ENGINEERING TEST REPORT

VRS
Model No.: 270-3240-020
FCC ID: XEU2703240

Applicant:

Rockwell Collins, Inc.
1300 Wilson Blvd, Suite 200
Arlington, VA
USA, 22209

Tested in Accordance With

Federal Communications Commission (FCC)
47 CFR, Parts 2 and 90 (Subpart R)

UltraTech's File No.: ETST-001F90

This Test report is Issued under the Authority of Tri M. Luu, Professional Engineer, Vice President of Engineering UltraTech Group of Labs Date: September 8, 2009	
Report Prepared by: JaeWook Choi Issued Date: September 8, 2009	Tested by: Hung Trinh Test Dates: September 3 ~ 7, 2009

- *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 Group of Labs

FC	VCI	Industry Canada Industrie Canada Approval Test Facility	NVLAP	BSMI	Korea KCC-RRL
91038	1309	46390-2049	200093-0	SL2-IN-E-1119R	CA2049

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3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4 August 18, 2009
Tel. #: 905-829-1570, Fax. #: 905-829-8050, Email: vic@ultratech-labs.com, Website: http://www.ultratech-labs.com

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EXHIBIT 1.   INTRODUCTION

1.1.   SCOPE

Reference:	FCC Parts 2 and 90
Title:	Code of Federal Regulations (CFR), Title 47 Telecommunication – Parts 2 & 90
Purpose of Test:	To obtain FCC Certification Authorization for Radio operating in the Frequency Band 769.15-770 MHz (25 KHz and 12.5 KHz Channel Spacing).
Test Procedures:	Both conducted and radiated emissions measurements were conducted in accordance with TIA/EIA Standard TIA/EIA-603 (01-Nov-2002) – 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	2008	Code of Federal Regulations – Telecommunication
ANSI C63.4	2003	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
TIA/EIA 603, Edition 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:	Rockwell Collins, Inc.
Address:	1300 Wilson Blvd, Suite 200 Arlington, VA USA, 22209
Contact Person:	Holly Riesz Phone #: 1-703-516-8210 Fax #: +1-703-516-8293 Email Address: hjriesz@rockwellcollins.com

MANUFACTURER	
Name:	Technisonic Industires Limited
Address:	240 Traders Blvd. E Mississauga, Ontario Canada, L4Z 1W7
Contact Person:	Alex Upchurch Phone #: +1-905-890-2113 Fax #: +1-905-890-5338 Email Address: alex.upchurch@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:	Rockwell Collins, Inc.
Product Name:	VRS
Model Name or Number:	270-3240-020
Serial Number:	001
Type of Equipment:	Licensed Non-Broadcast Transceiver
Power Supply Requirement:	9.0 – 19.0 VDC
Transmitting/Receiving Antenna Type:	Non-integral
Primary User Functions of EUT:	In vehicle repeater for repeating analog and digital voice

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2.3. EUT'S TECHNICAL SPECIFICATIONS

TRANSMITTER	
Equipment Type:	Mobile
Intended Operating Environment:	Commercial, Industrial or Business
Power Supply Requirement:	12 VDC
RF Output Power Rating:	0.1 – 2 Watts
Operating Frequency Range:	769.15-770 MHz
RF Output Impedance:	50 Ohms
Channel Spacing:	25 KHz and 12.5 KHz
Occupied Bandwidth (99%):	13.53 kHz (for 25 KHz Channel Spacing) 9.22 kHz (for 12.5 KHz Channel Spacing)
Emission Designation*:	16K0F3E, 11K0F3E, 8K10F1E, 8K10F1D
Antenna Connector Type:	TNC (Tx & Rx), SMA (Rx only)

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

For FM Voice Modulation:

Channel Spacing = 25 KHz, D = 5 KHz max, K = 1, M = 3 KHz
B_n = 2M + 2DK = 2(3) + 2(5)(1) = **16 KHz**
Emission designation: 16K0F3E

Channel Spacing = 12.5 KHz, D = 2.5 KHz max, K = 1, M = 3 KHz
B_n = 2M + 2DK = 2(3) + 2(2.5)(1) = **11 KHz**
Emission designation: 11K0F3E

For FM Data Modulation:

Channel Spacing = 12.5 KHz, R = 9600 bps, D = 3111 Hz, S = 4, K = 0.518
B_n = (R/$\log_2$S) + 2DK = 8023 $\cong$ **8.1 KHz**
Emission designation: 8K10F1E, 8K10F1D

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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	VRS Interface (Power/Audio IO/Digital IO)	1	DSUB-44	Direct Interface
2	Debug	1	RJ-45	Shielded
3	Key Fill	2	RJ-45	Shielded
4	Antenna (SMA)	1	SMA	Shielded
5	Antenna (TNC)	1	TNC	Shielded

Note: Debug port and Key Fill ports are covered fitted when in normal operation.

2.5. General Test Setup

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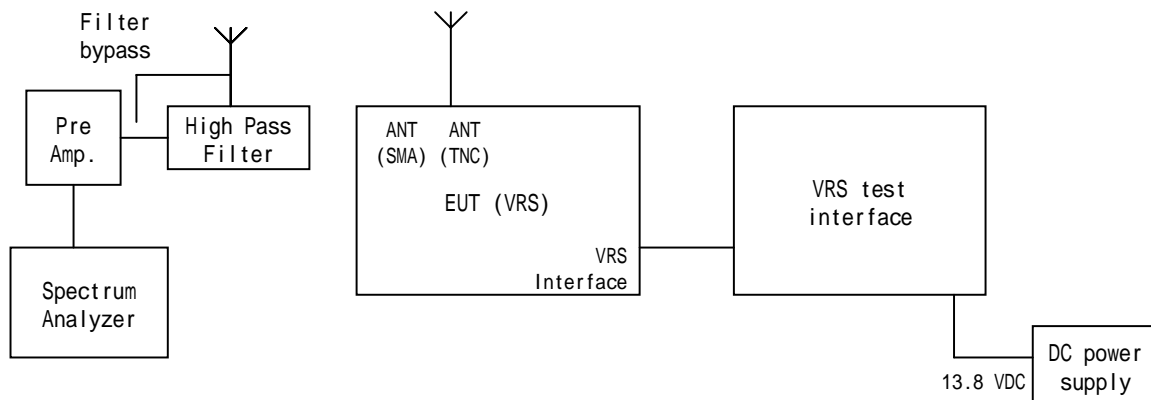
EXHIBIT 3. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

3.1. CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

Temperature:	21°C
Humidity:	51%
Pressure:	102 kPa
Power Input Source:	13.8 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 shall be tested with an antenna that is representative of the type that will be used with the equipment in normal operation.

Transmitter Test Signals	
Frequency Band(s):	769.15-770 MHz
Test Frequencies: (Near lowest, near middle & near highest frequencies in the frequency range of operation.)	769.5 MHz
Transmitter Wanted Output Test Signals: Transmitter Power (measured maximum output power): Normal Test Modulation: Modulating signal source:	2 watts / 0.1 watts FM Voice 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.

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: 2011-05-01.

4.2.   APPLICABILITY & SUMMARY OF EMISSION TEST RESULTS

FCC Section(s)	Test Requirements	Applicability (Yes/No)
1.1307, 1.1310, 2.1091 & 2.1093	RF Exposure Limit	Yes
2.1046 & 90.541	RF Power Output	Yes
2.1047(a) & 90.242(b)(8)	Audio Frequency Response	Not applicable to new standard. However, tests are conducted under FCC's recommendation.
2.1047(b) & 90.210	Modulation Limiting	Yes
2.1055 & 90.539	Frequency Stability	Yes
90.543(a)	Adjacent Channel Power	Yes
2.1049, 90.543(d)	Emission Limits – Authorized Bandwidth	Yes
2.1051, 2.1057 & 90.543(c)&(f)	Emission Limits – Spurious Emissions at Antenna Terminal	Yes
2.1053, 2.1057 & 90.543(c)&(f)	Emission Limits – Field Strength of Spurious Emissions	Yes

Portable VRS, **Model No.: 270-3240-020**, by **Rockwell Collins, Inc.** 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.

4.3.1.   DEVIATION OF STANDARD TEST PROCEDURES

None.

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EXHIBIT 5.   MEASUREMENTS, EXAMINATIONS & TEST DATA FOR EMC EMISSIONS

5.1.   TEST PROCEDURES

This section contains test results only. Details of test methods and procedures can be found in EXHIBIT 8. of this report

5.2.   MEASUREMENT UNCERTAINTIES

The measurement uncertainties stated were calculated in accordance with requirements of UKAS Document NIS 85 with a confidence level of 95%. Please refer to EXHIBIT 7. for Measurement Uncertainties.

5.3.   MEASUREMENT EQUIPMENT USED

The measurement equipment used complied with the requirements of the Standards referenced in the Methods & Procedures ANSI C63.4 and CISPR 16-1-1.

5.4.   ESSENTIAL/PRIMARY FUNCTIONS AS DECLARED BY THE MANUFACTURER

The essential function of the EUT is to communicate to and from radios over RF link.

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5.5.   RF EXPOSURE REQUIREMENTS [§§ 1.1310 & 2.1091]

5.5.1.   Limits

§ **1.1310:** The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in 1.1307(b).

LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Average Time (minutes)
(A) Limits for Occupational/Control Exposures				
30-300	61.4	0.163	1.0	6
300-1500	--	--	f/300	6
(B) Limits for General Population/Uncontrolled Exposure				
30-300	27.5	0.073	0.2	30
300-1500	--	--	f/1500	30

Note: f is frequency in MHz

5.5.2.   Method of Measurements

Calculation Method of RF Safety Distance:

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

Where,   P: power input to the antenna in mW
EIRP: Equivalent (effective) isotropic radiated power.
S: power density mW/cm^2
G: numeric gain of antenna relative to isotropic radiator
r: distance to centre of radiation in cm

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

FCC radio frequency exposure limits may be exceeded at distances closer than r cm from the antenna of this device.

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5.5.3.   Evaluation of RF Exposure Compliance Requirements

Maximum RF Power conducted, $P_{conducted}$**[dBm]** = 32.91 at 769.5 MHz

Maximum Antenna Gain, **G[dBi]** = 3

Maximum EIRP, P_{EIRP}**[dBm]** = 35.91

MPE Limit for Occupational/Controlled Exposure, $S_{controlled}$**[mW/cm^2]** = 769.5/300 = 2.57

MPE Limit for General Population/Uncontrolled Exposure, $S_{uncontrolled}$**[mW/cm^2]** = 769.5/1500 = 0.51

Calculated RF Safety Distance for Occupational/Controlled Exposure, $r_{safety\_controlled}$**[cm]** = 11.00

Calculated RF Safety Distance for General Population/Uncontrolled Exposure, $r_{safety\_uncontrolled}$**[cm]** = 24.59

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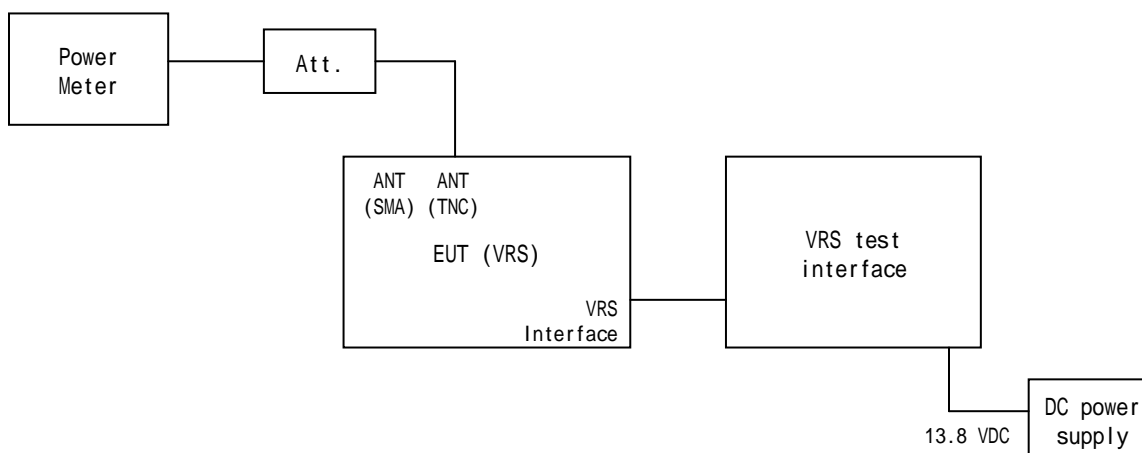## 5.6.   RF POWER OUTPUT [§§ 2.1046 & 90.205]

5.6.1.   Limits

Please refer to FCC 47 CFR 90.205 for specification details.

5.6.2.   Method of Measurements

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

5.6.3.   Test Arrangement

5.6.4.   Test Data

Channel	Fundamental Frequency (MHz)	Channel Spacing (kHz)	Measured Power (W)	Power Rating (W)
1	769.5	P25	0.08	0.1
3	769.5	P25	1.95	2
1001 (5)	769.5	N	0.08	0.1
1003 (7)	769.5	N	1.95	2
1005 (9)	769.5	W	0.09	0.1
1007 (10)	769.5	W	1.95	2

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5.7. AUDIO FREQUENCY RESPONSE [§§ 2.1047(a) & 90.242(b)(8)]

5.7.1. Limits

§ **2.1047(a):** Voice modulated communication equipment. A curve or equivalent data showing the frequency response of the audio modulating circuit over a range of 100 to 5000 Hz shall be submitted. For equipment required to have an audio low-pass filter, a curve showing the frequency response of the filter or of all circuitry installed between the modulation limiter and the modulated stage shall be submitted.
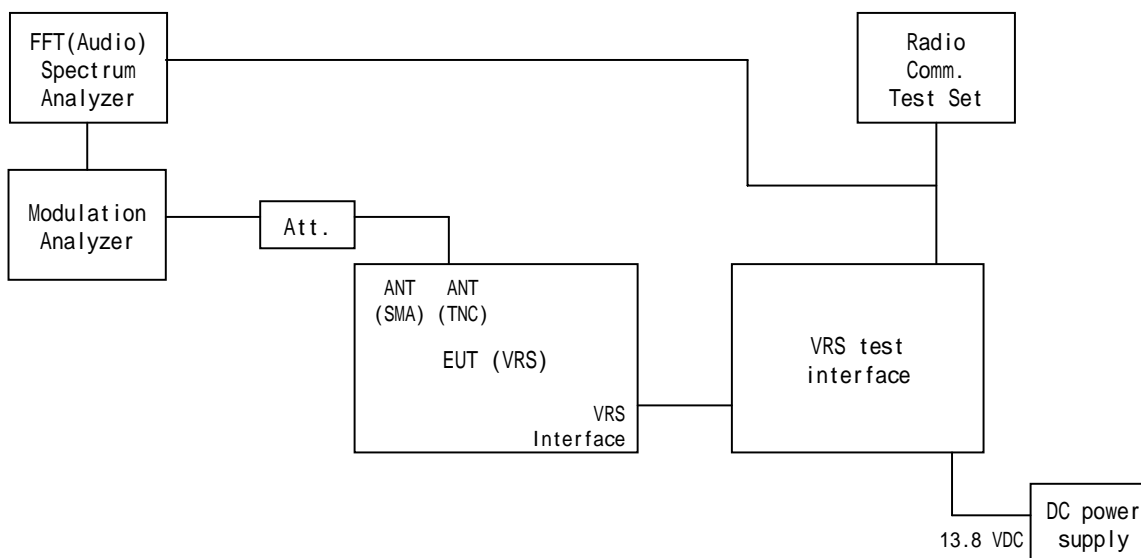
§ **90.242(b)(8):** Recommended audio filter attenuation characteristics are given below:

RF Band	Audio band	Minimum Attenuation Rel. to 1 KHz Attenuation
769.15-770 MHz	3 –20 KHz 20 – 30 KHz	$60 \log_{10}(f/3)$ dB where f is in KHz 50dB

5.7.2. Method of Measurements

The rated audio input signal was applied to the input of the audio low-pass 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 Digital Spectrum Analyzer. Tests were repeated at different audio signal frequencies from 0 to 50 KHz.

5.7.3. Test Arrangement

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5.7.4. Test Data

5.7.4.1. *12.5 KHz Channel Spacing, F3E, Frequency of All Modulation States*

<u>**Note**</u>: Due to the difficulty of measuring the Frequency Response of the internal low-pass filter, the Frequency Response of All Modulation States is performed to show the roll-off at 3 KHz in comparison with the recommended audio filter attenuation.

Frequency (KHz)	Audio In (dBV)	Audio Out (dBV)	Attenuation (Out - In) (dB)	Attenuation Rel. to 1 KHz (dB)	Recommended Attenuation (dB)
0.1	-7.03	-62.38	-55.4	-63.0	--
0.2	-7.03	-42.90	-35.9	-43.5	--
0.4	-7.03	-9.33	-2.3	-10.0	--
0.6	-7.03	-4.49	2.5	-5.1	--
0.8	-7.03	-2.16	4.9	-2.8	--
1.0	-7.03	-0.21	6.8	-0.9	--
1.5	-7.03	1.86	8.9	1.2	--
2.0	-7.03	1.94	9.0	1.3	--
2.5	-7.03	2.09	9.1	1.5	--
3.0	-7.03	0.64	7.7	0.0	0
3.5	-7.03	-24.92	-17.9	-25.6	-4
4.0	-7.03	-46.14	-39.1	-46.8	-7
4.5	-7.03	-63.76	-56.7	-64.4	-11
5.0	-7.03	-70.00	-63.0	-70.6	-13
6.0	-7.03	-70.00	-63.0	-70.6	-18
7.0	-7.03	-70.00	-63.0	-70.6	-22
8.0	-7.03	-70.00	-63.0	-70.6	-26
9.0	-7.03	-70.00	-63.0	-70.6	-29
10.0	-7.03	-70.00	-63.0	-70.6	-31
12.0	-7.03	-70.00	-63.0	-70.6	-36
14.0	-7.03	-70.00	-63.0	-70.6	-40
16.0	-7.03	-70.00	-63.0	-70.6	-44
18.0	-7.03	-70.00	-63.0	-70.6	-47
20.0	-7.03	-70.00	-63.0	-70.6	-49
22.0	-7.03	-70.00	-63.0	-70.6	-50
25.0	-7.03	-70.00	-63.0	-70.6	-50
30.0	-7.03	-70.00	-63.0	-70.6	-50
35.0	-7.03	-70.00	-63.0	-70.6	-50
40.0	-7.03	-70.00	-63.0	-70.6	-50
45.0	-7.03	-70.00	-63.0	-70.6	-50
50.0	-7.03	-70.00	-63.0	-70.6	-50

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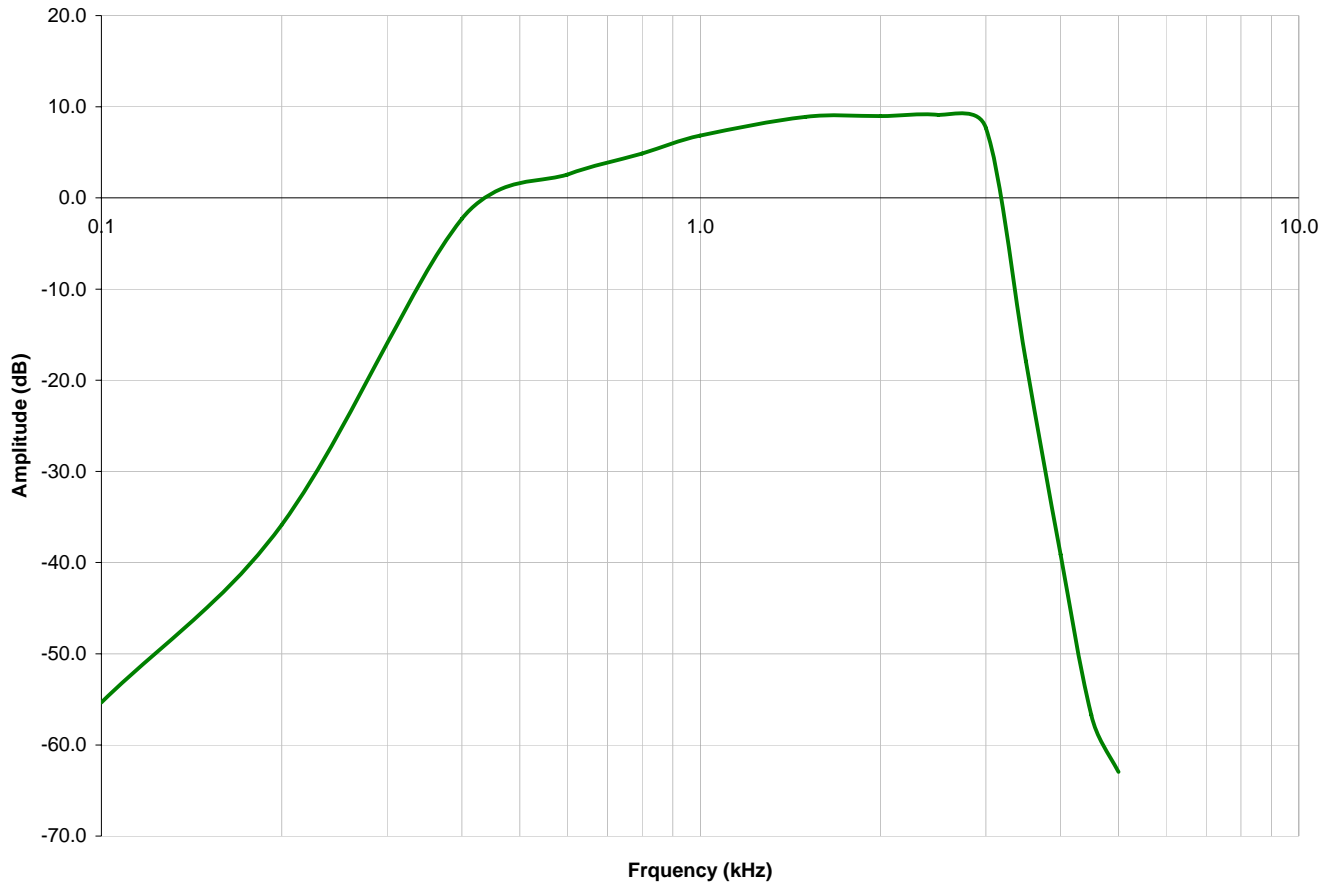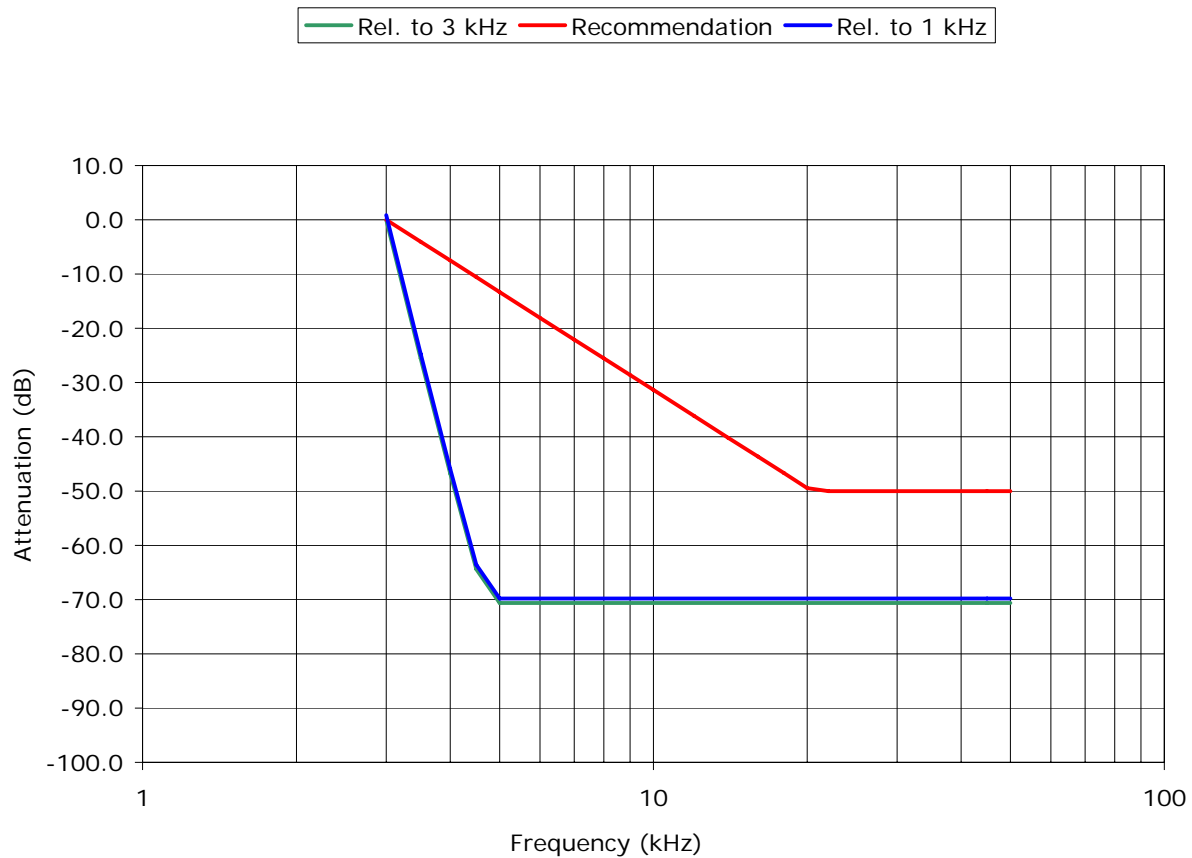
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5.7.4.2.   25 KHz Channel Spacing, F3E, Frequency of All Modulation States*

Note: Due to the difficulty of measuring the Frequency Response of the internal low-pass filter, the Frequency Response of All Modulation States is performed to show the roll-off at 3 KHz in comparison with the recommended audio filter attenuation.

Frequency (KHz)	Audio In (dBV)	Audio Out (dBV)	Attenuation (Out - In) (dB)	Attenuation Rel. to 1 KHz (dB)	Recommended Attenuation (dB)
0.1	7.17	-58.79	-66.0	-65.6	--
0.2	7.17	-36.91	-44.1	-43.7	--
0.4	7.17	-3.03	-10.2	-9.8	--
0.6	7.17	1.65	-5.5	-5.1	--
0.8	7.17	3.97	-3.2	-2.8	--
1.0	7.17	6.21	-1.0	-0.6	--
1.5	7.17	8.04	0.9	1.3	--
2.0	7.17	8.17	1.0	1.4	--
2.5	7.17	8.21	1.0	1.4	--
3.0	7.17	6.79	-0.4	0.0	0
3.5	7.17	-18.92	-26.1	-25.7	-4
4.0	7.17	-50.57	-57.7	-57.4	-7
4.5	7.17	-67.18	-74.4	-74.0	-11
5.0	7.17	-70.00	-77.2	-76.8	-13
6.0	7.17	-70.00	-77.2	-76.8	-18
7.0	7.17	-70.00	-77.2	-76.8	-22
8.0	7.17	-70.00	-77.2	-76.8	-26
9.0	7.17	-70.00	-77.2	-76.8	-29
10.0	7.17	-70.00	-77.2	-76.8	-31
12.0	7.17	-70.00	-77.2	-76.8	-36
14.0	7.17	-70.00	-77.2	-76.8	-40
16.0	7.17	-70.00	-77.2	-76.8	-44
18.0	7.17	-70.00	-77.2	-76.8	-47
20.0	7.17	-70.00	-77.2	-76.8	-49
22.0	7.17	-70.00	-77.2	-76.8	-50
25.0	7.17	-70.00	-77.2	-76.8	-50
30.0	7.17	-70.00	-77.2	-76.8	-50
35.0	7.17	-70.00	-77.2	-76.8	-50
40.0	7.17	-70.00	-77.2	-76.8	-50
45.0	7.17	-70.00	-77.2	-76.8	-50
50.0	7.17	-70.00	-77.2	-76.8	-50

ULTRATECH GROUP OF LABS   **File #: ETST-001F90**
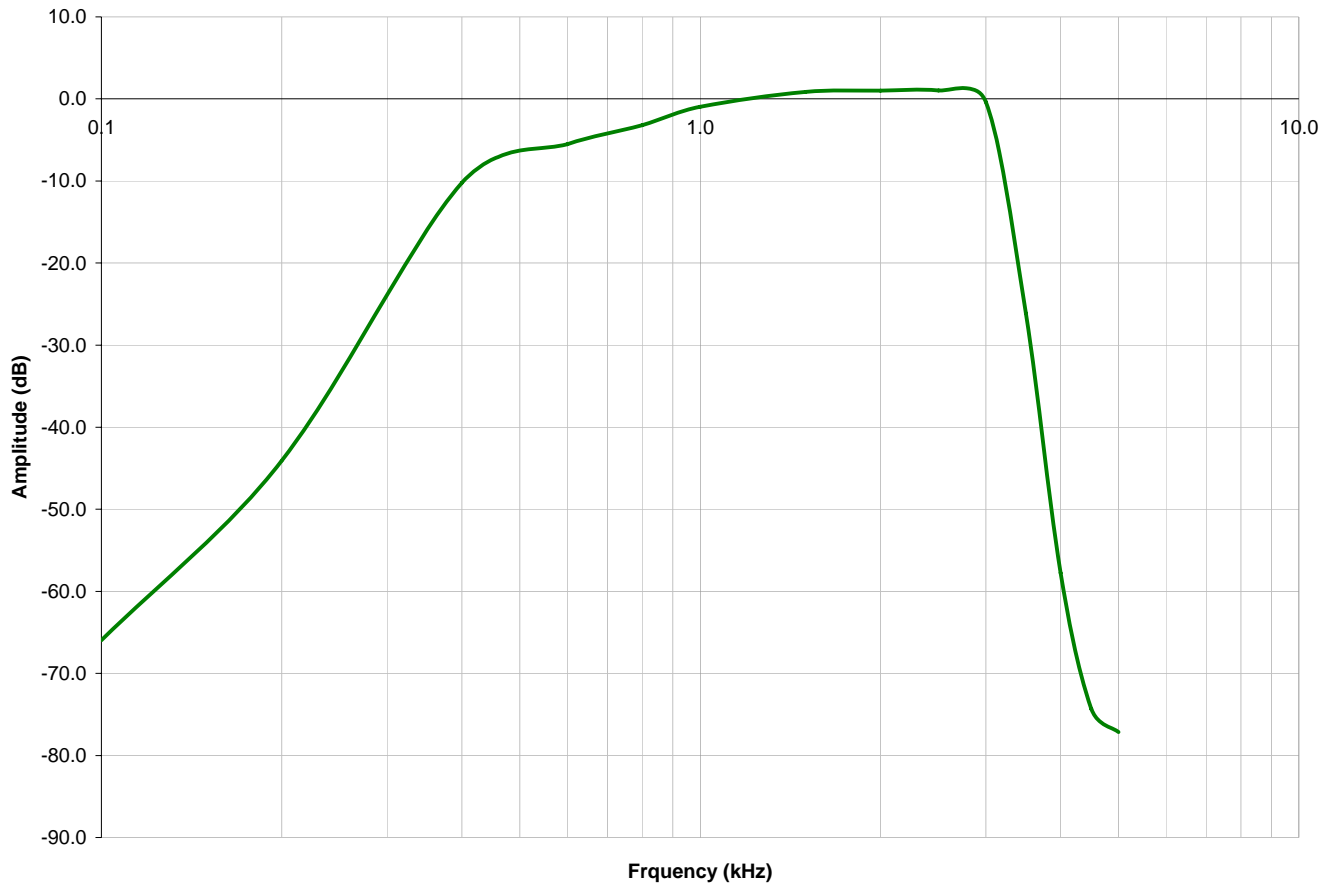3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4   August 18, 2009
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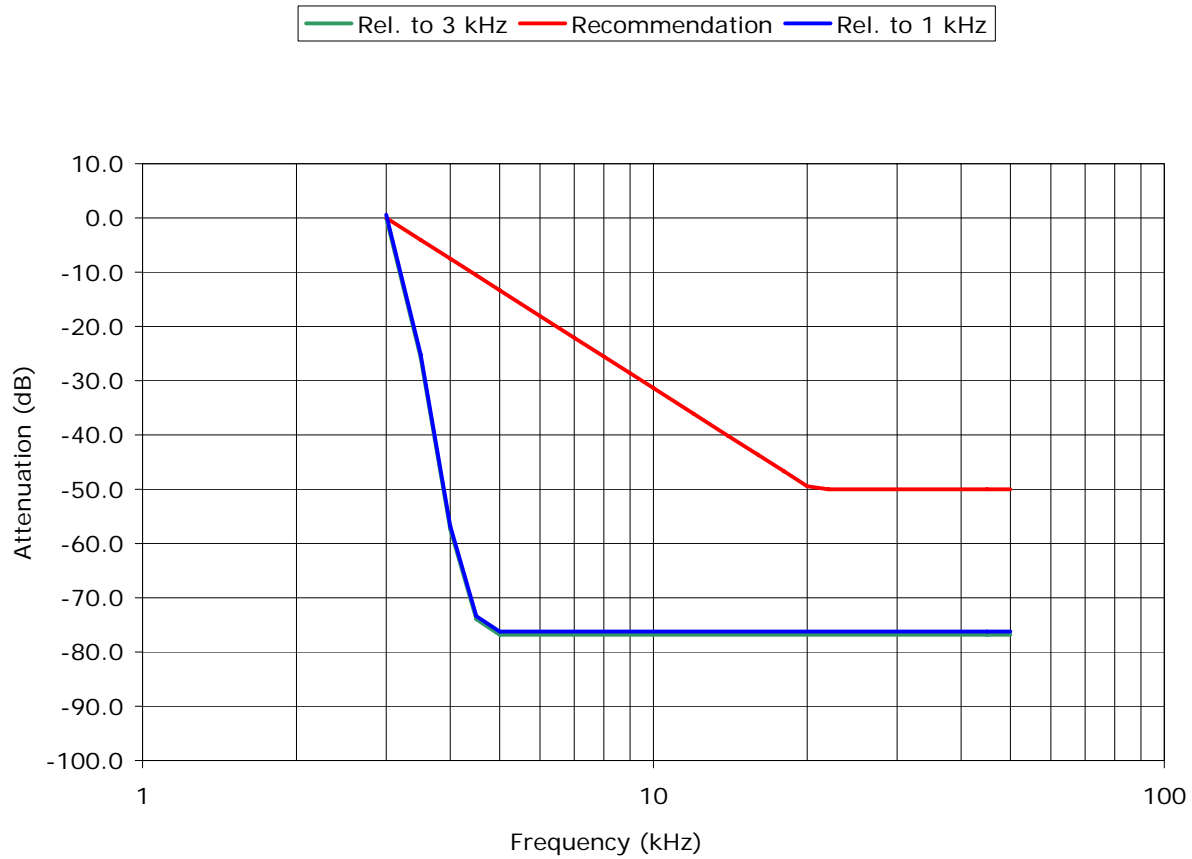**ULTRATECH GROUP OF LABS**   **File #: ETST-001F90**

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5.8. MODULATION LIMITING [§§ 2.1047 (b) & 90.210]

5.8.1. Limits

§ **2.1047(b):** Equipment which employs modulation limiting. A curve or family of curves showing the percentage of modulation versus the modulation input voltage shall be supplied. The information submitted shall be sufficient to show modulation limiting capability throughout the range of modulating frequencies and input modulating signal levels employed.

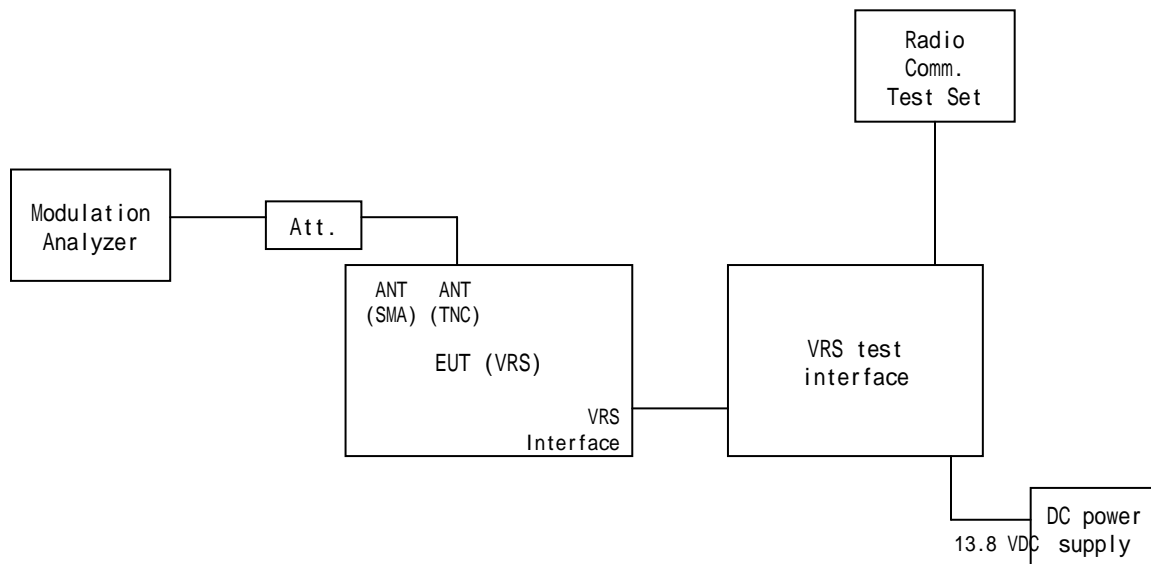Recommended frequency deviation characteristics are given below:

- 2.5 KHz for 12.5 KHz Channel Spacing System
- 5 KHz for 25 KHz Channel Spacing System

5.8.2. 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.

5.8.3. Test Arrangement

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5.8.4.   Test Data

5.8.4.1.   *Voice Modulation Limiting for 12.5 KHz Channel Spacing Operation*

MODULATING SIGNAL LEVEL	PEAK FREQUENCY DEVIATION (KHz) at the following modulating frequency:					MAXIMUM LIMIT
(mVrms)	0.1 KHz	0.5 KHz	1.0 KHz	3.0 KHz	5.0 KHz	(KHz)
50	0.09	0.16	0.23	0.52	0.09	2.5
100	0.09	0.22	0.38	0.95	0.09	2.5
150	0.09	0.31	0.55	1.40	0.09	2.5
200	0.09	0.38	0.73	1.64	0.09	2.5
250	0.09	0.46	0.87	1.65	0.09	2.5
300	0.09	0.52	1.05	1.65	0.09	2.5
350	0.09	0.62	1.14	1.65	0.09	2.5
400	0.09	0.68	1.29	1.65	0.09	2.5
450	0.09	0.78	1.55	1.65	0.09	2.5
500	0.09	0.85	1.79	1.65	0.09	2.5
600	0.09	0.99	1.81	1.65	0.09	2.5
700	0.09	1.13	1.81	1.65	0.09	2.5
800	0.09	1.31	1.81	1.65	0.09	2.5
900	0.09	1.42	1.81	1.65	0.09	2.5
1000	0.09	1.58	1.81	1.65	0.09	2.5
1500	0.09	1.81	1.81	1.65	0.09	2.5
2000	0.09	1.81	1.81	1.65	0.09	2.5

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Voice Signal Input Level = STD MOD Level + 16 dB
= 52.97 dB(mVrms) + 16 dB
= 68.97 dB(mVrms)
= 2807.76 mVrms

Modulation Frequency (KHz)	Peak Deviation (KHz)	Maximum Limit (KHz)
0.1	0.09	2.5
0.2	0.14	2.5
0.4	1.97	2.5
0.6	1.97	2.5
0.8	1.90	2.5
1.0	1.87	2.5
1.2	1.88	2.5
1.4	1.91	2.5
1.6	1.94	2.5
1.8	1.95	2.5
2.0	1.93	2.5
2.5	1.95	2.5
3.0	1.66	2.5
3.5	0.58	2.5
4.0	0.09	2.5
4.5	0.09	2.5
5.0	0.09	2.5
6.0	0.09	2.5
7.0	0.09	2.5
8.0	0.09	2.5
9.0	0.09	2.5
10.0	0.09	2.5

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5.8.4.2.   Voice Modulation Limiting for 25 KHz Channel Spacing Operation

MODULATING SIGNAL LEVEL	PEAK FREQUENCY DEVIATION (KHz) at the following modulating frequency:					MAXIMUM LIMIT
(mVrms)	0.1 KHz	0.5 KHz	1.0 KHz	3.0 KHz	5.0 KHz	(KHz)
50	0.09	0.24	0.41	0.97	0.09	5.0
100	0.09	0.37	0.73	1.88	0.09	5.0
150	0.09	0.54	1.06	2.81	0.09	5.0
200	0.09	0.69	1.42	3.22	0.09	5.0
250	0.09	0.85	1.76	3.28	0.09	5.0
300	0.09	1.00	2.11	3.28	0.09	5.0
350	0.09	1.18	2.44	3.28	0.09	5.0
400	0.09	1.33	2.73	3.28	0.09	5.0
450	0.09	1.48	3.10	3.28	0.09	5.0
500	0.09	1.65	3.44	3.28	0.09	5.0
600	0.09	1.96	3.50	3.28	0.09	5.0
700	0.09	2.26	3.45	3.28	0.09	5.0
800	0.09	2.63	3.55	3.28	0.09	5.0
900	0.09	2.88	3.58	3.28	0.09	5.0
1000	0.09	3.22	3.58	3.28	0.09	5.0
1500	0.09	3.88	3.68	3.28	0.09	5.0
2000	0.09	3.88	3.68	3.28	0.09	5.0

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Voice Signal Input Level = STD MOD Level + 16 dB
$\qquad$ = 52.83 dB(mVrms) + 16 dB
$\qquad$ = 68.83 dB(mVrms)
$\qquad$ = 2763.59 mVrms

Modulation Frequency (KHz)	Peak Deviation (KHz)	Maximum Limit (KHz)
0.1	0.09	5.0
0.2	0.21	5.0
0.4	3.87	5.0
0.6	3.60	5.0
0.8	3.52	5.0
1.0	3.49	5.0
1.2	3.51	5.0
1.4	3.58	5.0
1.6	3.64	5.0
1.8	3.65	5.0
2.0	3.65	5.0
2.5	3.71	5.0
3.0	3.16	5.0
3.5	1.05	5.0
4.0	0.11	5.0
4.5	0.09	5.0
5.0	0.09	5.0
6.0	0.09	5.0
7.0	0.09	5.0
8.0	0.09	5.0
9.0	0.09	5.0
10.0	0.09	5.0

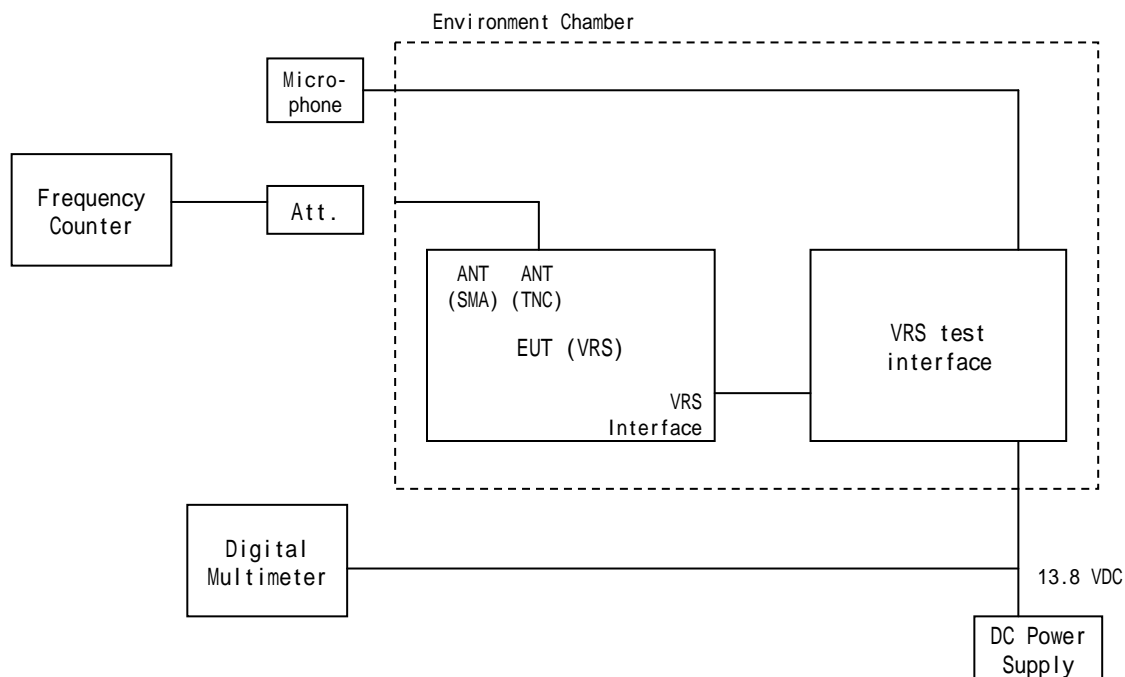## 5.9. FREQUENCY STABILITY [§§ 2.1055 & 90.213]

5.9.1. Limits

§ 90.539 (c): The frequency stability of mobile, portable, and control transmitters operating in the narrowband segment must be 400 parts per billion or better when AFC is locked to the base station. When AFC is not locked to the base station, the frequency stability must be at least 1.0 ppm for 6.25 kHz, 1.5 ppm for 12.5 kHz (2 channel aggregate), and 2.5 ppm for 25 kHz (4 channel aggregate).

5.9.2. Method of Measurements

Refer to Section 8.3 of this report for measurement details

5.9.3. Test Arrangement

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5.9.4.   Test Data

Product Name: Model No.:	VRS 270-3240-020
Center Frequency:	769.5 MHz
Full Power Level:	32.91 dBm
Frequency Tolerance Limit:	$\pm$ 1.5 ppm or $\pm$ 1154.25 Hz
Max. Frequency Tolerance Measured:	754 Hz or 0.98 ppm
Input Voltage Rating:	13.8 VDC (nominal)

Ambient Temperature (^{o}C)	CENTER FREQUENCY & RF POWER OUTPUT VARIATION		
	Supply Voltage (Nominal) 13.8 VDC	Supply Voltage (Battery End Point) 9 Vdc	Supply Voltage (Battery Fully Charged) 19 Vdc
	Hz	Hz	Hz
-30	N/A*	N/A	N/A
-20	-12	N/A	N/A
-10	42	N/A	N/A
0	80	N/A	N/A
+10	26	N/A	N/A
+20	0	13	21
+30	49	N/A	N/A
+40	52	N/A	N/A
+50	52	N/A	N/A
+60	5	N/A	N/A

* Manufacturer specifies operating temperature of -20°C ~ +60°C, see specification in user's manual for detail.

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5.10. Adjacent Channel Power [§ 90.543]

5.10.1. Limits

12.5 kHz MOBILE TRANSMITTER ACP REQUIREMENTS

Offset from center frequency (kHz)	Measurement bandwidth (kHz)	Maximum ACP relative (dBc)
9.375	6.25	− 40
15.625	6.25	− 60
21.875	6.25	− 60
37.50	25.00	− 60
62.50	25.00	− 65
87.50	25.00	− 65
150.00	100	− 65
250.00	100	− 65
350.00	100	− 65
>400 to 12 MHz	30 (s)	− 75
12 MHz to paired receive band	30 (s)	− 75
In the paired receive band	30 (s)	− 100

25 kHz MOBILE TRANSMITTER ACP REQUIREMENTS

Offset from center frequency (kHz)	Measurement bandwidth (kHz)	Maximum ACP relative (dBc)
15.625	6.25	− 40
21.875	6.25	− 60
37.50	25	− 60
62.50	25	− 65
87.50	25	− 65
150.00	100	− 65
250.00	100	− 65
350.00	100	− 65
>400 kHz to 12 MHz	30 (s)	− 75
12 MHz to paired receive band	30 (s)	− 75
In the paired receive band	30 (s)	− 100

5.10.2. Method of Measurements

For all measurements modulate the transmitter as it would be modulated in normal operating conditions.

All measurements are made at the transmitter's output port. If a transmitter has an integral antenna, a suitable power coupling device shall be used to couple the RF signal to the measurement instrument. The coupling device shall substantially maintain the proper transmitter load impedance. The ACP measurements may be made with a spectrum analyzer capable of making direct ACP measurements.

Measurement bandwidth, as used for non-swept measurements, implies an instrument that measures the power in many narrow bandwidths equal to the nominal resolution bandwidth and integrates these powers to determine the total power in the specified measurement bandwidth.

(1) Setting reference level. Set transmitter to maximum output power. Using a spectrum analyzer capable of ACP measurements, set the measurement bandwidth to the channel size.
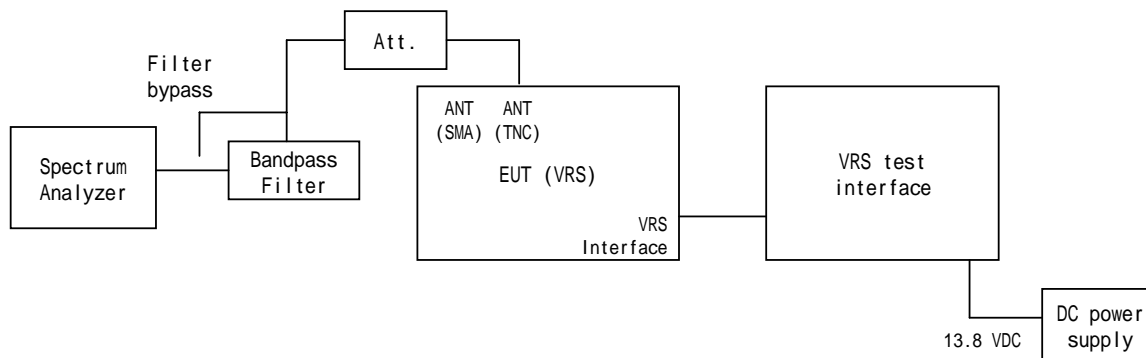
   For example, for a 6.25 kHz transmitter set the measurement bandwidth to 6.25 kHz. Set the frequency offset of the measurement bandwidth to zero and adjust the center frequency of the instrument to the assigned center frequency to measure the average power level of the transmitter. Record this power level in dBm as the *reference power level*.

(2) Non-swept power measurement. Using a spectrum analyzer capable of ACP measurements, set the measurement bandwidth and frequency offset from the assigned center frequency as shown in the tables above. Any value of resolution bandwidth may be used as long as it does not exceed 2 percent of the specified measurement bandwidth.

   Measure the power level in dBm. These measurements should be made at maximum power. Calculate ACP by subtracting the reference power level measured in (1) from the measurements made in this step. The absolute value of the calculated ACP must be greater than or equal to the absolute value of the ACP given in the table for each condition above.

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(3) Swept power measurement. Set a spectrum analyzer to 30 kHz resolution bandwidth, 1 MHz video bandwidth and average, sample, or RMS detection. Set the reference level of the spectrum analyzer to the RMS value of the transmitter power. Sweep above and below the carrier frequency to the limits defined in the tables. Calculate ACP by subtracting the reference power level measured in (1) from the measurements made in this step. The absolute value of the calculated ACP must be greater than or equal to the absolute value of the ACP given in the table for each condition above.

5.10.3. Test Arrangement

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5.10.4. Test Data

5.10.4.1. 25 kHz channel spacing, Analog Voice

- 769.5 MHz, Input 438 mV (maximum input) of 2.5 kHz sine wave, Channel #1007(#10)

- Reference power level = 32.91dBm

Offset (kHz)	Meas. BW (kHz)	LOWER	UPPER	Spec (dBc)
15.625	6.25	-63.92	-52.49	-40
21.875	6.25	-73.75	-75.30	-60
37.500	25.00	-70.07	-69.30	-60
62.500	25.00	-68.19	-68.05	-65
87.500	25.00	-67.92	-66.60	-65
150.000	100.00	-66.70	-66.05	-65
250.000	100.00	-67.02	-67.19	-65
350.000	100.00	-67.41	-67.58	-65
>400 to receive band	30 (Swept)	<-75	<-75	-75
12 MHz to paired rx band	30 (Swept)	<-75	<-75	-75
In the receive band	30 (Swept)	<-100	<-100	-100

5.10.4.2. 12.5 kHz channel spacing, Analog Voice

- 769.5 MHz, Input 445 mV (maximum input) of 2.5 kHz sine wave, Channel #1003(#7)

- Reference power level = 32.91dBm

Offset (kHz)	Meas. BW (kHz)	LOWER	UPPER	Spec (dBc)
9.375	6.25	-41.28	-41.73	-40
15.625	6.25	-73.89	-72.76	-60
21.875	6.25	-75.01	-74.82	-60
37.500	25.00	-69.17	-68.90	-60
62.500	25.00	-67.87	-67.56	-65
87.500	25.00	-66.55	-66.51	-65
150.000	100.00	-69.89	-70.56	-65
250.000	100.00	-71.37	-72.06	-65
350.000	100.00	-73.18	-72.50	-65
>400 to receive band	30 (Swept)	<-75	<-75	-75
12 MHz to paired rx band	30 (Swept)	<-75	<-75	-75
In the receive band	30 (Swept)	<-100	<-100	-100

5.10.4.3. 12.5 kHz channel spacing, P25 Digital Voice

- 769.5 MHz, Channel #3

- Reference power level = 32.91dBm

Offset (kHz)	Meas. BW (kHz)	LOWER	UPPER	Spec (dBc)
9.375	6.25	-44.25	-41.28	-40
15.625	6.25	-73.01	-72.59	-60
21.875	6.25	-76.81	-75.98	-60
37.500	25.00	-68.58	-69.57	-60
62.500	25.00	-66.61	-67.93	-65
87.500	25.00	-68.09	-68.03	-65
150.000	100.00	-68.12	-69.05	-65
250.000	100.00	-69.74	-70.52	-65
350.000	100.00	-70.48	-70.26	-65
>400 to receive band	30 (Swept)	<-75	<-75	-75
12 MHz to paired rx band	30 (Swept)	<-75	<-75	-75
In the receive band	30 (Swept)	<-100	<-100	-100

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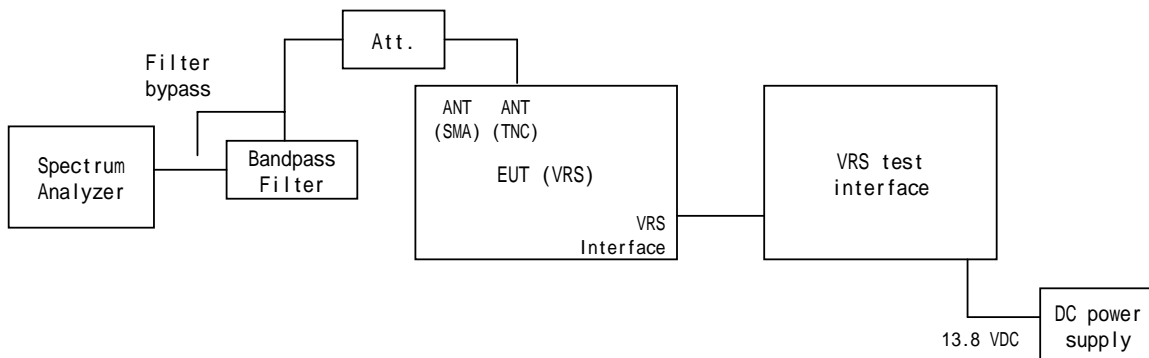## 5.11. OCCUPIED BANDWIDTH [§§ 2.1049, 90.543(d)]

5.11.1. Limits

Authorized bandwidth; Provided that the ACP requirements of this section are met, applicants may request any authorized bandwidth that does not exceed the channel size.

5.11.2. Method of Measurements

Refer to Section 8.4 of this report for measurement details and TIA-102.CAAA-B.
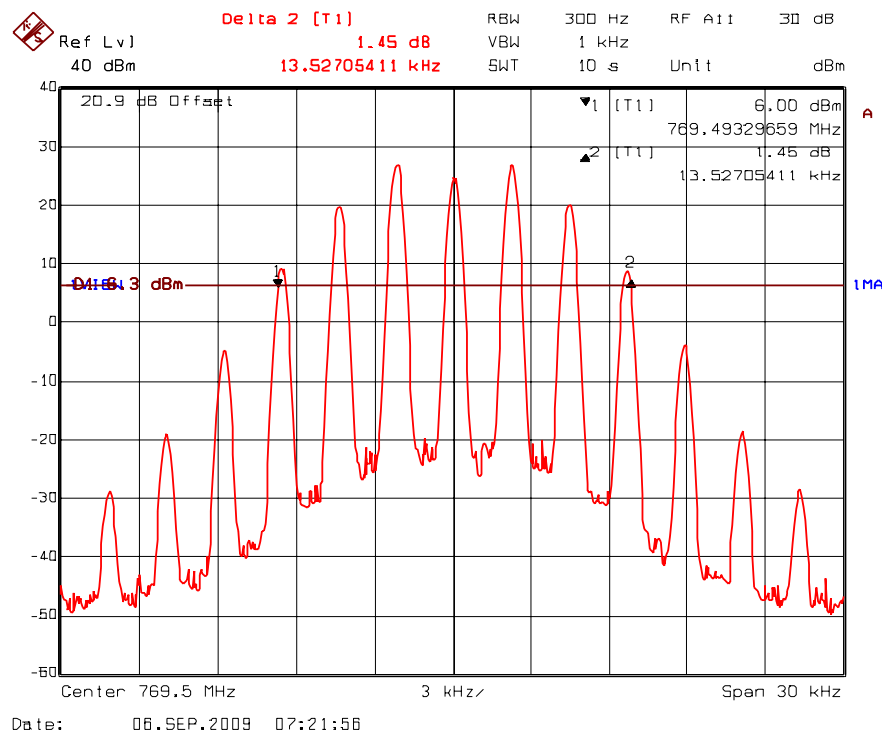
5.11.3. Test Arrangement

ULTRATECH GROUP OF LABS   **File #: ETST-001F90**
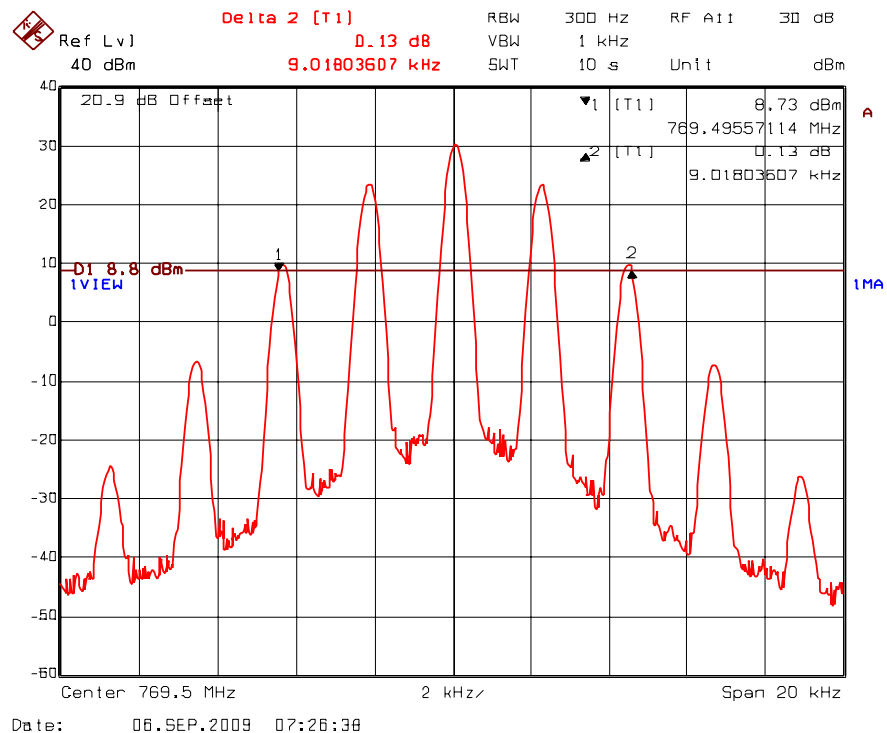3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4   August 18, 2009
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5.11.4. Test Data

5.11.4.1. 99% Occupied Bandwidth

Frequency (MHz)	Channel Spacing (KHz)	Modulation	*Measured 99% OBW at Maximum Freq. Deviation (KHz)	Maximum Authorized Bandwidth (KHz)
769.5	25	FM with 2.5 KHz sine wave signal	13.53	25
769.5	12.5	FM with 2.5 KHz sine wave signal	9.02	12.5
769.5	12.5	Digital	9.22	12.5

Note: 99% Occupied Bandwidth measurements were done using the built-in auto function of the analyzer.
*Refer to the following test data plots (1 through 3) for details.

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Plot # 1.:
Occupied Bandwidth
Carrier Frequency: 769.5 MHz
Channel Spacing: 25.0 KHz
Power: 2 W
Modulation: FM with 2.5 KHz sine wave signal
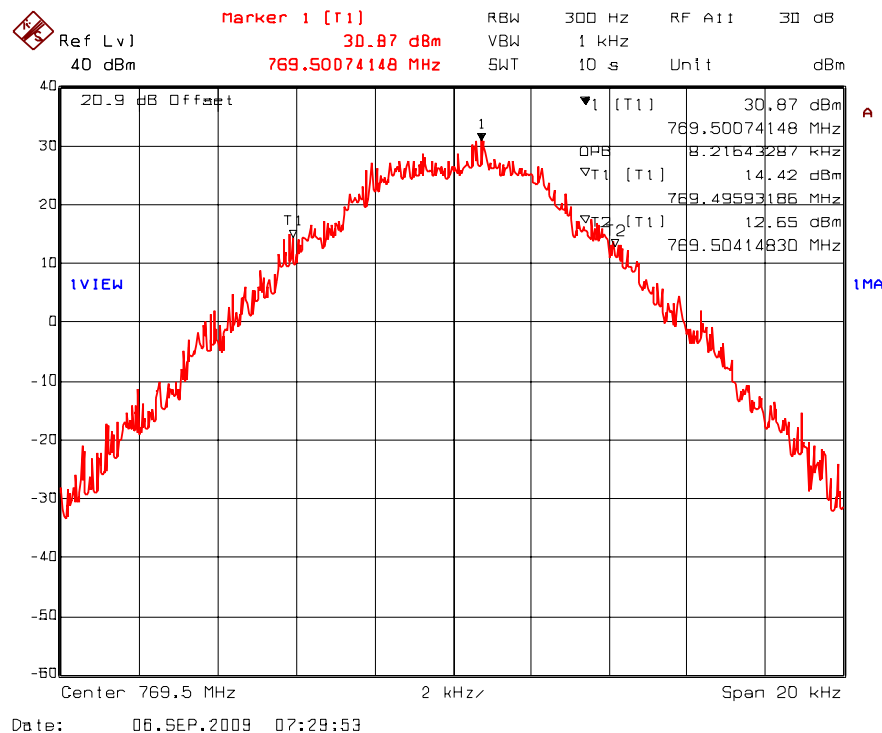
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Plot # 2.:
Occupied Bandwidth
Carrier Frequency: 769.5 MHz
Channel Spacing: 12.5 KHz
Power: 2 W
Modulation: FM with 2.5 KHz sine wave signal

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Plot # 3.:
Occupied Bandwidth
Carrier Frequency: 769.5 MHz
Channel Spacing: 12.5 KHz
Power: 2 W
Modulation: Digital

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5.12.   TRANSMITTER ANTENNA POWER SPURIOUS/HARMONIC CONDUCTED EMISSIONS [§§ 2.1051, 2.1057 & 90.210]
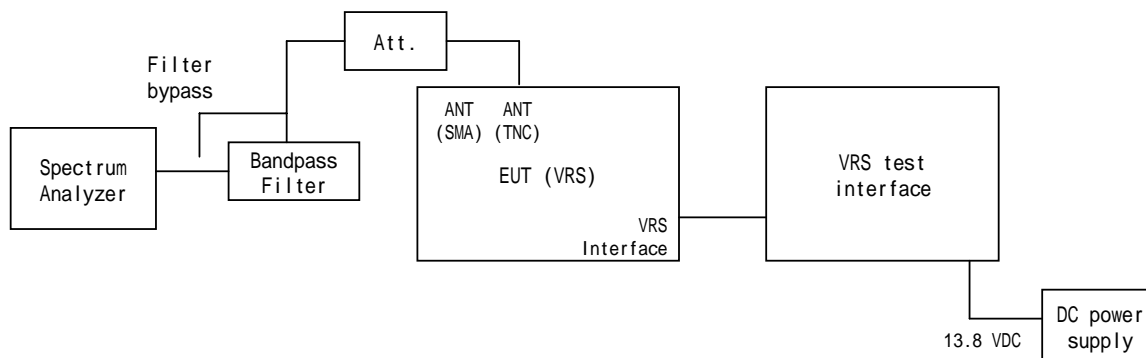
5.12.1. Limits

§90.543 (c): Out-of-band emission limit. On any frequency outside of the frequency ranges covered by the ACP tables in this section, the power of any emission must be reduced below the mean output power (P) by at least 43 + 10log (P) dB measured in a 100 kHz bandwidth for frequencies less than 1 GHz, and in a 1 MHz bandwidth for frequencies greater than 1 GHz.

§90.543 (f): For operations in the 763-775 MHz and 793-805 MHz bands, all emissions including harmonics in the band 1559-1610 MHz shall be limited to -70 dBW/MHz equivalent isotropically radiated power (EIRP) for wideband signals, and -80 dBW EIRP for discrete emissions of less than 700 Hz bandwidth. For the purpose of equipment authorization, a transmitter shall be tested with an antenna that is representative of the type that will be used with the equipment in normal operation.

5.12.2. Method of Measurements

Refer to Section 8.5 of this report for measurement details

5.12.3. Test Arrangement

ULTRATECH GROUP OF LABS   **File #: ETST-001F90**
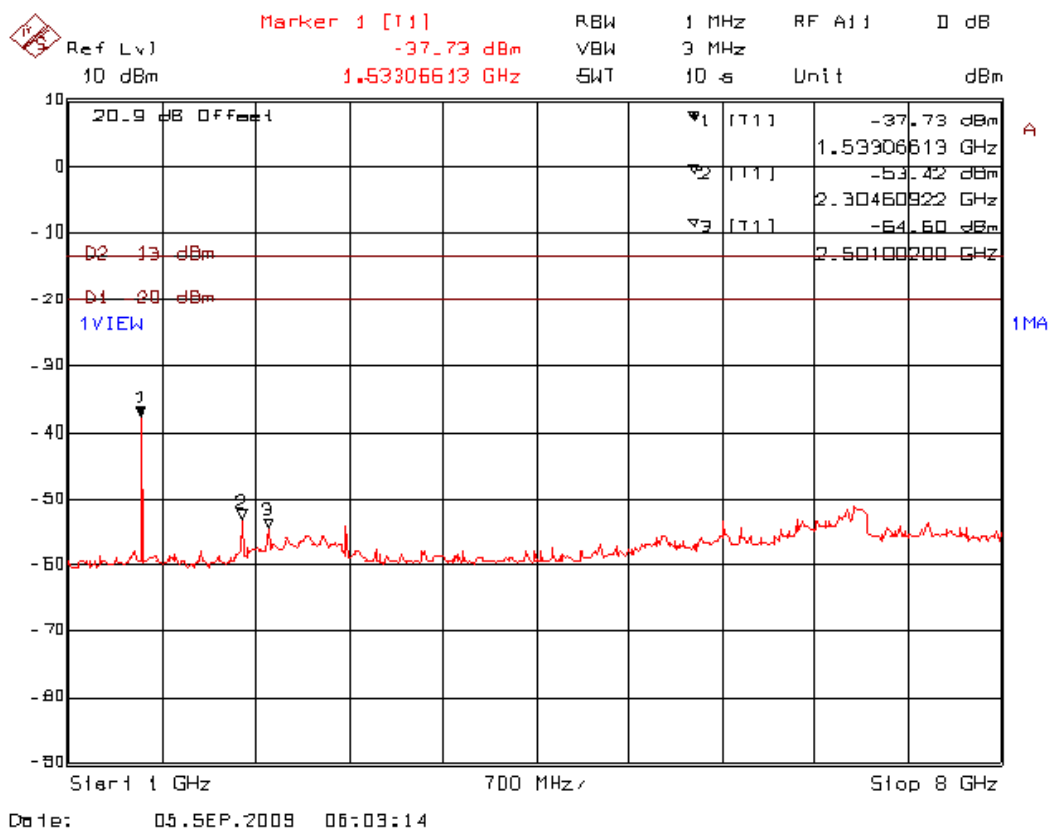3000 Bristol Circle, Oakville, Ontario, Canada L6H 6G4   August 18, 2009
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5.12.4. Test Data

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 12.5 KHz channel spacing and the more stringent limit of 43 + 10*log(P) would be applied for worst case.

5.12.4.1. Near Middle Frequency (769.5 MHz)

Plot # 4.:
Spurious Emissions at Antenna Terminals
Carrier Frequency: 769.5 MHz
Channel Spacing: 12.5 KHz Power: 2 W Modulation: analog

Plot # 5.:
Spurious Emissions at Antenna Terminals
Carrier Frequency: 769.5 MHz
Channel Spacing: 12.5 KHz Power: 2 W Modulation: analog
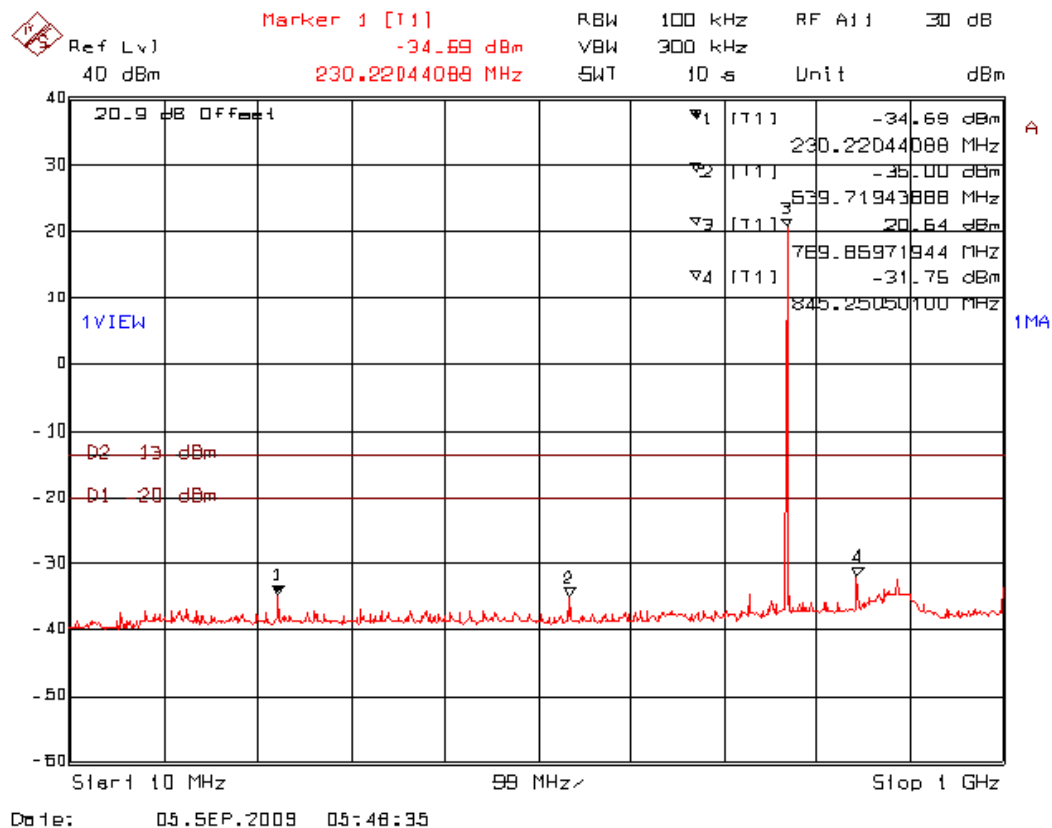High Pass Filter

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Plot # 6.:
Spurious Emissions at Antenna Terminals
Carrier Frequency: 769.5 MHz
Channel Spacing: 12.5 KHz Power: 0.1 W Modulation: analog
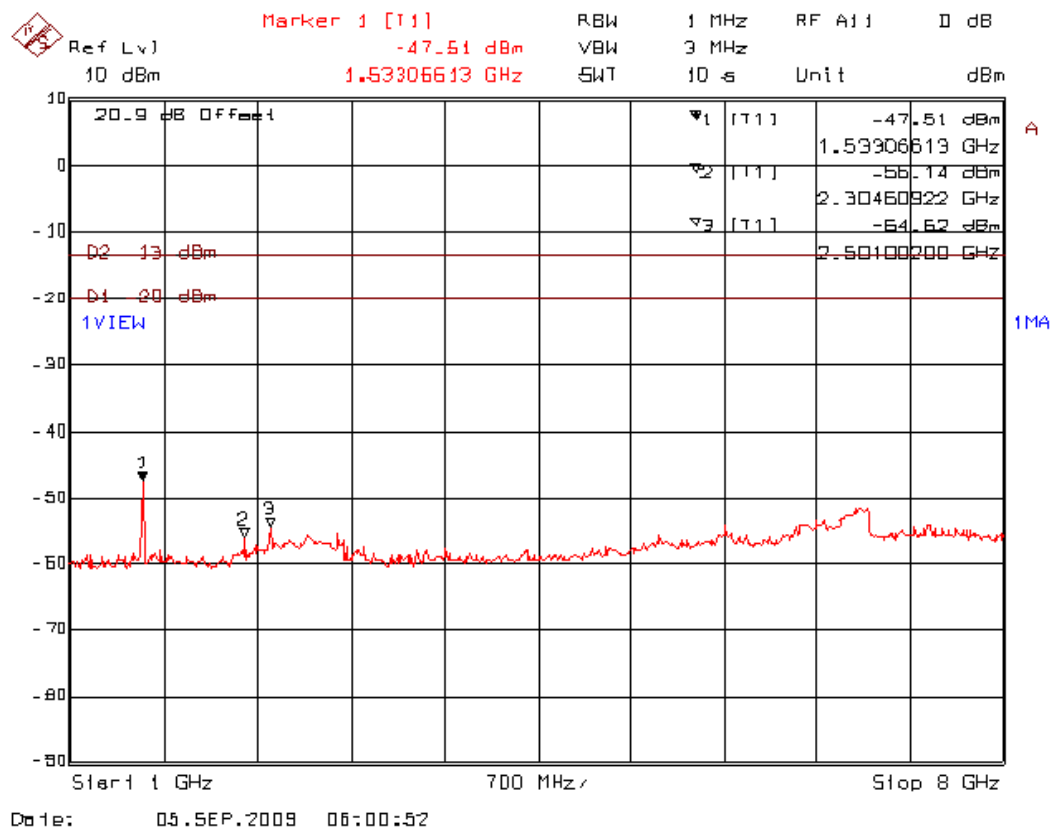

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Plot # 7.:
Spurious Emissions at Antenna Terminals
Carrier Frequency: 769.5 MHz
Channel Spacing: 12.5 KHz Power: 0.1 W Modulation: analog
High Pass Filter

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5.13. TRANSMITTER SPURIOUS/HARMONIC RADIATED EMISSIONS [§§ 2.1053, 2.1057 & 90.210]
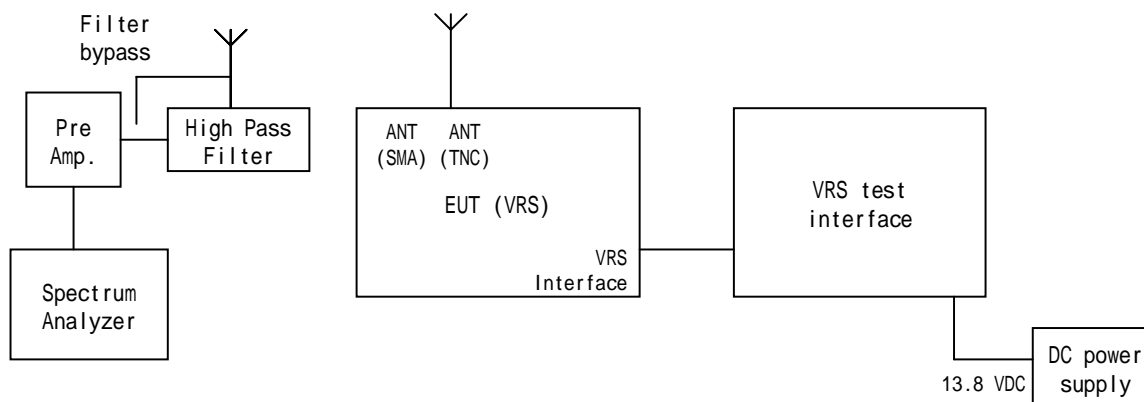
5.13.1. Limits

§90.543 (c): Out-of-band emission limit. On any frequency outside of the frequency ranges covered by the ACP tables in this section, the power of any emission must be reduced below the mean output power (P) by at least 43 + 10log (P) dB measured in a 100 kHz bandwidth for frequencies less than 1 GHz, and in a 1 MHz bandwidth for frequencies greater than 1 GHz.

§90.543 (f): For operations in the 763-775 MHz and 793-805 MHz bands, all emissions including harmonics in the band 1559-1610 MHz shall be limited to -70 dBW/MHz equivalent isotropically radiated power (EIRP) for wideband signals, and -80 dBW EIRP for discrete emissions of less than 700 Hz bandwidth. For the purpose of equipment authorization, a transmitter shall be tested with an antenna that is representative of the type that will be used with the equipment in normal operation.

5.13.2. Method of Measurements

The spurious/harmonic ERP measurements are using substitution method specified in Section 8.2 of this report.

5.13.3. Test Arrangement

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5.13.4. Test Data

Remarks:

- The RF spurious/harmonic emission characteristics for different channel spacing are indistinguishable. Therefore, the following radiated emissions were performed at 12.5 KHz channel spacing operation, and the results were compared with the more stringent limit of 43+10*log(P in Watts) for the worst-case.
- The radiated emissions were performed with high power setting (2 Watts) at 3 meters distance to represents the worst-case test configuration.
- The emissions were scanned from 30 MHz to 10th harmonics; all emissions within 20 dB below the limits were recorded.

5.13.4.1. Near Middle Frequency (769.5 MHz)

Carrier Frequency (MHz):	769.5
Power conducted (dBm):	32.91
Limit (dBm):	-13

The EUT had been tested from 30 MHz to 8 GHz, there was no signal found except harmonics.

Frequency (MHz)	E-Field (dBµV/m)	EMI Detector (Peak/QP)	Antenna Polarization (H/V)	ERP measured (dBm)	Limit (dBm)	Margin (dB)
769.500	--	--	--	--	--	--
769.500	--	--	--	--	--	--
1539.000	64.71	Peak	V	-36.46	-13	-23.5
1539.000	61.58	Peak	H	-39.59	-13	-26.6
2308.500	59.64	Peak	V	-42.25	-13	-29.3
2308.500	47.63	Peak	H	-54.26	-13	-41.3
3078.000	46.34	Peak	V	-54.92	-13	-41.9
3078.000	43.96	Peak	H	-57.30	-13	-44.3
3847.500	47.88	Peak	V	-53.19	-13	-40.2
3847.500	45.83	Peak	H	-55.24	-13	-42.2
4617.000	55.94	Peak	V	-47.03	-13	-34.0
4617.000	52.48	Peak	H	-50.49	-13	-37.5
5386.500	50.67	Peak	V	-52.43	-13	-39.4
5386.500	48.11	Peak	H	-54.99	-13	-42.0

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EXHIBIT 6. Test Equipments List

Test Instruments	Manufacturer	Model No.	Serial No.	Operating Range
Attenuator	Weinschel	46-20-34	BM1347	DC – 18 GHz
Attenuator	Weinschel	46-30-34	BM5354	DC – 18 GHz
BiConiLog Antenna	Emco	3142	10005	0.03 – 2 GHz
BiConiLog Antenna	ETS-Lindgren	3142B	1575	26 MHz – 2 GHz
Communication test set	Hewlett Packard	8920B	US39064699	AF SG DC – 20 kHz
EMC Analyzer	Hewlett Packard	8593EM	…	9kHz – 22 GHz
FFT (audio) EMI Receiver	Advantest	R9211E	82020336	10 mHz – 100 kHz, 1 MHz Input Impedance
High Pass Filter	Mini-Circuits	SHP-250	9027-12	Cut off 230 MHz
High Pass Filter	Mini-Circuits	SHP-300	10427	Cut off 230 MHz
High Pass Filter	Mini-Circuits	SHP-600	19949	Cut off 560 MHz
High Pass Filter	Mini-Circuits	SHP-800	15542	Cut off 800 MHz
Horn Antenna	Emco	3155	9701-5061	1 – 18 GHz
Horn Antenna	Emco	3155	9911-5955	1 – 18 GHz
Infinium Oscilloscope	Hewlett Packard	54810A	US38380192	500 MHz, 1 GSa/s
Log periodic Antenna	EMCO	3148	00023845	200MHz – 2GHz
Low Pass Filter	Mini-Circuits	BLP-100	15542	Cut off 98 MHz
Notch Filter	K & L	3TNF-100/200-N	UW316-1	100-200 MHz
Notch Filter	K & L	3TNF-250/500-N	UU041-1	250-500 MHz
Notch Filter	K & L	3TNF-500-1000-N/N	470	500-1000 MHz
Microwave Frequency Counter	EIP	545A	2683	10 Hz – 18 GHz
Modulation Analyzer	Hewlett Packard	8910B	3226A04606	150 kHz – 1300 MHz
Power Divider	Mini-Circuits	15542	105	1 MHz – 1 GHz

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Power Meter	Hewlett Packard	437B	3.13E+09	10 kHz – 50 GHz
Power Sensor	Hewlett Packard	8481A	1150A15143	9 kHz – 26.5 GHz
Preselector	Advantest	R3551	92970002	9 kHz – 1GHz
RF Amplifier	Com-Power	PA-103		1 MHz – 1 GHz
RF Amplifier	Hewlett Packard	84498	3008A00769	1 – 26.5 GHz
Signal Generator	Gigatronics	6061A	5130586	0.01- 1050 MHz
Spectrum Analyzer	Rohde & Schwarz	FSEK20/B4/B21	834157/005	9 kHz – 40 GHz
Spectrum Analyzer	Rohde & Schwarz	FSEK30	100077	20 Hz – 40 GHz
Spectrum Analyzer	Advantest	R3271	15050203	100 Hz – 26.5 GHz
Spectrum Analyzer / EMI Receiver	Hewlett Packard	8546A	3650A00371	9 kHz – 6.5 GHz Built-in amplifier 30dB
Temperature & Humidity Chamber	Tenney	T5	9723B	-40 ºC – +80 ºC range

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EXHIBIT 7.   MEASUREMENT UNCERTAINTY

The measurement uncertainties stated were calculated in accordance with the requirements of NIST Technical Note 1297 and NIS 81 (1994).

7.1.   RADIATED EMISSION MEASUREMENT UNCERTAINTY

CONTRIBUTION (Radiated Emissions)	PROBABILITY DISTRIBUTION	UNCERTAINTY ($\pm$ dB)	
		3 m	10 m
Antenna Factor Calibration	Normal (k=2)	$\pm$1.0	$\pm$1.0
Cable Loss Calibration	Normal (k=2)	$\pm$0.3	$\pm$0.5
EMI Receiver specification	Rectangular	$\pm$1.5	$\pm$1.5
Antenna Directivity	Rectangular	+0.5	+0.5
Antenna factor variation with height	Rectangular	$\pm$2.0	$\pm$0.5
Antenna phase center variation	Rectangular	0.0	$\pm$0.2
Antenna factor frequency interpolation	Rectangular	$\pm$0.25	$\pm$0.25
Measurement distance variation	Rectangular	$\pm$0.6	$\pm$0.4
Site imperfections	Rectangular	$\pm$2.0	$\pm$2.0
Mismatch: Receiver VRC Γ_1 = 0.2 Antenna VRC Γ_R = 0.67(Bi) 0.3 (Lp) Uncertainty limits 20Log(1$\pm\Gamma_1\Gamma_R$)	U-Shaped	+1.1 -1.25	$\pm$0.5
System repeatability	Std. Deviation	$\pm$0.5	$\pm$0.5
Repeatability of EUT		-	-
Combined standard uncertainty	Normal	+2.19 / -2.21	+1.74 / -1.72
Expanded uncertainty U	Normal (k=2)	+4.38 / -4.42	+3.48 / -3.44

Calculation for maximum uncertainty when 3m biconical antenna including a factor of k = 2 is used:

$U = 2u_c(y) = 2x(+2.19) = +4.38$ dB   And $U = 2u_c(y) = 2x(-2.21) = -4.42$ dB

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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).
- I f 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 = Tx on / (Tx on + Tx 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.
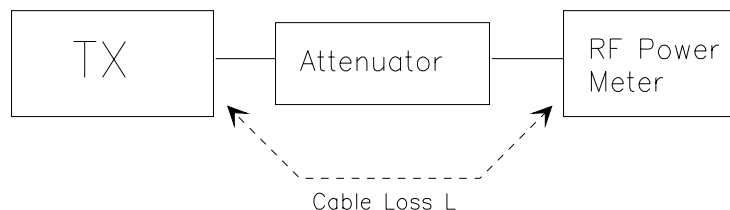
Step 2: Calculation of Average EIRP. See Figure 1
- ➢ The average output power of the transmitter shall be determined using a wideband, calibrated RF average power meter with the power sensor with an integration period that exceeds the repetition period of the transmitter by a factor 5 or more. The observed 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:

EIRP = A + G + 10log(1/x)

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

Figure 1.

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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 (dBμV/m) = Reading (dBμV) + 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.

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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 (dBuV/m) = Reading (dBuV) + 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:

$$P = P1 - L1 = (P2 + L2) - L1 = P3 + A + L2 - L1$$
$$EIRP = P + G1 = P3 + L2 - L1 + A + G1$$
$$ERP = EIRP - 2.15 \text{ dB}$$
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.

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Figure 2

Test Site

Figure 3

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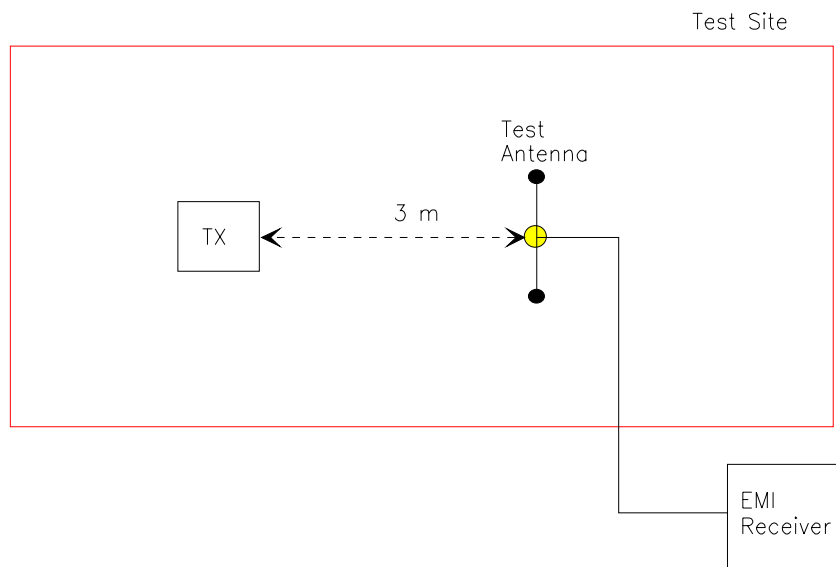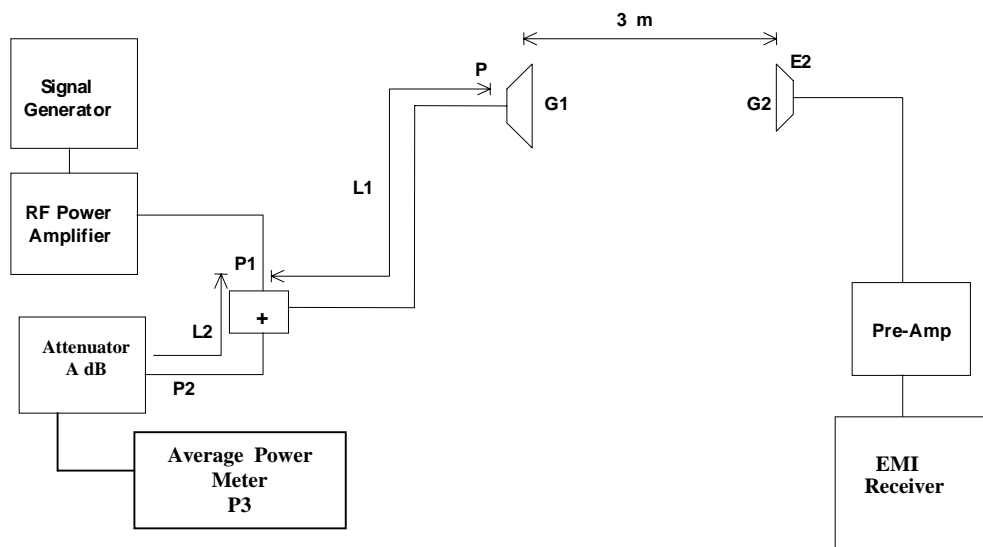
8.3.　FREQUENCY STABILITY

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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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.

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8.6. TRANSIENT FREQUENCY BEHAVIOR

1. Connect the transmitter under tests as shown in the above block diagram
2. Set the signal generator to the assigned frequency and modulate with a 1 KHz tone at $\pm$12.5 KHz deviation and its output level to be 50 dB below the transmitter rf output at the test receiver end.
3. Set the horizontal sweep rate on the storage scope to 10 milliseconds per division and adjust the display to continuously view the 1000 Hz tone from the Demodulator Output Port (DOP) of the Test Receiver. Adjust the vertical scale amplitude control of the scope to display the 1000 Hz at $\pm$4 divisions vertical Center at the display.
4. Adjust the scope so it will trigger on an increasing magnitude from the RF trigger signal of the transmitter under test when the transmitter was turned on. Set the controls to store the display.
5. The output at the DOP, due to the change in the ratio of the power between the signal generator input power and transmitter output power will, because of the capture effect of the test receiver, produce a change in display: For the first part of the sweep it will show the 1 KHz test signal. Then once the receiver's demodulator has been captured by the transmitter power, the display will show the frequency difference from the assigned frequency to the actual transmitter frequency versus time. The instant when the 1 KHz test signal is completely suppressed (including any capture time due to phasing) is considered to be t_{on}. The trace should be maintained within the allowed divisions during the period t_1 and t_2.
6. During the time from the end of t_2 to the beginning of t_3 the frequency difference should not exceed the limits set by the FCC in Part 90.214 and the outlined in the Carrier Frequency Stability sections. The allowed limit is equal to FCC frequency tolerance limits specified in FCC 90.213.
7. Repeat the above steps when the transmitter was turned off for measuring t_3.

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