FCC RF Test Report

APPLICANT	:	Vantiva USA LLC
EQUIPMENT	:	DOCSIS 3.1
BRAND NAME	:	Vantiva
MODEL NAME	:	CGM4981COM2
FCC ID	:	G954981X2
STANDARD	:	FCC Part 15 Subpart C §15.247
CLASSIFICATION	:	(DTS) Digital Transmission System
TEST DATE(S)	:	Nov. 14, 2023 ~ Dec. 01, 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
FR391301C	Rev. 01	Initial issue of report	Dec. 18, 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	≤ 30dBc	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 0.45 dB at 2389.970 MHz
3.6	15.207	AC Conducted Emission	15.207(a)	Pass	Under limit 19.13 dB at 2.736 MHz
3.7	15.203 & 15.247(b)	Antenna Requirement	15.203 & 15.247(b)	Pass	-

Conformity Assessment Condition:

1. The test results (PASS/FAIL) with all measurement uncertainty excluded are presented against the regulation limits or in accordance with the requirements stipulated by the applicant/manufacturer who shall bear all the risks of non-compliance that may potentially occur if measurement uncertainty is taken into account.
2. The measurement uncertainty please refer to each test result in the section “Measurement Uncertainty”

Disclaimer:

The product specifications of the EUT presented in the test report that may affect the test assessments are declared by the manufacturer who shall take full responsibility for the authenticity.

1 General Description

1.1 Applicant

Vantiva USA LLC
4855 Peachtree Industrial Blvd. Suite 200 Norcross, Georgia 30092

1.2 Manufacturer

Vantiva USA LLC
4855 Peachtree Industrial Blvd. Suite 200 Norcross, Georgia 30092

1.3 Product Feature of Equipment Under Test

Product Feature	
Equipment	DOCSIS 3.1
Brand Name	Vantiva
Model Name	CGM4981COM2
FCC ID	G954981X2
HW Version	FGR1
SW Version	6.2p30s1
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 Average Output Power to antenna	**<MIMO Ant.1+2+3+4>** 802.11b : 29.91 dBm (0.9795 W) 802.11g : 29.82 dBm (0.9594 W) 802.11ax HE20 : 29.89 dBm (0.9750 W) 802.11ax HE40 : 29.38 dBm (0.8670 W)
Antenna Type	PCB Antenna
Type of Modulation	802.11b : DSSS (DBPSK / DQPSK / CCK) 802.11g/n: OFDM (BPSK / QPSK / 16QAM / 64QAM) 802.11ac: OFDM (BPSK / QPSK / 16QAM / 64QAM / 256QAM) 802.11ax: OFDM (BPSK / QPSK / 16QAM / 64QAM / 256QAM / 1024QAM)
Antenna Function Description	See table below

	Ant. 1	Ant. 2	Ant. 3	Ant. 4
802.11 b/g/n/ac/ax SISO	V	V	V	V
802.11 b/g/n/ac/ax CDD 1S4T	V	V	V	V
802.11 n/ac/ax Tx Beamforming 1S4T	V	V	V	V

Note:

1. For WLAN SISO & MIMO mode, the whole testing has assessed only MIMO mode by referring to the higher normal output power.
2. For 802.11n/ac/ax 20/40MHz mode, the power setting of 802.11n/ac 20/40MHz mode is the same or lower than 802.11ax 20/40MHz mode. Therefore, the whole testing has assessed only 802.11ax HE20/HE40 mode.
3. The device supports multiple spatial streams, the worst case directional gain will occur when NSS = 1, therefore, the 1S4T(CDD&TXBF) mode is the worst; 1S4T: NSS=1, MIMO 4Tx
4. The device does not support partial RU tone for 802.11ax mode.
5. Please refer to the antenna report for the maximum single antenna gain and CDD (Cyclic Delay Diversity) directional gain and TXBF (Tx Beamforming) directional gain.

Frequency Band	Max Single Antenna gain (dBi)				CDD DG (dBi)		TXBF DG (dBi)	
	ANT1	ANT2	ANT3	ANT4	For Power	For PSD	For Power	For PSD
2.4GHz	5.22	2.98	3.57	3.73	5.22	5.84	5.84	5.84

1.5 Specification of Accessory

Specification of Accessory				
AC Adapter 1	**Brand Name**	Netbit	**Model Name**	NBC56A120460VU
AC Adapter 2	**Brand Name**	Netbit	**Model Name**	NBC56B120460VU
AC Adapter 3	**Brand Name**	Acbel	**Model Name**	ADK002

1.6 Modification of EUT

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

1.7 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		
Test Site No.	**Sporton Site No.**	**FCC Designation No.**	**FCC Test Firm Registration No.**
	CO01-KS 03CH06-KS TH01-KS	CN1257	314309

1.8 Test Software

Item	Site	Manufacturer	Name	Version
1.	TH01-KS	Tonscend	JS1120-3 test system China_210602	3.3.10
2.	03CH06-KS	AUDIX	E3	210616
3.	CO01-KS	AUDIX	E3	6.2009-8-24

1.9 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, and Wall installation plane. The worst cases (Y, Wall installation plane, the wall is non-metal panels) 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	-	-

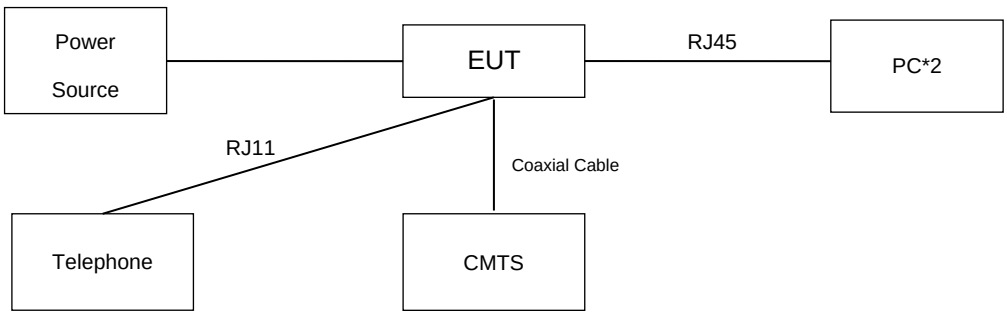
2.2 Test Mode

Final RSE test modes are considering the modulation and worse data rates refer to Appendix C.

For Radiated Test Cases, the tests were performance with Adapter and RJ45/RJ11/Coaxial Cable

Test Cases	
AC Conducted Emission	Mode 1 :ZigBee Tx + WLAN Tx(2.4G) + BLE Tx + Power from Adapter

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.	PC	Lenovo	Yangtian M4900c	Fcc DoC	N/A	Unshielded,1.8m
2.	(USB)Mouse	Lenovo	OEUUOA	Fcc DoC	Shielded, 1.8m	N/A
3.	(USB)Keyboard	Lenovo	SK-8821	Fcc DoC	Shielded, 1.8m	N/A
4.	Monitor	Lenovo	LS2033wA	Fcc DoC	N/A	Unshielded,1.8m
5.	PC	Dell	D12M	Fcc DoC	N/A	Unshielded,1.8m
6.	(USB)Mouse	Dell	MS111-P	Fcc DoC	Shielded, 1.8m	N/A
7.	(USB)Keyboard	Dell	SK-8120	Fcc DoC	Shielded, 1.8m	N/A
8.	Telephone	bubugao	HCD007(6082)TSD	N/A	N/A	N/A
9.	RJ45 Cable	N/A	N/A	N/A	N/A	N/A
10.	RJ11 Cable	N/A	N/A	N/A	N/A	N/A
11.	CMTS	TOPISION	N/A	N/A	N/A	N/A

2.5 EUT Operation Test Setup

For WLAN RF test items, an engineering test program “QRCT TX Tool” was provided and enabled to make EUT continuously transmit.

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 2.40 dB and 10dB attenuator.

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

= 2.40 + 10 = 12.40 (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 output power is 30dBm. If transmitting antenna with directional gain greater than 6dBi is used, the 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.

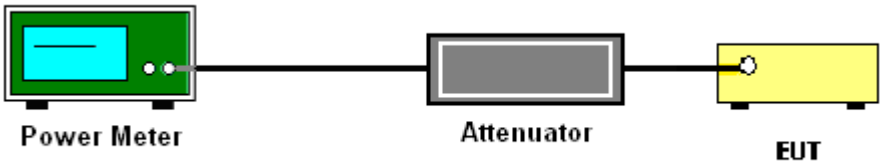
3.2.2 Measuring Instruments

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 11.9.2.3.1 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 Average Output Power

<CDD 1S4T mode>:

2.4GHz Band															
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	Setting
					Ant1	Ant2	Ant3	Ant4	SUM	Ant1+Ant2+ Ant3+Ant4	Ant1+Ant2+ Ant3+Ant4	Ant1+Ant2+ Ant3+Ant4	Ant1+Ant2+ Ant3+Ant4		Ant1 + Ant2 + Ant3 + Ant4
11b	1Mbps	4	1	2412	23.56	23.87	23.50	23.23	29.57	30.00	5.22	34.79	36.00	Pass	24
11b	1Mbps	4	6	2437	23.41	24.52	24.35	22.96	29.88	30.00	5.22	35.10	36.00	Pass	24
11b	1Mbps	4	11	2462	24.36	23.97	23.94	23.21	29.91	30.00	5.22	35.13	36.00	Pass	24
11g	6Mbps	4	1	2412	20.92	20.66	20.72	21.06	26.86	30.00	5.22	32.08	36.00	Pass	21.5
11g	6Mbps	4	6	2437	23.34	24.26	24.24	23.25	29.82	30.00	5.22	35.04	36.00	Pass	24
11g	6Mbps	4	11	2462	23.22	23.28	23.10	23.28	29.24	30.00	5.22	34.46	36.00	Pass	24
HE20	MCS0	4	1	2412	21.80	21.35	21.34	21.90	27.63	30.00	5.22	32.85	36.00	Pass	22
HE20	MCS0	4	6	2437	23.40	24.43	24.28	23.23	29.89	30.00	5.22	35.11	36.00	Pass	24
HE20	MCS0	4	11	2462	23.38	23.48	23.19	23.60	29.44	30.00	5.22	34.66	36.00	Pass	24
HE40	MCS0	4	3	2422	22.52	22.17	22.40	22.44	28.41	30.00	5.22	33.63	36.00	Pass	22.5
HE40	MCS0	4	6	2437	23.20	23.34	23.51	23.39	29.38	30.00	5.22	34.60	36.00	Pass	23.5
HE40	MCS0	4	7	2442	22.01	21.93	21.85	21.98	27.96	30.00	5.22	33.18	36.00	Pass	22
HE40	MCS0	4	8	2447	20.52	20.03	20.19	20.11	26.24	30.00	5.22	31.46	36.00	Pass	20.5
HE40	MCS0	4	9	2452	20.19	20.17	20.55	20.08	26.27	30.00	5.22	31.49	36.00	Pass	20.5

<TX BF 1S4T mode>:

2.4GHz Band															
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	Setting
					Ant1	Ant2	Ant3	Ant4	SUM	Ant1+Ant2+ Ant3+Ant4	Ant1+Ant2+ Ant3+Ant4	Ant1+Ant2+ Ant3+Ant4	Ant1+Ant2+ Ant3+Ant4		Ant1 + Ant2 + Ant3 + Ant4
HE20	MCS0	4	1	2412	21.14	20.99	20.81	21.05	27.02	30.00	5.84	32.86	36.00	Pass	21
HE20	MCS0	4	6	2437	23.40	24.03	24.01	23.41	29.74	30.00	5.84	35.58	36.00	Pass	23.5
HE20	MCS0	4	11	2462	21.09	21.00	21.05	20.80	27.01	30.00	5.84	32.85	36.00	Pass	21
HE40	MCS0	4	3	2422	21.43	21.42	21.48	21.40	27.45	30.00	5.84	33.29	36.00	Pass	21.5
HE40	MCS0	4	6	2437	22.69	22.75	22.81	22.47	28.70	30.00	5.84	34.54	36.00	Pass	22.5
HE40	MCS0	4	7	2442	18.61	18.45	18.62	18.48	24.56	30.00	5.84	30.40	36.00	Pass	18.5
HE40	MCS0	4	8	2447	18.57	18.42	18.45	18.39	24.48	30.00	5.84	30.32	36.00	Pass	18.5
HE40	MCS0	4	9	2452	16.89	16.78	17.07	16.87	22.92	30.00	5.84	28.76	36.00	Pass	17

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 11.10.5 Method AVGPSD.
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.
5. Detector = power averaging (rms), 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:

   Method (a): 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.

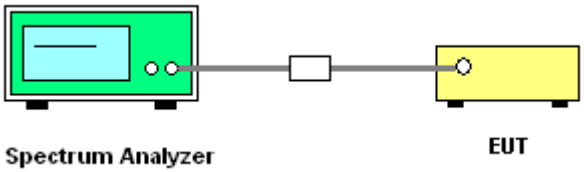
   Method (b): Measure and sum spectral maxima across the outputs.

   The measurement on each individual output were performed with the same span and number on each individual output. The maximum value (peak) of each spectrum is determined. These maximum values are then summed mathematically in linear power units across the outputs.

   Method (c): Measure and add 10 log(N_{ANT}) dB, where N_{ANT} is the number of outputs.

   The measurement on each individual output were performed with the same span and number on each individual output. The quantity 10 log(N_{ANT}) dB is added to each spectrum value before comparing to the emission limit.

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 30dB relative to the maximum PSD level in 100 kHz by RF conducted measurement.

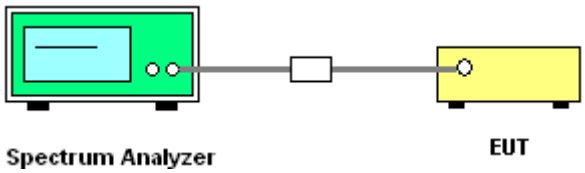
3.4.2 Measuring Instruments

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

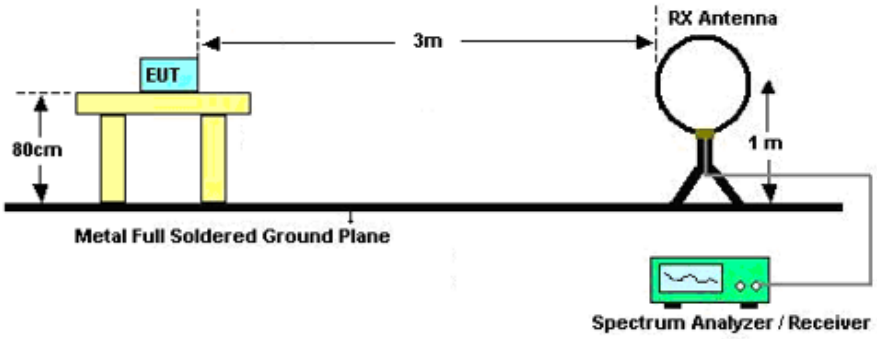
The measuring equipment is listed in the section 4 of this test report.

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.

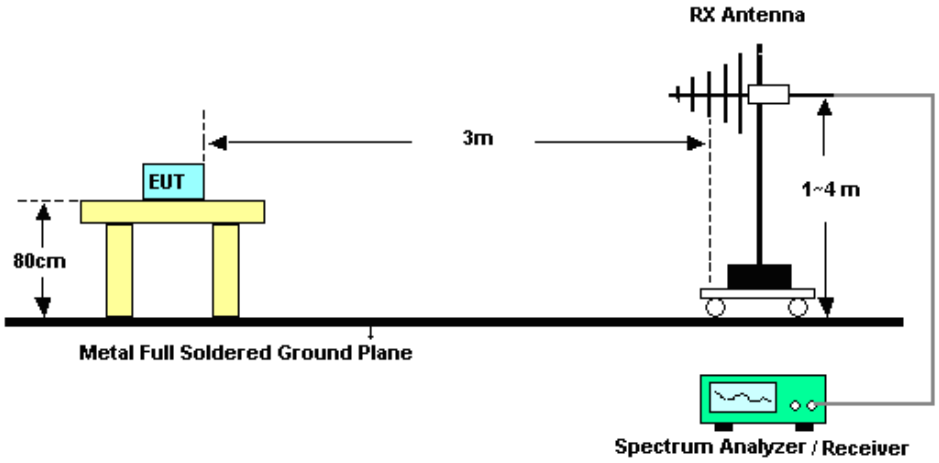
3.5.4 Test Setup

For radiated emissions below 30MHz

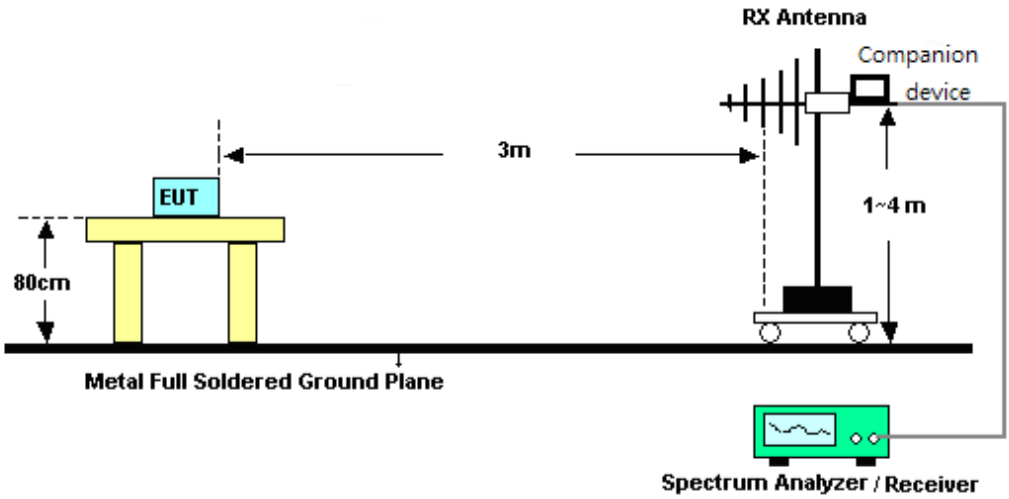


For radiated emissions from 30MHz to 1GHz

<CDD Mode>

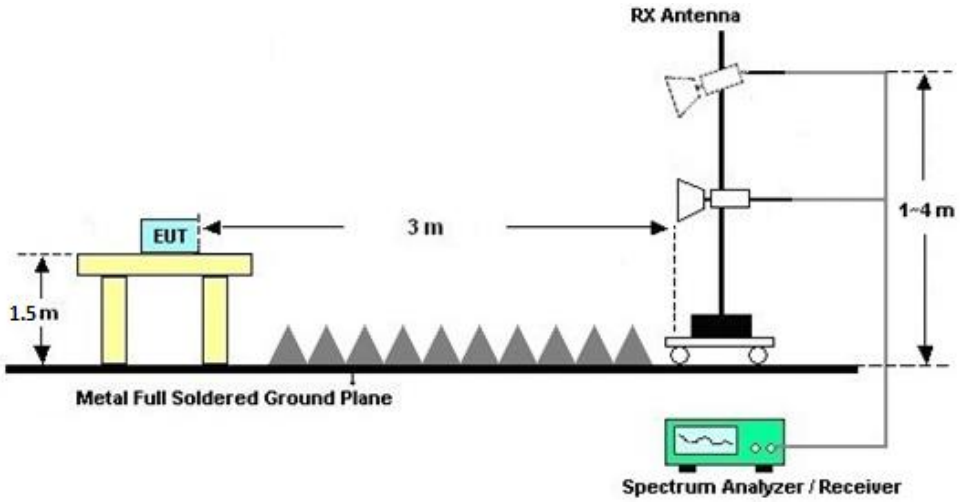


<TXBF Modes>

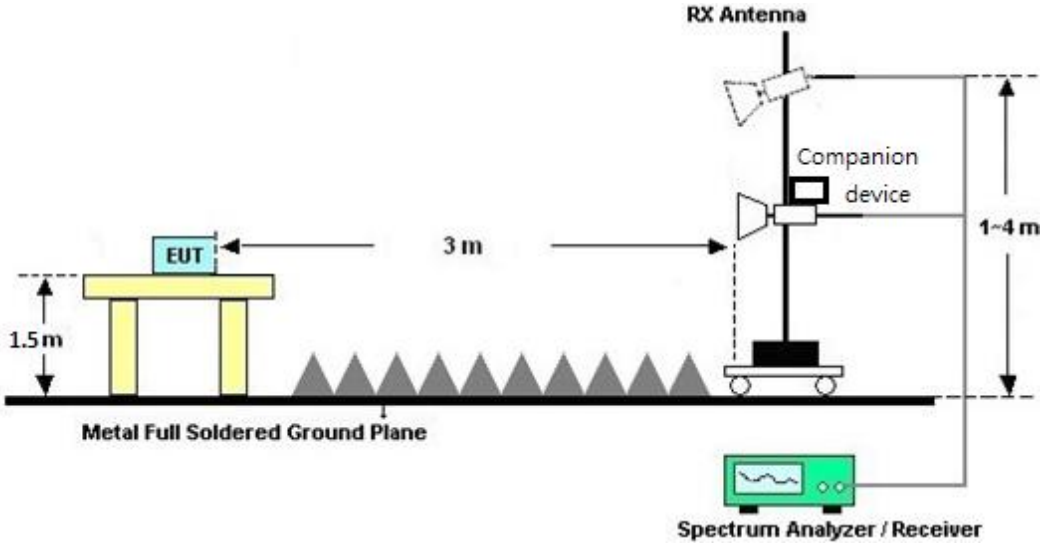


For radiated emissions above 1GHz

<CDD Mode>



<TXBF Modes>



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.

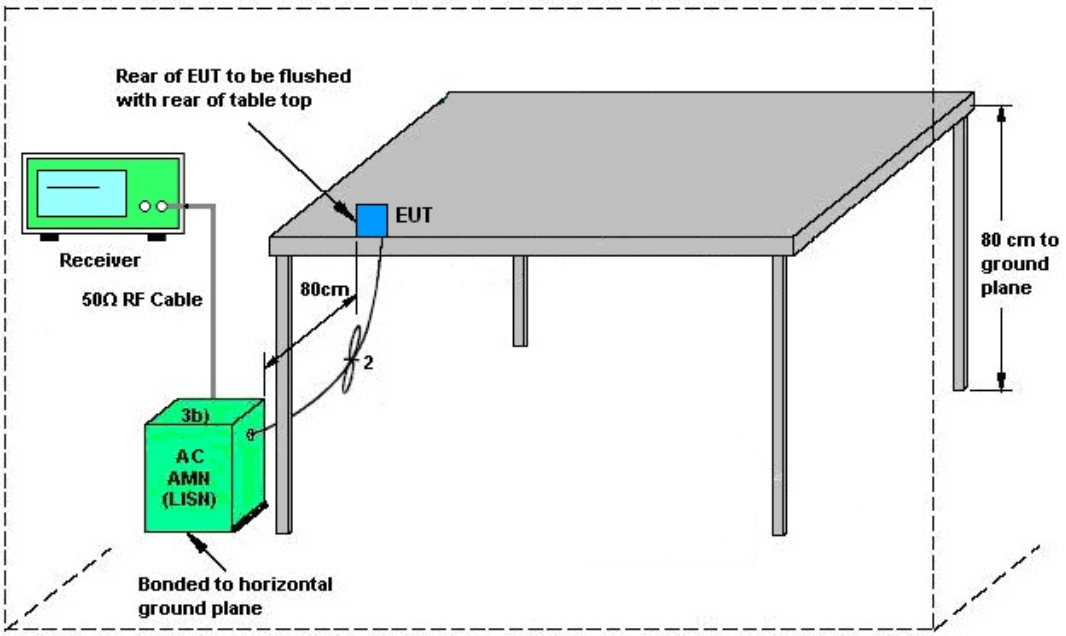
3.6.2 Measuring Instruments

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 $N_{ANT} \leq 4$.

The EUT supports CDD for 802.11b/g/n/ac/ax modes

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).

Directional gain = 10 log[($10^{G1/20}$ + $10^{G2/20}$ + … + $10^{GN/20}$)2 /N_{ANT}] dBi

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

<TXBF Mode>

FCC KDB 662911 D01 Multiple Transmitter Output v02r01

For TXBF transmissions, directional gain is calculated as

$$DirectionalGain = 10 \cdot \log \left[\frac{\sum_{j=1}^{N_{SS}} \left\{ \sum_{k=1}^{N_{ANT}} g_{j,k} \right\}^2}{N_{ANT}} \right]$$

where

Each antenna is driven by no more than one spatial stream;
N_{SS} = the number of independent spatial streams of data;
N_{ANT} = the total number of antennas
$g_{j,k} = 10^{G_k/20}$ if the kth antenna is being fed by spatial stream j, or zero if it is not;
G_k is the gain in dBi of the kth antenna.

The EUT supports beamforming for 802.11n/ac/ax modes.

The directional gain calculation is following F)2)e)ii).

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

The directional gain "DG" is as following table.

Frequency Band	Max Single Antenna gain (dBi)				CDD DG (dBi)		TXBF DG (dBi)	
	ANT1	ANT2	ANT3	ANT4	For Power	For PSD	For Power	For PSD
2.4GHz	5.22	2.98	3.57	3.73	5.22	5.84	5.84	5.84

Note:

1. Please refer to the antenna report for the maximum Single antenna gain and CDD (Cyclic Delay Diversity) directional gain and TXBF (Tx Beamforming) directional gain.
2. The device supports 1S4T(CDD&TXBF) mode; 1S4T: NSS=1, MIMO 4Tx.

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. 11, 2023	Nov. 14, 2023~ Nov. 28, 2023	Oct. 10, 2024	Conducted (TH01-KS)
Pulse Power Senor	Anritsu	MA2411B	0917070	300MHz~40GHz	Jan. 05, 2023	Nov. 14, 2023~ Nov. 28, 2023	Jan. 04, 2024	Conducted (TH01-KS)
Power Meter	Anritsu	ML2495A	1005002	50MHz Bandwidth	Jan. 05, 2023	Nov. 14, 2023~ Nov. 28, 2023	Jan. 04, 2024	Conducted (TH01-KS)
EMI Test Receiver	Keysight	N9038A	MY56400004	3Hz~8.5GHz;Max 30dBm	Oct. 10, 2023	Nov. 24, 2023~ Nov. 25, 2023	Oct. 09, 2024	Radiation (03CH06-KS)
EXA Spectrum Analyzer	Keysight	N9010B	MY60242126	10Hz-44GHz	Oct. 10, 2023	Nov. 24, 2023~ Nov. 25, 2023	Oct. 09, 2024	Radiation (03CH06-KS)
Loop Antenna	R&S	HFH2-Z2	100321	9kHz~30MHz	Oct. 10, 2023	Nov. 24, 2023~ Nov. 25, 2023	Oct. 09, 2024	Radiation (03CH06-KS)
Bilog Antenna	TeseQ	CBL6111D	49921	30MHz-1GHz	Apr. 09, 2023	Nov. 24, 2023~ Nov. 25, 2023	Apr. 08, 2024	Radiation (03CH06-KS)
Double Ridge Horn Antenna	ETS-Lindgren	3117	00218652	1GHz~18GHz	Apr. 06, 2023	Nov. 24, 2023~ Nov. 25, 2023	Apr. 05, 2024	Radiation (03CH06-KS)
SHF-EHF Horn	Com-power	AH-840	101093	18GHz~40GHz	Jan. 08, 2023	Nov. 24, 2023~ Nov. 25, 2023	Jan. 07, 2024	Radiation (03CH06-KS)
Amplifier	SONOMA	310N	380827	9KHz ~1GHZ	Jul. 06, 2023	Nov. 24, 2023~ Nov. 25, 2023	Jul. 05, 2024	Radiation (03CH06-KS)
Amplifier	MITEQ	EM18G40GGA	060728	18~40GHz	Jan. 05, 2023	Nov. 24, 2023~ Nov. 25, 2023	Jan. 04, 2024	Radiation (03CH06-KS)
high gain Amplifier	MITEQ	AMF-7D-00101800-30-10P	2082395	1Ghz-18Ghz	Jan. 05, 2023	Nov. 24, 2023~ Nov. 25, 2023	Jan. 04, 2024	Radiation (03CH06-KS)
Amplifier	Keysight	83017A	MY53270319	500MHz~26.5GHz	Oct. 10, 2023	Nov. 24, 2023~ Nov. 25, 2023	Oct. 09, 2024	Radiation (03CH06-KS)
AC Power Source	Chroma	61601	F104090004	N/A	NCR	Nov. 24, 2023~ Nov. 25, 2023	NCR	Radiation (03CH06-KS)
Turn Table	ChamPro	EM 1000-T	060762-T	0~360 degree	NCR	Nov. 24, 2023~ Nov. 25, 2023	NCR	Radiation (03CH06-KS)
Antenna Mast	ChamPro	EM 1000-A	060762-A	1 m~4 m	NCR	Nov. 24, 2023~ Nov. 25, 2023	NCR	Radiation (03CH06-KS)
EMI Receiver	R&S	ESCI7	100768	9kHz~7GHz;	May 16, 2023	Dec. 01, 2023	May 15, 2024	Conduction (CO01-KS)
AC LISN (for auxiliary equipment)	MessTec	AN3016	060103	9kHz~30MHz	Oct. 11, 2023	Dec. 01, 2023	Oct. 10, 2024	Conduction (CO01-KS)
AC LISN	MessTec	AN3016	060105	9kHz~30MHz	May 16, 2023	Dec. 01, 2023	May 15, 2024	Conduction (CO01-KS)
AC Power Source	Chroma	61602	ABP000000811	AC 0V~300V, 45Hz~1000Hz	Oct. 11, 2023	Dec. 01, 2023	Oct. 10, 2024	Conduction (CO01-KS)

NCR: No Calibration Required

5 Measurement Uncertainty

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

Conducted Spurious Emission & Bandedge	**±2.26 dB**
Occupied Channel Bandwidth	**±0.1%**
Conducted Power	**±0.46 dB**
Conducted Power Spectral Density	**±0.88 dB**
Frequency	**±0.4 Hz**

Uncertainty of AC Conducted Emission Measurement (0.15 MHz ~ 30 MHz)

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

Uncertainty of Radiated Emission Measurement (9 KHz ~ 30 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**3.32dB**

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

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**6.26dB**

Uncertainty of Radiated Emission Measurement (1 GHz ~ 18 GHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**5.02dB**

Uncertainty of Radiated Emission Measurement (18 GHz ~ 40 GHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**5.26dB**

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

Appendix A. Conducted Test Results

Ambient Condition: 25 ℃, 45 %RH	
Test Date: 2023/11/14~2023/11/22	**Test Engineer:** Long Wu

<CDD 1S4T mode>

DTS Bandwidth

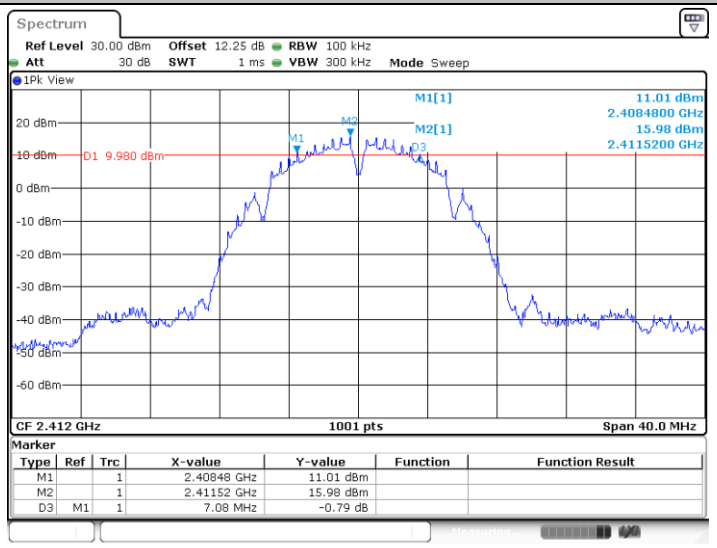
Test Result

TestMode	Antenna	Freq(MHz)	DTS BW [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
11B-CDD	Ant1	2412	7.08	2408.48	2415.56	0.5	PASS
	Ant2	2412	7.04	2408.48	2415.52	0.5	PASS
	Ant3	2412	7.08	2408.48	2415.56	0.5	PASS
	Ant4	2412	7.08	2408.48	2415.56	0.5	PASS
	Ant1	2437	7.56	2433.00	2440.56	0.5	PASS
	Ant2	2437	6.08	2433.96	2440.04	0.5	PASS
	Ant3	2437	7.08	2433.48	2440.56	0.5	PASS
	Ant4	2437	7.04	2433.48	2440.52	0.5	PASS
	Ant1	2462	7.04	2458.48	2465.52	0.5	PASS
	Ant2	2462	7.56	2458.00	2465.56	0.5	PASS
	Ant3	2462	6.56	2458.48	2465.04	0.5	PASS
	Ant4	2462	6.52	2458.96	2465.48	0.5	PASS
11G-CDD	Ant1	2412	16.36	2403.84	2420.20	0.5	PASS
	Ant2	2412	16.36	2403.84	2420.20	0.5	PASS
	Ant3	2412	16.28	2403.88	2420.16	0.5	PASS
	Ant4	2412	16.40	2403.80	2420.20	0.5	PASS
	Ant1	2437	16.32	2428.84	2445.16	0.5	PASS
	Ant2	2437	16.32	2428.84	2445.16	0.5	PASS
	Ant3	2437	16.32	2428.84	2445.16	0.5	PASS
	Ant4	2437	16.36	2428.84	2445.20	0.5	PASS
	Ant1	2462	16.36	2453.84	2470.20	0.5	PASS
	Ant2	2462	16.32	2453.84	2470.16	0.5	PASS
	Ant3	2462	16.36	2453.80	2470.16	0.5	PASS
	Ant4	2462	16.36	2453.84	2470.20	0.5	PASS
11AX20MIMO	Ant1	2412	18.84	2402.64	2421.48	0.5	PASS
	Ant2	2412	18.88	2402.60	2421.48	0.5	PASS
	Ant3	2412	18.84	2402.60	2421.44	0.5	PASS
	Ant4	2412	18.92	2402.60	2421.52	0.5	PASS

	Ant1	2437	18.96	2427.56	2446.52	0.5	PASS
	Ant2	2437	18.96	2427.52	2446.48	0.5	PASS
	Ant3	2437	18.80	2427.52	2446.32	0.5	PASS
	Ant4	2437	19.00	2427.52	2446.52	0.5	PASS
	Ant1	2462	18.96	2452.52	2471.48	0.5	PASS
	Ant2	2462	18.80	2452.56	2471.36	0.5	PASS
	Ant3	2462	18.96	2452.52	2471.48	0.5	PASS
	Ant4	2462	18.76	2452.52	2471.28	0.5	PASS
11AX40MIMO	Ant1	2422	37.76	2403.12	2440.88	0.5	PASS
	Ant2	2422	37.68	2403.20	2440.88	0.5	PASS
	Ant3	2422	37.76	2403.12	2440.88	0.5	PASS
	Ant4	2422	37.68	2403.20	2440.88	0.5	PASS
	Ant1	2437	37.76	2418.12	2455.88	0.5	PASS
	Ant2	2437	37.60	2418.12	2455.72	0.5	PASS
	Ant3	2437	37.68	2418.20	2455.88	0.5	PASS
	Ant4	2437	37.68	2418.20	2455.88	0.5	PASS
	Ant1	2442	38.08	2422.96	2461.04	0.5	PASS
	Ant2	2442	37.84	2423.04	2460.88	0.5	PASS
	Ant3	2442	37.84	2423.04	2460.88	0.5	PASS
	Ant4	2442	37.84	2423.12	2460.96	0.5	PASS
	Ant1	2447	37.92	2427.96	2465.88	0.5	PASS
	Ant2	2447	37.68	2428.12	2465.80	0.5	PASS
	Ant3	2447	37.68	2428.12	2465.80	0.5	PASS
	Ant4	2447	37.84	2428.04	2465.88	0.5	PASS
	Ant1	2452	37.84	2433.04	2470.88	0.5	PASS
	Ant2	2452	37.76	2433.04	2470.80	0.5	PASS
	Ant3	2452	37.68	2433.04	2470.72	0.5	PASS
	Ant4	2452	37.84	2433.04	2470.88	0.5	PASS

Test Graphs

11B-CDD_Ant1_2412



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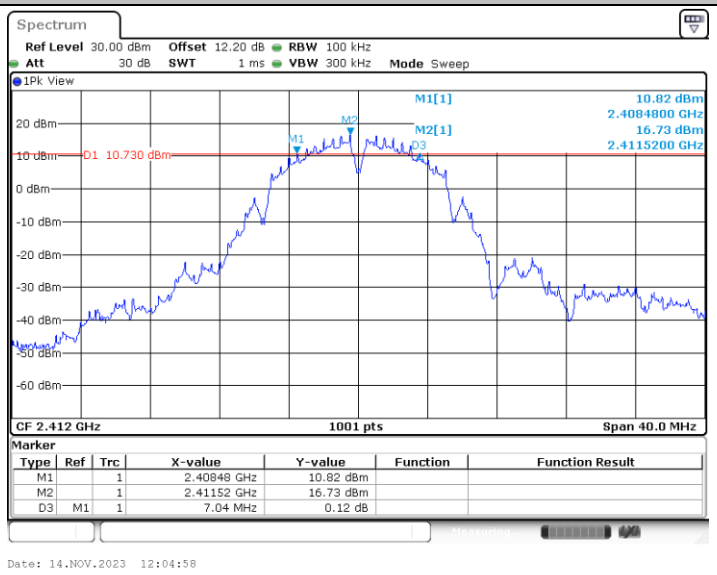

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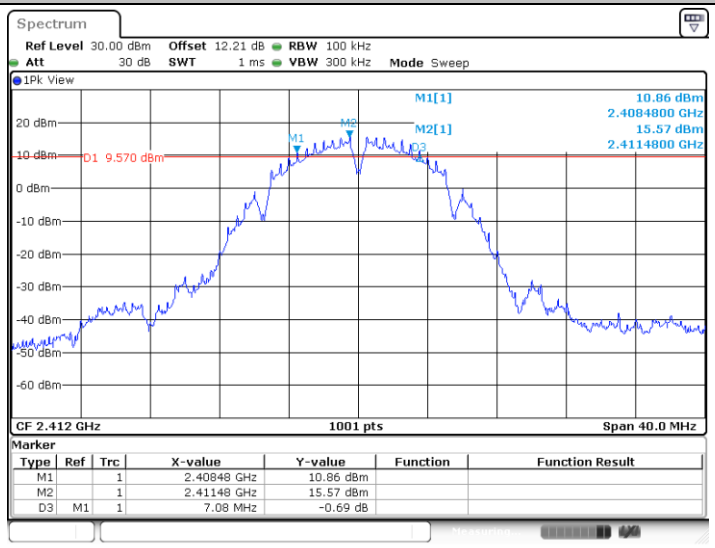

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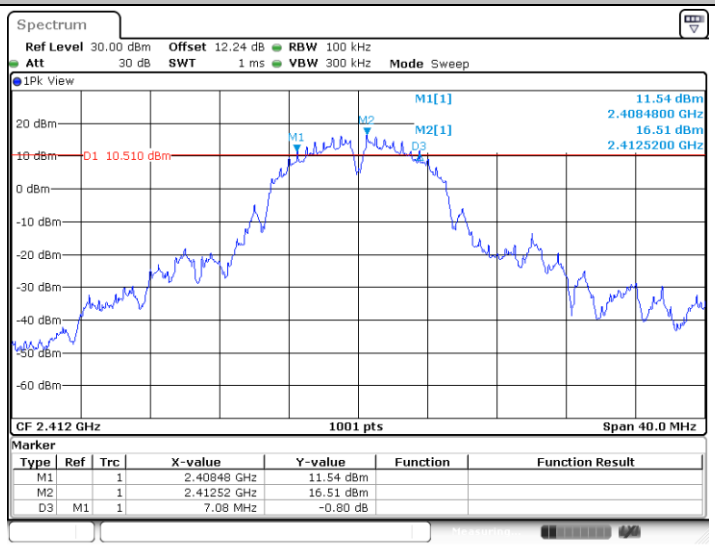

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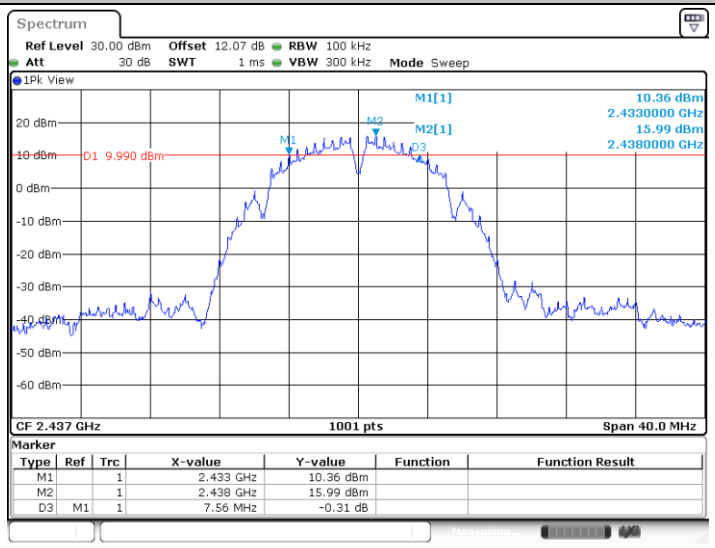

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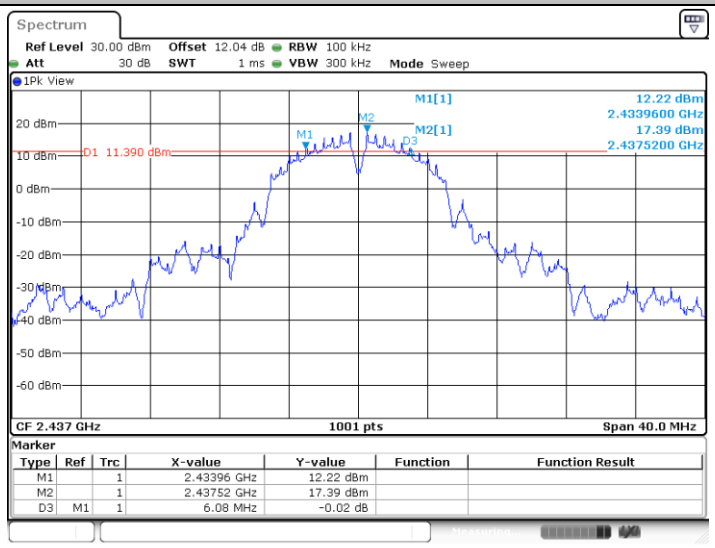

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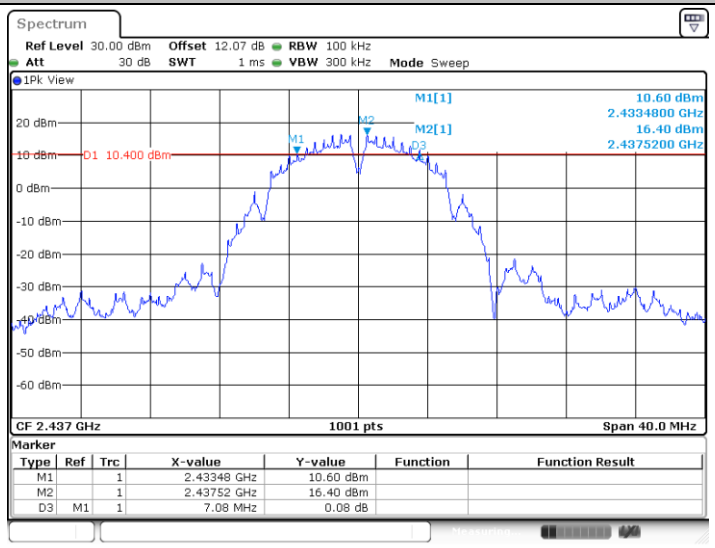

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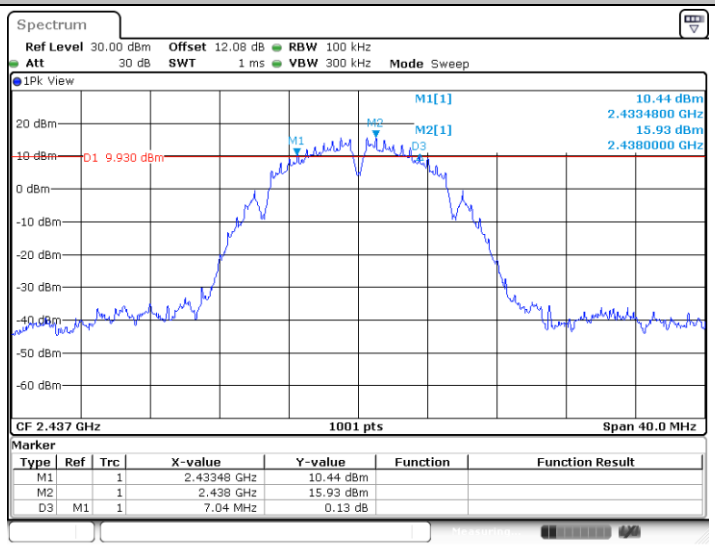

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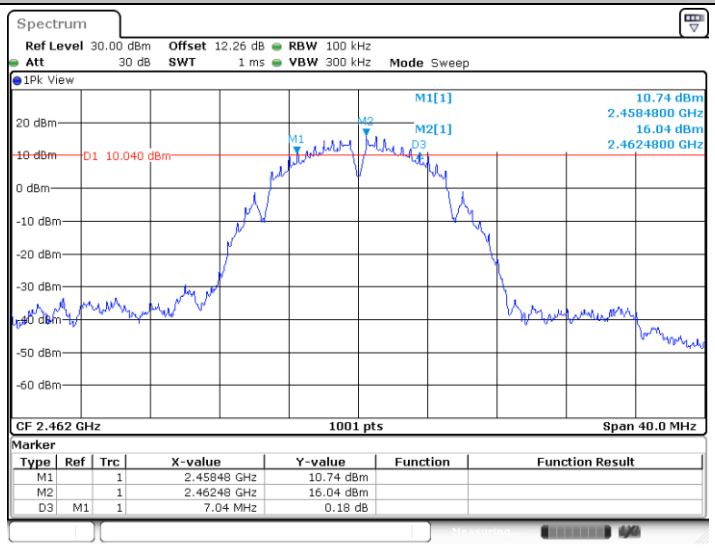

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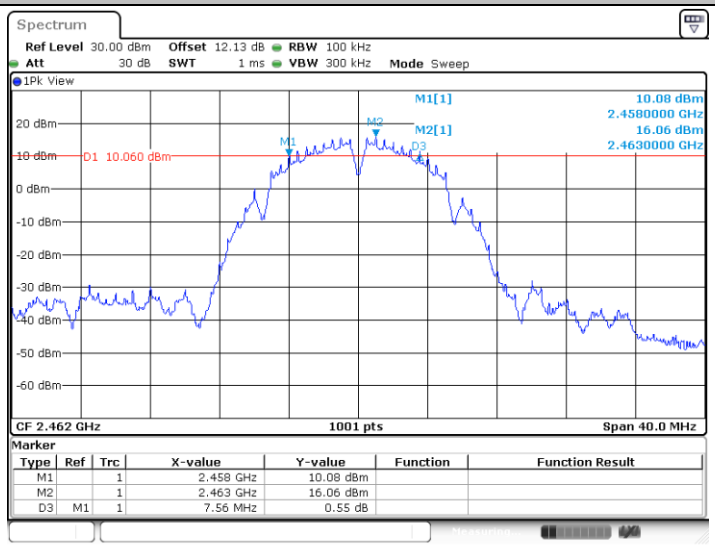

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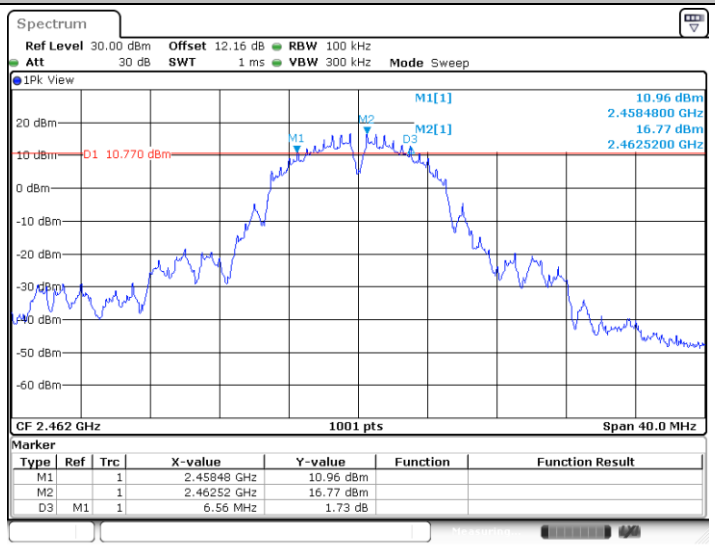

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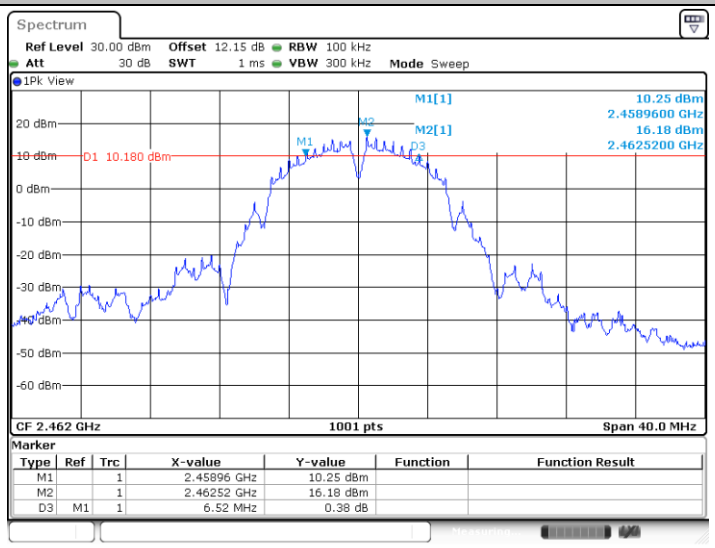

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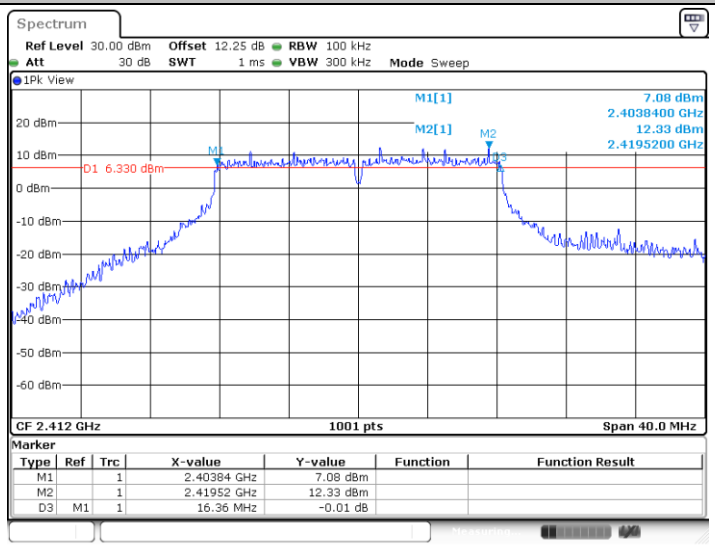

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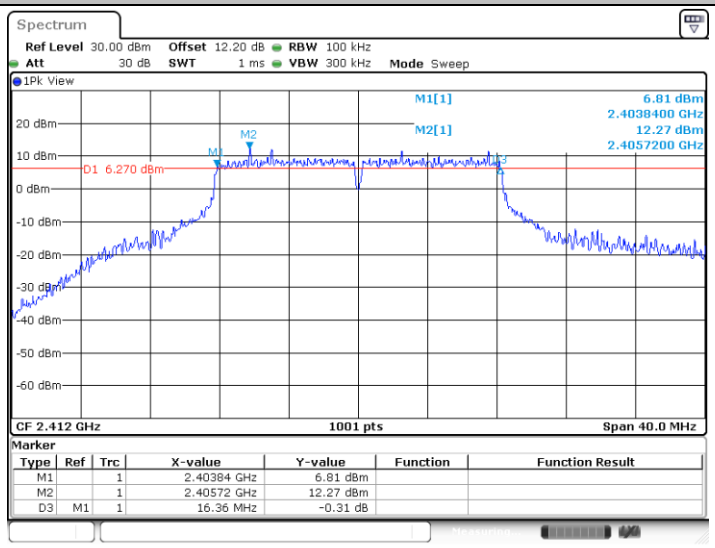

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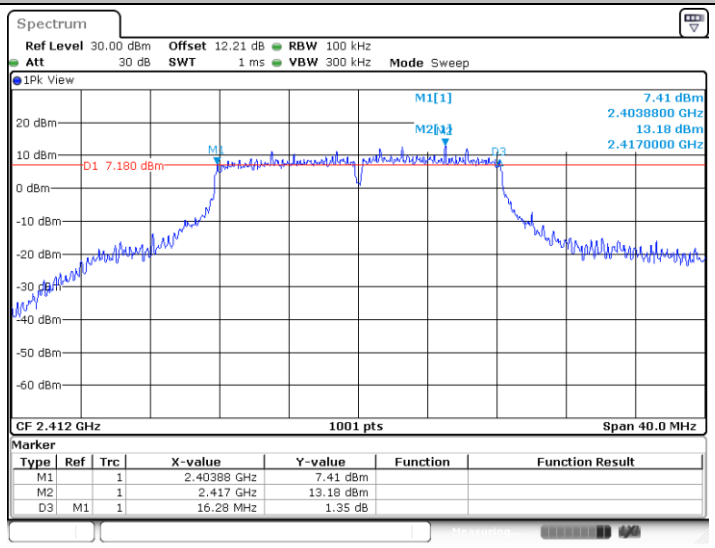

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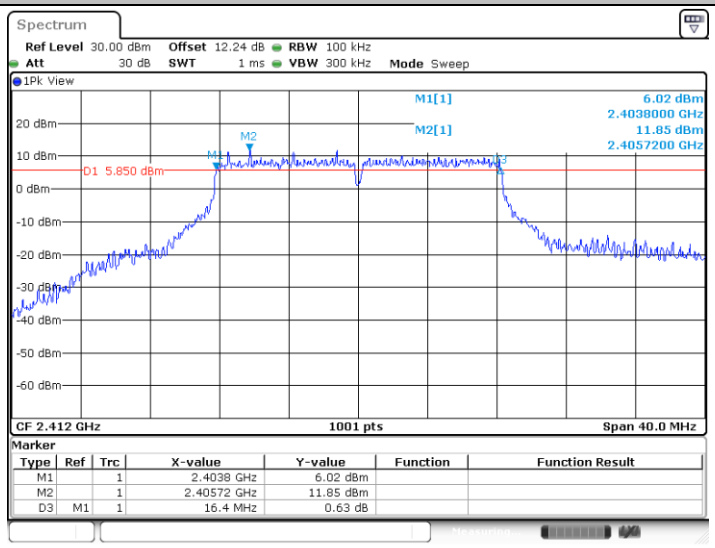

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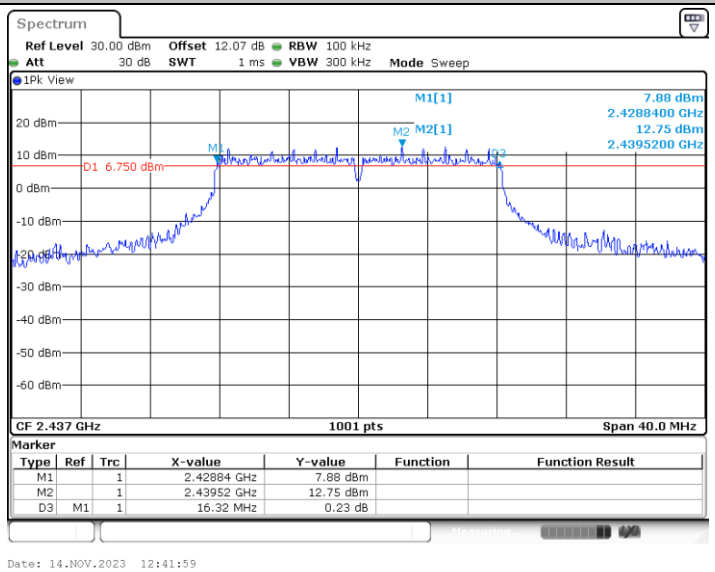

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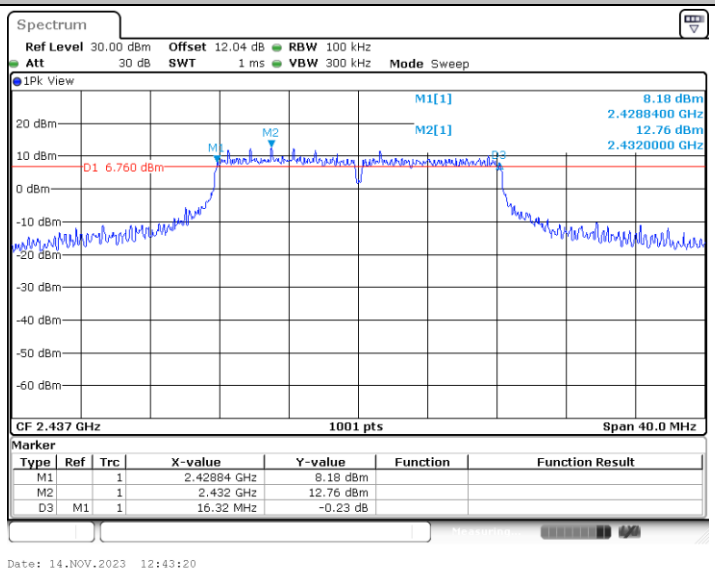

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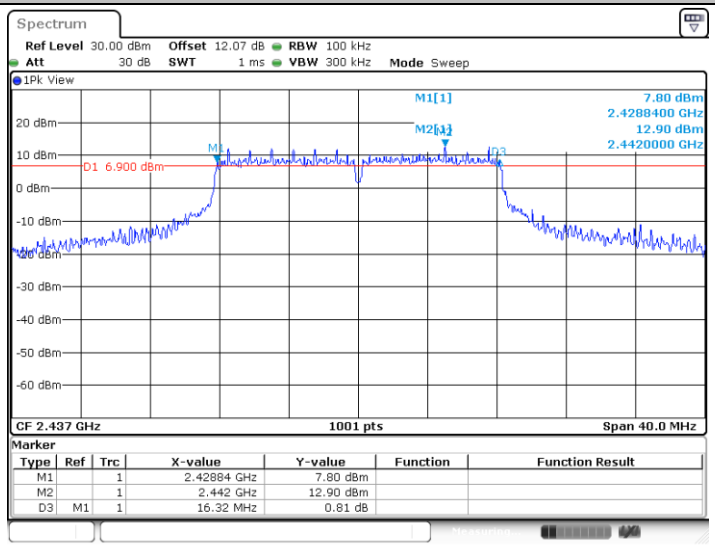

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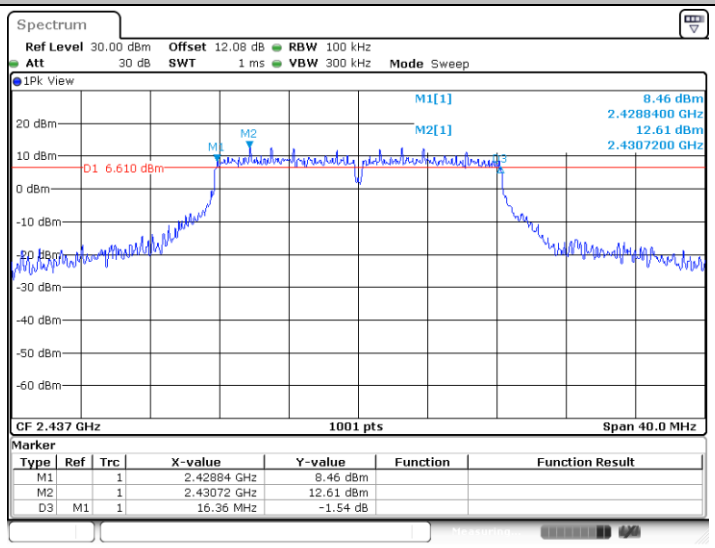
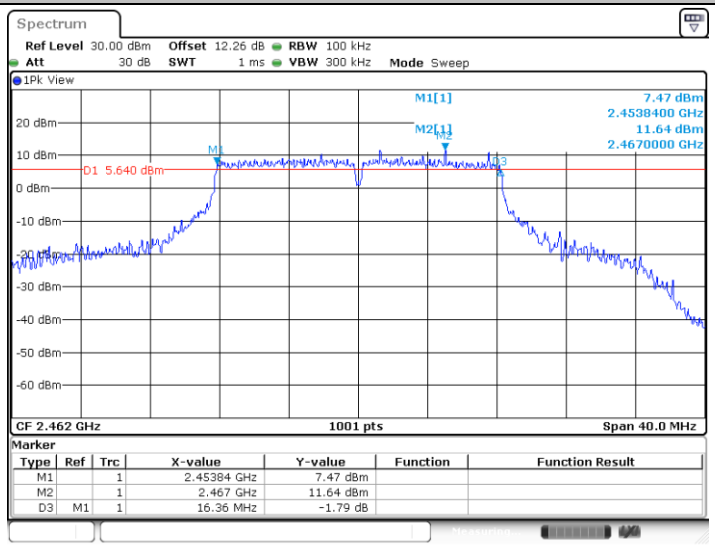


11G-CDD_Ant1_2462



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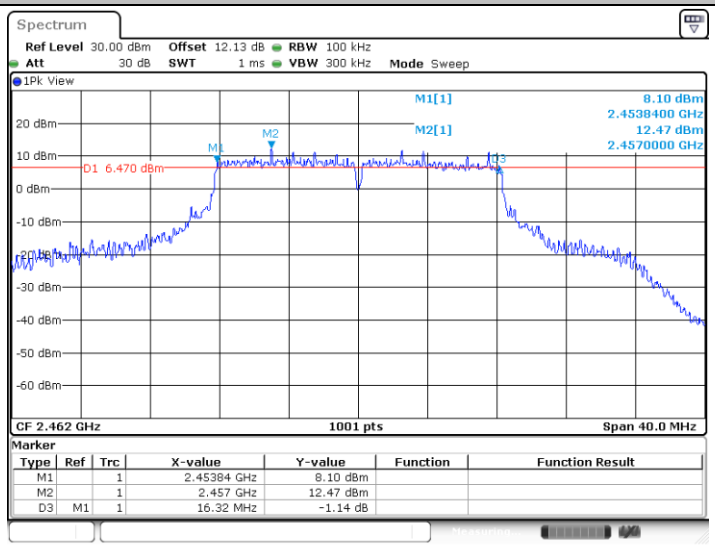

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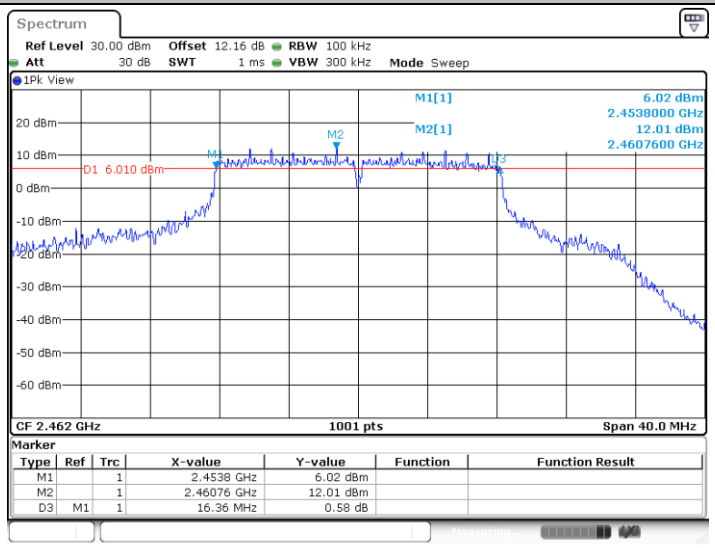

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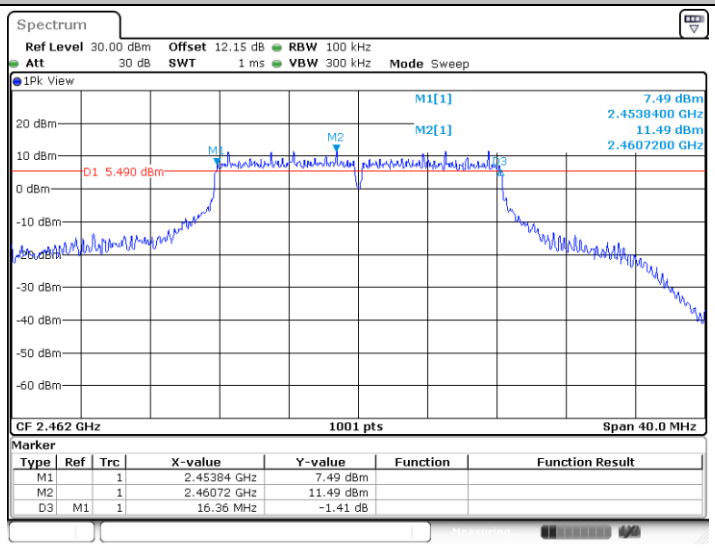

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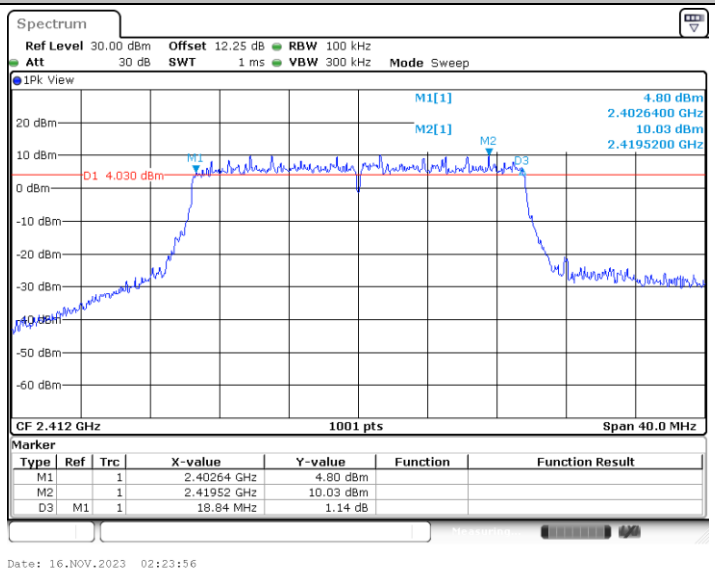

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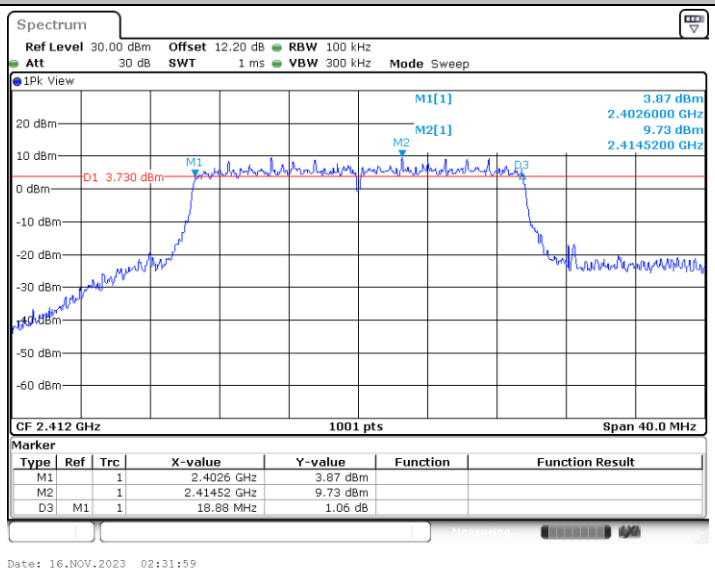

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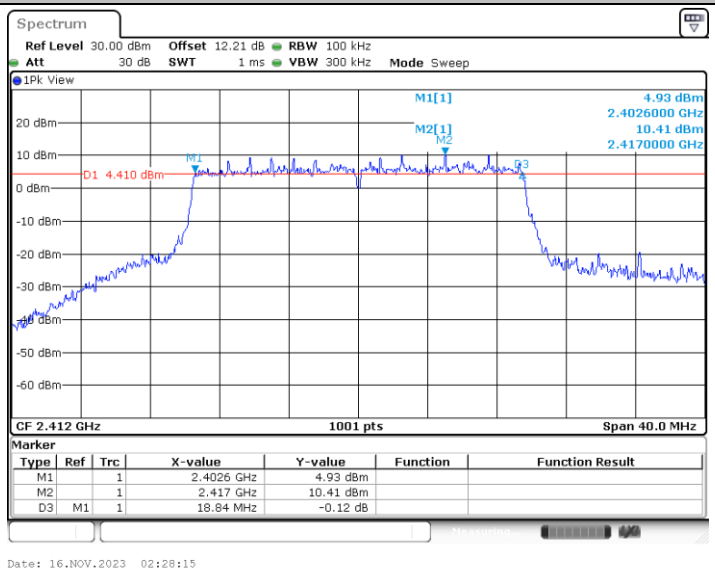

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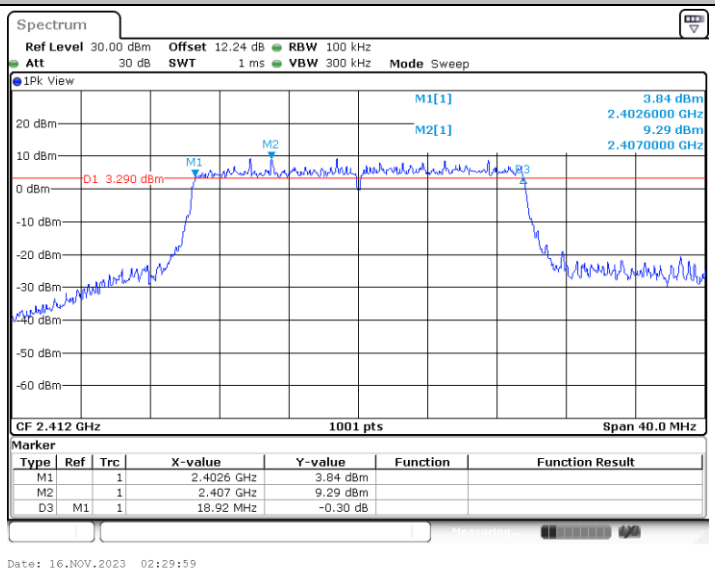

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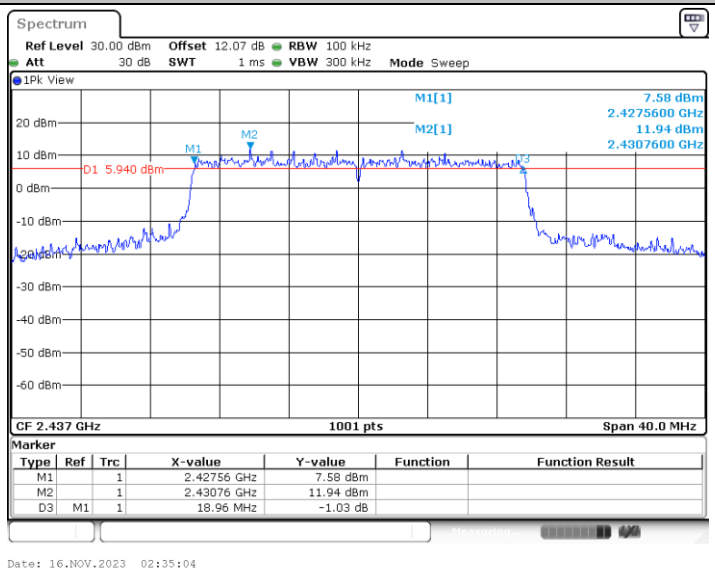

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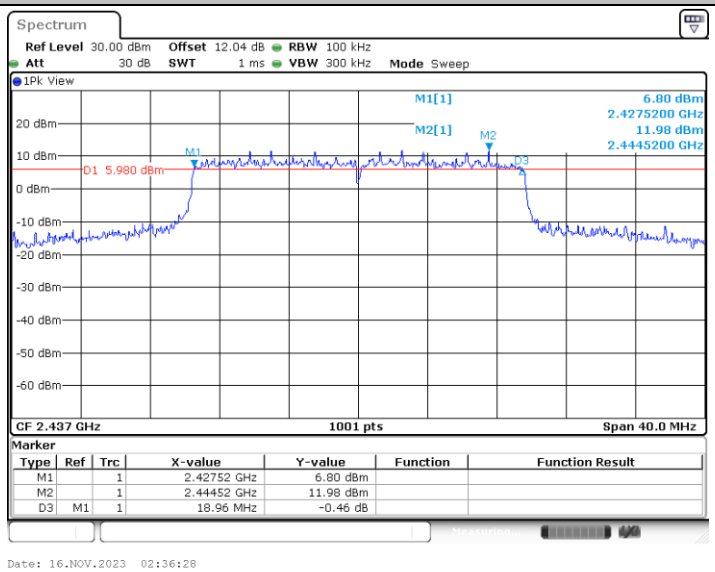

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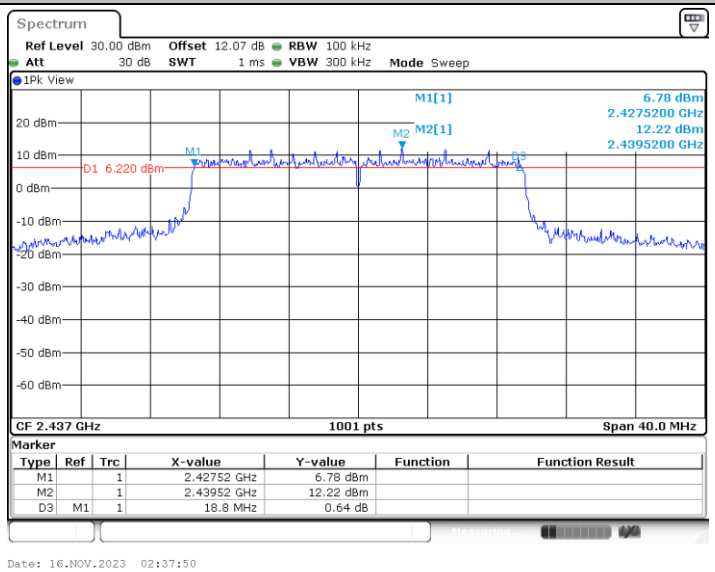

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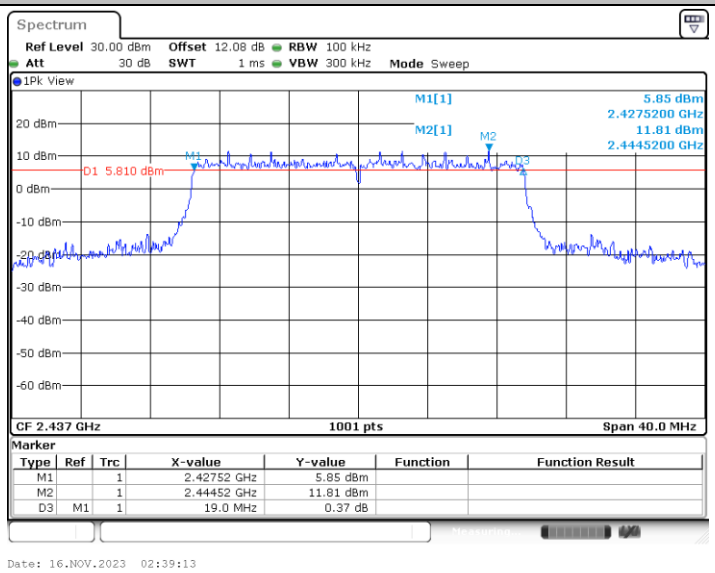

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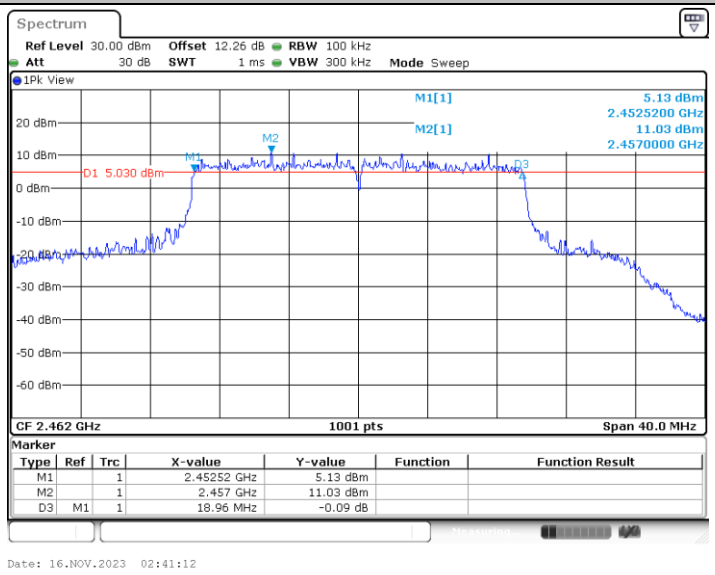

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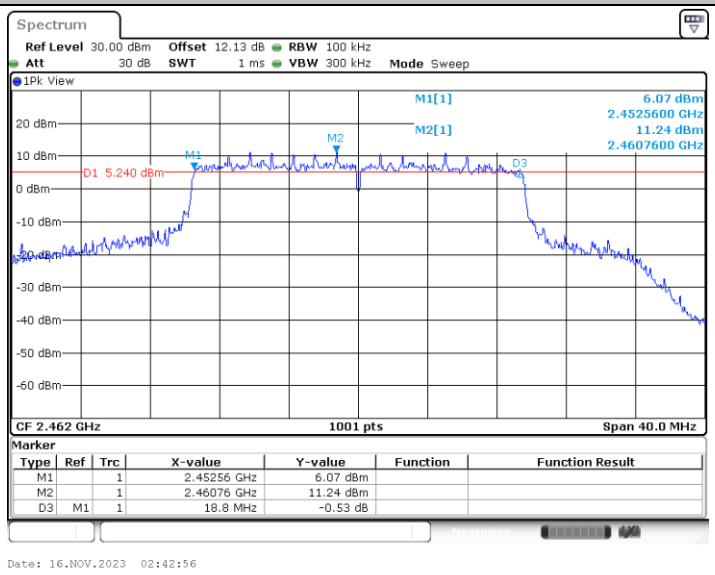

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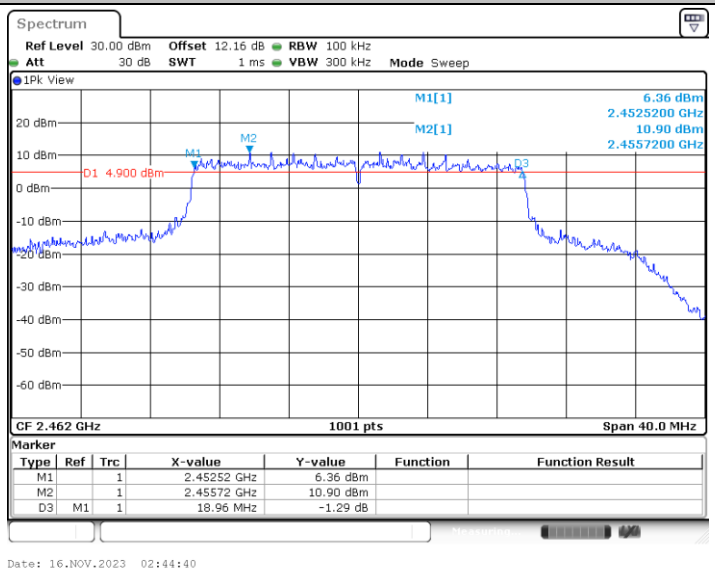

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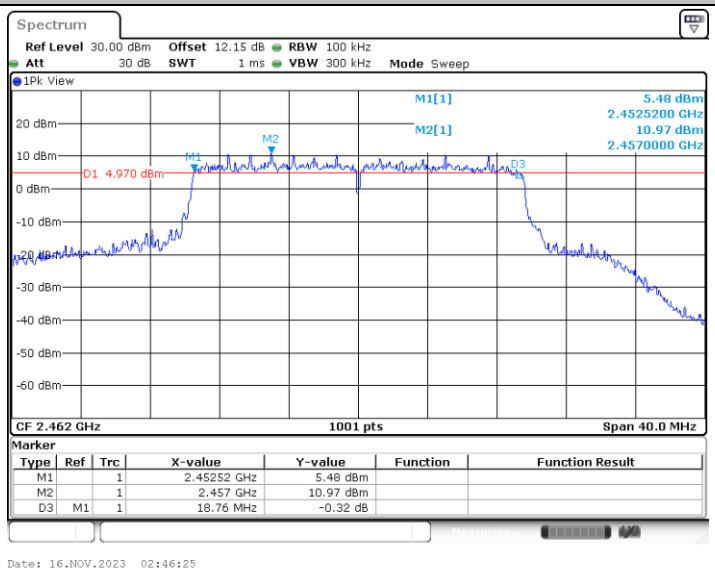

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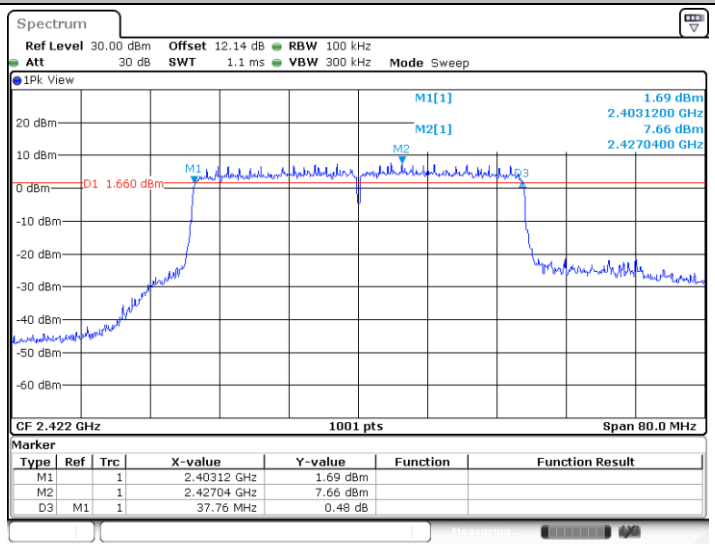

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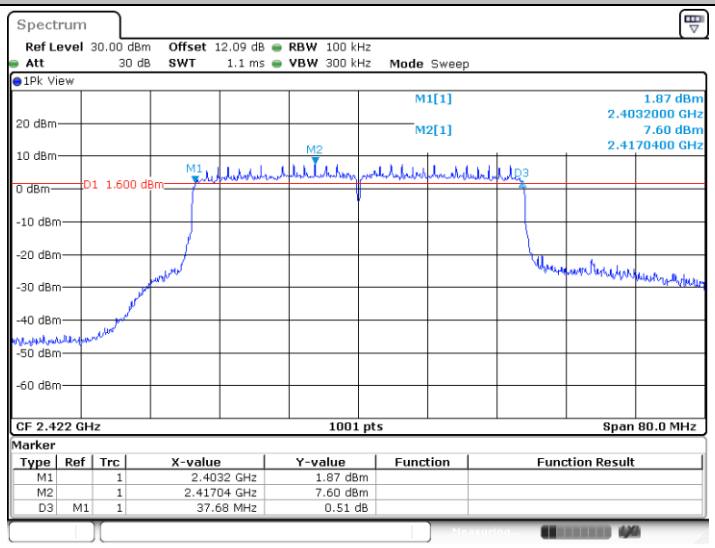

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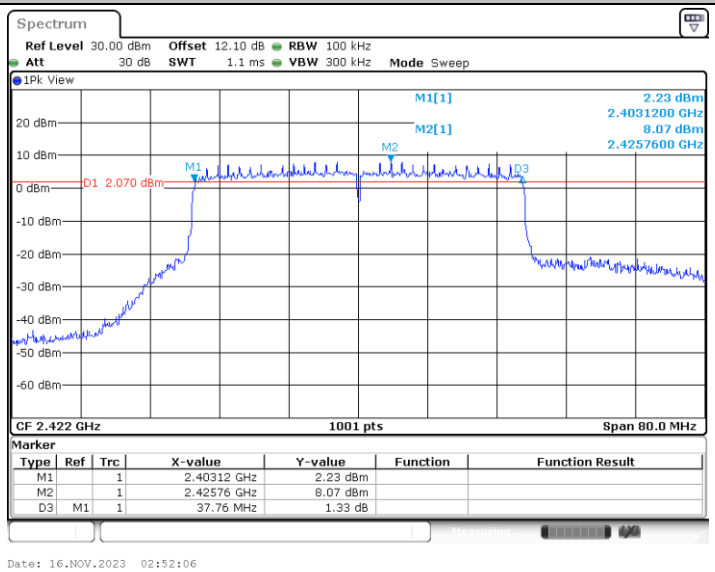

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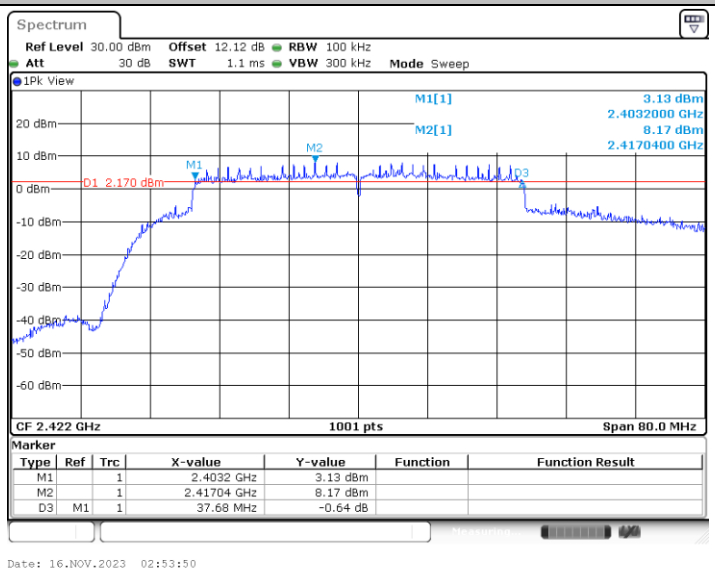

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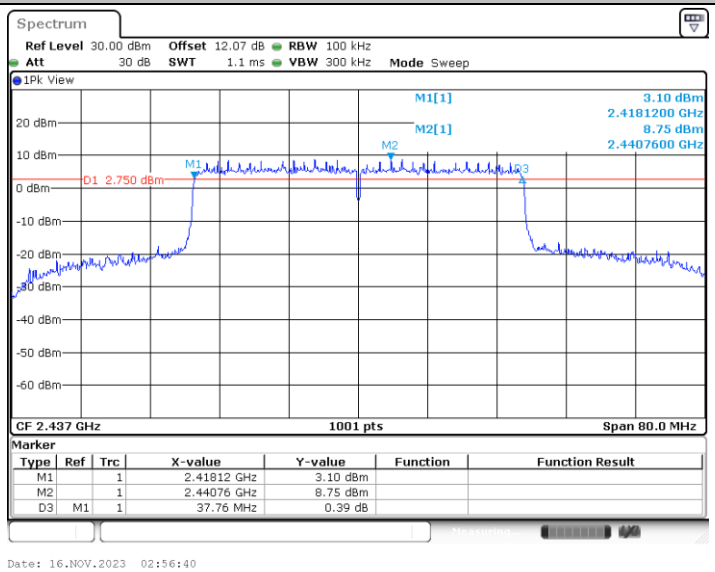

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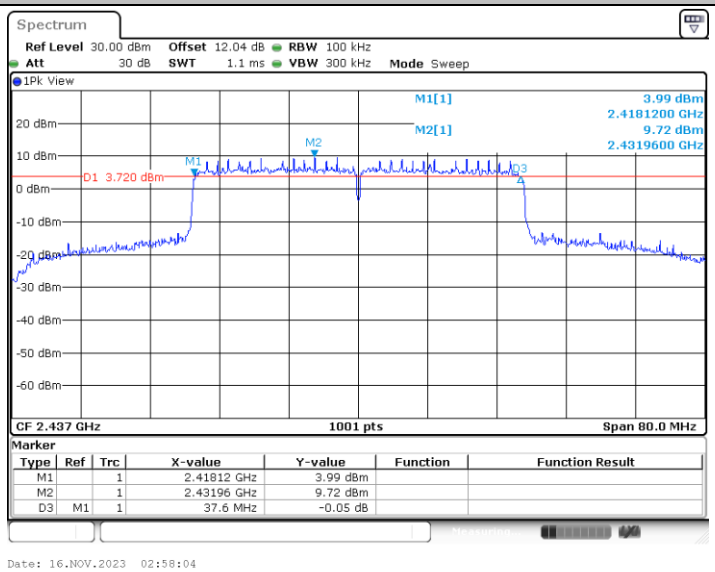

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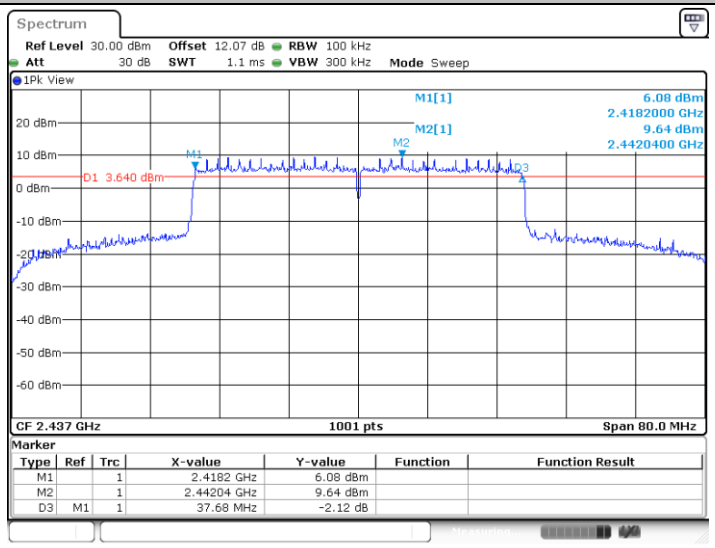

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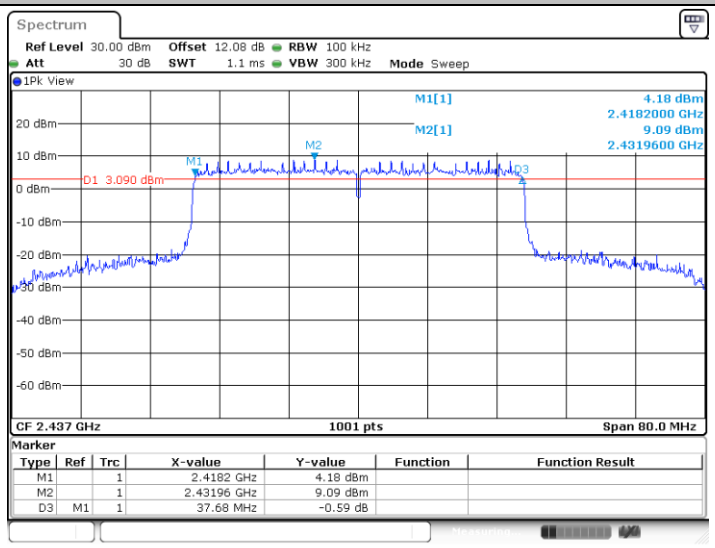

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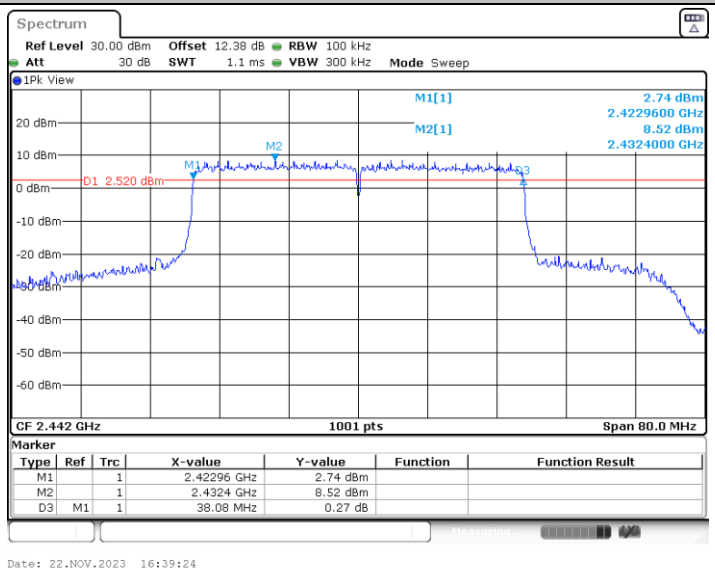

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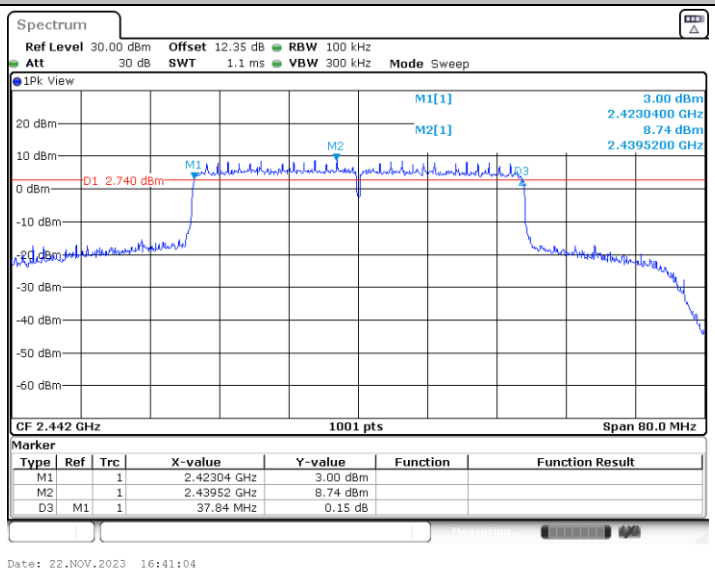

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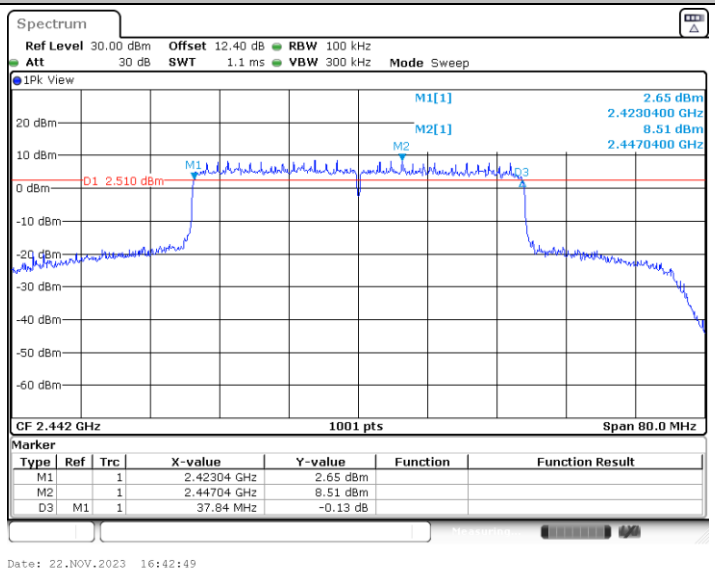

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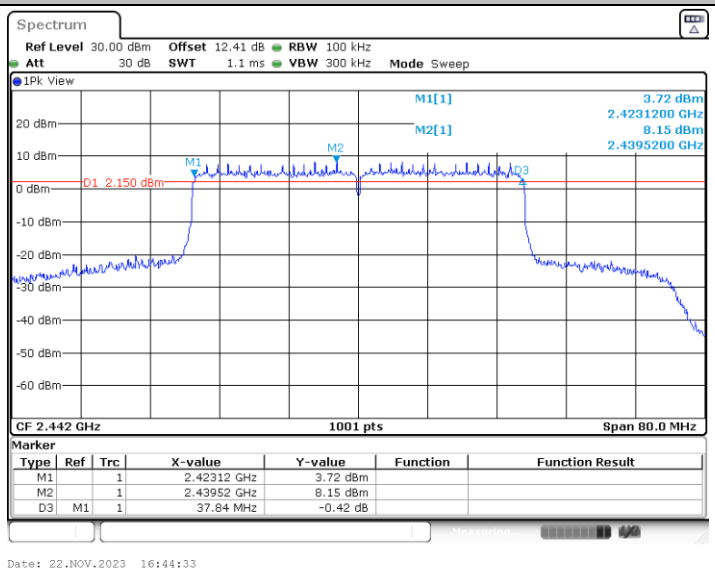

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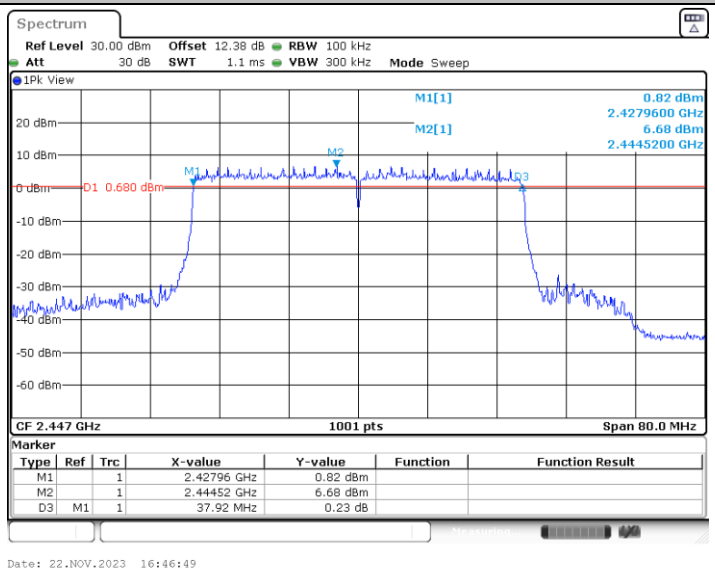

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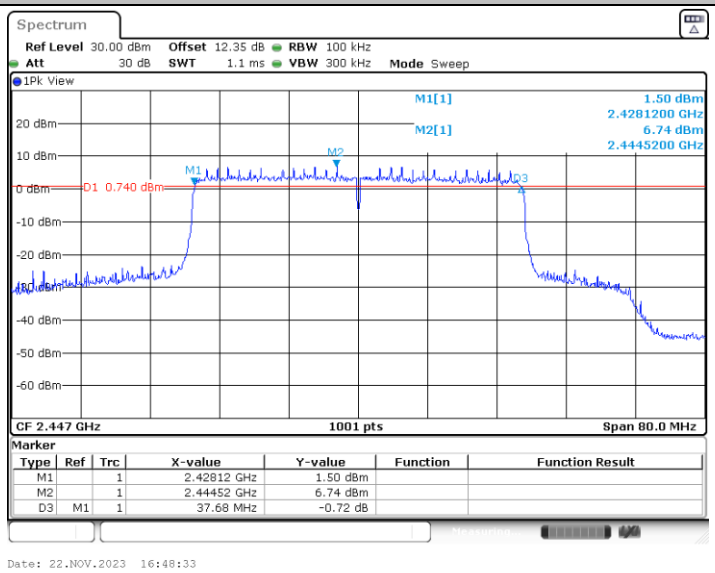

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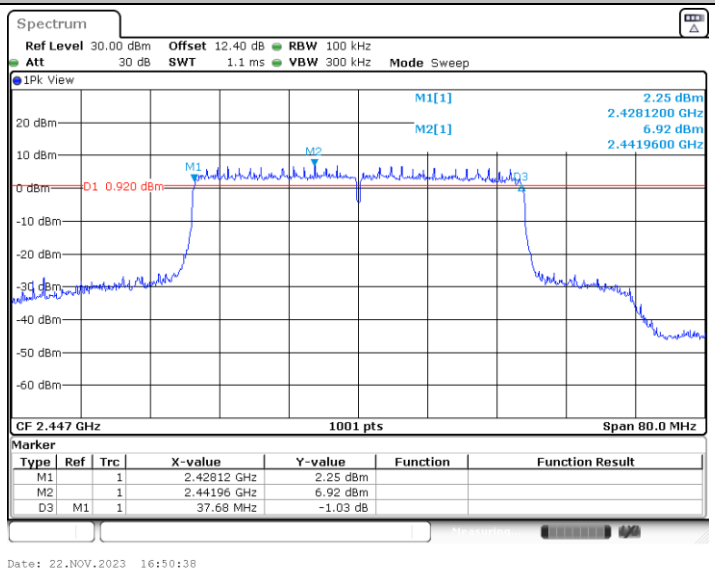

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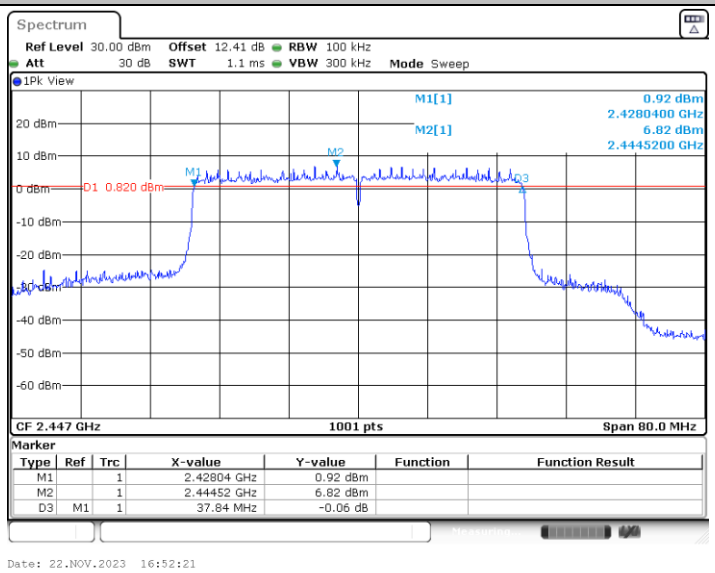

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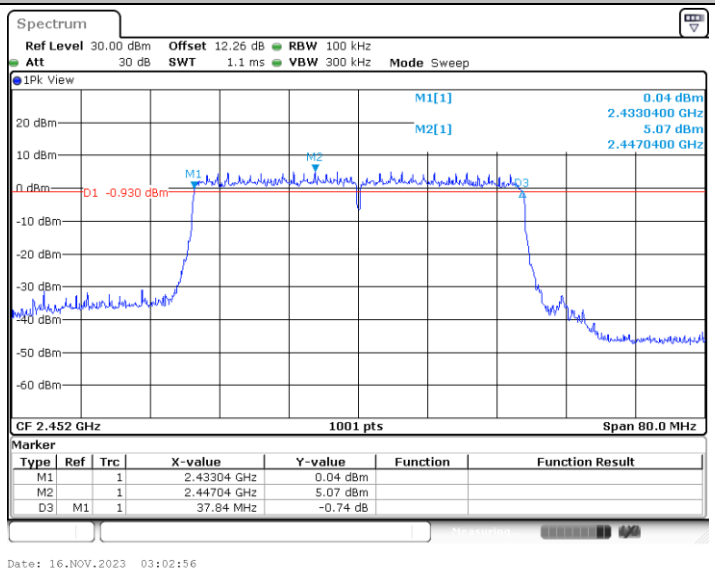

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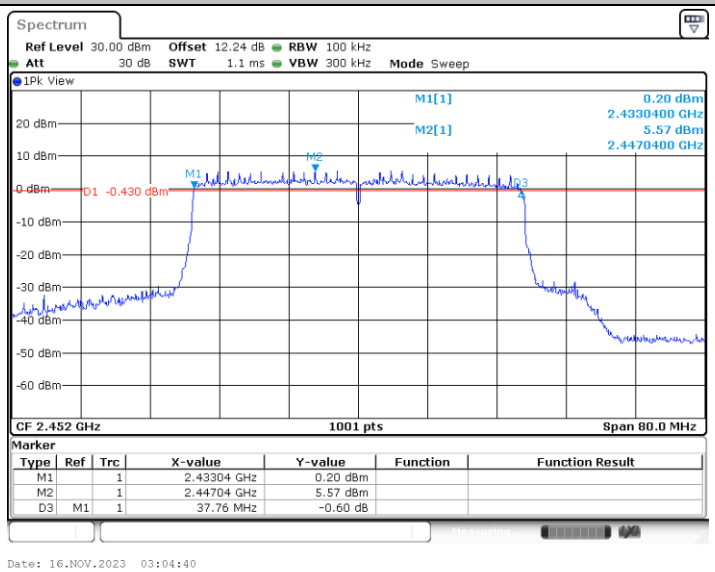

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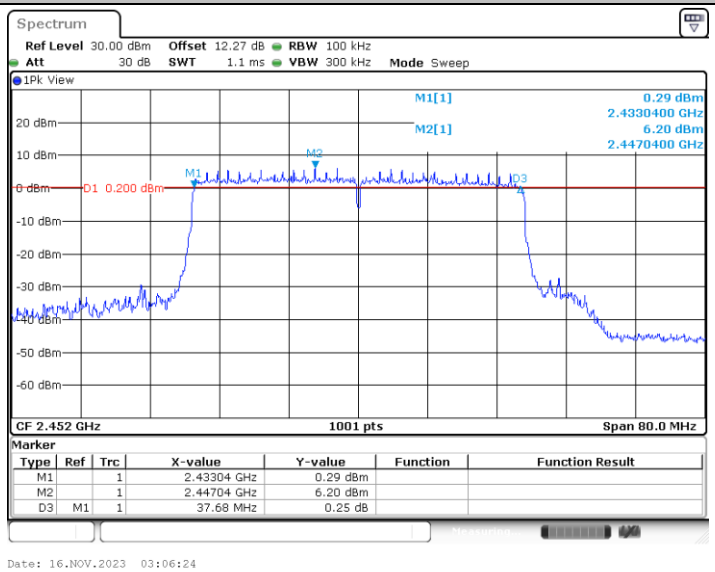

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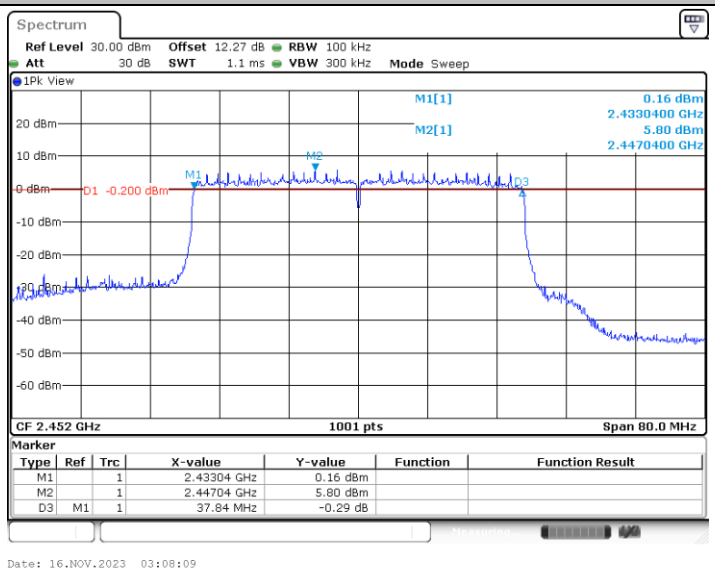


Occupied Channel Bandwidth

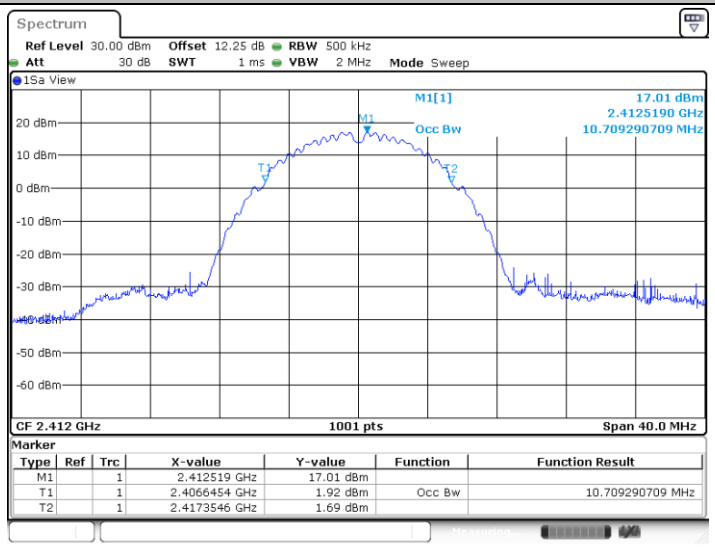
Test Result

TestMode	Antenna	Freq(MHz)	OCB [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
11B-CDD	Ant1	2412	10.709	2406.6454	2417.3546	---	---
	Ant2	2412	10.27	2406.8851	2417.1548	---	---
	Ant3	2412	10.749	2406.6454	2417.3946	---	---
	Ant4	2412	10.03	2407.0050	2417.0350	---	---
	Ant1	2437	10.669	2431.6454	2442.3147	---	---
	Ant2	2437	10.11	2431.9251	2442.0350	---	---
	Ant3	2437	10.39	2431.8052	2442.1948	---	---
	Ant4	2437	10.869	2431.5255	2442.3946	---	---
	Ant1	2462	10.509	2456.7652	2467.2747	---	---
	Ant2	2462	10.47	2456.6853	2467.1548	---	---
	Ant3	2462	9.99	2456.9251	2466.9151	---	---
	Ant4	2462	10.15	2456.9251	2467.0749	---	---
11G-CDD	Ant1	2412	18.581	2403.0889	2421.6703	---	---
	Ant2	2412	18.501	2403.0490	2421.5504	---	---
	Ant3	2412	18.062	2403.2088	2421.2707	---	---
	Ant4	2412	18.062	2403.1688	2421.2308	---	---
	Ant1	2437	18.741	2427.6494	2446.3906	---	---
	Ant2	2437	19.62	2427.1299	2446.7502	---	---
	Ant3	2437	19.58	2427.2897	2446.8701	---	---
	Ant4	2437	18.102	2427.8891	2445.9910	---	---
	Ant1	2462	18.342	2452.6494	2470.9910	---	---
	Ant2	2462	18.382	2452.4895	2470.8711	---	---
	Ant3	2462	18.861	2451.9700	2470.8312	---	---
	Ant4	2462	18.182	2452.6893	2470.8711	---	---
11AX20MIMO	Ant1	2412	19.341	2402.4096	2421.7502	---	---
	Ant2	2412	19.341	2402.4096	2421.7502	---	---
	Ant3	2412	19.301	2402.4096	2421.7103	---	---
	Ant4	2412	19.341	2402.4096	2421.7502	---	---
	Ant1	2437	19.7	2427.1698	2446.8701	---	---
	Ant2	2437	20.02	2426.9700	2446.9900	---	---
	Ant3	2437	19.82	2427.0500	2446.8701	---	---
	Ant4	2437	19.461	2427.2498	2446.7103	---	---
	Ant1	2462	19.461	2452.2098	2471.6703	---	---
	Ant2	2462	19.461	2452.1698	2471.6304	---	---

	Ant3	2462	19.66	2452.0100	2471.6703	---	---
	Ant4	2462	19.421	2452.2098	2471.6304	---	---
11AX40MIMO	Ant1	2422	38.042	2403.0589	2441.1009	---	---
	Ant2	2422	37.882	2403.1389	2441.0210	---	---
	Ant3	2422	37.962	2403.0589	2441.0210	---	---
	Ant4	2422	55.225	2401.0609	2456.2857	---	---
	Ant1	2437	38.282	2417.8991	2456.1808	---	---
	Ant2	2437	38.442	2417.8192	2456.2607	---	---
	Ant3	2437	38.601	2417.7393	2456.3407	---	---
	Ant4	2437	38.122	2417.8991	2456.0210	---	---
	Ant1	2442	37.962	2422.9790	2460.9411	---	---
	Ant2	2442	38.202	2422.8192	2461.0210	---	---
	Ant3	2442	38.202	2422.8991	2461.1009	---	---
	Ant4	2442	38.042	2422.9790	2461.0210	---	---
	Ant1	2447	37.962	2427.9790	2465.9411	---	---
	Ant2	2447	37.962	2427.9790	2465.9411	---	---
	Ant3	2447	37.962	2427.9790	2465.9411	---	---
	Ant4	2447	37.962	2427.9790	2465.9411	---	---
	Ant1	2452	37.882	2433.0589	2470.9411	---	---
	Ant2	2452	37.962	2432.9790	2470.9411	---	---
	Ant3	2452	37.882	2432.9790	2470.8611	---	---
	Ant4	2452	37.962	2432.9790	2470.9411	---	---

Test Graphs

11B-CDD_Ant1_2412



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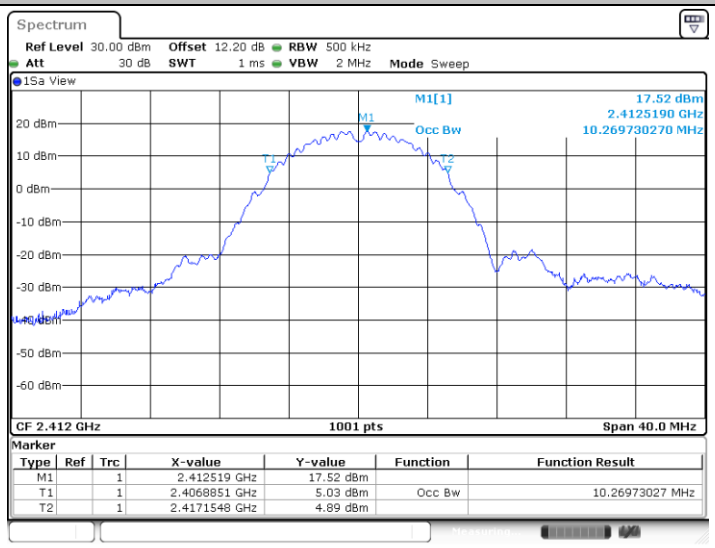
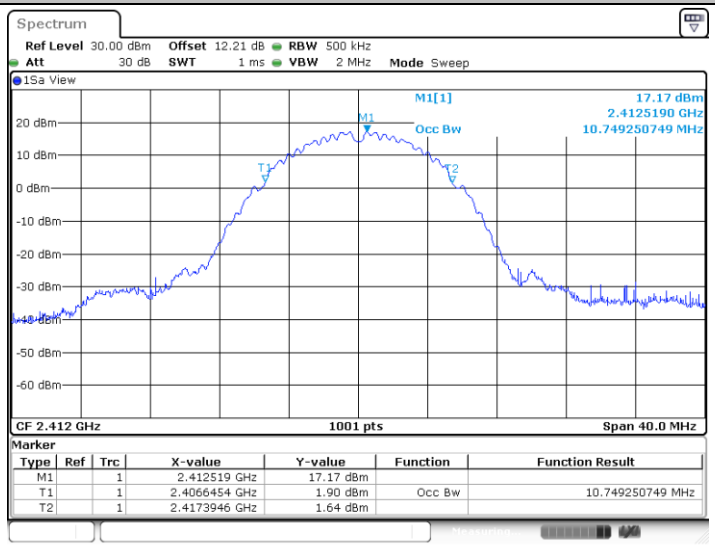
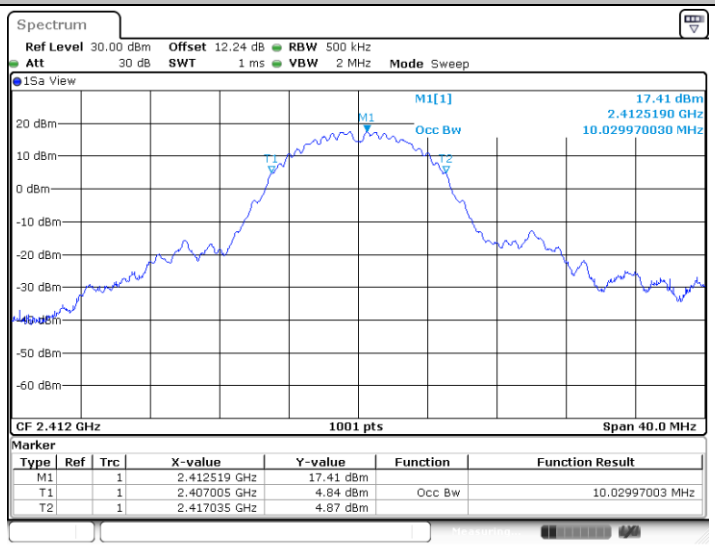


11B-CDD_Ant3_2412



11B-CDD_Ant4_2412



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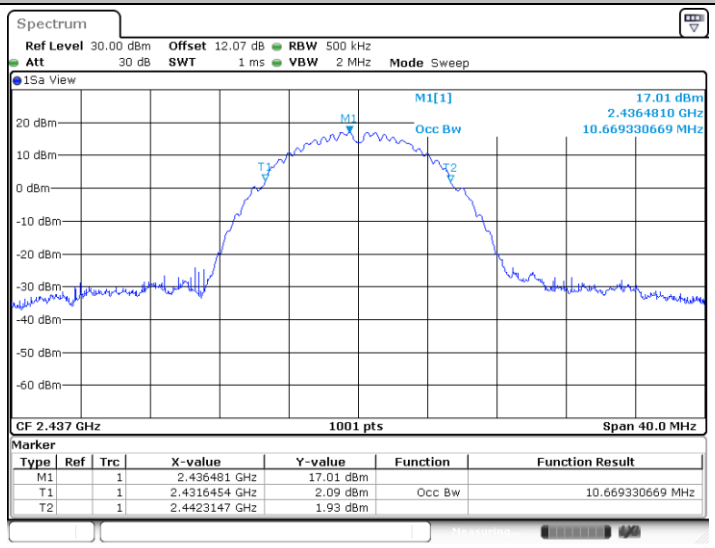

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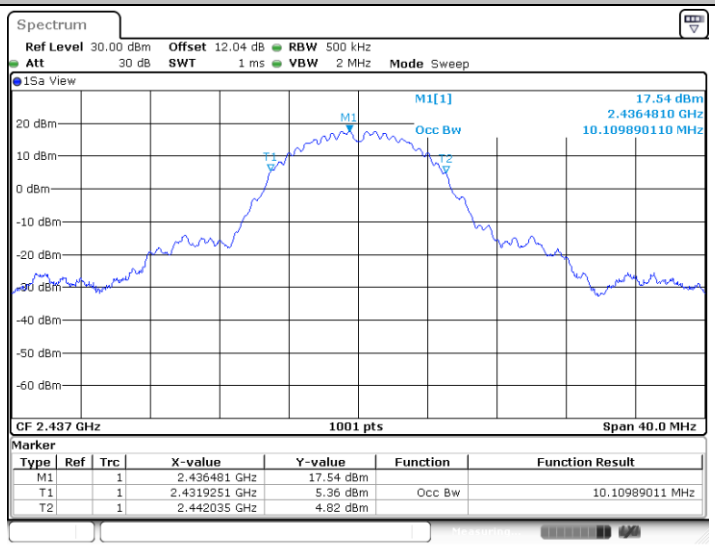

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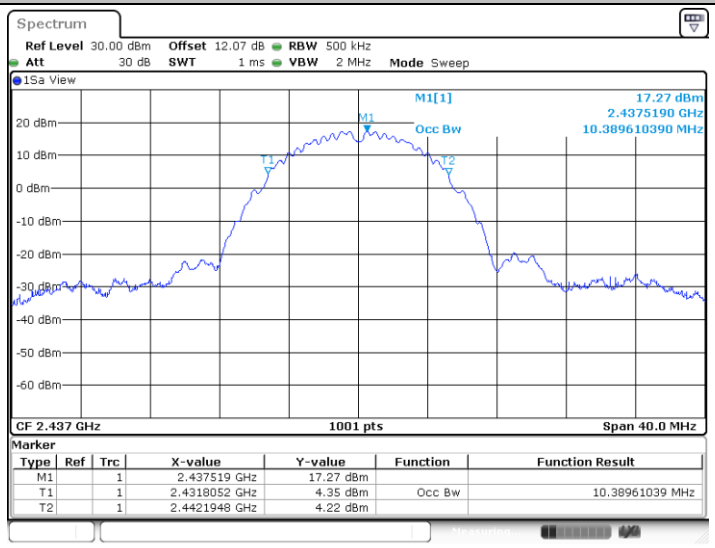

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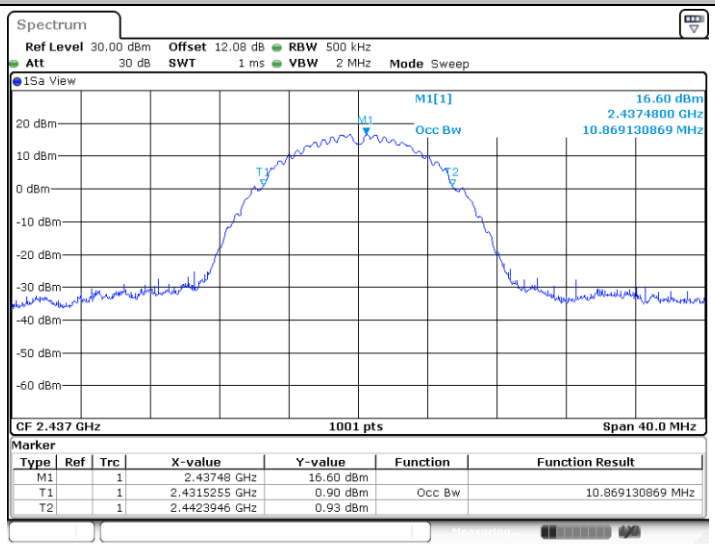
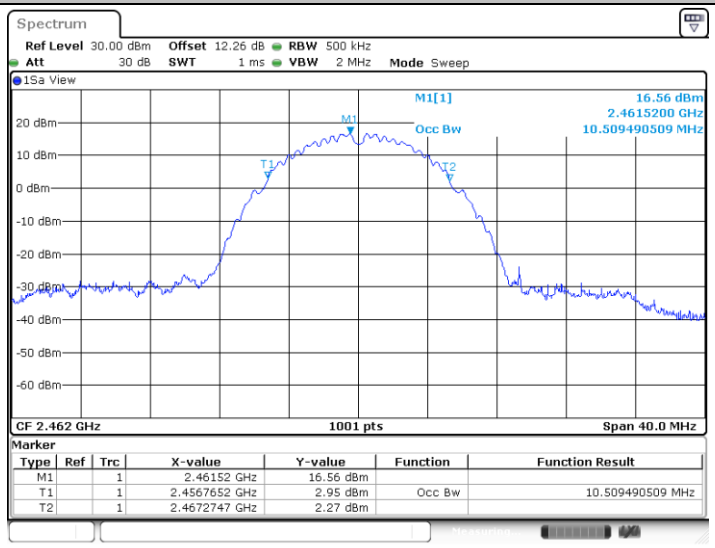


11B-CDD_Ant1_2462



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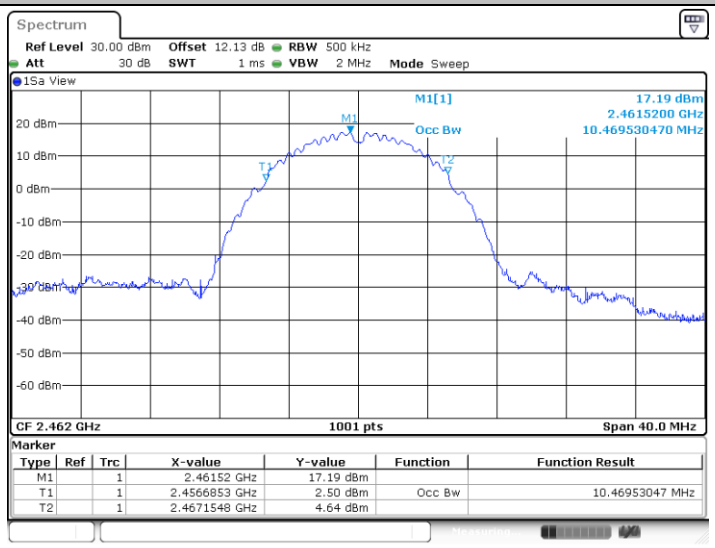

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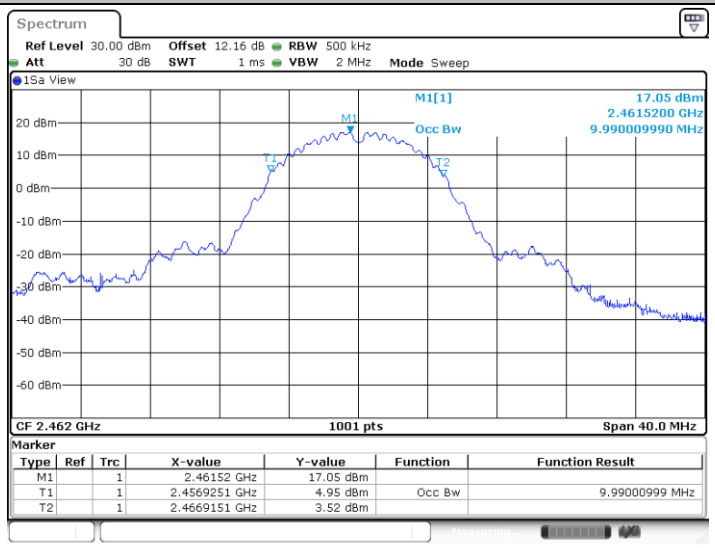

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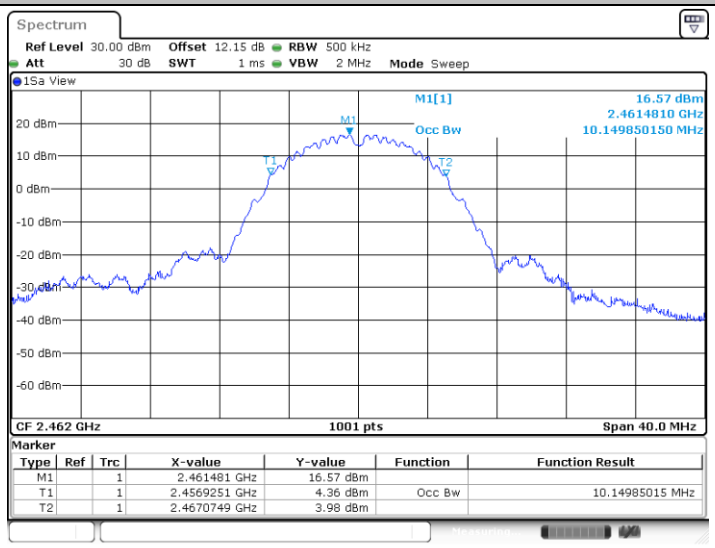

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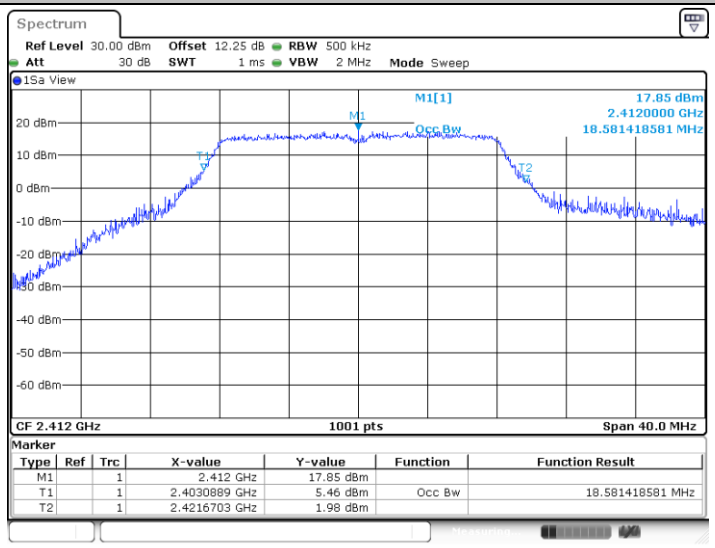

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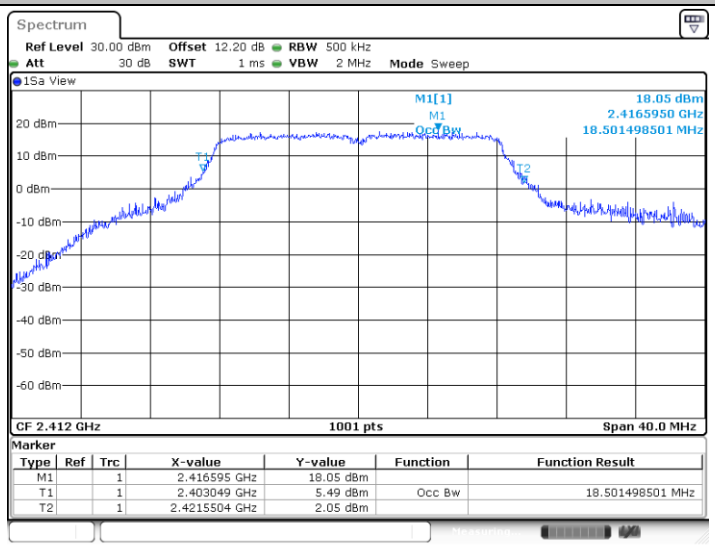

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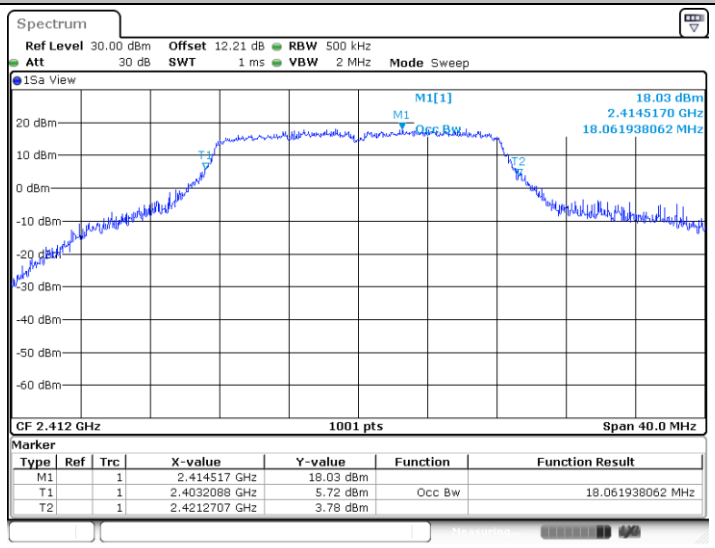

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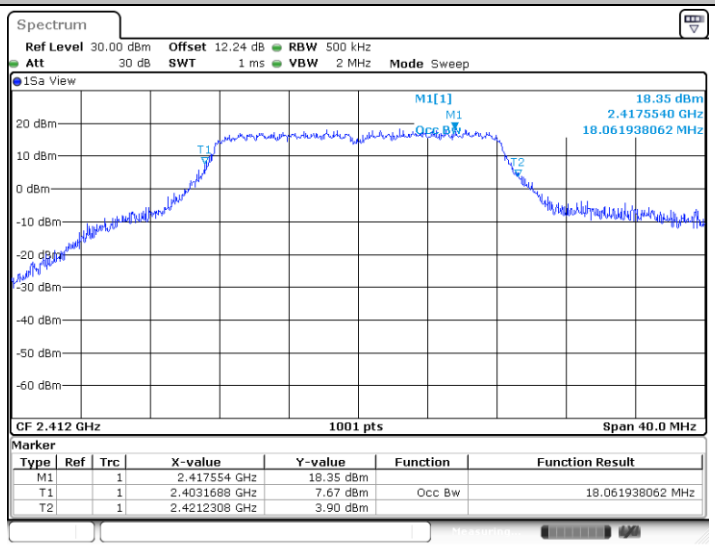

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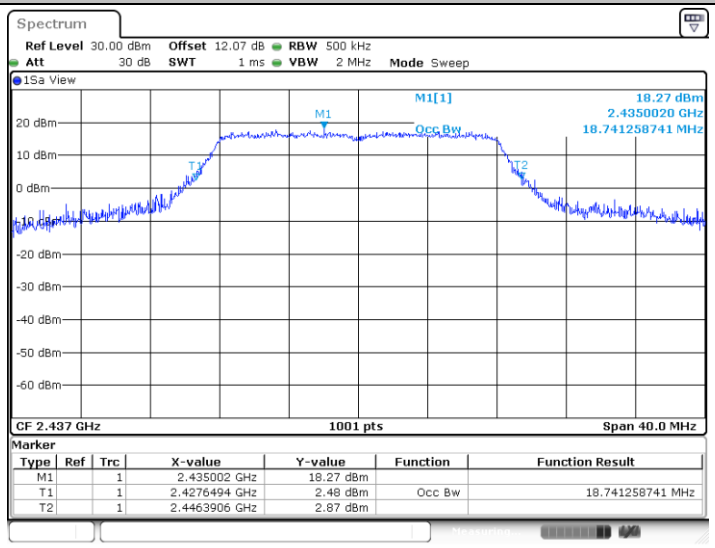

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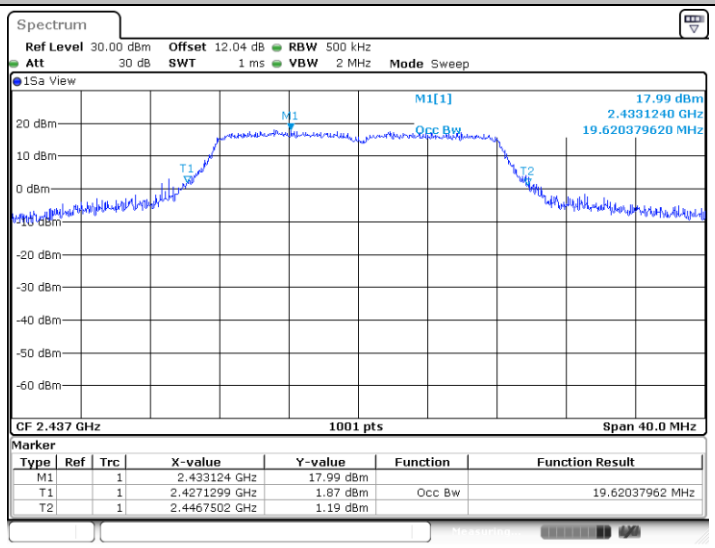

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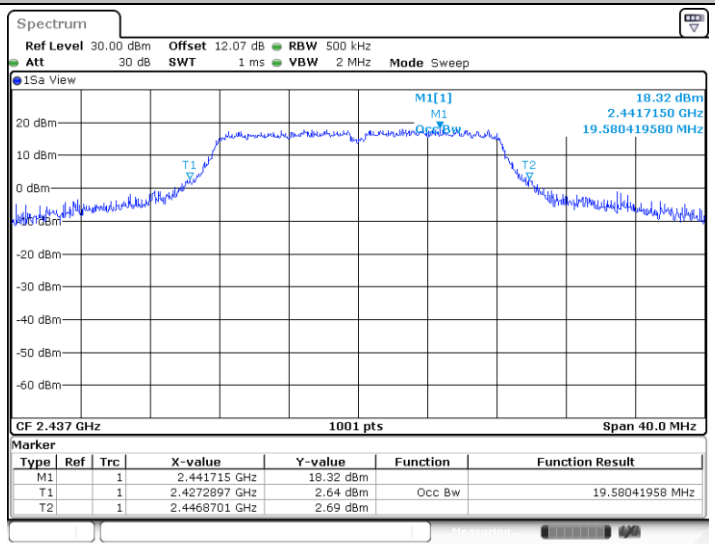

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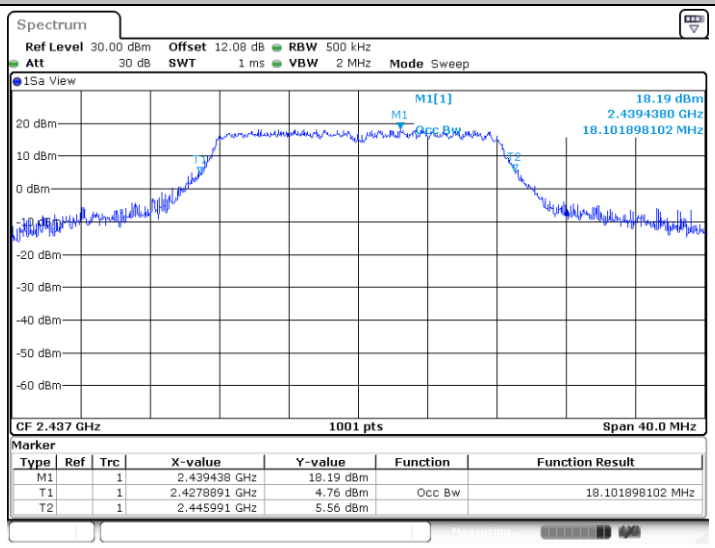

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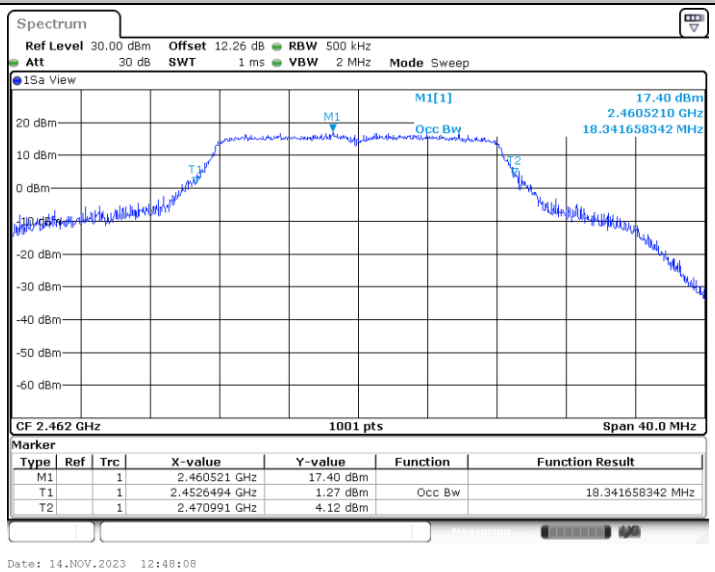

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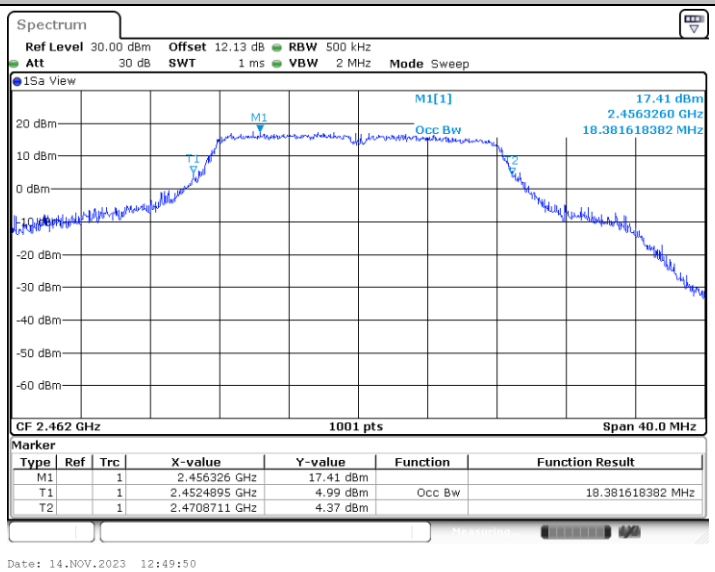

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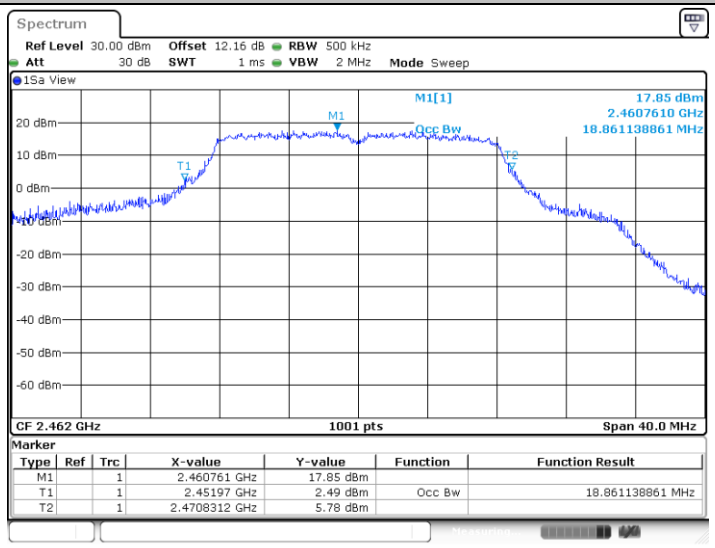

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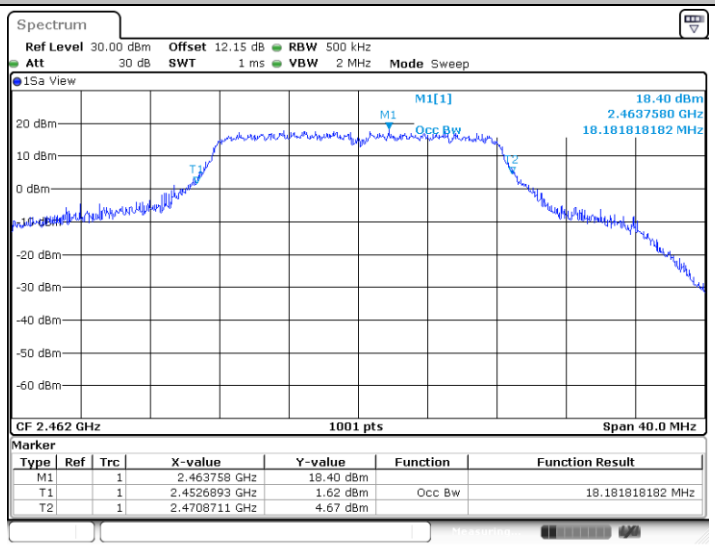

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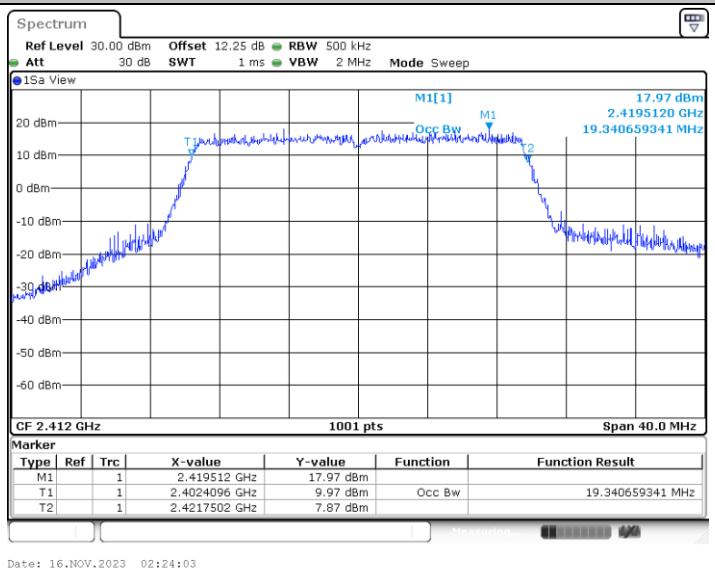

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