

NCC Test Report

Report No.: NCC_RF_SL20021201-TRB-002_DTS Rev_1.0

Test Model: R12

Received Date: 05/19/2020

Test Date: 05/21/2020/-06/18/2020

Issued Date: 08/19/2020

Applicant: Trimble, Inc.

Address: 935 Stewart Drive, Sunnyvale, CA 94085, USA

Manufacturer: Trimble, Inc.

Address: 935 Stewart Drive, Sunnyvale, CA 94085, 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:** 540430

ISED# / CAB identifier: 4842D



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Release Control Record

Issue No.	Description	Date Issued
NCC_RF_SL20021201-TRB-002_DTS	Original Release	06/26/2020
NCC_RF_SL20021201-TRB-002_DTS Rev_1.0	Remove 802.11n(HT20/HT40) Information	08/19/2020

1 Certificate of Conformity

Product: GNSS System integrated with WiFi/BT & UHF

Brand: Trimble

Test Model: R12

Sample Status: Engineering sample

Applicant: Trimble, Inc.

Test Date: 05/21/2020-06/18/2020

Standards: LP0002: 2018

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 : Deon , **Date:** 08/19/2020
Deon Dai / Test Engineer

Approved by : Chen Ge , **Date:** 08/19/2020
Chen Ge / Engineer Reviewer

2 Summary of Test Results

LP0002: 2018			
Standard Clause	Test Item	Result	Remarks
2.3	AC Power Conducted Emission	Pass	Meet the requirement of limit.
3.10.1.5	Radiated Emissions and Band Edge Measurement	Pass	Meet the requirement of limit.
3.10.1.6(2)(A)	6dB bandwidth	Pass	Meet the requirement of limit.
3.10.1.2(1)(C)	Conducted power	Pass	Meet the requirement of limit.
3.10.1.6(2)(B)	Power Spectral Density	Pass	Meet the requirement of limit.
2.2	Antenna Requirement	Pass	Antenna connector is U.FL. (The device is professionally installed)

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) (±)
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	GNSS System integrated with WiFi/BT & UHF
Brand	Trimble
Test Model	R12
Identification No. of EUT	N/A
Series Model	N/A
Model Difference	N/A
Status of EUT	Engineering Sample
Power Supply Rating	100-240VAC, 1.2A, 50-60Hz
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
Operating Frequency	2.412 ~ 2.462GHz
Number of Channel	11 for 802.11b, 802.11g
Antenna Type	SMD patch antenna
Antenna Gain	2 dBi
Antenna Connector	U.FL for -00; No external connector for -60 (00: 90913-00 & 90914-00, -60: 90913-60 & 90914-60)

Note:

1. The EUT uses following adapter.

Brand	TECH
Model	ATS065T-A190
Input Power	100-240V, 50-60Hz, 1.4A Max
Output Power	19Vdc; 3.43A
Power Line	1.2m

2. The above EUT information is declared by manufacturer and for more detailed features description, please refer to the manufacturer's specifications or user's manual.

3.2 Description of Test Modes

11 channels are provided for 802.11b, 802.11g:

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		

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

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)
-	802.11g	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)
-	802.11g	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

Test Condition:

APPLICABLE TO	ENVIRONMENTAL CONDITIONS	INPUT POWER	TESTED BY
RE≥1G	25deg. C, 65%RH	120Vac, 60Hz	Deon Dai
RE<1G	25deg. C, 65%RH	120Vac, 60Hz	Deon Dai
PLC	25deg. C, 68%RH	120Vac, 60Hz	-
APCM	21deg. C, 60%RH	120Vac, 60Hz	-

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	Lenovo	E430	MP-3B3NA	N/A	Provided by Customer
B.						
C.						
D.						
E.						
F.						
G.						

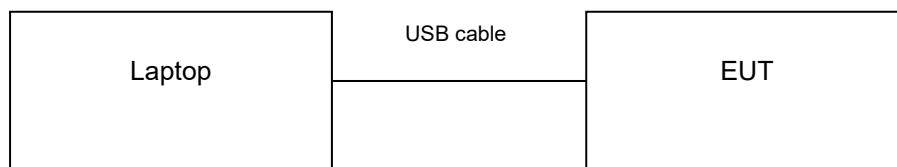
Note:

1. All power cords of the above support units are non-shielded (1.8m).
2. Items E~F acted as communication partners to transfer data.

ID	Descriptions	Qty.	Length (m)	Shielding (Yes/No)	Cores (Qty.)	Remarks
1.	RS232 to USB	1	1	N	0	Provided by Customer
2.						
3.						

Note: The core(s) is(are) originally attached to the cable(s).

3.3.1 Configuration of System under Test



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 : 2018

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 Receiver Rohde & Schwarz	ESW 44	100179	8/30/2019	8/30/2020
Hybrid Antenna SUNAR	JB6	A111717	03/09/2020	03/09/2021
Pre-Amplifier RF Bay, Inc.	LPA-6-30	11170601	04/27/2020	04/27/2021
Horn Antenna ETS-Lindgren	3117	218554	12/20/2019	12/20/2020
Preamplifier RF-Lambda	RAMP00M50GA	17032300047	09/19/2019	09/19/2020

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:

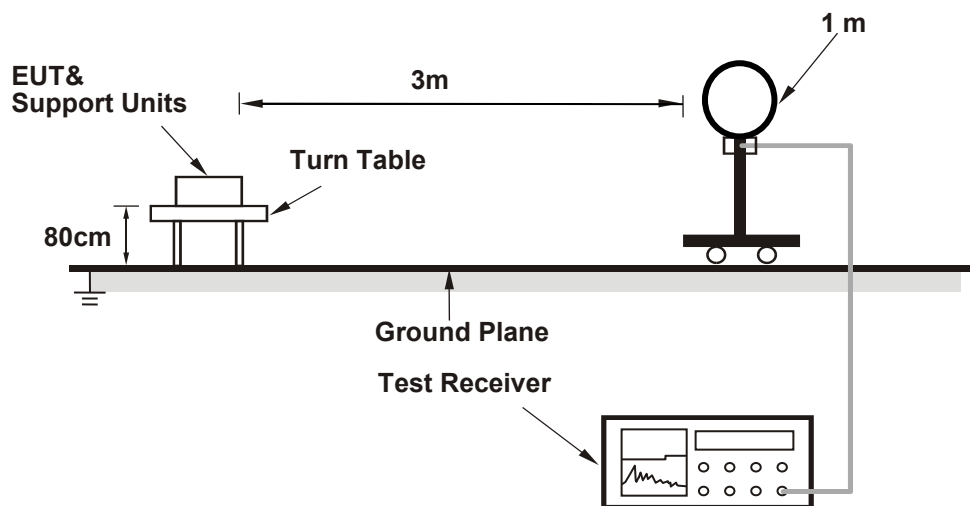
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz for Quasi-peak detection (QP) at frequency below 1GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.
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

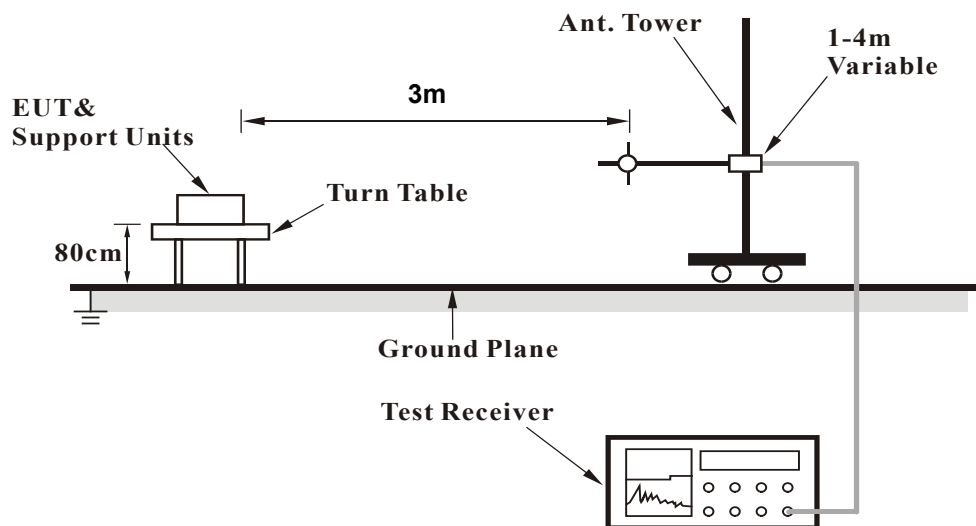
No deviation.

4.1.5 Test Setup

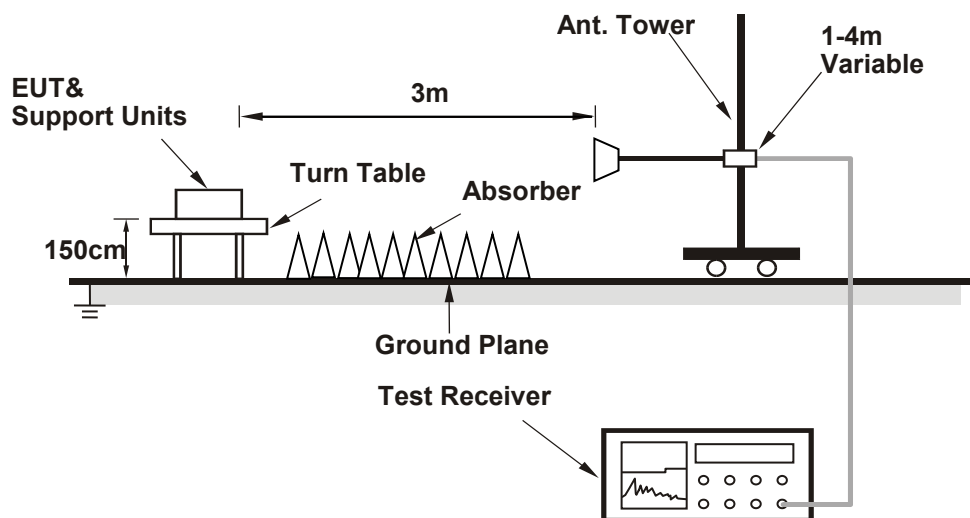
For Radiated emission below 30MHz



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

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

4.1.7 Test Results

BELOW 1GHz WORST-CASE DATA:

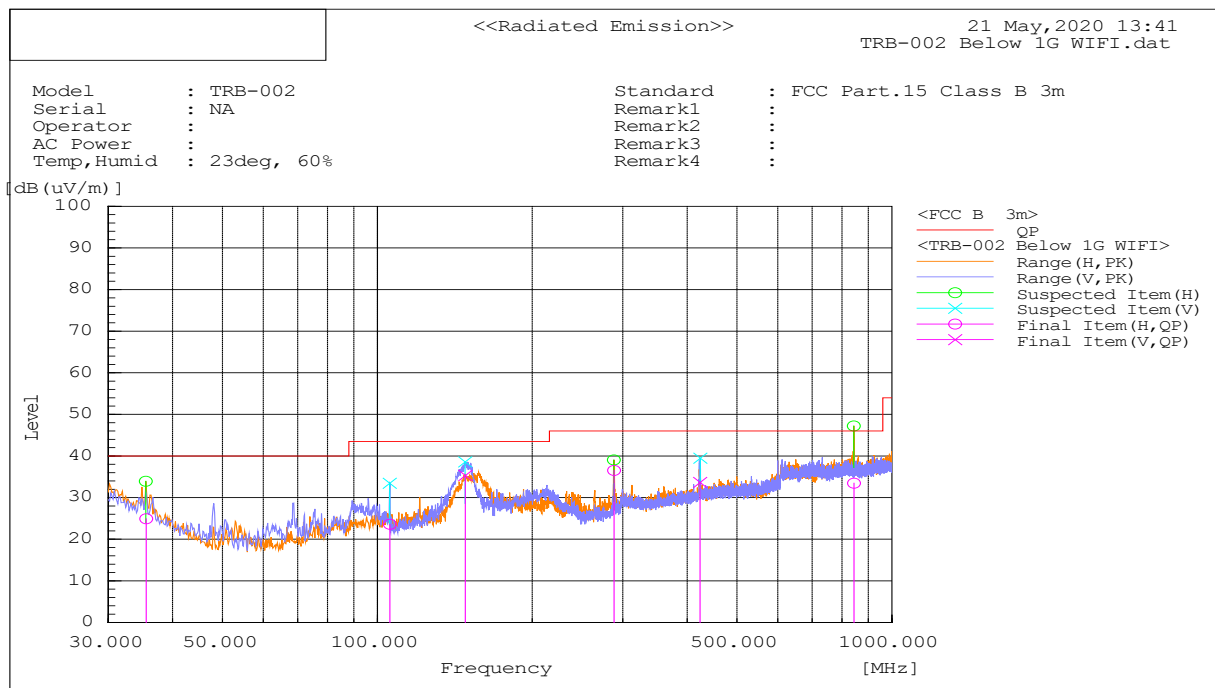
CHANNEL	802.11g Channel 6	DETECTOR FUNCTION	Quasi Peak
FREQUENCY RANGE	30MHz – 1GHz		

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	35.543	H	1.9	23	24.9	40	-15.1	99	57.8	Pass
2	105.723	H	5.9	17.7	23.6	43.5	-19.9	264	180.6	Pass
3	148.201	V	16	19.3	35.3	43.5	-8.2	120	359.8	Pass
4	288.427	H	15.5	21	36.5	46	-9.5	112	149.4	Pass
5	423.804	V	10.1	23.5	33.6	46	-12.4	112	194.5	Pass
6	843.553	H	3.5	30	33.5	46	-12.5	331	145.5	Pass

REMARKS:

1. Emission level (dBuV/m) = Raw Value (dBuV) + Cable Loss (dB) + AF (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: Vertical and Horizontal at 3m														
No	Frequency (MHz)	Polarization (H/V)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Limit AV [dB(uV/m)]	Limit PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]	Height (cm)	Angle (Deg)	Pass/Fail
1	1934.388	H	41.5	54.3	-10.2	31.3	44.1	54	74	-22.7	-29.9	294	47.6	Pass
2	3752.899	H	40.2	53.6	-7.1	33.1	46.5	54	74	-20.9	-27.5	201	0	Pass
3	4823.999	V	45.9	55	-5.9	40	49.1	54	74	-14	-24.9	237	1.3	Pass

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

Antenna Polarity & Test Distance: Vertical and Horizontal at 3m														
No	Frequency (MHz)	Polarization (H/V)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Limit AV [dB(uV/m)]	Limit PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]	Height (cm)	Angle (Deg)	Pass/Fail
1	1985.686	H	41.5	54.8	-10	31.5	44.8	54	74	-22.5	-29.2	373	278.9	Pass
2	2683.548	H	42.9	55.9	-9	33.9	46.9	54	74	-20.1	-27.1	265	138.3	Pass
3	4873.997	H	45.5	54.2	-6.1	39.4	48.1	54	74	-14.6	-25.9	201	42.9	Pass

Above 1GHz-25GHz – 802.11b – 2462MHz

Antenna Polarity & Test Distance: Vertical and Horizontal at 3m														
No	Frequency (MHz)	Polarization (H/V)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Limit AV [dB(uV/m)]	Limit PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]	Height (cm)	Angle (Deg)	Pass/Fail
1	1934.344	V	41.6	54.7	-10.2	31.4	44.5	54	74	-22.6	-29.5	102	314.4	Pass
2	4926.732	H	40	52.6	-6.1	33.9	46.5	54	74	-20.1	-27.5	165	40.3	Pass
3	8226.115	V	35	48.6	0.3	35.3	48.9	54	74	-18.7	-25.1	251	18.6	Pass

REMARKS:

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

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

Antenna Polarity & Test Distance: Vertical and Horizontal at 3m														
No	Frequency (MHz)	Polarization (H/V)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Limit AV [dB(uV/m)]	Limit PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]	Height (cm)	Angle (Deg)	Pass/Fail
1	1254.865	V	43.1	56.1	-13.7	29.4	42.4	54	74	-24.6	-31.6	258	324.7	Pass
2	1917.64	V	41.2	54.6	-10.3	30.9	44.3	54	74	-23.1	-29.7	108	22.8	Pass
3	4824.044	V	39.1	52.6	-5.9	33.2	46.7	54	74	-20.8	-27.3	373	0	Pass

Above 1GHz-25GHz – 802.11g – 2437MHz

Antenna Polarity & Test Distance: Vertical and Horizontal at 3m														
No	Frequency (MHz)	Polarization (H/V)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Limit AV [dB(uV/m)]	Limit PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]	Height (cm)	Angle (Deg)	Pass/Fail
1	3209.955	V	41	53.8	-8.4	32.6	45.4	54	74	-21.4	-28.6	158	127.2	Pass
2	4873.985	H	40.8	53	-6.1	34.7	46.9	54	74	-19.3	-27.1	165	0	Pass
3	12730.17	H	32.9	47.2	5.5	38.4	52.7	54	74	-15.6	-21.3	394	53	Pass

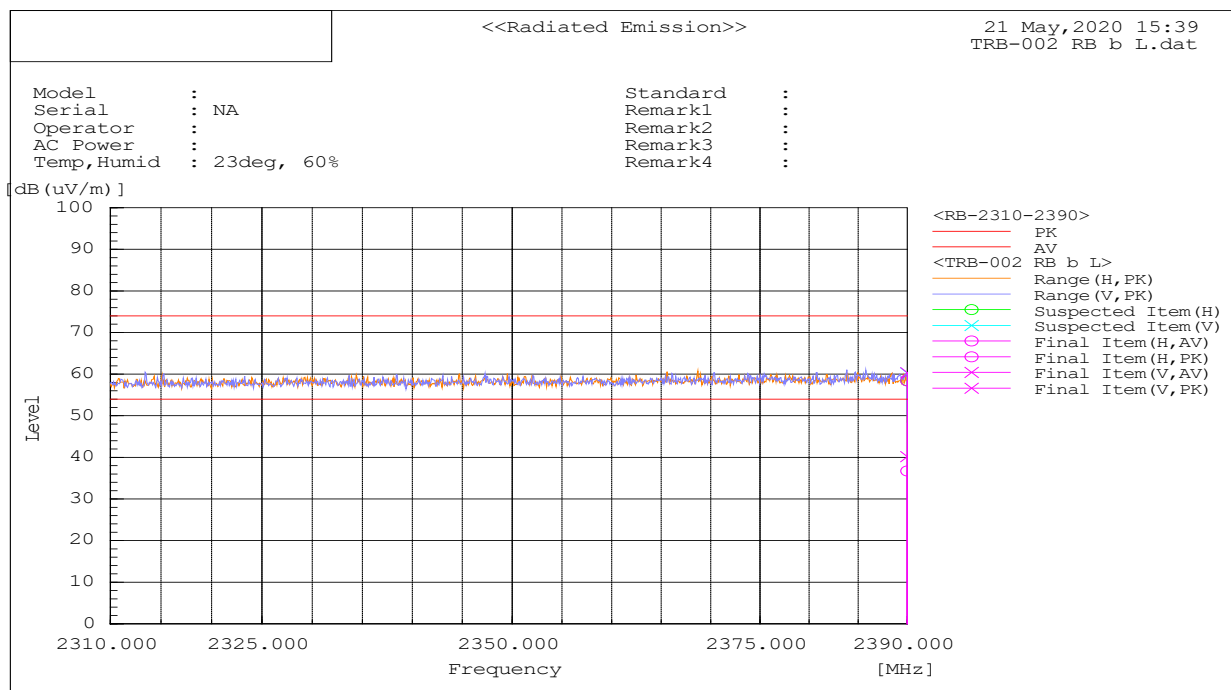
Above 1GHz-25GHz- 802.11g - 2462MHz

Antenna Polarity & Test Distance: Vertical and Horizontal at 3m														
No	Frequency (MHz)	Polarization (H/V)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Limit AV [dB(uV/m)]	Limit PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]	Height (cm)	Angle (Deg)	Pass/Fail
1	1934.12	V	41.5	54.4	-10.2	31.3	44.2	54	74	-22.7	-29.8	280	274.3	Pass
2	3651.863	V	39.9	53.1	-7.8	32.1	45.3	54	74	-21.9	-28.7	251	179.7	Pass
3	4923.995	H	41.5	54.5	-6.1	35.4	48.4	54	74	-18.6	-25.6	137	5.4	Pass

REMARKS:

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

Restricted band (802.11b low channel)



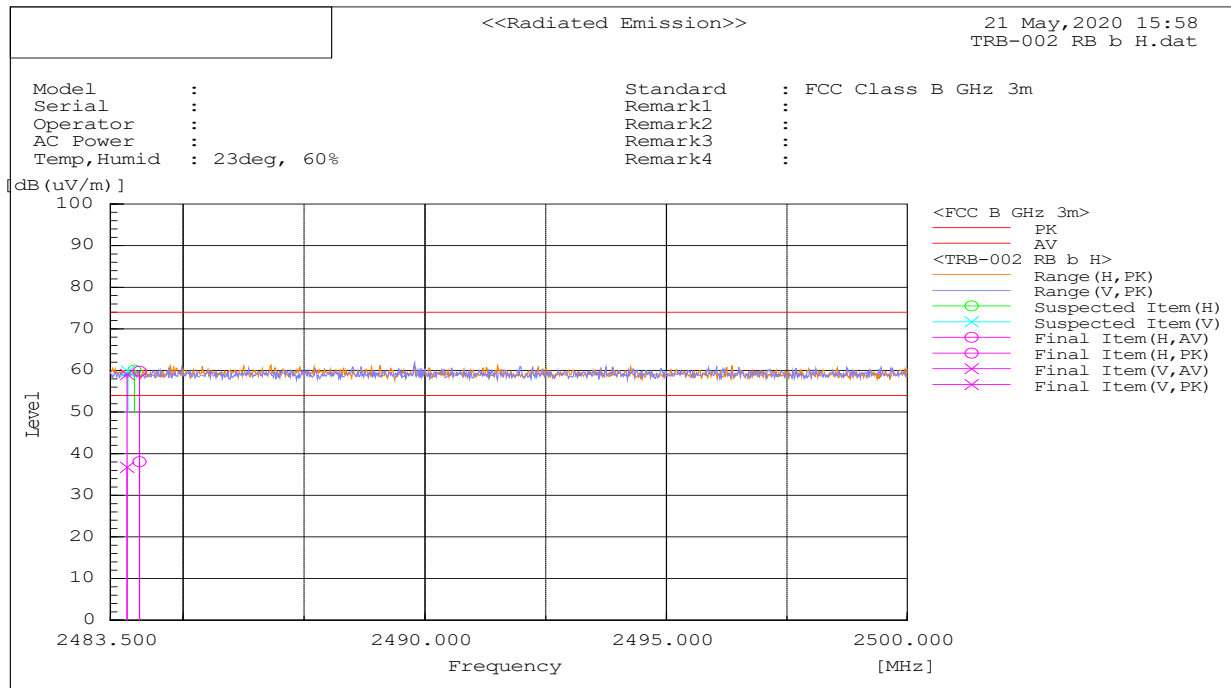
Antenna Polarity & Test Distance: Vertical and Horizontal at 3m

No.	Frequency (MHz)	Polarization (H/V)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Limit AV [dB(uV/m)]	Limit PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]	Height (cm)	Angle (Deg)	Pass/Fail
1	2390	H	1.6	23.3	35.1	36.7	58.4	54	74	-17.3	-15.6	100	297	Pass
2	2390	V	5.1	25.3	35.1	40.2	60.4	54	74	-13.8	-13.6	273	32.2	Pass

REMARKS:

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

Restricted band (802.11b high channel)



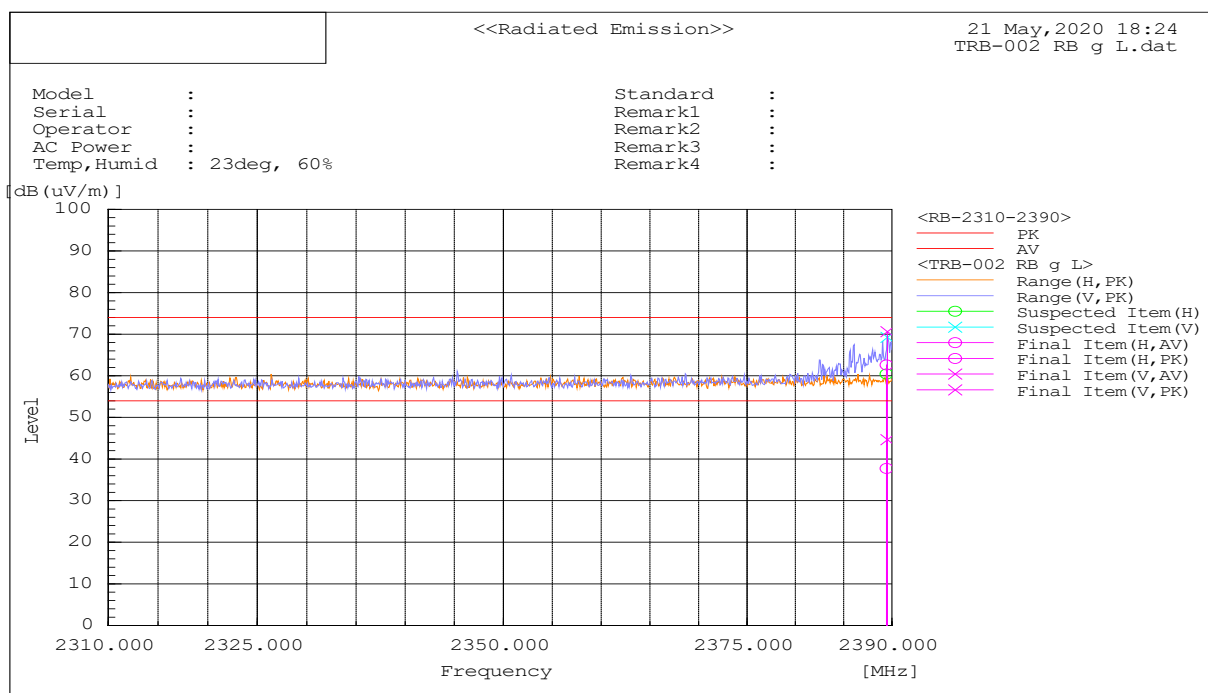
Antenna Polarity & Test Distance: Vertical and Horizontal at 3m

No.	Frequency (MHz)	Polarization (H/V)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Limit AV [dB(uV/m)]	Limit PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]	Height (cm)	Angle (Deg)	Pass/Fail
1	2483.84	V	1.1	23.5	35.6	36.7	59.1	54	74	17.3	14.9	290	353	Pass
2	2484.09	H	2.5	24.2	35.6	38.1	59.8	54	74	15.9	14.2	188	32.9	Pass

REMARKS:

- Level (dBuV) = Reading (dBuV) + Factor (dB(1/m)).
- Factor (dB(1/m)) = Antenna Factor(AF) (dB(1/m)) + Cable Loss (dB) –Preamplifier Gain (dB)
- Margin = Level (dBuV/m) - Limit value (dBuV/m)

Restricted band (802.11g low channel)



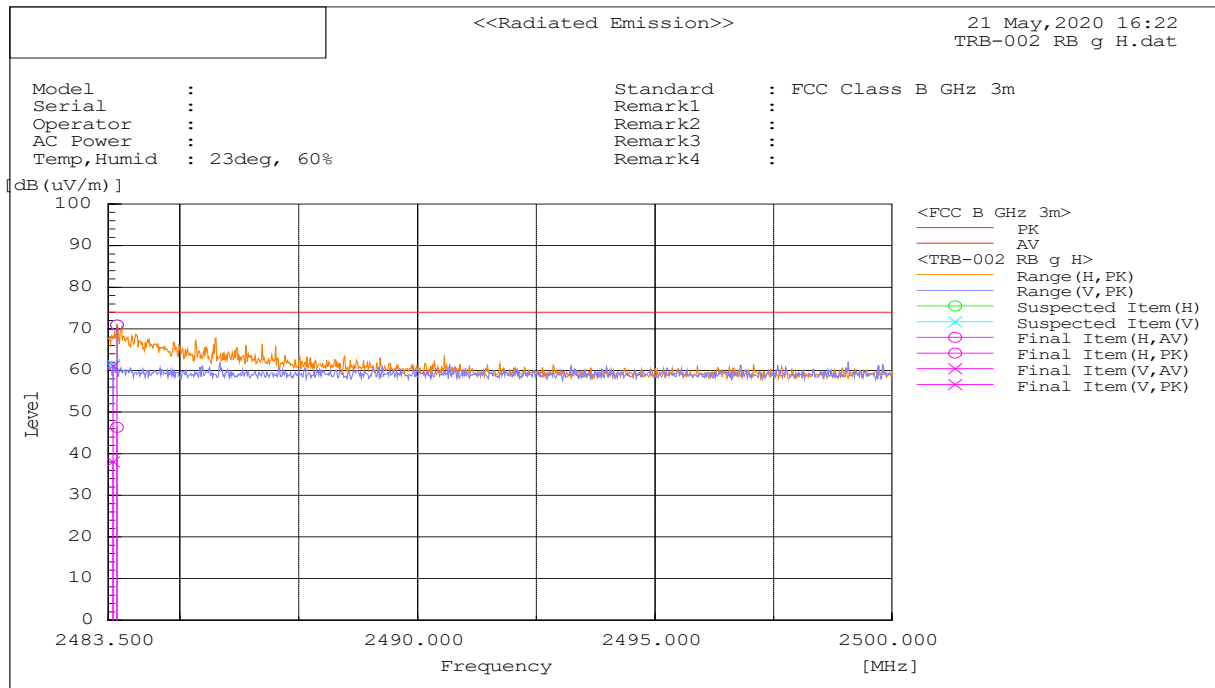
Antenna Polarity & Test Distance: Vertical and Horizontal at 3m

No.	Frequency (MHz)	Polarization (H/V)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Limit AV [dB(uV/m)]	Limit PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]	Height (cm)	Angle (Deg)	Pass/Fail
1	2389.44	H	2.6	27.5	35.1	37.7	62.6	54	74	16.3	11.4	129	233.1	Pass
2	2389.52	V	9.6	35.5	35.1	44.7	70.6	54	74	9.3	3.4	230	0.1	Pass

REMARKS:

- Level (dBuV) = Reading (dBuV) + Factor (dB(1/m)).
- Factor (dB(1/m)) = Antenna Factor(AF) (dB(1/m)) + Cable Loss (dB) - Preamplifier Gain (dB)
- Margin = Level (dBuV/m) - Limit value (dBuV/m)

Restricted band (802.11g high channel)



Antenna Polarity & Test Distance: Vertical and Horizontal at 3m

No.	Frequen cy (MHz)	Polariza tion (H/V)	Readin g AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/ m)]	Level PK dB(uV/ m)	Limit\AV dB(uV/ m)	Limit\PK [dB(uV/ m)]	Margin AV [dB]	Margin PK [dB]	Height (cm)	Angle (Deg)	Pass/ Fail
1	2483.59	V	2.4	25.4	35.6	38	61	54	74	16	13	171	19	Pass
2	2483.68	H	10.7	35.3	35.6	46.3	70.9	54	74	7.7	3.1	112	3	Pass

REMARKS:

- Level (dBuV) = Reading (dBuV) + Factor (dB(1/m)).
- Factor (dB(1/m)) = Antenna Factor(AF) (dB(1/m)) + Cable Loss (dB) –Preamplifier Gain (dB)
- Margin = Level (dBuV/m) - Limit value (dBuV/m)

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.	Date Of Calibration	Due Date Of Calibration
EMI Test Receiver ROHDE & SCHWARZ	ESIB 40	100179	11/01/2019	11/01/2020
Transient Limiter ELECTRO-METRICS	EM-7600-5	106	12/31/2019	12/31/2020
LISN EMCO	3816/2NM	214372	01/14/2020	01/14/2021

4.2.3 Test Procedures

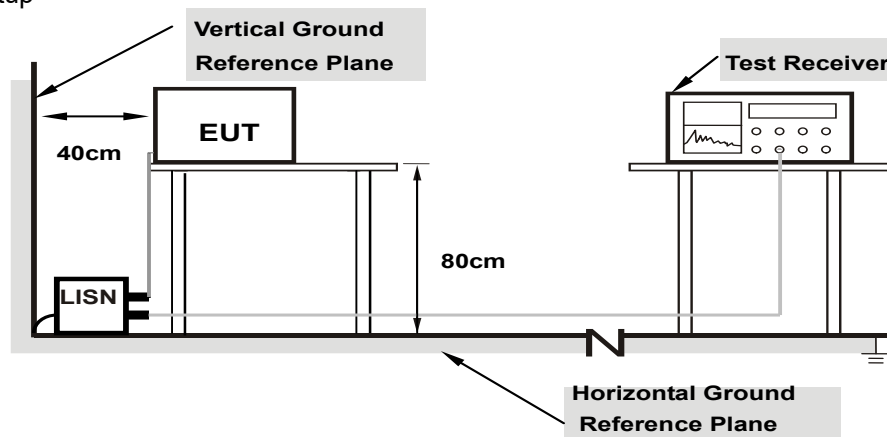
- The EUT was placed 0.4 meters from the conducting wall of the shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). Other support units were connected to the power mains through another LISN. The two LISNs provide 50 ohm/ 50uH of coupling impedance 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.

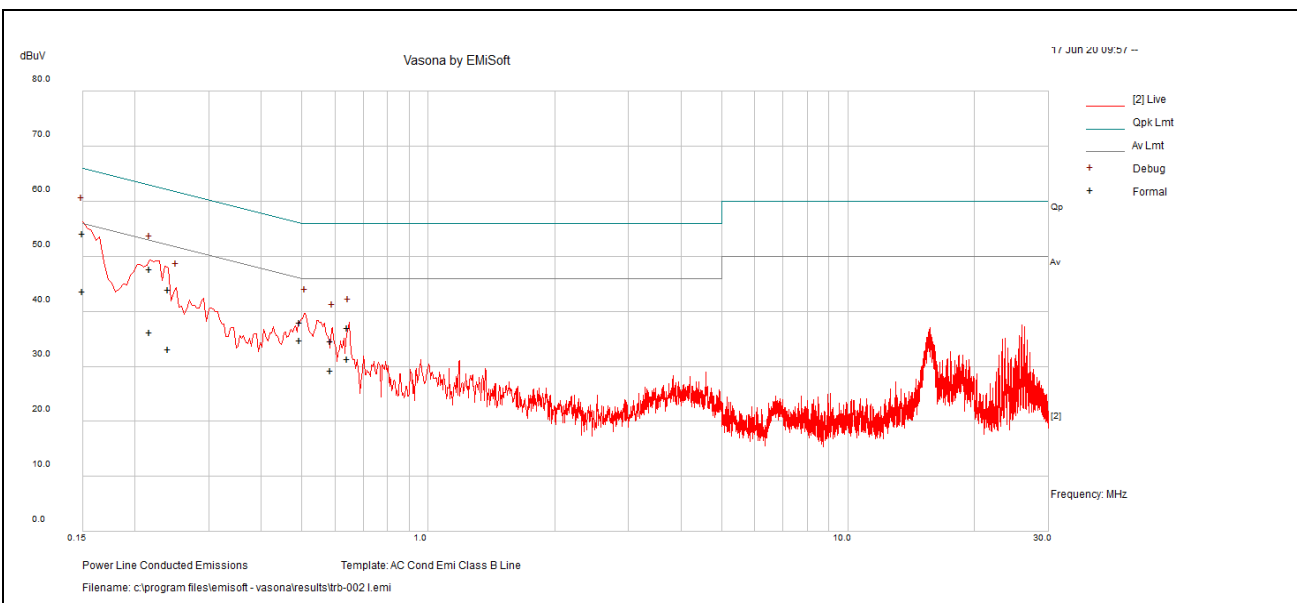
4.2.7 Test Results

Phase	Line (L)	Detector Function	Quasi-Peak / Average
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No	Freq.	Raw	Cale Loss	Factors	Level	Measurement Type	Line	Limit	Margin	Pass /Fail
	[MHz]	(dBuV)	(dB)	(dB)	(dBuV)			(dBuV)	(dB)	
1	0.150	44.92	9.29	0.04	54.25	Quasi Peak	Live	65.99	-11.74	Pass
2	0.217	38.23	9.39	0.04	47.67	Quasi Peak	Live	62.93	-15.26	Pass
3	0.495	28.46	9.45	0.04	37.95	Quasi Peak	Live	56.09	-18.14	Pass
4	0.241	34.51	9.42	0.04	43.97	Quasi Peak	Live	62.08	-18.1	Pass
5	0.642	27.52	9.46	0.04	37.02	Quasi Peak	Live	56	-18.98	Pass
6	0.587	25.07	9.46	0.04	34.56	Quasi Peak	Live	56	-21.44	Pass
7	0.150	34.37	9.29	0.04	43.7	Average	Live	55.99	-12.29	Pass
8	0.217	26.84	9.39	0.04	36.27	Average	Live	52.93	-16.66	Pass
9	0.495	25.2	9.45	0.04	34.69	Average	Live	46.09	-11.4	Pass
10	0.241	23.74	9.42	0.04	33.2	Average	Live	52.08	-18.88	Pass
11	0.642	21.89	9.46	0.04	31.39	Average	Live	46	-14.61	Pass
12	0.587	19.83	9.46	0.04	29.32	Average	Live	46	-16.68	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.

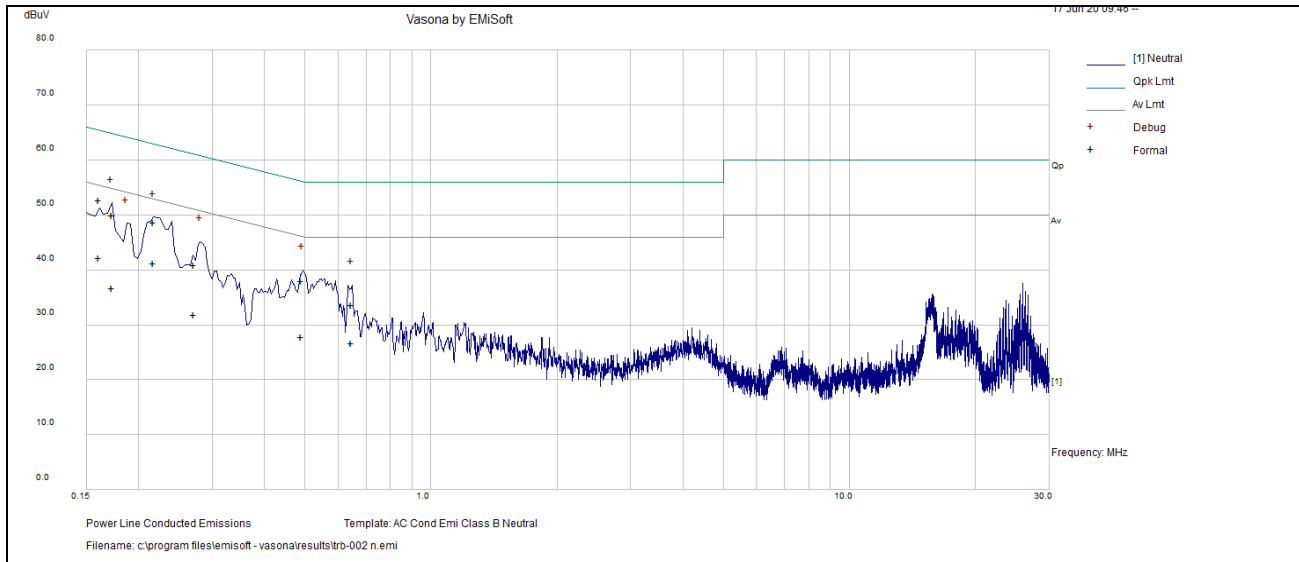


Phase	Neutral (N)	Detector Function	Quasi-Peak / Average
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No	Freq. [MHz]	Raw (dBuV)	Cale Loss (dB)	Factors (dB)	Level (dBuV)	Measurement Type	Line	Limit (dBuV)	Margin (dB)	Pass /Fail
1	0.161	43.45	9.31	0.03	52.79	Quasi Peak	Neutral	65.4	-12.61	Pass
2	0.218	39.28	9.39	0.03	48.7	Quasi Peak	Neutral	62.91	-14.21	Pass
3	0.271	31.41	9.44	0.03	40.87	Quasi Peak	Neutral	61.08	-20.21	Pass
4	0.173	40.65	9.33	0.03	50.02	Quasi Peak	Neutral	64.82	-14.8	Pass
5	0.492	28.59	9.45	0.03	38.07	Quasi Peak	Neutral	56.14	-18.07	Pass
6	0.646	24.16	9.46	0.03	33.65	Quasi Peak	Neutral	56	-22.35	Pass
7	0.161	32.82	9.31	0.03	42.16	Average	Neutral	55.4	-13.23	Pass
8	0.218	31.85	9.39	0.03	41.28	Average	Neutral	52.91	-11.63	Pass
9	0.271	22.36	9.44	0.03	31.82	Average	Neutral	51.08	-19.26	Pass
10	0.173	27.27	9.33	0.03	36.63	Average	Neutral	54.82	-18.19	Pass
11	0.492	18.32	9.45	0.03	27.8	Average	Neutral	46.14	-18.34	Pass
12	0.646	17.18	9.46	0.03	26.67	Average	Neutral	46	-19.33	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.

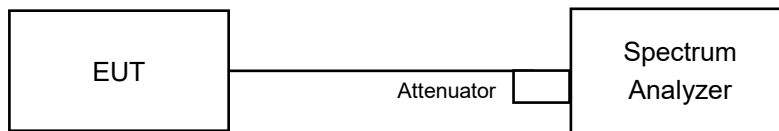


4.3 6dB Bandwidth Measurement

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

- Set resolution bandwidth (RBW) = 100kHz
- Set the video bandwidth (VBW) $\geq 3 \times$ RBW, Detector = Peak.
- Trace mode = max hold.
- Sweep = auto couple.
- 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.

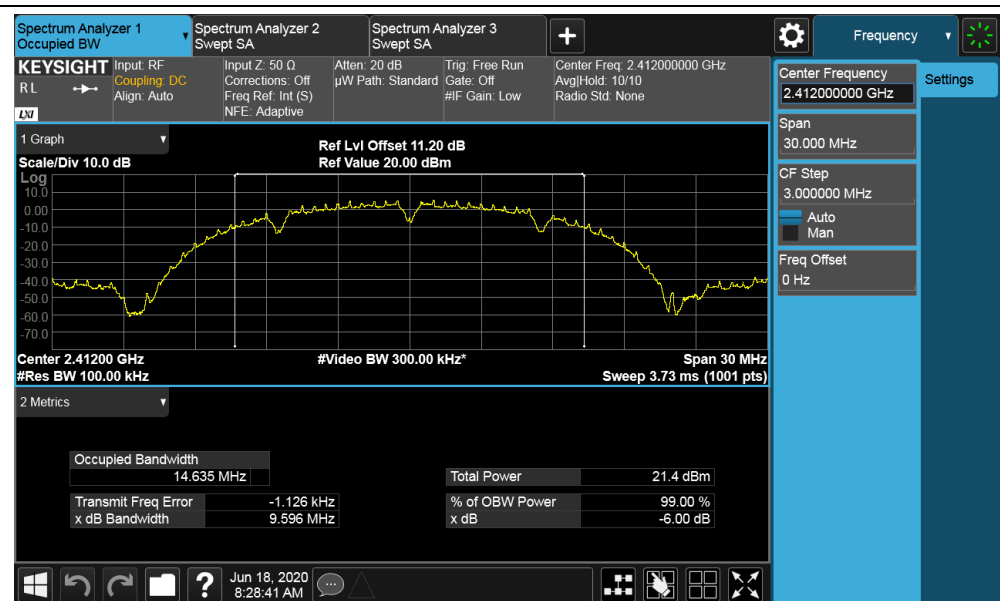
4.3.6 EUT Operating Conditions

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

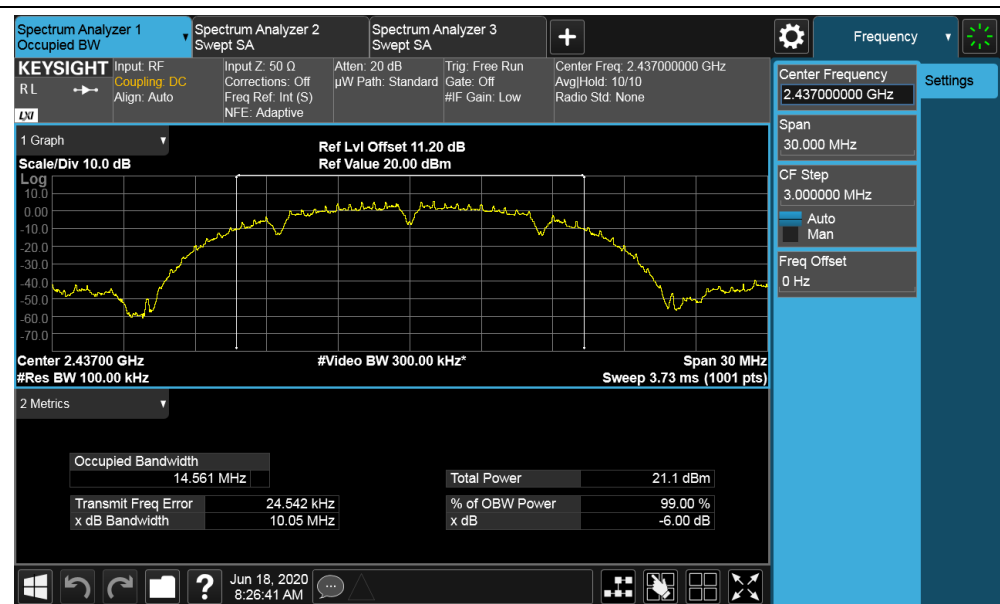
4.3.7 Test Result

Mode	Channel	Frequency (MHz)	6dB Bandwidth (MHz)	Minimum Limit (MHz)	Pass / Fail
802.11b	1	2412	9.596	0.5	PASS
	6	2437	10.046	0.5	PASS
	11	2462	10.023	0.5	PASS
802.11g	1	2412	15.063	0.5	PASS
	6	2437	15.020	0.5	PASS
	11	2462	14.426	0.5	PASS

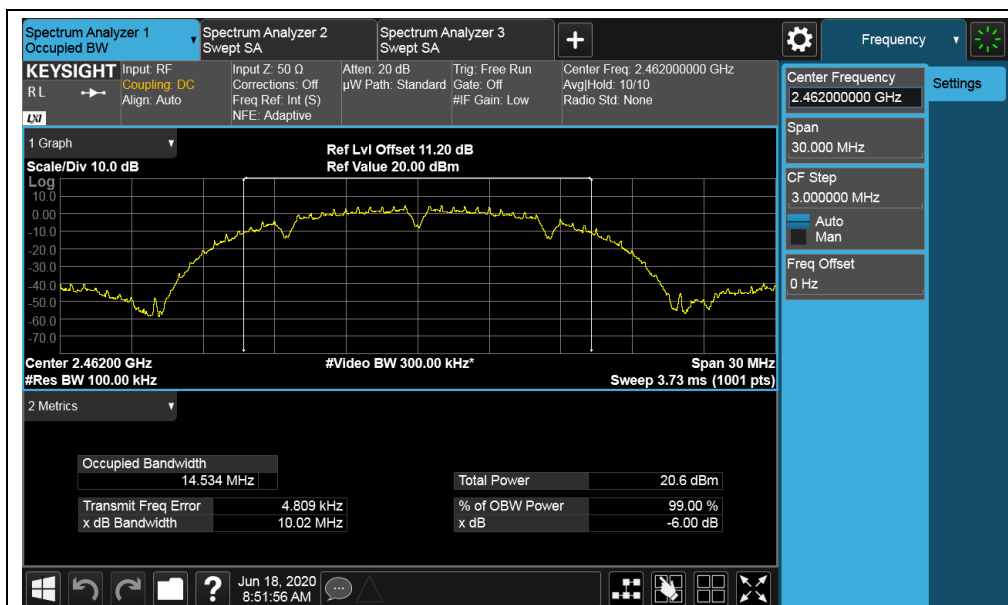
Test Plots:



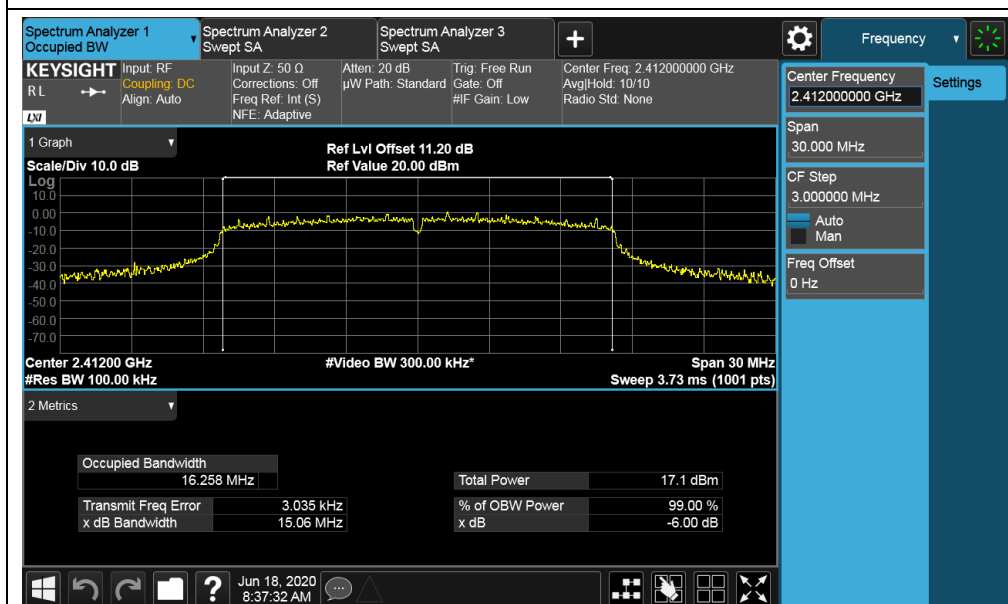
802.11b-2412MHz



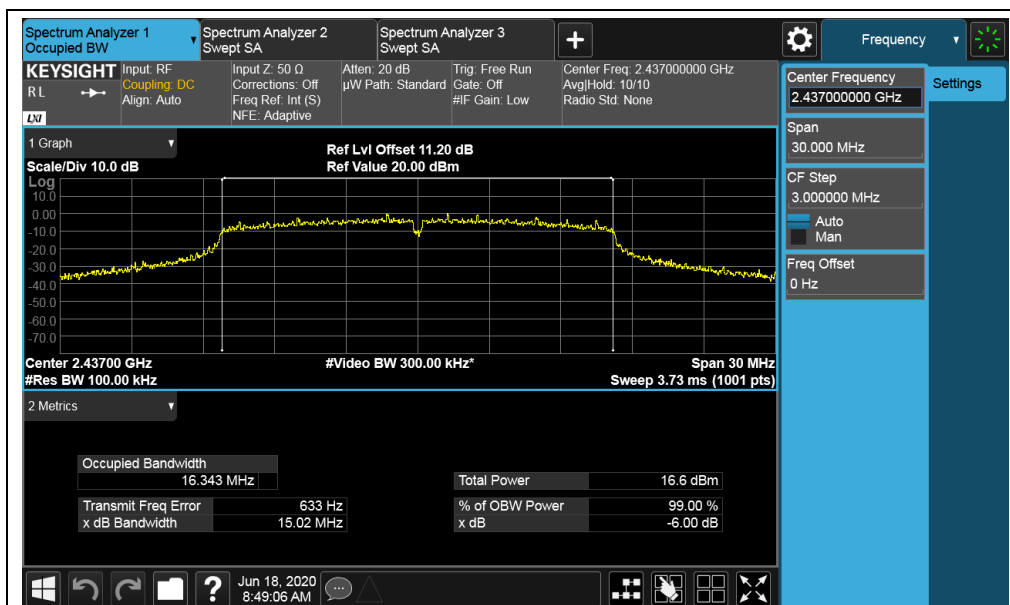
802.11b-2437MHz



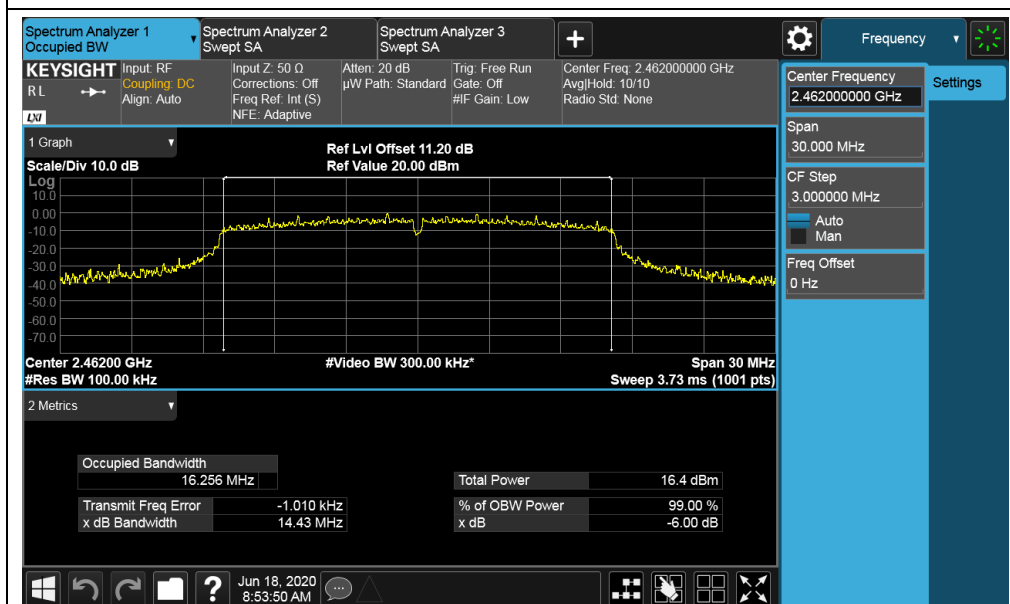
802.11b-2462MHz



802.11g-2412MHz



802.11g-2437MHz



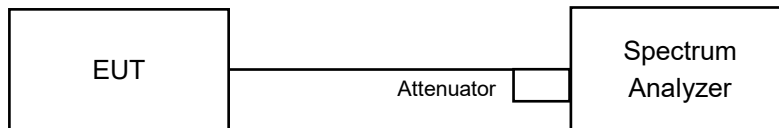
802.11g-2462MHz

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

- Set span to at least 1.5 times the OBW.
- Set RBW = 1-5% of the OBW, not to exceed 1 MHz.
- Set VBW $\geq 3 \times$ RBW.
- Number of points in sweep $\geq 2 \times$ span / RBW
- Sweep time = auto.
- Detector = RMS (i.e., power averaging), or sample detector mode.
- 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 $\geq 98\%$, and if each transmission is entirely at the maximum power control level, then the trigger shall be set to “free run”.
- 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

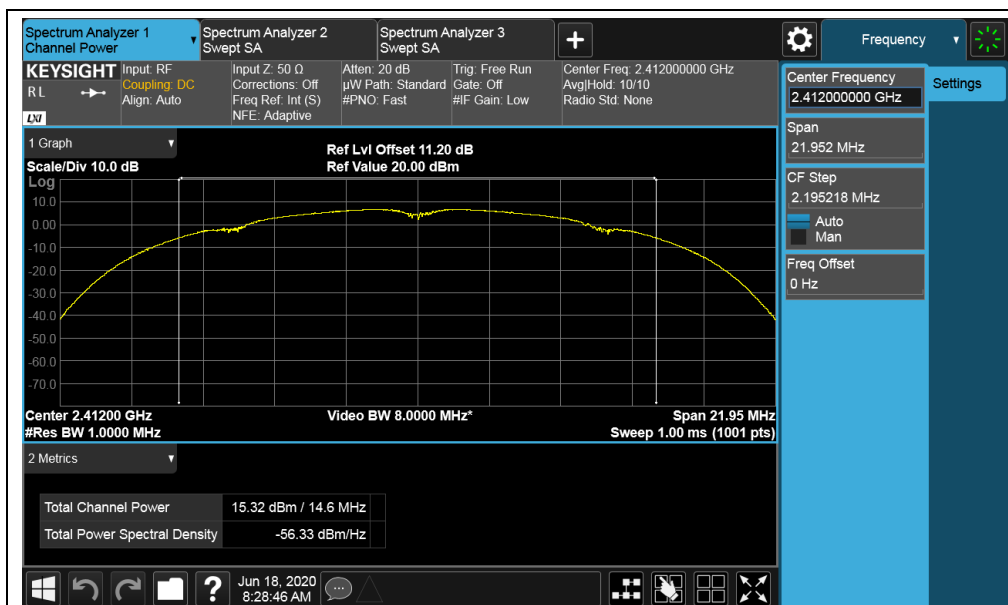
802.11b

Chan.	Chan. Freq. (MHz)	Output Power (dBm)	Limit (dBm)	Pass / Fail
1	2412	15.32	30	Pass
6	2437	14.89	30	Pass
11	2462	14.50	30	Pass

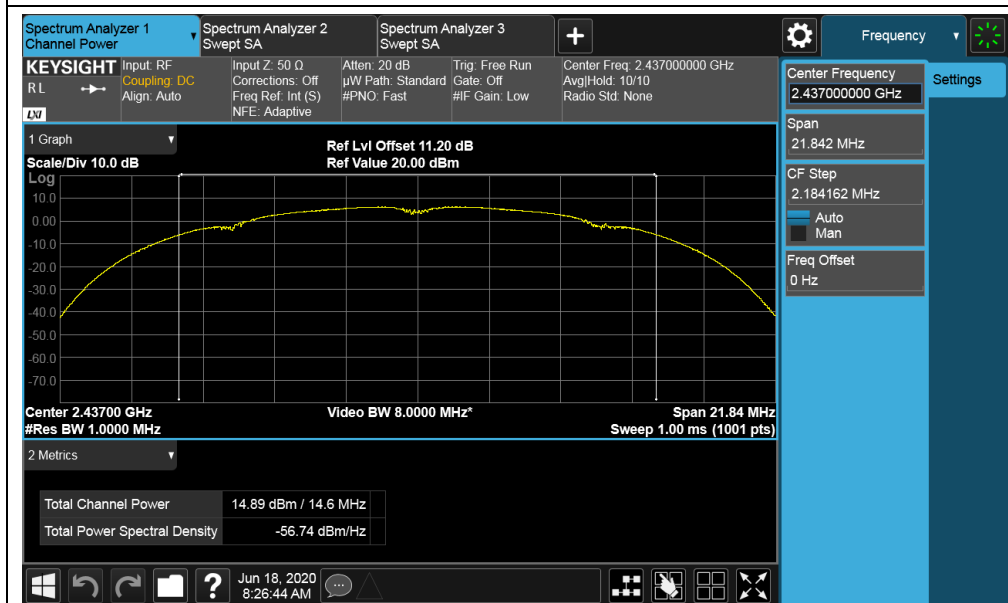
802.11g

Chan.	Chan. Freq. (MHz)	Output Power (dBm)	Limit (dBm)	Pass / Fail
1	2412	11.27	30	Pass
6	2437	10.86	30	Pass
11	2462	10.59	30	Pass

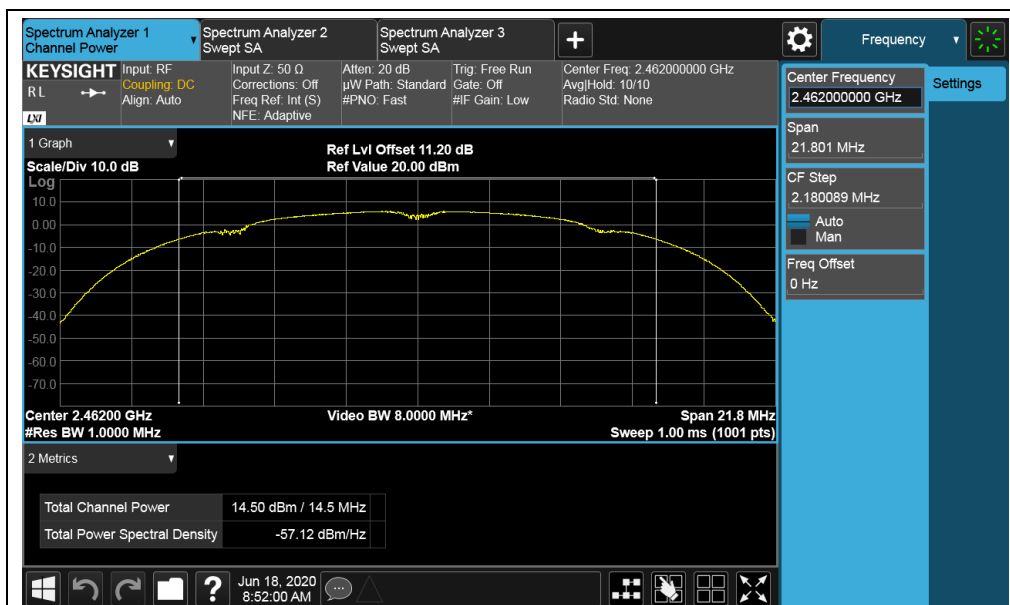
Test Plots:



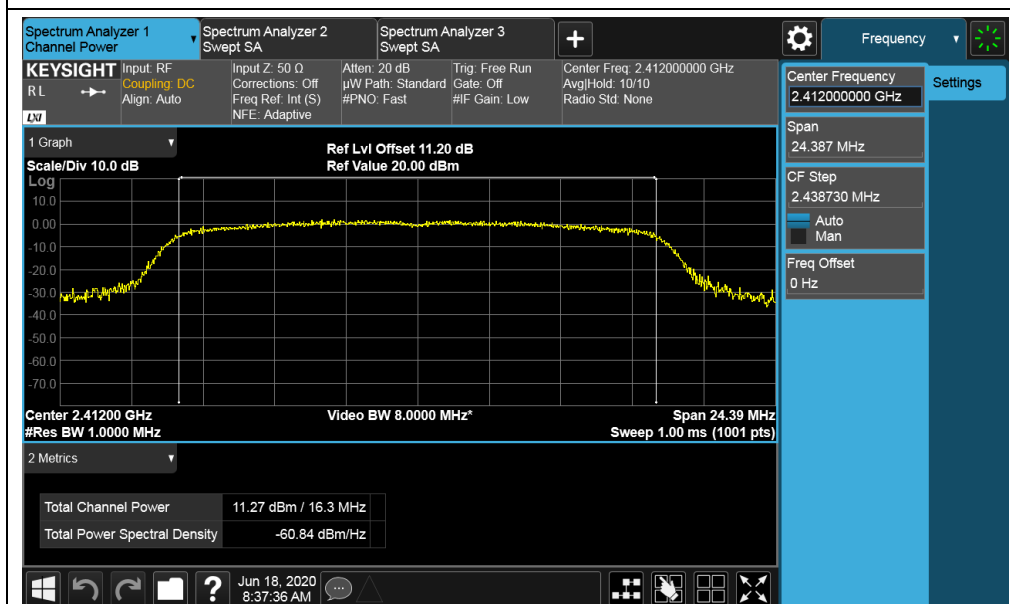
802.11b-2412MHz



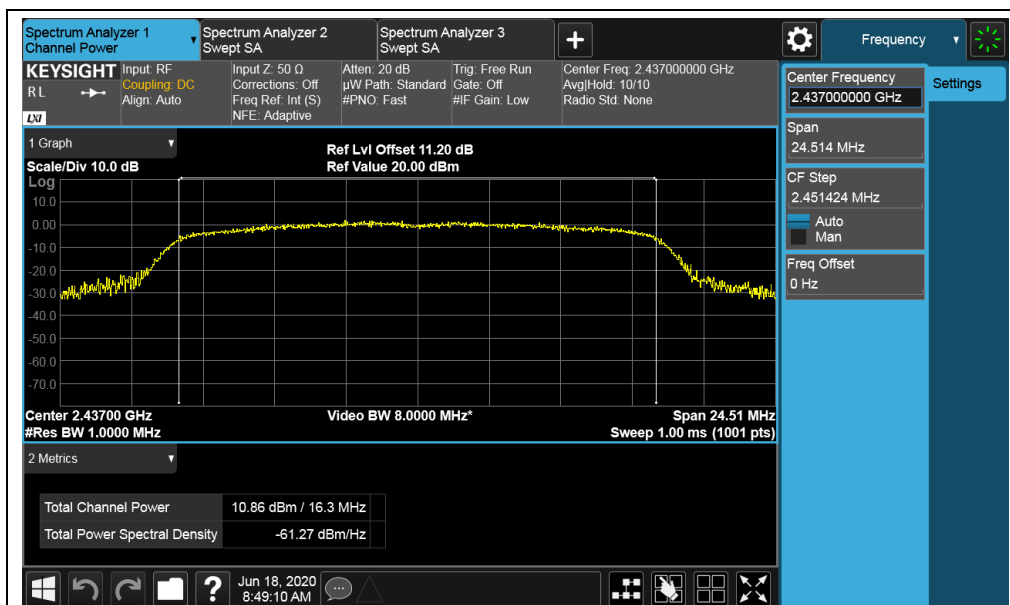
802.11b-2437MHz



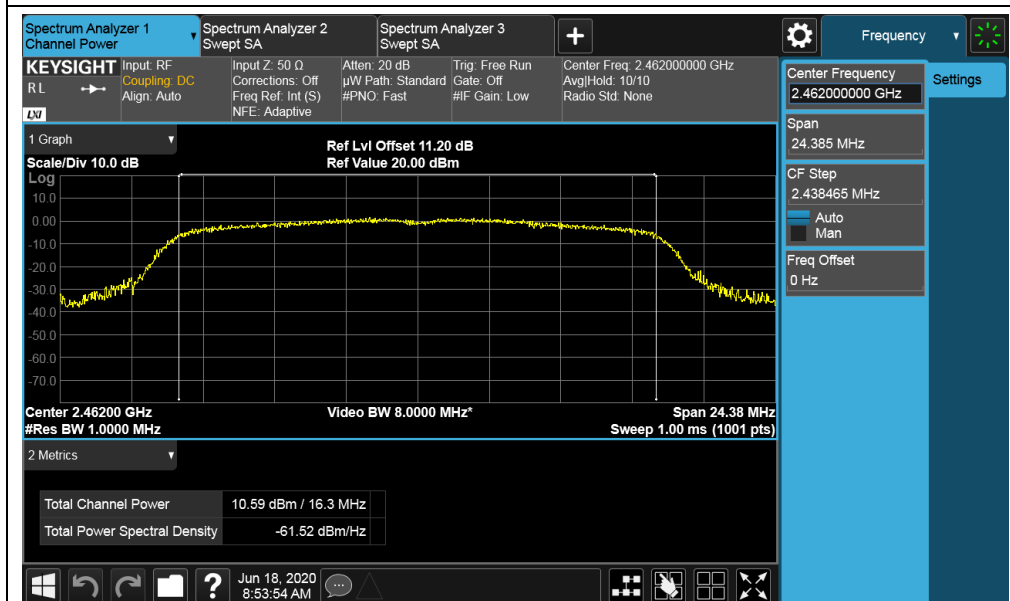
802.11b-2462MHz



802.11g-2412MHz



802.11g-2437MHz



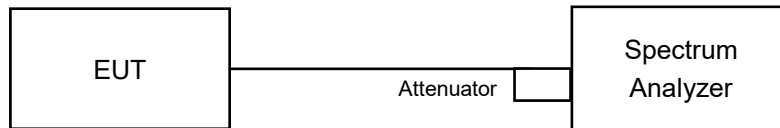
802.11g-2462MHz

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

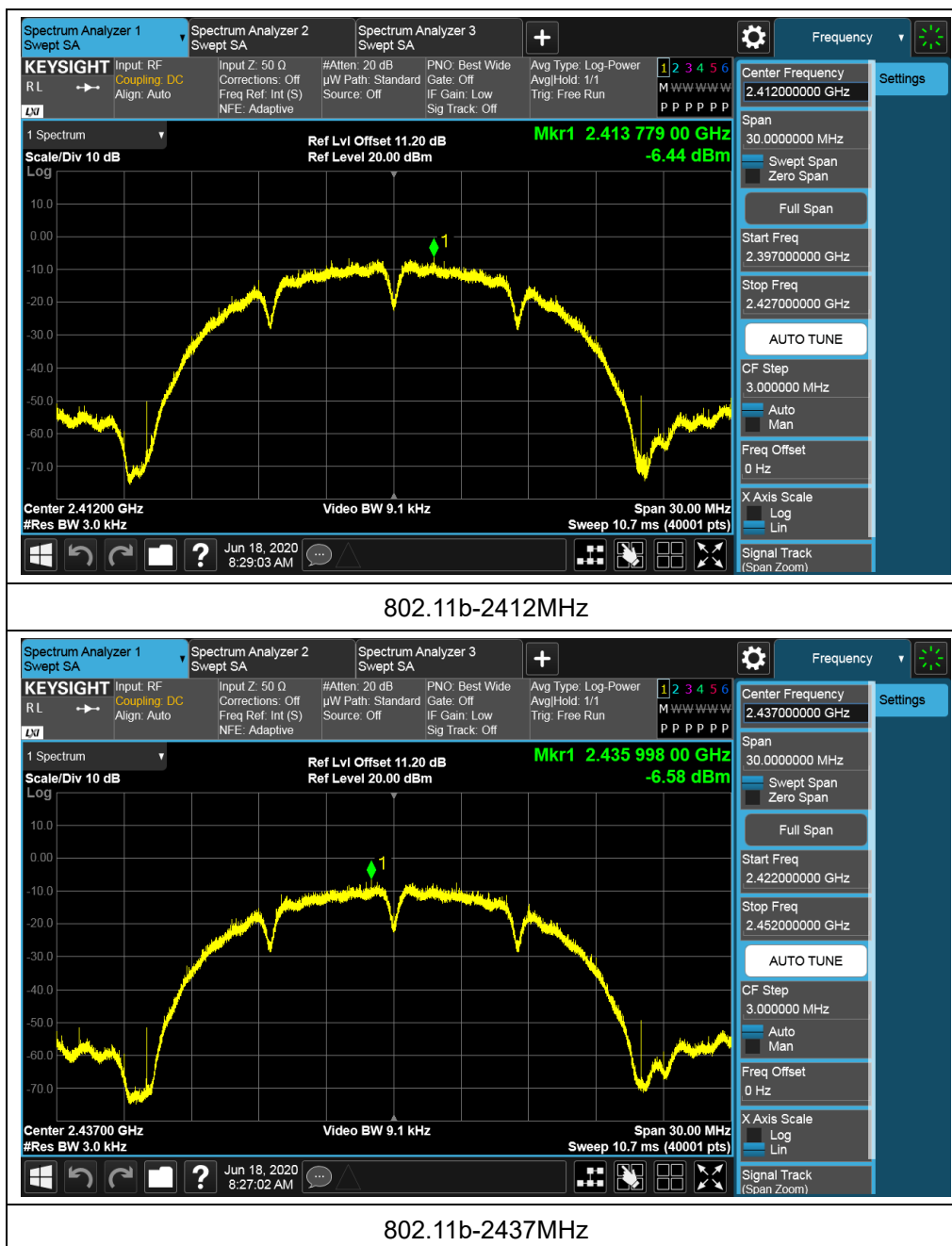
802.11b

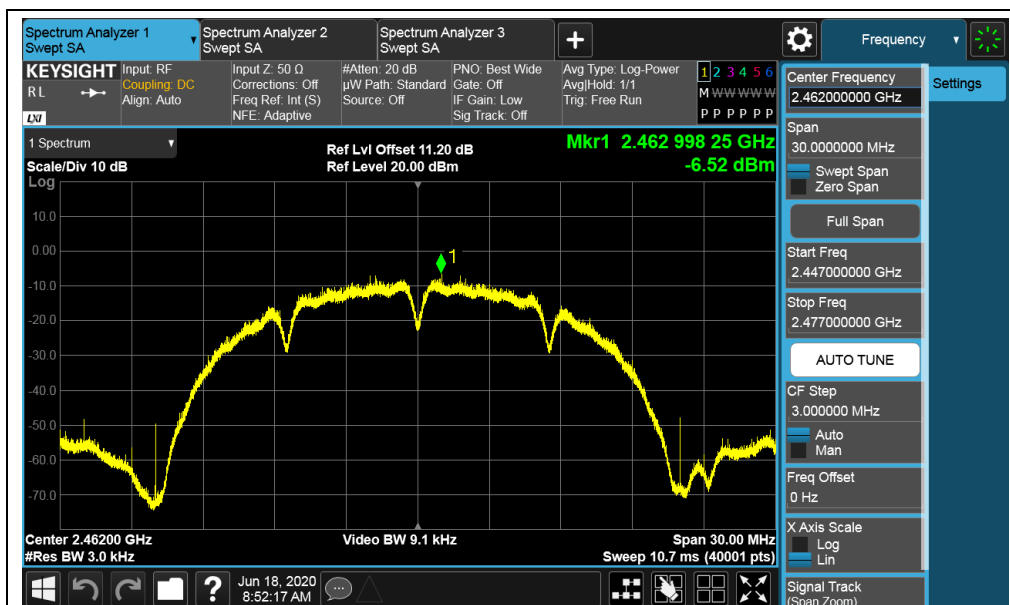
Chan.	Chan. Freq.(MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Pass / Fail
1	2412	-6.44	8	Pass
6	2437	-6.58	8	Pass
11	2462	-6.52	8	Pass

802.11g

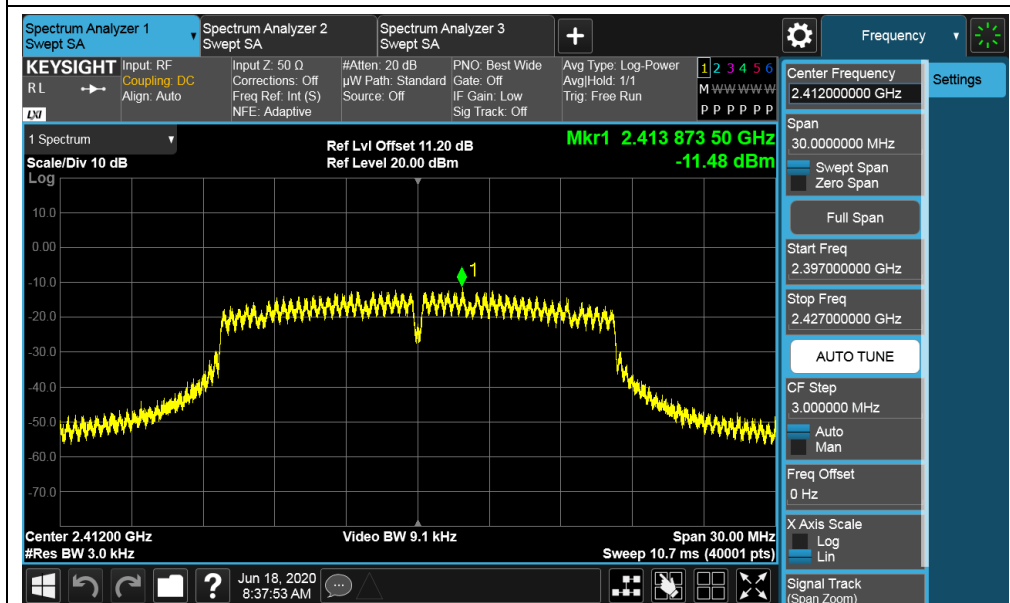
Chan.	Chan. Freq.(MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Pass / Fail
1	2412	-11.48	8	Pass
6	2437	-12.12	8	Pass
11	2462	-12.86	8	Pass

Test Plots:

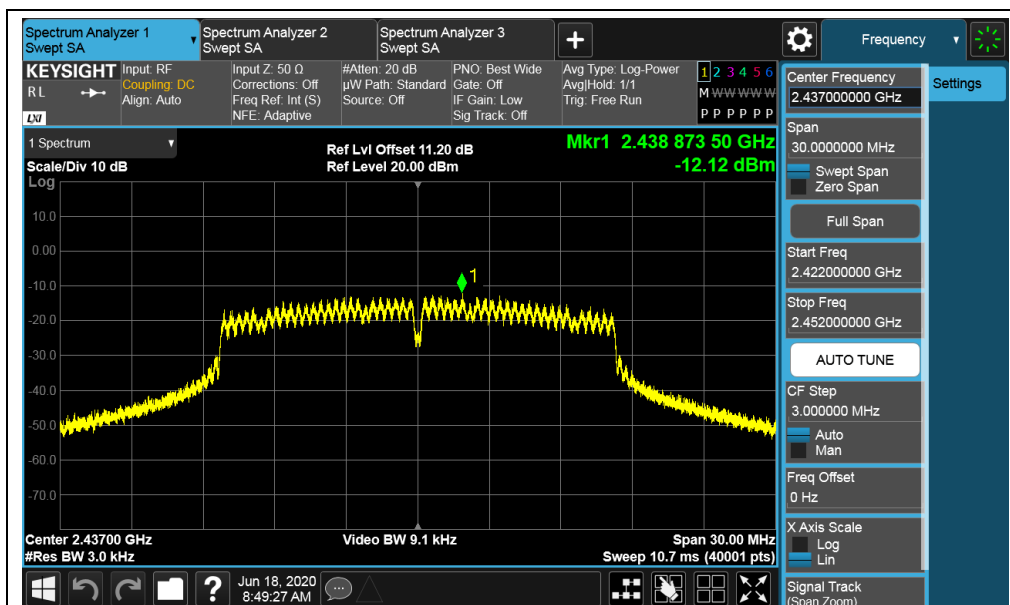




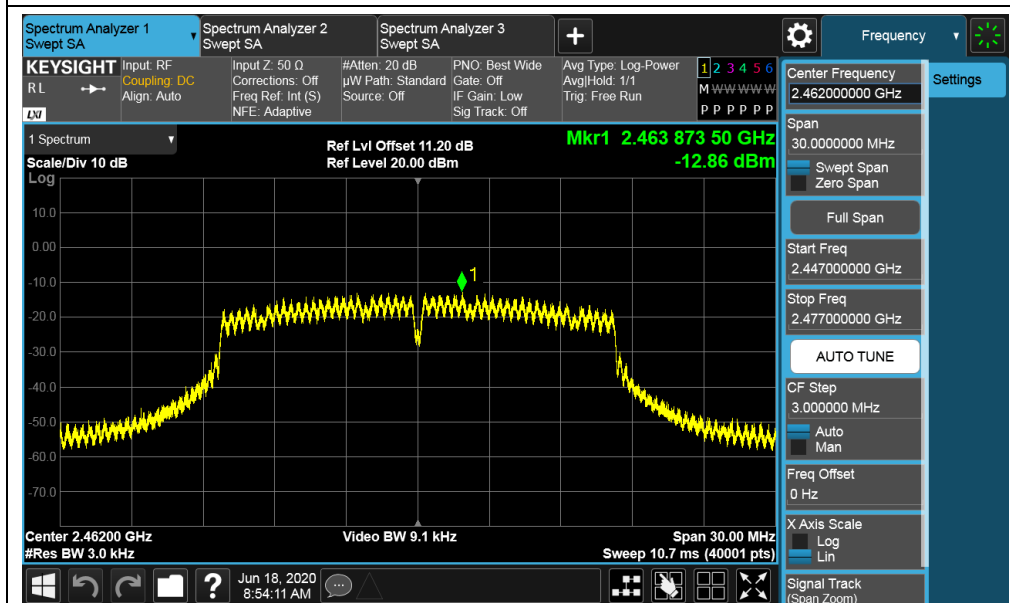
802.11b-2462MHz



802.11g-2412MHz



802.11g-2437MHz



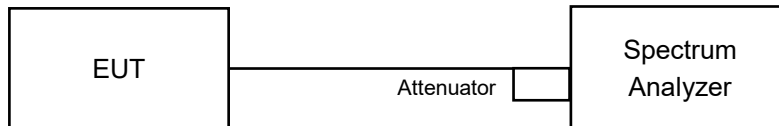
802.11g-2462MHz

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 OOBE

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.

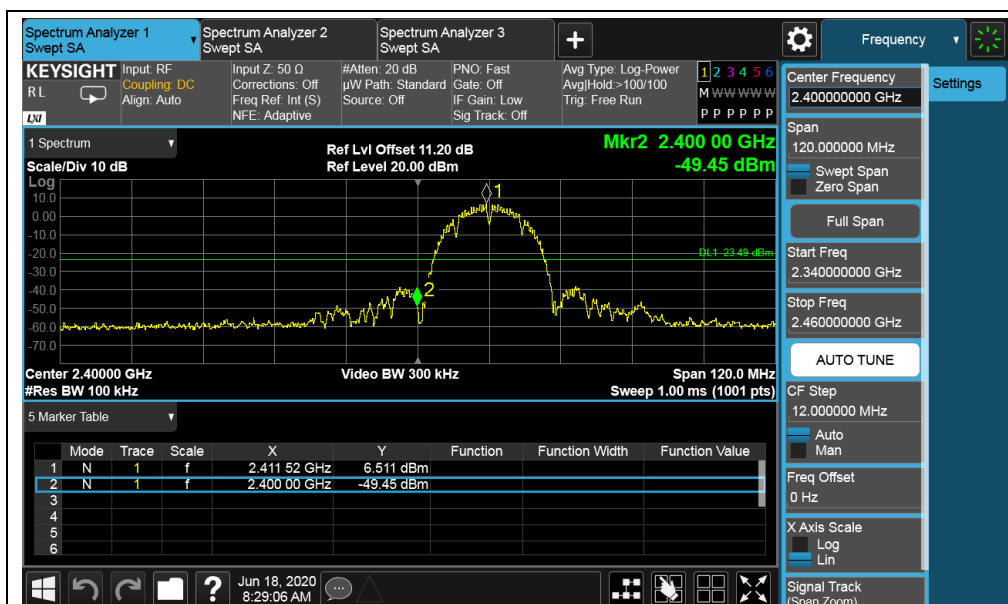
4.6.5 Deviation from Test Standard

No deviation.

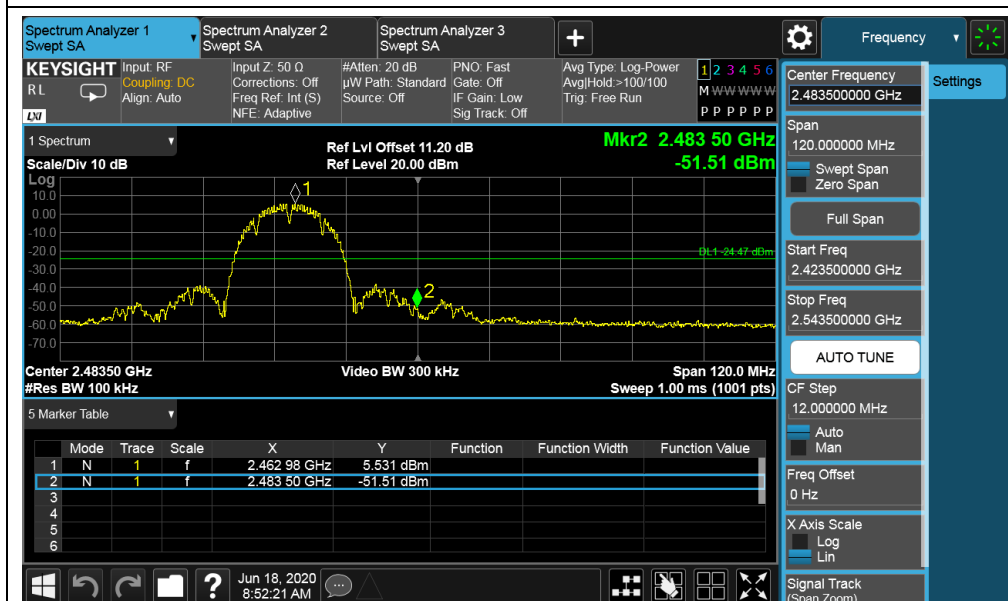
4.6.6 EUT Operating Condition

Same as Item 4.3.6

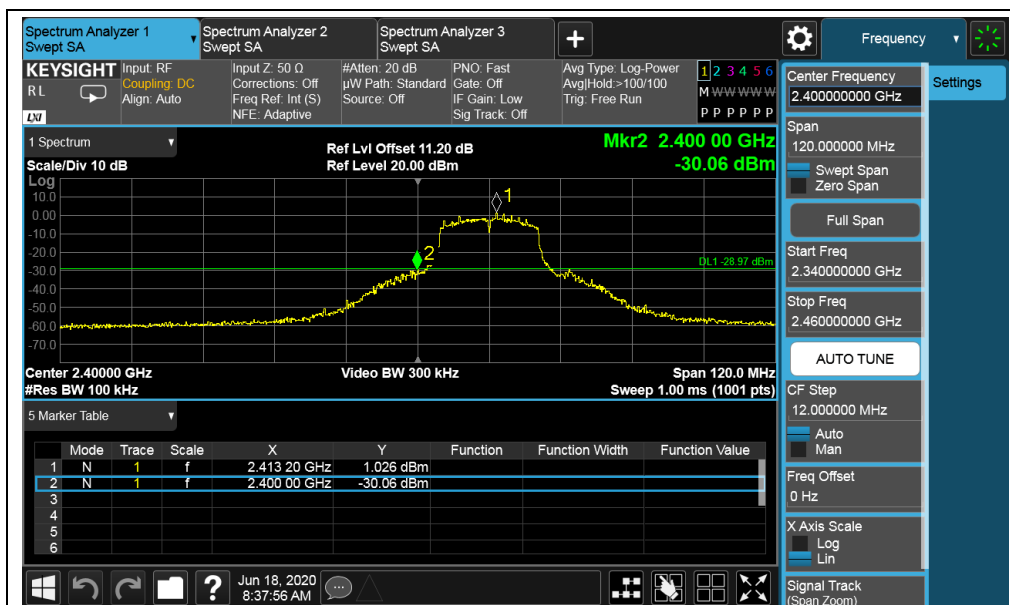
4.6.7 Test Results



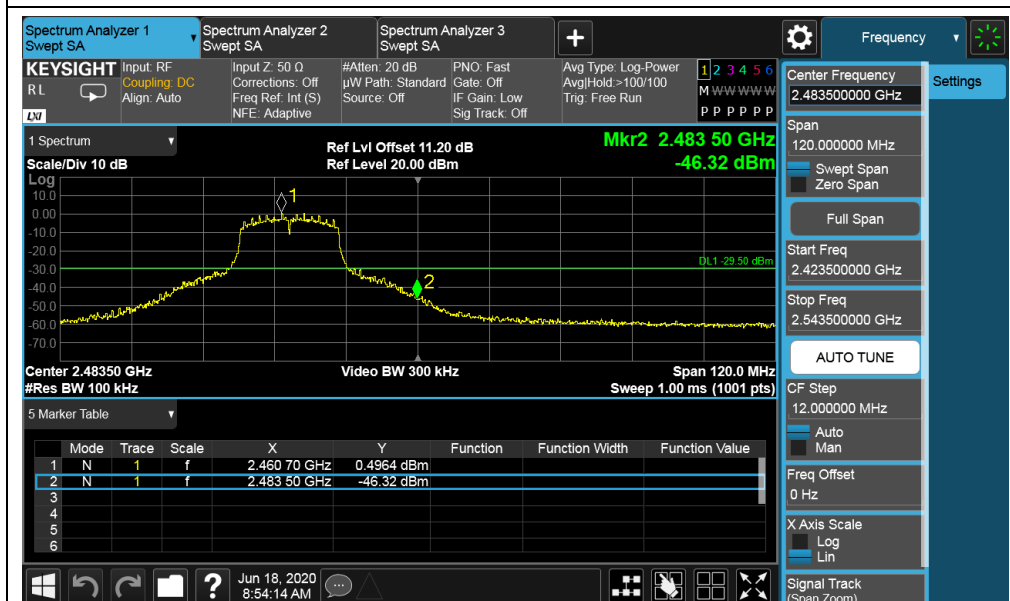
802.11b-2412MHz



802.11b-2462MHz



802.11g-2412MHz



802.11g-2462MHz

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:

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Sunnyvale OTA/Bluetooth Lab

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Littleton EMC/RF/Safety/Environmental Lab

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Web Site: www.cpsusa-bureauveritas.com

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

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