Radio Testing of the
Savant Systems, Inc.
Wireless Controller
Model: SAVANT POWER DIRECTOR

In accordance with FCC Part 15 Subpart C §15.247 and IC RSS-247 Issue 2 February 2017

America

Add value.
Inspire trust.

Savant Systems, Inc.
45 Perseverance Way
Hyannis MA USA 02601

COMMERCIAL-IN-CONFIDENCE

Date: July 2022
Document Number: 72180682A Issue 01 | Version Number: 01

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Authorized Signatory	Omar Castillo	July 28, 2022	

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD document control rules.

EXECUTIVE SUMMARY
A sample of this product was tested and found to be in compliance with FCC Part 15 Subpart C §15.247 and IC RSS-247 Issue 2 February 2017.

A2LA Cert. No. 2955.13

TÜV SÜD America, Inc.
10040 Mesa Rim Road
San Diego, CA 92121-2912

TÜV SÜD America, Inc.
Rancho Bernardo Facility
16936 Via Del Campo
San Diego, CA 92127

Phone: 858 678 1400
www.TÜV-sud-america.com

REPORT ON	Radio Testing of the Savant Systems, Inc. Model: SAVANT POWER DIRECTOR (Wireless Controller)
TEST REPORT NUMBER	72180682A
TEST REPORT DATE	July 2022
PREPARED FOR	Savant Systems, Inc. 45 Perseverance Way Hyannis MA USA 02601
CONTACT PERSON	Lori Pass Hardware Engineer lori.pass@savant.com (508) 683-2430
PREPARED BY	Ferdinand S. Custodio **Name** Authorized Signatory Title: Senior EMC Test Engineer / Wireless Team Lead
APPROVED BY	Omar Castillo **Name** Authorized Signatory Title: Senior EMC/Wireless Test Engineer
DATED	July 28, 2022

Revision History

72180682A Savant Systems, Inc. Model: SAVANT POWER DIRECTOR					
DATE	OLD REVISION	NEW REVISION	REASON	PAGES AFFECTED	APPROVED BY
07/28/2022	—	Initial Release			Omar Castillo

CONTENTS

Section		Page No
1	**REPORT SUMMARY**	**5**
1.2	Brief Summary of Results	7
1.3	Product Information	8
1.4	EUT Test Configuration	8
1.5	Deviations From The Standard	9
1.6	Modification Record	11
1.7	Test Methodology	11
1.8	Test Facility Location	11
1.9	Test Facility Registration	11
2	**TEST DETAILS**	**13**
2.1	Peak Output Power	14
2.2	Conducted Emissions	17
2.3	99% Emission Bandwidth	21
2.4	Minimum 6 dB RF Bandwidth	26
2.5	Out-Of-Band Emissions - Conducted	31
2.6	Band-Edge Compliance of RF Conducted Emissions	39
2.7	Radiated Spurious Emissions	49
2.8	Power Spectral Density	55
3	**TEST EQUIPMENT USED**	**59**
3.1	Test Equipment Used	60
3.2	Measurement Uncertainty	61
4	**DIAGRAM OF TEST SETUP**	**63**
4.1	Test Setup Diagram	64
5	**ACCREDITATION, DISCLAIMERS AND COPYRIGHT**	**67**
5.1	Accreditation, Disclaimers and Copyright	68

SECTION 1

REPORT SUMMARY

Radio Testing of the
Savant Systems, Inc.
SAVANT POWER DIRECTOR Wireless Controller

1.1 INTRODUCTION

The information contained in this report is intended to show verification of the SAVANT POWER DIRECTOR Wireless Controller to the requirements of FCC Part 15 Subpart C §15.247 and IC RSS-247 Issue 2 February 2017.

Objective	To perform Radio Testing to determine the Equipment Under Test's (EUT's) compliance with the Test Specification, for the series of tests carried out.
Manufacturer	Savant Systems, Inc.
EUT	HST-DIRECTOR-00 SAVANT POWER DIRECTOR
Model Number	HST-DIRECTOR-00
Model Name	SAVANT POWER DIRECTOR
FCC ID	ASU-DIRECTOR
IC Number	10052A-DIRECTOR
FCC Classification	Low power Communications Device Transmitter (DTS)
Serial Number(s)	345650037
Number of Samples Tested	1
Test Specification/Issue/Date	• FCC Part 15 Subpart C §15.247 (October 1, 2021). • RSS-247–Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices (Issue 2, February 2017). • RSS-Gen - General Requirements for Compliance of Radio Apparatus (Issue 5, Amendment 2 February 2021).
Start of Test	July 06, 2022
Finish of Test	July 10, 2022
Name of Engineer(s)	Ferdinand Custodio
Related Document(s)	• ANSI C63.10-2013. American National Standard of Procedures for Compliance testing of Unlicensed Wireless Devices. • KDB 558074 D01 15.247 v05r02 Guidance for compliance measurements on Digital Transmission System, Frequency Hopping Spread Spectrum System, and Hybrid System Devices operating under Section 15.247 of the FCC rules. • Supporting documents for EUT certification are separate exhibits.

1.2 BRIEF SUMMARY OF RESULTS

A brief summary of the tests carried out in accordance with FCC Part 15 Subpart C §15.247 and IC RSS-247 Issue 2 February 2017 with cross-reference to the corresponding IC RSS standard are shown below.

Section	§15.247 Spec Clause	RSS	Test Description	Result	Comments /Base Standard
2.1	§15.247(b)(3)	RSS-247 5.4(d)	Peak Output Power	Compliant	
2.2	§15.207(a)	RSS-Gen 8.8	Conducted Emissions	Compliant	
2.3	-	RSS-Gen 6.7	99% Emission Bandwidth	Compliant	
2.4	§15.247(a)(2)	RSS-247 5.2(a)	Minimum 6 dB RF Bandwidth	Compliant	
2.5	§15.247(d)	RSS-247 5.5	Out-of-Band Emissions - Conducted	Compliant	
2.6	§15.247(d)	RSS-247 5.5	Band-edge Compliance of RF Conducted Emissions	Compliant	
2.7	§15.247(d)	RSS-247 5.5	Radiated Spurious Emissions	Compliant	
	-	RSS-Gen 7.3 and 7.4	Receiver Spurious Emissions	N/A	
2.8	§15.247(e)	RSS-247 5.2(b)	Power Spectral Density for Digitally Modulated Device	Compliant	

N/A Not required as per RSS-Gen 5.3 The EUT does not fall into any category defined as Receiver under RSS-Gen.

1.3 PRODUCT INFORMATION

1.3.1 Technical Description

The Equipment Under Test (EUT) is a SAVANT POWER DIRECTOR Wireless Controller for smart energy management. The EUT consists of Linux application processor with 2x BLE microcontrollers and 1x WiFi/BLE module. The EUT acts as a bridge between BLE communications to IP network (either Ethernet or WiFi). The device is powered via either Power-over-Ethernet (PoE) or 5V AC-DC adapter.

1.3.2 EUT General Description

EUT Description	Wireless Controller for Smart Energy Management
Model Name	SAVANT POWER DIRECTOR
Model Number	HST-DIRECTOR-00
Rated Voltage	120VAC AC to 5V DC (3A)
Mode Verified	Bluetooth LE 5.1
Capability	BLE 5.1, 2.4/5.0 GHz IEEE 802.11 a/b/g/n/ac
Primary Unit (EUT)	☐ Production
	☒ Pre-Production
	☐ Engineering
Manufacturer Declared Temperature Range	0°C to 40°C
Antenna Type	Wi-Fi Dual-band Stubby Antenna
Manufacturer	World Products Inc.
Antenna Model	WPANT30094-R1A
Maximum Antenna Gain	2.0 dBi

1.3.3 Maximum Conducted Output Power

Bluetooth Low Energy (LE)	Frequency Range (MHz)	Gated RMS (dBm)	Duty Cycle (%)
	2402-2480	9.1	63.1% / 33.4%

See section 2.1.8 of this test report. Duty cycle figures are for both 1M and 2M PHY.

1.4 EUT TEST CONFIGURATION

1.4.1 Test Configuration Description

<table>
<tr><th>Test Configuration</th><th>Description</th></tr>
<tr><td>Default</td><td>Antenna Conducted Port Configuration. Direct measurement from the antenna port. The EUT is connected to a support laptop connected by a programming dongle, a 10 pin Tag Connect and a USB-C cable. nRF Connect and PuTTY were used on the support laptop for BLE 5.1 RF test configurations. The following settings were used for both 1M and 2M PHY configurations:

<table>
<tr><td>Transmit Power</td><td>8dBm</td></tr>
<tr><td>Packet Type</td><td>PRBS9</td></tr>
<tr><td>Packet Length</td><td>37 Bytes</td></tr>
</table>

For Cabinet Spurious Emissions, identical configurations are used with the antenna port terminated.</td></tr>
</table>

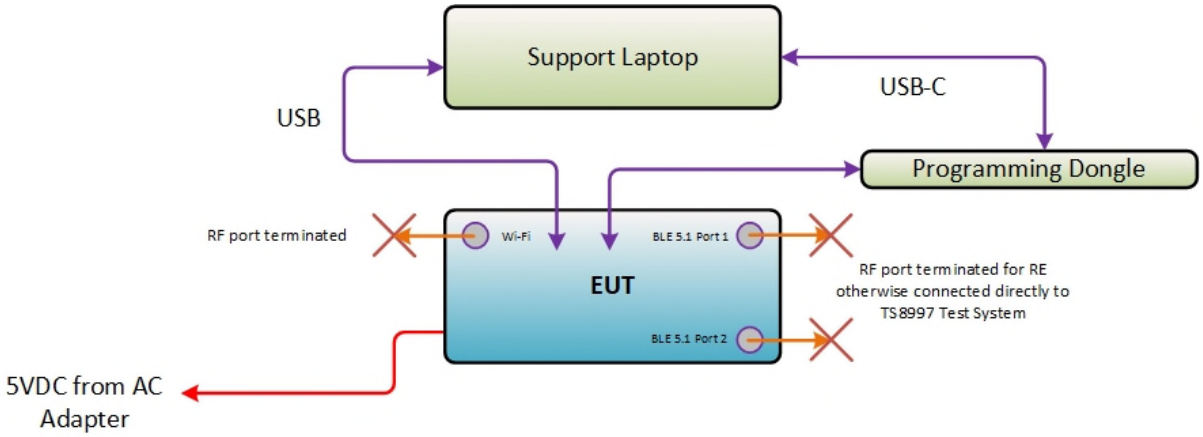
1.4.2 EUT Exercise Software

nRF Connect for Desktop v3.11.0

1.4.3 Support Equipment and I/O cables

Manufacturer	Equipment/Cable	Description
Lenovo	Support laptop	Model:Thinkpad T440S, S/N: PC-03BBGR
Racepoint	Laptop to EUT	Programming Dongle
-	TC2050-CTX	10 pin Tag Connect cable
Mean Well	EUT AC Adapter	Model: GST18U05 P1J

1.4.1 Simplified Test Configuration Diagram



1.5 DEVIATIONS FROM THE STANDARD

No deviations from the applicable test standards or test plan were made during testing.

1.6 MODIFICATION RECORD

Description of Modification	Modification Fitted By	Date Modification Fitted
Serial Number: No modifications		
N/A	-	-

The table above details modifications made to the EUT during the test programme. The modifications incorporated during each test (if relevant) are recorded on the appropriate test pages.

1.7 TEST METHODOLOGY

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

For conducted and radiated emissions, the equipment under test (EUT) was configured to measure its highest possible emission level. This level was based on the maximized cable configuration from exploratory testing per ANSI C63.10-2013. The test modes were adapted according to the Operating Instructions provided by the manufacturer/client.

1.8 TEST FACILITY LOCATION

1.8.1 TÜV SÜD America Inc. (Mira Mesa)

10040 Mesa Rim Road, San Diego, CA 92121-2912 (32.901268,-117.177681). Phone: (858) 678-1400 FAX: (858) 546-0364

1.8.2 TÜV SÜD America Inc. (Rancho Bernardo)

16936 Via Del Campo, San Diego, CA 92127-1708 (33.018644,-117.092409). Phone: (858) 678-1400 FAX: (858) 546-0364.

1.9 TEST FACILITY REGISTRATION

1.9.1 FCC – Designation No.: US1146

TÜV SÜD America Inc. (San Diego), is an accredited test facility with the site description report on file and has met all the requirements specified in §2.948 of the FCC rules. The acceptance letter from the FCC is maintained in our files and the Designation is US1146.

1.9.2 Innovation, Science and Economic Development Canada (ISED) Registration No.: 3067A-1 & 22806-1

The 10m Semi-anechoic chamber of TÜV SÜD America Inc. (San Diego Rancho Bernardo) has been registered by Certification and Engineering Bureau of Innovation, Science and Economic Development Canada for radio equipment testing with Registration No. 3067A-1.

The 3m Semi-anechoic chamber of TÜV SÜD America Inc. (San Diego Mira Mesa) has been registered by Certification and Engineering Bureau of Innovation, Science and Economic Development Canada for radio equipment testing with Registration No. 22806-1.

1.9.3 BSMI – Laboratory Code: SL2-IN-E-028R (US0102)

TÜV Product Service Inc. (San Diego) is a recognized EMC testing laboratory by the BSMI under the MRA (Mutual Recognition Arrangement) with the United States. Accreditation includes CNS 13438 up to 6GHz.

1.9.4 NCC (National Communications Commission - US0102)

TÜV SÜD America Inc. (San Diego) is listed as a Foreign Recognized Telecommunication Equipment Testing Laboratory and is accredited to ISO/IEC 17025 (A2LA Certificate No.2955.13) which under APEC TEL MRA Phase 1 was designated as a Conformity Assessment Body competent to perform testing of equipment subject to the Technical Regulations covered under its scope of accreditation including RTTE01, PLMN01 and PLMN08 for TTE type of testing and LP0002 for Low-Power RF Device type of testing.

1.9.5 VCCI – Registration No. A-0280 and A-0281

TÜV SÜD America Inc. (San Diego) is a VCCI registered measurement facility which includes radiated field strength measurement, radiated field strength measurement above 1GHz, mains port interference measurement and telecommunication port interference measurement.

1.9.6 RRA – Identification No. US0102

TÜV SÜD America Inc. (San Diego) is National Radio Research Agency (RRA) recognized laboratory under Phase I of the APEC Tel MRA.

1.9.7 OFCA – U.S. Identification No. US0102

TÜV SÜD America Inc. (San Diego) is recognized by Office of the Communications Authority (OFCA) under Appendix B, Phase I of the APEC Tel MRA.

SECTION 2

TEST DETAILS

Radio Testing of the
Savant Systems, Inc.
SAVANT POWER DIRECTOR Wireless Controller

2.1 PEAK OUTPUT POWER

2.1.1 Specification Reference

FCC 47 CFR Part 15, Clause 15.247(b)(3)
RSS-247, Clause 5.4 (d)

2.1.2 Standard Applicable

For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands, the maximum peak conducted output shall not exceed 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

2.1.3 Equipment Under Test and Modification State

Serial No: 345650037 / Default Test Configuration

2.1.4 Date of Test/Initial of test personnel who performed the test

July 06, 2022 / FSC

2.1.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.1.6 Environmental Conditions (Rancho Bernardo Satellite Facility)

Ambient Temperature	24.2°C
Relative Humidity	42.6%
ATM Pressure	99.5kPa

2.1.7 Additional Observations

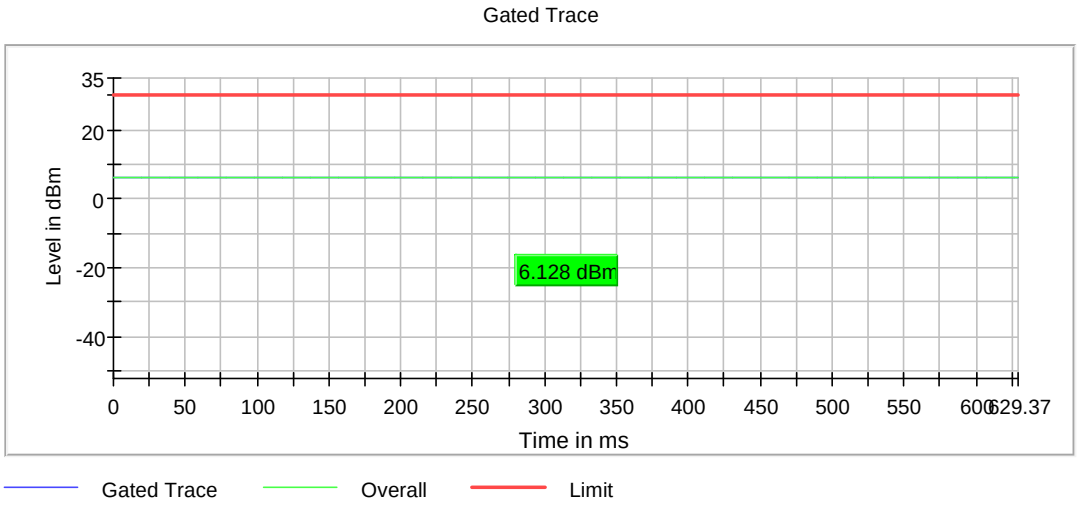
- This is a conducted test using direct connection to the TS8997 Test System.
- The path loss was all accounted for with the test system calibration.
- Test results presented are for both RF chains combined. Sample plots presented are from individual RF chain.
- Test methodology is per FCC title 47 part 15 §15.247(b), KDB 558074 D01 DTS Meas Guidance v05 and ANSI C63.10-2013 11.9.2.3.2.

2.1.8 Test Results

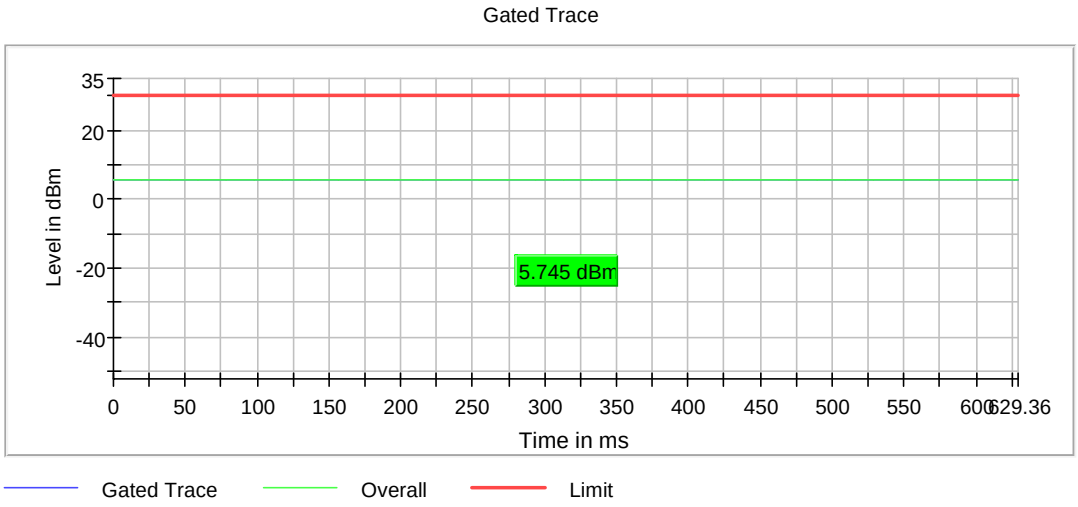
DUT Frequency (MHz)	PHY	Gated RMS* (dBm)	Limit Max (dBm)	DutyCycle (%)	Result
2402.000000	1M	9.1	30.0	63.143	PASS
2440.000000	1M	8.7		63.142	PASS
2480.000000	1M	7.9		63.141	PASS
2402.000000	2M	9.1		33.383	PASS
2440.000000	2M	8.7		33.382	PASS
2480.000000	2M	7.9		33.381	PASS

Gated RMS reported are for both RF chains combined

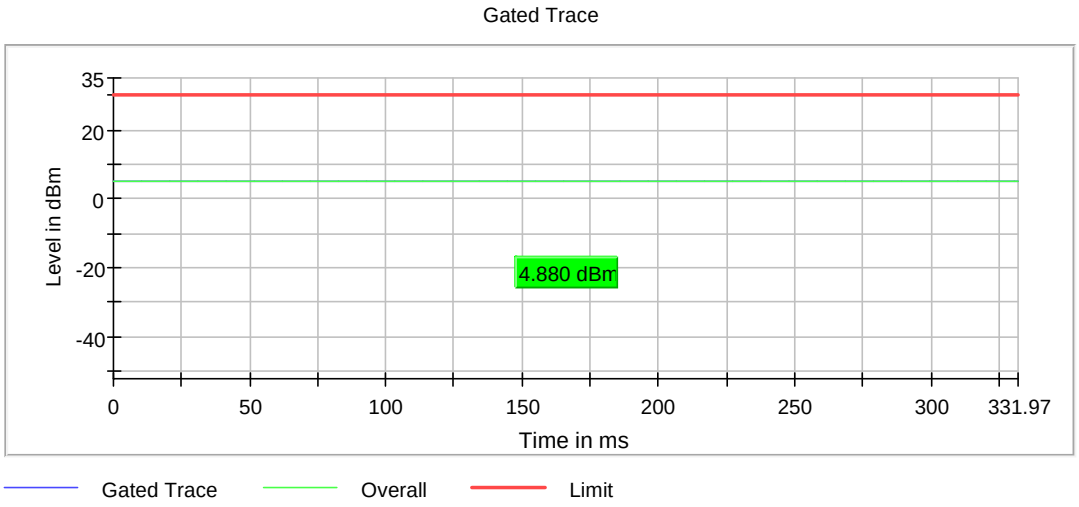
2.1.9 Sample Test Plots (single RF chain)



Bluetooth LE. Low Channel 1M PHY



Bluetooth LE. Mid Channel 1M PHY



Bluetooth LE. High Channel 2M PHY

2.1.10 Power Meter Settings

Setting	Instrument Value	Target Value
Measurement Time	1.000 s	1.000 s
Points	1000000	1000000
Time resolution	1.000 µs	1.000 µs

2.2 CONDUCTED EMISSIONS

2.2.1 Specification Reference

FCC 47 CFR Part 15, Clause 15.207(a)
RSS-GEN, Clause 8.8

2.2.2 Standard Applicable

An intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 µH/50 ohms line impedance stabilization network (LISN).

Frequency of emission (MHz)	Conducted limit (dBµV)	
	Quasi-peak	Average
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

**Decreases with the logarithm of the frequency.*

2.2.3 Equipment Under Test and Modification State

Serial No: 345650037 / Default Test Configuration

2.2.4 Date of Test/Initial of test personnel who performed the test

July 10, 2022 / FSC

2.2.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.2.6 Environmental Conditions (Mira Mesa Facility)

Ambient Temperature	25.3°C
Relative Humidity	42.4%
ATM Pressure	99.5kPa

2.2.7 Additional Observations

Measurement was done using EMC32 automated software. Reported level is the actual level with all the correction factors factored in. Correction Factor column is for informational purposes only. See Section 2.2.8 for sample computation.

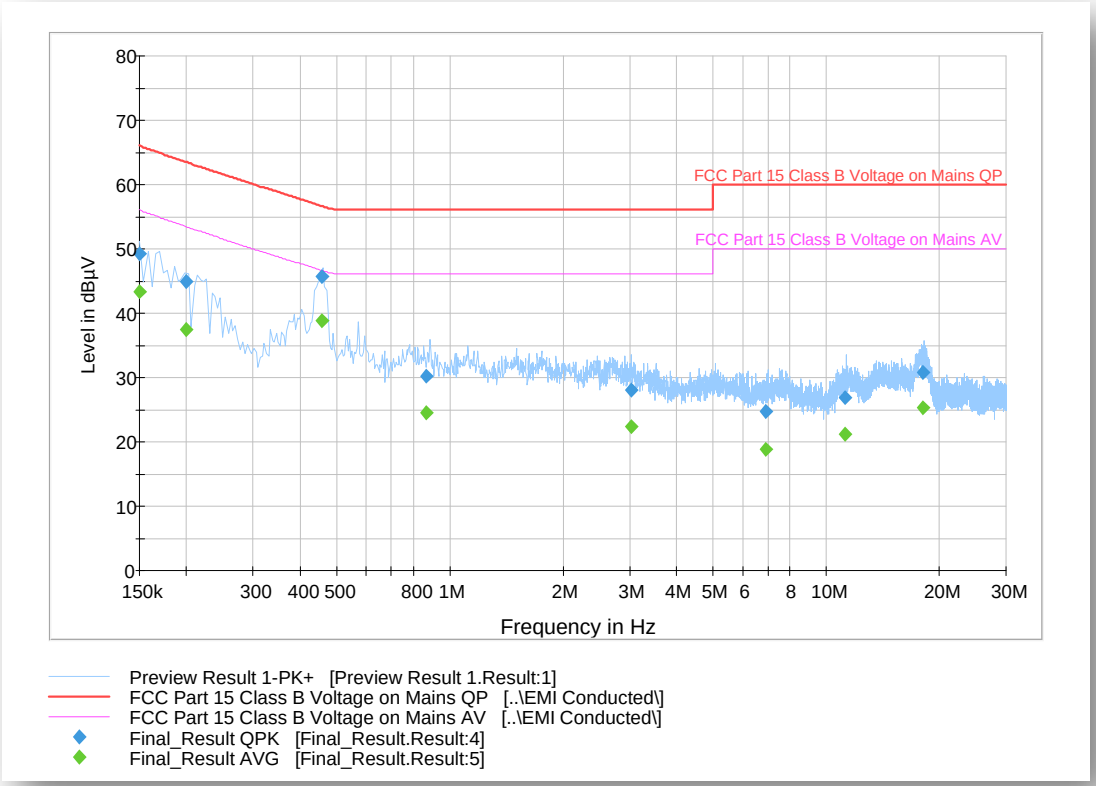
2.2.8 Sample Computation (Conducted Emission – Quasi Peak)

Measuring equipment raw measurement (dbµV) @ 150kHz			5.5
Correction Factor (dB)	Asset# 8607 (20 dB attenuator)	19.9	20.7
	Asset# 1177 (cable)	0.15	
	Asset# 1176 (cable)	0.35	
	Asset# 7568 (LISN)	0.30	
Reported QuasiPeak Final Measurement (dbµV) @ 150kHz			**26.2**

2.2.9 Test Results

Compliant. See attached plots and tables.

2.2.10 TX Mode (120V-60Hz) Line 1



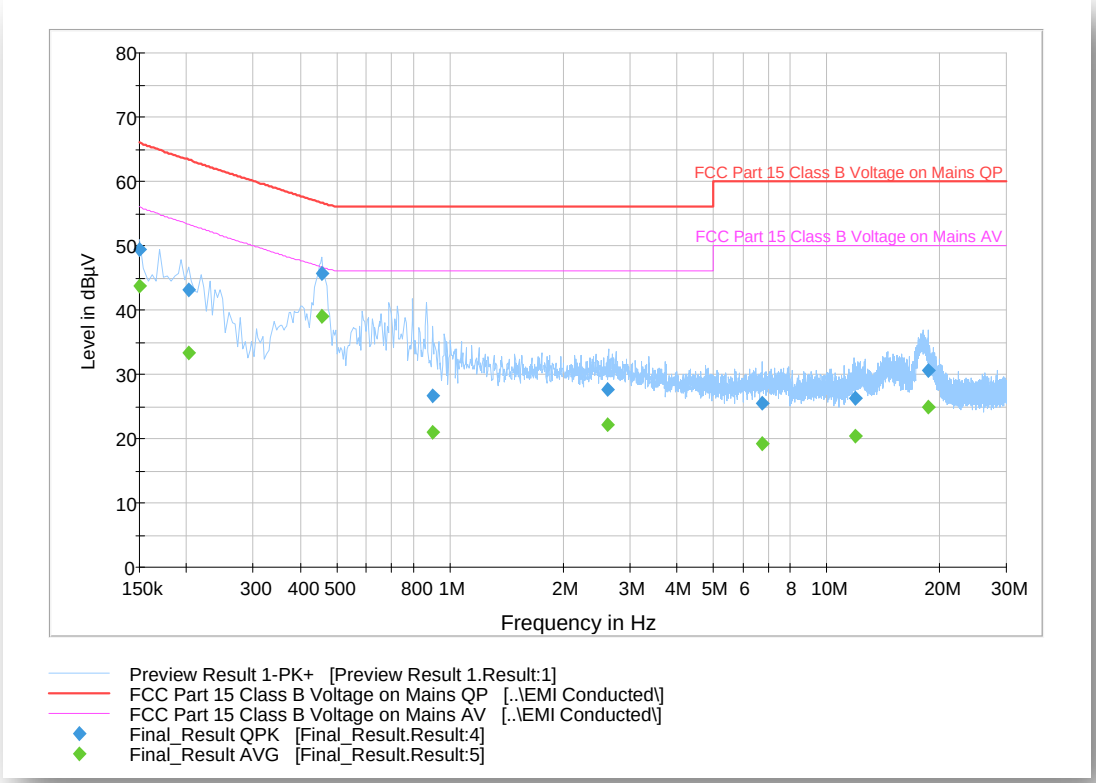
Quasi Peak Data

Frequency (MHz)	QuasiPeak (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.150000	49.28	66.00	16.72	1000.0	9.000	L1	ON	20.5
0.199000	45.00	63.50	18.50	1000.0	9.000	L1	ON	20.4
0.457500	45.59	56.68	11.10	1000.0	9.000	L1	ON	20.3
0.868000	30.19	56.00	25.81	1000.0	9.000	L1	ON	20.3
3.024370	28.10	56.00	27.90	1000.0	9.000	L1	ON	20.5
6.924295	24.65	60.00	35.35	1000.0	9.000	L1	ON	20.5
11.242550	26.89	60.00	33.11	1000.0	9.000	L1	ON	20.8
18.115490	30.82	60.00	29.18	1000.0	9.000	L1	ON	20.9

Average Data

Frequency (MHz)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.150000	43.38	56.00	12.62	1000.0	9.000	L1	ON	20.5
0.199000	37.54	53.47	15.94	1000.0	9.000	L1	ON	20.4
0.457500	38.83	46.67	7.84	1000.0	9.000	L1	ON	20.3
0.868000	24.53	46.00	21.47	1000.0	9.000	L1	ON	20.3
3.024370	22.31	46.00	23.69	1000.0	9.000	L1	ON	20.5
6.924295	18.89	50.00	31.11	1000.0	9.000	L1	ON	20.5
11.242550	21.13	50.00	28.87	1000.0	9.000	L1	ON	20.8
18.115490	25.22	50.00	24.78	1000.0	9.000	L1	ON	20.9

2.2.11 TX Mode (120V-60Hz) Line 2



Quasi Peak Data

Frequency (MHz)	QuasiPeak (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.150000	49.37	66.00	16.63	1000.0	9.000	N	ON	20.6
0.203000	43.19	63.33	20.14	1000.0	9.000	N	ON	20.5
0.458000	45.78	56.68	10.89	1000.0	9.000	N	ON	20.4
0.901990	26.65	56.00	29.35	1000.0	9.000	N	ON	20.4
2.611920	27.67	56.00	28.33	1000.0	9.000	N	ON	20.5
6.767695	25.48	60.00	34.52	1000.0	9.000	N	ON	20.5
11.877200	26.21	60.00	33.79	1000.0	9.000	N	ON	20.8
18.664840	30.58	60.00	29.42	1000.0	9.000	N	ON	20.9

Average Data

Frequency (MHz)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.150000	43.64	56.00	12.36	1000.0	9.000	N	ON	20.6
0.203000	33.26	53.30	20.04	1000.0	9.000	N	ON	20.5
0.458000	38.97	46.66	7.69	1000.0	9.000	N	ON	20.4
0.901990	20.92	46.00	25.08	1000.0	9.000	N	ON	20.4
2.611920	22.10	46.00	23.90	1000.0	9.000	N	ON	20.5
6.767695	19.25	50.00	30.75	1000.0	9.000	N	ON	20.5
11.877200	20.31	50.00	29.69	1000.0	9.000	N	ON	20.8
18.664840	24.96	50.00	25.04	1000.0	9.000	N	ON	20.9

2.3 99% EMISSION BANDWIDTH

2.3.1 Specification Reference

RSS-Gen Clause 6.7

2.3.2 Standard Applicable

The emission bandwidth (x dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated x dB below the maximum in-band spectral density of the modulated signal. Spectral density (power per unit bandwidth) is to be measured with a detector of resolution bandwidth in the range of 1% to 5% of the anticipated emission bandwidth, and a video bandwidth at least 3x the resolution bandwidth.
When the occupied bandwidth limit is not stated in the applicable RSS or reference measurement method, the transmitted signal bandwidth shall be reported as the 99% emission bandwidth, as calculated or measured.

- The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
- The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts.
- The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the occupied bandwidth (OBW) and video bandwidth (VBW) shall be approximately 3x RBW.

Note: Video averaging is not permitted.
A peak, or peak hold, may be used in place of the sampling detector as this may produce a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold may be necessary to determine the occupied bandwidth if the device is not transmitting continuously.
The trace data points are recovered and are directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded.
The difference between the two recorded frequencies is the 99% occupied bandwidth.

2.3.3 Equipment Under Test and Modification State

Serial No: 345650037 / Default Test Configuration

2.3.4 Date of Test/Initial of test personnel who performed the test

July 06, 2022 / FSC

2.3.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.3.6 Environmental Conditions (Rancho Bernardo Satellite Facility)

Ambient Temperature	24.2°C
Relative Humidity	42.6%
ATM Pressure	99.5kPa

2.3.7 Additional Observations

- This is a conducted test using direct connection to the TS8997 Test System.

- The path loss was all accounted for with the test system calibration.
- Test methodology is per Test according to FCC title 47 part 15 §15.247(a), KDB 558074 D01 DTS Meas Guidance v05 and ANSI C63.10-2013 11.8.1.

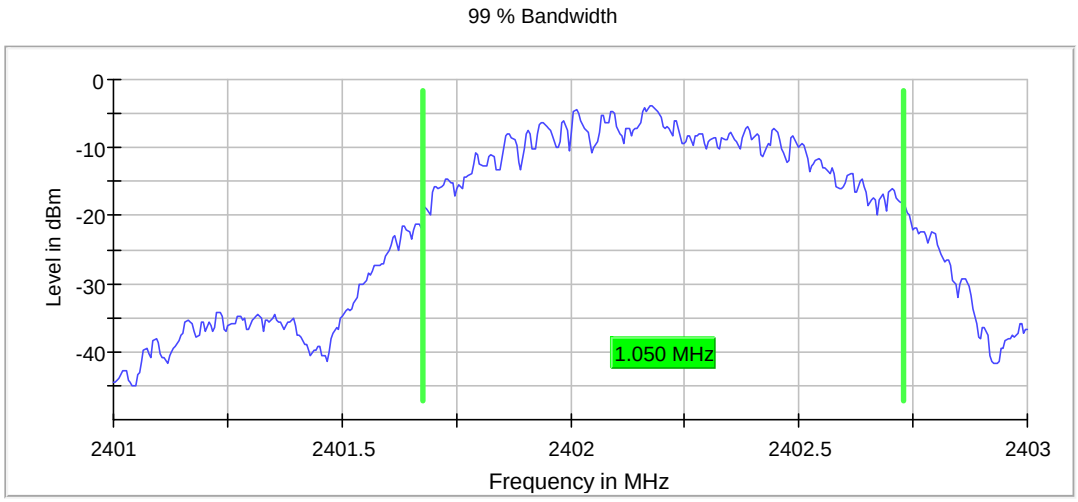
2.3.8 Sample Measurement Settings

Setting	Instrument Value	Target Value
Span	2.000 MHz	2.000 MHz
RBW	10.000 kHz	>= 10.000 kHz
VBW	30.000 kHz	>= 30.000 kHz
SweepPoints	400	~ 400
Sweeptime	189.648 µs	AUTO
Reference Level	0.000 dBm	0.000 dBm
Attenuation	20.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	FFT	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.30 dB	0.30 dB
Run	9 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.06 dB	0.30 dB

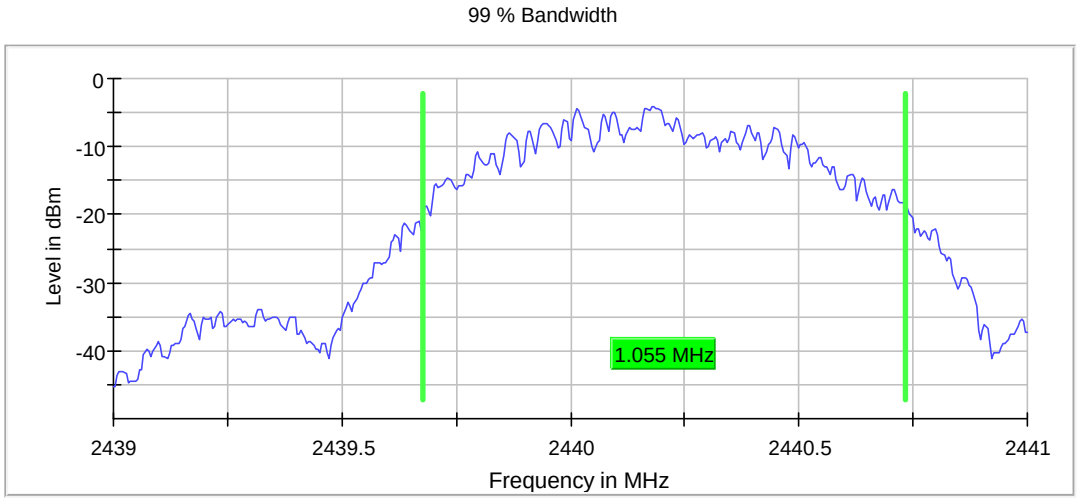
2.3.9 Test Results

DUT Frequency (MHz)	PHY	99% Bandwidth	Band Edge Left (MHz)	Band Edge Right (MHz)	Result
2402.000000	1M	1.050000	2401.677500	2402.727500	PASS
2440.000000	1M	1.055000	2439.677500	2440.732500	PASS
2480.000000	1M	1.050000	2479.687500	2480.737500	PASS
2402.000000	2M	2.040000	***2401.195000***	2403.235000	PASS
2440.000000	2M	2.050000	2439.195000	2441.245000	PASS
2480.000000	2M	2.040000	2479.205000	***2481.245000***	PASS

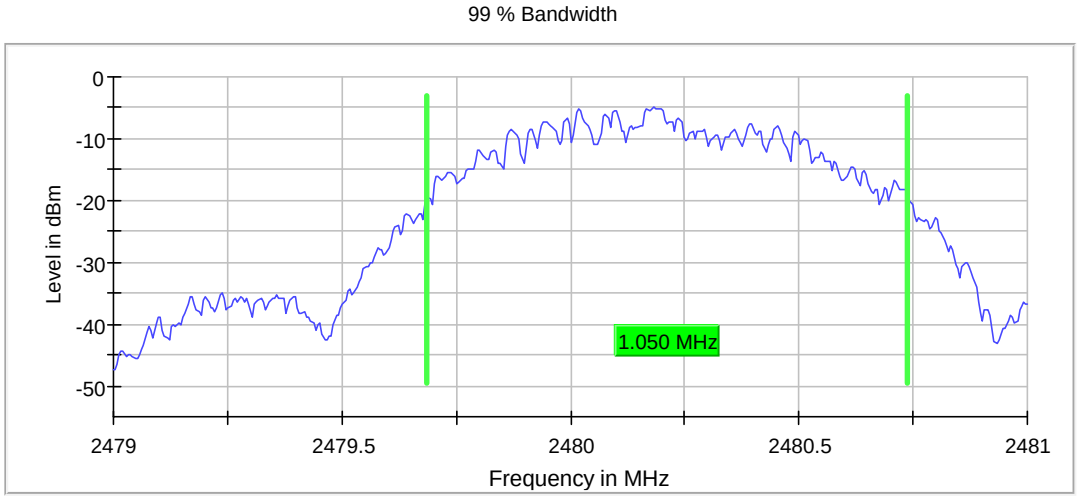
2.3.10 Test Plots



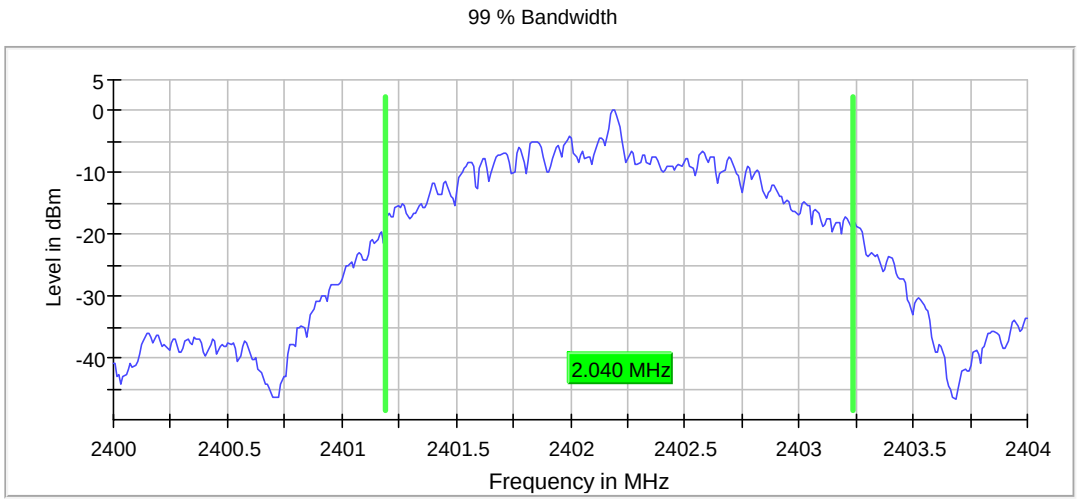
Bluetooth LE Low Channel 1M PHY



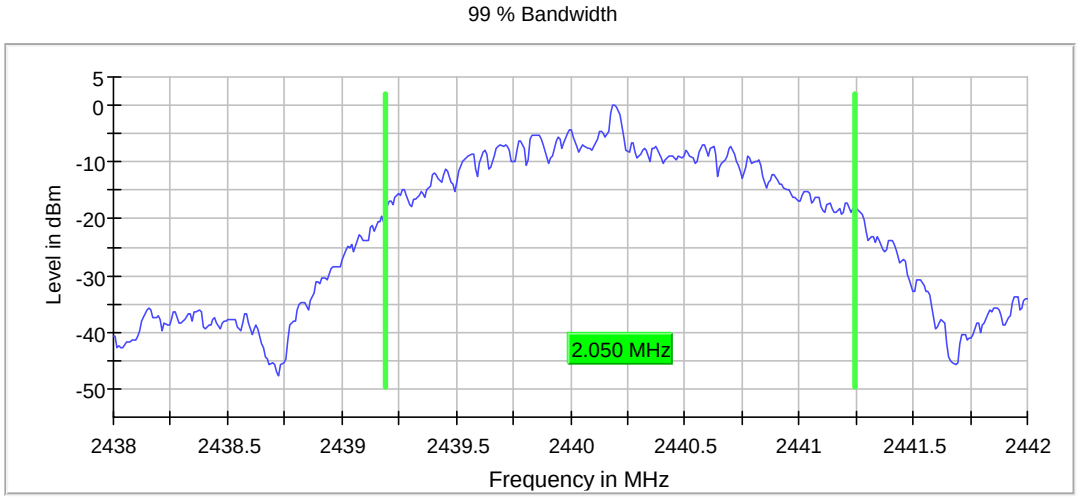
Bluetooth LE Middle Channel 1M PHY



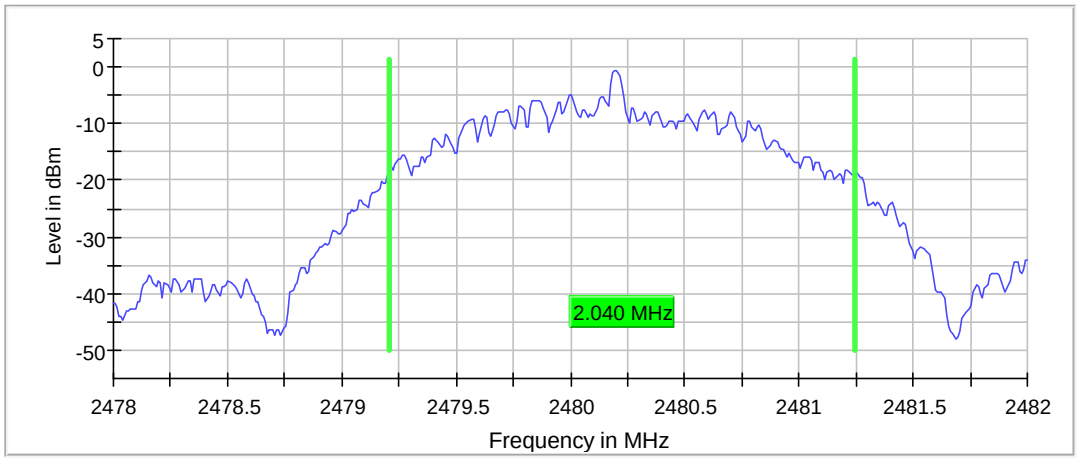
Bluetooth LE High Channel 1M PHY



Bluetooth LE Low Channel 2M PHY



Bluetooth LE Middle Channel 2M PHY



Bluetooth LE High Channel 2M PHY

2.4 MINIMUM 6 dB RF BANDWIDTH

2.4.1 Specification Reference

FCC 47 CFR Part 15, Clause 15.247(a)(2)
RSS-247, Clause 5.2 (a)

2.4.2 Standard Applicable

(2) Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

2.4.3 Equipment Under Test and Modification State

Serial No: 345650037 / Default Test Configuration

2.4.4 Date of Test/Initial of test personnel who performed the test

July 06, 2022 / FSC

2.4.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.4.6 Environmental Conditions (Rancho Bernardo Satellite Facility)

Ambient Temperature	24.2°C
Relative Humidity	42.6%
ATM Pressure	99.5kPa

2.4.7 Additional Observations

- This is a conducted test using direct connection to the TS8997 Test System.
- The path loss was all accounted for with the test system calibration.
- Test methodology is per FCC title 47 part 15 §15.247(a), KDB 558074 D01 DTS Meas Guidance v05 and ANSI C63.10-2013 11.8.1.

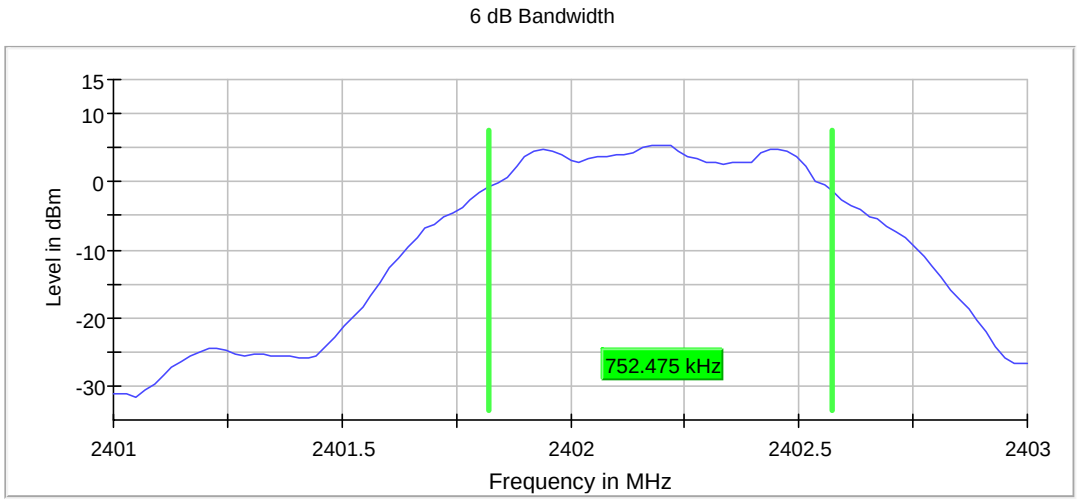
2.4.8 Sample Measurement Settings

Setting	Instrument Value	Target Value
Span	2.000 MHz	2.000 MHz
RBW	100.000 kHz	~ 100.000 kHz
VBW	300.000 kHz	~ 300.000 kHz
SweepPoints	101	~ 40
Sweeptime	18.938 µs	AUTO
Reference Level	-10.000 dBm	-10.000 dBm
Attenuation	10.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	FFT	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	11 / max. 150	max. 150
Stable	5 / 5	5
Max Stable Difference	0.18 dB	0.50 dB

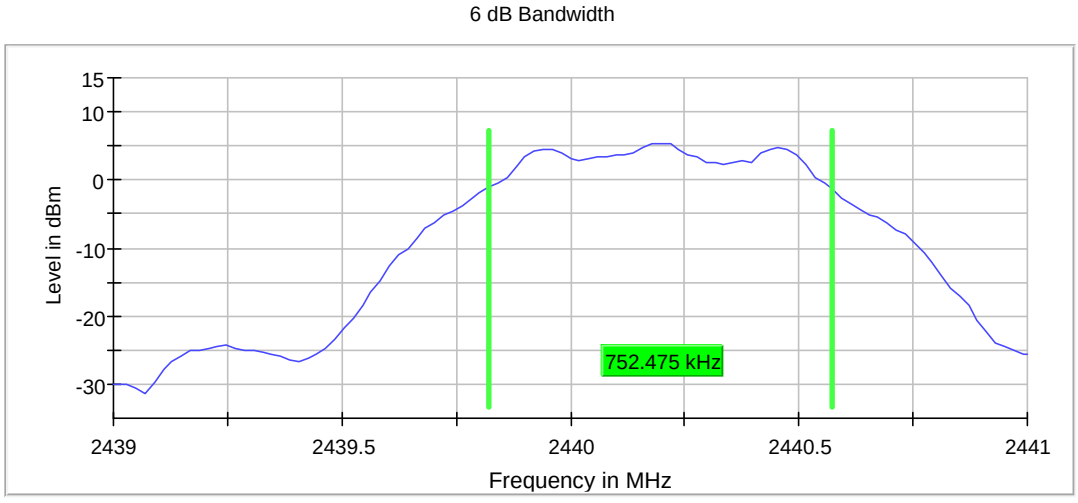
2.4.9 Test Results

DUT Frequency (MHz)	PHY	Limit Min (MHz)	Bandwidth (MHz)	Result
2402.000000	1M	0.500000	0.752475	PASS
2440.000000	1M		0.752475	PASS
2480.000000	1M		0.712871	PASS
2402.000000	2M		1.188119	PASS
2440.000000	2M		1.188119	PASS
2480.000000	2M		1.227723	PASS

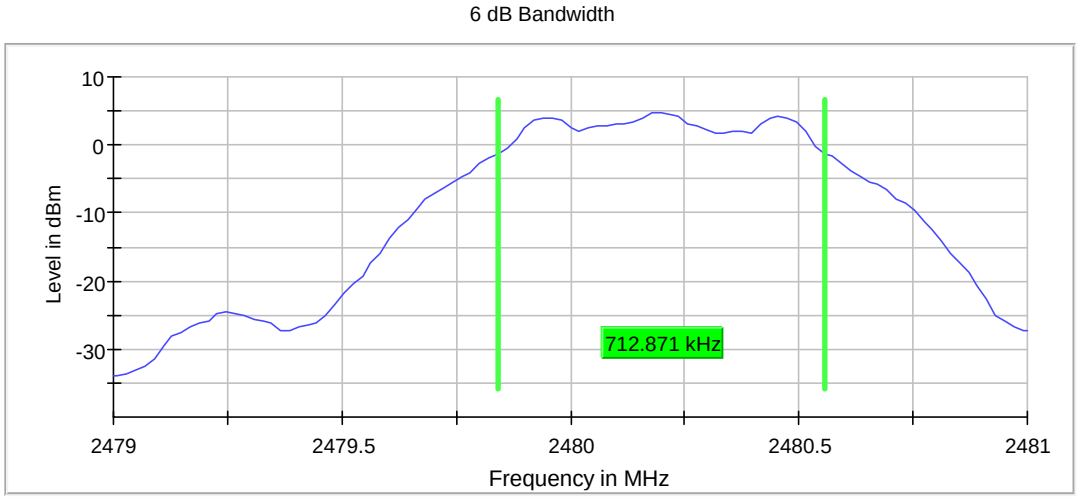
2.4.10 Test Plots



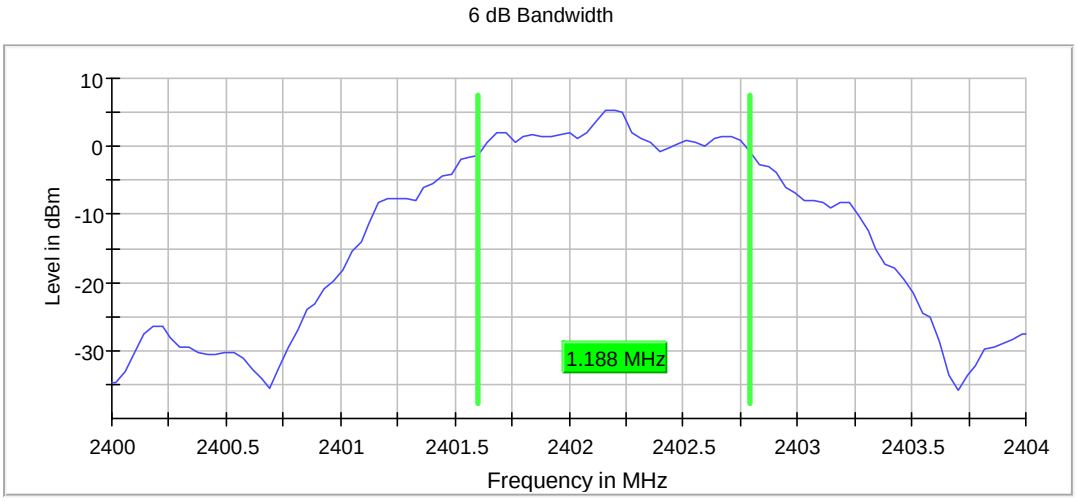
Bluetooth LE Low Channel 1M PHY



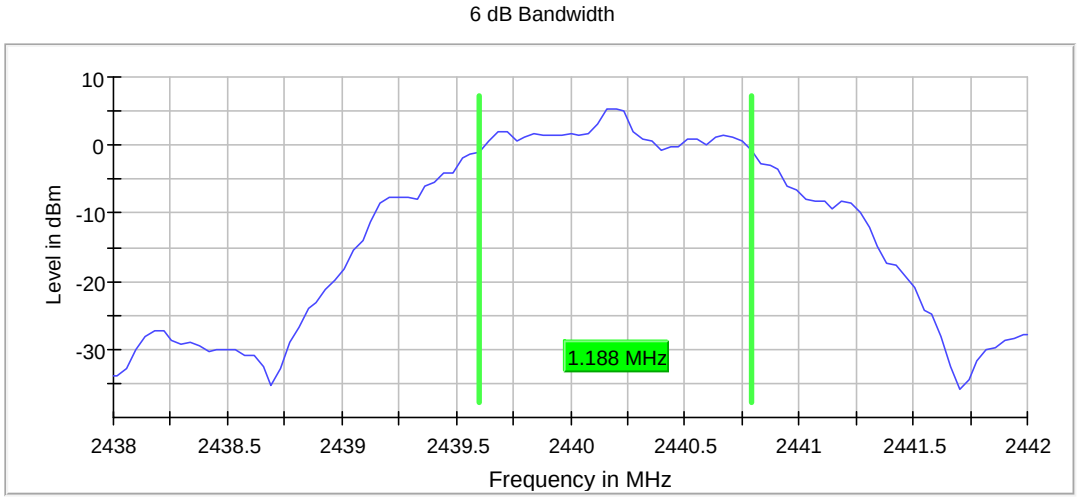
Bluetooth LE Middle Channel 1M PHY



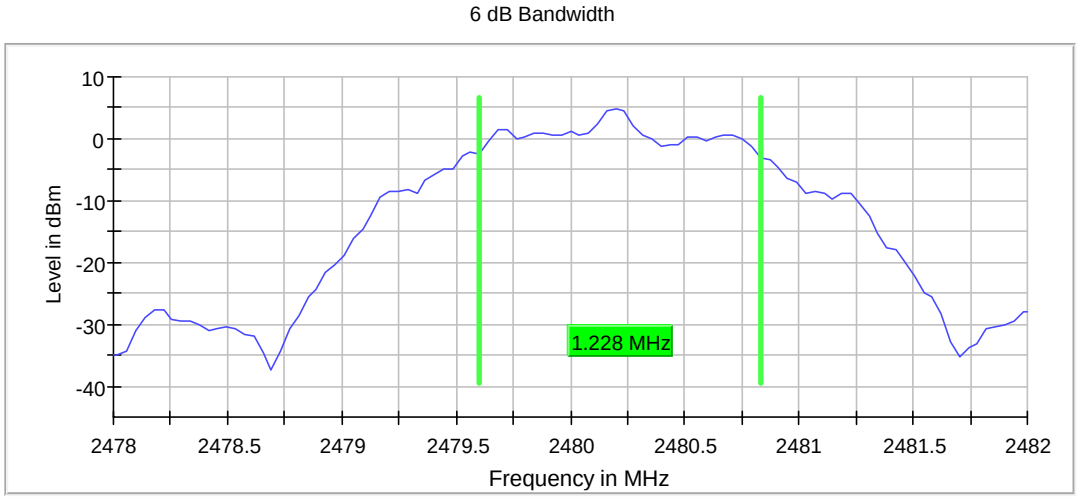
Bluetooth LE High Channel 1M PHY



Bluetooth LE Low Channel 2M PHY



Bluetooth LE Middle Channel 2M PHY



Bluetooth LE High Channel 2M PHY

2.5 OUT-OF-BAND EMISSIONS - CONDUCTED

2.5.1 Specification Reference

FCC 47 CFR Part 15, Clause 15.247(d)
RSS-247, Clause 5.5

2.5.2 Standard Applicable

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

2.5.3 Equipment Under Test and Modification State

Serial No: 345650037 / Default Test Configuration

2.5.4 Date of Test/Initial of test personnel who performed the test

July 06, 2022 / FSC

2.5.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

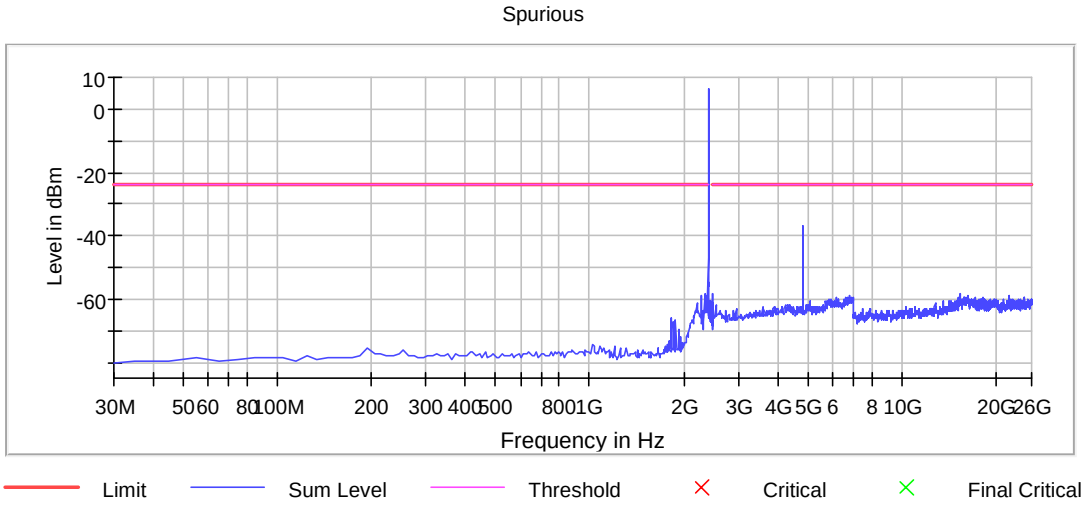
2.5.6 Environmental Conditions (Rancho Bernardo Satellite Facility)

Ambient Temperature	24.2°C
Relative Humidity	42.6%
ATM Pressure	99.5kPa

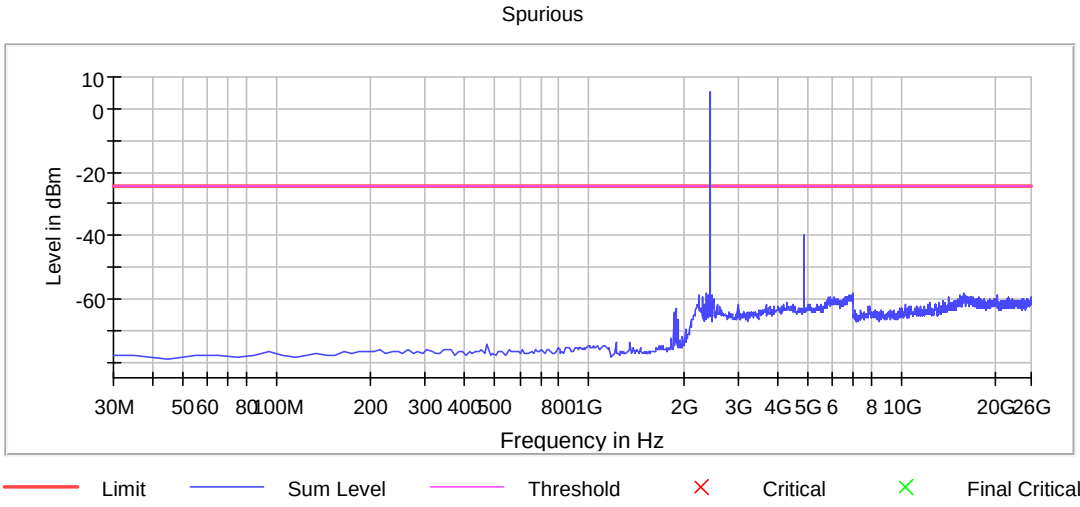
2.5.7 Additional Observations

- This is a conducted test using a spectrum analyser.
- The path loss was all accounted for using a transducer factor (TDF) including the maximum antenna gain of 2 dBi.
- Test methodology is per FCC title 47 part 15 §15.247(d), KDB 558074 D01 DTS Meas Guidance v05 and ANSI C63.10-2013 11.11.2 & 11.11.3.
- Both §15.205 and §15.247(d) requirements verified.
- Limits of §15.209 is converted to EIRP using formula from Clause 12.7.2(d) of ANSI C63.10-2013. Limit is based on 100kHz RBW, for above 1GHz, requirement is 1MHz RBW. Worst case RBW used in the range 30MHz to 30GHz.
- For §15.247(d) requirement, no emissions observed within the measurement threshold during prescan, further verification is not required.

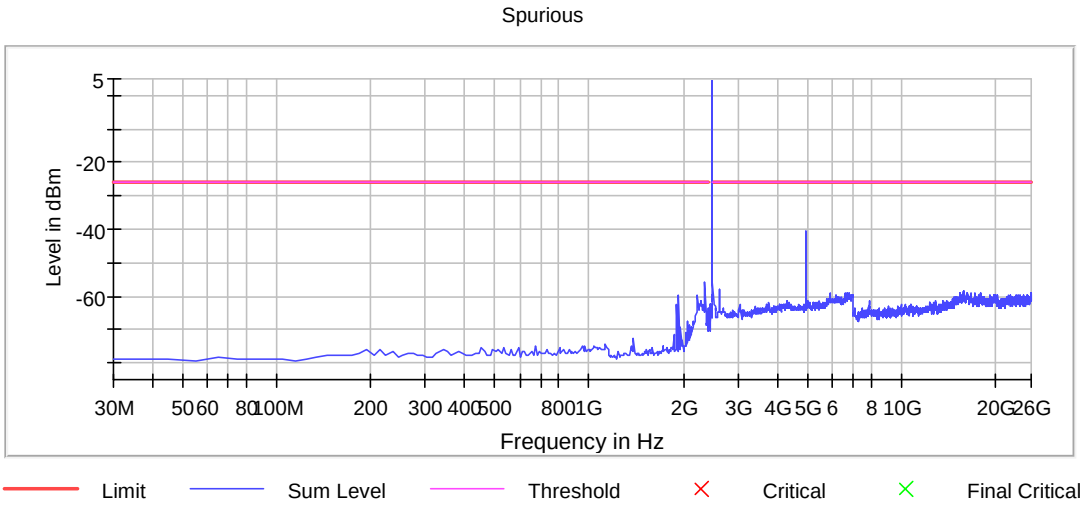
2.5.8 Test Results Plots (§15.247 requirements)



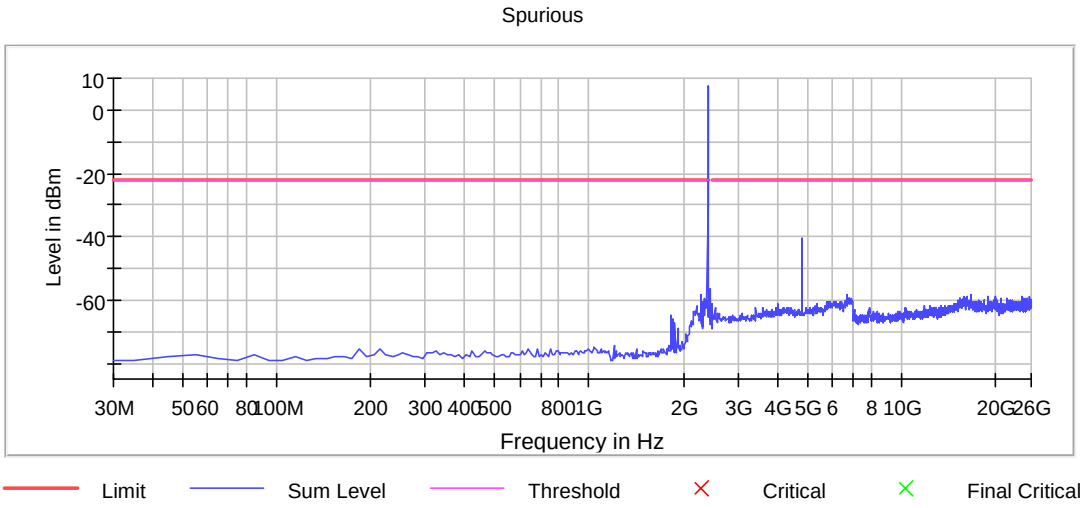
Low Channel 1M PHY



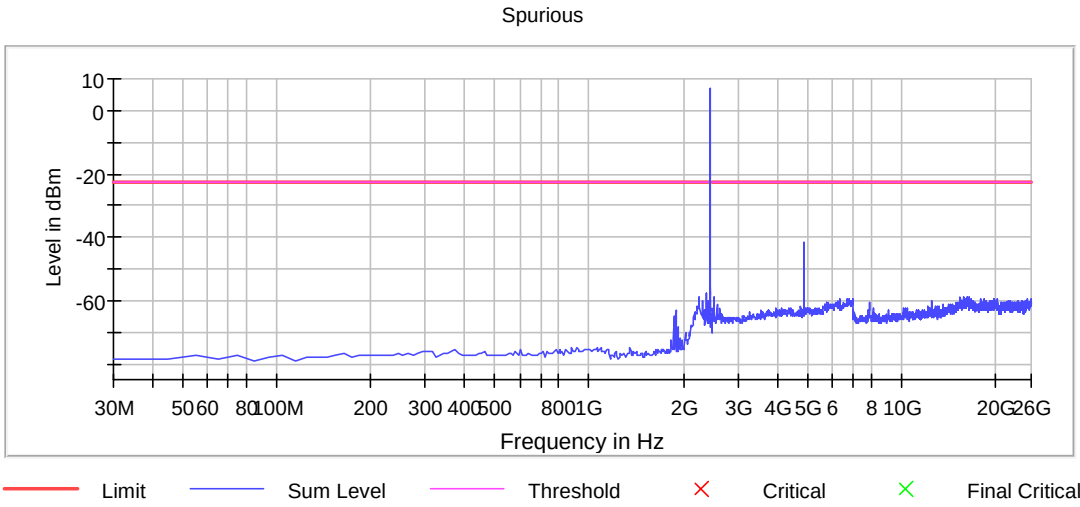
Middle Channel 1M PHY



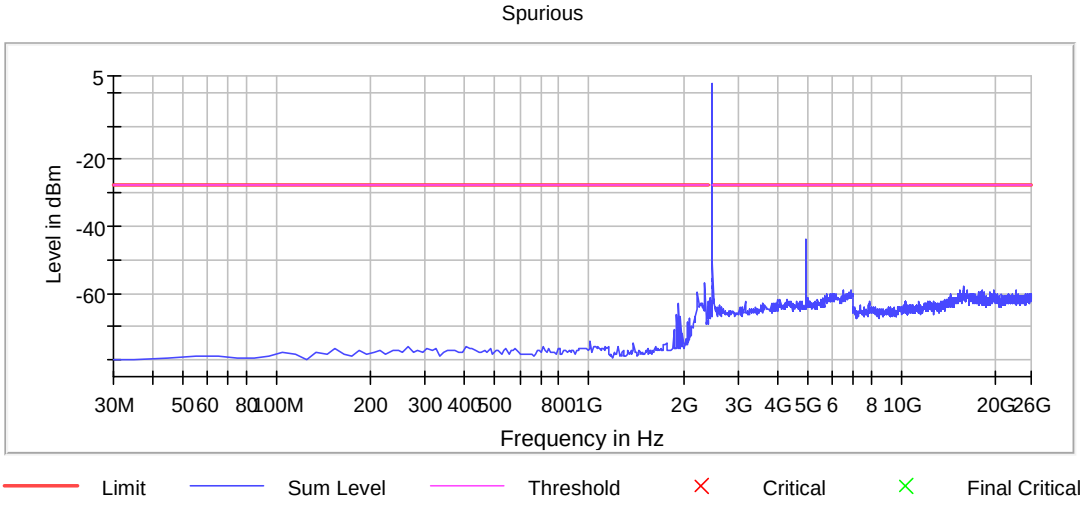
High Channel 1M PHY



Low Channel 2M PHY



Mid Channel 2M PHY



High Channel 2M PHY

2.5.9 Test Results Plots (§15.205 requirements)

Plots presented covering 30MHz up to 26GHz is using Peak Detector with the 2dBi antenna gain and 3dB multiple output operation correction factor factored in (10 log(N)) as TDF (Transducer Factor). Limit used is for Average measurement. To obtain corresponding Average value from Peak measurement, Duty Cycle Correction factor will be applied.

Sample Calculation (Worst Case 1M PHY)

Duty Cycle for 1M PHY = 63.1%
DCCF = 20 log (0.631)
= 3.4 dB

Limit at second harmonic = -41.23 dBm (from 54dBµV/m @ 3 meters)
Worst case second harmonic emissions = -38.18 dBm (Low Channel)

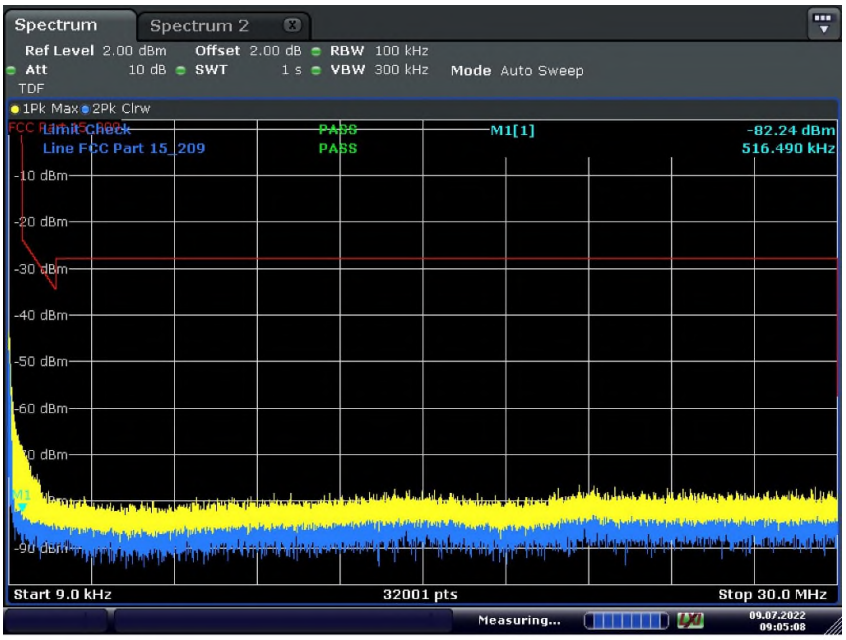
Average Calculation = -38.18 dBm -3.4 dB
= -41.58 dBm (complies with -41.23dBm Average limit)

Sample Calculation (Worst Case 2M PHY)

Duty Cycle for 1M PHY = 33.4%
DCCF = 20 log (0.334)
= 9.52 dB

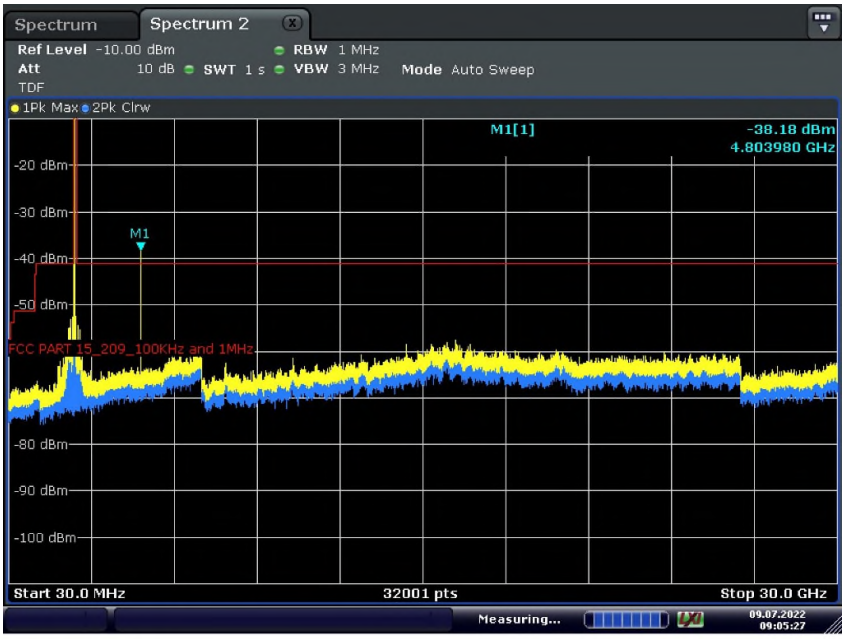
Limit at second harmonic = -41.23 dBm (from 54dBµV/m @ 3 meters)
Worst case second harmonic emissions = -38.18 dBm (Low Channel)

Average Calculation = -38.32 dBm -9.52 dB
= -47.84 dBm (complies with -41.23dBm Average limit)



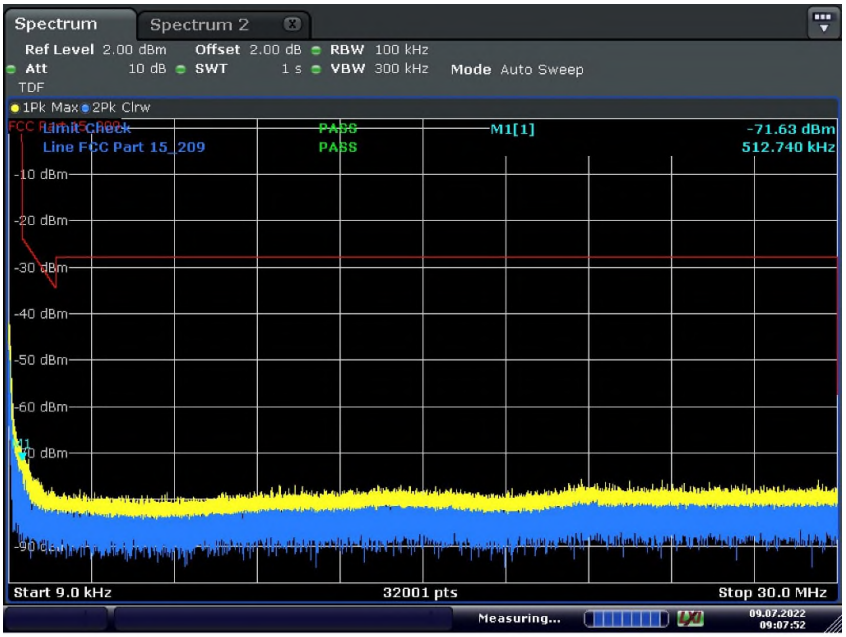
Date: 9.JUL.2022 09:05:09

BLE Low Channel 1M PHY (9kHz to 30MHz)



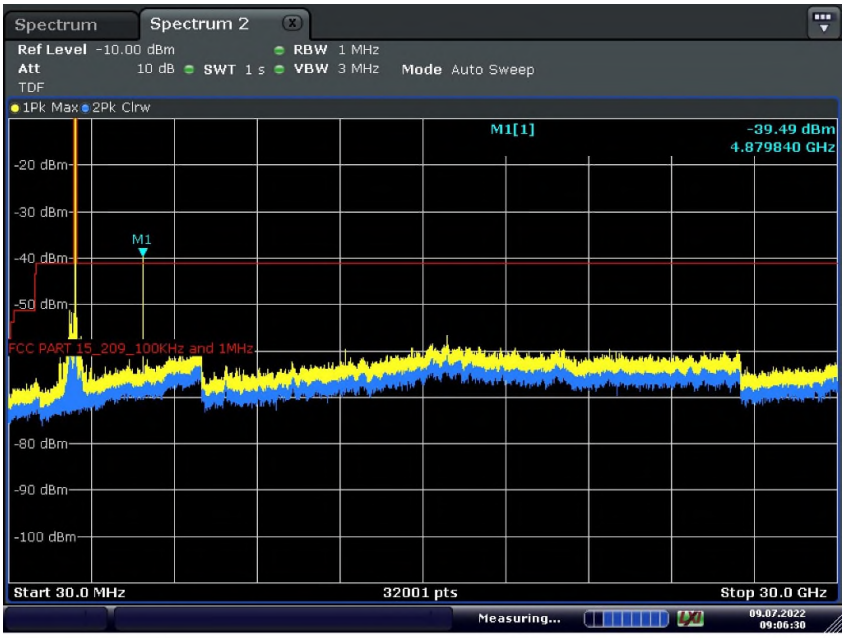
Date: 9.JUL.2022 09:05:27

BLE Low Channel 1M PHY (30MHz to 26GHz)



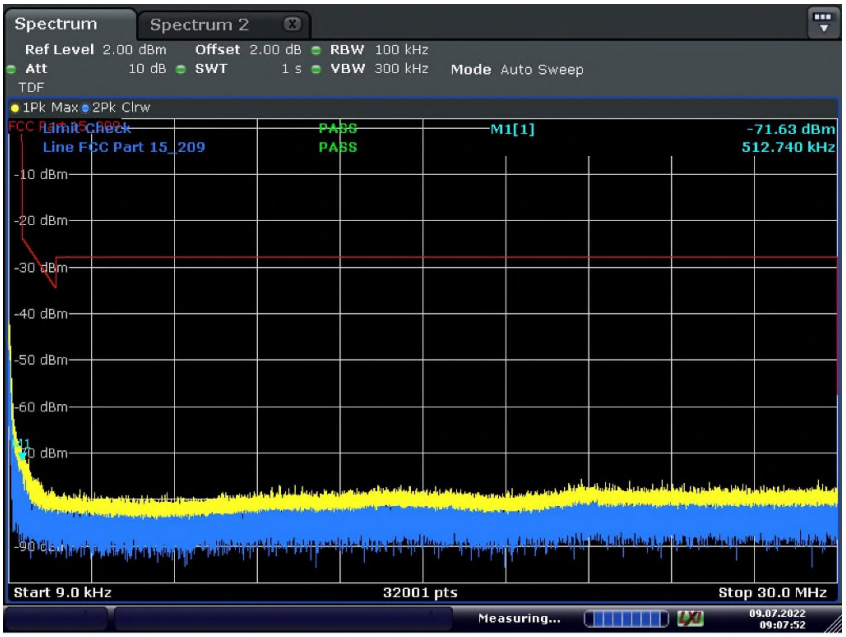
Date: 9.JUL.2022 09:07:53

BLE Mid Channel 1M PHY (9kHz to 30MHz)



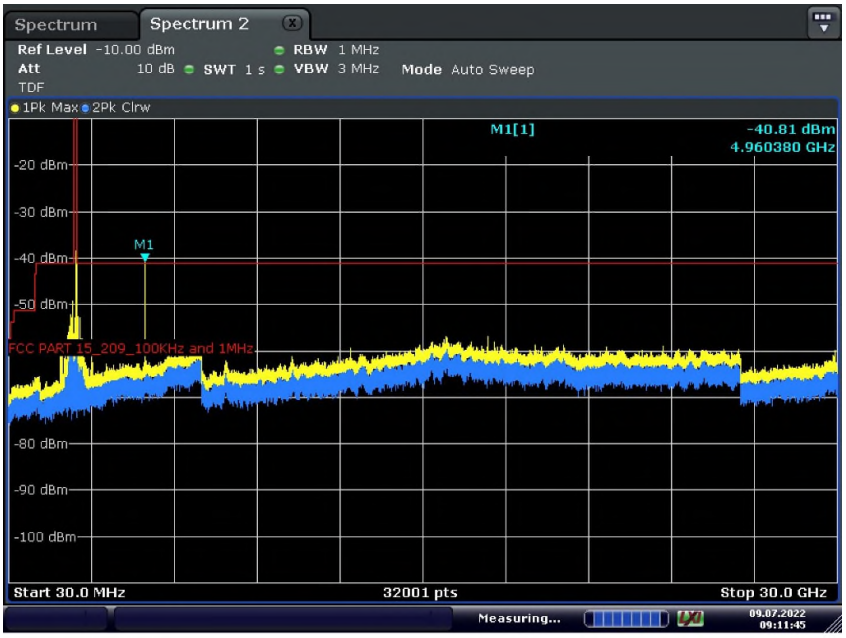
Date: 9.JUL.2022 09:06:30

BLE Mid Channel 1M PHY (30MHz to 26GHz)



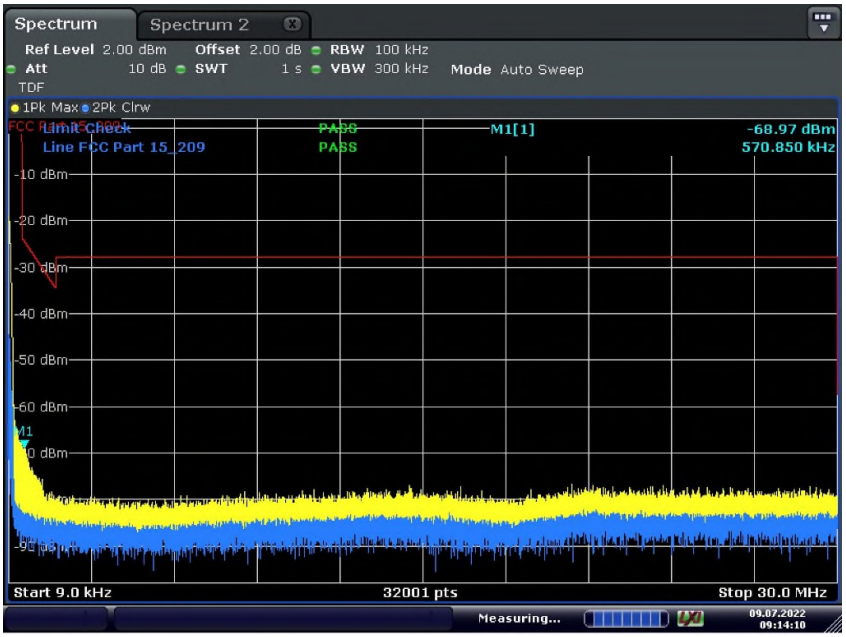
Date: 9.JUL.2022 09:07:53

BLE High Channel 1M PHY (9kHz to 30MHz)



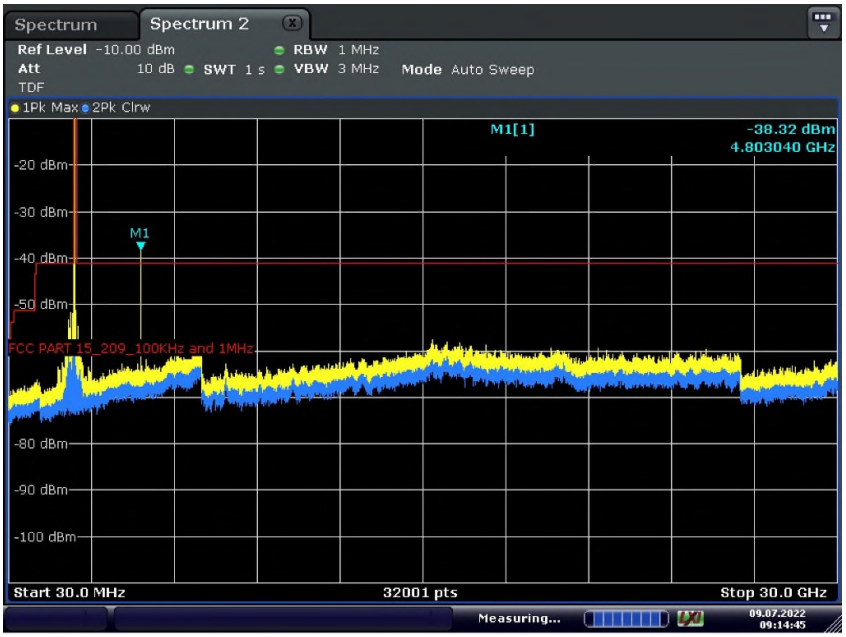
Date: 9.JUL.2022 09:11:46

BLE High Channel 1M PHY (30MHz to 26GHz)



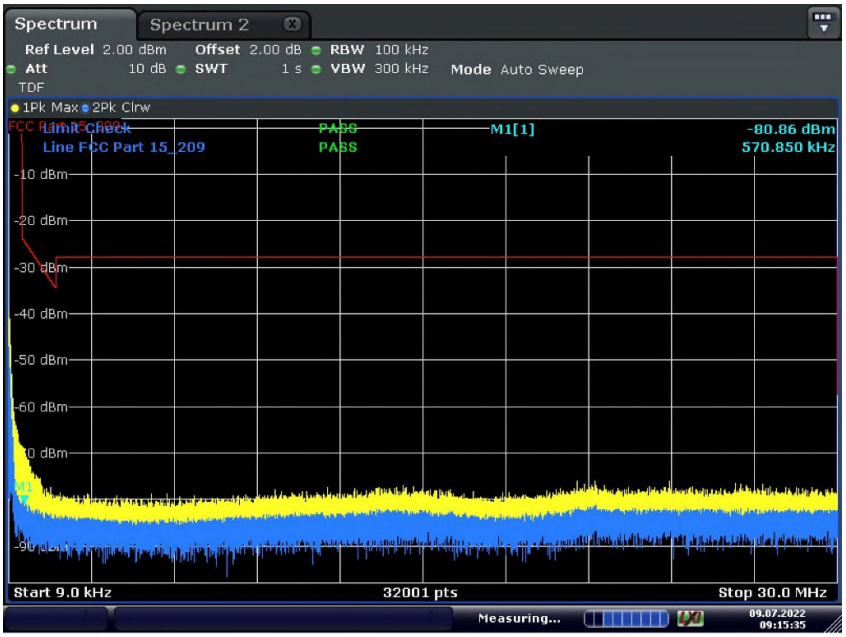
Date: 9.JUL.2022 09:14:11

BLE Low Channel 2M PHY (9kHz to 30MHz)



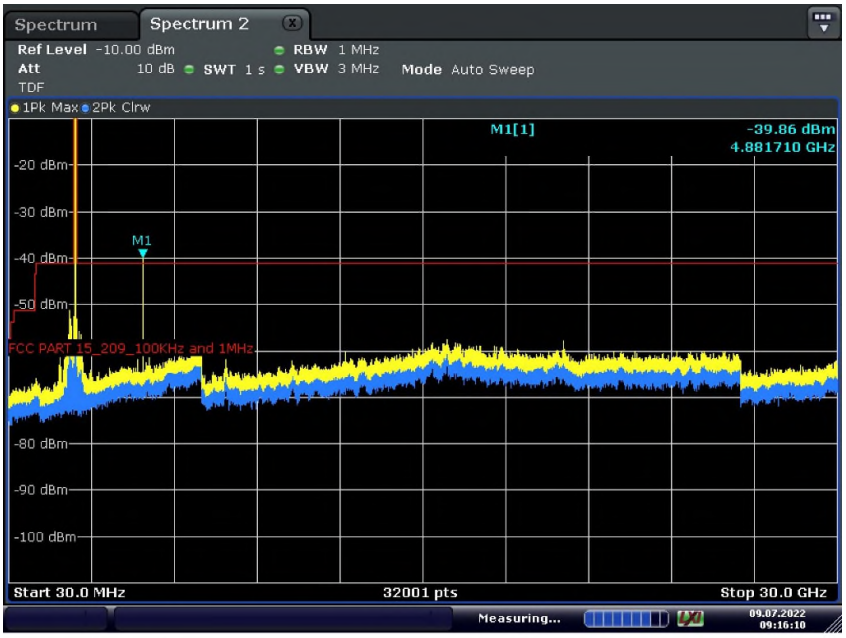
Date: 9.JUL.2022 09:14:45

BLE Low Channel 2M PHY (30MHz to 26GHz)



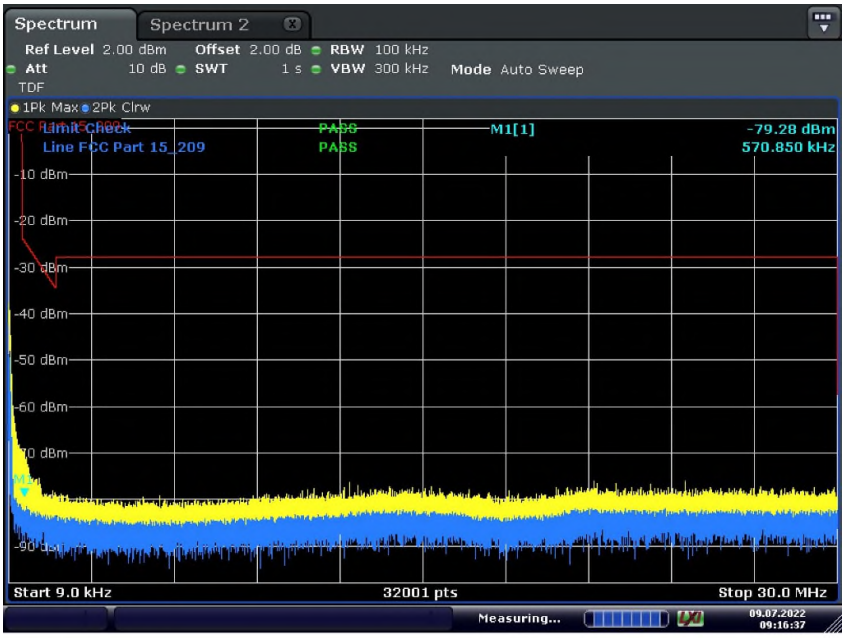
Date: 9.JUL.2022 09:15:36

BLE Mid Channel 2M PHY (9kHz to 30MHz)



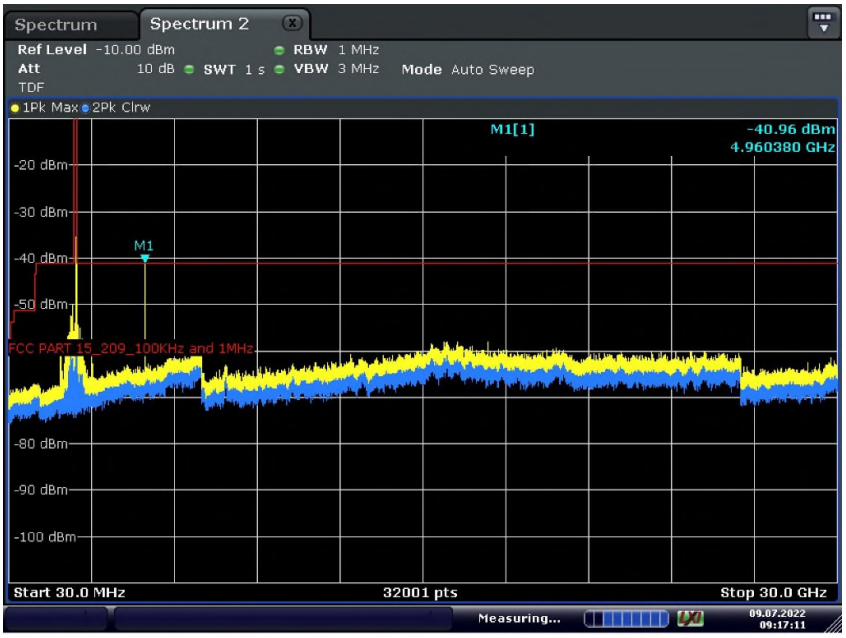
Date: 9.JUL.2022 09:16:10

BLE Mid Channel 2M PHY (30MHz to 26GHz)



Date: 9.JUL.2022 09:16:37

BLE High Channel 2M PHY (9kHz to 30MHz)



Date: 9.JUL.2022 09:17:11

BLE High Channel 2M PHY (30MHz to 26GHz)

2.6 BAND-EDGE COMPLIANCE OF RF CONDUCTED EMISSIONS

2.6.1 Specification Reference

FCC 47 CFR Part 15, Clause 15.247(d)
FCC 47 CFR Part 15, Clause 15.205
RSS-247, Clause 5.5

2.6.2 Standard Applicable

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

2.6.3 Equipment Under Test and Modification State

Serial No: 345650037 / Default Test Configuration

2.6.4 Date of Test/Initial of test personnel who performed the test

July 06, 2022 / FSC

2.6.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.6.6 Environmental Conditions (Rancho Bernardo Satellite Facility)

Ambient Temperature	24.2°C
Relative Humidity	42.6%
ATM Pressure	99.5kPa

2.6.7 Additional Observations

- This is a conducted test using direct connection to the Spectrum Analyzer being controlled by the TS8997 Test System.
- The path loss was all accounted for with the test system calibration.
- Test methodology is per FCC title 47 part 15 §15.247(d), KDB 558074 D01 DTS Meas Guidance v05 8.7 and ANSI C63.10-2013.

2.6.8 Sample Measurement Settings

Measurement 1		
Setting	**Instrument Value**	**Target Value**
Span	90.000 MHz	90.000 MHz
RBW	100.000 kHz	<= 100.000 kHz
VBW	300.000 kHz	>= 300.000 kHz
SweepPoints	1800	~ 1800
Sweeptime	113.672 µs	AUTO
Reference Level	0.000 dBm	0.000 dBm
Attenuation	20.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	FFT	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	4 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.00 dB	0.50 dB

Measurement 2		
Setting	**Instrument Value**	**Target Value**
Span	83.500 MHz	83.500 MHz
RBW	100.000 kHz	<= 100.000 kHz
VBW	300.000 kHz	>= 300.000 kHz
SweepPoints	1670	~ 1670
Sweeptime	94.727 µs	AUTO
Reference Level	0.000 dBm	0.000 dBm
Attenuation	20.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	FFT	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	10 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.03 dB	0.50 dB

2.6.9 Test Results (Lower Band Edge 1M PHY)

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2399.925000	-47.2	24.7	-22.5	PASS
2399.875000	-47.9	25.4	-22.5	PASS
2399.975000	-47.9	25.4	-22.5	PASS
2399.225000	-48.2	25.7	-22.5	PASS
2399.775000	-48.6	26.1	-22.5	PASS
2399.825000	-48.7	26.2	-22.5	PASS
2399.175000	-48.8	26.3	-22.5	PASS
2399.725000	-48.9	26.3	-22.5	PASS
2399.575000	-48.9	26.4	-22.5	PASS
2399.275000	-49.0	26.4	-22.5	PASS
2399.625000	-49.0	26.5	-22.5	PASS
2399.675000	-49.1	26.6	-22.5	PASS
2399.525000	-49.8	27.3	-22.5	PASS
2399.325000	-50.5	28.0	-22.5	PASS
2399.125000	-50.7	28.1	-22.5	PASS

2.6.10 Test Results (Upper Band Edge 1M PHY)

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2484.175000	-51.1	27.8	-23.4	PASS
2484.125000	-51.3	27.9	-23.4	PASS
2483.775000	-51.7	28.3	-23.4	PASS
2483.725000	-51.7	28.4	-23.4	PASS
2484.225000	-52.4	29.0	-23.4	PASS
2483.625000	-52.6	29.3	-23.4	PASS
2483.675000	-52.7	29.3	-23.4	PASS
2483.575000	-53.0	29.6	-23.4	PASS
2484.275000	-53.1	29.7	-23.4	PASS
2484.775000	-53.1	29.7	-23.4	PASS
2483.525000	-53.2	29.9	-23.4	PASS
2485.175000	-53.3	29.9	-23.4	PASS
2485.125000	-53.3	30.0	-23.4	PASS
2484.825000	-53.3	30.0	-23.4	PASS
2483.825000	-53.7	30.3	-23.4	PASS

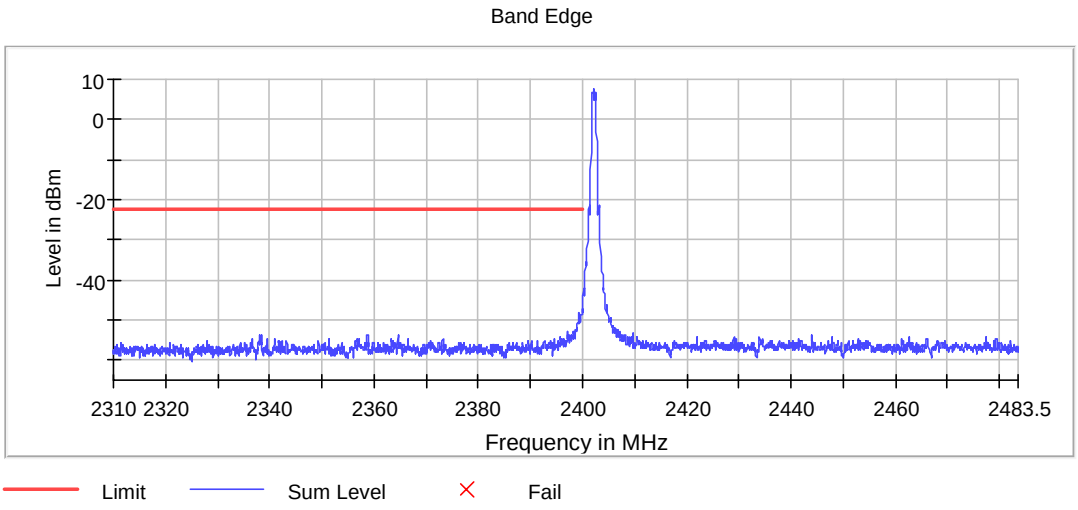
2.6.11 Test Results (Lower Band Edge 2M PHY)

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2399.975000	-34.1	11.5	-22.6	PASS
2399.925000	-35.4	12.8	-22.6	PASS
2399.875000	-37.3	14.7	-22.6	PASS
2399.825000	-38.3	15.7	-22.6	PASS
2399.775000	-41.0	18.4	-22.6	PASS
2399.725000	-43.0	20.4	-22.6	PASS
2399.475000	-43.4	20.8	-22.6	PASS
2399.425000	-43.5	20.9	-22.6	PASS
2399.525000	-44.5	21.9	-22.6	PASS
2399.675000	-44.8	22.2	-22.6	PASS
2399.575000	-45.3	22.7	-22.6	PASS
2399.275000	-45.6	23.0	-22.6	PASS
2399.625000	-45.7	23.1	-22.6	PASS
2399.325000	-45.7	23.1	-22.6	PASS
2399.375000	-46.0	23.5	-22.6	PASS

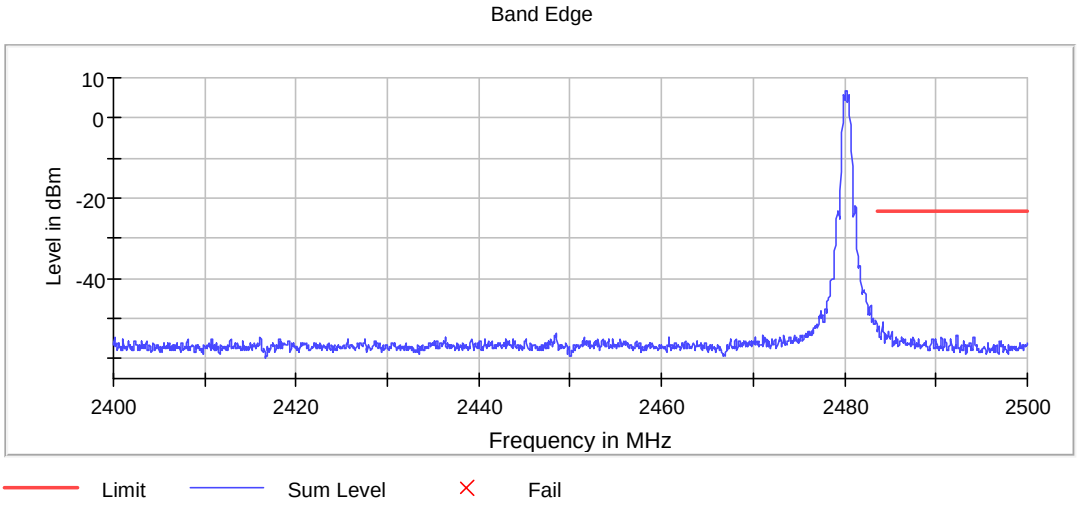
2.6.12 Test Results (Upper Band Edge 2M PHY)

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2483.575000	-48.0	24.6	-23.4	PASS
2483.625000	-48.1	24.8	-23.4	PASS
2483.525000	-48.2	24.9	-23.4	PASS
2483.675000	-49.6	26.2	-23.4	PASS
2484.425000	-50.1	26.7	-23.4	PASS
2484.125000	-50.3	27.0	-23.4	PASS
2483.775000	-50.4	27.0	-23.4	PASS
2483.725000	-50.7	27.3	-23.4	PASS
2484.075000	-50.7	27.3	-23.4	PASS
2484.475000	-50.8	27.4	-23.4	PASS
2484.275000	-50.8	27.4	-23.4	PASS
2484.325000	-50.9	27.5	-23.4	PASS
2485.625000	-51.0	27.6	-23.4	PASS
2483.825000	-51.0	27.7	-23.4	PASS
2483.875000	-51.1	27.7	-23.4	PASS

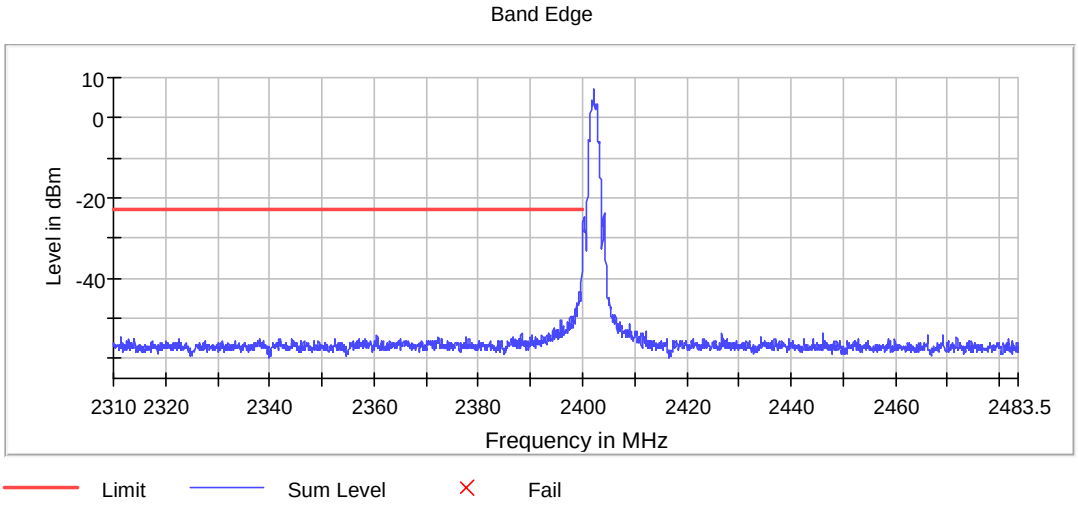
2.6.13 Test Plots



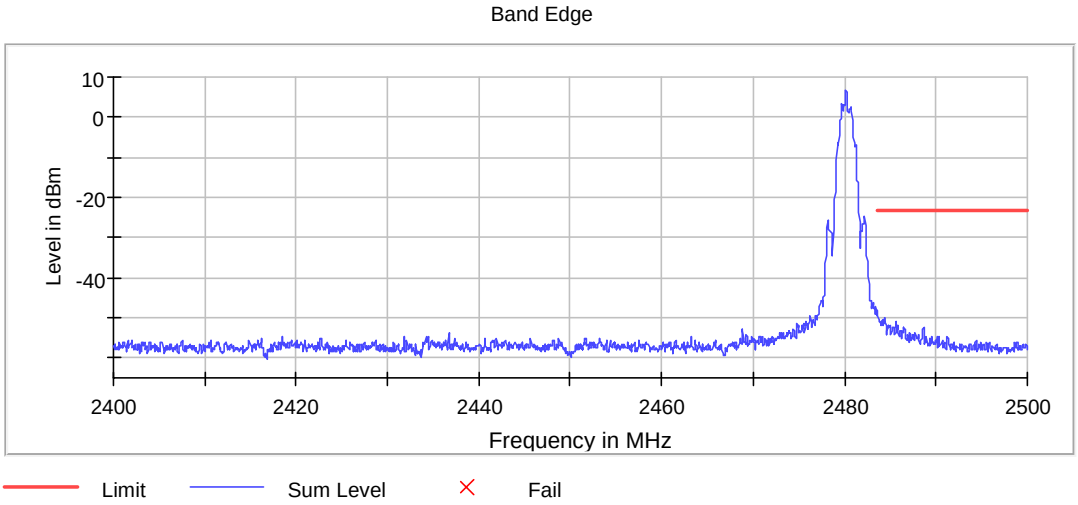
Bluetooth LE Low Band Edge 2400MHz 1M PHY



Bluetooth LE Upper Band Edge 2483.5MHz 1M PHY



Bluetooth LE Low Band Edge 2400MHz 2M PHY



Bluetooth LE Upper Band Edge 2483.5MHz 2M PHY

2.6.14 Upper band edge calculation (2483.5 MHz) within Restricted Band for 1M PHY:

- 2483.525000 MHz (in the restricted bands)
- Procedure is per Clause 12.7.2 of ANSI C63.10-2013.
- Use the following formula as per Clause 12.7.2(d) of ANSI C63.10-2013.

E(dBµV/m) = EIRP (dBm) + 95.2
= (-53.2 dBm + 2 dBi antenna gain + 3dB (from 10 log (N) where N is 2) + 95.2
= 47.0 dBµV/m @ 3 meters (Peak complies with 54 dBµV/m Average limit)

2.6.15 Upper band edge calculation (2483.5 MHz) within Restricted Band for 2M PHY:

- 2483.525000 MHz (in the restricted bands)
- Procedure is per Clause 12.7.2 of ANSI C63.10-2013.
- Use the following formula as per Clause 12.7.2(d) of ANSI C63.10-2013.

E(dBµV/m) = EIRP (dBm) + 95.2
= (-48.2 dBm + 2 dBi antenna gain + 3dB (from 10 log (N) where N is 2) + 95.2
= 52.0 dBµV/m @ 3 meters (Peak complies with 54 dBµV/m Average limit)

Note: 10 log (N) is to account multiple output operation of the EUT

2.7 RADIATED SPURIOUS EMISSIONS

2.7.1 Specification Reference

FCC 47 CFR Part 15, Clause 15.247(d)
RSS-247, Clause 5.5

2.7.2 Standard Applicable

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

2.7.3 Equipment Under Test and Modification State

Serial No: 345650037 / Default Test Configuration

2.7.4 Date of Test/Initial of test personnel who performed the test

July 10, 2022 / FSC

2.7.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.7.6 Environmental Conditions (Mira Mesa Facility)

Ambient Temperature	25.3°C
Relative Humidity	42.4%
ATM Pressure	99.5kPa

2.7.7 Additional Observations

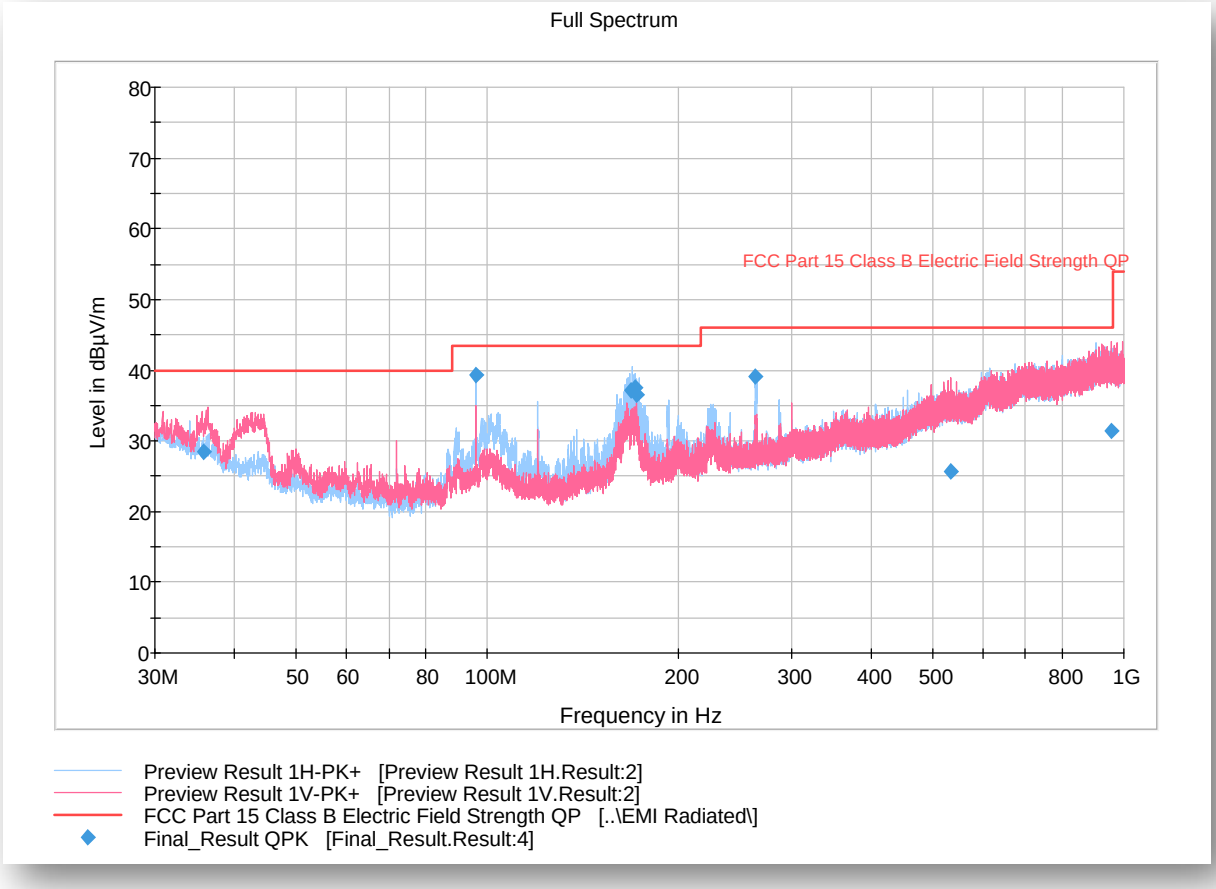
- This is a radiated test. The spectrum was searched from 9kHz to the 10th harmonic.
- There are no emissions found that do not comply to the restricted bands defined in FCC Part 15 Subpart C, 15.205 or Part 15.247(d).
- Only the worst case BLE (Low Channel) presented. There are no significant differences in emissions between channels when verifying cabinet spurious emissions.
- Antenna port terminated with 50 Ω load. Emissions coming out of the cabinet being verified

- Measurement was done using EMC32 automated software. Reported level is the actual level with all the correction factors factored in. Correction Factor column is for informational purposes only. See Section 2.7.8 for sample computation.

2.7.8 Sample Computation (Radiated Emission)

Measuring equipment raw measurement (dbµV) @ 30 MHz			-0.8
Correction Factor (dB)	Asset# 1066 (cable)	18.1	12.6
	Asset# 1172 (cable)	0.3	
	Asset# 1175(cable)	0.3	
	Asset# 1002 (antenna)	17.2	
Reported QuasiPeak Final Measurement (dbµV/m) @ 30MHz			**11.8**

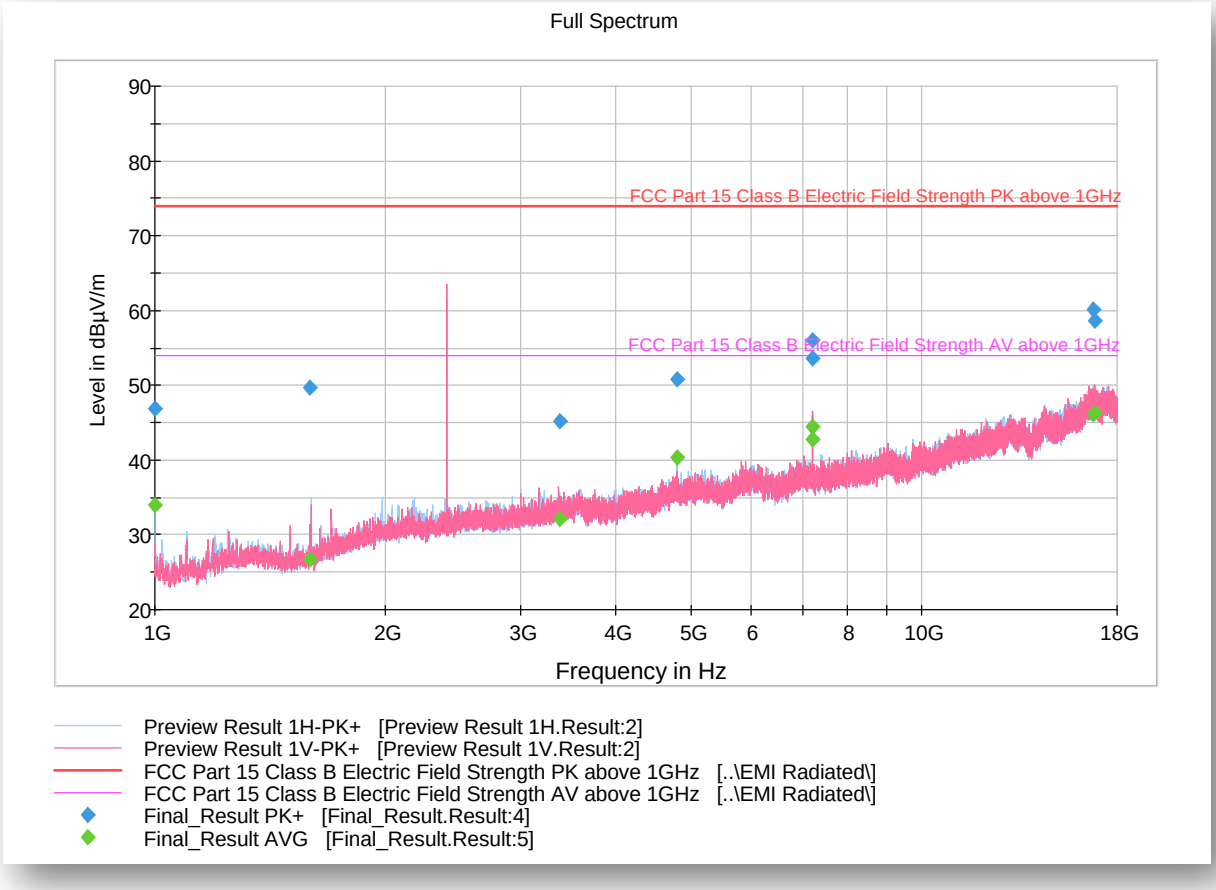
2.7.9 Test Results for 30MHz to 1GHz



Quasi Peak Data

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
35.882000	28.44	40.00	11.56	1000.	120.000	100.0	V	92.0	19
95.984667	39.36	43.50	4.14	1000.	120.000	204.0	H	20.0	15
168.00133	37.05	43.50	6.45	1000.	120.000	106.0	H	148.0	17
170.32266	37.45	43.50	6.05	1000.	120.000	108.0	H	159.0	17
171.86400	36.63	43.50	6.87	1000.	120.000	100.0	H	169.0	17
263.99633	39.04	46.00	6.96	1000.	120.000	225.0	H	152.0	20
533.52666	25.65	46.00	20.35	1000.	120.000	325.0	V	349.0	26
957.29200	31.31	46.00	14.69	1000.	120.000	320.0	V	123.0	31

2.7.10 Test Results for 1GHz to 18GHz



Peak Data

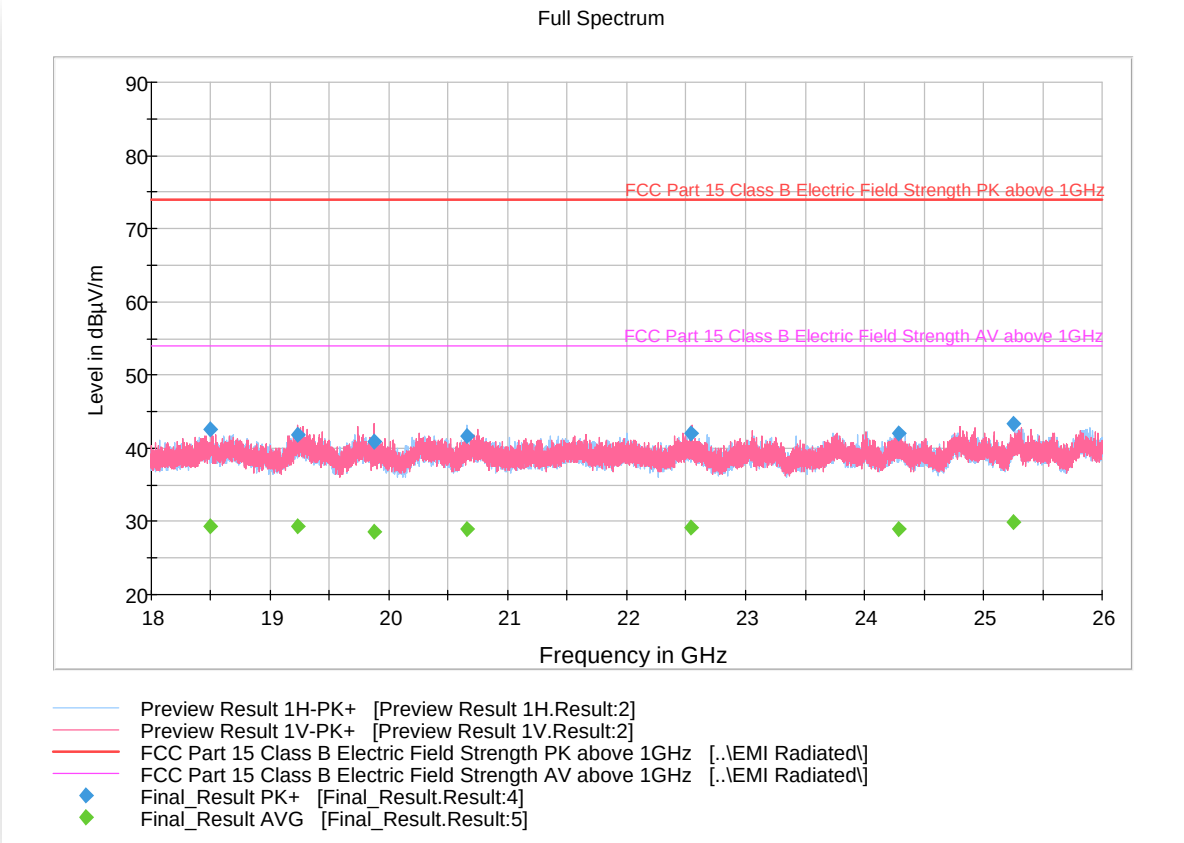
Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1000.00000	46.87	73.90	27.03	1000.0	1000.000	163.0	H	287.0	-6
1595.33333	49.66	73.90	24.24	1000.0	1000.000	175.0	H	22.0	-4
3377.10000	45.16	73.90	28.74	1000.0	1000.000	170.0	V	34.0	3
4804.06666	50.78	73.90	23.12	1000.0	1000.000	325.0	H	289.0	5
7206.26666	53.68	73.90	20.22	1000.0	1000.000	335.0	V	72.0	6
7206.66666	55.99	73.90	17.91	1000.0	1000.000	335.0	V	69.0	6
16796.0333	60.17	73.90	13.73	1000.0	1000.000	365.0	V	319.0	18
16812.8333	58.57	73.90	15.33	1000.0	1000.000	365.0	V	334.0	18

Average Data

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1000.00000	34.07	53.90	19.83	1000.0	1000.000	163.0	H	287.0	-6
1595.33333	26.81	53.90	27.09	1000.0	1000.000	175.0	H	22.0	-4
3377.10000	32.06	53.90	21.84	1000.0	1000.000	170.0	V	34.0	3
4804.06666	40.32	53.90	13.58	1000.0	1000.000	325.0	H	289.0	5
7206.26666	42.69	53.90	11.21	1000.0	1000.000	335.0	V	72.0	6
7206.66666	44.50	53.90	9.40	1000.0	1000.000	335.0	V	69.0	6
16796.0333	46.09	53.90	7.81	1000.0	1000.000	365.0	V	319.0	18
16812.8333	46.26	53.90	7.64	1000.0	1000.000	365.0	V	334.0	18

Test Notes: Fundamental will be ignored for this test (antenna port terminated).

2.7.11 Test Results for 18GHz to 26GHz



Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
18494.6305	42.63	73.90	31.27	1000.0	1000.000	163.0	V	312.0	-3
19231.0255	41.91	73.90	31.99	1000.0	1000.000	163.0	V	311.0	-2
19873.0510	40.92	73.90	32.98	1000.0	1000.000	162.0	V	31.0	-3
20658.9365	41.64	73.90	32.27	1000.0	1000.000	187.0	H	0.0	-2
22536.0780	41.96	73.90	31.94	1000.0	1000.000	140.0	V	322.0	0
24283.1320	42.11	73.90	31.79	1000.0	1000.000	187.0	H	22.0	1
25256.1580	43.29	73.90	30.61	1000.0	1000.000	163.0	H	246.0	2

Average Data

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
18494.6305	29.38	53.90	24.52	1000.0	1000.000	163.0	V	312.0	-3
19231.0255	29.35	53.90	24.55	1000.0	1000.000	163.0	V	311.0	-2
19873.0510	28.56	53.90	25.34	1000.0	1000.000	162.0	V	31.0	-3
20658.9365	28.91	53.90	24.99	1000.0	1000.000	187.0	H	0.0	-2
22536.0780	29.22	53.90	24.68	1000.0	1000.000	140.0	V	322.0	0
24283.1320	28.97	53.90	24.93	1000.0	1000.000	187.0	H	22.0	1
25256.1580	29.88	53.90	24.02	1000.0	1000.000	163.0	H	246.0	2

2.8 POWER SPECTRAL DENSITY

2.8.1 Specification Reference

FCC 47 CFR Part 15, Clause 15.247(e)
RSS-247, Clause 5.2(b)

2.8.2 Standard Applicable

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

2.8.3 Equipment Under Test and Modification State

Serial No: 345650037 / Default Test Configuration

2.8.4 Date of Test/Initial of test personnel who performed the test

June 06, 2022 / FSC

2.8.5 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

2.8.6 Environmental Conditions (Mira Mesa Facility)

Ambient Temperature	23.1°C
Relative Humidity	28.3 %
ATM Pressure	100.1kPa

2.8.7 Additional Observations

- This is a conducted test using direct connection to the TS8997 Test System.
- The path loss was all accounted for with the test system calibration.
- Test results presented (PSD Total) are for both RF chains combined. Sample plots presented are from individual RF chain.
- Test methodology is per FCC title 47 part 15 §15.247(a),(e), KDB 558074 D01 DTS Meas Guidance v05 F and ANSI C63.10-2013.

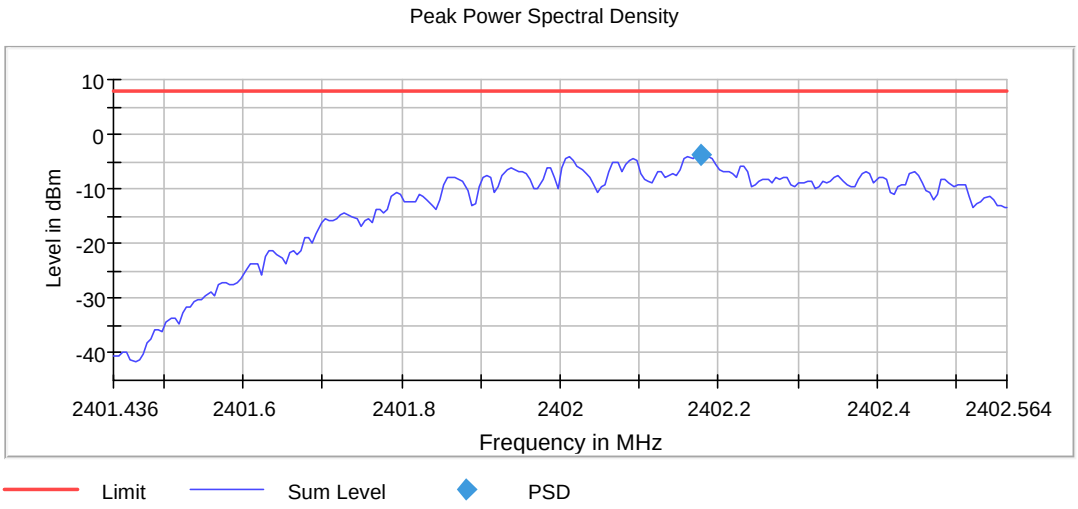
2.8.8 Test Results Summary

DUT Frequency (MHz)	PHY	Frequency (MHz)	PSD (dBm)	PSD Total (dBm)	Limit Max (dBm)	Result
2402.000000	1M	2402.177298	-3.625	-0.625	8.0	PASS
2440.000000	1M	2440.177298	-3.984	-0.984	8.0	PASS
2480.000000	1M	2480.182382	-4.716	-1.716	8.0	PASS
2402.000000	2M	2402.192736	-4.758	-1.758	8.0	PASS
2440.000000	2M	2440.197742	-4.788	-1.788	8.0	PASS
2480.000000	2M	2480.197670	-5.398	-2.398	8.0	PASS

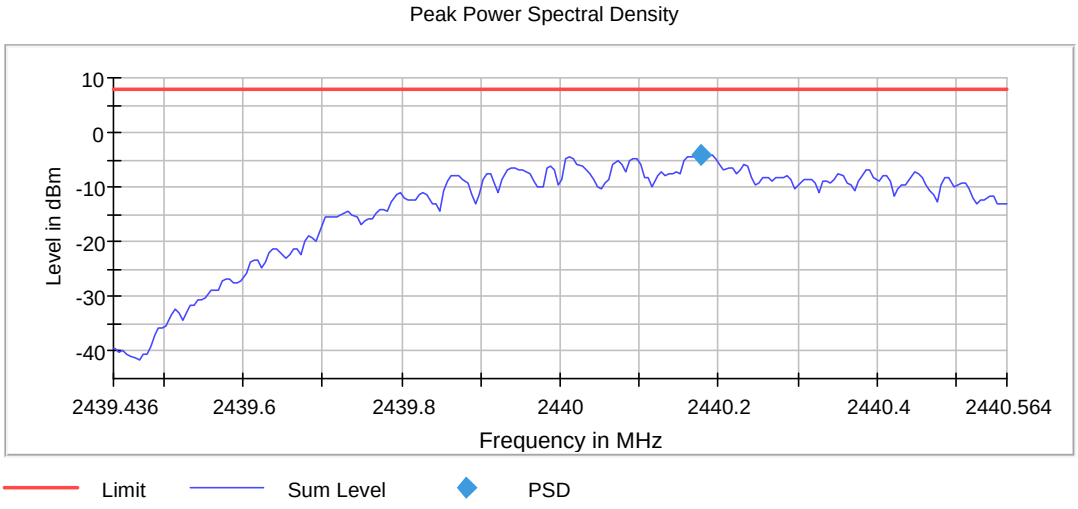
2.8.9 Sample Measurement Settings

Setting	Instrument Value	Target Value
Span	1.099 MHz	1.099 MHz
RBW	10.000 kHz	<= 10.000 kHz
VBW	30.000 kHz	>= 30.000 kHz
SweepPoints	220	~ 220
Sweeptime	1.100 ms	AUTO
Reference Level	-10.000 dBm	-10.000 dBm
Attenuation	10.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	Sweep	Sweep
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	8 / max. 150	max. 150
Stable	2 / 2	2
Max Stable Difference	0.21 dB	0.50 dB

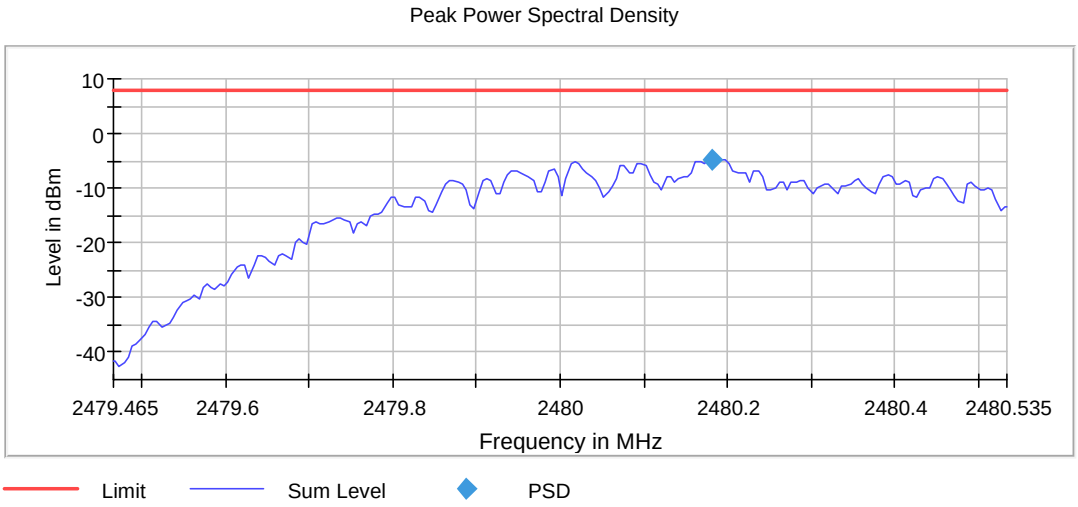
2.8.10 Worst CaseTest Plots



Bluetooth LE Low Channel



Bluetooth LE Mid Channel



Bluetooth LE High Channel

SECTION 3

TEST EQUIPMENT USED

3.1 TEST EQUIPMENT USED

List of absolute measuring and other principal items of test equipment.

ID Number (SDGE/SDRB)	Test Equipment	Type	Serial Number	Manufacturer	Cal Date	Cal Due Date
Conducted Port Setup						
7643	Signal/Spectrum Analyzer	FSV30	1321.3008K30/103166	Rhode & Schwarz	09/02/21	12/02/22
7655	Vector Signal Generator	SMBV100A	260734	Rhode & Schwarz	09/02/21	12/02/22
7654	Signal Generator	SMB 100A	175750	Rhode & Schwarz	09/02/21	12/02/22
7656	OSP with B157	OSP120	101310	Rhode & Schwarz	09/02/21	12/02/22
8825	20dB Attenuator	46-20-34	BK5773	Weinschel Corp.	Verified by 7643 and 7654	
AC Conducted Emissions						
1049	EMI Test Receiver	ESU40	100133	Rohde & Schwarz	10/01/21	10/01/22
7567	LISN	FCC-LISN-50-25-2-10	120304	Fischer Custom Comm.	03/28/22	03/28/23
8870	Bi-Directional Attenuator	34-20-34	BP8030	MCE / Weinschel	02/28/22	02/28/23
Radiated Emission						
1002	Bilog Antenna	3142C	00058717	ETS-Lindgren	10/21/21	10/21/23
7631	Double-ridged waveguide horn	3117	00205418	ETS-Lindgren	09/16/20	09/16/22
7611	Signal & Spectrum Analyzer	FSW26	102017	Rohde & Schwarz	02/09/22	02/09/23
1049	EMI Test Receiver	ESU	100133	Rohde & Schwarz	10/01/21	10/01/22
46797	Preamplifier	PS-122	181925	Com Power	10/11/21	10/11/22
9001	Horn antenna (18-26.5GHz)	HO42S	101	Custom Microwave	09/23/21	09/23/23
9002	Horn antenna (26-40 GHz)	HO28S	102	Custom Microwaves	09/23/21	09/23/23
40815	18GHz to 40GHz Low Noise Amplifier	SLKKa-30-6	19D18	Spacek Labs	10/11/21	10/11/22
Miscellaneous						
11312	Mini Environmental Quality Meter	850026	850027	Sper Scientific	07/19/21	07/19/22
7619	Barometer/ Temperature/Humidity	iBTHX-W	15250268	Omega	05/27/22	05/27/23
43003	True RMS Multimeter	85 III	69880143	Fluke	11/19/21	11/19/22
6672	D.C. Power Supply	E3611A	KR73012637	Hewlett Packard	Verified by 43003	
	Test Software	EMC32	V10.50.40	Rhode & Schwarz	N/A	

3.2 Measurement Uncertainty

Calculation of Measurement Uncertainty per CISPR 16-4-2:2011 with Corr. 1

3.2.1 AC Conducted Measurements

	Input Quantity (Contribution) X_i	Value		Prob. Dist.	Divisor	$u_i(x)$	$u_i(x)^2$
1	Receiver reading	0.10	dB	Normal, k=1	1.000	0.10	0.01
2	LISN-receiver attenuation	0.10	dB	Normal, k=2	2.000	0.05	0.00
3	LISN voltage division factor	0.30	dB	Normal, k=2	2.000	0.15	0.02
4	Receiver sinewave accuracy	0.36	dB	Normal, k=2	2.000	0.18	0.03
5	Receiver pulse amplitude	1.50	dB	Rectangular	1.732	0.87	0.75
6	Receiver pulse repetition rate	1.50	dB	Rectangular	1.732	0.87	0.75
7	Noise floor proximity	0.00	dB	Rectangular	1.732	0.00	0.00
8	AMN VDF frequency interpolation	0.10	dB	Rectangular	1.732	0.06	0.00
9	Mismatch	0.07	dB	U-shaped	1.414	0.05	0.00
10	LISN impedance	2.65	dB	Triangular	2.449	1.08	1.17
11	Effect of mains disturbance	0.00	dB			0.00	0.00
12	Effect of the environment						
	Combined standard uncertainty			Normal	1.66	dB	
	Expanded uncertainty			**Normal, k=2**	**3.31**	**dB**	

3.2.2 Radiated Measurements (30MHz to 1GHz)

	Input Quantity (Contribution) X_i	Value		Prob. Dist.	Divisor	$u_i(x)$	$u_i(x)^2$
1	Receiver reading	0.10	dB	Normal, k=1	1.000	0.10	0.01
2	Attenuation: antenna-receiver	0.20	dB	Normal, k=2	2.000	0.10	0.01
3	Antenna factor AF	0.58	dB	Normal, k=2	2.000	0.29	0.08
4	Receiver sinewave accuracy	0.15	dB	Normal, k=2	2.000	0.08	0.01
5	Receiver pulse amplitude	1.50	dB	Rectangular	1.732	0.87	0.75
6	Receiver pulse repetition rate	1.50	dB	Rectangular	1.732	0.87	0.75
7	Noise floor proximity	0.50	dB	Rectangular	1.732	0.29	0.08
8	Mismatch: antenna-receiver	0.95	dB	U-shaped	1.414	0.67	0.45
9	AF frequency interpolation	0.30	dB	Rectangular	1.732	0.17	0.03
10	AF height deviations	0.10	dB	Rectangular	1.732	0.06	0.00
11	Directivity difference at 3 m	3.12	dB	Rectangular	1.732	1.80	3.24
12	Phase center location at 3 m	1.00	dB	Rectangular	1.732	0.58	0.33
13	Cross-polarization	0.90	dB	Rectangular	1.732	0.52	0.27
14	Balance	0.00	dB	Rectangular	1.732	0.00	0.00
15	Site imperfections	3.99	dB	Triangular	2.449	1.63	2.65
16	Separation distance at 3 m	0.30	dB	Rectangular	1.732	0.17	0.03
17	Effect of setup table material	0.57	dB	Rectangular	1.732	0.33	0.11
18	Table height at 3 m	0.10	dB	Normal, k=2	2.000	0.05	0.00

19	Near-field effects	0.00	dB	Triangular	2.449	0.00	0.00
20	Effect of ambient noise on OATS	0.00	dB				0.00
	Combined standard uncertainty			Normal	2.97	dB	
	Expanded uncertainty			Normal, k=2	**5.94**	**dB**	

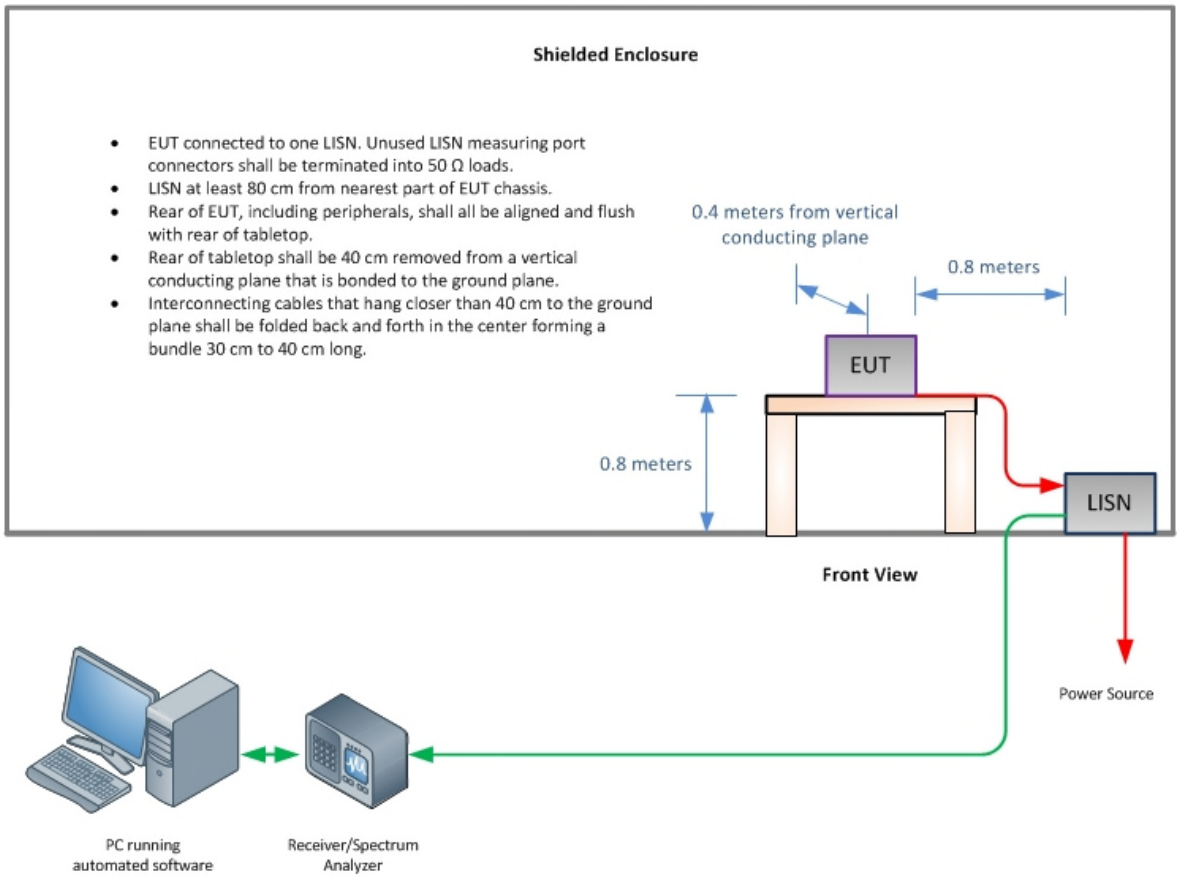
3.2.1 Radiated Emission Measurements (1GHz to 18GHz)

	Input Quantity (Contribution) X_i	Value		Prob. Dist.	Divisor	$u_i(x)$	$u_i(x)^2$
1	Receiver reading	0.10	dB	Normal, k=1	1.000	0.10	0.01
2	Attenuation: antenna-receiver	0.20	dB	Normal, k=2	2.000	0.10	0.01
3	Antenna factor AF	0.75	dB	Normal, k=2	2.000	0.38	0.14
4	Receiver sinewave accuracy	0.45	dB	Normal, k=2	2.000	0.23	0.05
5	Receiver pulse amplitude	1.50	dB	Rectangular	1.732	0.87	0.75
6	Receiver pulse repetition rate	1.50	dB	Rectangular	1.732	0.87	0.75
7	Noise floor proximity	0.50	dB	Rectangular	1.732	0.29	0.08
8	Mismatch: antenna-receiver	0.95	dB	U-shaped	1.414	0.67	0.45
9	AF frequency interpolation	0.30	dB	Rectangular	1.732	0.17	0.03
10	AF height deviations	0.10	dB	Rectangular	1.732	0.06	0.00
11	Directivity difference at 3 m	3.12	dB	Rectangular	1.732	1.80	3.24
12	Phase center location at 3 m	1.00	dB	Rectangular	1.732	0.58	0.33
13	Cross-polarisation	0.90	dB	Rectangular	1.732	0.52	0.27
14	Balance	0.00	dB	Rectangular	1.732	0.00	0.00
15	Site imperfections	3.25	dB	Triangular	2.449	1.33	1.76
16	Separation distance at 3 m	0.30	dB	Rectangular	1.732	0.17	0.03
17	Effect of setup table material	0.77	dB	Rectangular	1.732	0.44	0.20
18	Table height at 3 m	0.10	dB	Normal, k=2	2.000	0.05	0.00
19	Near-field effects	0.00	dB	Triangular	2.449	0.00	0.00
20	Effect of ambient noise on OATS	0.00	dB				0.00
	Combined standard uncertainty			Normal	2.85	dB	
	Expanded uncertainty			Normal, k=2	**5.70**	**dB**	

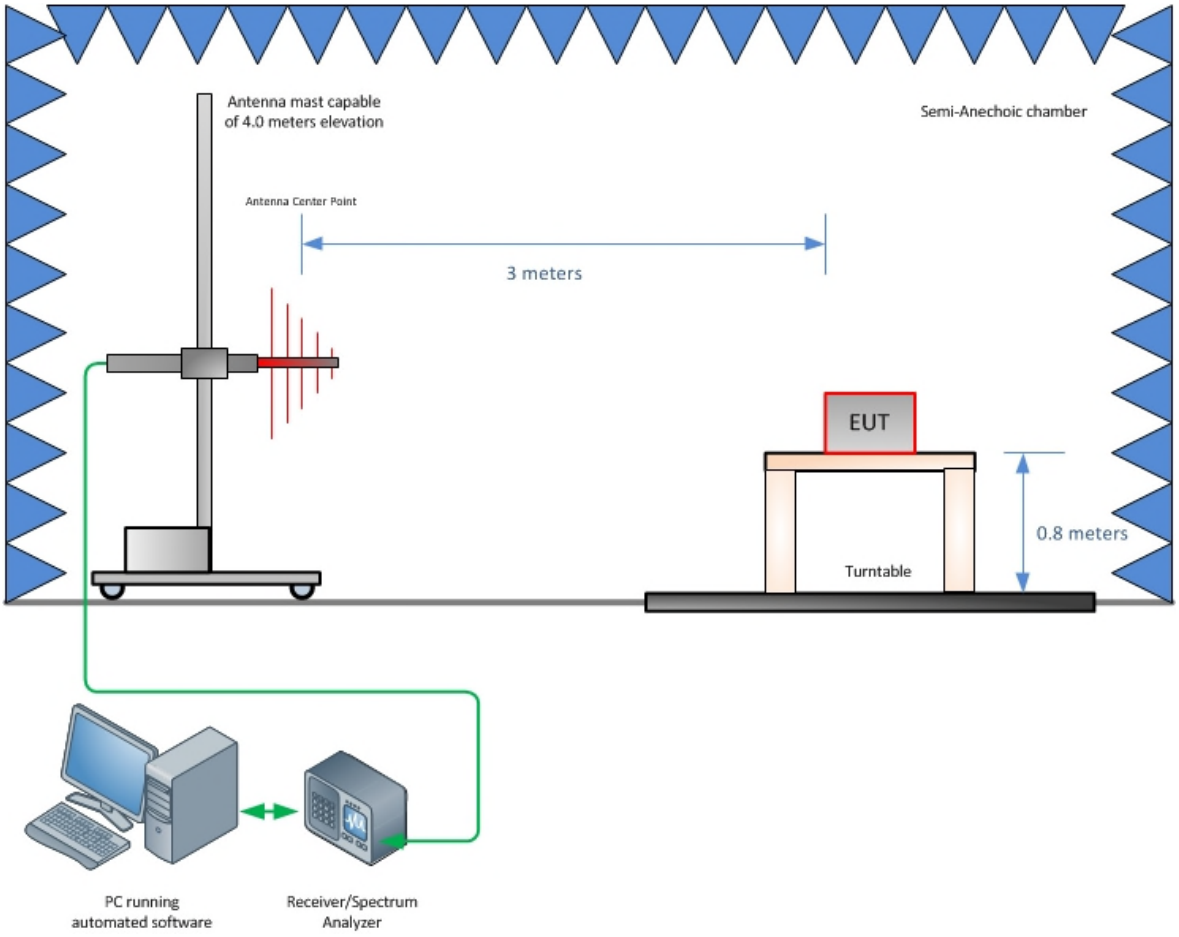
SECTION 4

DIAGRAM OF TEST SETUP

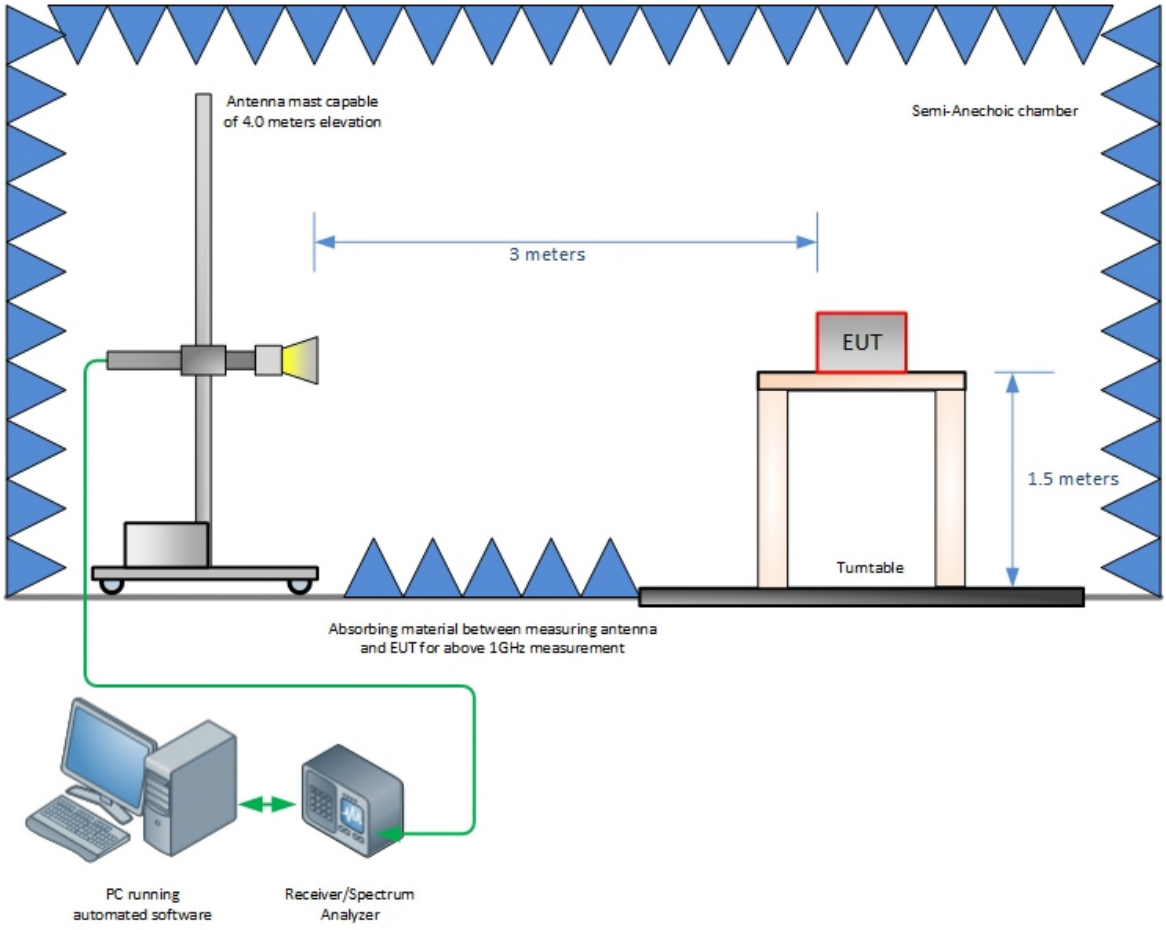
4.1 Test Setup Diagram



AC Conducted Emission Test Setup



Radiated Emission Test Setup (Below 1GHz)



Radiated Emission Test Setup (Above 1GHz)

SECTION 5

ACCREDITATION, DISCLAIMERS AND COPYRIGHT

5.1 ACCREDITATION, DISCLAIMERS AND COPYRIGHT

TÜV SÜD America Inc.'s reports apply only to the specific sample tested under stated test conditions. It is the manufacturer's responsibility to assure the continued compliance of production units of this model. TÜV SÜD America, Inc. shall have no liability for any deductions, inferences or generalizations drawn by the client or others from TÜV SÜD America, Inc.'s issued reports.

This report is the confidential property of the client. As a mutual protection to our clients, the public and TÜV SÜD America, Inc., extracts from the test report shall not be reproduced, except in full without TÜV SÜD America, Inc.'s written approval.

This report must not be used to claim product certification, approval, or endorsement by A2LA, NIST, or any agency of the federal government.

TÜV SÜD America, Inc. and its professional staff hold government
and professional organization certifications for
AAMI, ACIL, AEA, ANSI, IEEE, A2LA, NIST and VCCI.

A2LA Cert. No. 2955.13