Renovia, Inc.

TEST REPORT

SCOPE OF WORK
EMISSIONS TESTING – leva-02 (2.4 BLE)

REPORT NUMBER
103622007BOX-012b

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Non-Specific Radio Report Shell Rev. December 2017

EMISSIONS TEST REPORT

(FULL COMPLIANCE)

Report Number: 103622007BOX-012b
Project Number: G103622007

Report Issue Date: 07/12/2019

Model(s) Tested: leva-02 (2.4 GHz BLE)
Model(s) Partially Tested: None
Model(s) Not Tested but declared equivalent by the client: None

Standards: CFR47 FCC Part 15.247 Subpart C: 06/2019,
CFR47 FCC Part 15 Subpart B: 06/2019,
RSS-247 Issue 2 February 2017,
ICES-003 Issue 6 Published: January 2016 Updated: April 2017,
RSS-Gen Issue 5 April 2018,
RSS-102 Issue 5 March 2015

Tested by:
Intertek Testing Services NA, Inc.
70 Codman Hill Road
Boxborough, MA 01719
USA

Client:
Renovia, Inc.
263 Summer St
Boston, MA 02210
USA

Report prepared by

Kouma Sinn / EMC Staff Engineer

Report reviewed by

Michael Murphy / Engineering Supervisor

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1 Introduction and Conclusion

The tests indicated in section 2.0 were performed on the product constructed as described in section 4.0. The remaining test sections are the verbatim text from the actual data sheets used during the investigation. These test sections include the test name, the specified test Method, a list of the actual Test Equipment Used, documentation Photos, Results and raw Data. No additions, deviations, or exclusions have been made from the standard(s) unless specifically noted.

Based on the results of our investigation, we have concluded the product tested **complies** with the requirements of the standard(s) indicated. The results obtained in this test report pertain only to the item(s) tested. Intertek does not make any claims of compliance for samples or variants which were not tested.

2 Test Summary

Section	Test full name	Result
3	Client Information	--
4	Description of Equipment Under Test and Variant Models	--
5	System Setup and Method	--
6	Maximum Peak Output Power and Human RF exposure CFR47 FCC Part 15 Subpart C:06/2019, Section 15.247 (b)(3) RSS-247 Issue 2 February 2017, RSS-102 Issue 5 March 2015	Pass
7	6 dB Bandwidth and Occupied Bandwidth CFR47 FCC Part 15 Subpart C: 06/2019, Section 15.247 (a)(2) RSS-247 Issue 2 February 2017	Pass
8	Maximum Power Spectral Density CFR47 FCC Part 15 Subpart C: 06/2019, Section 15.247 (e) RSS-247 Issue 2 February 2017	Pass
9	Band Edge Compliance CFR47 FCC Part 15 Subpart C: 06/2019, Section 15.247 (d) RSS-247 Issue 2: 02/2017)	Pass
10	Transmitter spurious emissions CFR47 FCC Part 15 Subpart C: 06/2019, Section 15.247 (d) RSS-247 Issue 2 February 2017	Pass
11	Digital Device and Receiver Radiated Spurious Emissions (CFR47 FCC Part 15 Subpart B 15.109: 06/2019, ICES-003 Issue 6 Published: January 2016 Updated: April 2017	Pass
--	AC Mains Conducted Emissions FCC 47CFR Part 15.107: 06/2019 ICES-003 Issue 6 Published: January 2016 Updated: April 2017	N/A
12	Revision History	--

Notes: Not applicable as the EUT powers from internal battery with no connection to AC mains.

3 Client Information

This EUT was tested at the request of:

Client: Renovia Inc.
263 Summer Street
Boston, MA 02210
USA

Contact: Gina Prochilio
Telephone: 617-671-5829
Email: gcawston@renoviainc.com

4 Description of Equipment Under Test and Variant Models

Manufacturer: Renovia Inc.
263 Summer Street
Boston, MA 02210
USA

Equipment Under Test			
Description	Manufacturer	Model Number	Serial Number
2.4 GHz BLE	Renovia Inc.	Leva-02	830-00002 REV E

Receive Date:	06/17/2019
Received Condition:	Good
Type:	Production

Description of Equipment Under Test (provided by client)
The leva-02 system includes two physical devices: (1) the *leva-02 device* and (2) the *leva-02 case*. As described in detail in DD-00006, Hardware Design Description, the *leva-02 device* includes a microcontroller with a 915 MHz band ISM radio. The *leva-02 case* includes two microcontrollers: a 915 MHz band ISM radio and a 2.4 GHz band Bluetooth Low Energy (BLE) radio. The overall system also includes a *user interface device*, which can be an iOS or Android mobile telephone with BLE capability. The *leva-02 device* and *leva-02 case* are considered ME EQUIPMENT whereas the *user interface device* is considered a Non-ME EQUIPMENT.

Equipment Under Test Power Configuration			
Rated Voltage	Rated Current	Rated Frequency	Number of Phases
Internally Battery Powered	N/A	DC	N/A

Operating modes of the EUT:

No.	Descriptions of EUT Exercising
2	Pre-programmed to transmit at low, mid, and high channels
3	Pre-programmed to receive at low channel

Software used by the EUT:

No.	Descriptions of EUT Exercising
1	None

Radio/Receiver Characteristics	
Frequency Band(s)	2402-2480 MHz
Modulation Type(s)	GFSK
Maximum Output Power	Low Channel (2402 MHz): +1.72 dBm (EIRP) Mid Channel (2442 MHz): - 1.8 dBm (EIRP) High Channel (2480 MHz): - 2.5 dBm (EIRP)
Test Channels	Low Channel (2402 MHz) Mid Channel (2442 MHz) High Channel (2480 MHz)
Occupied Bandwidth	Low Channel (2402 MHz): 1.076 MHz Mid Channel (2442 MHz): 1.082 MHz High Channel (2480 MHz): 1.076 MHz
Frequency Hopper: Number of Hopping Channels	N/A
Frequency Hopper: Channel Dwell Time	N/A
Frequency Hopper: Max interval between two instances of use of the same channel	N/A
MIMO Information (# of Transmit and Receive antenna ports)	1
Equipment Type	Standalone
ETSI LBT/Adaptivity	N/A
ETSI Adaptivity Type	N/A
ETSI Temperature Category (I, II, III)	N/A
ETSI Receiver Category (1, 2, 3)	N/A
Antenna Type and Gain	Integral

Variant Models:

The following variant models were not tested as part of this evaluation, but have been identified by the manufacturer as being electrically identical models, depopulated models, or with reasonable similarity to the model(s) tested. Intertek does not make any claims of compliance for samples or variants which were not tested.

None

5 System Setup and Method

Cables					
ID	Description	Length (m)	Shielding	Ferrites	Termination
--	None	--	--	--	--

Support Equipment			
Description	Manufacturer	Model Number	Serial Number
None	--	--	--

5.1 Method:

Configuration as required by Configuration as required by FCC Part 15 Subpart C 15.247: 06/2019, FCC Part 15 Subpart B: 06/2019, RSS 247 Issue 2: 02/2017, ICES 003 Issue 6: 01/2016 updated 06/2016, ANSI C 63.10: 2013, and ANSI C 63.4: 2014.

5.2 EUT Block Diagram:

6 Maximum Peak Output Power and Human RF exposure

6.1 Method

Tests are performed in accordance with CFR47 FCC Part 15.247, RSS-247, RSS-102, and ANSI C63.10.

TEST SITE: 10m ALSE

The 10m ALSE is 13m (Length) x 21m (Depth) x 10m (Height) with the effective size in terms of space from the tips of the absorber is 12m (Length) x 20m (Depth) x 8.5m (Height). This chamber achieves broadband performance using a unique arrangement of hybrid and ferrite tile absorber. This chamber has a built in 3m diameter turntable (Embedded type). The metal structure of the table makes electrical connection around the entire circumference of the turntable to the ground plane with a metal brush type connection. The turntable is located on one end of the chamber and the antennas are mounted 3 and 10 meters away at the other end of the chamber on the adjustable an Antenna Mast. The antenna mast is a non-conductive bore sighted type with remote control of antenna height and polarization. The Antenna Mast and the turntable can be remotely controlled through the controller located in the adjacent Control room. A Styrofoam table 80 cm high is used for table-top equipment.

Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
Radiated Emissions, 10m	30-1000 MHz	4.6dB	6.3 dB
Radiated Emissions, 3m	30-1000 MHz	5.3 dB	6.3 dB
Radiated Emissions, 3m	1-6 GHz	4.5 dB	5.2 dB
Radiated Emissions, 3m	6-15 GHz	5.2 dB	5.5 dB
Radiated Emissions, 3m	15-18 GHz	5.0 dB	5.5 dB
Radiated Emissions, 3m	18-40 GHz	5.0 dB	5.5 dB

As shown in the table above our radiated emissions U_{lab} is less than the corresponding U_{CISPR} reference value in CISPR 16-4-2 Table 1, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required, based on CISPR 22 and CISPR 11 (for 2006 and later revisions) Clause 11.

Sample Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CF - AG
Where FS = Field Strength in dBμV/m
RA = Receiver Amplitude (including preamplifier) in dBμV
CF = Cable Attenuation Factor in dB
AF = Antenna Factor in dB
AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows.

Assume a receiver reading of 52.0 dBμV is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dBμV/m. This value in dBμV/m was converted to its corresponding level in μV/m.

RA = 52.0 dBμV
AF = 7.4 dB/m
CF = 1.6 dB
AG = 29.0 dB
FS = 32 dBμV/m

To convert from dBμV to μV or mV the following was used:

$UF = 10^{(NF / 20)}$ where UF = Net Reading in μV
NF = Net Reading in dBμV

Example:

FS = RA + AF + CF – AG = 52.0 + 7.4 + 1.6 – 29.0 = 32.0
$UF = 10^{(32\ dB\mu V / 20)}$ = 39.8 μV/m

Alternately, when BAT-EMC Emission Software is used, the “Level” includes all losses and gains and is compared directly in the “Margin” column to the “Limit”. The “Correction” includes Antenna Factor, Preamp, and Cable Loss. These are already accounted for in the “Level” column.

6.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV001'	Weather Station	Davis Instruments	7400	PE80519A61	01/23/2019	01/23/2020
EMC02'	ANTENNA, RIDGED GUIDE, 1-18 GHZ	EMCO	3115	2784	08/16/2018	08/16/2019
145-416'	Cables 145-420 145-423 145-425 145-408	Huber + Suhner	3m Track B cables	multiple	07/25/2018	07/25/2019
145128'	EMI Receiver (20 Hz - 40 Ghz)	Rohde & Schwarz	ESIB 40	839283/001	03/28/2019	03/28/2020

Software Utilized:

Name	Manufacturer	Version
None	--	--

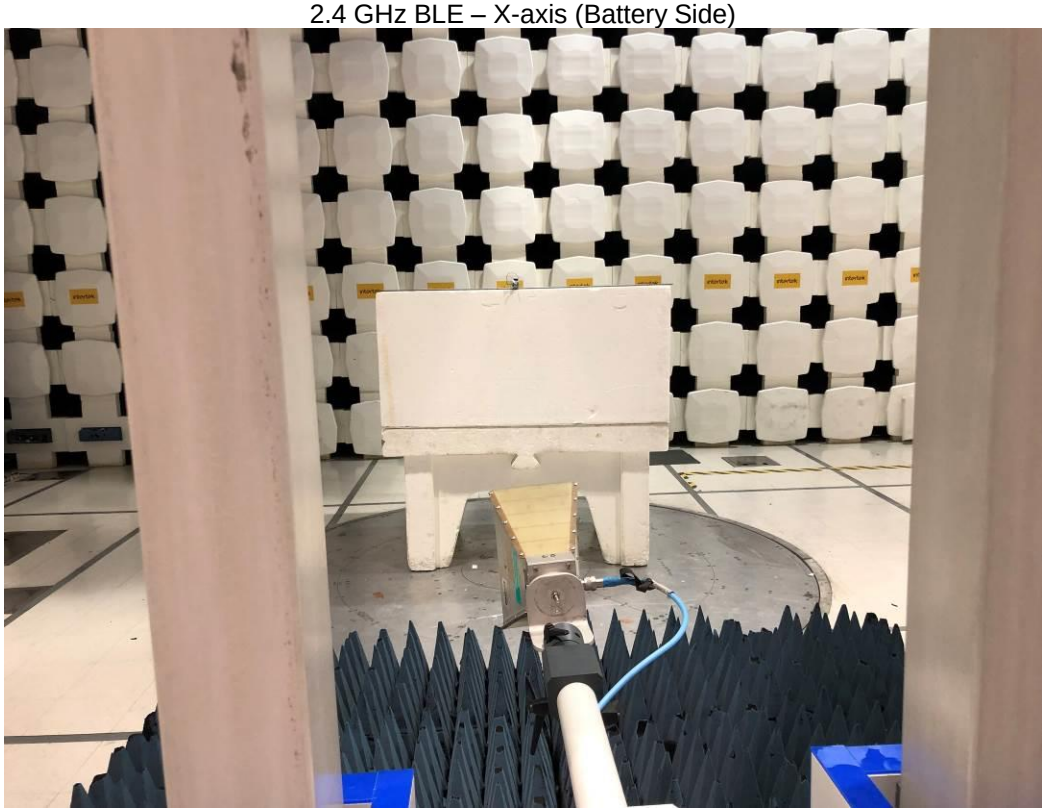
6.3 Results:

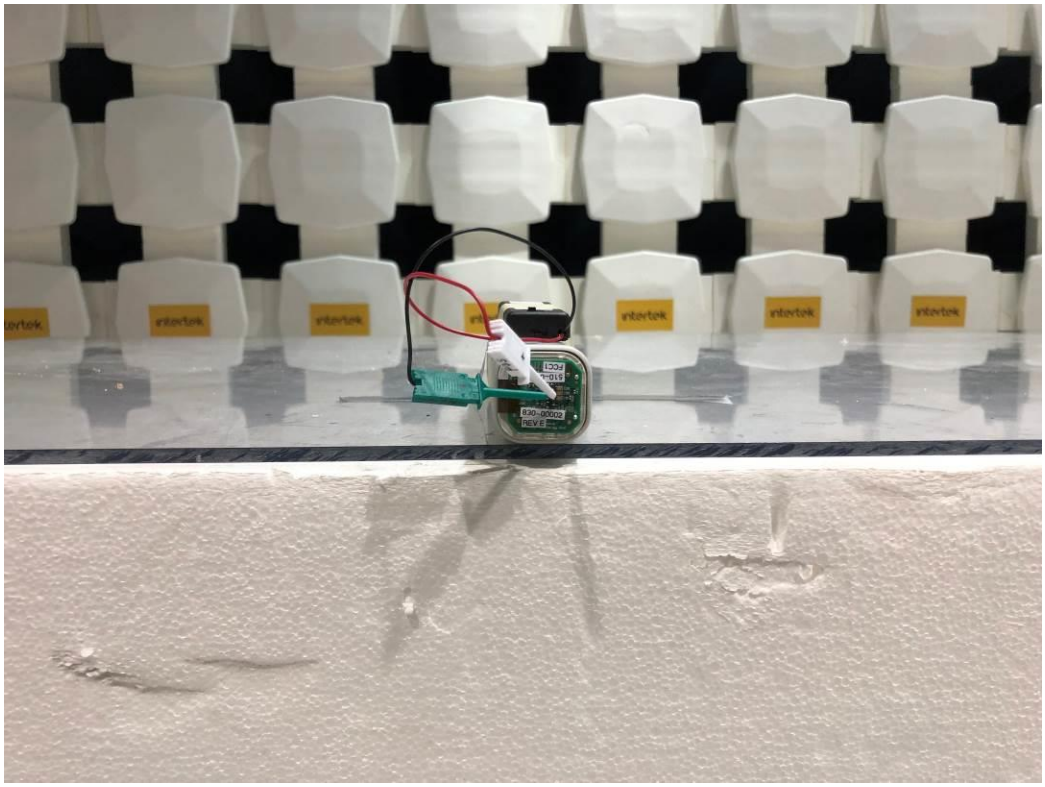
The sample tested was found to Comply.

§15.247 (b) (3) For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt or 30 dBm or 36 dBm (EIRP)

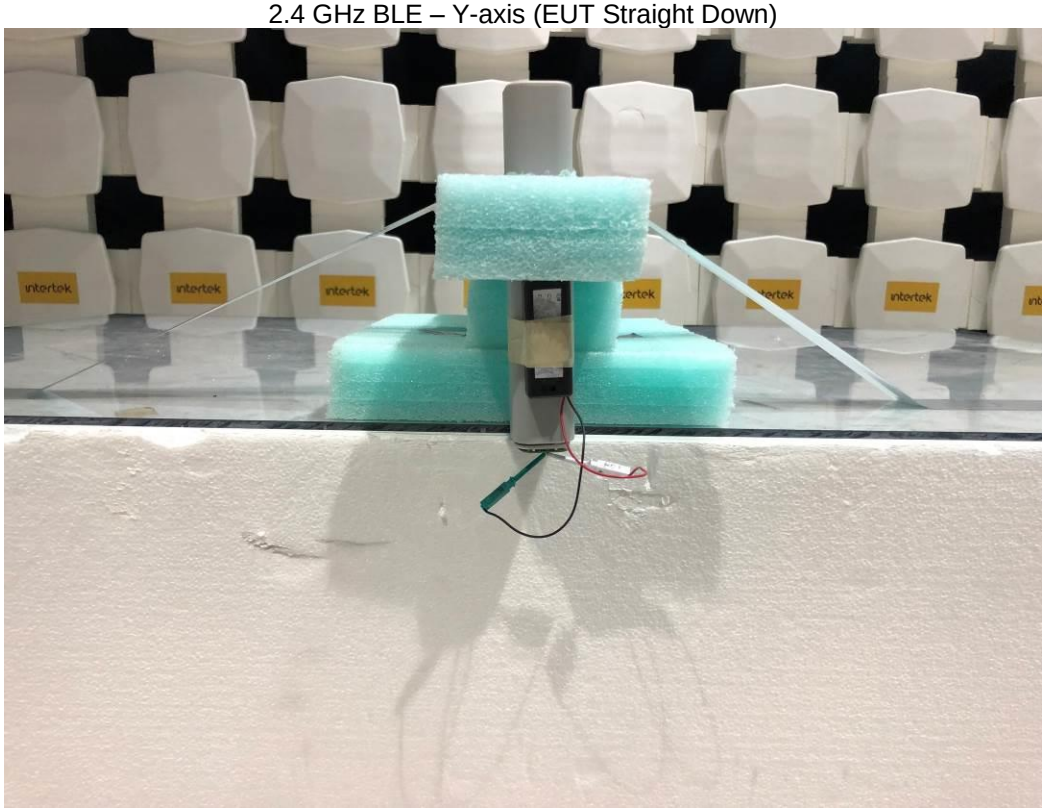
6.4 Setup Photographs

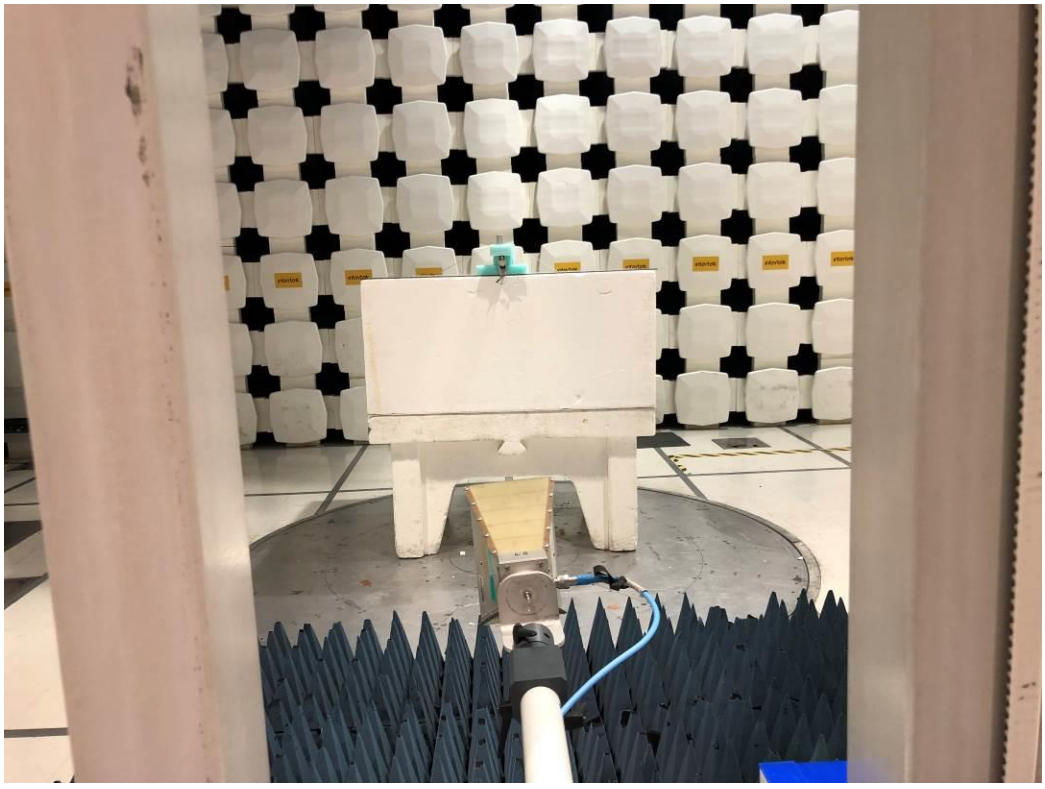
2.4 GHz BLE – X-axis (Battery Side)



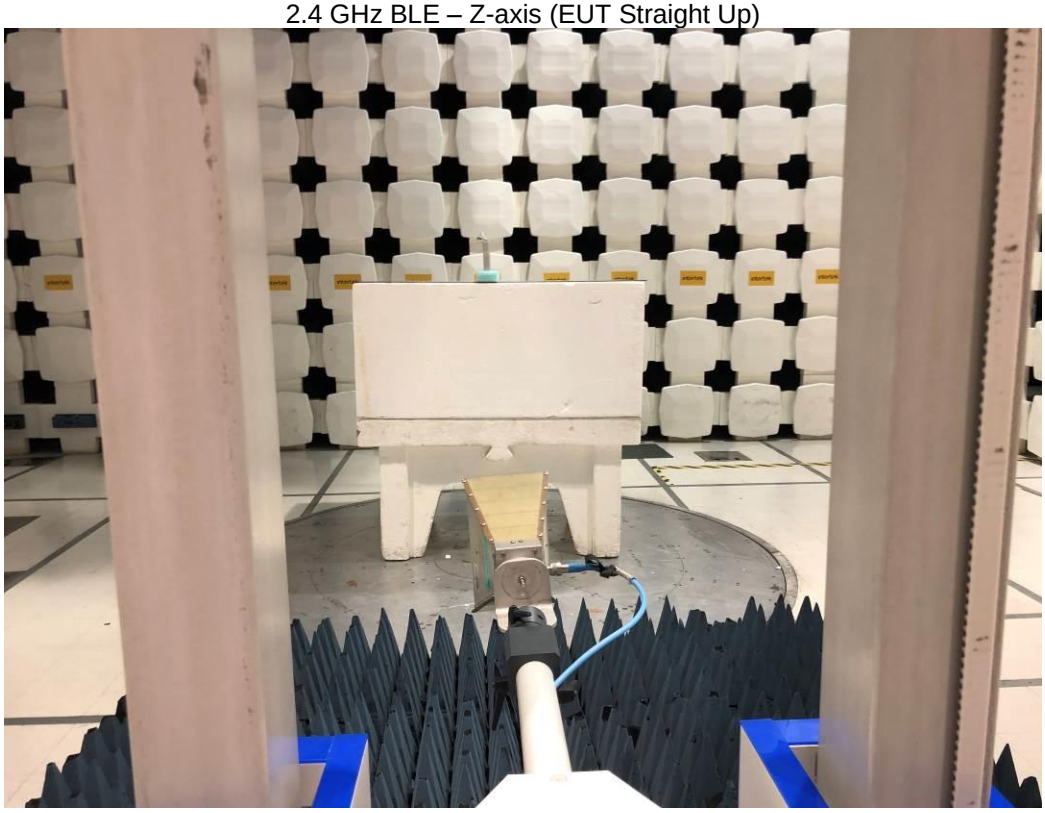


2.4 GHz BLE – Y-axis (EUT Straight Down)





2.4 GHz BLE – Z-axis (EUT Straight Up)



6.5 Test Data:

2.4 GHz BLE Low Channel Output Power (EIRP)

Company: Renovia | Antenna & Cables: LF | Bands: N, LF, HF, SHF
Model #: leva-02 | Antenna: EMC02 V3m_08-16-19.txt | EMC02 H3m_08-16-19.txt
Serial #: 830-00002 REV E | Cable(s): 145-416_7-25-19.txt | NONE.
Engineers: Kouma Sinn | Location: 10m chamber | Barometer: DAV002 | Filter: NONE
Project #: G103622007 | Date(s): 06/17/19
Standard: FCC Part 15.247 | Temp/Humidity/Pressure: 23C | 42% | 1005mbar
Receiver: 145128 | Limit Distance (m): 3
PreAmp: NONE. | Test Distance (m): 3
PreAmp Used? (Y or N): N | Voltage/Frequency: Internal battery | Frequency Range: 2402 MHz

Net = Reading (dBuV/m) + Antenna Factor (dB1/m) + Cable Loss (dB) - Preamp Factor (dB) - Distance Factor (dB)
Peak: PK Quasi-Peak: QP Average: AVG RMS: RMS; NF = Noise Floor, RB = Restricted Band; Bandwidth denoted as RBW/VBW

Detector Type	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	EIRP Net dBm	EIRP Limit dBm	Margin dB	Bandwidth
EIRP (dBm) = E (dBµV/m) + 20log(D) − 104.8; where D is the measurement distance in meters											
Low Channel, Flat battery side up											
PK	V	2402.000	55.14	28.45	6.22	0.00	0.00	-5.45	36.00	-41.45	1/3 MHz
PK	H	2402.000	62.27	28.49	6.22	0.00	0.00	1.72	36.00	-34.28	1/3 MHz
Low Channel, EUT pointing up											
PK	V	2402.000	55.36	28.45	6.22	0.00	0.00	-5.23	36.00	-41.23	1/3 MHz
PK	H	2402.000	55.69	28.49	6.22	0.00	0.00	-4.86	36.00	-40.86	1/3 MHz
Low Channel, EUT pointing down											
PK	V	2402.000	57.69	28.45	6.22	0.00	0.00	-2.90	36.00	-38.90	1/3 MHz
PK	H	2402.000	58.80	28.49	6.22	0.00	0.00	-1.75	36.00	-37.75	1/3 MHz

2.4 GHz BLE Mid Channel Output Power (EIRP)

Company: Renovia
Model #: leva-02
Serial #: 830-00002 REV E
Engineers: Kouma Sinn
Project #: G103622007
Standard: FCC Part 15.247
Receiver: 145128
PreAmp: NONE.
PreAmp Used? (Y or N): N
Date(s): 06/23/19
Location: 10m chamber
Limit Distance (m): 3
Test Distance (m): 3
Voltage/Frequency: Internal battery
Antenna & Cables: LF
Antenna: EMC02 V3m_08-16-19.txt
Cable(s): 145-416_7-25-19.txt
Barometer: DAV002
Temp/Humidity/Pressure: 24C
Bands: N, LF, HF, SHF
EMC02 H3m_08-16-19.txt
NONE.
Filter: NONE
36%
1001mbar
Frequency Range: 2442 MHz

Net = Reading (dBuV/m) + Antenna Factor (dB1/m) + Cable Loss (dB) - Preamp Factor (dB) - Distance Factor (dB)

Peak: PK Quasi-Peak: QP Average: AVG RMS: RMS; NF = Noise Floor, RB = Restricted Band; Bandwidth denoted as RBW/VBW

Detector Type	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	EIRP Net dBm	EIRP Limit dBm	Margin dB	Bandwidth
EIRP (dBm) = E (dBµV/m) + 20log(D) − 104.8; where D is the measurement distance in meters											
Mid Channel, Flat battery up											
PK	V	2442.000	54.90	28.48	6.25	0.00	0.00	-5.63	36.00	-41.63	1/3 MHz
PK	H	2442.000	58.72	28.49	6.25	0.00	0.00	-1.80	36.00	-37.80	1/3 MHz
Mid Channel, EUT pointing up											
PK	V	2442.000	53.29	28.48	6.25	0.00	0.00	-7.24	36.00	-43.24	1/3 MHz
PK	H	2442.000	50.65	28.49	6.25	0.00	0.00	-9.87	36.00	-45.87	1/3 MHz
Mid Channel, EUT pointing down											
PK	V	2442.000	55.88	28.48	6.25	0.00	0.00	-4.65	36.00	-40.65	1/3 MHz
PK	H	2442.000	50.65	28.49	6.25	0.00	0.00	-9.87	36.00	-45.87	1/3 MHz

2.4 GHz BLE High Channel Output Power (EIRP)

Company: Renovia
Model #: leva-02
Serial #: 830-00002 REV E
Engineers: Kouma Sinn
Project #: G103622007
Standard: FCC Part 15.247
Receiver: 145128
PreAmp: NONE.
Date(s): 06/23/19
Location: 10m chamber
Limit Distance (m): 3
Test Distance (m): 3
PreAmp Used? (Y or N): N
Voltage/Frequency: Internal battery
Antenna & Cables: LF
Antenna: EMC02 V3m_08-16-19.txt
Cable(s): 145-416_7-25-19.txt
Barometer: DAV002
Temp/Humidity/Pressure: 24C
Bands: N, LF, HF, SHF
EMC02 H3m_08-16-19.txt
NONE.
Filter: NONE
36%
1001mbar
Frequency Range: 2480 MHz

Net = Reading (dBuV/m) + Antenna Factor (dB1/m) + Cable Loss (dB) - Preamp Factor (dB) - Distance Factor (dB)

Peak: PK Quasi-Peak: QP Average: AVG RMS: RMS; NF = Noise Floor, RB = Restricted Band; Bandwidth denoted as RBW/VBW

Detector Type	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	EIRP Net dBm	EIRP Limit dBm	Margin dB	Bandwidth
EIRP (dBm) = E (dBµV/m) + 20log(D) − 104.8; where D is the measurement distance in meters											
High Channel, Flat battery up											
PK	V	2480.000	53.43	28.45	6.29	0.00	0.00	-7.09	36.00	-43.09	1/3 MHz
PK	H	2480.000	57.95	28.52	6.29	0.00	0.00	-2.50	36.00	-38.50	1/3 MHz
High Channel, EUT pointing up											
PK	V	2480.000	52.50	28.45	6.29	0.00	0.00	-8.02	36.00	-44.02	1/3 MHz
PK	H	2480.000	49.00	28.52	6.29	0.00	0.00	-11.45	36.00	-47.45	1/3 MHz
High Channel, EUT pointing down											
PK	V	2480.000	55.24	28.45	6.29	0.00	0.00	-5.28	36.00	-41.28	1/3 MHz
PK	H	2480.000	51.67	28.52	6.29	0.00	0.00	-8.78	36.00	-44.78	1/3 MHz

SAR Exemption Calculation

Maximum Conducted Output Power of Transmitter (EIRP) = +1.076 dBm = 1.486 Mw

Notes: EIRP output power (Worst-Case) was used SAR Tet Exclusion Thresholds calculation

FCC SAR Exemption per KDB 447498

a) For 100 MHz to 6 GHz and *test separation distances* ≤ 50 mm, the 1-g and 10-g *SAR test exclusion thresholds* are determined by the following:

[(*max. power of channel, including tune-up tolerance, mW*) / (*min. test separation distance, mm*)] · [$\sqrt{f_{(GHz)}}$] ≤ 3.0 for 1-g SAR, and ≤ 7.5 for 10-g extremity SAR,[30] where

- $f_{(GHz)}$ is the RF channel transmit frequency in GHz

SAR Test Exclusion Thresholds = (1.486/5)*(sqrt(2.402))
= 0.461 < 3.0 (below the limit SAR Exempt per FCC)

RSS 102 SAR Exemption

Table 1: SAR evaluation – Exemption limits for routine evaluation based on frequency and separation distance[4,5]

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of ≤5 mm	At separation distance of 10 mm	At separation distance of 15 mm	At separation distance of 20 mm	At separation distance of 25 mm
≤300	71 mW	101 mW	132 mW	162 mW	193 mW
450	52 mW	70 mW	88 mW	106 mW	123 mW
835	17 mW	30 mW	42 mW	55 mW	67 mW
1900	7 mW	10 mW	18 mW	34 mW	60 mW
2450	4 mW	7 mW	15 mW	30 mW	52 mW
3500	2 mW	6 mW	16 mW	32 mW	55 mW
5800	1 mW	6 mW	15 mW	27 mW	41 mW

The exemption limits in Table 1 are based on measurements and simulations of half-wave dipole antennas at separation distances of 5 mm to 25 mm from a flat phantom, providing a SAR value of approximately 0.4 W/kg for 1 g of tissue. For low frequencies (300 MHz to 835 MHz), the exemption limits are derived from a linear fit. For high frequencies (1900 MHz and above), the exemption limits are derived from a third order polynomial fit.

The conducted output power of the transmitter (EIRP) 1.486 mW @ 2402MHz is less than 2 mW limit specified at 3500 MHz, device meets SAR exclusion.

Test Personnel:	Kouma Sinn KPS	Test Date:	06/17/2019, 06/23/2019
Supervising/Reviewing Engineer: (Where Applicable)	N/A		
Product Standard:	CFR47 FCC Part 15.247 RSS-247, RSS-102	Limit Applied:	See report section 6.3
Input Voltage:	Internal Battery Powered		
Pretest Verification w/ Ambient Signals or BB Source:	N/A	Ambient Temperature:	23, 24 ºC
		Relative Humidity:	42, 36 %
		Atmospheric Pressure:	1005, 1001 mbars

Deviations, Additions, or Exclusions: None

7 6 dB Bandwidth and Occupied Bandwidth

7.1 Method

Tests are performed in accordance with CFR47 FCC Part 15.247, RSS-247, and ANSI C63.10.

TEST SITE: 10m ALSE

The 10m ALSE is 13m (Length) x 21m (Depth) x 10m (Height) with the effective size in terms of space from the tips of the absorber is 12m (Length) x 20m (Depth) x 8.5m (Height). This chamber achieves broadband performance using a unique arrangement of hybrid and ferrite tile absorber. This chamber has a built in 3m diameter turntable (Embedded type). The metal structure of the table makes electrical connection around the entire circumference of the turntable to the ground plane with a metal brush type connection. The turntable is located on one end of the chamber and the antennas are mounted 3 and 10 meters away at the other end of the chamber on the adjustable an Antenna Mast. The antenna mast is a non-conductive bore sighted type with remote control of antenna height and polarization. The Antenna Mast and the turntable can be remotely controlled through the controller located in the adjacent Control room. A Styrofoam table 80 cm high is used for table-top equipment.

Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
Radiated Emissions, 10m	30-1000 MHz	4.6dB	6.3 dB
Radiated Emissions, 3m	30-1000 MHz	5.3 dB	6.3 dB
Radiated Emissions, 3m	1-6 GHz	4.5 dB	5.2 dB
Radiated Emissions, 3m	6-15 GHz	5.2 dB	5.5 dB
Radiated Emissions, 3m	15-18 GHz	5.0 dB	5.5 dB
Radiated Emissions, 3m	18-40 GHz	5.0 dB	5.5 dB

As shown in the table above our radiated emissions U_{lab} is less than the corresponding U_{CISPR} reference value in CISPR 16-4-2 Table 1, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required, based on CISPR 22 and CISPR 11 (for 2006 and later revisions) Clause 11.

Sample Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CF - AG
Where FS = Field Strength in dBμV/m
RA = Receiver Amplitude (including preamplifier) in dBμV
CF = Cable Attenuation Factor in dB
AF = Antenna Factor in dB
AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows.

Assume a receiver reading of 52.0 dBμV is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dBμV/m. This value in dBμV/m was converted to its corresponding level in μV/m.

RA = 52.0 dBμV
AF = 7.4 dB/m
CF = 1.6 dB
AG = 29.0 dB
FS = 32 dBμV/m

To convert from dBμV to μV or mV the following was used:

$UF = 10^{(NF / 20)}$ where UF = Net Reading in μV
NF = Net Reading in dBμV

Example:

FS = RA + AF + CF – AG = 52.0 + 7.4 + 1.6 – 29.0 = 32.0
$UF = 10^{(32\ dB\mu V / 20)}$ = 39.8 μV/m

Alternately, when BAT-EMC Emission Software is used, the “Level” includes all losses and gains and is compared directly in the “Margin” column to the “Limit”. The “Correction” includes Antenna Factor, Preamp, and Cable Loss. These are already accounted for in the “Level” column.

7.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV001'	Weather Station	Davis Instruments	7400	PE80519A61	01/23/2019	01/23/2020
EMC02'	ANTENNA, RIDGED GUIDE, 1-18 GHZ	EMCO	3115	2784	08/16/2018	08/16/2019
145-416'	Cables 145-420 145-423 145-425 145-408	Huber + Suhner	3m Track B cables	multiple	07/25/2018	07/25/2019
145128'	EMI Receiver (20 Hz - 40 Ghz)	Rohde & Schwarz	ESIB 40	839283/001	03/28/2019	03/28/2020

Software Utilized:

Name	Manufacturer	Version
None	--	--

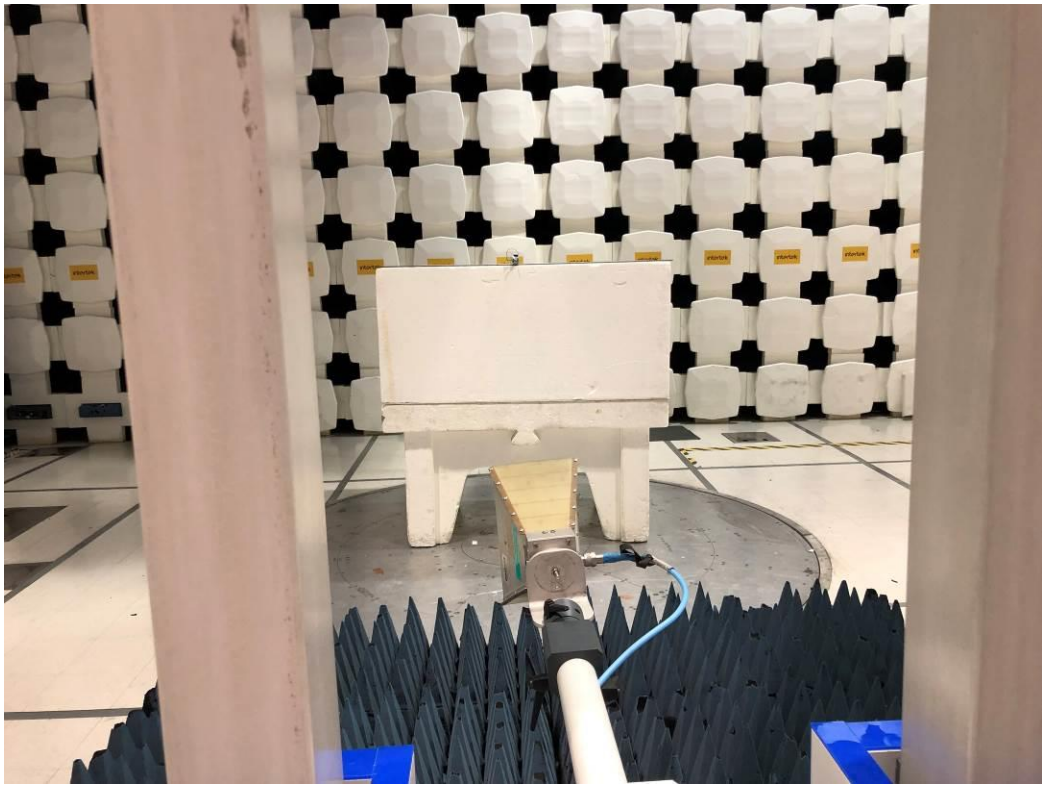
7.3 Results:

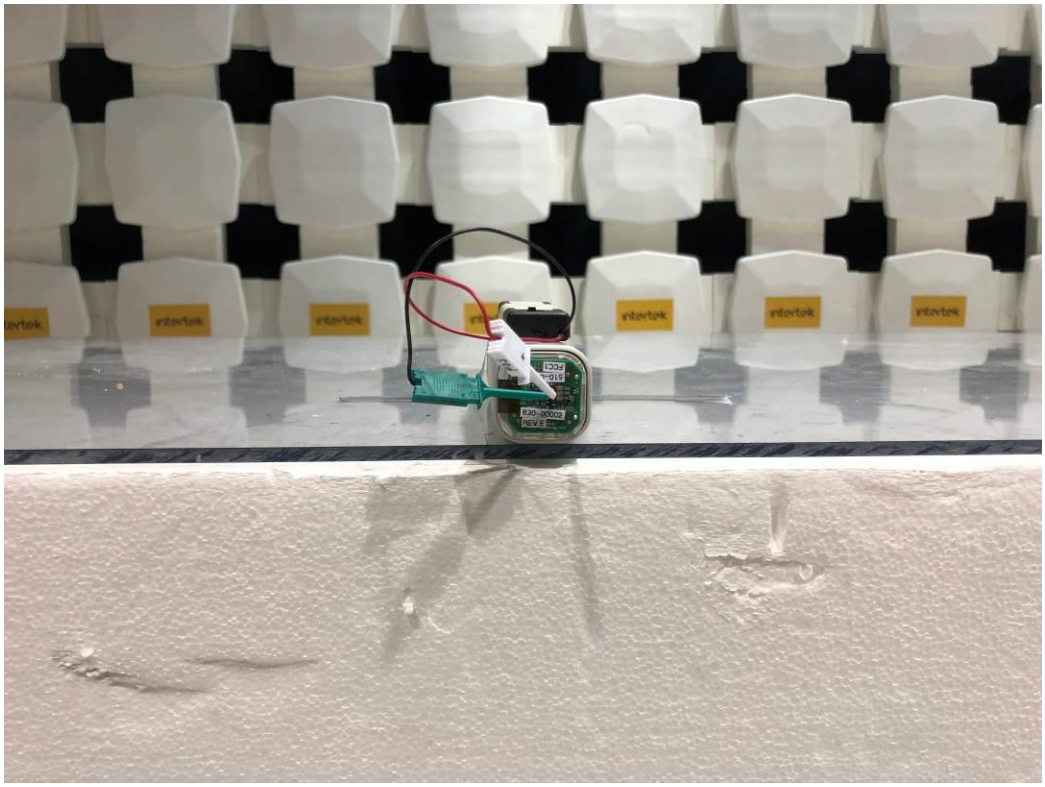
The sample tested was found to Comply.

§15.247 (a) (2) Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

7.4 Setup Photograph:

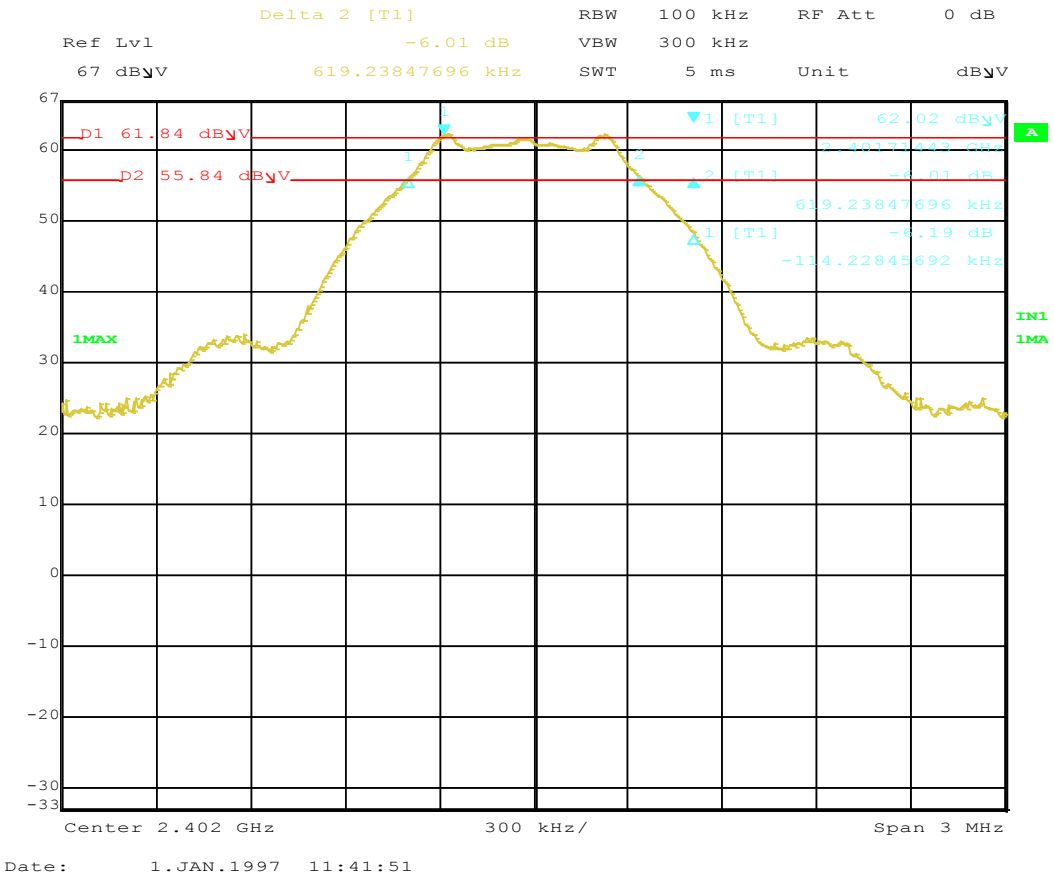
2.4 GHz BLE





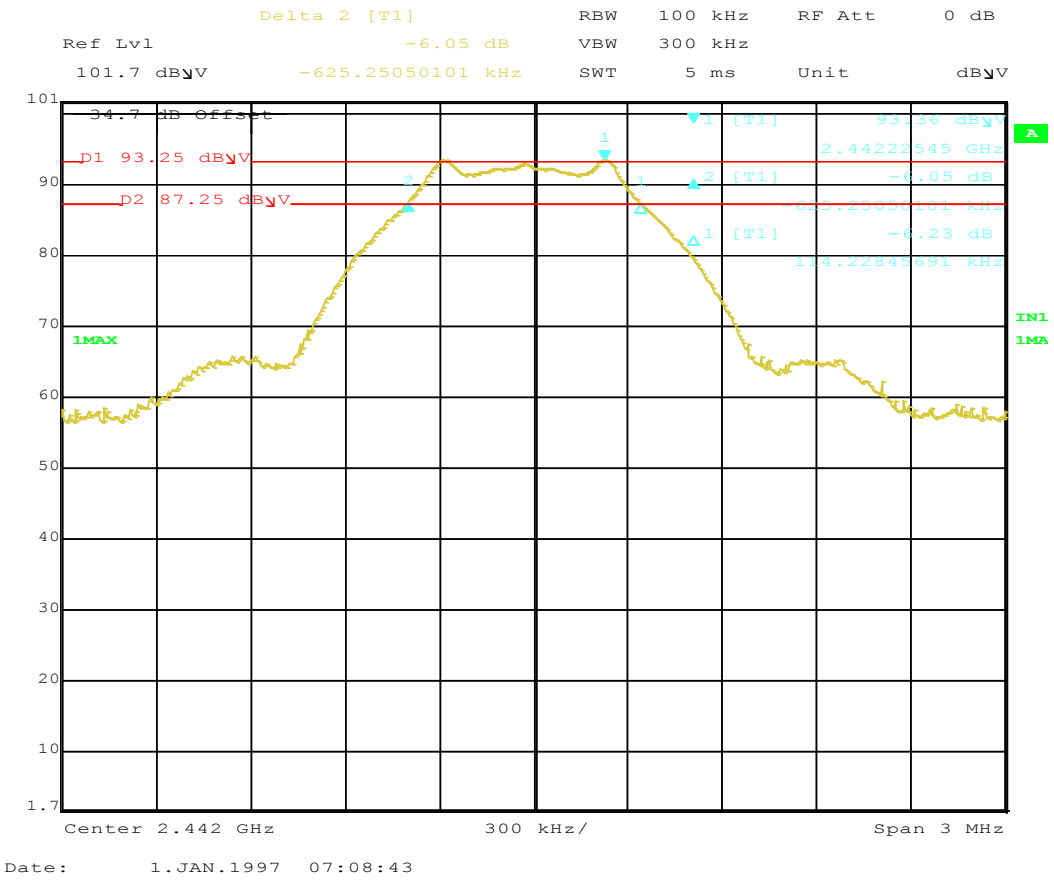
7.5 Plots/Data:

2.4 GHz BLE – Low Channel 6 dB Bandwidth



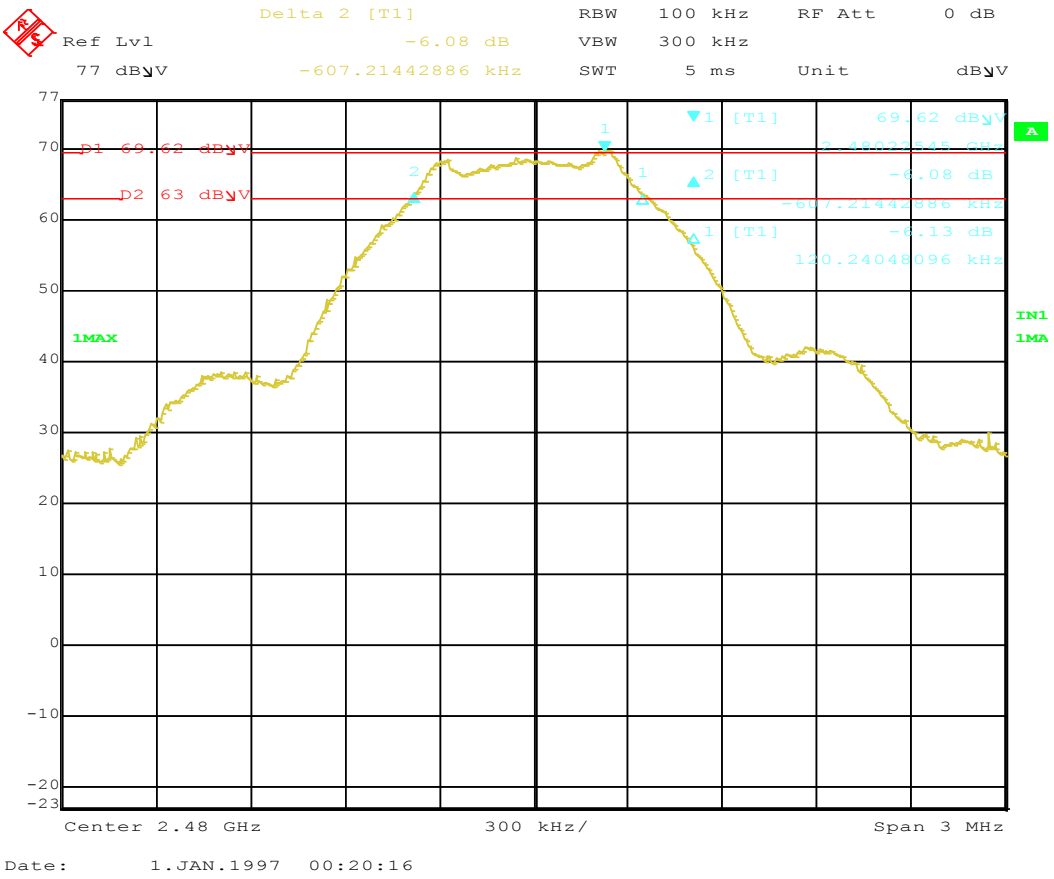
Notes: The date on the plot is default date on the instrument.

2.4 GHz BLE – Mid Channel 6 dB Bandwidth



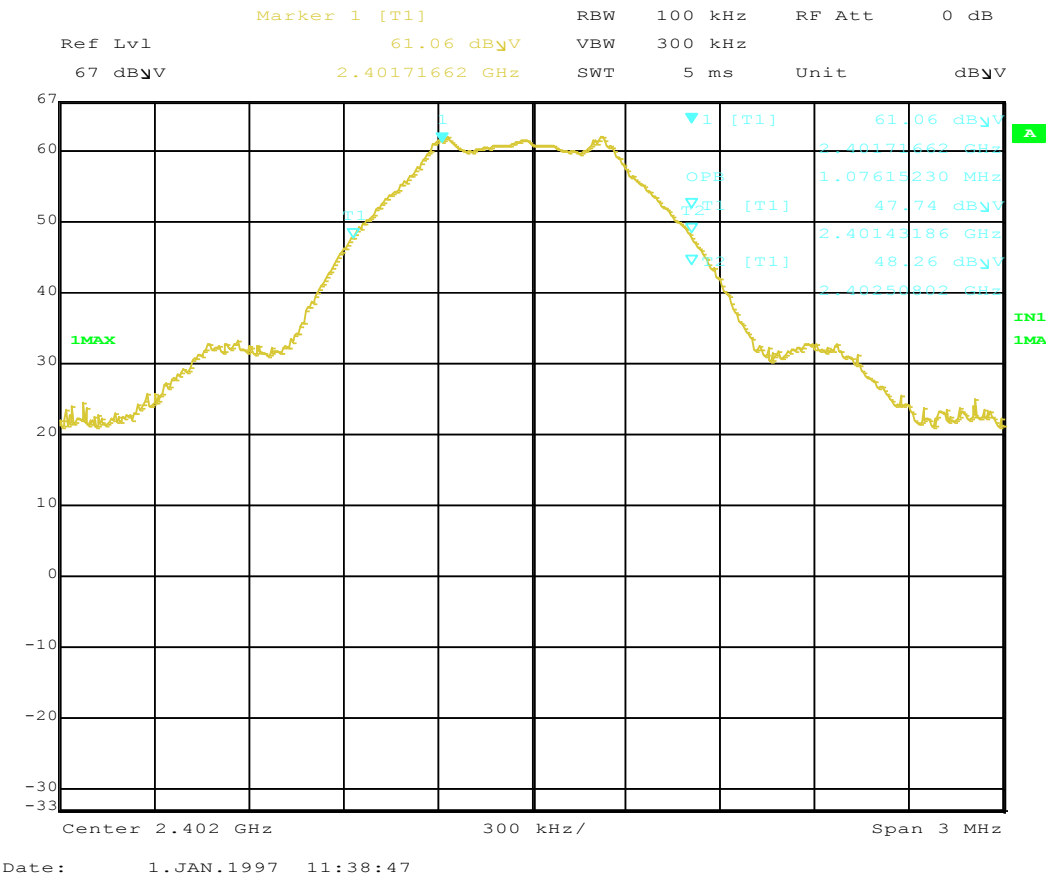
Notes: The date on the plot is default date on the instrument.

2.4 GHz BLE – High Channel 6 dB Bandwidth



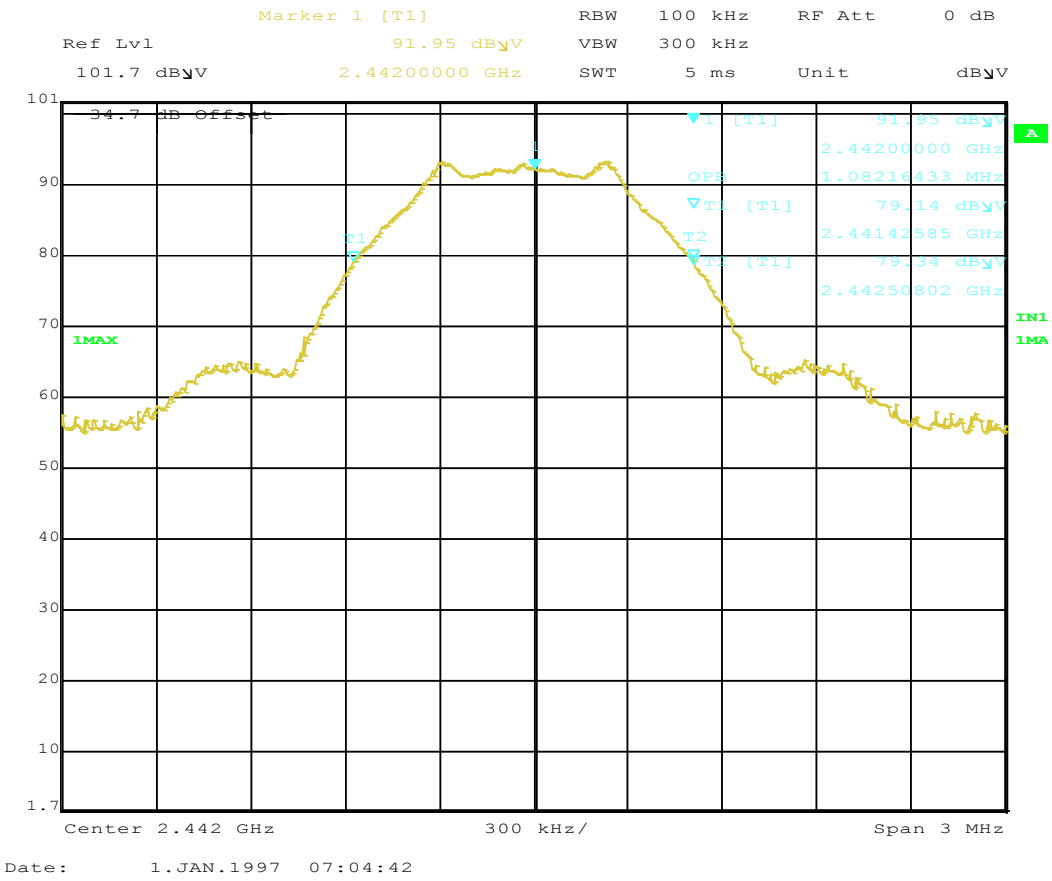
Notes: The date on the plot is default date on the instrument.

2.4 GHz BLE – Low Channel Occupied Bandwidth



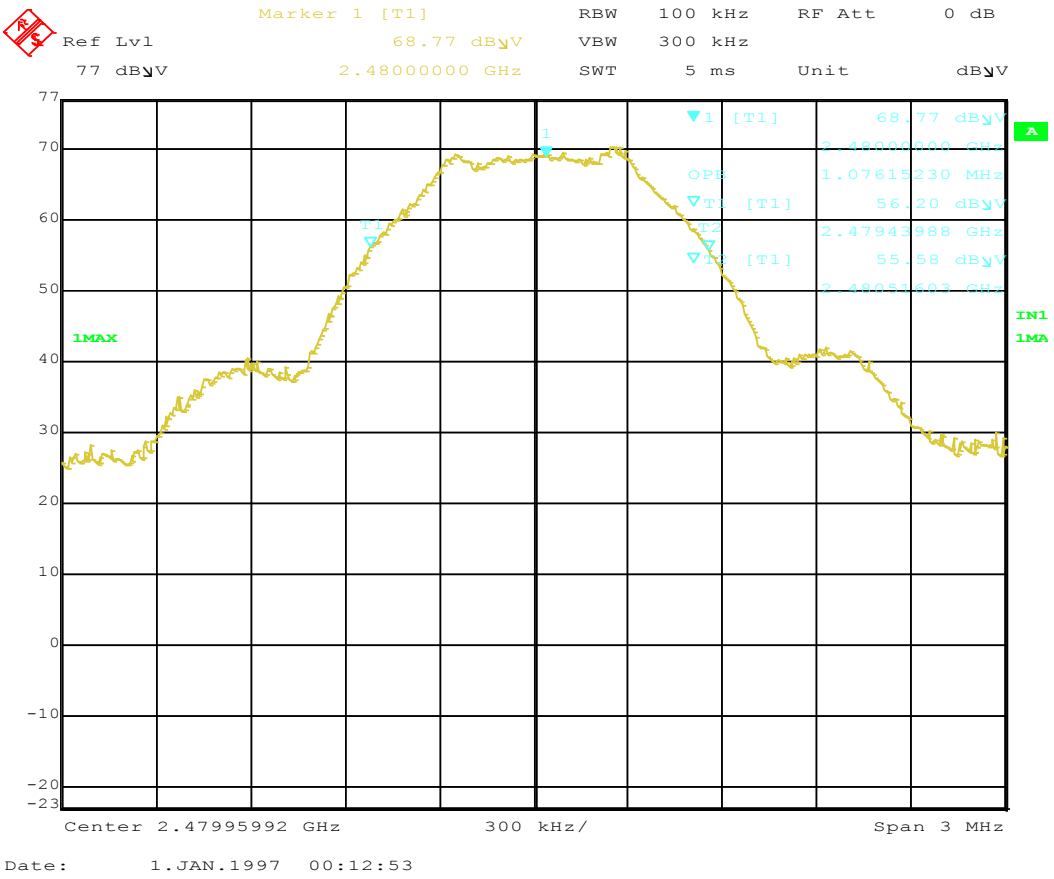
Notes: The date on the plot is default date on the instrument.

2.4 GHz BLE – Mid Channel Occupied Bandwidth



Notes: The date on the plot is default date on the instrument.

2.4 GHz BLE – High Channel Occupied Bandwidth



Notes: The date on the plot is default date on the instrument.

Test Personnel:	Kouma Sinn KPS	Test Date:	06/17/2019, 06/23/2019
Supervising/Reviewing Engineer: (Where Applicable)	N/A		
Product Standard:	CFR47 FCC Part 15.247 RSS-247	Limit Applied:	See report section 7.3
Input Voltage:	Internal Battery Powered		
Pretest Verification w/ Ambient Signals or BB Source:	N/A	Ambient Temperature:	23, 24 ºC
		Relative Humidity:	42, 36 %
		Atmospheric Pressure:	1005, 1001 mbars

Deviations, Additions, or Exclusions: None

8 Maximum Power Spectral Density

8.1 Method

Tests are performed in accordance with CFR47 FCC Part 15.247, RSS-247, and ANSI C63.10.

TEST SITE: 10m ALSE

The 10m ALSE is 13m (Length) x 21m (Depth) x 10m (Height) with the effective size in terms of space from the tips of the absorber is 12m (Length) x 20m (Depth) x 8.5m (Height). This chamber achieves broadband performance using a unique arrangement of hybrid and ferrite tile absorber. This chamber has a built in 3m diameter turntable (Embedded type). The metal structure of the table makes electrical connection around the entire circumference of the turntable to the ground plane with a metal brush type connection. The turntable is located on one end of the chamber and the antennas are mounted 3 and 10 meters away at the other end of the chamber on the adjustable an Antenna Mast. The antenna mast is a non-conductive bore sighted type with remote control of antenna height and polarization. The Antenna Mast and the turntable can be remotely controlled through the controller located in the adjacent Control room. A Styrofoam table 80 cm high is used for table-top equipment.

Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
Radiated Emissions, 10m	30-1000 MHz	4.6dB	6.3 dB
Radiated Emissions, 3m	30-1000 MHz	5.3 dB	6.3 dB
Radiated Emissions, 3m	1-6 GHz	4.5 dB	5.2 dB
Radiated Emissions, 3m	6-15 GHz	5.2 dB	5.5 dB
Radiated Emissions, 3m	15-18 GHz	5.0 dB	5.5 dB
Radiated Emissions, 3m	18-40 GHz	5.0 dB	5.5 dB

As shown in the table above our radiated emissions U_{lab} is less than the corresponding U_{CISPR} reference value in CISPR 16-4-2 Table 1, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required, based on CISPR 22 and CISPR 11 (for 2006 and later revisions) Clause 11.

Sample Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CF - AG
Where FS = Field Strength in dBμV/m
RA = Receiver Amplitude (including preamplifier) in dBμV
CF = Cable Attenuation Factor in dB
AF = Antenna Factor in dB
AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows.

Assume a receiver reading of 52.0 dBμV is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dBμV/m. This value in dBμV/m was converted to its corresponding level in μV/m.

RA = 52.0 dBμV
AF = 7.4 dB/m
CF = 1.6 dB
AG = 29.0 dB
FS = 32 dBμV/m

To convert from dBμV to μV or mV the following was used:

$UF = 10^{(NF / 20)}$ where UF = Net Reading in μV
NF = Net Reading in dBμV

Example:

FS = RA + AF + CF – AG = 52.0 + 7.4 + 1.6 – 29.0 = 32.0
$UF = 10^{(32\ dB\mu V / 20)}$ = 39.8 μV/m

Alternately, when BAT-EMC Emission Software is used, the “Level” includes all losses and gains and is compared directly in the “Margin” column to the “Limit”. The “Correction” includes Antenna Factor, Preamp, and Cable Loss. These are already accounted for in the “Level” column.

8.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV001'	Weather Station	Davis Instruments	7400	PE80519A61	01/23/2019	01/23/2020
EMC02'	ANTENNA, RIDGED GUIDE, 1-18 GHZ	EMCO	3115	2784	08/16/2018	08/16/2019
145-416'	Cables 145-420 145-423 145-425 145-408	Huber + Suhner	3m Track B cables	multiple	07/25/2018	07/25/2019
145128'	EMI Receiver (20 Hz - 40 Ghz)	Rohde & Schwarz	ESIB 40	839283/001	03/28/2019	03/28/2020

Software Utilized:

Name	Manufacturer	Version
None	--	--

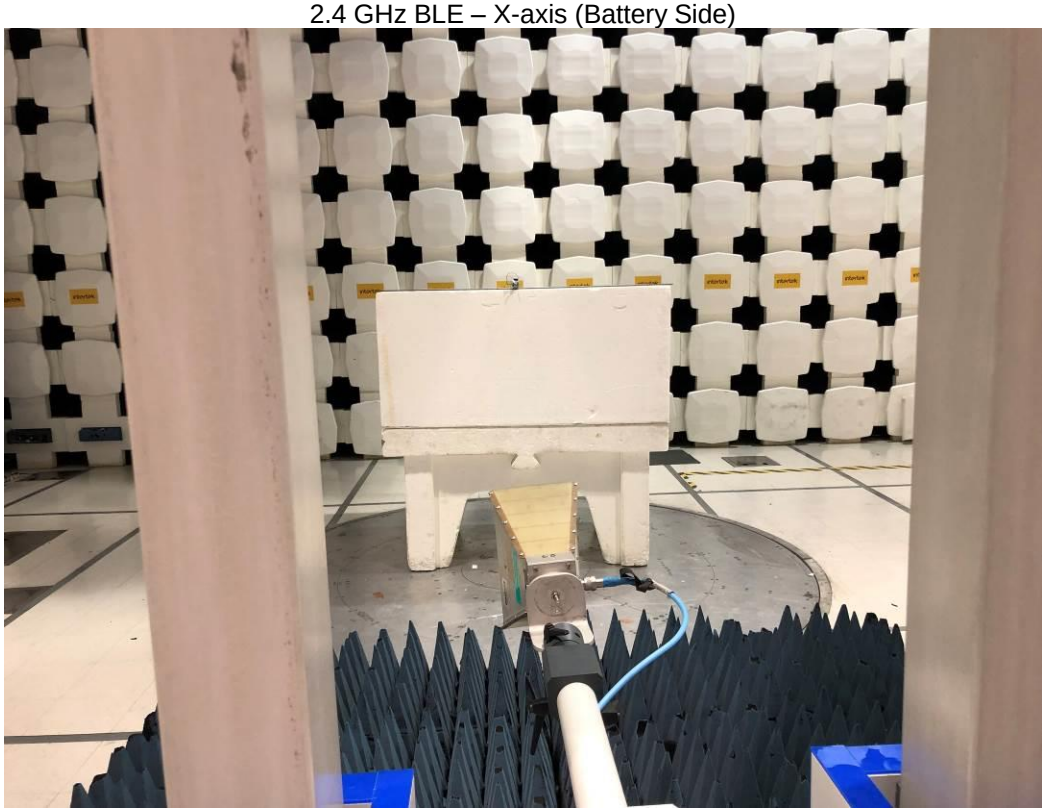
8.3 Results:

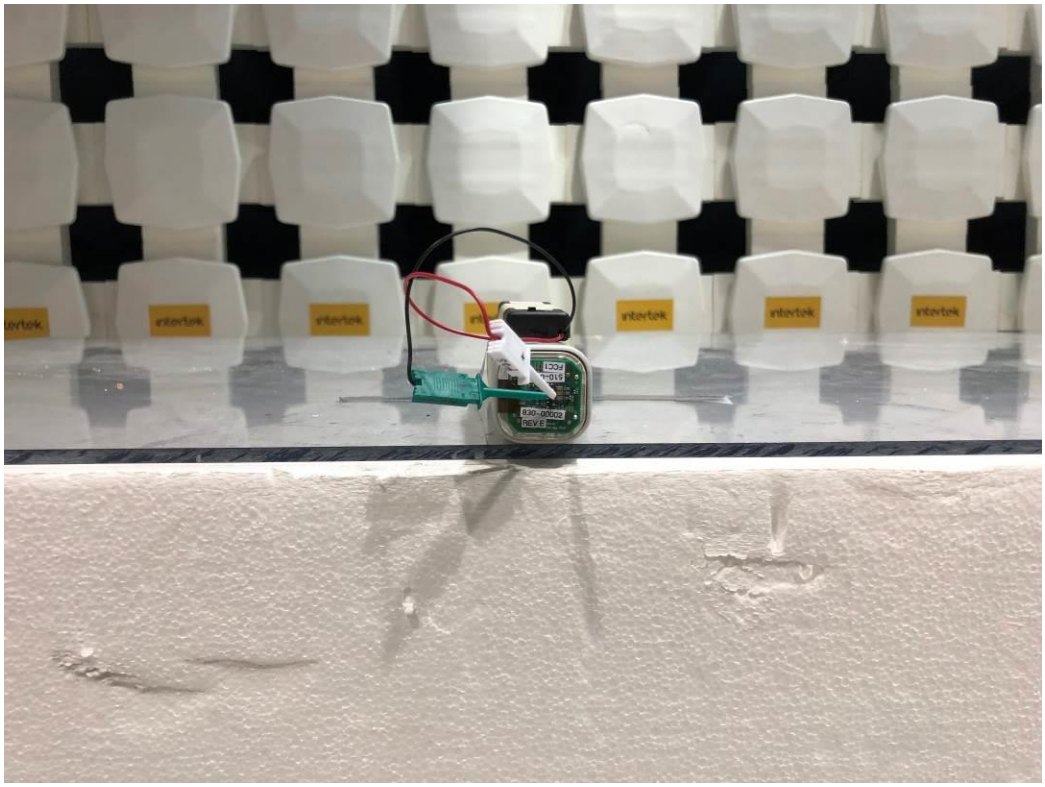
The sample tested was found to Comply.

§15.247 (e) For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

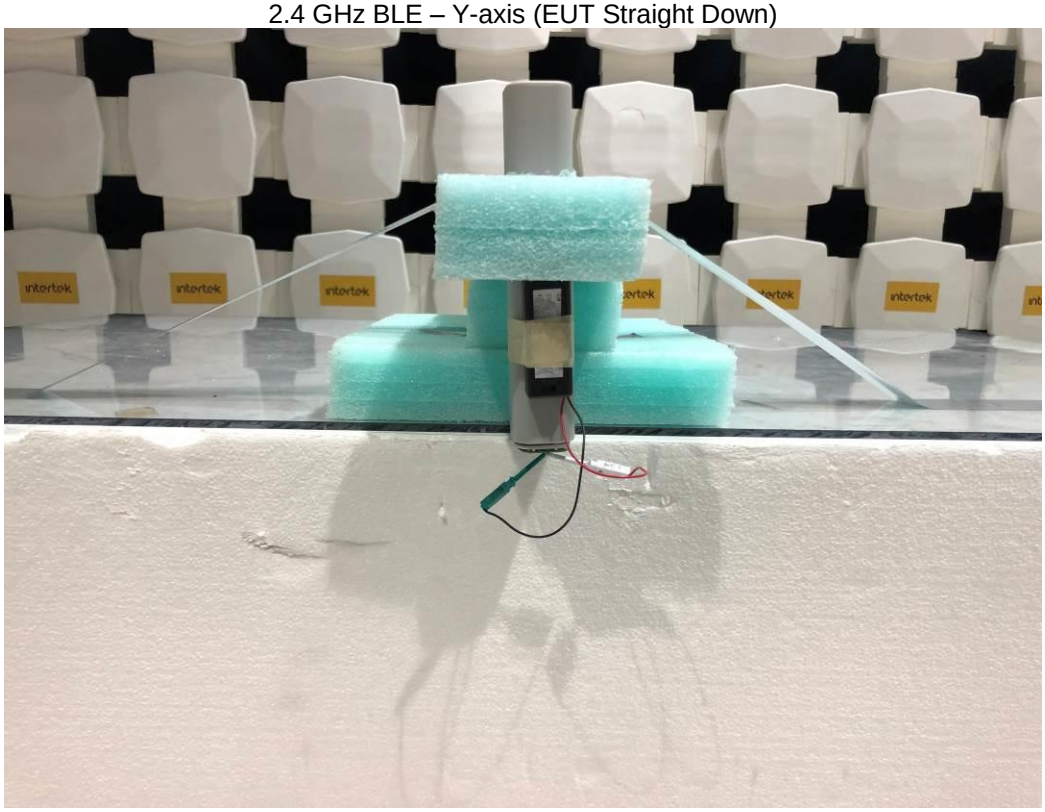
8.4 Setup Photograph:

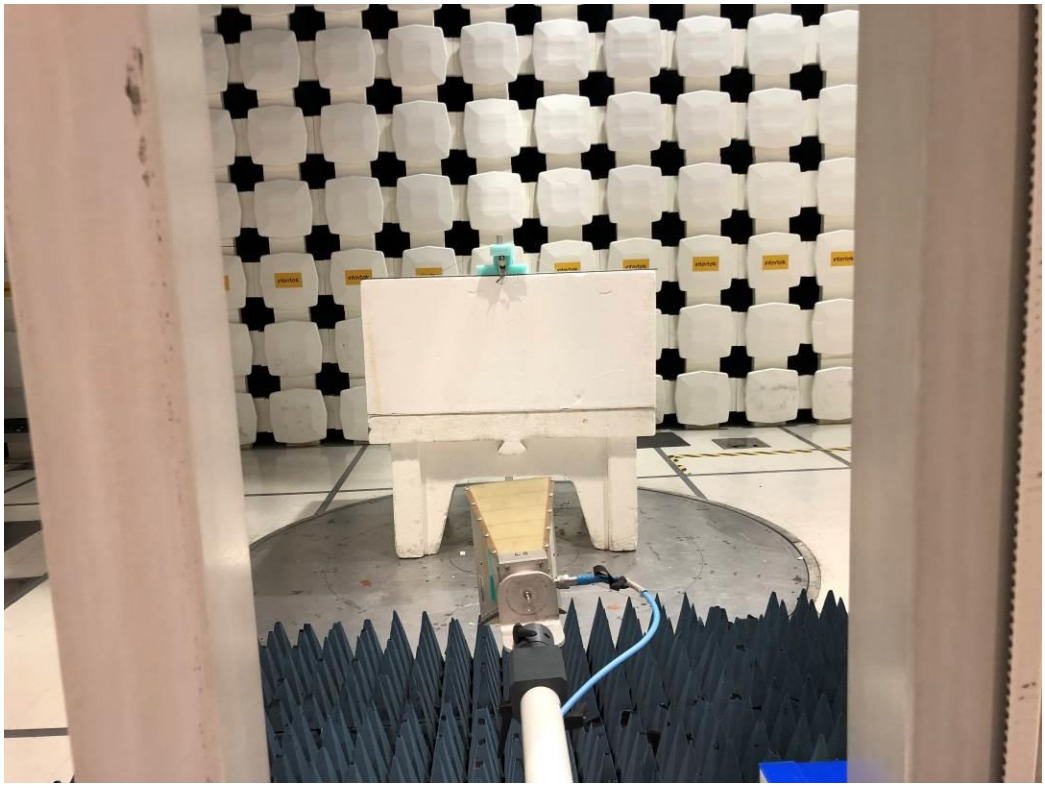
2.4 GHz BLE – X-axis (Battery Side)



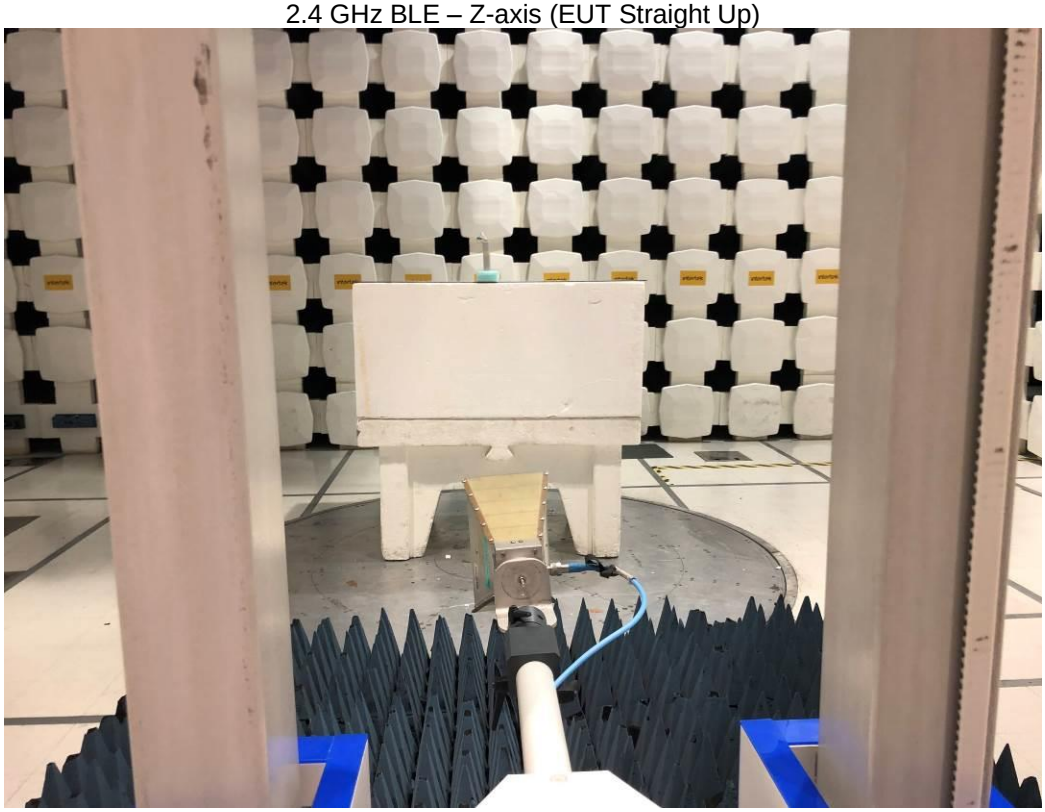


2.4 GHz BLE – Y-axis (EUT Straight Down)





2.4 GHz BLE – Z-axis (EUT Straight Up)



8.5 Test Data:

Low Channel Power Spectral Density (EIRP)

Company: Renovia | Antenna & Cables: LF | Bands: N, LF, HF, SHF
Model #: leva-02 | Antenna: EMC02 V3m_08-16-19.txt | EMC02 H3m_08-16-19.txt
Serial #: 830-00002 REV E | Cable(s): 145-416_7-25-19.txt | NONE.
Engineers: Kouma Sinn | Location: 10m chamber | Barometer: DAV002 | Filter: NONE
Project #: G103622007 | Date(s): 06/17/19
Standard: FCC Part 15.247 | Temp/Humidity/Pressure: 23C | 42% | 1005mbar
Receiver: 145128 | Limit Distance (m): 3
PreAmp: NONE. | Test Distance (m): 3
PreAmp Used? (Y or N): N | Voltage/Frequency: Internal battery | Frequency Range: 2402 MHz

Net = Reading (dBuV/m) + Antenna Factor (dB1/m) + Cable Loss (dB) - Preamp Factor (dB) - Distance Factor (dB)
Peak: PK Quasi-Peak: QP Average: AVG RMS: RMS; NF = Noise Floor, RB = Restricted Band; Bandwidth denoted as RBW/VBW

Detector Type	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	EIRP Net dBm	EIRP Limit dBm	Margin dB	Bandwidth
EIRP (dBm) = E (dBµV/m) + 20log(D) − 104.8; where D is the measurement distance in meters□											
Low Channel, Flat battery side up											
PK	V	2402.000	44.69	28.45	6.22	0.00	0.00	-15.90	8.00	-23.90	3/30kHz
PK	H	2402.000	53.40	28.49	6.22	0.00	0.00	-7.15	8.00	-15.15	3/30kHz
Low Channel, EUT pointing up											
PK	V	2402.000	46.27	28.45	6.22	0.00	0.00	-14.32	8.00	-22.32	3/30kHz
PK	H	2402.000	44.50	28.49	6.22	0.00	0.00	-16.05	8.00	-24.05	3/30kHz
Low Channel, EUT pointing down											
PK	V	2402.000	47.38	28.45	6.22	0.00	0.00	-13.21	8.00	-21.21	3/30kHz
PK	H	2402.000	47.98	28.49	6.22	0.00	0.00	-12.57	8.00	-20.57	3/30kHz

Mid Channel Power Spectral Density (EIRP)

Company: Renovia
Model #: leva-02
Serial #: 830-00002 REV E
Engineers: Kouma Sinn
Project #: G103622007
Standard: FCC Part 15.247
Receiver: 145128
PreAmp: NONE.
Date(s): 06/23/19
Location: 10m chamber
Limit Distance (m): 3
Test Distance (m): 3
PreAmp Used? (Y or N): N
Voltage/Frequency: Internal battery
Antenna & Cables: LF
Antenna: EMC02 V3m_08-16-19.txt
Cable(s): 145-416_7-25-19.txt
Barometer: DAV002
Temp/Humidity/Pressure: 24C
Bands: N, LF, HF, SHF
EMC02 H3m_08-16-19.txt
NONE.
Filter: NONE
36%
1001mbar
Frequency Range: 2442 MHz

Net = Reading (dBuV/m) + Antenna Factor (dB1/m) + Cable Loss (dB) - Preamp Factor (dB) - Distance Factor (dB)

Peak: PK Quasi-Peak: QP Average: AVG RMS: RMS; NF = Noise Floor, RB = Restricted Band; Bandwidth denoted as RBW/VBW

Detector Type	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	EIRP Net dBm	EIRP Limit dBm	Margin dB	Bandwidth
EIRP (dBm) = E (dBµV/m) + 20log(D) − 104.8; where D is the measurement distance in meters											
Mid Channel, Flat battery up											
PK	V	2442.000	45.63	28.48	6.25	0.00	0.00	-14.90	8.00	-22.90	3/30kHz
PK	H	2442.000	37.32	28.49	6.25	0.00	0.00	-23.20	8.00	-31.20	3/30kHz
Mid Channel, EUT pointing up											
PK	V	2442.000	42.30	28.48	6.25	0.00	0.00	-18.23	8.00	-26.23	3/30kHz
PK	H	2442.000	41.19	28.49	6.25	0.00	0.00	-19.33	8.00	-27.33	3/30kHz
Mid Channel, EUT pointing down											
PK	V	2442.000	45.87	28.48	6.25	0.00	0.00	-14.66	8.00	-22.66	3/30kHz
PK	H	2442.000	41.30	28.49	6.25	0.00	0.00	-19.22	8.00	-27.22	3/30kHz

High Channel Power Spectral Density (EIRP)

Company: Renovia
Model #: leva-02
Serial #: 830-00002 REV E
Engineers: Kouma Sinn
Project #: G103622007
Standard: FCC Part 15.247
Receiver: 145128
PreAmp: NONE.
Date(s): 06/23/19
Location: 10m chamber
Limit Distance (m): 3
Test Distance (m): 3
PreAmp Used? (Y or N): N
Voltage/Frequency: Internal battery
Antenna & Cables: LF
Antenna: EMC02 V3m_08-16-19.txt
Cable(s): 145-416_7-25-19.txt
Barometer: DAV002
Temp/Humidity/Pressure: 24C
Bands: N, LF, HF, SHF
EMC02 H3m_08-16-19.txt
NONE.
Filter: NONE
36%
1001mbar
Frequency Range: 2480 MHz

Net = Reading (dBuV/m) + Antenna Factor (dB1/m) + Cable Loss (dB) - Preamp Factor (dB) - Distance Factor (dB)

Peak: PK Quasi-Peak: QP Average: AVG RMS: RMS; NF = Noise Floor, RB = Restricted Band; Bandwidth denoted as RBW/VBW

Detector Type	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	EIRP Net dBm	EIRP Limit dBm	Margin dB	Bandwidth
EIRP (dBm) = E (dBµV/m) + 20log(D) − 104.8; where D is the measurement distance in meters											
High Channel, Flat battery up											
PK	V	2480.000	42.03	28.45	6.29	0.00	0.00	-18.49	8.00	-26.49	3/30kHz
PK	H	2480.000	46.50	28.52	6.29	0.00	0.00	-13.95	8.00	-21.95	3/30kHz
High Channel, EUT pointing up											
PK	V	2480.000	43.78	28.45	6.29	0.00	0.00	-16.74	8.00	-24.74	3/30kHz
PK	H	2480.000	39.62	28.52	6.29	0.00	0.00	-20.83	8.00	-28.83	3/30kHz
High Channel, EUT pointing down											
PK	V	2480.000	46.17	28.45	6.29	0.00	0.00	-14.35	8.00	-22.35	3/30kHz
PK	H	2480.000	39.04	28.52	6.29	0.00	0.00	-21.41	8.00	-29.41	3/30kHz

Test Personnel: Kouma Sinn KPS
Test Date: 06/17/2019, 06/23/2019
Supervising/Reviewing Engineer: (Where Applicable) N/A
Product Standard: CFR47 FCC Part 15.247 RSS-247
Limit Applied: See report section 8.3
Input Voltage: Internal Battery Powered
Pretest Verification w/ Ambient Signals or BB Source: N/A
Ambient Temperature: 23, 24 ºC
Relative Humidity: 42, 36 %
Atmospheric Pressure: 1005, 1001 mbars

Deviations, Additions, or Exclusions: None

9 Band Edge Compliance

9.1 Method

Tests are performed in accordance with FCC Part 15 Subpart C 15.247 RSS 247, and ANSI C 63.10.

TEST SITE: 10m ALSE

The 10m ALSE is 13m (Length) x 21m (Depth) x 10m (Height) with the effective size in terms of space from the tips of the absorber is 12m (Length) x 20m (Depth) x 8.5m (Height). This chamber achieves broadband performance using a unique arrangement of hybrid and ferrite tile absorber. This chamber has a built in 3m diameter turntable (Embedded type). The metal structure of the table makes electrical connection around the entire circumference of the turntable to the ground plane with a metal brush type connection. The turntable is located on one end of the chamber and the antennas are mounted 3 and 10 meters away at the other end of the chamber on the adjustable an Antenna Mast. The antenna mast is a non-conductive bore sighted type with remote control of antenna height and polarization. The Antenna Mast and the turntable can be remotely controlled through the controller located in the adjacent Control room. A Styrofoam table 80 cm high is used for table-top equipment.

Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
Radiated Emissions, 10m	30-1000 MHz	4.6dB	6.3 dB
Radiated Emissions, 3m	30-1000 MHz	5.3 dB	6.3 dB
Radiated Emissions, 3m	1-6 GHz	4.5 dB	5.2 dB
Radiated Emissions, 3m	6-15 GHz	5.2 dB	5.5 dB
Radiated Emissions, 3m	15-18 GHz	5.0 dB	5.5 dB
Radiated Emissions, 3m	18-40 GHz	5.0 dB	5.5 dB

As shown in the table above our radiated emissions U_{lab} is less than the corresponding U_{CISPR} reference value in CISPR 16-4-2 Table 1, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required, based on CISPR 22 and CISPR 11 (for 2006 and later revisions) Clause 11.

Sample Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CF - AG
Where FS = Field Strength in dBμV/m
RA = Receiver Amplitude (including preamplifier) in dBμV
CF = Cable Attenuation Factor in dB
AF = Antenna Factor in dB
AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows.

Assume a receiver reading of 52.0 dBμV is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dBμV/m. This value in dBμV/m was converted to its corresponding level in μV/m.

RA = 52.0 dBμV
AF = 7.4 dB/m
CF = 1.6 dB
AG = 29.0 dB
FS = 32 dBμV/m

To convert from dBμV to μV or mV the following was used:

$UF = 10^{(NF / 20)}$ where UF = Net Reading in μV
NF = Net Reading in dBμV

Example:

FS = RA + AF + CF – AG = 52.0 + 7.4 + 1.6 – 29.0 = 32.0
$UF = 10^{(32\ dB\mu V / 20)}$ = 39.8 μV/m

9.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV001'	Weather Station	Davis Instruments	7400	PE80519A61	01/23/2019	01/23/2020
EMC02'	ANTENNA, RIDGED GUIDE, 1-18 GHZ	EMCO	3115	2784	08/16/2018	08/16/2019
145-416'	Cables 145-420 145-423 145-425 145-408	Huber + Suhner	3m Track B cables	multiple	07/25/2018	07/25/2019
145128'	EMI Receiver (20 Hz - 40 Ghz)	Rohde & Schwarz	ESIB 40	839283/001	03/28/2019	03/28/2020

Software Utilized:

Name	Manufacturer	Version
None	--	--

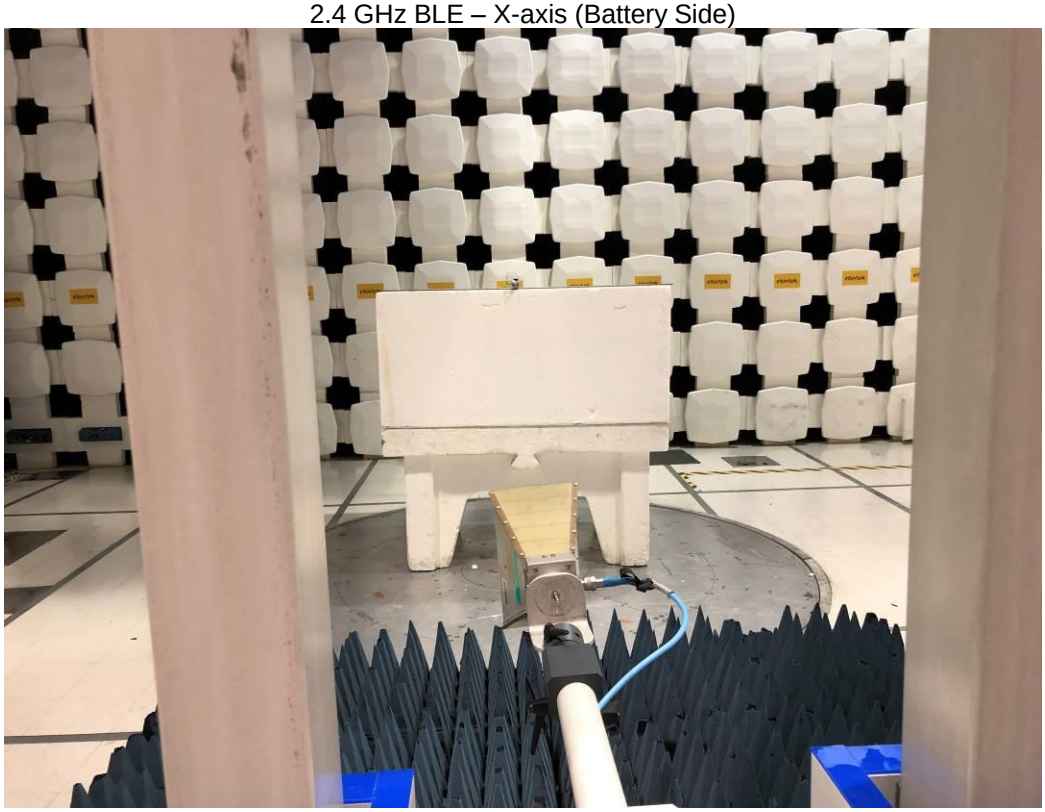
9.3 Results:

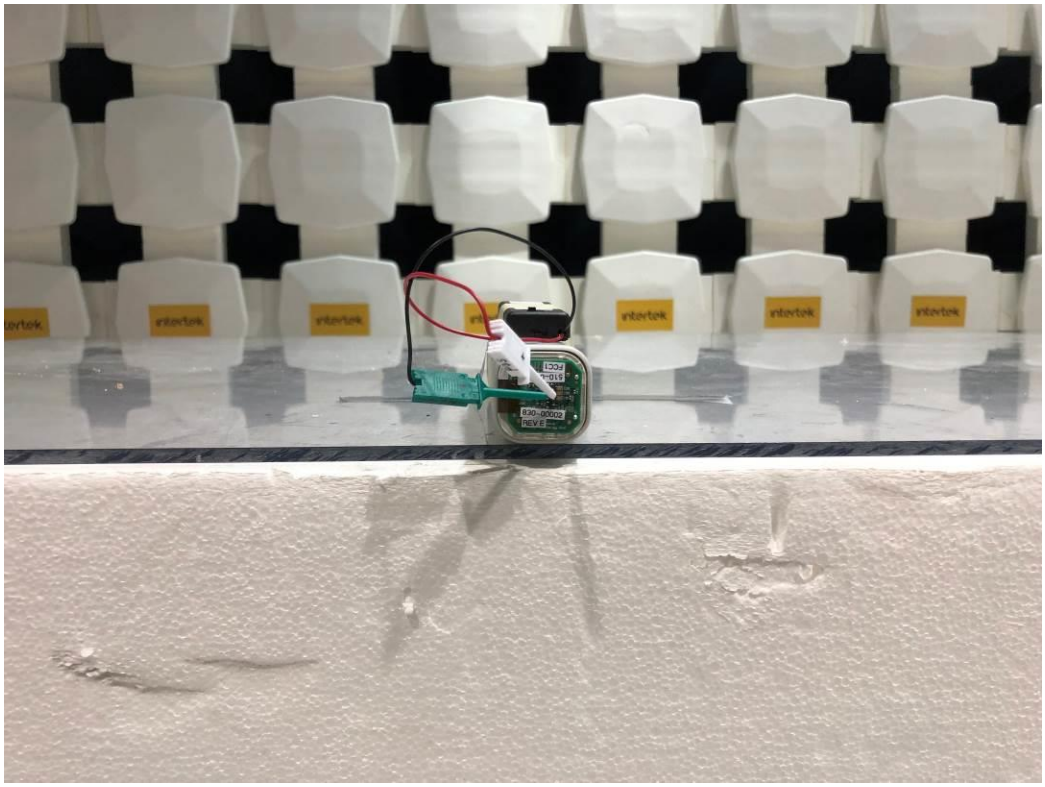
The sample tested was found to Comply.

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

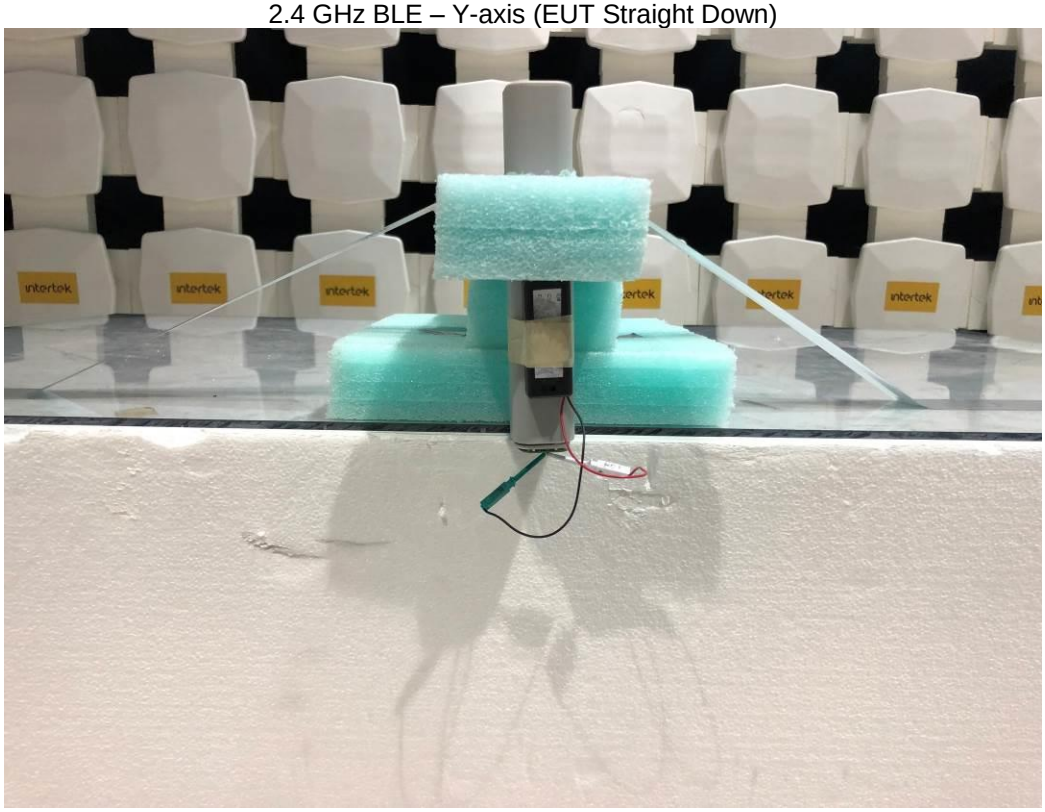
9.4 Setup Photograph:

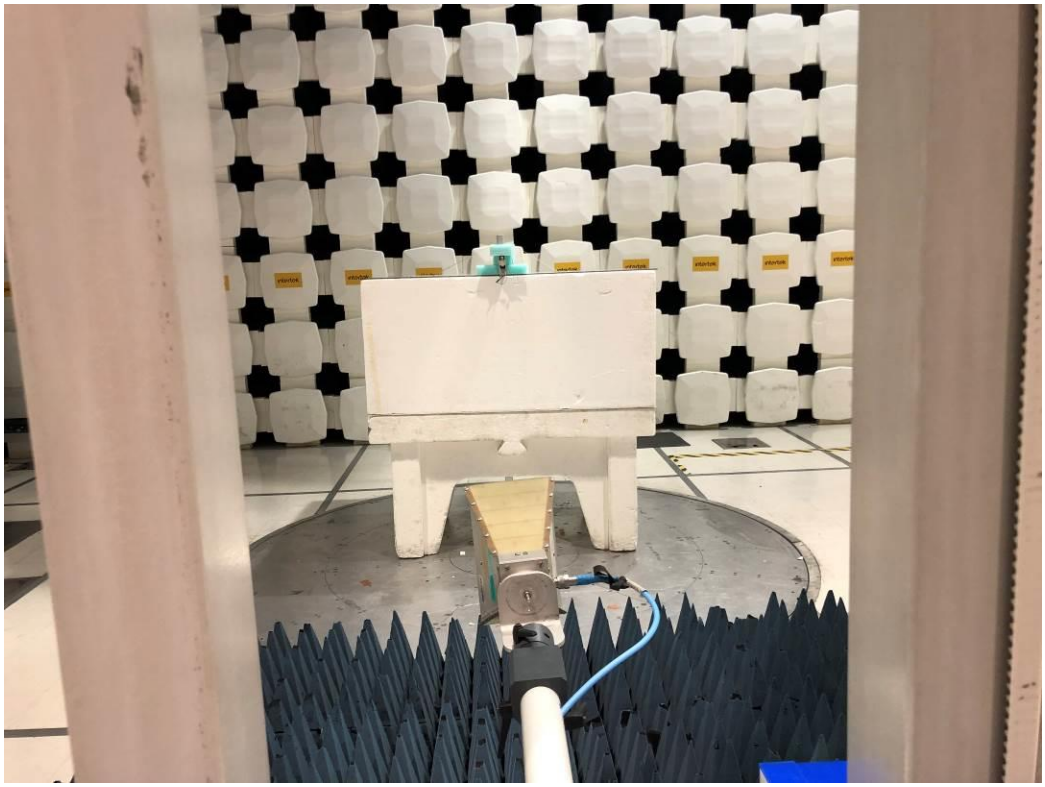
2.4 GHz BLE – X-axis (Battery Side)



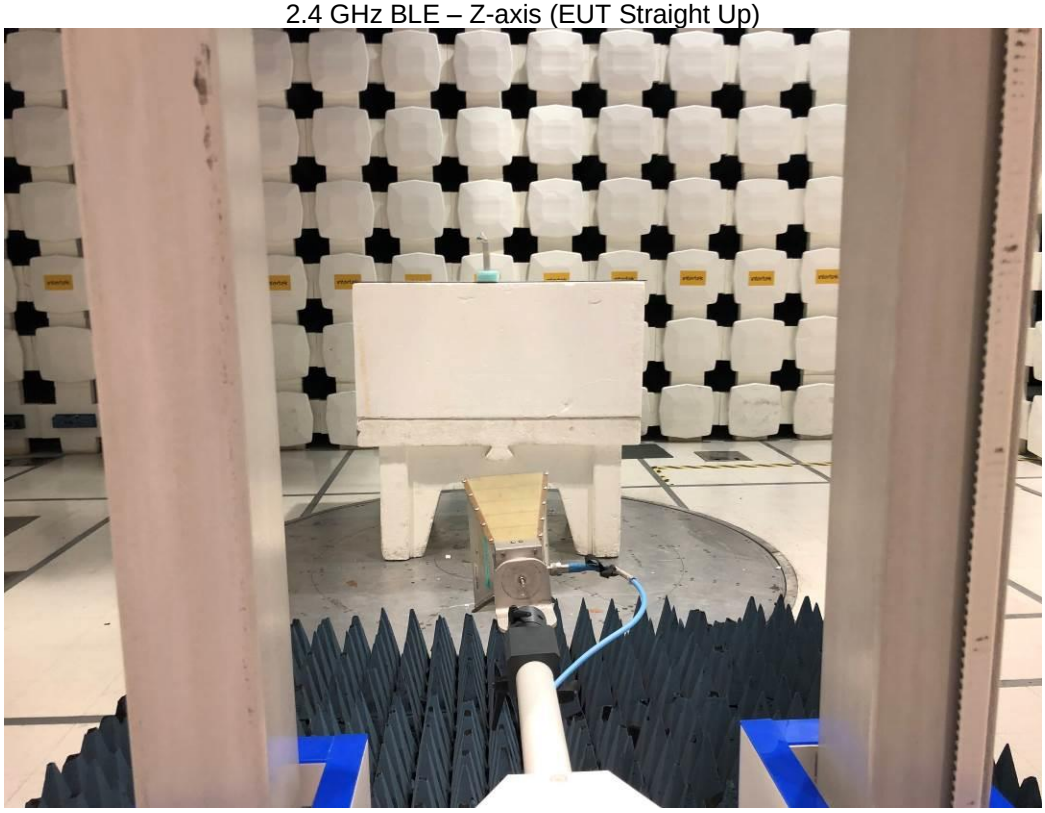


2.4 GHz BLE – Y-axis (EUT Straight Down)



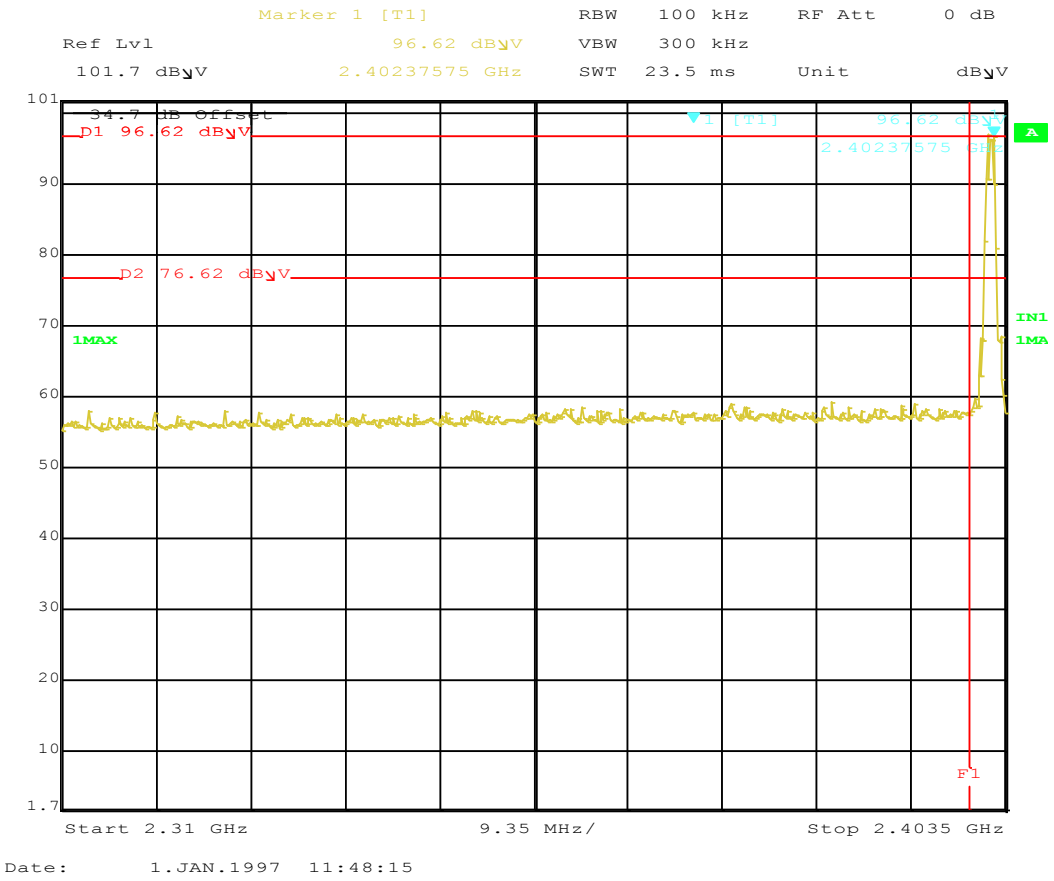


2.4 GHz BLE – Z-axis (EUT Straight Up)



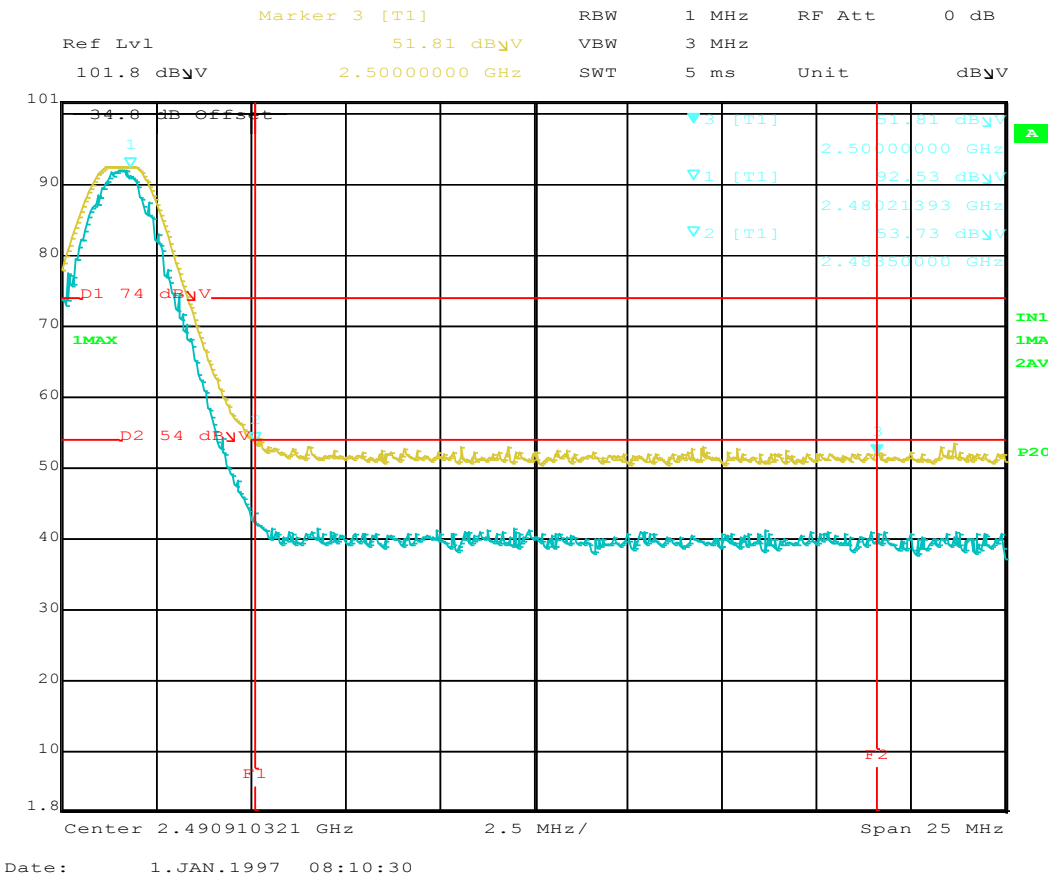
9.5 Plots/Data:

2.4 GHz BLE Lower Band Edge



Notes: The limit is 20 dB below the carrier with 100kHz ResBW. The date on the plot is default date on the instrument.

2.4 GHz BLE Upper Band Edge



Notes: The limit is 74 dBuV/m Peak and 54 dBuV/m Average. The yellow trace is Peak and blue trace is average. The frequency from F1 (2483.5 MHz) to F2 (2500 MHz) is the restricted band.

Test Personnel:	Kouma Sinn KPS	Test Date:	06/17/2019, 06/23/2019
Supervising/Reviewing Engineer: (Where Applicable)	N/A		
Product Standard:	CFR47 FCC Part 15.247 RSS-247, RSS-102	Limit Applied:	See report section 9.3
Input Voltage:	Internal Battery Powered		
Pretest Verification w/ Ambient Signals or BB Source:	N/A	Ambient Temperature:	23, 24 ºC
		Relative Humidity:	42, 36 %
		Atmospheric Pressure:	1005, 1001 mbars

Deviations, Additions, or Exclusions: None

10 Transmitter spurious emissions

10.1 Method

Tests are performed in accordance with FCC Part 15 Subpart C 15.247, FCC Part 15 Subpart B, RSS 247 ICES 003, ANSI C 63.10, and ANSI C 63.4.

TEST SITE: 10m ALSE

The 10m ALSE is 13m (Length) x 21m (Depth) x 10m (Height) with the effective size in terms of space from the tips of the absorber is 12m (Length) x 20m (Depth) x 8.5m (Height). This chamber achieves broadband performance using a unique arrangement of hybrid and ferrite tile absorber. This chamber has a built in 3m diameter turntable (Embedded type). The metal structure of the table makes electrical connection around the entire circumference of the turntable to the ground plane with a metal brush type connection. The turntable is located on one end of the chamber and the antennas are mounted 3 and 10 meters away at the other end of the chamber on the adjustable an Antenna Mast. The antenna mast is a non-conductive bore sighted type with remote control of antenna height and polarization. The Antenna Mast and the turntable can be remotely controlled through the controller located in the adjacent Control room. A Styrofoam table 80 cm high is used for table-top equipment.

Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
Radiated Emissions, 10m	30-1000 MHz	4.6dB	6.3 dB
Radiated Emissions, 3m	30-1000 MHz	5.3 dB	6.3 dB
Radiated Emissions, 3m	1-6 GHz	4.5 dB	5.2 dB
Radiated Emissions, 3m	6-15 GHz	5.2 dB	5.5 dB
Radiated Emissions, 3m	15-18 GHz	5.0 dB	5.5 dB
Radiated Emissions, 3m	18-40 GHz	5.0 dB	5.5 dB

As shown in the table above our radiated emissions U_{lab} is less than the corresponding U_{CISPR} reference value in CISPR 16-4-2 Table 1, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required, based on CISPR 22 and CISPR 11 (for 2006 and later revisions) Clause 11.

Sample Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CF - AG
Where FS = Field Strength in dBμV/m
RA = Receiver Amplitude (including preamplifier) in dBμV
CF = Cable Attenuation Factor in dB
AF = Antenna Factor in dB
AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows.

Assume a receiver reading of 52.0 dBμV is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dBμV/m. This value in dBμV/m was converted to its corresponding level in μV/m.

RA = 52.0 dBμV
AF = 7.4 dB/m
CF = 1.6 dB
AG = 29.0 dB
FS = 32 dBμV/m

To convert from dBμV to μV or mV the following was used:

$UF = 10^{(NF / 20)}$ where UF = Net Reading in μV
NF = Net Reading in dBμV

Example:

FS = RA + AF + CF – AG = 52.0 + 7.4 + 1.6 – 29.0 = 32.0
$UF = 10^{(32\ dB\mu V / 20)}$ = 39.8 μV/m

Alternately, when BAT-EMC Emission Software is used, the “Level” includes all losses and gains and is compared directly in the “Margin” column to the “Limit”. The “Correction” includes Antenna Factor, Preamp, and Cable Loss. These are already accounted for in the “Level” column.

10.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV001'	Weather Station	Davis Instruments	7400	PE80519A61	01/23/2019	01/23/2020
EMC02'	ANTENNA, RIDGED GUIDE, 1-18 GHZ	EMCO	3115	2784	08/16/2018	08/16/2019
145-416'	Cables 145-420 145-423 145-425 145-408	Huber + Suhner	3m Track B cables	multiple	07/25/2018	07/25/2019
145128'	EMI Receiver (20 Hz - 40 Ghz)	Rohde & Schwarz	ESIB 40	839283/001	03/28/2019	03/28/2020
145-416'	Cables 145-420 145-423 145-425 145-408	Huber + Suhner	3m Track B cables	multiple	07/25/2018	07/25/2019
145-410'	Cables 145-420 145-421 145-422 145-406	Huber + Suhner	10m Track A Cables	multiple	07/25/2018	07/25/2019
PRE11'	50dB gain pre-amp	Keith H	PRE11	PRE11	10/27/2018	10/27/2019
BONN001'	1-18GHz low noise pre-amp	Bonn	BLMA 0118-M	1811749	07/10/2018	07/10/2019
EMC04'	ANTENNA, RIDGED GUIDE, 18-40 GHZ	EMCO	3116	2090	10/26/2018	10/26/2019
CBLSHF102'	Cable, SMA - SMA, 9kHz-40GHz (Cable Kit 5)	Sucoflex (Huber Suhn	104PE	CBLSHF102	09/13/2018	09/13/2019
REA008'	band reject filter 2.4GHz	Reactel, Inc	12RX7-2441.75-x140 S	17-01	07/13/2018	07/13/2019
CBLHF2012-2M-1'	2m 9kHz-40GHz Coaxial Cable - SET1	Huber & Suhner	SF102	252675001	02/01/2019	02/01/2020
PRE8'	PREAMPLFIER 1- 40 GHz	MITEQ	NSP4000-NF	507145	10/25/2018	10/25/2019
REA006'	18GHz High Pass Filter	Reactel, Inc	7HS-18G/40G K11	(06)1	02/25/2019	02/25/2020
145145'	Broadband Hybrid Antenna 30 MHz - 3 GHz	Sunol Sciences Corp.	JB3	A122313	06/12/2019	06/12/2020

Software Utilized:

Name	Manufacturer	Version
BAT-EMC	Nexio	3.17.0.3
EMI Boxborough.xls	Intertek	08/27/2010

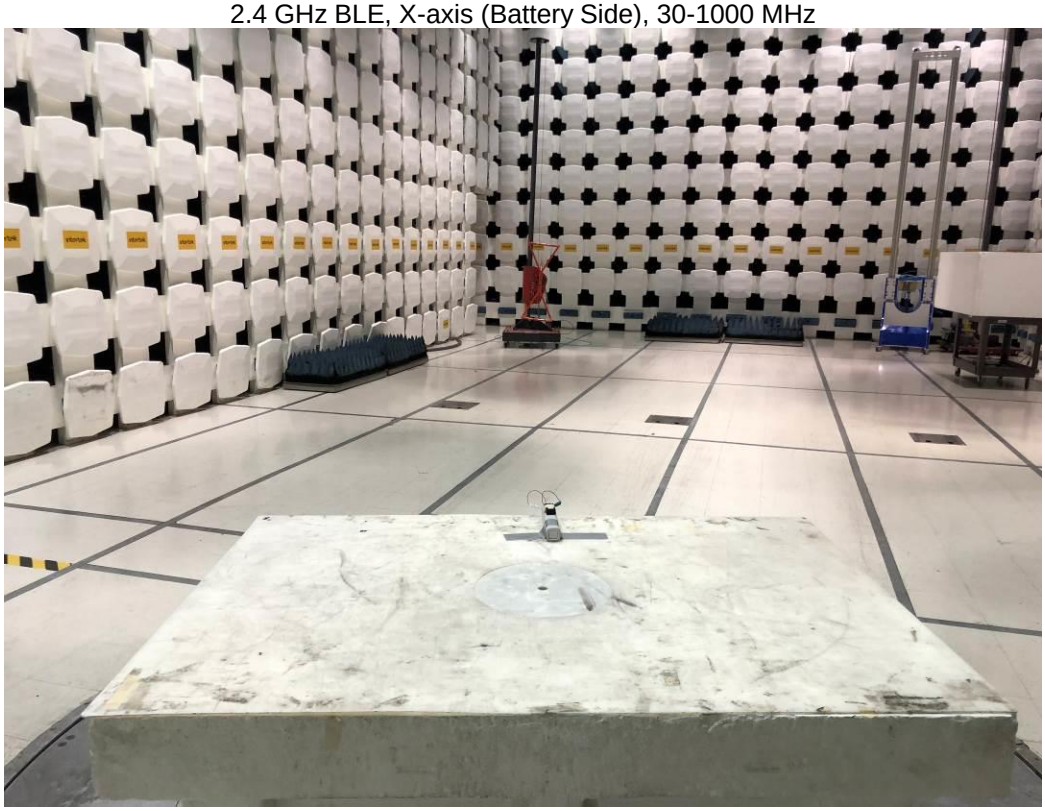
10.3 Results:

The sample tested was found to Comply.

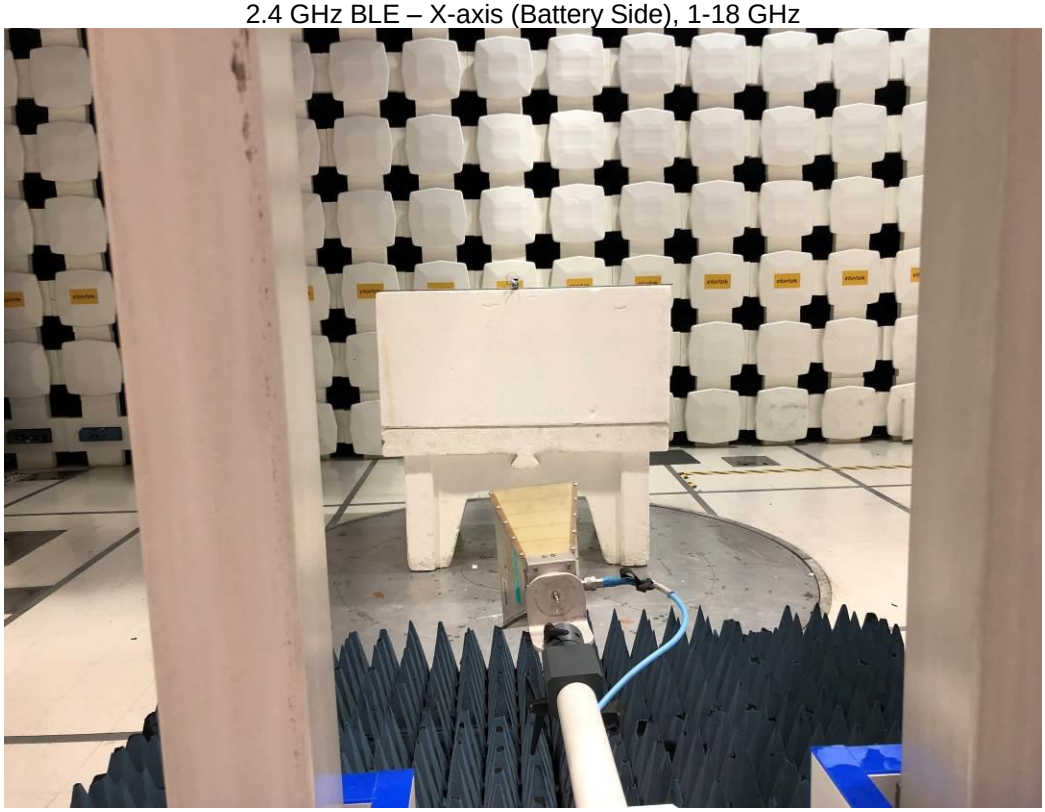
15.247 (d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that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

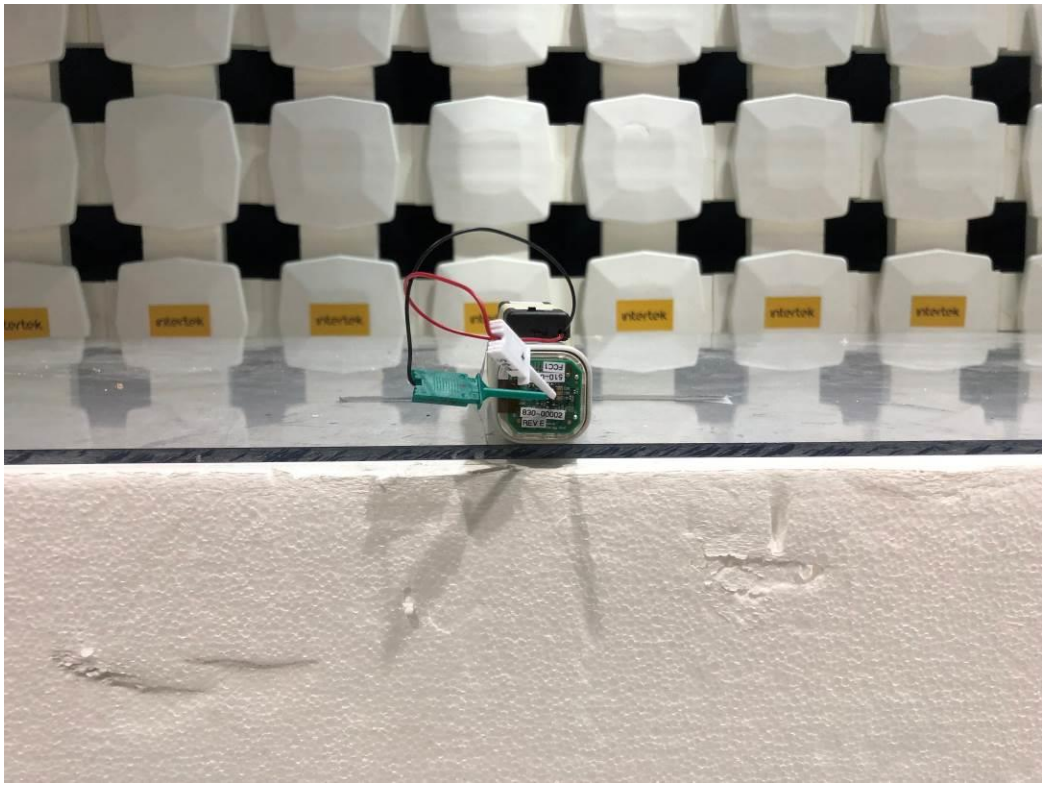
10.4 Setup Photographs:

2.4 GHz BLE, X-axis (Battery Side), 30-1000 MHz

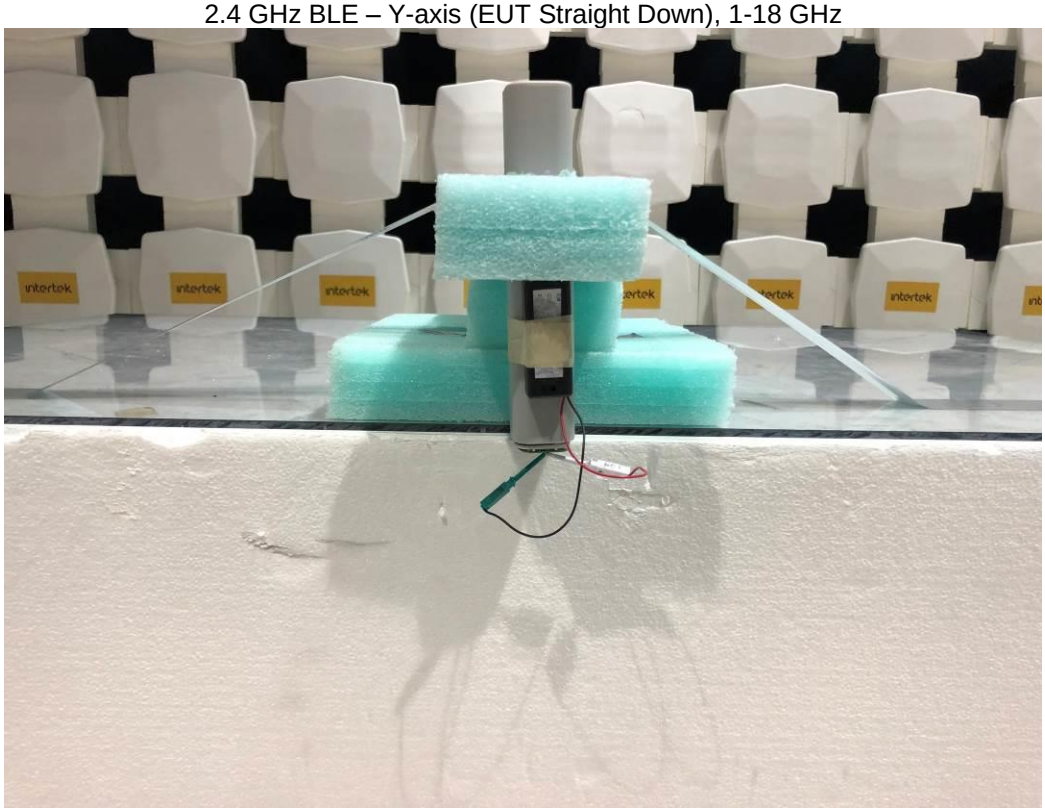


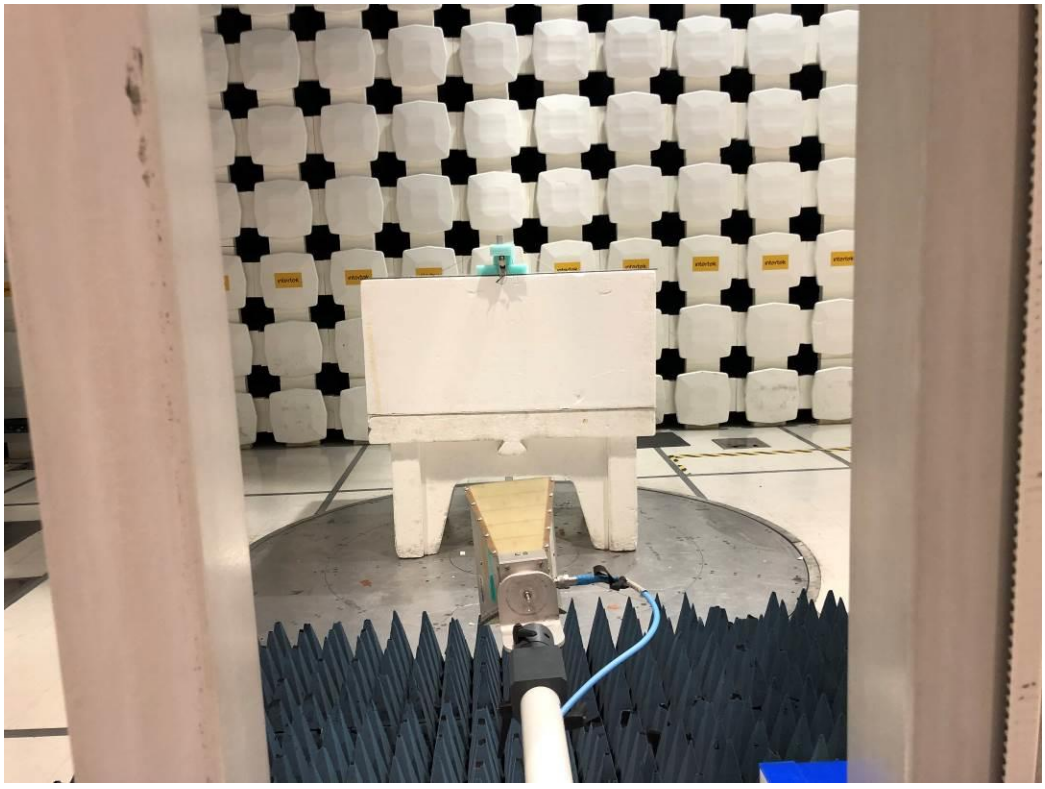
2.4 GHz BLE – X-axis (Battery Side), 1-18 GHz



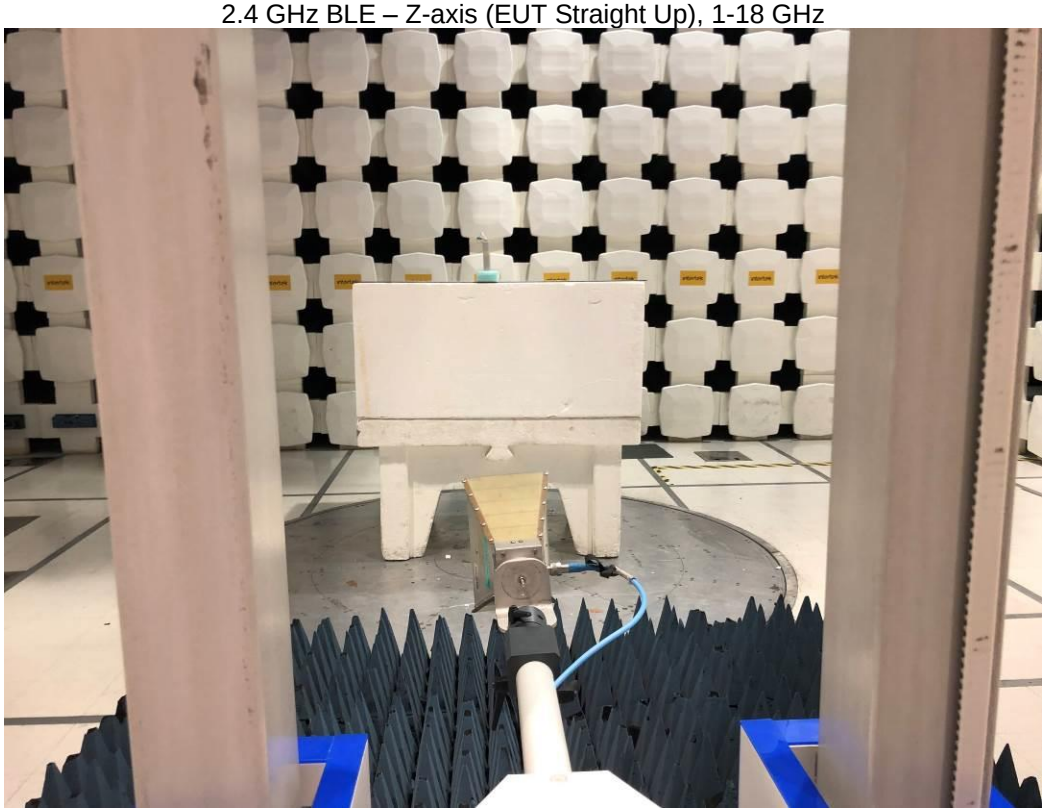


2.4 GHz BLE – Y-axis (EUT Straight Down), 1-18 GHz

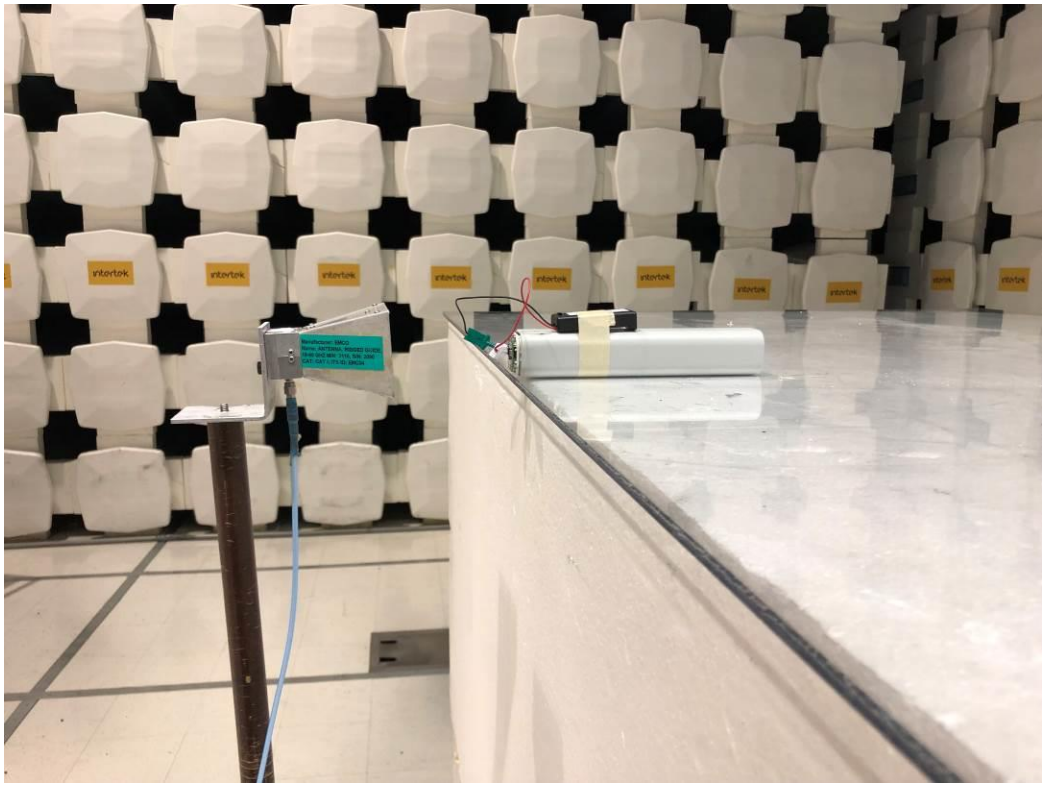




2.4 GHz BLE – Z-axis (EUT Straight Up), 1-18 GHz



2.4 GHz BLE, 18-25 GHz



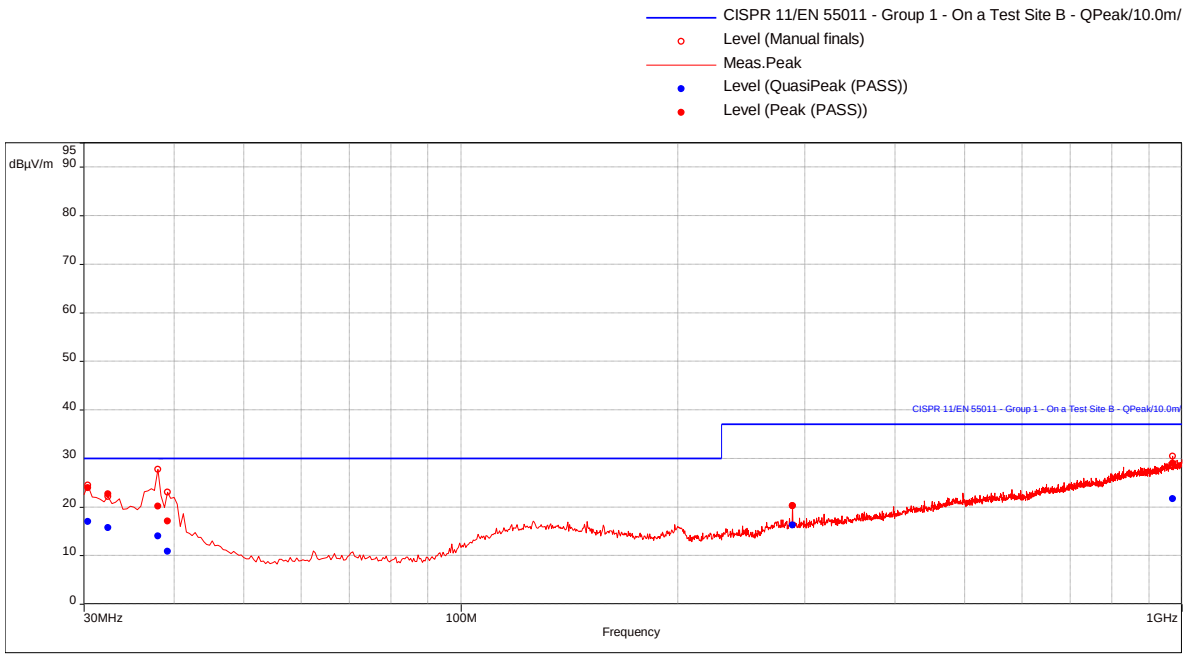
10.5 Plots/Data:

2.4 GHz BLE – Transmit at Low Channel (X-axis), 30-1000 MHz

Test Information:

Date and Time	6/17/2019 9:57:04 PM
Client and Project Number	Renovia
Engineer	Kouma Sinn
Temperature	23C
Humidity	42%
Atmospheric Pressure	1005mbar
Comments	30-1000MHz SA mode_Tx at low channel_Battery Side Up (Worst-case)

Graph:



Results:

QuasiPeak (PASS) (6)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
30.46315789	17.01	30.00	-12.99	359.00	1.00	Vertical	120000.00	-12.63
32.49473684	15.68	30.00	-14.32	99.00	3.73	Vertical	120000.00	-13.81
38.09473684	14.04	30.00	-15.96	55.00	3.12	Vertical	120000.00	-17.52
39.38947368	10.85	30.00	-19.15	32.00	1.02	Vertical	120000.00	-18.49
288.5263158	16.26	37.00	-20.74	277.00	1.00	Vertical	120000.00	-18.19
970.6421053	21.67	37.00	-15.33	359.00	1.97	Vertical	120000.00	-5.18

Notes: Only low channel on x-axis was performed from 30-1000 MHz.

2.4 GHz BLE – Transmit at Low Channel (X-axis), 1-3 GHz

Test Information:

Date and Time	6/17/2019 4:59:17 PM
Client and Project Number	Renovia
Engineer	Kouma Sinn
Temperature	23C
Humidity	42%
Atmospheric Pressure	1005mbar
Comments	1 to 3 GHz SA mode_Tx @ low channel 2402 MHz

Graph:

Results:

Peak (PASS) (1)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
1384.210526	42.74	74.00	-31.26	267.00	1.55	Horizontal	1000000.00	-22.61

Average (PASS) (1)

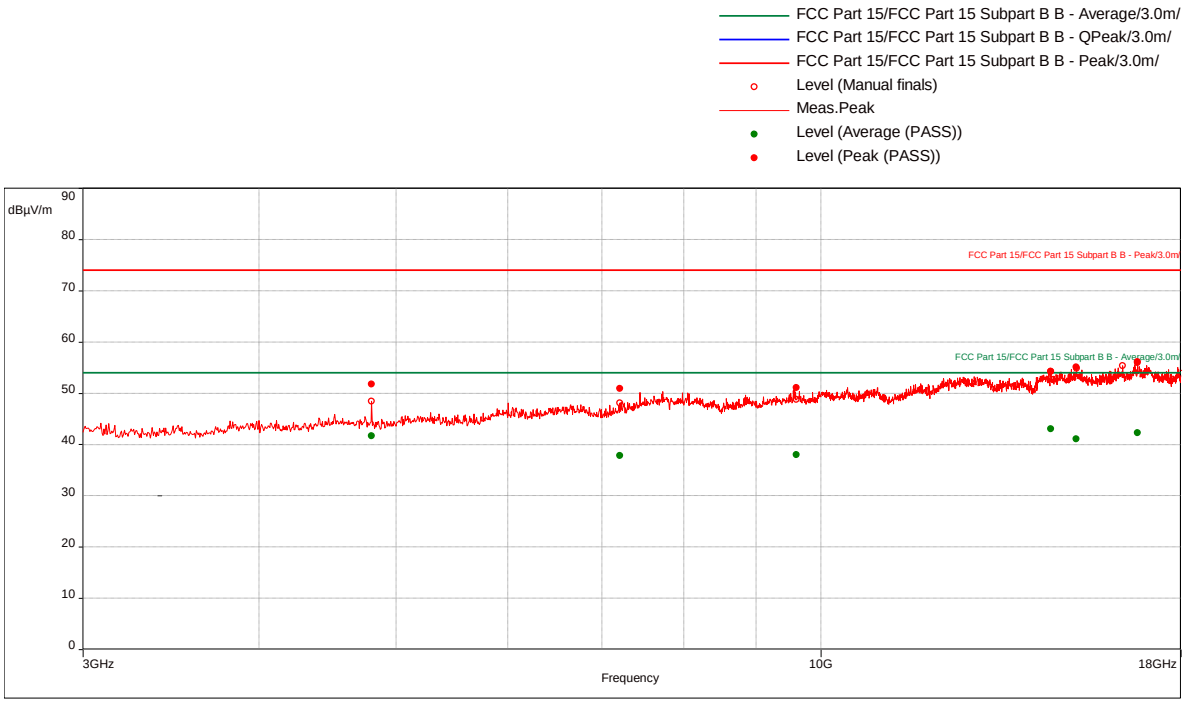
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
1384.210526	29.66	54.00	-24.34	267.00	1.55	Horizontal	1000000.00	-22.61

2.4 GHz BLE – Transmit at Low Channel (X-axis), 3-25 GHz

Test Information:

Date and Time	6/17/2019 4:22:40 PM
Client and Project Number	Renovia
Engineer	Kouma Sinn
Temperature	23C
Humidity	42%
Atmospheric Pressure	1005mbar
Comments	3 to 18 GHz SA mode_Tx @ low channel 2402 MHz

Graph:



Results:

Peak (PASS) (6)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
4803.421053	51.77	74.00	-22.23	180.00	1.40	Vertical	1000000.00	-11.44
7205	50.93	74.00	-23.07	226.00	3.30	Horizontal	1000000.00	-7.38
9611.052632	51.08	74.00	-22.92	195.00	3.59	Vertical	1000000.00	-4.45
14560	54.21	74.00	-19.79	39.00	2.45	Vertical	1000000.00	2.51
15177.36842	55.06	74.00	-18.94	216.00	3.89	Vertical	1000000.00	3.23
16774.73684	56.11	74.00	-17.89	11.00	1.00	Vertical	1000000.00	3.74

Average (PASS) (6)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
4803.421053	41.65	54.00	-12.35	180.00	1.40	Vertical	1000000.00	-11.44
7205	37.83	54.00	-16.17	226.00	3.30	Horizontal	1000000.00	-7.38
9611.052632	37.97	54.00	-16.03	195.00	3.59	Vertical	1000000.00	-4.45
14560	43.04	54.00	-10.96	39.00	2.45	Vertical	1000000.00	2.51
15177.36842	41.04	54.00	-12.96	216.00	3.89	Vertical	1000000.00	3.23
16774.73684	42.27	54.00	-11.73	11.00	1.00	Vertical	1000000.00	3.74

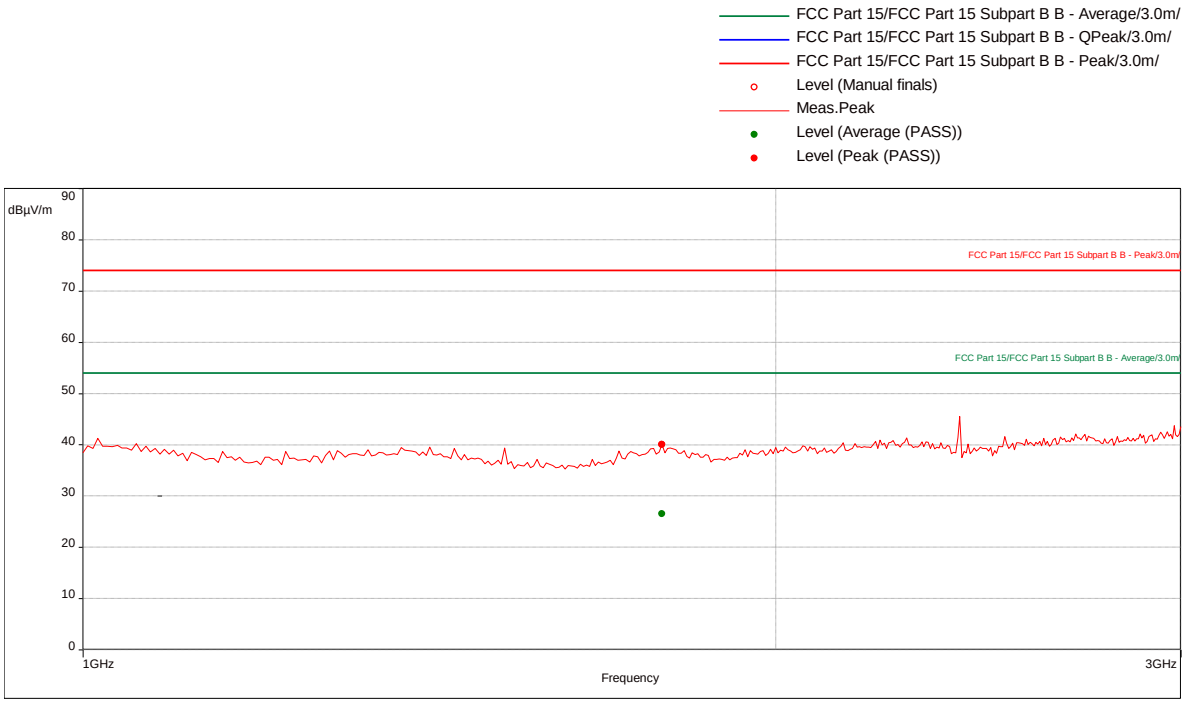
Notes: No emissions detected from 4.804-18.000 GHz. The readings in this range are noise floor readings. From 18-25 GHz, testing was performed manually with no emissions were detected at a distance of 10 cm.

2.4 GHz BLE – Transmit at Low Channel (Y-axis), 1-3 GHz

Test Information:

Date and Time	6/17/2019 6:40:29 PM
Client and Project Number	Renovia
Engineer	Kouma Sinn
Temperature	23C
Humidity	42%
Atmospheric Pressure	1005mbar
Comments	1 to 3 GHz SA mode_Tx @ low channel 2402 MHz_EUT straight down

Graph:



Results:

Peak (PASS) (1)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
1785.263158	40.06	74.00	-33.94	69.00	3.64	Vertical	1000000.00	-20.23

Average (PASS) (1)

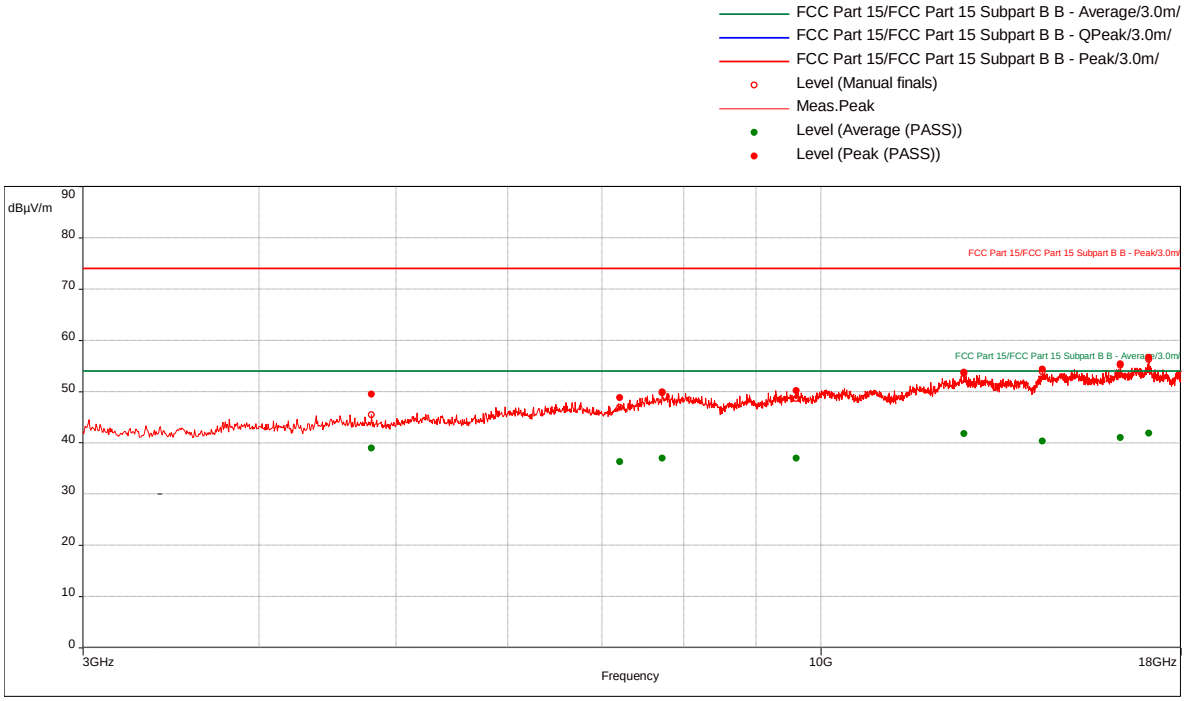
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
1785.263158	26.56	54.00	-27.44	69.00	3.64	Vertical	1000000.00	-20.23

2.4 GHz BLE – Transmit at Low Channel (Y-axis), 13-25 GHz

Test Information:

Date and Time	6/17/2019 6:00:48 PM
Client and Project Number	Renovia
Engineer	Kouma Sinn
Temperature	23C
Humidity	42%
Atmospheric Pressure	1005mbar
Comments	3 to 18 GHz SA mode_Tx @ low channel 2402 MHz_EUT straight down

Graph:



Results:

Peak (PASS) (8)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
4803.684211	49.48	74.00	-24.52	217.00	2.05	Horizontal	1000000.00	-11.45
7203.421053	48.80	74.00	-25.20	25.00	3.98	Horizontal	1000000.00	-7.38
7724.473684	49.92	74.00	-24.08	48.00	3.20	Vertical	1000000.00	-5.09
9607.631579	50.16	74.00	-23.84	201.00	2.95	Horizontal	1000000.00	-4.45
12635.26316	53.49	74.00	-20.51	70.00	2.65	Vertical	1000000.00	1.52
14360	54.33	74.00	-19.67	216.00	3.15	Horizontal	1000000.00	2.36
16313.94737	55.33	74.00	-18.67	246.00	2.30	Horizontal	1000000.00	3.09
17082.63158	56.64	74.00	-17.36	135.00	3.10	Vertical	1000000.00	3.45

Average (PASS) (8)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
4803.684211	38.96	54.00	-15.04	217.00	2.05	Horizontal	1000000.00	-11.45
7203.421053	36.29	54.00	-17.71	25.00	3.98	Horizontal	1000000.00	-7.38
7724.473684	37.00	54.00	-17.00	48.00	3.20	Vertical	1000000.00	-5.09
9607.631579	36.99	54.00	-17.01	201.00	2.95	Horizontal	1000000.00	-4.45
12635.26316	41.76	54.00	-12.24	70.00	2.65	Vertical	1000000.00	1.52
14360	40.31	54.00	-13.69	216.00	3.15	Horizontal	1000000.00	2.36
16313.94737	40.99	54.00	-13.01	246.00	2.30	Horizontal	1000000.00	3.09
17082.63158	41.85	54.00	-12.15	135.00	3.10	Vertical	1000000.00	3.45

Notes: No emissions were detected from 4.804-18.000 GHz. The readings in this range are noise floor readings. From 18-25 GHz, testing was performed manually with no emissions were detected at a distance of 10 cm.

2.4 GHz BLE – Transmit at Low Channel (Z-axis), 1-3 GHz

Test Information:

Date and Time	6/17/2019 5:09:37 PM
Client and Project Number	Renovia
Engineer	Kouma Sinn
Temperature	23C
Humidity	42%
Atmospheric Pressure	1005mbar
Comments	1 to 3 GHz SA mode_Tx @ low channel 2402 MHz_EUT straight up

Graph:

Results:

Peak (PASS) (1)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
1980.263158	40.96	74.00	-33.04	268.00	1.20	Vertical	1000000.00	-19.08

Average (PASS) (1)

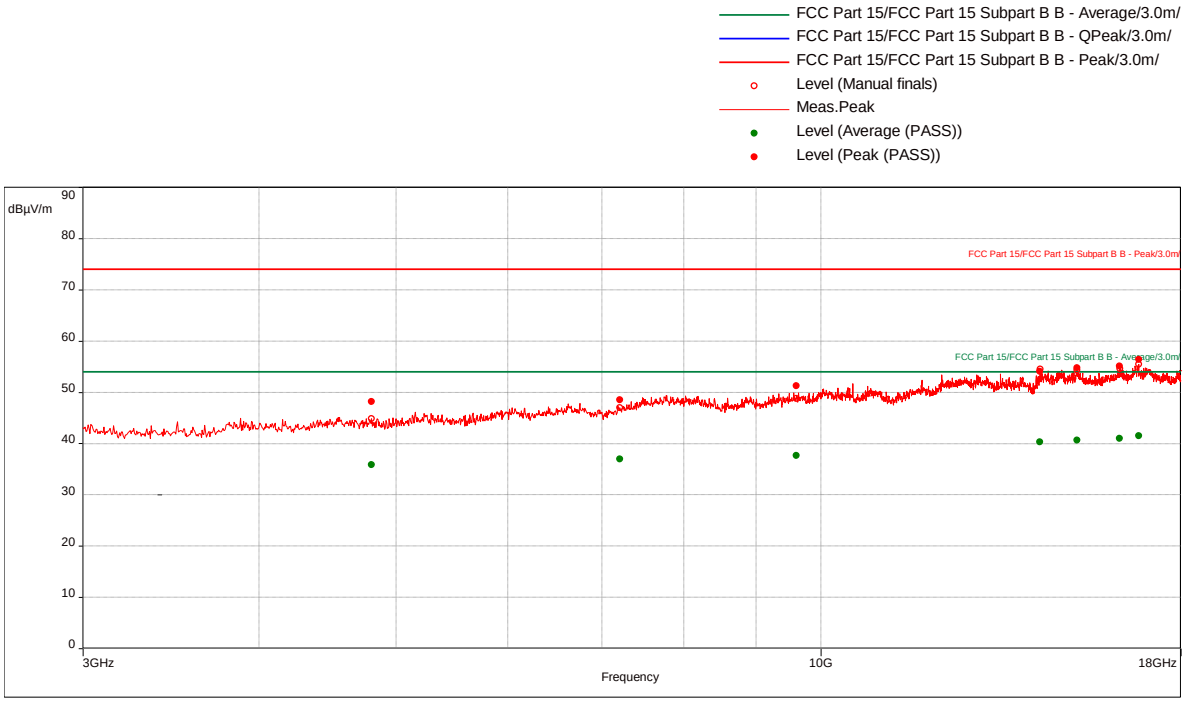
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
1980.263158	29.00	54.00	-25.00	268.00	1.20	Vertical	1000000.00	-19.08

2.4 GHz BLE – Transmit at Low Channel (Z-axis), 13-25 GHz

Test Information:

Date and Time	6/17/2019 5:18:06 PM
Client and Project Number	Renovia
Engineer	Kouma Sinn
Temperature	23C
Humidity	42%
Atmospheric Pressure	1005mbar
Comments	3 to 18 GHz SA mode_Tx @ low channel 2402 MHz_EUT straight up

Graph:



Results:

Peak (PASS) (7)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
4803.421053	48.16	74.00	-25.84	323.00	3.69	Horizontal	1000000.00	-11.44
7203.157895	48.54	74.00	-25.46	70.00	3.98	Vertical	1000000.00	-7.38
9610	51.21	74.00	-22.79	90.00	2.60	Horizontal	1000000.00	-4.45
14306.31579	54.08	74.00	-19.92	275.00	2.70	Vertical	1000000.00	2.25
15196.84211	54.78	74.00	-19.22	83.00	1.30	Horizontal	1000000.00	3.34
16292.36842	55.14	74.00	-18.86	195.00	1.55	Vertical	1000000.00	3.04
16805.52632	56.40	74.00	-17.60	0.00	2.10	Horizontal	1000000.00	3.62

Average (PASS) (7)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
4803.421053	35.86	54.00	-18.14	323.00	3.69	Horizontal	1000000.00	-11.44
7203.157895	36.93	54.00	-17.07	70.00	3.98	Vertical	1000000.00	-7.38
9610	37.66	54.00	-16.34	90.00	2.60	Horizontal	1000000.00	-4.45
14306.31579	40.27	54.00	-13.73	275.00	2.70	Vertical	1000000.00	2.25
15196.84211	40.64	54.00	-13.36	83.00	1.30	Horizontal	1000000.00	3.34
16292.36842	40.99	54.00	-13.01	195.00	1.55	Vertical	1000000.00	3.04
16805.52632	41.54	54.00	-12.46	0.00	2.10	Horizontal	1000000.00	3.62

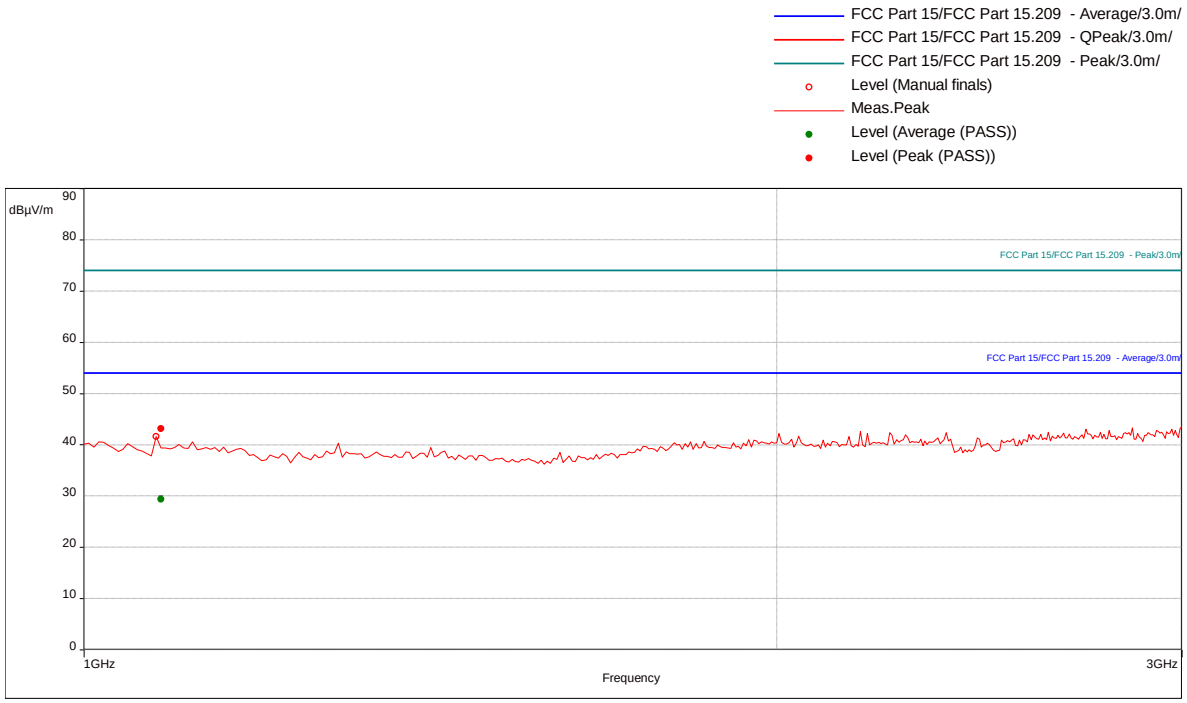
Notes: No emissions were detected from 4.803-18.000 GHz. The readings in this range are noise floor readings. From 18-25 GHz, testing was performed manually with no emissions were detected at a distance of 10 cm.

2.4 GHz BLE – Transmit at Mid Channel (X-axis), 1-3 GHz

Test Information:

Date and Time	6/23/2019 8:43:35 AM
Client and Project Number	Kouma Sinn
Engineer	Kouma Sinn
Temperature	23C
Humidity	43%
Atmospheric Pressure	1004mbar
Comments	1-3 GHz SA mode_Tx @ Mid Channel

Graph:



Results:

Peak (PASS) (1)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
1077.894737	43.08	74.00	-30.92	216.00	1.65	Horizontal	1000000.00	-24.97

Average (PASS) (1)

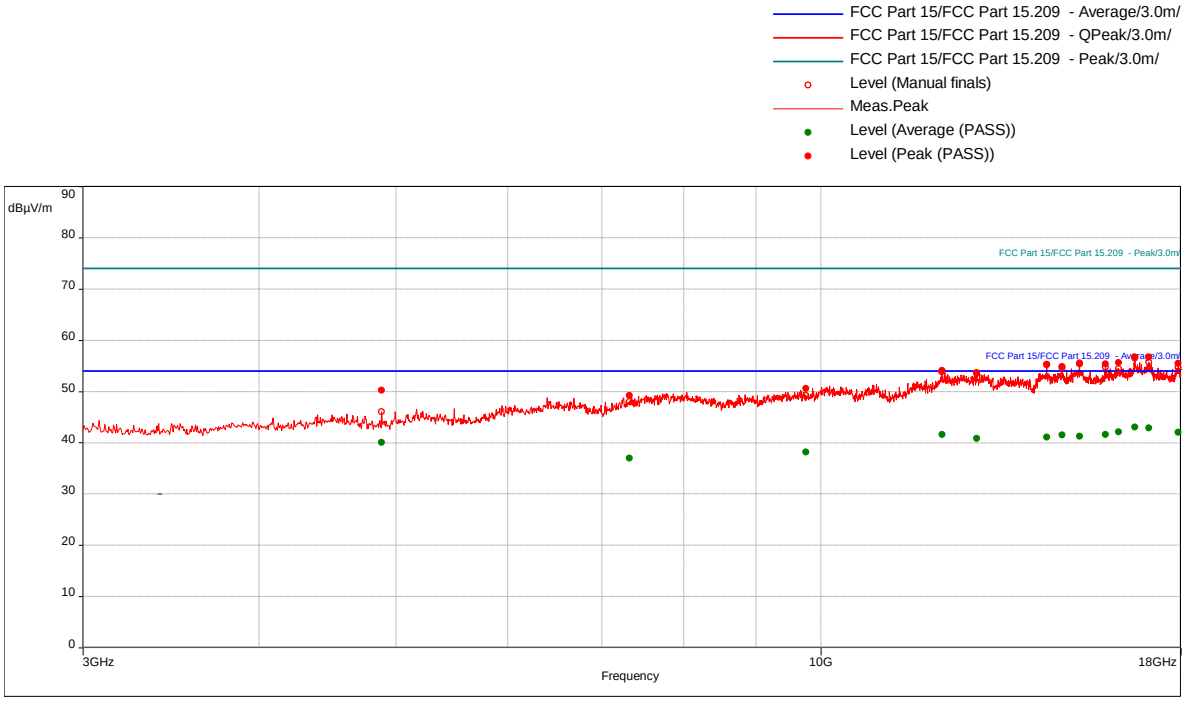
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
1077.894737	29.37	54.00	-24.63	216.00	1.65	Horizontal	1000000.00	-24.97

2.4 GHz BLE – Transmit at Mid Channel (X-axis), 3-25 GHz

Test Information:

Date and Time	6/23/2019 7:46:22 AM
Client and Project Number	Kouma Sinn
Engineer	Kouma Sinn
Temperature	23C
Humidity	43%
Atmospheric Pressure	1004mbar
Comments	3 to 18 GHz SA mode_Tx @ Mid Channel

Graph:



Results:

Peak (PASS) (13)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
4884.473684	50.22	74.00	-23.78	187.00	1.60	Vertical	1000000.00	-11.72
7320.789474	49.22	74.00	-24.78	48.00	1.60	Vertical	1000000.00	-7.10
9760	50.59	74.00	-23.41	329.00	2.80	Vertical	1000000.00	-4.41
12188.15789	54.06	74.00	-19.94	158.00	2.00	Vertical	1000000.00	1.14
12905.52632	53.61	74.00	-20.39	298.00	1.05	Vertical	1000000.00	1.78
14462.10526	55.26	74.00	-18.74	275.00	2.85	Vertical	1000000.00	2.34
14835.78947	54.83	74.00	-19.17	54.00	1.60	Vertical	1000000.00	3.13
15262.63158	55.38	74.00	-18.62	359.00	3.15	Horizontal	1000000.00	2.86
15921.31579	55.36	74.00	-18.64	90.00	1.65	Vertical	1000000.00	2.72
16262.63158	55.64	74.00	-18.36	136.00	3.89	Horizontal	1000000.00	2.86
16701.05263	56.71	74.00	-17.29	33.00	2.90	Horizontal	1000000.00	3.93
17079.73684	56.75	74.00	-17.25	313.00	3.25	Horizontal	1000000.00	3.43
17925.26316	55.47	74.00	-18.53	54.00	3.10	Horizontal	1000000.00	2.83

Average (PASS) (13)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
4884.473684	40.05	54.00	-13.95	187.00	1.60	Vertical	1000000.00	-11.72
7320.789474	36.98	54.00	-17.02	48.00	1.60	Vertical	1000000.00	-7.10
9760	38.15	54.00	-15.85	329.00	2.80	Vertical	1000000.00	-4.41
12188.15789	41.62	54.00	-12.38	158.00	2.00	Vertical	1000000.00	1.14
12905.52632	40.78	54.00	-13.22	298.00	1.05	Vertical	1000000.00	1.78
14462.10526	41.08	54.00	-12.92	275.00	2.85	Vertical	1000000.00	2.34
14835.78947	41.52	54.00	-12.48	54.00	1.60	Vertical	1000000.00	3.13
15262.63158	41.28	54.00	-12.72	359.00	3.15	Horizontal	1000000.00	2.86
15921.31579	41.62	54.00	-12.38	90.00	1.65	Vertical	1000000.00	2.72
16262.63158	42.10	54.00	-11.90	136.00	3.89	Horizontal	1000000.00	2.86
16701.05263	43.04	54.00	-10.96	33.00	2.90	Horizontal	1000000.00	3.93
17079.73684	42.89	54.00	-11.11	313.00	3.25	Horizontal	1000000.00	3.43
17925.26316	41.99	54.00	-12.01	54.00	3.10	Horizontal	1000000.00	2.83

Notes: No emissions detected from 4.884-18.000 GHz. The readings in this range are noise floor readings. From 18-25 GHz, testing was performed manually with no emissions were detected at a distance of 10 cm.

2.4 GHz BLE – Transmit at Mid Channel (Y-axis), 1-3 GHz

Test Information:

Date and Time	6/23/2019 10:49:34 AM
Client and Project Number	Kouma Sinn
Engineer	Kouma Sinn
Temperature	23C
Humidity	43%
Atmospheric Pressure	1004mbar
Comments	1-3GHz SA mode_Tx @ High Channel_EUT Straight down

Graph:

Results:

Peak (PASS) (1)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
1854.210526	45.29	74.00	-28.71	187.00	2.95	Vertical	1000000.00	-19.69

Average (PASS) (1)

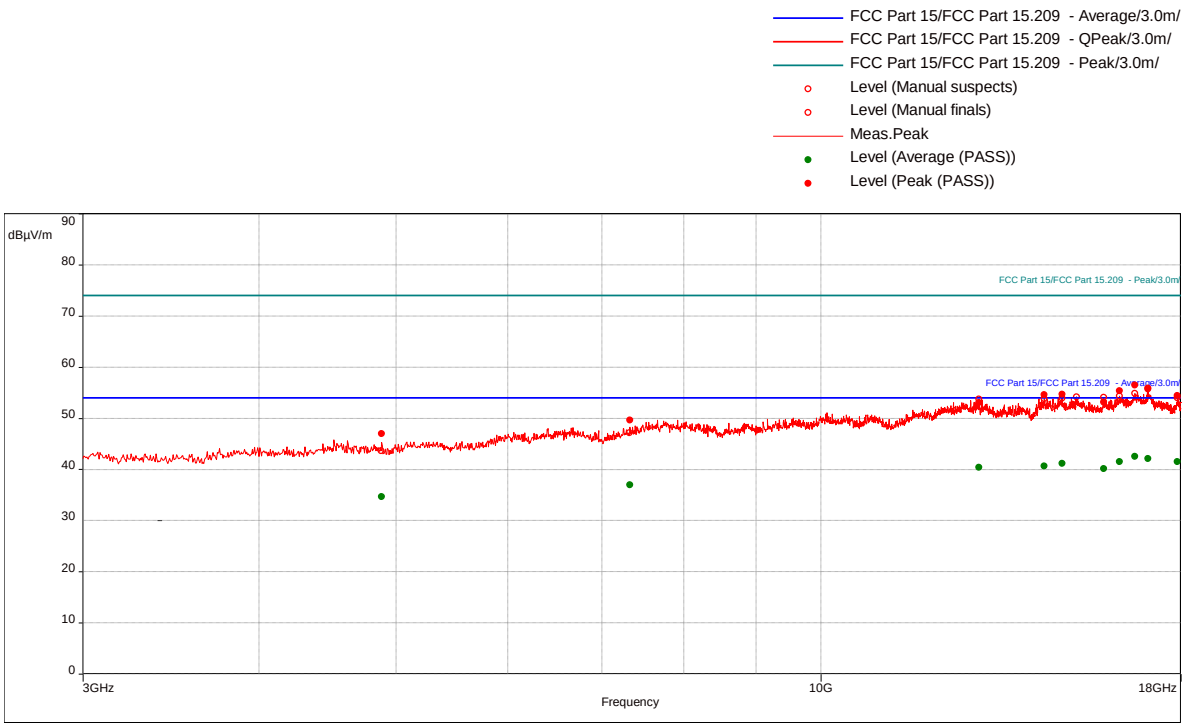
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
1854.210526	28.48	54.00	-25.52	187.00	2.95	Vertical	1000000.00	-19.69

2.4 GHz BLE – Transmit at Mid Channel (Y-axis), 3-25 GHz

Test Information:

Date and Time	6/23/2019 9:50:46 AM
Client and Project Number	Kouma Sinn
Engineer	Kouma Sinn
Temperature	23C
Humidity	43%
Atmospheric Pressure	1004mbar
Comments	3 -18GHz SA mode_Tx @ Mid Channel_EUT Straight down

Graph:



Results:

Peak (PASS) (10)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
4883.421053	46.96	74.00	-27.04	180.00	2.10	Vertical	1000000.00	-11.71
7324.473684	49.62	74.00	-24.38	246.00	1.80	Vertical	1000000.00	-7.08
12948.42105	53.09	74.00	-20.91	318.00	1.95	Horizontal	1000000.00	1.52
14401.57895	54.63	74.00	-19.37	25.00	3.44	Vertical	1000000.00	2.39
14834.73684	54.70	74.00	-19.30	196.00	1.75	Vertical	1000000.00	3.13
15870	53.14	74.00	-20.86	307.00	1.30	Horizontal	1000000.00	2.63
16283.15789	55.36	74.00	-18.64	306.00	2.00	Horizontal	1000000.00	2.98
16701.05263	56.44	74.00	-17.56	254.00	1.30	Vertical	1000000.00	3.93
17062.89474	55.70	74.00	-18.30	246.00	1.30	Vertical	1000000.00	3.33
17900	54.40	74.00	-19.60	210.00	3.39	Vertical	1000000.00	3.11

Average (PASS) (10)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
4883.421053	34.62	54.00	-19.38	180.00	2.10	Vertical	1000000.00	-11.71
7324.473684	36.97	54.00	-17.03	246.00	1.80	Vertical	1000000.00	-7.08
12948.42105	40.41	54.00	-13.59	318.00	1.95	Horizontal	1000000.00	1.52
14401.57895	40.65	54.00	-13.35	25.00	3.44	Vertical	1000000.00	2.39
14834.73684	41.19	54.00	-12.81	196.00	1.75	Vertical	1000000.00	3.13
15870	40.12	54.00	-13.88	307.00	1.30	Horizontal	1000000.00	2.63
16283.15789	41.52	54.00	-12.48	306.00	2.00	Horizontal	1000000.00	2.98
16701.05263	42.52	54.00	-11.48	254.00	1.30	Vertical	1000000.00	3.93
17062.89474	42.08	54.00	-11.92	246.00	1.30	Vertical	1000000.00	3.33
17900	41.50	54.00	-12.50	210.00	3.39	Vertical	1000000.00	3.11

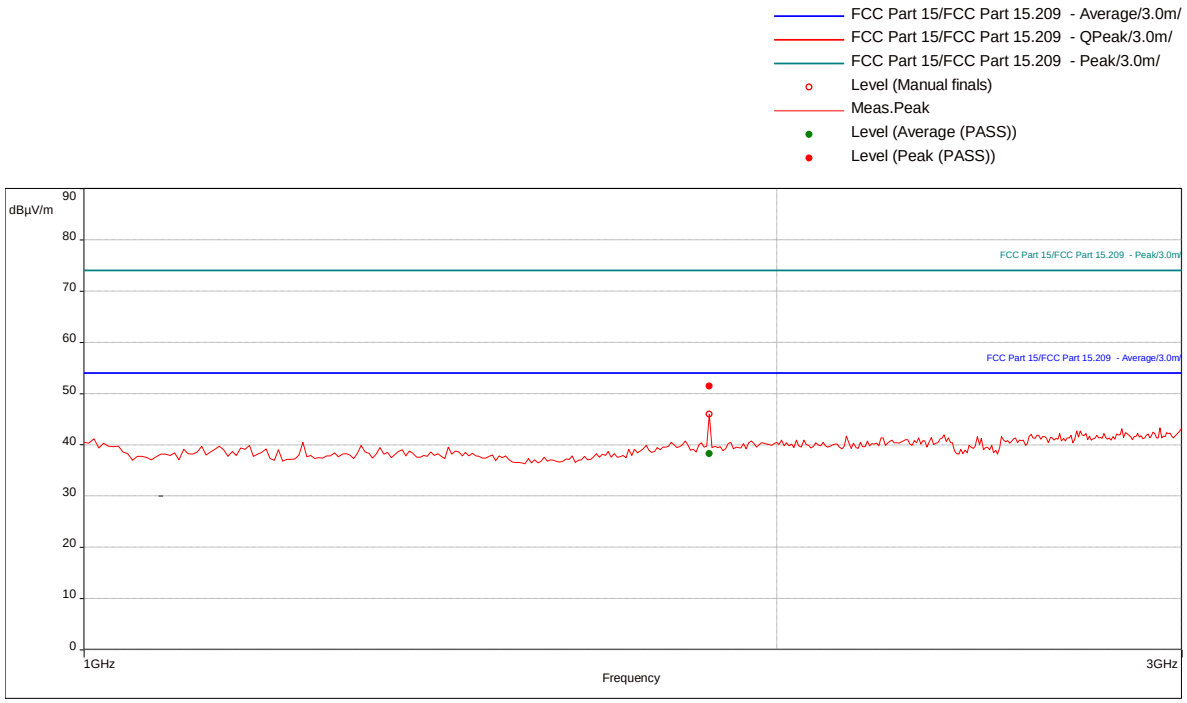
Notes: No emissions detected from 4.883-18.000 GHz. The readings in this range are noise floor readings. From 18-25 GHz, testing was performed manually with no emissions were detected at a distance of 10 cm.

2.4 GHz BLE – Transmit at Mid Channel (Z-axis), 1-3 GHz

Test Information:

Date and Time	6/23/2019 8:52:35 AM
Client and Project Number	Kouma Sinn
Engineer	Kouma Sinn
Temperature	23C
Humidity	43%
Atmospheric Pressure	1004mbar
Comments	1-3 GHz SA mode_Tx @ Mid Channel_EUT Straight Up

Graph:



Results:

Peak (PASS) (1)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
1867.894737	51.45	74.00	-22.55	0.00	2.90	Vertical	1000000.00	-19.67

Average (PASS) (1)

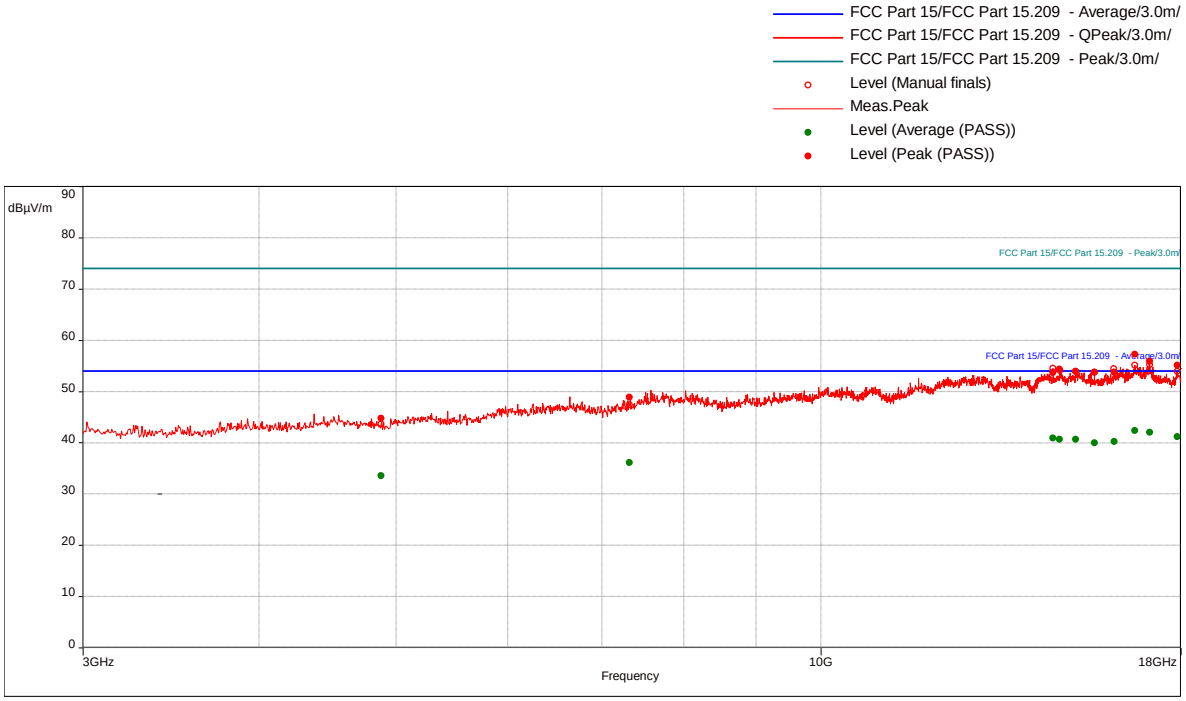
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
1867.894737	38.27	54.00	-15.73	0.00	2.90	Vertical	1000000.00	-19.67

2.4 GHz BLE – Transmit at Mid Channel (Z-axis), 3-25 GHz

Test Information:

Date and Time	6/23/2019 9:02:47 AM
Client and Project Number	Kouma Sinn
Engineer	Kouma Sinn
Temperature	23C
Humidity	43%
Atmospheric Pressure	1004mbar
Comments	3 -18GHz SA mode_Tx @ Mid Channel_EUT Straight Up

Graph:



Results:

Peak (PASS) (10)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
4882.368421	44.73	74.00	-29.27	253.00	3.30	Vertical	1000000.00	-11.71
7317.631579	48.82	74.00	-25.18	4.00	3.74	Horizontal	1000000.00	-7.11
14617.36842	53.61	74.00	-20.39	224.00	1.45	Vertical	1000000.00	2.70
14771.57895	54.34	74.00	-19.66	142.00	1.40	Vertical	1000000.00	3.18
15165.78947	53.94	74.00	-20.06	70.00	2.10	Horizontal	1000000.00	3.17
15635.78947	53.71	74.00	-20.29	106.00	2.70	Horizontal	1000000.00	2.54
16142.89474	53.70	74.00	-20.30	32.00	1.90	Vertical	1000000.00	2.27
16697.63158	57.23	74.00	-16.77	150.00	1.35	Horizontal	1000000.00	3.91
17113.68421	55.90	74.00	-18.10	18.00	1.75	Vertical	1000000.00	3.53
17892.89474	55.12	74.00	-18.88	91.00	1.60	Horizontal	1000000.00	3.02

Average (PASS) (10)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
4882.368421	33.56	54.00	-20.44	253.00	3.30	Vertical	1000000.00	-11.71
7317.631579	36.09	54.00	-17.91	4.00	3.74	Horizontal	1000000.00	-7.11
14617.36842	40.92	54.00	-13.08	224.00	1.45	Vertical	1000000.00	2.70
14771.57895	40.64	54.00	-13.36	142.00	1.40	Vertical	1000000.00	3.18
15165.78947	40.65	54.00	-13.35	70.00	2.10	Horizontal	1000000.00	3.17
15635.78947	39.92	54.00	-14.08	106.00	2.70	Horizontal	1000000.00	2.54
16142.89474	40.25	54.00	-13.75	32.00	1.90	Vertical	1000000.00	2.27
16697.63158	42.34	54.00	-11.66	150.00	1.35	Horizontal	1000000.00	3.91
17113.68421	42.01	54.00	-11.99	18.00	1.75	Vertical	1000000.00	3.53
17892.89474	41.18	54.00	-12.82	91.00	1.60	Horizontal	1000000.00	3.02

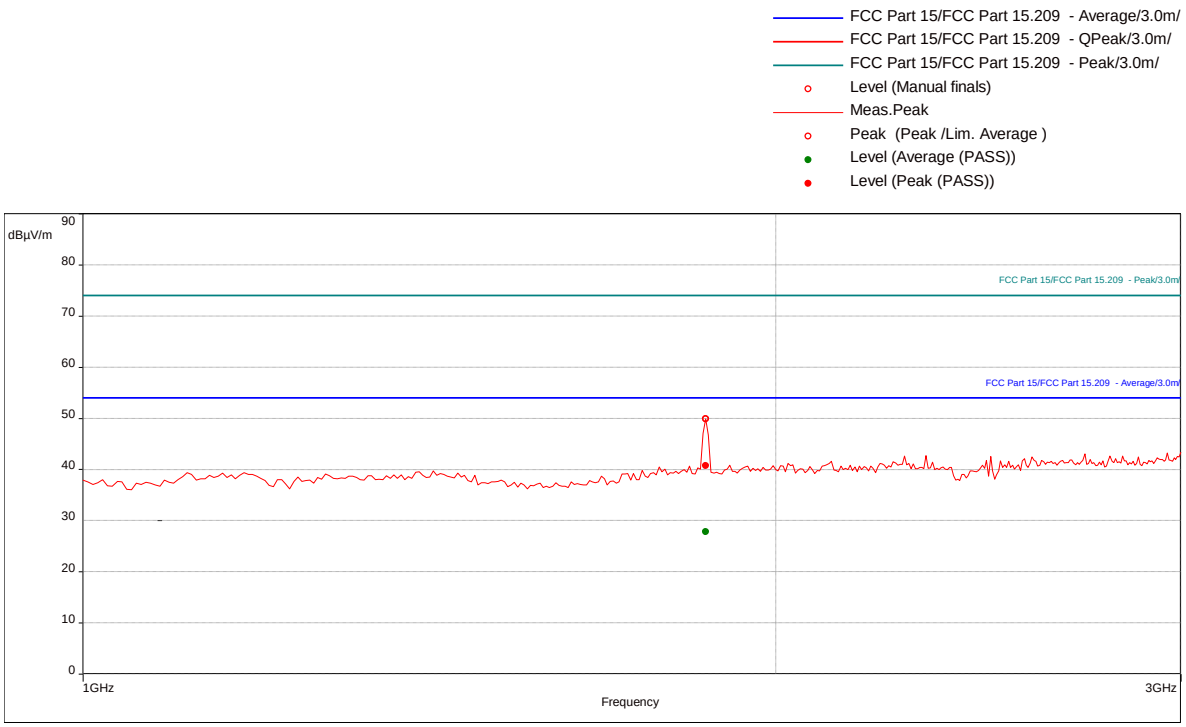
Notes: No emissions detected from 4.882-18.000 GHz. The readings in this range are noise floor readings. From 18-25 GHz, testing was performed manually with no emissions were detected at a distance of 10 cm.

2.4 GHz BLE – Transmit at High Channel (X-axis), 1-3 GHz

Test Information:

Date and Time	6/23/2019 1:04:27 PM
Client and Project Number	Kouma Sinn
Engineer	Kouma Sinn
Temperature	23C
Humidity	43%
Atmospheric Pressure	1004mbar
Comments	1-3 GHz SA mode_Tx @ High Channel_EUT Battery Side Up

Graph:



Results:

Peak (PASS) (1)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
1864.473684	40.74	74.00	-33.26	321.00	2.65	Vertical	1000000.00	-19.68

Average (PASS) (1)

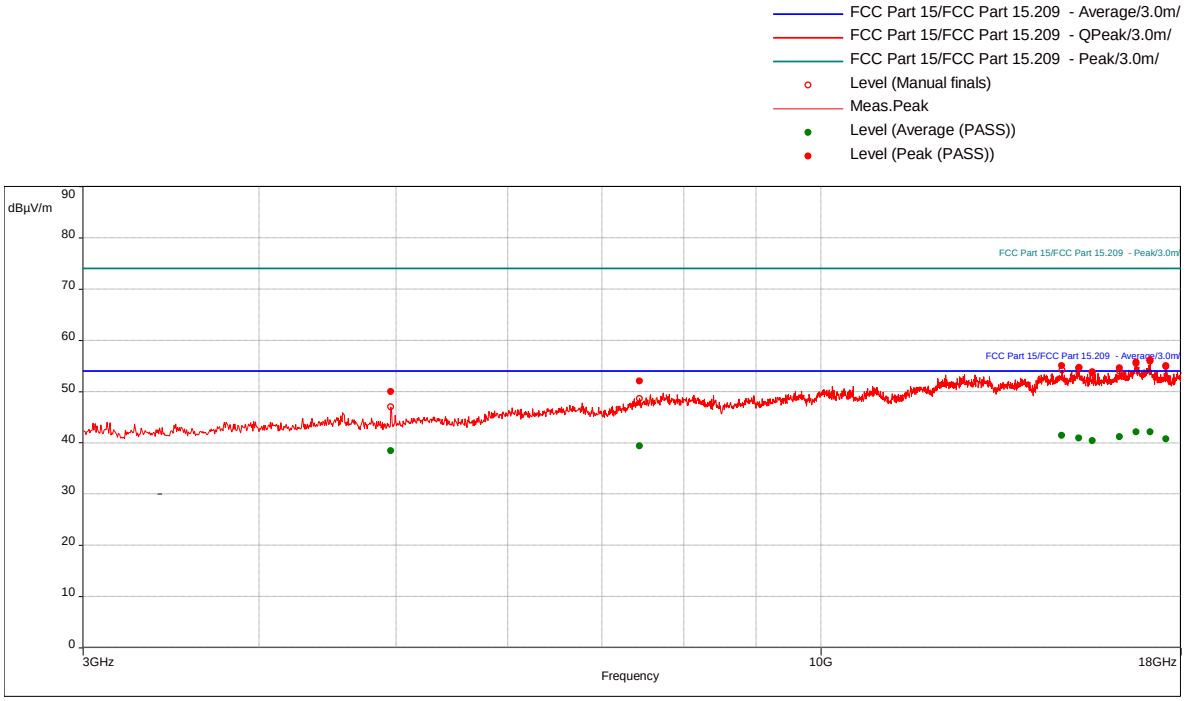
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
1864.473684	27.80	54.00	-26.20	321.00	2.65	Vertical	1000000.00	-19.68

2.4 GHz BLE – Transmit at High Channel (X-axis), 3-25 GHz

Test Information:

Date and Time	6/23/2019 1:12:39 PM
Client and Project Number	Kouma Sinn
Engineer	Kouma Sinn
Temperature	23C
Humidity	43%
Atmospheric Pressure	1004mbar
Comments	3-18 GHz SA mode_Tx @ High Channel_EUT Battery Side Up

Graph:



Results:

Peak (PASS) (9)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
4959.473684	49.97	74.00	-24.03	225.00	3.25	Horizontal	1000000.00	-11.58
7440.789474	52.05	74.00	-21.95	121.00	1.10	Vertical	1000000.00	-6.51
14826.05263	54.99	74.00	-19.01	313.00	3.84	Vertical	1000000.00	3.16
15241.84211	54.46	74.00	-19.54	62.00	3.10	Vertical	1000000.00	3.03
15581.57895	53.83	74.00	-20.17	137.00	3.34	Horizontal	1000000.00	2.79
16285.78947	54.57	74.00	-19.43	76.00	1.30	Vertical	1000000.00	3.00
16731.57895	55.68	74.00	-18.32	25.00	2.20	Horizontal	1000000.00	3.85
17123.15789	56.15	74.00	-17.85	329.00	2.50	Horizontal	1000000.00	3.51
17564.21053	54.87	74.00	-19.13	18.00	3.59	Vertical	1000000.00	2.22

Average (PASS) (9)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
4959.473684	38.38	54.00	-15.62	225.00	3.25	Horizontal	1000000.00	-11.58
7440.789474	39.39	54.00	-14.61	121.00	1.10	Vertical	1000000.00	-6.51
14826.05263	41.43	54.00	-12.57	313.00	3.84	Vertical	1000000.00	3.16
15241.84211	40.94	54.00	-13.06	62.00	3.10	Vertical	1000000.00	3.03
15581.57895	40.35	54.00	-13.65	137.00	3.34	Horizontal	1000000.00	2.79
16285.78947	41.15	54.00	-12.85	76.00	1.30	Vertical	1000000.00	3.00
16731.57895	42.13	54.00	-11.87	25.00	2.20	Horizontal	1000000.00	3.85
17123.15789	42.08	54.00	-11.92	329.00	2.50	Horizontal	1000000.00	3.51
17564.21053	40.75	54.00	-13.25	18.00	3.59	Vertical	1000000.00	2.22

Notes: No emissions detected from 4.959-18.000 GHz. The readings in this range are noise floor readings. From 18-25 GHz, testing was performed manually with no emissions were detected at a distance of 10 cm.

2.4 GHz BLE – Transmit at High Channel (Y-axis), 1-3 GHz

Test Information:

Date and Time	6/23/2019 10:49:34 AM
Client and Project Number	Kouma Sinn
Engineer	Kouma Sinn
Temperature	23C
Humidity	43%
Atmospheric Pressure	1004mbar
Comments	1-3GHz SA mode_Tx @ High Channel_EUT Straight down

Graph:

Results:

Peak (PASS) (1)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
1854.210526	45.29	74.00	-28.71	187.00	2.95	Vertical	1000000.00	-19.69

Average (PASS) (1)

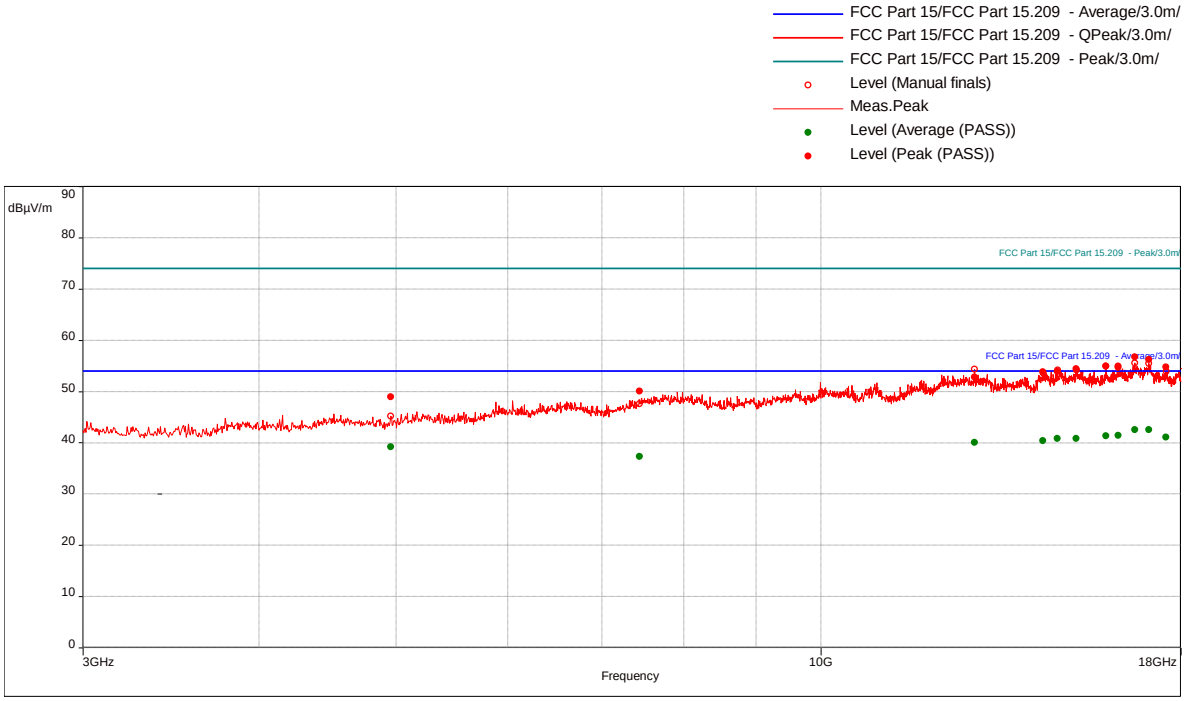
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
1854.210526	28.48	54.00	-25.52	187.00	2.95	Vertical	1000000.00	-19.69

2.4 GHz BLE – Transmit at High Channel (Y-axis), 3-25 GHz

Test Information:

Date and Time	6/23/2019 10:58:32 AM
Client and Project Number	Kouma Sinn
Engineer	Kouma Sinn
Temperature	23C
Humidity	43%
Atmospheric Pressure	1004mbar
Comments	3-18GHz SA mode_Tx @ High Channel_EUT Straight down

Graph:



Results:

Peak (PASS) (11)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
4960	48.96	74.00	-25.04	217.00	2.70	Horizontal	1000000.00	-11.58
7440.789474	50.06	74.00	-23.94	194.00	1.35	Horizontal	1000000.00	-6.51
12859.73684	52.82	74.00	-21.18	106.00	1.15	Vertical	1000000.00	1.65
14376.31579	53.81	74.00	-20.19	262.00	2.65	Horizontal	1000000.00	2.37
14717.36842	53.86	74.00	-20.14	75.00	3.64	Horizontal	1000000.00	3.09
15177.36842	54.40	74.00	-19.60	54.00	1.00	Vertical	1000000.00	3.23
15931.57895	54.95	74.00	-19.05	70.00	1.00	Vertical	1000000.00	2.71
16252.36842	54.89	74.00	-19.11	47.00	2.55	Vertical	1000000.00	2.79
16700.26316	56.71	74.00	-17.29	63.00	2.45	Vertical	1000000.00	3.93
17084.73684	56.25	74.00	-17.75	121.00	3.15	Horizontal	1000000.00	3.46
17571.84211	54.74	74.00	-19.26	32.00	3.44	Horizontal	1000000.00	2.23

Average (PASS) (11)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
4960	39.17	54.00	-14.83	217.00	2.70	Horizontal	1000000.00	-11.58
7440.789474	37.32	54.00	-16.68	194.00	1.35	Horizontal	1000000.00	-6.51
12859.73684	40.01	54.00	-13.99	106.00	1.15	Vertical	1000000.00	1.65
14376.31579	40.42	54.00	-13.58	262.00	2.65	Horizontal	1000000.00	2.37
14717.36842	40.82	54.00	-13.18	75.00	3.64	Horizontal	1000000.00	3.09
15177.36842	40.79	54.00	-13.21	54.00	1.00	Vertical	1000000.00	3.23
15931.57895	41.30	54.00	-12.70	70.00	1.00	Vertical	1000000.00	2.71
16252.36842	41.45	54.00	-12.55	47.00	2.55	Vertical	1000000.00	2.79
16700.26316	42.54	54.00	-11.46	63.00	2.45	Vertical	1000000.00	3.93
17084.73684	42.51	54.00	-11.49	121.00	3.15	Horizontal	1000000.00	3.46
17571.84211	41.10	54.00	-12.90	32.00	3.44	Horizontal	1000000.00	2.23

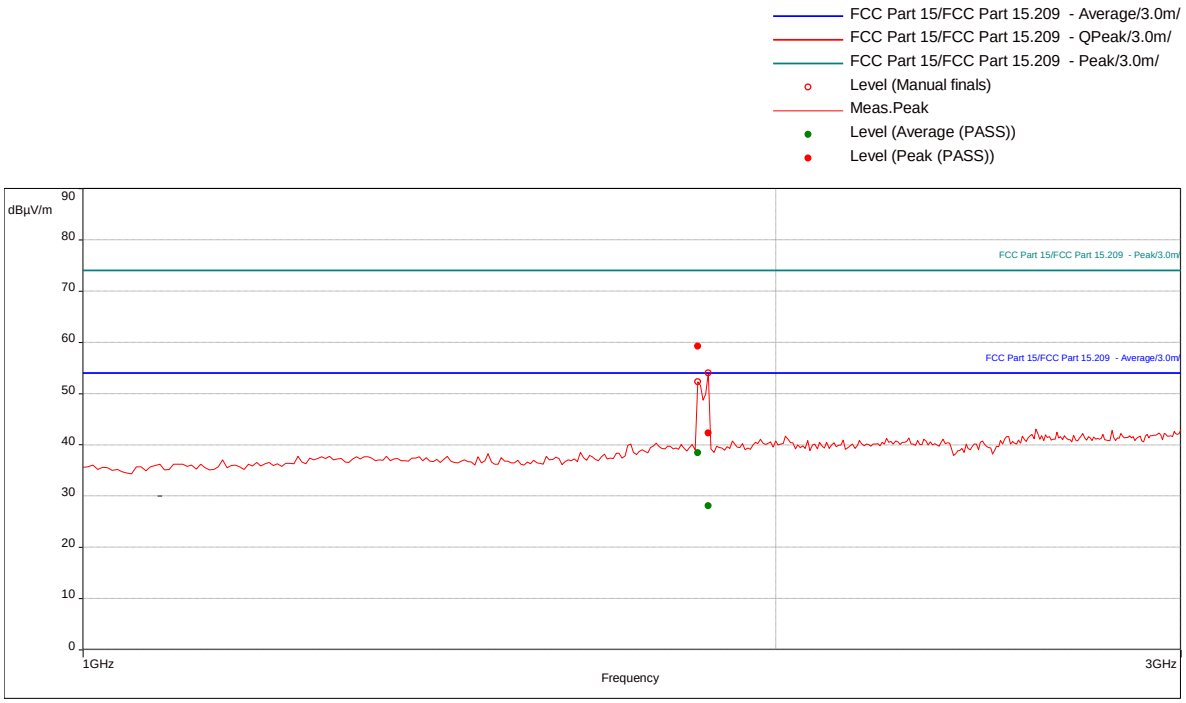
Notes: No emissions detected from 4.960-18.000 GHz. The readings in this range are noise floor readings. From 18-25 GHz, testing was performed manually with no emissions were detected at a distance of 10 cm.

2.4 GHz BLE – Transmit at High Channel (Z-axis), 1-3 GHz

Test Information:

Date and Time	6/23/2019 12:40:49 PM
Client and Project Number	Kouma Sinn
Engineer	Kouma Sinn
Temperature	23C
Humidity	43%
Atmospheric Pressure	1004mbar
Comments	1-3 GHz SA mode_Tx @ High Channel_EUT Straight Up

Graph:



Results:

Peak (PASS) (2)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
1851.842105	59.20	74.00	-14.80	91.00	2.70	Vertical	1000000.00	-19.70
1870	42.27	74.00	-31.73	238.00	1.20	Vertical	1000000.00	-19.67

Average (PASS) (2)

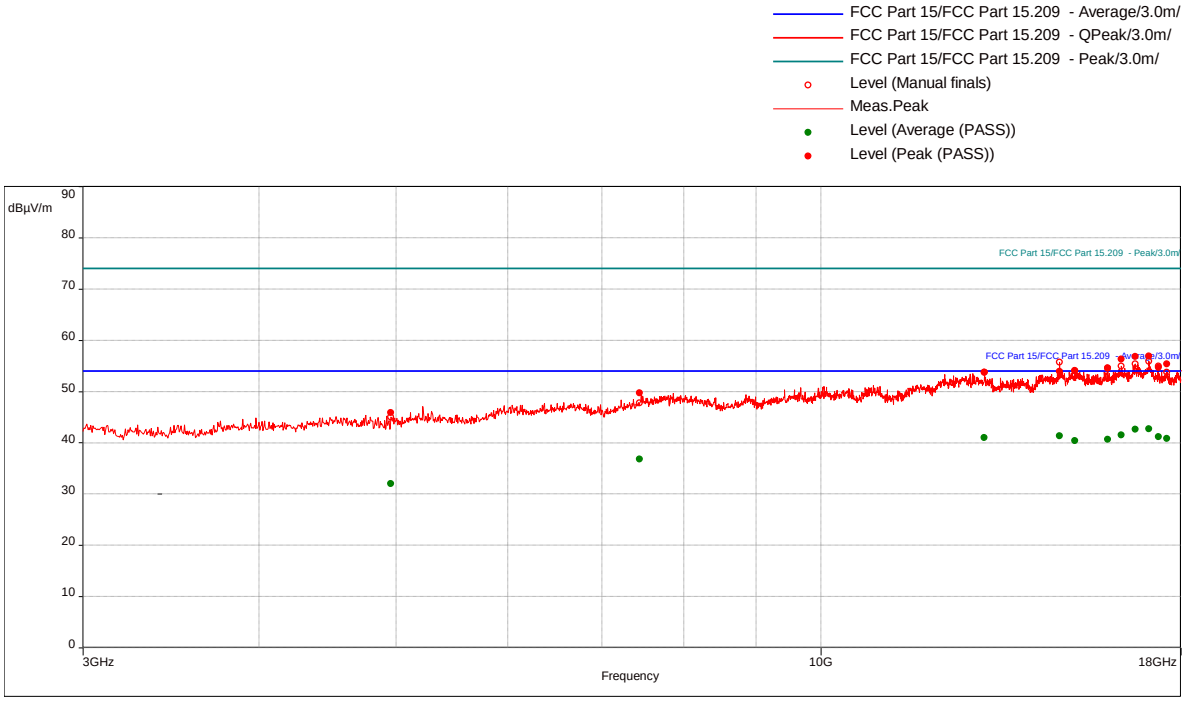
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
1851.842105	38.38	54.00	-15.62	91.00	2.70	Vertical	1000000.00	-19.70
1870	28.05	54.00	-25.95	238.00	1.20	Vertical	1000000.00	-19.67

2.4 GHz BLE – Transmit at High Channel (Z-axis), 3-25 GHz

Test Information:

Date and Time	6/23/2019 11:49:07 AM
Client and Project Number	Kouma Sinn
Engineer	Kouma Sinn
Temperature	23C
Humidity	43%
Atmospheric Pressure	1004mbar
Comments	3-18GHz SA mode_Tx @ High Channel_EUT Straight Up

Graph:



Results:

Peak (PASS) (11)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
4961.842105	45.88	74.00	-28.12	0.00	1.60	Horizontal	1000000.00	-11.57
7441.578947	49.68	74.00	-24.32	129.00	1.55	Horizontal	1000000.00	-6.50
13060.52632	53.72	74.00	-20.28	211.00	2.90	Vertical	1000000.00	1.62
14767.36842	53.94	74.00	-20.06	282.00	1.65	Horizontal	1000000.00	3.17
15146.84211	54.11	74.00	-19.89	92.00	1.90	Horizontal	1000000.00	3.08
15977.36842	54.63	74.00	-19.37	306.00	2.35	Vertical	1000000.00	2.66
16337.36842	56.29	74.00	-17.71	210.00	3.94	Horizontal	1000000.00	3.11
16711.31579	56.82	74.00	-17.18	62.00	1.01	Vertical	1000000.00	3.90
17086.05263	56.92	74.00	-17.08	129.00	1.71	Horizontal	1000000.00	3.47
17348.94737	54.64	74.00	-19.36	55.00	2.10	Vertical	1000000.00	2.26
17595	55.33	74.00	-18.67	77.00	1.35	Horizontal	1000000.00	2.28

Average (PASS) (11)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
4961.842105	31.99	54.00	-22.01	0.00	1.60	Horizontal	1000000.00	-11.57
7441.578947	36.79	54.00	-17.21	129.00	1.55	Horizontal	1000000.00	-6.50
13060.52632	41.01	54.00	-12.99	211.00	2.90	Vertical	1000000.00	1.62
14767.36842	41.35	54.00	-12.65	282.00	1.65	Horizontal	1000000.00	3.17
15146.84211	40.42	54.00	-13.58	92.00	1.90	Horizontal	1000000.00	3.08
15977.36842	40.69	54.00	-13.31	306.00	2.35	Vertical	1000000.00	2.66
16337.36842	41.50	54.00	-12.50	210.00	3.94	Horizontal	1000000.00	3.11
16711.31579	42.59	54.00	-11.41	62.00	1.01	Vertical	1000000.00	3.90
17086.05263	42.68	54.00	-11.32	129.00	1.71	Horizontal	1000000.00	3.47
17348.94737	41.20	54.00	-12.80	55.00	2.10	Vertical	1000000.00	2.26
17595	40.79	54.00	-13.21	77.00	1.35	Horizontal	1000000.00	2.28

Notes: No emissions detected from 4.962-18.000 GHz. The readings in this range are noise floor readings. From 18-25 GHz, testing was performed manually with no emissions were detected at a distance of 10 cm.

		Test Date:	02/08/2019, 02/16/2019, 02/24/2019, 06/17/2019, 06/23/2019
Test Personnel:	Kouma Sinn KPS		
Supervising/Reviewing Engineer: (Where Applicable)	N/A		
Product Standard:	CFR47 FCC Part 15.247 RSS-247	Limit Applied:	See report section 10.3
Input Voltage:	Internal Battery Powered		
Pretest Verification w/ Ambient Signals or BB Source:	BB Source	Ambient Temperature:	21, 21, 21, 23, 23 ºC
		Relative Humidity:	24, 22, 22, 42, 43 %
		Atmospheric Pressure:	999, 998, 1004, 1005, 1004 mbars

Deviations, Additions, or Exclusions: None

11 Digital Device and Receiver Radiated Spurious Emissions

11.1 Method

Tests are performed in accordance with FCC Part 15 Subpart B, ICES 003, and ANSI C 63.4.

TEST SITE: 10m ALSE

The 10m ALSE is 13m (Length) x 21m (Depth) x 10m (Height) with the effective size in terms of space from the tips of the absorber is 12m (Length) x 20m (Depth) x 8.5m (Height). This chamber achieves broadband performance using a unique arrangement of hybrid and ferrite tile absorber. This chamber has a built in 3m diameter turntable (Embedded type). The metal structure of the table makes electrical connection around the entire circumference of the turntable to the ground plane with a metal brush type connection. The turntable is located on one end of the chamber and the antennas are mounted 3 and 10 meters away at the other end of the chamber on the adjustable an Antenna Mast. The antenna mast is a non-conductive bore sighted type with remote control of antenna height and polarization. The Antenna Mast and the turntable can be remotely controlled through the controller located in the adjacent Control room. A Styrofoam table 80 cm high is used for table-top equipment.

Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
Radiated Emissions, 10m	30-1000 MHz	4.6dB	6.3 dB
Radiated Emissions, 3m	30-1000 MHz	5.3 dB	6.3 dB
Radiated Emissions, 3m	1-6 GHz	4.5 dB	5.2 dB
Radiated Emissions, 3m	6-15 GHz	5.2 dB	5.5 dB
Radiated Emissions, 3m	15-18 GHz	5.0 dB	5.5 dB
Radiated Emissions, 3m	18-40 GHz	5.0 dB	5.5 dB

As shown in the table above our radiated emissions U_{lab} is less than the corresponding U_{CISPR} reference value in CISPR 16-4-2 Table 1, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required, based on CISPR 22 and CISPR 11 (for 2006 and later revisions) Clause 11.

Sample Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CF - AG
Where FS = Field Strength in dBμV/m
RA = Receiver Amplitude (including preamplifier) in dBμV
CF = Cable Attenuation Factor in dB
AF = Antenna Factor in dB
AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows.

Assume a receiver reading of 52.0 dBμV is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dBμV/m. This value in dBμV/m was converted to its corresponding level in μV/m.

RA = 52.0 dBμV
AF = 7.4 dB/m
CF = 1.6 dB
AG = 29.0 dB
FS = 32 dBμV/m

To convert from dBμV to μV or mV the following was used:

$UF = 10^{(NF / 20)}$ where UF = Net Reading in μV
NF = Net Reading in dBμV

Example:

FS = RA + AF + CF – AG = 52.0 + 7.4 + 1.6 – 29.0 = 32.0
$UF = 10^{(32\ dB\mu V / 20)}$ = 39.8 μV/m

Alternately, when BAT-EMC Emission Software is used, the “Level” includes all losses and gains and is compared directly in the “Margin” column to the “Limit”. The “Correction” includes Antenna Factor, Preamp, and Cable Loss. These are already accounted for in the “Level” column.

11.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV001'	Weather Station	Davis Instruments	7400	PE80519A61	01/23/2019	01/23/2020
EMC02'	ANTENNA, RIDGED GUIDE, 1-18 GHZ	EMCO	3115	2784	08/16/2018	08/16/2019
145-416'	Cables 145-420 145-423 145-425 145-408	Huber + Suhner	3m Track B cables	multiple	07/25/2018	07/25/2019
145128'	EMI Receiver (20 Hz - 40 Ghz)	Rohde & Schwarz	ESIB 40	839283/001	03/28/2019	03/28/2020
145-416'	Cables 145-420 145-423 145-425 145-408	Huber + Suhner	3m Track B cables	multiple	07/25/2018	07/25/2019
145-410'	Cables 145-420 145-421 145-422 145-406	Huber + Suhner	10m Track A Cables	multiple	07/25/2018	07/25/2019
PRE11'	50dB gain pre-amp	Keith H	PRE11	PRE11	10/27/2018	10/27/2019
BONN001'	1-18GHz low noise pre-amp	Bonn	BLMA 0118-M	1811749	07/10/2018	07/10/2019
REA008'	band reject filter 2.4GHz	Reactel, Inc	12RX7-2441.75-x140 S	17-01	07/13/2018	07/13/2019
145145'	Broadband Hybrid Antenna 30 MHz - 3 GHz	Sunol Sciences Corp.	JB3	A122313	06/12/2019	06/12/2020

Software Utilized:

Name	Manufacturer	Version
BAT-EMC	Nexio	3.17.0.3

11.3 Results:

The sample tested was found to Comply.

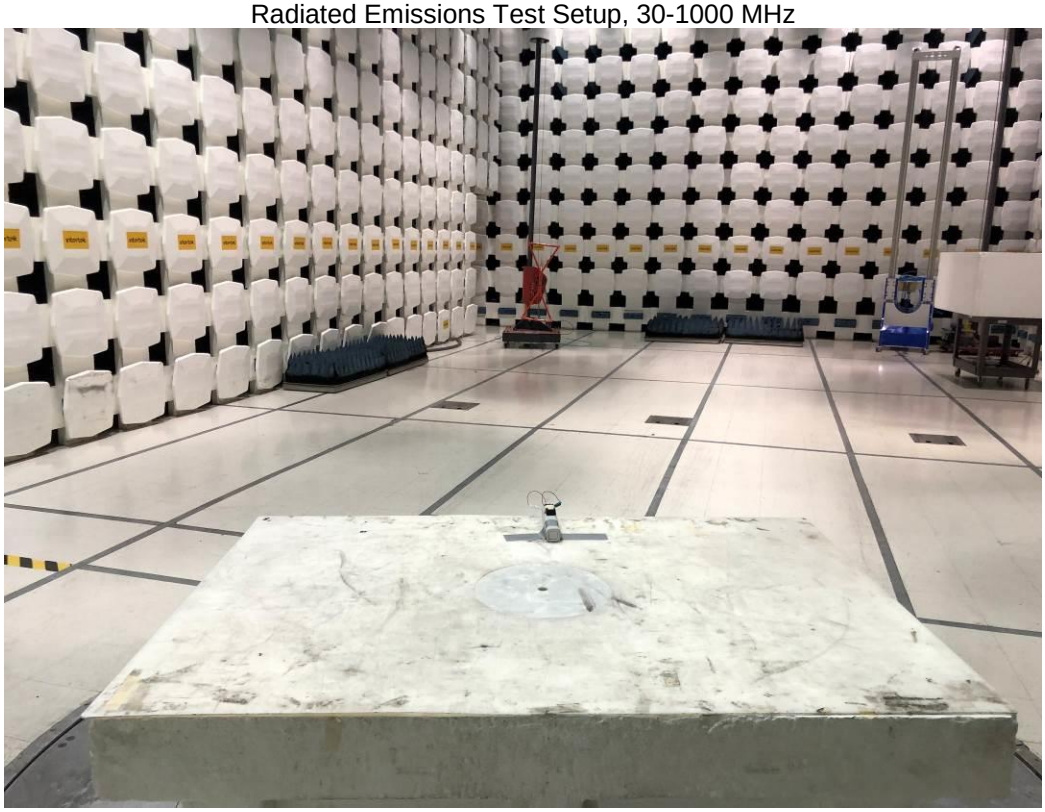
§15.109 Radiated emission limits.

The field strength of radiated emissions form unintentional radiators at a distance of 3 meters shall not exceed the following values.

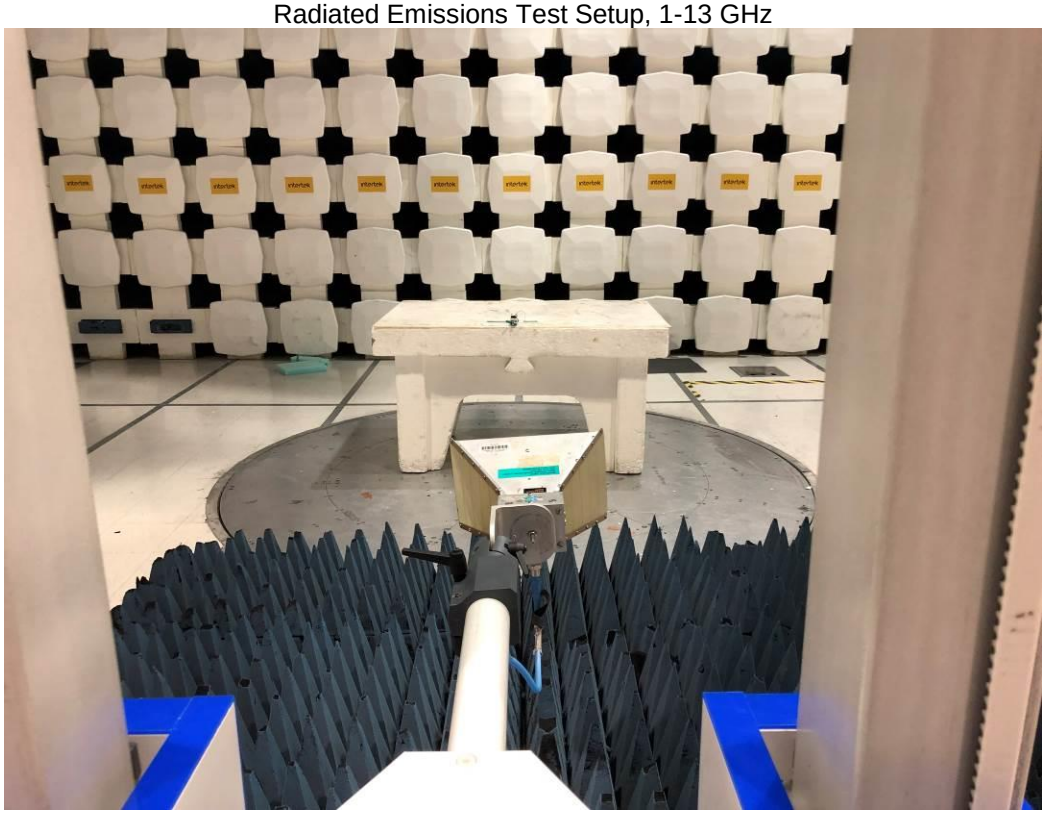
Frequency of emission (MHz)	Field strength (microvolts/meter)	Field strength (dBµV/m)
30-88	100	40.00
88-216	150	43.52
216-960	200	46.02
Above 960	500	54.00

11.4 Setup Photographs:

Radiated Emissions Test Setup, 30-1000 MHz



Radiated Emissions Test Setup, 1-13 GHz



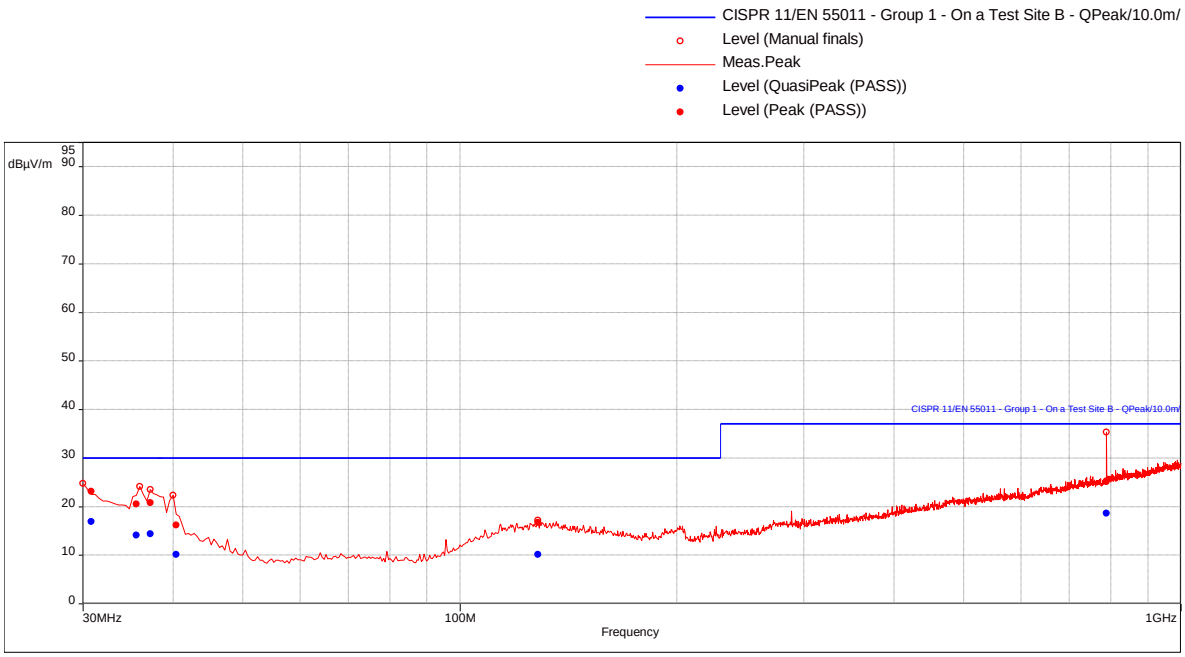
11.5 Plots/Data:

2.4 GHz BLE, 30-1000 MHz

Test Information:

Date and Time	6/17/2019 9:08:48 PM
Client and Project Number	Renovia
Engineer	Kouma Sinn
Temperature	23C
Humidity	42%
Atmospheric Pressure	1005mbar
Comments	30-1000MHz SA mode_Rx at low channel

Graph:



Results:

Peak (PASS) (6)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
30.61578947	23.09	30.00	-6.91	359.00	3.71	Vertical	120000.00	-12.69
35.58947368	20.55	30.00	-9.45	0.00	2.70	Vertical	120000.00	-15.77
37.01052632	20.76	30.00	-9.24	55.00	1.59	Vertical	120000.00	-16.86
40.34736842	16.18	30.00	-13.82	32.00	3.74	Vertical	120000.00	-19.16
128.4631579	16.72	30.00	-13.28	283.00	2.87	Vertical	120000.00	-18.77
788.4210526	25.07	37.00	-11.93	98.00	3.04	Vertical	120000.00	-8.15

QuasiPeak (PASS) (6)

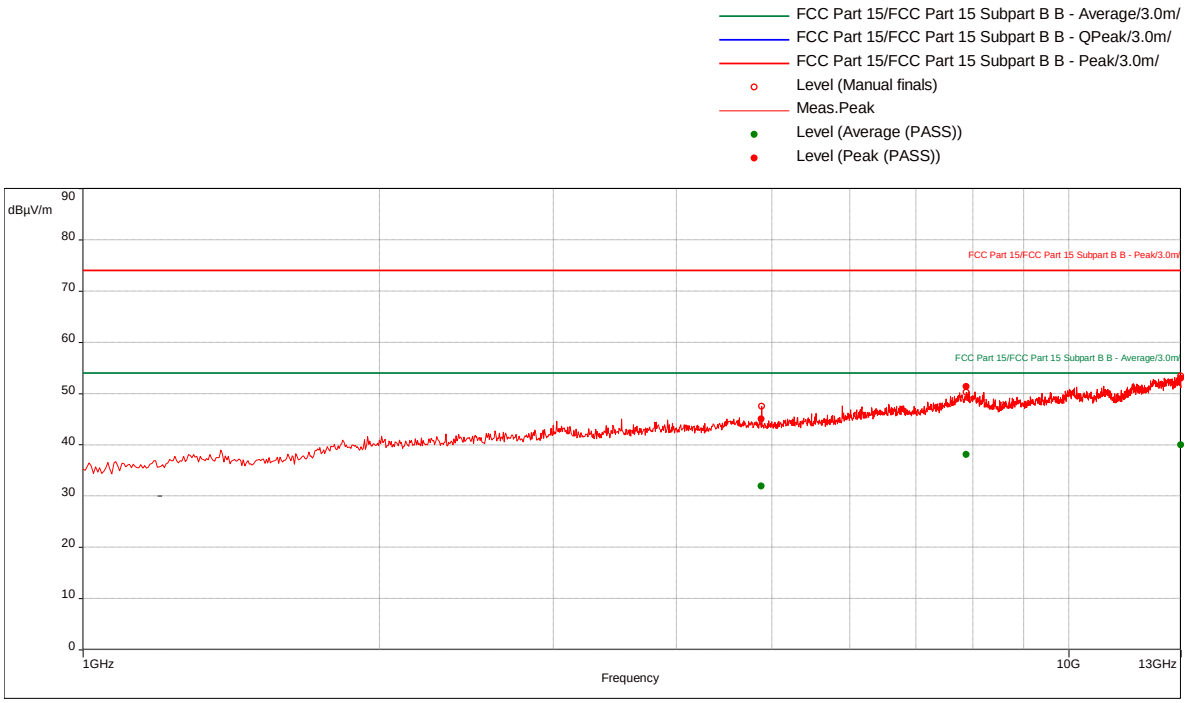
Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
30.61578947	16.85	30.00	-13.15	359.00	3.71	Vertical	120000.00	-12.69
35.58947368	14.05	30.00	-15.95	0.00	2.70	Vertical	120000.00	-15.77
37.01052632	14.35	30.00	-15.65	55.00	1.59	Vertical	120000.00	-16.86
40.34736842	10.09	30.00	-19.91	32.00	3.74	Vertical	120000.00	-19.16
128.4631579	10.12	30.00	-19.88	283.00	2.87	Vertical	120000.00	-18.77
788.4210526	18.57	37.00	-18.43	98.00	3.04	Vertical	120000.00	-8.15

2.4 GHz BLE, 1-13 GHz

Test Information:

Date and Time	6/17/2019 8:39:55 PM
Client and Project Number	Renovia
Engineer	Kouma Sinn
Temperature	23C
Humidity	42%
Atmospheric Pressure	1005mbar
Comments	1 to 13 GHz SA mode_Rx @ low channel 2402 MHz_Battery Side Up

Graph:



Results:

Peak (PASS) (3)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
4882.368421	44.99	74.00	-29.01	359.00	1.65	Horizontal	1000000.00	-11.71
7876.315789	51.36	74.00	-22.64	151.00	3.15	Horizontal	1000000.00	-5.21
12999.47368	52.93	74.00	-21.07	18.00	2.90	Vertical	1000000.00	1.23

Average (PASS) (3)

Frequency (MHz)	Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Azimuth (°) (dB)	Height (m) (dB)	Pol. (dB)	RBW (dB)	Correction (dB)
4882.368421	31.93	54.00	-22.07	359.00	1.65	Horizontal	1000000.00	-11.71
7876.315789	38.08	54.00	-15.92	151.00	3.15	Horizontal	1000000.00	-5.21
12999.47368	39.95	54.00	-14.05	18.00	2.90	Vertical	1000000.00	1.23

Test Personnel:	Kouma Sinn KPS	Test Date:	06/17/2019
Supervising/Reviewing Engineer: (Where Applicable)	N/A		
Product Standard:	CFR47 FCC Part 15.247 RSS-247	Limit Applied:	See report section 11.3
Input Voltage:	Internal Battery	Ambient Temperature:	23 ºC
Pretest Verification w/ Ambient Signals or BB Source:	BB Source	Relative Humidity:	42 %
		Atmospheric Pressure:	1005 mbars

Deviations, Additions, or Exclusions: None

12 Revision History

Revision Level	Date	Report Number	Prepared By	Reviewed By	Notes
0	07/12/2019	103511832BOX-012b	KPS	MFM	Original Issue