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

And

IC Radio Standards Specification: RSS-210 Issue 9, Annex A 2.9

For the

Estimote Polska Sp. z o. o.

Estimote Location Beacon
Model: F3.6

FCC ID: 2ABP2-EST0317
IC ID: 11753A-EST0317

UST Project: 17-0528
Issue Date: December 14, 2017

Total Pages in This Report: 33

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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 December 14, 2017

TESTING

NVLAP LAB CODE 200162-0

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MEASUREMENT TECHNICAL REPORT

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

MODEL: F3.6

FCC ID: 2ABP2-EST0317

IC ID: 11753A-EST0317

DATE: December 14, 2017

This report concerns (check one): Original grant [X]
Class II change

Equipment type: 2402 – 2480 MHz Transmitter Module

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:

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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 and IC Radio Standards Specification RSS-210 Issue, 9.

1.2 Characterization of Test Sample

The sample used for testing was received by US Tech on December 4, 2017 in good operating condition.

1.3 Product Description

The Equipment Under Test (EUT) is the Estimote Location Beacon, Model F3.6. The EUT is a standalone Bluetooth LE technology enabled device; it wirelessly communicates with other BTLE technology enabled products. The Estimote Location Beacon is battery powered by four (4) CR2477 3.0V battery ($LiMnO_2$). 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 Estimote Locatin Beacon Model F3.6 incorporates the following features:

Bluetooth LE Communication
Environmental Sensors: Accelerometer, Magnetometer, Temperature, Pressure, Ambient Light
Real Time Clock
GPIO Connector
Battery Powered
Passive NFC Tag Capability

The EUT is rated for a maximum output power of +10.0 dBm.

Radio: Bluetooth LE Standard
Modulation: GFSK (FHSS)
RF Output Power (EIRP): -40 dBm to +10 dBm
Data Rate: 2 Mbps (Max)
Channels: 40

1.4 Configuration of Tested System

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

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 US5301 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.

Table 1. EUT and Peripherals

PERIPHERAL MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	FCC/IC ID	CABLES P/D
Estimote Polska Sp. z. o. o.	F3.6	Engineering Sample	FCC ID: 2ABP2-EST0317 IC : 11753A-EST0317 (pending)	N/A

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

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	E4407B	AGILENT	US41442935	6/22/2018
SPECTRUM ANALYZER	N9342CN	AGILENT	SG05310114	7/21/2018
LOOP ANTENNA	SAS-200/562	AH SYSTEMS	142	12/28/2017 2 yr. extended
BICONICAL ANTENNA	3110B	EMCO	9306-1708	5/02/2019 2 yr.
LOG PERIODIC ANTENNA	3146	EMCO	9305-3236	9/21/2019 2 yr.
HORN ANTENNA	3115	EMCO	9107-3723	9/22/2018 2 yr.
PRE-AMPLIFIER	8449B	HEWLETT-PACKARD	3008A00480	12/01/2018
PRE-AMPLIFIER	8447D	HEWLETT-PACKARD	1937A02980	3/07/2018

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 10^{th} 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 dB_i	TYPE OF CONNECTOR
Antenna	Estimote Polska	2.4 Bluetooth LE Standard	Engineering Sample	0.0	PCB Meander, Monopole Trace Antenna

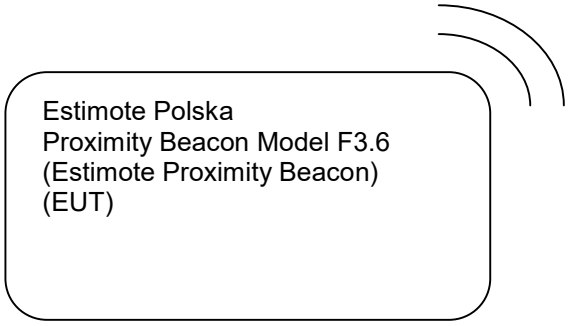


Figure 1. Block Diagram of Test Configuration

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 EUT employs pulsed transmission therefore a Duty Cycle correction factor was used. The pulse train was measured to determine the Duty Cycle correction factor.

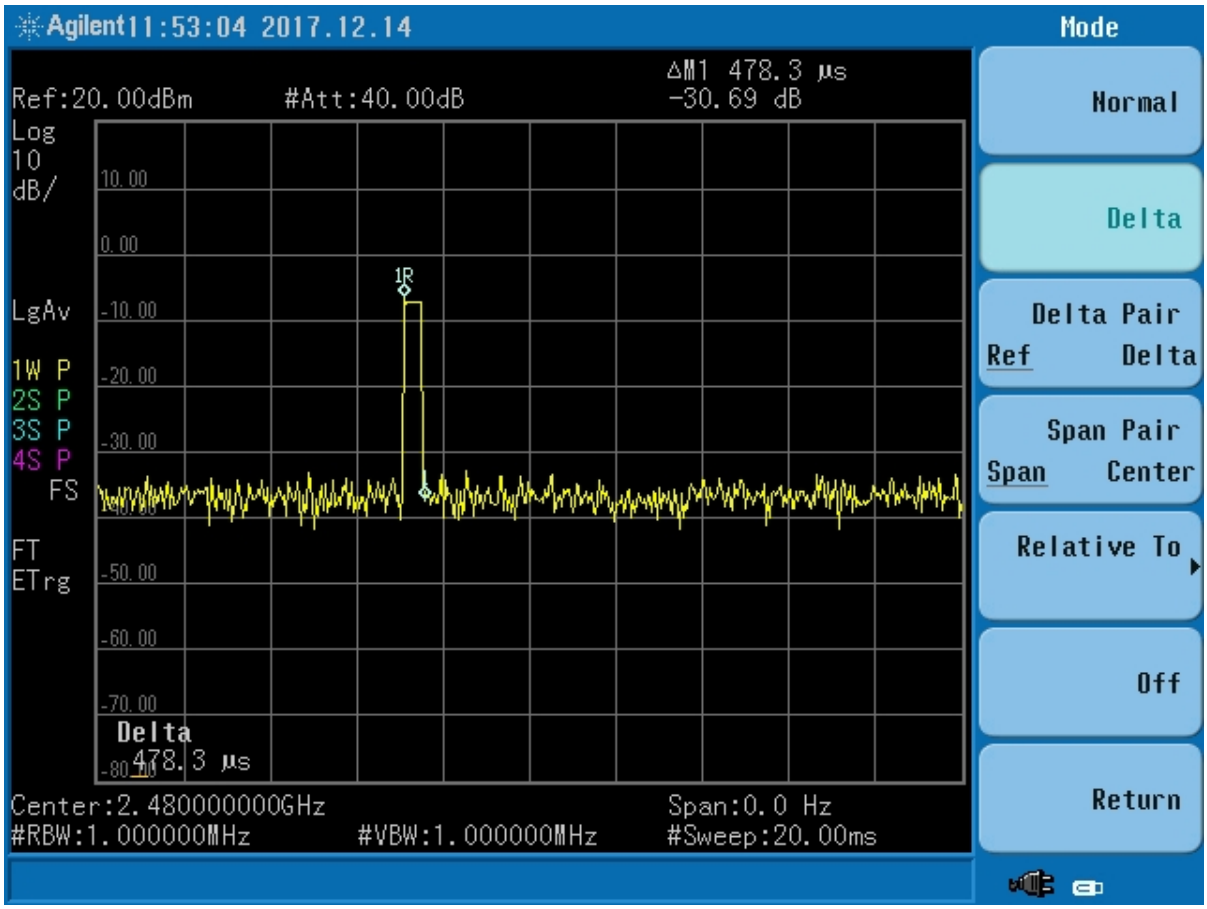


Figure 2. Single Pulse Width

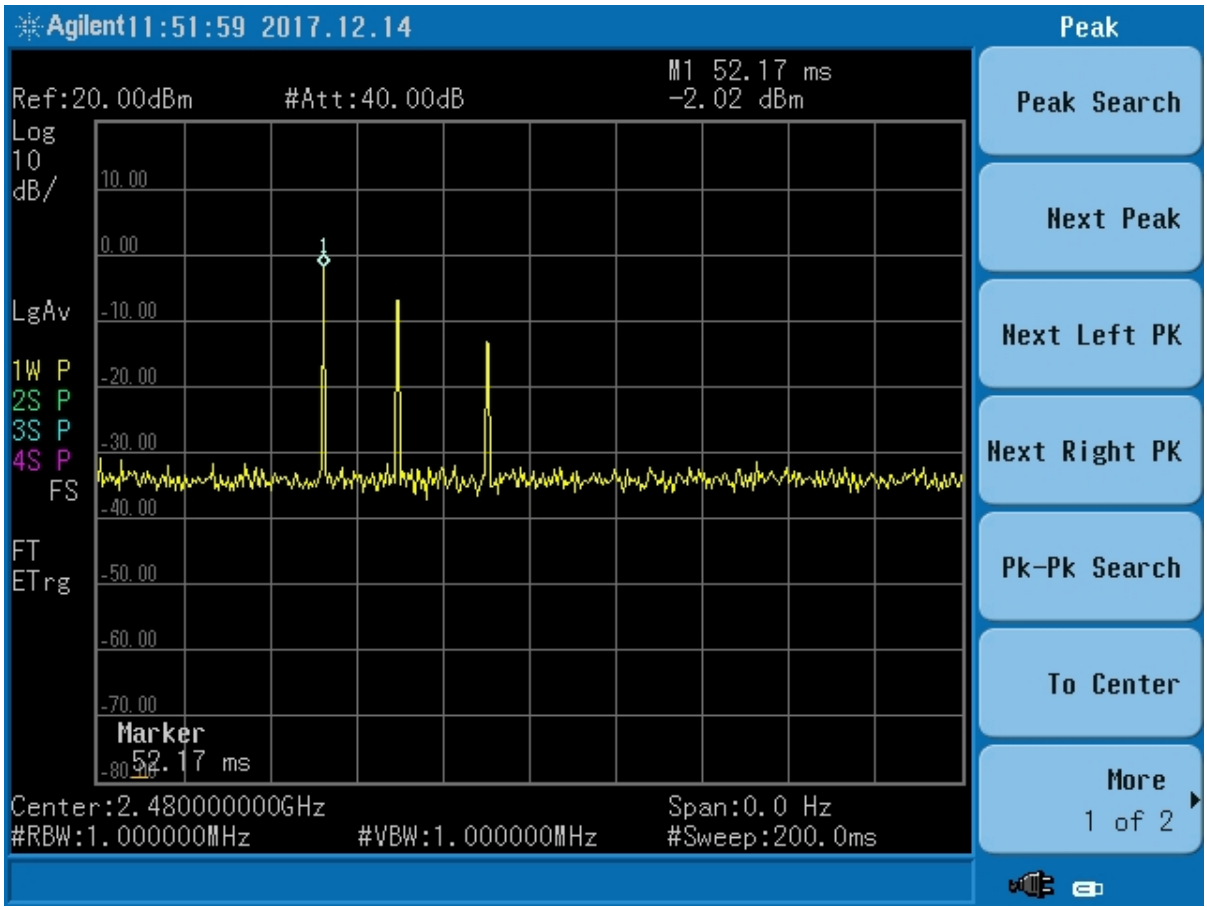


Figure 3. Pulse Train

Max ON time= 478.3 uSec x 3 = 1.435 mSec

Duty Cycle = 20 Log (1.435 mSec/100 mSec) = -36.86 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. The EUT is powered by four (4) CR2477 3.0V Lithium Primary Cell type batteries.

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 (>98% Duty Cycle) and tested per 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 performed 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 and to CFR 15.249 for intentional emissions.

Table 5. Spurious Radiated Emissions Below 30 MHz

9 kHz to 30 MHz, 15.209 limits							
Test: Radiated Emissions				**Client:** Estimote Polska Sp. z. o. o.			
Project: 17-0528				**Model:** F3.6			
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**
Loop X position							
0.07	30.06	60.90	90.96	101.5	m./meters.	10.6	**PK**
0.15	19.85	57.54	77.39	88.0	m./meters.	10.6	**PK**
0.68	17.36	42.32	59.68	81.9	m./meters.	22.2	**PK**
17.76	31.09	-4.18	26.91	49.5	m./meters.	22.6	**PK**
Loop Y position							
0.07	26.49	62.40	88.89	101.5	m./meters.	12.6	**PK**
0.15	21.02	57.54	78.56	87.9	m./meters.	9.3	**PK**
0.51	16.52	43.92	60.44	86.9	m./meters.	26.4	**PK**
17.76	30.84	-4.18	26.66	49.5	m./meters.	22.8	**PK**
Loop Z position							
0.07	26.46	62.40	88.86	101.8	m./meters.	12.9	**PK**
0.15	19.37	57.54	76.91	87.8	m./meters.	10.9	**PK**
0.62	16.91	42.32	59.23	83.4	m./meters.	24.2	**PK**
17.69	29.09	-4.18	24.91	49.5	m./meters.	24.6	**PK**

Sample Calculation at 0.070 MHz:

Magnitude of Measured Frequency	30.06	dBuV
+Antenna Factor + Cable Loss - Amplifier Gain	60.90	dB/m
Corrected Result	90.96	dBuV/m

Test Date: December 7, 2017
Tested By

Signature:  Name: Bruce Arnold

Table 6. Fundamental Emissions (Peak & AVG)

Test: FCC Part 15, Paragraph 15.209, 15.249(a)					**Client:** Estimote Polska Sp. z. o. o.			
Project: 17-0528					**Model:** F3.6			
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								
2402.30	72.56	--	31.91	104.47	114.0	3.0m./HORZ	9.5	**PK**
2402.30	71.44	-20.00	31.91	83.35	94.0	3.0m./HORZ	10.7	**AVG**
Mid - Channel								
2442.30	72.62	--	31.80	104.42	114.0	3.0m./HORZ	9.6	**PK**
2442.30	71.42	-20.00	31.80	83.22	94.0	3.0m./HORZ	10.8	**AVG**
High – Channel								
2480.30	69.69	++	31.95	101.64	114.0	3.0m./HORZ	12.4	**PK**
2480.30	68.23	-20.00	31.95	80.18	94.0	3.0m./HORZ	13.8	**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 2402.30 MHz:

Magnitude of Measured Frequency	72.56	dBuV
+Antenna Factor + Cable Loss - Amplifier Gain	31.91	dB/m
Corrected Result	104.47	dBuV/m

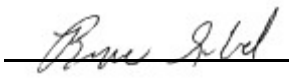
Test Date: December 7-8, 2017
Tested By
Signature:  Name: Bruce Arnold

Table 7. Harmonics Emissions (Peak & AVG)

Test: FCC Part 15, Paragraph 15.209, 15.249(a)					**Client:** Estimote Polska Sp. z. o. o.			
Project: 17-0528					**Model:** F3.6			
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								
4804.00	45.69		5.44	51.13	74.0	3.0m./HORZ	22.9	**PK**
4804.00	33.73	-20.00	5.44	19.17	54.0	3.0m./HORZ	34.8	**AVG**
Mid – Channel								
4883.60	44.71		4.65	49.36	74.0	3.0m./HORZ	24.6	**PK**
4884.40	32.28	-20.00	4.65	16.93	54.0	3.0m./HORZ	37.1	**AVG**
High – Channel								
4960.40	46.00		6.14	52.14	74.0	3.0m./HORZ	21.9	**PK**
4960.40	31.21	-20.00	6.14	17.35	54.0	3.0m./HORZ	36.7	**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 4804.00 MHz:

Magnitude of Measured Frequency	45.69	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain – Duty Cycle	5.44	dB/m
Duty Cycle Correction Factor	None	dB
Corrected Result	51.13	dBuV/m

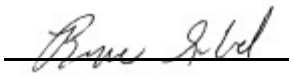
Test Date: December 7-8, 2017
Tested By
Signature:  Name: Bruce Arnold

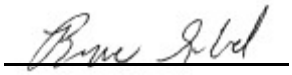
Table 8. Spurious Radiated Emissions other than Fundamental & Harmonics

>30 MHz 15.209, 15.249 limits							
Test: Radiated Emissions				**Client:** Estimote Polska Sp. z. o. o.			
Project: 17-0528				**Model:** F3.6			
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**
1171.00	51.18	-8.45	42.73	54.0	3.0m./HORZ	11.3	**PK**
2932.00	47.73	1.29	49.02	54.0	3.0m./HORZ	5.0	**PK**
1028.00	50.30	-9.80	40.50	54.0	3.0m./VERT	13.5	**PK**
3082.00	47.53	0.22	47.75	54.0	3.0m./VERT	6.3	**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 1171.00 MHz:

Magnitude of Measured Frequency	51.18	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain – Duty Cycle	-8.45	dB/m
Corrected Result	42.73	dBuV/m

Test Date: December 7-8, 2017
Tested By
Signature:  Name: Bruce Arnold

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

Band Edge measurements are made following the guidelines in ANSI C63.10-2013 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.

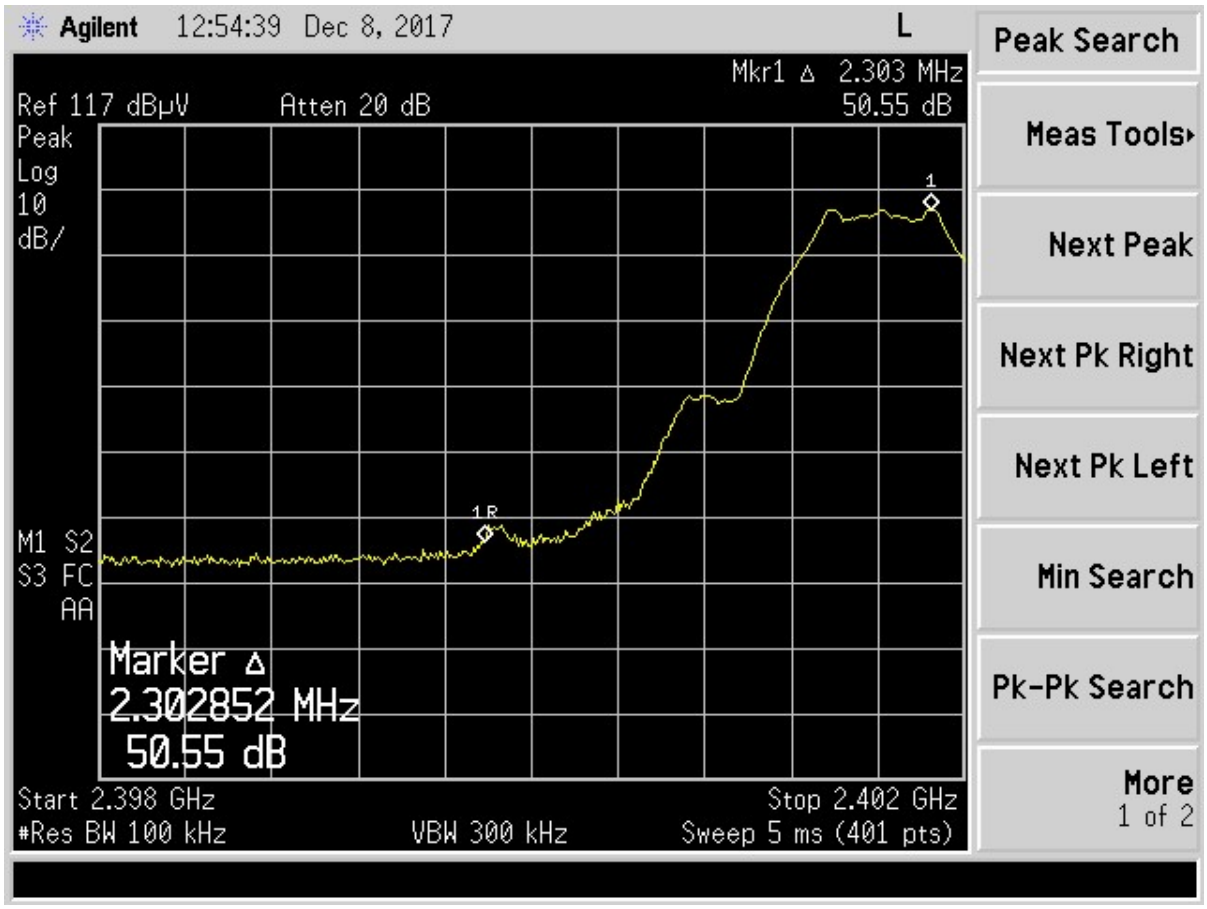


Figure 4. Band Edge Compliance, Low Channel Delta - Peak

Low Channel Corrected Measured Value from Table 6	101.47	dBuV
Low Channel Band Edge Delta from Figure 4	-50.55	dB
Calculated Result	50.92	dBuV/m
Band Edge Limit	54.00	dBuV/m
Calculated Result	50.92	dBuV/m
Band Edge Margin	3.08	dBuV/m

Note: Peak meets Average Limit

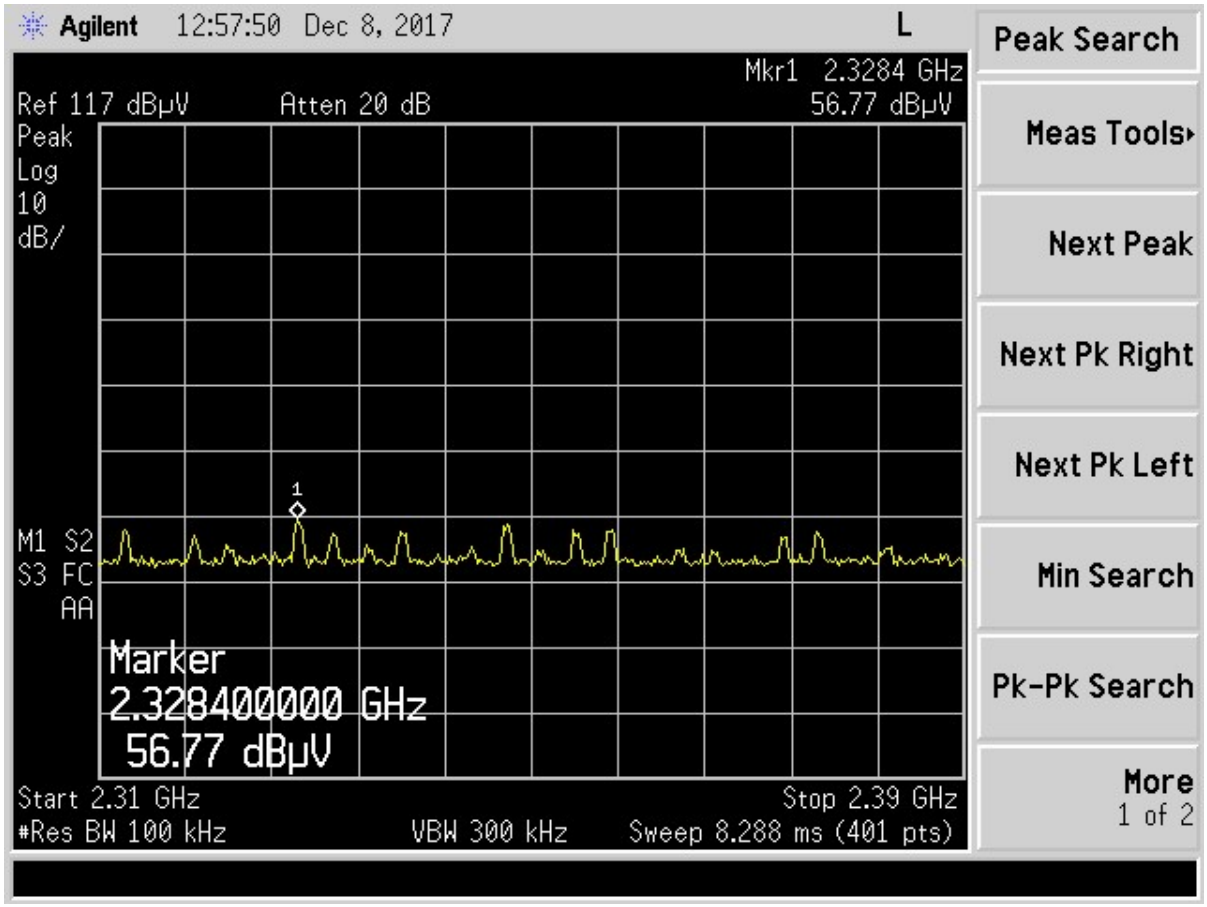


Figure 5. Radiated Restricted Band 2310 MHz to 2390 MHz, Peak

Table 9. 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: 17-0528				**Model:** F3.6			
Frequency (MHz)	**Test Data (dBuv)**	**Duty Cycle factor (db)**	**AF+CA+AMP**	**Corrected Results**	**Limit**	**Distance/Polarity**	**Margin**
2328.40	56.77		-3.21	53.56	74.0	3.0m./HORZ	20.4
2328.40	56.77	-20.00	-3.21	33.56	54.0	3.0m./HORZ	20.4

Worst case emissions presented.

Test Date: December 7-8, 2017
Tested By
Signature: _____ Name: Bruce Arnold

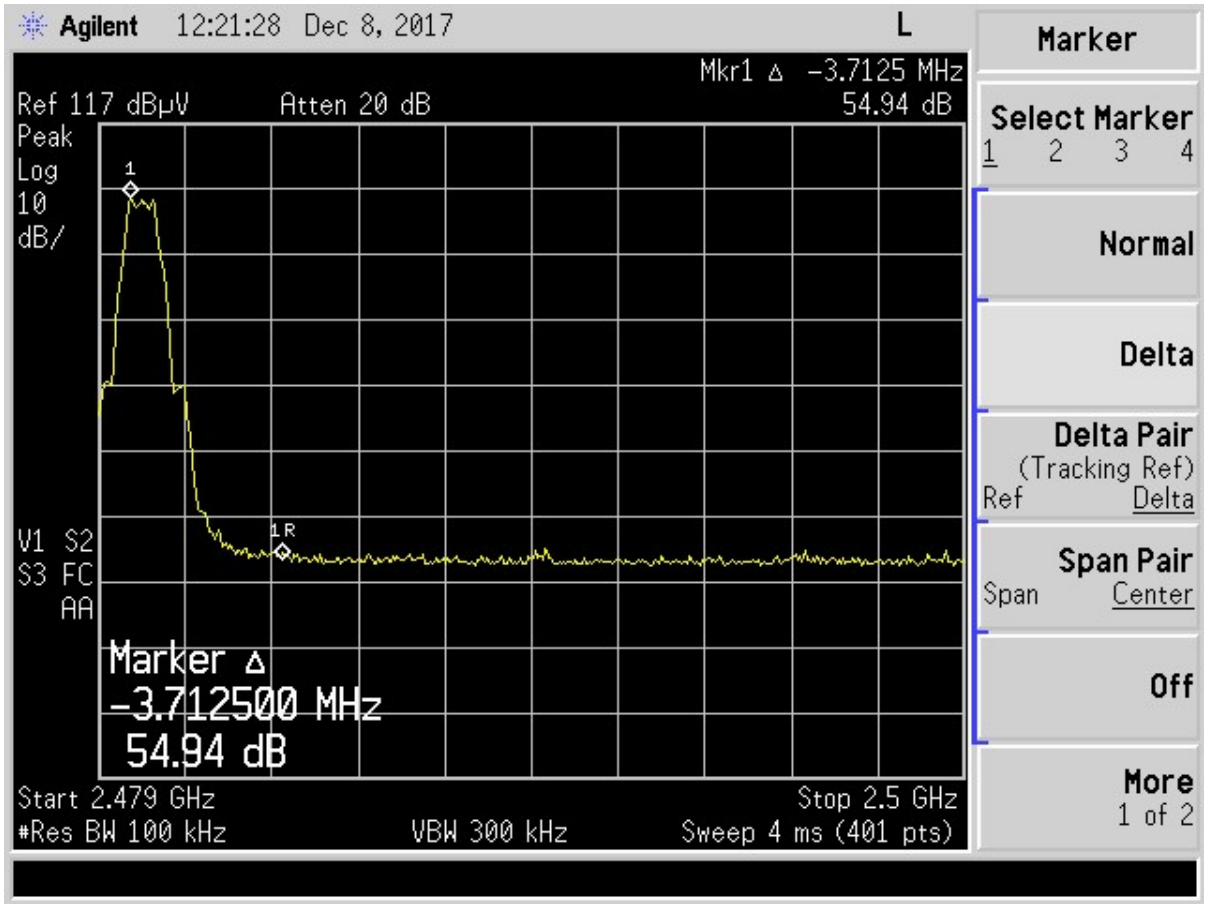


Figure 6. Band Edge Compliance, High Channel Delta – Peak

High Channel Corrected Measured Value from Table 6	101.64	dBuV
High Channel Band Edge Delta from Figure 6	-54.94	dB
Calculated Result	46.70	dBuV/m
Band Edge Limit	54.00	dBuV/m
Calculated Result	46.70	dBuV/m
Band Edge Margin	7.30	dBuV/m

Note: Peak meets Average Limit

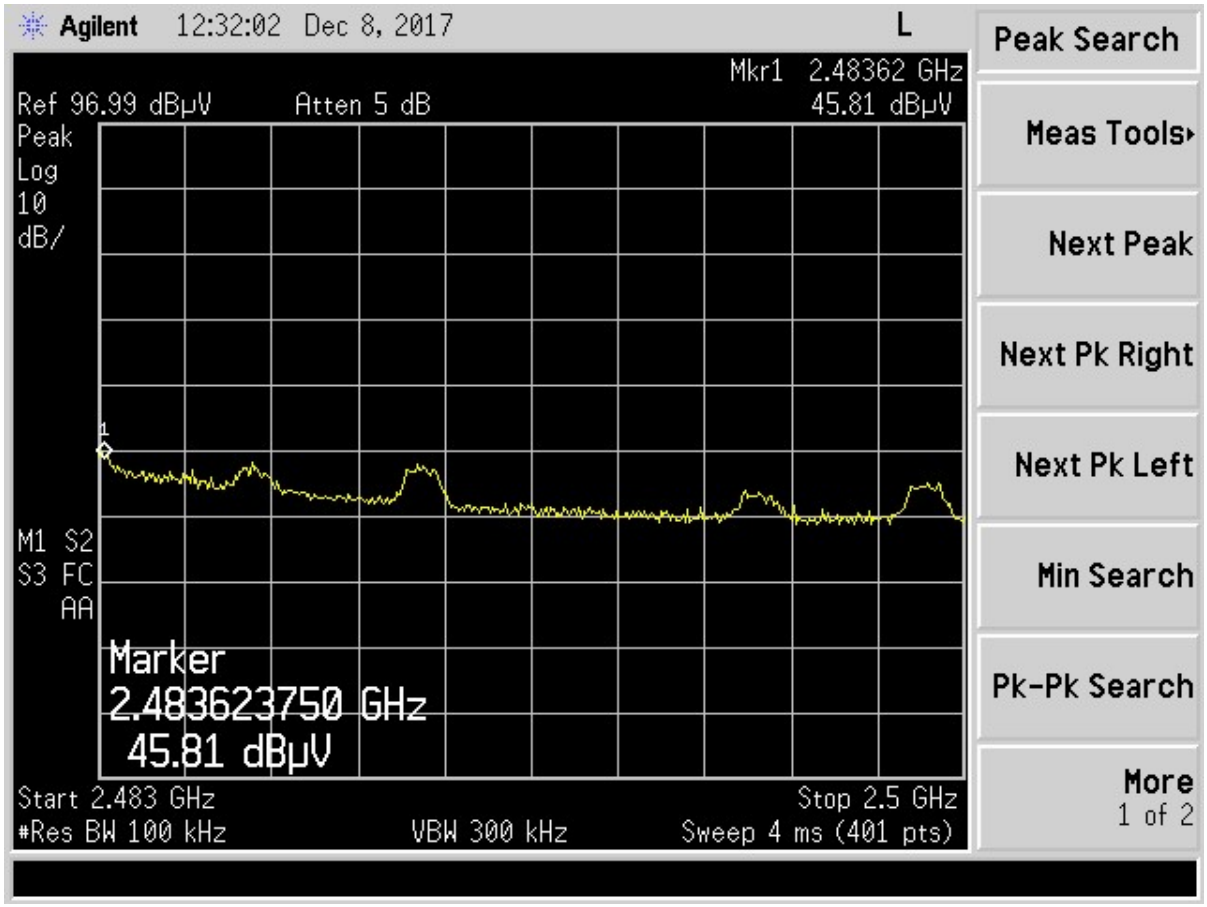


Figure 7. Radiated Restricted Band 2483.5 MHz to 2500 MHz, Peak

Table 10. Radiated Restricted Band 2483.5 MHz to 2500 MHz

2483.5 MHz to 2500 MHz Restricted Band Peak Measurements							
Test: Radiated Emissions				**Client:** Estimote Polska Sp.z.o.o.			
Project: 17-0528				**Model:** F3.6			
Frequency (MHz)	**Test Data (dBuv)**	**Duty Cycle factor (db)**	**AF+CA+AMP**	**Corrected Results**	**Limit**	**Distance/Polarity**	**Margin**
2483.60	45.81		-2.62	43.19	74.0	3.0m./HORZ	30.8
2483.60	45.81	-20.00	-2.62	23.19	54.0	3.0m./HORZ	30.8

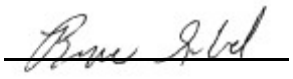
Test Date: December 7-8, 2017
Tested By
Signature: _____ Name: Bruce Arnold

2.12 99% Occupied Bandwidth (2.1049, RSS-210 (A.1.3))

These measurements were performed while the EUT was in a constant transmit mode. The automatic bandwidth measurement capability of the instrument was employed. The percent bandwidth was set to 99%.

Table 11. 99% Occupied Bandwidth

Frequency (MHz)	99% Occupied Bandwidth (MHz)
2402.00	1.092
2442.00	1.089
2480.00	1.091

Test Date: December 7-8, 2017
Tested By
Signature:  Name: Bruce Arnold

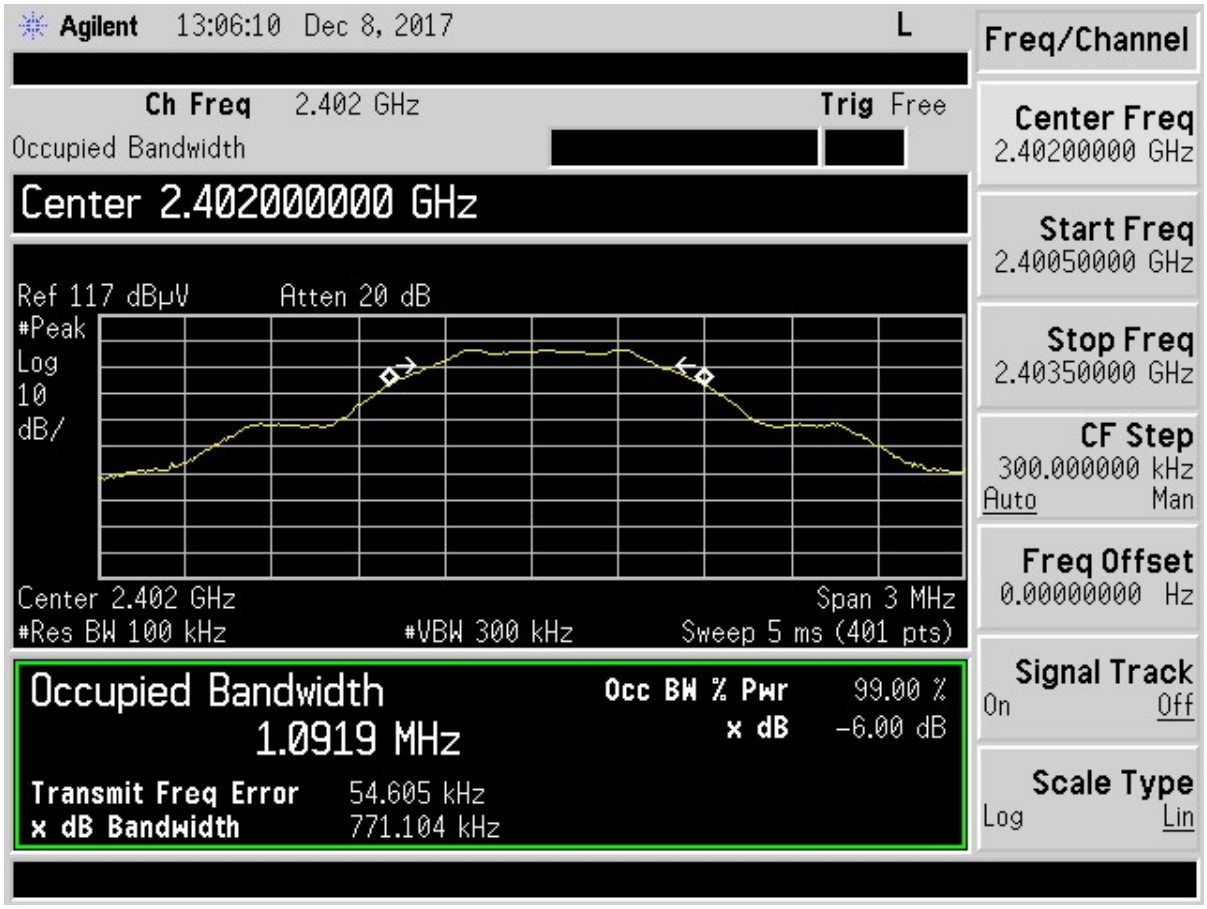


Figure 8. 99% Occupied Bandwidth – Low Channel

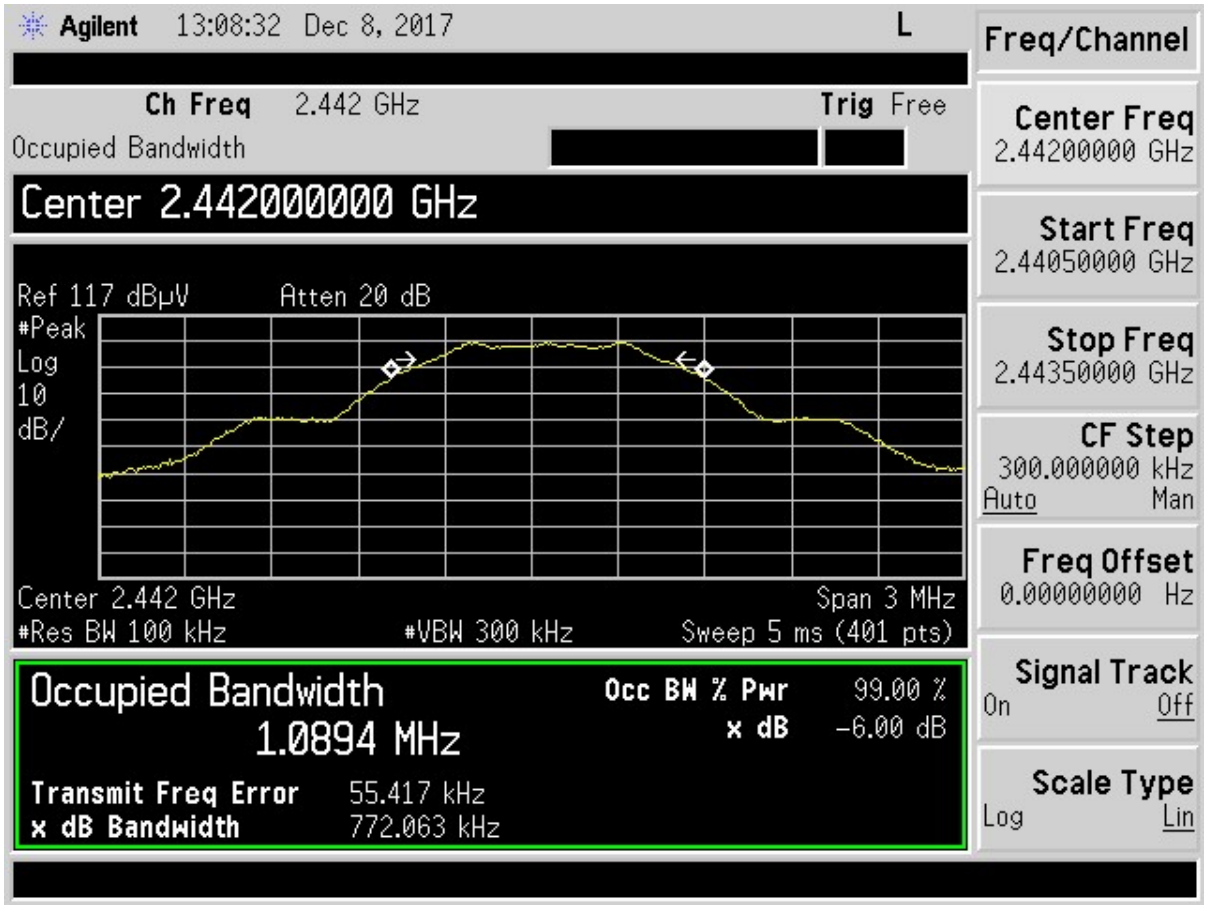


Figure 9. 99% Occupied Bandwidth – Mid Channel

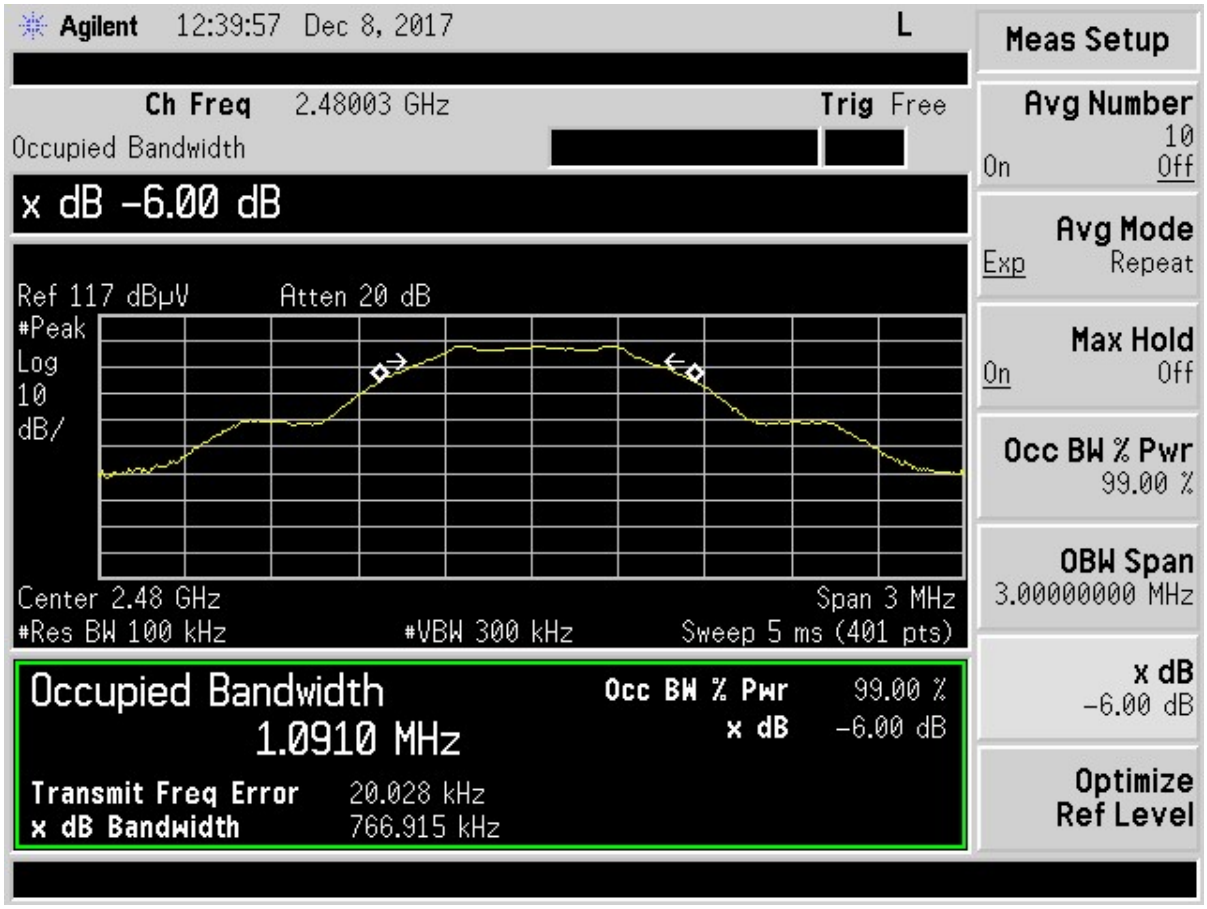


Figure 10. 99% Occupied Bandwidth – High Channel

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

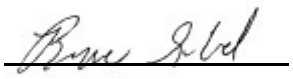
Since the EUT is battery powered, this test was not applied. The EUT is powered by one CR2477 3.0V Lithium Primary Cell type battery.

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

Table 12. 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: 17-0528				**Model:** F3.6		
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: December 7-8, 2017
Tested By
Signature:  Name: Bruce Arnold

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.

Table 13. Unintentional Radiator, Peak Radiated Emissions (CFR 15.109),

Test: FCC Part 15, Paragraph 15.109					**Client:** Estimote Polska Sp. z. o. o.			
Project: 17-0528					**Model:** F3.6			
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**
All spurious emission seen are more than 20 dB below the applicable limit.								

(*)= quasi peak detector used

Test Date: December 7-8, 2017
Tested By
Signature: _____ Name: Bruce Arnold

Table 14. Unintentional Radiator, Peak Radiated Emissions (CFR 15.109)

1 GHz to 12.5 GHz with Class B Limits								
Test: Radiated Emissions				**Client:** Estimote Polska Sp. z. o. o.				
Project: 17-0528				**Model:** F3.6				
Frequency (MHz)	**Test Data (dBuv)**	**Factor (dB)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**QP Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector PK, or QP**
All spurious emissions seen are more than 20 dB below the applicable limit.								

Test Date: December 7-8, 2017
Tested By
Signature: _____ Name: Bruce Arnold

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 ± 5.21dB.

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