



TEST REPORT

Applicant Name : Grandstream Networks, Inc.
Address : 126 Brookline Ave, 3rd Floor Boston, MA 02215, USA
Manufacturer Name : Grandstream Networks, Inc.
Address : 126 Brookline Ave, 3rd Floor Boston, MA 02215, USA
Report Number : SZNS210408-55720E-RFA
FCC ID: YZZGWN7660LR
IC 11964A-GWN7660LR

Test Standard (s)

FCC PART 15.247; RSS-GEN ISSUE 5, FEBRUARY 2021 AMENDMENT 2; RSS-247, ISSUE 2, FEBRUARY 2017

Sample Description

Product Type: Outdoor Long-Range Wi-Fi 6 Access Point
Model No.: GWN7660LR
Trade Mark: GRANDSTREAM
Date Received: 2021/04/08
Date of Test: 2021/05/11-2021/11/15
Report Date: 2021/11/15

Test Result:	Pass*
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* In the configuration tested, the EUT complied with the standards above.

Prepared and Checked By:

Ting Lü
EMC Engineer

Approved By:

Candy Li
EMC Engineer

Note: This report may contain data that are not covered by the A2LA accreditation and are marked with an asterisk "★".

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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Product	Outdoor Long-Range Wi-Fi 6 Access Point
Tested Model	GWN7660LR
HVIN	GWN7660LR
Frequency Range	Wi-Fi: 2412-2462MHz
Mode	802.11b/g/n20/n40/ax20/ax40
Maximum Conducted Peak Output Power	802.11b: 23.5dBm, 802.11g: 25.2dBm, 802.11n20: 24.2dBm, 802.11n40: 22.8dBm, 802.11ax20: 25.1dBm, 802.11ax40: 23.9dBm
Modulation Technique	Wi-Fi: DSSS, OFDM, OFDMA
Antenna Specification*	3.5dBi (It is provided by the applicant)
Voltage Range	DC 48V from POE
Sample serial number	SZNS210408-55720E-RF-S1(Assigned by ATC)
Sample/EUT Status	Good condition

Objective

This report is in accordance with Part 2-Subpart J, Part 15-Subparts A and C of the Federal Communication Commission's rules and RSS-GEN issue 5, February 2021 amendment 2 and RSS-247, Issue 2, February 2017 of the Innovation, Science and Economic Development Canada rules.

Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices and RSS-GEN issue 5, February 2021 amendment 2 and RSS-247, Issue 2, February 2017.

And KDB 558074 D01 15.247 Meas Guidance v05r02.

All emissions measurement was performed at Shenzhen Accurate Technology Co., Ltd. The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

Measurement Uncertainty

Parameter		Uncertainty
Occupied Channel Bandwidth		5%
RF output power, conducted		0.73dB
Unwanted Emission, conducted		1.6dB
AC Power Lines Conducted Emissions		2.72dB
Emissions, Radiated	30MHz - 1GHz	4.28dB
	1GHz - 18GHz	4.98dB
	18GHz - 26.5GHz	5.06dB
Temperature		1°C
Humidity		6%
Supply voltages		0.4%

Note: The extended uncertainty given in this report is obtained by combining the standard uncertainty times the coverage factor K with the 95% confidence interval. Otherwise required by the applicant or Product Regulations, Decision Rule in this report did not consider the uncertainty.

Test Facility

The test site used by Shenzhen Accurate Technology Co., Ltd. to collect test data is located on the 1/F., Building A, Changyuan New Material Port, Science & Industry Park, Nanshan District, Shenzhen, Guangdong, P.R. China.

The test site has been approved by the FCC under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database, FCC Registration No.: 708358, the FCC Designation No.: CN1189. Accredited by American Association for Laboratory Accreditation (A2LA) The Certificate Number is 429 7.01.

Listed by Innovation, Science and Economic Development Canada (ISED), the Registration Number is 5077A.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

The device supports Beamforming and Non-beamforming modes. The two modes have same output power, which is declared by manufacturer, so the worst case requirements for beamforming mode was recorded.

Channel List

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

For 802.11b, 802.11g, 802.11n-HT20, 802.11ax20 mode, EUT was tested with Channel 1, 6 and 11.

For 802.11n-HT40, 802.11ax40 mode, EUT was tested with Channel 3, 6 and 9.

Equipment Modifications

No modification was made to the EUT tested.

EUT Exercise Software

“QRCT 4”^{*} was use to the EUT tested. The software and power level was provided by the applicant.

The device was tested with the worst case was performed as below:

Mode	Data rate	Power level*		
		Low channel	Middle channel	High channel
802.11b	1 Mbps	21	21	21
802.11g	6 Mbps	20	20	20
802.11n20	MCS0	20	20	20
802.11n40	MCS0	20	20	20
802.11ax20	MCS0	20	20	20
802.11ax40	MCS0	20	20	20

The worse-case data rates are determined to be as above for each mode based upon investigations by measuring the output power and PSD across all data rates, bandwidths and modulations. The device supports SISO and MIMO in all modes, per pretest, the MIMO mode was the worst mode for all the modes. All the antenna ports have the same power level for SISO and MIMO modes.

Support Equipment List and Details

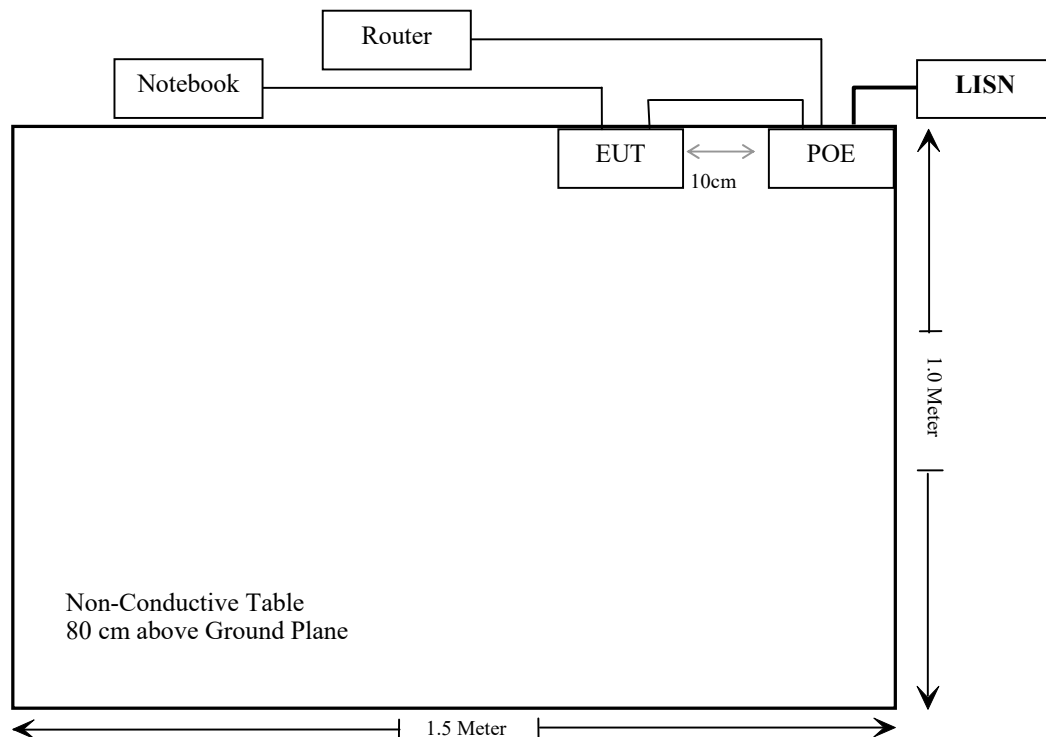
Manufacturer	Description	Model	Serial Number
GOSPELL	POE	G0720-480-050	G0720-480-050
DELL	Notebook	Latitude E6410	11429208685
HIKVISION	Router	DS-3WR03-E	10021642429

External I/O Cable

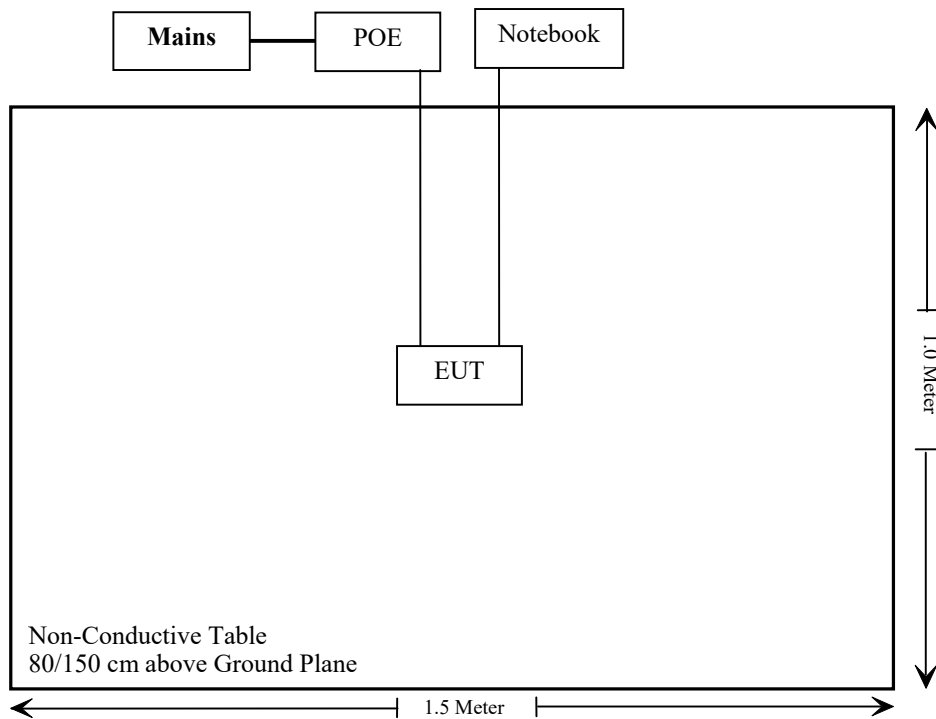
Cable Description	Length (m)	From Port	To
Un-shielded Un-detachable AC Cable	1.2	LISN	POE
Un-shielded detachable RJ45 Cable	1.5	POE	EUT
Un-shielded detachable RJ45 Cable	2.0	POE	Router
Un-Shielding Detachable RJ45 Cable	3.1	EUT	Notebook

Block Diagram of Test Setup

For conducted emission:



For radiated emission:



SUMMARY OF TEST RESULTS

FCC Rules	RSS-247 & RSS-Gen Rules	Description of Test	Result
§15.247 (i), §2.1091	RSS-102 § 4	Maximum Permissible Exposure(MPE) & RF Exposure Limit	Compliance
§15.203	RSS-Gen §6.8	Antenna Requirement	Compliance
§15.207 (a)	RSS-Gen §8.8	AC Line Conducted Emissions	Compliance
§15.205, §15.209, §15.247(d)	RSS-GEN § 8.10 & RSS-247 § 5.5	Spurious Emissions	Compliance
§15.247 (a)(2)	RSS- Gen§6.7 RSS-247 § 5.2 (a)	99% Occupied Bandwidth & 6 dB Emission Bandwidth	Compliance
§15.247(b)(3)	RSS-247 § 5.4(d)	Maximum Conducted Output Power	Compliance
§15.247(d)	RSS-247 § 5.5	100 kHz Bandwidth of Frequency Band Edge	Compliance
§15.247(e)	RSS-247 § 5.2 (b)	Power Spectral Density	Compliance

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Conducted Emissions Test					
Rohde& Schwarz	Test Receiver	ESPI3	100396	2020/12/24	2021/12/23
R & S	L.I.S.N.	ENV216	101314	2020/12/25	2021/12/24
Anritsu Corp	50Ω Coaxial Switch	MP59B	6200506474	2020/12/25	2021/12/24
Unknown	RF Coaxial Cable	N-2m	No.2	2020/12/25	2021/12/24
Conducted Emissions Test Software: ES-K1 V1.71					
Radiated Emissions Test					
Rohde&Schwarz	Test Receiver	ESR	101817	2020/12/24	2021/12/23
Rohde & Schwarz	Spectrum Analyzer	FSV-40	101495	2020/12/24	2021/12/23
A.H. Systems, inc.	Preamplifier	PAM-0118P	531	2021/07/08	2022/07/07
SONOMA INSTRUMENT	Amplifier	310 N	186131	2020/12/25	2021/12/24
Schwarzbeck	HORN ANTENNA	BBHA9170	9170-359	2020/01/05	2023/01/04
Quinstar	Amplifier	QLW-18405536-J0	15964001002	2020/11/28	2021/11/27
Schwarzbeck	Bilog Antenna	VULB9163	9163-323	2020/01/04	2023/01/03
Schwarzbeck	Horn Antenna	BBHA9120D	9120D-1067	2020/01/05	2023/01/04
Unknown	RF Coaxial Cable	N-5m	No.3	2020/12/25	2021/12/24
Unknown	RF Coaxial Cable	N-5m	No.4	2020/12/25	2021/12/24
Unknown	RF Coaxial Cable	N-1m	No.5	2020/12/25	2021/12/24
Unknown	RF Coaxial Cable	N-1m	No.6	2020/12/25	2021/12/24
Radiated Emission Test Software: EZ EMC V 1.1.4.2					
RF Conducted Test					
Rohde&Schwarz	Spectrum Analyzer	FSV40	101495	2020/12/24	2021/12/23
Tonscend	RF Control Unit	JS0806-2	19G8060182	2020/07/06	2021/07/05

*** Statement of Traceability:** Shenzhen Accurate Technology Co., Ltd. attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

FCC §15.247 (i) & §2.1091- MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Applicable Standard

According to subpart 15.247 (i) and subpart 2.1091 systems operating under the provisions of this section shall be operated in a manner that ensures the public is not exposed to RF energy level in excess of the communication guidelines.

Limits for General Population/Uncontrolled Exposure

Limits for General Population/Uncontrolled Exposure				
Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Averaging Time (Minutes)
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*(180/f ²)	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	f/1500	30
1500-100,000	/	/	1.0	30

f = frequency in MHz

* = Plane-wave equivalent power density

Result

Calculated Formulary:

Predication of MPE limit at a given distance

$$S = \frac{PG}{4\pi R^2}$$

S = power density (in appropriate units, e.g. mW/cm²)

P = power input to the antenna (in appropriate units, e.g., mW).

G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain.

R = distance to the center of radiation of the antenna (appropriate units, e.g., cm)

For simultaneously transmit system, the calculated power density should comply with:

$$\sum_i \frac{S_i}{S_{Limit,i}} \leq 1$$

Frequency (MHz)	Antenna Gain		Tune up conducted power		Evaluation Distance (cm)	Power Density (mW/cm ²)	MPE Limit (mW/cm ²)
	(dBi)	(numeric)	(dBm)	(mW)			
2412-2462	6.5	4.47	25.5	354.81	20	0.315	1
5150-5250	6.5	4.47	20.5	112.20	20	0.100	1
5250-5350	6.5	4.47	20.5	112.20	20	0.100	1
5470-5725	6.5	4.47	20.5	112.20	20	0.100	1
5725-5850	6.5	4.47	20.5	112.20	20	0.100	1

Note: 1. The tune up conducted power was declared by the applicant.

2. The 2.4G Wi-Fi can transmit at the same time with the 5G Wi-Fi.

3. For the 2.4G Wi-Fi, as it can support the beam-forming function, so the directional antenna gain should add the $10\lg 2$, $3.5\text{dBi}+10\lg 2=6.5\text{dBi}$.

4. For the 5G Wi-Fi, as it can support the beam-forming function, so the directional antenna gain should add the $10\lg 2$, $3.5\text{dBi}+10\lg 2=6.5\text{dBi}$.

Simultaneous transmitting consideration (worst case):

The ratio= $\text{MPE}_{2.4\text{G Wi-Fi}}/\text{limit}+\text{MPE}_{5\text{G Wi-Fi}}/\text{limit}=0.315+0.100=0.415<1.0$, so simultaneous exposure is compliant.

To maintain compliance with the FCC's RF exposure guidelines, place the equipment at least 20cm from nearby persons.

Result: Compliant.

RSS-102 § 4 – EXPOSURE LIMITS

Applicable Standard

According to RSS-102 §4:

Table 4: RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)				
Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m ²)	Reference Period (minutes)
0.003-10 ²¹	83	90	-	Instantaneous*
0.1-10	-	0.73/ f	-	6**
1.1-10	87/ f ^{0.5}	-	-	6**
10-20	27.46	0.0728	2	6
20-48	58.07/ f ^{0.25}	0.1540/ f ^{0.25}	8.944/ f ^{0.5}	6
48-300	22.06	0.05852	1.291	6
300-6000	3.142 f ^{0.3417}	0.008335 f ^{0.3417}	0.02619 f ^{0.6834}	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	616000/ f ^{1.2}
150000-300000	0.158 f ^{0.5}	4.21 x 10 ⁻⁴ f ^{0.5}	6.67 x 10 ⁻⁵ f	616000/f ^{1.2}

Note: f is frequency in MHz.
 * Based on nerve stimulation (NS).
 ** Based on specific absorption rate (SAR).

Calculated Formulary:

Predication of MPE limit at a given distance

$$S = \frac{PG}{4\pi R^2}$$

S = power density (in appropriate units, e.g. mW/cm²)

P = power input to the antenna (in appropriate units, e.g., mW).

G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain.

R = distance to the center of radiation of the antenna (appropriate units, e.g., cm)

For simultaneously transmit system, the calculated power density should comply with:

$$\sum_i \frac{S_i}{S_{Limit,i}} \leq 1$$

Frequency (MHz)	Antenna Gain		Turn up Power		Evaluation Distance (m)	Power Density (W/m ²)	MPE Limit (W/m ²)
	(dBi)	(numeric)	(dBm)	(W)			
2412-2462	6.5	4.47	25.5	0.355	0.2	3.15	5.37
5150-5250	6.5	4.47	15.5	0.035	0.2	0.32	9.01
5250-5350	6.5	4.47	20.5	0.112	0.2	1.00	9.13
5470-5725	6.5	4.47	20.0	0.100	0.2	0.89	9.39
5725-5850	6.5	4.47	21.0	0.126	0.2	1.12	9.69

- Note: 1. The tune up conducted power was declared by the applicant.
 2. The 2.4G Wi-Fi can transmit at the same time with the 5G Wi-Fi.
 3. For the 2.4G Wi-Fi, as it can support the beam-forming function, so the directional antenna gain should add the $10\lg 2$, $3.5\text{dBi} + 10\lg 2 = 6.5\text{dBi}$.
 4. For the 5G Wi-Fi, as it can support the beam-forming function, so the directional antenna gain should add the $10\lg 2$, $3.5\text{dBi} + 10\lg 2 = 6.5\text{dBi}$.

Simultaneous transmitting consideration (worst case):

The ratio = $\text{MPE}_{2.4\text{G Wi-Fi}}/\text{limit} + \text{MPE}_{5\text{G Wi-Fi}}/\text{limit} = 3.15/5.37 + 1.12/9.69 = 0.71 < 1.0$, so simultaneous exposure is compliant.

To maintain compliance with the ISED's RF exposure guidelines, place the equipment at least 20cm from nearby persons.

Result: Compliant.

§15.203 & RSS-Gen §6.8 ANTENNA REQUIREMENT

Applicable Standard

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. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the user of a standard antenna jack or electrical connector is prohibited. The structure and application of the EUT were analyzed to determine compliance with section §15.203 of the rules. §15.203 state that the subject device must meet the following criteria:

- a. Antenna must be permanently attached to the unit.
- b. Antenna must use a unique type of connector to attach to the EUT.

Unit must be professionally installed, and installer shall be responsible for verifying that the correct antenna is employed with the unit.

And according to FCC 47 CFR section 15.247 (b), if the transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

The applicant for equipment certification shall provide a list of all antenna types that may be used with the transmitter, where applicable (i.e. for transmitters with detachable antenna), indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna. The test report shall demonstrate the compliance of the transmitter with the limit for maximum equivalent isotropically radiated power (e.i.r.p.) specified in the applicable RSS, when the transmitter is equipped with any antenna type, selected from this list.

For expediting the testing, measurements may be performed using only the antenna with highest gain of each combination of transmitter and antenna type, with the transmitter output power set at the maximum level. However, the transmitter shall comply with the applicable requirements under all operational conditions and when in combination with any type of antenna from the list provided in the test report (and in the notice to be included in the user manual, provided below).

When measurements at the antenna port are used to determine the RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna's manufacturer.

The test report shall state the RF power, output power setting and spurious emission measurements with each antenna type that is used with the transmitter being tested.

For licence-exempt equipment with detachable antennas, the user manual shall also contain the following notice in a conspicuous location:

This radio transmitter [enter the device's ISED certification number] has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

Immediately following the above notice, the manufacturer shall provide a list of all antenna types which can be used with the transmitter, indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna type.

Antenna Connector Construction

The EUT has two external antennas arrangement for 2.4G Wi-Fi and 5G Wi-Fi, which were used unique type of connector to attach to the EUT. Please refer to the EUT photos.

Type	Antenna Gain	Impedance	Frequency Range
Dipole	3.5dBi	50 Ω	2412-2462MHz/5150-5850MHz

Result: Compliant.

§ 15.207 (a) & RSS-GEN §8.8 AC LINE CONDUCTED EMISSIONS

Applicable Standard

FCC§15.207 (a), RSS-Gen § 8.8

Unless stated otherwise in the applicable RSS, for radio apparatus that are designed to be connected to the public utility AC power network, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the range 150 kHz to 30 MHz shall not exceed the limits in table 4, as measured using a 50 μ H / 50 Ω line impedance stabilization network. This requirement applies for the radio frequency voltage measured between each power line and the ground terminal of each AC power-line mains cable of the EUT.

For an EUT that connects to the AC power lines indirectly, through another device, the requirement for compliance with the limits in table 4 shall apply at the terminals of the AC power-line mains cable of a representative support device, while it provides power to the EUT. The lower limit applies at the boundary between the frequency ranges. The device used to power the EUT shall be representative of typical applications.

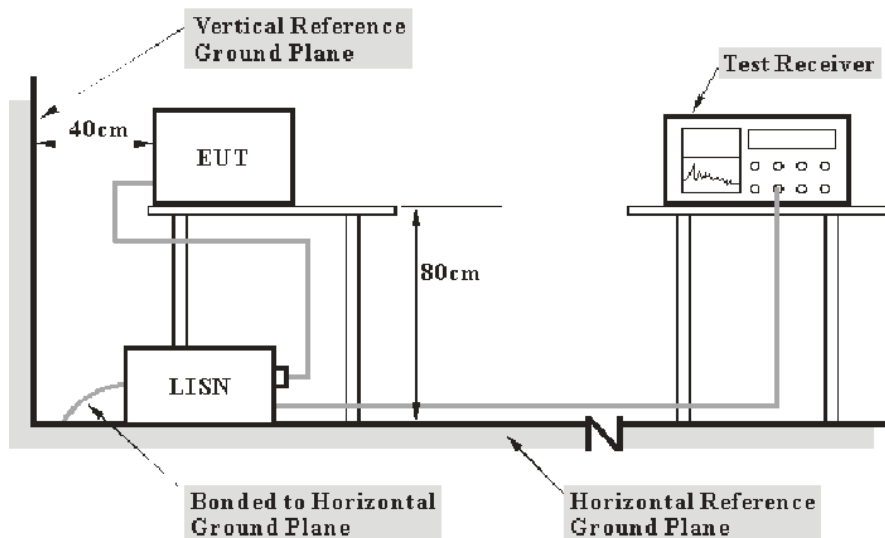
Table 4 - AC Power Lines Conducted Emission Limits		
Frequency range (MHz)	Conducted limit (dB μ V)	
	Quasi-Peak	Average
0.15 – 0.5	66 to 56 ¹	56 to 46 ¹
0.5 – 5	56	46
5 – 30	60	50

Note 1: The level decreases linearly with the logarithm of the frequency.

For an EUT with a permanent or detachable antenna operating between 150 kHz and 30 MHz, the AC power-line conducted emissions must be measured using the following configurations:

- Perform the AC power-line conducted emissions test with the antenna connected to determine compliance with the limits of table 4 outside the transmitter's fundamental emission band.
- Retest with a dummy load instead of the antenna to determine compliance with the limits of table 4 within the transmitter's fundamental emission band. For a detachable antenna, remove the antenna and connect a suitable dummy load to the antenna connector. For a permanent antenna, remove the antenna and terminate the RF output with a dummy load or network that simulates the antenna in the fundamental frequency band.

EUT Setup



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

The setup of EUT is according with per ANSI C63.10-2013 measurement procedure. The specification used was with the FCC Part 15.207 & RSS-247/RSS-Gen limits.

The spacing between the peripherals was 10 cm.

The external I/O cables were draped along the test table and formed a bundle 30 to 40 cm long in the middle.

EMI Test Receiver Setup

The EMI test receiver was set to investigate the spectrum from 150 kHz to 30 MHz.

During the conducted emission test, the EMI test receiver was set with the following configurations:

Frequency Range	IF B/W
150 kHz – 30 MHz	9 kHz

Test Procedure

During the conducted emission test, the adapter was connected to the outlet of the LISN.

Maximizing procedure was performed on the six (6) highest emissions of the EUT.

All final data was recorded in the Quasi-peak and average detection mode.

Corrected Factor & Margin Calculation

The Corrected factor is calculated by adding LISN VDF (Voltage Division Factor), Cable Loss and Transient Limiter Attenuation. The basic equation is as follows:

$$\text{Correction Factor} = \text{LISN VDF} + \text{Cable Loss} + \text{Transient Limiter Attenuation}$$

The “**Margin**” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of 7 dB means the emission is 7 dB below the limit. The equation for margin calculation is as follows:

$$\text{Margin} = \text{Limit} - \text{Level}$$

$$\text{Level} = \text{Reading level} + \text{Correction Factor}$$

Test Data

Environmental Conditions

Temperature:	25 °C
Relative Humidity:	65 %
ATM Pressure:	101.0 kPa

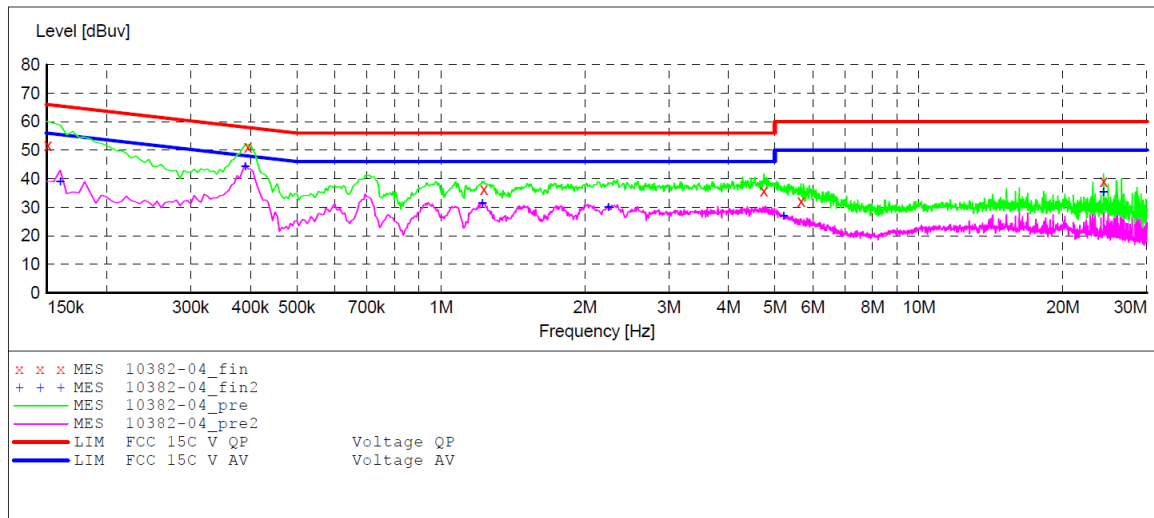
The testing was performed by Fan Yang on 2021-10-01.

EUT operation mode: Transmitting (worst case)

AC 120V/60 Hz, Line**SCAN TABLE: "V 150K-30MHz fin"**

Short Description: _SUB_STD_VTERM2 1.70

Start	Stop	Step	Detector	Meas.	IF	Transducer
Frequency	Frequency	Width		Time	Bandw.	
150.0 kHz	30.0 MHz	4.5 kHz	QuasiPeak	1.0 s	9 kHz	ENV216
Average						

**MEASUREMENT RESULT: "10382-04_fin"**

2021-10-1 01:44

Frequency MHz	Level dBuV	Transd dB	Limit dBuV	Margin dB	Detector	Line	PE
0.150000	51.70	10.8	66	14.3	QP	L1	GND
0.395000	51.00	11.0	58	7.0	QP	L1	GND
1.230000	36.30	11.2	56	19.7	QP	L1	GND
4.740000	35.90	11.4	56	20.1	QP	L1	GND
5.670000	32.30	11.5	60	27.7	QP	L1	GND
24.350000	39.00	11.7	60	21.0	QP	L1	GND

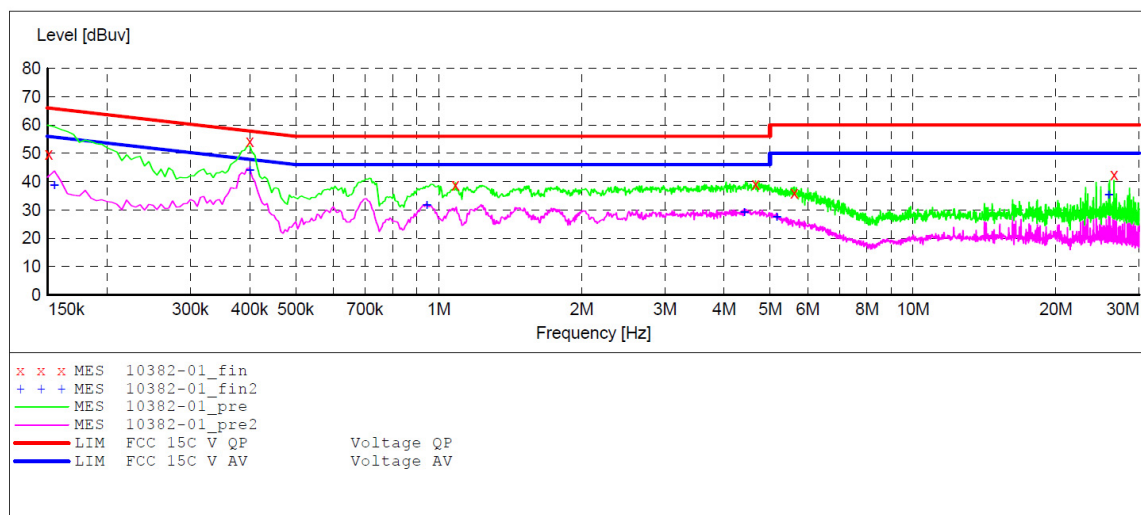
MEASUREMENT RESULT: "10382-04_fin2"

2021-10-1 01:44

Frequency MHz	Level dBuV	Transd dB	Limit dBuV	Margin dB	Detector	Line	PE
0.160000	38.30	10.8	56	16.7	AV	L1	GND
0.390000	44.00	11.0	48	4.0	AV	L1	GND
1.220000	31.20	11.2	46	14.8	AV	L1	GND
2.240000	30.00	11.3	46	16.0	AV	L1	GND
5.210000	26.90	11.4	50	23.1	AV	L1	GND
24.350000	35.30	11.7	50	14.7	AV	L1	GND

AC 120V/60 Hz, Neutral**SCAN TABLE: "V 150K-30MHz fin"**

Short Description: _SUB_STD_VTERM2 1.70
Start Stop Step Detector Meas. IF Transducer
Frequency Frequency Width Time Bandw.
150.0 kHz 30.0 MHz 4.5 kHz QuasiPeak 1.0 s 9 kHz ENV216
Average

**MEASUREMENT RESULT: "10382-01_fin"**

2021-10-1 01:39

Frequency MHz	Level dBuV	Transd dB	Limit dBuV	Margin dB	Detector	Line	PE
0.150000	48.80	10.8	66	17.2	QP	N	GND
0.400000	50.90	11.0	58	7.1	QP	N	GND
1.085000	35.50	11.1	56	20.5	QP	N	GND
4.660000	35.70	11.4	56	20.3	QP	N	GND
5.620000	32.80	11.5	60	27.2	QP	N	GND
26.550000	39.10	11.8	60	20.9	QP	N	GND

MEASUREMENT RESULT: "10382-01_fin2"

2021-10-1 01:39

Frequency MHz	Level dBuV	Transd dB	Limit dBuV	Margin dB	Detector	Line	PE
0.155000	38.90	10.8	56	17.1	AV	N	GND
0.400000	43.90	11.0	48	4.1	AV	N	GND
0.945000	31.70	11.1	46	14.3	AV	N	GND
4.410000	29.10	11.4	46	16.9	AV	N	GND
5.160000	27.30	11.4	50	22.7	AV	N	GND
25.875000	35.20	11.8	50	14.8	AV	N	GND

§15.205, §15.209, §15.247(d) & RSS-GEN § 8.10 & RSS-247 § 5.5 SPURIOUS EMISSIONS

Applicable Standard

FCC §15.247 (d); §15.209; §15.205;

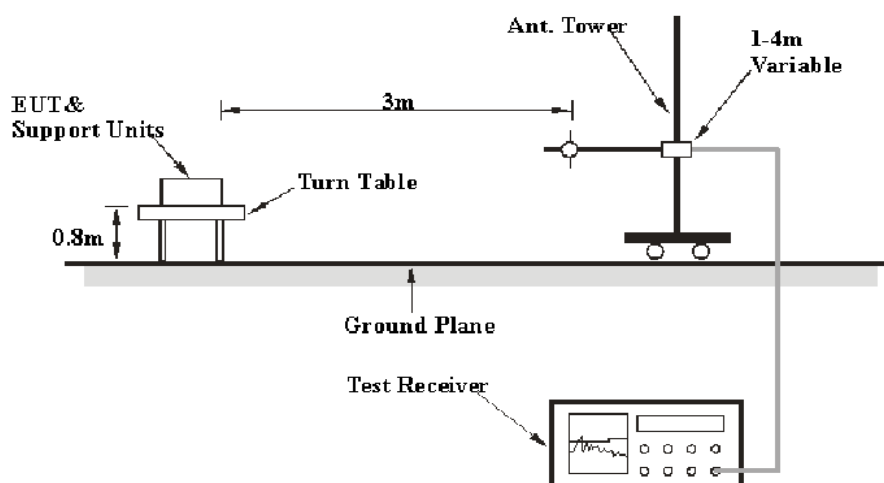
According to RSS-GEN § 8.10 & RSS-247 § 5.5

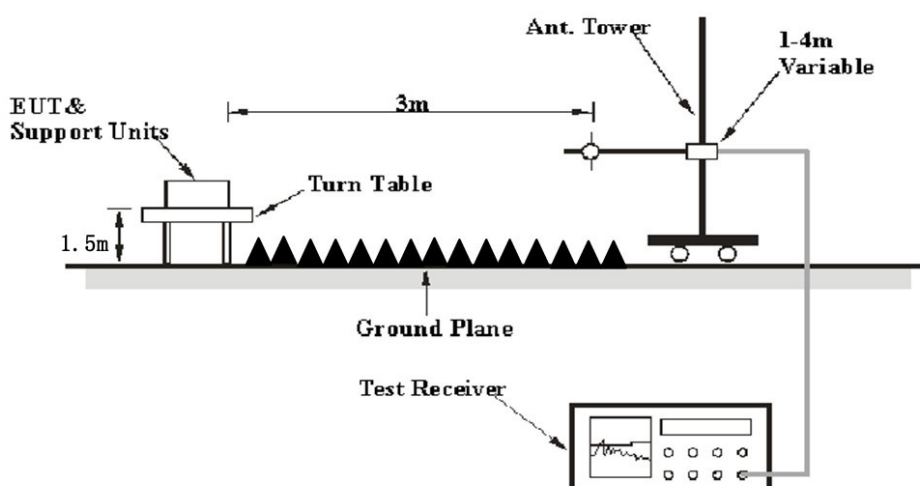
Restricted frequency bands, identified in table 7, are designated primarily for safety-of-life services (distress calling and certain aeronautical activities), certain satellite downlinks, radio astronomy and some government uses. Except where otherwise indicated, the following conditions related to the restricted frequency bands apply: (a) The transmit frequency, including fundamental components of modulation, of licence-exempt radio apparatus shall not fall within the restricted frequency bands listed in table 7 except for apparatus compliant with RSS-287, Emergency Position Indicating Radio Beacons (EPIRB), Emergency Locator Transmitters (ELT), Personal Locator Beacons (PLB), and Maritime Survivor Locator Devices (MSLD). (b) Unwanted emissions that fall into restricted frequency bands listed in table 7 shall comply with the limits specified in table 5 and table 6. (c) Unwanted emissions that do not fall within the restricted frequency bands listed in table 7 shall comply either with the limits specified in the applicable RSS or with those specified in table 5 and table 6.

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

EUT Setup

Below 1 GHz:



Above 1GHz:

The radiated emission tests were performed in the 3 meters test site, using the setup accordance with the ANSI C63.10-2013 & RSS-Gen. The specification used was the FCC 15.209, and FCC 15.247 & RSS-Gen limits.

The external I/O cables were draped along the test table and formed a bundle 30 to 40 cm long in the middle.

EMI Test Receiver & Spectrum Analyzer Setup

The system was investigated from 30 MHz to 25 GHz.

During the radiated emission test, the EMI test receiver & Spectrum Analyzer Setup were set with the following configurations:

Frequency Range	RBW	Video B/W	IF B/W	Measurement
30 MHz – 1000 MHz	100 kHz	300 kHz	120 kHz	QP
Above 1 GHz	1MHz	3 MHz	/	PK
	1MHz	10 Hz ^{Note 1}	/	Average
	1MHz	> 1/T ^{Note 2}	/	Average

Note 1: when duty cycle is no less than 98%

Note 2: when duty cycle is less than 98%

Test Procedure

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

Data was recorded in Quasi-peak detection mode for frequency range of 30 MHz-1 GHz, peak and Average detection modes for frequencies above 1 GHz.

Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.

Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.

Repeat above procedures until all measured frequencies were complete.

Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Factor and Cable Loss, and subtracting the Amplifier Gain from the Meter Reading. The basic equation is as follows:

$$\text{Corrected Amplitude} = \text{Meter Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Amplifier Gain}$$

The “**Margin**” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of -7dB means the emission is 7dB below the limit. The equation for margin calculation is as follows:

$$\text{Margin} = \text{Result} / \text{Corrected Amplitude} - \text{Limit}$$

Test Data

Environmental Conditions

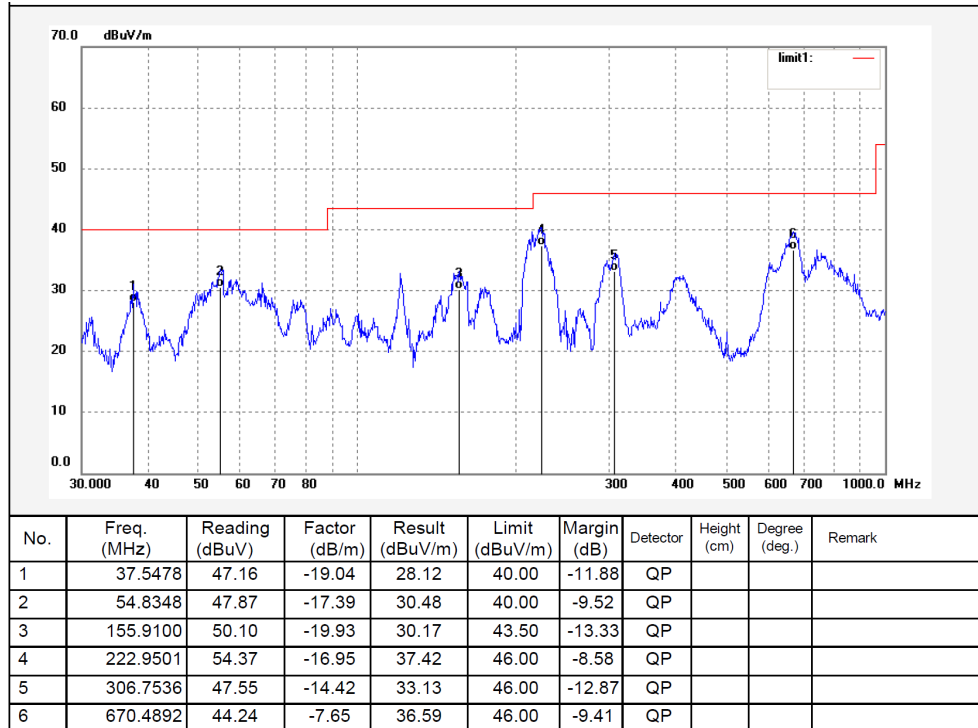
Temperature:	23~28.1°C
Relative Humidity:	44~48 %
ATM Pressure:	101.0~101.1 kPa

The testing was performed by Amy Cao on 2021-09-30 for below 1GHz and by Caro Hu on 2021-10-20 and 2021-10-23 for above 1GHz.

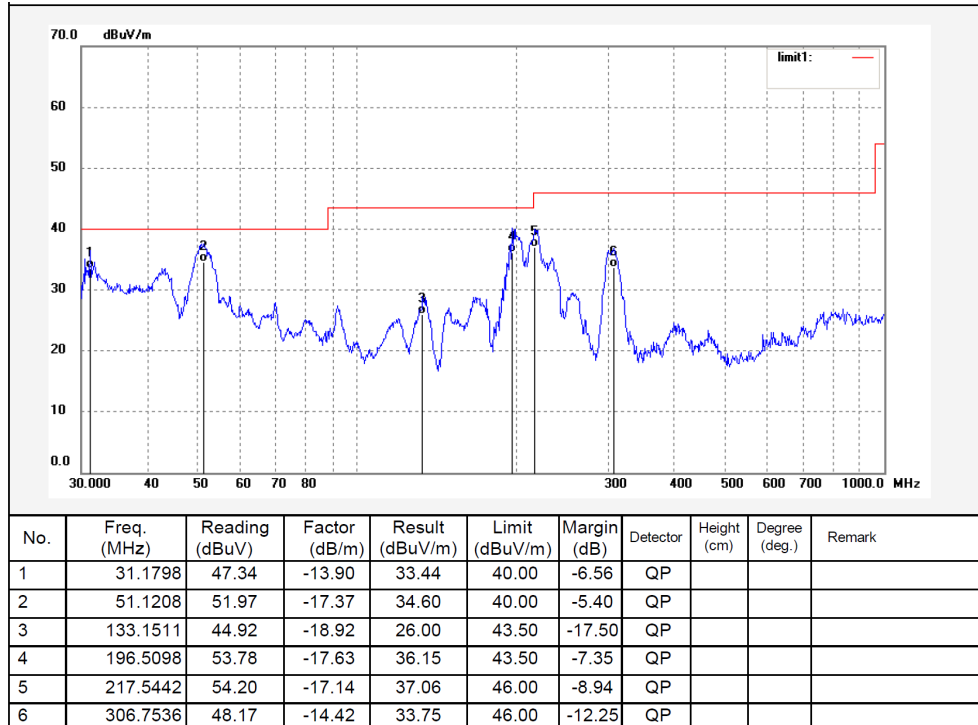
Test mode: Transmitting (Pre-scan in the X,Y and Z axes of orientation, the worst case Z-axis of orientation was recorded)

30 MHz~1 GHz: (worst case at 802.11g mode, low channel)

Horizontal



Vertical



1 GHz-25 GHz: (MIMO)

Frequency (MHz)	Receiver		Turn-Table	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	FCC Part 15.247 RSS-247	
	Reading (dBμV)	Detector (PK/QP/Ave.)	Angle Degree	Height (m)	Polar (H / V)			Limit (dBμV/m)	Margin (dB)
802.11b									
Low Channel(2412MHz)									
2310	68.42	PK	44	2.4	H	-6.84	61.58	74	-12.42
2310	54.12	Ave.	44	2.4	H	-6.84	47.28	54	-6.72
2310	68.20	PK	120	1.3	V	-6.84	61.36	74	-12.64
2310	53.22	Ave.	120	1.3	V	-6.84	46.38	54	-7.62
2390	75.84	PK	354	1.2	H	-6.44	69.40	74	-4.6
2390	54.27	Ave.	354	1.2	H	-6.44	47.83	54	-6.17
2390	75.33	PK	259	2.2	V	-6.44	68.89	74	-5.11
2390	53.38	Ave.	259	2.2	V	-6.44	46.94	54	-7.06
4824	47.69	PK	119	1.2	H	2.87	50.56	74	-23.44
4824	46.29	PK	97	1.2	V	2.87	49.16	74	-24.84
Middle Channel(2437MHz)									
4874	50.45	PK	26	2.2	H	3.01	53.46	74	-20.54
4874	48.32	PK	130	2.2	V	3.01	51.33	74	-22.67
High Channel(2462 MHz)									
2483.5	67.00	PK	115	2.4	H	-5.96	61.04	74	-12.96
2483.5	53.76	Ave.	115	2.4	H	-5.96	47.8	54	-6.2
2483.5	67.80	PK	310	1.7	V	-5.96	61.84	74	-12.16
2483.5	52.80	Ave.	310	1.7	V	-5.96	46.84	54	-7.16
2500	67.17	PK	295	1.9	H	-5.88	61.29	74	-12.71
2500	53.63	Ave.	295	1.9	H	-5.88	47.75	54	-6.25
2500	66.97	PK	310	1.7	V	-5.88	61.09	74	-12.91
2500	52.94	Ave.	310	1.7	V	-5.88	47.06	54	-6.94
4924	49.38	PK	236	1.7	H	3.17	52.55	74	-21.45
4924	48.52	PK	48	1.7	V	3.17	51.69	74	-22.31

Frequency (MHz)	Receiver		Turn-Table	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	FCC Part 15.247 RSS-247	
	Reading (dBμV)	Detector (PK/QP/Ave.)	Angle Degree	Height (m)	Polar (H / V)			Limit (dBμV/m)	Margin (dB)
802.11g									
Low Channel(2412MHz)									
2310	77.27	PK	333	1.3	H	-6.84	70.43	74	-3.57
2310	59.32	Ave.	333	1.3	H	-6.84	52.48	54	-1.52
2310	76.72	PK	293	2.1	V	-6.84	69.88	74	-4.12
2310	58.21	Ave.	293	2.1	V	-6.84	51.37	54	-2.63
2390	68.58	PK	320	2.4	H	-6.44	62.14	74	-11.86
2390	54.71	Ave.	320	2.4	H	-6.44	48.27	54	-5.73
2390	68.06	PK	292	2	V	-6.44	61.62	74	-12.38
2390	54.10	Ave.	292	2	V	-6.44	47.66	54	-6.34
4824	48.18	PK	333	2.4	H	2.87	51.05	74	-22.95
4824	47.31	PK	47	1.4	V	2.87	50.18	74	-23.82
Middle Channel(2437MHz)									
4874	48.71	PK	232	1.5	H	3.01	51.72	74	-22.28
4874	47.15	PK	184	1.5	V	3.01	50.16	74	-23.84
High Channel(2462 MHz)									
2483.5	66.82	PK	303	1.9	H	-5.96	60.86	74	-13.14
2483.5	53.33	Ave.	303	1.9	H	-5.96	47.37	54	-6.63
2483.5	65.80	PK	212	2	V	-5.96	59.84	74	-14.16
2483.5	52.90	Ave.	212	2	V	-5.96	46.94	54	-7.06
2500	73.12	PK	282	1.5	H	-5.88	67.24	74	-6.76
2500	56.73	Ave.	282	1.5	H	-5.88	50.85	54	-3.15
2500	71.94	PK	112	2.4	V	-5.88	66.06	74	-7.94
2500	55.20	Ave.	112	2.4	V	-5.88	49.32	54	-4.68
4924	48.22	PK	295	1.7	H	3.17	51.39	74	-22.61
4924	46.76	PK	138	1.7	V	3.17	49.93	74	-24.07

Frequency (MHz)	Receiver		Turn-Table	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	FCC Part 15.247 RSS-247	
	Reading (dBμV)	Detector (PK/QP/Ave.)	Angle Degree	Height (m)	Polar (H / V)			Limit (dBμV/m)	Margin (dB)
802.11n20									
Low Channel(2412MHz)									
2310	74.03	PK	114	1.7	H	-6.84	67.19	74	-6.81
2310	59.32	Ave.	114	1.7	H	-6.84	52.48	54	-1.52
2310	72.55	PK	290	2.1	V	-6.84	65.71	74	-8.29
2310	57.38	Ave.	290	2.1	V	-6.84	50.54	54	-3.46
2390	68.52	PK	123	1.8	H	-6.44	62.08	74	-11.92
2390	54.68	Ave.	123	1.8	H	-6.44	48.24	54	-5.76
2390	67.26	PK	275	2.5	V	-6.44	60.82	74	-13.18
2390	53.52	Ave.	275	2.5	V	-6.44	47.08	54	-6.92
4824	47.80	PK	223	1.3	H	2.87	50.67	74	-23.33
4824	46.22	PK	49	2	V	2.87	49.09	74	-24.91
Middle Channel(2437MHz)									
4874	48.72	PK	181	1	H	3.01	51.73	74	-22.27
4874	46.82	PK	59	1.2	V	3.01	49.83	74	-24.17
High Channel(2462 MHz)									
2483.5	66.74	PK	149	2.5	H	-5.96	60.78	74	-13.22
2483.5	53.60	Ave.	149	2.5	H	-5.96	47.64	54	-6.36
2483.5	64.99	PK	195	1.2	V	-5.96	59.03	74	-14.97
2483.5	52.90	Ave.	195	1.2	V	-5.96	46.94	54	-7.06
2500	75.56	PK	29	1.1	H	-5.88	69.68	74	-4.32
2500	58.92	Ave.	29	1.1	H	-5.88	53.04	54	-0.96
2500	73.91	PK	207	1.4	V	-5.88	68.03	74	-5.97
2500	57.24	Ave.	207	1.4	V	-5.88	51.36	54	-2.64
4924	48.38	PK	52	1.7	H	3.17	51.55	74	-22.45
4924	46.97	PK	236	1.7	V	3.17	50.14	74	-23.86

Frequency (MHz)	Receiver		Turn-Table	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBµV/m)	FCC Part 15.247 RSS-247	
	Reading (dBµV)	Detector (PK/QP/Ave.)	Angle Degree	Height (m)	Polar (H / V)			Limit (dBµV/m)	Margin (dB)
802.11n40									
Low Channel(2422MHz)									
2310	72.23	PK	215	1.8	H	-6.84	65.39	74	-8.61
2310	58.41	Ave.	215	1.8	H	-6.84	51.57	54	-2.43
2310	71.05	PK	193	1	V	-6.84	64.21	74	-9.79
2310	56.78	Ave.	193	1	V	-6.84	49.94	54	-4.06
2390	68.90	PK	121	1.1	H	-6.44	62.46	74	-11.54
2390	54.78	Ave.	121	1.1	H	-6.44	48.34	54	-5.66
2390	66.80	PK	205	1.6	V	-6.44	60.36	74	-13.64
2390	53.38	Ave.	205	1.6	V	-6.44	46.94	54	-7.06
4844	46.92	PK	86	1.9	H	2.92	49.84	74	-24.16
4844	44.95	PK	108	1.9	V	2.92	47.87	74	-26.13
Middle Channel(2437MHZ)									
4874	48.11	PK	108	1.4	H	3.01	51.12	74	-22.88
4874	47.17	PK	355	1.7	V	3.01	50.18	74	-23.82
High Channel(2452 MHz)									
2483.5	66.75	PK	232	2.4	H	-5.96	60.79	74	-13.21
2483.5	53.23	Ave.	232	2.4	H	-5.96	47.27	54	-6.73
2483.5	65.27	PK	7	2	V	-5.96	59.31	74	-14.69
2483.5	52.07	Ave.	7	2	V	-5.96	46.11	54	-7.89
2500	72.21	PK	56	1.1	H	-5.88	66.33	74	-7.67
2500	58.77	Ave.	56	1.1	H	-5.88	52.89	54	-1.11
2500	71.21	PK	164	1.1	V	-5.88	65.33	74	-8.67
2500	56.82	Ave.	164	1.1	V	-5.88	50.94	54	-3.06
4904	47.74	PK	129	1.7	H	3.11	50.85	74	-23.15
4904	45.97	PK	206	1.7	V	3.11	49.08	74	-24.92

Frequency (MHz)	Receiver		Turn-Table	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	FCC Part 15.247 RSS-247	
	Reading (dBμV)	Detector (PK/QP/Ave.)	Angle Degree	Height (m)	Polar (H / V)			Limit (dBμV/m)	Margin (dB)
802.11AX 20									
Low Channel(2412MHz)									
2310	70.03	PK	192	2.3	H	-6.84	63.19	74	-10.81
2310	56.94	Ave.	192	2.3	H	-6.84	50.10	54	-3.9
2310	68.53	PK	302	1.6	V	-6.84	61.69	74	-12.31
2310	55.78	Ave.	302	1.6	V	-6.84	48.94	54	-5.06
2390	68.31	PK	208	1.5	H	-6.44	61.87	74	-12.13
2390	54.53	Ave.	208	1.5	H	-6.44	48.09	54	-5.91
2390	65.77	PK	245	1.4	V	-6.44	59.33	74	-14.67
2390	54.05	Ave.	245	1.4	V	-6.44	47.61	54	-6.39
4824	47.81	PK	313	1.9	H	2.87	50.68	74	-23.32
4824	46.03	PK	62	2.5	V	2.87	48.90	74	-25.1
Middle Channel(2437MHz)									
4874	48.54	PK	320	1.5	H	3.01	51.55	74	-22.45
4874	46.81	PK	75	1.5	V	3.01	49.82	74	-24.18
High Channel(2462 MHz)									
2483.5	66.67	PK	23	2	H	-5.96	60.71	74	-13.29
2483.5	52.97	Ave.	23	2	H	-5.96	47.01	54	-6.99
2483.5	64.92	PK	281	2.2	V	-5.96	58.96	74	-15.04
2483.5	52.00	Ave.	281	2.2	V	-5.96	46.04	54	-7.96
2500	70.74	PK	322	1.4	H	-5.88	64.86	74	-9.14
2500	56.96	Ave.	322	1.4	H	-5.88	51.08	54	-2.92
2500	69.27	PK	144	1.9	V	-5.88	63.39	74	-10.61
2500	56.20	Ave.	144	1.9	V	-5.88	50.32	54	-3.68
4924	47.64	PK	335	1.7	H	3.17	50.81	74	-23.19
4924	45.67	PK	38	1.7	V	3.17	48.84	74	-25.16

Frequency (MHz)	Receiver		Turn- Table	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	FCC Part 15.247 RSS-247	
	Reading (dBμV)	Detector (PK/QP/Ave.)	Angle Degree	Height (m)	Polar (H / V)			Limit (dBμV/m)	Margin (dB)
802.11AX40									
Low Channel(2422MHz)									
2310	71.07	PK	140	1.2	H	-6.84	64.23	74	-9.77
2310	58.62	Ave.	140	1.2	H	-6.84	51.78	54	-2.22
2310	69.50	PK	127	2.4	V	-6.84	62.66	74	-11.34
2310	57.17	Ave.	127	2.4	V	-6.84	50.33	54	-3.67
2390	68.51	PK	178	1.5	H	-6.44	62.07	74	-11.93
2390	54.68	Ave.	178	1.5	H	-6.44	48.24	54	-5.76
2390	67.58	PK	63	1.2	V	-6.44	61.14	74	-12.86
2390	54.05	Ave.	63	1.2	V	-6.44	47.61	54	-6.39
4844	47.79	PK	85	2.2	H	2.92	50.71	74	-23.29
4844	46.00	PK	161	2.2	V	2.92	48.92	74	-25.08
Middle Channel(2442MHZ)									
4874	48.12	PK	22	2	H	3.01	51.13	74	-22.87
4874	47.12	PK	22	2.1	V	3.01	50.13	74	-23.87
High Channel(2452 MHz)									
2483.5	66.81	PK	91	2.2	H	-5.96	60.85	74	-13.15
2483.5	53.39	Ave.	91	2.2	H	-5.96	47.43	54	-6.57
2483.5	65.29	PK	150	1.6	V	-5.96	59.33	74	-14.67
2483.5	52.37	Ave.	150	1.6	V	-5.96	46.41	54	-7.59
2500	69.98	PK	326	2.3	H	-5.88	64.1	74	-9.9
2500	58.80	Ave.	326	2.3	H	-5.88	52.92	54	-1.08
2500	68.39	PK	37	2.3	V	-5.88	62.51	74	-11.49
2500	56.74	Ave.	37	2.3	V	-5.88	50.86	54	-3.14
4904	47.74	PK	174	1.7	H	3.11	50.85	74	-23.15
4904	46.27	PK	346	1.7	V	3.11	49.38	74	-24.62

2.4G Wi-Fi (802.11b mode, 2437MHz) & 5G Wi-Fi (802.11ac20 mode, 5500MHz) Simultaneously Transmission:

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/QP/Ave.		Height (m)	Polar (H/V)				
670.49	44.24	QP	330	2.2	H	-7.65	36.59	46	-9.41
53.25	47.34	QP	135	2.2	V	-13.90	33.44	40	-6.56
4874	50.45	PK	26	2.2	H	3.01	53.46	74	-20.54
4874	48.32	PK	130	2.2	V	3.01	51.33	74	-22.67
11000	37.73	PK	69	1.3	H	16.30	54.03	74	-19.97
11000	30.10	AV	69	1.3	H	16.30	46.40	54	-7.6
11000	36.07	PK	305	1.8	V	16.30	52.37	74	-21.63

Note:

Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor

Absolute Level (Corrected Amplitude) = Factor + Reading

Margin = Absolute Level (Corrected Amplitude) – Limit

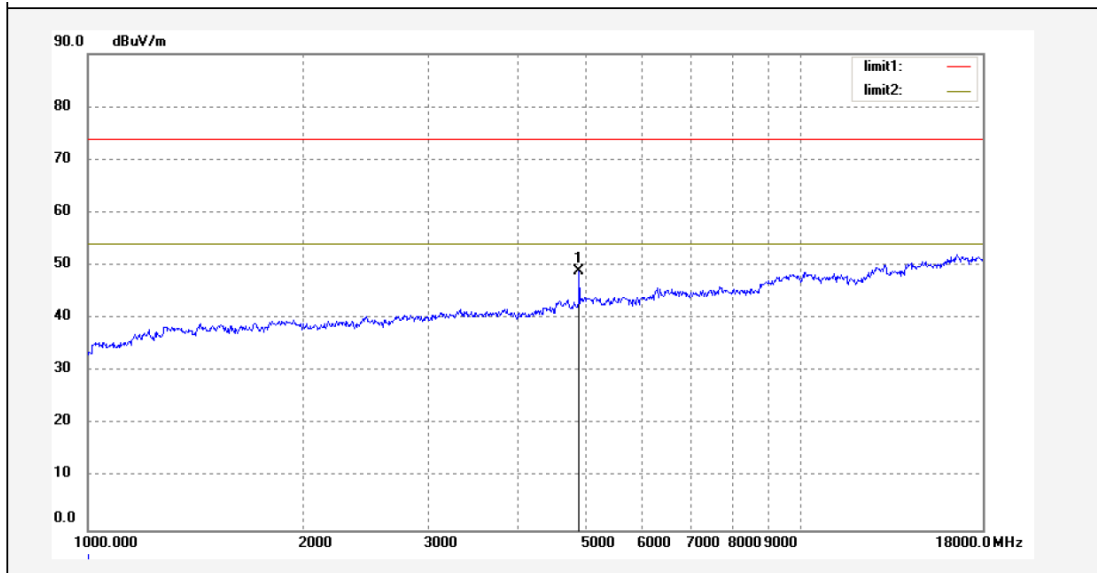
The other spurious emission which is 20dB below to the limit or in the noise floor was not recorded.

The test result of peak was less than the limit of average, so just peak values were recorded.

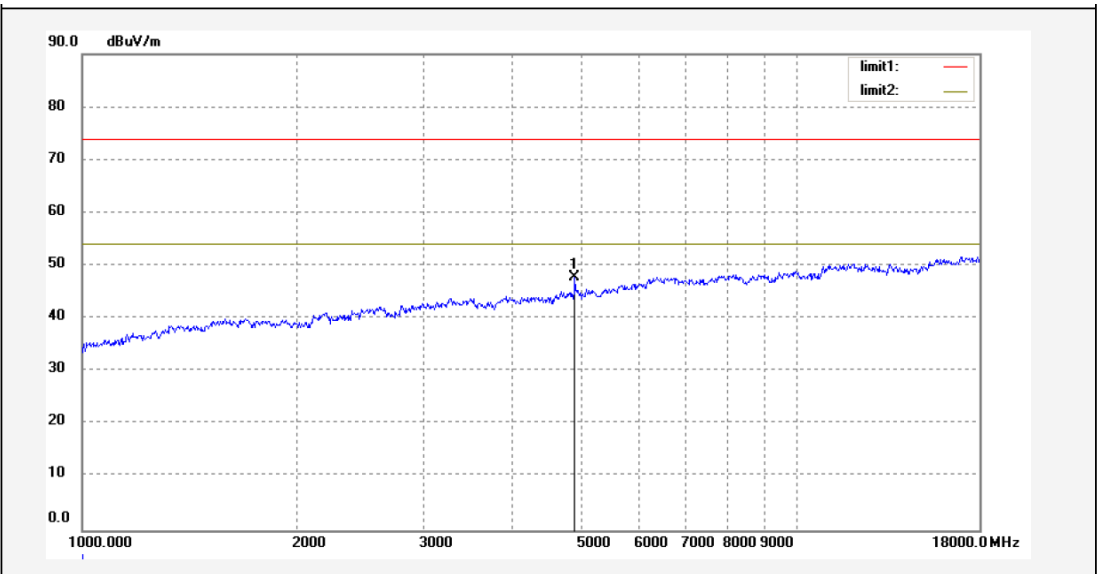
1-18 GHz:

Pre-scan Plots:

802.11 b Middle Channel
Horizontal



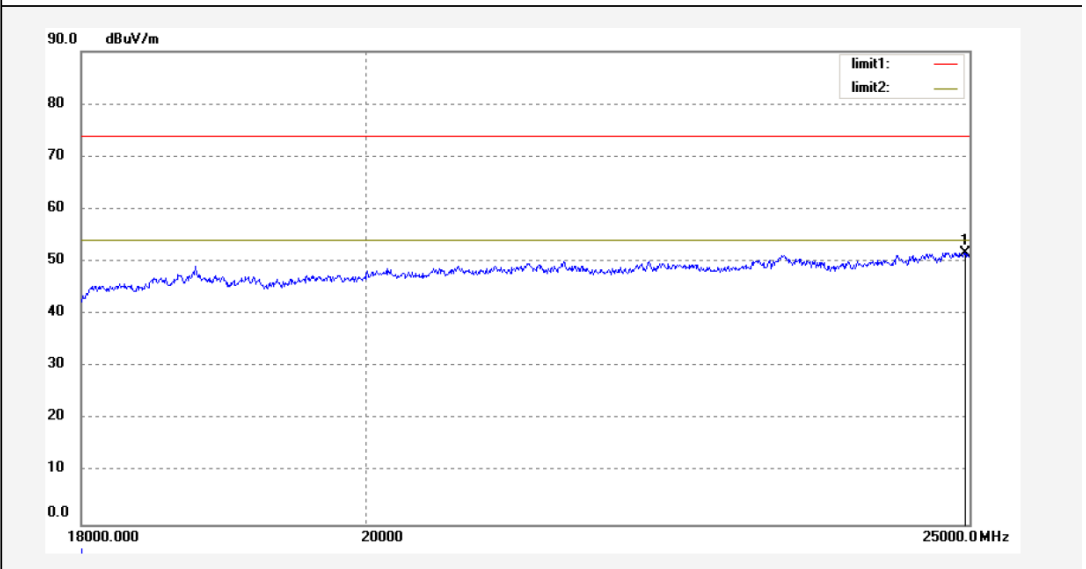
Vertical



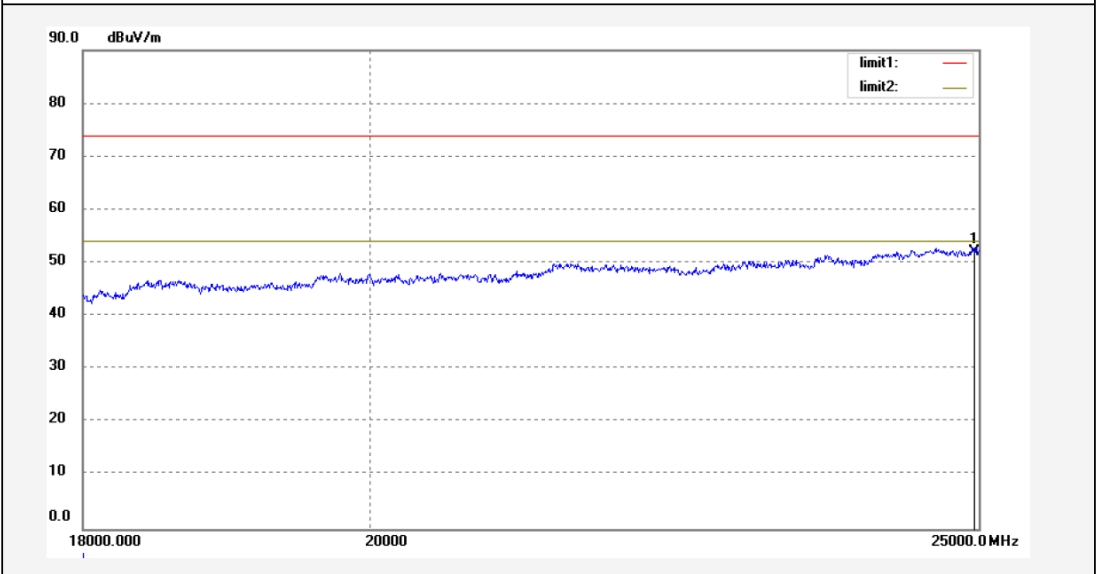
18 -25GHz:

Pre-scan Plots:

802.11 b Low Channel
Horizontal



Vertical



§15.247 (a)(2) & RSS-Gen§6.7 RSS-247 § 5.2 (a) 99% OCCUPIED BANDWIDTH & 6 dB EMISSION BANDWIDTH

Applicable Standard

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

The occupied bandwidth or the “99% emission bandwidth” is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

In some cases, the “6 dB bandwidth” is required, which is defined as the frequency range between two points, one at the lowest frequency below and one at the highest frequency above the carrier frequency, at which the maximum power level of the transmitted emission is attenuated 6 dB below the maximum in-band power level of the modulated signal, where the two points are on the outskirts of the in-band emission.

Test Procedure

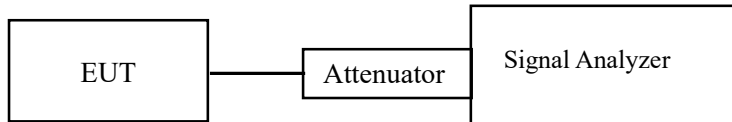
1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
3. Measure the frequency difference of two frequencies that were attenuated 6 dB from the reference level. Record the frequency difference as the emission bandwidth.
4. Repeat above procedures until all frequencies measured were complete.

The following conditions shall be observed for measuring the occupied bandwidth and 6 dB bandwidth:

- The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
- The span of the spectrum analyzer shall be set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span.
- The detector of the spectrum analyzer shall be set to “Sample”. However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or “Max Hold”) may be necessary to determine the occupied / 6 dB bandwidth if the device is not transmitting continuously.
- The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / 6 dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value. Video averaging is not permitted.

Note: It may be necessary to repeat the measurement a few times until the RBW and VBW are in compliance with the above requirement.

For the 99% emission bandwidth, the trace data points are recovered and directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached, and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded. The difference between the two recorded frequencies is the occupied bandwidth (or the 99% emission bandwidth).



Test Data

Environmental Conditions

Temperature:	27 °C
Relative Humidity:	57 %
ATM Pressure:	101.0 kPa

The testing was performed by Paul Liu on 2021-05-11.

EUT operation mode: Transmitting

Test Result: Pass

Please refer to the Appendix.

§15.247(b)(3) & RSS-247 § 5.4(d) MAXIMUM CONDUCTED OUTPUT POWER

Applicable Standard

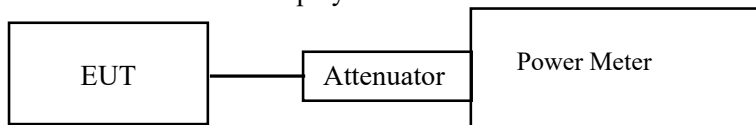
According to FCC §15.247(b) (3), for systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

For DTSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1 W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).

As an alternative to a peak power measurement, compliance can be based on a measurement of the maximum conducted output power. The maximum conducted output power is the total transmit power delivered to all antennas and antenna elements, averaged across all symbols in the signalling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or transmitting at a reduced power level. If multiple modes of operation are implemented, the maximum conducted output power is the highest total transmit power occurring in any mode.

Test Procedure

1. Place the EUT on a bench and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to one test equipment.
3. Add a correction factor to the display.



Test Data**Environmental Conditions**

Temperature:	27 °C
Relative Humidity:	57 %
ATM Pressure:	101.0 kPa

The testing was performed by Paul Liu on 2021-05-11.

EUT operation mode: Transmitting

Test Result: Pass

Please refer to the Appendix.

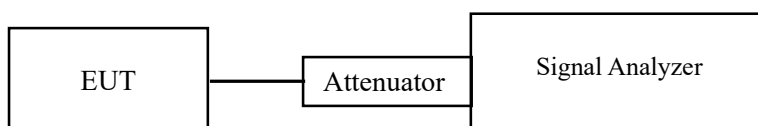
§ 15.247(d) & RSS-247 § 5.5 100 kHz BANDWIDTH OF FREQUENCY BAND EDGE

Applicable Standard

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW to 100 kHz and VBW of spectrum analyzer to 300 kHz with a convenient frequency span including 100 kHz bandwidth from band edge.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.



Test Data

Environmental Conditions

Temperature:	27 °C
Relative Humidity:	57 %
ATM Pressure:	101.0 kPa

The testing was performed by Paul Liu on 2021-05-11.

EUT operation mode: Transmitting (Worst case for Antenna 1 was recorded)

Test Result: Pass

Please refer to the Appendix.

§15.247(e) & RSS-247 § 5.2 (b) POWER SPECTRAL DENSITY

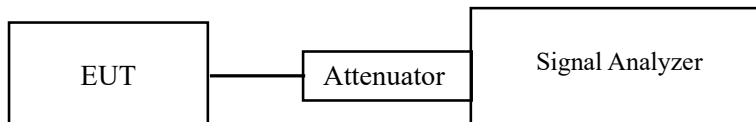
Applicable Standard

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

The transmitter power spectral density conducted from the transmitter 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 section 5.4(d), (i.e. the power spectral density shall be determined using the same method as is used to determine the conducted output power).

Test Procedure

1. Use this procedure when the maximum peak conducted output power in the fundamental emission is used to demonstrate compliance.
2. Set the RBW to: $3\text{kHz} \leq \text{RBW} \leq 100\text{ kHz}$.
3. Set the VBW $\geq 3 \times \text{RBW}$.
4. Set the span to 1.5 times the DTS bandwidth.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level within the RBW.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.



Test Data

Environmental Conditions

Temperature:	27 °C
Relative Humidity:	57 %
ATM Pressure:	101.0 kPa

The testing was performed by Paul Liu on 2021-05-11.

EUT operation mode: Transmitting

Test Result: Pass

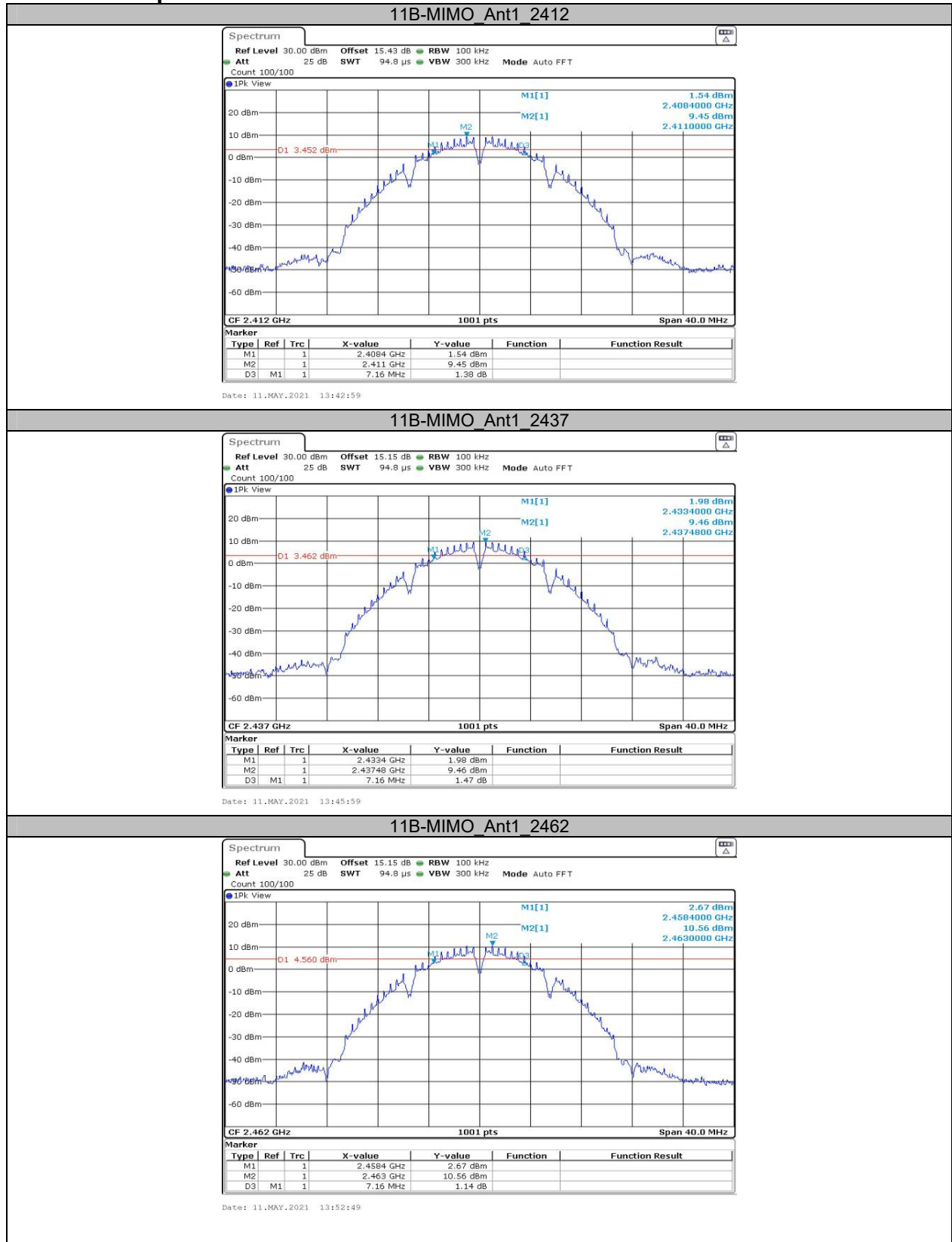
Please refer to the Appendix.

APPENDIX

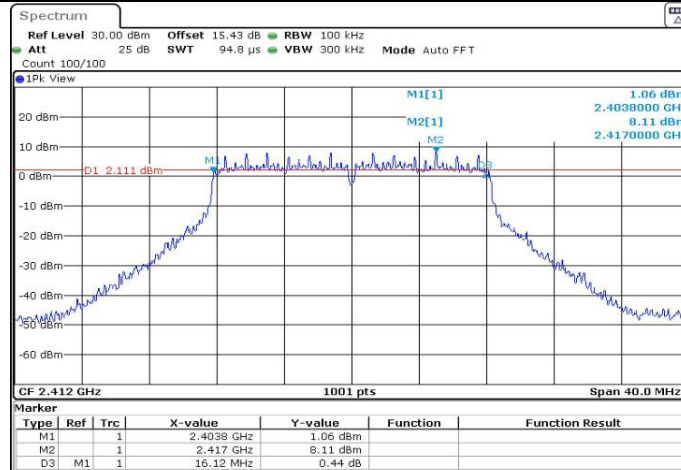
Appendix A: DTS Bandwidth Test Result

TestMode	Antenna	Channel	DTS BW [MHz]	Limit[MHz]	Verdict
11B-MIMO	Ant1	2412	7.160	0.5	PASS
	Ant1	2437	7.160	0.5	PASS
	Ant1	2462	7.160	0.5	PASS
11G-MIMO	Ant1	2412	16.120	0.5	PASS
	Ant1	2437	15.960	0.5	PASS
	Ant1	2462	16.360	0.5	PASS
11N20MIMO	Ant1	2412	17.640	0.5	PASS
	Ant1	2437	17.000	0.5	PASS
	Ant1	2462	17.600	0.5	PASS
11N40MIMO	Ant1	2422	36.480	0.5	PASS
	Ant1	2437	35.280	0.5	PASS
	Ant1	2452	35.520	0.5	PASS
11AX20MIMO	Ant1	2412	18.200	0.5	PASS
	Ant1	2437	18.120	0.5	PASS
	Ant1	2462	18.080	0.5	PASS
11AX40MIMO	Ant1	2422	37.920	0.5	PASS
	Ant1	2437	37.520	0.5	PASS
	Ant1	2452	37.760	0.5	PASS

Test Graphs

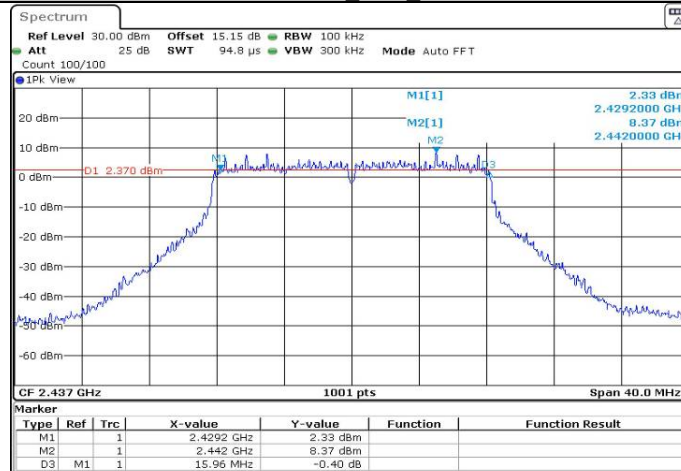


11G-MIMO_Ant1_2412



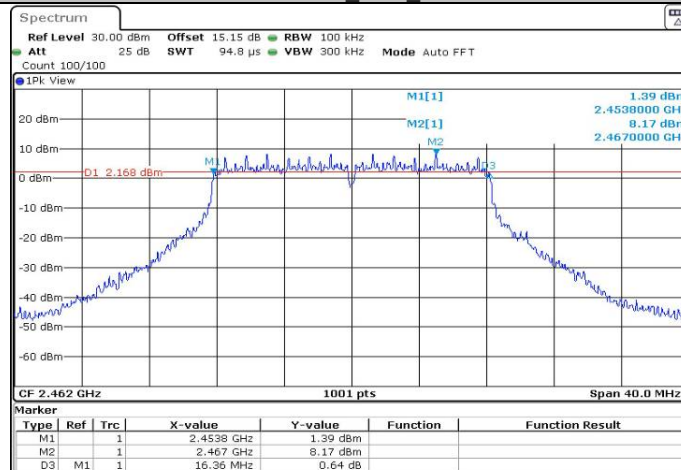
Date: 11.MAY.2021 13:55:24

11G-MIMO_Ant1_2437



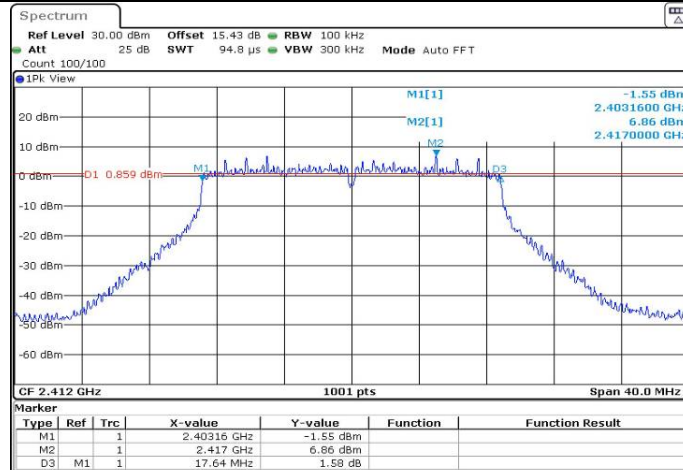
Date: 11.MAY.2021 14:03:51

11G-MIMO_Ant1_2462



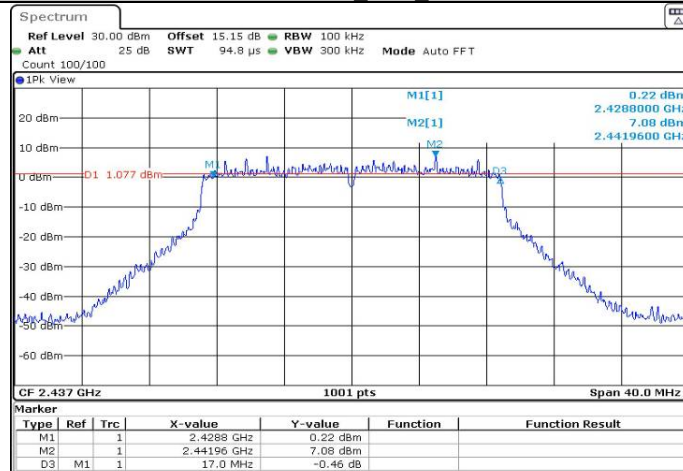
Date: 11.MAY.2021 14:05:47

11N20MIMO_Ant1_2412



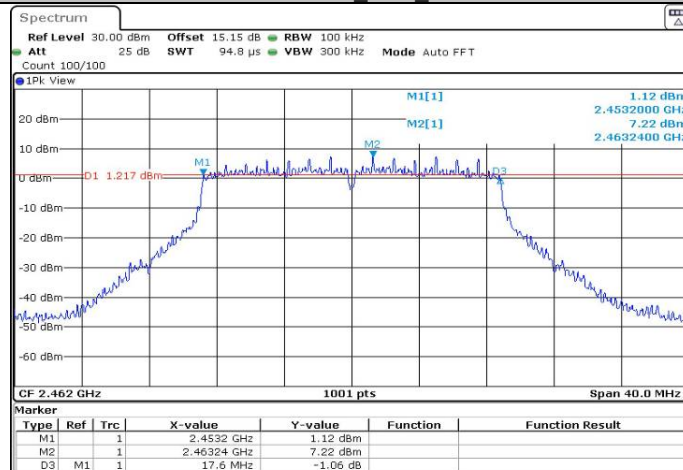
Date: 11.MAY.2021 14:09:28

11N20MIMO_Ant1_2437



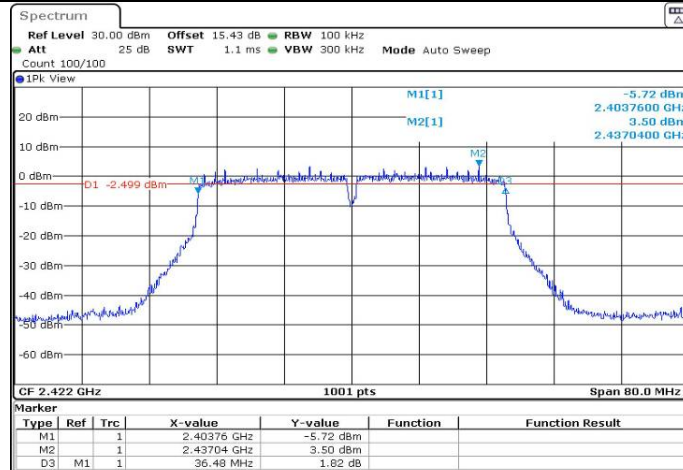
Date: 11.MAY.2021 14:14:23

11N20MIMO_Ant1_2462

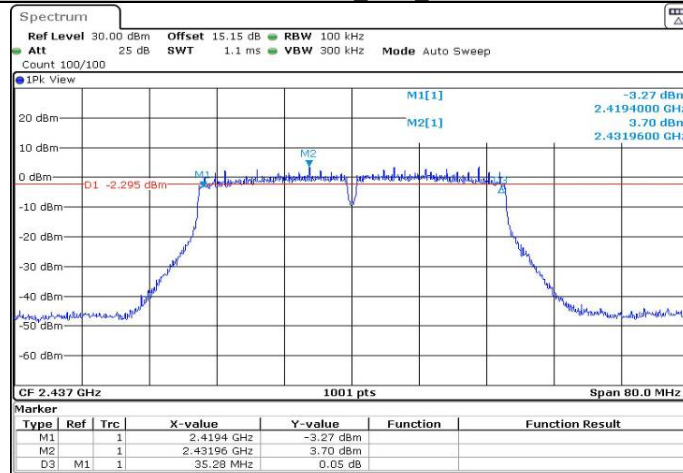


Date: 11.MAY.2021 14:16:05

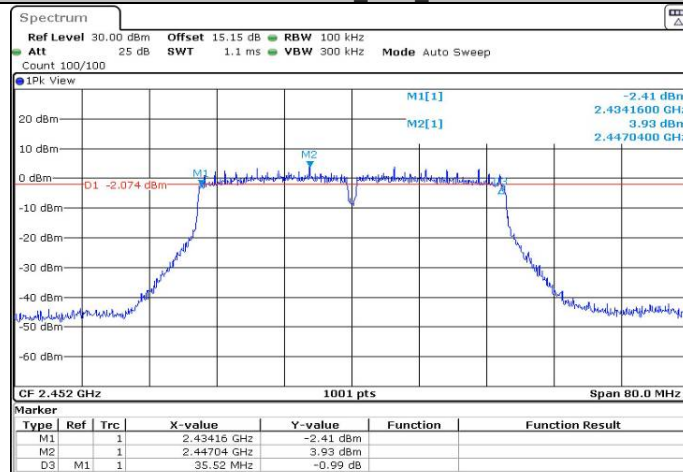
11N40MIMO_Ant1_2422



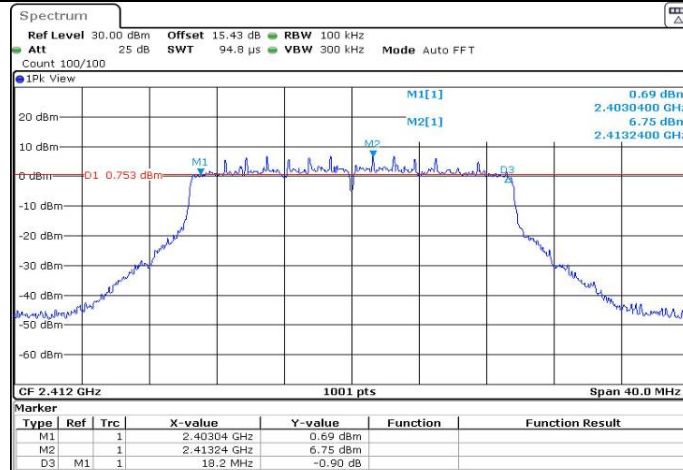
11N40MIMO_Ant1_2437



11N40MIMO_Ant1_2452

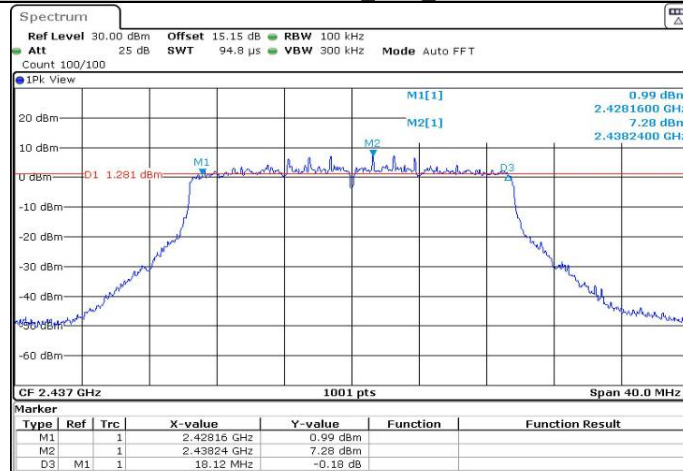


11AX20MIMO_Ant1_2412



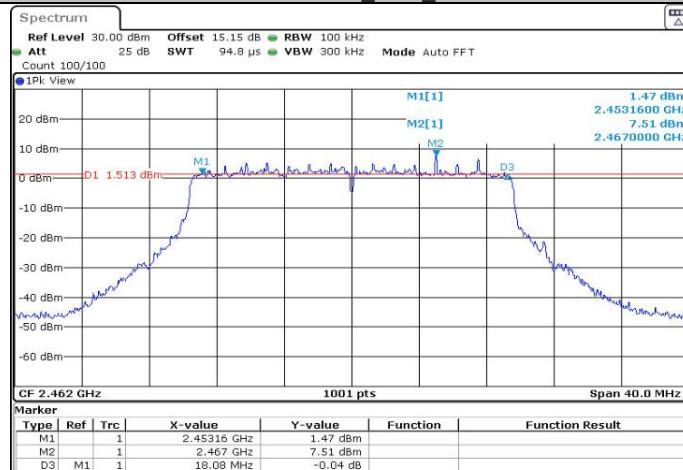
Date: 11.MAY.2021 14:24:47

11AX20MIMO_Ant1_2437



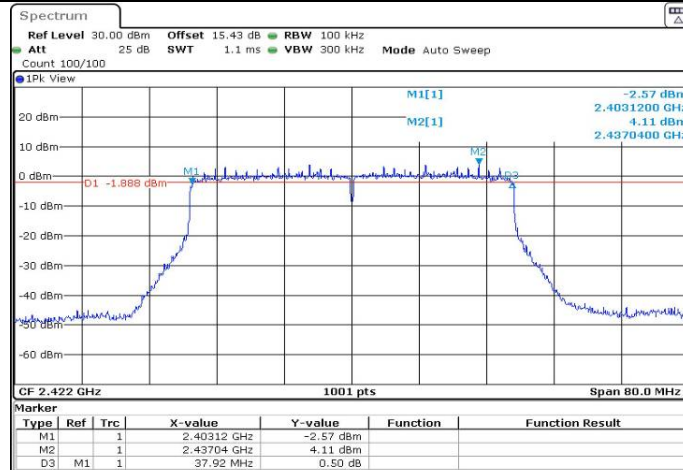
Date: 11.MAY.2021 14:26:53

11AX20MIMO_Ant1_2462



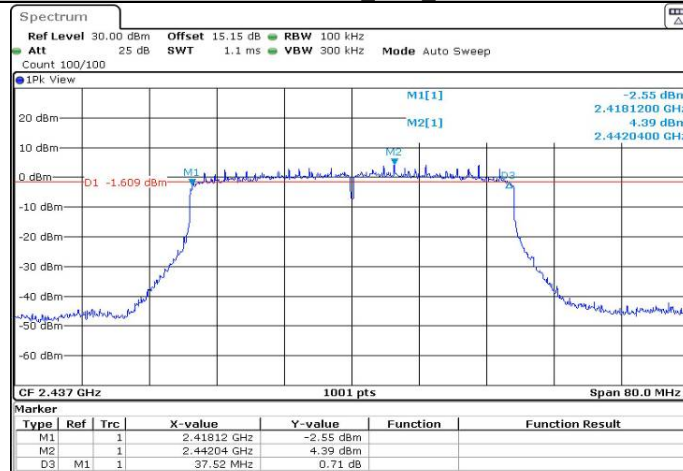
Date: 11.MAY.2021 14:28:33

11AX40MIMO_Ant1_2422



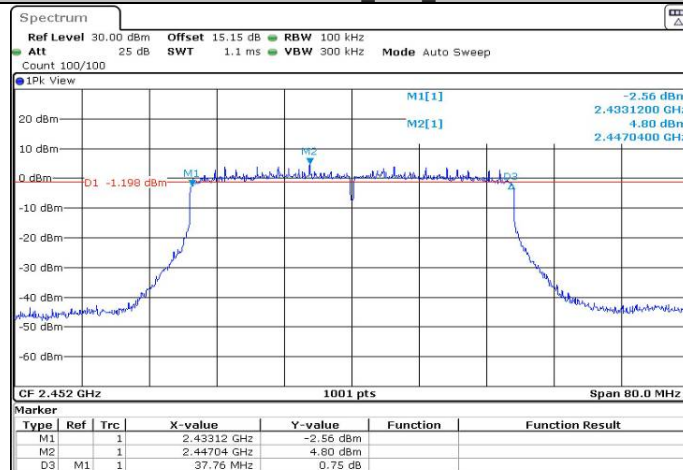
Date: 11.MAY.2021 14:30:27

11AX40MIMO_Ant1_2437



Date: 11.MAY.2021 14:32:51

11AX40MIMO_Ant1_2452

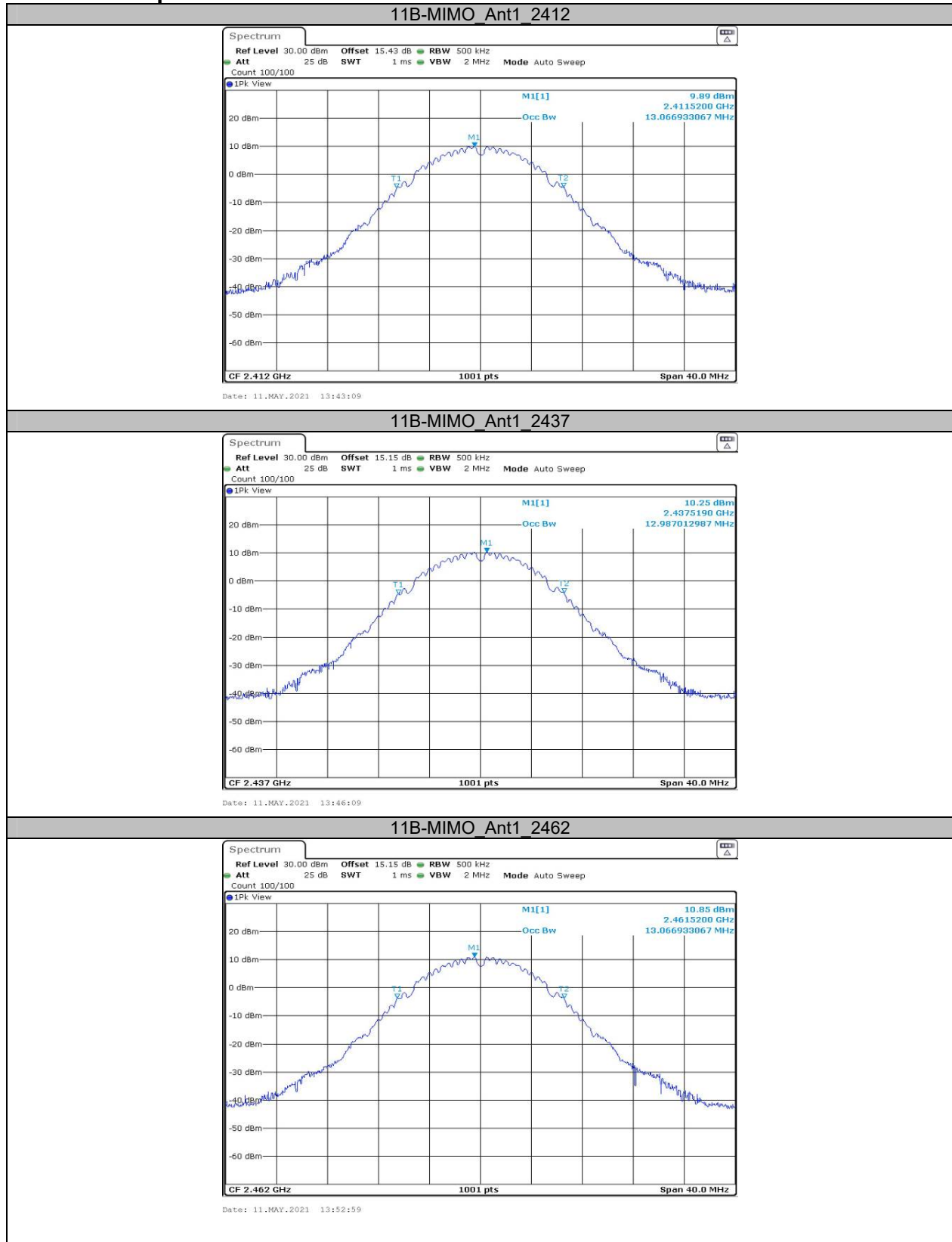


Date: 11.MAY.2021 14:34:33

Appendix B: Occupied Channel Bandwidth Test Result

TestMode	Antenna	Channel	OCB [MHz]	Limit[MHz]	Verdict
11B-MIMO	Ant1	2412	13.067	---	PASS
		2437	12.987	---	PASS
		2462	13.067	---	PASS
11G-MIMO	Ant1	2412	16.623	---	PASS
		2437	16.623	---	PASS
		2462	16.663	---	PASS
11N20MIMO	Ant1	2412	17.822	---	PASS
		2437	17.782	---	PASS
		2462	17.822	---	PASS
11N40MIMO	Ant1	2422	36.444	---	PASS
		2437	36.204	---	PASS
		2452	36.204	---	PASS
11AX20MIMO	Ant1	2412	19.021	---	PASS
		2437	18.981	---	PASS
		2462	18.981	---	PASS
11AX40MIMO	Ant1	2422	38.042	---	PASS
		2437	37.882	---	PASS
		2452	37.802	---	PASS

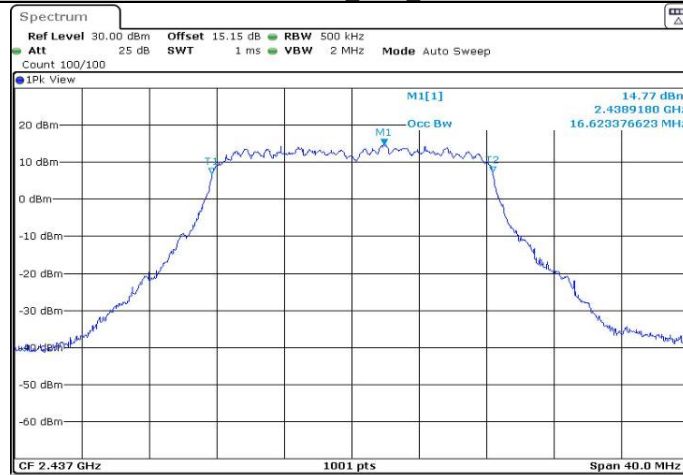
Test Graphs



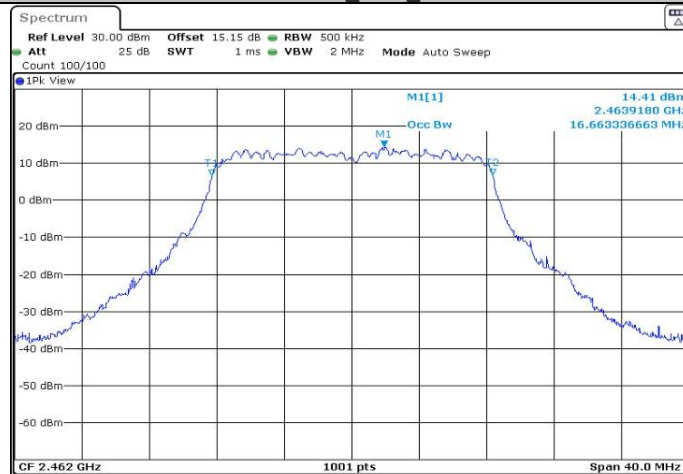
11G-MIMO_Ant1_2412



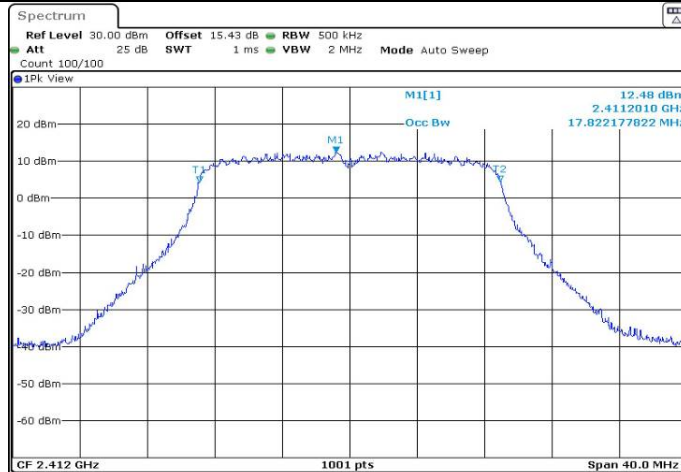
11G-MIMO_Ant1_2437



11G-MIMO_Ant1_2462

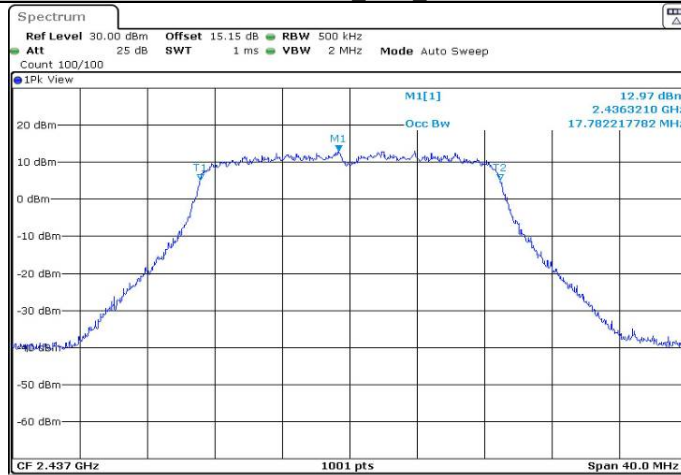


11N20MIMO_Ant1_2412



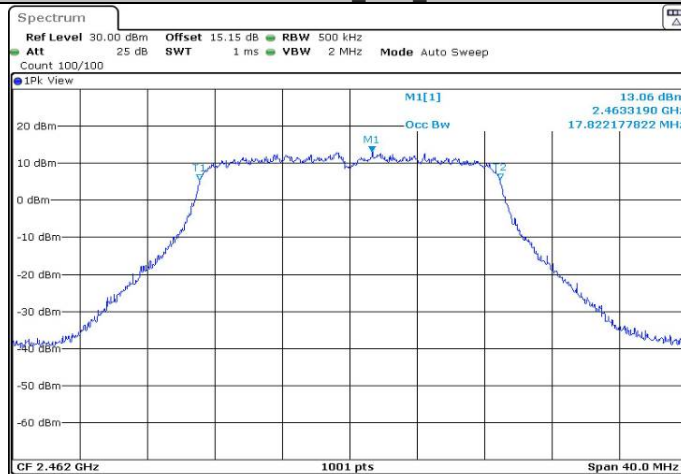
Date: 11.MAY.2021 14:09:38

11N20MIMO_Ant1_2437



Date: 11.MAY.2021 14:14:33

11N20MIMO_Ant1_2462



Date: 11.MAY.2021 14:16:15

11N40MIMO_Ant1_2422



11N40MIMO_Ant1_2437



11N40MIMO_Ant1_2452

