REPORT

For

Alpha Technologies Ltd.

7700 Riverfront Gate
Burnaby, BC, V5J 5M4, Canada

Date of Issue October 3, 2023
Report No.: 20.01.22053-2
Project No.: 22053
Equipment: WiFi/BT radio module for use in Alpha Equipment
Model No.: GL0005322

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TEST REPORT
47 CFR § 15.247, RSS-247

RSS-247 — Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
47 CFR § 15.247 - Operation within the bands 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz.

Report No. ..... :	20.01.22053-2	
Compiled by	Zara Vali	
Approved by	David Johanson	
Date of issue ..... :	3 October 2023	
Laboratory information:		
Testing Laboratory ..... :	LabTest Certification Inc.	
Address ..... :	Delta Lab: *Unit 205 – 8291 92ST. Delta, B.C. V4G 0A4, Canada* Richmond Lab: *Unit 3128-20800 Westminster HWY, Richmond, B.C. V6V 2W3 Canada*	
FCC Site Registration No.:	CA5970	
IC Site Registration No.:	5970A-2	
Applicant's name..... :	Alpha Technologies Ltd.	
Address ..... :	7700 Riverfront Gate, Burnaby, BC, V5J 5M4, Canada	
Manufacture's Name ..... :	Same as Applicant	
Address ..... :	Same as Applicant	
Test item description :		
Trade Mark ..... :	NA	
Equipment name:	WiFi/BT radio module for use in Alpha Equipment	
Model number ..... :	GL0005322	
Serial Number ..... :	Proto-009	
FCC ID ..... :	2BA9E-GL0005322	
IC ID ..... :	30668-GL0005322	
Possible test case verdicts:		
- test case does not apply to the test object ..... :	NA	
- test object does meet the requirement ..... :	P (Pass)	

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- test object does not meet the requirement .....:	F (Fail)
Testing:	
Date of receipt of test item .....:	June 19, 2023
Date (s) of performance of tests.....:	June 19 – July 26, 2023

Revision History

Revision	Date	Reason For Change	Author
0	2 August 2023	Initial Data	Zara Vali
1	3 October 2023	Duty Cycle Measurements added	Zara Vali

Result Summary

The tests indicated in result summary were performed on the product constructed as described below. The test sections are the verbatim text from the actual data sheets used during the investigation. These test sections include the test name, the specified test method, a list of the actual test equipment used, documentation photos, results, and raw data. No additions, deviations, or exclusions have been made from the standard(s) unless specifically noted.
The compliance status is a judgment based on the direct measurements and calculated highest emissions to appropriate standard limits. Measurement uncertainty values, provided on calibration certificates, were not be used in the judgment of the final status of compliance.
Based on the results of our investigation, we have concluded the product tested **complies** with the requirements of the standard(s) indicated. The results obtained in this test report pertain only to the item(s) tested. LabTest does not make any claims of compliance for samples or variants which were not tested.

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47 CFR § 15.247 and RSS-247			
Test Type	**Standard**	**Test Method**	**Result**
6dB Bandwidth Measurement	FCC Part 15.247 (a) (2) RSS-247 5.2 RSS Gen, Issue 5	KDB 558074 D01 v05r02 ANSI C63.10:2013	Pass
Radiated Peak Power Measurement	FCC 15.247 (b)(3) RSS-247 5.4 (d) RSS Gen, Issue 5	KDB 558074 D01 v05r02 ANSI C63.10:2013	Pass
Power Spectral Density	FCC 15.247(e) RSS-247 5.2 RSS Gen, Issue 5	KDB 558074 D01 v05r02 ANSI C63.10: 2013	Pass
Band Edge and Out of Band Emissions	FCC Part 15.247 (d) RSS-247 5.5 RSS Gen, Issue 5	KDB 558074 D01 v05r02 ANSI C63.10: 2013	Pass
Radiated Spurious Emissions	FCC Part 15.209 RSS-Gen Issue 5	ANSI C63.10: 2013	Pass
Radiated Restricted Band Edge Measurement	FCC Part 15. 247 (d) FCC Part 15. 205 FCC Part 15. 209 RSS-247 5.5	ANSI C63.10: 2013	Pass
General			
Antenna Requirement	FCC Part 15.203 RSS-Gen Issue 5	Inspection	Pass
Non-standard test method	NA		

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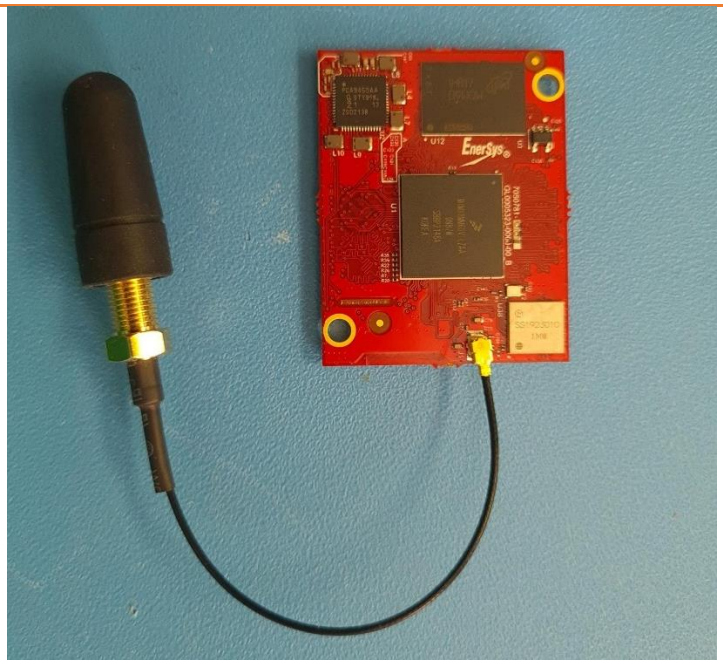
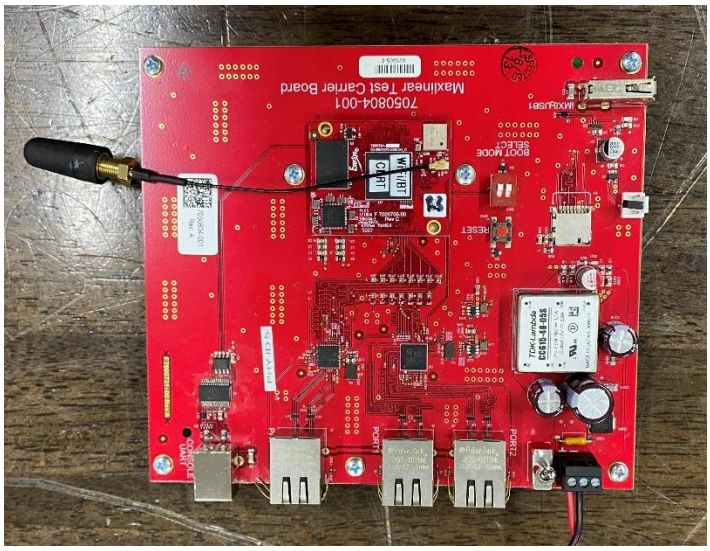
Description of Equipment Under Test and Variant Models

Description:
WiFi/BT radio module for use in Alpha Equipment
Alpha Communication Module utilizing Murata Type 1MW W-LAN Bluetooth module and Abracon PRO-EX-347 Antenna.



Module shown with antenna Abracon PRO-EX-347 attached with support cable



Module shown installed in Carrier PCB.
Antenna Abracon PRO-EX-347 attached with support cable.

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Variant Models: The following variant models were not tested as part of this evaluation, but have been identified by the manufacturer as being electrically identical models, depopulated models, or with reasonable similarity to the model(s) tested. LabTest does not make any claims of compliance for samples or variants which were not tested.
None

Radio Device Under Test Description

Application for ..... :	WiFi/BT radio module for use in Alpha Equipment
Operating Transmit Frequency ..... :	2412 - 2462 MHz
Operating Receive Frequency ..... :	2412 - 2462 MHz
Number of Channels ..... :	11
Maximum EIRP (dBm) ..... :	802.11b: 22.348 802.11g: 23.327 802.11n-HT20: 22.047
Modulation Type ..... :	802.11b: DSSS 802.11g/n: OFDM
Data Rate ..... :	802.11b: 1/2/5.5/11Mbps 802.11g: 6/9/12/18/24/36/48/54Mbps 802.11n-HT20: up to 72.2Mbps
Antenna Type/Gain ..... :	3 dBi
Operating condition ..... :	-30 to 85 °C
Dimension (W X D X H)	140 mm X 158 mm X 17 mm
Supply Voltage:	5Vdc @ > 0.5Amps
If DC Power:	☐ Internal Power Supply ■ External Power Supply or AC/DC adapter ☐ Battery ☐ Nickel Cadmium ☐ Alkaline, 4 X AA ☐ Nickel-Metal Hydride ☐ Lithium-Ion ☐ Other

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EUT Internal Operating Frequencies

#	Frequency	Description
1	2412 - 2462 MHz	WiFi
2	24 MHz	Crystal on the SOM PCB
3	32.768 kHz	Crystal on the SOM PCB

Client Equipment Used During Test

#	Product Type	Manufacturer	Model	Comments
1	WiFi/BT module	Alpha Technologies Ltd.	GL0005322	EUT
2	Switching mode power supply (AD/DC power adaptor)	Triad	WSX240-1000	AE
3	Laptop	Lenovo	ThinkPad	AE

Abbreviations:
EUT - Equipment Under Test,
AE - Auxiliary/Associated Equipment, or
SIM - Simulator (Not Subjected to Test)

Software and Firmware

#	Description	Version
1	Murata RF Test Tool	Version 1.21

Abbreviations:
EUT - Equipment Under Test,
AE - Auxiliary/Associated Equipment, or
SIM - Simulator (Not Subjected to Test)

Input/Output Ports

Port #	Name	Type*	Cable Max. >3m	Cable Shielded	Comments
1	Enclosure Port				
2	Antenna Port				

*Note: AC = AC Power Port DC = DC Power Port N/E = Non-Electrical
I/O = Signal Input or Output Port (Not Involved in Process Control)
TP = Telecommunication Ports

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Power Interface

Mode #	Voltage (V)	Current (A)	Frequency (DC/AC-Hz)	Phases (#)	Comments
1	5 VDC	0.5 Amps	DC	-	Provided by AD/DC power adaptor

EUT Operation Modes

Mode #	Description
1	WiFi mode: EUT is transmitting in the WiFi mode.

EUT Configuration Modes

Mode #	Description
1	EUT is connected to AC/DC power adaptor.

Duty Cycle Measuement of the EUT

The maximum achievable duty cycle was determined based on measurements performed on a spectrum analyzer in zero-span mode with RBW = 8MHz, VBW = 50MHz, and detector = peak or average per the guidance of Section 6.0 b) of KDB 558074 D01v04. The RBW and VBW were both greater than 50/T, where T is the minimum transmission duration, and the number of sweep points across T was greater than 100. The duty cycles are as follows:

Mode	Duty Cycle
802.11b	99.13%
802.11g	98.46%
802.11n-HT20	99.77%

Duty cycle (T = Transmission Duration)

802.11b (T =861.3 µs)

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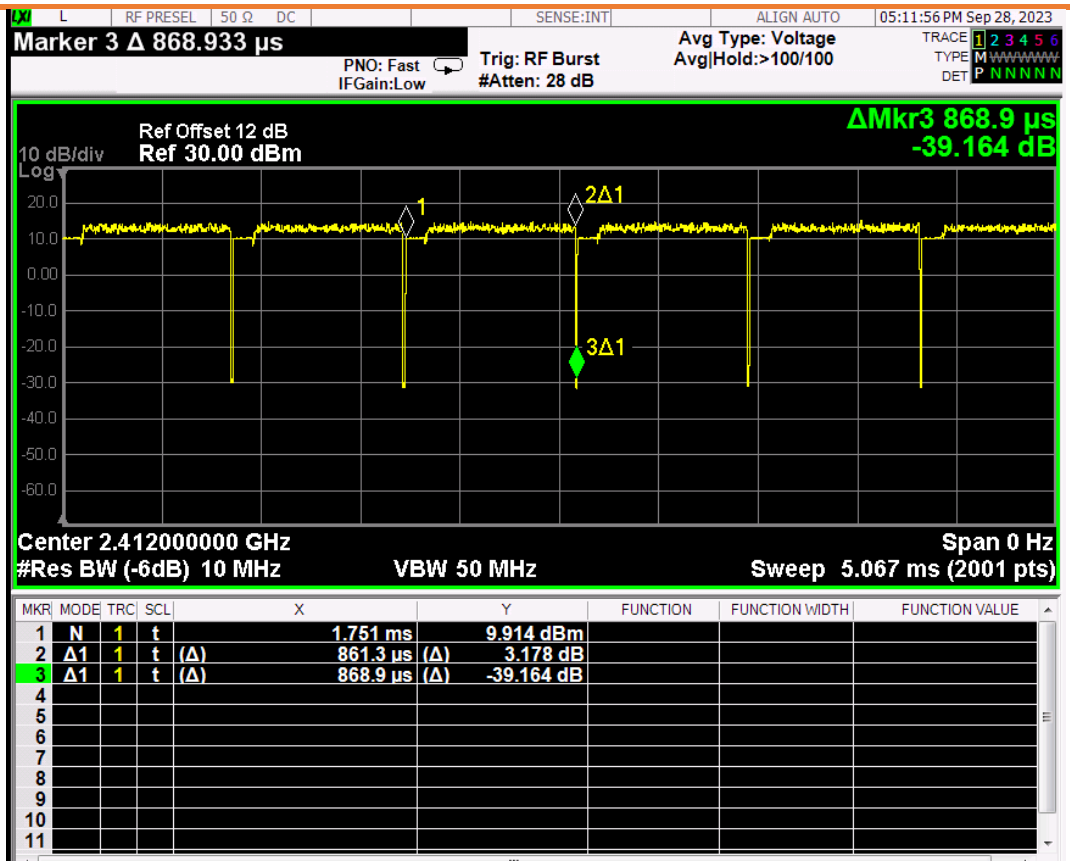

802.11g (T = 1.414 ms)

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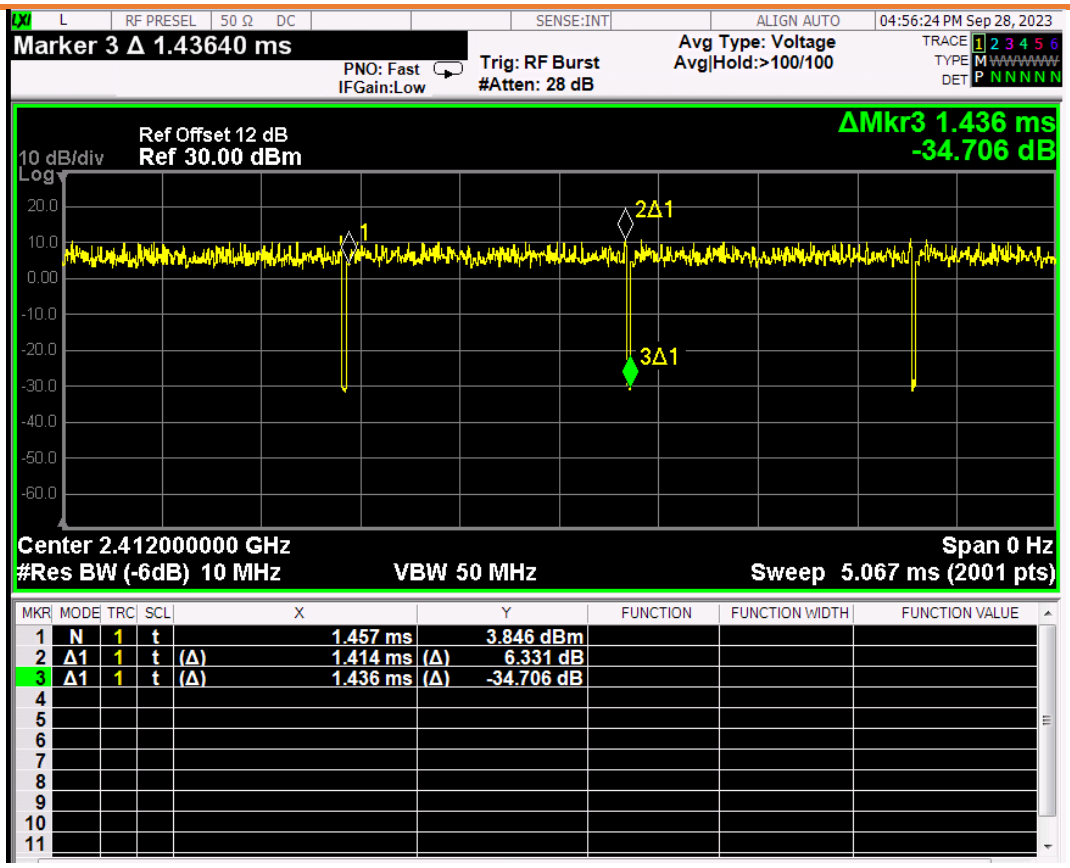

802.11n-HT20 (T = 1.335 ms)

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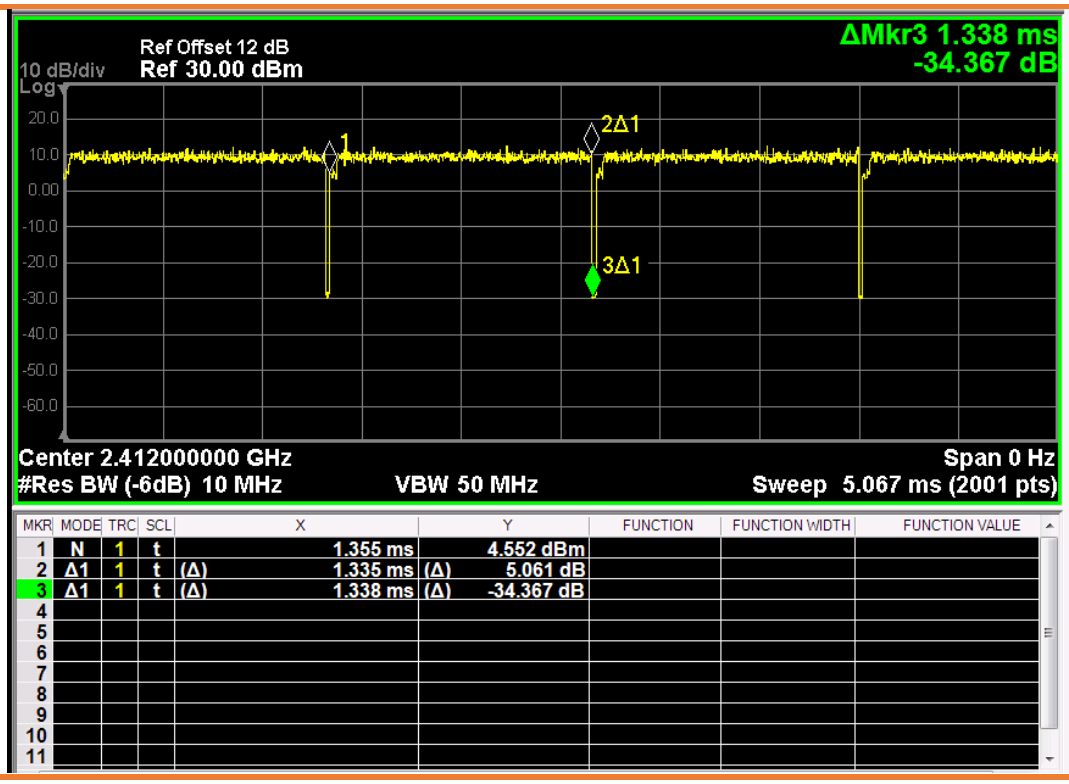

MKR	MODE	TRC	SCL	X	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE
1	N	1	t	1.355 ms	4.552 dBm			
2	Δ1	1	t	(Δ) 1.335 ms	(Δ) 5.061 dB			
3	Δ1	1	t	(Δ) 1.338 ms	(Δ) -34.367 dB			
4								
5								
6								
7								
8								
9								
10								
11								

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Test Equipment Verified for Function

Model #	Description	Checked Function	Results
N9038A	Spectrum Analyzer	Frequency and Amplitude	Connected 50MHz and -20 dBm Ref_siganl and checked OK.
JB1	Antenna, 30 to 2000MHz	Checked structure	Normal – no damage.
SAS-571	Antenna, 1 to 18GHz	Checked structure	Normal – no damage.
SAS-572	Antenna, 18 to 26.5 GHz	Checked structure	Normal – no damage.
AL-130	Antenna, 9kHz to 30MHz	Checked structure	Normal – no damage.

Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests:

Parameter	Uncertainty
Radio Frequency	± 1 ppm
Total RF Power: Conducted	± 1 dB
RF Power Density: Conducted	± 2.75 dB
Spurious Emissions: Conducted	± 3.0 dB
Temperature	± 1.0 °C
Humidity	± 5.0 %
DC and Low Frequency Voltages	± 3.0 %
Radiated Emission, 30 to 6,000MHz	± 4.93 dB
Conducted Measurements, 0.15 to 30MHz	± 3.52 dB

Uncertainty figures are valid to a confidence level of 95%.

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1- Antenna Requirement

Standard	47 CFR Part 15.203 RSS-Gen Issue 5	Room Temperature (°C)	24.4
Test Method	Inspection	Relative Humidity (%)	45.9
Test Location	Richmond Lab	Barometric Pressure (hPa)	1013.5
Test Engineer	Zara Vali	Date of Test	June 19, 2023
Compliant ☒	Non-Compliant ☐	Not Applicable ☐	

Test Methods

According to §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.

Test Results

Accordance to the above sections, Abracon PRO-EX-347 is considered sufficient to comply with the provisions of these section. Please see EUT photos for details.

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2- 6dB Bandwidth Measurement

Standard	FCC Part 15.247 (a) (2) RSS-247 5.2 RSS Gen, Issue 5	Room Temperature (°C)	26.8
Test Method	KDB 558074 D01 v05r02 ANSI C63.10:2013	Relative Humidity (RH%)	44.7
Test Location	Richmond lab	Barometric Pressure (hPa)	1018.1
Test Engineer	Zara Vali	Date of Test	July 26, 2023

Test Equipment	Manufacturer	Model	Identifier	Calibration	Calibration due
EMC Analyzer	Keysight	N9038A	702	02 November, 2022	02 November, 2023
Attenuator	Mini-Circuit	VAT-20+	n/a	IHC[1]	IHC[1]

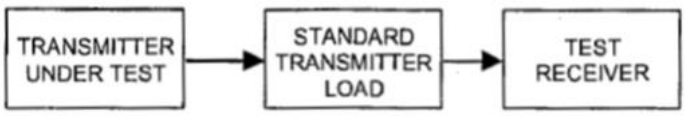
Note1) In House Calibration

Compliant ☒ Non-Compliant ☐ Not Applicable ☐

Test Method

1. The spectrum's automatic bandwidth measurement capability was used to perform the 6dB bandwidth measurement. The "X" dB bandwidth parameter was set to 6.
2. Set RBW = 100 kHz
3. VBW = 3 x RBW
4. Detector = Peak
5. Trace mode = Max Hold
6. Sweep = auto couple
7. Allow the trace to be stabilized.

Test Setup



EUT was connected directly to the spectrum analyzer with a 20 dB attenuator.
The EUT was set to **Operation Mode #1 with configuration Mode #1.**

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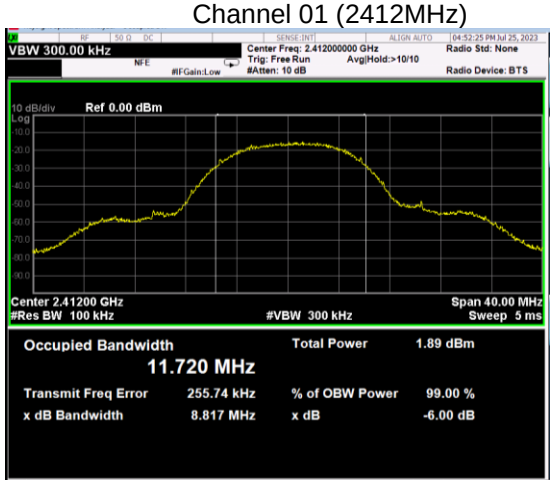
Test Results

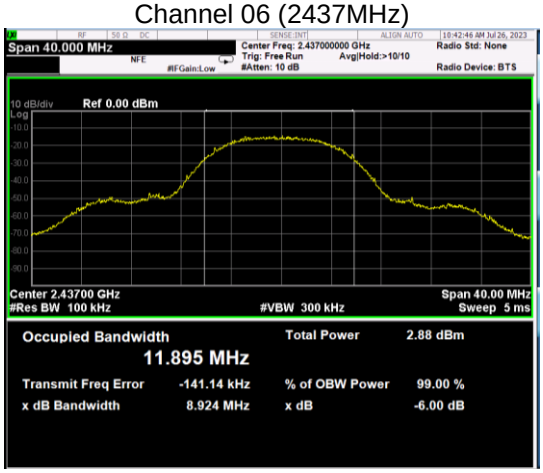
Test mode	Data Rate	Channel No.	Frequency (MHz)	6 dB Bandwidth (MHz)	99% OBW (MHz)	Limit (MHz)
802.11b	11Mbps	01	2412	8.817	11.720	≥0.5
802.11b	11Mbps	06	2437	8.924	11.895	≥0.5
802.11b	11Mbps	11	2462	8.663	11.948	≥0.5
802.11g	6Mbps	01	2412	15.74	16.418	≥0.5
802.11g	6Mbps	06	2437	15.81	16.735	≥0.5
802.11g	6Mbps	11	2462	15.78	16.418	≥0.5
802.11n-HT20	MCS0 (6.5 Mbps)	01	2412	16.37	17.634	≥0.5
802.11n-HT20	MCS0 (6.5 Mbps)	06	2437	16.40	17.687	≥0.5
802.11n-HT20	MCS0 (6.5 Mbps)	11	2462	16.39	17.628	≥0.5

802.11b 6dB Bandwidth

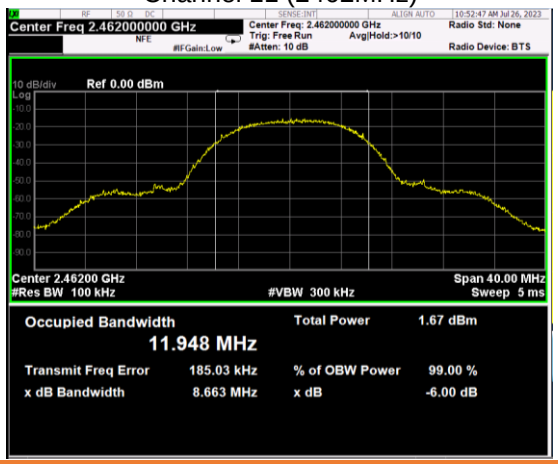
Channel 01 (2412MHz)



Channel 06 (2437MHz)



Channel 11 (2462MHz)



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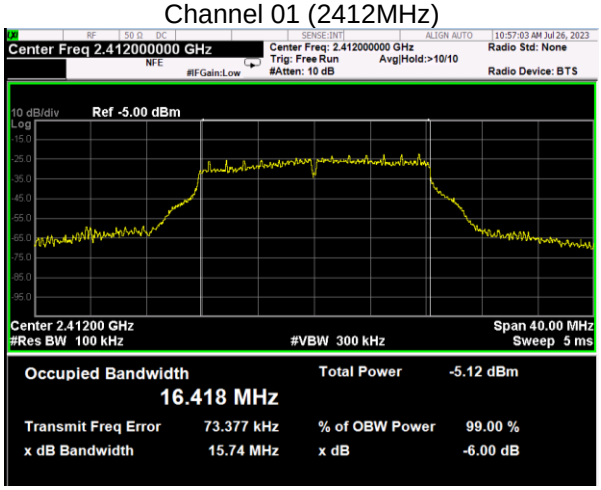
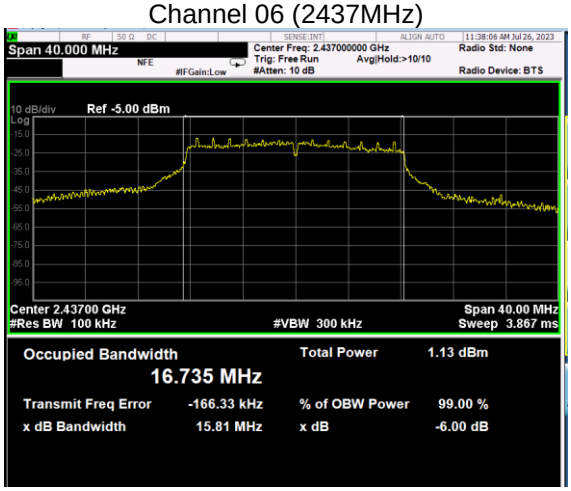
802.11g 6dB Bandwidth

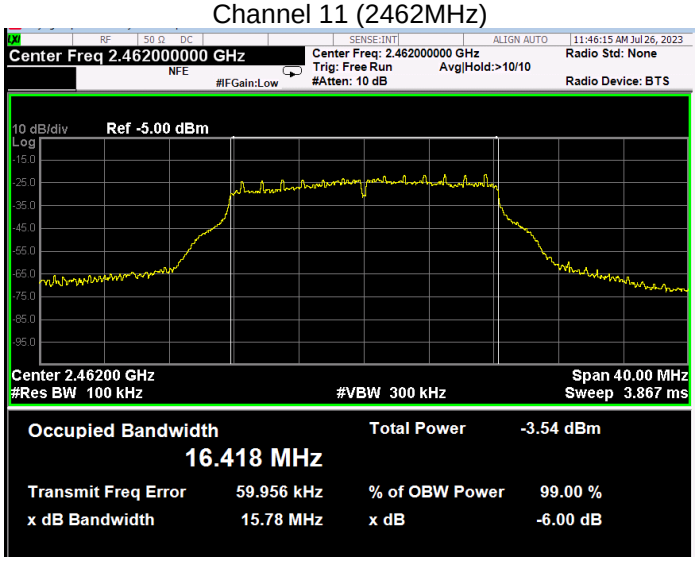
Channel 01 (2412MHz)



Channel 06 (2437MHz)



Channel 11 (2462MHz)



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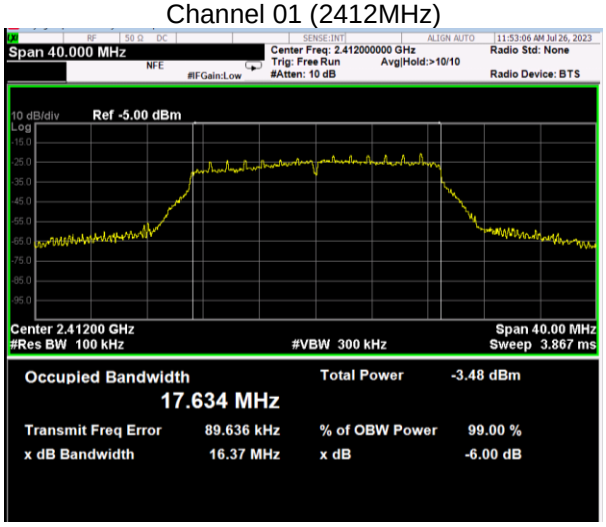
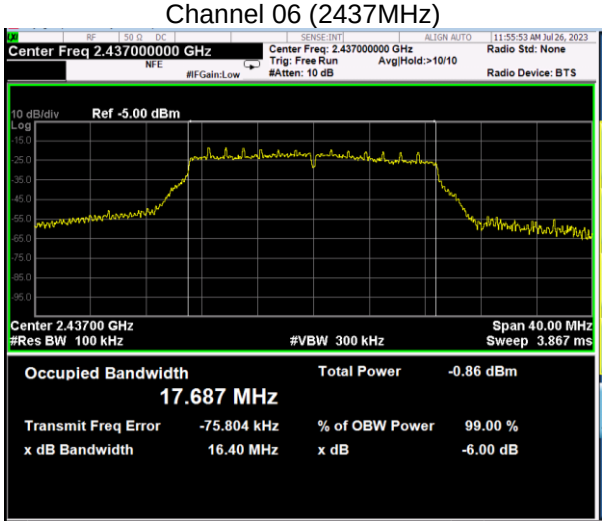
802.11n-HT20 6dB Bandwidth

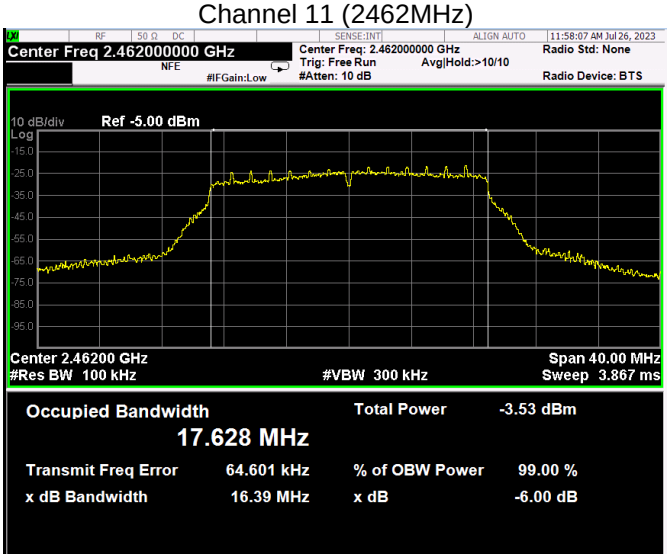
Channel 01 (2412MHz)



Channel 06 (2437MHz)



Channel 11 (2462MHz)



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3- Conducted Peak Power Measurement

Standard	FCC 15.247 (b)(3) RSS-247 5.4 (d) RSS Gen, Issue 5	Room Temperature (°C)	26.8
Test Method	KDB 558074 D01 v05r02 ANSI C63.10:2013	Relative Humidity (RH%)	44.7
Test Location	Richmond Lab	Barometric Pressure (hPa)	1018.2
Test Engineer	Zara Vali	Date of Test	July 26, 2023

Test Equipment Used	Manufacturer	Model	Identifier	Calibration	Calibration due
EMC Analyzer	Keysight	N9038A	702	02 November, 2022	02 November, 2023
RF Cable	MRO	n/a	n/a	IHC[1]	IHC[1]
Attenuator	Mini-Circuit	VAT-20+	n/a	IHC[1]	IHC[1]

Note1) In House Calibration

Compliant ☒ Non-Compliant ☐ Not Applicable ☐

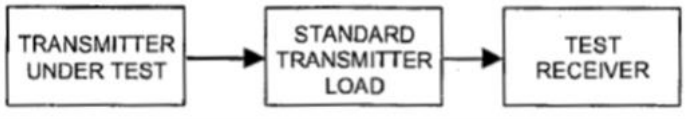
Test Method

1. The center frequency is set to the frequency of the channel under the test.
2. The RBW is set to the maximum allowable range by spectrum analyzer.
3. VBW should be at least three times the RBW.
4. Detector = Peak
5. Trace mode = Max Hold
6. Sweep = auto couple
7. Allow the trace to be stabilized.

Peak Power (dBm) = Peak Power Reading (dBm) + System (dB)
System Corrections (dB) = Cable Loss (dB/m) + Attenuator (dB)
Max EIRP (dBm) = Peak Power (dBm) + Antenna Gain (dBi),
Antenna Gain (dBi) = 3

Test Setup

Description of test set-up:



EUT was connected directly to the spectrum analyzer with a 20 dB attenuator and a short cable.
The EUT was set to **Operation Mode #1 with configuration Mode #1.**

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Test Results

Test Mode	Data Rate	Channel No.	Frequency (MHz)	Peak Power Reading (dBm)	System Corrections (dB)	Peak Power (dBm)	Limit (dBm)
802.11b	11Mbps	01	2412	-1.652	20.1	18.448	≤ 30.00
802.11b	11Mbps	06	2437	-0.752	20.1	19.348	≤ 30.00
802.11b	11Mbps	11	2462	-1.430	20.1	18.67	≤ 30.00
802.11g	6Mbps	01	2412	-2.597	20.1	17.503	≤ 30.00
802.11g	6Mbps	06	2437	0.227	20.1	20.327	≤ 30.00
802.11g	6Mbps	11	2462	-2.932	20.1	17.168	≤ 30.00
802.11n-HT20	MCS0 (6.5 Mbps)	01	2412	-2.005	20.1	18.095	≤ 30.00
802.11n-HT20	MCS0 (6.5 Mbps)	06	2437	-1.053	20.1	19.047	≤ 30.00
802.11n-HT20	MCS0 (6.5 Mbps)	11	2462	-3.157	20.1	16.943	≤ 30.00

Test Mode	Data Rate	Channel No.	Frequency (MHz)	Max EIRP (dBm)	EIRP Limit (dBm)
802.11b	11Mbps	01	2412	21.448	≤ 36
802.11b	11Mbps	06	2437	22.348	≤ 36
802.11b	11Mbps	11	2462	21.67	≤ 36
802.11g	6Mbps	01	2412	20.503	≤ 36
802.11g	6Mbps	06	2437	23.327	≤ 36
802.11g	6Mbps	11	2462	20.168	≤ 36
802.11n-HT20	MCS0 (6.5 Mbps)	01	2412	21.095	≤ 36
802.11n-HT20	MCS0 (6.5 Mbps)	06	2437	22.047	≤ 36
802.11n-HT20	MCS0 (6.5 Mbps)	11	2462	19.943	≤ 36

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4- Power Spectral Density

Standard	FCC 15.247(e) RSS-247 5.2 RSS Gen, Issue 5	Room Temperature (°C)	26.8
Test Method	KDB 558074 D01 v05r02 ANSI C63.10: 2013	Relative Humidity (RH%)	44.7
Test Location	Richmond Lab	Barometric Pressure (hPa)	1018.1
Test Engineer	Zara Vali	Date of Test	July 26, 2023

Test Equipment Used	Manufacturer	Model	Identifier	Calibration date	Calibration due
Spectrum Analyzer	Keysight	N9038A	702	02 November, 2022	02 November, 2023
Attenuator	Mini-Circuit	VAT-20+	n/a	IHC[1]	IHC[1]

Note1) In House Calibration

Compliant ☒ Non-Compliant ☐ Not Applicable ☐

Test Method

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 FCC 15.247. The same method of determining the conducted output power shall be used to determine the power spectral density.

1- Analyser is set to the centre frequency of the channel under investigation.
2- RBW is set to 3 kHz.
3- VBW is set to 10 kHz.
4- Detector is set to peak mode.
5- Sweep time is set to auto couple.
6- Trace mode is Max Hold.
7- Trace is set to stabilized.

System Corrections (dB) = Cable Loss (dB/m) + Attenuator (dB)

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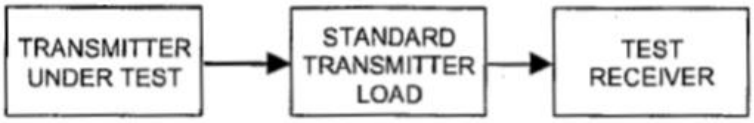
Test Setup

Description of test set-up:



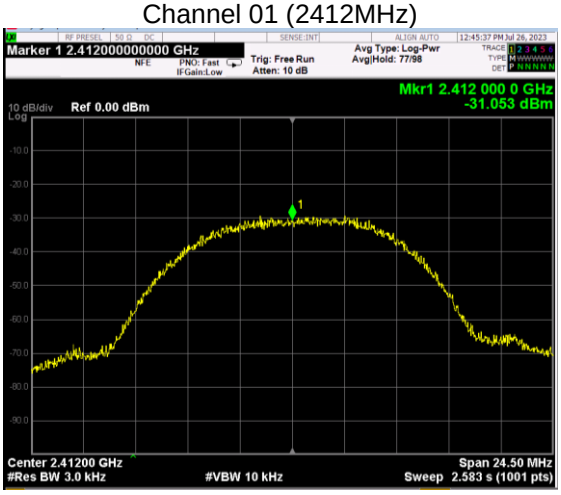
The EUT was connected directly to the spectrum analyzer/receiver with appropriate attenuation.
The EUT was set to **Operation Mode #1 with configuration Mode #1.**

Test Results

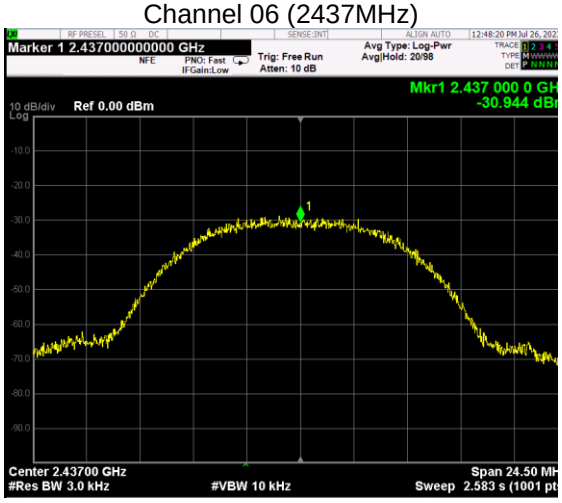
Test Mode	Data Rate	Channel No.	Frequency (MHz)	Un-Corrected PSD (dBm)	System Corrections (dB)	PSD Result (dBm)	Limit (dBm/3 kHz)
802.11b	11Mbps	01	2412	-31.053	20.1	-10.953	≤ 8
802.11b	11Mbps	06	2437	-30.944	20.1	-10.844	≤ 8
802.11b	11Mbps	11	2462	-31.459	20.1	-11.359	≤ 8
802.11g	6Mbps	01	2412	-35.065	20.1	-14.965	≤ 8
802.11g	6Mbps	06	2437	-35.231	20.1	-15.131	≤ 8
802.11g	6Mbps	11	2462	-35	20.1	-14.9	≤ 8
802.11n-HT20	MCS0	01	2412	-36.398	20.1	-16.298	≤ 8
802.11n-HT20	MCS0	06	2437	-32.670	20.1	-12.57	≤ 8
802.11n-HT20	MCS0	11	2462	-36.177	20.1	-16.077	≤ 8

802.11b Peak PSD

Channel 01 (2412MHz)



Channel 06 (2437MHz)



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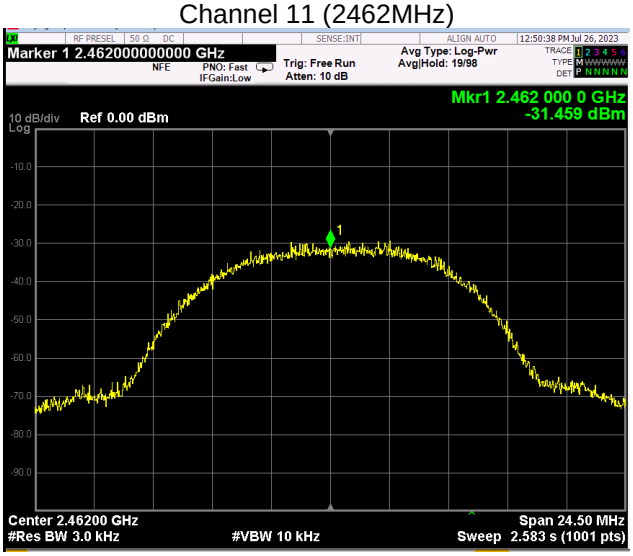
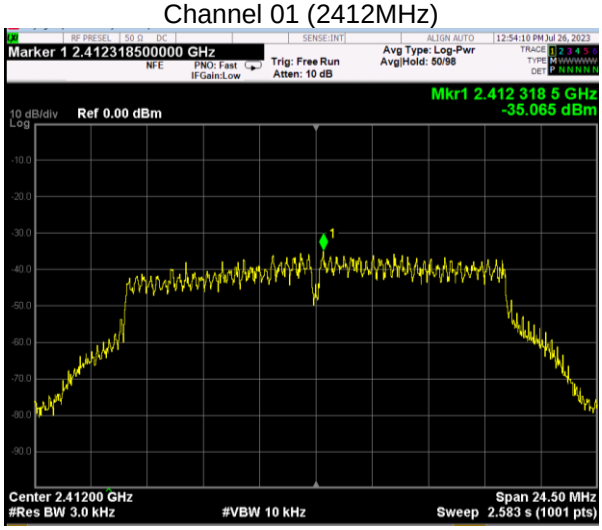
Channel 11 (2462MHz)

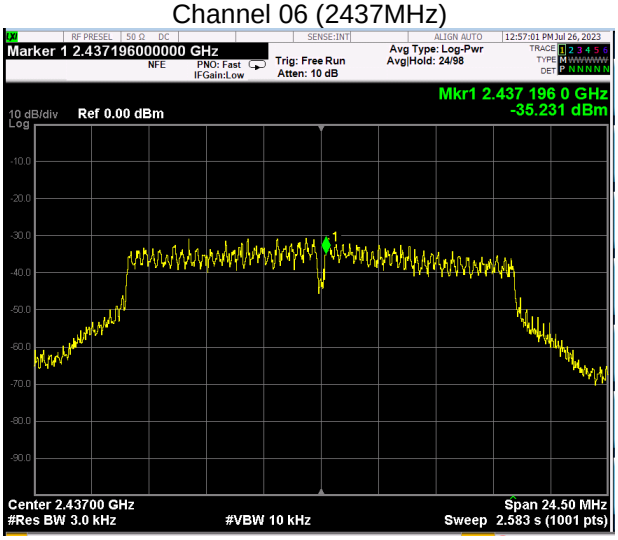


802.11g Peak PSD

Channel 01 (2412MHz)



Channel 06 (2437MHz)



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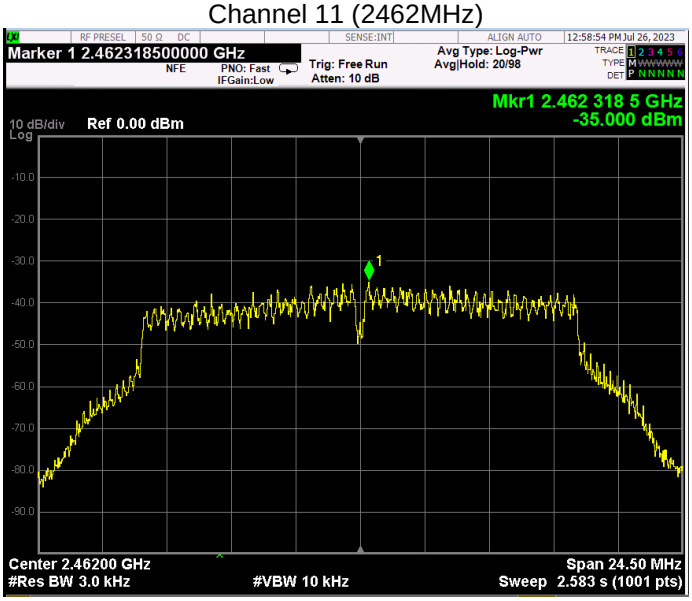
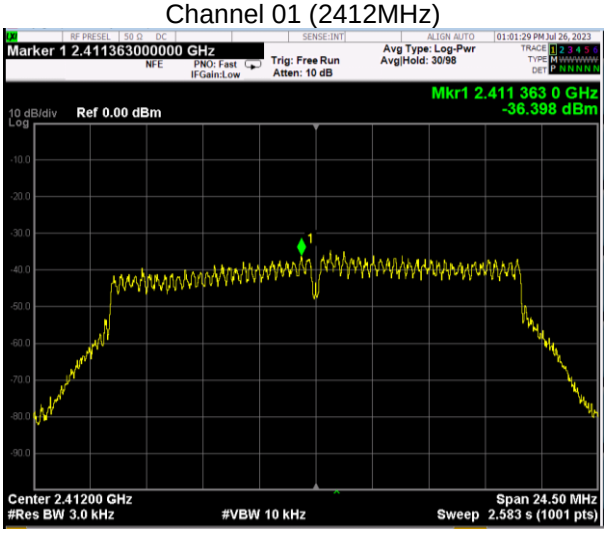
Channel 11 (2462MHz)

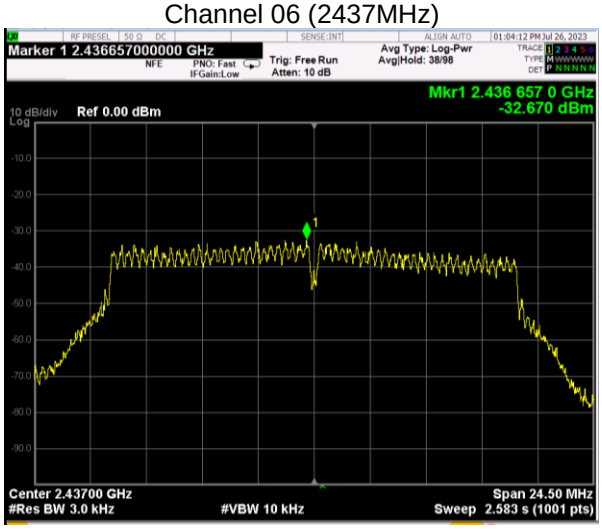


802.11n-HT20 Peak PSD

Channel 01 (2412MHz)



Channel 06 (2437MHz)



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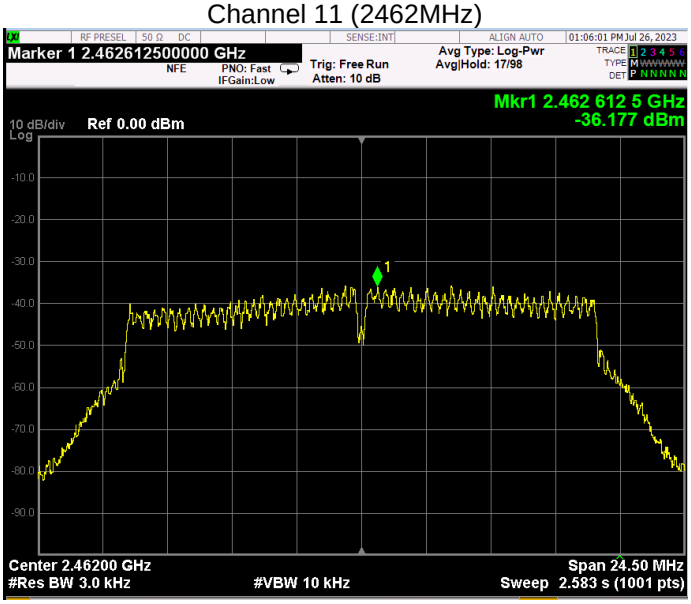
Channel 11 (2462MHz)



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5- Band Edge and Out of Band Emissions

Standard	FCC Part 15.247 (d) RSS-247 5.5 RSS Gen, Issue 5	Room Temperature (°C)	26.8
Test Method	KDB 558074 D01 v05r02 ANSI C63.10: 2013	Relative Humidity (RH%)	44
Test Location	Richmond Lab	Barometric Pressure (hPa)	1018.1
Test Engineer	Zara Vali	Date of Test	July 26, 2023

Test Equipment Used	Manufacturer	Model	Identifier	Calibration	Calibration due
Spectrum Analyzer	Keysight	N9038A	702	02 November, 2022	02 November, 2023
Attenuator	Mini-Circuit	VAT-20+	N/A	IHC[1]	IHC[1]

Note1) In House Calibration

Compliant ☒ Non-Compliant ☐ Not Applicable ☐

Test Method

Based on the FCC part 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.

Reference Level Measurement

1. Set instrument center frequency to the channel center frequency.
2. Set the span to ⩾ 1.5 times the DTS bandwidth.
3. Set the RBW = 100 kHz.
4. Set the VBW ≥ 3 x RBW.
5. Set the detector to peak mode.
6. Sweep time is set to auto couple
7. Set the trace mode to Max Hold.
8. Allow trace to fully stabilize.

Emission Level Measurement

1. Set the center frequency and span to encompass frequency range to be measured.
2. Set the RBW = 100 kHz.
3. Set the VBW ≥ 3 x RBW.
4. Set the detector to peak mode.
5. Set the trace mode to Max Hold.
6. Sweep time is set to auto couple
7. Allow trace to fully stabilize.

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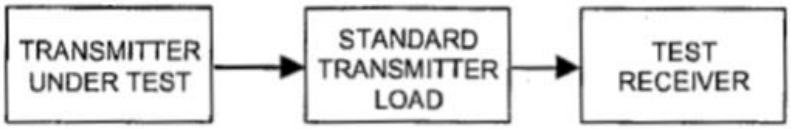
Test Setup



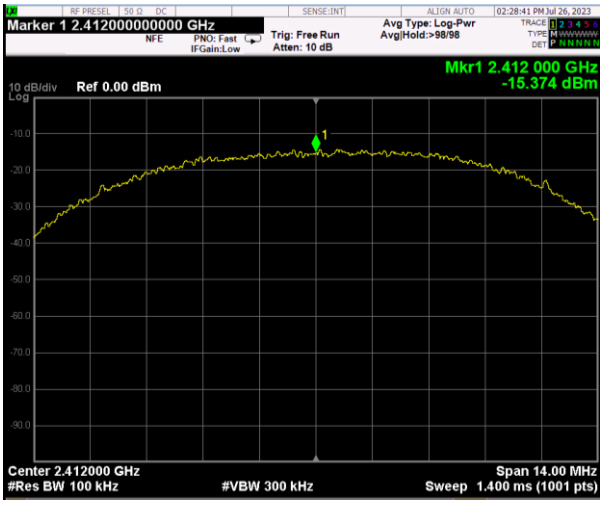
The EUT was connected directly to the spectrum analyser/receiver with appropriate attenuation.
The EUT was set to **Operation Mode #1 with configuration Mode #1.**

Test Results

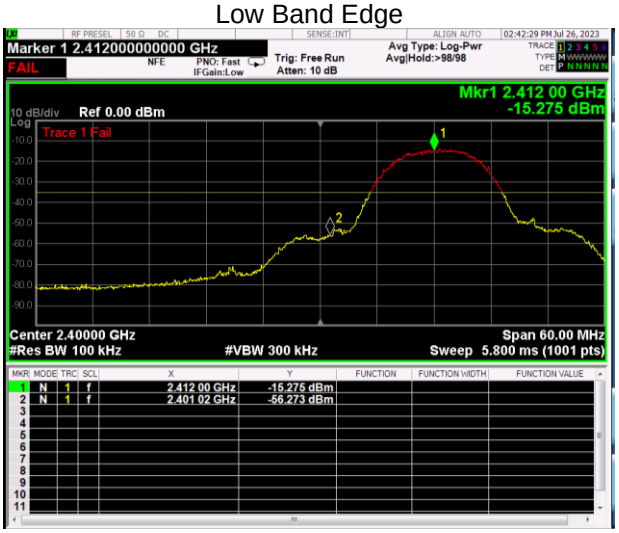
Test Mode	Data Rate	Channel No.	Frequency (MHz)	Limit
802.11b	11Mbps	01	2412	20 dBc
802.11b	11Mbps	06	2437	20 dBc
802.11b	11Mbps	11	2462	20 dBc
802.11g	6Mbps	01	2412	20 dBc
802.11g	6Mbps	06	2437	20 dBc
802.11g	6Mbps	11	2462	20 dBc
802.11n-HT20	MCS0	01	2412	20 dBc
802.11n-HT20	MCS0	06	2437	20 dBc
802.11n-HT20	MCS0	11	2462	20 dBc

802.11b Out-of-Band Emissions - Channel 01 (2412MHz)

100kHz PSD Reference Level



Low Band Edge



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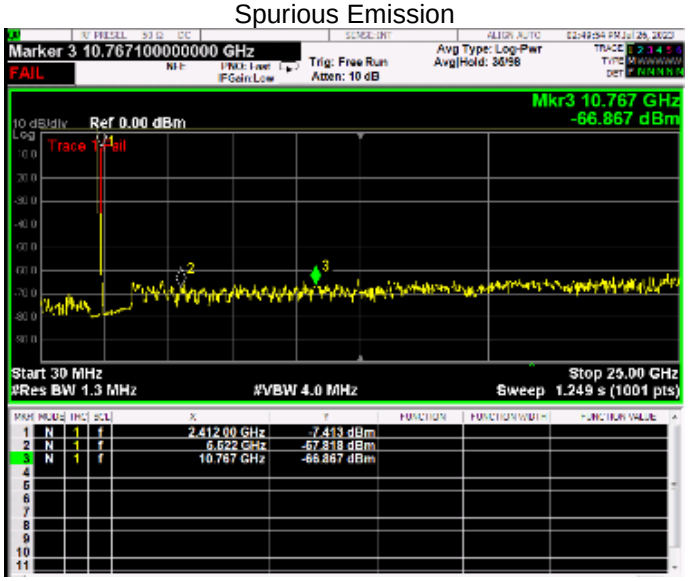
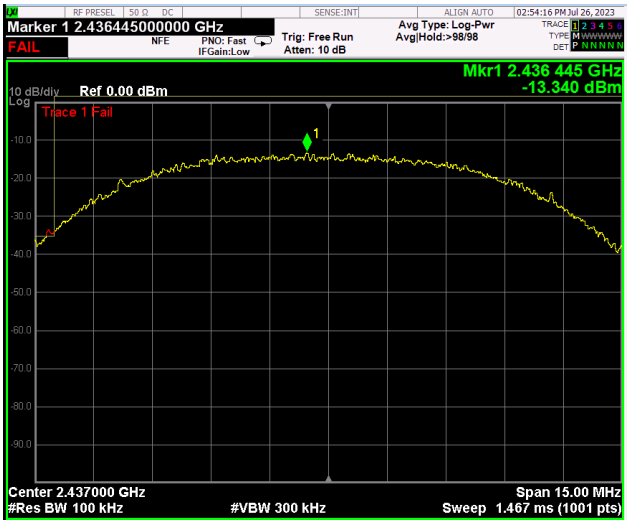
Spurious Emission

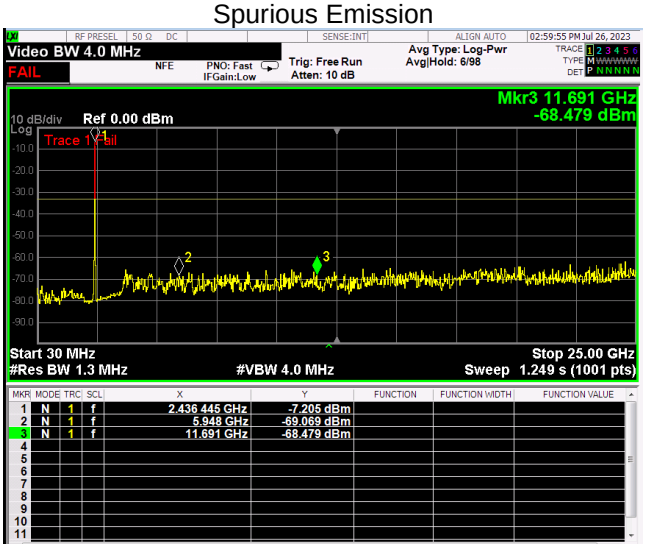


802.11b Out-of-Band Emissions - Channel 06 (2437MHz)

100kHz PSD Reference Level



Spurious Emission



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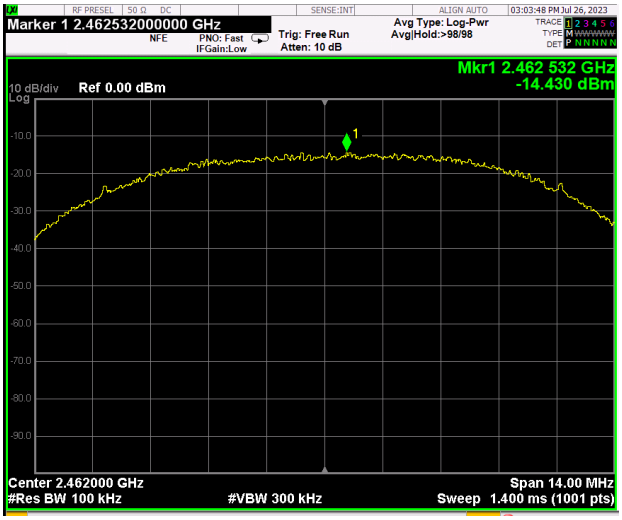
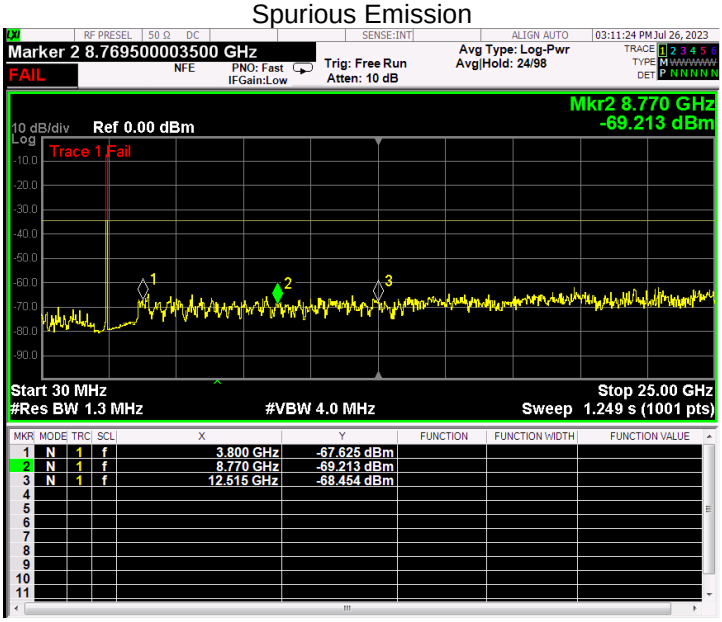
802.11b Out-of-Band Emissions - Channel 11 (2462MHz)

100kHz PSD Reference Level



High Band Edge

Spurious Emission



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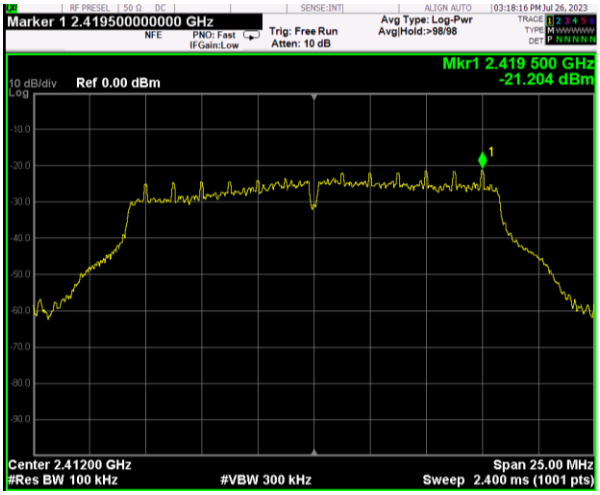
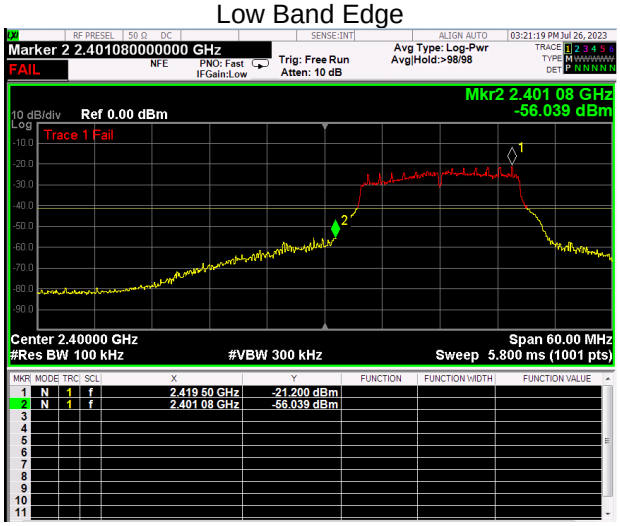
802.11g Out-of-Band Emissions - Channel 01 (2412MHz)

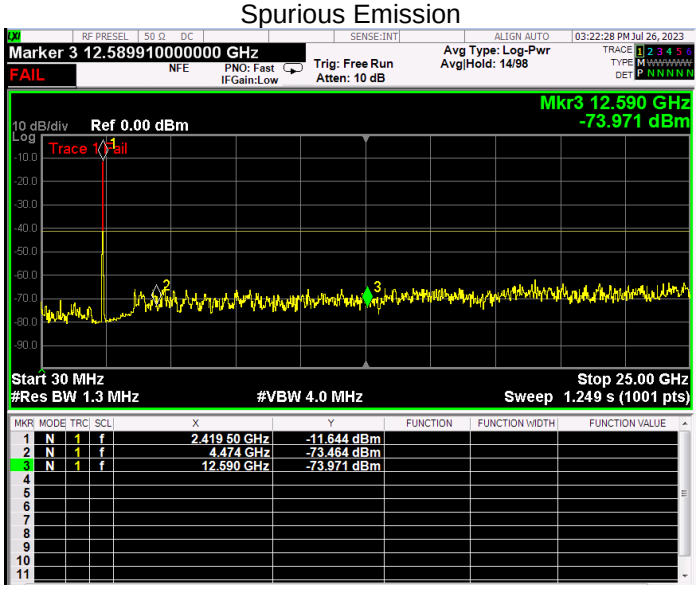
100kHz PSD Reference Level



Low Band Edge



Spurious Emission



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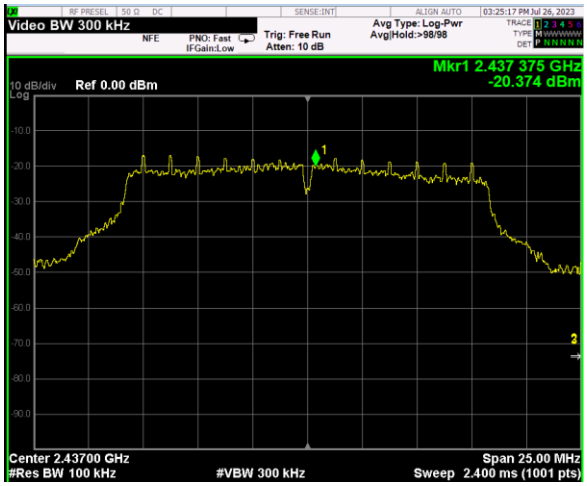
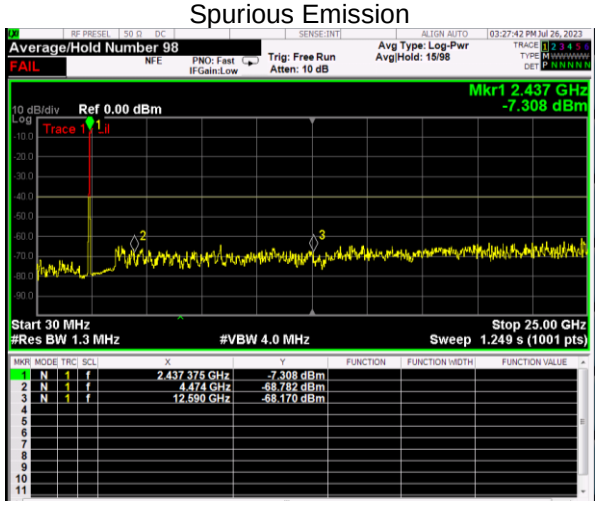
802.11g Out-of-Band Emissions - Channel 06 (2437MHz)

100kHz PSD Reference Level

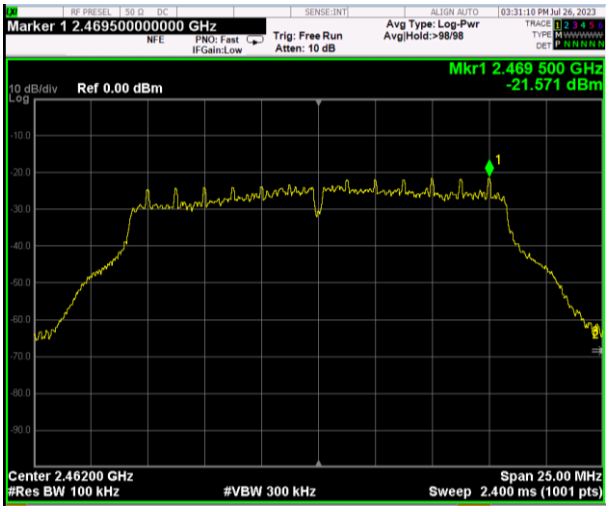


Spurious Emission

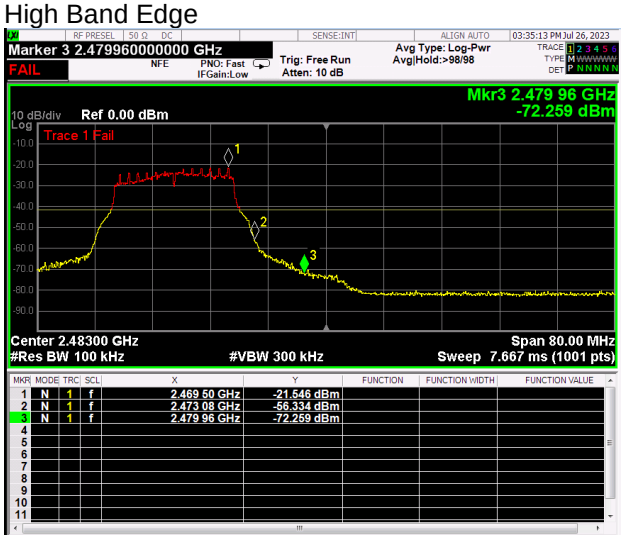


802.11g Out-of-Band Emissions - Channel 11 (2462MHz)

100kHz PSD Reference Level



High Band Edge



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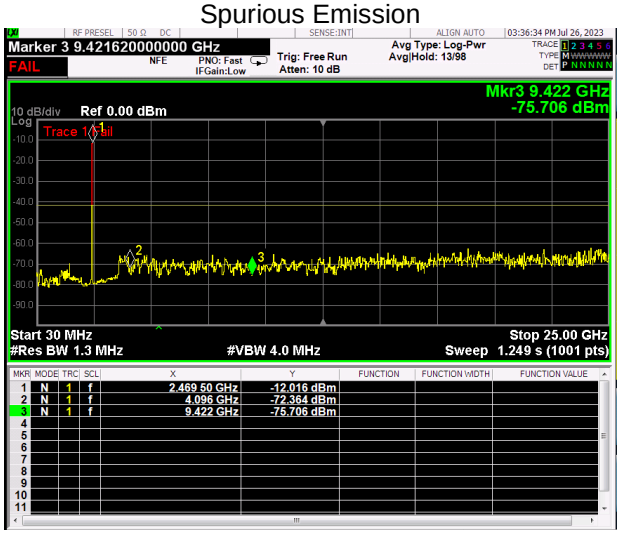
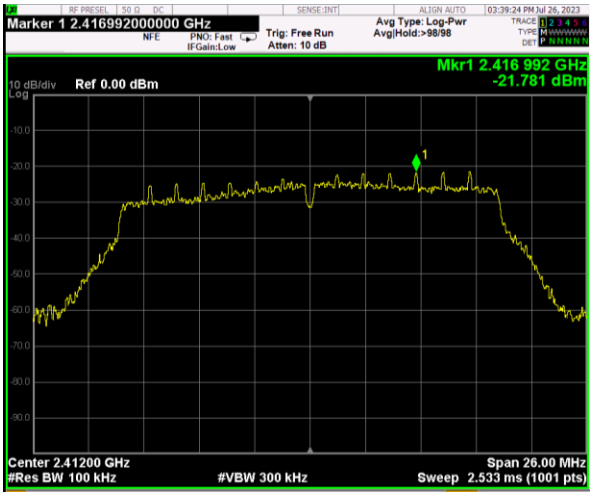
Spurious Emission

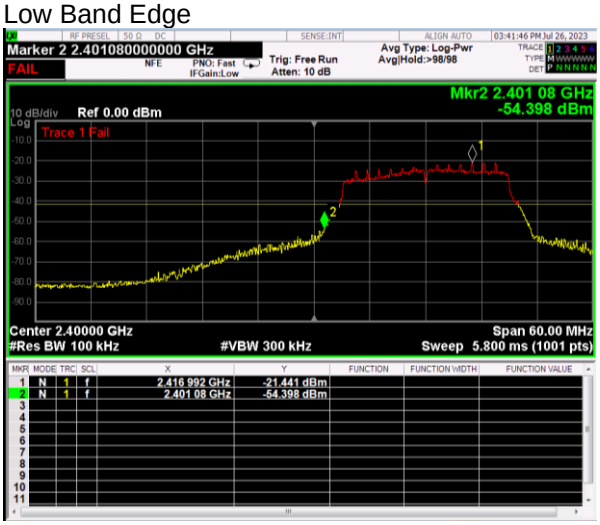


802.11n-HT20 Out-of-Band Emissions - Channel 01 (2412MHz)

100kHz PSD Reference Level



Low Band Edge



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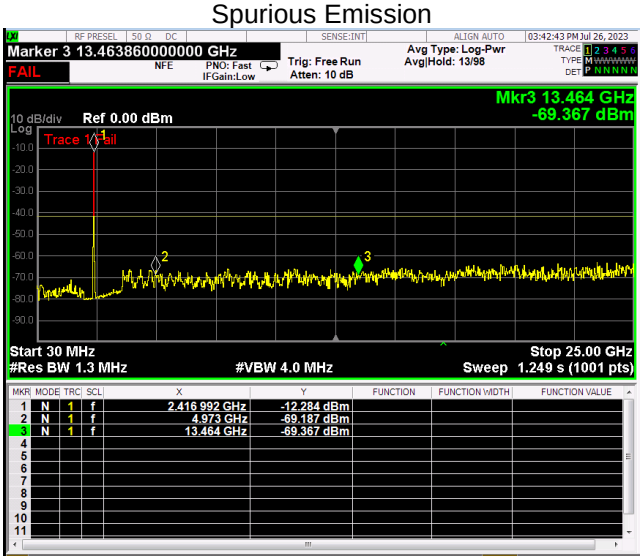
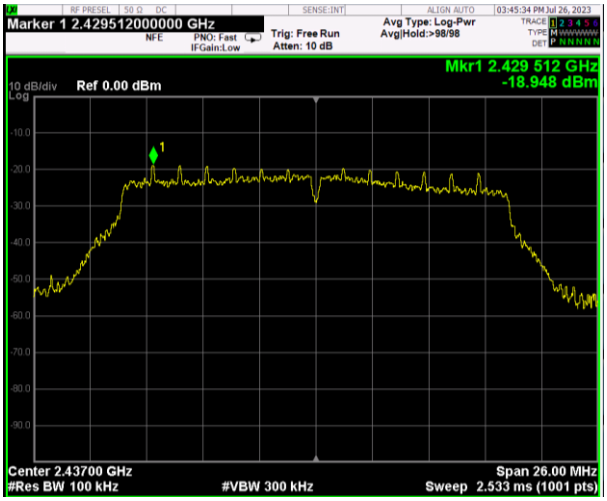
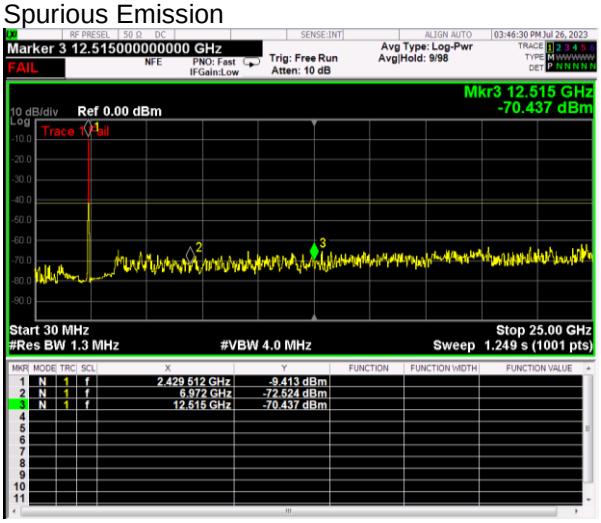


802.11n-HT20 Out-of-Band Emissions - Channel 06 (2437MHz)

100kHz PSD Reference Level



Spurious Emission



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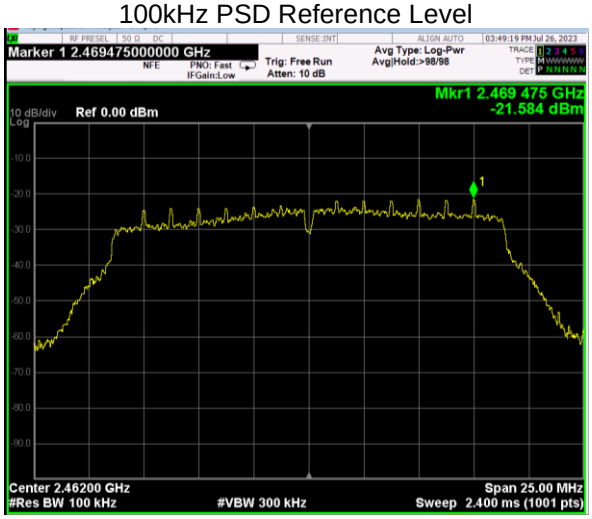
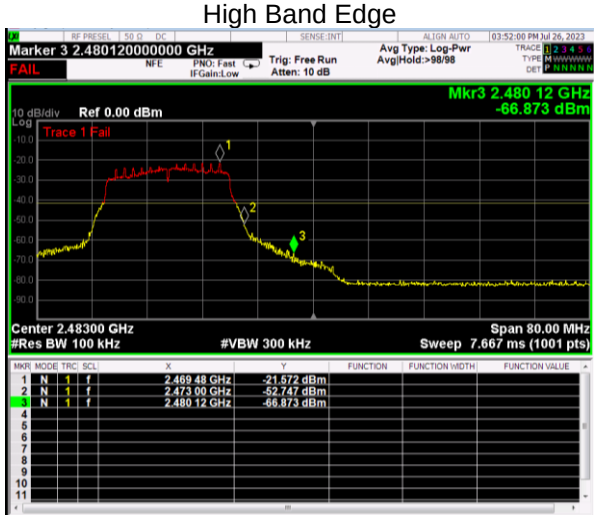
802.11n-HT20 Out-of-Band Emissions - Channel 11 (2462MHz)

100kHz PSD Reference Level



High Band Edge



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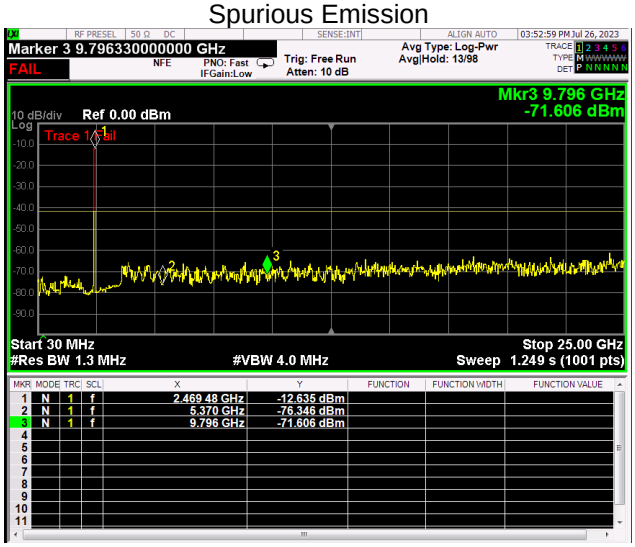

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6- Radiated Spurious Emissions

Standard	FCC Part 15.209 RSS-Gen Issue 5	Room Temperature (°C)	24.4
Basic Standard	ANSI C63.10: 2013	Relative Humidity (%)	46
Test Location	Richmond Lab	Barometric Pressure (hPa)	1013
Test Engineer	Zara Vali	Date of Test	19-29 June 2023

Test Equipment Used	Manufacturer	Model	Identifier	Calibration	Calibration due
Spectrum Analyzer	Keysight	N9038A	702	02 November, 2022	02 November, 2023
Double-ridged Guide Horn Antenna	A.H.Systems	SAS-571	227C	13 September, 2022	13 September, 2024
Horn Antenna	A.H.Systems	SAS-572	227D	NA	NA
Broadband Antenna	Sunol Sciences Co.	JB1	371	24 October, 2022	24 October, 2024
Loop Antenna	ComPower	AL-130	241	12 Jan 2022	12 Jan 2024
RF Cable	MRO	n/a	n/a	IHC[1]	IHC[1]
EMC Shielded Enclosure	USC	USC-26	374	IHC[2]	IHC[2]
Used Template of Tile 7!					

Note1) In House Calibration

Detector:	☒ Peak	☒ Quasi-Peak/AVG		
Frequency Range:	☒ 150kHz-30MHz	☒ 30-1000MHz	☒ 1-18 GHz	☒ 18-26.5GHz
RBW/VBW:	☒120/300kHz	☒ 1/3MHz		
Type of Facility:	☒ SAC	☒ FAC	☐ *in-situ*	
Distance:	☒ 3meter	☐ 10meter	☐ 1meter	
Arrangement of EUT:	☒ Table-top only	☐ Floor-standing only	☐ Rack Mounted	

Compliant ☒ Non-Compliant ☐ Not Applicable ☐

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Test Method

This test measures the radiating levels from the EUT, thus evaluating the potential for the EUT to cause radio frequency interference to other electronic devices. Testing was performed in accordance with the test standard(s) referenced in the test summary section of this report. The Equipment Under Test (EUT) was configured based upon the requirements of the applicable test standard. Initially, the primary emission frequencies are identified by positioning a broadband receive antenna three meter from the EUT.

A test was made with an Spectrum Analyzer, controlled by Test Software, Tile7!, for all Harmonics with the Analyzer in the peak mode. The IF bandwidth was 120 kHz(under 1GHz) and 1MHz(over 1GHz). To ensure that the maximum emission at each discrete frequency of interest is observed, the receive antenna is varied in height from one to four meters and rotated to produce horizontal and vertical polarities while the turntable is rotated to determine the worst emitting configuration. Measurements were then made using CISPR quasi peak (under 1GHz) and Averaging (over 1GHz). The numerical results are included herein to demonstrate compliance. For testing above 1GHz, average measurement is not performed if peak level is lower than average limit.

Test Result
Emission level (dBuV/m) = Detected level (dBuV) +Cable Loss (dB) + Antenna Factor (dB/m)

Test Setup

Description of test set-up:
The EUT was placed on a 0.8 m for under 1GHz and 1.5m for over 1GHz non-conducting table above a Turn table in SAC. The EUT was set to **Operation Mode #1 with configuration Mode #1.**

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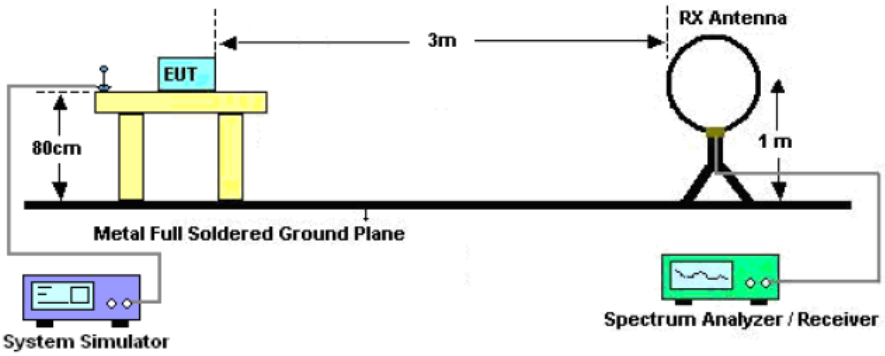
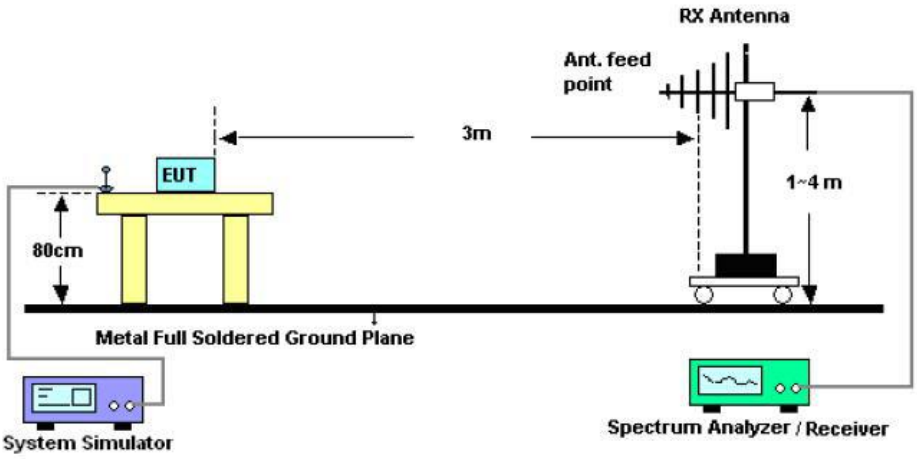
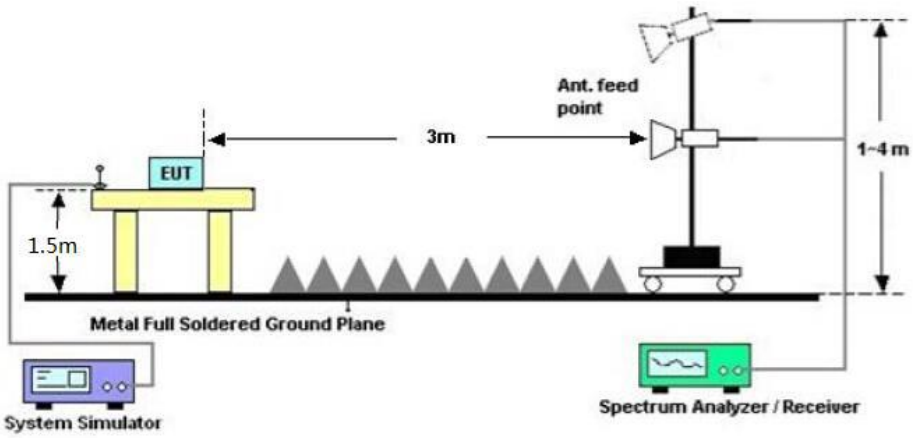
9kHz- 30MHz test setup with AL-130

30MHz – 1 GHz test setup with JB1 antenna

1-18 GHz test setup with SAS-571 and 18-26 GHz test setup with SAS-572


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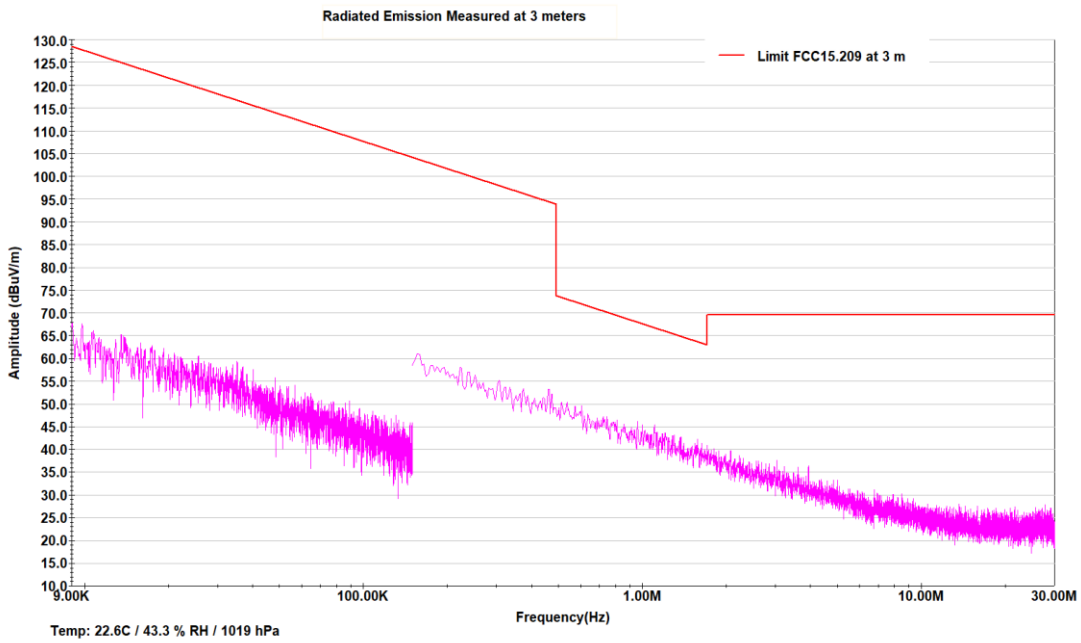
Test Results

Graphical Representation for Radiated Emission 9kHz to 30MHz



Note. Where the numerical data is not presented, the radiation is more than 20 dB below the limit line or is indicated as background noise.

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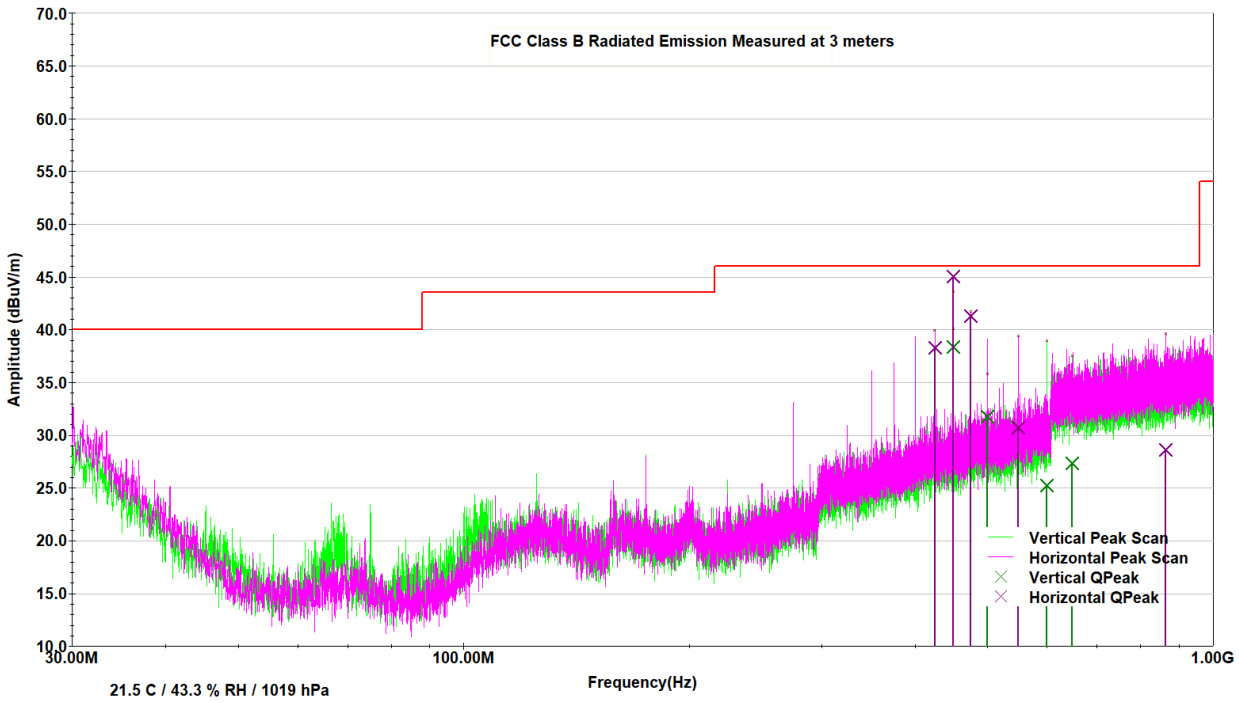
Graphical Representation fo Radiated Emission 30 MHz to 1 GHz



Frequency	Antenna Polarization	Raw QPeak	Antenna Factor	Correction Factor	QPeak	Margin	Limit
MHz	V/H	dBuV	dB/m	dB	dBuV/m	dB	dBuV/m
425.024	H	15.5	20.8	2	38.3	7.7	46
449.9958	H	21.8	21.1	2.1	45	1	46
475.0018	H	17.2	21.9	2.2	41.3	4.7	46
549.9985	H	5.5	22.9	2.3	30.7	15.3	46
864.1915	H	-0.9	26.6	2.9	28.6	17.4	46

Frequency	Antenna Polarization	Raw QPeak	Antenna Factor	Correction Factor	QPeak	Margin	Limit
MHz	V/H	dBuV	dB/m	dB	dBuV/m	dB	dBuV/m
450.01	V	15.6	20.7	2.1	38.3	7.7	46
500.015	V	7.7	21.9	2.2	31.8	14.2	46
599.9478	V	0	22.9	2.4	25.2	20.8	46
647.7203	V	1	23.8	2.5	27.3	18.7	46

Note. Where the numerical data is not presented, the radiation is more than 20 dB below the limit line or is indicated as background noise.

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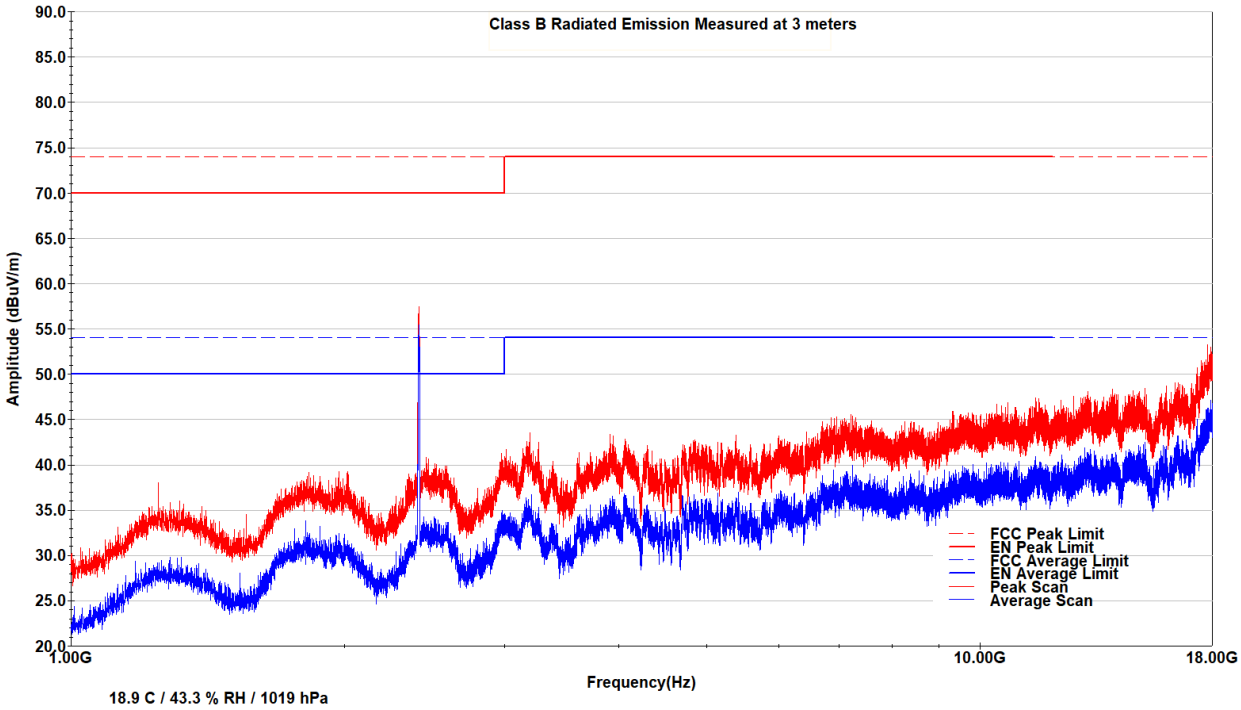
Graphical Representation for Radiated Emission 1 – 18 GHz, Low Channel



Note. Fundamental signal is shown at 2.4 GHz.
Note. Average measurement is not performed if peak level is lower than average limit.
Note. As other datarates were shown similar results, only one is presented.

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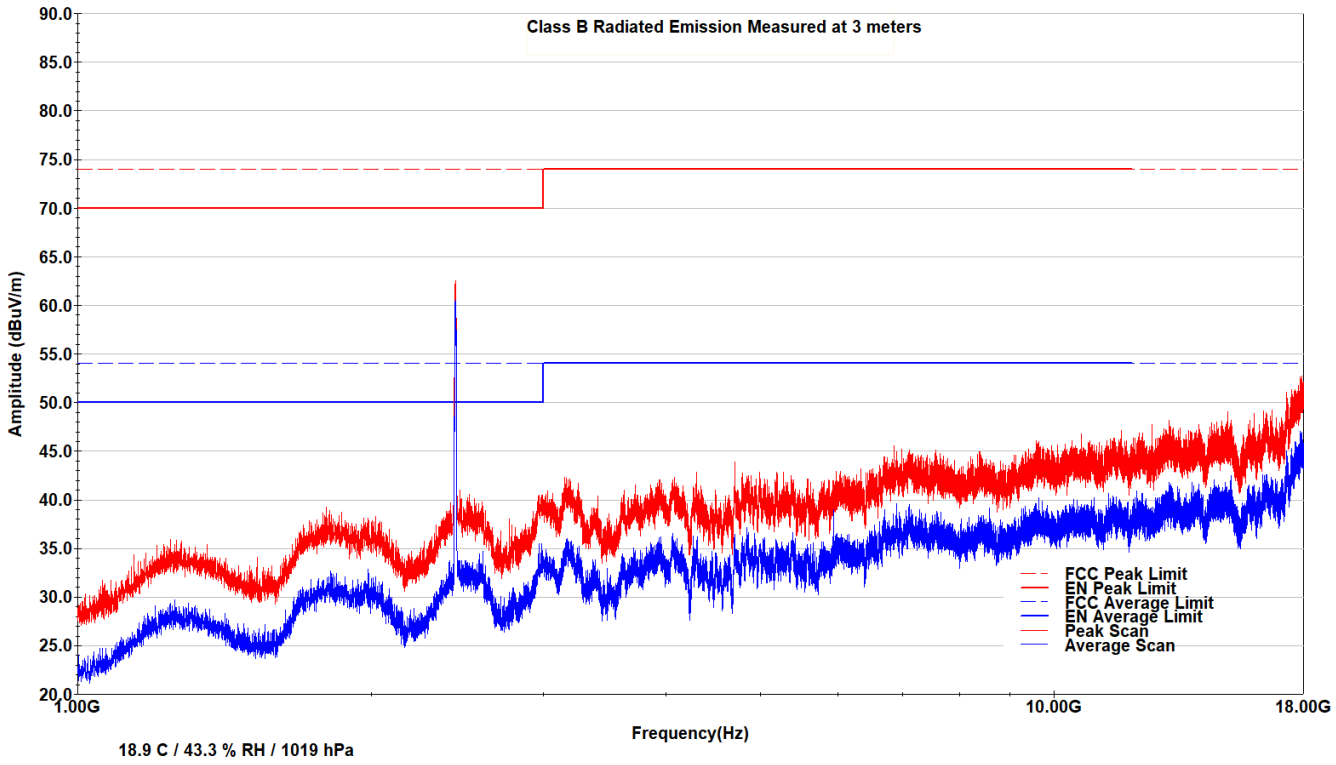
Graphical Representation for Radiated Emission 1 – 18 GHz, Mid Channel



Note. Fundamental signal is shown at 2.4 GHz.
Note. Average measurement is not performed if peak level is lower than average limit.
Note. As other datarates were shown similar results, only one is presented.

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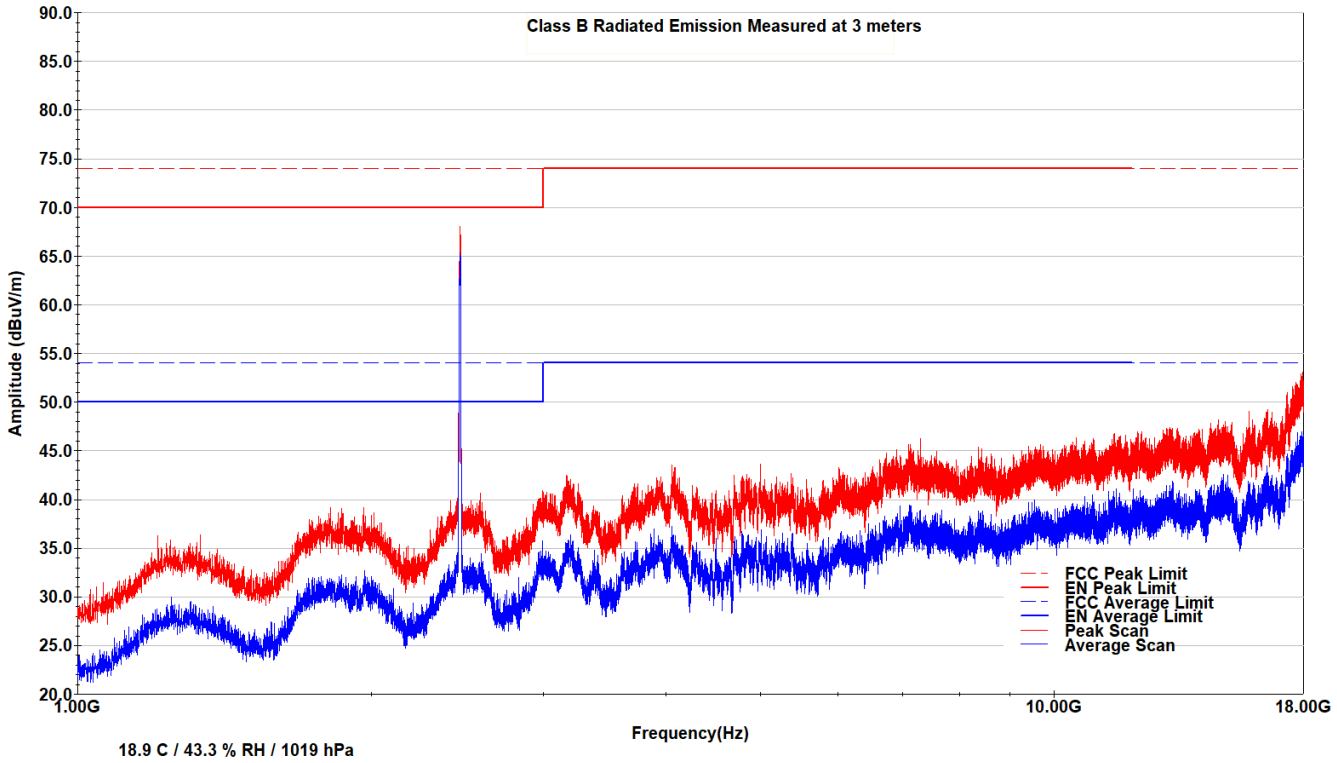
Graphical Representation for Radiated Emission 1 – 18 GHz, High Channel



Note. Fundamental signal is shown at 2.4 GHz.
Note. Average measurement is not performed if peak level is lower than average limit.
Note. As other datarates were shown similar results, only one is presented.

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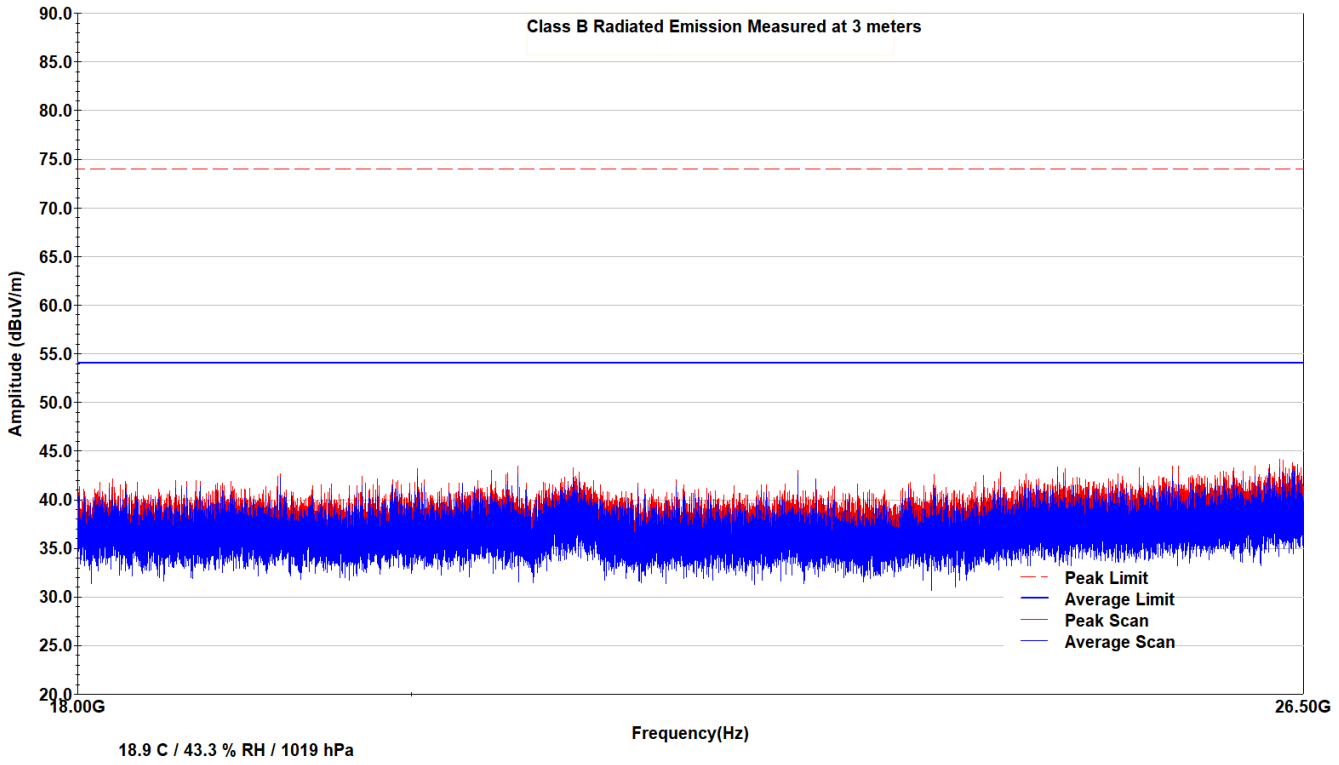
Graphical Representation for Radiated Emission 18 – 26.5 GHz



Note. Where the numerical data is not presented, the radiation is more than 20 dB below the limit line or is indicated as background noise.

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7- Radiated Restricted Band Edge Measurement

Standard	FCC Part 15. 247 (d) FCC Part 15. 205 FCC Part 15. 209 RSS-247 5.5	Room Temperature (°C)	24.4
Basic Standard	ANSI C63.10: 2013	Relative Humidity (%)	46
Test Location	Richmond Lab	Barometric Pressure (hPa)	1013
Test Engineer	Zara Vali	Date of Test	22 June 2023

Test Equipment Used	Manufacturer	Model	Identifier	Calibration	Calibration due
Spectrum Analyzer	Keysight	N9038A	702	02 November, 2022	02 November, 2023
Double-ridged Guide Horn Antenna	A.H.Systems	SAS-571	227C	13 September, 2022	13 September, 2024
Preamplifier	Agilent Technologies	8449B	273	IHC[1]	IHC[1]
RF Cable	MRO	n/a	n/a	IHC[1]	IHC[1]
EMC Shielded Enclosure	USC	USC-26	374	IHC[2]	IHC[2]
Used Template of Tile 7!					

Note1) In House Calibration

Detector:	☒ Peak
Frequency Range:	☒ 1-18 GHz
Type of Facility:	☒ FAC ☐ *in-situ*
Distance:	☒ 3meter ☐ 10meter ☐ 1meter
Arrangement of EUT:	☒ Table-top only ☐ Floor-standing only ☐ Rack Mounted

Compliant ☒ Non-Compliant ☐ Not Applicable ☐

Test Method

According to §15.247(d), 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).

Field strength measurements

1. Analyser centre frequency is set to the frequency of the radiated spurious emission of interest.
2. RBW = 1 MHz
3. VBW = Minimum 3 x RBW
4. Detector = Peak
5. Trace mode = Max Hold
6. Trace is set to be stabilized.

Test Result

Corrected Amplitude (dBuV/m) = Reading (dBuV) + Correction Factor (dB/m)
Correction Factor (dB/m) = Cable Loss (dB) + Antenna Factor (dB/m)
Margin (dB)= Limit (dBuV/m) – Corrected Amplitude (dBuV/m)

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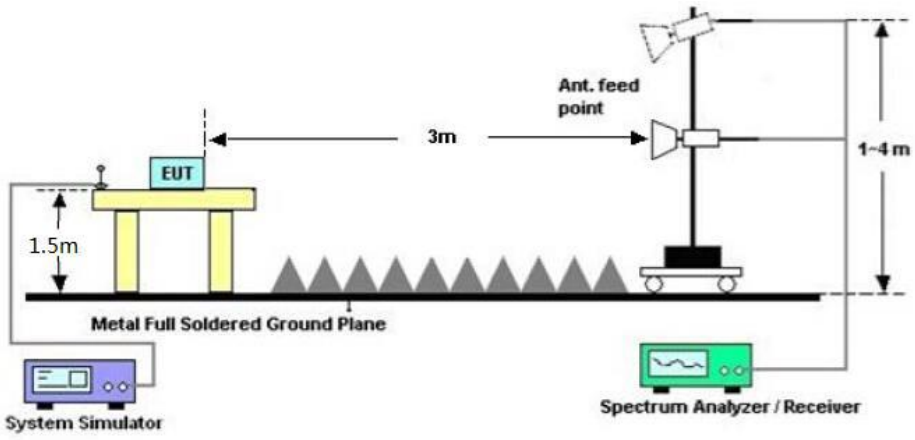
Test Setup

Description of test set-up:
The EUT is set 3 meter away from the testing antenna and the antenna is moved from 1-4 meter. The EUT is placed on a turntable, which is 1.5 meter above the ground plane, the table is rotated for 360 degrees to find out the highest emission in the restricted band. The reciving antenna should be changed the polarization both of horizontal and vertical. The EUT was set to **Operation Mode #1 with configuration Mode #1.** 

Test Results

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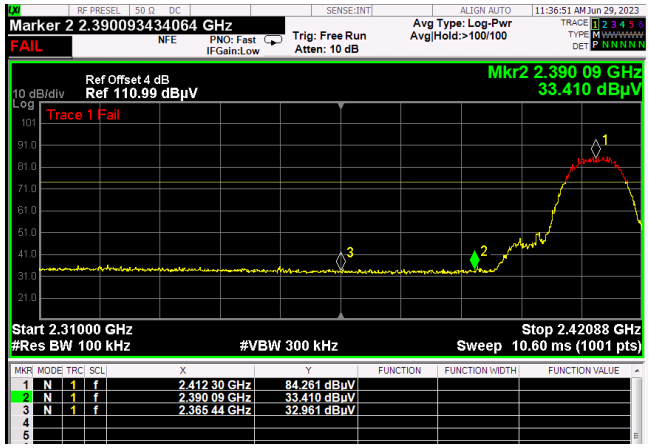
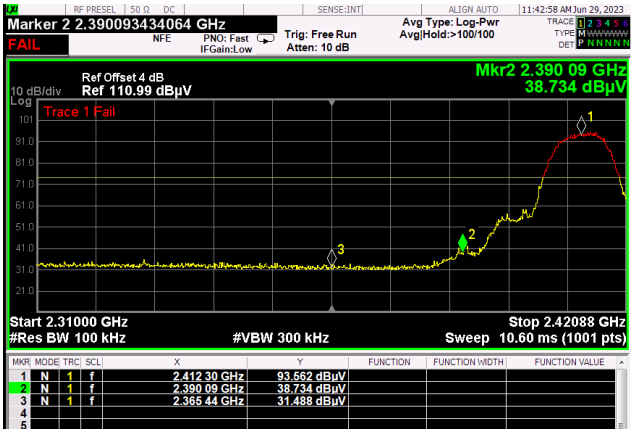
802.11b at Channel 2412MHz

Horizontal Polarization – Limit 74 dBuV/m – Peak Measurement



Horizontal Polarization – Limit 54 dBuV/m – Average Measurement

Vertical Polarization – Limit 74 dBuV/m – Peak Measurement



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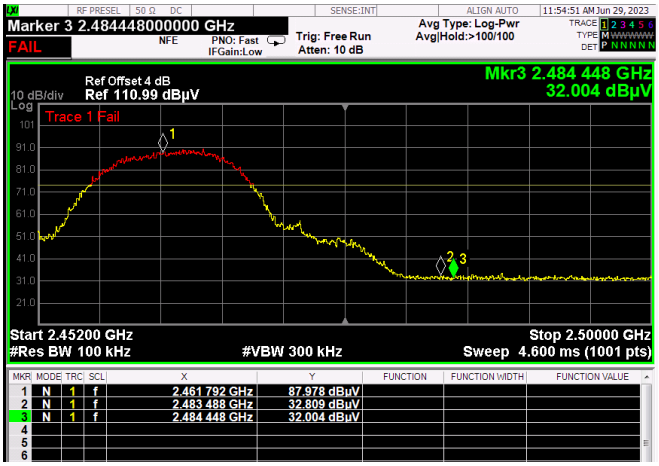
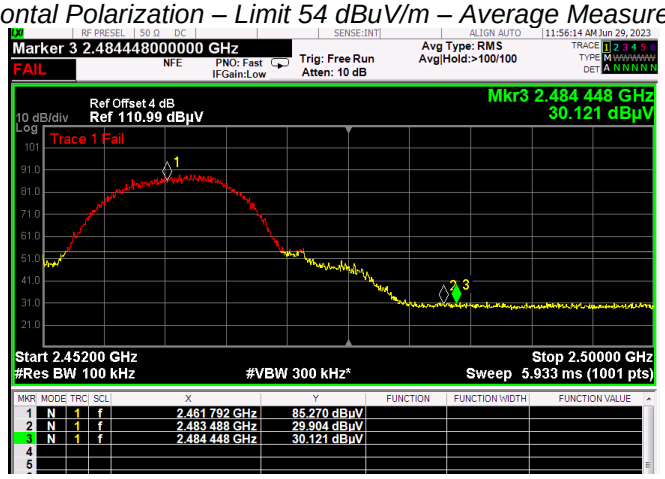
Vertical Polarization – Limit 54 dBuV/m – Average Measurement

802.11b at Channel 2462MHz

Horizontal Polarization – Limit 74 dBuV/m – Peak Measurement



Horizontal Polarization – Limit 54 dBuV/m – Average Measurement



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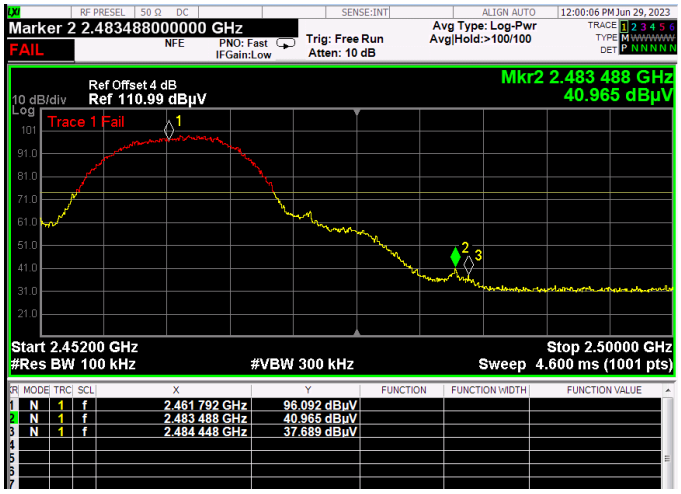
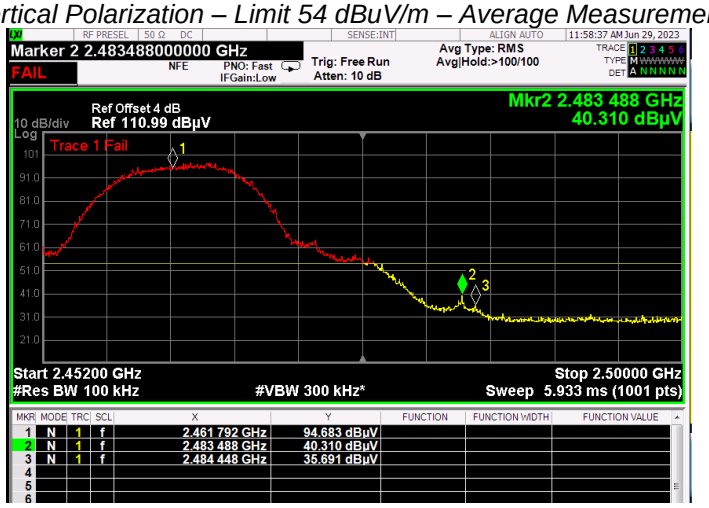
Vertical Polarization – Limit 74 dBuV/m – Peak Measurement

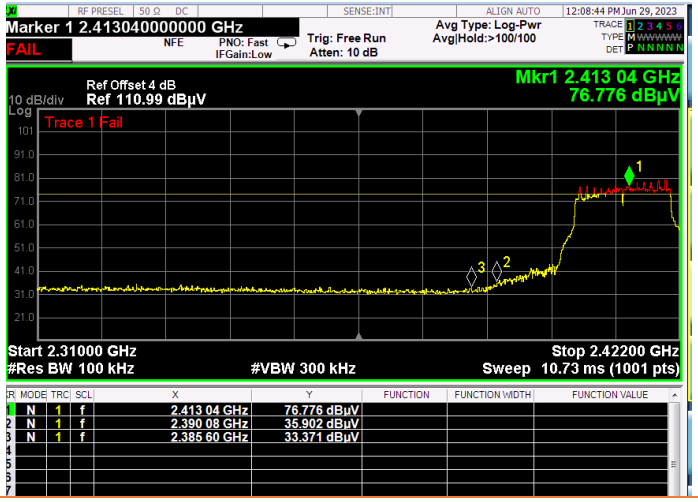


Vertical Polarization – Limit 54 dBuV/m – Average Measurement



802.11g at Channel 2412MHz

Horizontal Polarization – Limit 74 dBuV/m – Peak Measurement



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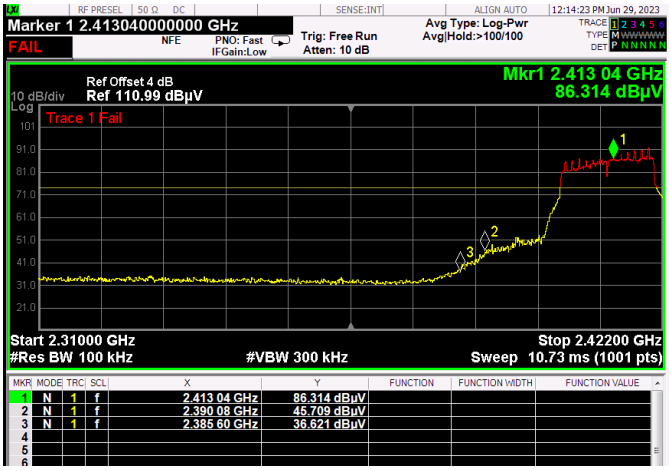
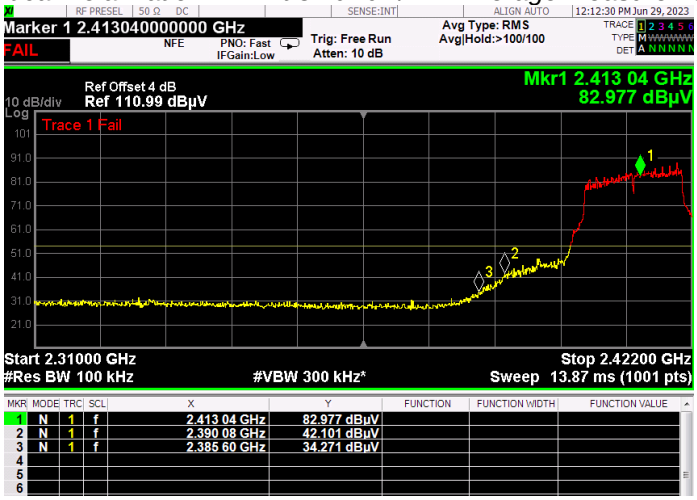
Horizontal Polarization – Limit 54 dBuV/m – Average Measurement

Vertical Polarization – Limit 74 dBuV/m – Peak Measurement



Vertical Polarization – Limit 54 dBuV/m – Average Measurement



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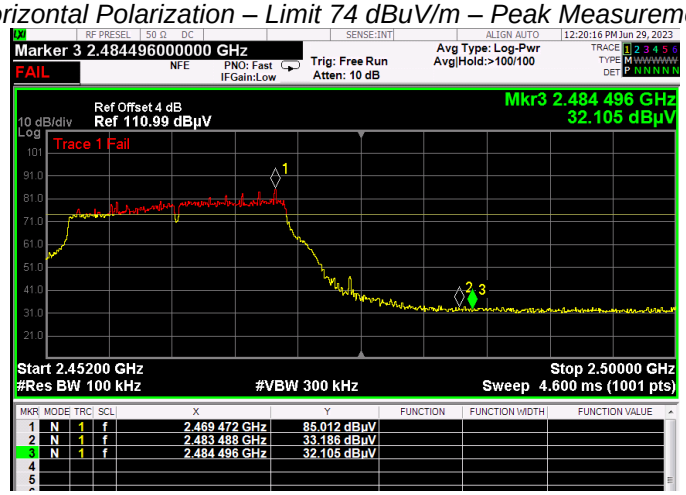
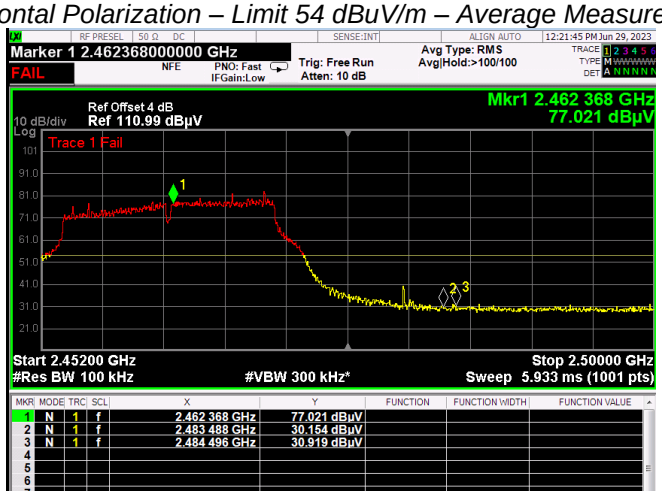
802.11g at Channel 2462MHz

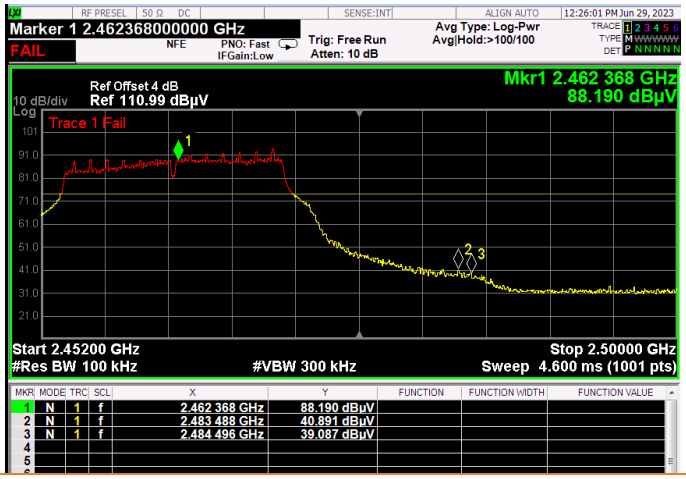
Horizontal Polarization – Limit 74 dBuV/m – Peak Measurement



Horizontal Polarization – Limit 54 dBuV/m – Average Measurement



Vertical Polarization – Limit 74 dBuV/m – Peak Measurement



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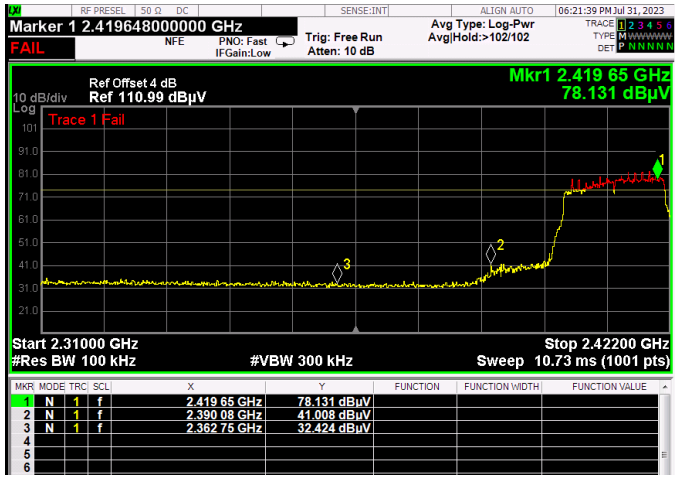
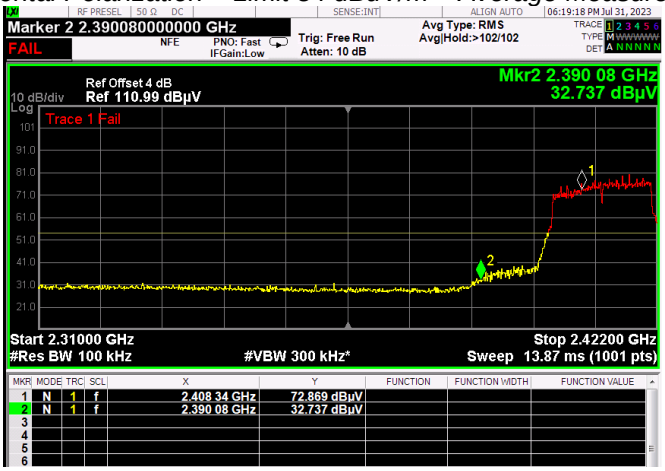
Vertical Polarization – Limit 54 dBuV/m – Average Measurement

802.11n- HT20 at Channel 2412MHz

Horizontal Polarization – Limit 74 dBuV/m – Peak Measurement



Horizontal Polarization – Limit 54 dBuV/m – Average Measurement



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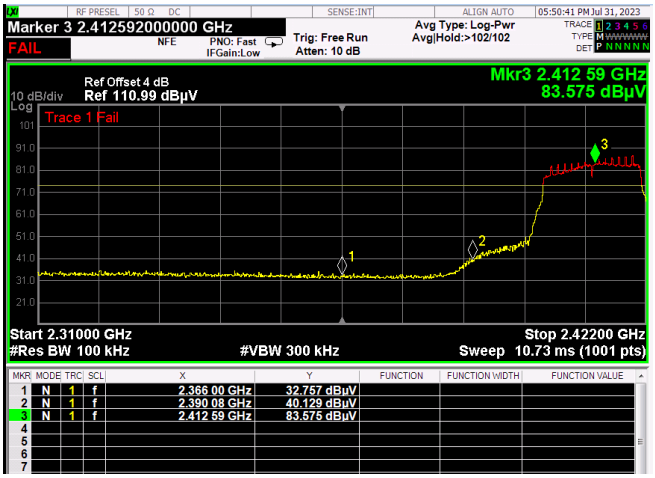
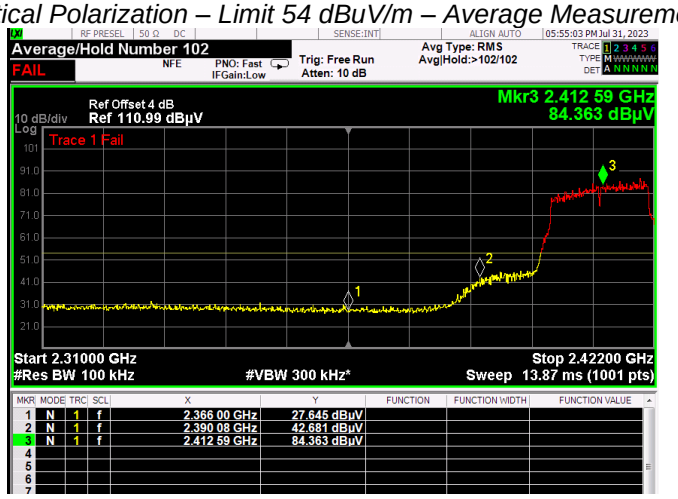
Vertical Polarization – Limit 74 dBuV/m – Peak Measurement

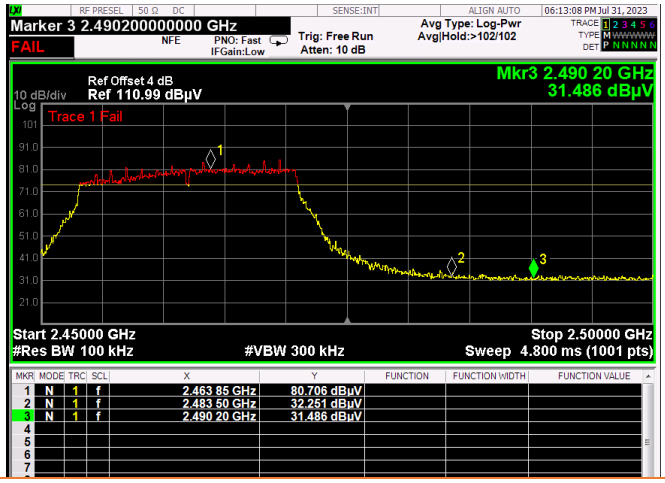


Vertical Polarization – Limit 54 dBuV/m – Average Measurement



802.11n- HT20 at Channel 2462MHz

Horizontal Polarization – Limit 74 dBuV/m – Peak Measurement



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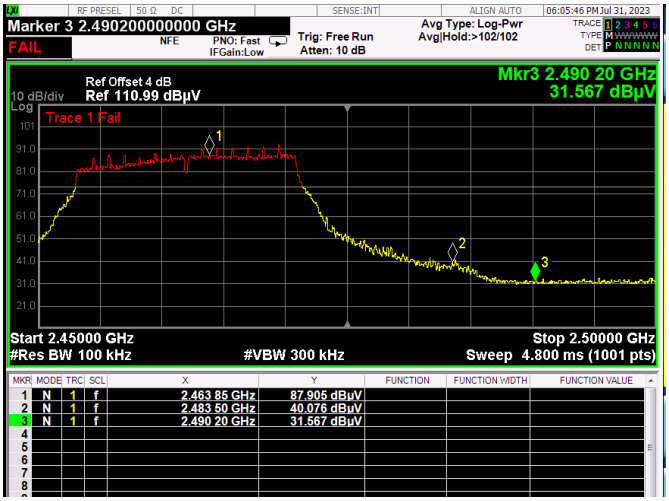
Horizontal Polarization – Limit 54 dBuV/m – Average Measurement

Vertical Polarization – Limit 74 dBuV/m – Peak Measurement



Vertical Polarization – Limit 54 dBuV/m – Average Measurement

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