Compliance Testing, LLC
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Test Report

Prepared for: Aviation Communication and Surveillance Systems

Model: NGT-9000D+ and NGT-9000RD+

Description: Mode-S transponder

Serial Number: LXE13068, LXE13369

FCC ID: 2ACTZMSS9019

To

FCC Part 87

Date of Issue: August 23, 2019

On the behalf of the applicant:	**Aviation Communication and Surveillance Systems** **19810 N. 7th Ave.** **Phoenix, AZ 85027**
Attention of:	**Mark D. Smith** **623-445-6643** **Mark.D.Smith@L3Harris.com**

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Poona Saber
Project Test Engineer

Test Report Revision History

Revision	Date	Revised By	Reason for Revision
1.0	August 23,2019	Poona Saber	Original Document
2.0	August 29,2019	Poona Saber	Revised material after Mark Smith's review
3.0	August 30,2019	Poona Saber	More revised text
4.0	November 2, 2019	Poona Saber	Revised test table summary rule section reference Added radiated spurious emission table on page 11
5.0	November 7, 2019	Poona Saber	Revised table on page 10 and Annex B Added duty cycle calculations on page 16

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ILAC / A2LA

Compliance Testing, LLC, has been accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer joint ISO-ILAC-IAF Communiqué dated January 2009).

The tests results contained within this test report all fall within our scope of accreditation, unless noted in the table below

Please refer to http://www.compliancetesting.com/labscope.html for current scope of accreditation.

Testing Certificate Number: **2152.01**

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#2152.01

FCC Site Reg. #349717

IC Site Reg. #2044A-2

Non-accredited tests contained in this report:

N/A

Standard Test Conditions Engineering Practices

Except as noted herein, the following conditions and procedures were observed during the testing:

All tests and measurement data shown were performed in accordance with FCC Rules and Regulations, Volume II; Part 2, Sub-part J, Sections 2.947, 2.1033(c), 2.1041, 2.1046, 2.1047, 2.1051, 2.1053, 2.1055, 2.1057 and the following individual Parts: FCC Part 87.

Measurement results, unless otherwise noted, are worst-case measurements.

Environmental Conditions		
Temperature (ºC)	**Humidity (%)**	**Pressure (mbar)**
24-25.3	24.1-32.2	956-962

Model: NGT-9000D+ and NGT-9000RD+
Description: Mode-S transponder

Additional Information:
NGT-9000D+ is the panel mount unit with S/N LXE13068 and NGT-9000RD+ is the remote unit with S/N LXE13369. The panel mount and remote mount units use identical internal circuit cards with the exception of the touch screen display. Both Conducted and radiated testing is done on panel mount unit and only radiated testing is repeated on remote mount unit.

NGT-9000 is a mode S transponder that provides 1090 MHz automatic dependent surveillance-broadcast information and also supports an optional active traffic (TAS/TCAS1) 1030 MHz function.

Following is declared as type of emission for NGT-9000D system:

- Transponder (Compliant with FAA TSO C112d with deviations): 14M0M1D
- TCAS/TAS (Compliant with FAA TSO C118a & TSO C147 with deviations): 18M0V1D
- Frequency range: 1030 ± 0.01 MHz and 1090 ± 1 MHz
- There are two sub-modes operation for 1090 MHz called: ATCRBS reply and Mode S and can be transmitted from both top and bottom antennas. ATCRBS interrogation mode is available at 1030 MHz from only top antenna.
- Transponder system (1090 MHz) uses pulse position modulation combined with pulse width modulation (M1D) while TCAS uses pulse position and amplitude modulation (V1D)
- In TCAS mode the transmitter always transmits to only one antenna port at a time and the maximum duty cycle is 0.012%
- In transponder mode the transmitter transmits to two antenna ports, top and bottom. The top and bottom antennas do not transmit simultaneously.
- The maximum duty cycle for transponder ATCRBS transmission is 0.338% and mode S transmission is 0.239%
- Unit is powered by 14 Vdc and 28 Vdc

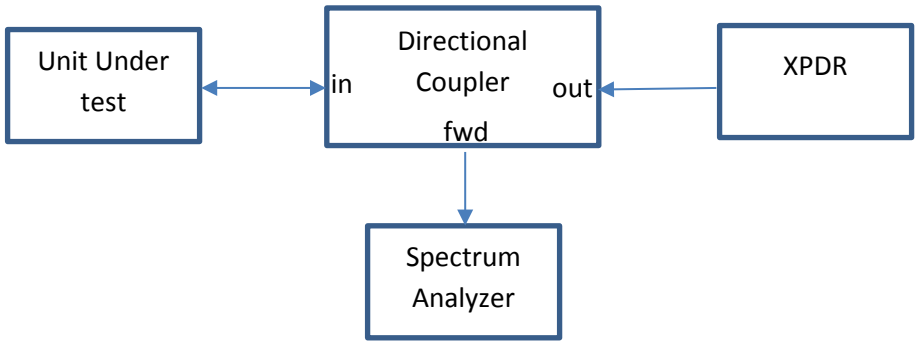
EUT Support Equipment

Qty	Description	Manufacturer	Model No.	Part No.
1	XPDR RF Simulation Module	ACSS	-	ACSS-001985
1	Mode S generic test Fixture	ACSS	-	ACSS-001969
1	ATC Test Set	IFR	ATC 1400A	
1	Transponder test set	IFR	SI-1404	
1	DC Power Supply	Agilent	N5746A	
1	AC Power Supply	Elgar	CW1251	
1	Oscilloscope	Tektronix	TDS 3054B	0175
1	Directional Coupler	Narda	3003-20	11210
1	Directional coupler	Narda	27002SC-40	
1	Directional Coupler	Werlatone	C3910-10	
1	10 dB 50 Watts attenuator	Pasternack	NA	PE7392-10
2	Dell Computers	Dell	NA	

.XPDR RF Simulation Module is comprised of RF generators and attenuators that are controlled by an FPGA card in the test computer. We use this to send interrogations and receive replies from the UUT.

.Mode-S Generic Test Fixture is used to control the power applied to the UUT (via DC power supply) as well as providing the UUT with the necessary discrete inputs to facilitate normal operation and test operations.

Test Setup with Directional coupler and Support Equipment



Test Results Summary

Specification	Test Name	Pass, Fail, N/A	Comments
2.1046, 87.131	Carrier Output Power (Conducted)	Pass	
2.1051, 87.139(a)(1)	Unwanted Emissions (Transmitter Conducted)	Pass	
2.1053 87.139 (a)(1)	Field Strength of Spurious Radiation	Pass	
2.1049, 87.139 (a)(1) 87.135	Emission Masks and Occupied Bandwidth	Pass	
2.1047	Audio Low Pass Filter (Voice Input)	N/A	The EUT does not contain an audio input
2.1047	Audio Frequency Response	N/A	The EUT does not contain an audio input
2.1047	Modulation Limiting	N/A	
2.1047	Modulation Characteristic	Pass	
2.1055, 87.133(a)	Frequency Stability (Temperature Variation)	Pass	
2.1055, 87.133(a)	Frequency Stability (Voltage Variation)	Pass	

Carrier Output Power (Conducted)

Engineer: Poona Saber

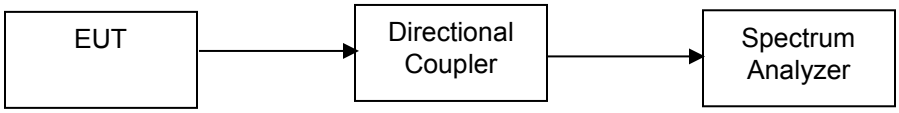
Test Date: 7/9/2019

Test Procedure

The Equipment Under Test (EUT) was connected through a directional coupler directly to a spectrum analyzer with the RBW > OBW and the VBW set to 3 X RBW which set the RBW greater than the transmit signal ensuring there was no signal suppression while measuring a modulated signal. The peak readings were taken for TCAS and Transponder systems for both ATCRBS(C) and S modes and the result was then compared to the limit.
The Average RMS power is the peak power multiplied by duty cycle of the Transponder and TCAS system.

Section 87.131, for Radio navigation equipment Note 7 specifies “Frequency, emission and maximum power will be determined by appropriate standards during the certification process.
TCAS output power is controlled by the requirements of FAA TSO-C118a AND TSO-C147 similarly to the output spectrum. In addition the Transponder output power is controlled by the requirements of FAA TSO C112d.

Test Setup



Output Power for TCAS System

Frequency	Antenna	Mode	Measured Power Peak (dBm)	Measured Power Peak (W)	Duty Cycle	Average power (W)	Average power (dBm)
1030 MHz	TOP	C	53.32	214.78	0.012 %	0.0258	14.1

Output Power for Transponder System

Frequency	Antenna	Mode	Measured Power Peak (dBm)	Measured Power Peak (W)	Duty Cycle	Average power (W)	Average power (dBm)
1090 MHz	TOP	ATCRBS	53.78	238.78	0.33%	0.7879	28.96
1090 MHz	Bottom	ATCRBS	53.98	250.03	0.33%	0.825	29.16
1090 MHz	TOP	S	53.82	240.99	0.239%	0.7952	29
1090 MHz	Bottom	S	53.92	246.60	0.239%	0.8137	29.1

See Appendix A-1 for duty cycle measurement plots

Conducted Spurious Emissions

Engineer: Poona Saber

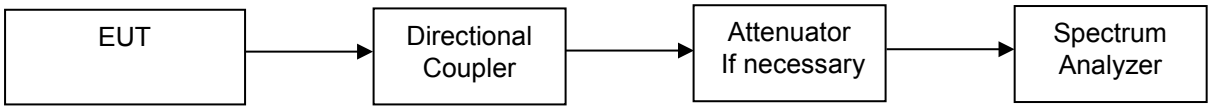
Test Date: 7/10/19

Test Procedure

The EUT was connected through 3 different directional couplers covering the range from 30MHz- 10GHz with attenuators in line if necessary, to spectrum analyzer to verify that the EUT met the requirements for spurious emissions based on the requirement of FCC part 87.139 (a)(3):

When the frequency is removed from the assigned frequency by more than 250 percent of the authorized bandwidth the attenuation for aircraft station transmitters must be at least 40 dB.

Test Setup



Mode	Antenna	Frequency (MHz)	Average Spurious Power (dBm)	Average Fundamental Power (dBm)	dBc	Limit (dBc)	Result
1030 MHz	Top	2058	-42.15	14.1	56.25	≥40	PASS
1090 MHz ATCRBS	Top	2180.04	-12.06	28.96	41.02	≥40	PASS
1090 MHz ATCRBS	Bottom	2180.06	-18.15	29.16	47.31	≥40	PASS
1090 MHz Mode S	Top	2180.03	-14.02	29	43.02	≥40	PASS
1090 MHz Mode S	Bottom	2180.02	-18.35	29.1	47.45	≥40	PASS

See Appendix B for test results

Radiated Spurious Radiation

Engineer: Poona Saber

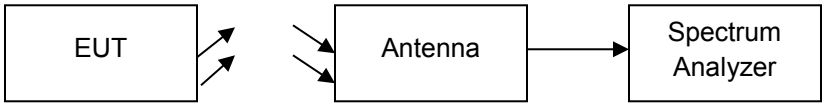
Test Date: 7/12/19

Test Procedure

The EUT was setup and tested in anechoic chamber. Both top and bottom antenna ports are connected into the simulator with matched load. The EUT is placed on non-conductive platform at a height of 0.8 meters above the ground plane of the semi-anechoic chambers for emissions below 1 GHz and at a height of 1.5 meter for emissions above 1 GHz. The test distance from measurement antenna is 3 meters and EUT was rotated 360 degrees and the receive antenna raised and lowered to find the maximum emissions from 30MHz to the 10th harmonic of the fundamental. The EUT was set to the maximum power level allowed and RBW is set to 100 KHz for measurements below 1Ghz and 1Mhz for measurements above 1GHz.

Radiated measurements are done on both Panel mount and Remote mount units.

Test Setup



Mode	Frequency (GHz)	Peak Spurious Power (dBm)	Average Fundamental Power (dBm)	dBc	Limit (dBc)	Result
1030 MHz	4.116	-33.49	14.1	47.59	≥40	PASS
1090 MHz ATCRBS	2.178	-23.87	28.96	52.83	≥40	PASS
1090 MHz Mode S	2.178	-23.84	29	52.84	≥40	PASS

See Appendix C for test results

Occupied Bandwidth

Engineer: Poona Saber

Test Date: 7/8/19

Requirement

Based on rule part 2.1049 the occupied Bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5 % of the total mean power of the given emission.

Based on section 87.137 Authorized Bandwidth for Emission M1D is 14 MHz and V1D is 18 MHZ.

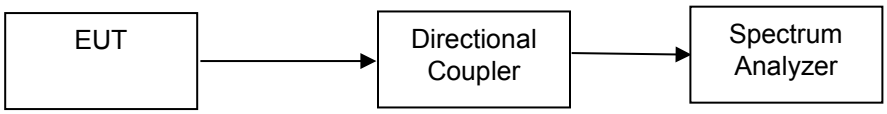
Operation of the TCAS (1030 MHz) system is administrated (licensed) by FAA in accordance with FAA TSO C-118a or TSO C-147. TCAS minimum operational performance standards (MOPS) are provided in RTCA document DO-197A. The allowable -20 dB bandwidth is specified in section 2.2.3.2.1 of DO-197a to be less than 40 MHz

Similarly, operation of the transponder (1090 MHz) system is administered by FAA in accordance with FAA TSO C-112d. Transponder MOPS are provided in RTCA document DO-181E. The allowable -20dB bandwidth is specified in section 2.2.4.2.3 of DO-181E to be less than 46 MHz.

Test Procedure

The following procedure shall be used for measuring (99 %) power bandwidth
The spectrum analyzer center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be set wide enough to capture all modulation products including the emission skirts.
The RBW shall be in the range of 1 % to 5 % of the anticipated OBW, and the VBW shall be set ≥ 3 × RBW.
Set the detection mode to peak, and the trace mode to max-hold.

Test Setup



See Appendix D for Test Results

Emission Masks (Occupied Bandwidth)

Engineer: Poona Saber

Test Date: 7/9/19

Test Procedure

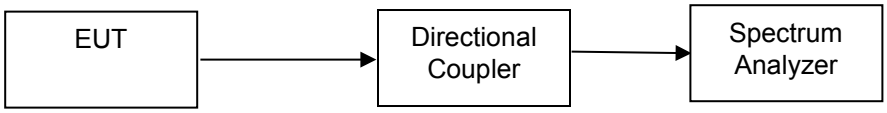
The EUT was connected with a directional coupler to a spectrum analyzer to verify that the EUT meets the required emissions mask requirements of part 87.139 (a) (1) & (2) as below. The RBW was set as close as possible to 1%-5% of the occupied bandwidth to ensure accurate readings.

a) Except for ELTs and when using single sideband (R3E, H3E, J3E), or frequency modulation (F9) or digital modulation (F9Y) for telemetry or telecommand in the 1435-1525 MHz, 2345-2395 MHz, or 5091-5150 MHz band or digital modulation (G7D) for differential GPS, the mean power of any emissions must be attenuated below the mean power of the transmitter (pY) as follows:

(1) When the frequency is removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth the attenuation must be at least 25 dB;

2) When the frequency is removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth the attenuation must be at least 35 dB.

Test Setup



See Appendix E for Test Results

Frequency Stability (Temperature Variation)

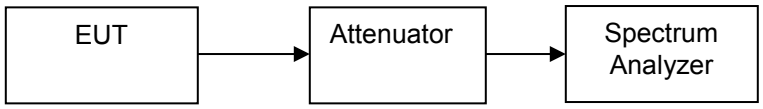
Engineer: Poona Saber

Test Date: 7/10/19

Test Procedure

The EUT was placed in an environmental test chamber and the RF output was connected directly to a frequency counter. The temperature was varied from -30ºC to 50ºC in 10ºC increments. After a sufficient time for temperature stabilization the RF output frequency was measured.
The frequency tolerance Limit that is used is based on rule part 87.133 (@) band (7) 960 to 1215 MHz which is 20 PPM

Test Setup



Measurement Results

1030 MHz

Tuned Frequency (Hz)	Frequency Tolerance ppm	Upper Limit (Hz)	Lower Limit (Hz)		Temperature centigrade	Measured Frequency (Hz)	Upper Margin (Hz)	Lower Margin (Hz)
1,030,000,000	20.0	1030020600	1029979400		-30	1030010000	10600.000000	30600.000000
		1030020600	1029979400		-20	1030005000	15600.000000	25600.000000
		1030020600	1029979400		-10	1030006250	14350.000000	26850.000000
		1030020600	1029979400		0	1030002500	18100.000000	23100.000000
		1030020600	1029979400		10	1029997500	23100.000000	18100.000000
		1030020600	1029979400		20	1029996250	24350.000000	16850.000000
		1030020600	1029979400		30	1029996430	24170.000000	17030.000000
		1030020600	1029979400		40	1029991250	29350.000000	11850.000000
		1030020600	1029979400		50	1029991250	29350.000000	11850.000000

1090 MHz

Tuned Frequency (Hz)	Frequency Tolerance ppm	Upper Limit (Hz)	Lower Limit (Hz)		Temperature centigrade	Measured Frequency (Hz)	Upper Margin (Hz)	Lower Margin (Hz)
1,090,000,000	20.0	1090021800	1089978200		-30	1089997500	24300.000000	19300.000000
		1090021800	1089978200		-20	1090001250	20550.000000	23050.000000
		1090021800	1089978200		-10	1090005000	16800.000000	26800.000000
		1090021800	1089978200		0	1090002500	19300.000000	24300.000000
		1090021800	1089978200		10	1089996250	25550.000000	18050.000000
		1090021800	1089978200		20	1089996254	25546.000000	18054.000000
		1090021800	1089978200		30	1089997275	24525.000000	19075.000000
		1090021800	1089978200		40	1089993750	28050.000000	15550.000000
		1090021800	1089978200		50	1089988750	33050.000000	10550.000000

Frequency Stability (Voltage Variation)

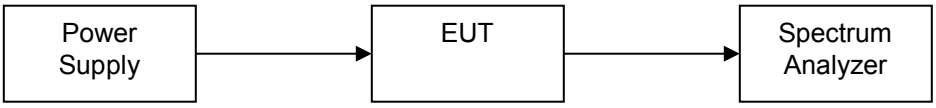
Engineer: Poona Saber

Test Date: 8/19/16

Test Procedure

The EUT was placed in a temperature chamber at 20±5°C and connected directly to a spectrum analyzer. The power supply voltage to the EUT was varied from 85% to 115% of the nominal value and the RF output was measured. This was measured with a variable DC voltage source at 14 and 28 Vdc.
The frequency tolerance Limit that is used is based on rule part 87.133 (@) band (7) 950 to 1215 MHz which is 20 PPM

Test Setup



Test Results

28 Vdc

Tuned Frequency (Hz)	Frequency Tolerance ppm	Upper Limit (Hz)	Lower Limit (Hz)	Nominal Voltatge	Voltage	Measured Frequency (Hz)	Upper Margin (Hz)	Lower Margin (Hz)
1,030,000,000	20.0	1030020600	1029979400	28.00	23.80	1030002000	18600	22600
		1030020600	1029979400		28.00	1029995000	25600	15600
		1030020600	1029979400		32.20	1030010100	10500	30700
1,090,000,000	20.0	1090021800	1089978200	28.00	23.80	1089992990	28810	14790
		1090021800	1089978200		28.00	1089993660	28140	15460
		1090021800	1089978200		32.20	1089993830	27970	15630

14 Vdc

Tuned Frequency (Hz)	Frequency Tolerance ppm	Upper Limit (Hz)	Lower Limit (Hz)	Nominal Voltatge	Voltage	Measured Frequency (Hz)	Upper Margin (Hz)	Lower Margin (Hz)
1,030,000,000	20.0	1030020600	1029979400	14.00	11.90	1029998000	22600	18600
		1030020600	1029979400		14.00	1029992000	28600	12600
		1030020600	1029979400		16.10	1030008000	12600	28600
1,090,000,000	20.0	1090021800	1089978200	14.00	11.90	1089993230	28570	15030
		1090021800	1089978200		14.00	1089994570	27230	16370
		1090021800	1089978200		16.10	1089993560	28240	15360

Modulation Characteristics

Section 2.1047 (d) states: “A curve or equivalent data which shows that the equipment will meet the modulation requirements of the rules under which the equipment is to be licensed “

Duty Cycle calculations:

TAS Transmitter Duty Cycle
The MLT shall be able to transmit 7 whisper/shout interrogations per second according to the format defined in Table 4-7.

TAS Whisper/Shout Attenuator Step	S1 Attenuation (dB)	P1, P3 Attenuation (dB)
1	No S1	21.0
2	22.6	17.5
3	19.1	14.0
4	15.6	10.5
5	12.1	7.0
6	8.6	3.5
7	5.1	0.0

Unit is tested in a special mode which accelerated the transmit rate to 50 transmissions per second at highest power step.

- 50 transmission sequences per second
- 3 pulses per transmission
- Each pulse is 0.8us wide

Duty cycle = 50*3*0.8 us=120 us/second * 100 = 0.012%

ATCRBS Reply Rate Capability
The unit shall be able to transmit 500 15-Pulse ATCRBS replies / sec on a continuous basis.

*Comment: This is a duty cycle of 6.75 µsec*500 = 3375 µsec (0.338%)*

Mode S Reply Rate Capability
The unit be able to transmit 35 Short Mode S and 23 Long Mode S Replies / sec on a continuous basis.

*Comment: This is a duty cycle of 30µsec*35 + 58µsec*23 = 2384µsec (0.239%)*

See Appendix F for Modulation characteristics screen captures

Modulation Details

1 ATCRBS Interrogations

Interrogations are sent out on an intentionally jittered 1+/- 0.2 second interval in increasing power levels according to the schedules shown in Table 1. By transmitting the weakest signals first, only the closest aircraft will reply. The interrogations progress in a roughly circular pattern weighted toward the front of the aircraft since that is the area from which the greatest closing speeds originate. In areas of high density, the sequence is halted when the computer has reached a limit defined by a complex set of three inequalities. In this manner, interference to other TCAS equipped aircraft in the area is minimized since the strongest interrogations are the first to be dropped.

Table 1: Whisper Shout Minimum Power Levels

(in Watts)	Sequence #1		Sequence #2		Sequence #3		Sequence #4		Sequence #5	
	S1	P1/P3	S1	P1/P3	S1	P1/P3	S1	P1/P3	S1	P1/P3
WSL 7									21.88	158.5
WSL 6							21.88	70.79		
WSL 5					9.77	31.62	9.77	31.62	9.77	31.62
WSL 4			4.37	14.13	4.37	14.13	4.37	14.13	4.37	14.13
WSL 3	1.95	6.31	1.95	6.31	1.95	6.31	1.95	6.31	1.95	6.31
WSL 2	0.87	2.82	0.87	2.82	0.87	2.82	0.87	2.82	0.87	2.82
WSL 1		1.26		1.26		1.26		1.26		1.26
P_{total} (W)		10.39		24.51		56.14		126.9		214.6

(in dBm)	Sequence #1		Sequence #2		Sequence #3		Sequence #4		Sequence #5	
	S1	P1/P3	S1	P1/P3	S1	P1/P3	S1	P1/P3	S1	P1/P3
WSL 7									43.4	52
WSL 6							43.4	48.5		
WSL 5					39.9	45	39.9	45	39.9	45
WSL 4			36.4	41.5	36.4	41.5	36.4	41.5	36.4	41.5
WSL 3	32.9	38	32.9	38	32.9	38	32.9	38	32.9	38
WSL 2	29.4	34.5	29.4	34.5	29.4	34.5	29.4	34.5	29.4	34.5
WSL 1		31		31		31		31		31
P_{total} (dBm)		40.2		43.9		47.5		51		53.3

Figure 1: ATCRBS Whisper Shout Interrogations

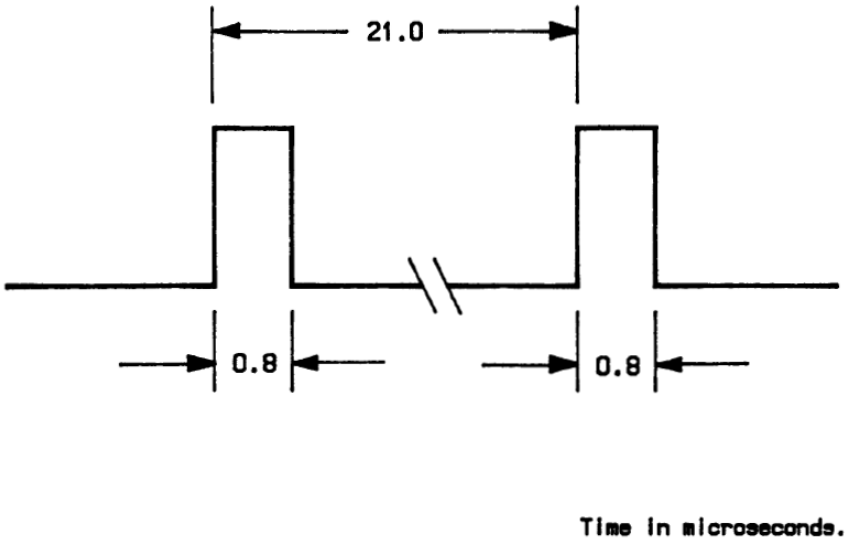


Figure 2 ATCRBS Mode C Interrogation

Pulse Widths:	0.8 ± 0.05 us
Rise Times (10% to 90%):	≥ 0.05 us, < 0.1 us
Fall Times (90% to 10%):	≥ 0.05 us, < 0.2 us

Pulses P1 and P3 will appear in all interrogation steps of the whisper / shout sequence and will be at the same power level. Pulse S1 will appear in all steps except the initial step on each antenna direction and at a level two or three dB below the level of P1, etc. according to the schedules shown in Figure 1 through Figure 4. The steps occur at intervals of two milliseconds until the entire program is complete. The program length depends upon the individual aircraft installation. Options are available from using either an omni-directional bottom antenna or a directional bottom antenna. The top antenna is always directional.

S1 =	-2 microseconds
P1 =	0 microseconds
P3 =	21 microseconds

2 ATCRBS Replies

ATCRBS replies are pulse amplitude modulated signals (PAM), and are formed in response to Mode A or Mode C interrogations. Mode A replies consist of a 4096 code which is an identifier and an optional SPI pulse. The Transmitter CCA transmits ATCRBS reply pulse waveforms as shown in Figure 3.

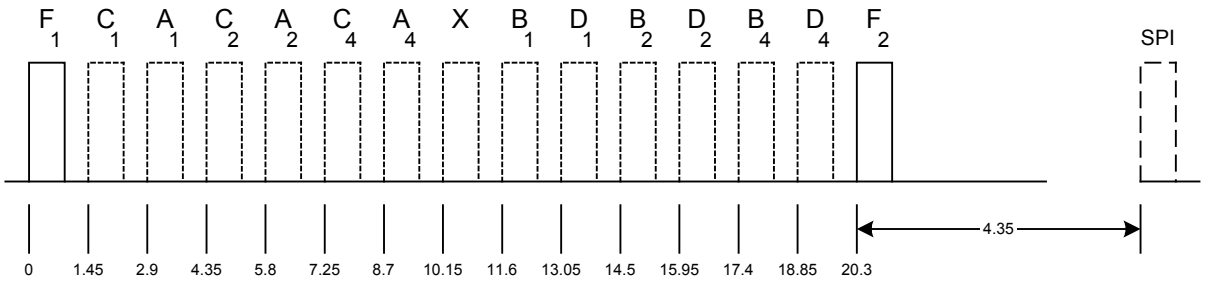


Figure 3: ATCRBS Reply

The designator of the information pulses and their positions from the first framing pulse are as follows:

Table 3: ATCRBS Reply Pulse Characteristics/Position

Pulse	Position (µsec)
FIRST FRAMING PULSE	0.0
C1	1.45
A1	2.90
C2	4.35
A2	5.80
C4	7.25
A4	8.70
X[1]	10.15
B1	11.60
D1	13.05
B2	14.50
D2	15.95
B4	17.40
D4	18.85
LAST FRAMING PULSE	20.30
SPI	24.65

Note 1: The X pulse is referenced here for possible future use.

The ATCRBS Reply Pulse Spacing Tolerance is as follows:

- First framing pulse to information/last framing pulse ± 0.1 µsec
- Last framing pulse to SPI pulse ± 0.1 µsec
- Any 2 pulses in pulse group (except First framing pulse) ± 0.15 µsec

The ATCRBS pulse characteristics are as specified in the table below.

Table 4: ATCRBS Reply Pulses (in microseconds)

			Rise Time		Decay Time	
Pulse Designator	**Pulse Duration**	**Duration Tolerance**	**Min.**	**Max.**	**Min.**	**Max**
ATCRBS Reply Pulses	0.45	± 0.10	0.05	0.1	0.05	0.2

3 Mode S Replies

Mode S (Short & Long) replies, including preamble, data pulse, pulse shape, pulse spacing tolerance, and delay and jitter characteristics will be as follows.

The Transmitter CCA transmits Mode S reply pulse waveforms as shown in Figure 4.

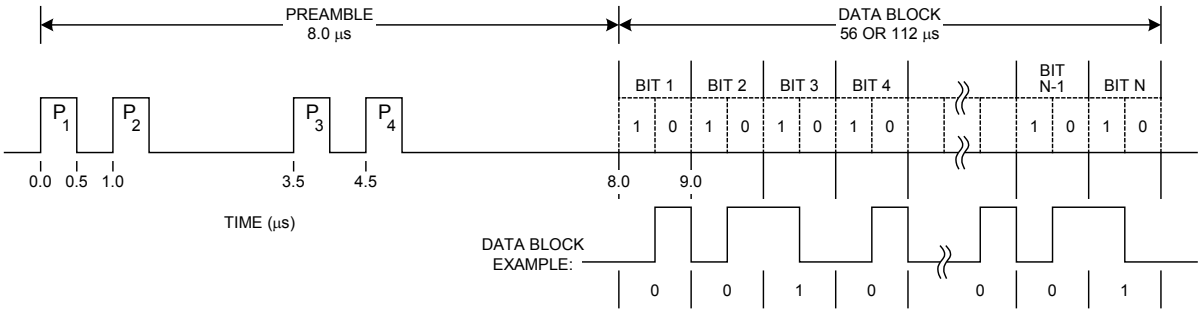


Figure 4: Mode S Reply

1. Mode S Reply
   a. The Mode S preamble consists of four 0.5 ± 0.05 microsecond pulses.
   b. The second, third and fourth pulses are spaced 1.0, 3.5, and 4.5 microseconds respectively from the first transmitted pulse.
   c. The block of reply data pulses begins 8.0 microseconds after the first transmitted pulse and is either 56 or 112 one microsecond intervals depending on the type of Mode S Reply.
   d. A pulse with a width of 0.5 ± 0.05 microseconds is transmitted either in the first (data bit "1") or in the second half (data bit "0") of each interval. Also, if a pulse transmitted in the second half of one interval is followed by a pulse transmitted in the first half of the next interval, the two pulses merge. Once the merging occurs, a 1.0 ± 0.05 microsecond pulse is transmitted
2. Mode S Reply Pulse Shape
   a. The pulse rise and decay time are as specified in the table below.

Table 5: Mode S Reply Pulses (in microseconds)

	Rise Time		Decay Time	
Pulse Designator	**Min.**	**Max.**	**Min.**	**Max**
Mode S Reply Pulses	0.05	0.1	0.05	0.2

3. Mode S Reply Pulse Spacing Tolerance
   a. Mode S Reply pulses start at a defined multiple of 0.5 microseconds from the first transmitted pulse.
   b. The pulse position tolerance must be ± 0.05 microseconds, measured from the first pulse of the reply.

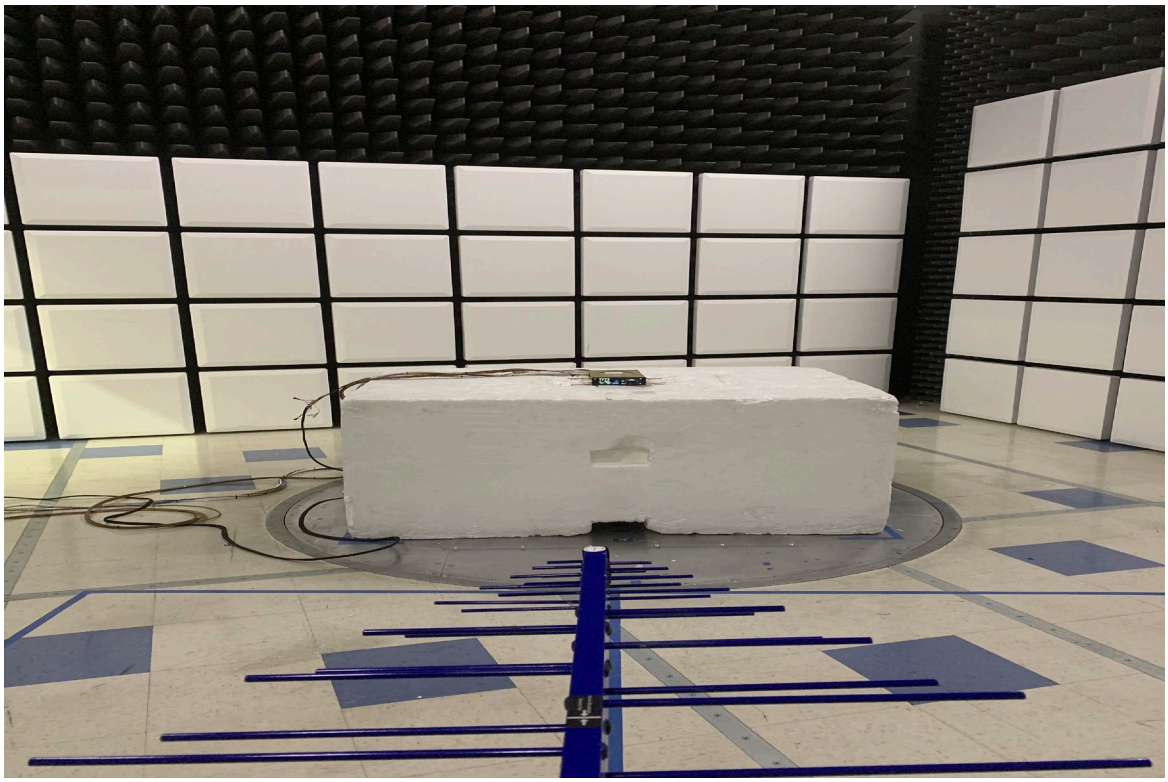
Test Equipment Utilized

Description	Manufacturer	Model #	CT Asset #	Last Cal Date	Cal Due Date
Horn Antenna	ARA	DRG-118/A	i00271	6/16/18	6/16/20
Bi-Log Antenna	Chase	CBL6111C	i00267	3/8/18	3/8/20
EMI Analyzer	Agilent	E7405A	i00379	1/16/19	1/16/20
3 Meter Semi-Anechoic Chamber	Panashield	3 Meter Semi-Anechoic Chamber	i00428	8/15/16	8/15/19
PSA Spectrum Analyzer	Agilent	E4445A	i00471	10/16/18	10/16/19
Spectrum Analyzer	Rohde & Schwarz	FSU26	i00501	4/2/19	4/2/20
Preamplifier for 1-18GHz horn antenna	Miteq	AFS44 00101 400 23-10P-44	i00509	N/A	N/A
Temperature Test Chamber	Thermotron	SE-1000-3-3	i00557	Functional Verification	Functional Verification
Hydra Data Bucket	Fluke	2635A	I00343	5/15/19	5/15/20
Network Analyzer	HP	8722D	I00521	7/24/19	7/24/20

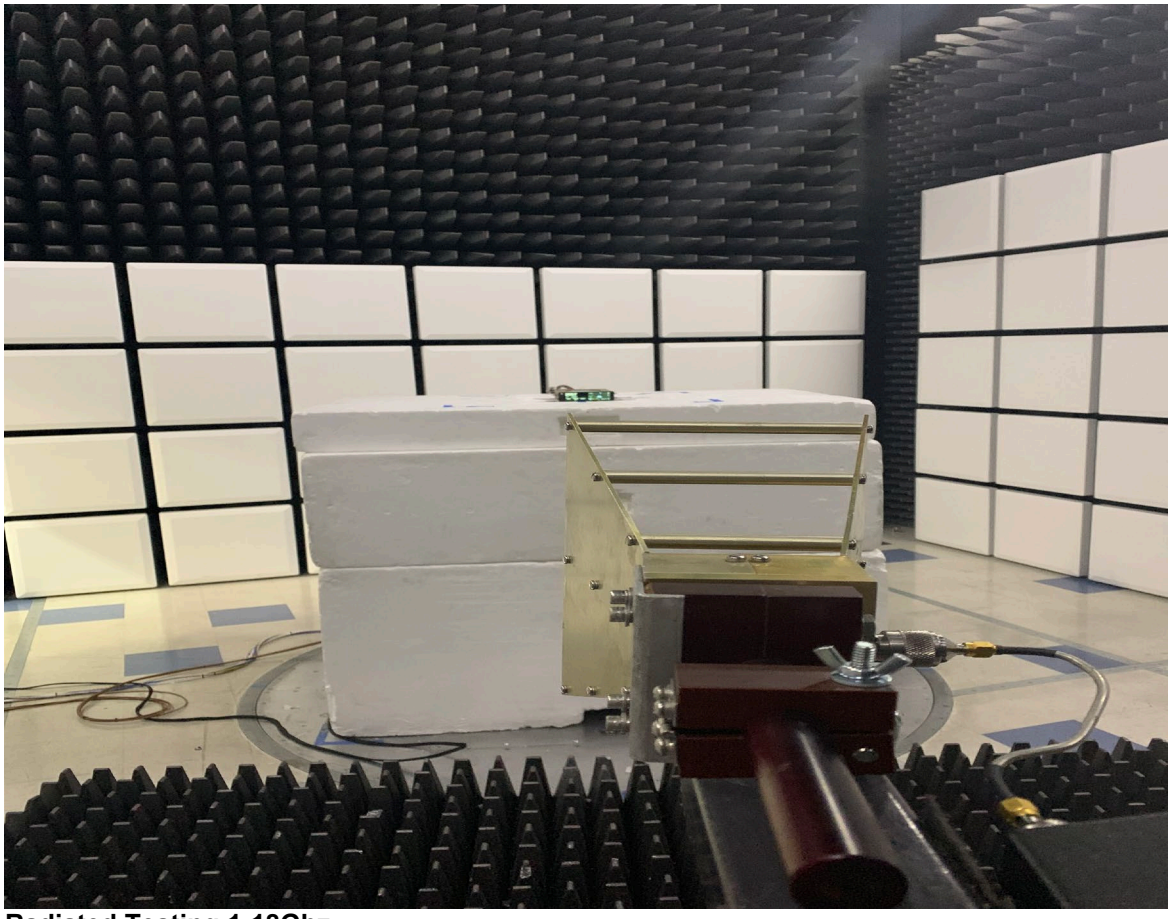
In addition to the above listed equipment standard RF connectors, Coupler and cables were utilized in the testing of the described equipment. Prior to testing these components were tested to verify proper operation.

END OF TEST REPORT

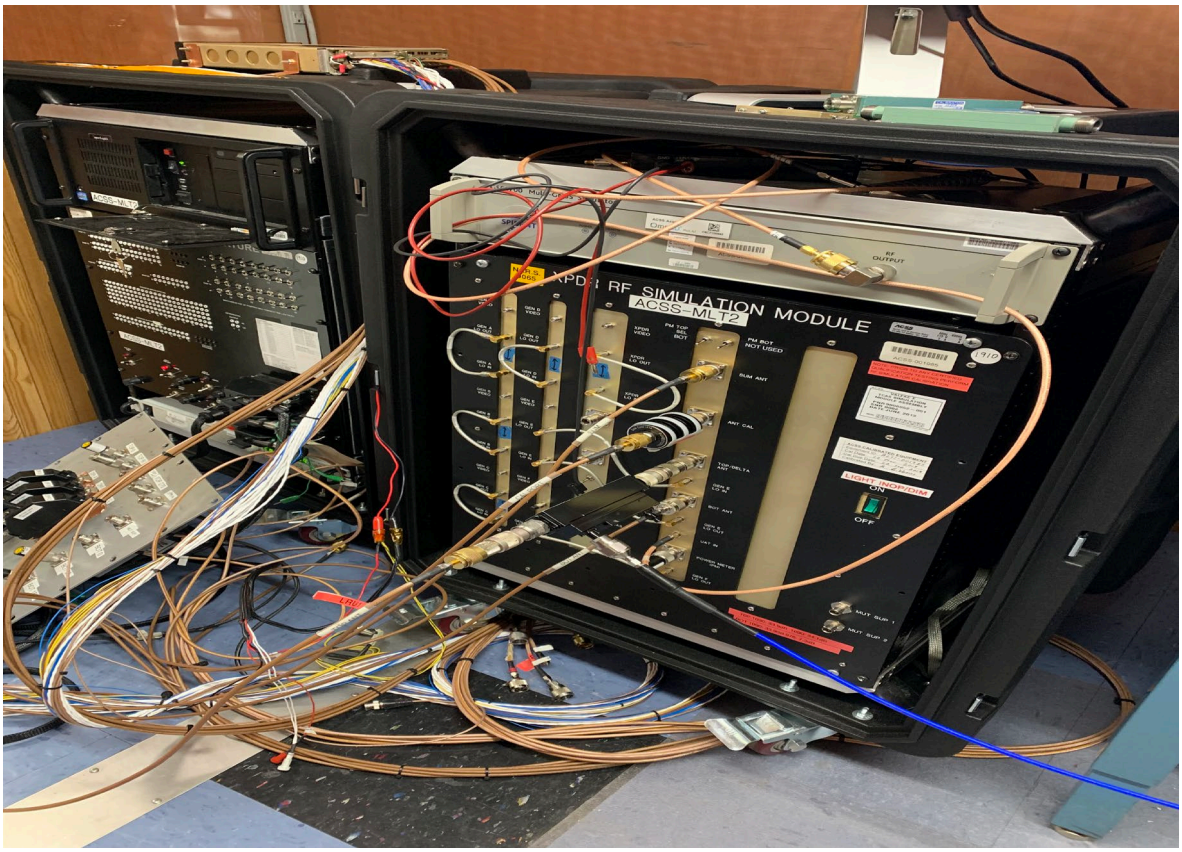
Test Setup Photos
FCC ID: P8CT3C-16



Radiated Testing 30Mhz-1Ghz



Radiated Testing 1-18Ghz



Conducted Testing setup