

NCC RF Test Report

Report No.: NCC_RF_SL20092201-CRE-023_2.4G

Test Models: M201923002, M201923003, M201923005, M201923006

Series Model: See section 3.1

Received Date: 01/12/2021

Test Date: 01/13/2021 - 03/12/2021

Issued Date: 03/15/2021

Applicant: Crestron Electronics, Inc.

Address: 15 Volvo DrRockleigh, NJ 07647, USA

Manufacturer: Crestron Electronics, Inc.

Address: 15 Volvo DrRockleigh, NJ 07647, USA

Issued By: Bureau Veritas Consumer Products Services, Inc.

Lab Address: 775 Montague Expressway, Milpitas, CA 95035

Test Location (1): 775 Montague Expressway, Milpitas, CA 95035

**FCC Registration /
Designation Number:** 540430s

ISED# / CAB identifier: 4842D



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Release Control Record

Issue No.	Description	Date Issued
NCC_RF_SL20092201-CRE-023_2.4G	Original Release	03/15/2021

1 Certificate of Conformity

Product: 10.1 & 7 inch Touch Screen Surface/Wall Mount

Brand: Crestron

Test Models: M201923002, M201923003, M201923005, M201923006

Sample Status: Engineer Sample

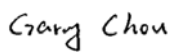
Applicant: Crestron Electronics, Inc.

Test Date: 01/13/2021 - 03/12/2021

Standards: LP0002: 2020

The above equipment has been tested by **Bureau Veritas Consumer Products Services, Inc., Milpitas Branch**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's EMC characteristics under the conditions specified in this report.

Prepared by :  , **Date:** 03/15/2021
Ellen Chu / Test Engineer


Approved by : _____ , **Date:** 03/15/2021
Gary Chou / Engineer Reviewer

2 Summary of Test Results

LP0002			
NCC Clause	Test Item	Result	Remarks
3.3	AC Power Conducted Emission	Pass	Power supplied by POE.
4.10.1.5	Radiated Emissions and Band Edge Measurement	PASS	Meet the requirement of limit.
4.10.1.6(2)(A)	6dB bandwidth & 99% bandwidth	PASS	Meet the requirement of limit.
4.10.1.2(1)(C)	Conducted power	PASS	Meet the requirement of limit.
4.10.1.6(2)(B)	Power Spectral Density	PASS	Meet the requirement of limit.
3.2	Antenna Requirement	PASS	The EUT uses a chip antenna and permanently attached to the device.

Note: N/A: EUT worked with battery.

2.1 Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2:

Measurement	Frequency	Expanded Uncertainty (k=2) ($\pm$)
Conducted Emissions at mains ports	150kHz ~ 30MHz	3.51dB
Radiated Emissions up to 1 GHz	30MHz ~ 1GHz	3.73dB
Radiated Emissions above 1 GHz	1GHz ~ 6GHz	4.64dB
	6GHz ~ 18GHz	4.82dB
	18GHz ~ 40GHz	4.91dB

2.2 Modification Record

There were no modifications required for compliance.

3 General Information

3.1 General Description of EUT

Product	10.1 & 7 inch Touch Screen Surface/Wall Mount	
Brand	Crestron	
Test Models	M201923002, M201923003, M201923005, M201923006	
Identification No. of EUT	N/A	
Series Model	M201923002	TSW-770-B-S
		TSW-770-W-S
		TSW-770P-B-S
		TSW-770P-W-S
		TSW-770-GV-B-S
		TSW-770-GV-W-S
		TSS-770-B-S
		TSS-770-W-S
		TSW-770R-W
		TSW-770R-B
		TSS-770-T-B-S
		TSS-770-T-W-S
	M201923003	TSW-1070-B-S
		TSW-1070-W-S
		TSW-1070P-B-S
		TSW-1070P-W-S
		TSW-1070-GV-B-S
		TSW-1070-GV-W-S
		TSS-1070-B-S
		TSS-1070-W-S
		TSW-1070R-W
		TSW-1070R-B
		TSS-1070-T-B-S
		TSS-1070-T-W-S
		TSW-1070-B-S-T-V
	M201923005	TS-770-B-S
		TS-770-W-S
		TS-770-GV-B-S
		TS-770-GV-W-S
		TS-770R-W
		TS-770R-B
	M201923006	TS-1070-B-S
		TS-1070-W-S
		TS-1070-GV-B-S
		TS-1070-GV-W-S
		TS-1070R-W
		TS-1070R-B

	TS-1070-B-S-T-V
Model Difference	All models are identical to each other except by their color.
Status of EUT	Engineering Sample
Power Supply Rating	Vdc supplied from POE, 48 Vdc, 350mA (802.3af POE Injector)
Modulation Type	CCK, DQPSK, DBPSK for DSSS 64QAM, 16QAM, QPSK, BPSK for OFDM
Modulation Technology	DSSS, OFDM
Transfer Rate	802.11b: up to 11Mbps 802.11g: up to 54Mbps 802.11n: up to 300Mbps
Operating Frequency	2.412 ~ 2.462GHz
Number of Channel	11 for 802.11b, 802.11g, 802.11n (HT20) 7 for 802.11n (HT40)
Antenna Type	PCB antenna, 4.6dBi Gain
Antenna Connector	IPEX
Accessories	No accessories sold with device

3.2 Description of Test Modes

11 channels are provided for 802.11b, 802.11g and 802.11n (HT20):

Channel	Frequency	Channel	Frequency
1	2412MHz	7	2442MHz
2	2417MHz	8	2447MHz
3	2422MHz	9	2452MHz
4	2427MHz	10	2457MHz
5	2432MHz	11	2462MHz
6	2437MHz		

7 channels are provided for 802.11n (HT40):

Channel	Frequency	Channel	Frequency
3	2422MHz	7	2442MHz
4	2427MHz	8	2447MHz
5	2432MHz	9	2452MHz
6	2437MHz		

Power setting is as below:

802.11b		802.11g	
Channel	Power Setting	Channel	Power Setting
1	16	1	12
6	16	6	13
11	16	11	12
802.11n (HT20)		802.11n (HT40)	
Channel	Power Setting	Channel	Power Setting
1	12	3	11
6	13	6	12
11	12	9	11

3.2.1 Test Mode Applicability and Tested Channel Detail

EUT CONFIGURE MODE	APPLICABLE TO				DESCRIPTION
	RE $\geq$ 1G	RE<1G	PLC	APCM	
-	√	√	√	√	-

Where RE $\geq$ 1G: Radiated Emission above 1GHz & Bandedge Measurement
 RE<1G: Radiated Emission below 1GHz
 PLC: Power Line Conducted Emission
 APCM: Antenna Port Conducted Measurement

NOTE: The EUT had been pre-tested on the positioned of each 3 axis. The worst case was found when positioned on **Y-plane**.

NOTE: "-" means no effect.

Radiated Emission Test (Above 1GHz):

- ☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
- ☒ Following channel(s) was (were) selected for the final test as listed below.

EUT CONFIGURE MODE	MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE	DATA RATE (Mbps)
-	802.11b	1 to 11	1, 6, 11	DSSS	DBPSK	1
-	802.11g	1 to 11	1, 6, 11	OFDM	BPSK	6
-	802.11n (HT20)	1 to 11	1, 6, 11	OFDM	BPSK	6.5
-	802.11n (HT40)	3 to 9	3, 6, 9	OFDM	BPSK	13.5

Radiated Emission Test (Below 1GHz):

- ☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
- ☒ Following channel(s) was (were) selected for the final test as listed below.

EUT CONFIGURE MODE	MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE	DATA RATE (Mbps)
-	802.11n (20MHz)	1 to 11	6	OFDM	BPSK	6.5

Power Line Conducted Emission Test:

- ☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
- ☒ Following channel(s) was (were) selected for the final test as listed below.

EUT CONFIGURE MODE	MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE	DATA RATE (Mbps)
-	802.11n (HT20)	1 to 11	6	OFDM	BPSK	6.5

Antenna Port Conducted Measurement:

- ☒ This item includes all test value of each mode, but only includes spectrum plot of worst value of each mode.
- ☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
- ☒ Following channel(s) was (were) selected for the final test as listed below.

EUT CONFIGURE MODE	MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE	DATA RATE (Mbps)
-	802.11b	1 to 11	1, 6, 11	DSSS	DBPSK	1
-	802.11g	1 to 11	1, 6, 11	OFDM	BPSK	6
-	802.11n (HT20)	1 to 11	1, 6, 11	OFDM	BPSK	6.5
-	802.11n (HT40)	3 to 9	3, 6, 9	OFDM	BPSK	13.5

Test Condition:

APPLICABLE TO	ENVIRONMENTAL CONDITIONS	INPUT POWER	TESTED BY
RE $\geq$ 1G	25deg. C, 65%RH	Vdc supplied from POE	Ellen Chu
RE<1G	25deg. C, 65%RH	Vdc supplied from POE	Ellen Chu
PLC	25deg. C, 68%RH	Vdc supplied from POE	Ellen Chu
APCM	21deg. C, 60%RH	Vdc supplied from POE	Ellen Chu

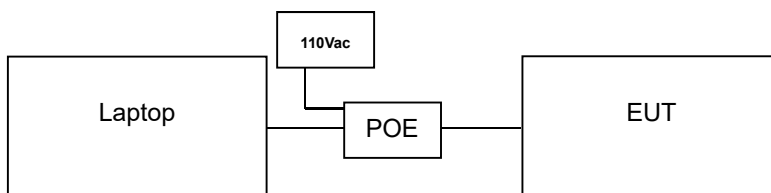
3.3 Description of Support Units

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

ID	Product	Brand	Model No.	Serial No.	FCC ID	Remarks
A.	Laptop	Dell	Precision 7510	FRYPPC2	N/A	Provided by Customer
B.	POE	I.T.E	PW180KB4800F03	N/A	N/A	Provide the power to EUT

ID	Descriptions	Qty.	Length (m)	Shielding (Yes/No)	Cores (Qty.)	Remarks
1.	Cat5E Lan	1	10m	No	0	Connect from EUT to POE

3.3.1 Configuration of System under Test



3.4 DUTY CYCLE OF TEST SIGNAL

Duty cycle of test signal is $\geq 98\%$, duty factor is not required.

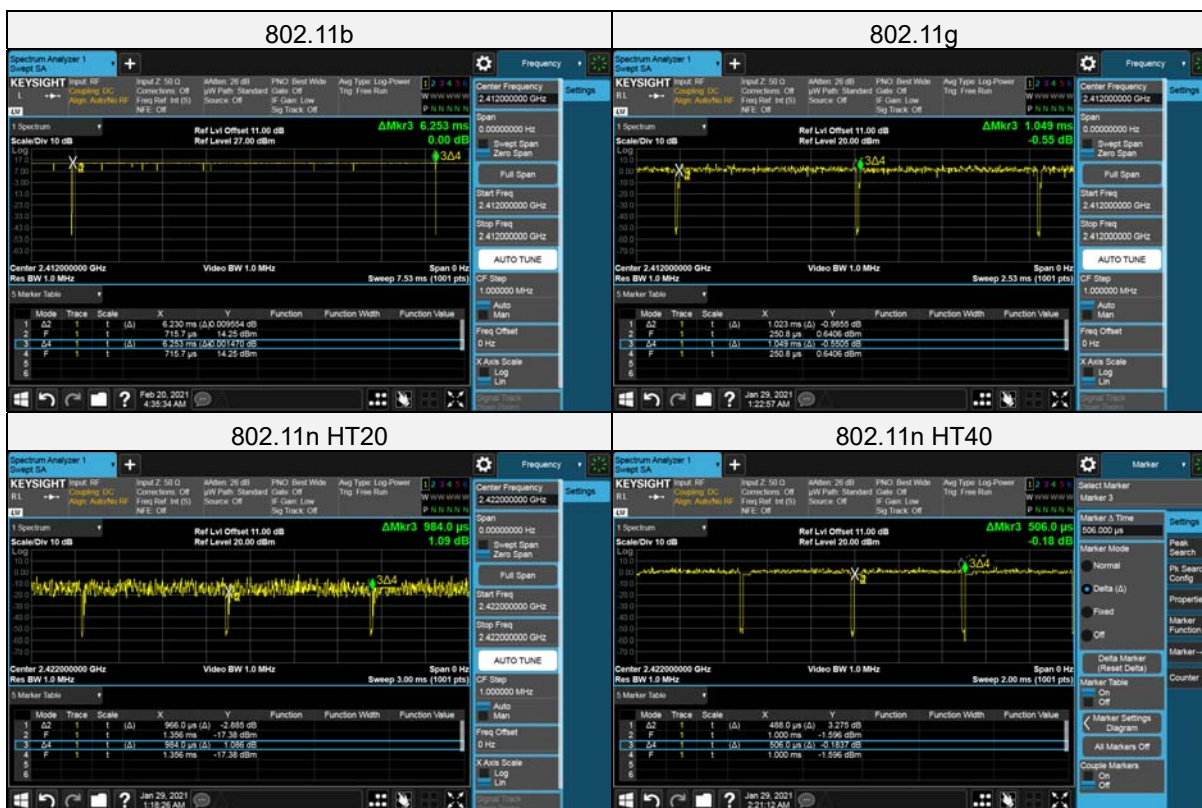
Duty cycle of test signal is $< 98\%$, duty factor is required.

802.11b: Duty cycle = 99.6%

802.11g: Duty cycle = 97.52%, Duty factor = 0.11

802.11n HT20: Duty cycle = 98.17%, Duty factor = 0.08

802.11n HT40: Duty cycle = 96.44%, Duty factor = 0.16



3.5 General Description of Applied Standards

The EUT is a RF Product. According to the specifications of the manufacturer, it must comply with the requirements of the following standards:

LP0002 : 2020

ANSI C63.10: 2013

558074 D01 15.247 Meas Guidance v05r02

All test items have been performed and recorded as per the above standards.

4 Test Types and Results

4.1 Radiated Emission and Bandedge Measurement

4.1.1 Limits of Radiated Emission and Bandedge Measurement

Radiated emissions which fall in the restricted bands must comply with the radiated emission limits specified as below table. Other emissions shall be at least 20dB below the highest level of the desired power:

Frequencies (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 ~ 0.490	2400/F(kHz)	300
0.490 ~ 1.705	24000/F(kHz)	30
1.705 ~ 30.0	30	30
30 ~ 88	100	3
88 ~ 216	150	3
216 ~ 960	200	3
Above 960	500	3

NOTE:

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 log Emission level (uV/m).
3. For frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20dB under any condition of modulation.

4.1.2 Test Instruments

DESCRIPTION & MANUFACTURER	MODEL NO.	SERIAL NO.	DATE OF CALIBRATION	DUE DATE OF CALIBRATION
EMI Test Receiver Keysight	ESW 44	1328.4100K- 101662-MH	08/30/2020	08/30/2021
Spectrum Analyzer Keysight	N9030B	0240376	06/15/2020	06/15/2021
Hybrid Antenna Sunol	JB1	A030702	09/04/2020	09/04/2021
Horn Antenna ETS-Lindgren	3117	218554	11/22/2020	11/22/2021
Preamplifier RF-Lambda	RAMP00M50GA	17032300048	06/18/2020	06/18/2021
Preamplifier RF Bay, Inc.	LPA-6-30	11170601	04/27/2020	04/27/2021

4.1.3 Test Procedures

For Radiated emission below 30MHz

- a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter chamber room. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. Parallel, perpendicular, and ground-parallel orientations of the antenna are set to make the measurement.
- d. For each suspected emission, the EUT was arranged to its worst case and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. The test-receiver system was set to Quasi-Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

NOTE:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 9 kHz at frequency below 30MHz.

For Radiated emission above 30MHz

- a. The EUT was placed on the top of a rotating table 0.8 meters (for 30MHz ~ 1GHz) / 1.5 meters (for above 1GHz) above the ground at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. The test-receiver system was set to quasi-peak detect function and specified bandwidth with maximum hold mode when the test frequency is below 1 GHz.
- f. The test-receiver system was set to peak and average detects function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz. If the peak reading value also meets average limit, measurement with the average detector is unnecessary.

Note:

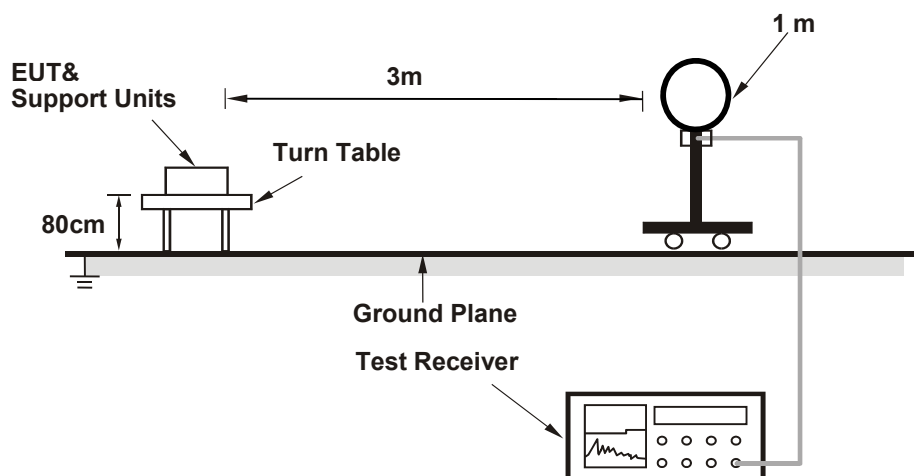
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz for Quasi-peak detection (QP) at frequency below 1GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is $\geq 1/T$ (Duty cycle < 98%) or 10Hz (Duty cycle $\geq 98\%$) for Average detection (AV) at frequency above 1GHz.
4. All modes of operation were investigated and the worst-case emissions are reported.

4.1.4 Deviation from Test Standard

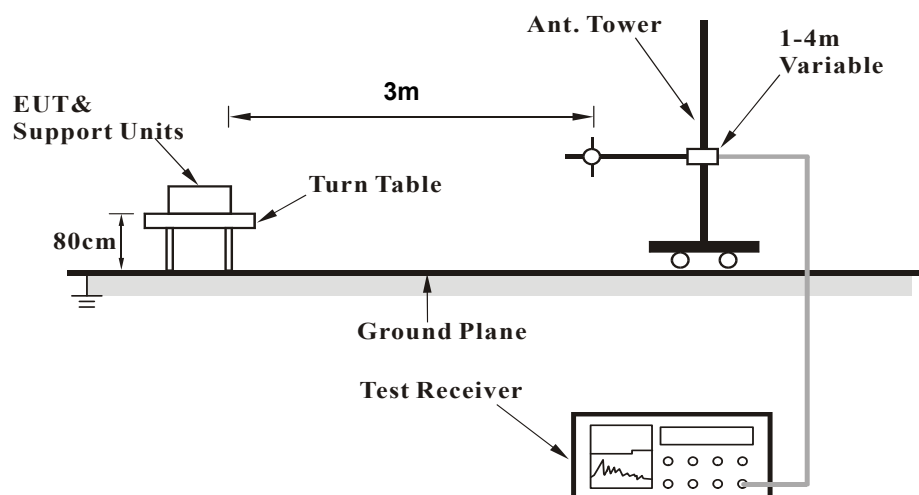
No deviation.

4.1.5 Test Setup

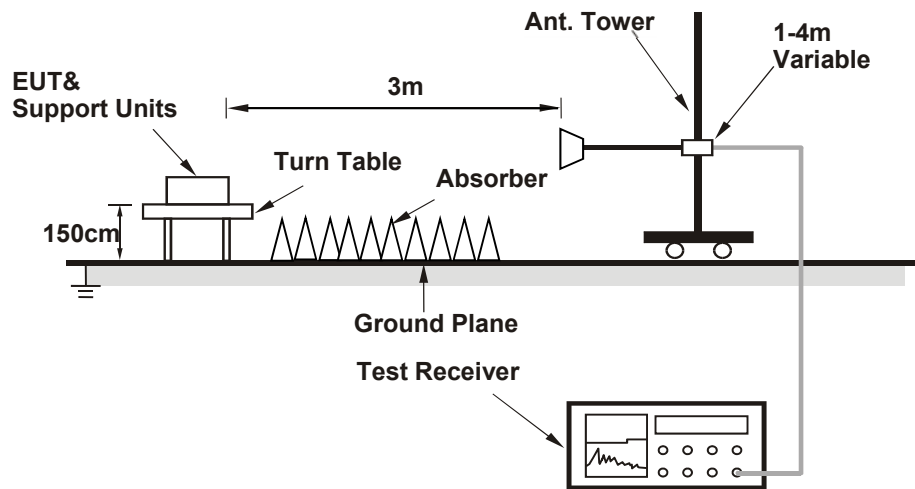
For Radiated emission below 30MHz



For Radiated emission 30MHz to 1GHz



For Radiated emission above 1GHz



For the actual test configuration, please refer to the attached file (Test Setup Photo).

4.1.6 EUT Operating Conditions

- a. Connected the EUT with the Notebook Computer which is placed on remote site.
- b. Controlling software has been activated to set the EUT on specific status.

4.1.7 Test Results

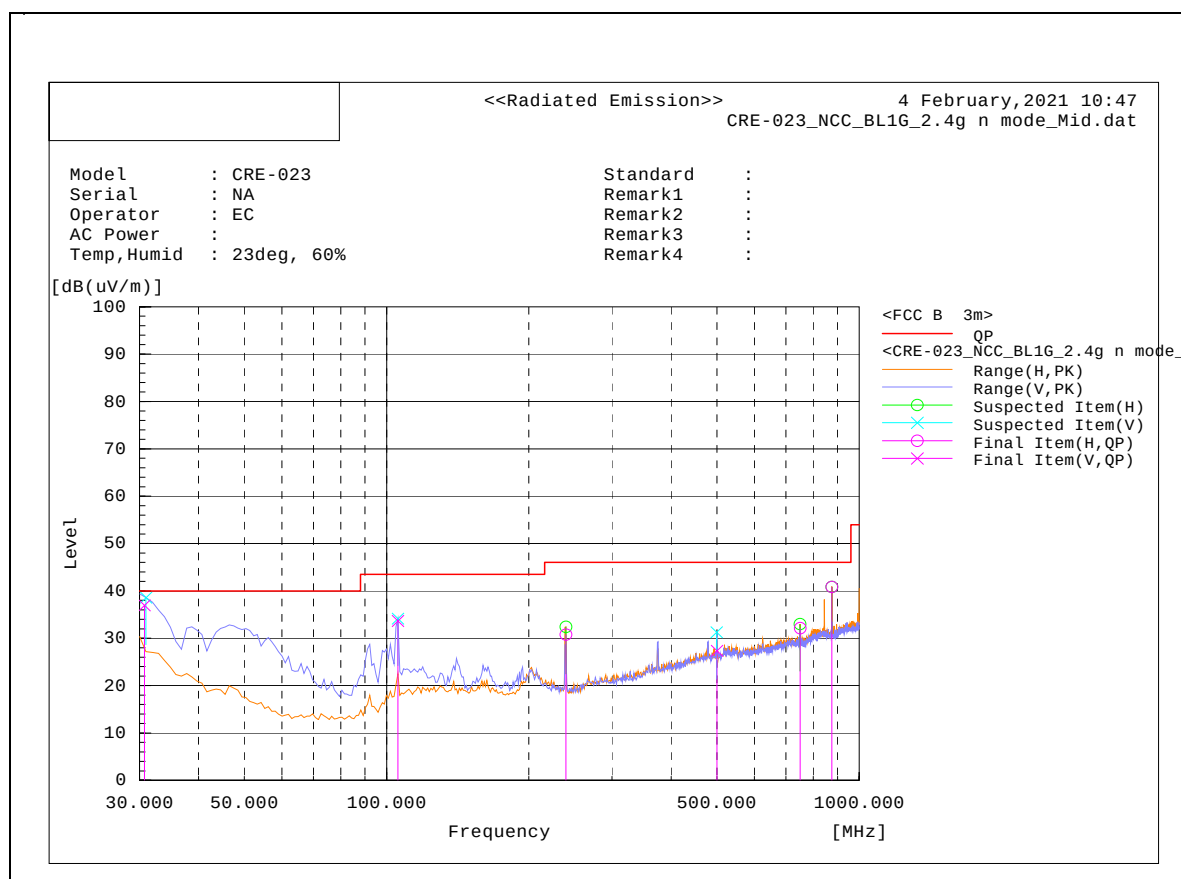
BELOW 1GHz WORST-CASE DATA:

CHANNEL	802.11n Channel 6	DETECTOR FUNCTION	Quasi Peak
FREQUENCY RANGE	30MHz – 1GHz		

Antenna Polarity & Test Distance: Vertical and Horizontal at 3m										
No.	Frequency (MHz)	Polarization (H/V)	Reading QP [dB(uV)]	Factor [dB(1/m)]	Level QP [dB(uV/m)]	Limit\QP dB(uV/m)	Margin QP [dB]	Height (cm)	Angle (Deg)	Pass/Fail
1	30.726	V	12.1	24.9	37	40	-3	100	125.8	Pass
2	105.702	V	15.8	17.9	33.7	43.5	-9.8	100	202	Pass
3	239.527	H	12.5	18.3	30.8	46	-15.2	115	153.5	Pass
4	499.976	V	2.6	24.8	27.4	46	-18.6	115	167.3	Pass
5	750.027	H	3.5	28.6	32.1	46	-13.9	134	248.3	Pass
6	874.998	H	10.8	30.1	40.9	46	-5.1	106	111.3	Pass

REMARKS:

1. Emission level (dBuV/m) = Reading Value (dBuV) + Factor (dB)
2. AF (dB/m) = Antenna Factor (dB/m) – Preamplifier Gain (dB).
3. The emission levels of other frequencies were less than 20dB margin against the limit.
4. Margin value = Emission level – Limit value.



Above 1GHz Test Data:

Above 1GHz-25GHz – 802.11b – 2412MHz

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading AV [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
4262.413	H	40.2	-8.4	Average	31.8	54	-22.2	146	359
7235.102	V	45	-2.3	Average	42.7	54	-11.3	192	332.8
9721.418	V	29.7	1.3	Average	31	54	-23	298	33.1
4262.413	H	52.7	-8.4	Peak	44.3	74	-29.7	146	359
7235.102	V	51.9	-2.3	Peak	49.6	74	-24.4	192	332.8
9721.418	V	42.1	1.3	Peak	43.3	74	-30.7	298	33.1

Above 1GHz-25GHz- 802.11b - 2437MHz

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading AV [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
5770.75	V	36.6	-4.9	Average	31.7	54	-22.3	238	0
7311.01	V	38.4	-2.3	Average	36.1	54	-17.9	100	318.8
17391.35	V	26.3	13.1	Average	39.4	54	-14.6	329	0
5770.75	V	48.4	-4.9	Peak	43.5	74	-30.5	238	0
7311.01	V	53	-2.3	Peak	50.8	74	-23.2	100	318.8
17391.35	V	38.7	13.1	Peak	51.8	74	-22.2	329	0

Above 1GHz-25GHz – 802.11b – 2462MHz

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading AV [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
4262.858	H	40.7	-8.4	Average	32.3	54	-21.7	117	2.3
7384.005	V	45.3	-2.1	Average	43.2	54	-10.8	117	334
9847.972	V	45.6	1.4	Average	47	54	-7	162	12.1
4262.858	H	53.9	-8.4	Peak	45.5	74	-28.5	117	2.3
7384.005	V	51.5	-2.1	Peak	49.4	74	-24.6	117	334
9847.972	V	49.7	1.4	Peak	51.1	74	-22.9	162	12.1

Above 1GHz-25GHz- 802.11g - 2412MHz

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading AV [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
3195.623	V	41.4	-8.9	Average	32.5	54	-21.5	100	283.5
4251.105	H	38.6	-8.4	Average	30.2	54	-23.8	313	358.4
6390.519	V	35.5	-3.4	Average	32.1	54	-21.9	103	1
3195.623	V	57.9	-8.9	Peak	49	74	-25	100	283.5
4251.105	H	50.7	-8.4	Peak	42.3	74	-31.7	313	358.4
6390.519	V	51.3	-3.4	Peak	47.9	74	-26.1	103	1

Above 1GHz-25GHz – 802.11g – 2437MHz

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading AV [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
1065.262	V	49.2	-15.5	Average	33.7	54	-20.3	223	208.6
2432.172	V	53.7	-10	Average	43.7	54	-10.3	147	24.8
9241.084	H	30.9	0.5	Average	31.4	54	-22.6	103	218.5
1065.262	V	68.4	-15.5	Peak	52.9	74	-21.1	223	208.6
2432.172	V	62.6	-10	Peak	52.6	74	-21.4	147	24.8
9241.084	H	43.6	0.5	Peak	44.1	74	-29.9	103	218.5

Above 1GHz-25GHz- 802.11g - 2462MHz

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading AV [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
3198.079	H	40.9	-8.9	Average	32	54	-22	132	210.6
4248.262	V	40	-8.5	Average	31.5	54	-22.5	117	350.9
7386.596	V	36.4	-2.1	Average	34.3	54	-19.7	117	46.4
3198.079	H	53.8	-8.9	Peak	44.9	74	-29.1	132	210.6
4248.262	V	55.5	-8.5	Peak	47	74	-27	117	350.9
7386.596	V	48.8	-2.1	Peak	46.7	74	-27.3	117	46.4

Above 1GHz-25GHz- 802.11n20 - 2412MHz

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading AV [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
3185.537	H	41.2	-8.9	Average	32.3	54	-21.7	283	100
4250.449	V	40.7	-8.4	Average	32.3	54	-21.7	103	348.9
6380.908	V	35.5	-3.4	Average	32.1	54	-21.9	132	84
3185.537	H	52	-8.9	Peak	43.1	74	-30.9	283	100
4250.449	V	55.7	-8.4	Peak	47.2	74	-26.8	103	348.9
6380.908	V	49.4	-3.4	Peak	46	74	-28	132	84

Above 1GHz-25GHz – 802.11n20 – 2437MHz

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading AV [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
2443.64	H	53.2	-10	Average	43.2	54	-10.8	307	29.3
4255.956	V	40.8	-8.4	Average	32.4	54	-21.6	132	319.3
6371.99	V	35.3	-3.4	Average	31.9	54	-22.1	314	46.5
2443.64	H	63.2	-10	Peak	53.2	74	-20.8	307	29.3
4255.956	V	57.4	-8.4	Peak	49	74	-25	132	319.3
6371.99	V	47.3	-3.4	Peak	43.9	74	-30.1	314	46.5

Above 1GHz-25GHz- 802.11n20 - 2462MHz

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading AV [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
7395.401	V	39.4	-2	Average	37.4	54	-16.6	150	351
2458.6	V	46.9	-9.9	Average	37	54	-17	100	7.9
1062.9	V	45.2	-15.5	Average	29.7	54	-24.3	100	124.4
7395.401	V	52.8	-2	Peak	50.8	74	-23.2	150	351
2458.6	V	57.6	-9.9	Peak	47.7	74	-26.3	100	7.9
1062.9	V	59.8	-15.5	Peak	44.3	74	-29.7	100	124.4

Above 1GHz-25GHz- 802.11n40 - 2422MHz

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading AV [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
3197.902	V	41.3	-8.9	Average	32.4	54	-21.6	329	250.4
4264.833	V	39.7	-8.4	Average	31.3	54	-22.7	147	351
8310.749	H	32.4	0.1	Average	32.5	54	-21.5	359	36.6
3197.902	V	52.1	-8.9	Peak	43.2	74	-30.8	329	250.4
4264.833	V	56.1	-8.4	Peak	47.7	74	-26.3	147	351
8310.749	H	44.6	0.1	Peak	44.7	74	-29.3	359	36.6

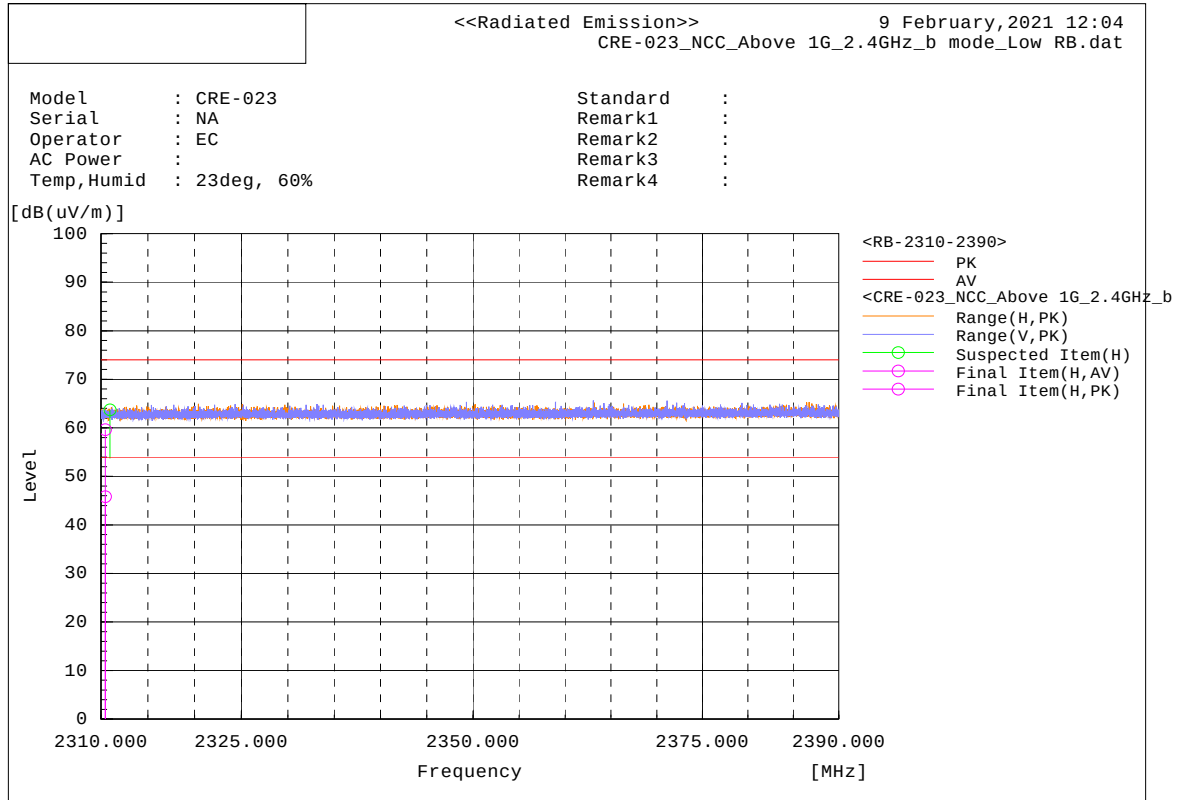
Above 1GHz-25GHz – 802.11n40 – 2437MHz

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading AV [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
1630.86	H	42.5	-14.2	Average	28.3	54	-25.7	162	33
4254.377	V	41.5	-8.4	Average	33.1	54	-20.9	103	305.6
7307.29	V	36	-2.3	Average	33.7	54	-20.3	177	311.1
1630.86	H	53.8	-14.2	Peak	39.6	74	-34.3	162	33
4254.377	V	56.5	-8.4	Peak	48.1	74	-25.9	103	305.6
7307.29	V	47.1	-2.3	Peak	44.8	74	-29.2	177	311.1

Above 1GHz-25GHz- 802.11n40 - 2452MHz

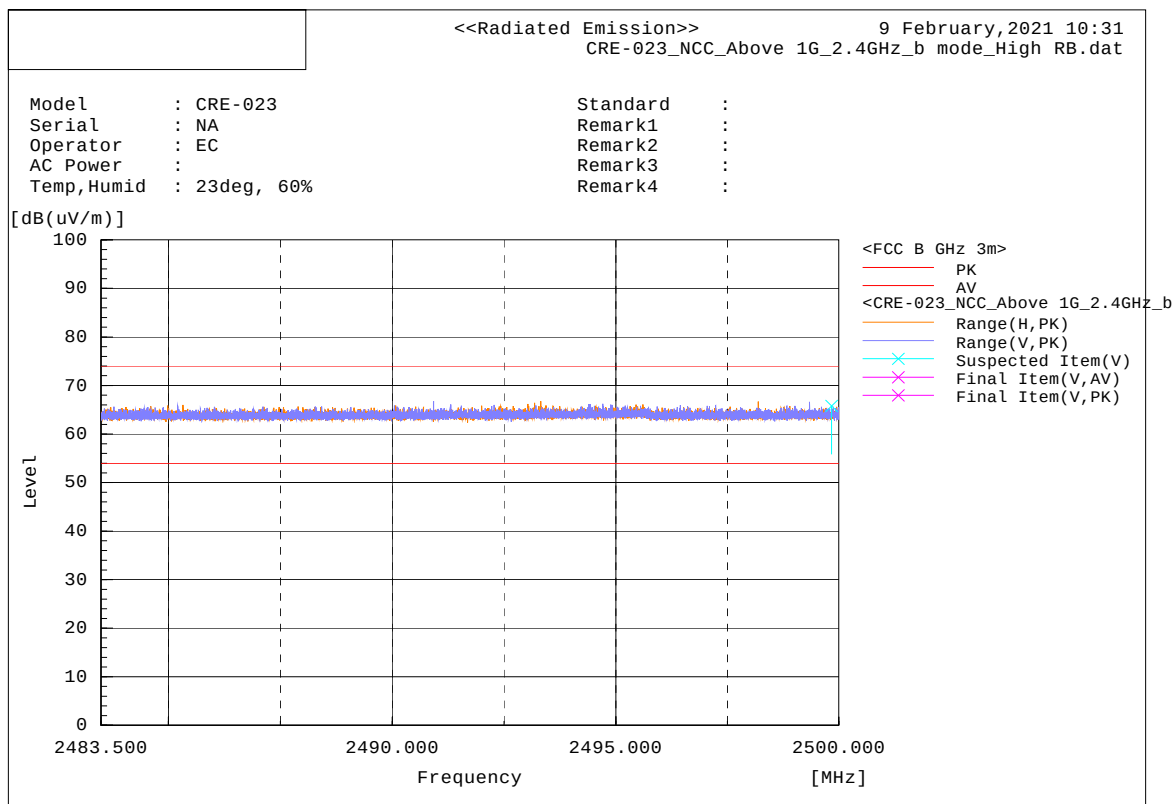
ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading AV [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
10012.23	V	30.5	1.6	Average	32.1	54	-21.9	185.3	243.7
3518.197	V	39.6	-8.9	Average	30.7	54	-23.3	162.2	182.6
3077.433	V	40.5	-9.2	Average	31.3	54	-22.7	282.7	282.1
10012.23	V	42	1.6	Peak	43.6	74	-30.4	185.3	243.7
3518.197	V	51.7	-8.9	Peak	42.8	74	-31.2	162.2	182.6
3077.433	V	52	-9.2	Peak	42.8	74	-31.2	282.7	282.1

RESTRICTED BAND (802.11b LOW CHANNEL)



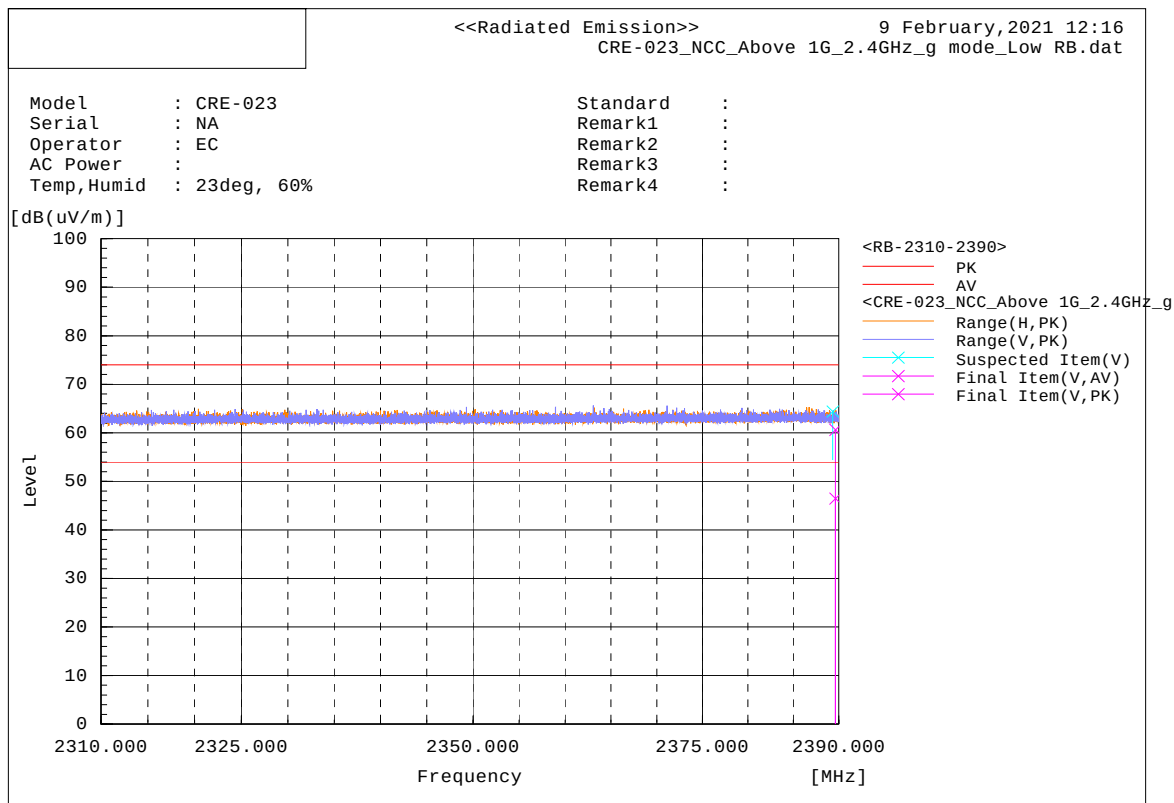
Frequency [MHz]	Pol	Reading [dB(uV)]	Measurement Type	Factor [dB(1/m)]	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
2310.456	H	7.1	Average	38.7	45.8	54	-8.2	369	278.6
2310.456	H	20.9	Peak	38.7	59.6	74	-14.4	369	278.6

RESTRICTED BAND (802.11b HIGH CHANNEL)



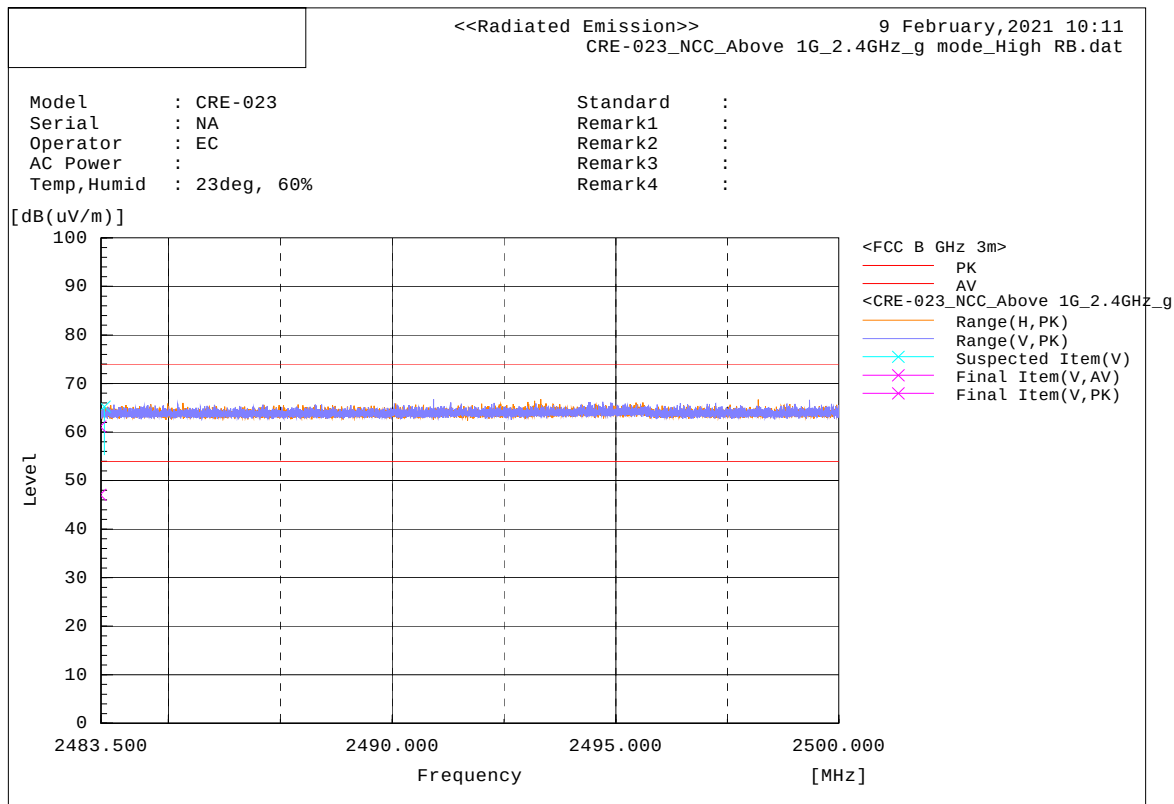
Frequency [MHz]	Pol	Reading [dB(uV)]	Measurement Type	Factor [dB(1/m)]	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
2499.189	V	7.6	Average	39.6	47.2	54	-6.8	238	3.4
2499.189	V	21.2	Peak	39.6	60.8	74	-13.2	238	3.4

RESTRICTED BAND (802.11g LOW CHANNEL)



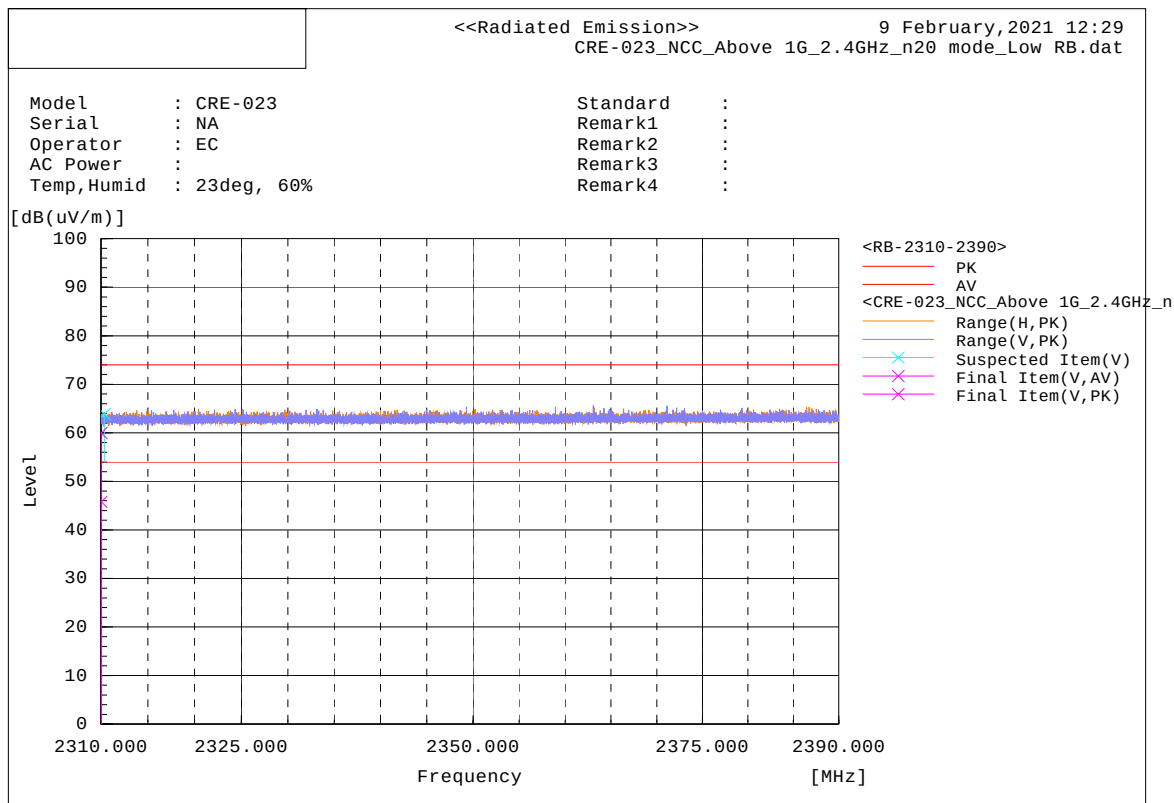
Frequency [MHz]	Pol	Reading [dB(uV)]	Measurement Type	Factor [dB(1/m)]	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
2389.633	V	7.4	Average	39.1	46.5	54	-7.5	313	240.2
2389.633	V	21.5	Peak	39.1	60.6	74	-13.4	313	240.2

RESTRICTED BAND (802.11g HIGH CHANNEL)



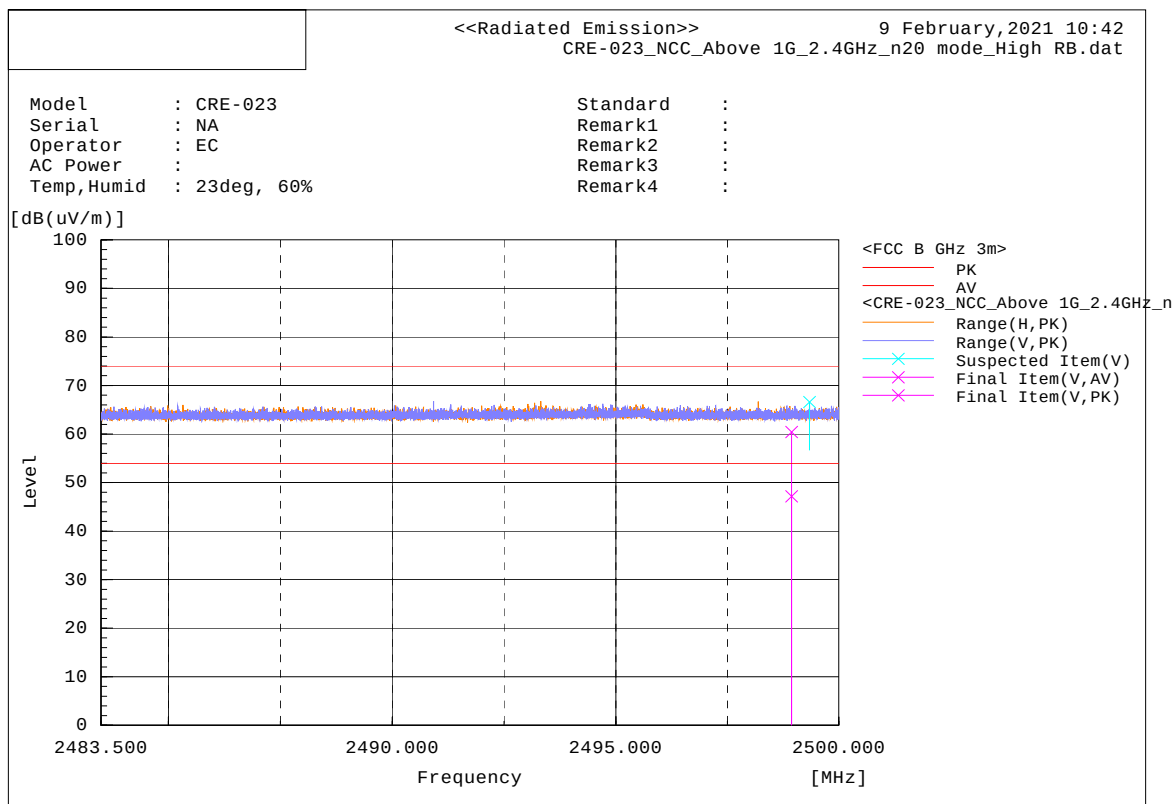
Frequency [MHz]	Pol	Reading [dB(uV)]	Measurement Type	Factor [dB(1/m)]	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
2483.52	V	7.5	Average	39.6	47.1	54	-6.9	379	308.3
2483.52	V	21.5	Peak	39.6	61.1	74	-12.9	379	308.3

RESTRICTED BAND (802.11n LOW CHANNEL)



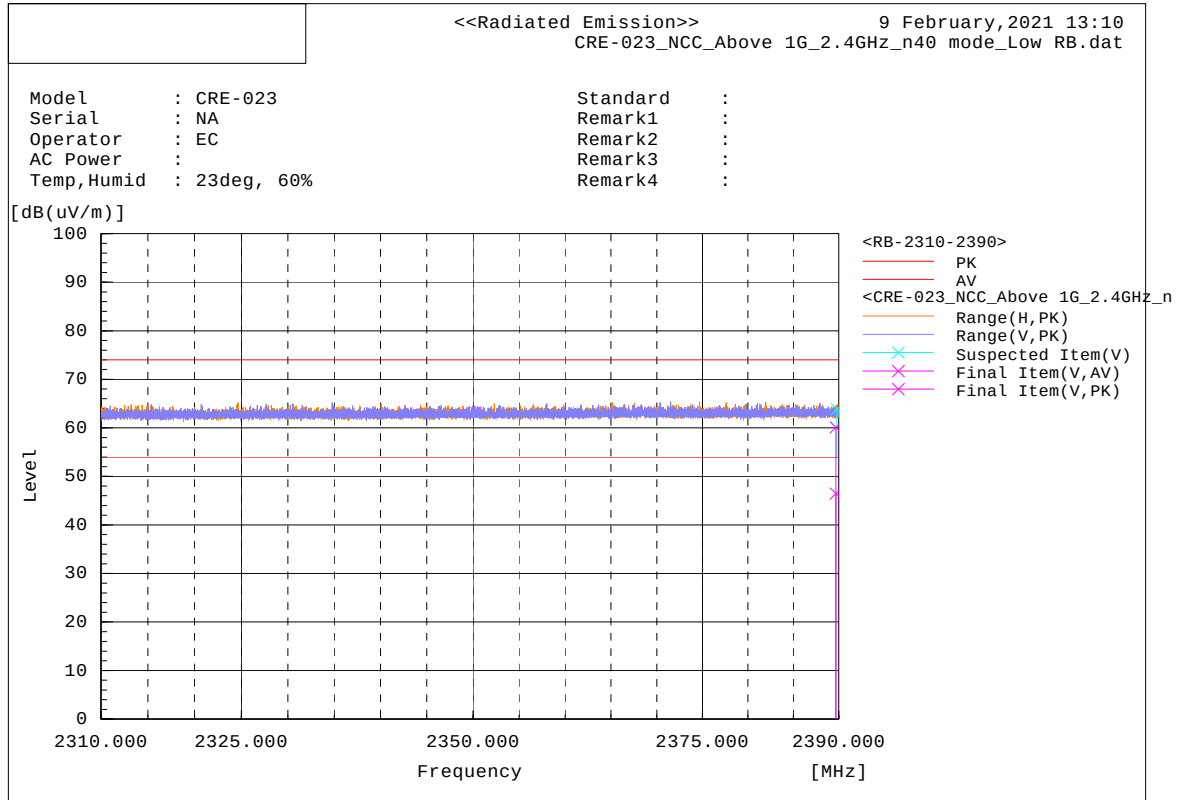
Frequency [MHz]	Pol	Reading [dB(uV)]	Measurement Type	Factor [dB(1/m)]	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
2310.021	V	7.1	Average	38.7	45.8	54	-8.2	275	24.9
2310.021	V	21.3	Peak	38.7	60	74	-14	275	24.9

RESTRICTED BAND (802.11n HIGH CHANNEL)



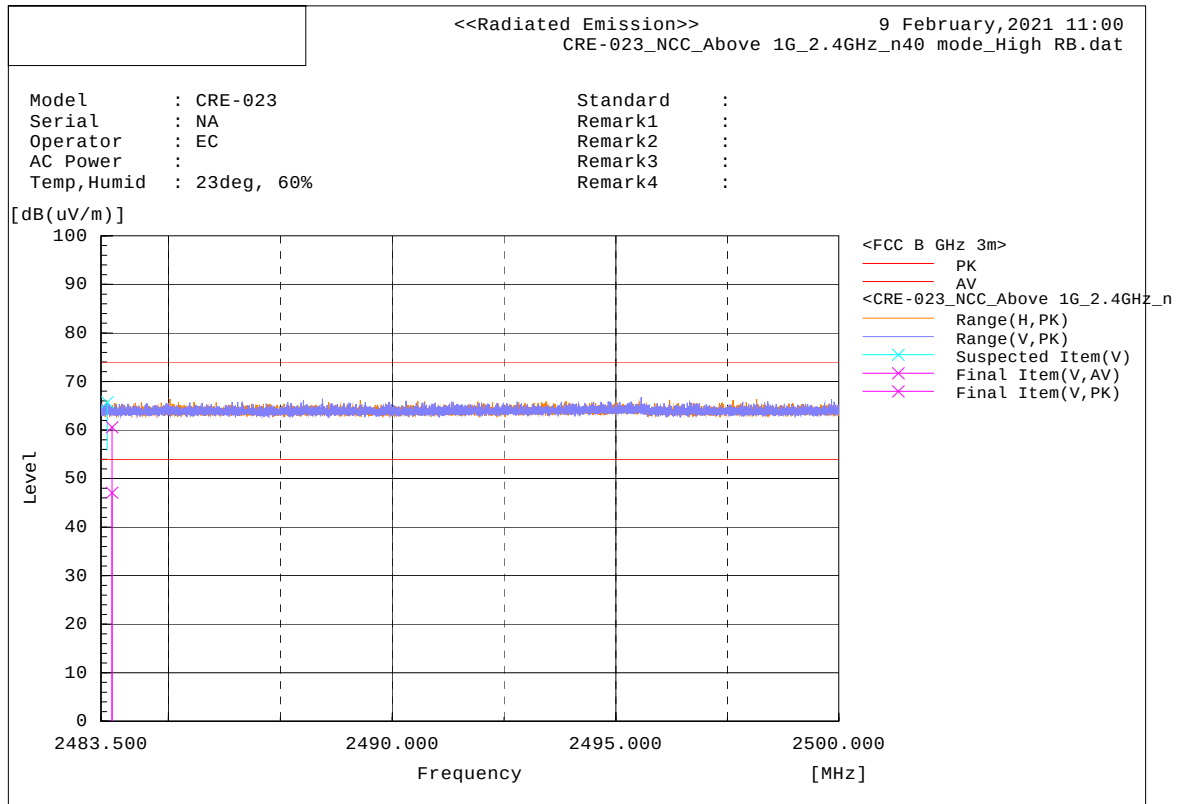
Frequency [MHz]	Pol	Reading [dB(uV)]	Measurement Type	Factor [dB(1/m)]	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
2498.939	V	7.6	Average	39.6	47.2	54	-6.8	341	6.2
2498.939	V	20.8	Peak	39.6	60.4	74	-13.6	341	6.2

RESTRICTED BAND (802.11n HT40 LOW CHANNEL)



Frequency [MHz]	Pol	Reading [dB(uV)]	Measurement Type	Factor [dB(1/m)]	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
2389.669	V	7.4	Average	39.1	46.5	54	-7.5	275	130
2389.669	V	21	Peak	39.1	60.1	74	-13.9	275	130

RESTRICTED BAND (802.11n HT40 HIGH CHANNEL)



Frequency [MHz]	Pol	Reading [dB(uV)]	Measurement Type	Factor [dB(1/m)]	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
2483.745	V	7.5	Average	39.6	47.1	54	-6.9	100	157.7
2483.745	V	21	Peak	39.6	60.6	74	-13.4	100	157.7

4.2 Conducted Emission Measurement

4.2.1 Limits of Conducted Emission Measurement

Frequency (MHz)	Conducted Limit (dBuV)	
	Quasi-peak	Average
0.15 - 0.5	66 - 56	56 - 46
0.50 - 5.0	56	46
5.0 - 30.0	60	50

Note: 1. The lower limit shall apply at the transition frequencies.

2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50MHz.

4.2.2 Test Instruments

Description & Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Due
EMI Test Receiver, Rohde & Schwarz	ESIB 40	100179	1/29/2021	1/29/2022
Transient Limiter, Electro-Metrics	EM-7600-5	106	12/31/2020	12/31/2021
LISN, ETS-Lindgren	3816/2NM	214372	1/29/2021	1/29/2022

NOTE: N/A

4.2.3 Test Procedures

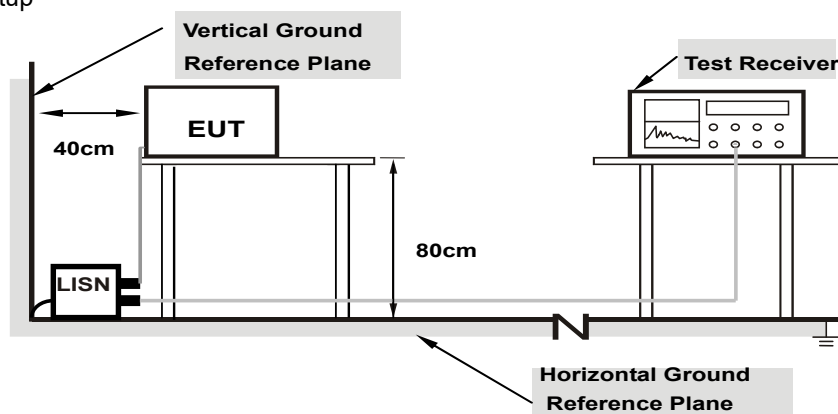
- The EUT was placed 0.4 meters from the conducting wall of the shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). Other support units were connected to the power mains through another LISN. The two LISNs provide 50 ohm/ 50uH of coupling impedance for the measuring instrument.
- Both lines of the power mains connected to the EUT were checked for maximum conducted interference.
- The frequency range from 150 kHz to 30MHz was searched. Emission levels under (Limit - 20dB) was not recorded.

NOTE: The resolution bandwidth and video bandwidth of test receiver is 9 kHz for quasi-peak detection (QP) and average detection (AV) at frequency 0.15MHz-30MHz.

4.2.4 Deviation from Test Standard

No deviation.

4.2.5 Test Setup



Note: 1.Support units were connected to second LISN.

For the actual test configuration, please refer to the attached file (Test Setup Photo).

4.2.6 EUT Operating Conditions

Same as 4.1.6.

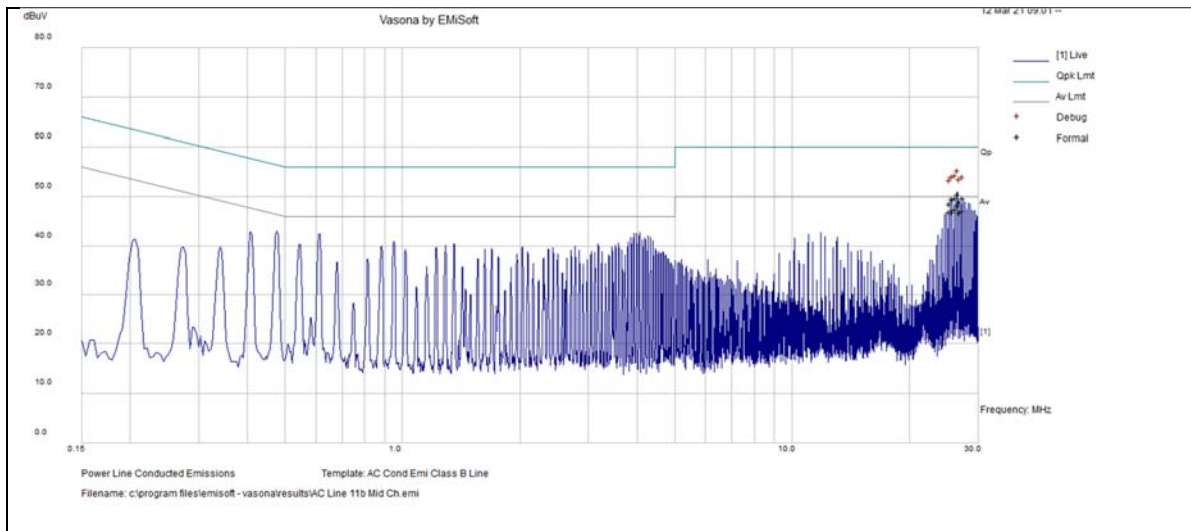
4.2.7 Test Results

Phase	Line (L)	Detector Function	Quasi-Peak / Average
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No	Frequency MHz	Raw dBuV	Cable Loss	Factors dB	Level dBuV	Measurement Type	Line/Neutral	Limit dBuV	Margin dB	Pass /Fail
1	26.63499	39.95	9.89	0.57	50.41	Quasi Peak	Line	60	-9.59	Pass
2	26.34188	39.19	9.88	0.55	49.62	Quasi Peak	Line	60	-10.38	Pass
3	27.49953	39.07	9.91	0.6	49.57	Quasi Peak	Line	60	-10.43	Pass
4	25.76487	39.08	9.86	0.53	49.48	Quasi Peak	Line	60	-10.52	Pass
5	26.91771	38.54	9.9	0.58	49.02	Quasi Peak	Line	60	-10.98	Pass
6	25.47228	38.14	9.84	0.52	48.51	Quasi Peak	Line	60	-11.49	Pass
7	26.63499	37.73	9.89	0.57	48.18	Average	Line	50	-1.82	Pass
8	26.34188	37	9.88	0.55	47.44	Average	Line	50	-2.56	Pass
9	27.49953	36.62	9.91	0.6	47.12	Average	Line	50	-2.88	Pass
10	25.76487	36.54	9.86	0.53	46.93	Average	Line	50	-3.07	Pass
11	26.91771	36.34	9.9	0.58	46.82	Average	Line	50	-3.18	Pass
12	25.47228	36.51	9.84	0.52	46.88	Average	Line	50	-3.12	Pass

REMARKS:

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

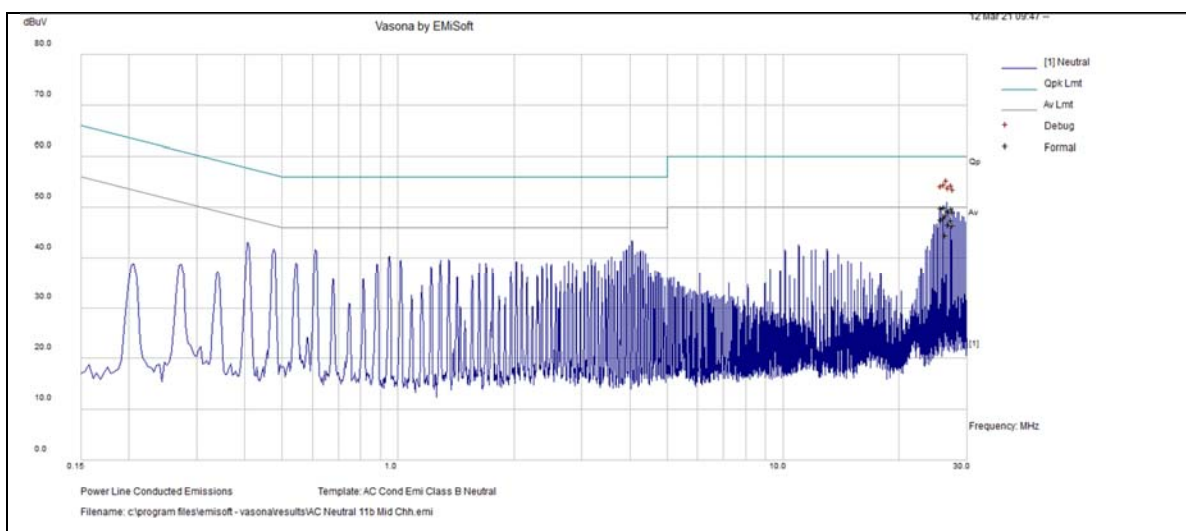


Phase	Neutral (N)	Detector Function	Quasi-Peak / Average
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No	Frequency MHz	Raw dBuV	Cable Loss	Factors dB	Level dBuV	Measurement Type	Line/Neutral	Limit dBuV	Margin dB	Pass /Fail
1	27.49463	38.97	9.9	0.74	49.62	Quasi Peak	Neutral	60	-10.38	Pass
2	26.61658	37.77	9.89	0.72	48.38	Quasi Peak	Neutral	60	-11.62	Pass
3	26.33599	39.33	9.88	0.71	49.92	Quasi Peak	Neutral	60	-10.08	Pass
4	25.75847	39.18	9.86	0.7	49.74	Quasi Peak	Neutral	60	-10.26	Pass
5	26.91548	38.57	9.9	0.73	49.2	Quasi Peak	Neutral	60	-10.8	Pass
6	27.7856	38.35	9.91	0.75	49	Quasi Peak	Neutral	60	-11	Pass
7	27.49463	36.7	9.9	0.74	47.34	Average	Neutral	50	-2.66	Pass
8	26.61658	33.81	9.89	0.72	44.42	Average	Neutral	50	-5.58	Pass
9	26.33599	37.21	9.88	0.71	47.8	Average	Neutral	50	-2.2	Pass
10	25.75847	36.98	9.86	0.7	47.53	Average	Neutral	50	-2.47	Pass
11	26.91548	35.9	9.9	0.73	46.53	Average	Neutral	50	-3.47	Pass
12	27.7856	35.73	9.91	0.75	46.39	Average	Neutral	50	-3.61	Pass

REMARKS:

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

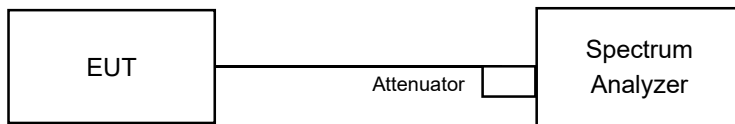


4.3 6dB Bandwidth & 99% Bandwidth Measurement

4.3.1 Limits of 6dB Bandwidth Measurement

The minimum of 6dB Bandwidth Measurement is 0.5 MHz.

4.3.2 Test Setup



4.3.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.3.4 Test Procedure

- a. Set resolution bandwidth (RBW) = 100kHz
- b. Set the video bandwidth (VBW) $\geq 3 \times$ RBW, Detector = Peak.
- c. Trace mode = max hold.
- d. Sweep = auto couple.
- e. Measure the maximum width of the emission that is constrained by the frequencies associated with the two amplitude points (upper and lower) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission

4.3.5 Deviation from Test Standard

No deviation.

4.3.6 EUT Operating Conditions

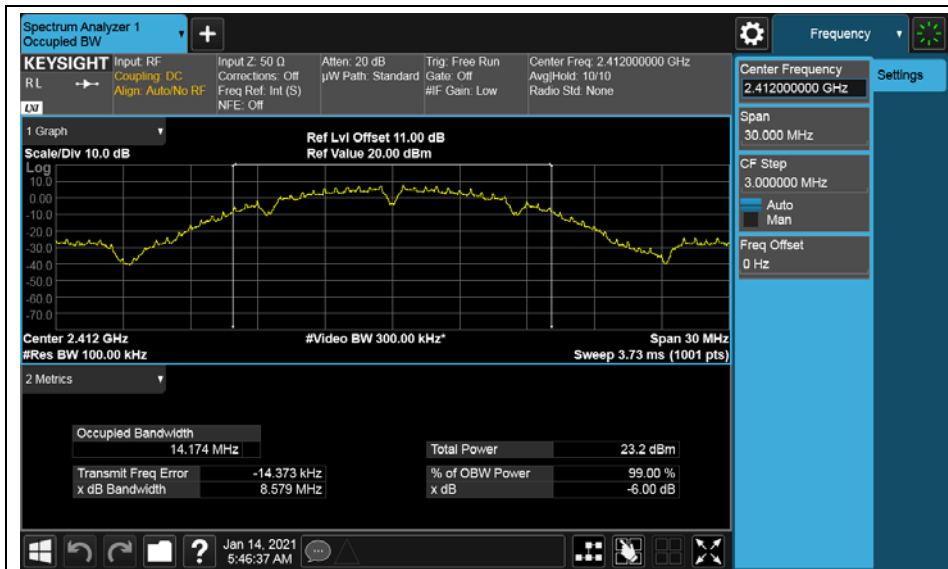
The software provided by client to enable the EUT under transmission condition continuously at lowest, middle and highest channel frequencies individually.

4.3.7 Test Result

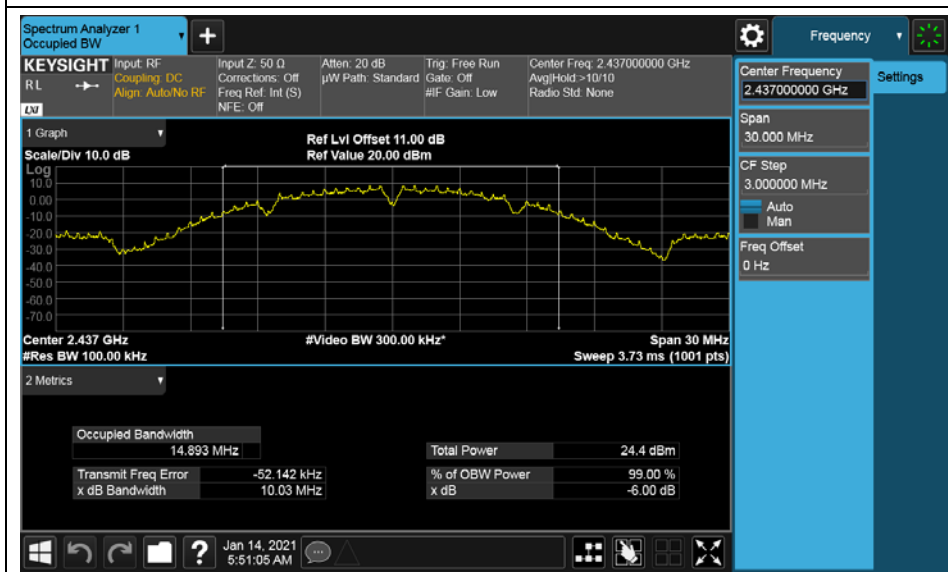
Mode	Channel	Frequency (MHz)	6dB Bandwidth (MHz)	Minimum Limit (MHz)	Pass / Fail
802.11b	1	2412	8.58	0.5	PASS
	6	2437	10.03	0.5	PASS
	11	2462	9.57	0.5	PASS
802.11g	1	2412	16.36	0.5	PASS
	6	2437	16.35	0.5	PASS
	11	2462	16.38	0.5	PASS
802.11n-HT20	1	2412	17.58	0.5	PASS
	6	2437	17.57	0.5	PASS
	11	2462	17.58	0.5	PASS
802.11n-HT40	3	2422	35.18	0.5	PASS
	6	2437	35.15	0.5	PASS
	9	2452	35.13	0.5	PASS

Mode	Channel	Frequency (MHz)	99% Bandwidth (MHz)
802.11b	1	2412	14.17
	6	2437	14.89
	11	2462	14.62
802.11g	1	2412	16.57
	6	2437	16.62
	11	2462	16.56
802.11n-HT20	1	2412	17.76
	6	2437	17.79
	11	2462	17.72
802.11n-HT40	3	2422	35.98
	6	2437	36.11
	9	2452	36.00

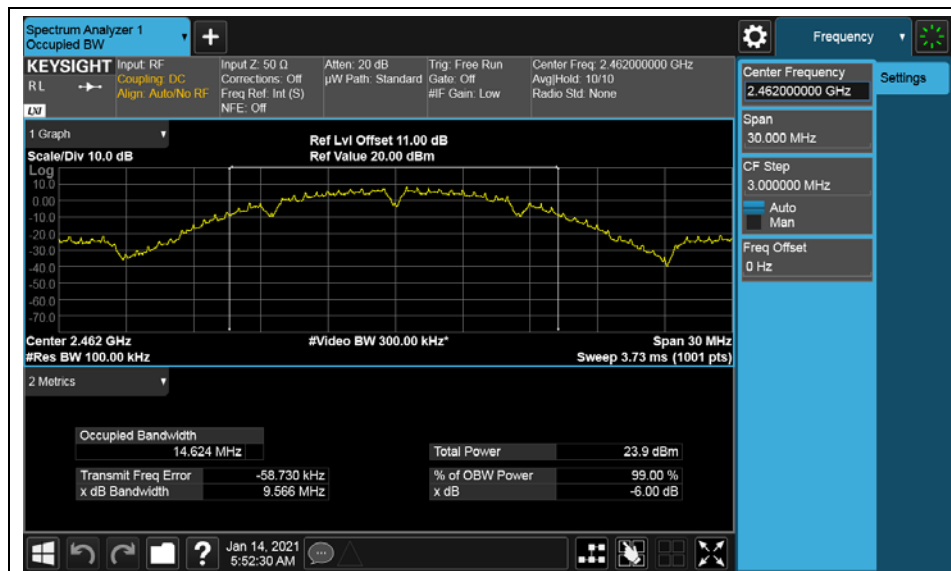
Test Plots:



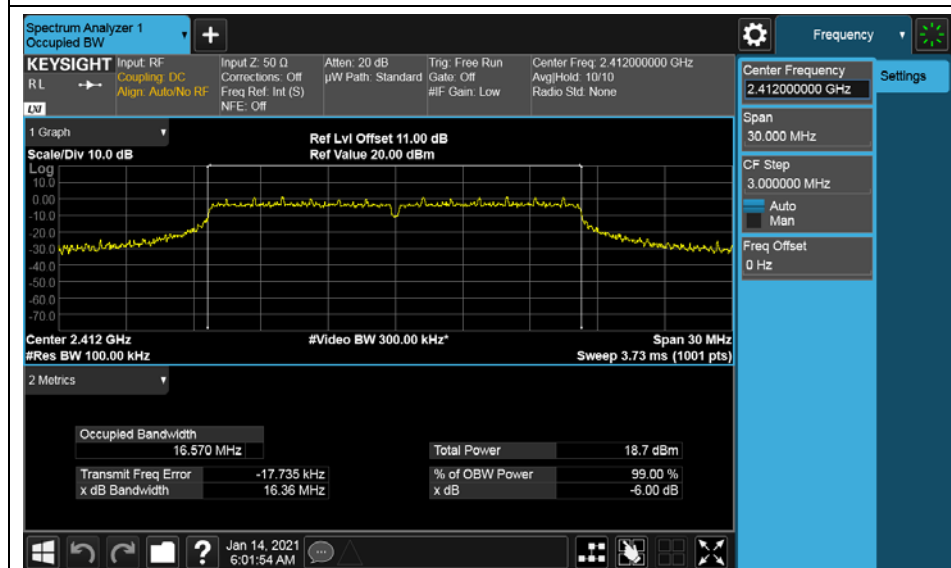
802.11b-2412MHz



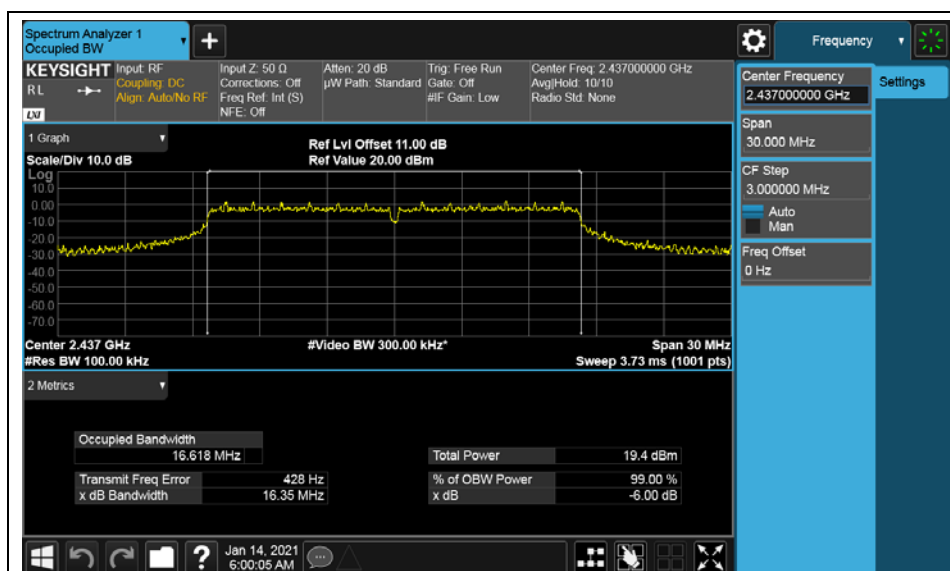
802.11b-2437MHz



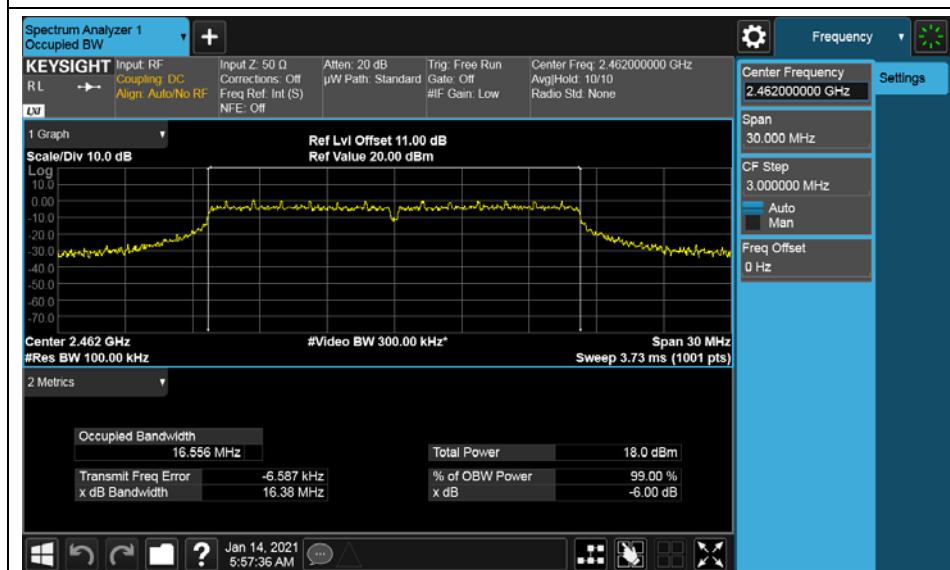
802.11b-2462MHz



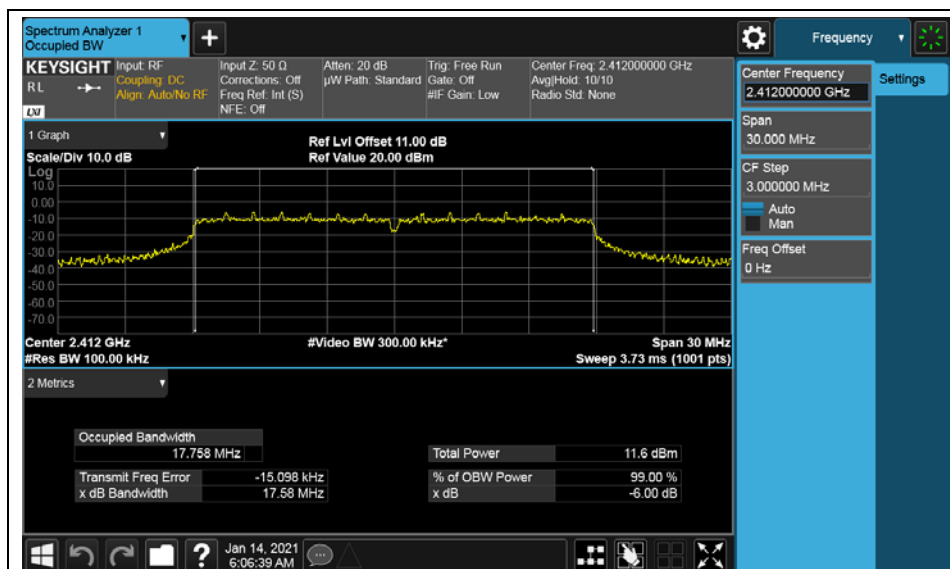
802.11g-2412MHz



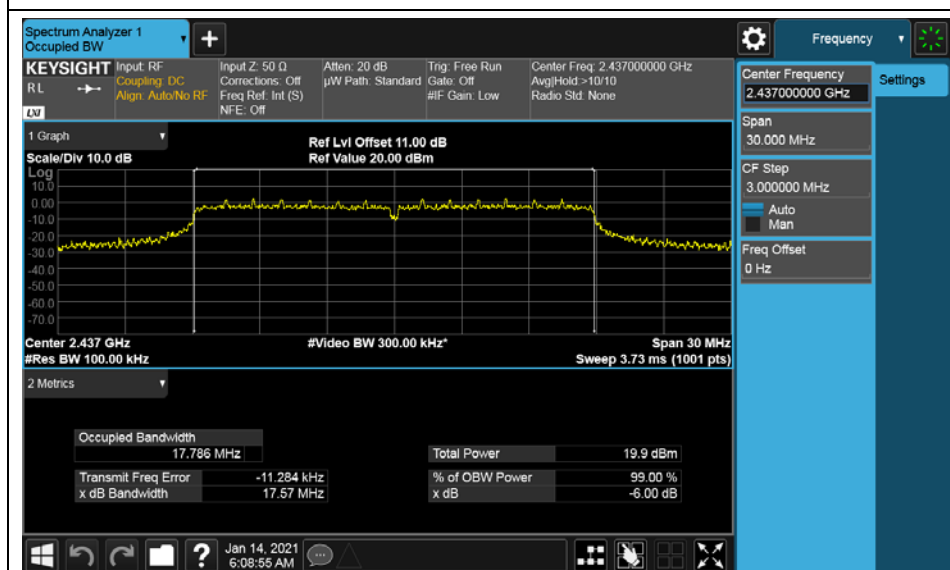
802.11g-2437MHz



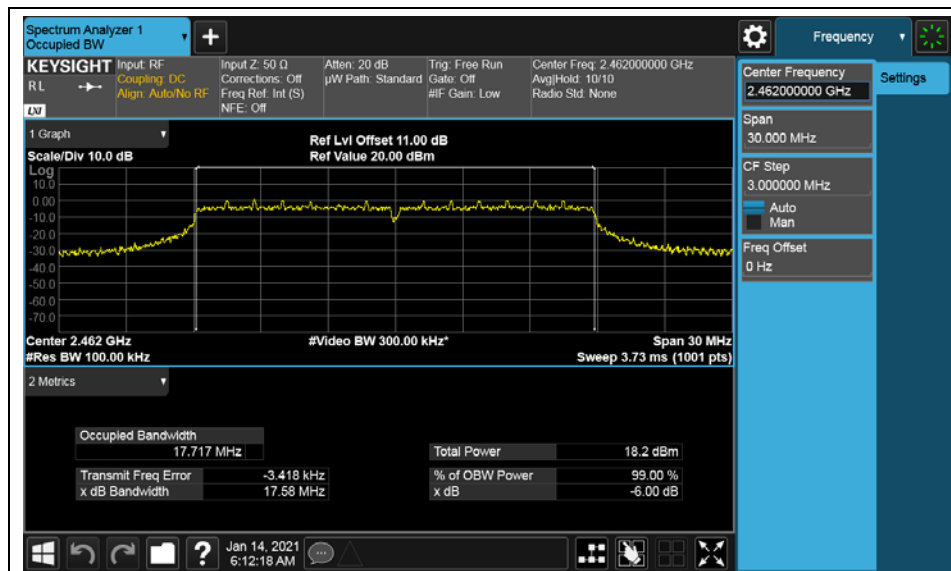
802.11g-2462MHz



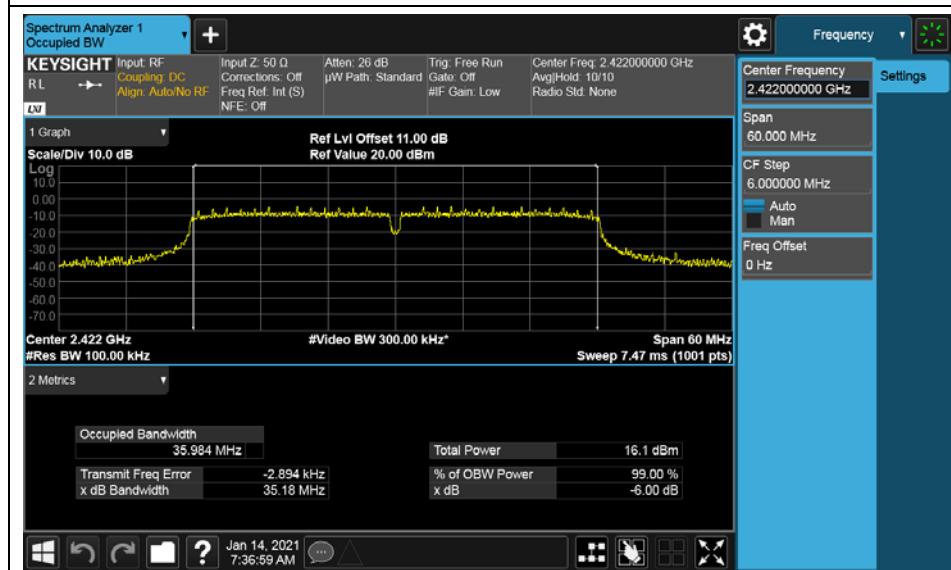
802.11n-HT20-2412MHz



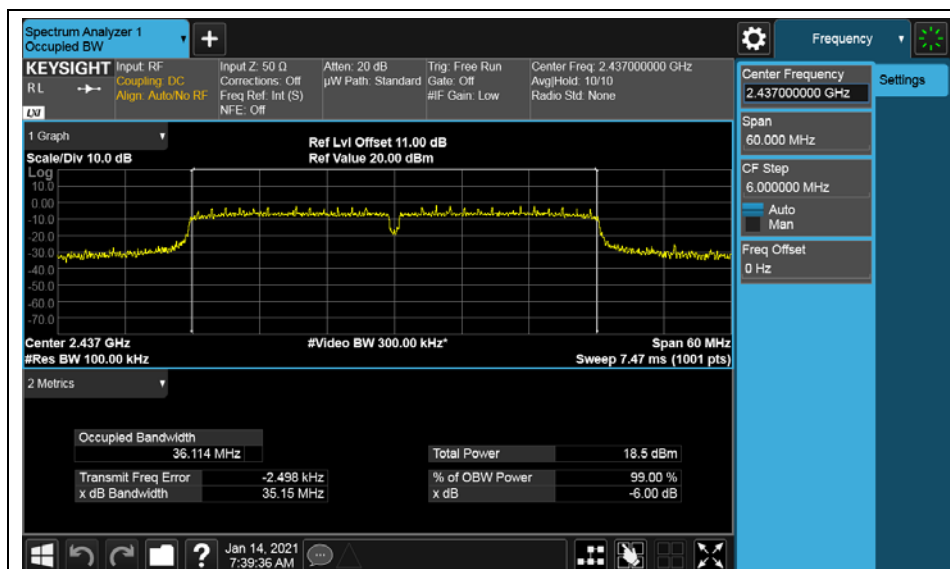
802.11n-HT20-2437MHz



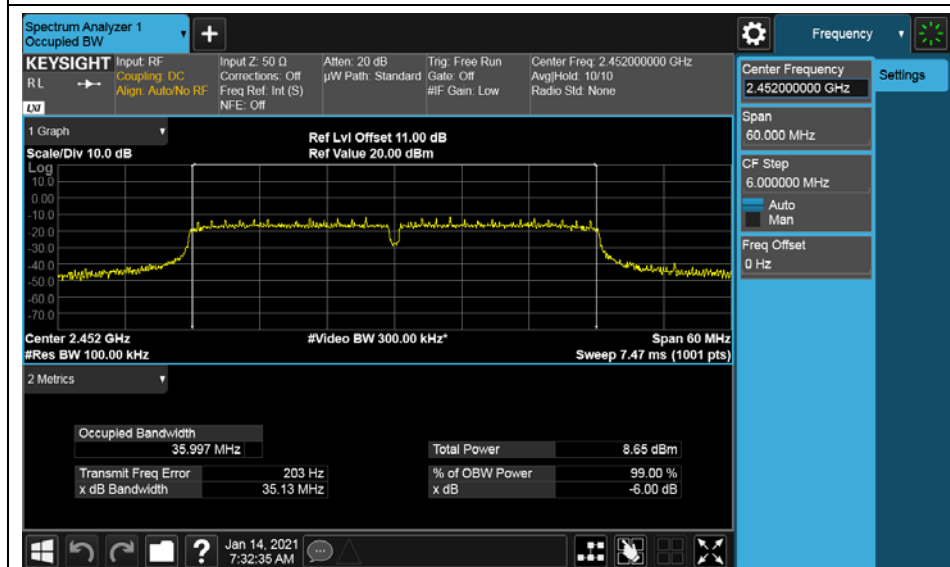
802.11n-HT20-2462MHz



802.11n-HT40-2422MHz



802.11n-HT40-2437MHz



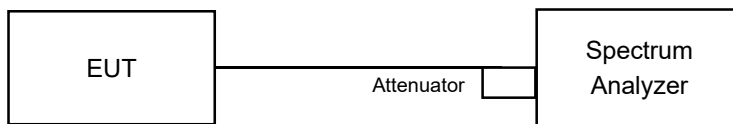
802.11n-HT40-2452MHz

4.4 Conducted Output Power Measurement

4.4.1 Limits of Conducted Output Power Measurement

For systems using digital modulation in the 2400–2483.5 MHz bands: 1 Watt (30dBm)

4.4.2 Test Setup



4.4.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.4.4 Test Procedures

- a. Set span to at least 1.5 times the OBW.
- b. Set RBW = 1-5% of the OBW, not to exceed 1 MHz.
- c. Set VBW $\geq 3 \times$ RBW.
- d. Number of points in sweep $\geq 2 \times$ span / RBW
- e. Sweep time = auto.
- f. Detector = RMS (i.e., power averaging), or sample detector mode.
- g. If transmit duty cycle < 98 %, use a sweep trigger with the level set to enable triggering only on full power pulses. If the EUT transmits continuously (i.e., with no off intervals) or at duty cycle ≥ 98 %, and if each transmission is entirely at the maximum power control level, then the trigger shall be set to “free run”.
- h. Trace average at least 100 traces in power averaging (i.e., RMS) mode.

4.4.5 Deviation from Test Standard

No deviation.

4.4.6 EUT Operating Conditions

Same as Item 4.3.6.

4.4.7 Test Results

802.11b

Channel	Frequency (MHz)	Conducted Power (dBm)	Limit (dBm)	Pass/Fail
1	2412	16.99	30	Pass
6	2437	18.18	30	Pass
11	2462	17.70	30	Pass

802.11g

Channel	Frequency (MHz)	Conducted Power (dBm)	Limit (dBm)	Pass/Fail
1	2412	12.80	30	Pass
6	2437	13.52	30	Pass
11	2462	12.07	30	Pass

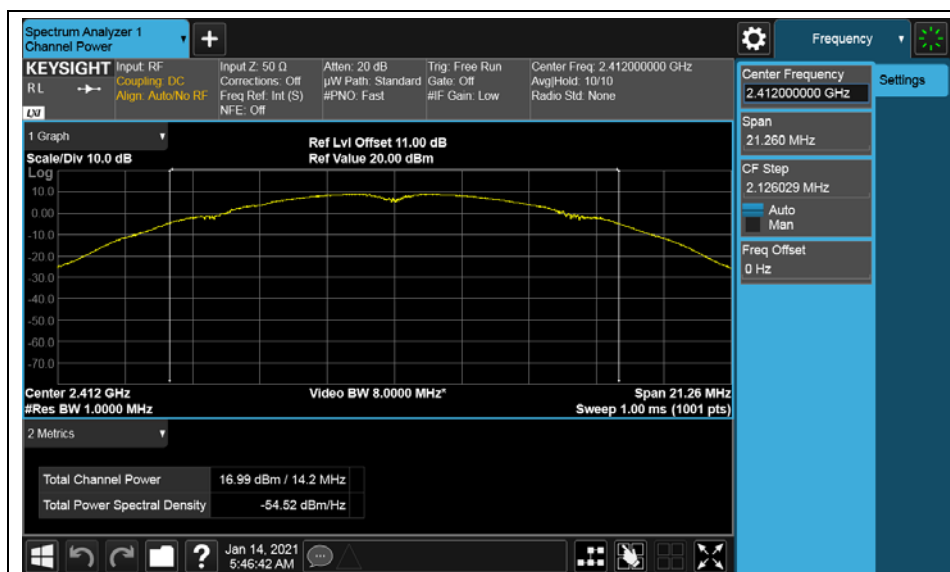
802.11n-HT20

Channel	Frequency (MHz)	Conducted Power (dBm)	Limit (dBm)	Pass/Fail
1	2412	13.11	30	Pass
6	2437	13.84	30	Pass
11	2462	12.14	30	Pass

802.11n-HT40

Channel	Frequency (MHz)	Conducted Power (dBm)	Limit (dBm)	Pass/Fail
3	2422	10.74	30	Pass
6	2437	13.07	30	Pass
9	2452	10.72	30	Pass

Test Plots:



802.11b-2412MHz



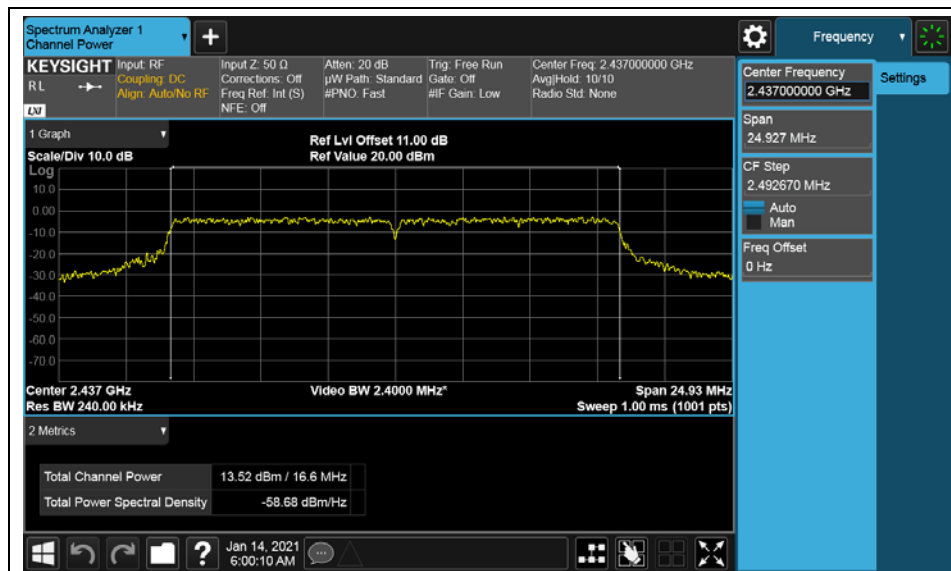
802.11b-2437MHz



802.11b-2462MHz



802.11g-2412MHz



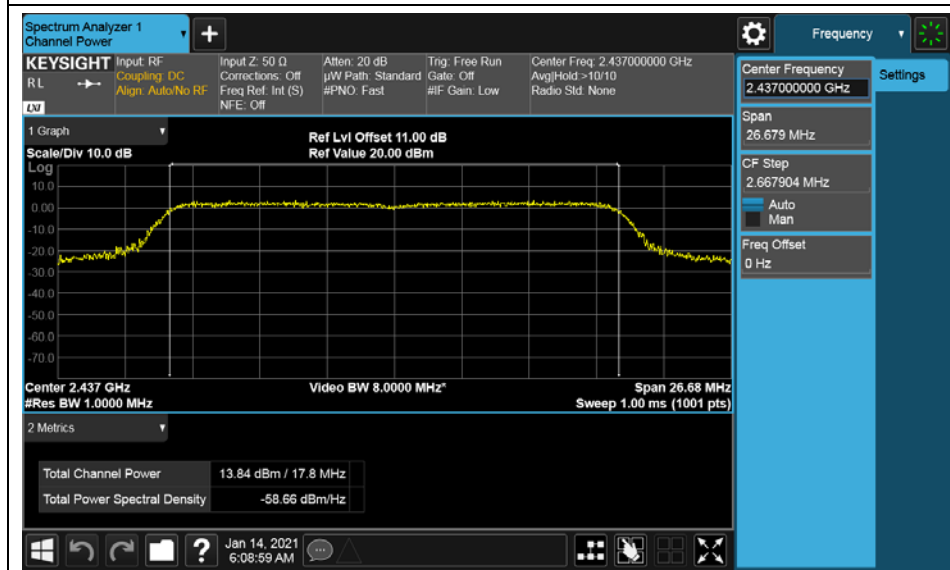
802.11g-2437MHz



802.11g-2462MHz



802.11n-HT20-2412MHz



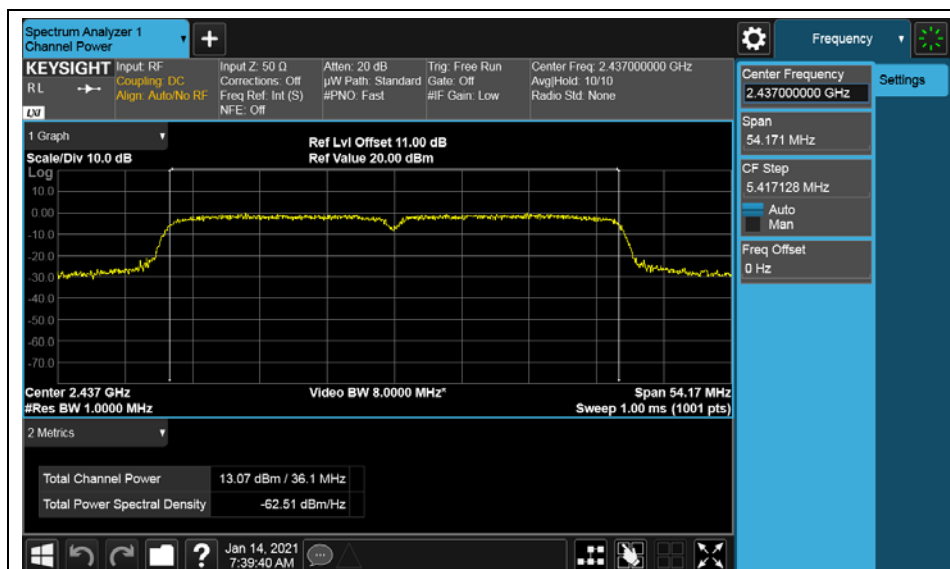
802.11n-HT20-2437MHz



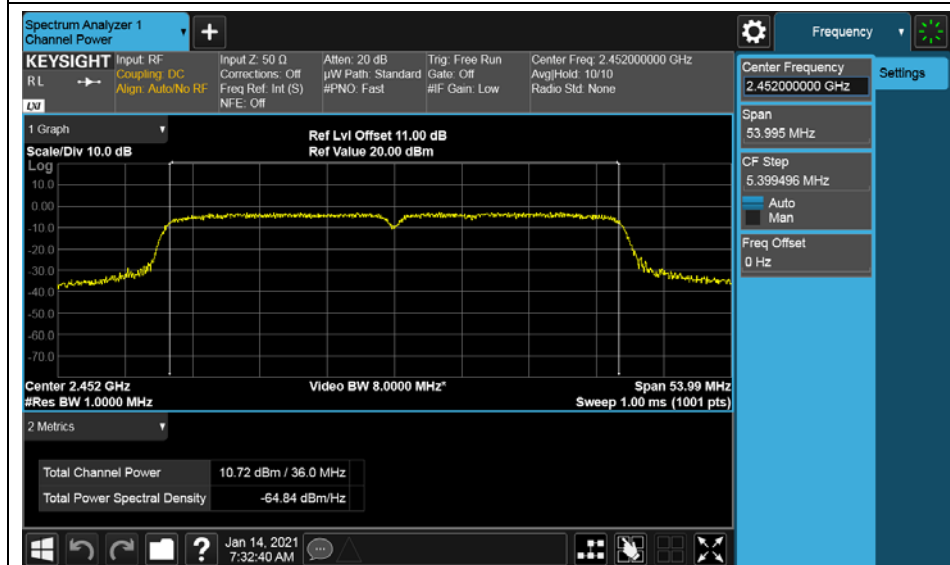
802.11n-HT20-2462MHz



802.11n-HT40-2422MHz



802.11n-HT40-2437MHz



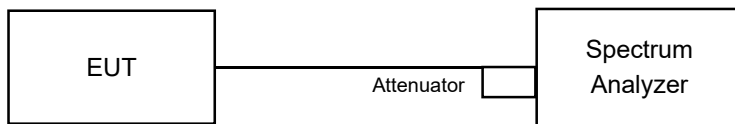
802.11n-HT40-2452MHz

4.5 Power Spectral Density Measurement

4.5.1 Limits of Power Spectral Density Measurement

The Maximum of Power Spectral Density Measurement is 8dBm in any 3 kHz.

4.5.2 Test Setup



4.5.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.5.4 Test Procedure

- Set analyzer center frequency to DTS channel center frequency.
- Set the span to 1.5 times the DTS bandwidth.
- Set the RBW to: $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$.
- Set the VBW $\geq 3 \times \text{RBW}$.
- Detector = peak.
- Sweep time = auto couple.
- Trace mode = max hold.
- Allow trace to fully stabilize.
- Use the peak marker function to determine the maximum amplitude level within the RBW.

4.5.5 Deviation from Test Standard

No deviation.

4.5.6 EUT Operating Condition

Same as Item 4.3.6

4.5.7 Test Results

802.11b

Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Pass/Fail
1	2412	-4.59	8	Pass
6	2437	-3.16	8	Pass
11	2462	-3.82	8	Pass

802.11g

Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Pass/Fail
1	2412	-10.69	8	Pass
6	2437	-8.91	8	Pass
11	2462	-10.07	8	Pass

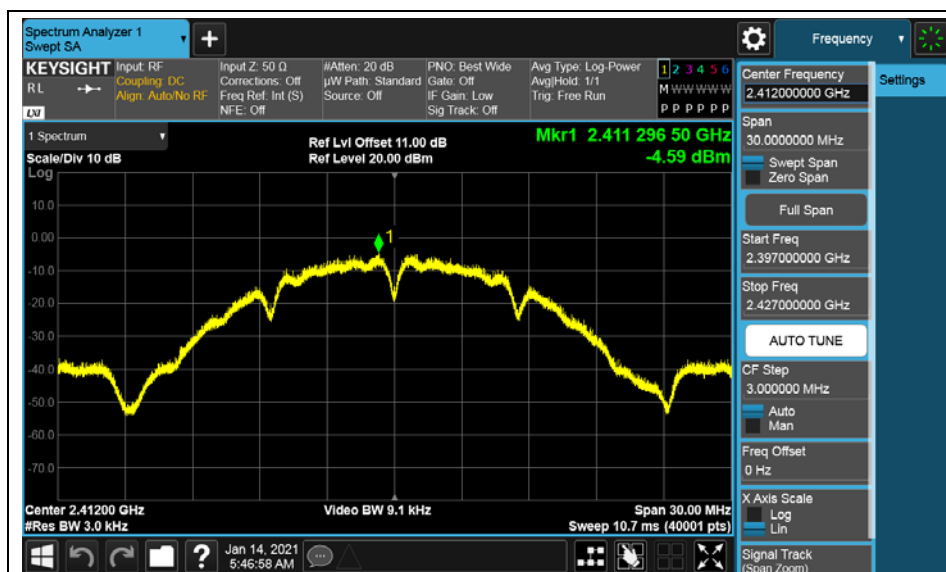
802.11n-HT20

Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Pass/Fail
1	2412	-10.33	8	Pass
6	2437	-9.40	8	Pass
11	2462	-11.45	8	Pass

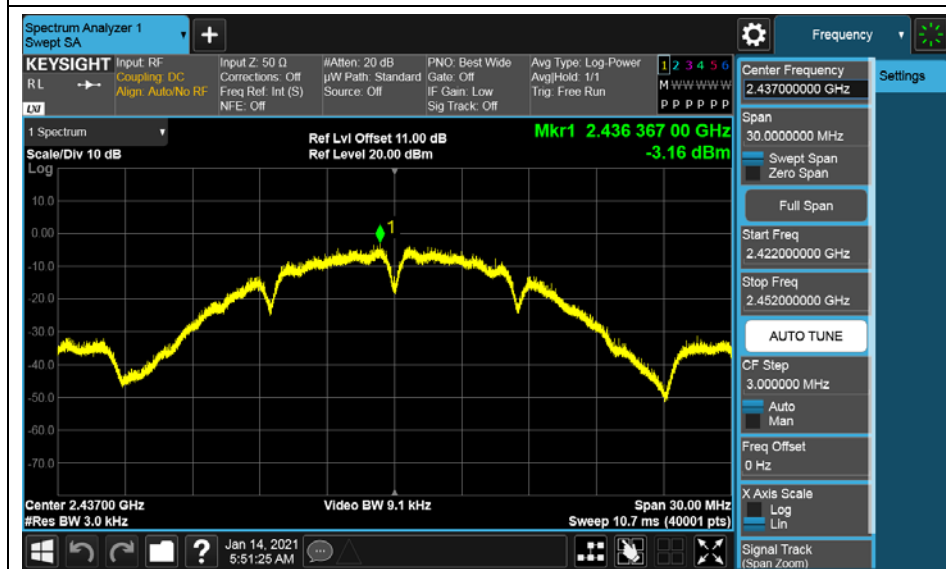
802.11n-HT40

Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Pass/Fail
3	2422	-15.10	8	Pass
6	2437	-12.05	8	Pass
9	2452	-15.82	8	Pass

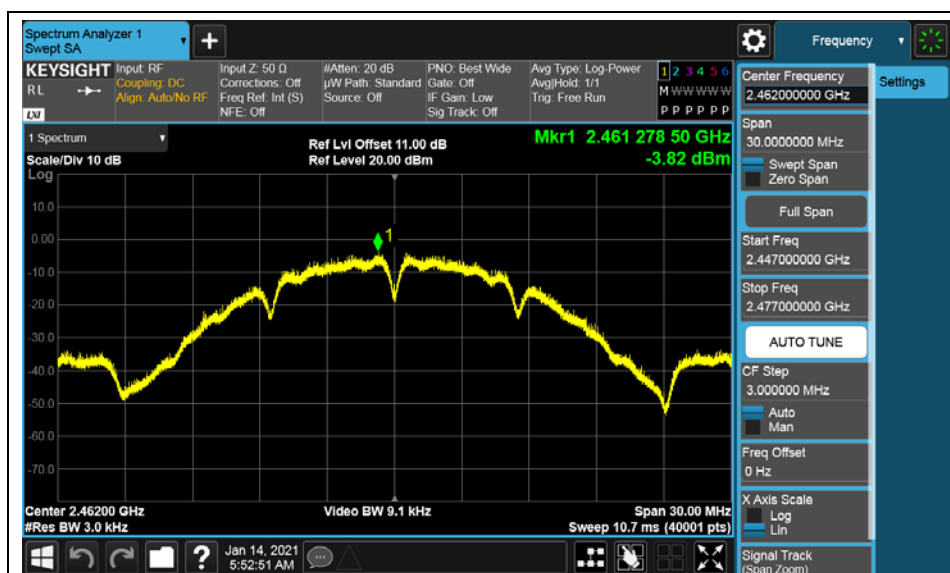
Test Plots:



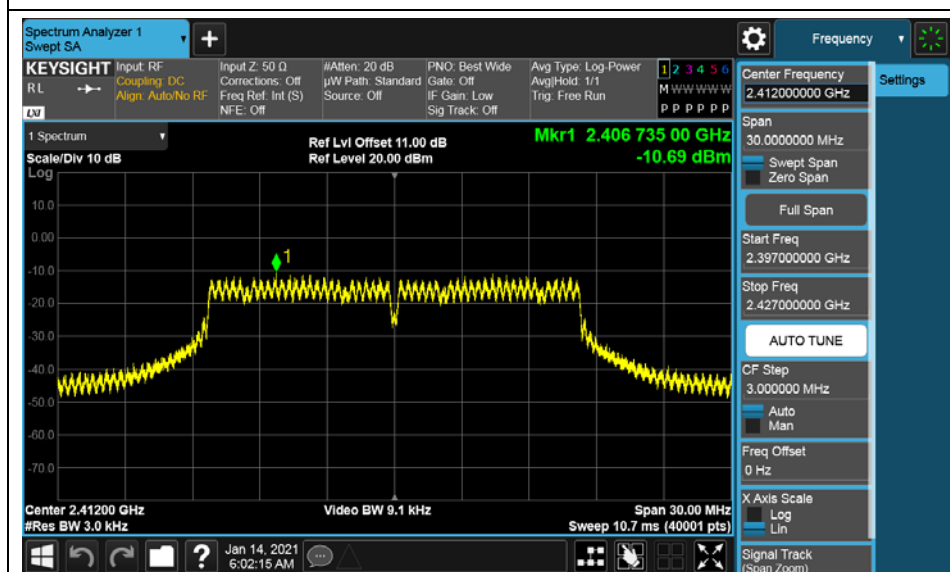
802.11b-2412MHz



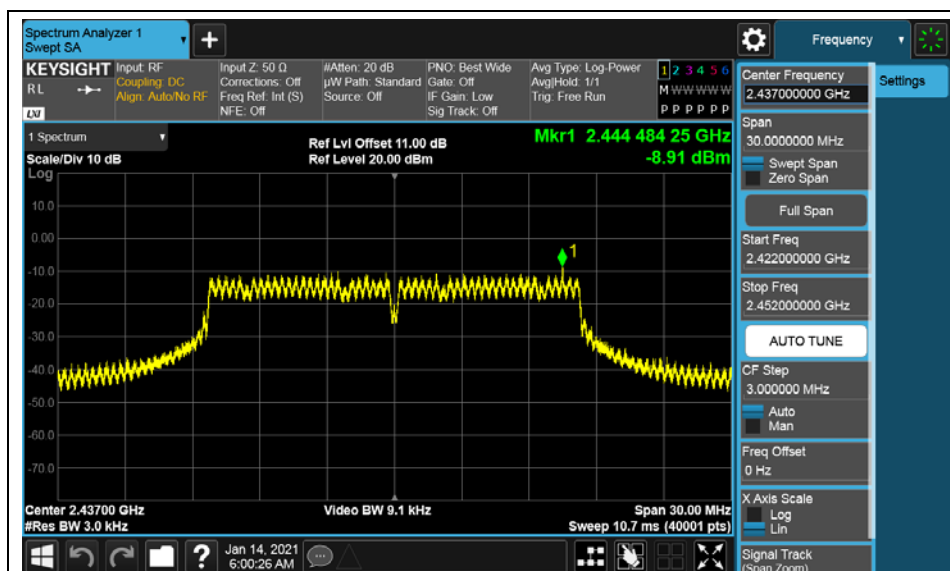
802.11b-2437MHz



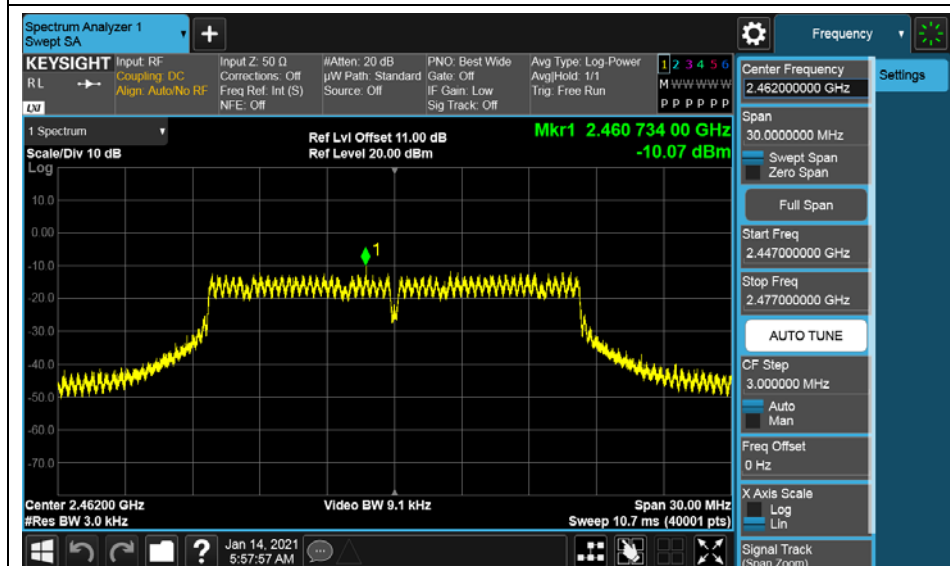
802.11b-2462MHz



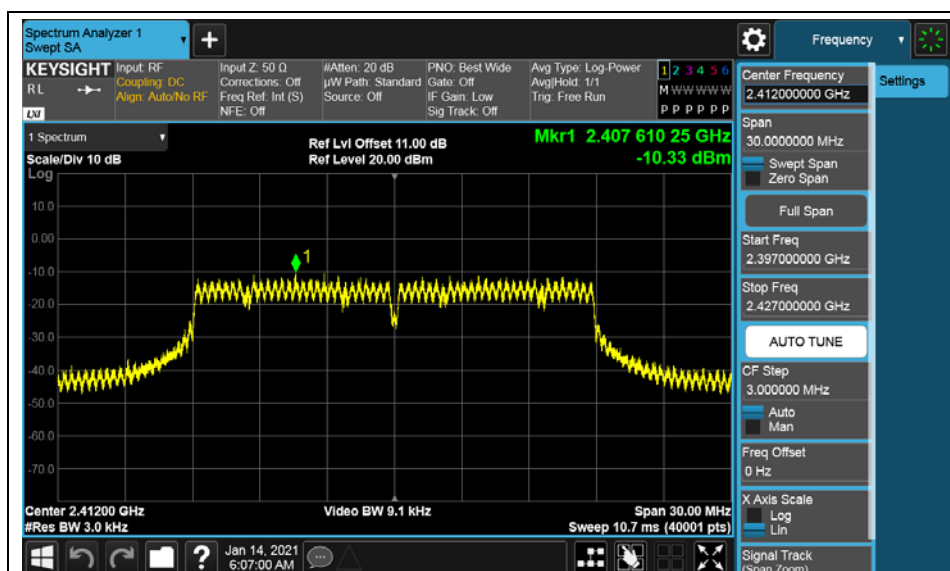
802.11g-2412MHz



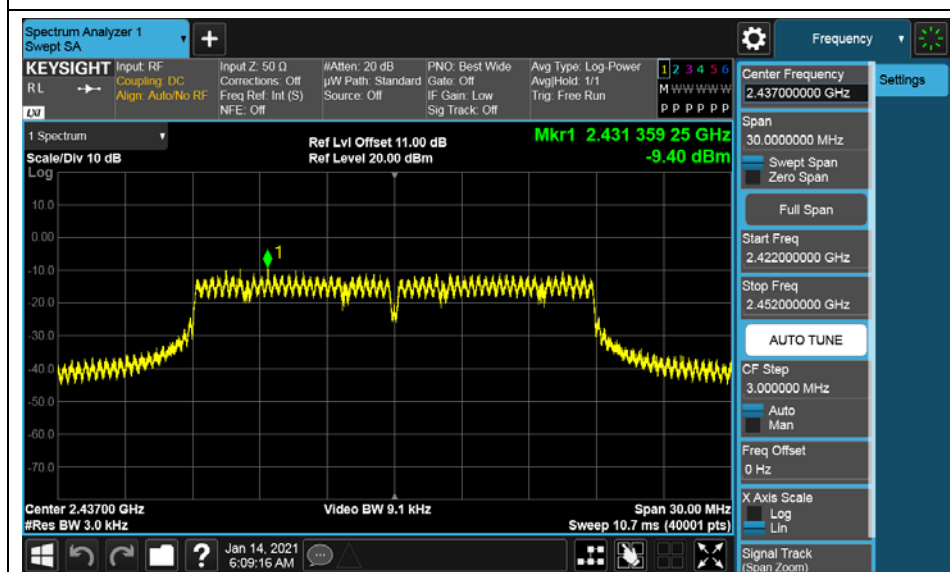
802.11g-2437MHz



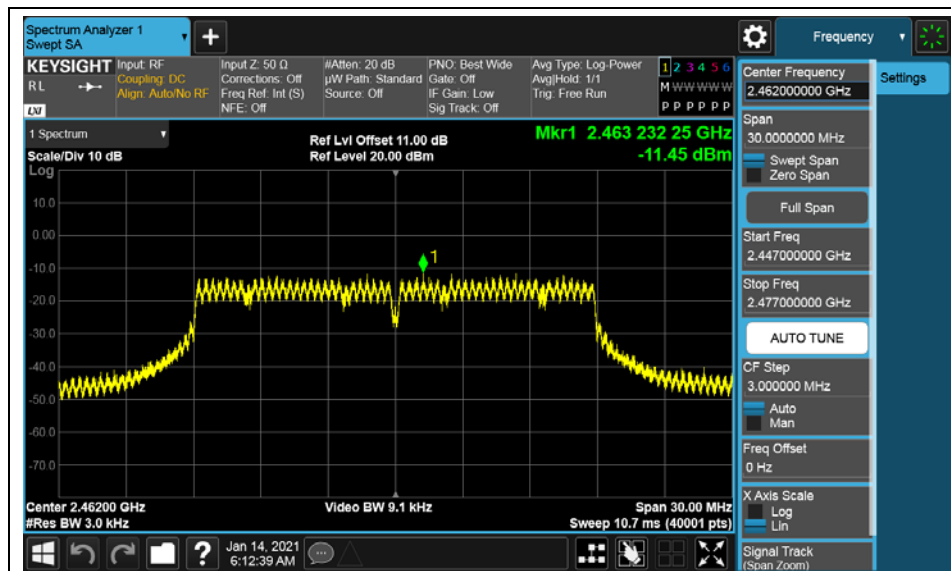
802.11g-2462MHz



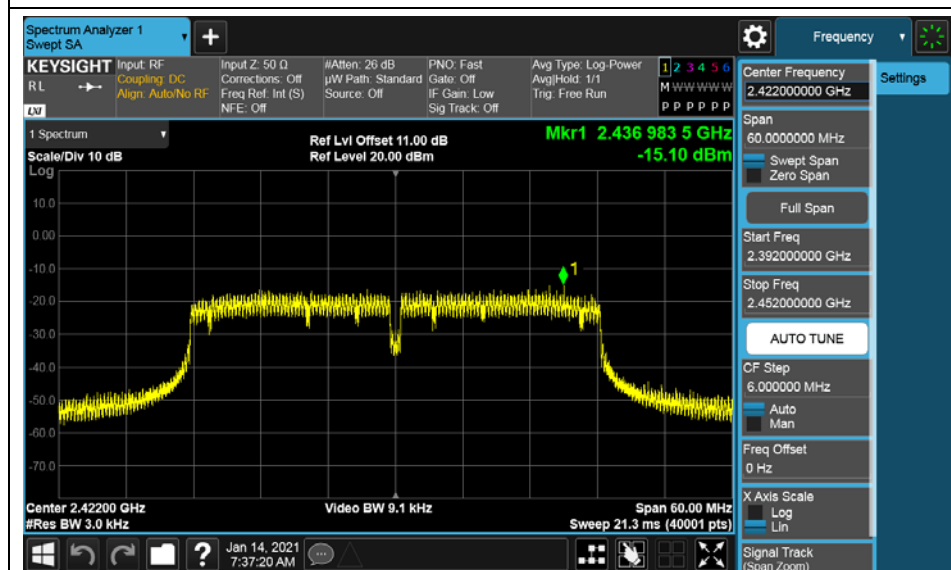
802.11n-HT20-2412MHz



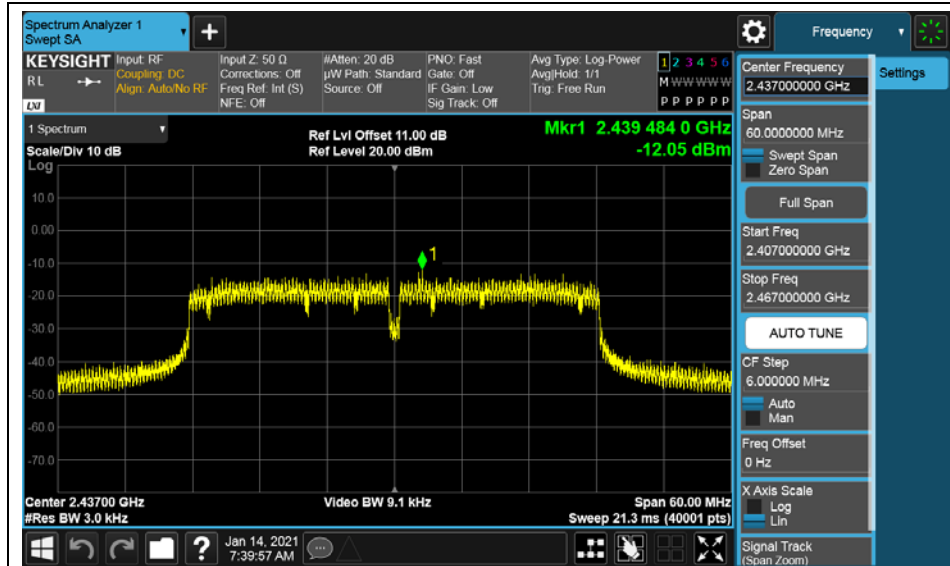
802.11n-HT20-2437MHz



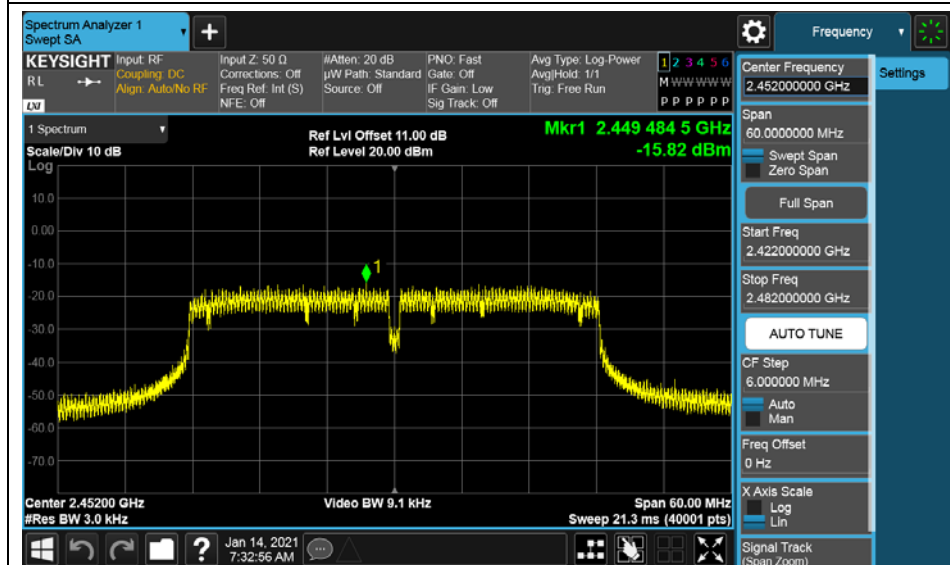
802.11n-HT20-2462MHz



802.11n-HT40-2422MHz



802.11n-HT40-2437MHz



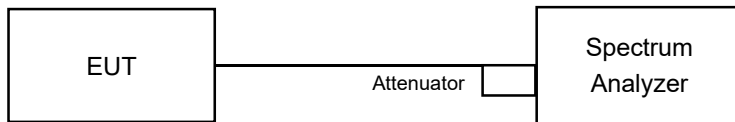
802.11n-HT40-2452MHz

4.6 Conducted Out of Band Emission Measurement

4.6.1 Limits of Conducted Out of Band Emission Measurement

Below 30dB of the highest emission level of operating band (in 100 kHz Resolution Bandwidth).

4.6.2 Test Setup



4.6.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.6.4 Test Procedure

MEASUREMENT PROCEDURE REF

1. Set the RBW = 100 kHz.
2. Set the VBW $\geq$ 300 kHz.
3. Detector = peak.
4. Sweep time = auto couple.
5. Trace mode = max hold.
6. Allow trace to fully stabilize.
7. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.

MEASUREMENT PROCEDURE OOB

1. Set RBW = 100 kHz.
2. Set VBW $\geq$ 300 kHz.
3. Detector = peak.
4. Sweep = auto couple.
5. Trace Mode = max hold.
6. Allow trace to fully stabilize.
7. Use the peak marker function to determine the maximum amplitude level.

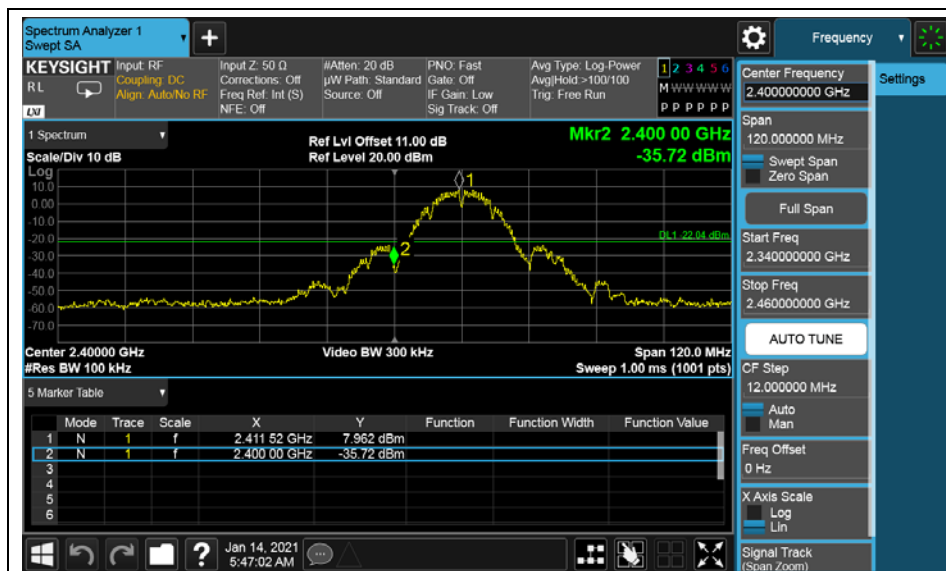
4.6.5 Deviation from Test Standard

No deviation.

4.6.6 EUT Operating Condition

Same as Item 4.3.6

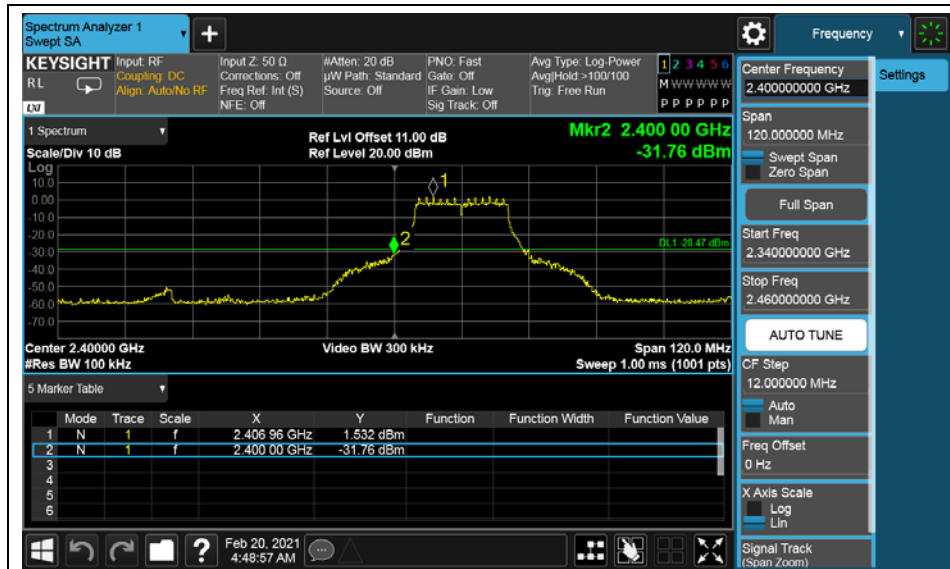
4.6.7 Test Results



802.11b-2412MHz



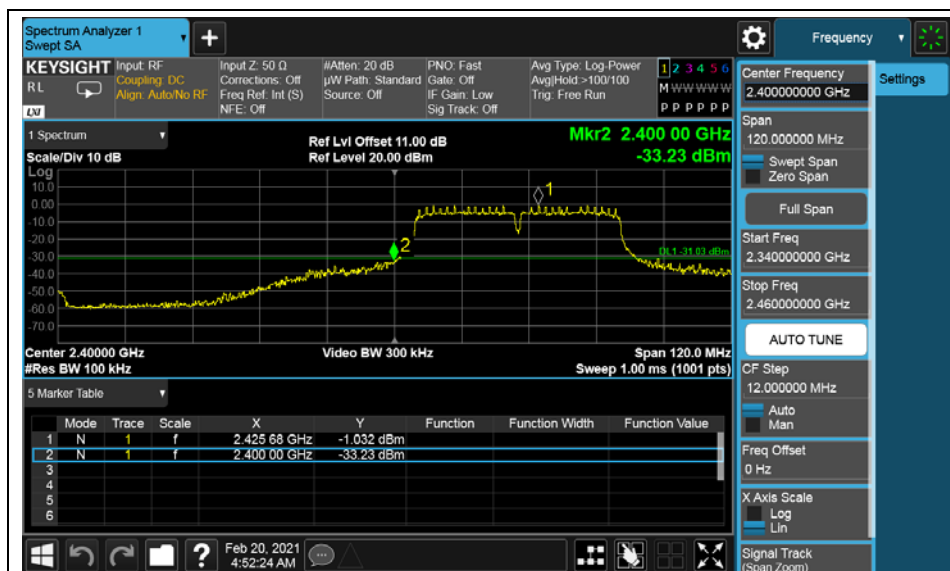
802.11b-2462MHz



802.11g-2412MHz



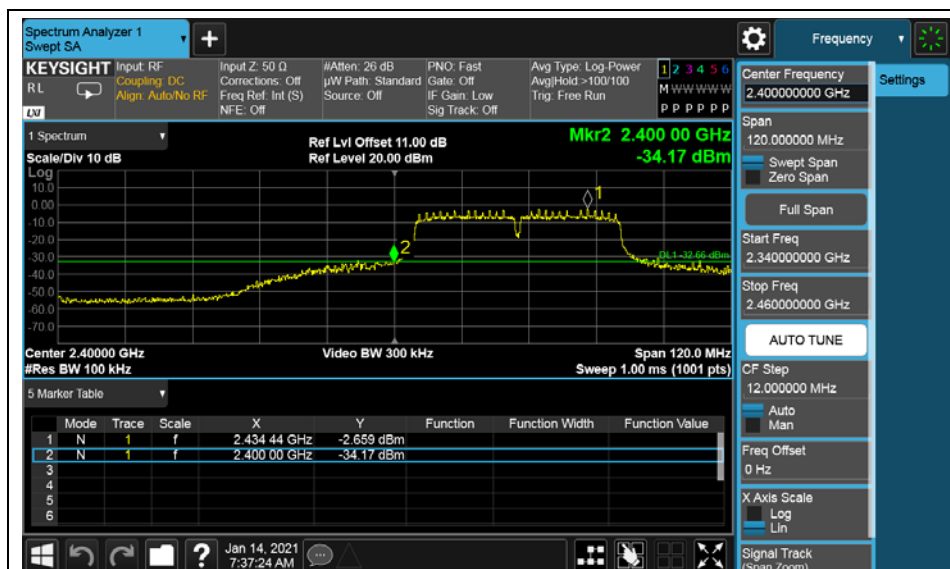
802.11g-2462MHz



802.11n-HT20-2412MHz



802.11n-HT20-2462MHz



802.11n-HT40-2422MHz



802.11n-HT40-2452MHz

5 Pictures of Test Arrangements

Please see setup photo file.

Appendix – Information on the Testing Laboratories

Bureau Veritas is a global leader in testing, inspection and certification (TIC) services. We help businesses improve safety, sustainability and productivity; and our clients include the majority of leading brands in retail, manufacturing and other industries. With a presence in every major country around the world, our quality assurance and compliance solutions are vital in helping our customers enhance product quality and concept-to-consumer journeys. We also assist with increasing speed to market, profitability and brand equity throughout the supply chain. Bureau Veritas is a leading wireless/IoT testing, inspection, audit and certification provider, with a global network of test laboratories to support the IoT industry in areas of connectivity, security, interoperability as well as quality, health & safety, and environmental/chemical requirements.

If you have any comments, please feel free to contact us at the following:

Milpitas EMC/RF/Safety/Telecom Lab

775 Montague Expressway, Milpitas, CA 95035

Tel: +1 408 526 1188

Sunnyvale OTA/Bluetooth Lab

1293 Anvilwood Avenue, Sunnyvale, CA

94089

Tel: +1 669 600 5293

Littleton EMC/RF/Safety/Environmental Lab

1 Distribution Center Cir #1, Littleton, MA 01460

Tel: +1 978 486 8880

Email: sales.eaw@us.bureauveritas.com

Web Site: www.cps.bureauveritas.com

The address and road map of all our labs can be found in our web site also.

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