Electromagnetic Compatibility Test Report

Tests Performed on a Trulli Audio

Bluetooth RF Module, Model TABT1

Radiometrics Document RP-9338

ACCREDITED
TESTING CERT #1495.01

Product Detail:
FCC ID: 2AXEJTABT1 IC: 26435-TABT1 Equipment type: Low power transmitter
Test Standards:
US CFR Title 47, Chapter I, FCC Part 15 Subpart C FCC Part 15 CFR Title 47: 2020 Canada ISED; RSS-210, Issue 10: 2019 as required for Category I Equipment IC RSS-GEN Issue 5: 2018 This report concerns: Original Grant for Certification FCC Part 15.209 & 15.249

Tests Performed For:	*Test Facility:*
Eagle Acoustics Manufacturing, LLC **DBA Trulli Audio** 200 Terrace Dr. Mundelein, IL 60060	**Radiometrics Midwest Corporation** 12 Devonwood Avenue Romeoville, IL 60446-1349 (815) 293-0772

Test Date(s):
September 2 to October 14, 2020

Document RP-9338 Revisions:		
Rev.	Issue Date	Revised By
0	October 23, 2020	
1	October 26, 2020	Joseph Strzelecki

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1.0 ADMINISTRATIVE DATA

Equipment Under Test:	
A Trulli Audio, Bluetooth RF Module Model: TABT1 This will be referred to as the EUT in this Report	
Date EUT Received at Radiometrics:	*Test Date(s):*
September 1, 2020	September 2 to October 14, 2020
Test Report Written and Authorized By:	*Test Witnessed By:*
Joseph Strzelecki Senior EMC Engineer	Steve Price Trulli Audio
Radiometrics' Personnel Responsible for Test:	*EUT Checked By:*
Joseph Strzelecki 10/21/2020 Date Joseph Strzelecki Senior EMC Engineer NARTE EMC-000877-NE Chris D'Alessio EMC Technician Dave Jarvis EMC Technician Richard L. Tichgelaar EMC Technician	Joseph Strzelecki Chris D'Alessio Richard Tichgelaar Dave Jarvis Radiometrics

2.0 TEST SUMMARY AND RESULTS

The EUT (Equipment Under Test) is a Bluetooth RF Module, Model TABT1, manufactured by Trulli Audio. The detailed test results are presented in a separate section. The following is a summary of the test results.

Test Results

Environmental Phenomena	Frequency Range	RSS Spec	RSS section	FCC Section	Test Result
All RF Radiated Emissions Fundamental and Spurious	30-25,000 MHz	RSS-210	B.10	15.249 15.209	Pass
Conducted Emissions, AC Mains	0.15 - 30 MHz	RSS-Gen	8.8	15.249 15.207	Pass
Occupied Bandwidth Test	Fundamental Freq.	RSS-Gen	6.6	15.249	Pass

The Bluetooth transmitter met the FCC 15.249 results.

IEC 17025 Decision Rule:
The declaration of pass or fail is based on the specifications listed above. The declaration of pass or fail did not consider measurement uncertainty.

3.0 EQUIPMENT UNDER TEST (EUT) DETAILS

3.1 EUT Description

The EUT is a Bluetooth RF Module, Model TABT1, manufactured by Trulli Audio. The EUT was in good working condition during the tests, with no known defects.

3.1.1 FCC Section 15.203 & RSS-GEN Antenna Requirements

The Bluetooth antenna is permanently attached to the printed circuit board. The 13.56 RFID antenna is connected by a unique ribbon cable, is internal to the EUT and it is not readily available to be modified by the end user. Therefore, it meets the 15.203 Requirements.

Since the measurements at the antenna port are used to determine the RF output power, RSS-GEN section 6.8 requires that the effective gain of the products antenna be stated, based on a measurement or on data from the antenna's manufacturer. The gain of the Bluetooth and the RFID are 0 dBi.

4.0 TESTED SYSTEM DETAILS

4.1 Tested System Configuration

The system was configured for testing in a typical fashion. The EUT was placed on an 80-cm or 150 cm high, nonconductive test stand. The testing was performed in conditions as close as possible to installed conditions. Wiring was consistent with manufacturer's recommendations. The EUT was tested as a stand-alone device. Power was supplied at 120 VAC, 60 Hz single-phase to its external power supply.

The identification for all equipment, plus descriptions of all cables used in the tested system, are:

Tested System Configuration List

Item	Description	Type*	Manufacturer	Model Number	Serial Number
1	Bluetooth RF Module	E	Trulli Audio	TABT1	018
2	Power supply	H	Trulli-InterTec	STR-052E	None

* Type: E = EUT, P = Peripheral, S = Support Equipment; H = Host Device

List of System Cables

QTY	Length (m)	Cable Description	Shielded?
1	2.0	USB Cord from power supply to EUT (TABT1)	Yes

The tested EUT has a firmware Version of 13605.

4.2 EUT Operating Modes

The EUT was transmitting continuously with its maximum user duty cycle. The software used to exercise the EUT was BueTest3 Version 2.6.11. The power setting on the software was set to 63.

4.3 Special Accessories

No special accessories were used during the tests in order to achieve compliance.

4.4 Equipment Modifications

No modifications were made to the EUT at Radiometrics' test facility in order to comply with the standards listed in this report.

5.0 TEST SPECIFICATIONS

Document	Date	Title
FCC CFR Title 47	2020	Code of Federal Regulations Title 47, Chapter 1, Federal Communications Commission, Part 15 - Radio Frequency Devices
IC RSS-210 Issue 10	2019	Low Power Licence-Exempt Radiocommunication Devices (All Frequency Bands) Category I Equipment
IC RSS-Gen Issue 5	2019	General Requirements and Information for the Certification of Radiocommunication Equipment (RSS-Gen)

6.0 TEST PROCEDURE DOCUMENTS

The tests were performed using the procedures from the following specifications:

Document	Date	Title
ANSI C63.4-2014	2014	Methods of Measurement of Radio Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.10-2013	2013	American National Standard for Testing Unlicensed Wireless Devices
558074 D01 DTS Meas Guidance	2019	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247; v05r02

7.0 RADIOMETRICS' TEST FACILITIES

The results of these tests were obtained at Radiometrics Midwest Corp. in Romeoville, Illinois, USA. Radiometrics is accredited by A2LA (American Association for Laboratory Accreditation) to conform to ISO/IEC 17025: 2017 "General Requirements for the Competence of Calibration and Testing Laboratories". Radiometrics' Lab Code is 121191 and Certification Number is 1495.01. Radiometrics' scope of accreditation includes all of the test methods listed herein. A copy of the accreditation can be accessed on our web site (www.radiomet.com). Radiometrics accreditation status can be verified at A2LA's web site (www.a2la2.org).

The following is a list of shielded enclosures located in Romeoville, Illinois used during the tests:

Chamber E: Is a custom-made anechoic chamber that measures 52' L X 30' W X 18' H. The walls and ceiling are fully lined with RF absorber. Pro-shield of Collinsville, Oklahoma manufactured the chamber. The floor has a 9' x 9' section of microwave absorber for testing above 1 GHz.

Test Station F: Is an area that measures 10' D X 12' W X 10' H. The floor and back wall are metal shielded. This area is used for conducted emissions measurements.

A separate ten-foot long, brass plated, steel ground rod attached via a 6-inch copper braid grounds each of the above chambers. Each enclosure is also equipped with low-pass power line filters.

The FCC has accepted these sites as test site number US1065. The FCC test site Registration Number is 732175. Details of the site characteristics are on file with the Industry Canada as site number IC 3124A-1.

A complete list of the test equipment is provided herein. The calibration due dates are indicated on the equipment list. The equipment is calibrated in accordance with ANSI/NCSL Z540-1 with traceability to the National Institute of Standards and Technology (NIST).

8.0 DEVIATIONS AND EXCLUSIONS FROM THE TEST SPECIFICATIONS

There were no deviations or exclusions from the test specifications.

9.0 CERTIFICATION

Radiometrics Midwest Corporation certifies that the data contained herein was taken under conditions that meet or exceed the requirements of the test specification and the data contained herein was taken with calibrated test equipment. The results relate only to the EUT listed herein.

10.0 TEST EQUIPMENT TABLE

RMC ID	Manufacturer	Description	Model No.	Serial No.	Frequency Range	Cal Period	Cal Date
AMP-05	RMC/Celeritek	Pre-amplifier	MW110G	1001	1.0-12GHz	12 Mo.	01/14/20
AMP-20	Avantek	Pre-amplifier	SF8-0652	15221	8-18GHz	12 Mo	04/23/20
AMP-59	Amplitech	Pre-amplifier	APTMP44	AMP-59	18-26 GHz	12 Mo.	01/06/20
ANT-48	RMC	Std Gain Horn	HW2020	1001	18-26 GHz	36 Mo.	08/09/19
ANT-66	ETS-Lindgren	Horn Antenna	3115	62580	1.0-18GHz	24 Mo.	03/05/19
ANT-68	EMCO	Log-Periodic Ant.	93146	9604-4456	200-1000MHz	24 Mo.	01/02/20
ANT-80	AH Systems	Bicon Antenna	SAS-540	294	20-330MHz	24 Mo.	12/14/18
CAB-106A	Teledyne	Coaxial Cable	N/A	106A	DC-2 GHz	24 Mo.	01/29/20
CAB-1090	Teledyne	Coaxial Cable	N/A	1090	DC-18 GHz	24 Mo.	02/12/19
CAB-160B	Teledyne	Coaxial Cable	N/A	160B	DC-18 GHz	24 Mo.	02/05/20
CAB-090A	Teledyne	Coaxial Cable	N/A	090A	DC-26 GHz	24 Mo.	02/07/20
CAB-295A	Teledyne	Coaxial Cable	N/A	295A	DC-26 GHz	24 Mo.	02/07/20
HPF-01	Solar	High Pass Filter	7930-100	HPF-1	0.15-30MHz	24 Mo.	03/02/20
HPF-06	Mini-Circuits	High Pass Filter	VHF-3800+	31035	3-11 GHz	24 Mo.	05/07/20
LSN-01	Electrometrics	50 uH LISN	FCC/VDE 50/2	1001	0.01-30MHz	24 Mo.	08/12/19
REC-11	HP / Agilent	Spectrum Analyzer	E7405A	US39110103	9Hz-26.5GHz	24 Mo	04/16/20
REC-20	HP / Agilent	Spectrum Analyzer	85460A/84562A	33330A00135 3410A00178	30Hz-6GHz	24 Mo.	08/14/19
REC-21	Agilent	Spectrum Analyzer	E7405A	MY45118341	9Hz-26.5 GHz	24 Mo.	01/14/20
THM-03	Fluke	Temp/Humid Meter	971	95850465	N/A	12 Mo.	06/03/20

Note: All calibrated equipment is subject to periodic checks.
The test equipment was in calibration during the tests.

Software Company	Test Software Name	Version	Applicable Tests
Radiometrics	EN550XX0	07.16.19	RF Conducted Emissions (FCC Part 15 & EN 55032)
Radiometrics	REREC11D	07.16.19	RF Radiated Emissions (FCC Part 15 & EN 55032)
Agilent	PSA/ESA-E/L/EMC	2.4.0.42	Bandwidth and screen shots

11.0 TEST SECTIONS

12.0 AC CONDUCTED EMISSIONS

The tests and limits are in accordance with FCC section 15.207 and RSS Gen section 8.8.

A computer-controlled analyzer was used to perform the conducted emissions measurements. The frequency range was divided into 500 subranges equally spaced on a logarithmic scale. The computer recorded the peak of each subrange. This data was then plotted on a semi-log graph generated by the computer. Adjusting the positions of the cables and orientation of the test system then maximizes the highest emissions.

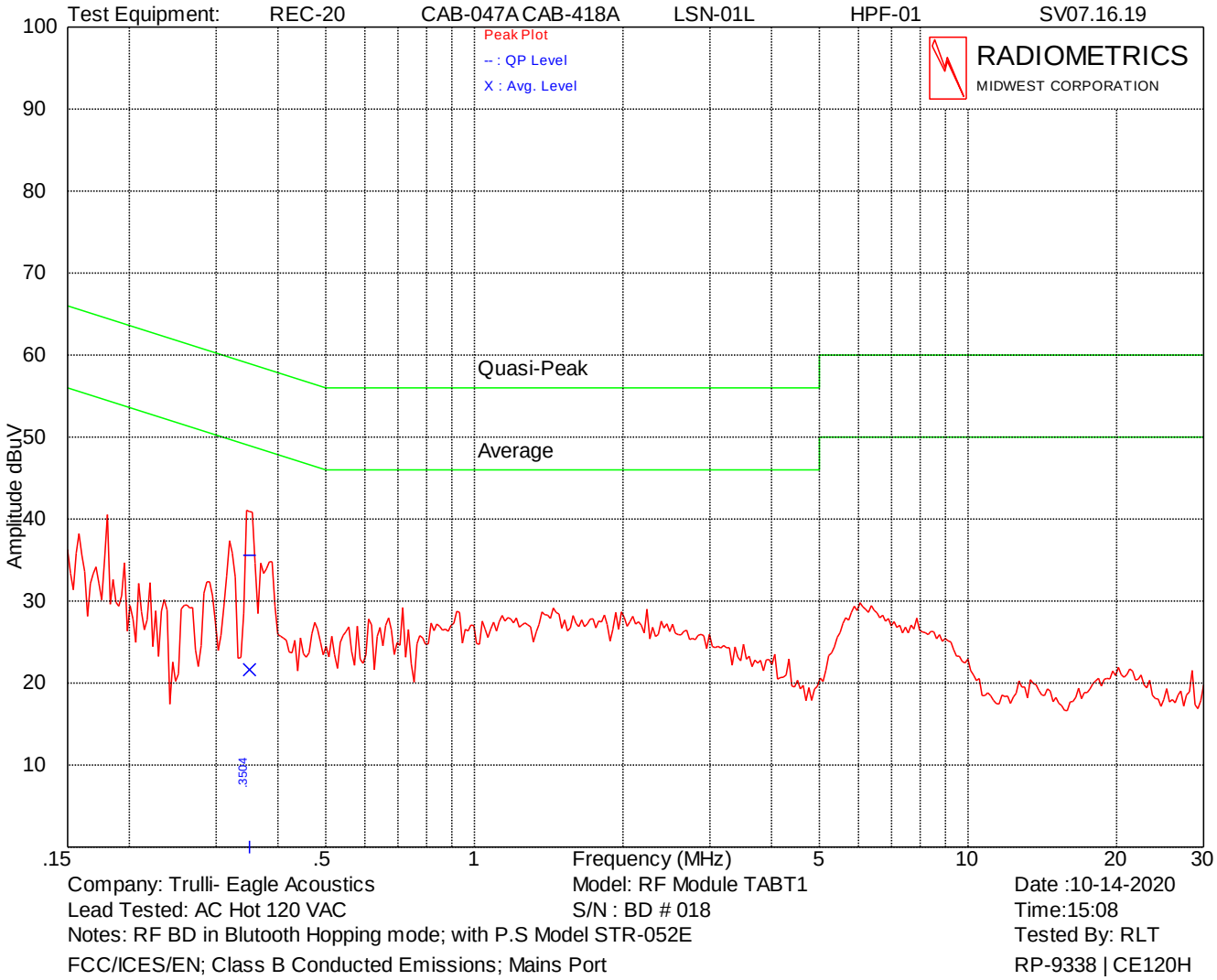
Mains Conducted emission measurements were performed using a 50 Ohm/50 uH Line Impedance Stabilization Network (LISN) as the pick-up device. Measurements were repeated on both leads within the power cord. If the EUT power cord exceeded 80 cm in length, the excess length of the power cord was made into a 30 to 40 cm bundle near the center of the cord. The LISN was placed on the floor at the base of the test platform and electrically bonded to the ground plane.

FCC Limits of Conducted Emissions at the AC Mains Ports

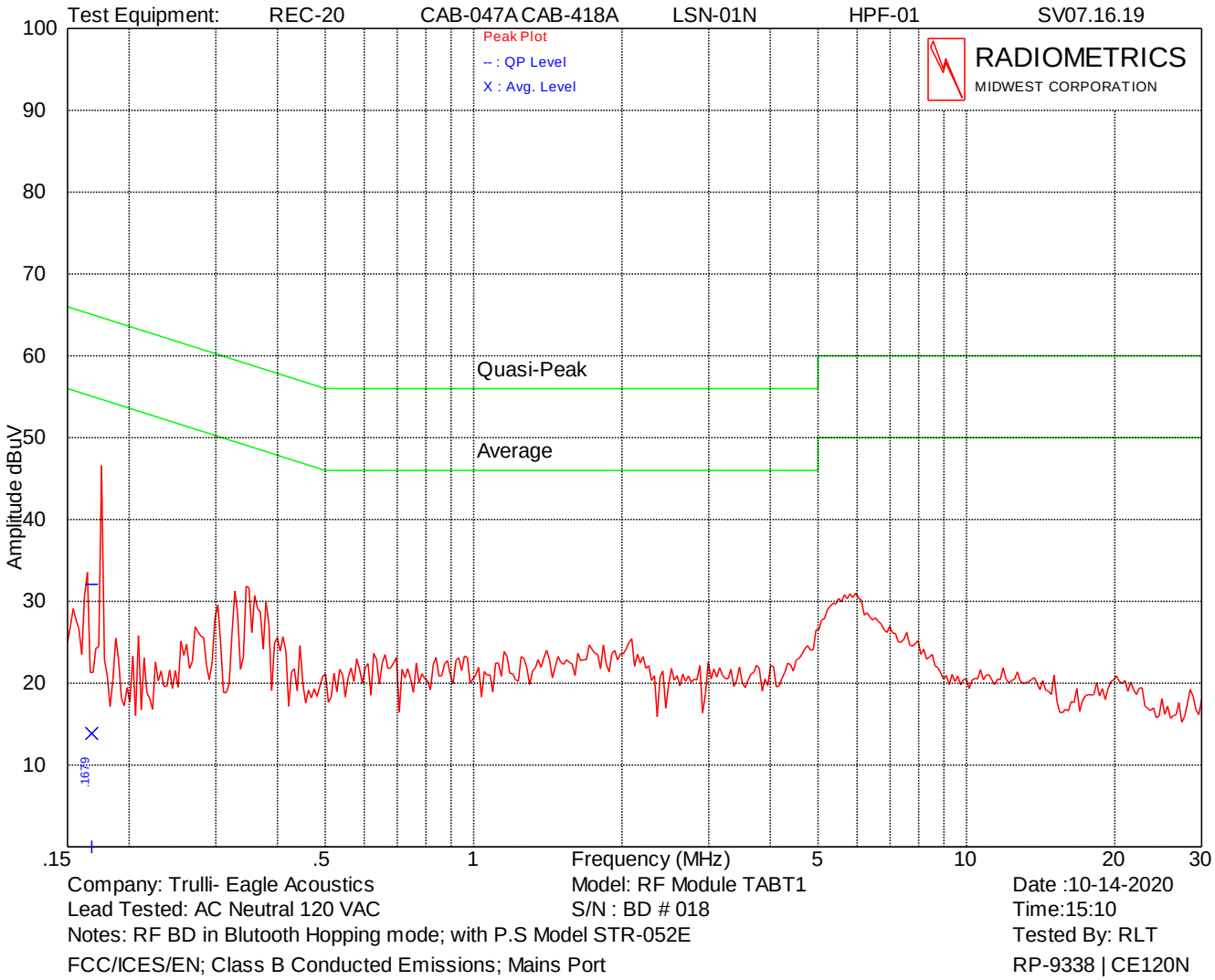
Frequency Range (MHz)	Class B Limits (dBuV)	
	Quasi-Peak	Average
0.150 - 0.50*	66 - 56	56 - 46
0.5 – 5.0	56	46
5.0 - 30	60	50
* The limit decreases linearly with the logarithm of the frequency in this range.		

The initial step in collecting conducted data is a peak detector scan and the plotting of the measurement range. Significant peaks are then marked as shown on the following table, and these signals are then measured with the quasi-peak detector. The following represents the worst case emissions from the EUT power supply, after testing all modes of operation.

Test Date: October 14, 2020
The Amplitude is the final corrected value with cable and LISN Loss.



Frequency (MHz)	QP Amplitude (dBuV)	QP Limit (dBuV)	Average Amplitude (dBuV)	Average Limit (dBuV)	Margin (dB)
0.350	35.6	59.0	21.6	49.0	23.4



QP Amplitude (dBuV)	QP Limit (dBuV)	Average Amplitude (dBuV)	Average Limit (dBuV)	Margin (dB)
32.1	65.1	13.9	55.1	33.0

Judgement: Pass by at least 10 dB.

12.1 Radiated RF Emissions

The procedures were in accordance to ANSI C63.10. Radiated emission measurements were performed with linearly polarized broadband antennas. The results obtained with these antennas can be correlated with results obtained with a tuned dipole antenna. The radiated emission measurements were performed with a spectrum analyzer. The bandwidth used from 30 MHz to 1000 MHz is 120 kHz. Above 1 GHz, a 1 MHz bandwidth is used. A 10 dB linearity check is performed prior to start of testing in order to determine if an overload condition exists. Figure 4 herein lists the details of the test equipment used during radiated emissions tests.

The EUT was rotated through three orthogonal axis as per 5.10.1 of ANSI C63.10 during the radiated tests.

For tests from 1 to 10 GHz, a high pass filter was used to reduce the fundamental emission. High pass filters were not needed above 10 GHz, since the preamplifiers attenuated the fundamental emission. The test setup drawing herein lists the details of the test equipment used during radiated emissions tests.

Radiated emissions measurements were performed inside of an anechoic chamber at a test distance of 3 meters. The anechoic chamber is designated as Chamber E. This Chamber meets the Site Attenuation requirements of ANSI C63.4. Chamber E is located at 12 Devonwood Ave. Romeoville, Illinois EMI test lab.

The entire frequency range from 30 to 25,000 MHz was slowly scanned. Measurements were performed using two antenna polarizations, (vertical and horizontal). The worst-case emissions were recorded. All measurements may be performed using either the peak, average or quasi-peak detector functions. If the peak detector data exceeds or is marginally close to the limits, the measurements are repeated using a quasi-peak detector or average function as required by the specification for final determination of compliance.

The detected emission levels were maximized by rotating the EUT, adjusting the positions of all cables, and by scanning the measurement antenna from 1 to 4 meters above the ground.

Unintentional Radiated Emissions Field Strength Limits

Frequency Range (MHz)	Test Distance (meters)	Class B Limits	
		uV/m	dB(uV/m)
30 - 88	3	100	40.0
88 - 216	3	150	43.5
216 - 960	3	200	46.0
Above 960	3	500	54.0

FCC 15.249 & RSS-210 B.10 Radiated Emissions Limits

Frequency Range	Test Distance (meters)	Field strength of fundamental		Field strength of harmonics	
		mV/m	dB(uV/m)	uV/m	dB(uV/m)
902-928 MHz	3	50	94.0	500	54.0
2400-2483.5 MHz	3	50	94.0	500	54.0
5725-5875 MHz	3	50	94.0	500	54.0
24.0-24.25 GHz	3	250	108.0	2500	68.0

12.1.1 Radiated Emissions Field Strength Sample Calculation

The field strength is calculated by adding the Antenna Factor and Cable Loss, and by subtracting the Amplifier Gain from the measured reading. The antenna factor converts the voltage reading in dBuV to field strength in dBuV/meter. The basic equation is as follows:

FS = RA + AF + CF - AG

Where: FS = Field Strength in dBuV/m
RA = Receiver Amplitude dBuV
AF = Antenna Factor dB/m
CF = Cable Attenuation Factor dB
AG = Amplifier Gain dB
HPF = High pass Filter Loss dB

12.2 Radiated Emissions Results

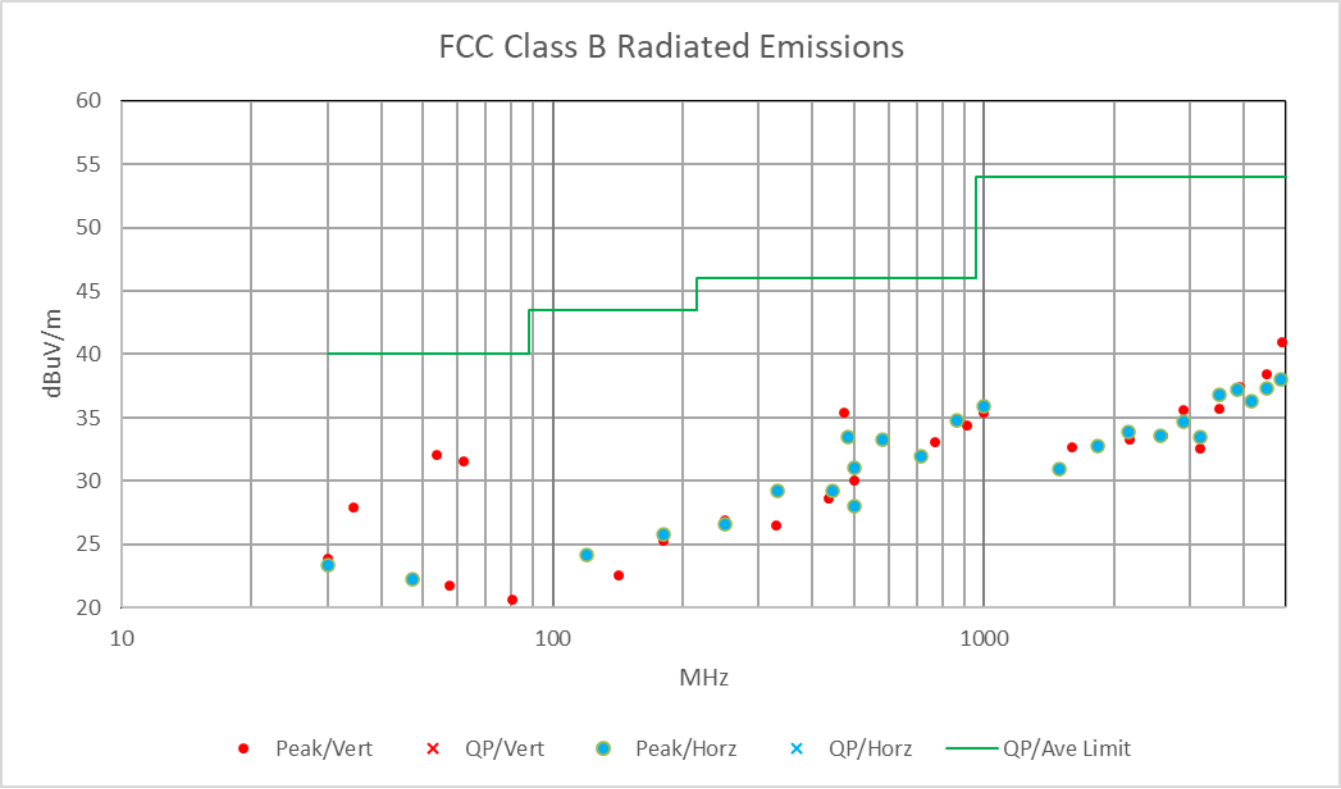
Test Date	September 22, 2020
Test Distance	3 Meters
Specification	FCC Part 15 Subpart C & RSS-210 Section B.10
Abbreviations	Pol = Antenna Polarization; V = Vertical; H = Horizontal; P = peak; Q = QP
Configuration	Bareboard with lithium battery and PS on table MHz; Power LVL 63

This table includes all emissions except Fundamental, Band edge, and harmonics emissions.

Freq. MHz	Meter Reading dBuV	Dect.	Ant. Pol.	Ant Factor dB/m	Cbl/amp Factors	Dist Fact dB	EUT dBuV/m	Limit dBuV/m	Margin Under Limit dB	Note
30.0	9.0	P	H	13.8	0.6	0.0	23.4	40.0	16.6	
47.1	11.8	P	H	9.8	0.7	0.0	22.3	40.0	17.7	
120.1	11.4	P	H	11.6	1.2	0.0	24.2	43.5	19.3	
180.3	11.0	P	H	13.4	1.4	0.0	25.8	43.5	17.7	
251.0	9.4	P	H	15.5	1.7	0.0	26.6	46.0	19.4	
332.0	13.1	P	H	14.1	2.0	0.0	29.2	46.0	16.8	
444.8	10.5	P	H	16.4	2.3	0.0	29.2	46.0	16.8	
483.2	13.9	P	H	17.2	2.4	0.0	33.5	46.0	12.5	
500.0	7.7	P	H	17.9	2.4	0.0	28.0	46.0	18.0	
501.5	10.7	P	H	18.0	2.4	0.0	31.1	46.0	14.9	
580.0	12.2	P	H	18.5	2.6	0.0	33.3	46.0	12.7	
711.3	8.0	P	H	21.1	2.9	0.0	32.0	46.0	14.0	
862.5	9.1	P	H	22.5	3.2	0.0	34.8	46.0	11.2	
998.8	8.4	P	H	24.0	3.5	0.0	35.9	54.0	18.1	
1497.5	37.8	P	H	25.2	-32.0	0.0	31.0	74.0	43.0	1
1837.5	37.7	P	H	26.8	-31.7	0.0	32.8	74.0	41.2	1
2152.5	37.6	P	H	27.7	-31.4	0.0	33.9	74.0	40.1	1
2567.5	36.5	P	H	28.6	-31.5	0.0	33.6	74.0	40.4	1
2890.0	36.4	P	H	29.4	-31.1	0.0	34.7	74.0	39.3	1
3172.5	32.6	P	H	30.9	-30.0	0.0	33.5	74.0	40.5	1
3520.0	34.6	P	H	31.2	-29.0	0.0	36.8	74.0	37.2	1
3860.0	32.7	P	H	32.9	-28.4	0.0	37.2	74.0	36.8	1
4175.0	32.0	P	H	32.3	-28.0	0.0	36.3	74.0	37.7	1
4522.5	31.8	P	H	32.5	-27.0	0.0	37.3	74.0	36.7	1
4865.0	31.2	P	H	33.2	-26.4	0.0	38.0	74.0	36.0	1
30.0	9.5	P	V	13.8	0.6	0.0	23.9	40.0	16.1	
34.4	14.9	P	V	12.4	0.6	0.0	27.9	40.0	12.1	
53.8	22.0	P	V	9.3	0.8	0.0	32.1	40.0	7.9	
57.6	11.8	P	V	9.2	0.8	0.0	21.8	40.0	18.2	
62.0	21.5	P	V	9.2	0.9	0.0	31.6	40.0	8.4	
80.8	10.3	P	V	9.3	1.0	0.0	20.6	40.0	19.4	
142.2	8.7	P	V	12.6	1.3	0.0	22.6	43.5	20.9	
180.3	10.5	P	V	13.4	1.4	0.0	25.3	43.5	18.2	
251.0	9.7	P	V	15.5	1.7	0.0	26.9	46.0	19.1	
328.3	10.4	P	V	14.1	2.0	0.0	26.5	46.0	19.5	

Freq. MHz	Meter Reading dBuV	Dect.	Ant. Pol.	Ant Factor dB/m	Cbl/amp Factors	Dist Fact dB	EUT dBuV/m	Limit dBuV/m	Margin Under Limit dB	Note
434.7	10.3	P	V	16.0	2.3	0.0	28.6	46.0	17.4	
471.9	16.0	P	V	17.0	2.4	0.0	35.4	46.0	10.6	
500.0	10.9	P	V	17.9	2.4	0.0	31.2	46.0	14.8	
501.5	9.6	P	V	18.0	2.4	0.0	30.0	46.0	16.0	
767.5	8.9	P	V	21.2	3.0	0.0	33.1	46.0	12.9	
915.0	8.2	P	V	22.9	3.3	0.0	34.4	46.0	11.6	
1000.0	7.9	P	V	24.0	3.5	0.0	35.4	54.0	18.6	
1602.5	39.6	P	V	25.2	-32.1	0.0	32.7	74.0	41.3	1
2172.5	37.0	P	V	27.7	-31.4	0.0	33.3	74.0	40.7	1
2597.5	36.3	P	V	28.7	-31.4	0.0	33.6	74.0	40.4	1
2892.5	37.3	P	V	29.4	-31.1	0.0	35.6	74.0	38.4	1
3172.5	31.7	P	V	30.9	-30.0	0.0	32.6	74.0	41.4	1
3515.0	33.5	P	V	31.2	-29.0	0.0	35.7	74.0	38.3	1
3917.5	32.8	P	V	32.9	-28.3	0.0	37.4	74.0	36.6	1
4157.5	32.1	P	V	32.3	-28.0	0.0	36.4	74.0	37.6	1
4512.5	33.0	P	V	32.5	-27.1	0.0	38.4	74.0	35.6	1
4902.5	34.1	P	V	33.2	-26.3	0.0	41.0	74.0	33.0	1

Note1 : Peak reading below Average limits, so average readings not performed for that frequency.
Judgment: Passed by at least 10 dB



Tabulated data from above represented graphically.

Bluetooth Fundamental, Band edge, and harmonics; FCC 15.249

	Tx	Spectrum Analyzer Readings dBuV									EUT	Peak	Ave	Peak	Ave	Margin
harm	Freq	Peak			Ave	Peak			Ave	Corr.	Emission	Tot. FS		Limit		Under
		Vertical Polarization				Horizontal Polarization				Fact	Freq					Limit
#	MHz	X	Y	Z	Max	X	Y	Z	Max	dB/m	MHz	dBuV/m		dBuV/m		dB
1	2402	101.0	93.5	96.7	81.0	94.5	95.7	102.8	82.8	-2.0	2402.0	100.8	80.8	114	94	13.2
BE	2402	60.7	52.1	55.3	40.7	54.2	55.4	62.5	42.5	-2.0	2390.0	60.5	40.5	74	54	13.6
2	2402	50.7	43.6	41.0	30.7	43.8	43.5	52.2	32.2	7.8	4804.0	60.0	40.0	74	54	14.0
3	2402	44.8	41.8	40.8	24.8	42.5	42.9	45.6	25.6	12.9	7206.0	58.5	38.5	74	54	15.5
4	2402	37.6	37.5	36.8	17.6	36.7	37.1	38.2	18.2	15.2	9608.0	53.4	33.4	74	54	20.6
1	2440	102.6	98.1	101.1	82.6	95.9	99.6	105.0	85.0	-1.9	2441.0	103.1	83.1	114	94	10.9
2	2440	49.3	43.7	45.7	29.3	43.5	43.8	52.2	32.2	8.0	4882.0	60.2	40.2	74	54	13.8
3	2440	46.6	42.2	41.1	26.6	42.7	45.5	47.6	27.6	13.6	7323.0	61.2	41.2	74	54	12.8
4	2440	37.6	38.1	36.8	18.1	38.3	37.7	38.2	18.3	15.0	9764.0	53.3	33.3	74	54	20.7
1	2480	104.0	98.5	100.2	84.0	96.7	100.0	104.3	84.3	-1.9	2480.0	102.4	82.4	114	94	11.6
BE	2480	55.3	53.0	53.6	35.3	51.6	54.7	56.4	36.4	-2.0	2483.5	54.4	34.4	74	54	19.6
2	2480	51.0	44.2	47.0	31.0	46.2	48.3	53.2	33.2	8.2	4960.0	61.4	41.4	74	54	12.6
3	2480	44.9	41.1	39.5	24.9	42.4	42.6	45.2	25.2	14.1	7440.0	59.3	39.3	74	54	14.7
4	2480	38.5	38.2	38.4	18.5	37.2	36.9	37.4	17.4	15.3	9920.0	53.8	33.8	74	54	20.2
Column numbers (see below for explanations)																
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

Column #1. harm = Harmonic; BE = Band Edge emissions
Column #2. Frequency of Transmitter.
Column #3. Uncorrected readings from the spectrum analyzer with First Axis Rotation.
Column #4. Uncorrected readings from the spectrum analyzer with Second Axis Rotation.
Column #5. Uncorrected readings from the spectrum analyzer with Third Axis Rotation.
Column #6. Average Reading based on peak reading reduced by the Duty cycle correction
Column #7. Uncorrected readings from the spectrum analyzer with First Axis Rotation.
Column #8. Uncorrected readings from the spectrum analyzer with Second Axis Rotation.
Column #9. Uncorrected readings from the spectrum analyzer with Third Axis Rotation.
Column #10. Average Reading based on peak reading reduced by the Duty cycle correction
Column #11. Corr. Factors = Cable Loss – Preamp Gain + Antenna Factor
Column #12. Frequency of Tested Emission
Column #13. Highest peak field strength at listed frequency.
Column #14. Highest Average field strength at listed frequency.
Column #15. Peak Limit.
Column #16. Average Limit.
Column #17. The margin (last column) is the worst-case margin under the peak or average limits for that row.

Judgment: Passed by at least 10 dB

All emissions outside of the band from 2340 to 2483.5 were below the limits of 15.209.
No other Emissions were detected from 30 to 25,000 MHz within 10 dB of the limits.

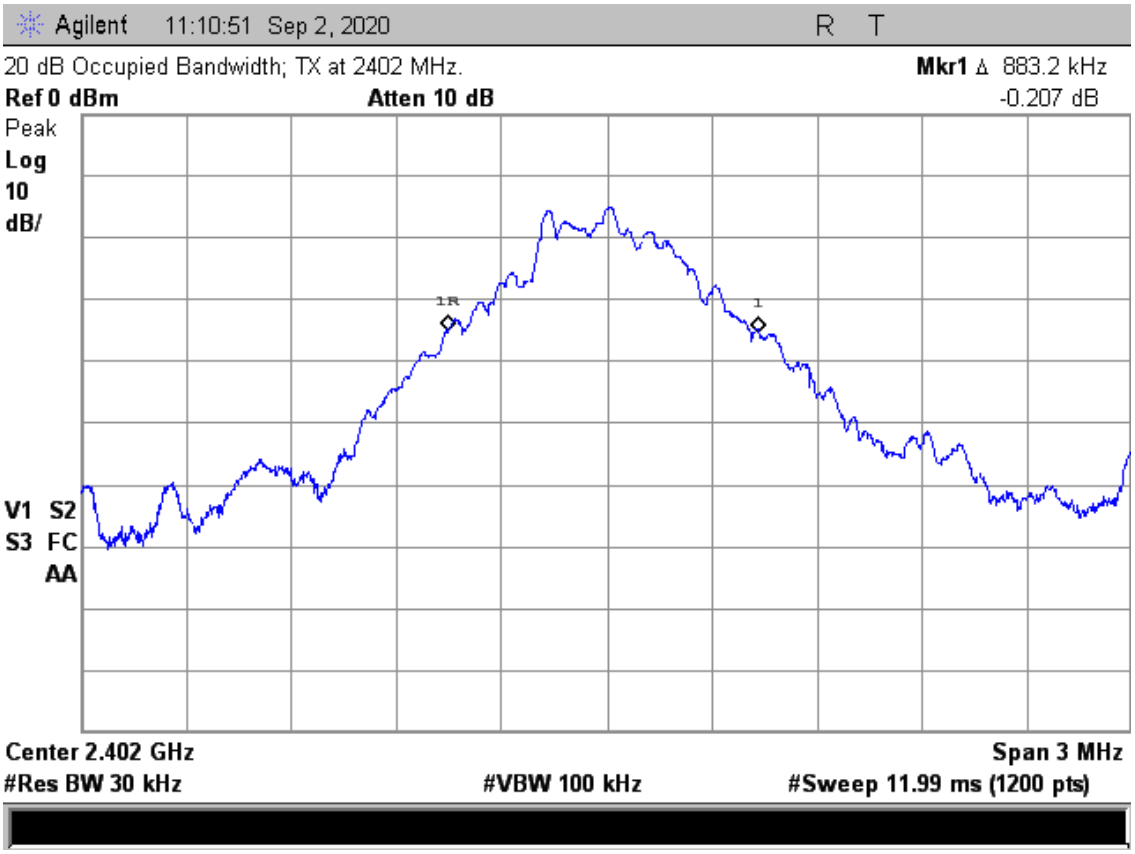
12.3 Occupied Bandwidth Data

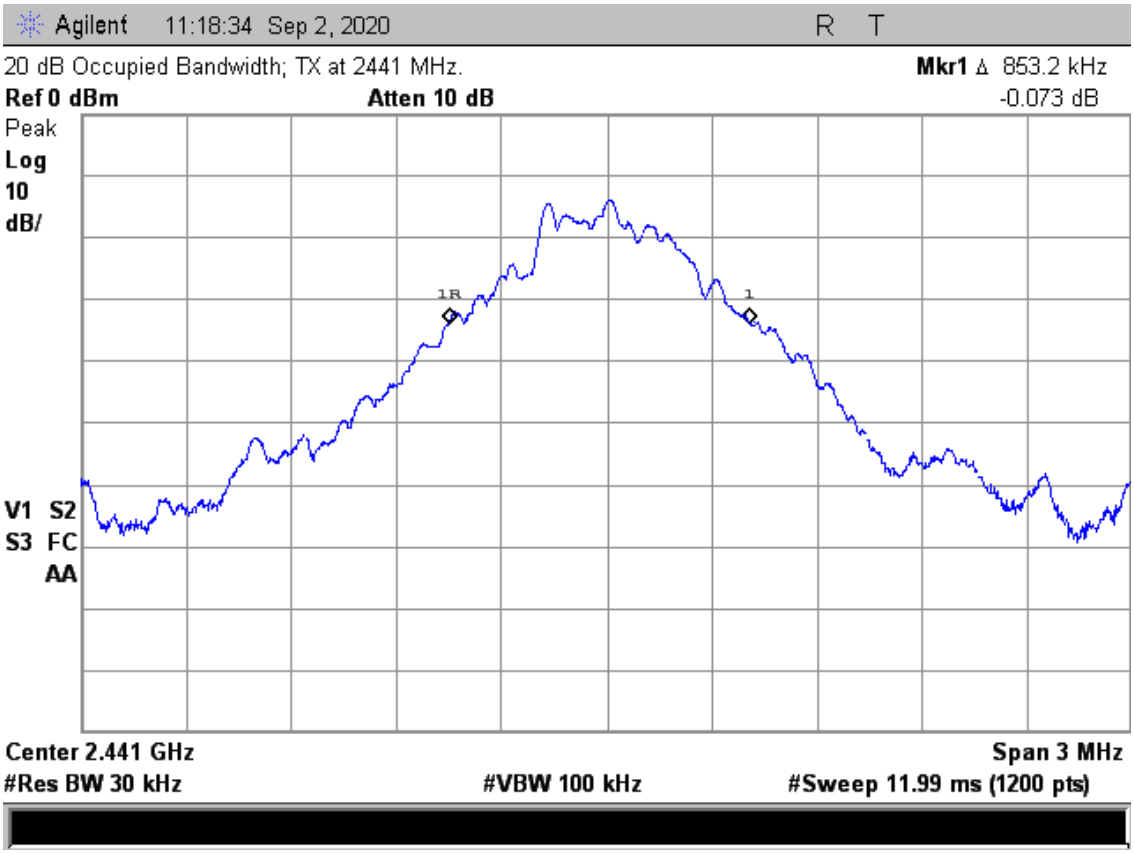
The occupied bandwidth of the RF output was measured using a spectrum analyzer. The bandwidth was measured using the peak detector function. The spectrum analyzer was set to the MAX HOLD mode to record the worst case of the modulation. The marker-to-peak function was set to the peak of the emission. Then the marker-delta function was used to measure 20 dB down one side of the emission. The marker-delta function was reset and then moved to the other side of the emission, until it is (as close as possible to) even with the reference marker level. The marker-delta reading at this point is the bandwidth of the emission. The plots of the occupied bandwidth for the EUT are supplied on the following pages.

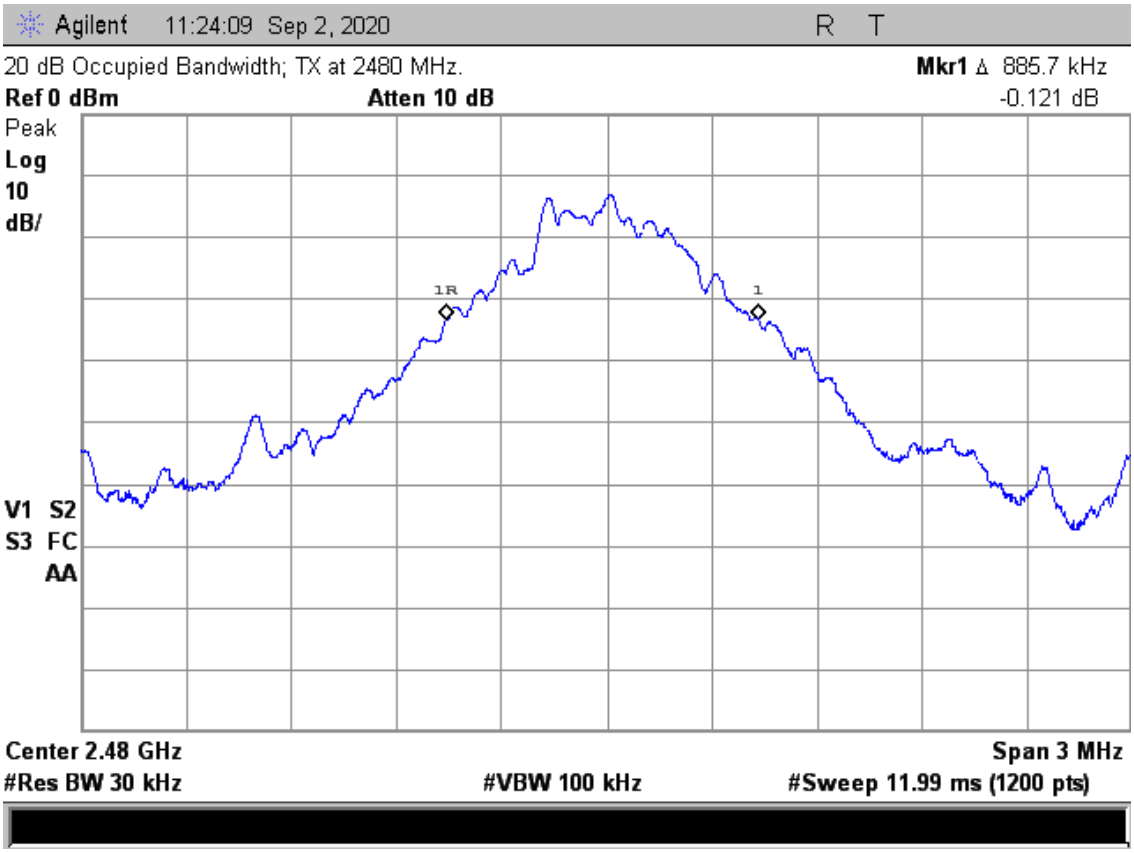
The 20 dB OBW is within the allowed 2400 to 2483.5 MHz authourized band.

EUT	Channel	20 dB OBW MHz	99% EBW MHz
BT	2402	0.8832	0.846
BT	2440	0.8532	0.843
BT	2480	0.8857	0.843

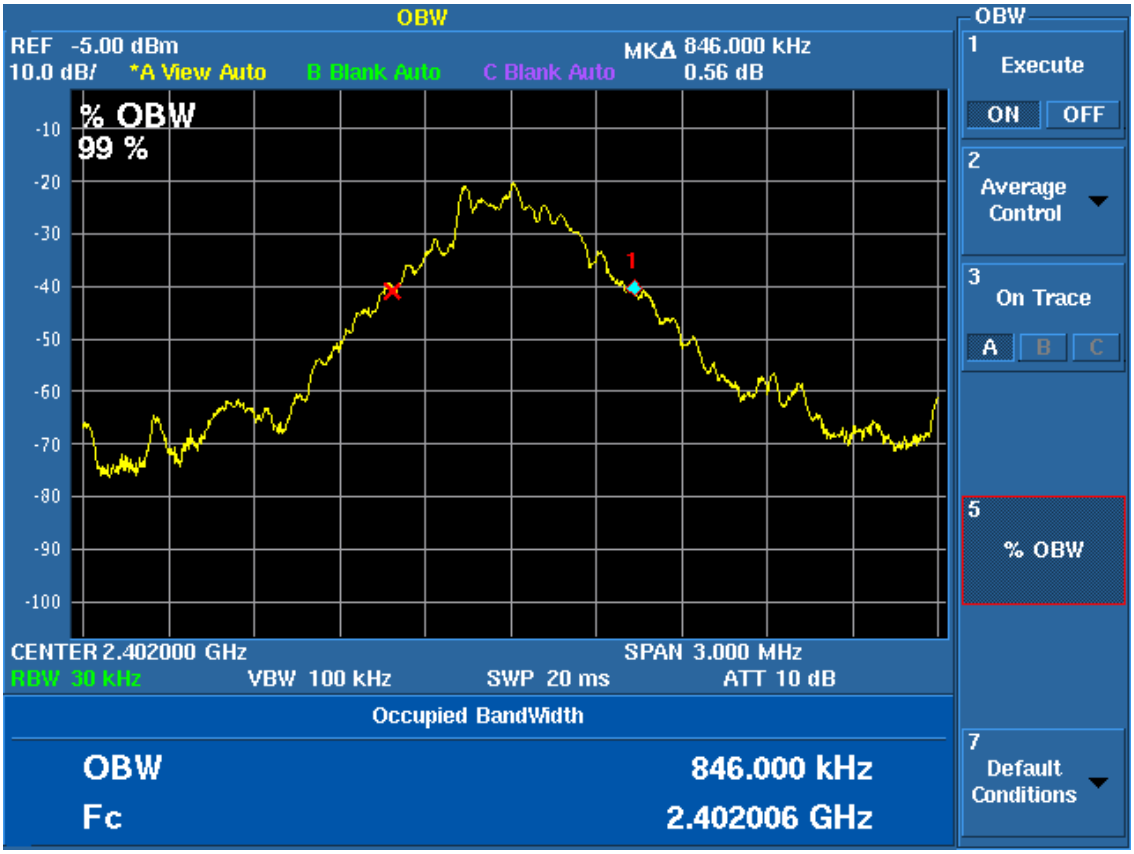
20 dB plots:

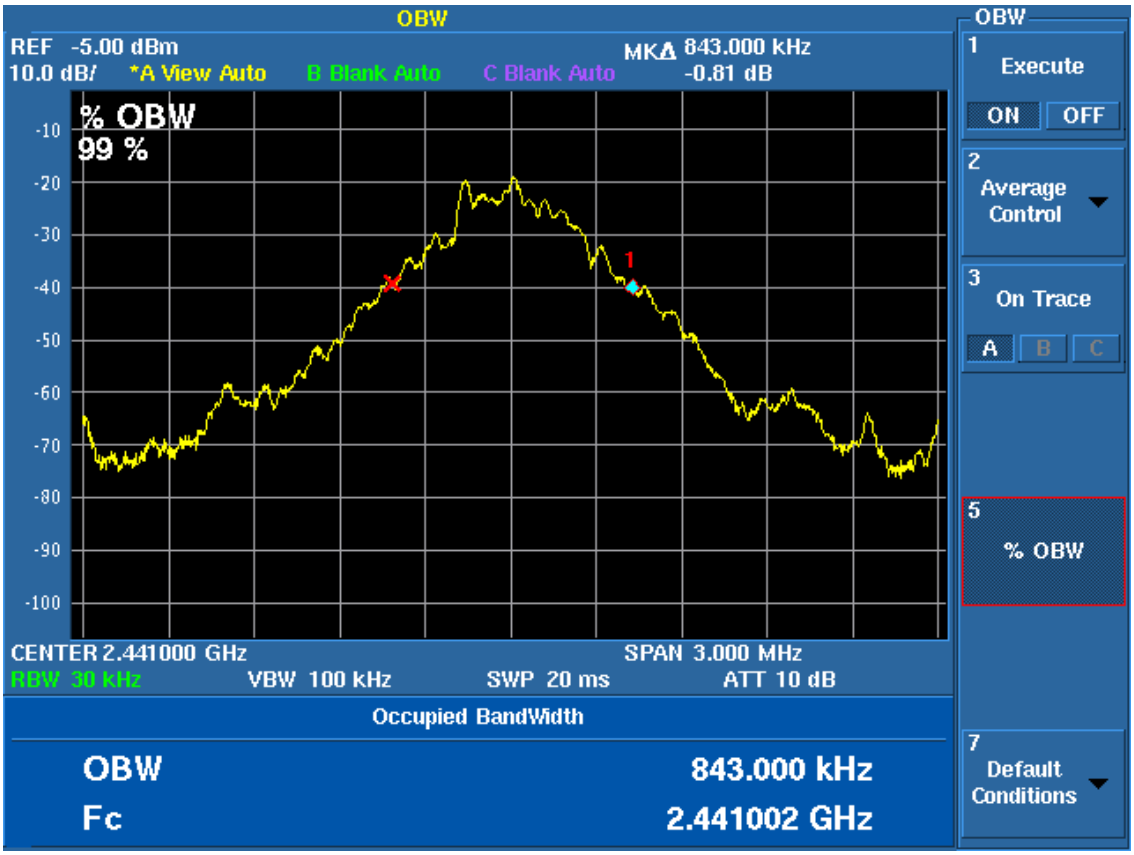


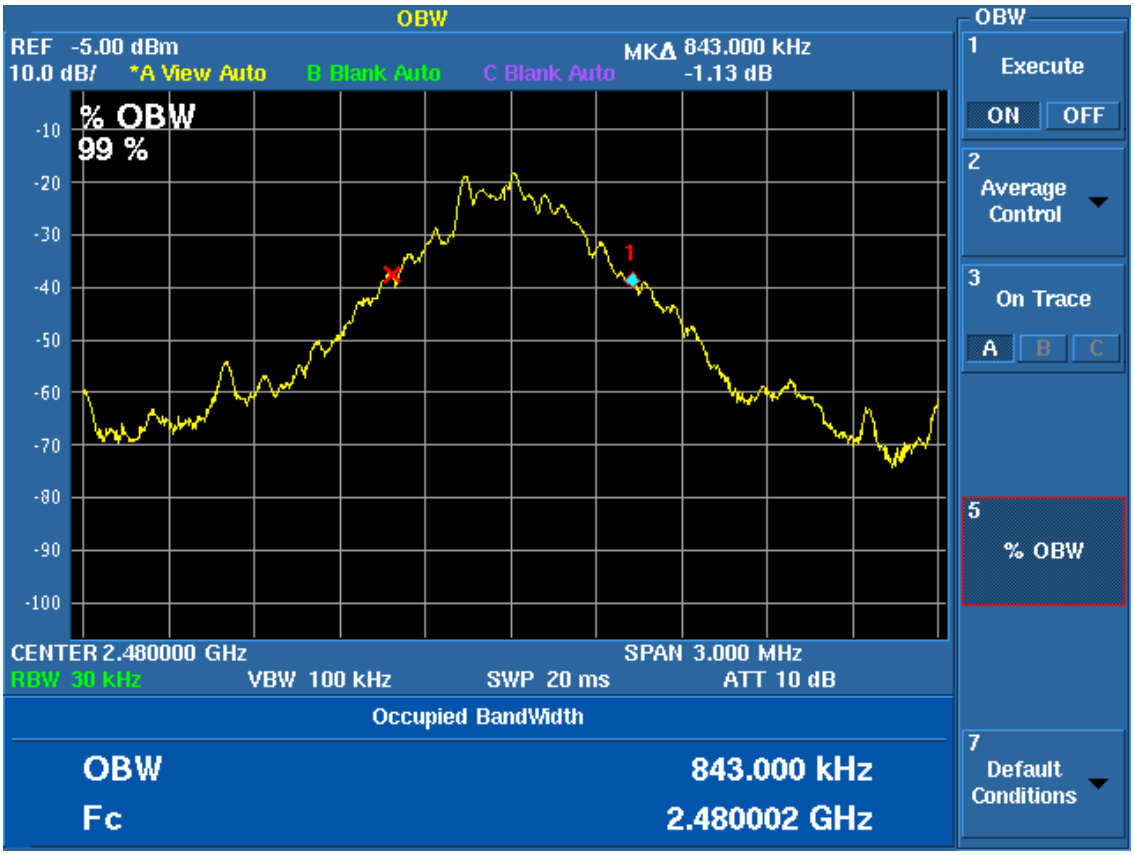

Agilent 11:18:34 Sep 2, 2020
R T
20 dB Occupied Bandwidth; TX at 2441 MHz.
Mkr1 Δ 853.2 kHz
-0.073 dB
Ref 0 dBm
Atten 10 dB
Peak
Log
10
dB/
1R
1
V1 S2
S3 FC
AA
Center 2.441 GHz
Span 3 MHz
#Res BW 30 kHz
#VBW 100 kHz
#Sweep 11.99 ms (1200 pts)


Agilent 11:24:09 Sep 2, 2020
R T
20 dB Occupied Bandwidth; TX at 2480 MHz.
Mkr1 Δ 885.7 kHz
-0.121 dB
Ref 0 dBm
Atten 10 dB
Peak
Log
10
dB/
1R
1
V1 S2
S3 FC
AA
Center 2.48 GHz
Span 3 MHz
#Res BW 30 kHz
#VBW 100 kHz
#Sweep 11.99 ms (1200 pts)

99%:


OBW
REF -5.00 dBm
10.0 dB/ *A View Auto B Blank Auto C Blank Auto
MKΔ 846.000 kHz
0.56 dB
% OBW
99 %
CENTER 2.402000 GHz
SPAN 3.000 MHz
RBW 30 kHz
VBW 100 kHz
SWP 20 ms
ATT 10 dB
Occupied BandWidth
OBW 846.000 kHz
Fc 2.402006 GHz
OBW
1 Execute
ON OFF
2 Average Control
3 On Trace
A B C
5 % OBW
7 Default Conditions


OBW
REF -5.00 dBm
10.0 dB/ *A View Auto B Blank Auto C Blank Auto
MKΔ 843.000 kHz
-0.81 dB
% OBW
99 %
CENTER 2.441000 GHz
SPAN 3.000 MHz
RBW 30 kHz
VBW 100 kHz
SWP 20 ms
ATT 10 dB
Occupied BandWidth
OBW 843.000 kHz
Fc 2.441002 GHz
OBW
1 Execute
ON OFF
2 Average Control
3 On Trace
A B C
5 % OBW
7 Default Conditions



12.4 Band-edge Compliance of RF Conducted Emissions

The spectrum analyzer was set to the MAX HOLD mode to record the worst case of the modulation at the band-edge, with the EUT set to the lowest frequency. The trace was allowed to stabilize.

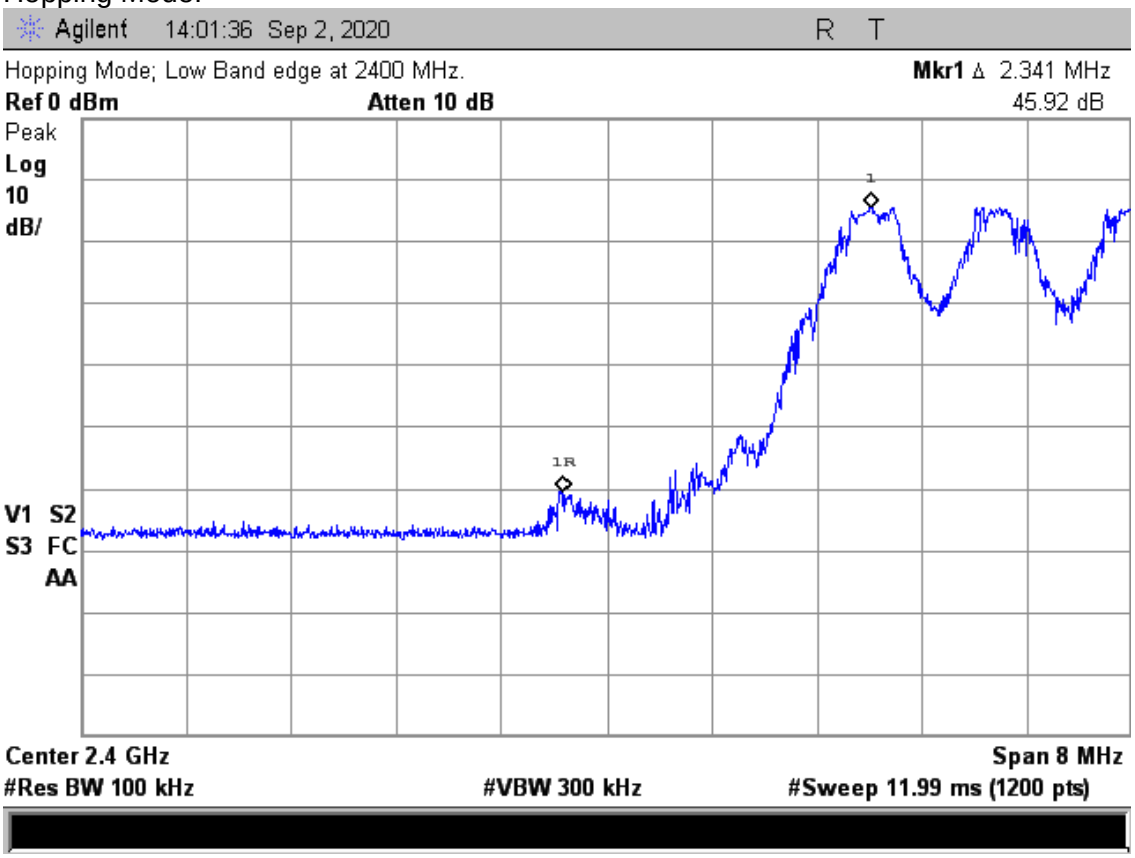
Tested by: Joseph Strzelecki/Richard Tichgelaar
Test Date: September 2, 2020

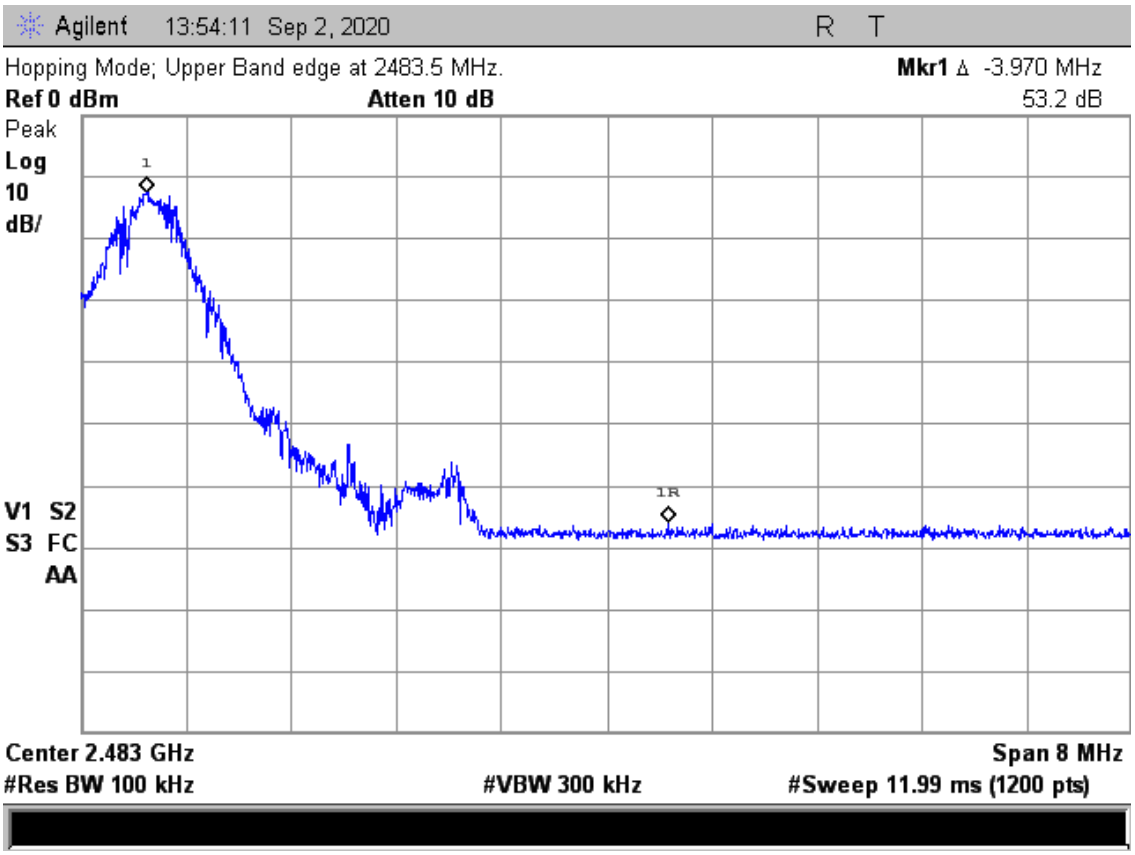
Mode	Freq (MHz)	Band Edge Delta Readings in dB
Hopping	2400.0	45.9
Hopping	2483.5	53.2
Non-hopping	2400.0	44.3
Non-hopping	2483.5	53.9

This information is used to calculate band edge for emissions at 2400 MHz in accordance with ANSI C63.10 Section 6.10.6. The lowest number was used for the calculations.

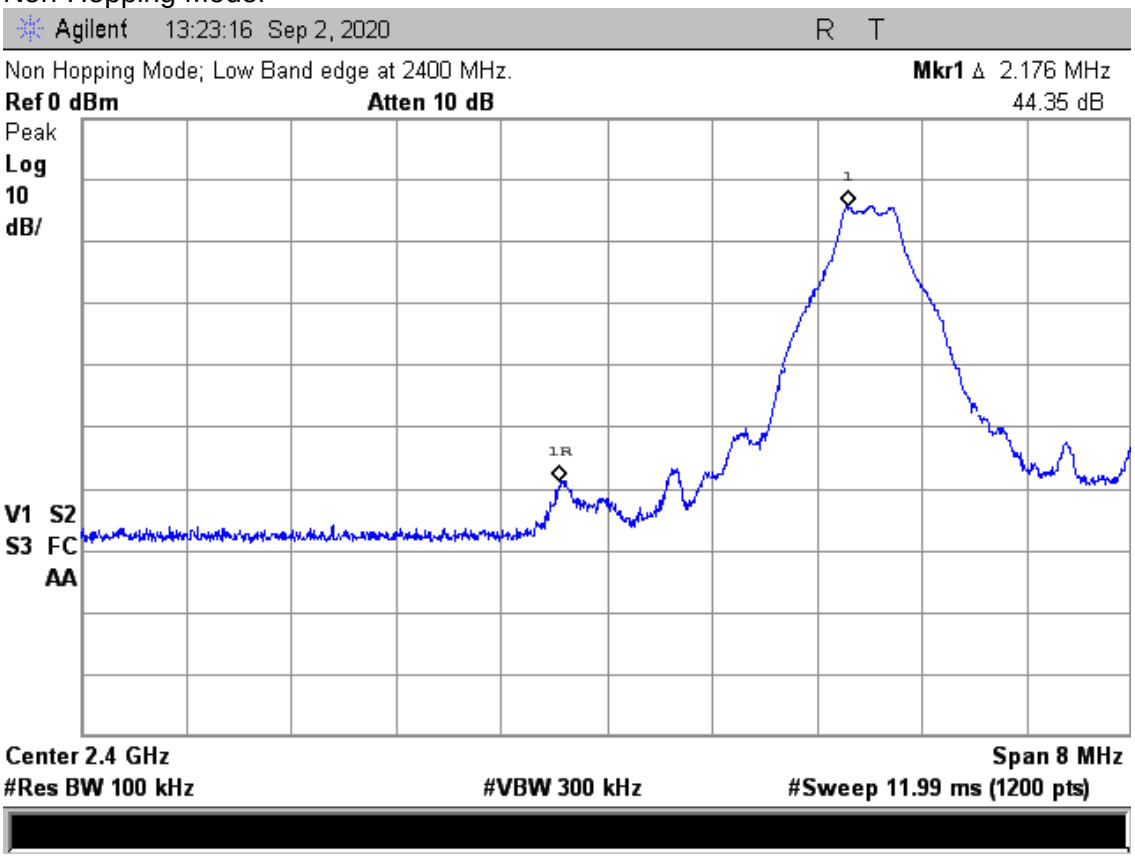
The emission at 2483.5 MHz was measured the conventional way since the upper edge of the occupied bandwidth is more than 2xRBW from the band edge. The results are presented in Section 12.2 herein. The emission at 2400 MHz was measured the conventional way, as well as shown in section 12.2, even though it was not specifically required.

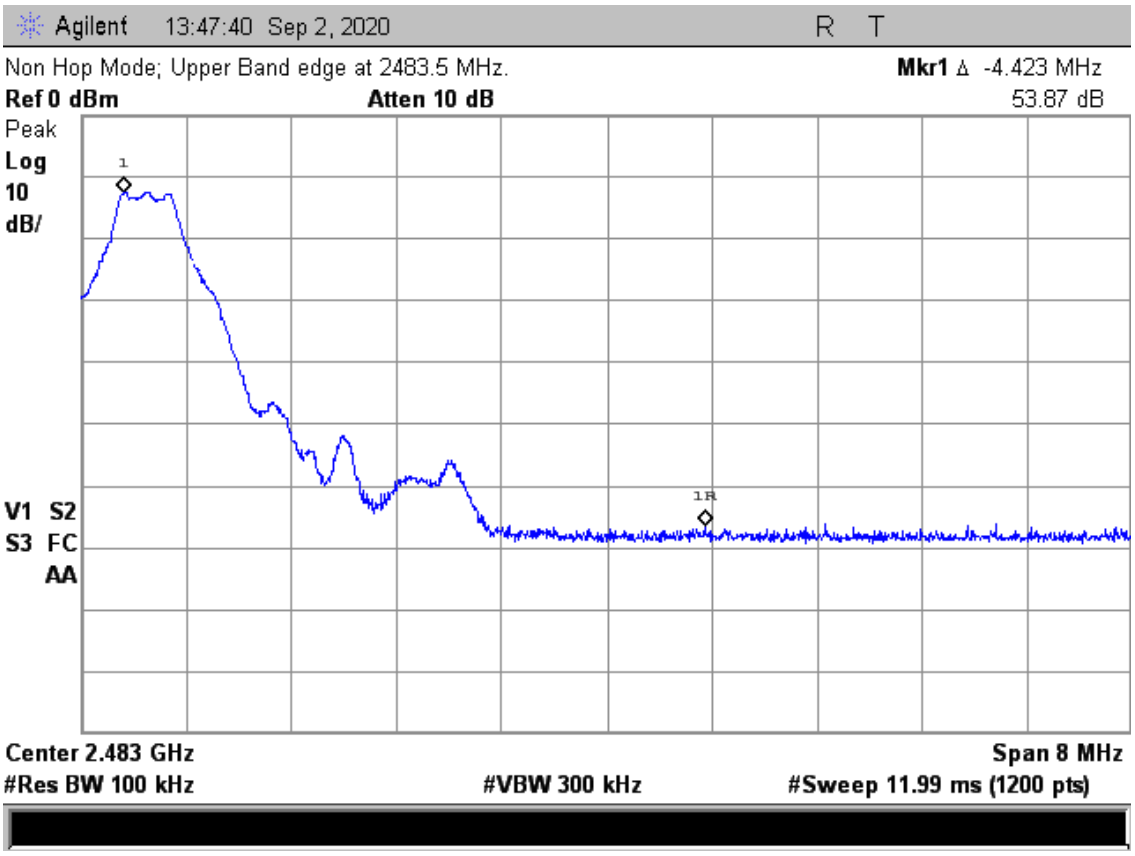
Hopping Mode:





Non-Hopping Mode:





12.5 Duty Cycle

The averave value of the pulsed emissions were measured as per section 7.5, formula (10) of of ANSI C63.10-2013.

a) The EUT was set to the “worst-case” pulse ON time.
b) The RF output was coupled to the input of a spectrum analyzer by a “near-field” coupling method. The signal received shall be of sufficient level to trigger adequately the spectrum analyzer sweep display.
c) The center frequency of the spectrum analyzer was set to the center of the RF signal.
d) The spectrum analyzer was set for ZERO SPAN.
e) The sweep time was of the analyzer was set to 100 ms and other times to show the duty cycle.
f) Since the pulse train has a period that exceeds 100 ms, or as an alternative to step f), then:
    1) The trigger on the spectrum analyzer was set to capture the greatest amount of pulse “ON time” over 100 ms.
    2) The 100 ms period that contains the maximum “on time” was found.
    3) The duty cycle was determined by dividing the total maximum “ON time” by 100 ms (tON/100 ms).
h) The duty cycle correction factor was used applying Equation (10) of ANSI C63.10 to the duty cycle determined in the preceding steps.

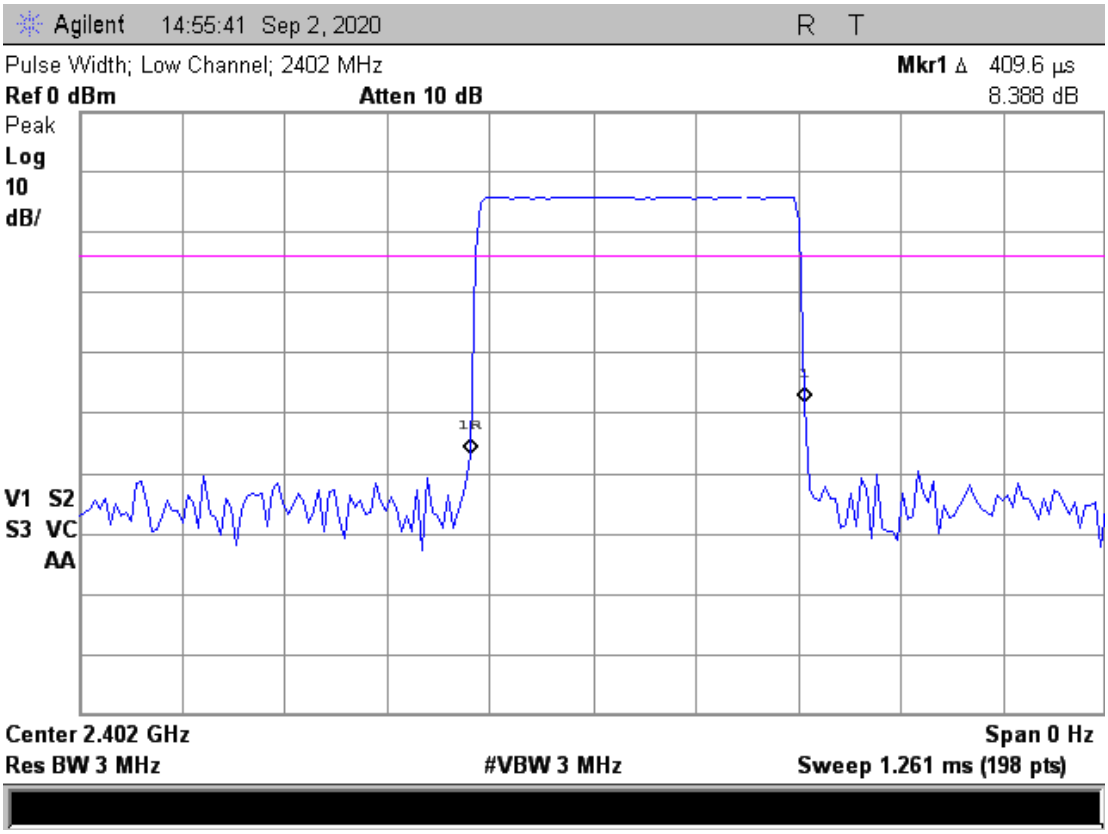
The Peak to average factor is calculated by the highest duty cycle in percent over any 100mS transmission. The factor in dB is 20 * Log(Duty cycle/100). The transmitter operates for a maximum duration of 6.55 ms in any 100 ms interval. 20 Log*(6.55mSec/100mSec) = -23.7 dB Peak to average Correction factor.

Freq. (MHz)	Pulse Width (mS)	# of pulses per 100 mS	On Time per 100mS (mS)	Correction (dB)
2402	0.4096	8	3.2768	-29.7
2441	0.4096	16	6.5536	-23.7
2480	0.4096	10	4.096	-27.8

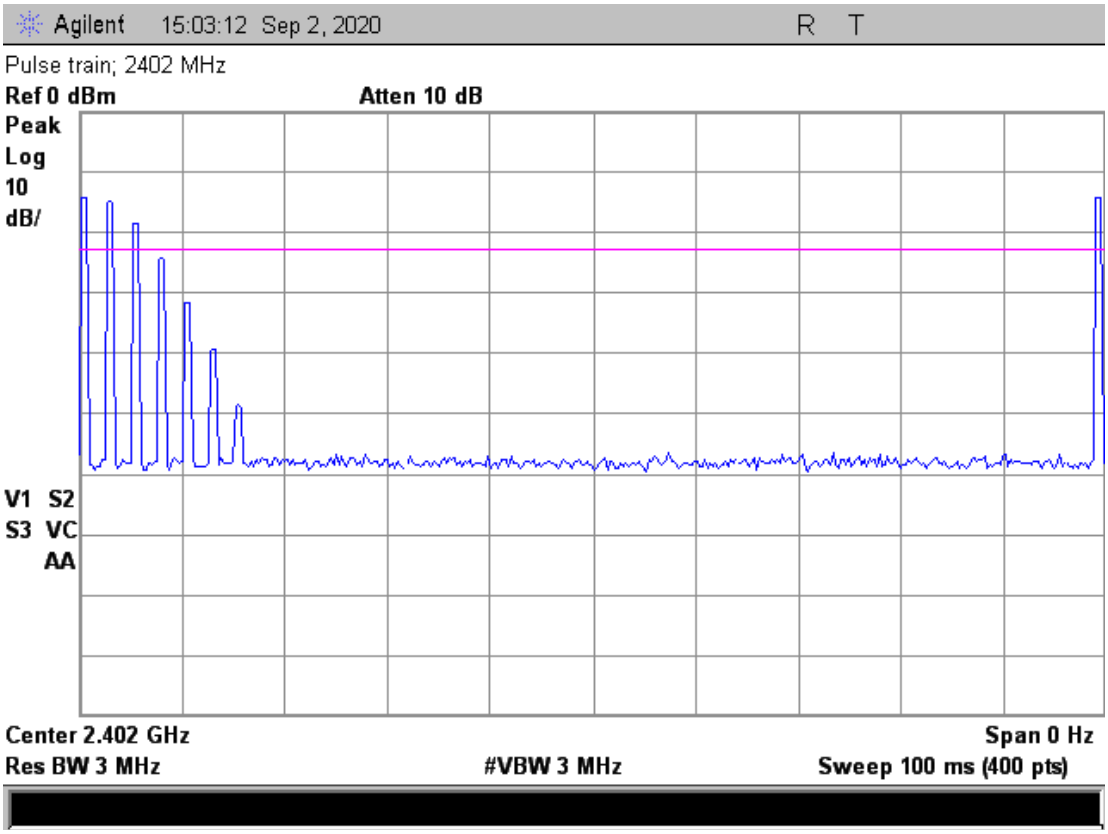
Since the difference between the peak and the average limits are 20 dB, there is no need to use a correction factor of more than 20 dB. Therefore, a 20 dB factor was used.

Tested by: Richard Tichgelaar
Test Date: September 2, 2020

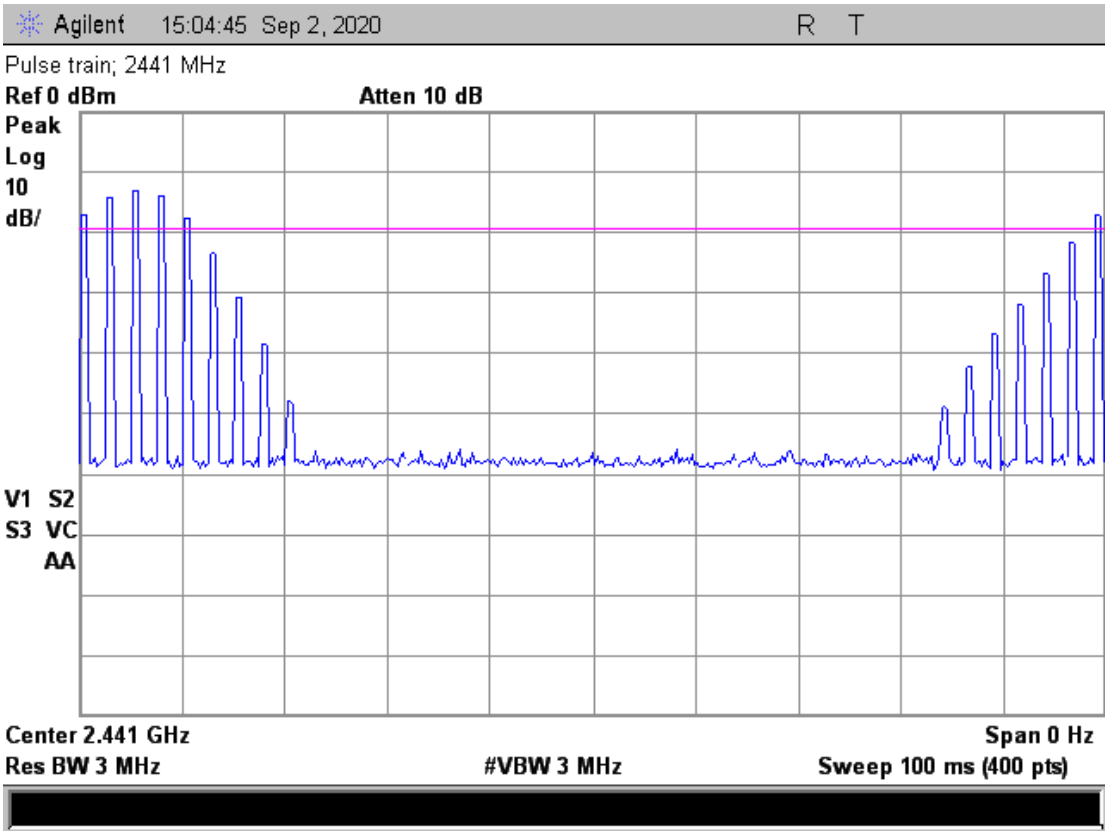
Figure 1. Duty Cycle Plots



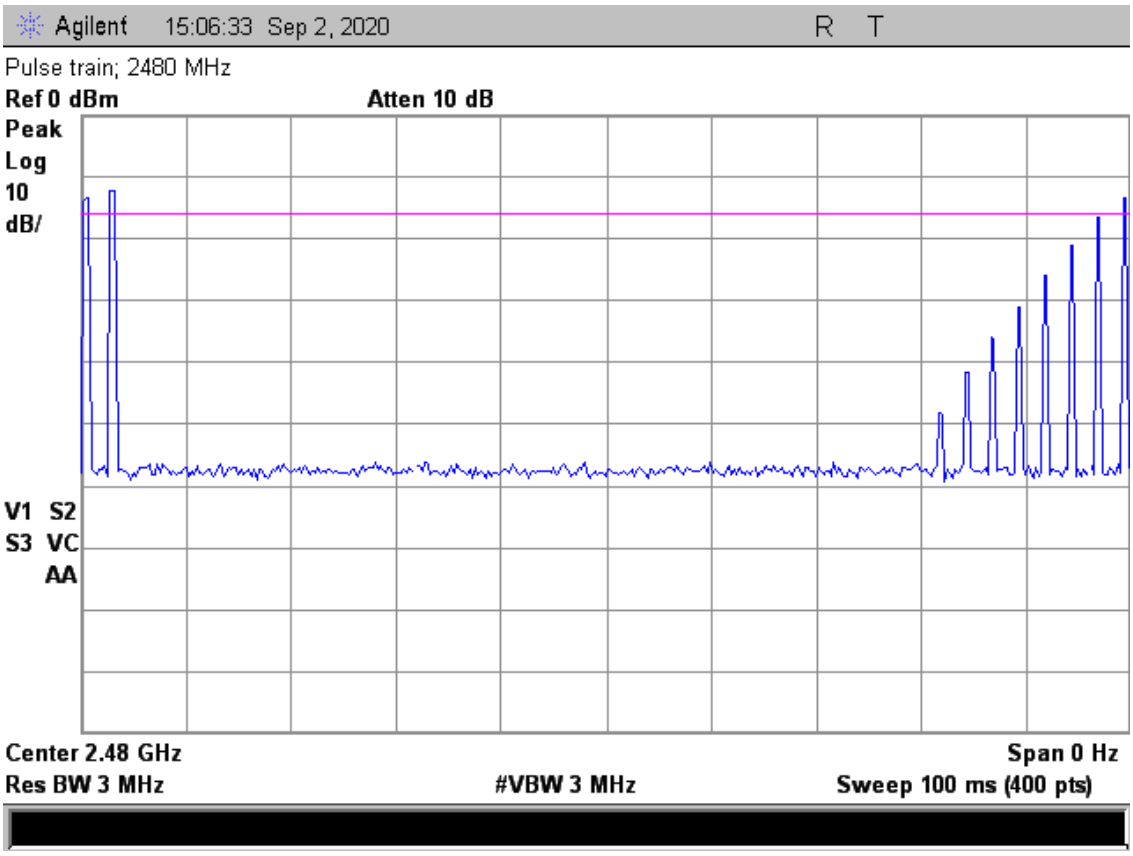
Width of each pulse; used for calculations.



Number of pulses (Low Channel)



Number of pulses (Middle Channel)



Number of pulses (High Channel)

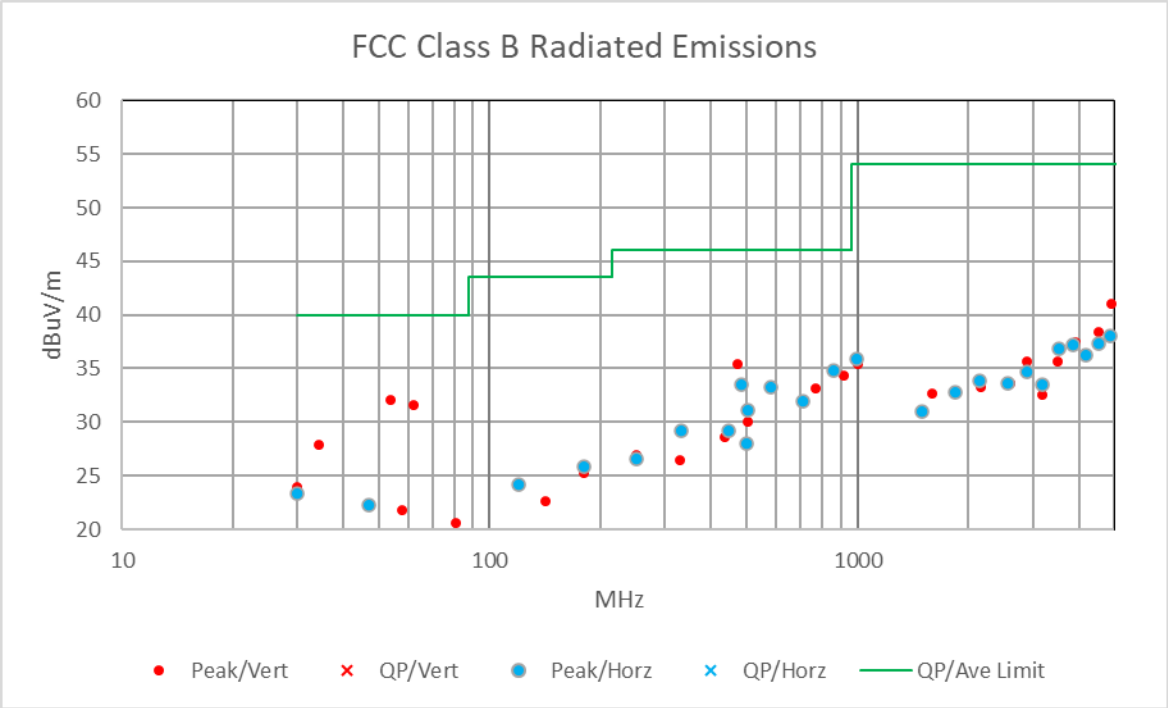
13.0 UNINTENTIONAL EMISSIONS (RECEIVE MODE)

Manufacturer	Trulli Audio	Specification	FCC Part 15.209 & RSS-GEN
Model	TABT1	Test Date	09/04/2020
Serial Number	018	Test Distance	3 Meters
Abbreviations	Pol = Antenna Polarization; V = Vertical; H = Horizontal; P = peak; Q = QP		
Notes	Corr. Factors = Cable Loss – Preamp Gain		
Configuration	Receive mode		

Freq. MHz	Meter Reading dBuV	Dect.	Ant. Pol.	Ant Factor dB/m	Cbl/amp Factors dB	Dist Fact dB	EUT dBuV/m	Limit dBuV/m	Margin Under Limit dB	Note
33.9	13.8	P	H	12.6	0.6	0.0	27.0	40.0	13.0	
94.1	15.7	P	H	9.9	1.0	0.0	26.6	43.5	16.9	
154.3	21.1	P	H	12.8	1.3	0.0	35.2	43.5	8.3	
179.2	13.6	P	H	13.4	1.4	0.0	28.4	43.5	15.1	
198.0	12.2	P	H	14.2	1.5	0.0	27.9	43.5	15.6	
244.4	12.2	P	H	15.2	1.7	0.0	29.1	46.0	16.9	
254.5	11.8	P	H	12.0	1.7	0.0	25.5	46.0	20.5	
316.9	10.1	P	H	14.5	1.9	0.0	26.5	46.0	19.5	
352.2	12.3	P	H	14.3	2.0	0.0	28.6	46.0	17.4	
371.7	12.4	P	H	14.5	2.1	0.0	29.0	46.0	17.0	
403.2	13.9	P	H	15.4	2.2	0.0	31.5	46.0	14.5	
470.6	12.1	P	H	17.0	2.4	0.0	31.5	46.0	14.5	
525.0	10.8	P	H	17.9	2.5	0.0	31.2	46.0	14.8	
627.5	9.2	P	H	19.1	2.7	0.0	31.0	46.0	15.0	
771.3	10.2	P	H	21.2	3.0	0.0	34.4	46.0	11.6	
1000.0	38.7	P	H	23.9	-32.2	0.0	30.4	54.0	23.6	
1495.0	40.6	P	H	25.2	-32.1	0.0	33.7	74.0	40.3	1
1837.5	37.7	P	H	26.8	-31.7	0.0	32.8	74.0	41.2	1
2000.0	40.5	P	H	27.4	-31.5	0.0	36.4	74.0	37.6	1
2152.5	37.6	P	H	27.7	-31.4	0.0	33.9	74.0	40.1	1
2460.0	40.3	P	H	28.3	-30.8	0.0	37.8	74.0	36.2	1
2740.0	42.1	P	H	28.8	-31.3	0.0	39.6	74.0	34.4	1
2890.0	36.4	P	H	29.4	-31.1	0.0	34.7	74.0	39.3	1
3000.0	40.5	P	H	30.2	-30.6	0.0	40.1	74.0	33.9	1
3145.0	39.8	P	H	30.8	-30.2	0.0	40.4	74.0	33.6	1
3520.0	34.6	P	H	31.2	-29.0	0.0	36.8	74.0	37.2	1
3687.5	39.0	P	H	31.9	-28.3	0.0	42.6	74.0	31.4	1
3860.0	32.7	P	H	32.9	-28.4	0.0	37.2	74.0	36.8	1
4000.0	36.8	P	H	32.7	-28.0	0.0	41.5	74.0	32.5	1
4172.5	37.1	P	H	32.3	-28.1	0.0	41.3	74.0	32.7	1
4617.5	36.7	P	H	32.7	-26.8	0.0	42.6	74.0	31.4	1
4877.5	37.1	P	H	33.2	-26.6	0.0	43.7	74.0	30.3	1
34.4	14.1	P	V	12.4	0.6	0.0	27.1	40.0	12.9	
53.8	2.5	Q	V	9.3	0.8	0.0	12.6	40.0	27.4	
62.0	21.5	P	V	9.2	0.9	0.0	31.6	40.0	8.4	
65.9	19.9	P	V	9.2	0.9	0.0	30.0	40.0	10.0	
93.5	18.9	P	V	9.9	1.0	0.0	29.8	43.5	13.7	
153.2	18.3	P	V	12.8	1.3	0.0	32.4	43.5	11.1	
198.0	12.5	P	V	14.2	1.5	0.0	28.2	43.5	15.3	
241.1	9.5	P	V	15.2	1.7	0.0	26.4	46.0	19.6	
253.3	13.1	P	V	11.9	1.7	0.0	26.7	46.0	19.3	
256.4	13.4	P	V	12.0	1.7	0.0	27.1	46.0	18.9	
266.5	12.1	P	V	12.2	1.7	0.0	26.0	46.0	20.0	

Freq. MHz	Meter Reading dBuV	Dect.	Ant. Pol.	Ant Factor dB/m	Cbl/amp Factors dB	Dist Fact dB	EUT dBuV/m	Limit dBuV/m	Margin Under Limit dB	Note
283.5	12.0	P	V	13.2	1.8	0.0	27.0	46.0	19.0	
309.4	11.8	P	V	15.1	1.9	0.0	28.8	46.0	17.2	
357.2	15.0	P	V	14.3	2.0	0.0	31.3	46.0	14.7	
403.9	13.8	P	V	15.4	2.2	0.0	31.4	46.0	14.6	
430.3	16.3	P	V	15.9	2.3	0.0	34.5	46.0	11.5	
448.6	14.6	P	V	16.5	2.3	0.0	33.4	46.0	12.6	
470.0	17.8	P	V	17.0	2.4	0.0	37.2	46.0	8.8	
493.3	15.4	P	V	17.4	2.4	0.0	35.2	46.0	10.8	
502.5	14.3	P	V	18.1	2.4	0.0	34.8	46.0	11.2	
562.5	16.9	P	V	18.3	2.6	0.0	37.8	46.0	8.2	
571.3	18.0	P	V	18.3	2.6	0.0	38.9	46.0	7.1	
743.8	10.2	P	V	20.9	3.0	0.0	34.1	46.0	11.9	
1000.0	41.8	P	V	23.9	-32.2	0.0	33.5	54.0	20.5	
1262.5	44.3	P	V	25.2	-32.3	0.0	37.2	74.0	36.8	1
1882.5	43.6	P	V	27.2	-31.8	0.0	39.0	74.0	35.0	1
1977.5	45.0	P	V	27.4	-31.6	0.0	40.8	74.0	33.2	1
2047.5	41.2	P	V	27.6	-31.4	0.0	37.4	74.0	36.6	1
2172.5	37.0	P	V	27.7	-31.4	0.0	33.3	74.0	40.7	1
2462.5	43.5	P	V	28.3	-30.8	0.0	41.0	74.0	33.0	1
2597.5	36.3	P	V	28.7	-31.4	0.0	33.6	74.0	40.4	1
2895.0	44.9	P	V	29.4	-31.1	0.0	43.2	74.0	30.8	1
3000.0	44.2	P	V	30.2	-30.6	0.0	43.8	74.0	30.2	1
3515.0	33.5	P	V	31.2	-29.0	0.0	35.7	74.0	38.3	1
3802.5	38.6	P	V	32.8	-28.3	0.0	43.1	74.0	30.9	1
4157.5	32.1	P	V	32.3	-28.0	0.0	36.4	74.0	37.6	1
4512.5	33.0	P	V	32.5	-27.1	0.0	38.4	74.0	35.6	1
4560.0	37.2	P	V	32.5	-27.0	0.0	42.7	74.0	31.3	1
4902.5	34.1	P	V	33.2	-26.3	0.0	41.0	74.0	33.0	1

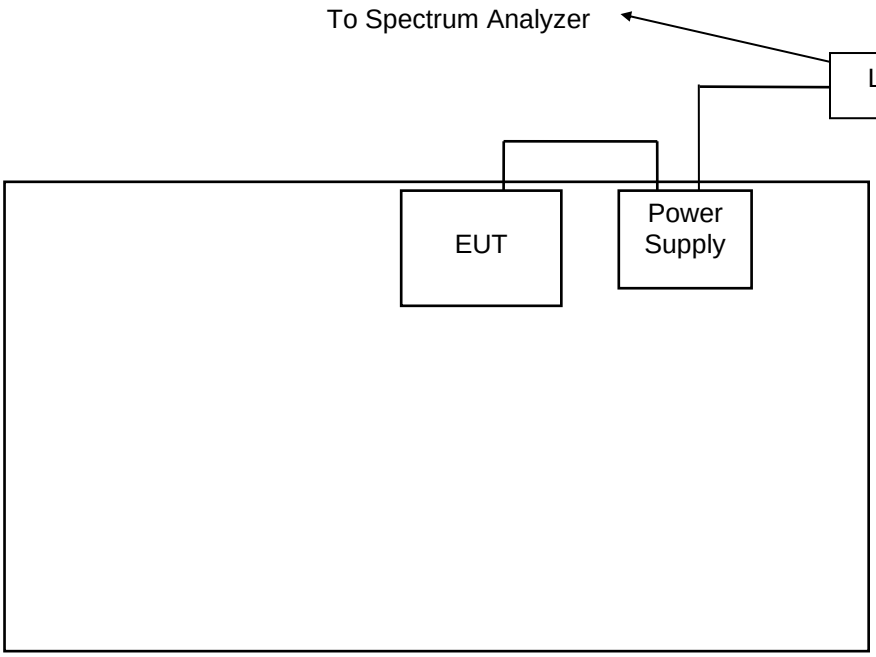
Note1 : Peak reading below Average limits, so average readings not performed for that frequency.
Judgment: Passed by 7.1 dB



Tabulated data from above represented graphically.

14.0 GENERAL TEST SETUPS

Figure 2. Conducted Emissions Test Setup



Notes:
- LISN's at least 80 cm from EUT chassis
- Vertical conductive plane 40 cm from rear of tabletop
- EUT power cord bundled

Figure 3. Radiated Emissions Setup for Tests from 30MHz to 1000MHz

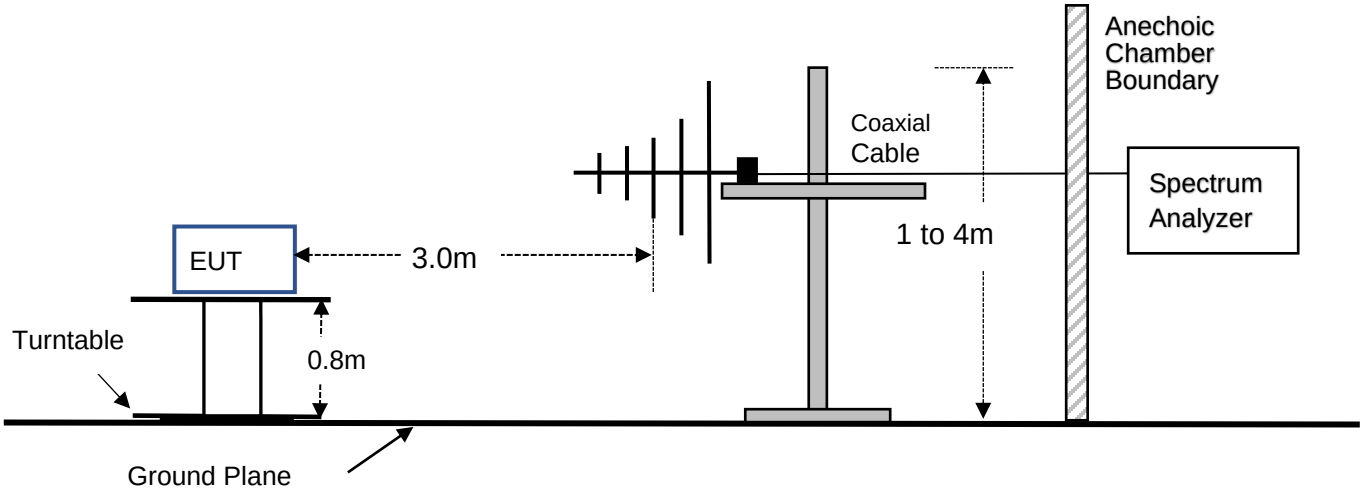
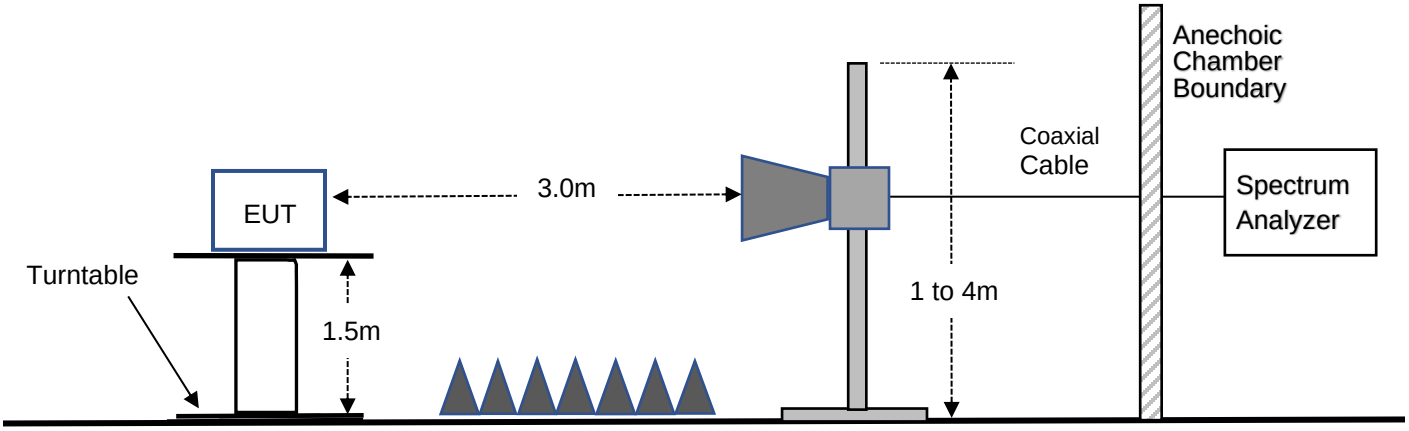


Figure 4. Radiated Emissions Setup for Tests over 1000MHz



Test Equipment for Radiated emissions

Frequency Range	Receive Antenna	Pre-Amplifier	Spectrum Analyzer	High Pass Filter
30 to 200 MHz	ANT-80	None	REC-21	None
200 to 1000 MHz	ANT-68	None	REC-21	None
1 to 9 GHz	ANT-66	AMP-05	REC-21	HPF-06
9 to 18 GHz	ANT-66	AMP-20	REC-21	None*
18 to 25 GHz	ANT-66	AMP-59	REC-21	None*

* A high pass filter was not needed since the fundamental frequency was outside of the amplifiers pass band.

15.0 MEASUREMENT INSTRUMENTATION UNCERTAINTY

Measurement	Uncertainty
Conducted Emissions, LISN method, 150 kHz to 30 MHz	2.2 dB
Radiated Emissions, E-field, 3 meters, 30 to 200 MHz	4.7 dB
Radiated Emissions, E-field, 3 meters, 200 to 1000 MHz	6.2 dB
Radiated Emissions, E-field, 3 meters, 1 to 6 GHz	5.0 dB
Radiated Emissions, E-field, 3 meters, 6 to 18 GHz	5.5 dB
Radiated Emissions, E-field, 3 meters, 18 to 26 GHz	5.9 dB
Bandwidth using marker delta method at a span of 20 MHz	8 kHz
99% Occupied Bandwidth using REC-43	1% of frequency span
Direct Amplitude measurement 1-26,000 MHz	1.5 dB
Temperature THM-02	0.6 Deg C

The uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k=2 in accordance with CISPR 16-4-2.

16.0 REVISION HISTORY

Document RP-9338 Revisions:			
Rev.	Affected Sections	Description	Rationale
1	Cover, 5.0	Deleted FCC part 15.247 and RSS-247	FCC rule 15.247 and RSS-247 is not applicable to this project