

Radio Frequency TEST REPORT

Report No.: 170700374TWN-001
Model No.: MACC0033, MACC0032
Issued Date: Dec. 08, 2017

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Test Method/ Standard: 47 CFR FCC Part 15.249 & ANSI C63.10 2013

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Summary of Tests

Test	Reference	Results
20dB Bandwidth	15.215(c)	Pass
Radiated Emission test	15.249(c), 15.209	Pass
Emission on the Band Edge	15.249(d)	Pass
Conducted Emission of AC Power	15.207	N/A

1. General information

1.1 Identification of the EUT

Product: multi function 2.4G RF remote
Model No.: MACC0033
Frequency Range: 2470MHz
Channel Number: 1 Channel
Frequency of Each Channel: 2470MHz
Type of Modulation: FSK
Rated Power: DC 3.3 V
Power Cord: N/A
Sample Received: Aug. 21, 2017
Sample condition: Workable
Test Date(s): Sep. 05, 2017~Nov. 22, 2017

Note 1: The test report only allows to be revised within three years from its original issued date unless further standard or the requirement was noticed.

Note 2: When determining the test conclusion, the Measurement Uncertainty of test has been considered.

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1.2 Description of EUT

The EUT is a multi function 2.4G RF remote, and was defined as information technology equipment.

The customer confirmed that all electrical components and layout of MACC0032 (9key) is identical with models: MACC0033 (12key). They are only different in appearance designs and model designations for marketing purposes.

For more detail features, please refer to user's Manual.

1.3 Antenna description

The EUT uses a permanently connected antenna.
It comply with the requirements of FCC 15.203

Antenna Type: Monopole Antenna
Connector Type: Fixed

2. Test specifications

2.1 Test standard

The EUT was performed according to the procedures in FCC Part 15 Subpart C Paragraph 15.249 for non-spread spectrum devices.

The test of radiated measurements according to FCC Part15 Section 15.33(a) had been conducted and the field strength of this frequency band were all meet limit requirement, thus we evaluate the EUT pass the specified test.

2.2 Operation mode

The EUT is supplied with DC 3.3 V from battery.

TX-MODE is based on power on.

The signal is maximized through rotation and placement in the three orthogonal axes.



X axis



Y axis



Z axis

After verifying three axes, we found the maximum electromagnetic field was occurred at Z axis. The final test data was executed under this configuration.

3. 20dB Bandwidth test

3.1 Operating environment

Temperature: 25 °C
Relative Humidity: 50 %
Atmospheric Pressure: 1008 hPa

3.2 Test setup & procedure

Step 1: The 20dB bandwidth was measured using a 50 ohm spectrum analyzer

Step 2: The span range for the SA display shall be between two times and five times the OBW.

Step 3: The nominal IF filter bandwidth (3 dB RBW) should be approximately 1 % to 5 % of the OBW, unless otherwise specified, depending on the applicable requirement.

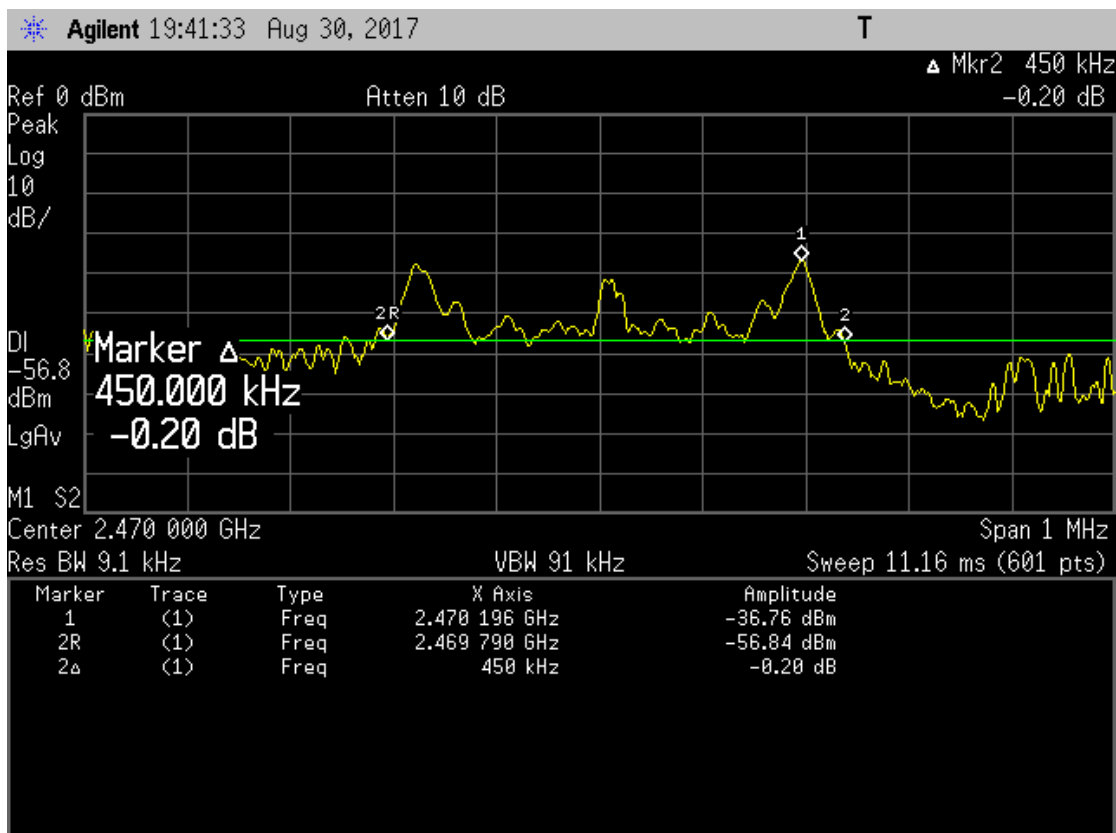
Step 4: The test was performed at 1 channel. The maximum 20dB modulation bandwidth is in the following Table.

3.3 Measured data of modulated bandwidth test results

Mode	Frequency (MHz)	20dB Occupied Bandwidth (MHz)
RF	2470	0.45

Please see the plot below.

Chain0 : 20dB Occupied Bandwidth @ 2470MHz



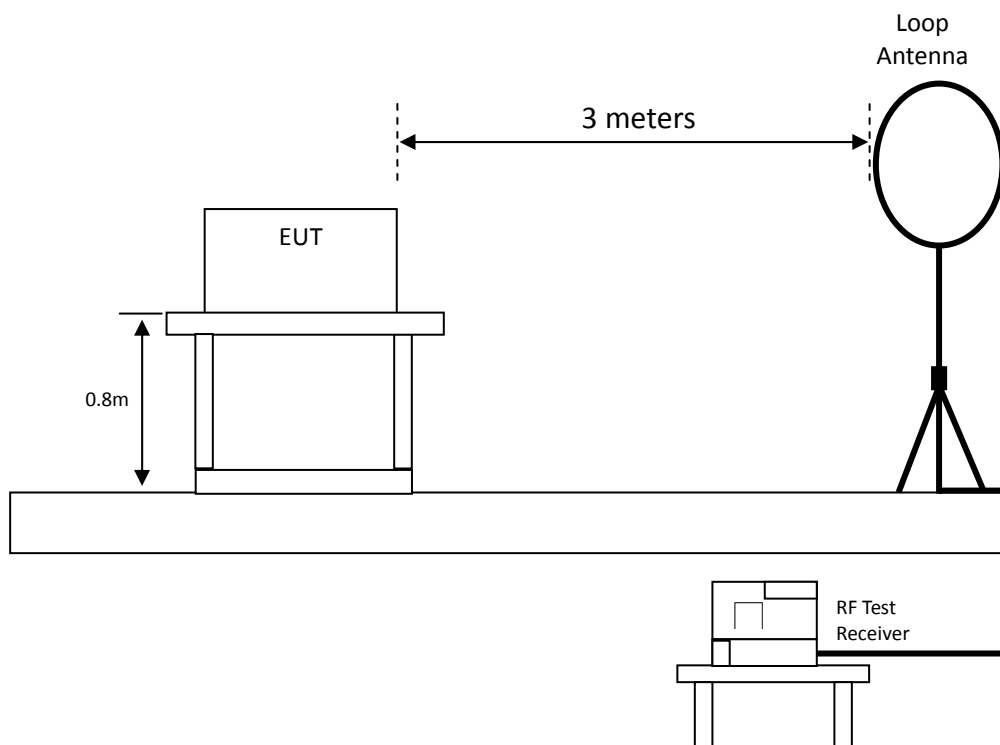
4. Radiated emission test FCC 15.249 (C)

4.1 Operating environment

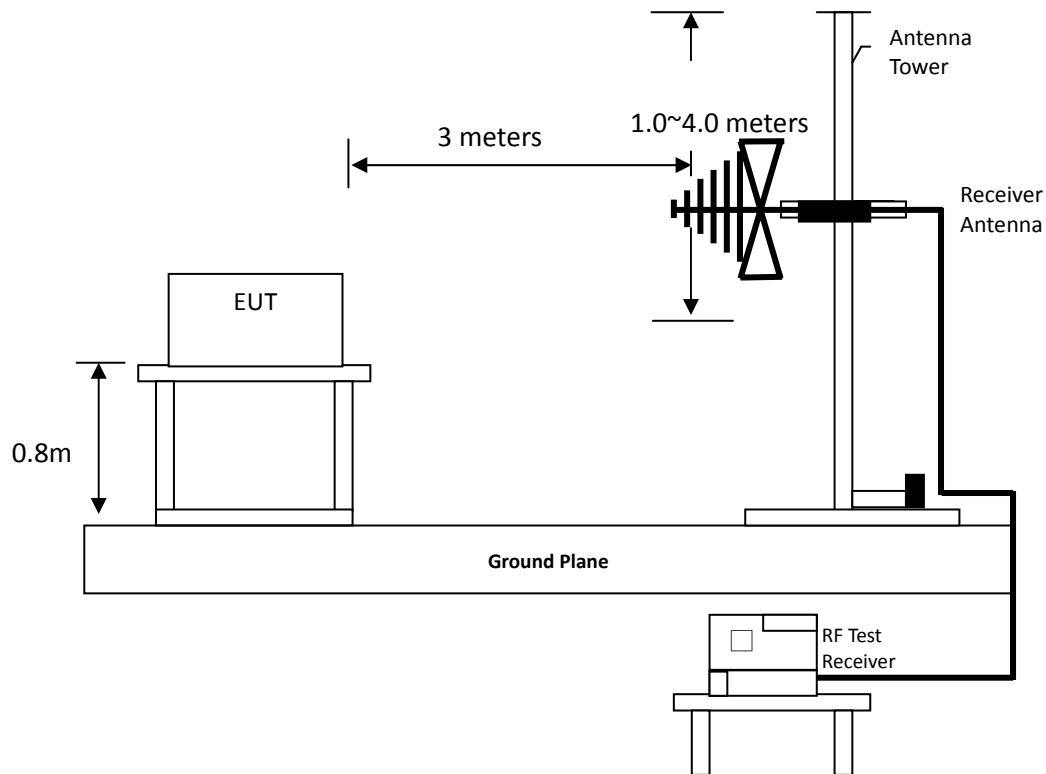
Temperature:	25	°C
Relative Humidity:	50	%
Atmospheric Pressure:	1008	hPa

4.2 Test setup & procedure

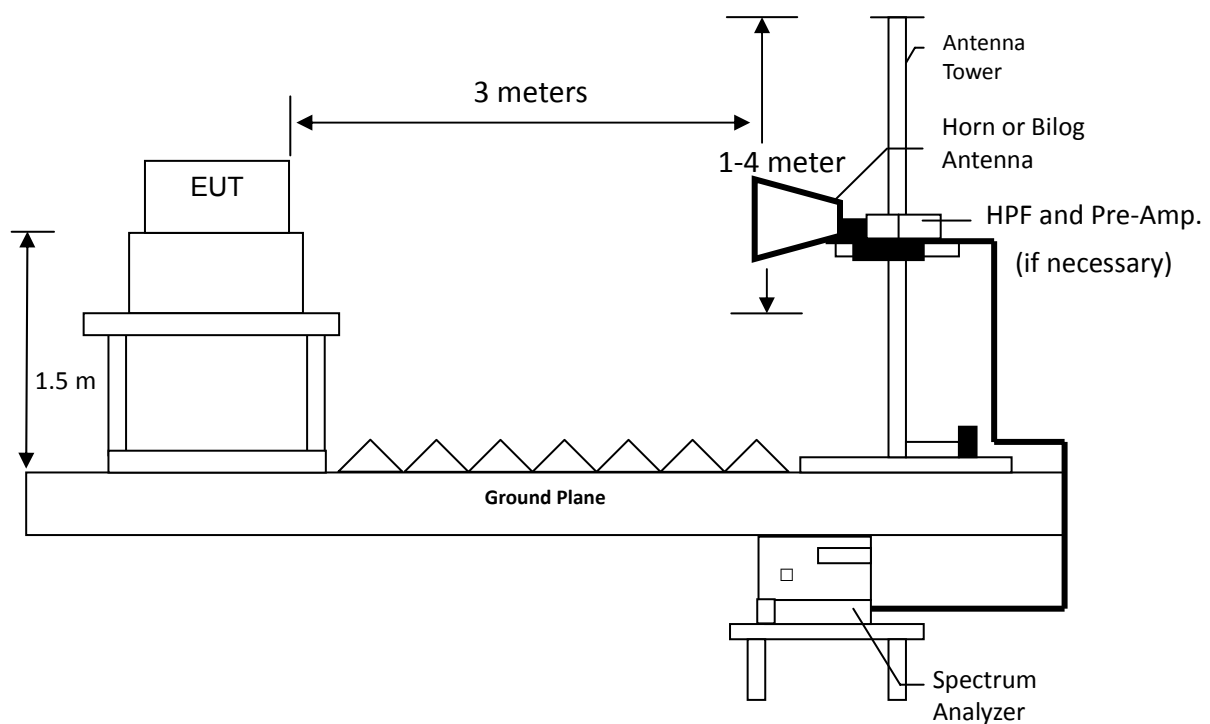
Radiated emission from 9kHz to 30MHz uses Loop Antenna:



Radiated emission below 1GHz using Bilog Antenna



Radiated emission above 1GHz using Horn Antenna



Radiated emissions were investigated cover the frequency range from 30MHz to 1000MHz using a receiver RBW of 120kHz record QP reading, and the frequency over 1GHz using a spectrum analyzer RBW of 1MHz and 10Hz VBW record Average reading. (15.209 paragraph), the Peak reading (1 MHz RBW/ 3 MHz VBW) recorded also on the report.

The EUT for testing is arranged on a turntable. If some peripherals apply to the EUT, the peripherals will be connected to EUT and the whole system. During the test, all cables were arranged to produce worst-case emissions. The signal is maximized through rotation. The height of antenna and polarization is changing constantly for exploring for maximum signal level. The height of antenna can be up to 4 meters and down to 1 meter.

The measurement for radiated emission will be done at the distance of three meters unless the signal level is too low to measure at that distance. In the case of the reading under noise floor, a pre-amplifier is used and/or the test is conducted at a closer distance. And then all readings are extrapolated back to the equivalent three meter reading using inverse scaling with distance.

The EUT configuration please refers to the "Spurious set-up photo.pdf".

4.3 Emission limit

4.3.1 Fundamental and harmonics emission limits

Frequency (MHz)	Field Strength of Fundamental		Field Strength of Harmonics	
	(mV/m@3m)	(dBuV/m@3m)	(uV/m@3m)	(dBuV/m@3m)
2400-2483.5	50	94	500	54

4.3.2 General radiated emission limits

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

Frequency MHz	15.209 Limits (dB μ V/m@3m)
30-88	40
88-216	43.5
216-960	46
Above 960	54

Remark:

1. In the above table, the tighter limit applies at the band edges.
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

4.4 Radiated spurious emission test data

4.4.1 Measurement results: frequency range from 9 kHz to 30 MHz

Polarity (circle)	Frequency (MHz)	Detection value	Factor (dB/m)	Reading (dB μ V)	Value (dB μ V/m)	Limit @ 3m (dB μ V/m)	Tolerance (dB)
Plane	0.02	QP	20.92	22.57	43.48	121.58	-78.10
Plane	0.03	QP	20.86	17.67	38.53	118.06	-79.53
Plane	0.07	QP	20.81	22.27	43.08	110.70	-67.62
Plane	0.09	QP	20.78	22.46	43.24	108.52	-65.28
Plane	0.12	QP	20.77	23.82	44.59	106.02	-61.43
Plane	0.14	QP	20.77	22.11	42.88	104.68	-61.80
Plane	0.69	QP	21.12	23.83	44.95	70.83	-25.88
Plane	2.00	QP	21.38	14.12	35.50	69.54	-34.04
Plane	9.58	QP	22.31	7.70	30.01	69.54	-39.53
Plane	13.88	QP	22.27	7.38	29.65	69.54	-39.89
Plane	17.58	QP	22.22	7.27	29.49	69.54	-40.05
Plane	24.45	QP	22.19	7.97	30.16	69.54	-39.38

4.4.2 Measurement results: frequencies equal to or less than 1 GHz

The test was performed on EUT under FSK mode. The worst case occurred at FSK mode at 2470MHz.

EUT: MACC0033

Worst case: 2470 MHz

Antenna Polarized (V/H)	Freq. (MHz)	Receiver Detector	Corr. Factor (dB/m)	Reading (dBuV)	Corrected Level (dBuV/m)	Limit @ 3 m (dBuV/m)	Margin (dB)
V	41.64	QP	16.50	3.87	20.37	40.00	-19.63
V	158.04	QP	16.44	4.61	21.05	43.50	-22.45
V	352.04	QP	18.79	5.21	24.00	46.00	-22.00
V	730.34	QP	26.21	6.98	33.19	46.00	-12.81
V	786.60	QP	27.10	6.47	33.57	46.00	-12.43
V	920.46	QP	28.78	6.80	35.58	46.00	-10.42
H	144.46	QP	16.26	4.65	20.91	43.50	-22.59
H	224.00	QP	14.75	7.71	22.46	46.00	-23.54
H	270.56	QP	16.50	8.10	24.60	46.00	-21.40
H	303.54	QP	17.50	11.38	28.88	46.00	-17.12
H	730.34	QP	26.21	7.29	33.50	46.00	-12.50
H	883.60	QP	28.42	5.19	33.61	46.00	-12.39

Remark:

1. Corr. Factor = Antenna Factor + Cable Loss
2. Corrected Level = Reading + Corr. Factor

4.4.3 Measurement results: frequency above 1GHz

EUT : MACC0033

Mode	Frequency (MHz)	Spectrum Analyzer Detector	Ant. Pol. (H/V)	Preamp. Gain (dB)	Correction Factor (dB/m)	Reading (dBμV)	Corrected Reading (dBμV/m)	Limit @ 3 m (dBμV/m)	Margin (dB)
2470MHz	4940	PK	V	39.88	31.57	4.71	36.28	74.00	-37.72
	7410	PK	V	37.94	34.63	0.10	34.73	74.00	-39.27
	4940	PK	H	39.88	31.57	-0.33	31.24	74.00	-42.76
	7410	PK	H	37.94	34.63	-0.44	34.19	74.00	-39.81

Remark:

1. Correction Factor = Antenna Factor + Cable Loss– Preamp. Gain
2. The frequency measured ranges from 1GHz to 25GHz.The data value listed above which is higher than the noise floor, the others please refer to noise floor level.

4.4.4 Measurement results: Fundamental and harmonics emission

EUT : MACC0033

Mode	Spectrum Analyzer	Ant. Pol. (H/V)	Correction Factor (dB/m)	Reading (dBuV)	Corrected Reading (dBuV/m)	Limit @ 3 m (dBuV/m)	Margin (dB)
2470MHz	PK	V	33.37	42.63	76.00	114	-38.00
	AV	V	33.37	26.75	60.12	94	-33.88
	PK	H	33.37	46.12	79.49	114	-34.51
	AV	H	33.37	28.96	62.33	94	-31.67

Remark:

1. Correction Factor = Antenna Factor + Cable Loss– Preamp. Gain
2. The frequency measured ranges from 1GHz to 25GHz.The data value listed above which is higher than the noise floor, the others please refer to noise floor level.

5. Radiated emission on the band edge FCC 15.249(d)

5.1 Operating environment

Temperature: 25 °C
Relative Humidity: 50 %
Atmospheric Pressure: 1008 hPa

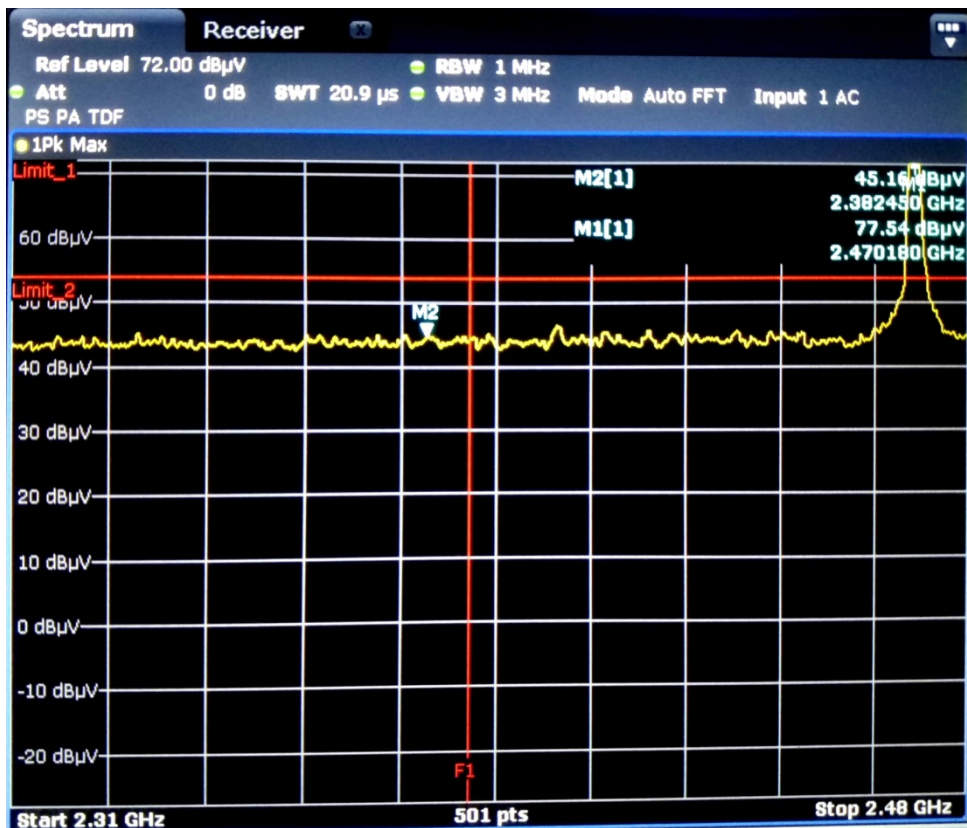
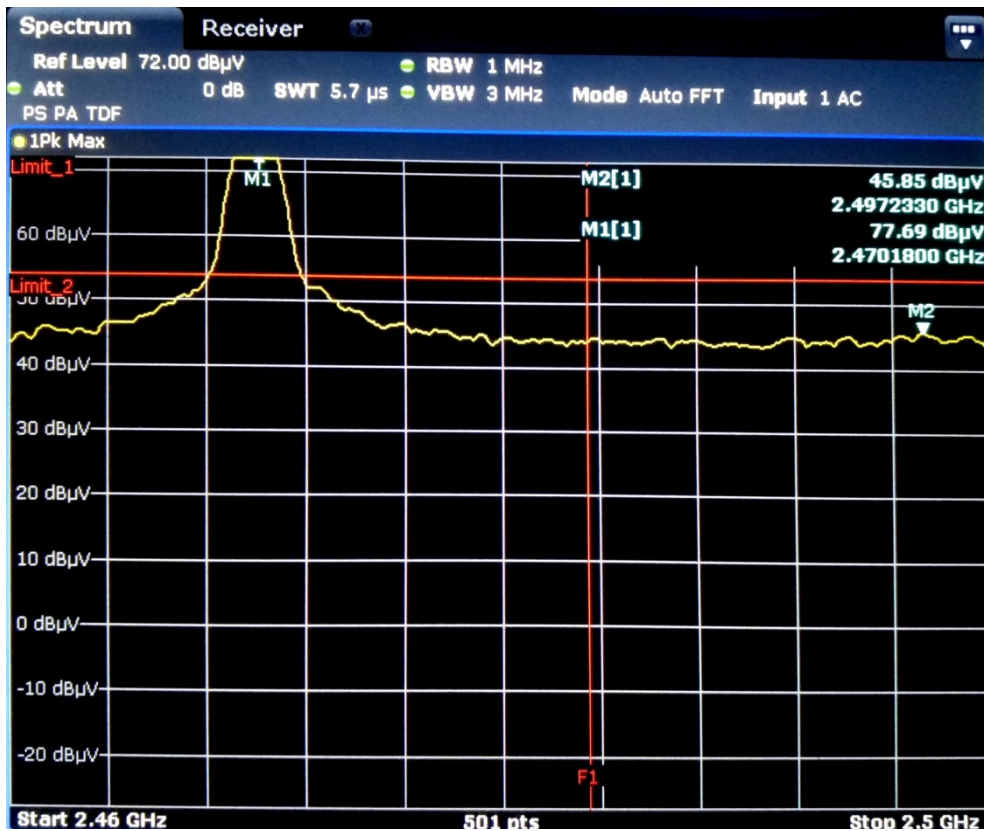
5.2 Radiated emission on the band edge test data

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 (2470MHz) or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.

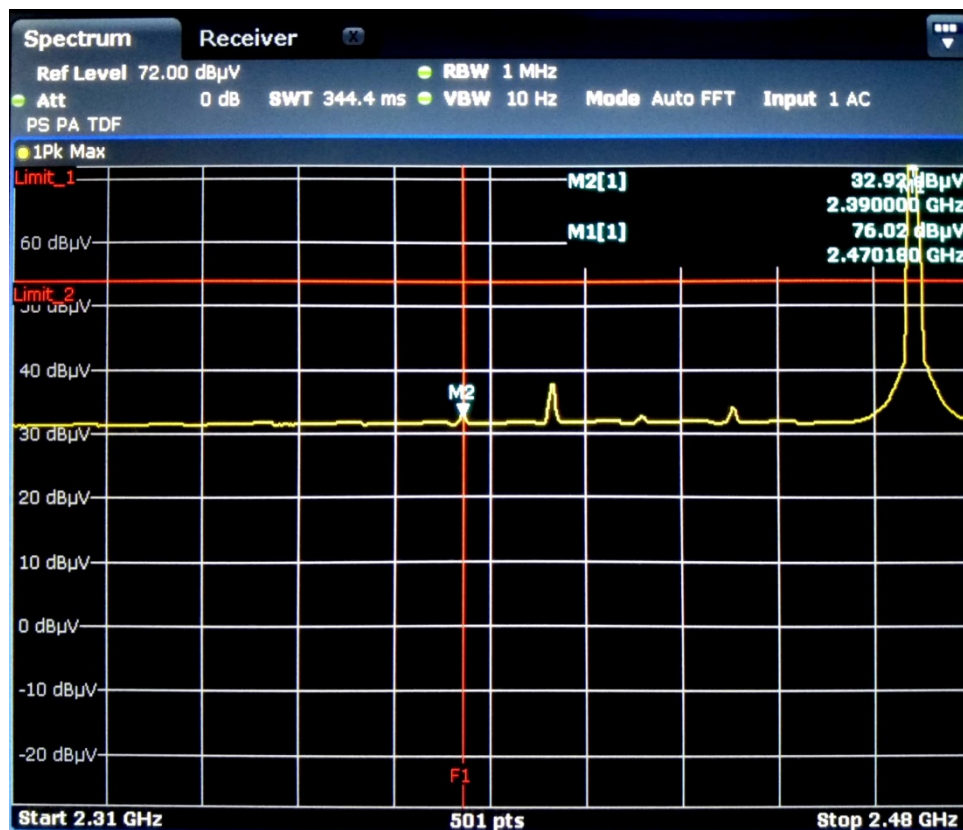
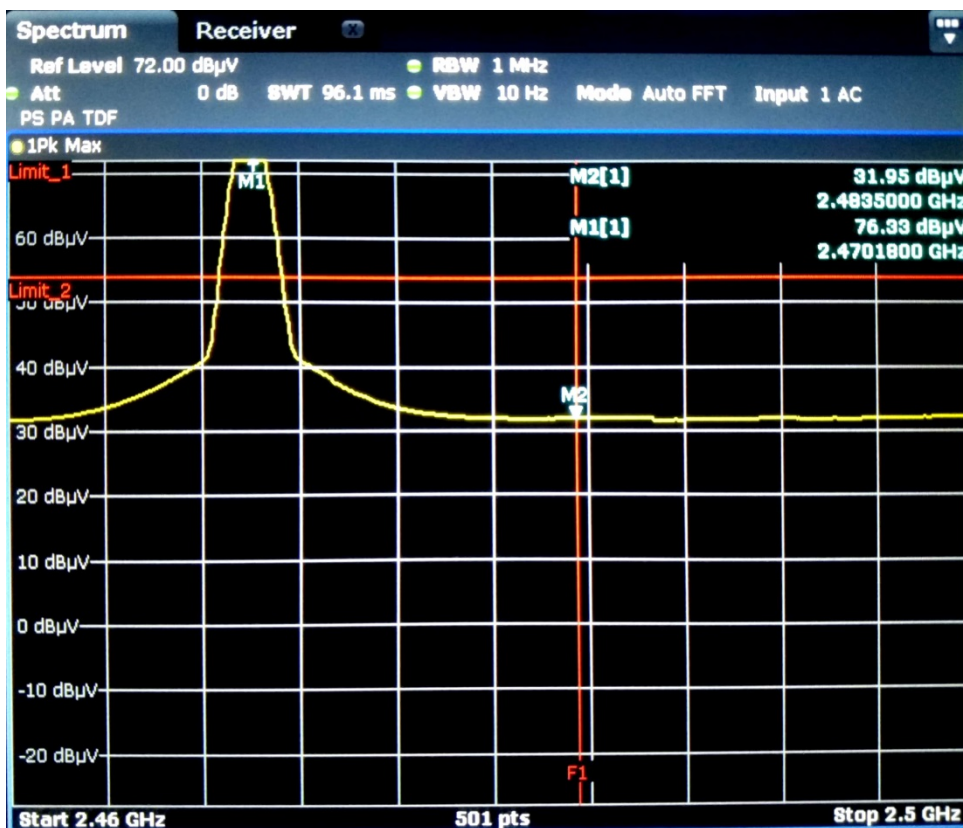
Mode	Frequency (MHz)	Spectrum Analyzer Detector	Ant. Pol. (H/V)	Correction Factor (dB/m)	Reading (dBμV)	Corrected Reading (dBμV/m)	Limit @ 3 m (dBμV/m)	Margin (dB)	Restricted band (MHz)
2470MHz	2382.450	PK	V	33.79	11.37	45.16	74	-28.84	2310~2390
	2390.000	AV	V	33.85	-0.93	32.92	54	-21.08	
	2497.233	PK	V	34.30	11.55	45.85	74	-28.15	2483.5~2500
	2483.500	AV	V	34.30	-2.35	31.95	54	-22.05	

Remark: Correction Factor = Antenna Factor + Cable Loss

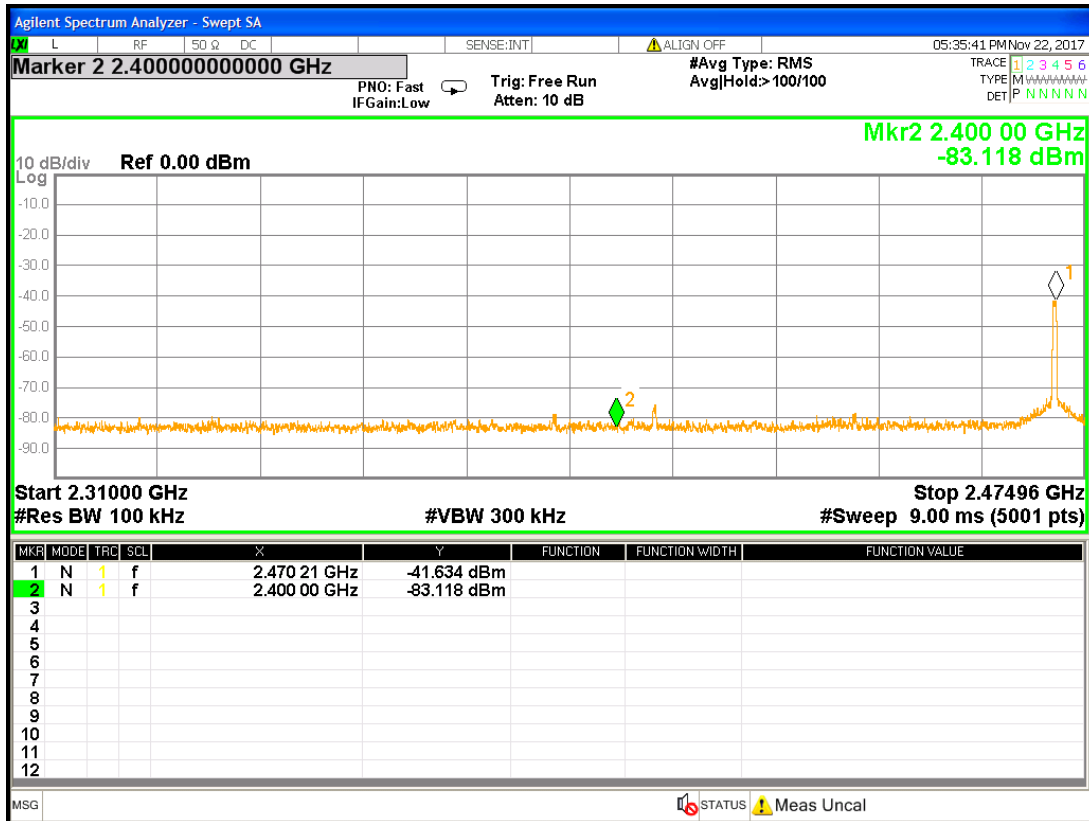
Chain0 : BandEdge @ 2470MHz Peak



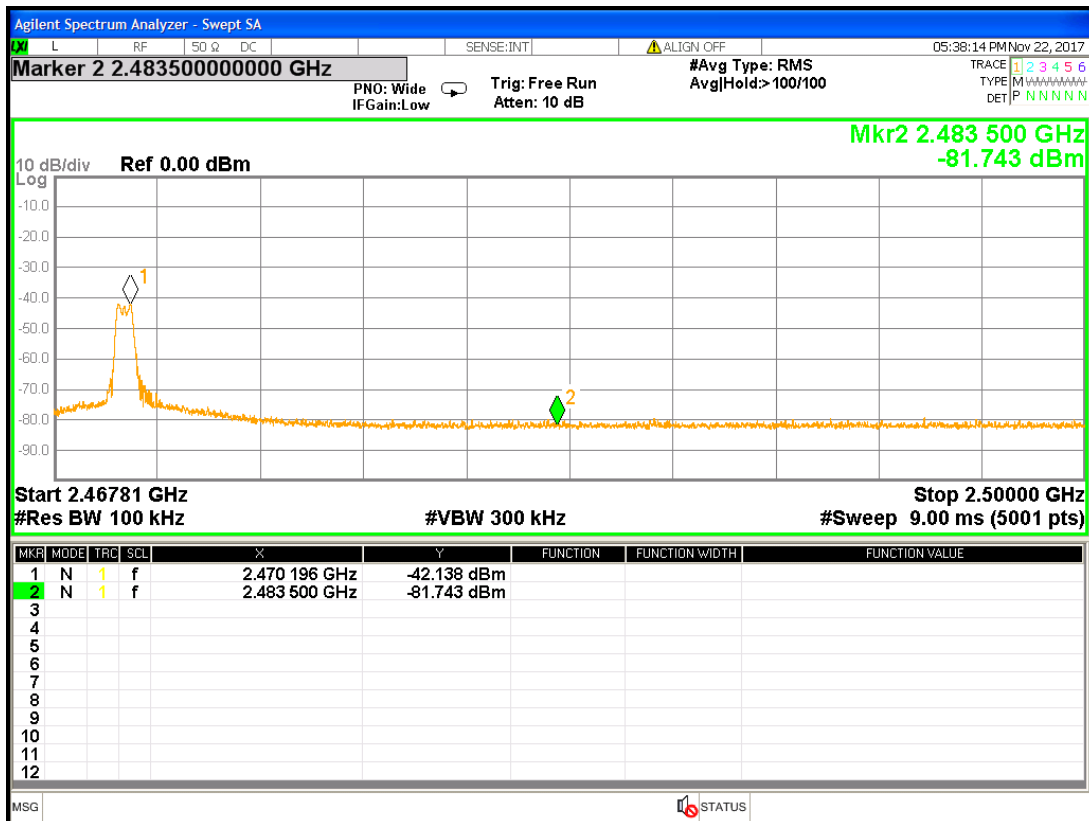
Chain0 : BandEdge @ 2470MHz AV



Chain0 : Authorized band bandedge @ 2400MHz



Chain0 : Authorized band bandedge @ 2483.5MHz



6. Conducted emission test FCC 15.207

Since the EUT is connected to DC source, therefore, the test can be waived.

Appendix A: Test equipment list

Test Equipment/ Test site	Brand	Model No.	Serial No.	Calibration Date	Next Calibration Date
ESCI EMI Test Receiver	Rohde & Schwarz	ESCI	100018	2016/11/30	2017/11/29
Spectrum Analyzer	Rohde & Schwarz	FSP30	100245	2017/02/15	2018/02/14
Horn Antenna (1-18G)	SHWARZBECK	BBHA 9120 D	9120D-456	2017/02/18	2018/02/17
Horn Antenna (14-42G)	SHWARZBECK	BBHA 9170	BBHA9170159	2014/09/16	2017/09/14
Broadband Antenna	SHWARZBECK	VULB 9168	9168-172	2017/04/05	2018/04/04
Pre-Amplifier	EMC Co.	EMC12635SE	980205	2016/10/08	2017/10/07
Pre-Amplifier	MITEQ	JS4-26004000--27-8A	828825	2016/09/12	2017/09/11
Power Meter	Anritsu	ML2495A	0844001	2016/11/09	2017/11/08
Power Sensor	Anritsu	MA2411B	0738452	2016/11/09	2017/11/08
Signal Analyzer	Agilent	N9030A	MY51380492	2017/08/29	2018/08/28
966-2(A) Cable 9kHz~26.5GHz	SUHNER	SMA / EX 100	N/A	2017/08/15	2018/08/14
966-2(B) Cable 9kHz~26.5GHz	SUHNER	SUCOFLEX 104P	CB0005	2017/08/15	2018/08/14
RF Cable 9kHz~26.5GHz	SUHNER	SUCOFLEX 102	CB0006	2017/05/04	2018/05/03
966-2_3m Semi-Anechoic Chamber	966_2	CEM-966_2	N/A	2017/03/29	2018/03/28
High Pass Filter	Wainwright	WHKX3.0/18G-12SS	N/A	2017/06/02	2018/06/01
Active Loop Antenna	SCHWARZBECK MESS-ELEKTRONIC	FMZB1519	1519-067	2017/03/30	2018/03/29

Note: No Calibration Required (NCR).

Test Equipment/ Test site	Brand	Model No.	Serial No.	Calibration Date	Next Calibration Date
WiMAX PSA Spectrum Analyzer 3Hz-26.5GHz	Agilent	E4440A	MY46186191	2017/05/22	2018/05/21
EMI Test Receiver	Rohde & Schwarz	ESR-7	101232	2017/01/23	2018/01/22
Test software	Audix	e3	4.20040112L	NCR	NCR

Note: No Calibration Required (NCR).

Appendix B: Measurement Uncertainty

This uncertainty represents an expanded uncertainty expressed at approximately the 95 % confidence level using a coverage factor of $k=2$.

Item	Uncertainty
Vertically polarized radiated disturbances from 30MHz~1GHz in a semi-anechoic chamber at a distance of 3m	5.14 dB
Horizontally polarized radiated disturbances from 30MHz~1GHz in a semi-anechoic chamber at a distance of 3m	5.22 dB
Vertically polarized Radiated disturbances from 1GHz~18GHz in a semi-anechoic chamber at a distance of 3m	3.64 dB
Horizontally polarized Radiated disturbances from 1GHz~18GHz in a semi-anechoic chamber at a distance of 3m	3.64 dB
Vertically polarized Radiated disturbances from 18GHz~40GHz in a semi-anechoic chamber at a distance of 3m	2.68 dB
Horizontally polarized Radiated disturbances from 18GHz~40GHz in a semi-anechoic chamber at a distance of 3m	2.68 dB
Radiated disturbances from 9kHz~30MHz in a semi-anechoic chamber at a distance of 3m	3.54 dB
Emission on the Band Edge Test	3.64 dB
20dB Bandwidth	1.22 dB
AC Power Line Conducted Emission	2.48 dB