




FCC RF Test Report

Test Report Number	STA-22021143-LC-FCC-RF_2.4G
FCC ID	2A8IP-efuseA9X
Applicant	F&S Elektronik Systeme GmbH
Applicant Address	Untere Waldplaetze 23, Stuttgart, Baden-Wuerttemberg, Germany, 70569
Product Name	Computer On Module
Model (s)	efusA9X
Family Model (s)	efusA9Xr2
Date of Receipt	06/07/2022
Date of Test	06/28/2022 - 09/15/2022
Report Issue Date	10/21/2022
Test Standards	47 CFR Part 15.247
Test Result	PASS
	<p>Issued by:</p> <p>Vista Compliance Laboratories 1261 Puerta Del Sol, San Clemente, CA 92673 USA www.vista-compliance.com</p>
 <hr/> <p>Devin Tai (Test Engineer)</p>	 <hr/> <p>David Zhang (Technical Manager)</p>
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REVISION HISTORY

Report Number	Version	Description	Issued Date
STA-22021143-LC-FCC-RF_2.4G	01	Initial report	10/21/2022

TABLE OF CONTENTS

1 TEST SUMMARY4

2 GENERAL INFORMATION.....5

 2.1 Applicant.....5

 2.2 Product information.....5

 2.3 Test standard and method5

3 TEST SITE INFORMATION.....6

4 MODIFICATION OF EUT / DEVIATIONS FROM STANDARDS.....6

5 TEST CONFIGURATION AND OPERATION.....6

 5.1 EUT Test Configuration.....6

 5.2 Supporting Equipment6

6 UNCERTAINTY OF MEASUREMENT7

7 TEST RESULTS.....8

 7.1 Antenna Requirement8

 7.2 DTS (6 dB) Bandwidth9

 7.4 Maximum Output Power.....13

 7.5 Power Spectral Density.....15

 7.6 Conducted Band-Edge measurements19

 7.8 Radiated Spurious Emissions into Restricted Frequency Bands23

 7.9 Conducted Emissions.....39

8 EUT AND TEST SETUP PHOTOS.....43

9 TEST INSTRUMENT LIST44

1 Test Summary

Test Item	Test Requirement	Test Method	Result
Antenna Requirement	47 CFR Part 15.247	ANSI C63.10 (2013)	Pass
DTS (6 dB) Channel Bandwidth	47 CFR Part 15.247	ANSI C63.10 (2013)	Pass
Conducted Maximum Output Power	47 CFR Part 15.247	ANSI C63.10 (2013)	Pass
Power Spectral Density	47 CFR Part 15.247	ANSI C63.10 (2013)	Pass
Conducted Band-Edge measurements	47 CFR Part 15.247	ANSI C63.10 (2013)	Pass
Radiated Emissions & Unwanted Emissions into Restricted Frequency Bands	47 CFR Part 15.247	ANSI C63.10 (2013)	Pass
AC Power Line Conducted Emissions	47 CFR Part 15.247	ANSI C63.10 (2013)	Pass

2 General Information

2.1 Applicant

Applicant	F&S Elektronik Systeme GmbH
Applicant Address	Untere Waldplaetze 23 Stuttgart Baden-Wuerttemberg Germany, 70569
Manufacturer	F&S Elektronik Systeme GmbH
Manufacturer Address	Untere Waldplaetze 23 Stuttgart Baden-Wuerttemberg Germany, 70569

2.2 Product information

Product Name	Computer On Module
Model Number	efusA9X
Family Model Number	efusA9Xr2
Serial Number	N/A
Operational Frequency	802.11b/g/n: 2412MHz to 2462MHz (11 Channels) 802.11n (40MHz): 2422MHz to 2452MHz (7 Channels)
Channel Bandwidth	20MHz, 40MHz
Type of Modulation	802.11b: DSSS(CCK/QPSK/BPSK) 802.11g/n: OFDM(BPSK/QPSK/16QAM/64QAM)
Antenna Information	Chip Antenna, 2.1 dBi Peak gain for 2.4G Band
Clock Frequencies	N/A
Port/Connectors	N/A
Input Power	F&S Efus baseboard input power 5Vdc, efusA9X modules power 3.3Vdc
Power Adapter Manu/Model	N/A
Power Adapter SN	N/A
Hardware version	N/A
Software version	N/A
Simultaneous Transmission	N/A
Additional Info	<ol style="list-style-type: none"> 1. This radio module is based on the certified radio module (FCC ID: N6C-SDPAC) but with different antenna design. 2. Difference between efusA9X and efusA9Xr2. <ul style="list-style-type: none"> - efusA9X: LAN controller Qualcomm AR8035-AL1 - efusA9Xr2: LAN controller Realtek RTL8211FD <p>No other changes. Both Phys are Gbit Phys and are connected by RGMII interface to CPU. All frequencies are the same.</p>

2.3 Test standard and method

Test standard	47 CFR Part 15.247
Test method	ANSI C63.10-2013 558074 D01 15.247 Meas Guidance v05r02

3 Test Site Information

Lab performing tests	Vista Laboratories, Inc.
Lab Address	1261 Puerta Del Sol, San Clemente, CA 92673 USA
Phone Number	+1 (949) 393-1123
Website	www.vista-compliance.com

Test Condition	Temperature	Humidity	Atmospheric Pressure
RF Testing	23.2°C	57.5%	996 mbar
Radiated Emission Testing	23.2°C	57.5%	996 mbar

4 Modification of EUT / Deviations from Standards

The EUT is an engineering test sample loaded with RF testing firmware specifically designed to support the RF TX/RX measurement in different aspects.

EUT test sample has u.FL connector for direct RF conducted measurement.

5 Test Configuration and Operation

5.1 EUT Test Configuration

The EUT is an engineering test sample loaded with RF testing firmware specifically designed to support the RF TX/RX measurement in different aspects.

The following software was used for testing and to monitor EUT performance

Software	Description
EMISoft Vasona	EMC/RF Spurious emission test software used during testing
RadioToolGUI.exe	Set the module into different WLAN test mode, to change channel, modulation, power level, bandwidth, etc.

5.2 Supporting Equipment

Description	Manufacturer	Model #	Serial #	Remark
Test Laptop	Dell	Latitude E6510	BSD73Q1	Provide by client
F&S Efus baseboard	EMBEDDED	EfUS-SINTF Rev1.50	4820	Provide by client

6 Uncertainty of Measurement

Test item	Measurement Uncertainty (dB)
RF Output Power (Conducted)	±1.2 dB
Power Spectral Density	±0.9 dB
Unwanted Emission (conducted)	±2.6 dB
Occupied Channel Bandwidth	±5 %
Radiated Emission (9KHz-30MHz)	±3.5 dB
Radiated Emission (30MHz-1GHz)	±4.6 dB
Radiated Emission (1-18GHz)	±4.9 dB
Radiated Emission (18-40GHz)	±3.5 dB

7 Test Results

7.1 Antenna Requirement

7.1.1 Requirement

Per § 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

7.1.2 Result

Analysis:

- EUT has a chip antenna which is soldered onto the main board. The antenna gain is 2.1 dBi for 2.4G band, 2.4dBi for 5G band. This meets the requirement of permanent attachment.

Conclusion:

- EUT complies with antenna requirement in § 15.203.

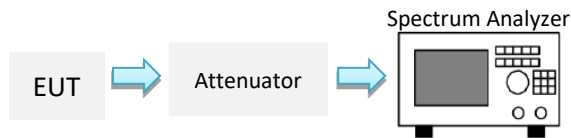
7.2 DTS (6 dB) Bandwidth

7.2.1 Requirement

§ 15.247 (a)(2)

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

7.2.2 Test Setup



7.2.3 Test Procedure

According to section 8.2, option 2, in KDB 558074 D01 DTS Meas Guidance v05r02 and subclause 11.8 of ANSI C63.10-2013:

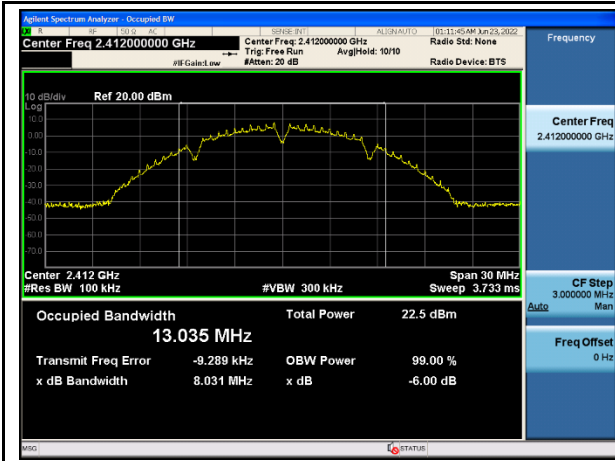
The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 dB, if the functionality described above (i.e., RBW = 100 kHz, VBW $\geq 3 \times$ RBW, peak detector with maximum hold) is implemented by the instrumentation function. When using this capability, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be ≥ 6 dB.

1. Set RBW = 100 kHz.
2. Set the video bandwidth (VBW) $\geq 3 \times$ RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. Use automatic bandwidth measurement capability on instrument to obtain BW result.

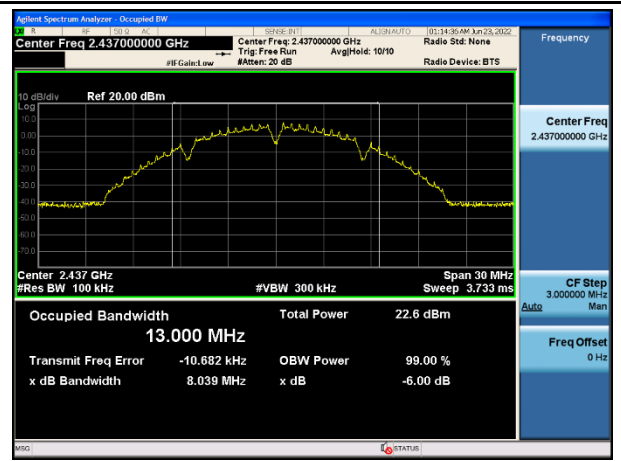
7.2.4 Test Result

Mode	Data rate	Frequency (MHz)	Measured Bandwidth (MHz)	Minimum Bandwidth (MHz)	Result
802.11b	1Mbps	2412	8.03	0.5	Pass
		2437	8.04	0.5	Pass
		2462	7.10	0.5	Pass
802.11g	6Mbps	2412	15.14	0.5	Pass
		2437	15.00	0.5	Pass
		2462	15.14	0.5	Pass
802.11n20	MCS0	2412	15.12	0.5	Pass
		2437	15.07	0.5	Pass
		2462	15.14	0.5	Pass
802.11n40	MCS0	2422	35.06	0.5	Pass
		2437	35.10	0.5	Pass
		2452	34.97	0.5	Pass

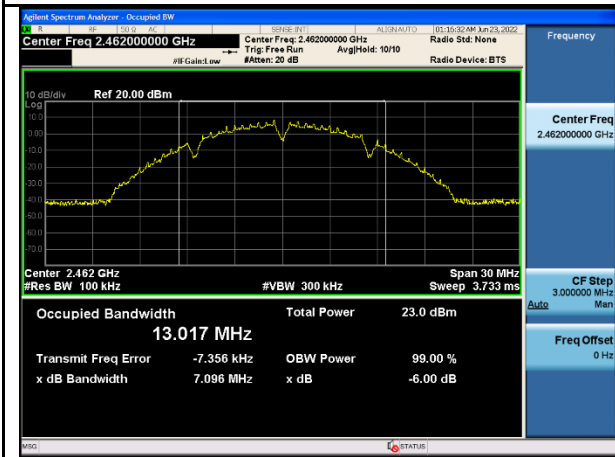
7.2.5 Test Plots



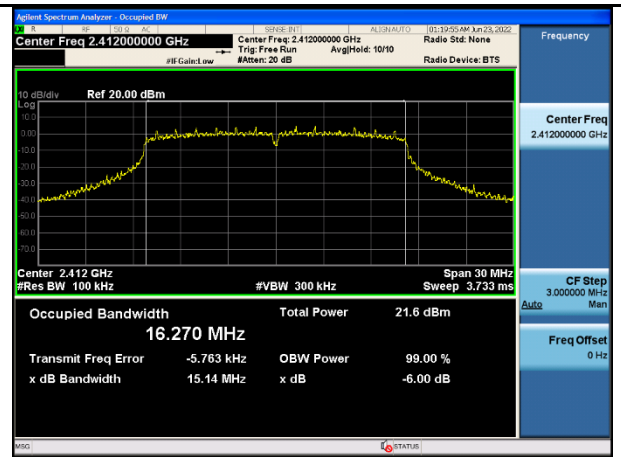
DTS BW_802.11b_Low CH



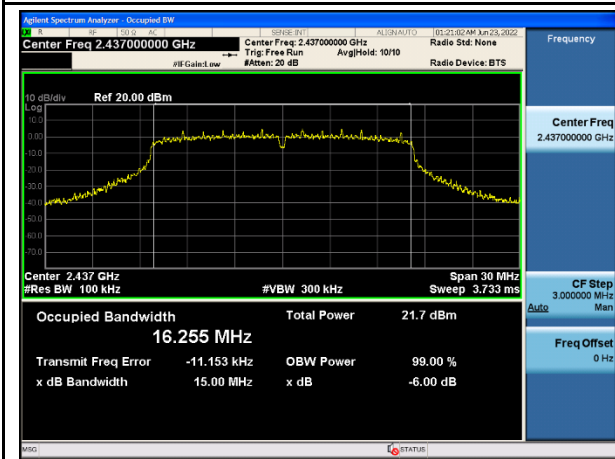
DTS BW_802.11b_Mid CH



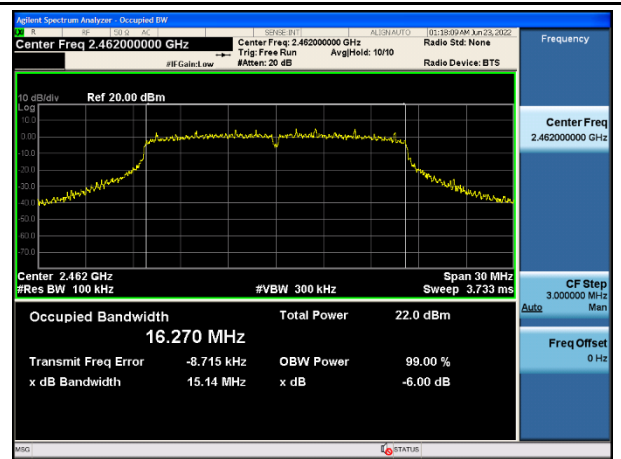
DTS BW_802.11b_High CH



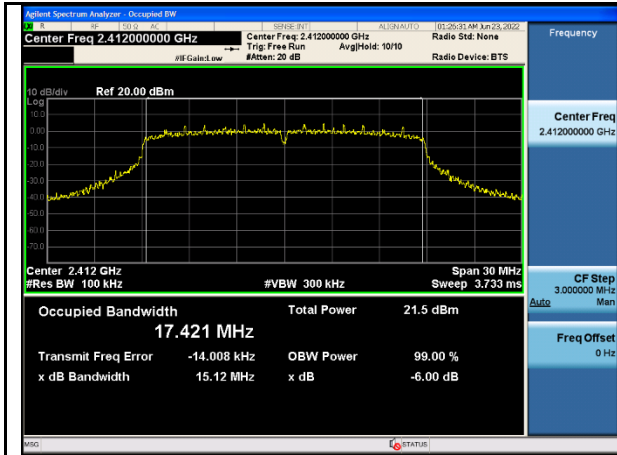
DTS BW_802.11g_Low CH



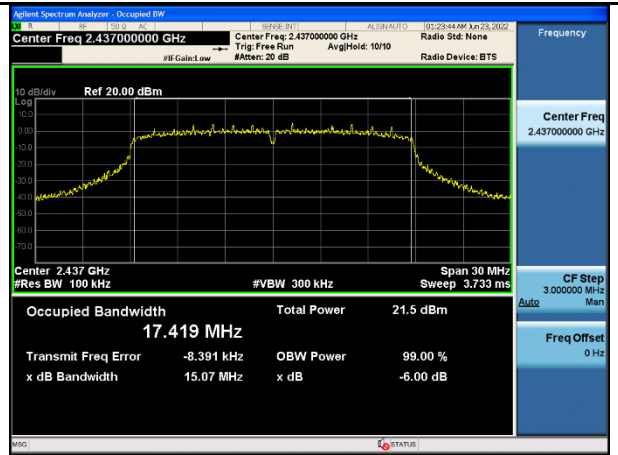
DTS BW_802.11g_Mid CH



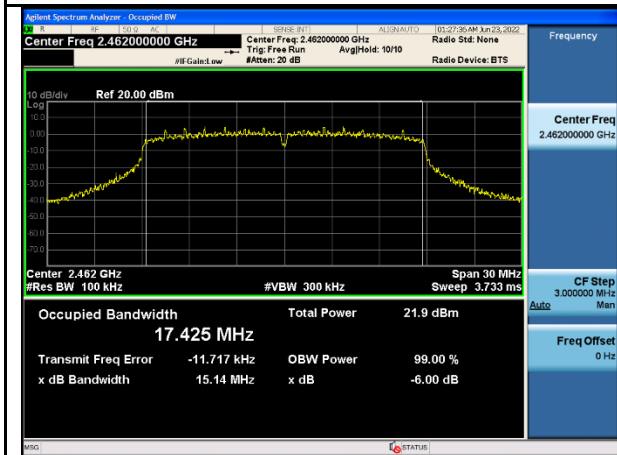
DTS BW_802.11g_High CH



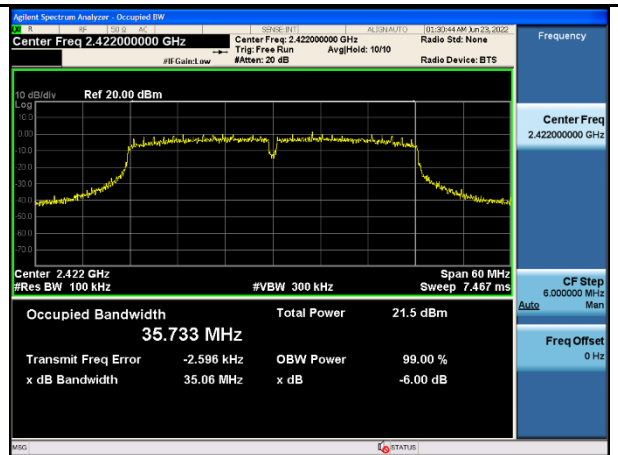
DTS BW_802.11n20_Low CH



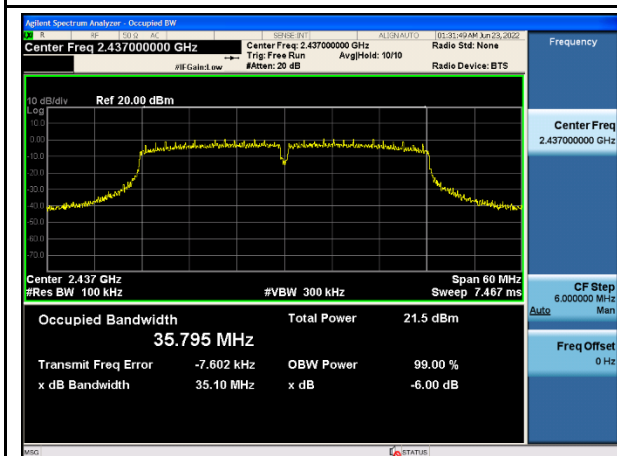
DTS BW_802.11 n20_Mid CH



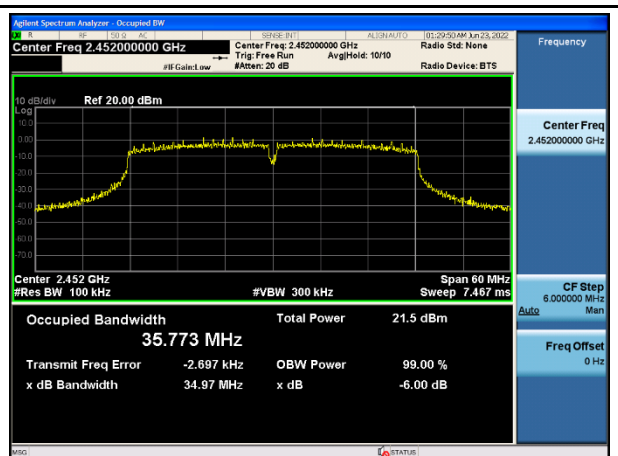
DTS BW_802.11 n20_High CH



DTS BW_802.11n40_Low CH



DTS BW_802.11 n40_Mid CH



DTS BW_802.11 n40_High CH

7.4 Maximum Output Power

7.4.1 Requirement

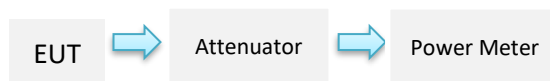
§ 15.247 (b)(3)

DTSs using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: the maximum output power is 1 Watt.

If transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

7.4.2 Test Setup

Power Meter



7.4.3 Test Procedure

Power measurement is according to clause 11.9.1.3 of ANSI C63.10-2013 PKPM1 Peak power meter method or clause 11.9.2.3 AVGPM method.

7.4.4 Test Result

Mode	Data rate	Frequency (MHz)	Measured Output Power (dBm)	Max Output Power (dBm)	Result
802.11b	1Mbps	2412	16.312	30	Pass
		2437	16.096	30	Pass
		2462	16.751	30	Pass
802.11g	6Mbps	2412	15.221	30	Pass
		2437	15.549	30	Pass
		2462	15.853	30	Pass
802.11n20	MCS0	2412	15.110	30	Pass
		2437	15.338	30	Pass
		2462	15.787	30	Pass
802.11n40	MCS0	2422	14.708	30	Pass
		2437	14.698	30	Pass
		2452	14.782	30	Pass

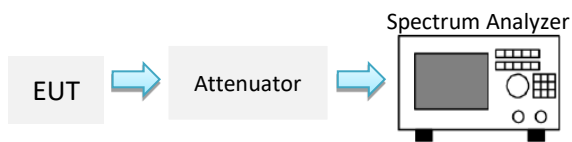
7.5 Power Spectral Density

7.5.1 Requirement

§ 15.247 (e)

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 is used to determine the power spectral density.

7.5.2 Test Setup



7.5.3 Test Procedure

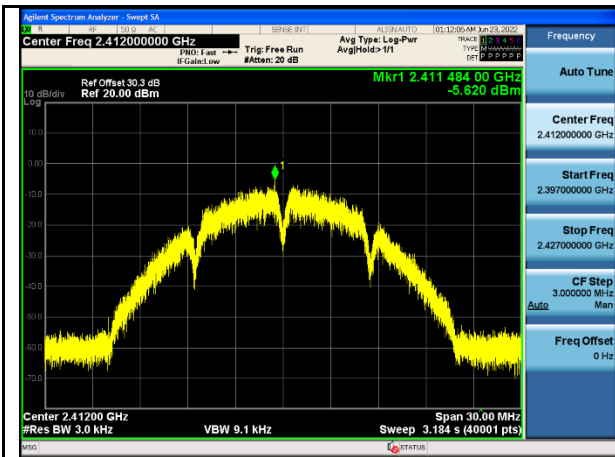
According to section 8.4 in KDB 558074 D01 DTS Meas Guidance v05r02 and subclause 11.10.2 PKPSD of ANSI C63.10-2013:

1. Set analyser centre frequency to DTS channel centre frequency.
2. Set the span to 1.5 X DTS bandwidth.
3. Set the RBW to: $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$.
4. Set the VBW $\geq 3 \times \text{RBW}$.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level within the RBW.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

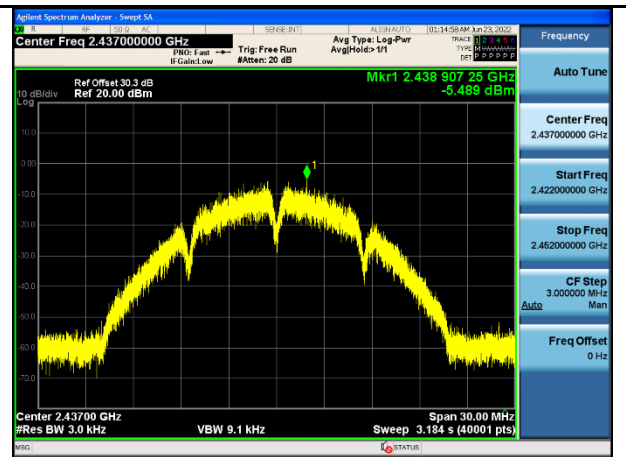
7.5.4 Test Result

Mode	Data rate	Frequency (MHz)	Measured PSD (dBm/3KHz)	Max PSD (dBm/3KHz)	Result
802.11b	1Mbps	2412	-5.620	8	Pass
		2437	-5.489	8	Pass
		2462	-5.424	8	Pass
802.11g	6Mbps	2412	-8.704	8	Pass
		2437	-8.763	8	Pass
		2462	-8.690	8	Pass
802.11n20	MCS0	2412	-9.552	8	Pass
		2437	-10.110	8	Pass
		2462	-9.496	8	Pass
802.11n40	MCS0	2422	-14.164	8	Pass
		2437	-13.553	8	Pass
		2452	-13.141	8	Pass

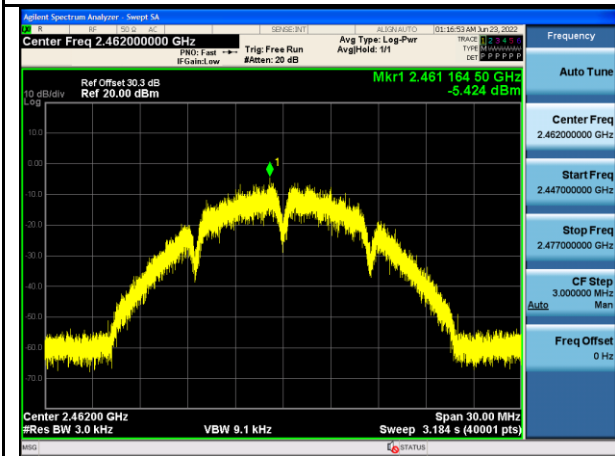
7.5.5 Test Plots



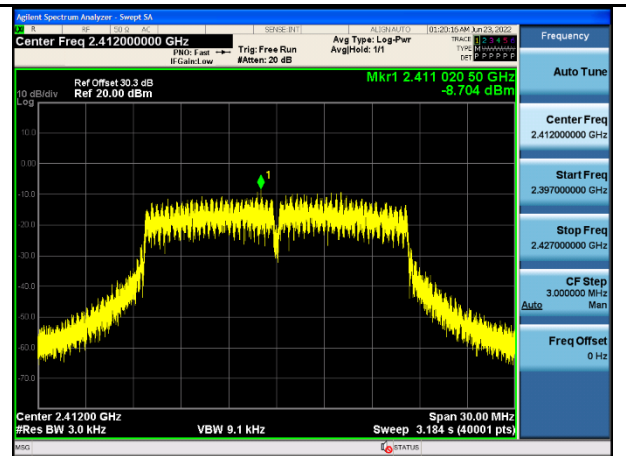
PSD-802.11b-Low CH



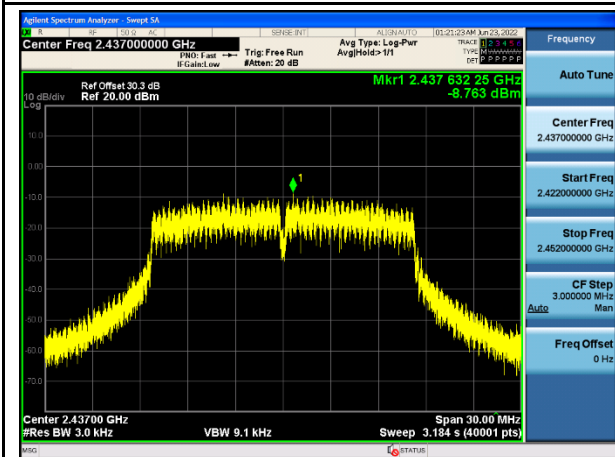
PSD-802.11b-Mid CH



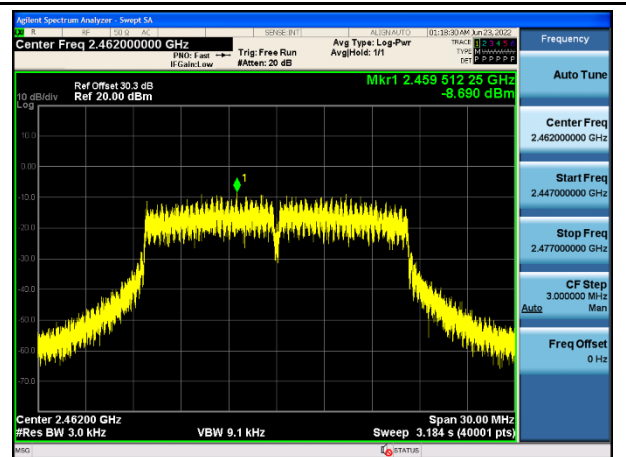
PSD-802.11b-High CH



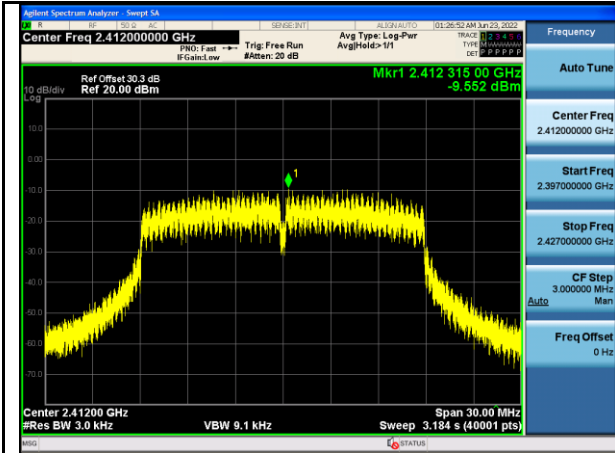
PSD-802.11g-Low CH



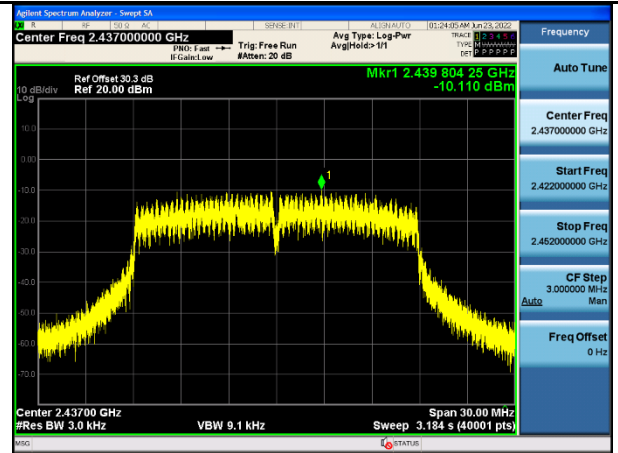
PSD-802.11g-Mid CH



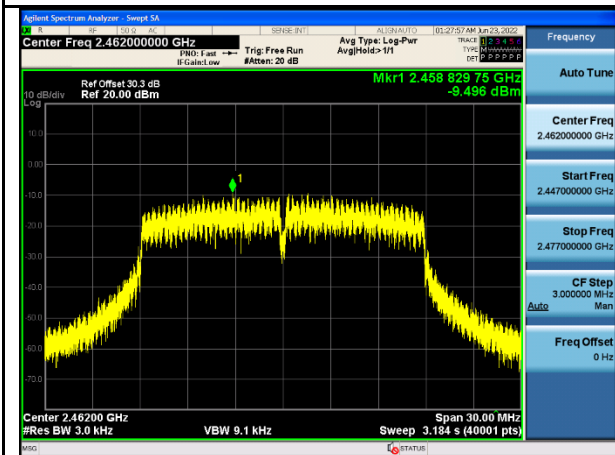
PSD-802.11b-High CH



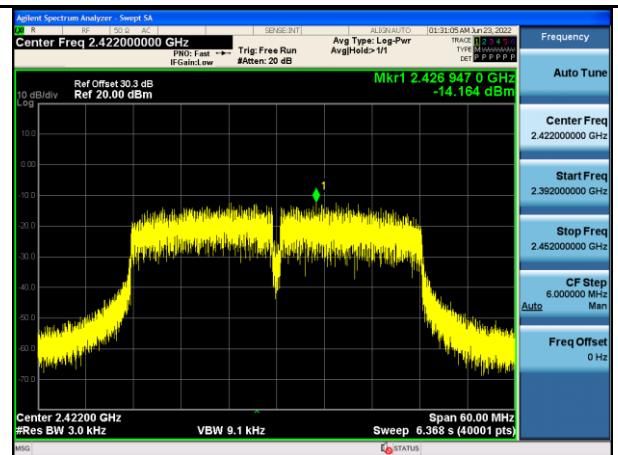
PSD-802.11n20-Low CH



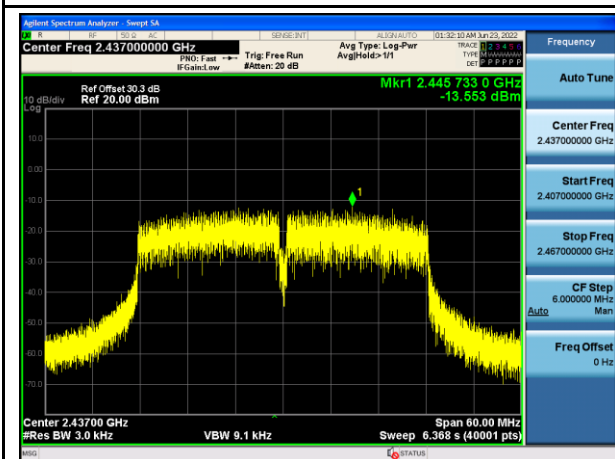
PSD-802.11n20-Mid CH



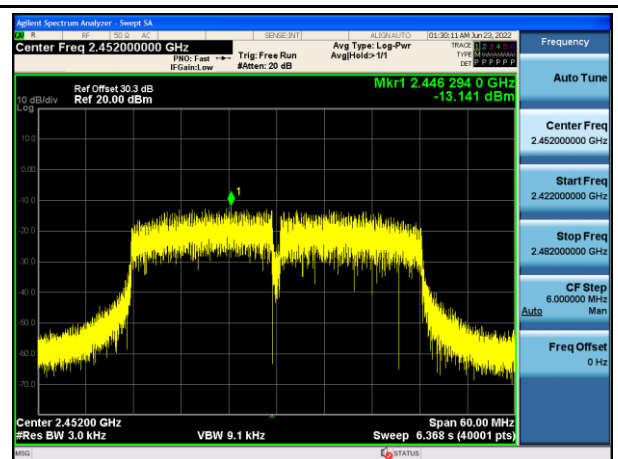
PSD-802.11n20-High CH



PSD-802.11n40-Low CH



PSD-802.11n40-Mid CH



PSD-802.11n40-High CH

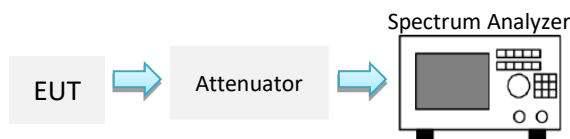
7.6 Conducted Band-Edge measurements

7.6.1 Requirement

§ 15.247 (d)

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.

7.6.2 Test Setup



7.6.3 Test Procedure

According to ANSI C63.10-2013 clause 11.13

1. The RF output of EUT was connected to the spectrum analyser by RF cable and attenuator. The path loss was compensated to the results for each measurement.
2. Set to the maximum power setting and enable the EUT transmit continuously.
3. Set RBW=100 KHZ, VBW=300 KHZ, Peak Detector. Unwanted Emissions measured in any 100 khz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 db relative to the maximum in-band peak PSD level in 100 KHZ when maximum peak conducted output power procedure is used. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 db instead of 20 db per 15.247(d).
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete and record the results in the test report.

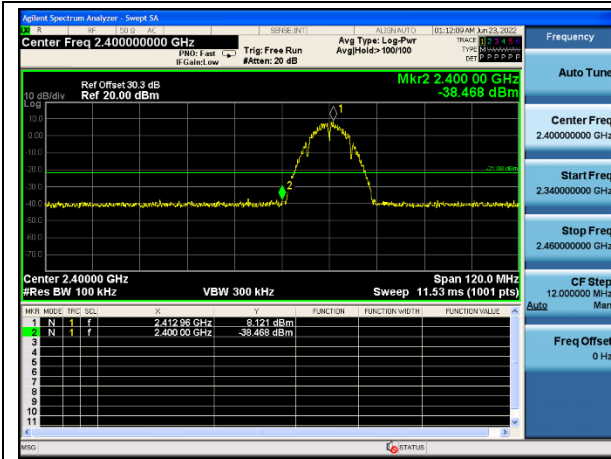
7.6.4 Test Result

Conducted Band edge

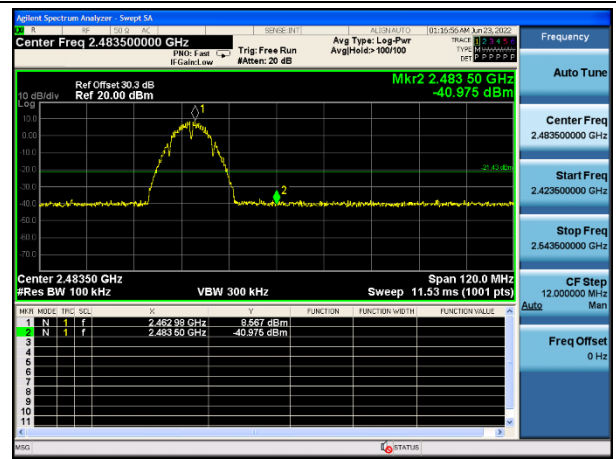
Test Data

Mode	Data rate	Frequency (MHz)	Ref level (dBm)	Measured result (dBm)	Limit (dBm) Δ -30dBc	Result
802.11b	1Mbps	2412	8.121	-38.468	-21.879	Pass
		2462	8.567	-40.975	-21.433	Pass
802.11g	6Mbps	2412	4.964	-30.056	-25.036	Pass
		2462	5.190	-41.183	-24.81	Pass
802.11n(20M)	MCS0	2412	5.515	-31.146	-24.485	Pass
		2462	5.993	-39.719	-24.007	Pass
802.11n(40M)	MCS0	2422	2.844	-31.915	-27.156	Pass
		2452	3.049	-38.458	-26.951	Pass

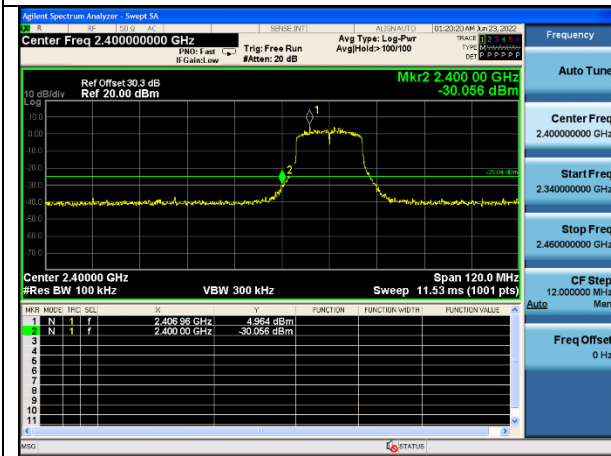
7.6.5 Test Plots



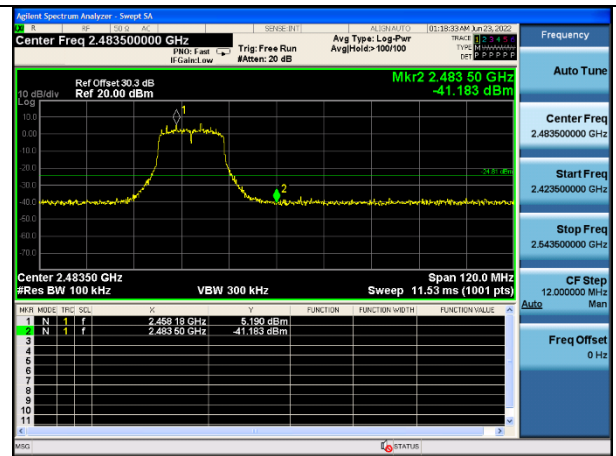
Band Edge-802.11b - Low CH



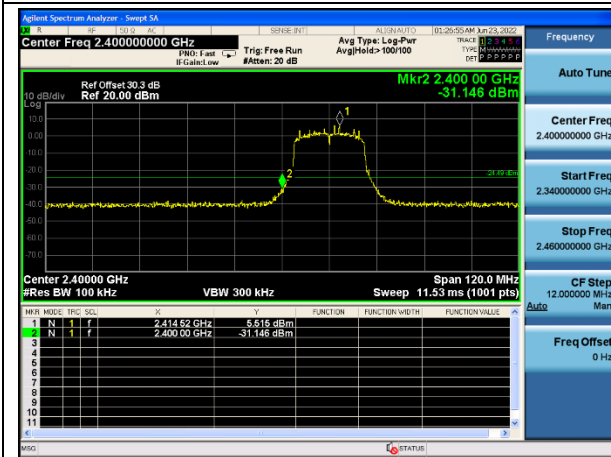
Band Edge-802.11b - High CH



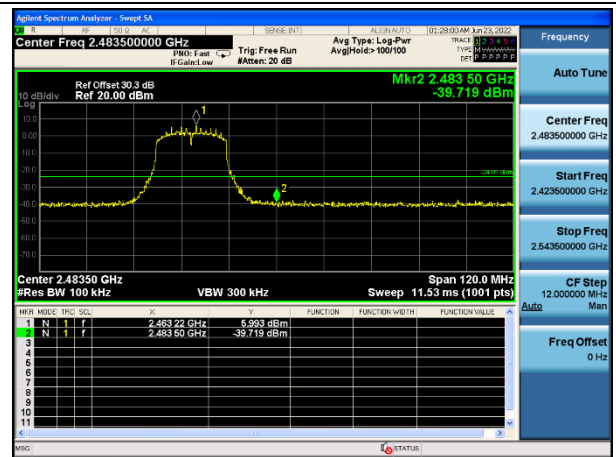
Band Edge-802.11g - Low CH



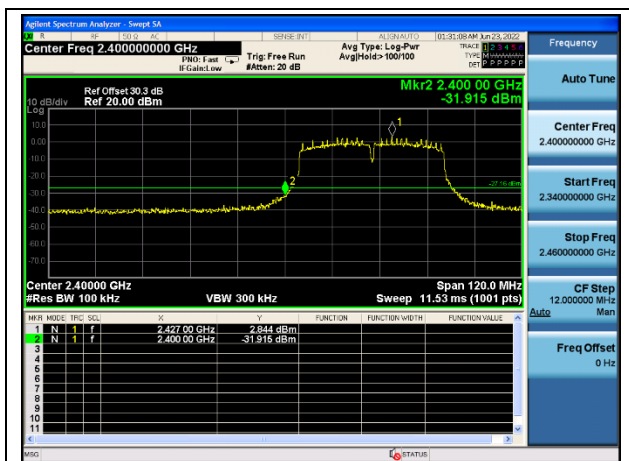
Band Edge-802.11g - High CH



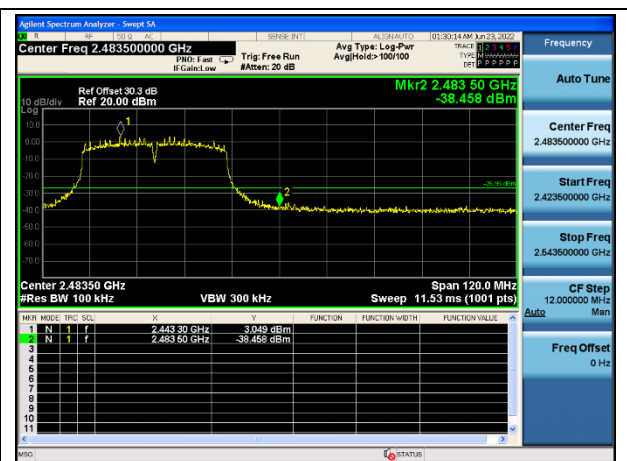
Band Edge-802.11n20 - Low CH



Band Edge-802.11n20 - High CH



Band Edge-802.11n20 -Low CH



Band Edge-802.11n20 -High CH

7.8 Radiated Spurious Emissions into Restricted Frequency Bands

7.8.1 Requirement

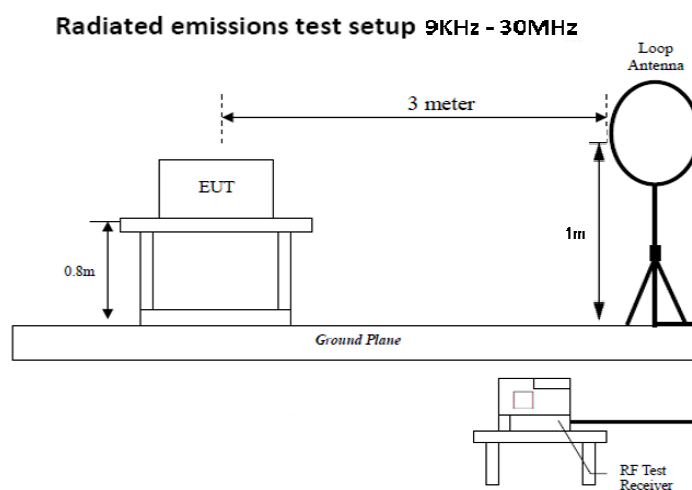
§ 15.247 (d)

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, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

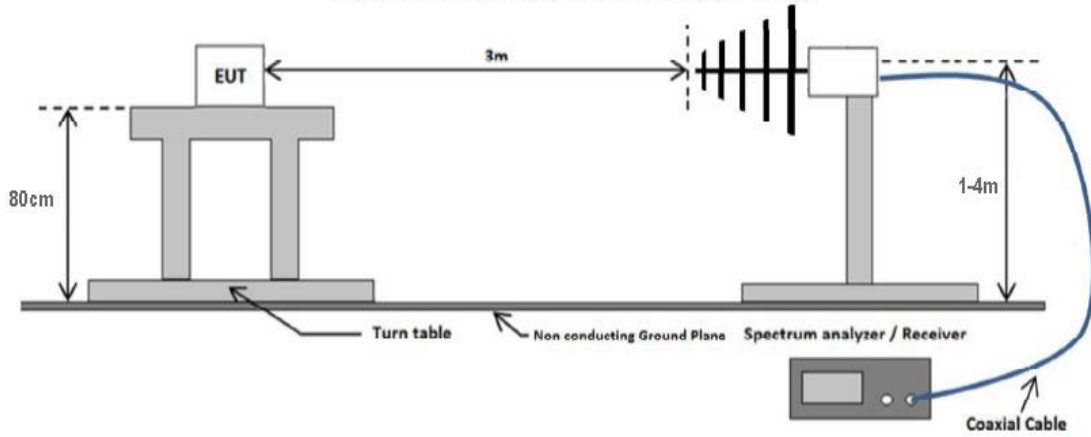
Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

Frequency Range (MHZ)	Field Strength ($\mu\text{V}/\text{m}$)
0.009~0.490	2400/F(KHz)
0.490~1.705	24000/F(KHz)
1.705~30.0	30
30 - 88	100
88 - 216	150
216 960	200
Above 960	500

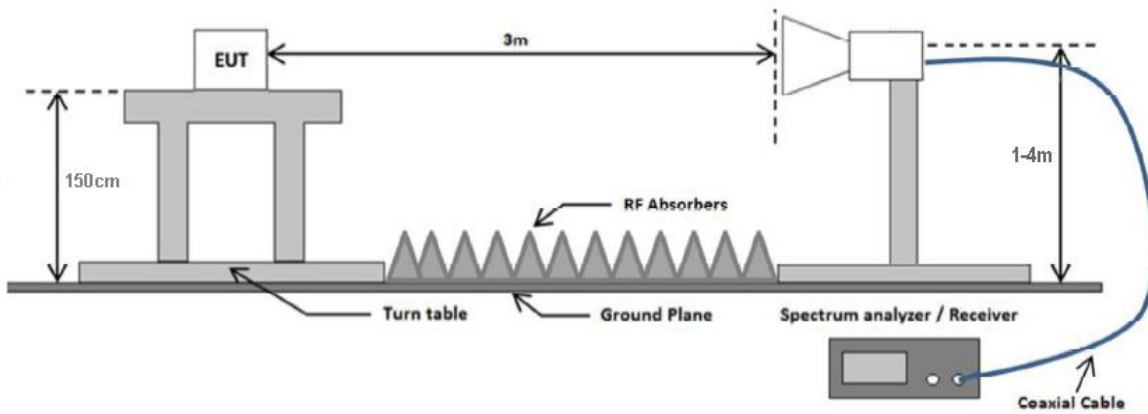
7.8.2 Test Setup



Radiated emissions test setup 30 MHz - 1 GHz



Radiated emissions test setup above 1 GHz



7.8.3 Test Procedure

According to section 8.6 in KDB 558074 D01 DTS Meas Guidance v05r02 and subclause 11.12.2.7 Radiated spurious emission measurements in ANSI C63.10-2013 as well as the procedures for maximizing and measuring radiated emissions that are described in ANSI C63.10 was followed. Boresight antenna mast was used during the scanning to point to EUT to maximize the emission. The process will be repeated in 3 EUT orientations.

1. The EUT was switched on and allowed to warm up to its normal operating condition.
2. The test was carried out at the selected frequency points obtained from the EUT characterization. Maximization of the emissions, was carried out by rotating the EUT, changing the antenna polarization, and adjusting the antenna height in the following manner:
 - a. Vertical or horizontal polarization (whichever gave the higher emission level over a full rotation of the EUT) was chosen.
 - b. The EUT was then rotated to the direction that gave the maximum emission.
 - c. Finally, the antenna height was adjusted to the height that gave the maximum emission.
3. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 300 Hz for frequency below 150KHz.
4. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 10 kHz for frequency between 150KHz – 30MHz.
5. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz for Quasi-Peak detection at frequency between 30MHz - 1GHz.
6. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and video bandwidth is 3MHz with Peak detection for Peak and average measurement at frequency above 1GHz.
7. Steps 2 and 3 were repeated for the next frequency point, until all selected frequency points were measured.

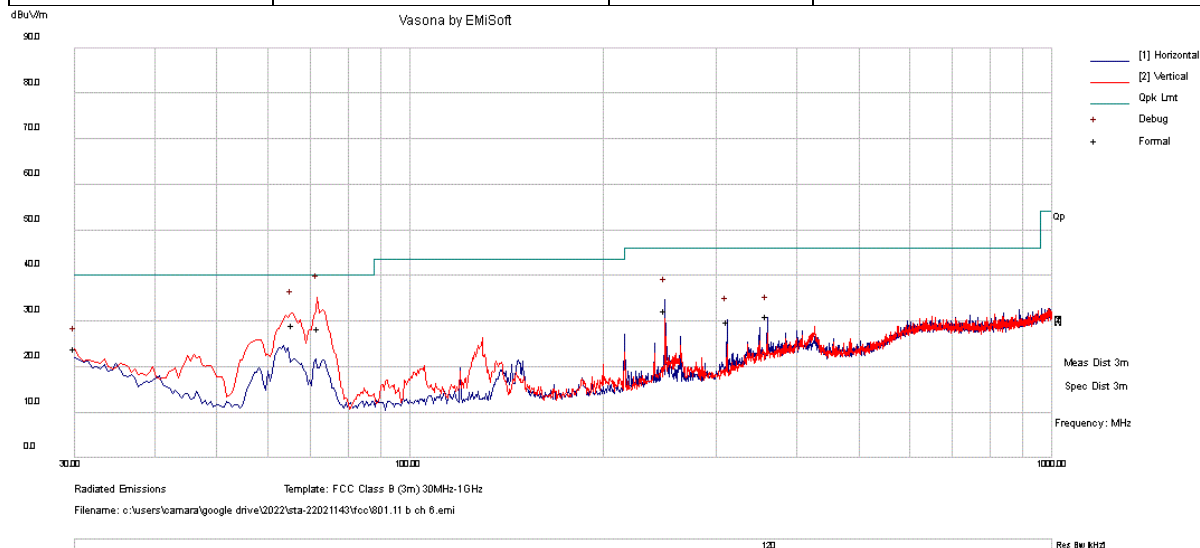
7.8.4 Test Result

Radiated Emission between 9KHz – 30MHz test result

Note: no substantial emission is found other than the noise floor. Different modes have been verified.

RADIATED EMISSIONS BELOW 1 GHZ

Test Standard:	FCC15.247, 15.209	Mode:	802.11b Mode
Frequency Range:	30 MHz - 1 GHz	Test Date:	07/06/2022
Antenna Type/Polarity:	Bi-Log/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Mid channel	Test Result:	Pass



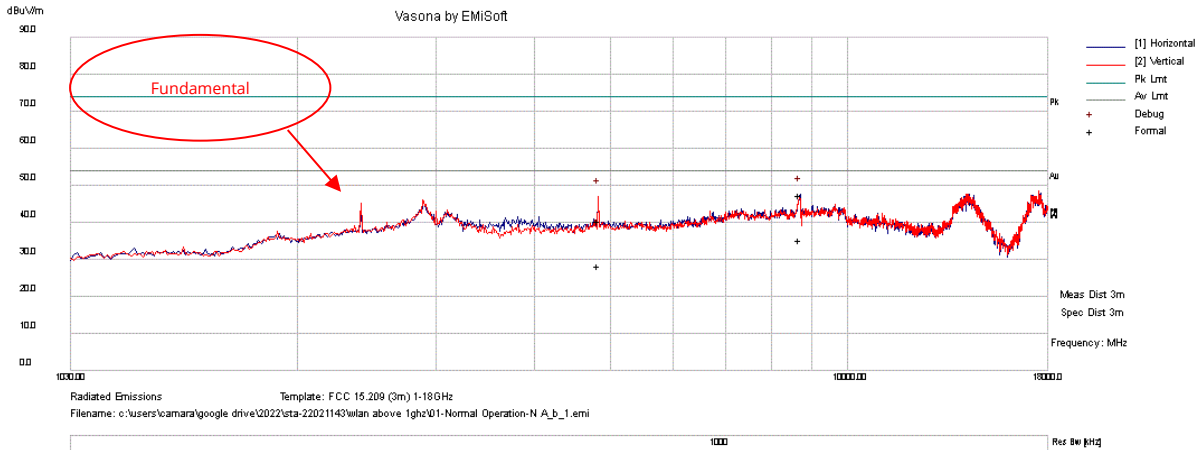
No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	71.954	45.4	3.2	-20.1	28.5	Quasi Max	V	146	20	40	-11.5	Pass
2	65.642	46.5	3.1	-20.3	29.3	Quasi Max	V	126	169	40	-10.7	Pass
3	249.954	41.8	5.3	-14.6	32.5	Quasi Max	H	100	103	46	-13.5	Pass
4	360.014	35.4	6.1	-10.4	31.1	Quasi Max	H	100	140	46	-14.9	Pass
5	311.995	37.6	5.8	-13.4	30	Quasi Max	H	113	0	46	-16	Pass
6	30.013	33.5	2.2	-11.5	24.2	Quasi Max	V	131	108	40	-15.8	Pass

Remarks:

1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) - Pre-amplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)

RADIATED EMISSIONS 1 - 18 GHZ

Test Standard:	FCC15.247, 15.209	Mode:	802.11b Mode
Frequency Range:	1 GHz - 18 GHz	Test Date:	06/27/2022-06/28/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Low Channel	Test Result:	Pass



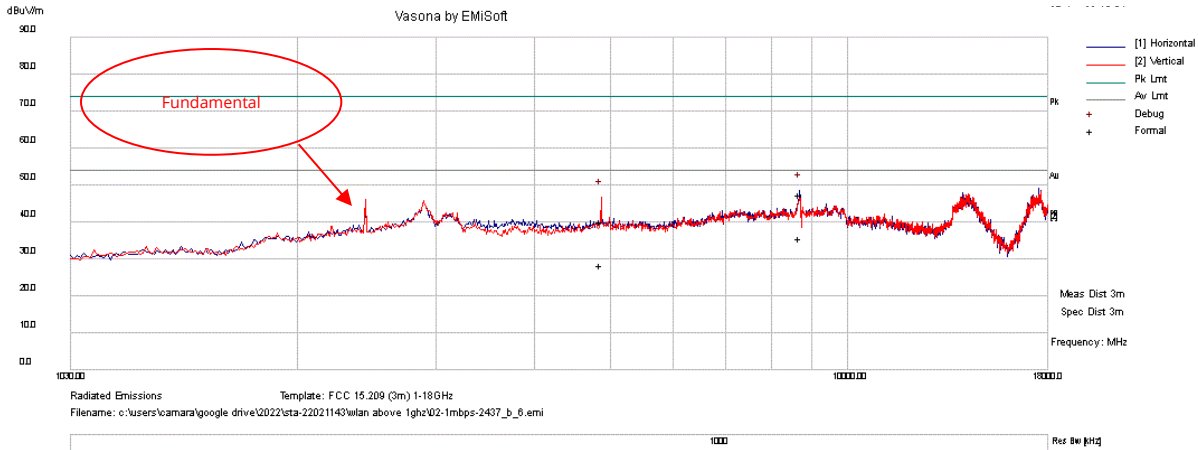
No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	8707.31	35.5	17.6	-5.7	47.4	Peak Max	H	100	216	74	-26.6	Pass
2	4827.188	36.2	9.1	-4.8	40.5	Peak Max	V	319	236	74	-33.5	Pass
3	8707.31	23.4	17.6	-5.7	35.3	Average Max	H	100	216	54	-18.7	Pass
4	4827.188	23.9	9.1	-4.8	28.2	Average Max	V	319	236	54	-25.8	Pass

Remarks:

1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) - Pre-amplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)

RADIATED EMISSIONS 1 - 18 GHZ

Test Standard:	FCC15.247, 15.209	Mode:	802.11b Mode
Frequency Range:	1 GHz – 18 GHz	Test Date:	06/27/2022-06/28/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Mid Channel	Test Result:	Pass



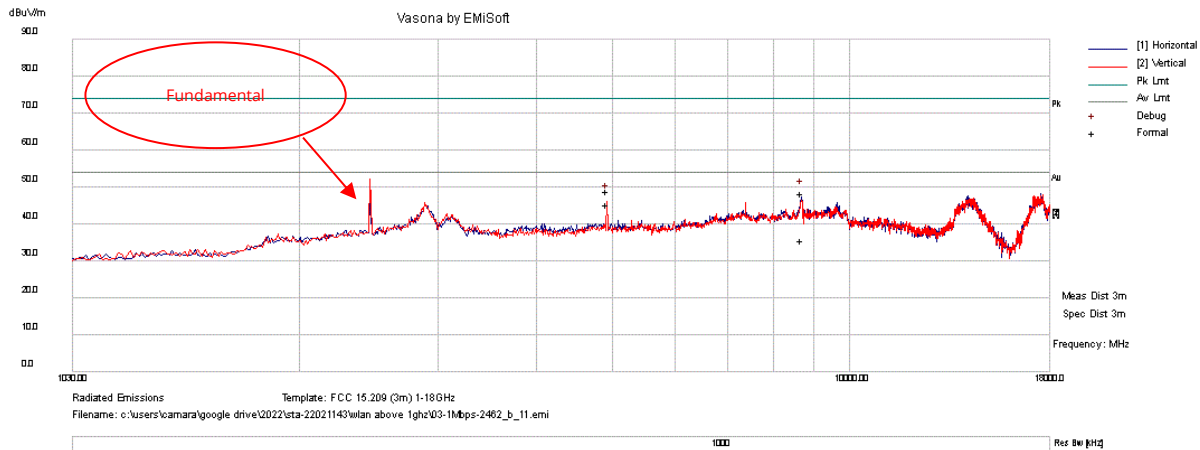
No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	8698.864	35.2	17.9	-5.7	47.4	Peak Max	H	290	290	74	-26.6	Pass
2	4867.565	36.3	9.1	-5.3	40.1	Peak Max	V	361	190	74	-33.9	Pass
3	8698.864	23.5	17.9	-5.7	35.7	Average Max	H	290	290	54	-18.3	Pass
4	4867.565	24.6	9.1	-5.3	28.4	Average Max	V	361	190	54	-25.6	Pass

Remarks:

1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) - Pre-amplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)

RADIATED EMISSIONS 1 - 18 GHZ

Test Standard:	FCC15.247, 15.209	Mode:	802.11b Mode
Frequency Range:	1 GHz - 18 GHz	Test Date:	06/27/2022-06/28/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	High Channel	Test Result:	Pass



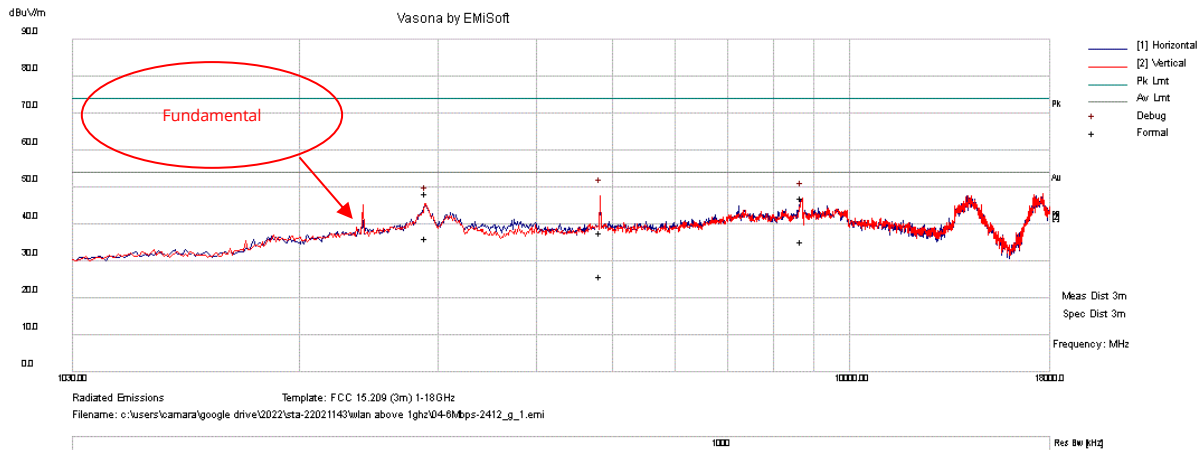
No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	8696.689	36.1	17.8	-5.7	48.2	Peak Max	H	274	319	74	-25.8	Pass
2	4923.896	45.9	9.1	-6.1	48.9	Peak Max	V	299	145	74	-25.1	Pass
3	8696.689	23.6	17.8	-5.7	35.7	Average Max	H	274	319	54	-18.3	Pass
4	4923.896	42.4	9.1	-6.1	45.4	Average Max	V	299	145	54	-8.6	Pass

Remarks:

1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) - Pre-amplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)

RADIATED EMISSIONS 1 - 18 GHZ

Test Standard:	FCC15.247, 15.209	Mode:	802.11g Mode
Frequency Range:	1 GHz – 18 GHz	Test Date:	06/27/2022-06/28/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Low Channel	Test Result:	Pass



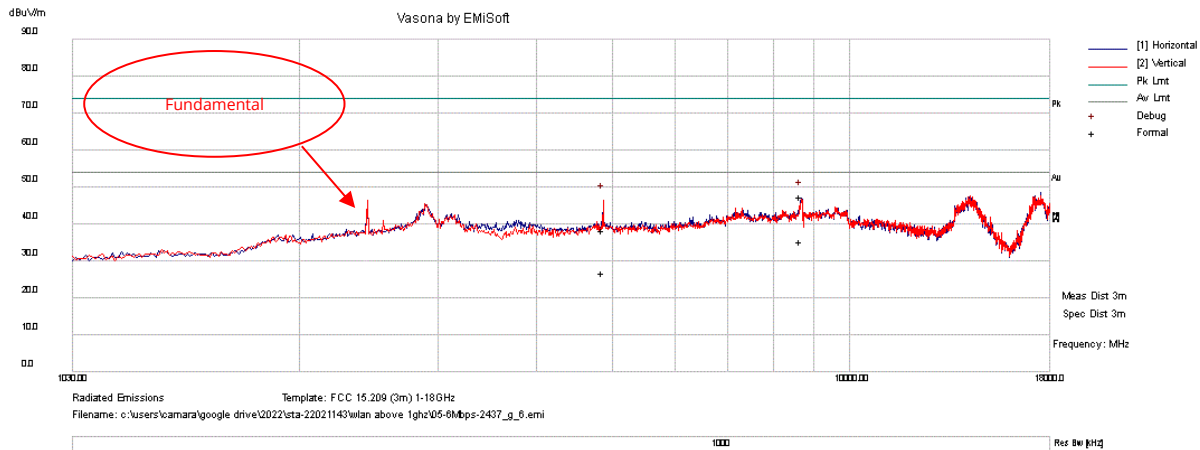
No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	4825.52	33.4	9.1	-4.7	37.8	Peak Max	V	182	355	74	-36.2	Pass
2	8707.868	35.1	17.6	-5.7	47	Peak Max	V	210	320	74	-27	Pass
3	2895.455	22.7	21.9	3.8	48.4	Peak Max	H	100	0	74	-25.6	Pass
4	4825.52	21.6	9.1	-4.7	26	Average Max	V	182	355	54	-28	Pass
5	8707.868	23.5	17.6	-5.7	35.4	Average Max	V	210	320	54	-18.6	Pass
6	2895.455	10.5	21.9	3.8	36.2	Average Max	H	100	0	54	-17.8	Pass

Remarks:

1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) - Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)

RADIATED EMISSIONS 1 - 18 GHZ

Test Standard:	FCC15.247, 15.209	Mode:	802.11g Mode
Frequency Range:	1 GHz – 18 GHz	Test Date:	06/27/2022-06/28/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Mid Channel	Test Result:	Pass



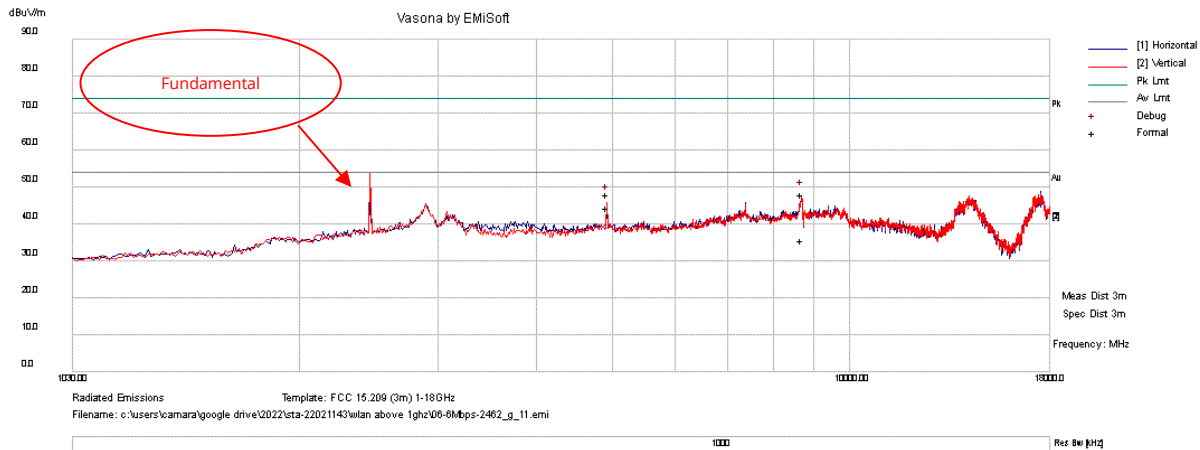
No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	8687.54	35.8	17.4	-5.7	47.5	Peak Max	H	151	48	74	-26.5	Pass
2	4868.583	34.6	9.1	-5.3	38.4	Peak Max	V	254	73	74	-35.6	Pass
3	8687.54	23.7	17.4	-5.7	35.4	Average Max	H	151	48	54	-18.6	Pass
4	4868.583	22.9	9.1	-5.3	26.7	Average Max	V	254	73	54	-27.3	Pass

Remarks:

1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) - Pre-amplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)

RADIATED EMISSIONS 1 - 18 GHZ

Test Standard:	FCC15.247, 15.209	Mode:	802.11g Mode
Frequency Range:	1 GHz - 18 GHz	Test Date:	06/27/2022-06/28/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	High Channel	Test Result:	Pass



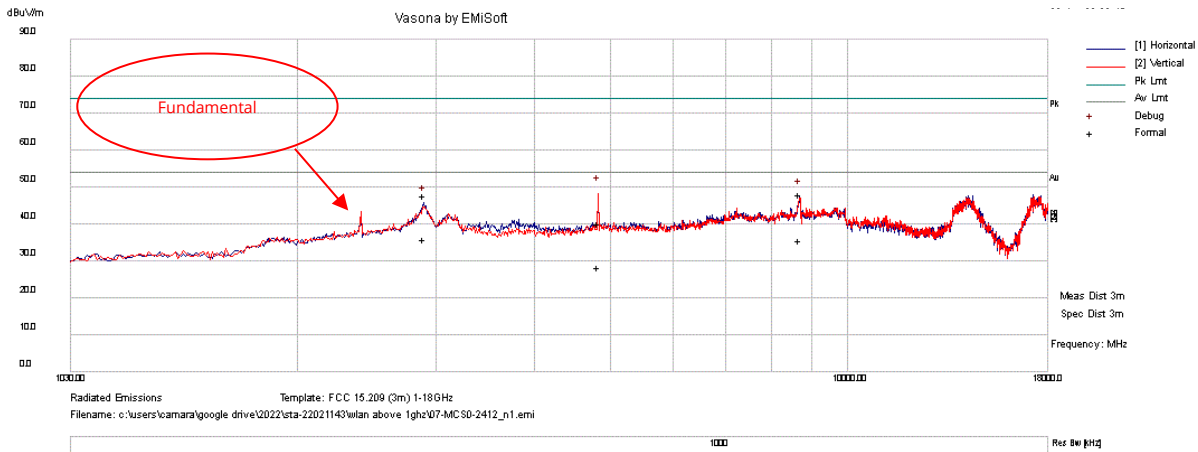
No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	8696.819	36	17.8	-5.7	48.1	Peak Max	V	239	360	74	-25.9	Pass
2	4923.969	45	9.1	-6.1	48	Peak Max	V	208	25	74	-26	Pass
3	8696.819	23.5	17.8	-5.7	35.6	Average Max	V	239	360	54	-18.4	Pass
4	4923.969	41.3	9.1	-6.1	44.3	Average Max	V	208	25	54	-9.7	Pass

Remarks:

1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) - Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)

RADIATED EMISSIONS 1 - 18 GHZ

Test Standard:	FCC15.247, 15.209	Mode:	802.11n20 Mode
Frequency Range:	1 GHz - 18 GHz	Test Date:	06/27/2022-06/28/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Low Channel	Test Result:	Pass



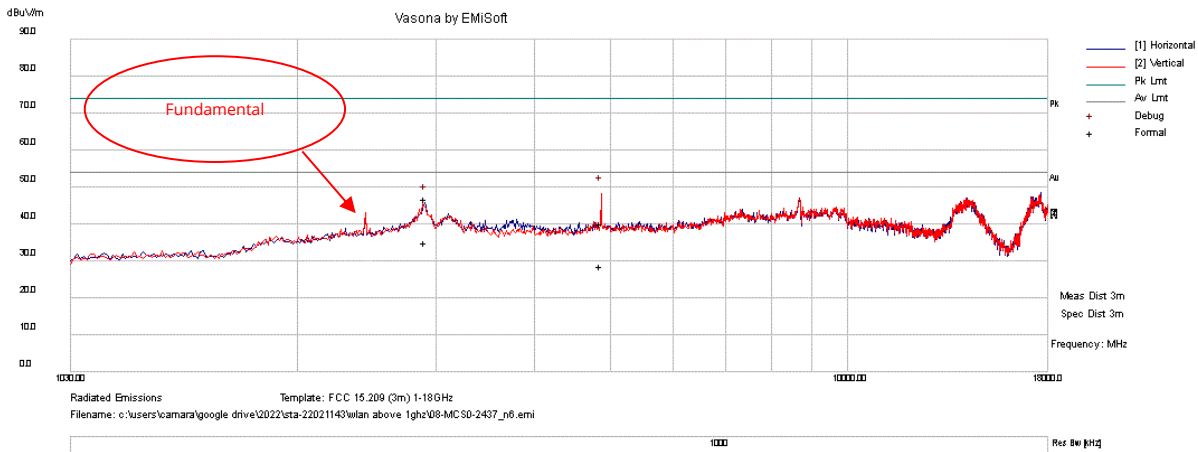
No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	4826.533	35.7	9.1	-4.8	40	Peak Max	V	393	320	74	-34	Pass
2	8697.441	35.8	17.8	-5.7	47.9	Peak Max	H	288	86	74	-26.1	Pass
3	2896.688	22.1	21.9	3.8	47.8	Peak Max	H	174	180	74	-26.2	Pass
4	4826.533	24	9.1	-4.8	28.3	Average Max	V	393	320	54	-25.7	Pass
5	8697.441	23.6	17.8	-5.7	35.7	Average Max	H	288	86	54	-18.3	Pass
6	2896.688	10.2	21.9	3.8	35.9	Average Max	H	174	180	54	-18.1	Pass

Remarks:

1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) - Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)

RADIATED EMISSIONS 1 - 18 GHZ

Test Standard:	FCC15.247, 15.209	Mode:	802.11n20 Mode
Frequency Range:	1 GHz - 18 GHz	Test Date:	06/27/2022-06/28/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Mid Channel	Test Result:	Pass



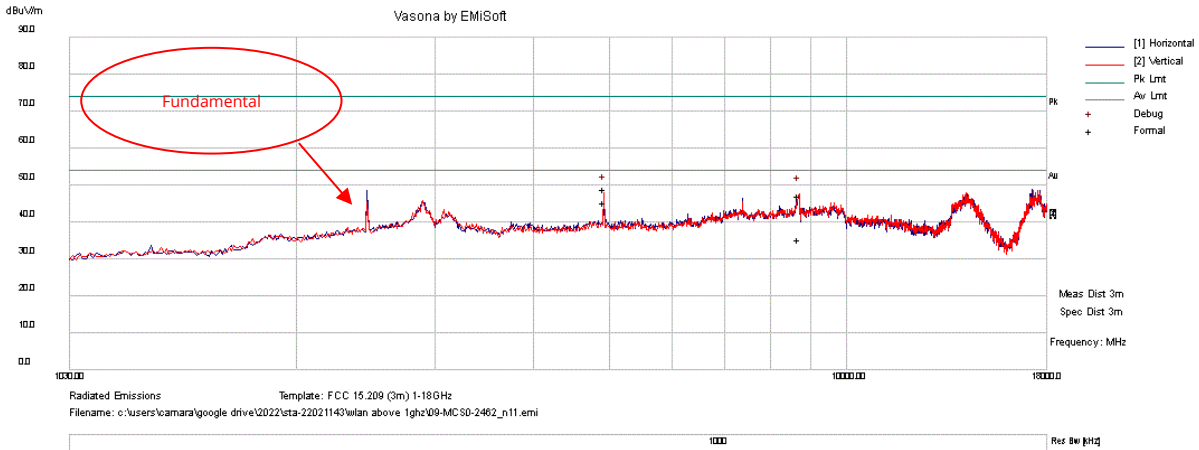
No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	4869.295	36.3	9.1	-5.3	40.1	Peak Max	V	334	48	74	-33.9	Pass
2	2906.758	22	20.8	3.9	46.7	Peak Max	H	304	172	74	-27.3	Pass
3	4869.295	24.8	9.1	-5.3	28.6	Average Max	V	334	48	54	-25.4	Pass
4	2906.758	10.3	20.8	3.9	35	Average Max	H	304	172	54	-19	Pass

Remarks:

1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) - Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)

RADIATED EMISSIONS 1 - 18 GHZ

Test Standard:	FCC15.247, 15.209	Mode:	802.11n20 Mode
Frequency Range:	1 GHz - 18 GHz	Test Date:	06/27/2022-06/28/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	High Channel	Test Result:	Pass



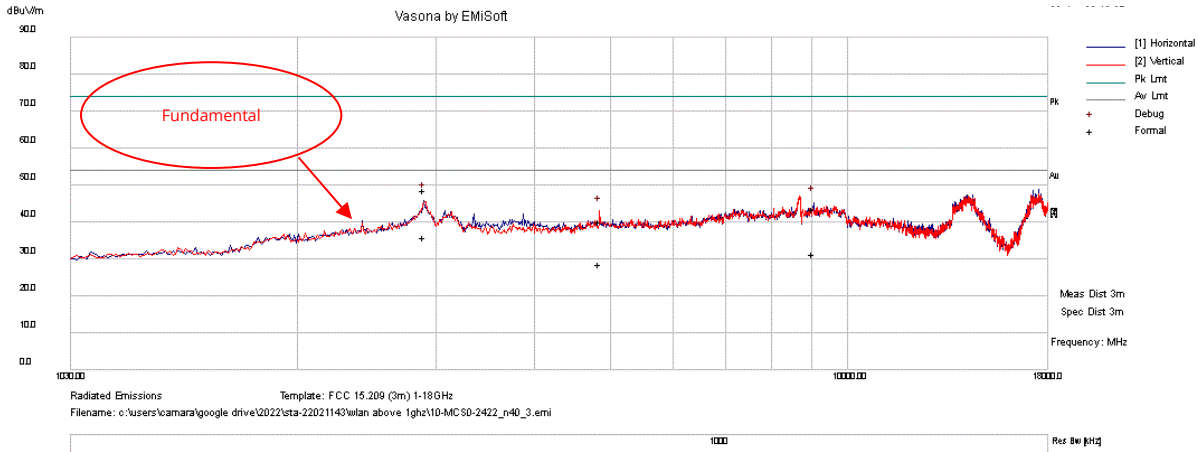
No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	4923.789	45.9	9.1	-6.1	48.9	Peak Max	V	261	40	74	-25.1	Pass
2	8707.72	35.1	17.6	-5.7	47	Peak Max	V	315	159	74	-27	Pass
3	4923.789	42.3	9.1	-6.1	45.3	Average Max	V	261	40	54	-8.7	Pass
4	8707.72	23.5	17.6	-5.7	35.4	Average Max	V	315	159	54	-18.6	Pass

Remarks:

1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) - Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)

RADIATED EMISSIONS 1 - 18 GHZ

Test Standard:	FCC15.247, 15.209	Mode:	802.11n40 Mode
Frequency Range:	1 GHz - 18 GHz	Test Date:	06/27/2022-06/28/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Low Channel	Test Result:	Pass



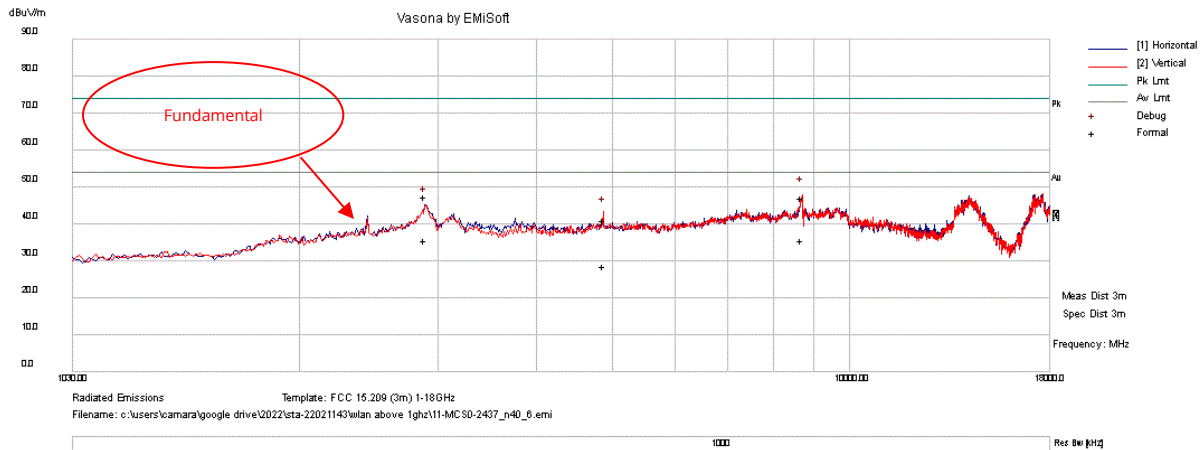
No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	2896.655	22.9	21.9	3.8	48.6	Peak Max	H	243	0	74	-25.4	Pass
2	9057.056	35.6	13.6	-5.9	43.3	Peak Max	H	329	0	74	-30.7	Pass
3	4849.207	36	9.1	-5	40.1	Peak Max	V	201	211	74	-33.9	Pass
4	2896.655	10.2	21.9	3.8	35.9	Average Max	H	243	0	54	-18.1	Pass
5	9057.056	23.4	13.6	-5.9	31.1	Average Max	H	329	0	54	-22.9	Pass
6	4849.207	24.5	9.1	-5	28.6	Average Max	V	201	211	54	-25.4	Pass

Remarks:

1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) - Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)

RADIATED EMISSIONS 1 - 18 GHZ

Test Standard:	FCC15.247, 15.209	Mode:	802.11n40 Mode
Frequency Range:	1 GHz – 18 GHz	Test Date:	06/27/2022-06/28/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	Mid Channel	Test Result:	Pass



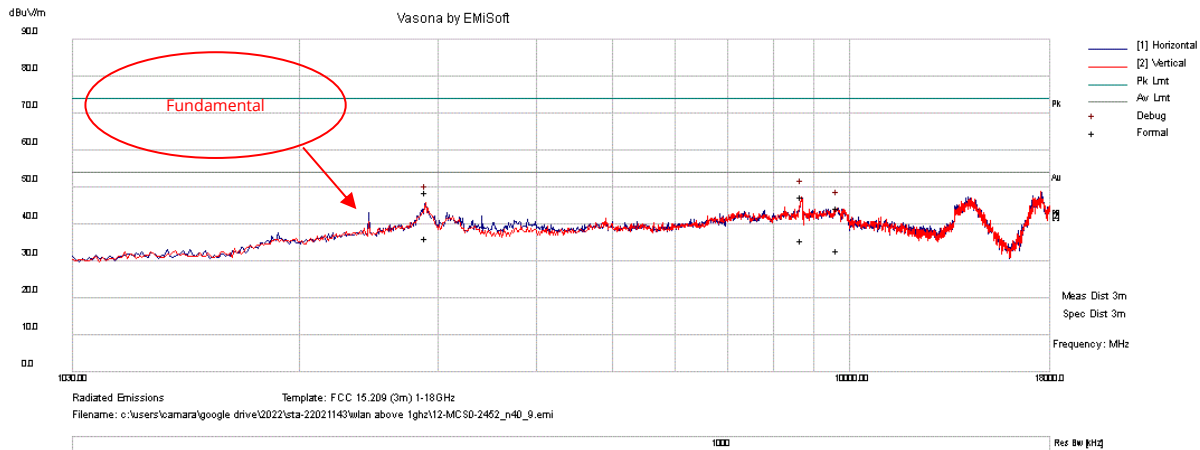
No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	8707.76	35.3	17.6	-5.7	47.2	Peak Max	V	213	44	74	-26.8	Pass
2	2887.946	21.8	21.9	3.8	47.5	Peak Max	H	268	88	74	-26.5	Pass
3	4872.748	37.4	9.1	-5.4	41.1	Peak Max	V	253	345	74	-32.9	Pass
4	8707.76	23.5	17.6	-5.7	35.4	Average Max	V	213	44	54	-18.6	Pass
5	2887.946	10.1	21.9	3.8	35.8	Average Max	H	268	88	54	-18.2	Pass
6	4872.748	24.7	9.1	-5.4	28.4	Average Max	V	253	345	54	-25.6	Pass

Remarks:

1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) - Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)

RADIATED EMISSIONS 1 - 18 GHZ

Test Standard:	FCC15.247, 15.209	Mode:	802.11n40 Mode
Frequency Range:	1 GHz - 18 GHz	Test Date:	06/27/2022-06/28/2022
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Devin Tai
Remark:	High Channel	Test Result:	Pass



No.	Frequency MHz	Raw dBuV	Cable Loss	AF dB/m	Level dBuV/m	Measurement Type	Pol	Hgt cm	Azt Deg	Limit dBuV/m	Margin dB	Pass/Fail
1	8697.479	35.2	17.8	-5.7	47.3	Peak Max	V	202	78	74	-26.7	Pass
2	2898.57	23	21.9	3.8	48.7	Peak Max	V	213	0	74	-25.3	Pass
3	9661.493	35.1	14.4	-5.2	44.3	Peak Max	V	340	336	74	-29.7	Pass
4	8697.479	23.5	17.8	-5.7	35.6	Average Max	V	202	78	54	-18.4	Pass
5	2898.57	10.4	21.9	3.8	36.1	Average Max	V	213	0	54	-17.9	Pass
6	9661.493	23.5	14.4	-5.2	32.7	Average Max	V	340	336	54	-21.3	Pass

Remarks:

1. Level (dBuV/m) = Raw (dBuV) + Cable loss(dB) + AF (dB/m).
2. AF (dB/m) = Antenna Factor (dB) - Pre-amplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value(dBuV/m)

Radiated Emission between 18GHz - 40GHz test result

Note: no substantial emission is found other than the noise floor. Different modes have been verified.

7.9 Conducted Emissions

7.9.1 Requirement

Per § 15.207 (a)

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).

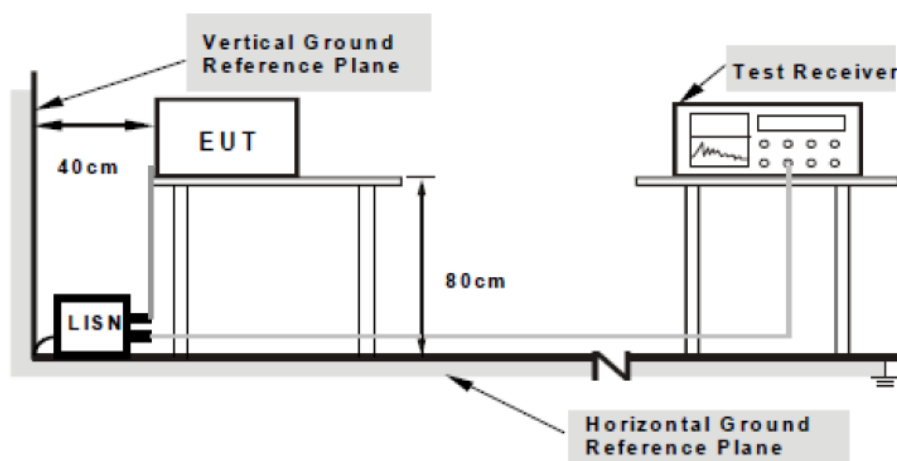
Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Limits for Conducted Emissions at the Mains Ports

Section	Frequency ranges (MHz)	Limit (dBuV)	
		QP	Average
Class B devices	0.15 – 0.5	66 – 56	56 – 46
	0.5 – 5	56	46
	5 - 30	60	50

NOTE 1 The lower limit shall apply at the transition frequencies.

7.9.2 Test setup



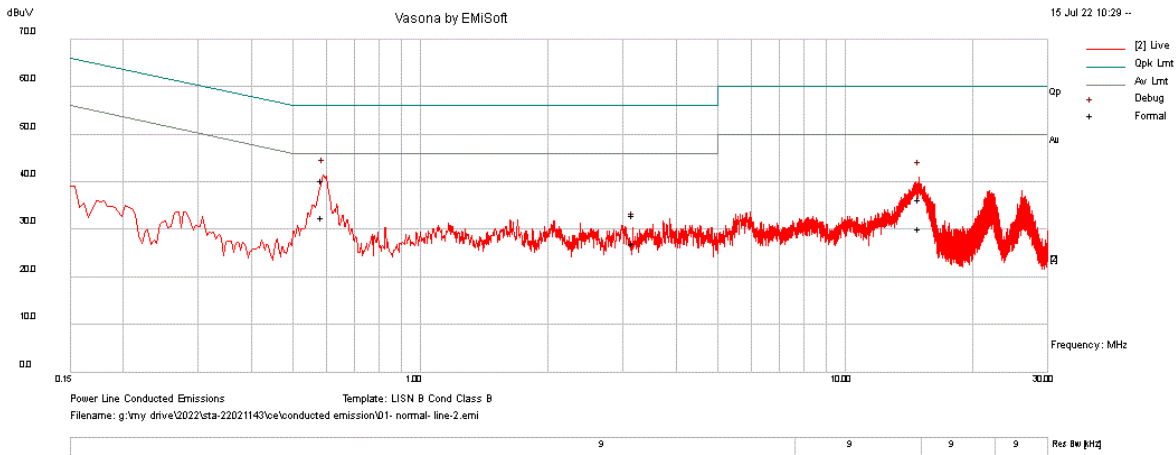
- Note:**
1. Support units were connected to second LISN.
 2. Both of LISNs (AMN) are 80cm from EUT and at least 80cm from other units and other metal planes support units.

7.9.3 Test Procedure

1. The EUT and supporting equipment were set up in accordance with the requirements of the standard on top of a 1.5m x 1m x 0.8m high, non-metallic table.
2. The power supply for the EUT was fed through a 50 Ω /50 μ H EUT LISN, connected to filtered mains.
3. The RF OUT of the EUT LISN was connected to the EMI test receiver via a low-loss coaxial cable. The LISN bonded to the reference ground plane used has a direct current (dc) resistance of less than 2.5 m Ω .
4. All other supporting equipment was powered separately from another main supply.
5. The EUT was switched on and allowed to warm up to its normal operating condition.
6. A scan was made on the Live / Neutral line (for AC mains) or Earth line (for DC power) over the required frequency range using an EMI test receiver.
7. High peaks, relative to the limit line, were then selected.
8. The EMI test receiver was then tuned to the selected frequencies and the necessary measurements made with a receiver bandwidth setting of 10 kHz. For FCC tests, only Quasi-peak measurements were made; while for CISPR/EN tests, both Quasi-peak and Average measurements were made
9. All possible modes of operation were investigated. Only the worst case emissions were measured and reported. All other emissions were relatively insignificant.

7.9.4 Test Result

Test Standard:	Part 15.207	Mode:	TX Mode
Frequency Range:	0.15-30MHz	Test Date:	07/15/2022
Antenna Type/Polarity:	N/A	Test Personnel:	Devin Tai
Remark:	Line 120VAC, 60Hz	Test Result:	Pass

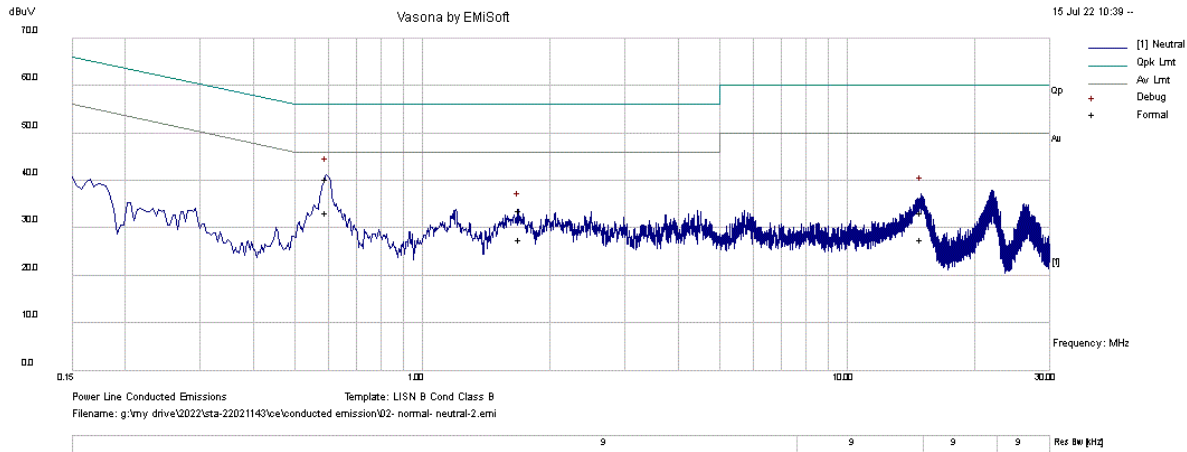


No.	Frequency (MHz)	Raw (dBuV)	Cable Loss (dB)	Factors (dB)	Level (dBuV)	Meas. Type	Line	Limit (dBuV)	Margin (dB)	Pass /Fail
1	0.588	30.1	10.1	0.1	40.3	Quasi Peak	Live	56	-15.7	Pass
2	14.906	25.4	10.6	0.3	36.3	Quasi Peak	Live	60	-23.7	Pass
3	3.177	22.6	10.3	0.1	33	Quasi Peak	Live	56	-23	Pass
4	0.588	22.3	10.1	0.1	32.5	Average	Live	46	-13.5	Pass
5	14.906	19.4	10.6	0.3	30.3	Average	Live	50	-19.7	Pass
6	3.177	16.8	10.3	0.1	27.2	Average	Live	46	-18.8	Pass

REMARKS:

1. The emission levels of other frequencies were very low against the limit.
2. Factor = Inert loss of LISN
3. Margin value = Emission level - Limit value
4. Emission Level = Raw Value + Cable loss + Factors Value.

Test Standard:	Part 15.207, RSS Gen 8.8	Mode:	TX Mode
Frequency Range:	0.15-30MHz	Test Date:	07/15/2022
Antenna Type/Polarity:	N/A	Test Personnel:	Devin Tai
Remark:	Neutral 120VAC, 60Hz	Test Result:	Pass



No.	Frequency (MHz)	Raw (dBuV)	Cable Loss (dB)	Factors (dB)	Level (dBuV)	Meas. Type	Line	Limit (dBuV)	Margin (dB)	Pass /Fail
1	0.594	30.1	10.1	0.1	40.3	Quasi Peak	Neutral	56	-15.7	Pass
2	1.693	23.5	10.2	0.1	33.8	Quasi Peak	Neutral	56	-22.2	Pass
3	14.897	22.5	10.6	0.3	33.4	Quasi Peak	Neutral	60	-26.6	Pass
4	0.594	23.1	10.1	0.1	33.3	Average	Neutral	46	-12.7	Pass
5	1.693	17.4	10.2	0.1	27.7	Average	Neutral	46	-18.3	Pass
6	14.897	16.7	10.6	0.3	27.6	Average	Neutral	50	-22.4	Pass

REMARKS:

1. The emission levels of other frequencies were very low against the limit.
2. Factor = Inert loss of LISN
3. Margin value = Emission level - Limit value
4. Emission Level = Raw Value + Cable loss + Factors Value.

8 EUT and Test Setup Photos

Refer to FCC filing

9 Test Instrument List

Equipment	Manufacturer	Model	Instrument Number	Cal. Date	Cal. Due
Semi-Anechoic Chamber	ETS-Lindgren	10M	VL001	10/18/2021	10/18/2022
Shielding Control Room	ETS-Lindgren	Series 81	VL006	N/A	N/A
Spectrum Analyzer	Keysight	N9020A	MY50110074	06/09/2022	06/09/2023
EMC Test Receiver	R&S	ESL6	100230	06/07/2022	06/07/2023
LISN (9KHz – 30MHz)	EMCO	3816/2	9705-1066	07/12/2022	07/12/2023
Bi-Log Antenna	ETS-Lindgren	3142E	217921	07/19/2022	07/19/2023
Horn Antenna (1-18GHz)	Electro-Metrics	EM-6961	6292	07/21/2022	07/21/2023
Horn Antenna (18-40GHz)	Com-Power	AH-840	101109	07/21/2022	07/21/2023
Preamplifier	RF Bay, Inc.	LPA-10-20	11180621	07/16/2022	07/16/2023
True RMS Multi-meter	UNI-T	UT181A	C173014829	06/07/2022	06/07/2023
Temp / Humidity / Pressure Meter	PCE Instruments	PCE-THB 40	R062028	06/07/2022	06/07/2023
RF Attenuator	Pasternack	PE7005-3	VL061	07/16/2022	07/16/2023
Preamplifier 100KHz - 40GHz	Aeroflex	33711-392-77150-11	064	07/16/2022	07/16/2023
EM Center Control	ETS-Lindgren	7006-001	160136	N/A	N/A
Turn Table	ETS-Lindgren	2181-3.03	VL002	N/A	N/A
Boresight Antenna Tower	ETS-Lindgren	2171B	VL003	N/A	N/A
Loop Antenna (9k-30MHz)	Com-Power	AL-130	121012	06/10/2022	06/10/2023
RE test cable(below 6GHz)	Vista	RE-6GHz-01	RE-6GHz-01	07/16/2022	07/16/2023
RE test cable (1-18GHz)	PhaseTrack	II-240	RE-18GHz-01	07/16/2022	07/16/2023
RE test cable (>18GHz)	Sucoflex	104	344903/4	07/16/2022	07/16/2023
Pulse limiter	Com-Power	LIT-930A	531727	07/16/2022	07/16/2023
CE test cable #1	FIRST RF	FRF-C-1002-001	CE-6GHz-01	07/16/2022	07/16/2023
CE test cable#2	FIRST RF	FRF-C-1002-001	CE-6GHz-02	07/16/2022	07/16/2023

Note:

- 1) This equipment is not for measurement purpose and only require functional verification. Calibration is not required.

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