RF TEST REPORT

SIEMIC
A Bureau Veritas Group Company

Report No.: FCC_IC_SL18040201-RIO-001-BLE
Supersede Report No.:

Applicant	:	Resinio Ltd
Product Name	:	Balena Fin
Model No.	:	BLNFN100001
Test Standard	:	47 CFR 15.247 RSS-247 issue 2
Test Method	:	ANSI C63.10: 2013 558074 D01 DTS Meas Guidance v04
FCC ID	:	2APW6BLN-FN-1-00001
IC	:	24038-BLNFN100001
Dates of test	:	05/01/2018 – 06/05/2018
Issue Date	:	06/08/2018
Test Result	:	☒ Pass ☐ Fail
Equipment complied with the specification [X] Equipment did not comply with the specification [ ]		

This Test Report is Issued Under the Authority of:	
Benjamin Jing	Chen Ge
Test Engineer	Engineer Reviewer

Issued By:
SIEMIC Laboratories
775 Montague Expressway, Milpitas, 95035 CA

ilac-MRA
ACCREDITED
TESTING CERT # 2742-01

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 & R&TTE 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_SL18040201-RIO-001-BLE	None	Original	06/08/2018

2 Executive Summary

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

Company: Resinio Ltd
Product: Balena Fin
Model: BLNFN100001

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	Resinio Ltd
Applicant Address	One London Wall 6th floor London EC2Y 5EB United Kingdom
Manufacturer Name	Resinio Ltd
Manufacturer Address	One London Wall 6th floor London EC2Y 5EB United Kingdom

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	Balena Fin
Model No.	BLNFN100001
Trade Name	Resin.io
Serial No.	N/A
Input Power	120VAC/60Hz
Power Adapter Manu/Model	VEL36US120-US-JA
Power Adapter SN	E317867
Hardware version	N/A
Software version	N/A
Date of EUT received	04/15/2018
Equipment Class/ Category	DTS
Port/Connectors	1 X RJ45, 2 X USB, 1 X micro USB, 1 X HDMI
Remark	NONE

6.2 Spec for BT Radio

Radio Type	Bluetooth
Operating Frequency	2402MHz-2480MHz
Modulation	GFSK (LE)
Channel Spacing	2MHz (LE)
Antenna Type	External antenna : ¼ Dipole - Omni Embedded antenna : SMD
Antenna Gain	External antenna : 2 dBi Embedded antenna : 1 dBi
Antenna Connector Type	U.FL -

Type	Channel No.	Frequency (MHz)	Power Setting
Bluetooth(BLE) 2402-2480MHz	0	2402	Default
	19	2440	Default
	39	2480	Default

6.3 EUT test modes/configuration Description

Mode	Note
Bluetooth	BLE (GFSK)

7 Supporting Equipment/Software and cabling Description

7.1 Supporting Equipment

Item	Supporting Equipment Description	Model	Serial Number	Manufacturer	Note
1	Laptop	LATITUDE 3550	N/A	Dell	-
2	Router	WNR2000	N/A	Netgear	

7.2 Cabling Description

Name	Connection Start		Connection Stop		Length / shielding Info		Note
	From	I/O Port	To	I/O Port	Length (m)	Shielding	
Ethernet	RJ-45	EUT	RJ-45	Laptop	Ethernet 1 m	no	Unshielded

7.3 Test Software Description

Test Item	Software	Description
RF Testing	Dut Labtool	Set the EUT to transmit continuously in diferent 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	☒ Pass ☐ N/A
	IC	Rss Gen 8.10	IC		
AC Conducted Emissions	FCC	15.207(a)	FCC	ANSI C63.10:2013	☒ Pass ☐ N/A
	IC	RSS Gen 7.2		RSS Gen Issue 5, April 2018	

DTS Band Requirement

Test Item	Test standard		Test Method/Procedure		Pass / Fail
6dB Bandwidth	FCC	15.247(a)(2)	FCC	558074 D01 DTS Meas Guidance v04	☒ Pass ☐ N/A
	IC	RSS-247 (5.2.1)	IC		
99% Occuipied Bandwidth	-	-	-	-	☒ Pass ☐N/A
	IC	RSS Gen 6.7		RSS Gen Issue 5, April 2018	
Band Edge and Radiated Spurious Emissions	FCC	15.247(d)	FCC	ANSI C63.10:2013 558074 D01 DTS Meas Guidance v04	☒ Pass ☐ N/A
	IC	RSS-247 (5.5)	IC		
Output Power	FCC	15.247(b)	FCC	558074 D01 DTS Meas Guidance v04	☒ Pass ☐ N/A
	IC	RSS-247 (5.4.4)	IC		
Receiver Spurious Emissions	IC	RSS Gen (7)	IC	RSS Gen Issue 5, April 2018	☐ Pass ☒ N/A
Antenna Gain > 6 dBi	FCC	15.247(e)	FCC	--	☐ Pass ☒ N/A
	IC	--	IC	-	
Power Spectral Density	FCC	15.247(e)	FCC	558074 D01 DTS Meas Guidance v04	☒ Pass ☐ N/A
	IC	RSS-247 (5.2.2)	IC		
RF Exposure requirement	FCC	15.247(i)	FCC	-	☒ Pass ☐ N/A
	IC	RSS Gen (3.4)	IC	RSS Gen Issue 5, April 2018	
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 Antenna Requirement

Spec	Requirement	Applicable
15.203	An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of §§15.211, 15.213, 15.217, 15.219, 15.221, or §15.236. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.	☒
Remark	N/A	
Result	☒ Pass ☐ Fail	

Test Data ☐ Yes ☒ N/A
Test Plot ☐ Yes (See below) ☒ N/A

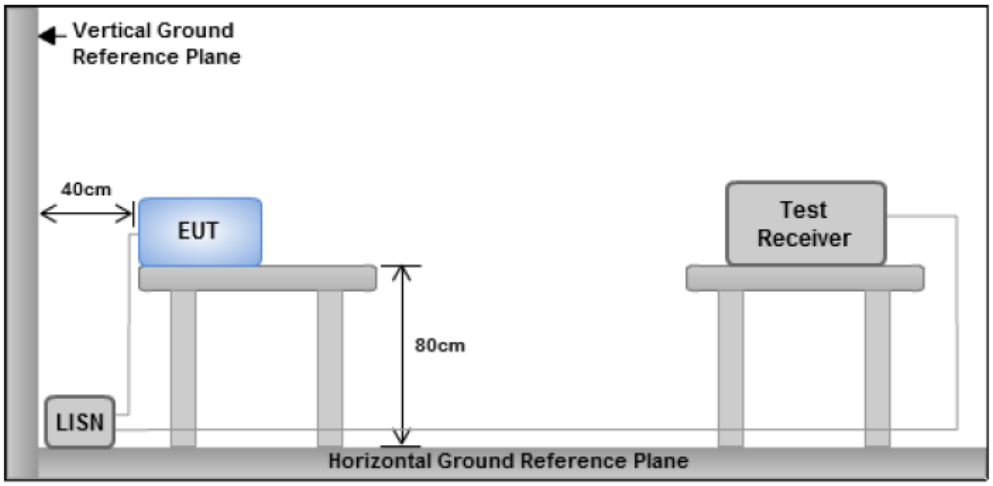
Antenna Connector Construction

Antenna Type	External antenna : ¼ Dipole - Omni Embedded antenna : SMD
Antenna Gain (Peak)	External antenna : 2 dBi Embedded antenna : 1 dBi
Antenna Connector Type	U.FL
Note	The antenna used U.FL antenna connectors which is a unique type which meet the requirement.

10.2 Conducted Emissions

Conducted Emission Limit FCC 15.207

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
FCC 15.207 RSS Gen 7.2	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 µH/50 ohms line impedance stabilization network (LISN). The lower limit applies at the boundary between the frequency ranges.	☒
Test Setup	 Note: 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	- 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	☒ Pass ☐ Fail	

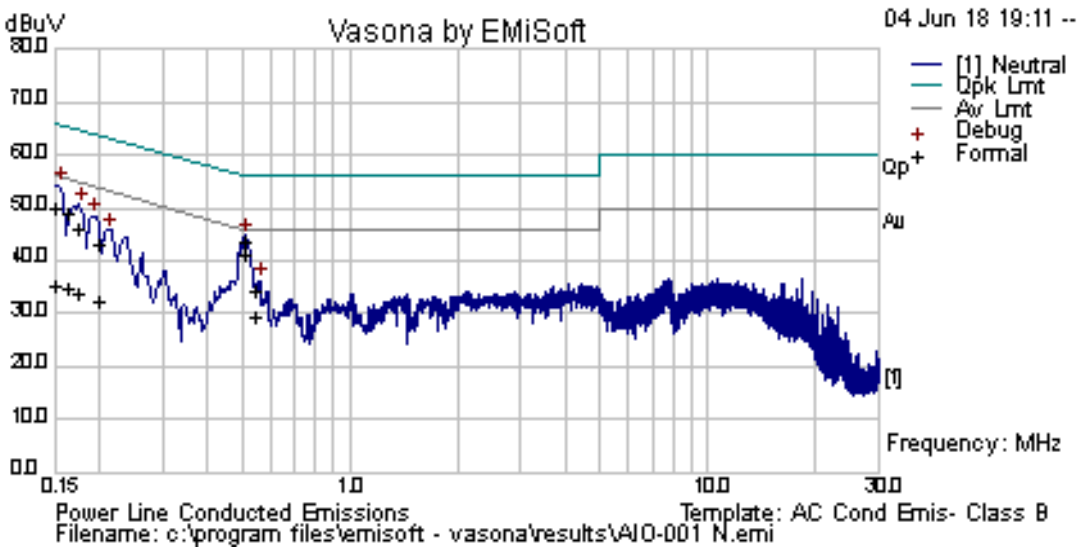
Test Data ☒ Yes ☐ N/A

Test Plot ☒ Yes (See below) ☐ N/A

Test was done by Benjamin at Conducted Emission test site.

Conducted Emission Test Results

Test specification:	Conducted Emissions			
Environmental Conditions:	Temp(°C):	21	Result:	☒ Pass ☐ Fail
	Humidity (%):	45		
	Atmospheric(mbar):	1021		
Mains Power:	120VAC, 60Hz			
Tested by:	Benjamin Jing			
Test Date:	06/04/2018			
Remarks	Conducted @ Neutral			

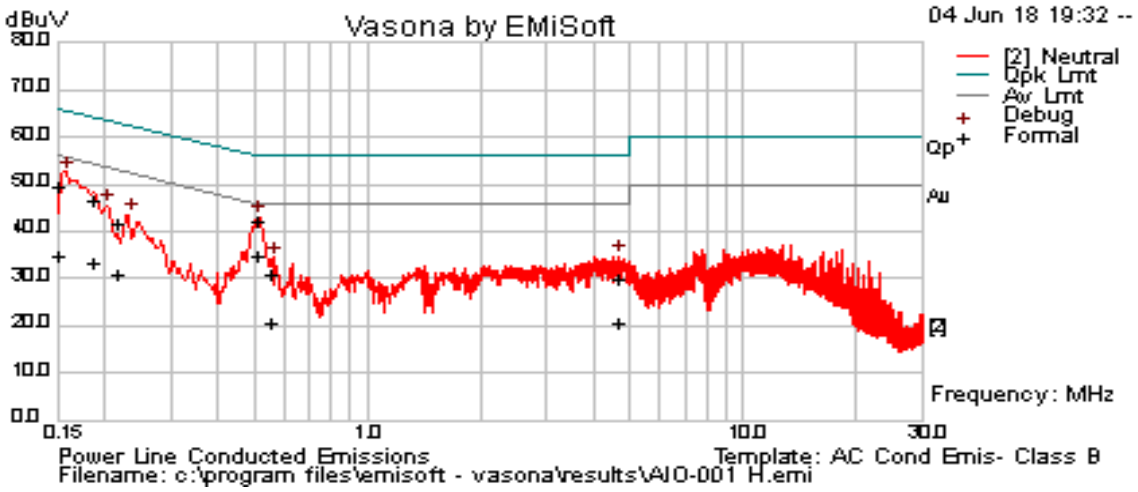


Neutral Plot at 120Vac, 60Hz

Frequency (MHz)	Raw (dBuV)	Cable Loss (dB)	Factors (dB)	Level (dBuV)	Measurement Type	Line/ Neutral	Limit (dBuV)	Margin (dB)	Pass /Fail
0.511695	34.25	9.33	0.04	43.62	Quasi Peak	Neutral	56	-12.38	Pass
0.150002	40.61	9.33	0.05	49.99	Quasi Peak	Neutral	66	-16.01	Pass
0.161495	39.61	9.33	0.05	48.98	Quasi Peak	Neutral	65.39	-16.4	Pass
0.175154	36.87	9.33	0.05	46.25	Quasi Peak	Neutral	64.71	-18.47	Pass
0.199395	33.66	9.32	0.04	43.03	Quasi Peak	Neutral	63.64	-20.61	Pass
0.54695	24.88	9.33	0.05	34.26	Quasi Peak	Neutral	56	-21.74	Pass
0.511695	31.63	9.33	0.04	41.01	Average	Neutral	46	-4.99	Pass
0.150002	26.03	9.33	0.05	35.41	Average	Neutral	56	-20.59	Pass
0.161495	25.63	9.33	0.05	35.01	Average	Neutral	55.39	-20.38	Pass
0.175154	24.62	9.33	0.05	33.99	Average	Neutral	54.71	-20.72	Pass
0.199395	23	9.32	0.04	32.36	Average	Neutral	53.64	-21.27	Pass
0.54695	20.3	9.33	0.05	29.68	Average	Neutral	46	-16.32	Pass

Conducted Emission Test Results

Test specification:	Conducted Emissions			
Environmental Conditions:	Temp(°C):	21	Result:	☒ Pass ☐ Fail
	Humidity (%):	42		
	Atmospheric(mbar):	1021		
Mains Power:	120Vac, 60Hz			
Tested by:	Benjamin Jing			
Test Date:	06/04/2018			
Remarks	Conducted @ Live			



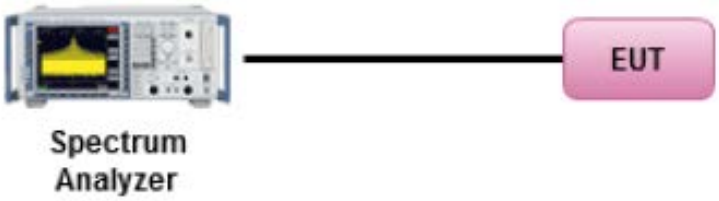
Live Plot at 120Vac, 60Hz

Frequency (MHz)	Raw (dBuV)	Cable Loss (dB)	Factors (dB)	Level (dBuV)	Measurement Type	Line/ Neutral	Limit (dBuV)	Margin (dB)	Pass /Fail
0.150002	40.1	9.33	0.05	49.48	Quasi Peak	Live	66	-16.52	Pass
0.511768	32.84	9.33	0.04	42.22	Quasi Peak	Live	56	-13.78	Pass
0.186662	37.34	9.32	0.04	46.71	Quasi Peak	Live	64.18	-17.48	Pass
0.216505	32.09	9.32	0.04	41.45	Quasi Peak	Live	62.95	-21.5	Pass
4.641004	20.58	9.35	0.08	30.01	Quasi Peak	Live	56	-25.99	Pass
0.554657	21.69	9.33	0.05	31.07	Quasi Peak	Live	56	-24.93	Pass
0.150002	25.68	9.33	0.05	35.06	Average	Live	56	-20.94	Pass
0.511768	25.64	9.33	0.04	35.01	Average	Live	46	-10.99	Pass
0.186662	24.21	9.32	0.04	33.58	Average	Live	54.18	-20.61	Pass
0.216505	21.32	9.32	0.04	30.68	Average	Live	52.95	-22.27	Pass
4.641004	11.09	9.35	0.08	20.51	Average	Live	46	-25.49	Pass
0.554657	11.36	9.33	0.05	20.74	Average	Live	46	-25.26	Pass

Note: The results above show only the worst case.

10.3 6dB Bandwidth

Requirement(s):

Spec	Requirement	Applicable
§ 15.247 RSS247(5.2.1)	6dB BW≥500KHz;	☒
RSS Gen 4.6.1	The resolution bandwidth shall be set to as close to 1% of selected span as is possible without being below 1%. The video bandwidth shall be set to 3 times the resolution bandwidth.	☒
Test Setup	 to	
Test Procedure	558074 D01 DTS Meas Guidance v04, 8.1 DTS bandwidth 6dB Emission bandwidth measurement procedure - Set RBW = 100 kHz. - Set the video bandwidth (VBW) ⩾ 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	05/16/2018	Environmental condition	Temperature 23ºC Relative Humidity 42% Atmospheric Pressure 1021mbar
Remark	N/A		
Result	☒ Pass ☐ Fail		

Test Data ☒ Yes ☐ N/A

Test Plot ☒ Yes ☐ N/A

Test was done by Benjamin at RF test site.

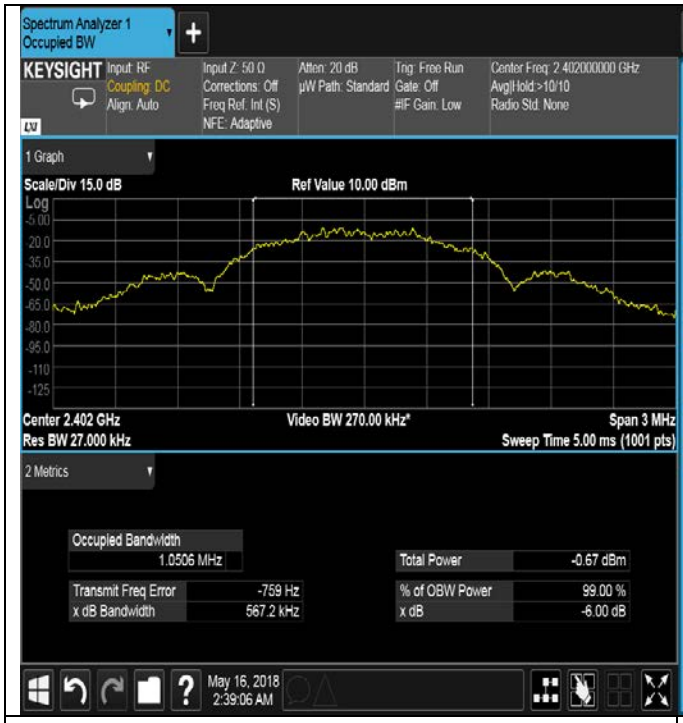
6dB Bandwidth measurement result

Type	Test mode	Freq (MHz)	CH	Result (MHz)	Limit (MHz)	Result
6dB BW	BT-LE	2402	Low	0.567	≥0.5	Pass
6dB BW	BT-LE	2440	Mid	0.599	≥0.5	Pass
6dB BW	BT-LE	2480	High	0.652	≥0.5	Pass

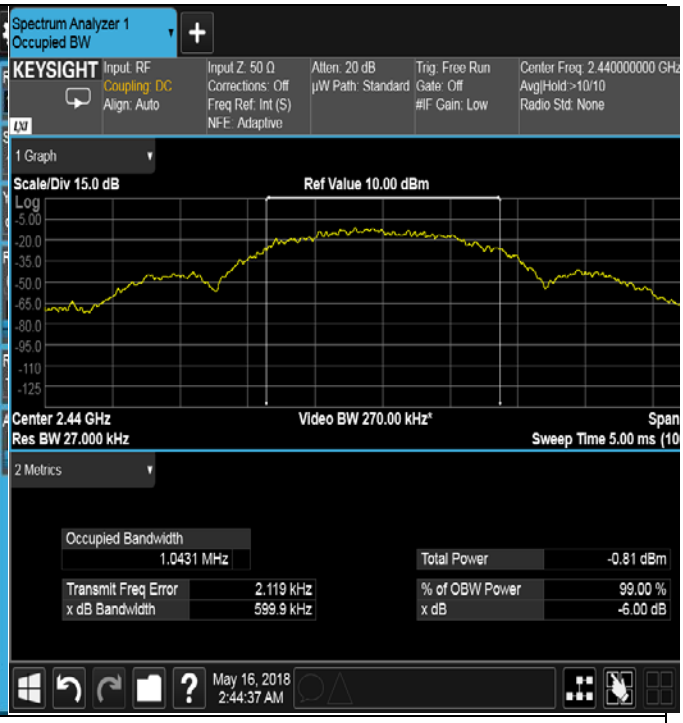
99% OBW measurement result

Type	Test mode	Freq (MHz)	CH	Result (MHz)
99% OBW	BT-LE	2402	Low	1.05
99% OBW	BT-LE	2440	Mid	1.04
99% OBW	BT-LE	2480	High	1.05

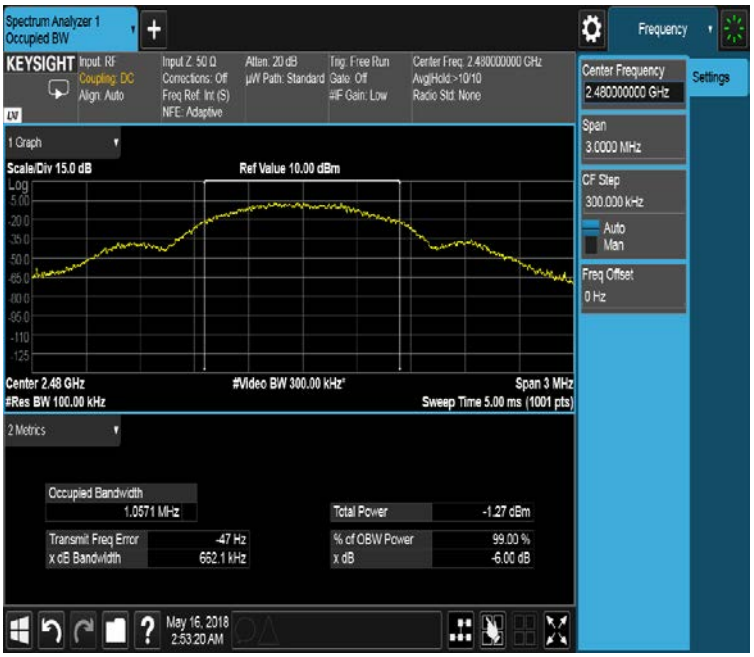
6dB Bandwidth Test Plots



6dB BW –Bluetooth LE 2402MHz



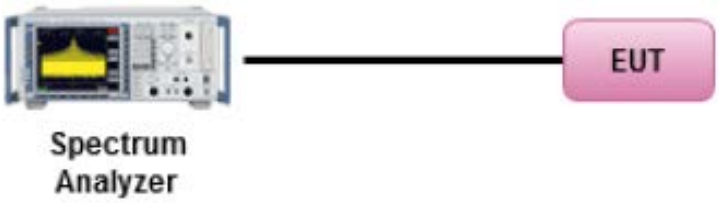
6dB BW –Bluetooth LE 2440MHz



6dB BW –Bluetooth LE 2480MHz

10.4 Output Power (Bluetooth LE)

Requirement(s):

Spec	Item	Requirement	Applicable
§ 15.247 RSS247 (5.4.4)	f)	DSSS in 902-928MHz, 2400-2483.5MHz, 5725-5850MHz: ≤1 Watt	☒
Test Setup			
Test Procedure	558074 D01 DTS Meas Guidance v04, 9.1.1 Measurement using a Spectrum Analyzer (SA) a) Set the span to 1.5 times the DTS bandwidth. b) Set RBW ≥ DTS bandwidth. c) Set VBW ≥ 3 x RBW. d) Sweep Time = auto couple. e) Detector = Peak. f) Trace Mode = max hold. g) Allow trace to fully stabilize. h) Use peak marker function to determine the peak amplitude level.		
Test Date	05/16/2018	Environmental condition	Temperature 23ºC Relative Humidity 44% Atmospheric Pressure 1021mbar
Remark	-		
Result	☒ Pass ☐ Fail		

Test Data ☒ Yes ☐ N/A

Test Plot ☐ Yes (See below) ☒ N/A

Test was done by Benjamin Jing at RF test site.

Output Power measurement result

Type	Test mode	Freq (MHz)	CH	Conducted Power (dBm)	Limit (dBm)	Result
Output power	Bluetooth LE	2402	Low	1.65	30	Pass
Output power	Bluetooth LE	2440	Mid	1.35	30	Pass
Output power	Bluetooth LE	2480	High	0.90	30	Pass

Test Plots

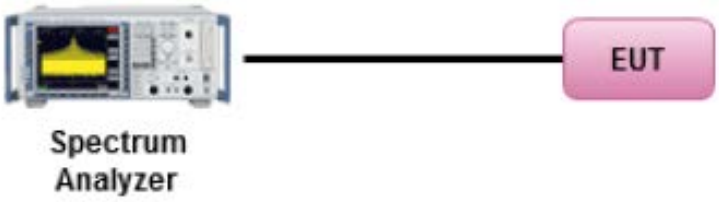
Output Power –Bluetooth LE 2402MHz

Output Power –Bluetooth LE 2440MHz

Output Power –Bluetooth LE 2480MHz

10.5 Band Edge

Requirement(s):

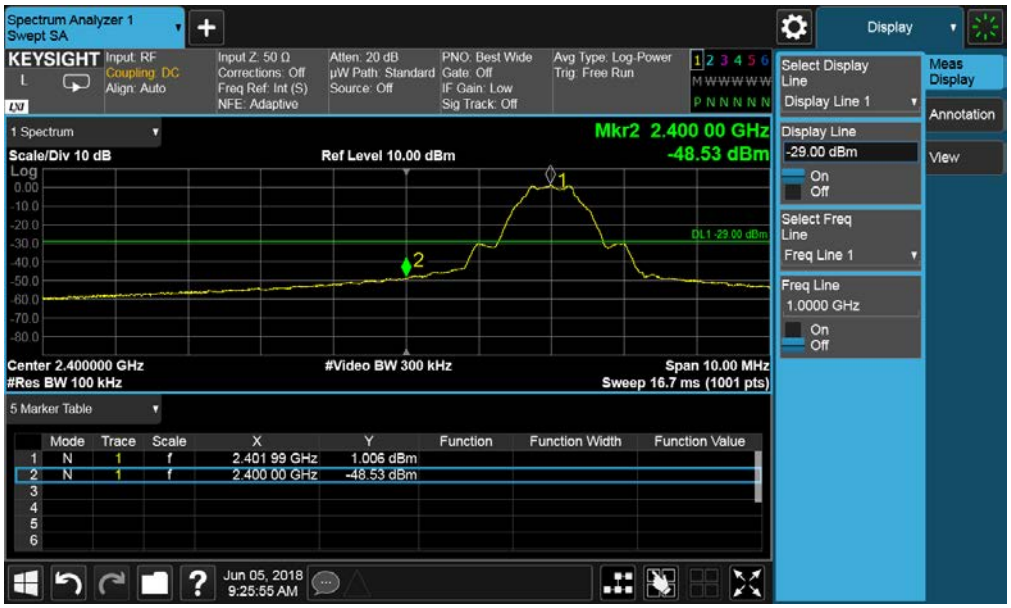
Spec	Item	Requirement	Applicable
§ 15.247 RSS247(5.5)	d)	For non-restricted band, In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be 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 ☐ 20 dB down ☒ 30 dB down	☒
Test Setup			
Test Procedure	558074 D01 DTS Meas Guidance v04 Band Edge measurement procedure 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 attunation shall be 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	06/05/2018	Environmental condition	Temperature 22ºC Relative Humidity 46% Atmospheric Pressure 1020mbar
Remark	-		
Result	☒ Pass ☐ Fail		

Test Data ☐ Yes ☒ N/A

Test Plot ☒ Yes (See below) ☐ N/A

Test was done by Benjamin Jing at RF test site.

Band Edge Test Plots (Bluetooth LE)



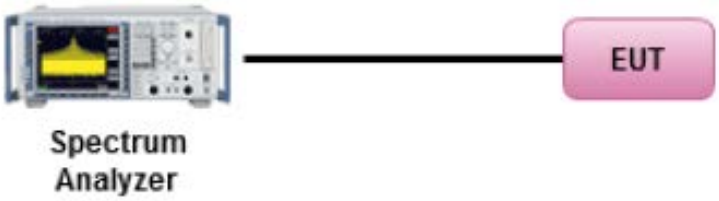
Band Edge-LE Low

Band Edge-LE High

10.6 Peak Spectral Density

Requirement(s):

Spec	Item	Requirement	Applicable
§ 15.247(e) RSS247(5.2.2)	1	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.	☒

Test Setup	
Test Procedure	558074 D01 DTS Meas Guidance v04, 10.2 Method PKPSD (peak PSD) Peak spectral density measurement procedure - Set analyzer center frequency to DTS channel center frequency. - Set the span to 1.5 times the DTS bandwidth. - Set the RBW to: 3 kHz ⩽ RBW ⩽ 100 kHz. - Set the VBW ⩾ 3 x RBW. - Detector = Peak - Sweep time = auto couple. - Trace mode = Max Hold - 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	05/16/2018	Environmental condition	Temperature Relative Humidity Atmospheric Pressure	22ºC 46% 1020mbar
Remark	-			
Result	☒ Pass ☐ Fail			

Test Data ☒ Yes ☐ N/A

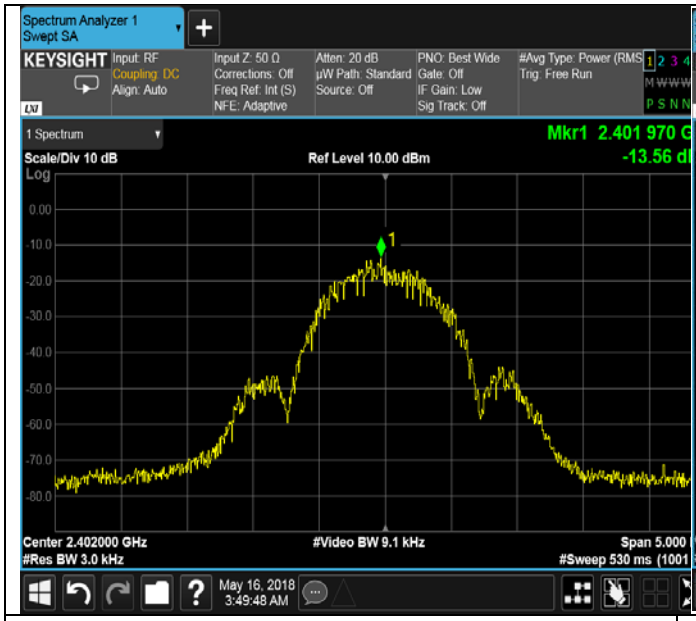
Test Plot ☒ Yes (See below) ☐ N/A

Test was done by Benjamin Jing at RF test site.

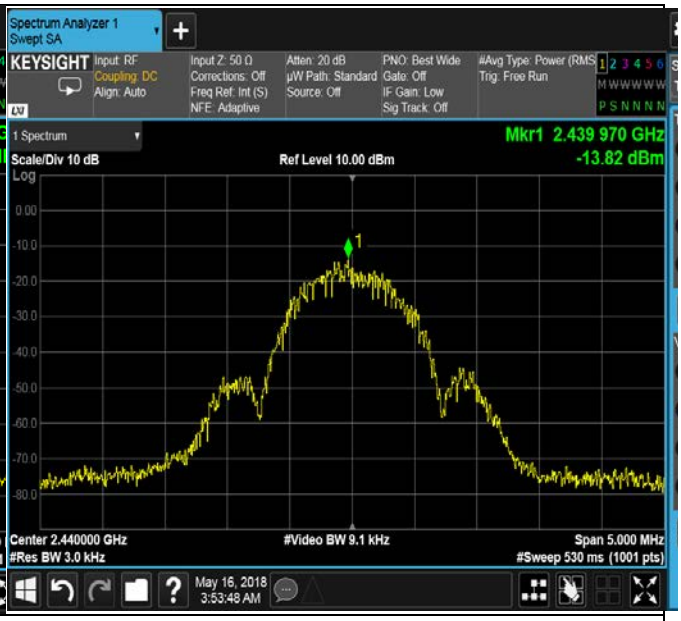
PSD measurement result (Bluetooth LE)

Type	Test mode	Freq (MHz)	CH	Conducted PSD (dBm/3KHz)	Limit (dBm/3KHz)	Result
PSD	Bluetooth LE	2402	Low	-13.5	≤8	Pass
PSD	Bluetooth LE	2440	Mid	-13.8	≤8	Pass
PSD	Bluetooth LE	2480	High	-14.3	≤8	Pass

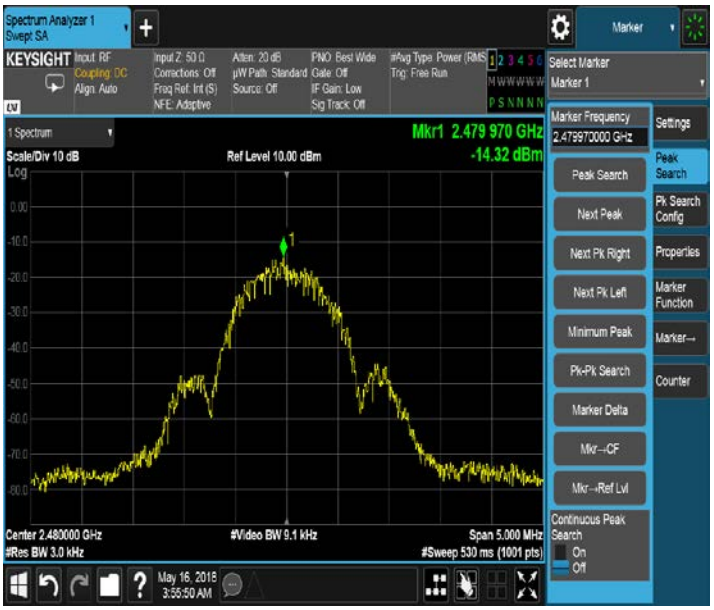
Test Plots (Bluetooth LE)



PSD -Bluetooth LE Low



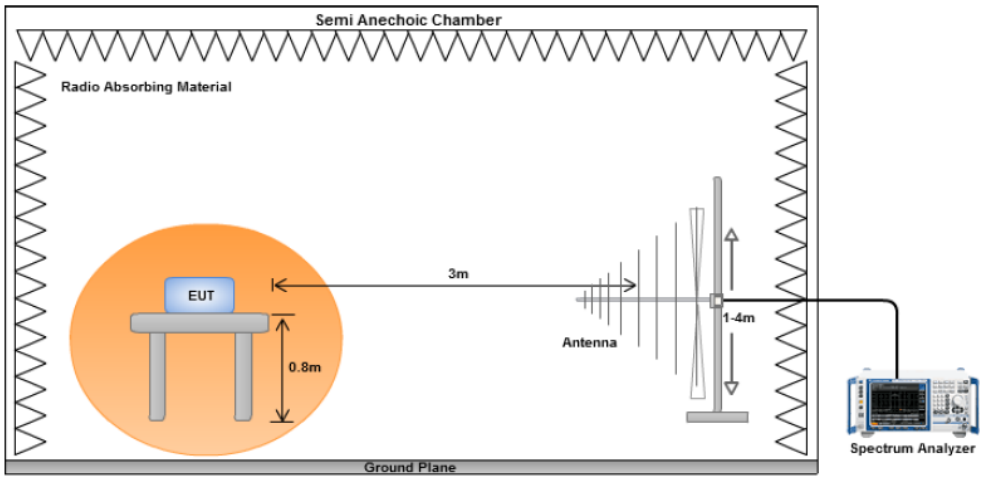
PSD -Bluetooth LE Mid



PSD -Bluetooth LE High

10.7 Radiated Spurious Emissions below 1GHz

Requirement(s):

<table>
<tr><th>Spec</th><th>Item</th><th>Requirement</th><th>Applicable</th></tr>
<tr><td>47CFR§15.247(d)
RSS247 (5.5)</td><td>a)</td><td>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
<table>
<tr><th>Frequency range (MHz)</th><th>Field Strength (uV/m)</th></tr>
<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>
</table></td><td>☒</td></tr>
<tr><td>Test Setup</td><td colspan="3"> 
</td></tr>
<tr><td>Procedure</td><td colspan="3">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:
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.</td></tr>
<tr><td>Remark</td><td colspan="3">The EUT was scanned up to 1GHz. Both horizontal and vertical polarities were investigated. The results show only the worst case.</td></tr>
<tr><td>Result</td><td colspan="3">☒ Pass ☐ Fail</td></tr>
</table>

Test Data ☒ Yes (See below) ☐ N/A

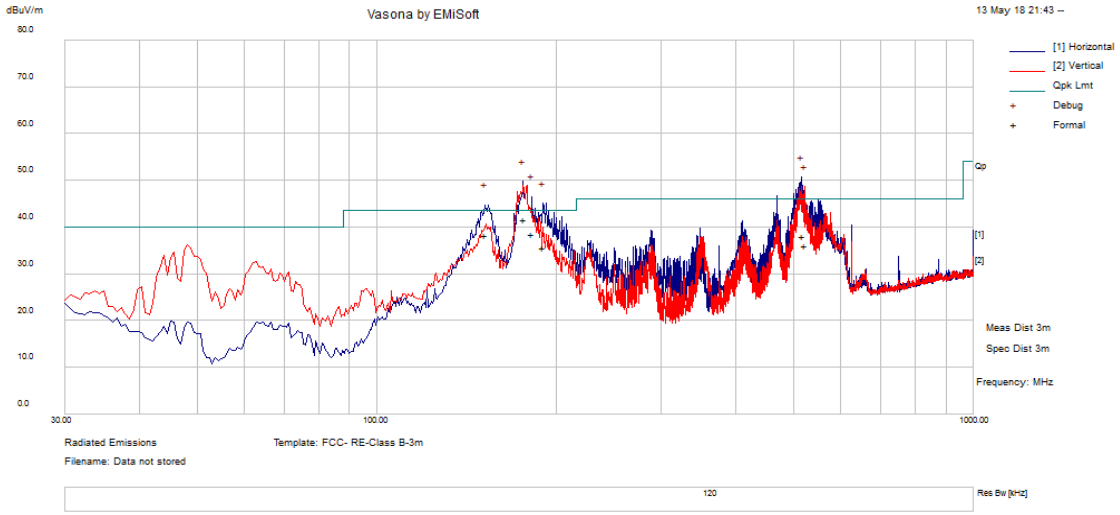
Test Plot ☒ Yes (See below) ☐ N/A

Test was done by Benjamin i at 10m chamber.

Radiated Emission Test Results (Below 1GHz)

Test specification	below 1GHz			
Environmental Conditions:	Temp (°C):	22	Result	Pass
	Humidity (%)	47.5		
	Atmospheric (mbar):	1020		
Mains Power:	120VAC, 60Hz			
Tested by:	Benjamin Jing			
Test Date:	05/16/2018			
Remarks:	Bluetooth LE 2440 MHz			

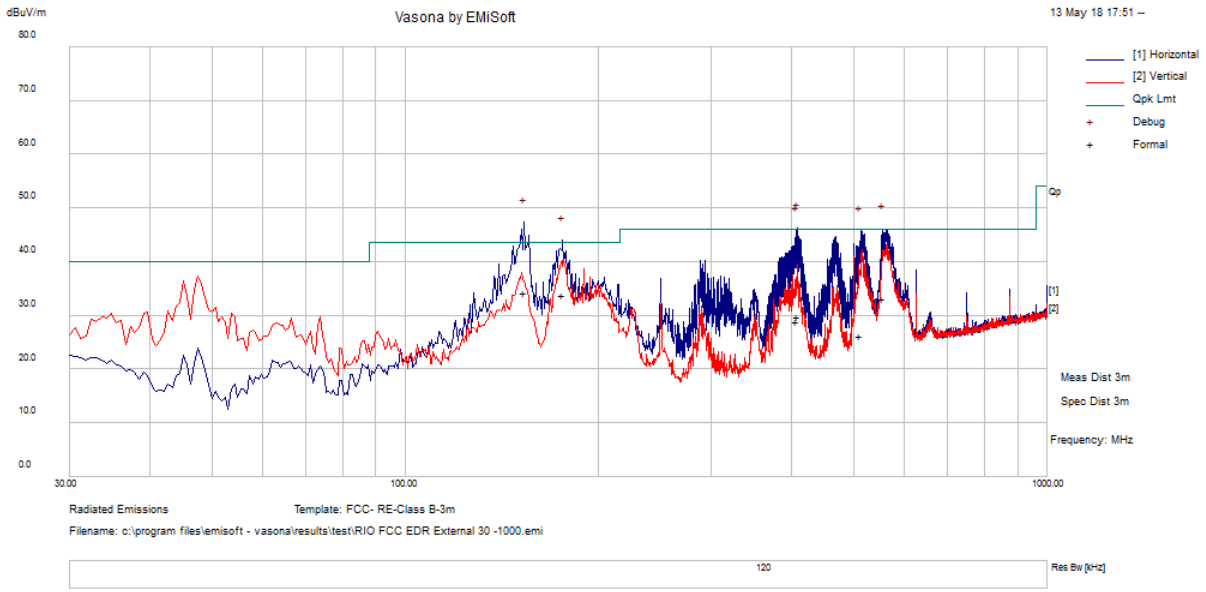
External Antenna



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
516.1216	40.98	14.34	-18.29	37.04	Quasi Max	H	198	156	46	-8.96	Pass
175.6222	51.55	12.4	-24.79	39.16	Quasi Max	V	143	29	43.5	-4.34	Pass
519.0197	40.1	14.37	-18.23	36.25	Quasi Max	H	182	112	46	-9.75	Pass
153.4781	48.33	12.21	-23.62	36.93	Quasi Max	H	133	85	43.5	-6.58	Pass
525.7934	40.61	14.44	-18.1	36.95	Quasi Max	H	192	141	46	-9.05	Pass
47.79344	49.01	11.43	-26.04	34.4	Quasi Max	V	112	261	40	-5.6	Pass

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

Embedded Antenna

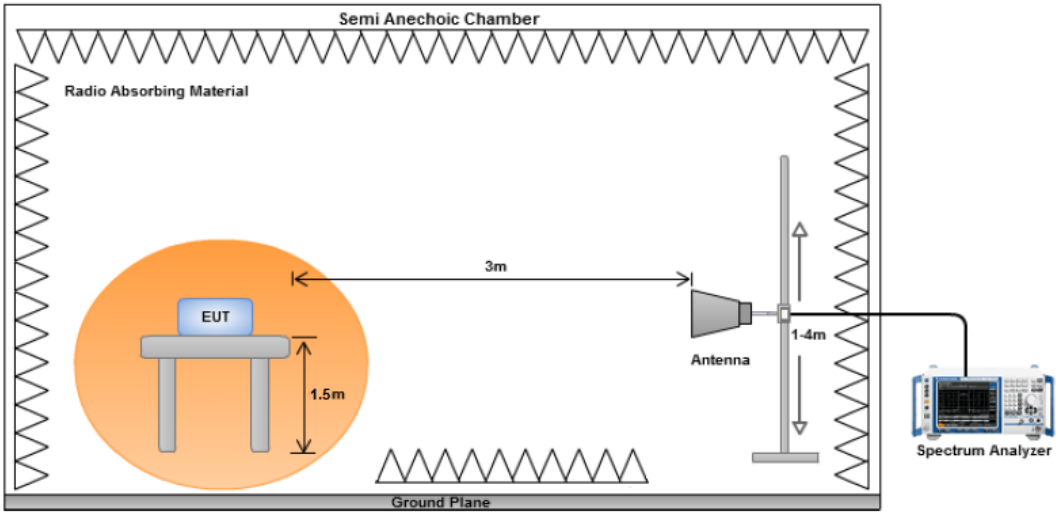


Frequency MHz	Raw dBuV	Cable Loss	AF dB	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass /Fail
511.9788	40.18	14.3	-18.4	36.08	Quasi Max	H	177	356	46	-9.92	Pass
510.0609	37.91	14.27	-18.46	33.72	Quasi Max	H	196	339	46	-12.29	Pass
514.3263	31.22	14.33	-18.32	27.22	Quasi Max	H	242	204	46	-18.78	Pass
153.5675	52.25	12.21	-23.62	40.85	Quasi Max	H	231	81	43.5	-2.65	Pass
508.5647	38.34	14.25	-18.48	34.11	Quasi Max	H	181	141	46	-11.89	Pass
518.1141	36.3	14.36	-18.25	32.42	Quasi Max	H	185	136	46	-13.58	Pass

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

10.8 Radiated Spurious Emissions between 1GHz – 25GHz

Requirement(s):

Spec	Item	Requirement	Applicable
47CFR§15.247(d), Rss247(a8.5)	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 ☐ 20 dB down ☒ 30 dB down	☒
	b)	or restricted band, emission must also comply with the radiated emission limits specified in 15.209	☒
Test Setup			
Procedure	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: 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	The EUT was scanned up to 26GHz. Both horizontal and vertical polarities were investigated. The results show only the worst case.		
Result	☒ Pass ☐ Fail		

Test Data ☒ Yes (See below) ☐ N/A

Test Plot ☐ Yes (See below) ☒ N/A

Test was done by Benjamin at 10m chamber.

Radiated Emission Test Results (Above 1GHz)
External Antenna

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
17787.63	38.86	8.1	8.28	55.24	Peak Max	V	159	48	74	-18.76	Pass
13211.2	37.35	6.98	4.73	49.06	Peak Max	V	130	142	74	-24.95	Pass
6140.579	38.6	4.74	-0.31	43.03	Peak Max	V	133	222	74	-30.97	Pass
3200.974	39.79	3.43	-1.51	41.71	Peak Max	V	100	340	74	-32.29	Pass
2008.797	40.93	2.74	-2.46	41.21	Peak Max	V	100	272	74	-32.79	Pass
2378.494	40.05	2.95	-3.64	39.37	Peak Max	V	161	217	74	-34.63	Pass

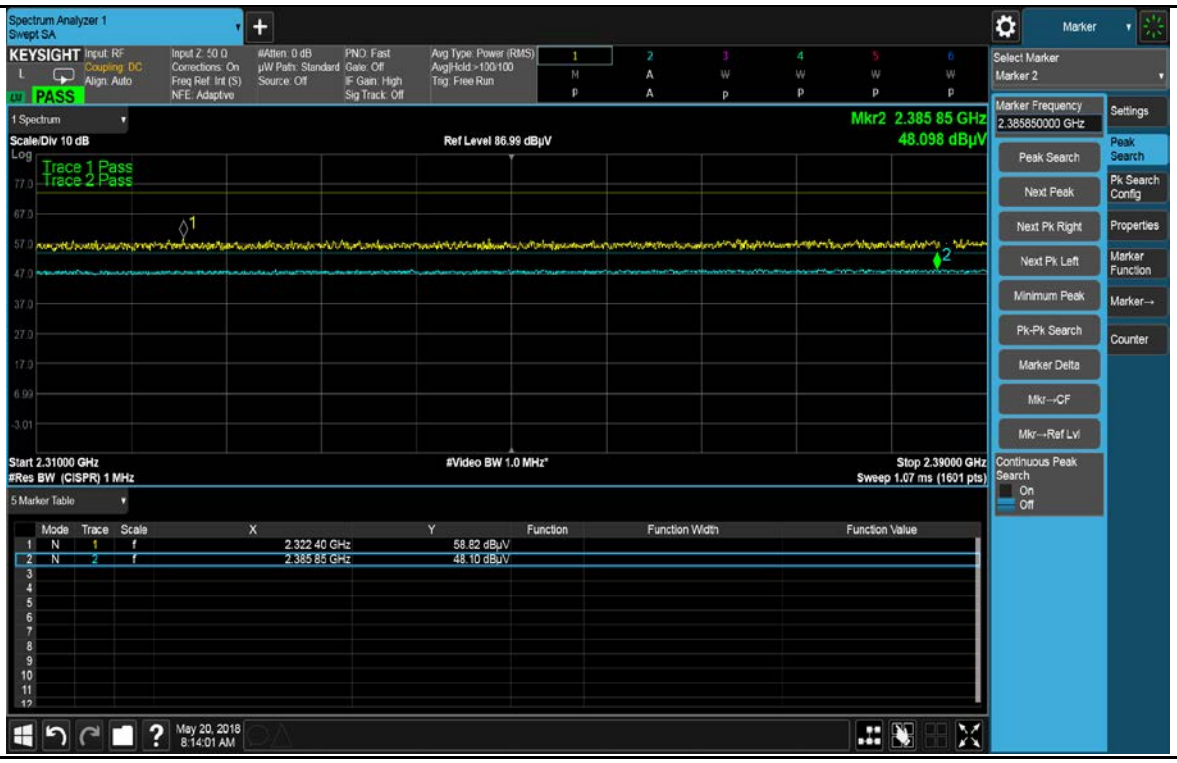
BLE – 2440MHz

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
17966.68	38.33	7.9	8.72	54.94	Peak Max	V	175	4	74	-19.06	Pass
12487.7	38.36	6.54	4.15	49.05	Peak Max	V	105	278	74	-24.96	Pass
2560.119	42.3	3.04	-3.31	42.03	Peak Max	V	193	91	74	-31.97	Pass
17966.68	26.63	7.9	8.72	43.25	Average Max	V	175	4	54	-10.75	Pass
12487.7	26.01	6.54	4.15	36.7	Average Max	V	105	278	54	-17.3	Pass
2560.119	29.23	3.04	-3.31	28.96	Average Max	V	193	91	54	-25.04	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
17913.3	38.68	7.96	8.66	55.3	Peak Max	V	122	118	74	-18.7	Pass
11838.07	38.26	6.31	3.08	47.66	Peak Max	V	216	86	74	-26.34	Pass
10171.72	38.94	5.93	1.4	46.28	Peak Max	V	278	356	74	-27.72	Pass
17913.3	26.66	7.96	8.66	43.28	Average Max	V	122	118	54	-10.72	Pass
11838.07	25.82	6.31	3.08	35.22	Average Max	V	216	86	54	-18.78	Pass
10171.72	26.7	5.93	1.4	34.04	Average Max	V	278	356	54	-19.97	Pass

Restricted Band Measurement Plots:



Restricted Band 2402MHz

Restricted Band 2480MHz

Embedded Antenna

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
17915.26	38.7	7.96	8.66	55.31	Peak Max	H	263	20	74	-18.69	Pass
9614.385	38.82	5.59	0.53	44.94	Peak Max	V	167	49	74	-29.06	Pass
2626.039	40.35	3.08	-3.05	40.38	Peak Max	V	274	257	74	-33.62	Pass
17915.26	26.61	7.96	8.66	43.23	Average Max	H	263	20	54	-10.77	Pass
9614.385	26.44	5.59	0.53	32.56	Average Max	V	167	49	54	-21.44	Pass
2626.039	27.9	3.08	-3.05	27.93	Average Max	V	274	257	54	-26.07	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
17913.3	38.68	7.96	8.66	55.3	Peak Max	V	122	118	74	-18.7	Pass
11838.07	38.26	6.31	3.08	47.66	Peak Max	V	216	86	74	-26.34	Pass
10171.72	38.94	5.93	1.4	46.28	Peak Max	V	278	356	74	-27.72	Pass
17913.3	26.66	7.96	8.66	43.28	Average Max	V	122	118	54	-10.72	Pass
11838.07	25.82	6.31	3.08	35.22	Average Max	V	216	86	54	-18.78	Pass
10171.72	26.7	5.93	1.4	34.04	Average Max	V	278	356	54	-19.97	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
17787.63	38.86	8.1	8.28	55.24	Peak Max	V	159	48	74	-18.76	Pass
13211.2	37.35	6.98	4.73	49.06	Peak Max	V	130	142	74	-24.95	Pass
6140.579	38.6	4.74	-0.31	43.03	Peak Max	V	133	222	74	-30.97	Pass
3200.974	39.79	3.43	-1.51	41.71	Peak Max	V	100	340	74	-32.29	Pass
2008.797	40.93	2.74	-2.46	41.21	Peak Max	V	100	272	74	-32.79	Pass
2378.494	40.05	2.95	-3.64	39.37	Peak Max	V	161	217	74	-34.63	Pass

Restricted Band Measurement Plots:

Restricted Band 2402MHz

Restricted Band 2480MHz

Annex A. TEST INSTRUMENT

Instrument	Model	Serial #	Cal Date	Cal Cycle	Cal Due	In use
Conducted Emissions						
EMI Test Receiver	ESIB 40	100179	04/21/2018	1 Year	04/21/2019	☑
Transient Limiter (9kHz - 100MHz)	EM-7600-5	106	09/07/2017	1 Year	09/07/2018	☑
LISN (9kHz - 30MHz)	3816/2NM	214372	09/27/2017	1 Year	09/27/2018	☑
Radiated Emissions						
Keysight EXA 44GHz Spectrum Analyzer	N9010A	MY51440112	11/02/2017	1 Year	11/02/2018	☑
Bi-Log antenna (30MHz~2GHz)	JB1	A030702	01/13/2018	1 Year	01/13/2019	☑
Horn Antenna (1GHz~26GHz)	3115	100059	08/11/2017	1 Year	08/11/2018	☑
Pre-Amplifier (1-40GHz)	SAS-474	579	05/01/2018	1 Year	05/01/2019	☑
Preamplifier (100KHz-7GHz)	LPA-6-30	11140711	02/09/2018	1 Year	02/09/2019	☑
3 Meters SAC	3M	N/A	09/09/2017	1 Year	09/09/2018	☐
10 Meters SAC	10M	N/A	10/06/2017	1 Year	10/06/2018	☑
RF Conducted Measurement						
Spectrum Analyzer	N9010A	10SL0219	11/16/2017	1 Year	11/16/2018	☑

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 & Telecommunications Terminal Equipment: EN45001 – EN ISO/IEC 17025
		Electromagnetic Compatibility: EN45001 – EN ISO/IEC 17025
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
		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
		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
Taiwan NCC CAB Recognition		LP0002, PSTN01, ADSL01, ID0002, IS6100, CNS14336, PLMN07, PLMN01, PLMN08
Taiwan BSMI CAB Recognition		CNS 13438
Japan VCCI		R-3083: Radiation 3 meter site C-3421: Main Ports Conducted Interference Measurement T-1597: Telecommunication Ports Conducted Interference Measurement
Australia CAB Recognition		EMC: AS/NZS CISPR 11, AS/NZS CISPR 14.1, AS/NZS CISPR22, AS/NZS 61000.6.3, AS/NZS 61000.6.4
		Radio communications: 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
Australia NATA Recognition		AS/ACIF S002, AS/ACIF S003, AS/ACIF S004, AS/ACIF S006, AS/ACIF S016,AS/ACIF S031, AS/ACIF S038, AS/ACIF S040, AS/ACIF S041, AS/ACIF S043.2