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TENNA TIP #4

Transponder Antennas for Composite Aircraft

Transponder systems are a direct descendant of the IFF (Identification Friend or Foe) systems that were developed during WWII to identify the friendlies. In operation the radar site transmits a pulse string in the same direction as the radar pulse, the transponder receiver in the airplane receives the pulse string, decodes it, encodes it with the airplanes code and retransmits the encoded pulse string back to the radar site. The receiver at the radar site decodes the pulse string and sends the signals off to the computer (in olden times straight to the scope) for enhancement etc. and thence on to the radar operator's scope. DME does pretty much the same thing in reverse with the aircraft's DME transmitter triggering the transponder at the radar site. Transponders operate at a frequency of 1030 and 1090 Mhz. and therefore a wave- length is about 11.5 inches. DME uses a bit more bandwidth and goes from 960 to 1215 Mhz. though the design center frequency is about the same and the same antenna can be used for both devices interchangeably. Most people these days would opt for GPS instead of DME because it does so much more so much better.

A composite builder has the option, unless it is graphite, of either installing a 1/4- wave monopole antenna, either internal or external or a 1/2- wave internal dipole antenna. If the option is for the external monopole a ground plane would be required and I would recommend about a 12 inch Al. sheet attached to the outside bottom skin of the fuselage with the antenna mounted in the center. I would not recommend putting the ground plane on the inside with the antenna element extending through the skin of the aircraft. There can be strange effects with the signal going half through and half not through the thickness of the skin. In my experience installing any kind of mesh and trying to get and keep a positive RF ground connection between the cable shield and the mesh and can be a very iffy proposition. I have seen quite a few really BAD installations of this type. If the option is for an internally mounted 1/4- wave monopole the situation is even worse. I have seen drawings showing both seat bottom and wing- tip installations and neither is anything that I could recommend. The wing tip is bad because the polarization is supposed to be vertical and the wing tip is not thick enough so the monopole must be tipped about 45 degrees which causes a half power polarization loss and the ground plane installation cannot be horizontal or large enough so there is more loss. Also if you bank your airplane in the proper direction (or improper depending on your view) you could get a perfect cross polarization effect that would transfer no energy between antennas. The under the seat

location is bad because there is so much "stuff" surrounding it and the large metal lump called the engine, not to mention the firewall, causing signal blockage from the front. I have heard numerous horror stories on the results of really bad installations. Conductive aircraft of course must have their antennas installed externally using the airframe as the ground plane.

My recommendation would be to install a Dipole antenna which does not require a ground plane though it would be about 6 inches in the vertical plane. The preferred locations would be out in the wing towards the tip if the wing is deep enough or as far back in the bottom of the tail cone as you could get it or in a ventral fin if you have one.

These equipments operate at a frequency approaching 10 times the frequency of aircraft VOR and COM systems with an accompanying increase in cable losses. This being the case a better cable than RG 58 is recommended for cables over about six to ten feet in length though a better antenna does help with less antenna loss. RG55/CU is the same as RG58 except it is double shielded and therefor has a bit less loss. RG142 is a very good double shielded Teflon cable with about 10% less loss than RG58 though it does cost quite a bit more. In general larger diameter cable such as RG 213 and RG 214 has less loss but is heavier and connectors are more expensive. Also RG 400 is double shielded.

The Sportcraft Antennas model SA-005 Transponder antenna is made from copper clad epoxy printed circuit board that has the antenna etched out of the copper to form a dipole antenna and an included etched in copper tapered balun. This antenna is 6" by 7" by .060" thick and the VSWR performance is so good as to be almost unbelievable. I have had numerous reports from customers describing the superior performance that these antennas have provided. One customer claimed a two radar sector increase in range.

Fig.1 shows the VSWR on a rectangular VSWR vs FREQ. chart and a Smith chart impedance plot.

#11 Prod.

Printed Circuit
Transponder Dipole

S22 SWR
REF 1.0
Δ 500.0 m /
2 1.0299

S22 Z
REF 1.0 Units
2 200.0 mUnits/
▽ 51.557 Ω -0.4609 Ω

hp

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SA-005 Transponder

A MARKER 2
1.09 GHz