

RF TEST REPORT



Report No.: FCC IC_SL17060501-ZBR-021-BLE_Rev2.0

Supersede Report No.:

Applicant	:	Zebra Technologies Corporation
Host Product Name	:	Mobile Thermal Printer
Module Model No.	:	ZQ3BT
Host Model No.	:	ZQ310 and ZQ320
Test Standard	:	47 CFR 15.247 RSS 247 Iss 1: May 2015
Test Method	:	ANSI C63.10: 2013 RSS Gen Iss 4: Nov 2014 558074 D01 DTS Meas Guidance v04
FCC ID	:	I28-ZBRZQ3BT
IC ID	:	3798B- ZBRZQ3BT
Dates of test	:	07/22/2017 – 08/16/2017
Issue Date	:	08/18/2017
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:

	
Rachana Khanduri	Chen Ge
Test Engineer	Engineer Reviewer

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



775 Montague Expressway, Milpitas, CA 95035, USA • Phone: (+1) 408 526 1188 • Facsimile (+1) 408 526 1088

Visit us at: www.siemic.com; Follow us at:



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

CONTENTS

1	REPORT REVISION HISTORY	4
2	EXECUTIVE SUMMARY	5
3	CUSTOMER INFORMATION	5
4	TEST SITE INFORMATION	5
5	MODIFICATION	5
6	EUT INFORMATION	6
6.1	EUT Description	6
6.2	Spec for BT Radio	6
6.3	EUT test modes/configuration Description.....	6
6.4	EUT Photos - External	7
6.5	EUT Photos - Internal	9
6.6	EUT Test Setup Photos	11
7	SUPPORTING EQUIPMENT/SOFTWARE AND CABLING DESCRIPTION.....	13
7.1	Supporting Equipment	13
7.2	Cabling Description	13
7.3	Test Software Description	13
8	TEST SUMMARY	14
9	MEASUREMENT UNCERTAINTY	15
9.1	Conducted Emissions	15
9.2	Radiated Emissions (30MHz to 1GHz).....	15
9.3	Radiated Emissions (1GHz to 40GHz).....	16
9.4	RF conducted measurement.....	16
10	MEASUREMENTS, EXAMINATION AND DERIVED RESULTS	17
10.1	Conducted Emissions.....	17
10.2	6dB & 99% Bandwidth	20
10.3	Output Power (Bluetooth LE).....	23
10.4	Band Edge	26
10.5	Peak Spectral Density	28
10.6	Radiated Spurious Emissions below 1GHz	31
10.7	Radiated Spurious Emissions between 1GHz – 25GHz	33
ANNEX A. TEST INSTRUMENT		36
ANNEX B. SIEMIC ACCREDITATION		37

1 Report Revision History

Report No.	Report Version	Description	Issue Date
FCC_IC_SL17060501-ZBR-021-BLE	None	Original	08/08/2017
FCC_IC_SL17060501-ZBR-021-BLE_Rev1.0	1.0	Update Radiated Emissions data	08/16/2017
FCC_IC_SL17060501-ZBR-021-BLE_Rev2.0	2.0	Update Radiated Emissions data	08/18/2017

2 Executive Summary

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

Company: Zebra Technologies Corporation
Host Product: Mobile Thermal Printer
Host Model No.: ZQ310 and ZQ320
Module Model No.: ZBRZQ3BT

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	Zebra Technologies Corp.
Applicant Address	3 Overlook Point, Lincolnshire, IL 60069
Manufacturer Name	Zebra Technologies Corp.
Manufacturer Address	3 Overlook Point, Lincolnshire, IL 60069

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

Host Product Name	Mobile Thermal Printer
Host Model No.	ZQ310 and ZQ320
Module Model No.	ZQ3BT
Trade Name	Zebra
Serial No.	N/A
Input Power	100-240VAC,50/60 Hz
Power Adapter Manu/Model	N/A
Power Adapter SN	N/A
Hardware version	N/A
Software version	N/A
Date of EUT received	07/28/2017
Equipment Class/ Category	DTS
Port/Connectors	USB
Remark	NONE

6.2 Spec for BT Radio

Radio Type	Bluetooth
Operating Frequency	2402MHz-2480MHz
Modulation	GFSK (LE)
Channel Spacing	2MHz (LE)
Antenna Type	Chip
Antenna Gain	1.69 dBi
Antenna Connector Type	-

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)

6.4 EUT Photos - External



EUT -Top View



EUT -Bottom View with battery



EUT -Bottom View without battery



EUT- Front View



EUT - Rear View



EUT - Left Side View



EUT – Right Side View



EUT - Battery View

6.5 EUT Photos - Internal



PCBA Open Case View 1



PCBA Open Case View 2



EUT PCBA Close-Up View



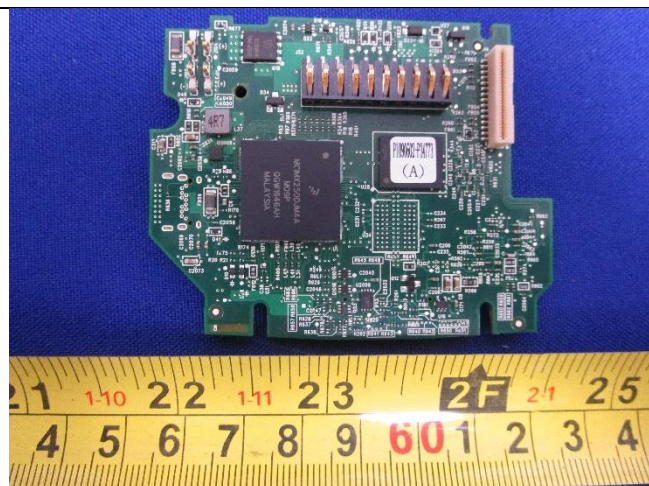
PCBA - Top View



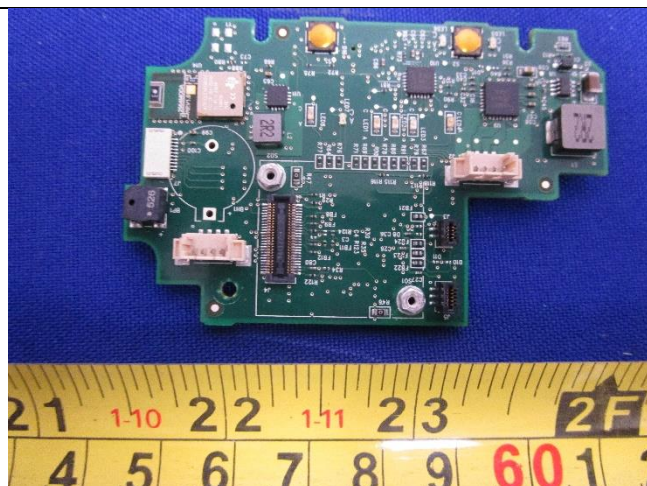
PCBA A and B Top View



PCBA A- Top View



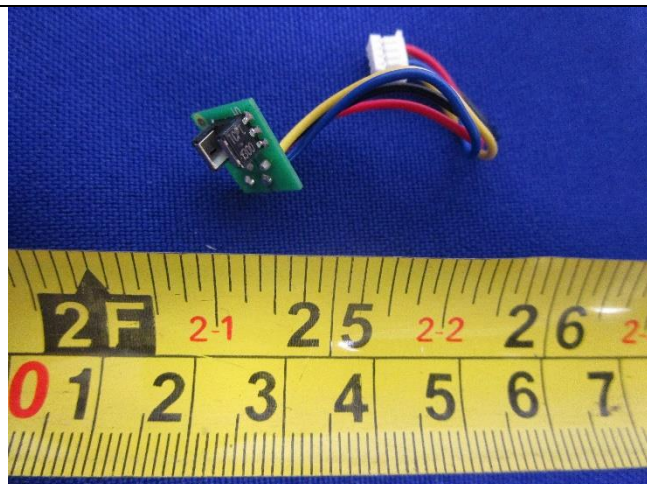
PCBA A – Bottom View



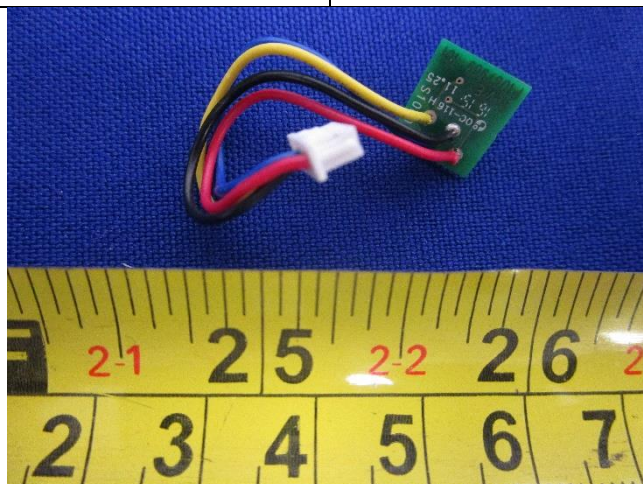
Main PCBA -Top View



Main PCBA- Bottom View

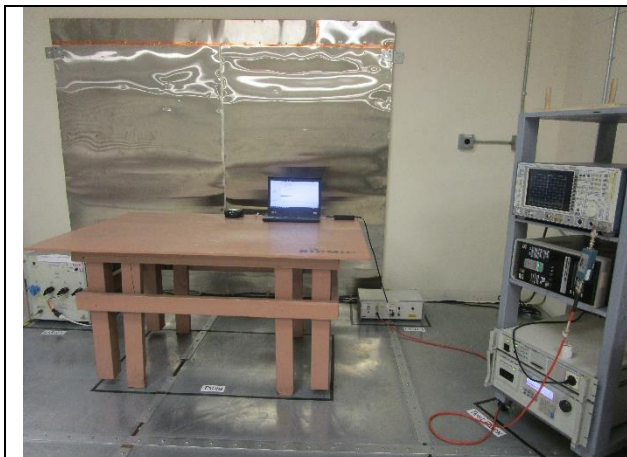


PCBA B – Top View

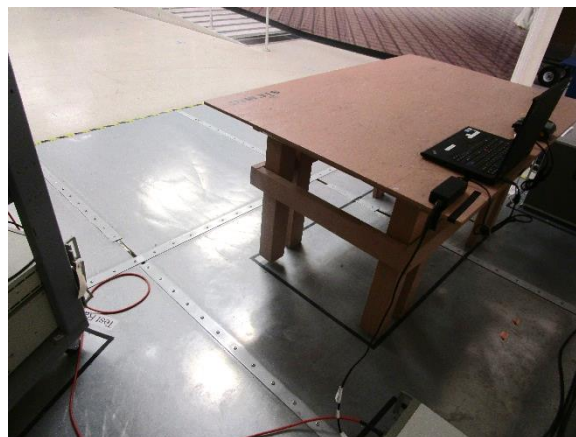


PCBA B – Bottom View

6.6 EUT Test Setup Photos



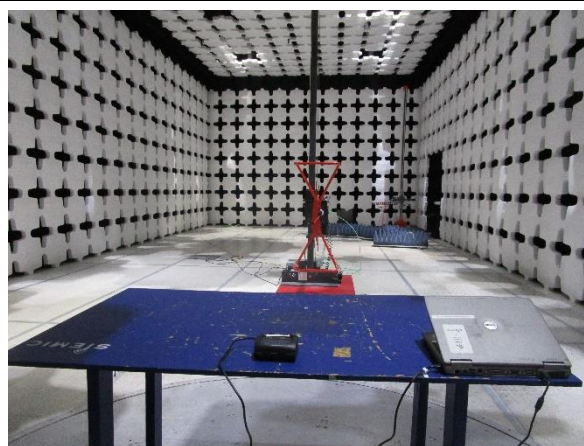
AC Line Conducted Emissions – Front View



AC Line Conducted Emissions – Rear View



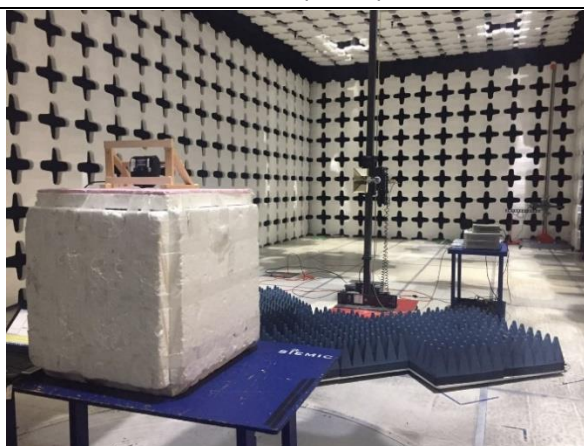
Radiated Emissions (<1GHz) – Front View



Radiated Emissions (<1GHz) – Rear View



Radiated Emissions (>1GHz) – Front View (EUT vertical)



Radiated Emissions (>1GHz) – Rear View (EUT vertical)



Radiated Emissions (>1GHz) – Front View (EUT horizontal)



Radiated Emissions (>1GHz) – Rear View(EUT horizontal)

7 Supporting Equipment/Software and cabling Description

7.1 Supporting Equipment

Item	Supporting Equipment Description	Model	Serial Number	Manufacturer	Note
1	Laptop	ThinkPad T420s	N/A	Lenovo	-

7.2 Cabling Description

Name	Connection Start		Connection Stop		Length / shielding Info		Note
	From	I/O Port	To	I/O Port	Length (m)	Shielding	
USB	USB	EUT	USB	Laptop	USB	2	Unshielded

7.3 Test Software Description

Test Item	Software	Description
RF Testing	Zebra Toolbox	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
	IC	RSS Gen 8.10	IC		☐ N/A
AC Conducted Emissions	FCC	15.207(a)	FCC	ANSI C63.10:2013	☒ Pass
	IC	RSS Gen 8.8	IC	RSS Gen Issue 4: 2014	☐ N/A

DTS Band Requirement

Test Item	Test standard		Test Method/Procedure		Pass / Fail
99% Occupied Bandwidth	-	-	-	-	☒ Pass
	IC	RSS Gen 6.6	IC	RSS Gen Issue 4: 2014 -	☐ N/A
6dB Bandwidth	FCC	15.247(a)(2)	FCC	558074 D01 DTS Meas Guidance v04	☒ Pass
	IC	RSS247 (5.2.1)	IC		☐ N/A
Band Edge and Radiated Spurious Emissions	FCC	15.247(d)	FCC	ANSI C63.10:2013 558074 D01 DTS Meas Guidance v04	☒ Pass
	IC	RSS247 (5.5)	IC		☐ N/A
Output Power	FCC	15.247(b)	FCC	558074 D01 DTS Meas Guidance v04	☒ Pass
	IC	RSS247 (5.4.4)	IC		☐ N/A
Receiver Spurious Emissions	IC	RSS Gen (4.8)	IC	RSS Gen Issue 4: 2014	☐ Pass ☒ N/A
Antenna Gain > 6 dBi	FCC	15.247(e)	FCC	-	☐ Pass
	IC	-	IC	-	☒ N/A
Power Spectral Density	FCC	15.247(e)	FCC	558074 D01 DTS Meas Guidance v04	☒ Pass
	IC	RSS247 (5.2.2)	IC		☐ N/A
RF Exposure requirement	FCC	15.247(i)	FCC	-	☐ Pass
	IC	RSS Gen(5.5)	IC	RSS Gen Issue 4: 2014	☒ N/A
Remark	- All measurement uncertainties do not take into consideration for all presented test results. - 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

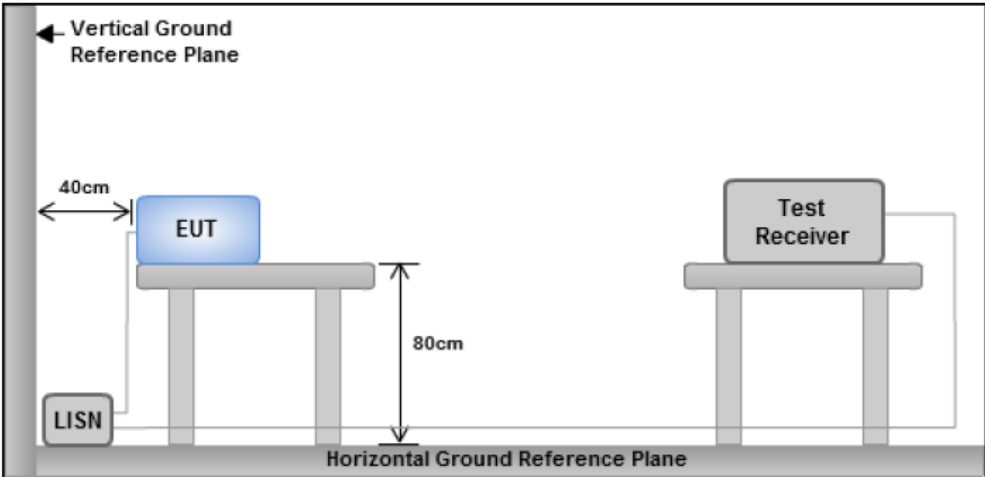
The total derived measurement uncertainty is +/- 0.95 dB.

10 Measurements, Examination and Derived Results

10.1 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.	☒
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		

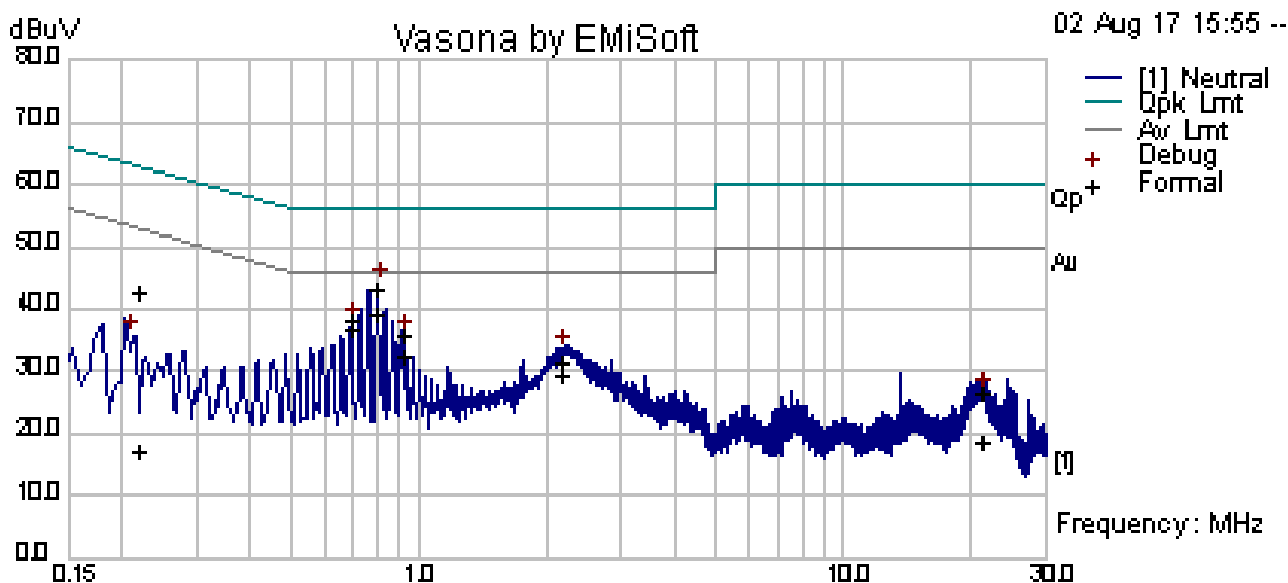
Test Data ☒ Yes ☐ N/A

Test Plot ☒ Yes (See below) ☐ N/A

Test was done by Rachana Khanduri 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:	Rachana Khanduri			
Test Date:	08/02/2017			
Remarks	Conducted @ Neutral			

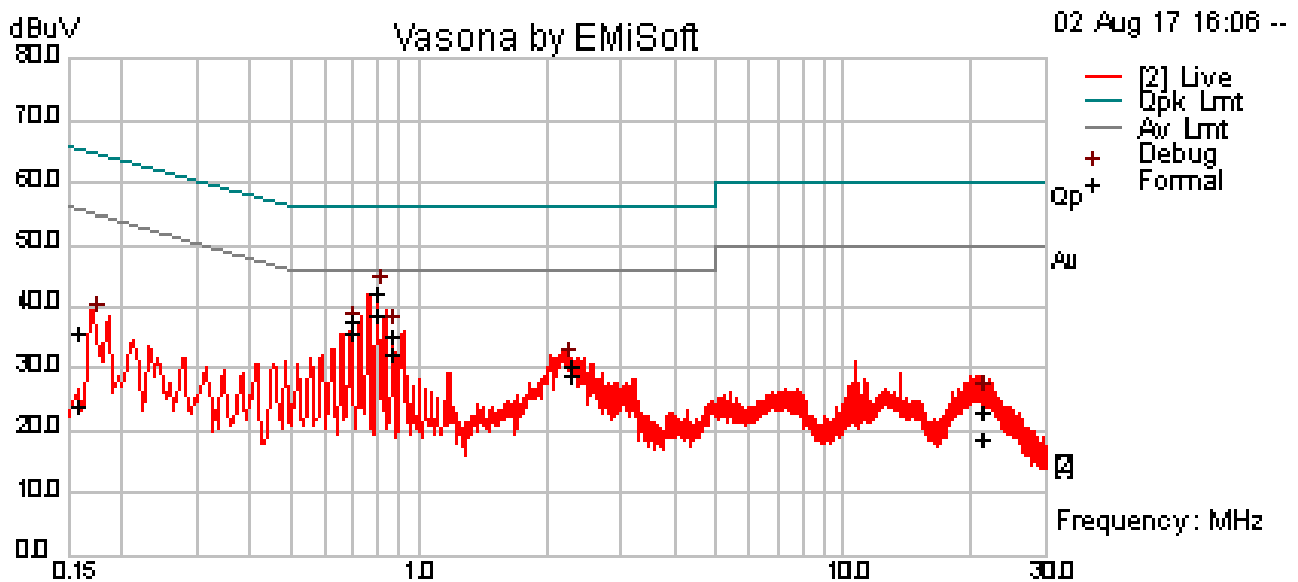


Neutral Plot at 120Vac, 60Hz

Frequency (MHz)	Raw (dBuV)	Cable Loss (dB)	Factors (dB)	Level (dBuV)	Measurement Type	Line / Neutral	Limit (dBuV)	Margin (dB)	Pass /Fail
0.80	32.50	10.01	0.55	43.06	Quasi Peak	Neutral	56.00	-12.94	Pass
0.69	26.03	10.01	0.56	36.61	Quasi Peak	Neutral	56.00	-19.39	Pass
0.92	25.49	10.01	0.53	36.04	Quasi Peak	Neutral	56.00	-19.96	Pass
2.17	21.06	10.02	0.50	31.58	Quasi Peak	Neutral	56.00	-24.42	Pass
0.22	31.29	10.00	1.15	42.44	Quasi Peak	Neutral	62.87	-20.43	Pass
21.27	15.85	10.07	0.68	26.60	Quasi Peak	Neutral	60.00	-33.40	Pass
0.80	28.76	10.01	0.55	39.32	Average	Neutral	46.00	-6.68	Pass
0.69	27.66	10.01	0.56	38.23	Average	Neutral	46.00	-7.77	Pass
0.92	21.70	10.01	0.53	32.24	Average	Neutral	46.00	-13.76	Pass
2.17	18.71	10.02	0.50	29.23	Average	Neutral	46.00	-16.77	Pass
0.22	5.83	10.00	1.15	16.98	Average	Neutral	52.87	-35.89	Pass
21.27	8.03	10.07	0.68	18.79	Average	Neutral	50.00	-31.21	Pass

Conducted Emission Test Results

Test specification:	Conducted Emissions			
Environmental Conditions:	Temp(°C):	22	Result:	☒ Pass ☐ Fail
	Humidity (%):	45		
	Atmospheric(mbar):	1021		
Mains Power:	120Vac, 60Hz			
Tested by:	Rachana Khanduri			
Test Date:	08/02/2017			
Remarks	Conducted @ Live			



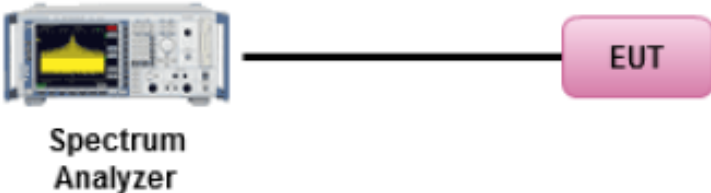
Live Plot at 120Vac, 60Hz

Frequency (MHz)	Raw (dBuV)	Cable Loss (dB)	Factors (dB)	Level (dBuV)	Measurement Type	Line / Neutral	Limit (dBuV)	Margin (dB)	Pass /Fail
0.80	31.80	10.01	0.55	42.36	Quasi Peak	Live	56.00	-13.64	Pass
0.69	25.47	10.01	0.56	36.04	Quasi Peak	Live	56.00	-19.96	Pass
0.87	24.89	10.01	0.54	35.44	Quasi Peak	Live	56.00	-20.56	Pass
2.27	18.44	10.02	0.50	28.96	Quasi Peak	Live	56.00	-27.04	Pass
0.16	24.34	10.00	1.64	35.98	Quasi Peak	Live	65.57	-29.59	Pass
21.09	12.36	10.07	0.68	23.11	Quasi Peak	Live	60.00	-36.89	Pass
0.80	28.10	10.01	0.55	38.66	Average	Live	46.00	-7.34	Pass
0.69	27.13	10.01	0.56	37.70	Average	Live	46.00	-8.30	Pass
0.87	21.76	10.01	0.54	32.31	Average	Live	46.00	-13.69	Pass
2.27	19.66	10.02	0.50	30.18	Average	Live	46.00	-15.82	Pass
0.16	12.57	10.00	1.64	24.21	Average	Live	55.57	-31.36	Pass
21.09	8.03	10.07	0.68	18.78	Average	Live	50.00	-31.22	Pass

Note: The results above show only the worst case.

10.2 6dB & 99% Bandwidth

Requirement(s):

Spec	Requirement	Applicable
§ 15.247 RSS247 (5.2.1)	6dB BW≥500KHz;	☒
RSS Gen 4.6.1	The transmitter shall be operated at its maximum carrier power measured under normal test conditions. The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts. The resolution bandwidth shall be set to as close to 1% of the selected span as is possible without being below 1%. The video bandwidth shall be set to 3 times the resolution bandwidth. Video averaging is not permitted. Where practical, a sampling detector shall be used given that a peak or peak hold may produce a wider bandwidth than actual. The trace data points are recovered and directly summed in linear terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points. This frequency is recorded. The span between the two recorded frequencies is the occupied bandwidth	☒
Test Setup		
Test Procedure	558074 D01 DTS Meas Guidance v04, 8.1 DTS bandwidth <u>6dB Emission bandwidth measurement procedure</u> - 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	08/02/2017	Environmental condition Temperature 23°C 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 Rachana Khanduri at RF test site.

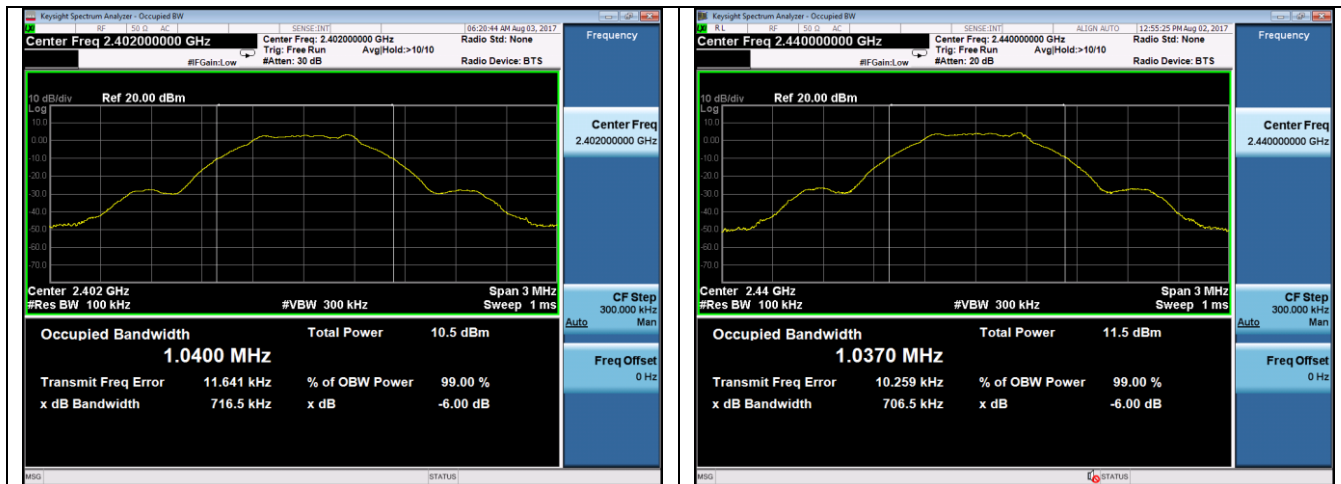
6dB Bandwidth measurement result

Type	Test mode	Freq (MHz)	CH	Result (MHz)	Limit (MHz)	Result
6dB BW	BT-LE	2402	Low	0.717	≥0.5	Pass
6dB BW	BT-LE	2440	Mid	0.707	≥0.5	Pass
6dB BW	BT-LE	2480	High	0.716	≥0.5	Pass

99% OBW measurement result for 2.4GHz

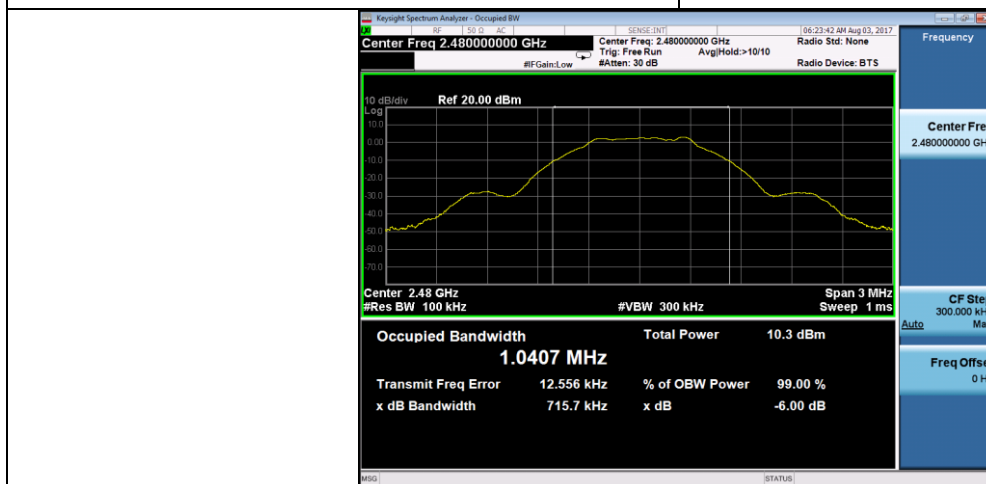
Type	Test mode	Freq (MHz)	CH	Result (MHz)
99% OBW	BT-LE	2402	Low	1.04
99% OBW	BT-LE	2440	Mid	1.04
99% OBW	BT-LE	2480	High	1.04

6dB & 99% Bandwidth Test Plots



6dB BW –Bluetooth LE 2402MHz

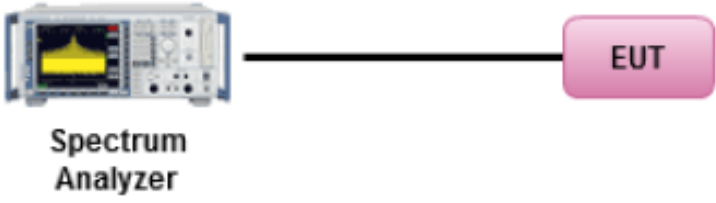
6dB BW –Bluetooth LE 2440MHz



6dB BW –Bluetooth LE 2480MHz

10.3 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	 Spectrum Analyzer EUT		
Test Procedure	558074 D01 DTS Meas Guidance v04, 9.1.1 <u>Measurement using a Spectrum Analyzer (SA)</u> - Set the span to 1.5 times the DTS bandwidth. - Set RBW ≥ DTS bandwidth. - Set VBW ≥ 3 x RBW. - Sweep Time = auto couple. - Detector = Peak. - Trace Mode = max hold. - Allow trace to fully stabilize. - Use peak marker function to determine the peak amplitude level.		
Test Date	07/22/2017	Environmental condition	Temperature 23°C Relative Humidity 44% Atmospheric Pressure 1021mbar
Remark	-		
Result	☒ Pass ☐ Fail		

Test Data ☒ Yes ☐ N/A

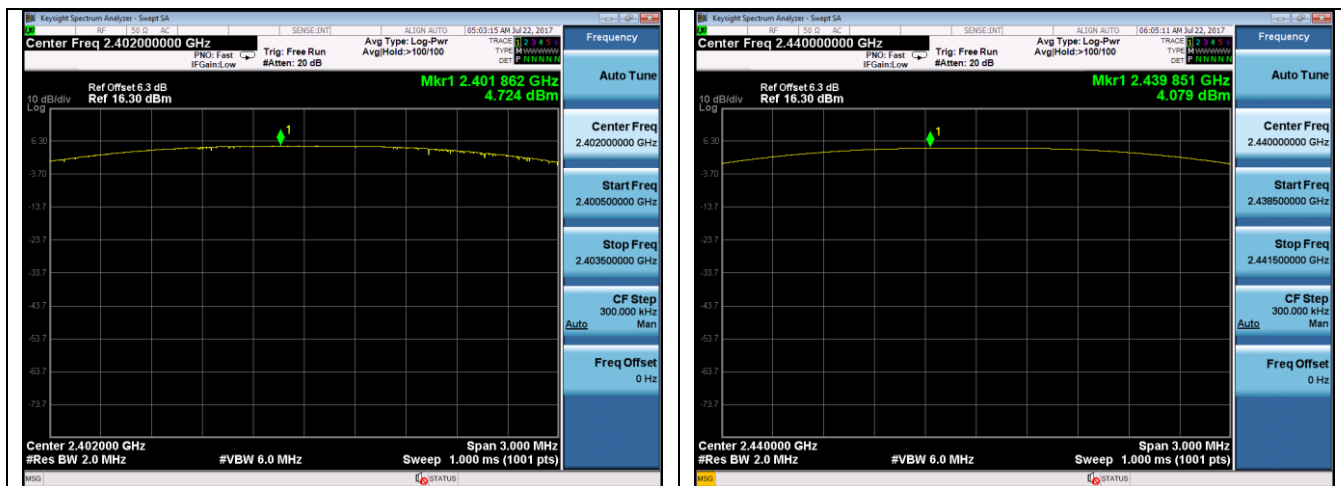
Test Plot ☐ Yes (See below) ☒ N/A

Test was done by Rachana Khanduri at RF test site.

Output Power measurement result

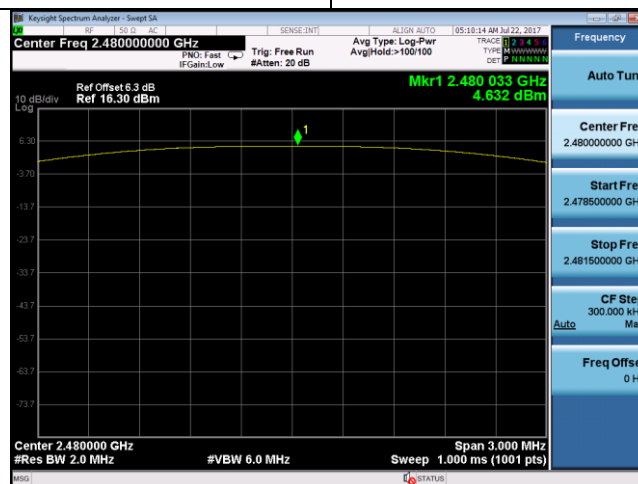
Type	Test mode	Freq (MHz)	CH	Conducted Power (dBm)	Limit (dBm)	Result
Output power	Bluetooth LE	2402	Low	4.72	30	Pass
Output power	Bluetooth LE	2440	Mid	4.08	30	Pass
Output power	Bluetooth LE	2480	High	4.63	30	Pass

Test Plots



Output Power –Bluetooth LE 2402MHz

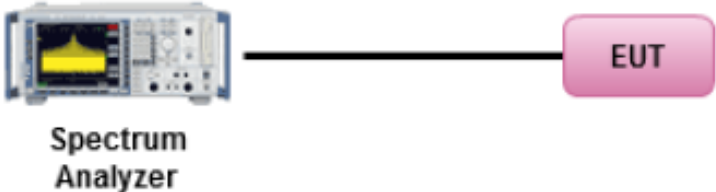
Output Power –Bluetooth LE 2440MHz



Output Power –Bluetooth LE 2480MHz

10.4 Band Edge

Requirement(s):

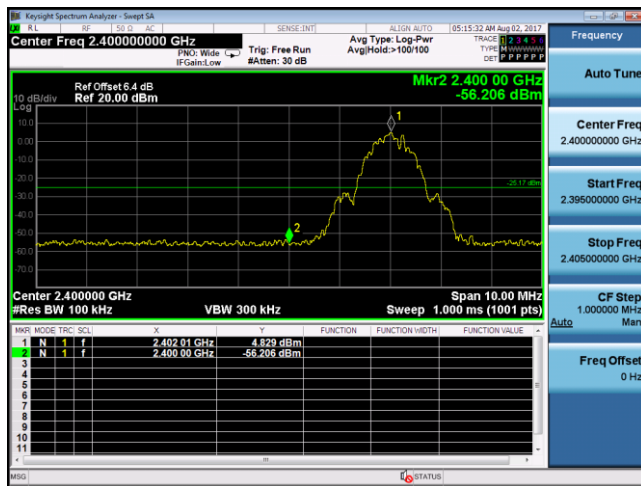
Spec	Item	Requirement	Applicable
§ 15.247 RSS247(5.5)	d)	For non-restricted band, In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be 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 <u>Band Edge measurement procedure</u> 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	08/02/2017	Environmental condition	Temperature 22°C Relative Humidity 46% Atmospheric Pressure 1020mbar
Remark	-		
Result	☒ Pass ☐ Fail		

Test Data ☐ Yes ☒ N/A

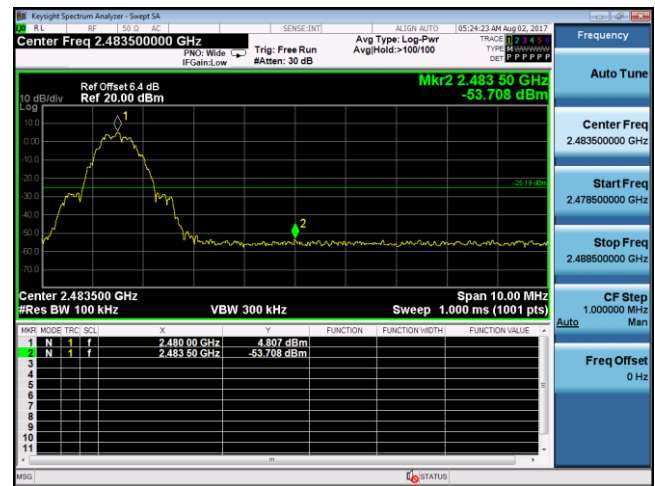
Test Plot ☒ Yes (See below) ☐ N/A

Test was done by Rachana Khanduri at RF test site.

Band Edge Test Plots (Bluetooth LE)



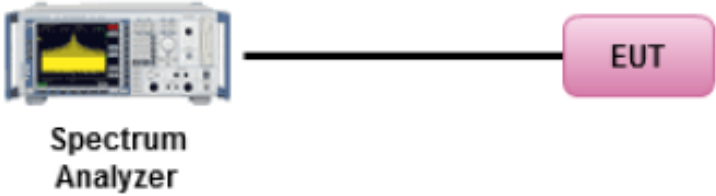
Band Edge-LE Low



Band Edge-LE High

10.5 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) <u>Peak spectral density measurement procedure</u> - Set analyzer center frequency to DTS channel center frequency. - Set the span to 1.5 times the DTS bandwidth. - Set the RBW to: $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$. - Set the VBW $\geq 3 \times \text{RBW}$. - 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	06/27/2017	Environmental condition	Temperature 22°C Relative Humidity 46% Atmospheric Pressure 1020mbar
Remark	-		
Result	☒ Pass ☐ Fail		

Test Data ☒ Yes ☐ N/A

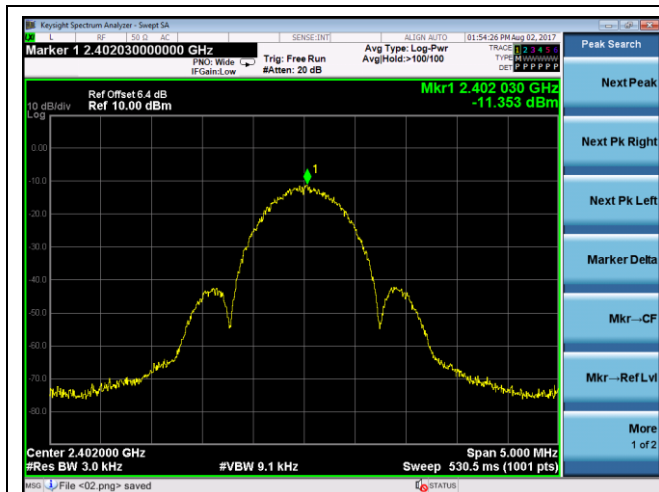
Test Plot ☒ Yes (See below) ☐ N/A

Test was done by Rachana Khanduri at RF test site.

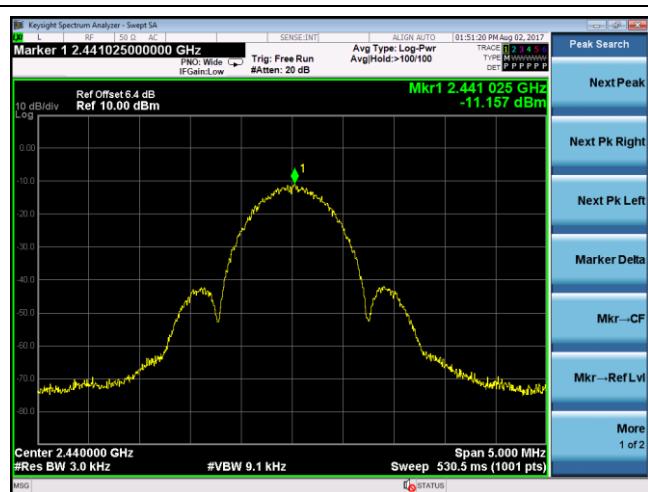
PSD measurement result (Bluetooth LE)

Type	Test mode	Freq (MHz)	CH	Conducted PSD (dBm/3KHz)	Limit (dBm/3KHz)	Result
PSD	Bluetooth LE	2402	Low	-11.35	≤8	Pass
PSD	Bluetooth LE	2440	Mid	-11.16	≤8	Pass
PSD	Bluetooth LE	2480	High	-11.36	≤8	Pass

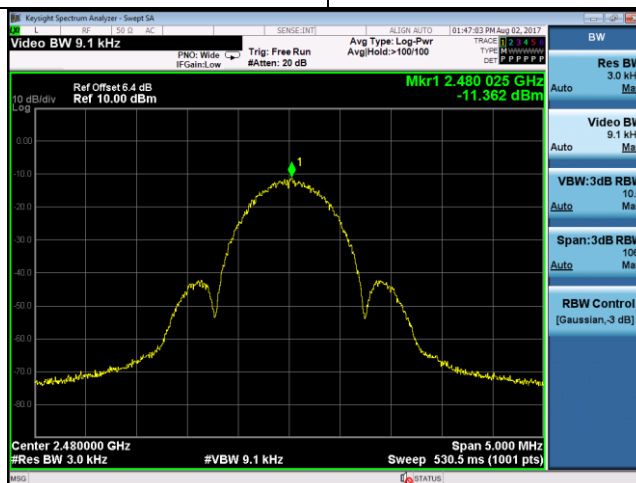
Test Plots (Bluetooth LE)



PSD -Bluetooth LE Low



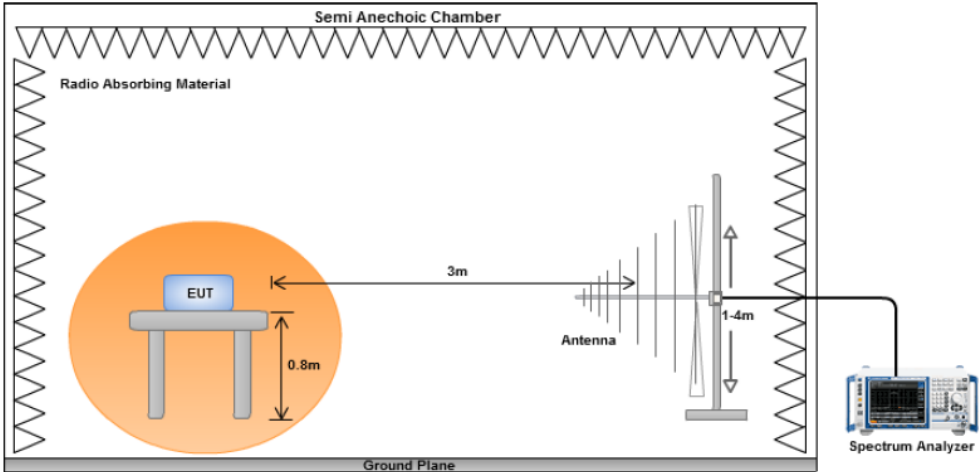
PSD -Bluetooth LE Mid



PSD -Bluetooth LE High

10.6 Radiated Spurious Emissions below 1GHz

Requirement(s):

Spec	Item	Requirement	Applicable										
47CFR§15.247(d) RSS247 (5.5)	a)	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>	Frequency range (MHz)	Field Strength (uV/m)	30 – 88	100	88 – 216	150	216 960	200	Above 960	500	☒
Frequency range (MHz)	Field Strength (uV/m)												
30 – 88	100												
88 – 216	150												
216 960	200												
Above 960	500												
Test Setup													
Procedure	1. 2. The EUT was switched on and allowed to warm up to its normal operating condition. 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.												
Remark	The EUT was scanned up to 1GHz. Both horizontal and vertical polarities were investigated. The results show only the worst case.												
Result	☒ Pass ☐ Fail												

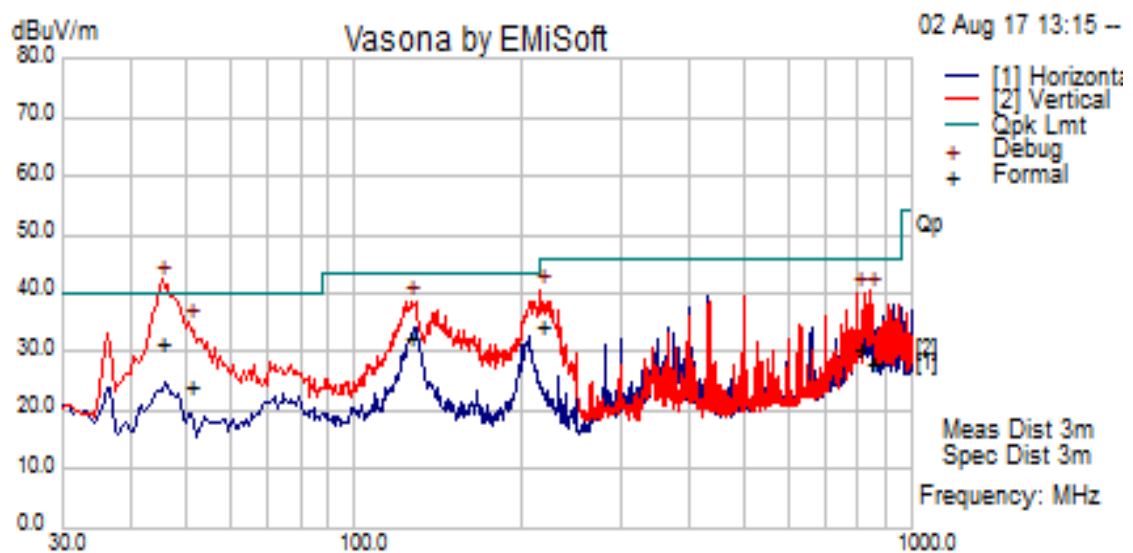
Test Data ☒ Yes (See below) ☐ N/A

Test Plot ☒ Yes (See below) ☐ N/A

Test was done by Rachana Khanduri 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:	Rachana Khanduri			
Test Date:	08/02/2017			
Remarks:	Bluetooth LE 2440 MHz			



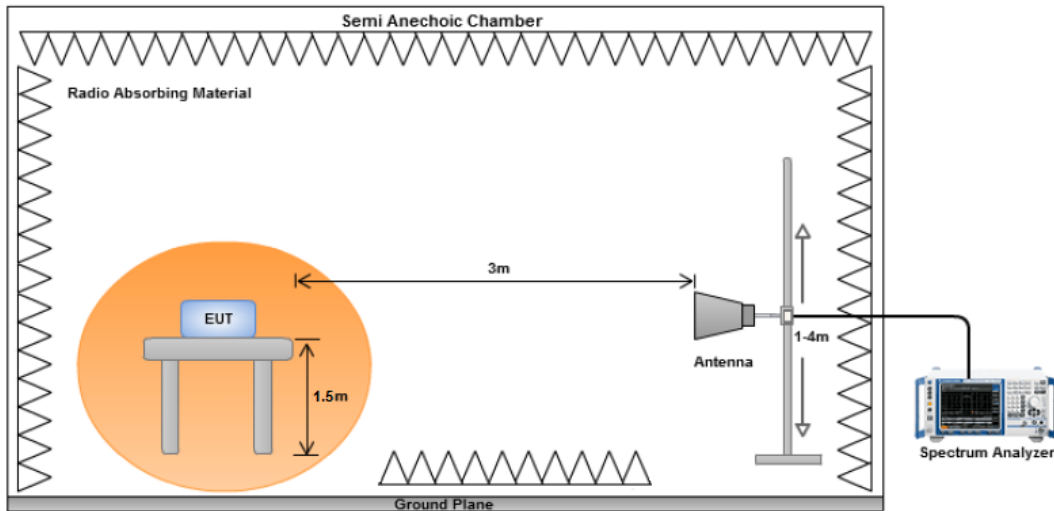
Quasi Max Measurement

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
45.30	45.08	11.53	-25.23	31.38	Quasi Max	V	248	203	40	-8.63	Pass
126.46	43.16	12.28	-22.93	32.51	Quasi Max	V	188	181	43.5	-10.99	Pass
50.68	39.38	11.58	-27.10	23.86	Quasi Max	V	282	341	40	-16.14	Pass
216.30	47.11	12.96	-25.83	34.24	Quasi Max	V	99	219	46	-11.76	Pass
843.34	26.04	16.32	-14.21	28.14	Quasi Max	V	99	64	46	-17.86	Pass
798.69	29.24	16.06	-15.09	30.20	Quasi Max	V	115	34	46	-15.80	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), 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	- The EUT was switched on and allowed to warm up to its normal operating condition. - 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: - Vertical or horizontal polarisation (whichever gave the higher emission level over a full rotation of the EUT) was chosen. - The EUT was then rotated to the direction that gave the maximum emission. - Finally, the antenna height was adjusted to the height that gave the maximum emission. - An average measurement was then made for that frequency point. - 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 Rachana Khanduri 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
4804	43.71	5.47	-2.03	47.15	Peak Max	H	120	75	74	-26.85	Pass
1331	57.54	3.01	-9.2	51.36	Peak Max	H	128	69	74	-22.65	Pass
1849	42.39	3.43	-6.82	39	Peak Max	V	344	109	74	-35	Pass
*11550	39.25	8.52	1.93	49.70	Peak Max	V	323	263	74	-24.30	Pass
4804	33.1	5.47	-2.03	36.54	Average Max	H	120	75	54	-17.46	Pass
1331	32.32	3.01	-9.2	26.14	Average Max	H	128	69	54	-27.86	Pass
1849	30.85	3.43	-6.82	27.46	Average Max	V	344	109	54	-26.54	Pass
*11550	27.53	8.52	1.93	37.98	Average Max	V	323	263	54	-16.02	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
4880	43.49	5.51	-2.15	46.85	Peak Max	H	182	87	74	-27.15	Pass
3981	39.67	4.95	-2.2	42.42	Peak Max	V	310	74	74	-31.58	Pass
1330	50.22	3.01	-9.21	44.02	Peak Max	H	111	228	74	-29.98	Pass
*12166	39.15	9.27	2.46	50.88	Peak Max	V	263	19	74	-23.12	Pass
4880	33.16	5.51	-2.15	36.52	Average Max	H	182	87	54	-17.48	Pass
3981	28.04	4.95	-2.2	30.79	Average Max	V	310	74	54	-23.21	Pass
1330	30.94	3.01	-9.21	24.75	Average Max	H	111	228	54	-29.25	Pass
*12166	27.45	9.27	2.46	39.18	Average Max	V	263	19	54	-14.82	Pass

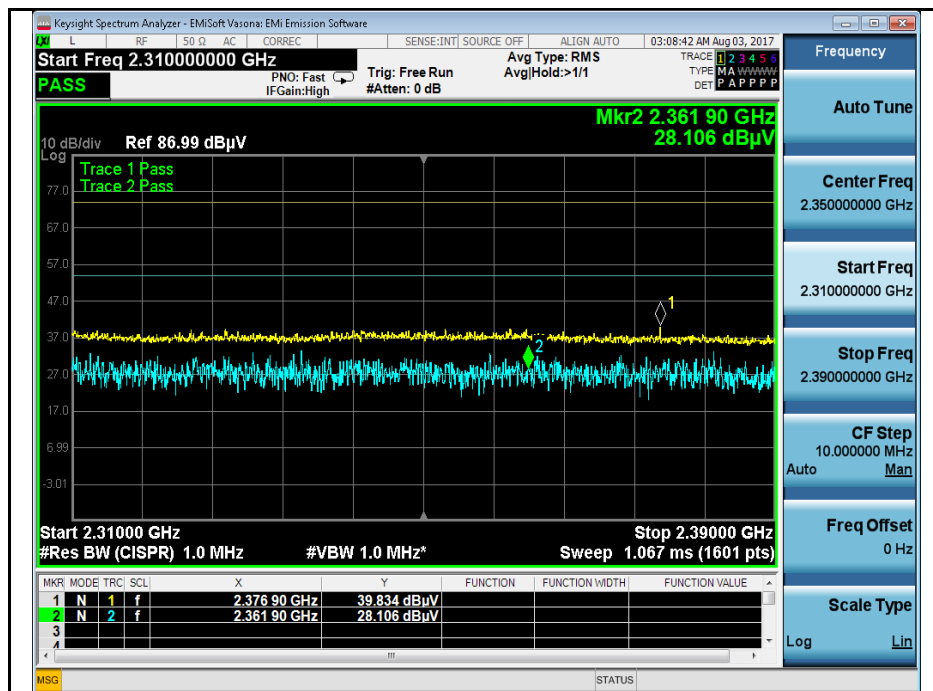
BLE – 2480MHz

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
4960	42.21	5.56	-2.17	45.6	Peak Max	H	101	63	74	-28.4	Pass
1331	54.78	3.01	-9.2	48.59	Peak Max	H	140	80	74	-25.41	Pass
1743	41.81	3.34	-7.64	37.51	Peak Max	H	176	284	74	-36.49	Pass
*14639	40.26	10.11	3.90	54.28	Peak Max	V	347	334	74	-19.72	Pass
4960	30.21	5.56	-2.17	33.6	Average Max	H	101	63	54	-20.41	Pass
1331	32.04	3.01	-9.2	25.86	Average Max	H	140	80	54	-28.14	Pass
1743	29.59	3.34	-7.64	25.29	Average Max	H	176	284	54	-28.71	Pass
*14639	26.63	10.11	3.90	40.65	Average Max	V	347	334	54	-13.35	Pass

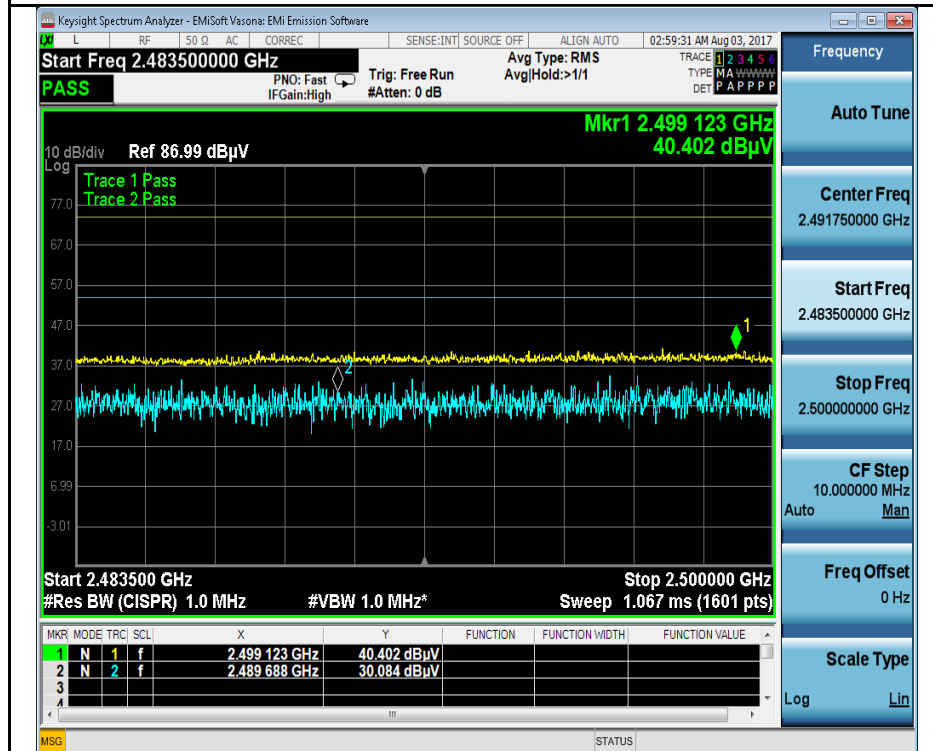
*EUT in horizontal orientation

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

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						
R & S Receiver	ESIB 40	100179	04/21/2017	1 Year	04/21/2018	☒
CHASE LISN	MN2050B	1018	08/16/2016	1 Year	08/16/2017	☒
Radiated Emissions						
Keysight EXA 44GHz Spectrum Analyzer	N9010A	MY51440112	11/02/2016	1 Year	11/02/2017	☒
Bi-Log antenna (30MHz~2GHz)	JB1	A030702	01/13/2017	1 Year	01/13/2018	☒
Horn Antenna (1GHz~26GHz)	3115	100059	08/11/2016	1 Year	08/11/2017	☒
Pre-Amplifier (1~40GHz)	SAS-474	579	05/04/2017	1 Year	05/04/2018	☒
Preamplifier (100KHz~7GHz)	LPA-6-30	11140711	02/09/2017	1 Year	02/09/2018	☒
3 Meters SAC	3M	N/A	09/09/2016	1 Year	09/09/2017	☐
10 Meters SAC	10M	N/A	10/06/2016	1 Year	10/06/2017	☒
RF Conducted Measurement						
Spectrum Analyzer	N9010A	10SL0219	11/16/2016	1 Year	11/16/2017	☒

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