FCC RF Test Report

APPLICANT	:	Ring LLC
EQUIPMENT	:	Always Home Cam
BRAND NAME	:	ring
MODEL NAME	:	5E92E9
FCC ID	:	2AEUPBHAZU001
STANDARD	:	FCC Part 15 Subpart C §15.247
CLASSIFICATION	:	(DTS) Digital Transmission System
TEST DATE(S)	:	Aug. 28, 2021 ~ Sep. 18, 2021

We, Sporton International (Kunshan) Inc., would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval of Sporton International (Kunshan) Inc., the test report shall not be reproduced except in full.

Reviewed by: Jason Jia / Supervisor

Approved by: Alex Wang / Manager

Sporton International (Kunshan) Inc.
No. 1098, Pengxi North Road, Kunshan Economic Development Zone Jiangsu Province 215300
People's Republic of China

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REVISION HISTORY

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FR170120C	Rev. 01	Initial issue of report	Sep. 18, 2021

SUMMARY OF TEST RESULT

Report Section	FCC Rule	Description	Limit	Result	Remark
3.1	15.247(a)(2)	6dB Bandwidth	≥ 0.5MHz	Pass	-
3.2	15.247(b)	Power Output Measurement	≤ 30dBm	Pass	-
3.3	15.247(e)	Power Spectral Density	≤ 8dBm/3kHz	Pass	-
3.4	15.247(d)	Conducted Band Edges	≤ 20dBc	Pass	-
		Conducted Spurious Emission		Pass	-
3.5	15.247(d)	Radiated Band Edges and Radiated Spurious Emission	15.209(a) & 15.247(d)	Pass	Under limit 3.02 dB at 2387.35 MHz
3.6	15.207	AC Conducted Emission	15.207(a)	Pass	Under limit 9.52 dB at 0.150 MHz
3.7	15.203 & 15.247(b)	Antenna Requirement	15.203 & 15.247(b)	Pass	-

Declaration of Conformity:
The test results with all measurement uncertainty excluded are presented in accordance with the regulation limits.
Comments and Explanations:
The declared of product specification for EUT presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.

1 General Description

1.1 Applicant

Ring LLC
1523 26th St, Santa Monica, CA 90404, USA

1.2 Manufacturer

Goertek Inc.
No.8877 Yingqian Street, High-Tech Industrial Development District, Weifang, Shandong, 261031, P.R.China

1.3 Product Feature of Equipment Under Test

Product Feature	
Equipment	Always Home Cam
Brand Name	ring
Model Name	5E92E9
FCC ID	2AEUPBHAZU001
HW Version	DVT1.1C
SW Version	DVT1.1C
EUT Stage	Identical Prototype

Remark: The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.

1.4 Product Specification of Equipment Under Test

Standards-related Product Specification	
Tx/Rx Channel Frequency Range	2412 MHz ~ 2462 MHz
Maximum (Peak) Output Power to antenna	802.11b : 24.69 dBm (0.2944 W) 802.11g : 28.03 dBm (0.6353 W) 802.11n HT20 : 27.92 dBm (0.6194 W) 802.11n HT40 : 26.53 dBm (0.4498 W)
Antenna Type / Gain	<Ant. 1>: FPC Antenna with gain 1.73 dBi <Ant. 2>: FPC Antenna with gain 3.07 dBi
Antenna Function for Transmitter	<table><tr><td></td><td>Ant. 1</td><td>Ant. 2</td></tr><tr><td>802.11 b/g/n SISO</td><td>V</td><td>V</td></tr><tr><td>802.11 b/g/n MIMO</td><td>V</td><td>V</td></tr></table>
Type of Modulation	802.11b : DSSS (DBPSK / DQPSK / CCK) 802.11g/n : OFDM (BPSK / QPSK / 16QAM / 64QAM)

Note: For WLAN SISO & MIMO mode, the whole testing has assessed only MIMO mode by referring to their higher conducted power.

1.5 Modification of EUT

No modifications are made to the EUT during all test items.

1.6 Testing Location

Sporton International (Kunshan) Inc. is accredited to ISO/IEC 17025:2017 by American Association for Laboratory Accreditation with Certificate Number 5145.02.

Test Firm	Sporton International (Kunshan) Inc.		
Test Site Location	No. 1098, Pengxi North Road, Kunshan Economic Development Zone Jiangsu Province 215300 People's Republic of China TEL : +86-512-57900158 FAX : +86-512-57900958		
Test Site No.	**Sporton Site No.**	**FCC Designation No.**	**FCC Test Firm Registration No.**
	CO01-KS 03CH05-KS TH01-KS	CN1257	314309

1.7 Test Software

Item	Site	Manufacturer	Name	Version
1.	03CH05-KS	AUDIX	E3	6.2009-8-24al
2.	CO01-KS	AUDIX	E3	6.2009-8-24

1.8 Applicable Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- 47 CFR Part 15 Subpart C §15.247
- FCC KDB 558074 D01 15.247 Meas Guidance v05r02
- FCC KDB 662911 D01 Multiple Transmitter Output v02r01.
- ANSI C63.10-2013

Remark:

1. All test items were verified and recorded according to the standards and without any deviation during the test.
2. This EUT has also been tested and complied with the requirements of FCC Part 15, Subpart B, recorded in a separate test report.

2 Test Configuration of Equipment Under Test

a. The EUT has been associated with peripherals and configuration operated in a manner tended to maximize its emission characteristics in a typical application. Frequency range investigated: conduction emission (150 kHz to 30 MHz), radiation emission (9 kHz to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower).

b. AC power line Conducted Emission was tested under maximum output power.

2.1 Carrier Frequency and Channel

Frequency Band	Channel	Freq. (MHz)	Channel	Freq. (MHz)
2400-2483.5 MHz	1	2412	7	2442
	2	2417	8	2447
	3	2422	9	2452
	4	2427	10	2457
	5	2432	11	2462
	6	2437		

2.2 Test Mode

Final test modes are considering the modulation and worse data rates as below table.

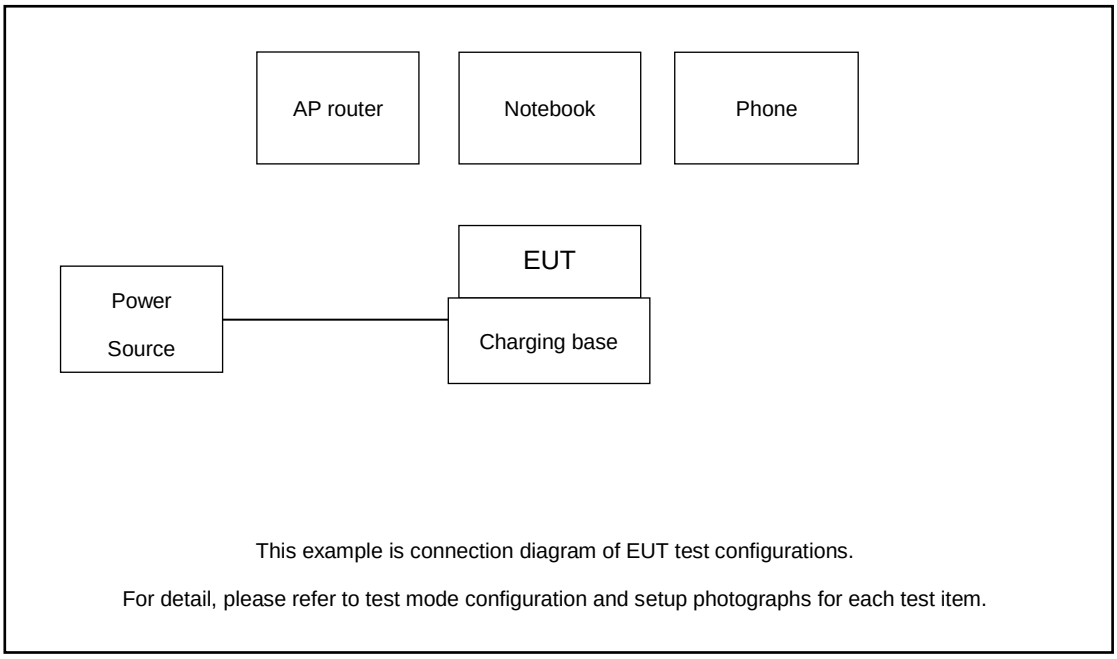
MIMO Antenna

Modulation	Data Rate
802.11b	**1 Mbps**
802.11g	**6 Mbps**
802.11n HT20	**MCS0**
802.11n HT40	**MCS0**

Test Cases	
AC Conducted Emission	Mode 1 :Bluetooth Link + WLAN Link(2.4G) + Adaptor + charging base
Remark: For Radiated Test Cases, The tests were performance with Charging base and Adapter.	

2.3 Connection Diagram of Test System

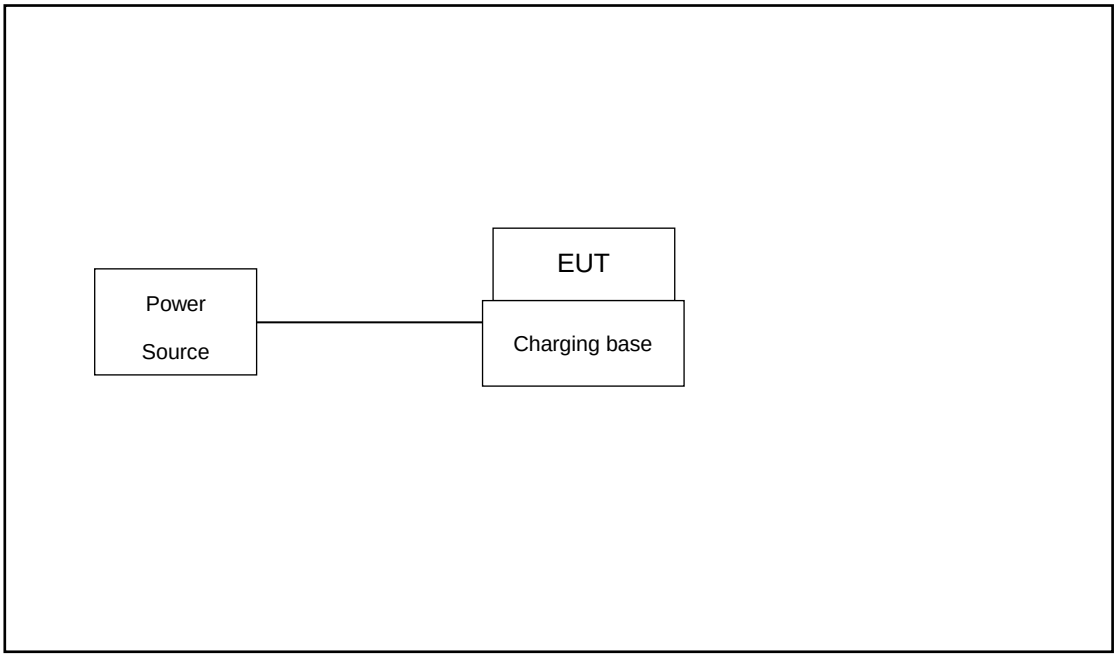
For Conducted Emission:



This example is connection diagram of EUT test configurations.

For detail, please refer to test mode configuration and setup photographs for each test item.

For Radiation:



2.4 Support Unit used in test configuration and system

Item	Equipment	Trade Name	Model Name	FCC ID	Data Cable	Power Cord
1.	WLAN AP	D-link	DIR-655	KA21R655B1	N/A	Unshielded, 1.8m
2.	Notebook	Lenovo	G480	QDS-BRCM1050I	N/A	AC I/P: Unshielded, 1.8 m DC O/P: Shielded, 1.8 m
3.	Mobile Phone	MOTO	N/A	N/A	N/A	N/A

2.5 EUT Operation Test Setup

For WLAN RF test items, an engineering test program was provided and enabled to make EUT continuous transmit.

For AC power line conducted emissions, the EUT was set to connect with the WLAN AP under large package sizes transmission.

2.6 Measurement Results Explanation Example

For all conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss between EUT conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.

Example:

The spectrum analyzer offset is derived from RF cable loss.

Offset = RF cable loss.

Following shows an offset computation example with cable loss 6.0 dB.

Offset(dB) = RF cable loss(dB).

= 6.0 (dB)

3 Test Result

3.1 6dB Bandwidth Measurement

3.1.1 Limit of 6dB Bandwidth

The minimum 6 dB bandwidth shall be at least 500 kHz.

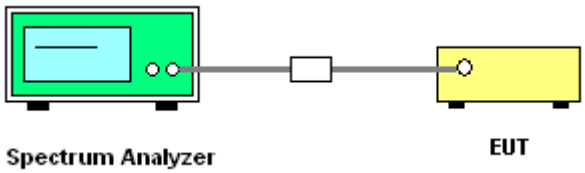
3.1.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.1.3 Test Procedures

1. The testing follows ANSI C63.10-2013 clause 11.8
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 100 kHz. Set the Video bandwidth (VBW) = 300 kHz. In order to make an accurate measurement. The 6 dB bandwidth must be greater than 500 kHz.
5. Measure and record the results in the test report.

3.1.4 Test Setup



3.1.5 Test Result of 6dB Bandwidth

Please refer to Appendix A.

3.2 Output Power Measurement

3.2.1 Limit of Output Power

For systems using digital modulation in the 2400-2483.5MHz, the limit for peak output power is 30dBm. If transmitting antenna with directional gain greater than 6dBi is used, the peak output power from the intentional radiator shall be reduced below the above stated value by the amount in dB that the directional gain of the antenna exceeds 6 dBi. In case of point-to-point operation, the limit has to be reduced by 1dB for every 3dB that the directional gain of the antenna exceeds 6dBi.

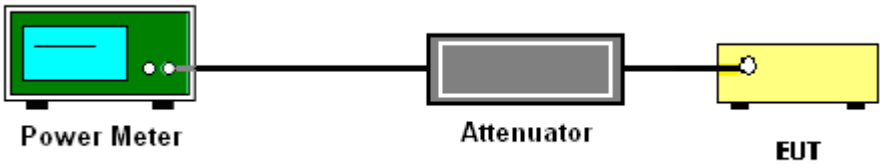
3.2.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.2.3 Test Procedures

1. The testing follows the Measurement Procedure of ANSI C63.10-2013 clause 11.9.1.3 PKPM1 Peak power meter or ANSI C63.10-2013 clause 11.9.2.3.2 Method AVGPM-G method.
2. The RF output of EUT was connected to the power meter by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Measure the conducted output power and record the results in the test report.
5. For MIMO mode, calculation method follows FCC KDB 662911 D01 Multiple Transmitter Output v02r01.

3.2.4 Test Setup



3.2.5 Test Result of Peak Output Power

2.4GHz Band MIMO															
Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Peak Conducted Power (dBm)			Conducted Power Limit (dBm)		DG (dBi)		EIRP Power (dBm)		EIRP Power Limit (dBm)		Pass /Fail
					Ant1	Ant2	SUM	Ant1	Ant2	Ant1	Ant2	Ant1	Ant2	Ant1	Ant2	
11b	1Mbps	2	1	2412	17.28	17.49	20.40	30.00		3.07		23.47		36.00		Pass
11b	1Mbps	2	6	2437	19.39	19.68	22.55	30.00		3.07		25.62		36.00		Pass
11b	1Mbps	2	11	2462	21.44	21.91	24.69	30.00		3.07		27.76		36.00		Pass
11g	6Mbps	2	1	2412	22.46	22.09	25.29	30.00		3.07		28.36		36.00		Pass
11g	6Mbps	2	2	2417	23.88	24.51	27.22	30.00		3.07		30.29		36.00		Pass
11g	6Mbps	2	6	2437	24.96	25.08	28.03	30.00		3.07		31.10		36.00		Pass
11g	6Mbps	2	11	2462	24.77	25.02	27.91	30.00		3.07		30.98		36.00		Pass
HT20	MCS0	2	1	2412	22.05	22.09	25.08	30.00		3.07		28.15		36.00		Pass
HT20	MCS0	2	2	2417	23.39	23.71	26.56	30.00		3.07		29.63		36.00		Pass
HT20	MCS0	2	6	2437	24.65	25.16	27.92	30.00		3.07		30.99		36.00		Pass
HT20	MCS0	2	11	2462	23.82	24.53	27.20	30.00		3.07		30.27		36.00		Pass
HT40	MCS0	2	3	2422	19.69	19.73	22.72	30.00		3.07		25.79		36.00		Pass
HT40	MCS0	2	4	2427	23.05	23.35	26.21	30.00		3.07		29.28		36.00		Pass
HT40	MCS0	2	6	2437	22.66	22.75	25.72	30.00		3.07		28.79		36.00		Pass
HT40	MCS0	2	9	2452	23.31	23.72	26.53	30.00		3.07		29.60		36.00		Pass

Note: Measured power (dBm) has offset with cable loss.

3.2.6 Test Result of Average Output Power

2.4GHz Band MIMO																
Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Average Conducted Power (dBm)			Conducted Power Limit (dBm)		DG (dBi)		EIRP Power (dBm)		EIRP Power Limit (dBm)		Pass /Fail
					Ant1	Ant2	SUM	Ant1	Ant2	Ant1	Ant2	Ant1	Ant2	Ant1	Ant2	
11b	1Mbps	2	1	2412	15.45	15.22	18.35	30.00		3.07		21.42		36.00		Pass
11b	1Mbps	2	6	2437	17.65	17.34	20.51	30.00		3.07		23.58		36.00		Pass
11b	1Mbps	2	11	2462	19.88	19.43	22.67	30.00		3.07		25.74		36.00		Pass
11g	6Mbps	2	1	2412	14.72	14.37	17.56	30.00		3.07		20.63		36.00		Pass
11g	6Mbps	2	2	2417	17.03	16.86	19.96	30.00		3.07		23.03		36.00		Pass
11g	6Mbps	2	6	2437	17.92	17.68	20.81	30.00		3.07		23.88		36.00		Pass
11g	6Mbps	2	11	2462	17.39	17.36	20.39	30.00		3.07		23.46		36.00		Pass
HT20	MCS0	2	1	2412	14.06	13.84	16.96	30.00		3.07		20.03		36.00		Pass
HT20	MCS0	2	2	2417	15.82	15.76	18.80	30.00		3.07		21.87		36.00		Pass
HT20	MCS0	2	6	2437	17.48	17.51	20.51	30.00		3.07		23.58		36.00		Pass
HT20	MCS0	2	11	2462	15.73	15.63	18.69	30.00		3.07		21.76		36.00		Pass
HT40	MCS0	2	3	2422	11.42	11.29	14.37	30.00		3.07		17.44		36.00		Pass
HT40	MCS0	2	4	2427	15.71	15.75	18.74	30.00		3.07		21.81		36.00		Pass
HT40	MCS0	2	6	2437	15.02	15.11	18.08	30.00		3.07		21.15		36.00		Pass
HT40	MCS0	2	9	2452	15.62	15.71	18.68	30.00		3.07		21.75		36.00		Pass

Note: Measured power (dBm) has offset with cable loss.

3.3 Power Spectral Density Measurement

3.3.1 Limit of Power Spectral Density

The peak power spectral density shall not be greater than 8dBm in any 3kHz band at any time interval of continuous transmission.

3.3.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.3.3 Test Procedures

1. The testing follows Measurement Procedure of ANSI C63.10-2013 clause 11.10.2 Method PKPSD.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 3 kHz. Video bandwidth VBW = 10 kHz In order to make an accurate measurement, set the span to 1.5 times DTS Channel Bandwidth. (6dB BW)
5. Detector = peak, Sweep time = auto couple, Trace mode = max hold, Allow trace to fully stabilize. Use the peak marker function to determine the maximum power level.
6. Measure and record the results in the test report.
7. For MIMO mode, calculation method follows FCC KDB 662911 D01 Multiple Transmitter Output v02r01.

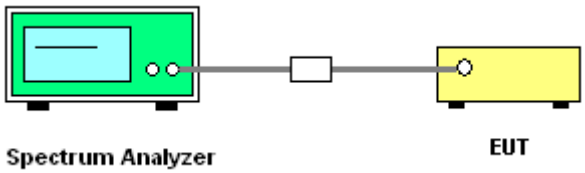
   If measurements performed using method (2) plus 10 log (N) exceeds the emission limit, the test should choose method (1) before declaring that the device fails the emission limit.

   Method (1): Measure and sum the spectra across the outputs.

   The total final Power Spectral Density is from a device with 2 transmitter outputs. The spectrum measurements of the individual outputs are all performed with the same span and number of points, the spectrum value in the first spectral bin of output 1 is summed with that in the first spectral bin of output 2 to obtain the value for the first frequency bin of the summed spectrum.

   Method (2): Measure and add 10 log (N) dB, where N is the number of outputs. (N=2)

3.3.4 Test Setup



3.3.5 Test Result of Power Spectral Density

Please refer to Appendix A.

3.4 Conducted Band Edges and Spurious Emission Measurement

3.4.1 Limit of Conducted Band Edges and Spurious Emission Measurement

In any 100 kHz bandwidth outside of the authorized frequency band, the emissions which fall in the non-restricted bands shall be attenuated at least 20 dB / 30dB relative to the maximum PSD level in 100 kHz by RF conducted measurement.

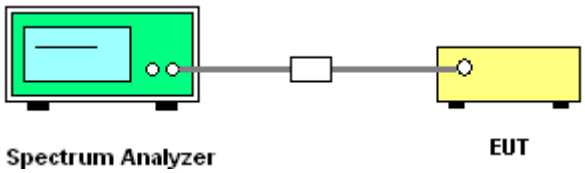
3.4.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.4.3 Test Procedures

1. The testing follows ANSI C63.10-2013 clause 11.13
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Set RBW = 100 kHz, VBW=300 kHz, Peak Detector. Unwanted Emissions measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz when maximum peak conducted output power procedure is used. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 dB instead of 20 dB per 15.247(d).
5. Measure and record the results in the test report.
6. The RF fundamental frequency should be excluded against the limit line in the operating frequency band.

3.4.4 Test Setup



3.4.5 Test Result of Conducted Band Edges and Spurious Emission

Please refer to Appendix A.

3.5 Radiated Band Edges and Spurious Emission Measurement

3.5.1 Limit of Radiated band edge and Spurious Emission Measurement

In any 100 kHz bandwidth outside the intentional radiator frequency band, all harmonics/spurious must be at least 20 dB below the highest emission level within the authorized band. If the output power of this device was measured by spectrum analyzer, the attenuation under this paragraph shall be 30 dB instead of 20 dB. In addition, radiated emissions which fall in the restricted bands must also comply with the limits as below.

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

3.5.2 Measuring Instruments

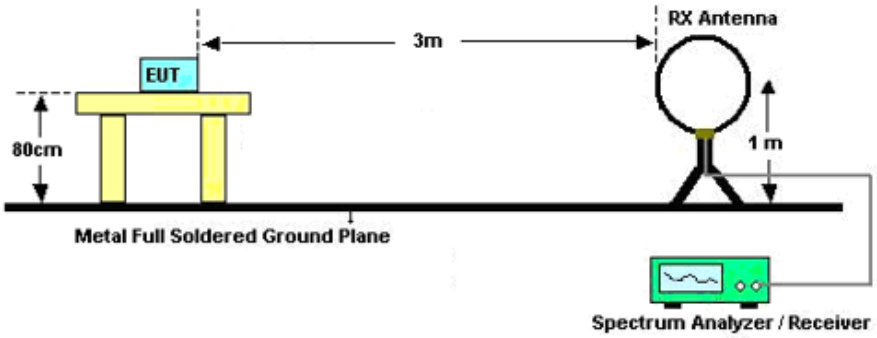
The measuring equipment is listed in the section 4 of this test report.

3.5.3 Test Procedures

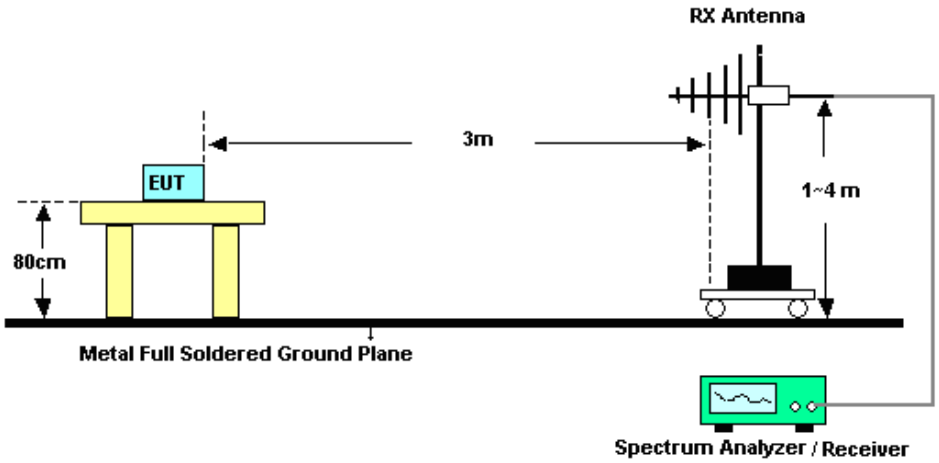
1. The testing follows ANSI C63.10-2013 clause 11.11 & 11.12
2. The EUT was arranged to its worst case and then tune the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level.
3. The EUT was placed on a turntable with 0.8 meter for frequency below 1GHz and 1.5 meter for frequency above 1GHz respectively above ground.
4. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower.
5. Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level
6. For testing below 1GHz, if the emission level of the EUT in peak mode was 3 dB lower than the limit specified, then peak values of EUT will be reported, otherwise, the emissions will be repeated one by one using the CISPR quasi-peak method and reported.
7. For testing above 1GHz, the emission level of the EUT in peak mode was 20dB lower than peak limit (that means the emission level in average mode also complies with the limit in average mode), then peak values of EUT will be reported, otherwise, the emissions will be measured in average mode again and reported.
8. Use the following spectrum analyzer settings:
   (1) Span shall wide enough to fully capture the emission being measured;
   (2) Set RBW=100 kHz for f < 1 GHz; VBW ≥ RBW; Sweep = auto; Detector function = peak; Trace = max hold;
   (3) Set RBW = 1 MHz, VBW= 3MHz for f ≥ 1 GHz for peak measurement.
   For average measurement:
   - VBW = 10 Hz, when duty cycle is no less than 98 percent.
   - VBW ≥ 1/T, when duty cycle is less than 98 percent where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.

3.5.4 Test Setup

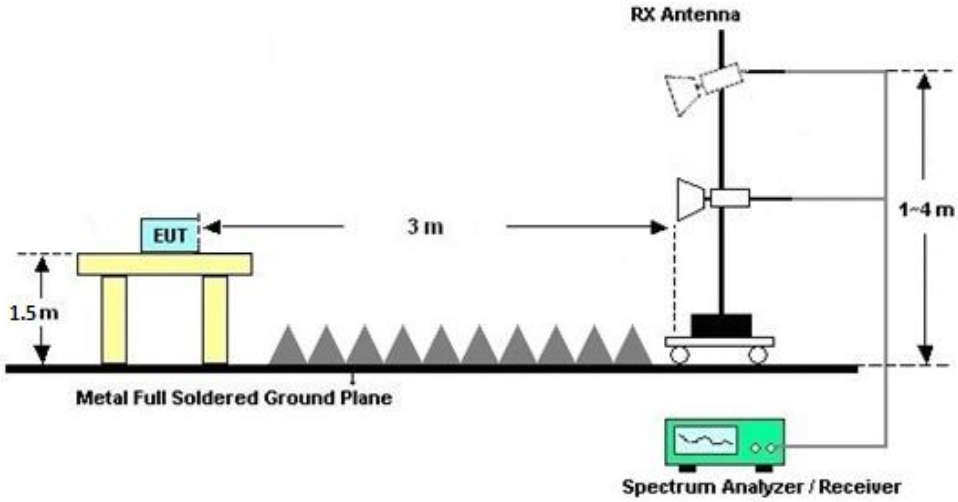
For radiated emissions below 30MHz



For radiated emissions from 30MHz to 1GHz



For radiated emissions above 1GHz



3.5.5 Test Results of Radiated Spurious Emissions (9kHz ~ 30MHz)

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit line was not reported.

There is a comparison data of both open-field test site and semi-Anechoic chamber, and the result came out very similar.

3.5.6 Test Result of Radiated Spurious at Band Edges

Please refer to Appendix C.

3.5.7 Duty Cycle

Please refer to Appendix A.

3.5.8 Test Result of Radiated Spurious Emission (30MHz ~ 10th Harmonic or 40GHz, whichever is lower)

Please refer to Appendix C.

3.6 AC Conducted Emission Measurement

3.6.1 Limit of AC Conducted Emission

For equipment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table.

Frequency of Emission (MHz)	Conducted Limit (dBμV)	
	Quasi-Peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

*Decreases with the logarithm of the frequency.

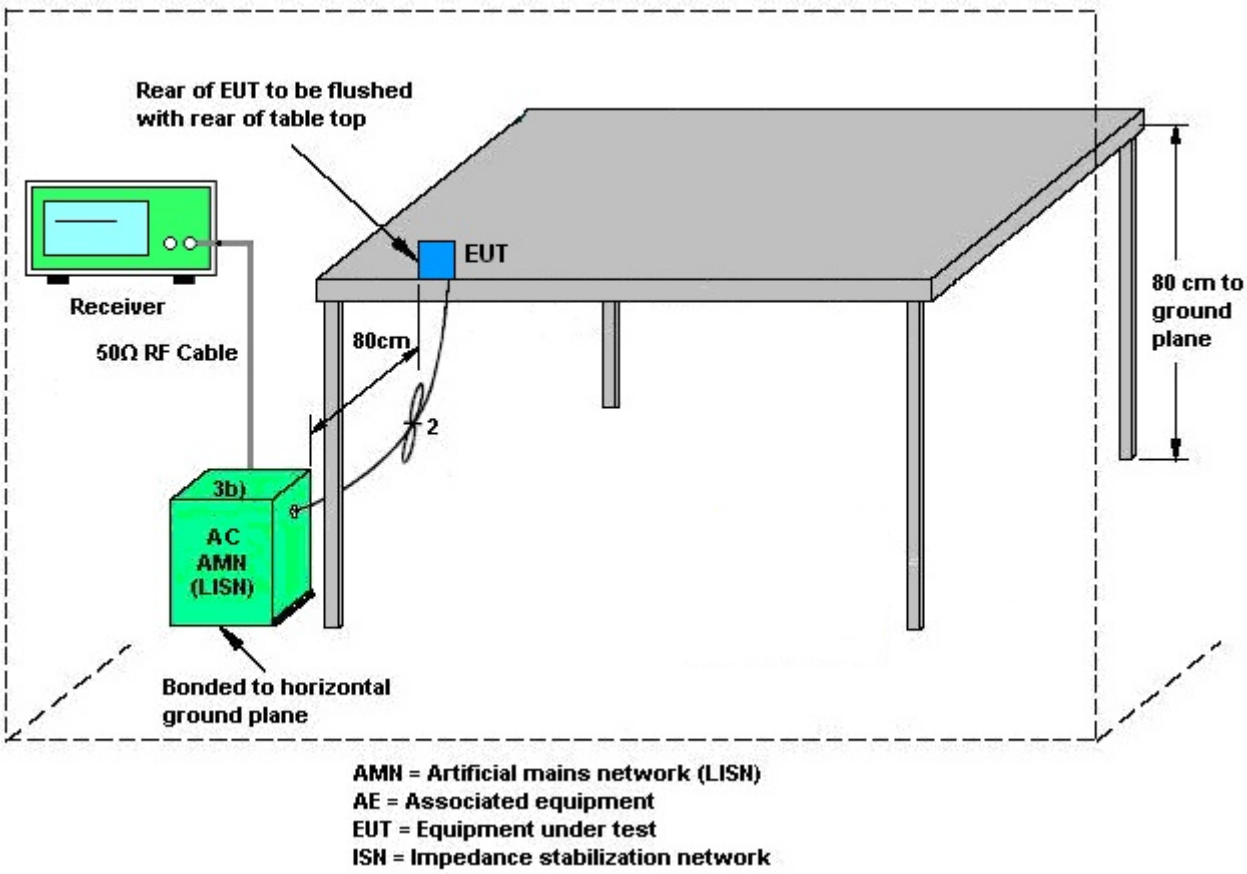
3.6.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.6.3 Test Procedures

1. The EUT was placed 0.4 meter from the conducting wall of the shielding room, and it was kept at least 80 centimeters from any other grounded conducting surface.
2. Connect EUT to the power mains through a line impedance stabilization network (LISN).
3. All the support units are connecting to the other LISN.
4. The LISN provides 50 ohm coupling impedance for the measuring instrument.
5. The FCC states that a 50 ohm, 50 microhenry LISN should be used.
6. Both sides of AC line were checked for maximum conducted interference.
7. The frequency range from 150 kHz to 30 MHz was searched.
8. Set the test-receiver system to Peak Detect Function and specified bandwidth (IF bandwidth = 9kHz) with Maximum Hold Mode.

3.6.4 Test Setup



3.6.5 Test Result of AC Conducted Emission

Please refer to Appendix B.

3.7 Antenna Requirements

3.7.1 Standard Applicable

If directional gain of transmitting Antennas is greater than 6dBi, the power shall be reduced by the same level in dB comparing to gain minus 6dBi. 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 rule.

3.7.2 Antenna Anti-Replacement Construction

An embedded-in antenna design is used.

3.7.3 Antenna Gain

<CDD Modes > for 802.11b/g

FCC KDB 662911 D01 Multiple Transmitter Output v02r01

For CDD transmissions, directional gain is calculated as

Directional gain = G_{ANT} + Array Gain, where Array Gain is as follows.

For power spectral density (PSD) measurements on all devices,

Array Gain = 10 log(N_{ANT}/N_{SS}=1) dB.

For power measurements on IEEE 802.11 devices,

Array Gain = 0 dB (i.e., no array gain) for $N_{ANT} \leq 4$.

Directional gain may be calculated by using the formulas applicable to equal gain antennas with G_{ANT} set equal to the gain of the antenna having the highest gain;

The EUT supports CDD mode.

For power, the directional gain G_{ANT} is set equal to the antenna having the highest gain, i.e., F)2)f)i).

For PSD, the directional gain calculation is following F)2)f)ii) of KDB 662911 D01 v02r01.

The power and PSD limit should be modified if the directional gain of EUT is over 6 dBi,

The directional gain “DG” is calculated as following table.

<CDD Modes>

	Ant. 1 (dBi)	Ant. 2 (dBi)	DG for Power (dBi)	DG for PSD (dBi)	Power Limit Reduction (dB)	PSD Limit Reduction (dB)
2.4 GHz	1.73	3.07	3.07	5.44	0.00	0.00

Power Limit Reduction = DG(Power) – 6dBi, (min = 0)

PSD Limit Reduction = DG(PSD) – 6dBi, (min = 0)

<MIMO Modes > for 802.11n

FCC KDB 662911 D01 Multiple Transmitter Output v02r01

The power and PSD limit should be modified if the directional gain of EUT is over 6 dBi,

The directional gain “DG” is calculated as following table.

	Ant. 1 (dBi)	Ant. 2 (dBi)	DG for Power (dBi)	DG for PSD (dBi)	Power Limit Reduction (dB)	PSD Limit Reduction (dB)
2.4 GHz	1.73	3.07	3.07	3.07	0.00	0.00

Power Limit Reduction = DG(Power) – 6dBi, (min = 0)

PSD Limit Reduction = DG(PSD) – 6dBi, (min = 0)

4 List of Measuring Equipment

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
Spectrum Analyzer	R&S	FSV40	101040	10Hz~40GHz	Nov. 01, 2020	Sep. 02, 2021~ Sep. 18, 2021	Oct. 31, 2021	Conducted (TH01-KS)
Pulse Power Senor	Anritsu	MA2411B	0917070	300MHz~40GHz	Jan. 07, 2021	Sep. 02, 2021~ Sep. 18, 2021	Jan. 06, 2022	Conducted (TH01-KS)
Power Meter	Anritsu	ML2495A	1005002	50MHz Bandwidth	Jan. 07, 2021	Sep. 02, 2021~ Sep. 18, 2021	Jan. 06, 2022	Conducted (TH01-KS)
EMI Test Receiver	Keysight	N9038A	MY56400004	3Hz~8.5GHz;Max 30dBm	Oct. 17, 2020	Aug. 28, 2021~ Aug. 29, 2021	Oct. 16, 2021	Radiation (03CH05-KS)
EXA Spectrum Analyzer	Keysight	N9010A	MY55150244	10Hz-44G,MAX 30dB	Apr. 13, 2021	Aug. 28, 2021~ Aug. 29, 2021	Apr. 12, 2022	Radiation (03CH05-KS)
Loop Antenna	R&S	HFH2-Z2	100321	9kHz~30MHz	Nov. 01, 2020	Aug. 28, 2021~ Aug. 29, 2021	Oct. 31, 2021	Radiation (03CH05-KS)
Bilog Antenna	TeseQ	CBL6111D	49922	30MHz-1GHz	Jun. 04, 2021	Aug. 28, 2021~ Aug. 29, 2021	Jun. 03, 2022	Radiation (03CH05-KS)
Double Ridge Horn Antenna	ETS-Lindgren	3117	00218652	1GHz~18GHz	Apr. 24, 2021	Aug. 28, 2021~ Aug. 29, 2021	Apr. 23, 2022	Radiation (03CH05-KS)
SHF-EHF Horn	Com-power	AH-840	101115	18GHz~40GHz	Nov. 10, 2020	Aug. 28, 2021~ Aug. 29, 2021	Nov. 09, 2021	Radiation (03CH05-KS)
Amplifier	SONOMA	310N	187289	9KHz-1GHz	Apr. 12, 2021	Aug. 28, 2021~ Aug. 29, 2021	Apr. 11, 2022	Radiation (03CH05-KS)
Amplifier	MITEQ	EM18G40GGA	060728	18~40GHz	Jan. 07, 2021	Aug. 28, 2021~ Aug. 29, 2021	Jan. 06, 2022	Radiation (03CH05-KS)
high gain Amplifier	MITEQ	AMF-7D-00101800-30-10P	2012228	1Ghz-18Ghz	Oct. 17, 2020	Aug. 28, 2021~ Aug. 29, 2021	Oct. 16, 2021	Radiation (03CH05-KS)
Amplifier	Keysight	83017A	MY53270316	500MHz~26.5GHz	Oct. 17, 2020	Aug. 28, 2021~ Aug. 29, 2021	Oct. 16, 2021	Radiation (03CH05-KS)
AC Power Source	Chroma	61601	F104090004	N/A	NCR	Aug. 28, 2021~ Aug. 29, 2021	NCR	Radiation (03CH05-KS)
Turn Table	ChamPro	EM 1000-T	060762-T	0~360 degree	NCR	Aug. 28, 2021~ Aug. 29, 2021	NCR	Radiation (03CH05-KS)
Antenna Mast	ChamPro	EM 1000-A	060762-A	1 m~4 m	NCR	Aug. 28, 2021~ Aug. 29, 2021	NCR	Radiation (03CH05-KS)
EMI Receiver	R&S	ESCI7	100768	9kHz~7GHz;	Apr. 21, 2021	Sep. 15, 2021	Apr. 20, 2022	Conduction (CO01-KS)
AC LISN (for auxiliary equipment)	MessTec	AN3016	060103	9kHz~30MHz	Oct. 17, 2020	Sep. 15, 2021	Oct. 16, 2021	Conduction (CO01-KS)
AC LISN	R&S	ENV216	100334	9kHz~30MHz	Oct. 17, 2020	Sep. 15, 2021	Oct. 16, 2021	Conduction (CO01-KS)
AC Power Source	Chroma	61602	ABP000000811	AC 0V~300V, 45Hz~1000Hz	Oct. 17, 2020	Sep. 15, 2021	Oct. 16, 2021	Conduction (CO01-KS)

NCR: No Calibration Required.

5 Uncertainty of Evaluation

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI 63.10-2013. All the measurement uncertainty value were shown with a coverage K=2 to indicate 95% level of confidence. The measurement data show herein meets or exceeds the CISPR measurement uncertainty values specified in CISPR 16-4-2 and can be compared directly to specified limit to determine compliance.

Uncertainty of Conducted Emission Measurement (150kHz ~ 30MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**2.94dB**

Uncertainty of Radiated Emission Measurement (30 MHz ~ 1000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**5.0dB**

Uncertainty of Radiated Emission Measurement (1000 MHz ~ 18000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**5.0dB**

Uncertainty of Radiated Emission Measurement (18000 MHz ~ 40000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**5.0dB**

---------- THE END ----------

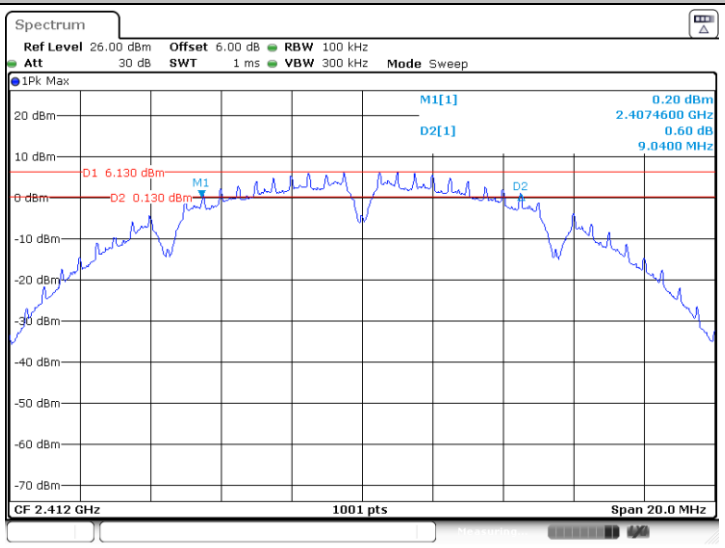
Appendix A. Conducted Test Results

6dB Bandwidth Test Result

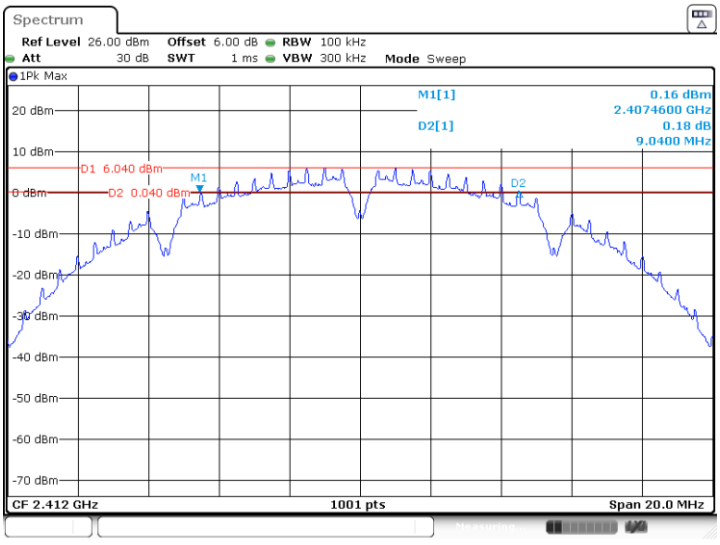
TestMode	Antenna	FC[MHz]	DTS BW [MHz]	Limit[MHz]	Verdict
11B-CDD	Ant1	2412	9.04	0.5	PASS
	Ant2	2412	9.04	0.5	PASS
	Ant1	2437	8.56	0.5	PASS
	Ant2	2437	9.02	0.5	PASS
	Ant1	2462	8.54	0.5	PASS
	Ant2	2462	8.56	0.5	PASS
11G-CDD	Ant1	2412	16.34	0.5	PASS
	Ant2	2412	16.34	0.5	PASS
	Ant1	2417	16.34	0.5	PASS
	Ant2	2417	16.36	0.5	PASS
	Ant1	2437	16.32	0.5	PASS
	Ant2	2437	16.34	0.5	PASS
	Ant1	2462	16.32	0.5	PASS
	Ant2	2462	16.34	0.5	PASS
11N20MIMO	Ant1	2412	17.60	0.5	PASS
	Ant2	2412	17.58	0.5	PASS
	Ant1	2417	17.58	0.5	PASS
	Ant2	2417	17.58	0.5	PASS
	Ant1	2437	17.58	0.5	PASS
	Ant2	2437	17.58	0.5	PASS
	Ant1	2462	17.60	0.5	PASS
	Ant2	2462	17.58	0.5	PASS
11N40MIMO	Ant1	2422	36.32	0.5	PASS
	Ant2	2422	36.32	0.5	PASS
	Ant1	2427	35.80	0.5	PASS
	Ant2	2427	35.64	0.5	PASS
	Ant1	2437	35.92	0.5	PASS
	Ant2	2437	35.12	0.5	PASS
	Ant1	2452	36.32	0.5	PASS
	Ant2	2452	36.32	0.5	PASS

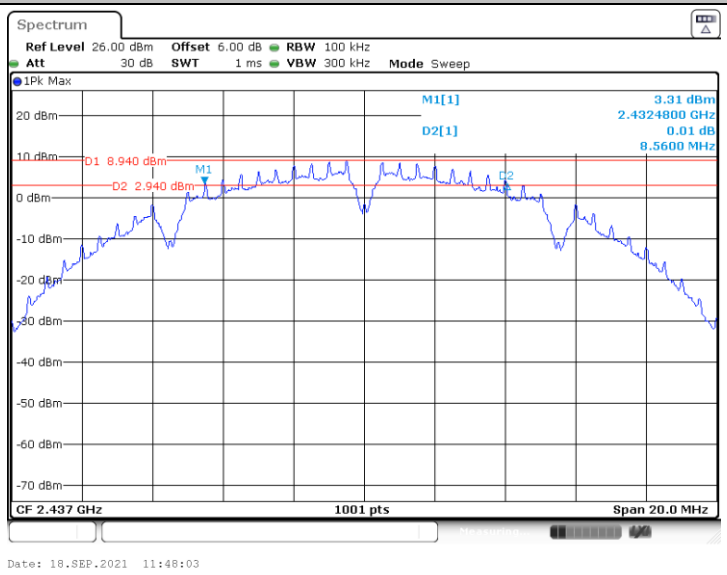
Test Graphs

11B-CDD_Ant1_2412



11B-CDD_Ant2_2412



11B-CDD_Ant1_2437


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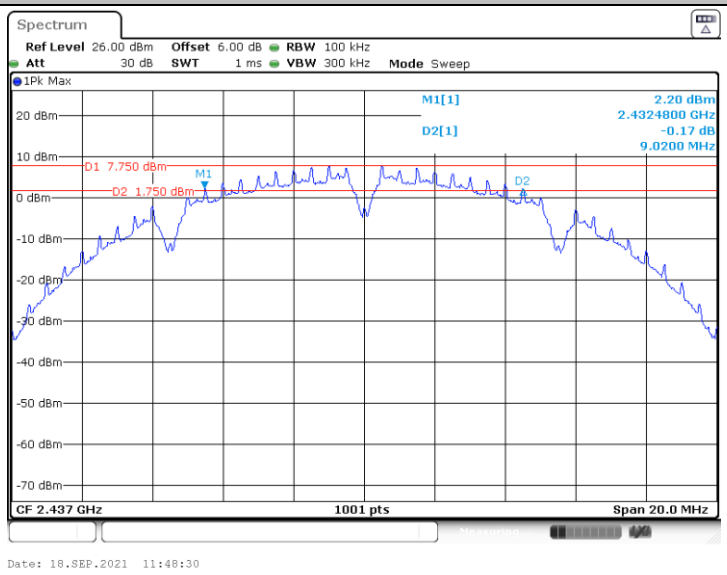
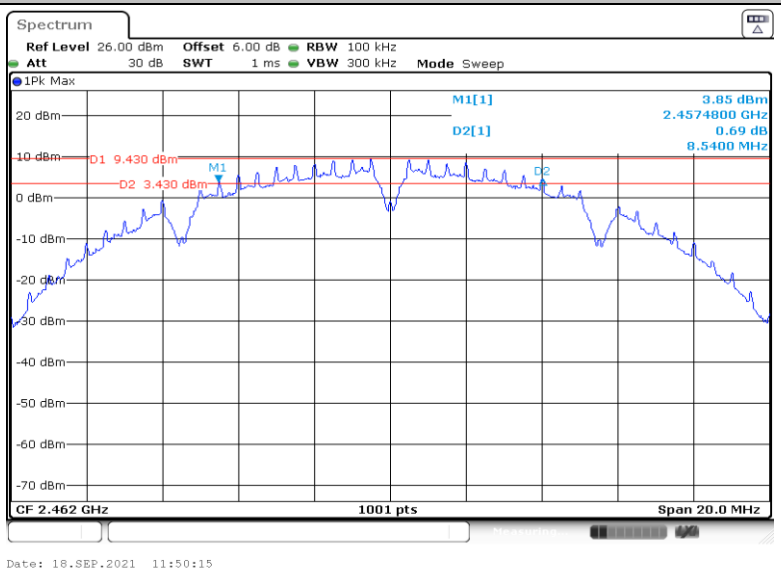


11B-CDD_Ant1_2462


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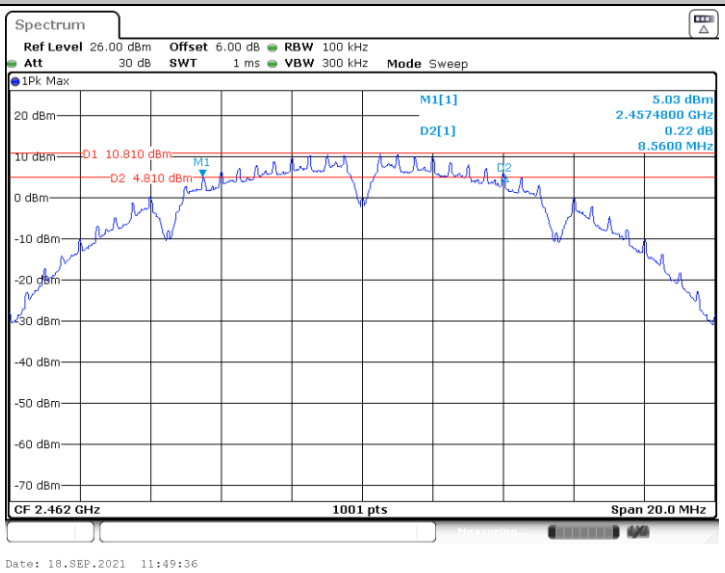
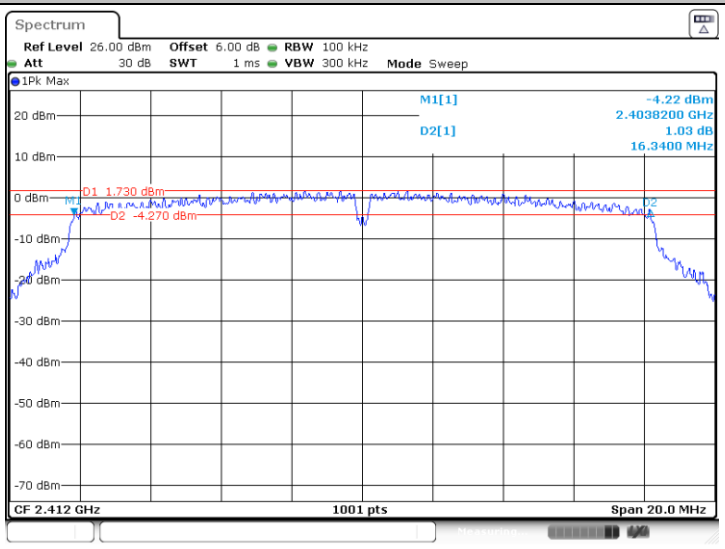
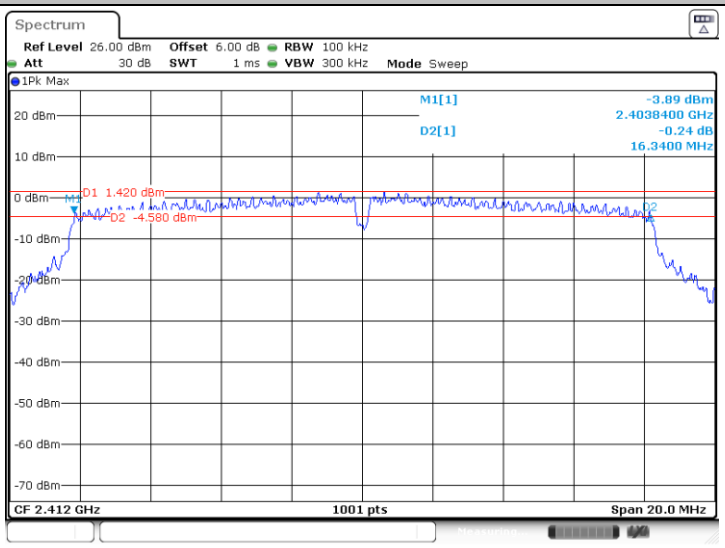
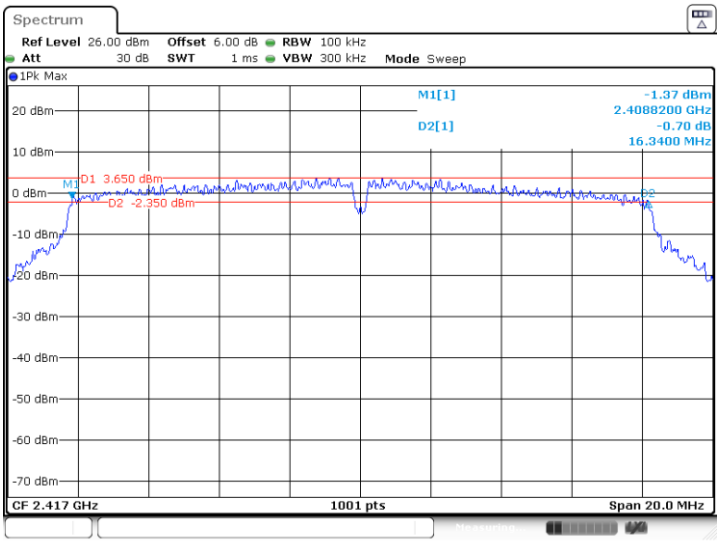


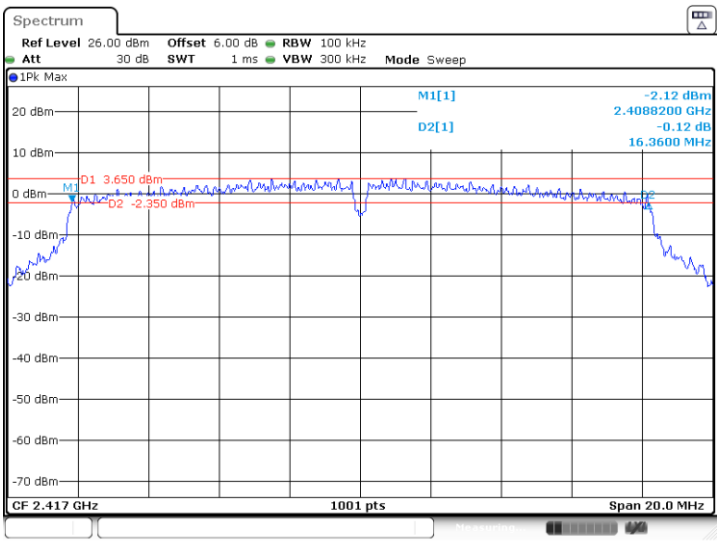
11G-CDD_Ant1_2412



11G-CDD_Ant2_2412



11G-CDD_Ant1_2417


11G-CDD_Ant2_2417


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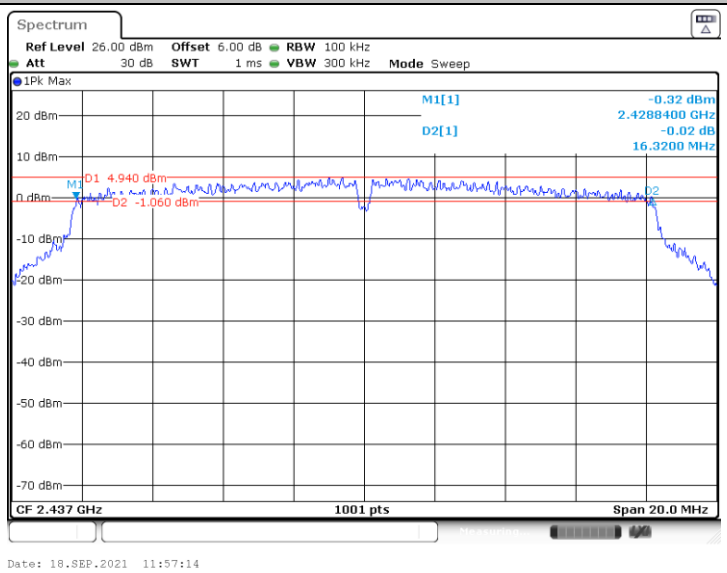

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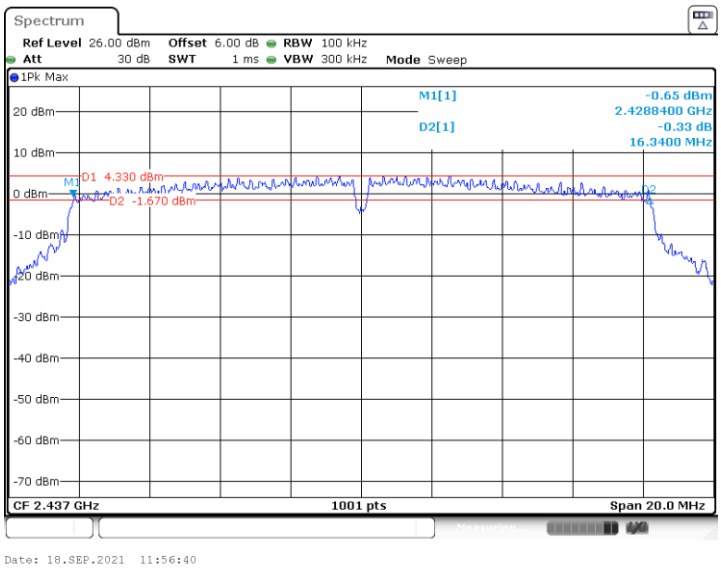

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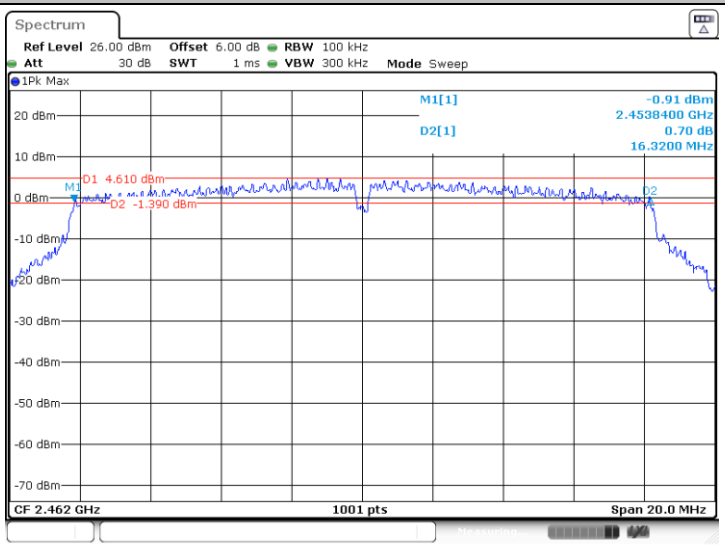
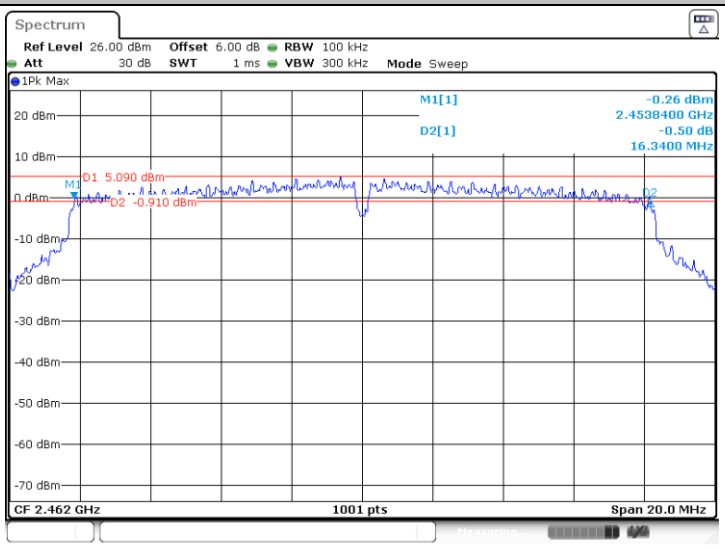
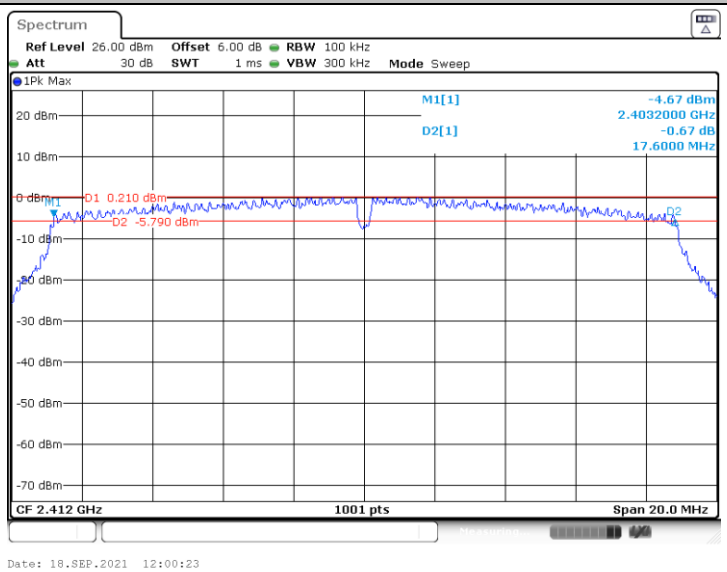


11G-CDD_Ant2_2462



11N20MIMO_Ant1_2412


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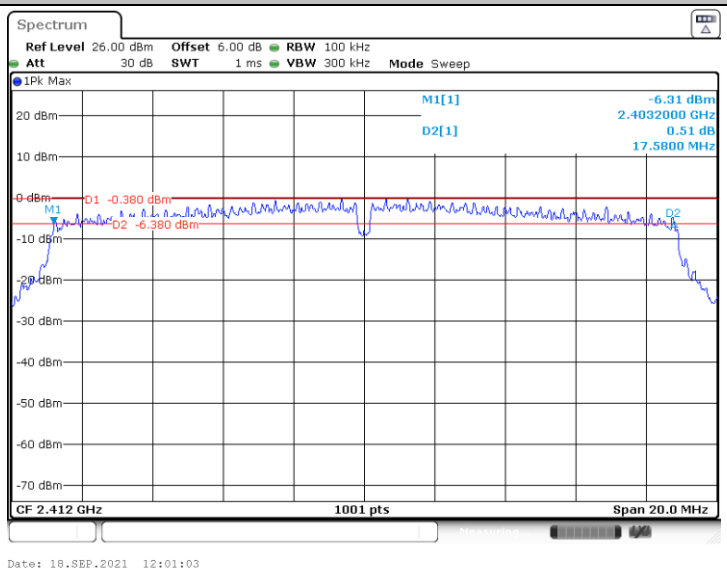

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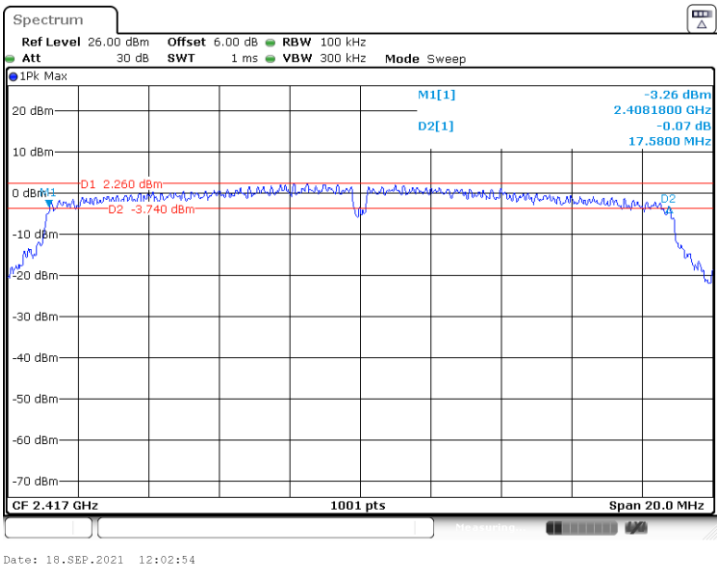

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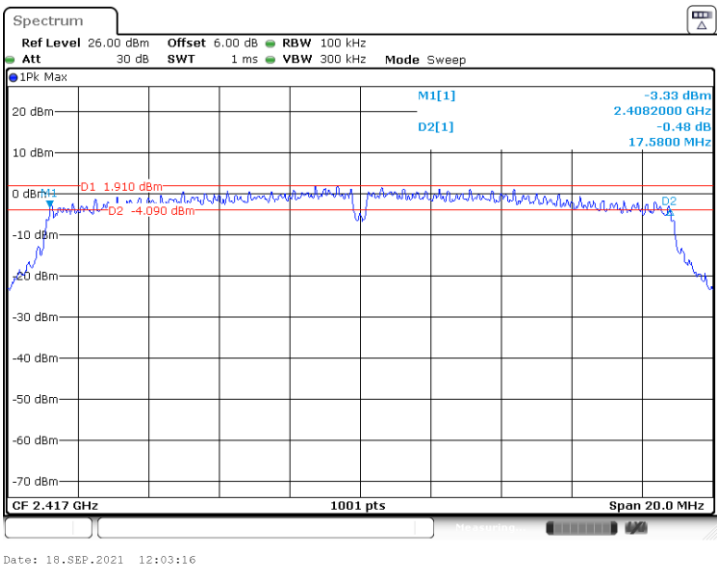

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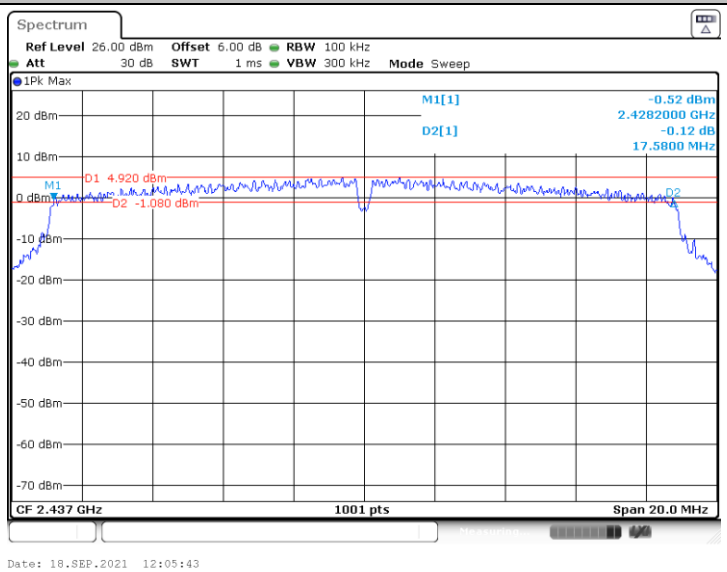
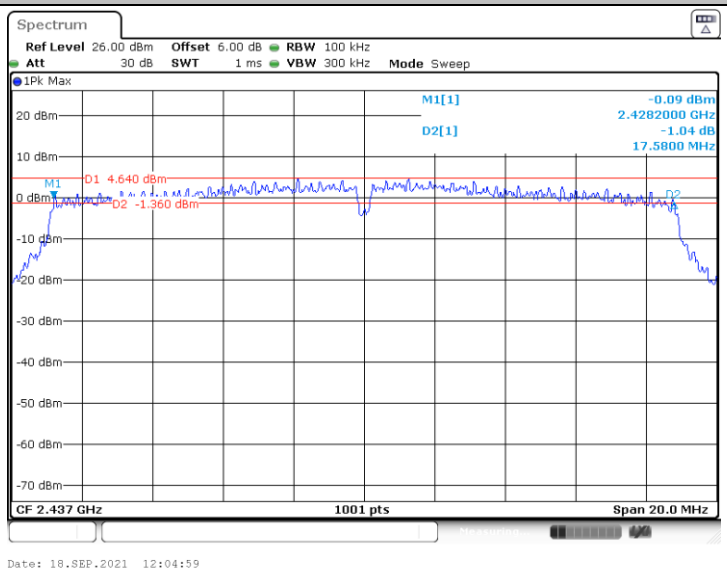


11N20MIMO_Ant2_2437


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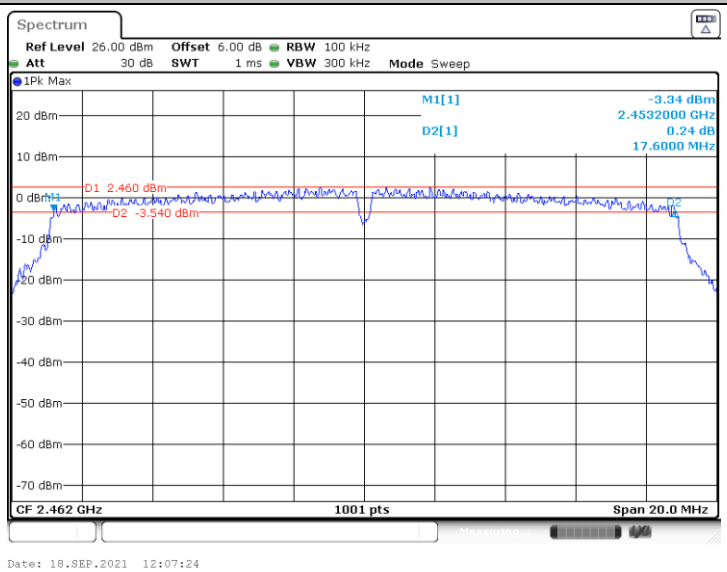

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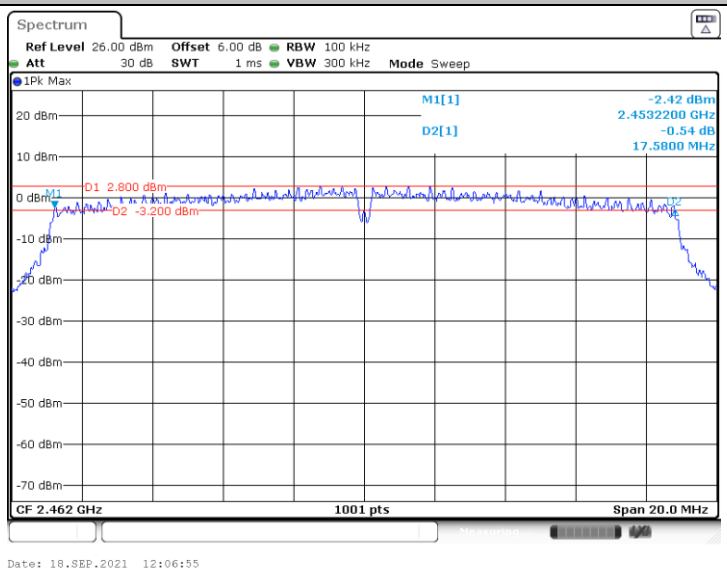
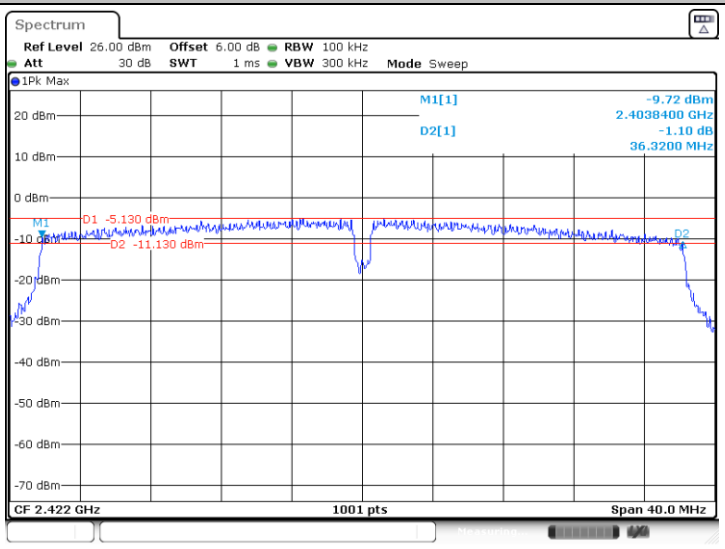
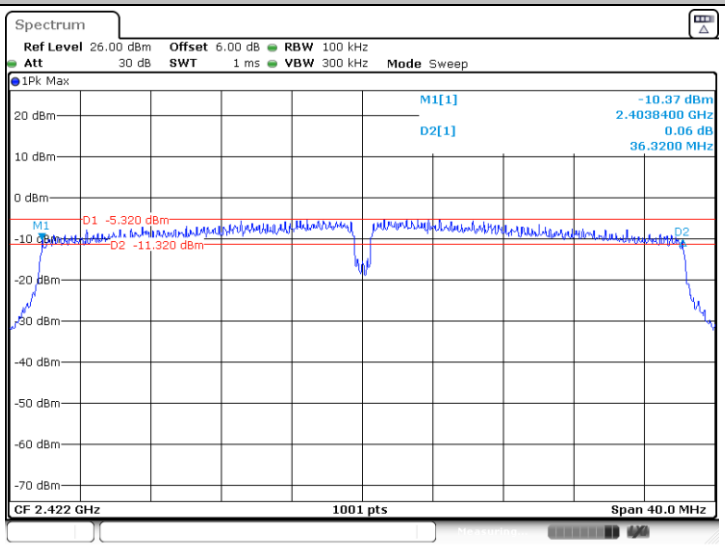
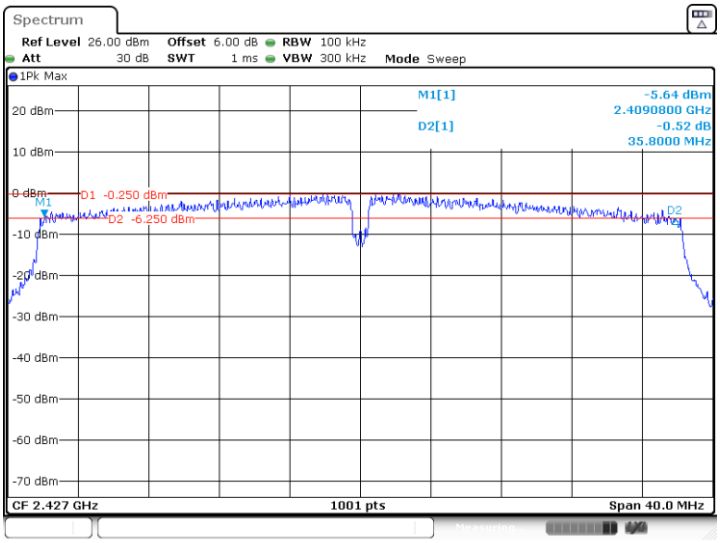


11N40MIMO_Ant1_2422



11N40MIMO_Ant2_2422



11N40MIMO_Ant1_2427


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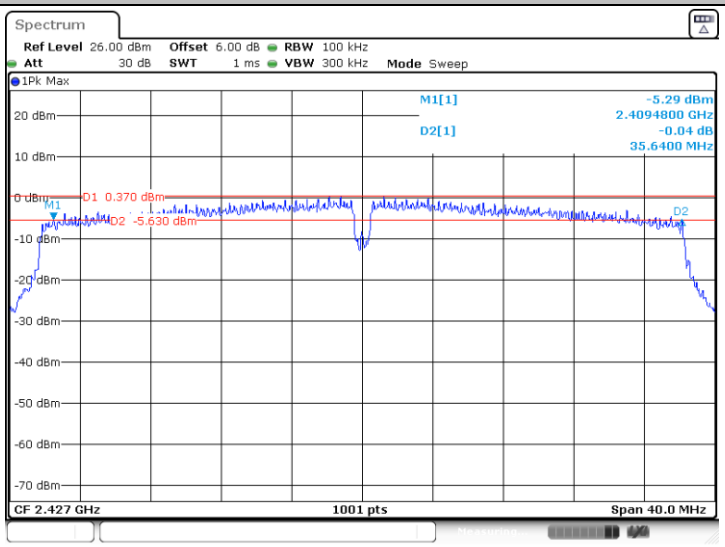

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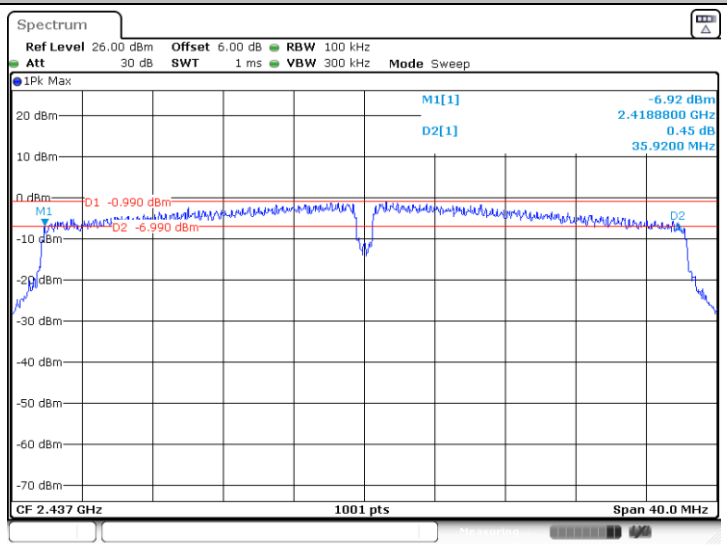

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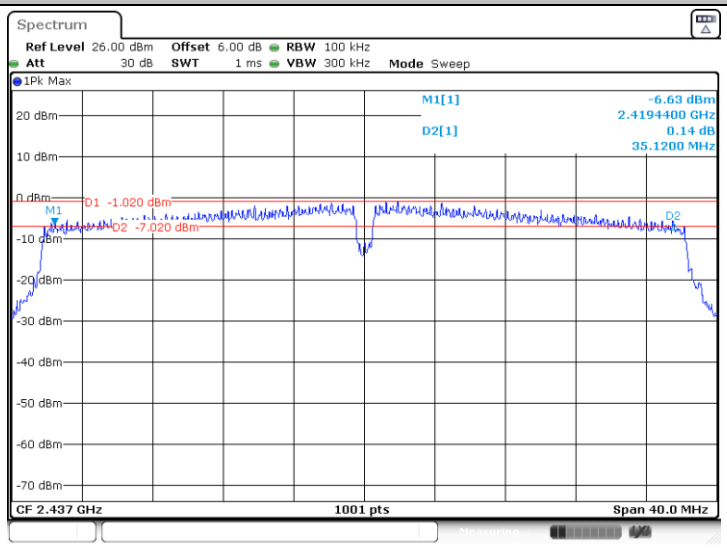
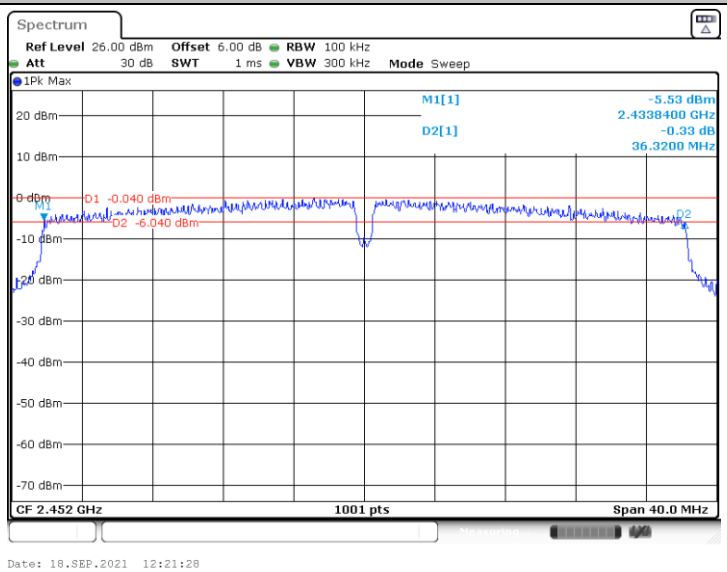
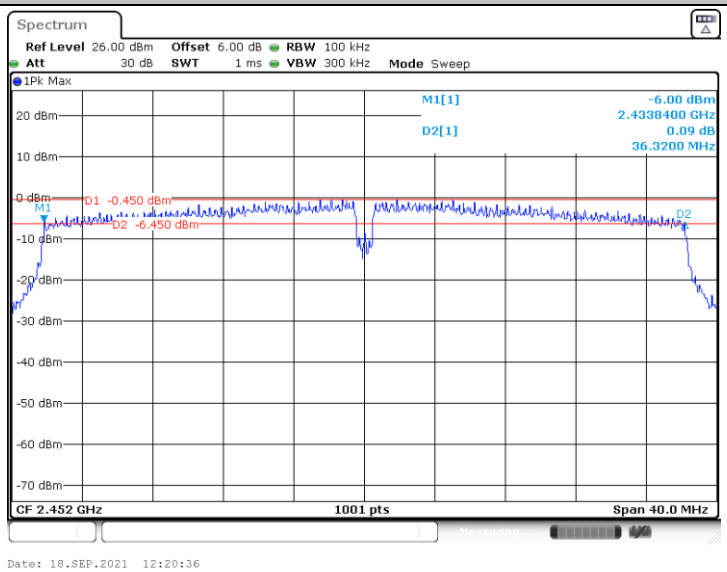


11N40MIMO_Ant1_2452


11N40MIMO_Ant2_2452


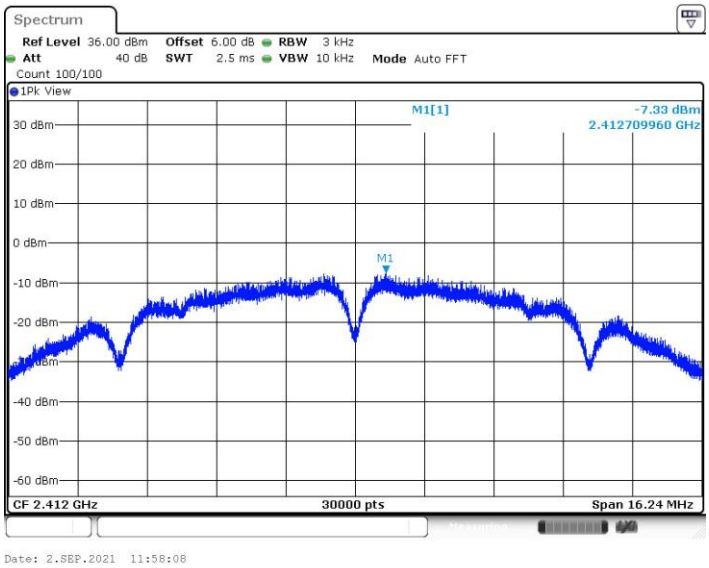
Maximum power spectral density Test Result

TestMode	Antenna	FC[MHz]	Result[dBm/3kHz]	Limit[dBm/3kHz]	Verdict
11B-CDD	Ant1	2412	-7.33	≤8	PASS
	Ant2	2412	-6.74	≤8	PASS
	total	2412	-4.01	≤8	PASS
	Ant1	2437	-4.88	≤8	PASS
	Ant2	2437	-4.86	≤8	PASS
	total	2437	-1.86	≤8	PASS
	Ant1	2462	-2.7	≤8	PASS
	Ant2	2462	-3.03	≤8	PASS
	total	2462	0.15	≤8	PASS
11G-CDD	Ant1	2412	-8.83	≤8	PASS
	Ant2	2412	-9.58	≤8	PASS
	total	2412	-6.18	≤8	PASS
	Ant1	2417	-7.54	≤8	PASS
	Ant2	2417	-7.81	≤8	PASS
	total	2417	-4.66	≤8	PASS
	Ant1	2437	-6.92	≤8	PASS
	Ant2	2437	-7.28	≤8	PASS
	total	2437	-4.09	≤8	PASS
	Ant1	2462	-7.25	≤8	PASS
	Ant2	2462	-7.23	≤8	PASS
	total	2462	-4.23	≤8	PASS
11N20MIMO	Ant1	2412	-9.95	≤8	PASS
	Ant2	2412	-10.26	≤8	PASS
	total	2412	-7.09	≤8	PASS
	Ant1	2417	-7.78	≤8	PASS
	Ant2	2417	-8.24	≤8	PASS
	total	2417	-4.99	≤8	PASS
	Ant1	2437	-6.12	≤8	PASS
	Ant2	2437	-6.57	≤8	PASS
	total	2437	-3.33	≤8	PASS
	Ant1	2462	-8.39	≤8	PASS
	Ant2	2462	-9.21	≤8	PASS
	total	2462	-5.77	≤8	PASS
11N40MIMO	Ant1	2422	-16.52	≤8	PASS
	Ant2	2422	-16	≤8	PASS
	total	2422	-13.24	≤8	PASS
	Ant1	2427	-11.32	≤8	PASS

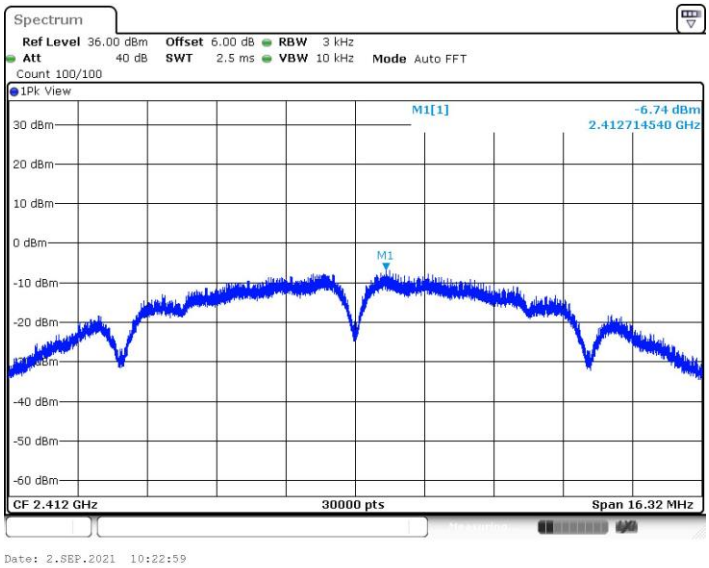
	Ant2	2427	-12.09	≤8	PASS
	total	2427	-8.68	≤8	PASS
	Ant1	2437	-12.75	≤8	PASS
	Ant2	2437	-12.02	≤8	PASS
	total	2437	-9.36	≤8	PASS
	Ant1	2452	-12.01	≤8	PASS
	Ant2	2452	-10.57	≤8	PASS
	total	2452	-8.22	≤8	PASS

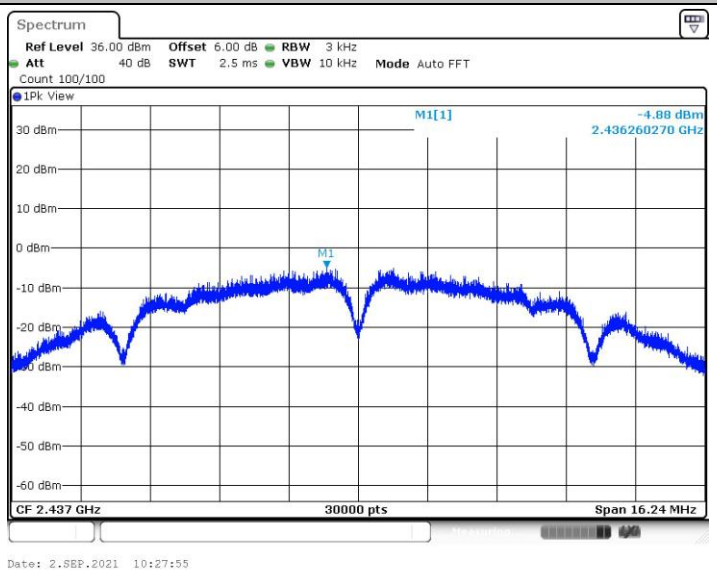
Test Graphs

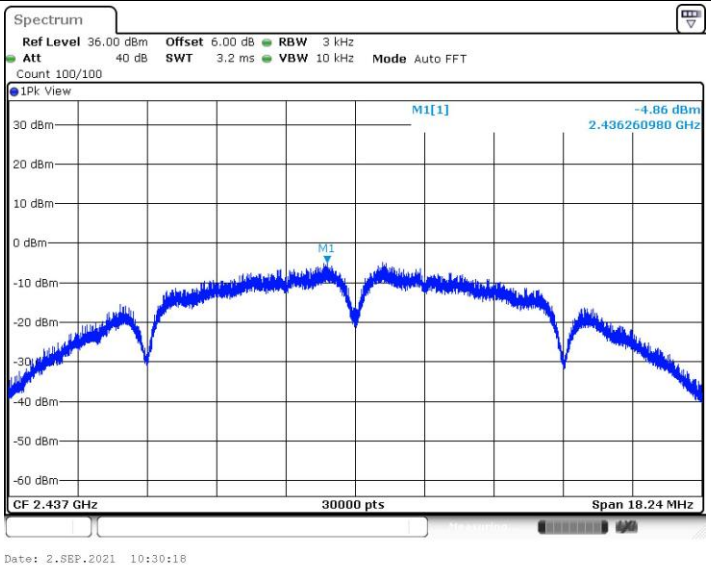
11B-CDD_Ant1_2412



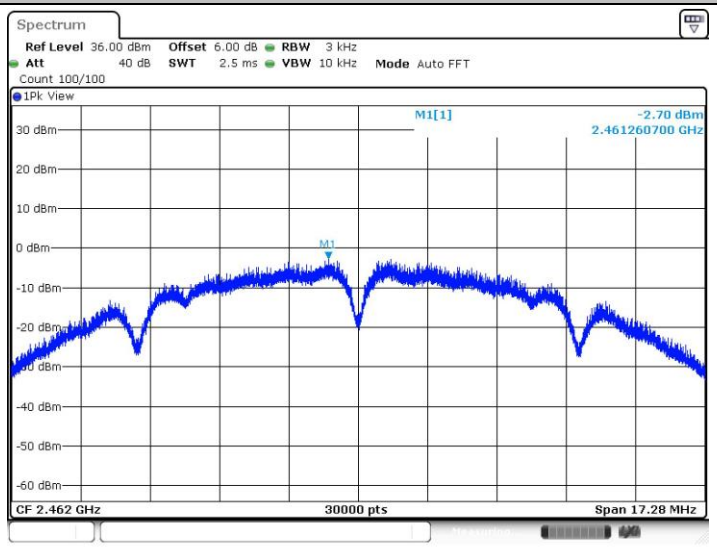
11B-CDD_Ant2_2412



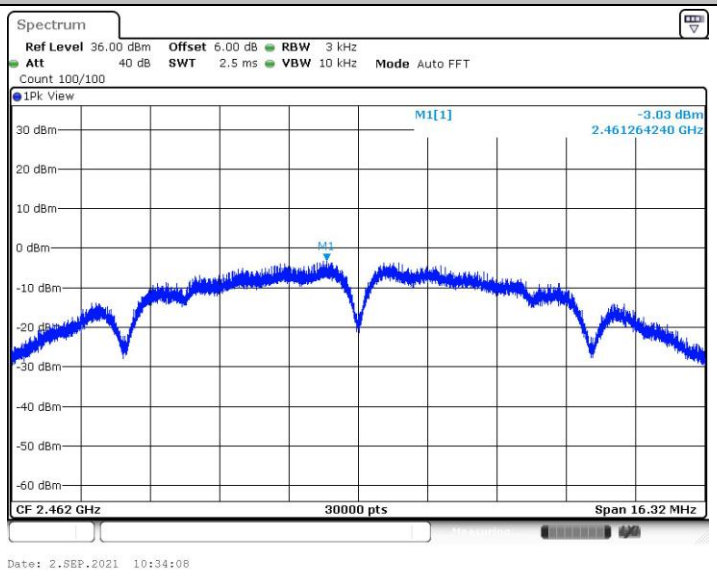
11B-CDD_Ant1_2437


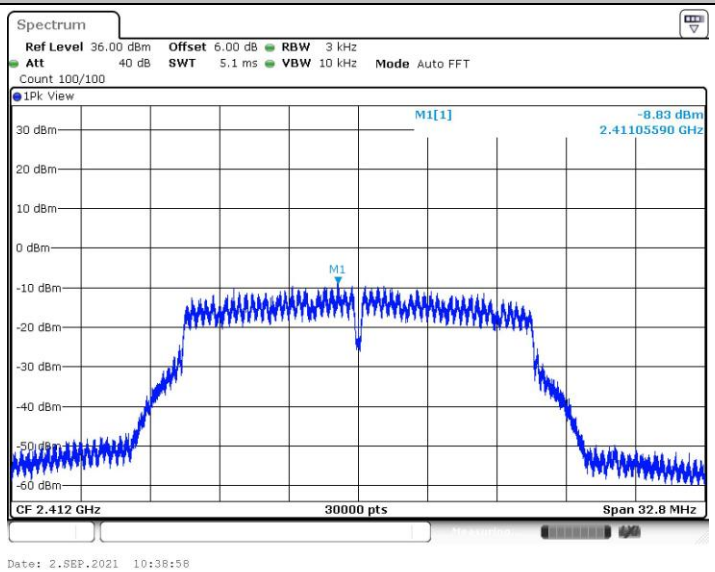
11B-CDD_Ant2_2437


11B-CDD_Ant1_2462



11B-CDD_Ant2_2462



11G-CDD_Ant1_2412


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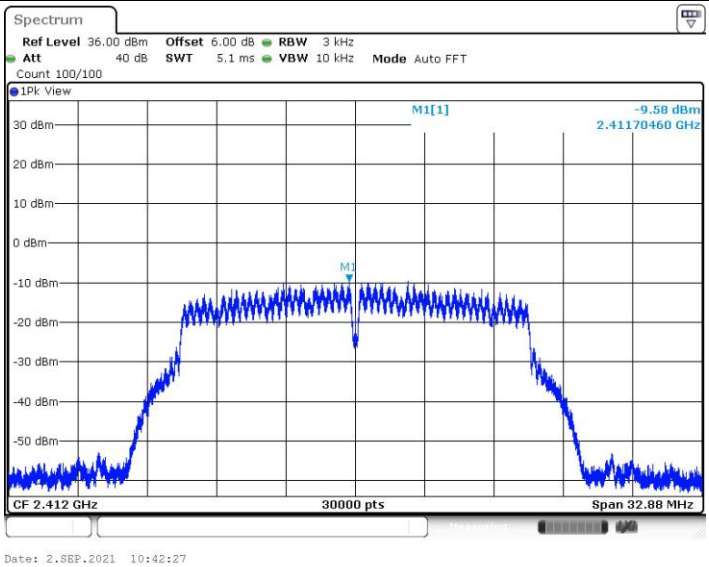
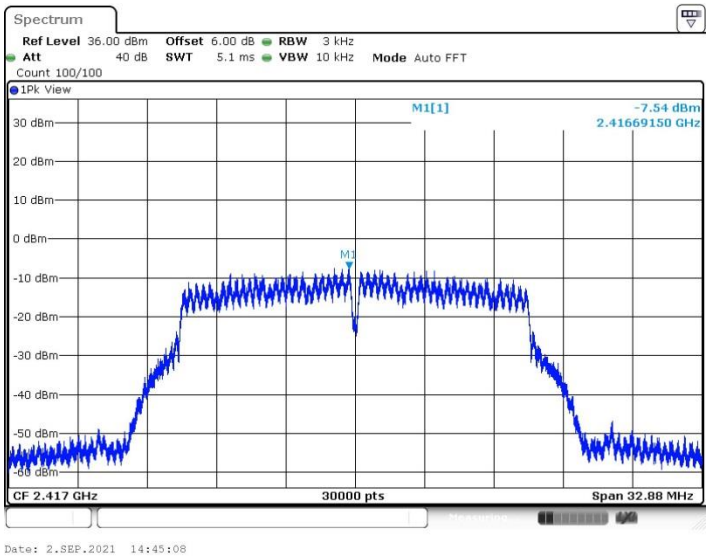
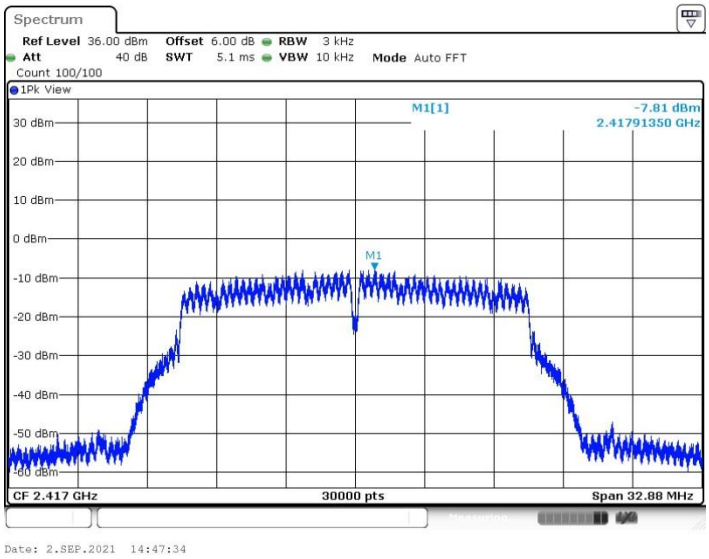


11G-CDD_Ant1_2417


11G-CDD_Ant2_2417


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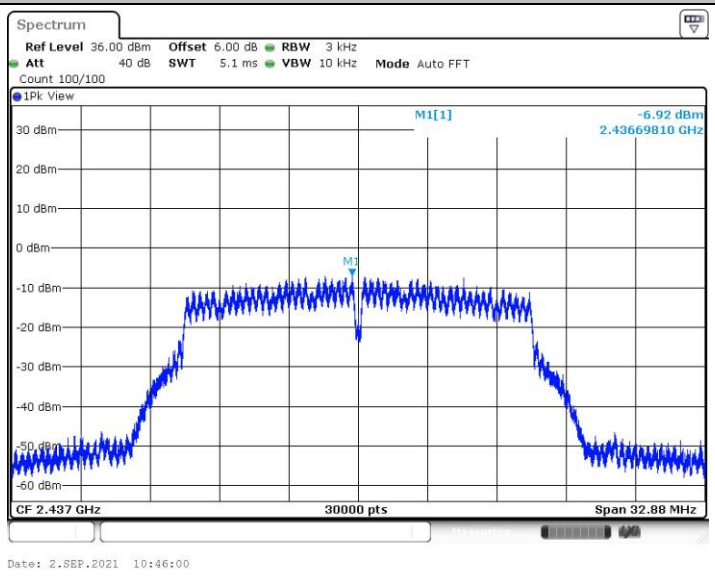

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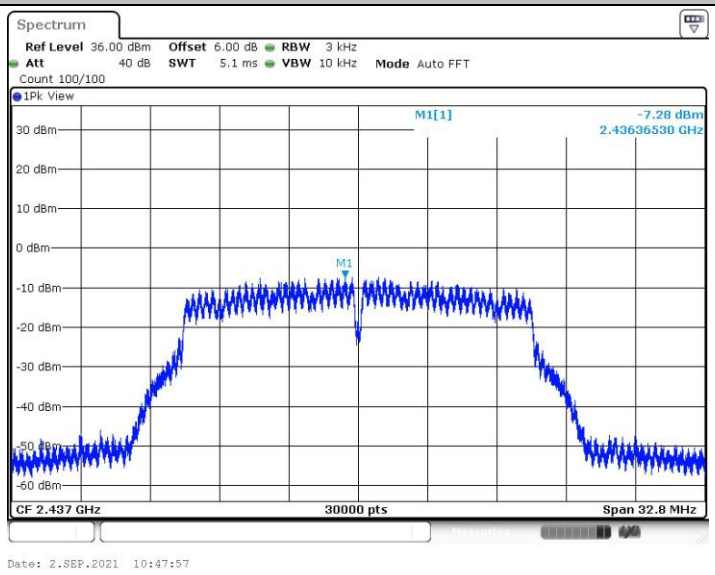

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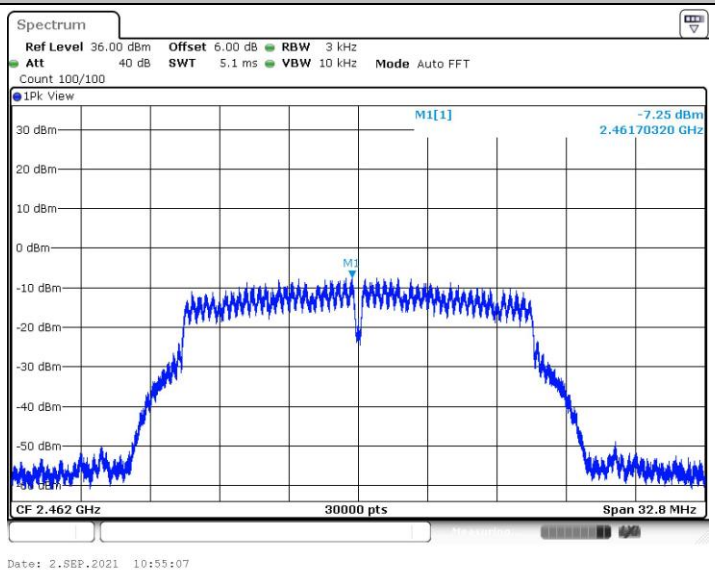
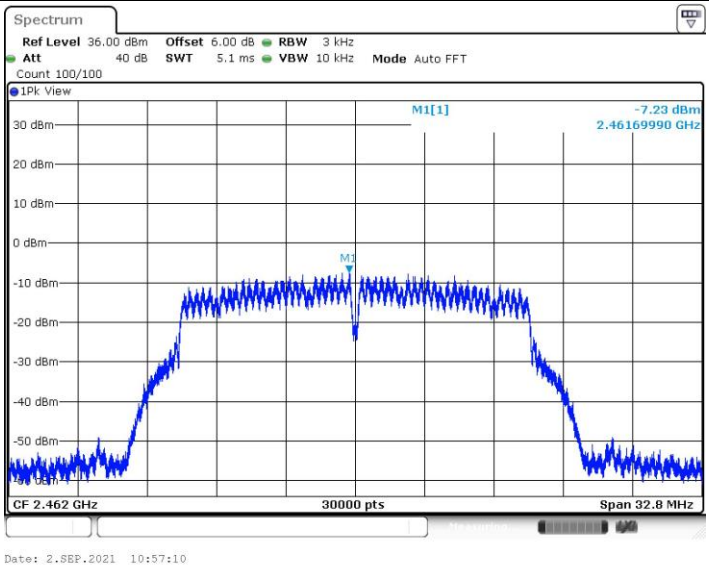
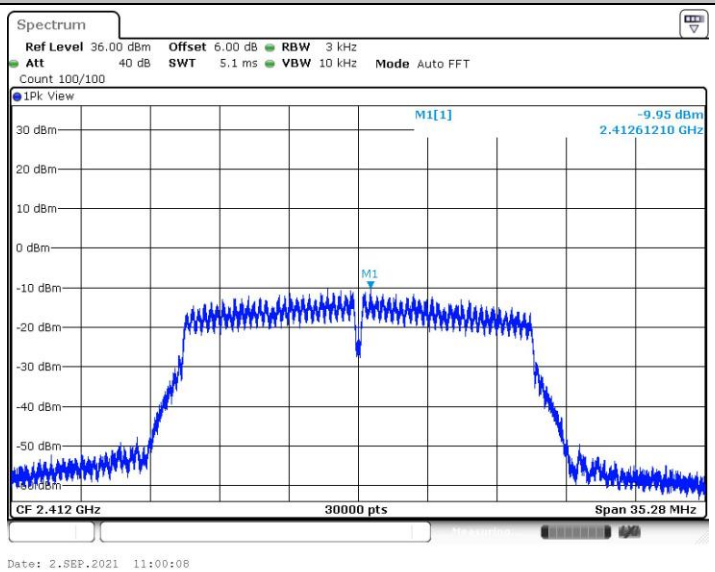
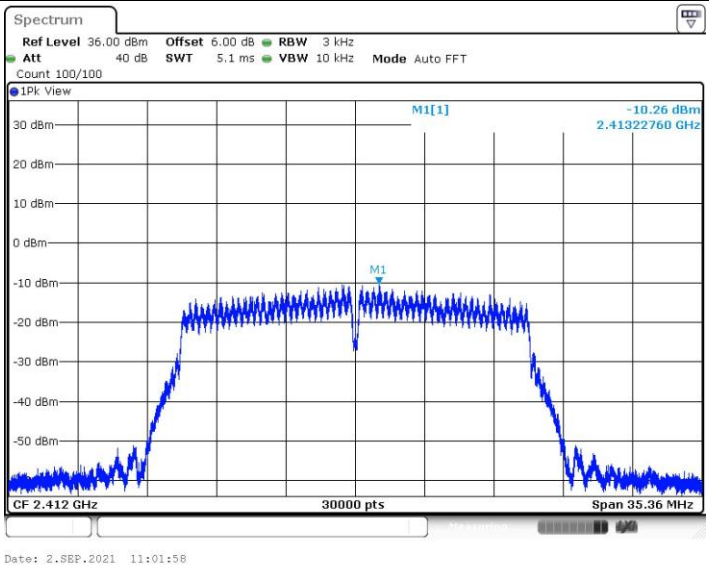


11G-CDD_Ant2_2462


11N20MIMO_Ant1_2412


11N20MIMO_Ant2_2412


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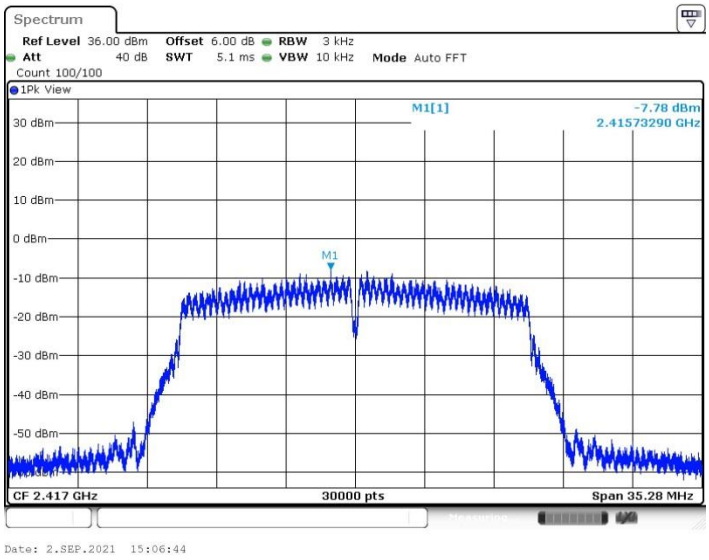

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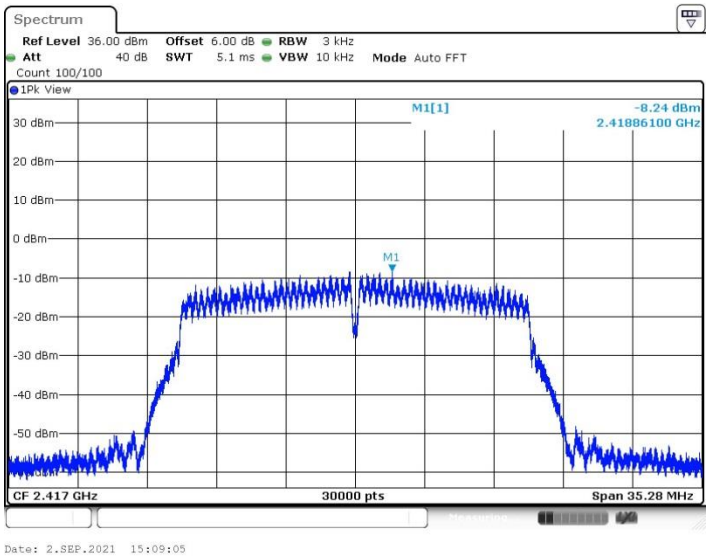

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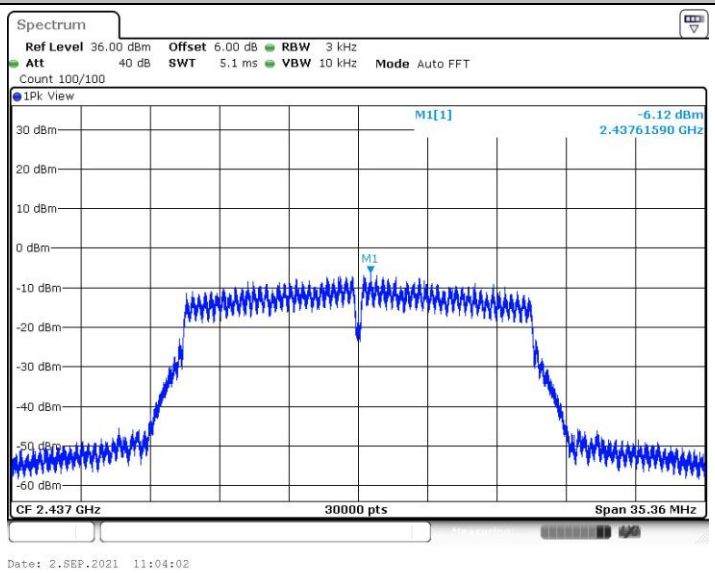

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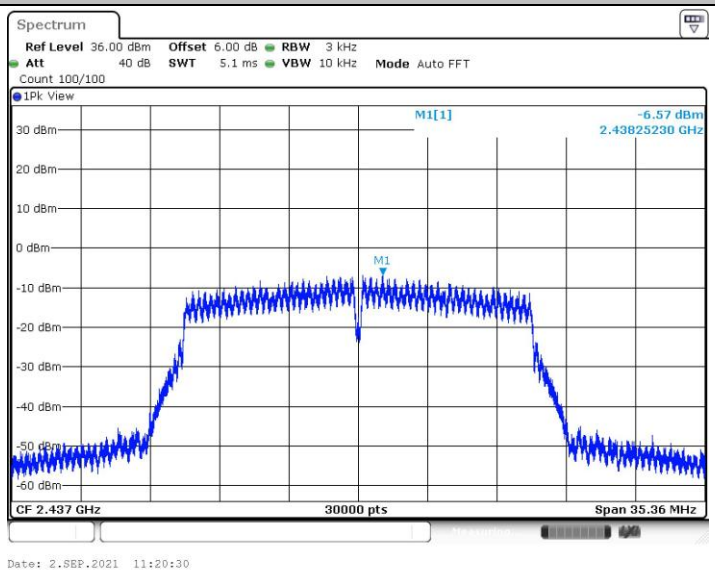

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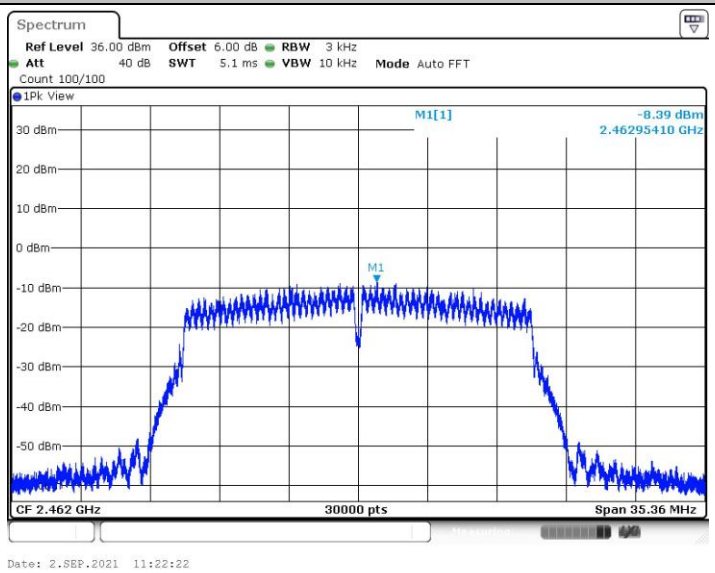

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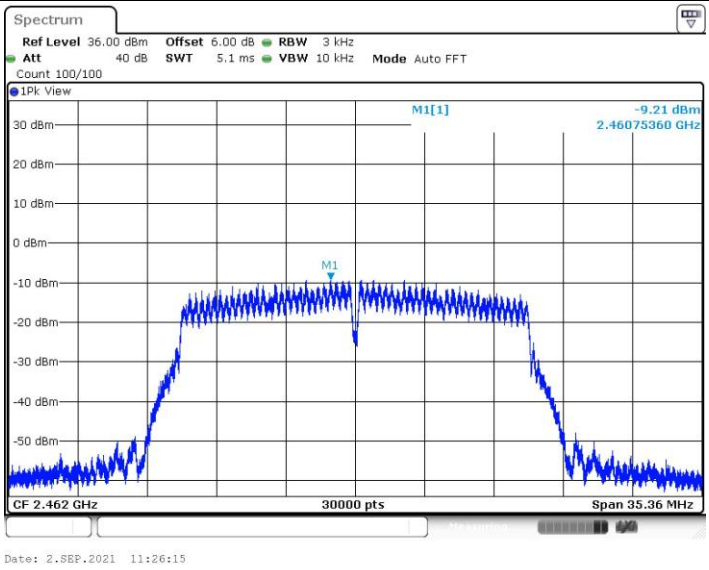
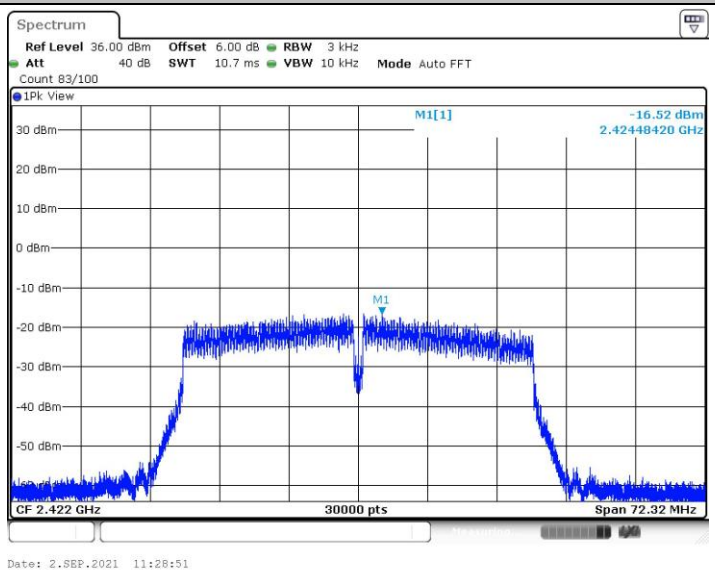
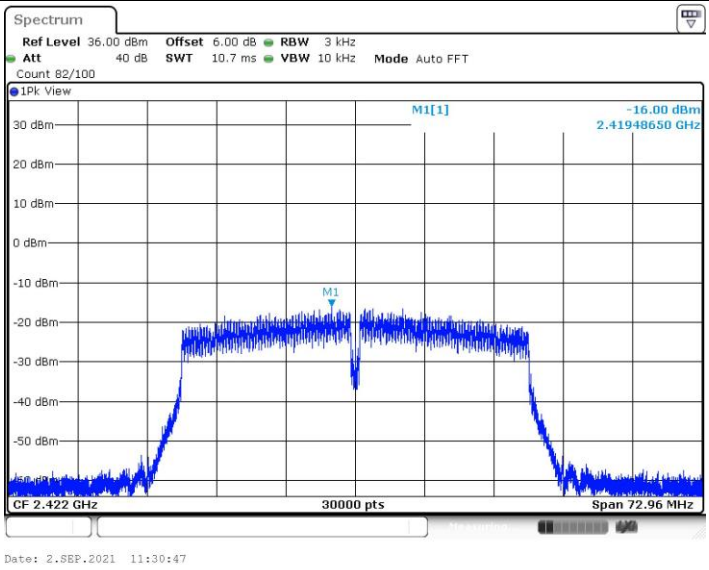
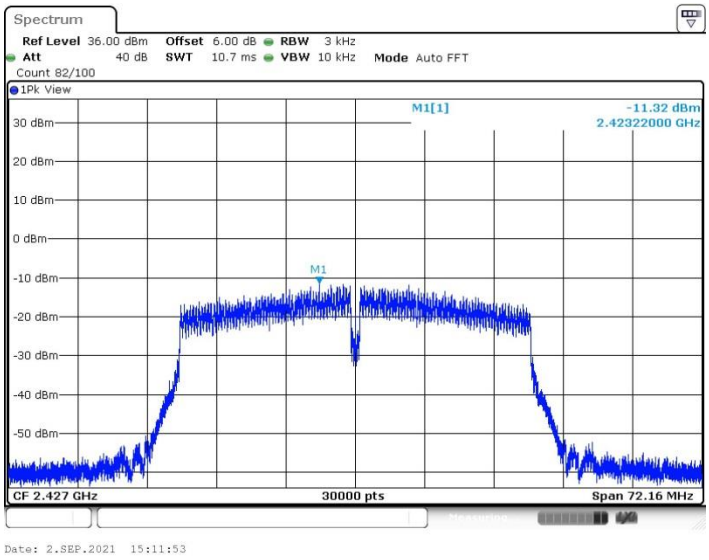


11N40MIMO_Ant1_2422


11N40MIMO_Ant2_2422


11N40MIMO_Ant1_2427


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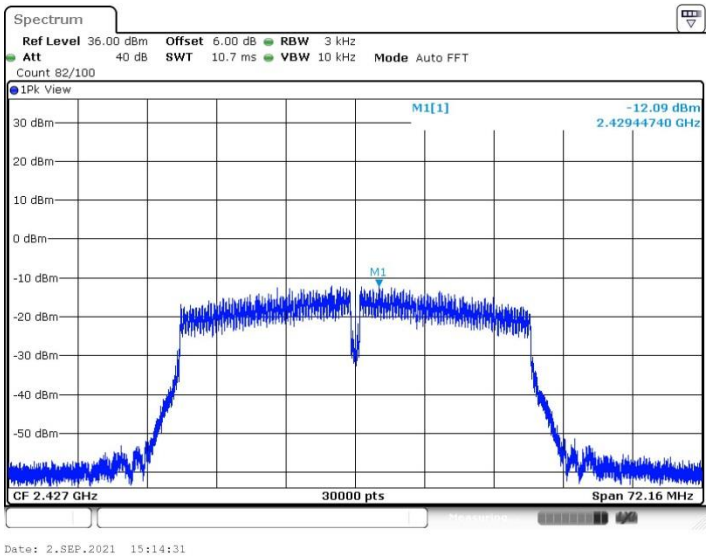

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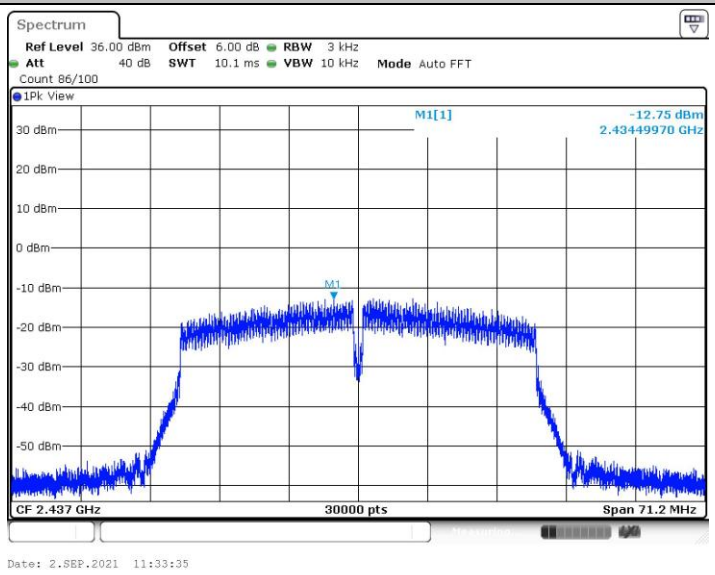

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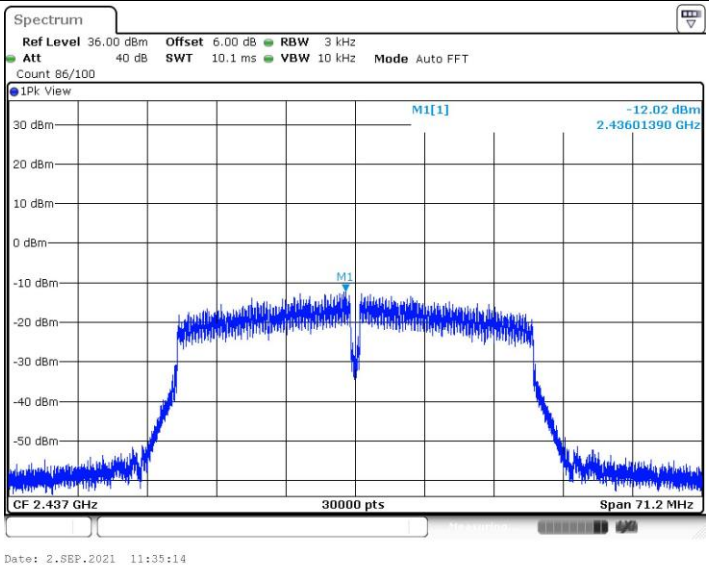
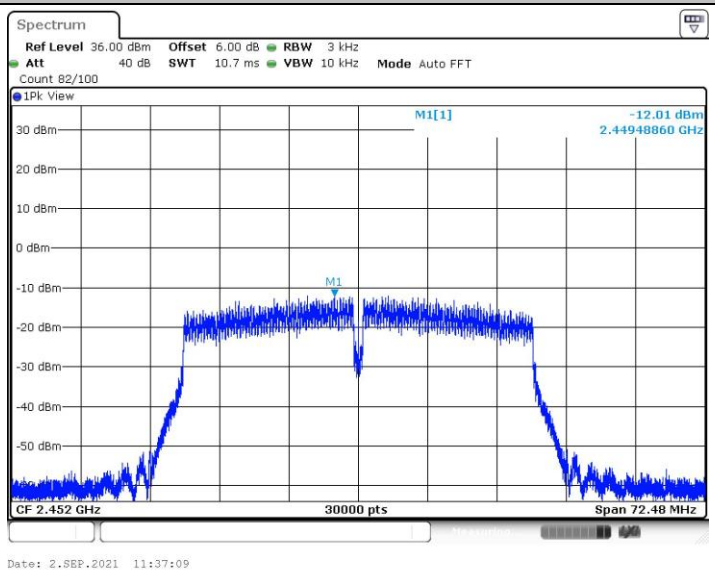
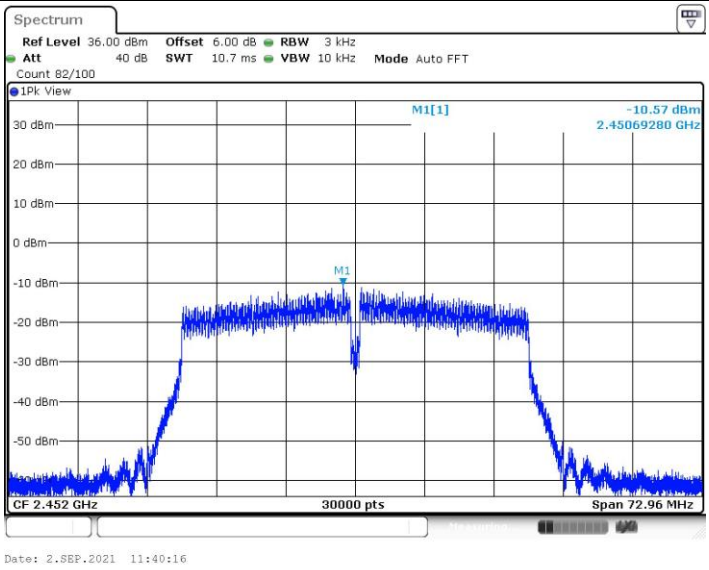


11N40MIMO_Ant1_2452


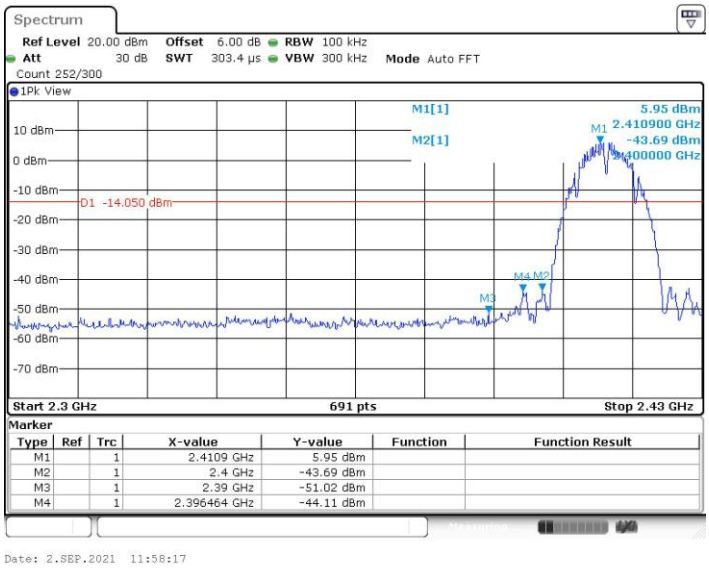
11N40MIMO_Ant2_2452


Band edge measurements Test Result

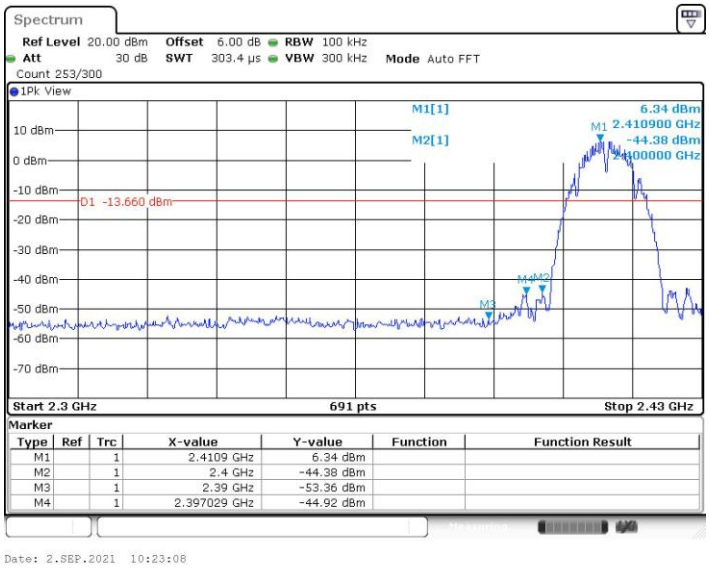
TestMode	Antenna	ChName	FC[MHz]	RefLevel[dBm]	Result[dBm]	Limit[dBm]	Verdict
11B-CDD	Ant1	Low	2412	5.95	-44.11	≤-14.05	PASS
	Ant2	Low	2412	6.34	-44.92	≤-13.66	PASS
	Ant1	High	2462	10.17	-49.91	≤-9.83	PASS
	Ant2	High	2462	10.66	-49.88	≤-9.34	PASS
11G-CDD	Ant1	Low	2412	2.19	-32.57	≤-17.81	PASS
	Ant2	Low	2412	1.01	-40.26	≤-18.99	PASS
	Ant1	Low	2417	4.11	-39.63	≤-15.89	PASS
	Ant2	Low	2417	3.58	-40.63	≤-16.42	PASS
	Ant1	High	2462	4.16	-46.14	≤-15.84	PASS
	Ant2	High	2462	3.94	-46.13	≤-16.06	PASS
11N20MIMO	Ant1	Low	2412	0.37	-36.43	≤-19.63	PASS
	Ant2	Low	2412	0.94	-41.29	≤-19.06	PASS
	Ant1	Low	2417	2.53	-42.95	≤-17.47	PASS
	Ant2	Low	2417	2.33	-42.05	≤-17.67	PASS
	Ant1	High	2462	2.72	-48.06	≤-17.28	PASS
	Ant2	High	2462	2.45	-48.38	≤-17.55	PASS
11N40MIMO	Ant1	Low	2422	-5.20	-42.36	≤-25.2	PASS
	Ant2	Low	2422	-4.79	-43.6	≤-24.79	PASS
	Ant1	Low	2427	-0.33	-43.78	≤-20.33	PASS
	Ant2	Low	2427	-0.70	-42.9	≤-20.7	PASS
	Ant1	High	2452	-0.10	-46.43	≤-20.1	PASS
	Ant2	High	2452	0.18	-47.75	≤-19.82	PASS

Test Graphs

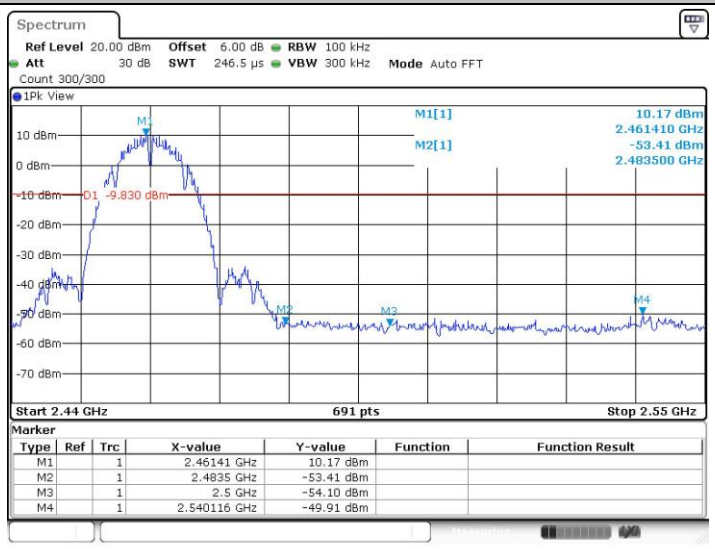
11B-CDD_Ant1_Low_2412



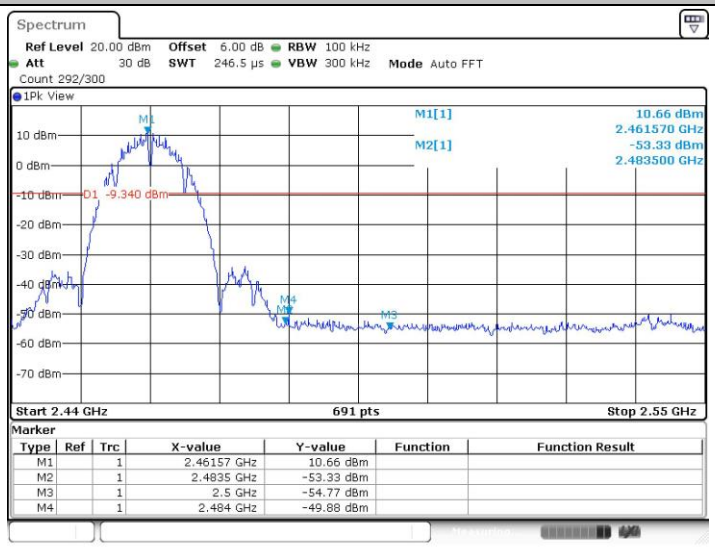
11B-CDD_Ant2_Low_2412



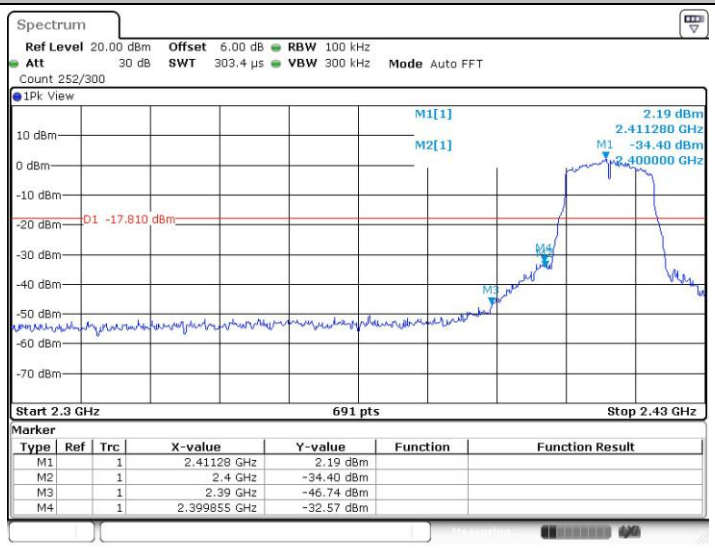
11B-CDD_Ant1_High_2462



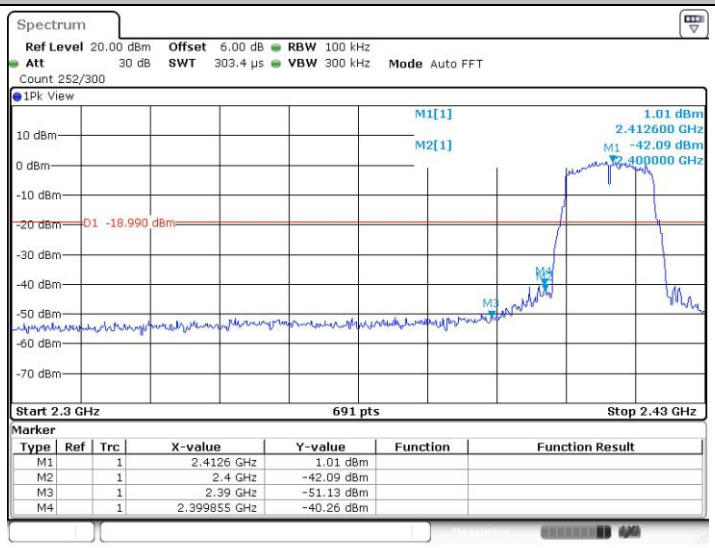
11B-CDD_Ant2_High_2462



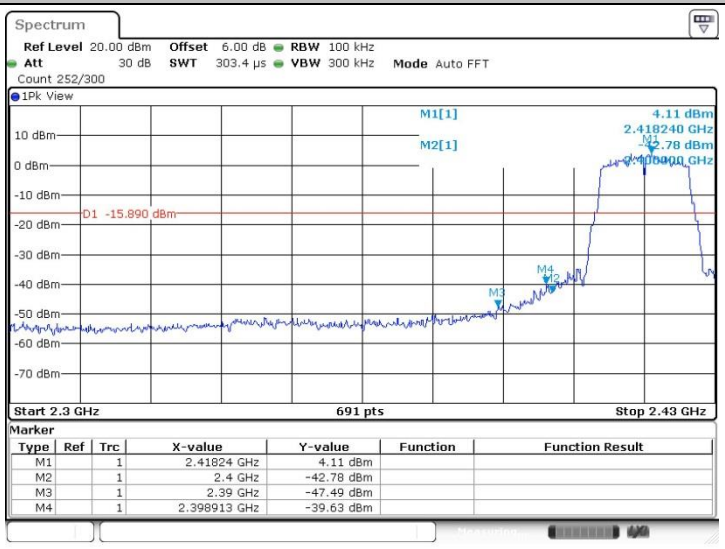
11G-CDD_Ant1_Low_2412



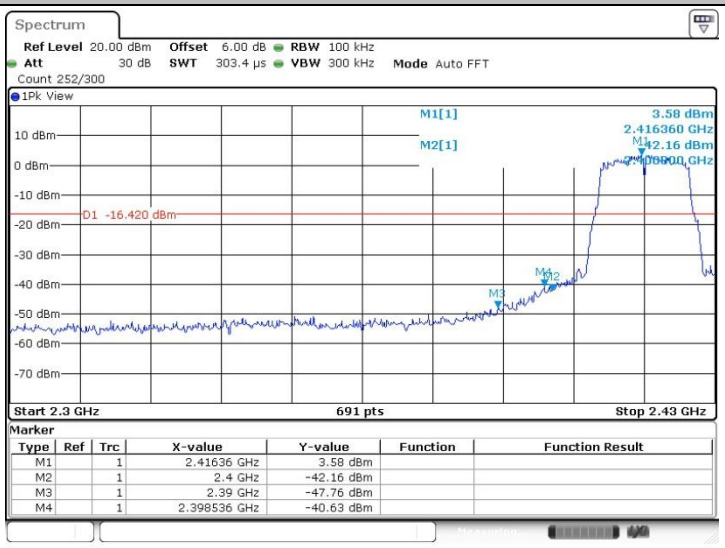
11G-CDD_Ant2_Low_2412



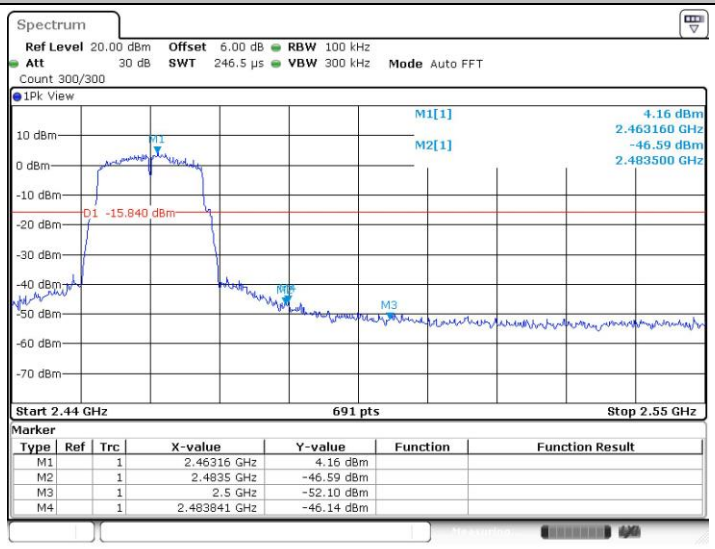
11G-CDD_Ant1_ Low _2417



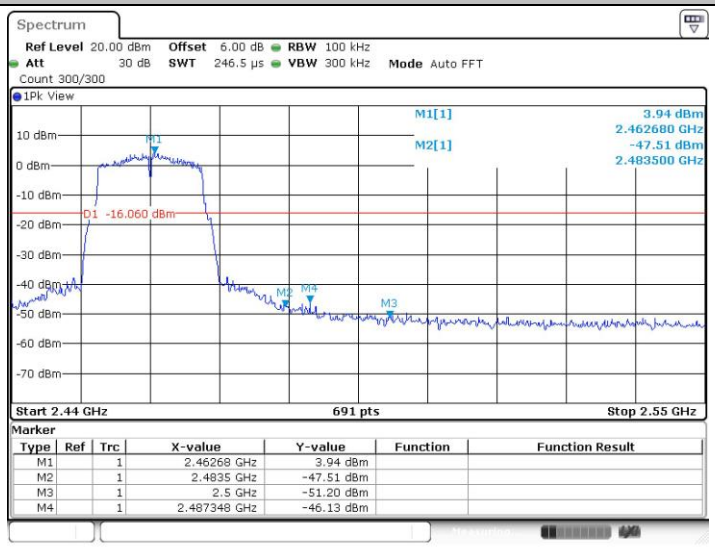
11G-CDD_Ant2_ Low _2417



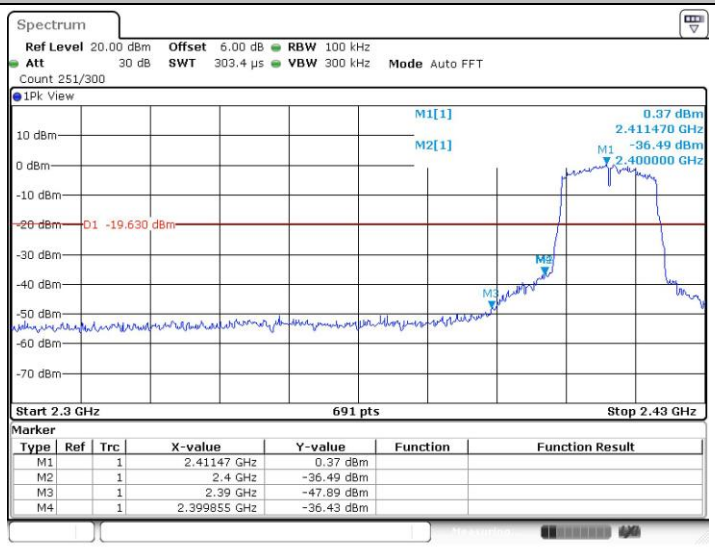
11G-CDD_Ant1_High_2462



11G-CDD_Ant2_High_2462



11N20MIMO_Ant1_Low_2412



11N20MIMO_Ant2_Low_2412