



SIMULTANEOUS TRANSMISSION TEST REPORT

Report Number. : R12663786-E4

Applicant : Ideal Industries Lighting LLC, DBA CREE Lighting
4401 Silicon Drive
Durham, NC 27703, USA

Model : WIM-CMB-OEM

FCC ID : 2ACQ6-WMB

IC : 11481A-WMB

EUT Description : 802.15.4/BLE Radio Module

Test Standard(s) : FCC 47 CFR PART 15 SUBPART C
ISED RSS-247 ISSUE 2
ISED RSS-GEN ISSUE 5

Date Of Issue:
2019-09-16

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REPORT REVISION HISTORY

Ver.	Issue Date	Revisions	Revised By
1	2019-07-03	Initial Issue	Brian T. Kiewra
2	2019-07-17	Updated applicant name, FCC/IC IDs, and firmware	Niklas Haydon
3	2019-09-16	Updated duty cycle table	Niklas Haydon

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: Ideal Industries Lighting LLC, DBA CREE Lighting
4401 Silicon Drive
Durham, NC 27703, USA

EUT DESCRIPTION: 802.15.4/BLE radio module

MODEL: WIM-CMB-OEM

SERIAL NUMBER: WRC-2, JN251C78092, JN251C78096, JN251C78093,

DATE TESTED: 2019-06-21 to 2019-07-02

APPLICABLE STANDARDS	
STANDARD	TEST RESULTS
CFR 47 Part 15 Subpart C	Compliant
ISED CANADA RSS-247 Issue 2	Compliant
ISED CANADA RSS-GEN Issue 5	Compliant

UL LLC tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by UL LLC based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

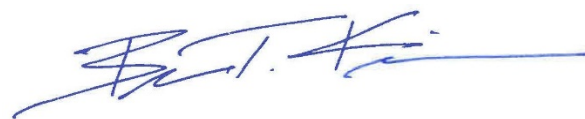
Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by UL LLC and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL LLC will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the U.S. Government.

Approved & Released
For UL LLC By:



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Operations Leader
UL – Consumer Technology Division

Prepared By:



Brian T. Kiewra
Project Engineer
UL – Consumer Technology Division

2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC CFR 47 Part 2, FCC CFR 47 Part 15, 558074 D01 v05r02, ANSI C63.10-2013, RSS-GEN Issue 5, RSS-247 Issue 2.

3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 12 Laboratory Drive, Research Triangle Park, NC 27709, USA and 2800 Perimeter Park Dr., Suite B, Morrisville, NC 27560, USA. The following table identifies which facilities were utilized for radiated emission measurements documented in this report. Specific facilities are also identified in the test results sections.

12 Laboratory Dr.	2800 Suite Perimeter Park Dr.
ISED Site Code: 2180C	
<input type="checkbox"/> Chamber A	<input type="checkbox"/> Chamber North
<input type="checkbox"/> Chamber C	<input checked="" type="checkbox"/> Chamber South

UL LLC (RTP) is accredited by NVLAP, Laboratory Code 200246-0

4. CALIBRATION AND UNCERTAINTY

4.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

4.2. SAMPLE CALCULATION

Where relevant, the following sample calculation is provided:

$$\begin{aligned} \text{Field Strength (dBuV/m)} &= \text{Measured Voltage (dBuV)} + \text{Antenna Factor (dB/m)} + \\ &\text{Cable Loss (dB)} - \text{Preamp Gain (dB)} \\ 36.5 \text{ dBuV} + 18.7 \text{ dB/m} + 0.6 \text{ dB} - 26.9 \text{ dB} &= 28.9 \text{ dBuV/m} \end{aligned}$$

4.3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus

PARAMETER	UNCERTAINTY
All emissions, radiated	±4.88 dB

Uncertainty figures are valid to a confidence level of 95%.

5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

The EUT is a 802.15.4/BLE radio module.

5.2. DESCRIPTION OF AVAILABLE ANTENNAS

Both 802.15.4 and BLE radio utilize a Johanson 2450AT18B100 antenna, with a maximum gain of 0.5 dBi.

5.3. SOFTWARE AND FIRMWARE

The Firmware used for Bluetooth on the EUT during testing is common F/W for all Bluetooth channels - UART commands based "radio_test_pca10040.hex", Rev 0

The firmware used for 802.15.4 on the EUT during testing is:

For CH11 (2405MHz): Firmware name: "128RFR2_MOD_11.hex", Rev0

For CH18 (2440MHz): Firmware name: "128RFR2_MOD_18.hex", Rev0

For CH25 (2475MHz): Firmware name: "128RFR2_MOD_25.hex", Rev0

For CH26 (2480MHz): Firmware name: "TAL_PRBS_CH26_1P2_DBM_FILT.hex", Rev0

5.4. SIMULTANEOUS TRANSMISSION CONFIGURATIONS

All worst-case orientations and power levels of each mode of operation were taken into consideration and it was determined that X-Axis and Z-Axis were worst-case orientations. Therefore, all final testing was performed with the EUT in the X and Z orientations.

Simultaneous transmission of the 802.15.4 and BLE radios was investigated as follows:

802.15.4 at 2405MHz and BLE at 2402MHz for low bandedge and harmonics/spurious.

802.15.4 at 2475MHz and BLE at 2480MHz for high bandedge

802.15.4 at 2480MHz and BLE at 2480MHz for high bandedge

802.15.4 at 2475MHz and BLE at 2478MHz for high bandedge

802.15.4 at 2480MHz and BLE at 2478MHz for high bandedge

802.15.4 at 2405MHz and BLE at 2402MHz for harmonics/spurious.

802.15.4 at 2440MHz and BLE at 2440MHz for harmonics/spurious.

Device was found to still be compliant.

5.5. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	Manufacturer	Model	Serial Number	FCC ID
DC power supply	Circuit Specialists	CSI3005X5	Non-Serialized	NA

I/O CABLES

I/O Cable List						
Cable No.	Port	# of Identical Ports	Connector Type	Cable Type	Cable Length (m)	Remarks
1	DC	1	Terminal	Unshielded	<3m	Provides DC power to EUT

TEST SETUP

The EUT is setup as standalone equipment and exercised using QRCT commands.

SETUP DIAGRAM FOR TESTS

Refer to UL Document R12663786-EP4

6. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the tests documented in this report:

Test Equipment Used - Radiated Disturbance Emissions Test Equipment (Morrisville - South Chamber)

Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
1-18 GHz					
AT0072)	Double-Ridged Waveguide Horn Antenna, 1 to 18 GHz	ETS Lindgren	3117	2019-04-22	2020-04-22
Gain-Loss Chains					
S-SAC03	Gain-loss string: 1-18GHz	Various	Various	2019-03-13	2020-03-13
Receiver & Software					
SA0025	Spectrum Analyzer	Agilent	N9030A	2019-02-28	2020-02-28
SOFTEMI	EMI Software	UL	Version 9.5	NA	NA

Note: All equipment within calibration at time of use.

7. SIMULTANEOUS TRANSMISSIONS TEST RESULTS

7.1. ON TIME AND DUTY CYCLE

LIMITS

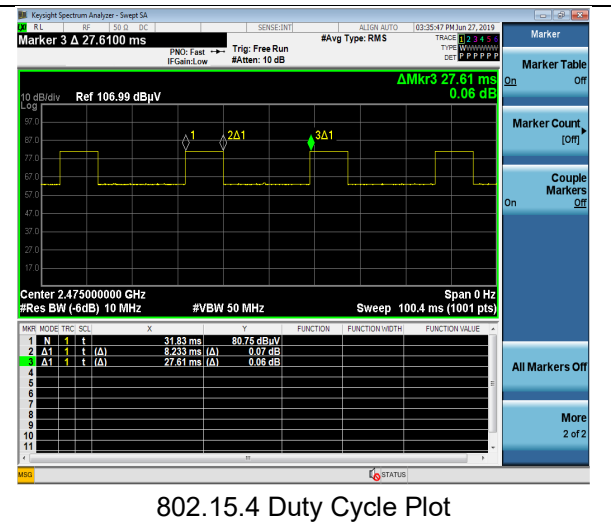
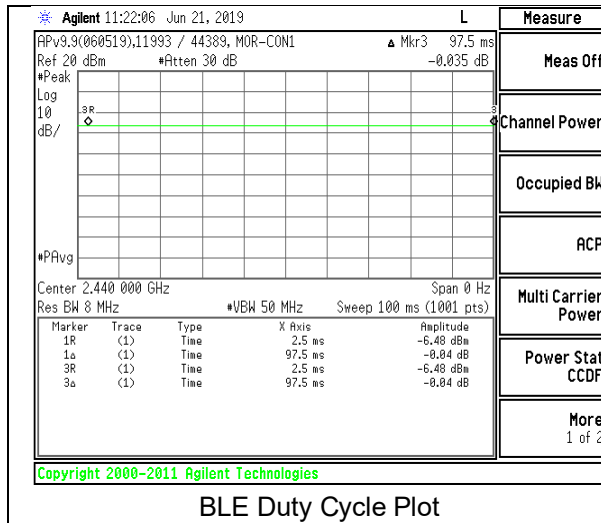
None; for reporting purposes only.

PROCEDURE

KDB 558074 Zero-Span Spectrum Analyzer Method.

ON TIME AND DUTY CYCLE RESULTS

Mode	ON Time B (msec)	Period (msec)	Duty Cycle x (linear)	Duty Cycle (%)
2.4 GHz band				
802.15.4	8.233	27.610	0.298	29.82%
BLE	97.500	97.500	1.000	100.00%



Note: 802.15.4 set to real world duty cycle for simultaneous transmission testing. The 802.15.4 radio was not duty cycle corrected up because it's considered a protocol limited device as described in FCC KDB 558074 D01 15.247 Meas Guidance v05r02, FAQ section.

7.2. LIMITS AND PROCEDURE

LIMITS

FCC §15.205 and §15.209
ISED RSS-GEN Section 8.9 (Transmitter)

Frequency Range (MHz)	Field Strength Limit (uV/m) at 3 m	Field Strength Limit (dBuV/m) at 3 m
0.009-0.490	2400/F(kHz) @ 300 m	-
0.490-1.705	24000/F(kHz) @ 30 m	-
1.705 - 30	30 @ 30m	-
30 - 88	100	40
88 - 216	150	43.5
216 - 960	200	46
Above 960	500	54

TEST PROCEDURE

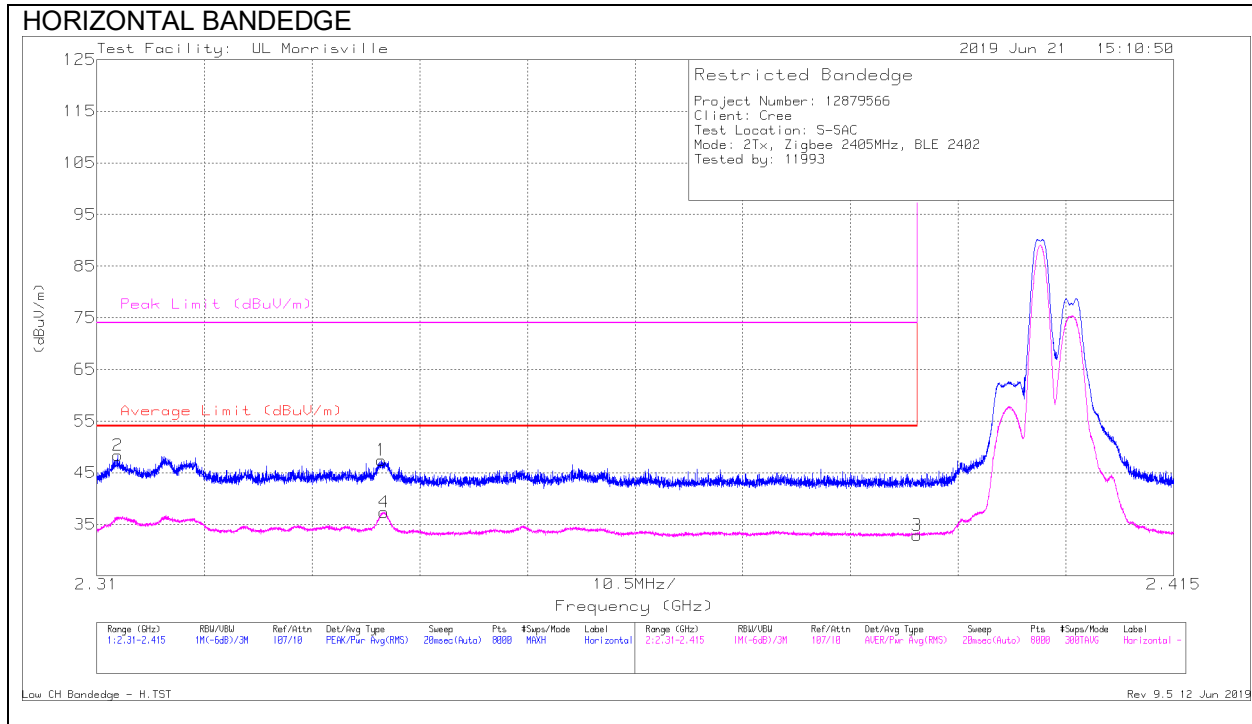
The EUT is placed on a non-conducting table 1.5 m above the ground plane for above 1GHz measurements. The antenna to EUT distance is 3 meters.

For peak measurements above 1 GHz, the resolution bandwidth is set to 1 MHz and the video bandwidth is set to 3 MHz. For average measurements above 1GHz, the resolution bandwidth and video bandwidth are set as described in ANSI C63.10:2013 for the applicable measurement. The particular averaging method used for this test program was RMS averaging.

The spectrum from 1 to 18 GHz is investigated with the transmitter set as stated in Section 5.4

The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized in both the vertical and the horizontal positions.

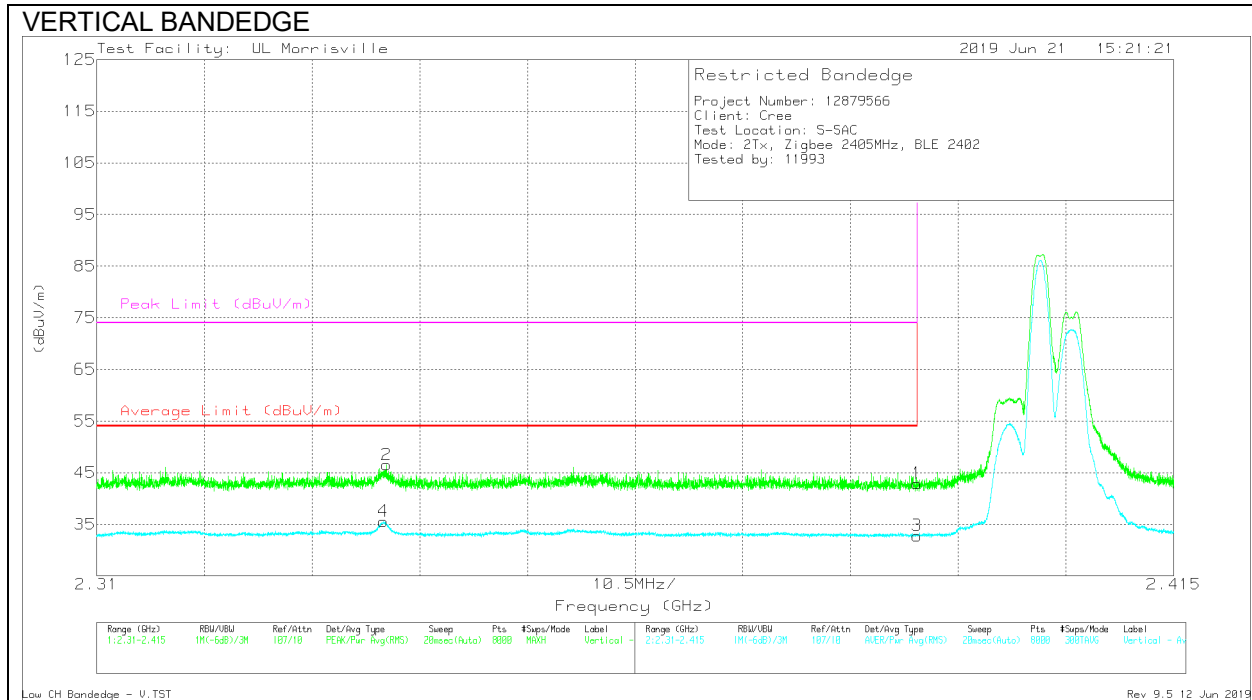
7.2.1. 802.15.4 (2405MHz) and BLE (2402MHz) – LOW BANDEDGE (X-AXIS)



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (dB/m)	Amp/Cbl/Filtr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.33779	39.52	Pk	31.6	-23.7	47.42	-	-	74	-26.58	247	153	H
2	* 2.31207	40.38	Pk	31.7	-23.7	48.38	-	-	74	-25.62	247	153	H
3	* 2.39	24.97	RMS	31.9	-24	32.87	54	-21.13	-	-	247	153	H
4	* 2.338	29.44	RMS	31.6	-23.7	37.34	54	-16.66	-	-	247	153	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
 Pk - Peak detector
 RMS - RMS detection

Note – The 802.15.4 radio was not duty cycle corrected up because it's considered a protocol limited device as described in FCC KDB 558074 D01 15.247 Meas Guidance v05r02, FAQ section.

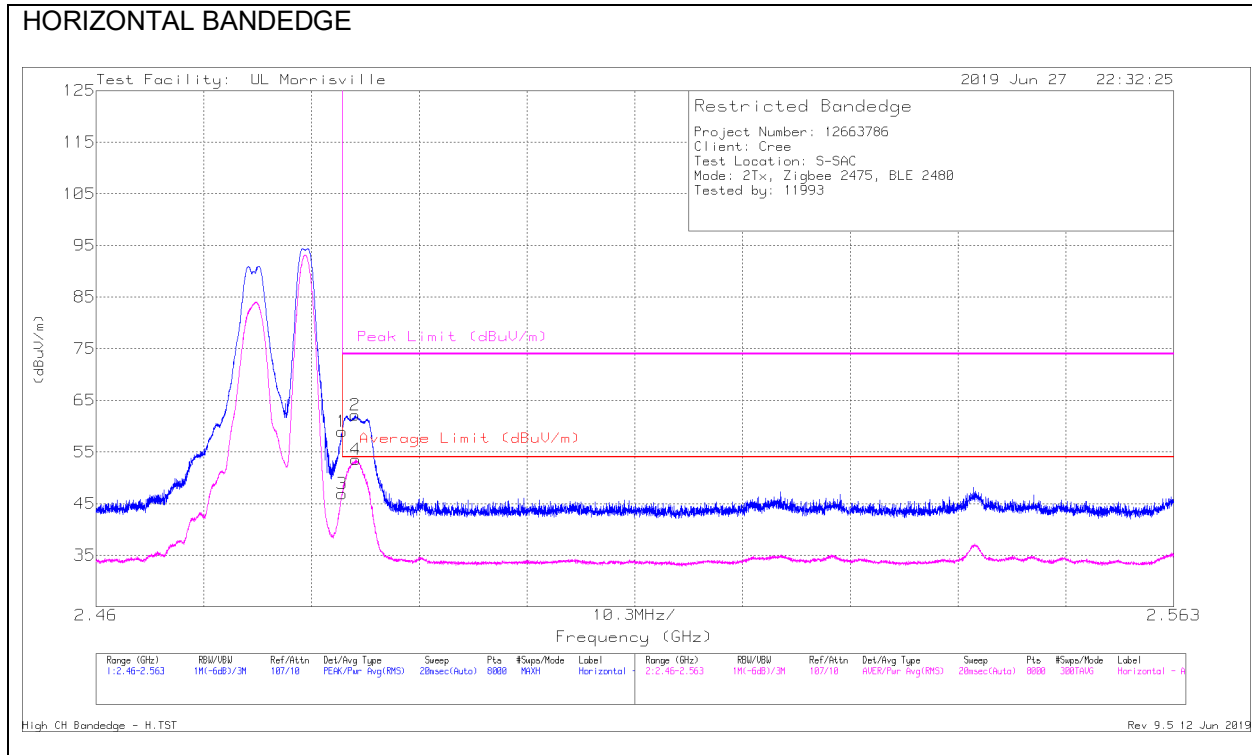


Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (dB/m)	Amp/Cbl/Fitr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.39	35.01	Pk	31.9	-24	42.91	-	-	74	-31.09	207	326	V
2	* 2.33826	38.63	Pk	31.6	-23.7	46.53	-	-	74	-27.47	207	326	V
3	* 2.39	24.89	RMS	31.9	-24	32.79	54	-21.21	-	-	207	326	V
4	* 2.33797	27.68	RMS	31.6	-23.7	35.58	54	-18.42	-	-	207	326	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
 Pk - Peak detector
 RMS - RMS detection

Note – The 802.15.4 radio was not duty cycle corrected up because it's considered a protocol limited device as described in FCC KDB 558074 D01 15.247 Meas Guidance v05r02, FAQ section.

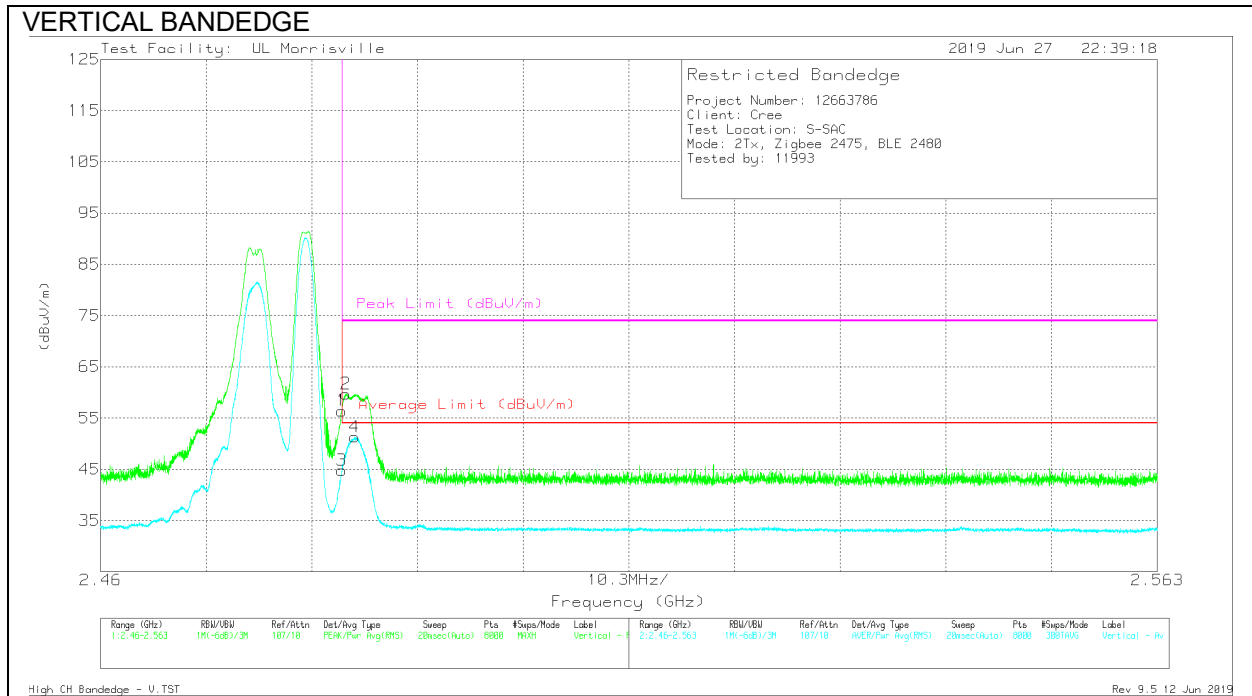
7.2.2. 802.15.4 (2475MHz) and BLE (2480MHz) – HIGH BANDEDGE (X-AXIS)



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (dB/m)	Amp/Cbl/Filtr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.4835	51.11	Pk	32.3	-24.5	58.91	-	-	74	-15.09	296	131	H
2	* 2.48476	54.31	Pk	32.3	-24.5	62.11	-	-	74	-11.89	296	131	H
3	* 2.4835	39.12	RMS	32.3	-24.5	46.92	54	-7.08	-	-	296	131	H
4	* 2.48484	45.71	RMS	32.3	-24.5	53.51	54	-4.9	-	-	296	131	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
 Pk - Peak detector
 RMS - RMS detection

Note – The 802.15.4 radio was not duty cycle corrected up because it's considered a protocol limited device as described in FCC KDB 558074 D01 15.247 Meas Guidance v05r02, FAQ section.

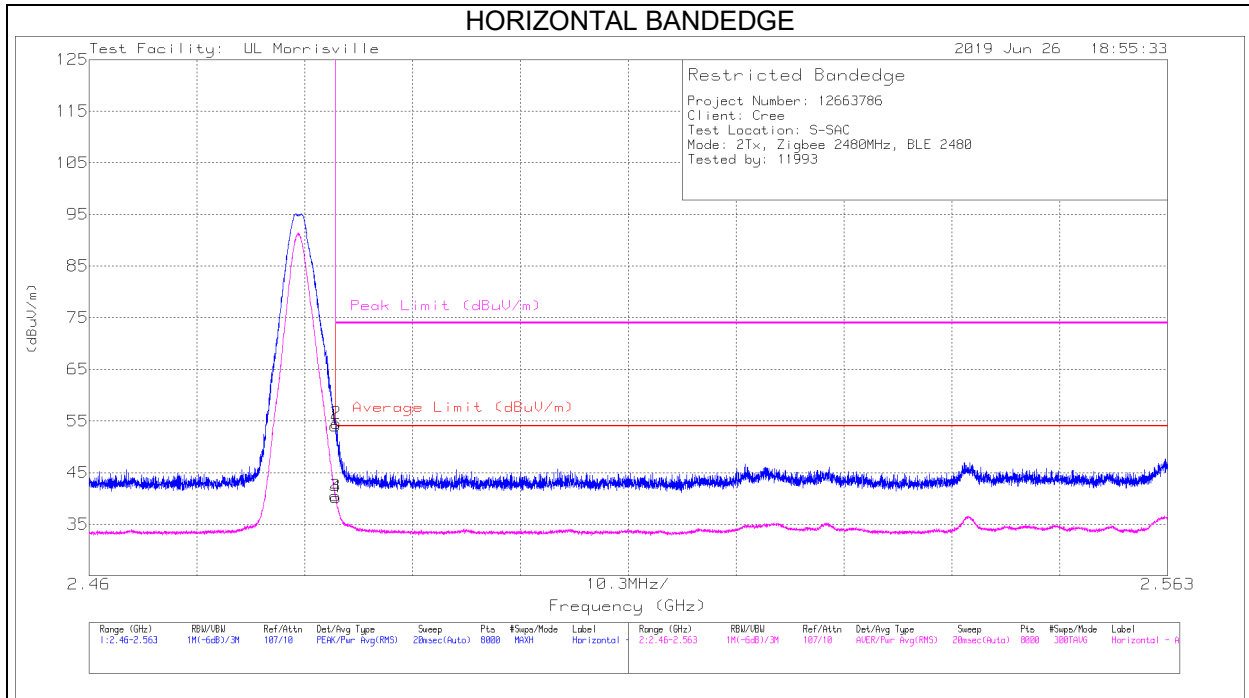


Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (dB/m)	Amp/Cbl/Filtr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.4835	48.63	Pk	32.3	-24.5	56.43	-	-	74	-17.57	209	164	V
2	* 2.48393	51.92	Pk	32.3	-24.5	59.72	-	-	74	-14.28	209	164	V
3	* 2.4835	37.02	RMS	32.3	-24.5	44.82	54	-9.18	-	-	209	164	V
4	* 2.48474	43.49	RMS	32.3	-24.5	51.29	54	-2.71	-	-	209	164	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
 Pk - Peak detector
 RMS - RMS detection

Note – The 802.15.4 radio was not duty cycle corrected up because it's considered a protocol limited device as described in FCC KDB 558074 D01 15.247 Meas Guidance v05r02, FAQ section.

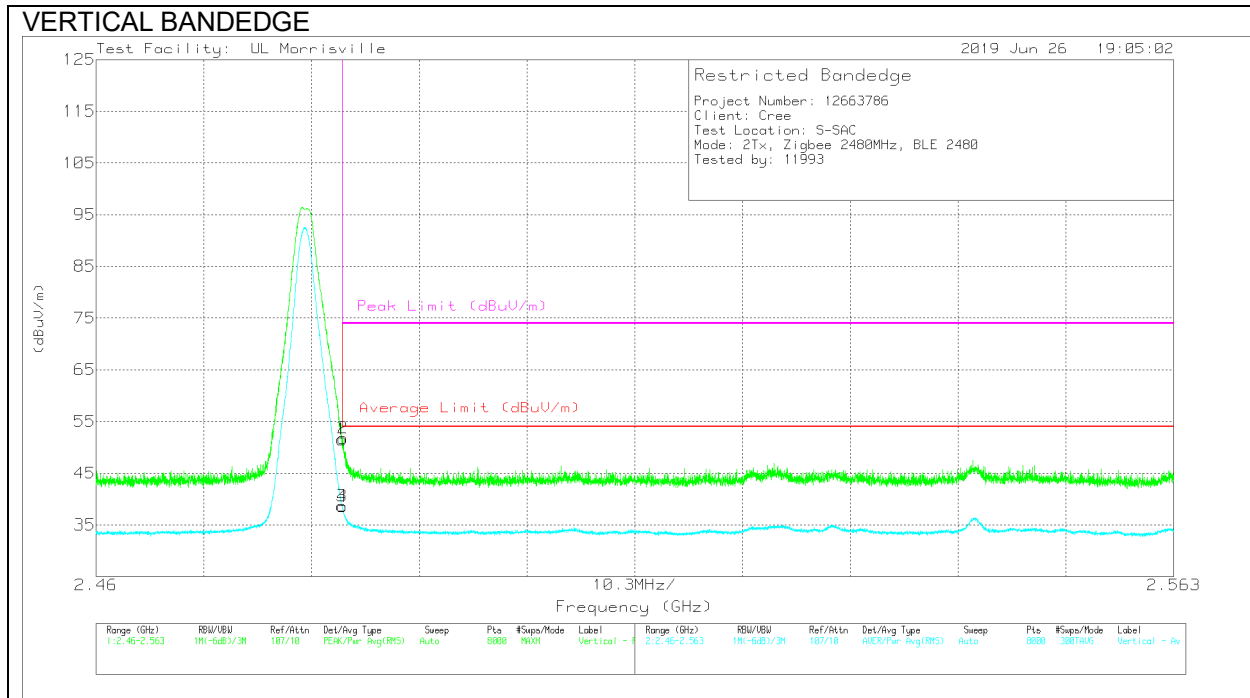
7.2.3. 802.15.4 (2480MHz) and BLE (2480MHz) – HIGH BANDEDGE (X-AXIS)



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (dB/m)	Amp/Cbl/Filtr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.4835	46.22	Pk	32.3	-24.5	54.02	-	-	74	-19.98	82	102	H
2	* 2.4836	46.76	Pk	32.3	-24.5	54.56	-	-	74	-19.44	82	102	H
3	* 2.4835	32.67	RMS	32.3	-24.5	40.47	54	-13.53	-	-	82	102	H
4	* 2.48357	32.4	RMS	32.3	-24.5	40.2	54	-13.8	-	-	82	102	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
 Pk - Peak detector
 RMS - RMS detection

Note – The 802.15.4 radio was not duty cycle corrected up because it's considered a protocol limited device as described in FCC KDB 558074 D01 15.247 Meas Guidance v05r02, FAQ section.

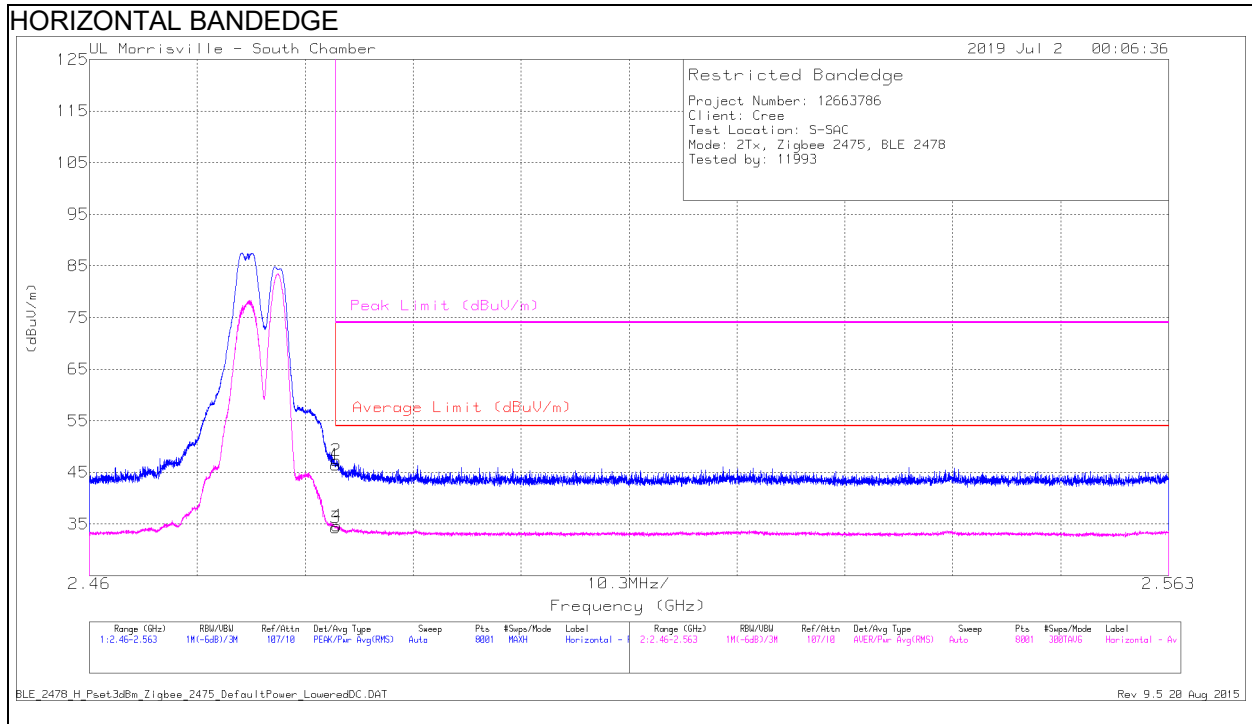


Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (dB/m)	Amp/Cbl/Filtr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.4835	43.73	Pk	32.3	-24.5	51.53	-	-	74	-22.47	57	110	V
2	* 2.48359	43.97	Pk	32.3	-24.5	51.77	-	-	74	-22.23	57	110	V
3	* 2.4835	30.84	RMS	32.3	-24.5	38.64	54	-15.36	-	-	57	110	V
4	* 2.48353	30.75	RMS	32.3	-24.5	38.55	54	-15.45	-	-	57	110	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
 Pk - Peak detector
 RMS - RMS detection

Note – The 802.15.4 radio was not duty cycle corrected up because it's considered a protocol limited device as described in FCC KDB 558074 D01 15.247 Meas Guidance v05r02, FAQ section.

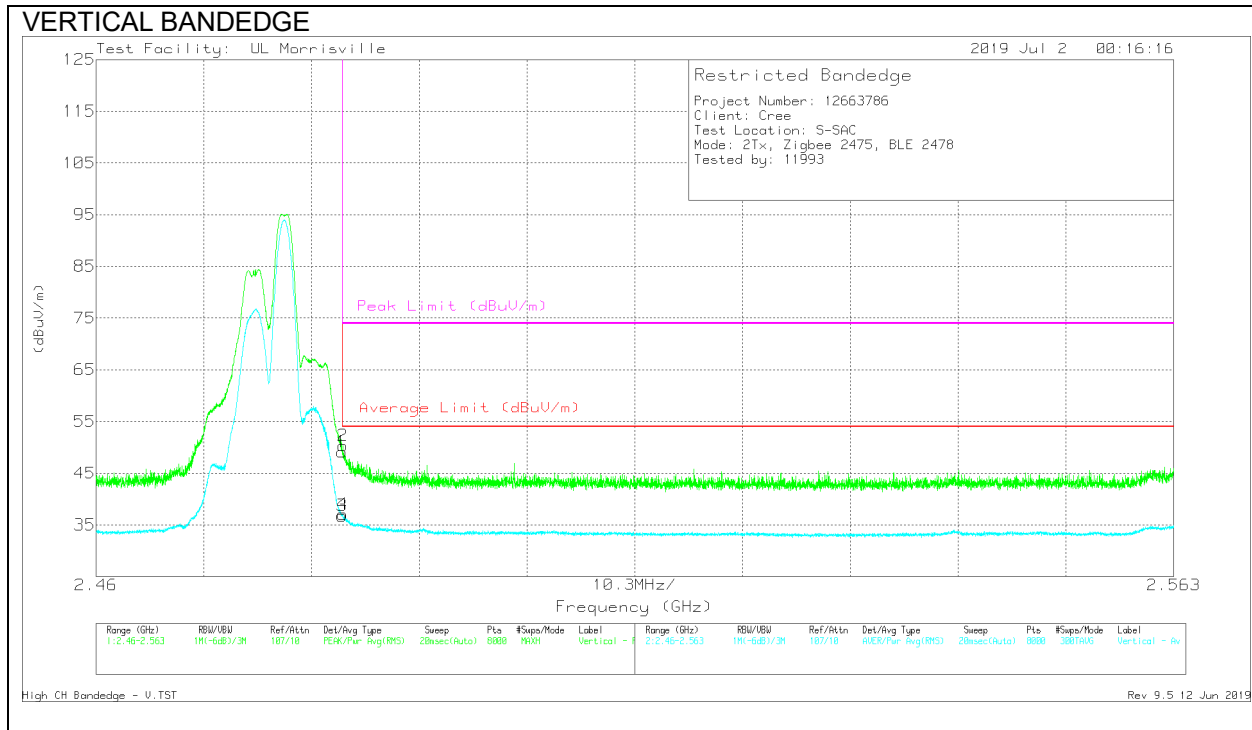
7.2.4. 802.15.4 (2475MHz) and BLE (2478MHz) – HIGH BANDEDGE (X-AXIS)



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (dB/m)	Amp/Cbl/Filtr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.484	38.66	Pk	32.3	-24.5	46.46	-	-	74	-27.54	200	158	H
2	* 2.484	39.51	Pk	32.3	-24.5	47.31	-	-	74	-26.69	200	158	H
3	* 2.484	26.51	RMS	32.3	-24.5	34.31	54	-19.69	-	-	200	158	H
4	* 2.484	26.86	RMS	32.3	-24.5	34.66	54	-19.34	-	-	200	158	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
 Pk - Peak detector
 RMS - RMS detection

Note – The 802.15.4 radio was not duty cycle corrected up because it's considered a protocol limited device as described in FCC KDB 558074 D01 15.247 Meas Guidance v05r02, FAQ section.

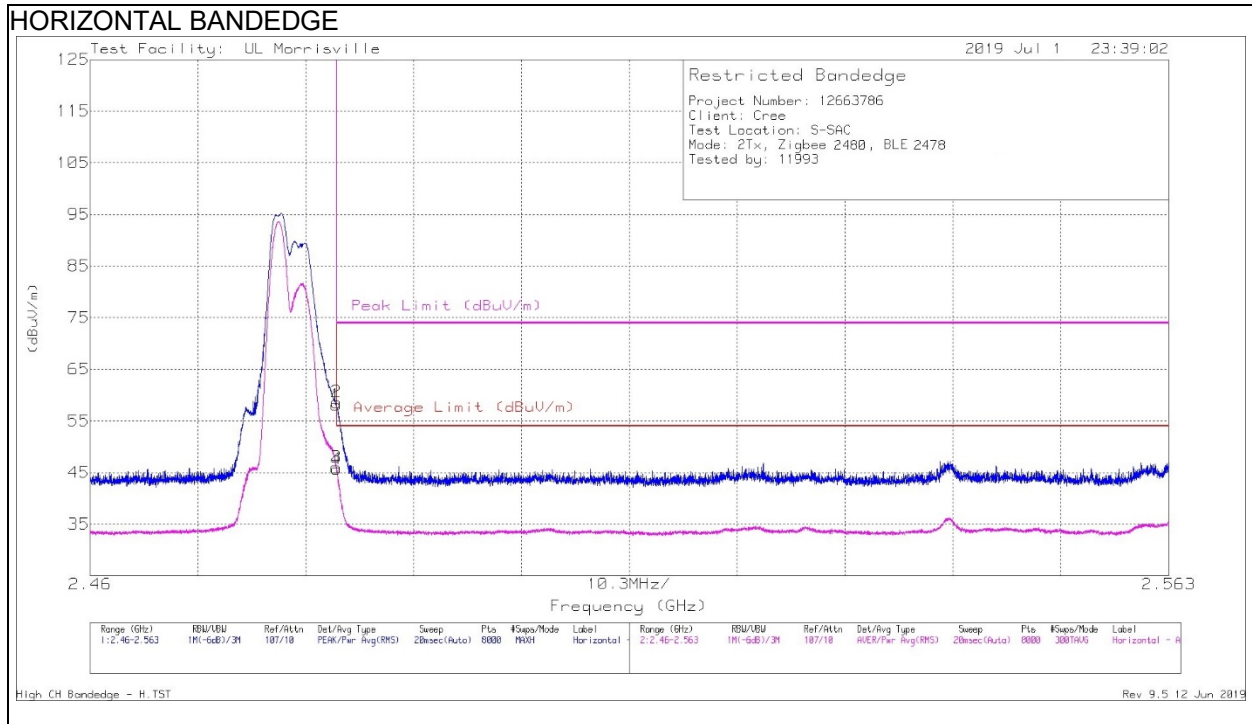


Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (dB/m)	Amp/Cbl/Filtr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.4835	41.33	Pk	32.3	-24.5	49.13	-	-	74	-24.87	212	166	V
3	* 2.4835	28.98	RMS	32.3	-24.5	36.78	54	-17.22	-	-	212	166	V
4	* 2.48357	29.26	RMS	32.3	-24.5	37.06	54	-16.94	-	-	212	166	V
2	* 2.48359	42.53	Pk	32.3	-24.5	50.33	-	-	74	-23.67	212	166	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
 Pk - Peak detector
 RMS - RMS detection

Note – The 802.15.4 radio was not duty cycle corrected up because it's considered a protocol limited device as described in FCC KDB 558074 D01 15.247 Meas Guidance v05r02, FAQ section.

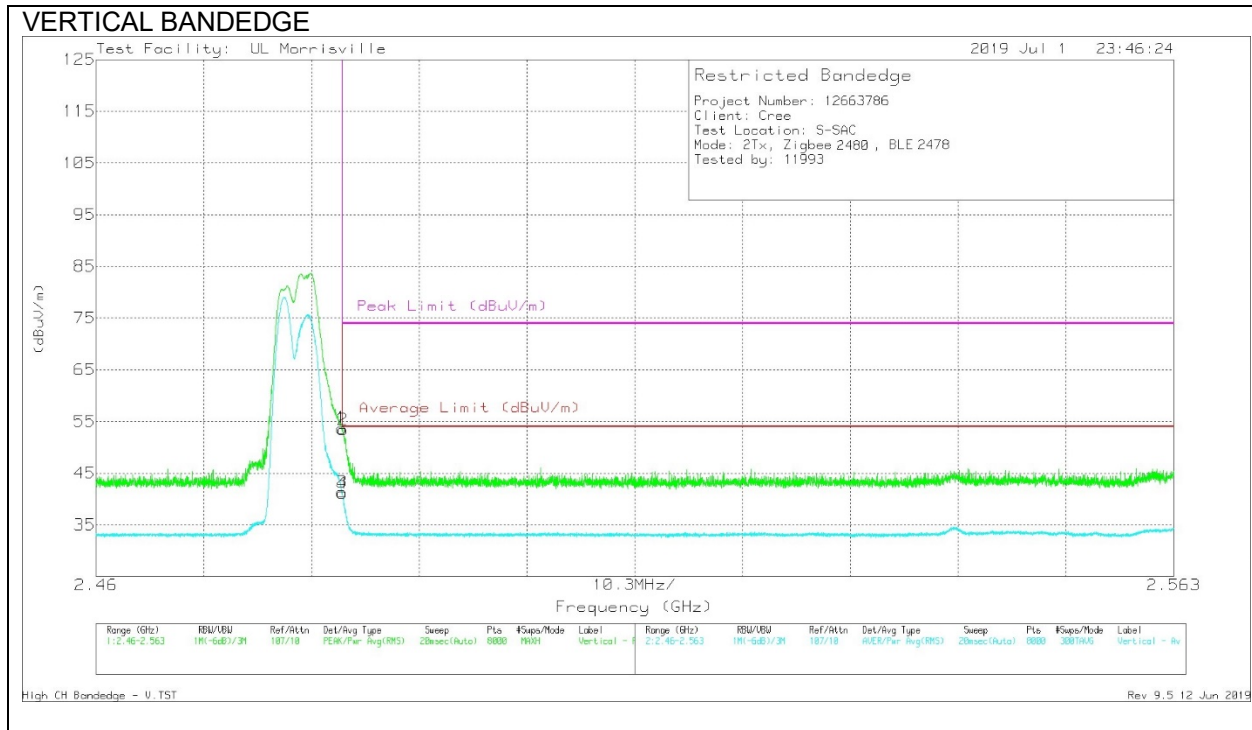
7.2.5. 802.15.4 (2480MHz) and BLE (2478MHz) – HIGH BANDEDGE (X-AXIS)



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (dB/m)	Amp/Cbl/Filtr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.4835	50.28	Pk	32.3	-24.5	58.08	-	-	74	-15.92	92	249	H
2	* 2.48353	50.85	Pk	32.3	-24.5	58.65	-	-	74	-15.35	92	249	H
3	* 2.4835	38.19	RMS	32.3	-24.5	45.99	54	-8.01	-	-	92	249	H
4	* 2.48354	37.89	RMS	32.3	-24.5	45.69	54	-8.31	-	-	92	249	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
 Pk - Peak detector
 RMS - RMS detection

Note – The 802.15.4 radio was not duty cycle corrected up because it's considered a protocol limited device as described in FCC KDB 558074 D01 15.247 Meas Guidance v05r02, FAQ section.

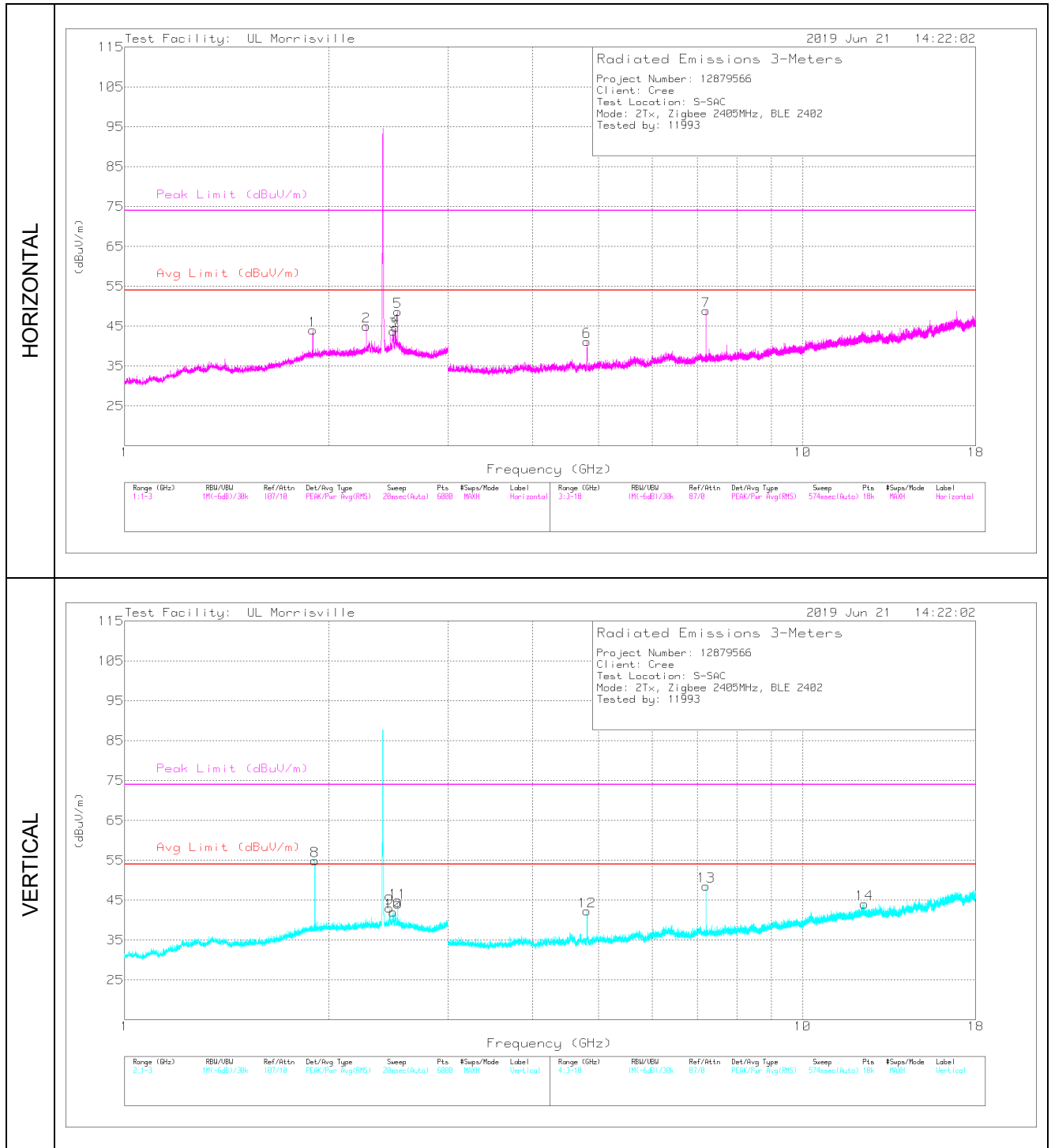


Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (dB/m)	Amp/Cbl/Fitr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.4835	45.92	Pk	32.3	-24.5	53.72	-	-	74	-20.28	86	293	V
2	* 2.4836	45.59	Pk	32.3	-24.5	53.39	-	-	74	-20.61	86	293	V
3	* 2.4835	33.59	RMS	32.3	-24.5	41.39	54	-12.61	-	-	86	293	V
4	* 2.48354	33.35	RMS	32.3	-24.5	41.15	54	-12.85	-	-	86	293	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
 Pk - Peak detector
 RMS - RMS detection

Note – The 802.15.4 radio was not duty cycle corrected up because it's considered a protocol limited device as described in FCC KDB 558074 D01 15.247 Meas Guidance v05r02, FAQ section.

7.2.6. HARMONICS AND SPURIOUS EMISSIONS 802.15.4 (2405MHz) and BLE (2402MHz) (X-AXIS)

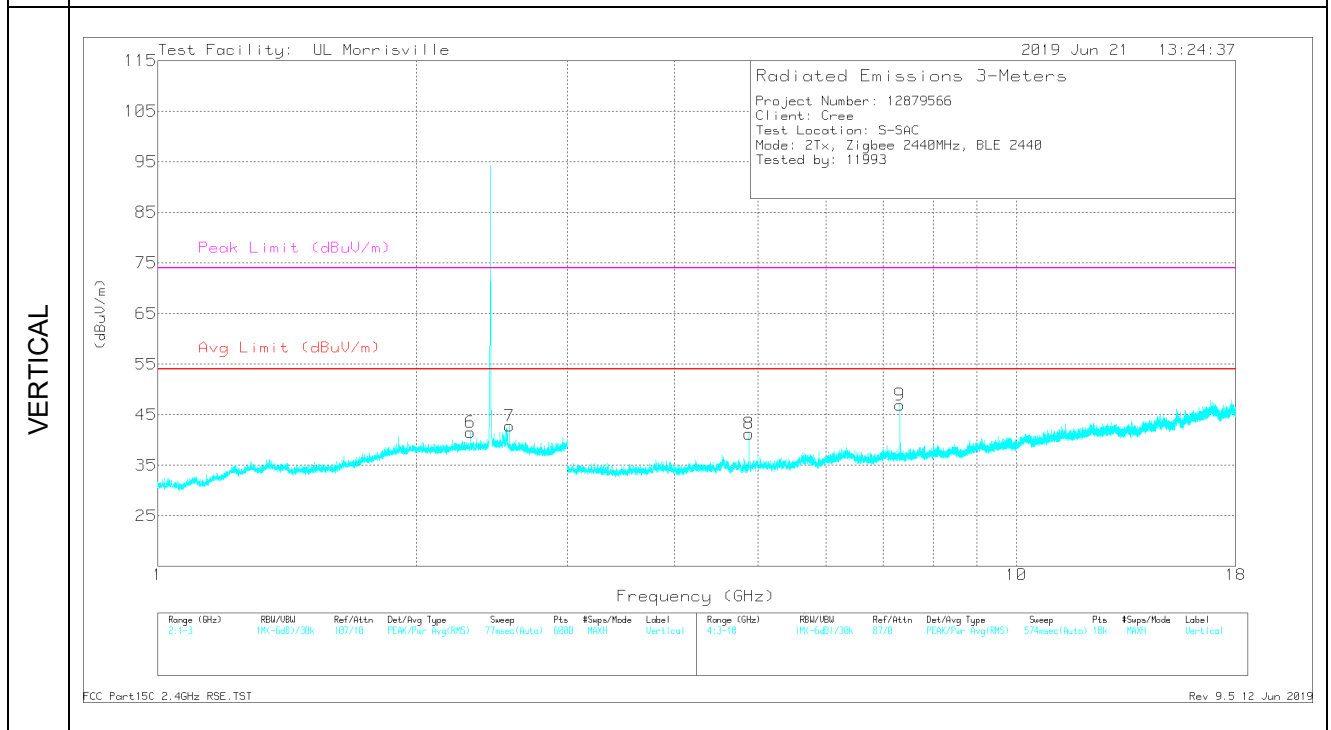
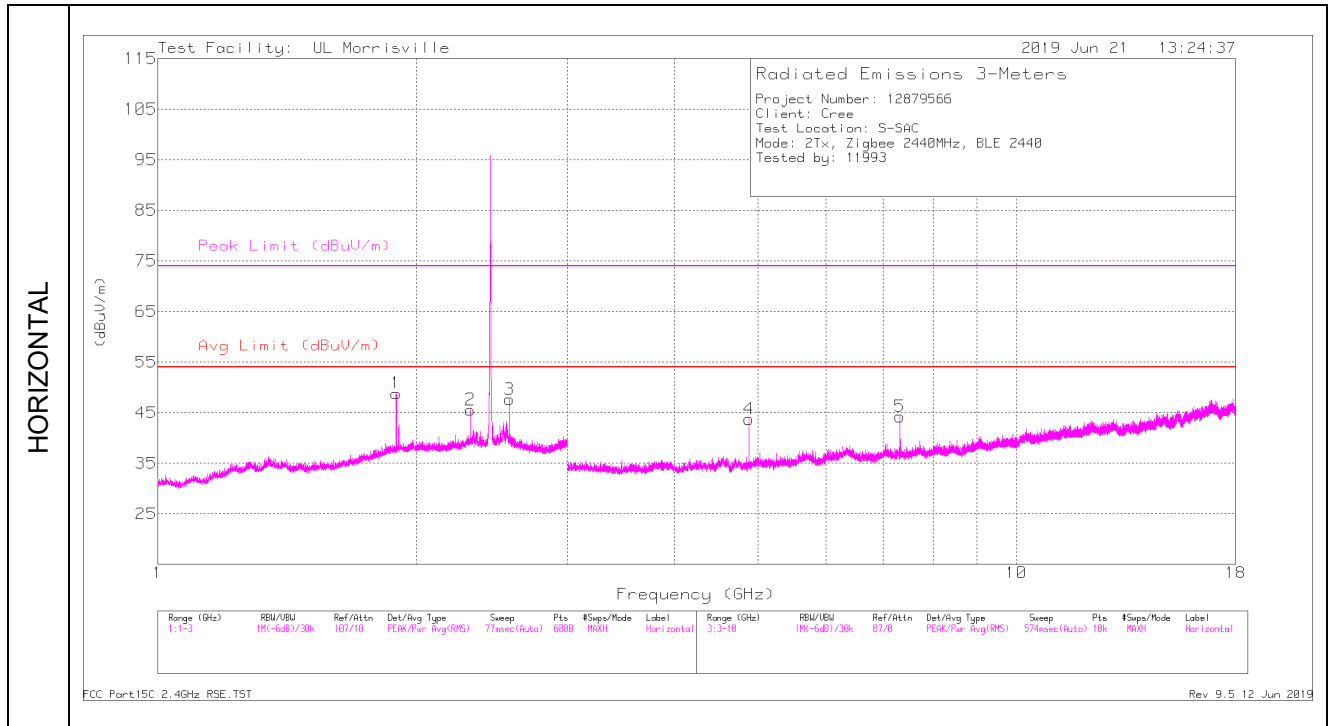


Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (dB/m)	Amp/Cbl/Filtr/Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
2	* 2.27432	43.21	PK2	31.8	-23.5	51.51	-	-	74	-22.49	236	213	H
	* 2.27403	34.61	MAv1	31.8	-23.5	42.91	54	-11.09	-	-	236	213	H
3	* 2.49032	41.82	PK2	32.3	-24.5	49.62	-	-	74	-24.38	266	207	H
	* 2.4911	31.27	MAv1	32.3	-24.5	39.07	54	-14.93	-	-	266	207	H
10	* 2.49167	41.55	PK2	32.3	-24.5	49.35	-	-	74	-24.65	56	102	V
	* 2.49148	29.62	MAv1	32.3	-24.5	37.42	54	-16.58	-	-	56	102	V
6	* 4.80439	43.92	PK2	34.2	-31	47.12	-	-	74	-26.88	120	102	H
	* 4.80432	35.59	MAv1	34.2	-31	38.79	54	-15.21	-	-	120	102	H
12	* 4.80911	44.52	PK2	34.2	-31	47.72	-	-	74	-26.28	309	102	V
	* 4.80908	36.39	MAv1	34.2	-31	39.59	54	-14.41	-	-	309	102	V
14	* 12.33406	34.4	PK2	38.8	-23.8	49.4	-	-	74	-24.6	89	133	V
	* 12.33408	22.32	MAv1	38.8	-23.8	37.32	54	-16.68	-	-	89	133	V
1	1.89582	35.23	Pk	31.1	-22.3	44.03	-	-	-	-	0-360	102	H
8	1.90882	46.23	Pk	31.1	-22.4	54.93	-	-	-	-	0-360	199	V
9	2.45891	35.12	Pk	32.2	-24.3	43.02	-	-	-	-	0-360	199	V
4	2.51059	36.92	Pk	32.4	-24.7	44.62	-	-	-	-	0-360	199	H
5	2.53026	41.07	Pk	32.4	-24.8	48.67	-	-	-	-	0-360	199	H
11	2.53026	36.84	Pk	32.4	-24.8	44.44	-	-	-	-	0-360	101	V
7	7.20607	41.21	Pk	35.7	-28	48.91	-	-	-	-	0-360	101	H
13	7.20607	40.87	Pk	35.7	-28	48.57	-	-	-	-	0-360	101	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
 PK2 - Maximum Peak
 MAv1 - Maximum RMS Average
 Pk - Peak detector

Note – The 802.15.4 radio was not duty cycle corrected up because it's considered a protocol limited device as described in FCC KDB 558074 D01 15.247 Meas Guidance v05r02, FAQ section.

7.2.7. HARMONICS AND SPURIOUS EMISSIONS 802.15.4 (2440MHz) and BLE (2440MHz) (X-AXIS)

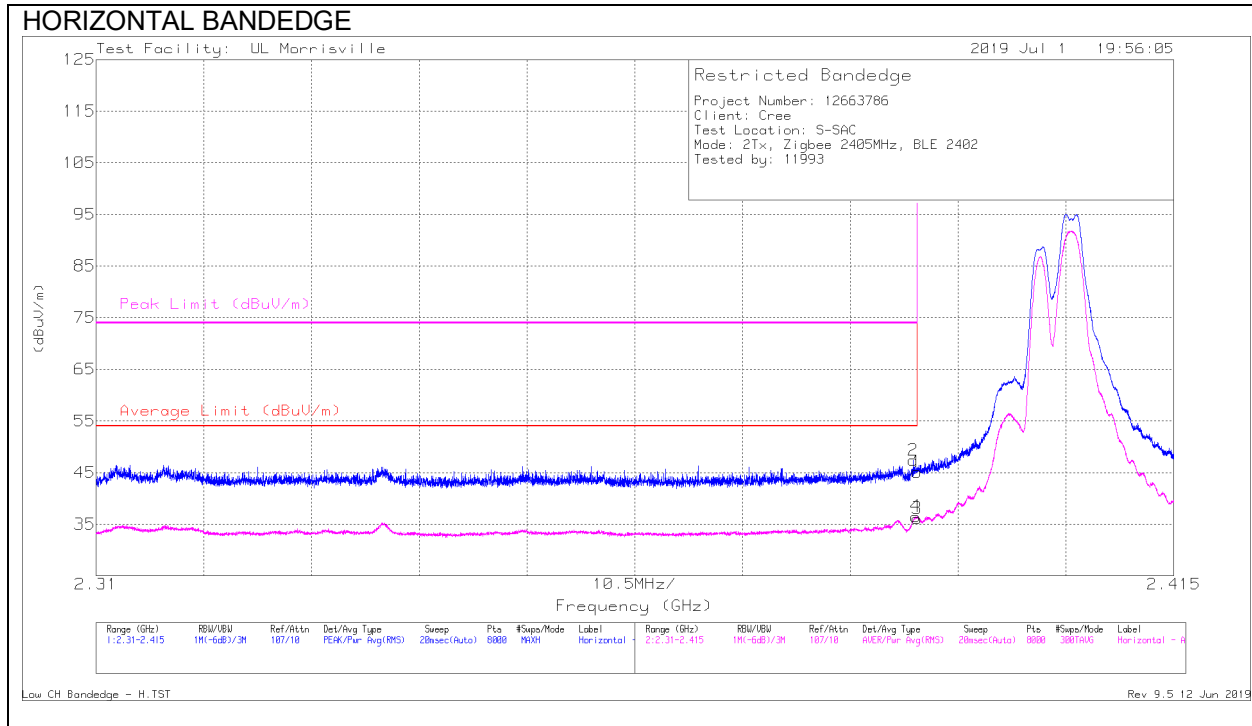


Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (dB/m)	Amp/Cbl/Filtr/Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
2	* 2.31226	43.53	PK2	31.7	-23.7	51.53	-	-	74	-22.47	309	295	H
	* 2.31197	35.5	MAv1	31.7	-23.7	43.5	54	-10.5	-	-	309	295	H
6	* 2.3123	39.48	PK2	31.7	-23.7	47.48	-	-	74	-26.52	42	101	V
	* 2.31196	29.32	MAv1	31.7	-23.7	37.32	54	-16.68	-	-	42	101	V
4	* 4.87938	47.86	PK2	34	-30.6	51.26	-	-	74	-22.74	116	130	H
	* 4.87928	37.77	MAv1	34	-30.6	41.17	54	-12.83	-	-	116	130	H
5	* 7.31899	42.32	PK2	35.7	-27.5	50.52	-	-	74	-23.48	96	103	H
	* 7.3193	33.42	MAv1	35.7	-27.5	41.62	54	-12.38	-	-	96	103	H
8	* 4.87938	44	PK2	34	-30.6	47.4	-	-	74	-26.6	118	101	V
	* 4.87936	34.71	MAv1	34	-30.6	38.11	54	-15.89	-	-	118	101	V
9	* 7.31911	44.44	PK2	35.7	-27.5	52.64	-	-	74	-21.36	122	102	V
	* 7.31934	36.04	MAv1	35.7	-27.5	44.24	54	-9.76	-	-	122	102	V
1	1.89582	40.04	Pk	31.1	-22.3	48.84	-	-	-	-	0-360	199	H
3	2.56826	40.34	Pk	32.3	-25	47.64	-	-	-	-	0-360	101	H
7	2.56826	35.47	Pk	32.3	-25	42.77	-	-	-	-	0-360	199	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
 PK2 - Maximum Peak
 MAv1 - Maximum RMS Average
 Pk - Peak detector

Note – The 802.15.4 radio was not duty cycle corrected up because it's considered a protocol limited device as described in FCC KDB 558074 D01 15.247 Meas Guidance v05r02, FAQ section.

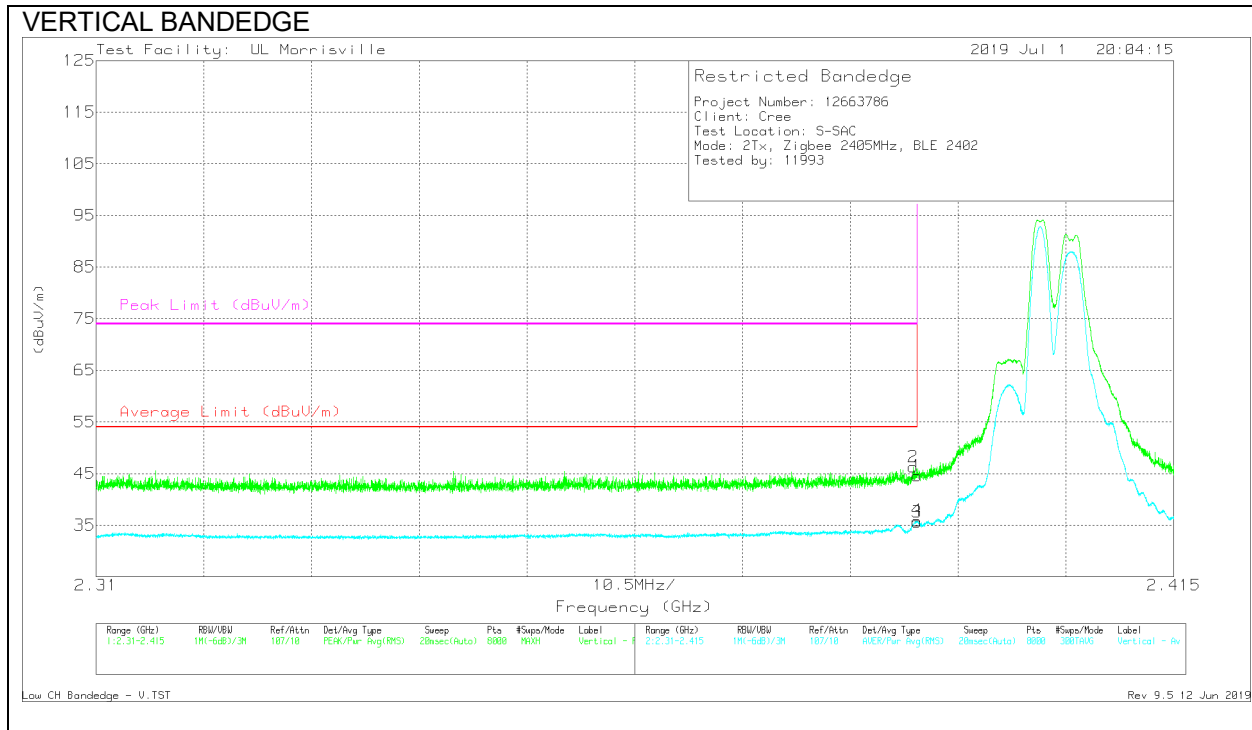
7.2.8. 802.15.4 (2405MHz) and BLE (2402MHz) – LOW BANDEDGE (Z-AXIS)



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (dB/m)	Amp/Cbl/Filtr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.39	37.23	Pk	31.9	-24	45.13	-	-	74	-28.87	223	248	H
2	* 2.38962	39.47	Pk	31.9	-24	47.37	-	-	74	-26.63	223	248	H
3	* 2.39	28.22	RMS	31.9	-24	36.12	54	-17.88	-	-	223	248	H
4	* 2.38987	28.61	RMS	31.9	-24	36.51	54	-17.49	-	-	223	248	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
 Pk - Peak detector
 RMS - RMS detection

Note – The 802.15.4 radio was not duty cycle corrected up because it's considered a protocol limited device as described in FCC KDB 558074 D01 15.247 Meas Guidance v05r02, FAQ section.

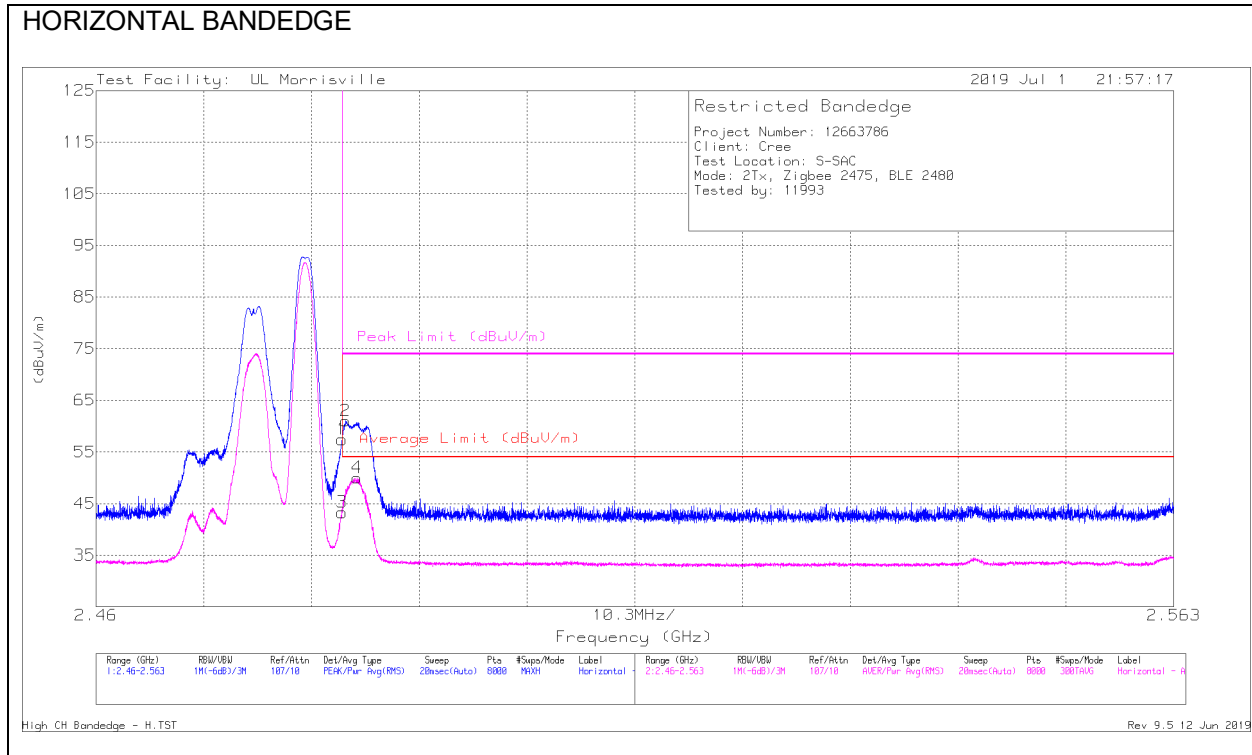


Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (dB/m)	Amp/Cbl/Filtr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.39	36.64	Pk	31.9	-24	44.54	-	-	74	-29.46	66	241	V
2	* 2.38964	38.37	Pk	31.9	-24	46.27	-	-	74	-27.73	66	241	V
3	* 2.39	27.68	RMS	31.9	-24	35.58	54	-18.42	-	-	66	241	V
4	* 2.38998	27.99	RMS	31.9	-24	35.89	54	-18.11	-	-	66	241	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
 Pk - Peak detector
 RMS - RMS detection

Note – The 802.15.4 radio was not duty cycle corrected up because it's considered a protocol limited device as described in FCC KDB 558074 D01 15.247 Meas Guidance v05r02, FAQ section.

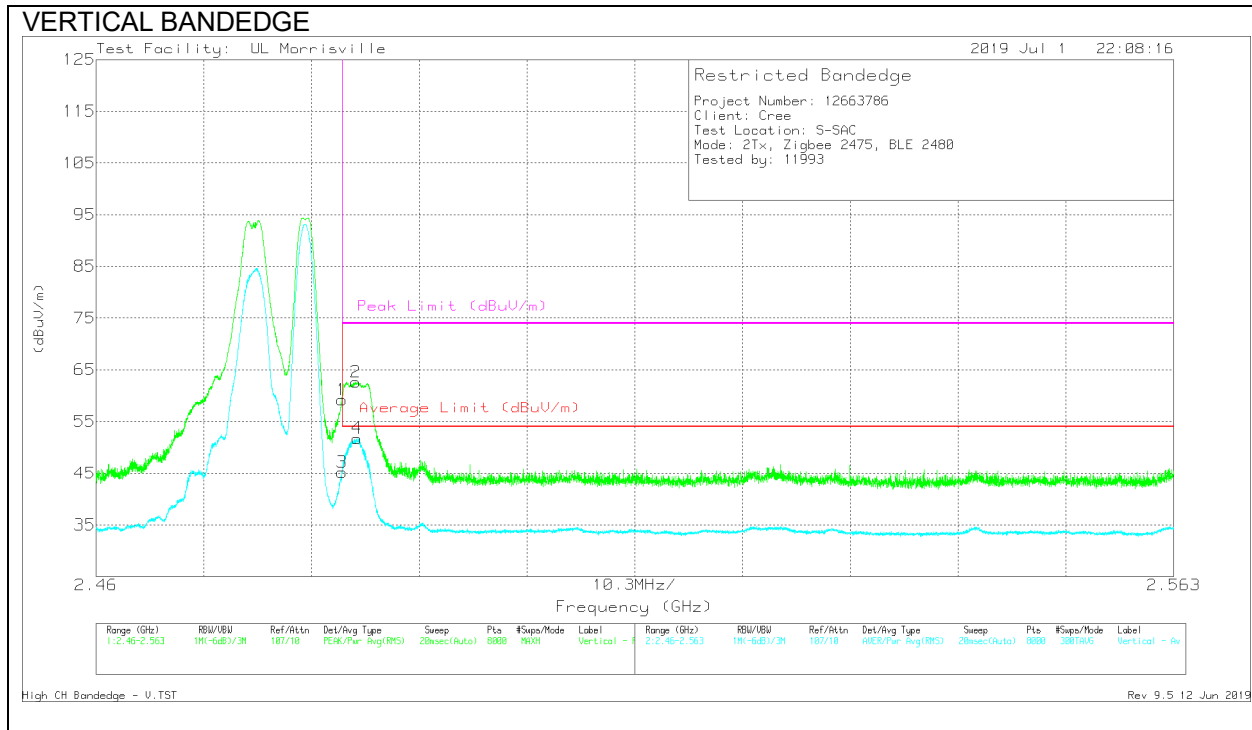
7.2.9. 802.15.4 (2475MHz) and BLE (2480MHz) – HIGH BANDEDGE (Z-AXIS)



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (dB/m)	Amp/Cbl/Filtr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.4835	49.62	Pk	32.3	-24.5	57.42	-	-	74	-16.58	217	180	H
2	* 2.48386	53.23	Pk	32.3	-24.5	61.03	-	-	74	-12.97	217	180	H
3	* 2.4835	35.49	RMS	32.3	-24.5	43.29	54	-10.71	-	-	217	180	H
4	* 2.48493	42.22	RMS	32.3	-24.5	50.02	54	-3.98	-	-	217	180	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
 Pk - Peak detector
 RMS - RMS detection

Note – The 802.15.4 radio was not duty cycle corrected up because it’s considered a protocol limited device as described in FCC KDB 558074 D01 15.247 Meas Guidance v05r02, FAQ section.

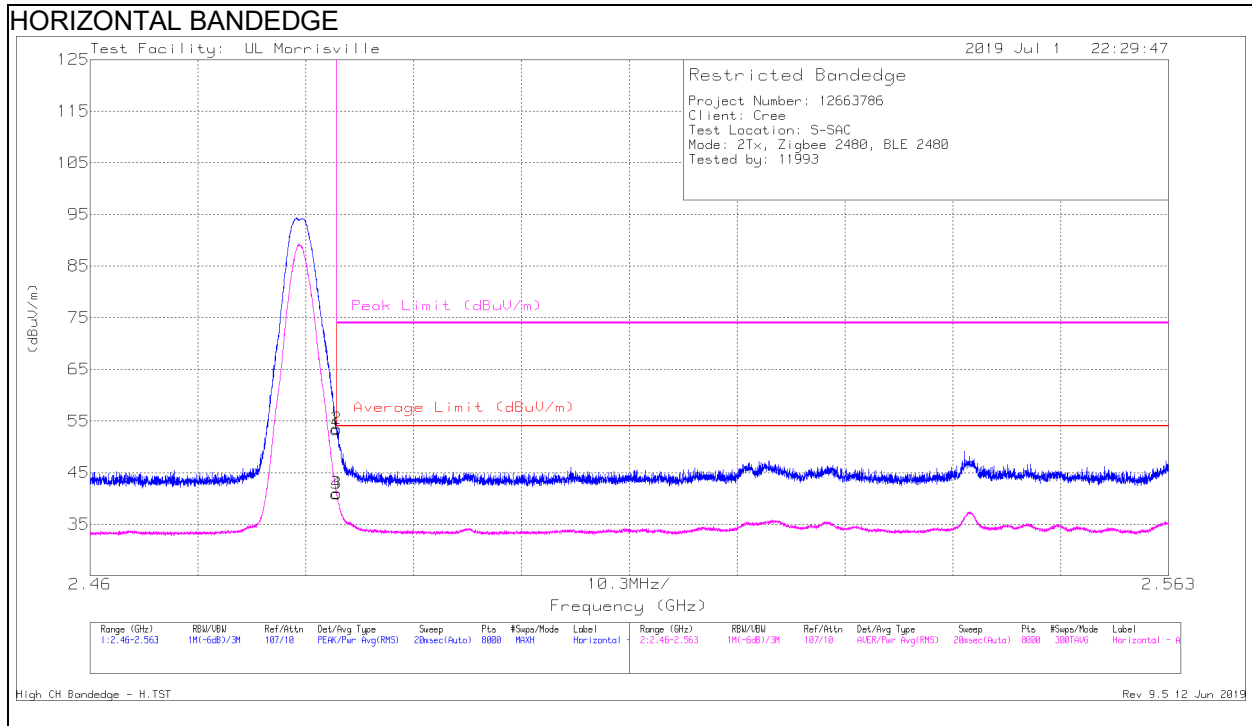


Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (dB/m)	Amp/Cbl/Filtr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.4835	51.41	Pk	32.3	-24.5	59.21	-	-	74	-14.79	28	171	V
2	* 2.48484	54.84	Pk	32.3	-24.5	62.64	-	-	74	-11.36	28	171	V
3	* 2.4835	37.35	RMS	32.3	-24.5	45.15	54	-8.85	-	-	28	171	V
4	* 2.48492	43.95	RMS	32.3	-24.5	51.75	54	-2.25	-	-	28	171	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
 Pk - Peak detector
 RMS - RMS detection

Note – The 802.15.4 radio was not duty cycle corrected up because it's considered a protocol limited device as described in FCC KDB 558074 D01 15.247 Meas Guidance v05r02, FAQ section.

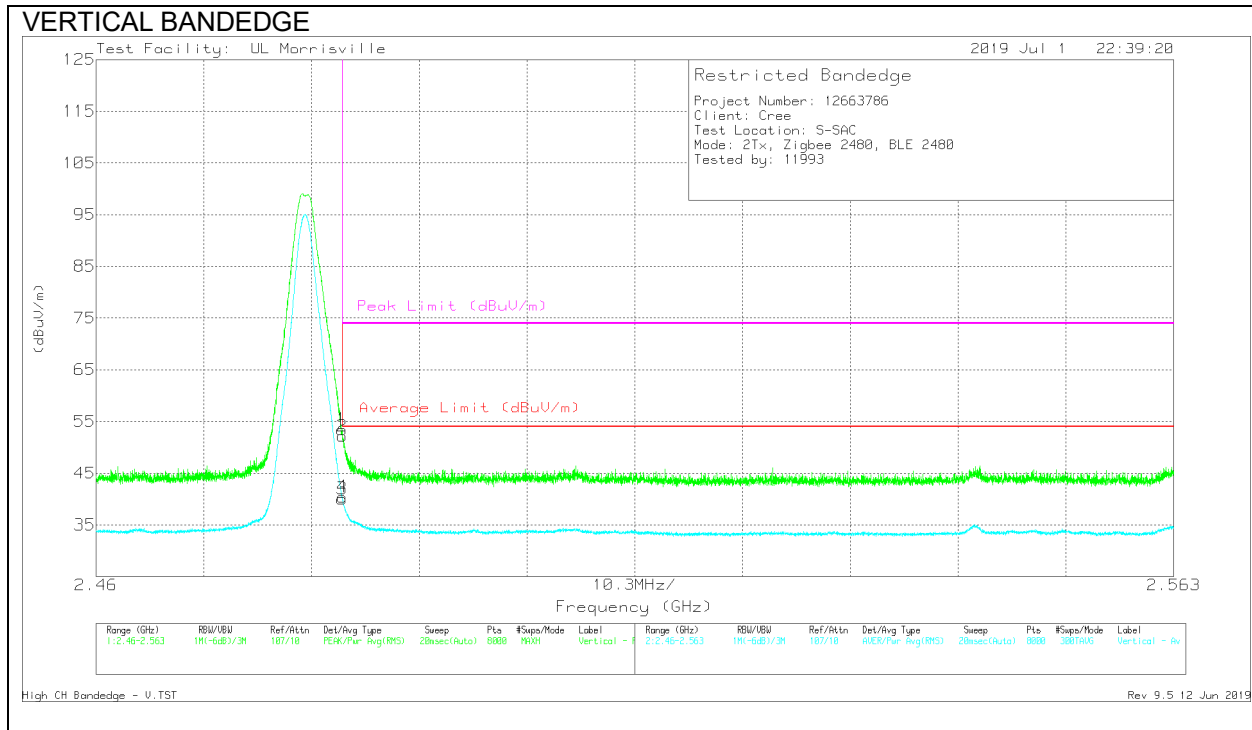
7.2.10. 802.15.4 (2480MHz) and BLE (2480MHz) – HIGH BANDEDGE (Z-AXIS)



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (dB/m)	Amp/Cbl/Filtr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.4835	45.49	Pk	32.3	-24.5	53.29	-	-	74	-20.71	227	222	H
2	* 2.48355	45.72	Pk	32.3	-24.5	53.52	-	-	74	-20.48	227	222	H
3	* 2.4835	33.14	RMS	32.3	-24.5	40.94	54	-13.06	-	-	227	222	H
4	* 2.48351	33.19	RMS	32.3	-24.5	40.99	54	-13.01	-	-	227	222	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
 Pk - Peak detector
 RMS - RMS detection

Note – The 802.15.4 radio was not duty cycle corrected up because it's considered a protocol limited device as described in FCC KDB 558074 D01 15.247 Meas Guidance v05r02, FAQ section.

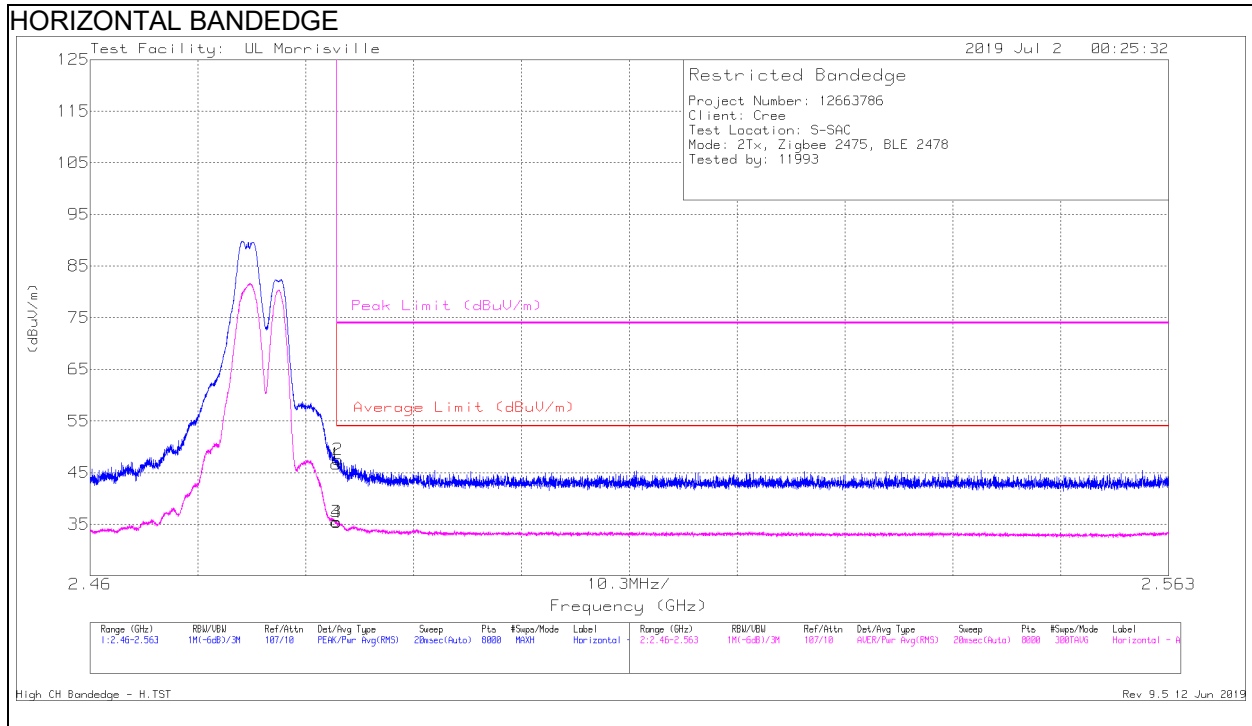


Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (dB/m)	Amp/Cbl/Filtr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.4835	45.66	Pk	32.3	-24.5	53.46	-	-	74	-20.54	105	204	V
2	* 2.48355	44.37	Pk	32.3	-24.5	52.17	-	-	74	-21.83	105	204	V
3	* 2.4835	32.27	RMS	32.3	-24.5	40.07	54	-13.93	-	-	105	204	V
4	* 2.48351	32.62	RMS	32.3	-24.5	40.42	54	-13.58	-	-	105	204	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
 Pk - Peak detector
 RMS - RMS detection

Note – The 802.15.4 radio was not duty cycle corrected up because it's considered a protocol limited device as described in FCC KDB 558074 D01 15.247 Meas Guidance v05r02, FAQ section.

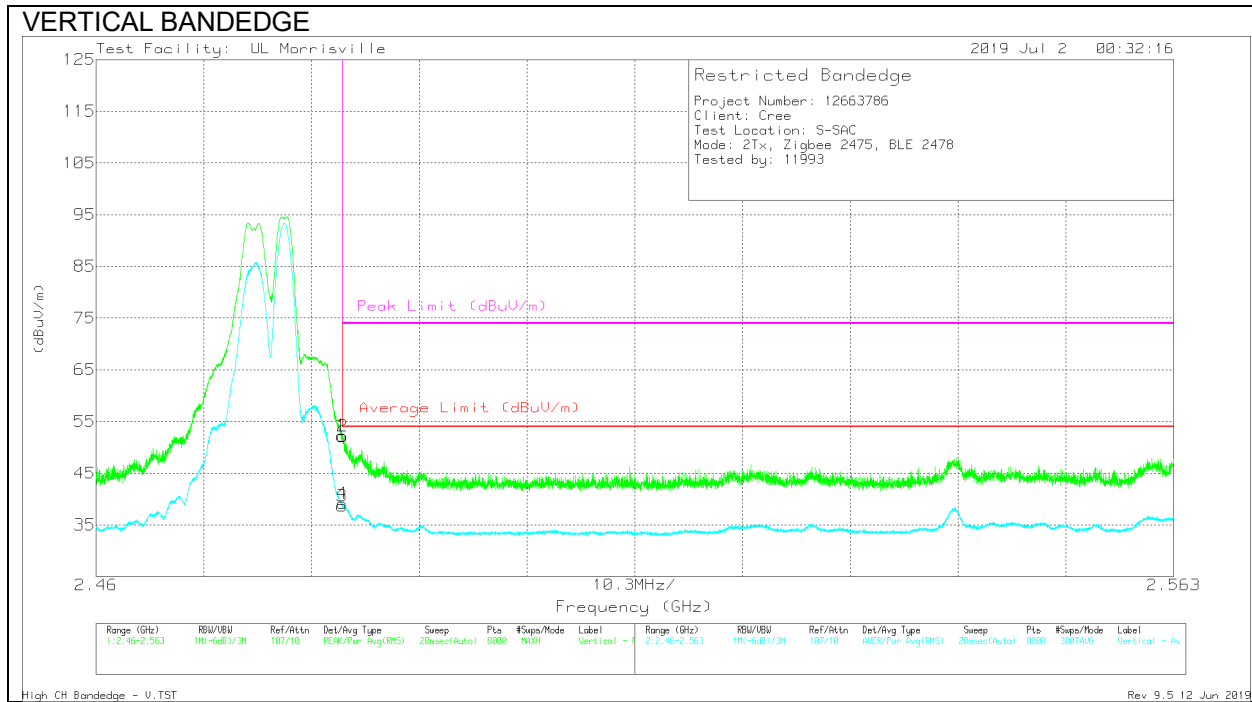
7.2.11. 802.15.4 (2475MHz) and BLE (2478MHz) – HIGH BANDEDGE (Z-AXIS)



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (dB/m)	Amp/Cbl/Filtr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.4835	38.84	Pk	32.3	-24.5	46.64	-	-	74	-27.36	48	183	H
2	* 2.48363	39.71	Pk	32.3	-24.5	47.51	-	-	74	-26.49	48	183	H
3	* 2.4835	27.66	RMS	32.3	-24.5	35.46	54	-18.54	-	-	48	183	H
4	* 2.48353	27.52	RMS	32.3	-24.5	35.32	54	-18.68	-	-	48	183	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
 Pk - Peak detector
 RMS - RMS detection

Note – The 802.15.4 radio was not duty cycle corrected up because it's considered a protocol limited device as described in FCC KDB 558074 D01 15.247 Meas Guidance v05r02, FAQ section.

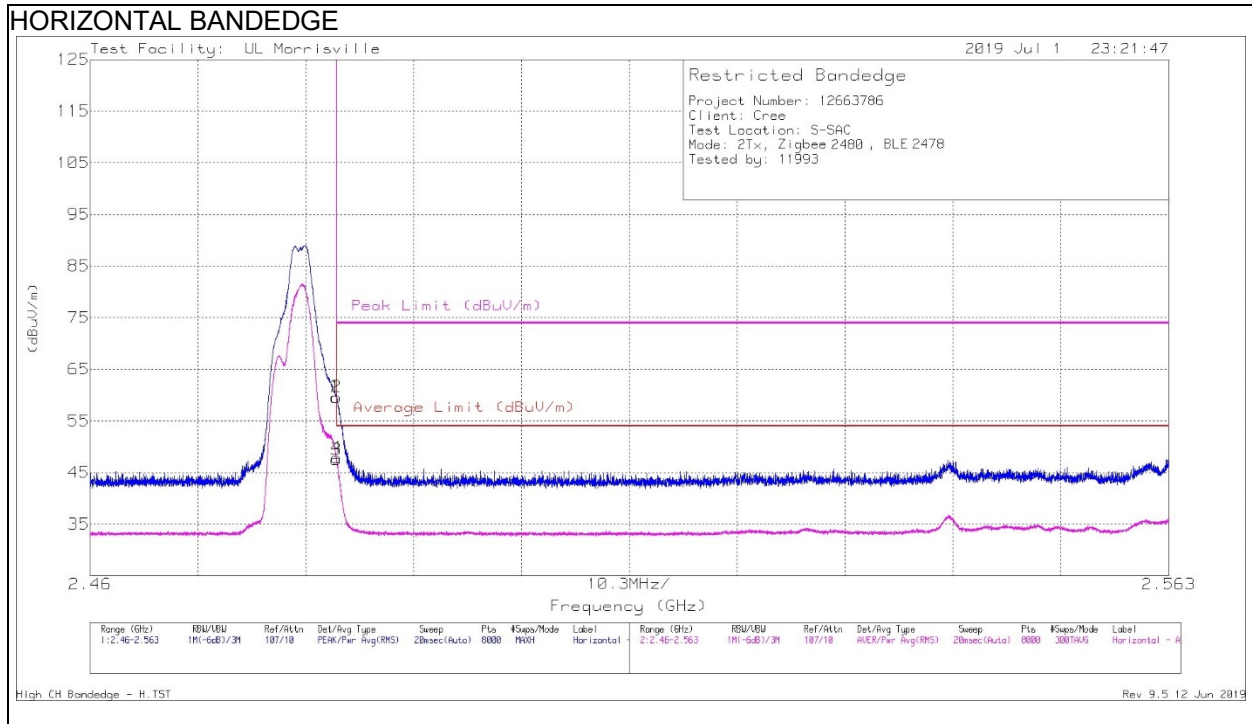


Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (dB/m)	Amp/Cbl/Filtr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.4835	44.46	Pk	32.3	-24.5	52.26	-	-	74	-21.74	117	166	V
2	* 2.48357	44.34	Pk	32.3	-24.5	52.14	-	-	74	-21.86	117	166	V
3	* 2.4835	30.86	RMS	32.3	-24.5	38.66	54	-15.34	-	-	117	166	V
4	* 2.48353	31.35	RMS	32.3	-24.5	39.15	54	-14.85	-	-	117	166	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
 Pk - Peak detector
 RMS - RMS detection

Note – The 802.15.4 radio was not duty cycle corrected up because it's considered a protocol limited device as described in FCC KDB 558074 D01 15.247 Meas Guidance v05r02, FAQ section.

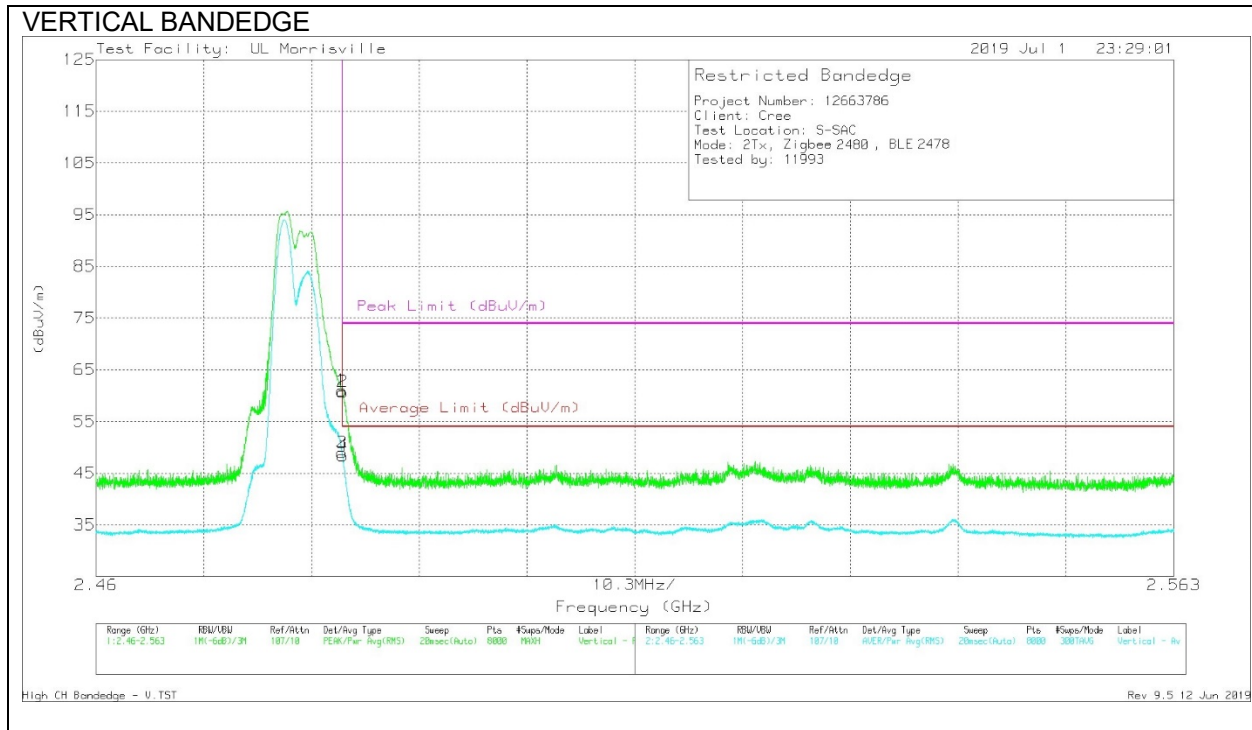
7.2.12. 802.15.4 (2480MHz) and BLE (2478MHz) – HIGH BANDEDGE (Z-AXIS)



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (dB/m)	Amp/Cbl/Filtr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.4835	51.81	Pk	32.3	-24.5	59.61	-	-	74	-14.39	209	281	H
2	* 2.48354	51.82	Pk	32.3	-24.5	59.62	-	-	74	-14.38	209	281	H
3	* 2.4835	39.68	RMS	32.3	-24.5	47.48	54	-6.52	-	-	209	281	H
4	* 2.48351	40.05	RMS	32.3	-24.5	47.85	54	-6.15	-	-	209	281	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
 Pk - Peak detector
 RMS - RMS detection

Note – The 802.15.4 radio was not duty cycle corrected up because it's considered a protocol limited device as described in FCC KDB 558074 D01 15.247 Meas Guidance v05r02, FAQ section.

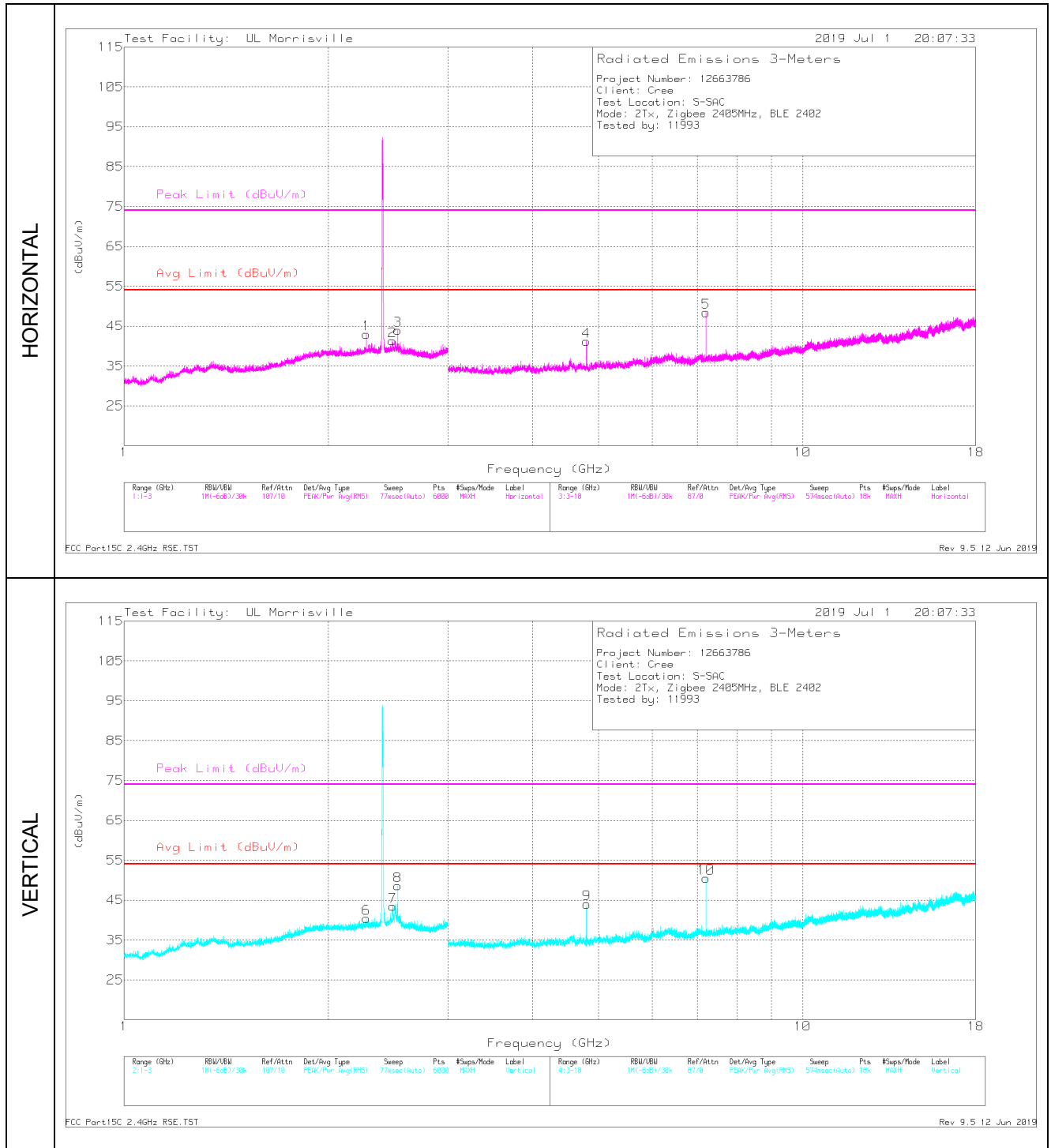


Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (dB/m)	Amp/Cbl/Filtr/Pad (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.4835	53.18	Pk	32.3	-24.5	60.98	-	-	74	-13.02	106	291	V
2	* 2.48357	52.93	Pk	32.3	-24.5	60.73	-	-	74	-13.27	106	291	V
3	* 2.4835	41.15	RMS	32.3	-24.5	48.95	54	-5.05	-	-	106	291	V
4	* 2.48357	40.6	RMS	32.3	-24.5	48.4	54	-5.6	-	-	106	291	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
 Pk - Peak detector
 RMS - RMS detection

Note – The 802.15.4 radio was not duty cycle corrected up because it's considered a protocol limited device as described in FCC KDB 558074 D01 15.247 Meas Guidance v05r02, FAQ section.

7.2.13. HARMONICS AND SPURIOUS EMISSIONS 802.15.4 (2405MHz) and BLE (2402MHz) (Z-AXIS)

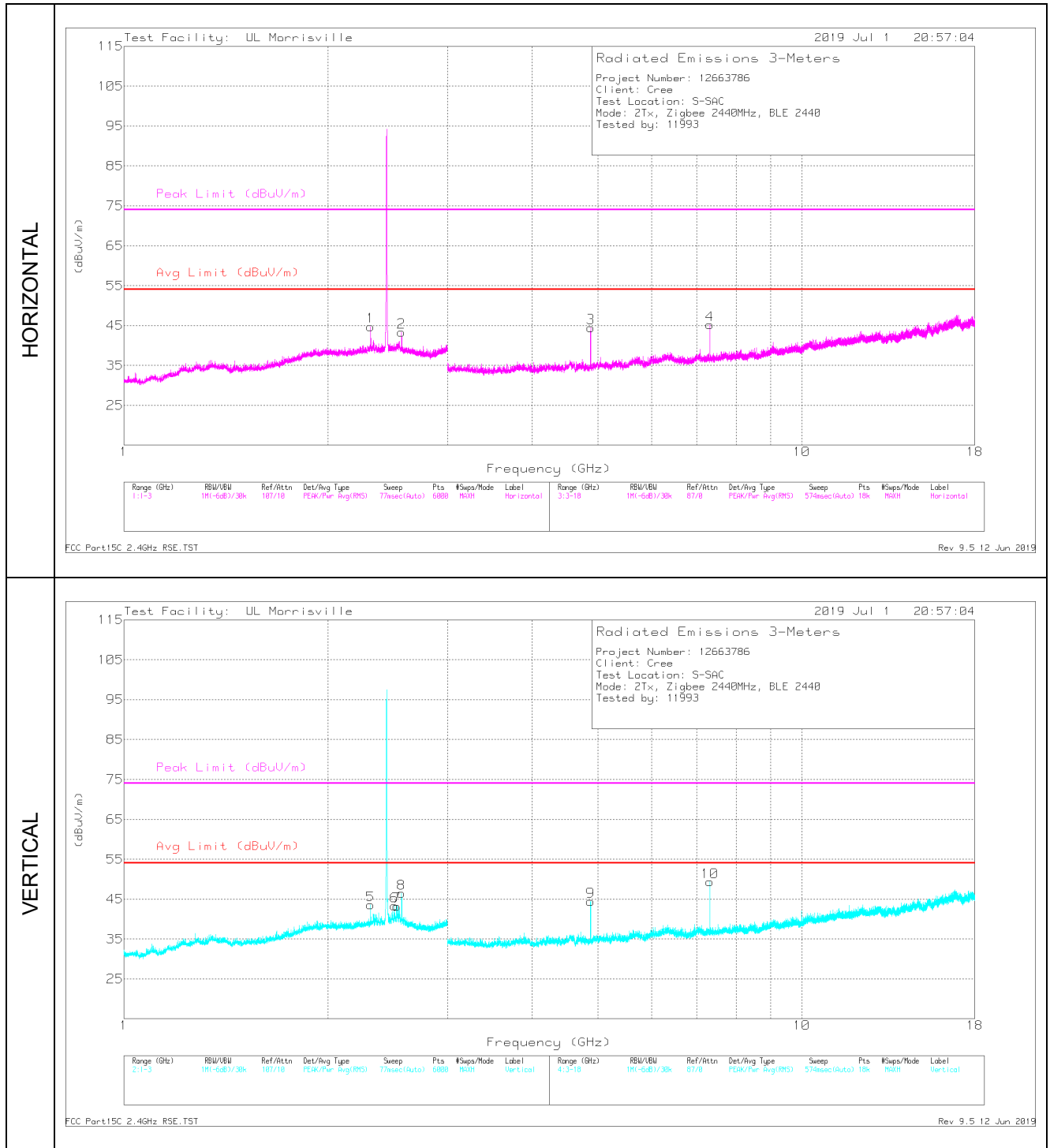


Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (dB/m)	Amp/Cbl/Filtr/Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.27441	41	PK2	31.8	-23.5	49.3	-	-	74	-24.7	198	212	H
	* 2.274	32.41	MAv1	31.8	-23.5	40.71	54	-13.29	-	-	198	212	H
2	* 2.48508	40.28	PK2	32.3	-24.5	48.08	-	-	74	-25.92	227	206	H
	* 2.48506	27.74	MAv1	32.3	-24.5	35.54	54	-18.46	-	-	227	206	H
6	* 2.27434	40.61	PK2	31.8	-23.5	48.91	-	-	74	-25.09	275	271	V
	* 2.27403	31.34	MAv1	31.8	-23.5	39.64	54	-14.36	-	-	275	271	V
7	* 2.48696	43.3	PK2	32.3	-24.5	51.1	-	-	74	-22.9	355	201	V
	* 2.48721	31.31	MAv1	32.3	-24.5	39.11	54	-14.89	-	-	355	201	V
4	* 4.80454	43.16	PK2	34.2	-31	46.36	-	-	74	-27.64	208	207	H
	* 4.80426	34.37	MAv1	34.2	-31	37.57	54	-16.43	-	-	208	207	H
9	* 4.80913	45.89	PK2	34.2	-31	49.09	-	-	74	-24.91	59	197	V
	* 4.80903	38.38	MAv1	34.2	-31	41.58	54	-12.42	-	-	59	197	V
3	2.52992	36.36	Pk	32.4	-24.8	43.96	-	-	-	-	0-360	101	H
8	2.53026	41.01	Pk	32.4	-24.8	48.61	-	-	-	-	0-360	101	V
10	7.20524	42.84	Pk	35.7	-28	50.54	-	-	-	-	0-360	101	V
5	7.20607	40.73	Pk	35.7	-28	48.43	-	-	-	-	0-360	101	H

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
 PK2 - Maximum Peak
 MAv1 - Maximum RMS Average
 Pk - Peak detector

Note – The 802.15.4 radio was not duty cycle corrected up because it's considered a protocol limited device as described in FCC KDB 558074 D01 15.247 Meas Guidance v05r02, FAQ section.

7.2.14. HARMONICS AND SPURIOUS EMISSIONS 802.15.4 (2440MHz) and BLE (2440MHz) (Z-AXIS)



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (dB/m)	Amp/Cbl/Filtr/Pad (dB)	Corrected Reading (dBuV/m)	Avg Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	PK Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* 2.31177	42.68	PK2	31.7	-23.7	50.68	-	-	74	-23.32	209	213	H
	* 2.31197	34.28	MAv1	31.7	-23.7	42.28	54	-11.72	-	-	209	213	H
5	* 2.31185	43.33	PK2	31.7	-23.7	51.33	-	-	74	-22.67	264	207	V
	* 2.31199	34.39	MAv1	31.7	-23.7	42.39	54	-11.61	-	-	264	207	V
3	* 4.87954	47.56	PK2	34	-30.6	50.96	-	-	74	-23.04	192	110	H
	* 4.87927	39.36	MAv1	34	-30.6	42.76	54	-11.24	-	-	192	110	H
4	* 7.31909	42.96	PK2	35.7	-27.5	51.16	-	-	74	-22.84	338	128	H
	* 7.31921	34.9	MAv1	35.7	-27.5	43.1	54	-10.9	-	-	338	128	H
9	* 4.87922	48.34	PK2	34	-30.6	51.74	-	-	74	-22.26	309	157	V
	* 4.87942	38.46	MAv1	34	-30.6	41.86	54	-12.14	-	-	309	157	V
10	* 7.32061	46.19	PK2	35.7	-27.5	54.39	-	-	74	-19.61	34	122	V
	* 7.32064	38.66	MAv1	35.7	-27.5	46.86	54	-7.14	-	-	34	122	V
6	2.50425	35.55	Pk	32.4	-24.6	43.35	-	-	-	-	0-360	199	V
7	2.52526	35.53	Pk	32.4	-24.7	43.23	-	-	-	-	0-360	199	V
2	2.56793	36.06	Pk	32.3	-25	43.36	-	-	-	-	0-360	199	H
8	2.56793	39.16	Pk	32.3	-25	46.46	-	-	-	-	0-360	101	V

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
 PK2 - Maximum Peak
 MAv1 - Maximum RMS Average
 Pk - Peak detector

Note – The 802.15.4 radio was not duty cycle corrected up because it's considered a protocol limited device as described in FCC KDB 558074 D01 15.247 Meas Guidance v05r02, FAQ section.

8. SETUP PHOTOS

Refer to UL Document R12663786-EP4

9. END OF REPORT