FCC Part 15.247

TEST REPORT

For

3Egreen Technology, INC.

5F, No. 283 Songjiang Road, Zhongshan District, Taipei, Taiwan

FCC ID: 2AMHJCM0300000

Report Type:	**Product Type:**
Original Report	Smart Energy Meter

Report Producer: Kaylee Chiang

Report Number: RXZ180817003-00A

Report Date: 2018-09-17

Reviewed By: Jerry Chang

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REVISION HISTORY

Revision	No.	Report Number	Issue Date	Description	Author/ Revised by
1.0	RXZ180817003	RXZ180817003-00A	2018.09.17	Original Report	Kaylee

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1 General Information

1.1 Product Description for Equipment Under Test (EUT)

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<tr><td>Applicant</td><td>3Egreen Technology, INC.</td></tr>
<tr><td></td><td>5F, No. 283 Songjiang Road, Zhongshan District, Taipei, Taiwan</td></tr>
<tr><td>Manufacturer</td><td>3Egreen Technology, INC.</td></tr>
<tr><td></td><td>5F, No. 283 Songjiang Road, Zhongshan District, Taipei, Taiwan</td></tr>
<tr><td>Brand(Trade) Name</td><td>3Egreen</td></tr>
<tr><td>Product (Equipment)</td><td>Smart Energy Meter</td></tr>
<tr><td>Model Name</td><td>CM03-01</td></tr>
<tr><td>Serial Model Name</td><td>CM04-01</td></tr>
<tr><td>Model Discrepancy</td><td>
<table>
<tr><td>Model / Difference project</td><td>CM03-01</td><td>CM04-01</td><td>Remark</td></tr>
<tr><td>Circuit design</td><td>33ohm</td><td>22ohm</td><td>Difference R4 resistance</td></tr>
<tr><td>Case design</td><td>43.5x38.6x85.0mm (L x W x H)</td><td>56.4x40.8x98.8mm (L x W x H)</td><td>The difference as the appearance size</td></tr>
</table>
</td></tr>
<tr><td>Frequency Range</td><td>2402-2480 MHz</td></tr>
<tr><td>Transmit Power</td><td>BLE Mode: 0.42 dBm</td></tr>
<tr><td>Modulation Technique</td><td>BLE Mode: GFSK</td></tr>
<tr><td>Transmit Data Rate</td><td>BLE Mode: 1 Mbps</td></tr>
<tr><td>Number of Channels</td><td>BLE Mode: 40 Channels</td></tr>
<tr><td>Antenna Specification</td><td>PCB Antenna/Gain: 3.3 dBi</td></tr>
<tr><td>Output</td><td>3Vdc from Battery</td></tr>
<tr><td>Received Date</td><td>Aug 17, 2018</td></tr>
<tr><td>Date of Test</td><td>Sep 08, 2018 ~ Sep 11, 2018</td></tr>
</table>

**All measurement and test data in this report was gathered from production sample serial number: 180817003 (Assigned by BACL, Taiwan)*

1.2 Objective

This report is prepared on behalf of *3Egreen Technology, INC.* in accordance with Part 2, Subpart J, Part 15, Subparts A and C of the Federal Communication Commission's rules.
The objective is to determine compliance with FCC Part 15.247 rules for Output Power, Antenna Requirements, 6 dB Bandwidth, Power Spectral Density, 100 kHz Bandwidth of Band Edges Measurement, Conducted and Radiated Spurious Emissions.

1.3 Related Submittal(s)/Grant(s)

N/A

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, there are totally 40 channels.

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

For BLE Modes were tested with channel 1, 20 and 40

2.2 Equipment Modifications

No modification was made to the EUT

2.3 EUT Exercise Software

No test software was used.

2.4 Support Equipment List and Details

Description	Manufacturer	Model Number	FCC ID/DOC	S/N
NB	DELL	E6410	PD98260NGU	10912240367

2.5 External Cable List and Details

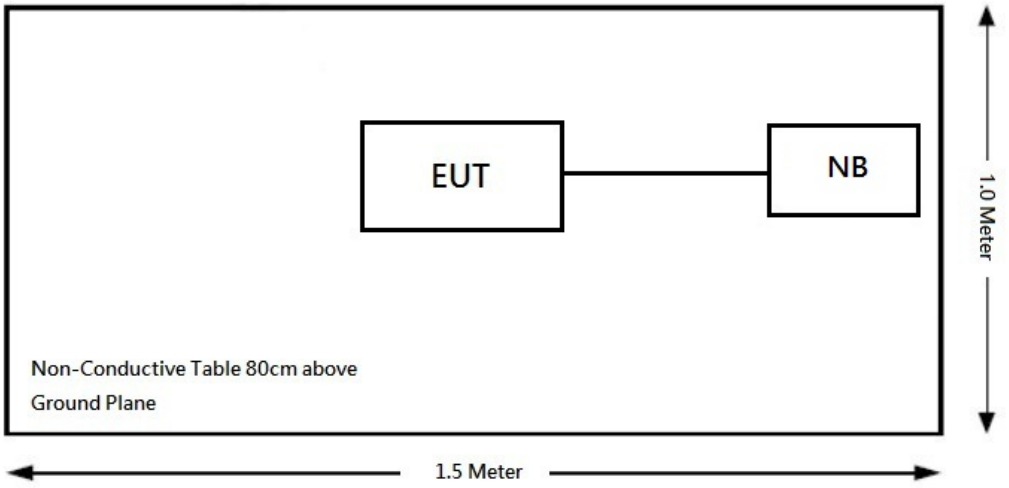
Cable Description	Length (m)	From	To
Mini USB Cable	1.5	NB	EUT

2.6 Block Diagram of Test Setup

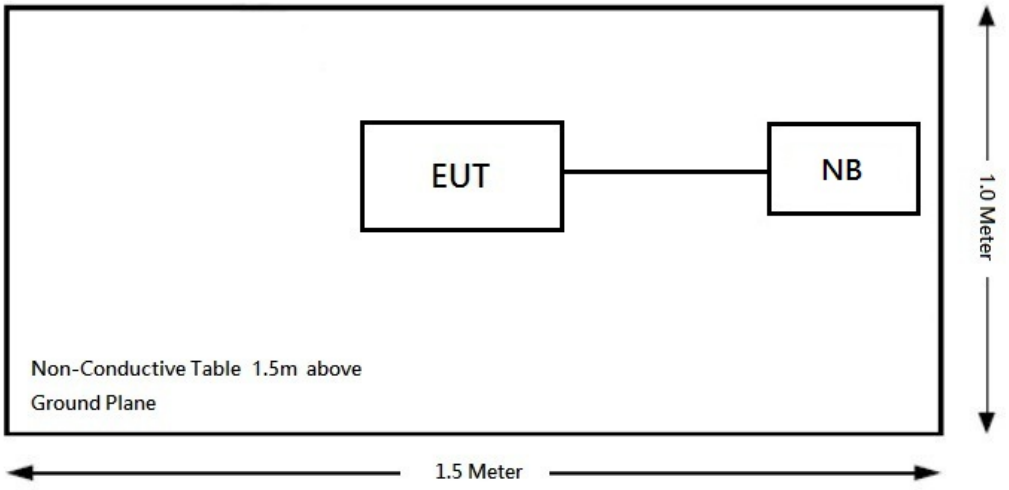
See test photographs attached in setup photos for the actual connections between EUT and support equipment.

Radiation:

Below 1GHz:



Above 1GHz:



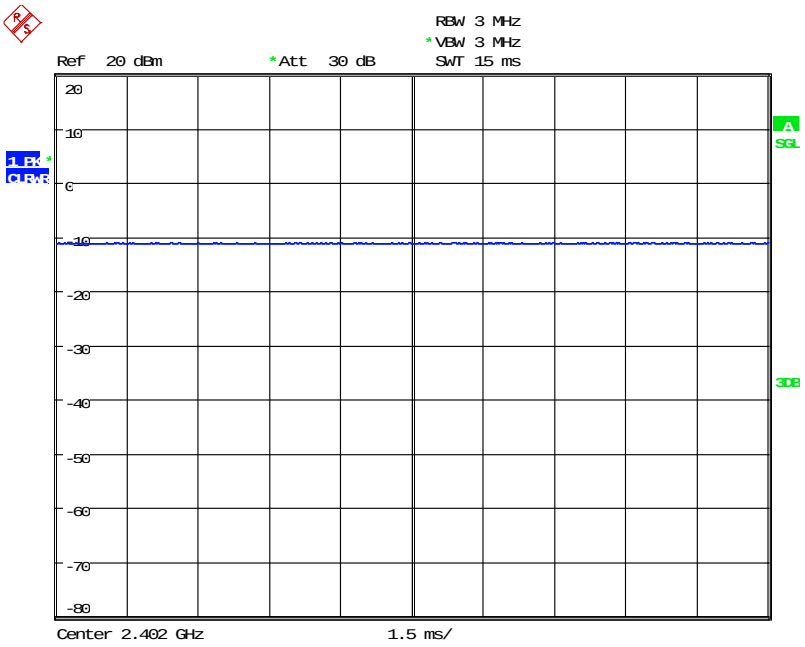
2.7 Duty Cycle

According to KDB 558074 D01 15.247 Meas Guidance v05 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), §1.1310, §2.1091	Maximum Permissible Exposure (MPE)	Compliance
§15.203	Antenna Requirement	Compliance
§15.207(a)	AC Line Conducted Emissions	Not applicable
§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

Not applicable: Device only supports battery.

4 Test Equipment List and Details

Description	Manufacturer	Model	Serial Number	Calibration Date	Calibration Due Date
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	2018/07/04	2019/07/03
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	2018/02/12	2019/02/13
Micro flex Cable	UTIFLEX	FSCM 64639 / (2M)	93D0127	2018/07/31	2019/07/30
Micro flex Cable	UTIFLEX	UFA210A-1-3149-300300	MFR64639 226389-001	2017/11/10	2018/11/09
Micro flex Cable	ROSNOL	K1K50-UP0264-K1K50-450CM	160309-1	2018/03/05	2019/03/04
Micro flex 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	2018/07/09	2019/07/08
VSWR	BACL	966-A	N/A	2018/07/16	2019/07/15
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
Attenuator	MINI-CIRCUITS	BW-S10W5+	N/A	2018/03/08	2019/03/07
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), §1.1310, § 2.1091 - Maximum Permissible Exposure (MPE)

5.1 Applicable Standard

According to subpart 15.247(i)and subpart §1.1310, systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

Limits for Maximum Permissible Exposure (MPE) (§1.1310, §2.1091)

(B) Limits for General Population/Uncontrolled Exposure				
Frequency Range (MHz)	**Electric Field Strength (V/m)**	**Magnetic Field Strength (A/m)**	**Power Density (mW/cm^2)**	**Averaging Time (minutes)**
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;

According to §1.1310 and §2.1091 RF exposure is calculated.

Calculated Formulary:

Predication of MPE limit at a given distance
$S = PG/4\pi R^2$ = power density (in appropriate units, e.g. mW/cm^2);
P = power input to the antenna (in appropriate units, e.g., mW);
G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain;
R = distance to the center of radiation of the antenna (appropriate units, e.g., cm);

5.2 RF Exposure Evaluation Result

MPE evaluation:

Mode	Frequency Range (MHz)	Antenna Gain		Target Power		Evaluation Distance (cm)	Power Density (mW/cm^2)	MPE Limit (mW/cm^2)
		(dBi)	(numeric)	(dBm)	(mW)			
BLE	2402-2480	3.3	2.14	0.5	1.12	20	0.0005	1

Result: MPE evaluation meet 20 cm the requirement of standard.

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 Antenna List and Details

Manufacturer	Type	Antenna Gain	Result
3Egreen Technology, INC	PCB Antenna	3.3 dBi	Compliance

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

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

7.1 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).

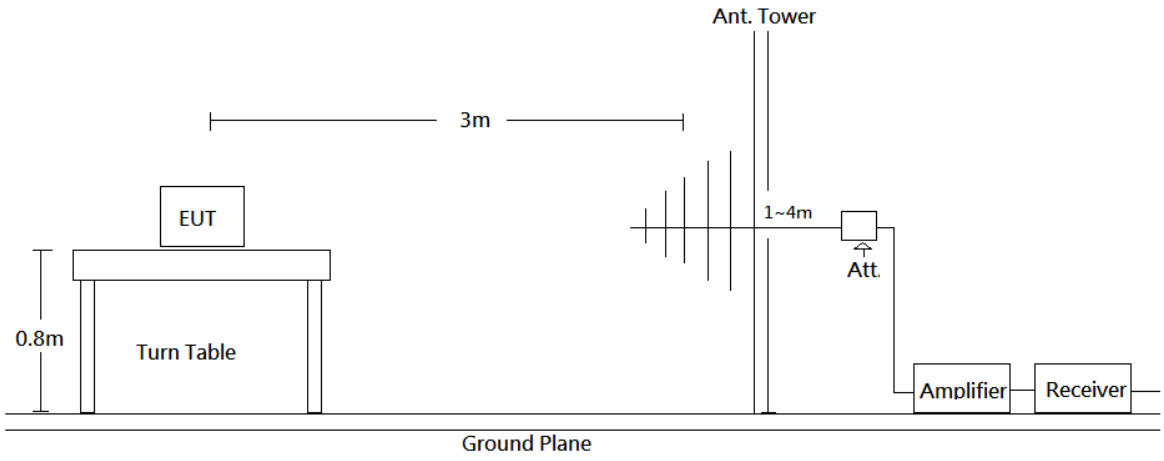
7.2 Measurement Uncertainty

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.

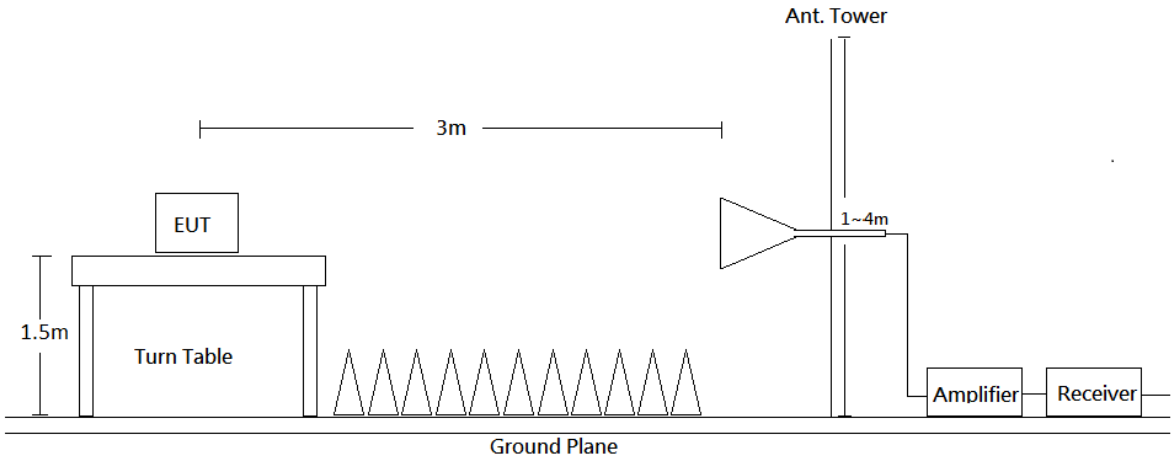
Frequency	Measurement uncertainty
30 MHz~200 MHz	3.76 dB (k=2, 95% level of confidence)
200 MHz~1 GHz	4.12 dB (k=2, 95% level of confidence)
1 GHz~6 GHz	4.84 dB (k=2, 95% level of confidence)
6 GHz~18 GHz	5.16 dB (k=2, 95% level of confidence)
18 GHz~26 GHz	4.84 dB (k=2, 95% level of confidence)
26 GHz~40 GHz	4.30 dB (k=2, 95% level of confidence)

7.3 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.

7.4 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

7.5 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.

7.6 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

7.7 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.

7.8 Test Environmental Conditions

Temperature:	25.2° C
Relative Humidity:	58 %
ATM Pressure:	1010 hPa

The Radiation Spurious Emissions testing was performed by Tom Hsu on 2018-09-08.
The Conducted Spurious Emissions testing was performed by Tom Hsu on 2018-09-11.

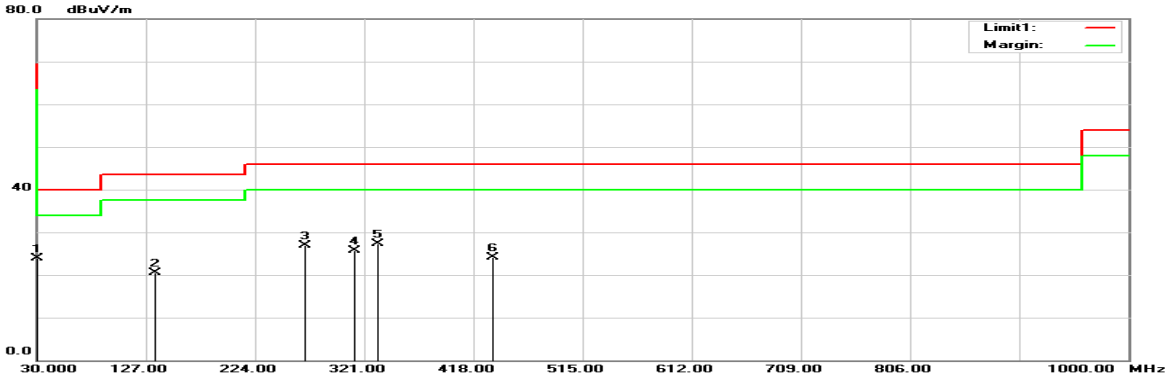
7.9 Test Results

Test Mode: Transmitting

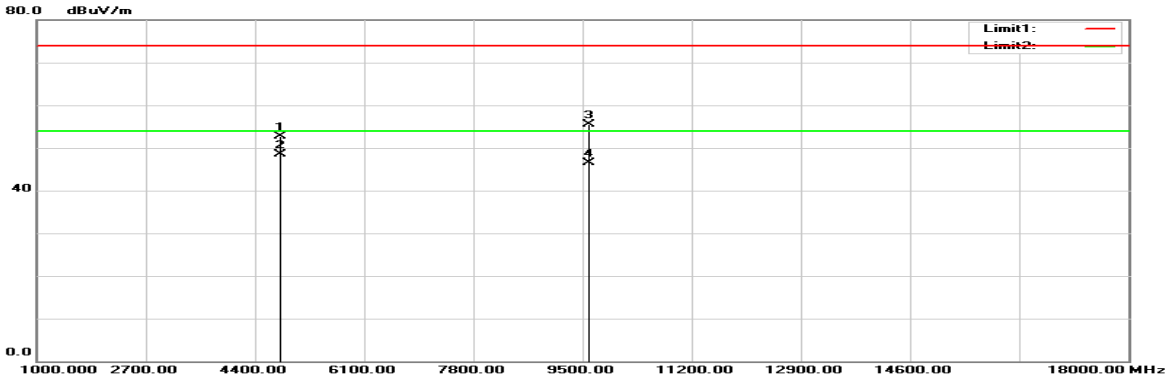
BLE Mode *(Pre-scan with three orthogonal axis, and worse case as Z axis.)*

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

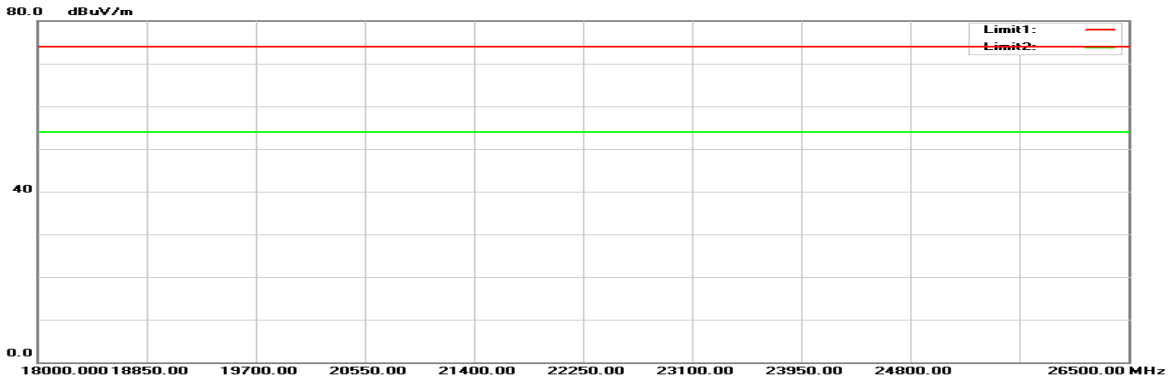
30MHz-1GHz:



1GHz-18GHz:

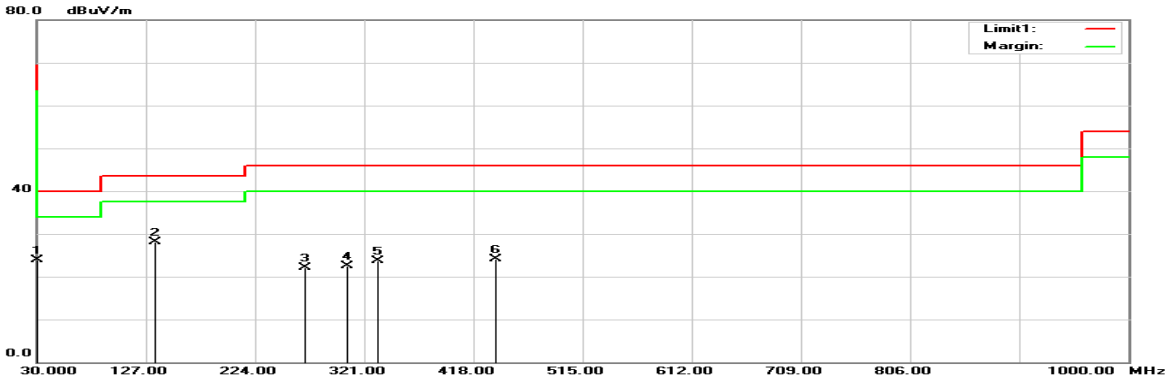


18GHz-26.5GHz:

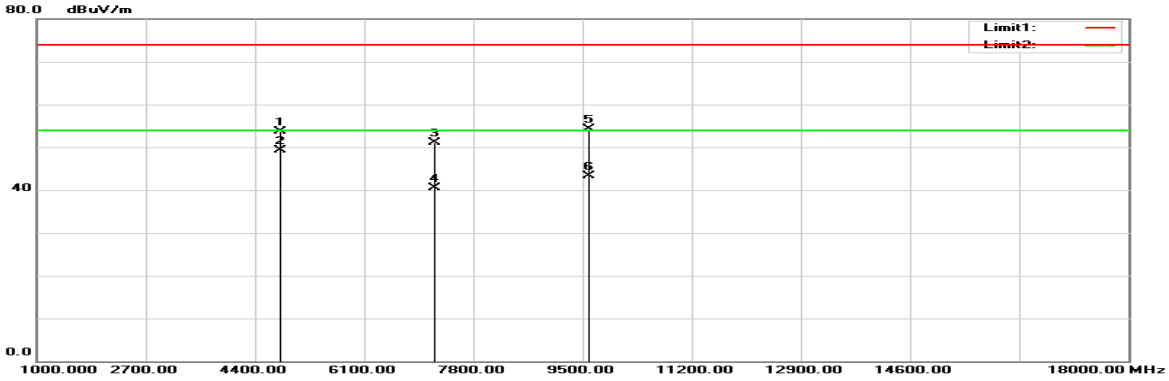


Vertical (*worst case is BLE mode low channel*)

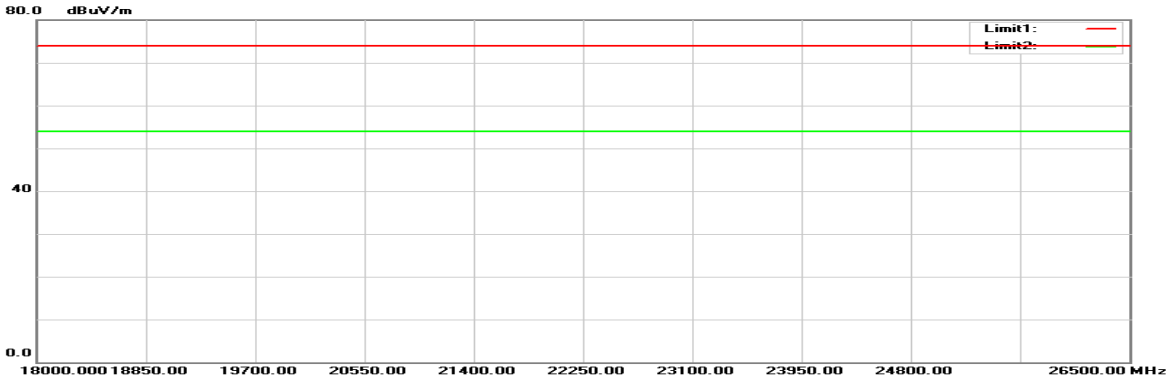
30MHz-1GHz:



1GHz-18GHz:



18GHz-26.5GHz:



Below 1GHz

Horizontal

Frequency (MHz)	Reading (dBµV)	Correct Factor(dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
30.0000	26.80	-2.92	23.88	40.00	-16.12	100	22	QP
135.7300	29.84	-9.34	20.50	43.50	-23.00	100	358	QP
268.6200	35.54	-8.62	26.92	46.00	-19.08	100	24	QP
312.2700	33.45	-7.67	25.78	46.00	-20.22	100	345	QP
332.6400	34.47	-7.22	27.25	46.00	-18.75	100	265	QP
435.4600	29.41	-5.38	24.03	46.00	-21.97	100	210	QP

Vertical

Frequency (MHz)	Reading (dBµV)	Correct Factor(dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
30.9700	27.56	-3.58	23.98	40.00	-16.02	100	173	QP
135.7300	37.48	-9.34	28.14	43.50	-15.36	100	51	QP
268.6200	30.82	-8.62	22.20	46.00	-23.80	100	49	QP
305.4800	30.24	-7.82	22.42	46.00	-23.58	100	62	QP
332.6400	30.86	-7.22	23.64	46.00	-22.36	100	49	QP
437.4000	29.48	-5.35	24.13	46.00	-21.87	100	82	QP

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.

Above 1GHz

Horizontal

Frequency (MHz)	Reading (dBµV)	Correct Factor(dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
Low channel								
2390.000	64.03	-3.88	60.15	74.00	-13.85	100	325	peak
2390.000	49.94	-3.88	46.06	54.00	-7.94	100	325	AVG
2402.000	100.81	-3.86	96.95	N/A	N/A	127	228	peak
2402.000	100.25	-3.86	96.39	N/A	N/A	127	228	AVG
4804.000	50.95	1.81	52.76	74.00	-21.24	102	125	peak
4804.000	46.61	1.81	48.42	54.00	-5.58	102	125	AVG
9608.000	42.51	12.97	55.48	74.00	-18.52	104	144	peak
9608.000	33.61	12.97	46.58	54.00	-7.42	104	144	AVG
Middle channel								
2440.000	101.89	-3.76	98.13	N/A	N/A	132	236	peak
2440.000	101.04	-3.76	97.28	N/A	N/A	132	236	AVG
4880.000	48.54	2.06	50.60	74.00	-23.40	100	126	peak
4880.000	43.67	2.06	45.73	54.00	-8.27	100	126	AVG
High channel								
2480.000	100.40	-3.66	96.74	N/A	N/A	129	239	peak
2480.000	99.78	-3.66	96.12	N/A	N/A	129	239	AVG
2483.500	64.50	-3.64	60.86	74.00	-13.14	100	244	peak
2483.500	50.39	-3.64	46.75	54.00	-7.25	100	244	AVG
4960.000	46.69	2.32	49.01	74.00	-24.99	100	119	peak
4960.000	40.17	2.32	42.49	54.00	-11.51	100	119	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

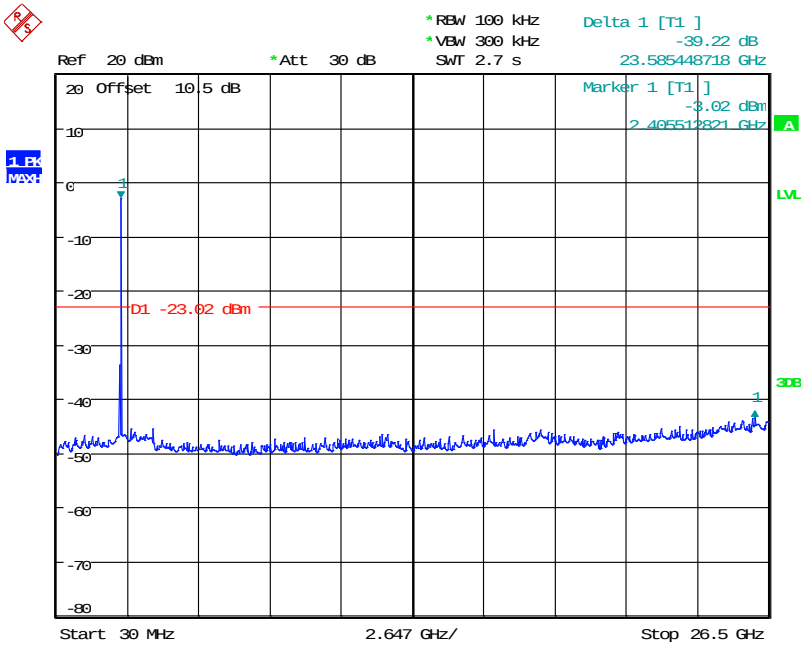
Frequency (MHz)	Reading (dBµV)	Correct Factor(dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Degree (°)	Remark
Low channel								
2390.000	64.35	-3.88	60.47	74.00	-13.53	100	257	peak
2390.000	50.21	-3.88	46.33	54.00	-7.67	100	257	AVG
2402.000	104.69	-3.86	100.83	N/A	N/A	132	293	peak
2402.000	104.28	-3.86	100.42	N/A	N/A	132	293	AVG
4804.000	51.94	1.81	53.75	74.00	-20.25	100	149	peak
4804.000	47.56	1.81	49.37	54.00	-4.63	100	149	AVG
7206.000	42.82	8.37	51.19	74.00	-22.81	100	240	peak
7206.000	32.11	8.37	40.48	54.00	-13.52	100	240	AVG
9608.000	41.32	12.97	54.29	74.00	-19.71	100	106	peak
9608.000	30.27	12.97	43.24	54.00	-10.76	100	106	AVG
Middle channel								
2440.000	104.36	-3.76	100.60	N/A	N/A	100	136	peak
2440.000	103.81	-3.76	100.05	N/A	N/A	100	136	AVG
4880.000	50.97	2.06	53.03	74.00	-20.97	110	95	peak
4880.000	47.03	2.06	49.09	54.00	-4.91	110	95	AVG
High channel								
2480.000	103.90	-3.66	100.24	N/A	N/A	100	297	peak
2480.000	102.50	-3.66	98.84	N/A	N/A	100	297	AVG
2483.500	64.35	-3.64	60.71	74.00	-13.29	100	209	peak
2483.500	50.20	-3.64	46.56	74.00	-27.44	100	209	AVG
4960.000	48.51	2.32	50.83	74.00	-23.17	100	92	peak
4960.000	43.40	2.32	45.72	54.00	-8.28	100	92	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	39.22	≥ 20	PASS
Mid	2440	40.75	≥ 20	PASS
High	2480	37.59	≥ 20	PASS

Low Channel



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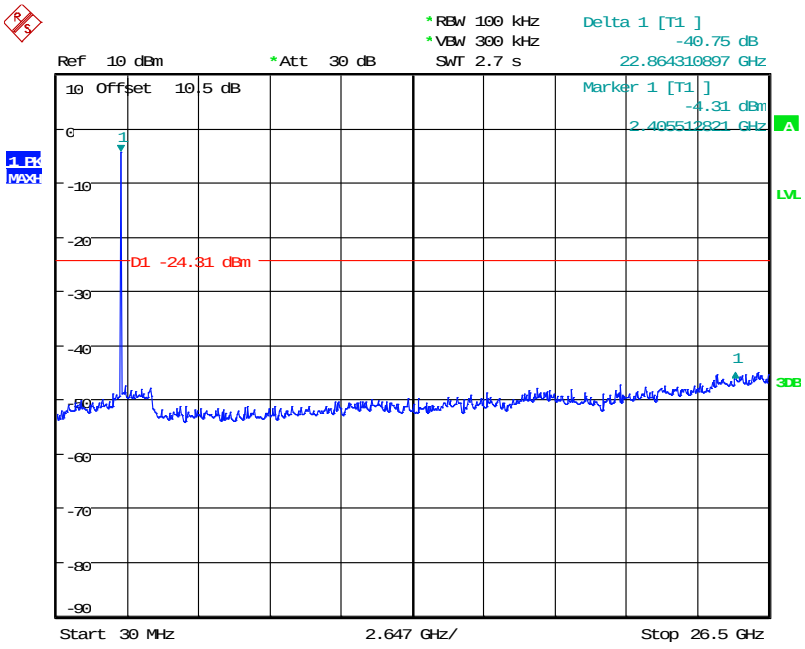
Middle Channel



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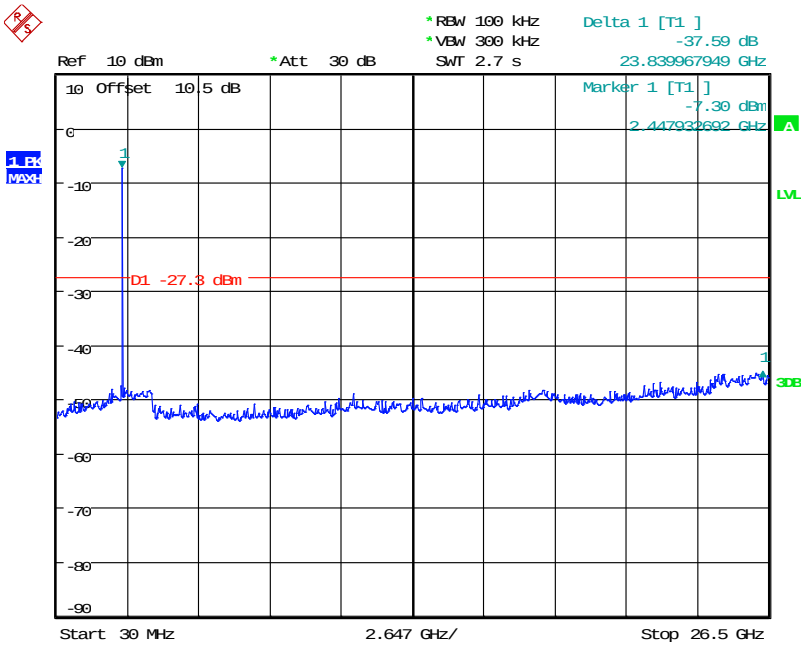
High Channel



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

8.1 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.

8.2 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.

8.3 Test Environmental Conditions

Temperature:	26° C
Relative Humidity:	58 %
ATM Pressure:	1010 hPa

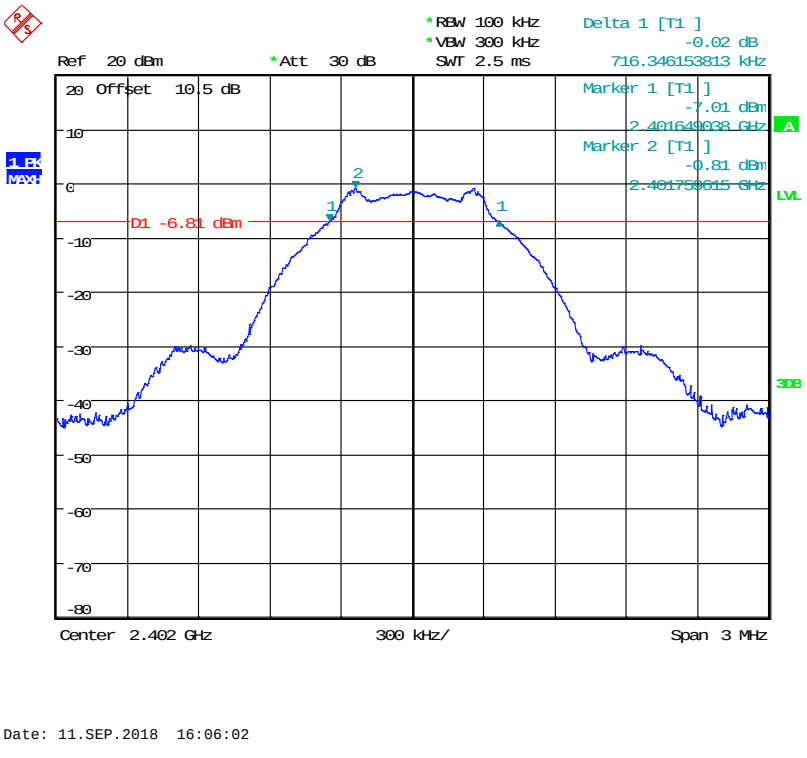
The testing was performed by Tom Hsu on 2018-09-11.

8.4 Test Results

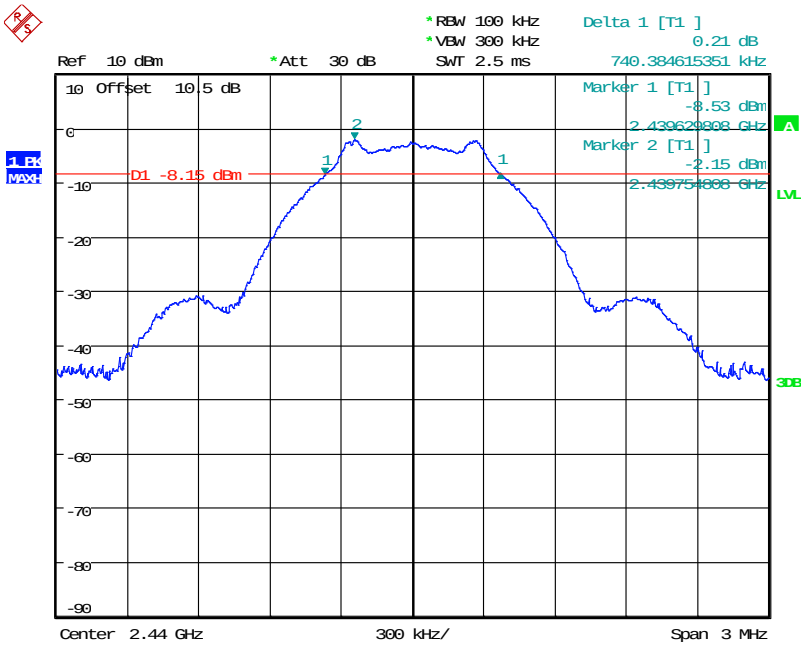
Channel	Frequency (MHz)	6 dB OBW (kHz)	Limit (kHz)	Result
Low	2402	716	> 500	Compliance
Middle	2442	740	> 500	Compliance
High	2480	736	> 500	Compliance

Please refer to the following plots

Low Channel



Middle Channel



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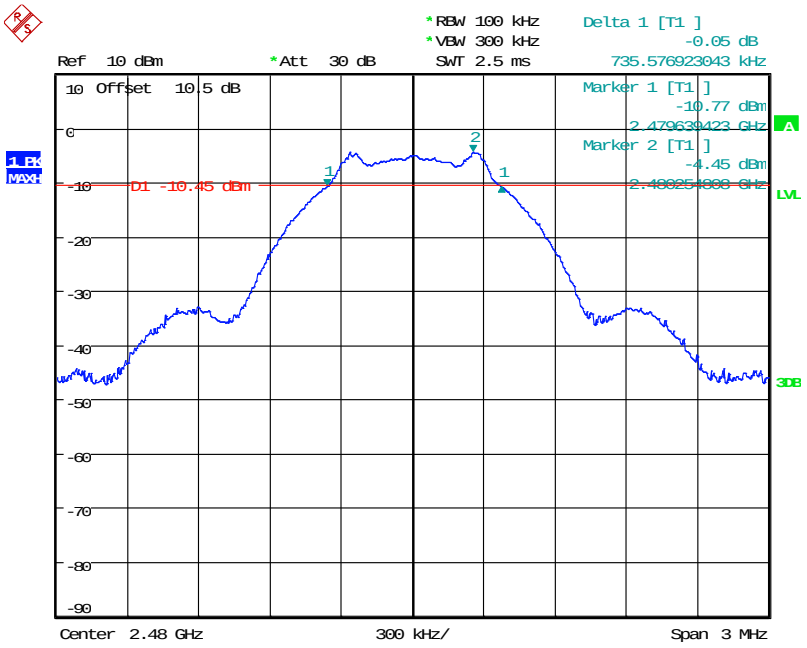
High Channel



Date: 11.SEP.2018 16:08:56

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

9.1 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.

9.2 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.

9.3 Test Environmental Conditions

Temperature:	25° C
Relative Humidity:	58 %
ATM Pressure:	1010 hPa

The testing was performed by Tom Hsu on 2018-09-11.

9.4 Test Results

Channel	Frequency	Maximum peak Conducted Output Power		Limit	Result
	(MHz)	(dBm)	(W)	(W)	
BLE Mode					
Low	2402	0.42	0.00110	1	PASS
Middle	2440	0.33	0.00108	1	PASS
High	2480	-0.97	0.00080	1	PASS

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

10.1 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)).

10.2 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.

10.3 Test Environmental Conditions

Temperature:	25° C
Relative Humidity:	58 %
ATM Pressure:	1010 hPa

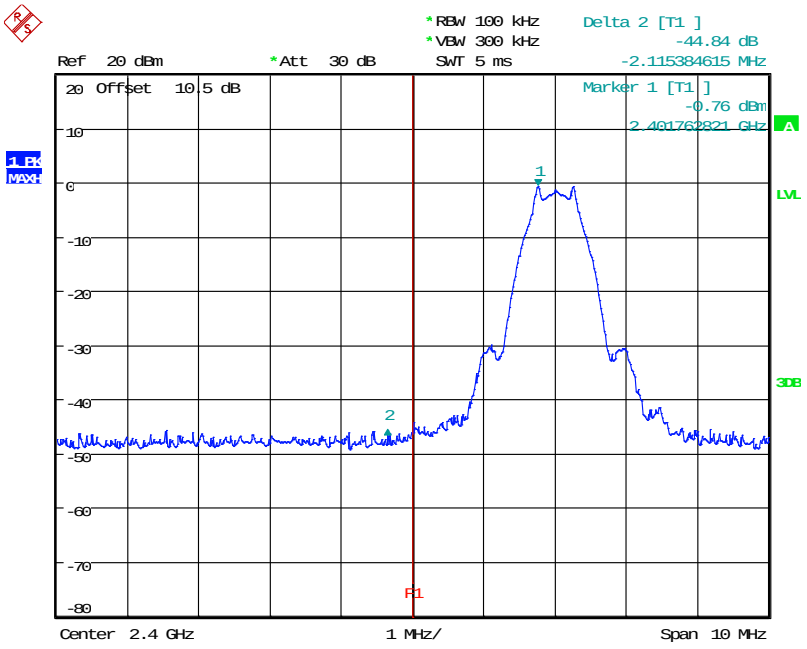
The testing was performed by Tom Hsu on 2018-09-11.

10.4 Test Results

Channel	Frequency (MHz)	Delta Peak to Band Emission (dBc)	Limit (dBc)	RESULT
Low	2402	44.84	≥ 20	PASS
High	2480	42.91	≥ 20	PASS

Please refer to the following plots

Band Edge, Left Side



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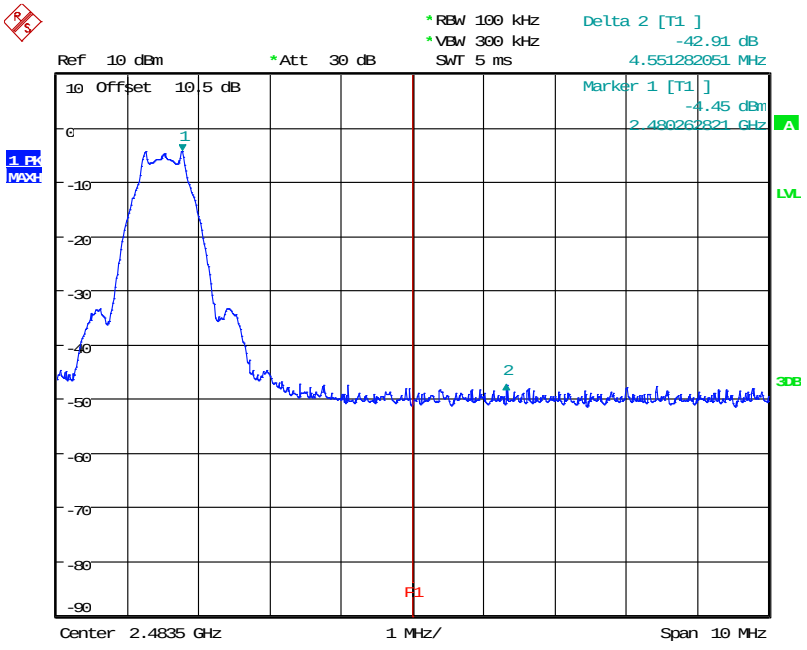
Band Edge, Right Side



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11 FCC §15.247(e) – Power Spectral Density

11.1 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.

11.2 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

11.3 Test Environmental Conditions

Temperature:	25° C
Relative Humidity:	58 %
ATM Pressure:	1010 hPa

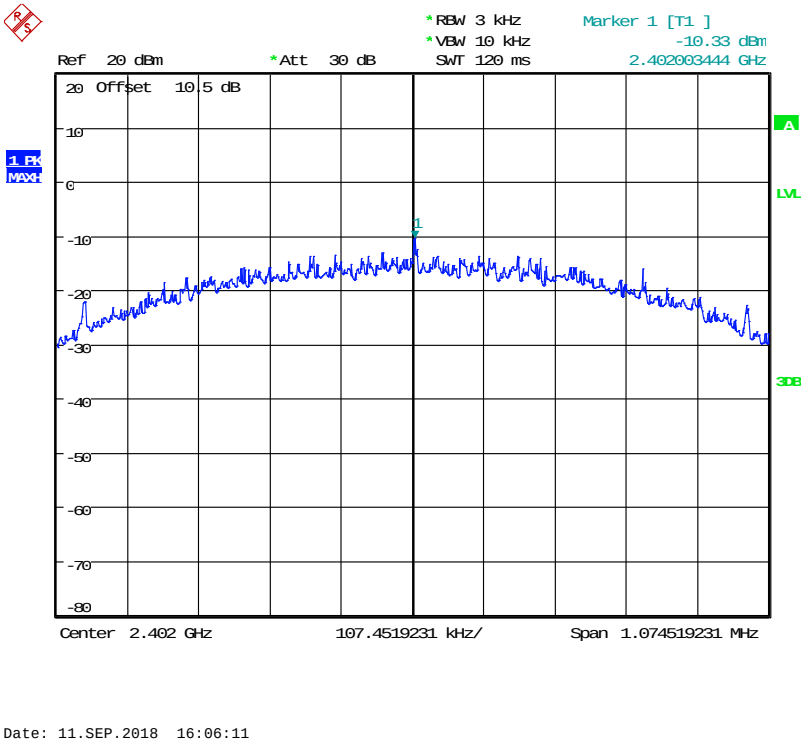
The testing was performed by Tom Hsu on 2018-09-11.

11.4 Test Results

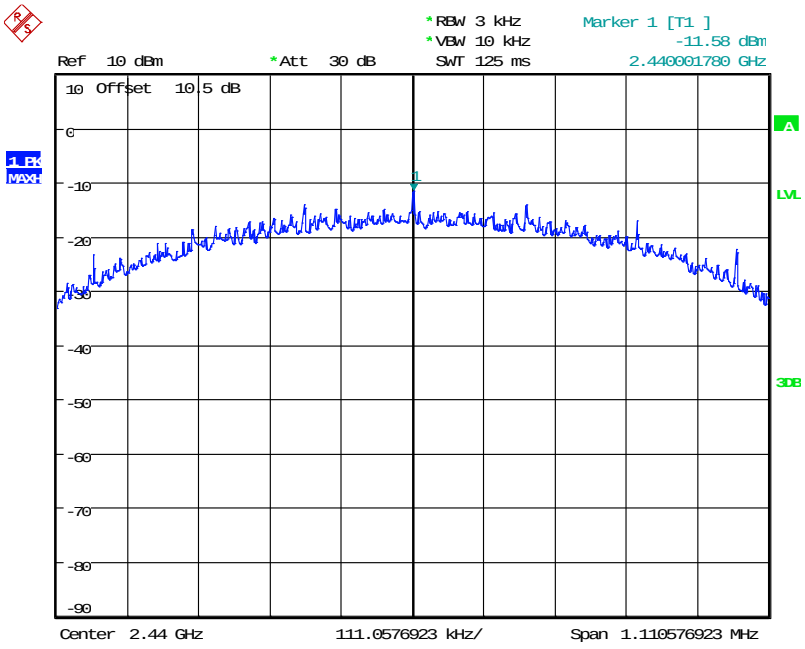
Channel	Frequency (MHz)	Power Spectral Density (dBm/3 kHz)	Limit (dBm/3 kHz)	Result
Low	2402	-10.33	8	Compliance
Middle	2440	-11.58	8	Compliance
High	2480	-13.45	8	Compliance

Please refer to the following plots

Low Channel



Middle Channel



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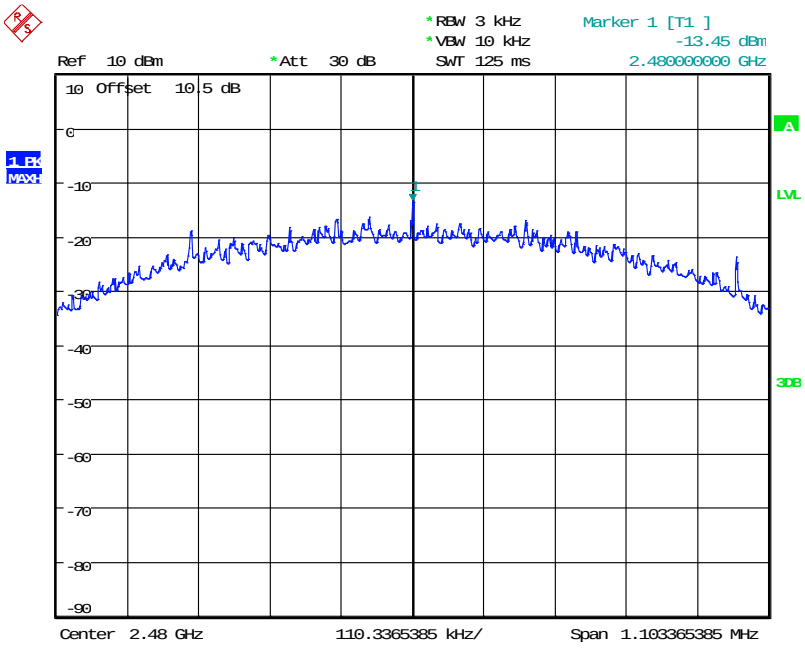
High Channel



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