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RTCA Special Committee 186, Working Group 5

ADS-B UAT MOPS

Meeting #11

Draft 1 of the Proposed Appendix E: Aircraft Antenna Characteristics

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SUMMARY
This is the first Draft of the proposed Appendix E: Aircraft Antenna Characteristics.

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Appendix E
Aircraft Antenna Characteristics

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E.1 Antenna Characteristics

E.1.1 Frequency Requirements

The antenna shall be designed to receive and transmit vertically polarized signals at 978 MHz. A Transponder / DME antenna that is capable of operation from 978 MHz to 1090 MHz is an acceptable candidate.

E.1.2 Impedance and VSWR

The VSWR produced by the antenna into a 50 ohm load shall not exceed 1.5:1 at 978 MHz +/- 1 MHz.

E.1.3 Polarization

The antenna shall be vertically polarized.

E.1.4 Radiation Pattern

Radiation pattern measurements shall be made when the antenna is installed at the center of a flat circular ground plane having a minimum diameter of 1.2 m (4 ft). The antenna gain shall not be less than the gain of a quarter-wave stub minus 3 dB over 90 percent of a coverage volume from 0 to 360 degrees in azimuth and from 5 to 30 degrees in elevation. As the ground plane is shortened and / or objects (such as other antennas) are placed nearby, the radiation pattern starts to distort. The following figures illustrate the difference between ideal and non-ideal patterns. Figure E-1 shows the ideal radiation pattern of a ¼ wave stub.

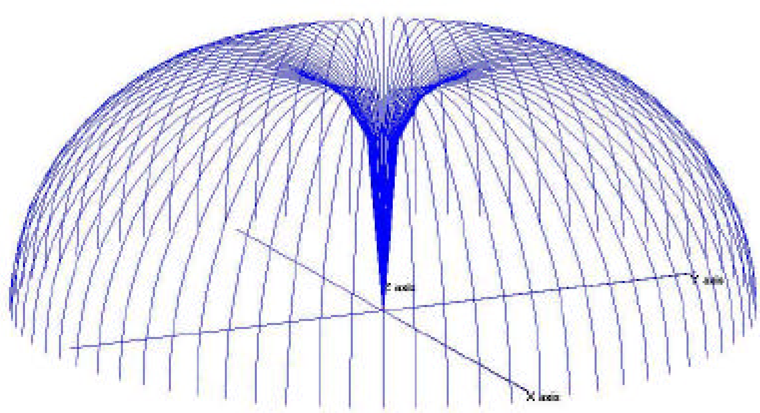
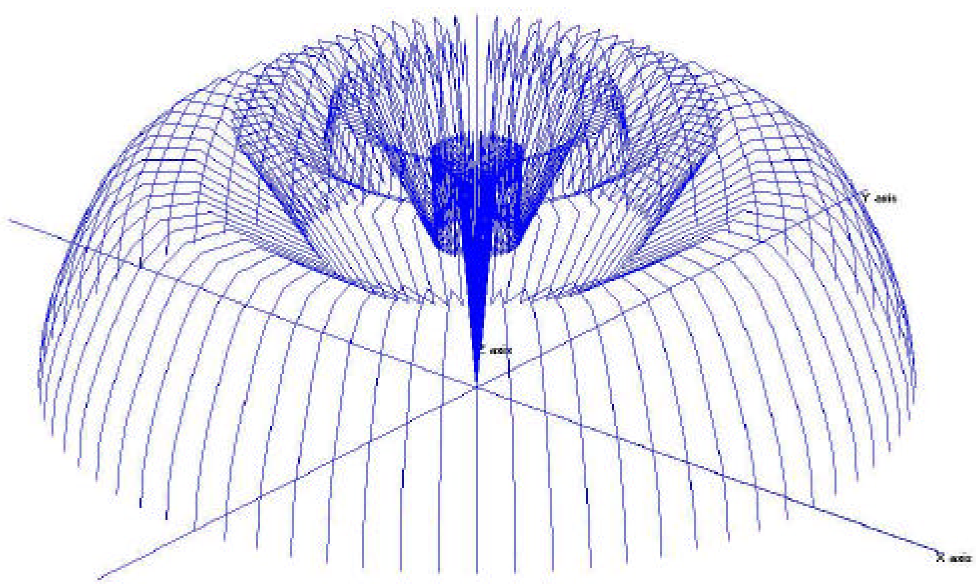


Figure E-1: Ideal Radiation Pattern of a ¼ Wave Stub

Figure E-2 shows a radiation pattern of a ¼ wave stub over a 4 foot diameter conductive plane that is elevated 6 feet above the earth. In general, as the ground plane increases, the radiation pattern approaches the ideal pattern shown in figure E-1. Objects close to the radiator (such as other antennas) will also distort the radiation pattern. The farther away the object, the less it distorts the pattern.



<u>Figure E-2:</u> Radiation Pattern of a ¼ Wave Stub over a 4 ft plane

E.2 Typical VSWR Measurements of Existing Transponder / DME Antennas

E.2.1 Sensor Systems L Band Blade Antenna P/N S65-5366-7L

Table E-1: Typical VSWR Measurements of Existing Transponder/DME Antennas

Freq (MHz).	S.W.R.	Feed Point Impedance	+/- J value
970	1.02	50.6	-2.17
975	1.03	48.7	-1.38
980	1.04	47.6	-0.68
985	1.04	47.8	0.15
990	1.03	48.6	0.6
995	1.01	48.9	0.2
1000	1.04	47.5	-1.19
1005	1.06	47.3	-1.5
1010	1.08	46.2	-1.9
1015	1.1	45.1	-0.6
1020	1.12	45	-0.39
1025	1.13	45	-0.15
1030	1.13	44.9	0.16
1035	1.13	44.2	0.7
1040	1.12	44.4	0.36
1045	1.13	43.9	0
1050	1.15	43.2	1.08
1055	1.15	43.2	1.71
1060	1.14	43.6	0.96
1065	1.14	43.8	1.03
1070	1.15	43.5	1.37
1075	1.16	43.1	1.27
1080	1.17	42.7	0.44
1085	1.17	42.4	0.47
1090	1.2	41.5	1.21
1095	1.23	40.7	1.9
1100	1.22	41	2.46

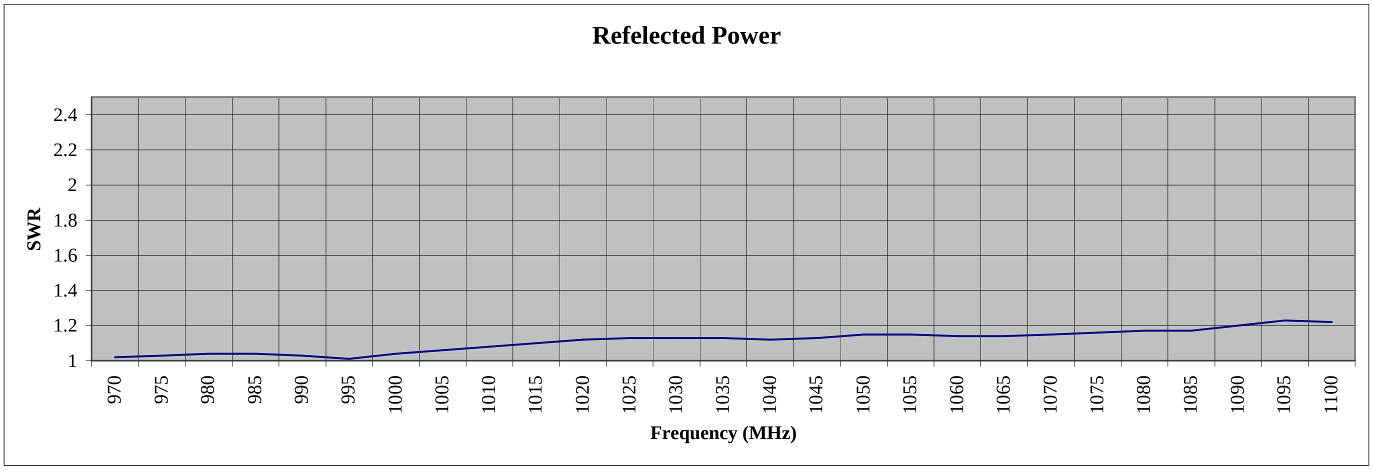


Figure E-2: Reflected Power

E.2.2 Aero Antenna P/N AT-130-1 (designed for 966 MHz UAT)

Table E-2: Aero-Antenna P/N AT-130-1

Freq. (MHz).	S.W.R.	Feed Point Impedance	+/- J value
970	1.16	58	6.69
975	1.16	59.4	4.49
980	1.17	60.3	2.7
985	1.18	61	0.21
990	1.21	61.8	-2.7
995	1.22	61.7	-7.4
1000	1.26	60.9	-11.1
1005	1.32	58.4	-15
1010	1.34	55.4	-16.2
1015	1.34	52.7	-17.9
1020	1.43	49.4	-18.5
1025	1.48	47	-18.7
1030	1.56	44.4	-19.2
1035	1.58	42.7	-18.7
1040	1.62	41.2	-18.5
1045	1.66	39.2	-17.6
1050	1.7	37.5	-17.3
1055	1.77	35.4	-16.7
1060	1.82	33.6	-15.9
1065	1.88	32.3	-15.7
1070	1.92	31.3	-15.5
1075	1.96	29.9	-15.2
1080	2.01	28.7	-14.6
1085	2.05	27.2	-14.1
1090	2.11	25.5	-13.4
1095	2.2	23.9	-12.7
1100	2.33	22.2	-11.7

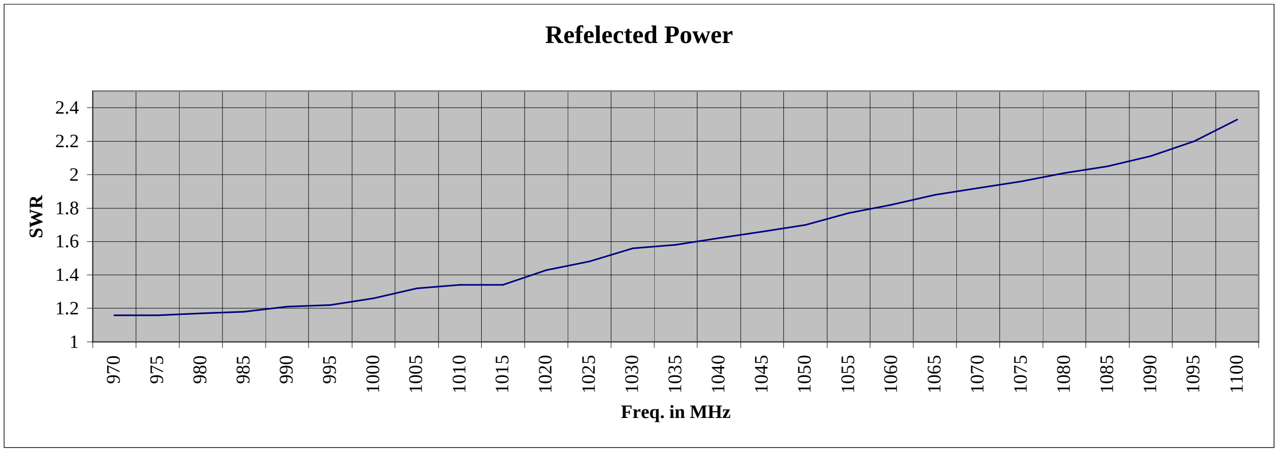


Figure E-3: Reflected Power

E.2.3 ¼ Wave Whip Antenna

Table E-3: ¼ Wave Whip Antenna

Freq. (MHz).	S.W.R.	Feed Point Impedance	+/- J value
970	1.26	41.5	6.3
975	1.31	40.4	8.1
980	1.38	40.6	11
985	1.4	41.5	12.8
990	1.41	42.5	14
995	1.43	43.4	15.4
1000	1.42	45	15.8
1005	1.39	46.5	15.5
1010	1.39	46.7	15.4
1015	1.4	47.3	16.2
1020	1.4	48.8	16.8
1025	1.4	49.9	17
1030	1.42	50.7	17.9
1035	1.45	51.9	18.9
1040	1.46	52.9	19.3
1045	1.47	54.9	19.6
1050	1.5	54	20.8
1055	1.52	55.7	21.6
1060	1.53	57.7	21.4
1065	1.52	59.2	20.8
1070	1.5	60.3	19.8
1075	1.52	60.8	20.5
1080	1.54	63.7	20.5
1085	1.53	64.4	19.4
1090	1.56	66.6	19.8
1095	1.58	68.4	19.4
1100	1.59	69.9	19

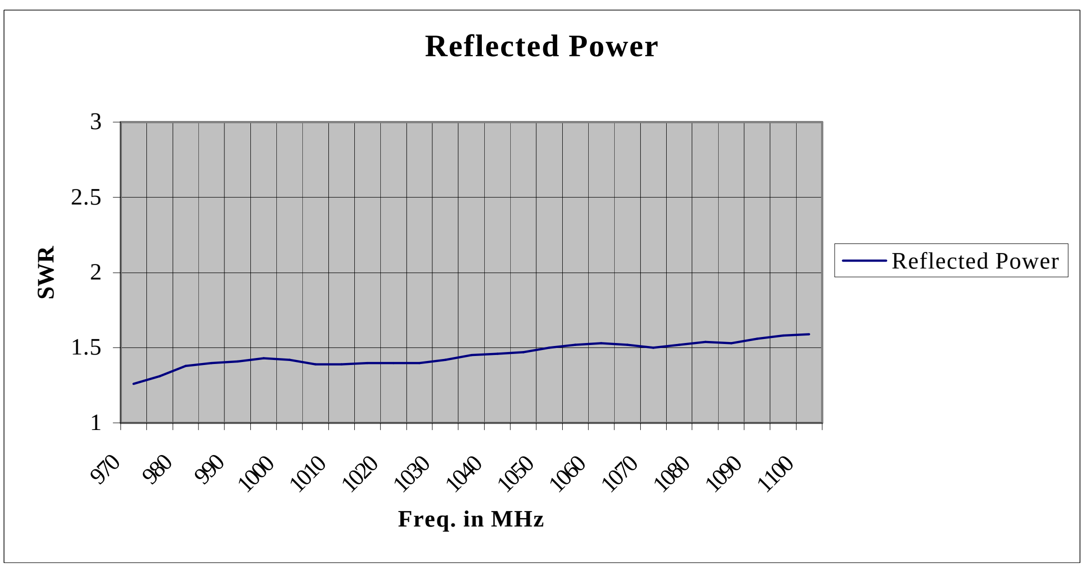


Figure E-4: Reflected Power

E.3 A Method of Sharing Antennas with Existing Transponder Installations

An alternative method of providing an antenna for the UAT is to use a frequency diplexer that is installed between an existing transponder and it's antenna.

To minimize impact on the transponder installation, the insertion loss in the 1090 / 1030 MHz band is minimized. A DC path in the transponder's diplexer channel will insure that the antenna BITE program, which can sense the presence of an antenna and confirm cable continuity by sensing a DC path to ground, will not be adversely affected. The transponder's diplexer channel will attenuate signals at 978 MHz, providing isolation from the UAT. In some cases, diplexer isolation actually exceeds isolation from using separate antennas transponder and UAT antennas. The latter is a function of distance between antennas.

The UAT's diplexer port can provide minimal insertion loss to the antenna at 978 MHz while manifesting a high impedance at the 1030 / 1090 MHz band.

E.3.1 Diplexer Characteristics

E.3.1.1 Specifications

E.3.1.2

UAT Channel:	Passband	977 to 979 MHz Min.
	Passband Insertion Loss	0.5 dB Max.
	DC coupling	None
Transponder Channel:	Passband	1015 MHz to 1105 MHz Min.
	Passband insertion Loss	0.4 dB Max.
	DC Coupled to antenna port	28 VDC @ 500 mA Max.
Both Channels	Channel-to-Channel isolation: 978-to-1090 MHz	**TBD** (50 dB min.)
	Channel-to-Channel isolation: 978-to-1030 MHz	**TBD** (30 dB min)
	Passband return loss	17 dB (all ports)
	Impedance	50 ohms (all ports)
	Power rating (Max.)	5 watts CW, 1000 watts peak
	Temperature range	-30 deg to +70 deg C
	Connectors	TNC female (all ports)

E.3.1.3 Typical Installation Diagram

The diagram below illustrates how a UAT can be can be added to a typical existing transponder installation by using frequency diplexers. Shaded boxes indicate the new components added to the existing installation. The diplexer can be added anywhere in the antenna's feedline. The most logical place for this addition would be in the aircraft's equipment bay in close proximity to both the UAT and transponder units. This way, existing feedlines would not have to be re-routed or altered.

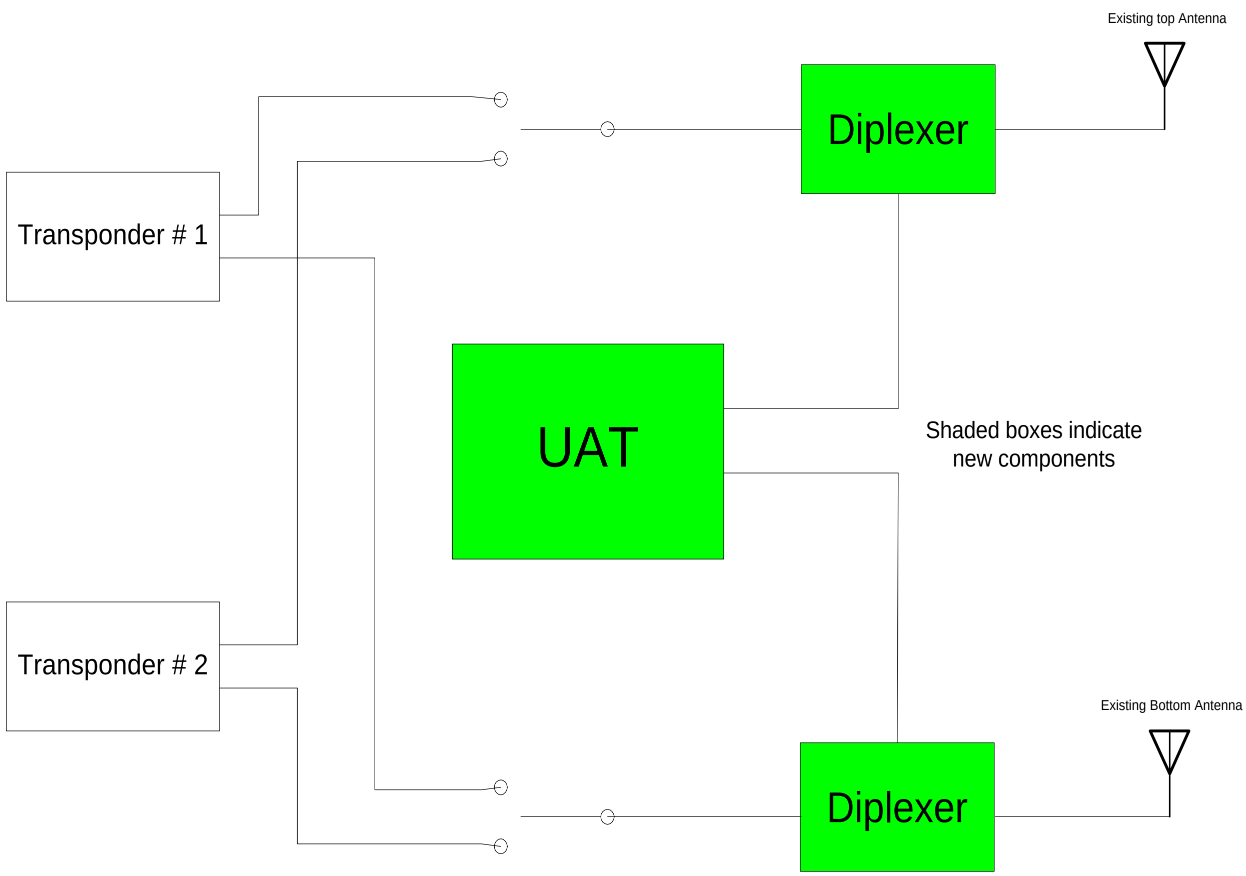


Figure E-5: Typical Installation