ENGINEERING TEST REPORT

VHF/FM Digital Airborne Transceiver
Model No.: TDFM-136B
FCC ID: IMATDFM-136B

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 90 (Subpart I)

UltraTech's File No.: TIL-059F90

This Test report is Issued under the Authority of Tri M. Luu, BASc Vice President of Engineering UltraTech Group of Labs Date: December 20, 2010	
Report Prepared by: Dan Huynh Issued Date: December 20, 2010	Tested by: Wei Wu, RFI/EMC Technician Test Dates: Nov. 27 – Dec. 4, 2008 Feb. 19, 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.*

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91038	1309	46390-2049	NvLap Lab Code 200093-0	SL2-IN-E-1119R	CA2049

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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 136-174 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	2008	Code of Federal Regulations, Title 47 -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
CISPR 16-1-1 +A1 +A2	2006 2006 2007	Specification for radio disturbance and immunity measuring apparatus and methods. Part 1-1: Measuring Apparatus
TIA-603-C	2004	Land Mobile FM or PM Communications Equipment Measurement and Performance Standards

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:	VHF/FM Digital Airborne Transceiver
Model Name or Number:	TDFM-136B
Serial Number:	ER280
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:	2-way voice communication

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:	1 or 10 Watts
Operating Frequency Range:	136-174 MHz
RF Output Impedance:	50 Ω
Channel Spacing:	25 kHz, 12.5 kHz
Occupied Bandwidth (99%):	14.73 kHz (for 25 kHz channel spacing, analog FM) 9.90 kHz (for 12.5 kHz channel spacing, analog FM) 8.30 kHz (for 12.5 kHz channel spacing, digital)
Emission Designation*:	16K0F3E, 11K0F3E, 8K10F1E
Oscillator Frequency(ies):	47.88MHz, 24.576MHz, 3.6864MHz, 32.768kHz, 12.8MHz 14.7456MHz, 165.888MHz (CPU internal PLL)
Antenna Connector Type:	BNC

* 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

Channel Spacing = 12.5 kHz, R = 9600 bps, D = 3130 Hz, S = 4, K = 0.518
$B_n = (R/\log_2 S) + 2DK = 9600 / \log_2 (4) + 2(3130)(0.518) = 8043 \cong$ **8.1 kHz**
Emission designation: 8K10F1E

2.4. LIST OF EUT'S PORTS

Port Number	EUT's Port Description	Number of Identical Ports	Connector Type	Shielded/Non-shielded
1	RF I/O	2	BNC Female	Shielded
2	Audio/Power I/O	1	15 pin "D" male	Shielded
3	Data Programming I/O	1	8 pin mini-"DIN" female	Shielded

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:	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 50 Ω RF Load.

Transmitter Test Signals	
Frequency Band(s):	136-174 MHz
Test Frequencies:	138.1 MHz, 151.0 MHz, 160.9 MHz & 173.3 MHz
Transmitter Wanted Output Test Signals:	
Transmitter Power (measured maximum output power):	10 Watts High and 1 Watt Low
Normal Test Modulation:	Analog FM and Digital
Modulating signal source:	External

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 Power Line Conducted Emissions were performed in UltraTech's shielded room, 24'(L) by 16'(W) by 8'(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.: 31040/SIT 1300B3) and Industry Canada office (Industry Canada Site No.: 2049A-3, Expiry Date: May 17, 2009).

4.2. APPLICABILITY & SUMMARY OF EMISSION TEST RESULTS

FCC Section(s)	Test Requirements	Applicability (Yes/No)
90.205 & 2.1046	RF Power Output	Yes
90.213 & 2.1055	Frequency Stability	Yes
90.242(b)(8) & 2.1047(a)	Audio Frequency Response	Not applicable to new standard. However, tests are conducted under FCC's recommendation.
90.210 & 2.1047(b)	Modulation Limiting	Yes
90.210 & 2.1049	Emission Limitation & Emission Mask	Yes
90.210, 2.1057 & 2.1051	Emission Limits - Spurious Emissions at Antenna Terminal	Yes
90.210, 2.1057 & 2.1053	Emission Limits - Field Strength of Spurious Emissions	Yes
90.214	Transient Frequency Behavior	N/A
1.1307, 1.1310, 2.1091 & 2.1093	RF Exposure Limit	Yes
VHF/FM Digital Airborne Transceiver, Model No.: TDFM-136B, by Technisonic Industries Limited has also been tested and found to comply with FCC Part 15, Subpart B - Radio Receivers and Class B 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

There were two modifications made to the unit:

1) The keyboard gasket, which was originally a silicone material, was replaced with a metalized plastic material.

2) The front panel interface board was given some extra chassis ground connections.

4.4. DEVIATION OF STANDARD TEST PROCEDURES

None.

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 81 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 TDFM-136B, Digital VHF/FM Transceiver is designed to provide secondary airborne communications to facilitate operations which are typically performed in a low altitude environment.

5.5. RF POWER OUTPUT [§§ 2.1046 & 90.205]

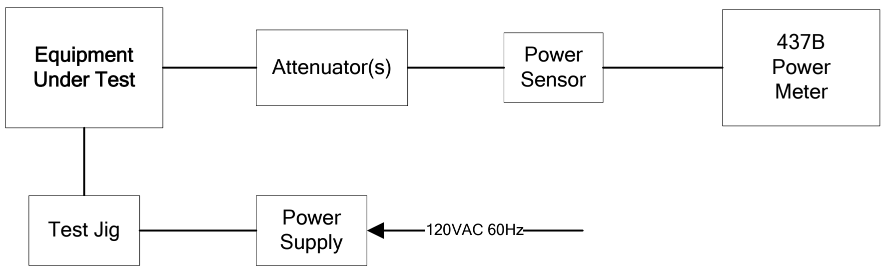
5.5.1. Limits

Please refer to FCC 47 CFR 90.205 for specification details.

5.5.2. Method of Measurements

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

5.5.3. Test Arrangement



5.5.4. Test Data

Channel	Operating Mode	Fundamental Frequency (MHz)	Measured (Average) Power (dBm)	Power Rating (dBm)
High Power Level, 10 Watts				
25	ANALOG_WIDE	138.1	38.87	40
26	ANALOG_WIDE	151.0	39.51	40
27	ANALOG_WIDE	160.9	39.43	40
28	ANALOG_WIDE	173.3	39.04	40
29	ANALOG_NARROW	138.1	38.84	40
30	ANALOG_NARROW	151.0	39.48	40
31	ANALOG_NARROW	160.9	39.44	40
32	ANALOG_NARROW	173.3	39.03	40
33	CNV_P25	138.1	38.80	40
34	CNV_P25	151.0	39.45	40
35	CNV_P25	160.9	39.42	40
36	CNV_P25	173.3	39.04	40

Channel	Operating Mode	Fundamental Frequency (MHz)	Measured (Average) Power (dBm)	Power Rating (dBm)
Low Power Level, 1 Watt				
13	ANALOG_WIDE	138.1	29.40	30
14	ANALOG_WIDE	151.0	29.67	30
15	ANALOG_WIDE	160.9	29.65	30
16	ANALOG_WIDE	173.3	29.37	30
17	ANALOG_NARROW	138.1	29.39	30
18	ANALOG_NARROW	151.0	29.67	30
19	ANALOG_NARROW	160.9	29.66	30
20	ANALOG_NARROW	173.3	29.36	30
21	CNV_P25	138.1	29.39	30
22	CNV_P25	151.0	29.67	30
23	CNV_P25	160.9	29.67	30
24	CNV_P25	173.3	29.37	30

5.6. FREQUENCY STABILITY [§§ 2.1055 & 90.213]

5.6.1. Limits

Refer to FCC 47 CFR 90.213 for specification details.

Frequency Range (MHz)	Frequency Tolerance (ppm)		
	Fixed and Base Stations	Mobile Stations	
		> 2 W	≤ 2 W
150–174	[2,4] 5	[3] 5	[1,3] 50

[1] Stations operating in the 154.45 to 154.49 MHz or the 173.2 to 173.4 MHz bands must have a frequency stability of 5 ppm.

[2] In the 150–174 MHz band, fixed and base stations with a 12.5 kHz channel bandwidth must have a frequency stability of 2.5 ppm. Fixed and base stations with a 6.25 kHz channel bandwidth must have a frequency stability of 1.0 ppm.

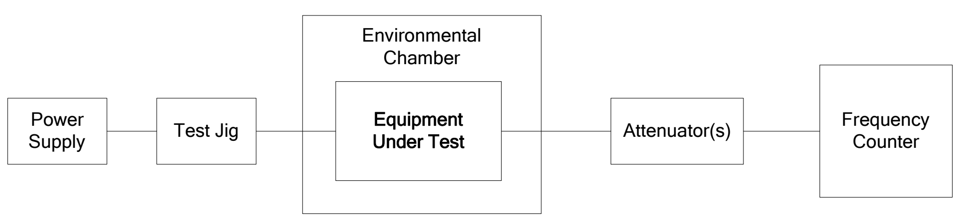
[3] In the 150–174 MHz band, mobile stations designed to operate with a 12.5 kHz channel bandwidth or designed to operate on a frequency specifically designated for itinerant use or designed for low-power operation of two watts or less, must have a frequency stability of 5.0 ppm. Mobile stations designed to operate with a 6.25 kHz channel bandwidth must have a frequency stability of 2.0 ppm.

[4] Paging transmitters operating on paging-only frequencies must operate with frequency stability of 5 ppm in the 150–174 MHz band and 2.5 ppm in the 421–512 MHz band.

5.6.2. Method of Measurements

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

5.6.3. Test Arrangement



5.6.4. Test Data

Center Frequency:	151 MHz
Full Power Level:	39.48 dBm
Frequency Tolerance Limit:	± 5 ppm or ± 755 Hz
Max. Frequency Tolerance Measured:	+192 Hz or 1.27 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
-45	-35	--	--
-30	17	--	-
-20	-20	--	--
-10	-19	--	--
0	16	--	--
+10	14	--	--
+20	-7	-7	-6
+30	11	--	--
+40	-5	--	--
+50	13	--	--
+60	11	--	--
+70	+192	--	--

5.7. AUDIO FREQUENCY RESPONSE [§ 2.1047(a)]

5.7.1. Limits

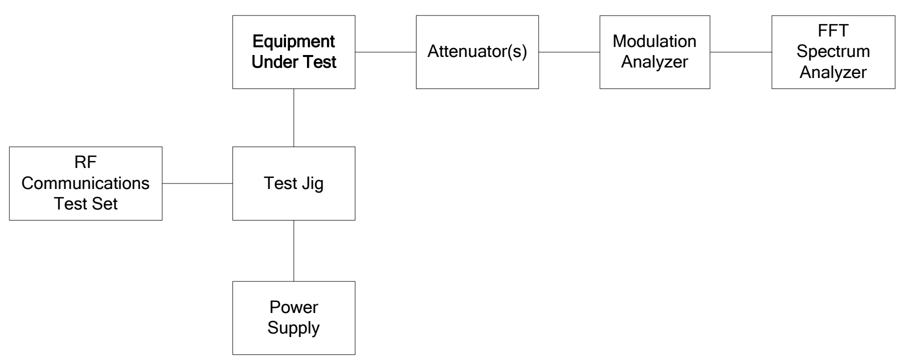
Recommended audio filter attenuation characteristics are given below:

Audio band	Minimum Attenuation Rel. to 1 kHz Attenuation
3 - 20 KHz	60 $\log_{10}(f/3)$ dB where f is in KHz
20 - 30 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

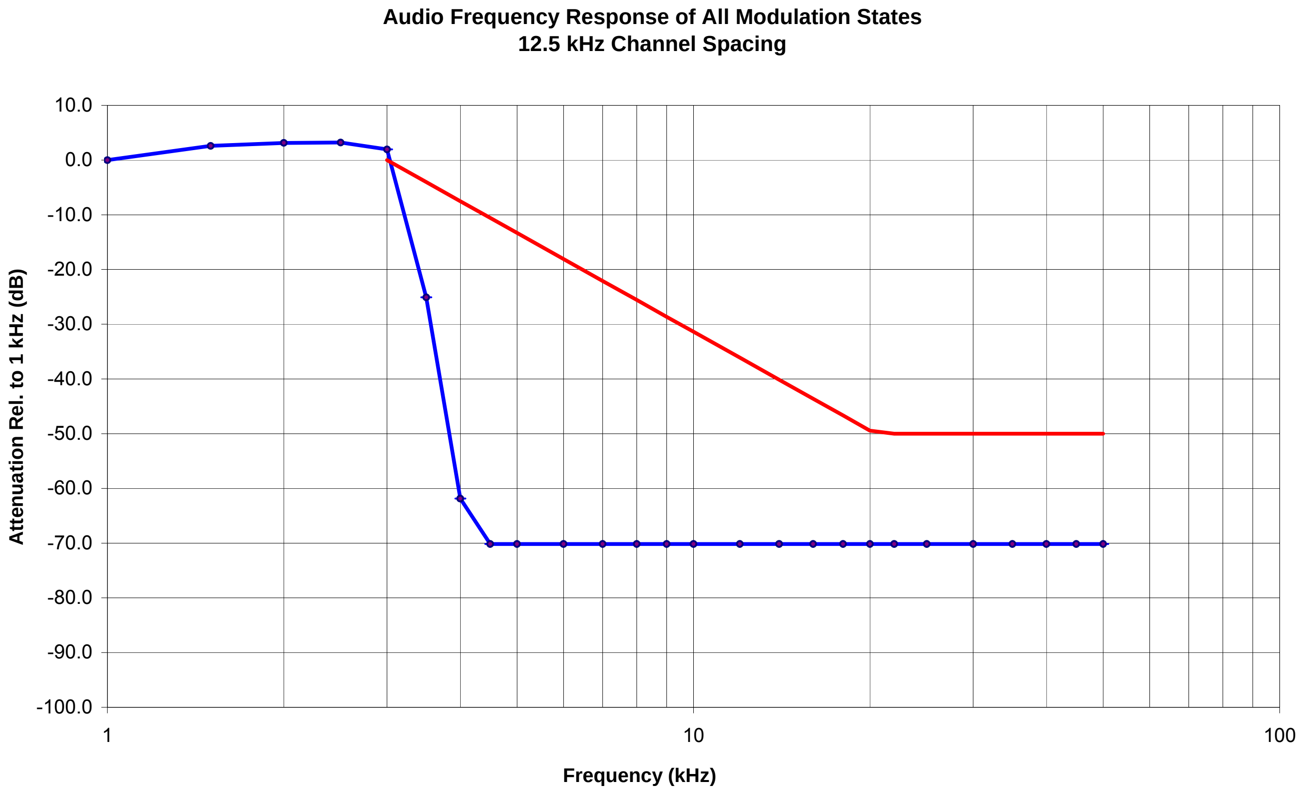


5.7.4. Test Data

Remark: 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.

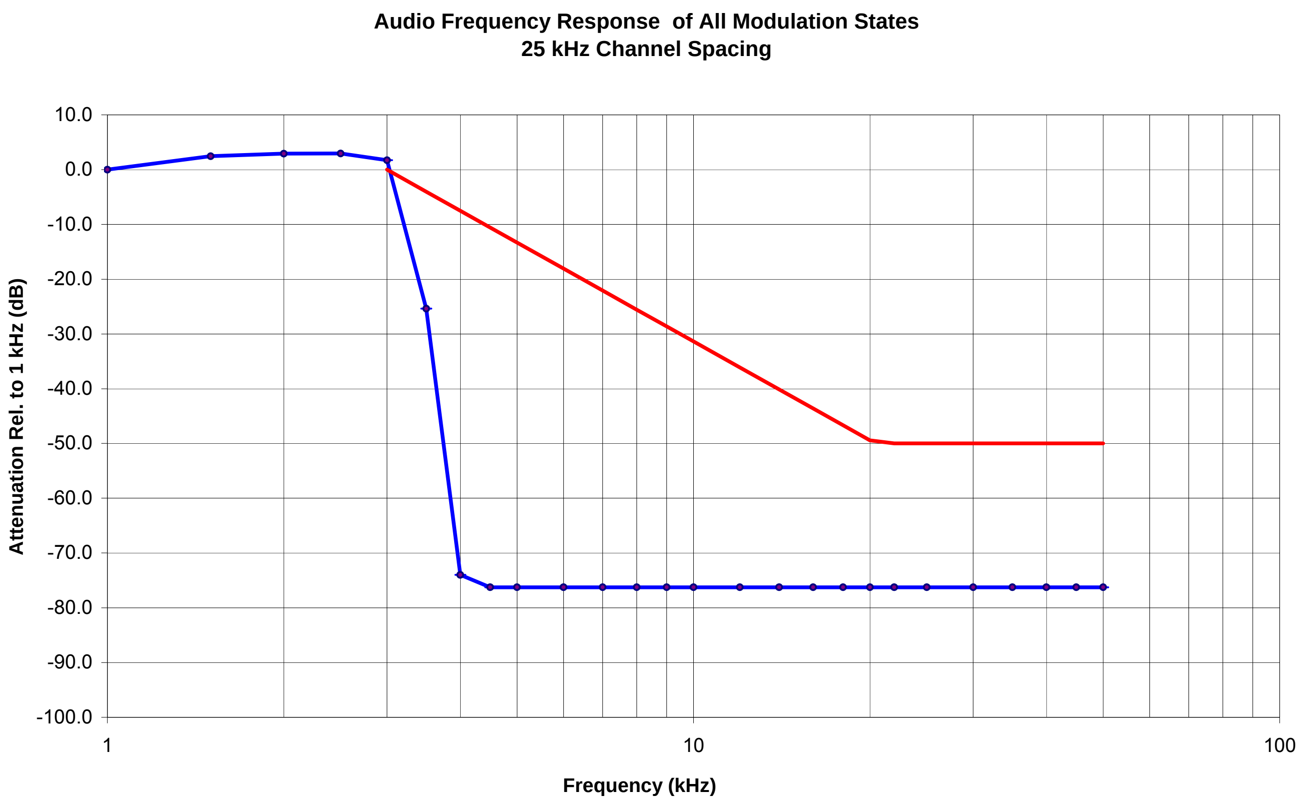
- **12.5 kHz Channel Spacing:**

Frequency (kHz)	Audio In (dBV)	Audio Out (dBV)	Attenuation (Out - In) (dB)	Attenuation Rel. to 1 kHz (dB)	Recommended Attenuation (dB)
0.1	-12.25	-70.00	-57.8	-70.2	--
0.2	-12.25	-38.15	-25.9	-38.3	--
0.4	-12.25	-7.69	4.6	-7.8	--
0.6	-12.25	-3.74	8.5	-3.9	--
0.8	-12.25	-1.76	10.5	-1.9	--
1.0	-12.25	0.15	12.4	0.0	--
1.5	-12.25	2.75	15.0	2.6	--
2.0	-12.25	3.29	15.5	3.1	--
2.5	-12.25	3.35	15.6	3.2	--
3.0	-12.25	2.11	14.4	2.0	0
3.5	-12.25	-24.92	-12.7	-25.1	-4
4.0	-12.25	-61.71	-49.5	-61.9	-7
4.5	-12.25	-70.00	-57.8	-70.2	-11
5.0	-12.25	-70.00	-57.8	-70.2	-13
6.0	-12.25	-70.00	-57.8	-70.2	-18
7.0	-12.25	-70.00	-57.8	-70.2	-22
8.0	-12.25	-70.00	-57.8	-70.2	-26
9.0	-12.25	-70.00	-57.8	-70.2	-29
10.0	-12.25	-70.00	-57.8	-70.2	-31
12.0	-12.25	-70.00	-57.8	-70.2	-36
14.0	-12.25	-70.00	-57.8	-70.2	-40
16.0	-12.25	-70.00	-57.8	-70.2	-44
18.0	-12.25	-70.00	-57.8	-70.2	-47
20.0	-12.25	-70.00	-57.8	-70.2	-49
22.0	-12.25	-70.00	-57.8	-70.2	-50
25.0	-12.25	-70.00	-57.8	-70.2	-50
30.0	-12.25	-70.00	-57.8	-70.2	-50
35.0	-12.25	-70.00	-57.8	-70.2	-50
40.0	-12.25	-70.00	-57.8	-70.2	-50
45.0	-12.25	-70.00	-57.8	-70.2	-50
50.0	-12.25	-70.00	-57.8	-70.2	-50


Audio Frequency Response of All Modulation States
12.5 kHz Channel Spacing
Attenuation Rel. to 1 kHz (dB)
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-90.0
-100.0
1
10
100
Frequency (kHz)

- **25 kHz Channel Spacing:**

Frequency (kHz)	Audio In (dBV)	Audio Out (dBV)	Attenuation (Out - In) (dB)	Attenuation Rel. to 1 kHz (dB)	Recommended Attenuation (dB)
0.1	-12.22	-67.01	-54.8	-73.3	--
0.2	-12.22	-33.05	-20.8	-39.3	--
0.4	-12.22	-1.72	10.5	-8.0	--
0.6	-12.22	2.21	14.4	-4.0	--
0.8	-12.22	4.22	16.4	-2.0	--
1.0	-12.22	6.25	18.5	0.0	--
1.5	-12.22	8.71	20.9	2.5	--
2.0	-12.22	9.19	21.4	2.9	--
2.5	-12.22	9.21	21.4	3.0	--
3.0	-12.22	7.97	20.2	1.7	0
3.5	-12.22	-19.12	-6.9	-25.4	-4
4.0	-12.22	-67.74	-55.5	-74.0	-7
4.5	-12.22	-70.00	-57.8	-76.3	-11
5.0	-12.22	-70.00	-57.8	-76.3	-13
6.0	-12.22	-70.00	-57.8	-76.3	-18
7.0	-12.22	-70.00	-57.8	-76.3	-22
8.0	-12.22	-70.00	-57.8	-76.3	-26
9.0	-12.22	-70.00	-57.8	-76.3	-29
10.0	-12.22	-70.00	-57.8	-76.3	-31
12.0	-12.22	-70.00	-57.8	-76.3	-36
14.0	-12.22	-70.00	-57.8	-76.3	-40
16.0	-12.22	-70.00	-57.8	-76.3	-44
18.0	-12.22	-70.00	-57.8	-76.3	-47
20.0	-12.22	-70.00	-57.8	-76.3	-49
22.0	-12.22	-70.00	-57.8	-76.3	-50
25.0	-12.22	-70.00	-57.8	-76.3	-50
30.0	-12.22	-70.00	-57.8	-76.3	-50
35.0	-12.22	-70.00	-57.8	-76.3	-50
40.0	-12.22	-70.00	-57.8	-76.3	-50
45.0	-12.22	-70.00	-57.8	-76.3	-50
50.0	-12.22	-70.00	-57.8	-76.3	-50


Audio Frequency Response of All Modulation States
25 kHz Channel Spacing
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
-70.0
-80.0
-90.0
-100.0
Attenuation Rel. to 1 kHz (dB)
1
10
100
Frequency (kHz)

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

5.8.1. Limits

Recommended frequency deviation characteristics are given below:

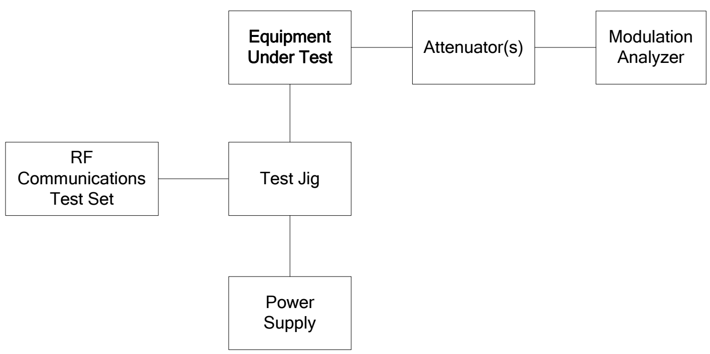
- ±2.5 kHz for 12.5 kHz channel spacing
- ±5 kHz for 25 kHz channel spacing

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



5.8.4. Test Data

5.8.4.1. Data Modulation Limiting

Remark: FM modulation with random data and Modulation Limiter set at a Maximum Frequency Deviation (Factory Setting).

- **For 12.5 kHz channel spacing:**

Data Rate (Kbps)	Peak Deviation (kHz)
9.6	3.13

5.8.4.2. Voice Modulation Limiting

- **For 12.5 kHz channel spacing:**

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)
10	0.05	0.07	0.10	0.19	0.05	2.5
50	0.05	0.21	0.34	0.83	0.05	2.5
100	0.05	0.35	0.65	1.61	0.05	2.5
150	0.05	0.51	0.96	1.79	0.05	2.5
200	0.05	0.68	1.26	1.83	0.05	2.5
250	0.05	0.86	1.56	1.84	0.05	2.5
300	0.05	1.01	1.85	1.85	0.05	2.5
350	0.05	1.15	1.85	1.85	0.05	2.5
400	0.05	1.29	1.88	1.85	0.05	2.5
450	0.05	1.45	1.88	1.85	0.05	2.5
500	0.06	1.59	1.89	1.85	0.06	2.5
600	0.06	1.89	1.91	1.85	0.06	2.5
700	0.06	1.91	1.94	1.85	0.06	2.5
800	0.06	1.93	1.95	1.85	0.06	2.5
900	0.06	1.93	1.95	1.85	0.06	2.5
1000	0.06	1.93	1.95	1.85	0.06	2.5

Voice Signal Input Level = STD MOD Level + 16 dB
= 47.75 dB(mVrms) + 16 dB
= 63.75 dB(mVrms)
= 1539.54 mVrms

Modulation Frequency (kHz)	**Peak Deviation (kHz)**	**Maximum Limit (kHz)**
0.1	0.06	2.5
0.2	2.03	2.5
0.4	2.06	2.5
0.6	2.07	2.5
0.8	2.06	2.5
1.0	1.99	2.5
1.2	2.01	2.5
1.4	2.11	2.5
1.6	2.13	2.5
1.8	2.12	2.5
2.0	2.11	2.5
2.5	2.23	2.5
3.0	1.94	2.5
3.5	0.71	2.5
4.0	0.06	2.5
4.5	0.05	2.5
5.0	0.06	2.5
6.0	0.06	2.5
7.0	0.06	2.5
8.0	0.06	2.5
9.0	0.06	2.5
10.0	0.06	2.5

- **For 25 kHz channel spacing:**

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)
10	0.08	0.14	0.21	0.38	0.09	5.0
50	0.10	0.38	0.66	1.66	0.11	5.0
100	0.10	0.68	1.25	3.18	0.11	5.0
150	0.11	1.01	1.84	3.51	0.11	5.0
200	0.11	1.27	2.48	3.57	0.11	5.0
250	0.11	1.55	3.06	3.57	0.11	5.0
300	0.11	1.90	3.65	3.60	0.11	5.0
350	0.11	2.25	3.70	3.61	0.11	5.0
400	0.11	2.53	3.70	3.67	0.11	5.0
450	0.11	2.81	3.70	3.67	0.11	5.0
500	0.11	3.13	3.70	3.67	0.11	5.0
600	0.11	3.74	3.75	3.68	0.11	5.0
700	0.11	3.78	3.80	3.68	0.11	5.0
800	0.11	3.80	3.82	3.68	0.11	5.0
900	0.11	3.80	3.84	3.68	0.11	5.0
1000	0.11	3.80	3.85	3.68	0.11	5.0

Voice Signal Input Level = STD MOD Level + 16 dB
= 47.78 dB(mVrms) + 16 dB
= 63.78 dB(mVrms)
= 1545.85 mVrms

Modulation Frequency (kHz)	**Peak Deviation (kHz)**	**Maximum Limit (kHz)**
0.1	0.10	5.0
0.2	4.01	5.0
0.4	4.07	5.0
0.6	4.06	5.0
0.8	4.02	5.0
1.0	3.89	5.0
1.2	3.95	5.0
1.4	4.13	5.0
1.6	4.15	5.0
1.8	4.13	5.0
2.0	4.21	5.0
2.5	4.20	5.0
3.0	3.83	5.0
3.5	1.37	5.0
4.0	0.11	5.0
4.5	0.11	5.0
5.0	0.11	5.0
6.0	0.11	5.0
7.0	0.11	5.0
8.0	0.11	5.0
9.0	0.11	5.0
10.0	0.11	5.0

5.9. OCCUPIED BANDWIDTH & EMISSION MASK [§§ 2.1049, 90.209 & 90.210]

5.9.1. Limits

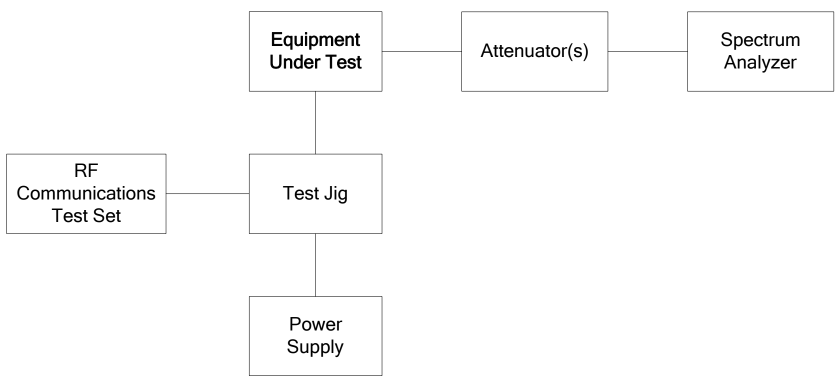
Emissions shall be attenuated below the mean output power of the transmitter as follows:

Frequency Band (MHz)	Channel Spacing (kHz)	Authorized Bandwidth (kHz)	Mask for equipment with Audio low pass filter	Mask for equipment Without audio low pass filter
150–174	25 12.5 6.25	20 11.25 6	B D E	C D E

5.9.2. Method of Measurements

Refer to Exhibit 8, Section 8.4 of this report for measurement details and TIA-603-C.

5.9.3. Test Arrangement



5.9.4. Test Data

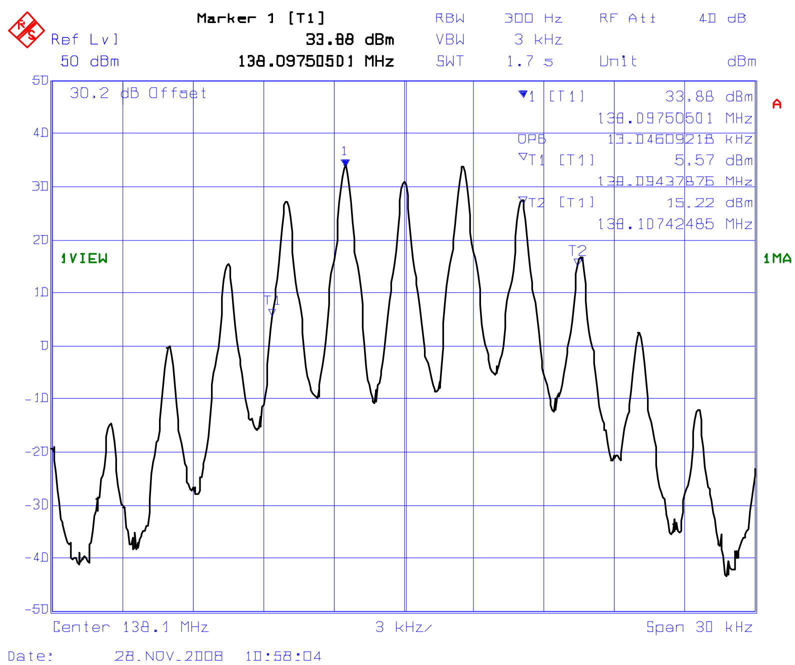
5.9.4.1. 99% Occupied Bandwidth

Frequency (MHz)	*Measured 99% OBW at Maximum Freq. Deviation (kHz)	Maximum Authorized Bandwidth (kHz)
25 kHz Channel Spacing, Analog		
138.1	13.05	20
151.0	13.11	20
160.9	14.67	20
173.3	14.73	20
12.5 kHz Channel Spacing, Analog		
138.1	9.86	11.25
151.0	9.86	11.25
160.9	9.82	11.25
173.3	9.90	11.25
12.5 kHz Channel Spacing, Digital		
138.1	8.02	11.25
151.0	8.30	11.25
160.9	8.10	11.25
173.3	7.98	11.25

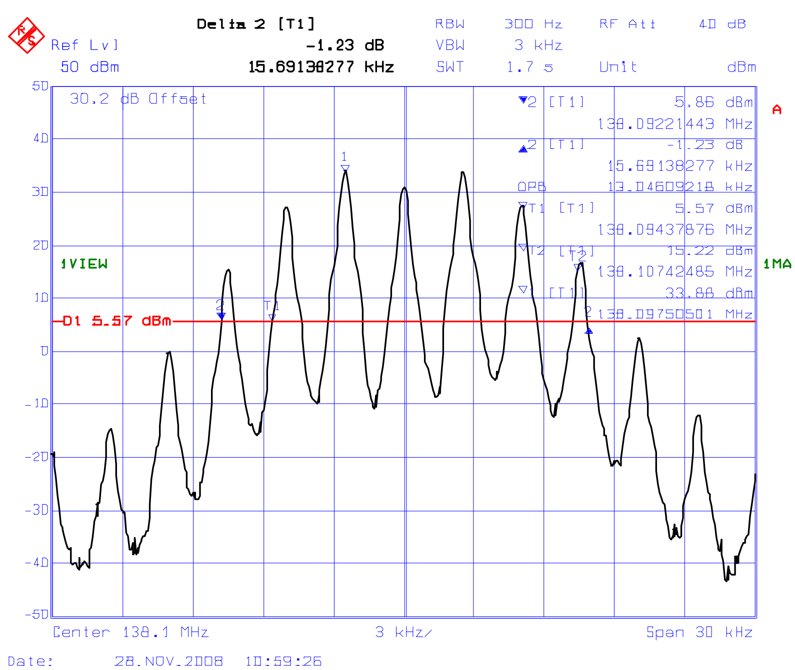
Note: 99% Occupied Bandwidth measurements were done using the built-in auto function of the spectrum analyzer.

*Refer to the following for detailed data plots.

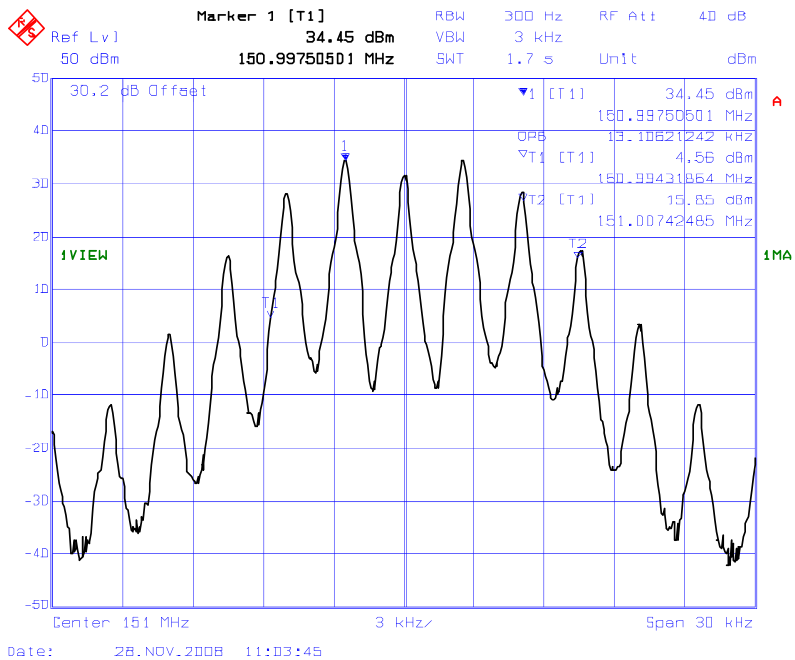
Plot 5.9.4.1.1(i) 99% Occupied Bandwidth
Carrier Frequency: 138.1 MHz; Channel Spacing: 25 kHz; Power: 10 W
Modulation: FM with 2.5 KHz sine wave signal



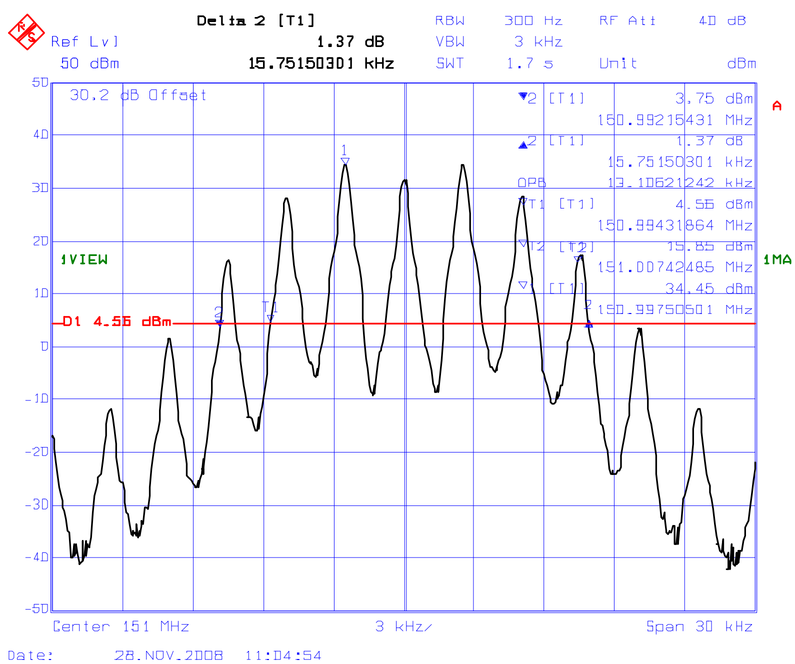
Plot 5.9.4.1.1(ii) 99% Occupied Bandwidth
Carrier Frequency: 138.1 MHz; Channel Spacing: 25 kHz; Power: 10 W
Modulation: FM with 2.5 KHz sine wave signal



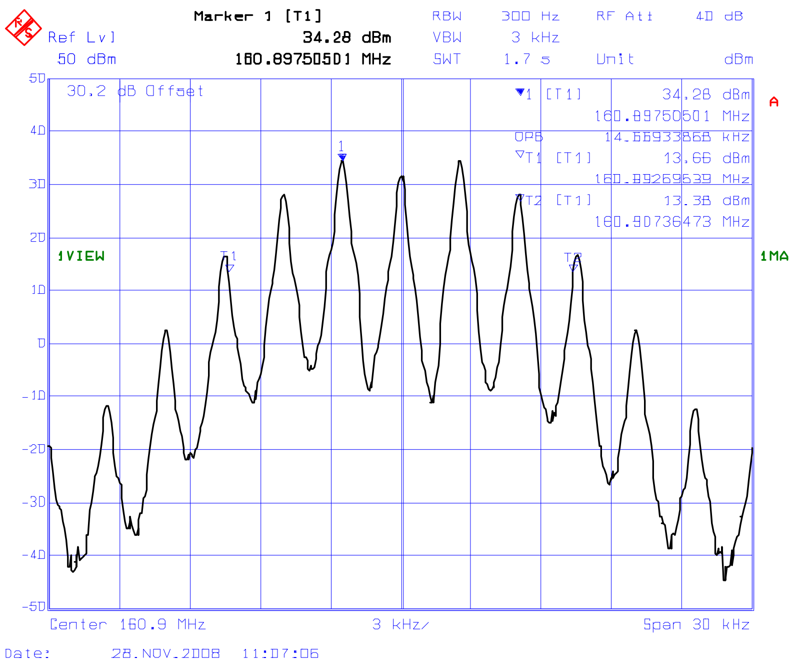
Plot 5.9.4.1.2(i) 99% Occupied Bandwidth
Carrier Frequency: 151.0 MHz; Channel Spacing: 25 kHz; Power: 10 W
Modulation: FM with 2.5 KHz sine wave signal



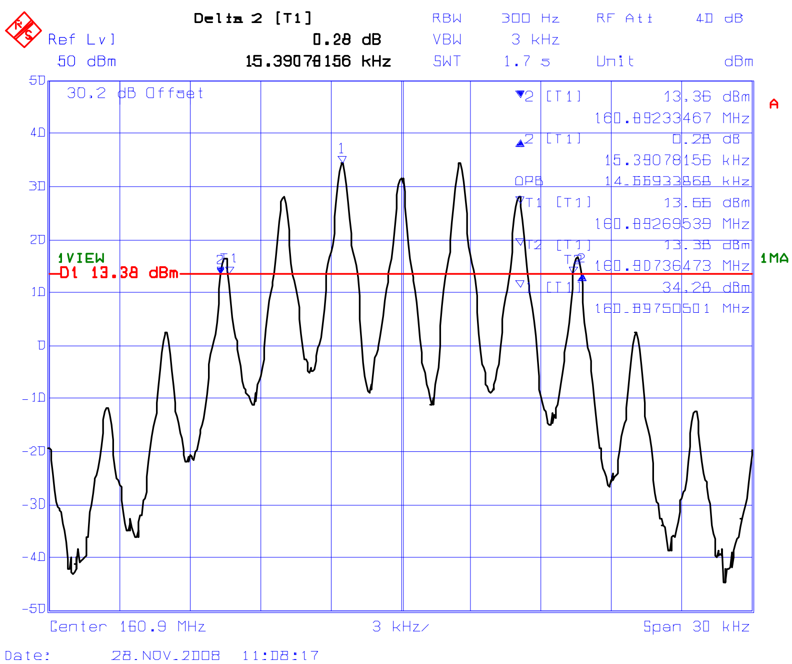
Plot 5.9.4.1.2(ii) 99% Occupied Bandwidth
Carrier Frequency: 151.0 MHz; Channel Spacing: 25 kHz; Power: 10 W
Modulation: FM with 2.5 KHz sine wave signal



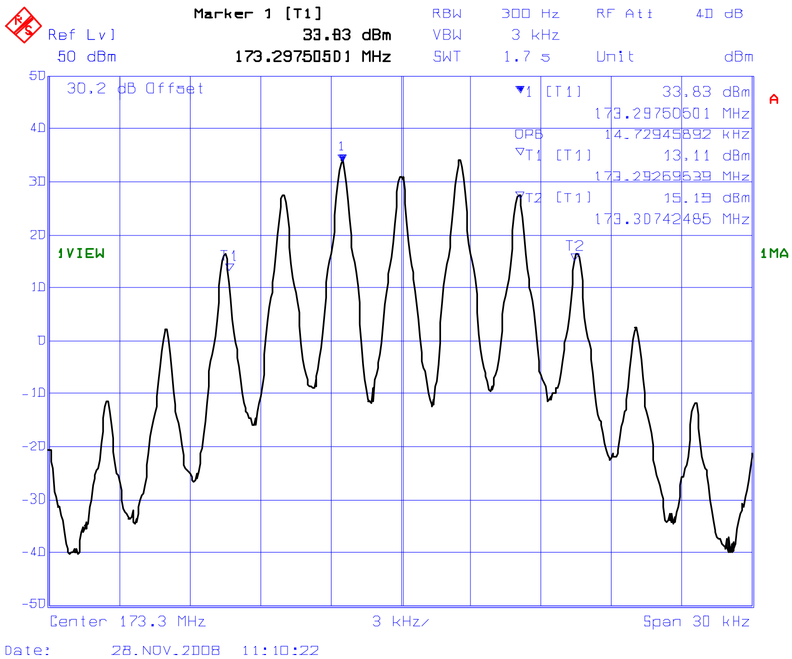
Plot 5.9.4.1.3(i) 99% Occupied Bandwidth
Carrier Frequency: 160.9 MHz; Channel Spacing: 25 kHz; Power: 10 W
Modulation: FM with 2.5 KHz sine wave signal



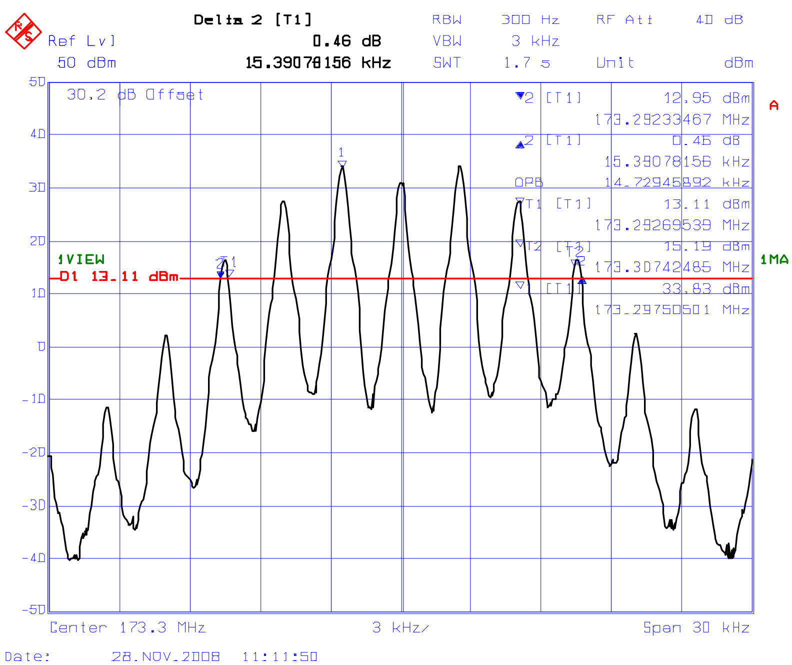
Plot 5.9.4.1.3(ii) 99% Occupied Bandwidth
Carrier Frequency: 160.9 MHz; Channel Spacing: 25 kHz; Power: 10 W
Modulation: FM with 2.5 KHz sine wave signal



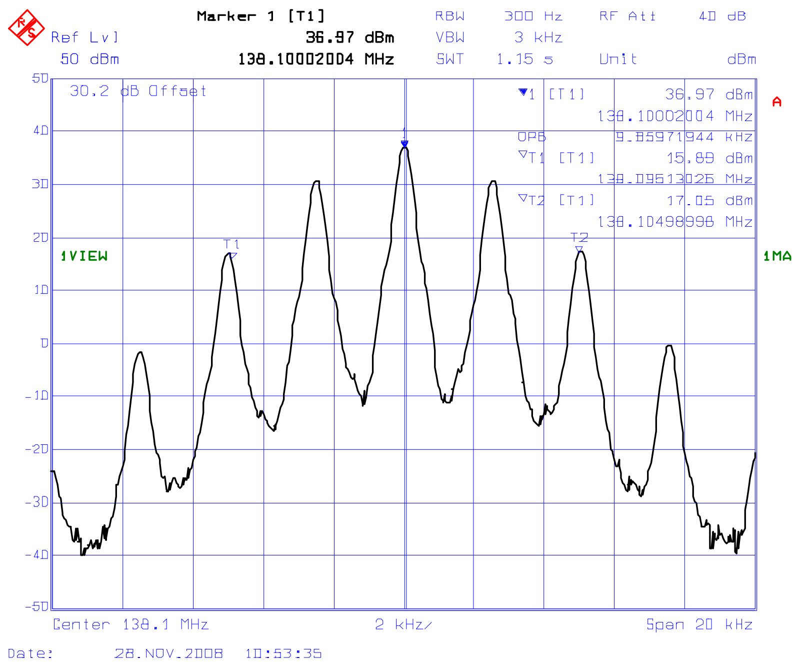
Plot 5.9.4.1.4(i) 99% Occupied Bandwidth
Carrier Frequency: 173.3 MHz; Channel Spacing: 25 kHz; Power: 10 W
Modulation: FM with 2.5 KHz sine wave signal



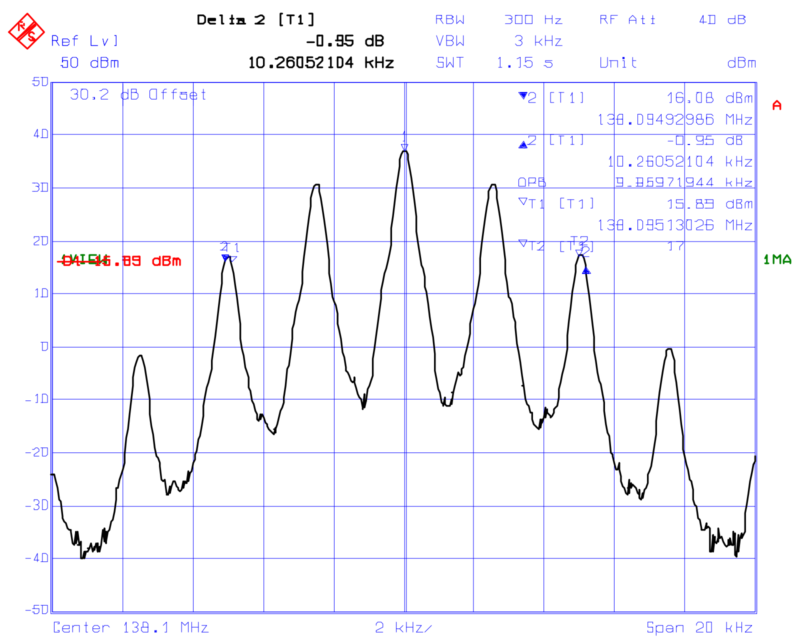
Plot 5.9.4.1.4(ii) 99% Occupied Bandwidth
Carrier Frequency: 173.3 MHz; Channel Spacing: 25 kHz; Power: 10 W
Modulation: FM with 2.5 KHz sine wave signal



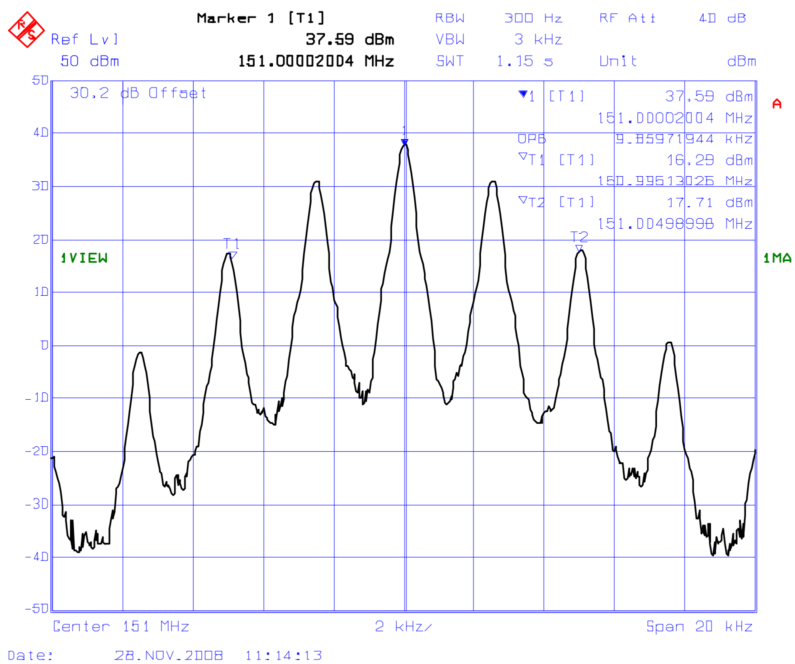
Plot 5.9.4.1.5(i) 99% Occupied Bandwidth
Carrier Frequency: 138.1 MHz; Channel Spacing: 12.5 kHz; Power: 10 W
Modulation: FM with 2.5 KHz sine wave signal



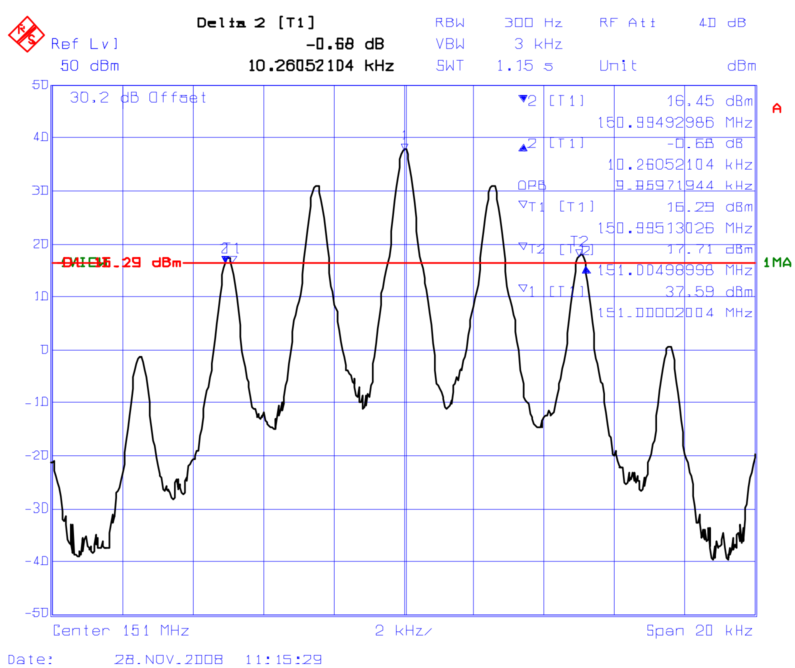
Plot 5.9.4.1.5(ii) 99% Occupied Bandwidth
Carrier Frequency: 138.1 MHz; Channel Spacing: 12.5 kHz; Power: 10 W
Modulation: FM with 2.5 KHz sine wave signal



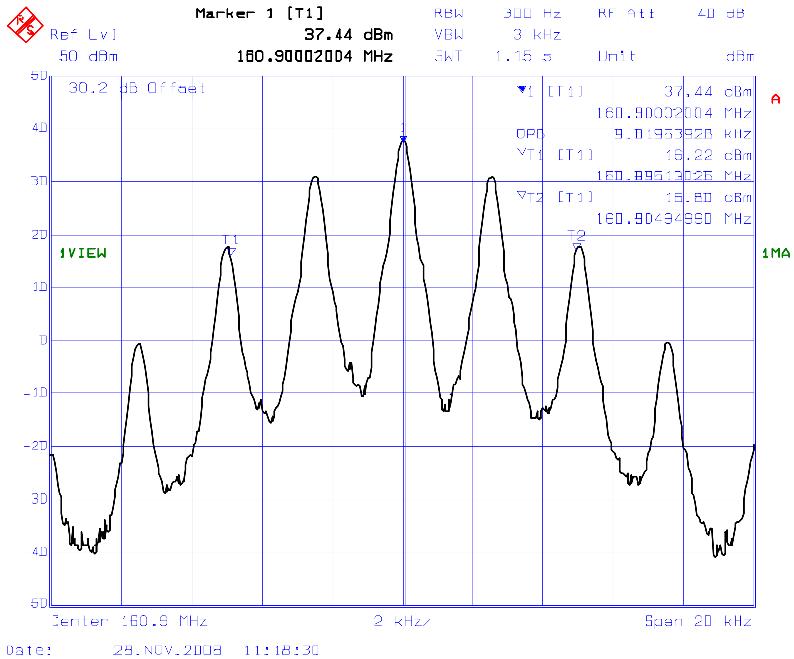
Plot 5.9.4.1.6(i) 99% Occupied Bandwidth
Carrier Frequency: 151.0 MHz; Channel Spacing: 12.5 kHz; Power: 10 W
Modulation: FM with 2.5 KHz sine wave signal



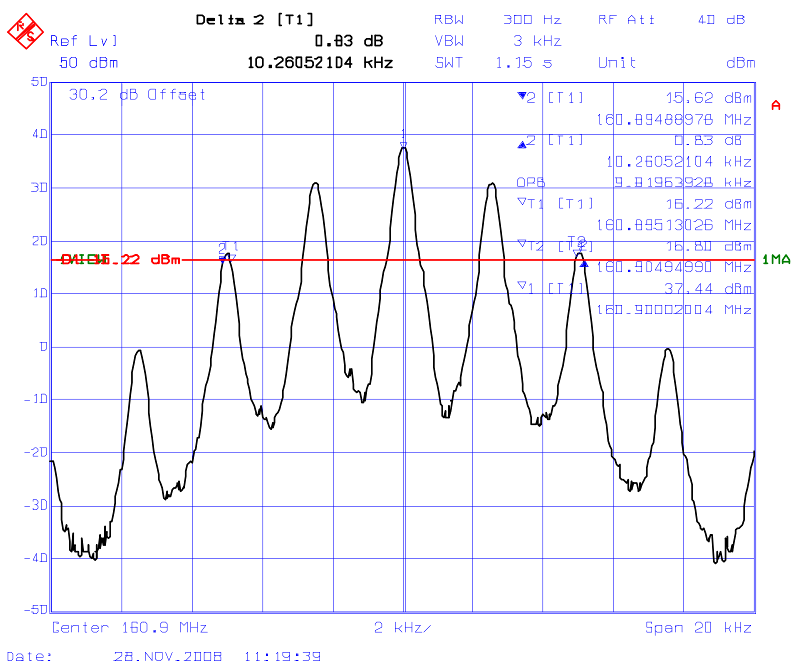
Plot 5.9.4.1.6(ii) 99% Occupied Bandwidth
Carrier Frequency: 151.0 MHz; Channel Spacing: 12.5 kHz; Power: 10 W
Modulation: FM with 2.5 KHz sine wave signal



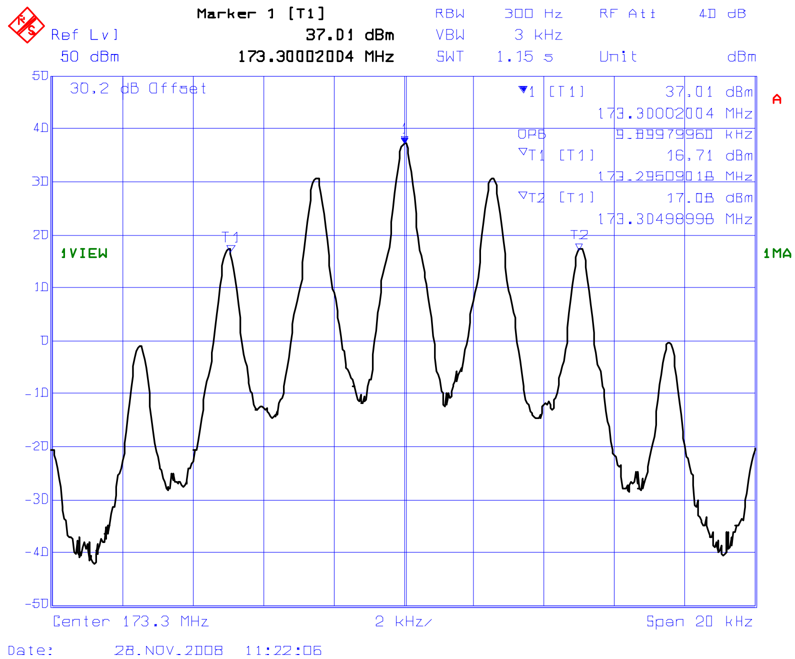
Plot 5.9.4.1.7(i) 99% Occupied Bandwidth
Carrier Frequency: 160.9 MHz; Channel Spacing: 12.5 kHz; Power: 10 W
Modulation: FM with 2.5 KHz sine wave signal



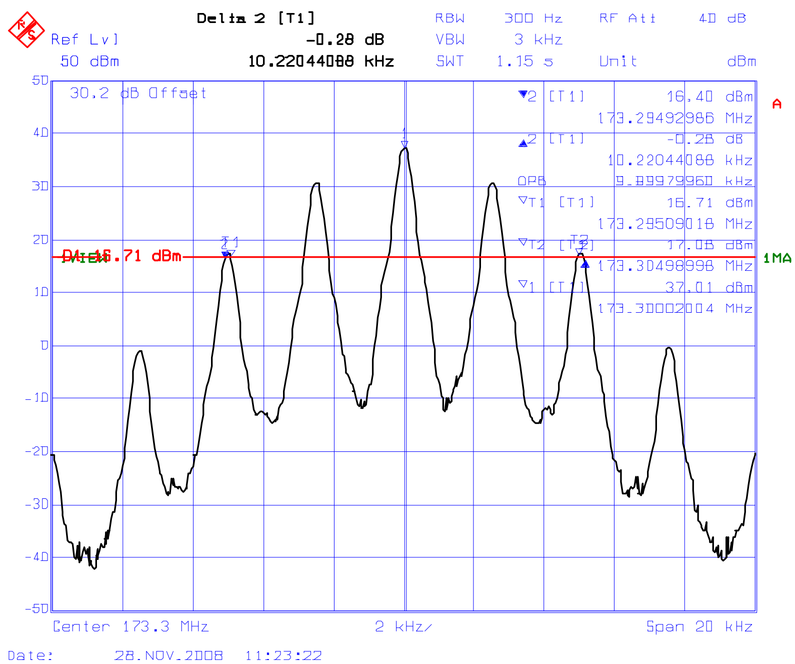
Plot 5.9.4.1.7(ii) 99% Occupied Bandwidth
Carrier Frequency: 160.9 MHz; Channel Spacing: 12.5 kHz; Power: 10 W
Modulation: FM with 2.5 KHz sine wave signal



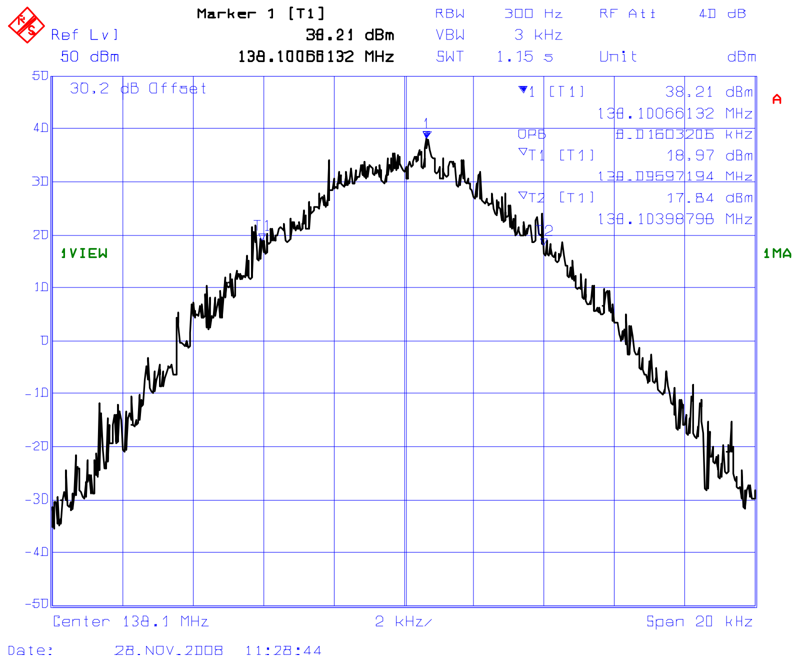
Plot 5.9.4.1.8(i) 99% Occupied Bandwidth
Carrier Frequency: 173.3 MHz; Channel Spacing: 12.5 kHz; Power: 10 W
Modulation: FM with 2.5 KHz sine wave signal



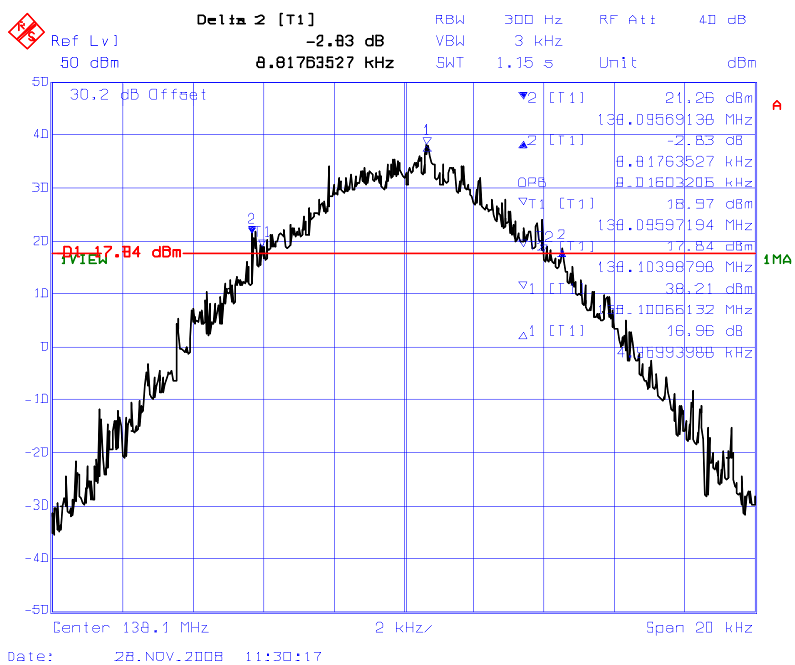
Plot 5.9.4.1.8(ii) 99% Occupied Bandwidth
Carrier Frequency: 173.3 MHz; Channel Spacing: 12.5 kHz; Power: 10 W
Modulation: FM with 2.5 KHz sine wave signal



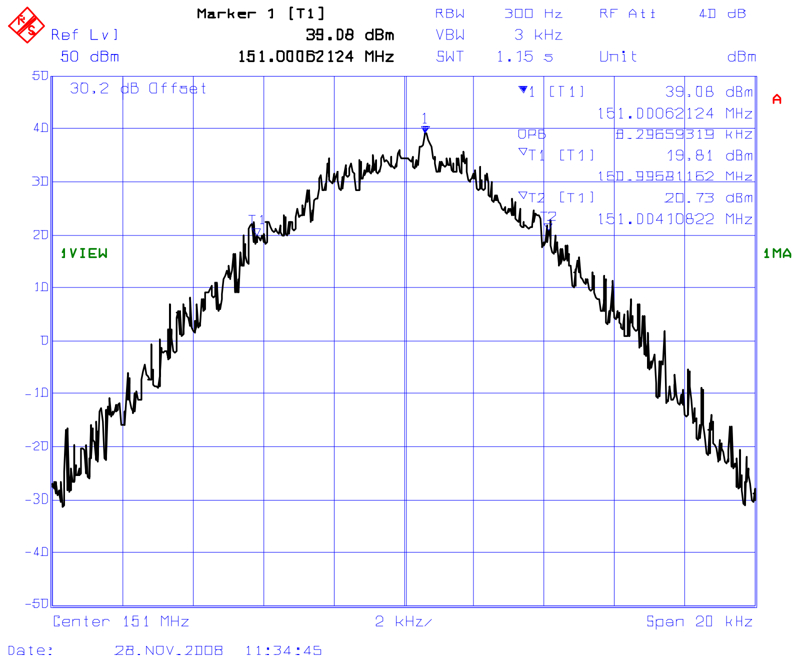
Plot 5.9.4.1.9(i) 99% Occupied Bandwidth
Carrier Frequency: 138.1 MHz; Channel Spacing: 12.5 kHz; Power: 10 W
Modulation: Digital



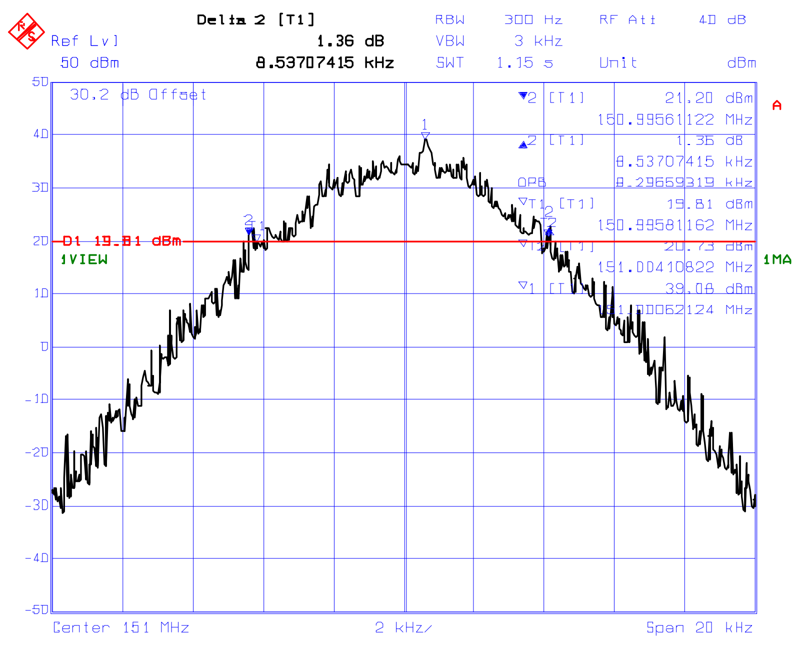
Plot 5.9.4.1.9(ii) 99% Occupied Bandwidth
Carrier Frequency: 138.1 MHz; Channel Spacing: 12.5 kHz; Power: 10 W
Modulation: Digital



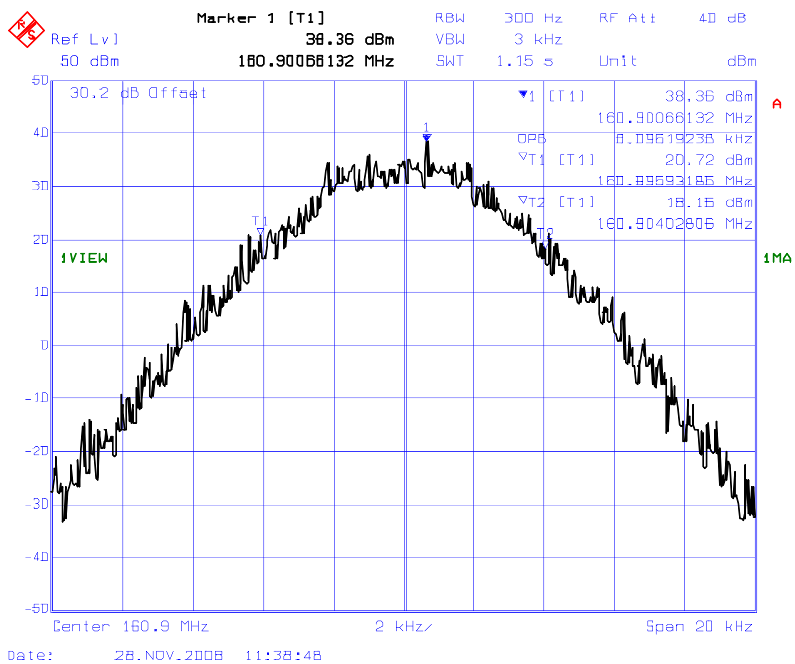
Plot 5.9.4.1.10(i) 99% Occupied Bandwidth
Carrier Frequency: 151.0 MHz; Channel Spacing: 12.5 kHz; Power: 10 W
Modulation: Digital



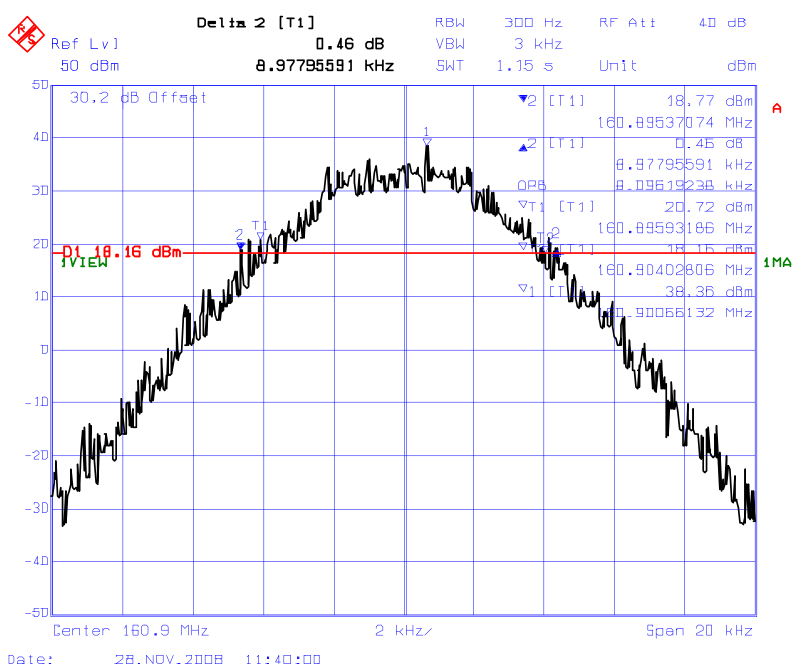
Plot 5.9.4.1.10(ii) 99% Occupied Bandwidth
Carrier Frequency: 151.0 MHz; Channel Spacing: 12.5 kHz; Power: 10 W
Modulation: Digital



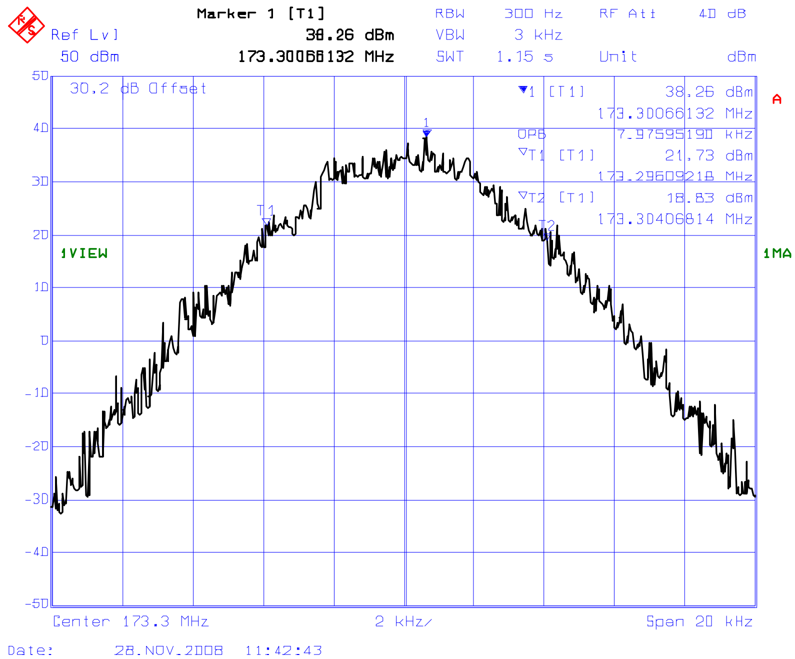
Plot 5.9.4.1.11(i) 99% Occupied Bandwidth
Carrier Frequency: 160.9 MHz; Channel Spacing: 12.5 kHz; Power: 10 W
Modulation: Digital



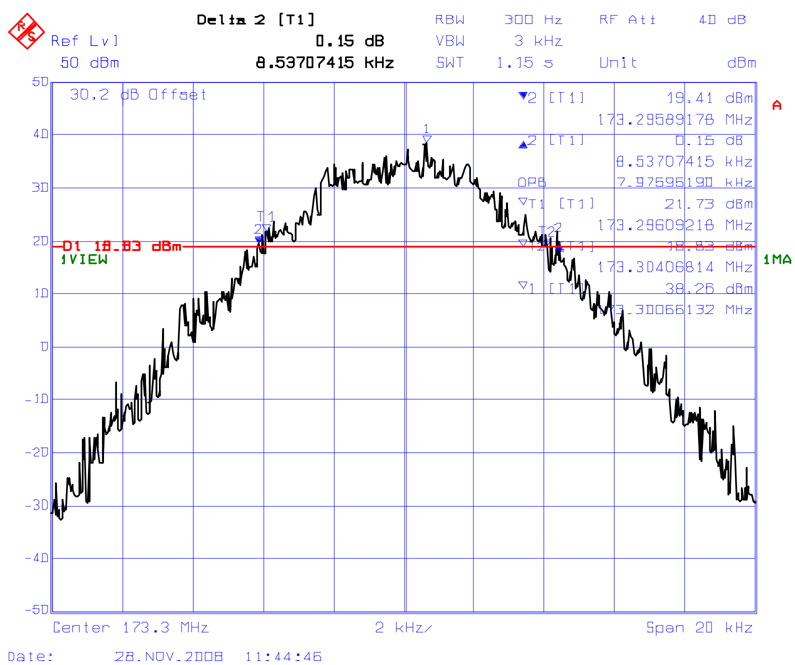
Plot 5.9.4.1.11(ii) 99% Occupied Bandwidth
Carrier Frequency: 160.9 MHz; Channel Spacing: 12.5 kHz; Power: 10 W
Modulation: Digital



Plot 5.9.4.1.12(i) 99% Occupied Bandwidth
Carrier Frequency: 173.3 MHz; Channel Spacing: 12.5 kHz; Power: 10 W
Modulation: FM with 2.5 KHz sine wave signal

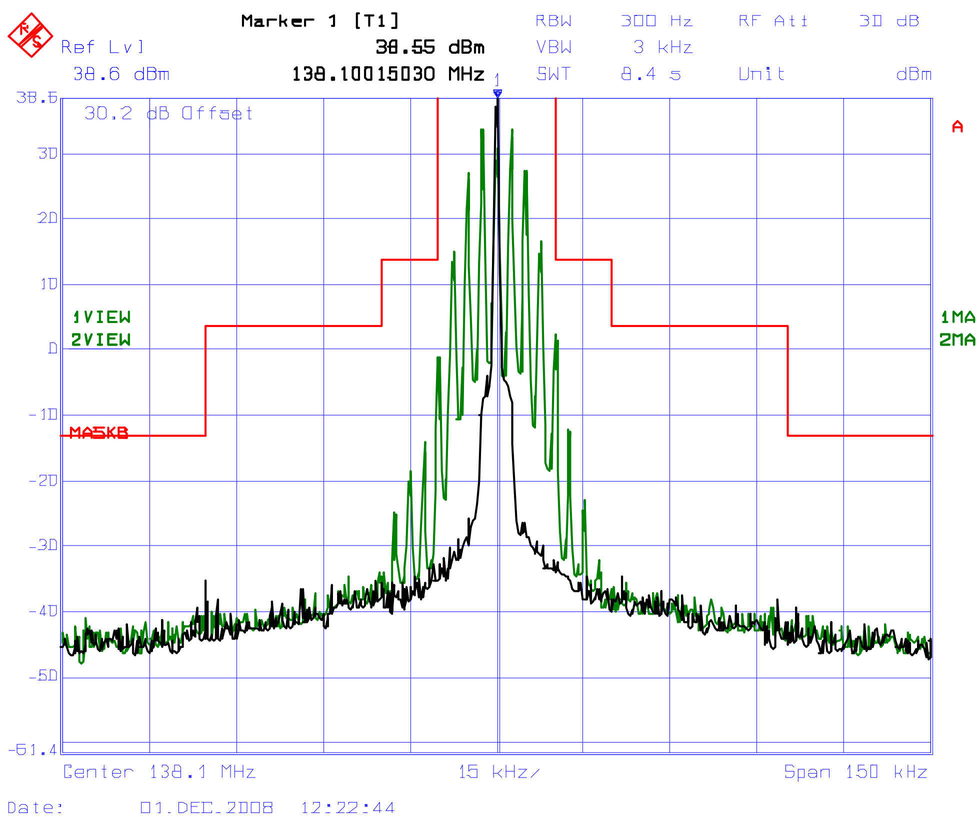


Plot 5.9.4.1.12(ii) 99% Occupied Bandwidth
Carrier Frequency: 173.3 MHz; Channel Spacing: 12.5 kHz; Power: 10 W
Modulation: Digital

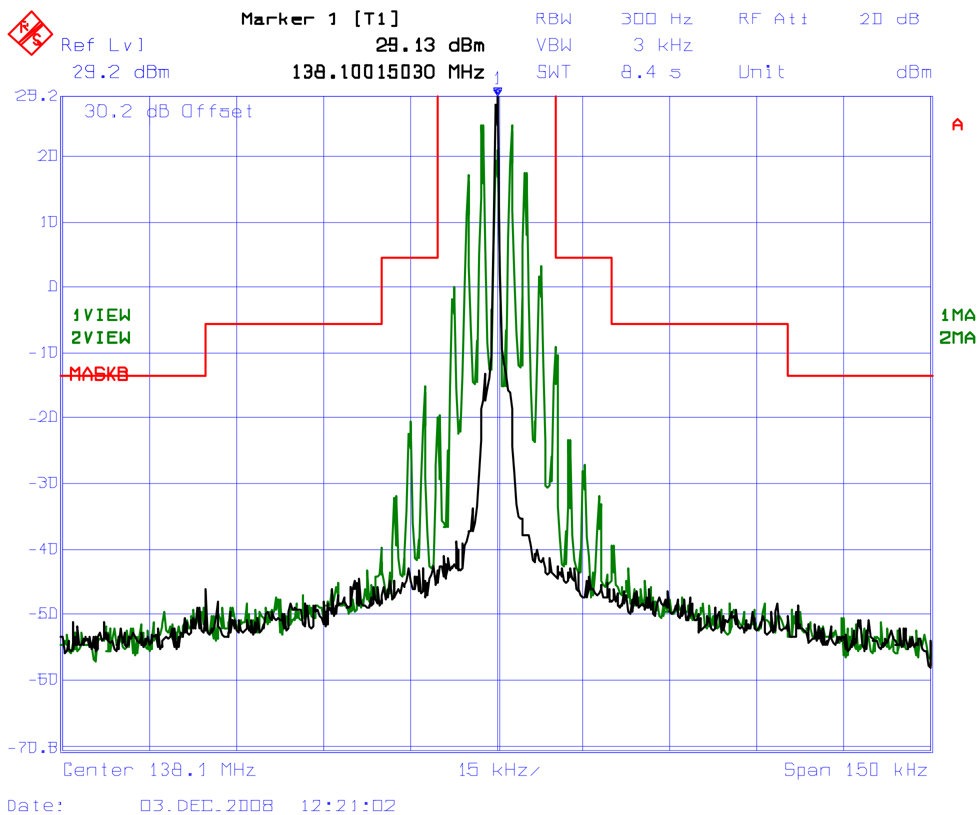


5.9.4.2. Emission Masks

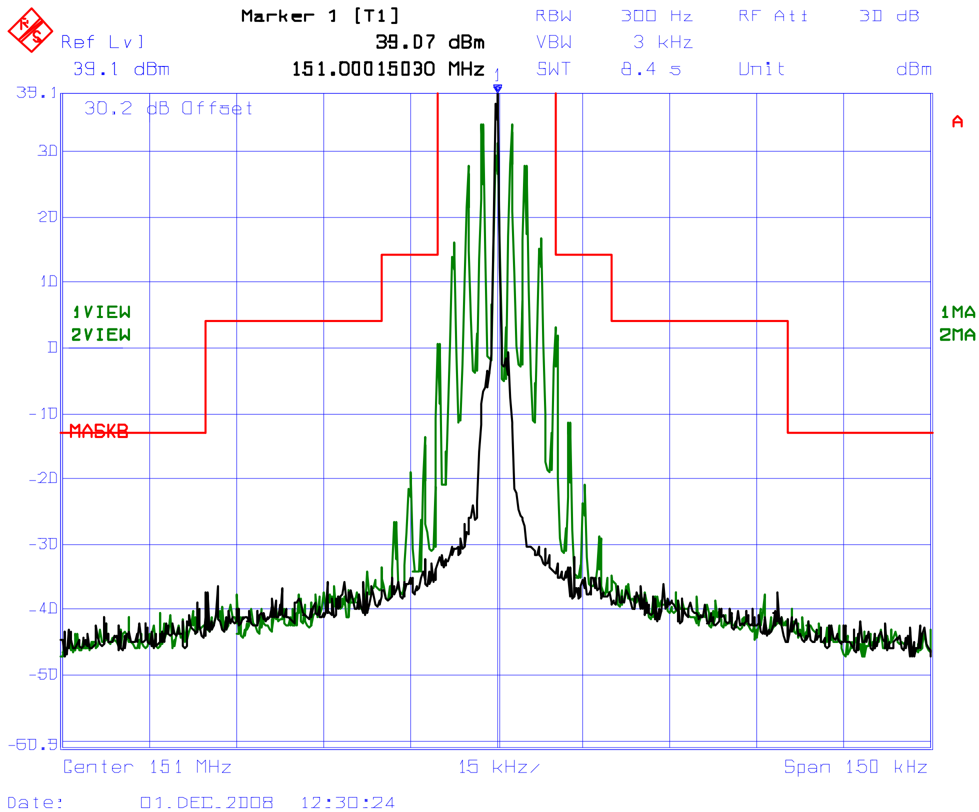
Plot 5.9.4.2.1 Emission Mask B
Carrier Frequency: 138.1 MHz; Power: 10 W
Modulation: Analog



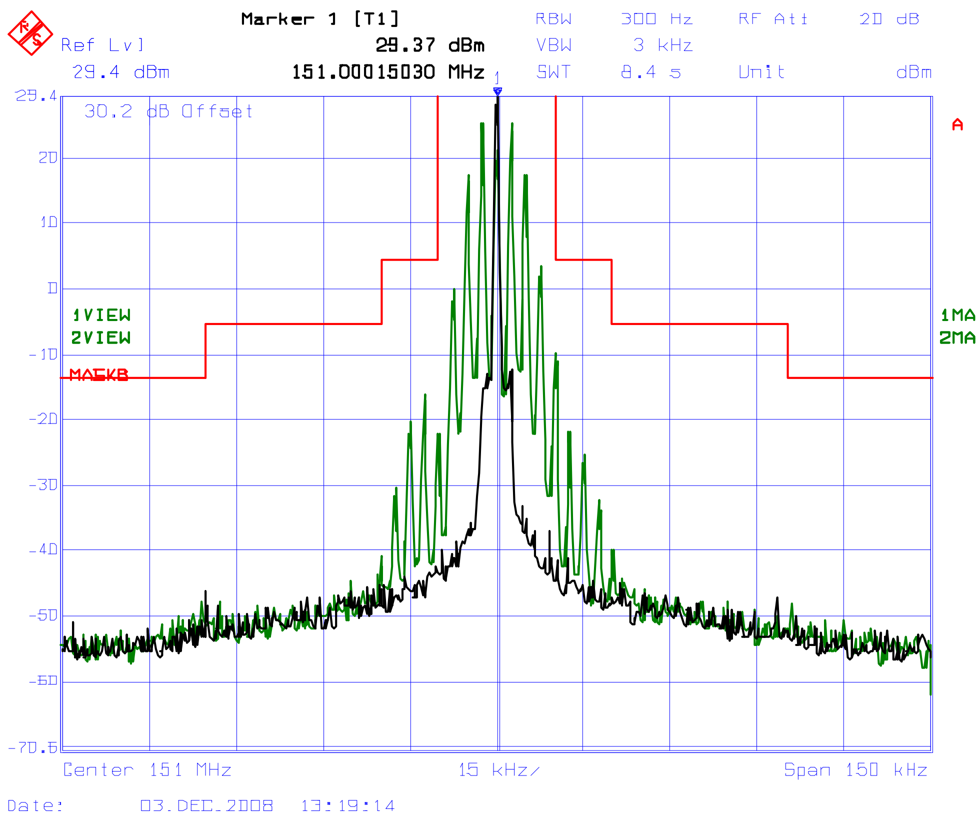
Plot 5.9.4.2.2 Emission Mask B
Carrier Frequency: 138.1 MHz; Power: 1 W
Modulation: Analog



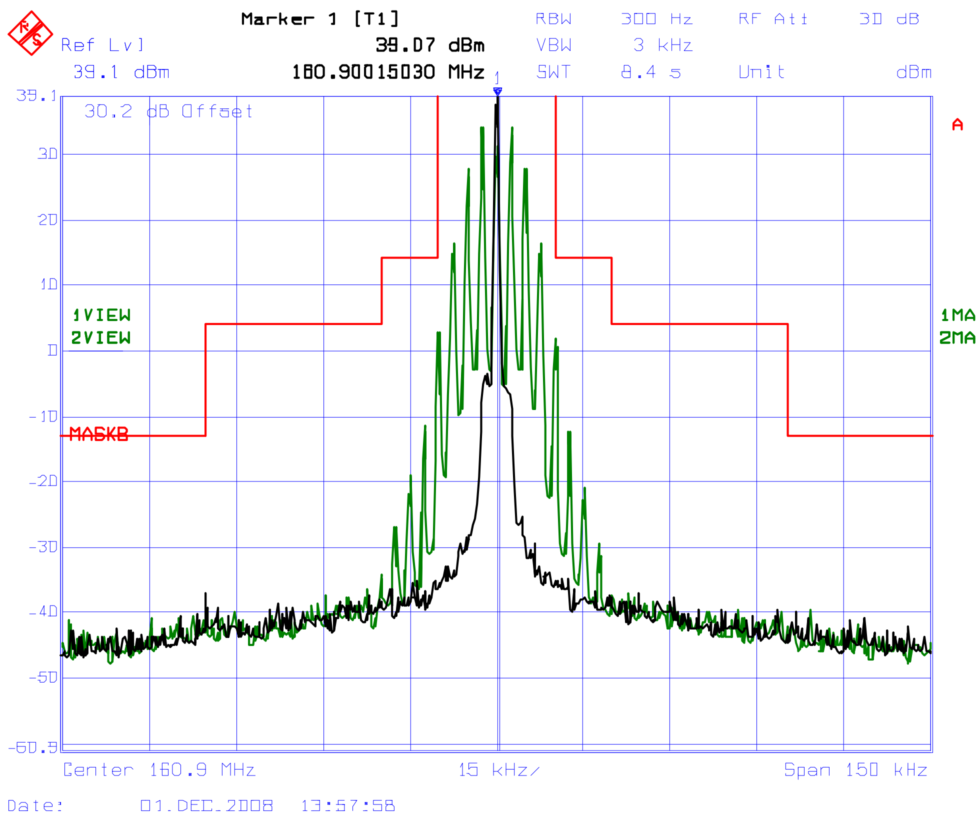
Plot 5.9.4.2.3 Emission Mask B
Carrier Frequency: 151.0 MHz; Power: 10 W
Modulation: Analog



Plot 5.9.4.2.4 Emission Mask B
Carrier Frequency: 151.0 MHz; Power: 1 W
Modulation: Analog



Plot 5.9.4.2.5 Emission Mask B
Carrier Frequency: 160.9 MHz; Power: 10 W
Modulation: Analog



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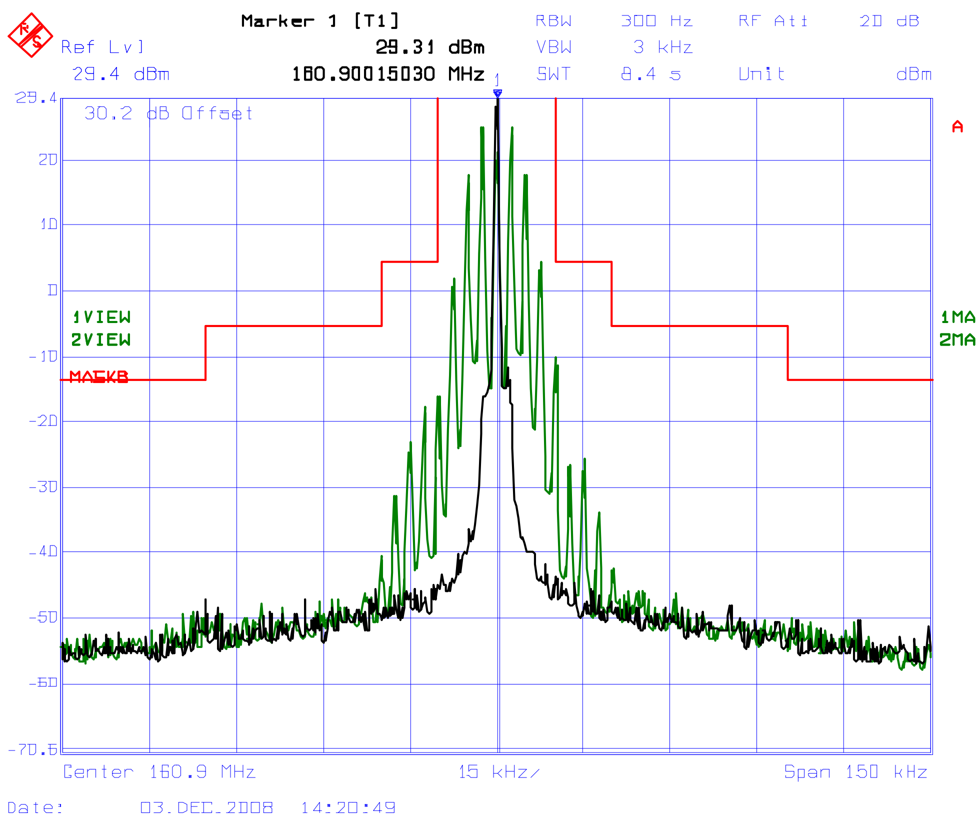
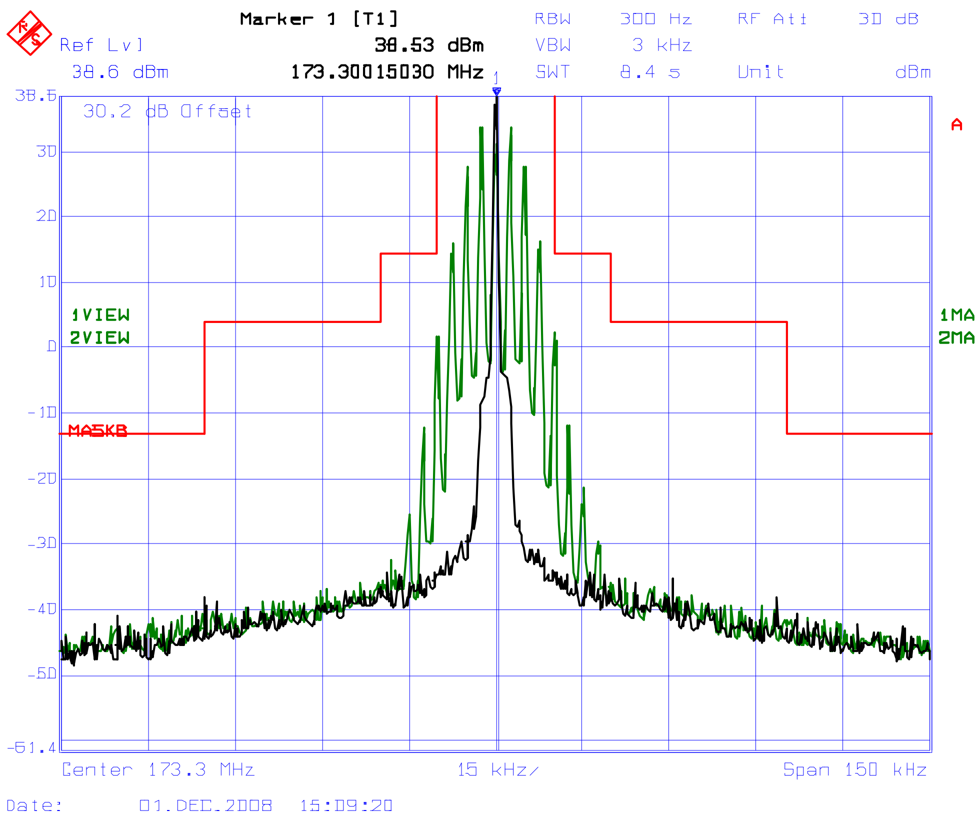
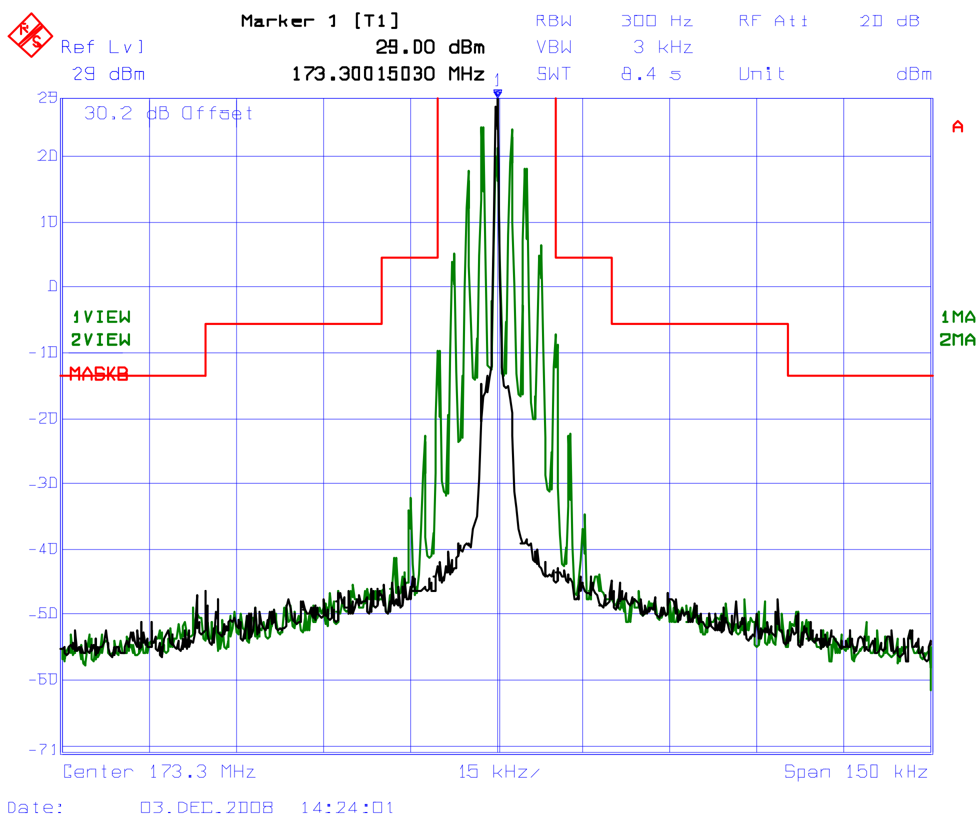
Plot 5.9.4.2.6 Emission Mask B
Carrier Frequency: 160.9 MHz; Power: 1 W
Modulation: Analog



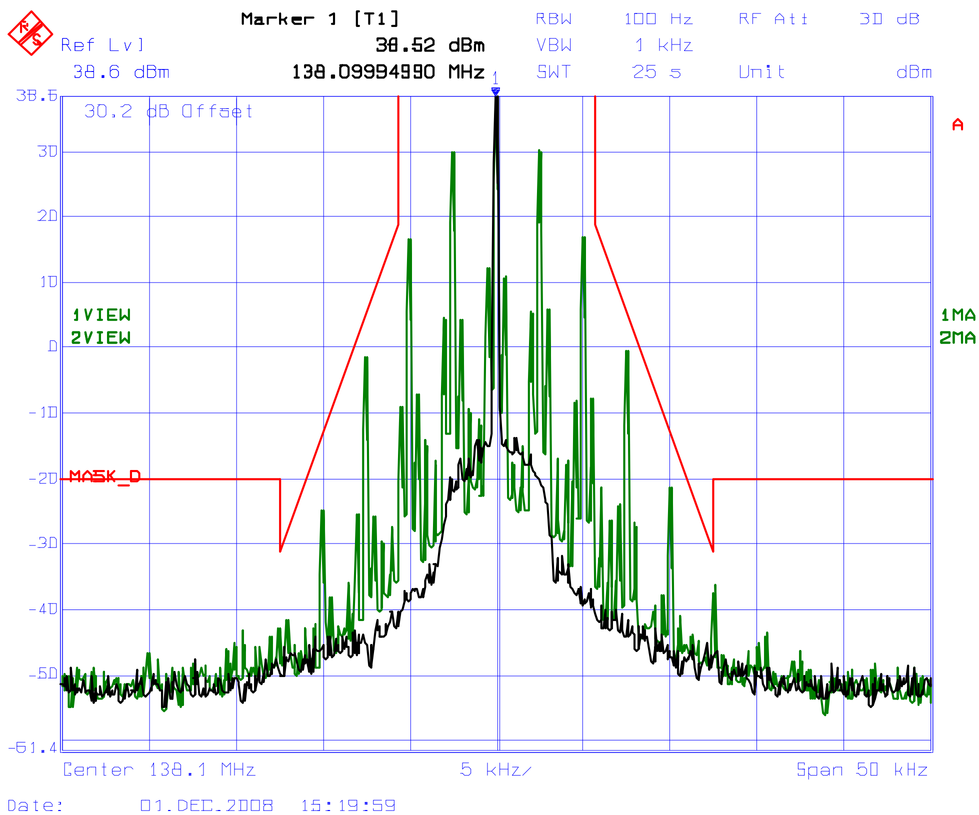
Plot 5.9.4.2.7 Emission Mask B
Carrier Frequency: 173.3 MHz; Power: 10 W
Modulation: Analog



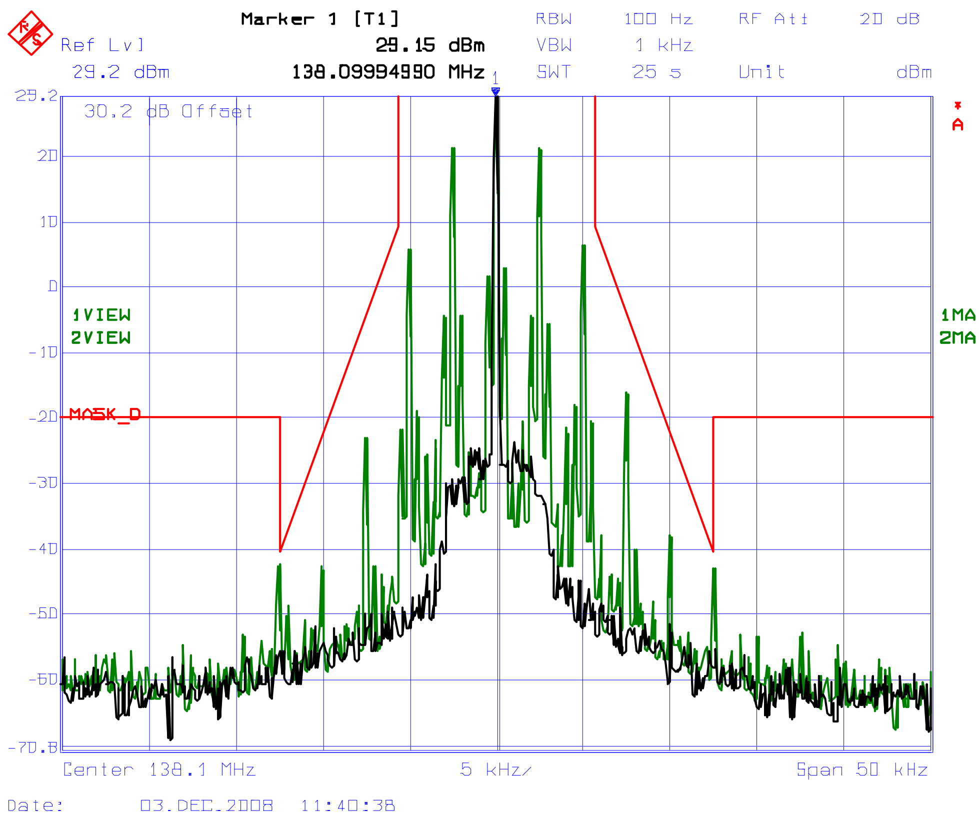
Plot 5.9.4.2.8 Emission Mask B
Carrier Frequency: 173.3 MHz; Power: 1 W
Modulation: Analog



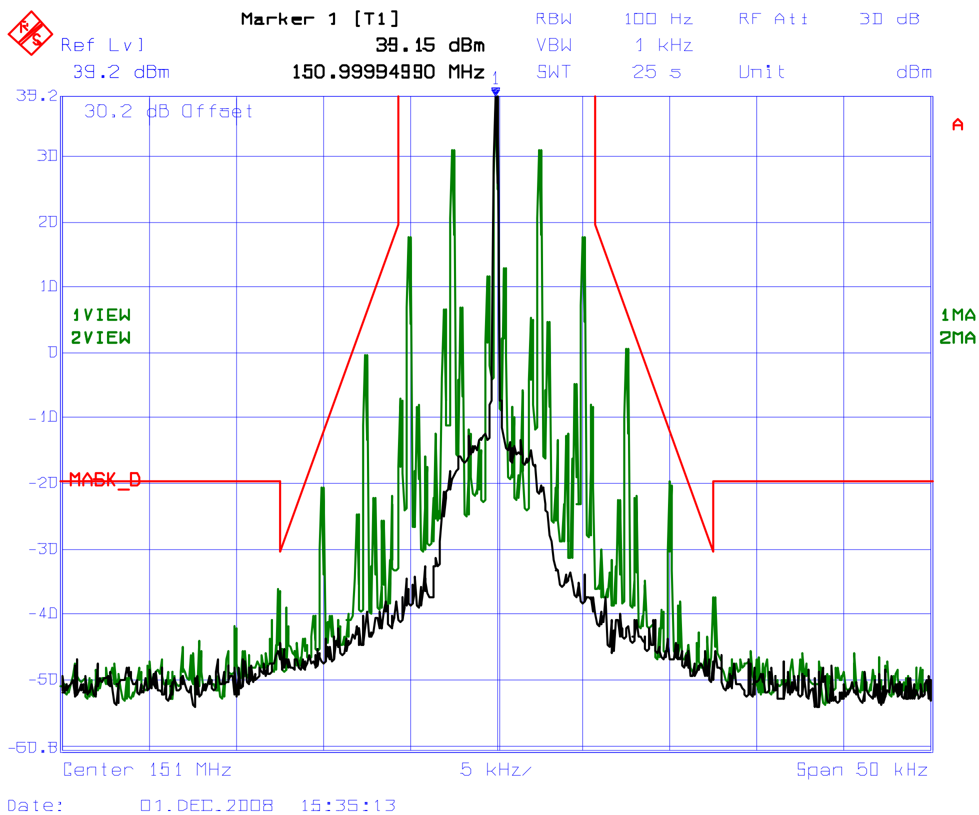
Plot 5.9.4.2.9 Emission Mask D
Carrier Frequency: 138.1 MHz; Power: 10 W
Modulation: Analog



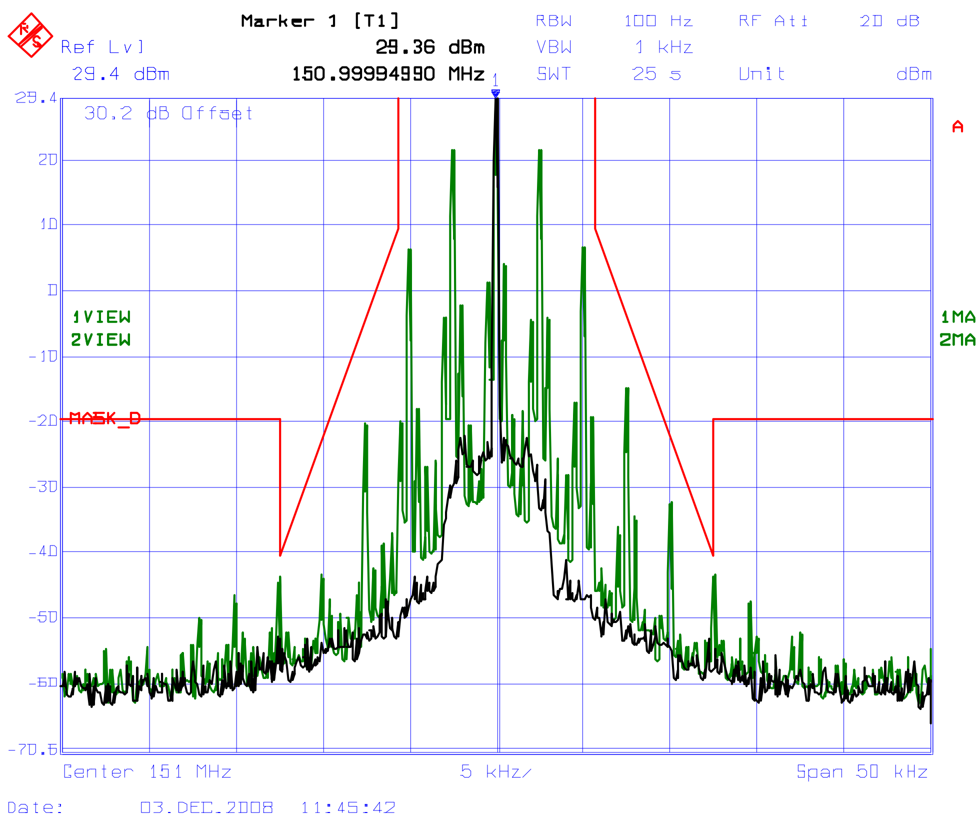
Plot 5.9.4.2.10 Emission Mask D
Carrier Frequency: 138.1 MHz; Power: 1 W
Modulation: Analog



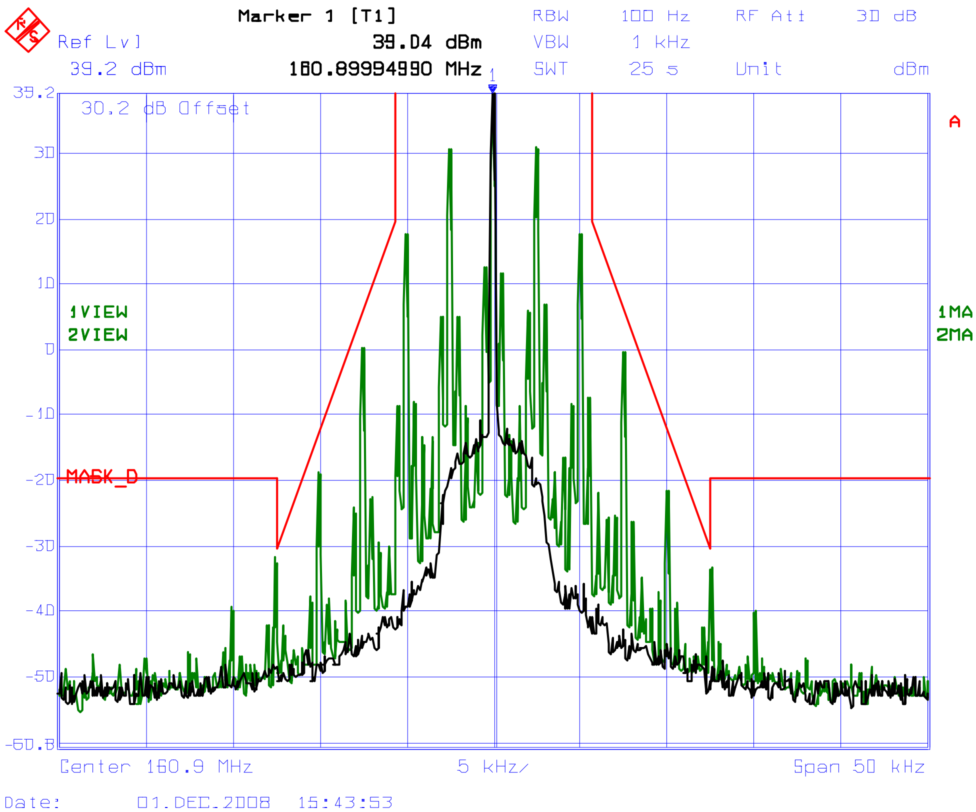
Plot 5.9.4.2.11 Emission Mask D
Carrier Frequency: 151.0 MHz; Power: 10 W
Modulation: Analog



Plot 5.9.4.2.12 Emission Mask D
Carrier Frequency: 151.0 MHz; Power: 1 W
Modulation: Analog



Plot 5.9.4.2.13 Emission Mask D
Carrier Frequency: 160.9 MHz; Power: 10 W
Modulation: Analog



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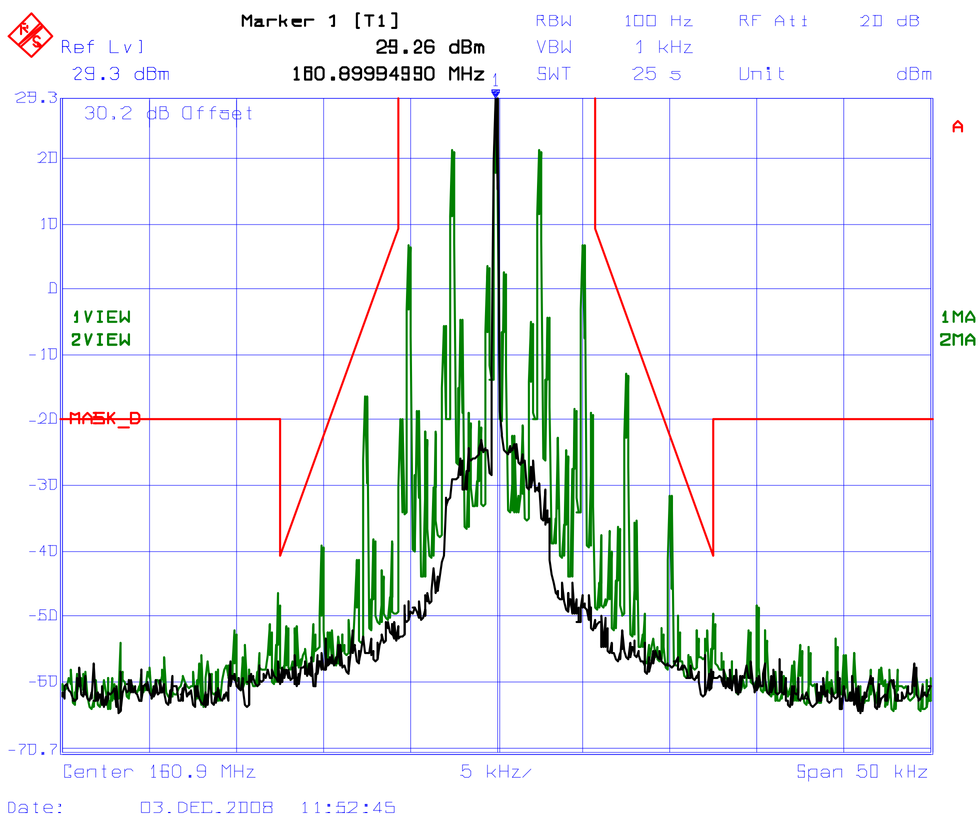
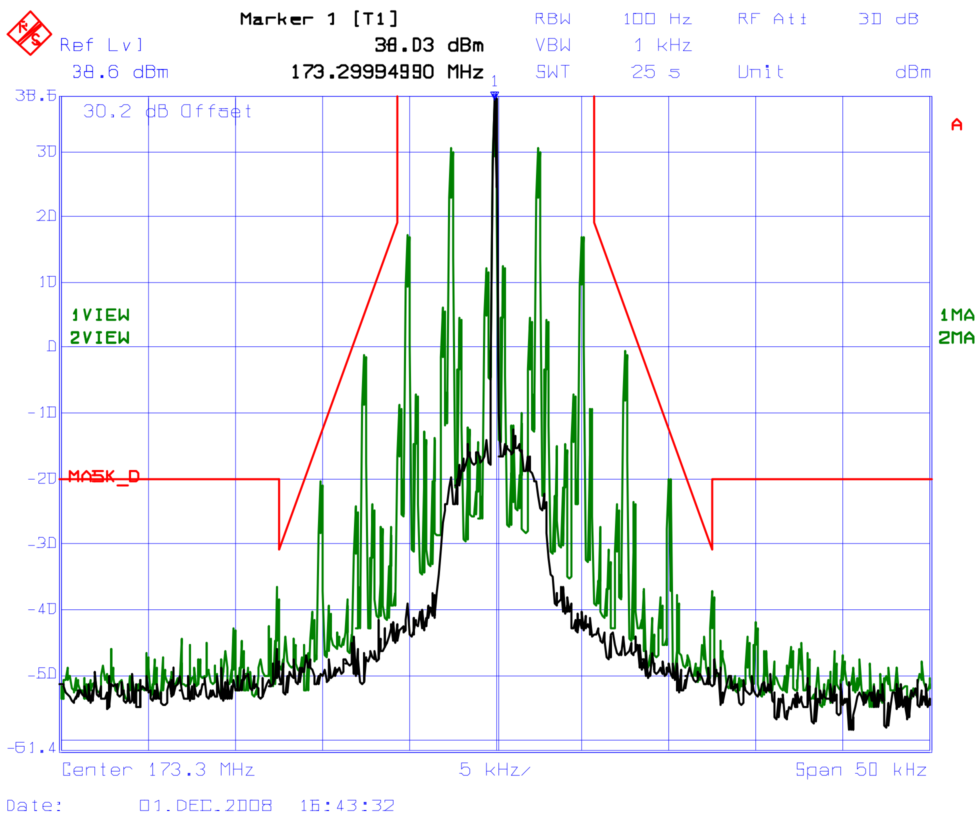
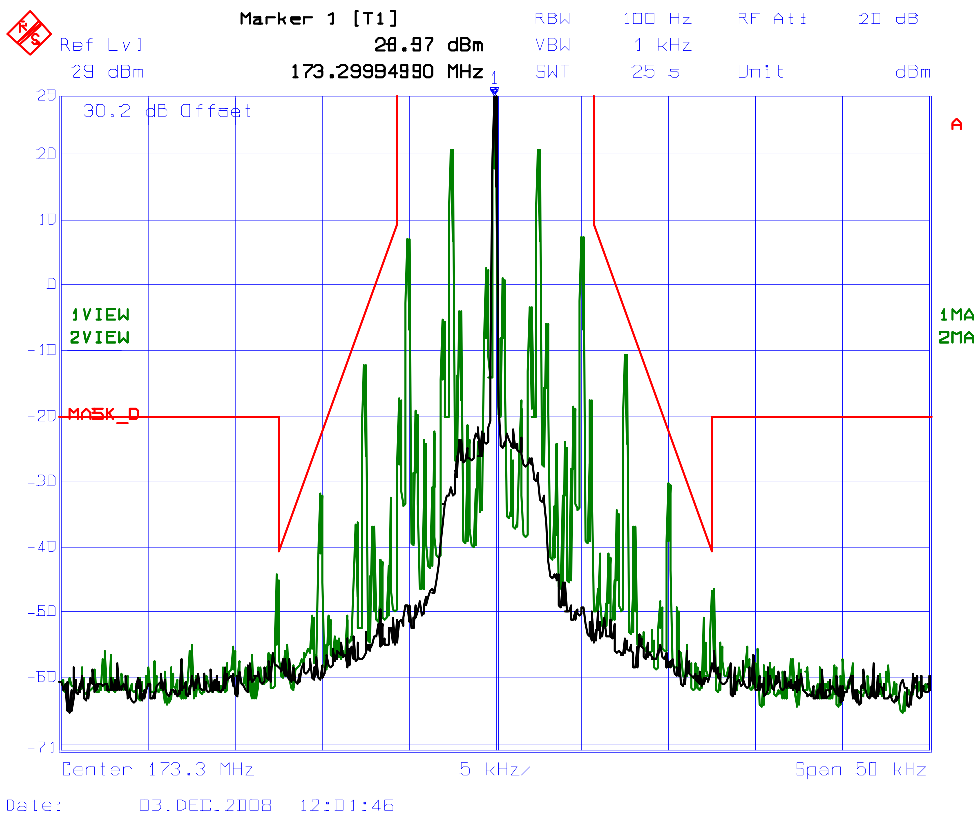
Plot 5.9.4.2.14 Emission Mask D
Carrier Frequency: 160.9 MHz; Power: 1 W
Modulation: Analog



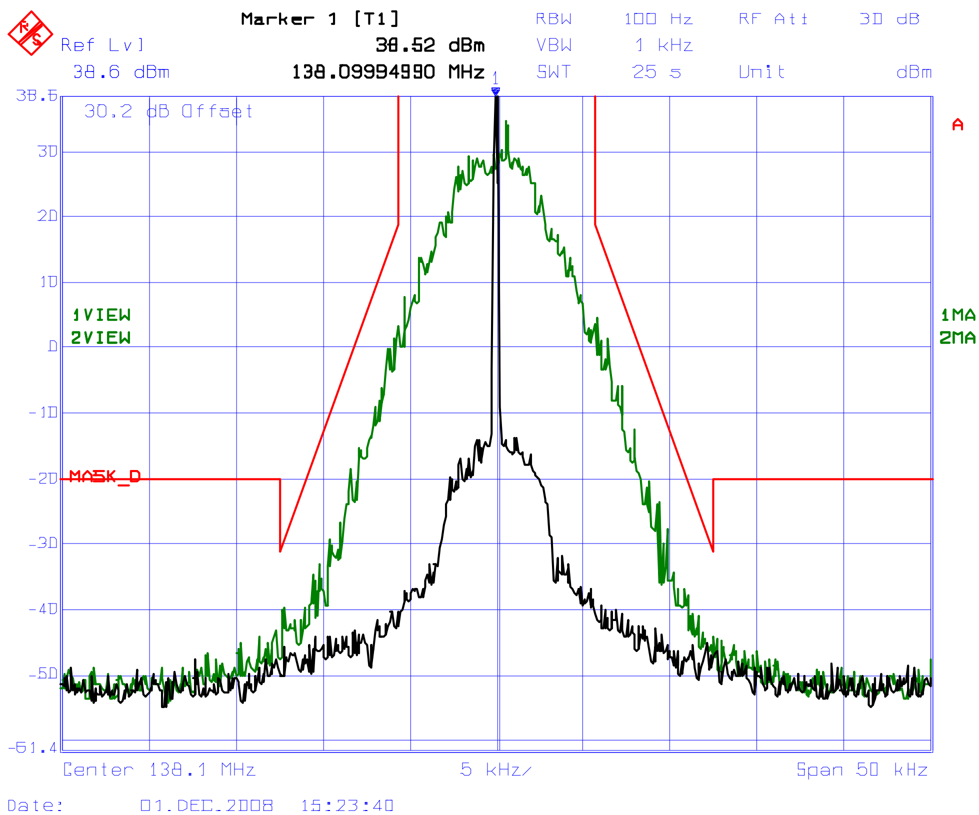
Plot 5.9.4.2.15 Emission Mask D
Carrier Frequency: 173.3 MHz; Power: 10 W
Modulation: Analog



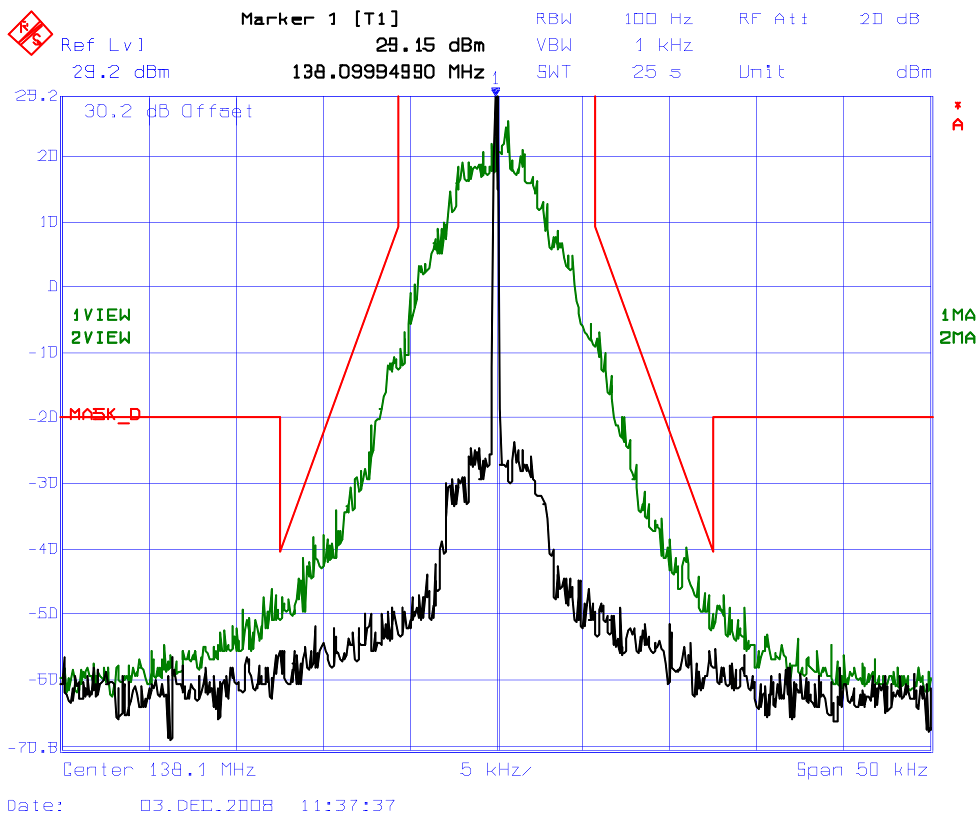
Plot 5.9.4.2.16 Emission Mask D
Carrier Frequency: 173.3 MHz; Power: 1 W
Modulation: Analog



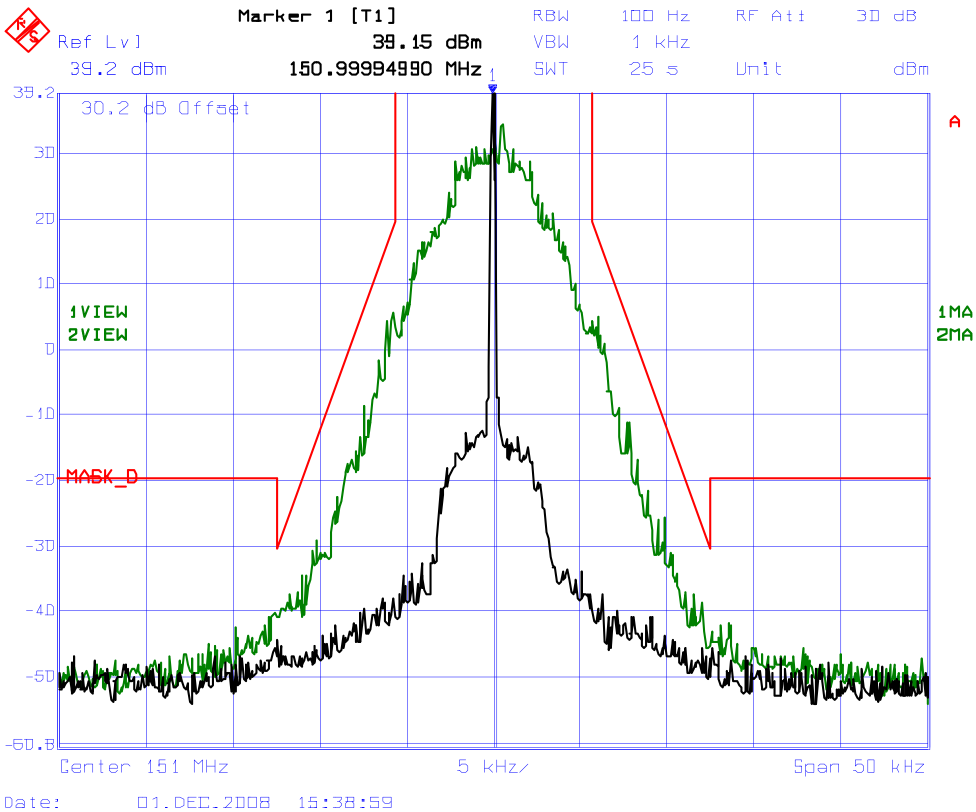
Plot 5.9.4.2.17 Emission Mask D
Carrier Frequency: 138.1 MHz; Power: 10 W
Modulation: Digital



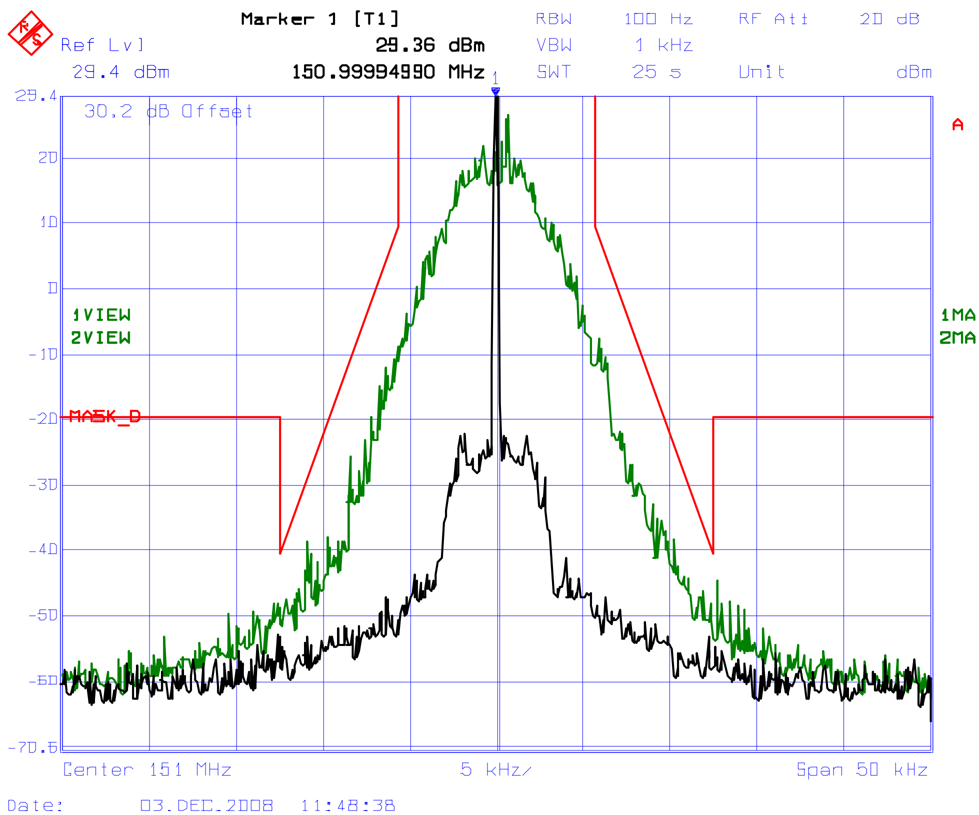
Plot 5.9.4.2.18 Emission Mask D
Carrier Frequency: 138.1 MHz; Power: 1 W
Modulation: Digital



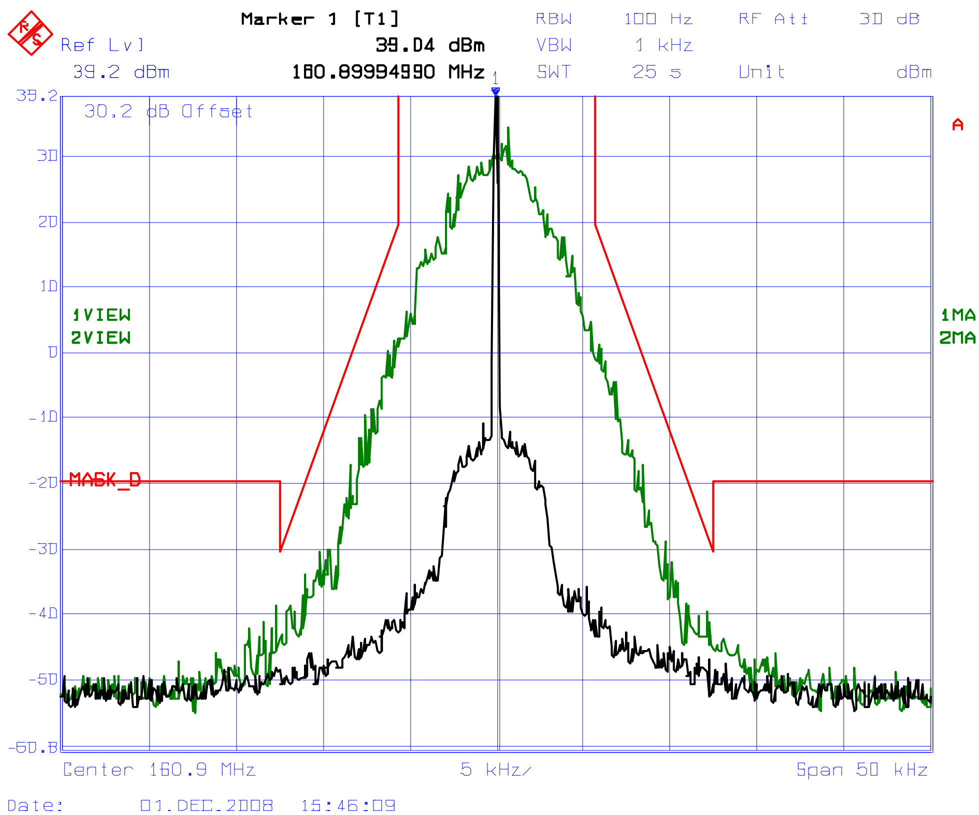
Plot 5.9.4.2.19 Emission Mask D
Carrier Frequency: 151.0 MHz; Power: 10 W
Modulation: Digital



Plot 5.9.4.2.20 Emission Mask D
Carrier Frequency: 151.0 MHz; Power: 1 W
Modulation: Digital



Plot 5.9.4.2.21 Emission Mask D
Carrier Frequency: 160.9 MHz; Power: 10 W
Modulation: Digital



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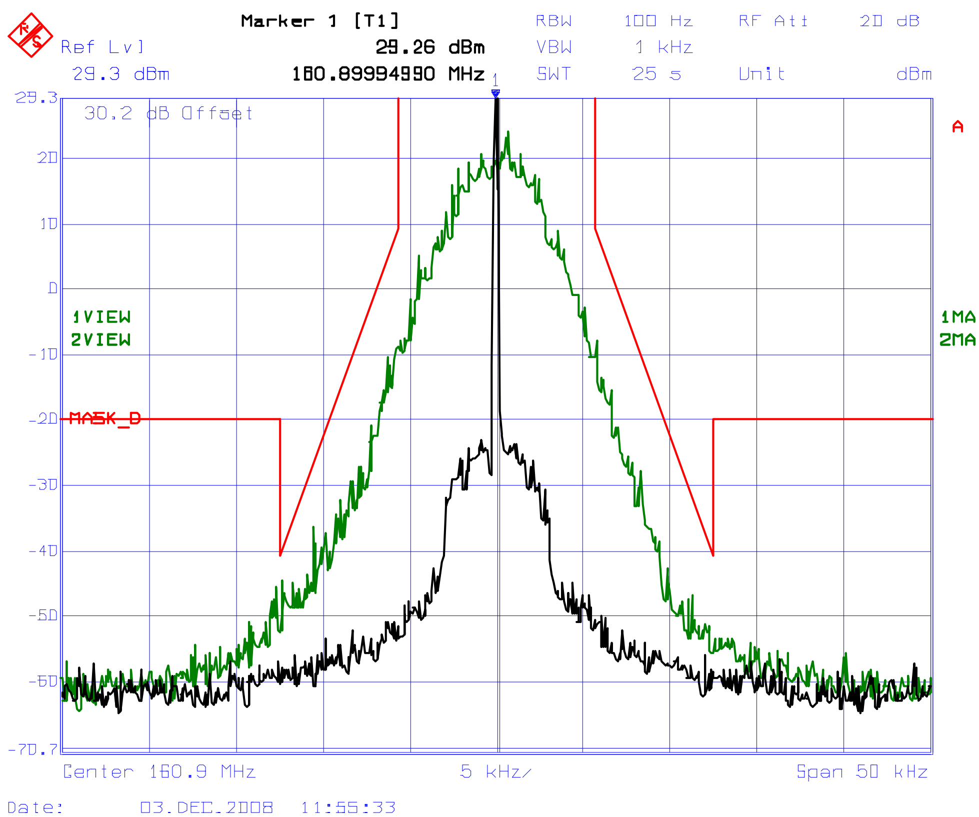
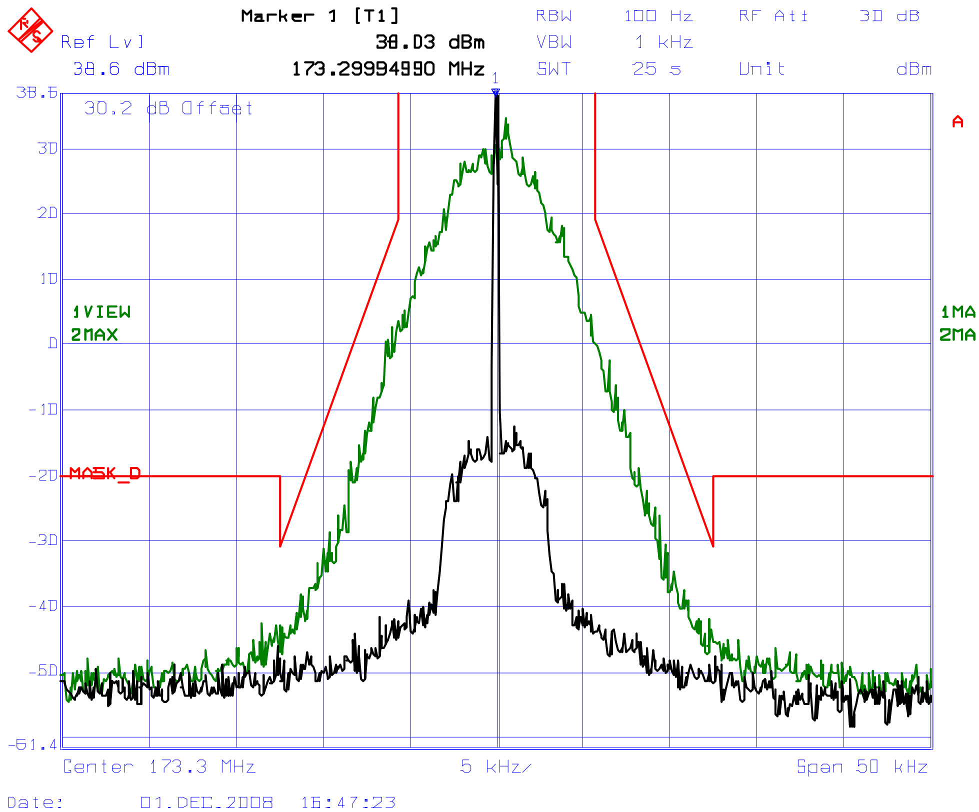
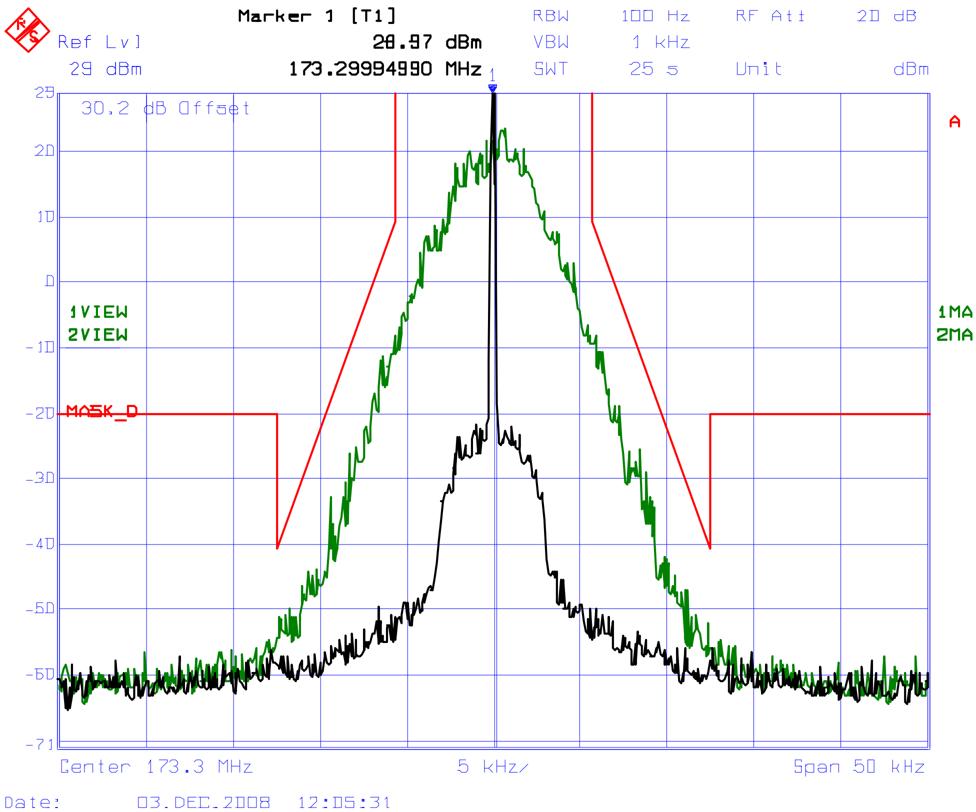
Plot 5.9.4.2.22 Emission Mask D
Carrier Frequency: 160.9 MHz; Power: 1 W
Modulation: Digital



Plot 5.9.4.2.23 Emission Mask D
Carrier Frequency: 173.3 MHz; Power: 10 W
Modulation: Digital



Plot 5.9.4.2.24 Emission Mask D
Carrier Frequency: 173.3 MHz; Power: 1 W
Modulation: Digital



5.10. TRANSMITTER ANTENNA POWER SPURIOUS/HARMONIC CONDUCTED EMISSIONS [§§ 2.1051 & 90.210]

5.10.1. Limits

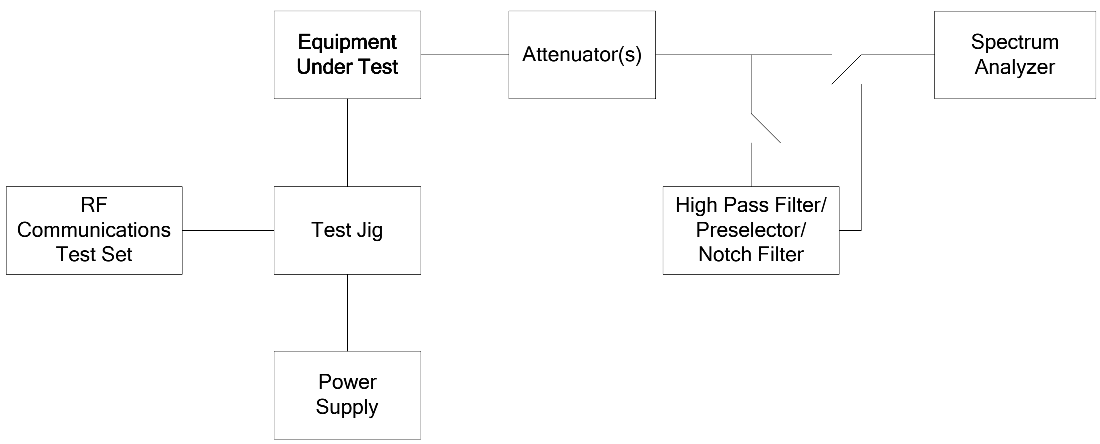
The power of any emission must be attenuated below the unmodulated carrier power (P) as follows:

FCC Rules	Frequency Range	Attenuation Limit (dBc)
90.210(b)	From the lowest radio frequency signal generated in the device to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.	At least 43 + 10 log(P) or -13 dBm
90.210(d)	From the lowest radio frequency signal generated in the device to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.	At least 50 + 10log (P) dB or 70 dB, whichever is the lesser attenuation or -20 dBm

5.10.2. Method of Measurements

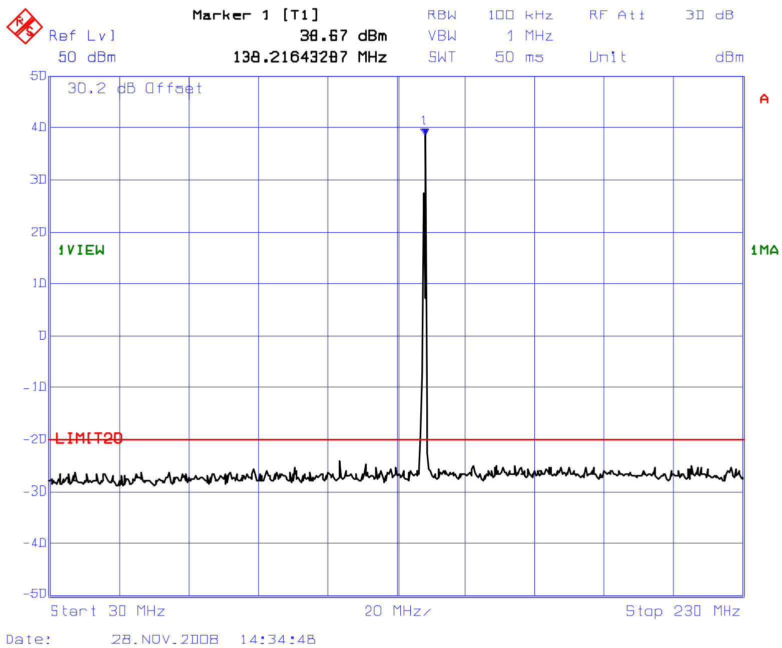
Refer to Exhibit 8 Section 8.5 of this report for measurement details

5.10.3. Test Arrangement

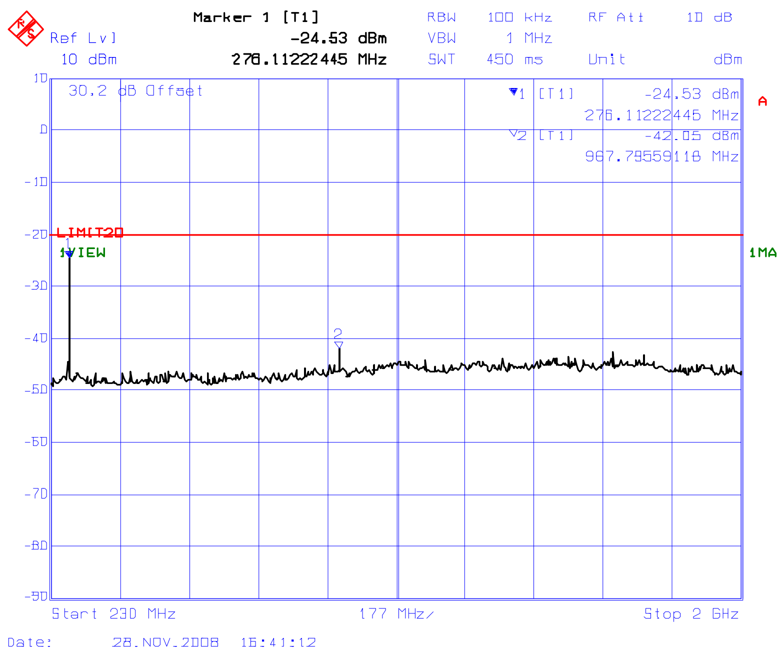


5.10.4. Test Data

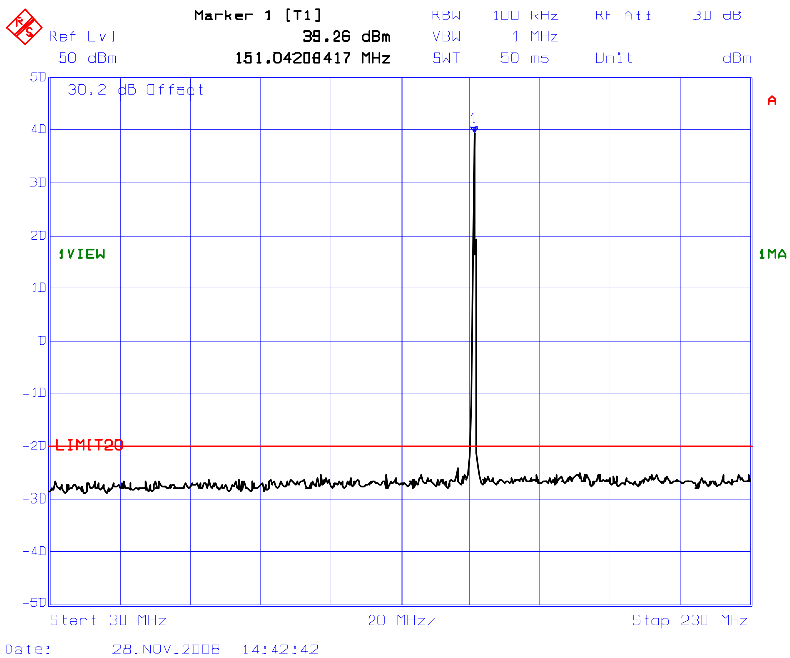
Plot 5.10.4.1(i) Spurious Emissions at Antenna Terminals
Carrier Frequency: 138.1 MHz; Power: 10 W; Modulation: Unmodulated



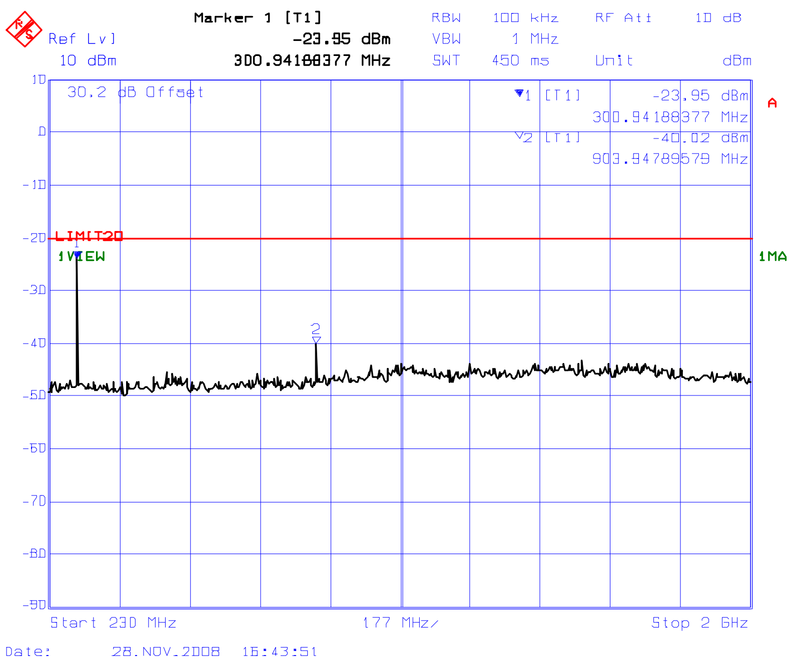
Plot 5.10.4.1(ii) Spurious Emissions at Antenna Terminals
Carrier Frequency: 138.1 MHz; Power: 10 W; Modulation: Unmodulated



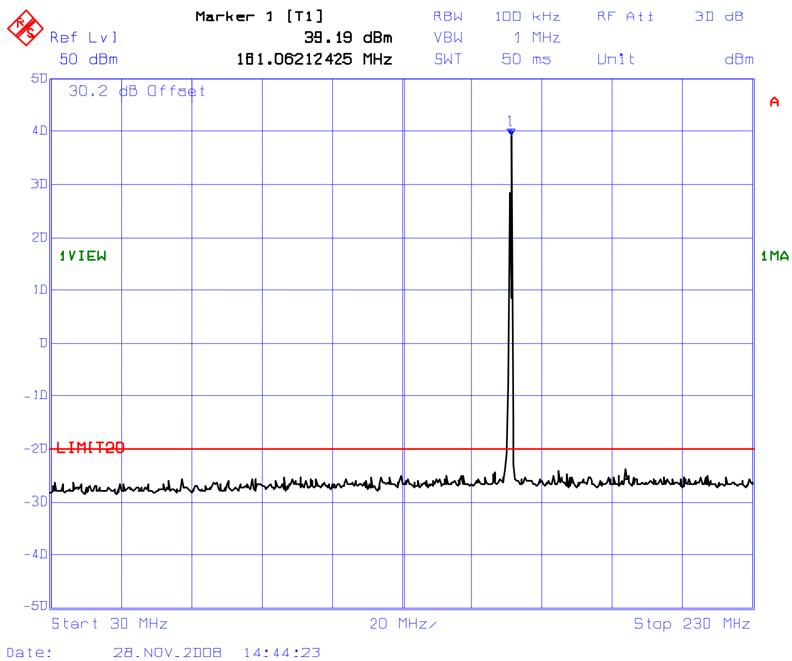
Plot 5.10.4.2(i) Spurious Emissions at Antenna Terminals
Carrier Frequency: 151.0 MHz; Power: 10 W; Modulation: Unmodulated



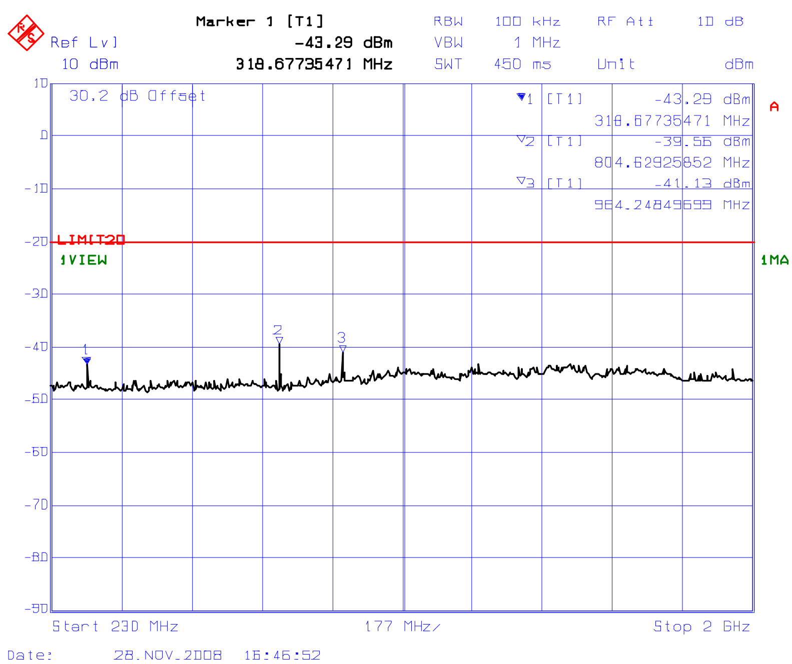
Plot 5.10.4.2(ii) Spurious Emissions at Antenna Terminals
Carrier Frequency: 151.0 MHz; Power: 10 W; Modulation: Unmodulated



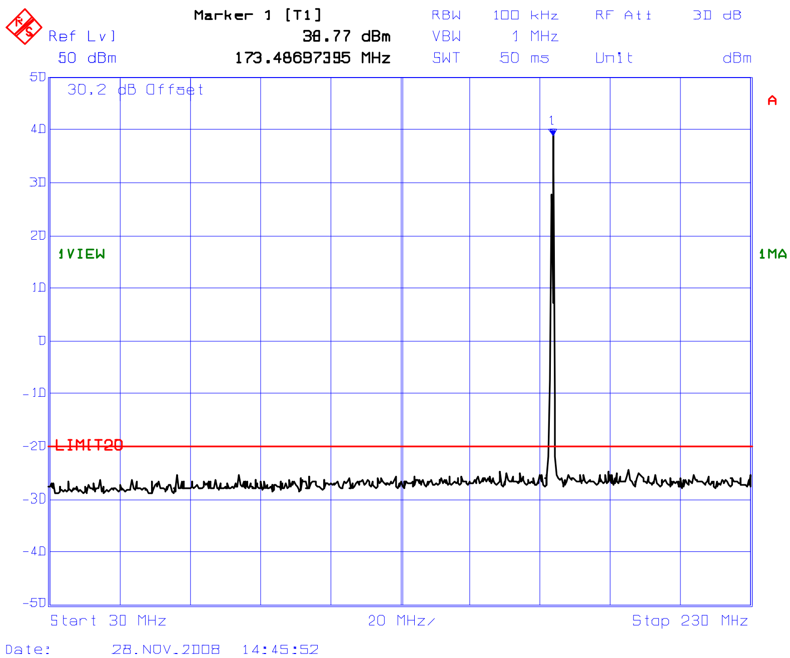
Plot 5.10.4.3(i) Spurious Emissions at Antenna Terminals
Carrier Frequency: 160.9 MHz; Power: 10 W; Modulation: Unmodulated



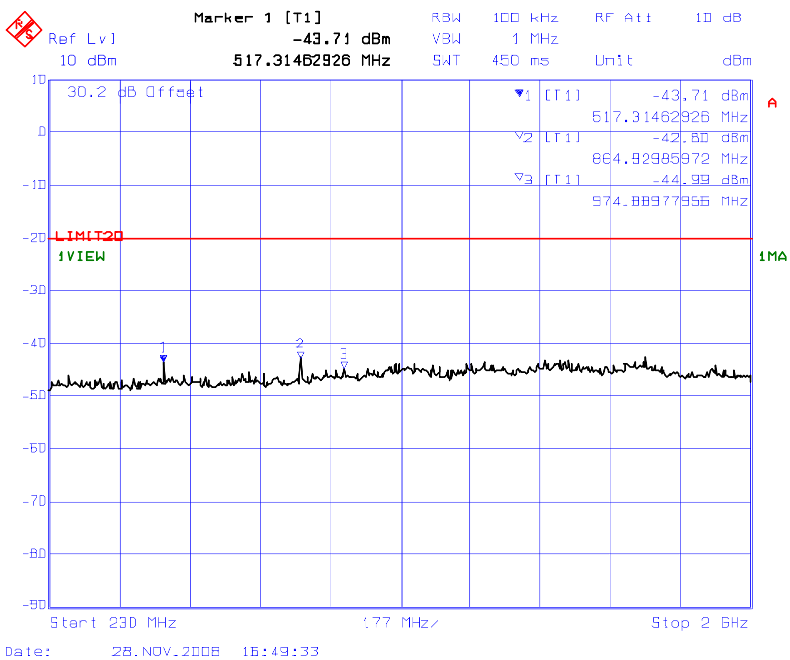
Plot 5.10.4.3(ii) Spurious Emissions at Antenna Terminals
Carrier Frequency: 160.9 MHz; Power: 10 W; Modulation: Unmodulated



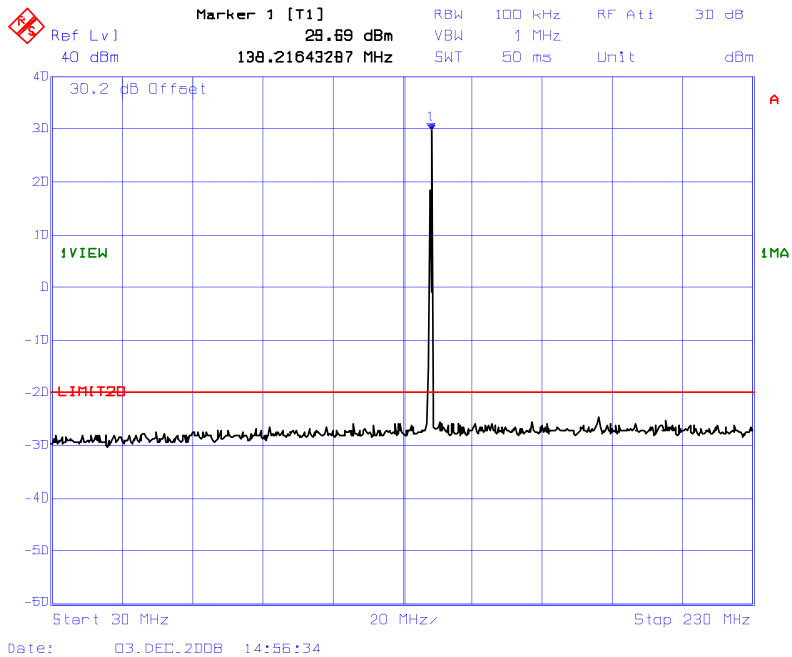
Plot 5.10.4.4(i) Spurious Emissions at Antenna Terminals
Carrier Frequency: 173.3 MHz; Power: 10 W; Modulation: Unmodulated



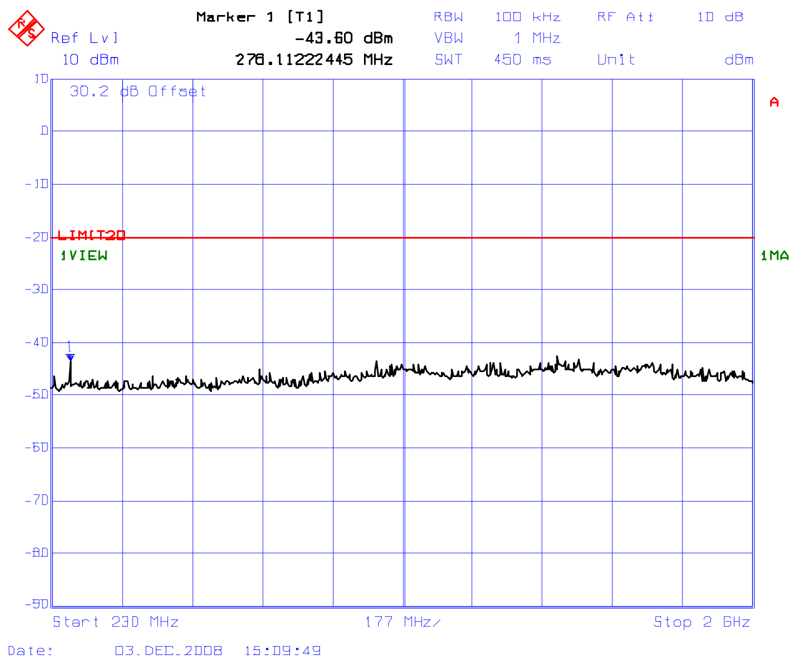
Plot 5.10.4.4(ii) Spurious Emissions at Antenna Terminals
Carrier Frequency: 173.3 MHz; Power: 10 W; Modulation: Unmodulated



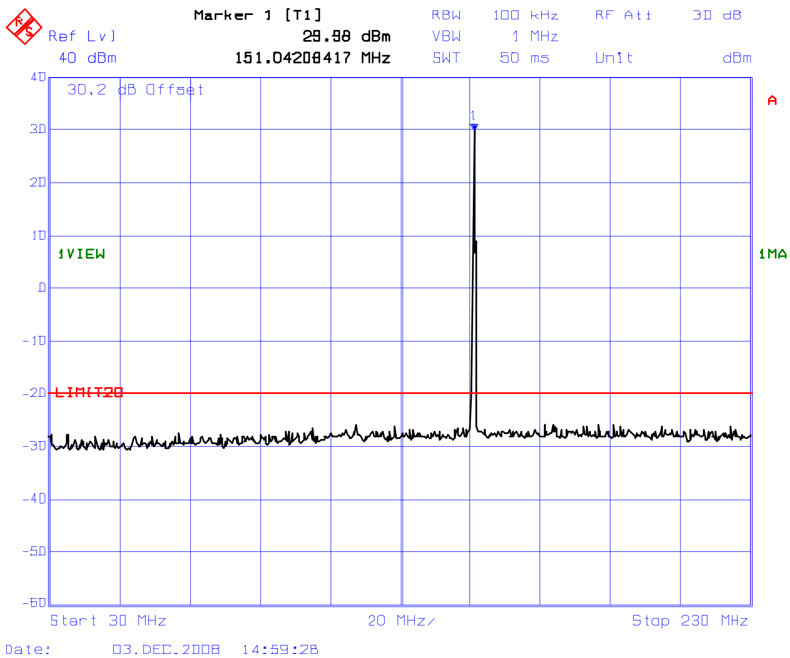
Plot 5.10.4.5(i) Spurious Emissions at Antenna Terminals
Carrier Frequency: 138.1 MHz; Power: 1 W; Modulation: Unmodulated



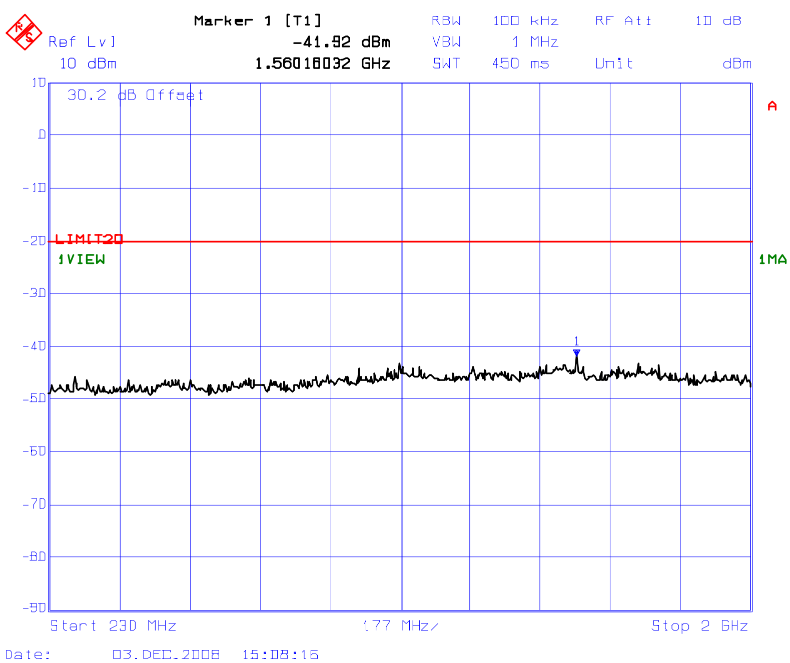
Plot 5.10.4.5(ii) Spurious Emissions at Antenna Terminals
Carrier Frequency: 138.1 MHz; Power: 1 W; Modulation: Unmodulated



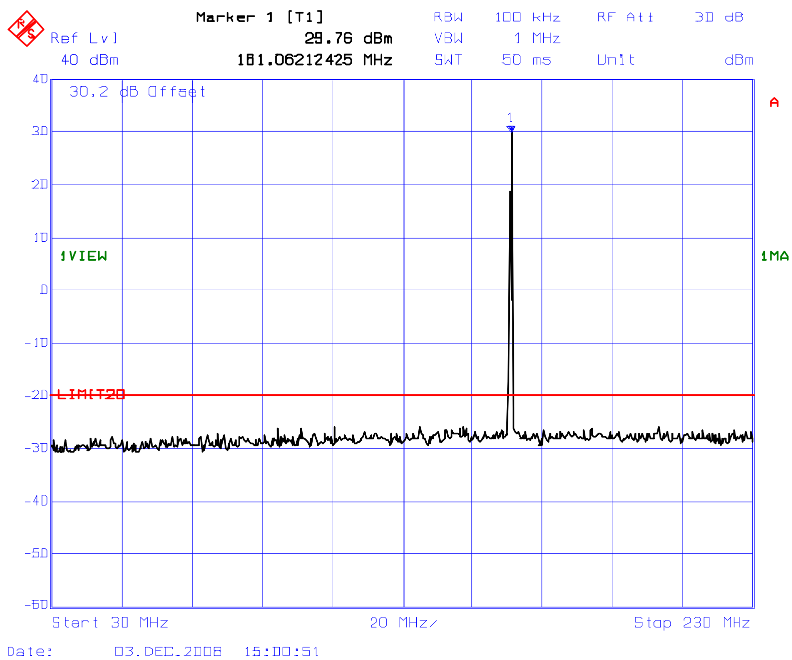
Plot 5.10.4.6(i) Spurious Emissions at Antenna Terminals
Carrier Frequency: 151.0 MHz; Power: 1 W; Modulation: Unmodulated



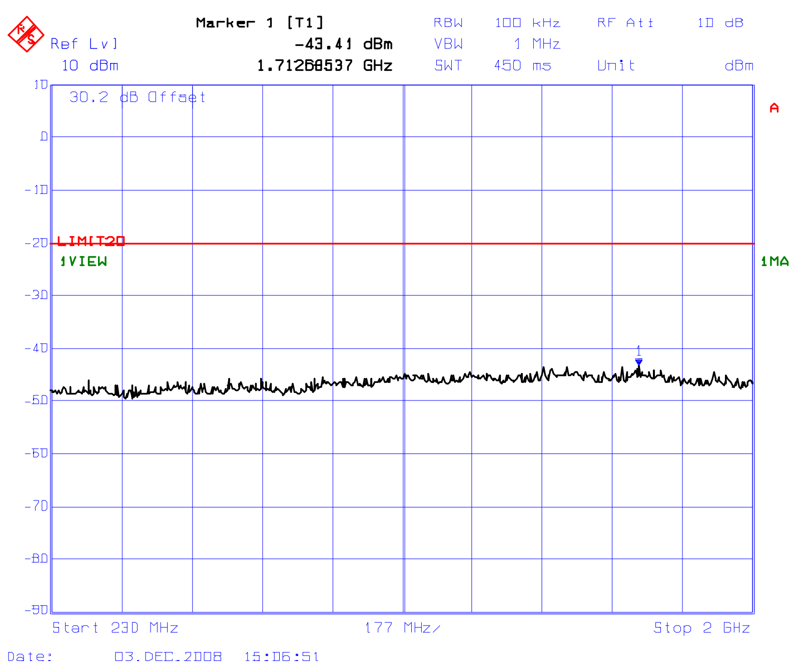
Plot 5.10.4.6(ii) Spurious Emissions at Antenna Terminals
Carrier Frequency: 151.0 MHz; Power: 1 W; Modulation: Unmodulated



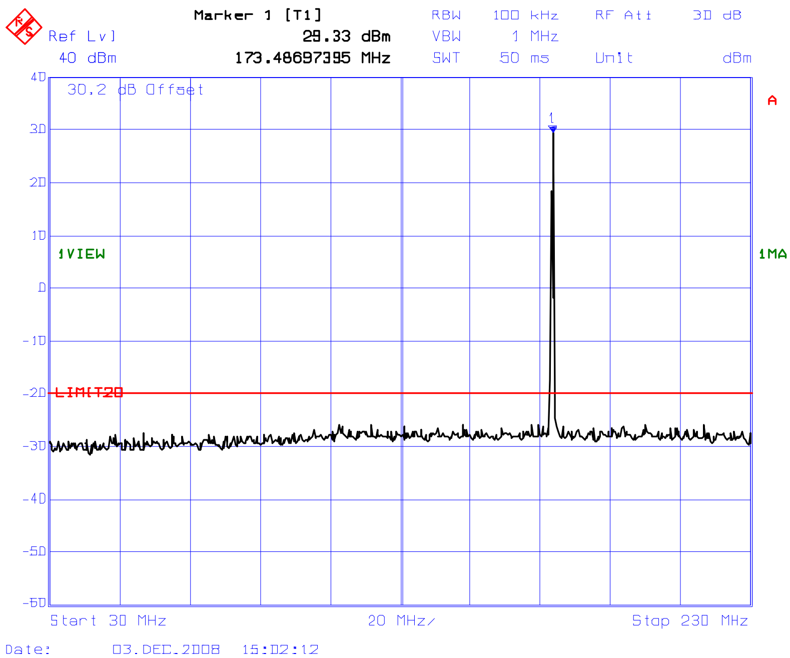
Plot 5.10.4.7(i) Spurious Emissions at Antenna Terminals
Carrier Frequency: 160.9 MHz; Power: 1 W; Modulation: Unmodulated



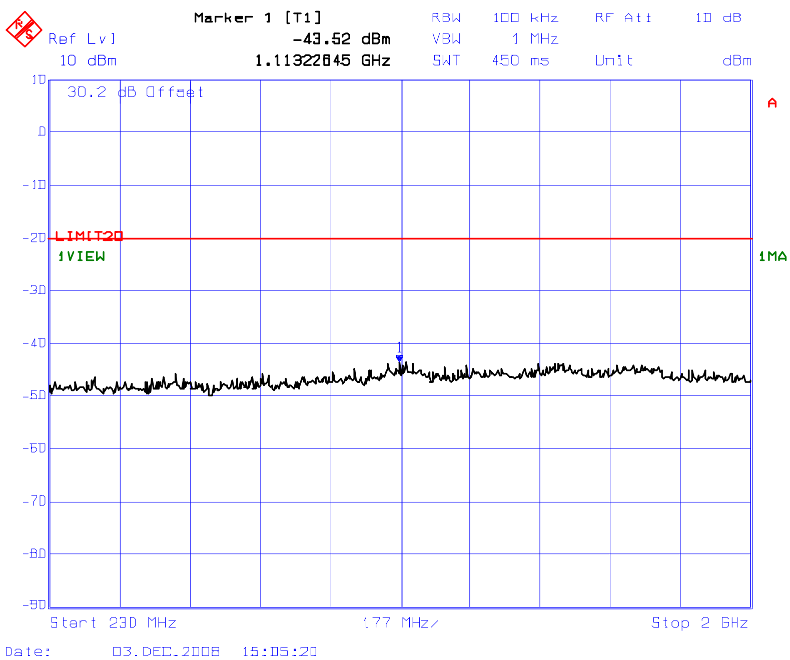
Plot 5.10.4.7(ii) Spurious Emissions at Antenna Terminals
Carrier Frequency: 160.9 MHz; Power: 1 W; Modulation: Unmodulated



Plot 5.10.4.8(i) Spurious Emissions at Antenna Terminals
Carrier Frequency: 173. MHz; Power: 1 W; Modulation: Unmodulated



Plot 5.10.4.8(ii) Spurious Emissions at Antenna Terminals
Carrier Frequency: 173.3 MHz; Power: 1 W; Modulation: Unmodulated



5.11. TRANSMITTER SPURIOUS/HARMONIC RADIATED EMISSIONS [§§ 2.1053 & 90.210]

5.11.1. Limits

The power of any emission must be attenuated below the unmodulated carrier power (P) as follows:

FCC Rules	Frequency Range	Attenuation Limit (dBc)
90.210(b)	From the lowest radio frequency signal generated in the device to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.	At least 43 + 10 log(P) or -13 dBm
90.210(d)	From the lowest radio frequency signal generated in the device to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.	At least 50 + 10log (P) dB or 70 dB, whichever is the lesser attenuation or -20 dBm

5.11.2. Method of Measurements

Refer to Exhibit 8 Section 8.2 of this report for measurement details.

5.11.3. Test Data

Remarks:

- The radiated emissions were performed with high power setting (10 Watts) and 12.5 kHz channel spacing at 3 m distance to represents the worst-case test configuration.
- The emissions were scanned from 30 MHz to 2 GHz; all significant emissions were recorded.

Carrier Frequency (MHz): 138.1
Power (dBm): 40
Limit (dBm): -20

Frequency (MHz)	E-Field (dBµV/m)	EMI Detector (Peak/QP)	Antenna Polarization (H/V)	ERP (dBm)	Limit (dBm)	Margin (dB)
All harmonics and spurious emissions are more than 20 dB below the specified attenuation limit.						

Carrier Frequency (MHz): 151.0
Power (dBm): 40
Limit (dBm): -20

Frequency (MHz)	E-Field (dBµV/m)	EMI Detector (Peak/QP)	Antenna Polarization (H/V)	ERP (dBm)	Limit (dBm)	Margin (dB)
All harmonics and spurious emissions are more than 20 dB below the specified attenuation limit.						

Carrier Frequency (MHz): 160.9
Power (dBm): 40
Limit (dBm): -20

Frequency (MHz)	E-Field (dBµV/m)	EMI Detector (Peak/QP)	Antenna Polarization (H/V)	ERP (dBm)	Limit (dBm)	Margin (dB)
All harmonics and spurious emissions are more than 20 dB below the specified attenuation limit.						

Carrier Frequency (MHz): 173.3
Power (dBm): 40
Limit (dBm): -20

Frequency (MHz)	E-Field (dBµV/m)	EMI Detector (Peak/QP)	Antenna Polarization (H/V)	ERP (dBm)	Limit (dBm)	Margin (dB)
All harmonics and spurious emissions are more than 20 dB below the specified attenuation limit.						

5.12. 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/cm²)	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/f²)	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/f²)	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.

5.12.1. 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/cm^2
G: numeric gain of antenna relative to isotropic radiator
r: distance to centre of radiation in cm

5.12.2. RF Evaluation

Evaluation of RF Exposure Compliance Requirements	
RF Exposure Requirements	**Compliance with FCC Rules**
Minimum calculated separation distance between antenna and persons required: ***89.1 cm**	Manufacturer' instruction for separation distance between antenna and persons required: **100 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

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

P = 40 dBm
G = 3 dBi (Maximum antenna gain to be used with this device as declared by the manufacturer)
S = 0.2 mW/cm^2
EIRP = 43 dBm = $10^{43/10}$ mW = 19952.6 mW (Worst Case)

(Minimum Safe Distance, r) = $\sqrt{\frac{EIRP}{4 \cdot \pi \cdot S}} = \sqrt{\frac{19952.6}{4 \cdot \pi \cdot (0.2)}} \approx 89.1cm$

5.13. TRANSIENT FREQUENCY BEHAVIOR [§ 90.214]

5.13.1. Limits

Transient frequencies must be within the maximum frequency difference limits during the time intervals indicated:

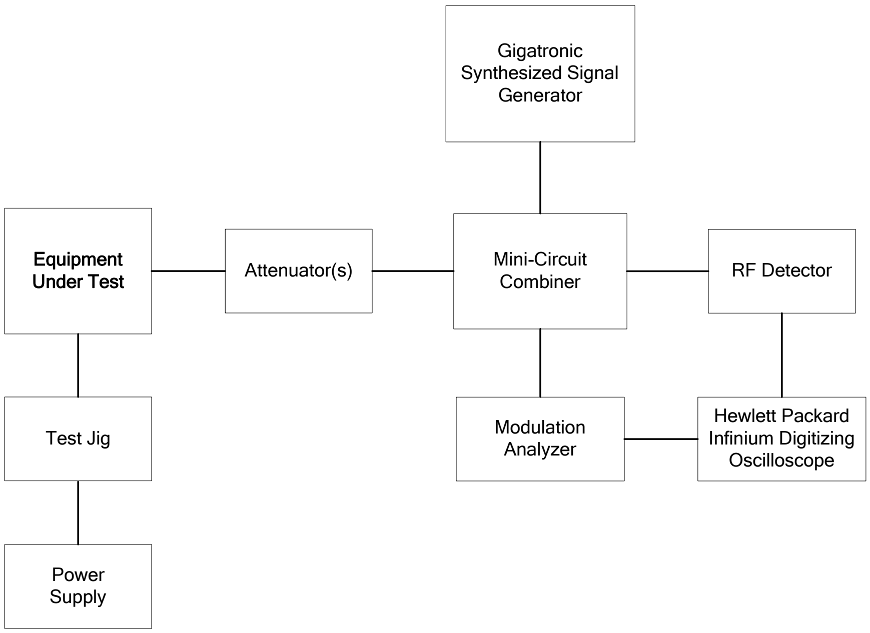
Time intervals [1, 2]	Maximum frequency difference [3]	All equipment	
		150 to 174 MHz	421 to 512MHz
Transient Frequency Behavior for Equipment Designed to Operate on 25 KHz Channels			
t_1 [4] ………………………..	± 25.0 KHz	5.0 ms	10.0 ms
t_2 ………………………….	± 12.5 KHz	20.0 ms	25.0 ms
t_3 [4] ………………………..	± 25.0 KHz	5.0 ms	10.0 ms
Transient Frequency Behavior for Equipment Designed to Operate on 12.5 KHz Channels			
t_1 [4] ………………………..	± 12.5 KHz	5.0 ms	10.0 ms
t_2 ………………………….	± 6.25 KHz	20.0 ms	25.0 ms
t_3 [4] ………………………..	± 12.5 KHz	5.0 ms	10.0 ms
Transient Frequency Behavior for Equipment Designed to Operate on 6.25 KHz Channels			
t_1 [4] ………………………..	±6.25 KHz	5.0 ms	10.0 ms
t_2 ………………………….	±3.125 KHz	20.0 ms	25.0 ms
t_3 [4] ………………………..	±6.25 KHz	5.0 ms	10.0 ms

1. t_{on} is the instant when a 1 KHz test signal is completely suppressed, including any capture time due to phasing.
   t_1 is the time period immediately following t_{on}.
   t_2 is the time period immediately following t_1.
   t_3 is the time period from the instant when the transmitter is turned off until t_{off}.
   t_{off} is the instant when the 1 KHz test signal starts to rise.
2. During the time from the end of t_2 to the beginning of t_3, the frequency difference must not exceed the limits specified in § 90.213.
3. Difference between the actual transmitter frequency and the assigned transmitter frequency.
4. If the transmitter carrier output power rating is 6 watts or less, the frequency difference during this time period may exceed the maximum frequency difference for this time period.

5.13.2. Method of Measurements

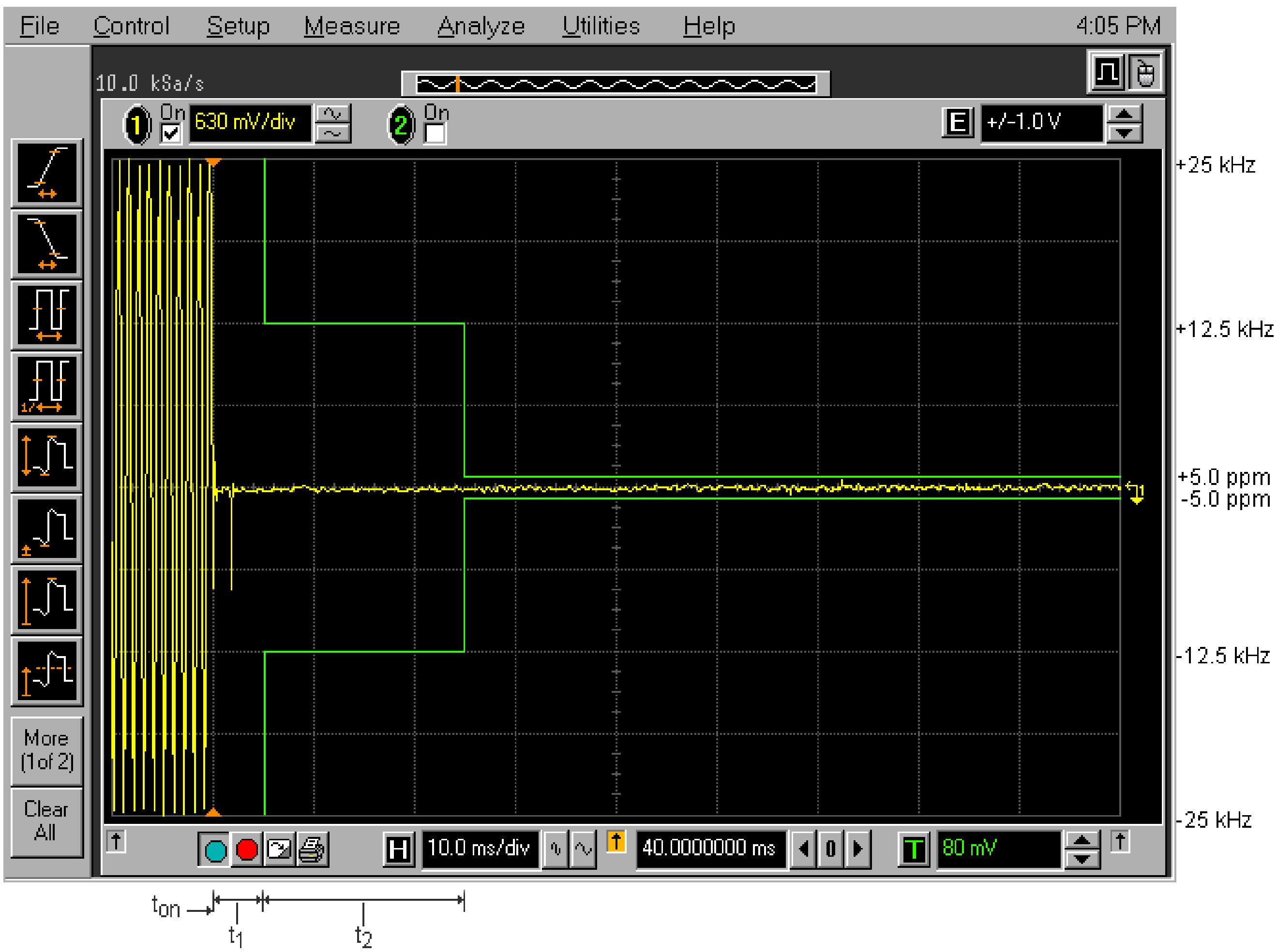
Refer to Exhibit 8, Section 8.6 of this test report and ANSI/TIA/EIA-603-C-2004, Section 2.2.19.

5.13.3. Test Arrangement

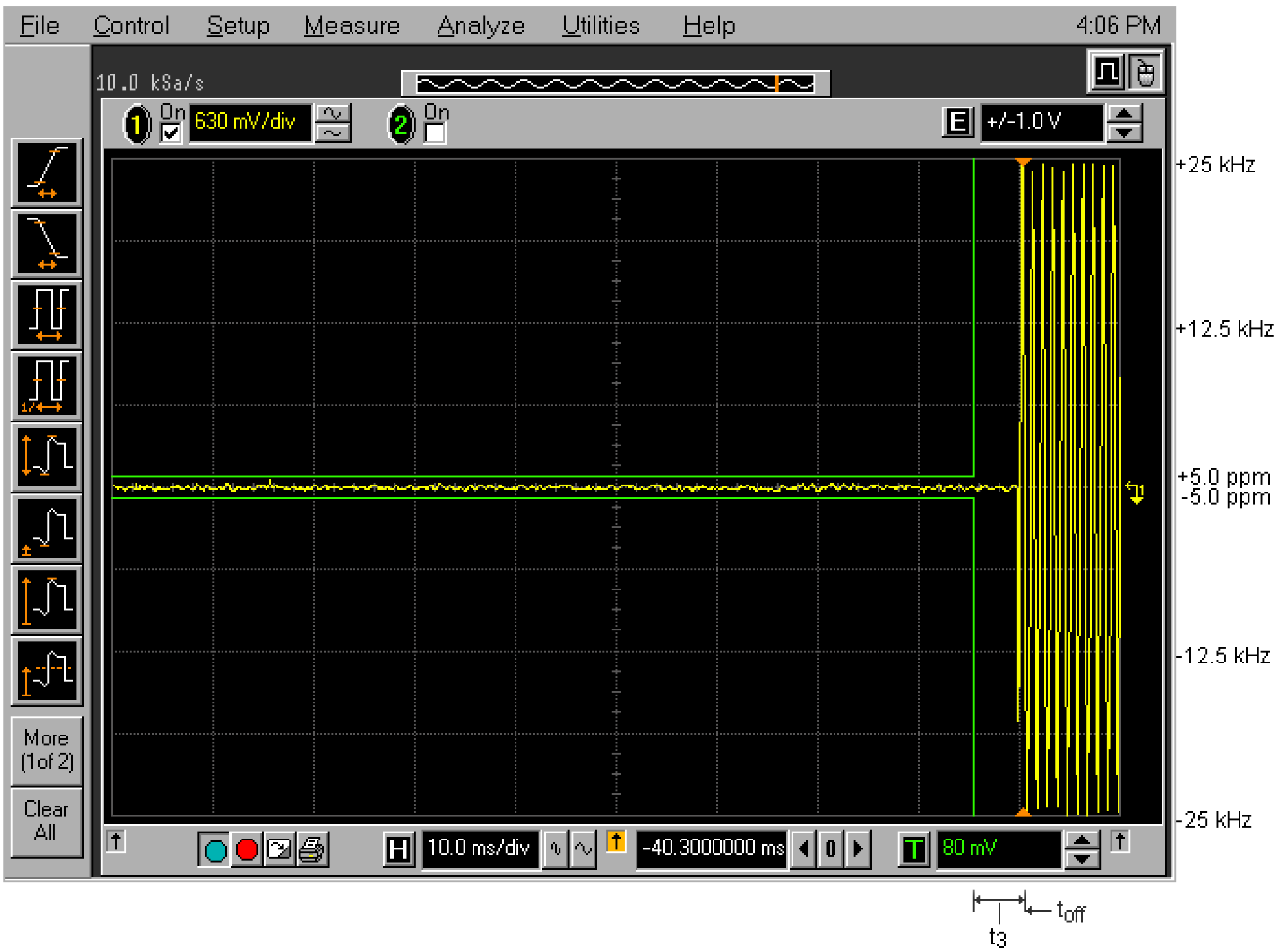


5.13.4. Test Data

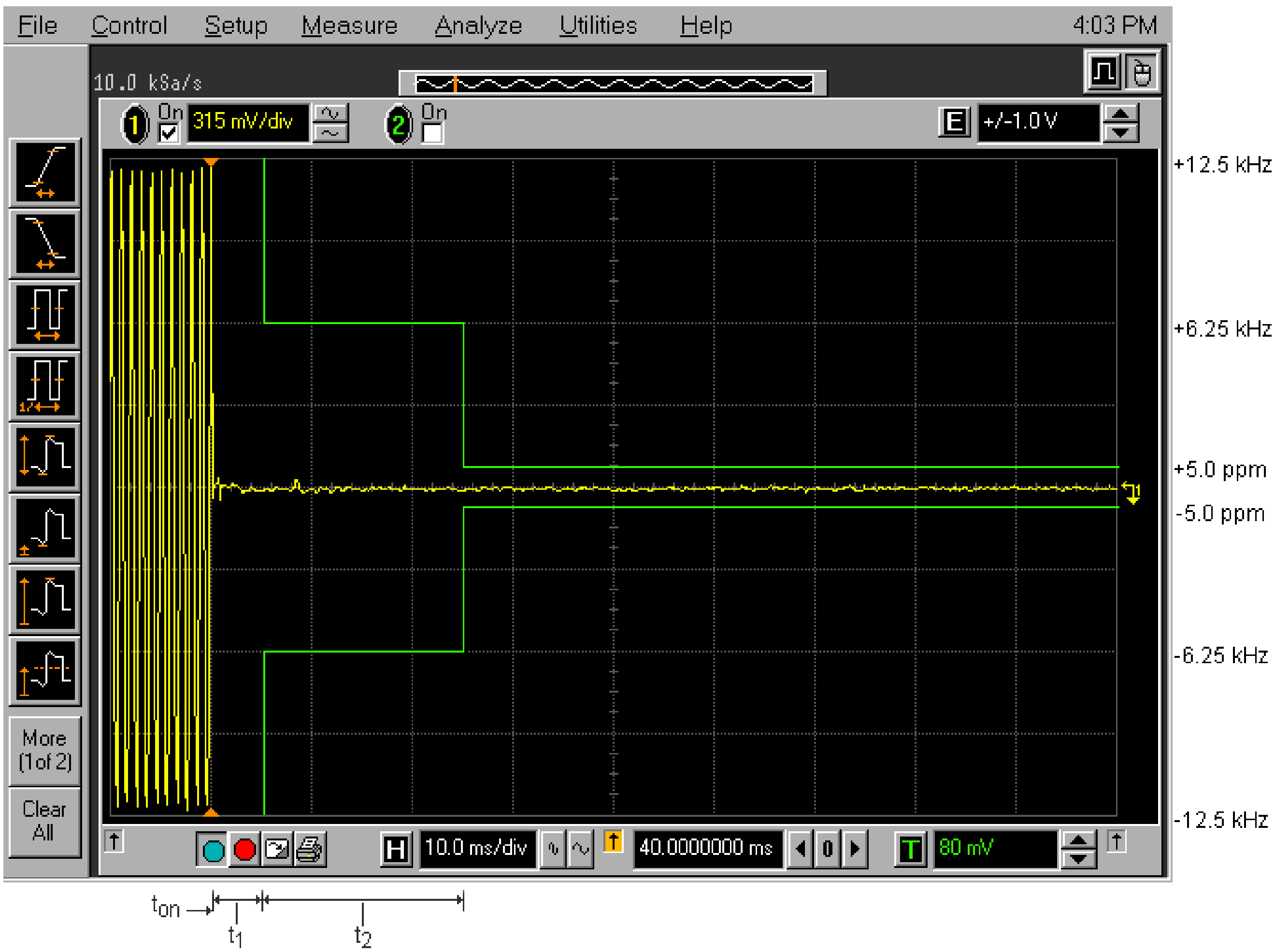
Plot 5.13.4.1 Transient Frequency Behavior
Carrier Frequency: 151.0 MHz; Channel Spacing: 25 kHz; Power: 10 W
Description: Switch on condition t_{on}, t_1, and t_2



Plot 5.13.4.2 Transient Frequency Behavior
Carrier Frequency: 151.0 MHz; Channel Spacing: 25 kHz; Power: 10 W
Description: Switch off condition t_3, t_{off}



Plot 5.13.4.3 Transient Frequency Behavior
Carrier Frequency: 151.0 MHz; Channel Spacing: 12.5 kHz; Power: 10 W
Description: Switch on condition t_{on}, t_1, and t_2



Plot 5.13.4.4 Transient Frequency Behavior
Carrier Frequency: 151.0 MHz; Channel Spacing: 12.5 kHz; Power: 10 W
Description: Switch off condition t_3, t_{off}

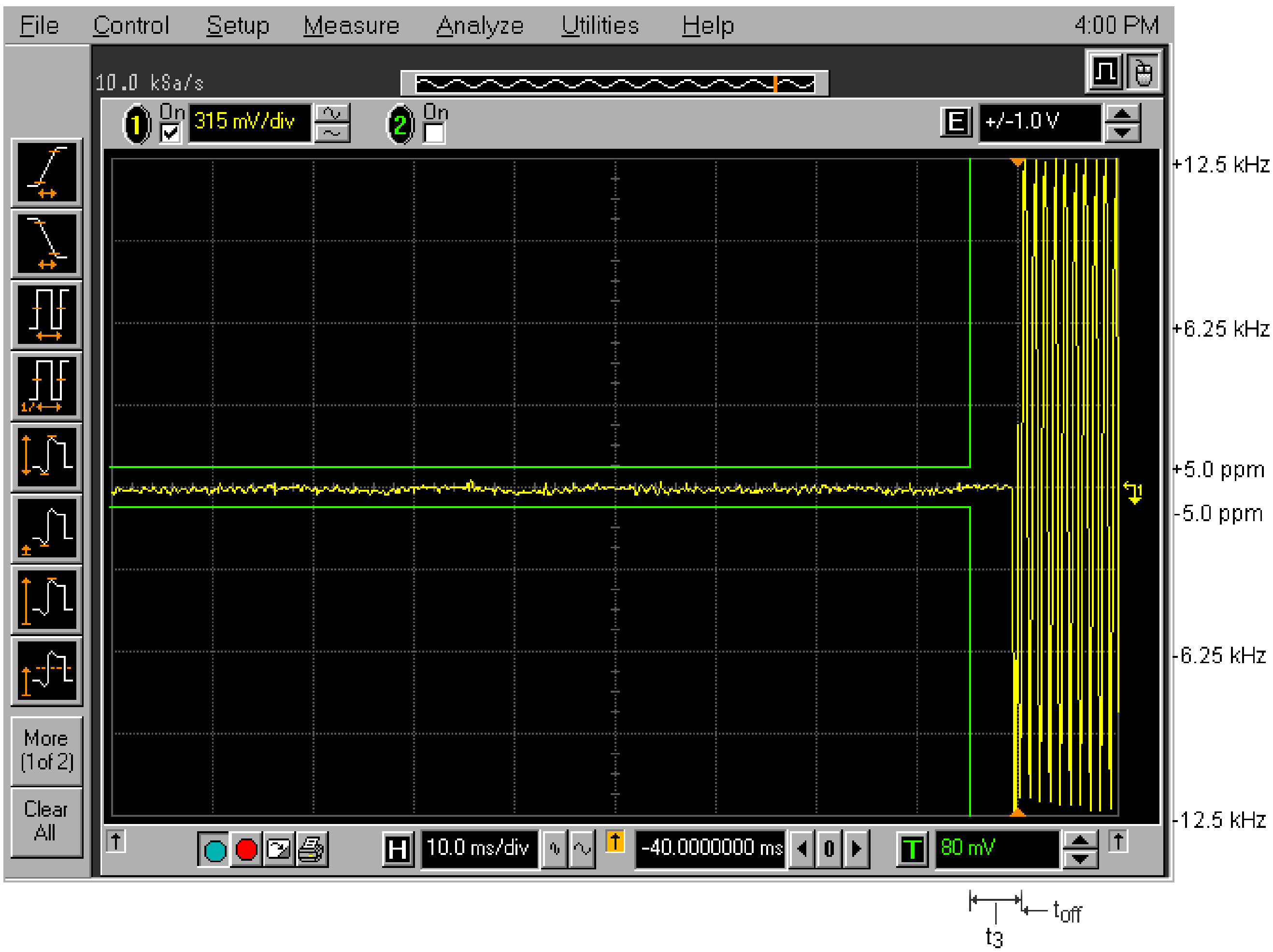


EXHIBIT 6. TEST EQUIPMENTS LIST

Test Instruments	Manufacturer	Model No.	Serial No.	Operating Range
Spectrum Analyzer	Rohde & Schwarz	FSEK20/B4/B21	834157/005	9 kHz - 40 GHz
EMI Receiver System/ Spectrum Analyzer with built-in Amplifier	Hewlett Packard	HP 8546A	3520A00248	9 kHz - 5.6 GHz, 50 Ohms
Microwave Amplifier	Hewlett Packard	HP 83017A	311600661	1 - 26.5 GHz
Biconilog Antenna	Emco	3142B	1575	0.03 - 2 GHz
Biconilog Antenna	Emco	3142C	34792	0.03 - 2 GHz
Horn Antenna	Emco	3115	5955	1 -1 8 GHZ
Horn Antenna	Emco	3115	5061	1 - 18 GHZ
RF Amplifier	Com-Power	PA-103A	161243	10 MHz - 1 GHz
Attenuator (30dB)	Aeroflex/Weinschel	46-30-34	BP9127	DC – 18 GHz
High Pass Filter	Mini Circuit	SHP 250	9027	Cut off 230 MHz
Power Meter	Hewlett Packard	437B	3125U06665	100 kHz - 50 GHz sensor dependent
Power Sensor	Hewlett Packard	8481A	US37295684	0.1 - 18 GHz
Modulation Analyzer	Hewlett Packard	8901B		150 kHz – 1300 MHz
Frequency Counter	EIP	545A		DC - 18 GHz
Combiner	Mini Circuit	ZFSC-3-4	15542	1 MHz – 1 GHz
RF Detector	Narda	503A-03	105	10 MHz - 18 GHz
Infinium Digital Oscilloscope	Hewlett-Packard	54801A	US38380192	DC – 500 MHz, 1G sampling
Environment Chamber	Envirotronics	SSH32C	11994847-S-11059	-60 to 177 degree C
RF Synthesized signal Generator	Giga-tronics	6061A	5130586	10 kHz - 1050 MHz AM&FM
Power Supply	Tenma	72-7295	490300297	1-40V DC 5A
FFT Digital Spectrum Analyzer	Advantest	R9211E	8202336	10mHz - 100 kHz
RF Communications Test Set	Hewlett Packard	8920B	US39064699	RF 30 MHz – 1 GHz AF DC - 25 kHz
Digital Voltmeter	Hewlett-Packard	3456A	2015A04523	DC - 250 kHz

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 (± dB)	
		3 m	10 m
Antenna Factor Calibration	Normal (k=2)	±1.0	±1.0
Cable Loss Calibration	Normal (k=2)	±0.3	±0.5
EMI Receiver specification	Rectangular	±1.5	±1.5
Antenna Directivity	Rectangular	+0.5	+0.5
Antenna factor variation with height	Rectangular	±2.0	±0.5
Antenna phase center variation	Rectangular	0.0	±0.2
Antenna factor frequency interpolation	Rectangular	±0.25	±0.25
Measurement distance variation	Rectangular	±0.6	±0.4
Site imperfections	Rectangular	±2.0	±2.0
Mismatch: Receiver VRC Γ_1 = 0.2 Antenna VRC Γ_R = 0.67(Bi) 0.3 (Lp) Uncertainty limits 20Log(1±$\Gamma_1\Gamma_R$)	U-Shaped	+1.1 -1.25	±0.5
System repeatability	Std. Deviation	±0.5	±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

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.

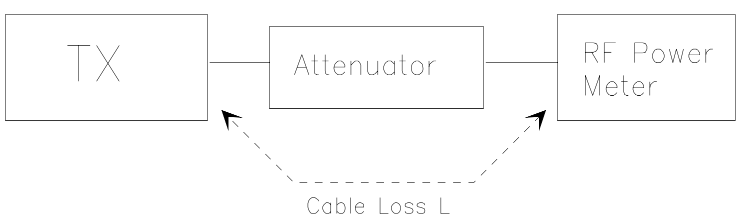
Step 2: Calculation of Average EIRP. See Figure 1

- 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.



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^{o} 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 (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^{o} 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 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.

Figure 2

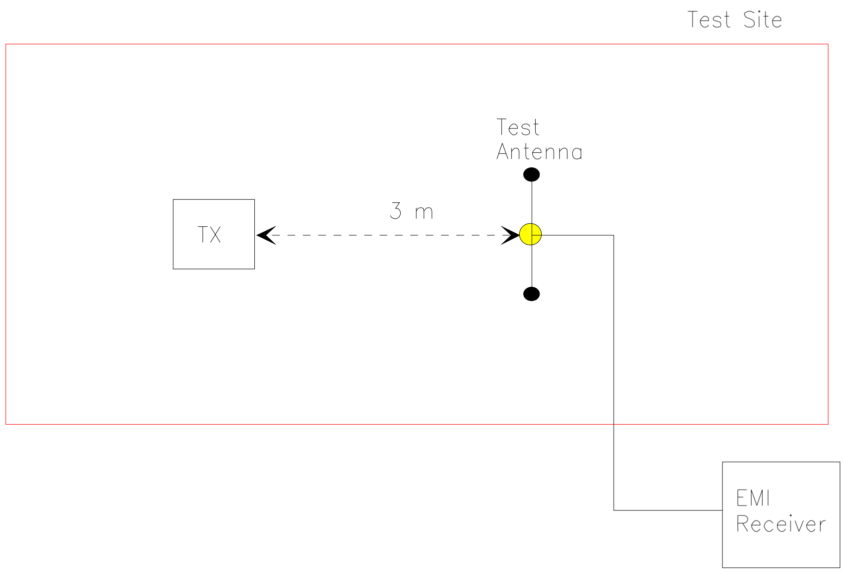
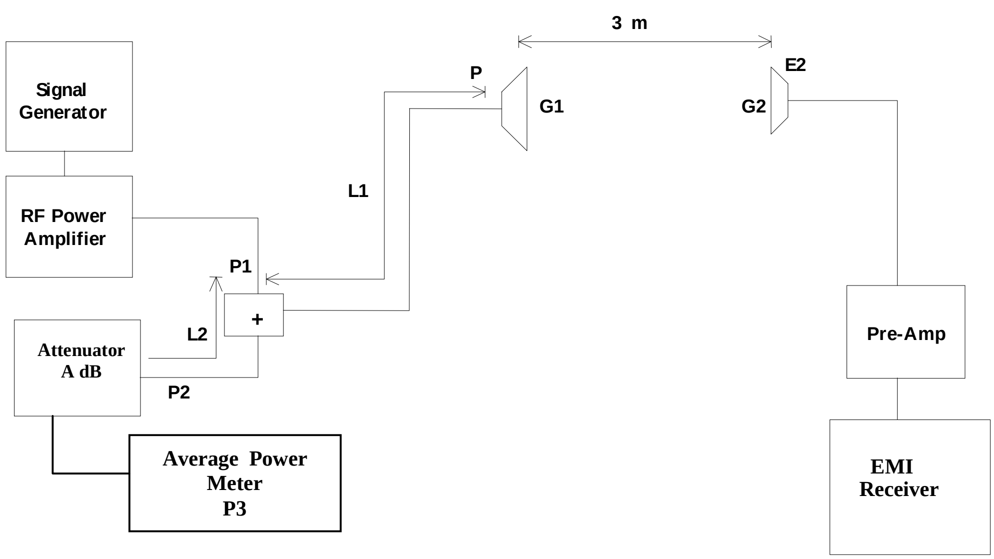


Figure 3



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).

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 ≥ 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 10^{th} 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.

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.