ENGINEERING TEST REPORT

HF Transceiver
Model No.: IC-F8100
FCC ID: AFJ329600

Applicant:

ICOM Incorporated
1-1-32, Kamiminami, Hirano-ku
Osaka
Japan, 547-0003

Tested in Accordance With

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

UltraTech's File No.: ICOM-296F90

This Test report is Issued under the Authority of Tri M. Luu, Professional Engineer, Vice President of Engineering UltraTech Group of Labs Date: June 15, 2012	
Report Prepared by: Dan Huynh Issued Date: June 15, 2012	Tested by: Wei Wu Test Dates: June 01-13, 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.*

UltraTech Group of Labs

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FCC	VCCI	Industry 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 and 90
Title:	Code of Federal Regulations (CFR), Title 47 Telecommunication – Parts 2 and 90
Purpose of Test:	To obtain FCC Certification Authorization for Radio operating in the Frequency Band 1.6 - 30 MHz.
Test Procedures:	Both conducted and radiated emissions measurements were conducted in accordance with TIA/EIA Standard TIA/EIA-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 2 and 90	2011	Code of Federal Regulations – 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 C	2004	Land Mobile FM or PM Communications Equipment Measurement and Performance Standards

EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1. CLIENT INFORMATION

APPLICANT	
Name:	Icom Incorporated
Address:	1-1-32, Kamiminami Hirano-ku, Osaka Japan, 547-0003
Contact Person:	Mr. Takayuki Watanabe Phone #: +81 6 6793 5302 Fax #: +81 6 6793 0013 Email Address: export@icom.co.jp

MANUFACTURER	
Name:	Icom Incorporated
Address:	1-1-32, Kamiminami Hirano-ku, Osaka Japan, 547-0003
Contact Person:	Mr. Takayuki Watanabe Phone #: +81 6 6793 5302 Fax #: +81 6 6793 0013 Email Address: export@icom.co.jp

2.2. EQUIPMENT UNDER TEST (EUT) INFORMATION

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

Brand Name:	ICOM Incorporated
Product Name:	HF Transceiver
Model Name or Number:	IC-F8100
Serial Number:	02001025
Type of Equipment:	Licensed Non-Broadcast Station Transmitter
Power Supply Requirement:	13.8 Vdc nominal
Transmitting/Receiving Antenna Type:	Non-integral
Primary User Functions of EUT:	HF Transceiver

2.3. EUT'S TECHNICAL SPECIFICATIONS

TRANSMITTER	
Equipment Type:	Fixed/mobile
Intended Operating Environment:	Commercial, Industrial or Business
Power Supply Requirement:	13.8 Vdc nominal
RF Output Power Rating:	125, 50 and 10 Watts (J3E, A1A) 75, 50 and 10 Watts(J2B, F1B) 30, 12.5 and 3 Watts (A3E)
Operating Frequency Range:	1.6 - 30 MHz
RF Output Impedance:	50 Ω
Occupied Bandwidth (99%):	A3E: 5.41 KHz A1A: 0.156 KHz J2B: 1.68 KHz F1B: 1.72 KHz F3E: 2.04KHz
Emission Designation*:	6K00A3E, 100HA1A, 2K80J2B and 2K80F1B, 2K80J3E
Antenna Connector Type:	Female HF

2.4. LIST OF EUT'S PORTS

Port Number	EUT's Port Description	Number of Identical Ports	Connector Type	Shielded/Non-shielded
1	DC power port	1	--	Non-shielded cable looped around a ferrite 3 turns
2	Fan port	1	--	Non-shielded cable
3	Speaker Jack port	1	--	Shielded
4	Accessory Connector ACC1	1	10 pin	Shielded
5	Accessory Connector ACC2	1	12 pin	Shielded
6	Antenna connector	1	HF	Shielded
7	Ground terminal	1	--	Non-shielded

2.5. ANCILLARY EQUIPMENT

The EUT was tested while connected to the following representative configuration of ancillary equipment necessary to exercise the ports during tests:

Ancillary Equipment # 1	
Description:	Controller (Front Panel)
Brand Name:	Icom Inc.
Model Name or Number:	HM-192
Serial Number:	00000012

Ancillary Equipment # 2	
Description:	Cooling fans
Brand Name:	Icom Inc.
Model Name or Number:	CFU-F8100
Serial Number:	N/A

Ancillary Equipment # 3	
Description:	External speckers
Brand Name:	Icom Inc.
Model Name or Number:	SP-25
Serial Number:	N/A

Ancillary Equipment # 4	
Description:	Microphone
Brand Name:	Icom Inc.
Model Name or Number:	HM-193
Serial Number:	N/A

Ancillary Equipment # 5	
Description:	Optional Junction Box
Brand Name:	Icom Inc.
Model Name or Number:	AD-119
Serial Number:	N/A

Ancillary Equipment # 6	
Description:	Automatic Antenna Tuner
Brand Name:	Icom Inc.
Model Name or Number:	AT-140
Serial Number:	N/A

2.6. GENERAL TEST SETUP

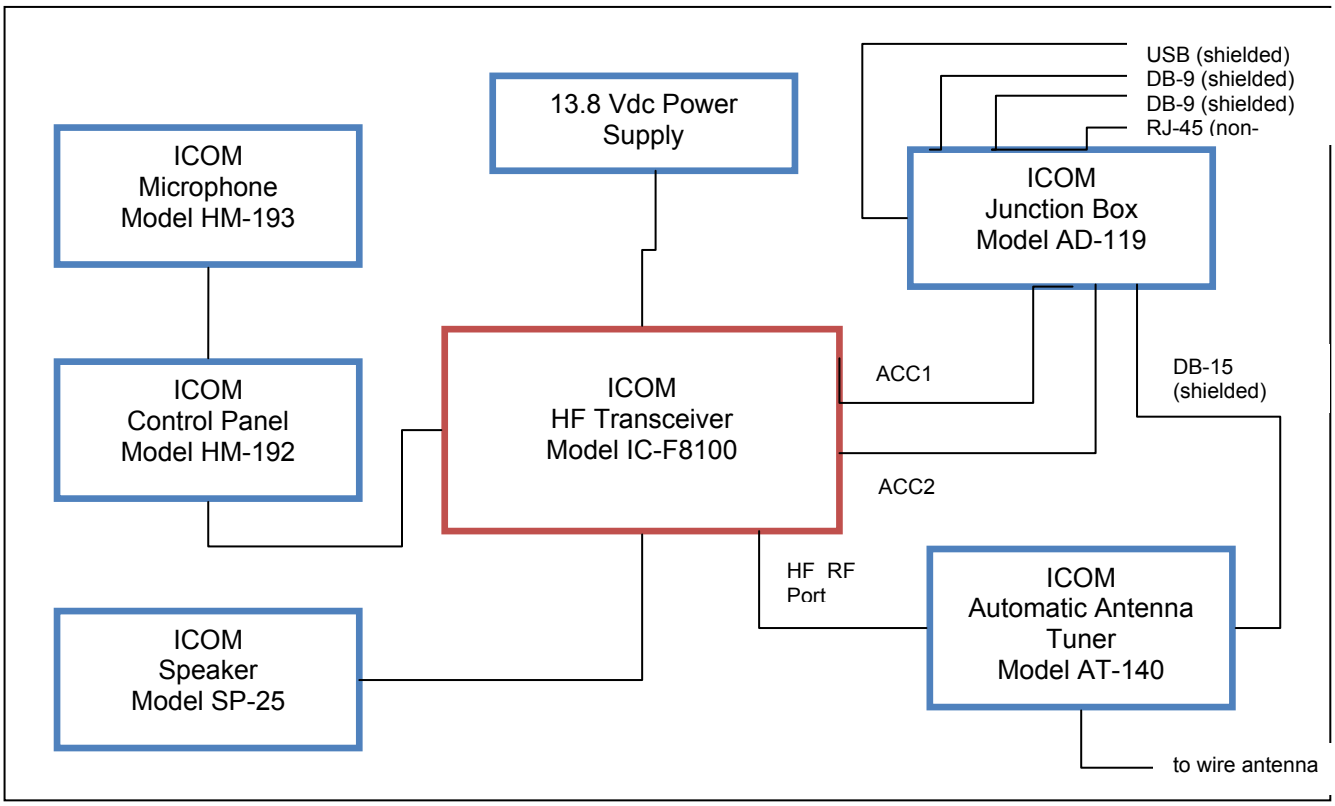


EXHIBIT 3. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

3.1. CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

Temperature:	21°C
Humidity:	51%
Pressure:	102 kPa
Power Input Source:	13.8 Vdc nominal

3.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TEST SIGNALS

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

Transmitter Test Signals	
Frequency Band(s):	1.6 - 30 MHz
Test Frequencies: (Near lowest, near middle & near highest frequencies in the frequency range of operation.)	1.71, 17.45, 29.75 MHz

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 EMISSION TEST RESULTS

FCC Section(s)	Test Requirements	Applicability (Yes/No)
2.1046, 90.205	RF Power Output	Yes
2.1047(a) & 90.242(b)(8)	Audio Frequency Response	Not applicable to current standard. However, tests are conducted under FCC's recommendation.
2.1047(b) & 90.210	Modulation Limiting	Yes
2.1049, 90.209 & 90.210	Emission Limitation & Emission Mask	Yes
2.1051, 2.1057, 90.210	Emission Limits - Spurious Emissions at Antenna Terminal	Yes
2.1053, 2.1057, 90.210	Emission Limits - Field Strength of Spurious Emissions	Yes
2.1055, 90.213	Frequency Stability	Yes
1.1307, 1.1310, 2.1091 & 2.1093	RF Exposure Limit	Yes
HF Transceiver, Model No.: IC-F8100, by ICOM Incorporated has also been tested and found to comply with FCC Part 15, Subpart B - Class A Unintenional Radiators. The engineering test report has been documented and kept on file and is available upon request.		

4.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

None.

4.3.1. DEVIATION OF STANDARD TEST PROCEDURES

N/A

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

5.1. RF POWER OUTPUT [§ 2.1046, 90.205]

5.1.1. Limits

Please refer to FCC 47 CFR 90.205 for detalied limit specifications:

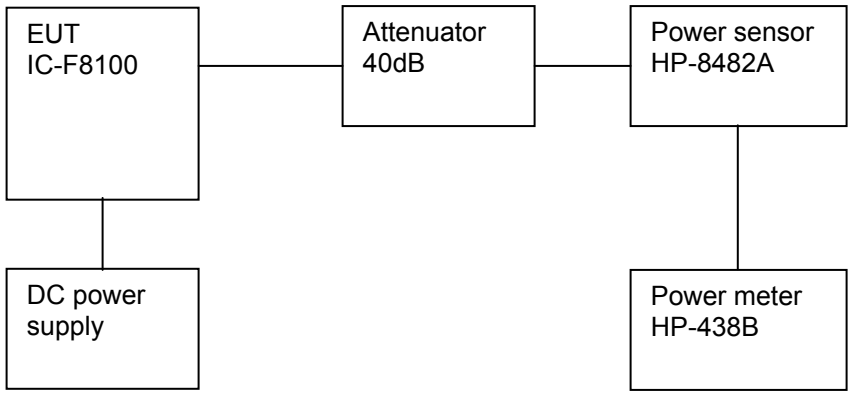
a) *Below 25 MHz.* For single sideband operations (J3E emission), the maximum transmitter peak envelope power is 1000 watts.
b) *25–50 MHz.* The maximum transmitter output power is 300 watts.

5.1.2. Method of Measurements

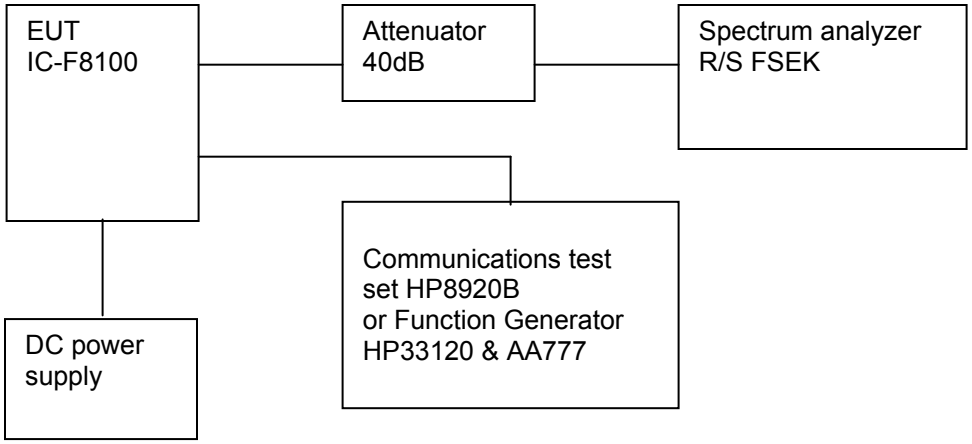
Refer to Section 7.1 (Conducted) and 7.2 (Radiated) of this report for measurement details

5.1.3. Test Arrangement

For Average Power Measurements: A3E, F1B:



For Peak Envelope Power (J2B, J3E) Peak Power (A1A) Measurements:



5.1.4. Test Data

Modulation: A3E

Frequencies MHz	Power level	Power Rating Watts	Power Rating dBm	Measured Average Power dBm	Measured Average Power Watts
1.710	High	30.00	44.77	45.13	32.58
1.710	Medium	12.50	40.97	41.30	13.49
1.710	Low	3.00	34.77	35.32	3.40
17.450	High	30.00	44.77	45.00	31.62
17.450	Medium	12.50	40.97	41.27	13.40
17.450	Low	3.00	34.77	35.53	3.57
29.750	High	30.00	44.77	44.86	30.62
29.750	Medium	12.50	40.97	41.08	12.82
29.750	Low	3.00	34.77	34.89	3.08

Modulation: A1A

Frequencies MHz	Power level	Power Rating Watts	Power Rating dBm	Measured Peak Power dBm	Measured Peak Power Watts
1.710	High	125.00	50.97	51.11	129.12
1.710	Medium	50.00	46.99	47.37	54.58
1.710	Low	10.00	40.00	40.65	11.61
17.450	High	125.00	50.97	50.85	121.62
17.450	Medium	50.00	46.99	47.18	52.24
17.450	Low	10.00	40.00	40.43	11.04
29.750	High	125.00	50.97	50.70	117.49
29.750	Medium	50.00	46.99	45.98	39.63
29.750	Low	10.00	40.00	40.28	10.67

Modulation: J2B

Frequencies MHz	Power level	Power Rating Watts	Power Rating dBm	Measured Peak Envelope Power dBm	Measured Peak Envelope Power Watts
1.710	High	75.00	48.75	49.05	80.35
1.710	Medium	50.00	46.99	47.30	53.70
1.710	Low	10.00	40.00	40.46	11.12
17.450	High	75.00	48.75	48.82	76.21
17.450	Medium	50.00	46.99	47.12	51.52
17.450	Low	10.00	40.00	40.35	10.84
29.750	High	75.00	48.75	48.60	72.44
29.750	Medium	50.00	46.99	46.83	48.19
29.750	Low	10.00	40.00	40.10	10.23

Modulation: F1B

Frequencies MHz	Power level	Power Rating Watts	Power Rating dBm	Measured Average Power dBm	Measured Average Power Watts
1.710	High	75.00	48.75	49.17	82.60
1.710	Medium	50.00	46.99	47.44	55.46
1.710	Low	10.00	40.00	40.70	11.75
17.450	High	75.00	48.75	48.91	77.80
17.450	Medium	50.00	46.99	47.22	52.72
17.450	Low	10.00	40.00	40.45	11.09
29.750	High	75.00	48.75	48.87	77.09
29.750	Medium	50.00	46.99	47.07	50.93
29.750	Low	10.00	40.00	40.33	10.79

Modulation: J3E

Frequencies MHz	Power level	Power Rating Watts	Power Rating dBm	Measured Peak Envelope Power dBm	Measured Peak Envelope Power Watts
1.710	High	125.00	50.97	51.48	140.60
1.710	Medium	50.00	46.99	47.79	60.12
1.710	Low	10.00	40.00	41.46	14.00
17.450	High	125.00	50.97	51.18	131.22
17.450	Medium	50.00	46.99	47.68	58.61
17.450	Low	10.00	40.00	41.05	12.74
29.750	High	125.00	50.97	51.05	127.35
29.750	Medium	50.00	46.99	46.53	44.98
29.750	Low	10.00	40.00	40.92	12.36

5.2. AUDIO FREQUENCY RESPONSE [§ 2.1047(a) & 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.

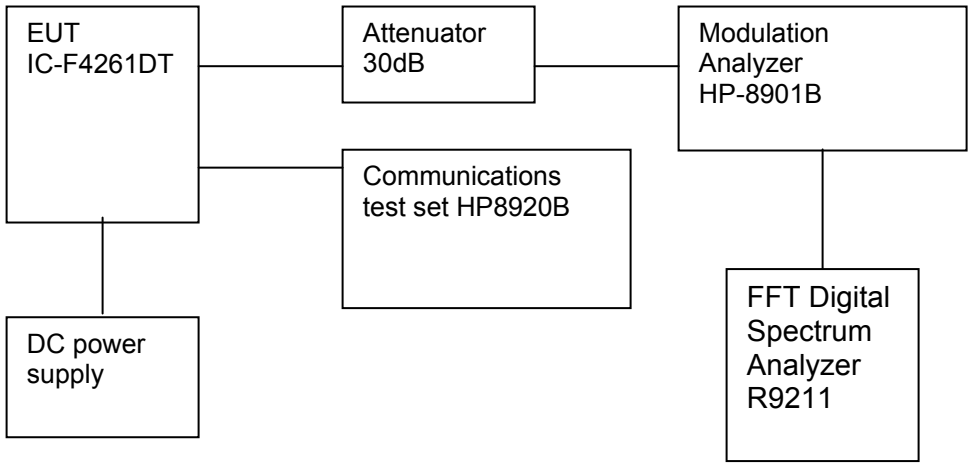
§ **90.242(b)(8):** Recommended audio filter attenuation characteristics are given below:

RF Band	Audio band	Minimum Attenuation Rel. to 1 kHz Attenuation
1.6 - 30 MHz	3 –20 KHz 20 – 30 KHz	60 $\log_{10}$(f/3) dB where f is in 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



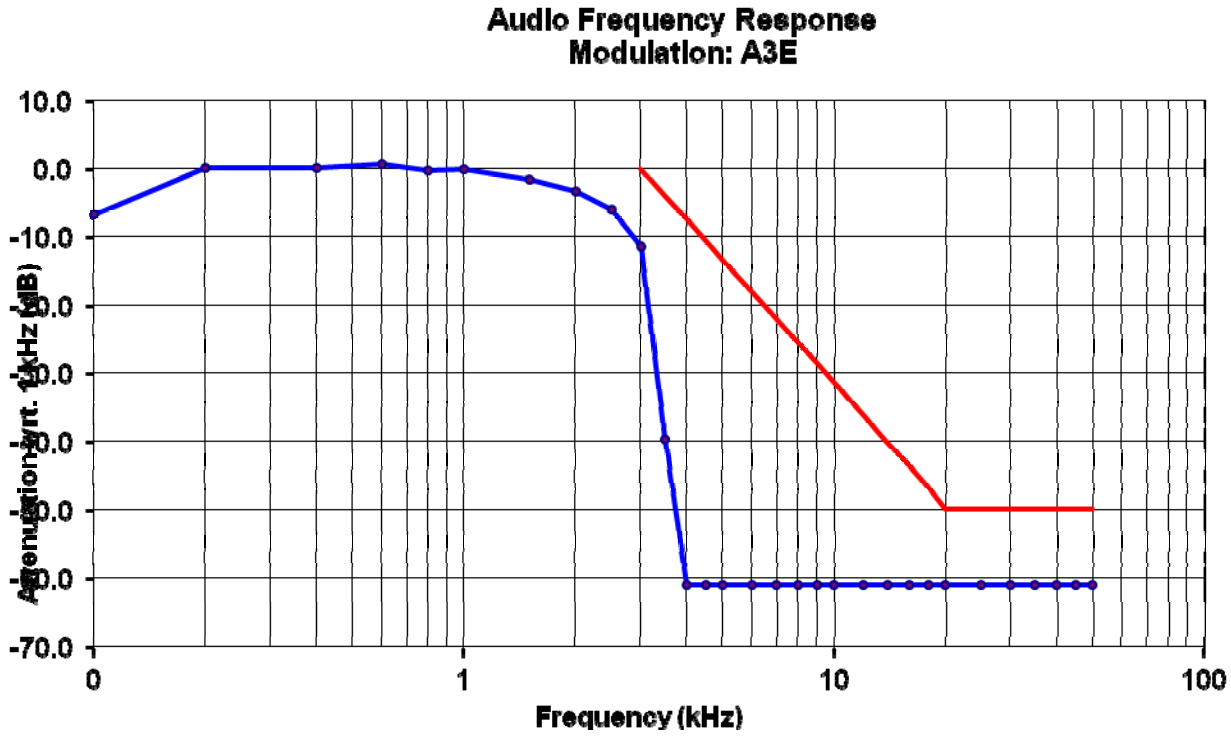
5.2.4. Test Data

5.2.4.1. Modulation: A3E, Audio Frequency Response of All Modulation States

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.

Audio input level STD: 6.5 mV

Frequency (KHz)	Audio In (dBV)	Audio Out (dBV)	Attenuation (Out - In) (dB)	Attenuation Rel. to 1 KHz (dB)	Recommended Attenuation (dB)
0.1	-43.74	-15.62	28.1	-6.6	--
0.2	-43.74	-9.00	34.7	0.1	--
0.4	-43.74	-9.05	34.7	0.0	--
0.6	-43.74	-8.48	35.3	0.6	--
0.8	-43.74	-9.26	34.5	-0.2	--
1.0	-43.74	-9.06	34.7	0.0	--
1.5	-43.74	-10.66	33.1	-1.6	--
2.0	-43.74	-12.30	31.4	-3.2	--
2.5	-43.74	-15.04	28.7	-6.0	--
3.0	-43.74	-20.33	23.4	-11.3	0
3.5	-43.74	-48.77	-5.0	-39.7	-4
4.0	-43.74	-70.00	-26.3	-60.9	-7
4.5	-43.74	-70.00	-26.3	-60.9	-11
5.0	-43.74	-70.00	-26.3	-60.9	-13
6.0	-43.74	-70.00	-26.3	-60.9	-18
7.0	-43.74	-70.00	-26.3	-60.9	-22
8.0	-43.74	-70.00	-26.3	-60.9	-26
9.0	-43.74	-70.00	-26.3	-60.9	-29
10.0	-43.74	-70.00	-26.3	-60.9	-31
12.0	-43.74	-70.00	-26.3	-60.9	-36
14.0	-43.74	-70.00	-26.3	-60.9	-40
16.0	-43.74	-70.00	-26.3	-60.9	-44
18.0	-43.74	-70.00	-26.3	-60.9	-47
20.0	-43.74	-70.00	-26.3	-60.9	-50
25.0	-43.74	-70.00	-26.3	-60.9	-50
30.0	-43.74	-70.00	-26.3	-60.9	-50
35.0	-43.74	-70.00	-26.3	-60.9	-50
40.0	-43.74	-70.00	-26.3	-60.9	-50
45.0	-43.74	-70.00	-26.3	-60.9	-50
50.0	-43.74	-70.00	-26.3	-60.9	-50



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

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

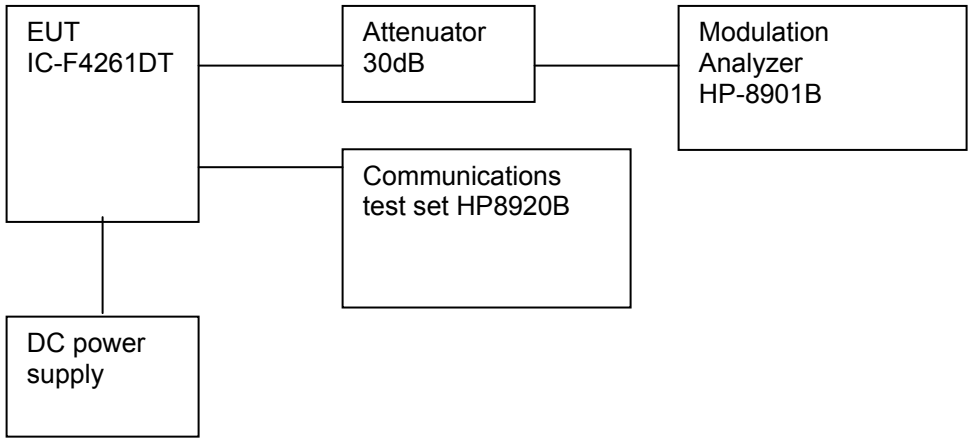
5.3.1. Limits

§ **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.

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.

5.3.3. Test Arrangement



5.3.4. Test Data

5.3.4.1. Modulation Limiting for A3E

Modulating Signal Level	Peak Modulation depth %					Maximum Limit
(mVrms)	0.1 kHz	0.5 kHz	1.0 kHz	3.0 kHz	5.0 kHz	%
1	7.88	10.65	11.03	4.61	2.09	100
2	10.53	19.34	18.63	7.23	2.00	100
4	16.72	35.21	33.74	11.35	1.86	100
6	23.19	49.20	46.30	15.46	1.73	100
8	29.89	63.60	59.20	19.08	1.62	100
10	34.17	73.10	68.90	21.76	1.55	100
15	44.00	88.40	86.90	28.81	1.38	100
20	50.10	88.40	87.10	35.28	1.31	100
25	49.70	88.40	87.10	35.71	1.28	100
30	50.00	88.50	87.10	35.78	1.17	100
35	50.00	88.50	87.10	35.78	1.09	100
40	50.00	88.50	87.10	35.78	1.02	100
45	50.00	88.50	87.10	35.78	1.01	100
50	50.00	88.50	87.10	35.78	0.90	100
60	50.00	88.60	87.10	35.78	0.83	100
70	50.00	88.60	87.10	35.78	0.71	100
80	50.00	88.70	87.10	35.78	0.63	100
90	50.00	88.70	87.10	35.78	0.60	100
100	50.00	88.70	87.10	35.78	0.58	100

Voice Signal Input Level	= STD MOD Level + 16 dB = 20*log(6.5 mVrms) + 16 dB = 32.26 dB(mVrms) = 41.01 mVrms	
Modulation Frequency (kHz	**Peak Depth (%)**	**Maximum Limit (%)**
0.1	50.00	100.0
0.2	85.10	100.0
0.4	87.10	100.0
0.6	88.30	100.0
0.8	88.20	100.0
1.0	87.10	100.0
1.2	84.30	100.0
1.4	80.70	100.0
1.6	78.60	100.0
1.8	75.90	100.0
2.0	73.80	100.0
2.5	59.20	100.0
3.0	35.78	100.0
3.5	2.55	100.0
4.0	0.97	100.0
4.5	0.96	100.0
5.0	0.90	100.0
6.0	1.07	100.0
7.0	1.03	100.0
8.0	1.12	100.0
9.0	0.94	100.0
10.0	1.18	100.0

5.3.4.2. Modulation Limiting for J2B

Input audio signal level (mV)	Measured RF Ouput Power (dBm)	Measured RF Ouput Power (Watts)
1	0.23	0.00
5	11.19	0.01
10	16.77	0.05
20	22.72	0.19
30	26.13	0.41
40	28.67	0.74
50	30.69	1.17
60	32.31	1.70
70	33.70	2.34
80	35.17	3.29
90	35.91	3.90
100	37.06	5.08
200	43.25	21.13
300	46.73	47.10
400	48.77	75.34
500	48.97	78.89
600	49.05	80.35
700	49.05	80.35
824	49.05	80.35

5.3.4.3. Modulation Limiting for J3E

Input audio signal level (mV)	Measured RF Ouput Power (dBm)	Measured RF Ouput Power (Watts)
0.5	33.25	2.11
1	39.15	8.22
2	45.78	37.84
4	50.69	117.22
6	51.36	136.77
8	51.45	139.64
10	51.46	139.96
15	51.48	140.60
20	51.48	140.60
50	51.48	140.60
100	51.48	140.60
200	51.48	140.60
300	51.48	140.60
400	51.48	140.60
500	51.48	140.60
600	51.48	140.60
700	51.48	140.60
800	51.48	140.60
900	51.48	140.60
1000	51.48	140.60

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

5.4.1. Limits

§ 90.209 Bandwidth limitations.

(1) For **A1A** or A1B emissions, the maximum authorized bandwidth is 0.25 kHz. The maximum authorized bandwidth for type **A3E** emission is 8 kHz.

(2) For operations below 25 MHz utilizing **J3E** emission, the bandwidth occupied by the emission shall not exceed 3000 Hz. The assigned frequency will be specified in the authorization. The authorized carrier frequency will be 1400 Hz lower in frequency than the assigned frequency. Only upper sideband emission may be used. In the case of regularly available double sideband radiotelephone channels, an assigned frequency for J3E emissions is available either 1600 Hz below or 1400 Hz above the double sideband radiotelephone assigned frequency.

(3) For all other types of emissions, the maximum authorized bandwidth shall not be more than that normally authorized for voice operations.

§ 90.210 Emission masks.

APPLICABLE EMISSION MASKS

Frequency band (MHz)	Mask for equipment with Audio low pass filter	Mask for equipment without audio low pass filter
Below 25 [1]	A or B	A or C
25–50	B	C

(a) *Emission Mask A.* For transmitters utilizing J3E emission, the carrier must be at least 40 dB below the peak envelope power and the power of emissions must be reduced below the output power (P in watts) of the transmitter as follows:

(1) On any frequency removed from the assigned frequency by more than 50 percent, but not more than 150 percent of the authorized bandwidth: At least 25 dB.
(2) On any frequency removed from the assigned frequency by more than 150 percent, but not more than 250 percent of the authorized bandwidth: At least 35 dB.
(3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 + 10 log P dB.

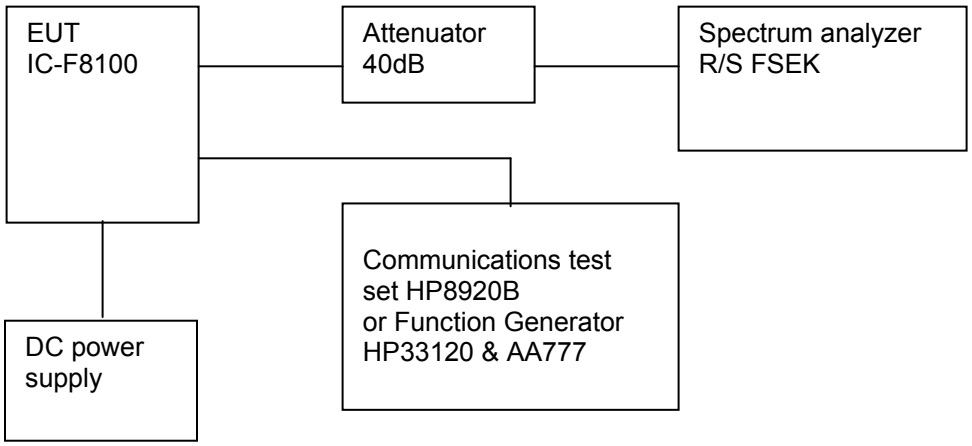
(b) *Emission Mask B.* For transmitters that are equipped with an audio lowpass filter, the power of any emission must be attenuated below the unmodulated carrier power (P) as follows:

(1) On any frequency removed from the assigned frequency by more than 50 percent, but not more than 100 percent of the authorized bandwidth: At least 25 dB.
(2) On any frequency removed from the assigned frequency by more than 100 percent, but not more than 250 percent of the authorized bandwidth: At least 35 dB.
(3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 + 10 log (P) dB.

5.4.2. Method of Measurements

Refer to Section 7.4 of this report for measurement details.

5.4.3. Test Arrangement



5.4.4. Test Data

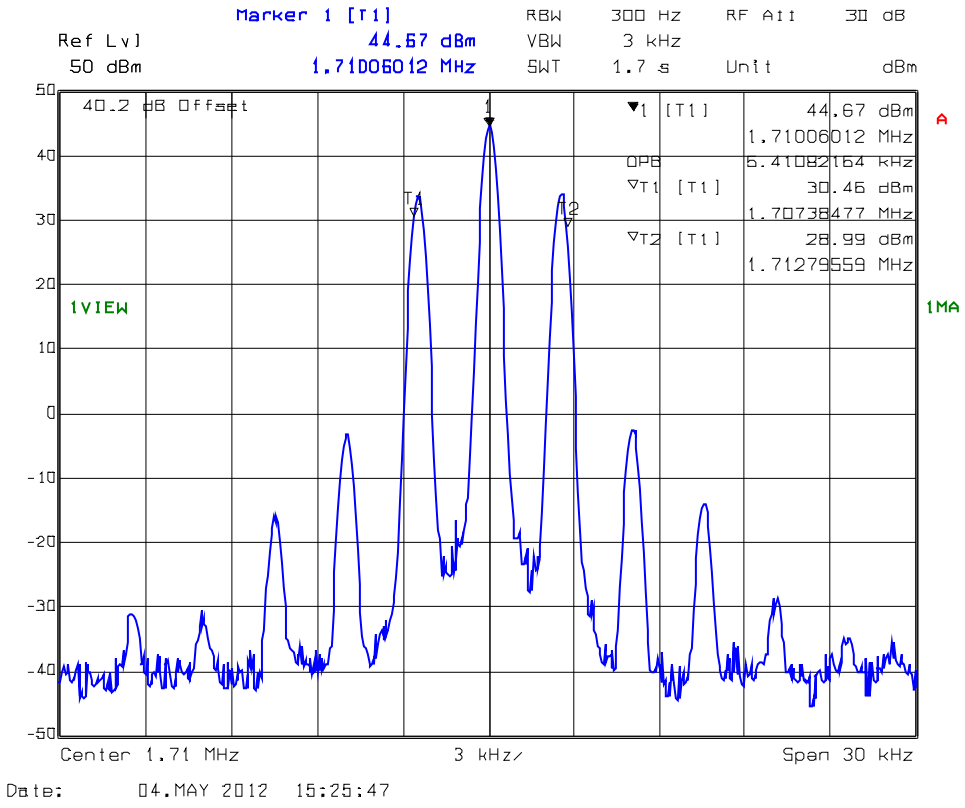
5.4.4.1. 99% Occupied Bandwidth

Frequency (MHz)	Modulation	*Measured 99% OBW at Maximum Freq. Deviation (kHz)	FCC Maximum Authorized Bandwidth @ 90.209 (kHz)
1.710	6K00A3E	5.41	8.0
17.450	6K00A3E	5.41	8.0
29.75	6K00A3E	5.41	8.0
1.710	100HA1A	0.156	0.25
17.450	100HA1A	0.152	0.25
29.75	100HA1A	0.156	0.25
1.710	2K80J2B	1.68	3.0
17.450	2K80J2B	1.66	3.0
29.75	2K80J2B	1.68	3.0
1.710	2K80F1B	1.72	3.0
17.450	2K80F1B	1.72	3.0
29.75	2K80F1B	1.70	3.0
1.710	2K80J3E	2.04	3.0
17.450	2K80J3E	2.04	3.0
29.75	2K80J3E	2.04	3.0

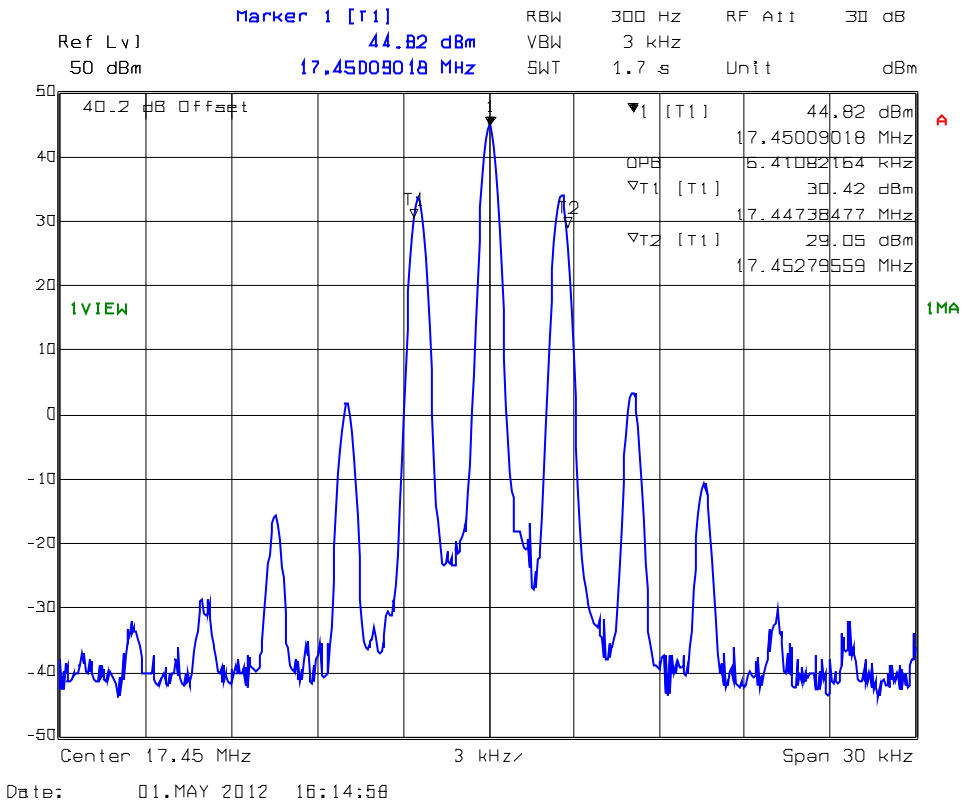
*Refer to the following test data plots below for details.

Plot 5.4.4.1.1. - 99% Occupied Bandwidth, Modulation: 6K00A3E

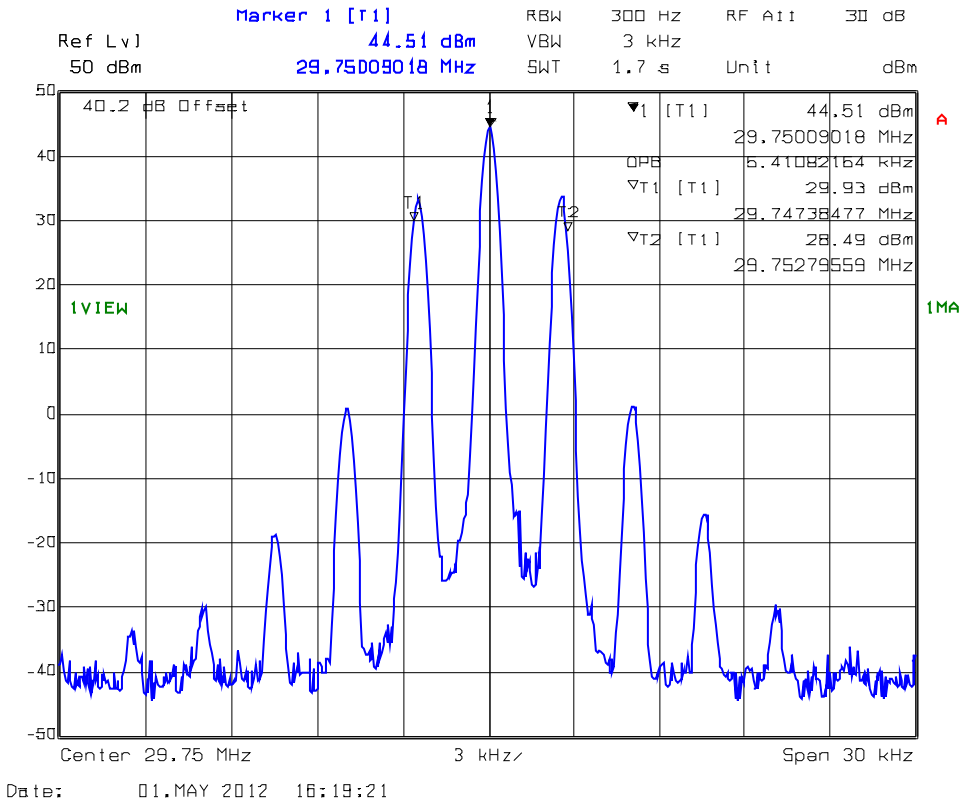
Test Frequency:	1.71 MHz
Output Power:	Maximum



Test Frequency:	17.45 MHz
Output Power:	Maximum

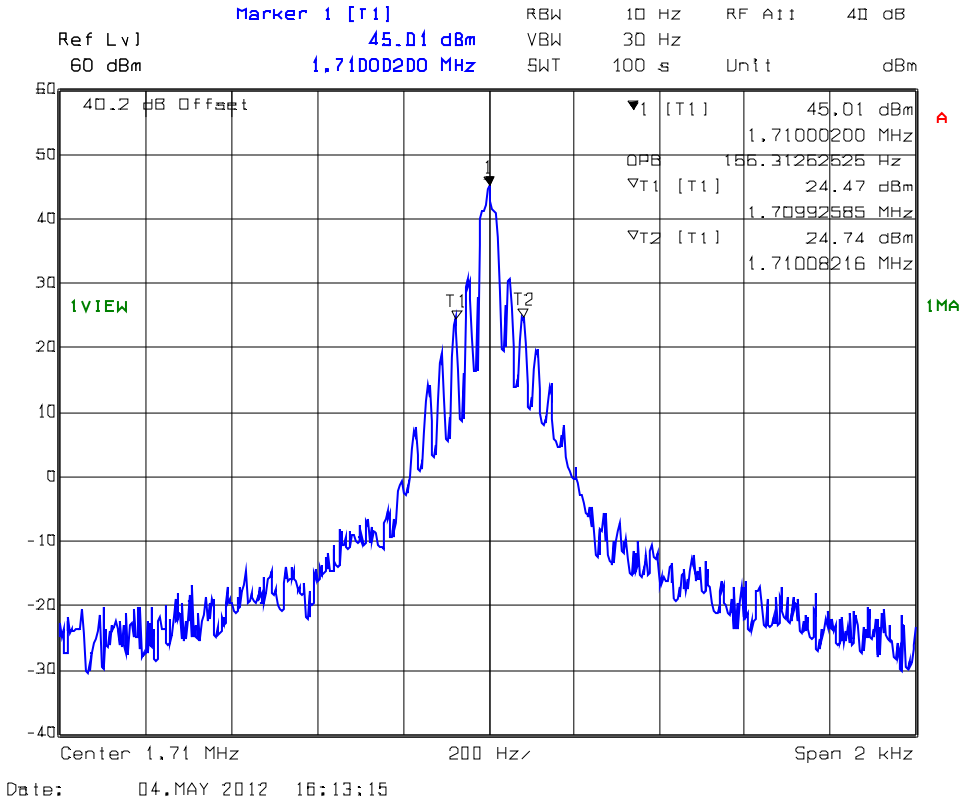


Test Frequency:	29.75 MHz
Output Power:	Maximum

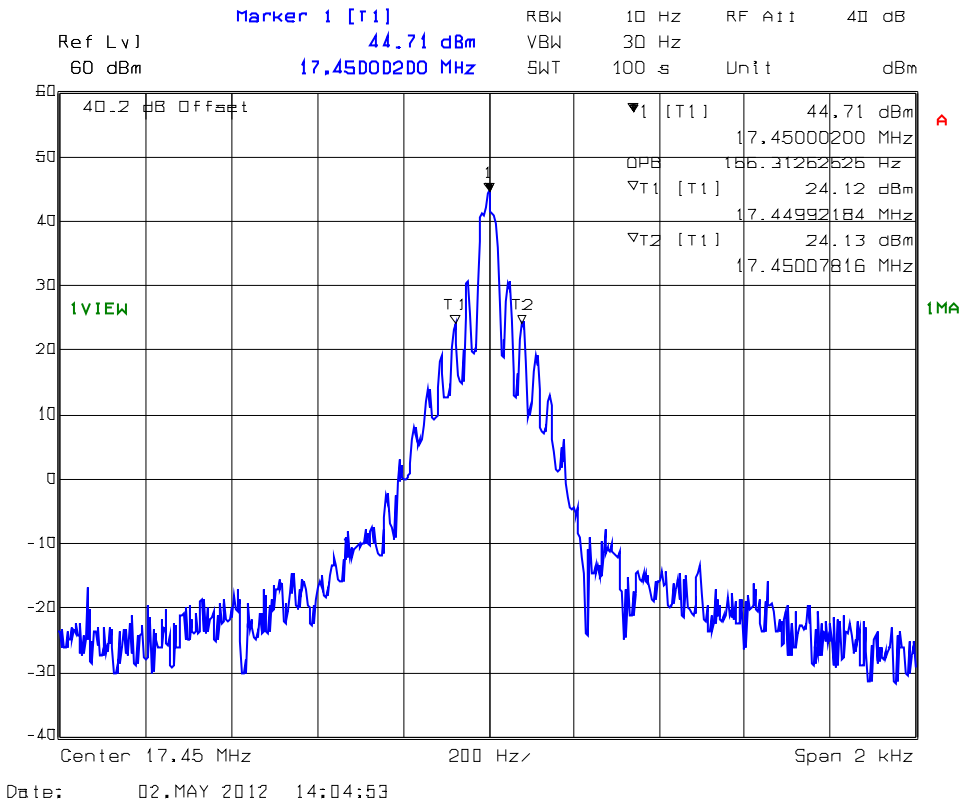


Plot 5.4.4.1.2. - 99% Occupied Bandwidth, Modulation: 100HA1A (16 dot / second, dot length 30 ms)

Test Frequency:	1.71 MHz
Output Power:	Maximum

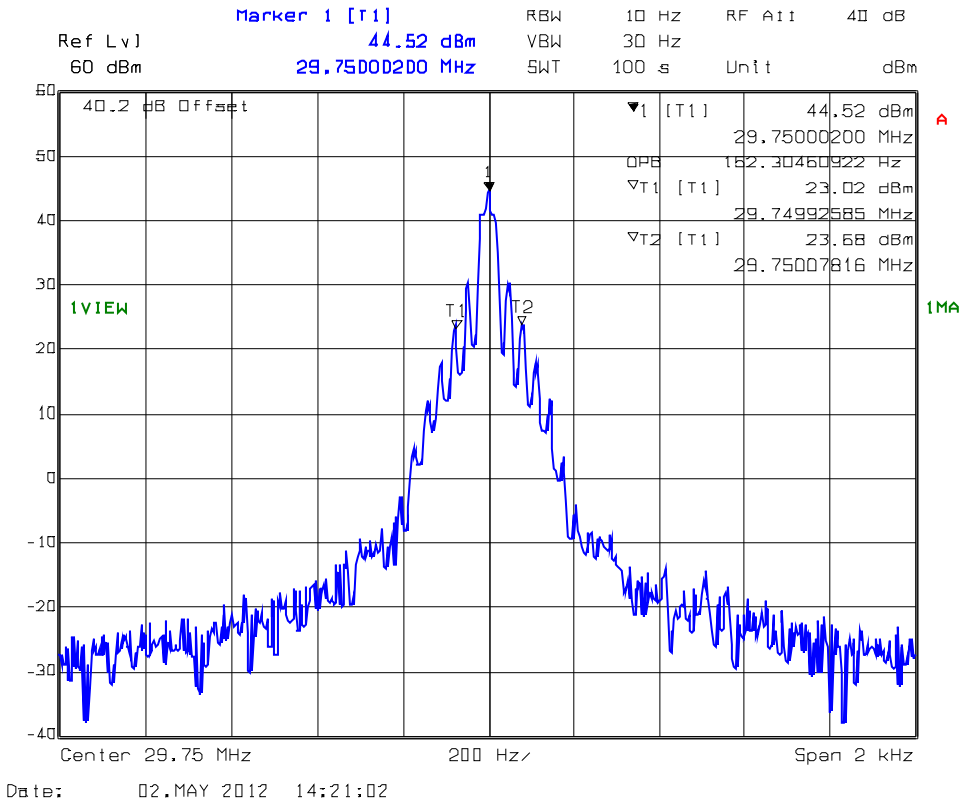


Test Frequency:	17.45 MHz
Output Power:	Maximum



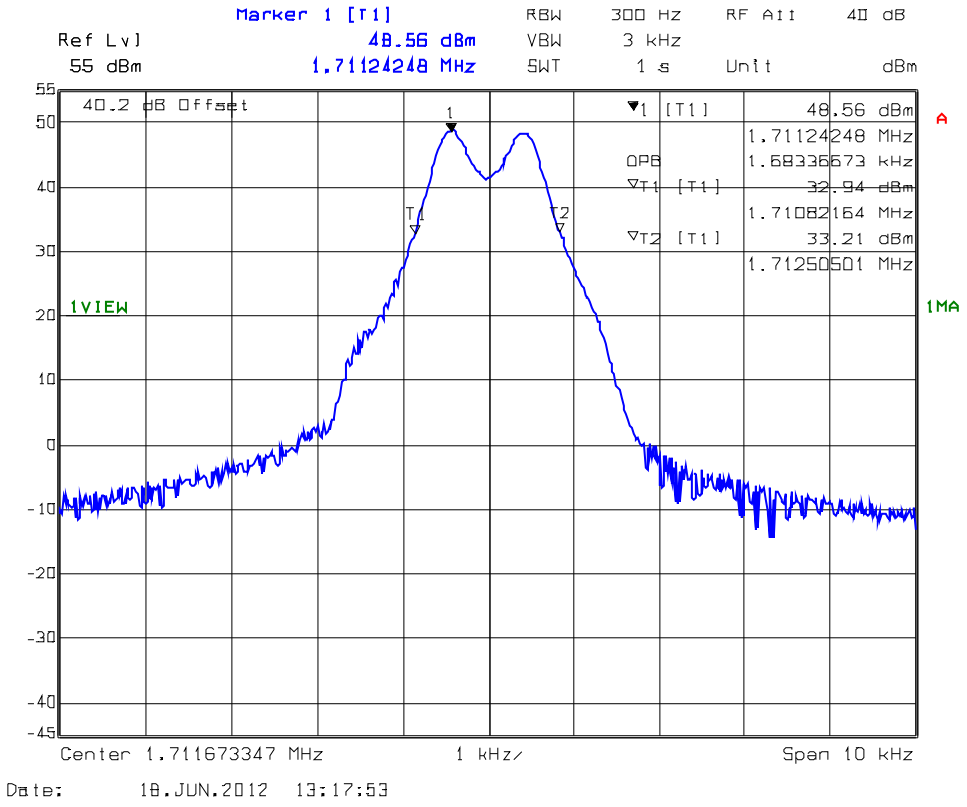
All test results contained in this engineering test report are traceable to National Institute of Standards and Technology (NIST)

Test Frequency:	29.75 MHz
Output Power:	Maximum

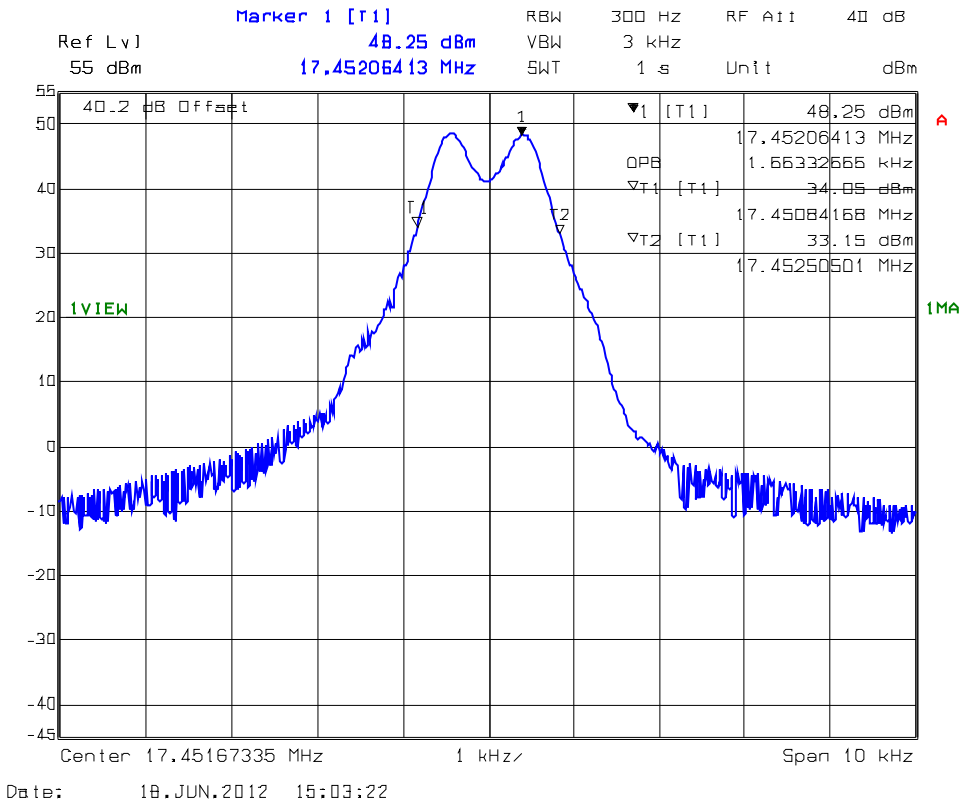


Plot 5.4.4.1.3. - 99% Occupied Bandwidth, Modulation: 2K80J2B (AFSK Tone Frequency 1.2KHz Shift Frequency 850Hz, Shift rate 100)

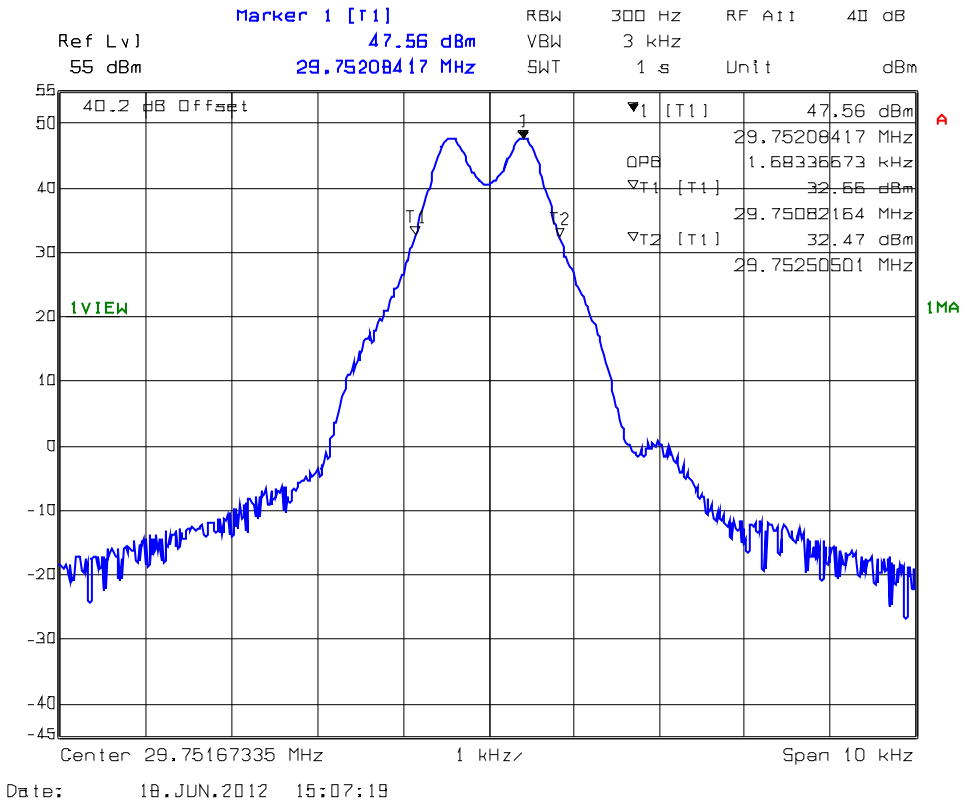
Test Frequency:	1.71 MHz
Output Power:	Maximum



Test Frequency:	17.45 MHz
Output Power:	Maximum

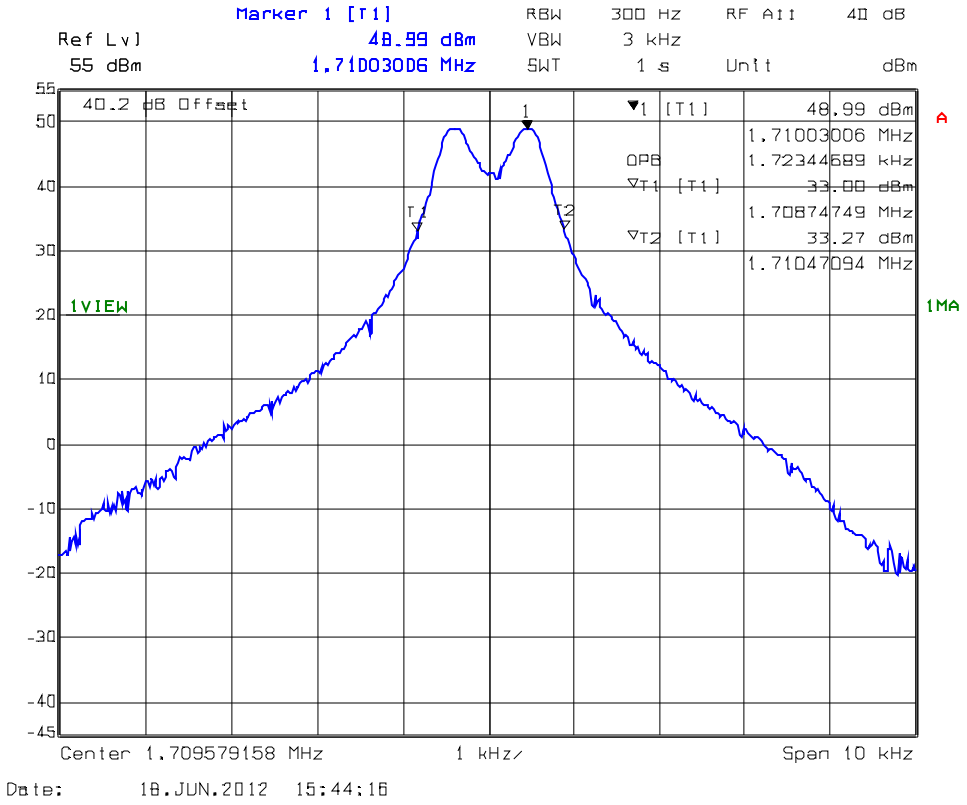


Test Frequency:	29.75 MHz
Output Power:	Maximum

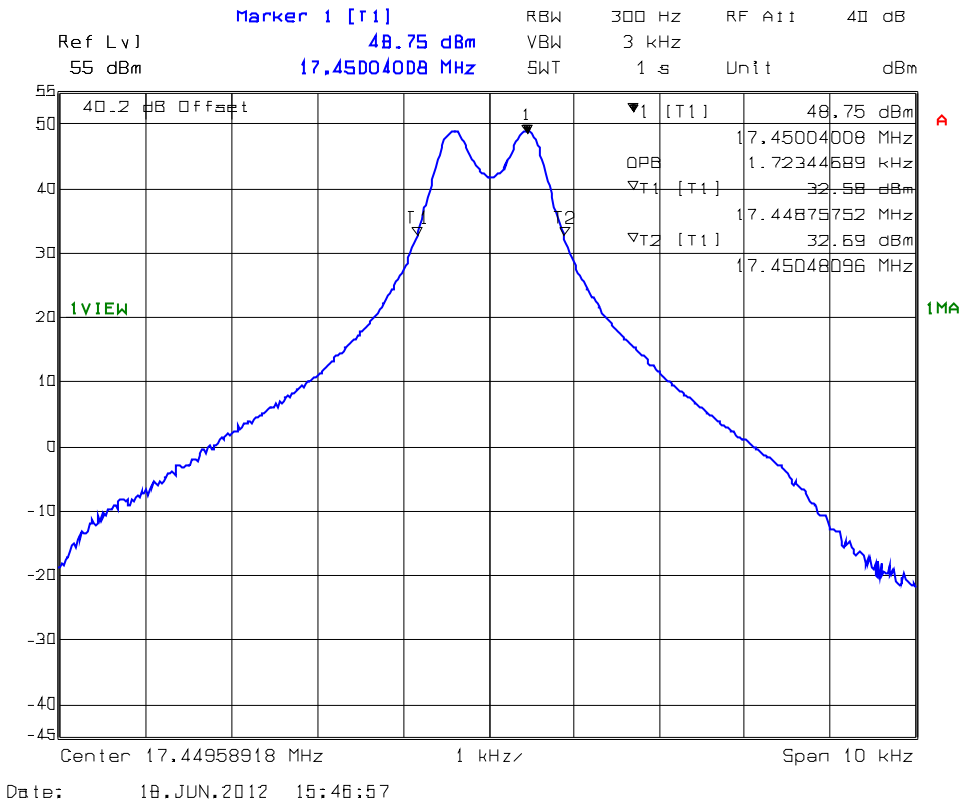


Plot 5.4.4.1.4. - 99% Occupied Bandwidth, Modulation: 2K80F1B (Shift Frequency 850Hz, Shift rate 100)

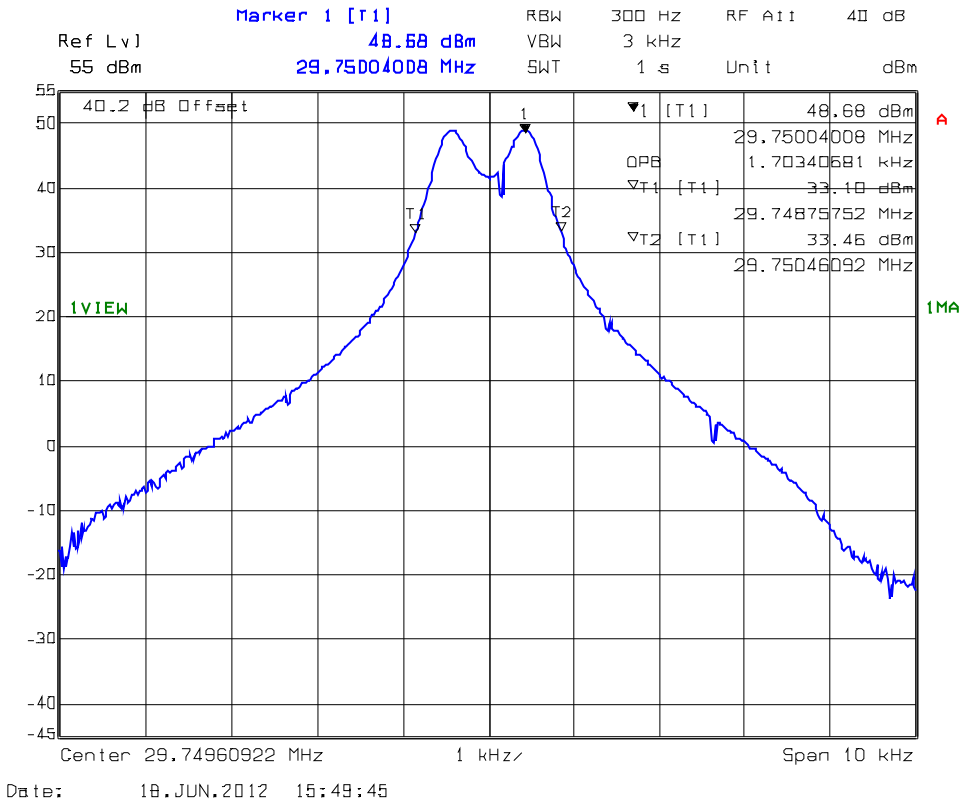
Test Frequency:	1.71 MHz
Output Power:	Maximum



Test Frequency:	17.45 MHz
Output Power:	Maximum

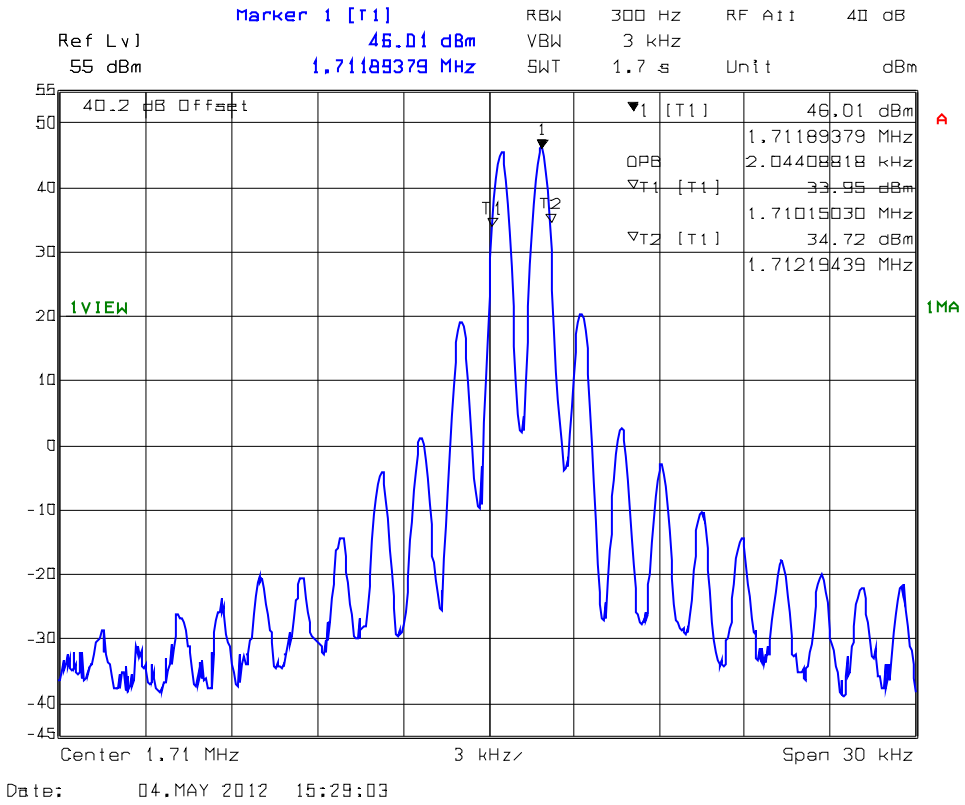


Test Frequency:	29.75 MHz
Output Power:	Maximum

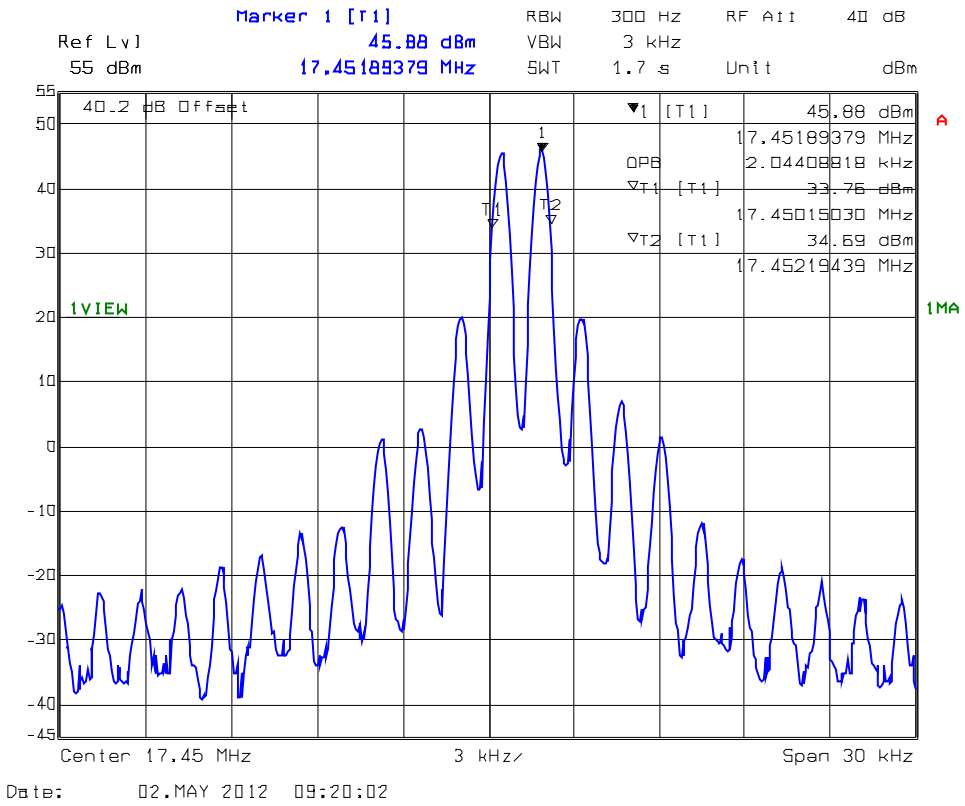


Plot 5.4.4.1.5. - 99% Occupied Bandwidth, Modulation: 2K80J3E (400 Hz + 1800 Hz)

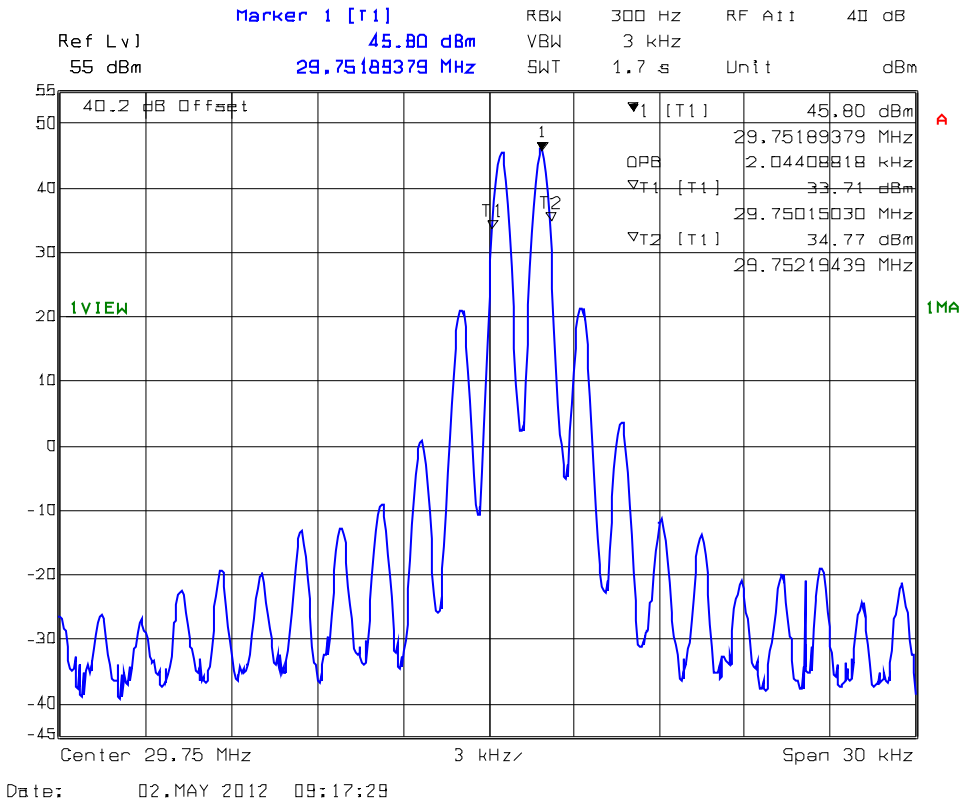
Test Frequency:	1.71 MHz
Output Power:	Maximum



Test Frequency:	17.45 MHz
Output Power:	Maximum

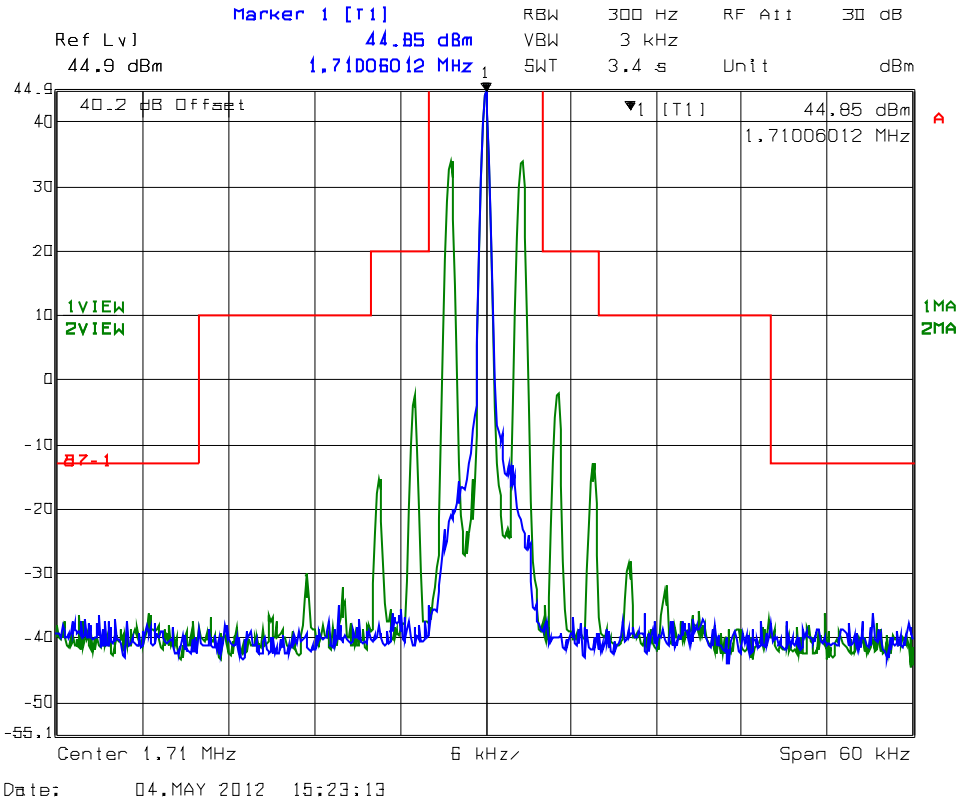


Test Frequency:	29.75 MHz
Output Power:	Maximum

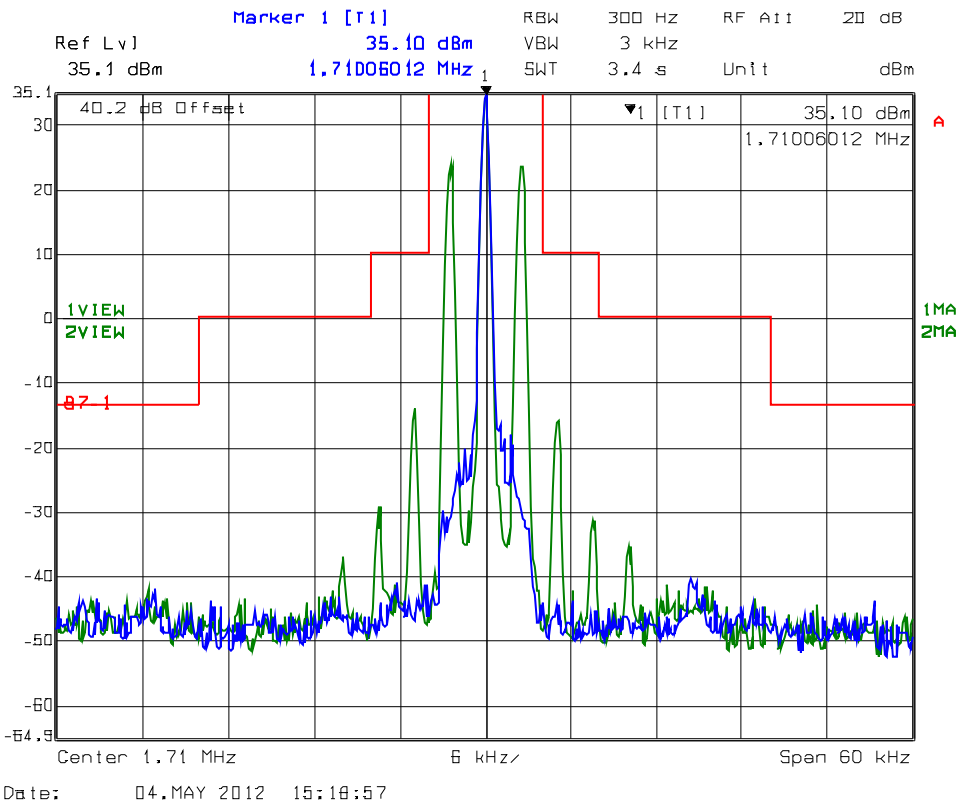


Plot 5.4.4.1.6. - Emissiom Mask B, Modulation: 6K00A3E

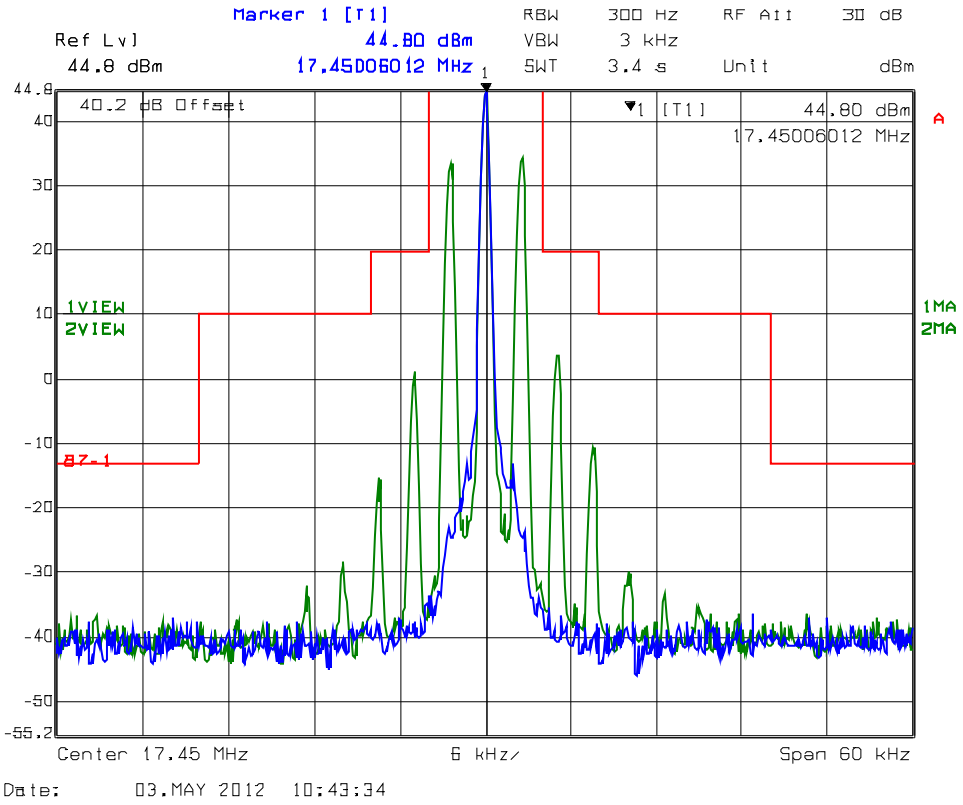
Test Frequency:	1.71 MHz
Power:	Maximum



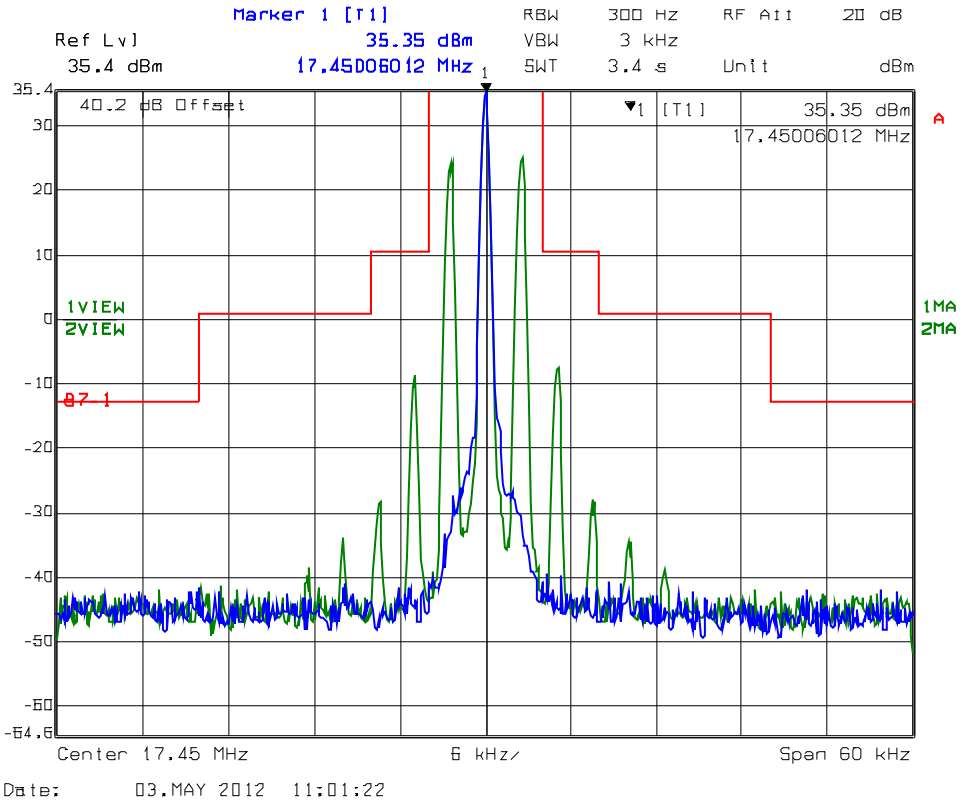
Test Frequency:	1.71 MHz
Power:	Minimum



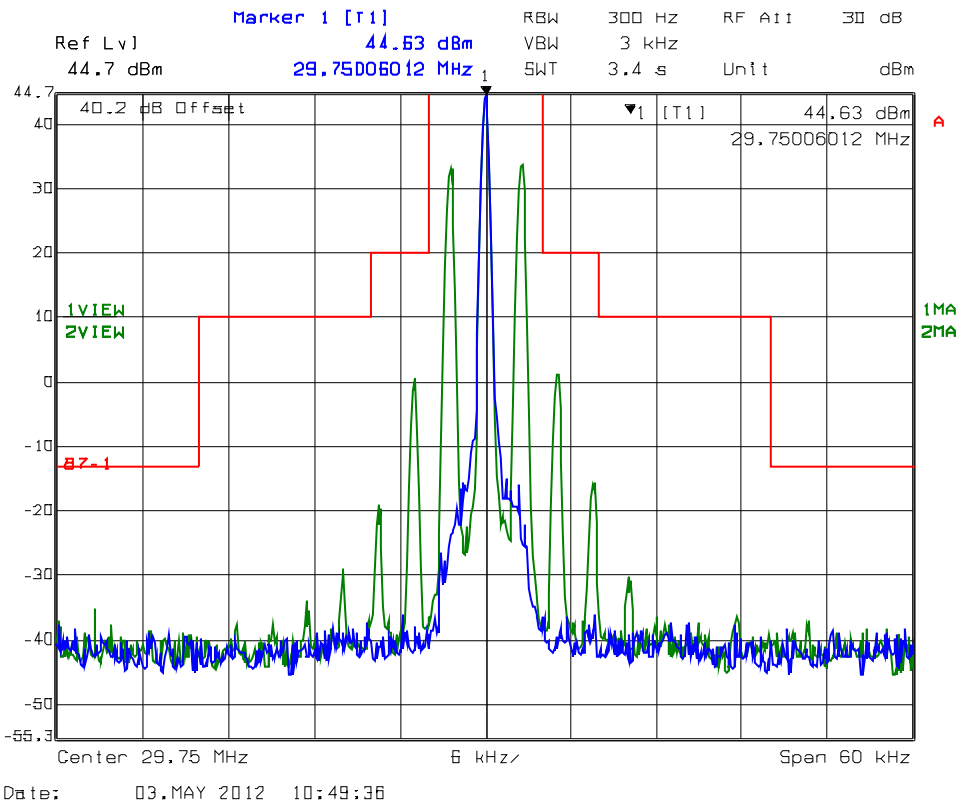
Test Frequency:	17.45 MHz
Power:	Maximum



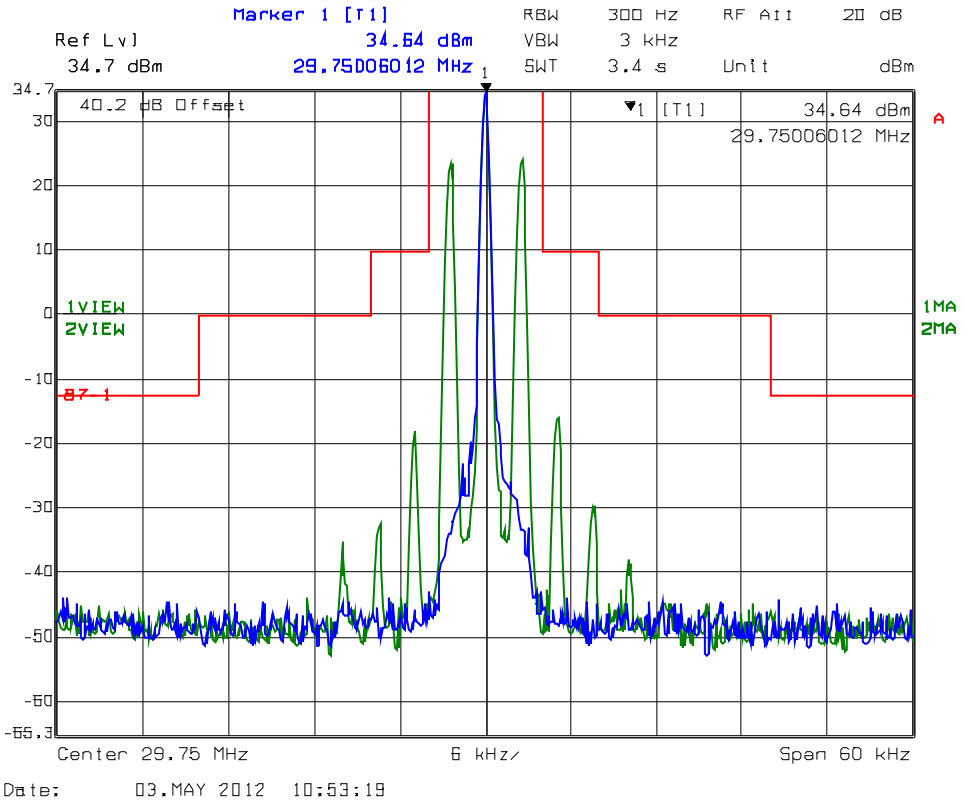
Test Frequency:	17.45 MHz
Power:	Minimum



Test Frequency:	29.75 MHz
Power:	Maximum

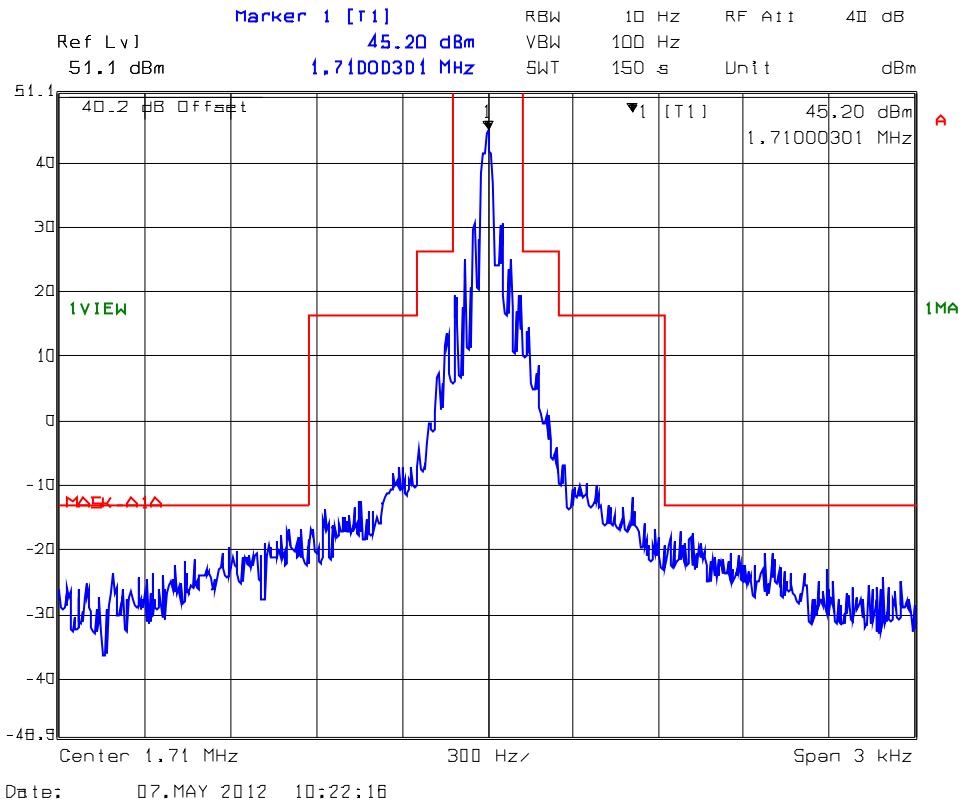


Test Frequency:	29.75 MHz
Power:	Minimum

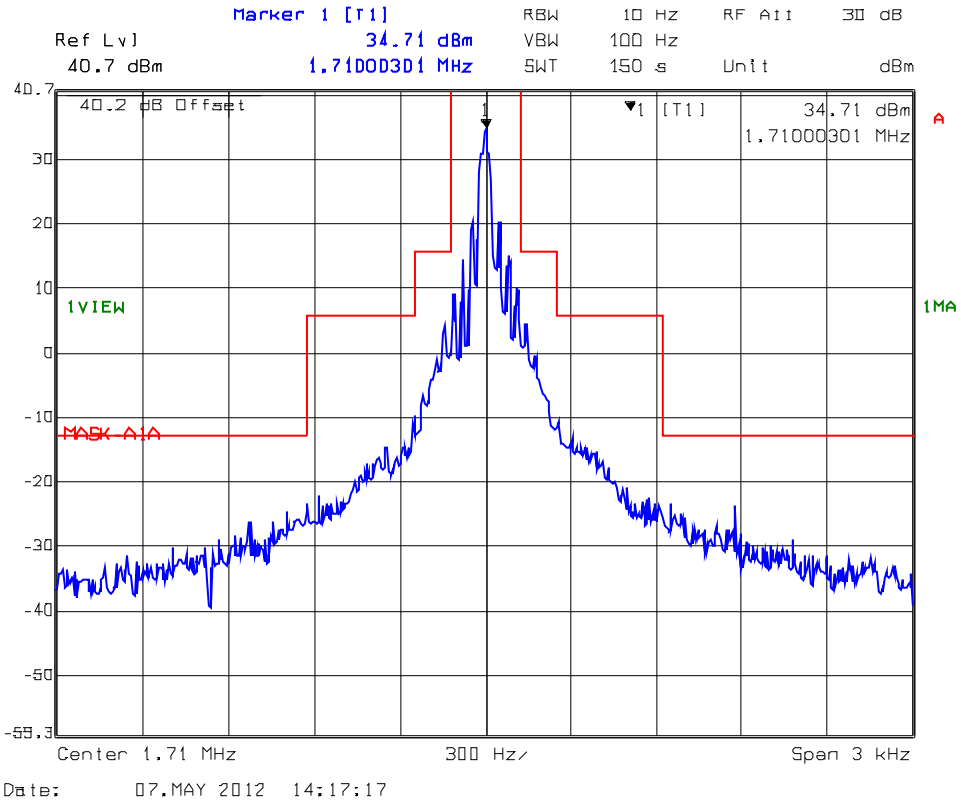


Plot 5.4.4.1.7. - Emissiom Mask B, Modulation: 100HA1A (16 dot / second, dot length 30 ms)

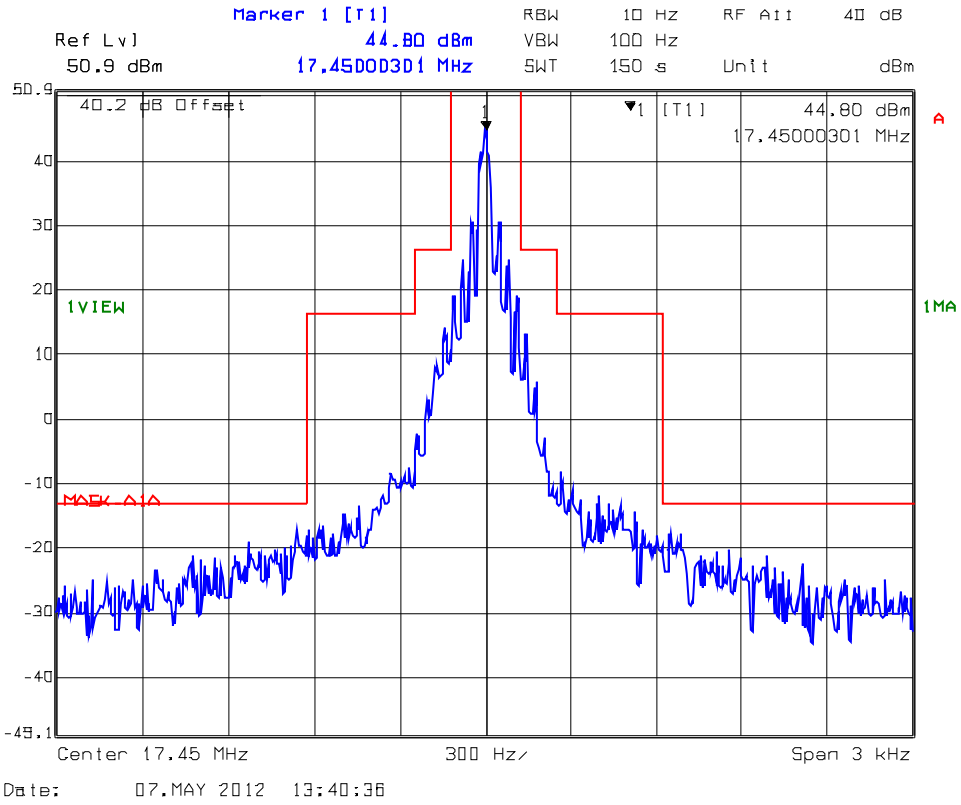
Test Frequency:	1.71 MHz
Power:	Maximum



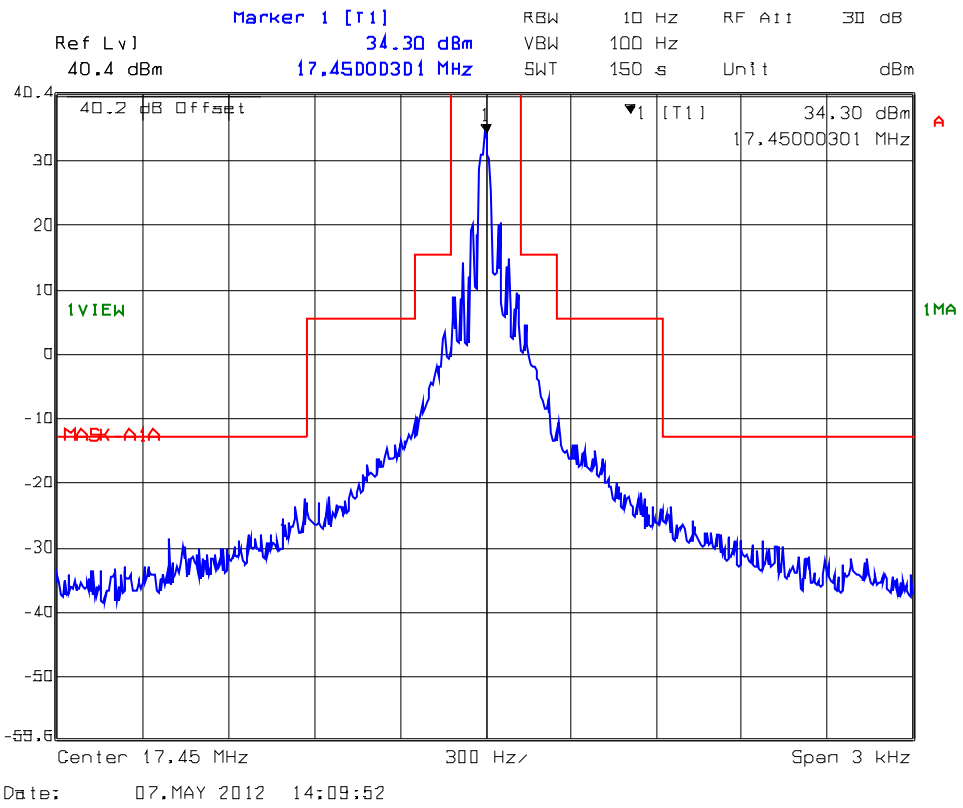
Test Frequency:	1.71 MHz
Power:	Minimum



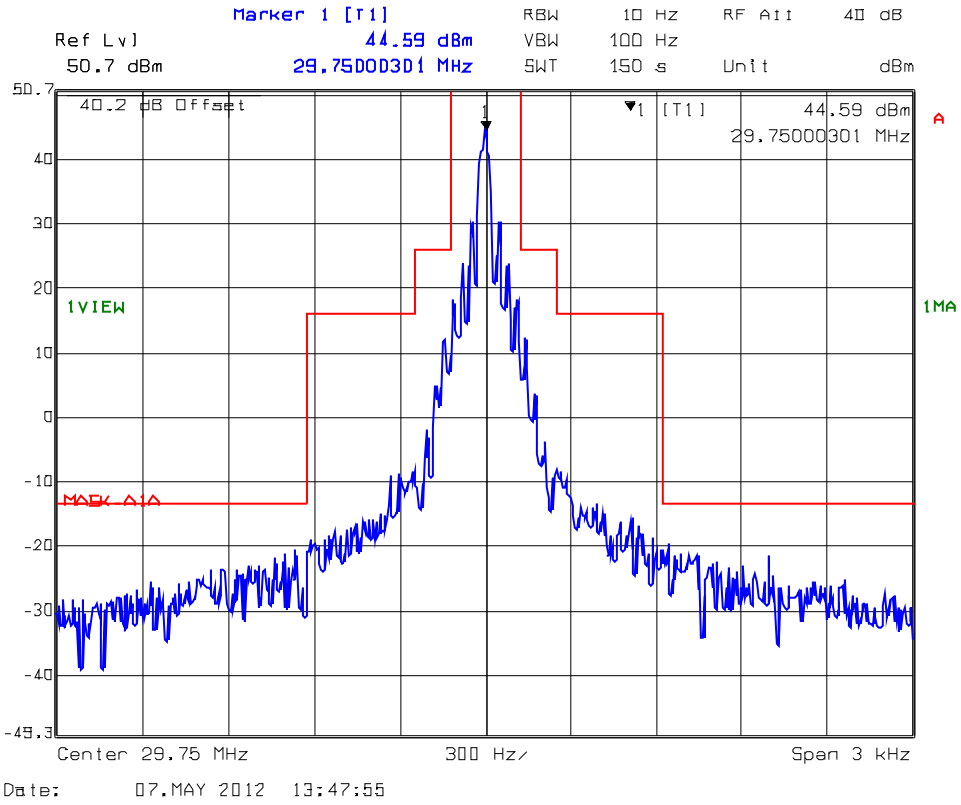
Test Frequency:	17.45 MHz
Power:	Maximum



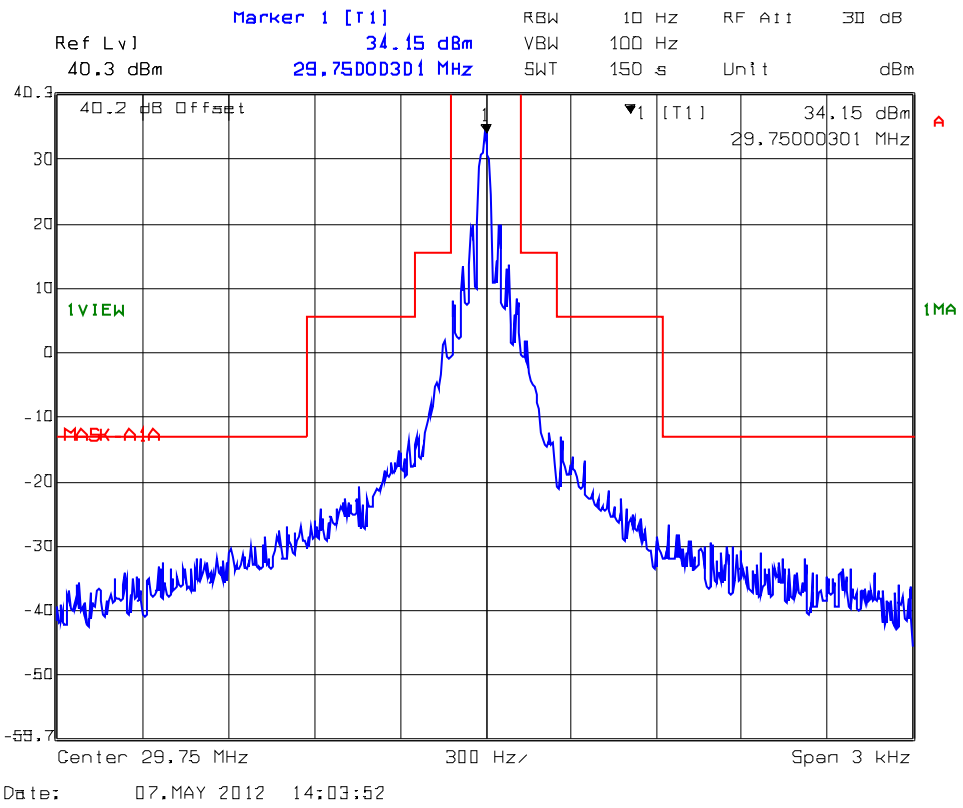
Test Frequency:	17.45 MHz
Power:	Minimum



Test Frequency:	29.75 MHz
Power:	Maximum



Test Frequency:	29.75 MHz
Power:	Minimum

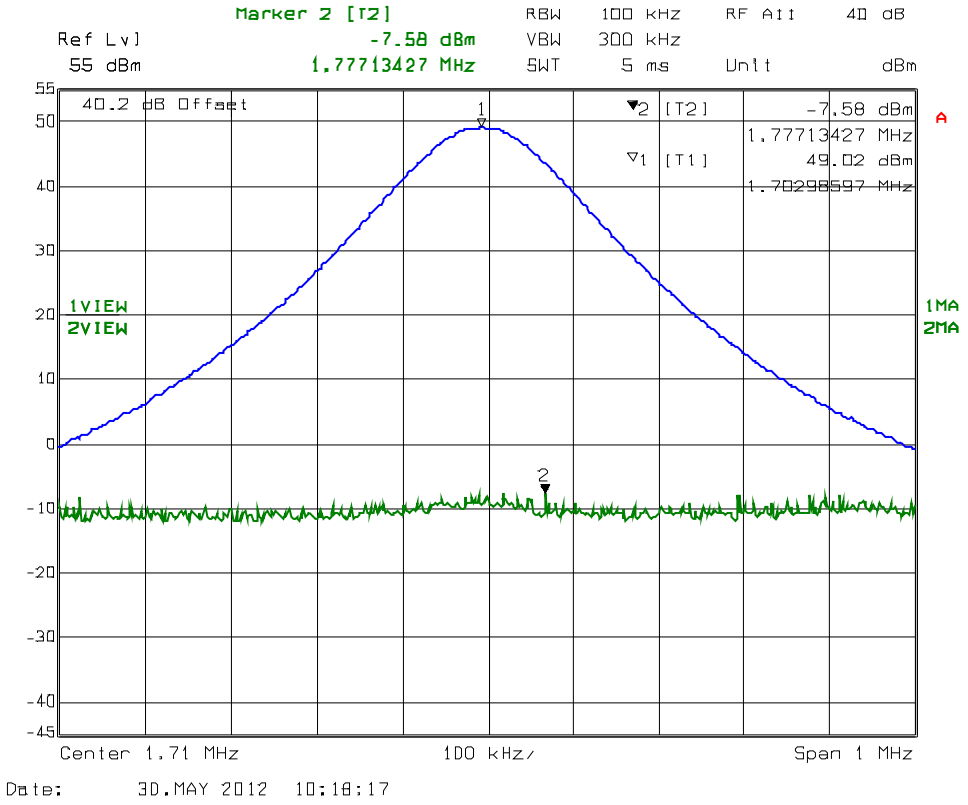


Plot 5.4.4.1.8. - J2B Carrier Suppresion & Emissiom Mask B, Modulation: 2K80J2B (AFSK Tone Frequency 1.2KHz Shift Frequency 850Hz, Shift rate 100)

Carrier Suppresion:

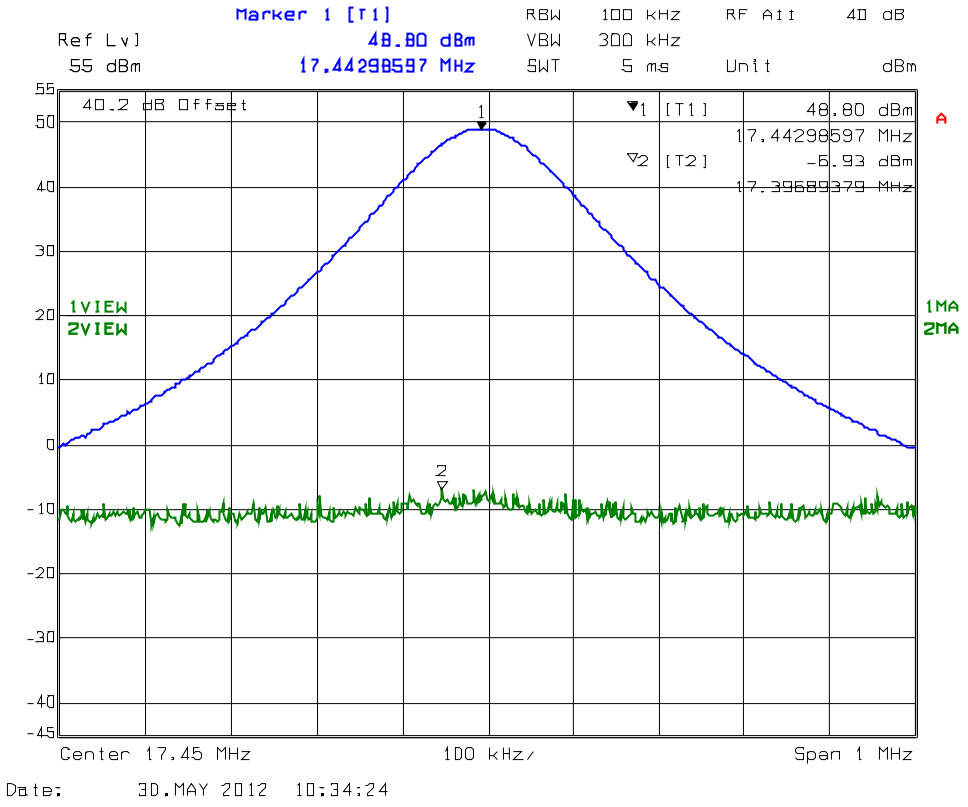
FCC 90.210 Requirement: The carrier must be at least 40 dB below the peak envelope power

Channel Frequency: 1.71 MHz



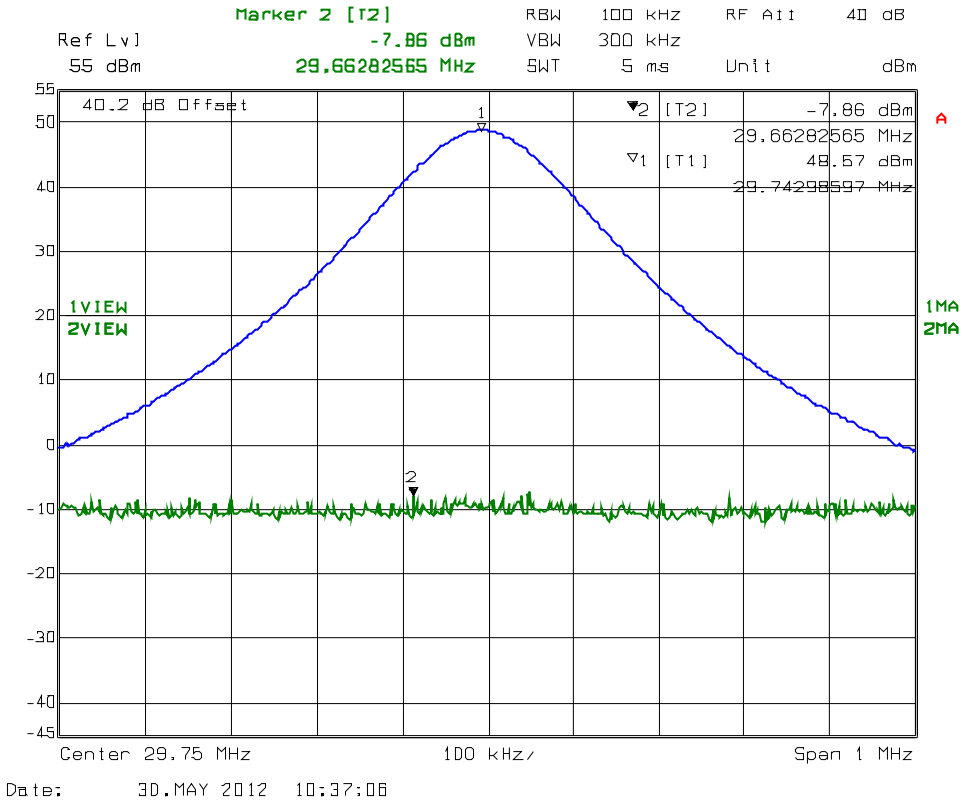
Test Result: Comply; the J2B modulated peak envelope power – unmodulated carrier power = 49.02 dBm – (-7.58) dBm) = 56.6 dB > 40 dB

Channel Frequency: 17.45 MHz



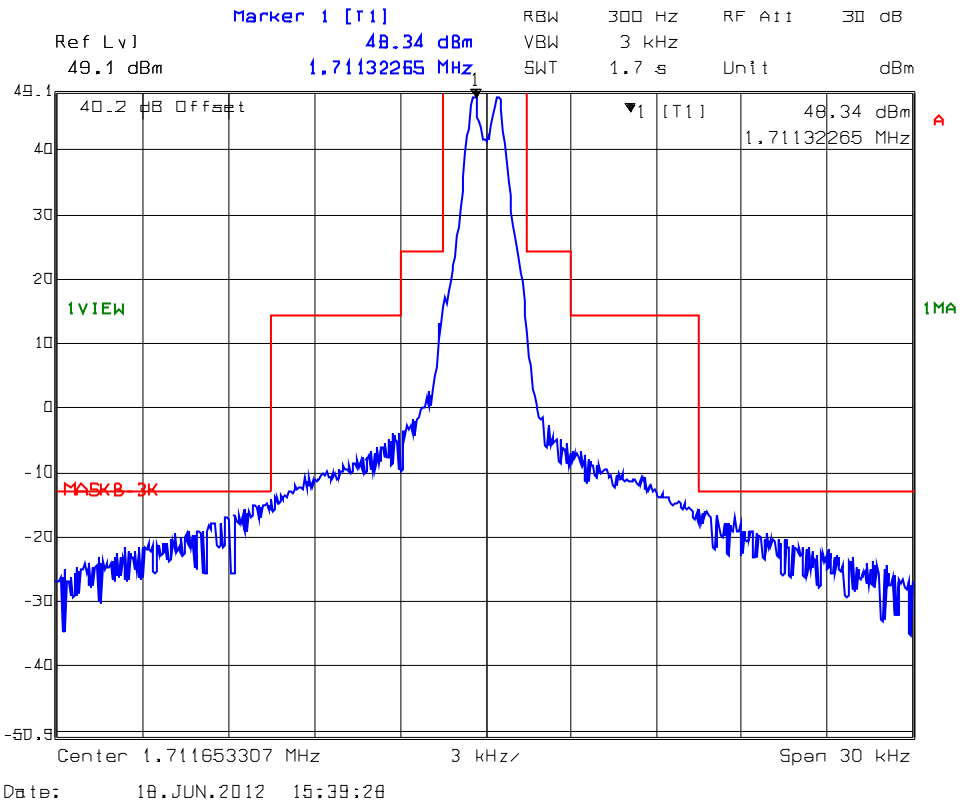
Test Result: Comply; the J2B modulated peak envelope power – unmodulated carrier power = 48.80 dBm – (-5.93 dBm) = 54.73 dB > 40 dB

Channel Frequency: 29.75 MHz

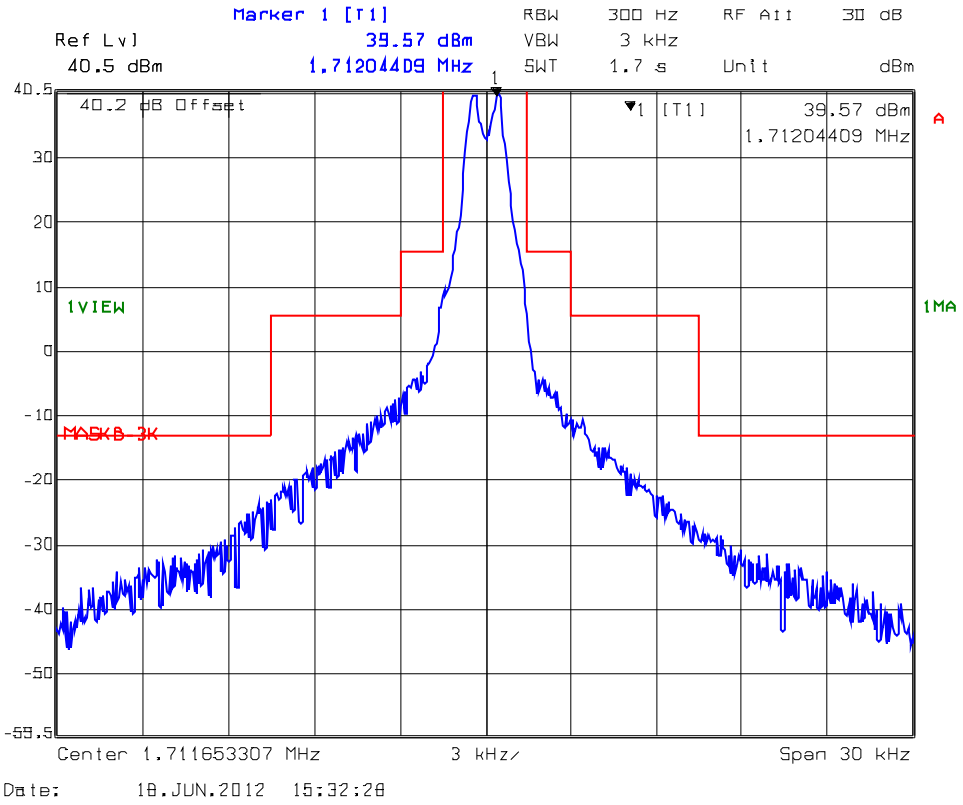


Test Result: Comply; the J2B modulated peak envelope power – unmodulated carrier power = 48.57 dBm – (-7.86 dBm) = 56.43 dB > 40 dB

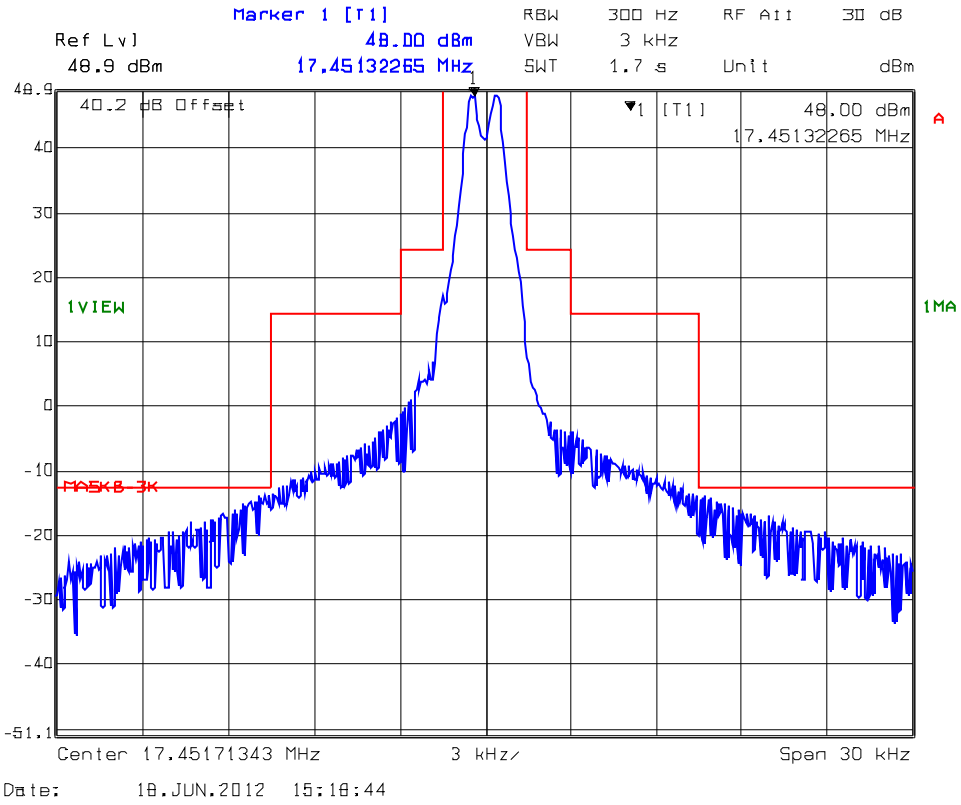
Test Frequency:	1.71 MHz
Power:	Maximum



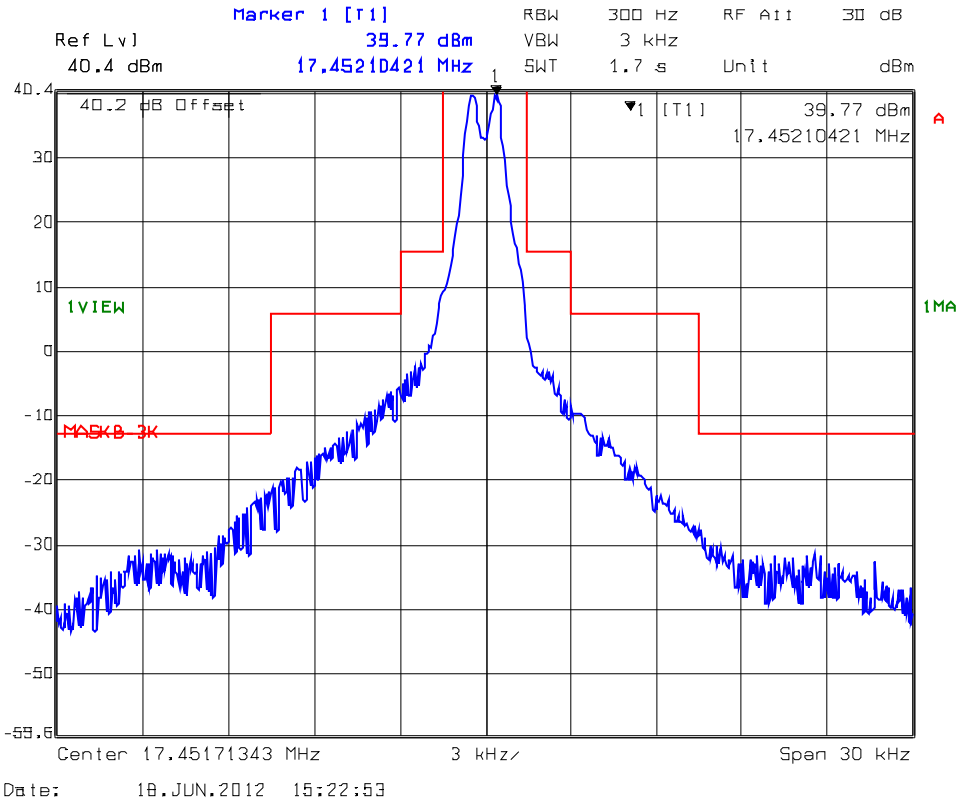
Test Frequency:	1.71 MHz
Power:	Minimum



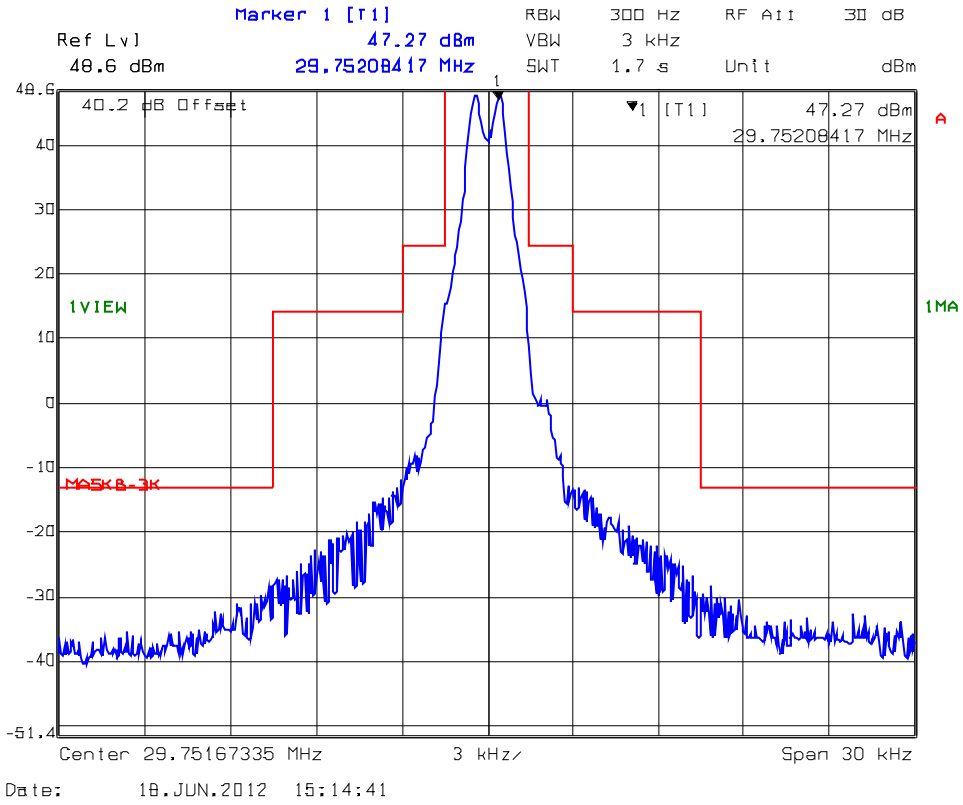
Test Frequency:	17.45 MHz
Power:	Maximum



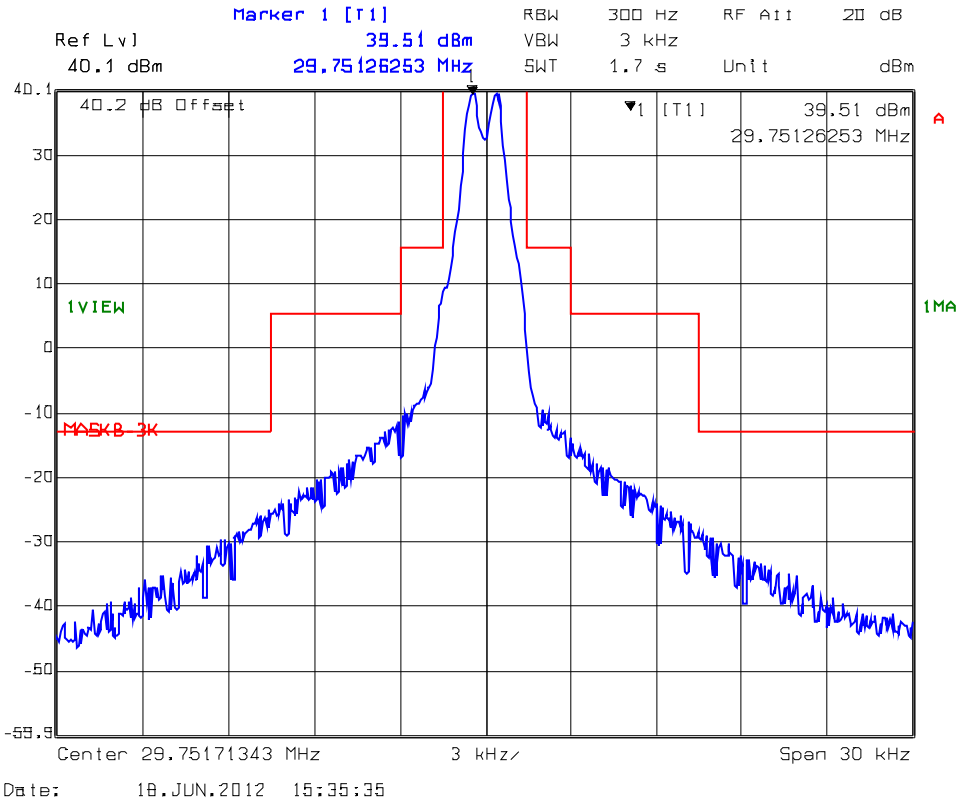
Test Frequency:	17.45 MHz
Power:	Minimum



Test Frequency:	29.75 MHz
Power:	Maximum

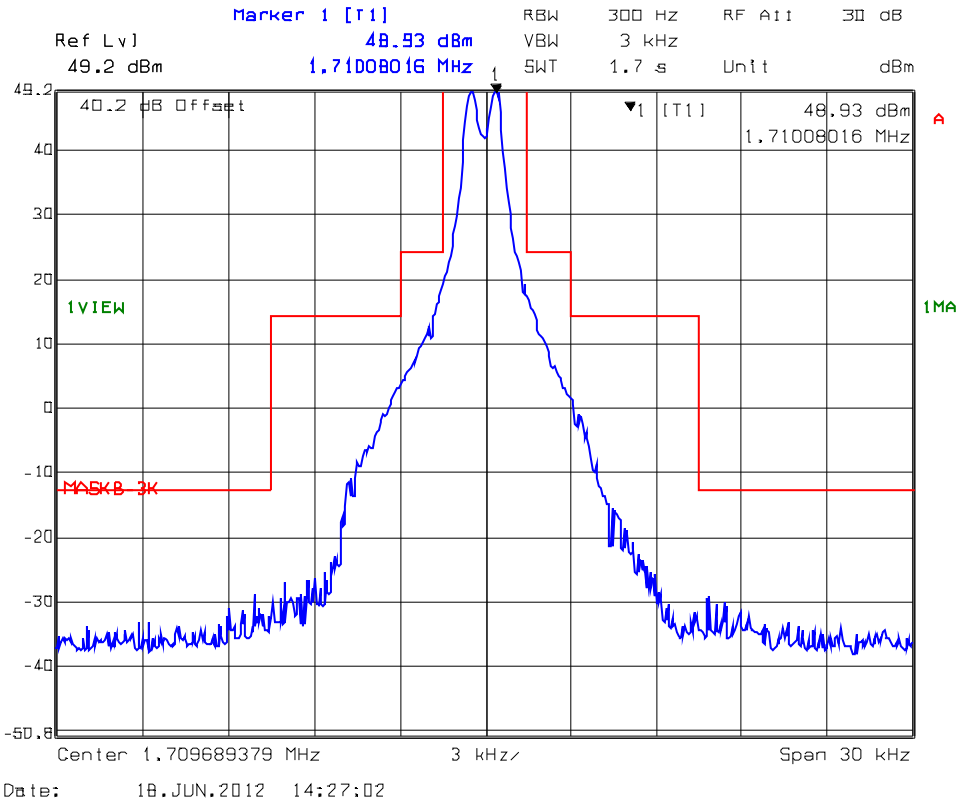


Test Frequency:	29.75 MHz
Power:	Minimum

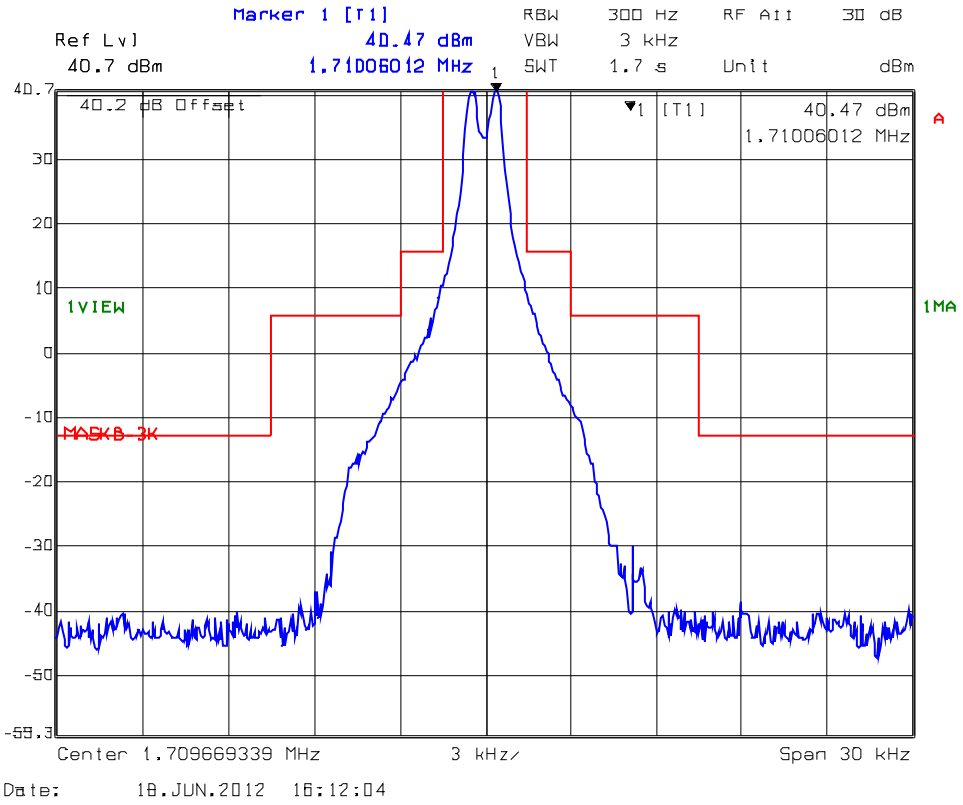


Plot 5.4.4.1.9. - Emissiom Mask B, Modulation: 2K80F1B (Shift Frequency 850Hz, Shift rate 100)

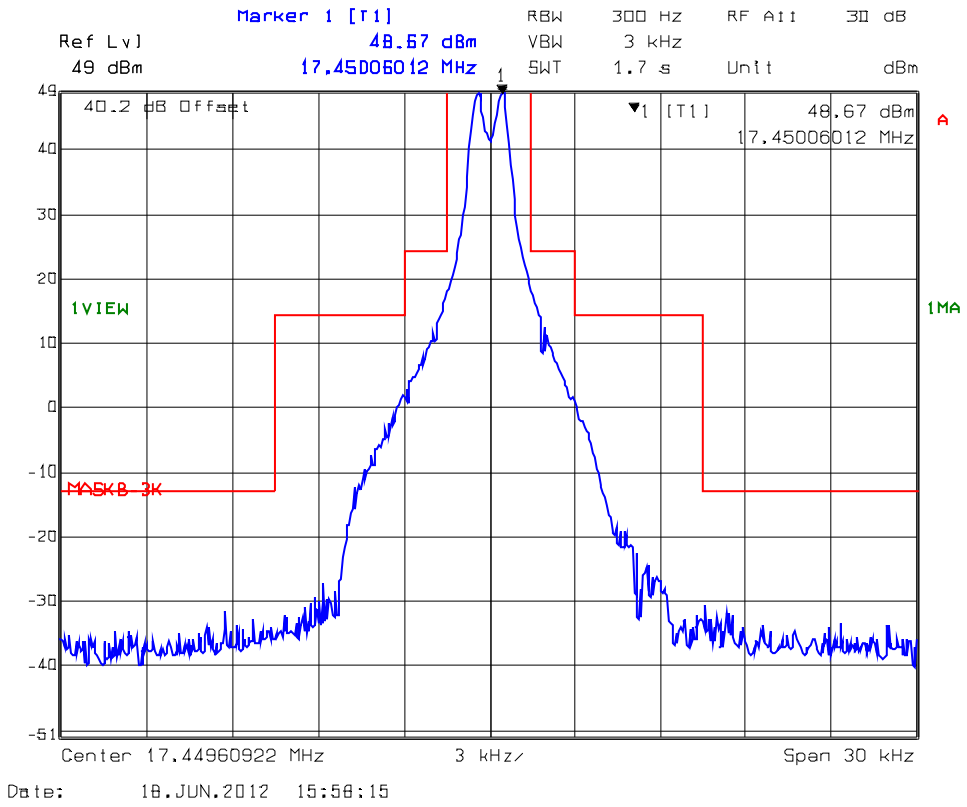
Test Frequency:	1.71 MHz
Power:	Maximum



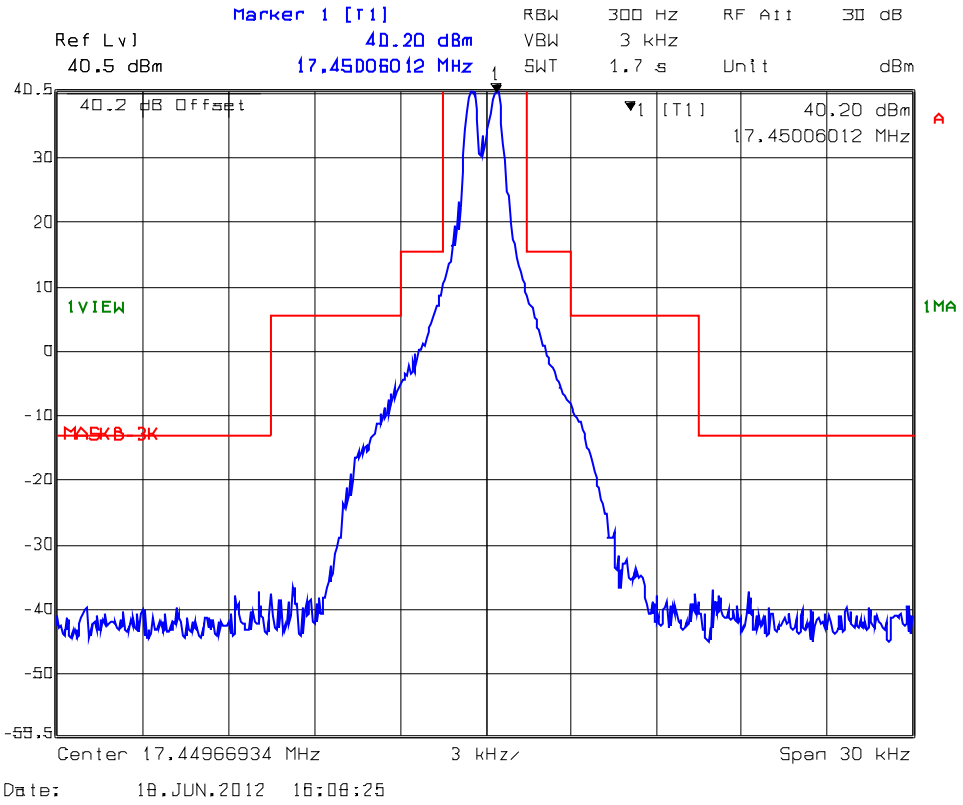
Test Frequency:	1.71 MHz
Power:	Minimum



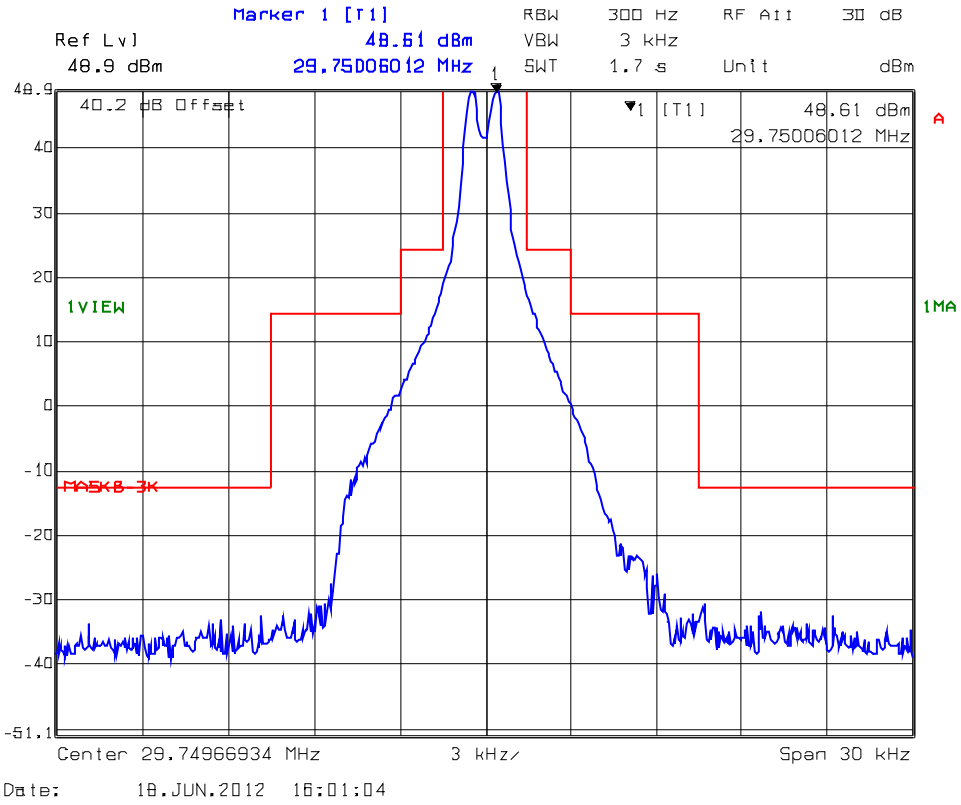
Test Frequency:	17.45 MHz
Power:	Maximum



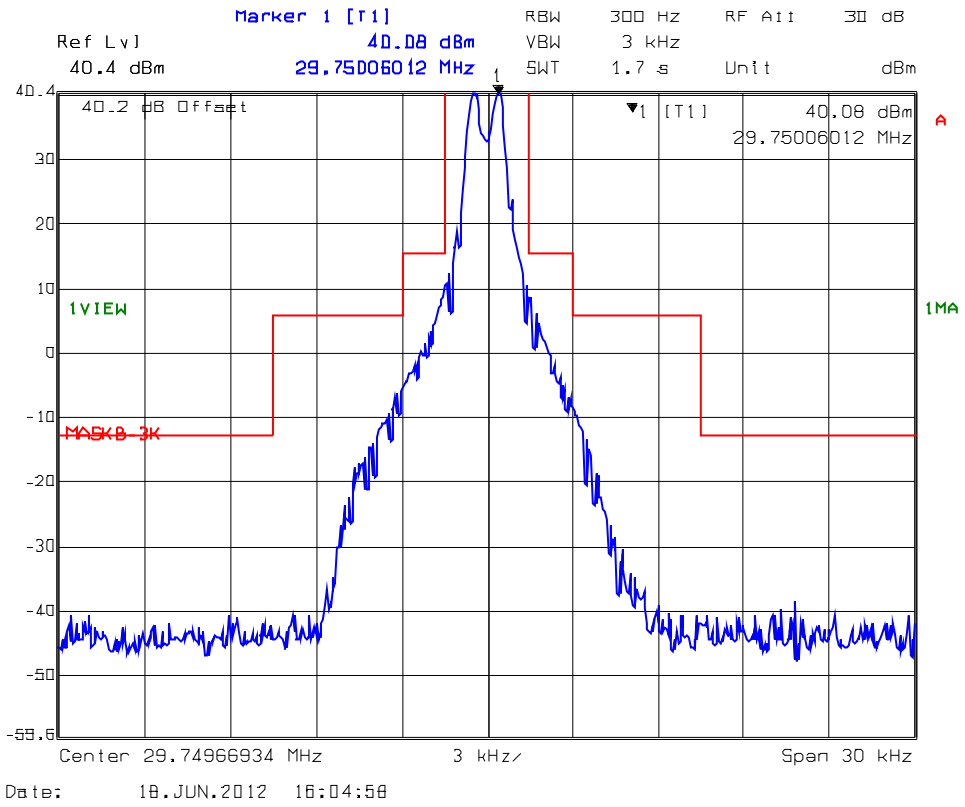
Test Frequency:	17.45 MHz
Power:	Minimum



Test Frequency:	29.75 MHz
Power:	Maximum



Test Frequency:	29.75 MHz
Power:	Minimum

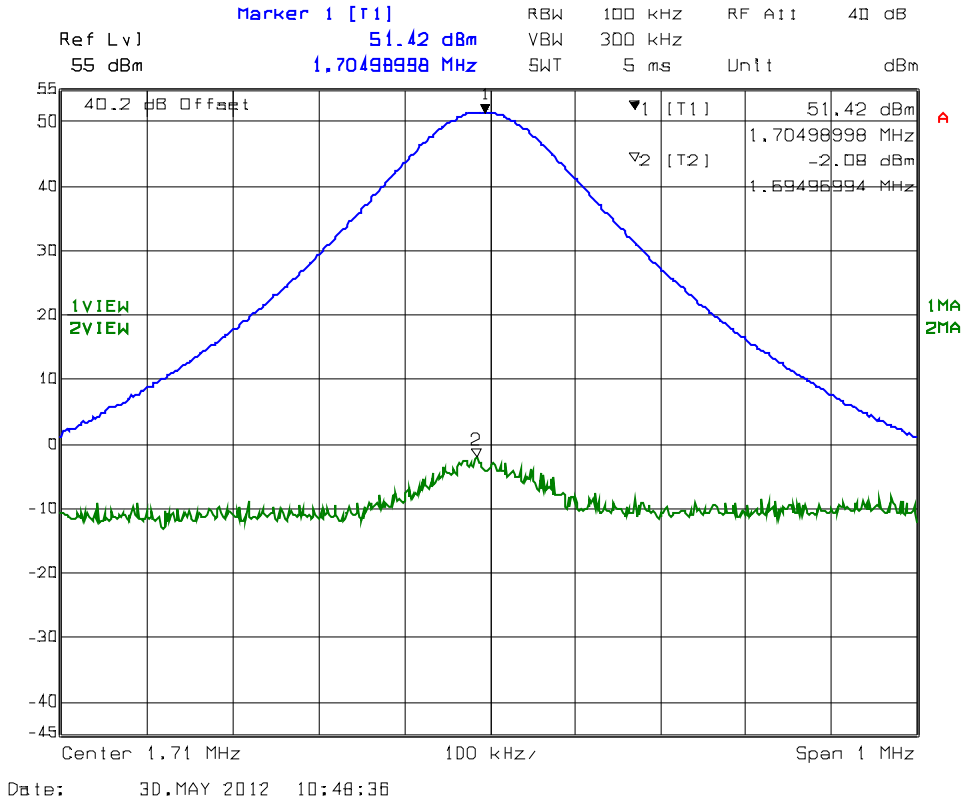


Plot 5.4.4.1.10. - J3E Carrier Suppresion & Emissiom Mask A, Modulation: 2K80J3E (400 Hz + 1800 Hz)

Carrier Suppresion:

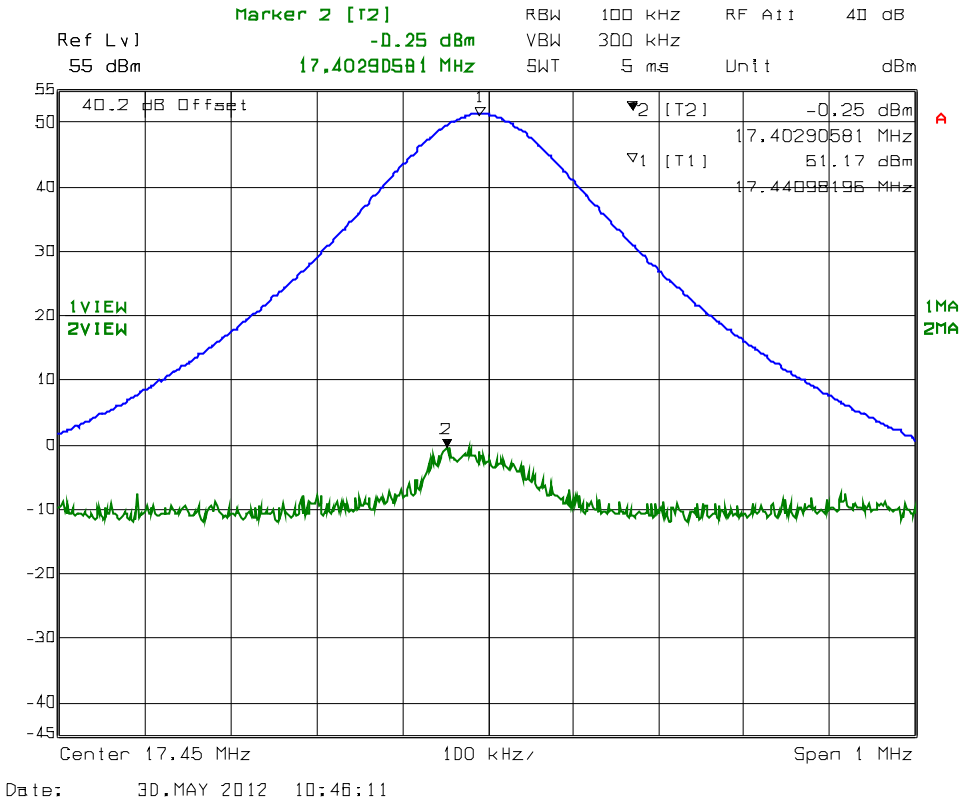
FCC 90.210 Requirement: The carrier must be at least 40 dB below the peak envelope power

Channel Frequency: 1.71 MHz



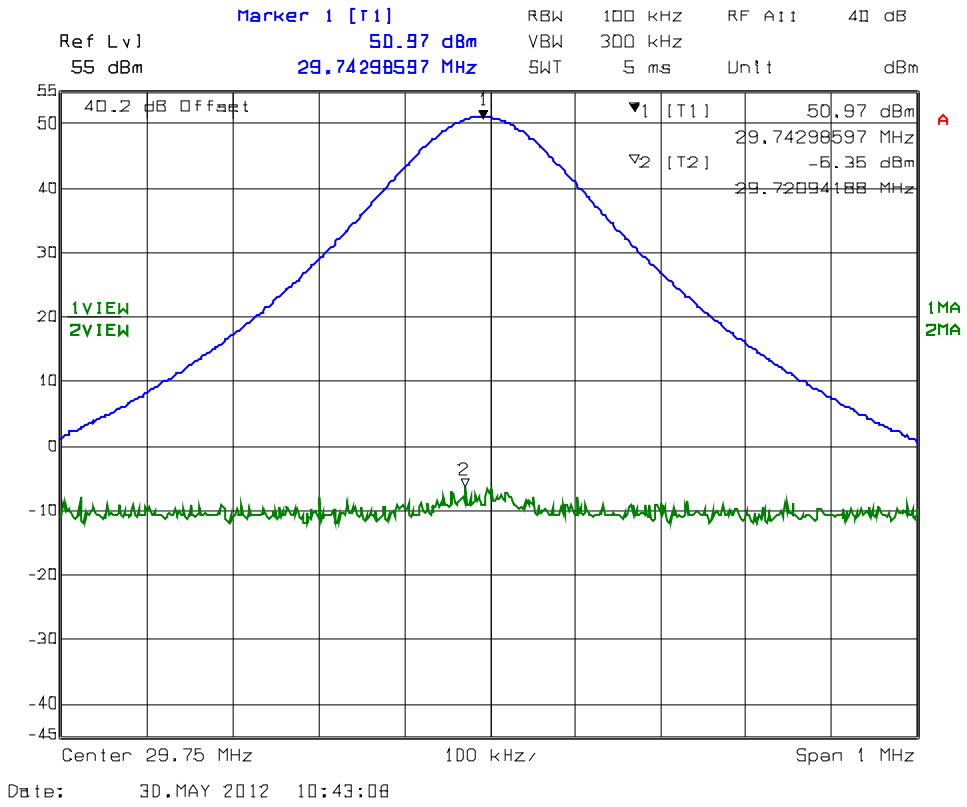
Test Result: Comply; the J3E modulated peak envelope power – unmodulated carrier power = 51.42 dBm – (-2.08 dBm) = 53.5 dB > 40 dB

Channel Frequency: 17.45 MHz



Test Result: Comply; the J3E modulated peak envelope power – unmodulated carrier power = 51.17 dBm – (-0.25 dBm) = 51.42 dB > 40 dB

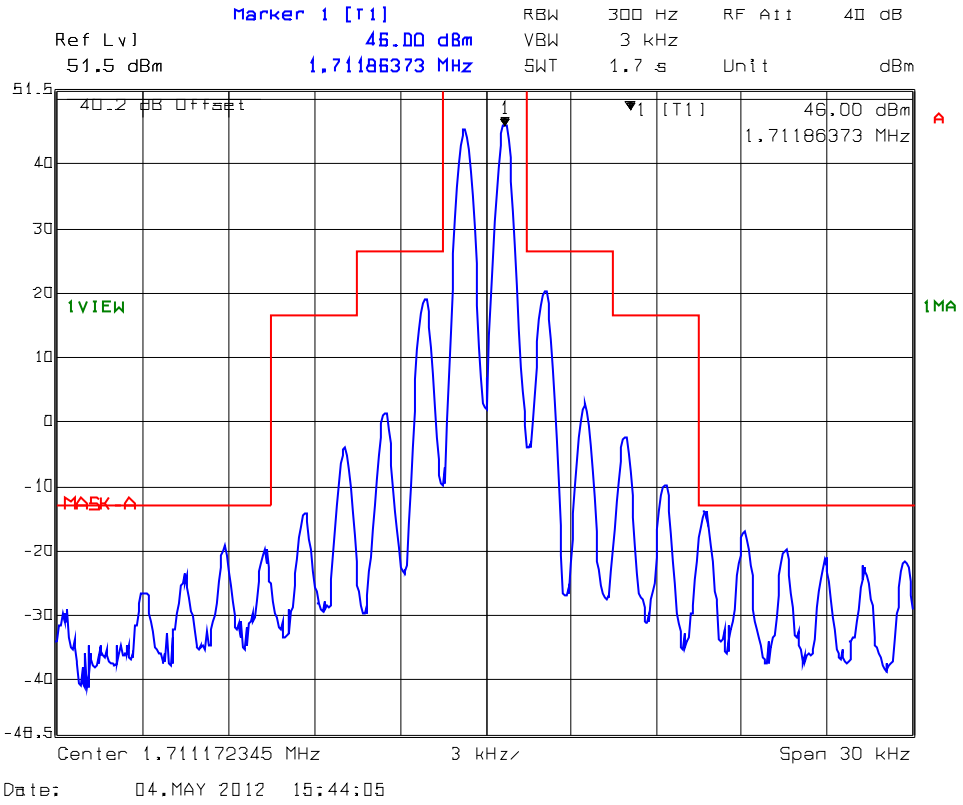
Channel Frequency: 29,75 MHz



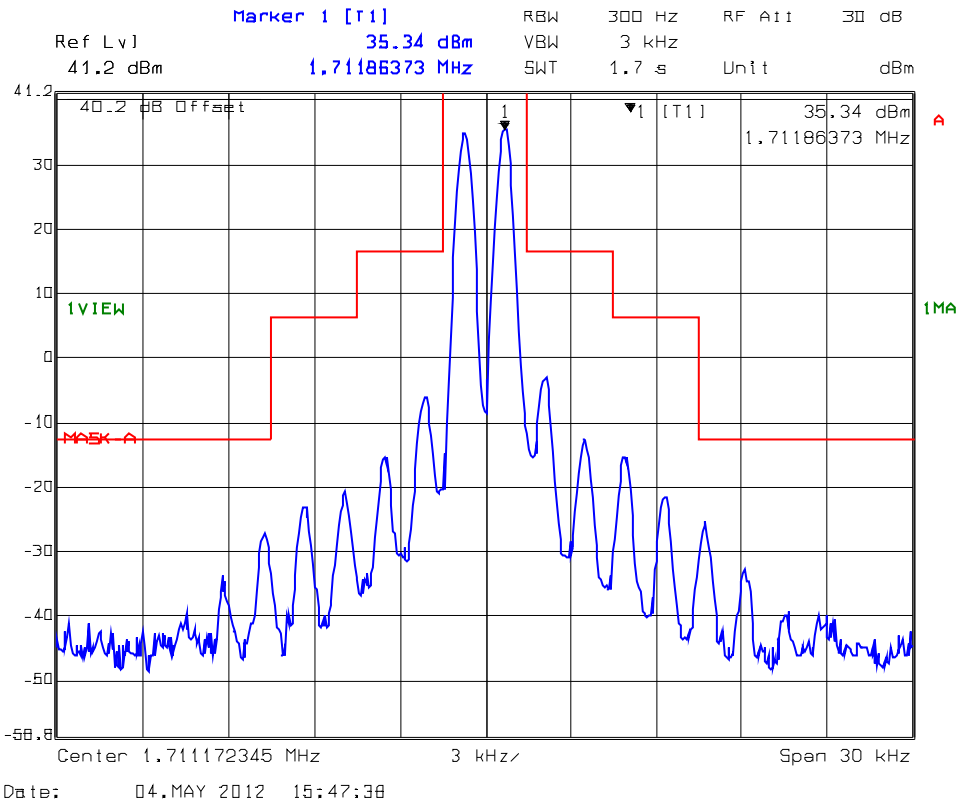
Test Result: Comply; the J3E modulated peak envelope power – unmodulated carrier power = 50.97 dBm – (-6.36 dBm) = 57.33 dB > 40 dB

Emission Mask A

Test Frequency:	1.71 MHz
Power:	Maximum

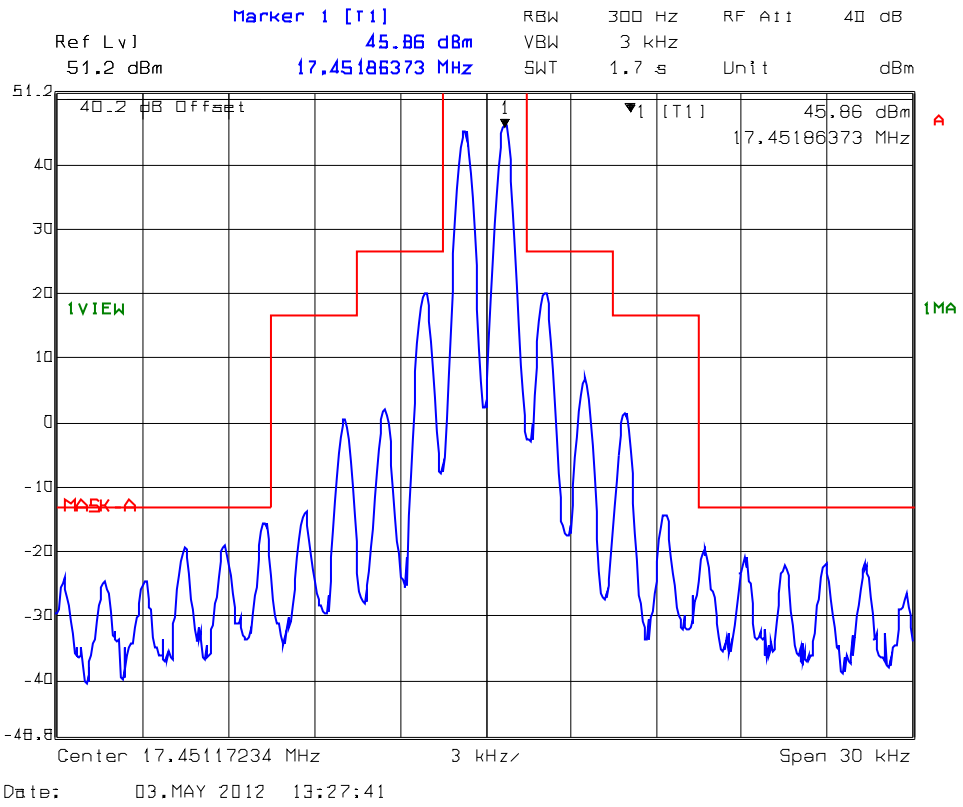


Test Frequency:	1.71 MHz
Power:	Minimum



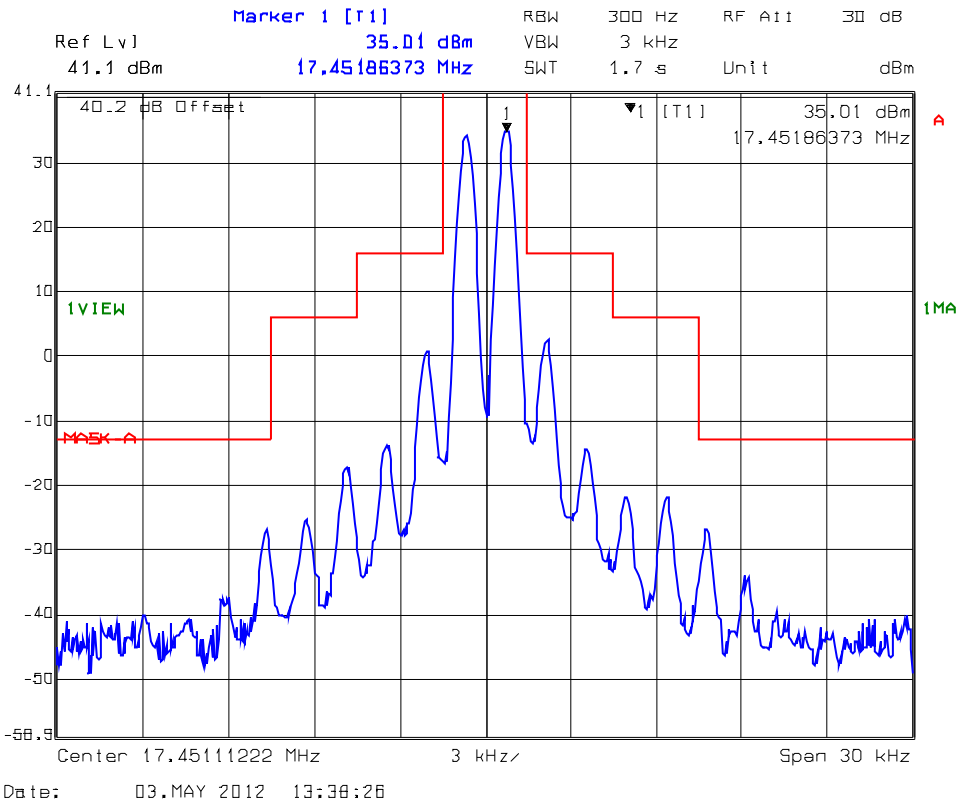
Emission Mask A

Test Frequency:	17.45 MHz
Power:	Maximum



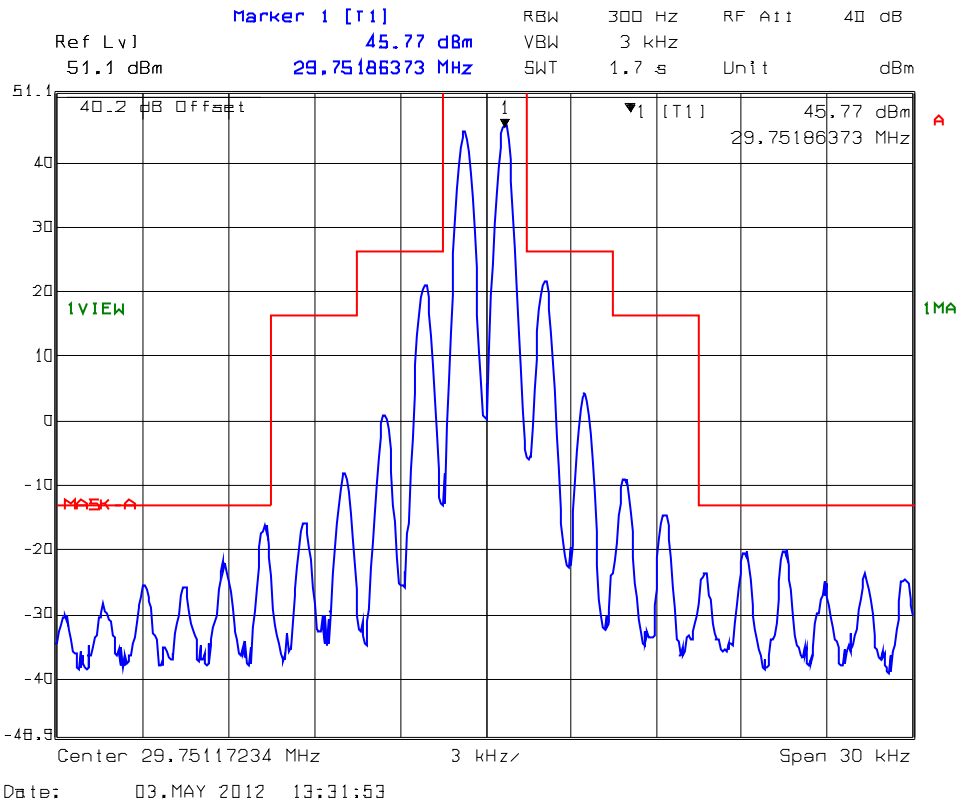
Emission Mask A

Test Frequency:	17.45 MHz
Power:	Minimum

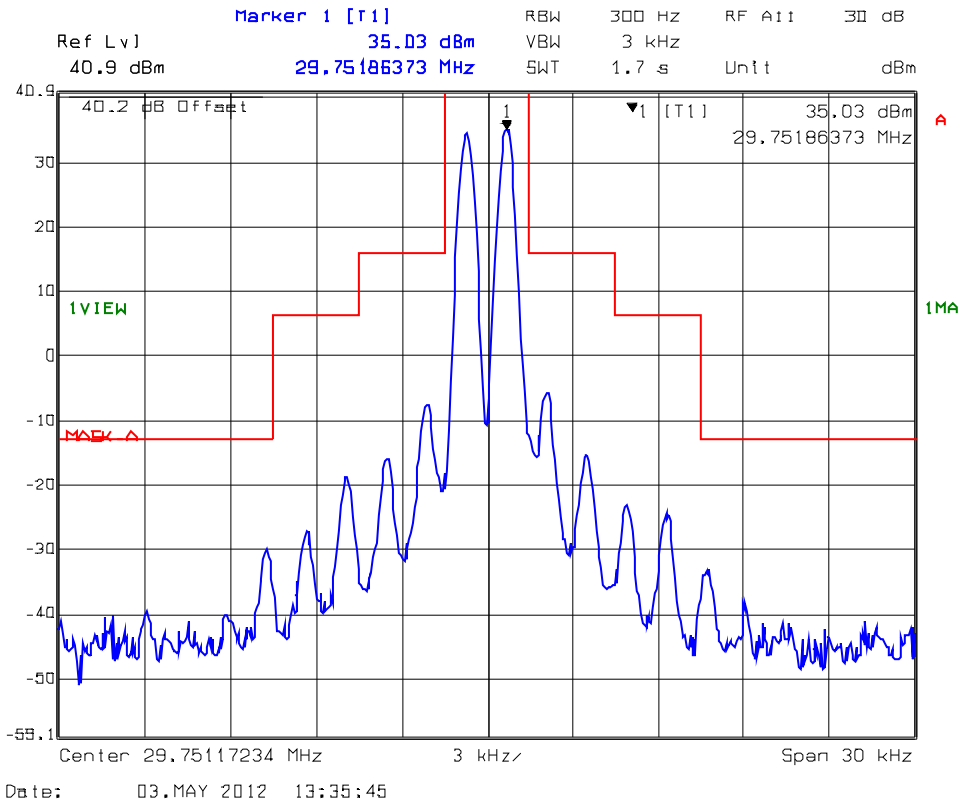


Emission Mask A

Test Frequency:	29.75 MHz
Power:	Maximum



Test Frequency:	29.75 MHz
Power:	Minimum



5.5. TRANSMITTER ANTENNA POWER SPURIOUS/HARMONIC CONDUCTED EMISSIONS [§ 2.1051, 2.1057, 90.210]

5.5.1. Limits

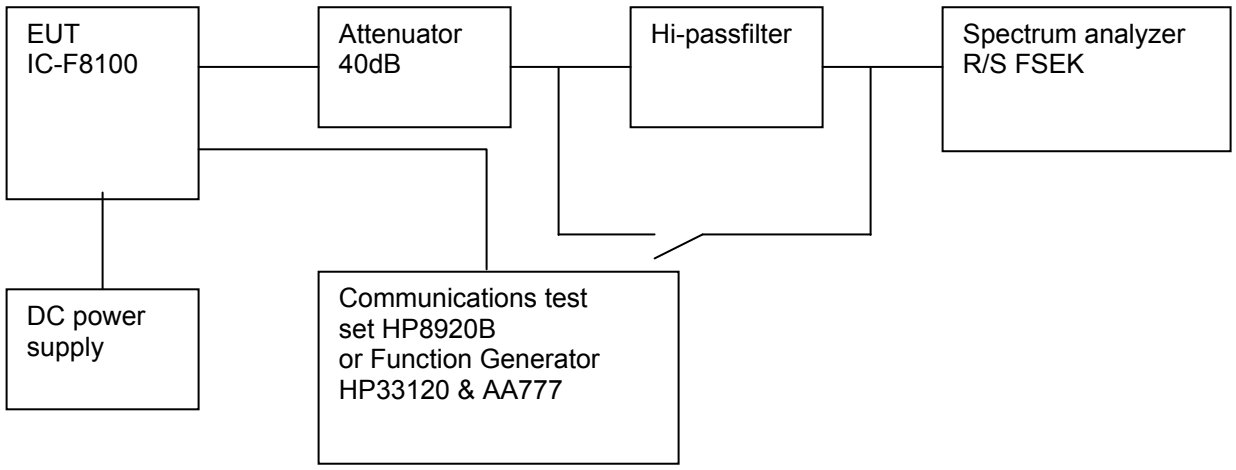
Emissions shall be attenuated below the mean output power of the transmitter as follows:

FCC Rules	Frequency Range	Attenuation Limit (dBc)
§ 90.210 (Mask A & B)	On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 + 10 log P dB.	At least 43 + 10 log (P) dB

5.5.2. Method of Measurements

Refer to Section 7.5 of this report for measurement details

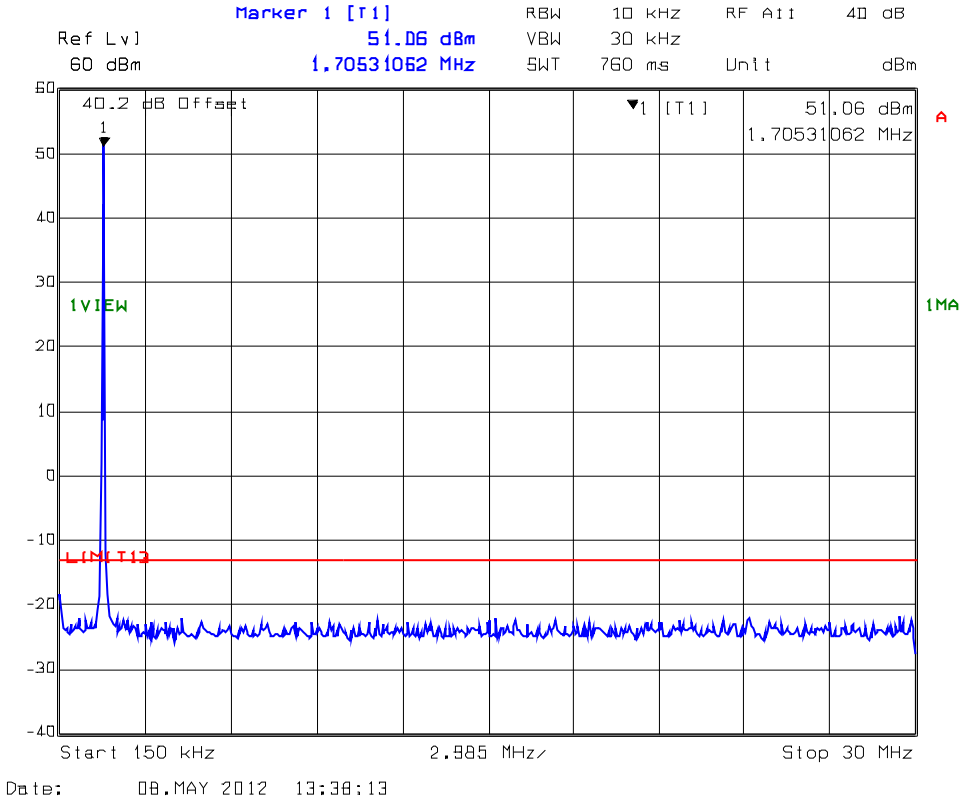
5.5.3. Test Arrangement

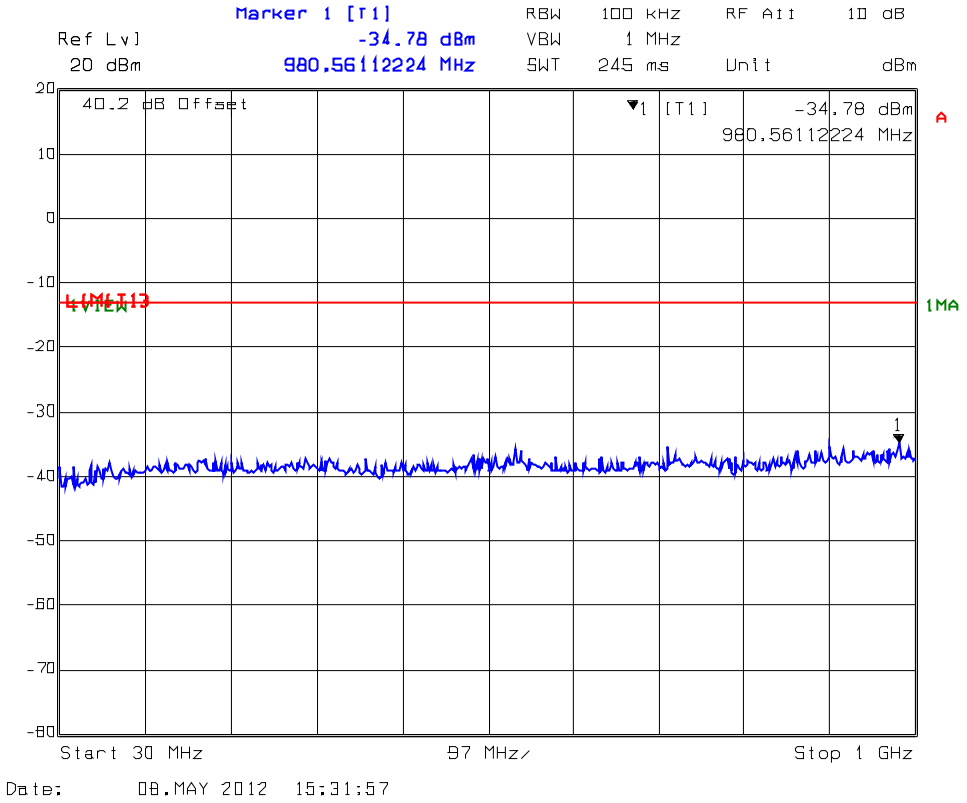


5.5.4. Test Data

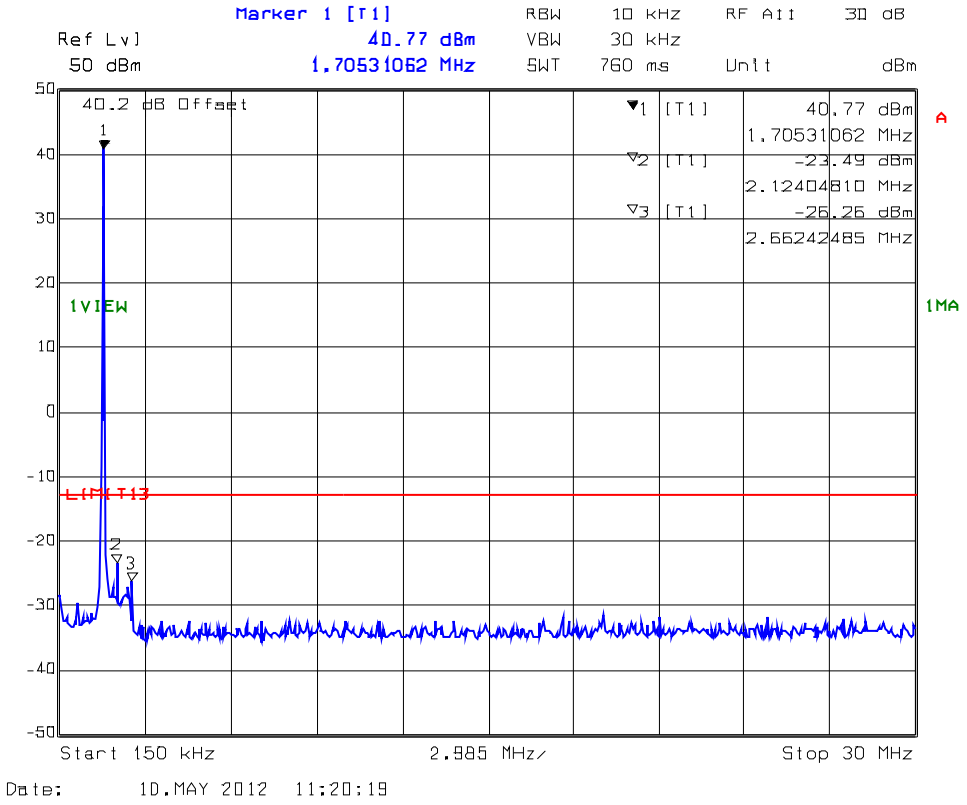
Comments: **The J3E emissions, set at maximum and minimum power (125 Watts & 10 watts) are chosen to be tested for worst case**

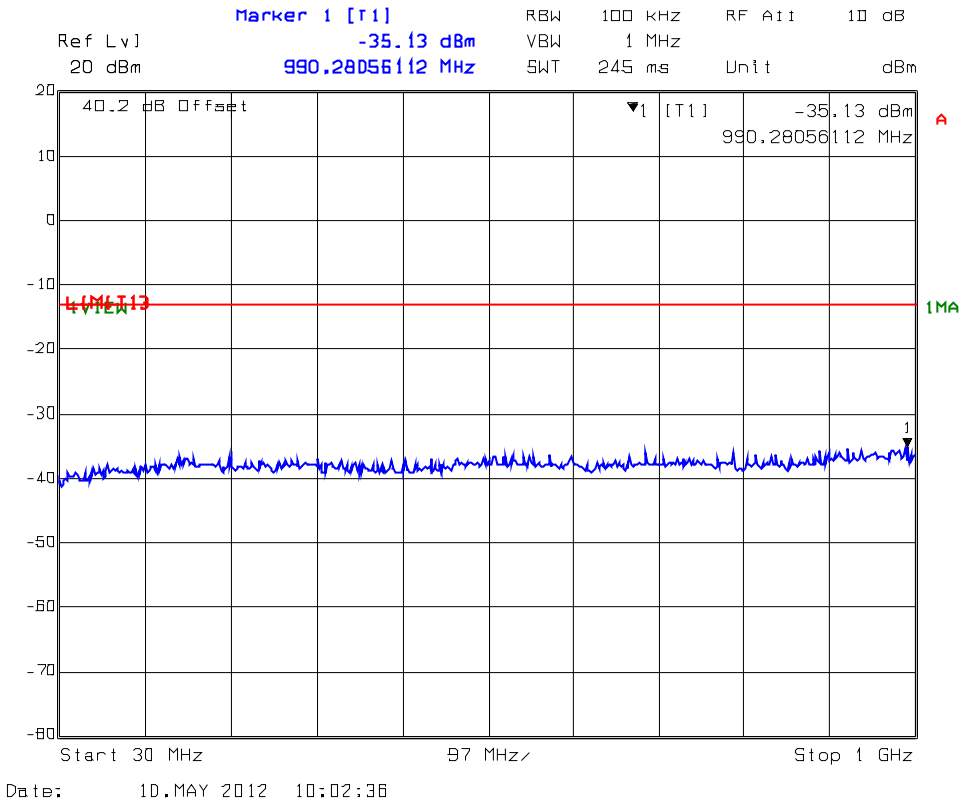
Plot 5.5.4.1.1. Conducted Transmitter Spurious Emissions form 0.15-1000 MHz for 1.71 MHz, Modulation: J3E, High Power



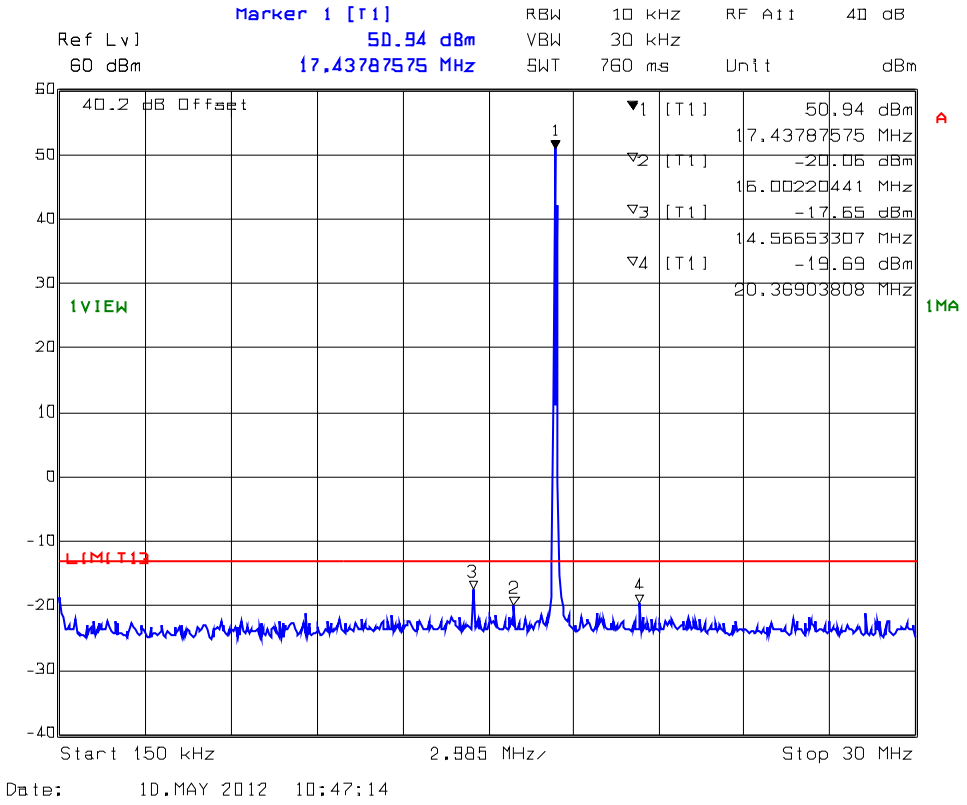

Marker 1 [T1]
RBW 100 kHz
RF Att 10 dB
Ref Lvl
-34.78 dBm
VBW 1 MHz
20 dBm
980.56112224 MHz
SWT 245 ms
Unit dBm
40.2 dB Offset
1 [T1] -34.78 dBm
980.56112224 MHz
A
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
LIMIT13
VIEW
1MA
1
Start 30 MHz
97 MHz/
Stop 1 GHz
Date: 08.MAY 2012 15:31:57

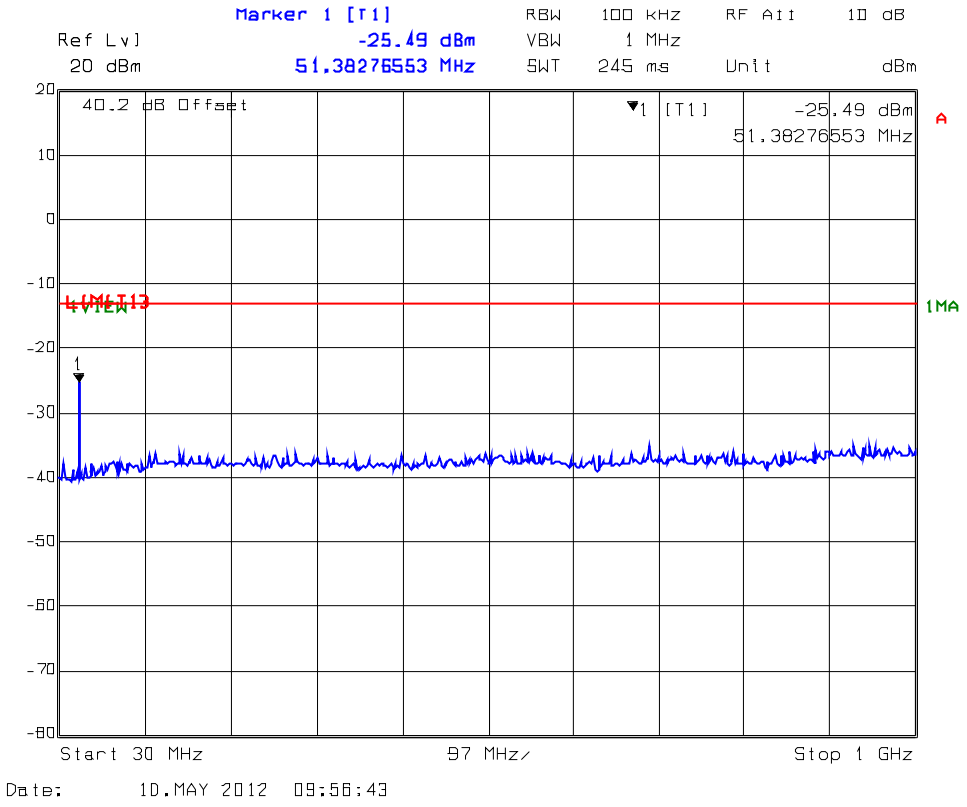
Plot 5.5.4.1.2. Conducted Transmitter Spurious Emissions form 0.15-1000 MHz for 1.71 MHz, Modulation: J3E, Low Power



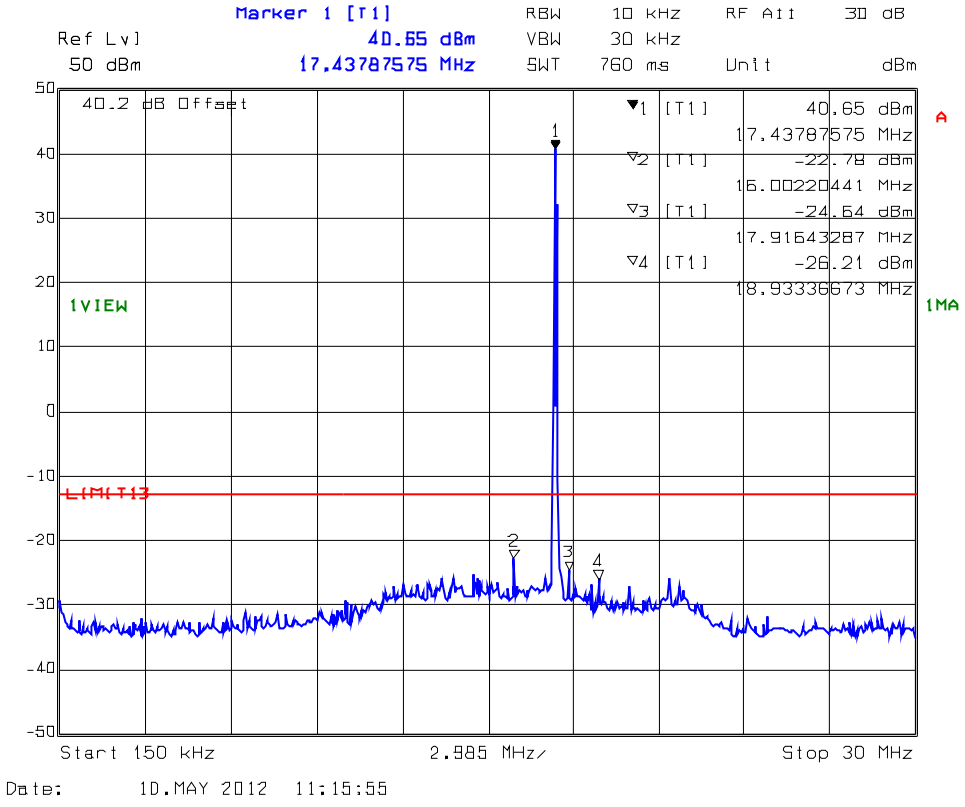

Marker 1 [T1]
RBW 100 kHz
RF Att 10 dB
Ref Lvl
-35.13 dBm
VBW 1 MHz
20 dBm
990.28056112 MHz
SWT 245 ms
Unit dBm
40.2 dB Offset
1 [T1] -35.13 dBm
990.28056112 MHz
A
1MA
VIEW
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Start 30 MHz
97 MHz/
Stop 1 GHz
Date: 10.MAY 2012 10:02:36

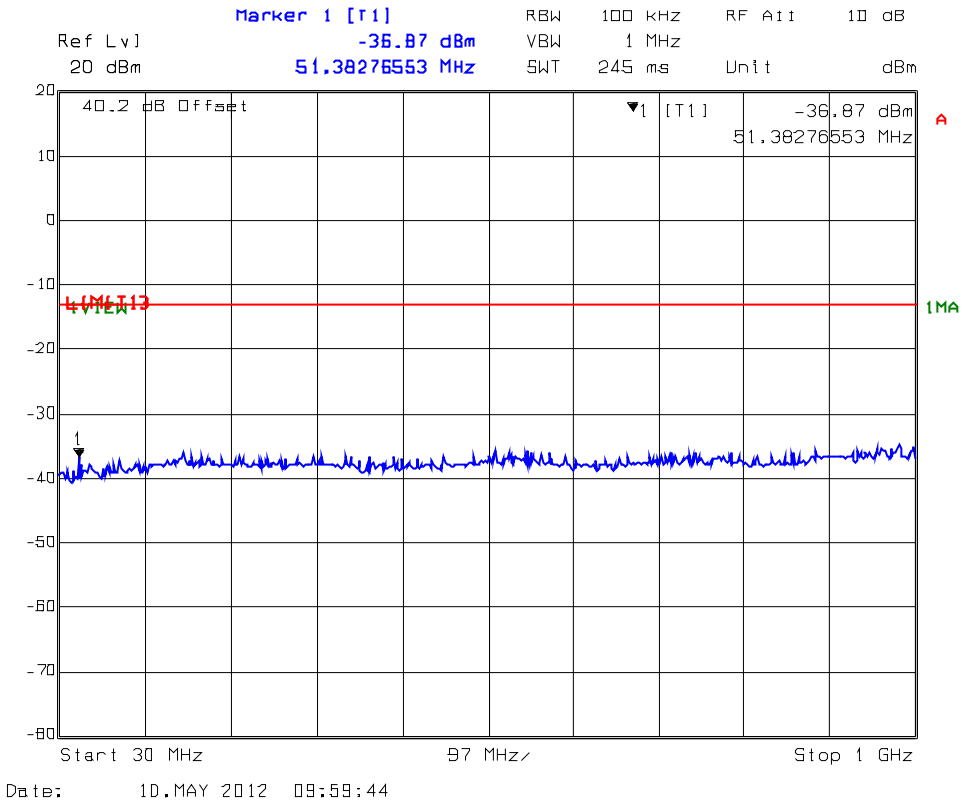
Plot 5.5.4.1.3. Conducted Transmitter Spurious Emissions form 0.150-1000 MHz for 17.45 MHz, Modulation: J3E, High Power



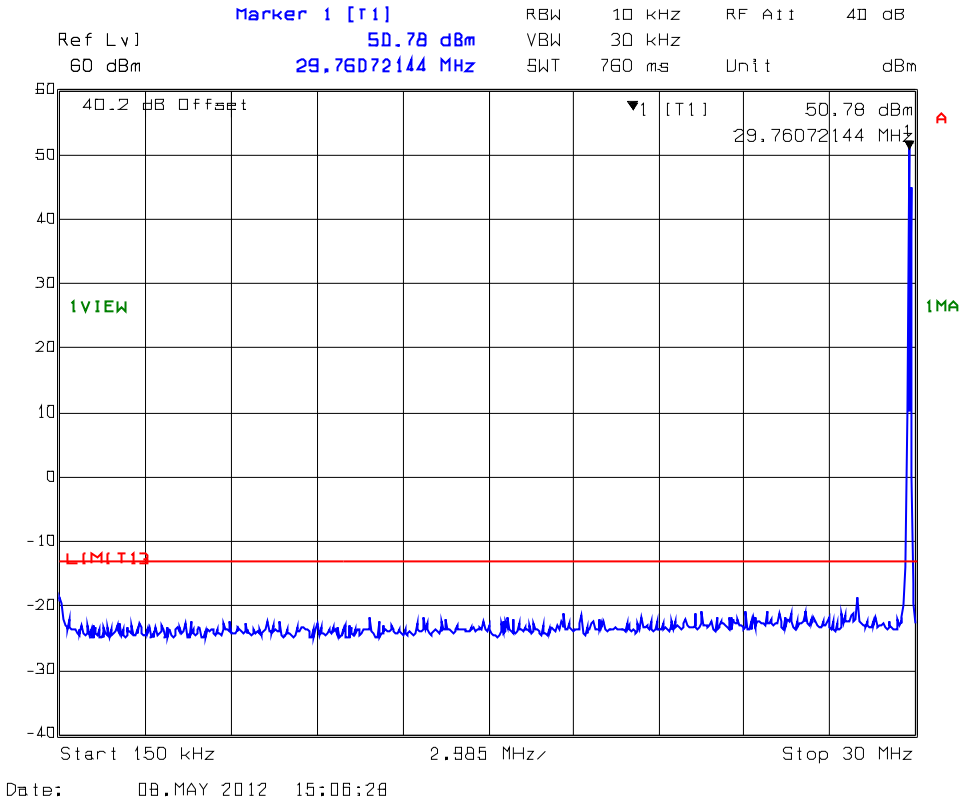

Marker 1 [T1]
RBW 100 kHz
RF Att 10 dB
Ref Lvl
-25.49 dBm
VBW 1 MHz
20 dBm
51.38276553 MHz
SWT 245 ms
Unit dBm
40.2 dB Offset
1 [T1] -25.49 dBm
51.38276553 MHz
A
VIEW
1MA
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Start 30 MHz
97 MHz/
Stop 1 GHz
Date: 10.MAY 2012 09:56:43

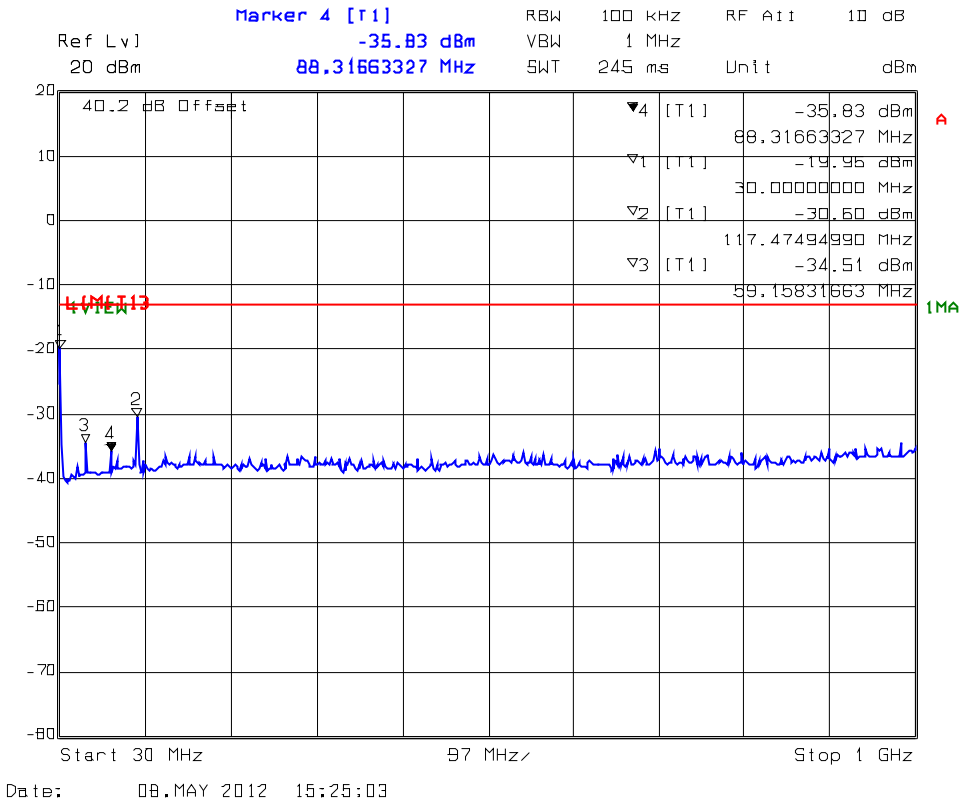
Plot 5.5.4.1.4. Conducted Transmitter Spurious Emissions form 0.150-1000 MHz for 17.45 MHz, Modulation: J3E, Low Power



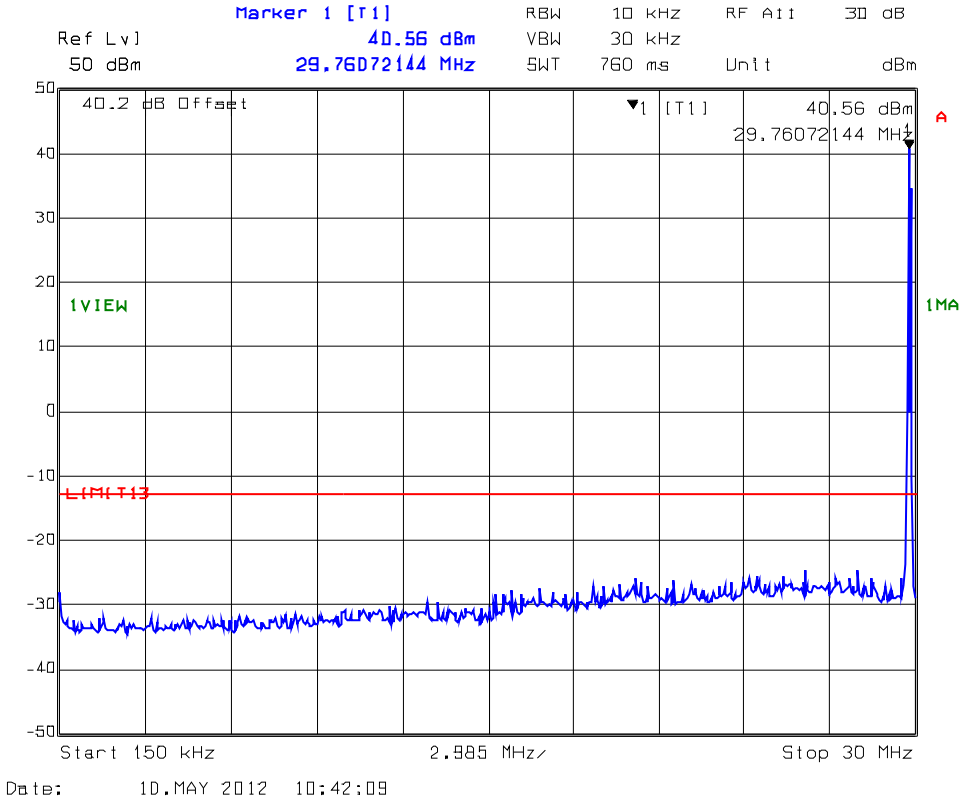

Marker 1 [T1]
RBW 100 kHz
RF Att 10 dB
Ref Lvl
-36.87 dBm
VBW 1 MHz
20 dBm
51.38276553 MHz
SWT 245 ms
Unit dBm
40.2 dB Offset
1 [T1] -36.87 dBm
51.38276553 MHz
A
LIMIT1
VIEW
1MA
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Start 30 MHz
97 MHz/
Stop 1 GHz
Date: 10.MAY 2012 09:59:44

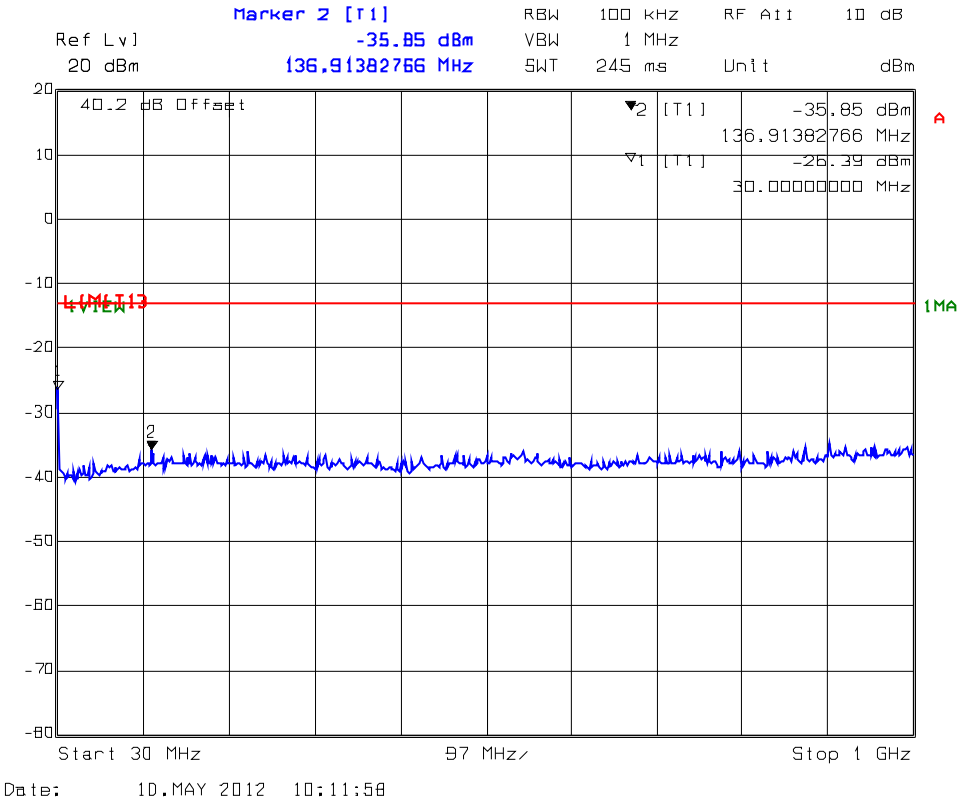
Plot 5.5.4.1.5. Conducted Transmitter Spurious Emissions form 0.15-1000 MHz for 29.75 MHz, Modulation: J3E, High Power




Marker 4 [T1]
RBW 100 kHz
RF Att 10 dB
Ref Lvl
-35.83 dBm
VBW 1 MHz
20 dBm
88.31663327 MHz
SWT 245 ms
Unit dBm
40.2 dB Offset
▼4 [T1] -35.83 dBm
88.31663327 MHz
▽1 [T1] -19.96 dBm
30.00000000 MHz
▽2 [T1] -30.60 dBm
117.47494990 MHz
▽3 [T1] -34.51 dBm
59.15831663 MHz
LIMIT1
VIEW
A
1MA
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Start 30 MHz
97 MHz/
Stop 1 GHz
Date: 08.MAY 2012 15:25:03

Plot 5.5.4.1.6. Conducted Transmitter Spurious Emissions form 0.15-1000 MHz for 29.75 MHz, Modulation: J3E, Low Power




Marker 2 [T1]
RBW 100 kHz
RF Att 10 dB
Ref Lvl
-35.85 dBm
VBW 1 MHz
20 dBm
136.91382766 MHz
SWT 245 ms
Unit dBm
40.2 dB Offset
2 [T1] -35.85 dBm
136.91382766 MHz
1 [T1] -26.39 dBm
30.00000000 MHz
A
1MA
VIEW
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Start 30 MHz
97 MHz/
Stop 1 GHz
Date: 10.MAY 2012 10:11:58

5.6. TRANSMITTER SPURIOUS/HARMONIC RADIATED EMISSIONS [§ 2.1053, 2.1057, 90.210]

5.6.1. Limits

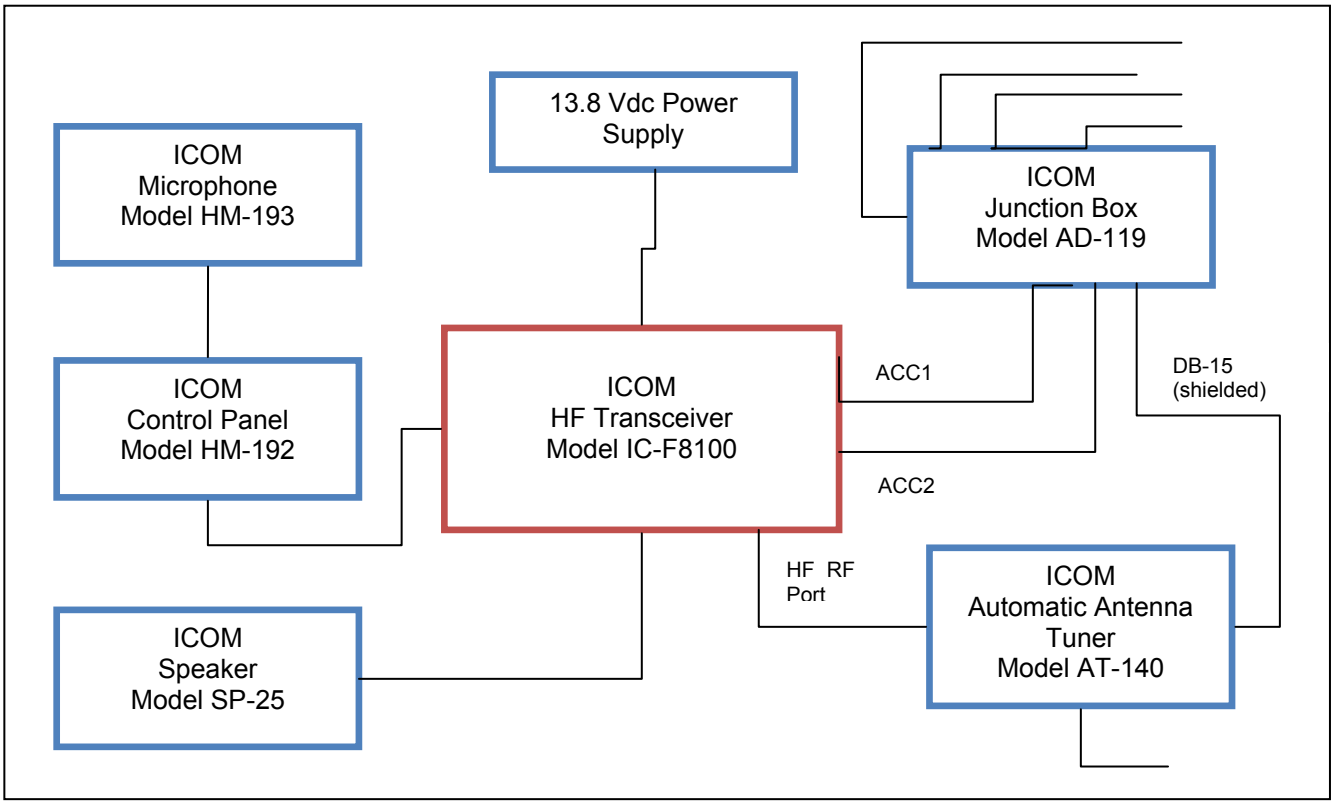
Emissions shall be attenuated below the mean output power of the transmitter as follows:

FCC Rules	Frequency Range	Attenuation Limit (dBc)
§ 90.210 (Mask A & B)	On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 + 10 log P dB.	At least 43 + 10 log (P) dB

5.6.2. Method of Measurements

The spurious/harmonic ERP measurements are using substitution method specified in Section 7.2 of this report.

5.6.3. Test Arrangement



5.6.4. Test Data

Remarks:

- The emissions were scanned from 0.15 to 1000 MHz; all spurious emissions that are in excess of 40dB below the specified limit shall be recorded.
- The J3E emissions, set at maximum power, are chosen to be tested for worst case.

5.6.4.1. Near Lowest Frequency (1.71 MHz)

Test Frequency (MHz):	1.71
Power $_{conducted}$ (dBm):	51.48
Limit (dBm):	-13 dBm

Frequency (MHz)	PEAK E-FIELD @3m (dBuV/m)		ERP (dBm)	
	Vertical / 0 degree	Horizontal / 90 degrees	Vertical / 0 degree	Horizontal / 90 degrees
3.42	38.5	38.53	-58.85	-58.82

All other spurious emissions are more than -60 dBm below the specified limit.

5.6.4.2. Near Middle Frequency (17.45 MHz)

Test Frequency (MHz):	17.45
Power $_{conducted}$ (dBm):	51.18
Limit (dBm):	-13 dBm

Frequency (MHz)	PEAK E-FIELD @3m (dBuV/m)		ERP (dBm)	
	Vertical / 0 degree	Horizontal / 90 degrees	Vertical / 0 degree	Horizontal / 90 degrees
34.90	-	41.5	--	-55.8
52.35	57.8	53.9	-39.6	-43.4
69.80	51.7	49.5	-45.7	-47.9
87.25	54.6	47.6	-42.8	-49.8
104.70	50.3	57.3	-47.0	-40.0
122.15	42.8	45.3	-54.6	-52.0
139.60	47.8	51.9	-49.6	-45.4
157.05	45.3	47.3	-52.0	-50.0
174.50	42.2	47.9	-55.1	-49.5

All other spurious emissions are more than -60dB below the specified limit

5.6.4.3. Near Highest Frequency (29.75 MHz)

Test Frequency (MHz):	29.75
Power $_{conducted}$ (dBm):	51.05
Limit (dBm):	-13 dBm

Frequency (MHz)	PEAK E-FIELD @3m (dBuV/m)		ERP (dBm)	
	Vertical / 0 degree	Horizontal / 90 degrees	Vertical / 0 degree	Horizontal / 90 degrees
59.50	60.9	61.8	-36.5	-35.6
89.25	63.9	62.8	-33.4	-34.6
119.00	70.3	72.4	-27.0	-24.9
148.75	58.7	59.8	-38.6	-37.5
178.50	53.2	57.7	-44.2	-39.7
208.25	49.1	52.0	-48.3	-45.4
238.00	47.9	59.5	-49.5	-37.9
267.75	38.8	43.0	-58.6	-54.4
297.50	40.0	43.2	-57.3	-54.2

All other spurious emissions are more than -60dB below the specified limit

5.7. FREQUENCY STABILITY [§ 2.1055, 90.213]

5.7.1. Limits

§ 90.213 Transmitters used must have minimum frequency stability as specified in the following table.

MINIMUM FREQUENCY STABILITY
[Parts per million (ppm)]

Frequency range (MHz)	Fixed and base stations	Mobile stations	
		Over 2 watts output power	2 watts or less output power
Below 25	[1,2,3] 100	100	200
25–50	20	20	50

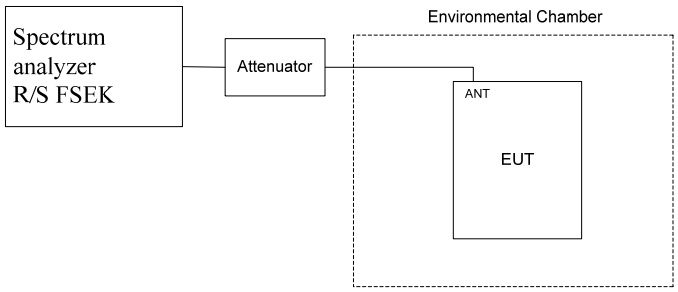
Notes:

(1) *1 Fixed and base stations with over 200 watts transmitterpower must have a frequency stability of 50 ppm except for equipment used in the Public Safety Pool where the frequency stability is 100 ppm.*
(2) ***2 For single sideband operations below 25 MHz, the carrier frequency must be maintained within 50 Hz of the authorized carrier frequency.***
(3) *3 Travelers information station transmitters operating from 530–1700 kHz and transmitters exceeding 200 watts peak envelope power used for disaster communications and long distance circuit operations pursuant to §§ 90.242 and 90.264 must maintain the carrier frequency to within 20 Hz of the authorized frequency.*

5.7.2. Method of Measurements

Refer to Section 7.3 of this report for measurement details

5.7.3. Test Arrangement



5.7.4. Test Data

Test Frequency:	29.75 MHz
Full Power Level:	51.48 dBm
Frequency Tolerance Limit:	50 Hz
Max. Frequency Tolerance Measured:	-6 Hz
Input Voltage Rating:	13.8 Vdc (nominal)

Ambient Temperature (^{o}C)	**Frequency Drift (Hz)**		
	Supply Voltage (Nominal) 13.8 Vdc	**Supply Voltage (85% of Nominla) 11.73 Vdc**	**Supply Voltage (115% of nominla) 15.87 Vdc**
-30	2	--	--
-20	-6	--	--
-10	-6	--	--
0	-4	--	--
10	-2	--	--
20	2	-2	2
30	-1	--	--
40	4	--	--
50	6	--	--
60	4	--	--

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

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

FCC 47 CFR § 1.1310:

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

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

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

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

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

5.8.1. Method of Measurements

Refer to Sections 1.1310, 2.1091

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

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

Calculation Method of RF Safety Distance:

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

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

For General /Un-controlled Exposure operating in 1.6 -3 MHz:

S = 180/f^2 = 180 / 1.6^2 = 70.3 mW/cm^2 (worst case)
Maximum EIRP = 51.48 + 0 dBi = 51.48 dBm = 140604.8 mW (worst case)

(Minimum Safe Distance, r) = $\sqrt{\frac{EIRP}{4 \cdot \pi \cdot S}} = \sqrt{\frac{140604.8}{4 \cdot \pi \cdot (70.3)}} \approx 12.6cm$

For Occupational/Controlled Exposure operating in 1.6 -3 MHz:

S = 900/f^2 = 900 / 1.6^2 = 351.6 mW/cm^2 (worst case)
Maximum EIRP = 51.48 + 0 dBi = 51.48 dBm = 140604.8 mW (worst case)

(Minimum Safe Distance, r) = $\sqrt{\frac{EIRP}{4 \cdot \pi \cdot S}} = \sqrt{\frac{140604.8}{4 \cdot \pi \cdot (351.6)}} \approx 5.64cm$

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: 20 **cm**	Manufacturer' instruction for separation distance between antenna and persons required: **80 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:

5.9. TEST EQUIPMENT LIST

Test Instruments	Manufacturer	Model No. or P/N	Serial No.	Frequency Range	CAL Due
Spectrum Analyzer	R/S	FSEK	834157/005	9 KHz – 40 GHz	28-Jul-12
Attenuator (40dB)	Aeroflex/Weinschel	53-40-34	MN917	DC-1 GHz	
High Pass Filter	Mini Circuit	SHP 25		Cut off 25 MHz	
Power Meter	Hewlett Packard	438A	3008A06729	100K--50G sensor dependent	24-Feb-13
Power Sensor	Hewlett Packard	8482A	US37295944	100KHz-4.2GHZ	13-Jan-13
Modullation Analyzer	Hewlett Packard	8901B	3226A04606	150KHz-1300MHz	12-Jan-13
Combiner	Mini Circuit	ZFSC-3-4	15542	1MHz - 1GHz	
RF Detector	Pasternack	PE8000-50		10M--1G Hz	
Infinium Digital Oscilloscope	Hewlett-Packard	54801A	US38380192	DC--500M Hz 1G sampling	7-Jun-12
Envirment Chamber	Envirotronics	SSH32C	11994847-S-11059	-60 to 177 degree C	11-Aug-12
RF Synthesized signal Generator	HP	8648C	3343U00391	100K-3200M Hz AM/ FM/ PM	14-Dec-12
Power supply	Tenma	72-7295	490300297	1-40V DC 5A	
FFT Digital Spectrum Analyzer	Advantest	R9211E	8202336	10mHz--100KHz	14-Dec-12
RF Communication Test Set	Hewlett Packard	8920B	US39064699	30MHz-1GHz	27-Oct-12
Horn antenna	ETS-LINDGREN	3117	119425	1-18GHz	2-Apr-13
Preamplifier	Hewlett Packard	8449B	3008A00769	1-26.5GHz	1-Dec-12
High Pass Filter	Mini Circuit	SHP 600		Cut off 560 MHz	
Power supply	XANTREX	XKW 60-50	26509	0-60V 0-50A DC	
High Pass Filter	Mini Circuit	SHP 800		Cut off 750 MHz	
Attenuator	Aeroflex/Weinschel	23-20-34	BH7876	DC-18 GHz	
Antenna	ETS	93148	1101	200-2000 MHz	22-Mar-13
Attenuator	Aeroflex/Weinschel	24-20-34	BJ2364	DC-18 GHz	
Frequency counter	EIP	545A	2683	10Hz-18 GHz	1-Mar-13
Biconical Antenna	R/S	HUF-Z2	893-229/014	20-200MHz	9-Feb-13
Loop Antenna	EMCO	6502	9104-2611	10KHz-30MHz	26-Aug-12
Tunable Bandreject Filter	K & L	3TFNF-30/76-N-N	36	28-300MHz	11/15/2012
Function Generator	Hewlett Packard	33120A	US34011688	15MHz	22-Aug-12

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

EXHIBIT 6. 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.

6.1. RADIATED EMISSION MEASUREMENT UNCERTAINTY

	Radiated Emission Measurement Uncertainty @ 3m, Horizontal (0.15-1000 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 (0.15-1000 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 7. MEASUREMENT METHODS

7.1. 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.

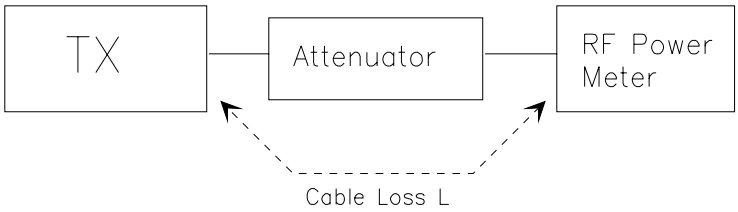
Step 2: Calculation of Average EIRP. See Figure 1

- 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.



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

7.2.1. 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.

7.2.2. 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 0.15-1000 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 0.15-1000 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

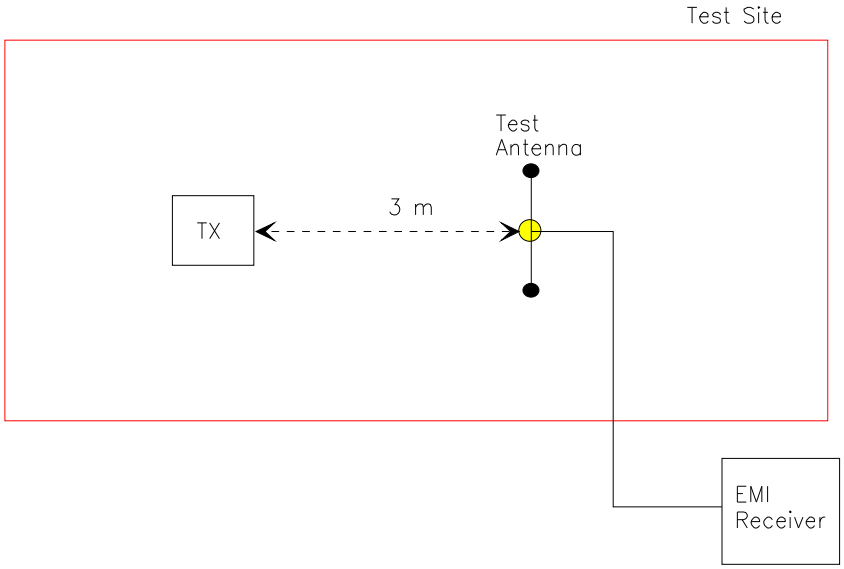
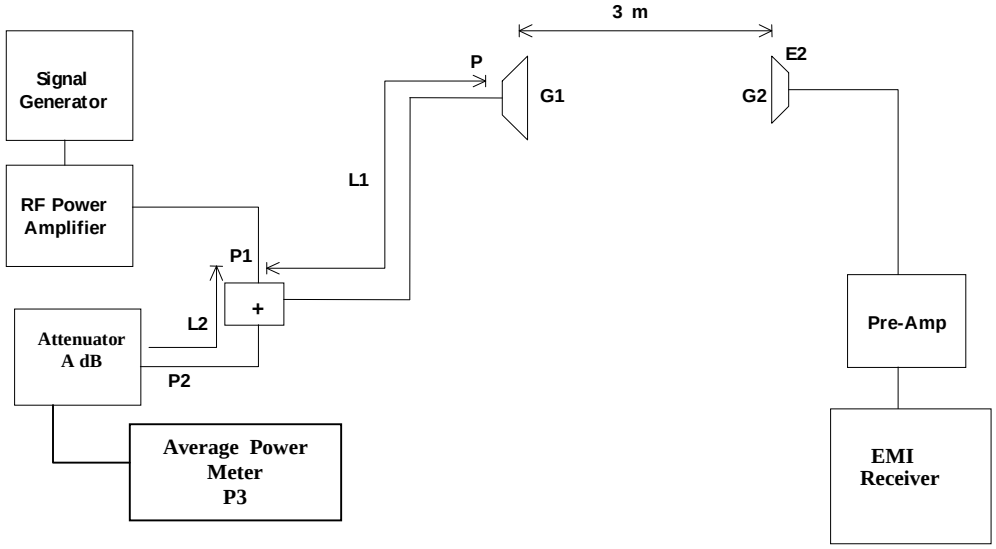


Figure 3



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7.3. 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).

7.4. 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.

7.5. 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.

7.6. 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 ±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 ±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.