



Regulatory Test Report

Prepared for Harman International Industries, Inc.

This report presents detailed information on

INFO3.8 CSM

Prepared by

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Engineer II

Approved by

Jason Kanakry

General Manager

Issue date: 08/07/2023

Report No: AH22120901-HAR-054-TR4 v2

This test result relates only to the described test object.

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Customer must not use this test report as the product certification of each accreditation body or each national organization.

The test is traceable to national standard or related international standard

Contents

- Test Request Information.....Error! Bookmark not defined.
- Test Laboratory Information4
- Statement of Conformity5
- Conducted Testing6
- Radiated Testing27

1. Test Request Information

Test Request #:	7700182070
Test Requested By:	Mark Bowman Harman International Industries, Inc. 30001 Cabot Drive, Novi, MI 48377
Test item Description:	INFO3.8 CSM
Part Number:	8709305
DUT Sample Number:	AH22120901-HAR-054#1, AH22120901-HAR-054#2
Hardware Version of DUT:	PV
Software Version of DUT:	17.80.200.219
Component Category of DUT:	N/A
FCC ID:	2AHPN-BE2867
ISED ID:	6434C-BE2867
Type of Test:	FCC/ISED Certification
Test Method:	CFR Title 47 FCC Part 15.247, ISED Canada RSS-247 Issue 2, ISED Canada RSS-Gen Issue 5 and ANSI C63.10-2013, KDB 558074 D01 15.247 Meas Guidance v05r02
Deviations from standard:	None
Approved Test Plan Number:	N/A
Test Plan Revision:	N/A
Date test sample received:	10-07-2022
Date test started:	12-12-2022
Date test finished:	02-28-2023

2. Test Laboratory Information

Location of Test Lab:	The radiated and conducted emissions test sites are located at Bureau Veritas 815 N. Opdyke Rd #100, Auburn Hills, MI 48326, Phone: +1-248-836-4700
Key Contact:	Jason Kanakry (General Manager) Jason.Kanakry@BureauVeritas.com Phone: +1-248-836-4747
Laboratory Accreditations:	BUREAU VERITAS CONSUMER PRODUCTS SERVICES, INC is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017 General requirements for the competence of testing and calibration laboratories.
ISO/IEC 17025:2017:	5678.01
FCC Test Site Number:	US1278 (242530)
IC Test Site Number:	US0229 (26240)

3. Statement of Conformity

RSS-GEN	RSS 247	Part 15	Comments
6.4		15.15(b)	There are no controls accessible to the user that varies the output power to operate in violation of the regulatory requirements.
		15.19	The label is shown in the label exhibit.
		15.21	Information to the user is shown in the instruction manual exhibit.
		15.27	No special accessories are required for compliance.
3.2		15.31	The EUT was tested in accordance with the measurement standards in this section.
6.13.2		15.33	Frequency range was investigated according to this section, unless noted in specific rule section under which the equipment operates.
6.13.1		15.35	The EUT emissions were measured using the measurement detector and bandwidth specified in this section, unless noted in specific rule section under which the equipment operates.
6.8		15.203	EUT employs integrated PCB antenna with 5.98dBi gain.
8.10		15.205 15.209	The fundamental is not in a Restricted band and the spurious and harmonic emissions in the Restricted bands comply with the general emission limits of 15.209 or RSS-Gen as applicable
8.8		15.207	N/A. EUT is vehicle battery powered only.

CFR Title 47 FCC Part 15.247, ISED Canada RSS-247 Issue 2

4. Conducted Testing

4.1 Test Summary

This test report supports an application for certification of a transmitter operating pursuant to:

CFR Title 47 FCC Part 15.247, ISED Canada RSS-247 Issue 2

The product is **INFO3.8 CSM**. It is a Digital Transmission System that operates in 2402 – 2480 MHz frequency range.

Details	Description
Frequency Range (MHz)	2402 – 2480
Modulation	GFSK
Number of Channels	40
Tested Frequencies	2402,2440,2480
DUT Antenna Type	Integrated PCB antenna
Equipment type	Digital Transmission System
DUT Antenna Gain	5.98dBi ☒ Provided by Customer with Gain Report ☐ Not Provided by Customer
DUT Power Class/Power Settings	Power Class: 0 (MRVL_Class2) Power Level : 4 dBm
DUT Software Tool/Settings	BT_WLAN_Test_Tool_NXP_Chips_v2.4 tool used to configure device Bluetooth low energy modes and data rates.

We found that the product met the above requirements without modification.

Test samples were received in good condition.

Test Item	Sample #	Result
FCC 15.247 Bluetooth Low Energy	AH22120901-HAR-054#1	Meets Requirement

Notes: Testing is performed on 1MHz data rate.

Test Results Summary

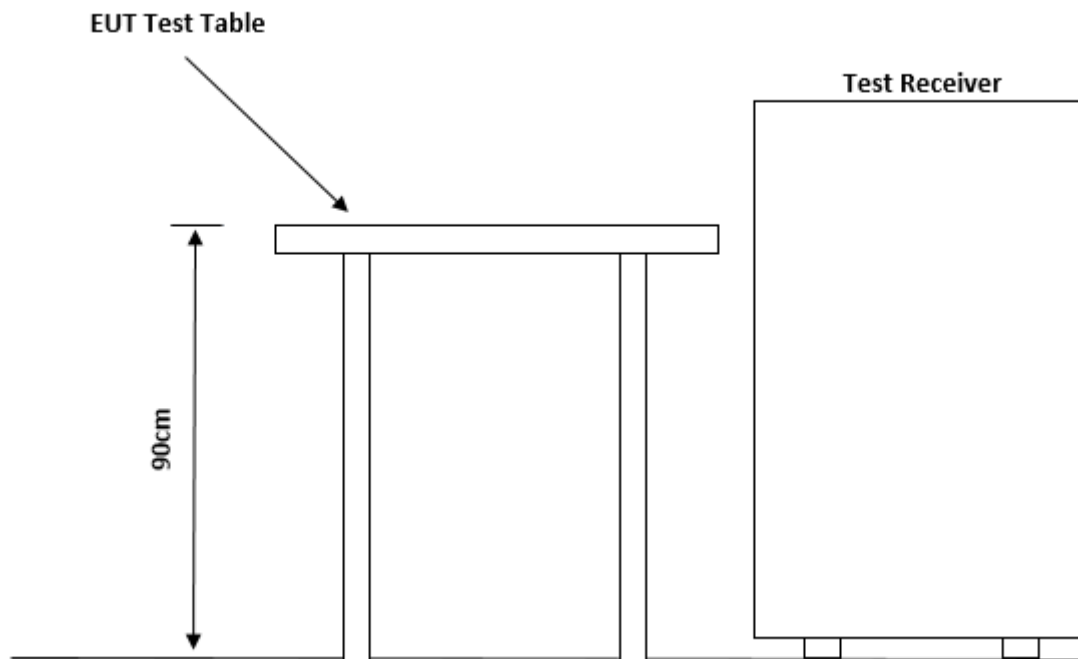
Test	Frequency (MHz)	LE CH-0 Result	LE CH-19 Result	LE CH-39 Result
Peak Output Power	2402	Pass	Pass	Pass
Minimum Emission Bandwidth 6Db	2402	Pass	Pass	Pass
Occupied Channel Bandwidth 99%	2402	Pass	Pass	Pass
Power Spectral Density	2402	Pass	Pass	Pass
Peak Power Spectral Density	2402	Pass	Pass	Pass
Tx Spurious Emissions	2402	Pass	Pass	Pass
Band Edge Low	2402	Pass	Pass	Pass
Peak Output Power	2440	Pass	Pass	Pass
Minimum Emission Bandwidth 6Db	2440	Pass	Pass	Pass
Occupied Channel Bandwidth 99%	2440	Pass	Pass	Pass
Power Spectral Density	2440	Pass	Pass	Pass
Peak Power Spectral Density	2440	Pass	Pass	Pass
Tx Spurious Emissions	2440	Pass	Pass	Pass
Peak Output Power	2480	Pass	Pass	Pass
Minimum Emission Bandwidth 6Db	2480	Pass	Pass	Pass
Occupied Channel Bandwidth 99%	2480	Pass	Pass	Pass
Power Spectral Density	2480	Pass	Pass	Pass
Peak Power Spectral Density	2480	Pass	Pass	Pass
Tx Spurious Emissions	2480	Pass	Pass	Pass
Band Edge High	2480	Pass	Pass	Pass

Notes: 2402, 2440 and 2480 Frequencies were selected as representative test channels

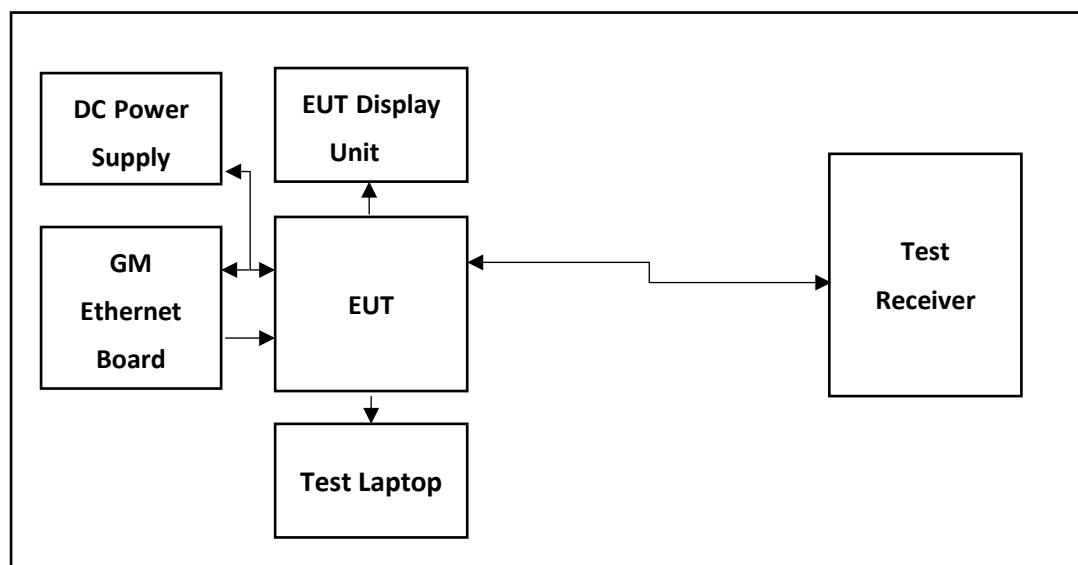
4.2 Test Setup

Conducted Test Site Description

The site is accommodated to test tabletop and floor standing test equipment.



TEST SETUP DIAGRAM



4.3 Test Equipment Used

ID #	Equipment	Manufacturer	Model #	Serial #	Cal Due
BVD0226	Spectrum Analyzer 10Hz-44GHz	Rohde & Schwarz	FSV3044	101018	4/20/2024
BVD0227	8 port switch unit for Wireless Test system	Rohde & Schwarz	OSP150	101100	11/24/2025
BVD0228	8 port switch unit for Wireless Test system	Rohde & Schwarz	OSP220	101632	11/14/2025
BVD0224	Signal Generator 100kHz-40GHz	Rohde & Schwarz	SMB100A	181741	4/20/2024
BVD0225	Signal Generator 100k-6GHz with GPS simulator	Rohde & Schwarz	SMW200A	107664	4/20/2023
BVD0250	Wireless Connectivity Tester 70M-6GHz	Rohde & Schwarz	CMW270	102113	4/20/2024
BVD0302	DC power supply 1-15VDC 60A 110/220 11.5A max input	BK Precision	1693	257F17180	N/A
BVD0321	Fixed Attenuator 2W 20dB -40GHz	Mini-Circuits	BW-K20-2W44+	2103	3/21/2023
BVD0430	Multimeter	Fluke	117	49710262SV	11/11/2023
BVD0229	Temp and Humidity Meter	Fluke	971	12001009	5/1/2023
N/A	Test-PC	Lenovo ThinkPad	E560	PF0L0N9R	N/A

Notes:- DC power supply verified before use with calibrated Multimeter.

Customer Supplied Equipment

ID #	Equipment	Manufacturer	Model	Serial #	Version No.
N/A	Harness	Harman	N/A	N/A	N/A
N/A	Display Unit	Innolux Corp	INFOMM-15524	0024	N/A
N/A	Ethernet Board	GM	N/A	N/A	CSMate rev.4
N/A	GM BT WLAN Test Tool NXP Chips S/W	Harman	N/A	N/A	2.4

Equipment List (Software)

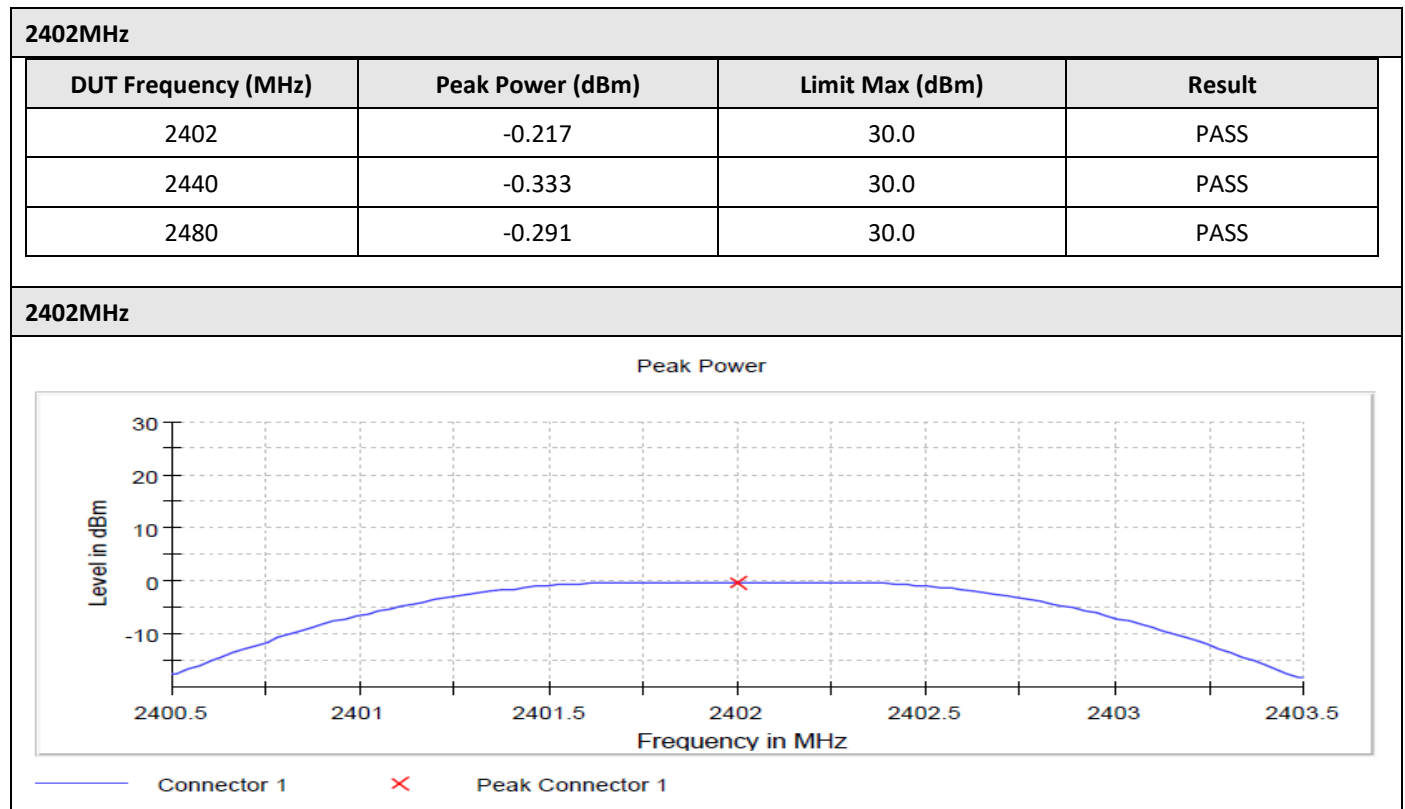
ID #	Equipment	Manufacturer	Model	Version No	
N/A	EMC Test Software	Rodhe & Schwarz	EMC32	11.20.00	N/A

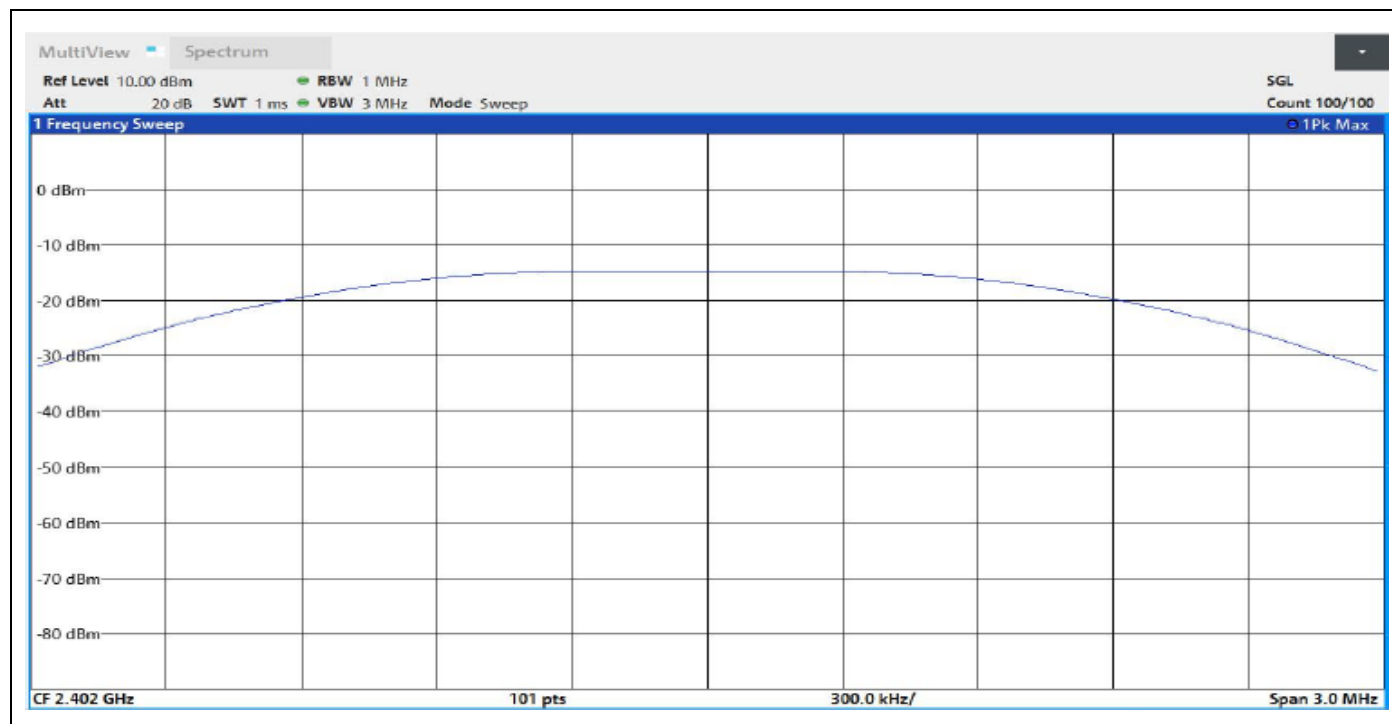
4.4 Test Data

4.4.1 Peak output power

Test according to FCC title 47 part 15 §15.247(b), RSS-247 Section 5.4(d), KDB 558074 D01 DTS Meas Guidance v05r02 and ANSI C63.10-2013 11.9.1.1

Measurement uncertainty calculated in accordance with ETSI TR 100 028-1. Expanded Combined Uncertainty of absolute Level Measurement ($K=2$) < 1 dB





4.4.2 Minimum Emission Bandwidth 6 dB

Test according to FCC title 47 part 15 §15.247(a), RSS-247 Section 5.2, KDB 558074 D01 DTS Meas Guidance v05r02 and ANSI C63.10-2013 11.8.1

Measurement uncertainty calculated in accordance with ETSI TR 100 028-1. Expanded Uncertainty (K=2) < 2%

Channel Frequency	Bandwidth (MHz)	Band Edge Left (MHz)	Band Edge Right (MHz)	Limit Min (MHz)
CH0-2402	0.712872	2401.623762	2402.336634	0.500000
CH19-2440	0.712872	2439.623762	2440.336634	0.500000
CH39-2480	0.712872	2479.623762	2480.336634	0.500000

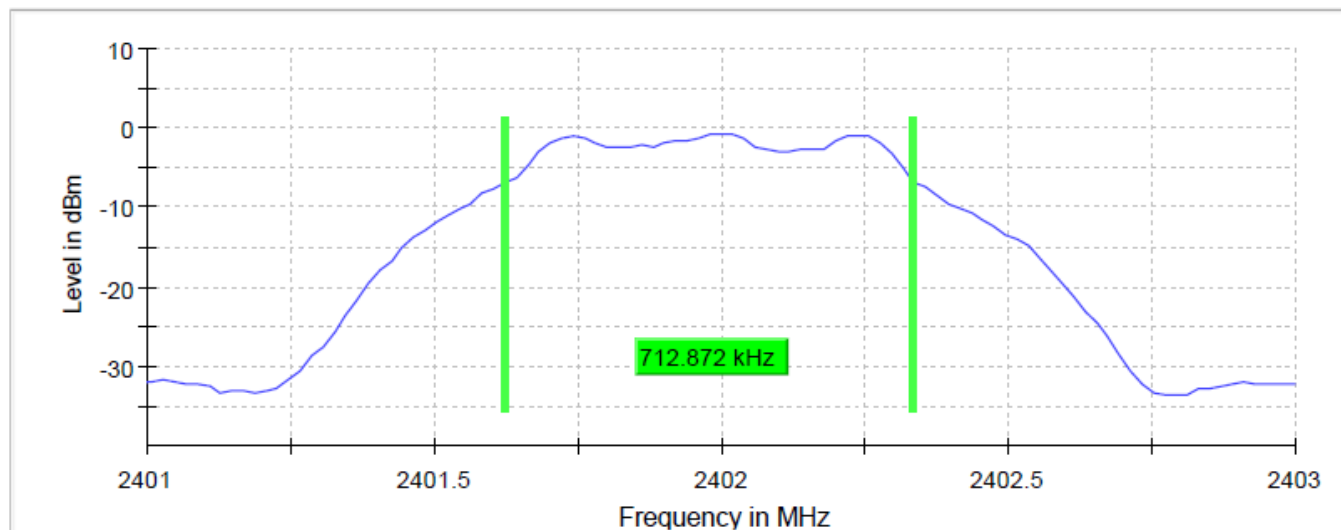
Spectrum Analyzer Settings

Setting	Instrument Value	Target Value
Start Frequency	2.40100 GHz	2.40100 GHz
Stop Frequency	2.40300 GHz	2.40300 GHz
Span	2.000 MHz	2.000 MHz
RBW	100.000 kHz	~ 100.000 kHz
VBW	300.000 kHz	~ 300.000 kHz
SweepPoints	101	~ 40
Sweptime	1.000 ms	AUTO
Reference Level	0.000 dBm	0.000 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	AUTO
Preamplifier	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	7 / max. 150	max. 150
Stable	5 / 5	5
Max Stable Difference	0.10 dB	0.50 dB

CH0-2402MHz

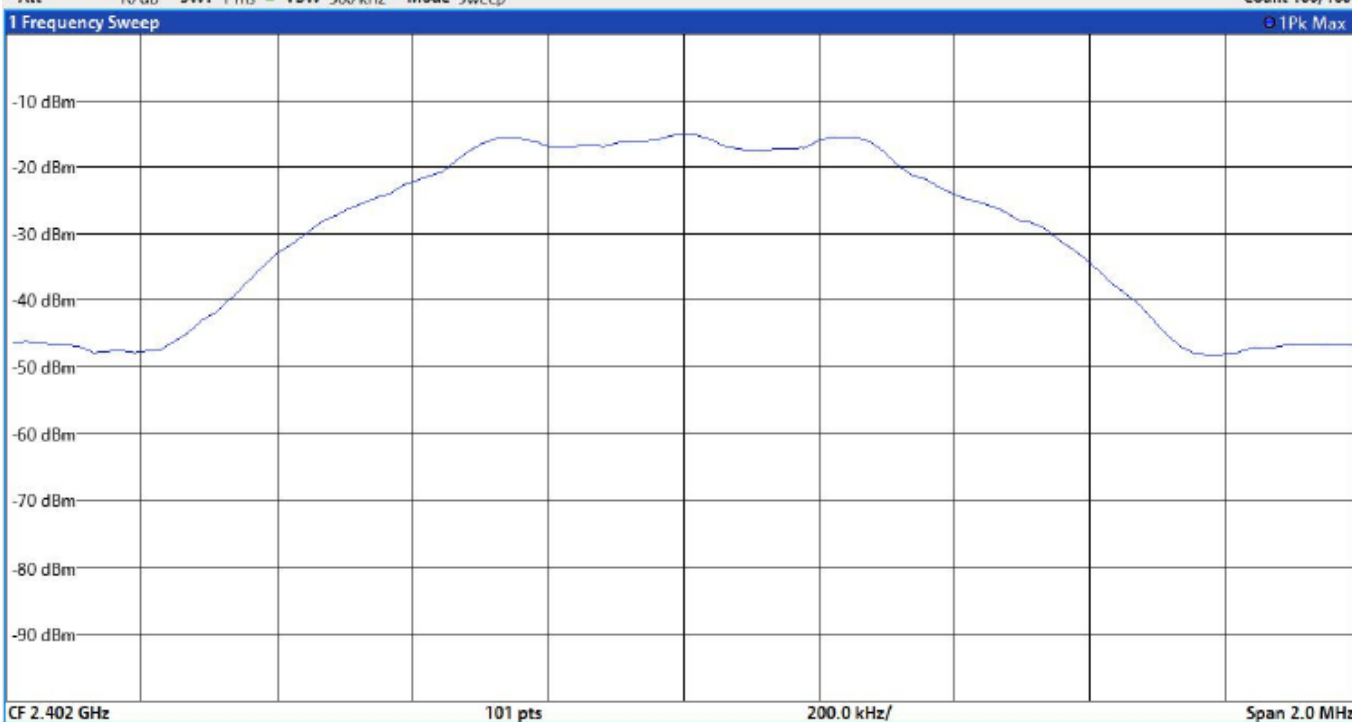
6 dB Bandwidth



MultiView Spectrum

Ref Level 0.00 dBm Att 10 dB SWT 1 ms RBW 100 kHz VBW 300 kHz Mode Sweep

SGL Count 100/100



4.4.3 Occupied Channel Bandwidth 99%

Test according to RSS-GEN Section 6.7, KDB 558074 D01 DTS Meas Guidance v05r02 and ANSI C63.10-2013

Measurement uncertainty calculated in accordance with ETSI TR 100 028-1. Expanded Uncertainty (K=2) < 2%

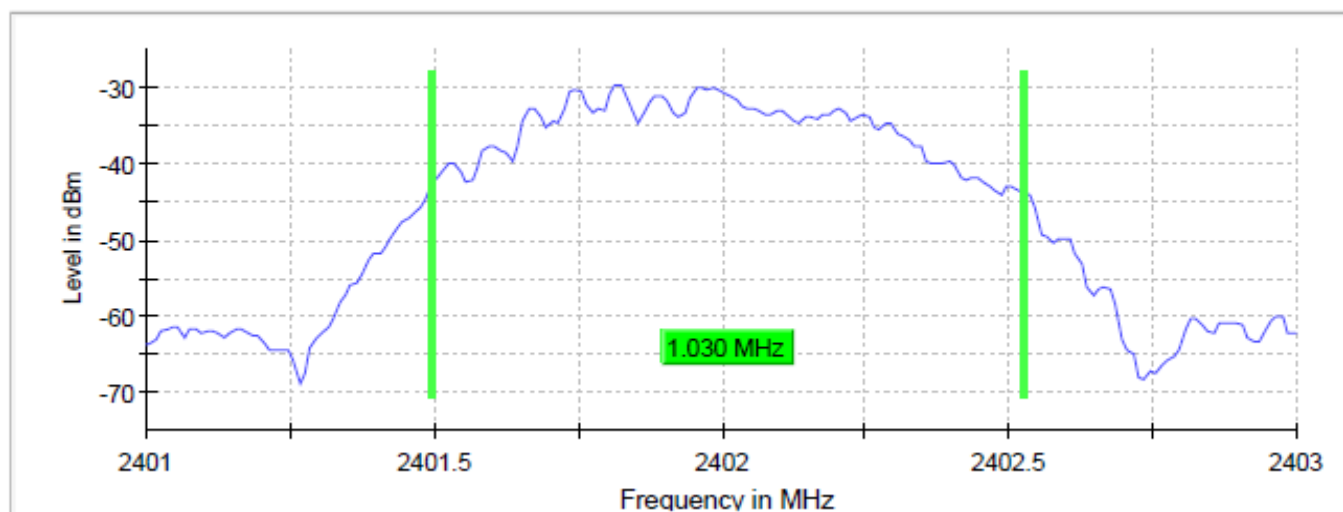
Channel Frequency	Bandwidth (MHz)	Band Edge Left (MHz)	Band Edge Right (MHz)	Limit
CH0-2402	1.030000	2401.495000	2402.525000	2400-2483.5
CH19-2440	1.030000	2439.495000	2440.525000	2400-2483.5
CH39-2480	1.040000	2479.485000	2480.525000	2400-2483.5

Spectrum Analyzer Settings

Setting	Instrument Value	Target Value
Start Frequency	2.40100 GHz	2.40100 GHz
Stop Frequency	2.40300 GHz	2.40300 GHz
Span	2.000 MHz	2.000 MHz
RBW	20.000 kHz	>= 20.000 kHz
VBW	100.000 kHz	>= 60.000 kHz
SweepPoints	200	~ 200
Sweptime	1.000 ms	AUTO
Reference Level	0.000 dBm	0.000 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	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.30 dB	0.30 dB
Run	8 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.06 dB	0.30 dB

CH0-2402MHz

99 % Bandwidth



MultiView Spectrum

Ref Level 0.00 dBm

Att 10 dB

SWT 1 ms

RBW 20 kHz

VBW 100 kHz

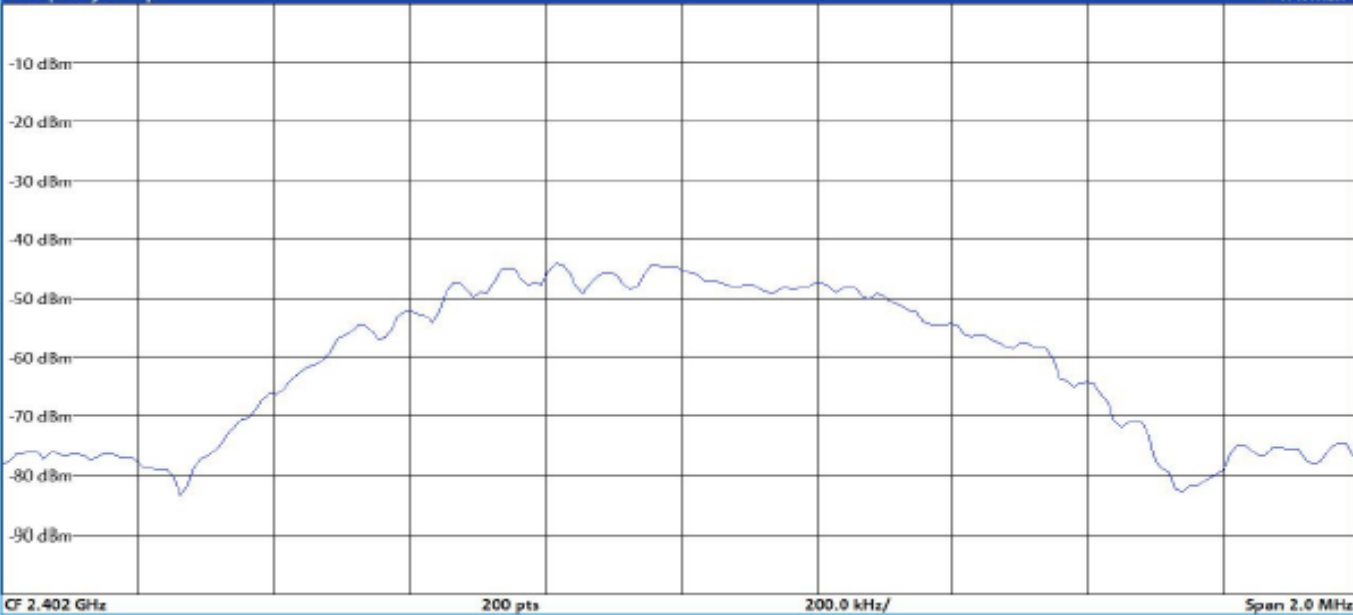
Mode Sweep

SGL

Count 100/100

1 Frequency Sweep

1Pk Max



4.4.4 Peak Power Spectral Density

Test according to FCC title 47 part 15 §15.247(e), RSS-247 Section 5.2, KDB 558074 D01 DTS Meas Guidance v05r02 F and ANSI C63.10-2013 Section 11.10.2

Measurement uncertainty calculated in accordance with ETSI TR 100 028-1. Expanded Uncertainty (K=2) < 1.3 dB

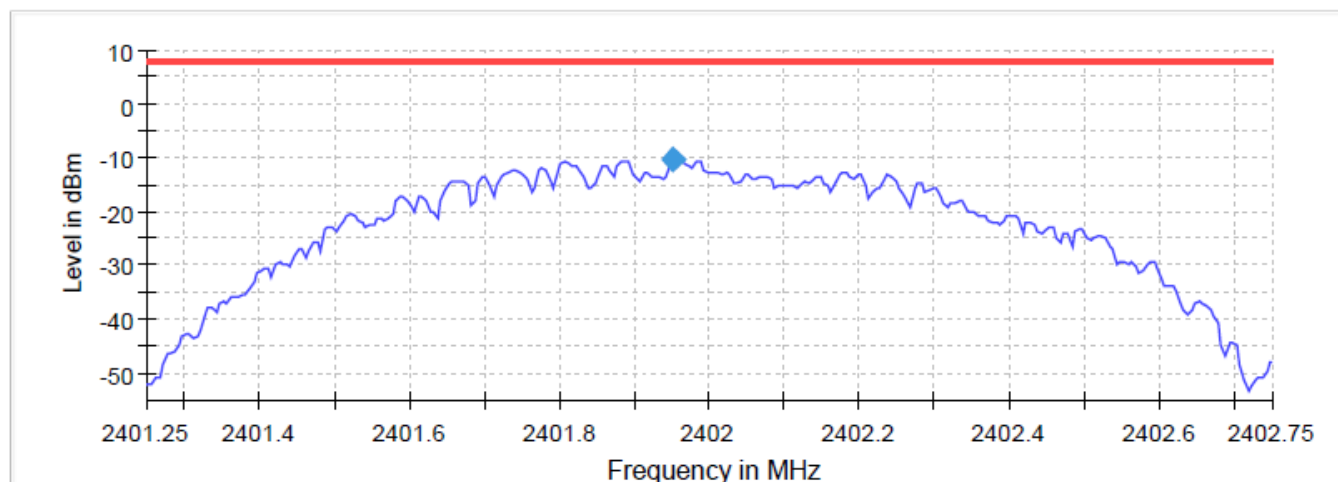
Channel	DUT Frequency (MHz)	Frequency (MHz)	PSD (dBm)	Limit (dBm)
CH0-2402	2402.000000	2401.952500	-10.215	8.0
CH19-2440	2440.000000	2439.952500	-10.304	8.0
CH39-2480	2480.000000	2479.952500	-10.296	8.0

Spectrum Analyzer Settings

Setting	Instrument Value	Target Value
Start Frequency	2.40125 GHz	2.40125 GHz
Stop Frequency	2.40275 GHz	2.40275 GHz
Span	1.500 MHz	1.500 MHz
RBW	10.000 kHz	<= 10.000 kHz
VBW	30.000 kHz	>= 30.000 kHz
SweepPoints	300	~ 300
SweepTime	1.500 ms	AUTO
Reference Level	0.000 dBm	0.000 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	4 / max. 150	max. 150
Stable	2 / 2	2
Max Stable Difference	0.15 dB	0.50 dB

CH0-2402MHz

Peak Power Spectral Density



— Limit — Sum Level ◆ PSD

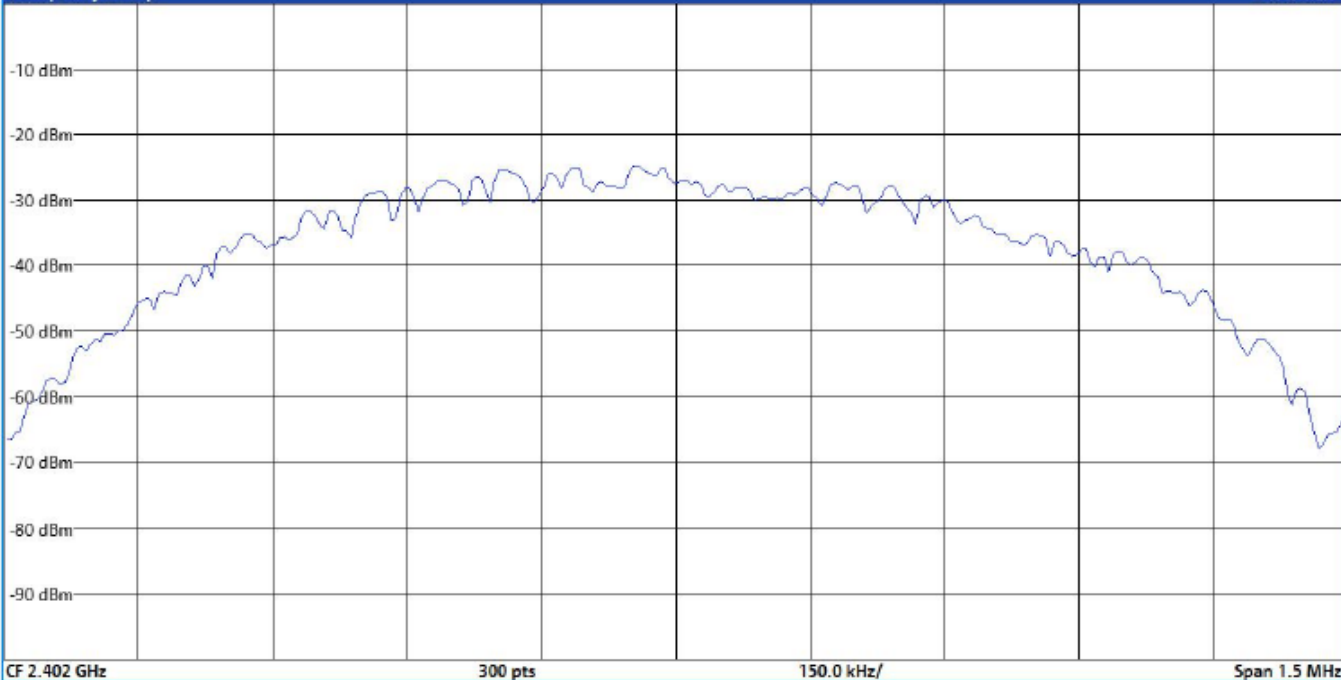
MultiView Spectrum

Ref Level 0.00 dBm RBW 10 kHz
Att 10 dB SWT 1.5 ms VBW 30 kHz Mode Sweep

SGL
Count 100/100

1 Frequency Sweep

01Pk Max



CF 2.402 GHz

300 pts

150.0 kHz/

Span 1.5 MHz

4.4.5 Tx Spurious Emission

Test according to FCC title 47 part 15 §15.247(d), RSS-247 Section 5.5, KDB 558074 D01 DTS Meas Guidance v05r02 Section 8.5 and ANSI C63.10-2013 11.11.2 & 11.11.3

Measurement uncertainty calculated in accordance with ETSI TR 100 028-1. Expanded Uncertainty (K=2) < 1.8 dB

Spectrum Analyzer Settings- Pre Measurements

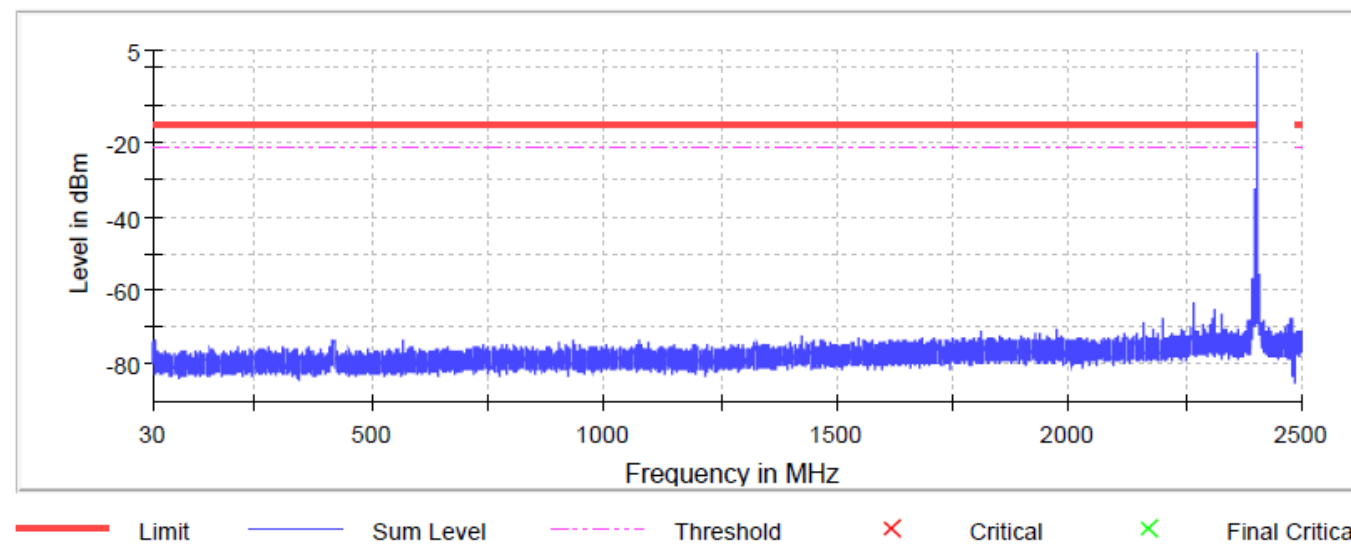
Setting	Instrument Value	Target Value
RBW	100.000 kHz	<= 100.000 kHz
VBW	300.000 kHz	>= 300.000 kHz
SweepPoints	100001	~ 320001
SweepTime	101.000 ms	AUTO
Reference Level	0.000 dBm	0.000 dBm
Attenuation	10.000 dB	AUTO
Detector	MaxPeak	MaxPeak
SweepCount	3	3
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
SweepType	Sweep	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	10 / max. 10	max. 10
Stable	3 / 3	3
Max Stable Difference	0.00 dB	0.50 dB

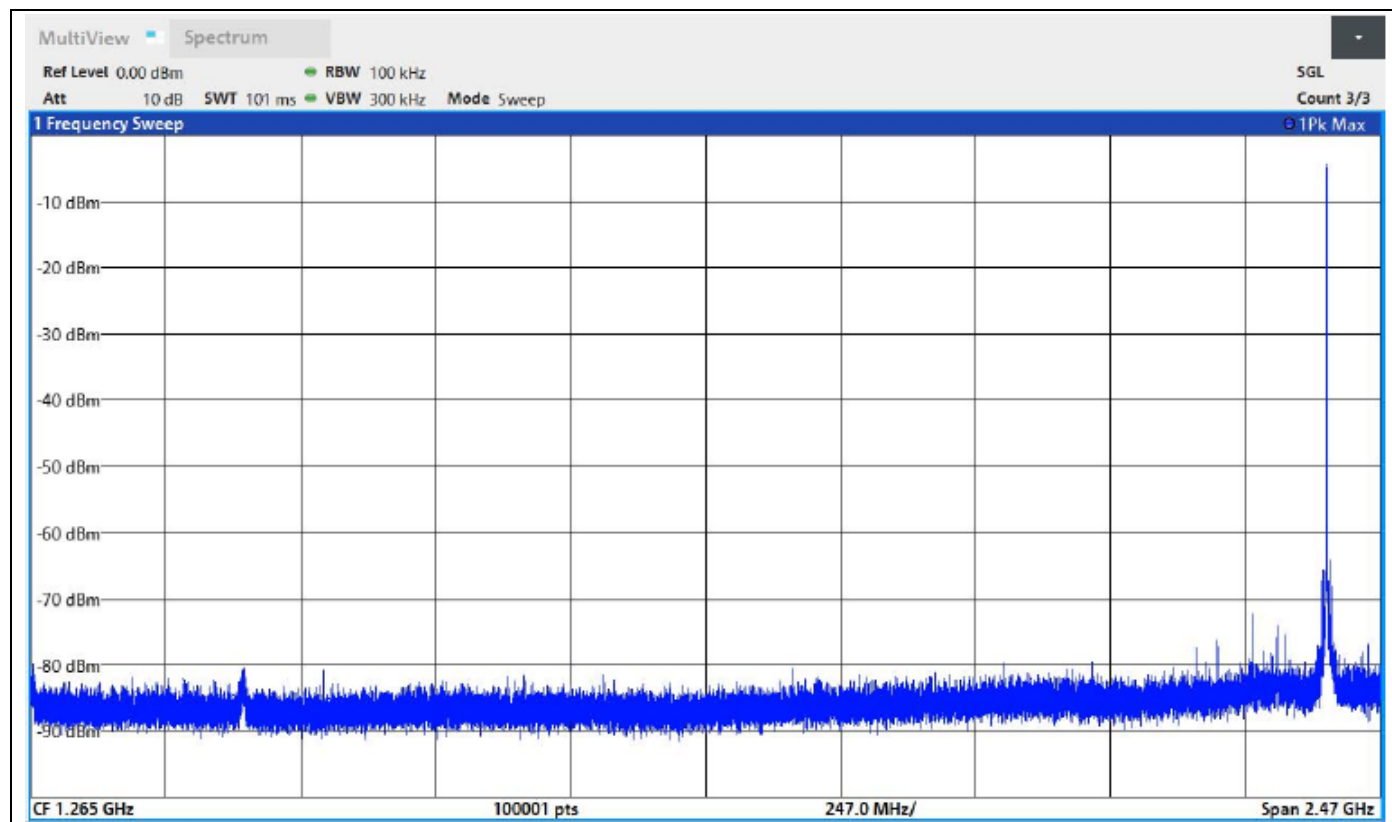
CH0-2402MHz

Pre Measurement

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)
2394.519705	-56.5	41.2	-15.4
2394.544405	-56.6	41.2	-15.4
2399.978350	-56.6	41.2	-15.4
2399.953650	-57.2	41.8	-15.4
2394.495005	-57.2	41.8	-15.4
2394.569104	-57.3	41.9	-15.4
2393.531715	-58.1	42.7	-15.4
2393.507015	-58.1	42.7	-15.4
2393.556414	-58.4	43.0	-15.4
2399.583154	-58.8	43.4	-15.4
2399.607854	-59.1	43.7	-15.4
2393.482315	-59.1	43.7	-15.4
2394.001010	-59.1	43.7	-15.4
2393.976310	-59.1	43.7	-15.4
2399.558454	-59.1	43.7	-15.4

Spurious



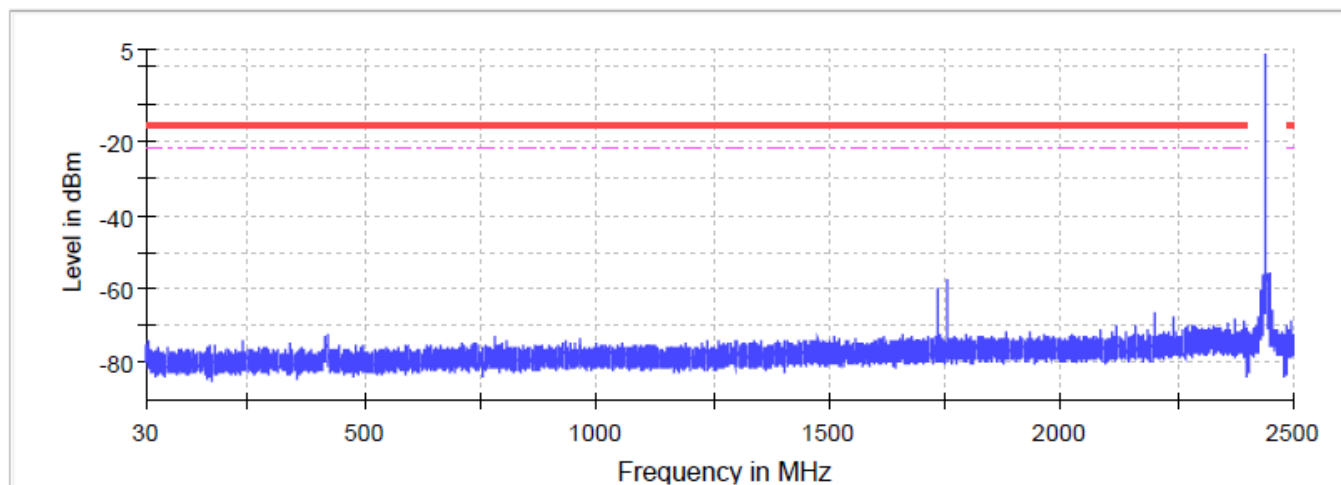


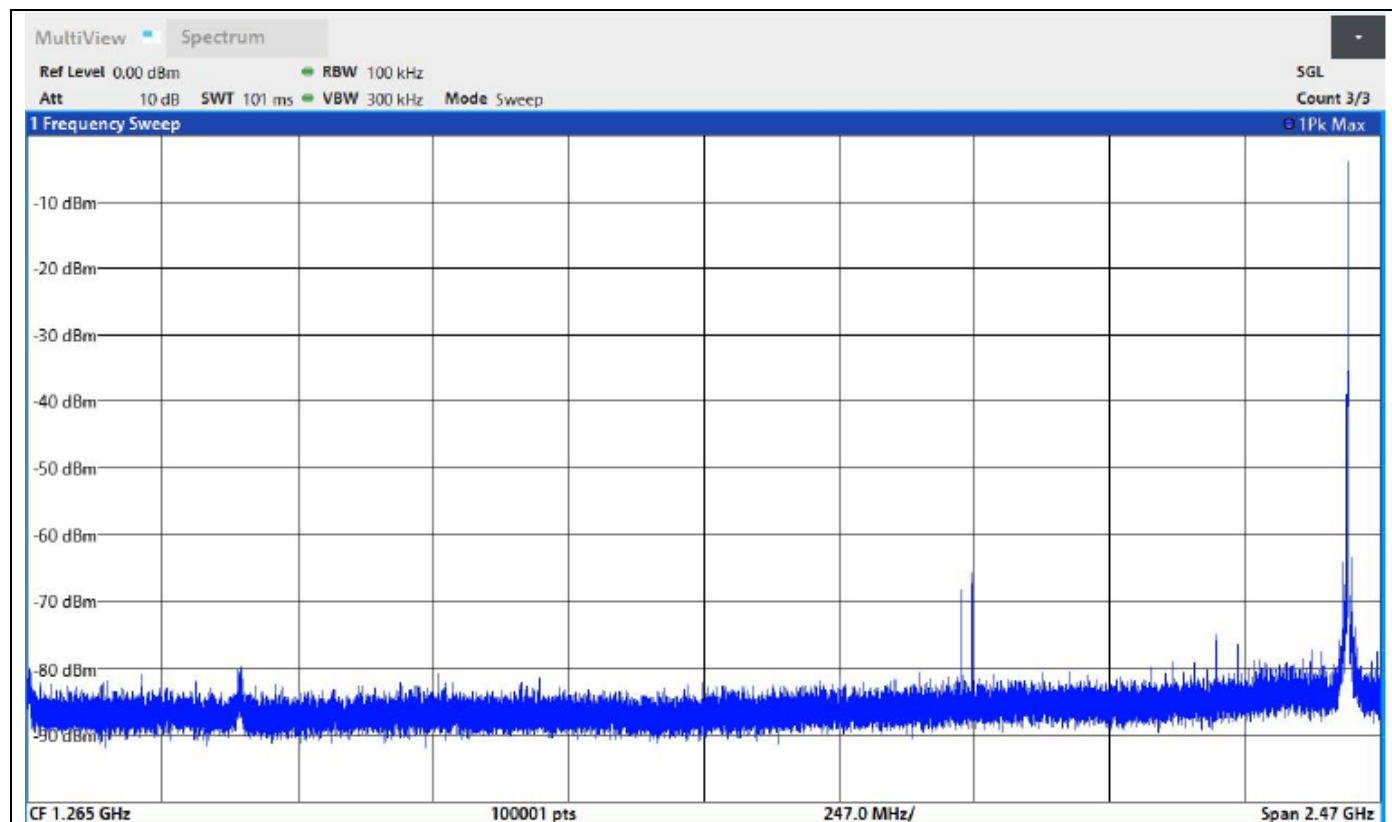
CH19-2440MHz

Pre Measurement

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)
1753.857511	-57.1	41.1	-16.0
1753.882211	-57.1	41.1	-16.0
1753.906911	-57.6	41.7	-16.0
1753.832812	-57.9	41.9	-16.0
1753.931611	-58.6	42.6	-16.0
1753.981010	-58.6	42.7	-16.0
1753.956310	-58.7	42.7	-16.0
1754.005710	-58.9	42.9	-16.0
1736.073689	-59.6	43.7	-16.0
1736.048990	-59.8	43.9	-16.0
1736.098389	-60.0	44.0	-16.0
1753.808112	-60.3	44.4	-16.0
1754.030410	-60.4	44.4	-16.0
1736.024290	-61.7	45.7	-16.0
1736.123089	-62.5	46.5	-16.0

Spurious



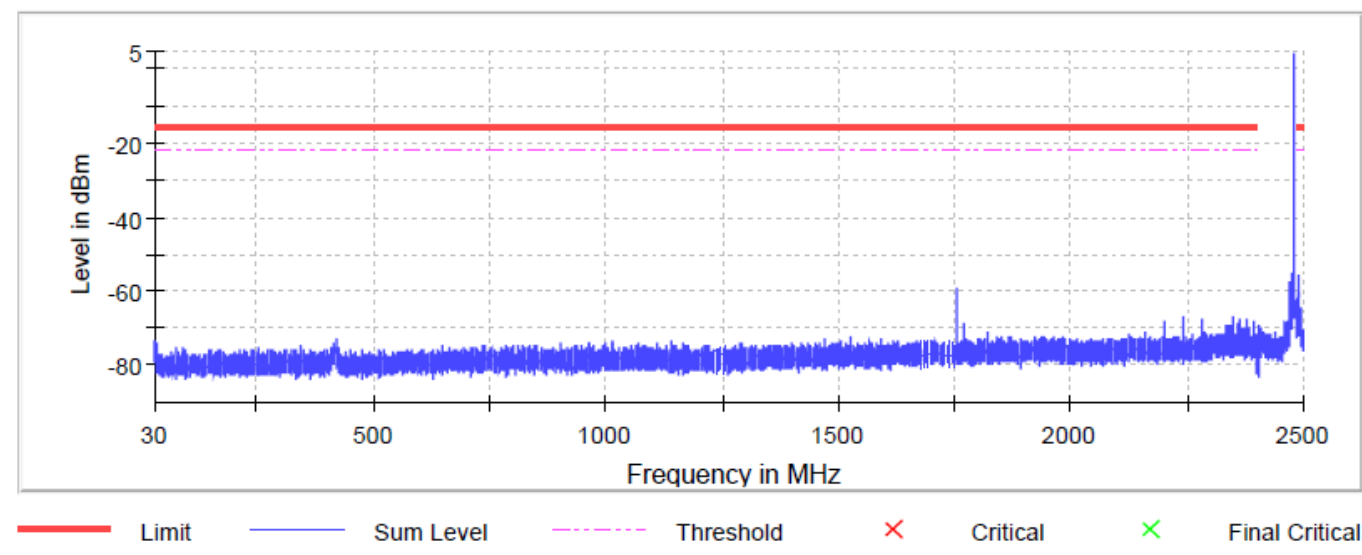


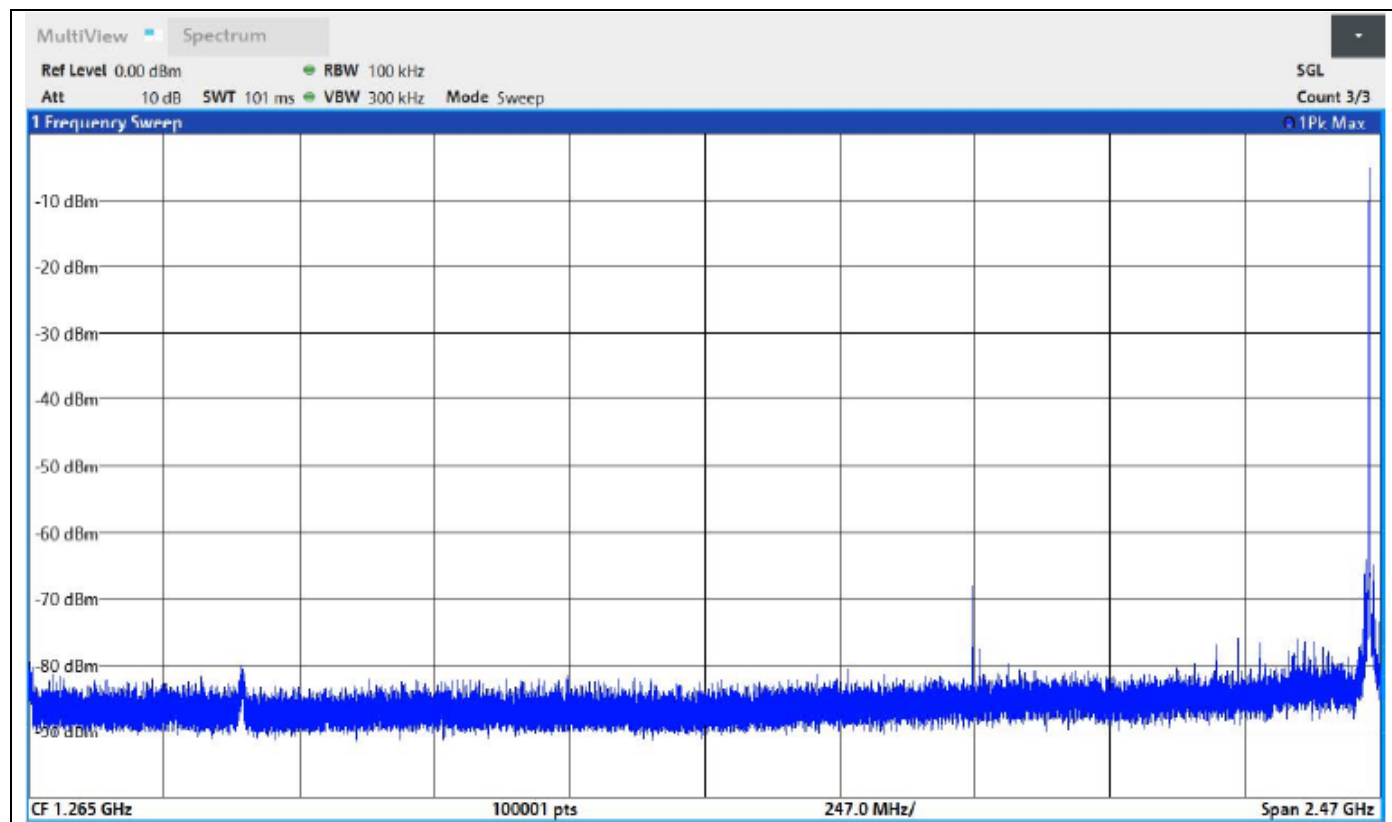
CH39-2480MHz

Pre Measurement

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)
2487.489575	-55.8	39.9	-15.9
2487.464875	-55.8	40.0	-15.9
2487.514275	-56.5	40.6	-15.9
2487.440176	-57.0	41.1	-15.9
2487.538975	-57.8	41.9	-15.9
2487.563674	-57.8	41.9	-15.9
2487.390776	-58.0	42.2	-15.9
2487.415476	-58.0	42.2	-15.9
2487.588374	-58.9	43.1	-15.9
2487.366076	-59.2	43.4	-15.9
1753.882211	-59.3	43.5	-15.9
1753.906911	-59.4	43.6	-15.9
2488.428166	-60.0	44.2	-15.9
2487.958870	-60.1	44.2	-15.9
2487.934171	-60.1	44.2	-15.9

Spurious



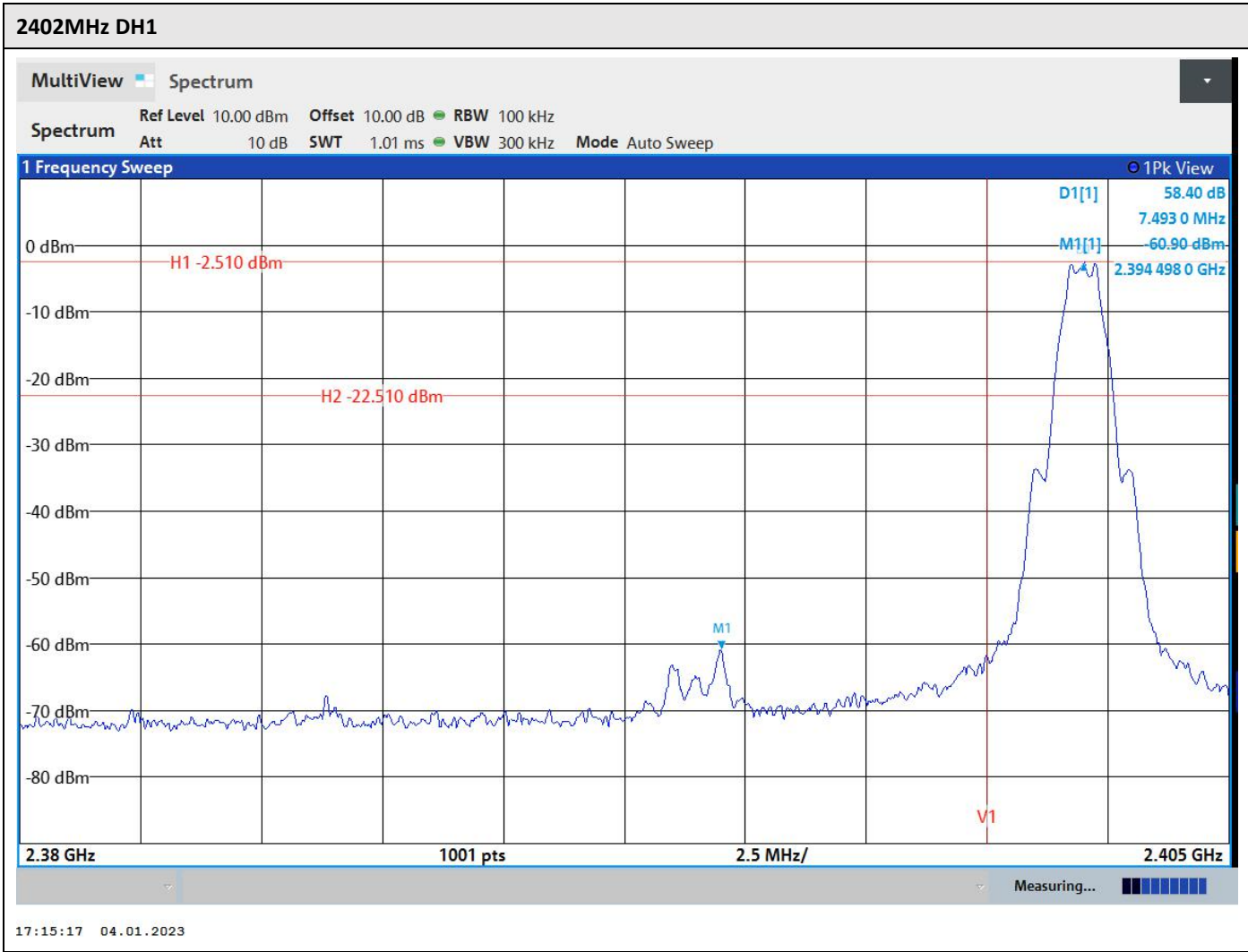


4.4.6 Band Edge Low (2402 MHz)

Test according to FCC title 47 part 15 §15.247(d), RSS-247 Section 5.5, KDB 558074 D01 DTS Meas Guidance v05r02 and ANSI C63.10-2013 11.11.3

Measurement uncertainty calculated in accordance with ETSI TR 100 028-1. Expanded Uncertainty (K=2) < 0.8 dB

Data Rate	Frequency (MHz)	Level(dBm)
1MHz	2394.4980	-2.5

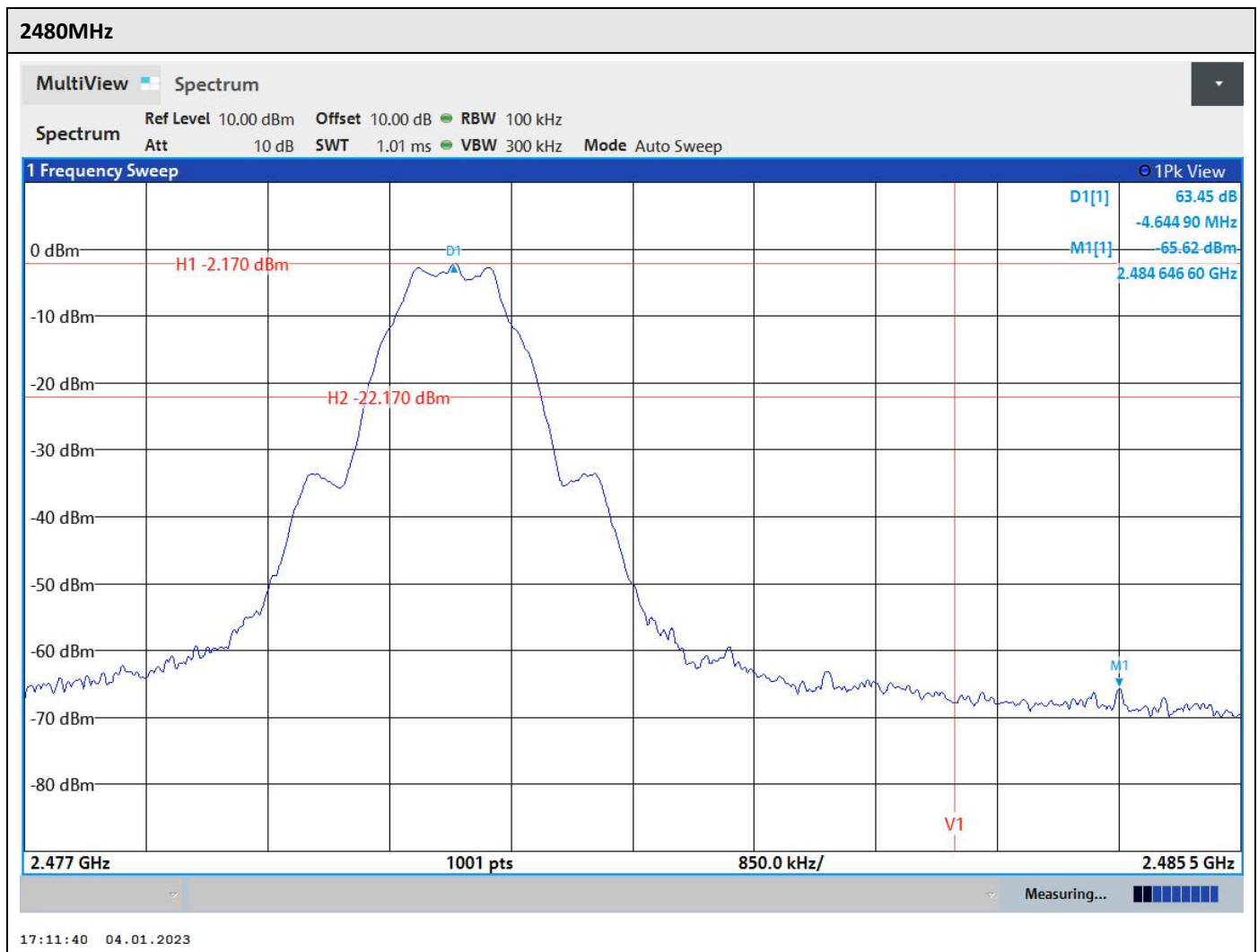


4.4.7 Band Edge High (2480 MHz)

Test according to FCC title 47 part 15 §15.247(d), RSS-247 Section 5.5, KDB 558074 D01 DTS Meas Guidance v05r02 and ANSI C63.10-2013 11.11.3

Measurement uncertainty calculated in accordance with ETSI TR 100 028-1. Expanded Uncertainty (K=2) < 0.8 dB

Data Rate	Frequency (MHz)	Level(dBm)
1MHz	2484.64660	-2.1



5. Radiated Testing

5.1 Test Summary

Start: 12/21/2022	End: 02/28/2023	Temperature: 23.2°C Humidity: 23.3 %R.H	Initials: AB
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DUT S/N	AH22120901-HAR-054#2		DUT Operating Mode	BLE
Comment	1MHz			
Antenna	Frequency Range	Polarization	Result Over/Under Limit	Notes
Loop	9kHz-30MHz	Parallel	☐ Over ☒ Under	√
		Perpendicular	☐ Over ☒ Under	√
		Ground-Parallel	☐ Over ☒ Under	√
Log Periodic	30MHz-1GHz	Horizontal	☐ Over ☒ Under	√
		Vertical	☐ Over ☒ Under	√
Horn	1GHz-18GHz	Horizontal	☐ Over ☒ Under	√
		Vertical	☐ Over ☒ Under	√
Horn	18GHz-27.5GHz	Horizontal	☐ Over ☒ Under	√
		Vertical	☐ Over ☒ Under	√

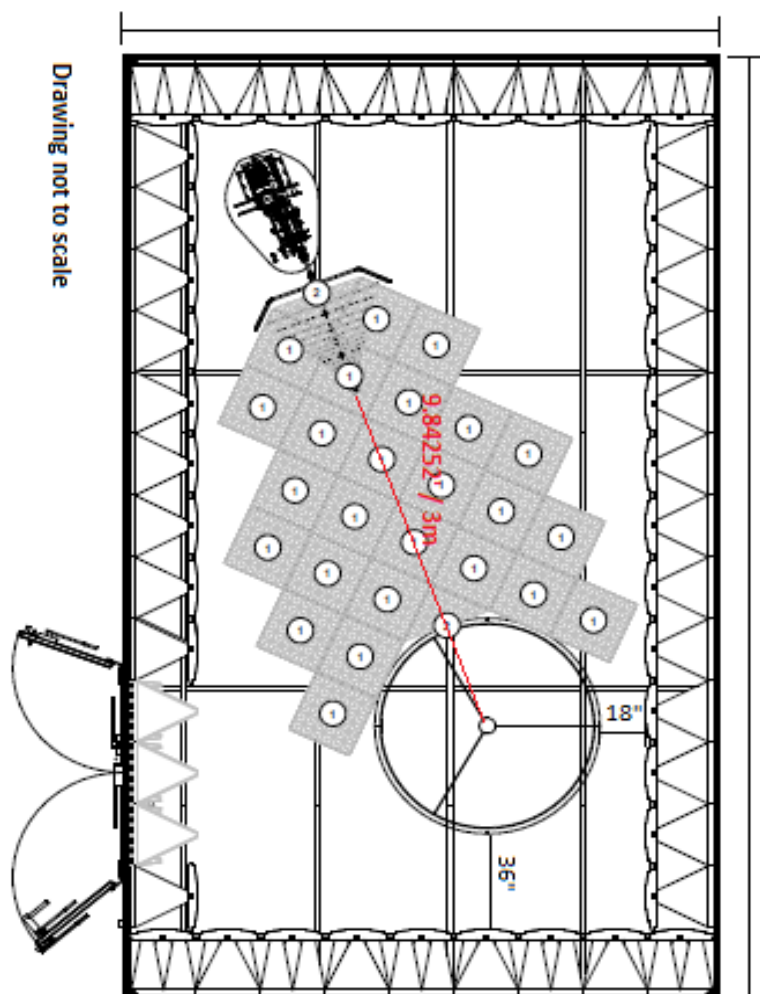
Notes: √ meets the requirements of the acceptance criteria.

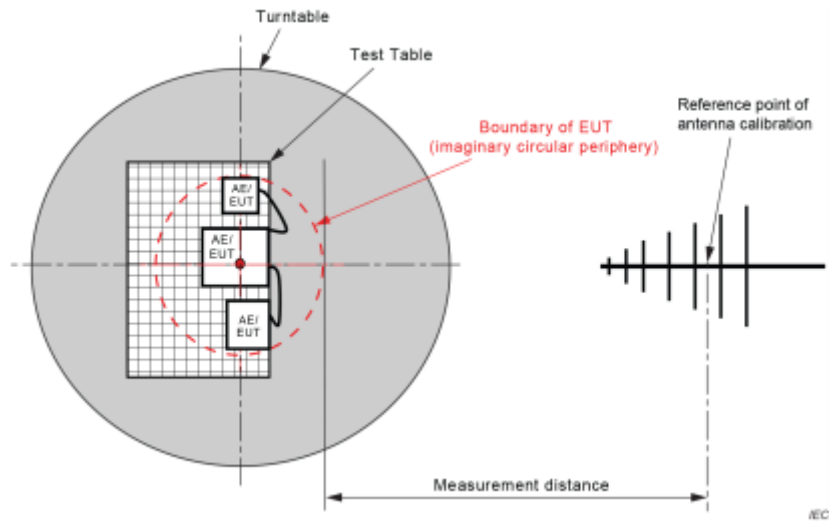
5.2 Test Setup

Semi-Anechoic Chamber Test Site-3 meter

Chamber Location	815 N Opdyke Rd Auburn Hills, Michigan 48326
Chamber Manufacturer:	ETS-Lindgren
Chamber Type	Semi-Anechoic
Model	FACT™ 3-2.0 Plus
Chamber Dimensions (L x W x H)	18'x18'x30'
Quiet Zone Diameter	2.0 meters
Quiet Zone Test Heights	1 & 2 meters (front only)
Test Distance	3.0 meters
Test Frequency Range	1-40 GHz
Measured Performance	4.87 dB Site sVSWR

Chamber Dimensions





5.3 Test Equipment Used

ID #	Equipment	Manufacturer	Model #	Serial #	Cal Due
BVD0217	Receiver 2Hz-44GHz	Rohde & Schwarz	ESW44	101871	4/20/2023
BVD0118	Antenna Mast Position Controller	ETS	7006-001	00214778/00 214648	N/A
BVD0111	3 Meter Anechoic Chamber	ETS	N/A	N/A	N/A
BVD0247	Turn Table	ETS	920250	N/A	N/A
BVD0323	Foam Test Table For 3 Meter Chamber	ETS-Lindgren	LDT-1.5	N/A	N/A
BVD0069	Bore Sight Tower	ETS	2171B	226732	N/A
BVD0259	Optima 12V Blue top Marine battery	Optima	D34M	N/A	N/A
BVD0184	Preamplifier 29dB 1-18GHz	Rohde & Schwarz	TS-PR18	101646	5/6/2023
BVD0185	Preamplifier 45dB 18-40GHz	Rohde & Schwarz	TS-PR1840	100064	4/6/2023
BVD0267	Double Ridge Waveguide 800MHz-18GHz	Rohde & Schwarz	HF907	102832	5/5/2023
BVD0021	UltraLog Antenna 30-6000 MHz	Rohde & Schwarz	HL562E	101113	7/21/2023
BVD0320	18-40GHz Horn Antenna	L3 Narda ATM	PNR 180-442-KF	136164-01	4/4/2023
BVD0011	Loop Antenna 9kHz-30MHz	Rohde & Schwarz	FMZB1519B	145	5/4/2023
BVD0045	Field Probe Mast	Rohde & Schwarz	TS-FPMA	N/A	N/A
BVD0480	Band Reject Filter 50dB from 2400 to 2500MHz	Micro-Tronics	BRM50702	G482	4/11/2023
BVD0394	Double Shielded N-Type Cable 6.9 Meter	Rohde & Schwarz	N-Type	N/A	3/11/2023
BVD0398	Double Shielded N-Type Cable 2 Meter	Rohde & Schwarz	N-Type	N/A	12/29/2024
BVD0486	Sucoflex K-Type Coaxial Cable 5 Meter	Huber+Suhner, inc	K-Type Coaxial	474343	8/30/2023
BVD0407	Double Shielded N-Type Cable 410mm (For PreAmp)	Rohde & Schwarz	N-Type	N/A	8/31/2023
BVD0495	SMA Shielded Cable approx 100mm (for Pre-Amp)	Rohde & Schwarz	SMA-Type	N/A	4/6/2023
BVD0552	Double Shielded N-Type Cable 440mm (For PreAmp)	Electronic Assemblies	N-Type	N/A	5/7/2023
BVD0229	Temp and Humidity Meter	Fluke	971	12001009	5/1/2023

Equipment List (Software)

ID #	Equipment	Manufacturer	Model	Version No.	
N/A	EMC Test Software	Rodhe & Schwarz	EMC32	11.20.00	N/A

Customer Supplied Equipment

ID #	Equipment	Manufacturer	Model	Serial #	Version No.
N/A	Harness	Harman	N/A	N/A	N/A
N/A	Display Unit	Innolux Corp	INFOMM-15524	0024	N/A
N/A	Ethernet Board	GM	N/A	N/A	CSMate rev.4
N/A	GM BT WLAN Test Tool NXP Chips S/W	Harman	N/A	N/A	2.4

5.4 Test Limits and Procedures

Radiated emissions that fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a). Other emissions shall be at least 20dB below the highest level of the desired power.

Frequencies (MHz)	Field strength ($\mu\text{V/m}$)	Field strength (dB $\mu\text{V/m}$)	Measurement distance (meters)
0.009 ~ 0.490	2400/F(kHz)	48.5 - 13.8	300
0.490 ~ 1.705	24000/F(kHz)	33.8 - 23	30
1.705 ~ 30.0	30	29.54	30
30 ~ 88	100	40.0	3
88 ~ 216	150	43.5	3
216 ~ 960	200	46.0	3
Above 960	500	54.0	3

Note:

- The lower limit shall apply at the transition frequencies.
- As per 15.35(b), for frequencies above 1000MHz, the field strength limits based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20dB under any condition of modulation.
- For performing measurements at a specified distance of 3m, the values are extrapolated using extrapolation factor.
Frequencies below 30MHz are extrapolated using 40dB/decade.
Frequencies above 30MHz are extrapolated using 20dB/decade.

Frequencies (MHz)	Formula for Limits derivation for below 30MHz	Limits for frequencies below 30MHz (dB $\mu\text{V/m}$)
0.009 ~ 0.490	$2400/F(\text{kHz}) + 40 \text{ Log } (300\text{m}/3\text{m})$	128.5 ~ 93.8
0.490 ~ 1.705	$24000/F(\text{kHz}) + 40 \text{ Log } (30\text{m}/3\text{m})$	73.8 ~ 62.96
1.705 ~ 30.0	$29.54 + 40 \text{ Log } (30\text{m}/3\text{m})$	69.54

The limits in CFR 47, Part 15, Subpart C, paragraph 15.209 (a), are identical to those in RSS-GEN Section 8.9, Table 6, since the measurements are performed in terms of magnetic field strength and converted to electric field strength levels (as reported in the table) using the free space impedance of 377Ω .

For example, the measurement frequency 2185KHz resulted in a level of 30.26 dB $\mu\text{V/m}$, which is equivalent to $30.26 - 51.48 = -21.22$ dB $\mu\text{A/m}$, which has the same margin, -39.28dB, to the corresponding RSS-GEN Table 6 limit as it has to the 15.209(a) limit.

The measurement procedures are as per ANSI C63.10-2013 Sections 6.3, Section 6.4, Section 6.5, and Section 6.6

1. The table height for emissions measurements
 - i) Below 1 GHz, the table height is 80 cm above the reference ground plane.
 - ii) Above 1 GHz, the table height is 1.5 m
2. Radiated emission tests are performed in the frequency range
 - i) 9 kHz to 30 MHz, using a calibrated loop antenna
 - ii) 30 MHz to 1GHz, using a calibrated log antenna
 - iii) Above 1 GHz using a calibrated horn antenna
3. Measurements performed with the EUT rotated from 0° to 360°, the antenna height scanned between 1m and 4 m, and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations.

5.5 Test Plots

Uncertainty

Radiated Emissions (30MHz to 40GHz)

Test Engineer Initials: AB

The test is to measure the radiated emissions of the EUT. Some error sources that can contribute to the total uncertainty:

- Uncertainty of the receiver
- Uncertainty of the antenna
- Uncertainty of cables
- Uncertainty due to the mismatches
- NSA Calibration
- Etc., details see the below table

30MHz to 1GHZ

Source of Uncertainty	Value (dB)	ProbabilityDistribution	Division	Sensitivity Coefficient	Expanded Uncertainty
Receiver Reading	0.12	Rectangular	1.732	1	0.069284
Cable Insertion Loss	0.21	Normal	2	1	0.105
Filter Insertion Loss	0.25	Normal	2	1	0.125
Antenna Factor	0.65	Normal	2	1	0.325
Receiver CW accuracy	0.5	Rectangular	1.732	1	0.2886836
Pulse Amplitude Response	1.5	Rectangular	1.732	1	0.86605081
PRF Response	1.5	Rectangular	1.732	1	0.86605081
Mismatch Filter – Receiver	0.25	U-Shape	2.449	1	0.1768033
NSA Calibration	4.0	Triangular	1.414	1	1.633332
ETS Foam Table (LDT-1.5)	1.8	Rectangular	1.732	1	1.039261
Combined Standard Uncertainty (square root of the sum of the squares)					2.113781
Expanded Uncertainty (K=2)					4.227562

The total derived measurement uncertainty is +/- 4.228 dB

1GHz to 40GHz

Source of Uncertainty	Value (dB)	Probability Distribution	Division	Sensitivity Coefficient	Expanded Uncertainty
Receiver Reading	0.12	Rectangular	1.732	1	0.069284
Cable Insertion Loss	0.21	Normal	2	1	0.105000
Filter Insertion Loss	0.25	Normal	2	1	0.125000
Antenna Factor	0.65	Normal	2	1	0.325000
Receiver CW accuracy	0.5	Rectangular	1.732	1	0.2886836
Pulse Amplitude Response	1.5	Rectangular	1.732	1	0.866051
PRF Response	1.5	Rectangular	1.732	1	0.866051
Mismatch Filter – Receiver	0.25	U-Shape	1.414	1	0.176803
VSWR Calibration	2.0	Triangular	2.449	1	0.816659
ETS Foam Table (LDT-1.5)	1.8	Rectangular	1.732	1	1.039261
Combined Standard Uncertainty (square root of the sum of the squares)					1.869213
Expanded Uncertainty (K=2)					3.738426

The total derived measurement uncertainty is +/- 3.738 dB.

Remarks:

1. Level Q-Peak Reading (dBμV/m) = Raw Q-Peak Level + Correction Factor
2. Correction Factor (dB) = Antenna Factor + Cable Loss – Preamplifier Gain
3. Margin = Level Q-Peak Reading – Limit

Remarks:

1. Level Peak Reading (dBμV/m) = Raw Peak Level + Correction Factor
2. Correction Factor (dB) = Antenna Factor + Cable Loss – Preamplifier Gain
3. Margin = Level Peak Reading – Limit

Remarks:

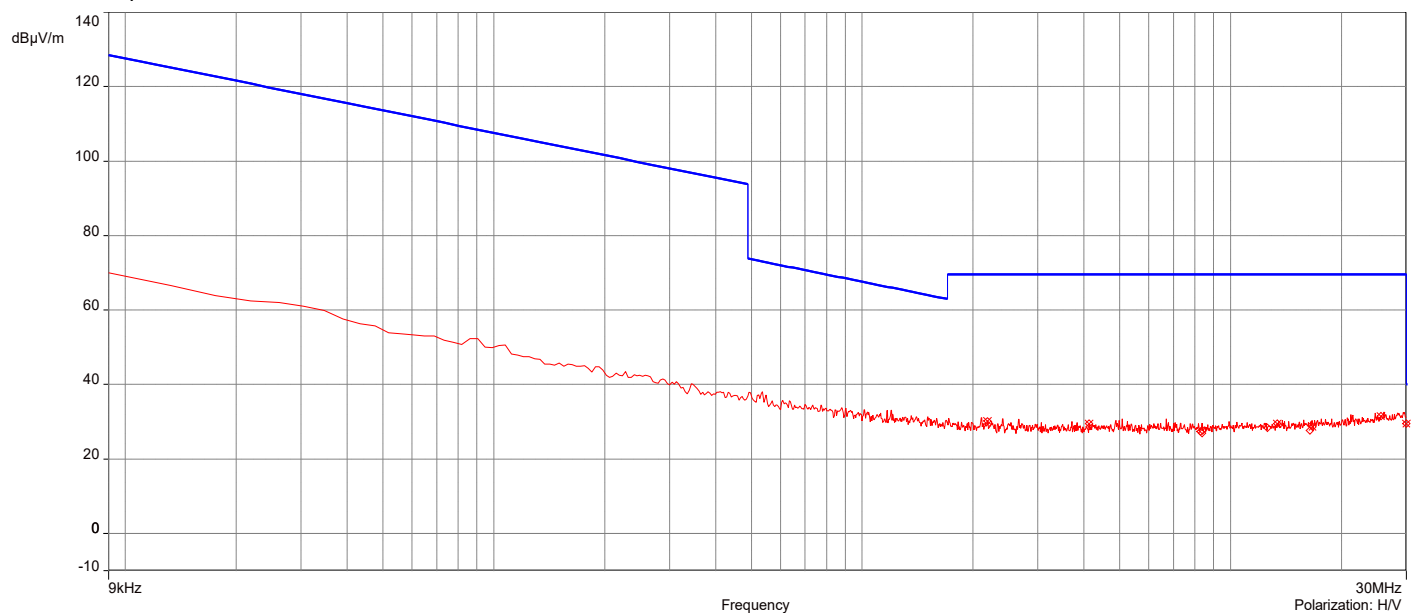
1. Level Average Reading (dBμV/m) = Raw Average Level + Correction Factor
2. Correction Factor (dB) = Antenna Factor + Cable Loss – Preamplifier Gain
3. Margin = Level Average Reading – Limit

AH22120901-HAR-054#2_BLE_Ch 19_1MHz_9kHz-30MHz_Ground-Parallel

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No	Frequency (MHz)	Level Q-Peak Reading (dBμV/m)	Correction Factor (dB)	Limit dBμV/m	Margin (dB)	Height (m)	Angle (°)	Polarization	Judgement
1.	2.185801MHz	30.26	19.49	69.54	-39.28	1.00	155.30	H/V	Passed
2.	4.126924MHz	29.54	19.69	69.54	-40.00	1.00	30.50	H/V	Passed
3.	13.399752MHz	29.45	19.85	69.54	-40.09	1.00	274.30	H/V	Passed
4.	16.694949MHz	28.62	19.92	69.54	-40.92	1.00	103.90	H/V	Passed
5.	25.560698MHz	31.52	20.98	69.54	-38.02	1.00	205.00	H/V	Passed
6.	30MHz	29.53	21.85	40.00	-10.47	1.00	242.40	H/V	Passed

Overall Graphs:

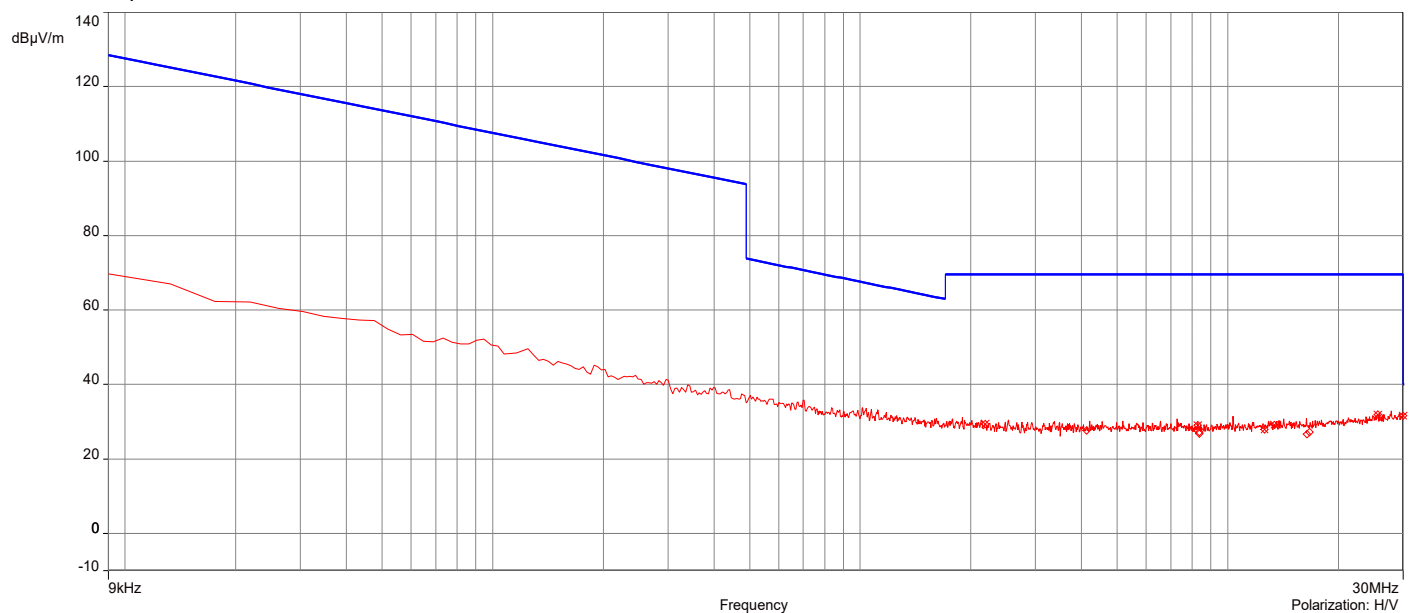


AH22120901-HAR-054#2_BLE_Ch 19_1MHz_9kHz-30MHz_Parallel

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No	Frequency (MHz)	Level Q-Peak Reading (dBμV/m)	Correction Factor (dB)	Limit dBμV/m	Margin (dB)	Height (m)	Angle (°)	Polarization	Judgement
1.	2.190086MHz	29.40	19.49	69.54	-40.14	1.00	262.70	H/V	Passed
2.	8.291984MHz	29.04	19.45	69.54	-40.50	1.00	64.60	H/V	Passed
3.	12.577024MHz	27.96	19.83	69.54	-41.58	1.00	10.90	H/V	Passed
4.	13.378327MHz	29.15	19.85	69.54	-40.39	1.00	149.30	H/V	Passed
5.	25.599263MHz	31.97	20.99	69.54	-37.57	1.00	336.70	H/V	Passed
6.	30MHz	31.58	21.85	40.00	-8.42	1.00	326.10	H/V	Passed

Overall Graphs:

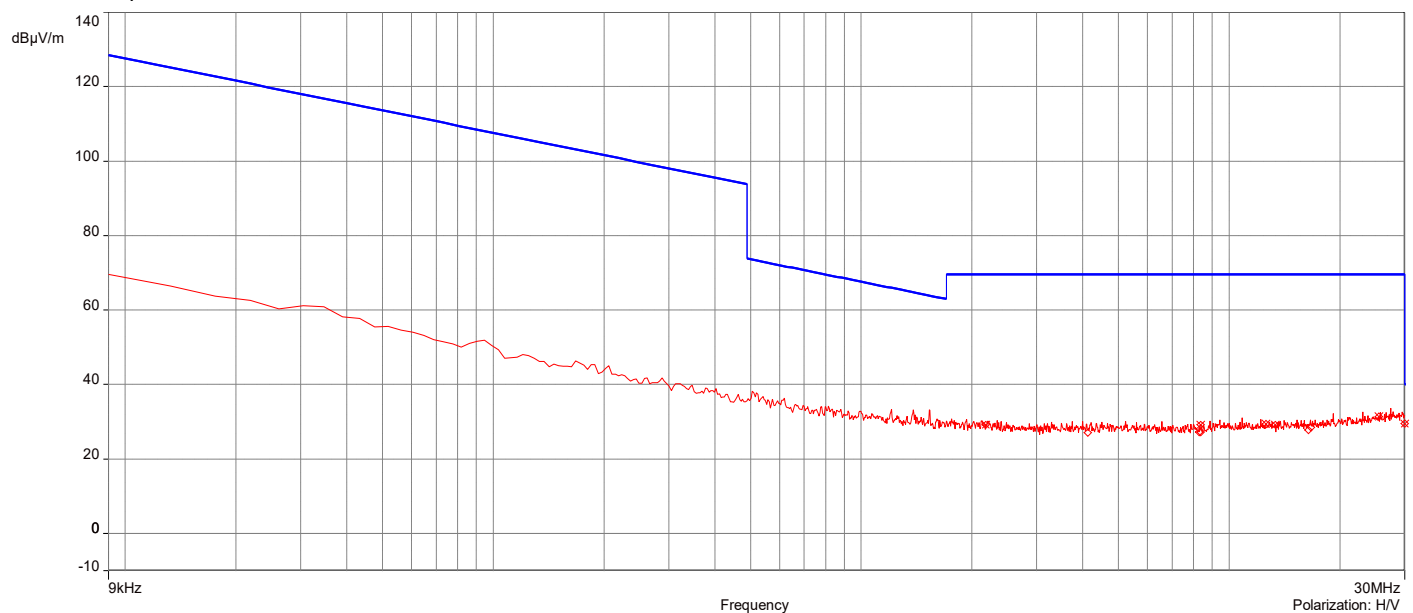


AH22120901-HAR-054#2_BLE_Ch 19_1MHz_9kHz-30MHz_Perpendicular

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No	Frequency (MHz)	Level Q- Peak Reading (dBμV/m)	Correction Factor (dB)	Limit dBμV/m	Margin (dB)	Height (m)	Angle (°)	Polarization	Judgement
1.	2.181516MHz	29.26	19.49	69.54	-40.28	1.00	260.00	H/V	Passed
2.	8.364829MHz	29.17	19.45	69.54	-40.37	1.00	134.10	H/V	Passed
3.	12.577024MHz	29.36	19.83	69.54	-40.18	1.00	6.90	H/V	Passed
4.	13.361187MHz	29.19	19.85	69.54	-40.35	1.00	39.30	H/V	Passed
5.	25.526417MHz	31.33	20.98	69.54	-38.21	1.00	143.60	H/V	Passed
6.	30MHz	29.46	21.85	40.00	-10.54	1.00	39.30	H/V	Passed

Overall Graphs:

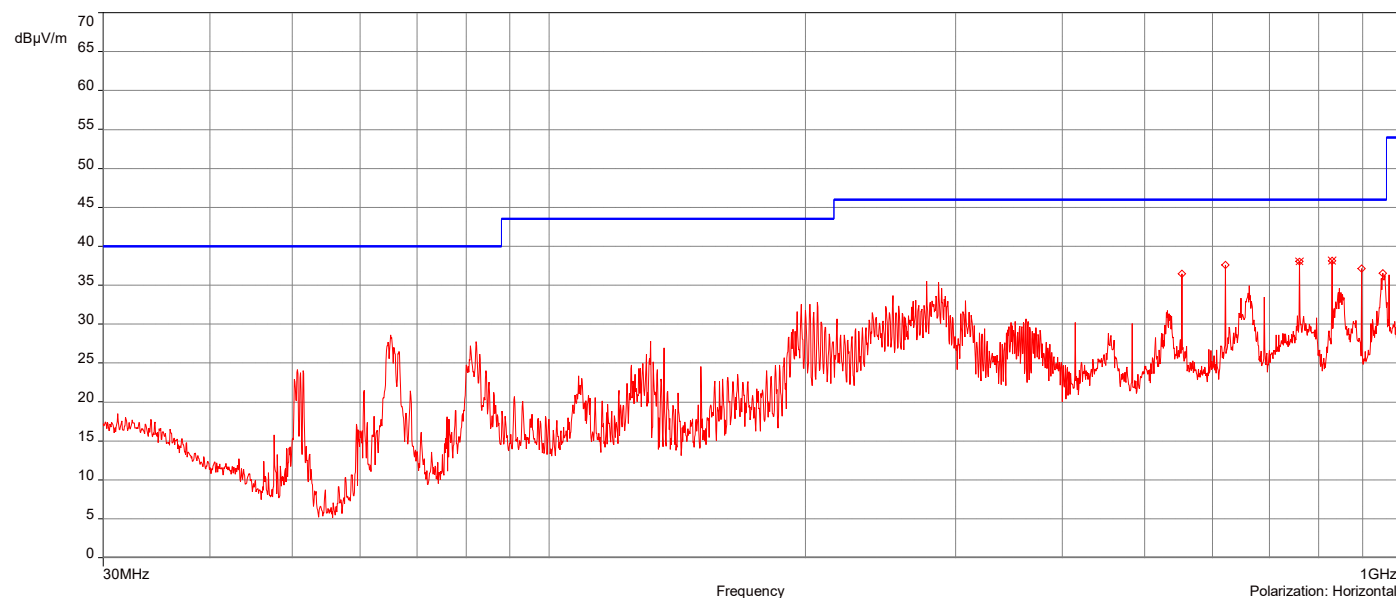


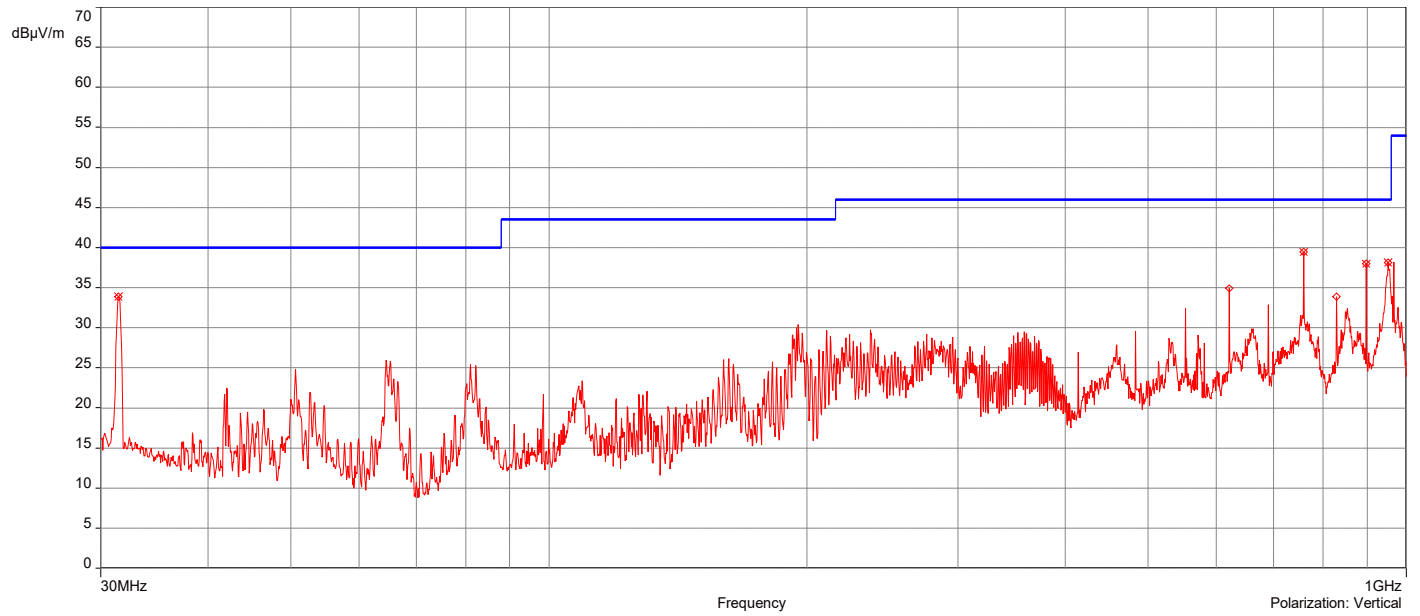
AH22120901-HAR-054#2_BLE_1MHz_Ch 19_30MHz-1GHz

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No	Frequency (MHz)	Level Q- Peak Reading (dBμV/m)	Correction Factor (dB)	Limit dBμV/m	Margin (dB)	Height (m)	Angle (°)	Polarization	Judgement
1.	31.483617MHz	33.89	-7.45	40.00	-6.11	1.75	13.00	Vertical	Passed
2.	759.59704MHz	39.47	-3.28	46.00	-6.53	1.25	155.80	Vertical	Passed
3.	897.68751MHz	38.00	-1.68	46.00	-8.00	1.00	138.80	Vertical	Passed
4.	952.41014MHz	38.11	-1.07	46.00	-7.89	1.25	15.10	Vertical	Passed
5.	759.59704MHz	38.08	-2.18	46.00	-7.92	1.25	68.90	Horizontal	Passed
6.	828.64227MHz	38.14	-0.86	46.00	-7.86	1.00	67.40	Horizontal	Passed

Overall Graphs:





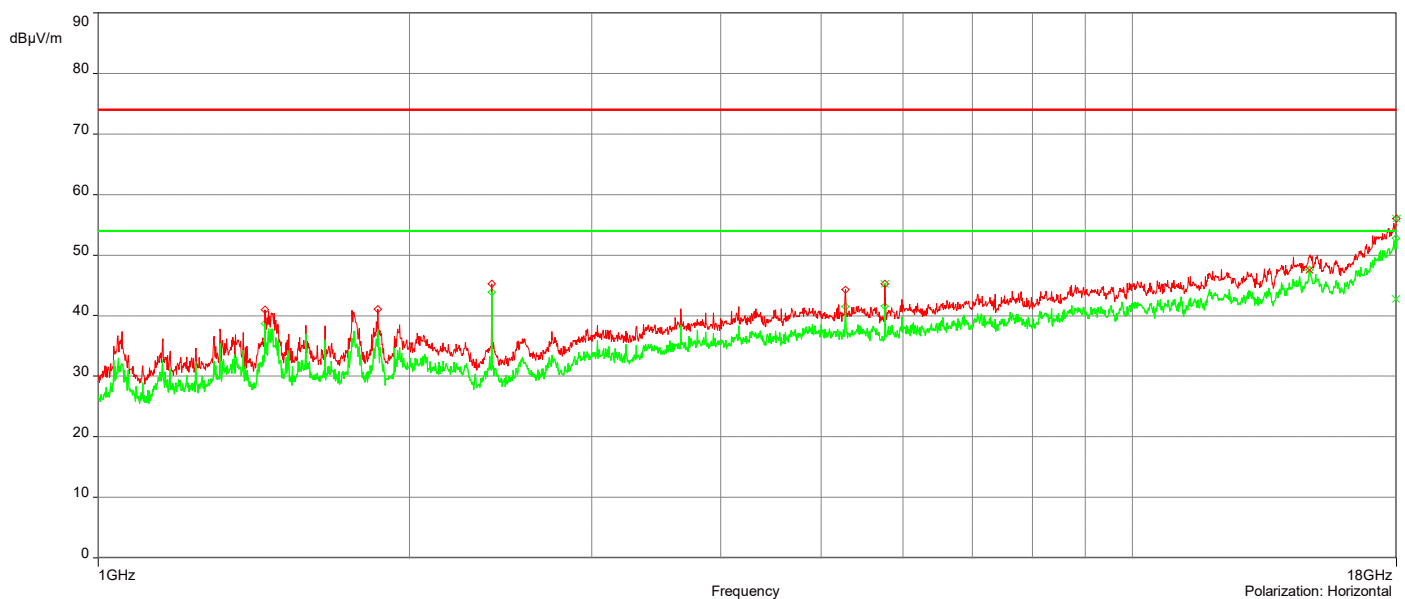
AH22120901-HAR-054#2_BLE_1MHz_Ch 0_1-18GHz

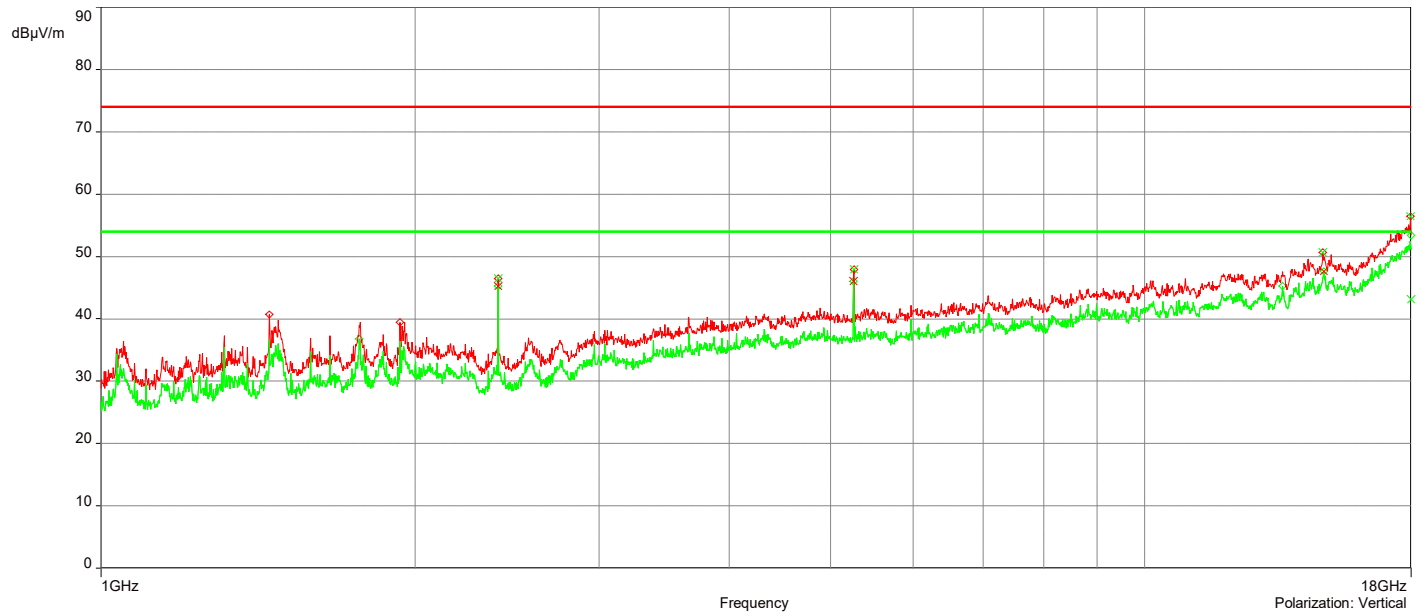
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No	Frequency (MHz)	Level Peak Reading (dBμV/m)	Correction Factor (dB)	Limit dBμV/m	Margin (dB)	Height (m)	Angle (°)	Polarization	Judgement
1.	2.4020412GHz	46.43	-1.99	74.00	-27.57	1.00	237.40	Vertical	Passed
2.	5.2636254GHz	47.89	4.41	74.00	-26.11	1.00	357.20	Vertical	Passed
3.	14.821407GHz	50.67	15.56	74.00	-23.33	2.50	306.90	Vertical	Passed
4.	17.989GHz	56.43	21.50	74.00	-17.57	1.00	223.20	Vertical	Passed
5.	5.7641401GHz	45.23	4.60	74.00	-28.77	4.00	175.10	Horizontal	Passed
6.	17.993GHz	56.05	21.58	74.00	-17.95	3.50	223.60	Horizontal	Passed

No	Frequency (MHz)	Level Average Reading (dBμV/m)	Correction Factor (dB)	Limit dBμV/m	Margin (dB)	Height (m)	Angle (°)	Polarization	Judgment
1.	2.4015412GHz	45.29	-1.99	54.00	-8.71	1.00	243.00	Vertical	Passed
2.	5.2626254GHz	46.08	4.41	54.00	-7.92	1.00	357.20	Vertical	Passed
3.	14.852907GHz	47.67	15.32	54.00	-6.33	2.00	208.80	Vertical	Passed
4.	17.995GHz	43.16	21.65	54.00	-10.84	2.00	152.10	Vertical	Passed
5.	14.824907GHz	47.55	15.70	54.00	-6.45	2.00	201.20	Horizontal	Passed
6.	17.99GHz	42.74	21.50	54.00	-11.26	3.00	190.90	Horizontal	Passed

Overall Graphs:





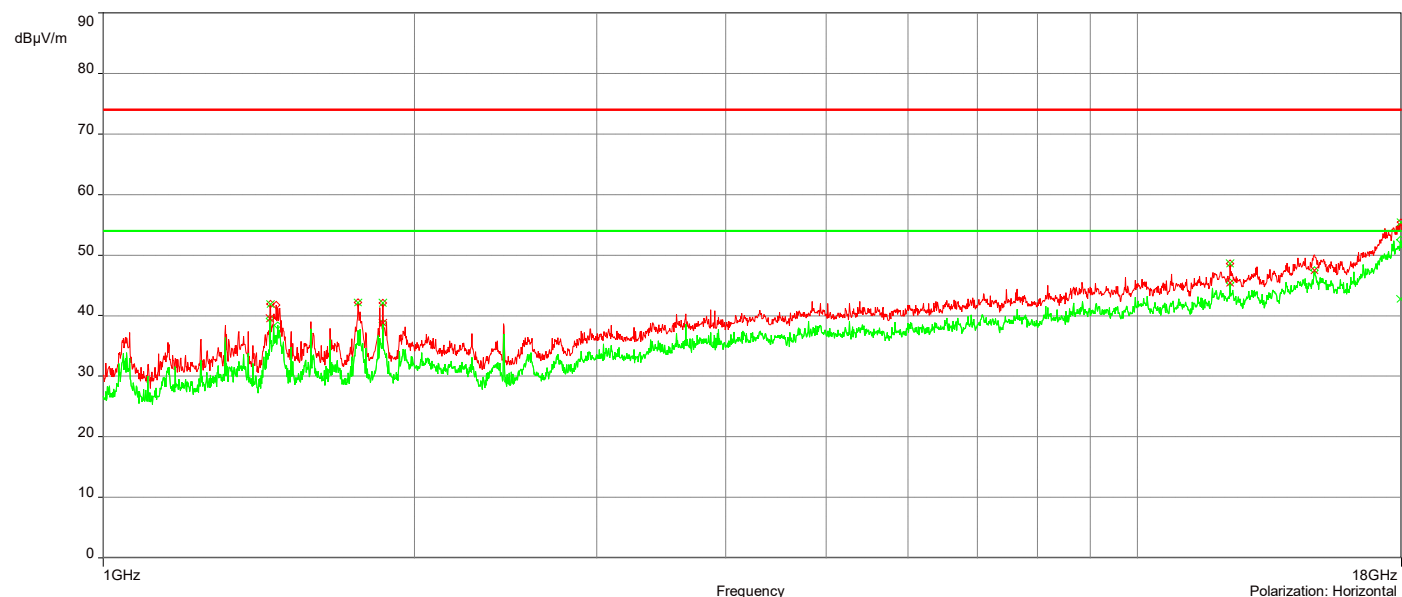
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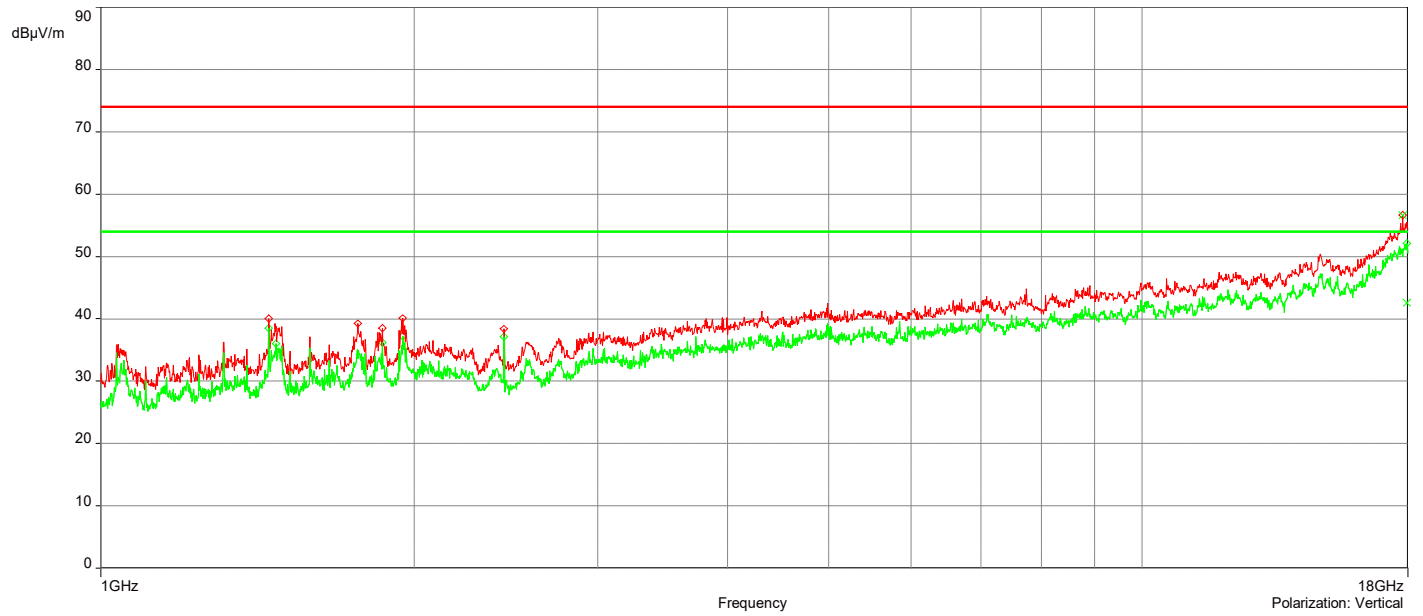
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No	Frequency (MHz)	Level Peak Reading (dBμV/m)	Correction Factor (dB)	Limit dBμV/m	Margin (dB)	Height (m)	Angle (°)	Polarization	Judgement
1.	17.790994GHz	56.61	20.04	74.00	-17.39	1.50	82.00	Vertical	Passed
2.	1.4505132GHz	41.89	-7.02	74.00	-32.11	1.00	195.80	Horizontal	Passed
3.	1.7635225GHz	42.20	-4.81	74.00	-31.80	1.00	122.40	Horizontal	Passed
4.	1.8640254GHz	42.08	-4.24	74.00	-31.92	1.00	132.40	Horizontal	Passed
5.	12.295332GHz	48.61	11.61	74.00	-25.39	1.50	148.60	Horizontal	Passed
6.	17.9855GHz	55.48	21.38	74.00	-18.52	3.50	184.80	Horizontal	Passed

No	Frequency (MHz)	Level Average Reading (dBμV/m)	Correction Factor (dB)	Limit dBμV/m	Margin (dB)	Height (m)	Angle (°)	Polarization	Judgment
1.	17.955999GHz	42.64	21.02	54.00	-11.36	3.50	31.10	Vertical	Passed
2.	1.4500132GHz	39.53	-7.03	54.00	-14.47	1.00	195.80	Horizontal	Passed
3.	1.8640254GHz	38.86	-4.24	54.00	-15.14	1.00	132.40	Horizontal	Passed
4.	12.295332GHz	45.45	11.61	54.00	-8.55	1.50	148.60	Horizontal	Passed
5.	14.824407GHz	47.45	15.69	54.00	-6.55	2.50	191.60	Horizontal	Passed
6.	17.956999GHz	42.78	20.97	54.00	-11.22	3.00	163.10	Horizontal	Passed

Overall Graphs:





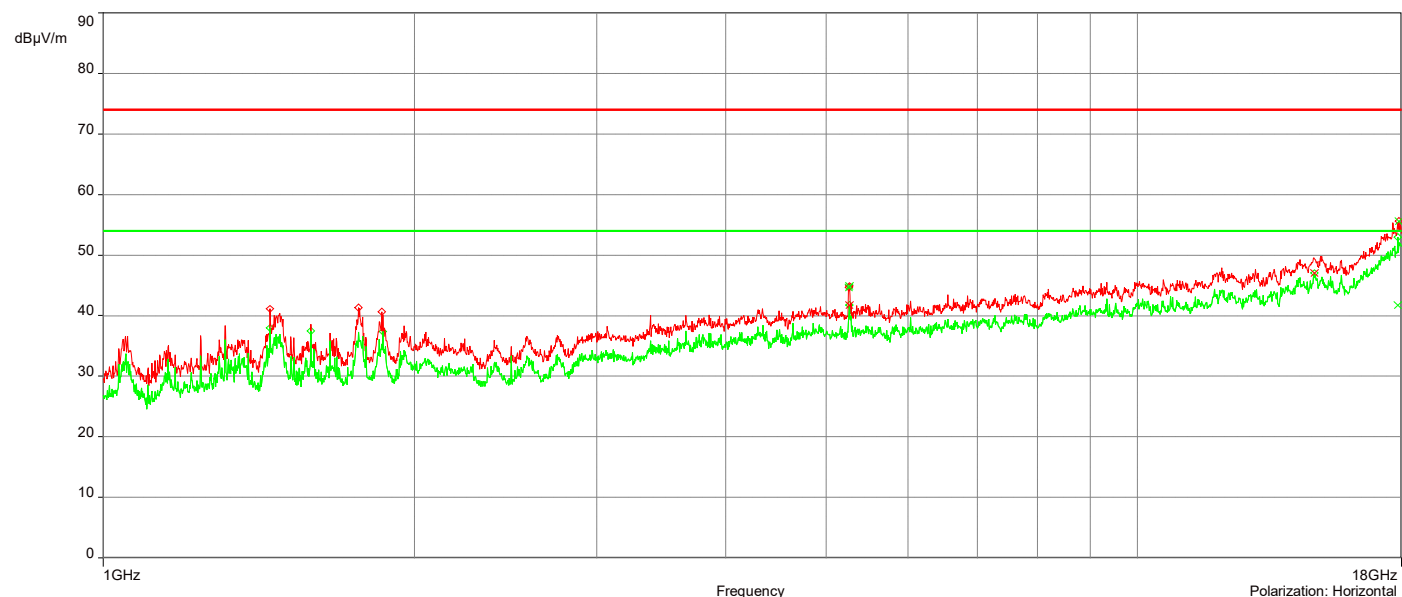
AH22120901-HAR-054#2_BLE_1MHz_Ch 39_1-18GHz

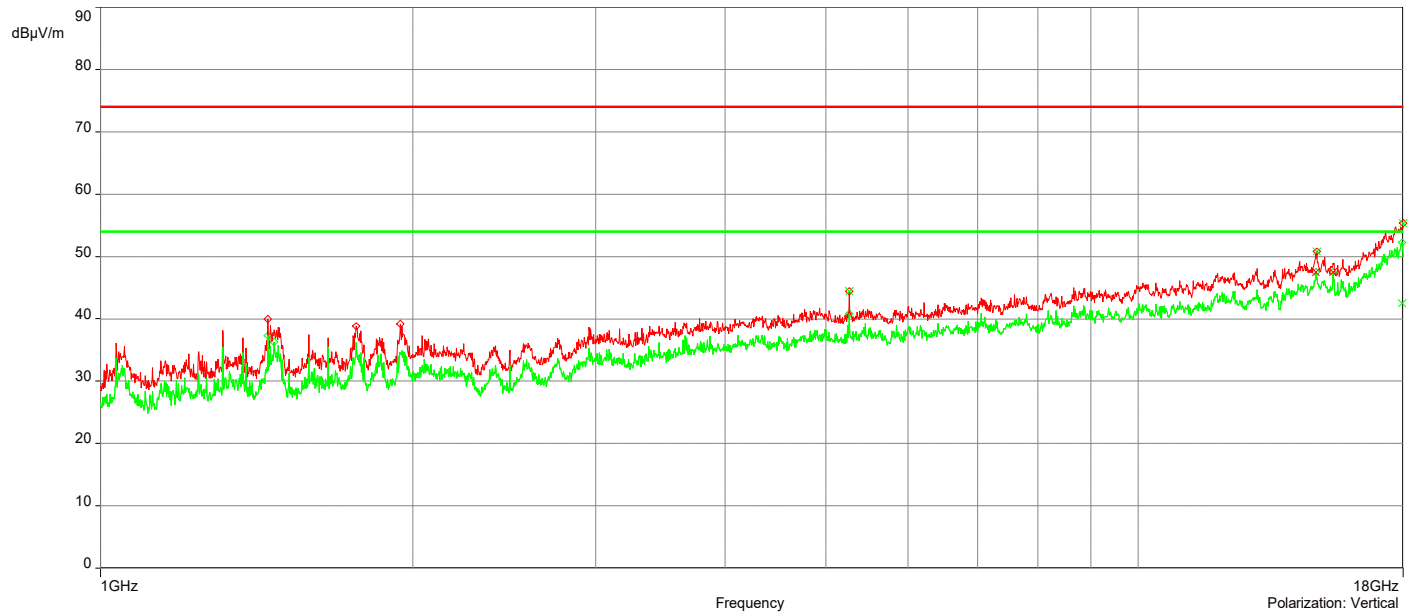
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No	Frequency (MHz)	Level Peak Reading (dBμV/m)	Correction Factor (dB)	Limit dBμV/m	Margin (dB)	Height (m)	Angle (°)	Polarization	Judgement
1.	5.2686255GHz	44.37	4.42	74.00	-29.63	1.50	299.40	Vertical	Passed
2.	14.858408GHz	50.81	15.24	74.00	-23.19	4.00	282.90	Vertical	Passed
3.	17.996GHz	55.32	21.68	74.00	-18.68	3.00	55.40	Vertical	Passed
4.	5.2596253GHz	44.68	4.42	74.00	-29.32	1.50	153.30	Horizontal	Passed
5.	5.2686255GHz	44.94	4.44	74.00	-29.06	2.00	77.30	Horizontal	Passed
6.	17.902497GHz	55.65	20.50	74.00	-18.35	4.00	164.40	Horizontal	Passed

No	Frequency (MHz)	Level Average Reading (dBμV/m)	Correction Factor (dB)	Limit dBμV/m	Margin (dB)	Height (m)	Angle (°)	Polarization	Judgment
1.	14.823907GHz	47.46	15.60	54.00	-6.54	1.00	75.40	Vertical	Passed
2.	15.408424GHz	47.46	14.32	54.00	-6.54	4.00	186.90	Vertical	Passed
3.	17.958499GHz	42.56	21.04	54.00	-11.44	1.50	2.10	Vertical	Passed
4.	5.2636254GHz	41.71	4.43	54.00	-12.29	2.00	77.30	Horizontal	Passed
5.	14.825407GHz	47.07	15.71	54.00	-6.93	3.50	74.40	Horizontal	Passed
6.	17.849996GHz	41.73	20.24	54.00	-12.27	3.00	271.10	Horizontal	Passed

Overall Graphs:





AH22120901-HAR-054#2_BLE_Ch 0_18-27.5GHz

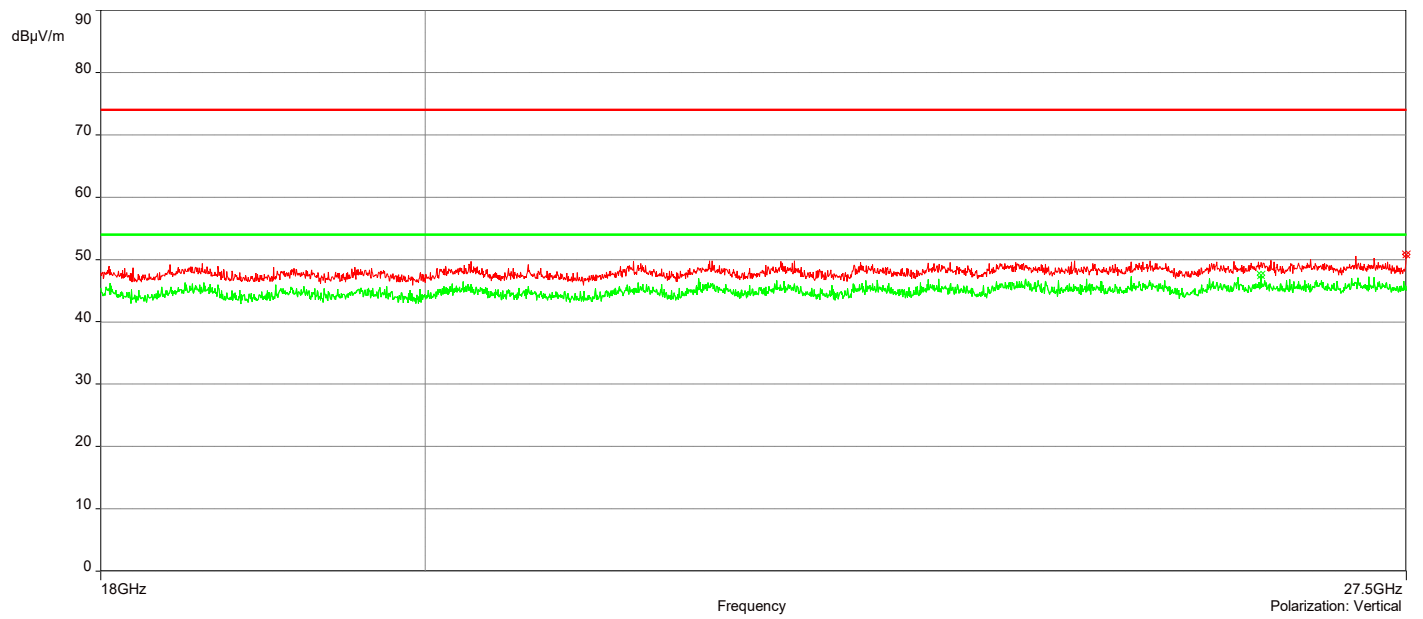
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No	Frequency (MHz)	Level Peak Reading (dBμV/m)	Correction Factor (dB)	Limit dBμV/m	Margin (dB)	Height (m)	Angle (°)	Polarization	Judgement
1.	27.49905GHz	50.85	5.40	74.00	-23.15	2.00	112.40	Vertical	Passed
2.	25.208485GHz	50.38	2.95	74.00	-23.62	2.36	44.90	Horizontal	Passed

No	Frequency (MHz)	Level Average Reading (dBμV/m)	Correction Factor (dB)	Limit dBμV/m	Margin (dB)	Height (m)	Angle (°)	Polarization	Judgment
1.	26.234537GHz	47.46	4.08	54.00	-6.54	2.45	359.90	Vertical	Passed
2.	26.682959GHz	47.87	4.32	54.00	-6.13	3.84	157.40	Horizontal	Passed

Overall Graphs:





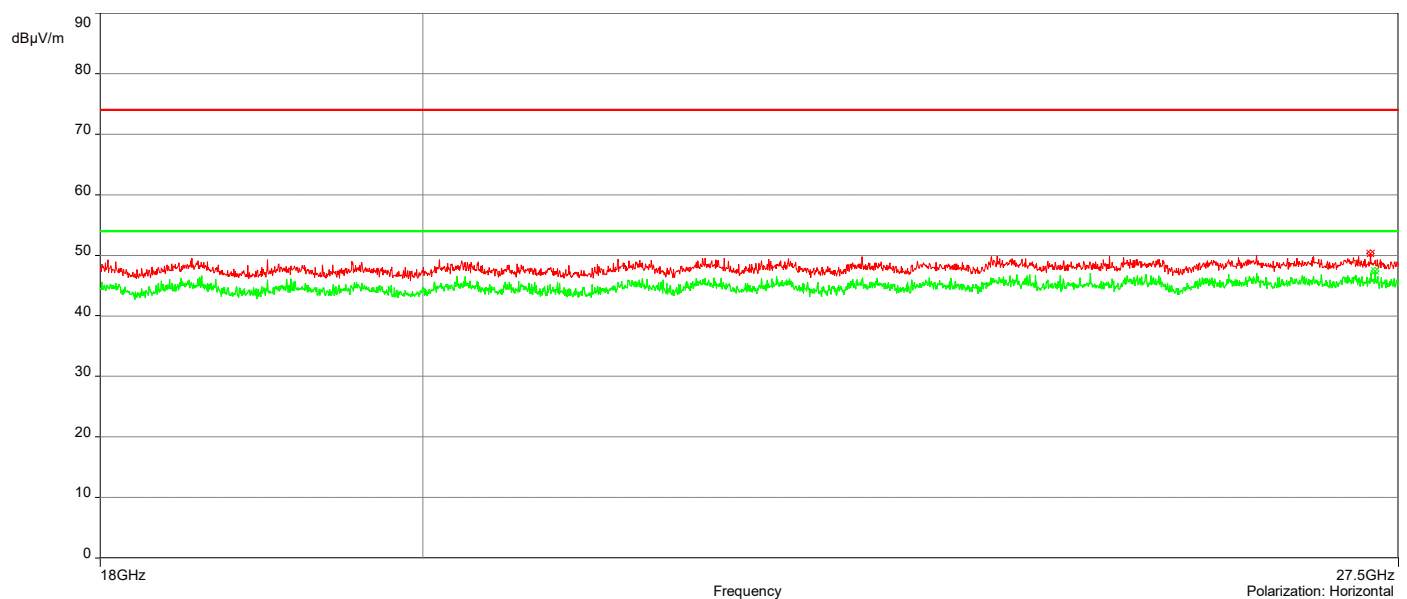
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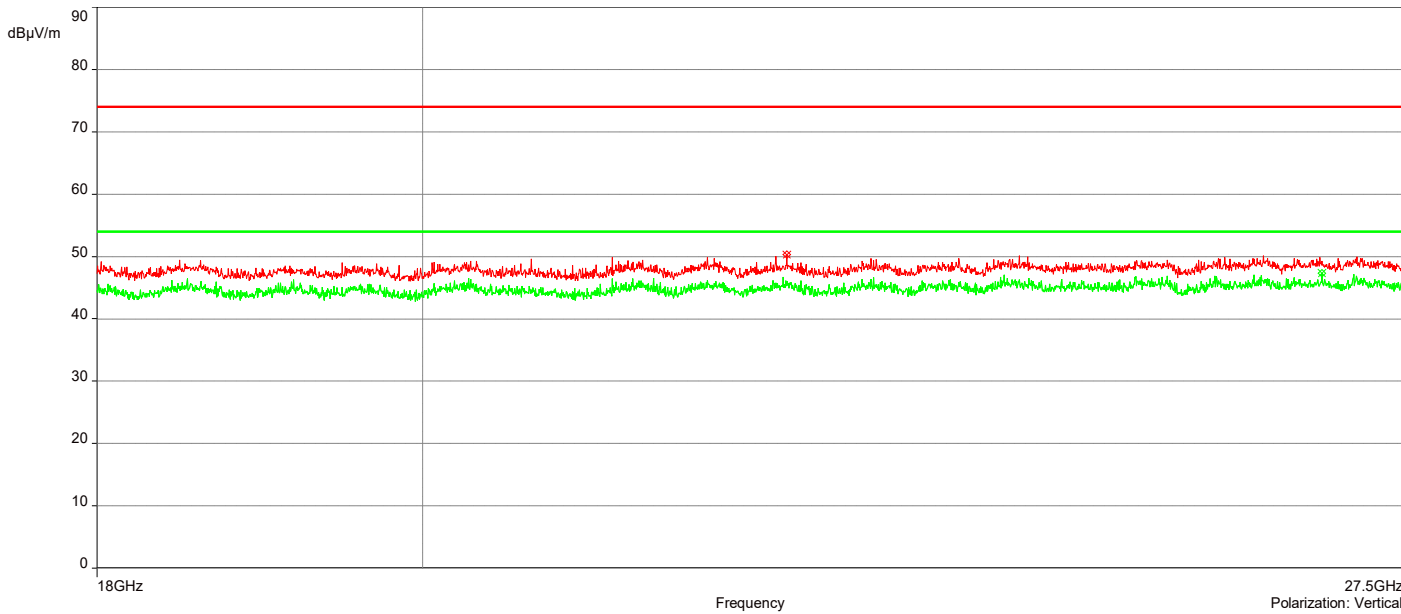
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No	Frequency (MHz)	Level Peak Reading (dBμV/m)	Correction Factor (dB)	Limit dBμV/m	Margin (dB)	Height (m)	Angle (°)	Polarization	Judgement
1.	22.5018GHz	50.29	1.45	74.00	-23.71	3.49	112.60	Vertical	Passed
2.	27.251563GHz	50.33	5.41	74.00	-23.67	2.84	0.10	Horizontal	Passed

No	Frequency (MHz)	Level Average Reading (dBμV/m)	Correction Factor (dB)	Limit dBμV/m	Margin (dB)	Height (m)	Angle (°)	Polarization	Judgment
1.	26.750888GHz	47.27	4.69	54.00	-6.73	1.02	247.60	Vertical	Passed
2.	27.291465GHz	47.38	5.57	54.00	-6.62	3.06	225.20	Horizontal	Passed

Overall Graphs:





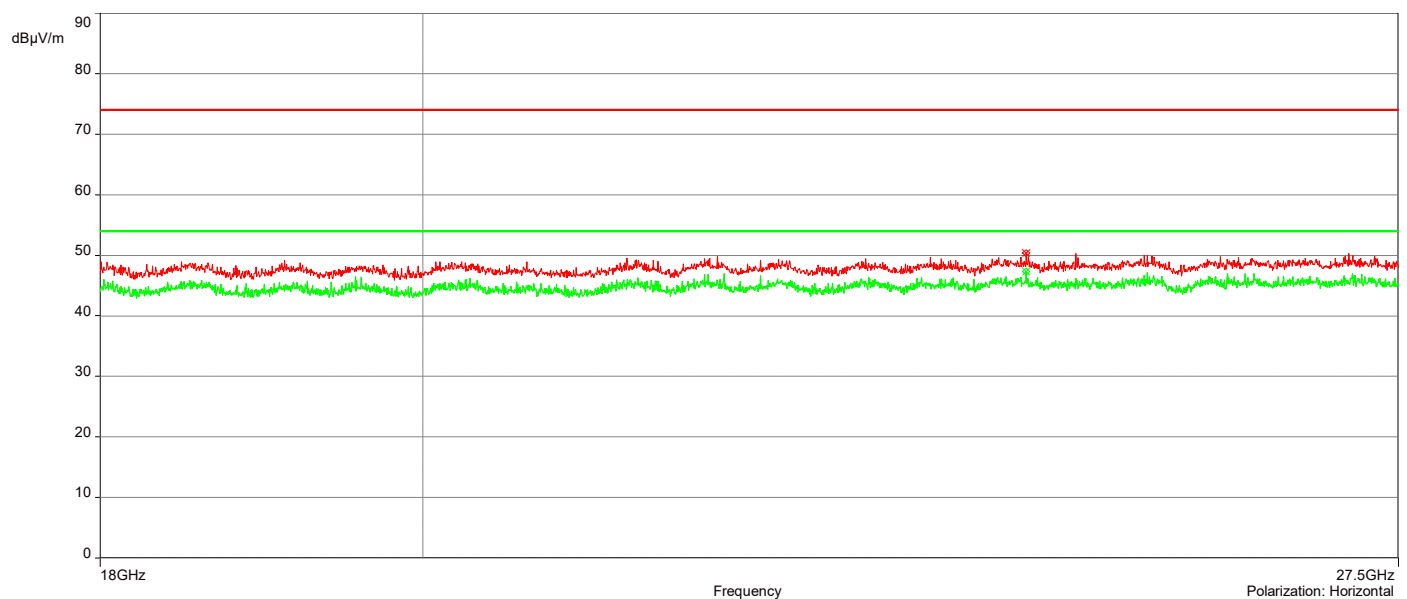
AH22120901-HAR-054#2_BLE_Ch 39_18-27.5GHz

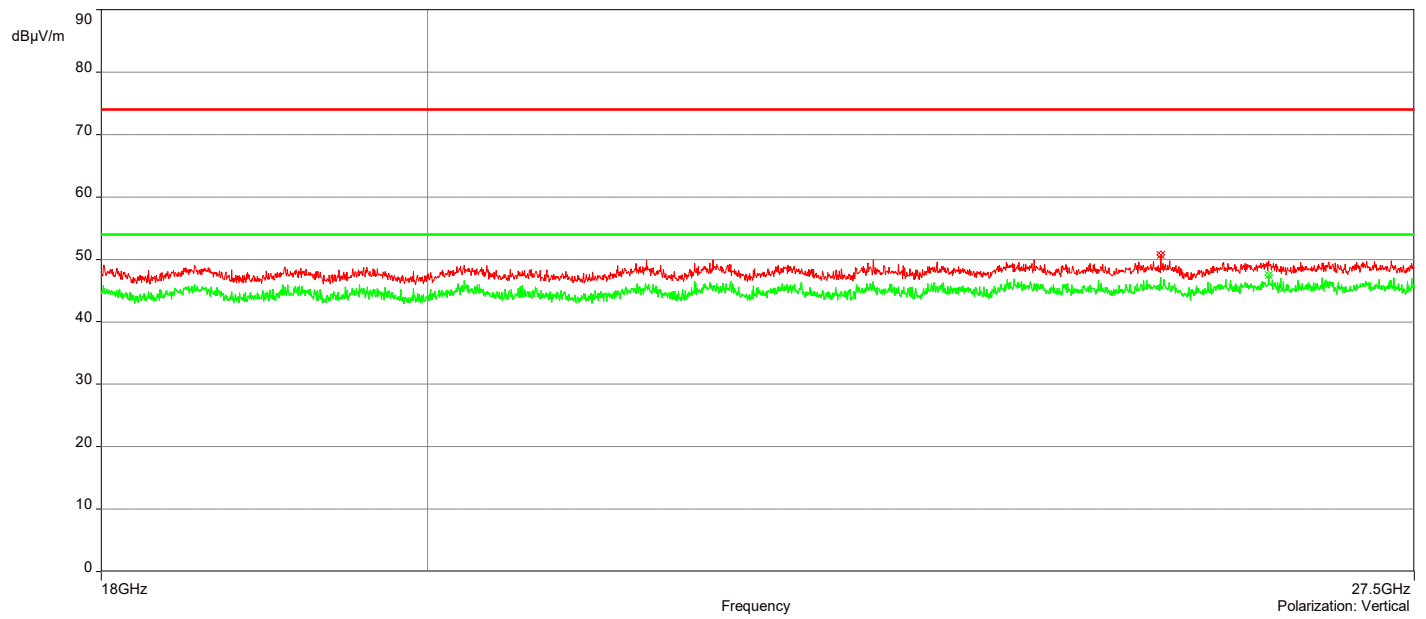
2/28/2023 1:43:27 PM

No	Frequency (MHz)	Level Peak Reading (dBμV/m)	Correction Factor (dB)	Limit dBμV/m	Margin (dB)	Height (m)	Angle (°)	Polarization	Judgement
1.	25.339117GHz	50.75	2.99	74.00	-23.25	1.03	314.90	Vertical	Passed
2.	24.351543GHz	50.36	2.54	74.00	-23.64	1.68	0.10	Horizontal	Passed

No	Frequency (MHz)	Level Average Reading (dBμV/m)	Correction Factor (dB)	Limit dBμV/m	Margin (dB)	Height (m)	Angle (°)	Polarization	Judgment
1.	26.238337GHz	47.53	4.09	54.00	-6.47	1.03	224.90	Vertical	Passed
2.	24.351543GHz	47.33	2.54	54.00	-6.67	1.68	0.10	Horizontal	Passed

Overall Graphs:





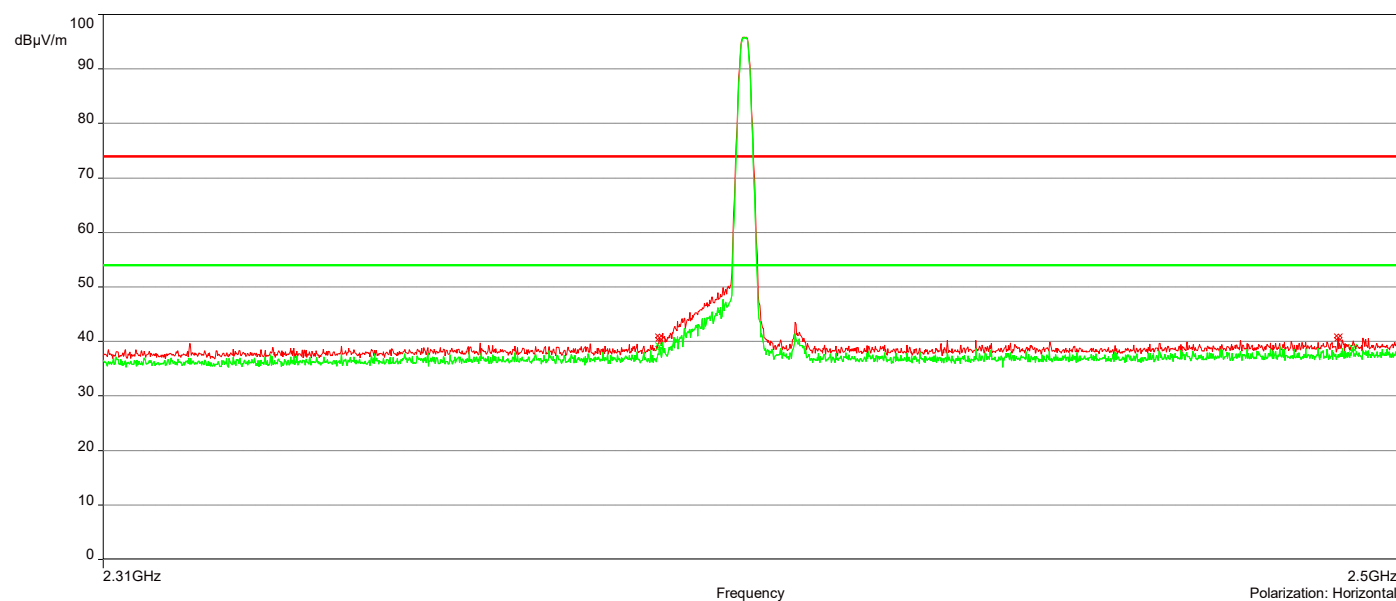
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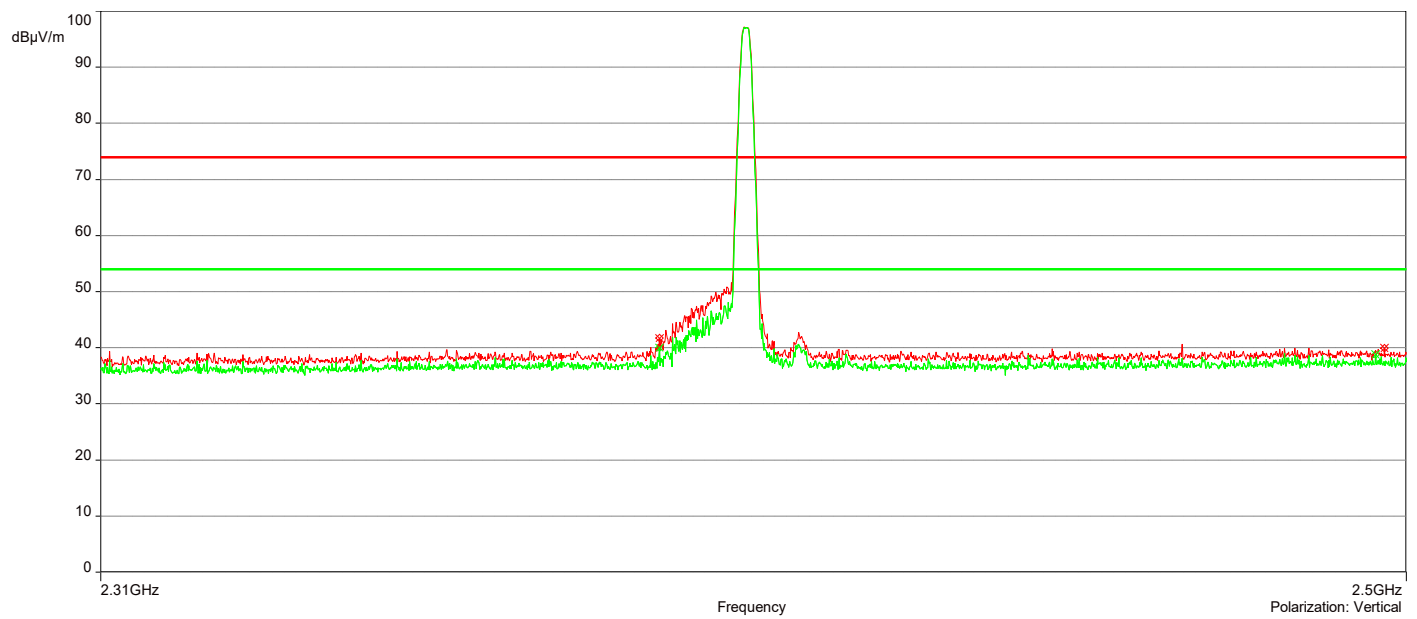
12/21/2022 3:46:01 PM

No	Frequency (MHz)	Level Peak Reading (dBμV/m)	Correction Factor (dB)	Limit dBμV/m	Margin (dB)	Height (m)	Angle (°)	Polarization	Judgement
1.	2.3894597GHz	41.76	-3.05	74.00	-32.24	1.00	247.40	Vertical	Passed
2.	2.4966733GHz	39.97	-2.59	74.00	-34.03	1.02	224.90	Vertical	Passed
3.	2.3895548GHz	40.69	-3.08	74.00	-33.31	3.69	134.90	Horizontal	Passed
4.	2.4904002GHz	40.67	-2.43	74.00	-33.33	1.48	67.40	Horizontal	Passed

No	Frequency (MHz)	Level Average Reading (dBμV/m)	Correction Factor (dB)	Limit dBμV/m	Margin (dB)	Height (m)	Angle (°)	Polarization	Judgment
1.	2.3894597GHz	39.98	-3.05	54.00	-14.02	1.00	247.40	Vertical	Passed
2.	2.4953427GHz	38.80	-2.60	54.00	-15.20	2.37	157.40	Vertical	Passed
3.	2.3895548GHz	39.04	-3.08	54.00	-14.96	3.69	134.90	Horizontal	Passed
4.	2.4925863GHz	38.82	-2.41	54.00	-15.18	1.88	269.90	Horizontal	Passed

Overall Graphs:





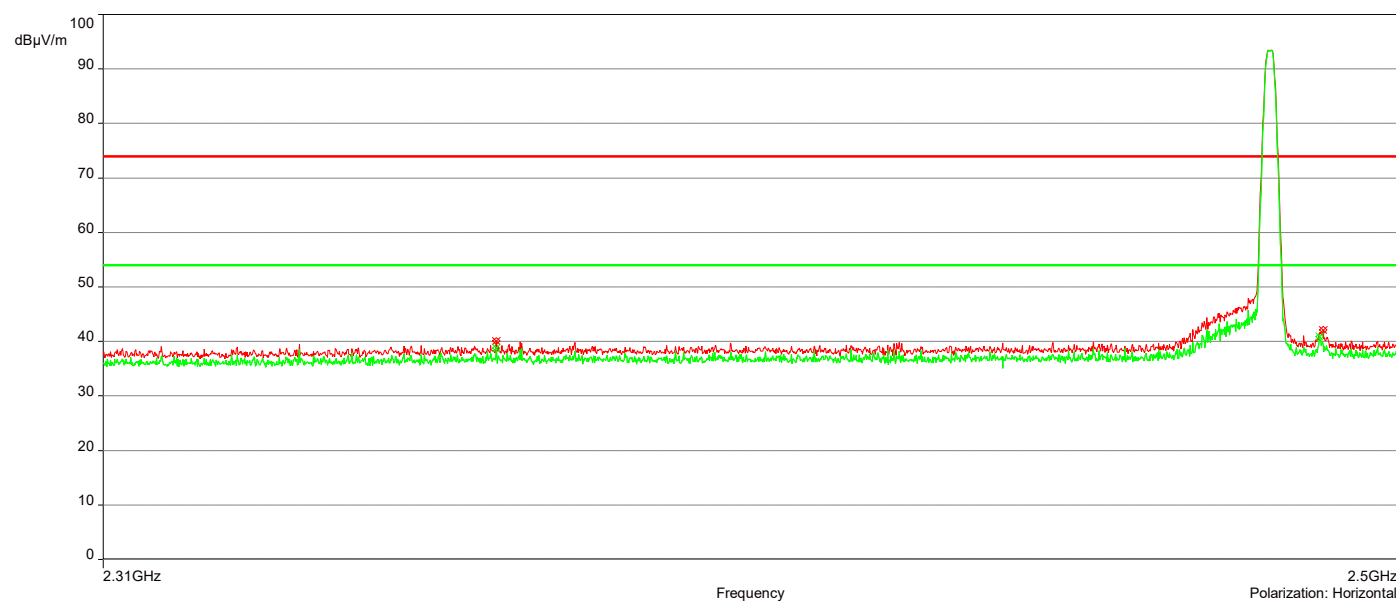
AH22120901-HAR-054#2_Restricted Bandedge_BLE_1MHz_Ch 39

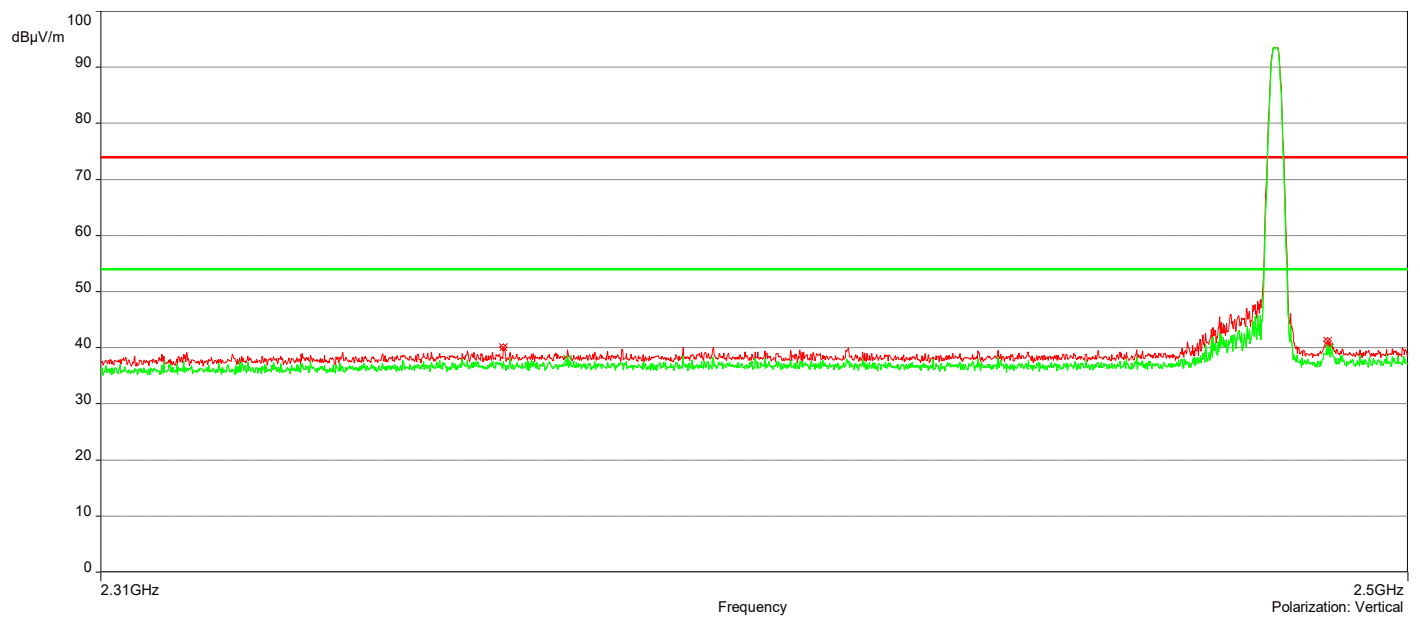
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No	Frequency (MHz)	Level Peak Reading (dBμV/m)	Correction Factor (dB)	Limit dBμV/m	Margin (dB)	Height (m)	Angle (°)	Polarization	Judgement
1.	2.3669335GHz	40.09	-2.97	74.00	-33.91	1.00	112.40	Vertical	Passed
2.	2.487929GHz	41.14	-2.64	74.00	-32.86	1.00	247.40	Vertical	Passed
3.	2.365983GHz	40.13	-3.12	74.00	-33.87	2.66	314.90	Horizontal	Passed
4.	2.4881191GHz	42.12	-2.44	74.00	-31.88	4.00	292.40	Horizontal	Passed

No	Frequency (MHz)	Level Average Reading (dBμV/m)	Correction Factor (dB)	Limit dBμV/m	Margin (dB)	Height (m)	Angle (°)	Polarization	Judgment
1.	2.3761531GHz	38.06	-2.99	54.00	-15.94	2.52	179.90	Vertical	Passed
2.	2.4882141GHz	40.01	-2.64	54.00	-13.99	1.00	247.40	Vertical	Passed
3.	2.365983GHz	38.78	-3.12	54.00	-15.22	2.66	314.90	Horizontal	Passed
4.	2.4875488GHz	40.91	-2.45	54.00	-13.09	3.37	337.40	Horizontal	Passed

Overall Graphs:





Document Revisions

Version	Date	Modifier	Changes
1.0	03/14/2022	Aravind Buddana	• Initial Release
2.0	08/07/2023	Aravind Buddana	• Updated KDB version references. • Updated the Test summary with device description and EUT Software configurations. • Updated Section 4.4.4, 4.4.6 and 4.4.7 measurement references. • Updated radiated emissions Test limits and measurement procedures.

End of Report