FCC PART 15.247

TEST REPORT

For

CAPTANA GMBH

Bundesstrasse 16, D-77955 Ettenheim, Germany

FCC ID: 2APO5-SHELFCAM

Report Type:	**Product Type:**
Original Report	Shelfcam

Report Number: RTZ201222003-00B

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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Product	Shelfcam
Tested Model	shelfEye
Multiple Model	shelfEye Pro
Model Differences	All the same except for pixels of the camera
Frequency Range	2412-2462MHz
Maximum Conducted Peak Output Power	18.21dBm(802.11b), 14.98dBm(802.11g), 15.02dBm(802.11n-HT20), 15.12dBm(802.11n-HT40)
Modulation Technique	DSSS, OFDM
Antenna Specification*	Internal Antenna: 2.23dBi(provided by the applicant)
Voltage Range	DC3.7V from battery or DC 5.0V from USB Port
Date of Test	2021-01-04 to 2021-02-02
Sample serial number	RTZ201222003-RF-S1(Assigned by ATC)
Received date	2020-12-22
Sample/EUT Status	Good condition

Objective

This test report is in accordance with Part 2-Subpart J, Part 15-Subparts A and C of the Federal Communication Commission's rules.

The tests were performed in order to determine compliance with FCC Part 15, Subpart C, and section 15.203, 15.205, 15.207, 15.209 and 15.247 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 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
AC Power Lines Conducted Emissions		±2.72dB
Emissions, Radiated	30MHz - 1GHz	±4.28dB
	1GHz- 18GHz	±4.98dB
	18GHz- 26.5GHz	±5.06dB

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 (ISEDC), the Registration Number is 5077A-2.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

For 802.11b, 802.11g, 802.11n-HT20 and 802.11n-HT40 mode, 11 channels are provided to testing:

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, 802.11n-HT40, EUT was tested with Channel 1, 6 and 11.
For 802.11n-HT40, EUT was tested with Channel 3, 6 and 9.

EUT Exercise Software

“AmebaPRO mptool 1v8” exercise software was used. 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	38	38	38
802.11g	6 Mbps	38	38	38
802.11n-HT20	MCS0	36	36	36
802.11n-HT40	MCS0	36	36	36

Duty cycle

Test Result: Compliant. Please refer to the Appendix Wi-Fi.

Support Equipment List and Details

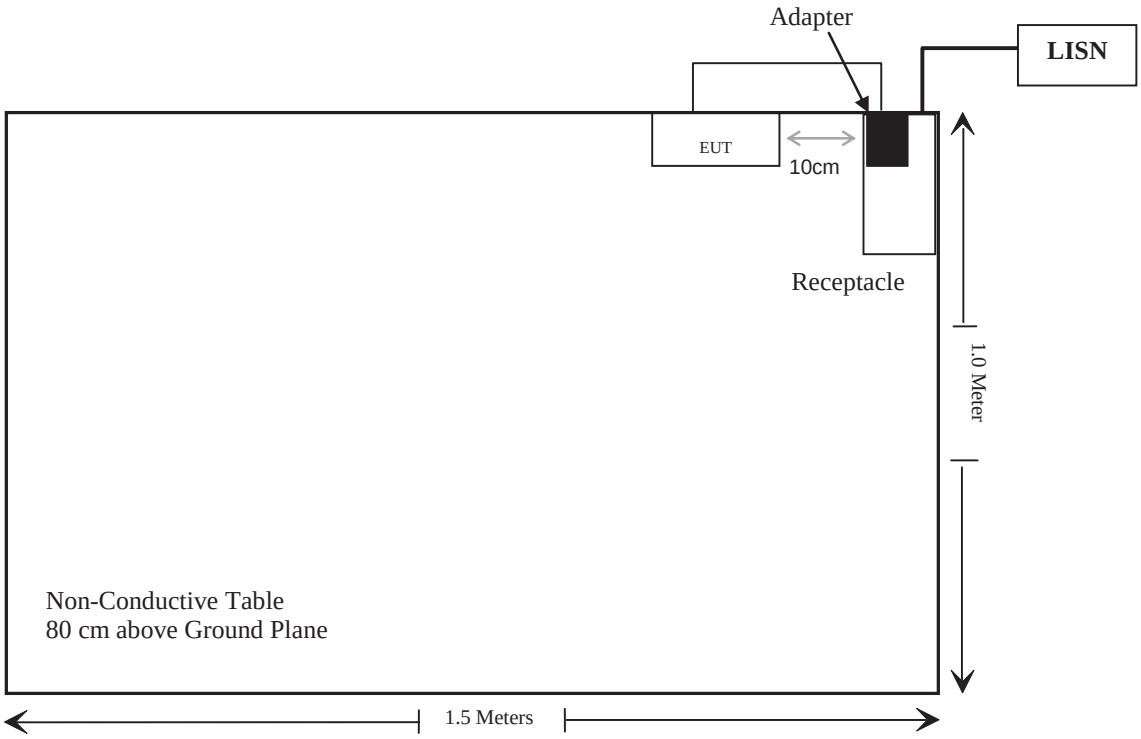
Manufacturer	Description	Model	Serial Number
HUAWEI	Adapter	HW-050200C01	Unknown

External I/O Cable

Cable Description	Length(m)	From Port	To
Un-Shielding Detachable USB Cable	0.95	Adapter	EUT

Block Diagram of Test Setup

For conducted emission:



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
§1.1307 (b) (1) & §2.1091	MaximuM Permissible exposure (MPE)	Compliance
§15.203	Antenna Requirement	Compliance
§15.207 (a)	AC Line Conducted Emissions	Compliance
§15.205, §15.209, §15.247(d)	Spurious Emissions	Compliance
§15.247 (a)(2)	6 dB Emission Bandwidth & Occupied Bandwidth	Compliance
§15.247(b)(3)	Maximum Conducted Output Power	Compliance
§15.247(d)	100 kHz Bandwidth of Frequency Band Edge	Compliance
§15.247(e)	Power Spectral Density	Compliance

Note: For the difference of shelfEye and shelfEye Pro, according to the test result of FCC Part 15B test Result, the model (shelfEye) is worst case, only worst case was performed in report.

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Conducted emission test					
Rohde & Schwarz	Test Receiver	ESCS30	100307	2020/12/25	2021/12/24
Schwarzbeck	L.I.S.N.	NLSK8126	8126431	2020/12/25	2021/12/24
Rohde & Schwarz	Pulse Limiter	ESH3-Z2	100815	2020/12/25	2021/12/24
Anritsu Corp	50ΩCoaxial Switch	MP59B	6200506474	2020/12/25	2021/12/24
Radiated emission test					
Rohde& Schwarz	Test Receiver	ESR	101817	2020/12/24	2021/12/23
Rohde&Schwarz	Spectrum Analyzer	FSV40	101495	2020/12/24	2021/12/23
SONOMA INSTRUMENT	Amplifier	310 N	186131	2020/12/25	2021/12/24
A.H. Systems, inc.	Preamplifier	PAM-0118P	531	2020/07/08	2021/07/07
Quinstar	Amplifier	QLW-184055 36-J0	15964001002	2020/11/28	2021/11/27
Anritsu Corp	50 Coaxial Switch	MP59B	6100237248	2020/12/25	2021/12/24
Schwarzbeck	Bilog Antenna	VULB9163	9163-323	2020/01/05	2023/01/04
Schwarzbeck	Horn Antenna	BBHA9120D	9120D-1067	2020/01/05	2023/01/04
Schwarzbeck	HORN ANTENNA	BBHA9170	9170-359	2020/01/05	2023/01/04
RF conducted test					
Rohde&Schwarz	Spectrum Analyzer	FSV40	101495	2020/12/24	2021/12/23
Rohde & Schwarz	Open Switch and Control Unit	OSP120 +OSP -B157	101244 + 100866	2020/12/24	2021/12/23
Rohde & Schwarz	Test Receiver	ESPI3	100396	2020/12/24	2021/12/23

*** 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).

§1.1307 (b) (1) & §2.1091- MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Applicable Standard

According to subpart 1.1307 (b)(1), 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/cm^2)
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 worst case:

Frequency (MHz)	Antenna Gain		Tune Up Conducted Output Power		Evaluation Distance (cm)	Power Density (mW/cm^2)	MPE Limit (mW/cm^2)
	(dBi)	(numeric)	(dBm)	(mW)			
2412-2462	2.23	1.67	19	79.43	20	0.026	1.0

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

Result: Compliance

FCC §15.203 - 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.

Antenna Connector Construction

The EUT has one internal antenna arrangement, which was permanently attached and the antenna gain is 2.23 dBi, fulfill the requirement of this section. Please refer to the EUT photos.

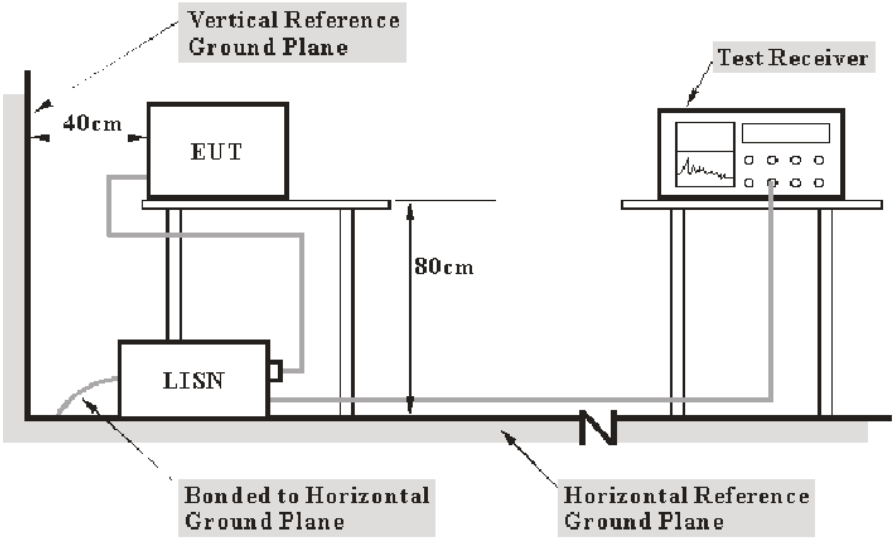
Result: Compliance.

FCC §15.207 (a) – AC LINE CONDUCTED EMISSIONS

Applicable Standard

FCC§15.207

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 limits.

The spacing between the peripherals was 10 cm.

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

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.

Transd Factor & Margin Calculation

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

Transd Factor = LISN VDF + Cable Loss

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:

Margin = Limit – level
Level= reading level+ Transd Factor

Test Data

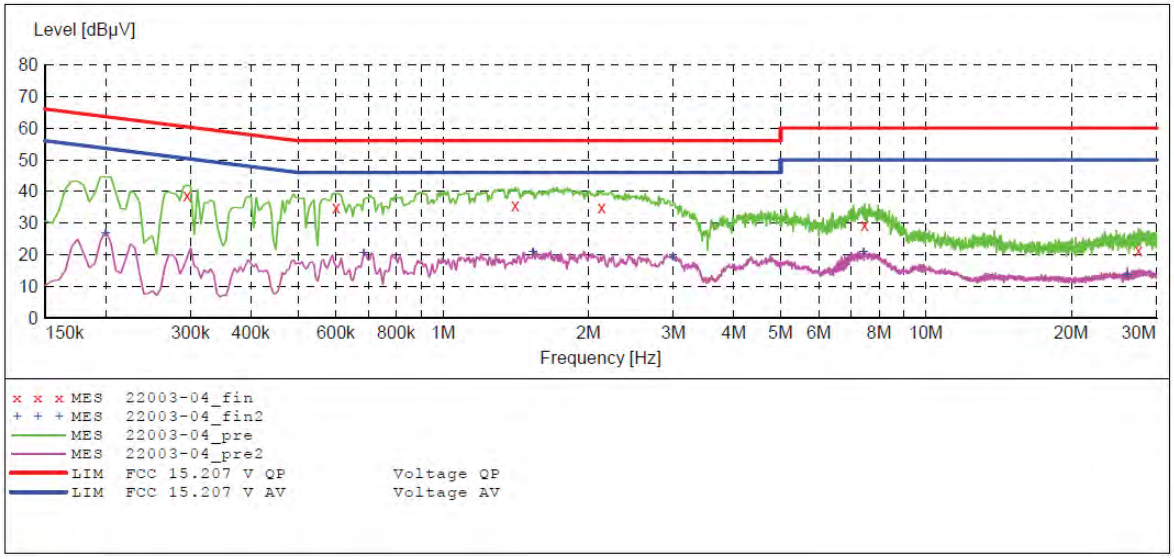
Environmental Conditions

Temperature:	24 ℃
Relative Humidity:	48 %
ATM Pressure:	101.0 kPa

The testing was performed by Ting Lü on 2021-01-04.

EUT operation mode: Transmitting (Worst case as below)

AC 120V/60 Hz, Line



MEASUREMENT RESULT: "22003-04_fin"

1/4/2021 5:45PM

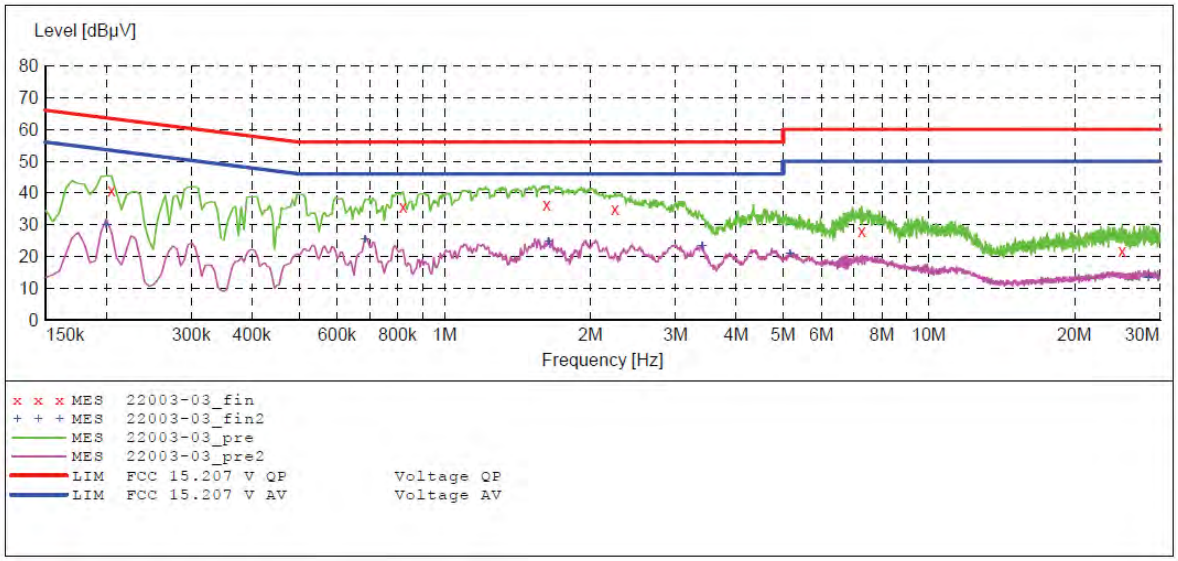
Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.295000	38.70	10.5	60	21.3	QP	L1	GND
0.600000	34.80	10.5	56	21.2	QP	L1	GND
1.410000	35.50	10.6	56	20.5	QP	L1	GND
2.130000	34.80	10.6	56	21.2	QP	L1	GND
7.460000	29.50	10.8	60	30.5	QP	L1	GND
27.565000	21.50	10.9	60	38.5	QP	L1	GND

MEASUREMENT RESULT: "22003-04_fin2"

1/4/2021 5:45PM

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.200000	27.10	10.4	54	26.9	AV	L1	GND
0.685000	20.70	10.5	46	25.3	AV	L1	GND
1.535000	20.90	10.6	46	25.1	AV	L1	GND
2.990000	19.40	10.7	46	26.6	AV	L1	GND
7.430000	20.90	10.8	50	29.1	AV	L1	GND
26.155000	13.80	10.9	50	36.2	AV	L1	GND

AC 120V/60 Hz, Neutral



MEASUREMENT RESULT: "22003-03_fin"

1/4/2021 5:39PM

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.205000	41.00	10.4	63	22.0	QP	N	GND
0.820000	35.70	10.6	56	20.3	QP	N	GND
1.625000	36.30	10.6	56	19.7	QP	N	GND
2.250000	34.80	10.7	56	21.2	QP	N	GND
7.270000	27.90	10.8	60	32.1	QP	N	GND
25.105000	21.90	10.9	60	38.1	QP	N	GND

MEASUREMENT RESULT: "22003-03_fin2"

1/4/2021 5:39PM

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	PE
0.200000	29.90	10.4	54	24.1	AV	N	GND
0.685000	25.60	10.5	46	20.4	AV	N	GND
1.640000	24.90	10.6	46	21.1	AV	N	GND
3.400000	23.50	10.7	46	22.5	AV	N	GND
5.170000	21.10	10.7	50	28.9	AV	N	GND
28.435000	13.40	10.9	50	36.6	AV	N	GND

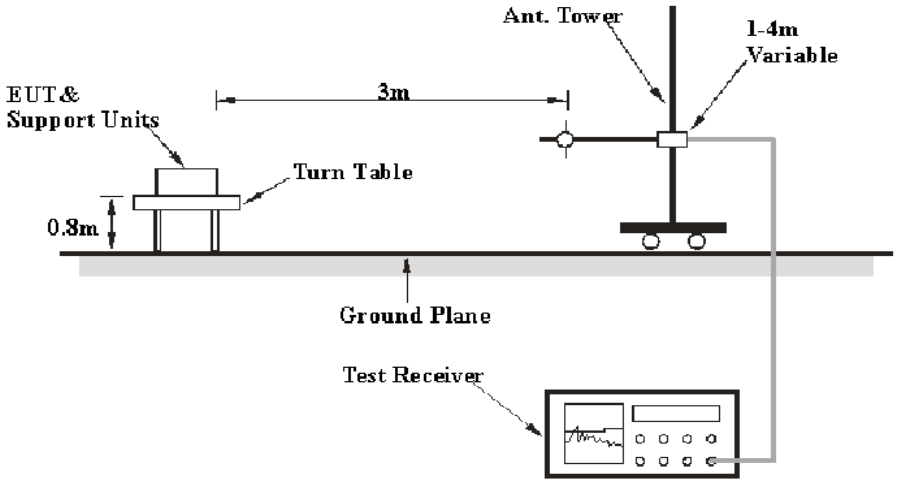
FCC §15.209, §15.205 & §15.247(d) - SPURIOUS EMISSIONS

Applicable Standard

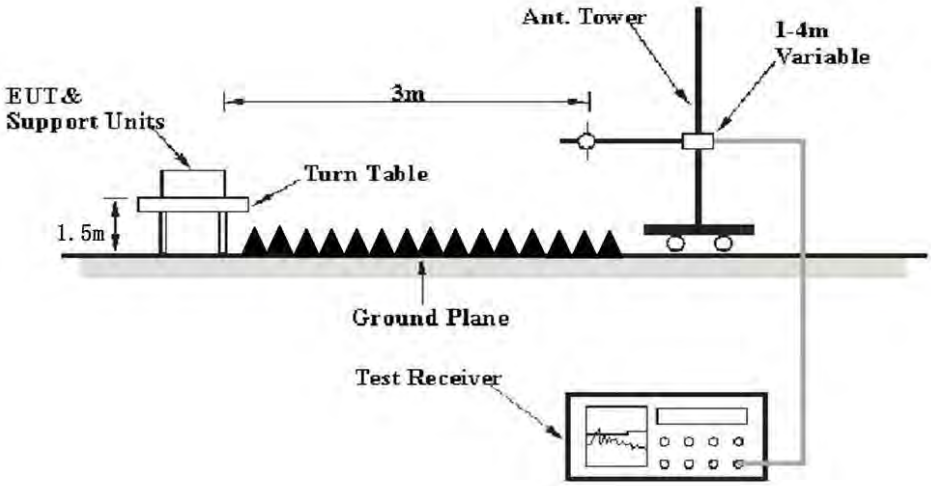
FCC §15.247 (d); §15.209; §15.205;

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. The specification used was the FCC 15.209, and FCC 15.247 limits.

EMI Test Receiver & Spectrum Analyzer Setup

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.

Factor & Margin Calculation

The Factor 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:

Factor = Meter Reading + Antenna Factor + Cable Loss - 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:

Margin = Result-Limit
Result = Reading + Factor

Test Data

Environmental Conditions

Temperature:	24 ℃
Relative Humidity:	48 %
ATM Pressure:	101.0 kPa

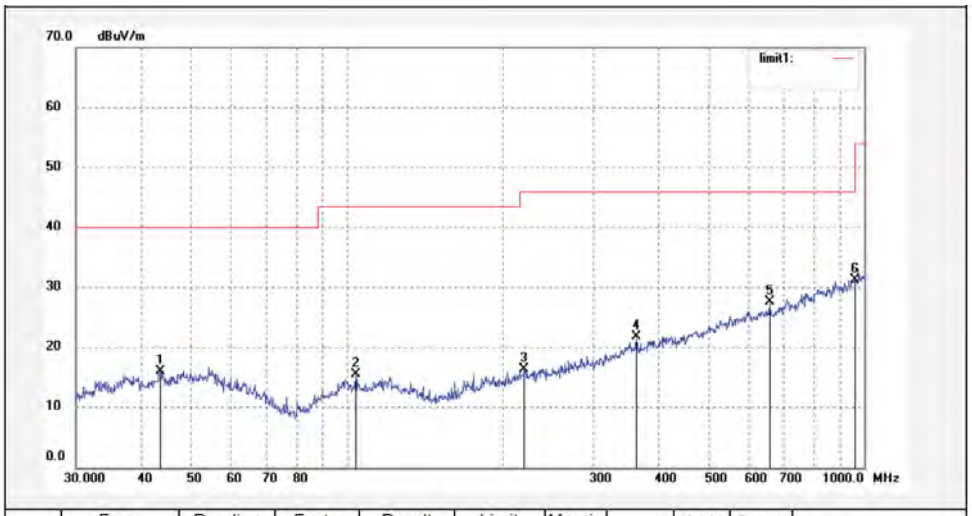
The testing was performed by Ting Lü on 2021-01-09.

EUT operation mode: Transmitting
***18~25GHz**: The test values lower than the limits of 20dB or in the noise floor level, the test data were not recorded in the report.*

30 MHz~1 GHz: *(worst case at 802.11b mode)*

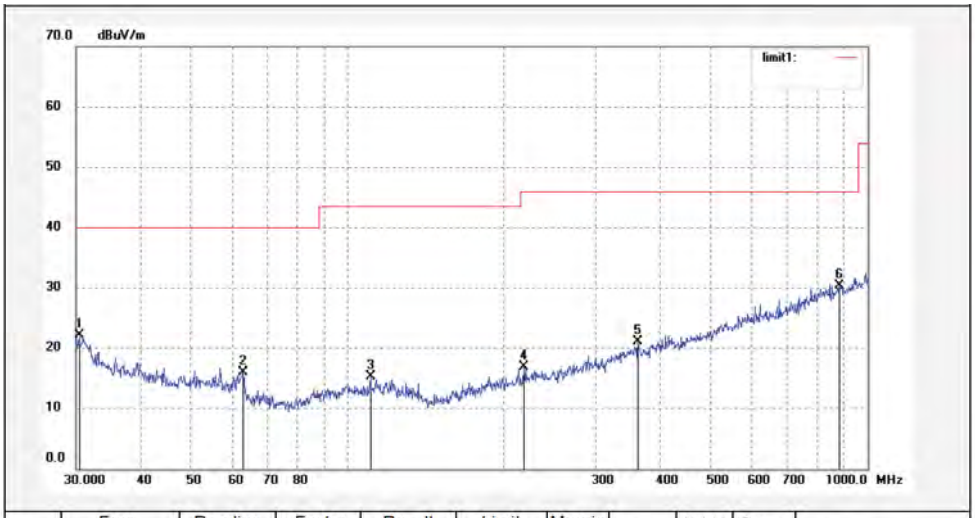
TX Chanel 1:

Horizontal



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	43.6584	27.46	-11.39	16.07	40.00	-23.93	peak			
2	104.1701	27.95	-12.50	15.45	43.50	-28.05	peak			
3	220.6171	27.17	-10.81	16.36	46.00	-29.64	peak			
4	362.9844	28.34	-6.54	21.80	46.00	-24.20	peak			
5	656.5300	28.76	-1.20	27.56	46.00	-18.44	peak			
6	958.7943	27.31	3.97	31.28	46.00	-14.72	peak			

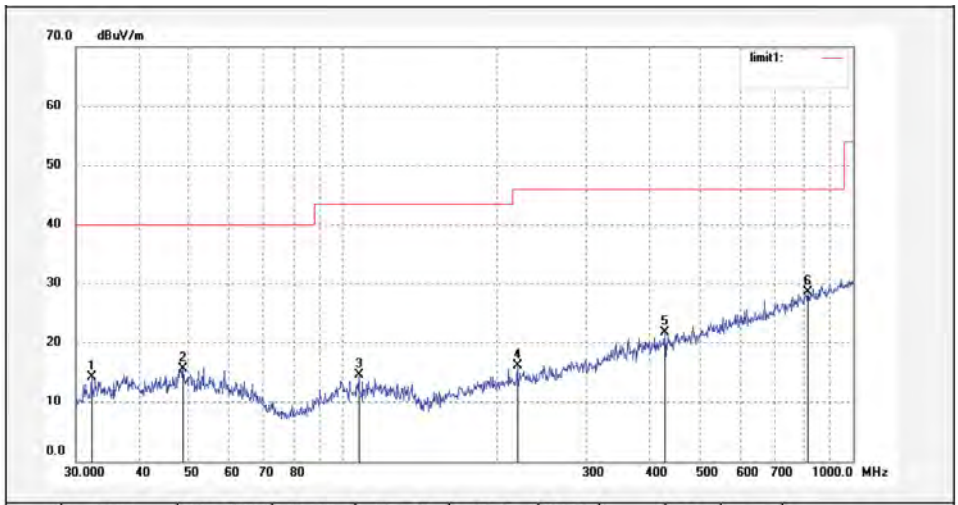
Vertical



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	30.4237	29.68	-7.52	22.16	40.00	-17.84	peak			
2	62.8708	29.66	-13.63	16.03	40.00	-23.97	peak			
3	110.5687	27.84	-12.54	15.30	43.50	-28.20	peak			
4	218.3085	27.69	-10.88	16.81	46.00	-29.19	peak			
5	361.7139	27.65	-6.56	21.09	46.00	-24.91	peak			
6	881.4067	28.04	2.41	30.45	46.00	-15.55	peak			

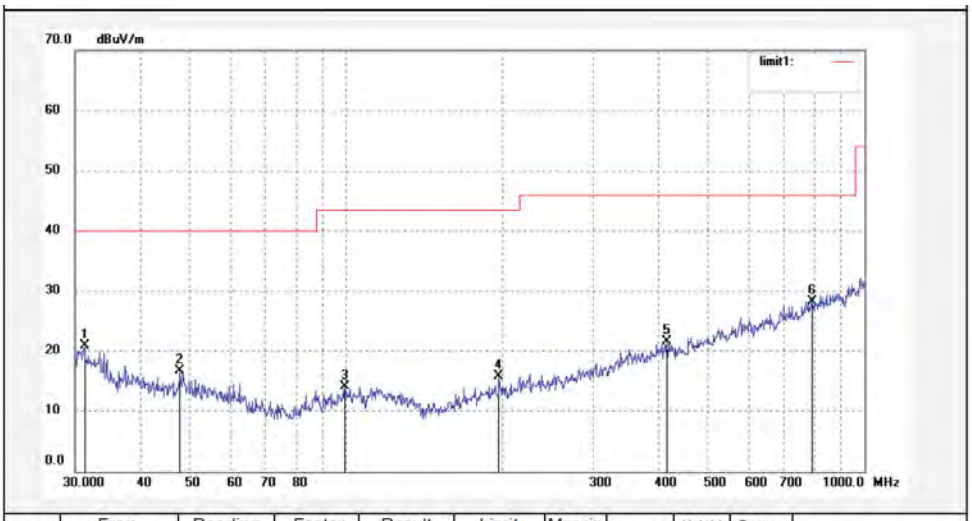
TX Chanel 6:

Horizontal



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	32.1795	28.10	-13.92	14.18	40.00	-25.82	peak			
2	48.6719	26.69	-11.08	15.61	40.00	-24.39	peak			
3	107.5101	27.31	-12.63	14.68	43.50	-28.82	peak			
4	219.8449	27.01	-10.84	16.17	46.00	-29.83	peak			
5	428.0193	26.99	-5.24	21.75	46.00	-24.25	peak			
6	815.9678	27.04	1.56	28.60	46.00	-17.40	peak			

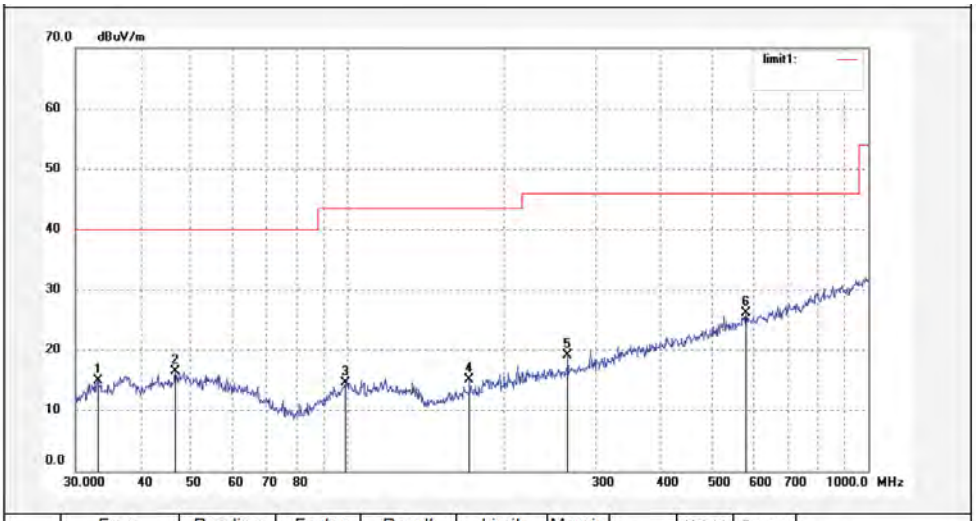
Vertical



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	31.2893	28.77	-7.80	20.97	40.00	-19.03	peak			
2	47.8260	27.97	-11.26	16.71	40.00	-23.29	peak			
3	99.5281	26.09	-11.94	14.15	43.50	-29.35	peak			
4	197.2001	27.24	-11.42	15.82	43.50	-27.68	peak			
5	416.1791	26.96	-5.41	21.55	46.00	-24.45	peak			
6	793.3960	27.10	1.16	28.26	46.00	-17.74	peak			

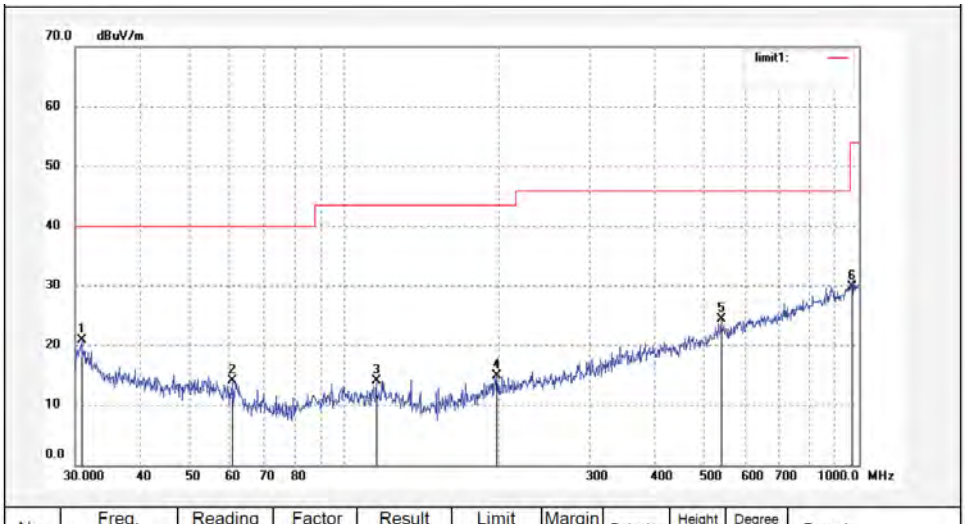
TX Chanel 11:

Horizontal



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	33.0950	28.78	-13.88	14.90	40.00	-25.10	peak			
2	46.6664	27.68	-11.10	16.58	40.00	-23.42	peak			
3	98.8326	26.74	-12.17	14.57	43.50	-28.93	peak			
4	171.3926	27.75	-12.66	15.09	43.50	-28.41	peak			
5	264.7457	28.89	-9.81	19.08	46.00	-26.92	peak			
6	582.7425	28.28	-2.03	26.25	46.00	-19.75	peak			

Vertical



No.	Freq. (MHz)	Reading (dBuV/m)	Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Degree (deg.)	Remark
1	30.8535	28.53	-7.67	20.86	40.00	-19.14	peak			
2	60.7044	26.91	-12.86	14.05	40.00	-25.95	peak			
3	115.3205	26.03	-11.92	14.11	43.50	-29.39	peak			
4	197.8928	26.38	-11.42	14.96	43.50	-28.54	peak			
5	539.4775	27.45	-2.95	24.50	46.00	-21.50	peak			
6	968.9338	25.70	4.11	29.81	54.00	-24.19	peak			

Above 1 GHz:

802.11b

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	FCC 15.209/15.247	
	Reading (dBμV)	PK/QP/Ave.		Height (m)	Polar (H/V)			Limit (dBμV/m)	Margin (dB)
Low Channel (2412 MHz)									
4824.00	40.00	PK	147	1.5	H	1.10	41.10	74	-32.90
4824.00	29.95	Ave.	147	1.5	H	1.10	31.05	54	-22.95
4824.00	42.00	PK	147	1.5	V	1.10	43.10	74	-30.90
4824.00	31.50	Ave.	147	1.5	V	1.10	32.60	54	-21.40
Middle Channel (2437 MHz)									
4874.00	40.15	PK	26	1.5	H	1.32	41.47	74	-32.53
4874.00	29.65	Ave.	26	1.5	H	1.32	30.97	54	-23.03
4874.00	41.15	PK	85	1.5	V	1.32	42.47	74	-31.53
4874.00	31.26	Ave.	85	1.5	V	1.32	32.58	54	-21.42
High Channel (2462 MHz)									
4924.00	40.46	PK	167	1.5	H	1.53	41.99	74	-32.01
4924.00	30.46	Ave.	167	1.5	H	1.53	31.99	54	-22.01
4924.00	40.46	PK	167	1.5	V	1.53	41.99	74	-32.01
4924.00	29.69	Ave.	167	1.5	V	1.53	31.22	54	-22.78

802.11g:

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	FCC 15.209/15.247	
	Reading (dBμV)	PK/QP/Ave.		Height (m)	Polar (H/V)			Limit (dBμV/m)	Margin (dB)
Low Channel (2412 MHz)									
4824.00	42.50	PK	216	1.5	H	1.10	43.60	74	-30.40
4824.00	32.60	Ave.	216	1.5	H	1.10	33.70	54	-20.30
4824.00	41.25	PK	163	1.5	V	1.10	42.35	74	-31.65
4824.00	31.54	Ave.	163	1.5	V	1.10	32.64	54	-21.36
Middle Channel (2437 MHz)									
4874.00	39.25	PK	42	1.5	H	1.32	40.57	74	-33.43
4874.00	29.57	Ave.	42	1.5	H	1.32	30.89	54	-23.11
4874.00	38.71	PK	38	1.5	V	1.32	40.03	74	-33.97
4874.00	28.63	Ave.	38	1.5	V	1.32	29.95	54	-24.05
High Channel (2462 MHz)									
4924.00	41.25	PK	136	1.5	H	1.53	42.78	74	-31.22
4924.00	31.25	Ave.	136	1.5	H	1.53	32.78	54	-21.22
4924.00	40.52	PK	194	1.5	V	1.53	42.05	74	-31.95
4924.00	30.29	Ave.	194	1.5	V	1.53	31.82	54	-22.18

802.11n20:

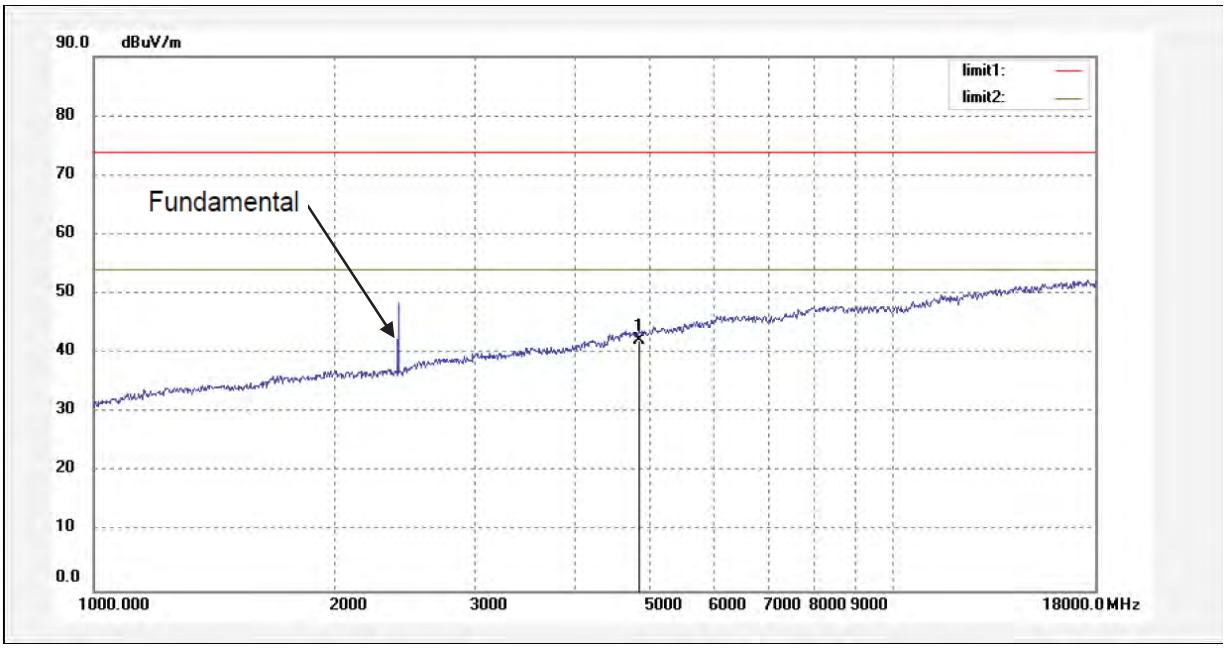
Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	FCC 15.209/15.247	
	Reading (dBμV)	PK/QP/Ave.		Height (m)	Polar (H/V)			Limit (dBμV/m)	Margin (dB)
Low Channel (2412 MHz)									
4824.00	39.77	PK	126	1.5	H	1.10	40.87	74	-33.13
4824.00	29.30	Ave.	126	1.5	H	1.10	30.40	54	-23.60
4824.00	39.80	PK	284	1.5	V	1.10	40.90	74	-33.10
4824.00	29.74	Ave.	284	1.5	V	1.10	30.84	54	-23.16
Middle Channel (2437 MHz)									
4874.00	40.17	PK	29	1.5	H	1.32	41.49	74	-32.51
4874.00	30.81	Ave.	29	1.5	H	1.32	32.13	54	-21.87
4874.00	41.30	PK	42	1.5	V	1.32	42.62	74	-31.38
4874.00	31.52	Ave.	42	1.5	V	1.32	32.84	54	-21.16
High Channel (2462 MHz)									
4924.00	40.17	PK	153	1.5	H	1.53	41.70	74	-32.30
4924.00	30.02	Ave.	153	1.5	H	1.53	31.55	54	-22.45
4924.00	42.31	PK	257	1.5	V	1.53	43.84	74	-30.16
4924.00	32.27	Ave.	257	1.5	V	1.53	33.80	54	-20.20

802.11n40:

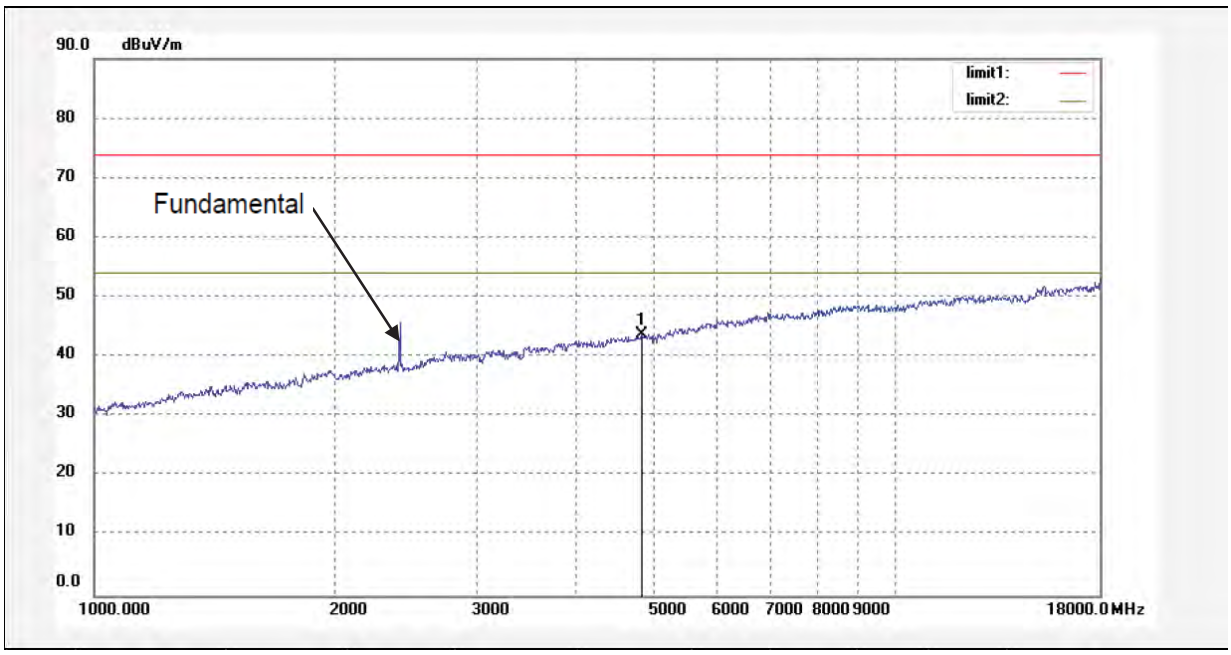
Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	FCC 15.209/15.247	
	Reading (dBμV)	PK/QP/Ave.		Height (m)	Polar (H/V)			Limit (dBμV/m)	Margin (dB)
Low Channel (2422 MHz)									
4844.00	42.10	PK	169	1.5	H	1.10	43.20	74	-30.80
4844.00	32.40	Ave.	169	1.5	H	1.10	33.50	54	-20.50
4844.00	43.60	PK	128	1.5	V	1.10	44.70	74	-29.30
4844.00	32.21	Ave.	128	1.5	V	1.10	33.31	54	-20.69
Middle Channel (2437 MHz)									
4874.00	42.73	PK	49	1.5	H	1.32	44.05	74	-29.95
4874.00	32.52	Ave.	49	1.5	H	1.32	33.84	54	-20.16
4874.00	42.39	PK	56	1.5	V	1.32	43.71	74	-30.29
4874.00	32.51	Ave.	56	1.5	V	1.32	33.83	54	-20.17
High Channel (2452 MHz)									
4904.00	41.96	PK	317	1.5	H	1.53	43.49	74	-30.51
4904.00	31.87	Ave.	317	1.5	H	1.53	33.40	54	-20.60
4904.00	42.62	PK	235	1.5	V	1.53	44.15	74	-29.85
4904.00	32.27	Ave.	235	1.5	V	1.53	33.80	54	-20.20

Pre-scan plots:
802.11b
TX Chanel 1:

Horizontal

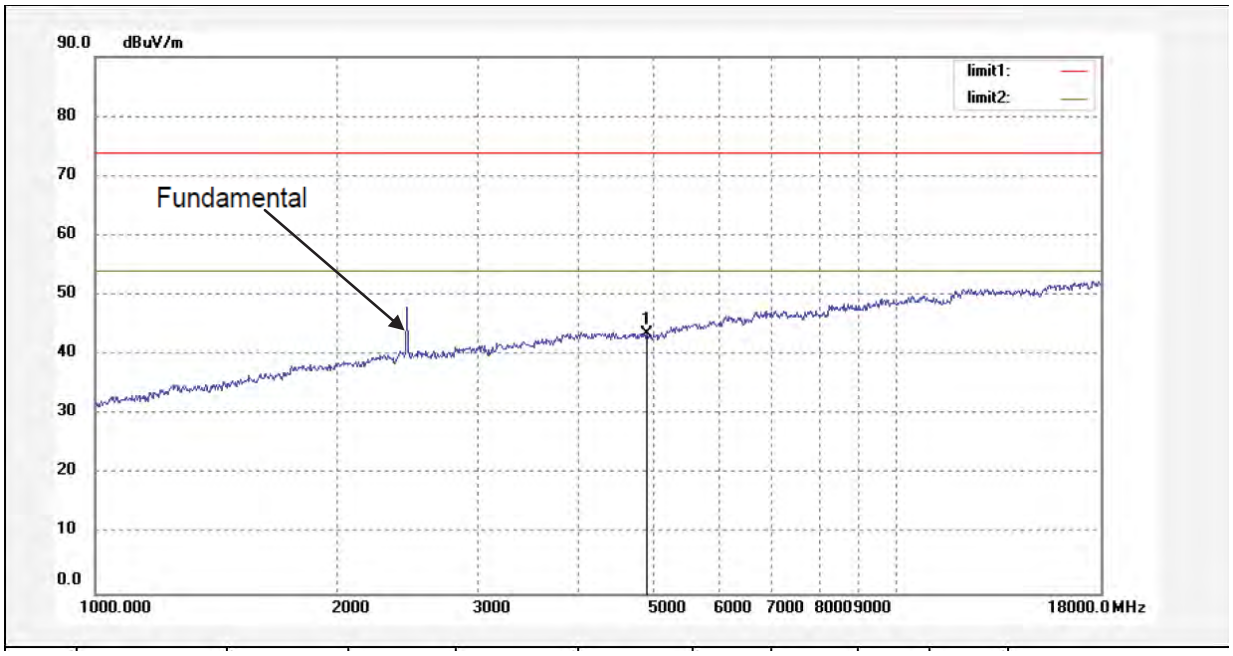


Vertical



TX Chanel 6:

Horizontal



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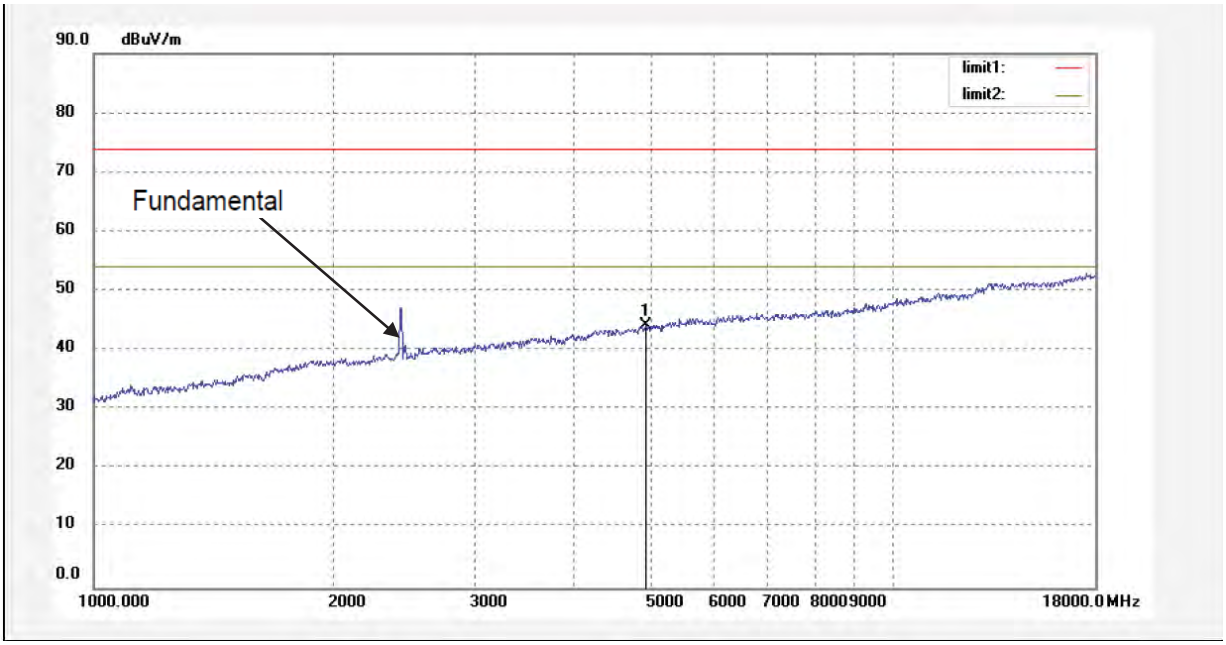
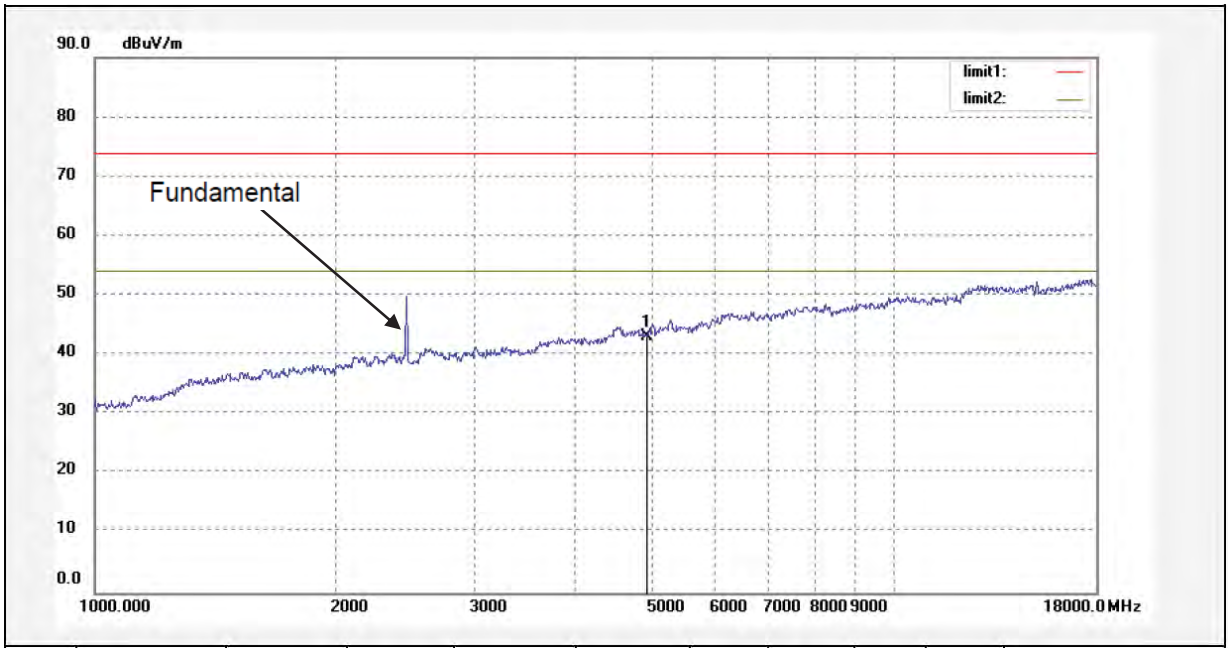
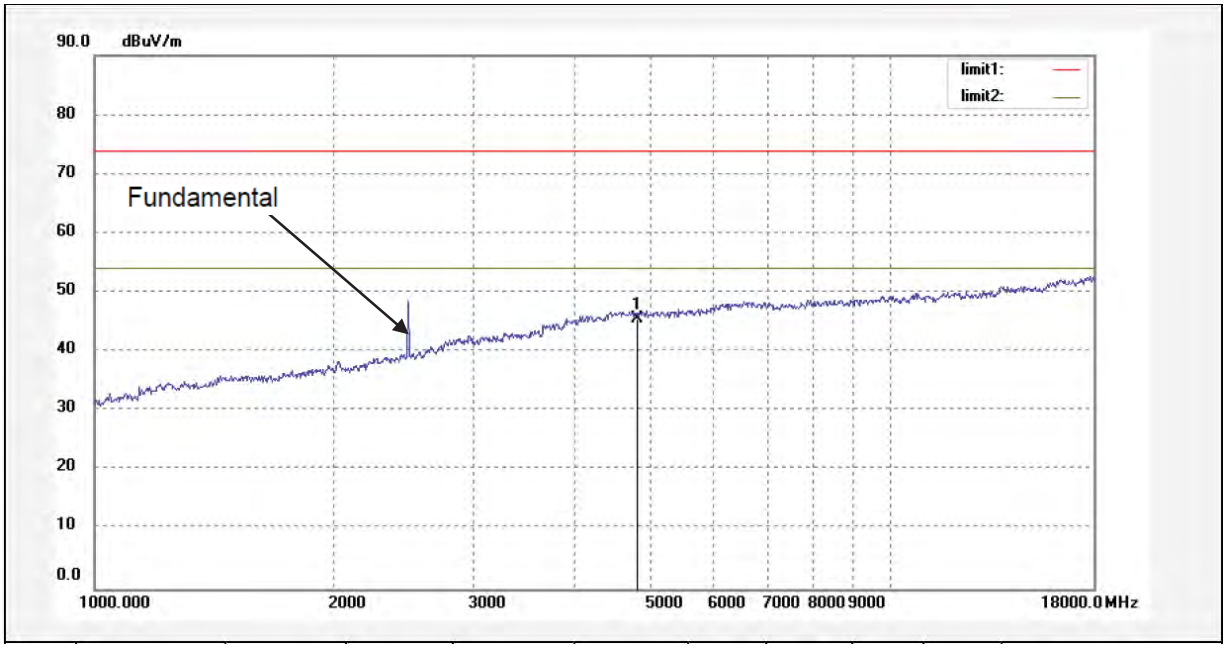


TX Chanel 11:

Horizontal

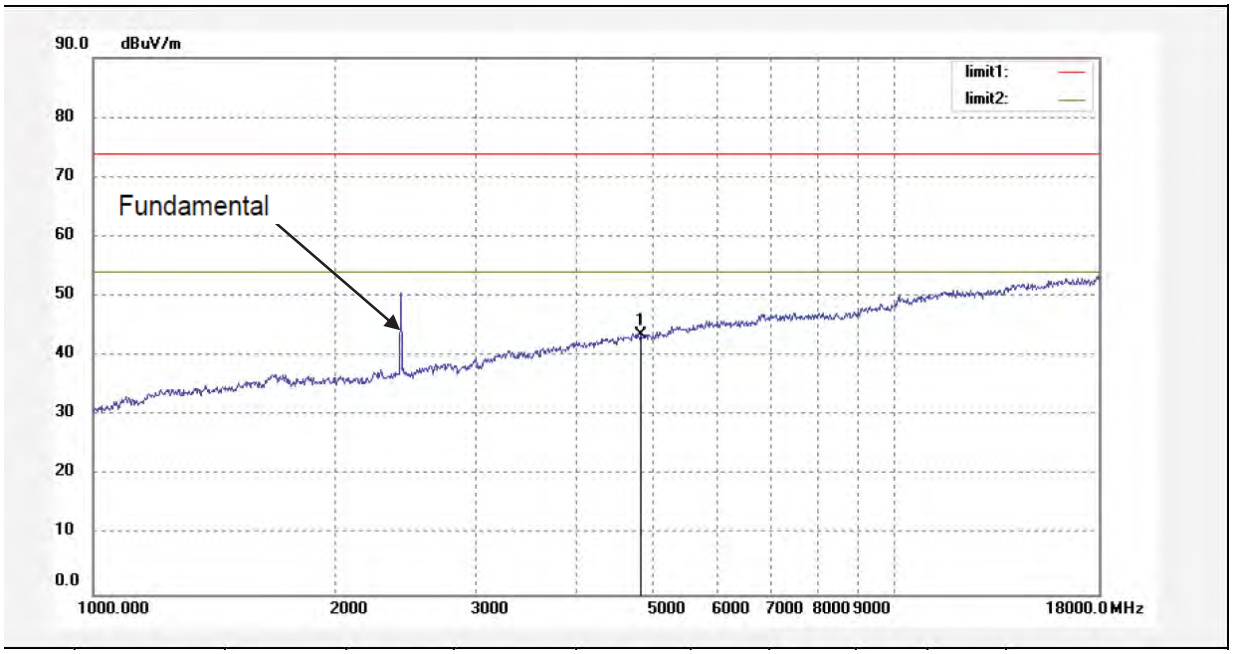


Vertical

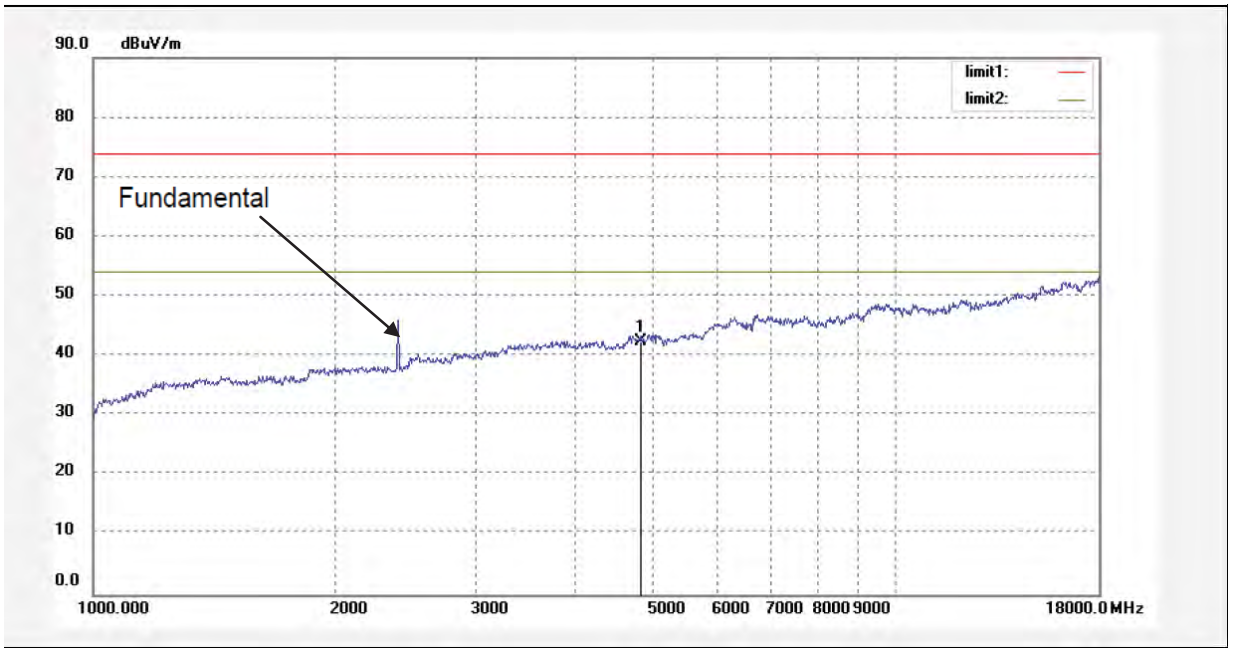


802.11g
TX Chanel 1:

Horizontal

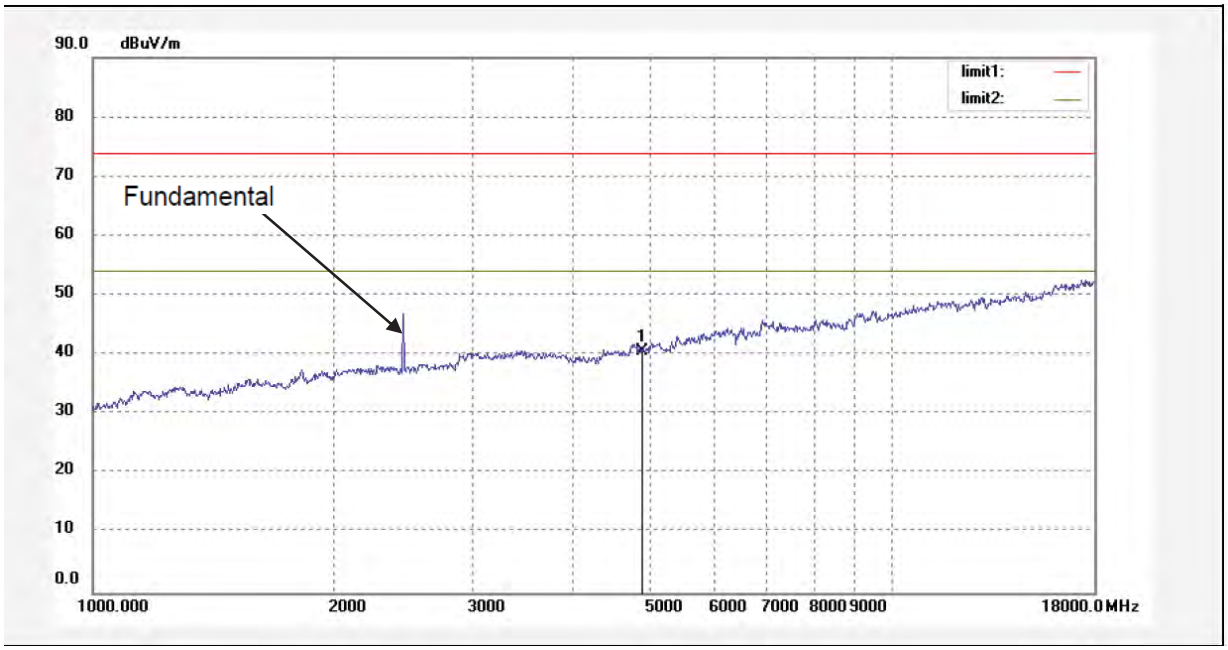


Vertical

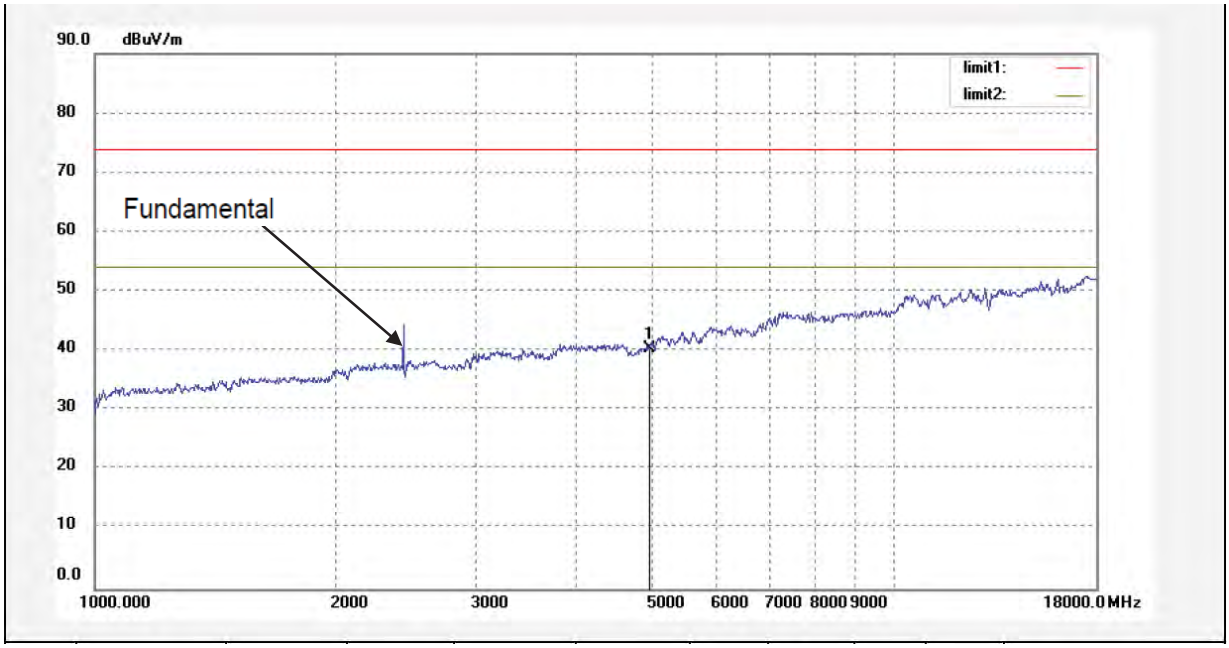


TX Chanel 6:

Horizontal

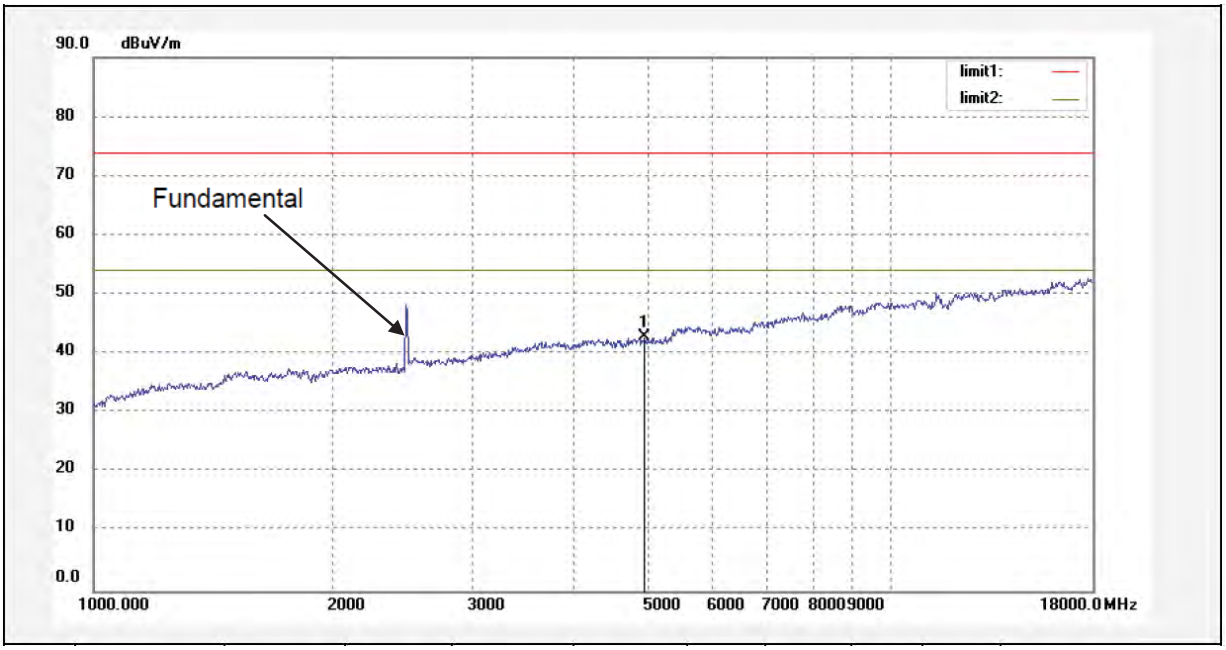


Vertical

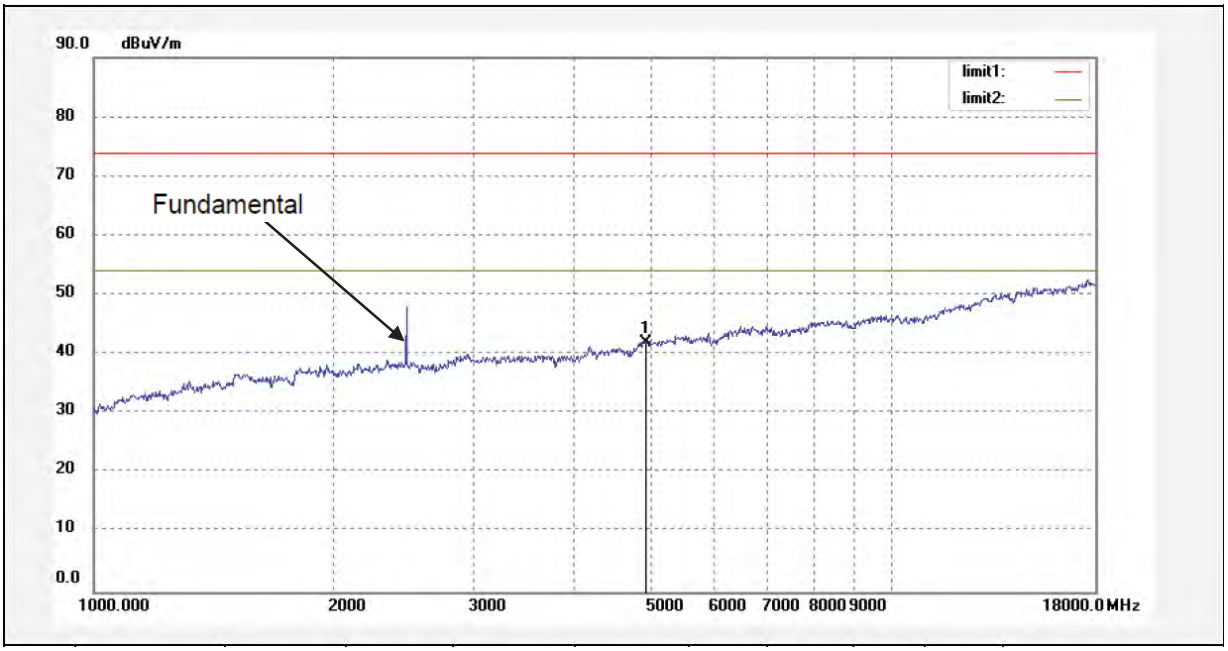


TX Chanel 11:

Horizontal

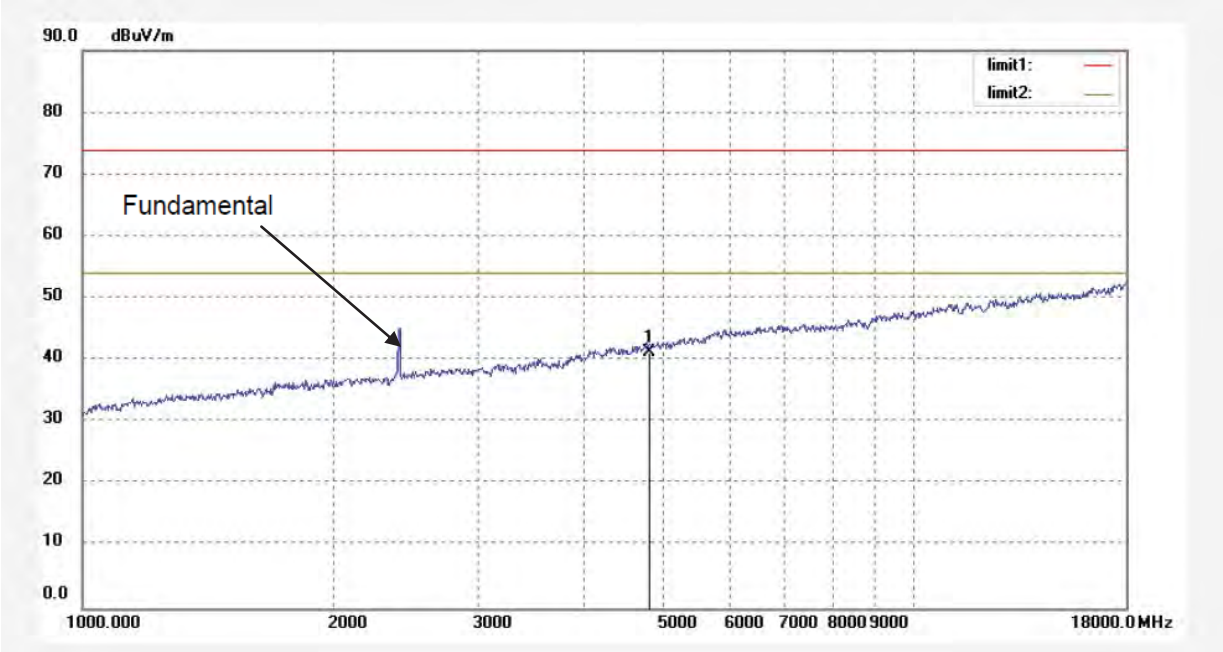


Vertical

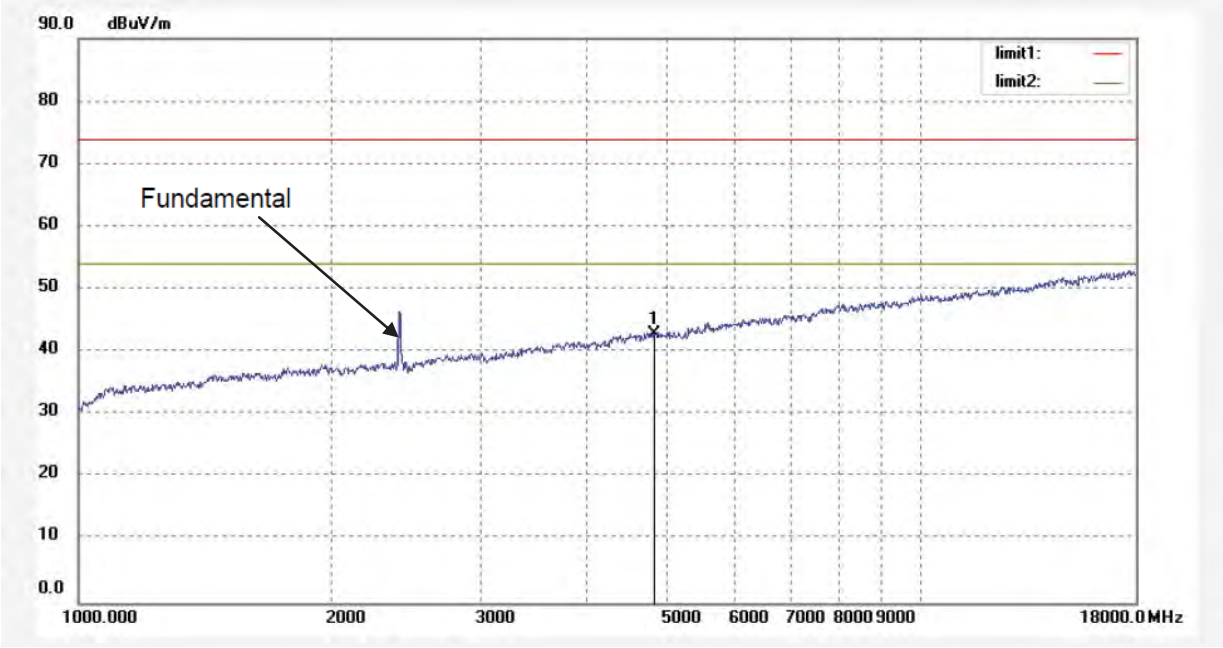


802.11n20
TX Chanel 1:

Horizontal

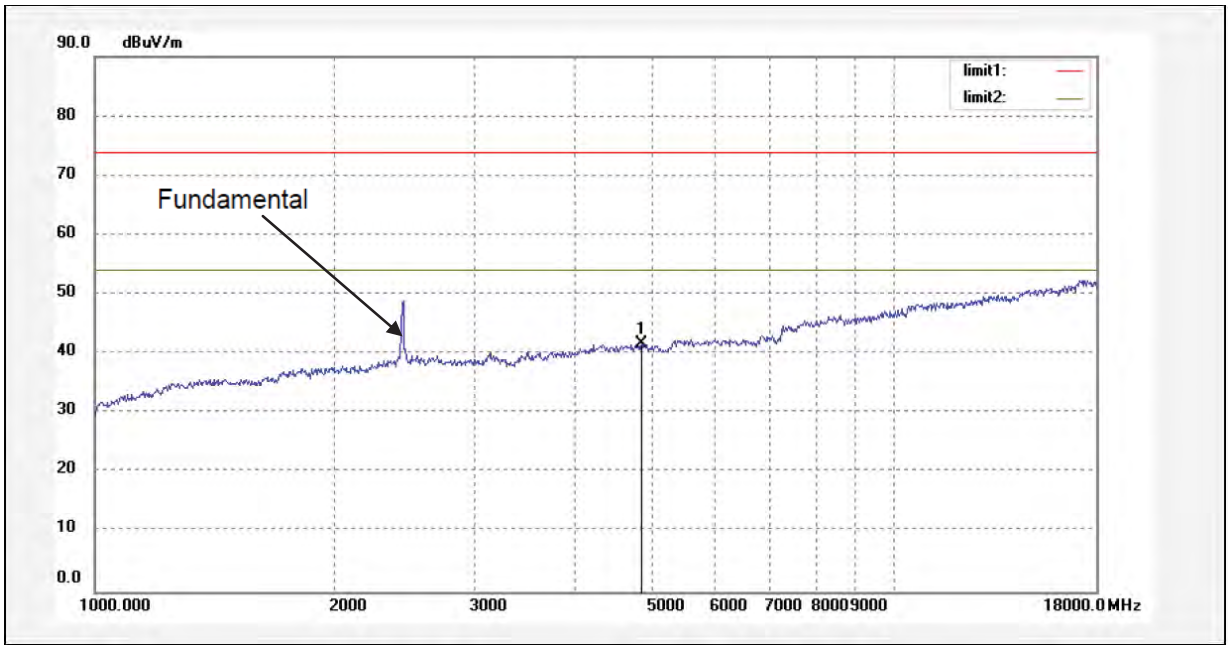


Vertical

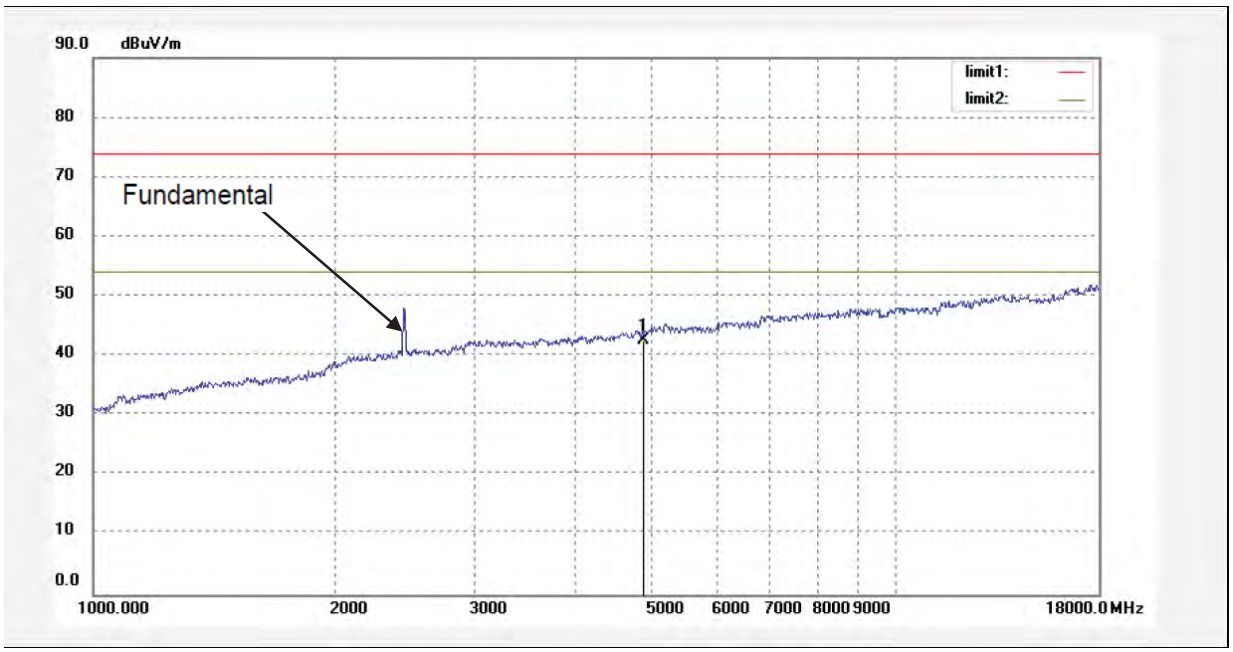


TX Chanel 6:

Horizontal

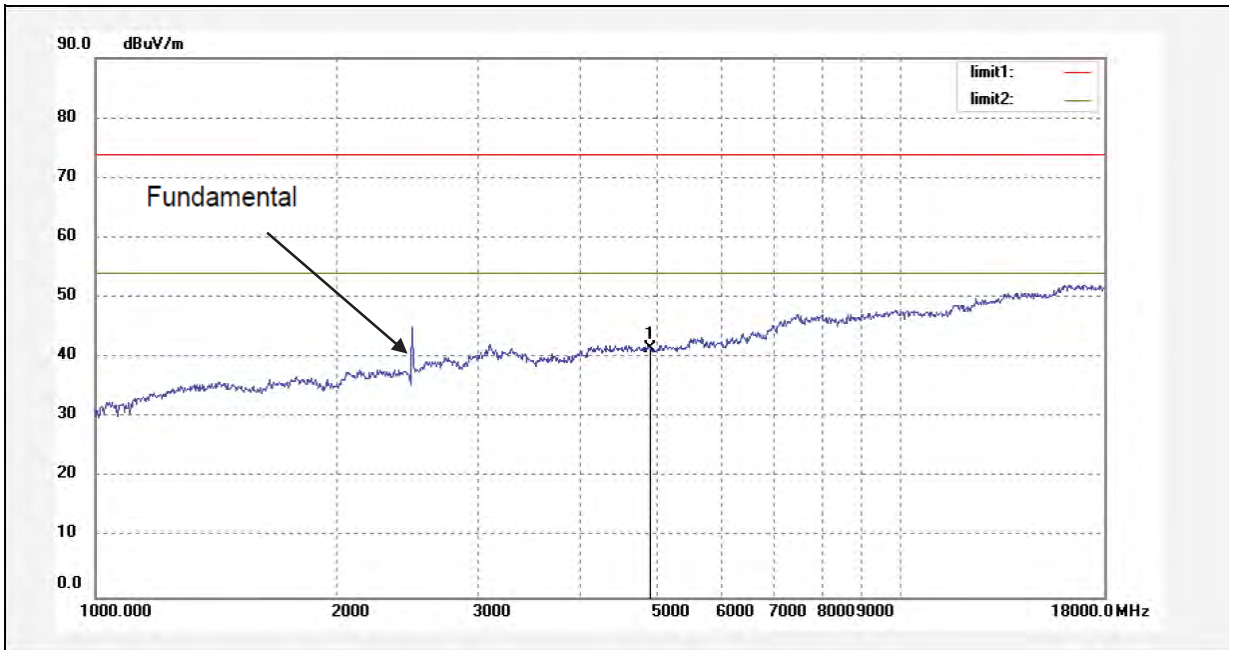


Vertical



TX Chanel 11:

Horizontal



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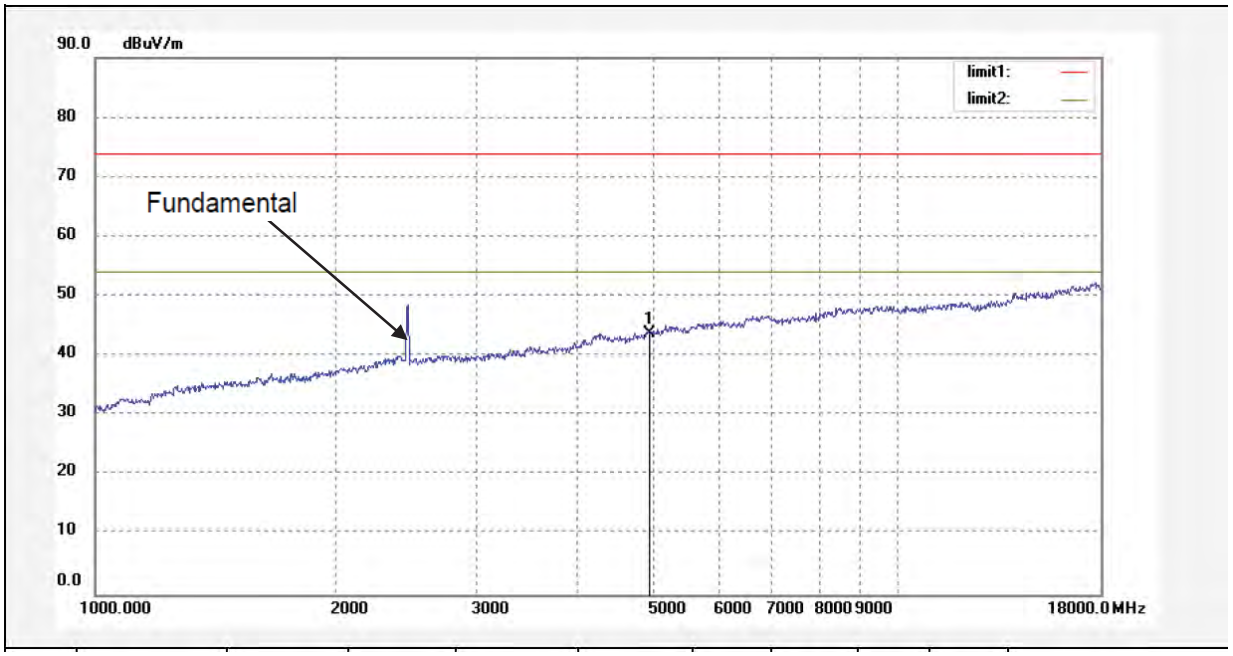
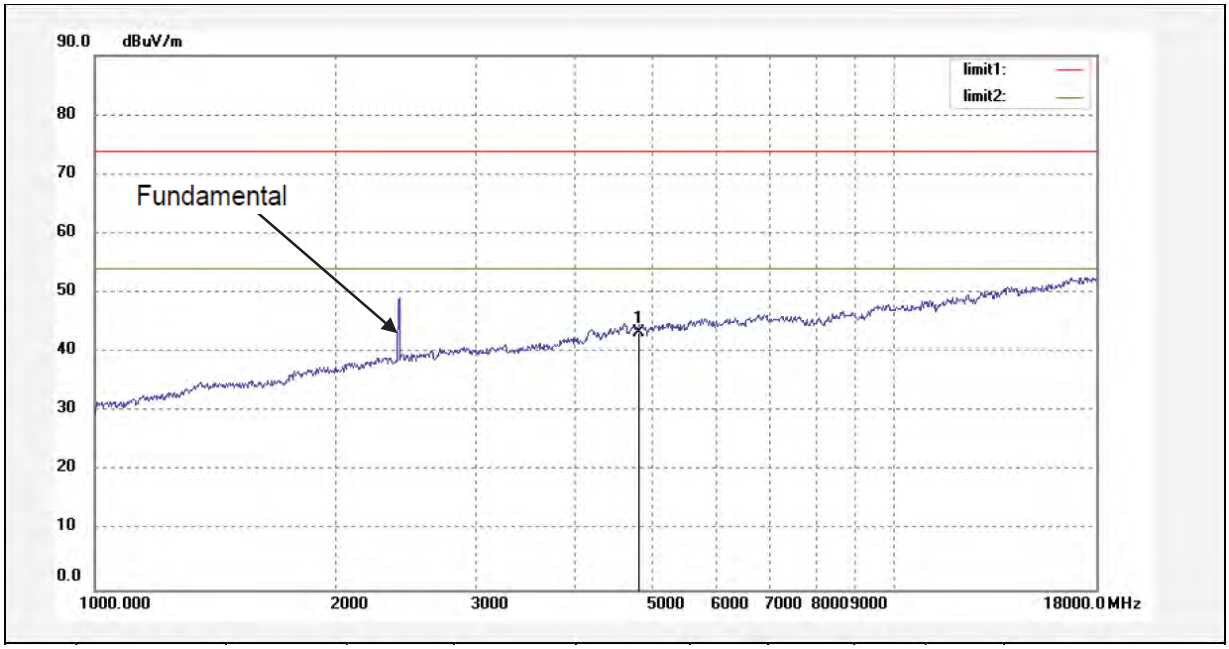
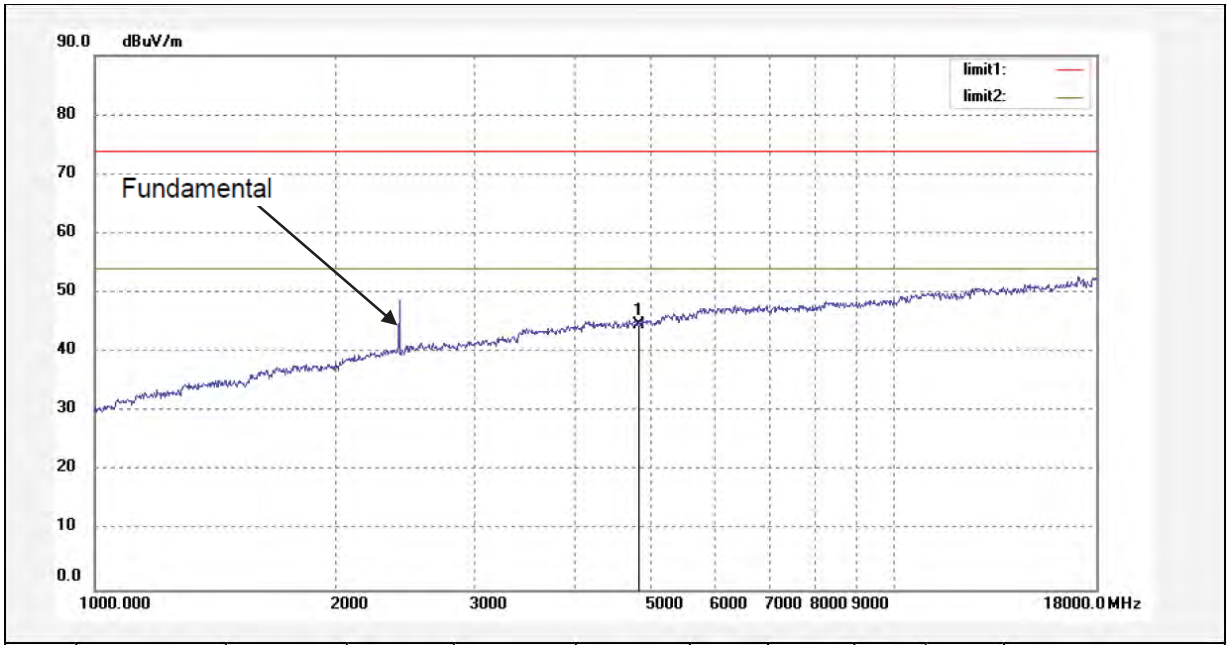


802.11n40
TX Chanel 3:

Horizontal

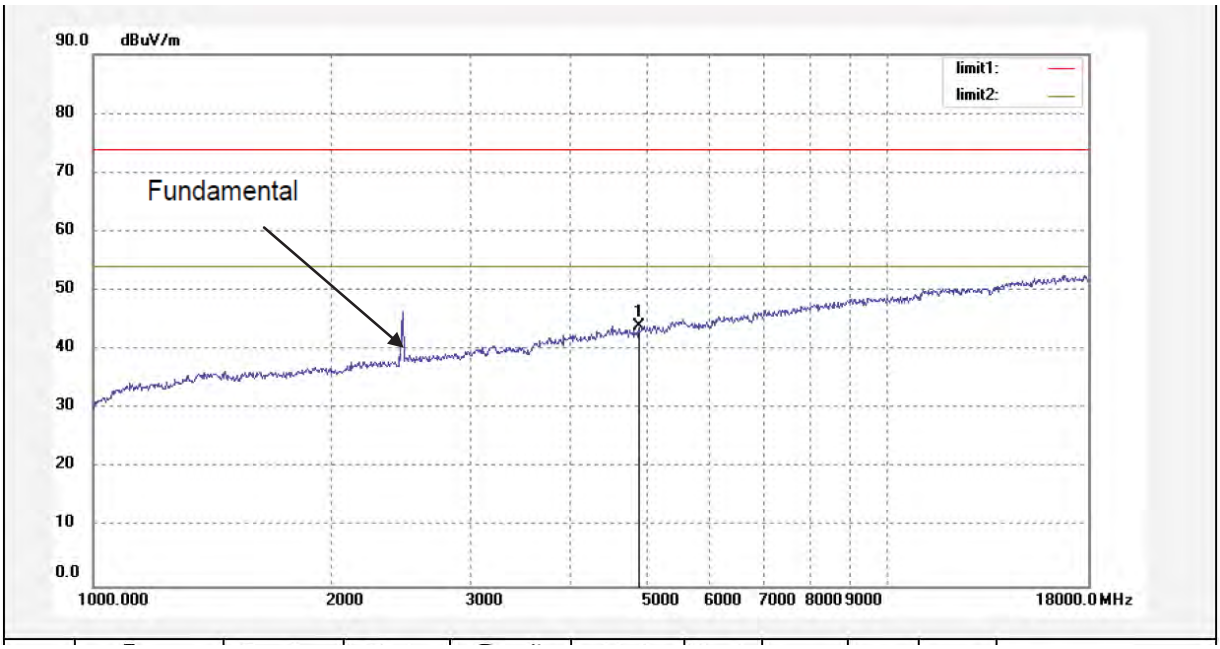


Vertical

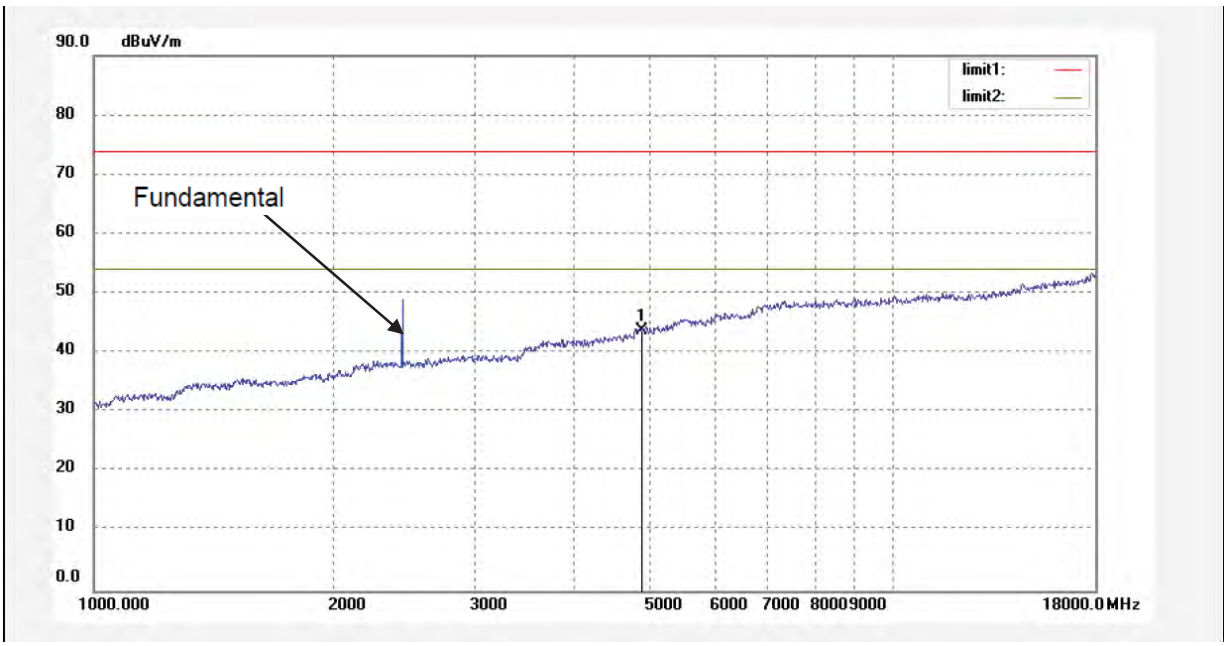


TX Chanel 6:

Horizontal

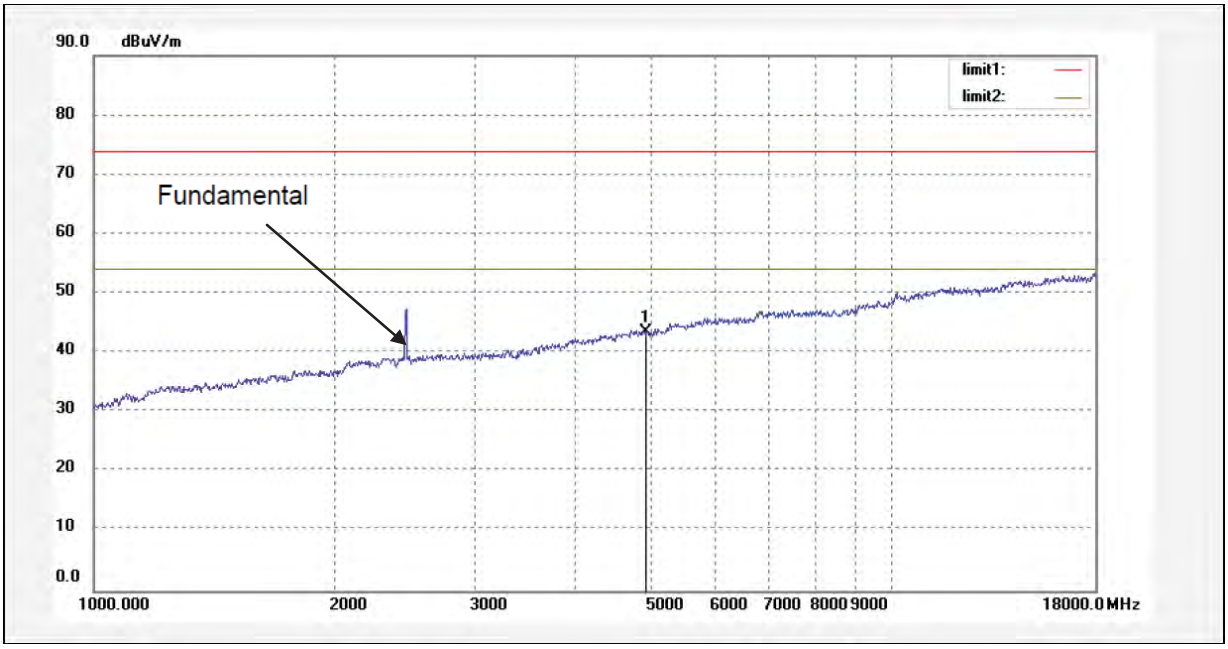


Vertical

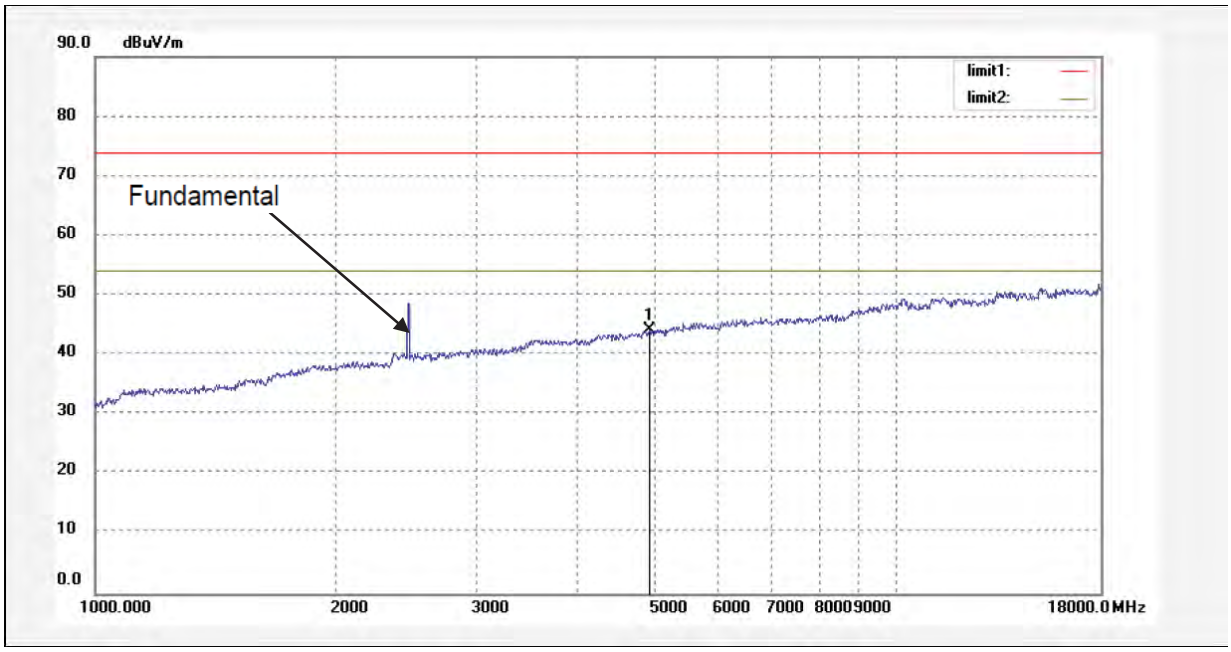


TX Chanel 9:

Horizontal



Vertical



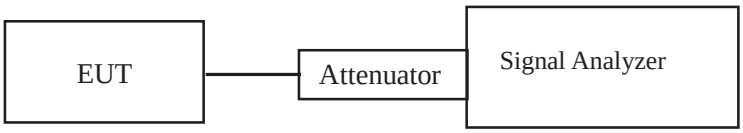
FCC §15.247(a) (2) – 6 dB EMISSION BANDWIDTH & OCCUPIED BANDWIDTH

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.

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.



Test Data

Environmental Conditions

Temperature:	24 °C
Relative Humidity:	48 %
ATM Pressure:	101.0 kPa

The testing was performed by Ting Lü on 2021-01-14.

EUT operation mode: Transmitting

Test Result: Compliant. Please refer to the Appendix Wi-Fi.

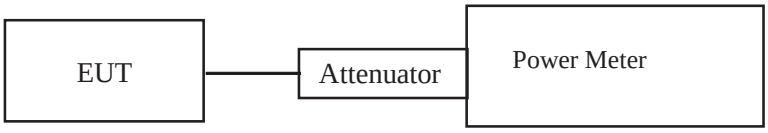
FCC §15.247(b) (3) - MAXIMUM CONDUCTED OUTPUT POWER

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.

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:	24 ℃
Relative Humidity:	48 %
ATM Pressure:	101.0 kPa

The testing was performed by Ting Lü on 2021-01-14.

EUT operation mode: Transmitting

Test Result: Compliant. Please refer to the Appendix Wi-Fi.

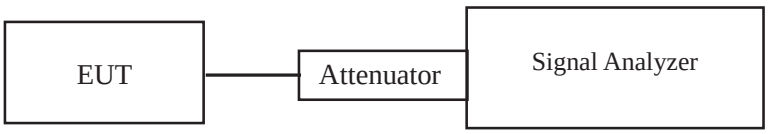
FCC §15.247(d) – 100 kHz BANDWIDTH OF FREQUENCY BAND EDGE

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:	24 °C
Relative Humidity:	48 %
ATM Pressure:	101.0 kPa

The testing was performed by Ting Lü on 2021-01-14.

EUT operation mode: Transmitting

Test Result: Compliant.

Conducted Band Edge Result:

Please refer to the Appendix Wi-Fi.

Radiated Band Edge Result:

802.11b

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	FCC 15.205	
	Reading (dBμV)	PK/QP/Ave.		Height (m)	Polar (H/V)			Limit (dBμV/m)	Margin (dB)
Low Channel (2412 MHz)									
2310.00	49.11	PK	230	1.5	H	-6.69	42.42	74	-31.58
2310.00	39.21	Ave.	230	1.5	H	-6.69	32.52	54	-21.48
2310.00	47.40	PK	230	1.5	V	-6.69	40.71	74	-33.29
2310.00	37.86	Ave.	230	1.5	V	-6.69	31.17	54	-22.83
2390.00	49.19	PK	154	1.5	H	-6.32	42.87	74	-31.13
2390.00	39.53	Ave.	154	1.5	H	-6.32	33.21	54	-20.79
2390.00	48.18	PK	154	1.5	V	-6.32	41.86	74	-32.14
2390.00	38.73	Ave.	154	1.5	V	-6.32	32.41	54	-21.59
High Channel (2462 MHz)									
2483.50	48.09	PK	98	1.5	H	-5.89	42.2	74	-31.80
2483.50	38.05	Ave.	98	1.5	H	-5.89	32.16	54	-21.84
2483.50	47.47	PK	98	1.5	V	-5.89	41.58	74	-32.42
2483.50	37.41	Ave.	98	1.5	V	-5.89	31.52	54	-22.48
2500.00	46.86	PK	283	1.5	H	-5.81	41.05	74	-32.95
2500.00	36.36	Ave.	283	1.5	H	-5.81	30.55	54	-23.45
2500.00	49.23	PK	283	1.5	V	-5.81	43.42	74	-30.58
2500.00	39.45	Ave.	283	1.5	V	-5.81	33.64	54	-20.36

802.11g:

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	FCC 15.205	
	Reading (dBμV)	PK/QP/Ave.		Height (m)	Polar (H/V)			Limit (dBμV/m)	Margin (dB)
Low Channel (2412 MHz)									
2310.00	47.31	PK	259	1.5	H	-6.69	40.62	74	-33.38
2310.00	37.52	Ave.	259	1.5	H	-6.69	30.83	54	-23.17
2310.00	48.30	PK	105	1.5	V	-6.69	41.61	74	-32.39
2310.00	38.83	Ave.	105	1.5	V	-6.69	32.14	54	-21.86
2390.00	46.32	PK	321	1.5	H	-6.32	40.00	74	-34.00
2390.00	36.83	Ave.	321	1.5	H	-6.32	30.51	54	-23.49
2390.00	47.29	PK	159	1.5	V	-6.32	40.97	74	-33.03
2390.00	37.44	Ave.	159	1.5	V	-6.32	31.12	54	-22.88
High Channel (2462 MHz)									
2483.50	52.24	PK	152	1.5	H	-5.89	46.35	74	-27.65
2483.50	42.71	Ave.	152	1.5	H	-5.89	36.82	54	-17.18
2483.50	56.75	PK	128	1.5	V	-5.89	50.86	74	-23.14
2483.50	46.05	Ave.	128	1.5	V	-5.89	40.16	54	-13.84
2500.00	45.86	PK	254	1.5	H	-5.81	40.05	74	-33.95
2500.00	35.46	Ave.	254	1.5	H	-5.81	29.65	54	-24.35
2500.00	46.75	PK	205	1.5	V	-5.81	40.94	74	-33.06
2500.00	36.38	Ave.	205	1.5	V	-5.81	30.57	54	-23.43

802.11n20:

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	FCC 15.205	
	Reading (dBμV)	PK/QP/Ave.		Height (m)	Polar (H/V)			Limit (dBμV/m)	Margin (dB)
Low Channel (2412 MHz)									
2310.00	46.91	PK	257	1.5	H	-6.69	40.22	74	-33.78
2310.00	36.39	Ave.	257	1.5	H	-6.69	29.70	54	-24.30
2310.00	48.35	PK	159	1.5	V	-6.69	41.66	74	-32.34
2310.00	38.02	Ave.	159	1.5	V	-6.69	31.33	54	-22.67
2390.00	47.75	PK	328	1.5	H	-6.32	41.43	74	-32.57
2390.00	37.58	Ave.	328	1.5	H	-6.32	31.26	54	-22.74
2390.00	47.43	PK	258	1.5	V	-6.32	41.11	74	-32.89
2390.00	37.10	Ave.	258	1.5	V	-6.32	30.78	54	-23.22
High Channel (2462 MHz)									
2483.50	53.42	PK	258	1.5	H	-5.89	47.53	74	-26.47
2483.50	43.23	Ave.	258	1.5	H	-5.89	37.34	54	-16.66
2483.50	56.19	PK	209	1.5	V	-5.89	50.30	74	-23.70
2483.50	46.41	Ave.	209	1.5	V	-5.89	40.52	54	-13.48
2500.00	46.78	PK	327	1.5	H	-5.81	40.97	74	-33.03
2500.00	36.57	Ave.	327	1.5	H	-5.81	30.76	54	-23.24
2500.00	48.46	PK	320	1.5	V	-5.81	42.65	74	-31.35
2500.00	38.54	Ave.	320	1.5	V	-5.81	32.73	54	-21.27

802.11n40:

Frequency (MHz)	Receiver		Turntable Degree	Rx Antenna		Corrected Factor (dB/m)	Corrected Amplitude (dBμV/m)	FCC 15.205	
	Reading (dBμV)	PK/QP/Ave.		Height (m)	Polar (H/V)			Limit (dBμV/m)	Margin (dB)
Low Channel (2422 MHz)									
2310.00	45.71	PK	234	1.5	H	-6.69	39.02	74	-34.98
2310.00	35.69	Ave.	234	1.5	H	-6.69	29.00	54	-25.00
2310.00	47.31	PK	72	1.5	V	-6.69	40.62	74	-33.38
2310.00	37.85	Ave.	72	1.5	V	-6.69	31.16	54	-22.84
2390.00	48.06	PK	337	1.5	H	-6.32	41.74	74	-32.26
2390.00	38.48	Ave.	337	1.5	H	-6.32	32.16	54	-21.84
2390.00	46.76	PK	81	1.5	V	-6.32	40.44	74	-33.56
2390.00	36.28	Ave.	81	1.5	V	-6.32	29.96	54	-24.04
High Channel (2452 MHz)									
2483.50	55.02	PK	95	1.5	H	-5.89	49.13	74	-24.87
2483.50	45.47	Ave.	95	1.5	H	-5.89	39.58	54	-14.42
2483.50	53.82	PK	125	1.5	V	-5.89	47.93	74	-26.07
2483.50	43.37	Ave.	125	1.5	V	-5.89	37.48	54	-16.52
2500.00	48.38	PK	154	1.5	H	-5.81	42.57	74	-31.43
2500.00	38.07	Ave.	154	1.5	H	-5.81	32.26	54	-21.74
2500.00	45.98	PK	197	1.5	V	-5.81	40.17	74	-33.83
2500.00	35.47	Ave.	197	1.5	V	-5.81	29.66	54	-24.34

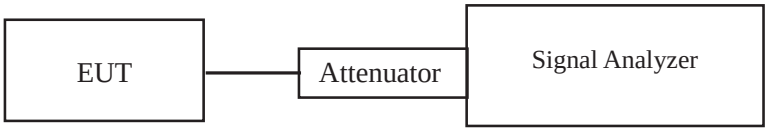
FCC §15.247(e) - POWER SPECTRAL DENSITY

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.

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: 3kHz≤ RBW≤100 kHz.
3. Set the VBW ≥ 3×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:	24 °C
Relative Humidity:	48 %
ATM Pressure:	101.0 kPa

The testing was performed by Ting Lü on 2021-01-14.

EUT operation mode: Transmitting

Test Result: Compliant. Please refer to the Appendix Wi-Fi.

APPENDIX Wi-Fi

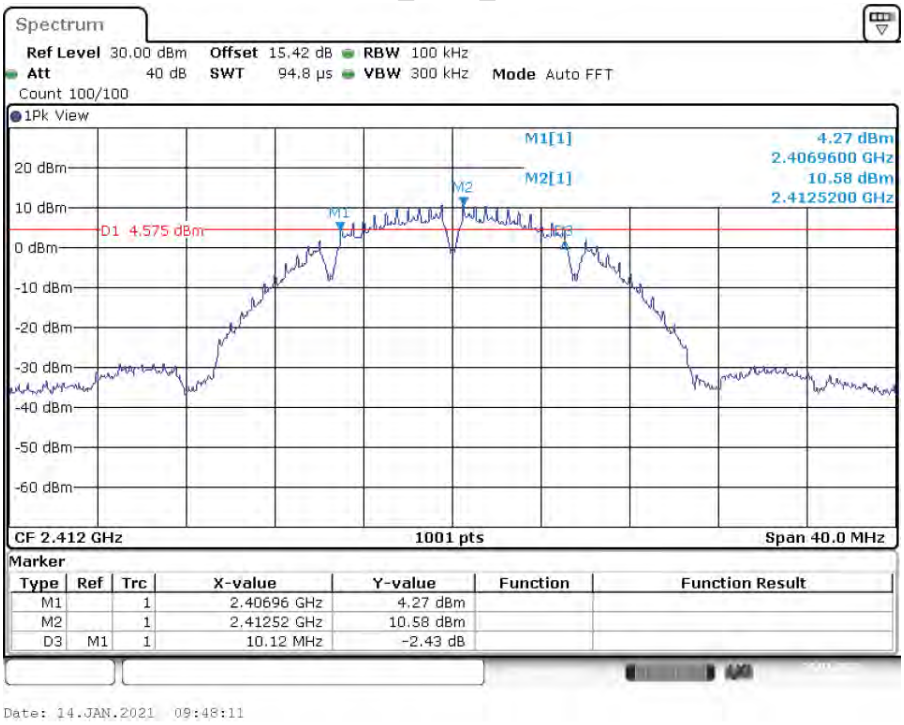
Appendix A: 6dB Emission Bandwidth

Test Result

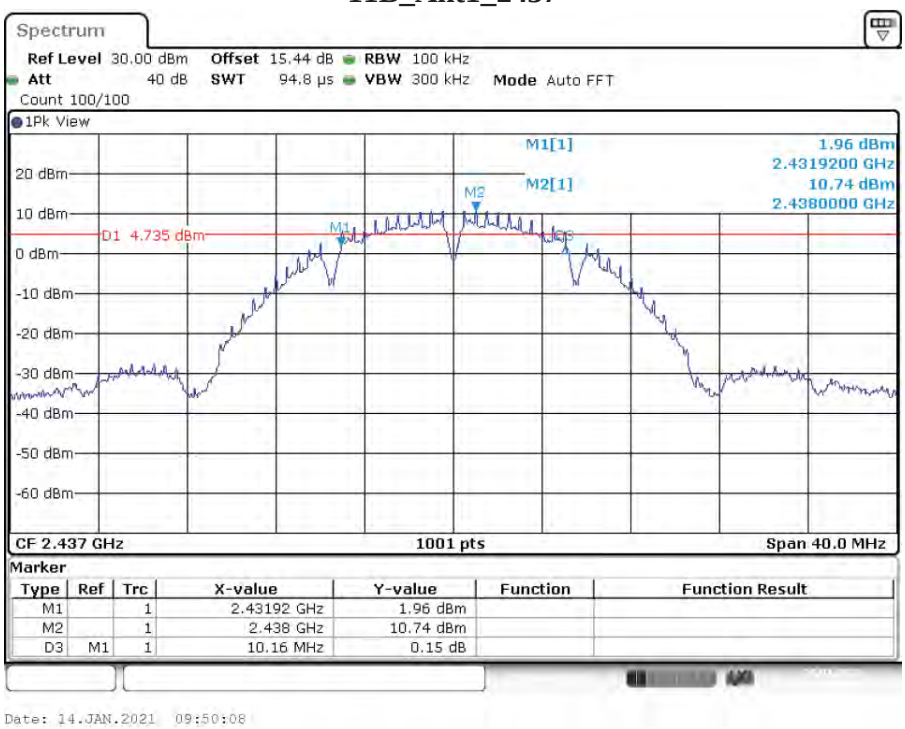
Test Mode	Antenna	Channel	DTS BW [MHz]	Limit[MHz]	Verdict
11B	Ant1	2412	10.120	0.5	PASS
		2437	10.160	0.5	PASS
		2462	10.120	0.5	PASS
11G	Ant1	2412	16.400	0.5	PASS
		2437	16.400	0.5	PASS
		2462	16.400	0.5	PASS
11N20SISO	Ant1	2412	17.640	0.5	PASS
		2437	17.680	0.5	PASS
		2462	17.680	0.5	PASS
11N40SISO	Ant1	2422	36.080	0.5	PASS
		2437	36.240	0.5	PASS
		2452	36.240	0.5	PASS

Test Graphs

11B_Ant1_2412



11B_Ant1_2437



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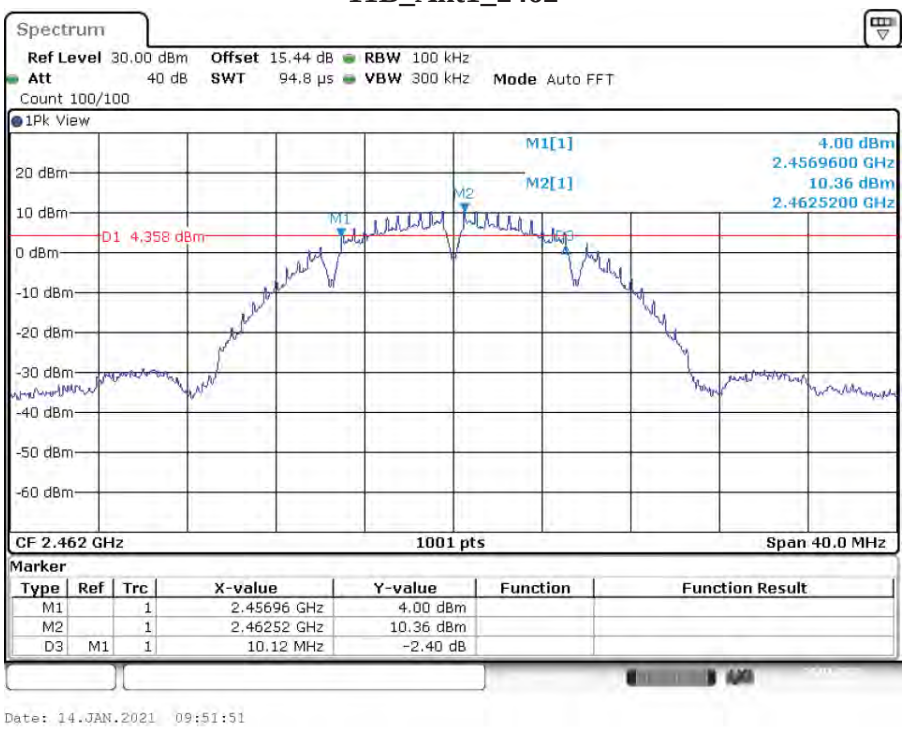
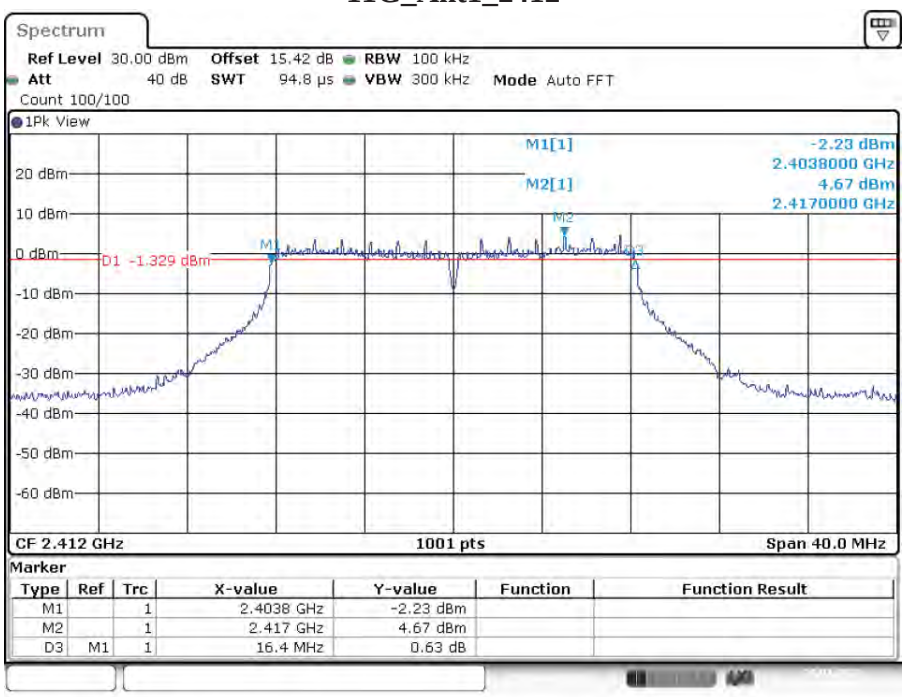
11B_Ant1_2462



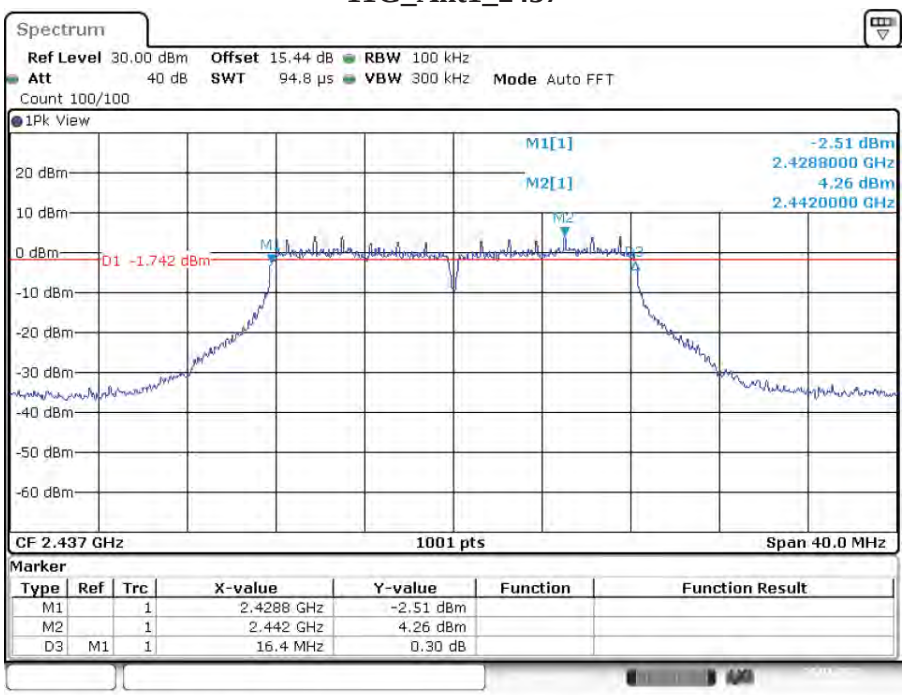
Date: 14.JAN.2021 09:51:51

11G_Ant1_2412



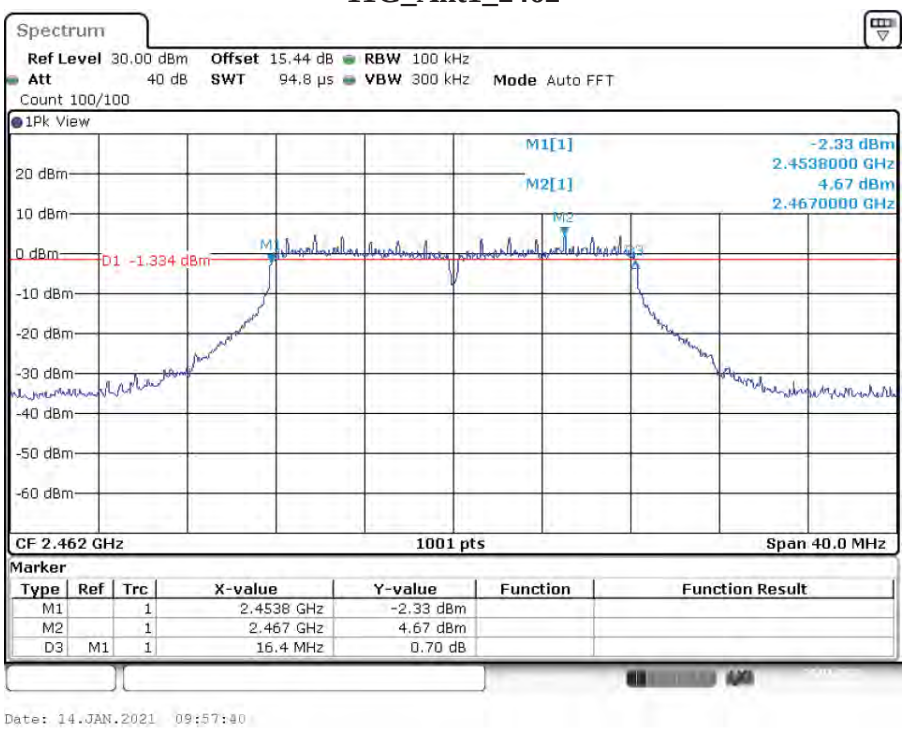
Date: 14.JAN.2021 09:53:59

11G_Ant1_2437



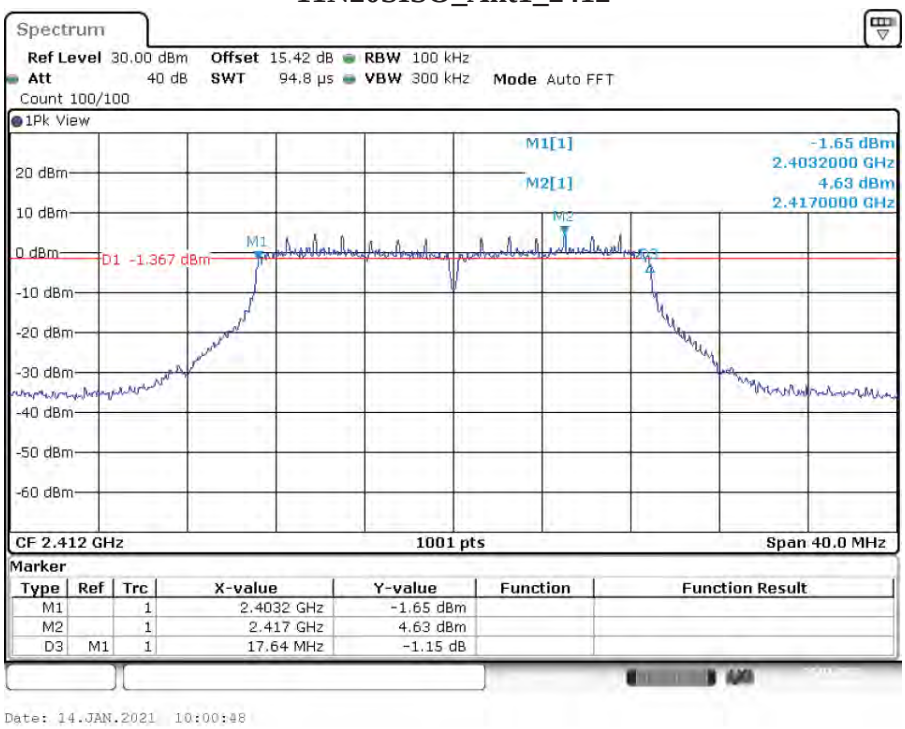
Date: 14.JAN.2021 09:55:54

11G_Ant1_2462



Date: 14.JAN.2021 09:57:40

11N20SISO_Ant1_2412



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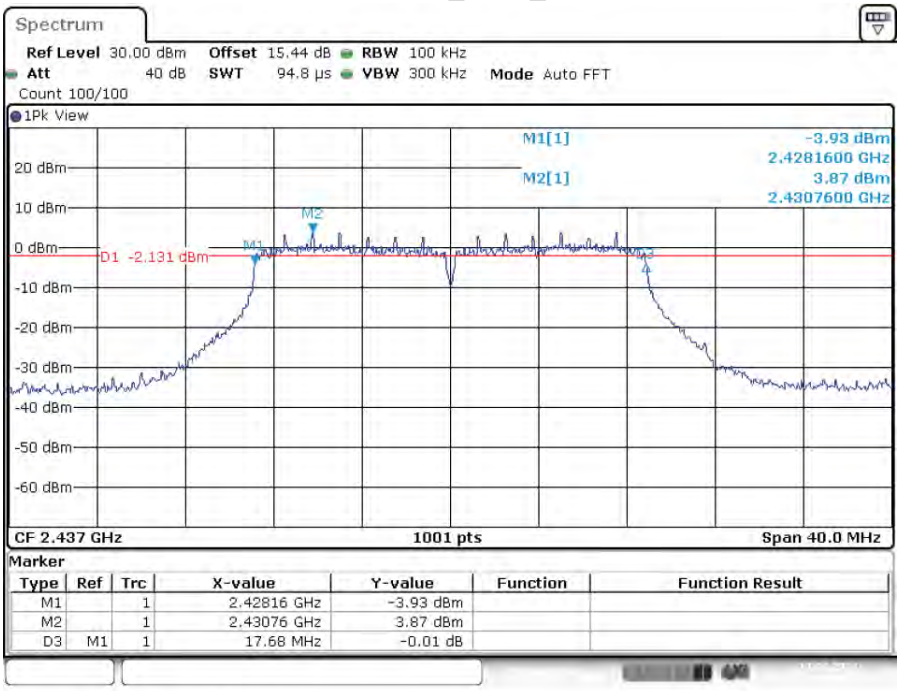

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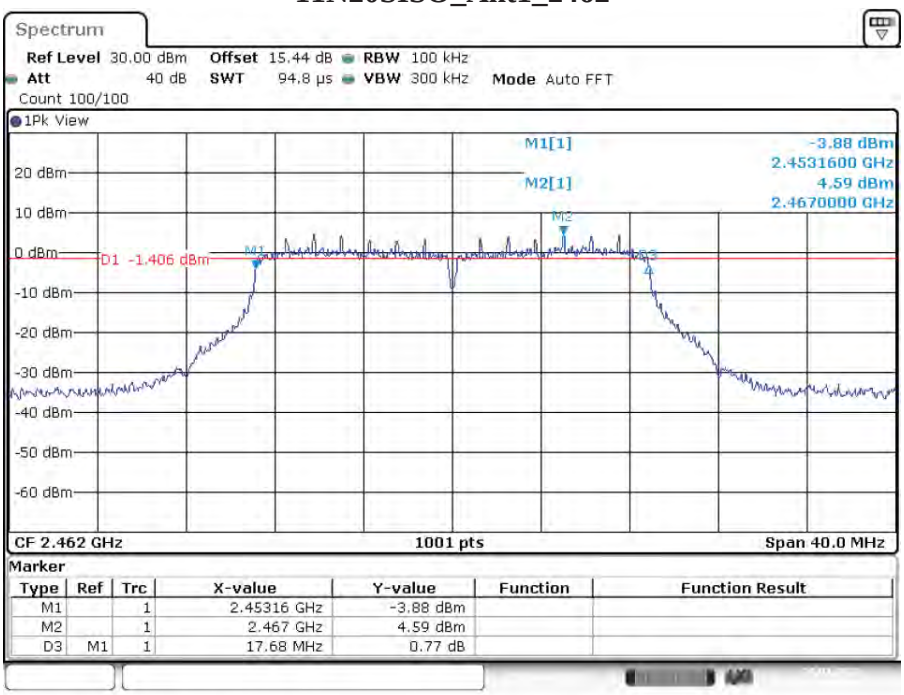
11N20SISO_Ant1_2462



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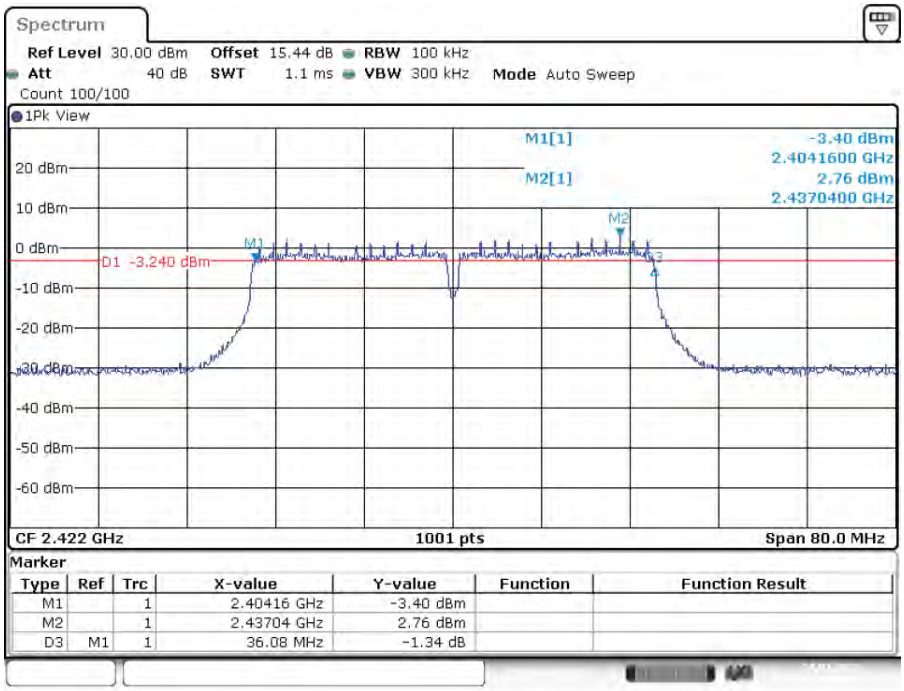
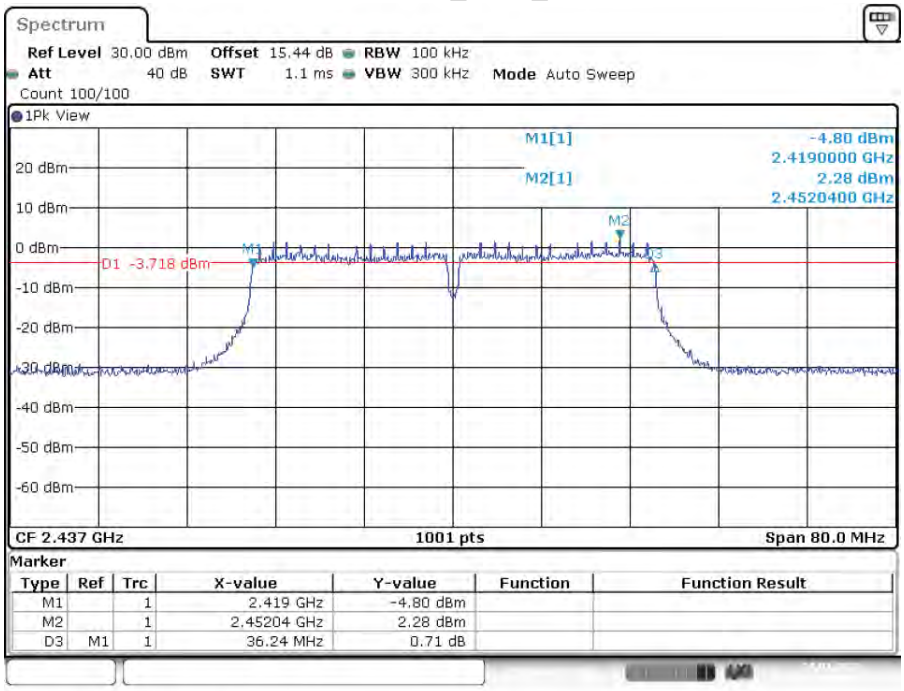
11N40SISO_Ant1_2422



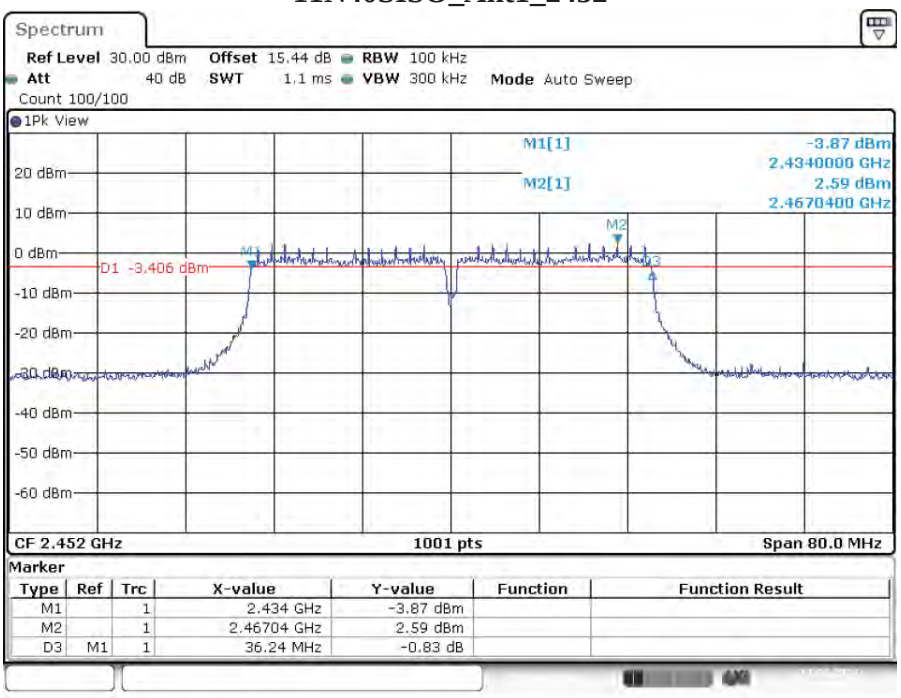
Date: 14.JAN.2021 10:08:03

11N40SISO_Ant1_2437



Date: 14.JAN.2021 10:09:53

11N40SISO_Ant1_2452



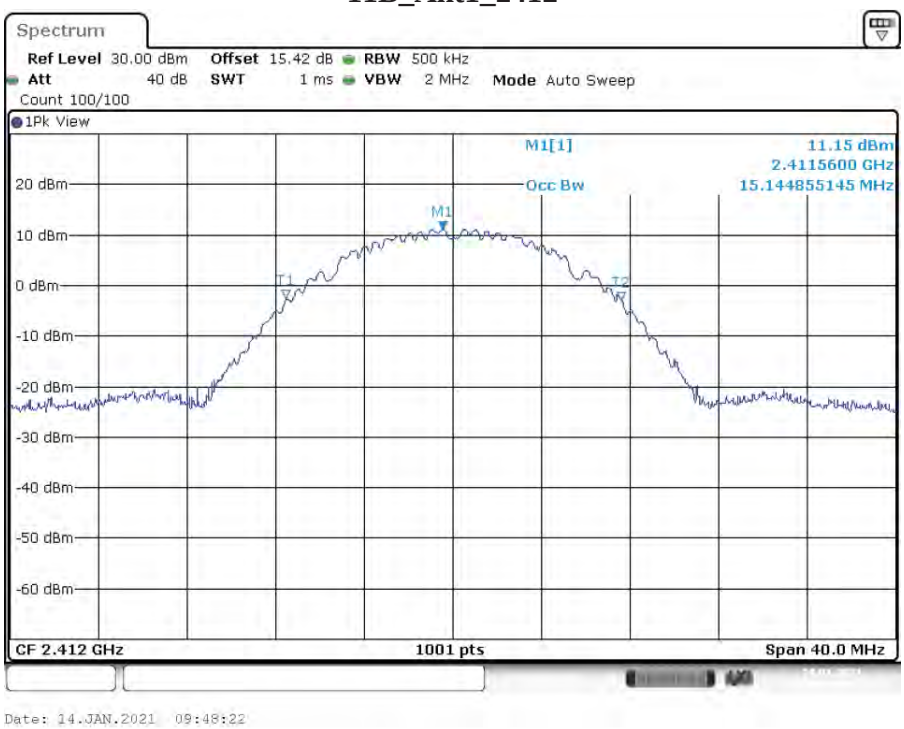
Appendix B: Occupied Channel Bandwidth

Test Result

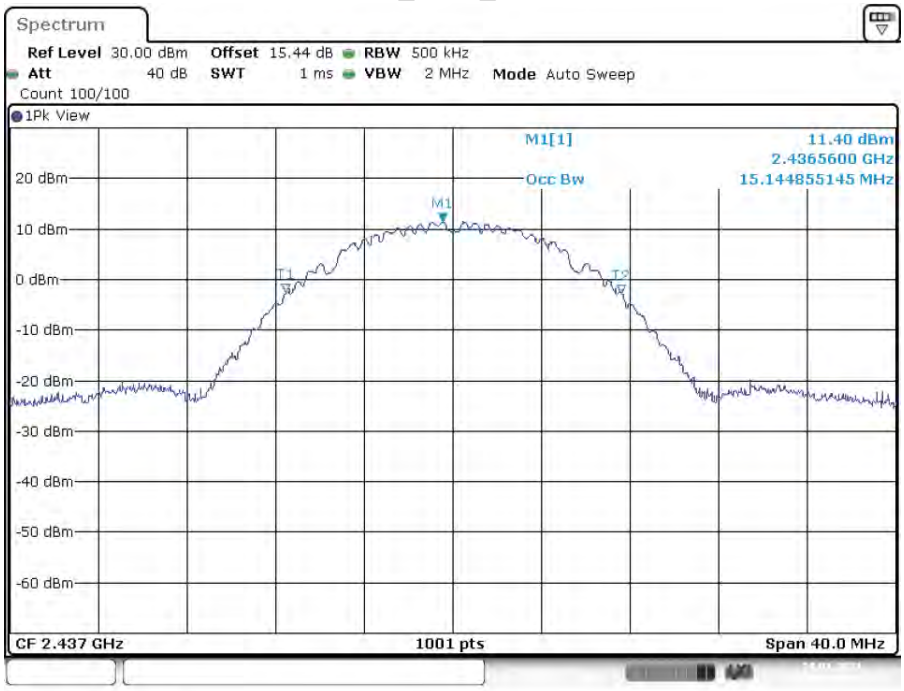
Test Mode	Antenna	Channel	OCB [MHz]	Limit[MHz]	Verdict
11B	Ant1	2412	15.145	---	PASS
		2437	15.145	---	PASS
		2462	15.185	---	PASS
11G	Ant1	2412	18.022	---	PASS
		2437	18.062	---	PASS
		2462	18.102	---	PASS
11N20SISO	Ant1	2412	18.941	---	PASS
		2437	18.861	---	PASS
		2462	18.901	---	PASS
11N40SISO	Ant1	2422	37.483	---	PASS
		2437	37.483	---	PASS
		2452	37.562	---	PASS

Test Graphs

11B_Ant1_2412



11B_Ant1_2437



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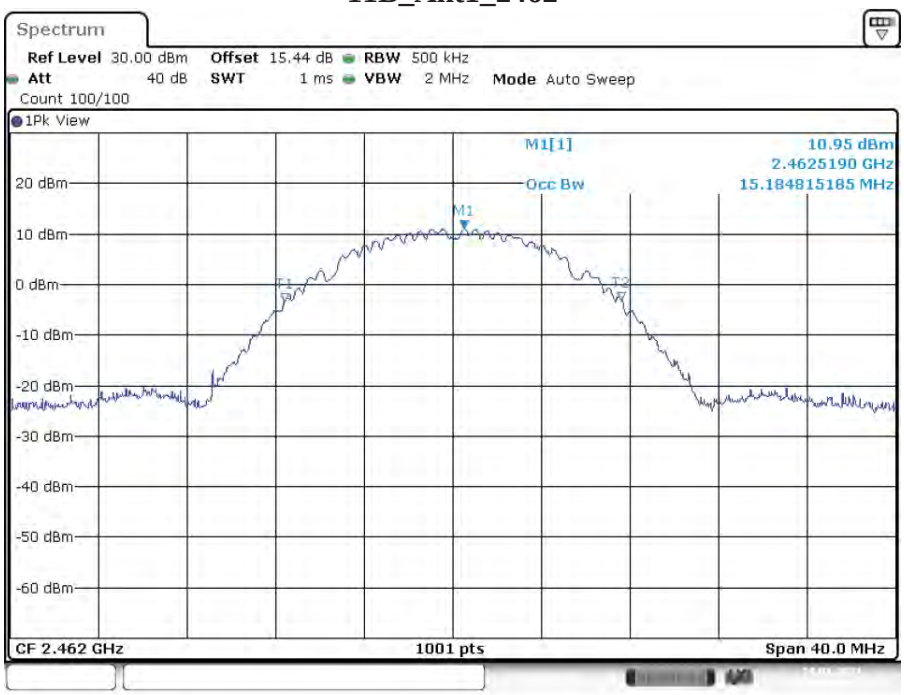
11B_Ant1_2462



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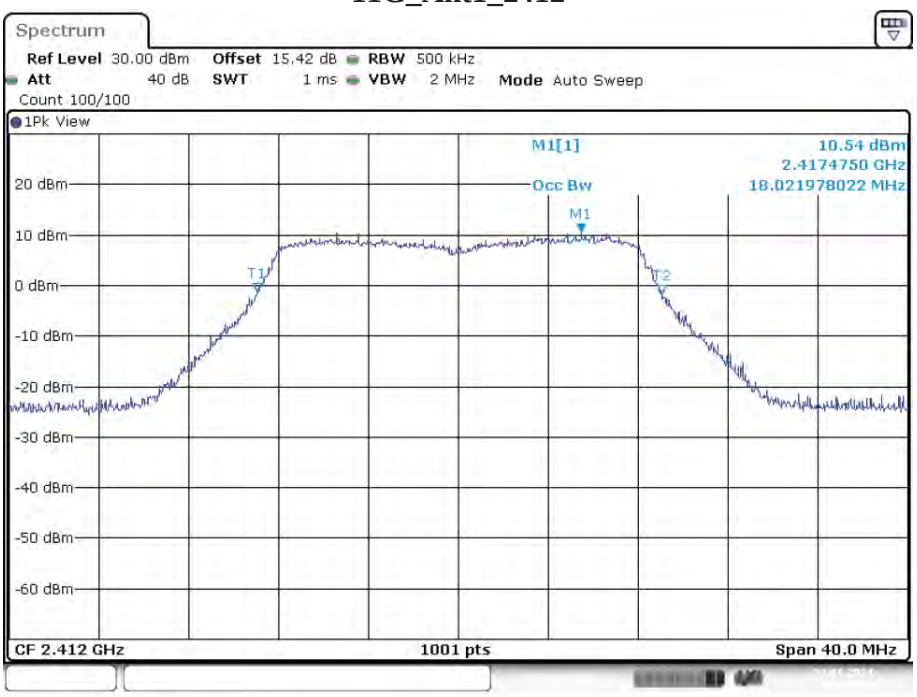
11G_Ant1_2412



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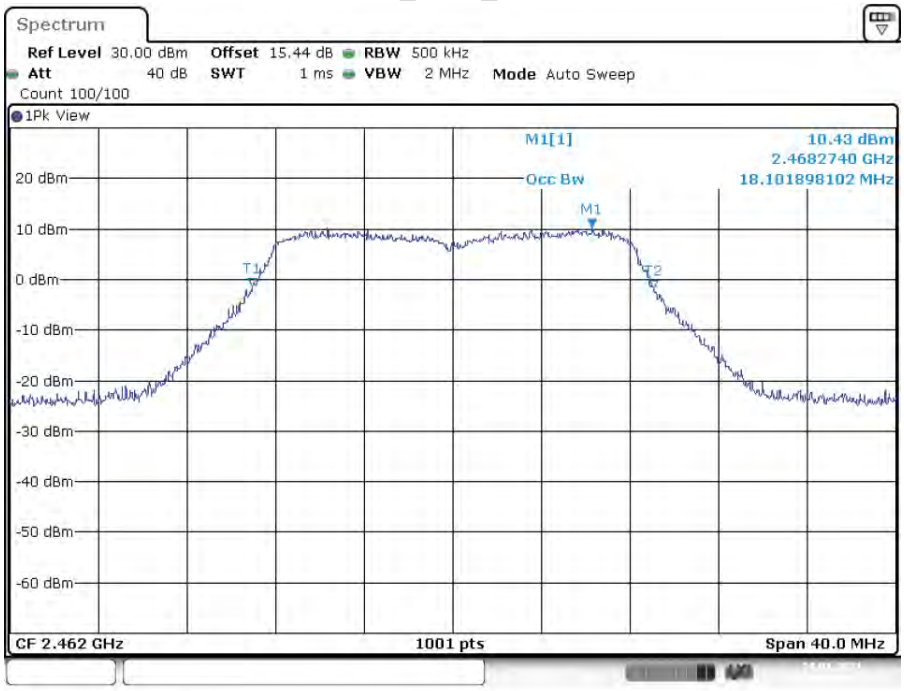
11G_Ant1_2437

Date: 14.JAN.2021 09:56:04

11G_Ant1_2462



Date: 14.JAN.2021 09:57:51

11N20SISO_Ant1_2412

Date: 14.JAN.2021 10:00:59

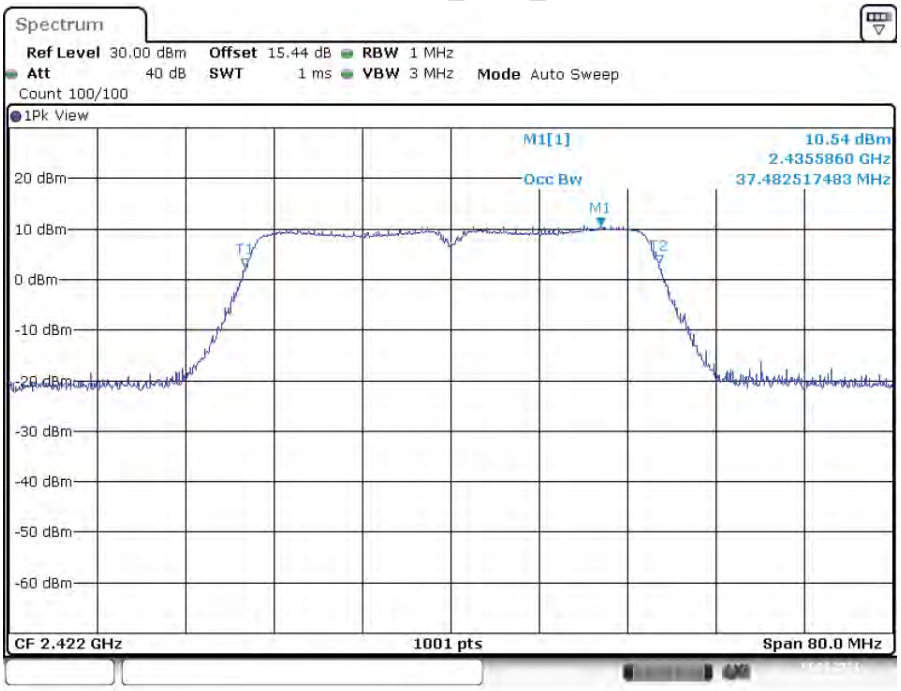
11N20SISO_Ant1_2437

Date: 14.JAN.2021 10:04:05

11N20SISO_Ant1_2462

Date: 14.JAN.2021 10:06:00

11N40SISO_Ant1_2422



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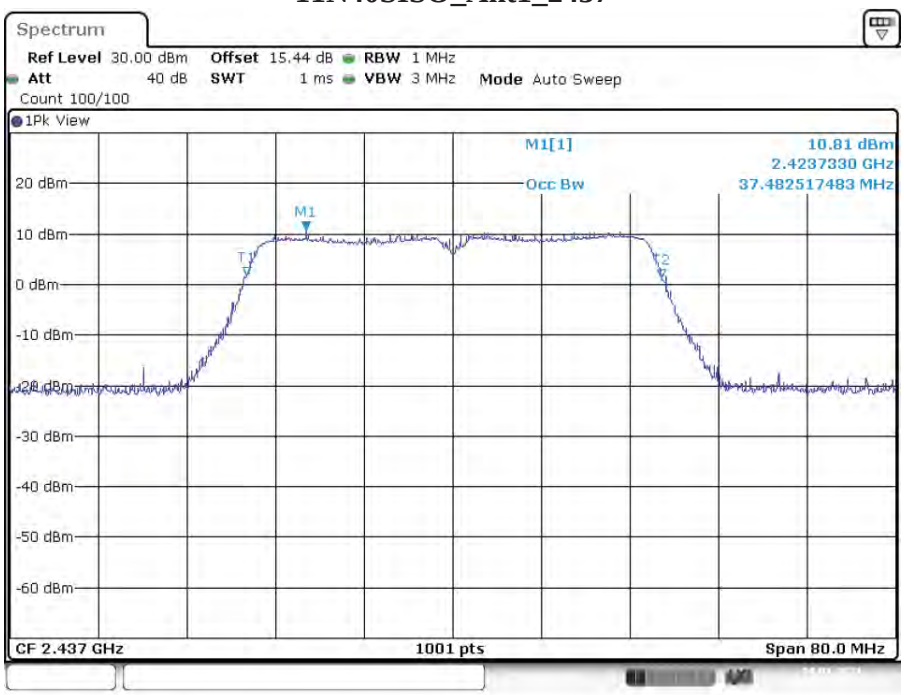
11N40SISO_Ant1_2437



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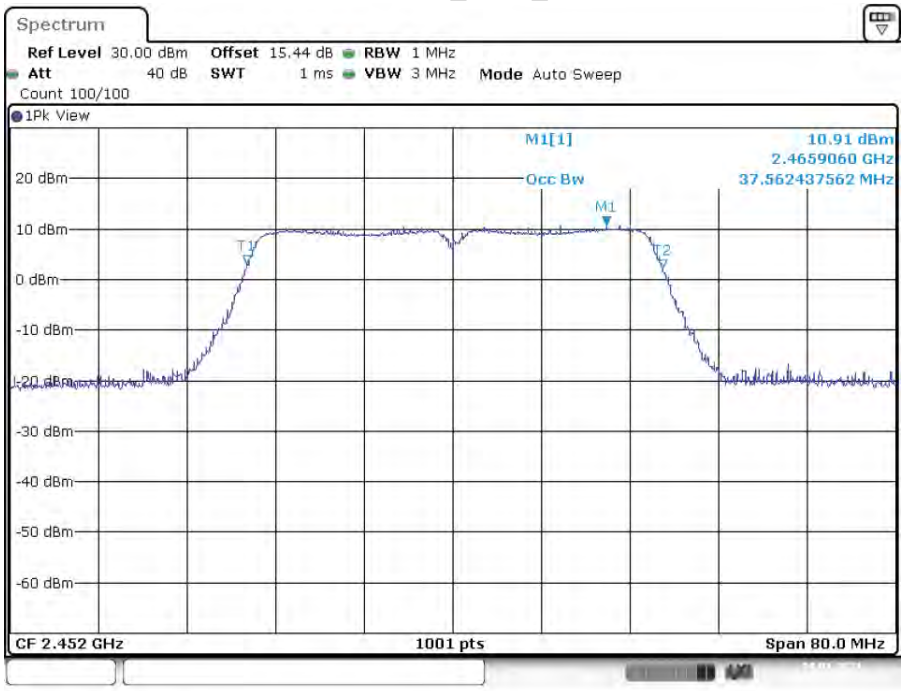
11N40SISO_Ant1_2452



Date: 14.JAN.2021 10:12:01

Appendix C: Maximum conducted output power (Peak)

Test Result

Test Mode	Antenna	Channel	Conducted power [dBm]	Limit[dBm]	Verdict
11B	Ant1	2412	18.21	30	PASS
		2437	18.03	30	PASS
		2462	18.01	30	PASS
11G	Ant1	2412	14.98	30	PASS
		2437	14.35	30	PASS
		2462	14.21	30	PASS
11N20SISO	Ant1	2412	15.02	30	PASS
		2437	14.12	30	PASS
		2462	14.01	30	PASS
11N40SISO	Ant1	2412	15.01	30	PASS
		2437	15.12	30	PASS
		2462	15.03	30	PASS

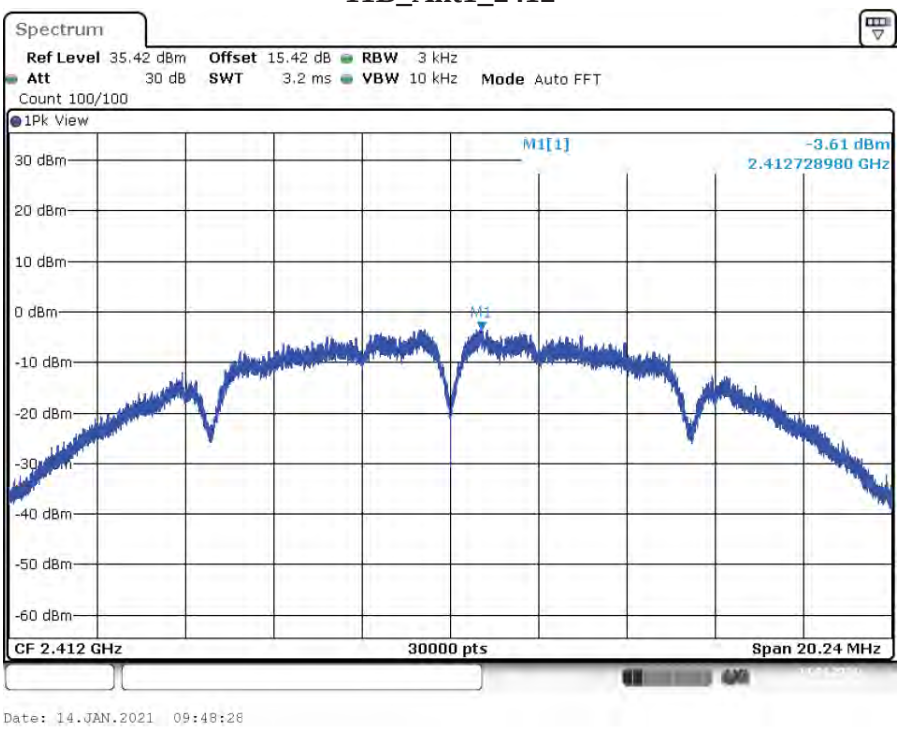
Appendix D: Power spectral density

Test Result

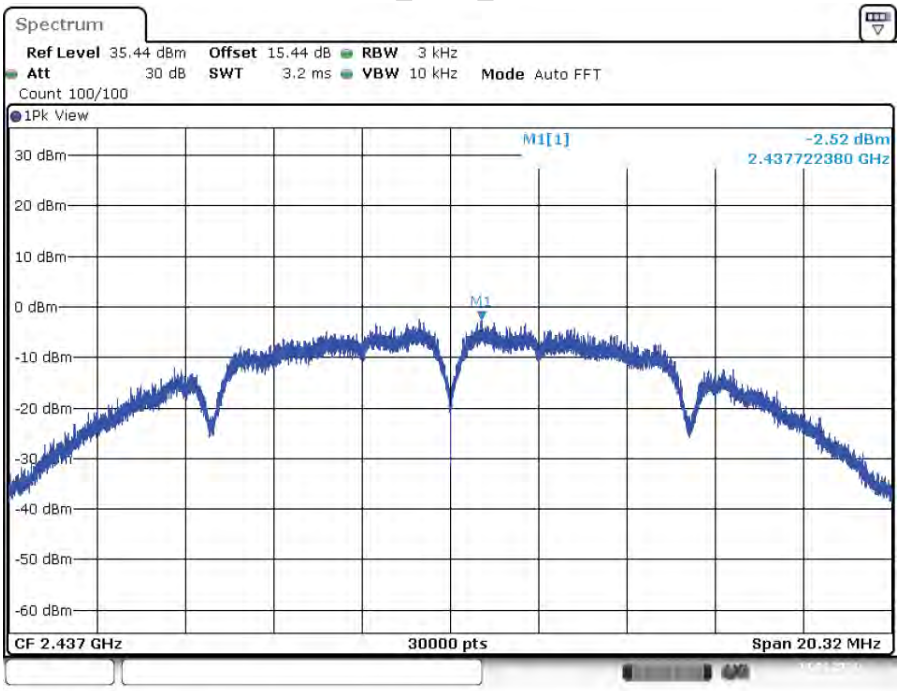
Test Mode	Antenna	Channel	Result[dBm/3kHz]	Limit[dBm/3kHz]	Verdict
11B	Ant1	2412	-3.61	<=8	PASS
		2437	-2.52	<=8	PASS
		2462	-3.72	<=8	PASS
11G	Ant1	2412	-9.58	<=8	PASS
		2437	-9.06	<=8	PASS
		2462	-9.19	<=8	PASS
11N20SISO	Ant1	2412	-9.27	<=8	PASS
		2437	-9.28	<=8	PASS
		2462	-9.92	<=8	PASS
11N40SISO	Ant1	2422	-11.93	<=8	PASS
		2437	-11.3	<=8	PASS
		2452	-11.87	<=8	PASS

Test Graphs

11B_Ant1_2412



11B_Ant1_2437



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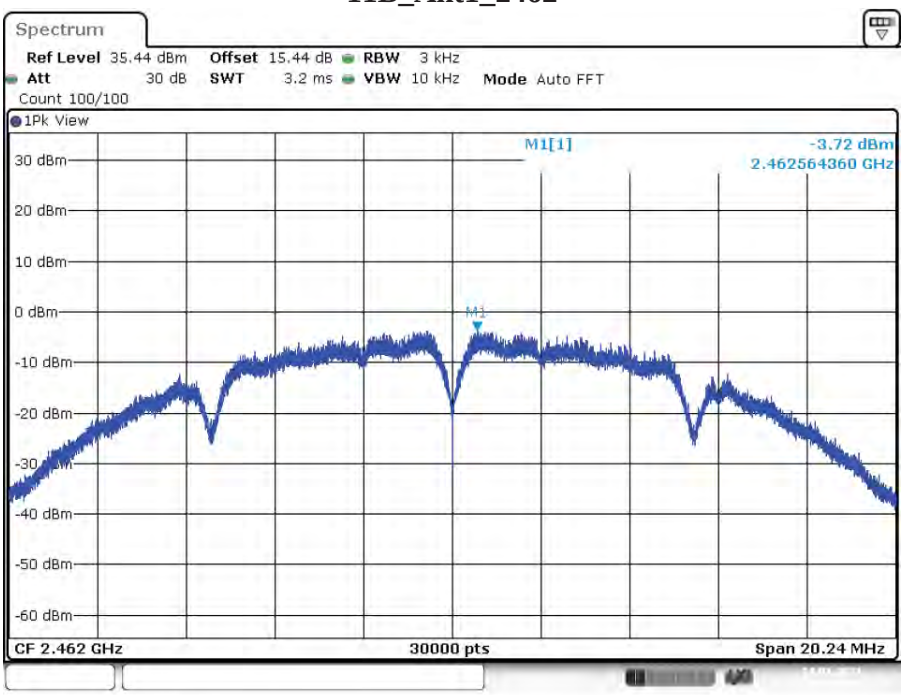
11B_Ant1_2462



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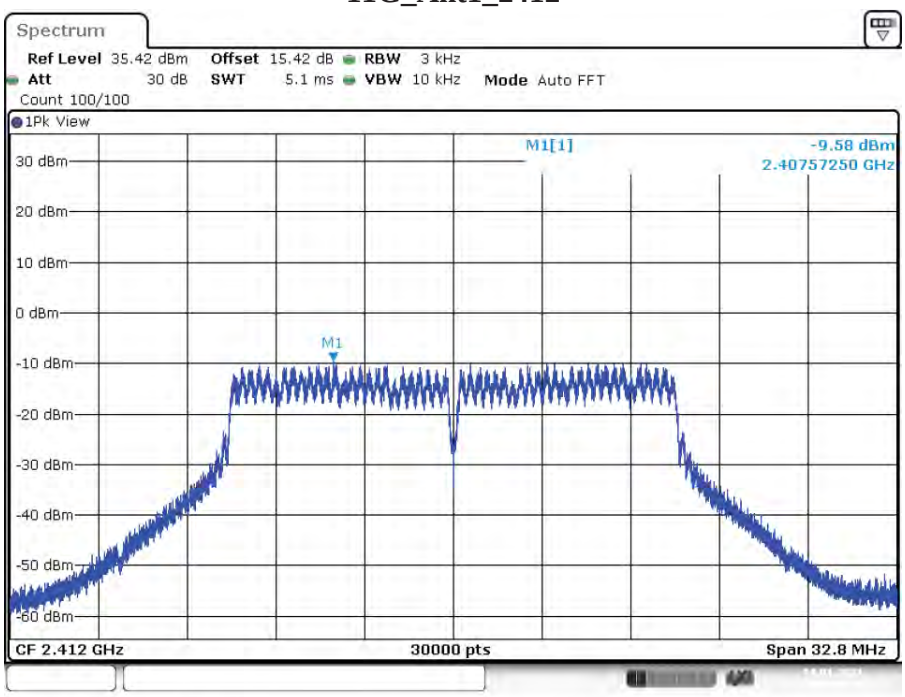

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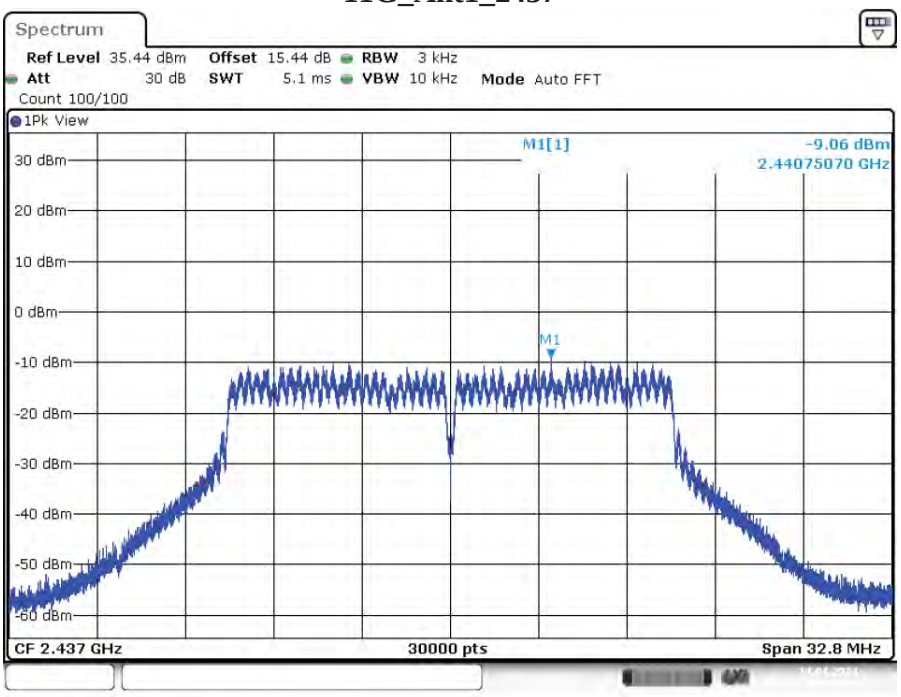

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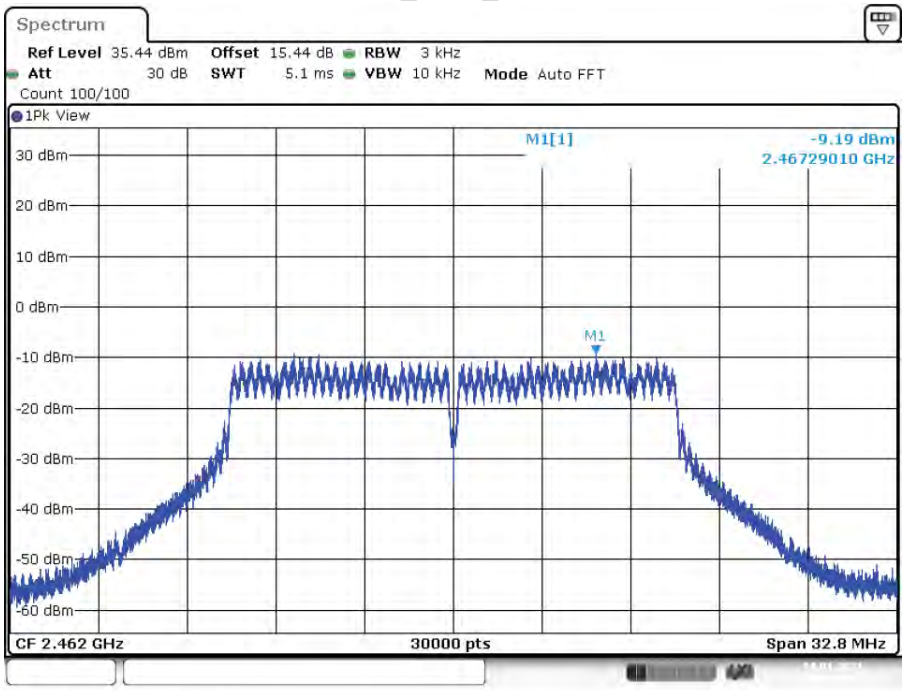

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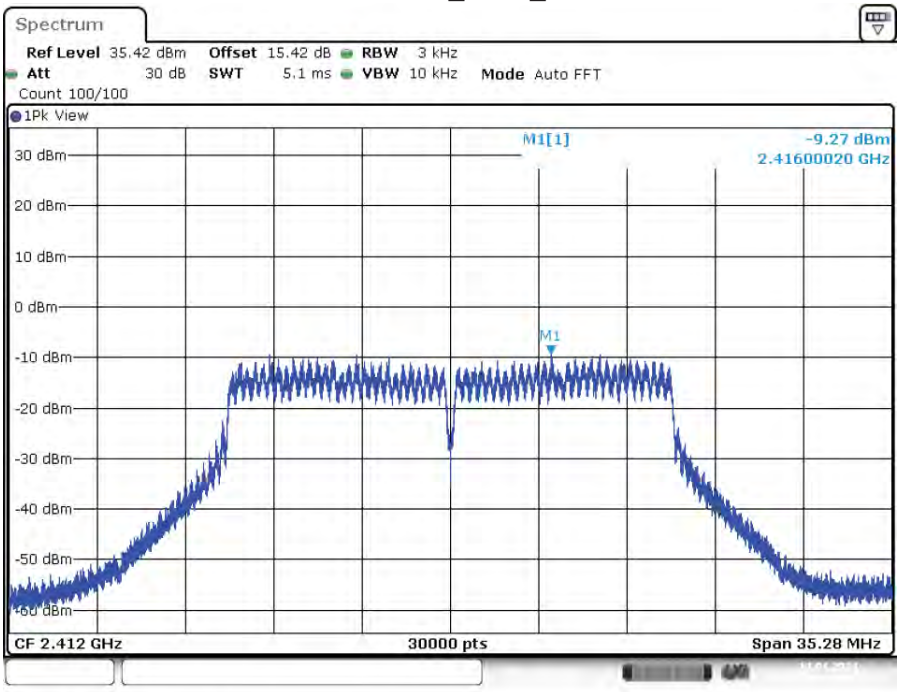
11N20SISO_Ant1_2412



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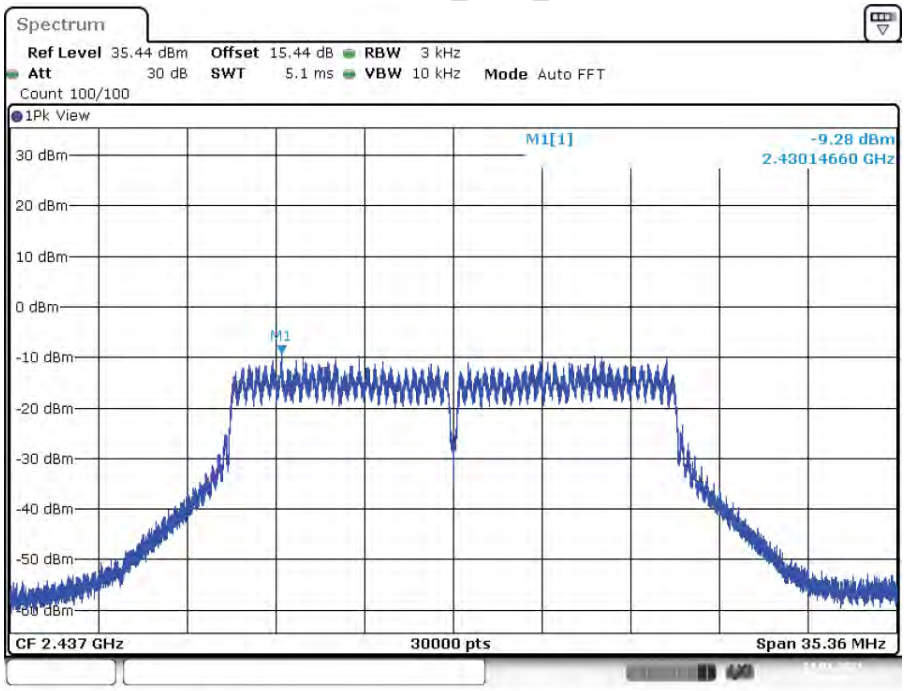

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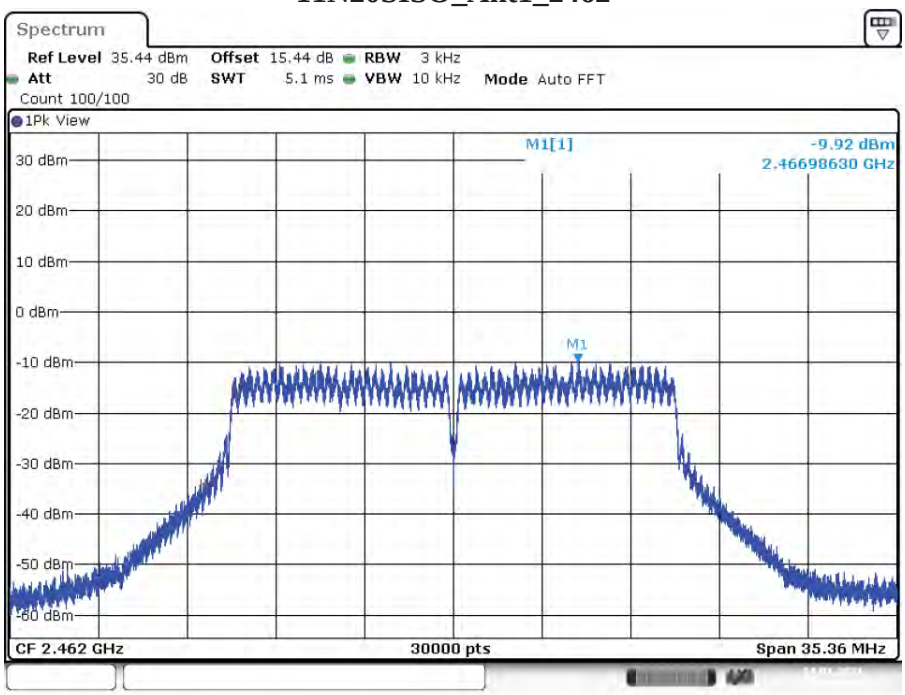

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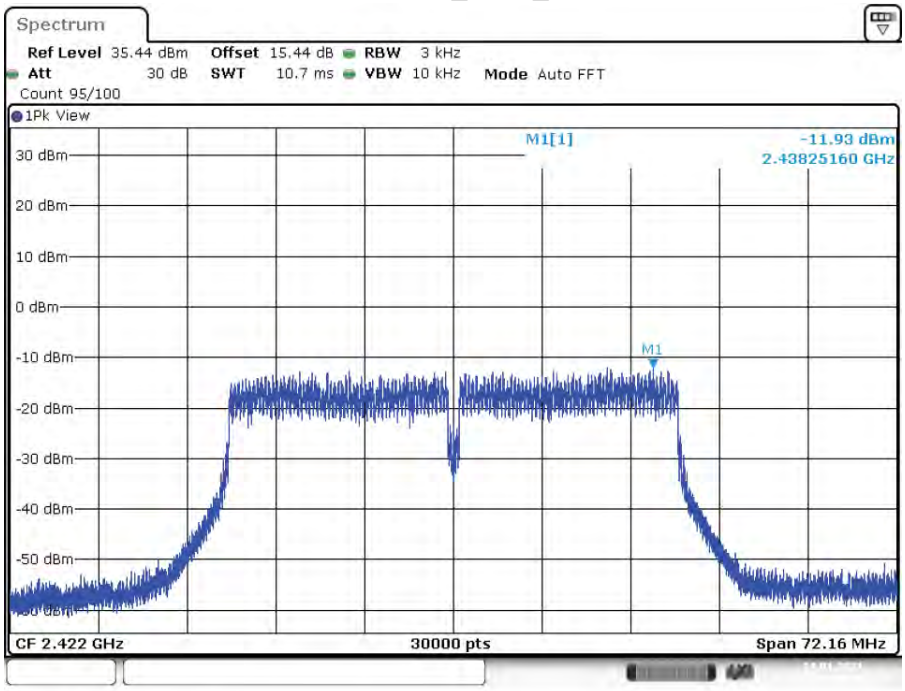

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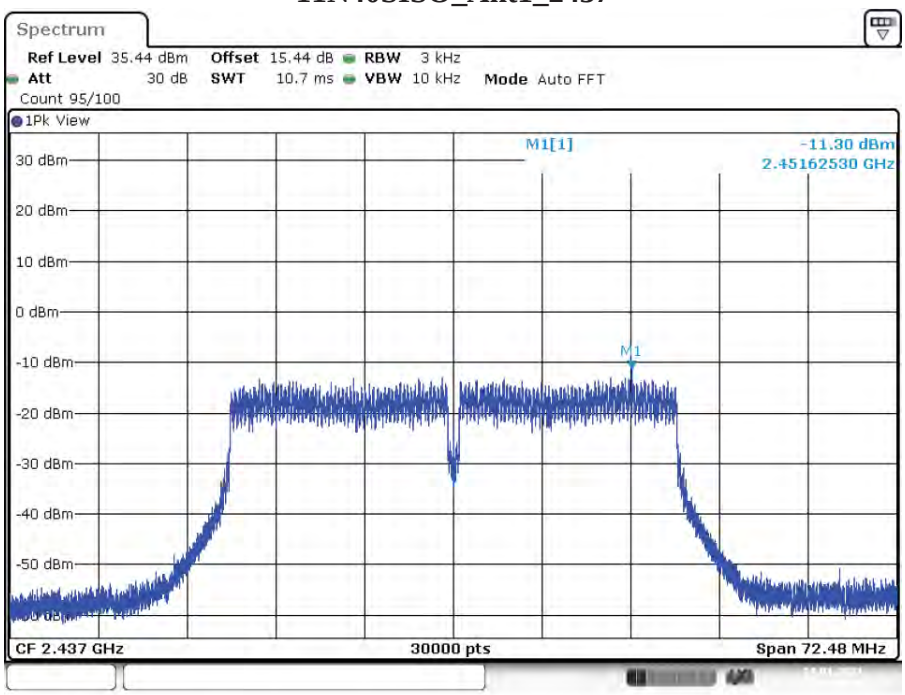

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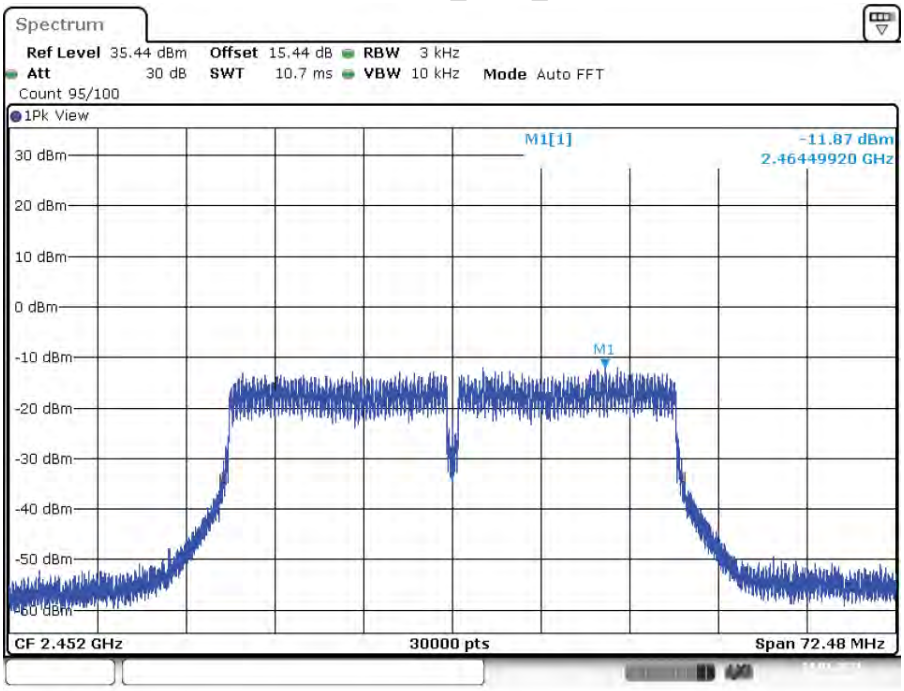

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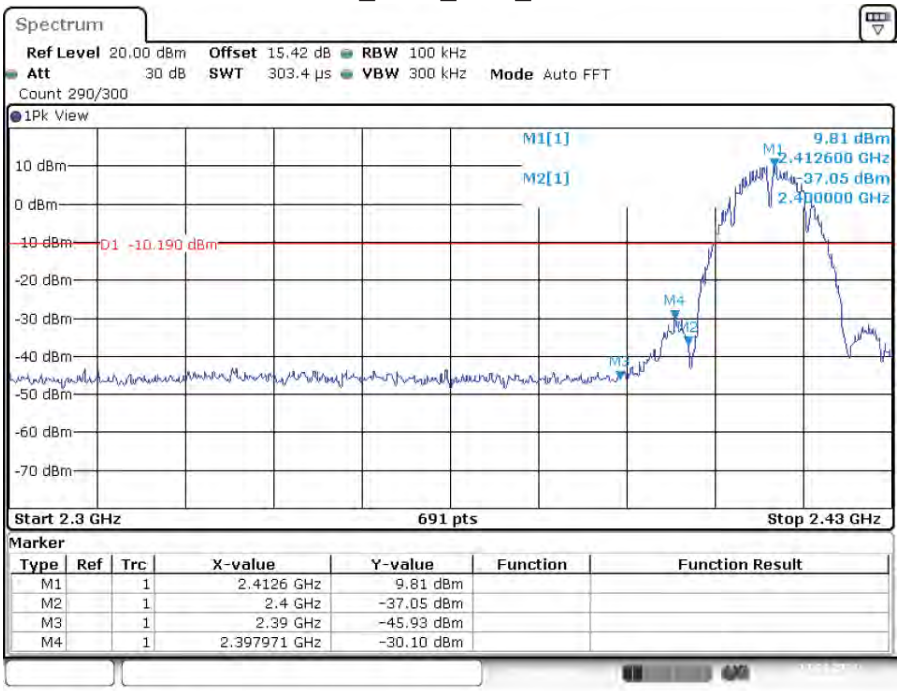
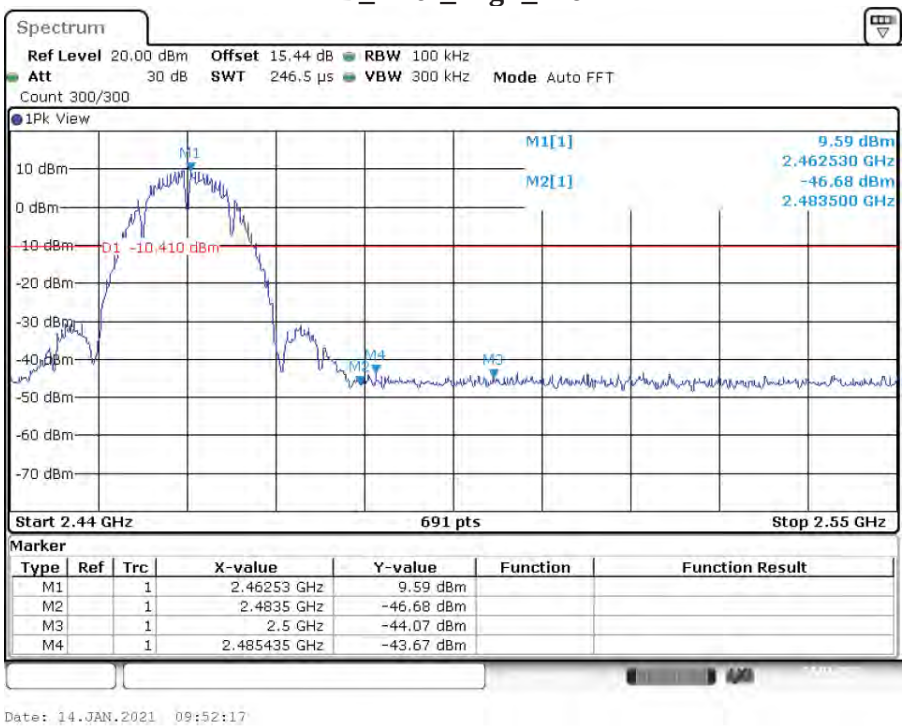
Appendix E: Band edge measurements

Test Graphs

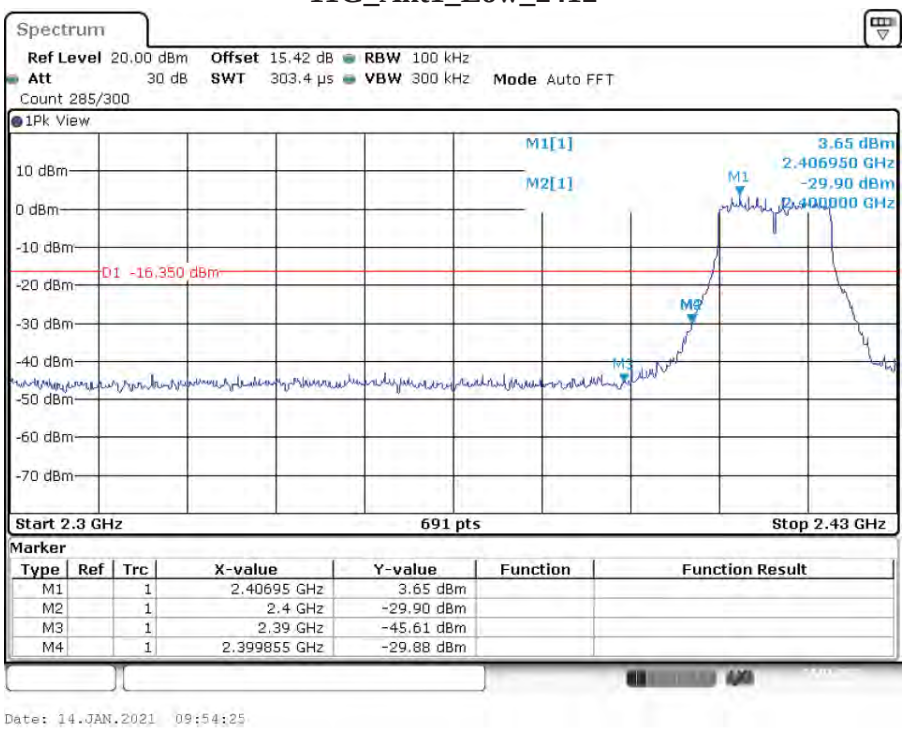
11B_Ant1_Low_2412



11B_Ant1_High_2462



11G_Ant1_Low_2412



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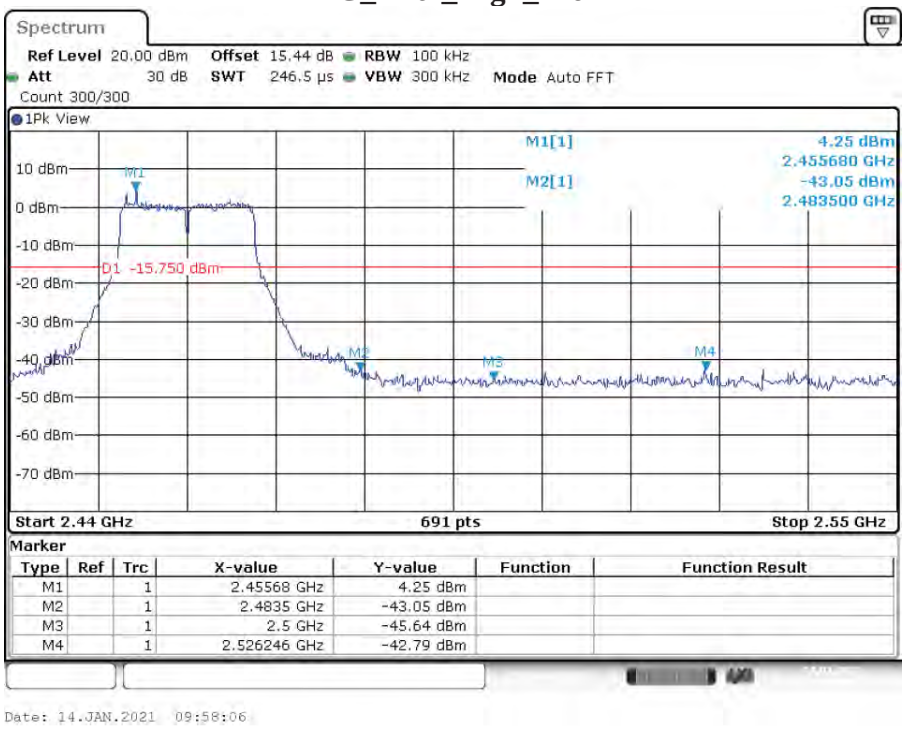

11N20SISO_Ant1_Low_2412

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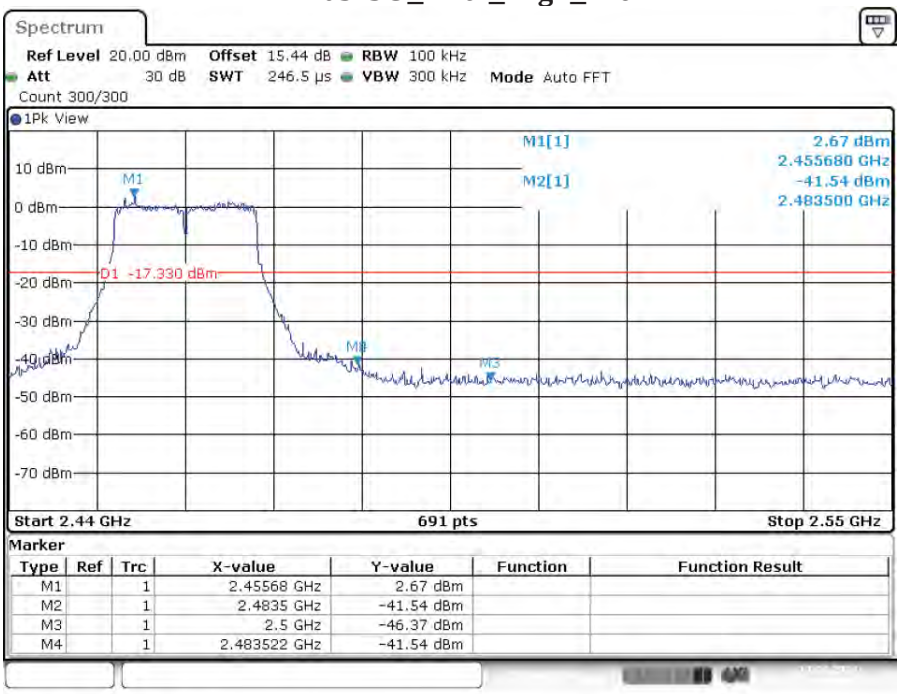
11N20SISO_Ant1_High_2462



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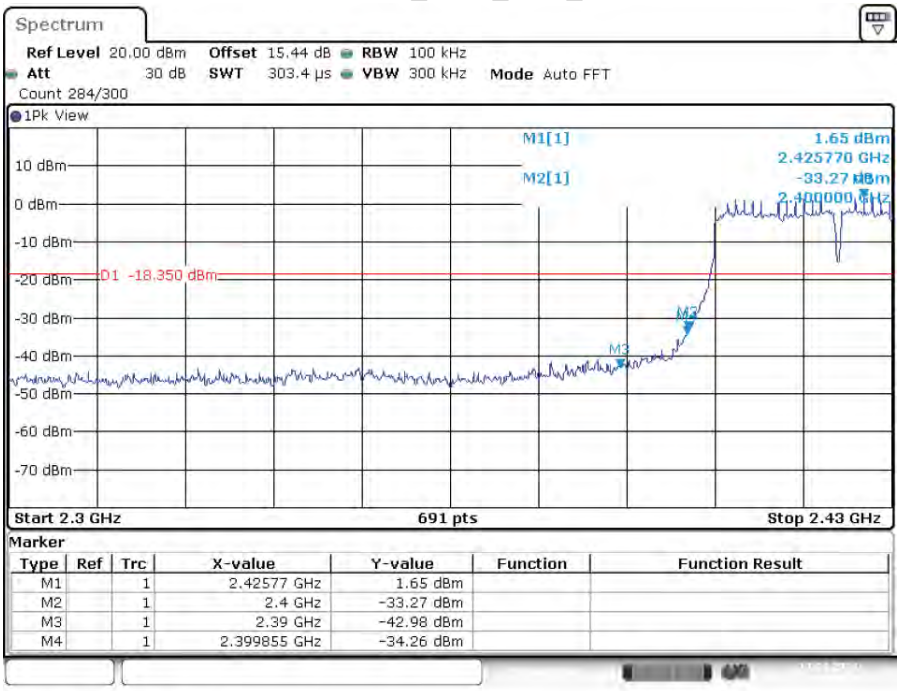
11N40SISO_Ant1_Low_2422



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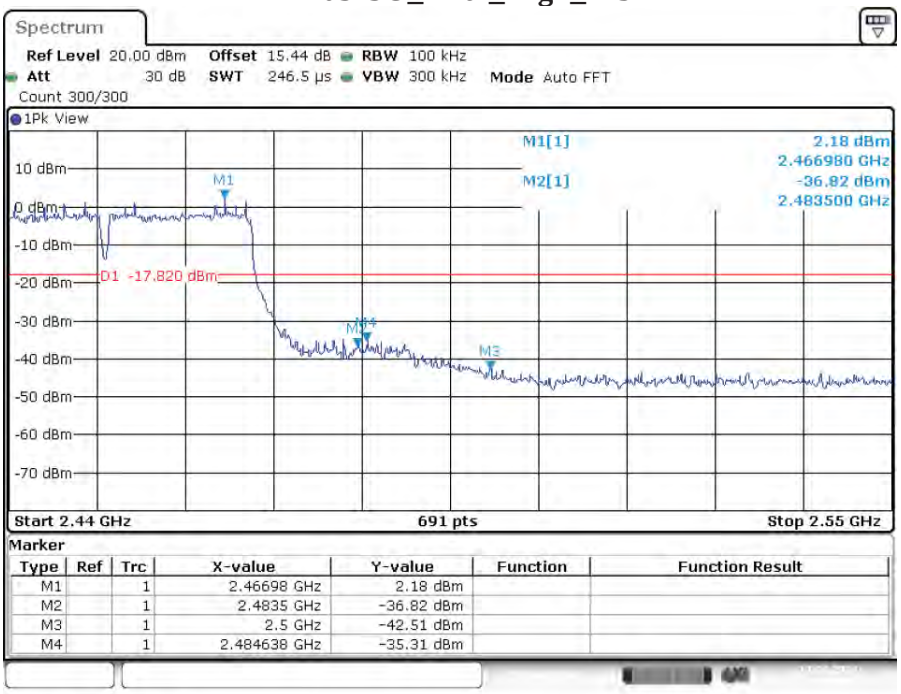
11N40SISO_Ant1_High_2452



Date: 14.JAN.2021 10:12:16

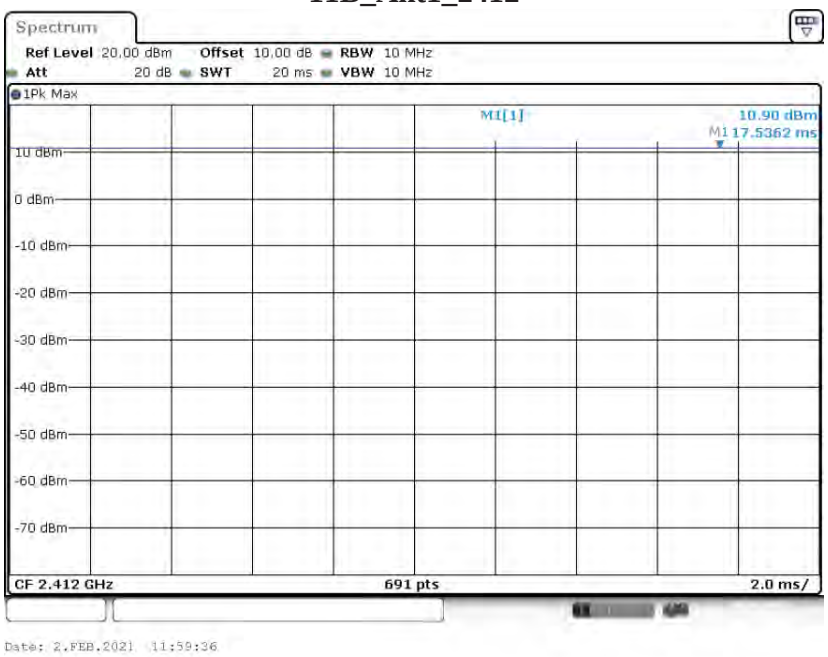
Appendix F: Duty Cycle

Test Result

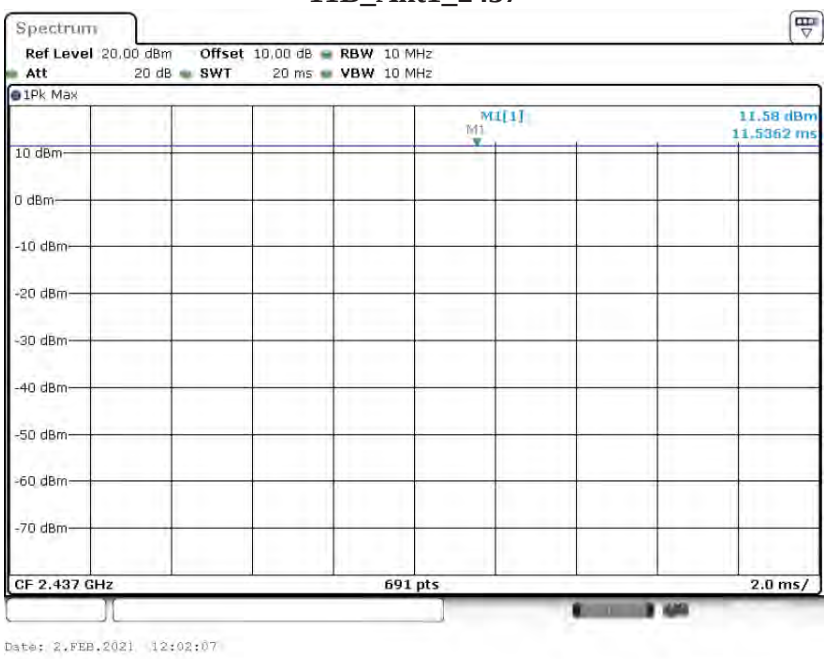
Test Mode	Antenna	Channel	Transmission Duration [ms]	Transmission Period [ms]	Duty Cycle [%]
11B	Ant1	2412	-	-	100
		2437	-	-	100
		2462	-	-	100
11G	Ant1	2412	-	-	100
		2437	-	-	100
		2462	-	-	100
11N20SISO	Ant1	2412	-	-	100
		2437	-	-	100
		2462	-	-	100
11N40SISO	Ant1	2422	-	-	100
		2437	-	-	100
		2452	-	-	100

Test Graphs

11B_Ant1_2412



11B_Ant1_2437



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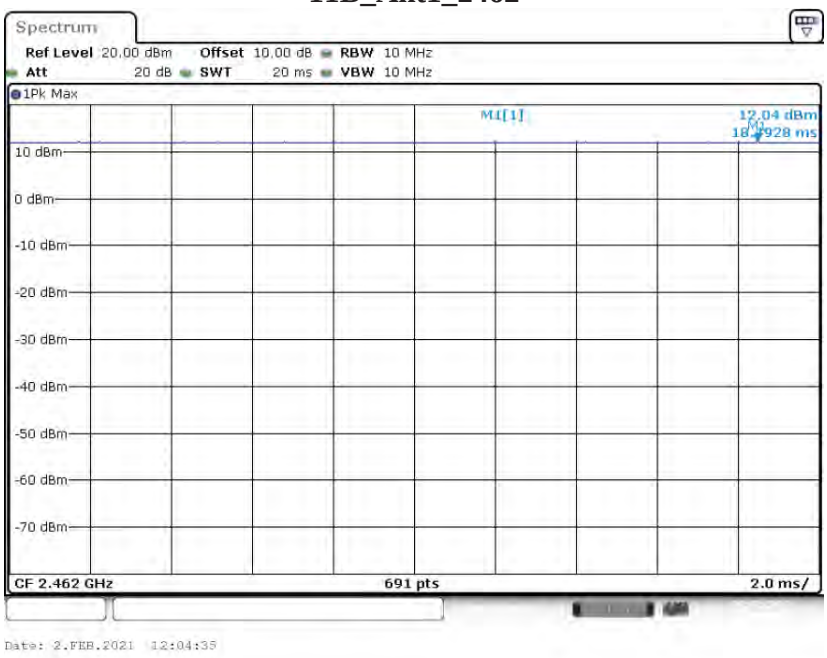
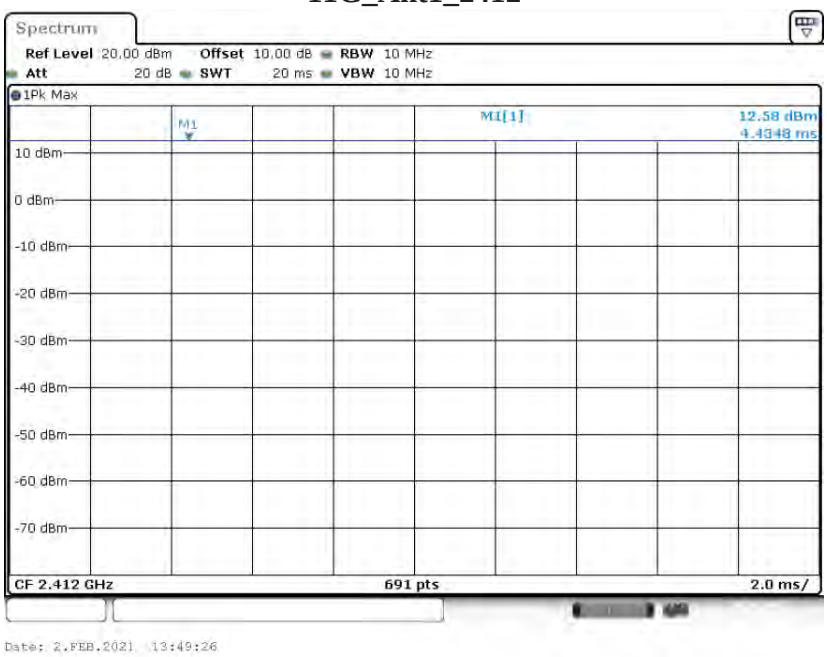


11G_Ant1_2412



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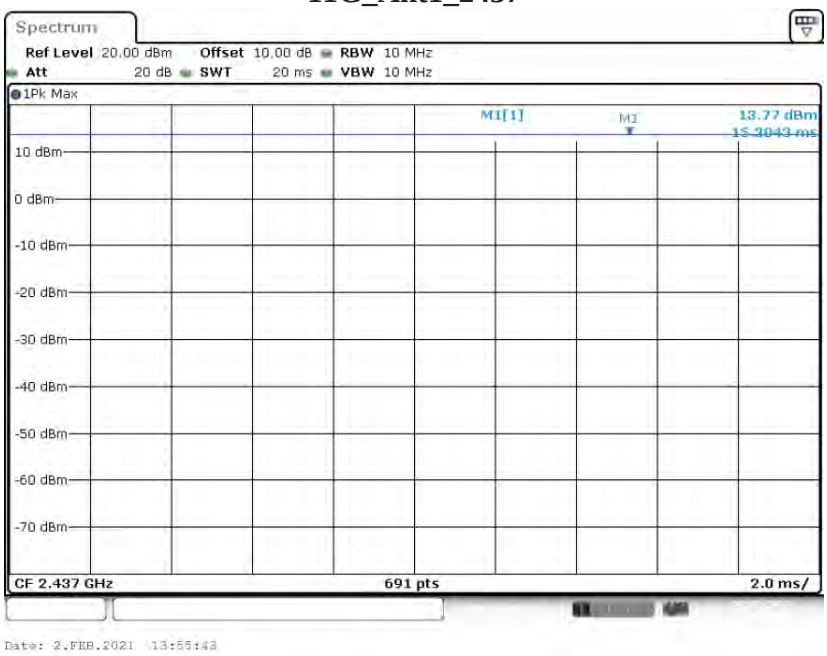

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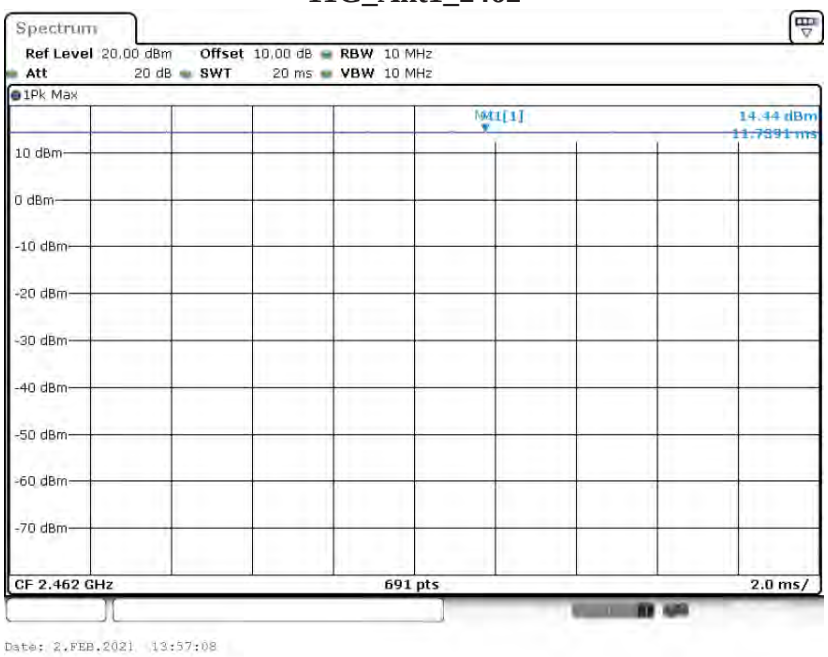
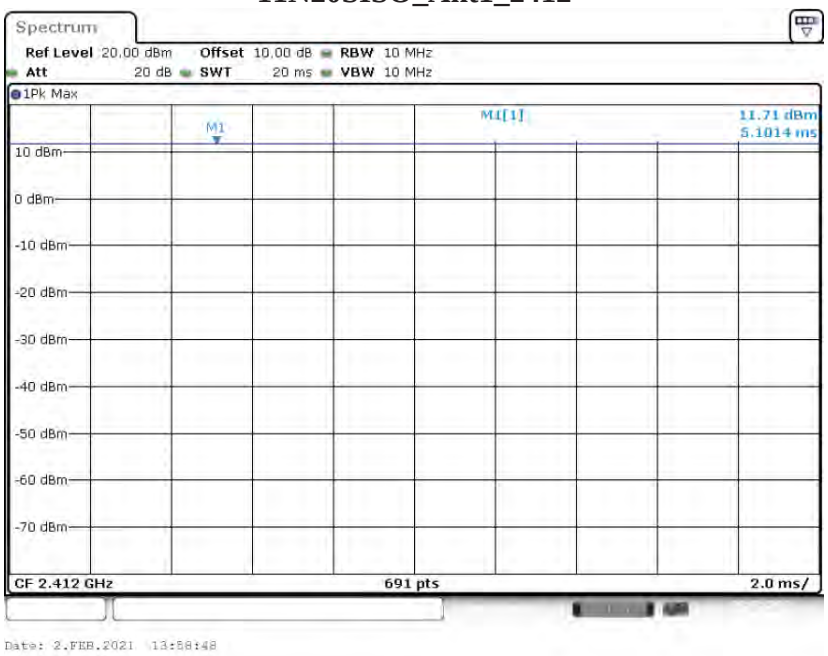


11N20SISO_Ant1_2412



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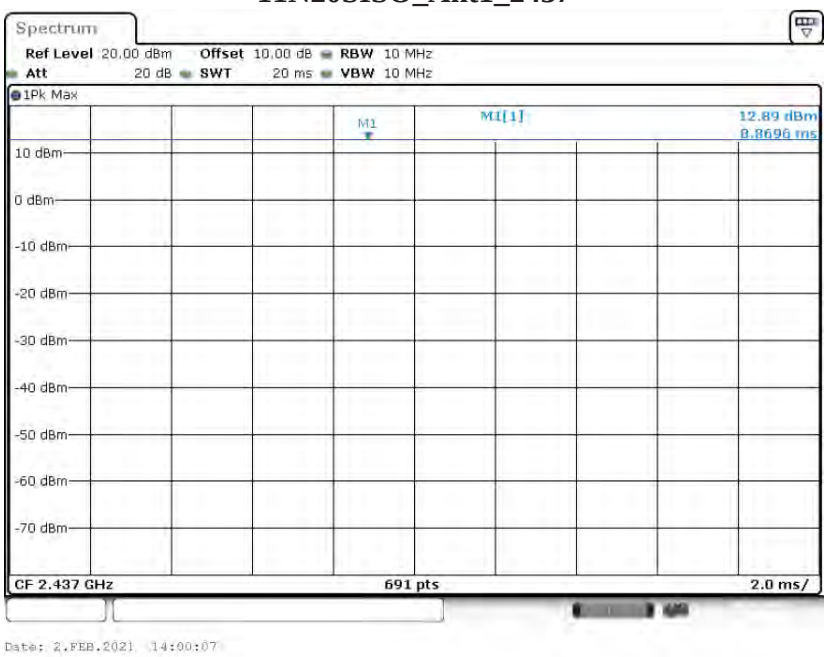

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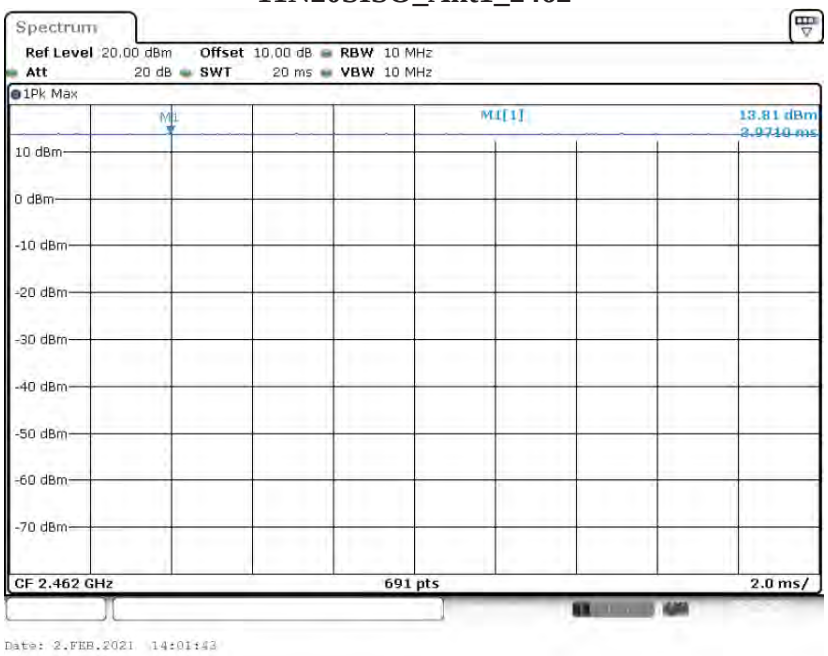

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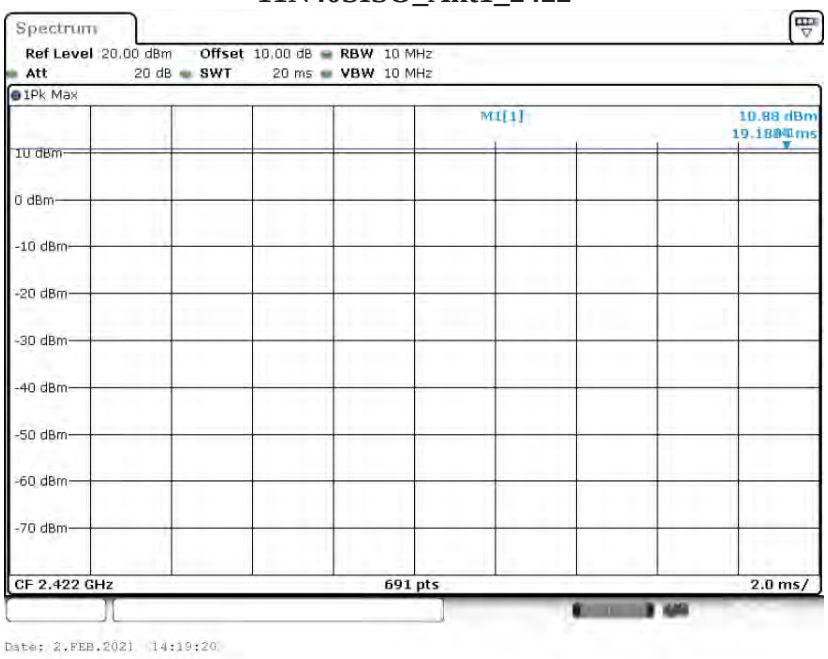

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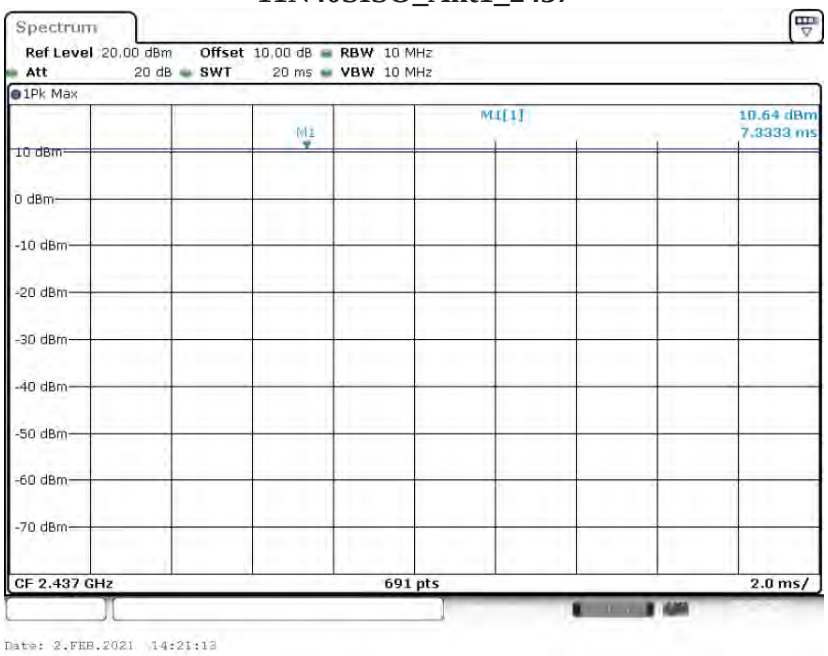

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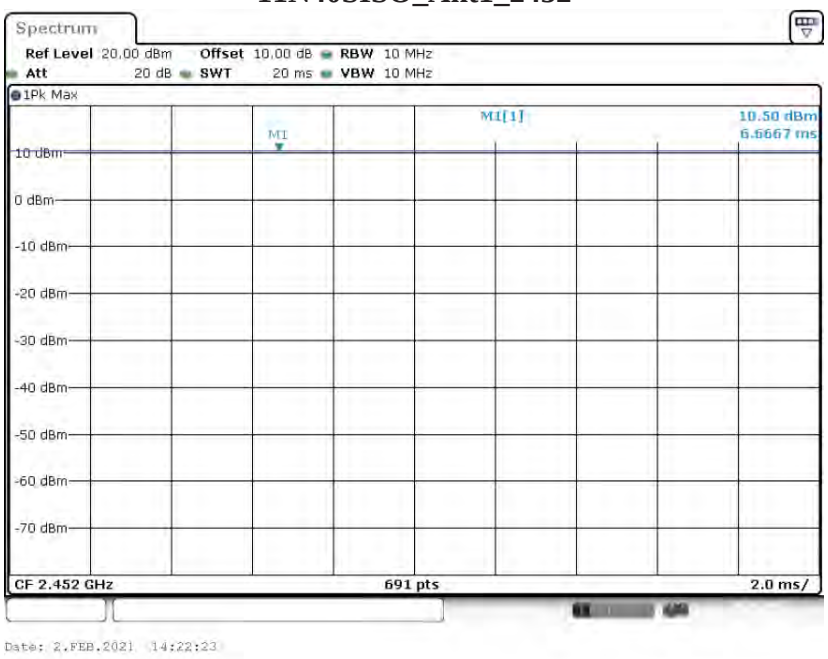

******* END OF REPORT *******