ENGINEERING TEST REPORT

VHF/UHF LO RF Module
Model No.: T3014
FCC ID: IMA-T3014

Applicant:

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

Tested in Accordance With

Federal Communications Commission (FCC)
47 CFR, Part 2, Parts 80 and 90

UltraTech's File No.: TIL-090F80-90

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

Date: December 24, 2012

Report Prepared by: Dharmajit Solanki Issued Date: December 24, 2012	Tested by: Mr. Hung Trinh Test Dates: December 18 - 24, 2012

- *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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FCC	VCCI	Industry Canada Industrie Canada Approved Test Facility	NVLAP	BSMI	Korea KCC-RRL
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, 80 and 90
Title:	Code of Federal Regulations (CFR), Title 47 –Telecommunication, Part 80 Stations in the maritime services and Part 90 Private land mobile radio services
Purpose of Test:	To gain FCC Equipment Authorization for Radio operating in parts 80 and 90.
Test Procedures:	Both conducted and radiated emissions measurements were conducted in accordance with TIA/EIA Standard TIA-603-D – 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	2012	Code of Federal Regulations, Title 47 – Telecommunication
ANSI C63.4	2009	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
TIA/EIA 603, Edition D	2010	Land Mobile FM or PM Communications Equipment Measurement and Performance Standards
CISPR 22 & EN 55022	2008-09, Edition 6.0 2006	Information Technology Equipment - Radio Disturbance Characteristics - Limits and Methods of Measurement
CISPR 16-1-1 +A1 +A2	2006 2006 2007	Specification for radio disturbance and immunity measuring apparatus and methods. Part 1-1: Measuring Apparatus
CISPR 16-1-2 +A1 +A2	2003 2004 2006	Specification for radio disturbance and immunity measuring apparatus and methods. Part 1-2: Conducted disturbances

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 M^{c}Intosh 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 M^{c}Intosh 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/UHF LO RF Module
Model Name or Number:	T3014
Serial Number:	655CMX0732
Type of Equipment:	Licensed Non-Broadcast Station Transmitter
Power Supply Requirement:	7.5 VDC Nominal
Transmitting/Receiving Antenna Type:	Non-integral
Primary User Functions of EUT:	RF Transceivers Module operate in VHF & UHF Lo bands

2.3. EUT'S TECHNICAL SPECIFICATIONS

Transmitter	
Equipment Type:	Mobile
Intended Operating Environment:	Commercial, industrial or business environment
Power Supply Requirement:	7.5 VDC Nominal
RF Output Power Rating:	VHF: 1 W to 6 W UHF: 1 W to 5 W
Operating Frequency Range:	136-174MHz, 380-470 MHz
RF Output Impedance:	50 Ω
Channel Spacing:	25 kHz,12.5 kHz, 6.25 kHz (2 SLOT TDMA)
Modulation Employed:	FM W/N, C4FM, CQPSK, 2 SLOT TDMA
Emission Designation:	16K0F3E*, 20K0F1E* 11K0F3E, 8K10F1D, 8K10F1E, 8K10F1W
Antenna Connector Type:	MCX
Max Gain of Antenna used:	3 dBi

* Note: The emission designation 16K0F3E with 25 KHz Channel bandwidth is only applied to the device operated in FCC Rules Part 80 frequencies. The operation of 16K0F3E emission will be disabled in the firmware by the manufacturer for device that operates under FCC Rules Part 90 frequencies (Private Land Mobile).

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

The 99% energy rule (title 47CFR 2.989) was used for digital mode and is more accurate than Carson's rule. It basically states that 99% of the modulation energy falls within X kHz, in this case, 8.10 kHz Measurements were performed in accordance with TIA/EIA TSB102.CAAB Section 2.2.5.2. The emission mask was obtained from 47CFR 90.210(d).

F1D portion of the designator indicates digital data. Therefore, the entire designator for 12.5 kHz channelization digital data is 8K10F1D.

F1E portion of the designator indicates digital voice. Therefore, the entire designator for 12.5 kHz channelization digital voice is 8K10F1E.

F1W portion of the designator indicates digital TDMA. Therefore, the entire designator for 12.5 kHz channelization digital TDMA is 8K10F1W.

Digital Modulation (20 kHz Channelization, Digital Voice with encryption): Emission Designator 20K0F1E
In this case, the maximum modulating frequency is 6 kHz with a 4 kHz deviation.
BW = 2(M+D) = 2*(6 kHz + 4 kHz) = 20 kHz = 20K0
F1E portion of the designator indicates digital voice.

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	J1 Main Audio and Control Interface	1	Molex Surface Mount FM	Molex, PCB Surface Mount, 60 Pins, Male
2	M101 DC Power Terminals	1	Custom Brass pins	PCB mounted pins
3	J101 Antenna Connector	1	Surface Mount MCX FM	MCX Male Plug Shielded

2.5. ANCILLARY EQUIPMENT

Ancillary Equipment # 1	
Description:	Test Jig
Brand name:	Technisonic Industries Limited
Model Name or Number:	N/A
Connected to EUT's Port:	I/O Port

EXHIBIT 3. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

3.1. CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

Temperature:	21°C to 24°C
Humidity:	40 to 52%
Pressure:	102 kPa
Power input source:	7.5 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:	Test Jig.
Transmitter Test Antenna:	The EUT is tested with the transmitter antenna port terminated to a 50 Ω Load.

Transmitter Test Signals	
Frequency Band(s):	136 - 174 MHz 380 - 470 MHz
Test Frequency(ies):	151.1 MHz,161.8 MHz and 173.8 MHz 406.3 MHz, 450.1 MHz and 469.8 MHz
Transmitter Wanted Output Test Signals:	
• Transmitter Power (measured maximum output power):	VHF: 38.43 dBm; UHF: 37.40 dBm
• Normal Test Modulation:	F3E and unmodulated
• Modulating signal source:	Internal

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: 2014-04-04.

4.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC Section(s)	Test Requirements	Applicability (Yes/No)
2.1046, 80.215 & 90.205	RF Power Output	Yes
2.1047(a) & 80.213	Modulation Characteristics - Audio Frequency Response	Yes, See Note1
2.1047(b), 80.213	Modulation Characteristics - Modulation Limiting	Yes, See Note1
2.1049, 80.205, 80.211, 90.209 & 90.210	Occupied Bandwidth and Emission Limitations/Masks	Yes, See Note1
2.1051, 2.1057, 80.211 & 90.210	Spurious Emissions at Antenna Terminal	Yes, See Note1
2.1053, 2.1057, 80.211 & 90.210	Field Strength of Spurious Emissions	Yes
2.1055, 80.209 & 90.213	Frequency Stability	Yes
90.214	Transient Frequency Behavior	Yes, See Note1
80.217	Suppression of Interference aboard ships	Yes, See Note2
1.1307, 1.1310 & 2.1091	RF Exposure Limit	Yes
15.107	AC Power Line Conducted Emissions	Yes

Note1: Please refer to test data from attached FCC ID:AZ489FT4886 test report for compliance details.

Note2: Complies with FCC Part 15, Subpart B.

4.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

None

4.4. DEVIATION OF STANDARD TEST PROCEDURES

None

EXHIBIT 5. TEST DATA

5.1. RF POWER OUTPUT [§§ 2.1046, 80.215 & 90.205]

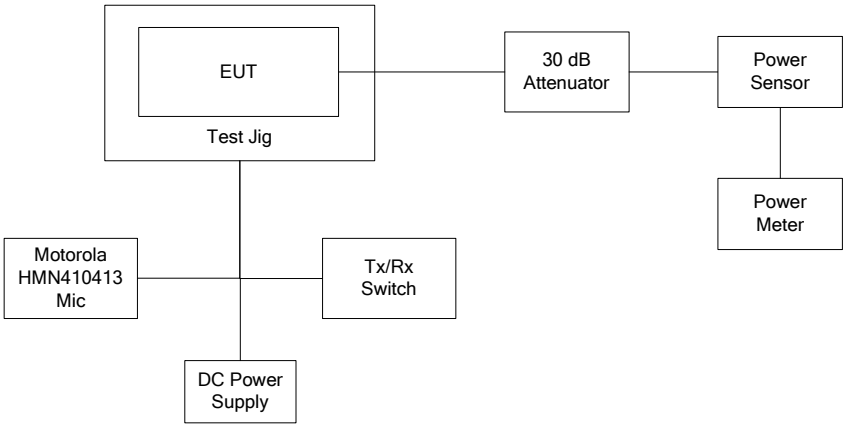
5.1.1. Limits

Please refer to FCC 47 CFR §§ 80.215 and 90.205 for specification details.

5.1.2. Method of Measurements

Refer to Section 8.1 of this report for measurement details.

5.1.3. Test Arrangement



5.1.4. Test Data

Channel	Frequency MHz	Measured Conducted Power Output		Power Output Rating (W)
		(dBm)	(W)	
VHF Band				
2	151.10	30.26	**1.06**	1.00
3	161.80	30.15	1.04	1.00
4	173.80	30.14	1.03	1.00
9	151.10	38.43	**6.97***	6.00
10	161.80	38.33	6.81	6.00
11	173.80	38.30	6.76	6.00
UHF Band				
5	406.30	29.72	0.94	1.00
6	450.10	30.05	1.01	1.00
7	469.80	30.06	**1.01**	1.00
12	406.30	37.06	5.08	5.00
13	450.10	37.34	5.42	5.00
14	469.80	37.40	**5.50**	5.00

Conducted Power Verification of FCC ID: AZ489FT4886 Certification and EUT			
Fundamental Frequency (MHz)	**Conducted Output Power from FCC ID: AZ489FT4886 Certification (W)**	**Conducted Output Power Measured from EUT (W)**	**Power Rating (W)**
154.225	1.0	1.06 (at 151.10 MHz)	1.0
154.225	**6.6**	**6.97*** (at 151.10 MHz)	6.0
425.0125	1.0	1.01 (at 469.80 MHz)	1.0
425.0125	5.7	5.50 (at 469.80 MHz)	5.0

*** Note:** As we see that the conducted power measured in VHF band is more than the conducted power in the above certification filing, we can't demonstrate compliance of this module based on the conducted tests results from this filing, hence all conducted test were repeated only for the VHF band to demonstrate compliance with FCC rules. Since the measured conducted power in UHF band is less than the power measured in the above certification filing, we hereby request exemption of repeating conducted tests for UHF band as explained in cover letter and manufacturer attestation submitted with this filing.

5.2. AUDIO FREQUENCY RESPONSE [§ 2.1047(a), 80.213(e) & 90.242(b)(8)]

5.2.1. 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.

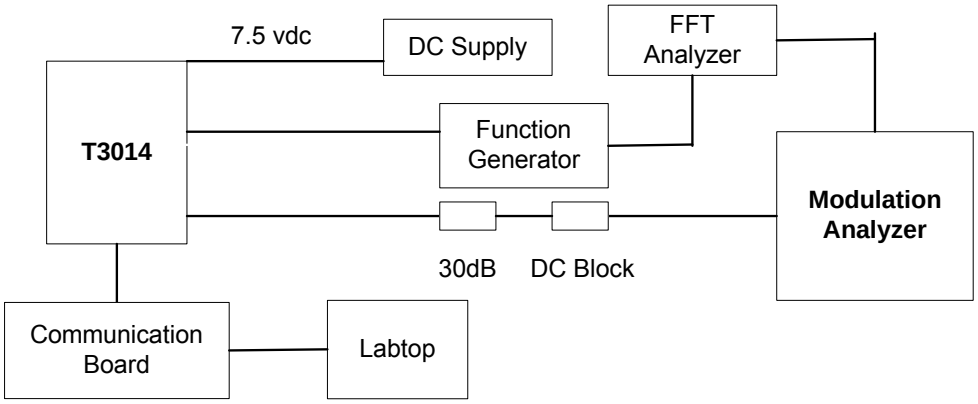
§ **90.242(b)(8):** Recommended audio filter attenuation characteristics are given below:

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

5.2.2. 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.

5.2.3. Test Arrangement



5.2.4. Test Equipment List

Refer to Exhibit 6.

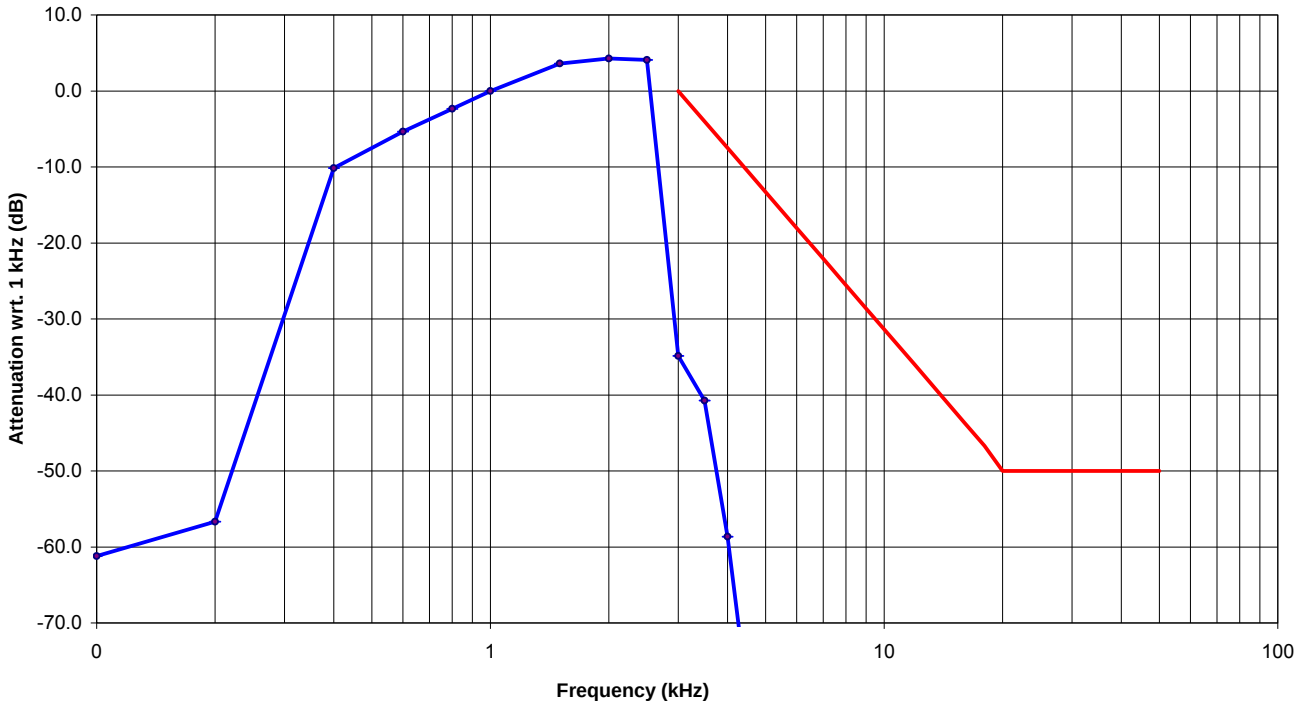
5.2.5. Test Data (VHF Band)

5.2.5.1. 12.5 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	-8.47	-61.33	-52.9	-61.2	--
0.2	-8.47	-56.81	-48.3	-56.7	--
0.4	-8.47	-10.29	-1.8	-10.2	--
0.6	-8.47	-5.48	3.0	-5.4	--
0.8	-8.47	-2.47	6.0	-2.4	--
1.0	-8.47	-0.12	8.4	0.0	--
1.5	-8.47	3.48	12.0	3.6	--
2.0	-8.47	4.13	12.6	4.3	--
2.5	-8.47	3.95	12.4	4.1	--
3.0	-8.47	-35.00	-26.5	-34.9	0
3.5	-8.47	-40.85	-32.4	-40.7	-4
4.0	-8.47	-58.75	-50.3	-58.6	-7
4.5	-8.47	-80.00	-71.5	-79.9	-11
5.0	-8.47	-80.00	-71.5	-79.9	-13
6.0	-8.47	-80.00	-71.5	-79.9	-18
7.0	-8.47	-80.00	-71.5	-79.9	-22
8.0	-8.47	-80.00	-71.5	-79.9	-26
9.0	-8.47	-80.00	-71.5	-79.9	-29
10.0	-8.47	-80.00	-71.5	-79.9	-31
12.0	-8.47	-80.00	-71.5	-79.9	-36
14.0	-8.47	-80.00	-71.5	-79.9	-40
16.0	-8.47	-80.00	-71.5	-79.9	-44
18.0	-8.47	-80.00	-71.5	-79.9	-47
20.0	-8.47	-80.00	-71.5	-79.9	-50
25.0	-8.47	-80.00	-71.5	-79.9	-50
30.0	-8.47	-80.00	-71.5	-79.9	-50
35.0	-8.47	-80.00	-71.5	-79.9	-50
40.0	-8.47	-80.00	-71.5	-79.9	-50
45.0	-8.47	-80.00	-71.5	-79.9	-50
50.0	-8.47	-80.00	-71.5	-79.9	-50

Audio Frequency Response
12.5 kHz Channel Spacing

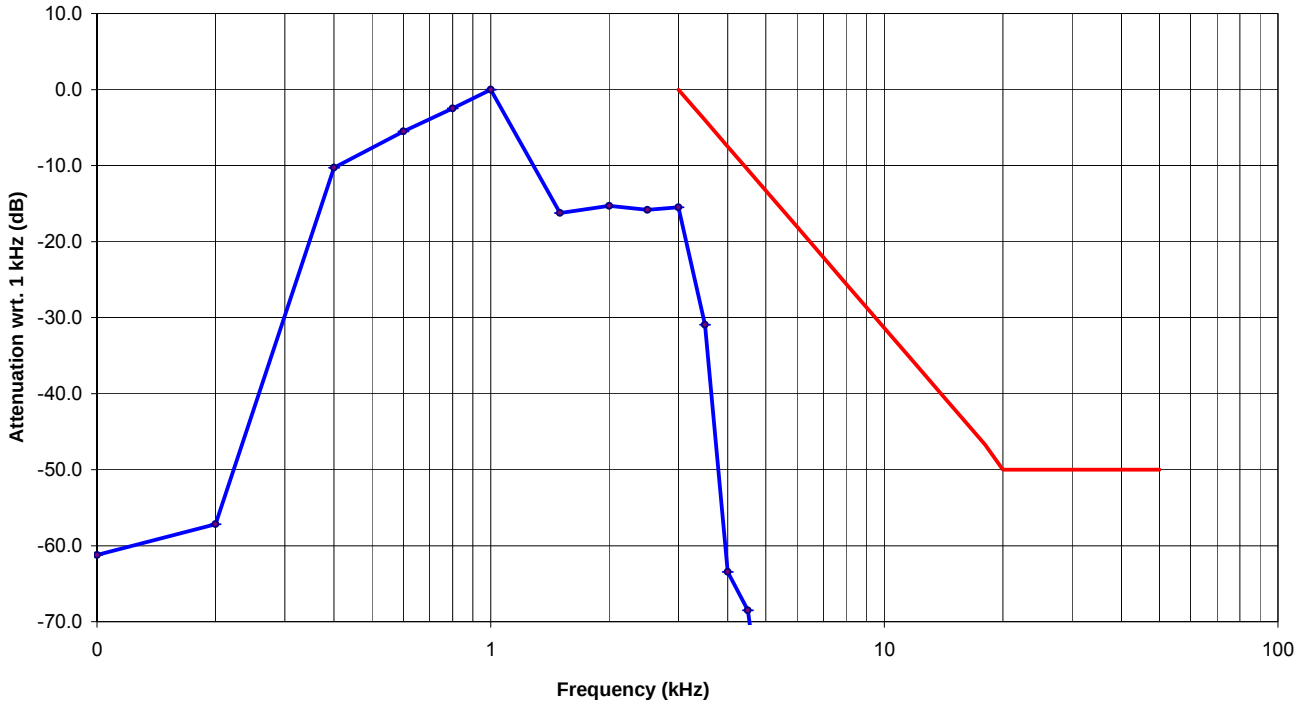


5.2.5.2. 25 KHz Channel Spacing, F3E, Frequency of All Modulation States*(Test not for FCC Certification purpose)

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	-8.47	-55.30	-46.8	-61.2	--
0.2	-8.47	-51.25	-42.8	-57.2	--
0.4	-8.47	-4.35	4.1	-10.3	--
0.6	-8.47	0.43	8.9	-5.5	--
0.8	-8.47	3.47	11.9	-2.5	--
1.0	-8.47	5.94	14.4	0.0	--
1.5	-8.47	-10.31	-1.8	-16.3	--
2.0	-8.47	-9.37	-0.9	-15.3	--
2.5	-8.47	-9.89	-1.4	-15.8	--
3.0	-8.47	-9.54	-1.1	-15.5	0
3.5	-8.47	-25.00	-16.5	-30.9	-4
4.0	-8.47	-57.50	-49.0	-63.4	-7
4.5	-8.47	-62.56	-54.1	-68.5	-11
5.0	-8.47	-80.00	-71.5	-85.9	-13
6.0	-8.47	-80.00	-71.5	-85.9	-18
7.0	-8.47	-80.00	-71.5	-85.9	-22
8.0	-8.47	-80.00	-71.5	-85.9	-26
9.0	-8.47	-80.00	-71.5	-85.9	-29
10.0	-8.47	-80.00	-71.5	-85.9	-31
12.0	-8.47	-80.00	-71.5	-85.9	-36
14.0	-8.47	-80.00	-71.5	-85.9	-40
16.0	-8.47	-80.00	-71.5	-85.9	-44
18.0	-8.47	-80.00	-71.5	-85.9	-47
20.0	-8.47	-80.00	-71.5	-85.9	-50
25.0	-8.47	-80.00	-71.5	-85.9	-50
30.0	-8.47	-80.00	-71.5	-85.9	-50
35.0	-8.47	-80.00	-71.5	-85.9	-50
40.0	-8.47	-80.00	-71.5	-85.9	-50
45.0	-8.47	-80.00	-71.5	-85.9	-50
50.0	-8.47	-80.00	-71.5	-85.9	-50

Audio Frequency Response
25 kHz Channel Spacing



5.3. MODULATION LIMITING [§ 2.1047 (b), 74.463, 80.213 & 90.210]

5.3.1. 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.

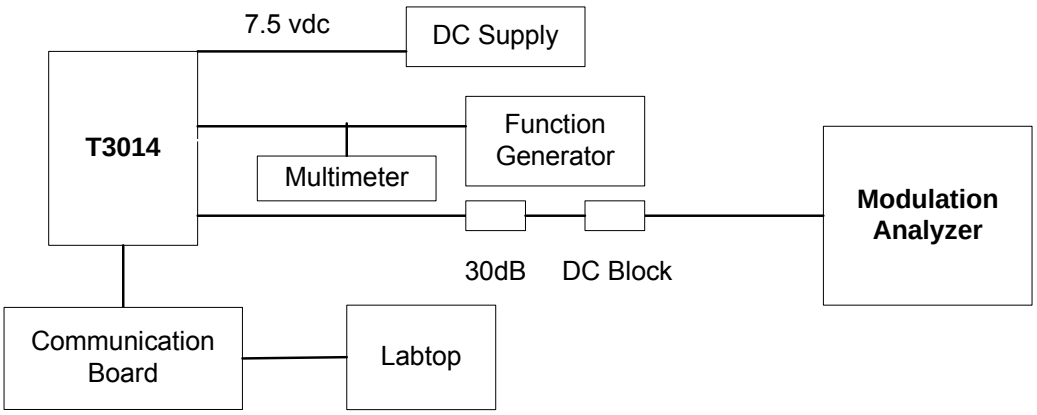
Recommended frequency deviation characteristics are given below:
- 2.5 KHz for 12.5 KHz Channel Spacing System
- 5 KHz for 25 KHz Channel Spacing System

5.3.2. 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.

5.3.3. Test Arrangement



5.3.4. Test Equipment List

Refer to Exhibit 6.

5.3.5. Test Data

5.3.5.1. 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)
2	0.16	0.18	0.21	0.39	0.16	2.5
4	0.16	0.20	0.27	0.75	0.16	2.5
6	0.16	0.23	0.35	0.99	0.16	2.5
8	0.16	0.27	0.43	1.04	0.16	2.5
10	0.16	0.30	0.50	1.31	0.16	2.5
15	0.16	0.37	0.68	1.80	0.16	2.5
20	0.16	0.45	0.89	2.38	0.16	2.5
25	0.16	0.60	1.26	2.38	0.16	2.5
30	0.16	0.76	1.64	2.38	0.16	2.5
35	0.16	0.86	1.65	2.38	0.16	2.5
40	0.16	0.87	1.66	2.38	0.16	2.5
45	0.16	0.87	1.65	2.38	0.16	2.5
50	0.16	0.86	1.66	2.38	0.16	2.5
60	0.16	0.86	1.66	2.38	0.16	2.5
70	0.16	0.87	1.65	2.38	0.16	2.5
80	0.16	0.86	1.66	2.38	0.16	2.5
90	0.16	0.87	1.64	2.38	0.16	2.5
100	0.16	0.95	1.73	2.38	0.20	2.5

Voice Signal Input Level = STD MOD Level + 16 dB
= 67.13 dB(mVrms)
= 2271.45 mVrms

Modulation Frequency (KHz)	Peak Deviation (KHz)	Maximum Limit (KHz)
0.1	0.14	2.5
0.2	0.15	2.5
0.4	0.17	2.5
0.6	0.15	2.5
0.8	1.38	2.5
1.0	1.66	2.5
1.2	1.94	2.5
1.4	2.34	2.5
1.6	2.36	2.5
1.8	2.38	2.5
2.0	2.41	2.5
2.5	2.40	2.5
3.0	2.29	2.5
3.5	0.95	2.5
4.0	0.18	2.5
4.5	0.17	2.5
5.0	0.17	2.5
6.0	0.15	2.5
7.0	0.16	2.5
8.0	0.17	2.5
9.0	0.16	2.5
10.0	0.16	2.5

5.3.5.2. Voice Modulation Limiting for 25 KHz Channel Spacing Operation (Tests not for FCC Certification purpose)

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)
2	0.14	0.19	0.27	0.63	0.15	5.0
4	0.14	0.25	0.43	1.30	0.15	5.0
6	0.14	0.31	0.57	1.47	0.15	5.0
8	0.14	0.38	0.74	1.96	0.15	5.0
10	0.14	0.43	0.87	2.63	0.15	5.0
15	0.14	0.58	1.25	3.48	0.15	5.0
20	0.14	0.74	1.65	4.67	0.15	5.0
25	0.14	1.05	3.15	4.67	0.15	5.0
30	0.14	1.37	3.15	4.67	0.15	5.0
35	0.14	1.59	3.23	4.67	0.15	5.0
40	0.14	1.60	3.19	4.67	0.15	5.0
45	0.14	1.60	3.20	4.67	0.15	5.0
50	0.14	1.58	3.22	4.67	0.15	5.0
60	0.14	1.59	3.20	4.67	0.15	5.0
70	0.14	1.58	3.21	4.67	0.15	5.0
80	0.14	1.59	3.22	4.67	0.15	5.0
90	0.14	1.59	3.26	4.67	0.16	5.0
100	0.14	1.75	3.34	4.67	0.24	5.0

Voice Signal Input Level = STD MOD Level + 16 dB
= 67.60 dB(mVrms)
= 2397.64 mVrms

Modulation Frequency (KHz)	Peak Deviation (KHz)	Maximum Limit (KHz)
0.1	0.16	5.0
0.2	0.15	5.0
0.4	1.31	5.0
0.6	2.40	5.0
0.8	2.96	5.0
1.0	3.33	5.0
1.2	3.79	5.0
1.4	4.63	5.0
1.6	4.71	5.0
1.8	4.72	5.0
2.0	4.72	5.0
2.5	4.68	5.0
3.0	4.58	5.0
3.5	2.04	5.0
4.0	0.26	5.0
4.5	0.21	5.0
5.0	0.24	5.0
6.0	0.23	5.0
7.0	0.22	5.0
8.0	0.22	5.0
9.0	0.22	5.0
10.0	0.21	5.0

5.3.5.3. Digital Modulation for 12.5/6.25 KHz Channel Spacing

Modulation	Peak Deviation (kHz)	Limit (kHz)
Digital 12.5 kHz C4FM	2.9	2.5
Digital 12.5 kHz CQPSK	2.9	2.5

5.4. OCCUPIED BANDWIDTH & EMISSION MASK [§ 2.1049, 80.205, 80.211, 90.209 & 90.210]

5.4.1. Limits

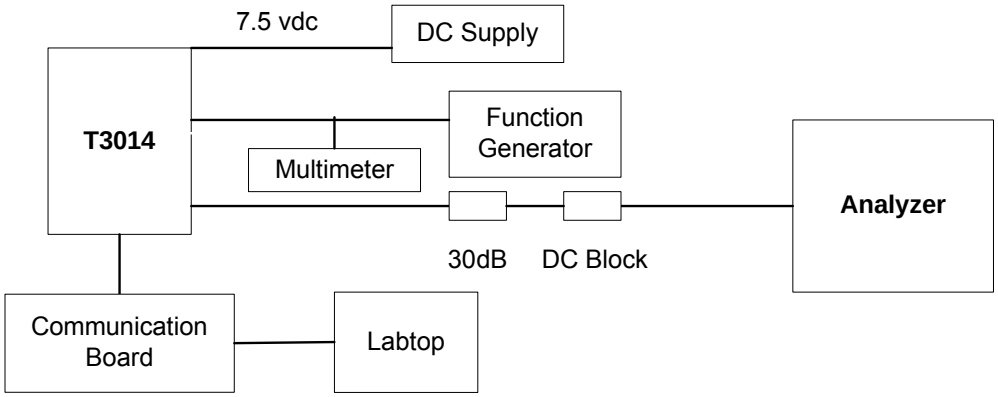
Emissions shall be attenuated below the mean output power of the transmitter as follows:

Frequency Range (MHz)	Maximum Authorized BW (KHz)	Channel Spacing (KHz)	Recommended Frequency Deviation (KHz)	FCC Applicable Mask
150-174	20.0	25	5.0	Mask B – Voice Mask C – Data
150-174	11.25	12.5	2.5	Mask D – Voice & Data
150-174	6	6.25	1.25	Mask E – Voice & Data

5.4.2. Method of Measurements

Refer to Section **Error! Reference source not found.** of this report for measurement details and TIA-102.CAAA-B.

5.4.3. Test Arrangement



5.4.4. Test Equipment List

Refer to Exhibit 6.

5.4.5. Test Data

5.4.5.1. 99% Occupied Bandwidth (VHF Band)

Frequency (MHz)	Channel Spacing (KHz)	Modulation	Measured 99% OBW at Maximum Freq. Deviation (KHz)	Maximum Authorized Bandwidth (KHz)
151.1	25*	FM with 2.5 KHz sine wave signal	15.09	20.0
161.8	25*	FM with 2.5 KHz sine wave signal	15.03	20.0
173.8	25*	FM with 2.5 KHz sine wave signal	15.03	20.0
151.1	12.5	FM with 2.5 KHz sine wave signal	10.1	11.25
161.8	12.5	FM with 2.5 KHz sine wave signal	9.98	11.25
173.8	12.5	FM with 2.5 KHz sine wave signal	9.98	11.25
151.1	12.5	Digital C4FM	8.34	11.25
161.8	12.5	Digital C4FM	8.18	11.25
173.8	12.5	Digital C4FM	8.30	11.25
151.1	12.5	Digital CQPSK	8.30	11.25
161.8	12.5	Digital CQPSK	8.30	11.25
173.8	12.5	Digital CQPSK	8.14	11.25
151.1	12.5	2 Slot TDMA	8.18	11.25
161.8	12.5	2 Slot TDMA	8.14	11.25
173.8	12.5	2 Slot TDMA	8.14	11.25

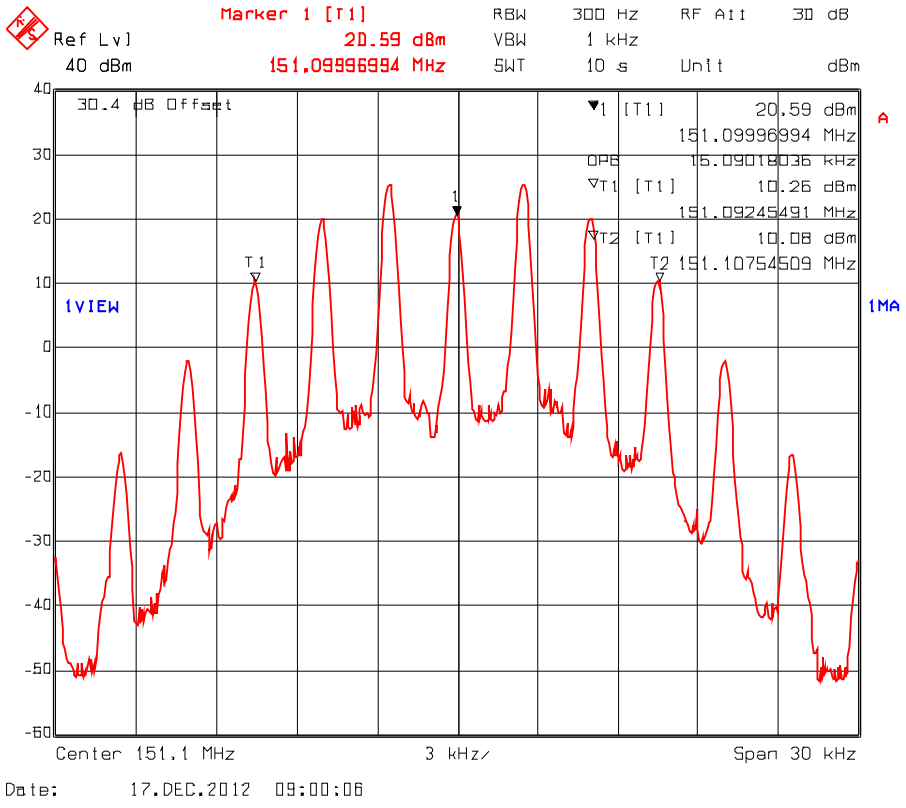
* 25 kHz Measurements are not for FCC Certification purpose.

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 15) for details.

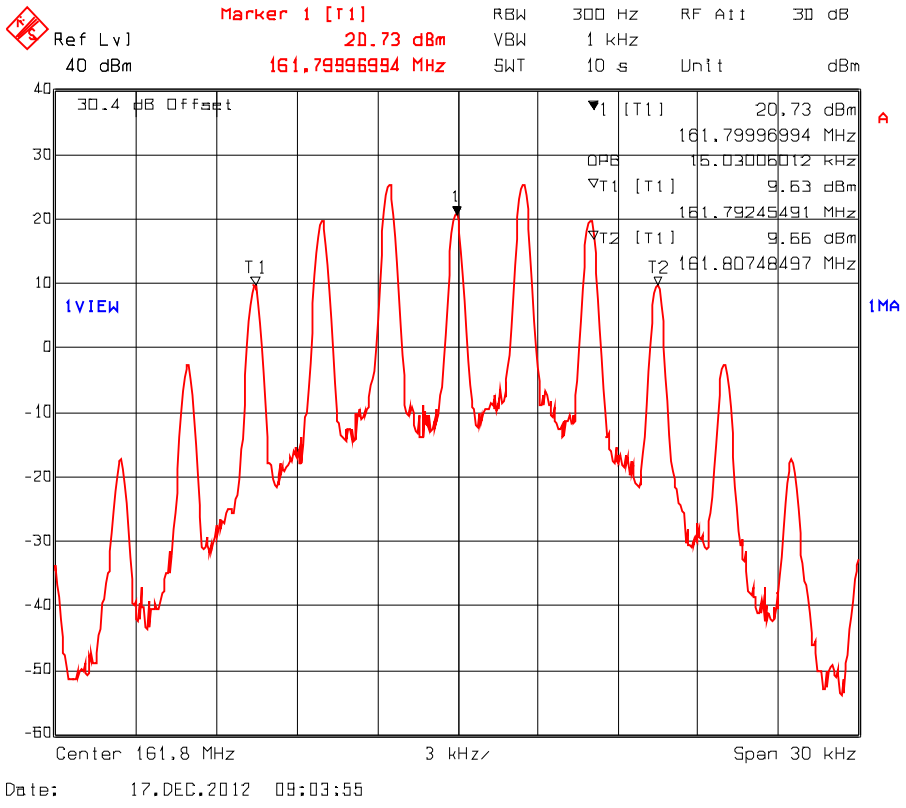
Plot # 1.: 99 % Occupied Bandwidth

Carrier Frequency: 151.1 MHz
Channel Spacing: 25.0 KHz
Power: 6 W
Modulation: FM with 2.5 KHz sine wave signal



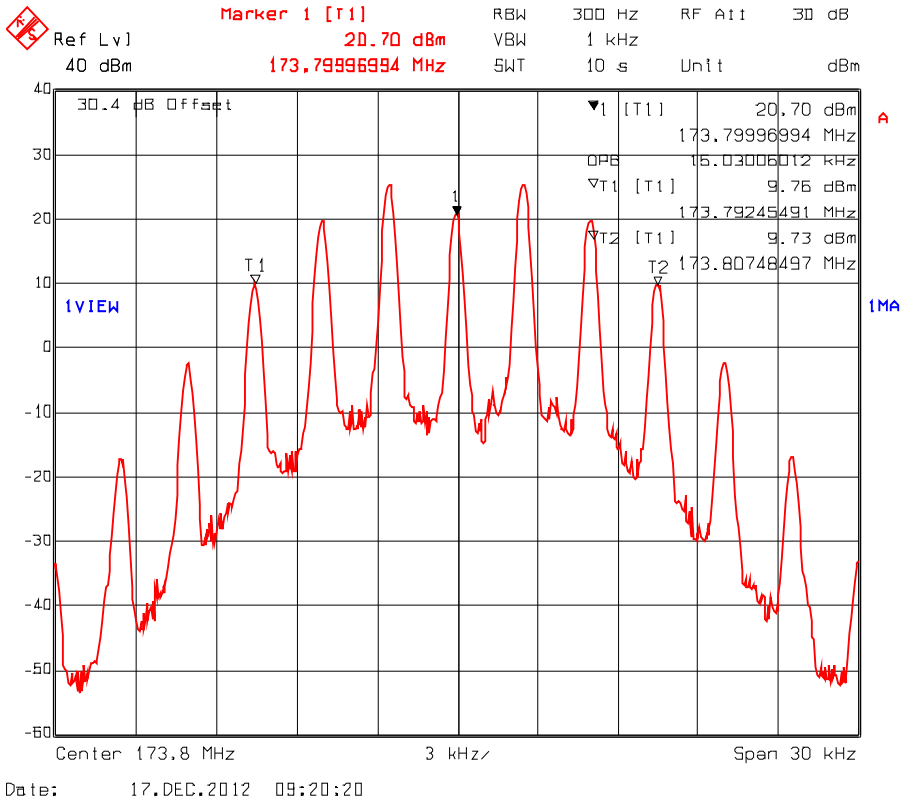
Plot # 2.: 99 % Occupied Bandwidth

Carrier Frequency: 161.8 MHz
Channel Spacing: 25.0 KHz
Power: 6 W
Modulation: FM with 2.5 KHz sine wave signal



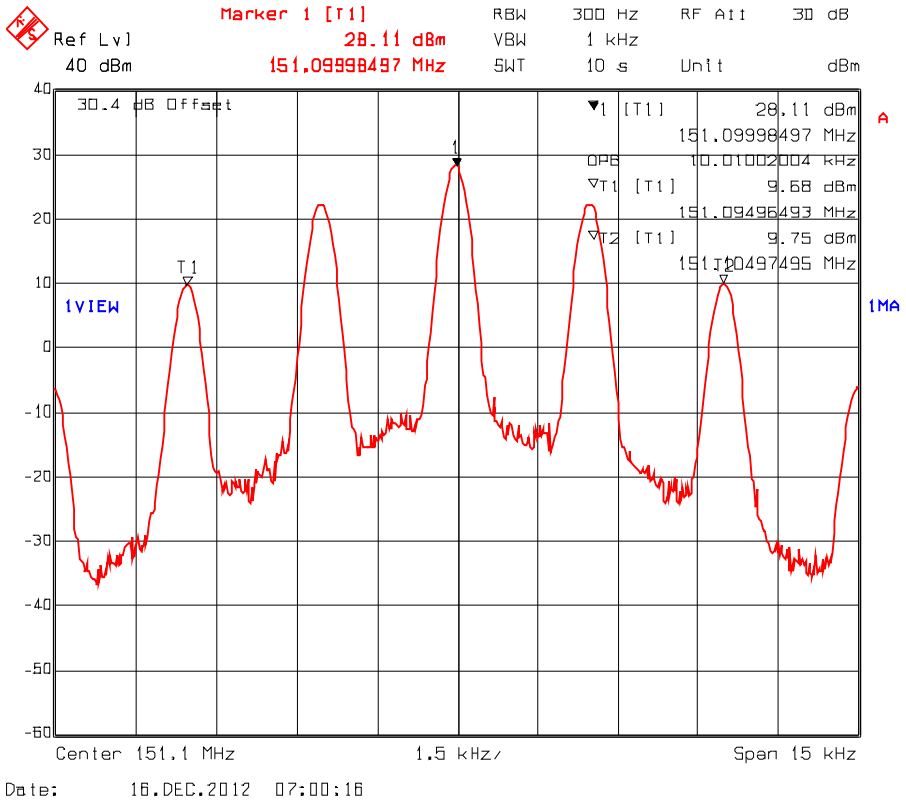
Plot # 3.: 99 % Occupied Bandwidth

Carrier Frequency: 173.8 MHz
Channel Spacing: 25.0 KHz
Power: 6 W
Modulation: FM with 2.5 KHz sine wave signal



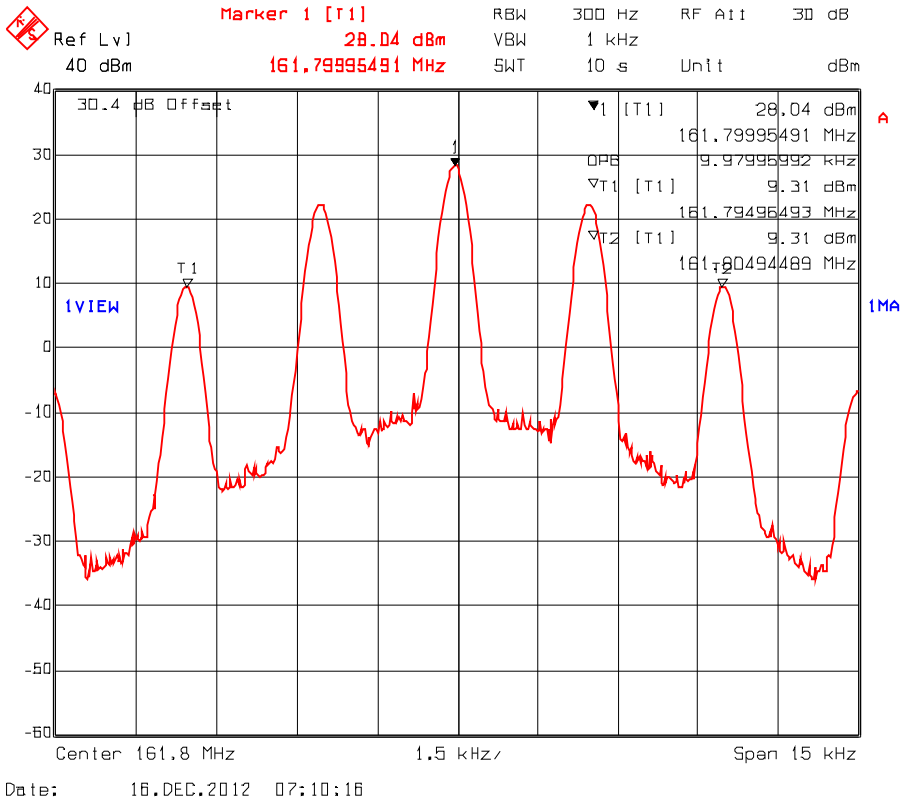
Plot # 4.: 99 % Occupied Bandwidth

Carrier Frequency: 151.1 MHz
Channel Spacing: 12.5 KHz
Power: 6 W
Modulation: FM with 2.5 KHz sine wave signal



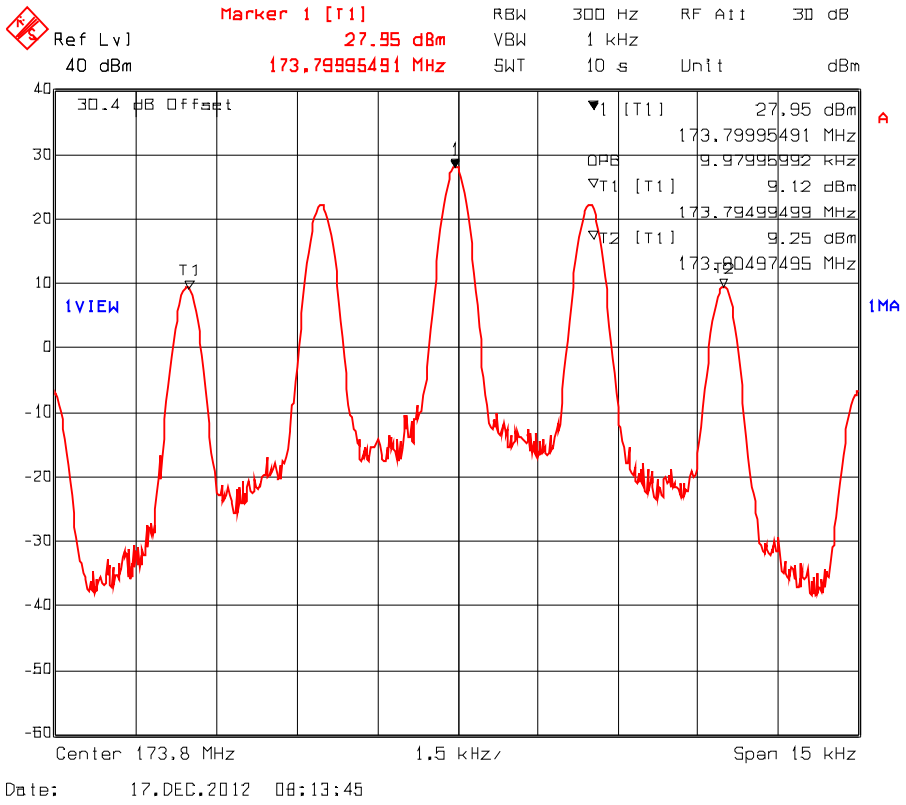
Plot # 5.: 99 % Occupied Bandwidth

Carrier Frequency: 161.8 MHz
Channel Spacing: 12.5 KHz
Power: 6 W
Modulation: FM with 2.5 KHz sine wave signal



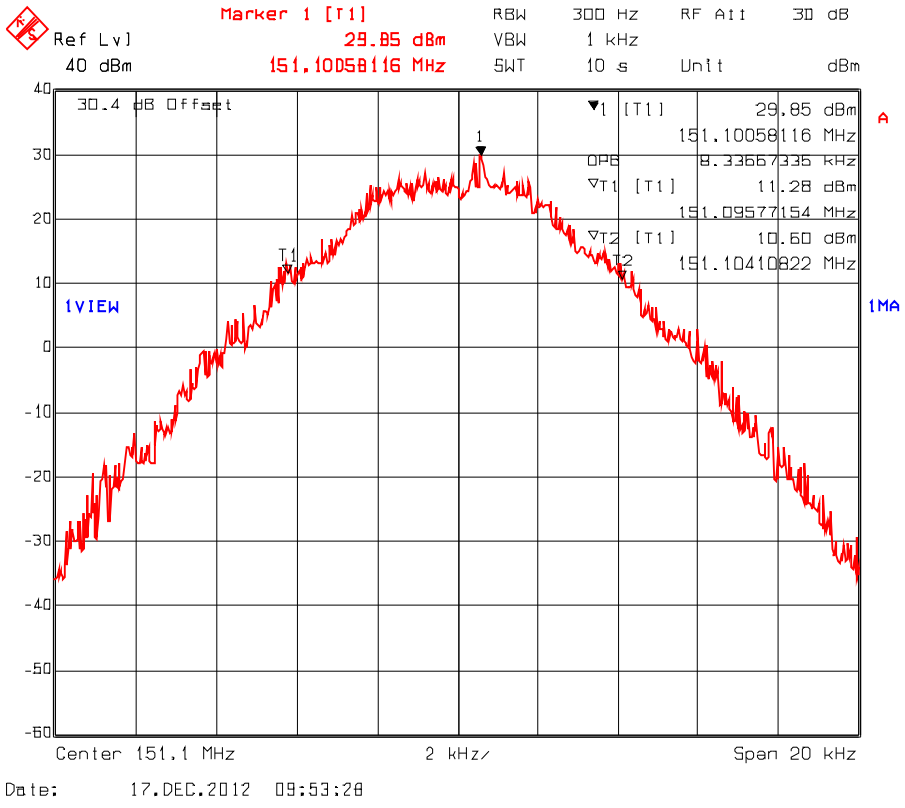
Plot # 6.: 99 % Occupied Bandwidth

Carrier Frequency: 173.8 MHz
Channel Spacing: 12.5 KHz
Power: 6 W
Modulation: FM with 2.5 KHz sine wave signal



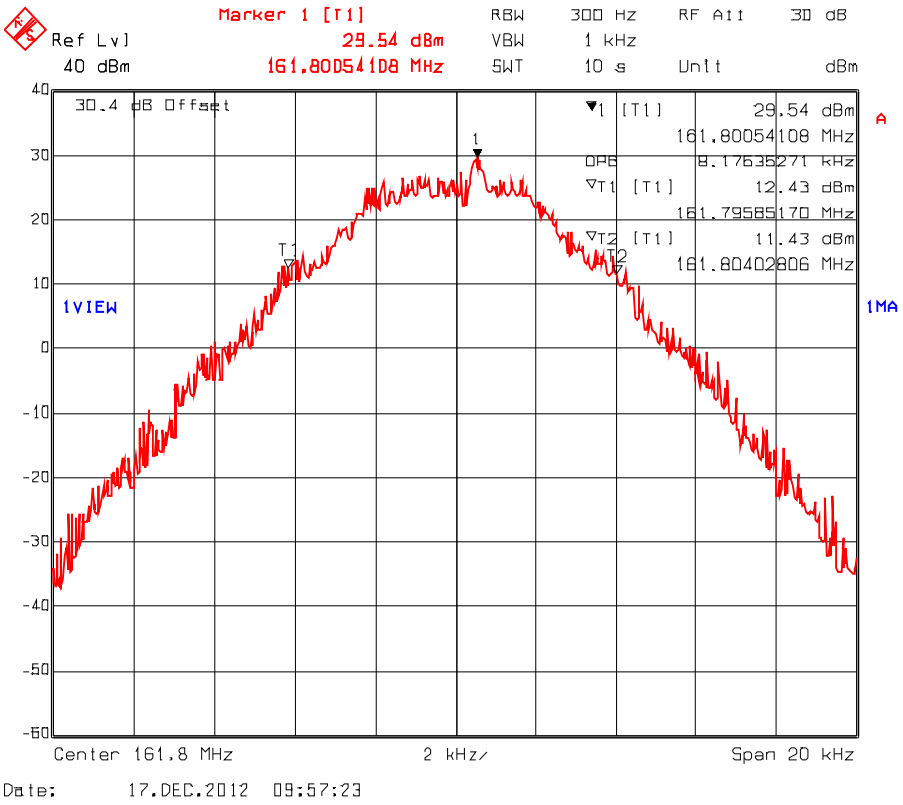
Plot # 7.: 99 % Occupied Bandwidth

Carrier Frequency: 151.1 MHz
Channel Spacing: 12.5 KHz
Power: 6 W
Modulation: Digital C4FM



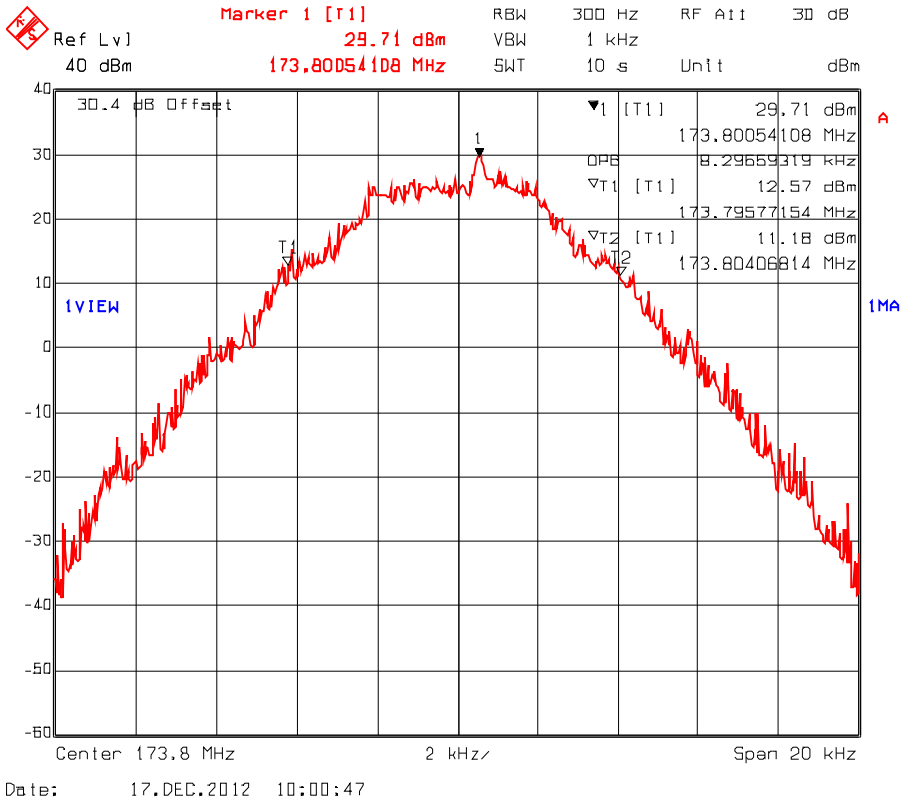
Plot # 8.: 99 % Occupied Bandwidth

Carrier Frequency: 161.8 MHz
Channel Spacing: 12.5 KHz
Power: 6 W
Modulation: Digital C4FM



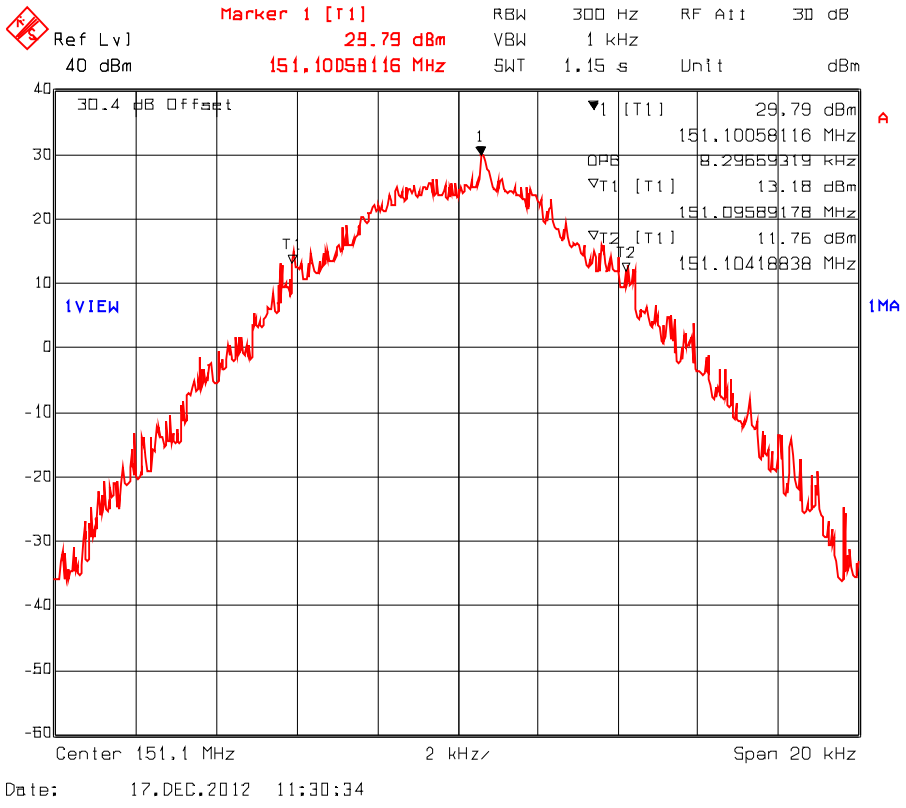
Plot # 9.: 99 % Occupied Bandwidth

Carrier Frequency: 173.8 MHz
Channel Spacing: 12.5 KHz
Power: 6 W
Modulation: Digital C4FM



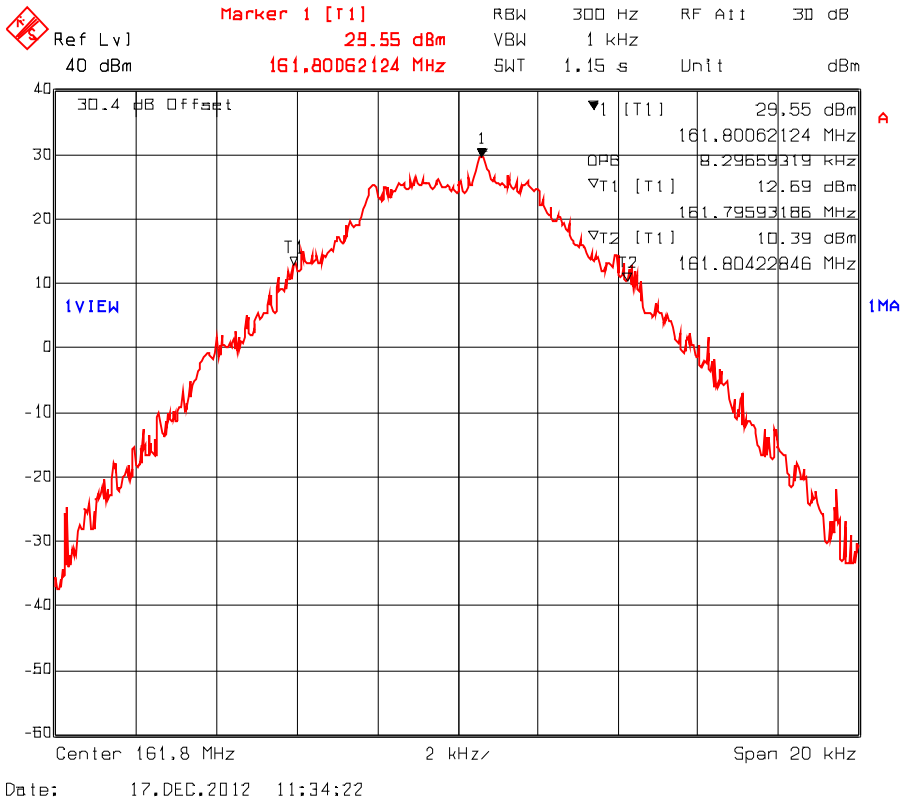
Plot # 10.: 99 % Occupied Bandwidth

Carrier Frequency: 151.1 MHz
Channel Spacing: 12.5 KHz
Power: 6 W
Modulation: Digital CQPSK



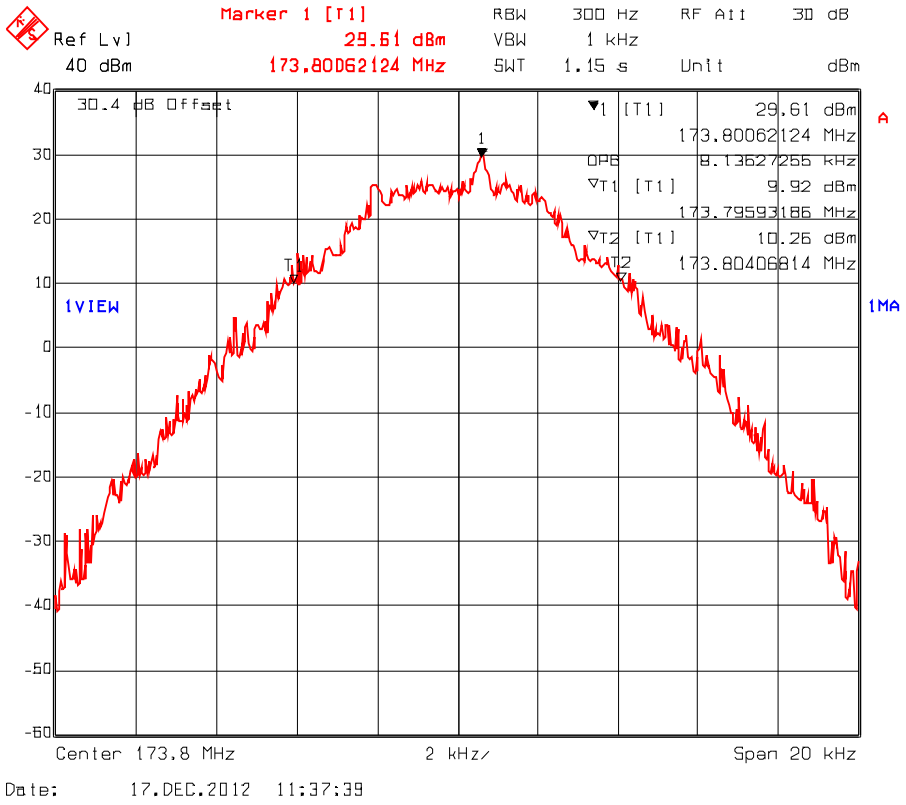
Plot # 11.: 99 % Occupied Bandwidth

Carrier Frequency: 161.8 MHz
Channel Spacing: 12.5 KHz
Power: 6 W
Modulation: Digital CQPSK



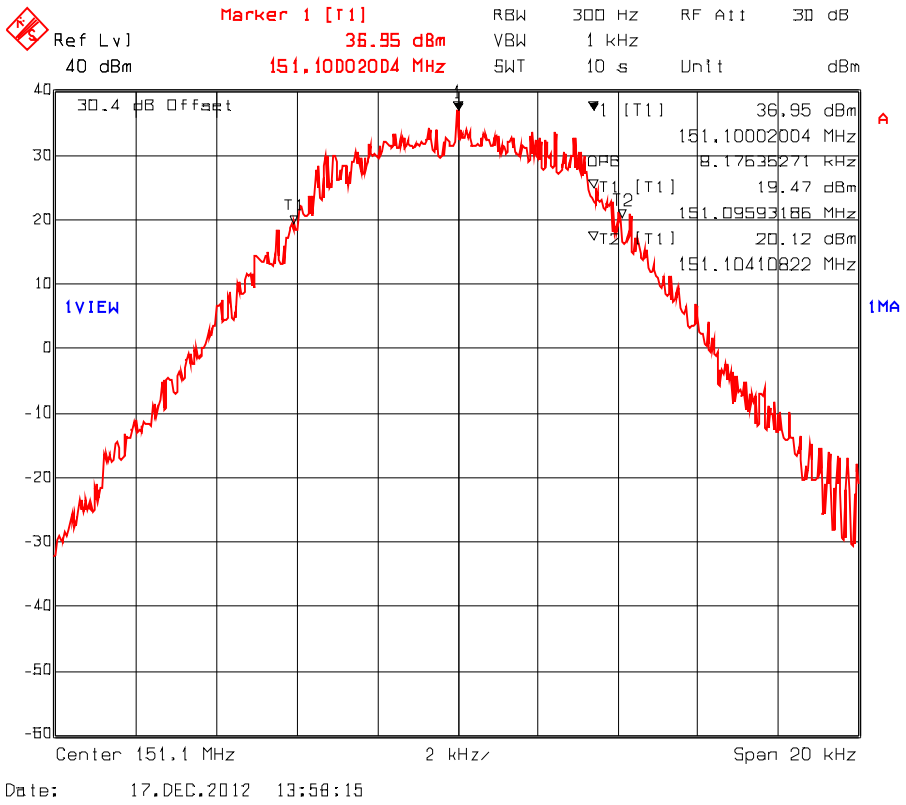
Plot # 12.: 99 % Occupied Bandwidth

Carrier Frequency: 173.8 MHz
Channel Spacing: 12.5 KHz
Power: 6 W
Modulation: Digital CQPSK



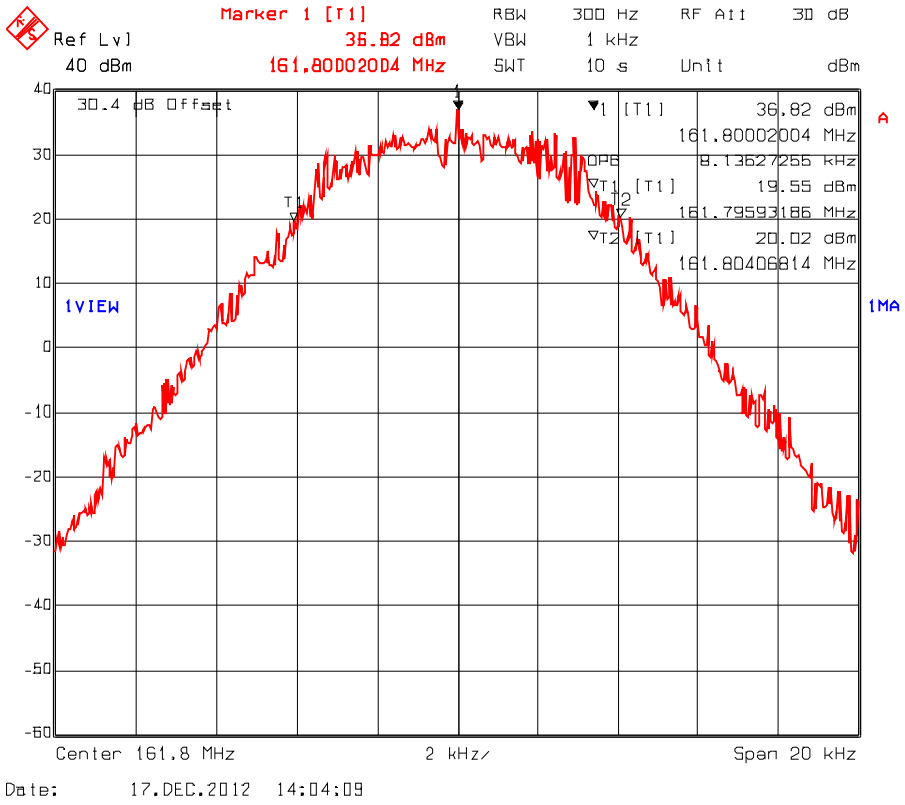
Plot # 13.: 99 % Occupied Bandwidth

Carrier Frequency: 151.1 MHz
Channel Spacing: 12.5 KHz
Power: 6 W
Modulation: 2 slot TDMA



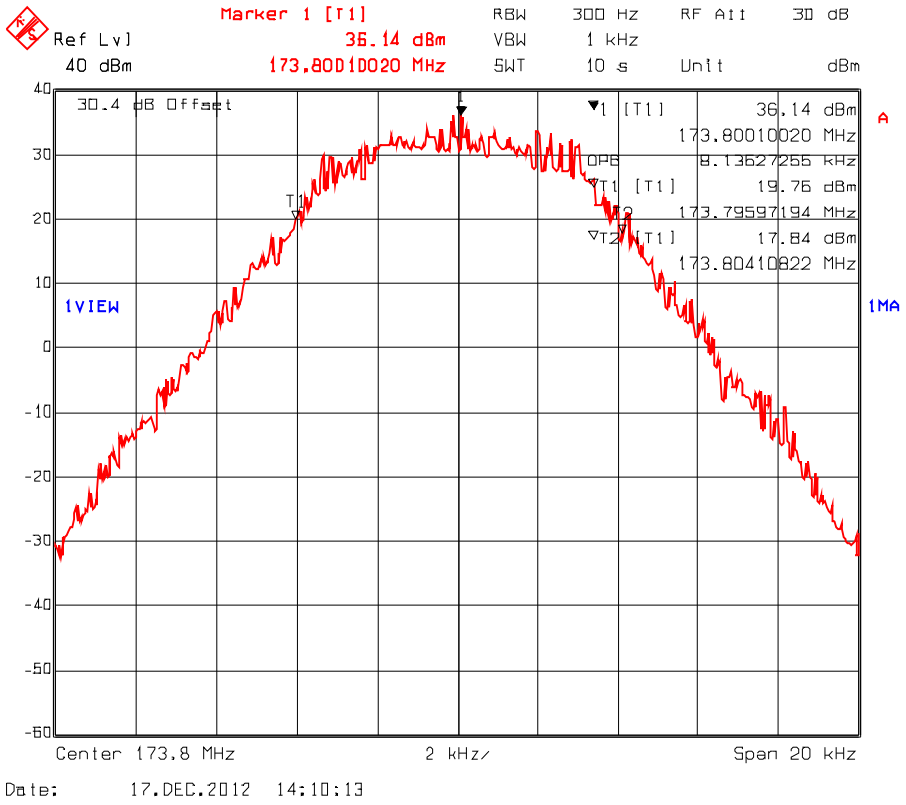
Plot # 14.: 99 % Occupied Bandwidth

Carrier Frequency: 161.8 MHz
Channel Spacing: 12.5 KHz
Power: 6 W
Modulation: 2 slot TDMA



Plot # 15.: 99 % Occupied Bandwidth

Carrier Frequency: 173.8 MHz
Channel Spacing: 12.5 KHz
Power: 6 W
Modulation: 2 slot TDMA

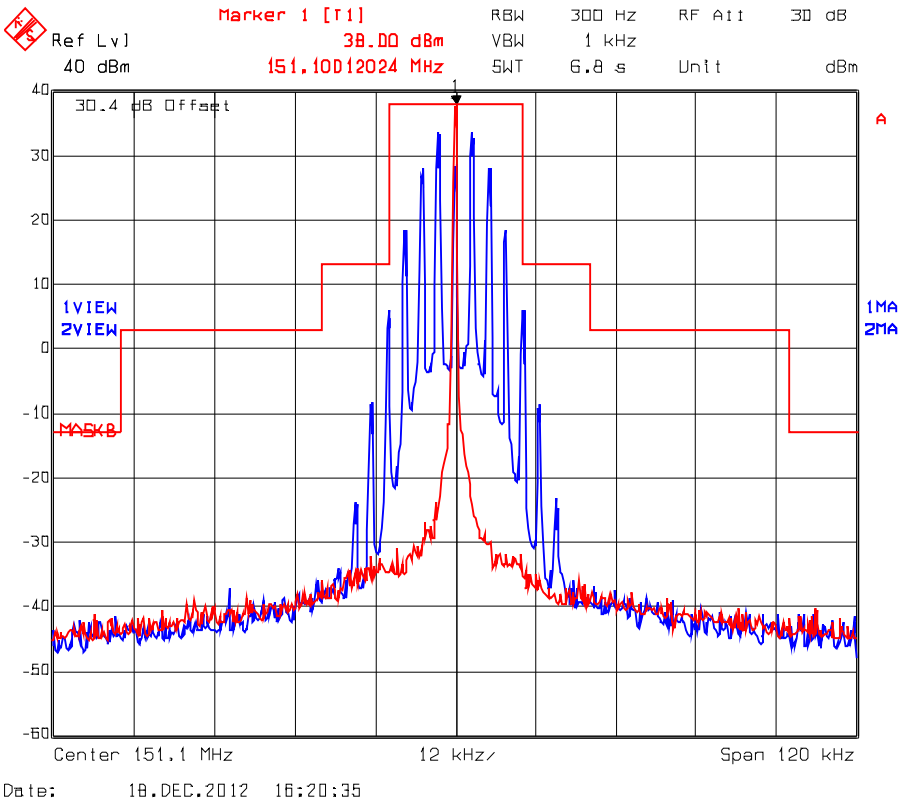


5.4.5.2. Emission Masks (VHF Band)

Conform. See the following test data plots (16 through 45) for details.

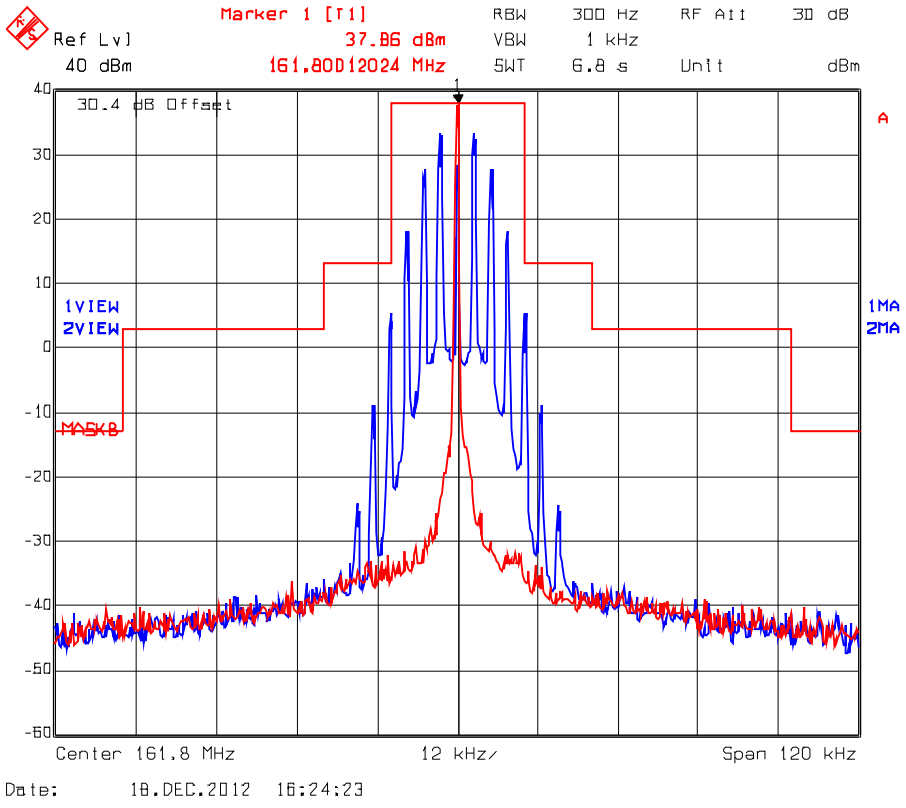
Plot # 16.: Emission Mask B

Carrier Frequency: 151.1 MHz
Channel Spacing: 25 kHz
Power: 6 W
Modulation: FM with 2.5 kHz sine wave



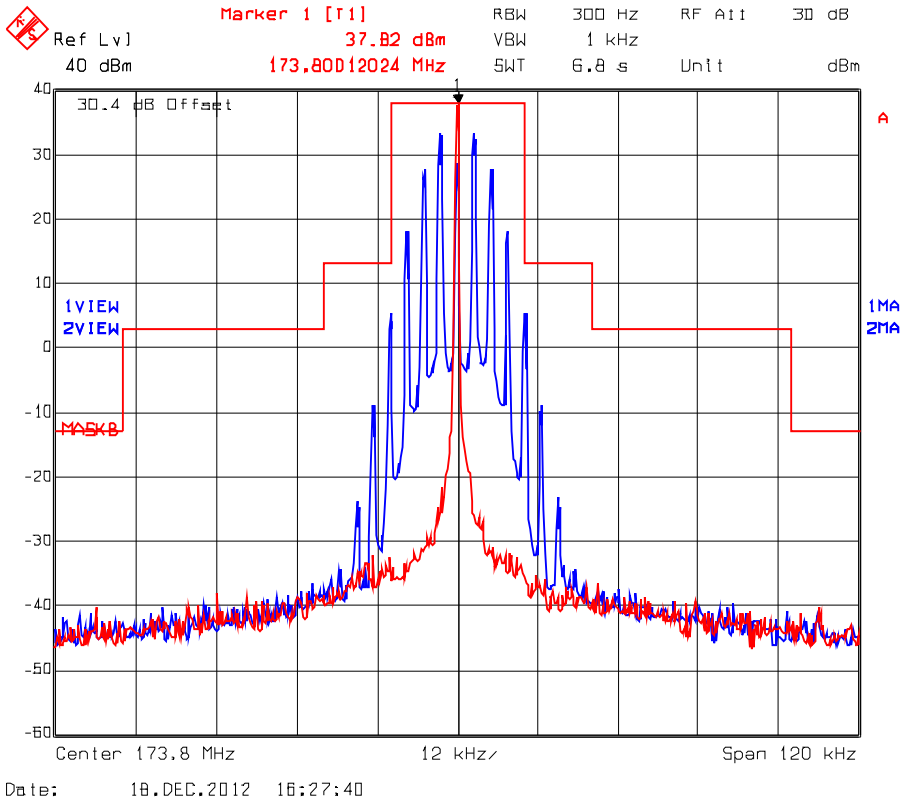
Plot # 17.: Emission Mask B

Carrier Frequency: 161.8 MHz
Channel Spacing: 25 kHz
Power: 6 W
Modulation: FM with 2.5 kHz sine wave



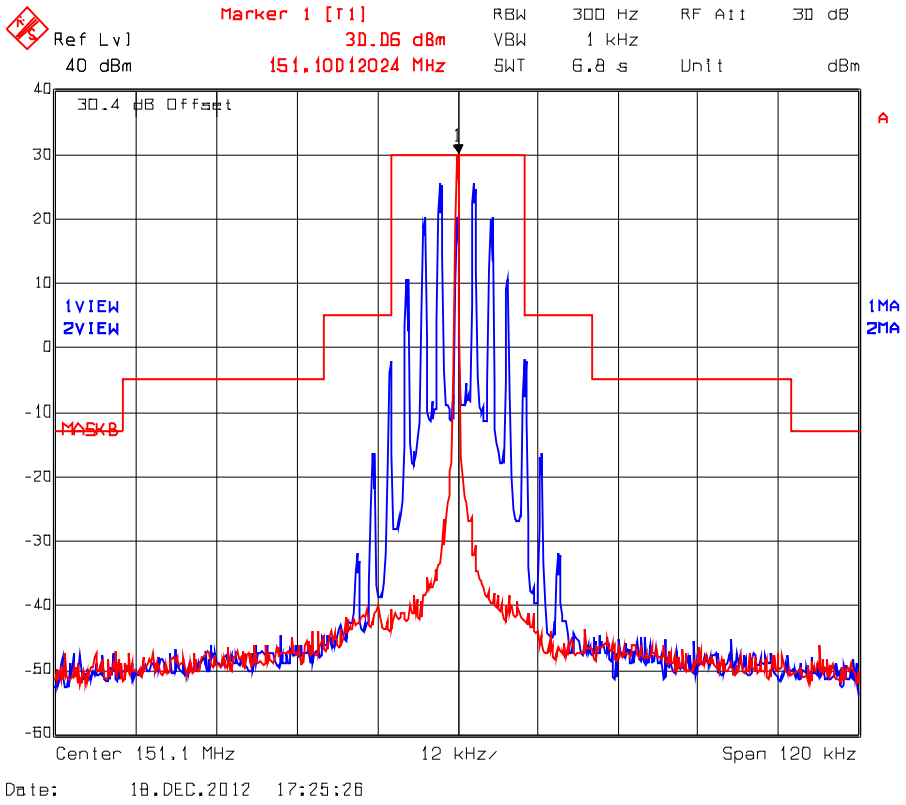
Plot # 18.: Emission Mask B

Carrier Frequency: 173.8 MHz
Channel Spacing: 25 kHz
Power: 6 W
Modulation: FM with 2.5 kHz sine wave



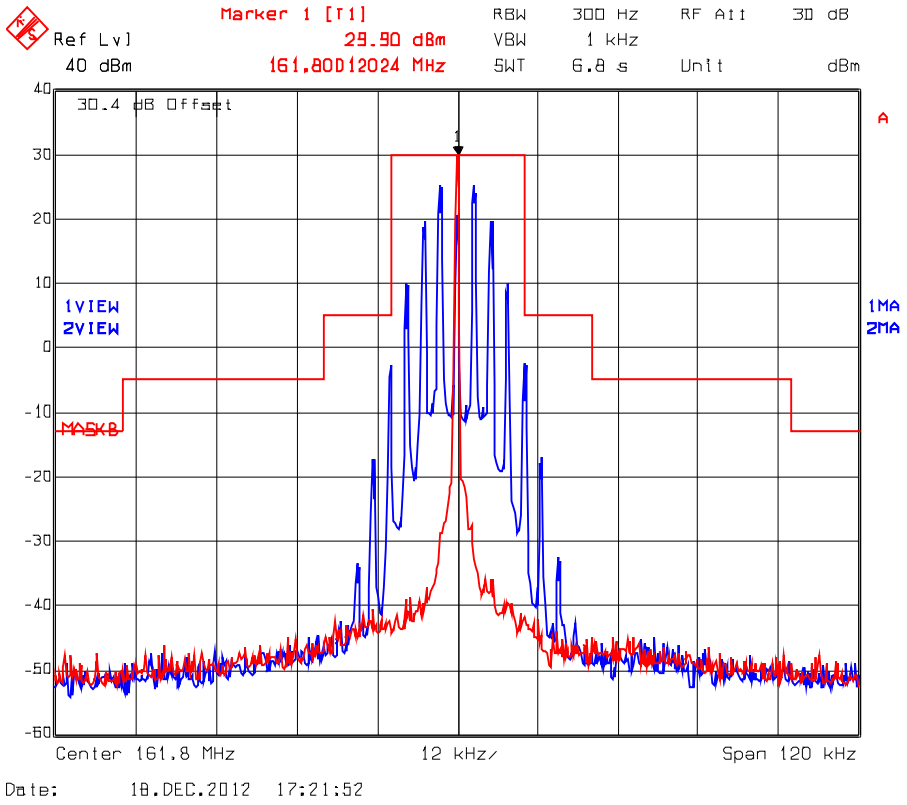
Plot # 19.: Emission Mask B

Carrier Frequency: 151.1 MHz
Channel Spacing: 25 kHz
Power: 1 W
Modulation: FM with 2.5 kHz sine wave



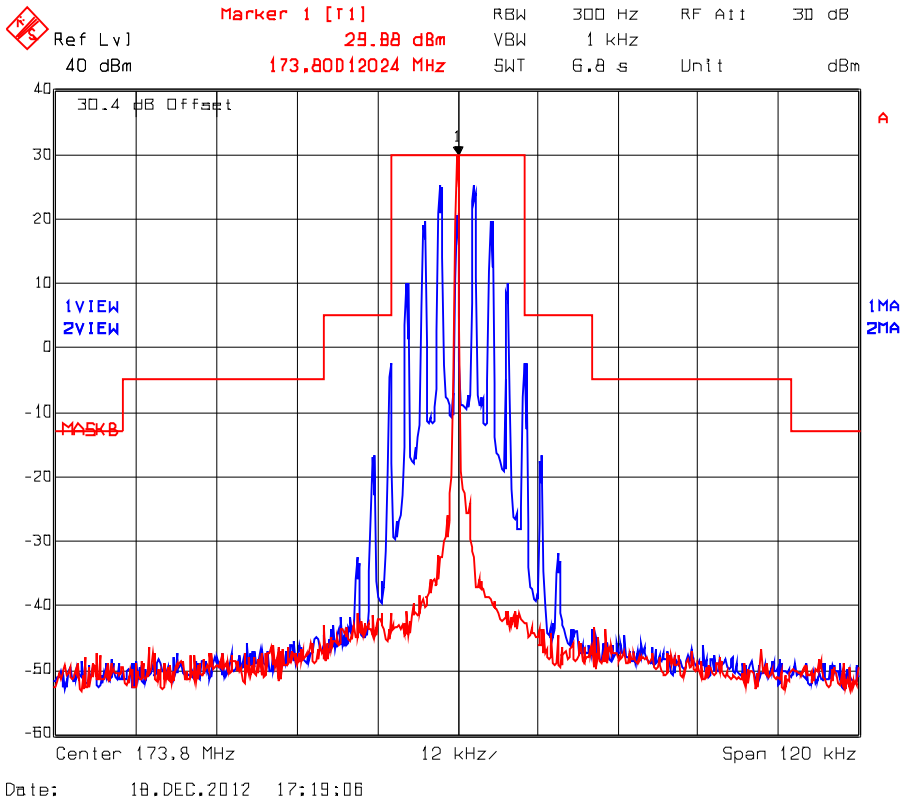
Plot # 20.: Emission Mask B

Carrier Frequency: 161.8 MHz
Channel Spacing: 25 kHz
Power: 1 W
Modulation: FM with 2.5 kHz sine wave



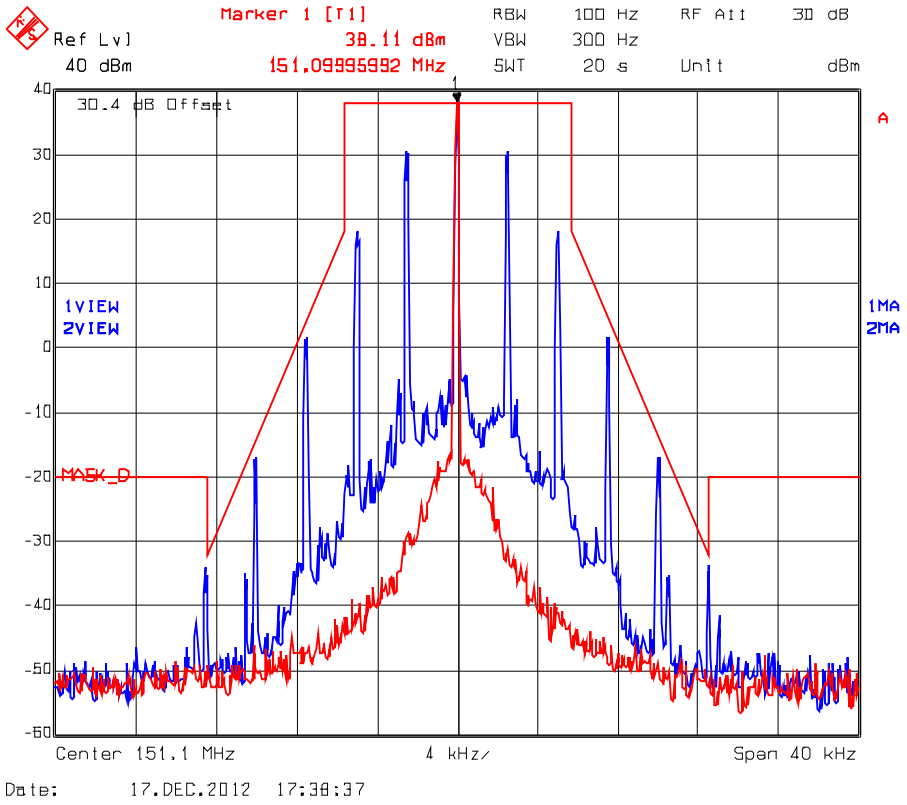
Plot # 21.: Emission Mask B

Carrier Frequency: 173.8 MHz
Channel Spacing: 25 kHz
Power: 1 W
Modulation: FM with 2.5 kHz sine wave



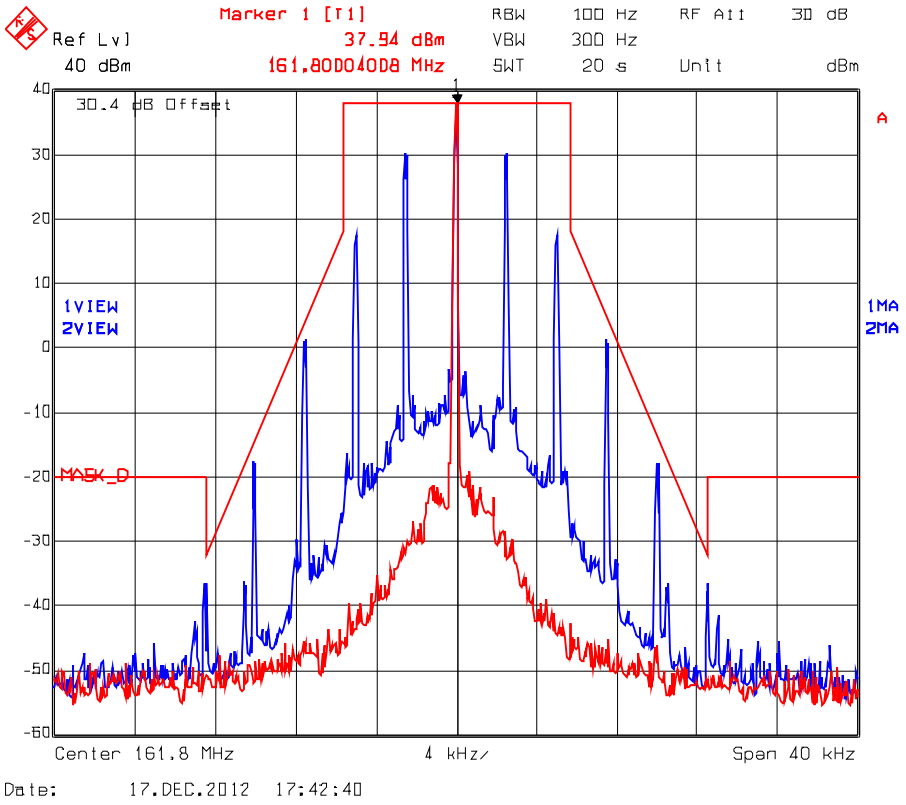
Plot # 22.: Emission Mask D

Carrier Frequency: 151.1 MHz
Channel Spacing: 12.5 kHz
Power: 6 W
Modulation: FM with 2.5 kHz sine wave



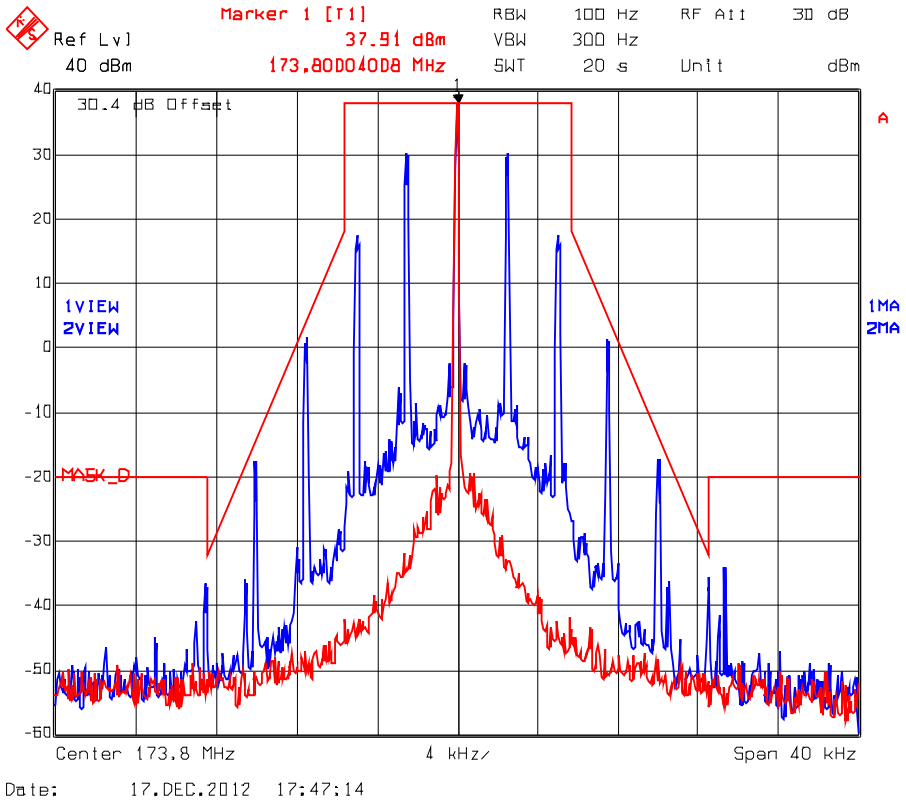
Plot # 23.: Emission Mask D

Carrier Frequency: 161.8 MHz
Channel Spacing: 12.5 kHz
Power: 6 W
Modulation: FM with 2.5 kHz sine wave



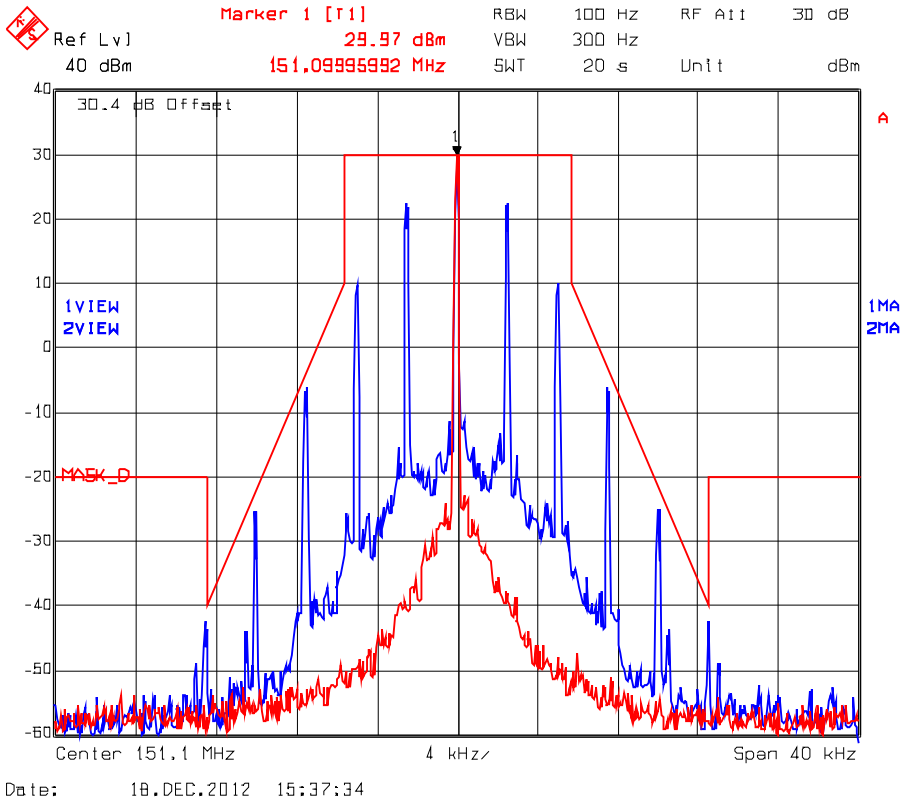
Plot # 24.: Emission Mask D

Carrier Frequency: 173.8 MHz
Channel Spacing: 12.5 kHz
Power: 6 W
Modulation: FM with 2.5 kHz sine wave



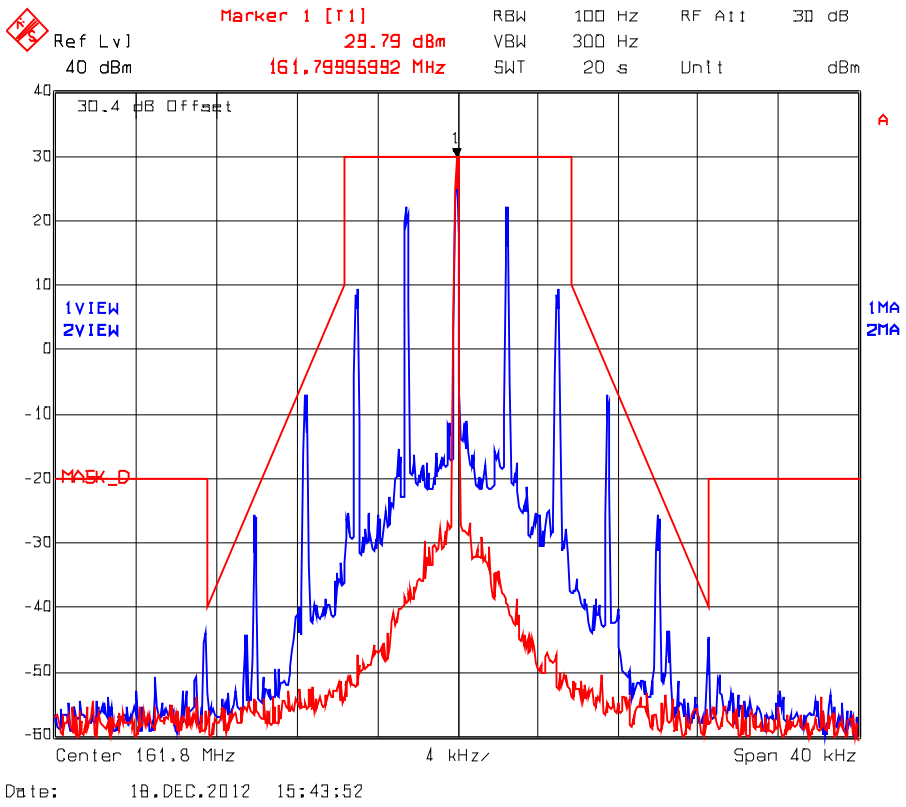
Plot # 25.: Emission Mask D

Carrier Frequency: 151.1 MHz
Channel Spacing: 12.5 kHz
Power: 1 W
Modulation: FM with 2.5 kHz sine wave



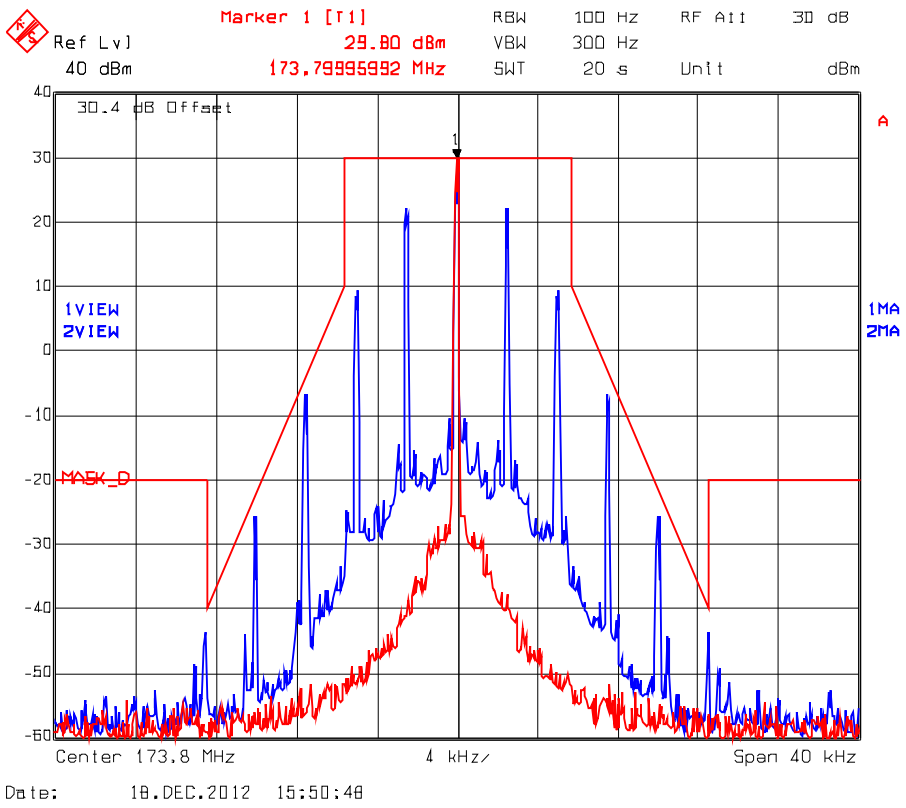
Plot # 26.: Emission Mask D

Carrier Frequency: 161.8 MHz
Channel Spacing: 12.5 kHz
Power: 1 W
Modulation: FM with 2.5 kHz sine wave



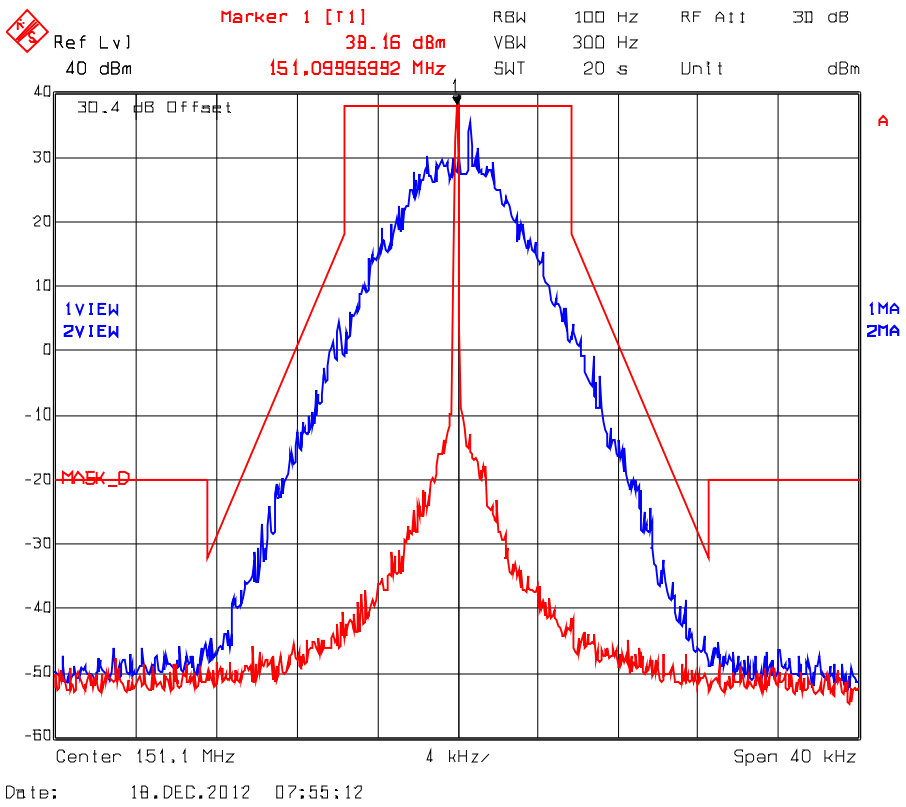
Plot # 27.: Emission Mask D

Carrier Frequency: 173.8 MHz
Channel Spacing: 12.5 kHz
Power: 1 W
Modulation: FM with 2.5 kHz sine wave



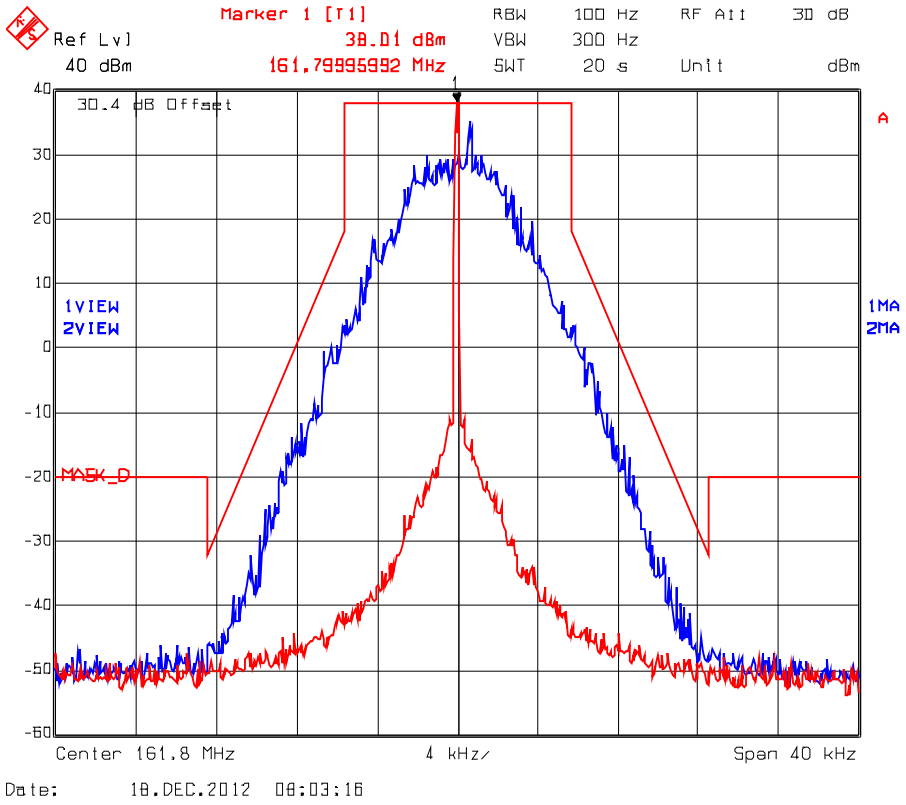
Plot # 28.: Emission Mask D

Carrier Frequency: 151.1 MHz
Channel Spacing: 12.5 kHz
Power: 6 W
Modulation: Digital C4FM



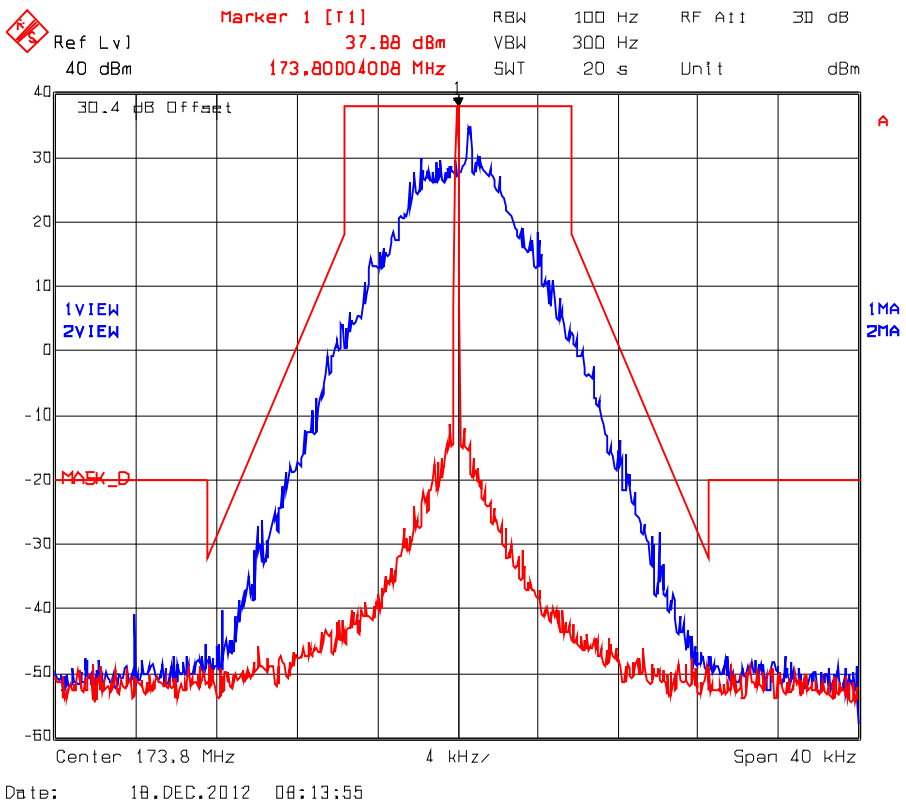
Plot # 29.: Emission Mask D

Carrier Frequency: 161.8 MHz
Channel Spacing: 12.5 kHz
Power: 6 W
Modulation: Digital C4FM



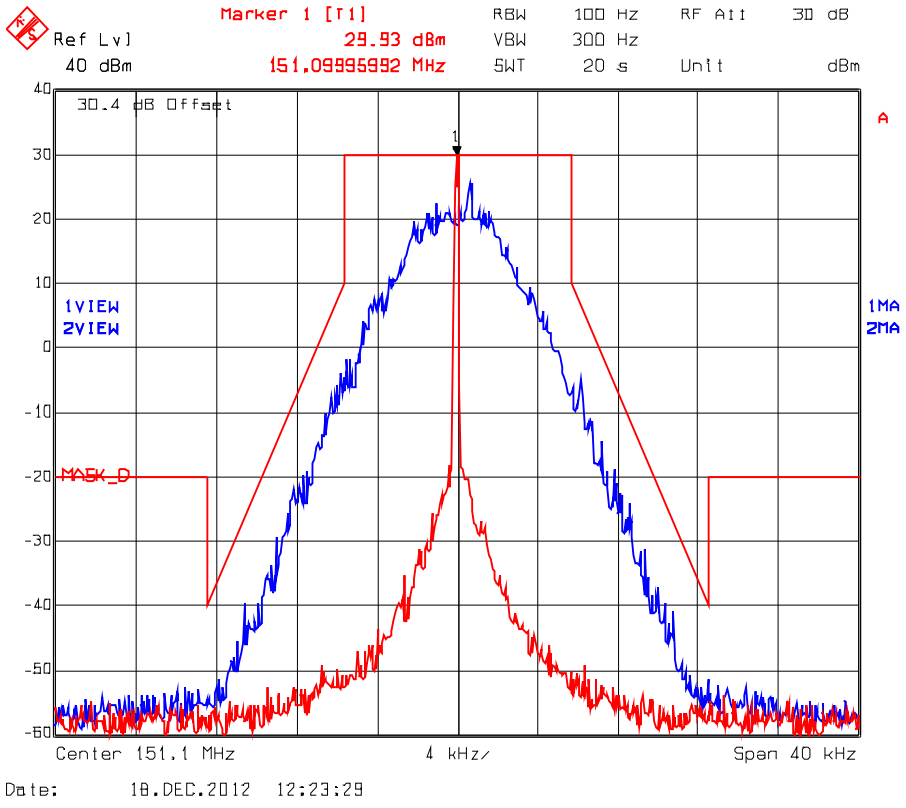
Plot # 30.: Emission Mask D

Carrier Frequency: 173.8 MHz
Channel Spacing: 12.5 kHz
Power: 6 W
Modulation: Digital C4FM



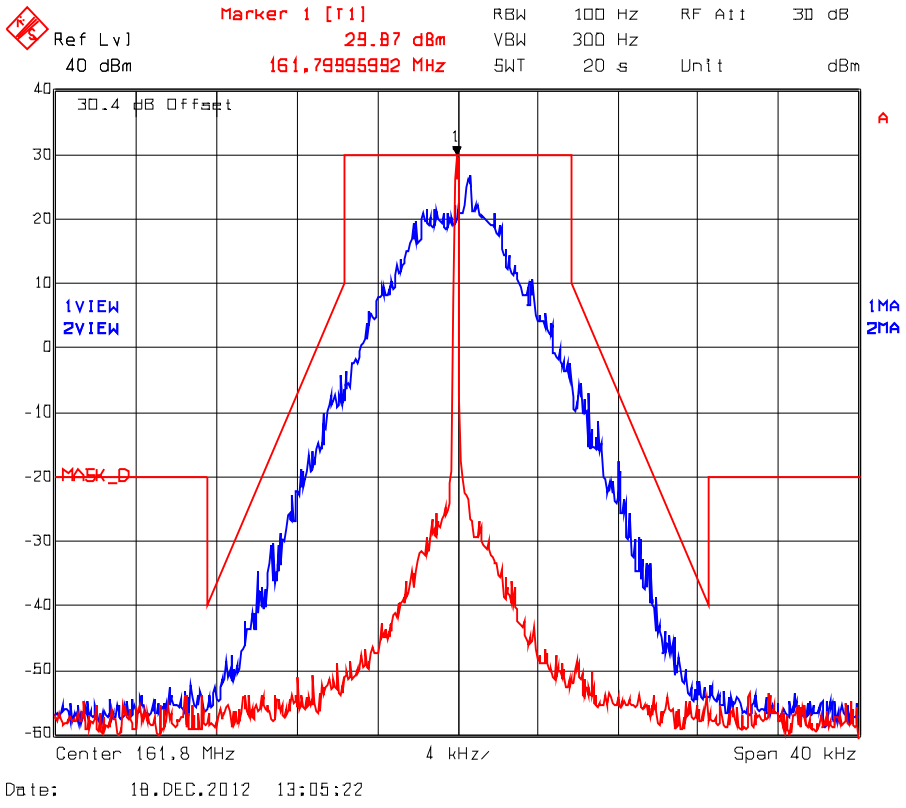
Plot # 31.: Emission Mask D

Carrier Frequency: 151.1 MHz
Channel Spacing: 12.5 kHz
Power: 1 W
Modulation: Digital C4FM



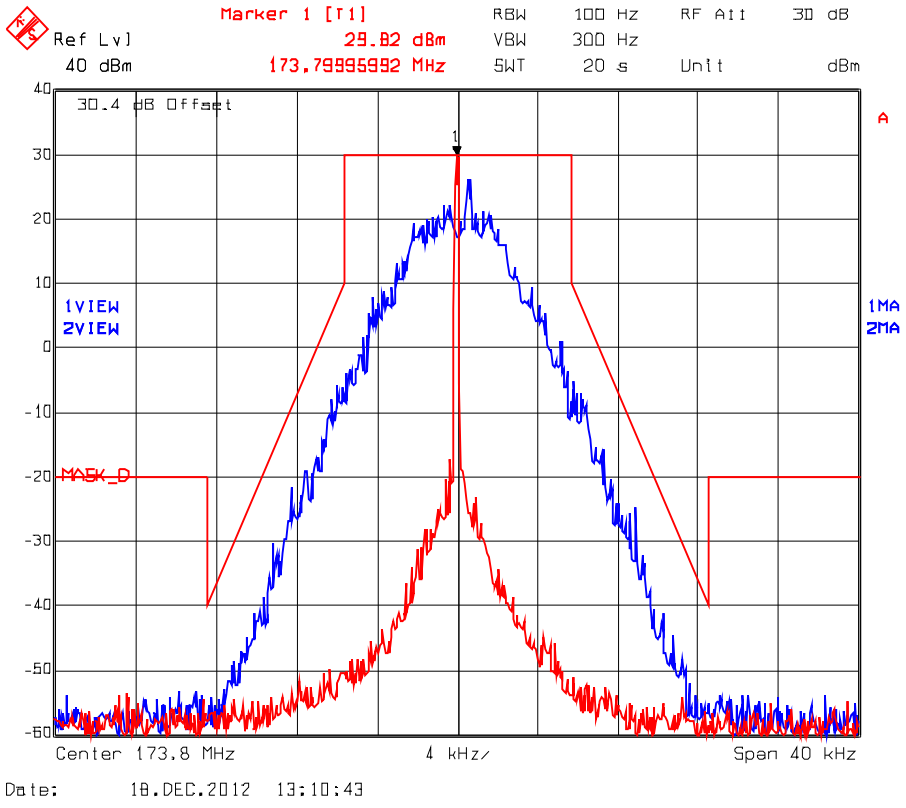
Plot # 32.: Emission Mask D

Carrier Frequency: 161.8 MHz
Channel Spacing: 12.5 kHz
Power: 1 W
Modulation: Digital C4FM



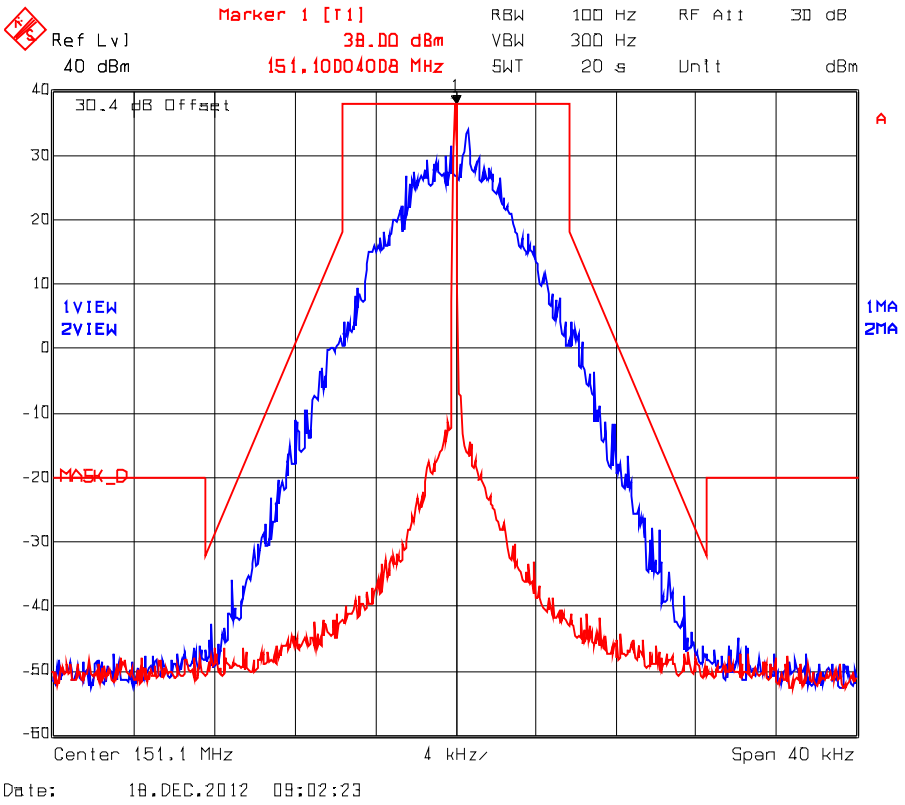
Plot # 33.: Emission Mask D

Carrier Frequency: 173.8 MHz
Channel Spacing: 12.5 kHz
Power: 1 W
Modulation: Digital C4FM



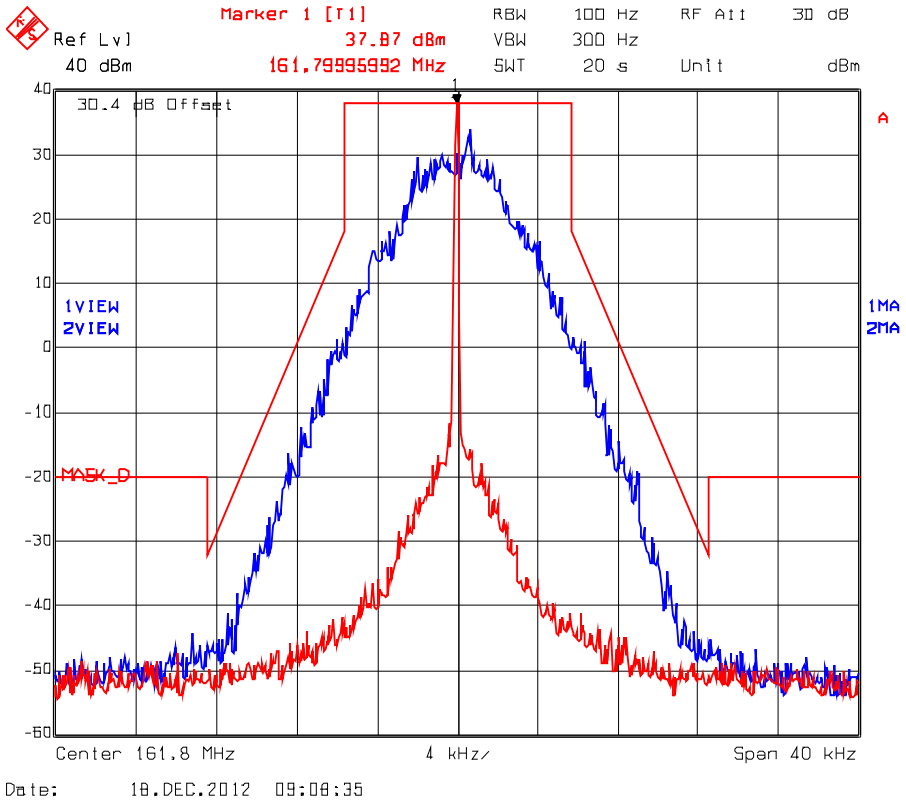
Plot # 34.: Emission Mask D

Carrier Frequency: 151.1 MHz
Channel Spacing: 12.5 kHz
Power: 6 W
Modulation: Digital CQPSK



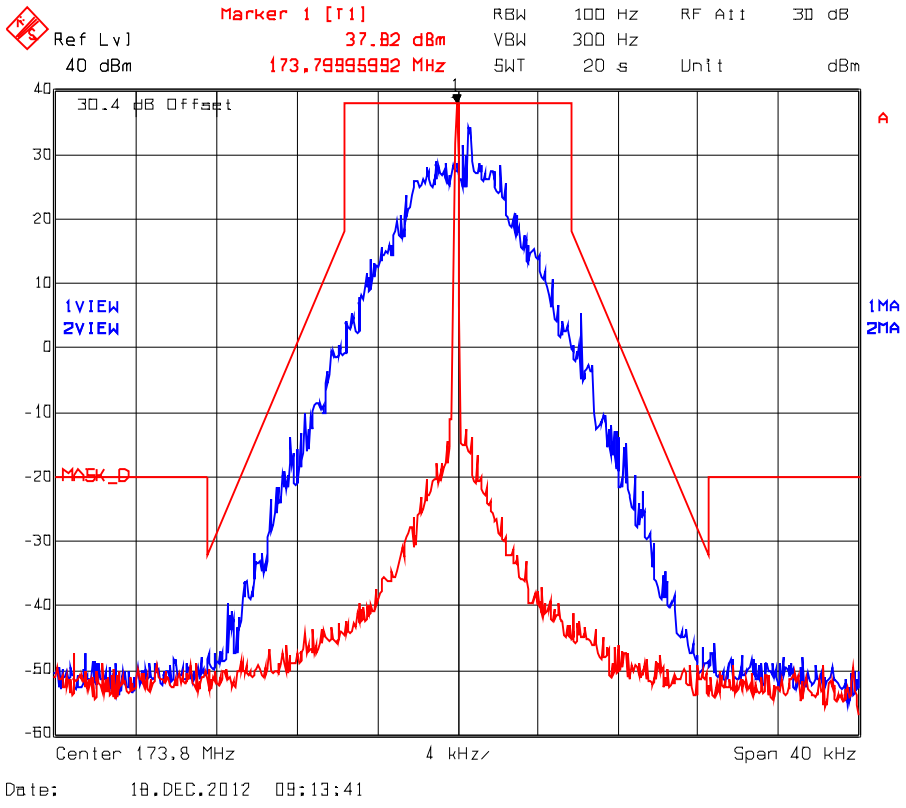
Plot # 35.: Emission Mask D

Carrier Frequency: 161.8 MHz
Channel Spacing: 12.5 kHz
Power: 6 W
Modulation: Digital CQPSK



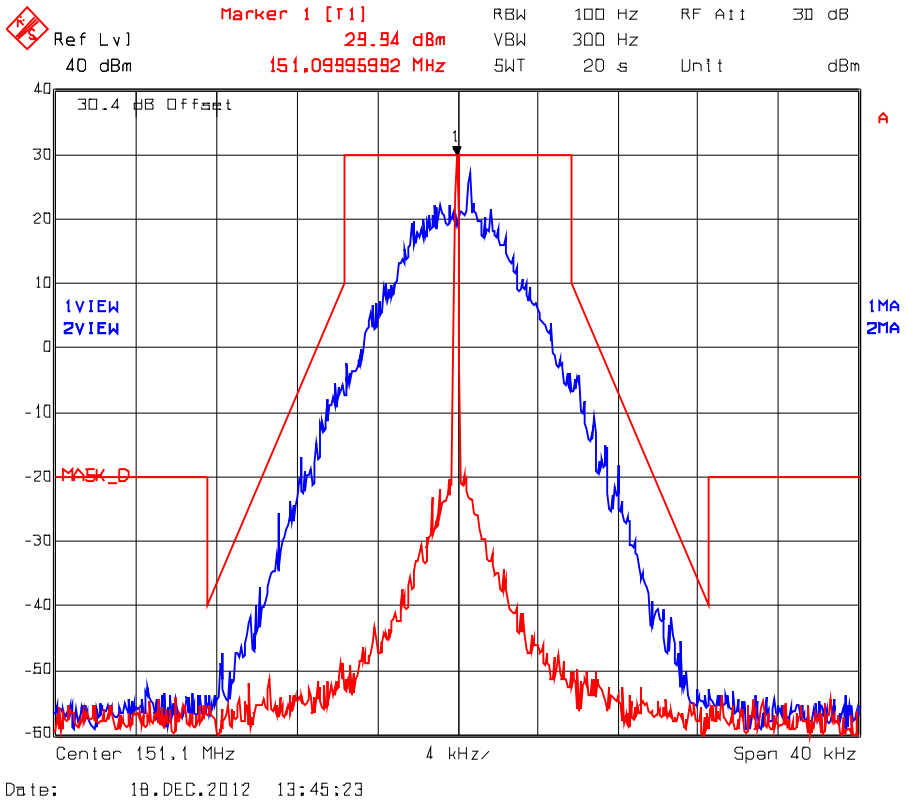
Plot # 36.: Emission Mask D

Carrier Frequency: 173.8 MHz
Channel Spacing: 12.5 kHz
Power: 6 W
Modulation: Digital CQPSK



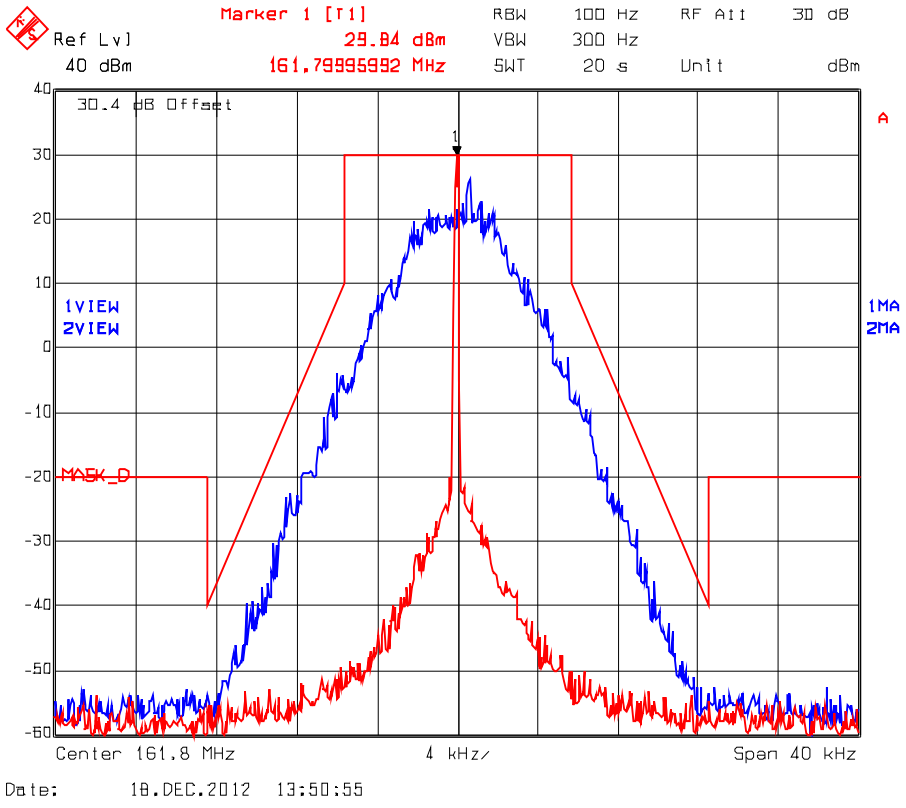
Plot # 37.: Emission Mask D

Carrier Frequency: 151.1 MHz
Channel Spacing: 12.5 kHz
Power: 1 W
Modulation: Digital CQPSK



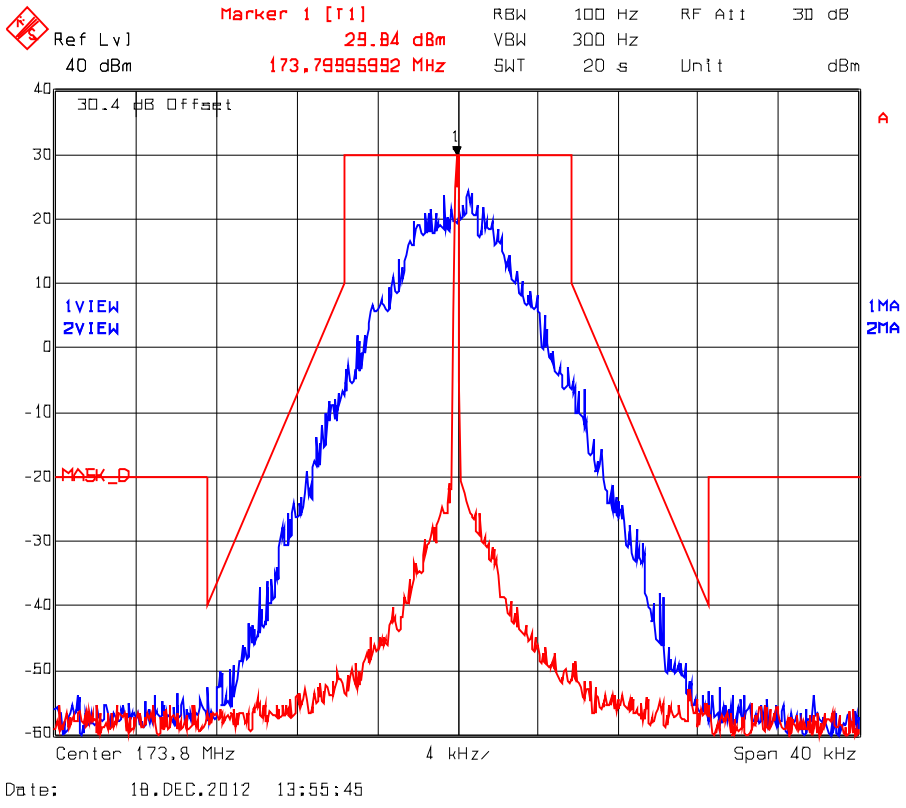
Plot # 38.: Emission Mask D

Carrier Frequency: 161.8 MHz
Channel Spacing: 12.5 kHz
Power: 1 W
Modulation: Digital CQPSK



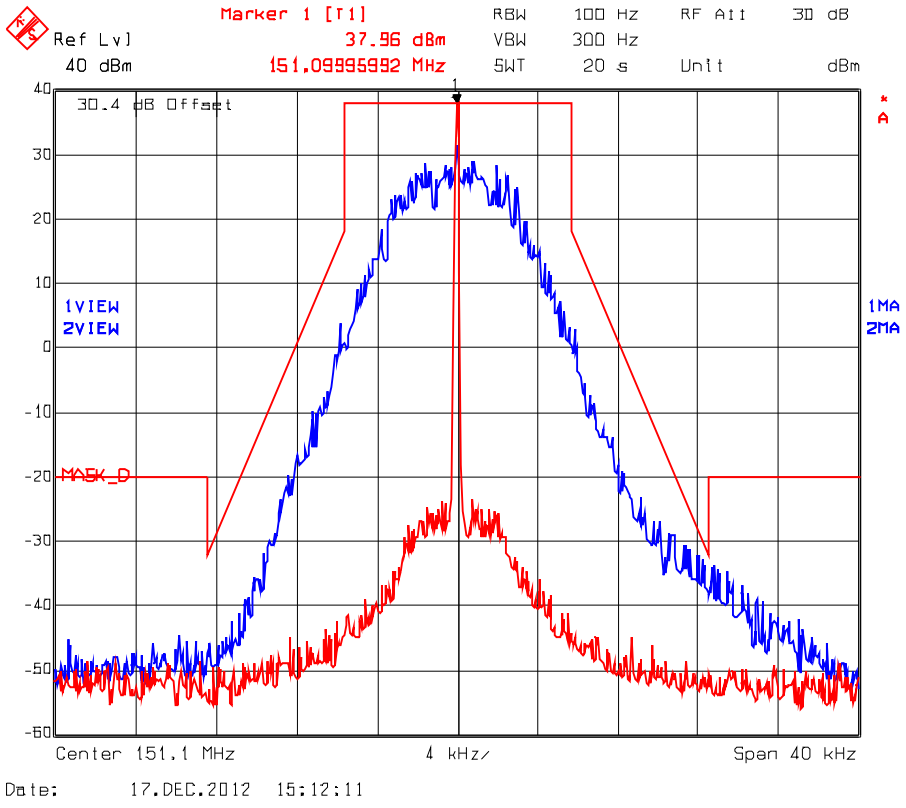
Plot # 39.: Emission Mask D

Carrier Frequency: 173.8 MHz
Channel Spacing: 12.5 kHz
Power: 1 W
Modulation: Digital CQPSK



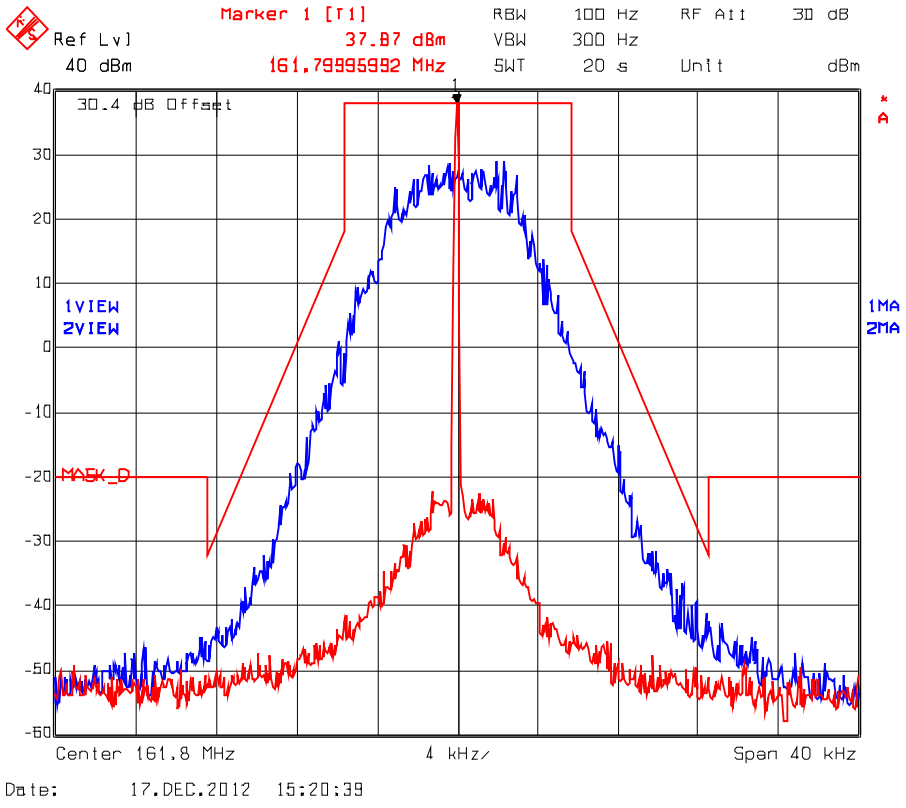
Plot # 40.: Emission Mask D

Carrier Frequency: 151.1 MHz
Channel Spacing: 12.5 kHz
Power: 6 W
Modulation: 2 slot TDMA



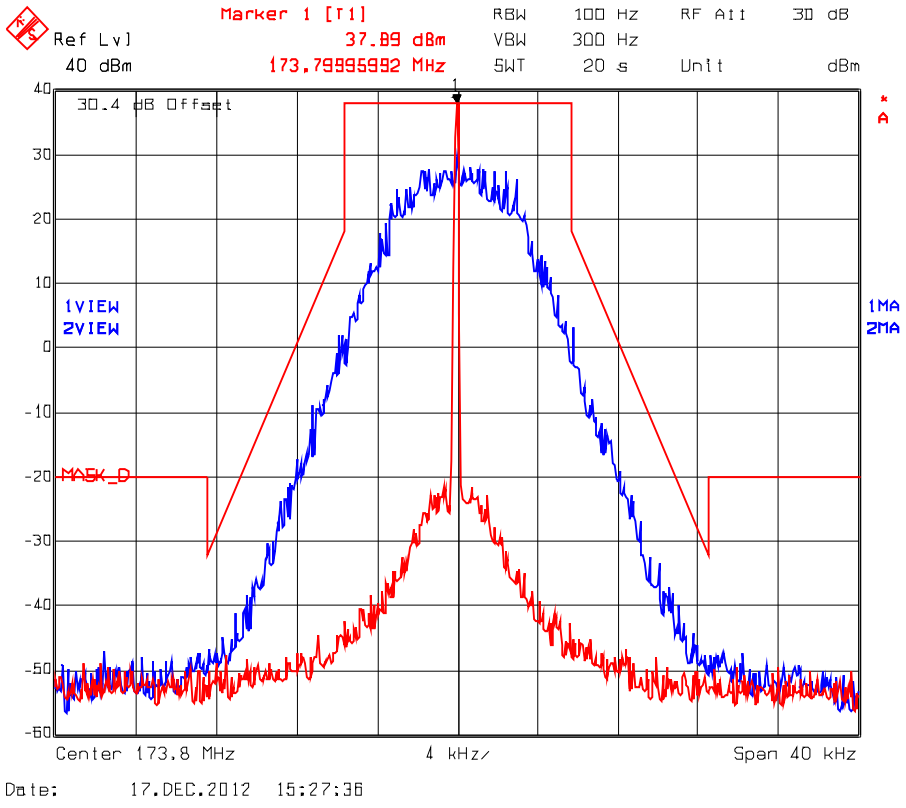
Plot # 41.: Emission Mask D

Carrier Frequency: 161.8 MHz
Channel Spacing: 12.5 kHz
Power: 6 W
Modulation: 2 slot TDMA



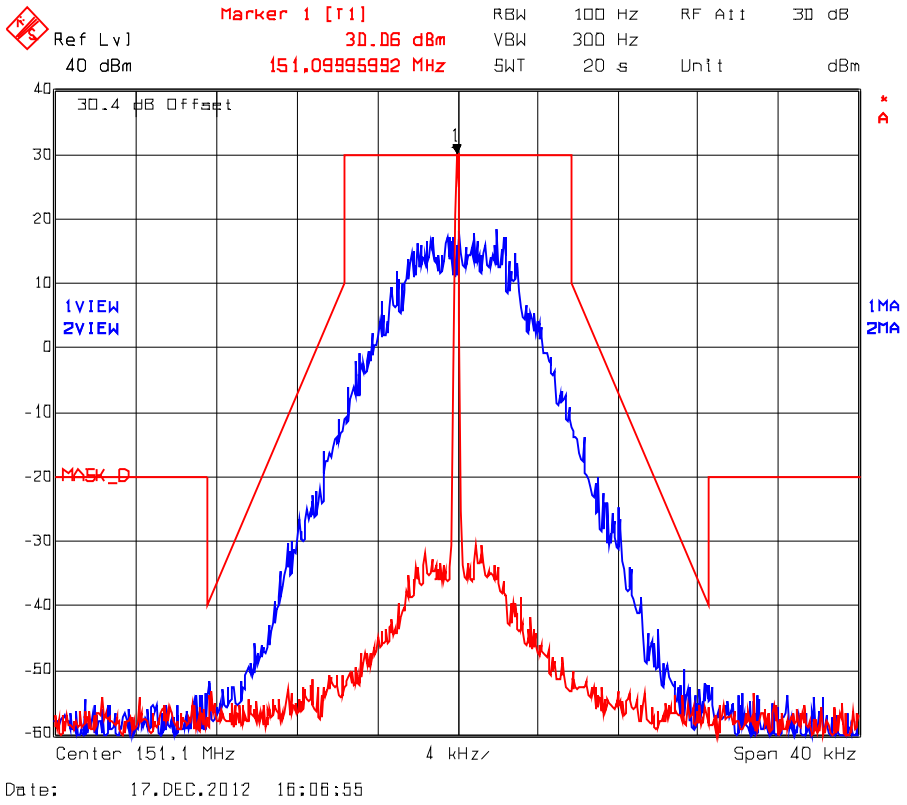
Plot # 42.: Emission Mask D

Carrier Frequency: 173.8 MHz
Channel Spacing: 12.5 kHz
Power: 6 W
Modulation: 2 slot TDMA



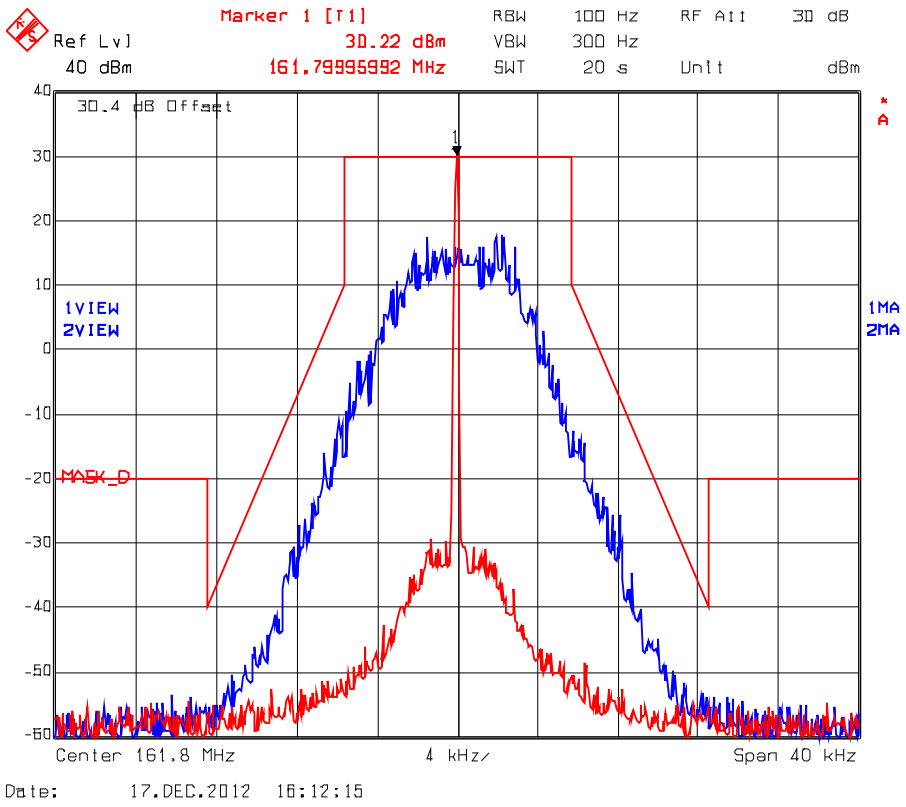
Plot # 43.: Emission Mask D

Carrier Frequency: 151.1 MHz
Channel Spacing: 12.5 kHz
Power: 1 W
Modulation: 2 slot TDMA



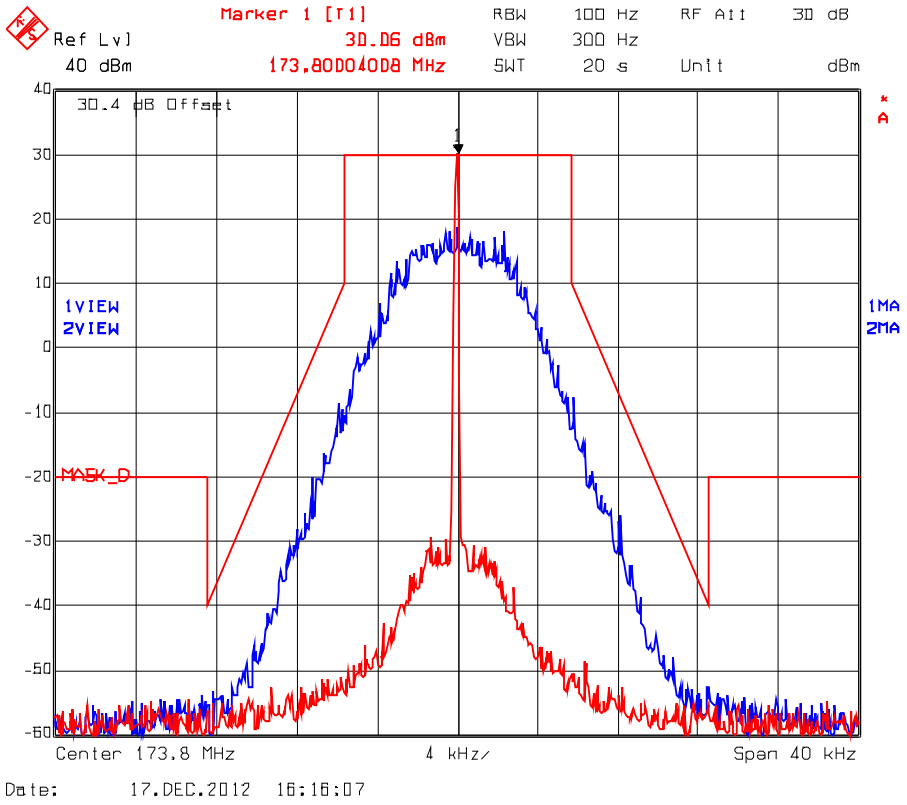
Plot # 44.: Emission Mask D

Carrier Frequency: 161.8 MHz
Channel Spacing: 12.5 kHz
Power: 1 W
Modulation: 2 slot TDMA



Plot # 45.: Emission Mask D

Carrier Frequency: 173.8 MHz
Channel Spacing: 12.5 kHz
Power: 1 W
Modulation: 2 slot TDMA



5.5. TRANSMITTER ANTENNA POWER SPURIOUS/HARMONIC CONDUCTED EMISSIONS [§2.1051, 2.1057, 80.211(f) & 90.210]

5.5.1. Limits

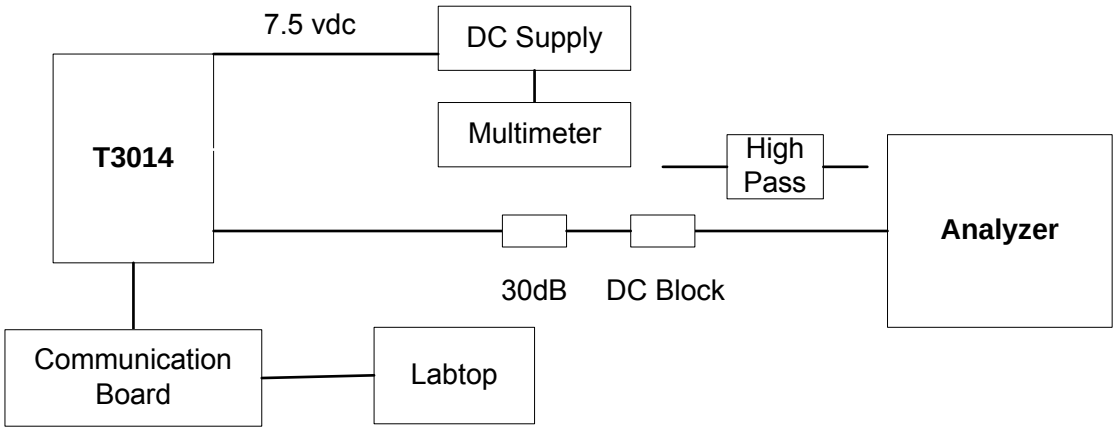
Emissions shall be attenuated below the mean output power of the transmitter as follows:

FCC Rules	Frequency Range	Attenuation Limit (dBc)
§ 90.210(b)	10 MHz to Lowest frequency of the radio to 10th harmonic of the highest frequency of the radio	At least 43 + 10 log(P) or -13 dBm
§ 90.210(d)	10 MHz to Lowest frequency of the radio to 10th harmonic of the highest frequency of the radio	At least 50 + 10 log (P) dB or 70 dB, whichever is the lesser attenuation.

5.5.2. Method of Measurements

Refer to Section **Error! Reference source not found.** of this report for measurement details

5.5.3. Test Arrangement



5.5.4. Test Equipment List

Refer to Exhibit 6.

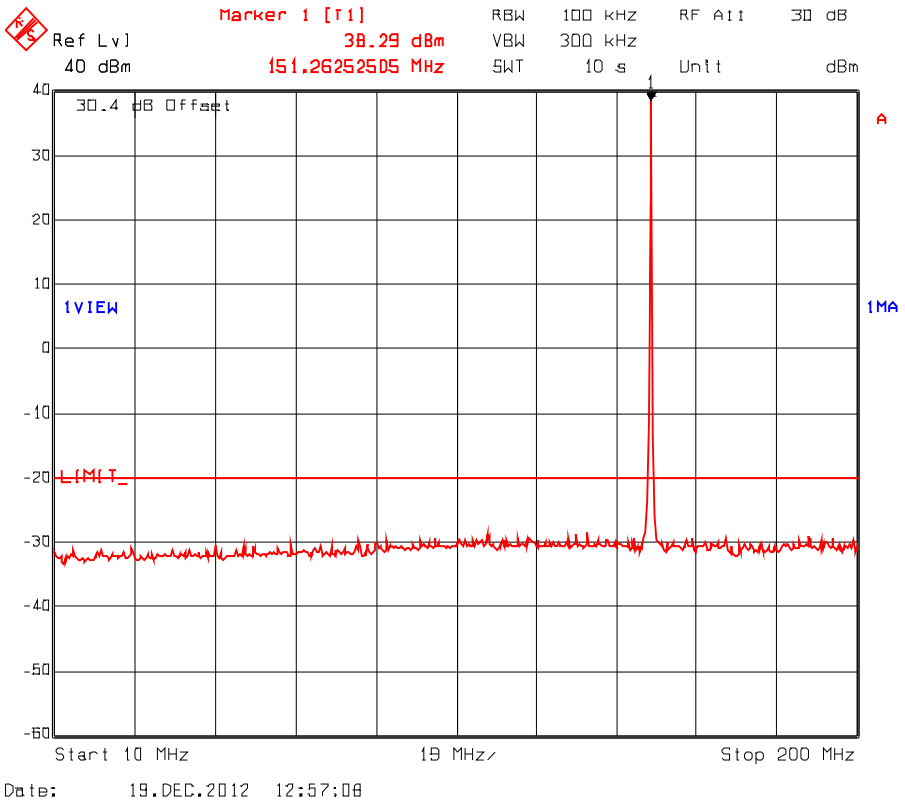
5.5.5. Test Data (VHF Band)

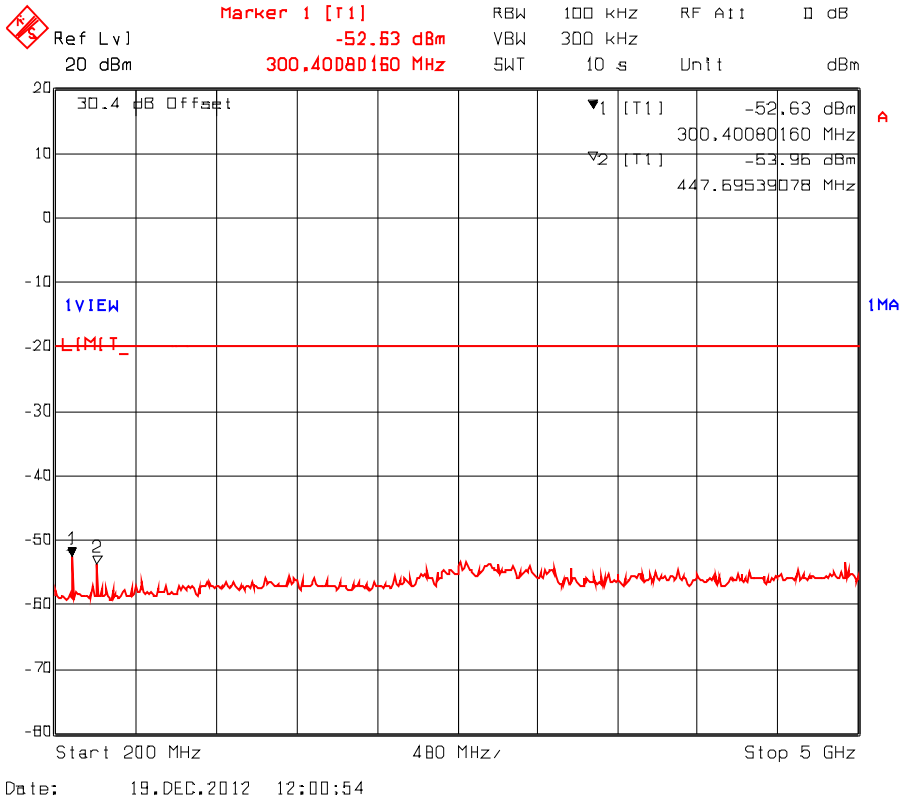
Note: There was no difference in spurious/harmonic emissions on the pre-scans for different channel spacing and modulation types. Therefore, the RF spurious/harmonic emissions in this section would be performed for 12.5 kHz channel spacing and the more stringent limit of 50 + 10*log(P) would be applied for worst case.

5.5.5.1. Near Lowest Frequency (151.1 MHz)

Plot # 46.: Spurious Emissions at Antenna Port

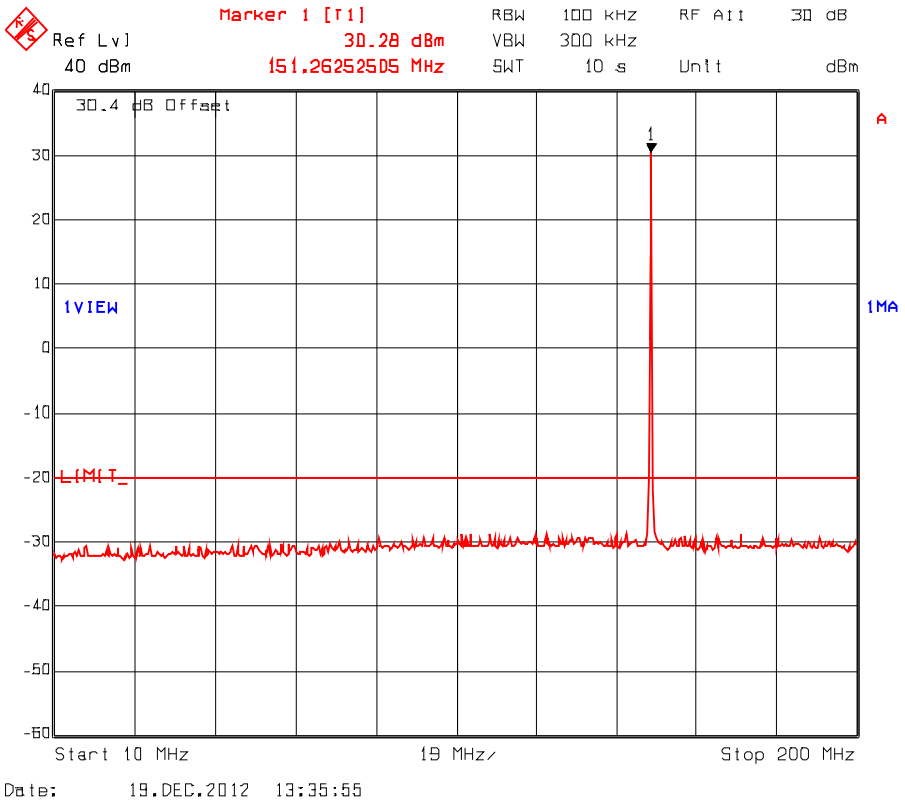
Carrier Frequency: 151.1 MHz
Channel Spacing: 12.5 KHz; Power: 6 W

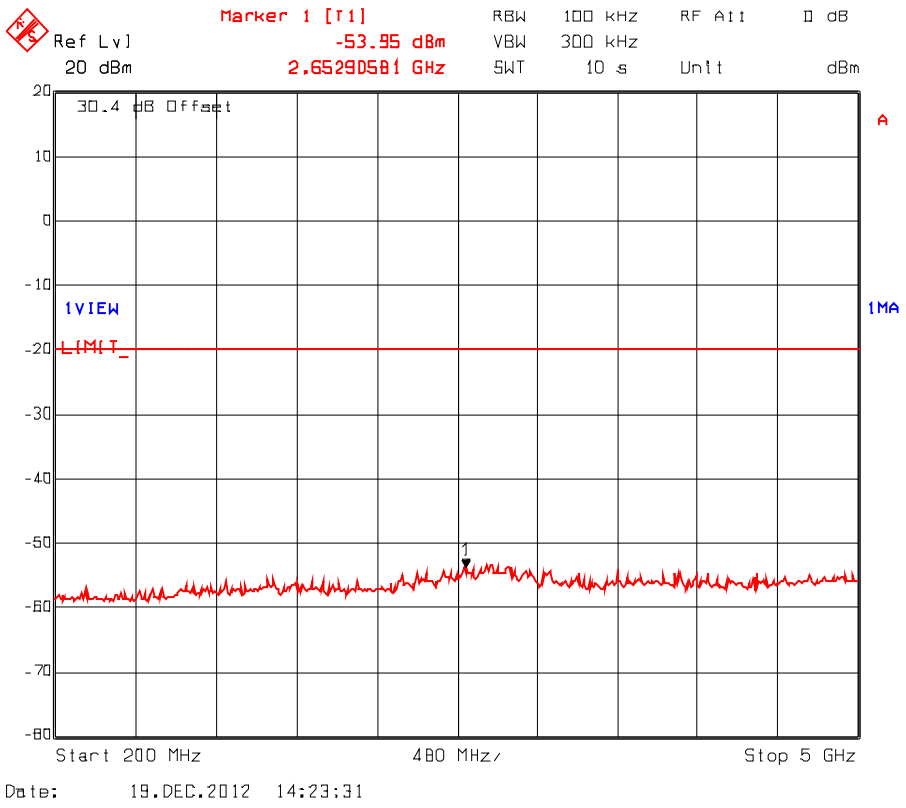



Marker 1 [T1]
-52.63 dBm
300.40080160 MHz
RBW 100 kHz
VBW 300 kHz
SWT 10 s
RF Att 0 dB
Unit dBm
Ref Lvl
20 dBm
30.4 dB Offset
1 [T1] -52.63 dBm
300.40080160 MHz
2 [T1] -53.96 dBm
447.69539078 MHz
A
1VIEW
LIMIT
1MA
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Start 200 MHz
480 MHz/
Stop 5 GHz
Date: 19.DEC.2012 12:00:54

Plot # 47.: Spurious Emissions at Antenna Port

Carrier Frequency: 151.1 MHz
Channel Spacing: 12.5 KHz; Power: 1 W

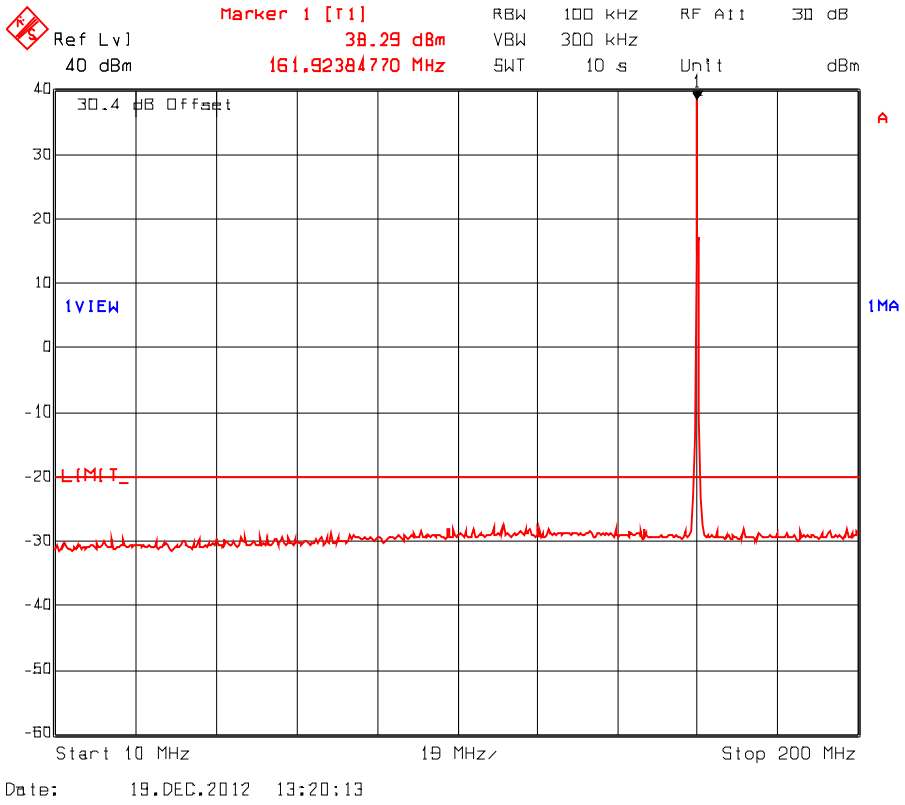


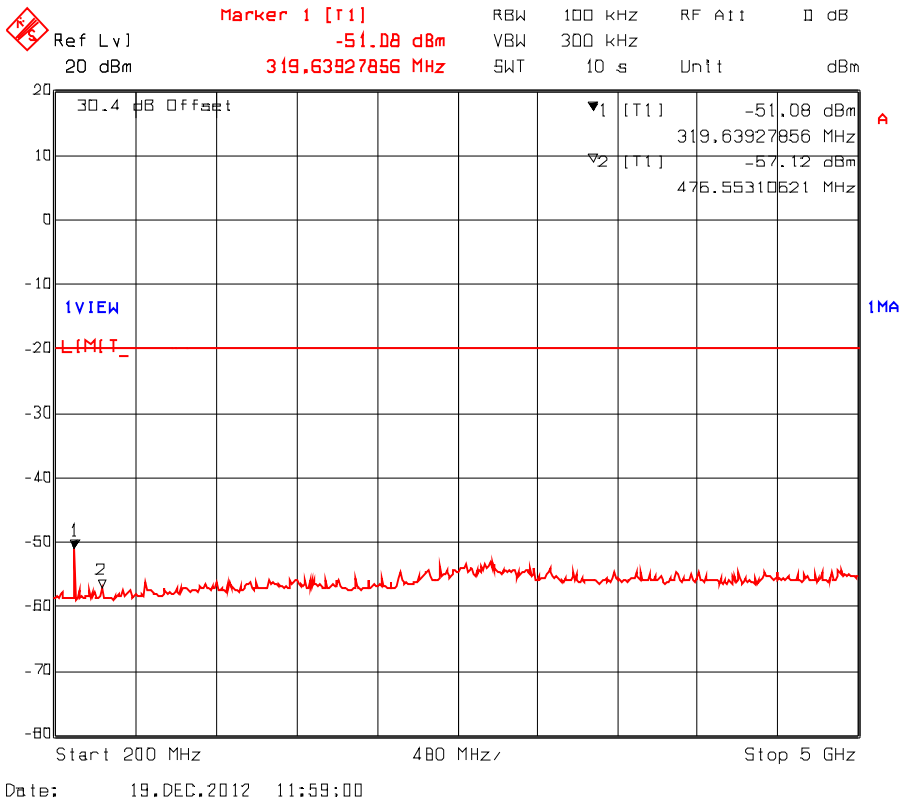

Marker 1 [T1]
-53.95 dBm
2.65290581 GHz
RBW 100 kHz
VBW 300 kHz
SWT 10 s
RF Att 0 dB
Unit dBm
Ref Lvl
20 dBm
30.4 dB Offset
VIEW
LIMIT
A
1MA
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Start 200 MHz
480 MHz/
Stop 5 GHz
Date: 19.DEC.2012 14:23:31

5.5.5.2. Near Middle Frequency (161.8 MHz)

Plot # 48.: Spurious Emissions at Antenna Port

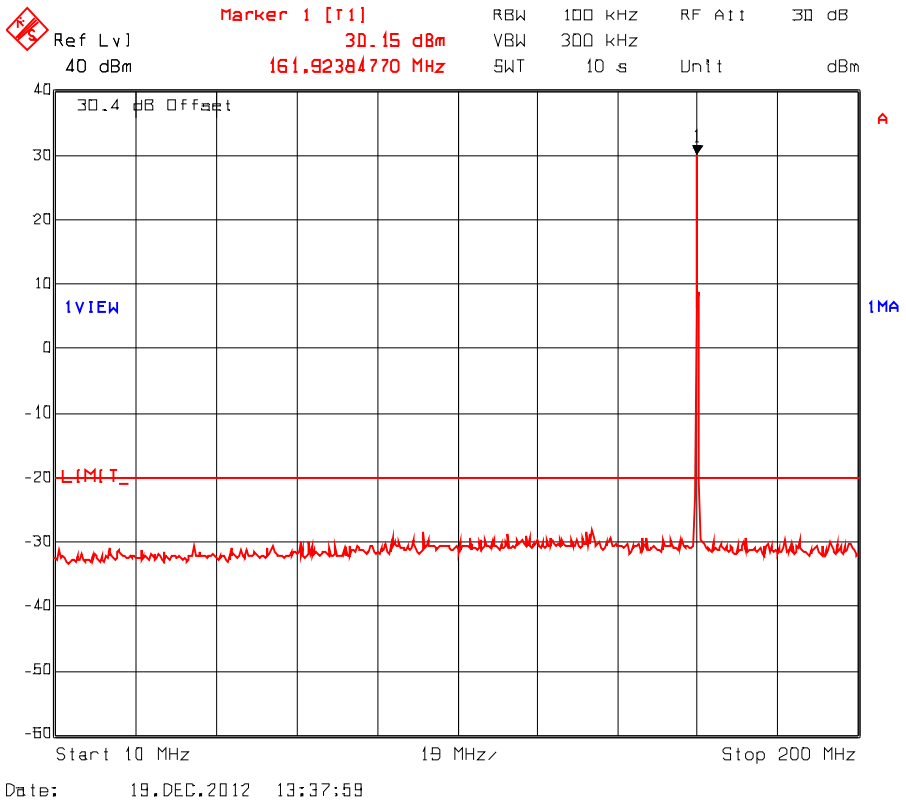
Carrier Frequency: 161.8 MHz
Channel Spacing: 12.5 KHz; Power: 6 W

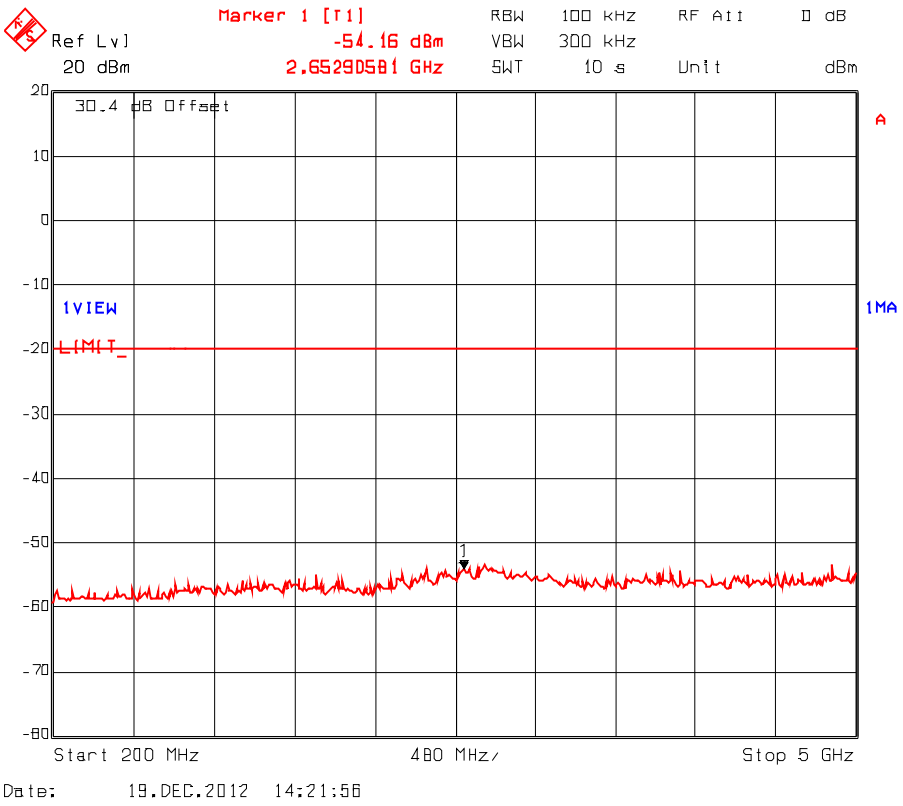



Marker 1 [T1]
RBW 100 kHz
RF Att 0 dB
Ref Lvl
-51.08 dBm
VBW 300 kHz
20 dBm
319.63927856 MHz
SWT 10 s
Unit dBm
30.4 dB Offset
1 [T1] -51.08 dBm
319.63927856 MHz
2 [T1] -57.12 dBm
476.55310621 MHz
A
1VIEW
LIMIT
1MA
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Start 200 MHz
480 MHz/
Stop 5 GHz
Date: 19.DEC.2012 11:59:00

Plot # 49.: Spurious Emissions at Antenna Port

Carrier Frequency: 161.8 MHz
Channel Spacing: 12.5 KHz; Power: 1 W

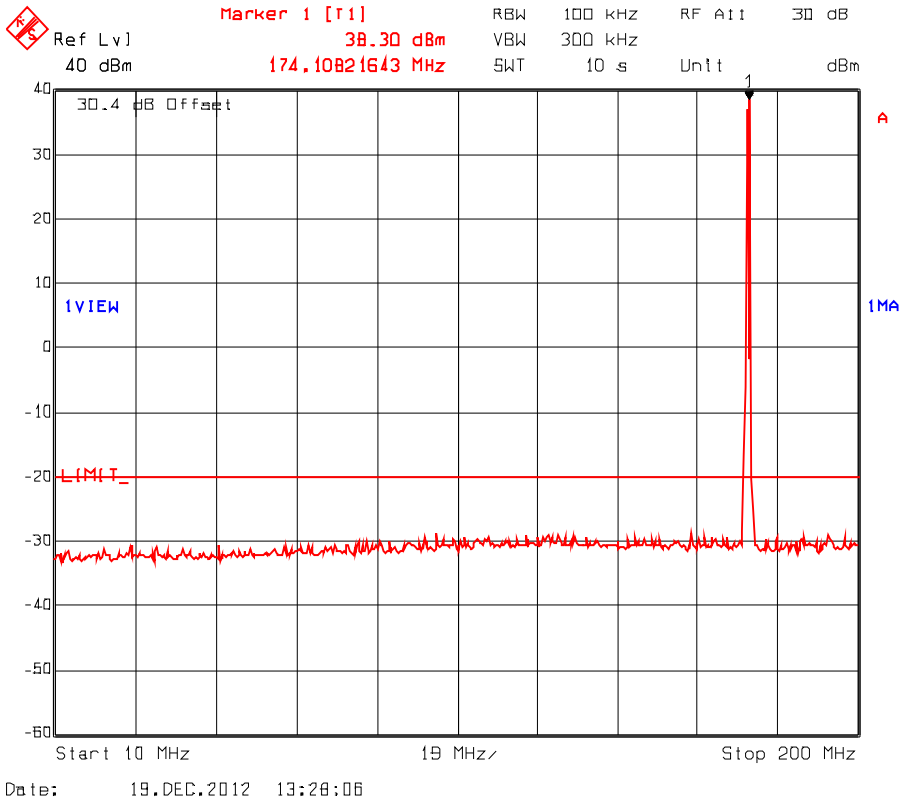


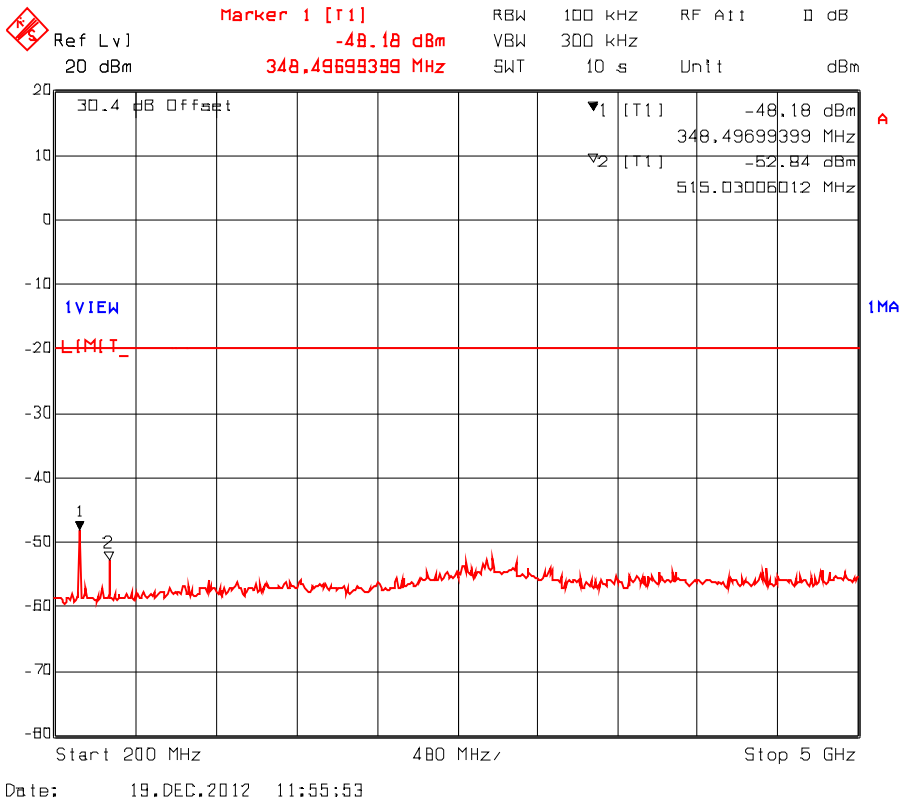

Marker 1 [T1]
-54.16 dBm
2.65290581 GHz
RBW 100 kHz
VBW 300 kHz
SWT 10 s
RF Att 0 dB
Unit dBm
Ref Lvl
20 dBm
30.4 dB Offset
VIEW
LIMIT
1MA
A
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Start 200 MHz
480 MHz/
Stop 5 GHz
Date: 19.DEC.2012 14:21:56

5.5.5.3. Near Highest Frequency (173.8 MHz)

Plot # 50.: Spurious Emissions at Antenna Port

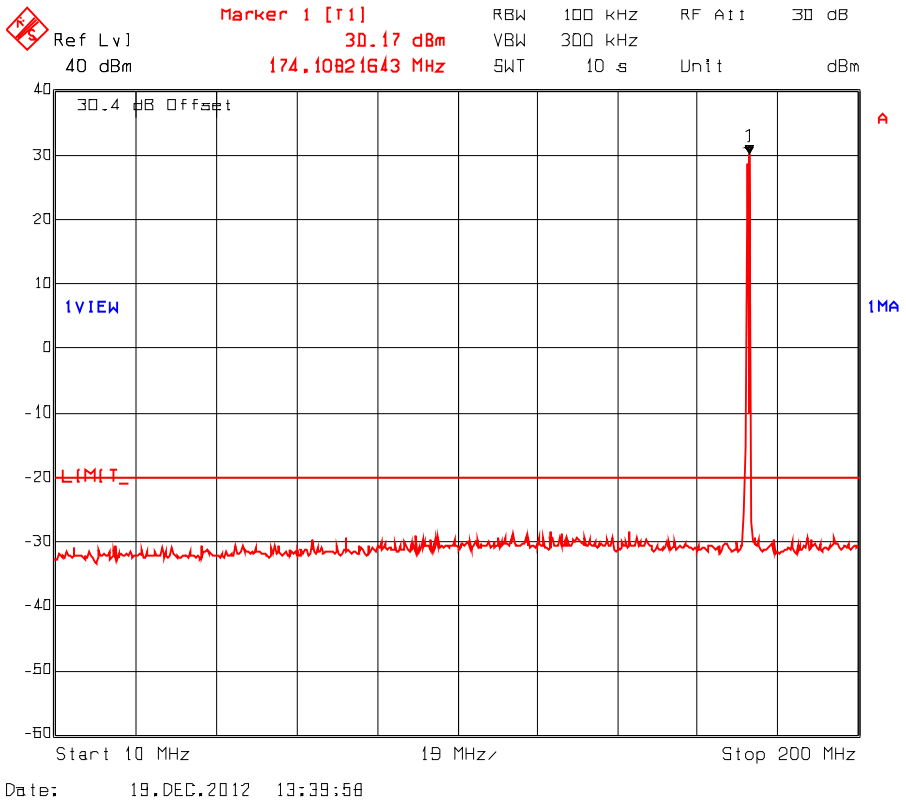
Carrier Frequency: 173.8 MHz
Channel Spacing: 12.5 KHz; Power: 6 W

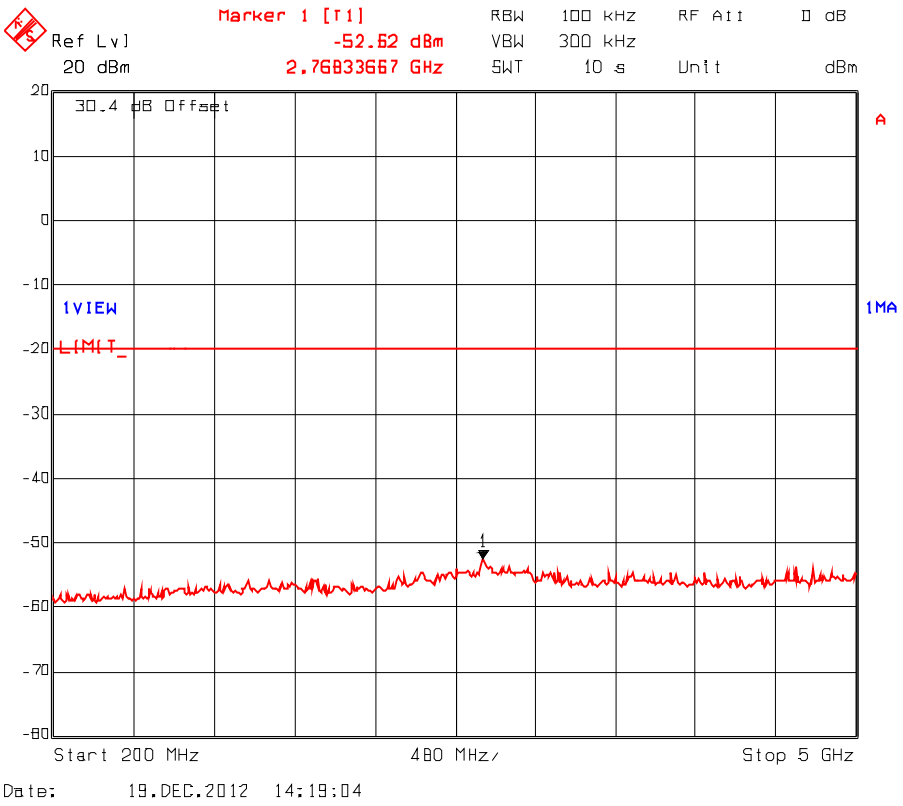



Marker 1 [T1]
-48.18 dBm
348.49699399 MHz
RBW 100 kHz
VBW 300 kHz
SWT 10 s
RF Att 0 dB
Unit dBm
Ref Lvl
20 dBm
30.4 dB Offset
1 [T1] -48.18 dBm
348.49699399 MHz
2 [T1] -52.84 dBm
515.03006012 MHz
1VIEW
LIMIT
1MA
A
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Start 200 MHz
480 MHz/
Stop 5 GHz
Date: 19.DEC.2012 11:55:53

Plot # 51.: Spurious Emissions at Antenna Port

Carrier Frequency: 173.8 MHz
Channel Spacing: 12.5 KHz; Power: 1 W




Marker 1 [T1]
-52.52 dBm
2.76833667 GHz
RBW 100 kHz
VBW 300 kHz
SWT 10 s
RF Att 0 dB
Unit dBm
Ref Lvl
20 dBm
30.4 dB Offset
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
VIEW
LIMIT
A
1MA
Start 200 MHz
480 MHz/
Stop 5 GHz
Date: 19.DEC.2012 14:19:04

5.6. TRANSMITTER SPURIOUS/HARMONIC RADIATED EMISSIONS [§§ 2.1053, 80.211 & 90.210]

5.6.1. Limits

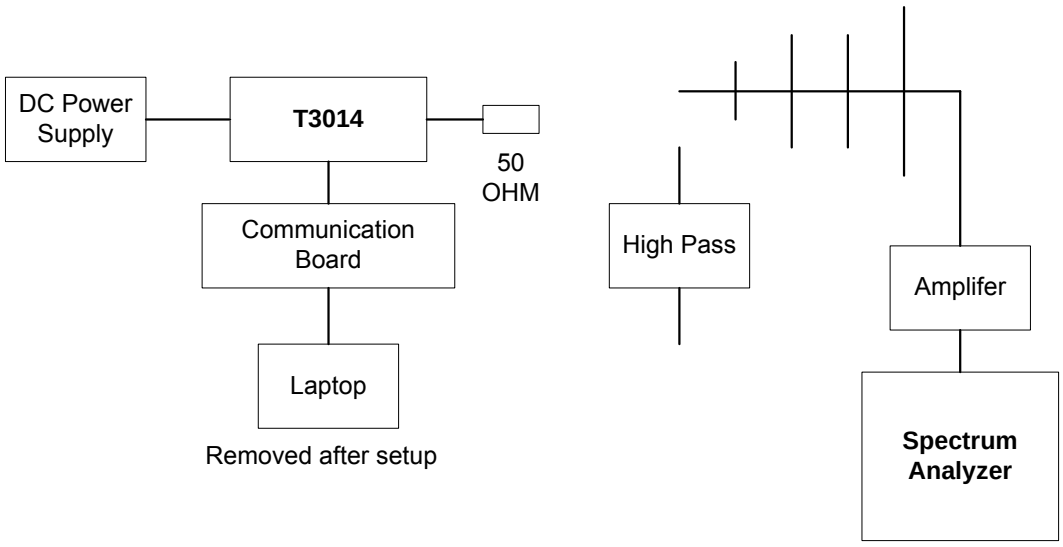
Emissions shall be attenuated below the mean output power of the transmitter as follows:

FCC Rules	Attenuation Limit (dBc)
§ 80.211(f)	At least 43 plus $10\log_{10}$ (mean power in watts) dB
§ 90.210(b)	At least 43 + 10 log (P) dB
§ 90.210(d)	At least 50 + 10 log (P) dB or 70 dB, whichever is the lesser attenuation.

5.6.2. Method of Measurements

See substitution test method specified in 8.2 of this report

5.6.3. Test Arrangement



5.6.4. Test Data

Remarks:

- The emissions were scanned from 30 MHz to 10th harmonics; all spurious emissions that are in excess of 20dB below the specified limit shall be recorded.
- Exploratory tests were conducted with modulations in the range of typical modes of operation to identify the worst-case modulation. There were no discernable differences detected. The high power setting was used to represents the worst-case test configuration for the final measurement.
- The more stringent limit will be applied for compliance.

VHF Band:

Test Frequency (MHz):	151.1					
Limit (dBm):	-20					
Frequency (MHz)	**E-Field (dBµV/m)**	**EMI Detector (Peak/QP)**	**Antenna Polarization (H/V)**	**ERP (dBm)**	**Limit (dBm)**	**Margin (dB)**
30 - 5000	*	Peak	H/V	*	-20	*

* All harmonics and spurious emissions are more than 20 dB below the specified attenuation limit.

Test Frequency (MHz):	161.8					
Limit (dBm):	-20					
Frequency (MHz)	**E-Field (dBµV/m)**	**EMI Detector (Peak/QP)**	**Antenna Polarization (H/V)**	**ERP (dBm)**	**Limit (dBm)**	**Margin (dB)**
30 - 5000	*	Peak	H/V	*	-20	*

* All harmonics and spurious emissions are more than 20 dB below the specified attenuation limit.

Test Frequency (MHz):	173.8					
Limit (dBm):	-20					
Frequency (MHz)	**E-Field (dBµV/m)**	**EMI Detector (Peak/QP)**	**Antenna Polarization (H/V)**	**ERP (dBm)**	**Limit (dBm)**	**Margin (dB)**
30 - 5000	*	Peak	H/V	*	-20	*

* All harmonics and spurious emissions are more than 20 dB below the specified attenuation limit.

UHF Band:

Test Frequency (MHz):	406.3					
Limit (dBm):	-20					
Frequency (MHz)	**E-Field (dBµV/m)**	**EMI Detector (Peak/QP)**	**Antenna Polarization (H/V)**	**ERP (dBm)**	**Limit (dBm)**	**Margin (dB)**
30 - 5000	*	Peak	H/V	*	-20	*

* All harmonics and spurious emissions are more than 20 dB below the specified attenuation limit.

Test Frequency (MHz):	450.1					
Limit (dBm):	-20					
Frequency (MHz)	**E-Field (dBµV/m)**	**EMI Detector (Peak/QP)**	**Antenna Polarization (H/V)**	**ERP (dBm)**	**Limit (dBm)**	**Margin (dB)**
30 - 5000	*	Peak	H/V	*	-20	*

* All harmonics and spurious emissions are more than 20 dB below the specified attenuation limit.

Test Frequency (MHz):	469.8					
Limit (dBm):	-20					
Frequency (MHz)	**E-Field (dBµV/m)**	**EMI Detector (Peak/QP)**	**Antenna Polarization (H/V)**	**ERP (dBm)**	**Limit (dBm)**	**Margin (dB)**
30 - 5000	*	Peak	H/V	*	-20	*

* All harmonics and spurious emissions are more than 20 dB below the specified attenuation limit.

5.7. FREQUECNY STABILITY [§§ 2.1055, 80.209 & 90.213]

5.7.1. Limits

§ 80.209 (a) The frequency tolerance requirements applicable to transmitters in the maritime services are shown in the following table. Tolerances are given as parts in 10^6 unless shown in Hz.

Frequency bands and categories of stations	Tolerances [1]
Band 156-162 MHz:	
(i) Coast stations:	
For carriers licensed to operate with a carrier power:	
Below 3 watts	10
3 to 100 watts	5 [3]
(ii) Ship stations	10 [2]
Band 400-466 MHz:	
(i) On-board stations	5
(ii) Radiolocation and telecommand stations.	5

[1] Transmitters authorized prior to January 2, 1990, with frequency tolerances equal to or better than those required after this date will continue to be authorized in the maritime services provided they retain approval and comply with the applicable standards in this part.
[2] For transmitters in the radiolocation and associated telecommand service operating on 154.584 MHz, 159.480 MHz, 160.725 MHz and 160.785 MHz the frequency tolerance is 15 parts in 10^6.
[3] For transmitters operated at private coast stations with antenna heights less than 6 meters (20 feet) above ground and output power of 25 watts or less the frequency tolerance is 10 parts in 10^6.

See § 90.213

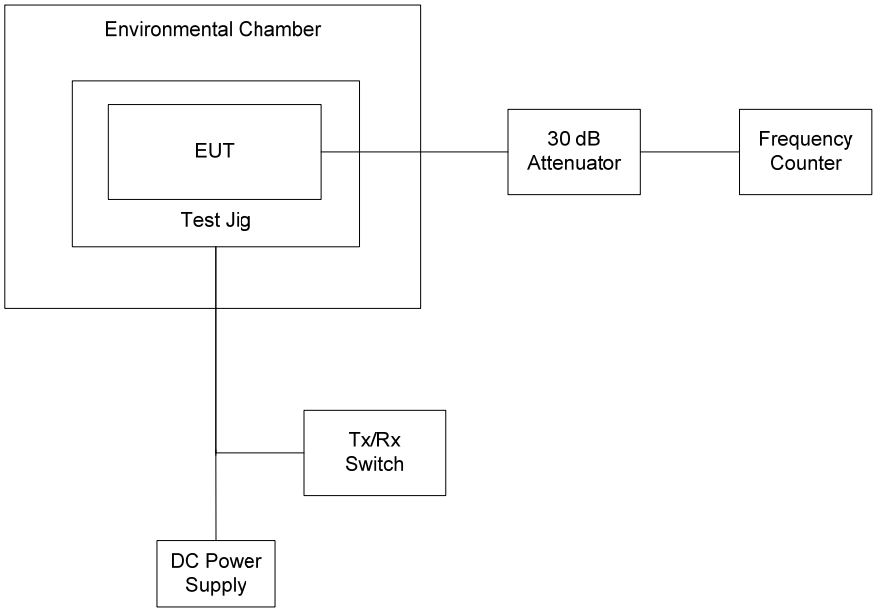
Frequency Band	Minimum Frequency Stability (ppm)		
	Fixed and Base Stations	Mobile Stations	
		> 2 W	≤ 2 W
150–174 MHz	[2,6]5	[3]5	[1,3]50
421–512 MHz	[4,6,7]2 .5	[5]5	[5]5

[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] In the 421–512 MHz band, fixed and base stations with a 12.5 kHz channel bandwidth must have a frequency stability of 1.5 ppm. Fixed and base stations with a 6.25 kHz channel bandwidth must have a frequency stability of 0.5 ppm.
[5] In the 421–512 MHz band, mobile stations designed to operate with a 12.5 kHz channel bandwidth must have a frequency stability of 2.5 ppm. Mobile stations designed to operate with a 6.25 kHz channel bandwidth must have a frequency stability of 1.0 ppm.
[6] Paging transmitters operating on paging-only frequencies must operate with frequency stability of 5 ppm in the 150–174
[7] Control stations may operate with the frequency tolerance specified for associated mobile frequencies.

5.7.2. Method of Measurements

Refer to Section 8.3 of this report for measurement details

5.7.3. Test Arrangement



5.7.4. Test Data

Center Frequency:	151.1 MHz
Full Power Level:	38.43 dBm
Frequency Tolerance Limit (Worst Case):	±2.5 ppm or 378 Hz
Max. Frequency Tolerance Measured:	-59 Hz or -0.4 ppm
Input Voltage Rating:	7.5 VDC

Ambient Temperature (°C)	**Frequency Drift (Hz)**		
	Supply Voltage (Nominal) 7.5 VDC	**Supply Voltage (85% of Nominal) 6.375 VDC**	**Supply Voltage (115% of Nominal) 8.625 VDC**
-30	-48	--	--
-20	-53	--	--
-10	-37	--	--
0	-42	--	--
10	-46	--	--
20	-55	-59	-57
30	-58	--	--
40	-40		
50	-58	--	--
60	-56	--	--

Center Frequency:	406.3 MHz
Full Power Level:	37.40 dBm
Frequency Tolerance Limit (Worst Case):	±1.5 ppm or 609 Hz
Max. Frequency Tolerance Measured:	-41 Hz or -0.1 ppm
Input Voltage Rating:	7.5 VDC

Ambient Temperature (°C)	**Frequency Drift (Hz)**		
	Supply Voltage (Nominal) 7.5 VDC	**Supply Voltage (85% of Nominal) 6.375 VDC**	**Supply Voltage (115% of Nominal) 8.625 VDC**
-30	-24	--	--
-20	-32	--	--
-10	09	--	--
0	-23	--	--
10	-09	--	--
20	-41	-41	-40
30	-20	--	--
40	+35		
50	-30	--	--
60	-39	--	--

5.8. EXPOSURE OF HUMANS TO RF FIELD [[§§ 1.1310 & 2.1091]

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

FCC 47 CFR § 1.1310:

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

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

f = frequency in MHz
* = Plane-wave equivalent power density

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

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

5.8.1. Method of Measurements

See RSS-102 & FCC 47 CFR §§ 1.1310, 2.1091

In order to demonstrate compliance with MPE requirements, 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

5.8.2. RF Evaluation

Evaluation of RF Exposure Compliance Requirements	
RF Exposure Requirements	**Compliance with FCC Rules**
*Minimum calculated separation distance between antenna and persons required: **74.5 cm**	Manufacturer' instruction for separation distance of **80 cm** between antenna and persons required: See the user's manual for information.
Antenna installation and device operating instructions for installers (professional/unskilled users), and the parties responsible for ensuring compliance with the RF exposure requirement	Antenna installation and device operating instructions shall be provided to installers to maintain and ensure compliance with RF exposure requirements.
Caution statements and/or warning labels that are necessary in order to comply with the exposure limits	Refer to User's Manual for RF Exposure Information.
Any other RF exposure related issues that may affect MPE compliance	None.

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

RF EXPOSURE DISTANCE LIMITS

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

S = 0.2 mW/cm^2 (General Population/Uncontrolled Exposure)

EIRP = 38.43 dBm + 3dBi Antenna Gain = 41.43 dBm = $10^{41.43/10}$ mW = 13900 mW (Worst Case)

(Minimum Safe Distance, r) = $\sqrt{\frac{EIRP}{4 \cdot \pi \cdot S}} = \sqrt{\frac{13900}{4 \cdot \pi \cdot (0.2)}} \approx 74.5cm$

5.9. POWER LINE CONDUCTED EMISSIONS [§ 15.107(a)]

5.9.1. Limits

The equipment shall meet the limits of the following table:

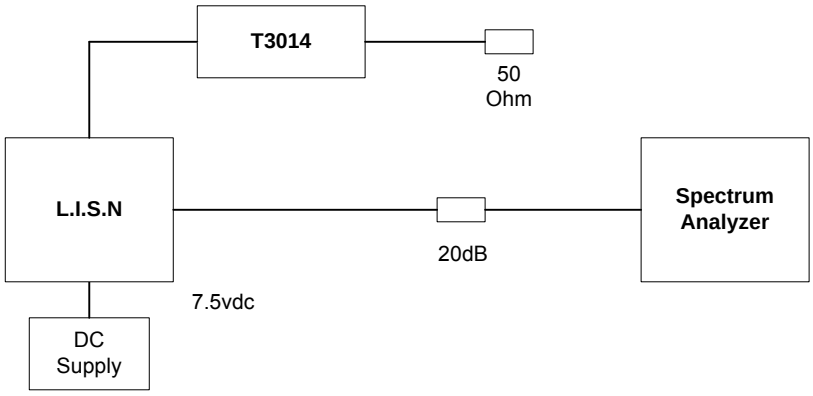
Frequency of emission (MHz)	Conducted Limits (dBμV)	
	Quasi-peak	Average
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

*Decreases with the logarithm of the frequency.

5.9.1.1. Method of Measurements

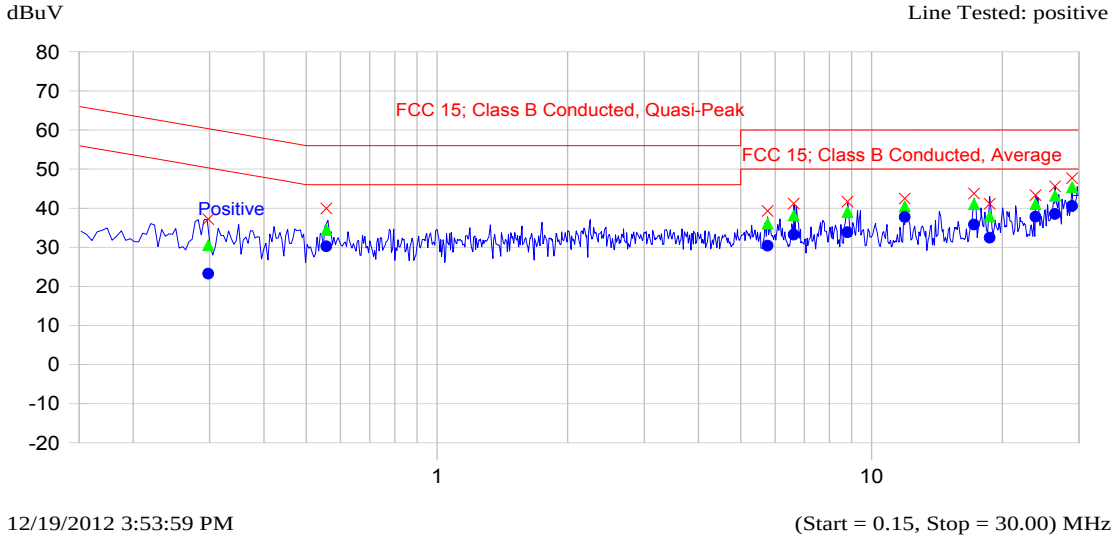
Refer to Ultratech Test Procedures ULTR-P001-2004 & ANSI C63.4-2009 for method of measurements.

5.9.2. Test Arrangement



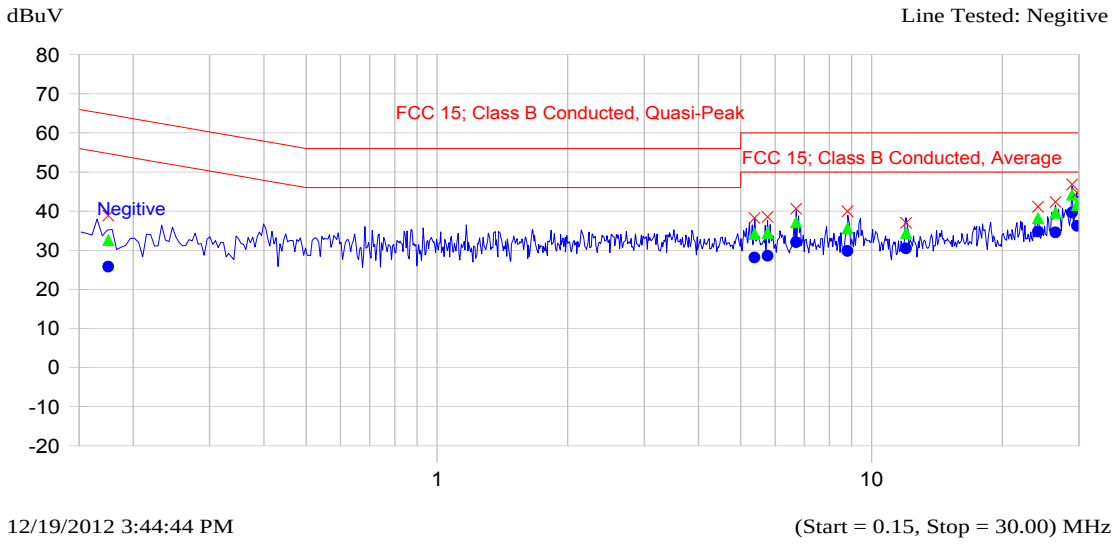
5.9.3. Test Data

Plot 5.9.3.1. Power Line Conducted Emissions (Tx Mode)
Line Voltage: 7.5 VDC; Line Tested: Positive



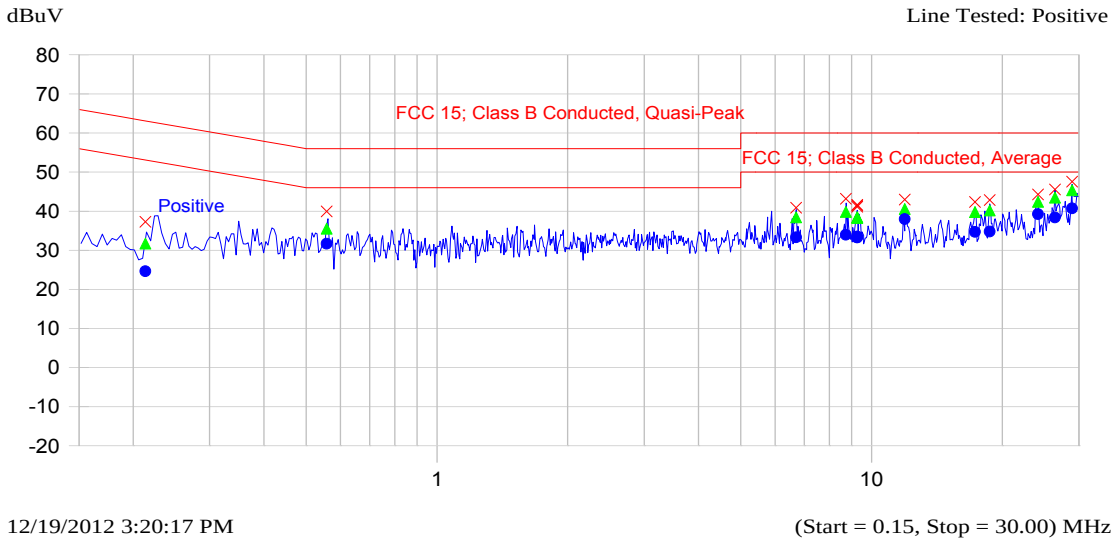
Frequency MHz	Peak dBuV	QP dBuV	Delta QP-QP Limit dB	Avg dBuV	Delta Avg-Avg Limit dB	Trace Name
0.298	37.2	30.5	-31.2	23.2	-28.5	Positive
0.556	39.9	34.4	-21.6	30.2	-15.8	Positive
5.768	39.3	36.0	-24.0	30.4	-19.6	Positive
6.625	41.2	38.1	-21.9	33.2	-16.8	Positive
8.803	41.6	39.0	-21.0	33.9	-16.1	Positive
11.922	42.5	40.4	-19.6	37.7	-12.3	Positive
17.219	43.8	41.0	-19.0	35.8	-14.2	Positive
18.696	41.1	37.9	-22.1	32.4	-17.6	Positive
23.844	43.3	41.0	-19.0	37.8	-12.2	Positive
26.417	45.6	43.2	-16.8	38.5	-11.5	Positive
28.907	47.7	45.4	-14.6	40.5	-9.5	Positive

Plot 5.9.3.2. Power Line Conducted Emissions (Tx Mode)
Line Voltage: 7.5 VDC; Line Tested: Negative



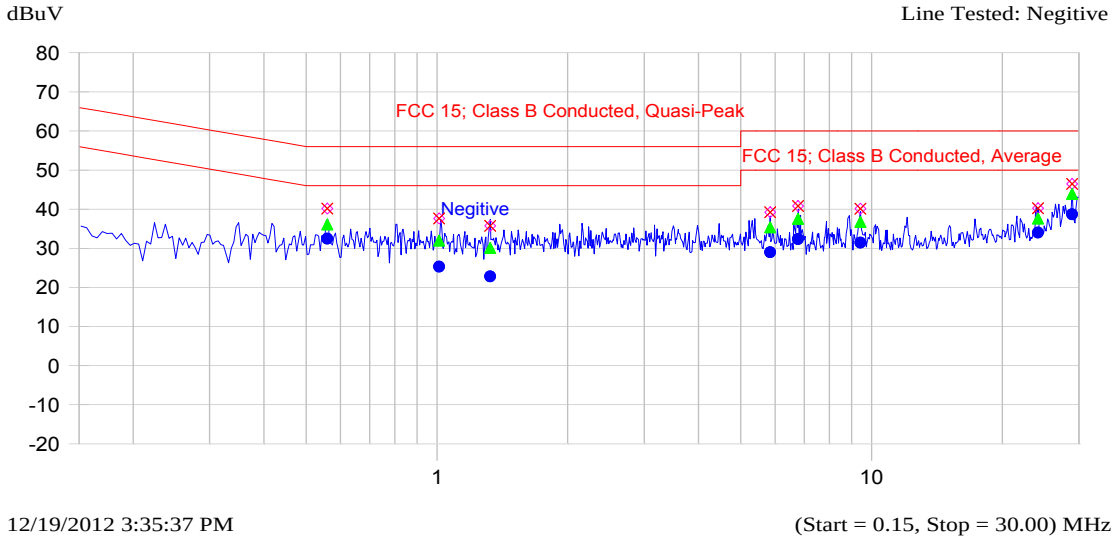
Frequency MHz	Peak dBuV	QP dBuV	Delta QP-QP Limit dB	Avg dBuV	Delta Avg-Avg Limit dB	Trace Name
0.175	38.9	32.6	-32.7	25.8	-29.5	Negitive
5.377	38.2	34.2	-25.8	28.1	-21.9	Negitive
5.765	38.5	34.4	-25.6	28.6	-21.4	Negitive
6.699	40.6	37.1	-22.9	32.1	-17.9	Negitive
8.807	40.0	35.6	-24.4	29.8	-20.2	Negitive
11.996	37.0	34.4	-25.6	30.5	-19.5	Negitive
24.152	41.1	38.2	-21.8	34.7	-15.3	Negitive
26.493	42.3	39.6	-20.4	34.6	-15.4	Negitive
28.906	46.8	44.2	-15.8	39.6	-10.4	Negitive
29.683	44.7	41.6	-18.4	36.3	-13.7	Negitive

Plot 5.9.3.3. Power Line Conducted Emissions (Rx Mode)
Line Voltage: 7.5 VDC; Line Tested: Positive



Frequency MHz	Peak dBuV	QP dBuV	Delta QP-QP Limit dB	Avg dBuV	Delta Avg-Avg Limit dB	Trace Name
0.214	37.2	31.7	-32.5	24.6	-29.5	Positive
0.558	39.9	35.5	-20.5	31.7	-14.3	Positive
6.703	40.9	38.4	-21.6	33.3	-16.7	Positive
8.727	43.2	39.8	-20.2	34.0	-16.0	Positive
9.271	41.1	38.3	-21.7	33.3	-16.7	Positive
9.274	41.4	38.3	-21.7	33.5	-16.5	Positive
9.272	41.6	38.5	-21.5	33.3	-16.7	Positive
11.922	43.0	40.6	-19.4	38.0	-12.0	Positive
17.298	42.4	39.8	-20.2	34.7	-15.3	Positive
18.702	42.8	40.2	-19.8	34.8	-15.2	Positive
24.154	44.3	42.4	-17.6	39.2	-10.8	Positive
26.415	45.5	43.5	-16.5	38.4	-11.6	Positive
28.908	47.5	45.4	-14.6	40.7	-9.3	Positive

Plot 5.9.3.4. Power Line Conducted Emissions (Rx Mode)
Line Voltage: 7.5 VDC; Line Tested: Negative



Frequency MHz	Peak dBuV	QP dBuV	Delta QP-QP Limit dB	Avg dBuV	Delta Avg-Avg Limit dB	Trace Name
0.559	40.2	36.1	-19.9	32.4	-13.6	Negitive
1.011	37.6	32.0	-24.0	25.3	-20.7	Negitive
1.326	35.7	30.1	-25.9	22.8	-23.2	Negitive
5.846	39.2	35.4	-24.6	29.0	-21.0	Negitive
6.779	40.8	37.5	-22.5	32.4	-17.6	Negitive
9.428	40.1	36.8	-23.2	31.4	-18.6	Negitive
24.155	40.2	37.6	-22.4	34.0	-16.0	Negitive
28.910	46.4	43.9	-16.1	38.7	-11.3	Negitive

EXHIBIT 6. TEST EQUIPMENT LIST

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range	Cal. Due Date
Spectrum Analyzer	Rohde & Schwarz	FSEK30	100077	20 Hz – 40 GHz	2 Nov 2013
Attenuator (30dB)	Aeroflex/Weinschel	46-30-34	BR9127	DC-18 GHz	Cal on use
High Pass Filter	Mini Circuit	SHP 250	--	Cut off 250 MHz	Cal on use
Frequency Counter	EIP	545A	2683	10Hz - 18 GHz	01 Mar 2013
Signal Generator	Marconi Instruments	2024	112255/164	9KHz-2.4GHz	20 Sep 2013
Environmental Chamber	Envirotronics	SSH32C	11994847-S-11059	-60 to 177 °C	16 Aug 2013
Power supply	Tenma	72-7295	490300297	1-40V DC 5A	Cal on use
Preamplifier	Hewlett Packard	8449B	3008A00769	1-26.5GHz	01 Dec 2013
High Pass Filter	Mini Circuit	SHP 600	--	Cut off 560 MHz	Cal on use
Attenuator	Aeroflex/Weinschel	23-20-34	BH7876	DC-18 GHz	Cal on use
Antenna	ETS	93148	1101	200-2000 MHz	22 Mar 2013
Antenna	EMCO	3142C	26873	26-3000MHz	04 May 2013
EMI Receiver	Rohde & Schwarz	ESU40	100037	20 Hz-40 GHz	19 Mar 2013
Preamplifier	AH System	PAM-0118	225	20MHz-18GHz	16 Mar 2013
Power Meter	Hewlett Packard	438A	3008A06729	100K--50G sensor dependent	24 Feb 2013
Power Sensor	Hewlett Packard	8482A	US37295944	0.1 - 4GHz	17 Feb 2013
Modulation Analyzer	Hewlett Packard	8901B	3226A04606	150KHz-1300MHz	12 Jan 2013
Spectrum Analyzer	Agilent	E7401A	US40240432	9 kHz–1.5 GHz	01 May 2013
Attenuator	Pasternack	PE7010-20	--	DC-2 GHz	09 Jan 2013
LISN	EMCO	3825/2	8907-1531	10KHz-100MHz	05 Apr 2013
Biconi-Log Antenna	ETS Lindgren	3142B	1575	26 – 3000 MHz	04 May 2013
Horn Antenna	EMCO	3155	9701-5061	1 – 18 GHz	25 Jan 2013

EXHIBIT 7. MEASUREMENT UNCERTAINTY

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

7.1. LINE CONDUCTED EMISSION MEASUREMENT UNCERTAINTY

	Line Conducted Emission Measurement Uncertainty (150 kHz – 30 MHz):	**Measured**	**Limit**
u_c	**Combined standard uncertainty:** $u_c(y) = \sqrt{\sum_{i=1}^{m} u_i^2(y)}$	**± 1.57**	**± 1.8**
U	**Expanded uncertainty U:** $U = 2u_c(y)$	**± 3.14**	**± 3.6**

7.2. RADIATED EMISSION MEASUREMENT UNCERTAINTY

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

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

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

EXHIBIT 8. MEASUREMENT METHODS

8.1. CONDUCTED POWER MEASUREMENTS

The following shall be applied to the combination(s) of the radio device and its intended antenna(e).

- 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:

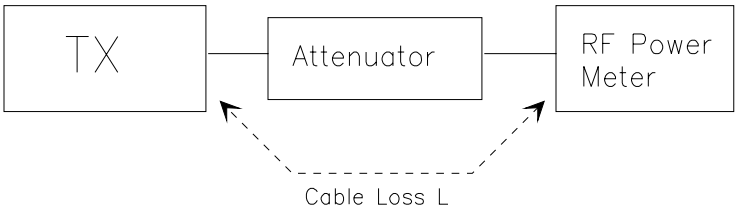
Step 1: Duty Cycle measurements if the transmitter's transmission is transient
- Using a EMI Receiver with the frequency span set to 0 Hz and the sweep time set at a suitable value to capture the envelope peaks and the duty cycle of the transmitter output signal;
- The duty cycle of the transmitter, 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 was 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 (dBuV/m) = Reading (dBuV) + 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° 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

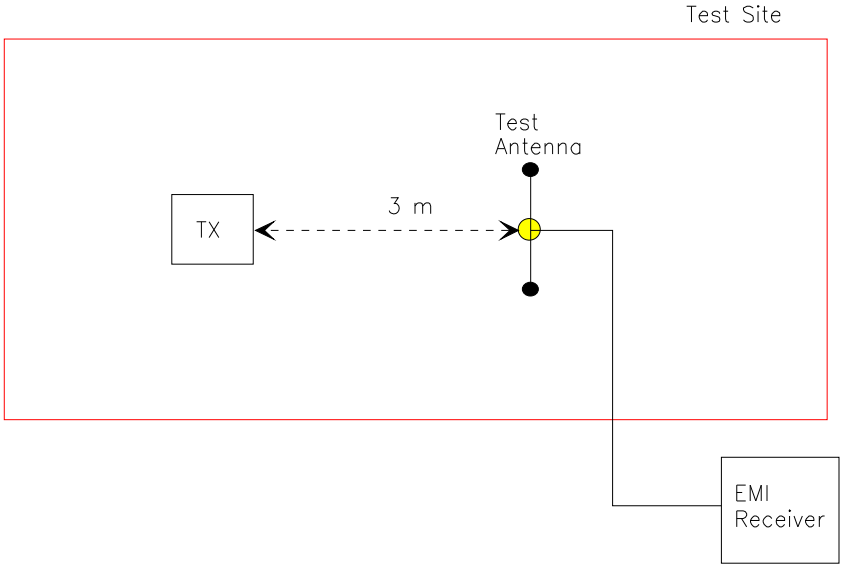
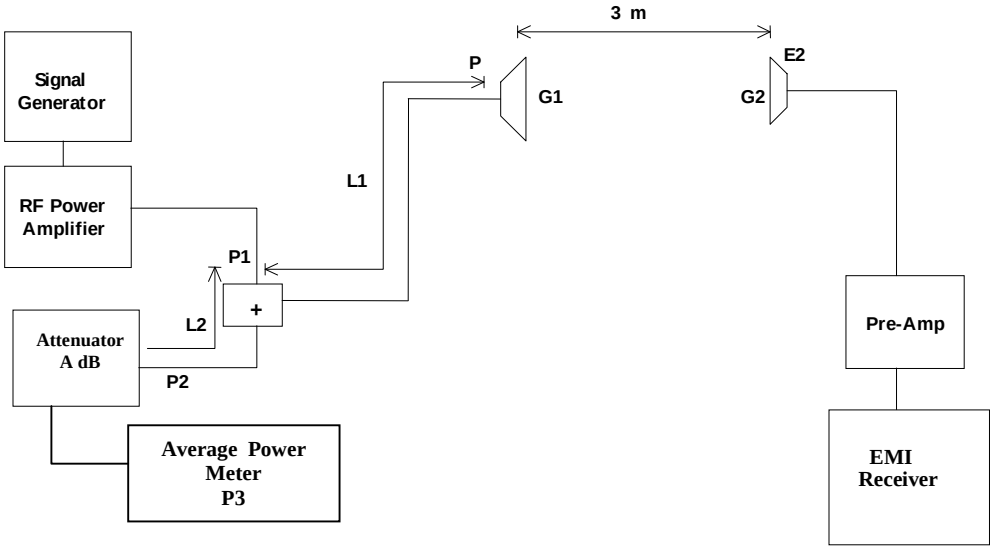


Figure 3



8.3. FREQUENCY STABILITY

Refer to § 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).