

FCC PART 15.249  
EMI MEASUREMENT AND TEST REPORT  
For

Hex Airbot, Inc.

No.30 Duyun Road, Jinyang Gaoxin Industries Park, Guiyang, Guizhou, China

**FCC ID: 2ABTF14004**

February 10, 2014

This Report Concerns: Original Report	Equipment Type: Flexbot
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Report No.:	BSL13071011Y-1E3-55
Receive EUT	January 22,2014 /
Date/Test Date:	January 22 - February 10, 2014
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# 1. GENERAL INFORMATION

## 1.1. Report information

- 1.1.1.This report is not a certificate of quality; it only applies to the sample of the specific product/equipment given at the time of its testing. The results are not used to indicate or imply that they are application to the similar items. In addition, such results must not be used to indicate or imply that BSL approves recommends or endorses the manufacture, supplier or use of such product/equipment, or that BSL in any way guarantees the later performance of the product/equipment.
- 1.1.2.The sample/s mentioned in this report is/are supplied by Applicant, BSL therefore assumes no responsibility for the accuracy of information on the brand name, model number, origin of manufacture or any information supplied.
- 1.1.3.Additional copies of the report are available to the Applicant at an additional fee. No third part can obtain a copy of this report through BSL, unless the applicant has authorized BSL in writing to do so.

Test Facility -

The test site used to collect the radiated data is located on the address of BSL Testing Co.,LTD.

(FCC Registered Test Site Number: 191509) on

NO. 24, ZH Park, Nantou, Shenzhen, 518000 China

The Test Site is constructed and calibrated to meet the FCC requirements.

## 1.2. Measurement Uncertainty

The reported uncertainty of measurement  $y \pm U$ , where expended uncertainty  $U$  is based on a standard uncertainty multiplied by a coverage factor of  $k=2$ , providing a level of confidence of approximately 95 %.

No.	Item	Uncertainty
1	Conducted Emission Test	+/-1.25dB
2	RF Power, Conducted	+/-0.20dB
3	Spurious emissions, conducted	+/-0.33dB
4	All emissions, radiated (<1G)	+/-3.47dB
5	All emissions, radiated (>1G)	+/-3.82dB
6	Temperature	+/-0.5°CdB
7	Humidity	+/-2%

## 2. PRODUCT DESCRIPTION

### 2.1. EUT Description

Description : Flexbot  
 Applicant : Hex Airbot, Inc.  
 No.30 Duyun Road, Jinyang Gaoxin Industries Park, Guiyang,  
 Guizhou, China  
 Manufacturer : SeeedStudio  
 F5, Bldg 8, Shiling Industrial Park, Xinwei, #32 Tongsha  
 Road,Xili Town, Nanshan Dist.Shenzhen 518055 China  
 Model Number : 14004,14006  
 Modulation type : GFSK  
 Antenna gain : 0dBi  
 Frequency : 2402-2480MHz  
 Number of Channels : 79 Channels  
 Bluetooth version : 2.1  
 Power Supply : Transmitting:DC 3.7V By battery (The fully charged battery is  
 used during the measurement) charging: DC 5V By Adapter

The series products, model name: 14004,14006 have the same circuit diagram,PCB layout, software, RF Module, Features and functionality. The differences are the model name, so, we select Flexbot 14004 to test.

Channel List					
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
00	2402	27	2429	54	2456
01	2403	28	2430	55	2457
02	2404	29	2431	56	2458
03	2405	30	2432	57	2459
04	2406	31	2433	58	2460
05	2407	32	2434	59	2461
06	2408	33	2435	60	2462
07	2409	34	2436	61	2463
08	2410	35	2437	62	2464
09	2411	36	2438	63	2465
10	2412	37	2439	64	2466
11	2413	38	2440	65	2467
12	2414	39	2441	66	2468
13	2415	40	2442	67	2469
14	2416	41	2443	68	2470
15	2417	42	2444	69	2471
16	2418	43	2445	70	2472
17	2419	44	2446	71	2473
18	2420	45	2447	72	2474
19	2421	46	2448	73	2475
20	2422	47	2449	74	2476
21	2423	48	2450	75	2477
22	2424	49	2451	76	2478
23	2425	50	2452	77	2479
24	2426	51	2453	78	2480
25	2427	52	2454		
26	2428	53	2455		

## 2.2. Block Diagram of EUT Configuration

### Radiated emissions test



### Conducted Emission test

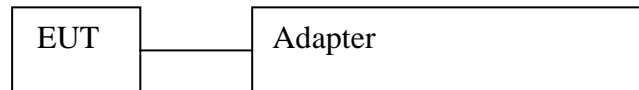


Figure 1 EUT Setup

## 2.3. Support Equipment List

Name	Model No	S/N	Manufacturer	Used (Y/N)
Adapter	CYSK05-050100	N/A	Yu Long	Y

## 2.4. Test Conditions

Items	Required (IEC 68-1)	Actual
Temperature (°C)	15-35	20-25
Humidity (%RH)	25-75	50-63
Barometric pressure (mbar)	860-1060	950-1000

### 3. TEST RESULTS SUMMARY

#### FCC 15 Subpart C, Paragraph 15.249:2012

FCC Rules	Description of Test	Result
Section 15.207	Conducted Emission	Compliant
Section 15.249(a)	The fundamental field strength and the harmonics	Compliant
Section 15.209 Section 15.249(d)	Radiated Emission	Compliant
Section 15.249(d)	Band Edge	Compliant
Section 15.203	Antenna Requirement	Compliant
Section 15.249	20dB Bandwidth	Compliant

Remark: "N/A" means "Not applicable".

Statement: All testing was performed using the test procedures found in ANSI C63.4-2003.

#### Modifications

No modification was made.

#### 4. TEST EQUIPMENT USED

EQUIPMENT/FACILITIES	MANUFACTURER	MODEL	SERIAL NO.	DATE OF CAL.	CAL. INTERVAL
3m Semi-Anechoic Chamber	Chengyu Electron	9 (L)*6 (W)* 6 (H)	BSL086	Aug. 23 2013	1 Year
EMI Test Receiver	Rohde & Schwarz	ESCI3	BSL001	Sep. 28 2013	1 Year
BiConiLog Antenna	Rohde & Schwarz	HL562	BSL009	Sep. 28 2013	1 Year
Double -ridged waveguide horn	Rohde & Schwarz	9120D	BSL008	Aug. 27 2013	1 Year
Horn Antenna	ETS-LINDGREN	3160	BSL072	Dec. 28 2013	1 Year
Cable	Rohde & Schwarz	N/A	BSL045	Aug. 27 2013	1 Year
Cable	Rohde & Schwarz	N/A	BSL046	Aug. 27 2013	1 Year
Cable	Rohde & Schwarz	N/A	BSL047	Aug. 27 2013	1 Year
Amplifier(100kHz-40G Hz)	R&S	SMR40	BSL007	Sep. 28 2013	1 Year
Band filter	Amindeon	82346	BSL049	Aug. 27 2013	1 Year
Active Loop Antenna	EMTES	EM15	BSL011	Sep. 28 2013	1 Year
Coaxial Switch	YUANFANG	TA218B	BSL004	Aug. 27 2013	1 Year
Spectrum analyzer	Rohde & Schwarz	FSP40	BSL049	Sep. 28 2013	1 Year
Shielding Room	zhongyu Electron	7.0(L)x3.0(W)x3.0(H)	BSL085	Sep. 28 2013	1 Year
EMI Test Receiver	R&S	ESPI	BSL002	Sep. 28 2013	1 Year
10dB Pulse Limita	R&S	N/A	BSL003	Sep. 28 2013	1 Year
Coaxial Switch	YUANFANG	TA218B	BSL004	Aug. 27 2013	1 Year
LISN	Rohde & Schwarz	ESH3-Y5	BSL005	Sep. 28 2013	1 Year
Coaxial Cable	YUANFANG	N/A	BSL048	Aug. 27 2013	1 Year
EMI TEST SOFTWARE	AUDIX	E3	N/A	N/A	N/A

## **5. ANTENNA REQUIREMENT**

### **5.1. Standard Applicable**

For intentional device, according to FCC 47 CFR Section 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

### **5.2. Antenna Connected Construction**

According to § 15.203, An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

The antenna used in this product is PCB antenna. The antenna is permanently attached. Refer to the product photo.

### **5.3. Result**

Compliance



## 6. CONDUCTED POWER LINE TEST

### 6.1. Test Equipment

Please refer to section 4 this report.

### 6.2. Test Procedure

The EUT and simulators are connected to the main power through a line impedance stabilization network (L.I.S.N.). This provides a 50ohm/50uh coupling impedance for the measuring equipment. The peripheral devices are also connected to the main power through a LISN that provides a 50ohm/50uh coupling impedance with 50ohm termination.

Both sides of A.C. Line are checked for maximum conducted interference. In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ASIN C63.4:2003 on conducted measurement. Conducted emissions were measured over the frequency range from 0.15MHz to 30MHz using a receiver bandwidth of 9kHz.

### 6.3. Test Setup



For the actual test configuration, Please refer to the related items-Photos of testing

### 6.4. Conducted Power line Emission Limits

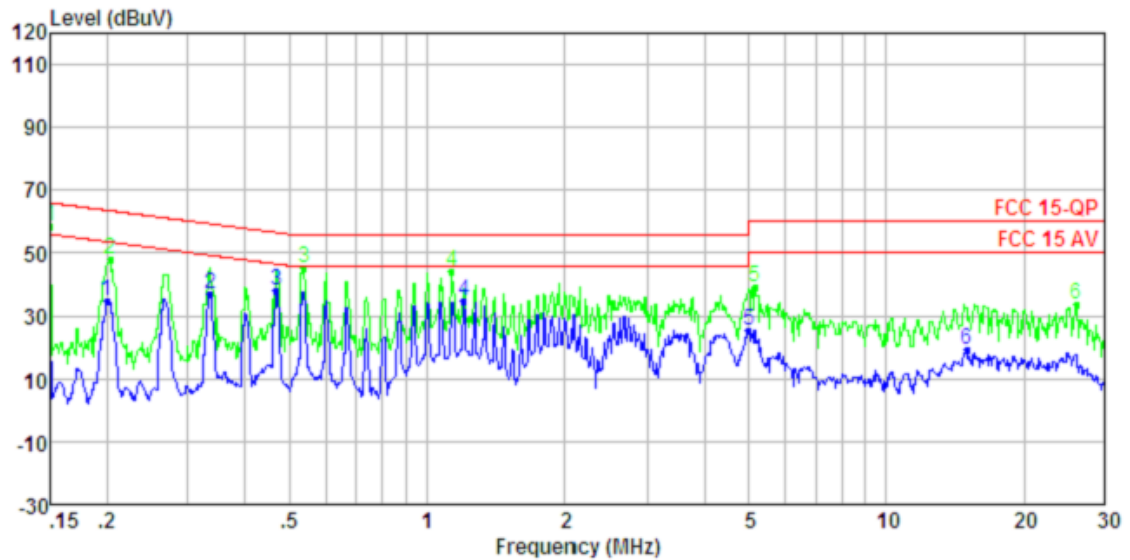
FCC Part 15 Paragraph 15.207 (dBuV)		
Frequency Range (MHZ)	Class A QP/AV	Class B QP/AV
0.15-0.5	79/66	65-56/56-46
0.5-5.0	73/60	56-46
5.0-3.0	73/60	60-50

**Note:** In the above table, the tighter limit applies at the band edges.

## 6.5. Conducted Power Line Test Result

PASS

### Link Mode



Condition:

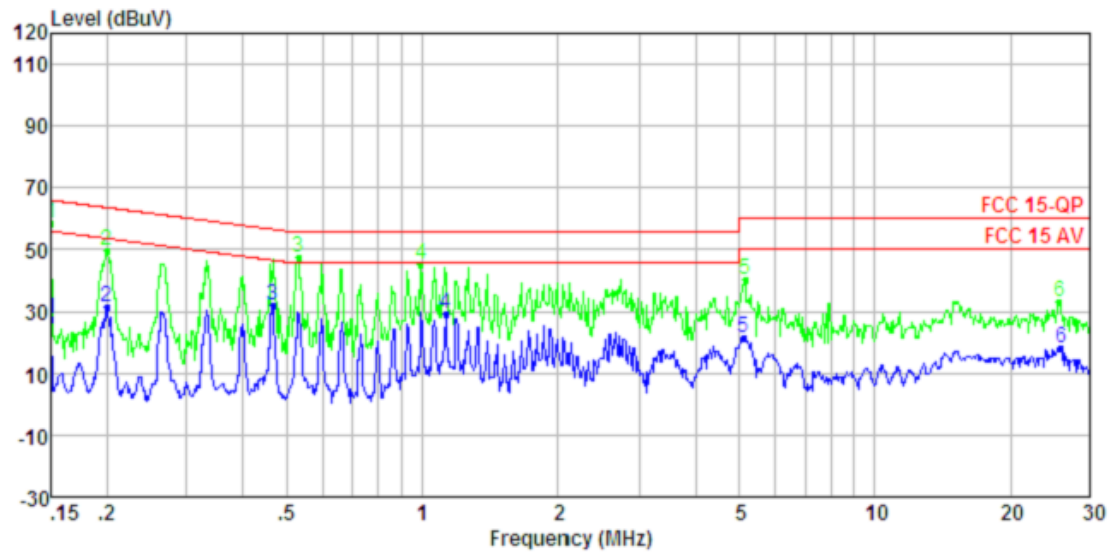
: RBW:9.000KHz VBW:30.000KHz

	Freq	Level	Limit	Over	Remark	Pol/Phase
	MHz	dBuV	dBuV	dB		
1 max	0.20	34.68	53.62	-18.94	Average	LINE
2	0.34	37.19	49.31	-12.12	Average	LINE
3	0.47	38.05	46.54	-8.49	Average	LINE
4	1.20	34.77	46.00	-11.23	Average	LINE
5	5.00	25.25	50.00	-24.75	Average	LINE
6	14.99	19.28	50.00	-30.72	Average	LINE

Condition:

: RBW:9.000KHz VBW:30.000KHz

	Freq	Level	Limit	Over	Remark	Pol/Phase
	MHz	dBuV	dBuV	dB		
1 max	0.15	58.50	66.00	-7.50	QP	LINE
2	0.20	47.78	63.49	-15.71	QP	LINE
3	0.54	45.25	56.00	-10.75	QP	LINE
4	1.14	44.37	56.00	-11.63	QP	LINE
5	5.17	39.36	60.00	-20.64	QP	LINE
6	26.00	33.41	60.00	-26.59	QP	LINE



Condition:

: RBW:9.000KHz VBW:30.000KHz

	Freq	Level	Limit	Over		
	MHz	dBuV	Line	Limit	Remark	Pol/Phase
1 max	0.15	27.49	56.00	-28.51	Average	NEUTRAL
2	0.20	31.69	53.62	-21.93	Average	NEUTRAL
3	0.47	32.26	46.58	-14.32	Average	NEUTRAL
4	1.13	29.36	46.00	-16.64	Average	NEUTRAL
5	5.11	21.46	50.00	-28.54	Average	NEUTRAL
6	25.86	18.27	50.00	-31.73	Average	NEUTRAL

Condition:

: RBW:9.000KHz VBW:30.000KHz

	Freq	Level	Limit	Over		
	MHz	dBuV	Line	Limit	Remark	Pol/Phase
1 max	0.15	58.81	66.00	-7.19	QP	NEUTRAL
2	0.20	49.90	63.62	-13.72	QP	NEUTRAL
3	0.53	47.38	56.00	-8.62	QP	NEUTRAL
4	0.99	45.53	56.00	-10.47	QP	NEUTRAL
5	5.17	40.54	60.00	-19.46	QP	NEUTRAL
6	25.73	33.12	60.00	-26.88	QP	NEUTRAL

## 7. RADIATED EMISSION TEST

### 7.1. Test Equipment

Please refer to section 4 this report.

### 7.2. Test Procedure

The EUT and its simulators are placed on a turntable, which is 0.8 meter high above ground. The turntable can rotate 360 degrees to determine the position of the maximum emission level. EUT is set 3.0 meters away from the receiving antenna, which is mounted on an antenna tower. The antenna can be moved up and down between 1.0 meter and 4 meters to find out the maximum emission level.

Calibrated Loop antenna is used as receiving antenna for frequencies below 30MHz, Calibrated Bilog antenna is used as receiving antenna for frequencies between 30 MHz and 1 GHz, Calibrated Horn antenna is used as receiving antenna for frequencies above 1000MHz. Both horizontal and vertical polarizations of the antenna are set on measurement. In order to find the maximum emission levels, all of the interface cables must be manipulated according to ANSI C63.4: 2003 on radiated emission measurement.

The bandwidth of test receiver is set at 9kHz in below 30MHz. and set at 120kHz in 30-1000MHz, and 1MHz in above 1000MHz.

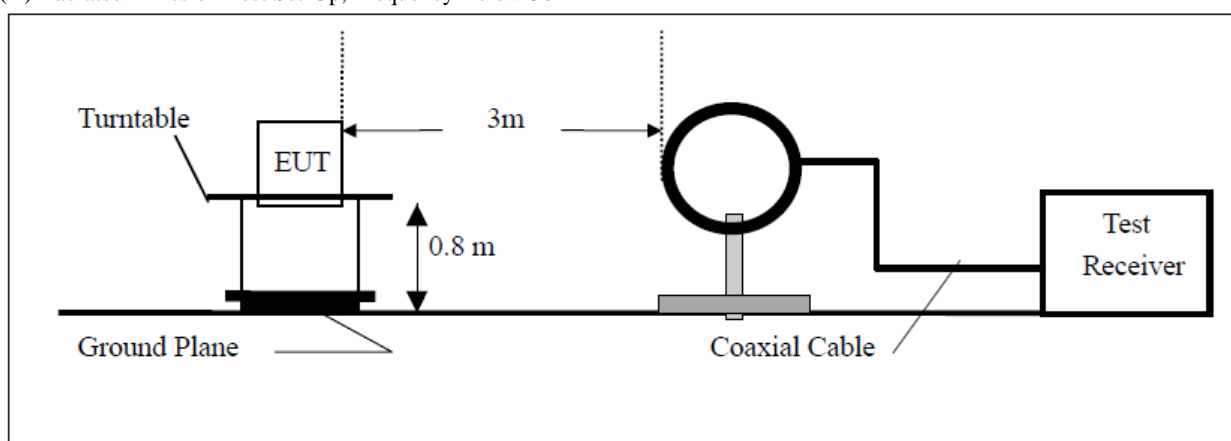
The frequency range from 9kHz to 25GHz is checked.

The final measurement in band 9-90kHz, 110-490kHz and above 1000MHz is performed with Peak detector and Average detector. Except those frequency bands mention above, the final measurement for frequencies below 1000MHz is performed with Quasi Peak detector.

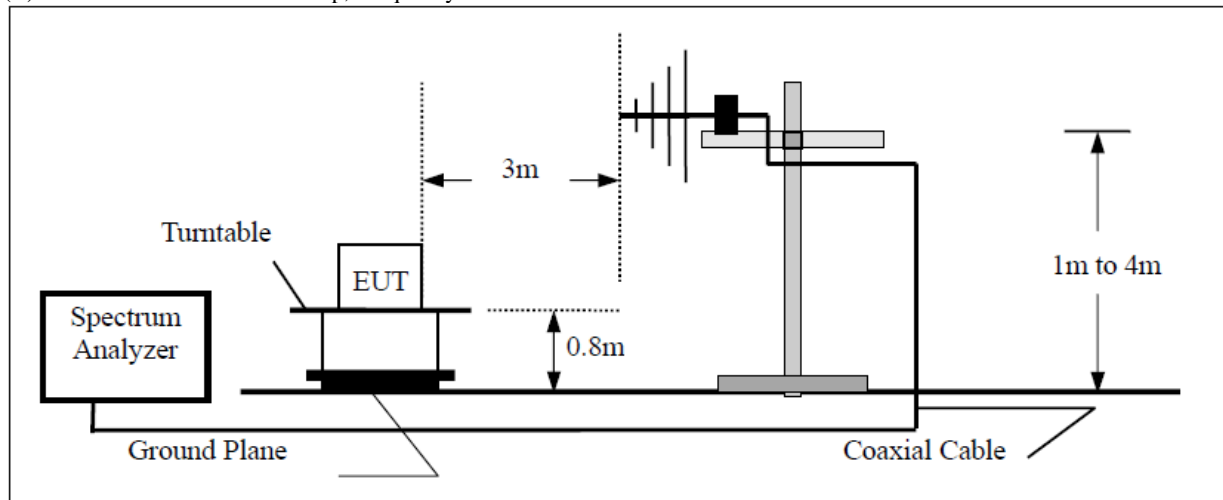
Through three orthogonal axes to determine which attitude and equipment arrangement produces the highest emission relative to the limit. And X direction is worst mode

### 7.3. Radiated Test Setup

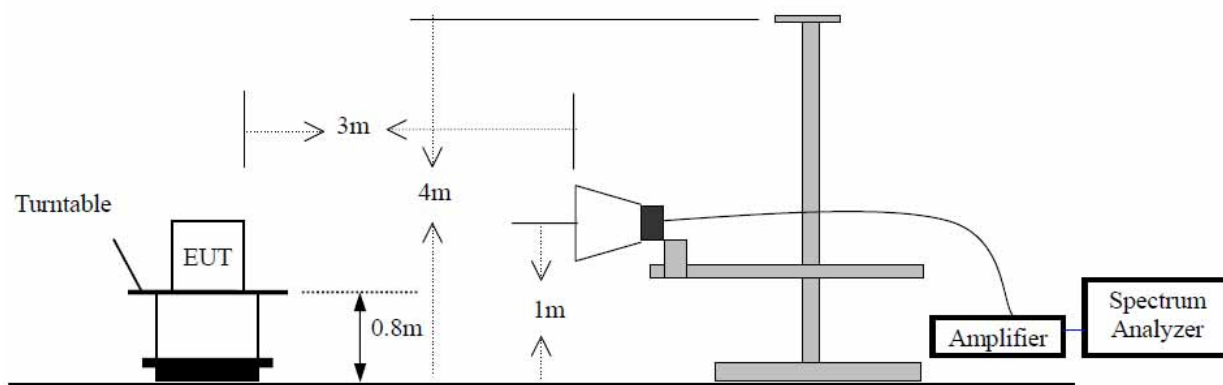
(A) Radiated Emission Test Set-Up, Frequency Below 30MHz



(B) Radiated Emission Test Set-Up, Frequency Below 1000MHz



(C) Radiated Emission Test Set-Up, Frequency above 1000MHz



## 7.4. Radiated Emission Limit

All emission from a digital device, including any network of conductors and apparatus connected thereto, shall not exceed the level of field strength specified below :

### A. Fundamental and Harmonics Radiated Emissions 15.249(a) Limit

Fundamental Frequency (MHZ)	Field as strength of Fundamental(3m)			Field as strength of Harmonics(3m)		
	mV/m	dBuV/m		uV/m	dBuV/m	
902-928	50	94(AV)	114(Peak)	500	54(AV)	74(Peak)
2400-2483.5	50	94(AV)	114(Peak)	500	54(AV)	74(Peak)

Note: (1) RF Voltage (dBuV)=20 log Voltage(uV)

(2) Distance refers to the distance in meters between the measuring instrument antenna and the closed point of any part of the device or system.

(3) The emission limit in this paragraph is based on measurement instrumentation employing an average detector. Measurement using instrumentation with a peak detector function, corresponding to 20dB above the maximum permitted average limit.

### B. Spurious Radiated Emissions.

Frequency (MHz)	Limit			
	Field Strength of Quasi-peak Value (microvolts/m)	Field Strength of Quasi-peak Value (dBμV/m)	Measurement distance (m)	The final measurement in band 9-90kHz, 110-490kHz and above 1000MHz is performed with Average detector. Except those frequency bands mention above, the final measurement for frequencies below 1000MHz is performed with Quasi Peak detector.
0.009 - 0.490	2400/F(kHz)	/	300	
0.490 - 1.705	24000/F(kHz)	/	30	
1.705-30	30	29.5	30	
30 - 88	100	40	3	
88 - 216	150	43.5	3	
216 - 960	200	46	3	
Above 960	500	54	3	

Note: (1) RF Voltage (dBuV)=20 log Voltage(uV)

(2) In the Above Table, the tighter limit applies at the band edges.

(3) Distance refers to the distance in meters between the measuring instrument antenna and the closed point of any part of the device or system.

## 7.5. Radiated Emission Test Result

Pass

### A. Fundamental Radiated Emissions Data

#### CH Low

Freq. (MHz)	Read Level (dBuV) AV/PK	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Emission (dBuV/m) AV/PK	HORIZ/ VERT	Limits (dBuV/m) AV/PK	Margin (dB)
2402	68.07/83.51	27.47	5.42	30.17	70.79/86.23	VERT	94/114	-23.21/-27.77
2402	70.22/92.99	27.47	5.42	30.17	72.94/95.71	HORIZ	94/114	-21.06/-18.29

#### CH Middle

Freq. (MHz)	Read Level (dBuV) AV/PK	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Emission (dBuV/m) AV/PK	HORIZ/ VERT	Limits (dBuV/m) AV/PK	Margin (dB)
2441	67.97/88.71	27.40	5.40	30.15	70.62/91.36	VERT	94/114	-23.38/-22.64
2441	69.8/95.02	27.40	5.40	30.15	72.45/97.67	HORIZ	94/114	-21.55/-16.33

#### CH High

Freq. (MHz)	Read Level (dBuV) AV/PK	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Emission (dBuV/m) AV/PK	HORIZ/ VERT	Limits (dBuV/m) AV/PK	Margin (dB)
2480	64.66/88.43	27.50	5.46	29.98	67.64/91.41	VERT	94/114	-26.36/-22.59
2480	65.81/93.24	27.50	5.46	29.98	68.79/96.22	HORIZ	94/114	-25.21/-17.78

Remark:

Final Emission = Receiver Read level + Antenna Factor + Cable Loss – Preamplifier Factor

## B. General Radiated Emissions Data

**For below 9kHz-30MHz Spurious**

Freq. (MHz)	Emission(dBuV/m) PK / AV	Limits(dBuV/m) PK / AV	Margin (dB)
-	-	-	-
-	-	-	-

Note:

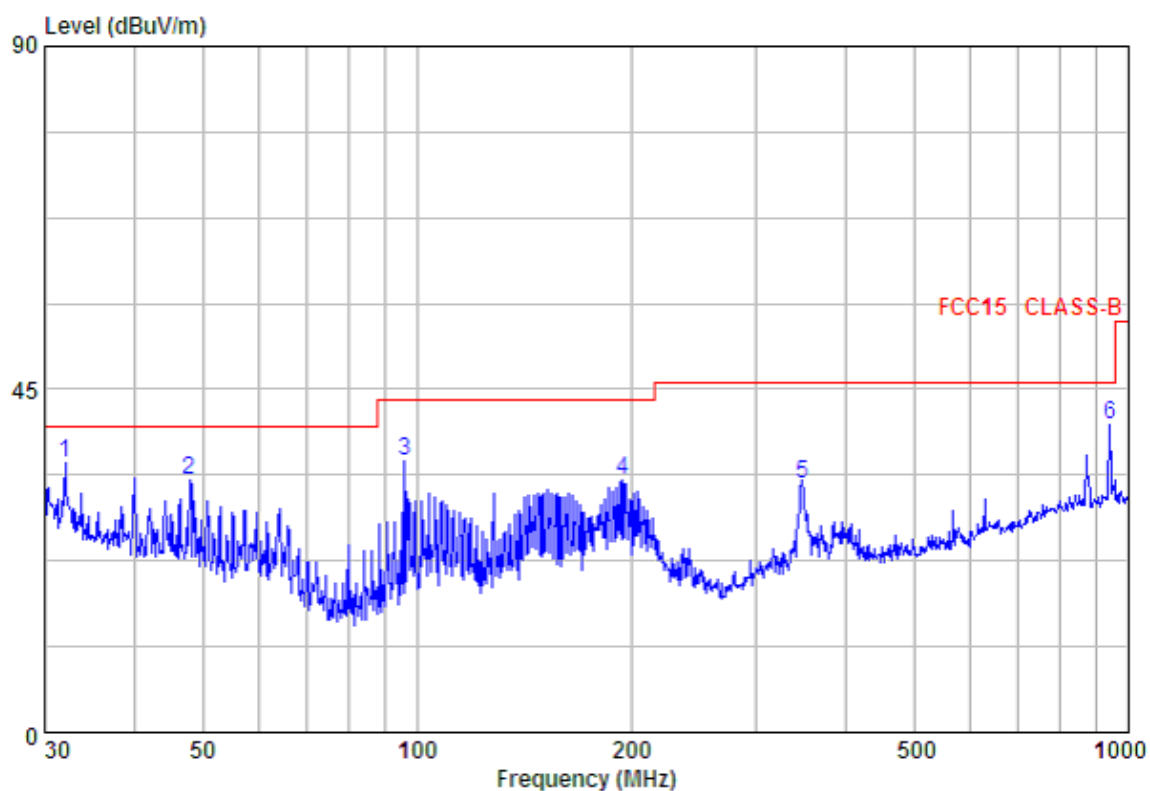
1. Emissions attenuated more than 20 dB below the permissible value are not reported.



For 30M-1000MHz Spurious

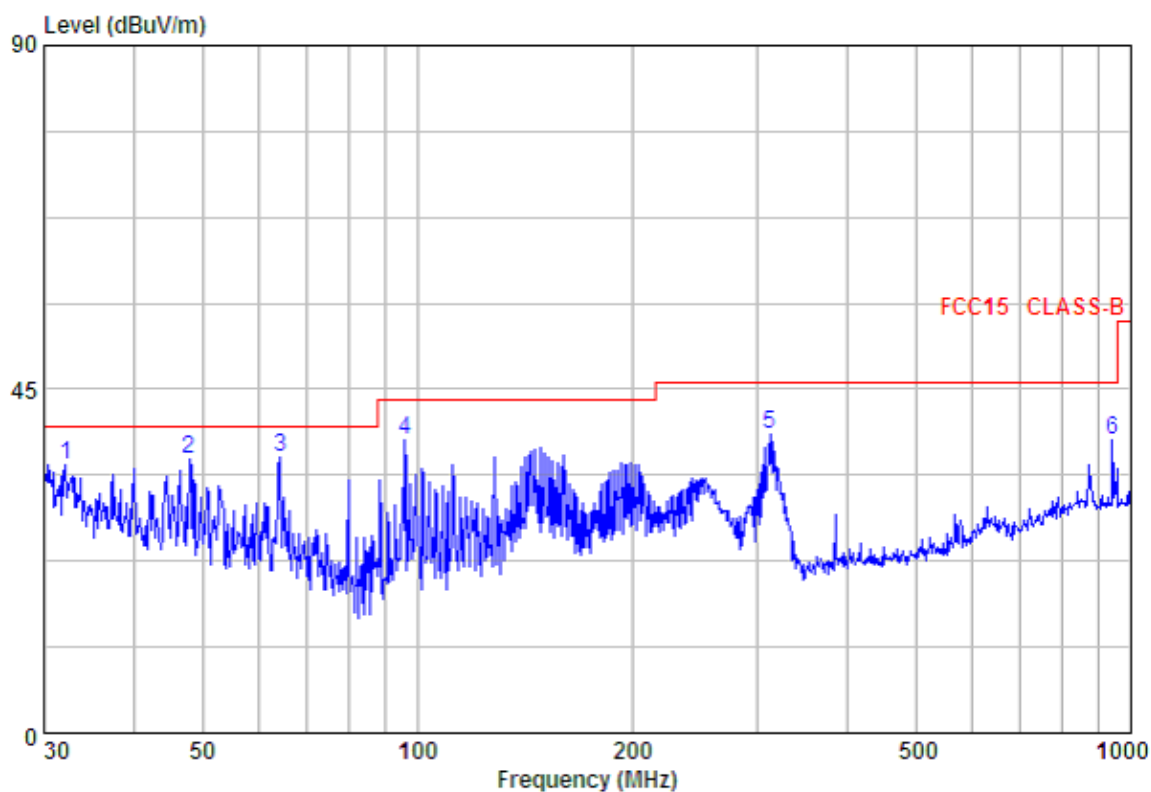
Corrected Factor = Antenna Factor + Cable Loss – Amplifier Gain

**2441MHz** Transmitting(*Worst case mode*)



Condition : FCC15 CLASS-B 3m VERTICAL  
: RBW:120.000KHz VBW:300.000KHz SWT:Auto

	Freq	Level	Limit	Over	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB		
1 max	32.07	35.34	40.00	-4.66	QP	VERTICAL
2	47.99	33.14	40.00	-6.86	QP	VERTICAL
3	96.10	35.52	43.50	-7.98	QP	VERTICAL
4	194.45	33.15	43.50	-10.35	QP	VERTICAL
5	348.03	32.54	46.00	-13.46	QP	VERTICAL
6	942.13	40.36	46.00	-5.64	QP	VERTICAL



Condition : FCC15 CLASS-B 3m HORIZONTAL  
 : RBW:120.000KHz VBW:300.000KHz SWT:Auto

	Freq	Level	Limit	Over	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB		
1	32.18	35.19	40.00	-4.81	QP	HORIZONTAL
2	47.99	35.97	40.00	-4.03	QP	HORIZONTAL
3 max	64.21	36.07	40.00	-3.93	QP	HORIZONTAL
4	96.10	38.26	43.50	-5.24	QP	HORIZONTAL
5	312.18	39.20	46.00	-6.80	QP	HORIZONTAL
6	942.13	38.41	46.00	-7.59	QP	HORIZONTAL

**For 1000MHz-25000MHz Spurious****CH Low**

Freq. (MHz)	Emission(dBuV/m) AV/PK	HORIZ/ VERT	Limits(dBuV/m) AV/PK	Margin (dB)
4804	34.83/50.55	VERT	54.0/74.0	-19.17/-23.45
7206	35.12/49.09		54.0/74.0	-18.88/-24.91
9608	34.28/48.56		54.0/74.0	-19.72/-25.44
4804	36.22/51.61	HORIZ	54.0/74.0	-17.78/-22.39
7206	35.38/50.66		54.0/74.0	-18.62/-23.34
9608	35.25/50.51		54.0/74.0	-18.75/-23.49

**CH Middle**

Freq. (MHz)	Emission(dBuV/m) AV/PK	HORIZ/ VERT	Limits(dBuV/m) AV/PK	Margin (dB)
4882	37.23/49.66	VERT	54.0/74.0	-16.77/-24.34
7323	35.72/49.5		54.0/74.0	-18.28/-24.5
9764	36.12/50.53		54.0/74.0	-17.88/-23.47
4882	37.53/51.72	HORIZ	54.0/74.0	-16.47/-22.28
7323	36.85/50.59		54.0/74.0	-17.15/-23.41
9764	36.23/50.17		54.0/74.0	-17.77/-23.83

**CH High**

Freq. (MHz)	Emission(dBuV/m) AV/PK	HORIZ/ VERT	Limits(dBuV/m) AV/PK	Margin (dB)
4960	35.73/51.39	VERT	54.0/74.0	-18.27/-22.61
7440	35.28/50.73		54.0/74.0	-18.72/-23.27
9920	35.56/50.08		54.0/74.0	-18.44/-23.92
4960	38.74/51.87	HORIZ	54.0/74.0	-15.26/-22.13
7440	37.55/51.19		54.0/74.0	-16.45/-22.81
9920	36.89/50.5		54.0/74.0	-17.11/-23.5

**Note:**

1. The average measurement was not performed when the peak measured data under the limit of average detection.
2. Emissions attenuated more than 20 dB below the permissible value are not reported.

## **8. BAND EDGE**

### **8.1. Test Equipment**

Please refer to Section 4 this report.

### **8.2. Test Procedure**

The EUT and its simulators are placed on a turn table which is 0.8 meter above ground. The turn table can rotate 360 degrees to determine the position of the maximum emission level. The EUT was positioned such that the distance from antenna to the EUT was 3 meters. The antenna can move up and down between 1 meter and 4 meters to find out the maximum emission level. Both horizontal and vertical polarization of the antenna are set on measurement. In order to find the maximum emission, all of the interface cables must be manipulated according to ANSI C63.4: 2003 on radiated measurement. The bandwidth setting below 1GHz and above 1GHz on the field strength meter is 120 kHz and 1MHz respectively.

### **8.3. Band Edge FCC 15.249(d) Limit**

Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in Section 15.209, whichever is the lesser attenuation.

## 8.4. Band Edge Test Result

### Pass

ALL of the restriction bands were tested, and only the data of worst case was exhibited.

#### CH Low

Freq. (MHz)	Emission(dBuV/m) AV/PK	HORIZ/ VERT	Limits(dBuV/m) AV/PK	Margin (dB)
2390	38.03/47.75	VERT	54.0/74.0	-15.97/-26.25
2400	48.32/64.29		54.0/74.0	-5.68/-9.71
2390	36.42/44.81	HORIZ	54.0/74.0	-17.58/-29.19
2400	47.58/63.86		54.0/74.0	-6.42/-10.14

#### CH High

Freq. (MHz)	Emission(dBuV/m) AV/PK	HORIZ/ VERT	Limits(dBuV/m) AV/PK	Margin (dB)
2483.5	42.93/51.59	VERT	54.0/74.0	-11.07/-22.41
2500.00	38.48/50.93		54.0/74.0	-15.52/-23.07
2483.5	41.94/51.07	HORIZ	54.0/74.0	-12.06/-22.93
2500.00	37.75/49.39		54.0/74.0	-16.25/-24.61

#### Remark:

- Factor = Antenna Factor + Cable Loss – Pre-amplifier.

## 9. 20-DB BANDWIDTH

### 9.1. Test Equipment

Please refer to Section 4 this report.

### 9.2. Test Procedure

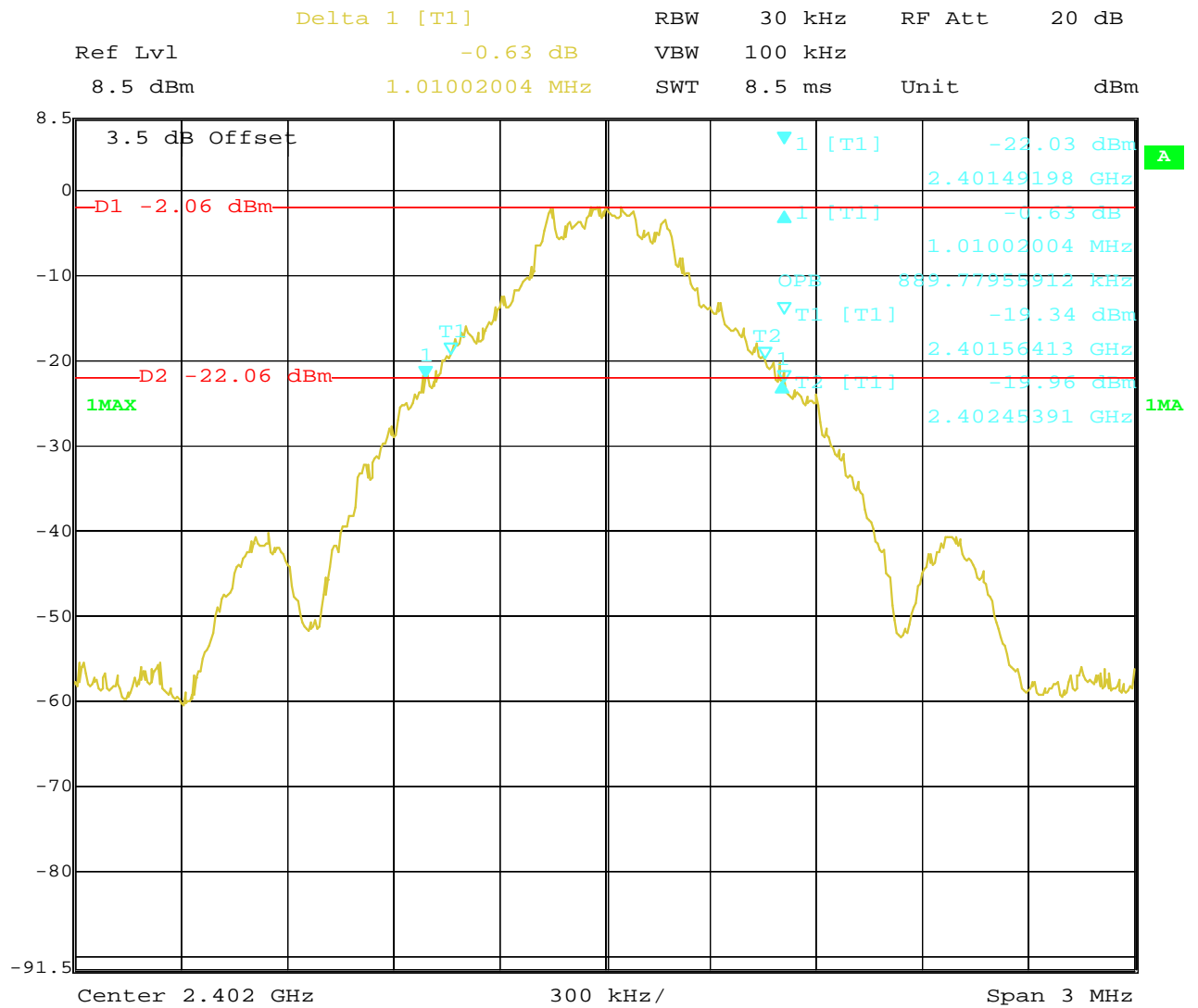
1. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
2. Set center frequency of spectrum analyzer = operating frequency.
3. The spectrum analyzer as RBW=30 KHz, VBW=100 KHz, Sweep=auto
4. Mark the peak frequency and -20dB (upper and lower) frequency.

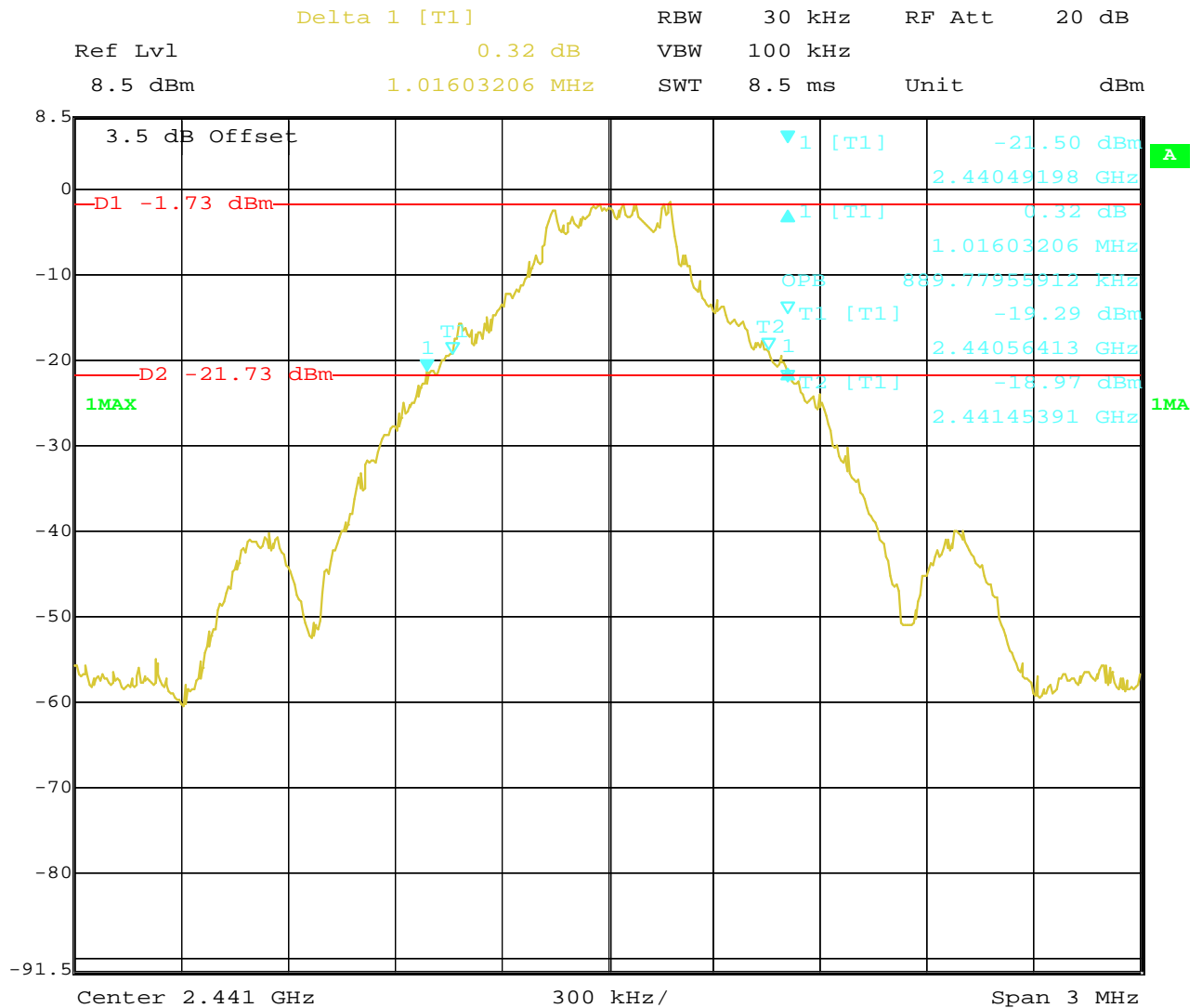
### 9.3. Limit

Please refer section15.249

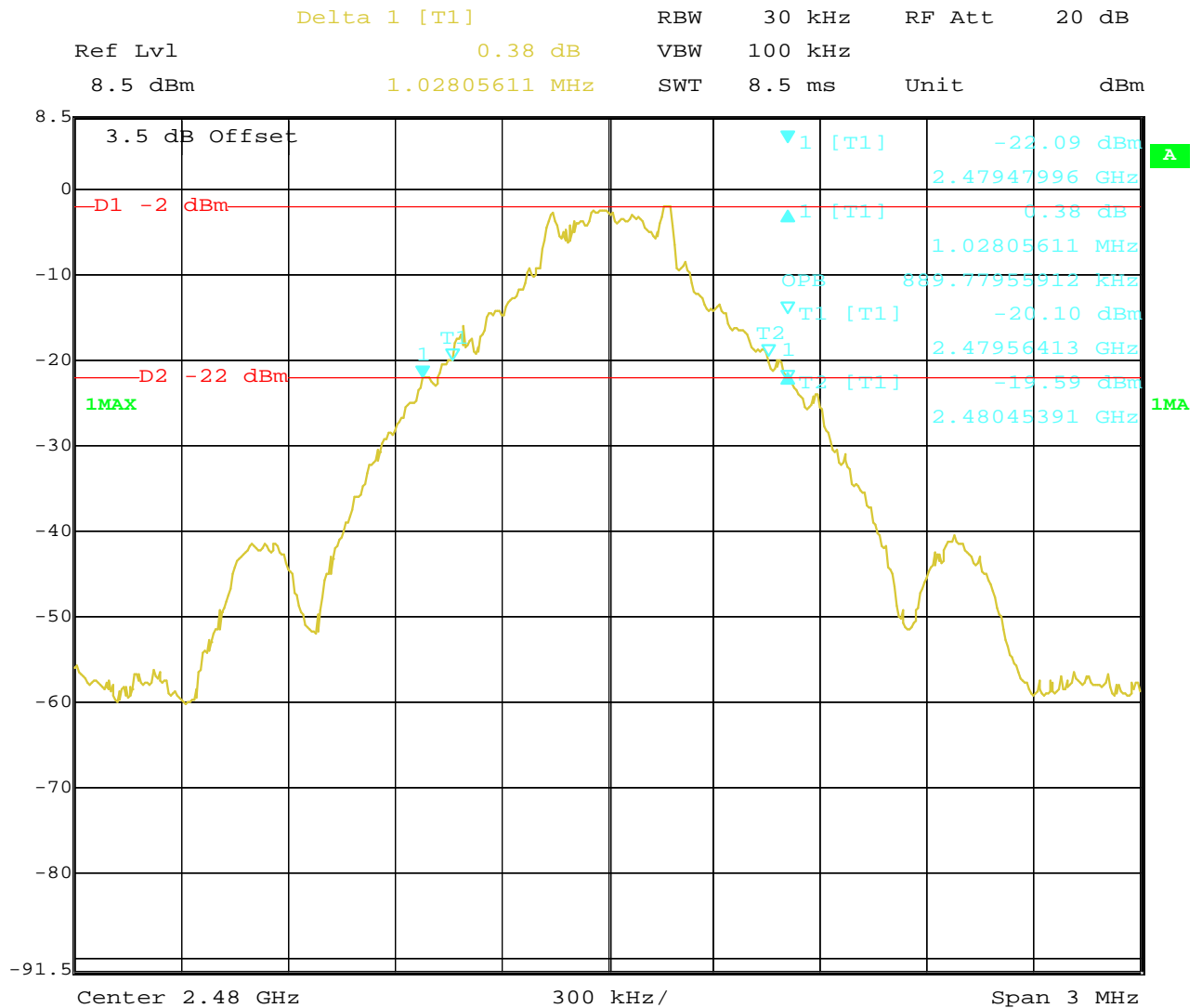
### 9.4. Test Result /Plots

Limit	Channel Frequency (MHz)	20dB Bandwidth (MHz)
/	2402	1.010
/	2441	1.016
/	2480	1.028









**End Of The Report**