

Testing Tomorrow's Technology

Application

For

Part 2, Subpart J, Paragraph 2.907 Equipment Authorization of Certification for an Intentional Radiator per Part 15, Subpart B, paragraph 15.109, Subpart C, paragraphs 15.207, 15.209 and 15.249

For the

Estimote Polska Sp. z. o. o.

**Estimote Sticker
Model: B0**

FCC ID: 2ABP2-EST0217

**UST Project: 17-0238
Issue Date: July 19, 2017**

Total Pages in This Report: 43

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Testing Tomorrow's Technology

I certify that I am authorized to sign for the Test Agency and that all of the statements in this report and in the Exhibits attached hereto are true and correct to the best of my knowledge and belief:

US TECH (Agent Responsible For Test):

By: George Yang

Name: 

Title: Laboratory Manager

Date July 19, 2017



TESTING

NVLAP LAB CODE 200162-0

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Model:

FCC Part 15 Certification/ RSS 210
2ABP2-EST0217
17-0238
July 19, 2017
Estimote Polska Sp. z. o. o.
B0

MEASUREMENT TECHNICAL REPORT

COMPANY NAME: Estimote Polska Sp. z. o. o.

MODEL: Sticker B0

FCC ID: 2ABP2-EST0217

DATE: July 19, 2017

This report concerns (check one): Original grant ☒
Class II change

Equipment type: 2400 – 2483.5 MHz Low Power BTLE Transmitter/Beacon

Deferred grant requested per 47 CFR 0.457(d)(1)(ii)? Yes _____ No X

If yes, defer until: N/A
date

agrees to notify the Commission by N/A
date
of the intended date of announcement of the product so that the grant can be
issued on that date.

Report prepared by:

US Tech
3505 Francis Circle
Alpharetta, GA 30004
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Table of Contents

<u>Paragraph</u>	<u>Title</u>	<u>Page</u>
1	General Information.....	7
1.1	Purpose of this Report	7
1.2	Characterization of Test Sample	7
1.3	Product Description	7
1.4	Configuration of Tested System.....	8
1.5	Test Facility.....	8
1.6	Related Submittals.....	8
2	Tests and Measurements	10
2.1	Test Equipment.....	10
2.2	Modifications to EUT Hardware	11
2.3	Number of Measurements for Intentional Radiators (15.31(m)).....	11
2.4	Frequency Range of Radiated Measurements (Part 15.33).....	11
2.4.1	Intentional Radiator	11
2.4.2	Unintentional Radiator	12
2.5	Measurement Detector Function and Bandwidth (CFR 15.35)	12
2.5.1	Detector Function and Associated Bandwidth.....	12
2.5.2	Corresponding Peak and Average Requirements	12
2.5.3	Pulsed Transmitter Averaging	12
2.6	EUT Antenna Requirements (CFR 15.203)	13
2.7	Restricted Bands of Operation (Part 15.205).....	14
2.8	Transmitter Duty Cycle (CFR 35 (c))	14
2.9	Intentional Radiator, Power Line Conducted Emissions (CFR 15.207).....	15
2.10	Intentional Radiator, Radiated Emissions (CFR 15.209, 15.249(a),(c)) (IC RSS 210, A2.9 (a))	15
2.11	Band Edge Measurements – (CFR 15.249 (d))	22
2.12	Occupied Bandwidth (Part 2.1049).....	35
2.13	Unintentional Radiator, Power line Conducted Emissions (CFR 15.107)	39
2.14	Unintentional Radiator, Radiated Emissions (CFR 15.109).....	40
2.15	Measurement Uncertainty	43
2.15.1	Conducted Emissions Measurement Uncertainty	43
2.15.2	Radiated Emissions Measurement Uncertainty	43

US Tech Test Report:
FCC ID:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ABP2-EST0217
17-0238
July 19, 2017
Estimote Polska Sp. z o. o.
B0

List of Figures

<u>Figures</u>	<u>Title</u>	<u>Page</u>
Figure 1.	Block Diagram of Test Configuration	13
Figure 2.	Band Edge Compliance, Low Channel Delta - Peak.....	23
Figure 3.	Band Edge Compliance, Low Channel Delta - Average.....	24
Figure 4.	Radiated Restricted Band 2310 MHz to 2390 MHz, Peak	25
Figure 5.	Radiated Restricted Band 2310 MHz to 2390 MHz, AVG	27
Figure 6.	Band Edge Compliance, High Channel Delta – Peak	29
Figure 7.	Band Edge Compliance, High Channel Delta – Average	30
Figure 8.	Radiated Restricted Band 2483.5 MHz to 2500 MHz, Peak	31
Figure 9.	Radiated Restricted Band 2483.5 MHz to 2500 MHz, AVG	33
Figure 10.	Occupied Bandwidth – Low Channel	36
Figure 11.	Occupied Bandwidth – Mid Channel.....	37
Figure 12.	Occupied Bandwidth – High Channel	38

US Tech Test Report:
FCC ID:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ABP2-EST0217
17-0238
July 19, 2017
Estimote Polska Sp. z o. o.
B0

List of Tables

<u>Table</u>	<u>Title</u>	<u>Page</u>
Table 1.	EUT and Peripherals.....	9
Table 2.	Test Instruments	10
Table 3.	Number of Test Frequencies for Intentional Radiators.....	11
Table 4.	Allowed Antenna(s).....	13
Table 5.	Spurious Radiated Emissions Below 30 MHz (X-Position).....	16
Table 6.	Spurious Radiated Emissions Below 30 MHz (Y-Position).....	17
Table 7.	Spurious Radiated Emissions Below 30 MHz (Z-Position).....	18
Table 8.	Fundamental Emissions (Peak & AVG)	19
Table 9.	Harmonics Emissions (Peak & AVG)	20
Table 10.	Spurious Radiated Emissions other than Fundamental & Harmonics	21
Table 11.	Radiated Restricted Band 2310 MHz to 2390 MHz, Peak.....	26
Table 12.	Radiated Restricted Band 2310 MHz to 2390 MHz, Average	28
Table 13.	Radiated Restricted Band 2483.5 MHz to 2500 MHz, Peak.....	32
Table 14.	Radiated Restricted Band 2483.5 MHz to 2500 MHz, Average	34
Table 15.	20 dB Bandwidth and 99% Occupied Bandwidth	35
Table 16.	Transmitter Power Line Conducted Emissions Test Data, Part 15.107 ...	39
Table 17.	Unintentional Radiator, Peak Radiated Emissions (CFR 15.109),	41
Table 18.	Unintentional Radiator, Peak Radiated Emissions (CFR 15.109)	42

List of Attachments

Agency Agreement
Application Forms
Confidentiality Request Letter
Equipment Label(s)
Block Diagram(s)
Schematic(s)
Test Configuration Photographs
Internal Photographs
External Photographs
Theory of Operation
User's Manual

US Tech Test Report:
FCC ID:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ABP2-EST0217
17-0238
July 19, 2017
Estimote Polska Sp. z. o. o.
B0

1 General Information

1.1 Purpose of this Report

This report is prepared as a means of conveying test results and information concerning the suitability of this exact product for public distribution according to the FCC Rules and Regulations Part 15, Section 249.

1.2 Characterization of Test Sample

The sample used for testing was received by US Tech on June 1, 2017 in good operating condition.

1.3 Product Description

The Equipment Under Test (EUT) is the Estimote Polska Sp. z. o. o. Sticker, Model B0. The EUT is a standalone Bluetooth LE technology enabled device; it wirelessly communicates with other BTLE technology enabled products.

The EUT is battery powered by either one CR2020 or one CR2032 3.0V battery (LiMnO₂). The difference in batteries results in the use of a battery carriage that is slightly taller for use with the thicker CR2032 battery; there are no other differences between the two models. The device can be used standalone without the silicon enclosure or encased within the silicon enclosure. The EUT operates in the unlicensed 2.4 GHz band. The regulatory range (2.400-2.4835 GHz) is divided into 40 channels. In the advertising state the device sends data on 3 channels with the center frequencies at 2402, 2426, and 2480 MHz. In the connectivity state the device uses the remaining 37 channels in a frequency hopping scheme to reduce interference between units. The EUT incorporates an accelerometer which is capable of detecting and recognizing movement and orientation changes. The EUT is rated for a maximum output power of +4.0 dBm.

Radio: Bluetooth LE Standard
Range: Up to 70 Meters (230 Feet)
Modulation: GFSK (FHSS)
RF Output Power (EIRP): -20 dBm to +4 dBm
Data Rate: 1 Mbps (Max)

1.4 Configuration of Tested System

The test sample was tested per *ANSI C63.10.2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices* and *ANSI C63.4:2014, Methods of Measurement of Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (2014)*.

A list of EUT and Peripherals is found in Table 1 below. A block diagram of the tested system is shown in Figure 1. Test configuration photographs are provided in separate Appendices

The EUT was tested both as a standalone device without the silicon case and with the silicon case. Differences in the test results are negligible; therefore the results taken while the EUT was encased in the silicon cover are presented as the representative test results.

1.5 Test Facility

Testing was performed at US Tech's measurement facility at 3505 Francis Circle, Alpharetta, GA 30004. This site has been fully described and registered with the FCC. Its designation number is 186022. Additionally this site has also been fully described and submitted to Industry Canada (IC), and has been approved under file number 9900A-1.

1.6 Related Submittals

The EUT is subject to the following FCC authorizations:

- a) Certification under section 15.249 as a transmitter.
- b) Verification under 15.101 as a digital device and receiver.

The Verification requirement shares many common report elements with the Certification report. Therefore, though this report is mostly intended to provide data for the Certification process, the Verification authorization report (part 15.107 and 15.109) for the EUT is included herein.

US Tech Test Report:
FCC ID:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ABP2-EST0217
17-0238
July 19, 2017
Estimote Polska Sp. z. o. o.
B0

Table 1. EUT and Peripherals

PERIPHERAL MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	FCC/IC ID:	CABLES P/D
Estimote Polska Sp. z. o. o.	Estimote Sticker, Model B0	Engineering Sample	FCC ID: 2ABP2-EST0217	N/A

U= Unshielded
S= Shielded
P= Power
D= Data

US Tech Test Report:
FCC ID:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ABP2-EST0217
17-0238
July 19, 2017
Estimote Polska Sp. z o. o.
B0

2 Tests and Measurements

2.1 Test Equipment

The table below lists test equipment used to evaluate this product. Model numbers, serial numbers and their calibration status are indicated.

Table 2. Test Instruments

TEST INSTRUMENT	MODEL NUMBER	MANUFACTURER	SERIAL NUMBER	CALIBRATION DUE DATE
SPECTRUM ANALYZER	8593E	HEWLETT PACKARD	3205A60124	8/23/2017
LOOP ANTENNA	SAS-200/562	AH SYSTEMS	142	9/28/2017 2 yr
BICONICAL ANTENNA	3110B	EMCO	9307-1431	8/25/2017 2 yr
LOG PERIODIC ANTENNA	3146	EMCO	9305-3600	9/21/2018 2 yr
HORN ANTENNA	3115	EMCO	9107-3723	9/22/2018 2 yr
PRE-AMPLIFIER	8449B	HEWLETT-PACKARD	3008A00480	10/26/2017
PRE-AMPLIFIER	8477D	HEWLETT-PACKARD	1937A02980	11/01/2017

Note: The calibration interval of the above test instruments are 12 months unless stated otherwise and all calibrations are traceable to NIST/USA.

2.2 Modifications to EUT Hardware

No physical modifications were made by US Tech in order to bring the EUT into compliance with FCC Part 15, Subpart C Intentional Radiator Limits for the transmitter portion of the EUT or the Subpart B Unintentional Radiator Limits (receiver and digital device) Requirements.

2.3 Number of Measurements for Intentional Radiators (15.31(m))

Measurements of intentional radiators or receivers shall be performed and reported for each band in which the device can be operated with the device operating at the number of frequencies in each band specified in Table 3 below.

Table 3. Number of Test Frequencies for Intentional Radiators

Frequency Range over which the device operates	Number of Frequencies	Location in the Range of Operation
1 MHz or less	1	Middle
1 to 10 MHz	2	1 near the top 1 near the bottom
Greater than 10 MHz	3	1 near top 1 near middle 1 near bottom

Because the EUT operates at 2402 MHz to 2480 MHz, 3 test frequencies were used.

2.4 Frequency Range of Radiated Measurements (Part 15.33)

2.4.1 Intentional Radiator

The spectrum was investigated for the intentional radiator from the lowest RF signal generated in the EUT, without going below 9 kHz to the 10th harmonic of the highest fundamental frequency generated or 40 GHz, whichever is the lowest.

2.4.2 Unintentional Radiator

For the digital device, an unintentional radiator, the frequency range tested was 30 MHz to 1000 MHz, or to 5 times the highest internal clock frequency.

2.5 Measurement Detector Function and Bandwidth (CFR 15.35)

The radiated and conducted emissions limits shown herein are based on the parameters listed below.

2.5.1 Detector Function and Associated Bandwidth

On frequencies below 1000 MHz, the limits herein are based upon measurement equipment employing a CISPR Quasi-peak detector function and related measurement bandwidths (i.e. 9 kHz from 150 kHz to 30 MHz and 120 kHz from 30 MHz to 1000 MHz). Alternatively, measurements may be made with equipment employing a peak detector function as long as the same bandwidths specified for the Quasi-peak device are used.

2.5.2 Corresponding Peak and Average Requirements

Above 1000 MHz, radiated limits are based on measuring instrumentation employing an average detector function. When average radiated emissions are specified there is also a corresponding Peak requirement, as measured using a peak detector, of 20 dB greater than the average limit. For all measurements above 1000 MHz the Resolution Bandwidth shall be at least 1 MHz.

2.5.3 Pulsed Transmitter Averaging

When the radiated emissions limit is expressed as an average value, and the transmitter is pulsed, the measured field strength shall be determined by applying a Duty Cycle Correction Factor based upon dividing the total ON time during the first 100 ms period by 100 ms (or by the period if less than 100 ms). The duty cycle may be expressed logarithmically in dB.

NOTE: If the transmitter was programmed to transmit at >98% duty cycle, then, wherever applicable (where the detection mode was AVG), the duty cycle factor calculated will be applied.

2.6 EUT Antenna Requirements (CFR 15.203)

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. Only the antenna(s) listed in Table 4 will be used with this device.

Table 4. Allowed Antenna(s)

REPORT REFERENCE	MANUFACTURER	TYPE OF ANTENNA	MODEL	GAIN dBi	TYPE OF CONNECTOR
Antenna	Estimote Polska	2.4 Bluetooth LE Standard	Engineering Sample	0.0	PCB Meander, Monopole Trace Antenna

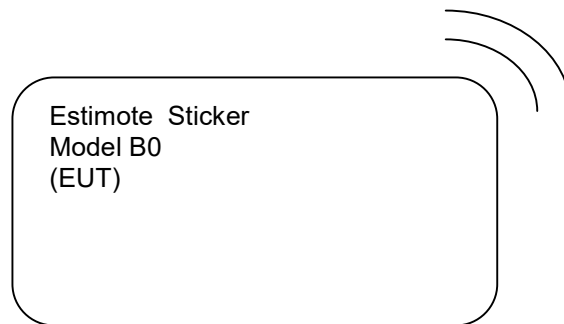


Figure 1. Block Diagram of Test Configuration

2.7 Restricted Bands of Operation (Part 15.205)

Only spurious emissions can fall in the frequency bands of CFR 15.205. The field strength of these spurious emissions cannot exceed the limits of 15.209. Radiated harmonics and other spurious emissions are examined for this requirement see paragraph 2.1

2.8 Transmitter Duty Cycle (CFR 35 (c))

The manufacturer claimed duty cycle: The BLE transmitter declared by the manufacturer uses a 1Mbit/s data rate on-air an Estimote Proximity Beacon, on its shortest advertising interval, occupies advertising channels with a duty cycle of about 0.75%.

The manufacturer claimed total duty cycle = .75 Numeric Duty Cycle
Duty Cycle = $20 \log (.0075)$ = -42.5 dB

Since the Duty Cycle is less than -20 dB, only a -20 dB Duty Cycle correction factor will be applied in this test report.

2.9 Intentional Radiator, Power Line Conducted Emissions (CFR 15.207)

Since the EUT is battery powered, this test was not applied.

2.10 Intentional Radiator, Radiated Emissions (CFR 15.209, 15.249(a),(c)) (IC RSS 210, A2.9 (a))

Radiated Spurious measurements: the EUT was placed into a continuous transmit mode of operation (0.75% duty cycle) and tested per FCC KDB Publication 558074 and ANSI C63.10:2013. A preliminary scan was performed on the EUT to find signal frequencies that were caused by the transmitter part of the device. To obtain worse case results the EUT was tested in X, Y and Z axes or in the orientation of normal operation if the device is designed to operation in a fixed position.

Radiated measurements were then conducted between the frequency range of 9 KHz (or lowest frequency used/generated by the device) up to the tenth harmonic of the device (no greater than 40 GHz). In the band below 30 MHz a resolution bandwidth (RBW) of 9 kHz was used; emissions below 1 GHz were tested with a RBW of 120 KHz and emissions above 1 GHz were tested with a RBW of 1 MHz. All video bandwidth settings were at least three times the RBW value.

The EUT was investigated to CFR 15.209, General requirements for unwanted spurious emissions.

US Tech Test Report:
 FCC ID:
 Test Report Number:
 Issue Date:
 Customer:
 Model:

FCC Part 15 Certification/ RSS 210
 2ABP2-EST0217
 17-0238
 July 19, 2017
 Estimote Polska Sp. z o. o.
 B0

Table 5. Spurious Radiated Emissions Below 30 MHz (X-Position)

9 kHz to 30 MHz, 15.209 limits							
Test: Radiated Emissions				Client: Estimote Polska Sp. z. o. o.			
Project: 17-0238				Model: B0			
Frequency (MHz)	Test Data (dBuV)	AF+CA-AMP (dB/m)	Results (dBuV/m)	QP Limits (dBuV/m)	Antenna Distance/ Polarization	Margin (dB)	Detector PK, or AVG
0.15	21.21	57.54	78.75	104.0	m./meters.	25.3	PK
0.51	19.48	43.92	63.40	73.0	m./meters.	9.6	PK
4.52	21.81	26.17	47.98	69.5	m./meters.	21.6	PK
7.85	16.24	20.49	36.73	69.5	m./meters.	32.8	PK
11.55	17.88	16.50	34.38	69.5	m./meters.	35.1	PK
27.93	16.88	10.56	27.44	69.5	m./meters.	42.1	PK

Sample Calculation at 0.15 MHz:

Magnitude of Measured Frequency	21.21	dBuV
+Antenna Factor + Cable Loss - Amplifier Gain	57.54	dB/m
Corrected Result	78.75	dBuV/m

Test Date: June 19, 2017

Tested By

Signature: 

Name: Robert K. Mills

US Tech Test Report:
FCC ID:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ABP2-EST0217
17-0238
July 19, 2017
Estimote Polska Sp. z. o. o.
B0

Table 6. Spurious Radiated Emissions Below 30 MHz (Y-Position)

9 kHz to 30 MHz, 15.209 limits							
Test: Radiated Emissions				Client: Estimote Polska Sp. z. o. o.			
Project: 17-0238				Model: B0			
Frequency (MHz)	Test Data (dBuV)	AF+CA-AMP (dB/m)	Results (dBuV/m)	QP Limits (dBuV/m)	Antenna Distance/ Polarization	Margin (dB)	Detector PK, or AVG
0.16	20.45	57.54	77.99	103.5	m./meters.	25.6	PK
0.66	19.94	42.32	62.26	71.2	m./meters.	8.9	PK
4.52	20.73	26.17	46.90	69.5	m./meters.	22.6	PK
9.29	19.41	17.19	36.60	69.5	m./meters.	32.9	PK
14.78	16.12	16.50	32.62	69.5	m./meters.	36.9	PK
29.05	17.53	10.56	28.09	69.5	m./meters.	41.4	PK

Sample Calculation at 0.16 MHz:

Magnitude of Measured Frequency	20.45	dBuV
+Antenna Factor + Cable Loss - Amplifier Gain	57.54	dB/m
Corrected Result	77.99	dBuV/m

Test Date: June 19, 2017

Tested By

Signature: 

Name: Robert K. Mills

US Tech Test Report:
 FCC ID:
 Test Report Number:
 Issue Date:
 Customer:
 Model:

FCC Part 15 Certification/ RSS 210
 2ABP2-EST0217
 17-0238
 July 19, 2017
 Estimote Polska Sp. z o. o.
 B0

Table 7. Spurious Radiated Emissions Below 30 MHz (Z-Position)

9 kHz to 30 MHz, 15.209 limits							
Test: Radiated Emissions				Client: Estimote Polska Sp. z o. o.			
Project: 17-0238				Model: B0			
Frequency (MHz)	Test Data (dBuV)	AF+CA-AMP (dB/m)	Results (dBuV/m)	QP Limits (dBuV/m)	Antenna Distance/ Polarization	Margin (dB)	Detector PK, or AVG
0.16	21.85	57.54	79.39	103.4	m./meters.	24.0	PK
0.67	18.52	42.32	60.84	71.0	m./meters.	10.2	PK
1.48	18.69	38.27	56.96	69.5	m./meters.	12.5	PK
7.60	17.58	20.49	38.07	69.5	m./meters.	31.4	PK
16.98	17.35	1.52	18.87	69.5	m./meters.	50.6	PK
29.95	15.94	10.56	26.50	69.5	m./meters.	43.0	PK

Sample Calculation at 0.16 MHz:

Magnitude of Measured Frequency	21.85	dBuV
+Antenna Factor + Cable Loss - Amplifier Gain	57.54	dB/m
Corrected Result	79.39	dBuV/m

Test Date: June 19, 2017

Tested By

Signature: 

Name: Robert K. Mills

US Tech Test Report:
 FCC ID:
 Test Report Number:
 Issue Date:
 Customer:
 Model:

FCC Part 15 Certification/ RSS 210
 2ABP2-EST0217
 17-0238
 July 19, 2017
 Estimote Polska Sp. z. o. o.
 B0

Table 8. Fundamental Emissions (Peak & AVG)

Test: FCC Part 15, Paragraph 15.209, 15.249(a)					Client: Estimote Polska Sp. z. o. o.			
Project: 17-0238					Model: B0			
Frequency (MHz)	Test Data (dBuV)	Factor (dB)	AF+CA -AMP (dB/m)	Results (dBuV/m)	Limits (dBuV/m)	Antenna Distance/ Polarization	Margin (dB)	Detector Mode
Low - Channel								
2401.33	49.62	-	31.88	81.50	114.0	3.0m./HORZ	32.5	PK
2401.33	45.22	-	33.21	78.43	94.0	3.0m./HORZ	15.6	AVG
Mid - Channel								
2441.55	50.15	-	31.88	82.03	114.0	3.0m./HORZ	32.0	PK
2441.55	41.12	-	33.21	74.33	94.0	3.0m./HORZ	19.7	AVG
High - Channel								
2480.30	47.50	-	31.88	79.38	114.0	3.0m./HORZ	34.6	PK
2480.30	40.82	-	33.21	74.03	94.0	3.0m./HORZ	20.0	AVG

Notes:

1. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic
2. (~) Measurements taken at 1 meter were extrapolated to 3 meters using a factor of (-9.5 dB) where applicable.
3. The EUT was placed in three orthogonal positions and the transmitter was in constant broadcast mode, with the duty cycle programmed for >98% ON time in continuous transmit mode.
4. The emissions were measured with the receive antenna in vertical and horizontal polarizations. The data listed in the above table was worst case.

Sample Calculation at 2401.33 MHz:

Magnitude of Measured Frequency	49.62	dBuV
+Antenna Factor + Cable Loss - Amplifier Gain	31.88	dB/m
Corrected Result	81.50	dBuV/m

Test Date: June 16, 2017

Tested By

Signature:  Name: Robert K. Mills

US Tech Test Report:
 FCC ID:
 Test Report Number:
 Issue Date:
 Customer:
 Model:

FCC Part 15 Certification/ RSS 210
 2ABP2-EST0217
 17-0238
 July 19, 2017
 Estimote Polska Sp. z o. o.
 B0

Table 9. Harmonics Emissions (Peak & AVG)

Test: FCC Part 15, Paragraph 15.209, 15.249(a)					Client: Estimote Polska Sp. z o. o.			
Project: 17-0238					Model: B0			
Frequency (MHz)	Test Data (dBuV)	Factor (dB)	AF+CA -AMP (dB/m)	Results (dBuV/m)	Limits (dBuV/m)	Antenna Distance/ Polarization	Margin (dB)	Detector Mode
Low - Channel								
4803.73	45.00	-	6.17	51.17	74.0	3.0m./HORZ	22.8	PK
4803.73	23.62	-	8.40	32.02	54.0	3.0m./HORZ	22.0	AVG
7210.78	48.62	-	18.81	67.43	74.0	3.0m./HORZ	6.6	PK
7210.78	24.79	-	18.81	43.60	54.0	3.0m./HORZ	10.4	AVG
Mid - Channel								
4886.13	44.76	-	7.40	52.16	74.0	3.0m./HORZ	21.8	PK
4886.13	21.91	-	8.40	30.31	54.0	3.0m./HORZ	23.7	AVG
7326.00	49.13	-	19.19	68.32	74.0	3.0m./HORZ	5.7	PK
7326.00	22.15	-	19.19	41.34	54.0	3.0m./HORZ	12.7	AVG
High - Channel								
4961.90	44.06	-	8.64	52.70	74.0	3.0m./HORZ	21.3	PK
4961.90	22.86	-	8.64	31.50	54.0	3.0m./HORZ	22.5	AVG
7439.60	49.80	-	19.23	69.03	74.0	3.0m./HORZ	5.0	PK
7439.60	24.65	-	19.23	43.88	54.0	3.0m./HORZ	10.1	AVG

Notes:

1. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic
2. (~) Measurements taken at 1 meter were extrapolated to 3 meters using a factor of (-9.5 dB) where applicable.
3. The EUT was placed in three orthogonal positions and the transmitter was in constant broadcast mode, with the duty cycle programmed for >98% ON time in continuous transmit mode.
4. The emissions were measured with the receive antenna in vertical and horizontal polarizations. The data listed in the above table was worst case.

Sample Calculation at 4803.73 MHz:

Magnitude of Measured Frequency	45.00	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain – Duty Cycle	6.17	dB/m
<u>Duty Cycle Correction Factor</u>	N/A	dB
Corrected Result	51.17	dBuV/m

Test Date: June 16, 2017

Tested By

Signature:  Name: Robert K. Mills

US Tech Test Report:
 FCC ID:
 Test Report Number:
 Issue Date:
 Customer:
 Model:

FCC Part 15 Certification/ RSS 210
 2ABP2-EST0217
 17-0238
 July 19, 2017
 Estimote Polska Sp. z. o. o.
 B0

Table 10. Spurious Radiated Emissions other than Fundamental & Harmonics

Test: FCC Part 15, Paragraph 15.209, 15.249(a)			Client: Estimote Polska Sp. z. o. o.					
Project: 17-0238			Model: B0					
Frequency (MHz)	Test Data (dBuV)	Factor (dB)	AF+CA -AMP (dB/m)	Results (dBuV/m)	Limits (dBuV/m)	Antenna Distance/ Polarization	Margin (dB)	Detector Mode
836.20	31.27	-	-0.89	30.38	46.0	3.0m./HORZ	15.6	PK
702.50	32.85	-	-3.13	29.72	46.0	3.0m./VERT	16.3	PK
1143.00	46.73	-	-7.73	39.00	54.0	3.0m./HORZ	15.0	PK
3128.00	44.62	-	3.02	47.64	54.0	3.0m./HORZ	6.4	PK
1105.00	47.52	-	-7.57	39.95	54.0	3.0m./VERT	14.0	PK
3075.00	44.83	-	2.34	47.17	54.0	3.0m./VERT	6.8	PK

Notes:

1. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic
2. (~) Measurements taken at 1 meter were extrapolated to 3 meters using a factor of (-9.5 dB) where applicable.
3. The EUT was placed in three orthogonal positions and the transmitter was in constant broadcast mode, with the duty cycle programmed for >98% ON time in continuous transmit mode.
4. The emissions were measured with the receive antenna in vertical and horizontal polarizations. The data listed in the above table was worst case.

Sample Calculation at 836.20 MHz:

Magnitude of Measured Frequency	31.27	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain – Duty Cycle	-0.89	dB/m
Duty Cycle Correction Factor	N/A	dB
Corrected Result	30.38	dBuV/m

Test Date: June 16, 2017

Tested By

Signature:  Name: Robert K. Mills

US Tech Test Report:
FCC ID:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ABP2-EST0217
17-0238
July 19, 2017
Estimote Polska Sp. z o. o.
B0

2.11 Band Edge Measurements – (CFR 15.249 (d))

Band Edge measurements are made following the guidelines in FCC KDB Publication No. 558074 with the EUT initially operating on the Lowest Channel and then operating on the Highest Channel within its band of operation. Radiated measurements are performed to demonstrate compliance with the requirement of 15.249(d) that all emissions outside of the band edges be attenuated by at least 50 dB or 15.209 limits, when compared to its highest in-band value (contained in a 100 kHz band).

To capture the band edge, set the Spectrum Analyzer frequency span to 2 MHz to capture the peak level of the emission operating on the channel closest to the band edge as well as any modulation products falling outside of the authorized band of operation. See figure and calculations following for more detail.

US Tech Test Report:
 FCC ID:
 Test Report Number:
 Issue Date:
 Customer:
 Model:

FCC Part 15 Certification/ RSS 210
 2ABP2-EST0217
 17-0238
 July 19, 2017
 Estimote Polska Sp. z o. o.
 B0

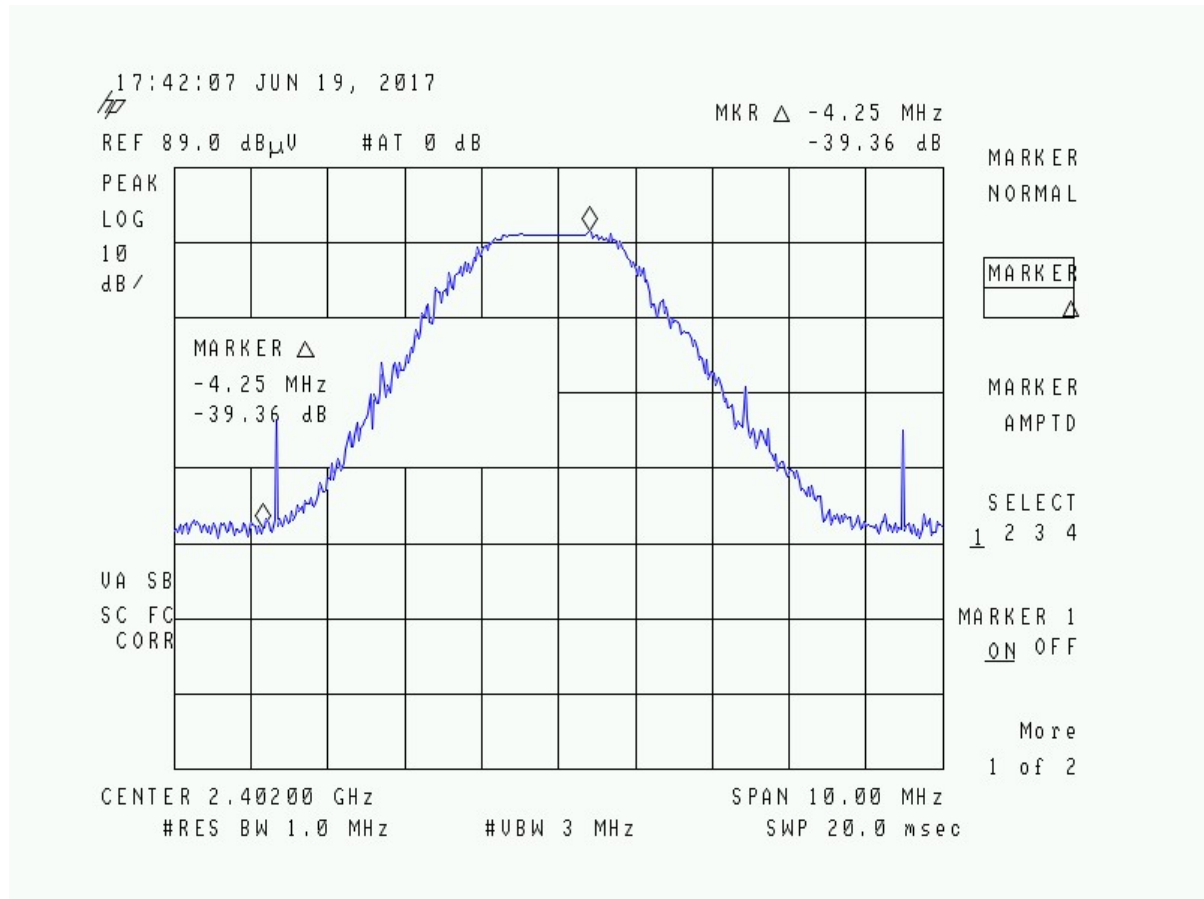


Figure 2. Band Edge Compliance, Low Channel Delta - Peak

Low Channel Corrected Measured Value from Table 7	81.50	dBuV
Low Channel Band Edge Delta from Figure 4	-39.36	dB
Calculated Result	42.12	dBuV/m
Band Edge Limit	74.00	dBuV/m
Calculated Result	42.12	dBuV/m
Band Edge Margin	31.88	dBuV/m

US Tech Test Report:
FCC ID:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ABP2-EST0217
17-0238
July 19, 2017
Estimote Polska Sp. z o. o.
B0

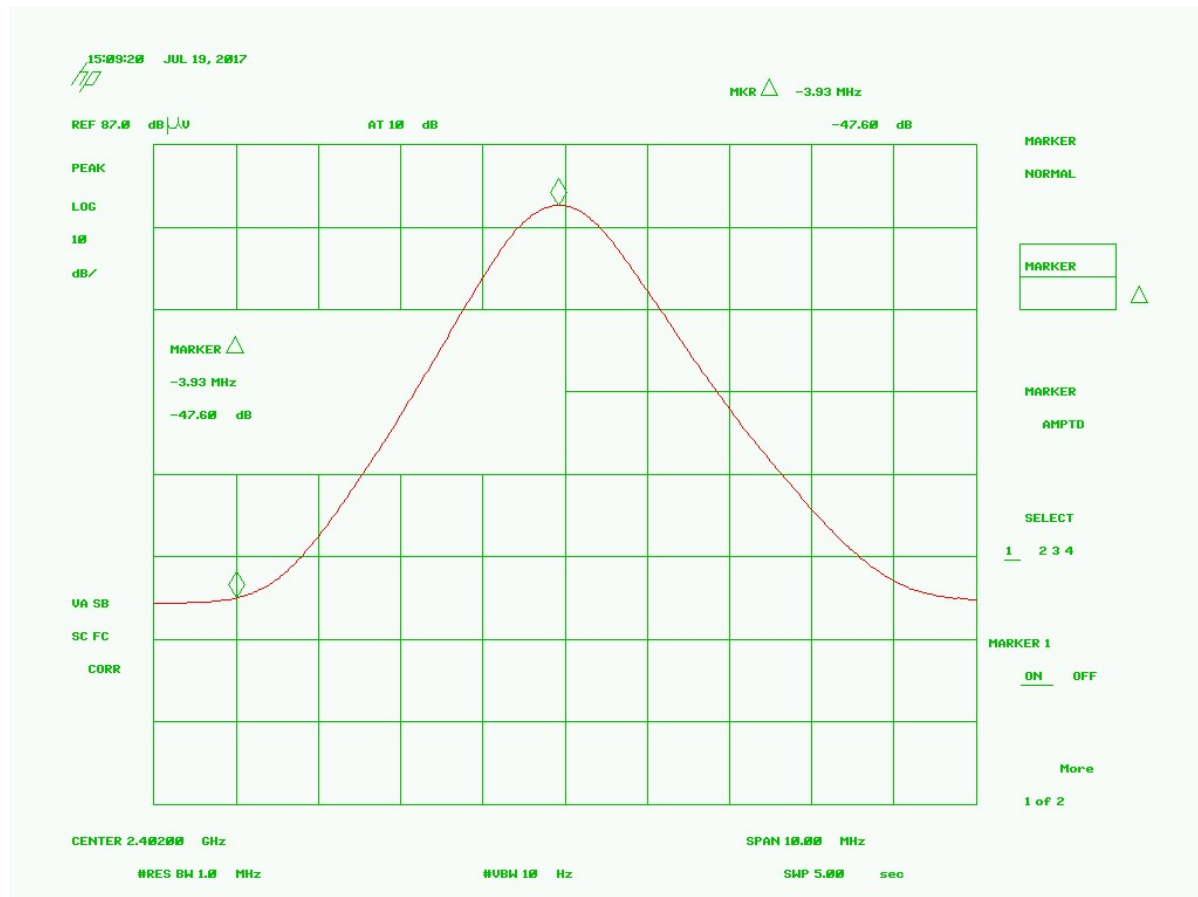


Figure 3. Band Edge Compliance, Low Channel Delta - Average

Low Channel Corrected Measured Value from Table 7	78.43	dBuV
Low Channel Band Edge Delta from Figure 4	-47.60	dB
Calculated Result	30.83	dBuV/m
Band Edge Limit	54.00	dBuV/m
Calculated Result	30.83	dBuV/m
Band Edge Margin	23.17	dBuV/m

US Tech Test Report:
 FCC ID:
 Test Report Number:
 Issue Date:
 Customer:
 Model:

FCC Part 15 Certification/ RSS 210
 2ABP2-EST0217
 17-0238
 July 19, 2017
 Estimote Polska Sp. z o. o.
 B0

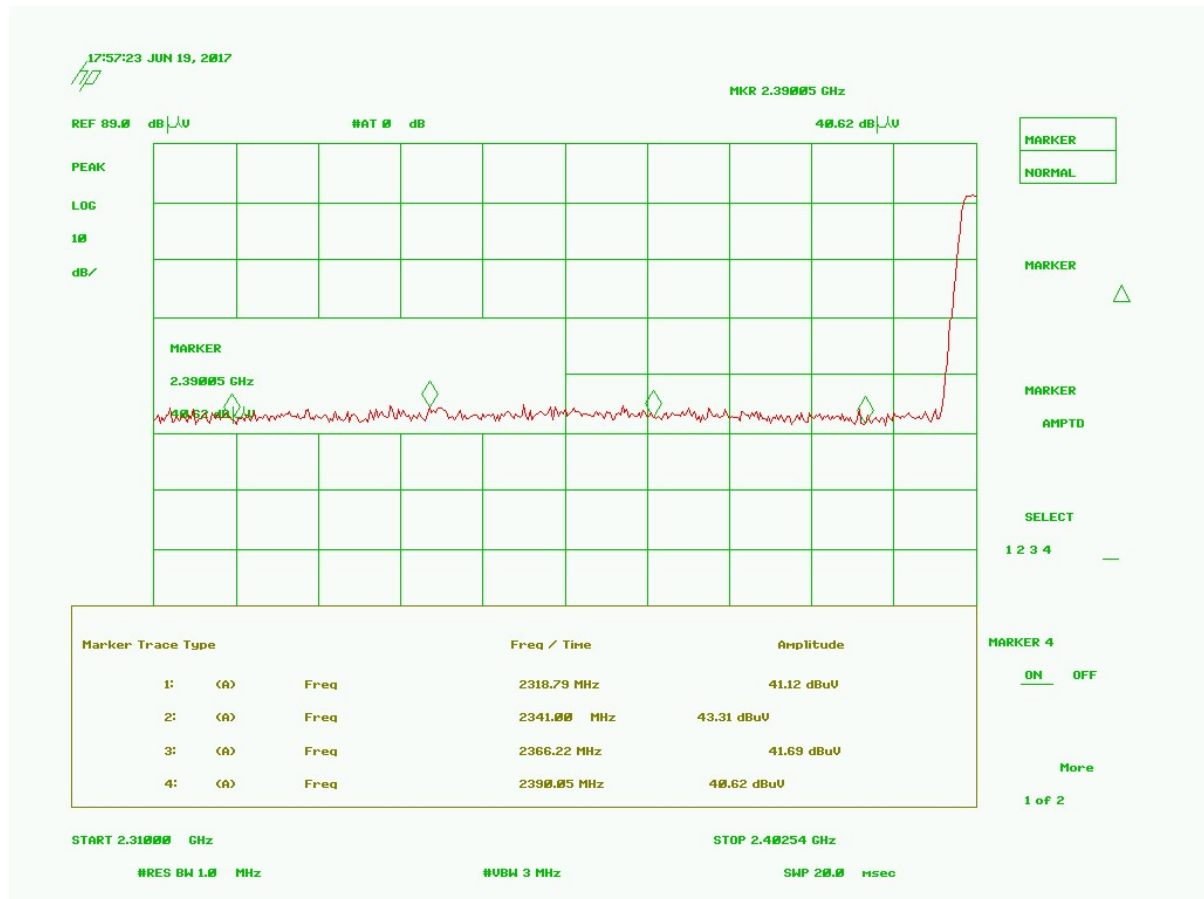


Figure 4. Radiated Restricted Band 2310 MHz to 2390 MHz, Peak

US Tech Test Report:
 FCC ID:
 Test Report Number:
 Issue Date:
 Customer:
 Model:

FCC Part 15 Certification/ RSS 210
 2ABP2-EST0217
 17-0238
 July 19, 2017
 Estimote Polska Sp. z o. o.
 B0

Table 11. Radiated Restricted Band 2310 MHz to 2390 MHz, Peak

2310 MHz to 2390 MHz Restricted Band Peak Measurements							
Test: Radiated Emissions				Client: Estimote Polska Sp.z.o.o.			
Project: 17-0238				Model: Sticker B0			
Frequency (MHz)	Test Data (dBuV)	AF+CA-AMP (dB/m)	Results (dBuV/m)	PK Limits (dBuV/m)	Antenna Distance/ Polarization	Margin (dB)	Detector PK, or AVG
2318.79	41.12	-0.60	40.52	74.0	3.0m./HORZ	33.5	PK
2341.00	43.31	-0.60	42.71	74.0	3.0m./HORZ	31.3	PK
2366.22	41.69	-0.60	41.09	74.0	3.0m./HORZ	32.9	PK
2390.05	40.62	-0.60	40.02	74.0	3.0m./HORZ	34.0	PK

Sample Calculation at 2318.79 MHz:

Magnitude of Measured Frequency	41.12	dBuV
+Antenna Factor + Cable Loss - Amplifier Gain	-0.60	dB/m
Corrected Result	40.52	dBuV/m

Test Date: June 19, 2017

Tested By
 Signature:  Name: Robert K. Mills

US Tech Test Report:
 FCC ID:
 Test Report Number:
 Issue Date:
 Customer:
 Model:

FCC Part 15 Certification/ RSS 210
 2ABP2-EST0217
 17-0238
 July 19, 2017
 Estimote Polska Sp. z o. o.
 B0

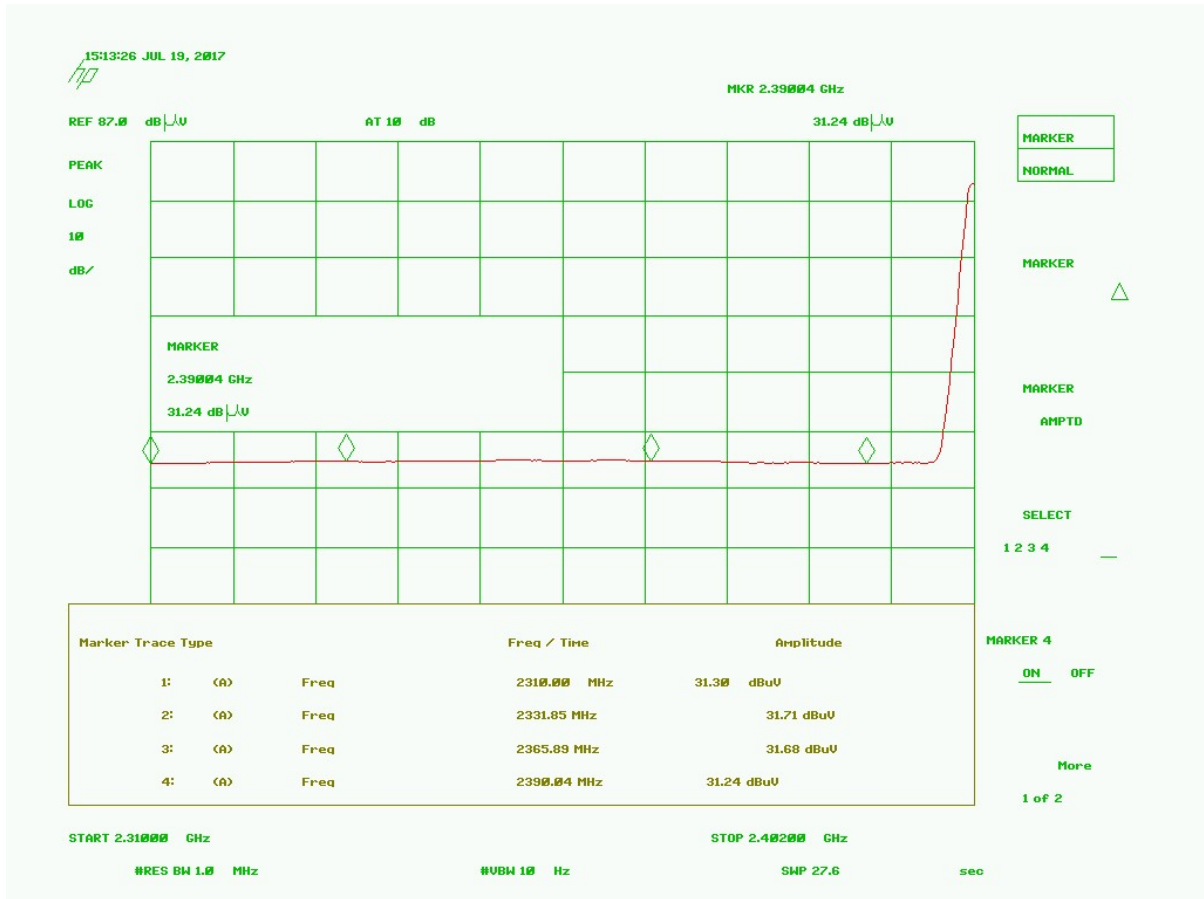


Figure 5. Radiated Restricted Band 2310 MHz to 2390 MHz, AVG

US Tech Test Report:
 FCC ID:
 Test Report Number:
 Issue Date:
 Customer:
 Model:

FCC Part 15 Certification/ RSS 210
 2ABP2-EST0217
 17-0238
 July 19, 2017
 Estimote Polska Sp. z o. o.
 B0

Table 12. Radiated Restricted Band 2310 MHz to 2390 MHz, Average

2310 MHz to 2390 MHz Restricted Band Peak Measurements								
Test: Radiated Emissions					Client: Estimote Polska Sp.z.o.o.			
Project: 17-0238					Model: B0			
Frequency (MHz)	Test Data (dBuV)	Additional Factor (dB)	AF+CA-AMP+Duty Cycle (dB/m)	Results (dBuV/m)	AVG Limits (dBuV/m)	Antenna Distance/ Polarization	Margin (dB)	Detector PK, or AVG
2310.00	31.30	-	-0.60	30.70	54.0	3.0m./HORZ	23.3	AVG
2331.85	31.71	-	-0.60	31.11	54.0	3.0m./HORZ	22.9	AVG
2365.89	31.68	-	-0.60	31.08	54.0	3.0m./HORZ	22.9	AVG
2390.04	31.24	-	-0.60	30.64	54.0	3.0m./HORZ	23.4	AVG

Sample Calculation at 2310.00 MHz:

Magnitude of Measured Frequency	31.30	dBuV
+Antenna Factor + Cable Loss - Amplifier Gain	-0.60	dB/m
Corrected Result	30.70	dBuV/m

Test Date: July 19, 2017

Tested By

Signature:  Name: Robert K. Mills

US Tech Test Report:
 FCC ID:
 Test Report Number:
 Issue Date:
 Customer:
 Model:

FCC Part 15 Certification/ RSS 210
 2ABP2-EST0217
 17-0238
 July 19, 2017
 Estimote Polska Sp. z o. o.
 B0

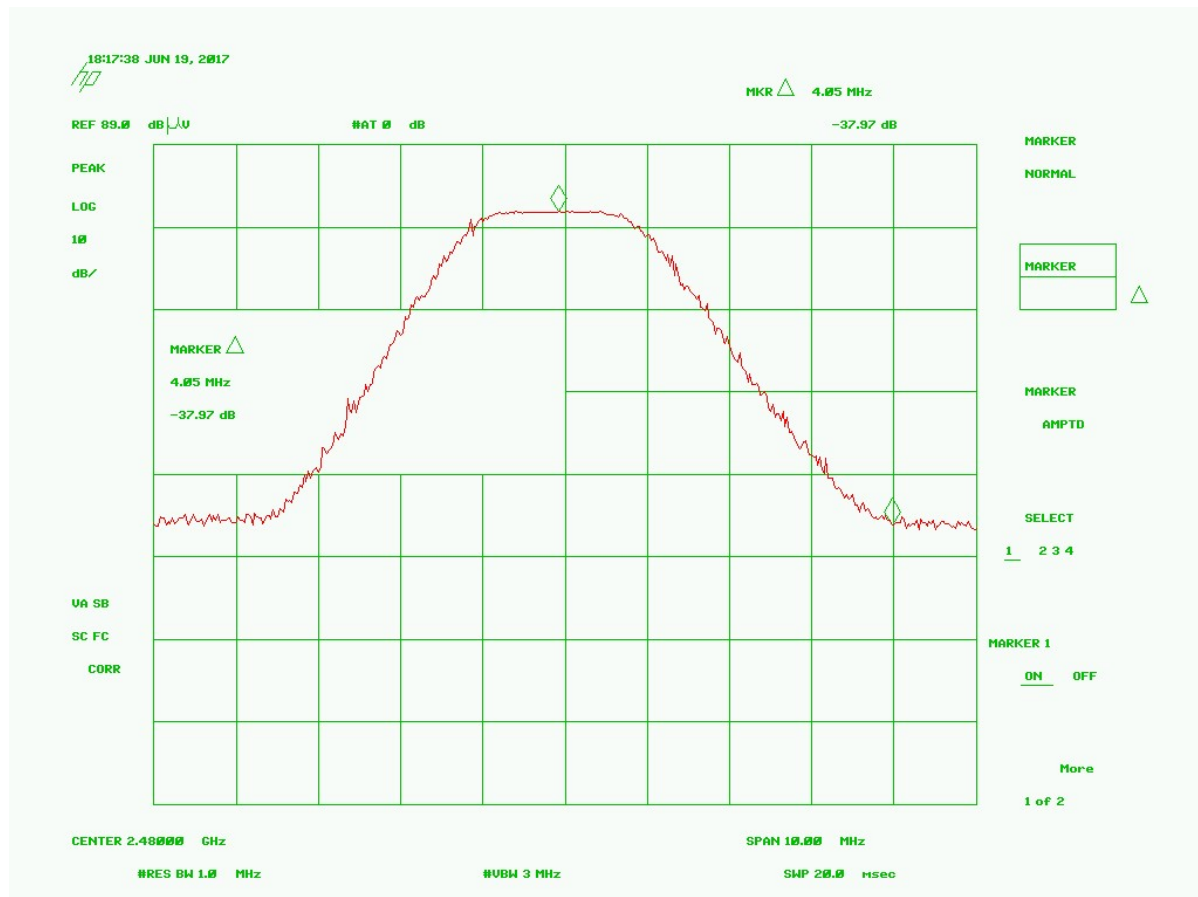


Figure 6. Band Edge Compliance, High Channel Delta – Peak

High Channel Corrected Measured Value from Table 8	82.03	dBuV
High Channel Band Edge Delta from Figure 6	-37.97	dB
Calculated Result	44.06	dBuV/m
Band Edge Limit	94.00	dBuV/m
Calculated Result	44.06	dBuV/m
Band Edge Margin	44.94	dBuV/m

US Tech Test Report:
 FCC ID:
 Test Report Number:
 Issue Date:
 Customer:
 Model:

FCC Part 15 Certification/ RSS 210
 2ABP2-EST0217
 17-0238
 July 19, 2017
 Estimote Polska Sp. z o. o.
 B0

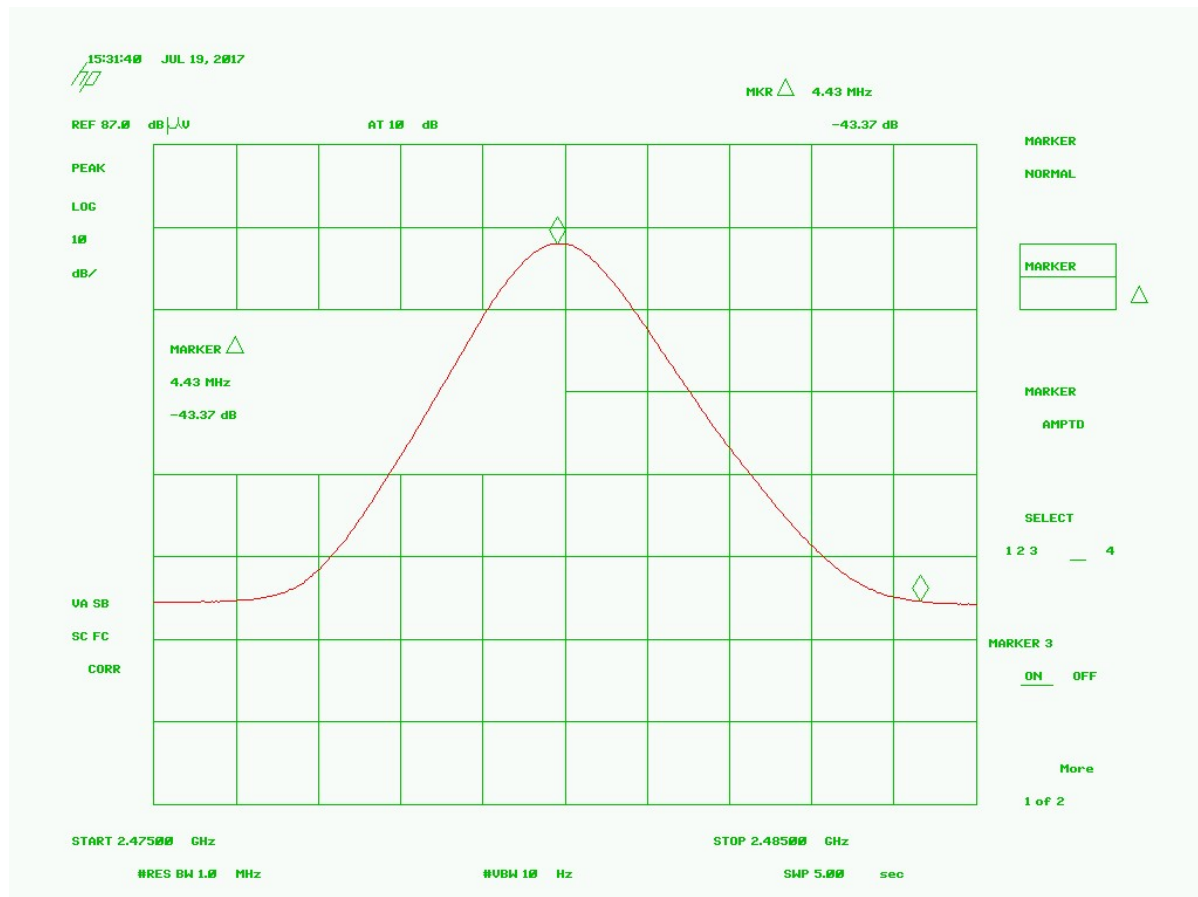


Figure 7. Band Edge Compliance, High Channel Delta – Average

High Channel Corrected Measured Value from Table 8	74.03	dBuV
High Channel Band Edge Delta from Figure 6	-43.37	dB
Calculated Result	30.66	dBuV/m
Band Edge Limit	54.00	dBuV/m
Calculated Result	30.66	dBuV/m
Band Edge Margin	23.34	dBuV/m

US Tech Test Report:
FCC ID:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ABP2-EST0217
17-0238
July 19, 2017
Estimote Polska Sp. z o. o.
B0

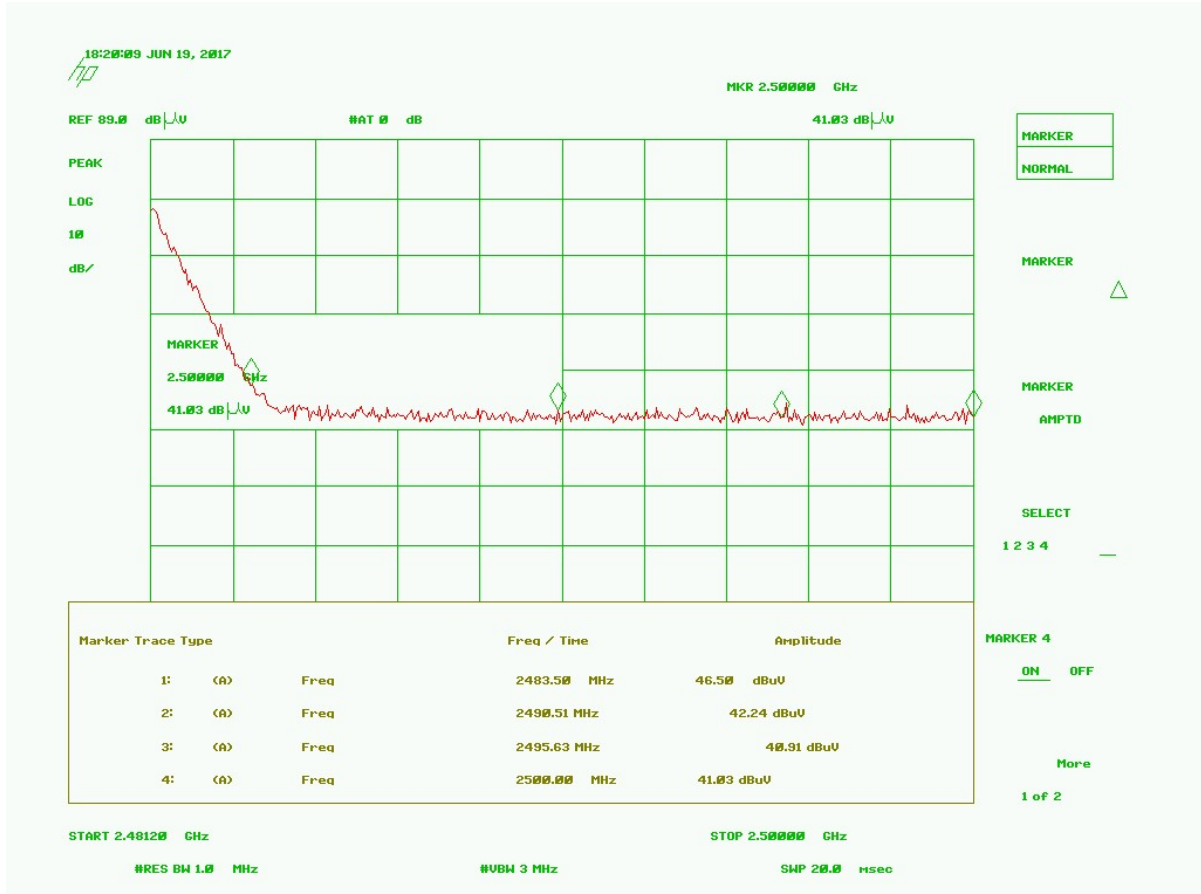


Figure 8. Radiated Restricted Band 2483.5 MHz to 2500 MHz, Peak

US Tech Test Report:
 FCC ID:
 Test Report Number:
 Issue Date:
 Customer:
 Model:

FCC Part 15 Certification/ RSS 210
 2ABP2-EST0217
 17-0238
 July 19, 2017
 Estimote Polska Sp. z o. o.
 B0

Table 13. Radiated Restricted Band 2483.5 MHz to 2500 MHz, Peak

2483.5 MHz to 2500 MHz Restricted Band Peak Measurements							
Test: Radiated Emissions				Client: Estimote Polska Sp.z.o.o.			
Project: 17-0238				Model: B0			
Frequency (MHz)	Test Data (dBuV)	AF+CA-AMP (dB/m)	Results (dBuV/m)	PK Limits (dBuV/m)	Antenna Distance/ Polarization	Margin (dB)	Detector PK, or AVG
2483.50	46.50	-0.44	46.06	74.0	3.0m./HORZ	27.9	PK
2490.51	42.24	-0.44	41.80	74.0	3.0m./HORZ	32.2	PK
2495.63	40.91	-0.44	40.47	74.0	3.0m./HORZ	33.5	PK
2500.00	41.03	0.83	41.86	74.0	3.0m./HORZ	32.1	PK

Sample Calculation at 2483.50 MHz:

Magnitude of Measured Frequency	46.50	dBuV
+Antenna Factor + Cable Loss - Amplifier Gain	-0.44	dB/m
Corrected Result	46.06	dBuV/m

Test Date: June 19, 2017

Tested By

Signature: 

Name: Robert K. Mills

US Tech Test Report:
FCC ID:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ABP2-EST0217
17-0238
July 19, 2017
Estimote Polska Sp. z o. o.
B0

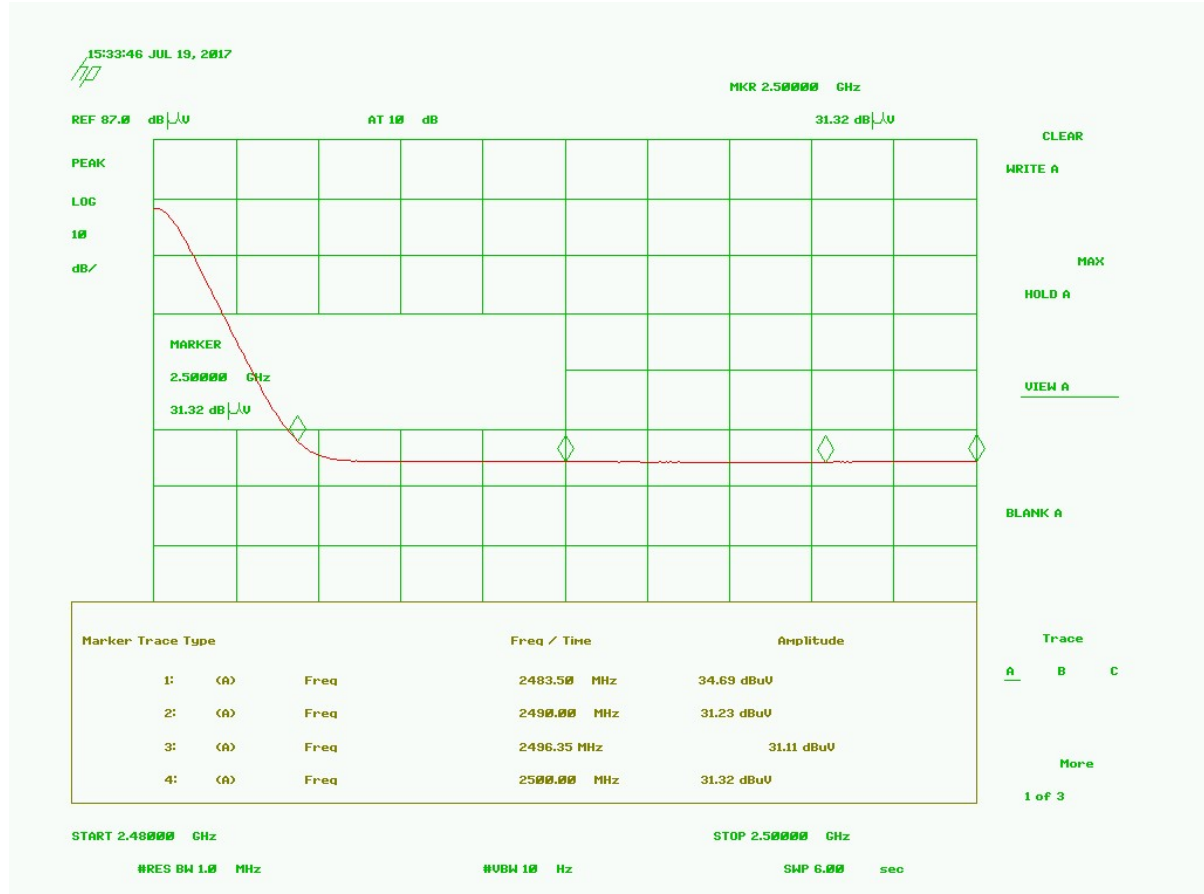


Figure 9. Radiated Restricted Band 2483.5 MHz to 2500 MHz, AVG

US Tech Test Report:
 FCC ID:
 Test Report Number:
 Issue Date:
 Customer:
 Model:

FCC Part 15 Certification/ RSS 210
 2ABP2-EST0217
 17-0238
 July 19, 2017
 Estimote Polska Sp. z. o. o.
 B0

Table 14. Radiated Restricted Band 2483.5 MHz to 2500 MHz, Average

2483.5 MHz to 2500 MHz Restricted Band Average Measurements								
Test: Radiated Emissions					Client: Estimote Polska Sp.z.o.o.			
Project: 17-0238					Model: Sticker B0			
Frequency (MHz)	Test Data (dBuV)	Additional Factor (dB)	AF+CA-AMP+Duty Cycle (dB/m)	Results (dBuV/m)	AVG Limits (dBuV/m)	Antenna Distance/ Polarization	Margin (dB)	Detector PK, or AVG
2483.50	34.69	-	-0.44	34.25	54.0	3.0m./HORZ	19.8	AVG
2490.00	31.23	-	-0.44	30.79	54.0	3.0m./HORZ	23.2	AVG
2496.35	31.11	-	-0.44	30.67	54.0	3.0m./HORZ	23.3	AVG
2500.00	31.32	-	0.83	32.15	54.0	3.0m./HORZ	21.9	AVG

Sample Calculation at 2483.50 MHz:

Magnitude of Measured Frequency	34.69	dBuV
+Antenna Factor + Cable Loss - Amplifier Gain	-0.44	dB/m
Corrected Result	34.25	dBuV/m

Test Date: July 19, 2017

Tested By

Signature: 

Name: Robert K. Mills

US Tech Test Report:
FCC ID:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ABP2-EST0217
17-0238
July 19, 2017
Estimote Polska Sp. z o. o.
B0


2.12 Occupied Bandwidth (Part 2.1049)

These measurements were performed while the EUT was in a constant transmit mode. A method similar to the marker delta method was used to capture the points. The RBW was set to approximately 1/100 of the manufacturers claimed RBW and with the VBW \geq RBW. The results of this test are given in Table 12 and Figures 10-12.

Table 15. 20 dB Bandwidth and 99% Occupied Bandwidth

Frequency (MHz)	20 dB Bandwidth (MHz)	99% Occupied Bandwidth (MHz)
2402	1.988	N/A
2442	1.913	N/A
2480	1.950	N/A

Test Date: July 19, 2017
Tested By

Signature:  Name: Robert K. Mills

US Tech Test Report:
FCC ID:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ABP2-EST0217
17-0238
July 19, 2017
Estimote Polska Sp. z o. o.
B0

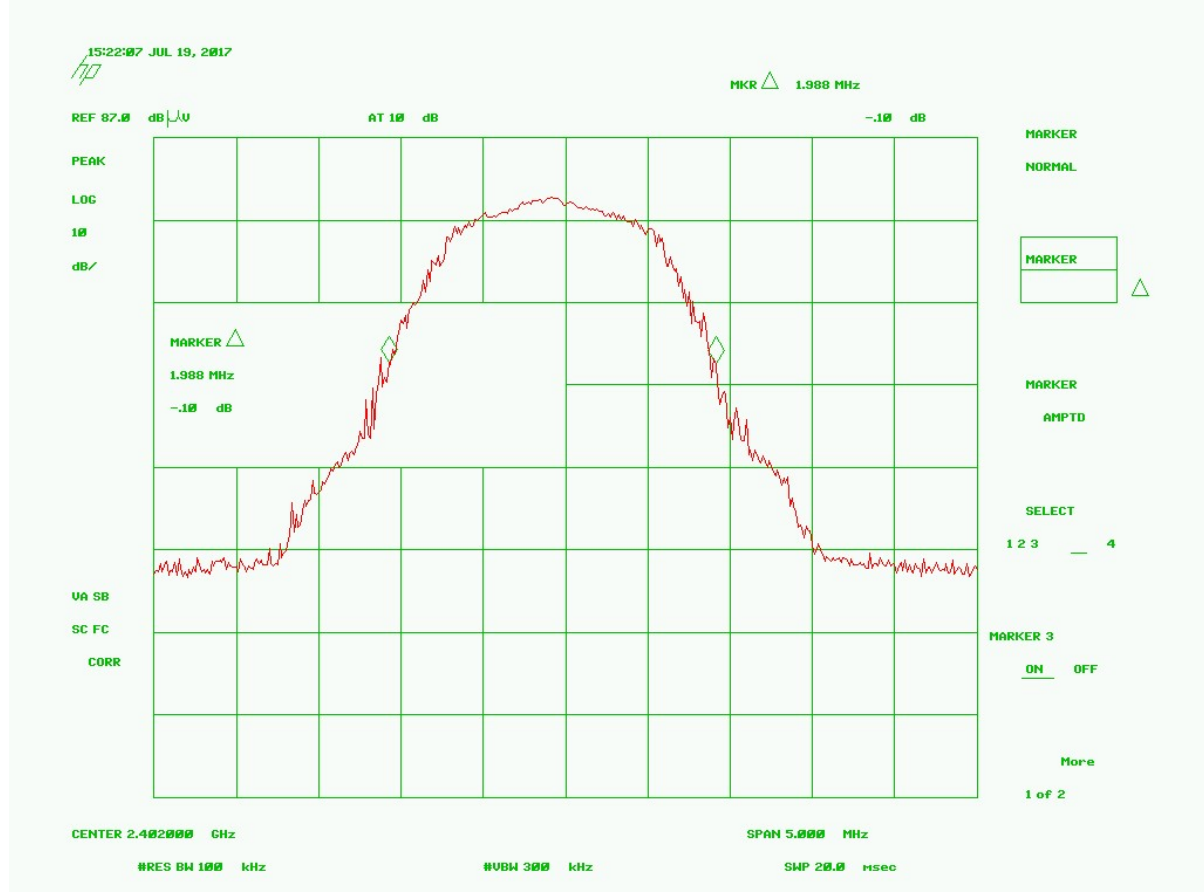


Figure 10. Occupied Bandwidth – Low Channel

US Tech Test Report:
FCC ID:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ABP2-EST0217
17-0238
July 19, 2017
Estimote Polska Sp. z o. o.
B0

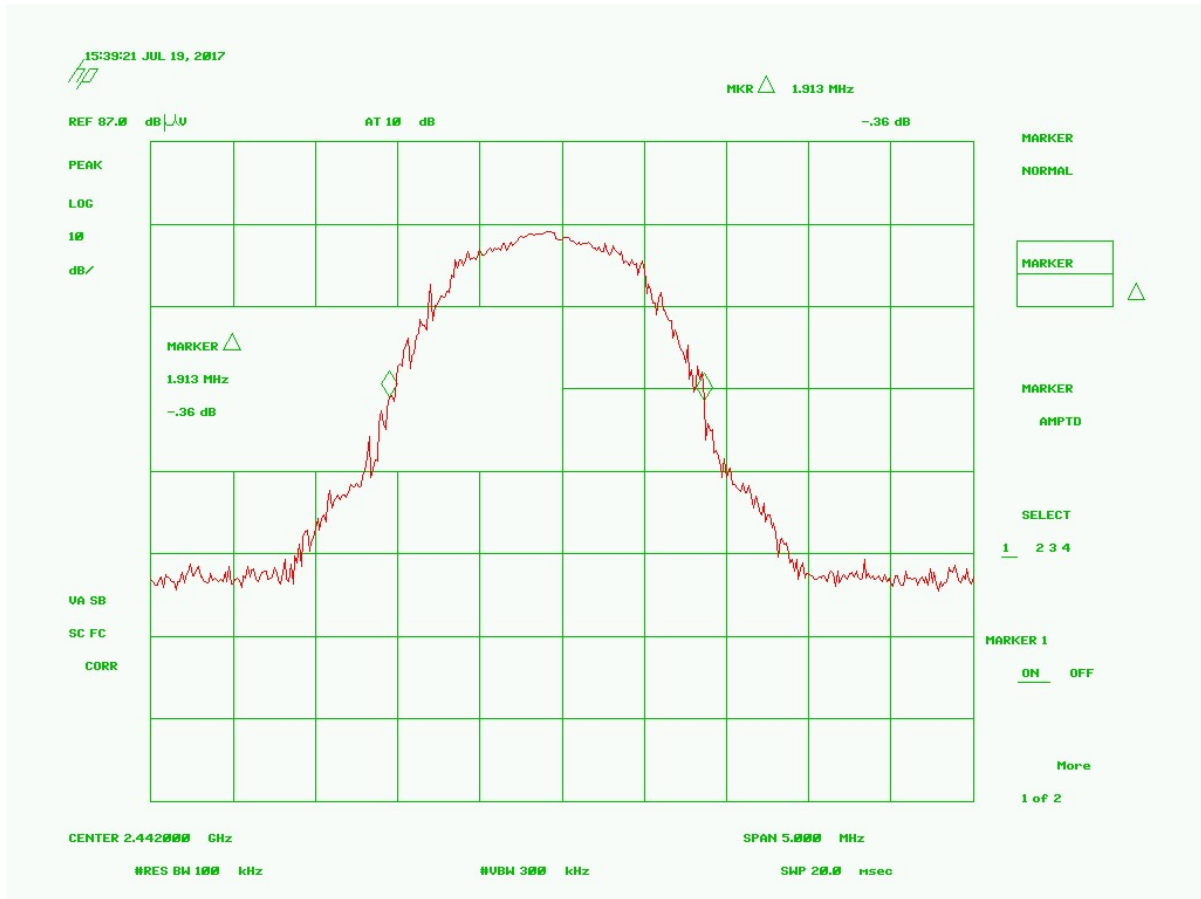


Figure 11. Occupied Bandwidth – Mid Channel

US Tech Test Report:
FCC ID:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ABP2-EST0217
17-0238
July 19, 2017
Estimote Polska Sp. z o. o.
B0

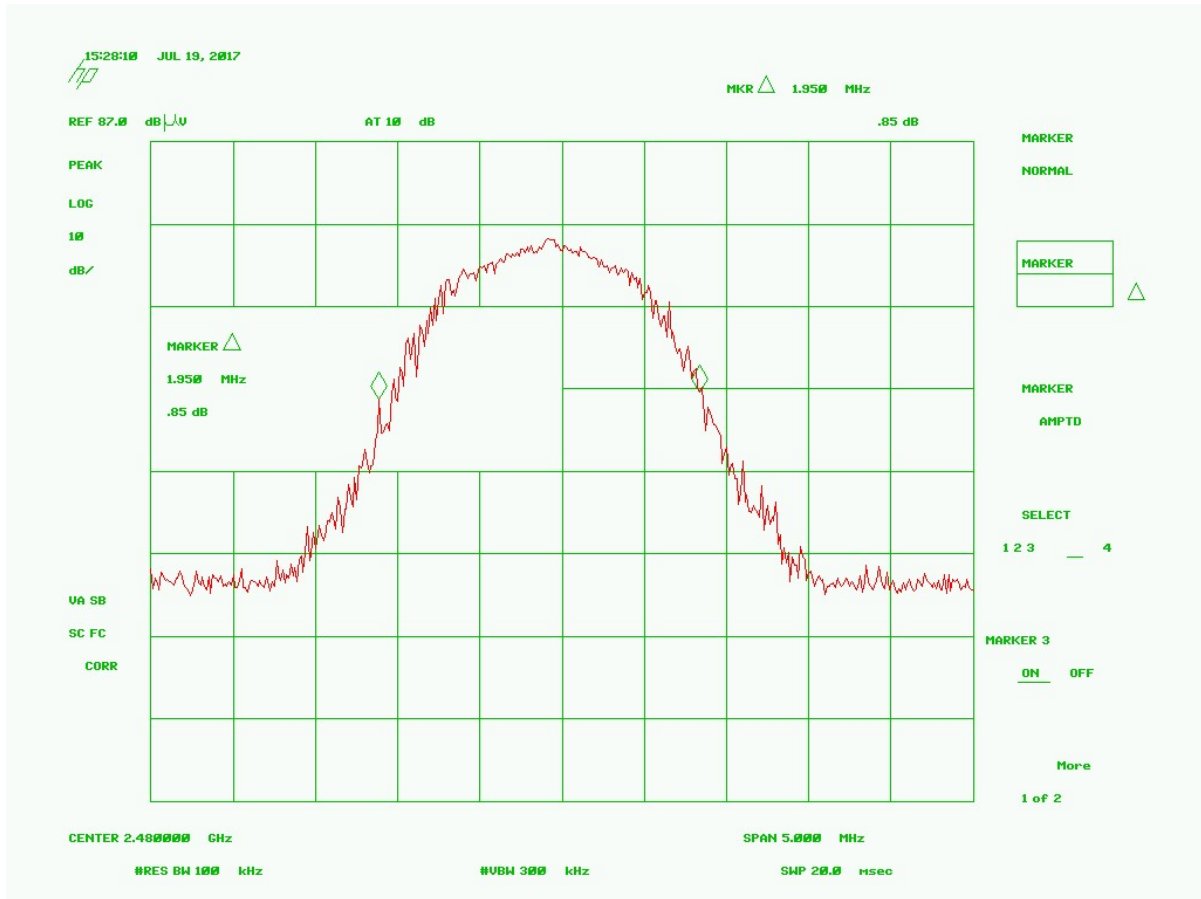


Figure 12. Occupied Bandwidth – High Channel

US Tech Test Report:
FCC ID:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ABP2-EST0217
17-0238
July 19, 2017
Estimote Polska Sp. z. o. o.
B0

2.13 Unintentional Radiator, Power line Conducted Emissions (CFR 15.107)

Since the EUT is battery powered, this test was not applied.

NOTE: The test data provided in this section is to support the Verification requirement for the digital apparatus and the radios within.

Table 16. Transmitter Power Line Conducted Emissions Test Data, Part 15.107

150KHz to 30 MHz with Class B Limits						
Test: Power Line Conducted Emissions				Client: Estimote Polska Sp. z. o. o.		
Project: 17-0238				Model: B0		
Frequency (MHz)	Test Data (dBuV)	LISN+CL-PA (dB)	Results (dBuV)	AVG Limits (dBuV)	Margin (dB)	Detector PK, QP, or AVG
The EUT is battery powered: therefore this test is not applicable.						

SAMPLE CALCULATION: N/A

Test Date: July 19, 2017

Tested By

Signature:  Name: Robert K. Mills

US Tech Test Report:
FCC ID:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ABP2-EST0217
17-0238
July 19, 2017
Estimote Polska Sp. z o. o.
B0

2.14 Unintentional Radiator, Radiated Emissions (CFR 15.109)

Radiated emissions disturbance Measurements were performed with an instrument having both peak and quasi-peak detectors over the frequency range of 30 MHz to 12.5 GHz. Measurements of the radiated emissions were made with the receiver antenna at a distance of 3 m from the boundary of the test unit.

The test antenna was varied from 1 m to 4 m in height while watching the analyzers' display for the maximum magnitude of the signal at the test frequency. The antenna polarization (horizontal or vertical) and test sample azimuth were varied during the measurements to find the maximum field strength readings to record.

The worst-case radiated emissions in the range of 30 MHz to 12.5 GHz are more than 20 dB below the limit.

NOTE: The test data provided in this section is to support the Verification requirement for the digital apparatus and the radios within.

US Tech Test Report:
FCC ID:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ABP2-EST0217
17-0238
July 19, 2017
Estimote Polska Sp. z. o. o.
B0

Table 17. Unintentional Radiator, Peak Radiated Emissions (CFR 15.109),

30 to 1000 MHz with Class B Limits								
Test: Radiated Emissions					Client: Estimote Polska Sp. Z. o. o.			
Project: 17-0238					Model: B0			
Frequency (MHz)	Test Data (dBuV)	Factor (dB)	AF+CA -AMP (dB/m)	Results (dBuV/m)	Limits (dBuV/m)	Antenna Distance/ Polarization	Margi n (dB)	Detecto r Mode
All emissions were more than 20 dB below the applicable limit.								

Sample Calculation N/A

Test Date: June 16, 2017

Tested By

Signature:  Name: Robert K. Mills

US Tech Test Report:
FCC ID:
Test Report Number:
Issue Date:
Customer:
Model:

FCC Part 15 Certification/ RSS 210
2ABP2-EST0217
17-0238
July 19, 2017
Estimote Polska Sp. z o. o.
B0

Table 18. Unintentional Radiator, Peak Radiated Emissions (CFR 15.109)

30 to 1000 MHz with Class B Limits								
Test: Radiated Emissions					Client: Estimote Polska Sp. Z. o. o.			
Project: 17-0238					Model: B0			
Frequency (MHz)	Test Data (dBuV)	Factor (dB)	AF+CA -AMP (dB/m)	Results (dBuV/m)	Limits (dBuV/m)	Antenna Distance/ Polarization	Margi n (dB)	Detecto r Mode
All emissions were more than 20 dB below the applicable limit.								

Sample Calculation N/A

Test Date: June 16, 2017

Tested By

Signature:  Name: Robert K. Mills

2.15 Measurement Uncertainty

The measurement uncertainties given were calculated using the method detailed in CISPR 16-4. A coverage factor of $k=2$ was used to give a level of confidence of approximately 95%.

2.15.1 Conducted Emissions Measurement Uncertainty

Measurement Uncertainty (within a 95% confidence level) for this test is ± 2.78 dB.

This EUT is battery powered; therefore this tested was deemed not applicable.

2.15.2 Radiated Emissions Measurement Uncertainty

For a measurement distance of 3 m the measurement uncertainty (with a 95% confidence level) for this test using a Biconical Antenna (30 MHz to 200 MHz) is ± 5.39 dB. This value includes all elements of measurement.

The measurement uncertainty (with a 95% confidence level) for this test using a Log Periodic Antenna (200 MHz to 1000 MHz) is ± 5.18 dB.

The measurement uncertainty (with a 95% confidence level) for this test using a Horn Antenna is ± 5.21 dB.

The data listed in this test report does have sufficient margin to negate the effects of uncertainty. Therefore, the EUT unconditionally meets this requirement.