PCTEST
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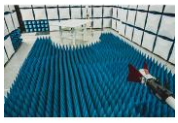


MEASUREMENT REPORT
FCC Part 15.247 Bluetooth (Low Energy)

Applicant Name:
28 Gorilla, LLC.
12 S San Marco Pl
Chandler, AZ 85255
United States

Date of Testing:
1/12/2021-1/24/2021
Test Site/Location:
PCTEST Lab. Morgan Hill, CA, USA
Test Report Serial No.:
1C2101120008-01-R2.2AX2O

FCC ID:	**2AX2O–280010319**
APPLICANT:	**28 Gorilla, LLC.**

Model:	28-0010038
EUT Type:	AE Wireless Temperature Sensor
Max. RF Output Power:	0.597mW (-2.24dBm) Peak Conducted
Frequency Range:	2402 – 2480MHz
FCC Classification:	Digital Transmission System (DTS)
FCC Rule Parts:	Part 15 Subpart C (15.247)
Test Procedure(s):	ANSI C63.10-2013, KDB 558074 D01 v05r02

This equipment has been shown to be capable of compliance with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in ANSI C63.10-2013 and KDB 558074 D01 v05r02. Test results reported herein relate only to the item(s) tested.

This revised Test Report (S/N: 1C2101120008-01-R2.2AX2O) supersedes and replaces the previously issued test report (S/N: 1C2101120008-01-R1.2AX2O) on the same subject device for the same type of testing as indicated. Please discard or destroy the previously issued test report(s) and dispose of it accordingly.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

Randy Ortanez
President

ACCREDITED
CERT #2041.02

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 Scope

Measurement and determination of electromagnetic emissions (EMC) of radio frequency devices including intentional and/or unintentional radiators for compliance with the technical rules and regulations of the Federal Communications Commission and the Innovation, Science and Economic Development Canada.

1.2 PCTEST Test Location

These measurement tests were conducted at the PCTEST facility located at 18855 Adams Court, Morgan Hill, CA 95037. The measurement facility is compliant with the test site requirements specified in ANSI C63.4-2014 and KDB 414788 D01 v01r01.

1.3 Test Facility / Accreditations

Measurements were performed at PCTEST Engineering Lab located in Morgan Hill, CA 95037, U.S.A.

- PCTEST is an ISO 17025-2017 accredited test facility under the American Association for Laboratory Accreditation (A2LA) with Certificate number 2041.02 for Specific Absorption Rate (SAR), Hearing Aid Compatibility (HAC) testing, where applicable, and Electromagnetic Compatibility (EMC) testing for FCC and Innovation, Science, and Economic Development Canada rules.

- PCTEST TCB is a Telecommunication Certification Body (TCB) accredited to ISO/IEC 17065-2012 by A2LA (Certificate number 2041.03) in all scopes of FCC Rules and ISED Standards (RSS).

- PCTEST facility is a registered (22831) test laboratory with the site description on file with ISED.

2.0 PRODUCT INFORMATION

2.1 Equipment Description

The Equipment Under Test (EUT) is the **28 Gorilla, LLC. AE Wireless Temperature Sensor FCC ID: 2AX2O–280010319**. The data found in this test report was taken with the EUT operating in Bluetooth low energy mode. While in low energy mode, the Bluetooth transmitter hops pseudo-randomly between 40 channels, three of which are “advertising channels”. When the transmitter is hopping only between the three advertising channels, the EUT does not fall under the category of a “hopper” as defined in 15.247(a)(iii) which states that a “frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels.” As operation on only the advertising channels does not qualify the EUT as a hopper, the EUT is certified as a DTS device in this mode.

Test Device Serial No.: 1011, 1012, 1013

2.2 Device Capabilities

This device contains the following capabilities:

Bluetooth (LE)

Ch.	Frequency (MHz)
0	2402
:	:
19	2440
:	:
39	2480

Table 2-1. Bluetooth (Low Energy) Frequency / Channel Operations

Measured Duty Cycles	
BLE Mode	**Duty Cycle (%)**
1M	65.4
2M	36.7

Table 2-2. Measured Duty Cycles

2.3 Antenna Description

Following antenna was used for the testing.

Frequency [GHz]	Antenna Gain (dBi)
2.4	0.2

Table 2-3. Highest Antenna Gain

2.4 Test Support Equipment

1	Dell Laptop	Model:	E7440	S/N:	6P0BG12
	w/AC/DC Adapter	Model:	LA130PM121	S/N:	0VJCH5

Table 2-4. Test Support Equipment List

2.5 Test Configuration

The EUT was tested per the guidance of ANSI C63.10-2013 and KDB 558074 D01 v05r02. ANSI C63.10-2013 was used to reference the appropriate EUT setup for radiated spurious emissions testing and AC line conducted testing. See Sections 3.2 for radiated emissions test setups, and 7.2, 7.3, 7.4, 7.5, and 7.6 for antenna port conducted emissions test setups.

The EUT is battery powered. A laptop was used as a support equipment to transmit at low, mid and high channels.

For emissions from 1GHz – 18GHz, low, mid, and high channels were tested with highest power and worst case configuration. The emissions below 1GHz and above 18GHz were tested with the highest transmitting power and the worst case channel.

The EUT was manipulated through three orthogonal planes of X-orientation (flatbed), Y-orientation (landscape), and Z-orientation (portrait) during the testing. Only the worst case emissions were reported in this test report.

For AC line conducted and radiated test below 1GHz, following configuration was investigated:

- EUT powered by host PC via USB cable with wire charger

2.6 Software and Firmware

The test was conducted with firmware version V1.1.0 installed on the EUT.

2.7 EMI Suppression Device(s)/Modifications

No EMI suppression device(s) were added and/or no modifications were made during testing.

3.0 DESCRIPTION OF TESTS

3.1 Evaluation Procedure

The measurement procedures described in the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices (ANSI C63.10-2013) and the guidance provided in KDB 558074 D01 v05r02 were used in the measurement of the EUT**.**

Deviation from measurement procedure…….....None

3.2 Radiated Emissions

The radiated test facilities consisted of an indoor 3 meter semi-anechoic chamber used for final measurements and exploratory measurements, when necessary. The measurement area is contained within the semi-anechoic chamber which is shielded from any ambient interference. The test site inside the chamber is a 6m x 5.2m elliptical, obstruction-free area in accordance with Figure 5.7 of Clause 5 in ANSI C63.4-2014. Absorbers are arranged on the floor between the turn table and the antenna mast in such a way so as to maximize the reduction of reflections for measurements above 1GHz. An 80cm tall test table made of Styrodur is placed on top of the turn table. For measurements above 1GHz, an additional Styrodur pedestal is placed on top of the test table to bring the total table height to 1.5m.

Per KDB 414788, radiated emission test sites other than open-field test sites (e.g., shielded anechoic chambers), may be employed for emission measurements below 30MHz if characterized so that the measurements correspond to those obtained at an open-field test site. To determine test site equivalency, a reference sample transmitting at 149kHz was measured on an open field test site (asphalt with no ground plane) and then measured in the 3m semi-anechoic chamber. A calibrated 60cm loop antenna was rotated about its vertical axis
while the reference device was rotated through the X, Y and Z axis in order to capture the worst case level. A maximum deviation of 2.77dB at 149kHz was measured when comparing the 3 meter semi-anechoic chamber to the open field site.

For all measurements, the spectrum was scanned through all EUT azimuths and from 1 to 4 meter receive antenna height using a broadband antenna from 30MHz up to the upper frequency shown in 15.33 depending on the highest frequency generated or used in the device or on which the device operates or tunes. For frequencies above 1GHz, linearly polarized double ridge horn antennas were used. For frequencies below 30MHz, a calibrated loop antenna was used. When exploratory measurements were necessary, they were performed at 1 meter test distance inside the semi-anechoic chamber using broadband antennas, broadband amplifiers, and spectrum analyzers to determine the frequencies and modes producing the maximum emissions. Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The test set-up was placed on top of the 1 x 1.5 meter table. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each emission. Appropriate precaution was taken to ensure that all emissions from the EUT were maximized and investigated. The system configuration, mode of operation, turntable azimuth, and receive antenna height was noted for each frequency found.

Final measurements were made in the semi-anechoic chamber using calibrated, linearly polarized broadband and horn antennas. The test setup was configured to the setup that produced the worst case emissions. The spectrum analyzer was set to investigate all frequencies required for testing to compare the highest radiated disturbances with respect to the specified limits. The turntable containing the EUT was rotated through 360 degrees and the height of the receive antenna was varied 1 to 4 meters and stopped at the azimuth and height producing the maximum emission. Each emission was maximized by changing the orientation of the EUT through three orthogonal planes and changing the polarity of the receive antenna, whichever produced the worst-case emissions.

3.3 Environmental Conditions

The temperature is controlled within range of 15°C to 35°C. The relative humidity is controlled within range of 10% to 75%. The atmospheric pressure is monitored within the range 86-106kPa (860-1060mbar).

4.0 ANTENNA REQUIREMENTS

Excerpt from §15.203 of the FCC Rules/Regulations:
"An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can 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 antenna(s) of the EUT are **permanently attached.**
- There are no provisions for connection to an external antenna.

Conclusion:

The EUT complies with the requirement of §15.203.

5.0 MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.10-2013. All measurement uncertainty values are shown with a coverage factor of k = 2 to indicate a 95% level of confidence. The measurement uncertainty shown below meets or exceeds the U_{CISPR} measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

Contribution	Expanded Uncertainty (±dB)
Conducted Bench Top Measurements	1.65
Line Conducted Disturbance	2.75
Radiated Disturbance (<1GHz)	4.30
Radiated Disturbance (>1GHz)	4.78
Radiated Disturbance (>18GHz)	4.79

6.0 TEST EQUIPMENT CALIBRATION DATA

Test Equipment Calibration is traceable to the National Institute of Standards and Technology (NIST). Measurements antennas used during testing were calibrated in accordance to the requirements of ANSI C63.5-2017.

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Agilent Technologies	N9030A	3Hz-44GHz PXA Signal Analyzer	3/4/2020	Annual	3/4/2021	MY49430244
Anritsu	ML2496A	Power Meter	4/9/2020	Annual	4/9/2021	2002005
Anritsu	MA2411B	Pulse Power Sensor	3/10/2020	Annual	3/10/2021	1911105
ATM	180-442A-KF	Horn; Antenna 20dB Nominal (Small 18-40 GHz)	8/11/2020	Annual	8/11/2021	T058701-01
ETS-Lindgren	3142E–PA	Pre-Amplifier (30MHz - 6GHz)	3/4/2020	Annual	3/4/2021	102325
ETS-Lindgren	3142E	BiConiLog Antenna (26-6000MHz)	9/15/2020	Annual	9/15/2021	00208204
ETS-Lindgren	3117	Double Ridged Guide Antenna (1-18 GHz)	4/21/2020	Annual	4/21/2021	205956
Rohde & Schwarz	FSV40	Signal Analyzer (10Hz-40GHz)	3/2/2020	Annual	3/2/2021	101619
Rohde & Schwarz	HFH2-Z2	Loop Antenna	3/12/2020	Annual	3/12/2021	100546
Rohde & Schwarz	ESW44	EMI Test Receiver	8/7/2020	Annual	8/7/2021	101668
Rohde & Schwarz	TS-PR1840	Pre-Amplifier (18GHz - 40GHz)	4/23/2020	Annual	4/23/2021	100052

Table 6-1. Test Equipment List

Note:

For equipment listed above that has a calibration date or calibration due date that falls within the test date range, care was taken to ensure that this equipment was used after the calibration date and before the calibration due date.

7.0 TEST RESULTS

7.1 Summary

Company Name: 28 Gorilla, LCC.

FCC ID: 2AX2O–280010319

FCC Classification: Digital Transmission System (DTS)

Number of Channels: 40

FCC Part Section(s)	Test Description	Test Limit	Test Condition	Test Result	Reference
15.247(a)(2)	6dB Bandwidth	> 500kHz	CONDUCTED	PASS	Section 7.2
15.247(b)(3)	Transmitter Output Power	< 1 Watt		PASS	Sections 7.3
15.247(e)	Transmitter Power Spectral Density	< 8dBm / 3kHz Band		PASS	Section 7.4
15.247(d)	Band Edge / Out-of-Band Emissions	≥ 20dBc		PASS	Sections 7.5, 7.6
15.205 15.209	General Field Strength Limits (Restricted Bands and Radiated Emission Limits)	Emissions in restricted bands must meet the radiated limits detailed in 15.209	RADIATED	PASS	Sections 7.7, 7.7.3, 7.8
15.207	AC Conducted Emissions 150kHz – 30MHz	< FCC 15.207 limits	AC LINE CONDUCTED	N/A	N/A

Table 7-1. Summary of Test Results

Notes:

1. All modes of operation were investigated. The test results shown in the following sections represent the worst case emissions.
2. The analyzer plots shown in this section were all taken with a correction table loaded into the analyzer. The correction table was used to account for the losses of the cables and attenuators used as part of the system to connect the EUT to the analyzer at all frequencies of interest.
3. All antenna port conducted emissions testing was performed on a test bench with the antenna port of the EUT connected to the spectrum analyzer through calibrated cables and attenuators.
4. For conducted spurious emissions, automated test software was used to measure emissions and capture the corresponding plots necessary to show compliance. The measurement software utilized is PCTEST "Bluetooth LE Automation," Version 3.6.
5. For radiated band edge, automated test software was used to measure emissions and capture the corresponding plots necessary to show compliance. The measurement software utilized is PCTEST "Chamber Automation," Version 1.3.1.
6. The end product is battery powered. AC Line conducted emissions test is not applicable.

7.2 6dB Bandwidth Measurement – Bluetooth (LE)

§15.247(a.2)

Test Overview and Limit

The bandwidth at 6dB down from the highest in-band spectral density is measured with a spectrum analyzer connected to the transmitter antenna terminal of the EUT while the EUT is operating at maximum power and at the appropriate frequencies. All modes of operation were investigated and the worst case configuration results are reported in this section.

The minimum permissible 6dB bandwidth is 500 kHz.

Test Procedure Used

ANSI C63.10-2013 – Section 11.8.2 Option 2
KDB 558074 D01 v05r02 – Section 8.2

Test Settings

1. The signal analyzers' automatic bandwidth measurement capability of the spectrum analyzer was used to perform the 6dB bandwidth measurement. The "X" dB bandwidth parameter was set to X = 6. The bandwidth measurement was not influenced by any intermediate power nulls in the fundamental emission.
2. RBW = 100kHz
3. VBW ≥ 3 x RBW
4. Detector = Peak
5. Trace mode = max hold
6. Sweep = auto couple
7. The trace was allowed to stabilize

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

Figure 7-1. Test Instrument & Measurement Setup

Test Notes

None

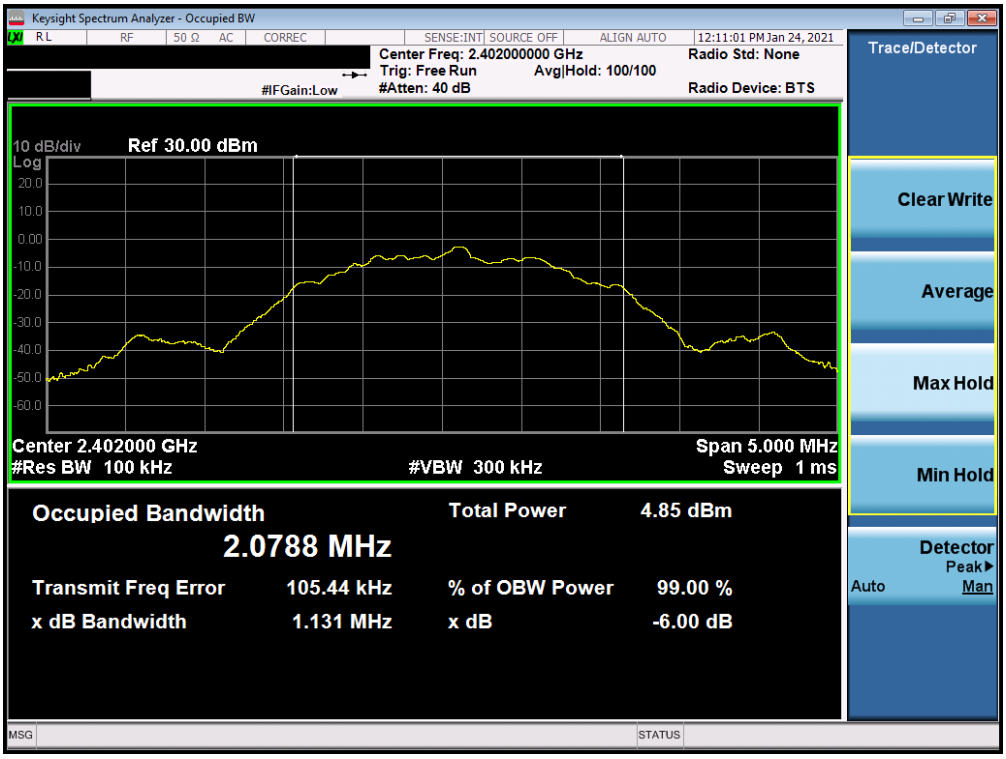
Frequency [MHz]	Data Rate [Mbps]	Channel No.	Measured Bandwidth [kHz]	Minimum Bandwidth [kHz]	Pass / Fail
2402	1.0	0	685.4	500	Pass
2440	1.0	19	688.0	500	Pass
2480	1.0	39	684.6	500	Pass
2402	2.0	0	1131.4	500	Pass
2440	2.0	19	1129.7	500	Pass
2480	2.0	39	1126.1	500	Pass

Table 7-2. Conducted Bandwidth Measurements

Plot 7-1. 6dB Bandwidth Plot (Bluetooth (LE), 1Mbps, Ch. 0)

Plot 7-2. 6dB Bandwidth Plot (Bluetooth (LE), 1Mbps, Ch. 19)

Plot 7-3. 6dB Bandwidth Plot (Bluetooth (LE), 1Mbps, Ch. 39)



Plot 7-4. 6dB Bandwidth Plot (Bluetooth (LE), 2Mbps, Ch. 0)

Plot 7-5. 6dB Bandwidth Plot (Bluetooth (LE), 2Mbps, Ch. 19)

Plot 7-6. 6dB Bandwidth Plot (Bluetooth (LE), 2Mbps, Ch. 39)

7.3 Output Power Measurement – Bluetooth (LE)

§15.247(b.3)

Test Overview and Limits

The transmitter antenna terminal of the EUT is connected to the input of a spectrum analyzer. Measurements are made while the EUT is operating at maximum power and at the appropriate frequencies.

The maximum peak conducted output power of digital modulation systems operating in the 2400-2483.5MHz band is 1 Watt.

The conducted output power limit on paragraph above is based on the use of antennas with directional gains that do not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, the conducted ouput power from the intentional radiator shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Test Procedure Used

KDB 558074 D01 v05r02 – Section 8.3.1.3
ANSI C63.10-2013 - Section 11.9.1.3
ANSI C63.10-2013 - Section 11.9.2.3.2

Test Settings

Method PKPM1 (Peak Power Measurement)

The maximum peak conducted output power may be measured using a broadband peak RF power meter. The power meter shall have a video bandwidth that is greater than or equal to the DTS bandwidth and shall utilize a fast-responding diode detector.

Method AVGPM-G (Average Power Measurement)

Average power measurements were performed only when the EUT was transmitting at its maximum power control level using a broadband power meter with a pulse sensor. The power meter implemented triggering and gating capabilities which were set up such that power measurements were recorded only during the ON time of the transmitter. The trace was averaged over 100 traces to obtain the final measured average power

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

Figure 7-2. Test Instrument & Measurement Setup for Peak and Average Power Measurement

Test Notes

None

7.3.1 Peak Output Power Measurement – Bluetooth (LE)

§15.247(b.3)

Frequency [MHz]	Data Rate [Mbps]	Channel No.	Peak Conducted Power		Conducted Power Limit [dBm]	Conducted Power Margin [dB]
			[dBm]	[mW]		
2402	1.0	0	-2.30	0.589	30.00	-32.30
2440	1.0	19	-2.28	0.592	30.00	-32.28
2480	1.0	39	-2.24	0.597	30.00	-32.24
2402	2.0	0	-2.30	0.589	30.00	-32.30
2440	2.0	19	-2.30	0.589	30.00	-32.30
2480	2.0	39	-2.25	0.596	30.00	-32.25

Table 7-3. Peak Conducted Output Power Measurements (Bluetooth LE)

7.3.2 Average Output Power Measurement – Bluetooth (LE)

§15.247(b.3)

Frequency [MHz]	Data Rate [Mbps]	Channel No.	Average Conducted Power		Conducted Power Limit [dBm]	Conducted Power Margin [dB]
			[dBm]	[mW]		
2402	1.0	0	-2.80	0.525	30.00	-32.80
2440	1.0	19	-2.73	0.533	30.00	-32.73
2480	1.0	39	-2.70	0.537	30.00	-32.70
2402	2.0	0	-2.82	0.522	30.00	-32.82
2440	2.0	19	-2.78	0.527	30.00	-32.78
2480	2.0	39	-2.75	0.531	30.00	-32.75

Table 7-4. Average Conducted Output Power Measurements (Bluetooth LE)

7.4 Power Spectral Density – Bluetooth (LE)

§15.247(e)

Test Overview and Limit

The peak power density is measured with a spectrum analyzer connected to the antenna terminal of the EUT while the EUT is operating at maximum power and at the appropriate frequencies.

The maximum permissible power spectral density is 8 dBm in any 3 kHz band.

Test Procedure Used

ANSI C63.10-2013 – Section 11.10.2 Method PKPSD
KDB 558074 D01 v05r02 – Section 8.4 DTS Maximum Power Spectral Density level in the fundamental emission

Test Settings

1. Analyzer was set to the center frequency of the DTS channel under investigation
2. Span = 1.5 times the DTS channel bandwidth
3. RBW = 3kHz
4. VBW = 1MHz
5. Detector = peak
6. Sweep time = auto couple
7. Trace mode = max hold
8. Trace was allowed to stabilize

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

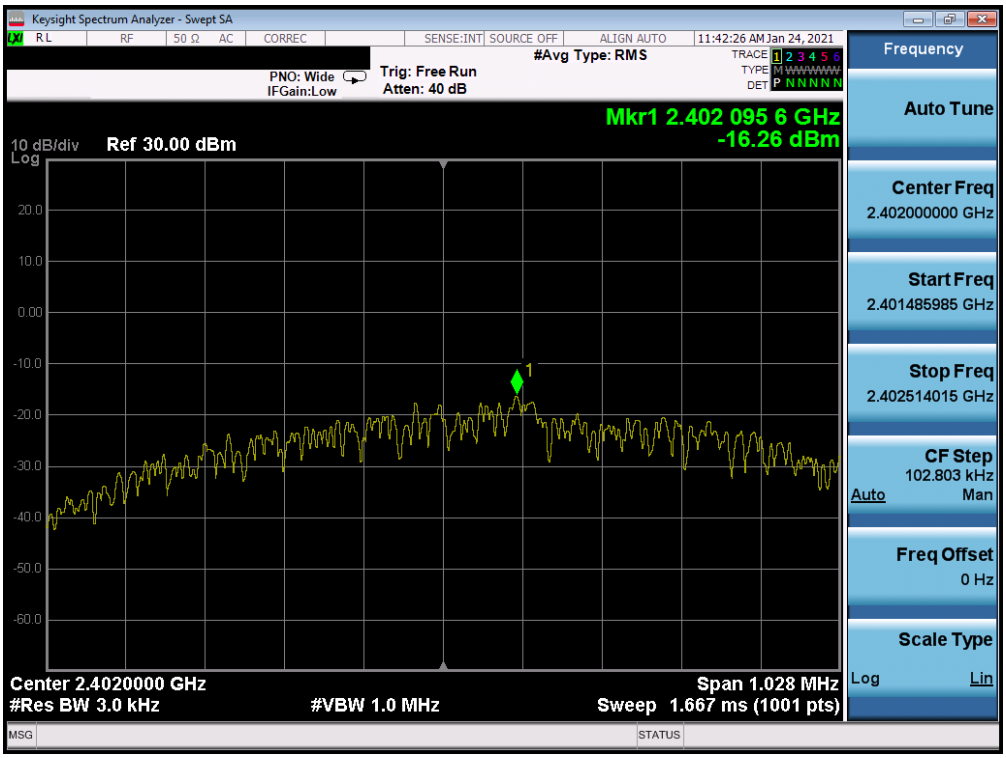
Figure 7-3. Test Instrument & Measurement Setup

Test Notes

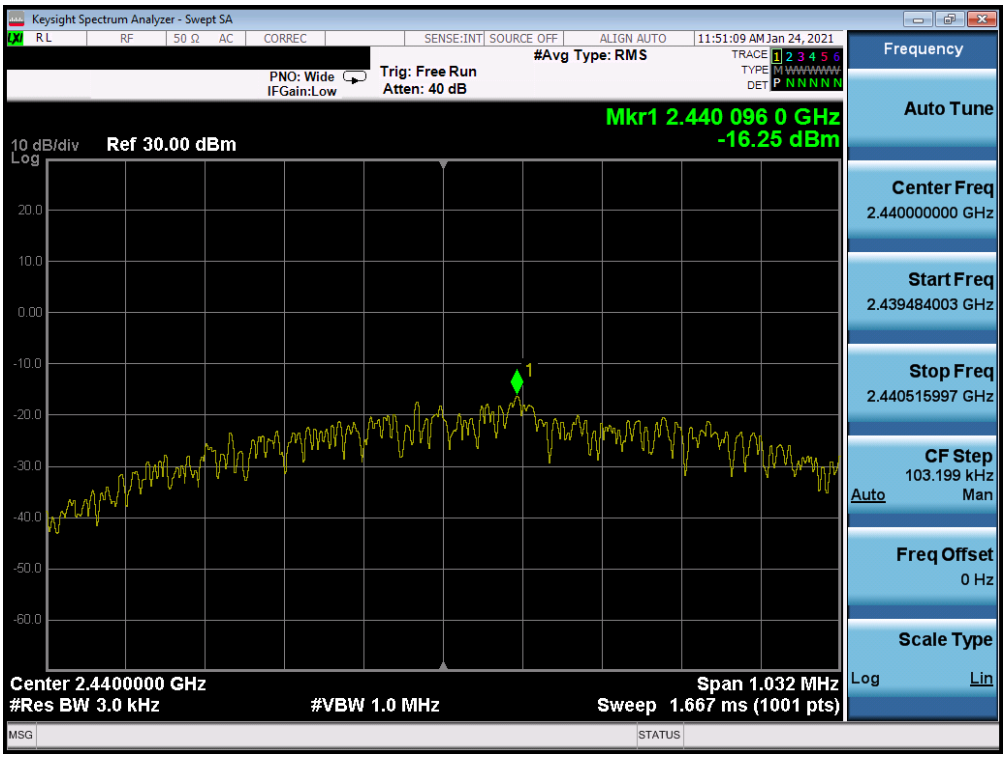
None

Frequency [MHz]	Data Rate [Mbps]	Channel No.	Measured Power Spectral Density [dBm / 3kHz]	Maximum Permissible Power Density [dBm / 3kHz]	Margin [dB]
2402	1.0	0	-16.26	8.0	-24.26
2440	1.0	19	-16.25	8.0	-24.25
2480	1.0	39	-16.45	8.0	-24.45
2402	2.0	0	-16.52	8.0	-24.52
2440	2.0	19	-16.19	8.0	-24.19
2480	2.0	39	-16.34	8.0	-24.34

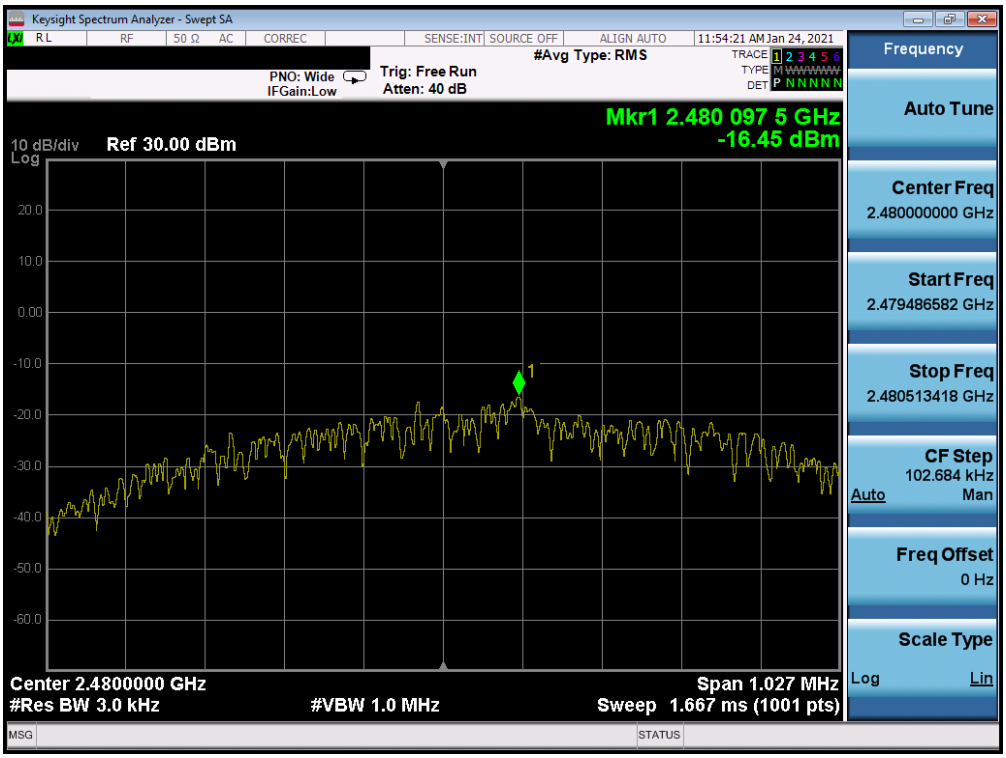
Table 7-5. Conducted Power Density Measurements



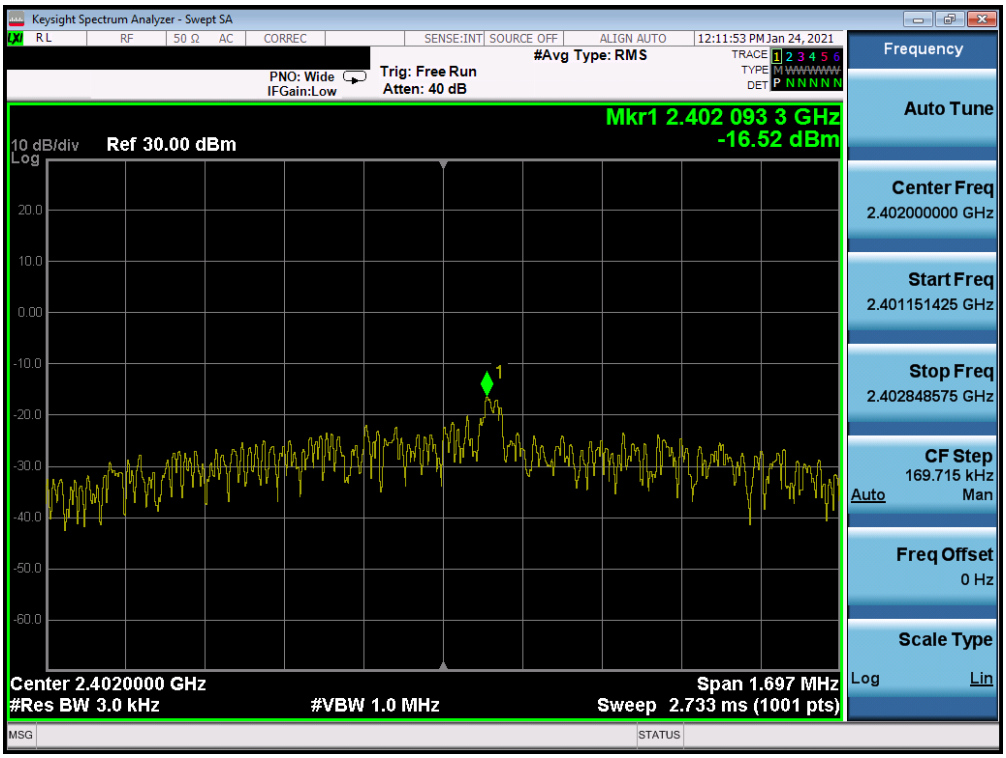
Plot 7-7. Power Spectral Density Plot (Bluetooth (LE), 1Mbps, Ch. 0)



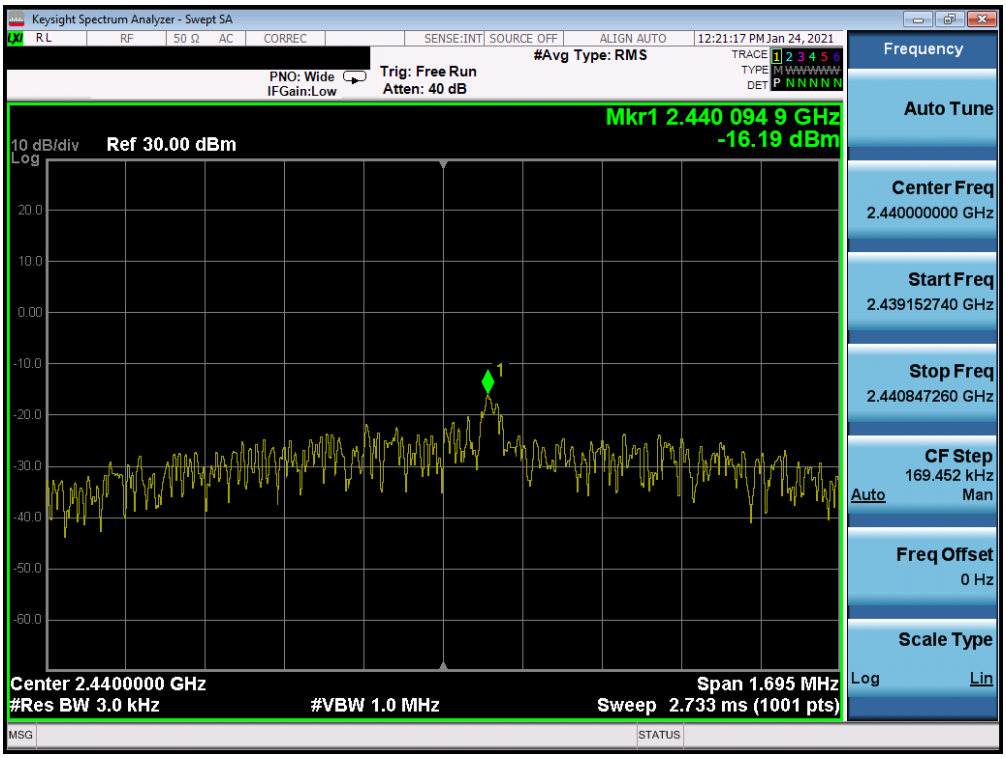
Plot 7-8. Power Spectral Density Plot (Bluetooth (LE), 1Mbps, Ch. 19)



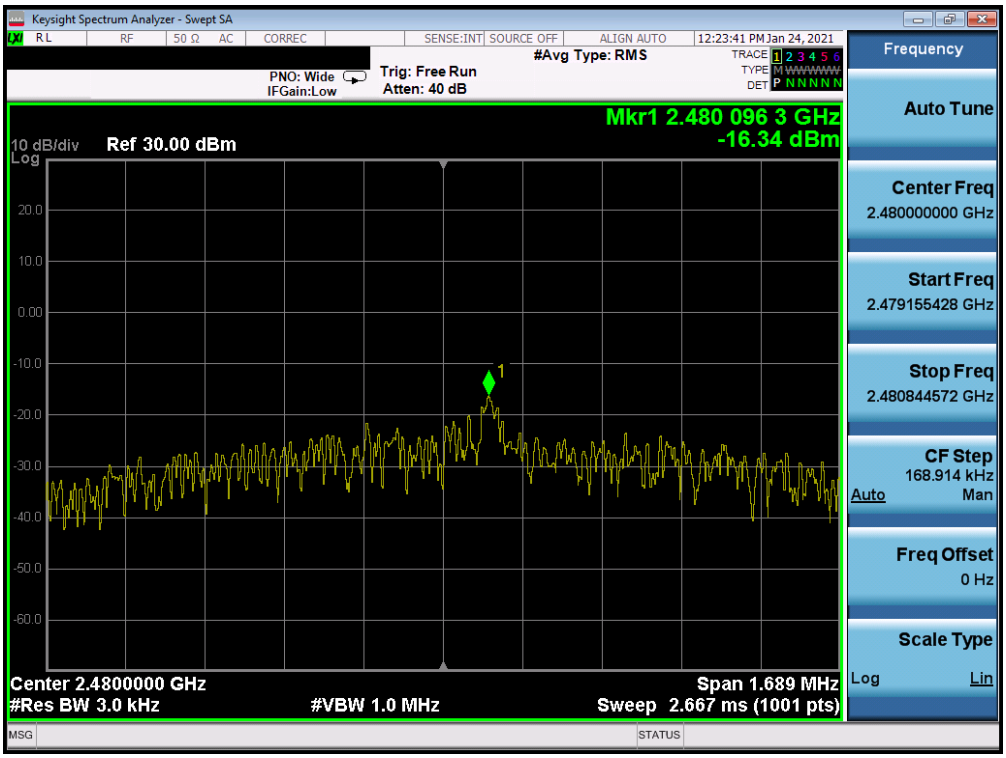
Plot 7-9. Power Spectral Density Plot (Bluetooth (LE), 1Mbps, Ch. 39)



Plot 7-10. Power Spectral Density Plot (Bluetooth (LE), 2Mbps, Ch. 0)



Plot 7-11. Power Spectral Density Plot (Bluetooth (LE), 2Mbps, Ch. 19)



Plot 7-12. Power Spectral Density Plot (Bluetooth (LE), 2Mbps, Ch. 39)

7.5 Conducted Emissions at the Band Edge

§15.247(d)

Test Overview and Limit

For the following out of band conducted spurious emissions plots at the band edge, the EUT was set to transmit at maximum power with the largest packet size available. These settings produced the worst-case emissions.

The limit for out-of-band spurious emissions at the band edge is 20dB below the fundamental emission level, as determined from the in-band power measurement of the DTS channel performed in a 100kHz bandwidth.

Test Procedure Used

ANSI C63.10-2013 – Section 11.11.3
KDB 558074 D01 v05r02 – Section 8.7.2

Test Settings

1. Start and stop frequency were set such that the band edge would be placed in the center of the plot
2. Span was set large enough so as to capture all out of band emissions near the band edge
3. RBW = 100kHz
4. VBW = 300kHz
5. Detector = Peak
6. Number of sweep points ≥ 2 x Span/RBW
7. Trace mode = max hold
8. Sweep time = auto couple
9. The trace was allowed to stabilize

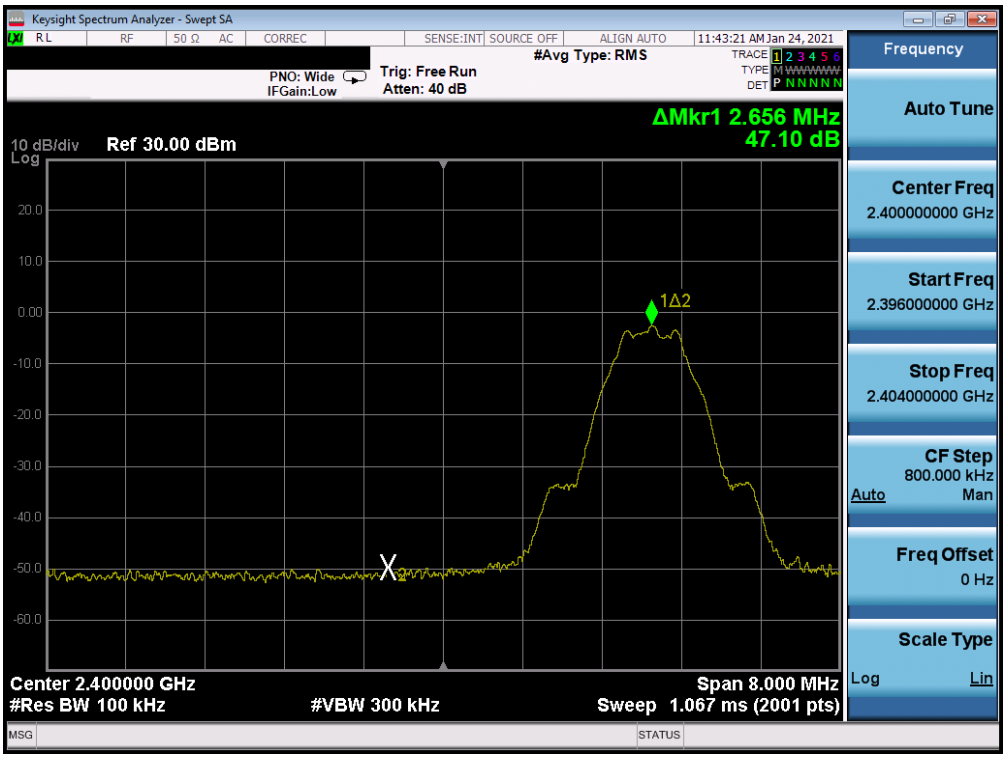
Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

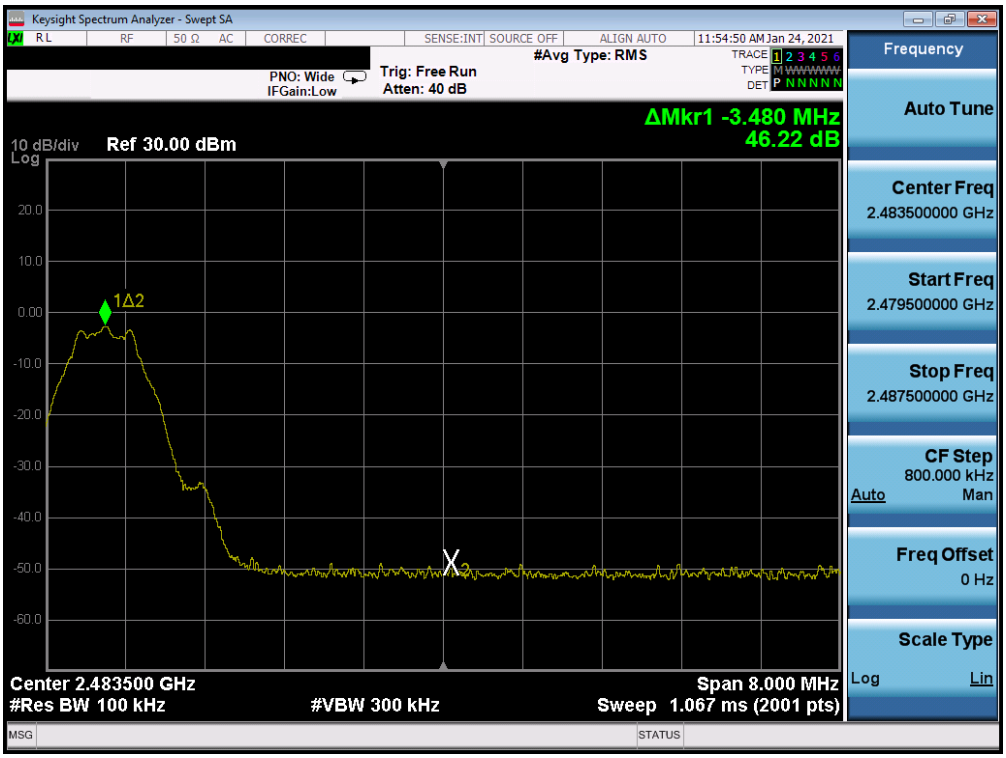
Figure 7-4. Test Instrument & Measurement Setup

Test Notes

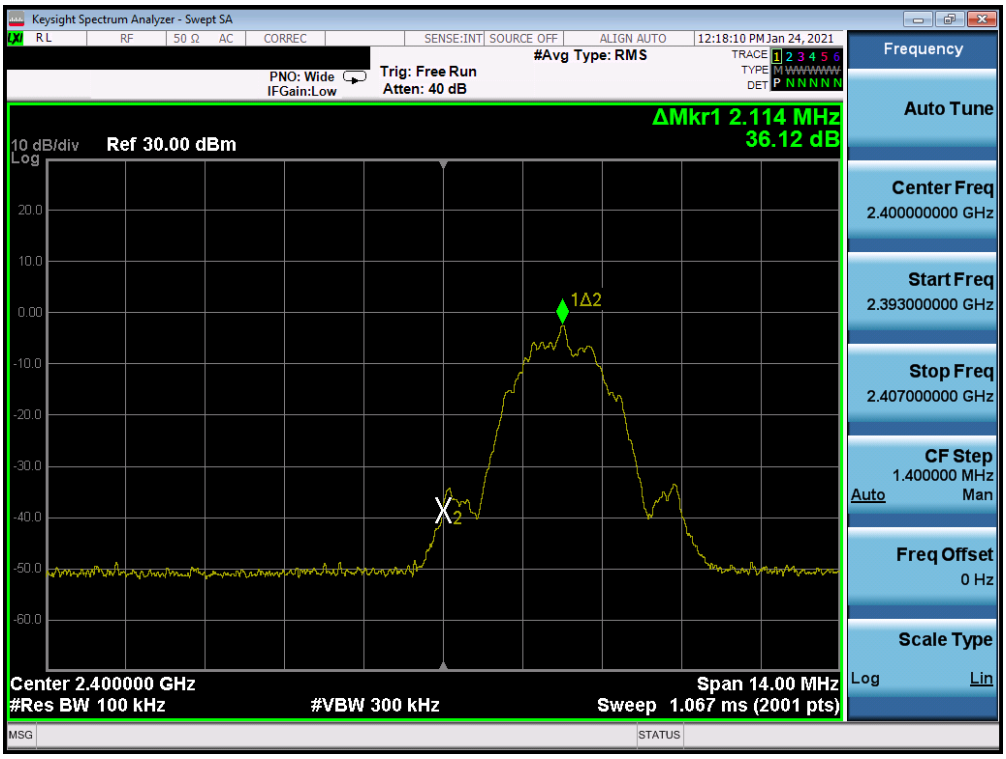
None



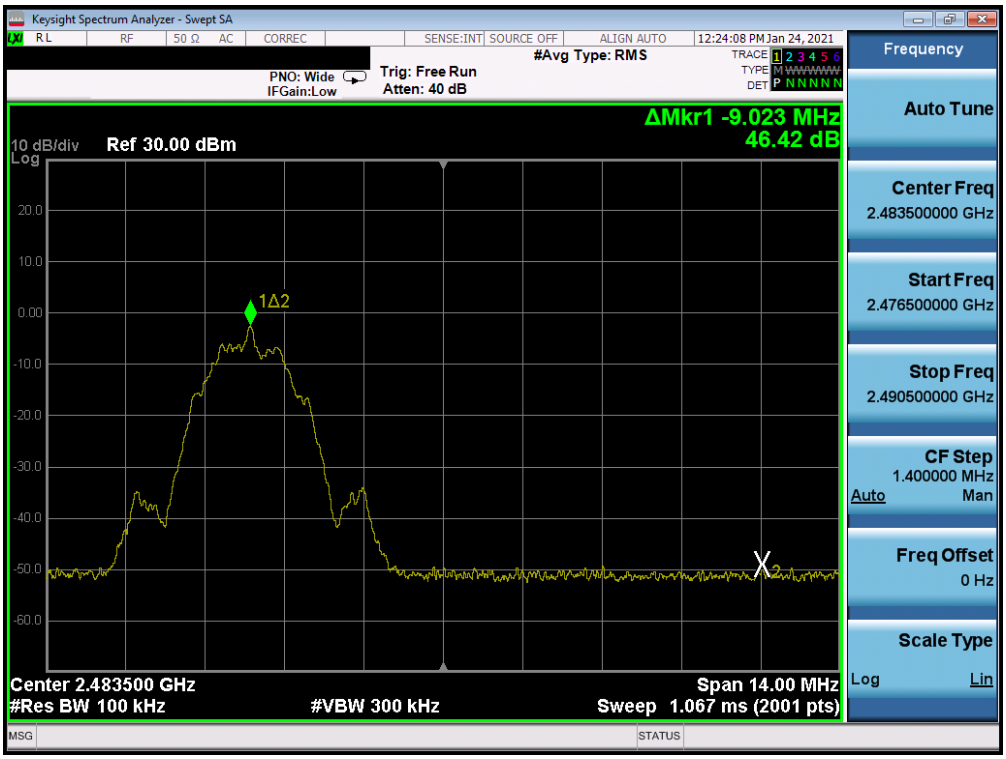
Plot 7-13. Band Edge Plot (Bluetooth (LE), 1Mbps, Ch. 0)



Plot 7-14. Band Edge Plot (Bluetooth (LE), 1Mbps, Ch. 39)



Plot 7-15. Band Edge Plot (Bluetooth (LE), 2Mbps, Ch. 0)



Plot 7-16. Band Edge Plot (Bluetooth (LE), 2Mbps, Ch. 39)

7.6 Conducted Spurious Emissions

§15.247(d)

Test Overview and Limit

For the following out of band conducted spurious emissions plots, the EUT was set to transmit at maximum power with the largest packet size available. The worst case spurious emissions were found in this configuration.

The limit for out-of-band spurious emissions at the band edge is 20dB below the fundamental emission level, as determined from the in-band power measurement of the DTS channel performed in a 100kHz bandwidth per the procedure in Section 8.5 of KDB 558074 D01 v05r02 and Section 11.11.3 of ANSI C63.10-2013.

Test Procedure Used

ANSI C63.10-2013 – Section 11.11.3
KDB 558074 D01 v05r02 – Section 8.5

Test Settings

1. Start frequency was set to 30MHz and stop frequency was set to 25GHz (separated into two plots per channel)
2. RBW = 1MHz
3. VBW = 3MHz
4. Detector = Peak
5. Trace mode = max hold
6. Sweep time = auto couple
7. The trace was allowed to stabilize

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

Figure 7-5. Test Instrument & Measurement Setup

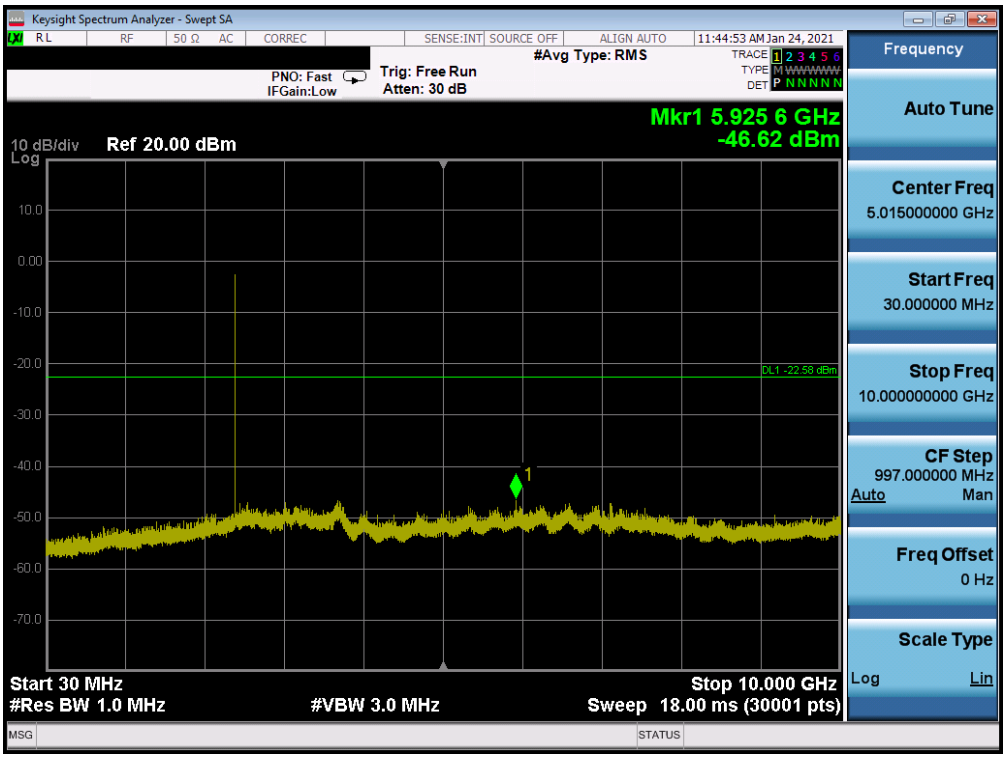
Test Notes

1. RBW was set to 1MHz rather than 100kHz in order to increase the measurement speed.

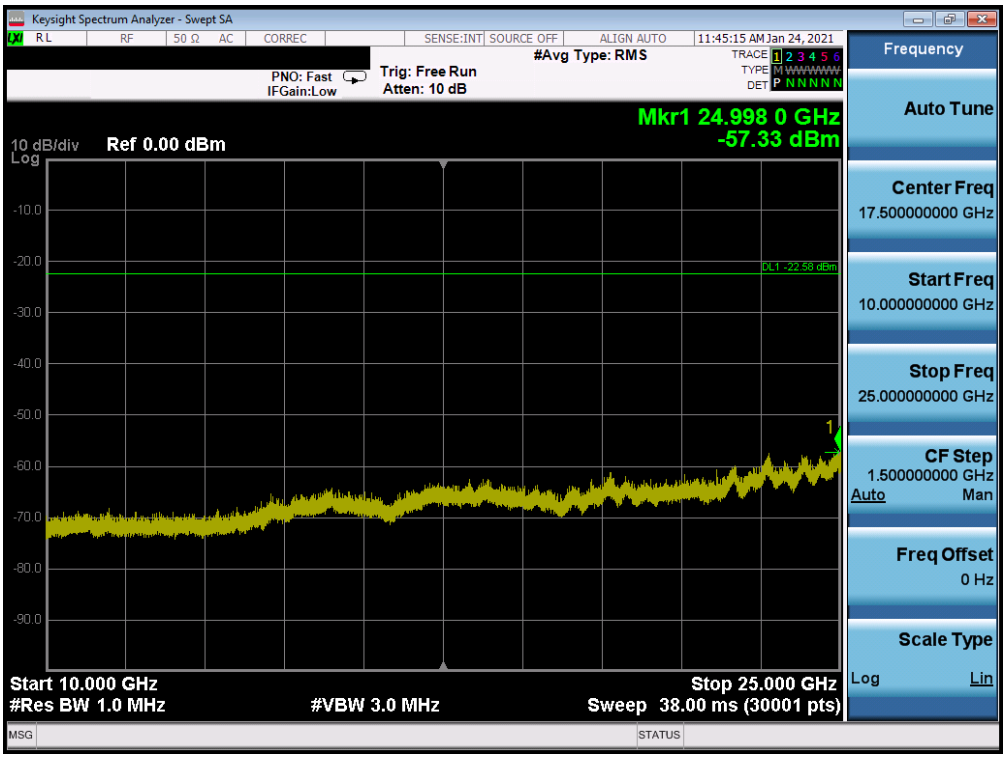
2. The display line shown in the following plots denotes the limit at 20dB below the fundamental emission level measured in a 100kHz bandwidth. However, since the traces in the following plots are measured with a 1MHz RBW, the display line may not necessarily appear to be 20dB below the level of the fundamental in a 1MHz bandwidth.

3. For plots showing conducted spurious emissions near the limit, the frequencies were investigated with a reduced RBW to ensure that no emissions were present.

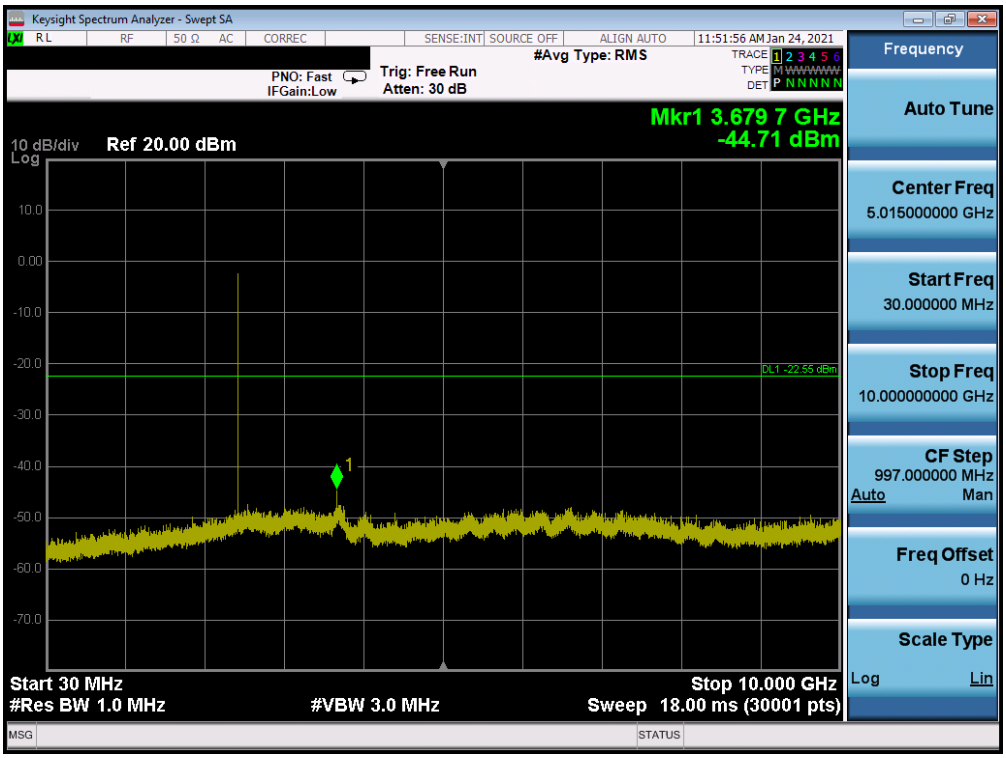
4. The unit was tested with both data rates and only the highest emission is reported.



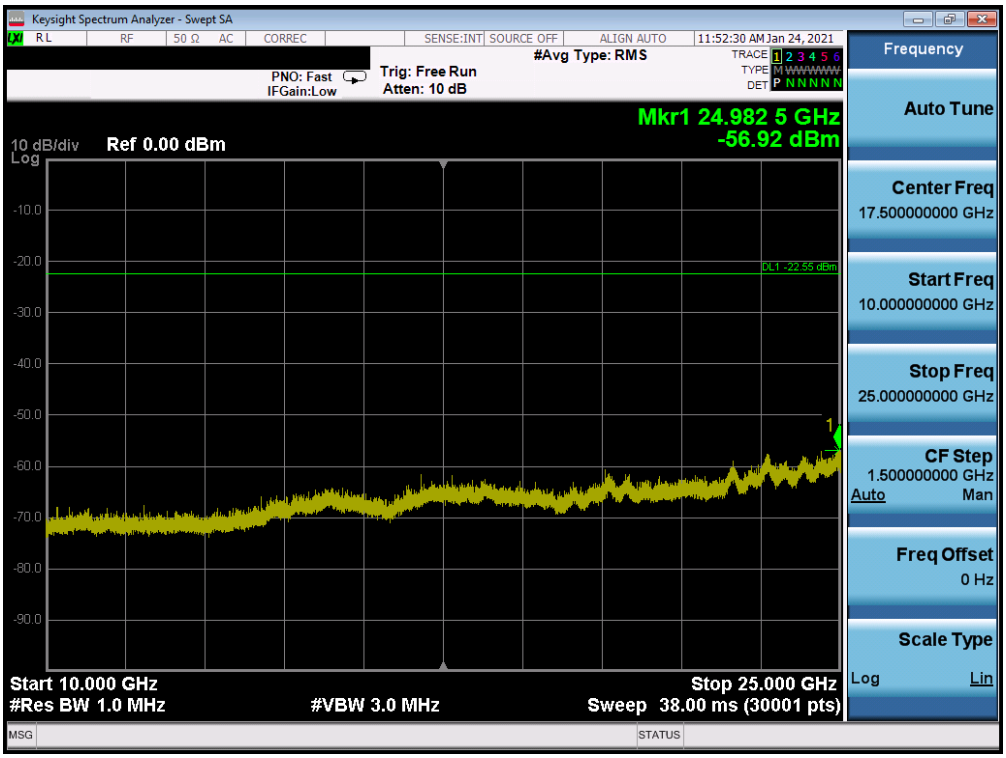
Plot 7-17. Conducted Spurious Plot (Bluetooth (LE), 1Mbps, Ch. 0)



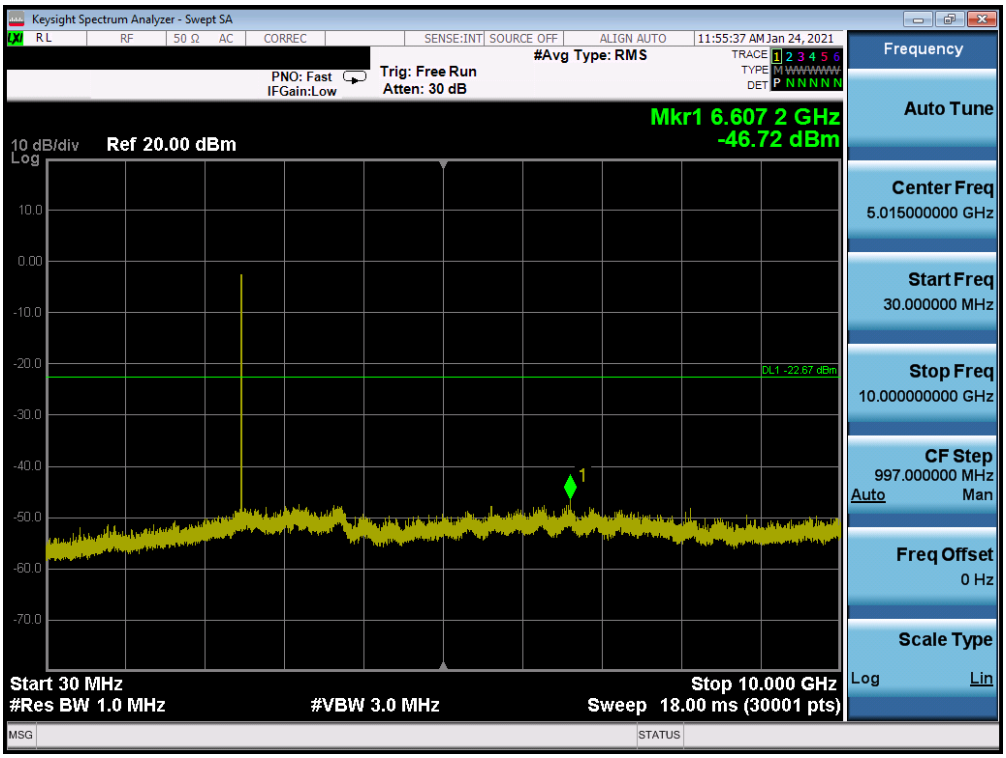
Plot 7-18. Conducted Spurious Plot (Bluetooth (LE), 1Mbps, Ch. 0)



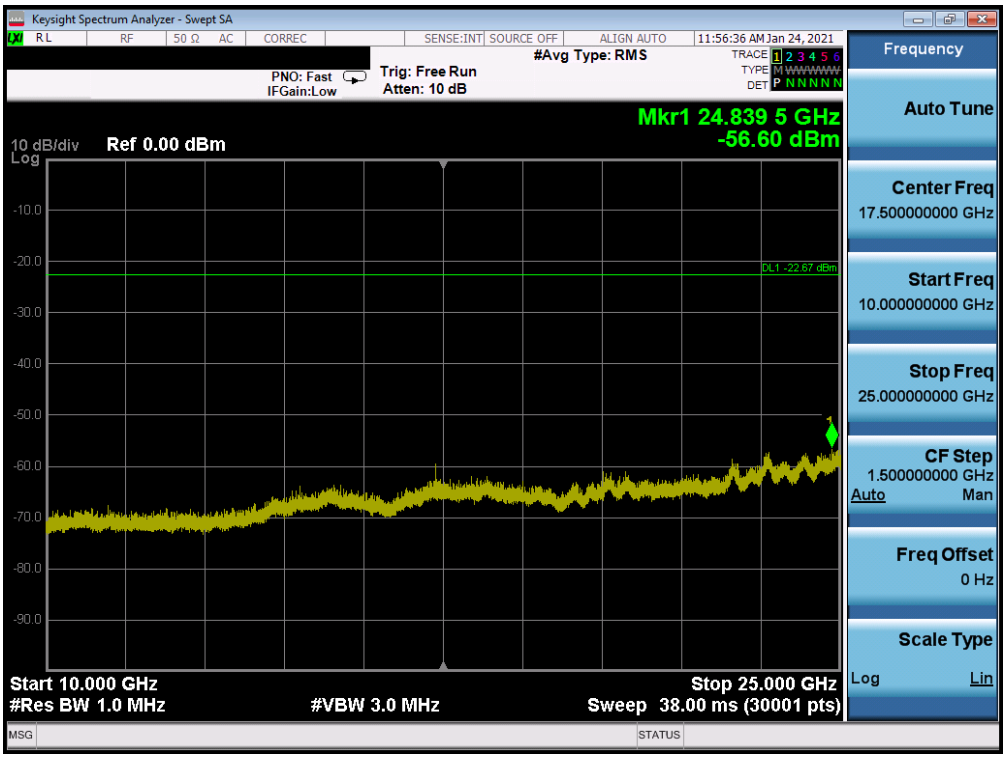
Plot 7-19. Conducted Spurious Plot (Bluetooth (LE), 1Mbps, Ch. 19)



Plot 7-20. Conducted Spurious Plot (Bluetooth (LE), 1Mbps, Ch. 19)



Plot 7-21. Conducted Spurious Plot (Bluetooth (LE), 1Mbps, Ch. 39)



Plot 7-22. Conducted Spurious Plot (Bluetooth (LE), 1Mbps, Ch. 39)

7.7 Radiated Spurious Emission – Above 1GHz

§15.205 §15.209 §15.247(d)

Test Overview and Limit

All out of band radiated spurious emissions are measured with a spectrum analyzer connected to a receive antenna while the EUT is operating at maximum power and at the appropriate frequencies. Only the radiated emissions of the configuration that produced the worst case emissions are reported in this section.

All out of band emissions appearing in a restricted band as specified in Section 15.205 of the Title 47 CFR must not exceed the limits shown in Table 7-6 per Section 15.209.

Frequency	Field Strength [µV/m]	Measured Distance [Meters]
Above 960.0 MHz	500	3

Table 7-6. Radiated Limits

Test Procedures Used

ANSI C63.10-2013 – Section 6.6.4.3

KDB 558074 D01 v05r02 – Section 8.6, 8.7

Test Settings

Average Field Strength Measurements

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 1MHz
3. VBW = 3MHz
4. Detector = power average (RMS)
5. Number of measurement points = 1001 (Number of points must be ≥ 2 x span/RBW)
6. Sweep time = auto
7. Trace (RMS) averaging was performed over at least 100 traces

Peak Field Strength Measurements

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 1MHz
3. VBW = 3MHz
4. Detector = Peak
5. Sweep time = auto couple
6. Trace mode = max hold
7. Trace was allowed to stabilize

Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.

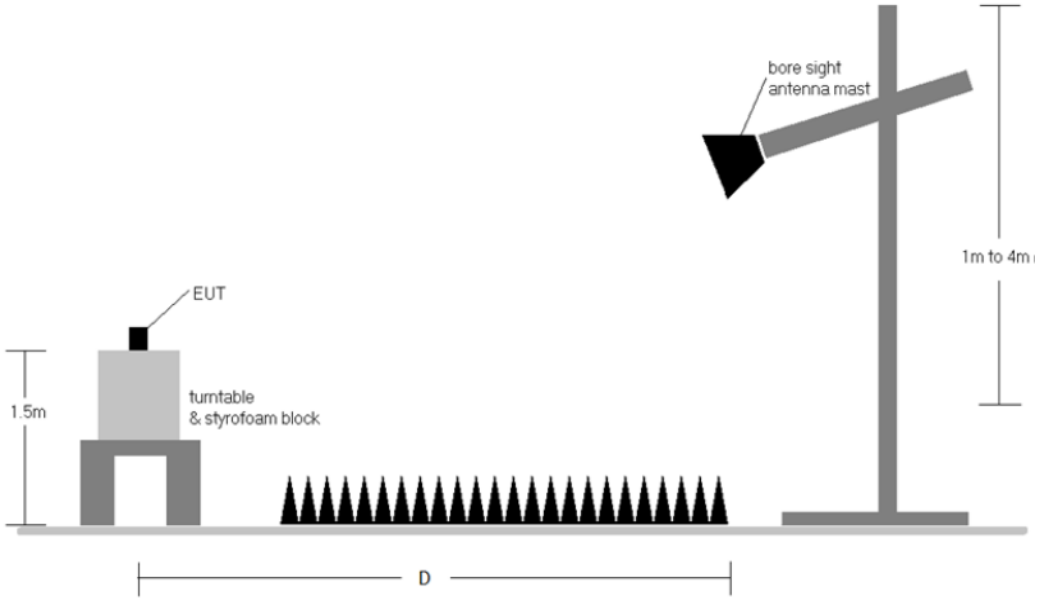


Figure 7-6. Radiated Test Setup >1GHz

Test Notes

1. The optional test procedures for antenna port conducted measurements of unwanted emissions per the guidance of KDB 558074 D01 v05r02 were not used to evaluate this device for compliance to radiated limits. All radiated spurious emissions levels were measured in a radiated test setup.
2. All emissions lying in restricted bands specified in §15.205 are below the limit shown in Table 7-6.
3. The antenna is manipulated through typical positions, polarity and length during the tests. The EUT is manipulated through three orthogonal planes.
4. The spectrum is measured from 9kHz to the 10th harmonic of the fundamental frequency of the transmitter using CISPR quasi peak detector below 1GHz. Above 1 GHz, average and peak measurements were taken using linearly polarized horn antennas.
5. Emissions below 18GHz were measured at a 3 meter test distance (D = 3) while emissions above 18GHz were measured at a 1 meter test distance (D = 1) with the application of a distance correction factor.
6. The "-" shown in the following RSE tables are used to denote a noise floor measurement.

Sample Calculations

Determining Spurious Emissions Levels

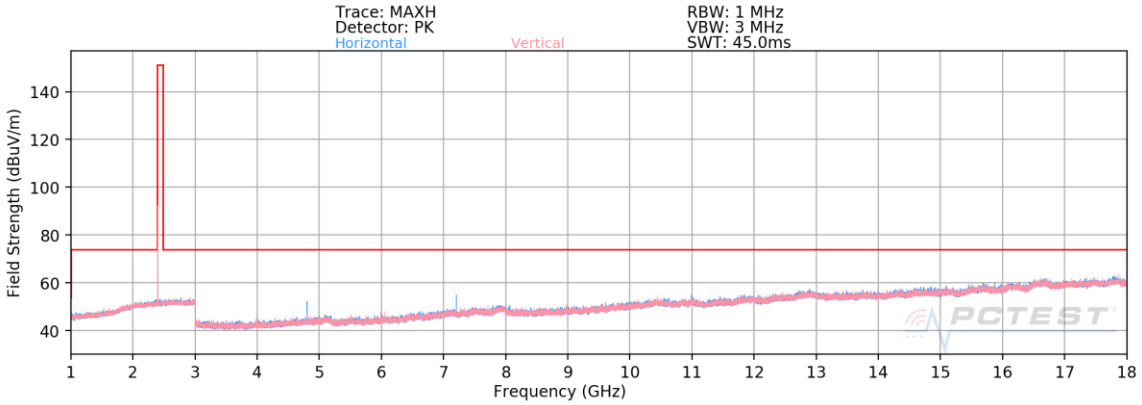
- Field Strength Level $_{[dB\mu V/m]}$ = Analyzer Level $_{[dBm]}$ + 107 + AFCL $_{[dB/m]}$
- AFCL $_{[dB/m]}$ = Antenna Factor $_{[dB/m]}$ + Cable Loss $_{[dB]}$ + Preamplifier Gain $_{[dB]}$ + DCCF $_{[dB]}$
  DCCF is applied only to average measurements.
- Margin $_{[dB]}$ = Field Strength Level $_{[dB\mu V/m]}$ – Limit $_{[dB\mu V/m]}$

Radiated Band Edge Measurement Offset

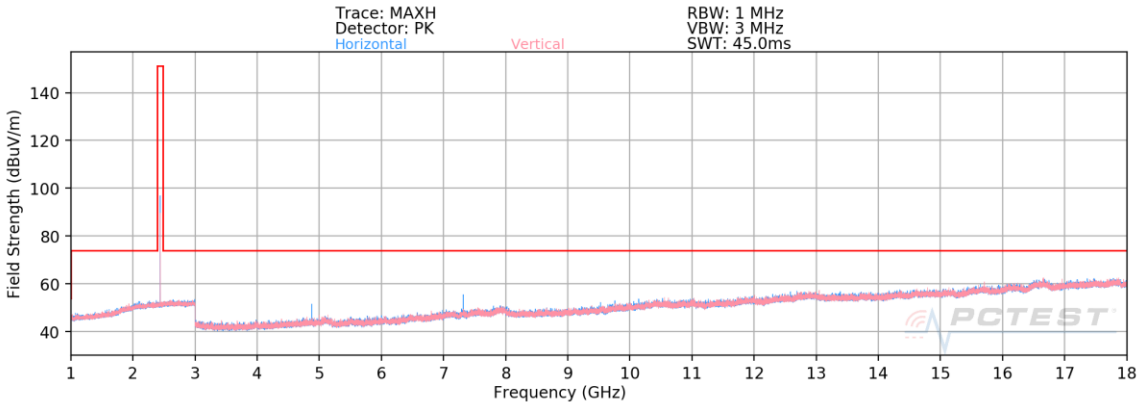
- The amplitude offset shown in the radiated restricted band edge plots in Section 7.7.3 was calculated using the formula:
  Offset (dB) = (Antenna Factor + Cable Loss + Attenuator) – Preamplifier Gain + DCCF
  DCCF is applied only to average measurements.

Radiated Spurious Emissions – Above 1GHz

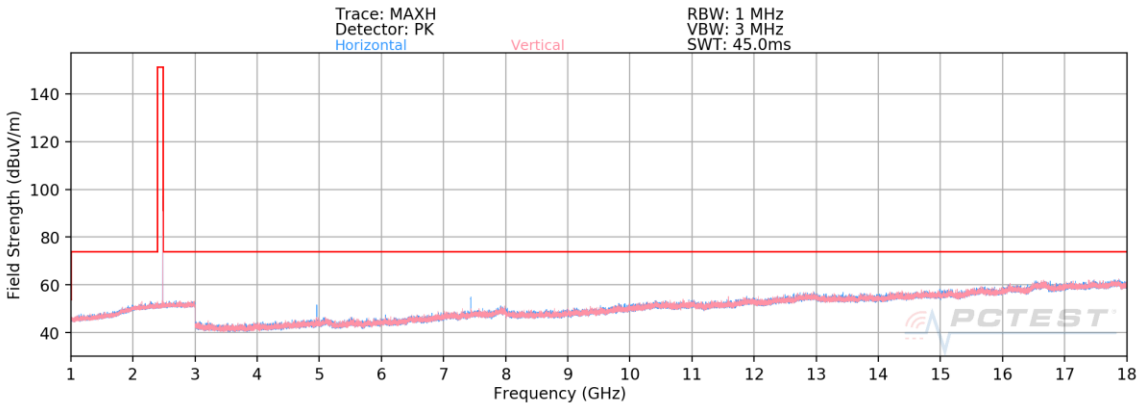
§15.205 §15.209 §15.247(d)



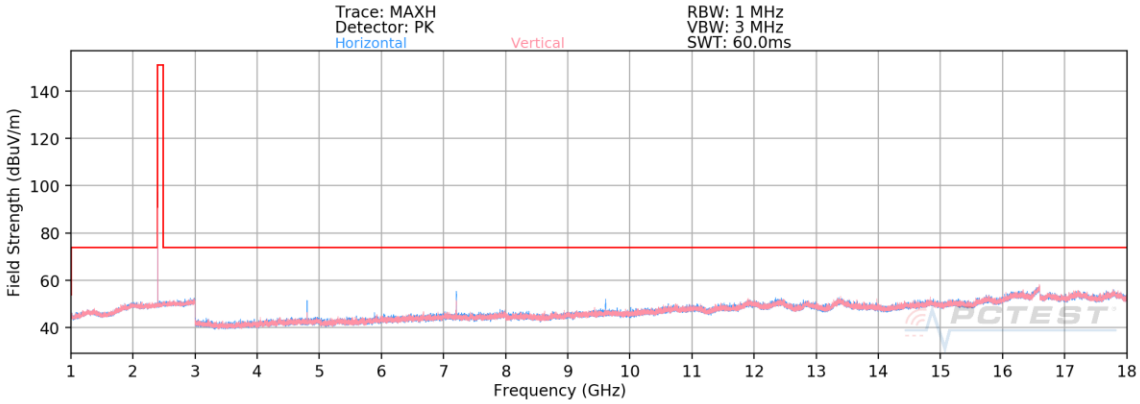
Plot 7-23. Radiated Spurious Emissions 1-18GHz (1Mbps, Ch. 0)



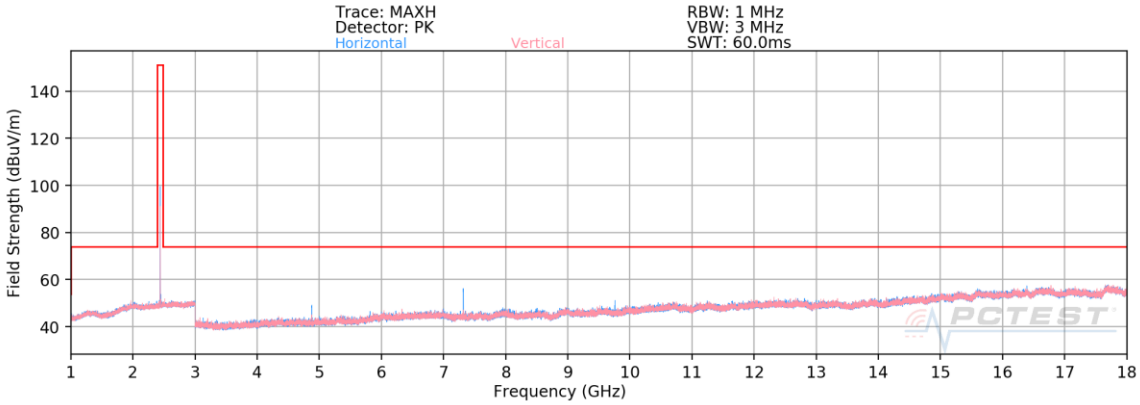
Plot 7-24. Radiated Spurious Emissions 1-18GHz (1Mbps, Ch. 19)



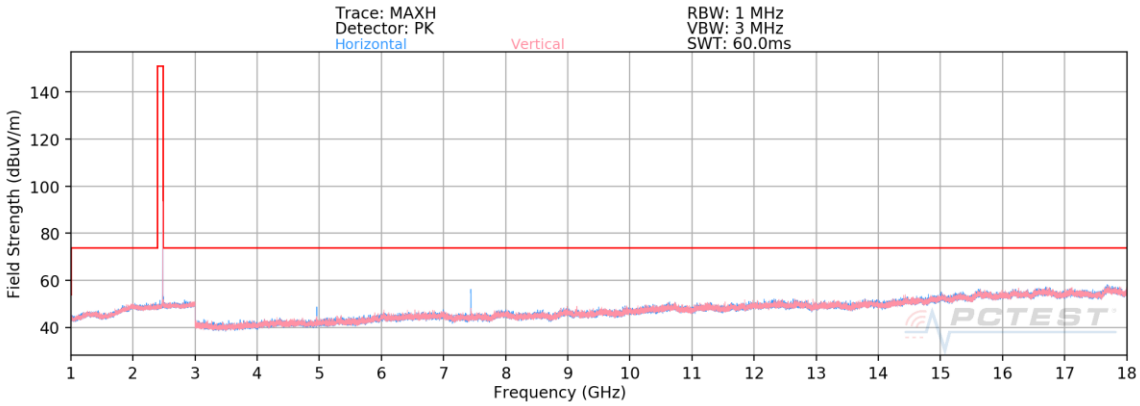
Plot 7-25. Radiated Spurious Emissions 1-18GHz (1Mbps, Ch. 39)



Plot 7-26. Radiated Spurious Emissions 1-18GHz (2Mbps, Ch. 0)



Plot 7-27. Radiated Spurious Emissions 1-18GHz (2Mbps, Ch. 19)



Plot 7-28. Radiated Spurious Emissions 1-18GHz (2Mbps, Ch. 39)

7.7.1 Radiated Spurious Emission Measurements – Above 1GHz

§15.205 §15.209 §15.247(d)

Bluetooth Mode:	LE
Data Rate	1Mbps
Distance of Measurements:	3 Meters
Operating Frequency:	2402MHz
Channel:	0

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	DCCF [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4804.00	Avg	H	109	326	-69.06	9.09	1.85	48.88	53.98	-5.10
4804.00	Peak	H	109	326	-62.45	9.09	--	53.64	73.98	-20.34
12010.00	Avg	H	109	355	-84.49	21.24	1.85	45.60	53.98	-8.37
12010.00	Peak	H	109	355	-73.05	21.24	--	55.19	73.98	-18.78

Table 7-7. Radiated Spurious Emission Measurements 1-18GHz

Bluetooth Mode:	LE
Data Rate	1Mbps
Distance of Measurements:	3 Meters
Operating Frequency:	2440MHz
Channel:	19

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	DCCF [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4880.00	Avg	H	105	329	-69.46	9.46	1.85	48.85	53.98	-5.13
4880.00	Peak	H	105	329	-63.46	9.46	--	53.00	73.98	-20.98
7320.00	Avg	H	101	47	-70.86	13.93	1.85	51.92	53.98	-2.06
7320.00	Peak	H	101	47	-63.80	13.93	--	57.13	73.98	-16.85
12200.00	Avg	H	109	1	-85.74	21.35	1.85	44.46	53.98	-9.52
12200.00	Peak	H	109	1	-75.17	21.35	--	53.18	73.98	-20.80

Table 7-8. Radiated Spurious Emission Measurements 1-18GHz

Bluetooth Mode:	LE
Data Rate	1Mbps
Distance of Measurements:	3 Meters
Operating Frequency:	2480MHz
Channel:	39

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	DCCF [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4960.00	Avg	H	113	325	-69.91	9.41	1.85	48.35	53.98	-5.63
4960.00	Peak	H	113	325	-62.89	9.41	--	53.52	73.98	-20.46
7440.00	Avg	H	109	23	-72.84	14.77	1.85	50.78	53.98	-3.20
7440.00	Peak	H	109	23	-65.37	14.77	--	56.40	73.98	-17.58
12400.00	Avg	H	-	-	-86.11	21.89	1.85	44.63	53.98	-9.35
12400.00	Peak	H	-	-	-74.93	21.89	--	53.96	73.98	-20.02

Table 7-9. Radiated Spurious Emission Measurements 1-18GHz

Bluetooth Mode:	LE
Data Rate	2Mbps
Distance of Measurements:	3 Meters
Operating Frequency:	2402MHz
Channel:	0

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	DCCF [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4804.00	Avg	H	239	267	-72.83	6.40	4.36	44.93	53.98	-9.04
4804.00	Peak	H	239	267	-62.86	6.40	--	50.54	73.98	-23.43
12010.00	Avg	H	118	10	-82.15	15.33	4.36	44.54	53.98	-9.44
12010.00	Peak	H	118	10	-70.84	15.33	--	51.49	73.98	-22.49

Table 7-10. Radiated Spurious Emission Measurements 1-18GHz

Bluetooth Mode:	LE
Data Rate	2Mbps
Distance of Measurements:	3 Meters
Operating Frequency:	2440MHz
Channel:	19

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	DCCF [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4880.00	Avg	H	110	23	-76.33	6.33	4.36	41.36	53.98	-12.62
4880.00	Peak	H	110	23	-62.30	6.33	--	51.03	73.98	-22.95
7320.00	Avg	H	113	9	-74.17	9.86	4.36	47.05	53.98	-6.93
7320.00	Peak	H	113	9	-58.36	9.86	--	58.50	73.98	-15.48
12200.00	Avg	H	-	-	-81.91	15.44	4.36	44.89	53.98	-9.09
12200.00	Peak	H	-	-	-69.53	15.44	--	52.91	73.98	-21.07

Table 7-11. Radiated Spurious Emission Measurements 1-18GHz

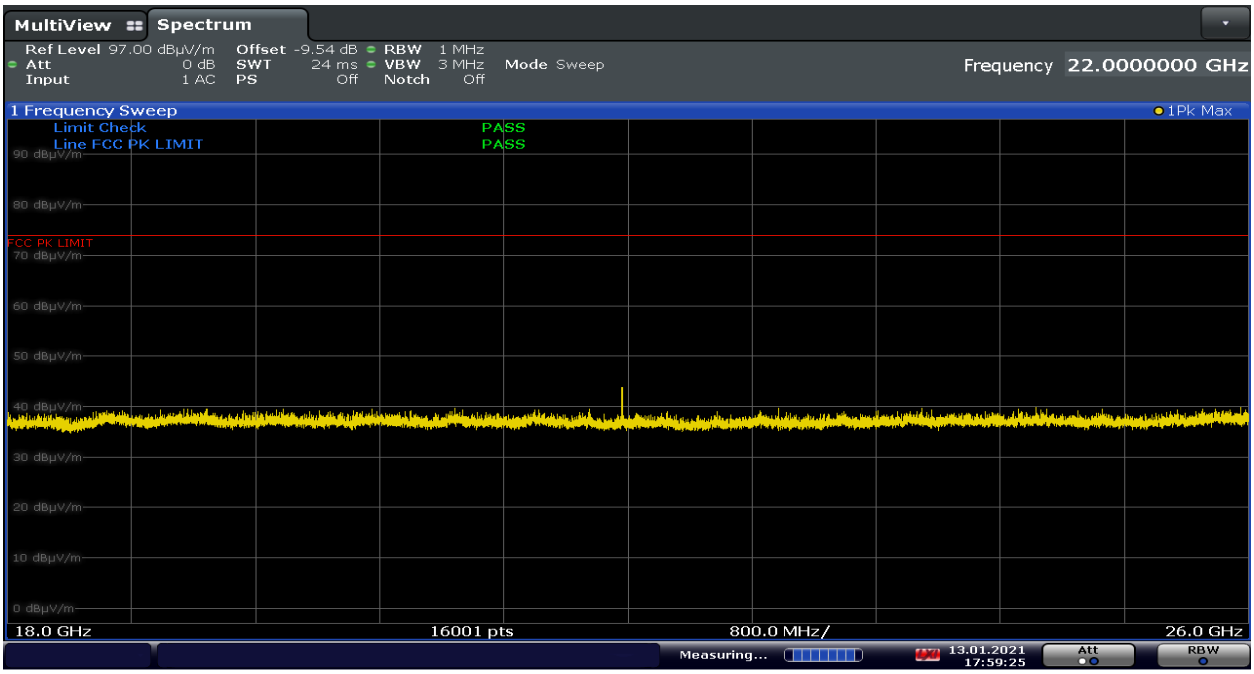
Bluetooth Mode:	LE
Data Rate	2Mbps
Distance of Measurements:	3 Meters
Operating Frequency:	2480MHz
Channel:	39

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	DCCF [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4960.00	Avg	H	138	290	-77.07	7.11	4.36	41.40	53.98	-12.58
4960.00	Peak	H	138	290	-62.94	7.11	--	51.17	73.98	-22.81
7440.00	Avg	H	117	18	-75.99	10.51	4.36	45.88	53.98	-8.10
7440.00	Peak	H	117	18	-59.92	10.51	--	57.59	73.98	-16.39
12400.00	Avg	H	-	-	-81.79	15.38	4.36	44.95	53.98	-9.03
12400.00	Peak	H	-	-	-69.42	15.38	--	52.96	73.98	-21.02

Table 7-12. Radiated Spurious Emission Measurements 1-18GHz

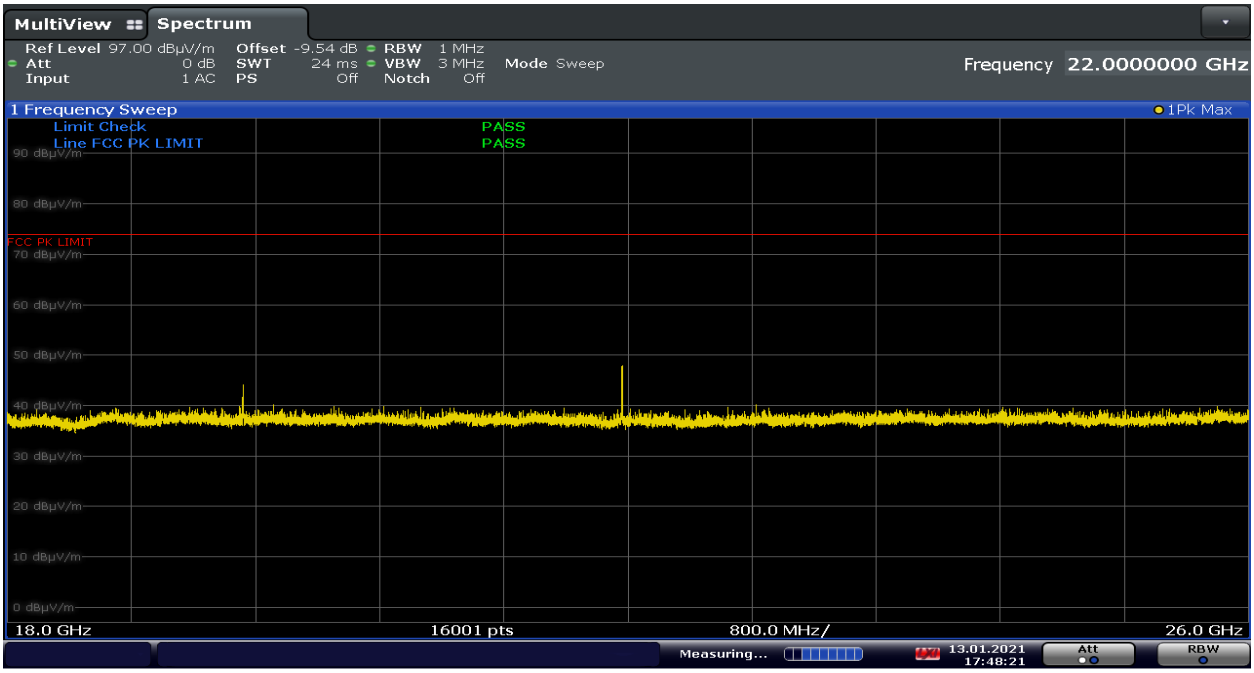
Radiated Spurious Emissions – Above 18GHz

§15.205 §15.209 §15.247(d)



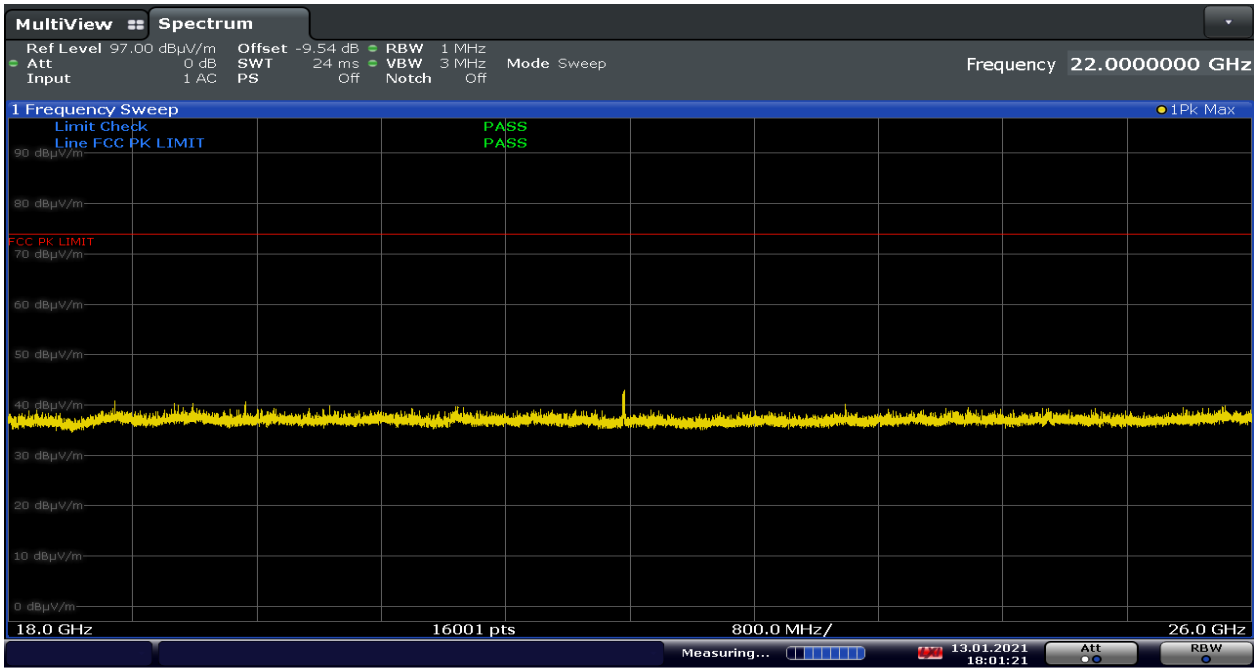
17:59:26 13.01.2021

Plot 7-29. Radiated Spurious Plot Above 18GHz (1Mbps, Ch.19, Pol. H)



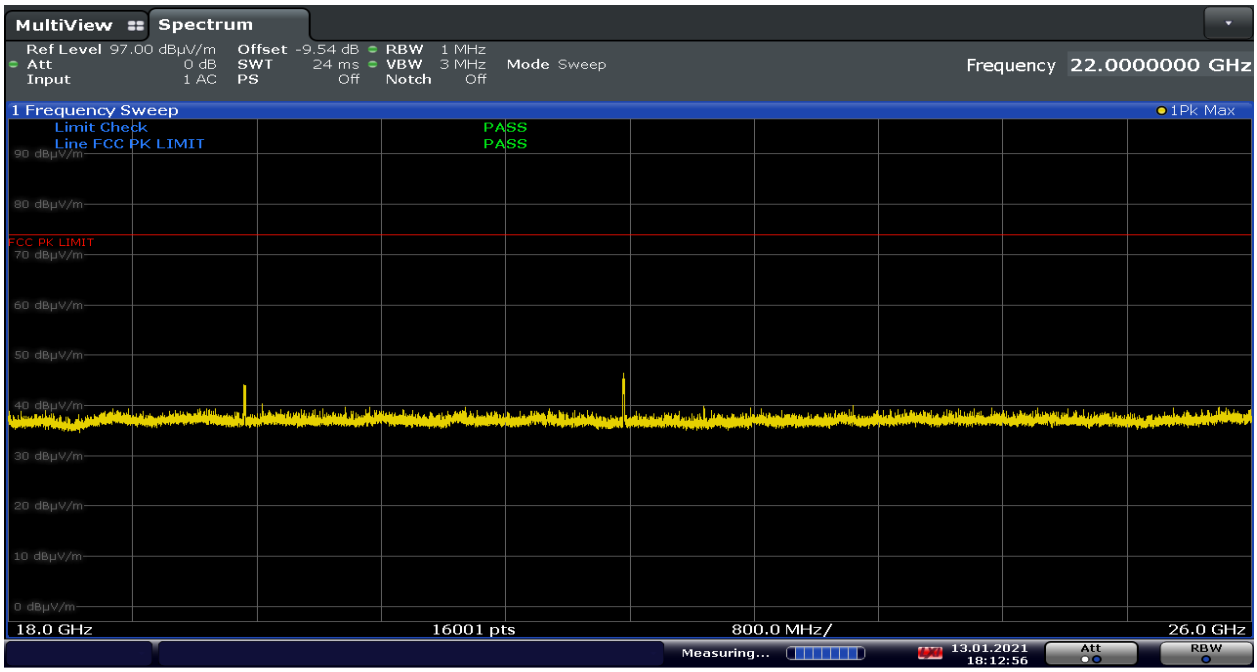
17:48:22 13.01.2021

Plot 7-30. Radiated Spurious Plot Above 18GHz (1Mbps, Ch.19, Pol. V)



18:01:21 13.01.2021

Plot 7-31. Radiated Spurious Plot Above 18GHz (2Mbps, Ch.19, Pol. H)



18:12:57 13.01.2021

Plot 7-32. Radiated Spurious Plot Above 18GHz (2Mbps, Ch.19, Pol. V)

7.7.2 Radiated Spurious Emission Measurements – Above 18GHz

§15.205 §15.209 §15.247(d)

Bluetooth Mode:	LE
Data Rate	1Mbps
Distance of Measurements:	1 Meter
Operating Frequency:	2440MHz
Channel:	19

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	DCCF [dB]	Dist. Corr. Factor [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
19520.00	Avg	V	150	101	-57.23	-6.28	1.85	-9.54	35.80	53.98	-18.18
19520.00	Peak	V	150	101	-45.84	-6.28	--	-9.54	45.34	73.98	-28.64
21960.00	Avg	V	150	105	-55.17	-6.84	1.85	-9.54	37.30	53.98	-16.68
21960.00	Peak	V	150	105	-42.90	-6.84	--	-9.54	47.72	73.98	-26.26

Table 7-13. Radiated Spurious Emission Measurements Above 18GHz

Bluetooth Mode:	LE
Data Rate	2Mbps
Distance of Measurements:	1 Meter
Operating Frequency:	2440MHz
Channel:	19

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	DCCF [dB]	Dist. Corr. Factor [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
19520.00	Avg	V	150	102	-57.33	-6.28	4.36	-9.54	38.21	53.98	-15.77
19520.00	Peak	V	150	102	-45.74	-6.28	--	-9.54	45.44	73.98	-28.54
21960.00	Avg	V	150	108	-56.45	-6.84	4.36	-9.54	38.53	53.98	-15.45
21960.00	Peak	V	150	108	-43.15	-6.84	--	-9.54	47.47	73.98	-26.51

Table 7-14. Radiated Spurious Emission Measurements Above 18GHz

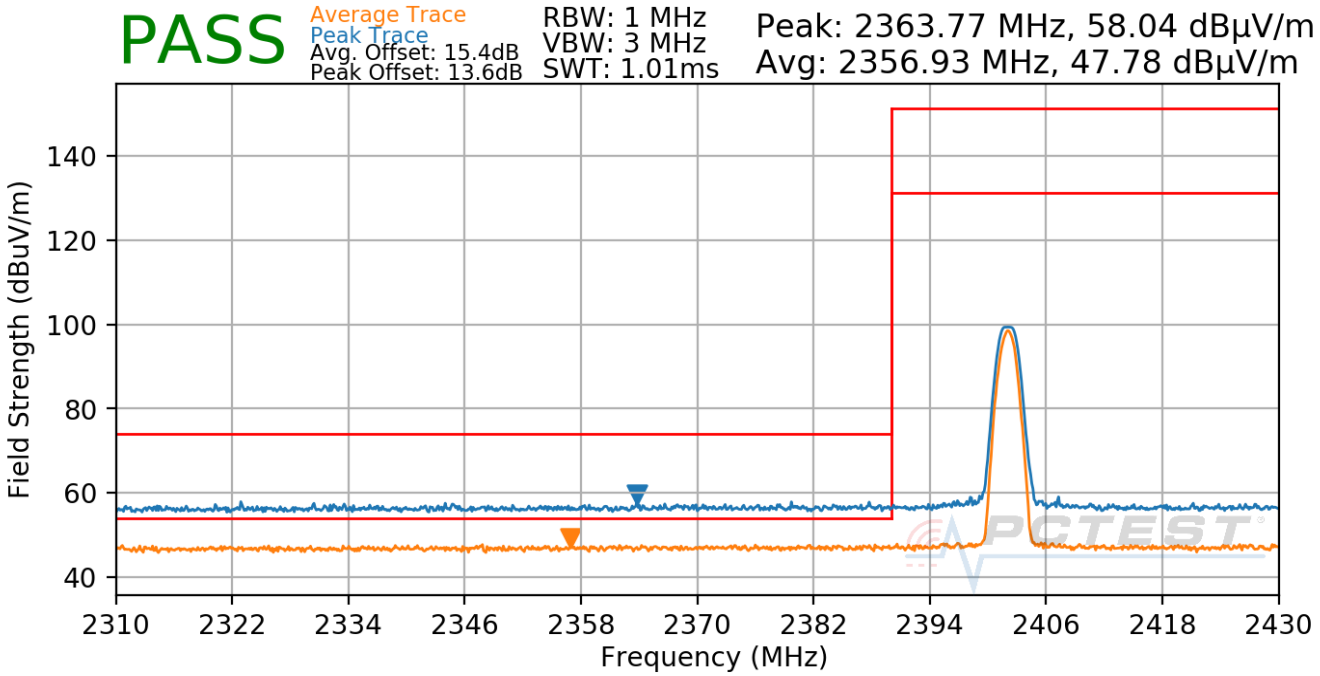
7.7.3 Radiated Restricted Band Edge Measurements

§15.205 §15.209

The amplitude offset shown in the following plots for average measurements was calculated using the formula:

Average Offset (dB) = (Antenna Factor + Cable Loss + Attenuator) – Preamplifier Gain + DCCF

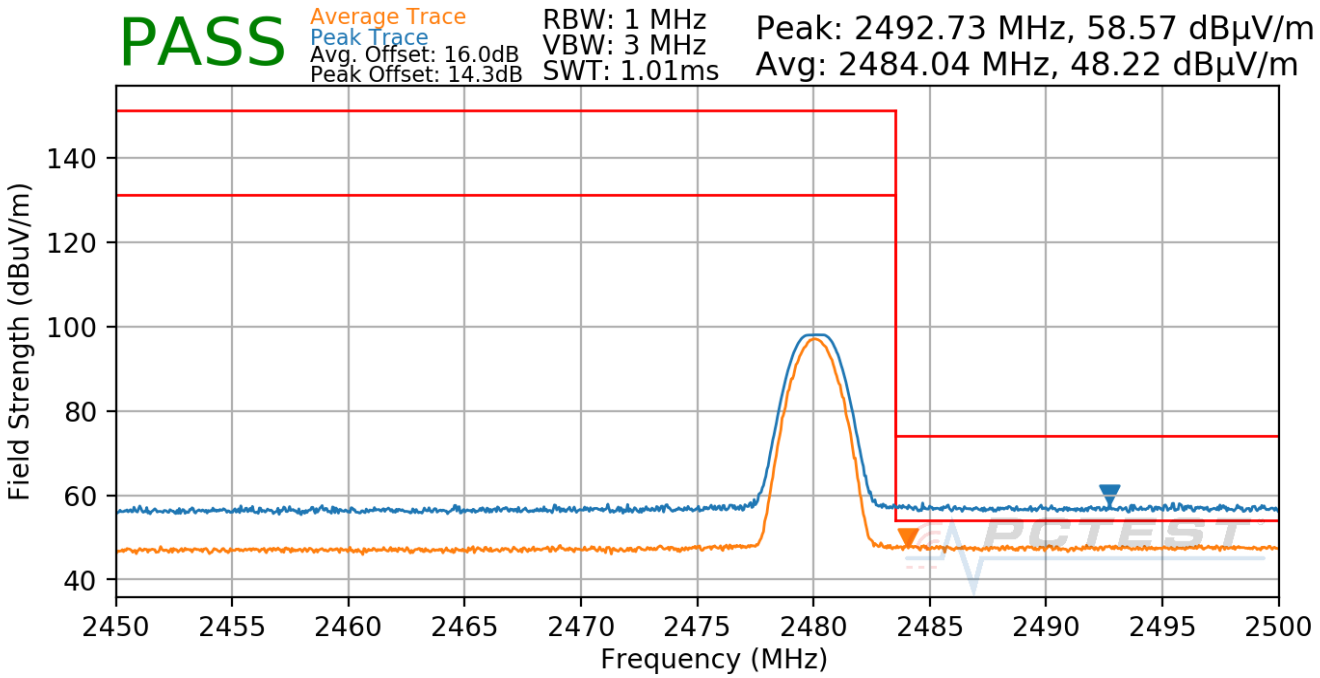
Bluetooth Mode:	LE
Data Rate	1Mbps
Measurement Distance:	3 Meters
Operating Frequency:	2402MHz
Channel:	0



Plot 7-33. Radiated Restricted Lower Band Edge Measurement

DCCF = 10*log(1/DC) = 10*log(1/0.654) = 1.85dB

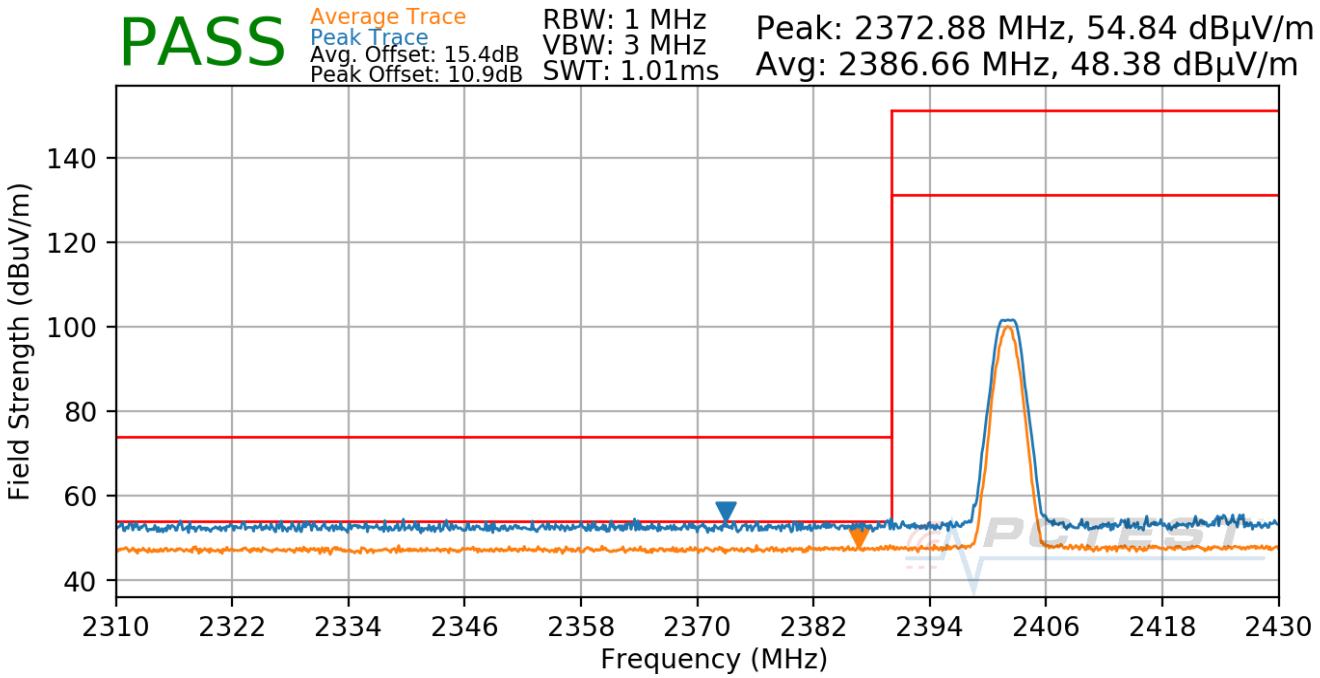
Bluetooth Mode:	LE
Data Rate:	1Mbps
Measurement Distance:	3 Meters
Operating Frequency:	2480MHz
Channel:	39



Plot 7-34. Radiated Restricted Upper Band Edge Measurement

DCCF = 10*log(1/DC) = 10*log(1/0.654) = 1.85dB

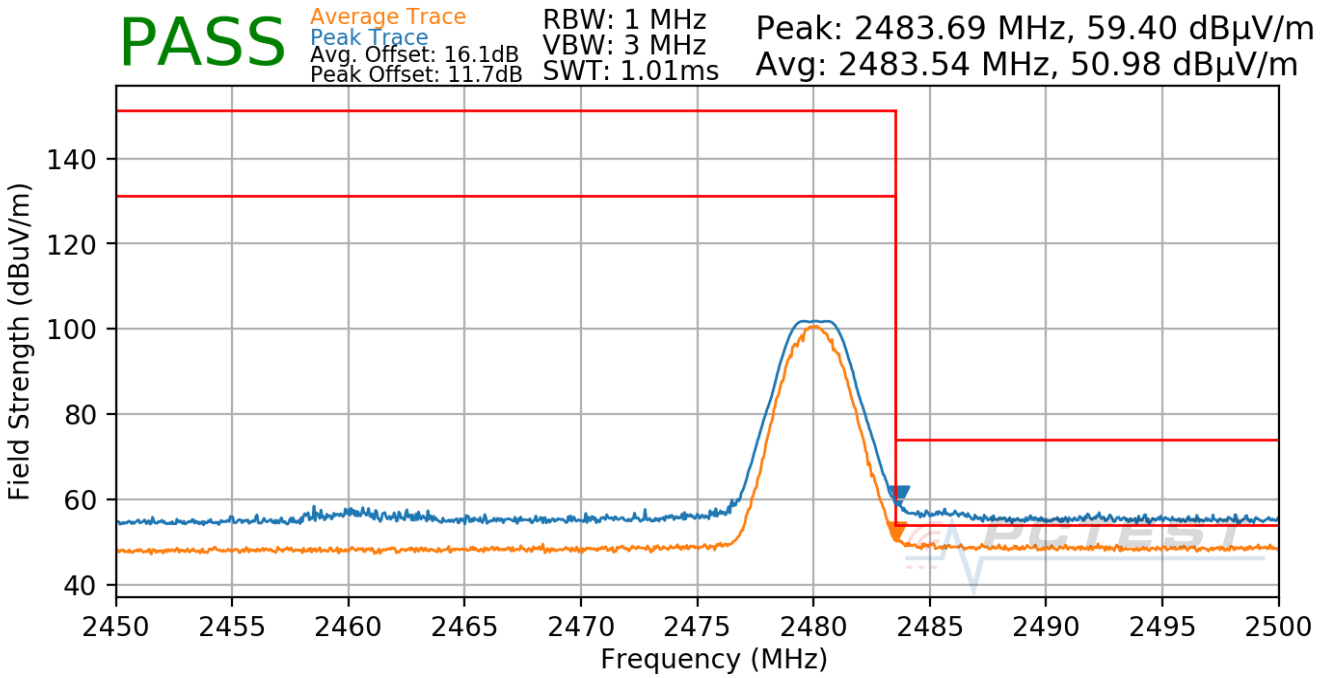
Bluetooth Mode:	LE
Data Rate	2Mbps
Measurement Distance:	3 Meters
Operating Frequency:	2402MHz
Channel:	0



Plot 7-35. Radiated Restricted Lower Band Edge Measurement

DCCF = 10*log(1/DC) = 10*log(1/0.367) = 4.36dB

Bluetooth Mode:	LE
Data Rate	2Mbps
Measurement Distance:	3 Meters
Operating Frequency:	2480MHz
Channel:	39



Plot 7-36. Radiated Restricted Upper Band Edge Measurement

DCCF = 10*log(1/DC) = 10*log(1/0.367) = 4.36dB

7.8 Radiated Spurious Emissions – Below 1GHz

§15.209

Test Overview and Limit

All out of band radiated spurious emissions are measured with a spectrum analyzer connected to a receive antenna while the EUT is operating at its maximum duty cycle, at maximum power, and at the appropriate frequencies. All data rates and modes were investigated for radiated spurious emissions. Only the radiated emissions of the configuration that produced the worst case emissions are reported in this section.

All out of band emissions appearing in a restricted band as specified in Section 15.205 of the Title 47 CFR must not exceed the limits shown in Table 7-15 per Section 15.209.

Frequency	Field Strength [μV/m]	Measured Distance [Meters]
0.009 – 0.490 MHz	2400/F (kHz)	300
0.490 – 1.705 MHz	24000/F (kHz)	30
1.705 – 30.00 MHz	30	30
30.00 – 88.00 MHz	100	3
88.00 – 216.0 MHz	150	3
216.0 – 960.0 MHz	200	3
Above 960.0 MHz	500	3

Table 7-15. Radiated Limits

Test Procedures Used

ANSI C63.10-2013

Test Settings

Quasi-Peak Field Strength Measurements

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 120kHz (for emissions from 30MHz – 1GHz)
3. Detector = quasi-peak
4. Sweep time = auto couple
5. Trace mode = max hold
6. Trace was allowed to stabilize

Peak Field Strength Measurements

1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW = 120kHz (for emissions from 30MHz – 1GHz)
3. VBW = 300kHz
4. Detector = peak
5. Sweep time = auto couple
6. Trace mode = max hold
7. Trace was allowed to stabilize

Test Setup

The EUT and measurement equipment were set up as shown in the diagrams below.

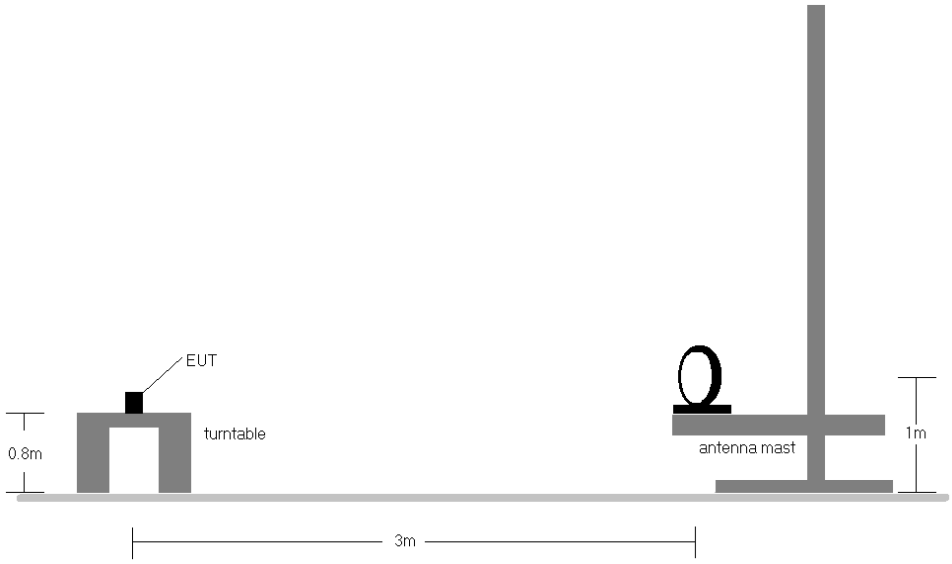


Figure 7-7. Radiated Test Setup < 30MHz

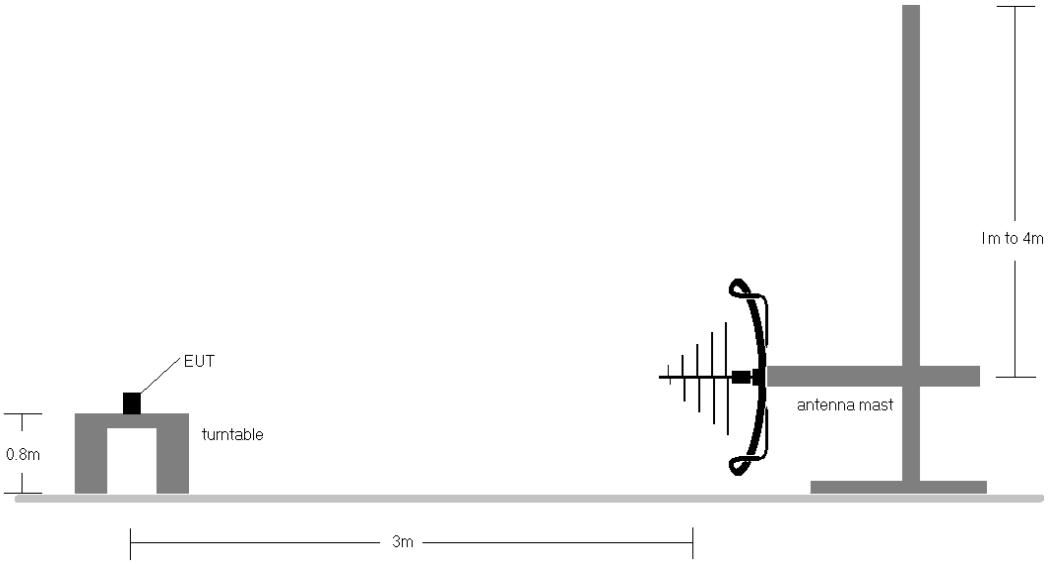


Figure 7-8. Radiated Test Setup < 1GHz

Test Notes

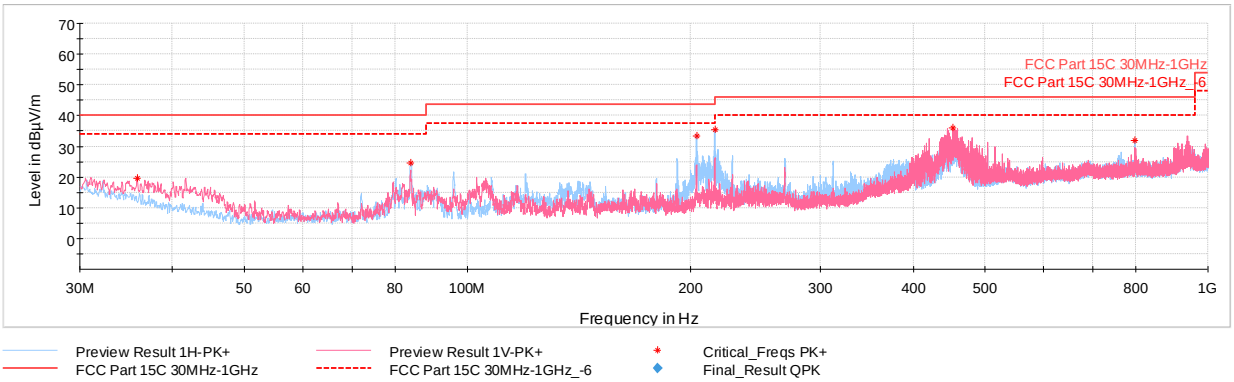
1. All emissions lying in restricted bands specified in §15.205 are below the limit shown in Table 7-15.
2. The broadband receive antenna is manipulated through vertical and horizontal polarizations during the tests. The EUT is manipulated through three orthogonal planes. For below 30MHz measurements, the loop antenna was positioned in three orthogonal planes (X front, Y side, Z top) to determine the orientation resulting in the worst-case emissions.
3. The spectrum is investigated using a peak detector and final measurements are recorded using CISPR quasi peak detector.
4. Emissions were measured at a 3 meter test distance.
5. Emissions are investigated while operating on the worst channel, band, and modulation that produced the worst case results during the transmitter spurious emissions testing.
6. No spurious emissions were detected within 20dB of the limit below 30MHz.
7. For measurements made below 1GHz, the results recorded using the broadband antenna are known to correlate with the results obtained by using a tuned dipole with an acceptable degree of accuracy. The VSWR for the measurement antenna was found to be less than 2:1.
8. The wide spectrum spurious emissions plots shown on the following pages are used only for the purpose of emission identification.
9. EUT was powered by host PC via USB cable with wire charger.
10. The unit was tested with both data rates and only the highest emission is reported.

Sample Calculation

- Field Strength Level $_{[dB\mu V/m]}$ = Analyzer Level $_{[dBm]}$ + 107 + AFCL $_{[dB/m]}$
- AFCL $_{[dB/m]}$ = Antenna Factor $_{[dB/m]}$ + Cable Loss $_{[dB]}$ – Preamplifier Gain $_{[dB]}$
- Margin $_{[dB]}$ = Field Strength Level $_{[dB\mu V/m]}$ – Limit $_{[dB\mu V/m]}$

Radiated Spurious Emissions Measurements (Below 1GHz)

§15.209



Plot 7-37. Radiated Spurious Emissions 30MHz-1GHz (1Mbps, Ch.19, with Laptop)

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
35.87	Max-Peak	V	100	27	-72.76	-14.73	19.51	40.00	-20.49
83.93	Max-Peak	H	250	322	-61.27	-21.08	24.65	40.00	-15.35
204.02	Max-Peak	H	100	145	-56.99	-16.77	33.24	43.52	-10.28
216.05	Max-Peak	H	100	150	-55.06	-16.56	35.38	43.52	-8.14
452.48	Max-Peak	V	100	310	-62.06	-8.91	36.03	46.02	-9.99
796.54	Max-Peak	H	100	183	-72.88	-2.36	31.76	46.02	-14.26

Table 7-16. Radiated Spurious Emissions 30MHz-1GHz (1Mbps, Ch.19, with Laptop)

8.0 CONCLUSION

The data collected relate only the item(s) tested and show that the **28 Gorilla, LLC. AE Wireless Temperature Sensor FCC ID: 2AX2O–280010319** is in compliance with Part 15 Subpart C (15.247) of the FCC Rules.