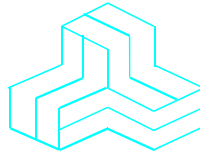


ENGINEERING TEST REPORT



Multiple P25 Airborne Transceiver
Model No.: TDFM-7300-3
FCC ID: IMA-TDFM-7300-3

Applicant:

Technisonic Industries Limited
240 Traders Blvd. E.
Mississauga, Ontario
Canada L4Z 1W7

Tested in Accordance With

Federal Communications Commission (FCC)
47 CFR, Parts 2 and 87 (Subpart D)

UltraTech's File No.: TIL-072FCC87

This Test report is Issued under the Authority of
Tri M. Luu, Professional Engineer,
Vice President of Engineering
UltraTech Group of Labs

Date: August 19, 2011

Report Prepared by: Dharmajit Solanki

Tested by: Wayne Wu, RFI Engineer

Issued Date: August 19, 2011

Test Dates: July 21 - 27, 2011

- The results in this Test Report apply only to the sample(s) tested, and the sample tested is randomly selected.
- This report must not be used by the client to claim product endorsement by NVLAP or any agency of the US Government.

UltraTech

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FCC

91038



1309



Approved Test Facility

46390-2049



NvLap Lab
Code 200093-0



SL2-IN-E-1119R



Korea KCC-RRL
CA2049

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EXHIBIT 1. INTRODUCTION

1.1. SCOPE

Reference:	FCC Parts 2 and 87
Title:	Code of Federal Regulations (CFR), Title 47 Telecommunication – Parts 2 & 87
Purpose of Test:	To obtain FCC Certification Authorization for Radio operating in the Frequency Band 117.975 - 137 MHz.
Test Procedures:	Both conducted and radiated emissions measurements were conducted in accordance with TIA/EIA Standard, TIA-603-C – Land Mobile FM or PM Communications Equipment Measurement and performance Standards.

1.2. RELATED SUBMITTAL(S)/GRANT(S)

None.

1.3. NORMATIVE REFERENCES

Publication	Year	Title
FCC CFR Parts 0-19, 80-End	2010	Code of Federal Regulations – Telecommunication
ANSI C63.4	2003, 2009	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
CISPR 16-1-1	2003	Specification for Radio Disturbance and Immunity measuring apparatus and methods
TIA-603-C	2004	Land Mobile FM or PM Communications Equipment Measurement and Performance Standards

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EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1. CLIENT INFORMATION

APPLICANT	
Name:	Technisonic Industries Ltd.
Address:	240 Traders Blvd. E. Mississauga, Ontario Canada L4Z 1W7
Contact Person:	Mr. Steve McIntosh Phone #: 905-890-2113 ext 205 Fax #: 905-890-5338 Email Address: stevem@til.ca

MANUFACTURER	
Name:	Technisonic Industries Ltd.
Address:	240 Traders Blvd. E. Mississauga, Ontario Canada L4Z 1W7
Contact Person:	Mr. Steve McIntosh Phone #: 905-890-2113 ext 205 Fax #: 905-890-5338 Email Address: stevem@til.ca

2.2. EQUIPMENT UNDER TEST (EUT) INFORMATION

The following information (with the exception of the Date of Receipt) has been supplied by the applicant.

Brand Name:	Technisonic Industries Limited
Product Name:	Multiple P25 Airborne Transceiver
Model Name or Number:	TDFM-7300-3
Serial Number:	Sample 1
Type of Equipment:	Licensed Non-Broadcast Station Transmitter
External Power Supply:	28 Vdc nominal
Transmitting/Receiving Antenna Type:	Non-integral
Primary User Functions of EUT:	VHF Aviation Band Two-Way Radio Communication

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2.3. EUT'S TECHNICAL SPECIFICATIONS

TRANSMITTER	
Equipment Type:	Mobile
Intended Operating Environment:	Commercial, Industrial or Business
Power Supply Requirement:	28.0 Vdc nominal
RF Output Power Rating:	2.5W (CW), 5.0W (PEP)
Operating Frequency Range:	118 – 136.975 MHz (25 kHz Ch Spacing) 118 – 136.992 MHz (8.33 kHz Ch Spacing)
RF Output Impedance:	50 Ω
Channel Spacing:	25 kHz & 8.33 kHz
Occupied Bandwidth (99%):	5.53 kHz
Emission Designation*:	6K00A3E & 5K60A3E
Oscillator Frequency(ies):	16 MHz
Antenna Connector Type:	BNC

* For an average case of commercial telephony, the Necessary Bandwidth is calculated as follows:

Calculation of Necessary Bandwidth for Telephony (Commercial Quality)

Telephony, double-sideband (single channel):

$$B_n = 2M$$

Where: B_n = Necessary bandwidth in hertz

M = Maximum modulation frequency in hertz

$$M = 3000\text{Hz}$$

$$B_n = 2(3000) = 6000\text{ Hz} = 6.00\text{ KHz}$$

2.4. LIST OF EUT'S PORTS

Port Number	EUT's Port Description	Number of Identical Ports	Connector Type	Cable Type (Shielded/Non-shielded)
1	RF I/O	5	BNC Female	Shielded
2	Audio/Power I/O	1	DB25	Non-shielded
3	Audio I/O	1	DB-9	Non-shielded

NOTES:

- (1) *Ports of the EUT which in normal operation were connected to ancillary equipment through interconnecting cables via a representative interconnecting cable to simulate the input/output characteristics.*
- (2) *Ports which are not connected to cables during normal intended operation (for factory/technical services uses only): Data Programming I/O*

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EXHIBIT 3. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

3.1. CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

Temperature:	21°C to 251°C
Humidity:	45% to 60%
Pressure:	102 kPa
Power Input Source:	28 Vdc Nominal

3.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TEST SIGNALS

Operating Modes:	The transmitter was operated in a continuous transmission mode with the carrier modulated as specified in the Test Data.
Special Test Software:	N/A
Special Hardware Used:	N/A
Transmitter Test Antenna:	The EUT is tested with the antenna port terminated to a 50Ω RF Load.

Transmitter Test Signals	
Frequency Band(s):	118 – 136.992 MHz
Test Frequencies: (Near lowest, near middle & near highest frequencies in the frequency range of operation.)	118, 127.5 & 136.975 MHz
Transmitter Wanted Output Test Signals: Transmitter Power (measured maximum output power): Normal Test Modulation: Modulating signal source:	 2.77 Watts (Carrier) AM or 2500 Hz tone at an input level 16 dB greater than that necessary to produce 50 percent modulation. External

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EXHIBIT 4. SUMMARY OF TEST RESULTS

4.1. LOCATION OF TESTS

All of the measurements described in this report were performed at Ultratech Group of Labs located in the city of Oakville, Province of Ontario, Canada.

- AC Powerline Conducted Emissions were performed in UltraTech's shielded room, 16'(L) by 12'(W) by 12'(H).
- Radiated Emissions were performed at the Ultratech's 3-10 TDK Semi-Anechoic Chamber situated in the Town of Oakville, province of Ontario. This test site been calibrated in accordance with ANSI C63.4, and found to be in compliance with the requirements of Sec. 2.948 of the FCC Rules. The descriptions and site measurement data of the Oakville 3-10 TDK Semi-Anechoic Chamber has been filed with FCC office (FCC File No.: 91038) and Industry Canada office (Industry Canada File No.: 2049A-3). Expiry Date: 2014-04-14.

4.2. APPLICABILITY & SUMMARY OF EMISSION TEST RESULTS

FCC Section(s)	Test Requirements	Applicability (Yes/No)
2.1046 & 87.131	RF Power Output	Yes
1.1307, 1.1310, 2.1091 & 2.1093	RF Exposure Limit	Yes*
2.1047(a) & 87.141(f)	Modulation Characteristics - Audio Frequency Response of Low pass Filter	Yes
2.1047(b) & 87.141	Modulation Characteristics - Modulation Limiting	Yes
2.1049, 87.135, 87.137 & 87.139	Occupied Bandwidth and Emission Limitations	Yes
2.1051, 2.1057 & 87.139,	Spurious Emissions at Antenna Terminal	Yes
2.1053, 2.1057 & 87.139	Field Strength of Spurious Emissions	Yes
2.1055 & 87.133	Frequency Stability	Yes
Multiple P25 Airborne Transceiver, Model No.: TDFM-7300-3, by Technisonic Industries Limited has also been tested and found to comply with FCC Part 15, Subpart B - Radio Receivers and Class A Digital Devices. The engineering test report has been documented and kept on file and it is available upon request.		

4.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

None

4.4. DEVIATION OF STANDARD TEST PROCEDURES

None

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EXHIBIT 5. MEASUREMENTS DATA

5.1. RF POWER OUTPUT [§§ 2.1046 & 87.131]

5.1.1. Limits

§§ 87.131 The following table lists authorized emissions and maximum power. Power must be determined by direct measurement.

Class of station	Frequency band/ frequency	Authorized emission(s) ²	Maximum power ¹
Aeronautical advisory	VHF	A3E	10 watts ³
Aeronautical multicom	VHF	A3E	10 watts
Aeronautical search and rescue	VHF	A3E	10 watts
Aviation support	VHF	A3E	50 watts
Airport control tower	VHF	A3E	50 watts
Aeronautical utility mobile	VHF	A3E	10 watts
Aircraft	VHF	A3E	50 watts

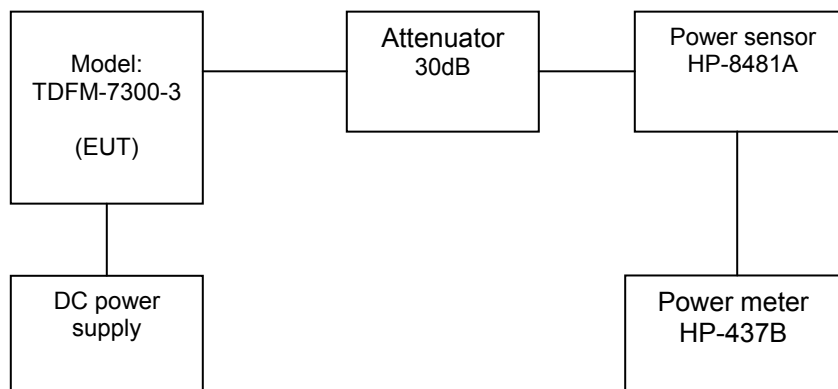
Notes:

- (1) The power is measured at the transmitter output terminals and the type of power is determined according to the emission designator as follows:
 - (i) Mean power (pY) for amplitude modulated emissions and transmitting both sidebands using unmodulated full carrier.
 - (ii) Peak envelope power (pX) for all emission designators other than those referred to in paragraph (i) of this note.
- (2) Excludes automatic link establishment.
- (3) Power is limited to 0.5 watt, but may not exceed 2 watts when station is used in an automatic unattended mode.

5.1.2. Method of Measurements

Refer to Exhibit 8, Section 8.1 (Conducted) and 8.2 (Radiated) of this report for measurement details

5.1.3. Test Arrangement



5.1.4. Test Data

Carrier Power Measurement:

Transmitter Channel Output	Fundamental Frequency (MHz)	Measured (mean) Power @ Antenna Port (watts)	Maximum Power Limit (watts)
Lowest	118.000	2.77	10
Middle	127.500	2.48	10
Highest	136.975	2.60	10

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5.2. FREQUENCY STABILITY [§§ 2.1055 & 87.133]

5.2.1. Limits

§§ 87.133 The carrier frequency of each station must be maintained within the tolerance in the following table:

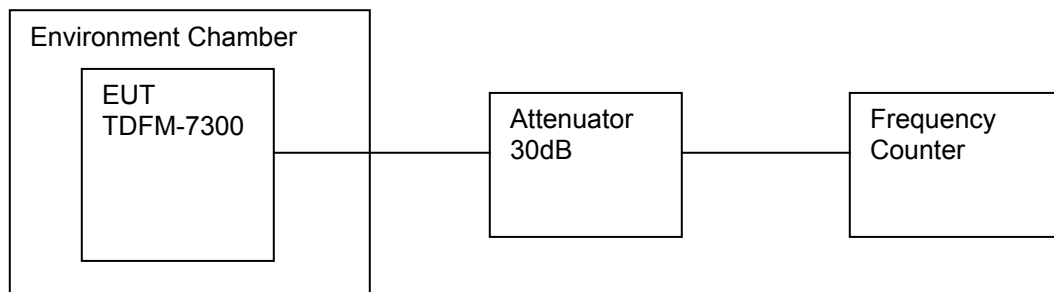
Frequency band (lower limit exclusive, upper limit inclusive), and categories of station	Tolerance (ppm)
(5) Band - 108 to 137 MHz: Aircraft and other mobile stations in the Aviation Services.	*30

* For emissions G1D and G7D, the tolerance is 5 parts per 10^6 .

5.2.2. Method of Measurements

Refer to Exhibit 8, Section 8.3 of this report for measurement details

5.2.3. Test Arrangement



5.2.4. Test Data

Center Frequency:	118 MHz
Full Power Level:	2.77 watts
Frequency Tolerance Limit:	30 ppm or 3540 Hz (Manufacturer's rating: ± 2.5 ppm)
Max. Frequency Tolerance Measured:	-18 Hz or 0.15 ppm
Input Voltage Rating:	28 Vdc (nominal)

Ambient Temperature (°C)	Frequency Drift (Hz)		
	Supply Voltage (Nominal) 28 Vdc	Supply Voltage (85% of nominal) 23.8 Vdc	Supply Voltage (115% of nominal) 32.2 Vdc
-30	-15	--	-
-20	-9	--	--
-10	-6	--	--
0	-3	--	--
+10	-1	--	--
+20	3	+2	+4
+30	-14	--	--
+40	-18	--	--
+50	-11	--	--
+60	9	--	--
+70	-15	--	--

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5.3. MODULATION CHARACTERISTICS - AUDIO FREQUENCY RESPONSE [§§ 2.1047(a) & 87.141(f)]

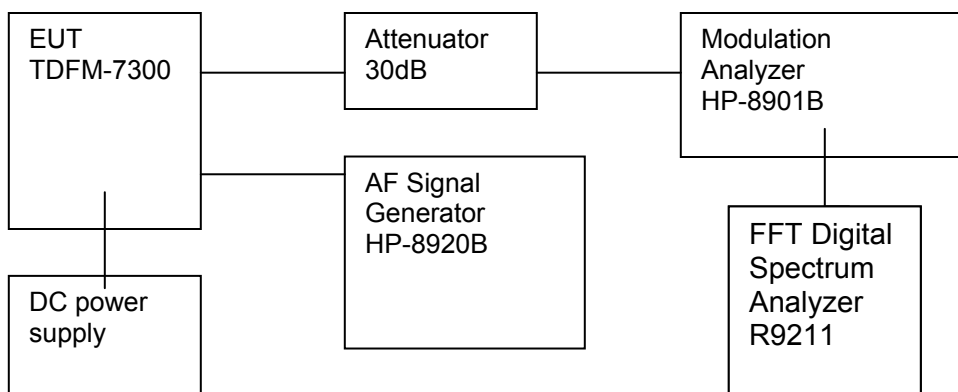
5.3.1. Limits

§§ 87.141(f) Each frequency modulated transmitter equipped with a modulation limiter must have a low pass filter between the modulation limiter and the modulated stage. At audio frequencies between 3 kHz and 15 kHz, the filter must have an attenuation greater than the attenuation at 1 kHz by at least $40 \log_{10} (f/3)$ db where “f” is the frequency in kilohertz. Above 15 kHz, the attenuation must be at least 28 db greater than the attenuation at 1 kHz.

5.3.2. Method of Measurements

The rated audio input signal was applied to the input of the audio lowpass filter (or of all modulation stages) using an audio oscillator, this input signal level and its corresponding output signal were then measured and recorded using the FFT (Audio) spectrum analyzer. Tests were repeated at different audio signal frequencies from 0 to 50 kHz.

5.3.3. Test Arrangement



5.3.4. Test Data

Note: Due to the difficulty of measuring the Frequency Response of the internal low-pass filter, the Frequency Response of All Modulation States was performed to show the roll-off at 3 kHz in comparison with FCC Limit for audio low-pass filter.

25 kHz Channel Spacing, Frequency of All Modulation States*

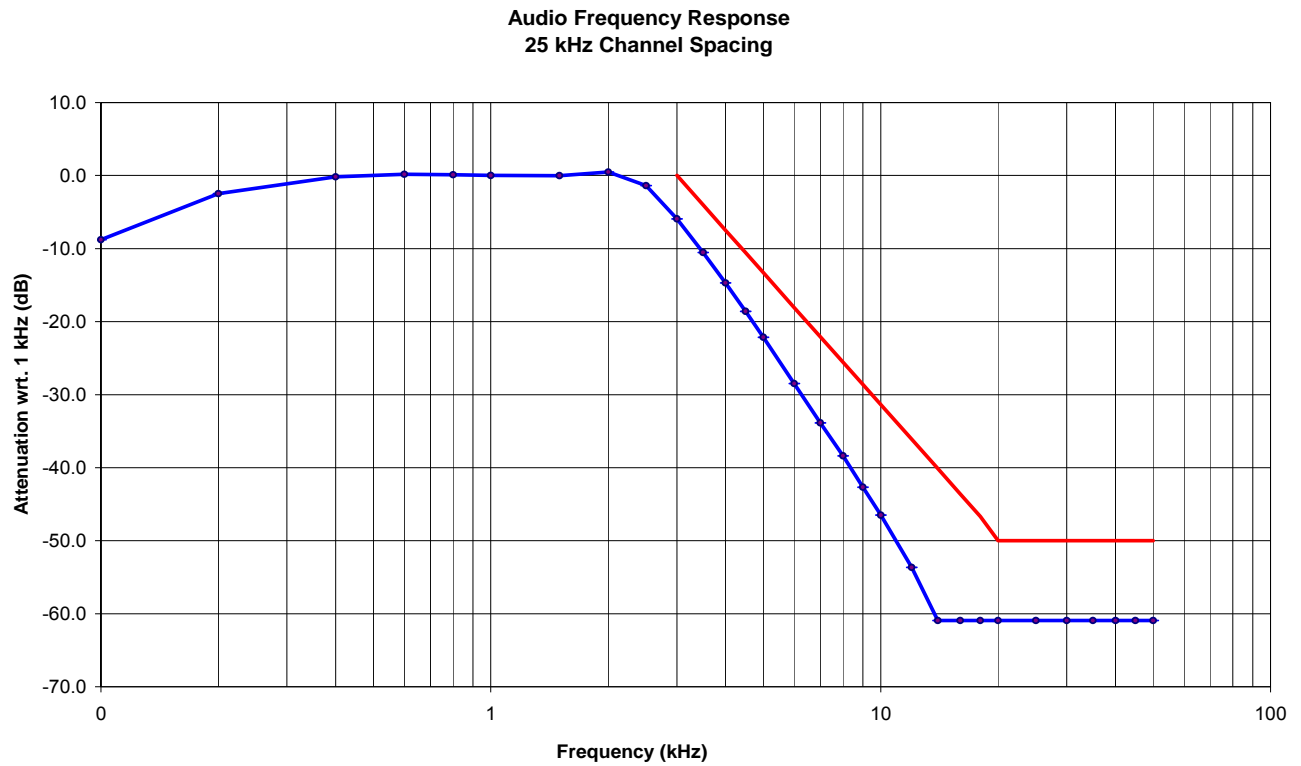
Frequency (kHz)	Audio IN (dBV)	Audio OUT (dBV)	Attenuation (OUT - IN) (dB)	Attenuation wrt. 1 kHz (dB)	Recommended Attenuation (dB)
0.1	-25.60	-17.83	7.8	-8.8	--
0.2	-25.60	-11.53	14.1	-2.5	--
0.4	-25.60	-9.23	16.4	-0.2	--
0.6	-25.60	-8.88	16.7	0.2	--
0.8	-25.60	-8.93	16.7	0.1	--
1.0	-25.60	-9.04	16.6	0.0	--
1.5	-25.60	-9.07	16.5	0.0	--
2.0	-25.60	-8.56	17.0	0.5	--
2.5	-25.60	-10.44	15.2	-1.4	--
3.0	-25.60	-14.96	10.6	-5.9	0
3.5	-25.60	-19.59	6.0	-10.6	-4
4.0	-25.60	-23.75	1.9	-14.7	-7
4.5	-25.60	-27.63	-2.0	-18.6	-11
5.0	-25.60	-31.17	-5.6	-22.1	-13
6.0	-25.60	-37.53	-11.9	-28.5	-18
7.0	-25.60	-42.91	-17.3	-33.9	-22
8.0	-25.60	-47.44	-21.8	-38.4	-26
9.0	-25.60	-51.72	-26.1	-42.7	-29
10.0	-25.60	-55.56	-30.0	-46.5	-31
12.0	-25.60	-62.70	-37.1	-53.7	-36
14.0	-25.60	-70.00	-44.4	-61.0	-40
16.0	-25.60	-70.00	-44.4	-61.0	-44
18.0	-25.60	-70.00	-44.4	-61.0	-47
20.0	-25.60	-70.00	-44.4	-61.0	-49
25.0	-25.60	-70.00	-44.4	-61.0	-50
30.0	-25.60	-70.00	-44.4	-61.0	-50
35.0	-25.60	-70.00	-44.4	-61.0	-50
40.0	-25.60	-70.00	-44.4	-61.0	-50
45.0	-25.60	-70.00	-44.4	-61.0	-50
50.0	-25.60	-70.00	-44.4	-61.0	-50

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5.4. MODULATION CHARACTERISTICS – MODULATION LIMITING [§§ 2.1047(b) & 87.141]

5.4.1. Limits

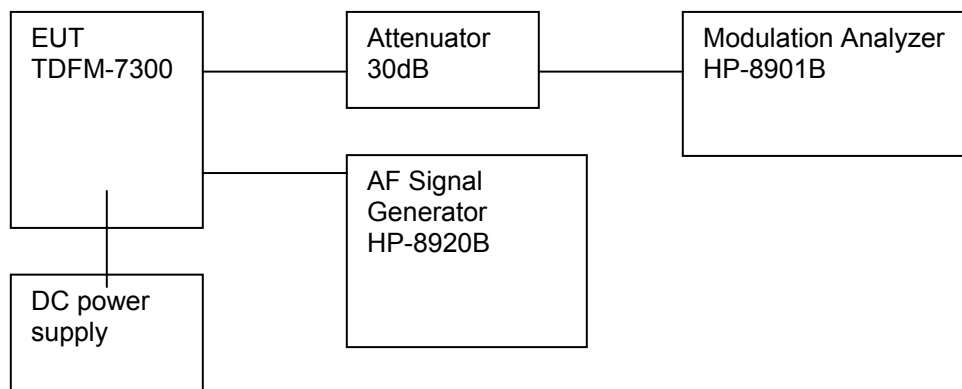
- §§ 87.141(a) When A3E emission is used, the modulation percentage must not exceed 100 percent. This requirement does not apply to emergency locator transmitters or survival craft transmitters.
- §§ 87.141(b) A double sideband full carrier amplitude modulated radiotelephone transmitter with rated carrier power output exceeding 10 watts must be capable of automatically preventing modulation in excess of 100 percent.
- §§ 87.141(c) If any licensed radiotelephone transmitter causes harmful interference to any authorized radio service because of excessive modulation, the Commission will require the use of the transmitter to be discontinued until it is rendered capable of automatically preventing modulation in excess of 100 percent.

5.4.2. Method of Measurements

For Audio Transmitter:- The carrier frequency deviation was measured with the tone input signal level varied from 0 Vp to audio input rating level plus 16 dB at frequencies 0.1, 0.5, 1.0, 3.0 and 5.0 kHz. The maximum deviation was recorded at each test condition.

For Data Transmitter with Maximum Frequency Deviation set by Factory: The EUT was set at maximum frequency deviation, and its peak frequency deviation was then measured using EUT's internal random data source.

5.4.3. Test Arrangement



5.4.4. Test Data

MODULATING SIGNAL LEVEL (mVrms)	Modulation (%) at the following modulating frequency:					MODULATION LIMIT (%)
	0.1 kHz	0.5 kHz	1.0 kHz	3.0 kHz	5.0 kHz	
2	1.16	2.41	2.28	1.38	0.54	100
5	2.15	5.16	5.05	2.69	0.79	100
10	3.87	9.86	9.79	5.06	1.11	100
15	5.65	14.96	14.52	7.36	1.51	100
20	7.63	19.92	19.76	9.81	1.82	100
25	9.41	24.71	24.42	12.15	2.18	100
30	11.12	29.66	29.22	14.43	2.63	100
35	12.91	34.64	34.08	16.84	2.94	100
40	14.86	39.52	38.90	19.17	3.32	100
45	16.54	44.40	43.70	21.50	3.65	100
50	18.57	49.50	48.60	23.83	4.08	100
60	22.17	60.00	59.00	28.71	4.77	100
70	25.92	70.80	69.10	33.49	5.58	100
80	30.24	79.60	77.00	39.04	6.46	100
90	33.02	81.80	79.30	42.50	6.88	100
100	37.15	86.10	81.60	47.70	7.64	100
150	56.10	87.50	82.90	48.20	7.84	100
200	78.30	87.60	83.00	48.20	7.84	100
250	89.20	87.70	83.20	48.20	7.84	100
300	90.10	87.70	83.50	48.20	7.84	100
350	90.10	87.70	83.50	48.20	7.83	100

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Voice Signal Input Level = STD MOD Level + 16 dB
= 34.4 dB(mVrms) + 16 dB
= 50.4 dB(mVrms)
= 331.25 mVrms

Standard Modulation Level measured at 50 % Modulation @ 1.0 kHz.

MODULATING FREQUENCY (KHz)	MODULATION (%)	MODULATION LIMIT (%)
0.1	88.30	100.0
0.2	87.80	100.0
0.4	87.20	100.0
0.6	85.40	100.0
0.8	83.70	100.0
1.0	82.20	100.0
1.2	81.40	100.0
1.4	80.70	100.0
1.6	79.30	100.0
1.8	73.30	100.0
2.0	74.80	100.0
2.5	65.70	100.0
3.0	48.20	100.0
3.5	29.09	100.0
4.0	17.94	100.0
4.5	11.65	100.0
5.0	7.77	100.0
6.0	3.94	100.0
7.0	2.33	100.0
8.0	1.48	100.0
9.0	1.09	100.0
10.0	0.77	100.0

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5.5. OCCUPIED BANDWIDTH AND EMISSION LIMITATIONS [§§ 2.1049, 87.135, 87.137 & 87.139]

§§ 87.137(a) The assignable emissions, corresponding emission designators and authorized bandwidths are as follows:

Class of emission	Emission designator	Authorized bandwidth (kHz)		
		Below 50 MHz	Above 50 MHz	Frequency deviation
A3E ⁽¹⁾	6K00A3E	.....	50 ⁽²⁾	

(1) For use with an authorized bandwidth of 8.0 kilohertz at radiobeacon stations. A3E will not be authorized:

- (i) At existing radiobeacon stations that are not authorized to use A3 and at new radiobeacon stations unless specifically recommended by the FAA for safety purposes.
- (ii) At existing radiobeacon stations currently authorized to use A3, subsequent to January 1, 1990, unless specifically recommended by the FAA for safety purposes.

(2) In the band 117.975–136 MHz, the authorized bandwidth is 25 kHz for transmitters approved after January 1, 1974.

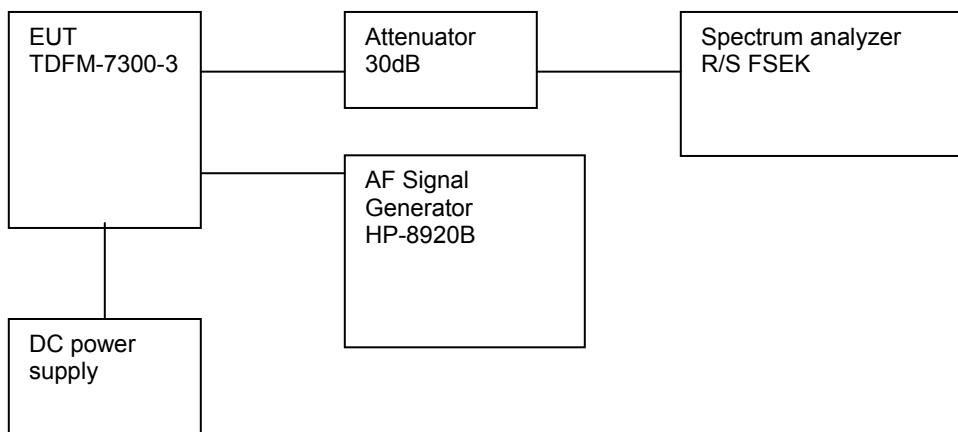
§§ 87.139(a) Except for ELTs and when using single sideband (R3E, H3E, J3E), or frequency modulation (F9) or digital modulation (F9Y) for telemetry or telecommand in the frequency bands 1435–1535 MHz and 2310–2390 MHz or digital modulation (G7D) for differential GPS, the mean power of any emission must 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.
- (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; and the attenuation for aeronautical station transmitters must be at least 43 + 10 log₁₀ pY dB.

5.5.1. Method of Measurements

Refer to TIA-102.CAAA-B.

5.5.2. Test Arrangement



5.5.3. Test Data

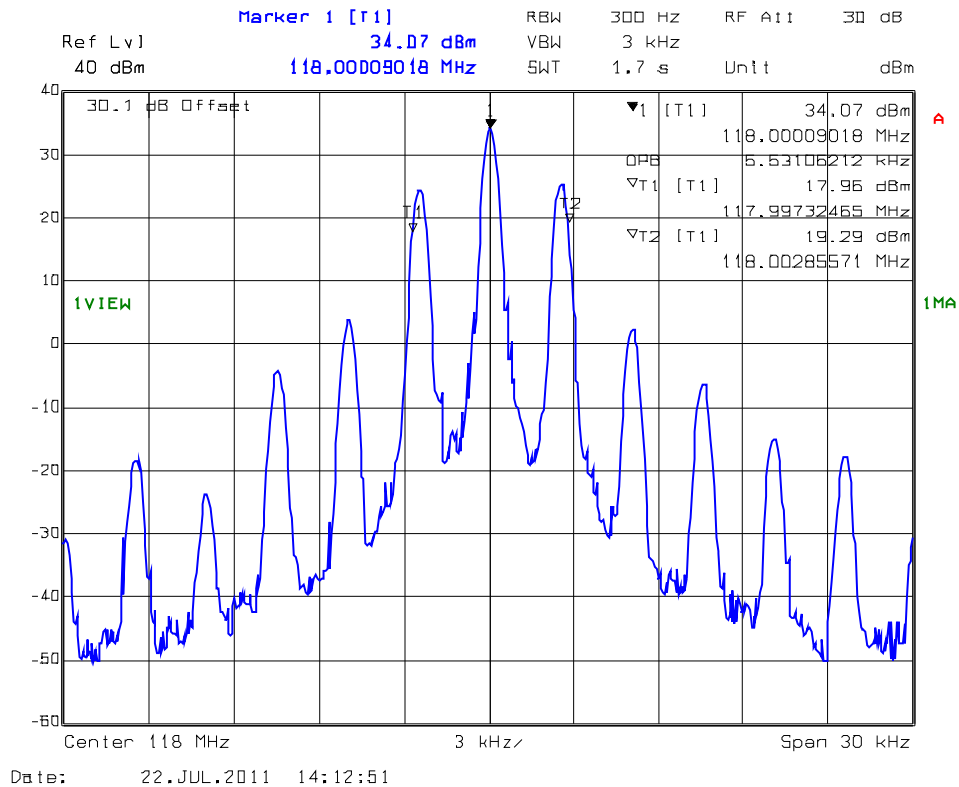
Frequency (MHz)	Channel Spacing (KHz)	Modulation	*Measured 99% OBW at Maximum Freq. Deviation (KHz)	Maximum Authorized Bandwidth (KHz)
118	25.0/8.33	FM with 2.5 KHz sine wave signal	5.53	25.00
127.5	25.0/8.33	FM with 2.5 KHz sine wave signal	5.53	25.00
136.975	25.0/8.33	FM with 2.5 KHz sine wave signal	5.53	25.00

Note: 99% Occupied Bandwidth measurements were done using the built-in auto function of the spectrum analyzer.

*Refer to the following test data plots for details.

Plot # 1.: 99% Occupied Bandwidth

Frequency: 118 MHz



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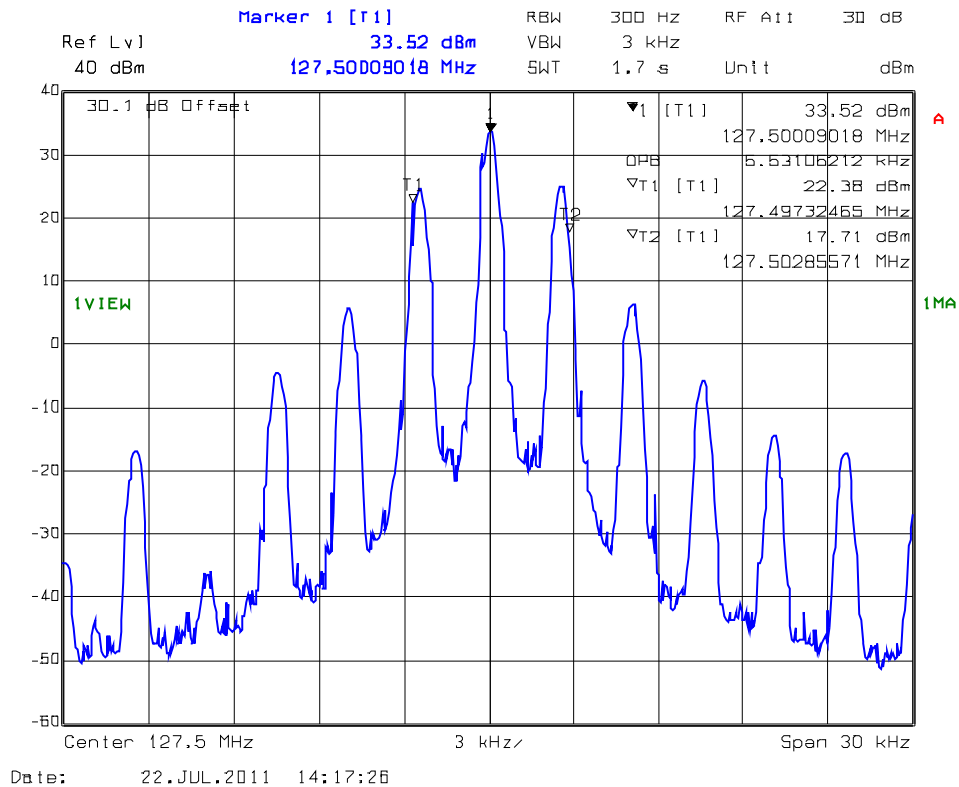
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Plot # 2.: 99% Occupied Bandwidth

Frequency: 127.5 MHz



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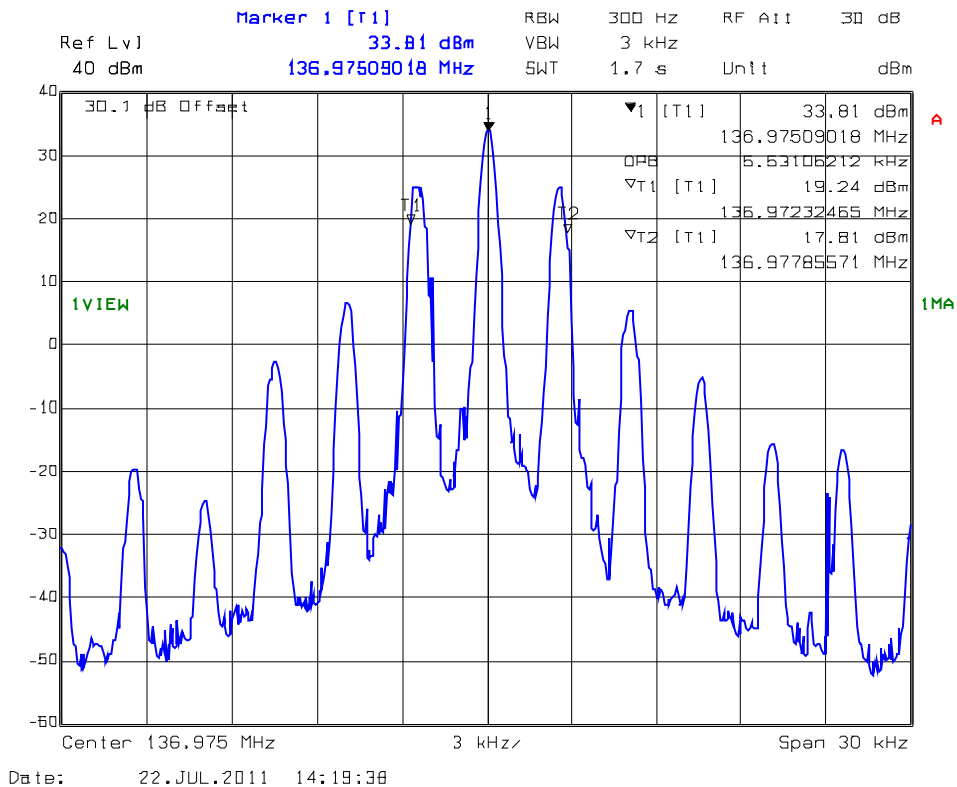
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Plot # 3.: 99% Occupied Bandwidth

Frequency: 136.975 MHz



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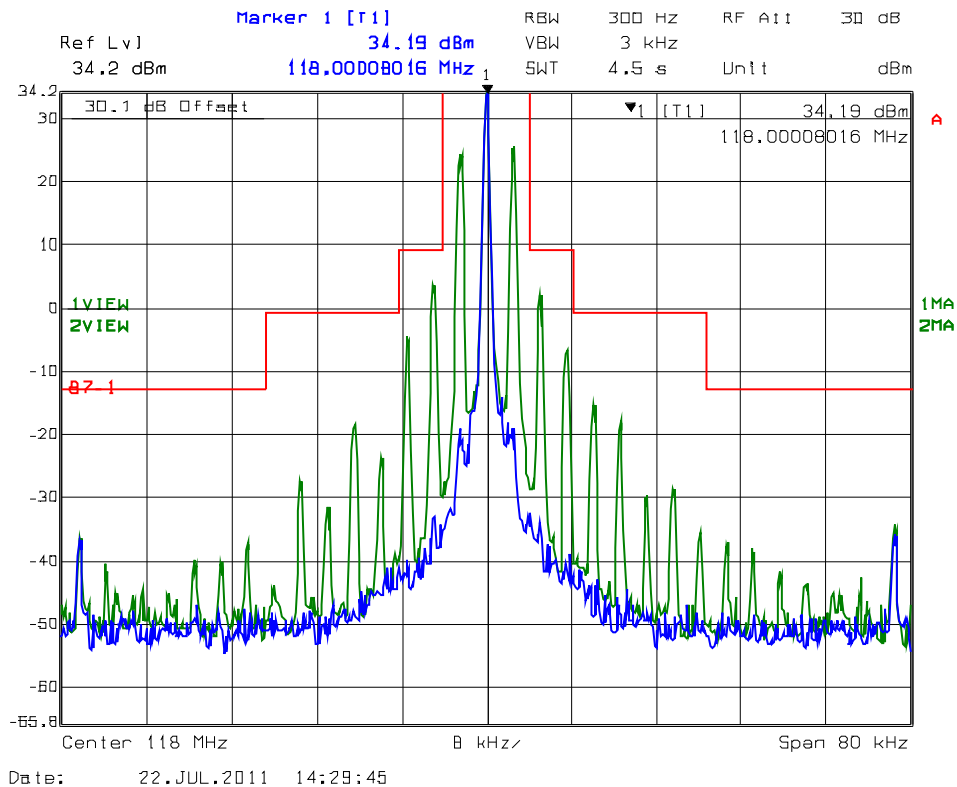
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Plot # 4.: Emission Limitations

Frequency: 118 MHz, 8.33 Ch Spacing



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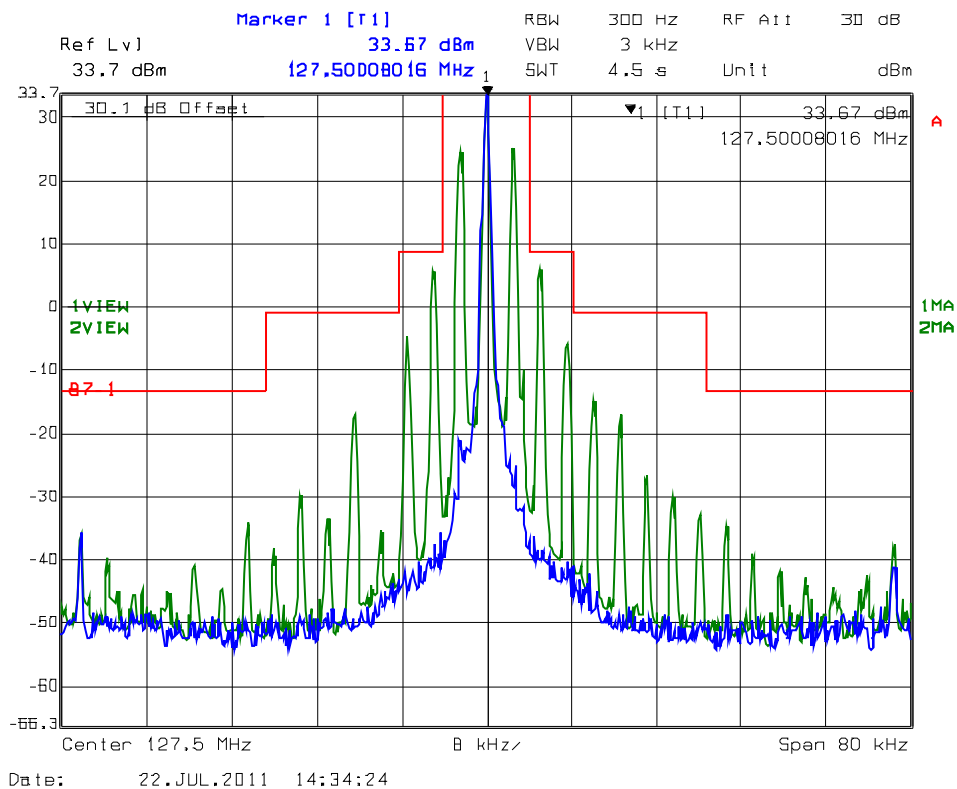
3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4
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Plot # 5.: Emission Limitations
Frequency: 127.5 MHz, 8.33 Ch Spacing



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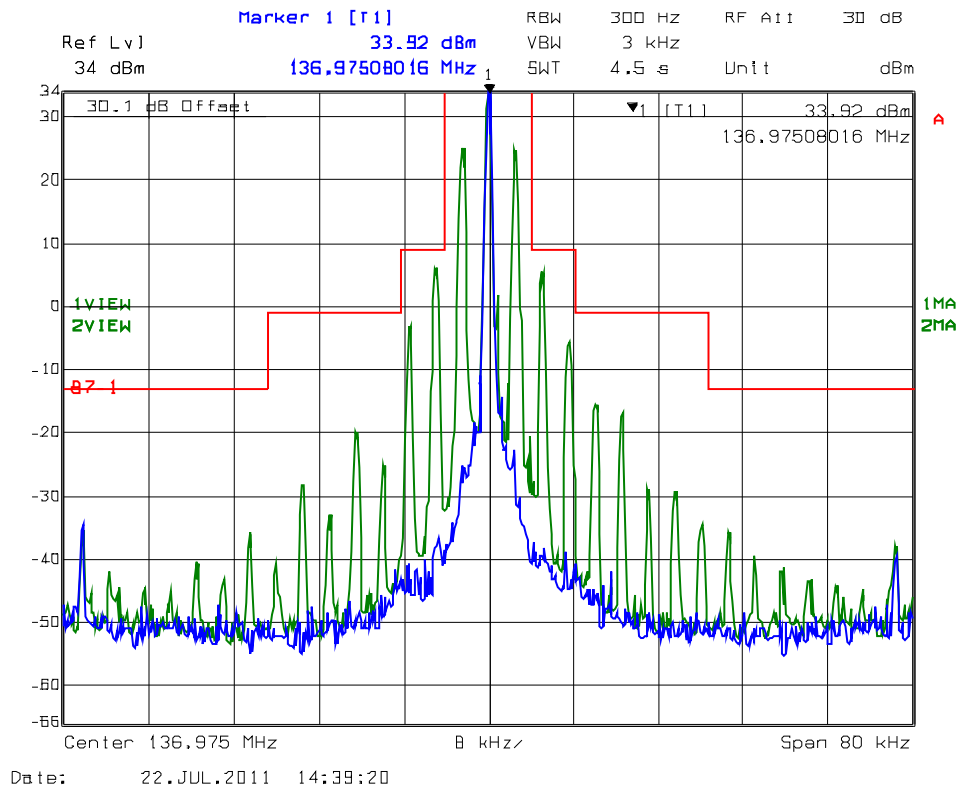
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Plot # 6.: Emission Limitations

Frequency: 136.975 MHz, 8.33 Ch Spacing



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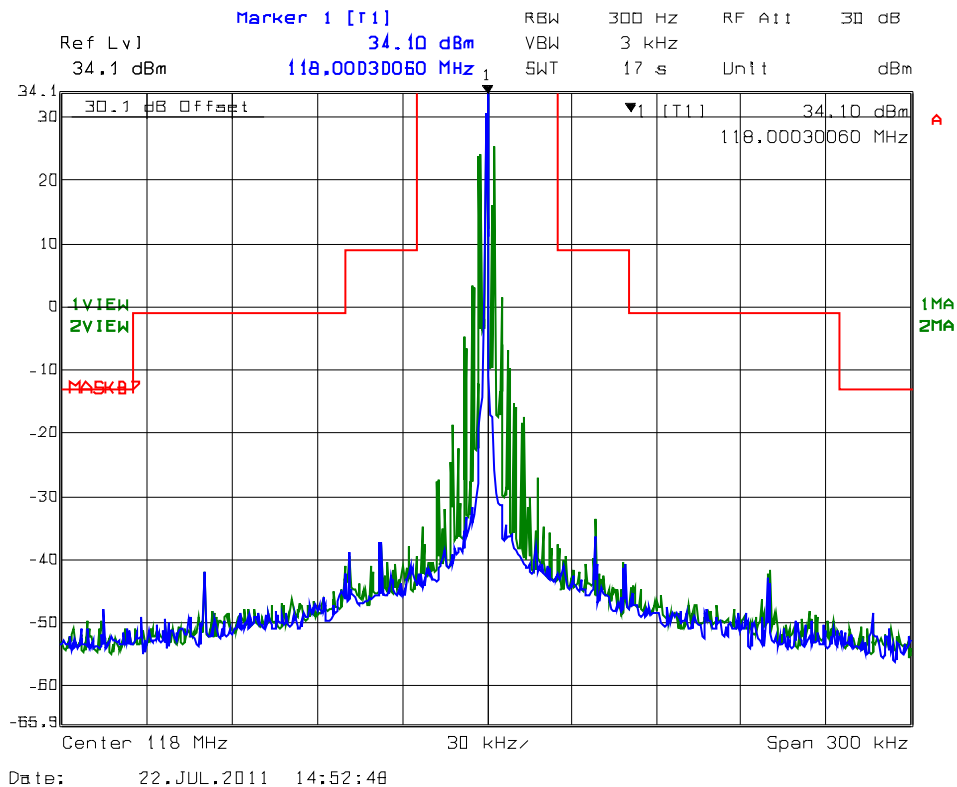
File #: TIL-072FCC87

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Plot # 7.: Emission Limitations

Frequency: 118 MHz, 25.0 Ch Spacing



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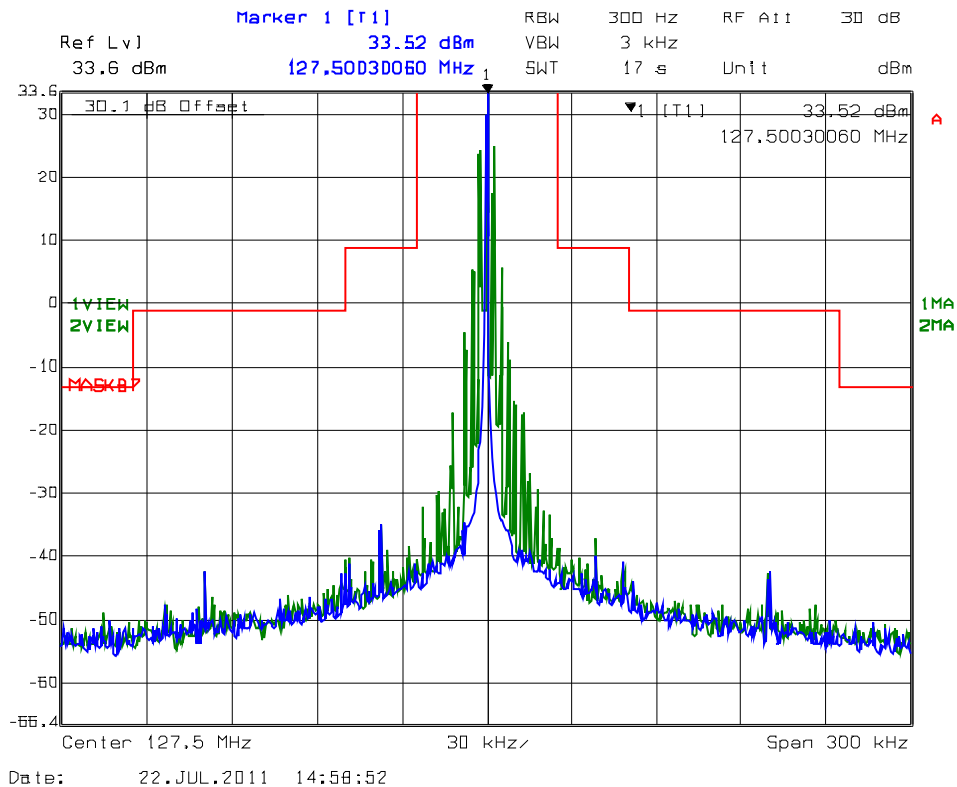
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Plot # 8.: Emission Limitations
Frequency: 127.5 MHz, 25.0 Ch Spacing



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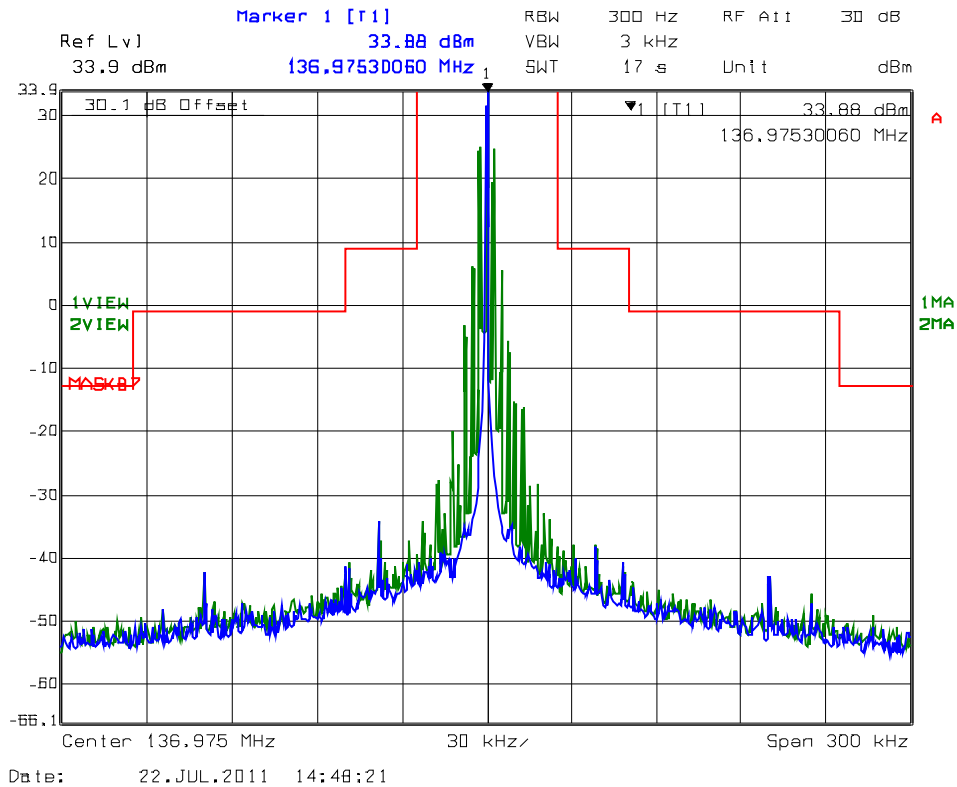
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Plot # 9.: Emission Limitations

Frequency: 136.975 MHz, 25.0 Ch Spacing



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5.6. TRANSMITTER ANTENNA POWER SPURIOUS/HARMONIC CONDUCTED EMISSIONS [§§ 2.1051, 87.139]

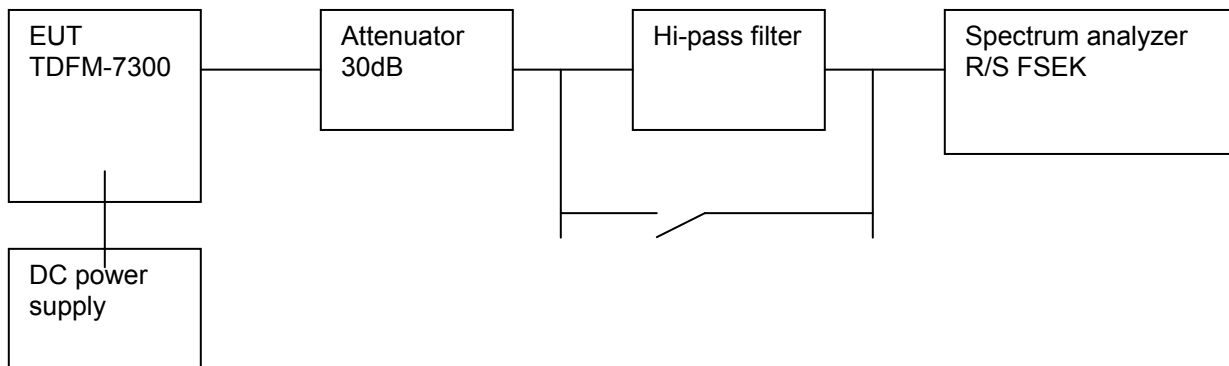
5.6.1. Limits

§§ 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; and the attenuation for aeronautical station transmitters must be at least $43 + 10 \log_{10} pY$ dB.

5.6.2. Method of Measurements

Refer to Exhibit 8 of this report for measurement method.

5.6.3. Test Arrangement

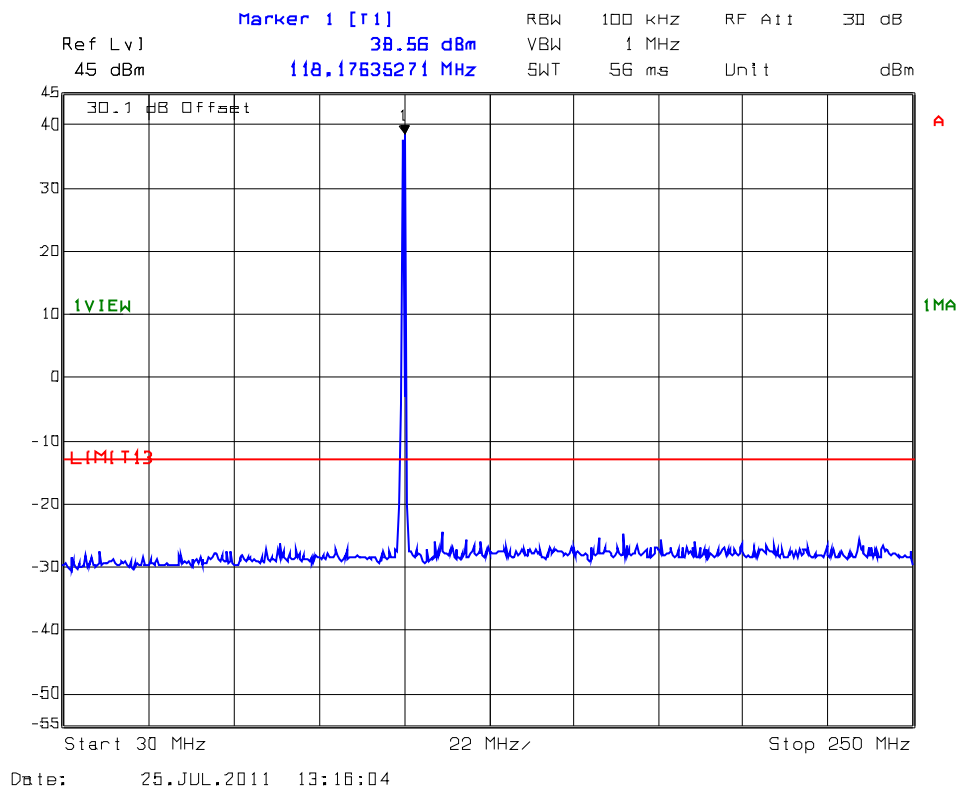


5.6.4. Test Data

Note: There was no difference in spurious/harmonic emissions on the pre-scans for different channel spacing and modulation types. Therefore, the RF spurious/harmonic emissions in this section would be performed for 25 KHz channel spacing and the more stringent limit of $43 + 10 \log_{10} pY$ dB would be applied for worst case.

Plot # 10.: Spurious Emissions at Antenna Port

Carrier Frequency: 118 MHz



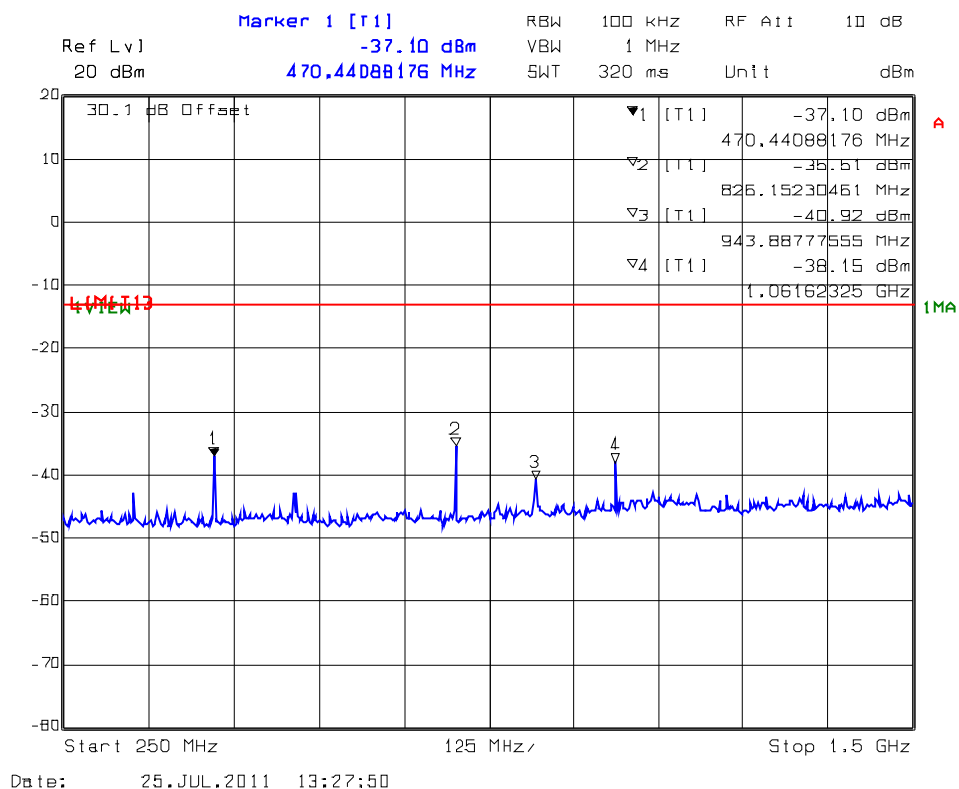
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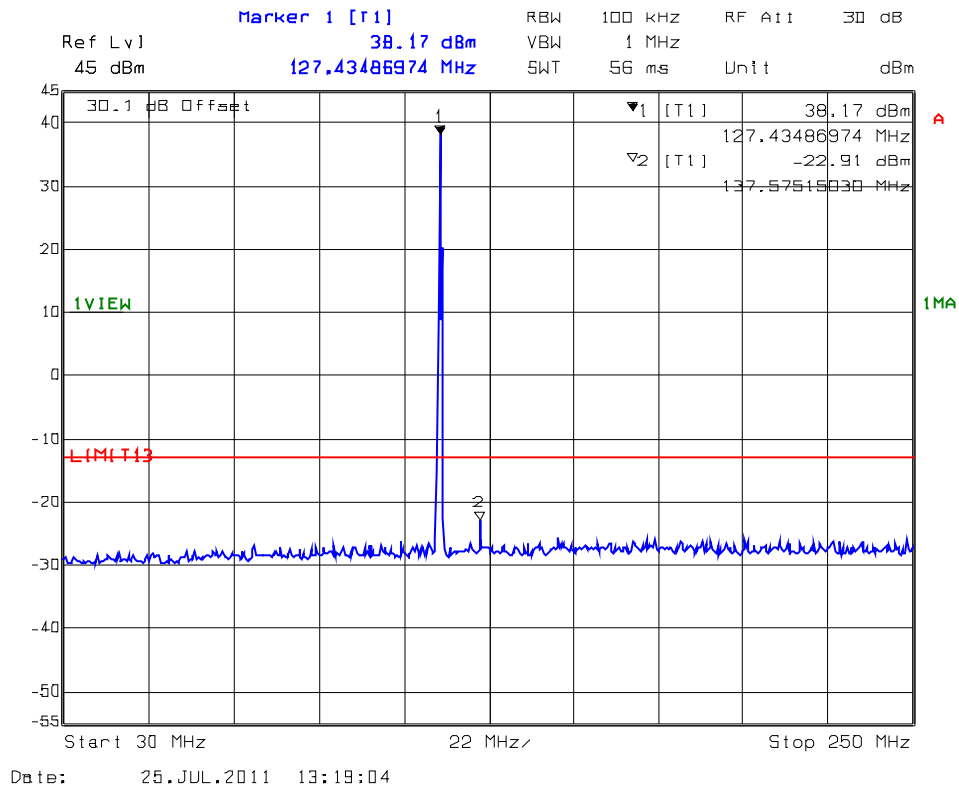
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Plot # 11.: Spurious Emissions at Antenna Port

Carrier Frequency: 127.5 MHz



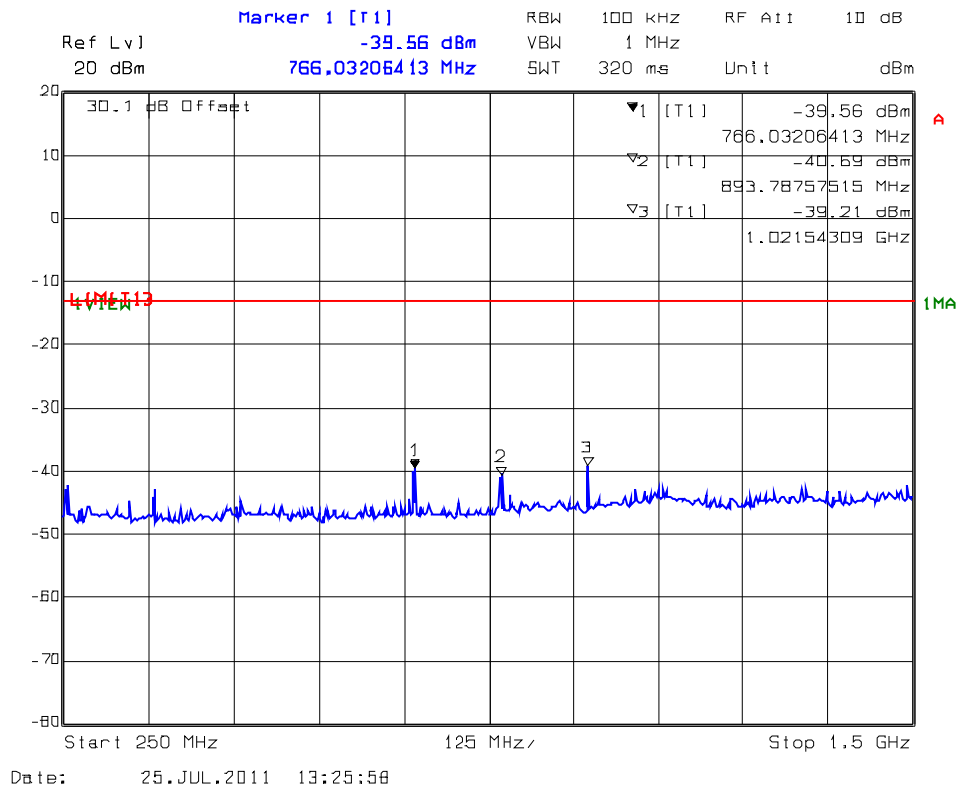
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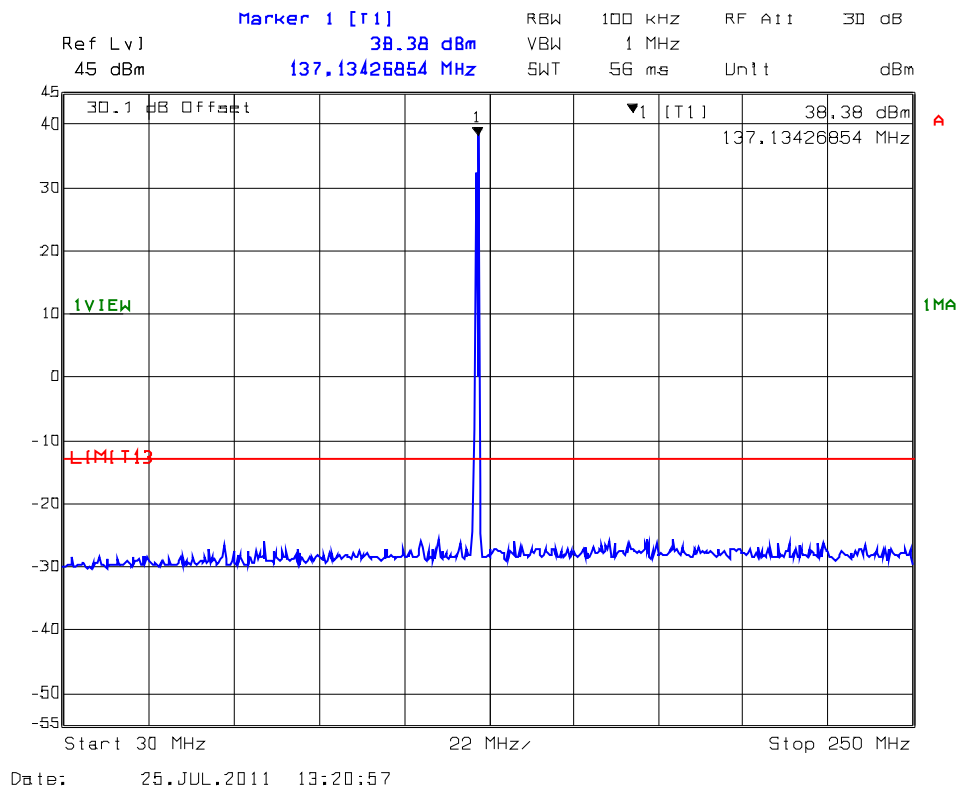
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Plot # 12.: Spurious Emissions at Antenna Port

Carrier Frequency: 136.975 MHz



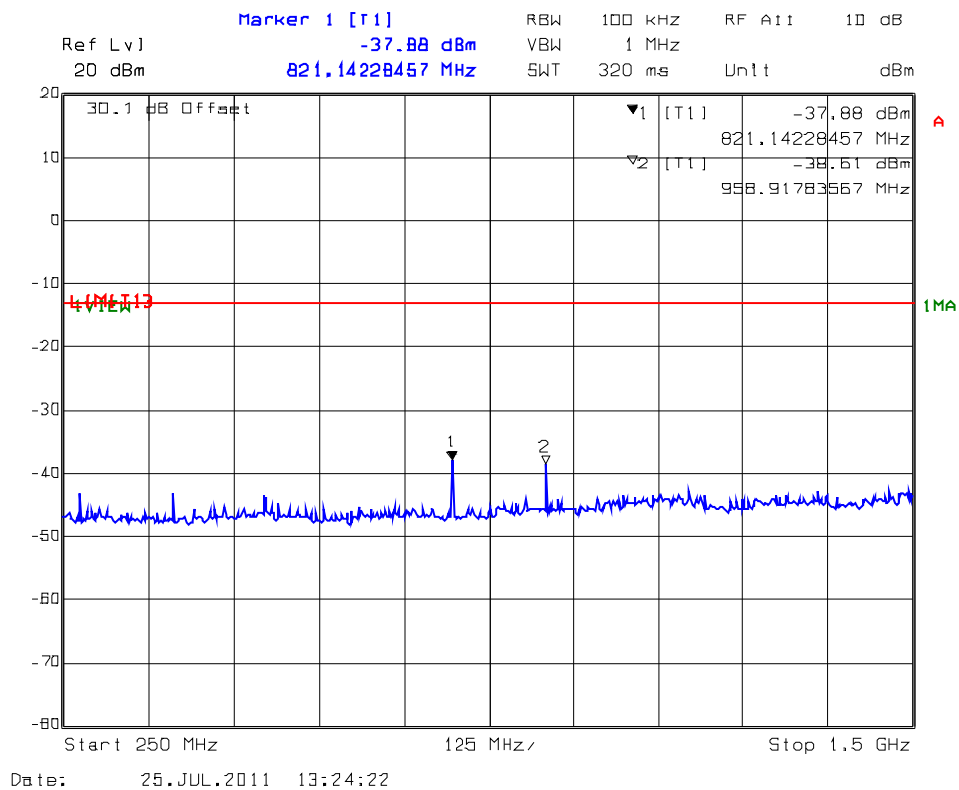
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5.7. TRANSMITTER SPURIOUS/HARMONIC RADIATED EMISSIONS [§§ 2.1053, 87.139]

5.7.1. Limits

§§ 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; and the attenuation for aeronautical station transmitters must be at least $43 + 10 \log_{10} pY$ dB.

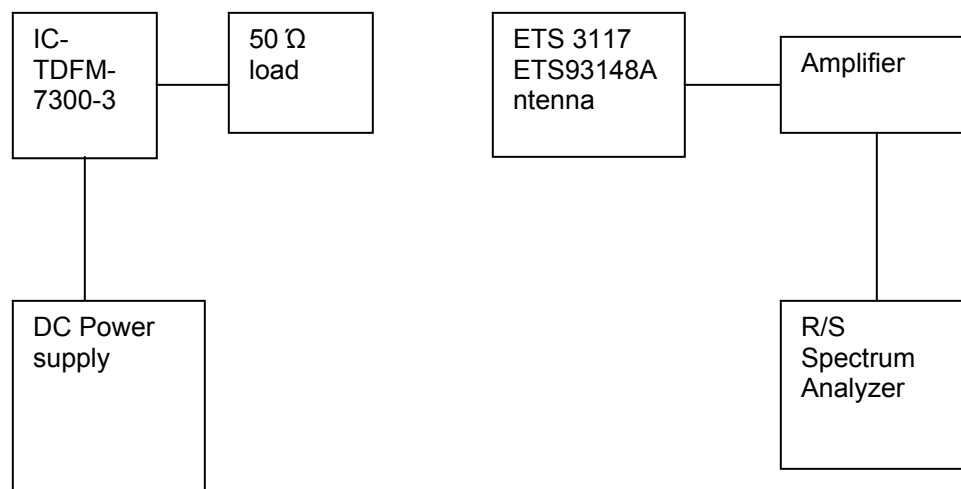
5.7.2. Method of Measurements

The spurious/harmonic ERP measurements are using substitution method specified in Section 8.2 of this report and its value in dBc is calculated as follows:

- (1) If the transmitter's antenna is an integral part of the EUT, the ERP is measured using substitution method.
- (2) If the transmitter's antenna is non-integral and diverse, the lowest ERP of the carrier with 0 dBi antenna gain is used for calculation of the spurious/harmonic emissions in dBc:
Lowest ERP of the carrier = $EIRP - 2.15 \text{ dB} = P_c + G - 2.15 \text{ dB} = P_c \text{ dBm (conducted)} + 0 \text{ dBi} - 2.15 \text{ dB}$
- (3) Spurious /harmonic emissions levels expressed in dBc (dB below carrier) are as follows:

$$ERP_{\text{spurious/harmonic}} (\text{dBc}) = ERP_{\text{carrier}} (\text{dBm}) - ERP_{\text{spurious/harmonic emission}} (\text{dBm})$$

5.7.3. Test Arrangement



5.7.4. Test Data

5.7.4.1. Near Lowest Frequency (118.000 MHz)

Fundamental Frequency: 118.000 MHz
RF Output Power: 2.77 W
Limit: -13.0 dBm
Test Frequency Range: 30 MHz – 2 GHz

Radiated Emissions were scanned up to 10th Harmonics and all emissions found are more than 20 dB below the limit.

5.7.4.2. Near Middle Frequency (127.500 MHz)

Fundamental Frequency: 127.500 MHz
RF Output Power: 2.48 W
Limit: -13.0 dBm
Test Frequency Range: 30 MHz – 2 GHz

Radiated Emissions were scanned up to 10th Harmonics and all emissions found are more than 20 dB below the limit.

5.7.4.3. Near Highest Frequency (136.975 MHz)

Fundamental Frequency: 136.975 MHz
RF Output Power: 2.60 W
Limit: -13.0 dBm
Test Frequency Range: 30 MHz – 2 GHz

Radiated Emissions were scanned up to 10th Harmonics and all emissions found are more than 20 dB below the limit.

5.8. RF EXPOSURE REQUIRMENTS [§§ 1.1310 & 2.1091]

The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation.

FCC 47 CFR § 1.1310:

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3–3.0	614	1.63	*(100)	6
3.0–30	1842/f	4.89/f	*(900/f ²)	6
30–300	61.4	0.163	1.0	6
300–1500 .....	.....	.....	f/300	6
1500–100,000 .....	.....	.....	5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3–1.34	614	1.63	*(100)	30
1.34–30	824/f	2.19/f	*(180/f ²)	30
30–300	27.5	0.073	0.2	30
300–1500 .....	.....	.....	f/1500	30
1500–100,000 .....	.....	.....	1.0	30

f = frequency in MHz

* = Plane-wave equivalent power density

NOTE 1 TO TABLE 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

NOTE 2 TO TABLE 1: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

5.8.1. Method of Measurements

Refer to Sections 1.1310, 2.1091

In order to demonstrate compliance with MPE requirements (see Section 2.1091), the following information is typically needed:

- (1) Calculation that estimates the minimum separation distance (20 cm or more) between an antenna and persons required to satisfy power density limits defined for free space.
- (2) Antenna installation and device operating instructions for installers (professional/unskilled users), and the parties responsible for ensuring compliance with the RF exposure requirement
- (3) Any caution statements and/or warning labels that are necessary in order to comply with the exposure limits
- (4) Any other RF exposure related issues that may affect MPE compliance

Calculation Method of RF Safety Distance:

$$S = \frac{P \cdot G}{4 \cdot \pi \cdot r^2} = \frac{EIRP}{4 \cdot \pi \cdot r^2}$$

Where: P: power input to the antenna in mW
EIRP: Equivalent (effective) isotropic radiated power
S: power density mW/cm²
G: numeric gain of antenna relative to isotropic radiator
r: distance to centre of radiation in cm

5.8.2. RF Evaluation

Evaluation of RF Exposure Compliance Requirements	
RF Exposure Requirements	Compliance with FCC Rules
Minimum calculated separation distance between antenna and persons required: 47 cm	Manufacturer' instruction for separation distance between antenna and persons required: 90 cm
Antenna installation and device operating instructions for installers (professional/unskilled users), and the parties responsible for ensuring compliance with the RF exposure requirement	Antenna installation and device operating instructions shall be provided to installers to maintain and ensure compliance with RF exposure requirements.
Caution statements and/or warning labels that are necessary in order to comply with the exposure limits	Refer to User's Manual for RF Exposure Information.
Any other RF exposure related issues that may affect MPE compliance	None.

*The minimum separation distance between the antenna and bodies of users are calculated using the following formula:

RF EXPOSURE DISTANCE LIMITS

$$r = \sqrt{\frac{P \cdot G}{4 \cdot \pi \cdot S}} = \sqrt{\frac{EIRP}{4 \cdot \pi \cdot S}}$$

S = 0.2 mW/cm²

EIRP = 34.42 dBm + 3 dBi = 37.42 dBm = 5527 mW (worst case)

$$(\text{Minimum Safe Distance, } r) = \sqrt{\frac{EIRP}{4 \cdot \pi \cdot S}} = \sqrt{\frac{5527}{4 \cdot \pi \cdot (0.2)}} \approx 47\text{cm}$$

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EXHIBIT 6. TEST EQUIPMENT LIST

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range	Cal. DueDate
Spectrum Analyzer	Rhode & Schwarz	FSEK	834157/005	9 KHz – 40 GHz	18 Jul 2012
Attenuator (30dB)	Aeroflex/Weinschel	46-30-34	BR9127	DC-18 GHz	Cal. on use
Power Meter	Hewlett Packard	437B	3125U06665	100K--50G sensor dependent	20 Aug 2011
Log Periodic Antenna	ETS-LINDGREN	93148	1101	200-2000 MHz	04 Jan 2012
Bi-conical Antenna	ETS-LINDGREN	3110B	3379	30-300MHz	20 Nov 2011
Horn Antenna	ETS-LINDGREN	3117	119425	1-18GHz	15 Feb 2012
Power Sensor	Hewlett Packard	8481A	2237A33409	0.1 - 18 GHz	27 Aug 2011
RF Communication Test Set	Hewlett Packard	8920B	US39064699	30MHz-1GHz	27 Oct 2012
Modulation Analyzer	Hewlett Packard	8901B	3226A04606	150KHz-1300MHz	17 Dec 2011
FFT Spectrum Analyzer	Advantest	R9211E	8202336	10mHz--100KHz	12 Nov 2011
Frequency Counter	EIP	545A	2683	10Hz - 18 GHz	31 Jan 2012
RF Synthesized signal Generator	HP	8648C	3343U00391	100K-3200M Hz AM/ FM/ PM	16 Dec 2011
High Pass Filter	Mini Circuit	SHP 250	--	Cut off 230 MHz	Cal. on use
Combiner	Mini Circuit	ZFSC-3-4	15542	1MHz - 1GHz	Cal. on use
Power supply	Tenma	72-7295	490300297	1-40V DC 5A	Cal. on use

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EXHIBIT 7. MEASUREMENT UNCERTAINTY

The measurement uncertainties stated were calculated in accordance with the requirements of CISPR 16-4-2 @ IEC:2003 and JCGM 100:2008 (GUM 1995) – Guide to the Expression of Uncertainty in Measurement.

7.1. RADIATED EMISSION MEASUREMENT UNCERTAINTY

	Radiated Emission Measurement Uncertainty @ 3m, Horizontal (30-1000 MHz):	Measured	Limit
u_c	Combined standard uncertainty: $u_c(y) = \sqrt{\sum_{i=1}^m u_i^2(y)}$	± 2.15	± 2.6
U	Expanded uncertainty U: $U = 2u_c(y)$	± 4.30	± 5.2

	Radiated Emission Measurement Uncertainty @ 3m, Vertical (30-1000 MHz):	Measured	Limit
u_c	Combined standard uncertainty: $u_c(y) = \sqrt{\sum_{i=1}^m u_i^2(y)}$	± 2.39	± 2.6
U	Expanded uncertainty U: $U = 2u_c(y)$	± 4.78	± 5.2

	Radiated Emission Measurement Uncertainty @ 3 m, Horizontal & Vertical (1 – 18 GHz):	Measured	Limit
u_c	Combined standard uncertainty: $u_c(y) = \sqrt{\sum_{i=1}^m u_i^2(y)}$	± 1.87	Under consideration
U	Expanded uncertainty U: $U = 2u_c(y)$	± 3.75	Under consideration

EXHIBIT 8. MEASUREMENT METHODS

8.1. CONDUCTED POWER MEASUREMENTS

- The following shall be applied to the combination(s) of the radio device and its intended antenna(e).
- If the RF level is user adjustable, all measurements shall be made with the highest power level available to the user for that combination.
- The following method of measurement shall apply to both conducted and radiated measurements.
- The radiated measurements are performed at the Ultratech Calibrated Open Field Test Site.
- The measurement shall be performed using normal operation of the equipment with modulation.

Test procedure shall be as follows:

Step 1: Duty Cycle measurements if the transmitter's transmission is transient

- Using a EMI Receiver with the frequency span set to 0 Hz and the sweep time set at a suitable value to capture the envelope peaks and the duty cycle of the transmitter output signal;
- The duty cycle of the transmitter, $x = T_x \text{ on} / (T_x \text{ on} + T_x \text{ off})$ with $0 < x < 1$, is measure and recorded in the test report. For the purpose of testing, the equipment shall be operated with a duty cycle that is equal or more than 0.1.

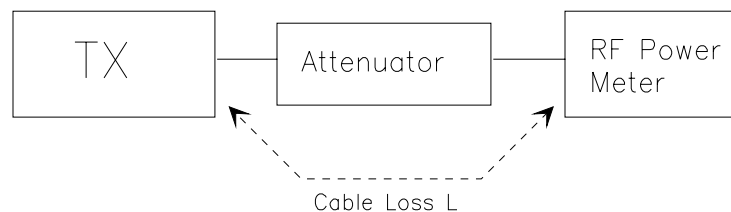
Step 2: Calculation of Average EIRP. See Figure 1

- The average output power of the transmitter shall be determined using a wideband, calibrated RF average power meter with the power sensor with an integration period that exceeds the repetition period of the transmitter by a factor 5 or more. The observed value shall be recorded as "A" (in dBm);
- The e.i.r.p. shall be calculated from the above measured power output "A", the observed duty cycle x, and the applicable antenna assembly gain "G" in dBi, according to the formula:

$$\text{EIRP} = A + G + 10\log(1/x)$$

{X = 1 for continuous transmission => $10\log(1/x) = 0 \text{ dB}$ }

Figure 1.



8.2. RADIATED POWER MEASUREMENTS (ERP & EIRP) USING SUBSTITUTION METHOD

8.2.1. MAXIMIZING RF EMISSION LEVEL (E-FIELD)

- (a) The measurements were performed with full rf output power and modulation.
- (b) Test was performed at listed 3m open area test site (listed with FCC, IC, ITI, NVLAP, ACA & VCCI).
- (c) The transmitter under test was placed at the specified height on a non-conducting turntable (80 cm height)
- (d) The BICONILOG antenna (20 MHz to 1 GHz) or HORN antenna (1 GHz to 18 GHz) was used for measuring.
- (e) Load an appropriate correction factors file in EMI Receiver for correcting the field strength reading level

Total Correction Factor recorded in the EMI Receiver = Cable Loss + Antenna Factor
 $E \text{ (dB}\mu\text{V/m)} = \text{Reading (dB}\mu\text{V)} + \text{Total Correction Factor (dB/m)}$

- (f) Set the EMI Receiver and #2 as follows:

Center Frequency: test frequency
Resolution BW: 100 KHz
Video BW: same
Detector Mode: positive
Average: off
Span: 3 x the signal bandwidth

- (g) The test antenna was lowered or raised from 1 to 4 meters until the maximum signal level was detected.
- (h) The transmitter was rotated through 360° about a vertical axis until a higher maximum signal was received.
- (i) The test antenna was lowered or raised again from 1 to 4 meters until a maximum was obtained. This level was recorded.
- (j) The recorded reading was corrected to the true field strength level by adding the antenna factor, cable loss and subtracting the pre-amplifier gain.
- (k) The above steps were repeated with both transmitters' antenna and test receiving antenna placed in vertical and horizontal polarization. Both readings with the antennas placed in vertical and horizontal polarization shall be recorded.
- (l) Repeat for all different test signal frequencies.

8.2.2. Measuring the EIRP of Spurious/Harmonic Emissions using Substitution Method

- (a) Set the EMI Receiver (for measuring E-Field) and Receiver #2 (for measuring EIRP) as follows:

Center Frequency: equal to the signal source
Resolution BW: 100 KHz
Video BW: VBW > RBW
Detector Mode: positive
Average: off
Span: 3 x the signal bandwidth

- (b) Load an appropriate correction factors file in EMI Receiver for correcting the field strength reading level

Total Correction Factor recorded in the EMI Receiver = Cable Loss + Antenna Factor
 $E \text{ (dBuV/m)} = \text{Reading (dBuV)} + \text{Total Correction Factor (dB/m)}$

- (c) Select the frequency and E-field levels obtained in the Section 8.2.1 for ERP/EIRP measurements.
(d) Substitute the EUT by a signal generator and one of the following transmitting antenna (substitution antenna):
 - ◆ DIPOLE antenna for frequency from 30-1000 MHz or
 - ◆ HORN antenna for frequency above 1 GHz }.(e) Mount the transmitting antenna at 1.5 meter high from the ground plane.
(f) Use one of the following antenna as a receiving antenna:
 - ◆ DIPOLE antenna for frequency from 30-1000 MHz or
 - ◆ HORN antenna for frequency above 1 GHz }.(g) If the DIPOLE antenna is used, tune it's elements to the frequency as specified in the calibration manual.
(h) Adjust both transmitting and receiving antenna in a VERTICAL polarization.
(i) Tune the EMI Receivers to the test frequency.
(j) Lower or raise the test antenna from 1 to 4 meters until the maximum signal level was detected.
(k) The transmitter was rotated through 360° about a vertical axis until a higher maximum signal was received.
(l) Lower or raise the test antenna from 1 to 4 meters until the maximum signal level was detected.
(m) Adjust input signal to the substitution antenna until an equal or a known related level to that detected from the transmitter was obtained in the test receiver.
(n) Record the power level read from the Average Power Meter and calculate the ERP/EIRP as follows:

$$P = P1 - L1 = (P2 + L2) - L1 = P3 + A + L2 - L1$$

$$\text{EIRP} = P + G1 = P3 + L2 - L1 + A + G1$$

$$\text{ERP} = \text{EIRP} - 2.15 \text{ dB}$$

$$\text{Total Correction factor in EMI Receiver \# 2} = L2 - L1 + G1$$

Where:

P:	Actual RF Power fed into the substitution antenna port after corrected.
P1:	Power output from the signal generator
P2:	Power measured at attenuator A input
P3:	Power reading on the Average Power Meter
EIRP:	EIRP after correction
ERP:	ERP after correction

- (o) Adjust both transmitting and receiving antenna in a HORIZONTAL polarization, then repeat step (k) to (o)
(p) Repeat step (d) to (o) for different test frequency
(q) Repeat steps (c) to (j) with the substitution antenna oriented in horizontal polarization.
(r) Actual gain of the EUT's antenna is the difference of the measured EIRP and measured RF power at the RF port. Correct the antenna gain if necessary.

Figure 2

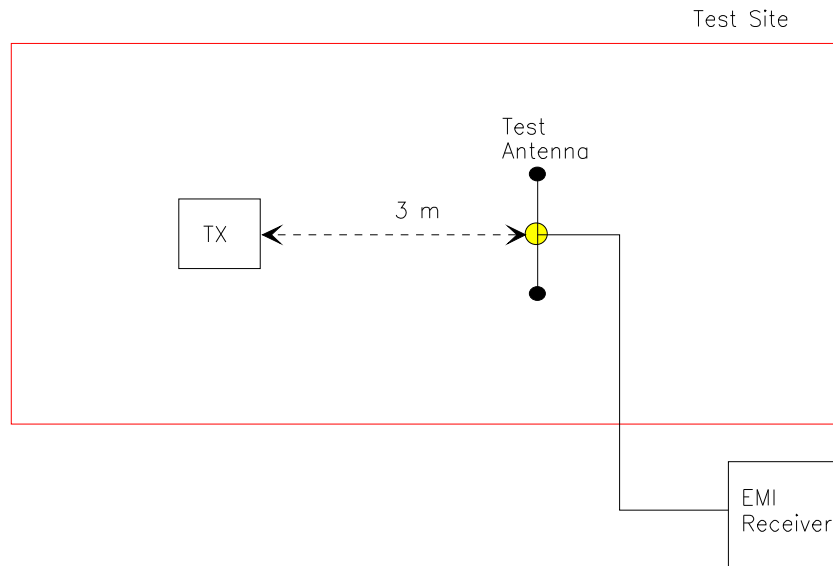
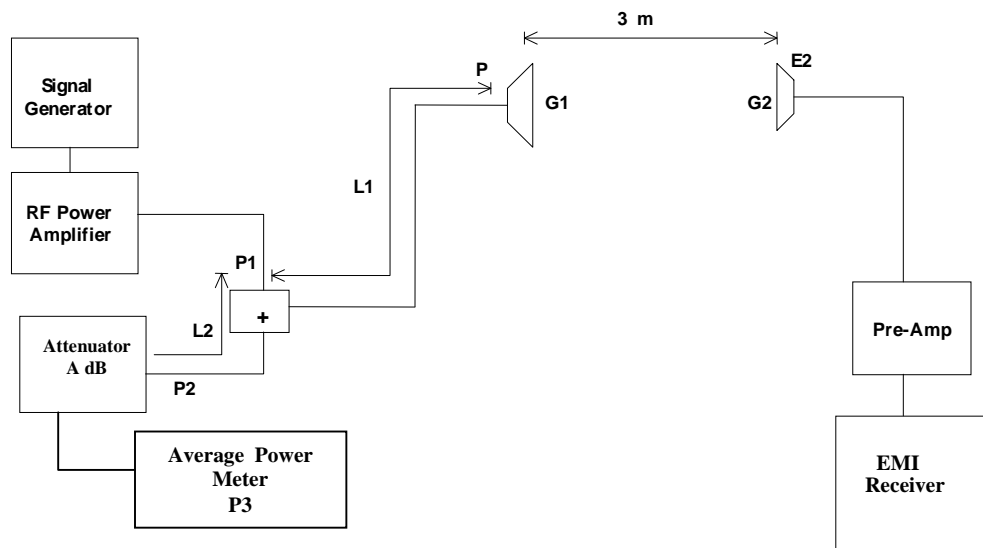


Figure 3



8.3. FREQUENCY STABILITY

Refer to FCC @ 2.1055.

- (a) The frequency stability shall be measured with variation of ambient temperature as follows: From -30 to +50 centigrade except that specified in subparagraph (2) & (3) of this paragraph.
- (b) Frequency measurements shall be made at extremes of the specified temperature range and at intervals of not more than 10 centigrade through the range. A period of time sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. The short-term transient effects on the frequency of the transmitter due to keying (except for broadcast transmitters) and any heating element cycling normally occurring at each ambient temperature level also shall be shown. Only the portion or portions of the transmitter containing the frequency determining and stability circuitry need be subjected to the temperature variation test.
- (d) The frequency stability supply shall be measured with variation of primary supply voltage as follows:
 - (1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.
 - (2) For hand carried, battery powered equipment, reduce primary supply voltage to the battery operating end point which shall be specified by the manufacturer.
 - (3) The supply voltage shall be measured at the input to the cable normally provide with the equipment, or at the power supply terminals if cables are not normally provided. Effects on frequency of transmitter keying (except for broadcast transmitters) and any heating element cycling at the nominal supply voltage and at each extreme also shall be shown.
- (e) When deemed necessary, the Commission may require tests of frequency stability under conditions in addition to those specifically set out in paragraphs (a), (b), (c) and (d) of this section. (For example, measurements showing the effect of proximity to large metal objects, or of various types of antennas, may be required for portable equipment).

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File #: TIL-072FCC87
August 19, 2011

All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

8.4. EMISSION MASK

Voice or Digital Modulation Through a Voice Input Port @ 2.1049(c)(i): The transmitter was modulated by a 2.5 KHz tone signal at an input level 16 dB greater than that required to produce 50% modulation (e.g.: ± 2.5 KHz peak deviation at 1 KHz modulating frequency). The input level was established at the frequency of maximum response of the audio modulating circuit.

Digital Modulation Through a Data Input Port @ 2.1049(h): Transmitters employing digital modulation techniques - when modulated by an input signal such that its amplitude and symbol rate represent the maximum rated conditions under which the equipment will be operated. The signal shall be applied through any filter networks, pseudo-random generators or other devices required in normal service. Additionally, the Emission Masks shall be shown for operation with any devices used for modifying the spectrum when such devices are operational at the discretion of the user.

The following EMI Receiver bandwidth shall be used for measurement of Emission Mask/Out-of-Band Emission Measurements:

- (1) For 25 KHz Channel Spacing: RBW = 300 Hz
- (2) For 12.5 KHz or 6.25 KHz Channel Spacings: RBW = 100 Hz

The all cases the Video Bandwidth shall be equal or greater than the measuring bandwidth.

8.5. SPURIOUS EMISSIONS (CONDUCTED)

With transmitter modulation characteristics described in Out-of-Band Emissions measurements @ 2.1049, the transmitter spurious and harmonic emissions were scanned. The spurious and harmonic emissions were measured with the EMI Receiver controls set as RBW = 30 KHz minimum, VBW \geq RBW and SWEEP TIME = AUTO). The transmitter was operated at a full rated power output, and modulated as follows:

FCC 47 CFR 2.1057 - Frequency spectrum to be investigated: The spectrum was investigated from the lowest radio generated in the equipment up to at least the 10th harmonic of the carrier frequency or to the highest frequency practicable in the present state of the art of measuring techniques, whichever is lower. Particular attention should be paid to harmonics and subharmonics of the carrier frequency. Radiation at the frequencies of multiplier stages should be checked. The amplitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be reported.

FCC 47 CFR 2.1051 - Spurious Emissions at Antenna Terminal: The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of the harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in 2.1049 as appropriate. The magnitude of spurious emissions, which are attenuated more than 20 dB below the permissible value, need not be specified.