FCC Part 15.247

TEST REPORT

For

TOPMORE TECHNOLOGY INC.

No.1-1, Taiyuan 2nd St., Zhubei City, Hsinchu County 302, Taiwan (R.O.C.)

FCC ID: 2ANH6-D12-SPKR

Report Type:	**Product Type:**
Original Report	Crystal Cube

Report Producer : **Jane Lee** Jane Lee

Report Number : **RXZ1805011-00A**

Report Date : **2018-06-19**

Reviewed By: **Jerry Chang** Jerry J. Chang

Prepared By: **Bay Area Compliance Laboratories Corp.(Taiwan)**
70, Lane 169, Sec. 2, Datong Road, Xizhi Dist.,
New Taipei City 22183, Taiwan, R.O.C.
Tel: +886 (2) 2647 6898
Fax: +886 (2) 2647 6895
www.bacl.com.tw

Revision History

Revision	No.	Report Number	Issue Date	Description	Author/ Revised by
1.0	RXZ1805011	RXZ1805011-00A	2018.06.19	Original Report	Jane

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1 General Information

1.1 Product Description for Equipment under Test (EUT)

Applicant	TOPMORE TECHNOLOGY INC.
	No.1-1, Taiyuan 2nd St., Zhubei City, Hsinchu County 302, Taiwan (R.O.C.)
Manufacturer	Shenzhen ABC Industrial Co., Ltd.
	Rm526, Block C, Huafeng Headquarters Bldg, Xixiang Avenue No. 288, Bao'an, Shenzhen, China
Brand(Trade) Name	TOPMORE
Product (Equipment)	Crystal Cube
Model Name	D12
Frequency Range	2402 ~ 2480 MHz
Transmit Power	BLE Mode: -5.86 dBm (0.00026W)
Modulation Technique	BLE Mode: GFSK
Transmit Data Rate	BLE Mode: 1 Mbps
Number of Channels	BLE Mode: 40 Channels
Antenna Specification	PCB Antenna / -0.68 dBi
Module model	ATS2823
Output:	5V from USB 3.7V from Battery
Received Date	May 21, 2018
Date of Test	May 21, 2018 ~ June 19, 2018

**All measurement and test data in this report was gathered from production sample serial number: 1805011 (Assigned by BACL, Taiwan).*

1.2 Objective

This report is prepared on behalf of *TOPMORE TECHNOLOGY INC.* in accordance with Part 2, Subpart J, Part 15, Subparts A and C of the Federal Communication Commission's rules.

The tests were performed in order to determine the BLE mode of EUT compliance with FCC Part 15, Subpart C, and section 15.203, 15.205, 15.207, 15.209 and 15.247 rules.

1.3 Related Submittal(s)/Grant(s)

FCC Part 15.247 DSS submission with FCC ID: 2ANH6-D12-SPKR

1.4 Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

1.5 Test Facility

The Test site used by Bay Area Compliance Laboratories Corp. (Taiwan) to collect test data is located on

☒70, Lane 169, Sec. 2, Datong Road, Xizhi Dist., New Taipei City 22183, Taiwan, R.O.C.

☐68-3, Lane 169, Sec. 2, Datong Road, Xizhi Dist., New Taipei City 22183, Taiwan, R.O.C.

Bay Area Compliance Laboratories Corp. (Taiwan) Lab is accredited to ISO 17025 by Taiwan Accreditation Foundation (TAF code: 3180) and the FCC designation No.TW3180 under the Mutual Recognition Agreement (MRA) in FCC Test. The facility also complies with the radiated and AC line conducted test site criteria set forth in ANSI C63.10.

The Federal Communications Commission has the reports on file and is listed under FCC Registration No.: 974454. The test site has been approved by the FCC for public use and is listed in the FCC Public Access Link (PAL) database.

2 System Test Configuration

2.1 Description of Test Configuration

For BT BLE mode, 40 channels are provided to testing:

Channel	Frequency (MHz)	Channel	Frequency (MHz)
1	2402	21	2442
2	2404	--	--
3	2406	--	--
4	2408	38	2476
--	--	39	2478
20	2440	40	2480

EUT was tested with Channel 1, 20 and 40.

2.2 Equipment Modifications

No modification was made to the EUT.

2.3 EUT Exercise Software

Test Software		FCC Test tools v1.07		
Test Frequency		2402MHz	2440MHz	2480MHz
Power Level Setting	BLE	0	0	0

2.4 Support Equipment List and Details

Description	Manufacturer	Model Number	BSMI	FCC ID	S/N
NB	DELL	E6410	N/A	N/A	N/A

2.5 External Cable List and Details

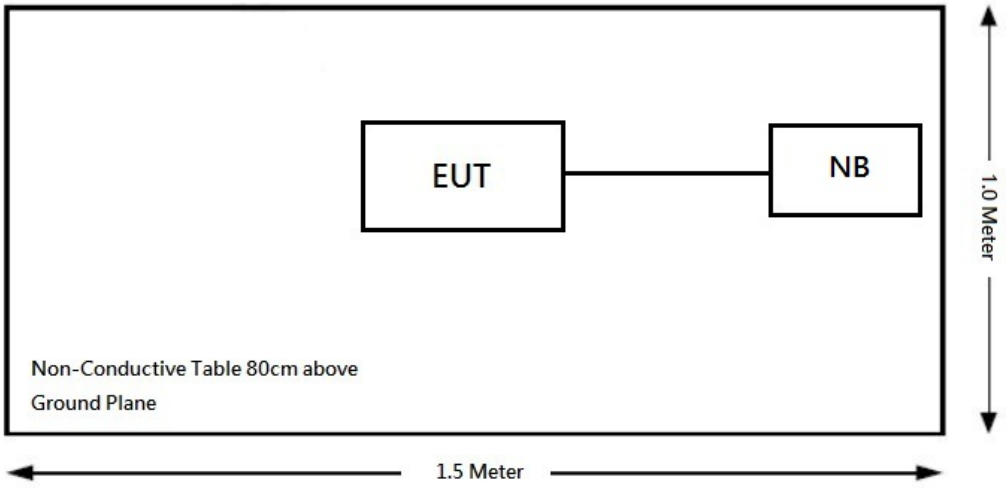
Cable Description	Length (m)	From	To
N/A	N/A	N/A	N/A

2.6 Block Diagram of Test Setup

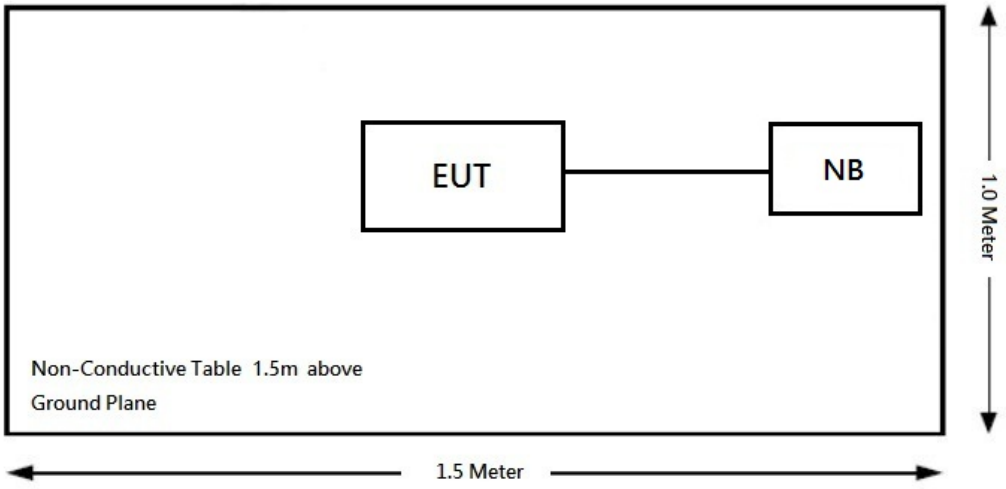
See test photographs attached in annex set up photo for the actual connections between EUT and support equipment.

Radiation:

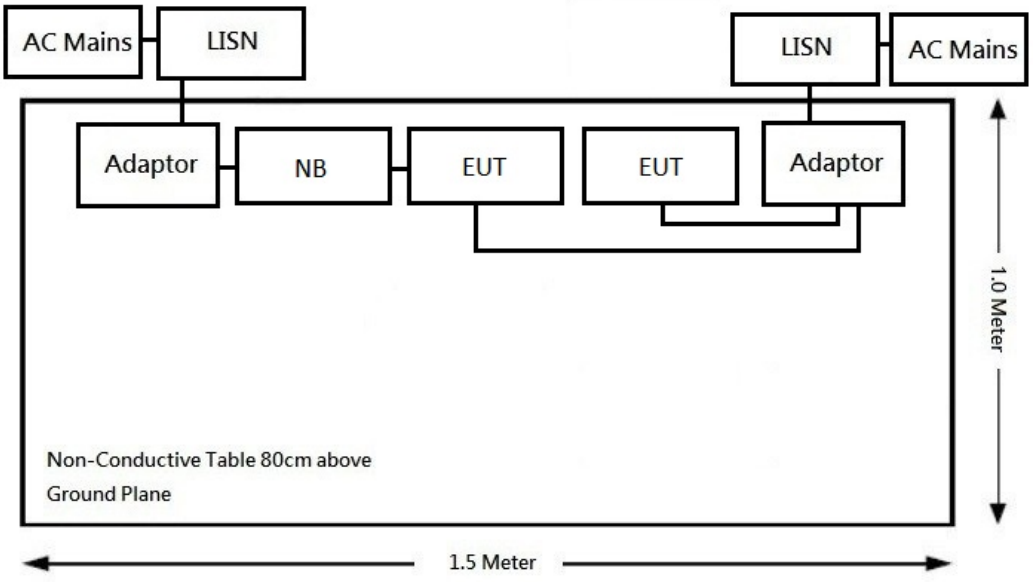
Below 1GHz:



Above 1GHz:



Conduction:


AC Mains
LISN
LISN
AC Mains
Adaptor
NB
EUT
EUT
Adaptor
1.0 Meter
Non-Conductive Table 80cm above
Ground Plane
1.5 Meter

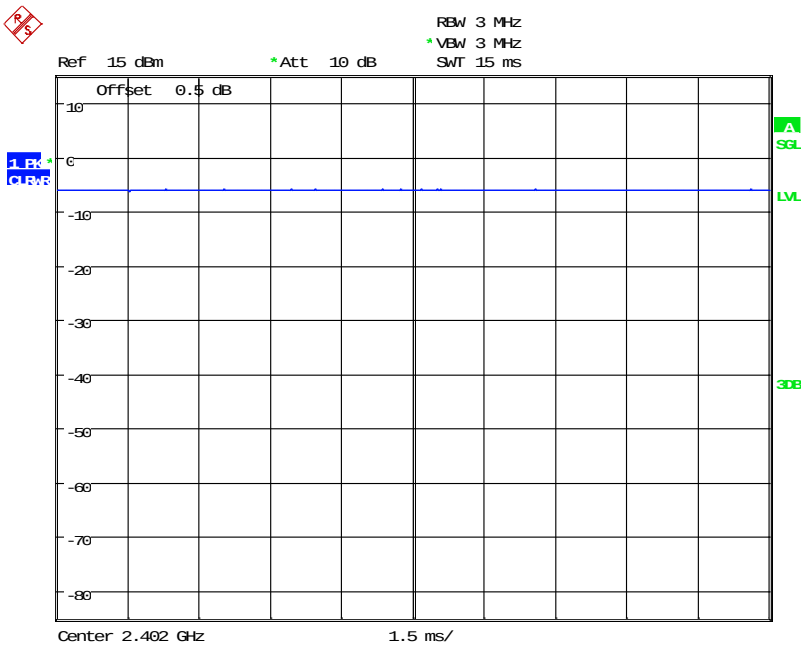
2.7 Duty Cycle

According to KDB 558074 D01 DTS Meas Guidance v04 section 6.0:

All measurements are to be performed with the EUT transmitting at 100% duty cycle at its maximum power control level; however, if 100% duty cycle cannot be achieved, measurements of duty cycle, x, and maximumpower transmission duration, T, are required for each tested mode of operation.

Radio Mode	On Time (ms)	Period (ms)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)
BLE	15	15	100	0

Note: Duty Cycle Correction Factor = 10*log(1/duty cycle)



3 Summary of Test Results

FCC Rules	Description of Test	Result
§15.247(i), §2.1093	RF Exposure	Compliance
§15.203	Antenna Requirement	Compliance
§15.207(a)	AC Line Conducted Emissions	Compliance
§15.205, §15.209, §15.247(d)	Spurious Emissions	Compliance
§15.247(a)(2)	6 dB Emission Bandwidth	Compliance
§15.247(b)(3)	Maximum Peak Output Power	Compliance
§15.247(d)	100 kHz Bandwidth of Frequency Band Edge	Compliance
§15.247(e)	Power Spectral Density	Compliance

4 Test Equipment List and Details

Description	Manufacturer	Model	Serial Number	Calibration Date	Calibration Due Date
AC Line Conduction Room (CON-A)					
LISN	Rohde & Schwarz	ENV216	101248	2017/07/20	2018/07/19
EMI Test Receiver	Rohde & Schwarz	ESR7	101419	2017/11/06	2018/11/05
Pulse Limiter	Rohde & Schwarz	ESH3Z2	TXZEM104	2017/08/10	2018/08/09
RF Cable	EMEC	EM-CB5D	001	2017/07/10	2018/07/09
Software	AUDIX	E3	V9.150826k	N.C.R	N.C.R
Radiated Room (966-A)					
Bilog Antenna with 6 dB Attenuator	SUNOL SCIENCES & MINI-CIRCUITS	JB6/UNAT-6+	A050115/15542_01	2017/12/20	2018/12/19
Horn Antenna	EMCO	3115	9311-4158	2018/04/20	2019/04/19
Horn Antenna	ETS-Lindgren	3116	62638	2017/09/13	2018/09/12
Preamplifier	Sonoma	310N	130602	2017/07/03	2018/07/02
Preamplifier	EM Electronics Corp.	EM01G18G	060657	2017/12/14	2018/12/13
Microware Preamplifier	EM Electronics Corporatino	EM18G40G	060656	2018/01/15	2019/01/14
EMI Test Receiver	Rohde & Schwarz	ESR7	101419	2017/11/06	2018/11/05
Spectrum Analyzer	Rohde & Schwarz	FSV40	101203	2017/07/13	2018/07/12
Microflex Cable	UTIFLEX	UFB311A-Q-1440-300300	220490-006	2017/10/31	2018/10/30
Microflex Cable	UTIFLEX	UFA210A-1-3149-300300	MFR64639 226389-001	2017/11/10	2018/11/09
Microflex Cable	ROSNOL	K1K50-UP0264-K1K50-450CM	160309-1	2018/03/05	2019/03/04
Microflex Cable	ROSNOL	K1K50-UP0264-K1K50-80CM	160309-2	2018/01/17	2019/01/16
Turn Table	Champro	TT-2000	060772-T	N.C.R	N.C.R
Antenna Tower	Champro	AM-BS-4500-B	060772-A	N.C.R	N.C.R
Controller	Champro	EM1000	60772	N.C.R	N.C.R
Software	Farad	EZ_EMC	BACL-03A1	N.C.R	N.C.R
NSA	BACL	966-A	N/A	2017/07/24	2018/07/23
VSWR	BACL	966-A	N/A	2017/07/25	2018/07/24

Conducted Room					
Spectrum Analyzer	Rohde & Schwarz	FSU26	200268	2018/05/04	2019/05/03
Cable	WOKEN	SFL402	S02-160323-07	2018/02/12	2019/02/11
Power Sensor	KEYSIGHT	U2021XA	MY54080018	2018/03/07	2019/03/06

***Statement of Traceability:** BACL Corp. attests that all of the calibrations on the equipment items listed above were traceable to the SI System of Units via the R.O.C. Center for Measurement Standards of the Electronics Testing Center, Taiwan (ETC) or to another internationally recognized National Metrology Institute (NMI), and were compliant with the current Taiwan Accreditation Foundation (TAF) requirements*

5 FCC §15.247(i) & 2.1093 - RF Exposure

5.1 Applicable Standard

According to FCC §15.247(i)

Systems operating under the provisions of this section shall be operated in a manner that ensure that the public is not exposed to radio frequency energy level in excess of the Commission's guideline.

According to KDB 447498 D01 General RF Exposure Guidance, the 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances
≤ 50 mm are determined by:

[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] • [$\sqrt{}$f(GHz)] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where

1. f(GHz) is the RF channel transmit frequency in GHz.
2. Power and distance are rounded to the nearest mW and mm before calculation.
3. The result is rounded to one decimal place for comparison.
4. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test Exclusion.

5.2 RF Exposure Evaluation Result

FCC

Worse case:

SAR evaluation:

Mode	Frequency	Tunp-up Power		Evaluation Distrance	Calculated Value	Threshold	SAR Test Exclusion
	(MHz)	(dBm)	(mW)	(mm)		(1-g SAR)	
BT	2402-2480	-5.5	0.282	5	0.1	3	Yes
BLE	2402-2480	-4.5	0.355	5	0.1	3	Yes

Result: SAR test is exempted.

6 FCC §15.203 – Antenna Requirements

6.1 Applicable Standard

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 user of a standard antenna jack or electrical connector is prohibited.

And according to FCC 47 CFR section 15.247 (b), if the transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceed 6 dBi.

6.2 Measurement Uncertainty

Manufacturer	Type	Antenna Gain	Result
Actions(Zhuhai) Technology Co., Limited	PCB Antenna	-0.68 dBi	Compliance

The EUT has an internal antenna arrangement, which was permanently attached, fulfill the requirement of this section.

7 FCC §15.207(a) – AC Line Conducted Emissions

7.1 Applicable Standard

According to §15.207

For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 μH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequencies ranges.

Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	Quasi-Peak	Average
0.15-0.5	66 to 56 Note 1	56 to 46 Note 2
0.5-5	56	46
5-30	60	50

Note 1: Decreases with the logarithm of the frequency.

Note 2: A linear average detector is required

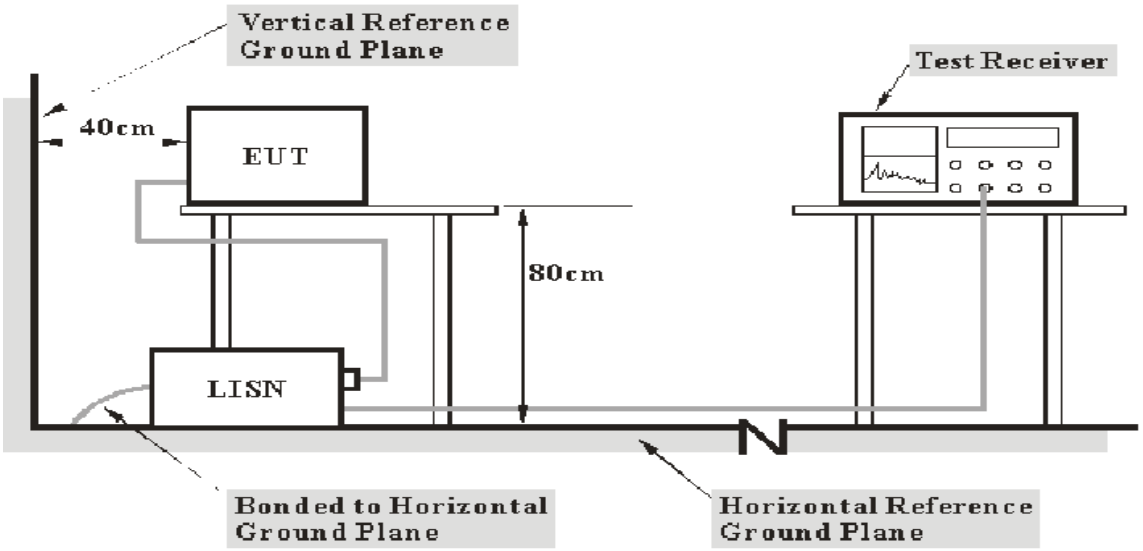
7.2 Measurement Uncertainty

Input quantities to be considered for conducted disturbance measurements maybe receiver reading, attenuation of the connection between LISN/ISN and receiver, LISN/ISN voltage division factor, LISN/ISN VDF frequency interpolation and receiver related input quantities, etc.

Based on CISPR 16-4-2:2011, the expended combined standard uncertainty of conducted disturbance test at Bay Area Compliance Laboratories Corp. (Taiwan) is shown as below. And the uncertainty will not be taken into consideration for the test data recorded in the report

Port	Expanded Measurement uncertainty
AC Mains	4.64 dB (k=2, 95% level of confidence)

7.3 EUT Setup



Note: 1. Support units were connected to second LISN.
2. Both of LISNs (AMN) 80 cm from EUT and at the least 80 cm from other units and other metal planes support units.

The setup of EUT is according with per ANSI C63.10-2013 measurement procedure. The specification used was with the FCC Part 15.207 limits.

7.4 EMI Test Receiver Setup

The EMI test receiver was set to investigate the spectrum from 150 kHz to 30 MHz.

During the conducted emission test, the EMI test receiver was set with the following configurations

Frequency Range	IF B/W
150 kHz – 30 MHz	9 kHz

7.5 Test Procedure

During the conducted emission test, the adapter was connected to the outlet of the LISN.

Maximizing procedure was performed on the six (6) highest emissions of the EUT.

All data was recorded in the Quasi-peak and average detection mode.

7.6 Corrected Factor & Margin Calculation

The factor is calculated by adding LISN/ISN VDF (Voltage Division Factor), Cable Loss and Transient Limiter Attenuation. The basic equation is as follows:

Factor = LISN VDF + Cable Loss + Transient Limiter Attenuation

The "Over Limit" column of the following data tables indicates the degree of compliance with the applicable limit. For example, an over limit of -7 dB means the emission is 7 dB below the limit. The equation for Over Limit calculation is as follows:

Over Limit = Level – Limit Line

7.7 Environmental Conditions

Temperature:	25 ℃
Relative Humidity:	55 %
ATM Pressure:	1010 hPa

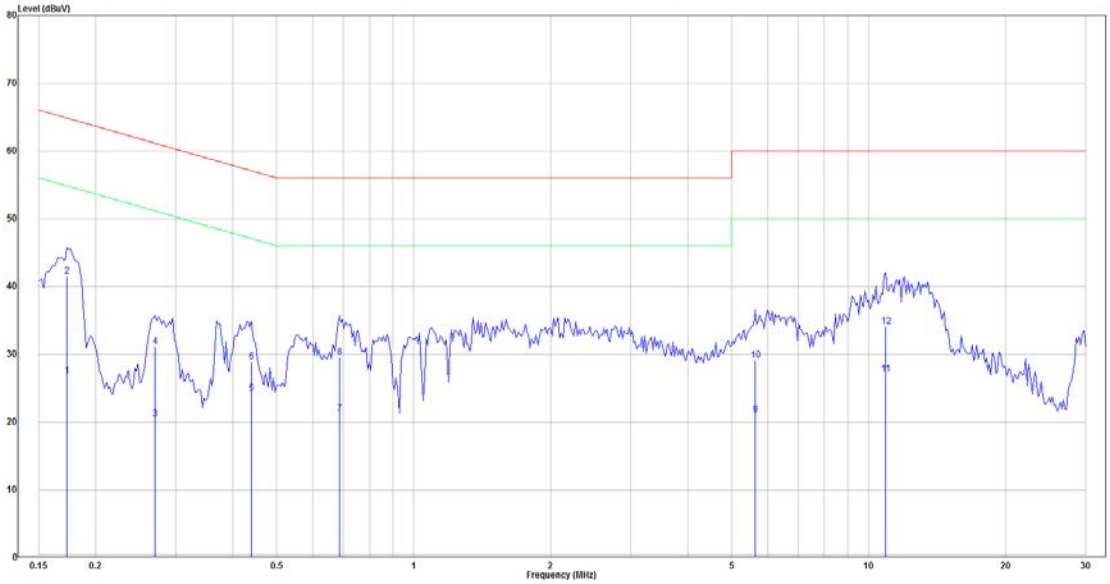
The testing was performed by Tom Hsu on 2018-06-04.

7.8 Test Results: PASS

7.9 Test Data

Test Mode: Transmitting

AC120 V, 60 Hz, Line



No.	Frequency	Reading	Correct	Result	Limit	Over limit	Remark
	(MHz)	(dBµV)	Factor(dB)	(dBµV)	(dBµV)	(dB)	
1	0.173	7.29	19.50	26.79	54.81	-28.02	Average
2	0.173	21.96	19.50	41.46	64.81	-23.35	QP
3	0.270	0.97	19.50	20.47	51.10	-30.63	Average
4	0.270	11.60	19.50	31.10	61.10	-30.00	QP
5	0.440	4.71	19.51	24.22	47.07	-22.85	Average
6	0.440	9.36	19.51	28.87	57.07	-28.20	QP
7	0.687	1.74	19.52	21.26	46.00	-24.74	Average
8	0.687	10.08	19.52	29.60	56.00	-26.40	QP
9	5.630	1.35	19.69	21.04	50.00	-28.96	Average
10	5.630	9.43	19.69	29.12	60.00	-30.88	QP
11	10.906	7.27	19.77	27.04	50.00	-22.96	Average
12	10.906	14.38	19.77	34.15	60.00	-25.85	QP

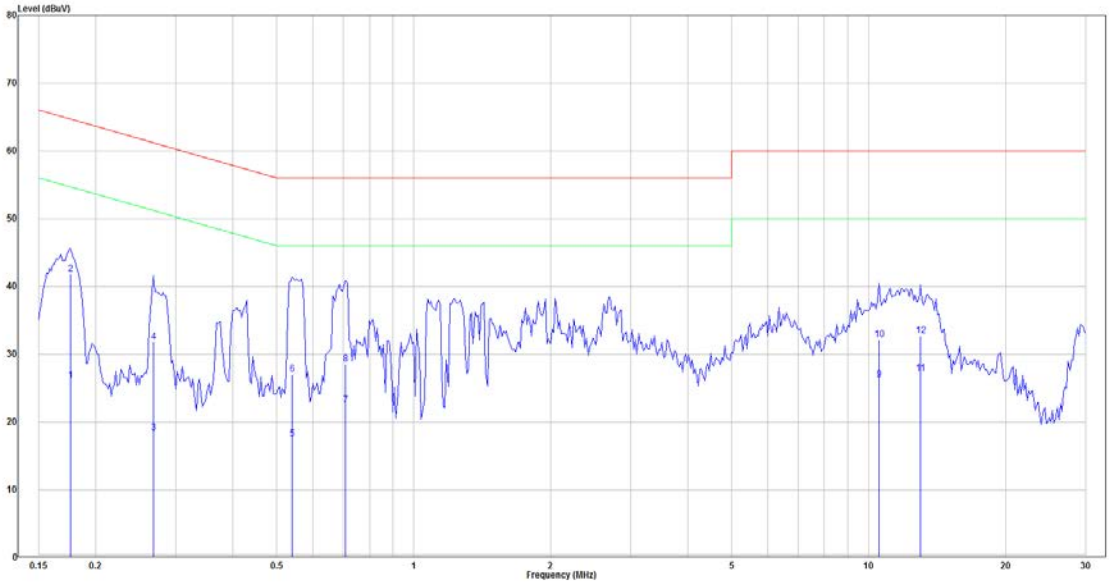
Note:

Level = Read Level + Factor

Over Limit = Level – Limit Line

Factor = (LISN, ISN, PLC or current probe) Factor + Cable Loss + Attenuator

AC120 V, 60 Hz, Neutral



No.	Frequency	Reading	Correct	Result	Limit	Over limit	Remark
	(MHz)	(dBµV)	Factor(dB)	(dBµV)	(dBµV)	(dB)	
1	0.176	6.51	19.63	26.14	54.68	-28.54	Average
2	0.176	22.19	19.63	41.82	64.68	-22.86	QP
3	0.268	-1.23	19.63	18.40	51.17	-32.77	Average
4	0.268	12.20	19.63	31.84	61.17	-29.33	QP
5	0.541	-2.10	19.65	17.55	46.00	-28.45	Average
6	0.541	7.44	19.65	27.09	56.00	-28.91	QP
7	0.709	2.84	19.66	22.50	46.00	-23.50	Average
8	0.709	8.86	19.66	28.52	56.00	-27.48	QP
9	10.564	6.38	19.92	26.30	50.00	-23.70	Average
10	10.564	12.23	19.92	32.15	60.00	-27.85	QP
11	12.996	7.22	19.95	27.17	50.00	-22.83	Average
12	12.996	12.80	19.95	32.75	60.00	-27.25	QP

Note:

Level = Read Level + Factor

Over Limit = Level – Limit Line

Factor = (LISN, ISN, PLC or current probe) Factor + Cable Loss + Attenuator

8 FCC §15.209, §15.205 , §15.247(d) – Spurious Emissions

8.1 Applicable Standard

As per FCC §15.35(d): Unless otherwise specified, on any frequency or frequencies above 1000 MHz, the radiated emission limits are based on the use of measurement instrumentation employing an average detector function. Unless otherwise specified, measurements above 1000 MHz shall be performed using a minimum resolution bandwidth of 1 MHz.

As Per FCC §15.205(a) except as show in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 – 0.110	16.42 – 16.423	960 – 1240	4. 5 – 5. 15
0.495 – 0.505	16.69475 – 16.69525	1300 – 1427	5. 35 – 5. 46
2.1735 – 2.1905	25.5 – 25.67	1435 – 1626.5	7.25 – 7.75
4.125 – 4.128	37.5 – 38.25	1645.5 – 1646.5	8.025 – 8.5
4.17725 – 4.17775	73 – 74.6	1660 – 1710	9.0 – 9.2
4.20725 – 4.20775	74.8 – 75.2	1718.8 – 1722.2	9.3 – 9.5
6.215 – 6.218	108 – 121.94	2200 – 2300	10.6 – 12.7
6.26775 – 6.26825	123 – 138	2310 – 2390	13.25 – 13.4
6.31175 – 6.31225	149.9 – 150.05	2483.5 – 2500	14.47 – 14.5
8.291 – 8.294	156.52475 – 156.52525	2690 – 2900	15.35 – 16.2
8.362 – 8.366	156.7 – 156.9	3260 – 3267	17.7 – 21.4
8.37625 – 8.38675	162.0125 –167.17	3.332 – 3.339	22.01 – 23.12
8.41425 – 8.41475	167.72 – 173.2	3 3458 – 3 358	23.6 – 24.0
12.29 – 12.293	240 – 285	3.600 – 4.400	31.2 – 31.8
12.51975 – 12.52025	322 – 335.4		36.43 – 36.5
12.57675 – 12.57725	399.9 – 410		Above 38.6
13.36 – 13.41	608 – 614		

As per FCC §15.209(a): Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength (micro volts/meter)	Measurement Distance (meters)
0.009 - 0.490	2400/F(kHz)	300
0.490 - 1.705	24000/F(kHz)	30
1.705 - 30.0	30	30
30 - 88	100**	3
88 - 216	150**	3
216 - 960	200**	3
Above 960	500	3

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

As per FCC §15.247 (d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c).

8.2 Measurement Uncertainty

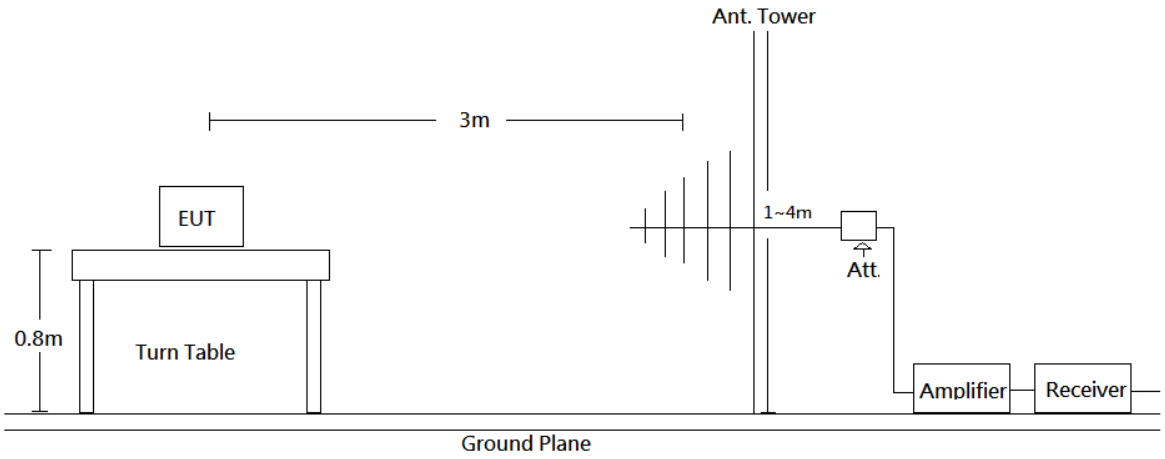
All measurements involve certain levels of uncertainties, especially in field of EMC. The factors contributing to uncertainties are spectrum analyzer, cable loss, antenna factor calibration, antenna directivity, antenna factor variation with height, antenna phase center variation, antenna factor frequency interpolation, measurement distance variation, site imperfections, mismatch (average), and system repeatability.

Based on CISPR 16-4-2:2011, the expended combined standard uncertainty of radiation emissions at Bay Area Compliance Laboratories Corp. (Taiwan) is shown in below table. And the uncertainty will not be taken into consideration for the test data recorded in the report.

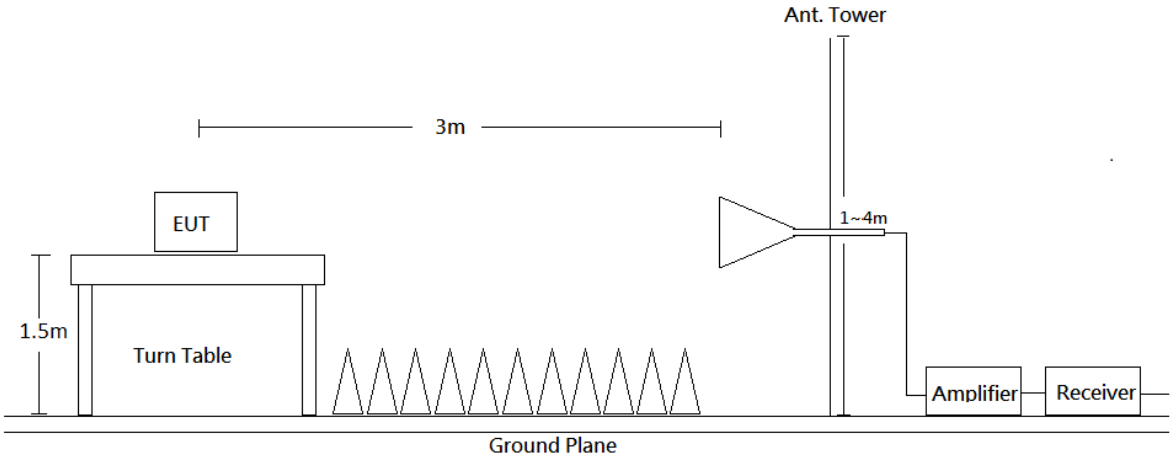
Frequency	Measurement uncertainty
30 MHz~200 MHz	4.21 dB (k=2, 95% level of confidence)
200 MHz~1 GHz	4.41 dB (k=2, 95% level of confidence)
1 GHz~6 GHz	4.51 dB (k=2, 95% level of confidence)
6 GHz~18 GHz	4.88 dB (k=2, 95% level of confidence)
18 GHz~26 GHz	4.30 dB (k=2, 95% level of confidence)
26 GHz~40 GHz	4.30 dB (k=2, 95% level of confidence)

8.3 EUT Setup

Blow 1 GHz:



Above 1 GHz:



Radiated emission tests were performed in the 3 meters chamber test site, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC Part 15.209 and FCC 15.247 Limits.

8.4 EMI Test Receiver & Spectrum Analyzer Setup

The system was investigated from 30 MHz to 26.5 GHz. During the radiated emission test, the EMI test receiver was set with the following configurations measurement method 6.3 in ANSI C63.10.

Frequency Range	RBW	VBW	Detector	Duty cycle	Measurement method
30-1000 MHz	120 kHz	/	QP		QP
Above 1 GHz	1 MHz	3 MHz	PK		PK
	1 MHz	3 MHz	RMS	>98%	Ave
	1 MHz	1/T	PK	<98%	Ave

8.5 Test Procedure

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

All data was recorded in the Quasi-peak detector mode from 30 MHz to 1 GHz and PK and average detector modes for frequencies above 1 GHz.

8.6 Corrected Factor & Margin Calculation

The Correct Factor is calculated by adding the Antenna Factor and Cable Loss, and subtracting the Amplifier Gain from the Meter Reading. The basic equation is as follows:

Correct Factor = Antenna Factor + Cable Loss - Amplifier Gain

The “Margin” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of -7 dB means the emission is 7 dB below the limit. The equation for margin calculation is as follows:

Margin = Result –Limit

8.7 Test Results Summary

According to the data in the following table, the EUT complied with the FCC §15.209 Limit. Refer to CISPR16-4-2:2011 and CISPR 16-4-1:2009, the measured level complies with the limit if

$$Lm + U(Lm) \leq Llim + Ucispr$$

In BACL, U(Lm) is less than Ucispr, if Lm is less than Llim, it implies that the EUT complies with the limit.

8.8 Environmental Conditions

Temperature:	25 ℃
Relative Humidity:	55 %
ATM Pressure:	1010 hPa

The Radiation Spurious Emissions testing was performed by Tom Hsu on 2018-05-31.

The Conducted Spurious Emissions testing was performed by Tom Hsu on 2018-06-01 ~ 2018-06-19.

8.9 Test Results: PASS

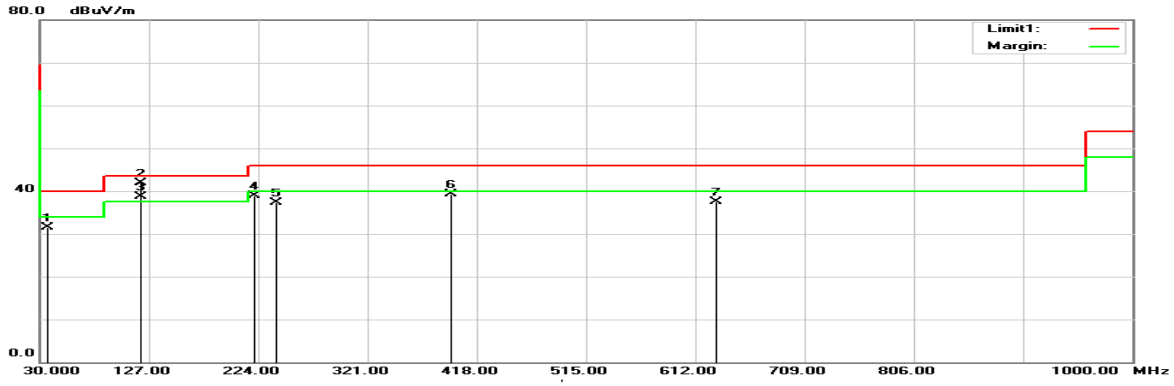
8.10 Test Data

Test Mode: Transmitting

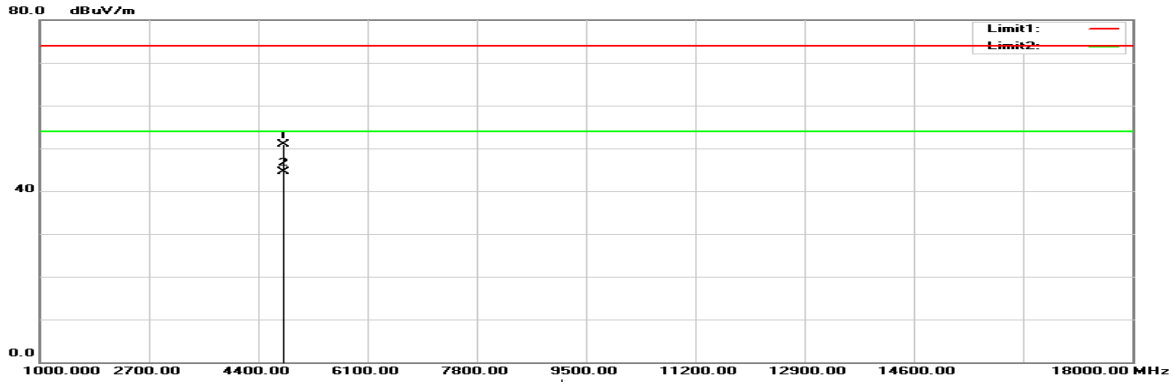
BLE Mode

Horizontal (*worst case is BLE mode low channel*)

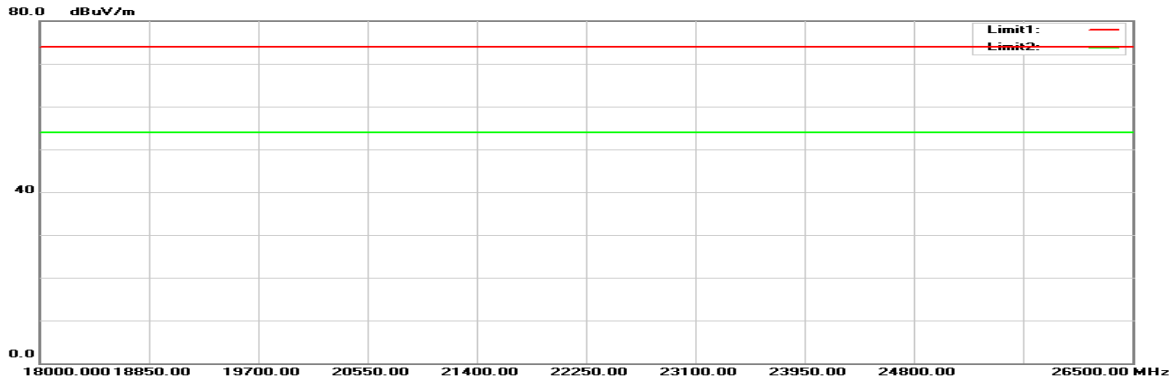
30MHz-1GHz:



1GHz-18GHz:

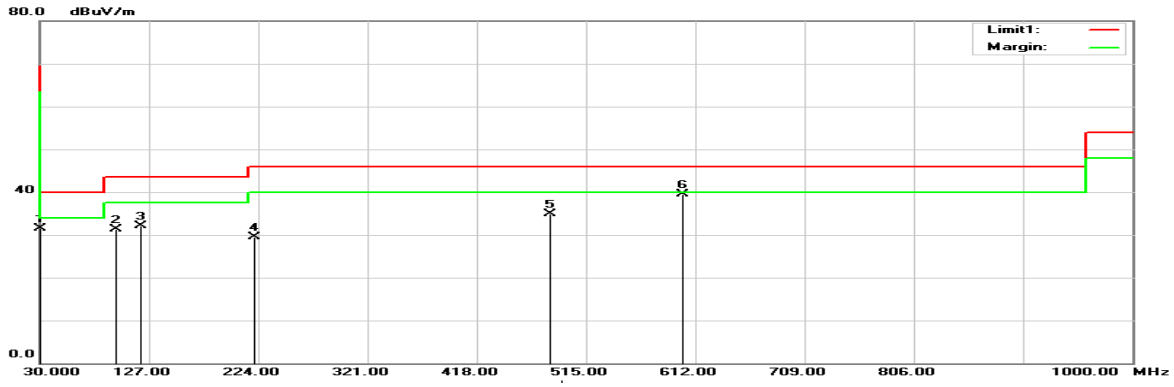


18GHz-26.5GHz:

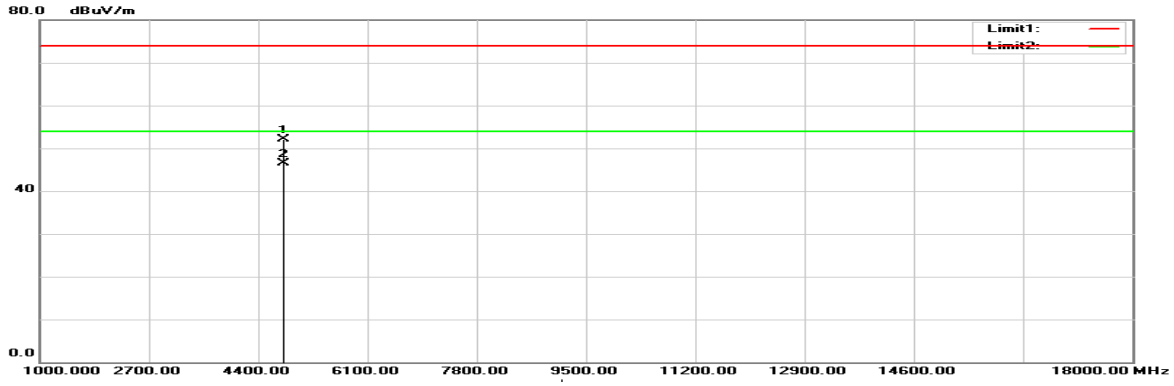


Vertical (*worst case is BLE mode low channel*)

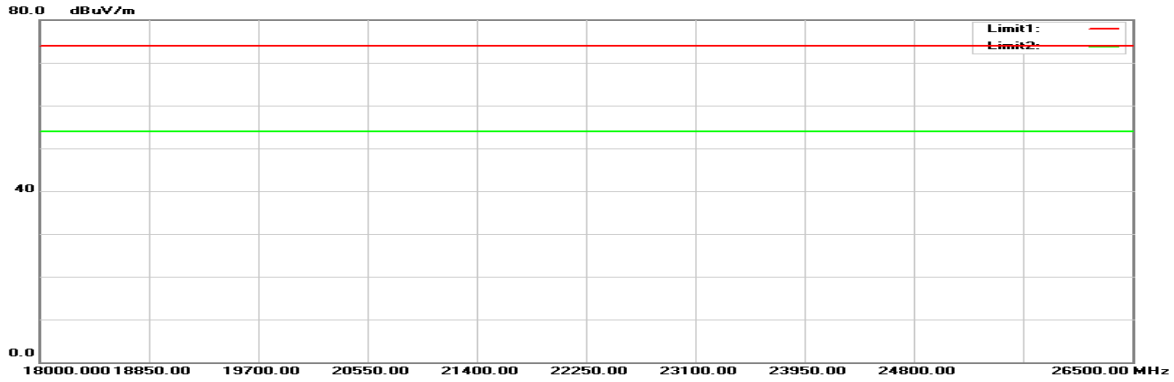
30MHz-1GHz:



1GHz-18GHz:



18GHz-26.5GHz:



Horizontal

Frequency (MHz)	Reading (dBμV)	Correct Factor(dB/m)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
BLE, Low channel								
36.7900	39.64	-8.09	31.55	40.00	-8.45	100	330	QP
119.2400	52.54	-10.66	41.88	43.50	-1.62	100	352	QP
220.1200	51.38	-12.38	39.00	46.00	-7.00	100	359	QP
240.4900	49.41	-12.04	37.37	46.00	-8.63	100	155	QP
394.7200	46.92	-7.70	39.22	46.00	-6.78	100	172	QP
630.4300	41.27	-3.74	37.53	46.00	-8.47	100	58	QP
2390.000	64.16	-4.81	59.35	74.00	-14.65	300	201	peak
2390.000	50.04	-4.81	45.23	54.00	-8.77	300	201	AVG
2402.000	95.69	-4.78	90.91	N/A	N/A	255	278	peak
2402.000	95.14	-4.78	90.36	N/A	N/A	255	278	AVG
4804.000	49.68	1.16	50.84	74.00	-23.16	300	52	peak
4804.000	43.43	1.16	44.59	54.00	-9.41	300	52	AVG
BLE, Middle channel								
30.0000	34.76	-3.26	31.50	40.00	-8.50	100	165	QP
119.2400	51.85	-10.66	41.19	43.50	-2.31	100	2	QP
221.0900	51.45	-12.38	39.07	46.00	-6.93	100	0	QP
246.3100	48.62	-11.96	36.66	46.00	-9.34	100	152	QP
395.6900	47.31	-7.67	39.64	46.00	-6.36	100	122	QP
627.5200	41.29	-3.78	37.51	46.00	-8.49	100	60	QP
2440.000	95.64	-4.68	90.96	N/A	N/A	250	280	peak
2440.000	95.22	-4.68	90.54	N/A	N/A	250	280	AVG
4880.000	50.36	1.42	51.78	74.00	-22.22	285	38	peak
4880.000	44.24	1.42	45.66	54.00	-8.34	285	38	AVG
BLE, High channel								
30.9700	34.63	-3.93	30.70	40.00	-9.30	100	199	QP
119.2400	53.01	-10.66	42.35	43.50	-1.15	100	149	QP
221.0900	51.87	-12.38	39.49	46.00	-6.51	100	340	QP
245.3400	48.56	-11.96	36.60	46.00	-9.40	100	141	QP
395.6900	47.25	-7.67	39.58	46.00	-6.42	100	121	QP
618.7900	42.24	-3.90	38.34	46.00	-7.66	100	58	QP
2480.000	97.15	-4.57	92.58	N/A	N/A	300	282	peak
2480.000	96.69	-4.57	92.12	N/A	N/A	300	282	AVG
2483.500	63.01	-4.57	58.44	74.00	-15.56	300	273	peak
2483.500	50.22	-4.57	45.65	54.00	-8.35	300	273	AVG
4960.000	47.65	1.69	49.34	74.00	-24.66	270	50	peak
4960.000	40.89	1.69	42.58	54.00	-11.42	270	50	AVG

Result = Reading + Correct Factor
Margin = Result – Limit
Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain
Spurious emissions more than 20 dB below the limit were not reported.

Vertical

Frequency (MHz)	Reading (dBμV)	Correct Factor(dB/m)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
BLE, Low channel								
30.9700	35.49	-3.93	31.56	40.00	-8.44	100	204	QP
97.9000	46.31	-15.01	31.30	43.50	-12.20	100	29	QP
119.2400	42.74	-10.66	32.08	43.50	-11.42	100	79	QP
220.1200	41.95	-12.38	29.57	46.00	-16.43	100	91	QP
482.9900	40.91	-5.96	34.95	46.00	-11.05	100	192	QP
600.3600	43.62	-4.18	39.44	46.00	-6.56	100	188	QP
2390.000	63.46	-4.81	58.65	74.00	-15.35	110	136	peak
2390.000	49.05	-4.81	44.24	54.00	-9.76	110	136	AVG
2402.000	90.26	-4.78	85.48	N/A	N/A	117	175	peak
2402.000	89.38	-4.78	84.60	N/A	N/A	117	175	AVG
4804.000	51.01	1.16	52.17	74.00	-21.83	100	135	peak
4804.000	45.26	1.16	46.42	54.00	-7.58	100	135	AVG
BLE, Middle channel								
30.9700	34.57	-3.93	30.64	40.00	-9.36	100	85	QP
112.4500	43.37	-11.45	31.92	43.50	-11.58	100	85	QP
221.0900	41.56	-12.38	29.18	46.00	-16.82	100	70	QP
421.8800	39.65	-7.13	32.52	46.00	-13.48	100	143	QP
495.6000	40.96	-5.72	35.24	46.00	-10.76	100	206	QP
583.8700	43.69	-4.45	39.24	46.00	-6.76	100	180	QP
2440.000	91.68	-4.68	87.00	N/A	N/A	100	171	peak
2440.000	91.15	-4.68	86.47	N/A	N/A	100	171	AVG
4880.000	52.22	1.42	53.64	74.00	-20.36	100	170	peak
4880.000	47.55	1.42	48.97	54.00	-5.03	100	170	AVG
BLE, High channel								
30.9700	33.88	-3.93	29.95	40.00	-10.05	100	161	QP
119.2400	42.69	-10.66	32.03	43.50	-11.47	100	71	QP
220.1200	42.85	-12.38	30.47	46.00	-15.53	100	82	QP
413.1500	40.48	-7.32	33.16	46.00	-12.84	100	213	QP
482.0200	41.48	-5.97	35.51	46.00	-10.49	100	217	QP
581.9300	44.24	-4.48	39.76	46.00	-6.24	100	175	QP
2480.000	91.98	-4.57	87.41	N/A	N/A	122	168	peak
2480.000	91.24	-4.57	86.67	N/A	N/A	122	168	AVG
2483.500	63.79	-4.57	59.22	74.00	-14.78	110	88	peak
2483.500	49.79	-4.57	45.22	54.00	-8.78	110	88	AVG
4960.000	47.64	1.69	49.33	74.00	-24.67	110	306	peak
4960.000	40.01	1.69	41.70	54.00	-12.30	110	306	AVG

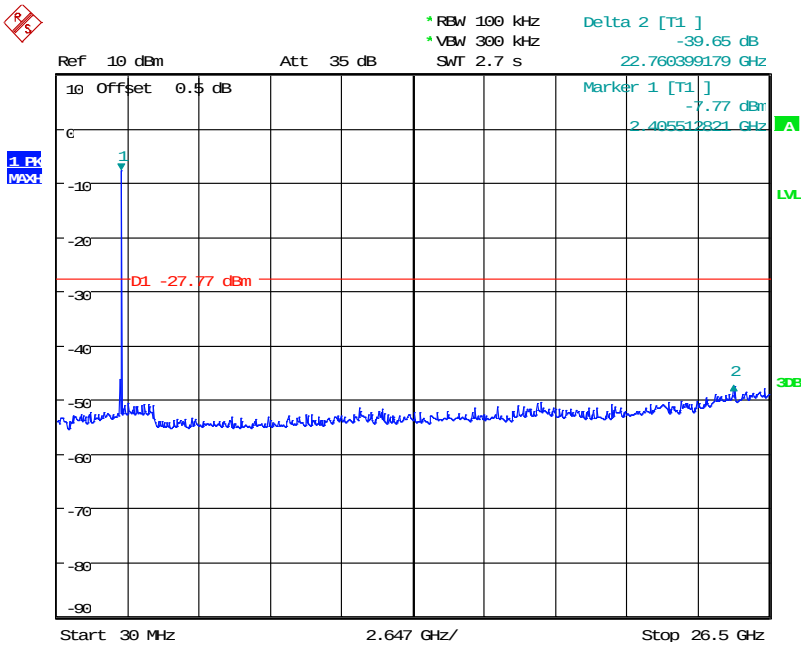
Result = Reading + Correct Factor
Margin = Result – Limit
Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain

Spurious emissions more than 20 dB below the limit were not reported.

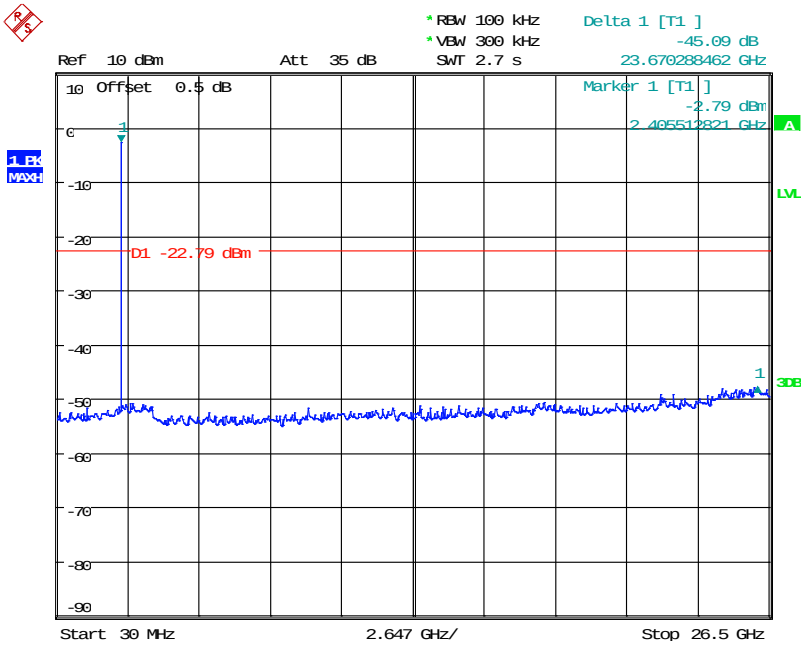
Conducted Spurious Emissions:

Channel	Frequency (MHz)	Delta Peak to Band Emission (dBc)	Limit (dBc)	RESULT
Low	2402	39.65	≥ 20	PASS
Mid	2440	45.09	≥ 20	PASS
High	2480	43.23	≥ 20	PASS

Low Channel



Middle Channel



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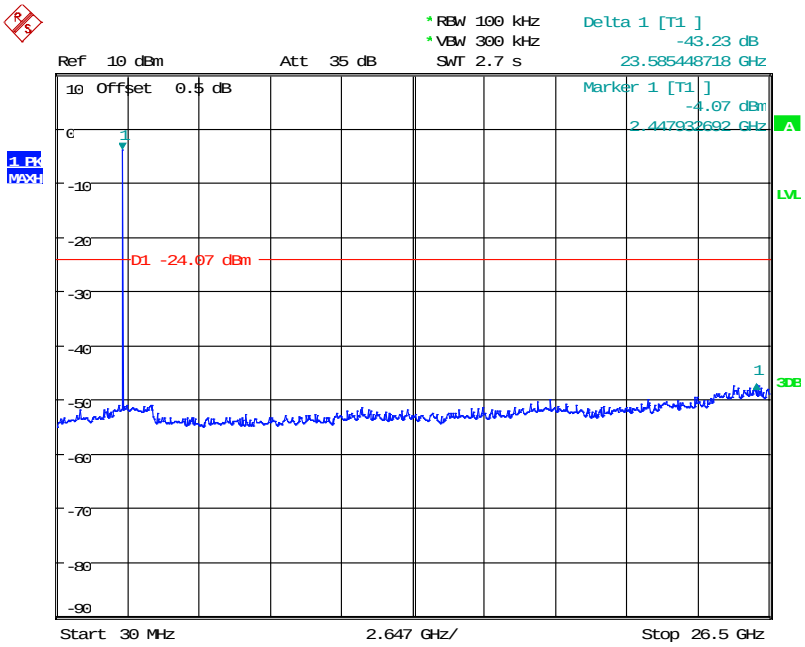
High Channel



Date: 19.JUN.2018 11:10:08

9 FCC §15.247(a)(2) – 6 dB Emission Bandwidth

9.1 Applicable Standard

According to FCC §15.247(a)(2).

Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

9.2 Test Procedure

The steps for the first option are as follows:

a) Set RBW = 100 kHz.

b) Set the VBW ≥ [3 × RBW].

c) Detector = peak.

d) Trace mode = max hold.

e) Sweep = auto couple.

f) Allow the trace to stabilize.

g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

9.3 Environmental Conditions

Temperature:	25 ℃
Relative Humidity:	55 %
ATM Pressure:	1010 hPa

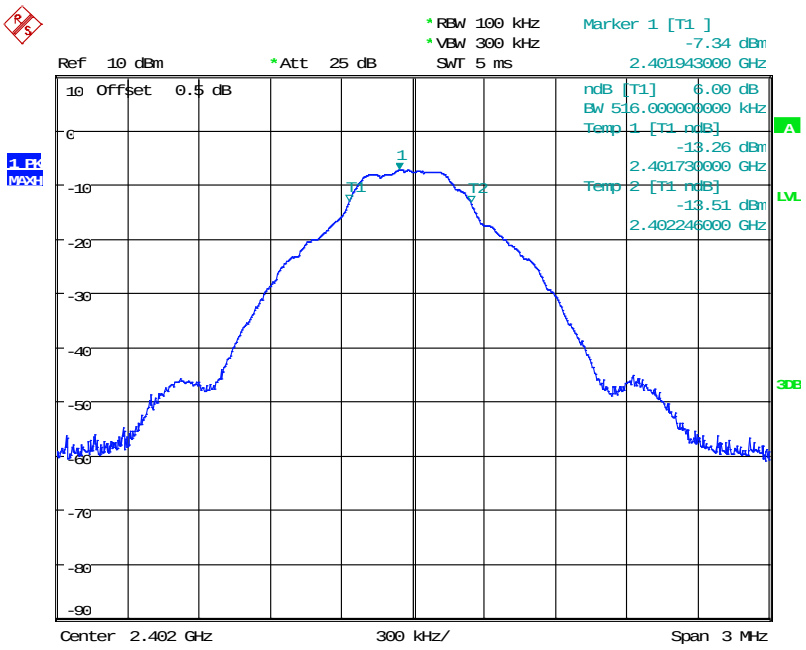
The testing was performed by Tom Hsu on 2018-06-01.

9.4 Test Results

Channel	Frequency (MHz)	6 dB OBW (kHz)	Limit (kHz)	Result
Low	2402	516	> 500	Compliance
Middle	2440	514	> 500	Compliance
High	2480	519	> 500	Compliance

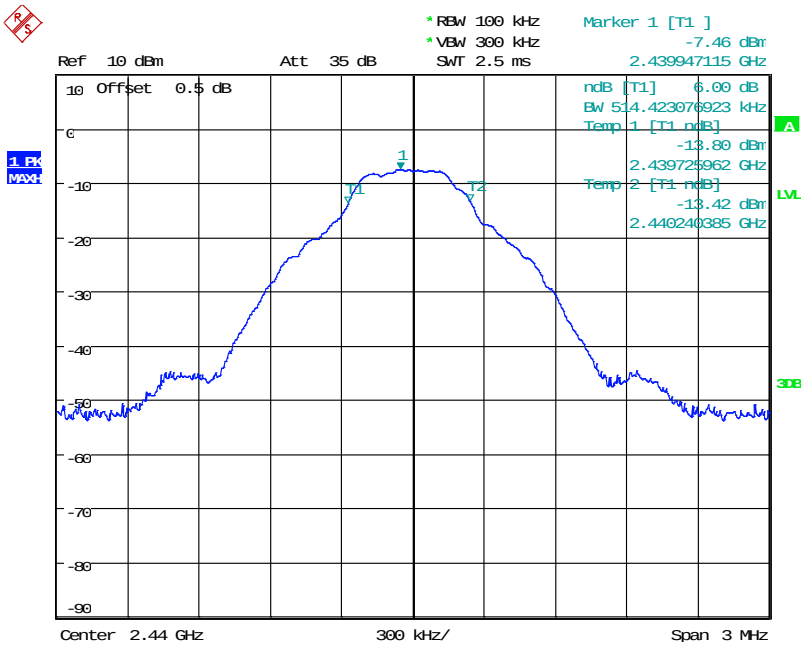
Please refer to the following plots

Low Channel



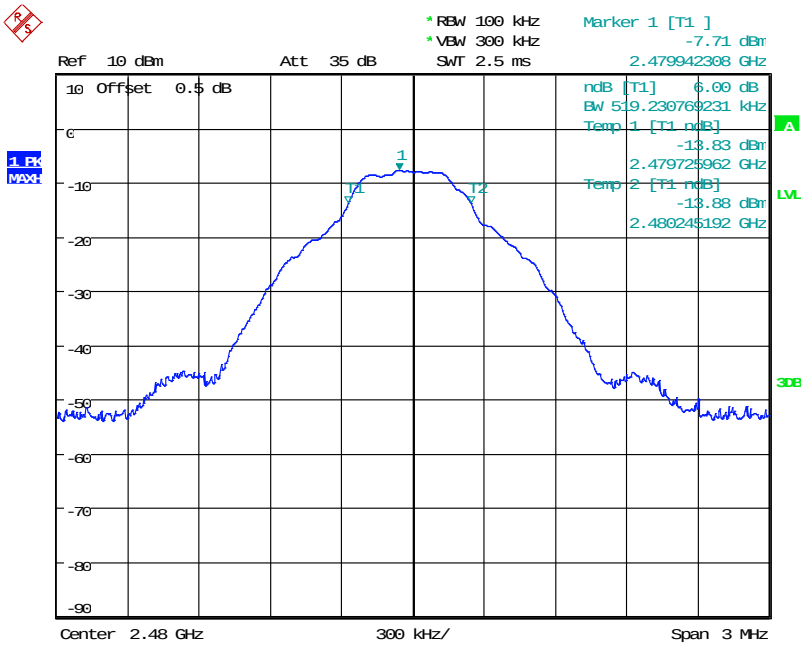
Date: 1.JUN.2018 13:30:02

Middle Channel



Date: 1.JUN.2018 13:22:29

High Channel



Date: 1.JUN.2018 13:24:35

10 FCC §15.247(b)(3) – Maximum Output Power

10.1 Applicable Standard

According to FCC §15.247(b)(3).

Systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

10.2 Test Procedure

1. Place the EUT on a bench and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to measuring equipment.

10.3 Environmental Conditions

Temperature:	25 ℃
Relative Humidity:	55 %
ATM Pressure:	1010 hPa

The testing was performed by Tom Hsu on 2018-06-01.

10.4 Test Results

Channel	Frequency (MHz)	Peak Conducted Output Power		Limit (W)	Result
		(dBm)	(W)		
Low	2402	-5.86	0.00026	1	Compliance
Middle	2440	-6.49	0.00022	1	Compliance
High	2480	-6.42	0.00023	1	Compliance

11 FCC§15.247(d) –100kHz Bandwidth of Frequency Band Edge

11.1 Applicable Standard

According to FCC §15.247(d).

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

11.2 Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW to 100 kHz and VBW of spectrum analyzer to 300 kHz with a convenient frequency span including 100 kHz bandwidth from band edge.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.

11.3 Environmental Conditions

Temperature:	25 ℃
Relative Humidity:	55 %
ATM Pressure:	1010 hPa

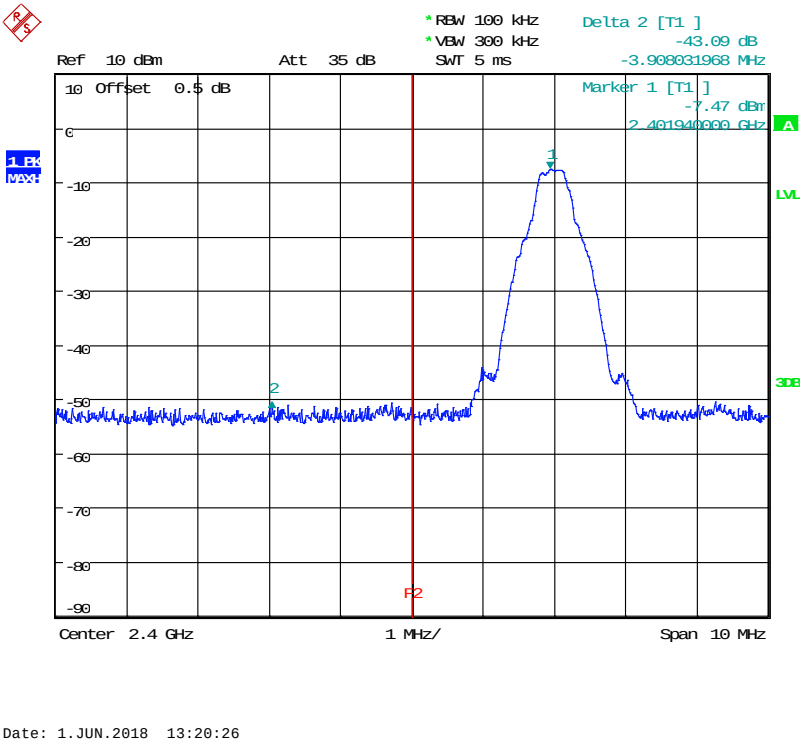
The testing was performed by Tom Hsu on 2018-06-01.

11.4 Test Results

Please refer to the following plots

Channel	Frequency (MHz)	Delta Peak to Band Emission (dBc)	Limit (dBc)	Result
Low	2402	43.09	≥ 20	PASS
High	2480	42.59	≥ 20	PASS

Band Edge, CH low



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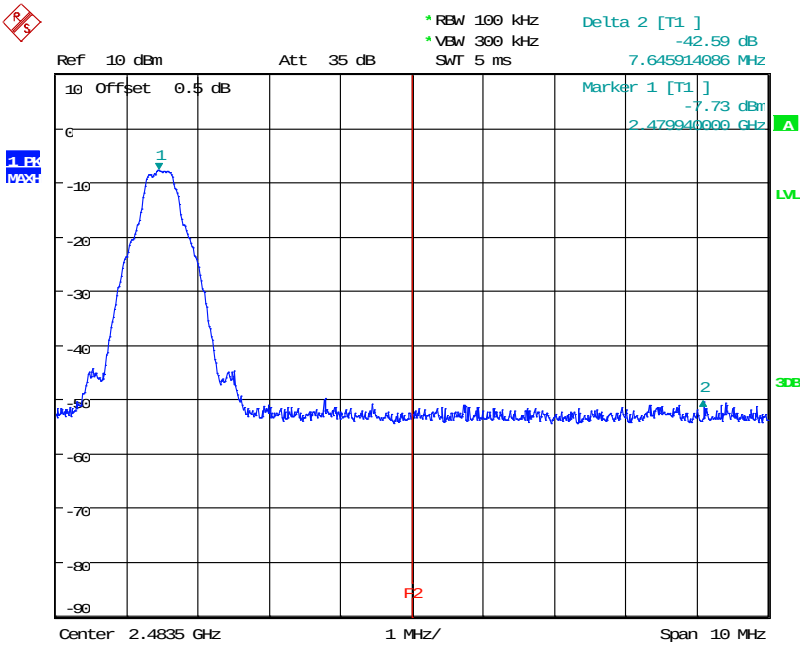
Band Edge, CH High



Date: 1.JUN.2018 13:25:33

12 FCC §15.247(e) – Power Spectral Density

12.1 Applicable Standard

According to FCC §15.247(e).

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

12.2 Test Procedure

According to ANSI C63.10-2013

a) Set analyzer center frequency to DTS channel center frequency.

b) Set the span to 1.5 times the DTS bandwidth.

c) Set the RBW to 3 kHz ≤ RBW ≤ 100 kHz.

d) Set the VBW ≥ [3 × RBW].

e) Detector = peak.

f) Sweep time = auto couple.

g) Trace mode = max hold.

h) Allow trace to fully stabilize.

i) Use the peak marker function to determine the maximum amplitude level within the RBW.

j) If measured value exceeds requirement, then reduce RBW (but no less than 3 kHz) and repeat

12.3 Environmental Conditions

Temperature:	25 ℃
Relative Humidity:	55 %
ATM Pressure:	1010 hPa

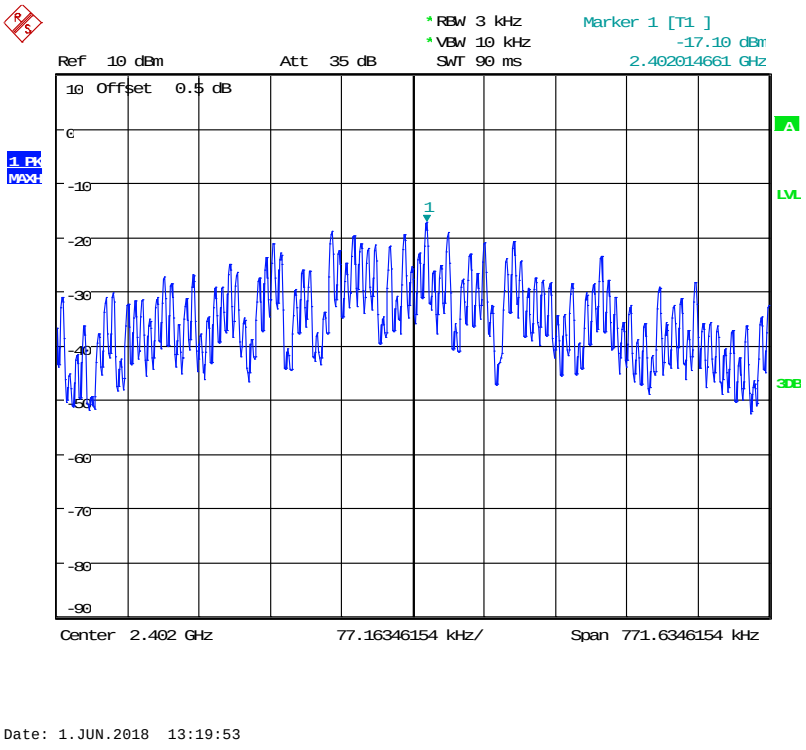
The testing was performed by Tom Hsu on 2018-06.01.

12.4 Test Results

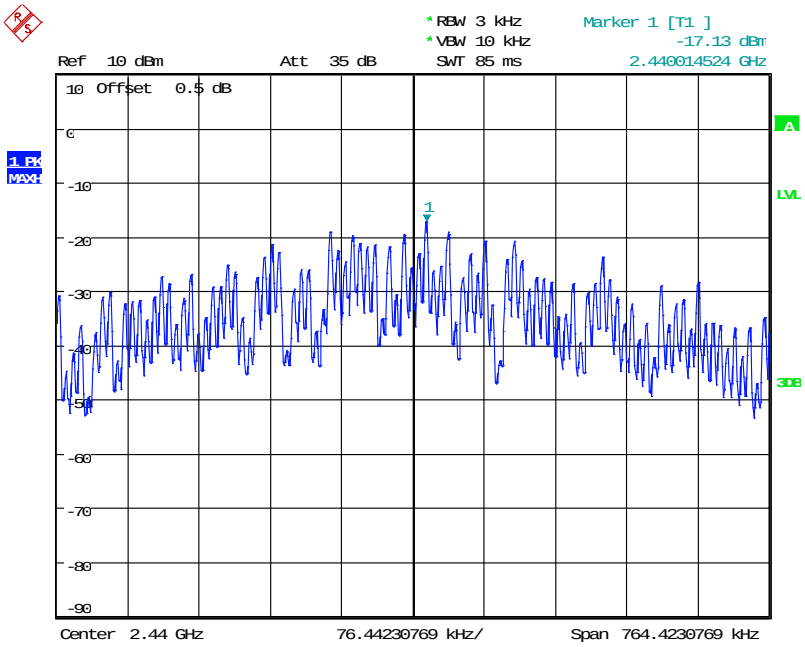
Channel	Frequency (MHz)	PSD (dBm/3 kHz)	Limit (dBm/3 kHz)	Result
Low	2402	-17.10	8	Compliance
Middle	2440	-17.13	8	Compliance
High	2480	-17.35	8	Compliance

Please refer to the following plots

Low Channel



Middle Channel



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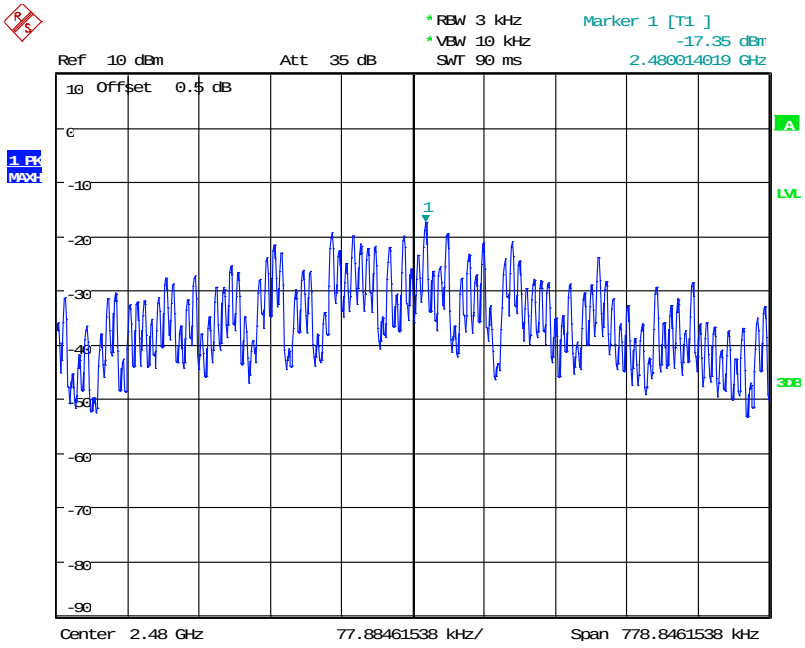
High Channel



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