FCC RF Test Report

APPLICANT	:	Lenovo(Shanghai) Electronics Technology Co., Ltd.
EQUIPMENT	:	Standalone VR Headset
BRAND NAME	:	Lenovo
MODEL NAME	:	Lenovo VRX 6060
FCC ID	:	O57VRX6060
STANDARD	:	FCC Part 15 Subpart C §15.247
CLASSIFICATION	:	(DTS) Digital Transmission System
TEST DATE(S)	:	Jan. 17, 2023 ~ Feb. 20, 2023

We, Sporton International Inc. (Kunshan), 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 Inc. (Kunshan), the test report shall not be reproduced except in full.

Jason Jia

Approved by: Jason Jia

ACCREDITED
Cert #5145.02

Sporton International Inc. (Kunshan)
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
FR310533C	Rev. 01	Initial issue of report	Mar. 01, 2023

SUMMARY OF TEST RESULT

Report Section	FCC Rule	Description	Limit	Result	Remark
3.1	15.247(a)(2)	6dB Bandwidth	≥ 0.5MHz	Pass	-
3.1	-	99% Bandwidth	-	Report Only	-
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 4.36 dB at 2483.50 MHz
3.6	15.207	AC Conducted Emission	15.207(a)	Pass	Under limit 16.30 dB at 0.156 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

Lenovo(Shanghai) Electronics Technology Co., Ltd.
Section 304-305, Building No. 4, # 222, Meiyue Road, China (Shanghai) Pilot Free Trade Zone

1.2 Manufacturer

Lenovo PC HK Limited.
23/F, Lincoln House, Taikoo Place 979 King's Road, Quarry Bay, Hong Kong, China

1.3 Product Feature of Equipment Under Test

Product Feature	
Equipment	Standalone VR Headset
Brand Name	Lenovo
Model Name	Lenovo VRX 6060
FCC ID	O57VRX6060
SN	Conducted: 1784874200039 Conduction: 1784874200003 Radiation: 1784874200143
HW Version	SIT
SW Version	Aurora_userdebug_S163001_2212262040_kona
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	**<MIMO Ant. 0+1>** 802.11b : 22.36 dBm (0.1722 W) 802.11g : 26.06 dBm (0.4036 W) 802.11n HT20 : 25.37 dBm (0.3443 W) 802.11n HT40 : 25.38 dBm (0.3451 W) 802.11ax HE20 : 24.05 dBm (0.2541 W) 802.11ax HE40 : 23.37 dBm (0.2173 W)
99% Occupied Bandwidth	802.11b : 13.267 MHz 802.11g : 16.703 MHz 802.11n HT20 : 17.862 MHz 802.11n HT40 : 36.204 MHz 802.11ax HE20 : 19.021 MHz 802.11ax HE40 : 37.962 MHz
Antenna Type / Gain	**<Ant 0>:** PIFA Antenna type with gain 1.84 dBi **<Ant 1>:** PIFA Antenna type with gain 1.40 dBi
Type of Modulation	802.11b : DSSS (DBPSK / DQPSK / CCK) 802.11g/n : OFDM (BPSK / QPSK / 16QAM / 64QAM) 802.11ax : OFDM (BPSK / QPSK / 16QAM / 64QAM / 256QAM / 1024QAM / 4096QAM)

Note:

1. For WLAN SISO & CDD MIMO mode, the whole testing has assessed only MIMO mode by referring to the higher output power.
2. 802.11ax support full RU tone and partial RU tone, both full RU and partial RU-left (for low CH) and partial RU-right (for high CH) are tested for conducted power/PSD/RSE, the full RU PSD > partial PSD, therefore the full RU perform full test and Partial RU verified power/PSD/RSE.

1.5 Modification of EUT

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

1.6 Testing Location

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

Test Firm	Sporton International Inc. (Kunshan)		
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	6.2009-8-24
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). For radiated measurement, pre-scanned in three orthogonal panels, X, Y, Z. The worst cases (Z plane) were recorded in this report.

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

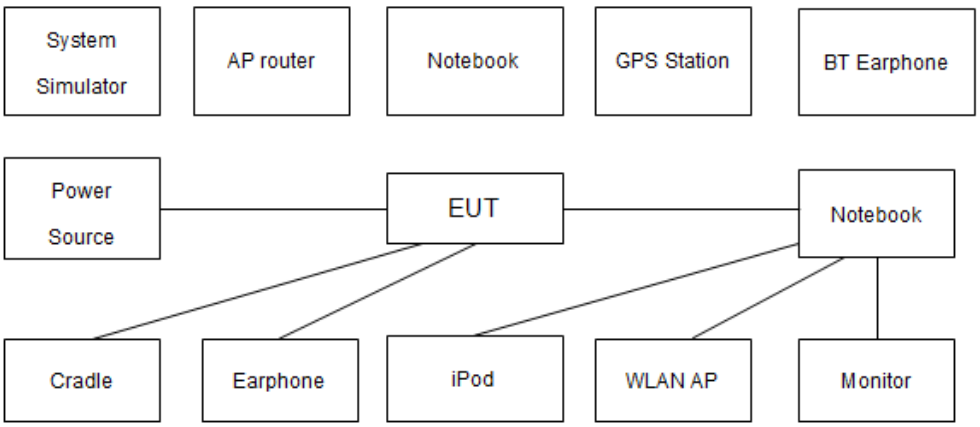
Final test modes are considering the modulation and worse data rates as below table.

MIMO Antenna

Modulation	Data Rate
802.11b	1 Mbps
802.11g	6 Mbps
802.11n HT20	MCS0
802.11n HT40	MCS0
802.11ax HE20	MCS0
802.11ax HE40	MCS0

Test Cases	
AC Conducted Emission	Mode 1 :Bluetooth Link+ Bluetooth Link(Nordic BLE)+ WLAN Link(2.4G)+ USB Cable(Charging From Adapter)+ Earphone
Remark: For Radiated Test Cases, The tests were performance with Adapter, Earphone and USB Cable.	

2.3 Connection Diagram of Test System



This example is connection diagram of EUT test configurations.

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

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.	Bluetooth Earphone	Lenovo	LBH308	N/A	N/A	N/A
4.	Adapter	N/A	N/A	N/A	N/A	N/A
5.	Earphone	Lenovo	P121	N/A	N/A	Unshielded,1.2m

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 and attenuator factor 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 and attenuator factor.

Offset = RF cable loss + attenuator factor.

Following shows an offset computation example with cable loss 2.95 dB and 10dB attenuator.

Offset(dB) = RF cable loss(dB) + attenuator factor(dB).

= 2.95 + 10 = 12.95 (dB)

3 Test Result

3.1 6dB and 99% Bandwidth Measurement

3.1.1 Limit of 6dB and 99% Bandwidth

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

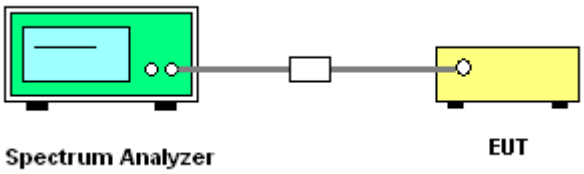
3.1.2 Measuring Instruments

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. For 99% Bandwidth Measurement, the spectrum analyzer's resolution bandwidth (RBW) = 1%~5% of OBW and set the Video bandwidth (VBW) = 3MHz.
6. Measure and record the results in the test report.

3.1.4 Test Setup



3.1.5 Test Result of 6dB and 99% Occupied 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.

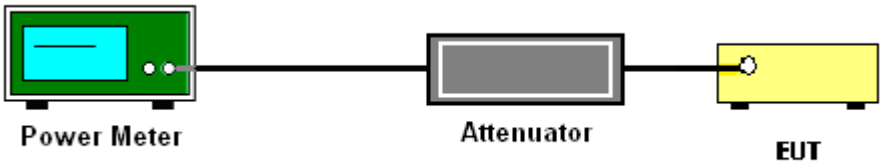
3.2.2 Measuring Instruments

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 11.9.2.3.1 Method AVGPM 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

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
					Ant0	Ant1	SUM	Ant0	Ant1	Ant0	Ant1	Ant0	Ant1	Ant0	Ant1	
11b	1Mbps	2	1	2412	19.52	19.18	22.36	30.00		1.84		24.20		36.00		Pass
11b	1Mbps	2	6	2437	18.63	18.81	21.73	30.00		1.84		23.57		36.00		Pass
11b	1Mbps	2	11	2462	19.12	18.43	21.80	30.00		1.84		23.64		36.00		Pass
11g	6Mbps	2	1	2412	22.87	23.23	26.06	30.00		1.84		27.90		36.00		Pass
11g	6Mbps	2	6	2437	22.32	23.15	25.77	30.00		1.84		27.61		36.00		Pass
11g	6Mbps	2	11	2462	22.25	22.53	25.40	30.00		1.84		27.24		36.00		Pass
HT20	MCS0	2	1	2412	21.95	22.45	25.22	30.00		1.84		27.06		36.00		Pass
HT20	MCS0	2	6	2437	22.06	22.55	25.32	30.00		1.84		27.16		36.00		Pass
HT20	MCS0	2	11	2462	22.45	22.26	25.37	30.00		1.84		27.21		36.00		Pass
HT40	MCS0	2	3	2422	21.95	22.23	25.10	30.00		1.84		26.94		36.00		Pass
HT40	MCS0	2	6	2437	22.01	22.70	25.38	30.00		1.84		27.22		36.00		Pass
HT40	MCS0	2	9	2452	22.17	22.41	25.30	30.00		1.84		27.14		36.00		Pass

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	RU Config.	Peak Conducted Power (dBm)			Conducted Power Limit (dBm)		DG (dBi)		EIRP Power (dBm)		EIRP Power Limit (dBm)		Pass /Fail
						Ant0	Ant1	SUM	Ant0	Ant1	Ant0	Ant1	Ant0	Ant1	Ant0	Ant1	
HE20	MCS0	2	1	2412	Full	20.73	21.32	24.05	30.00		1.84		25.89		36.00		Pass
HE20	MCS0	2	1	2412	26/0	13.82	13.85	16.85	30.00		1.84		18.69		36.00		Pass
HE20	MCS0	2	1	2412	52/37	17.13	15.42	19.37	30.00		1.84		21.21		36.00		Pass
HE20	MCS0	2	1	2412	106/53	19.29	16.67	21.18	30.00		1.84		23.02		36.00		Pass
HE20	MCS0	2	6	2437	Full	20.54	21.08	23.83	30.00		1.84		25.67		36.00		Pass
HE20	MCS0	2	6	2437	26/0	13.81	14.14	16.99	30.00		1.84		18.83		36.00		Pass
HE20	MCS0	2	6	2437	52/37	16.89	15.71	19.35	30.00		1.84		21.19		36.00		Pass
HE20	MCS0	2	6	2437	106/53	18.41	16.62	20.62	30.00		1.84		22.46		36.00		Pass
HE20	MCS0	2	11	2462	Full	20.75	20.83	23.80	30.00		1.84		25.64		36.00		Pass
HE20	MCS0	2	11	2462	26/8	13.97	13.45	16.73	30.00		1.84		18.57		36.00		Pass
HE20	MCS0	2	11	2462	52/40	16.46	14.03	18.42	30.00		1.84		20.26		36.00		Pass
HE20	MCS0	2	11	2462	106/54	18.86	16.68	20.92	30.00		1.84		22.76		36.00		Pass
HE40	MCS0	2	3	2422	Full	20.17	20.55	23.37	30.00		1.84		25.21		36.00		Pass
HE40	MCS0	2	6	2437	Full	19.97	20.26	23.13	30.00		1.84		24.97		36.00		Pass
HE40	MCS0	2	9	2452	Full	19.74	20.57	23.19	30.00		1.84		25.03		36.00		Pass

3.2.6 Test Result of Average Output Power (Reporting Only)

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Duty Factor (dB)		Average Conducted Power with duty factor (dBm)		
					Ant 1	Ant 2	Ant0	Ant1	SUM
11b	1Mbps	2	1	2412	0.07	0.08	16.86	16.59	19.74
11b	1Mbps	2	6	2437	0.07	0.08	16.10	16.39	19.26
11b	1Mbps	2	11	2462	0.07	0.08	16.58	16.03	19.32
11g	6Mbps	2	1	2412	0.02	0.04	14.91	15.72	18.34
11g	6Mbps	2	6	2437	0.02	0.04	14.49	15.50	18.03
11g	6Mbps	2	11	2462	0.02	0.04	14.90	15.41	18.17
HT20	MCS0	2	1	2412	0.00	0.00	14.18	14.65	17.43
HT20	MCS0	2	6	2437	0.00	0.00	14.03	14.72	17.40
HT20	MCS0	2	11	2462	0.00	0.00	14.56	14.63	17.61
HT40	MCS0	2	3	2422	0.00	0.00	14.35	14.81	17.60
HT40	MCS0	2	6	2437	0.00	0.00	14.42	14.89	17.67
HT40	MCS0	2	9	2452	0.00	0.00	14.50	14.90	17.71

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	RU Config.	Duty Factor (dB)		Average Conducted Power with duty factor (dBm)		
						Ant0	Ant1	Ant0	Ant1	SUM
HE20	MCS0	2	1	2412	Full	0.00	0.00	11.53	11.96	14.76
HE20	MCS0	2	1	2412	26/0	0.00	0.00	2.94	3.15	6.06
HE20	MCS0	2	1	2412	52/37	0.00	0.00	5.22	2.94	7.24
HE20	MCS0	2	1	2412	106/53	0.00	0.00	7.93	5.07	9.74
HE20	MCS0	2	6	2437	Full	0.00	0.00	11.32	11.71	14.53
HE20	MCS0	2	6	2437	26/0	0.00	0.00	3.03	3.18	6.12
HE20	MCS0	2	6	2437	52/37	0.00	0.00	5.91	4.47	8.26
HE20	MCS0	2	6	2437	106/53	0.00	0.00	7.72	5.86	9.90
HE20	MCS0	2	11	2462	Full	0.00	0.00	11.84	11.83	14.85
HE20	MCS0	2	11	2462	26/8	0.00	0.00	3.45	3.17	6.32
HE20	MCS0	2	11	2462	52/40	0.00	0.00	5.26	3.08	7.32
HE20	MCS0	2	11	2462	106/54	0.00	0.00	7.95	5.79	10.01
HE40	MCS0	2	3	2422	Full	0.00	0.00	11.36	11.94	14.67
HE40	MCS0	2	6	2437	Full	0.00	0.00	11.58	11.79	14.70
HE40	MCS0	2	9	2452	Full	0.00	0.00	11.53	11.95	14.76

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.

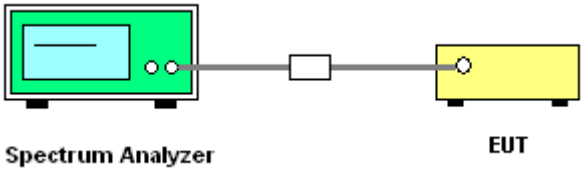
   If measurements performed using method (2) plus 10 log (N) exceeds the emission limit, the test should choose method (1) before declaring that the device fails the emission limit.

   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.

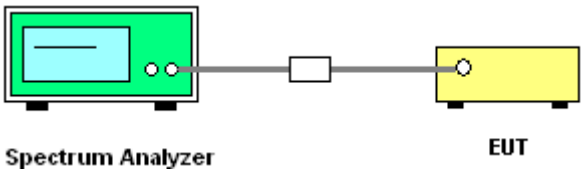
3.4.2 Measuring Instruments

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

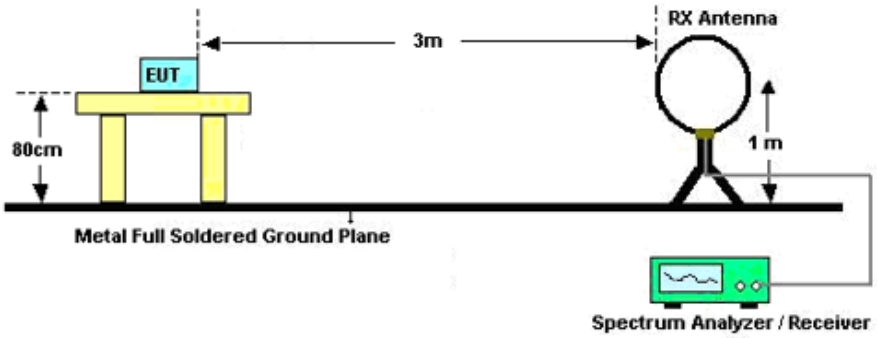
The measuring equipment is listed in the section 4 of this test report.

3.5.3 Test Procedures

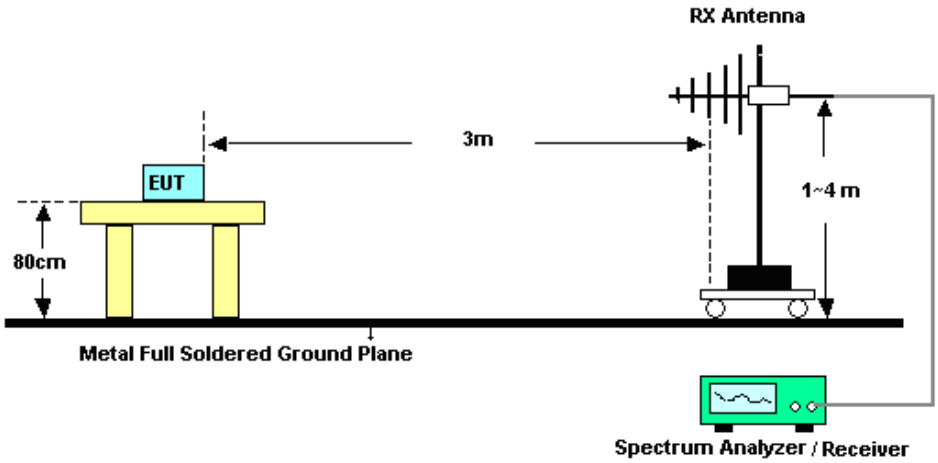
1. The testing follows ANSI C63.10-2013 clause 11.11 & 11.12
2. The EUT was arranged to its worst case and then tune the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better 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

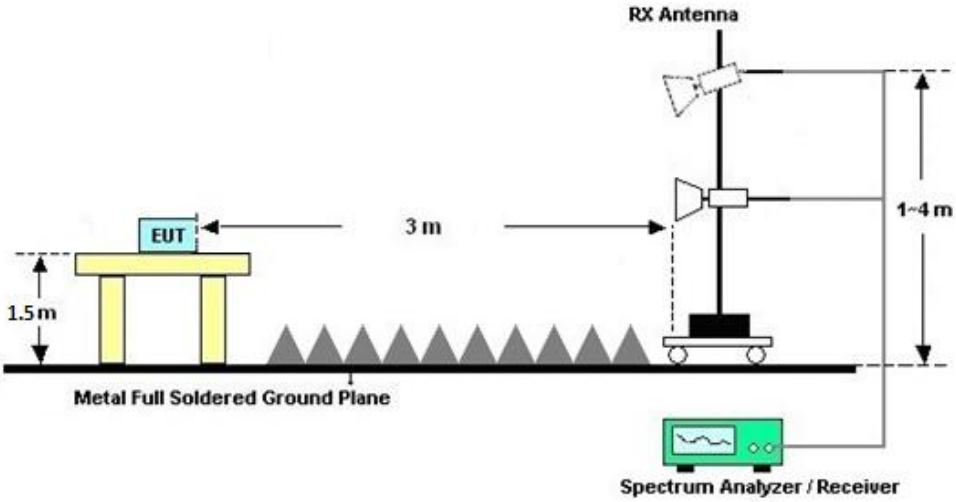
For radiated emissions below 30MHz



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 D.

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.

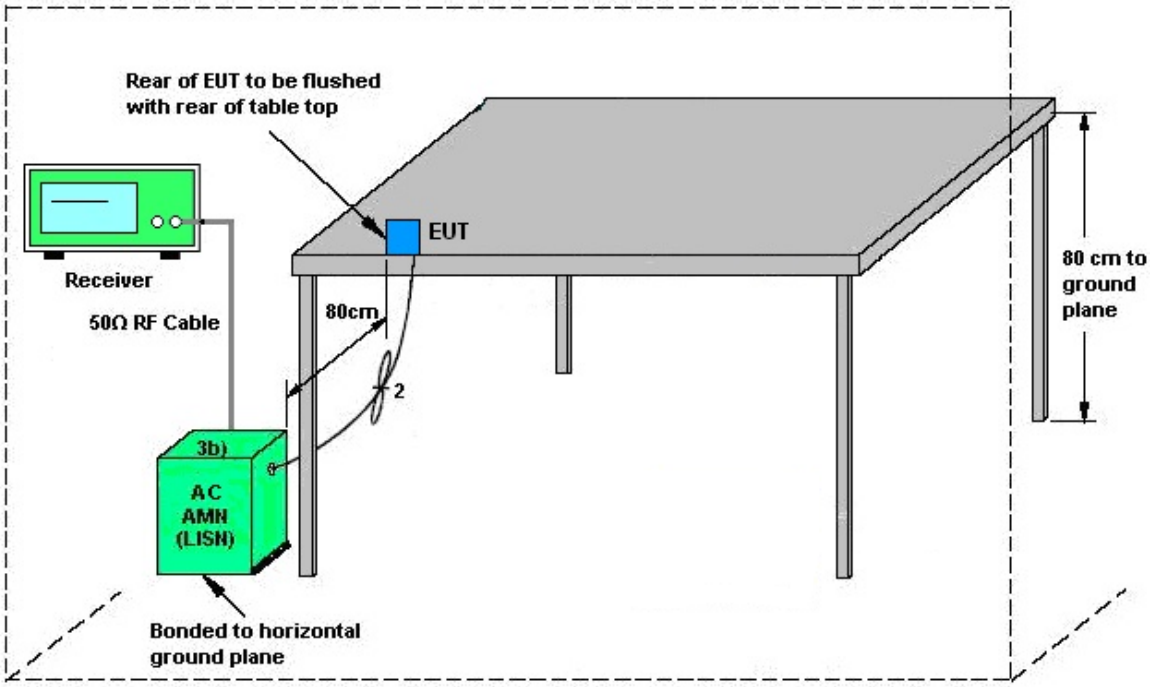
3.6.2 Measuring Instruments

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



AMN = Artificial mains network (LISN)
AE = Associated equipment
EUT = Equipment under test
ISN = Impedance stabilization network

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 >

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.

	Ant. 0 (dBi)	Ant. 1 (dBi)	DG for Power (dBi)	DG for PSD (dBi)	Power Limit Reduction (dB)	PSD Limit Reduction (dB)
2.4 GHz	1.84	1.40	1.84	4.63	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	Oct. 12, 2022	Jan. 17, 2023~ Feb. 20, 2023	Oct. 11, 2023	Conducted (TH01-KS)
Pulse Power Senor	Anritsu	MA2411B	0917070	300MHz~40GHz	Jan. 05, 2023	Jan. 17, 2023~ Feb. 20, 2023	Jan. 04, 2024	Conducted (TH01-KS)
Power Meter	Anritsu	ML2495A	1435004	50MHz Bandwidth	Mar. 02, 2022	Jan. 17, 2023~ Feb. 20, 2023	Mar. 01, 2023	Conducted (TH01-KS)
EMI Test Receiver	Keysight	N9038A	MY56400004	3Hz~8.5GHz;Max 30dBm	Oct. 13, 2022	Feb. 09, 2023	Oct. 12, 2023	Radiation (03CH05-KS)
EXA Spectrum Analyzer	Keysight	N9010A	MY55150244	10Hz-44G,MAX 30dB	Mar. 24, 2022	Feb. 09, 2023	Mar. 23, 2023	Radiation (03CH05-KS)
Loop Antenna	R&S	HFH2-Z2	100321	9kHz~30MHz	Oct. 16, 2022	Feb. 09, 2023	Oct. 15, 2023	Radiation (03CH05-KS)
Bilog Antenna	TeseQ	CBL6111D	49922	30MHz-1GHz	May 24 ,2022	Feb. 09, 2023	May 23, 2023	Radiation (03CH05-KS)
Double Ridge Horn Antenna	ETS-Lindgren	3117	00218642	1GHz~18GHz	Apr. 18, 2022	Feb. 09, 2023	Apr. 17, 2023	Radiation (03CH05-KS)
SHF-EHF Horn	Com-power	AH-840	101093	18GHz~40GHz	Jan. 08, 2023	Feb. 09, 2023	Jan. 07, 2024	Radiation (03CH05-KS)
Amplifier	SONOMA	310N	380826	9KHz-1GHz	Jul. 11, 2022	Feb. 09, 2023	Jul. 10, 2023	Radiation (03CH05-KS)
Amplifier	EM	EM18G40GA	060852	18~40GHz	Jan. 05, 2023	Feb. 09, 2023	Jan. 04, 2024	Radiation (03CH05-KS)
high gain Amplifier	EM	EM01G18GA	060839	1Ghz-18Ghz	Oct. 12, 2022	Feb. 09, 2023	Oct. 11, 2023	Radiation (03CH05-KS)
Amplifier	EM	EM01G18GA	060833	1Ghz-18Ghz	Jan. 05, 2023	Feb. 09, 2023	Jan. 04, 2024	Radiation (03CH05-KS)
AC Power Source	Chroma	61601	F104090004	N/A	NCR	Feb. 09, 2023	NCR	Radiation (03CH05-KS)
Turn Table	ChamPro	EM 1000-T	060762-T	0~360 degree	NCR	Feb. 09, 2023	NCR	Radiation (03CH05-KS)
Antenna Mast	ChamPro	EM 1000-A	060762-A	1 m~4 m	NCR	Feb. 09, 2023	NCR	Radiation (03CH05-KS)
EMI Receiver	R&S	ESCI7	100768	9kHz~7GHz;	May 24, 2022	Jan. 30, 2023	May 23, 2023	Conduction (CO01-KS)
AC LISN (for auxiliary equipment)	MessTec	AN3016	060103	9kHz~30MHz	Oct. 13, 2022	Jan. 30, 2023	Oct. 12, 2023	Conduction (CO01-KS)
AC LISN	MessTec	AN3016	060105	9kHz~30MHz	May 24, 2022	Jan. 30, 2023	May 23, 2023	Conduction (CO01-KS)
AC Power Source	Chroma	61602	ABP000000811	AC 0V~300V, 45Hz~1000Hz	Oct. 12, 2022	Jan. 30, 2023	Oct. 11, 2023	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 Measurement

Test Item	Uncertainty
Conducted Power	±0.46 dB
Conducted Emissions	±0.48 dB
Occupied Channel Bandwidth	±0.1 %
Conducted Power Spectral Density	±0.40 dB

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

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	2.78dB

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

Ambient Condition: 25 ℃, 45 %RH	
Test Date: 2023.1.17~2023.2.3	**Test Engineer:** Jiang Jun

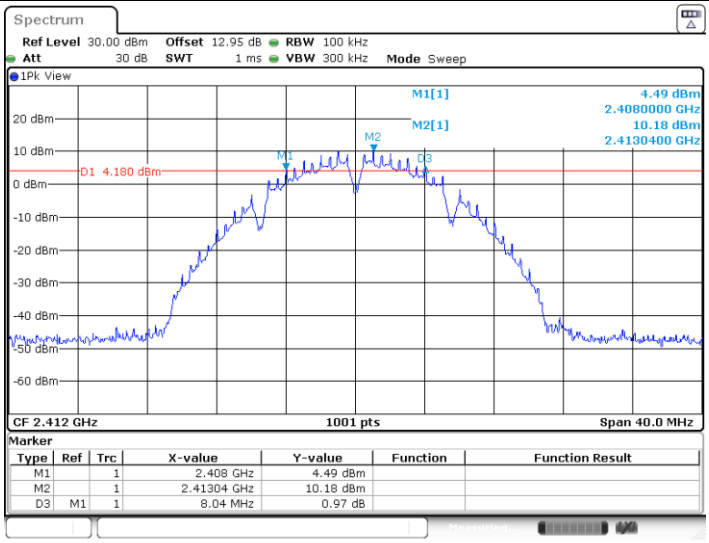
DTS Bandwidth

Test Result

TestMode	Antenna	Freq(MHz)	DTS BW [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
11B-CDD	Ant0	2412	8.04	2408.00	2416.04	0.5	PASS
	Ant1	2412	8.04	2408.48	2416.52	0.5	PASS
	Ant0	2437	7.56	2433.00	2440.56	0.5	PASS
	Ant1	2437	8.00	2433.04	2441.04	0.5	PASS
	Ant0	2462	8.08	2457.96	2466.04	0.5	PASS
	Ant1	2462	8.08	2457.48	2465.56	0.5	PASS
11G-CDD	Ant0	2412	15.92	2404.24	2420.16	0.5	PASS
	Ant1	2412	15.96	2404.24	2420.20	0.5	PASS
	Ant0	2437	16.32	2428.84	2445.16	0.5	PASS
	Ant1	2437	16.32	2428.88	2445.20	0.5	PASS
	Ant0	2462	16.08	2453.84	2469.92	0.5	PASS
	Ant1	2462	16.36	2453.84	2470.20	0.5	PASS
11N20MIMO	Ant0	2412	17.56	2403.24	2420.80	0.5	PASS
	Ant1	2412	15.64	2405.16	2420.80	0.5	PASS
	Ant0	2437	17.56	2428.24	2445.80	0.5	PASS
	Ant1	2437	17.32	2428.24	2445.56	0.5	PASS
	Ant0	2462	16.56	2453.24	2469.80	0.5	PASS
	Ant1	2462	16.92	2453.24	2470.16	0.5	PASS
11N40MIMO	Ant0	2422	35.12	2404.48	2439.60	0.5	PASS
	Ant1	2422	35.12	2404.48	2439.60	0.5	PASS
	Ant0	2437	35.76	2418.84	2454.60	0.5	PASS
	Ant1	2437	35.36	2419.24	2454.60	0.5	PASS
	Ant0	2452	35.28	2434.32	2469.60	0.5	PASS
	Ant1	2452	35.68	2433.92	2469.60	0.5	PASS
11AX20MIMO	Ant0	2412	18.28	2403.08	2421.36	0.5	PASS
	Ant1	2412	18.32	2403.04	2421.36	0.5	PASS
	Ant0	2437	18.96	2427.52	2446.48	0.5	PASS
	Ant1	2437	18.44	2427.68	2446.12	0.5	PASS
	Ant0	2462	18.68	2452.56	2471.24	0.5	PASS
	Ant1	2462	17.92	2452.56	2470.48	0.5	PASS
11AX40MIMO	Ant0	2422	35.36	2404.16	2439.52	0.5	PASS
	Ant1	2422	34.96	2405.76	2440.72	0.5	PASS
	Ant0	2437	37.52	2417.96	2455.48	0.5	PASS
	Ant1	2437	37.04	2418.20	2455.24	0.5	PASS
	Ant0	2452	35.68	2433.92	2469.60	0.5	PASS
	Ant1	2452	36.40	2433.20	2469.60	0.5	PASS

Test Graphs

11B-CDD_Ant0_2412



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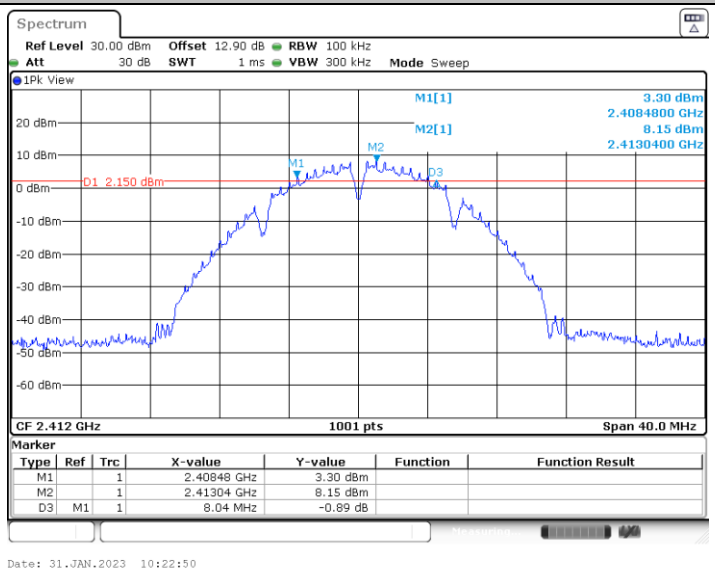

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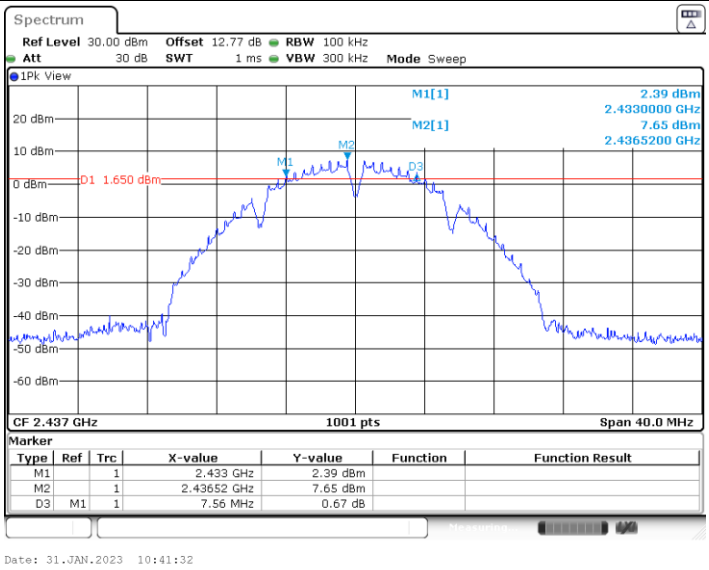

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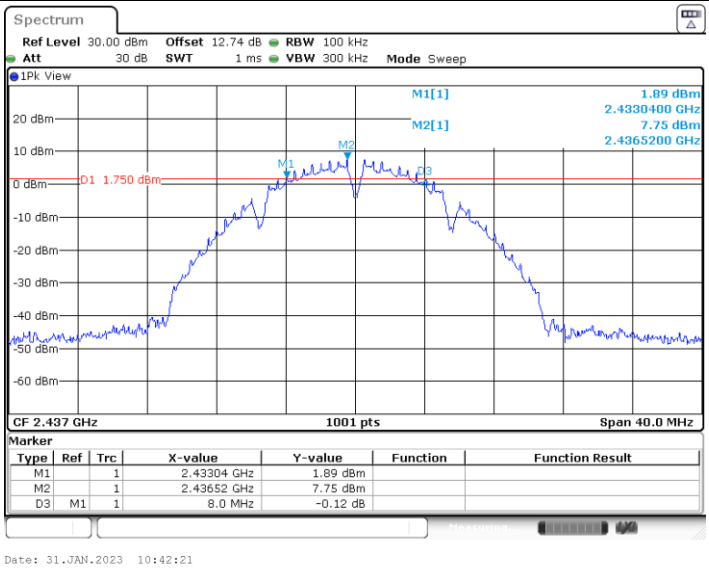

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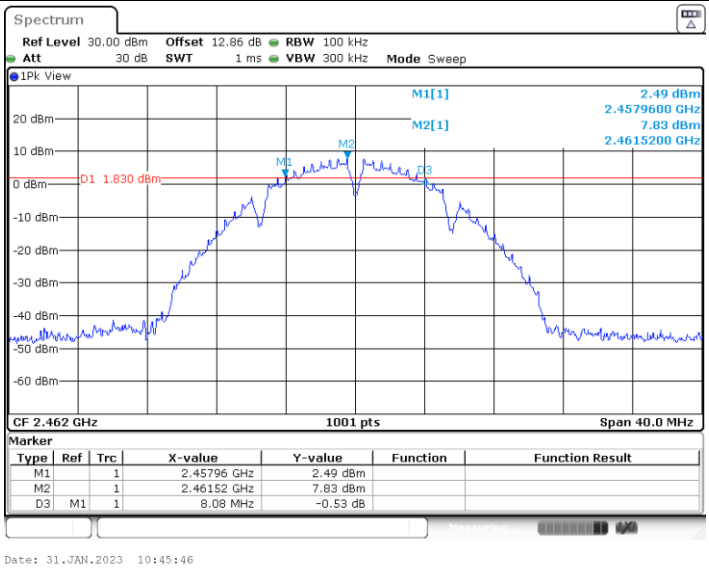

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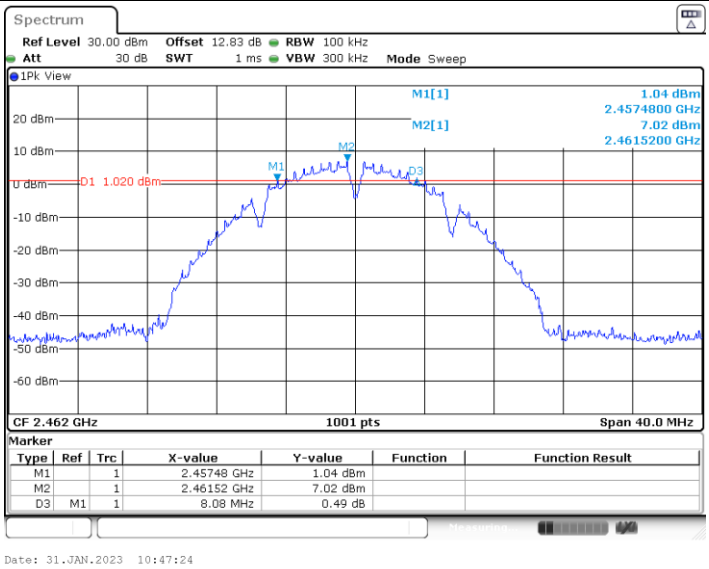

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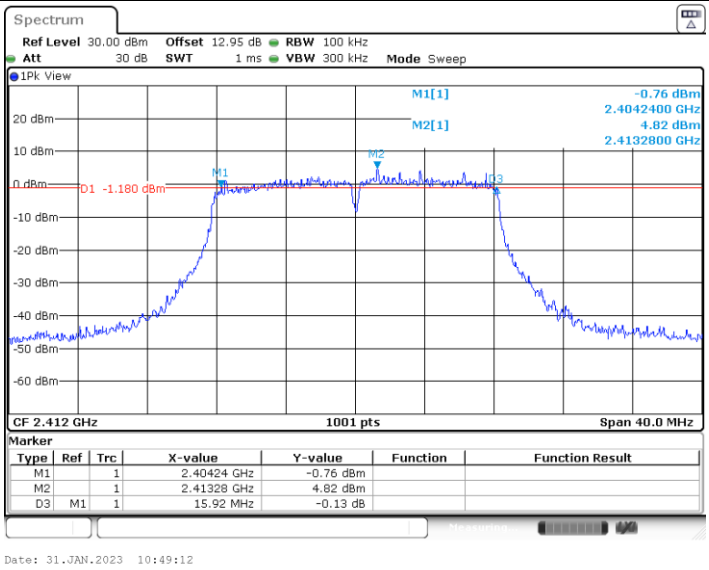

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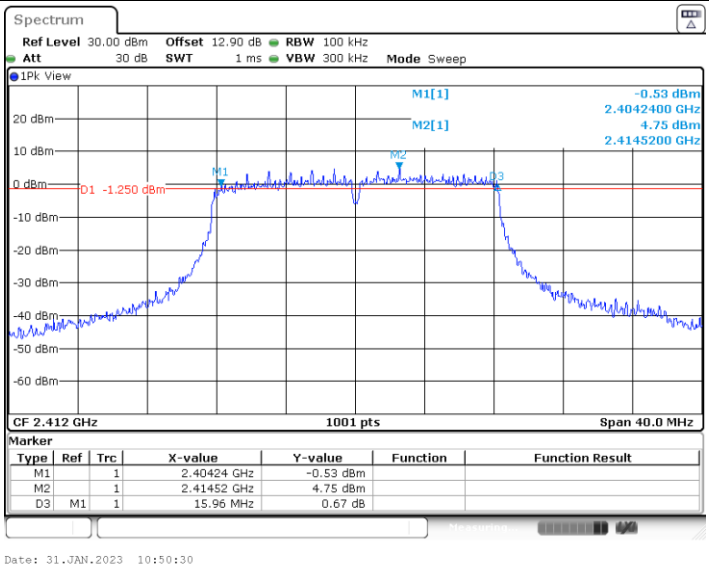

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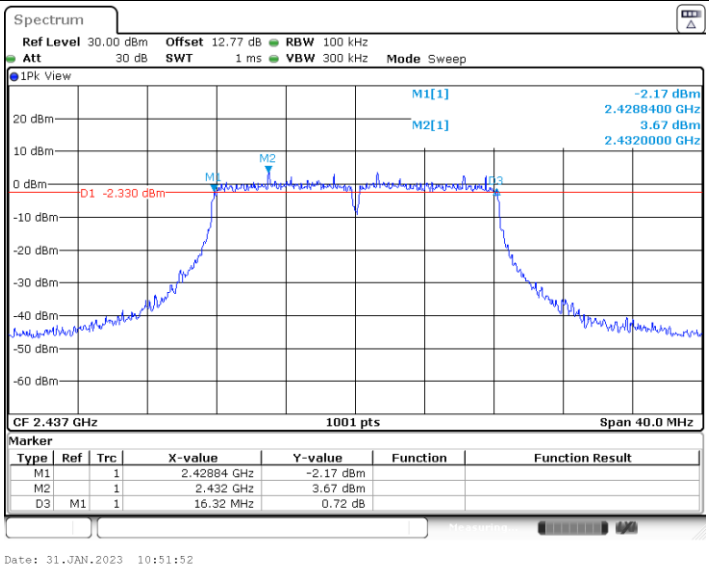

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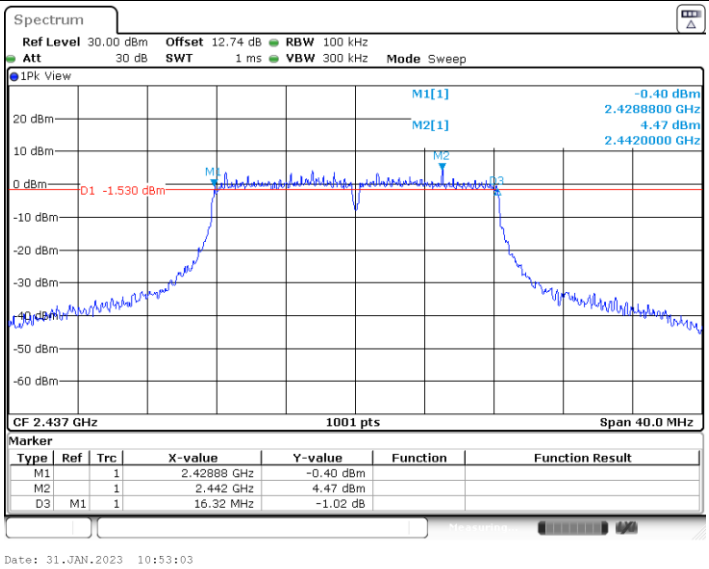

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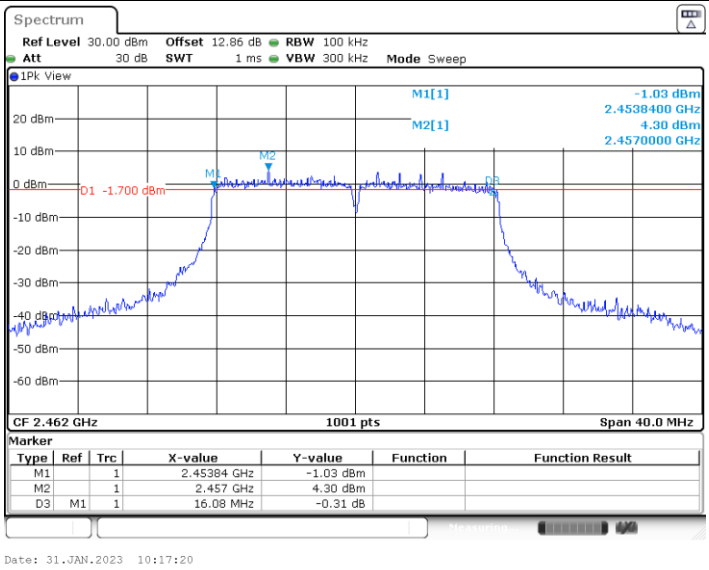

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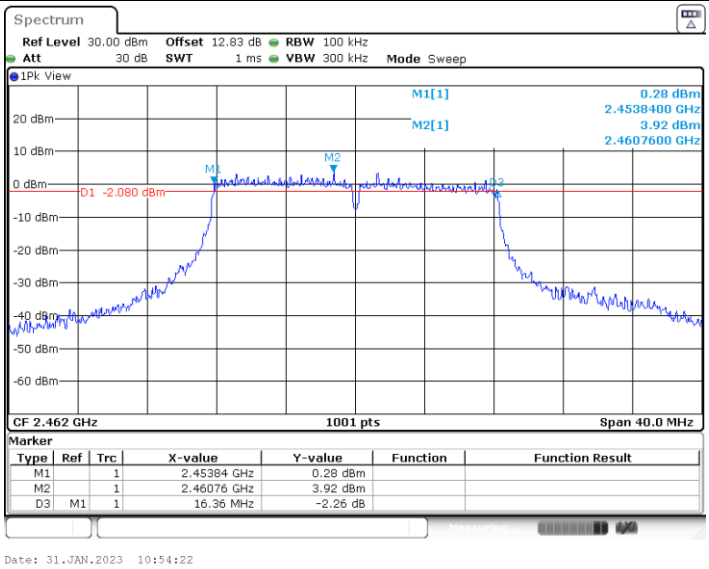

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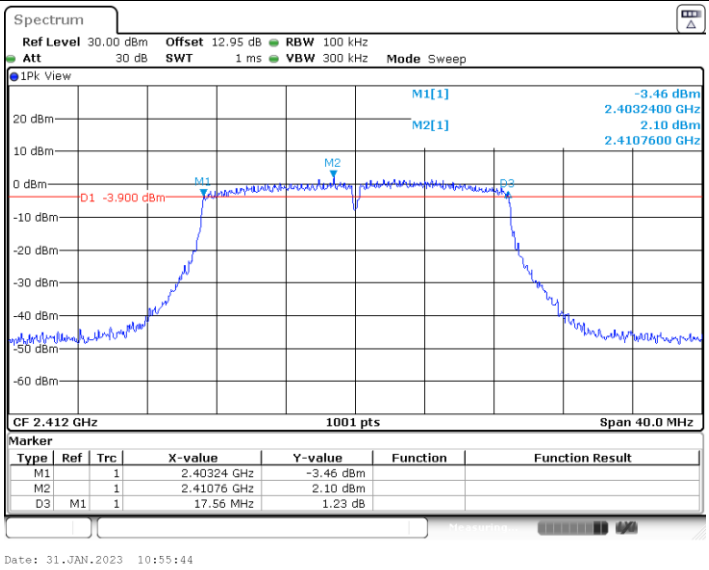

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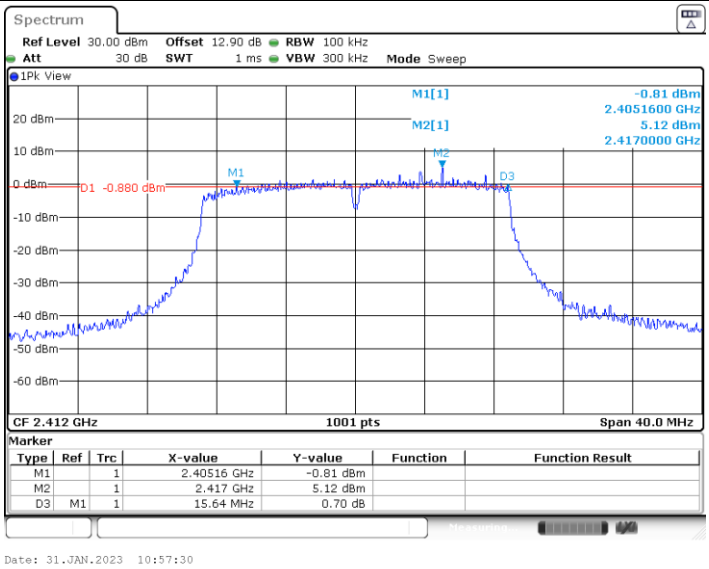

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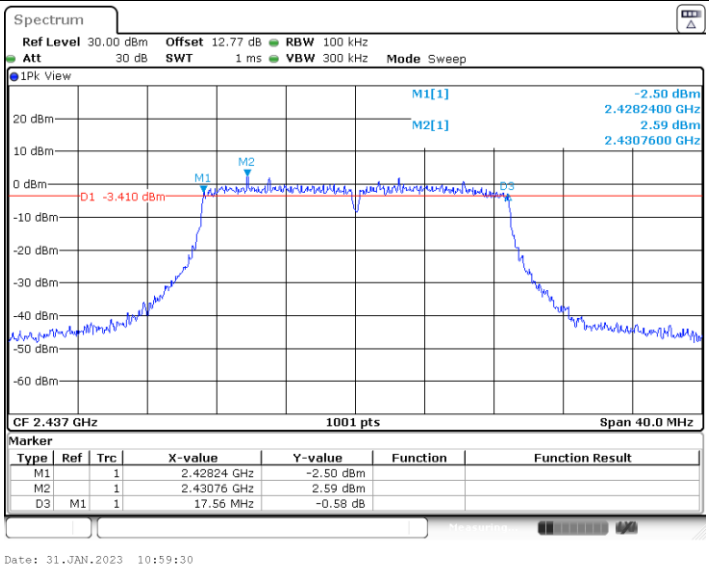

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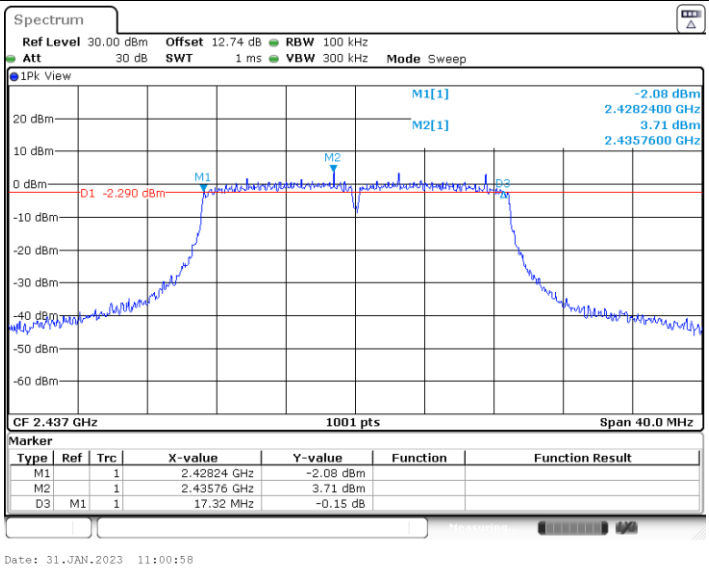

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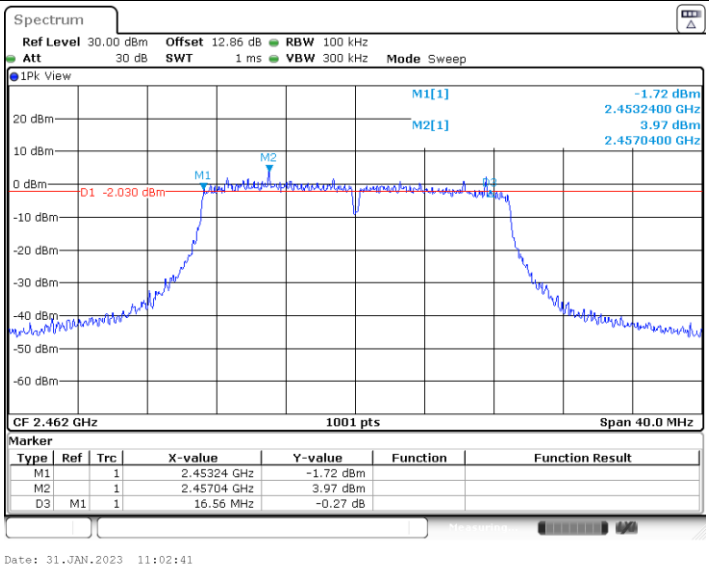

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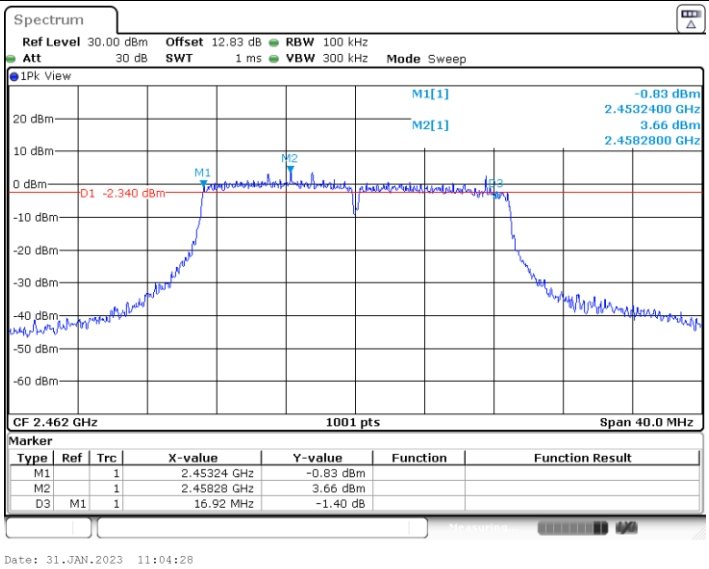

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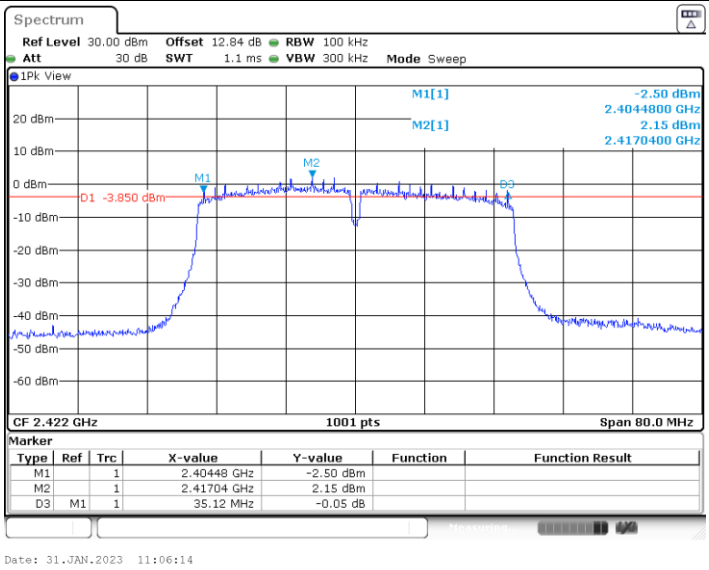
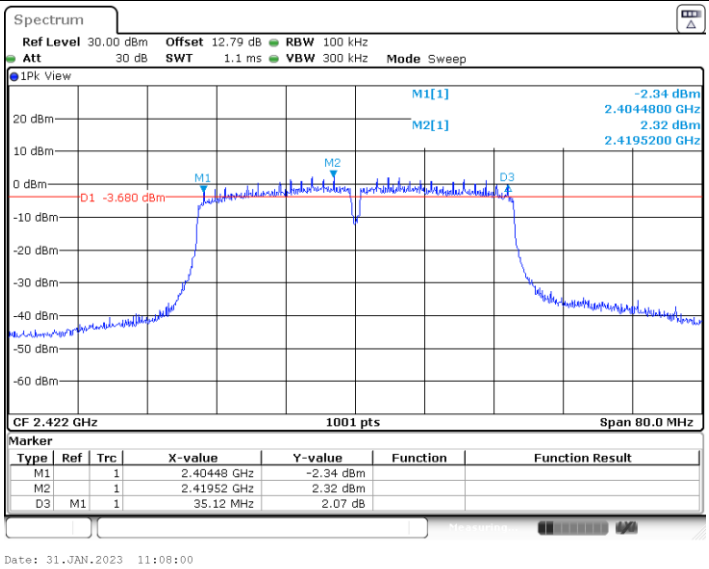


11N40MIMO_Ant1_2422



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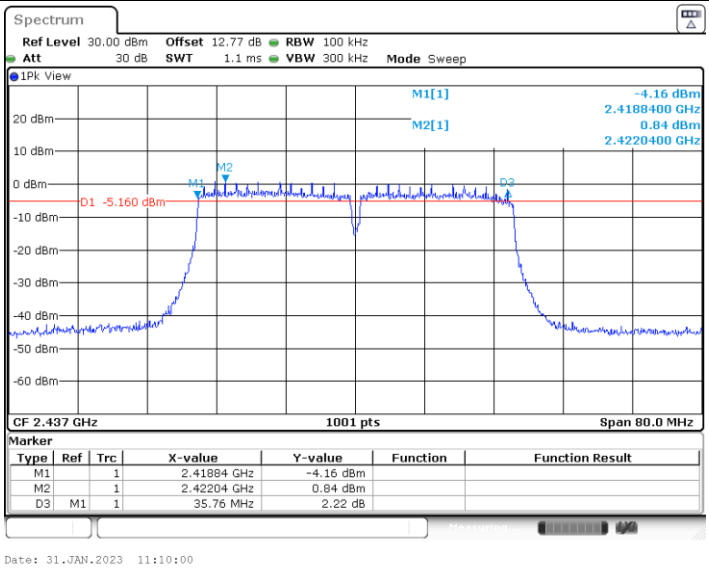

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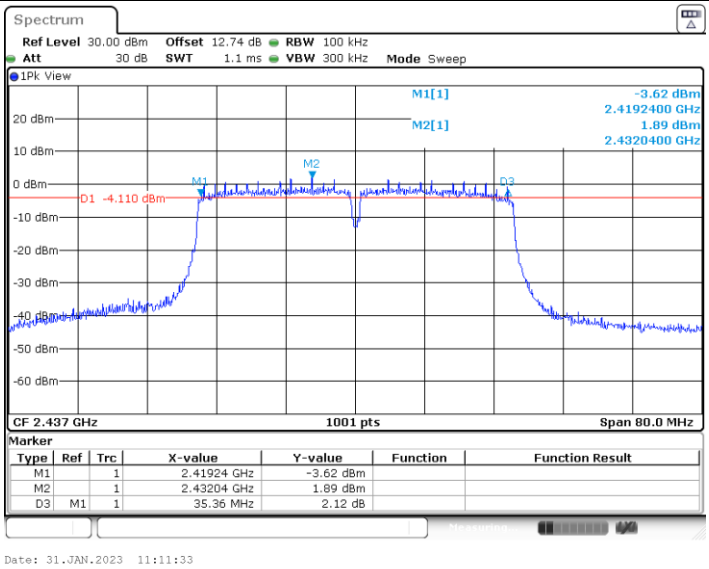

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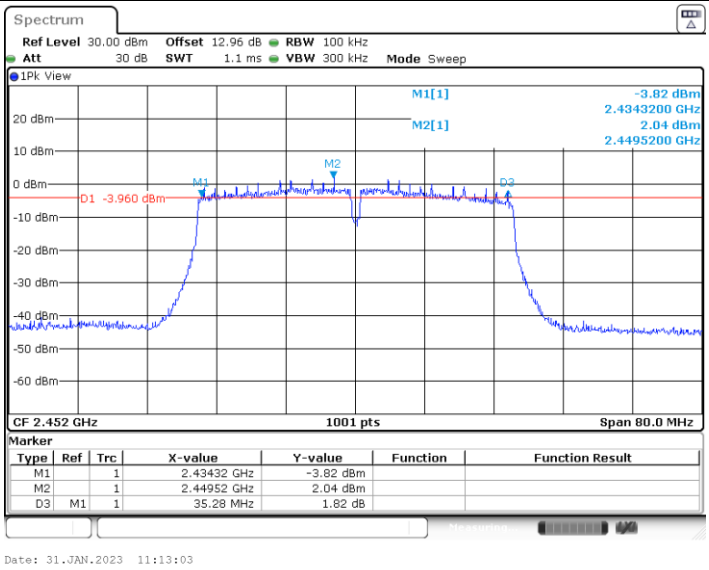

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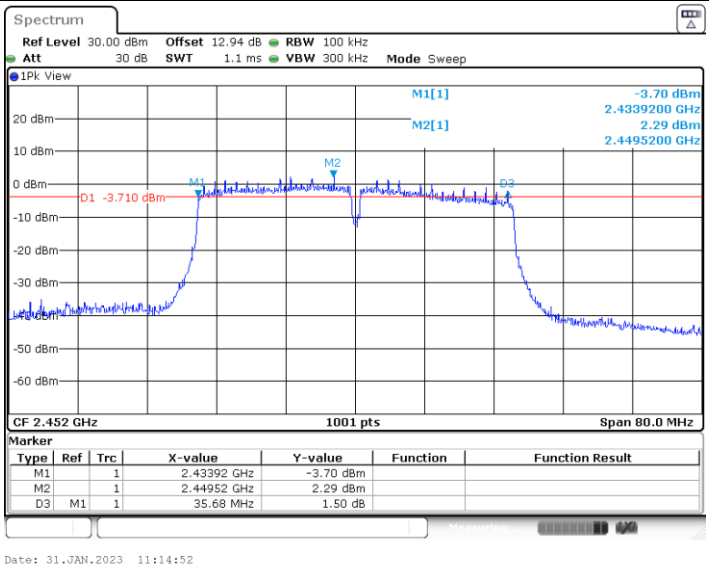

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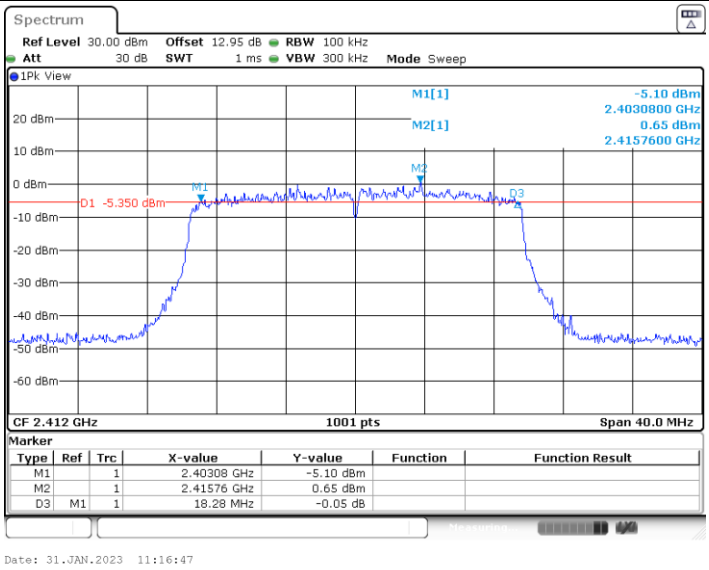

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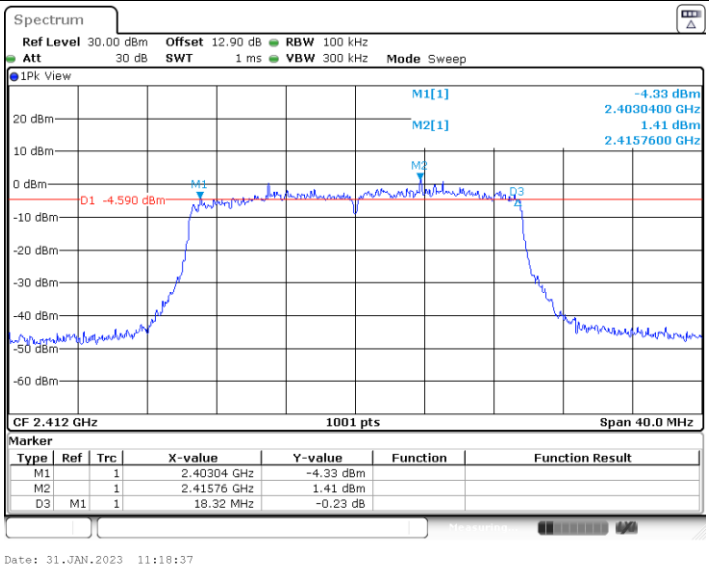

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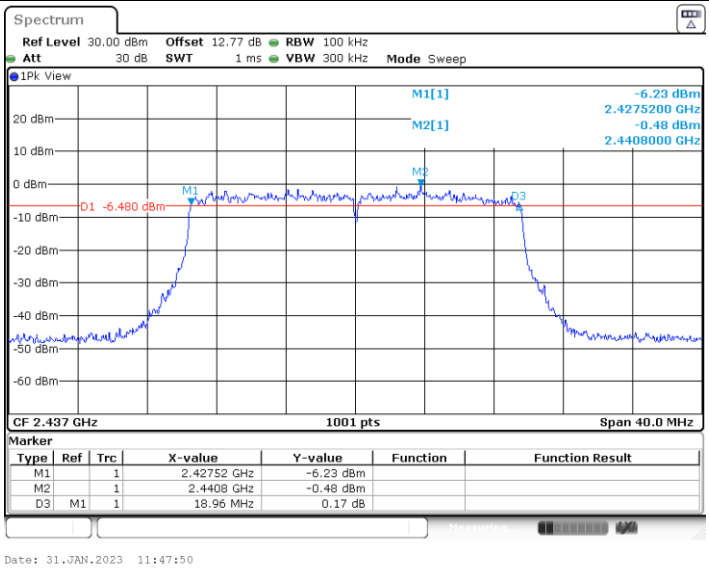

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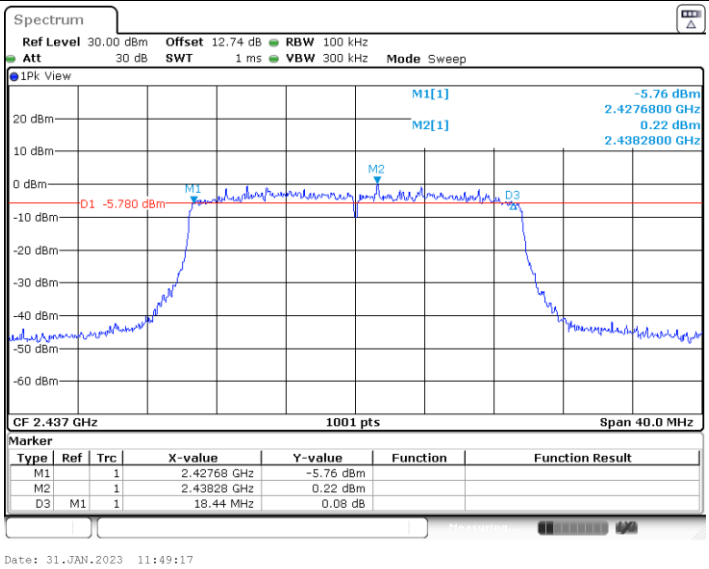

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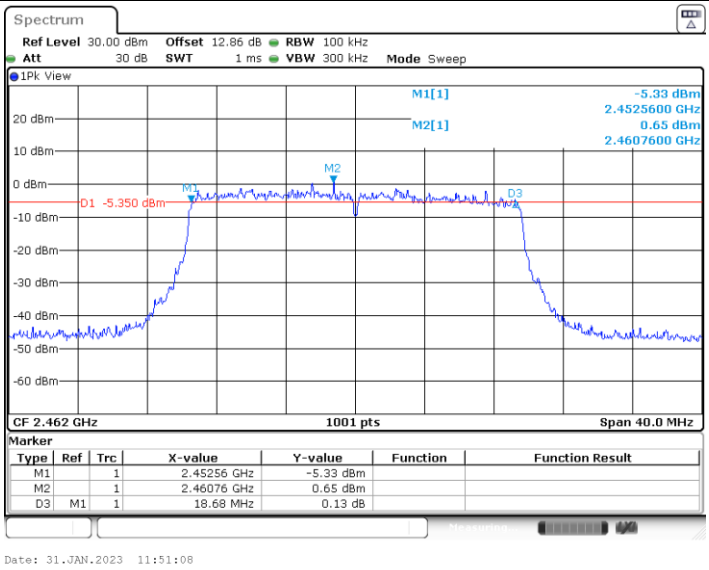

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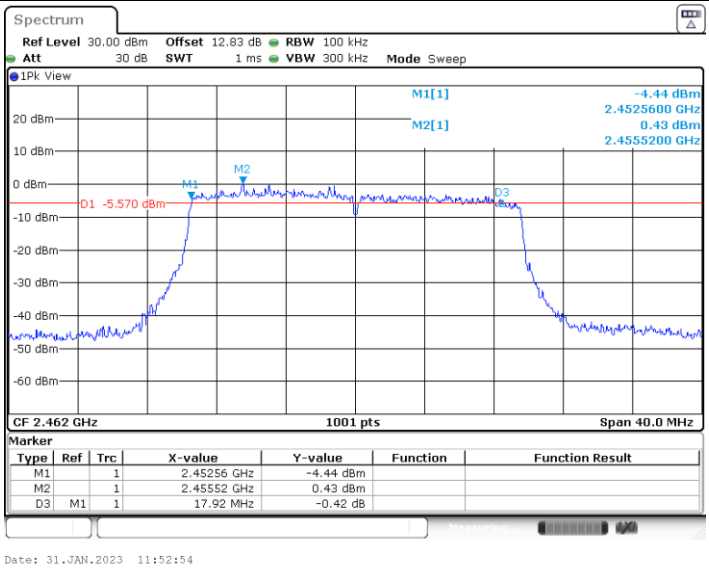

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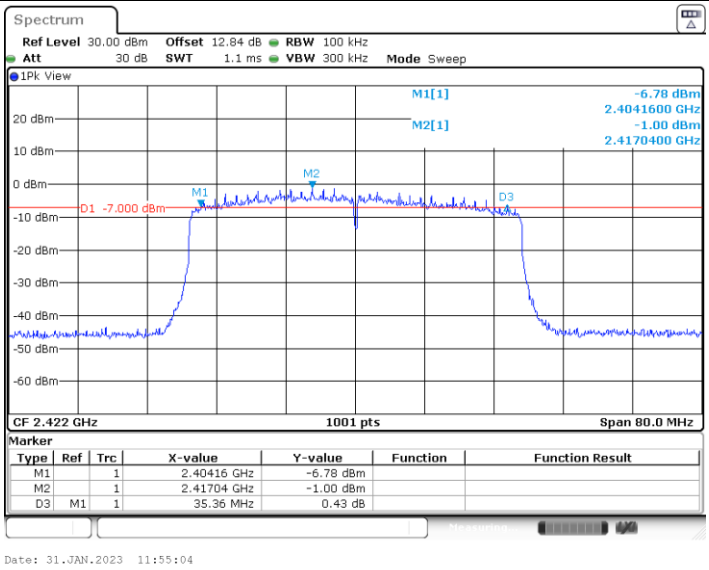

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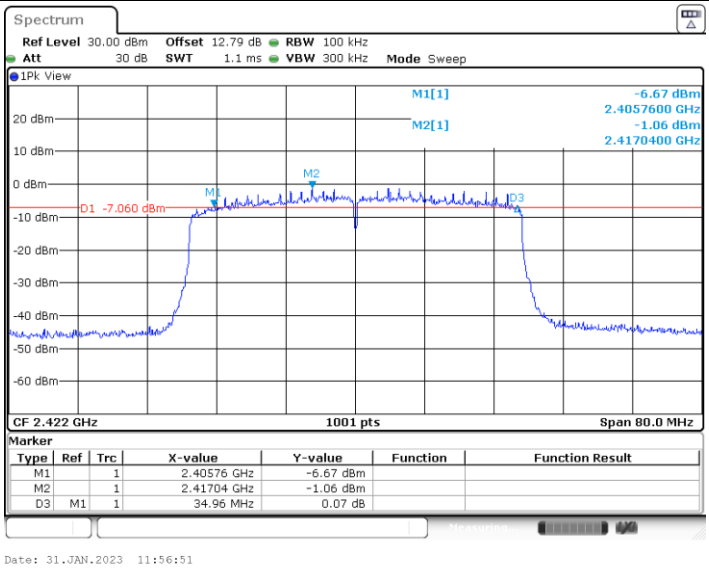

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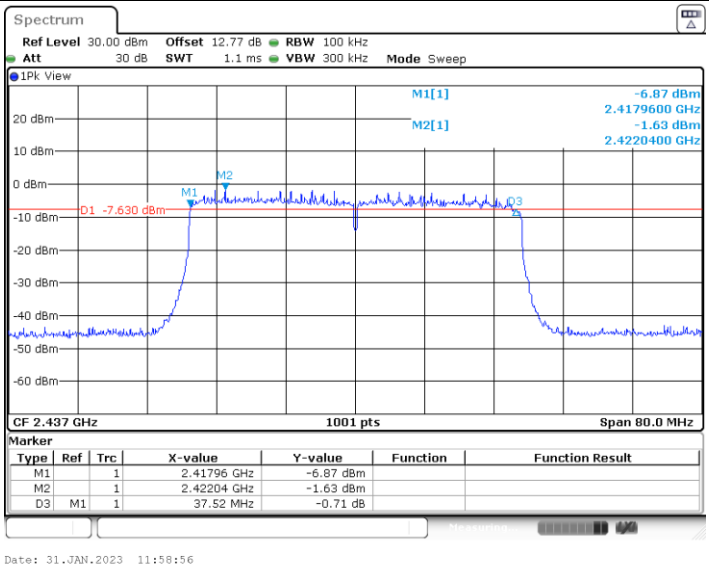

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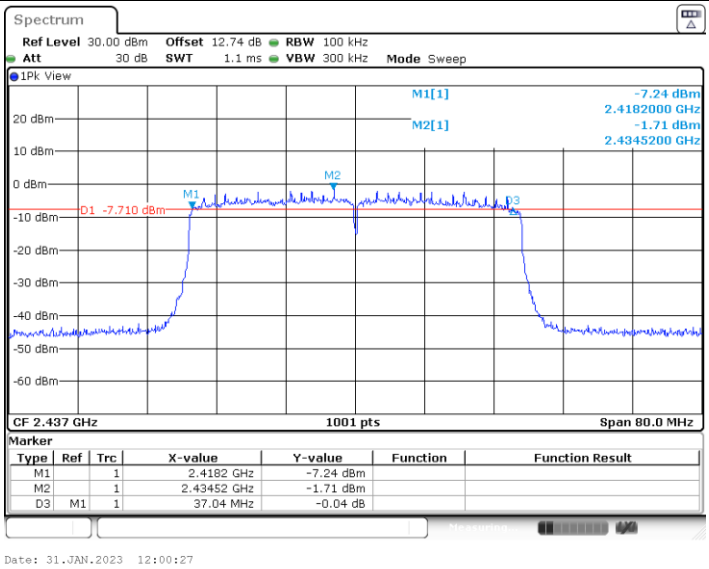

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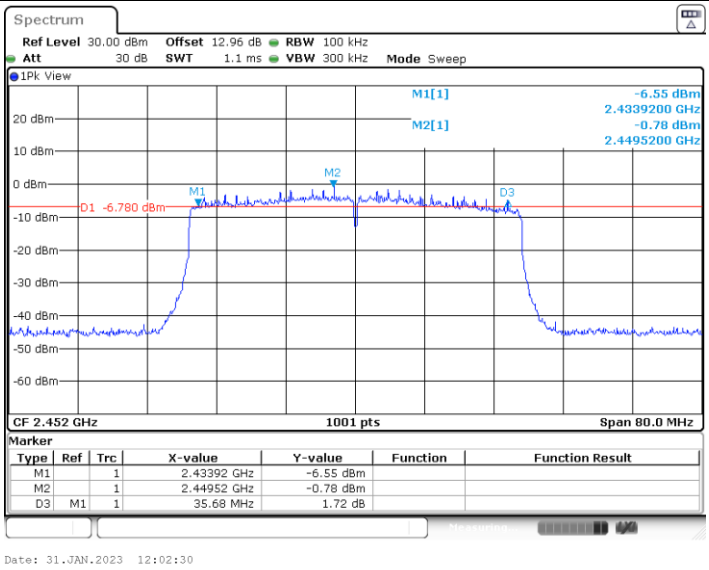

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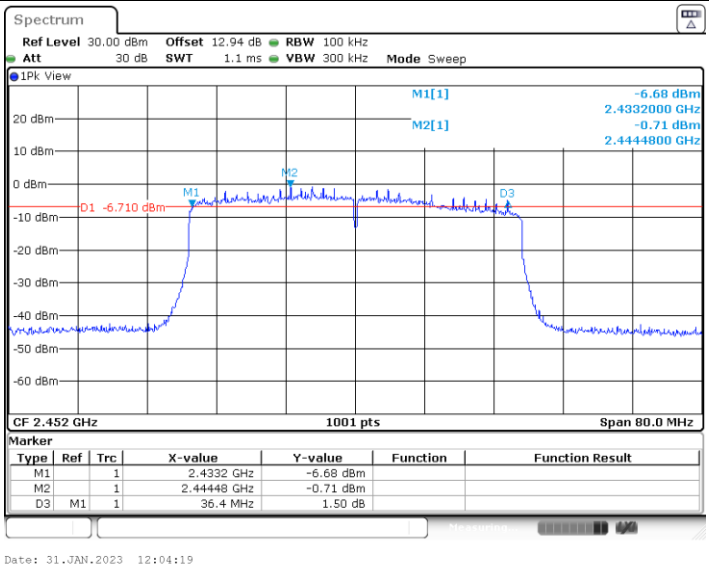


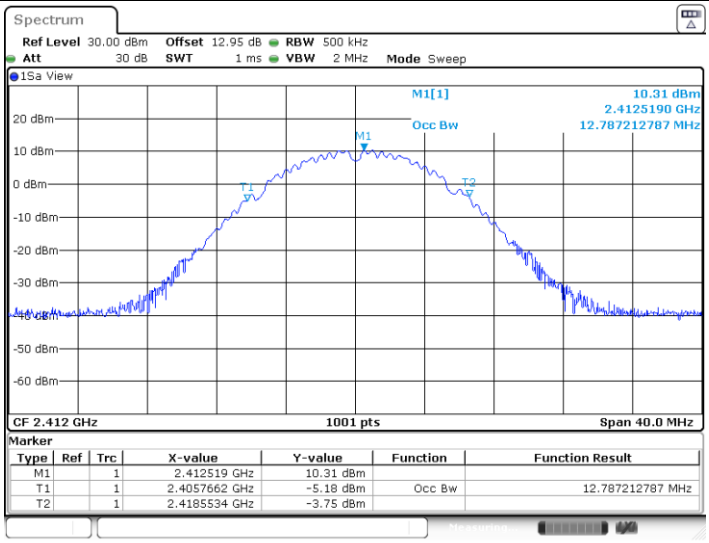
Occupied Channel Bandwidth

Test Result

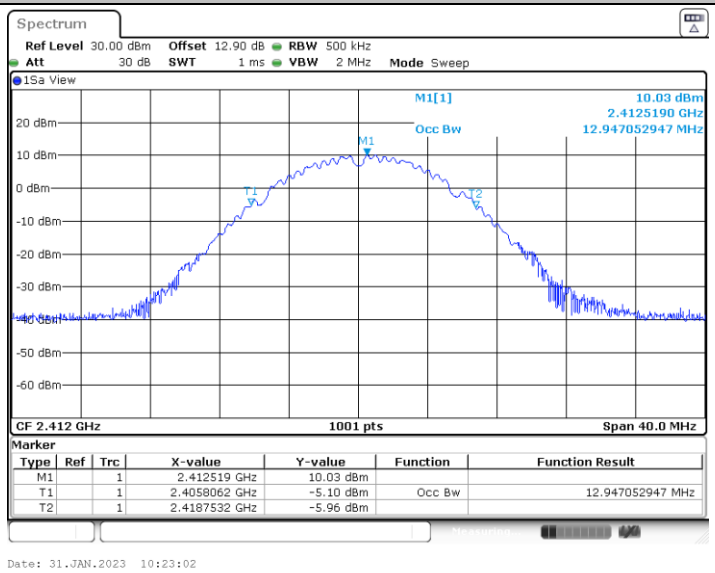
TestMode	Antenna	Freq(MHz)	OCB [MHz]	FL[MHz]	FH[MHz]
11B-CDD	Ant0	2412	12.787	2405.7662	2418.5534
	Ant1	2412	12.947	2405.8062	2418.7532
	Ant0	2437	13.267	2430.2068	2443.4735
	Ant1	2437	13.187	2430.2867	2443.4735
	Ant0	2462	13.027	2455.3666	2468.3936
	Ant1	2462	13.067	2455.2468	2468.3137
11G-CDD	Ant0	2412	16.464	2403.8082	2420.2717
	Ant1	2412	16.464	2403.8482	2420.3117
	Ant0	2437	16.703	2428.6084	2445.3117
	Ant1	2437	16.543	2428.7283	2445.2717
	Ant0	2462	16.703	2453.5684	2470.2717
	Ant1	2462	16.583	2453.6484	2470.2318
11N20MIMO	Ant0	2412	17.622	2403.2488	2420.8711
	Ant1	2412	17.622	2403.2887	2420.9111
	Ant0	2437	17.862	2428.0490	2445.9111
	Ant1	2437	17.702	2428.1688	2445.8711
	Ant0	2462	17.782	2453.0490	2470.8312
	Ant1	2462	17.782	2453.0490	2470.8312
11N40MIMO	Ant0	2422	35.804	2404.0180	2439.8222
	Ant1	2422	35.964	2404.1778	2440.1419
	Ant0	2437	36.204	2418.7782	2454.9820
	Ant1	2437	36.044	2418.9381	2454.9820
	Ant0	2452	36.044	2433.9381	2469.9820
	Ant1	2452	35.964	2433.8581	2469.8222
11AX20MIMO	Ant0	2412	18.941	2402.5694	2421.5105
	Ant1	2412	18.901	2402.6494	2421.5504
	Ant0	2437	19.021	2427.4895	2446.5105
	Ant1	2437	18.941	2427.5295	2446.4705
	Ant0	2462	19.021	2452.4496	2471.4705
	Ant1	2462	18.981	2452.4496	2471.4306
11AX40MIMO	Ant0	2422	37.642	2403.1389	2440.7812
	Ant1	2422	37.642	2403.2987	2440.9411
	Ant0	2437	37.962	2417.8991	2455.8611
	Ant1	2437	37.802	2418.0589	2455.8611
	Ant0	2452	37.802	2433.0589	2470.8611
	Ant1	2452	37.562	2433.0589	2470.6214

Test Graphs

11B-CDD_Ant0_2412



11B-CDD_Ant1_2412



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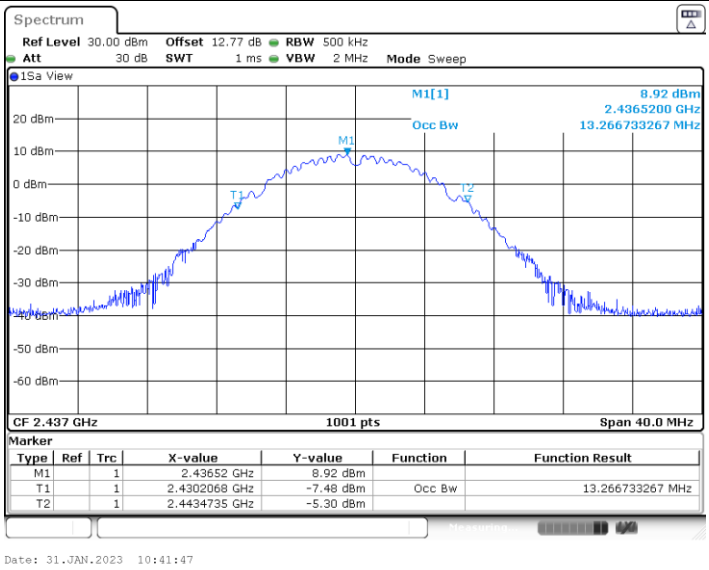

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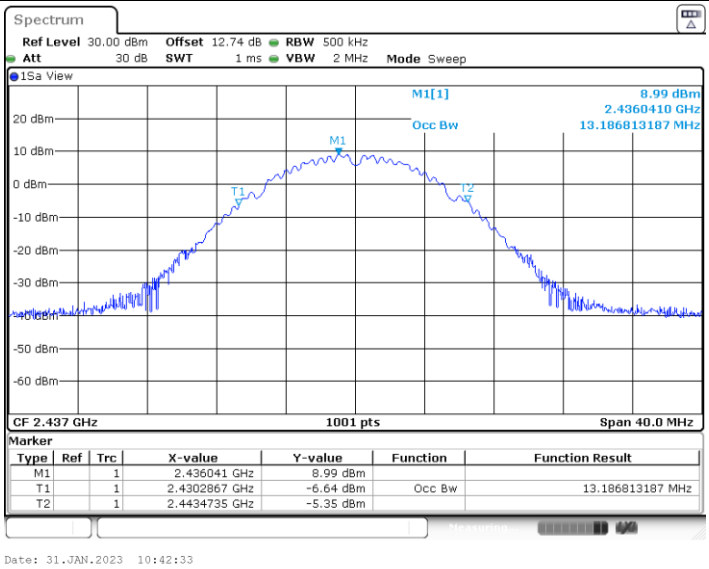

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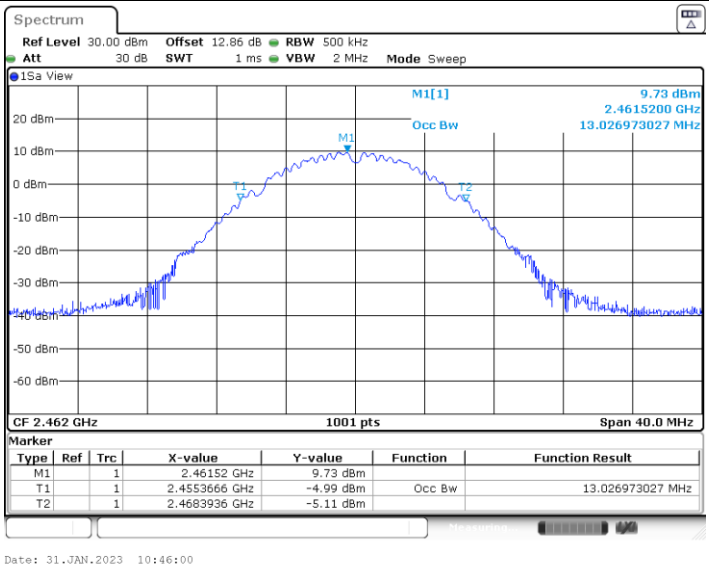

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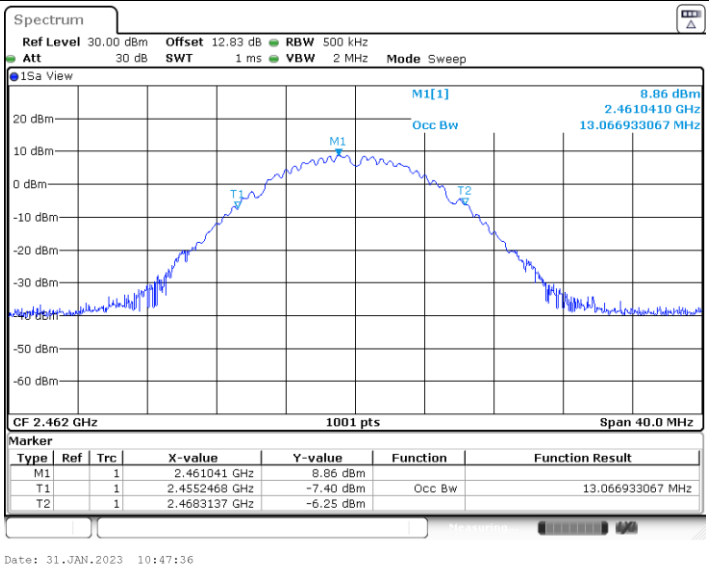

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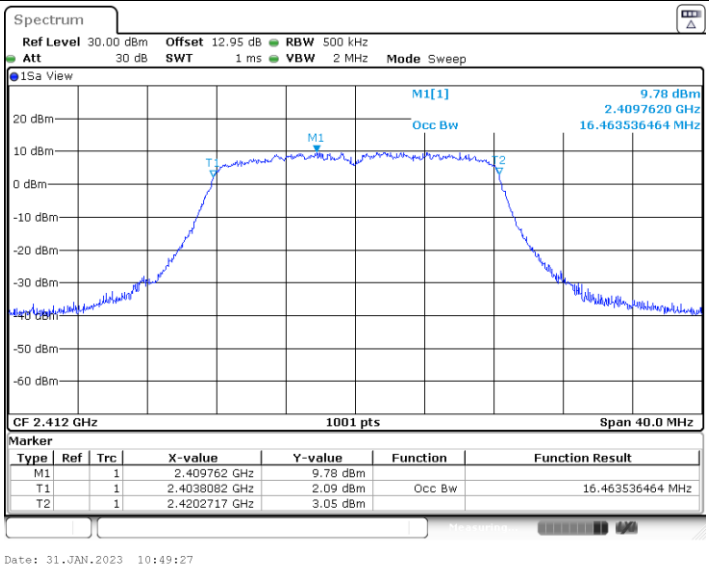

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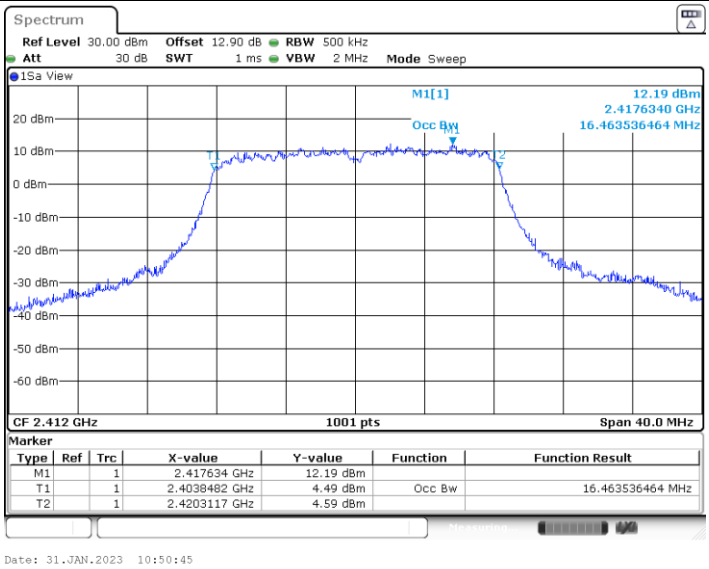

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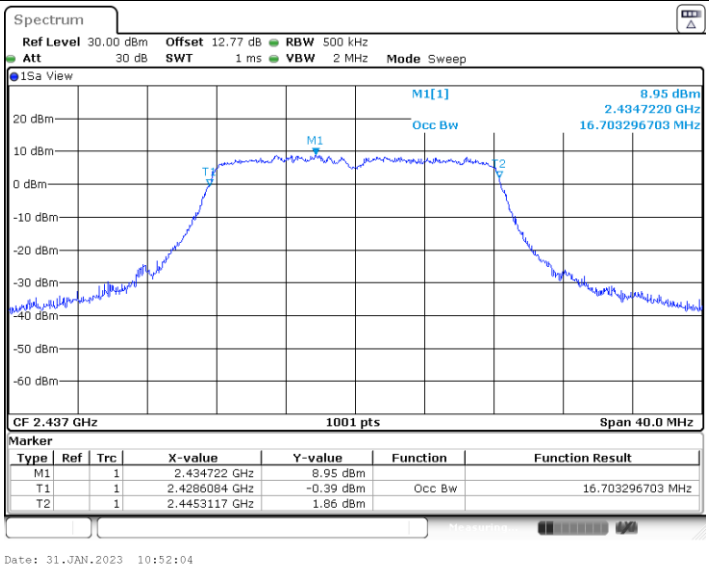

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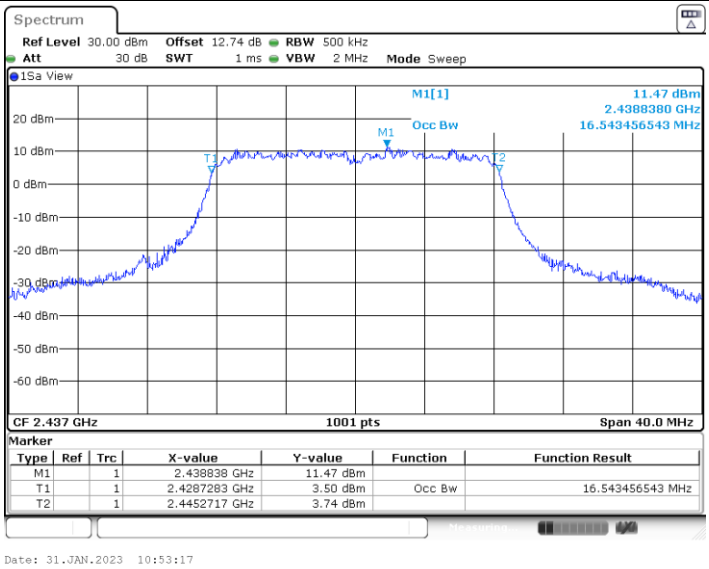

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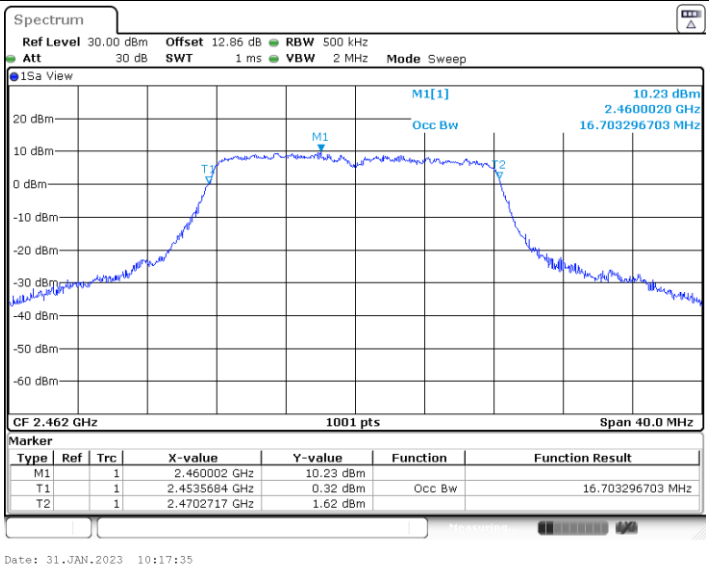

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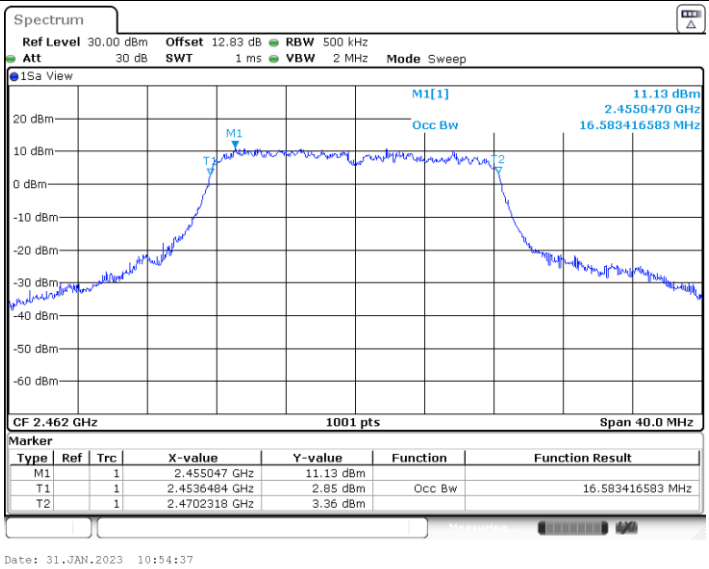

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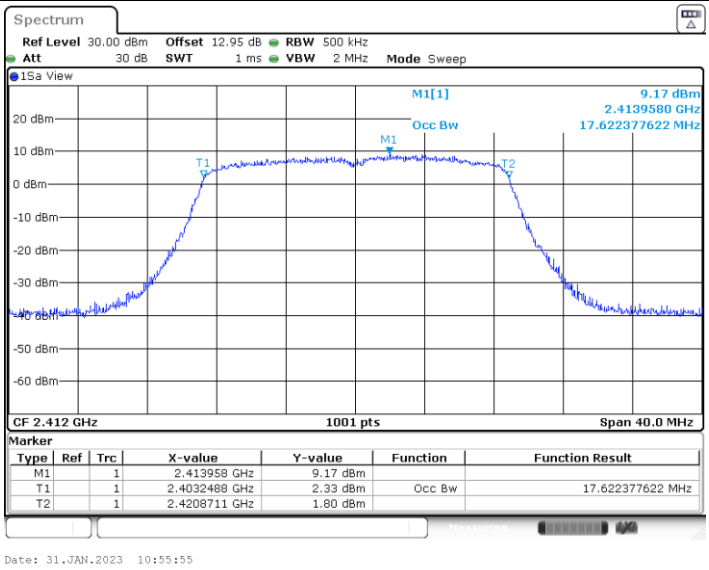

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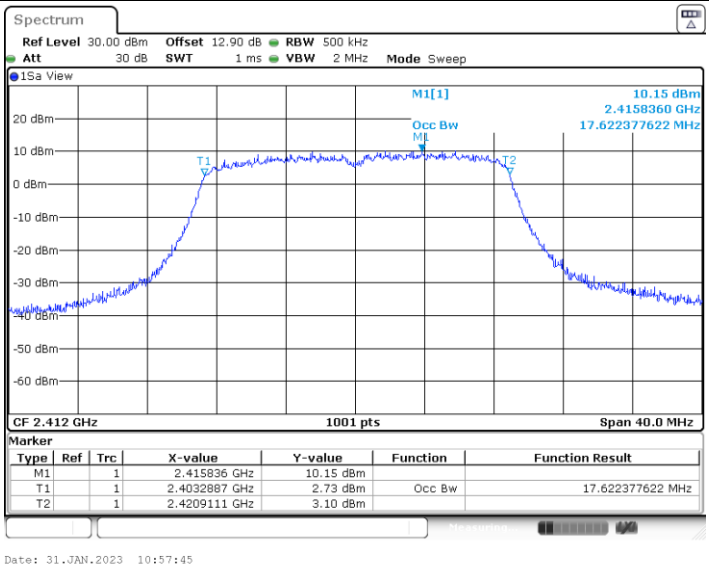

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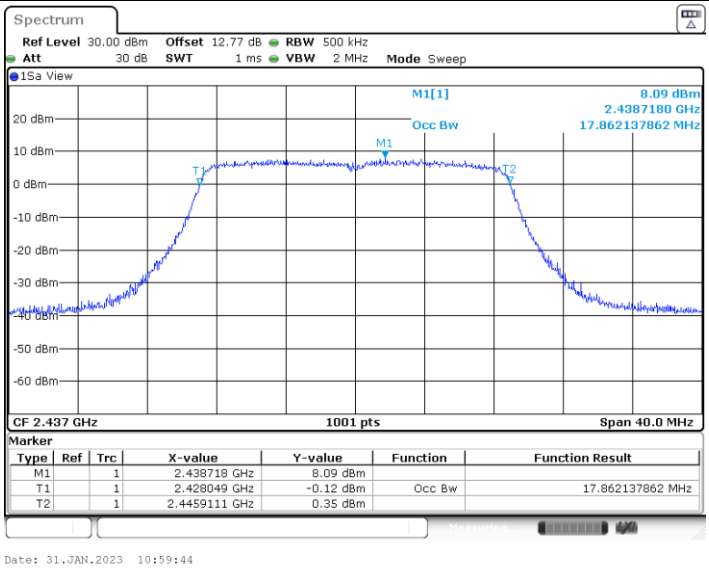

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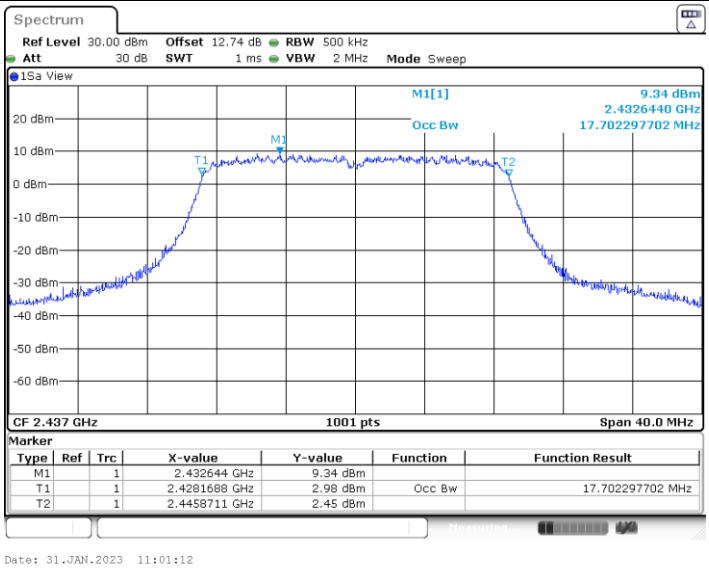

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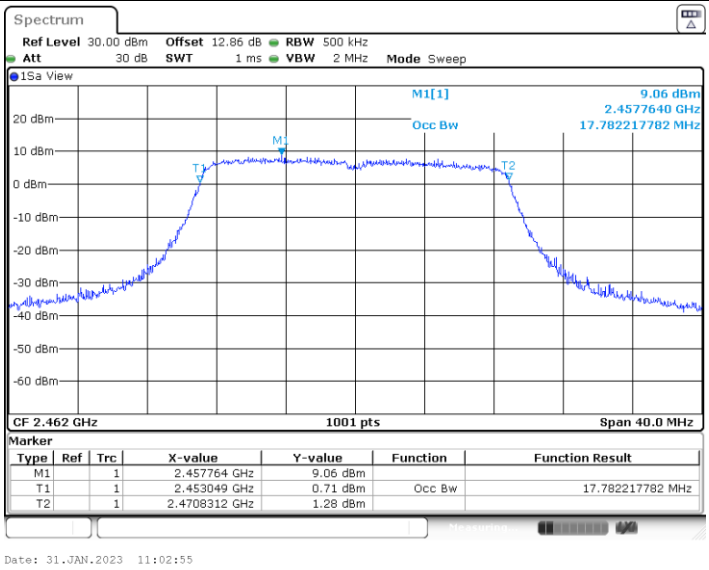

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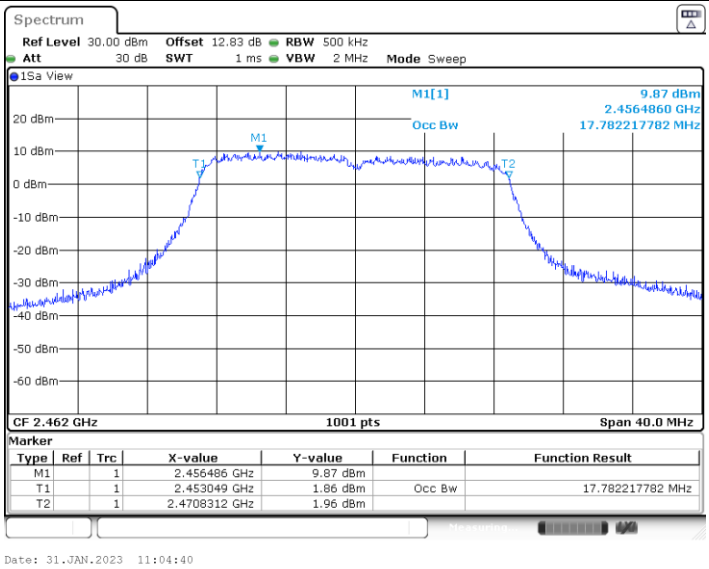

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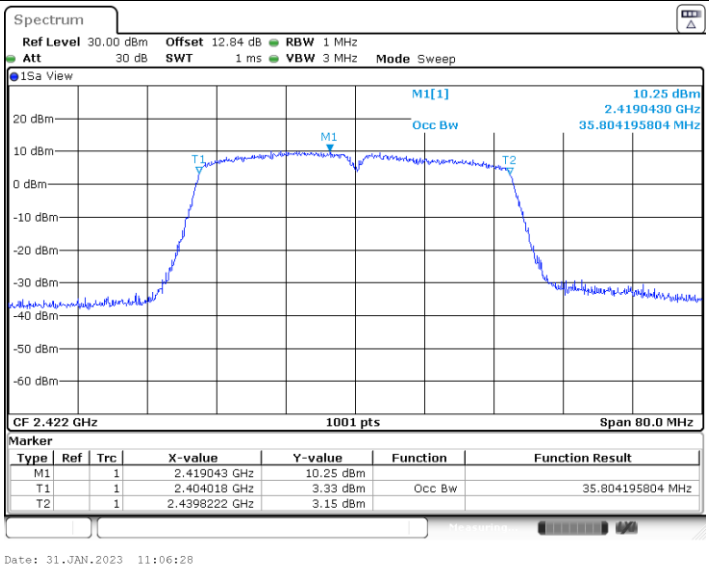

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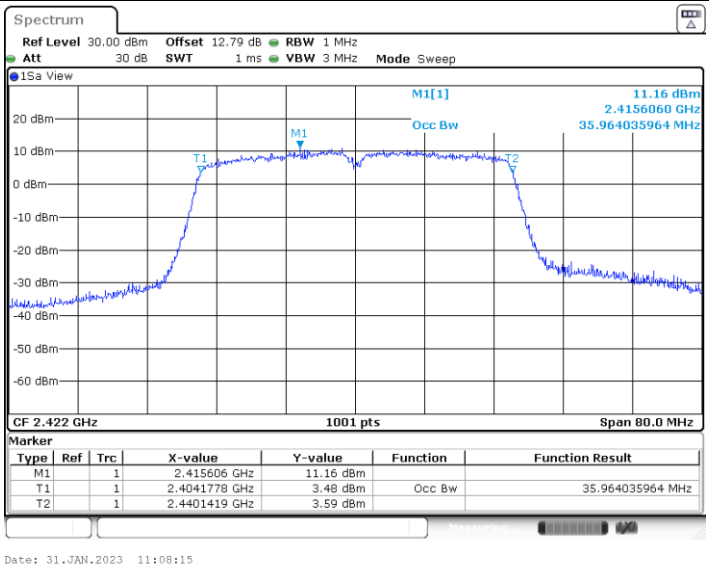

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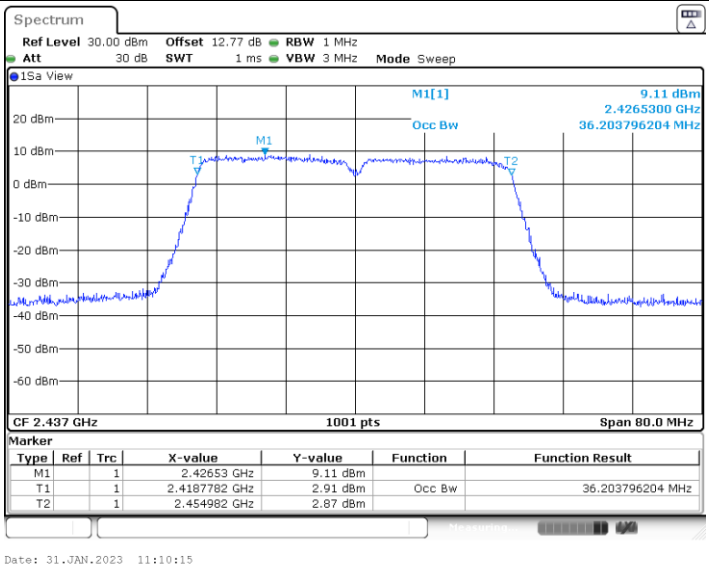

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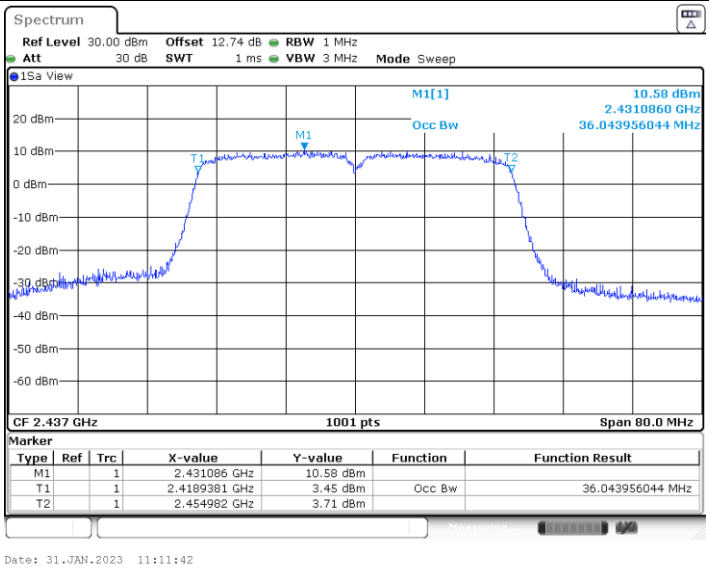

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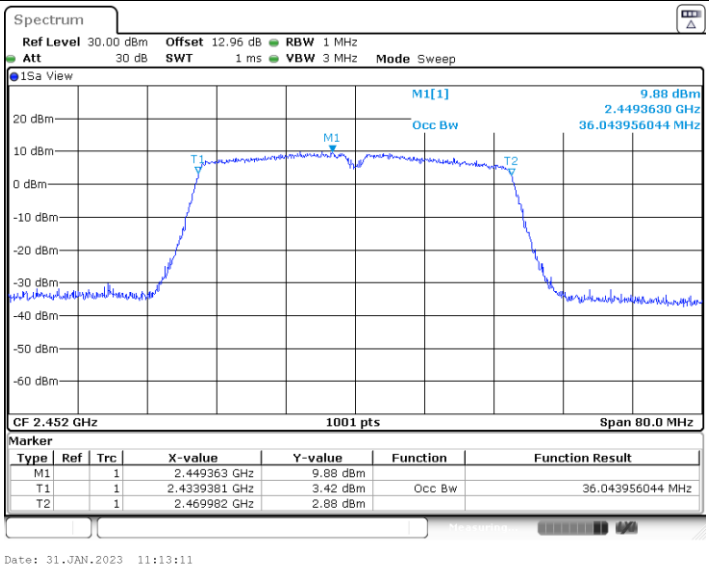

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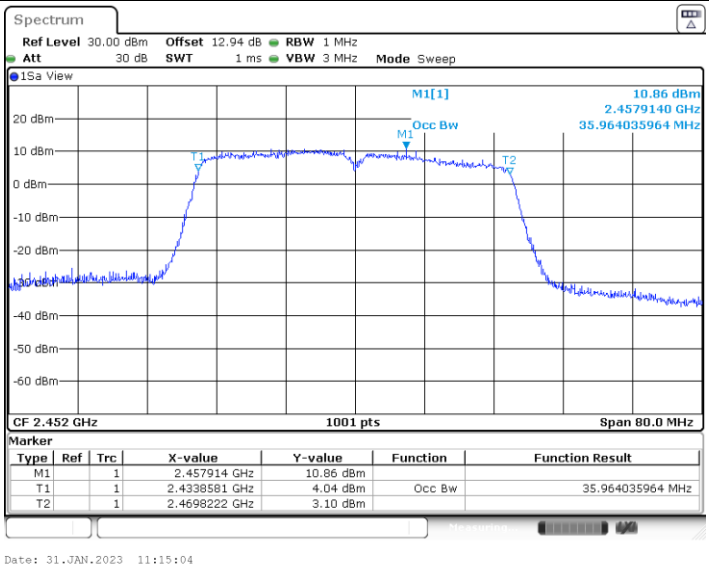

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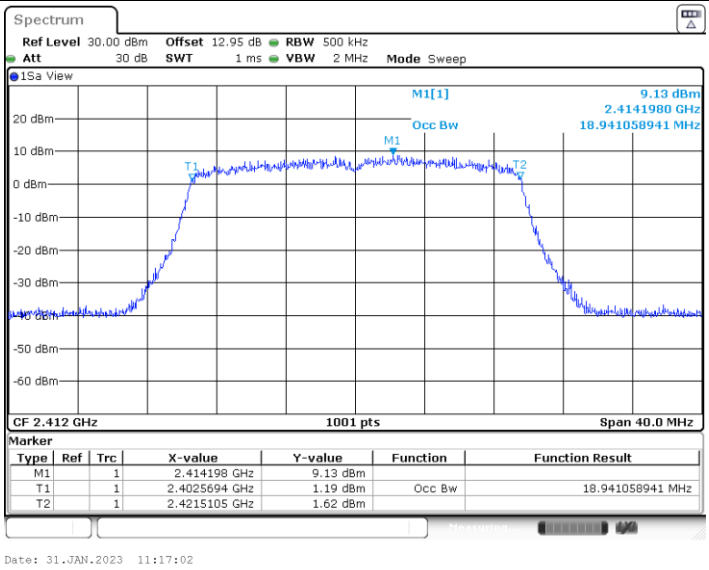

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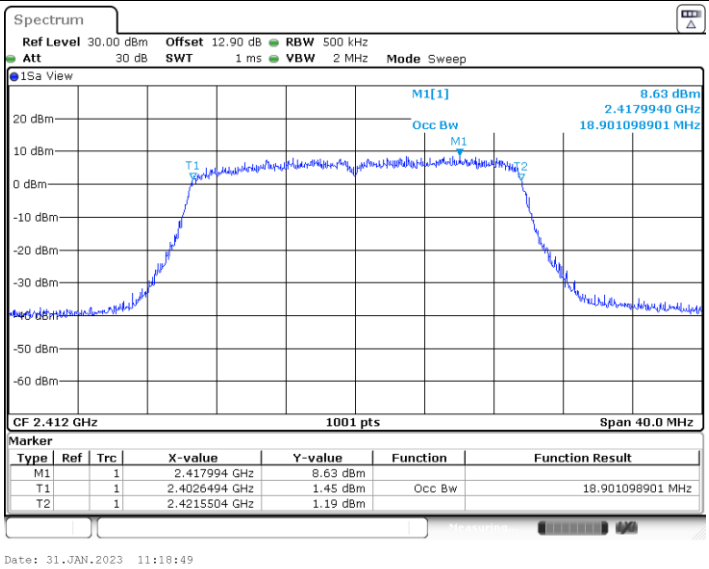

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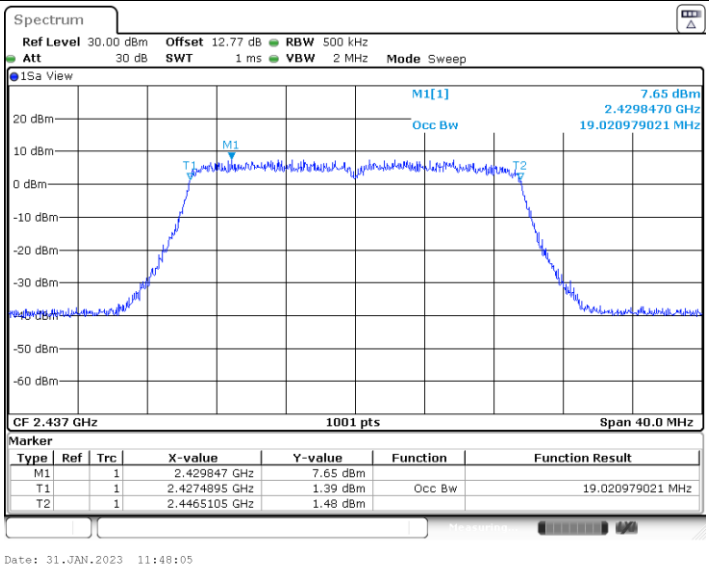

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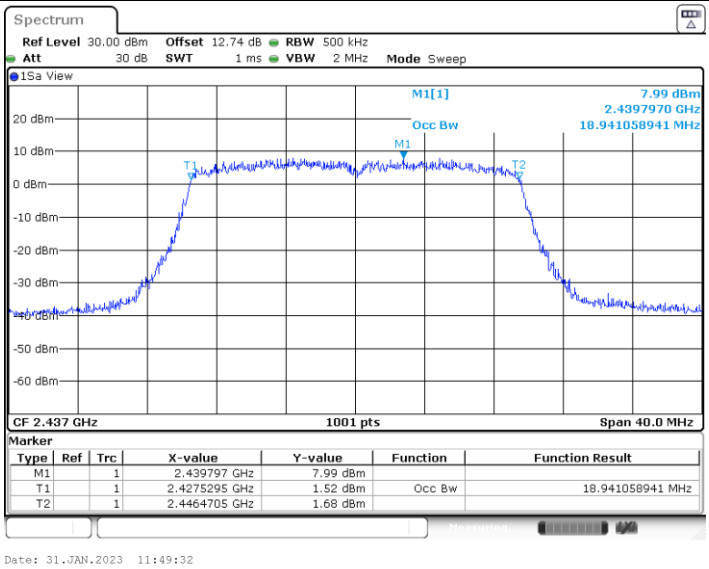
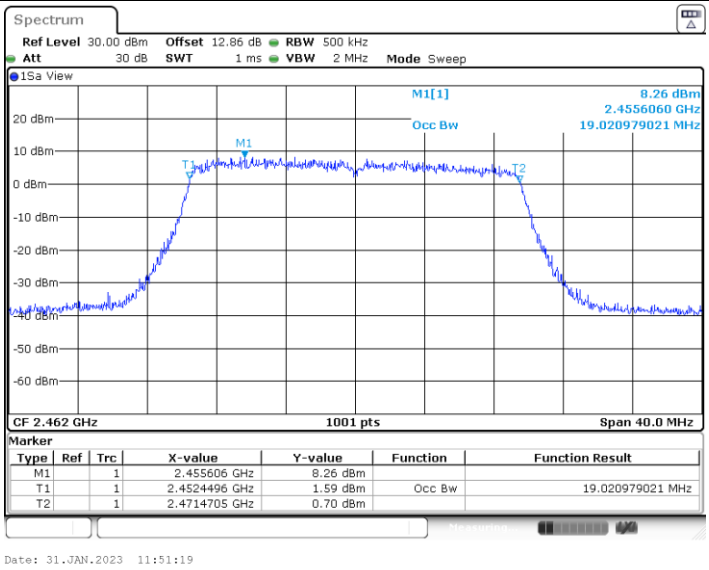
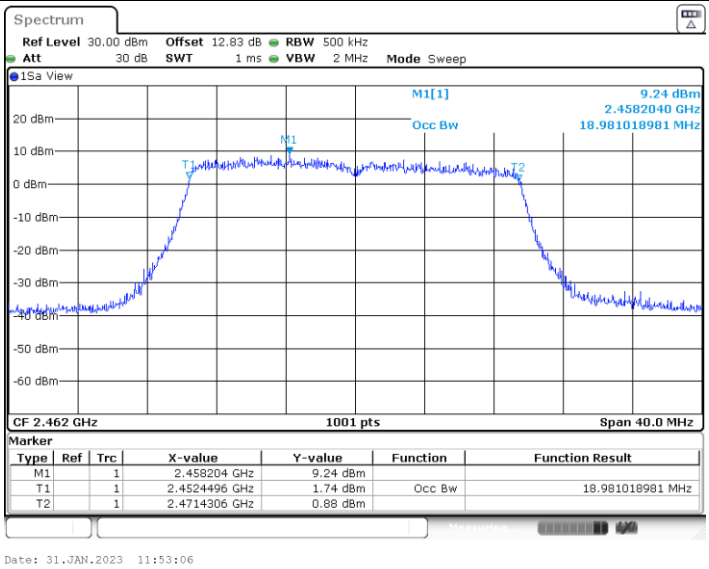


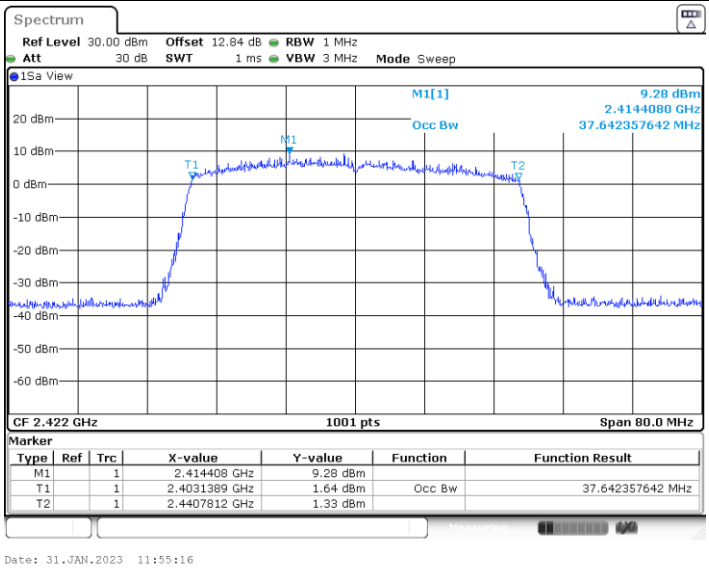
11AX20MIMO_Ant0_2462



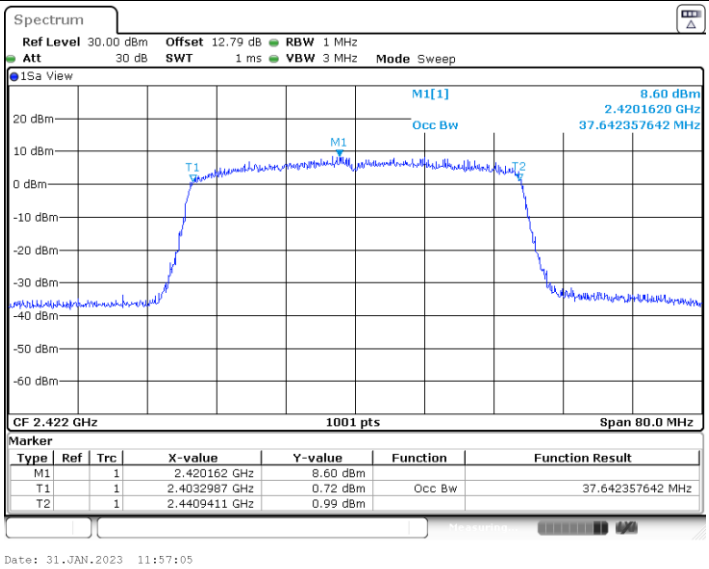
11AX20MIMO_Ant1_2462



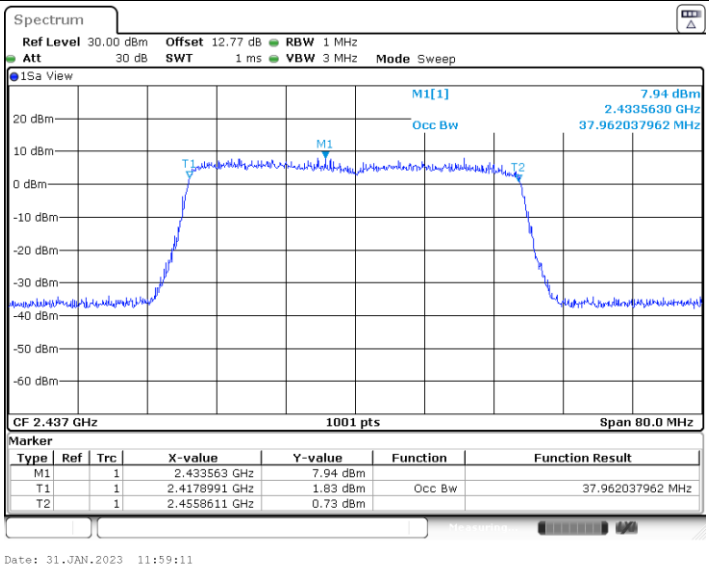
11AX40MIMO_Ant0_2422



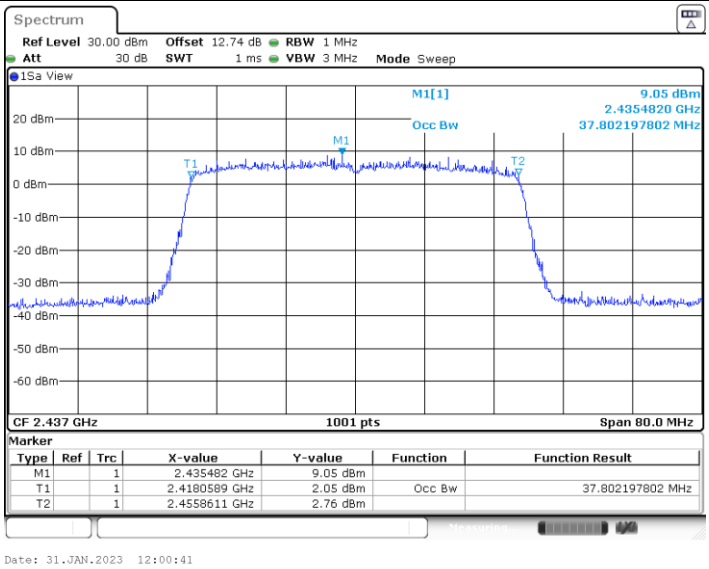
11AX40MIMO_Ant1_2422



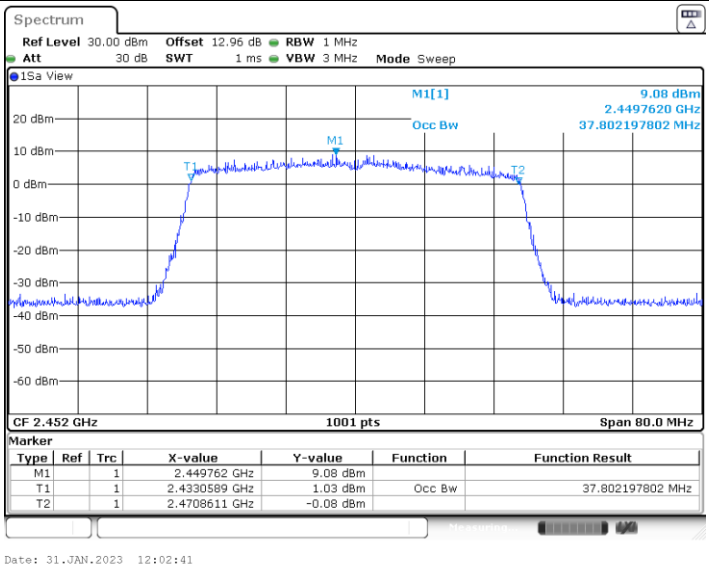
11AX40MIMO_Ant0_2437



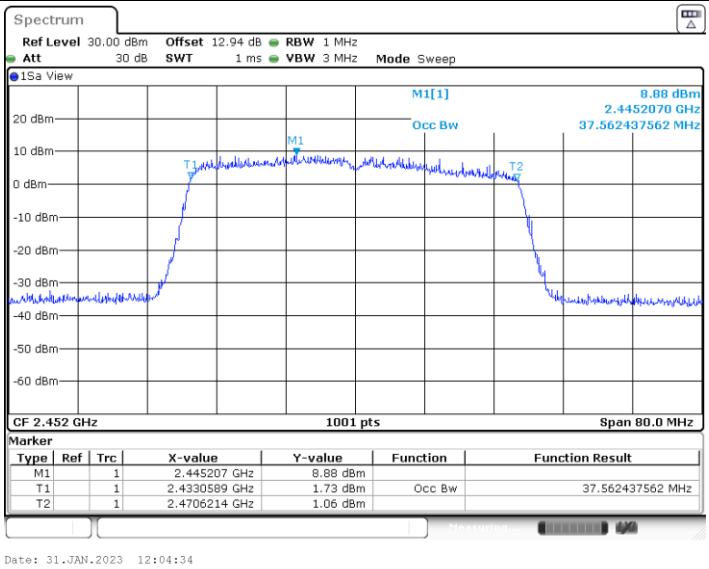
11AX40MIMO_Ant1_2437



11AX40MIMO_Ant0_2452



11AX40MIMO_Ant1_2452



Maximum power spectral density

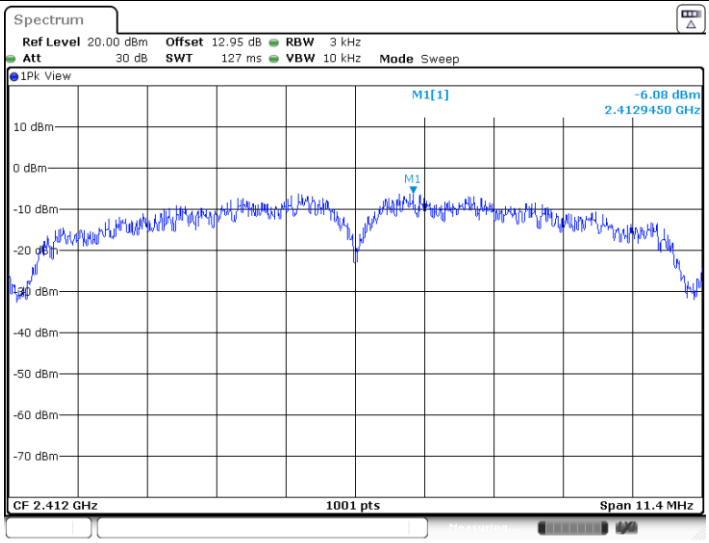
Test Result

TestMode	Antenna	Freq(MHz)	Result [dBm/3kHz]	Limit [dBm/3kHz]	Verdict
11B-CDD	Ant0	2412	-6.08	≤8.00	PASS
	Ant1	2412	-6.09	≤8.00	PASS
	total	2412	-3.07	≤8.00	PASS
	Ant0	2437	-7.83	≤8.00	PASS
	Ant1	2437	-7.8	≤8.00	PASS
	total	2437	-4.80	≤8.00	PASS
	Ant0	2462	-6	≤8.00	PASS
	Ant1	2462	-6.72	≤8.00	PASS
	total	2462	-3.33	≤8.00	PASS
11G-CDD	Ant0	2412	-10.13	≤8.00	PASS
	Ant1	2412	-8.58	≤8.00	PASS
	total	2412	-6.28	≤8.00	PASS
	Ant0	2437	-10.78	≤8.00	PASS
	Ant1	2437	-10.38	≤8.00	PASS
	total	2437	-7.57	≤8.00	PASS
	Ant0	2462	-8.7	≤8.00	PASS
	Ant1	2462	-10.34	≤8.00	PASS
	total	2462	-6.43	≤8.00	PASS
11N20MIMO	Ant0	2412	-9.88	≤8.00	PASS
	Ant1	2412	-9.5	≤8.00	PASS
	total	2412	-6.68	≤8.00	PASS
	Ant0	2437	-10.07	≤8.00	PASS
	Ant1	2437	-10.86	≤8.00	PASS
	total	2437	-7.44	≤8.00	PASS
	Ant0	2462	-9.94	≤8.00	PASS
	Ant1	2462	-10.31	≤8.00	PASS
	total	2462	-7.11	≤8.00	PASS
11N40MIMO	Ant0	2422	-11.8	≤8.00	PASS
	Ant1	2422	-11.19	≤8.00	PASS
	total	2422	-8.47	≤8.00	PASS
	Ant0	2437	-11.61	≤8.00	PASS
	Ant1	2437	-11.84	≤8.00	PASS
	total	2437	-8.71	≤8.00	PASS
	Ant0	2452	-13.16	≤8.00	PASS
	Ant1	2452	-12.46	≤8.00	PASS
	total	2452	-9.79	≤8.00	PASS
11AX20MIMO	Ant0	2412	-13.71	≤8.00	PASS
	Ant1	2412	-13.21	≤8.00	PASS
	total	2412	-10.44	≤8.00	PASS
	Ant0	2437	-14.24	≤8.00	PASS
	Ant1	2437	-14.23	≤8.00	PASS

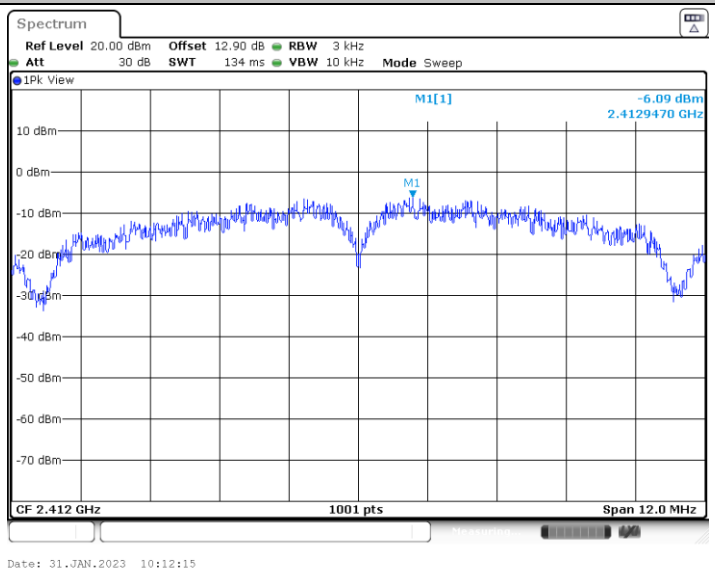
	total	2437	-11.22	≤8.00	PASS
	Ant0	2462	-13.85	≤8.00	PASS
	Ant1	2462	-13.77	≤8.00	PASS
	total	2462	-10.80	≤8.00	PASS
11AX40MIMO	Ant0	2422	-16.3	≤8.00	PASS
	Ant1	2422	-16.11	≤8.00	PASS
	total	2422	-13.19	≤8.00	PASS
	Ant0	2437	-16.3	≤8.00	PASS
	Ant1	2437	-17.09	≤8.00	PASS
	total	2437	-13.67	≤8.00	PASS
	Ant0	2452	-16.26	≤8.00	PASS
	Ant1	2452	-15.98	≤8.00	PASS
	total	2452	-13.11	≤8.00	PASS

Test Graphs

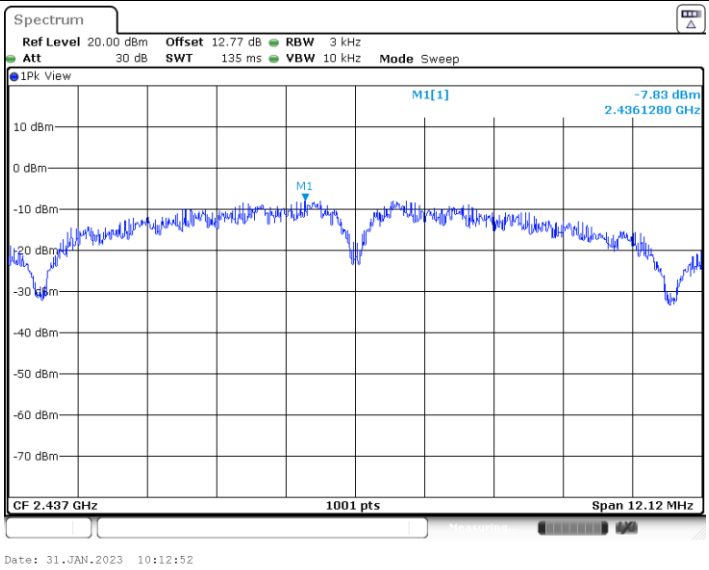
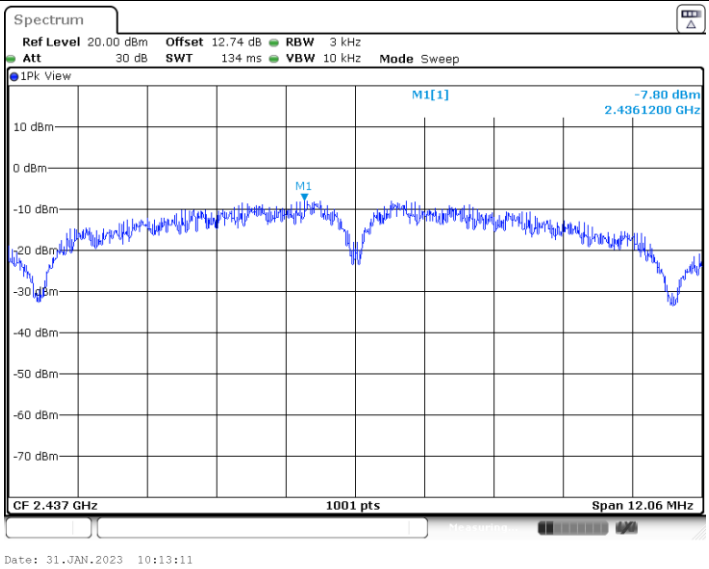
11B-CDD_Ant0_2412



11B-CDD_Ant1_2412



11B-CDD_Ant0_2437



11B-CDD_Ant1_2437