger aircraft have enough height for an aperture of a full half wavelength but the smaller types need an antenna that is shortened a bit. Think of aperture as the capture area of an antenna. Mounted high in the vertical tail the antenna is high enough to see all the way around while the fuselage mounted antenna may suffer some signal loss due to blockage from engine, passengers, and miscellaneous "stuff". The SA-006 COMM antenna was designed to replace some very bad antennas that were sold in the early days to two place composite builders. It is constructed of .016 inch 2024 Alclad aluminum so that it can conform to the inside curvature of the fuselage and is 26 inches high by 12 inches fore and aft. After the tail is sealed up of course it is very difficult to replace the tail antenna so this antenna was made as a replacement. This antenna was test flown mounted in the fuselage of the LANCAIR 320 prototype aircraft and a transmission was received from an aircraft at a distance of about 170 miles.

The SA-008 COMM antenna is designed for installation in aircraft with larger vertical tails such as the Lancair IV, Glasair, Express and the many versions of Ex's. This dipole antenna is a full half wavelength which provides the maximum aperture at this frequency. This antenna is shipped with the elements folded up so the elements must be unfolded and adjusted in sweep to fit into the available space in the Vert. stab., riveted in this configuration and then bonded in. Remember that graphite composite material is conductive so it must be treated as if it were metal. This means that on the Lancair IV, the only place to install internal antennas is inside the fiber glass wingtips, the dorsal / vertical stabilizer and perhaps the Plexiglas windows.

Graphite structures do complicate matters for antenna installations. If spar caps are constructed of graphite materials horizontally polarized antennas should not be mounted nearby because practically no signal will be able to get past the long conductors that will act as reflectors. The same goes for any long conductors in the same alignment as the antenna such as horizontal and vertical tail spars, control cables, push rods, wires etc. Each aircraft needs to be analyzed individually for the best antenna locations.

I do not recommend any antenna on the market that has a little black box in the center of the antenna. This device is a ferrite transformer which provides a very good VSWR and a very good bandwidth but at the cost of being a very lossy (absorbs energy)device. The very best specification that I have seen on ferrite transformers is a loss of 2.5 dB and the worst goes up to 12 dB. As a reference, a 3-dB loss gives an output of

50% and 10 dB gives just 10% out. So if you have a 5 watt transmitter into an antenna like this, you get just .5 watt out, and it works the same on receiving. Not a bargain. An antenna you can easily make yourself would be to just solder quarter wave elements to the inner and outer conductors of the coaxial cable and go with it. Also if you were planning to go with Jim Weir of RST's designs don't bother with the ferrite beads. At these frequencies the beads don't do anything that I could detect in the RF lab. A good balun would work better as a dipole feed because it balances the currents on the elements and matches the impedance at the same time and it doesn't absorb RF energy. My antenna designs do not need a balun because I use a modified version of a feed called a Gamma match that feeds the antenna at the fifty-ohm point and automatically balances the currents on the elements.

When installing any antenna remember that antennas do interfere with each other when installed too close together and that close metallic (or conductive : remember graphite) objects that are as long or longer in the same polarization/plane will reflect RF energy away from them. Close meaning one wavelength or closer and closer being worse. One wavelength is about eight feet at VHF frequencies. Less than a quarter wavelength is really bad from both a VSWR and the radiation pattern standpoint. The formula for wavelength is: 11803/ FREQ. in Mhz. = wavelength in inches.

So there being only one good location for an internal COMM antenna (unless you have twin verticals) and antennas don't work well close together, it follows that for aircraft with dual transceivers and no good location for a second antenna there is a need for a two set switching device of some type. I recommend a RF switch, single pole double throw type. A switch like this will allow you to receive and transmit on a single frequency and when switching from one set to the other, the switch will connect the proper set to the antenna. This type of switch is available from ham radio outlets. Another type of switch that allows receiving on two sets at the same time while transmitting straight to the antenna is now available due to popular demand from Sportcraft Antennas.

After you airplane is flying it would be a good idea to check the radiation pattern for holes or nulls. A good way of doing this would be to climb to about 5000 feet at fifty miles or so from an airport with an ATIS and fly flat circles while listening to the signal strength. After a few turns you should be aware of the directions of the weak or non existent signal reception. This works better than field strength meter on the ground.

These suggestions and recommendations come from 35 years of spacecraft and aircraft antenna experience and are meant to help in obtaining optimum antenna performance and do not mean that anything else will not "work". I have seen a lot of really bad antenna installations whose owners are perfectly happy with their antenna performance.

I will address some other antenna installation problem areas in the future.

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Below are frequently used antenna terms and with short definitions .

- **Active Elements?** The part of the antenna that actually does the radiating or the receiving of the RF energy.
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- **Aperture?** The capture area of the antenna. On a dipole or monopole it is the overall dimension of the active elements, on dish antennas it is the diameter of the dish.
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- **Feed point?** Generally the point at which the coaxial cable attaches to the antenna but could be where the feed device attaches to the active elements
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- **VSWR? Voltage Standing Wave Ratio.** The measurement of the ratio of incident to reflected RF energy. An indication of the quality of energy transference. The lower the number the better. 1:1 is perfect. 2:1 is good ,3:1 is OK, 4:1 and up is poor to terrible.
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- **Radiation Pattern?** A pattern showing the relative signal level around an antenna. Signal strength can be severely reduced in particular directions by other antennas, vertical stabilizers**,** landing gears etc.
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- **Balun?** A device that converts a balanced transmission line (such as TV twin lead) to a coaxial line which is an unbalanced line. Provides balanced currents on dipole antennas while matching the
  impedance of the cable to the antenna.
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- **Smith Chart?** A funny looking circular chart made up of only one straight line plus a whole lot of circles and circular arcs that is used for tuning antennas among many other things.