

RF TEST REPORT



Report No.: FCC_IC_SL17100301-SFE-031_BLE

Supersede Report No.:

Applicant	:	Lumenetix
Product Name	:	Light Engine – Color Tuning Module
Model No.	:	CTM1
Alternate Model Name	:	DDM1
Test Standard	:	47 CFR 15.247
Test Method	:	ANSI C63.10: 2013 558074 D01 DTS Meas Guidance v04
FCC ID	:	Q8A-CTM1-DDM1
Dates of test	:	2/8/2018
Issue Date	:	2/8/2018
Test Result	:	<input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail
Equipment complied with the specification	[X]	
Equipment did not comply with the specification	[]	

This Test Report is Issued Under the Authority of:

Shuo Zhang	Gary Chou
Test Engineer	Engineer Reviewer

Issued By:
SIEMIC Laboratories
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Laboratory Introduction

SIEMIC, headquartered in the heart of Silicon Valley, with superior facilities in US and Asia, is one of the leading independent testing and certification facilities providing customers with one-stop shop services for Compliance Testing and Global Certifications.



In addition to testing and certification, SIEMIC provides initial design reviews and compliance management throughout a project. Our extensive experience with China, Asia Pacific, North America, European, and International compliance requirements, assures the fastest, most cost effective way to attain regulatory compliance for the global markets.

Accreditations for Conformity Assessment

Country/Region	Accreditation Body	Scope
USA	FCC, A2LA	EMC, RF/Wireless, Telecom
Canada	IC, A2LA, NIST	EMC, RF/Wireless, Telecom
Taiwan	BSMI, NCC, NIST	EMC, RF, Telecom, Safety
Hong Kong	OFTA, NIST	RF/Wireless, Telecom
Australia	NATA, NIST	EMC, RF, Telecom, Safety
Korea	KCC/RRA, NIST	EMI, EMS, RF, Telecom, Safety
Japan	VCCI, JATE, TELEC, RFT	EMI, RF/Wireless, Telecom
Mexico	NOM, COFETEL, Caniety	Safety, EMC, RF/Wireless, Telecom
Europe	A2LA, NIST	EMC, RF, Telecom, Safety
Israel	MOC, NIST	EMC, RF, Telecom, Safety

Accreditations for Product Certifications

Country	Accreditation Body	Scope
USA	FCC TCB, NIST	EMC, RF, Telecom
Canada	IC FCB, NIST	EMC, RF, Telecom
Singapore	iDA, NIST	EMC, RF, Telecom
EU	NB	EMC & Radio Equipment Directive
Japan	MIC (RCB 208)	RF, Telecom
Hong Kong	OFTA (US002)	RF, Telecom

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1 Report Revision History

Report No.	Report Version	Description	Issue Date
FCC_IC_SL17100301-SFE-031_BLE	None	Original	2/08/2018

2 Executive Summary

The purpose of this test program was to demonstrate compliance of following product

Company: Lumenetix Inc.
Host Product: Light Engine – Color Tuning Module
Host Model No.: CTM1

against the current Stipulated Standards. The specified model product stated above has demonstrated compliance with the Stipulated Standard listed on 1st page.

3 Customer information

Applicant Name	Lumenetix Inc.
Applicant Address	4742 Scotts Valley Dr Scotts Valley, CA 95066
Manufacturer Name	Lumenetix Inc.
Manufacturer Address	4742 Scotts Valley Dr Scotts Valley, CA 95066

4 Test site information

Lab performing tests	SIEMIC Laboratories
Lab Address	775 Montague Expressway, Milpitas, CA 95035
FCC Test Site No.	881796
IC Test Site No.	4842D-2
VCCI Test Site No.	A0133

5 Modification

Index	Item	Description	Note
-	-	-	-

6 EUT Information

6.1 EUT Description

Product Name	Light Engine – Color Tuning Module
Model No.	CTM1
Alternate Model Name	DDM1
Trade Name	Lumenetix
Serial No.	C1102AAH09330AA
Input Power (EUT-Battery)	24V dc
Software Version	Version 2768 (firmware)
Date of EUT received	02/08/2018
Equipment Class/ Category	DTS
Port/Connectors	-

6.2 Spec for BT Radio

Radio Type	Bluetooth
Operating Frequency	2402MHz-2480MHz
Modulation	GFSK (LE)
Channel Spacing	2MHz (LE)
Antenna Type	SMT MID Chip
Antenna Gain	3 dBi
Antenna Connector Type	-
Note	-

6.3 EUT test modes/configuration Description

Mode	Note
Bluetooth	BLE (GFSK)

6.4 EUT Photos |External Photo



EUT-Top View with Battery



EUT- Bottom View

6.5 EUT Photos |internal Photo



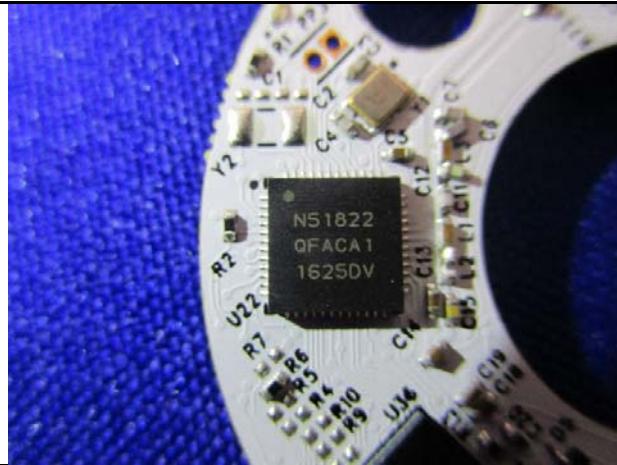
PCB View 1



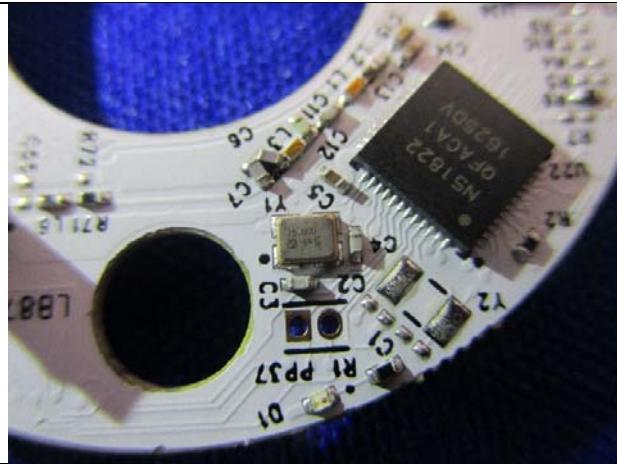
PCB View 2



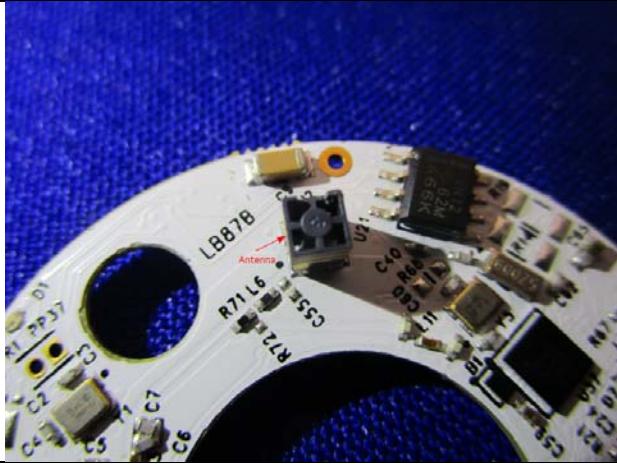
PCB View 3



Bluetooth Module View



Oscillator View



Antenna View

6.6 EUT Test Setup Photos



7 Supporting Equipment/Software and cabling Description

7.1 Supporting Equipment

Item	Supporting Equipment Description	Model	Serial Number	Manufacturer	Note
2	AC/DC Adaptor	ANP101-24P1-277-41360L-1	1715A00008	Amperor	-

7.2 Cabling Description

Item	Connection Start		Connection Stop		Length / shielding Info		Note
	From	I/O Port	To	I/O Port	Length (m)	Shielding	
1	ADAPTOR	N/A	EUT	Power jack	0.1	NO	-

7.3 Test Software Description

Test Item	Software	Description
RF Testing	PUTTY	Set the EUT to transmit continuously in different test mode

8 Test Summary

Test Item	Test standard		Test Method/Procedure		Pass / Fail
Restricted Band of Operation	FCC	15.205	FCC	ANSI C63.10:2013 558074 D01 DTS Meas Guidance v04	<input checked="" type="checkbox"/> Pass
					<input type="checkbox"/> N/A
AC Conducted Emissions	FCC	15.207(a)	FCC	ANSI C63.10:2013	<input checked="" type="checkbox"/> Pass
					<input type="checkbox"/> N/A

DTS Band Requirement

Test Item	Test standard		Test Method/Procedure		Pass / Fail
99% Occupied Bandwidth	-	-	-	-	<input type="checkbox"/> Pass <input type="checkbox"/> N/A
	IC	RSS Gen 6.6	IC	RSS Gen Issue 4: 2014 -	
6dB Bandwidth	FCC	15.247(a)(2)	FCC	558074 D01 DTS Meas Guidance v04	<input checked="" type="checkbox"/> Pass
	IC	RSS247 (5.2.1)	IC		<input type="checkbox"/> N/A
Band Edge and Radiated Spurious Emissions	FCC	15.247(d)	FCC	ANSI C63.10:2013 558074 D01 DTS Meas Guidance v04	<input checked="" type="checkbox"/> Pass
	IC	RSS247 (5.5)	IC		<input type="checkbox"/> N/A
Output Power	FCC	15.247(b)	FCC	558074 D01 DTS Meas Guidance v04	<input checked="" type="checkbox"/> Pass
	IC	RSS247 (5.4.4)	IC		<input type="checkbox"/> N/A
Receiver Spurious Emissions	IC	RSS Gen (4.8)	IC	RSS Gen Issue 4: 2014	<input type="checkbox"/> Pass <input checked="" type="checkbox"/> N/A
Antenna Gain > 6 dBi	FCC	15.247(e)	FCC	-	<input type="checkbox"/> Pass
	IC	-	IC	-	<input checked="" type="checkbox"/> N/A
Power Spectral Density	FCC	15.247(e)	FCC	558074 D01 DTS Meas Guidance v04	<input checked="" type="checkbox"/> Pass
	IC	RSS247 (5.2.2)	IC		<input type="checkbox"/> N/A
RF Exposure requirement	FCC	15.247(i)	FCC	-	<input checked="" type="checkbox"/> Pass
	IC	RSS Gen(5.5)	IC	RSS Gen Issue 4: 2014	<input type="checkbox"/> N/A
Remark	1. All measurement uncertainties do not take into consideration for all presented test results. 2. The applicant shall ensure frequency stability by showing that an emission is maintained within the band of operation under all normal operating conditions as specified in the user's manual.				

9 Measurement Uncertainty

9.1 Conducted Emissions

The test is to measure the conducted emissions to the mains port of the EUT.

Some error sources that can contribute to the total uncertainty:

- Uncertainty of the receiver
- Uncertainty of the LISN
- Uncertainty of cables
- Uncertainty due to the mismatches
- Etc, see the below table for details

Source of Uncertainty	Value (dB)	Probability Distribution	Division	Sensitivity Coefficient	Expanded Uncertainty
Receiver Reading	0.12	Rectangular	1.732	1	0.069284
Cable Insertion Loss	0.21	Normal	2	1	0.105
Filter Insertion Loss	0.25	Normal	2	1	0.125
LISN Insertion Loss	0.40	Normal	2	1	0.20
Receiver CW accuracy	0.5	Rectangular	1.732	1	0.2886836
Pulse Amplitude Response	1.5	Rectangular	1.732	1	0.86605081
PRF Response	1.5	Rectangular	1.732	1	0.86605081
Mismatch LISN - Receiver	0.25	U-Shape	1.414	1	0.1768033
LISN Impedance	2.5	Triangular	2.449	1	1.0208248
Combined Standard Uncertainty					1.928133
Expanded Uncertainty (K=2)					3.856266

The total derived measurement uncertainty is +/- 3.86 dB.

9.2 Radiated Emissions (30MHz to 1GHz)

The test is to measure the radiated emissions of the EUT.

Some error sources that can contribute to the total uncertainty:

- Uncertainty of the receiver
- Uncertainty of the antenna
- Uncertainty of cables
- Uncertainty due to the mismatches
- NSA Calibration
- Etc., details see the below table

Source of Uncertainty	Value (dB)	Probability Distribution	Division	Sensitivity Coefficient	Expanded Uncertainty
Receiver Reading	0.12	Rectangular	1.732	1	0.069284
Cable Insertion Loss	0.21	Normal	2	1	0.105
Filter Insertion Loss	0.25	Normal	2	1	0.125
Antenna Factor	0.65	Normal	2	1	0.325
Receiver CW accuracy	0.5	Rectangular	1.732	1	0.2886836
Pulse Amplitude Response	1.5	Rectangular	1.732	1	0.86605081
PRF Response	1.5	Rectangular	1.732	1	0.86605081
Mismatch Filter - Receiver	0.25	U-Shape	1.414	1	0.1768033
NSA Calibration	4.0	U-Shape	1.414	1	2.8288543
Combined Standard Uncertainty					3.0059131
Expanded Uncertainty (K=2)					6.0118262

The total derived measurement uncertainty is +/- 6.00 dB.

9.3 Radiated Emissions (1GHz to 40GHz)

The test is to measure the radiated emissions of the EUT.

Some error sources that can contribute to the total uncertainty:

- Uncertainty of the receiver
- Uncertainty of the antenna
- Uncertainty of cables
- Uncertainty due to the mismatches
- VSWR Calibration
- Etc., details see the below table

Source of Uncertainty	Value (dB)	Probability Distribution	Division	Sensitivity Coefficient	Expanded Uncertainty
Receiver Reading	0.12	Rectangular	1.732	1	0.0692840
Cable Insertion Loss	0.21	Normal	2	1	0.1050000
Filter Insertion Loss	0.25	Normal	2	1	0.1250000
Antenna Factor	0.65	Normal	2	1	0.3250000
Receiver CW accuracy	0.5	Rectangular	1.732	1	0.2886836
Pulse Amplitude Response	1.5	Rectangular	1.732	1	0.8660508
PRF Response	1.5	Rectangular	1.732	1	0.8660508
Mismatch Filter - Receiver	0.25	U-Shape	1.414	1	0.1768033
VSWR Calibration	2.0	U-Shape	1.414	1	1.4144272
Combined Standard Uncertainty					4.2363
Expanded Uncertainty (K=2)					8.4726

The total derived measurement uncertainty is +/- 8.47 dB.

9.4 RF conducted measurement

The test is to measure the RF output power from the EUT.

Some error sources that can contribute to the total uncertainty:

- Uncertainty of the Reference Level Uncertainty
- Uncertainty of variable attenuators
- Uncertainty of cables
- Uncertainty due to the mismatches

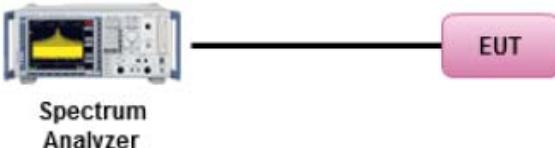
Source of Uncertainty	Value (dB)	Probability Distribution	Division	Sensitivity Coefficient	Expanded Uncertainty
Reference Level	0.12	Rectangular	1.732	1	0.069284
Cable Insertion Loss	0.21	Normal	2	1	0.105
Attenuator	0.25	Normal	2	1	0.125
Mismatch	0.25	U-Shape	1.414	1	0.1768033
Combined Standard Uncertainty					0.476087
Expanded Uncertainty (K=2)					0.952174

The total derived measurement uncertainty is +/- 0.95 dB.

10 Measurements, Examination and Derived Results

10.1 Output Power (Bluetooth LE)

Requirement(s):

Spec	Item	Requirement	Applicable
§ 15.247	a)	FHSS in 2400-2483.5MHz with \geq 75 channels: \leq 1 Watt	<input type="checkbox"/>
	b)	FHSS in 5725-5850MHz: \leq 1 Watt	<input type="checkbox"/>
	c)	For all other FHSS in the 2400-2483.5MHz band: \leq 0.125 Watt.	<input type="checkbox"/>
	d)	FHSS in 902-928MHz with \geq 50 channels: \leq 1 Watt	<input type="checkbox"/>
	e)	FHSS in 902-928MHz with \geq 25 & $<$ 50 channels: \leq 0.25 Watt	<input type="checkbox"/>
	f)	DSSS in 902-928MHz, 2400-2483.5MHz, 5725-5850MHz: \leq 1 Watt	<input checked="" type="checkbox"/>
Test Setup	 Spectrum Analyzer ————— EUT		
Test Procedure	558074 D01 DTS Meas Guidance v04 Measurements may be performed using a wideband gated RF power meter provided that the gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Since the measurement is made only during the ON time of the transmitter, no duty cycle correction factor is required. <ul style="list-style-type: none"> - Connect EUT's RF output power to power meter - Set EUT to be continuous transmission mode - Measurement the average output power using power meter and record the result - Repeat above steps for different test channel and other modulation type. 		
Test Date	02/07/2018	Environmental condition	Temperature 23°C Relative Humidity 44% Atmospheric Pressure 1021mbar
Remark	-		
Result	<input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail		

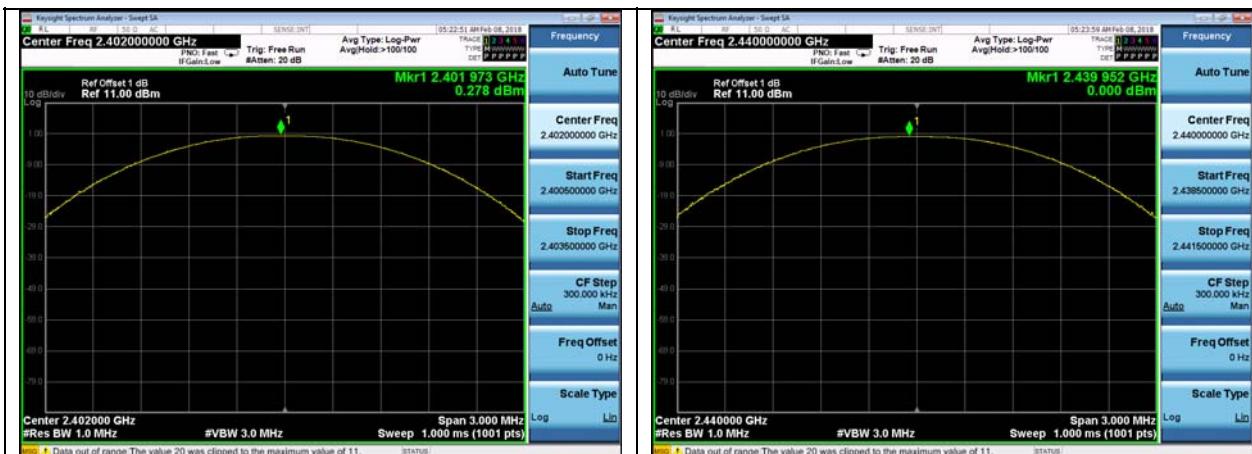
Test Data Yes N/A

Test Plot Yes (See below) N/A

Test was done by Shuo Zhang at RF Test Site.

Output Power measurement result (Bluetooth)

Type	Test mode	Freq (MHz)	CH	Conducted Power (dBm)	Limit (dBm)	Result
Output power	Bluetooth LE	2402	Low	0.28	30	Pass
		2440	Mid	0.00	30	Pass
		2480	High	-0.76	30	Pass



Output Power –Bluetooth LE 2402MHz

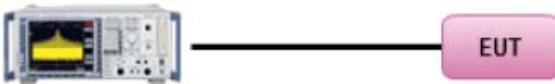
Output Power –Bluetooth LE 2440MHz



Output Power –Bluetooth LE 2480MHz

10.2 Band Edge (Bluetooth LE)

Requirement(s):

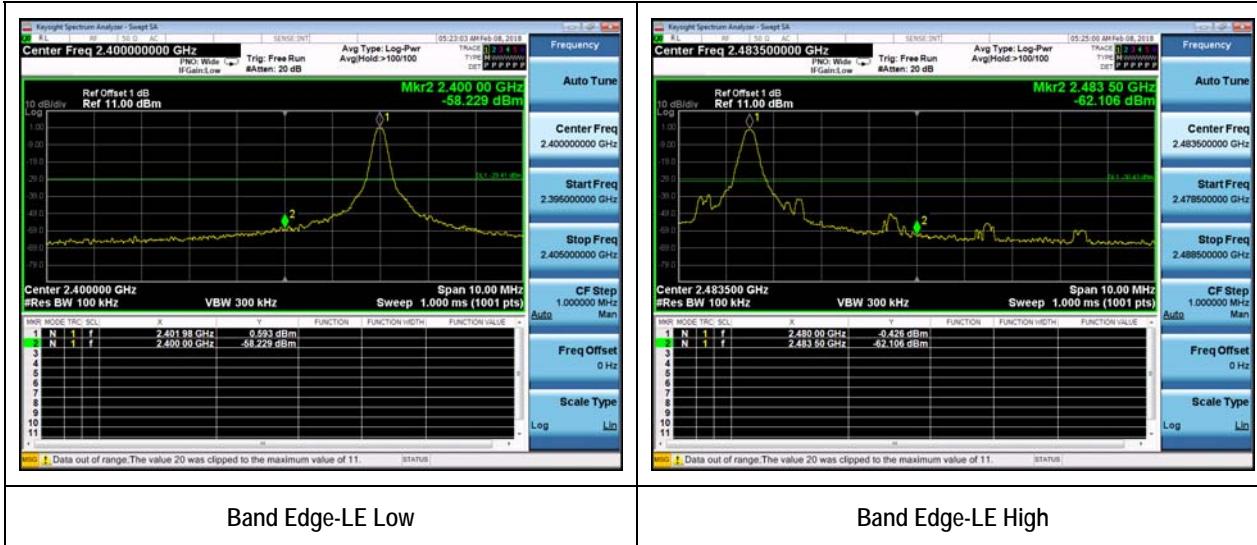
Spec	Item	Requirement	Applicable
§ 15.247	d)	For non-restricted band, In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB or 30dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, determined by the measurement method on output power to be used. Attenuation below the general limits specified in § 15.209 (a) is not required <input type="checkbox"/> 20 dB down <input checked="" type="checkbox"/> 30 dB down	<input checked="" type="checkbox"/>
Test Setup	 Spectrum Analyzer ————— EUT		
Test Procedure	<p>558074 D01 DTS Meas Guidance v04</p> <p><u>Band Edge measurement procedure</u></p> <ol style="list-style-type: none"> 1. Set the EUT to maximum power setting and enable the EUT transmit continuously. 2. Band edge emissions must be at least 30 dB down from the highest emission level within the authorized band as a measured. The attenuation shall be 30 dB instead of 20 dB when Peak conducted output power procedure is used. 3. Change modulation and channel bandwidth then repeat step 1 to 2. 4. Measured and record the results in the test report. 		
Test Date	02/08/2018	Environmental condition	Temperature 22°C Relative Humidity 46% Atmospheric Pressure 1020mbar
Remark	-		
Result	<input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail		

Test Data Yes N/A

Test Plot Yes (See below) N/A

Test was done by Shuo Zhang at RF Test Site.

Band Edge Test Plots (Bluetooth LE)



10.3 6dB Bandwidth (Bluetooth LE)

Requirement(s):

Spec	Item	Requirement	Applicable
§ 15.247	a)(2)	6dB BW \geq 500KHz;	<input checked="" type="checkbox"/>
Test Setup	 <p>Spectrum Analyzer</p>		
Test Procedure	<p>558074 D01 DTS Meas Guidance v04, 8.1 DTS bandwidth</p> <p><u>6dB Emission bandwidth measurement procedure</u></p> <ul style="list-style-type: none"> - Set RBW = 100 kHz. - Set the video bandwidth (VBW) \geq 3 x RBW. - Detector = Peak. - Trace mode = max hold. - Sweep = auto couple. - Allow the trace to stabilize. - 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. 		
Test Date	02/08/2018	Environmental condition	Temperature 23°C Relative Humidity 42% Atmospheric Pressure 1021mbar
Remark	N/A		
Result	<input checked="" type="checkbox"/> Pass	<input type="checkbox"/> Fail	

Test Data Yes N/A

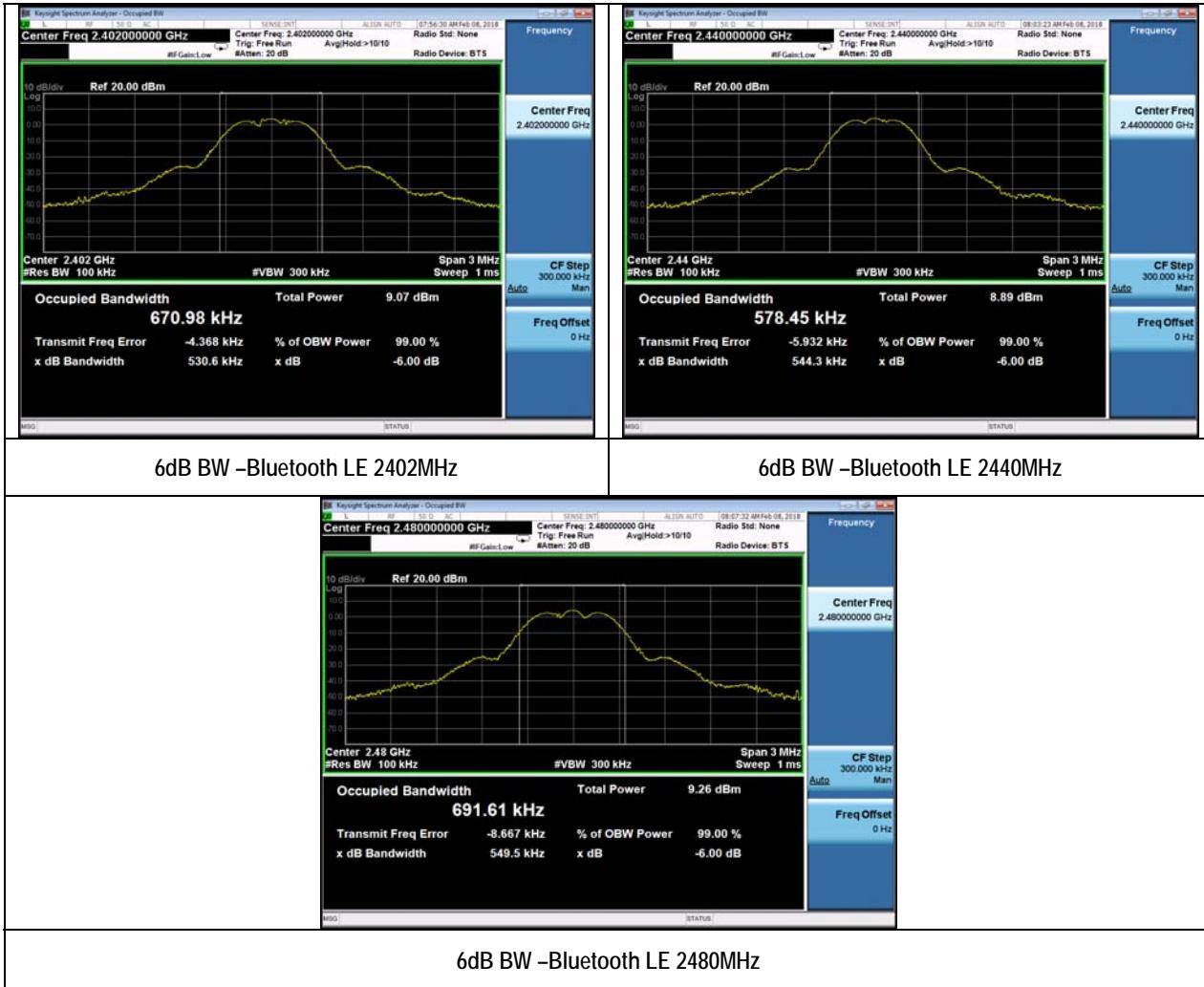
Test Plot Yes N/A

Test was done by Shuo Zhang at RF Test Site.

6dB Bandwidth measurement result for 2.4GHz

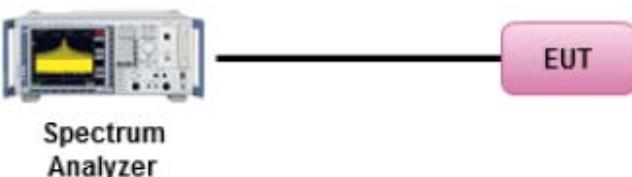
Type	Test mode	Freq (MHz)	CH	Result (MHz)	Limit (MHz)	Result
6dB BW	BT-LE	2402	Low	0.530	≥0.5	Pass
		2440	Mid	0.544	≥0.5	Pass
		2480	High	0.549	≥0.5	Pass

Test Plots



10.4 Peak Spectral Density (Bluetooth LE)

Requirement(s):

Spec	Item	Requirement	Applicable
§ 15.247(e)	e)	DSSS: $\leq 8\text{dBm}/3\text{kHz}$	<input checked="" type="checkbox"/>
	f)	DSSS in hybrid sys with FH turned off: $\leq 8\text{dBm}/3\text{kHz}$	<input type="checkbox"/>
Test Setup	 <p>Spectrum Analyzer ————— EUT</p>		
Test Procedure	<p>558074 D01 DTS Meas Guidance v04, 10.2 Method PKPSD (peak PSD)</p> <p><u>Peak spectral density measurement procedure</u></p> <ul style="list-style-type: none"> - Set analyzer center frequency to DTS channel center frequency. - Set the span to 1.5 times the DTS bandwidth. - Set the RBW to: $3\text{ kHz} \leqslant \text{RBW} \leqslant 100\text{ kHz}$. - Set the VBW $\geqslant 3 \times \text{RBW}$. - Detector = Peak - Sweep time = auto couple. - Trace mode = Trace Max Hold over 100 traces - Allow trace to fully stabilize. - Use the peak marker function to determine the maximum amplitude level within the RBW. - If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat. 		
Test Date	02/08/2018	Environmental condition	Temperature 22°C Relative Humidity 46% Atmospheric Pressure 1020mbar
Remark	-		
Result	<input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail		

Test Data Yes N/A

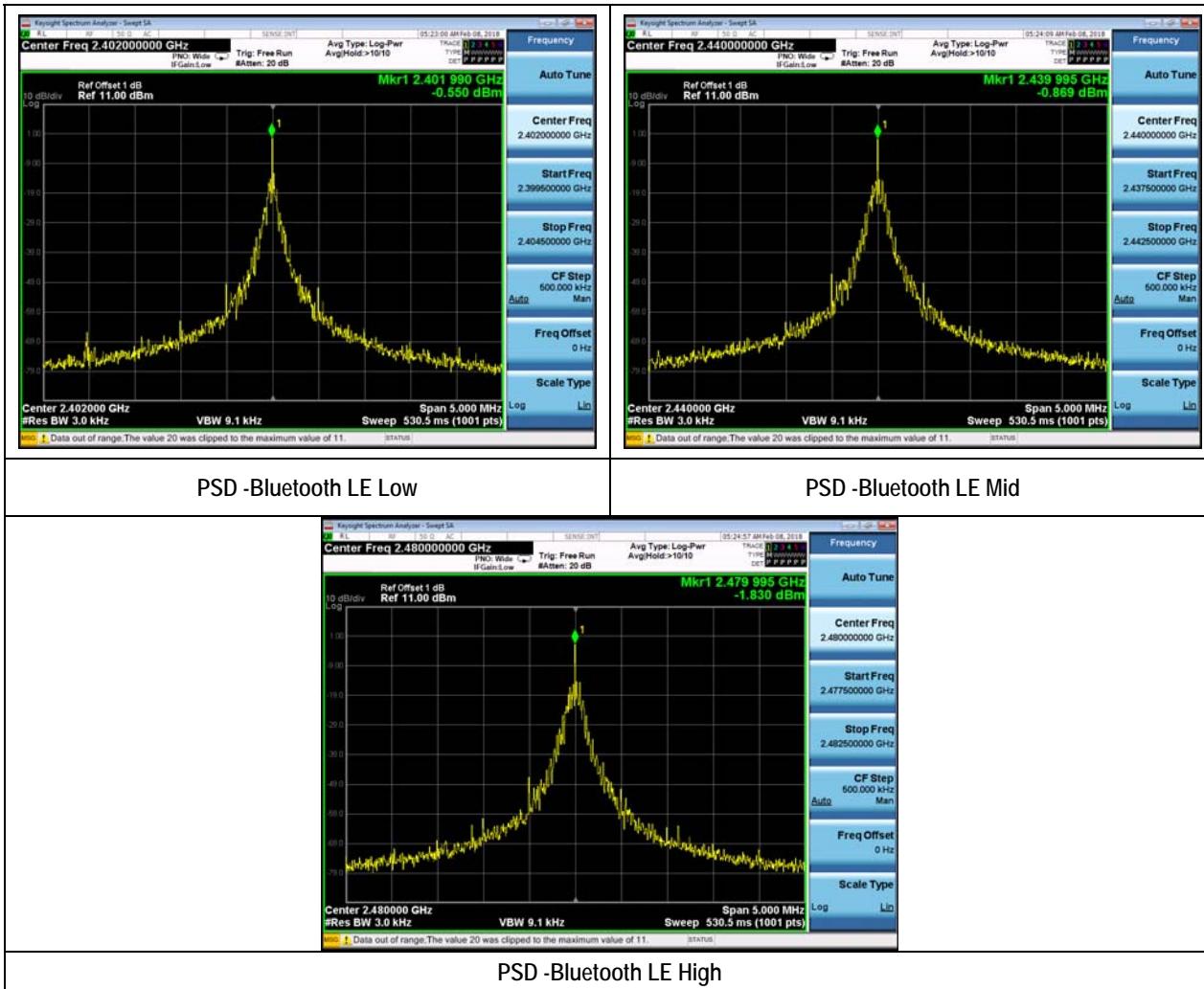
Test Plot Yes (See below) N/A

Test was done by Shuo Zhang at RF Test Site.

PSD measurement result (Bluetooth LE)

Type	Test mode	Freq (MHz)	CH	Conducted PSD (dBm/3KHz)	Limit (dBm/3KHz)	Result
PSD	Bluetooth LE	2402	Low	-0.55	≤8	Pass
		2440	Mid	-0.869	≤8	Pass
		2480	High	-1.830	≤8	Pass

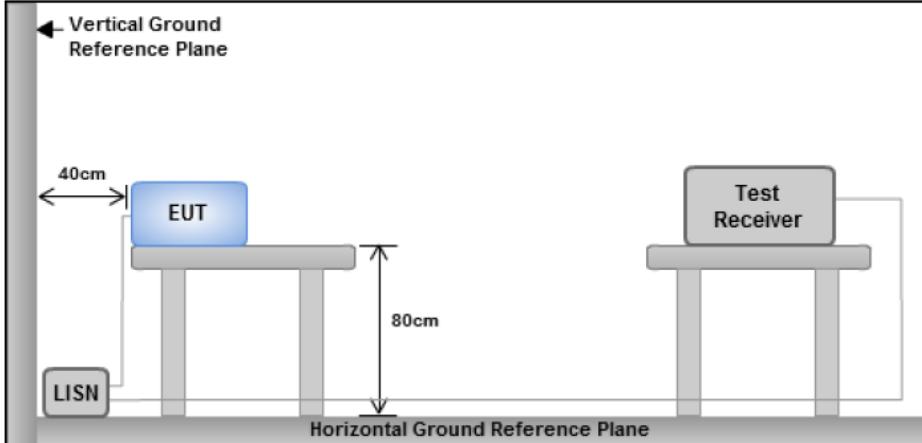
Test Plots (Bluetooth LE)



10.5 Conducted Emissions

Conducted Emission Limit

Frequency ranges (MHz)	Limit (dBuV)	
	QP	Average
0.15 ~ 0.5	66 ~ 56	56 ~ 46
0.5 ~ 5	56	46
5 ~ 30	60	50

Spec	Item	Requirement	Applicable
RSS247(A8.1)	a)	For Low-power radio-frequency devices 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 μ H/50 ohms line impedance stabilization network (LISN). The lower limit applies at the boundary between the frequency ranges.	<input checked="" type="checkbox"/>
Test Setup		 <p>Note:</p> <ol style="list-style-type: none"> 1. Support units were connected to second LISN. 2. Both of LISNs (AMN) are 80 cm from EUT and at least 80 cm from other units and other metal planes 	
Procedure			<ul style="list-style-type: none"> The EUT and supporting equipment were set up in accordance with the requirements of the standard on top of a 1.5m x 1m x 0.8m high, non-metallic table, as shown in Annex B. The power supply for the EUT was fed through a 50Ω/50μH EUT LISN, connected to filtered mains. The RF OUT of the EUT LISN was connected to the EMI test receiver via a low-loss coaxial cable. All other supporting equipment was powered separately from another main supply.
Remark	EUT was tested at 120VAC, 60Hz		
Result	<input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail		

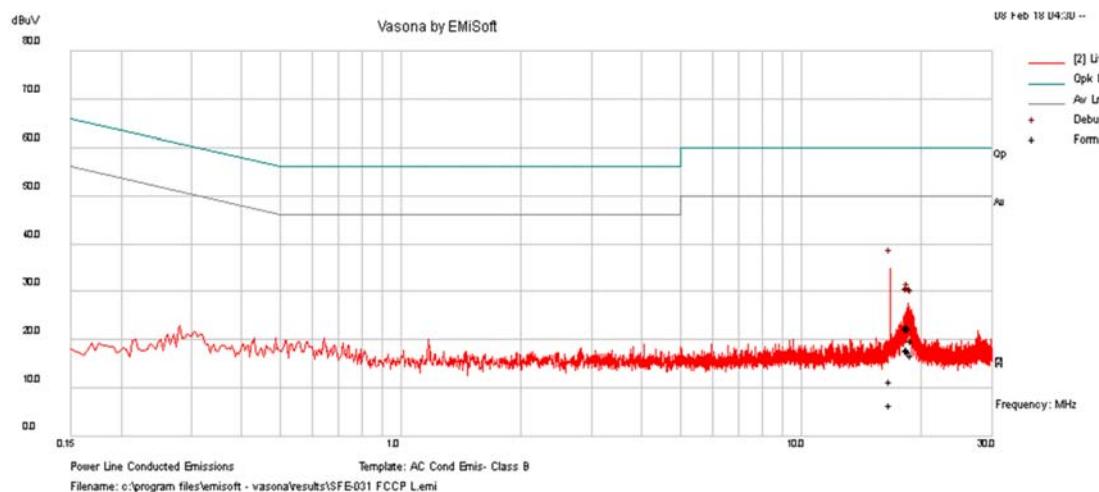
Test Data Yes N/A

Test Plot Yes (See below) N/A

Test was done by Shuo Zhang at Conducted Emission test site.

Conducted Emission Test Results

Test specification:	Conducted Emissions		
Environmental Conditions:	Temp(°C):	21	Result: <input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail
	Humidity (%):	42	
	Atmospheric(mbar):	1021	
Mains Power:	120Vac, 60Hz		
Tested by:	Shuo Zhang		
Test Date:	02/08/2018		
Remarks	TX MODE 2440 MHz- Line		

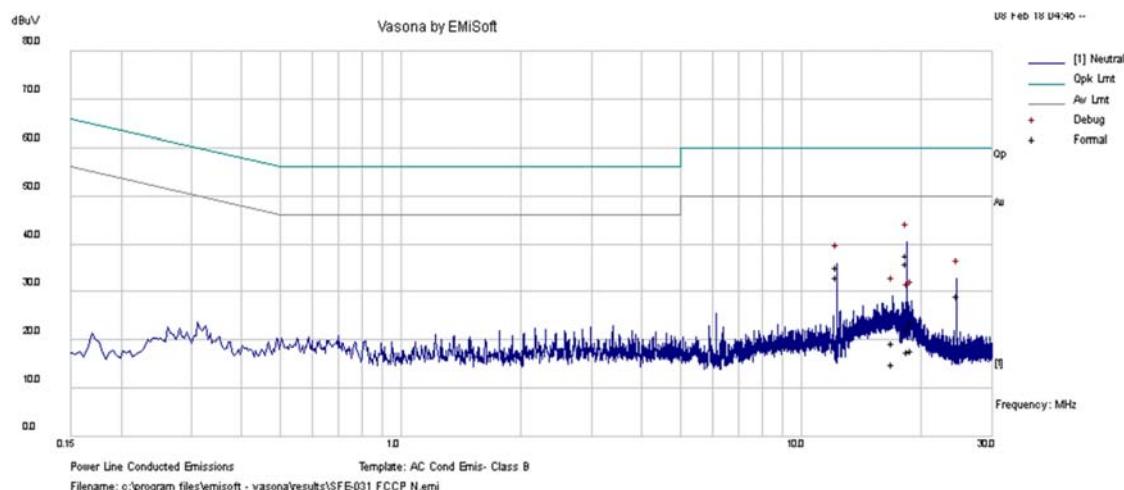


Live Plot at 120VAC, 60Hz

Frequency (MHz)	Raw (dBuV)	Cable Loss (dB)	Factors (dB)	Level (dBuV)	Measurement Type	Line / Neutral	Limit (dBuV)	Margin (dB)	Pass /Fail
16.728788	1.63	9.38	0.4	11.41	Quasi Peak	Live	60	-48.59	Pass
18.495581	12.88	9.38	0.43	22.69	Quasi Peak	Live	60	-37.31	Pass
18.565381	12.46	9.38	0.43	22.27	Quasi Peak	Live	60	-37.73	Pass
18.70107	12.67	9.38	0.44	22.49	Quasi Peak	Live	60	-37.51	Pass
18.427253	12.56	9.38	0.43	22.38	Quasi Peak	Live	60	-37.62	Pass
18.873551	9.96	9.38	0.44	19.78	Quasi Peak	Live	60	-40.22	Pass
16.728788	-3.32	9.38	0.4	6.45	Average	Live	50	-43.55	Pass
18.495581	8.37	9.38	0.43	18.19	Average	Live	50	-31.81	Pass
18.565381	8.02	9.38	0.43	17.83	Average	Live	50	-32.17	Pass
18.70107	7.84	9.38	0.44	17.65	Average	Live	50	-32.35	Pass
18.427253	8.02	9.38	0.43	17.83	Average	Live	50	-32.17	Pass
18.873551	6.86	9.38	0.44	16.68	Average	Live	50	-33.32	Pass

Conducted Emission Test Results

Test specification:	Conducted Emissions		
Environmental Conditions:	Temp(°C):	21	Result: <input checked="" type="checkbox"/> Pass
	Humidity (%):	42	
Mains Power:	Atmospheric(mbar):	1021	<input type="checkbox"/> Fail
Tested by:	120Vac, 60Hz		
Test Date:	Shuo Zhang		
Remarks	02/08/2018		
	TX MODE 2440 MHz- Neutral		

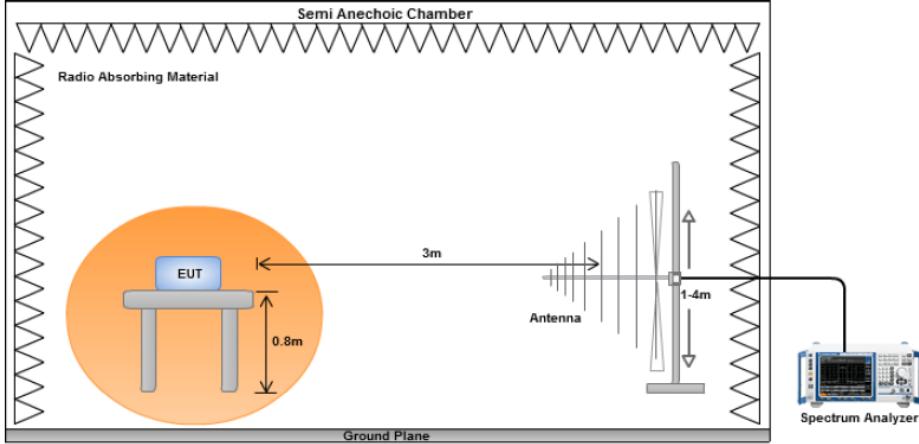


Neutral Plot at 120VAC, 60Hz

Frequency (MHz)	Raw (dBuV)	Cable Loss (dB)	Factors (dB)	Level (dBuV)	Measurement Type	Line / Neutral	Limit (dBuV)	Margin (dB)	Pass /Fail
18.432635	27.91	9.38	0.43	37.72	Quasi Peak	Neutral	60	-22.28	Pass
12.288521	23.19	9.47	0.29	32.95	Quasi Peak	Neutral	60	-27.05	Pass
24.576844	19.09	9.39	0.54	29.02	Quasi Peak	Neutral	60	-30.98	Pass
16.96509	9.52	9.38	0.4	19.3	Quasi Peak	Neutral	60	-40.7	Pass
18.908349	13.67	9.38	0.44	23.49	Quasi Peak	Neutral	60	-36.51	Pass
18.561413	12.35	9.38	0.43	22.16	Quasi Peak	Neutral	60	-37.84	Pass
18.432635	25.97	9.38	0.43	35.78	Average	Neutral	50	-14.22	Pass
12.288521	25.2	9.47	0.29	34.96	Average	Neutral	50	-15.04	Pass
24.576844	19.09	9.39	0.54	29.02	Average	Neutral	50	-20.98	Pass
16.96509	5.28	9.38	0.4	15.06	Average	Neutral	50	-34.94	Pass
18.908349	8.02	9.38	0.44	17.84	Average	Neutral	50	-32.16	Pass
18.561413	7.84	9.38	0.43	17.65	Average	Neutral	50	-32.35	Pass

10.6 Radiated Spurious Emissions below 1GHz

Requirement(s):

Spec	Item	Requirement	Applicable										
47CFR§15.247(d)	a)	<p>Except higher limit as specified elsewhere in other section, the emissions from the low-power radio-frequency devices shall not exceed the field strength levels specified in the following table and the level of any unwanted emissions shall not exceed the level of the fundamental emission. The tighter limit applies at the band edges</p> <table border="1"> <thead> <tr> <th>Frequency range (MHz)</th> <th>Field Strength (uV/m)</th> </tr> </thead> <tbody> <tr> <td>30 – 88</td> <td>100</td> </tr> <tr> <td>88 – 216</td> <td>150</td> </tr> <tr> <td>216.960</td> <td>200</td> </tr> <tr> <td>Above 960</td> <td>500</td> </tr> </tbody> </table>	Frequency range (MHz)	Field Strength (uV/m)	30 – 88	100	88 – 216	150	216.960	200	Above 960	500	<input checked="" type="checkbox"/>
Frequency range (MHz)	Field Strength (uV/m)												
30 – 88	100												
88 – 216	150												
216.960	200												
Above 960	500												
Test Setup													
Procedure	<ol style="list-style-type: none"> 1. The EUT was switched on and allowed to warm up to its normal operating condition. 2. The test was carried out at the selected frequency points obtained from the EUT characterisation. Maximization of the emissions, was carried out by rotating the EUT, changing the antenna polarization, and adjusting the antenna height in the following manner: <ol style="list-style-type: none"> a. Vertical or horizontal polarisation (whichever gave the higher emission level over a full rotation of the EUT) was chosen. b. The EUT was then rotated to the direction that gave the maximum emission. c. Finally, the antenna height was adjusted to the height that gave the maximum emission. 3. A Quasi-peak measurement was then made for that frequency point. 4. Steps 2 and 3 were repeated for the next frequency point, until all selected frequency points were measured. 												
Remark	<p>The EUT was scanned up to 1GHz. Both horizontal and vertical polarities were investigated. The results show only the worst case.</p>												
Result	<input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail												

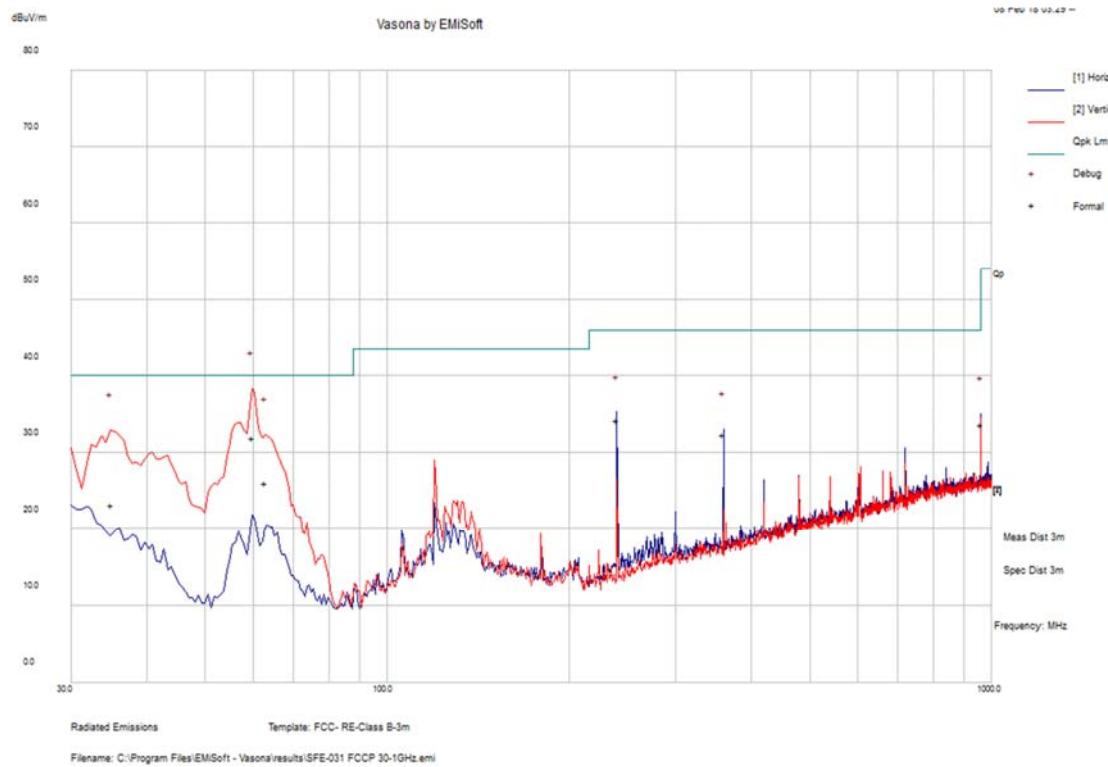
Test Data Yes (See below) N/A

Test Plot Yes (See below) N/A

Test was done by Shuo Zhang at 10m chamber.

Radiated Emission Test Results (Below 1GHz)

Test specification		Below 1GHz	
Environmental Conditions:		Temp (°C):	22
		Humidity (%)	47.5
		Atmospheric (mbar):	1020
Mains Power:	120VAC, 60Hz		
Tested by:	Shuo Zhang		
Test Date:	02/08/2018		
Remarks:	TX MODE 2440 MHz		

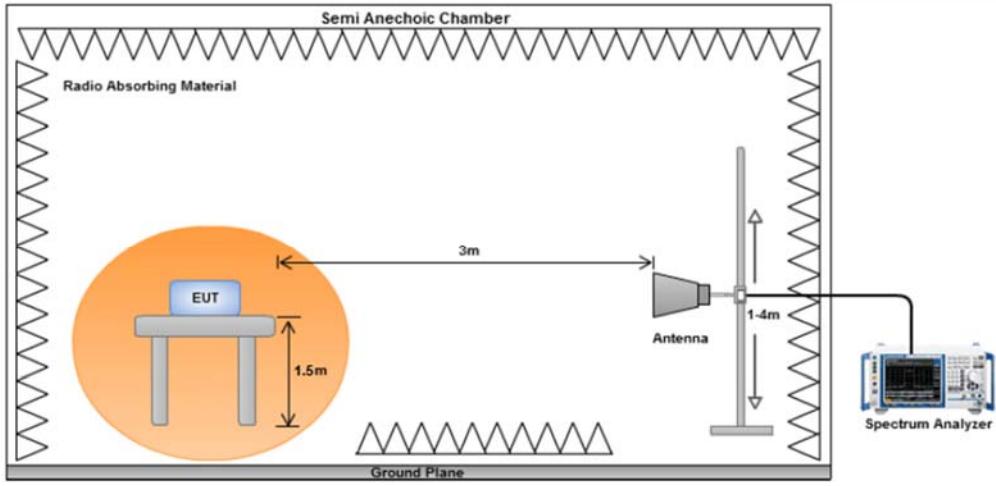


Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail
59.945	48.02	11.66	-27.74	31.95	Quasi Max	V	162	109	40	-8.06	Pass
35.034688	29.18	11.37	-17.41	23.14	Quasi Max	V	177	85	40	-16.86	Pass
62.768438	42.05	11.67	-27.69	26.04	Quasi Max	V	145	254	40	-13.96	Pass
239.997188	46.21	13.08	-25.09	34.2	Quasi Max	H	125	122	46	-11.8	Pass
959.99125	30.22	16.93	-13.55	33.59	Quasi Max	H	100	196	46	-12.41	Pass
360.011563	40.06	13.89	-21.59	32.36	Quasi Max	H	100	87	46	-13.64	Pass

Note: Both horizontal and vertical polarities were investigated. The results above show only the worst case.

10.7 Radiated Spurious Emissions between 1GHz – 25GHz

Requirement(s):

Spec	Item	Requirement	Applicable
47CFR§15.247(d),	a)	For non-restricted band, 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 or 30dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, determined by the measurement method on output power to be used. Attenuation below the general limits specified in § 15.209(a) is not required <input type="checkbox"/> 20 dB down <input checked="" type="checkbox"/> 30 dB down	<input checked="" type="checkbox"/>
	b)	or restricted band, emission must also comply with the radiated emission limits specified in 15.209	<input checked="" type="checkbox"/>
Test Setup			
Procedure	<ol style="list-style-type: none"> 1. The EUT was switched on and allowed to warm up to its normal operating condition. 2. The test was carried out at the selected frequency points obtained from the EUT characterisation. Maximization of the emissions, was carried out by rotating the EUT, changing the antenna polarization, and adjusting the antenna height in the following manner: <ol style="list-style-type: none"> a. Vertical or horizontal polarisation (whichever gave the higher emission level over a full rotation of the EUT) was chosen. b. The EUT was then rotated to the direction that gave the maximum emission. c. Finally, the antenna height was adjusted to the height that gave the maximum emission. 3. An average measurement was then made for that frequency point. 4. Steps 2 and 3 were repeated for the next frequency point, until all selected frequency points were measured. 		
Remark	<p>The EUT was scanned up to 26GHz. Both horizontal and vertical polarities were investigated. The results show only the worst case.</p>		
Result	<input checked="" type="checkbox"/> Pass <input type="checkbox"/> Fail		

Test Data Yes (See below) N/A

Test Plot Yes (See below) N/A

Test was done by Shuo Zhang at 10m chamber.

Radiated Emission Test Results (Above 1GHz)

BLE – 2402MHz

Frequency (MHz)	Raw (dBuV)	Cable Loss (dB)	AF (dB)	Level (dBuV/m)	Measurement Type	Pol (V/H)	Hgt (cm)	Azt (Deg)	Limit (dBuV/m)	Margin (dB)	Pass /Fail
14265	39.32	8.02	7.75	55.09	Peak Max	V	294	57	74	-18.91	Pass
4804.7	40.46	3.47	-3.91	40.02	Peak Max	H	285	144	74	-33.98	Pass
7209.08	39.27	5.31	0.96	45.54	Peak Max	H	336	160	74	-28.46	Pass
14265	26.33	8.02	7.75	42.1	Average Max	V	294	57	54	-11.9	Pass
4804.7	27.57	3.47	-3.91	27.13	Average Max	H	285	144	54	-26.87	Pass
7209.08	26.44	5.31	0.96	32.71	Average Max	V	342	95	54	-21.29	Pass

BLE – 2440MHz

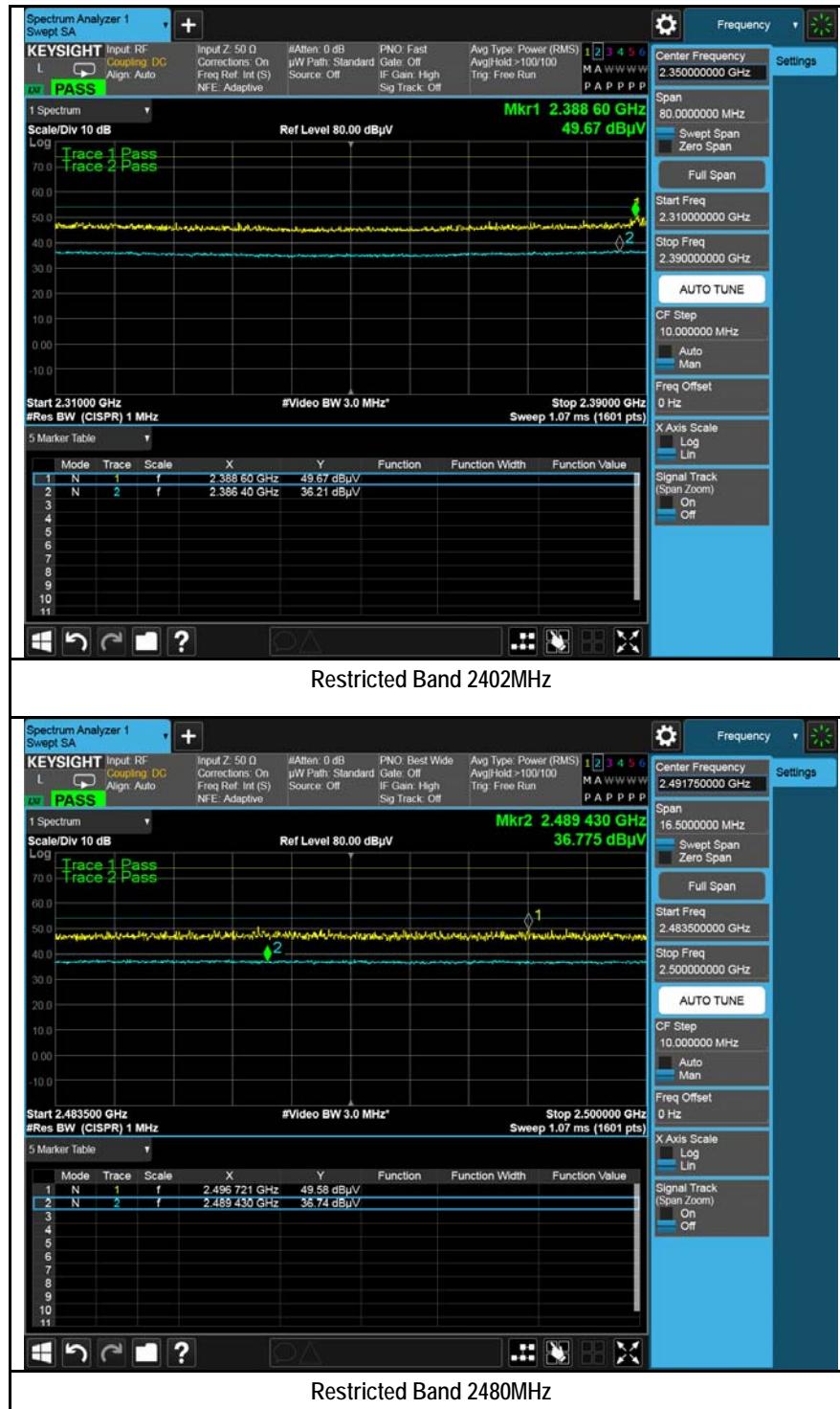
Frequency (MHz)	Raw (dBuV)	Cable Loss (dB)	AF (dB)	Level (dBuV/m)	Measurement Type	Pol (V/H)	Hgt (cm)	Azt (Deg)	Limit (dBuV/m)	Margin (dB)	Pass /Fail
13405	37.45	8.47	5.96	51.88	Peak Max	V	249	21	74	-22.12	Pass
4880.2	38.67	4.2	-2.15	40.72	Peak Max	V	321	334	74	-33.28	Pass
7320.06	39.89	5.35	0.89	46.13	Peak Max	V	99	221	74	-27.87	Pass
13405	25.42	8.47	5.96	39.85	Average Max	V	249	21	54	-14.15	Pass
4880.2	25.68	4.2	-2.15	27.73	Average Max	V	321	334	54	-26.27	Pass
7320.06	26.24	5.35	0.89	32.48	Average Max	V	99	221	54	-21.52	Pass

BLE – 2480MHz

Frequency (MHz)	Raw (dBuV)	Cable Loss (dB)	AF (dB)	Level (dBuV/m)	Measurement Type	Pol (V/H)	Hgt (cm)	Azt (Deg)	Limit (dBuV/m)	Margin (dB)	Pass /Fail
11319.88	38.38	7.47	2.72	48.57	Peak Max	V	382	49	74	-25.43	Pass
4960.29	39.42	4.25	-2.17	41.5	Peak Max	V	172	137	74	-32.5	Pass
7438.92	40.53	5.4	0.6	46.53	Peak Max	H	198	328	74	-27.47	Pass
11319.81	26.67	7.47	2.72	36.86	Average Max	V	382	49	54	-17.14	Pass
4960.29	25.82	4.25	-2.17	27.9	Average Max	V	172	137	54	-26.1	Pass
7438.92	26.54	5.4	0.6	32.54	Average Max	H	198	328	54	-21.46	Pass

Note: Both horizontal and vertical polarities were investigated. The results above show only the worst case.

Restricted Band Measurement Plots:



Annex A. TEST INSTRUMENT

Instrument	Model	Serial #	Cal Date	Cal Cycle	Cal Due	In use
Radiated Emissions						
Keysight EXA 44GHz Spectrum Analyzer	N9010A	MY51440112	11/02/2016	1 Year	11/02/2017	<input checked="" type="checkbox"/>
Bi-Log antenna (30MHz~2GHz)	JB1	A030702	01/13/2017	1 Year	01/13/2018	<input checked="" type="checkbox"/>
Horn Antenna (1GHz~26GHz)	3115	100059	08/11/2016	1 Year	08/11/2017	<input checked="" type="checkbox"/>
Horn Antenna (18GHz~40GHz)	PA-840	181251	06/23/2017	1 Year	06/23/2018	<input checked="" type="checkbox"/>
Preamplifier (100KHz-7GHz)	LPA-6-30	11170602	02/09/2017	1 Year	02/09/2018	<input checked="" type="checkbox"/>
Pre-Amplifier (1-40GHz)	SAS-474	579	05/04/2017	1 Year	05/04/2018	<input checked="" type="checkbox"/>

Annex B. SIEMIC Accreditation

Accreditations	Document	Scope / Remark
ISO 17025 (A2LA)		Please see the documents for the detailed scope
ISO Guide 65 (A2LA)		Please see the documents for the detailed scope
TCB Designation		A1 , A2 , A3 , A4 , B1 , B2 , B3 , B4 , C
FCC DoC Accreditation		FCC Declaration of Conformity Accreditation
FCC Site Registration		3 meter site
FCC Site Registration		10 meter site
IC Site Registration		3 meter site
IC Site Registration		10 meter site
EU NB		Radio Equipment: EN45011: EN ISO/IEC 17065
		Electromagnetic Compatibility: EN45011 – EN ISO/IEC 17065
Singapore iDA CB(Certification Body)	 	Phase I, Phase II
Vietnam MIC CAB Accreditation		Please see the document for the detailed scope
Hong Kong OFCA		(Phase II) OFCA Foreign Certification Body for Radio and Telecom
		(Phase I) Conformity Assessment Body for Radio and Telecom
Industry Canada CAB		Radio: Scope A – All Radio Standard Specification in Category I
		Telecom: CS-03 Part I, II, V, VI, VII, VIII

Japan Recognized Certification Body Designation		Radio: A1. Terminal equipment for purpose of calling Telecom: B1. Specified radio equipment specified in Article 38-2, Paragraph 1, Item 1 of the Radio Law
Korea CAB Accreditation		EMI: KCC Notice 2008-39, RRL Notice 2008-3: CA Procedures for EMI KN22: Test Method for EMI EMS: KCC Notice 2008-38, RRL Notice 2008-4: CA Procedures for EMS KN24, KN61000-4-2, -4-3, -4-4, -4-5, -4-6, -4-8, -4-11: Test Method for EMS
Taiwan NCC CAB Recognition		Radio: RRL Notice 2008-26, RRL Notice 2008-2, RRL Notice 2008-10, RRL Notice 2007-49, RRL Notice 2007-20, RRL Notice 2007-21, RRL Notice 2007-80, RRL Notice 2004-68
Taiwan BSMI CAB Recognition		Telecom: President Notice 20664, RRL Notice 2007-30, RRL Notice 2008-7 with attachments 1, 3, 5, 6; President Notice 20664, RRL Notice 2008-7 with attachment 4
Japan VCCI		LP0002, PSTN01, ADSL01, ID0002, IS6100, CNS14336, PLMN07, PLMN01, PLMN08
Australia CAB Recognition		R-3083: Radiation 3 meter site C-3421: Main Ports Conducted Interference Measurement T-1597: Telecommunication Ports Conducted Interference Measurement
Australia NATA Recognition		EMC: AS/NZS CISPR 11, AS/NZS CISPR 14.1, AS/NZS CISPR22, AS/NZS 61000.6.3, AS/NZS 61000.6.4 Radiocommunications: AS/NZS 4281, AS/NZS 4268, AS/NZS 4280.1, AS/NZS 4280.2, AS/NZS 4295, AS/NZS 4582, AS/NZS 4583, AS/NZS 4769.1, AS/NZS 4769.2, AS/NZS 4770, AS/NZS 4771 Telecommunications: AS/ACIF S002:05, AS/ACIF S003:06, AS/ACIF S004:06 AS/ACIF S006:01, AS/ACIF S016:01, AS/ACIF S031:01, AS/ACIF S038:01, AS/ACIF S040:01, AS/ACIF S041:05, AS/ACIF S043.2:06, AS/ACIF S60950.1