



**MET Labs**

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November 11, 2019

EmNet, LLC.  
121 S Niles Ave, Suite 22  
South Bend, IN 46617

Dear Ruben Kertesz,

Enclosed is the EMC test report for compliance testing of the EmNet, LLC., BluX Radar Sensor, tested to the requirements of Title 47 of the Code of Federal Regulations (CFR), Part 15.517, Subpart F for Ultra-Wideband Operation.

Based on these results, Eurofins MET Labs, Inc. certifies that the BluX Radar Sensor, tested as configured, meets the requirements and interference limitations for Digital Devices under Title 47 of the CFR, Part 15.517, Subpart F for Ultra-Wideband Operation.

Thank you for using the services of Eurofins MET Labs, Inc. If you have any questions regarding these results or if MET can be of further service to you, please feel free to contact me.

Sincerely yours,  
EUROFINS MET LABS, INC.

A handwritten signature in black ink, appearing to read "Jesse Trawinski", written over a light blue horizontal line.

Jesse Trawinski  
Documentation Department

Reference: (\EmNet, LLC.\EMC104239-FCC517)

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## **Electromagnetic Compatibility Criteria Test Report**

For the

**EmNet, LLC.  
BluX Radar Sensor**

**FCC ID: 2ATOZBXR8**

**Verified under**  
the FCC Certification Rules contained in  
Title 47 of the CFR, Part 15.517, Subpart F  
for Ultra-Wideband Operation

**MET Report: EMC104239-FCC517**

November 11, 2019

**Prepared For:**

**EmNet, LLC.  
121 S Niles Ave, Suite 22  
South Bend, IN 46617**

**Prepared By:**  
**Eurofins MET Labs, Inc.**  
914 West Patapsco Ave.  
Baltimore MD 21230

**Electromagnetic Compatibility Criteria  
Test Report**

for the

**EmNet, LLC.  
BluX Radar Sensor**

**Title 47 of the CFR, Part 15.517, Subpart F  
for Ultra-Wideband Operation**



Deepak Giri, Project Engineer  
Electromagnetic Compatibility Lab



Jesse Trawinski  
Documentation Department

**Engineering Statement:** The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of Part 15, Section 15.517 of the FCC Rules under normal use and maintenance.



Deepak Giri,  
Manager, Electromagnetic Compatibility Lab

## Report Status Sheet

Revision	Report Date	Reason for Revision
Ø	November 11, 2019	Initial Issue.

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## List of Terms and Abbreviations

AC	Alternating Current
ACF	Antenna Correction Factor
Cal	Calibration
<i>d</i>	Measurement Distance
dB	Decibels
dB $\mu$ A	Decibels above one <b>microamp</b>
dB $\mu$ V	Decibels above one <b>microvolt</b>
dB $\mu$ A/m	Decibels above one <b>microamp per meter</b>
dB $\mu$ V/m	Decibels above one <b>microvolt per meter</b>
DC	Direct Current
E	Electric Field
BluX Radar Sensor	Equipment Under Test
<i>f</i>	Frequency
FCC	Federal Communications Commission
GRP	Ground Reference Plane
H	Magnetic Field
HCP	Horizontal Coupling Plane
Hz	Hertz
kHz	kilohertz
kV	kilovolt
LISN	Line Impedance Stabilization Network
MHz	Megahertz
$\mu$ H	<b>microhenry</b>
$\mu$ F	<b>microfarad</b>
$\mu$ s	<b>microseconds</b>
PRF	Pulse Repetition Frequency
RF	Radio Frequency
RMS	Root-Mean-Square
TWT	Traveling Wave Tube
V/m	Volts <b>per meter</b>
VCP	Vertical Coupling Plane

# I. Executive Summary

**A. Purpose of Test**

An EMC evaluation to determine compliance of the EmNet, LLC. BluX Radar Sensor, with the requirements of Part 15, Subpart F, §15.517 was performed. All references are to the most current version of Title 47 of the Code of Federal Regulations in effect. In accordance with §2.1033, the following data is presented in support of the Certification of the BluX Radar Sensor. EmNet, LLC. EmNet, LLC. should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the BluX Radar Sensor, has been **permanently** discontinued.

**B. Executive Summary**

The following tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 15, Subpart F, §15.517 . All tests were conducted using measurement procedure ANSI C63.10-2013.

Reference	Compliance
15.521(b), 15.203 Antenna Requirements	Compliant EUT is installed underground in the sewer tunnel where general population access is prohibited and is also only serviced with professional installers only.
15.521(j), 15.207 Conducted Emissions	N/A EUT is battery powered
15.517(a) Indoor Operation Requirement	EUT is LPR unit, but an exceptional authorization has been obtained from FCC under special condition. EUT complies with other requirements listed in 15.517(a).
15.221(c) 15.209 Radiated Emissions for digital circuitry	Compliant
15.517(b) UWB Bandwidth	Compliant
15.517(c) Emission Below 960 MHz	Compliant
15.517(c) Radiated Emission Above 960 MHz	Compliant
15.517(d) GPS emissions Requirements	Compliant Emission close to the limit lines were re-investigated to determine the measurement accuracy and were found compliant. EIRP was determined as per ANSI C63.10 2013 Section 10.3.9 from field strength measurement.
15.517(e) Peak Level Emission	Compliant EIRP was determined as per ANSI C63.10 2013 Section 10.3.9 from field strength measurement.
15.525 UWB FCC Coordination requirement	Applicant has been advised of these requirements

**Table 1. Executive Summary of EMC Part 15.517 Compliance Testing**

NOTE: Spread spectrum systems are sharing these bands on a noninterference basis with systems supporting critical Government requirements that have been allocated the usage of these bands, secondary only to ISM equipment operated under the provisions of part 18 of this chapter. Many of these Government systems are airborne radiolocation systems that emit a high EIRP which can cause interference to other users. Also, investigations of the effect of spread spectrum interference to U. S. Government operations in the 3100 – 10,600 MHz band may require a future decrease in the power limits allowed for spread spectrum operation.

\* The BluX Radar Sensor has charge contacts. However, a charger does not exist, at present. When one becomes available the customer intends to come back for conducted emissions.

## II. Equipment Configuration

## A. Overview

Eurofins MET Labs, Inc. was contracted by EmNet, LLC. to perform testing on the BluX Radar Sensor, under EmNet, LLC. purchase order number 918.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the EmNet, LLC., BluX Radar Sensor.

The results obtained relate only to the item(s) tested.

<b>Type of Submission/Rule:</b>	Part 15.517 Original Filing
<b>Model(s) Tested:</b>	BluX Radar Sensor
<b>Model(s) Number:</b>	BluX Radar Sensor
<b>BluX Radar Sensor Specifications:</b>	Primary Power: 14.4 V DC
	-10 dB Bandwidth: 1290 MHz
	FCC ID: 2ATOZBXR B
	Equipment Code: UWB
<b>Lab Ambient (Normal) Test Conditions:</b>	Temperature: 15-35° C
	Relative Humidity: 30-60%
	Atmospheric Pressure: 860-1060 mbar
<b>Evaluated by:</b>	Deepak Giri
<b>Date(s):</b>	November 11, 2019

**Table 2. BluX Radar Sensor Overview**

## B. References

<b>CFR 47, Part 2</b>	Federal Communication Commission, Code of Federal Regulations, Title 47, Part 15: Frequency Allocations and Radio Treaty Matters; General Rules and Regulations
<b>CFR 47, Part 15</b>	Federal Communication Commission, Code of Federal Regulations, Title 47, Part 15: Radio Frequency Devices
<b>ANSI C63.4-2014</b>	Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical And Electronic Equipment in the Range of 9 kHz to 40 GHz
<b>ANSI C63.10-2013</b>	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
<b>ISO/IEC 17025: 2017</b>	General Requirements for the Competence of Testing and Calibration Laboratories

### C. Test Site

All testing was performed at Eurofins MET Labs, Inc., 914 West Patapsco Avenue, Baltimore, MD 21230. All equipment used in making physical determinations is accurate and bears recent traceability to the National Institute of Standards and Technology.

Radiated Emissions measurements were performed in a semi-anechoic chamber. In accordance with §2.948(a)(3), a complete site description is contained at Eurofins MET Labs. In accordance with §2.948(d), Eurofins MET Labs has been accredited by the National Voluntary Laboratory Accreditation Program (Lab Code: 100273-0).

### D. Description of Test Sample

The BLU-X radar is a level sensing device designed to monitor water levels in sewers. It uses ultra-wideband pulsed radar technology to track water level. This information is measured and stored on the Chasqui telecommunications board every 5 minutes. In between measurements, the radar is completely powered down.

The logged data are transmitted from the Chasqui to web servers at 3-hour intervals by default but they can be configured to transmit every reading (/5 minutes). Transmission is performed using an LTE-Cat1 modem. In between data upload intervals, the modem is completely powered down.

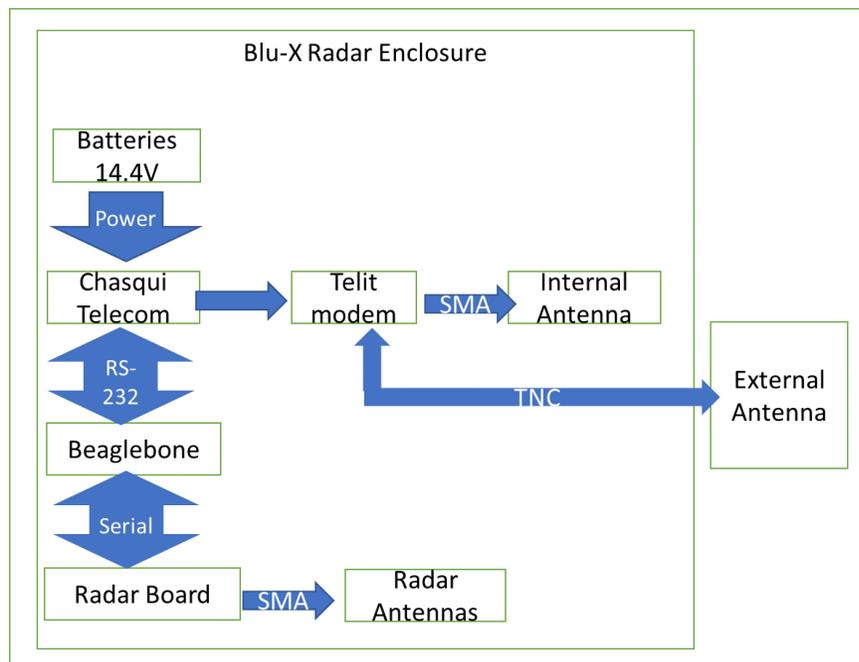


Figure 1. Block Diagram of BluX Radar Sensor

### E. Equipment Configuration

All equipment incorporated as part of the BluX Radar Sensor is included in the following list.

Name / Description	Model Number
BluX Radar Sensor	X4SIP02

**Table 3. Equipment Configuration**

### F. Support Equipment

This device does not need support equipment.

### G. Mode of Operation

The systems provided are the end devices. It simulates normal operation because it is the device that gets deployed in the field. The unit can be configured to test for the following:

- Non-present or non-communicating radar (disconnect radar from Chasqui)
- Poor or missing cellular connection (disconnect cellular antenna)
- External cellular antenna – connect the external bulkhead connector to Chasqui
- Internal cellular antenna – leave the internal antenna connected to the Chasqui

### H. Method of Monitoring BluX Radar Sensor Operation

LED sequence for Radar:

Case 1: LEDs are enabled in JSON file - Red LED initially ON at power-up, then they all turn off. Once radar task starts, Red LED blinks at 1 Hz, the Blue LED blinks rapidly (not governed, just every time there is a radar measurement), the Green LED blinks when SD card is written to, then when the radar task is finished the Orange LED blinks (others are off).

Case 2: Error condition / something goes wrong - Orange/Green/Blue LED are just on solid

LED sequence for Telecommunications device (Chasqui):

Process 1: First time it is powered on (person connects the molex cable to the chasqui) – The device gets the date from the cellular network, turns off the modem, goes to sleep, waits 5 minutes to wakeup and enter normal operation:

Case 1: Device successfully connects to network and gets the date

- Wait 10 second (no LEDs are on)
- Amber status light is on (solid) to indicate trying to communicate with network, LED next to modem is on (indicating that modem is on).
- Amber status light is off, green status light is on for 3 seconds.
- All lights turn off (system goes to sleep for 5 minutes before entering normal operating mode).

Case 2: Device does not successfully connect to the network

- Wait 10 second (no LEDs are on)
- Amber status light is on (solid) to indicate trying to communicate with network, LED next to modem is on (indicating that modem is on).
- Amber status light remains on up to 60 seconds.
- All lights turn off (system goes to sleep for 5 minutes before retrying network date/time acquisition).

Case 3: Failure of Telit modem

- Wait 10 second (no LEDs are on)
- Amber status light is on (solid) to indicate trying to communicate with network, LED next to modem is off (indicating that modem is not active).
- Amber status light turns off and red status light turns on for at least 3 seconds.
- All lights turn off (system goes to sleep for 5 minutes before retrying network date/time acquisition).

Process 2: When in normal operating mode, the device wakes up every 5 minutes to take measurements from radar, save the data to the chasqui, and then sends the data up to the Emnet, LLC server:

Case 1: Device successfully reads from the radar, logs the data to the telecommunications device (Chasqui), sends the data to the server, and receives a hash back from the server.

- Green and amber status lights flash while polling the radar
- Amber status light stops flashing and green status light turns solid to indicate writing data to memory
- Green status turns off and amber light turns solid to indicate trying to communicate with network, LED next to modem is on (indicating that modem is on).
- Amber status light is off, green status light is on for 3 seconds to indicate successful transmission
- All lights turn off (system goes to sleep for 5 minutes before the next reading).

Case 2: Device cannot read from radar.

- Green and amber status lights flash while polling the radar
- Red light flashes to indicate failure to receive data from radar.

## I. Modifications

### a) Modifications to BluX Radar Sensor

No modifications were made to the BluX Radar Sensor.

### b) Modifications to Test Standard

No modifications were made to the Test Standard.

## J. Disposition of BluX Radar Sensor

The test sample including all support equipment (if any), submitted to the Electro-Magnetic Compatibility Lab for testing was returned to EmNet, LLC. upon completion of testing.

### **III. Electromagnetic Compatibility Criteria for Intentional Radiators**

## Electromagnetic Compatibility Criteria for Intentional Radiators

### § 15.203, 15.521(b) Antenna Requirement

**Test Requirement:** § 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. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

The structure and application of the BluX Radar Sensor were analyzed to determine compliance with Section 15.203 of the Rules. Section 15.203 states that the subject device must meet at least one of the following criteria:

- a.) Antenna must be permanently attached to the unit.
- b.) Antenna must use a unique type of connector to attach to the BluX Radar Sensor.
- c.) Unit must be professionally installed. Installer shall be responsible for verifying that the correct antenna is employed with the unit.

**Results:** The BluX Radar Sensor was compliant with the requirements of this section.

EUT is installed underground in the sewer tunnel where general population access is prohibited and is also only serviced with professional installers only. All the antenna connectors are internal to the EUT.

Type of Antenna: The antennas are PCB-based linear-tapered slot antennas (LTSA)

Gain of Antenna: 6 dBi

**Test Engineer(s):** Deepak Giri

**Test Date(s):** 08/13/2019

## Electromagnetic Compatibility Criteria for Intentional Radiators

### § 15.521(c), 15.209(a) Radiated Emission Limits

**Test Requirement(s):** § 15.521 (c): Emissions from digital circuitry used to enable the operation of the UWB transmitter shall comply with the limits in §15.209, rather than the limits specified in this subpart, provided it can be clearly demonstrated that those emissions from the UWB device are due solely to emissions from digital circuitry contained within the transmitter and that the emissions are not intended to be radiated from the transmitter's antenna. Emissions from associated digital devices, as defined in §15.3(k), e.g., emissions from digital circuitry used to control additional functions or capabilities other than the UWB transmission, are subject to the limits contained in Subpart B of this part.

§ 15.209 (a): Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in Table 4.

Frequency (MHz)	§ 15.209(a), Radiated Emission Limits (dBµV/m) @ 3m
30 - 88	40.00
88 - 216	43.50
216 - 960	46.00
Above 960	54

**Table 4. Radiated Emissions Limits Calculated from FCC Part 15, § 15.209 (a)**

**Test Procedure:** The transmitter was set to transmit at maximum output power and placed on a 0.8 m high acrylic table inside in a semi-anechoic chamber. The antenna was located 3 m from the BluX Radar Sensor. Measurements were performed with the BluX Radar Sensor rotated 360 degrees and varying the receiving antenna height from 1 to 4 meters to determine worst case orientation for maximum emissions.

For frequencies from 30 MHz to 1 GHz, measurements were made using a quasi-peak detector with a 120 kHz bandwidth. For frequencies above 1 GHz, peak measurements were made with a resolution bandwidth of 1 MHz and a video bandwidth of 3 MHz and average measurements were made with RMS detector.

In accordance with §15.35(b) the limit on the radio frequency emissions as measured using instrumentation with a peak detector function shall be 20 dB above the maximum permitted average limit for the frequency being investigated unless a different peak emission limit is otherwise specified in the rules.

Test was performed with the Transmitter ON along with other accessory boards representing the worst case event though 15.521(c) states the requirement for measurement of digital emission only.

$$\text{Field Strength (dBuV/m)} = \text{Raw Data (dBuV/m)} + \text{Cable} + \text{ACF} - \text{Pre-Amp}$$

**Test Results:** The emissions were investigated up to 40 GHz. The BluX Radar Sensor was found compliant with the Radiated Emission limits of **§15.209** for digital emission requirement stated in 15.521(c). See following pages for detailed test results. Emission plots shown are cumulative plots of both antenna polarization and EUT’s orientation along 3 different axis. Emissions close to the limit line were investigated with appropriate detectors and resolution bandwidth for that frequency range.

**Test Engineer(s):** Deepak Giri

**Test Date(s):** 08/12/19

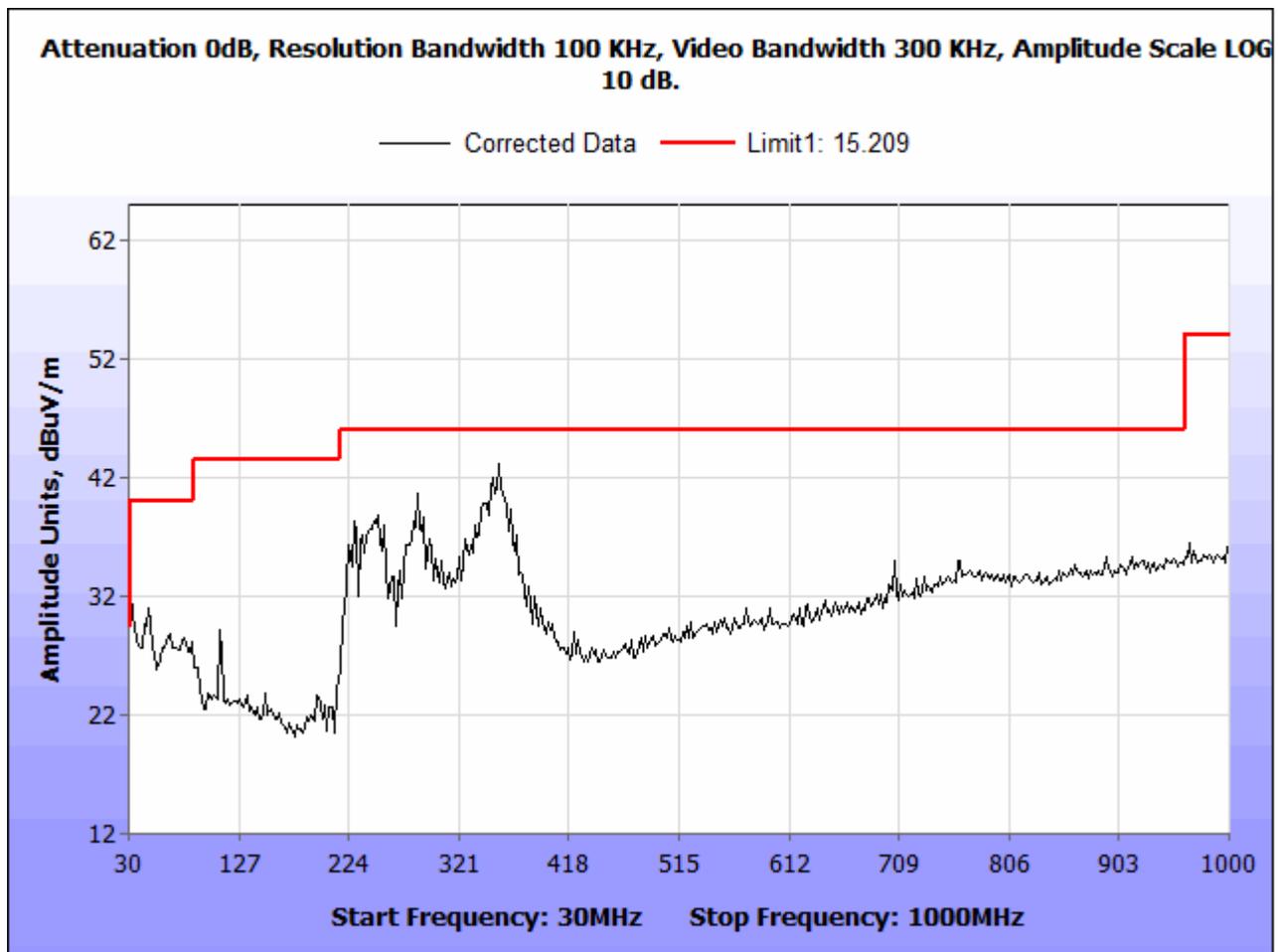


Figure 2. Radiated Emissions 30 MHz – 1 GHz

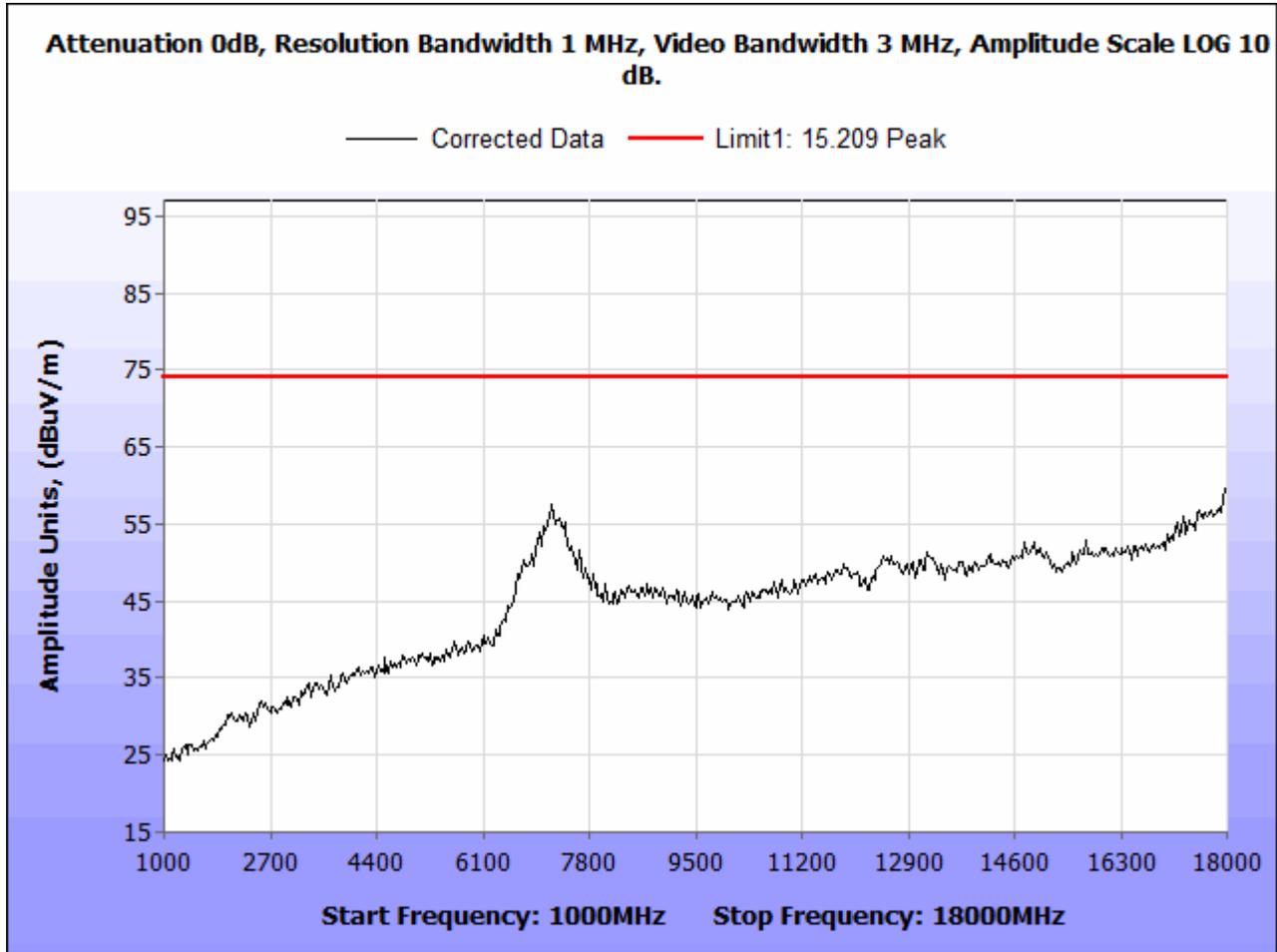


Figure 3. Radiated Emissions Peak, 1 GHz – 18 GHz

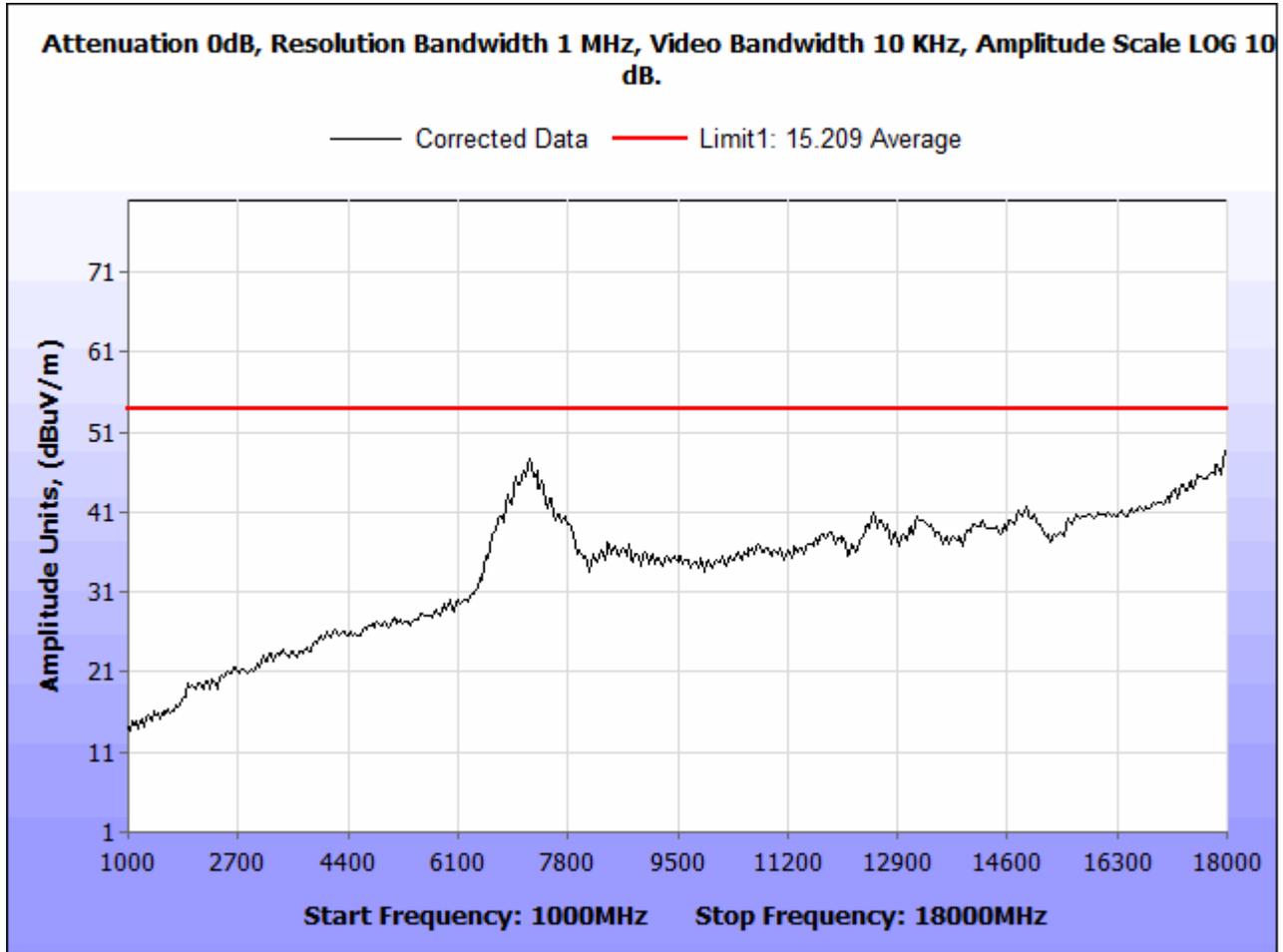


Figure 4. Radiated Emissions Average, 1 GHz – 18 GHz

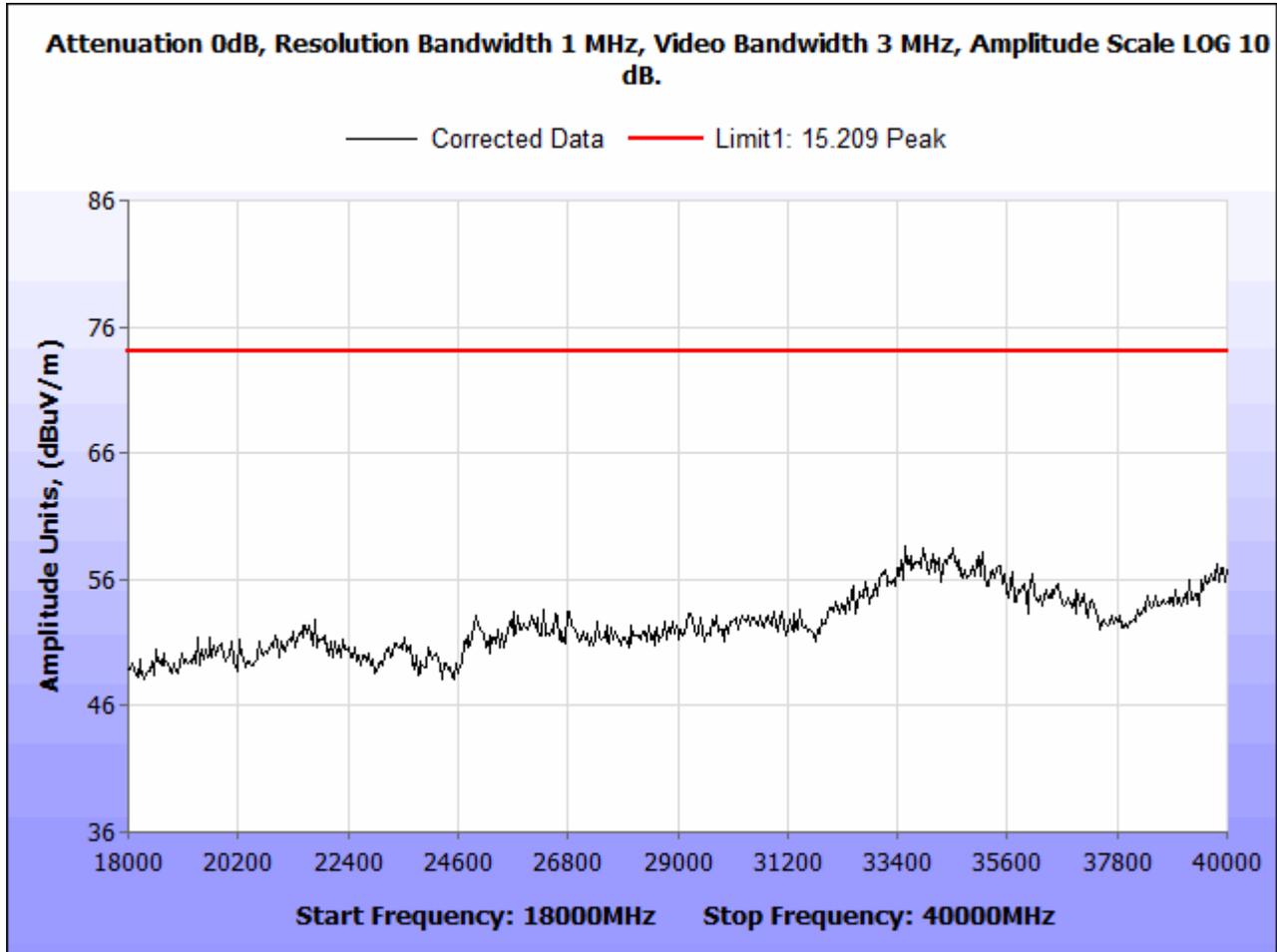


Figure 5. Radiated Emissions Peak, 18 GHz – 40 GHz

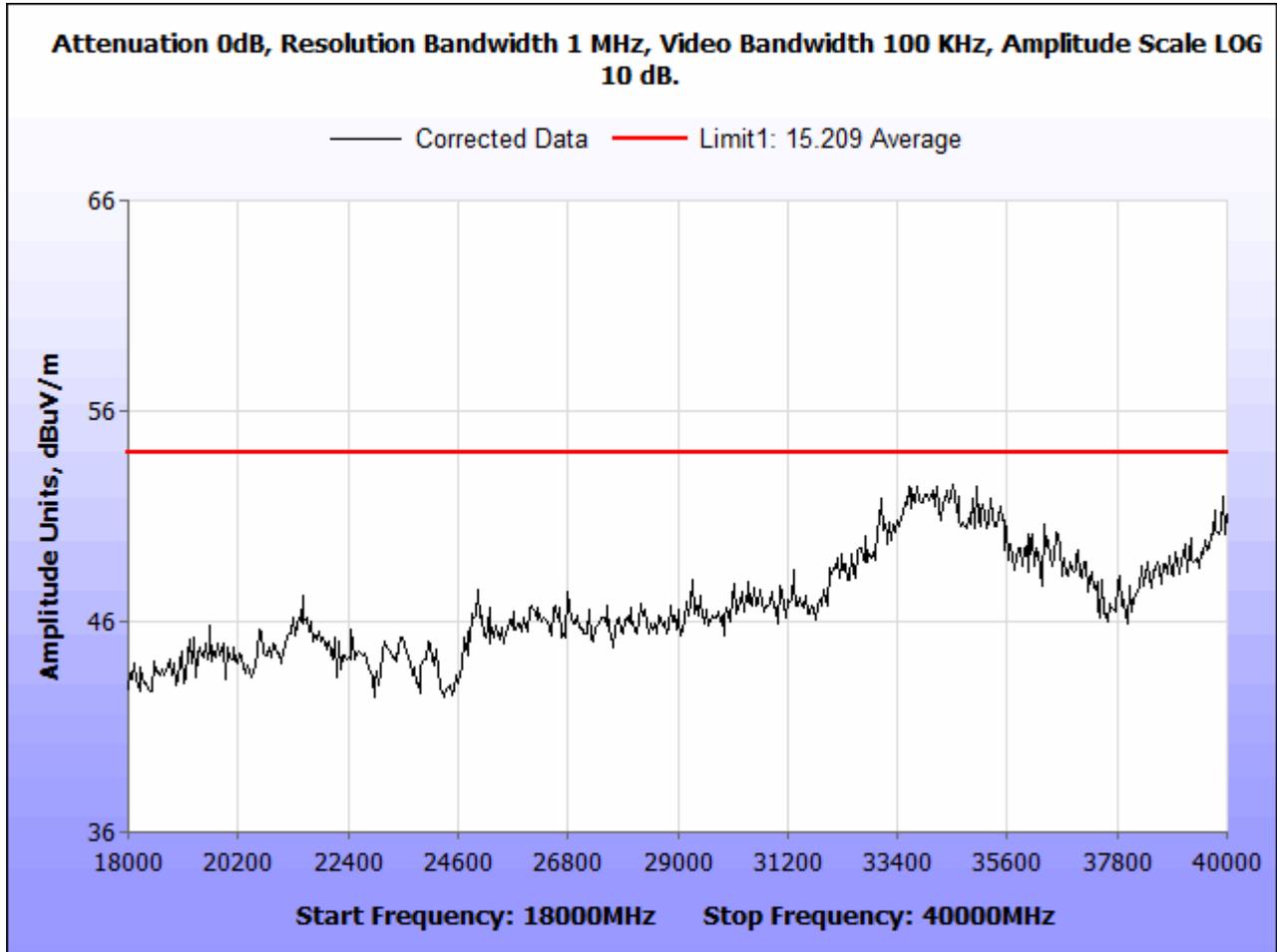


Figure 6. Radiated Emissions Average, 18 GHz – 40 GHz

## Electromagnetic Compatibility Criteria for Intentional Radiators

### § 15.517(a), 15.521(a) Ultra-Wide Operation

**Test Requirements:** § 15.517(a) Operation under the provisions of this section is limited to UWB transmitters employed solely for indoor operation.

(1) Indoor UWB devices, by the nature of their design, must be capable of operation only indoors. The necessity to operate with a fixed indoor infrastructure, e.g., a transmitter that must be connected to the AC power lines, may be considered sufficient to demonstrate this.

(2) The emissions from equipment operated under this section shall not be intentionally directed outside of the building in which the equipment is located, such as through a window or a doorway, to perform an outside function, such as the detection of persons about to enter a building.

(3) The use of outdoor mounted antennas, e.g., antennas mounted on the outside of a building or on a telephone pole, or any other outdoors infrastructure is prohibited.

(4) Field disturbance sensors installed inside of metal or underground storage tanks are considered to operate indoors provided the emissions are directed towards the ground.

(5) A communications system shall transmit only when the intentional radiator is sending information to an associated receiver.

§ 15.521(a), UWB devices may not be employed for the operation of toys. Operation onboard an aircraft, a ship or a satellite is prohibited.

**Test Results:** EUT is used in Sewer system with proper instructions documented in the User Manual and is marketed as Indoor Chamber use only. EUT complies with 15.517(a) and 15.521(a)

**Test Engineer:** Deepak Giri

## Electromagnetic Compatibility Criteria for Intentional Radiators

### § 15.517(b), 15.521(e) Ultra-Wide Operation Bandwidth

**Test Requirements:** § 15.517(b): The UWB bandwidth of a UWB system operating under the provisions of this section must be contained between 3100 MHz and 10,600 MHz.

§ 15.521(e): The frequency at which the highest radiated emission occurs, f<sub>M</sub>, must be contained within the UWB bandwidth.

**Test Procedure:** The transmitter was set to transmit at maximum output power and placed on a 1 m high wooden stand inside in a anechoic chamber. The measuring antenna was located 1 meter from the BluX Radar Sensor. Measurements were performed with the BluX Radar Sensor rotated 360 degrees and varying the receiving antenna height to determine worst case orientation for maximum emissions. Measurement was performed according the to procedure stated in Sectio 10.1 of ANSI C63.10 2013.

**Test Results:** The BluX Radar Sensor was found compliant with the Radiated Emission limits of **§15.517(b) and requirement of 15.521(e)**. Plots showns are cumulative emission plot of antenna polarities and EUT orientations. Offset factors cable, antenna and pre-amp were added in the test software.

⌘	Higher end F(h)	Lower end F(l)	-10dB Bandwidth
Frequency MHz	7855	6565	1290 MHz

**Test Engineer:** Deepak Giri

**Test Date(s):** 10/1/2019

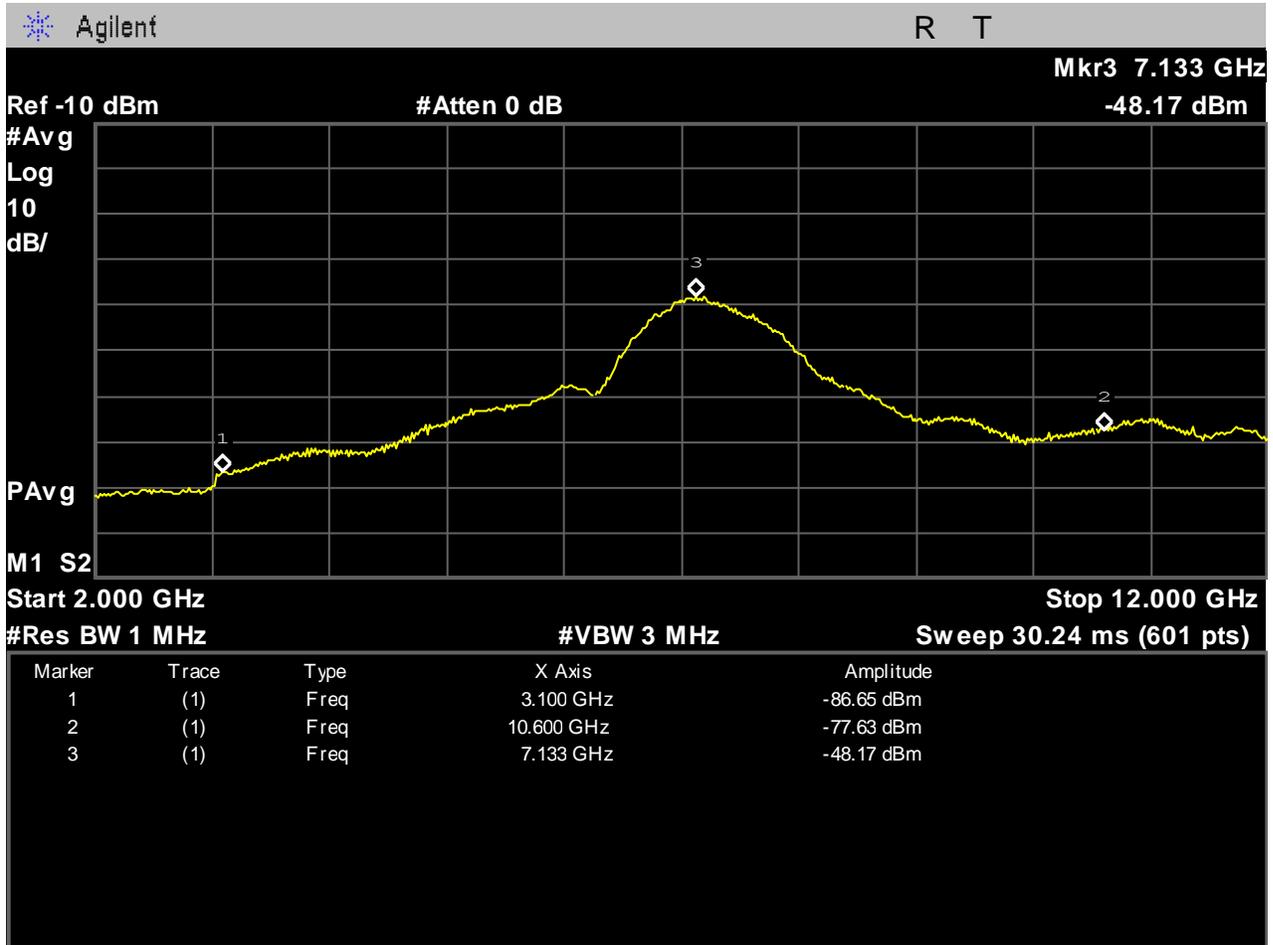


Figure 6. UWB Bandwidth, Test Results UWB Bandwidth contained between 3100 MHz – 10.6 GHz

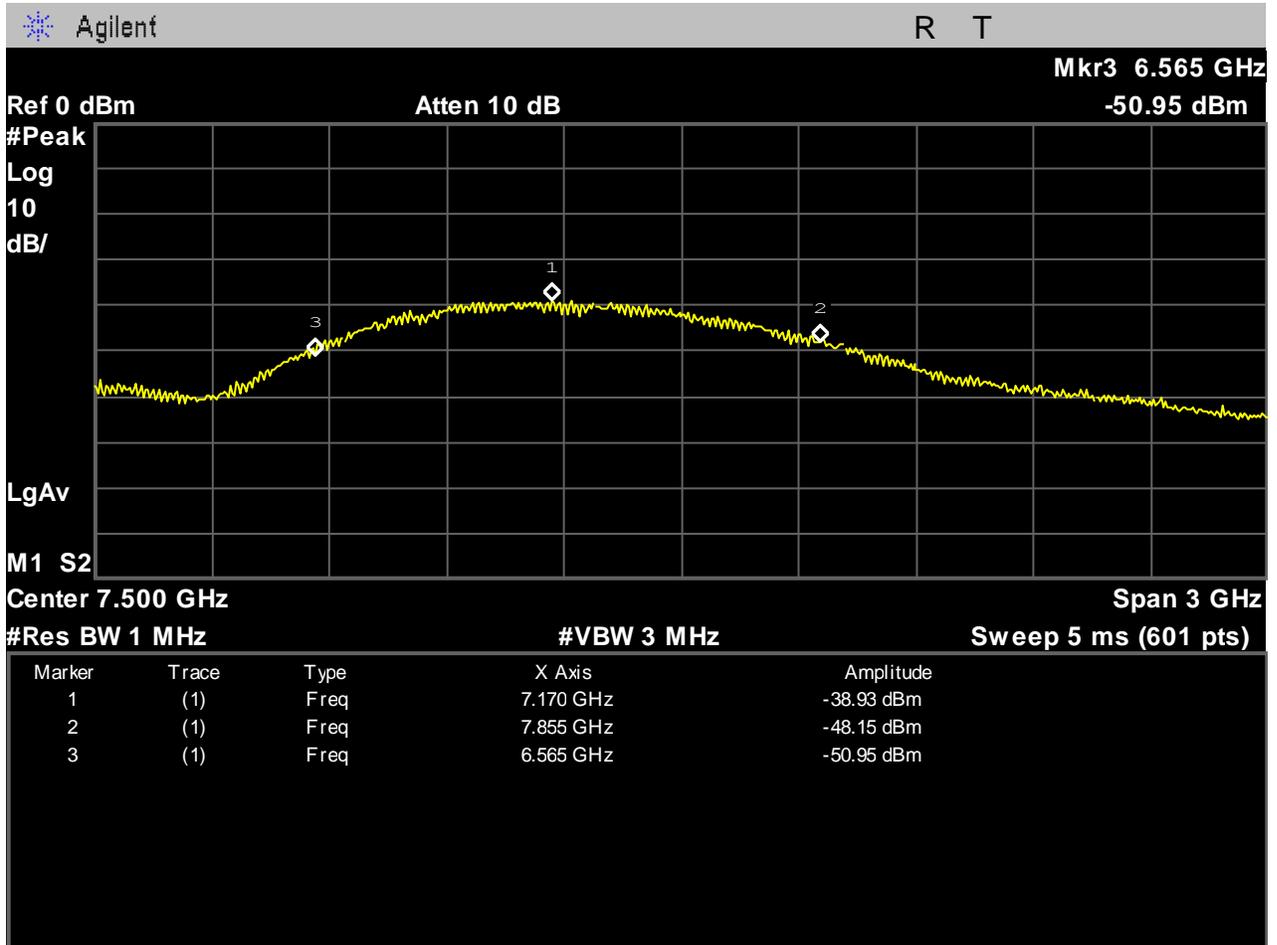


Figure 6. UWB Bandwidth, Test Results, 10dB Bandwidth

## Electromagnetic Compatibility Criteria for Intentional Radiators

### § 15.517(c),15.521(d,h) Radiated Emission Limits

**Test Requirements:** §15.517(c): The radiated emissions at or below 960 MHz from a device operating under the provisions of this section shall not exceed the emission levels in §15.209. The radiated emissions above 960 MHz from a device operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of 1 MHz:

Frequency in MHz	EIRP in dBm
960 – 1610	– 75.3
1610 – 1990	– 53.3
1990 – 3100	– 51.3
3100 – 10600	– 41.3
Above 10600	– 51.3

**Table 5. Radiated Emission Requirements from §15.517(c)**

§15.521(d): Within the tables in §§15.509, 15.511, 15.513, 15.515, 15.517, and 15.519, the tighter emission limit applies at the band edges. Radiated emission levels at and below 960 MHz are based on measurements employing a CISPR quasi-peak detector. Radiated emission levels above 960 MHz are based on RMS average measurements over a 1 MHz resolution bandwidth. The RMS average measurement is based on the use of a spectrum analyzer with a resolution bandwidth of 1 MHz, an RMS detector, and a 1 millisecond or less averaging time. Unless otherwise stated, if pulse gating is employed where the transmitter is quiescent for intervals that are long compared to the nominal pulse repetition interval, measurements shall be made with the pulse train gated on. Alternative measurement procedures may be considered by the Commission.

**Test Procedure:** The transmitter was set to transmit at maximum output power and placed on a 0.8 m high acrylic table inside in a semi-anechoic chamber. The antenna was located 3 m from the BluX Radar Sensor for below 960 MHz and at 1m for above 960MHz. Measurements were performed with the BluX Radar Sensor rotated 360 degrees and varying the receiving antenna height to determine worst case orientation for maximum emissions. Measurement was performed in accordance with Section 10.3.7 of ANSI C63.10 2013.

For frequencies from 30 MHz to 960 MHz, measurements were made using a quasi-peak detector with a 120 kHz bandwidth. For frequencies above 960MHz, measurements were made with a resolution bandwidth of 1 MHz to comply with the Average limit stated in 15.517(c).

$$\begin{aligned} \text{Field Strength (dBuV/m)} &= \text{Raw Data (dBuV/m)} + \text{Cable} + \text{ACF} - \text{Pre-Amp} \\ \text{EIRP(dBm)} &= \text{Field Strength(dBuV/m)} + 20\log(\text{measurement distance(m)}) - 104.77 \end{aligned}$$

**Test Results:** The emissions were investigated up to 40 GHz. The BluX Radar Sensor was found compliant with the Radiated Emission limits of §15.517(c). See following pages for detailed test results.

Emission plots shown are cumulative plots of both antenna polarization and EUT's orientation along 3 different axes. Offset Factors and unit conversion factors were loaded in the test software. Emissions close to the limit line were investigated using shorter measurement span, appropriate detectors, and resolution bandwidth for that frequency range.

**Test Engineer:** Deepak Giri

**Test Date(s):** 10/01/19

### Electromagnetic Compatibility Criteria for Intentional Radiators

#### § 15.517(c) Radiated Emission Limits

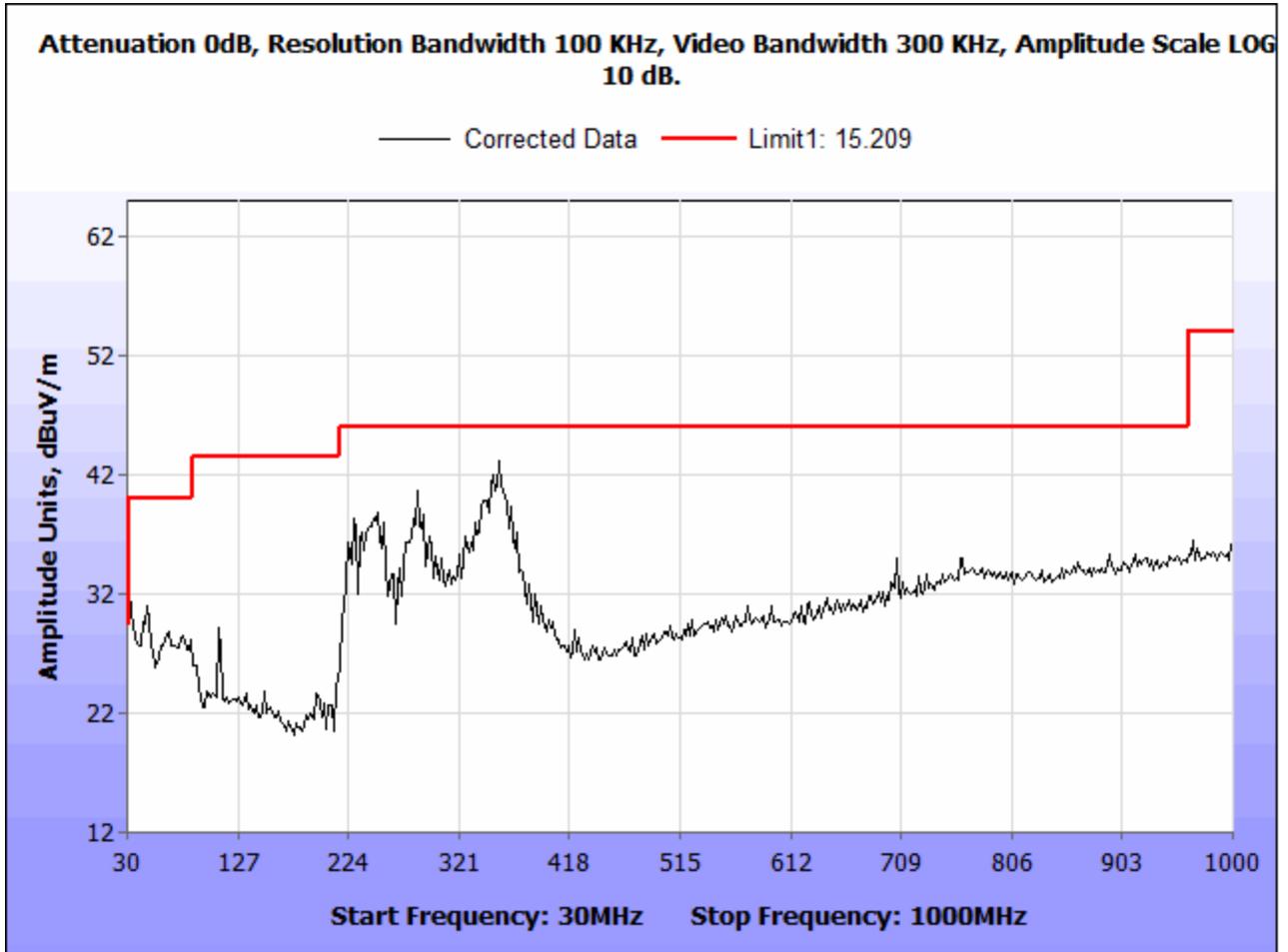


Figure 7. Radiated Emission Limits Test Results, 30 MHz – 1000 MHz

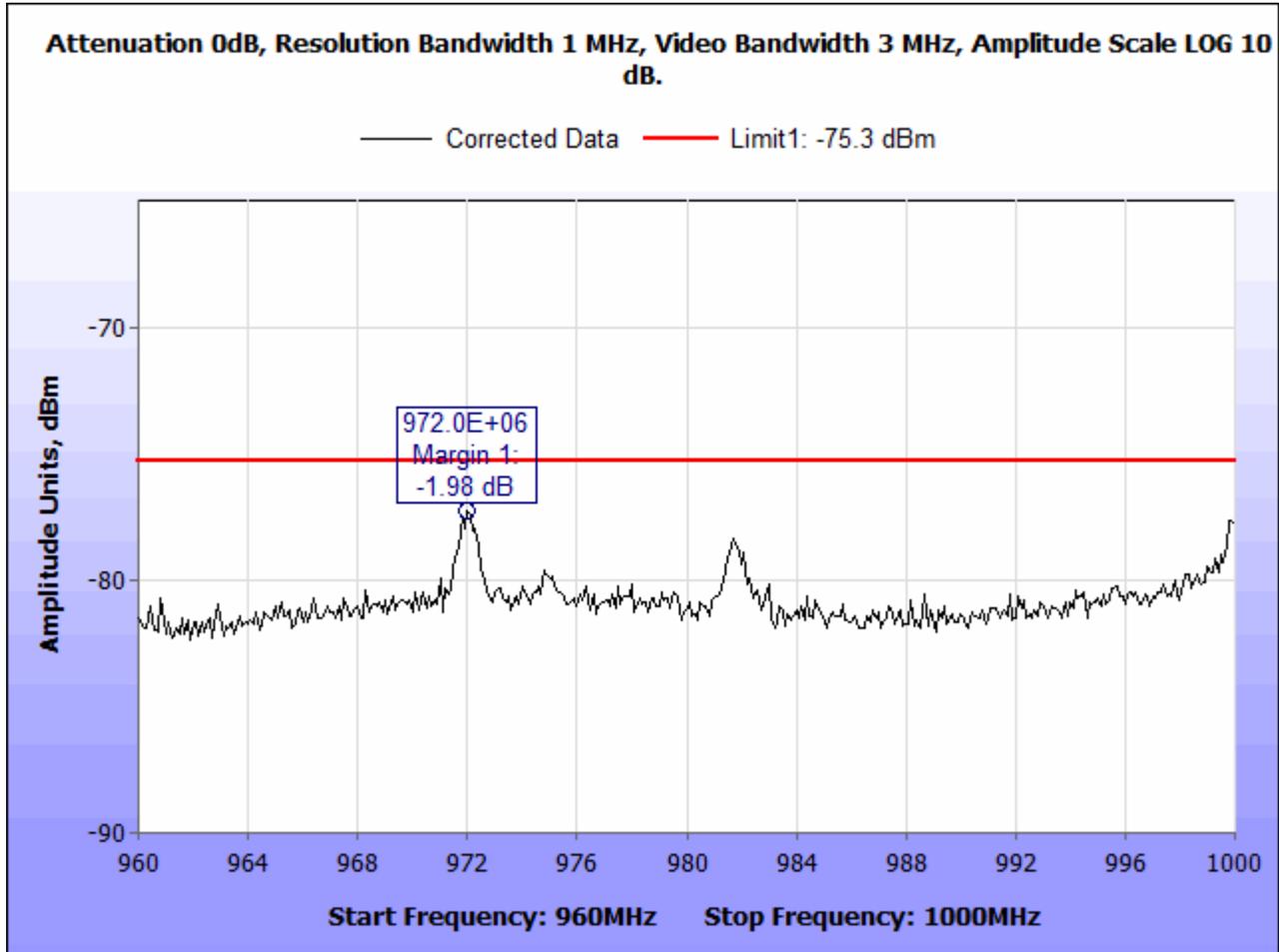


Figure 8. Radiated Emission Limits Test Results, 960 MHz – 1 GHz

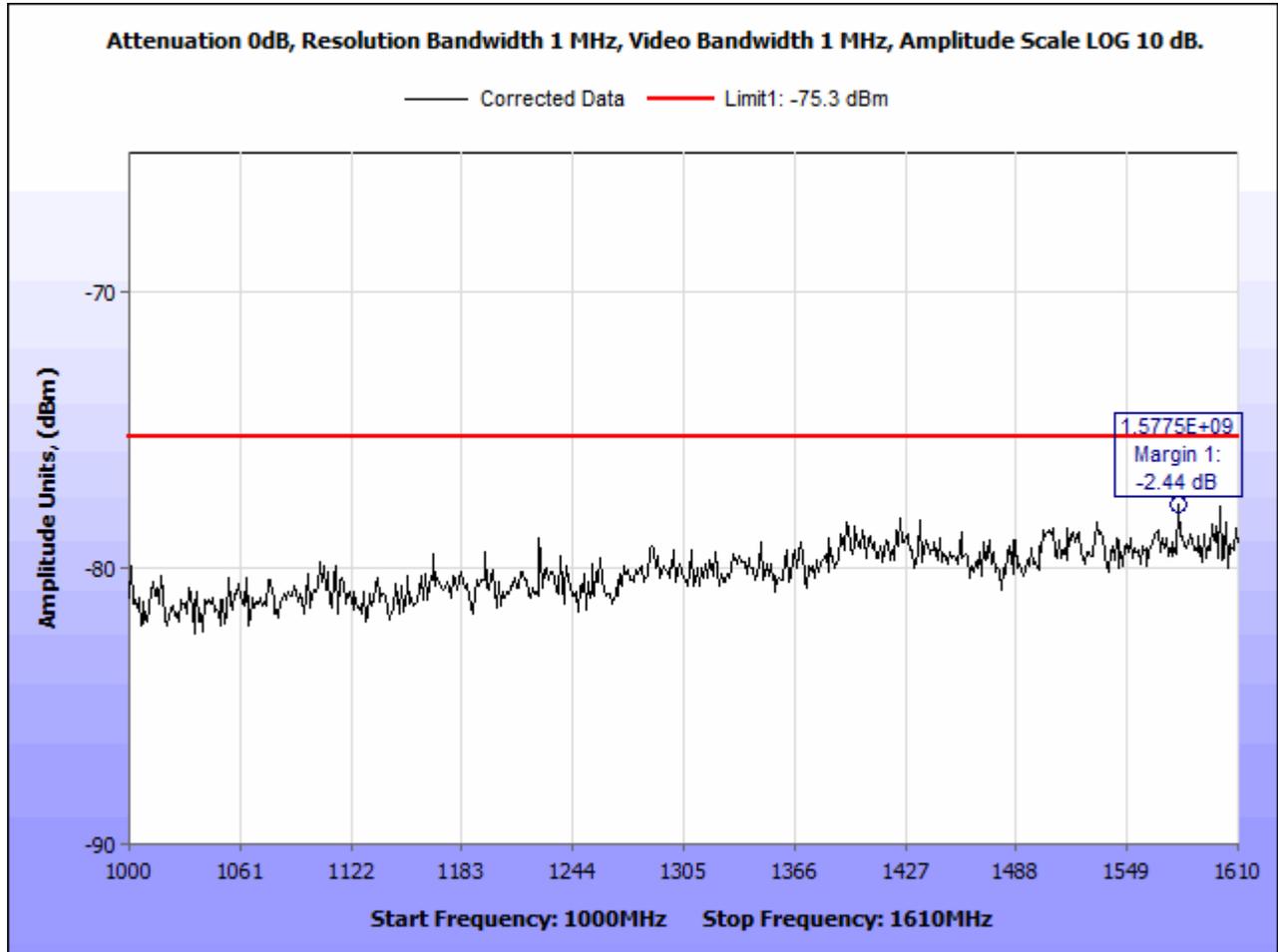


Figure 9. Radiated Emission Limits Test Results, 1 GHz – 1.610 GHz

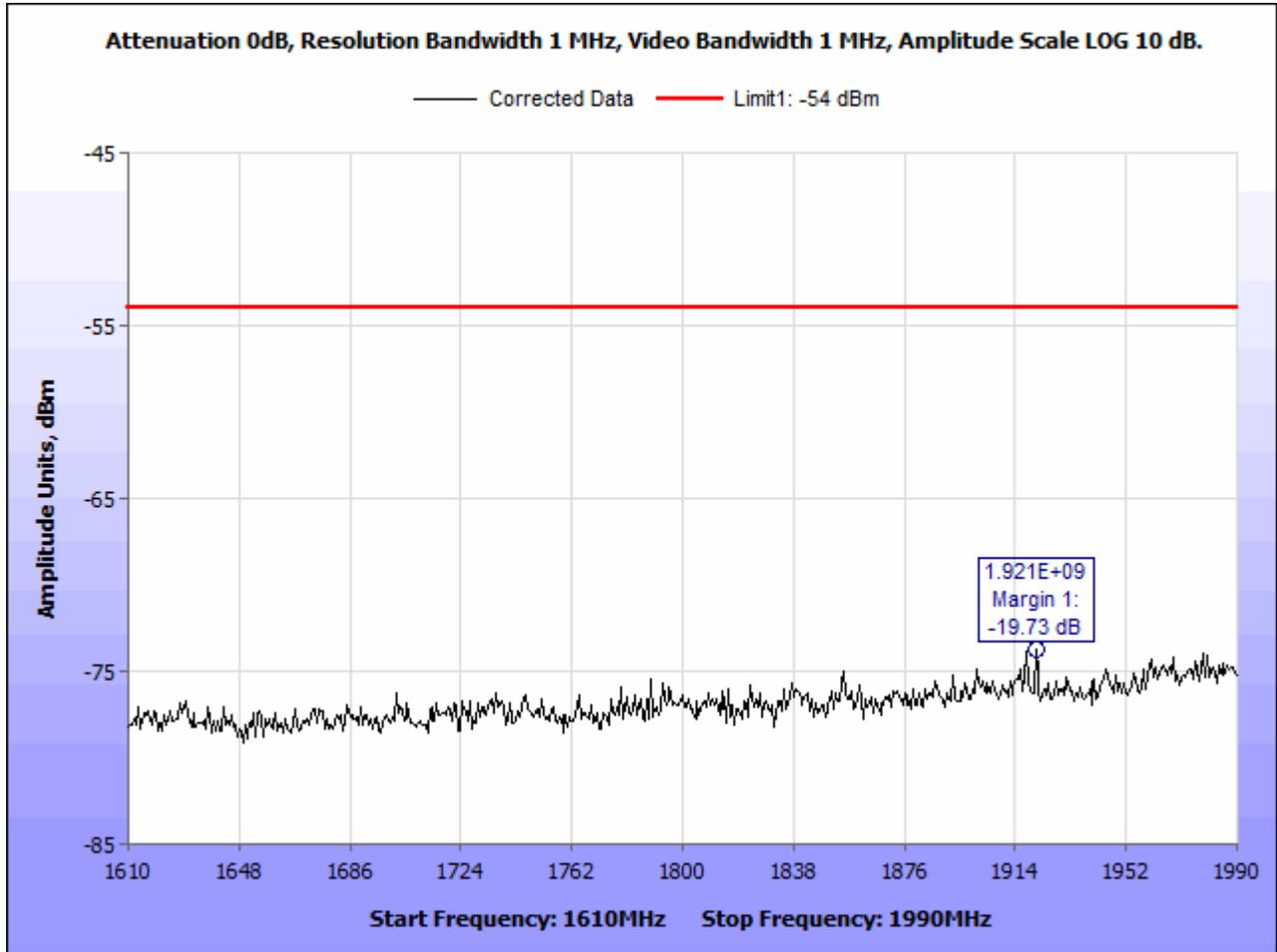


Figure 10. Radiated Emission Limits Test Results, 1610 MHz – 1990 MHz

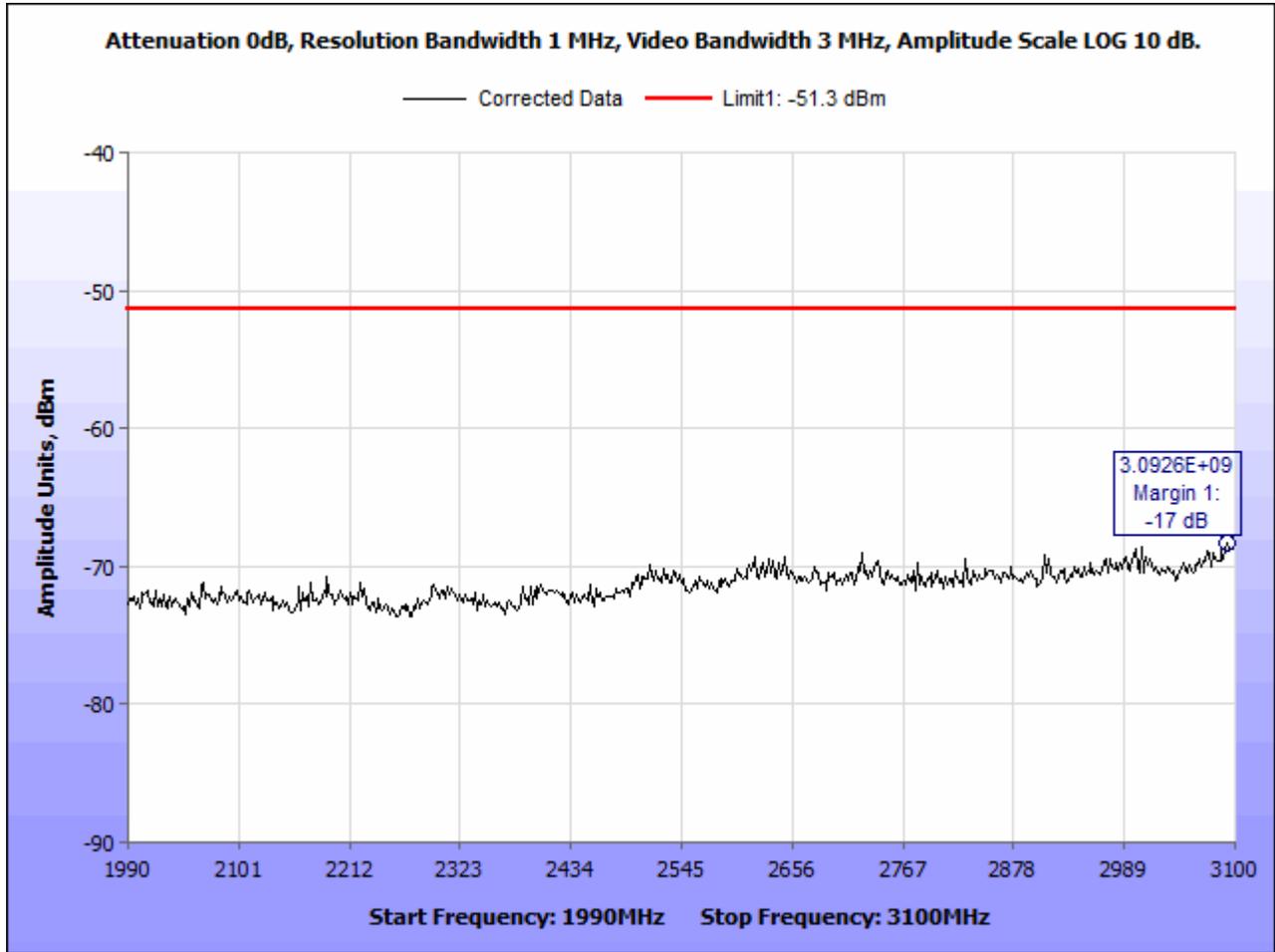


Figure 11. Radiated Emission Limits Test Results, 1990 MHz – 3100 MHz

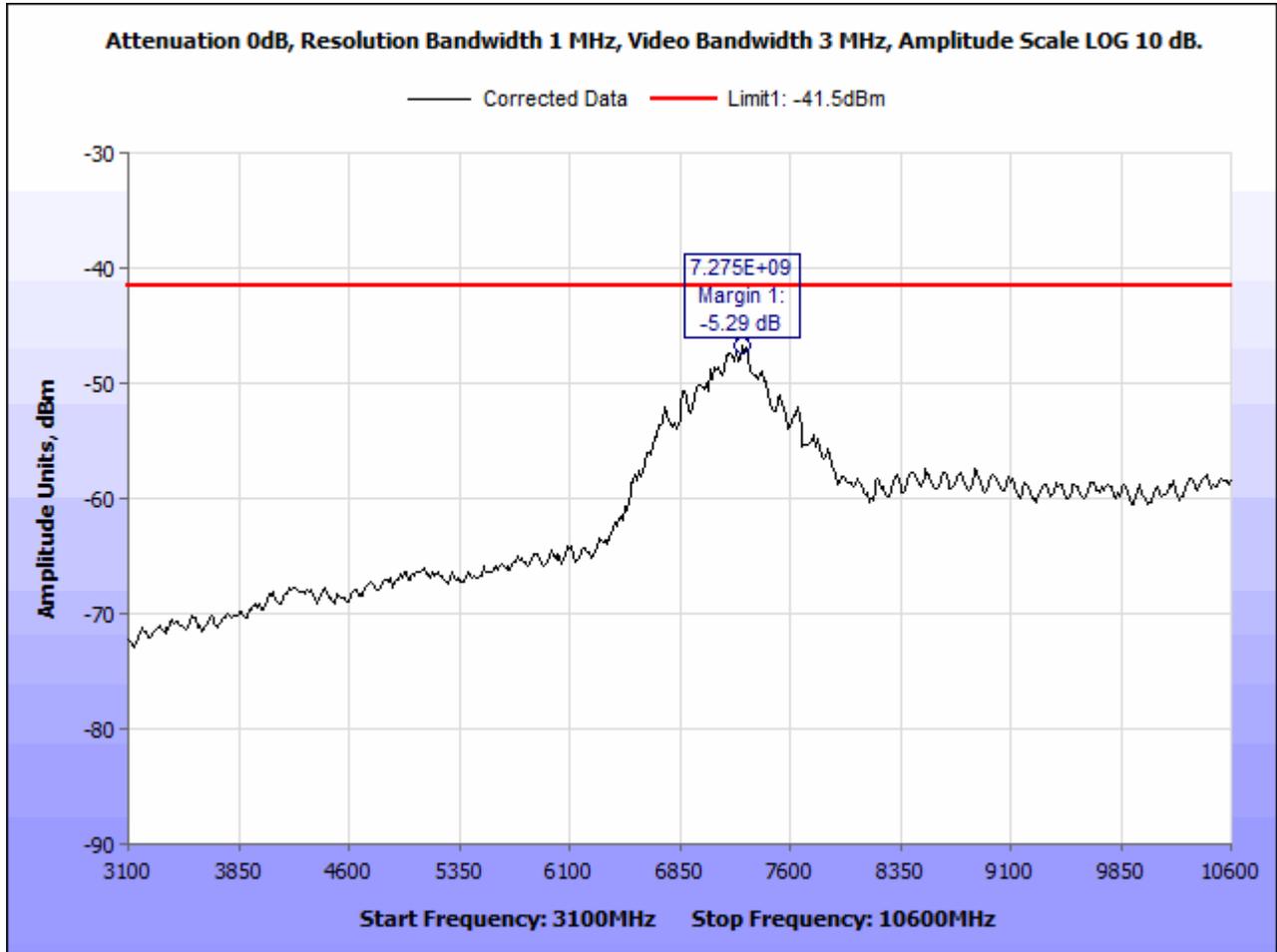


Figure 12. Radiated Emission Limits Test Results, 3100 MHz – 10.6 GHz

Note: Emission marked in the plot above is fundamental frequency.

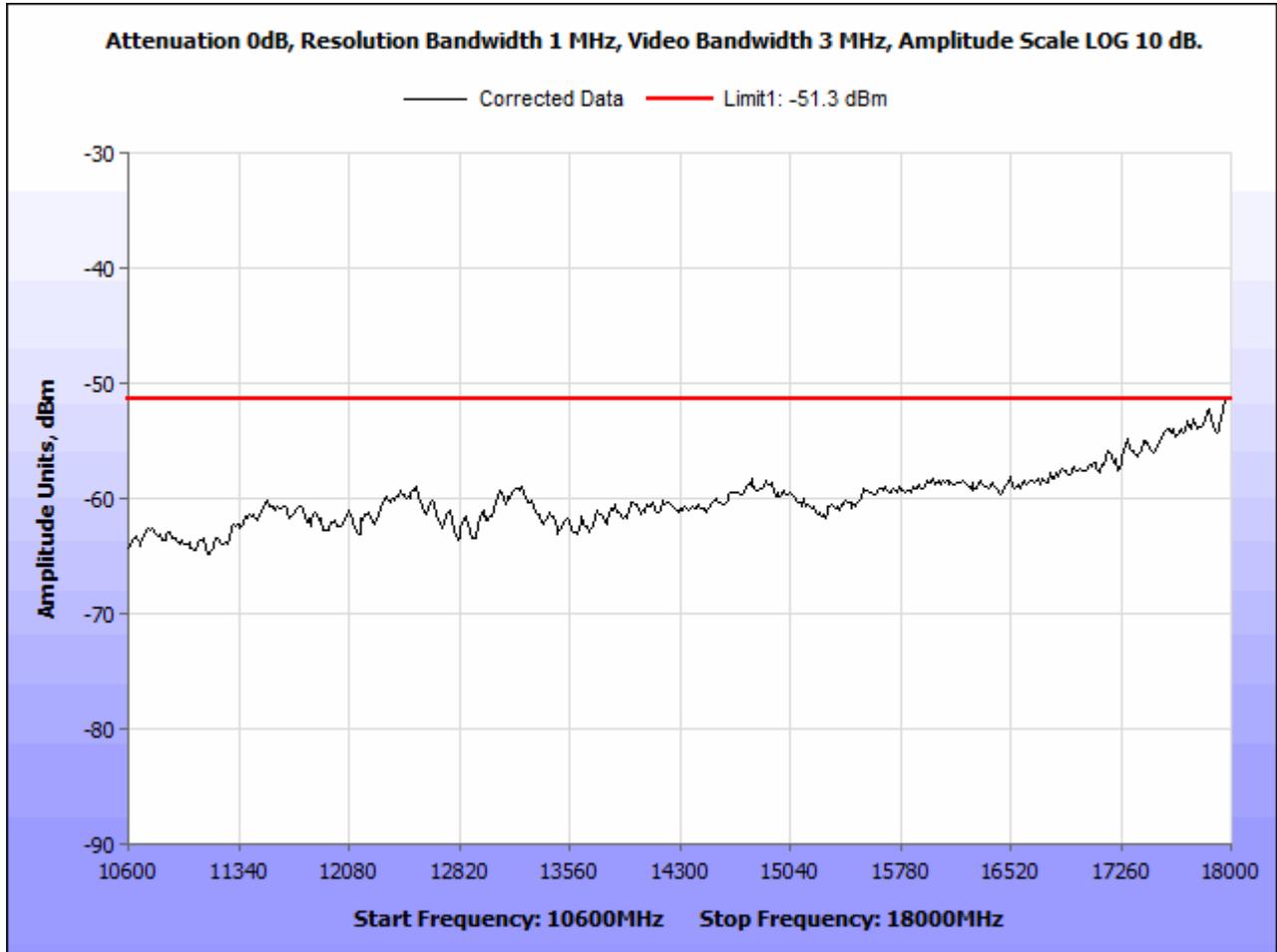


Figure 13. Radiated Emission Limits Test Results, 10.6 GHz – 18 GHz

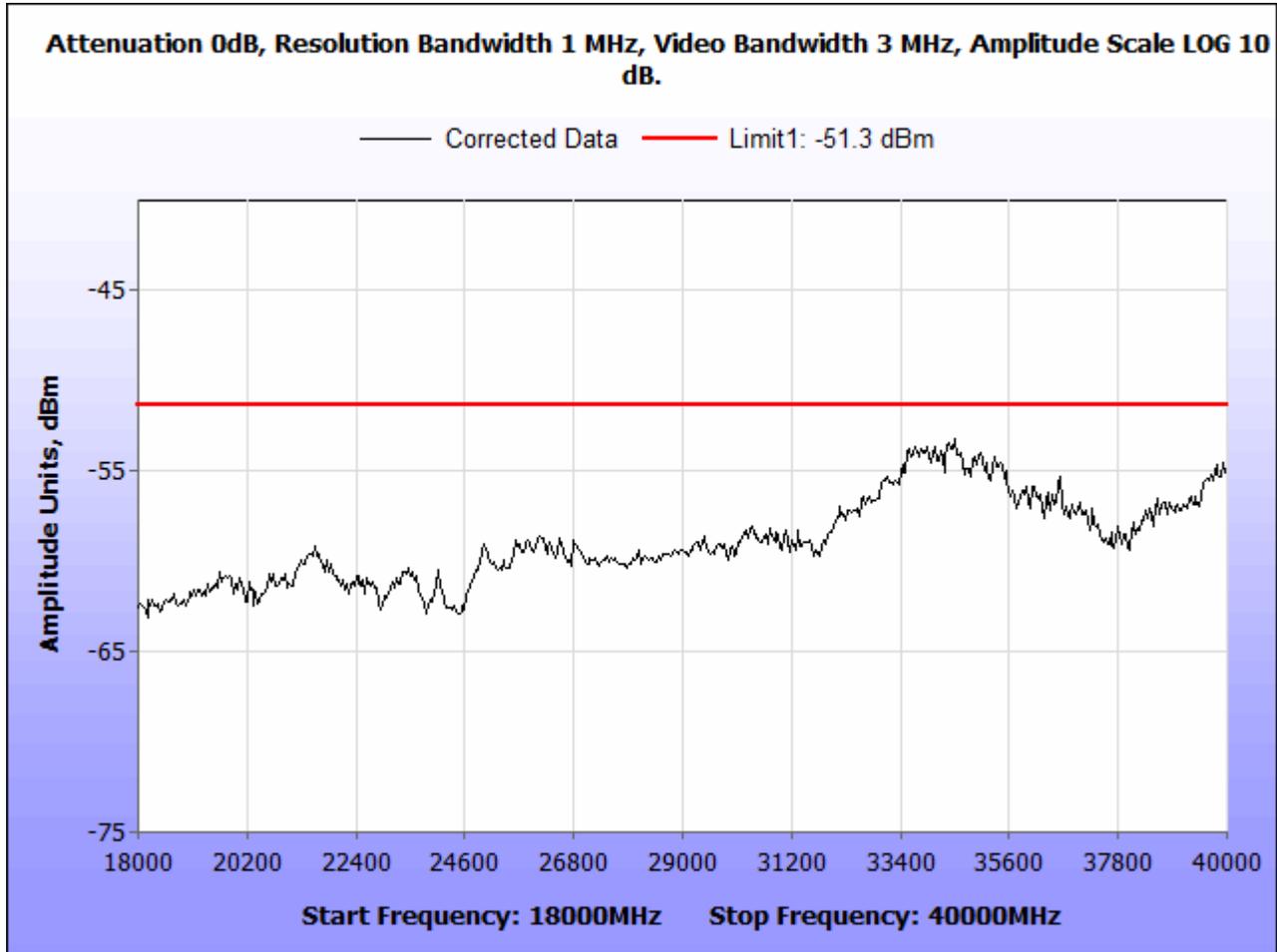


Figure 14. Radiated Emission Limits Test Results, 18 GHz – 40 GHz

## Electromagnetic Compatibility Criteria for Intentional Radiators

### § 15.517(d) Radiated Emissions in GPS bands

**Test Requirements:** §15.517(d): In addition to the radiated emission limits specified in the table in paragraph (c) of this section, UWB transmitters operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of no less than 1 kHz:

Frequency in MHz	EIRP in dBm
1164 – 1240	– 85.3
1559 – 1610	– 85.3

**Table 6. Radiated Emission Requirements from §15.517(d)**

**Test Procedure:**

The transmitter was set to transmit at maximum output power and placed on anechoic chamber. The antenna was located 1 m from the BluX Radar Sensor. Measurements were performed with the BluX Radar Sensor rotated 360 degrees and varying the receiving antenna height from 1 to 4 meters to determine worst case orientation for maximum emissions. Measurement was performed in accordance with Section 10.3.10 of ANSI C63.10 2013.

Measurements were made with a resolution bandwidth of 1 MHz to comply with the Average limit stated in 15.517(d).

$$\begin{aligned} \text{Field Strength (dBuV/m)} &= \text{Raw Data (dBuV/m)} + \text{Cable} + \text{ACF} - \text{Pre-Amp} \\ \text{EIRP(dBm)} &= \text{Field Strength(dBuV/m)} + 20\log(\text{measurement distance(m)}) - 104.77 \end{aligned}$$

**Test Results:** The BluX Radar Sensor was found compliant with the Radiated Emission limits of §15.517(d). See following pages for detailed test results. Emission plots shown are cumulative plots of both antenna polarization and EUT's orientation along 3 different axes. Offset Factors and unit conversion factors were loaded in the test software. Emissions close to the limit line were investigated using shorter measurement span, appropriate detectors, and resolution bandwidth for that frequency range.

**Test Engineer:** Deepak Giri

**Test Date:** 08/12/19

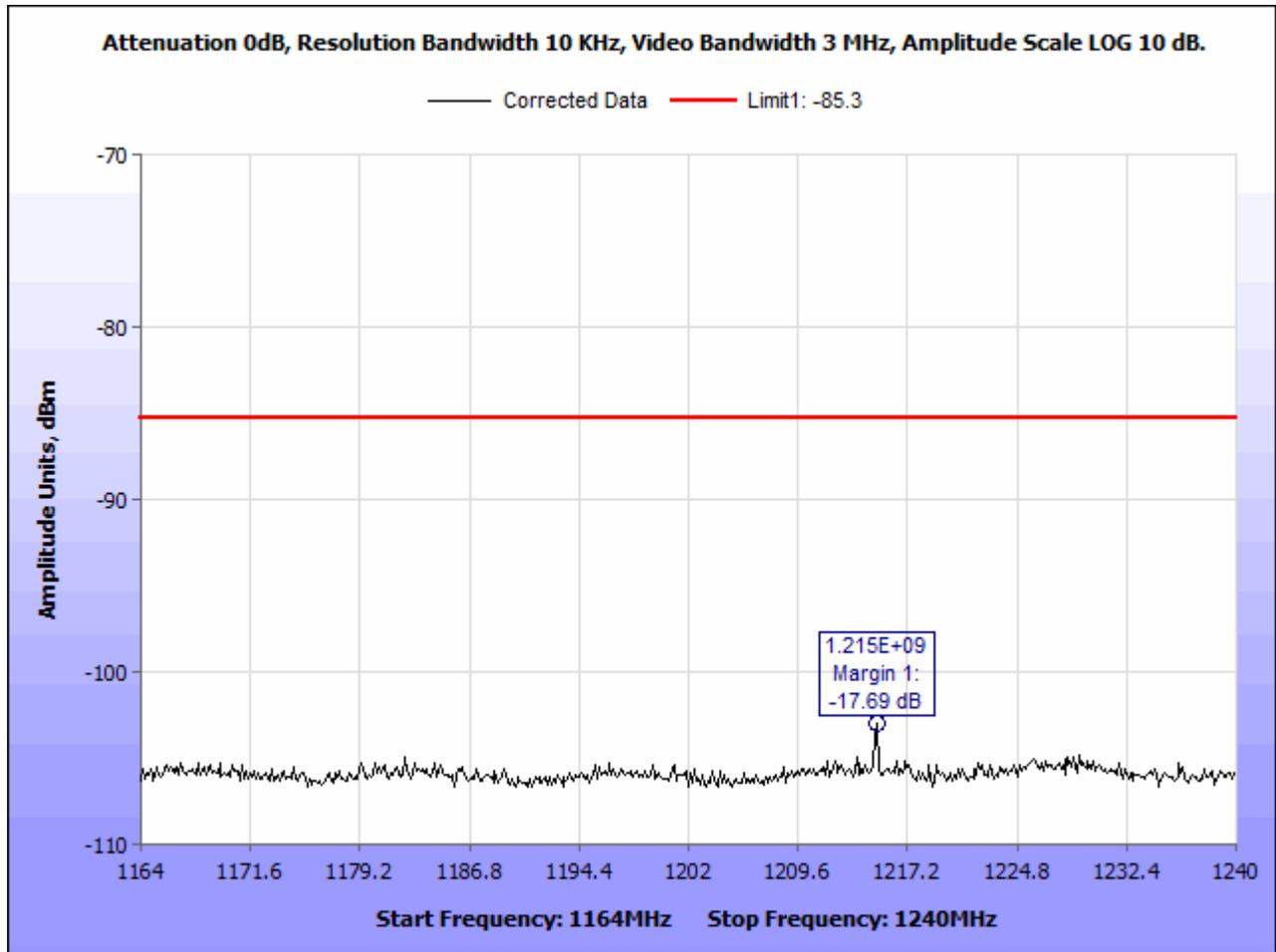


Figure 15. GPS emissions Requirements, 1164 MHz – 1240 MHz

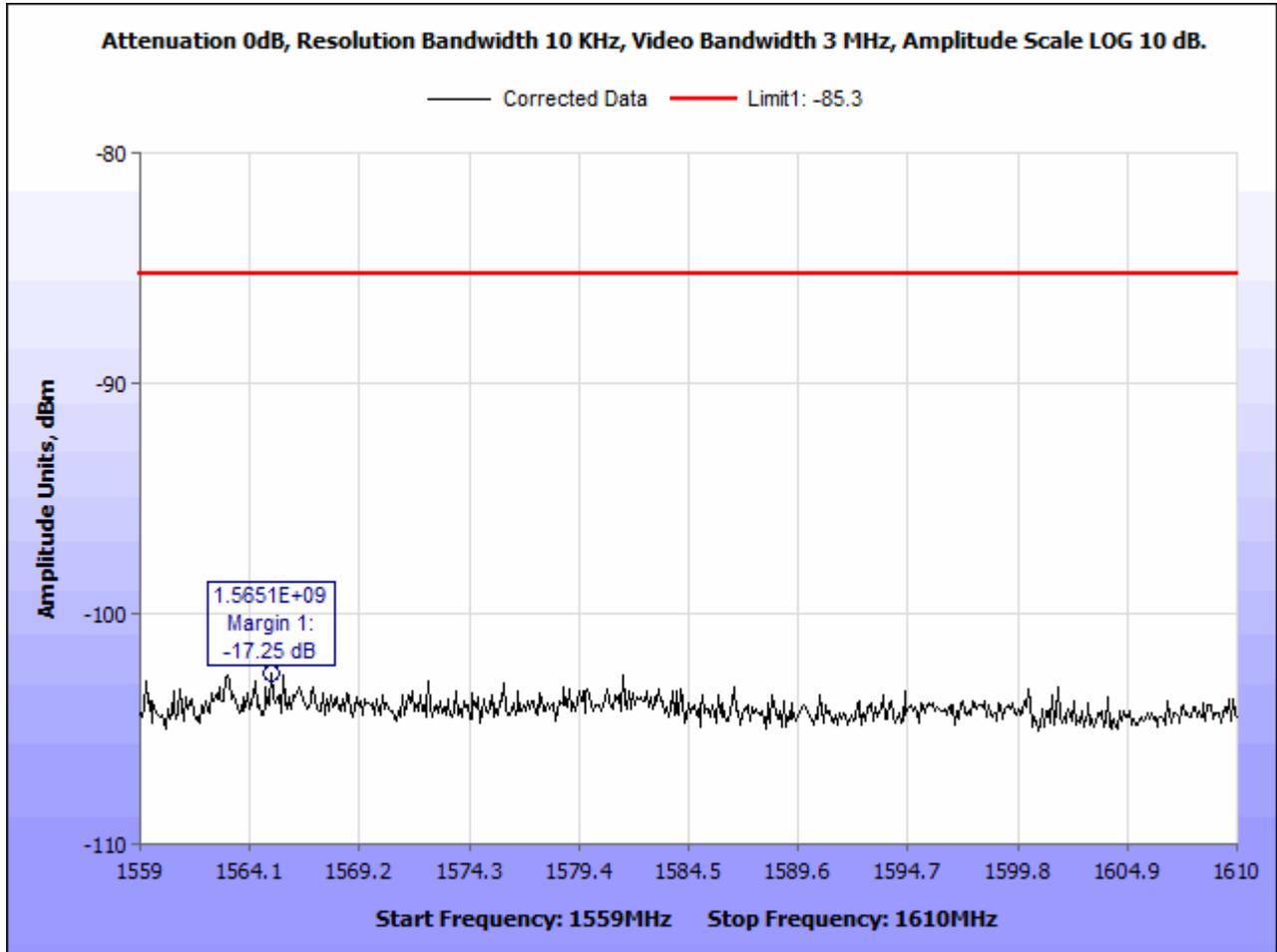


Figure 16. GPS emissions Requirements, 1559 MHz – 1610 MHz

## Electromagnetic Compatibility Criteria for Intentional Radiators

### § 15.517(e) 15.521(g) Peak Emissions within a 50 MHz Bandwidth

**Test Requirements:** §15.517(e): The peak level of the emissions contained within a 50 MHz bandwidth centered on the frequency at which the highest radiated emission occurs,  $f_M$ . That limit is 0 dBm EIRP. It is acceptable to employ a different resolution bandwidth, and a correspondingly different peak emission limit, following the procedures described in §15.521.

§15.521(g): If a resolution bandwidth other than 50 MHz is employed, the peak EIRP limit shall be  $20 \log(\text{RBW}/50)$  dBm where RBW is the resolution bandwidth in megahertz that is employed.

**Test Procedure:**

The transmitter was set to transmit at maximum output power and placed on a acrylic table inside in a anechoic chamber. The antenna was located 1m from the BluX Radar Sensor. Measurements were performed with the BluX Radar Sensor rotated 360 degrees and varying the receiving antenna height determine worst case orientation for maximum emissions. Measurement was performed in accordance with Section 10.3.5 of ANSI C63.10 2013.

Measurement was performed considering guidance stated in FCC 15.521(g) as well.

$$\begin{aligned} \text{Field Strength (dBuV/m)} &= \text{Raw Data( dBuV/m)} + \text{Cable} + \text{ACF} - \text{Pre-Amp} \\ \text{EIRP(dBm)} &= \text{Field Strength(dBuV/m)} + 20\log(\text{measurement distance(m)}) - 104.77 \end{aligned}$$

**Test Results:** The BluX Radar Sensor was found compliant with the Radiated Emission limits of §15.517(e). See following pages for detailed test results. Emission plots shown are cumulative plots of both antenna polarization and EUT's orientation along 3 different axes. Offset Factors and unit conversion factors were loaded in the test software.

EIRP was determined as per ANSI C63.10 2013 Section 10.3.9 from field strength measurement.

Implemented RBW	3 MHz
Required RBW	50 MHz
$20\log(3\text{MHz}/50 \text{ MHz})$	(-) 24.4 dBm
Final Limit	(-) 24.4 dBm EIRP

**Test Engineer:** Deepak Giri

**Test Date:** 08/12/19

### Electromagnetic Compatibility Criteria for Intentional Radiators

#### § 15.517(e) Peak Emissions within a 50 MHz Bandwidth

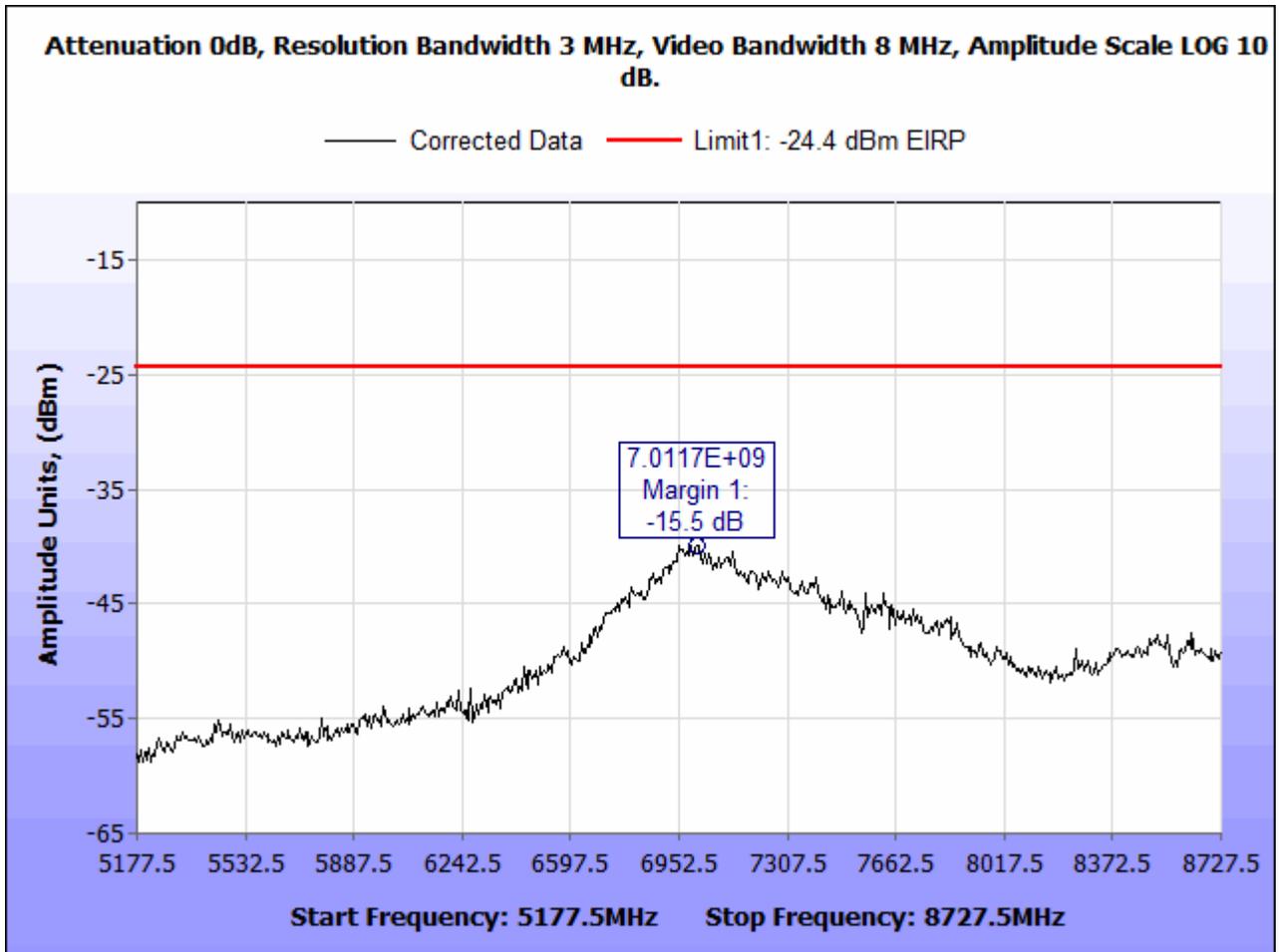


Figure 17. Peak Radiated Emissions Level EIRP

## Electromagnetic Compatibility Criteria for Intentional Radiators

### § 15.517(f) UWB Statement to User

**Test Requirements:** §15.517(f): UWB systems operating under the provisions of this section shall bear the following or similar statement in a conspicuous location on the device or in the instruction manual supplied with the device:

“This equipment may only be operated indoors. Operation outdoors is in violation of 47 U.S.C. 301 and could subject the operator to serious legal penalties.”

**Test Results:** EUT user manual include the statement shown above. Hence, 15.517(f) requirement is fulfilled.

## **IV. Test Equipment**

## Test Equipment

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of ANSI/ISO/IEC 17025:2005.

Asset	Equipment	Manufacturer	Model	Calibration Date	Calibration Due Date
1T4744	Antenna, Horn	ETS-Lindgren	3116	11/27/2018	11/27/2019
1T4905	Horn Antenna	Com-Power	AH-118	05/07/2019	11/07/2020
1T4753	Antenna - Bilog	Sunol Sciences	JB6	08/30/2018	02/29/2020
1T2342	LPA Antenna	EMCO	3146	See Note	See Note
1T4409	EMI Receiver	Rohde & Schwarz	ESIB7	01/04/2019	01/04/2021
1T4771	PSA Spectrum Analyzer	Agilent Technologies	E4446A	05/16/2018	11/16/2019
1T4771	PSA Spectrum Analyzer	Agilent Technologies	E4446A	05/16/2018	11/16/2019
1T4771	PSA Spectrum Analyzer	Agilent Technologies	E4446A	05/16/2018	11/16/2019
1T8743	Preamplifier	A.H. Systems, Inc.	PAM-0118P	03/11/2015	03/11/2016
1T4752	Pre-Amplifier	Miteq	JS44-18004000-35-8P	See Note	See Note
1T4300	SEMI-ANECHOIC CHAMBER (NSA)	EMC TEST SYSTEMS	NONE	06/30/2019	06/30/2020
1T4149A	HF Wireless Chamber - NSA			06/30/2019	06/30/2020

**Table 7. Test Equipment**

Note: Functionally tested equipment is verified using calibrated instrumentation at the time of testing.

## **V. Certification & User's Manual Information**

## Certification & User's Manual Information

### A. Certification Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, Subpart I — Marketing of Radio frequency devices:

#### § 2.801 Radio-frequency device defined.

As used in this part, a radio-frequency device is any device which in its operation is capable of Emitting radio-frequency energy by radiation, conduction, or other means. Radio- frequency devices include, but are not limited to:

- (a) The various types of radio communication transmitting devices described throughout this chapter.
- (b) *The incidental, unintentional and intentional radiators defined in Part 15 of this chapter.*
- (c) The industrial, scientific, and medical equipment described in Part 18 of this chapter.
- (d) Any part or component thereof which in use emits radio-frequency energy by radiation, conduction, or other means.

#### § 2.803 Marketing of radio frequency devices prior to equipment authorization.

- (a) Except as provided elsewhere in this chapter, no person shall sell or lease, or offer for sale or lease (including advertising for sale or lease), or import, ship or distribute for the purpose of selling or leasing or offering for sale or lease, any radio frequency device unless:
  - (1) In the case of a device subject to certification, such device has been authorized by the Commission in accordance with the rules in this chapter and is properly identified and labeled as required by §2.925 and other relevant sections in this chapter; or
  - (2) In the case of a device that is not required to have a grant of equipment authorization issued by the Commission, but which must comply with the specified technical standards prior to use, such device also complies with all applicable administrative (including verification of the equipment or authorization under a Declaration of Conformity, where required), technical, labeling and identification requirements specified in this chapter.
- (d) Notwithstanding the provisions of paragraph (a) of this section, the offer for sale solely to business, commercial, industrial, scientific or medical users (but not an offer for sale to other parties or to end users located in a residential environment) of a radio frequency device that is in the conceptual, developmental, design or pre-production stage is permitted prior to equipment authorization or, for devices not subject to the equipment authorization requirements, prior to a determination of compliance with the applicable technical requirements *provided* that the prospective buyer is advised in writing at the time of the offer for sale that the equipment is subject to the FCC rules and that the equipment will comply with the appropriate rules before delivery to the buyer or to centers of distribution.

- (e)(1) Notwithstanding the provisions of paragraph (a) of this section, prior to equipment authorization or determination of compliance with the applicable technical requirements any radio frequency device may be operated, but not marketed, for the following purposes and under the following conditions:
- (i) *Compliance testing*;
  - (ii) Demonstrations at a trade show provided the notice contained in paragraph (c) of this section is displayed in a conspicuous location on, or immediately adjacent to, the device;
  - (iii) Demonstrations at an exhibition conducted at a business, commercial, industrial, scientific or medical location, but excluding locations in a residential environment, provided the notice contained in paragraphs (c) or (d) of this section, as appropriate, is displayed in a conspicuous location on, or immediately adjacent to, the device;
  - (iv) Evaluation of product performance and determination of customer acceptability, provided such operation takes place at the manufacturer's facilities during developmental, design or pre-production states; or
  - (v) Evaluation of product performance and determination of customer acceptability where customer acceptability of a radio frequency device cannot be determined at the manufacturer's facilities because of size or unique capability of the device, provided the device is operated at a business, commercial, industrial, scientific or medical user's site, but not at a residential site, during the development, design or pre-production stages.
- (e)(2) For the purpose of paragraphs (e)(1)(iv) and (e)(1)(v) of this section, the term *manufacturer's facilities* includes the facilities of the party responsible for compliance with the regulations and the manufacturer's premises, as well as the facilities of other entities working under the authorization of the responsible party in connection with the development and manufacture, but not the marketing, of the equipment.
- (f) For radio frequency devices subject to verification and sold solely to business, commercial, industrial, scientific and medical users (excluding products sold to other parties or for operation in a residential environment), parties responsible for verification of the devices shall have the option of ensuring compliance with the applicable technical specifications of this chapter at each end user's location after installation, provided that the purchase or lease agreement includes a proviso that such a determination of compliance be made and is the responsibility of the party responsible for verification of the equipment.

## Certification & User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, Subpart J — Equipment Authorization Procedures:

### § 2.901 Basis and Purpose

- (a) In order to carry out its responsibilities under the Communications Act and the various treaties and international regulations, and in order to promote efficient use of the radio spectrum, the Commission has developed technical standards for radio frequency equipment and parts or components thereof. The technical standards applicable to individual types of equipment are found in that part of the rules governing the service wherein the equipment is to be operated.<sup>1</sup> *In addition to the technical standards provided, the rules governing the service may require that such equipment be verified by the manufacturer or importer, be authorized under a Declaration of Conformity, or receive an equipment authorization from the Commission by one of the following procedures: certification or registration.*
- (b) The following sections describe the verification procedure, the procedure for a Declaration of Conformity, and the procedures to be followed in obtaining certification from the Commission and the conditions attendant to such a grant.

### § 2.907 Certification.

- (a) Certification is an equipment authorization issued by the Commission, based on representation and test data submitted by the applicant.
- (b) Certification attaches to all units subsequently marketed by the grantee which are identical (see Section 2.908) to the sample tested except for permissive changes or other variations authorized by the Commission pursuant to Section 2.1043.

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<sup>1</sup> In this case, the equipment is subject to the rules of Part 15. More specifically, the equipment falls under Subpart B (of Part 15), which deals with unintentional radiators.

## Certification & User's Manual Information

### § 2.948 Description of measurement facilities.

- (a) Each party making measurements of equipment that is subject to an equipment authorization under Part 15 or Part 18 of this chapter, regardless of whether the measurements are filed with the Commission or kept on file by the party responsible for compliance of equipment marketed within the U.S. or its possessions, shall compile a description of the measurement facilities employed.
- (1) If the measured equipment is subject to the verification procedure, the description of the measurement facilities shall be retained by the party responsible for verification of the equipment.
- (i) *If the equipment is verified through measurements performed by an independent laboratory, it is acceptable for the party responsible for verification of the equipment to rely upon the description of the measurement facilities retained by or placed on file with the Commission by that laboratory. In this situation, the party responsible for the verification of the equipment is not required to retain a duplicate copy of the description of the measurement facilities.*
- (ii) If the equipment is verified based on measurements performed at the installation site of the equipment, no specific site calibration data is required. It is acceptable to retain the description of the measurement facilities at the site at which the measurements were performed.
- (2) If the equipment is to be authorized by the Commission under the certification procedure, the description of the measurement facilities shall be filed with the Commission's Laboratory in Columbia, Maryland. The data describing the measurement facilities need only be filed once but must be updated as changes are made to the measurement facilities or as otherwise described in this section. At least every three years, the organization responsible for filing the data with the Commission shall certify that the data on file is current.

## Certification & User's Manual Information

### B. Label and User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 15, Subpart A — General:

#### § 15.19 Labeling requirements.

(a) *In addition to the requirements in Part 2 of this chapter, a device subject to certification or verification shall be labeled as follows:*

- (1) Receivers associated with the operation of a licensed radio service, e.g., FM broadcast under Part 73 of this chapter, land mobile operation under Part 90, etc., shall bear the following statement in a conspicuous location on the device:

This device complies with Part 15 of the FCC Rules. Operation is subject to the condition that this device does not cause harmful interference.

- (2) A stand-alone cable input selector switch, shall bear the following statement in a conspicuous location on the device:

This device is verified to comply with Part 15 of the FCC Rules for use with cable television service.

- (3) All other devices shall bear the following statement in a conspicuous location on the device:

*This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.*

- (4) Where a device is constructed in two or more sections connected by wires and marketed together, the statement specified under paragraph (a) of this section is required to be affixed only to the main control unit.

- (5) When the device is so small or for such use that it is not practicable to place the statement specified under paragraph (a) of this section on it, the information required by this paragraph shall be placed in a prominent location in the instruction manual or pamphlet supplied to the user or, alternatively, shall be placed on the container in which the device is marketed. However, the FCC identifier or the unique identifier, as appropriate, must be displayed on the device.

#### § 15.21 Information to user.

The users manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

## Verification & User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 15, Subpart B — Unintentional Radiators:

### § 15.105 Information to the user.

- (a) For a Class B digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a residential environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

**End of Report**