

Report No.: SEWA2301000005RG03

Rev.: 01

Page: 1 of 259

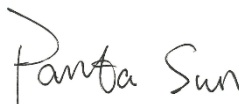
# TEST REPORT

**Application No.:** SEWA2301000005RG  
**Applicant:** Quectel Wireless Solutions Co., Ltd.  
**Address of Applicant:** Building 5, Shanghai Business Park Phase III (Area B), No.1016 Tianlin Road, Minhang District, Shanghai, China 200233  
**Manufacturer:** Quectel Wireless Solutions Co., Ltd.  
**Address of Manufacturer:** Building 5, Shanghai Business Park Phase III (Area B), No.1016 Tianlin Road, Minhang District, Shanghai, China 200233  
**EUT Description:** Wi-Fi & Bluetooth Module  
**Model No.:** AF51Y  
**Trade Mark:** Quectel  
**FCC ID:** XMR202303AF51Y  
**Standards:** FCC 47 CFR Part 2, Subpart J  
FCC 47 CFR Part 15, Subpart C  
**Date of Receipt:** 2023/01/09  
**Date of Test:** 2023/01/09 to 2023/02/23  
**Date of Issue:** 2023/02/23

<b>Test Result :</b>	<b>PASS *</b>
----------------------	---------------

\* In the configuration tested, the EUT detailed in this report complied with the standards specified above.

Authorized Signature:



Panta Sun  
Wireless Laboratory Manager



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Report No.: SEWA2301000005RG03  
 Rev.: 01  
 Page: 2 of 259

## 1 Version

Revision Record				
Version	Chapter	Date	Modifier	Remark
01		2023/02/23		Original

Prepared By	
	(Tizzy Song) / Test Engineer
Checked By	
	(Well Wei) / Reviewer



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Report No.: SEWA2301000005RG03

Rev.: 01

Page: 3 of 259

## 2 Test Summary

Test Item	FCC Rule No.	Test Method	Test Result	Result
Antenna Requirement	15.203/15.247(b)	--	Clause 4.1	PASS
AC Power Line Conducted Emission	15.207	ANSI C63.10 2013 Section 6.2	Clause 4.2	PASS
Duty Cycle	--	--	Clause 4.3	Reporting only
Conducted Output Power	15.247 (b)(3)	ANSI C63.10 2013 Section 11.9.2.3	Clause 4.4	PASS
DTS (6 dB) Bandwidth & 99% Occupied Bandwidth	15.247 (a)(2)	ANSI C63.10 2013 Section 11.8 Option 2 / 6.9.3	Clause 4.5	PASS
Power Spectral Density	15.247 (e)	ANSI C63.10 2013 Section 11.10.2	Clause 4.6	PASS
Band-edge for RF Conducted Emissions	15.247(d)	ANSI C63.10 2013 Section 11.11	Clause 4.7	PASS
RF Conducted Spurious Emissions	15.247(d)	ANSI C63.10 2013 Section 11.11	Clause 4.8	PASS
Radiated Spurious Emissions	15.247(d);15.205/15.209	ANSI C63.10 2013 Section 11.12	Clause 4.9	PASS
Restricted bands around fundamental frequency (Radiated Emission)	15.247(d);15.205/15.209	ANSI C63.10 2013 Section 11.12	Clause 4.10	PASS



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Report No.: SEWA2301000005RG03

Rev.: 01

Page: 4 of 259

## Contents

1	Version .....	2
2	Test Summary .....	3
3	General Information .....	5
3.1	Details of Client.....	5
3.2	Test Location .....	5
3.3	Test Facility .....	5
3.4	General Description of EUT .....	6
3.5	Test Environment and Mode .....	8
3.6	Description of Support Units .....	8
3.7	Worst-case configuration and mode.....	8
4	Test results and Measurement Data.....	9
4.1	Antenna Requirement .....	9
4.2	AC Power Line Conducted Emissions.....	11
4.3	Duty Cycle.....	15
4.4	Conducted Output Power .....	16
4.5	DTS (6 dB) Bandwidth & 99% Occupied Bandwidth .....	17
4.6	Power Spectral Density.....	18
4.7	Band-edge for RF Conducted Emissions .....	19
4.8	RF Conducted Spurious Emissions.....	20
4.9	Radiated Spurious Emissions .....	21
4.10	Restricted bands around fundamental frequency.....	25
5	Measurement Uncertainty (95% confidence levels, k=2).....	28
6	Equipment List.....	29
7	Photographs - Setup Photos.....	32



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Report No.: SEWA2301000005RG03

Rev.: 01

Page: 5 of 259

### 3 General Information

#### 3.1 Details of Client

Applicant:	Quectel Wireless Solutions Co., Ltd.
Address of Applicant:	Building 5, Shanghai Business Park Phase III (Area B), No.1016 Tianlin Road, Minhang District, Shanghai, China 200233
Manufacturer:	Quectel Wireless Solutions Co., Ltd.
Address of Manufacturer:	Building 5, Shanghai Business Park Phase III (Area B), No.1016 Tianlin Road, Minhang District, Shanghai, China 200233

#### 3.2 Test Location

Company:	SGS-CSTC Standards Technical Services (Suzhou) Co., Ltd.
Address:	South of No. 6 Plant, No. 1, Runsheng Road, Suzhou Industrial Park, Suzhou Area, China (Jiangsu) Pilot Free Trade Zone
Post code:	215000
Test engineer:	Ives Cheng, Tizzy Song

#### 3.3 Test Facility

The test facility is recognized, certified, or accredited by the following organizations:

• **A2LA (Certificate No. 6336.01)**

SGS-CSTC STANDARDS TECHNICAL SERVICES (SUZHOU) CO., LTD. is accredited by the American Association for Laboratory Accreditation(A2LA). Certificate No. 6336.01.

• **Innovation, Science and Economic Development Canada**

SGS-CSTC STANDARDS TECHNICAL SERVICES (SUZHOU) CO., LTD. has been recognized by ISED as an accredited testing laboratory.

CAB identifier: CN0120.

IC#: 27594.

• **FCC –Designation Number: CN1312**

SGS-CSTC STANDARDS TECHNICAL SERVICES (SUZHOU) CO., LTD. has been recognized as an accredited testing laboratory.

Designation Number: CN1312.

Test Firm Registration Number: 717327



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Report No.: SEWA2301000005RG03

Rev.: 01

Page: 6 of 259

### 3.4 General Description of EUT

EUT Description:	Wi-Fi & Bluetooth Module		
Model No.:	AF51Y		
Trade Mark:	Quectel		
Hardware Version:	R1.0		
Software Version:	NA		
SN:	RF Conducted	D1A22KI1A000024	
	RSE & AC power line	D1A22KI19000040	
Operation Frequency:	802.11b/g/n(HT20):	2412MHz to 2462MHz	
	802.11n(HT40):	2422MHz to 2452MHz	
Modulation Type:	802.11b:	DSSS (DBPSK, DQPSK, CCK)	
	802.11g/n:	OFDM (BPSK, QPSK, 16QAM, 64QAM)	
Number of Channels:	802.11b/g/n(HT20): 11 802.11n(HT40): 7		
Channel Spacing:	5MHz		
Smart System:	<input checked="" type="checkbox"/> SISO	802.11b/g/n	
	<input checked="" type="checkbox"/> MIMO	STBC: 802.11n: 2Tx & 2Rx	
		TXBF: 802.11n: 2Tx & 2Rx	
	<input checked="" type="checkbox"/> Diversity	802.11g: 2Tx & 2Rx	
Antenna Type:	External Antenna		
Antenna Gain:	3.44dBi(Ant0); 5.26dBi(Ant1)		
	Note: The antenna gain are derived from the gain information report provided by the manufacturer.		
RF Cable:	1.0dB		
Remark: As above information is provided and confirmed by the applicant. SGS is not liable to the accuracy, suitability, reliability or/and integrity of the information.			



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Report No.: SEWA2301000005RG03

Rev.: 01

Page: 7 of 259

Operation Frequency of each channel (802.11b/g/n HT20)							
Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency
1	2412MHz	4	2427MHz	7	2442MHz	10	2457MHz
2	2417MHz	5	2432MHz	8	2447MHz	11	2462MHz
3	2422MHz	6	2437MHz	9	2452MHz		
Operation Frequency of each channel (802.11n HT40)							
Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency
3	2422MHz	6	2437MHz	9	2452MHz		
4	2427MHz	7	2442MHz				
5	2432MHz	8	2447MHz				



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Report No.: SEWA2301000005RG03

Rev.: 01

Page: 8 of 259

### 3.5 Test Environment and Mode

Environment Parameter	101.0 kPa Selected Values During Tests	
Relative Humidity	44-46 % RH Ambient	
Value	Temperature(°C)	Voltage(V)
NTNV	22~25	3.8
Remark: NV: Normal Voltage NT: Normal Temperature		

### 3.6 Description of Support Units

Description	Manufacturer	Model No.
Motherboard	Quectel	NA
Remark: all above the information of table are provided by client.		

### 3.7 Worst-case configuration and mode

Low data rate was used to test on antenna port conducted tests and radiated spurious emissions since it has the highest maximum power. Following are the worst-case data rates set for test:

Modulation Type	SISO - Data Rate	CDD/MIMO - Data Rate
802.11b	1 Mbps	/
802.11g	6 Mbps	12 Mbps
802.11n (HT 20)	MCS0 (6.5 Mbps)	MCS0 (13 Mbps)
802.11n (HT 40)	MCS0 (13.5 Mbps)	MCS0 (27 Mbps)



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## 4 Test results and Measurement Data

### 4.1 Antenna Requirement

<b>Standard requirement:</b>	47 CFR Part 15C Section 15.203 /247(b)
<p>15.203 requirement: An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.</p> <p>15.247(b) (4) requirement: The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.</p>	
<p>The antenna is External Antenna on the main PCB and no consideration of replacement. The best case gain of the antenna is 3.44dBi(Ant0); 5.26dBi(Ant1)*</p> <p><i>*Note:</i> <i>The antenna gain are derived from the gain information report provided by the manufacturer.</i></p> <p><i>Remark:</i> <i>As above information is provided and confirmed by the applicant. SGS is not liable to the accuracy, suitability, reliability or/and integrity of the information.</i></p>	



Report No.: SEWA2301000005RG03

Rev.: 01

Page: 10 of 259

## Cyclic Delay Diversity (CDD) System:

FCC KDB 662911 D01 Multiple Transmitter Output v02r01

If all antennas have the same gain,  $G_{ANT}$ , Directional gain =  $G_{ANT}$  + Array Gain, where Array Gain is as follows.

- For power measurements on IEEE 802.11 devices:

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

Array Gain = 0 dB (i.e., no array gain) for channel widths  $\geq 40$  MHz for any  $N_{ANT}$ ;

Array Gain =  $5 \log(N_{ANT}/N_{SS}=1)$  dB or 3 dB, whichever is less, for 20-MHz channel widths with  $N_{ANT} \geq 5$ .

Unequal antenna gains, with equal transmit powers. For antenna gains given by  $G_1, G_2, \dots, G_N$  dBi

- If transmit signals are correlated, then

Directional gain =  $10 \log[(10^{G_1/20} + 10^{G_2/20} + \dots + 10^{G_N/20})^2 / N_{ANT}]$  dBi [Note the "20"s in the denominator of each exponent and the square of the sum of terms; the object is to combine the signal levels coherently.]

- If all transmit signals are completely uncorrelated, then

Directional gain =  $10 \log[(10^{G_1/10} + 10^{G_2/10} + \dots + 10^{G_N/10}) / N_{ANT}]$  dBi

The Power and PSD limit should be modified if the directional gain of eut is over 6dBi.

Power Limit Reduction =

The EUT supports CDD System.

Unequal antenna gain:

ANT Gain0 (dBi)	ANT Gain1 (dBi)	Power DG (dBi)	PSD DG (dBi)	Power Limit Reduction(dB)	PSD Limit Reduction(dB)
3.44	5.26	4.44	7.41	0	1.41

Power Limit Reduction = Directional gain – 6dBi, (Directional gain < 6dBi ) =0

PSD Limit Reduction = Directional gain – 6dBi, (Directional gain > 6dBi ) =7.41 – 6 = 1.41



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Report No.: SEWA2301000005RG03

Rev.: 01

Page: 11 of 259

## 4.2 AC Power Line Conducted Emissions

Test Requirement:	47 CFR Part 15C Section 15.207		
Test Method:	ANSI C63.10: 2013 Section 6.2		
Test Frequency Range:	150kHz to 30MHz		
Receiver Setup:	RBW = 9kHz, VBW = 30kHz		
Limit:	Frequency range (MHz)	Limit (dBuV)	
		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.			
Test Procedure:	<p>1) The mains terminal disturbance voltage test was conducted in a shielded room.</p> <p>2) The EUT was connected to AC power source through a LISN 1 (Line Impedance Stabilization Network) which provides a 50Ω/50μH + 5Ω linear impedance. The power cables of all other units of the EUT were connected to a second LISN 2, which was bonded to the ground reference plane in the same way as the LISN 1 for the unit being measured. A multiple socket outlet strip was used to connect multiple power cables to a single LISN provided the rating of the LISN was not exceeded.</p> <p>3) The tabletop EUT was placed upon a non-metallic table 0.8m above the ground reference plane. And for floor-standing arrangement, the EUT was placed on the horizontal ground reference plane,</p> <p>4) The test was performed with a vertical ground reference plane. The rear of the EUT shall be 0.4 m from the vertical ground reference plane. The vertical ground reference plane was bonded to the horizontal ground reference plane. The LISN 1 was placed 0.8 m from the boundary of the unit under test and bonded to a ground reference plane for LISNs mounted on top of the ground reference plane. This distance was between the closest points of the LISN 1 and the EUT. All other units of the EUT and associated equipment was at least 0.8 m from the LISN 2. In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.10: 2013 on conducted measurement.</p>		



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Report No.: SEWA2301000005RG03

Rev.: 01

Page: 12 of 259

Test Setup:	
Exploratory Test Mode:	<p>Transmitting with all kind of modulations, data rates at lowest, middle and highest channel.</p> <p>Charge + Transmitting mode.</p>
Final Test Mode:	<p>Refer to section 3.7 for details.</p> <p>Only the worst case is recorded in the report.</p>
Instruments Used:	Refer to section 6 for details.
Test Results:	Pass



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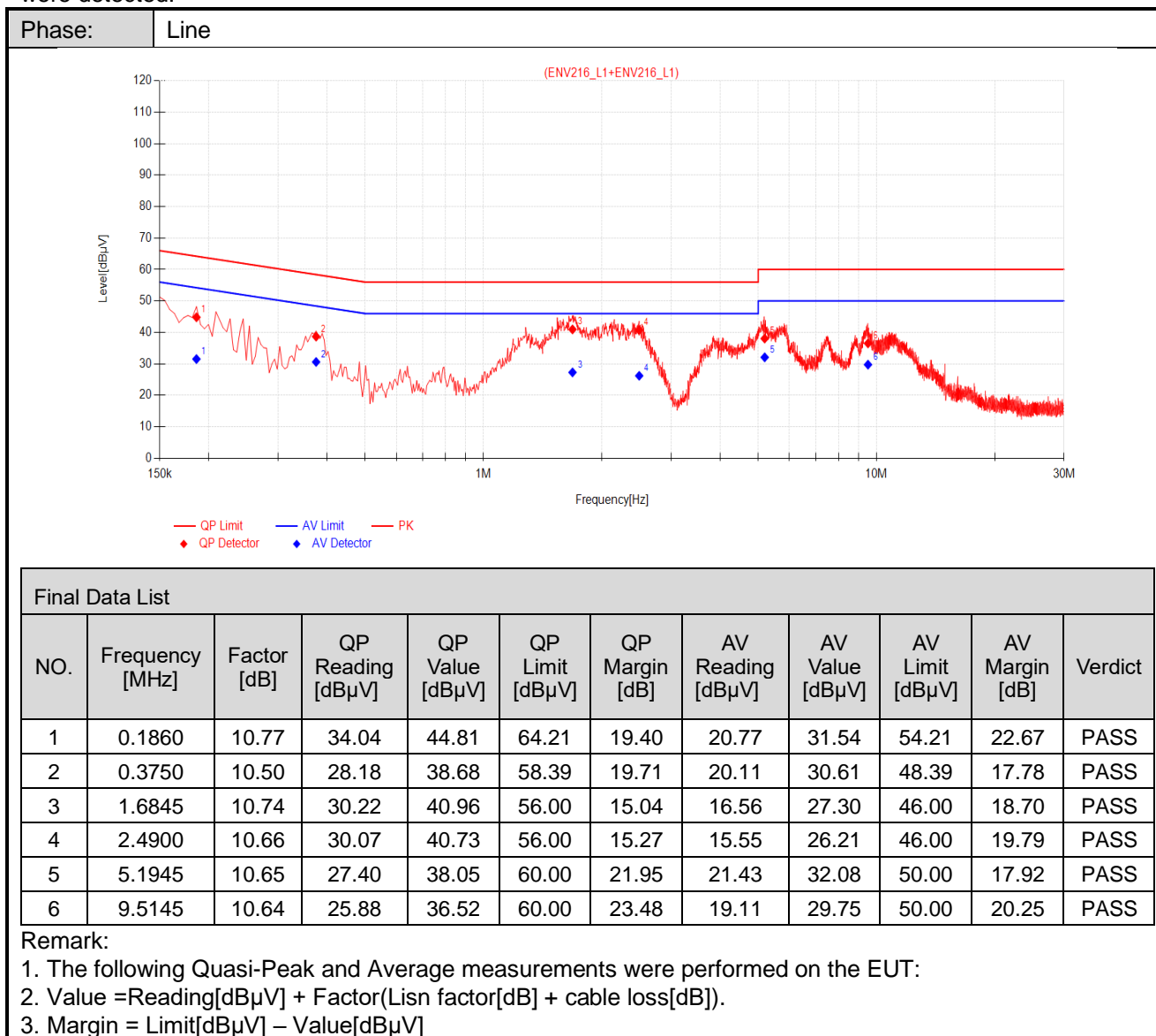
Rev.: 01

Page: 13 of 259

### Measurement Data

An initial pre-scan was performed on the live and neutral lines with peak detector.

Quasi-Peak and Average measurement were performed at the frequencies with maximized peak emission were detected.



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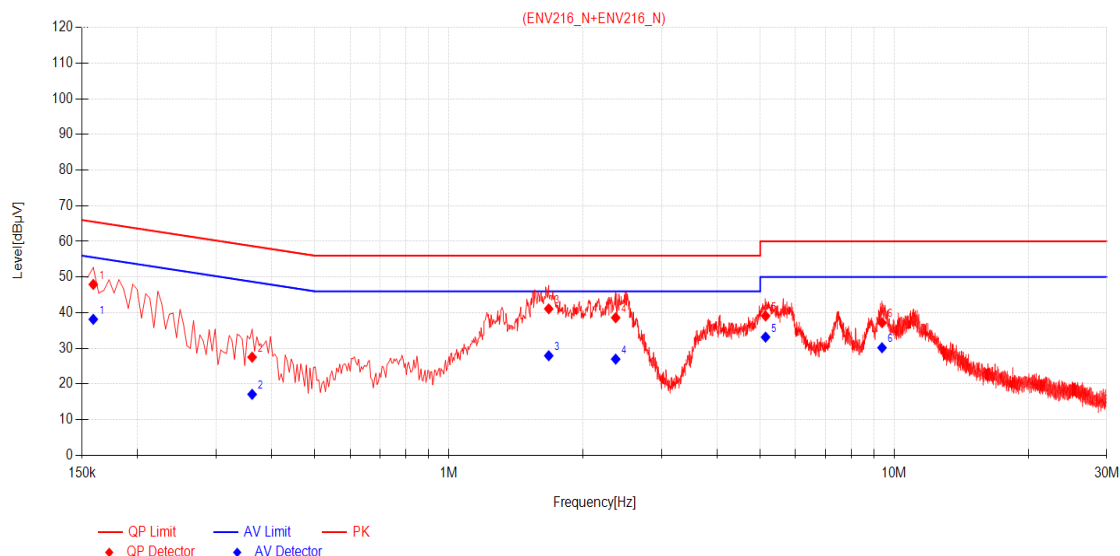


Report No.: SEWA2301000005RG03

Rev.: 01

Page: 14 of 259

Phase: Neutral



## Final Data List

NO.	Frequency [MHz]	Factor [dB]	QP Reading [dBμV]	QP Value [dBμV]	QP Limit [dBμV]	QP Margin [dB]	AV Reading [dBμV]	AV Value [dBμV]	AV Limit [dBμV]	AV Margin [dB]	Verdict
1	0.1590	10.72	37.21	47.93	65.52	17.59	27.42	38.14	55.52	17.38	PASS
2	0.3615	10.81	16.72	27.53	58.69	31.16	6.30	17.11	48.69	31.58	PASS
3	1.6755	10.77	30.31	41.08	56.00	14.92	17.17	27.94	46.00	18.06	PASS
4	2.3685	10.77	27.82	38.59	56.00	17.41	16.21	26.98	46.00	19.02	PASS
5	5.1405	10.63	28.46	39.09	60.00	20.91	22.52	33.15	50.00	16.85	PASS
6	9.3885	10.64	26.55	37.19	60.00	22.81	19.53	30.17	50.00	19.83	PASS

## Remark:

1. The following Quasi-Peak and Average measurements were performed on the EUT:
2. Value = Reading[dBμV] + Factor(Lin factor[dB] + cable loss[dB]).
3. Margin = Limit[dBμV] – Value[dBμV]



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Report No.: SEWA2301000005RG03

Rev.: 01

Page: 15 of 259

### 4.3 Duty Cycle

The detailed test data see: **Appendix**



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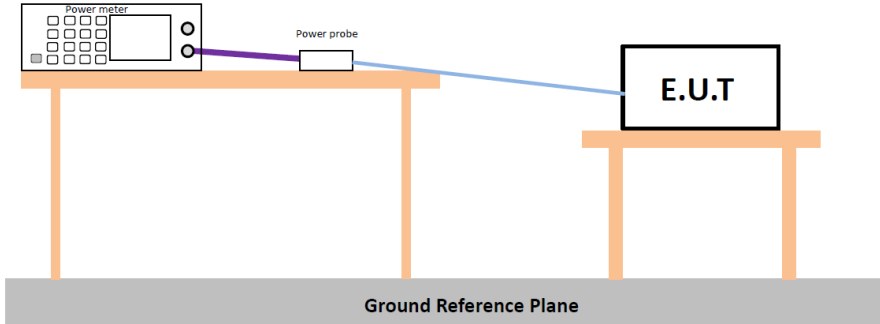
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Report No.: SEWA2301000005RG03

Rev.: 01

Page: 16 of 259

## 4.4 Conducted Output Power

Test Requirement:	47 CFR Part 15C Section 15.247 (b)(3)
Test Method:	ANSI C63.10 :2013 Section11.9.2.3
Test Setup:	 <p>* Test with power meter (Detector function: Peak)</p>
Test Instruments:	Refer to section 6 for details.
Exploratory Test Mode:	Transmitting with all kind of modulations, data rates
Final Test Mode:	Refer to section 3.7 for details.
Limit:	30dBm
Test Results:	Pass
The detailed test data see: <b>Appendix</b>	



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Report No.: SEWA2301000005RG03

Rev.: 01

Page: 17 of 259

## 4.5 DTS (6 dB) Bandwidth & 99% Occupied Bandwidth

Test Requirement:	47 CFR Part 15C Section 15.247 (a)(2)
Test Method:	ANSI C63.10: 2013 Section 11.8 Option 2 / 6.9.3
Test Setup:	
Instruments Used:	Refer to section 6 for details.
Exploratory Test Mode:	Transmitting with all kind of modulations, data rates
Final Test Mode:	Refer to section 3.7 for details.
Limit:	$\geq 500$ kHz
Test Results:	Pass
The detailed test data see: <b>Appendix</b>	



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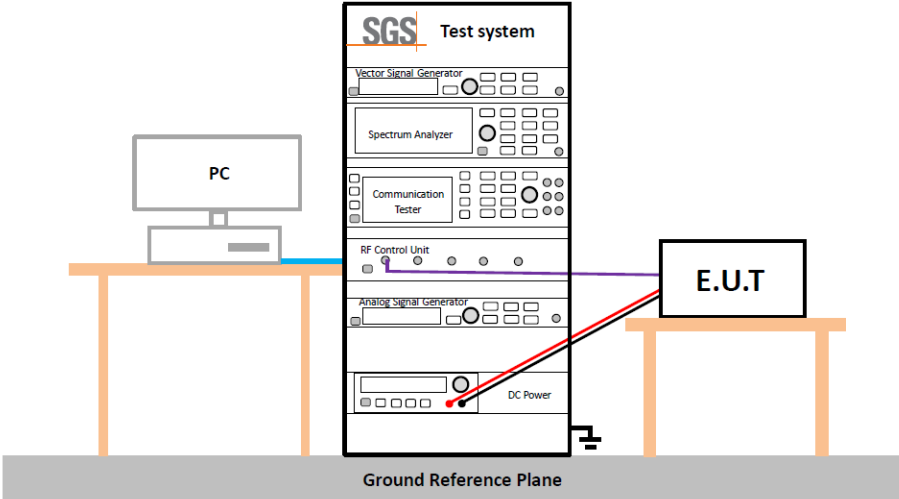
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Report No.: SEWA2301000005RG03

Rev.: 01

Page: 18 of 259

## 4.6 Power Spectral Density

Test Requirement:	47 CFR Part 15C Section 15.247 (e)
Test Method:	ANSI C63.10 :2013 Section 11.10.2
Test Setup:	
Test Instruments:	Refer to section 6 for details.
Exploratory Test Mode:	Transmitting with all kind of modulations, data rates
Final Test Mode:	Refer to section 3.7 for details.
Limit:	$\leq 8.00\text{dBm}/3\text{kHz}$
Test Results:	Pass
The detailed test data see: <b>Appendix</b>	



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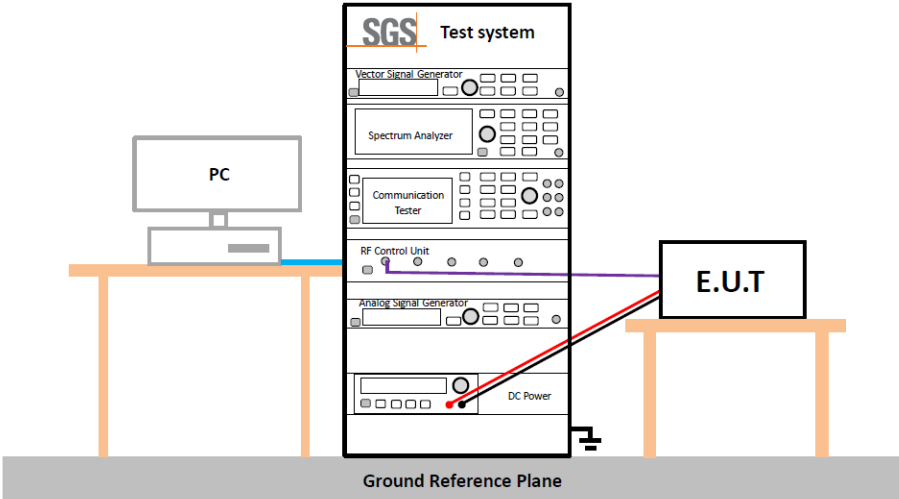


Report No.: SEWA2301000005RG03

Rev.: 01

Page: 19 of 259

### 4.7 Band-edge for RF Conducted Emissions

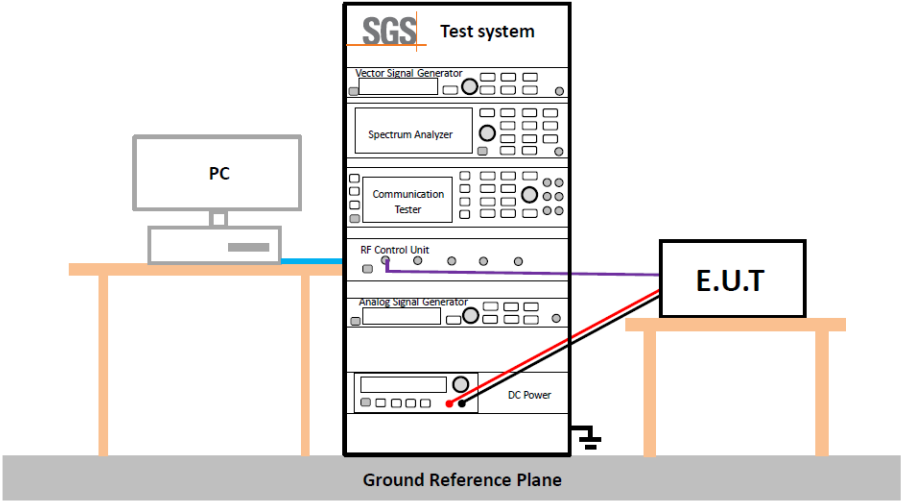
Test Requirement:	47 CFR Part 15C Section 15.247 (d)
Test Method:	ANSI C63.10: 2013 Section 11.11
Test Setup:	
Instruments Used:	Refer to section 6 for details.
Exploratory Test Mode:	Transmitting with all kind of modulations, data rates
Final Test Mode:	Refer to section 3.7 for details.
Limit:	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.
Test Results:	Pass
The detailed test data see: <b>Appendix</b>	

Report No.: SEWA2301000005RG03

Rev.: 01

Page: 20 of 259

## 4.8 RF Conducted Spurious Emissions

Test Requirement:	47 CFR Part 15C Section 15.247 (d)
Test Method:	ANSI C63.10: 2013 Section 11.11
Test Setup:	
Instruments Used:	Refer to section 6 for details.
Exploratory Test Mode:	Transmitting with all kind of modulations, data rates
Final Test Mode:	Refer to section 3.7 for details.
Limit:	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.
Test Results:	Pass
The detailed test data see: <b>Appendix</b>	

Report No.: SEWA2301000005RG03

Rev.: 01

Page: 21 of 259

## 4.9 Radiated Spurious Emissions

Test Requirement:	47 CFR Part 15C Section 15.209 and 15.205				
Test Method:	ANSI C63.10 :2013 Section 11.12				
Test Site:	Measurement Distance: 3m (Semi-Anechoic Chamber)				
Test Frequency:	9kHz ~ 25GHz				
Receiver Setup:	Frequency	Detector	RBW	VBW	Remark
	0.009MHz-0.090MHz	Peak	10kHz	30kHz	Peak
	0.009MHz-0.090MHz	Average	10kHz	30kHz	Average
	0.090MHz-0.110MHz	Quasi-peak	10kHz	30kHz	Quasi-peak
	0.110MHz-0.490MHz	Peak	10kHz	30kHz	Peak
	0.110MHz-0.490MHz	Average	10kHz	30kHz	Average
	0.490MHz -30MHz	Quasi-peak	10kHz	30kHz	Quasi-peak
	30MHz-1GHz	Quasi-peak	120kHz	300kHz	Quasi-peak
	Above 1GHz	Peak	1MHz	3MHz	Peak
		Peak	1MHz	3MHz	Peak
Limit:	Frequency	Field strength (microvolt/meter)	Limit (dBuV/m)	Remark	Measurement distance (m)
	0.009MHz-0.490MHz	2400/F(kHz)	-	-	300
	0.490MHz-1.705MHz	24000/F(kHz)	-	-	30
	1.705MHz-30MHz	30	-	-	30
	30MHz-88MHz	100	40.0	Quasi-peak	3
	88MHz-216MHz	150	43.5	Quasi-peak	3
	216MHz-960MHz	200	46.0	Quasi-peak	3
	960MHz-1GHz	500	54.0	Quasi-peak	3
	Above 1GHz	500	54.0	Average	3
	Remark: 15.35(b), Unless otherwise specified, the limit on peak radio frequency emissions is 20dB above the maximum permitted average emission limit applicable to the equipment under test. This peak limit applies to the total peak emission level radiated by the device.				



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### Test Setup:

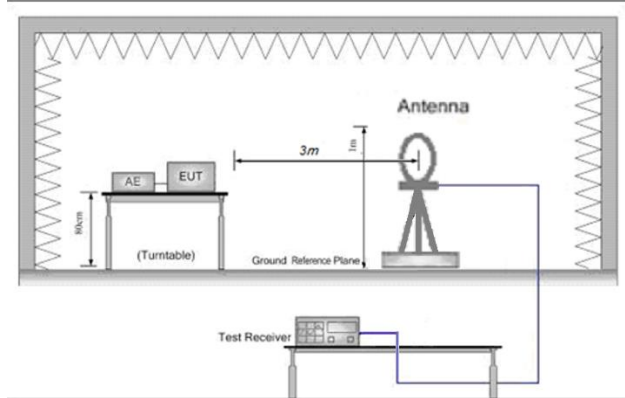


Figure 1. Below 30MHz

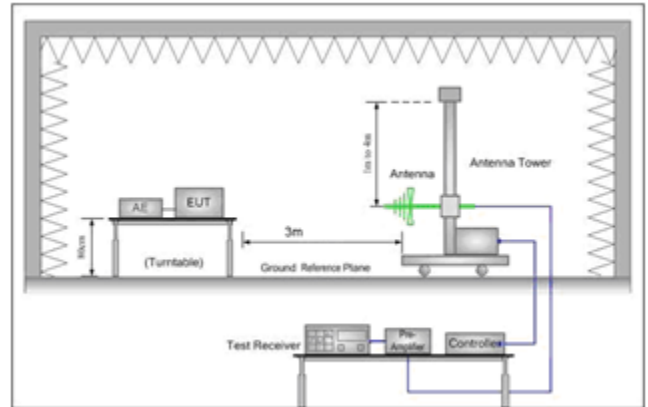


Figure 2. 30MHz to 1GHz

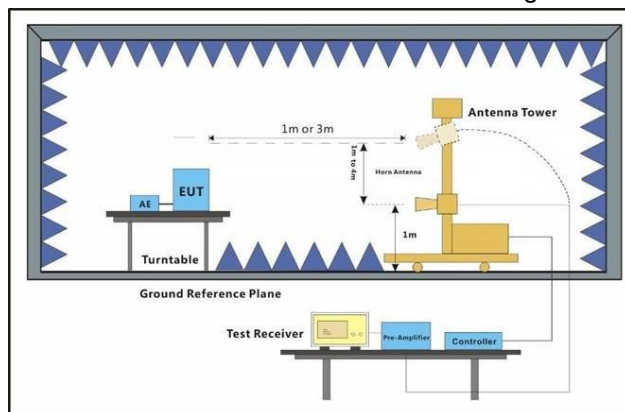


Figure 3. Above 1 GHz

### Test Procedure:

- For below 1GHz, the EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 or 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
- For above 1GHz, the EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation (Distance from antenna to EUT is 1m for measurements >18GHz).
- The EUT was set 3 or 10 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters (for the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) and the rotatable table was turned from 0 degrees to 360 degrees to find the



Report No.: SEWA2301000005RG03

Rev.: 01

Page: 23 of 259

	<p>maximum reading.</p> <p>f. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.</p> <p>g. Test the EUT in the lowest channel, the middle channel ,the Highest channel.</p> <p>h. The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, And found the X axis positioning which it is worse case.</p> <p>i. Repeat above procedures until all frequencies measured was complete.</p> <p>j. 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</p> <p>k. The disturbance above 18GHz was very low, and the harmonics were the highest point could be found when testing, so only the harmonics had been displayed.</p> <p>l. At a measurement distance of 1 meter the limit line was increased by <math>20 \cdot \text{LOG}(3/1) = 9.54 \text{ dB}</math>.</p>
Test Configuration:	<p>Measurements below 30MHz</p> <ul style="list-style-type: none"> <li>• RBW = 10 kHz</li> <li>• VBW = 30 kHz</li> <li>• Detector = Peak &amp; Average &amp; Quasi-peak</li> <li>• Trace mode = max hold</li> </ul> <p>Measurements 30 ~ 1000MHz</p> <ul style="list-style-type: none"> <li>• RBW = 120 kHz</li> <li>• VBW = 300 kHz</li> <li>• Detector = Quasi-peak</li> <li>• Trace mode = max hold</li> </ul> <p>Measurements Below 1000MHz</p> <ul style="list-style-type: none"> <li>• RBW = 120 kHz</li> <li>• VBW = 300 kHz</li> <li>• Detector = Quasi-peak</li> <li>• Trace mode = max hold</li> </ul> <p>Peak Measurements Above 1000 MHz</p> <ul style="list-style-type: none"> <li>• RBW = 1 MHz</li> <li>• VBW <math>\geq 3 \text{ MHz}</math></li> <li>• Detector = Peak</li> <li>• Sweep time = auto</li> <li>• Trace mode = max hold</li> </ul> <p>Average Measurements Above 1000MHz</p> <ul style="list-style-type: none"> <li>• RBW = 1 MHz</li> <li>• VBW = 10Hz, when duty cycle is no less than 98 percent.</li> <li>• VBW <math>\geq 1/T</math>, 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.</li> </ul>
Exploratory Test Mode:	<p>Transmitting with all kind of modulations, data rates.</p> <p>Charge + Transmitting mode.</p>
Final Test Mode:	<p>Refer to section 3.7 for details.</p>



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Report No.: SEWA2301000005RG03

Rev.: 01

Page: 24 of 259

Instruments Used:	Refer to section 6 for details.
Test Results:	Pass
The detailed test data see: <b>Appendix</b>	



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Report No.: SEWA2301000005RG03

Rev.: 01

Page: 25 of 259

### 4.10 Restricted bands around fundamental frequency

Test Requirement:	47 CFR Part 15C Section 15.209 and 15.205		
Test Method:	ANSI C63.10: 2013 Section 11.12		
Test Site:	Measurement Distance: 3m (Semi-Anechoic Chamber)		
Limit:	Frequency	Limit (dBuV/m)	Remark
	30MHz-88MHz	40.0	Quasi-peak
	88MHz-216MHz	43.5	Quasi-peak
	216MHz-960MHz	46.0	Quasi-peak
	960MHz-1GHz	54.0	Quasi-peak
	Above 1GHz	54.0	Average Value
		74.0	Peak Value

Test Setup:

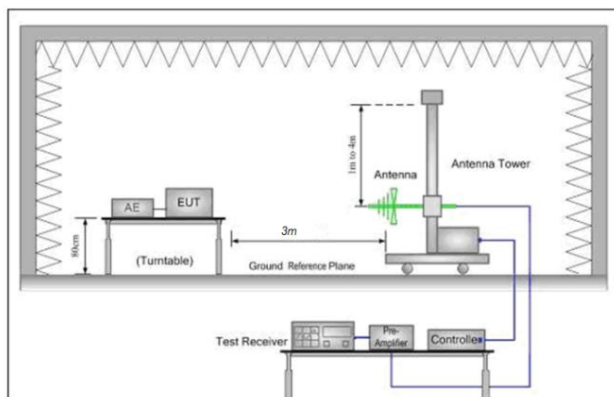


Figure 1. 30MHz to 1GHz

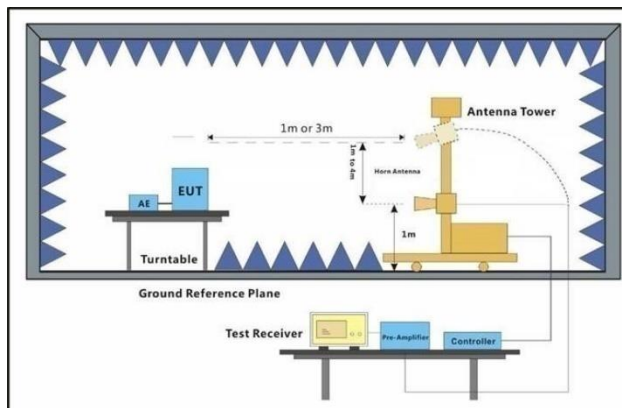


Figure 2. Above 1 GHz

Report No.: SEWA2301000005RG03

Rev.: 01

Page: 26 of 259

Test Procedure:	<p>a. For below 1GHz, the EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 or 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.</p> <p>b. For above 1GHz, the EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.</p> <p>c. The EUT was set 3 or 10 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.</p> <p>d. The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.</p> <p>e. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.</p> <p>f. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.</p> <p>g. Place a marker at the end of the restricted band closest to the transmit frequency to show compliance. Also measure any emissions in the restricted bands. Save the spectrum analyzer plot. Repeat for each power and modulation for lowest and highest channel</p> <p>h. Test the EUT in the lowest channel , the Highest channel</p> <p>i. The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, And found the X axis positioning which it is worse case.</p> <p>j. Repeat above procedures until all frequencies measured was complete.</p>
Test Configuration:	<p>Measurements Below 1000MHz</p> <ul style="list-style-type: none"> <li>• RBW = 120 kHz</li> <li>• VBW = 300 kHz</li> <li>• Detector = Quasi-peak</li> <li>• Trace mode = max hold</li> </ul> <p>Peak Measurements Above 1000 MHz</p> <ul style="list-style-type: none"> <li>• RBW = 1 MHz</li> <li>• VBW ≥ 3 MHz</li> <li>• Detector = Peak</li> <li>• Sweep time = auto</li> <li>• Trace mode = max hold</li> </ul> <p>Average Measurements Above 1000MHz</p> <ul style="list-style-type: none"> <li>• RBW = 1 MHz</li> <li>• VBW = 10Hz, when duty cycle is no less than 98 percent.</li> <li>• 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.</li> </ul>
Exploratory Test Mode:	Transmitting with all kind of modulations, data rates. Charge + Transmitting mode.
Final Test Mode:	Refer to section 3.7 for details.
Instruments Used:	Refer to section 6 for details.



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Report No.: SEWA2301000005RG03

Rev.: 01

Page: 27 of 259

Test Results:	Pass
The detailed test data see: <b>Appendix</b>	



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Report No.: SEWA2301000005RG03

Rev.: 01

Page: 28 of 259

## 5 Measurement Uncertainty (95% confidence levels, k=2)

No.	Item	Measurement Uncertainty
1	Total RF power, conducted	$\pm 0.54\text{dB}$
2	RF power density, conducted	$\pm 1.03\text{dB}$
3	Spurious emissions, conducted	$\pm 0.54\text{dB}$
4	Radio Frequency	$\pm 1.0\%$
5	Duty Cycle	$\pm 0.37\%$
6	Occupied Bandwidth	$\pm 1.0\%$
7	Conduction Emission	$\pm 2.90\text{dB}$ (150kHz to 30MHz)
8	Radiated Emission	$\pm 3.13\text{dB}$ (9k -30MHz)
		$\pm 4.88\text{dB}$ (30M -1GHz)
		$\pm 4.75\text{dB}$ (1GHz to 18GHz)
		$\pm 4.77\text{dB}$ (Above 18GHz)

**Remark:**

The  $U_{\text{lab}}$  (lab Uncertainty) is less than  $U_{\text{CISPR/ETSI}}$  (CISPR/ETSI Uncertainty), so the test results

- compliance is deemed to occur if no measured disturbance level exceeds the disturbance limit;
- non-compliance is deemed to occur if any measured disturbance level exceeds the disturbance limit.



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Report No.: SEWA2301000005RG03

Rev.: 01

Page: 29 of 259

## 6 Equipment List

RF Test Equipment					
Test Equipment	Manufacturer	Model No.	Inventory No.	Cal. date (yyyy/mm/dd)	Cal.Due date (yyyy/mm/dd)
Shielding Room	Brilliant-emc	N/A	SUWI-04-01-06	2021/05/08	2024/05/07
Temperature and humidity meter	MingGao	TH101B	SUWI-01-01-07	2022/02/16	2023/02/15
				2023/02/06	2024/02/05
Signal Analyzer	ROHDE&SCHWARZ	FSV3030	SUWI-01-02-02	2022/05/17	2023/05/16
Measurement Software	Tonscend	JS1120-3 Test System V3.1.55	SUWI-02-09-09	NCR	NCR
Signal Analyzer	ROHDE&SCHWARZ	FSW43	SUWI-01-02-04	2022/05/28	2023/05/27
Wideband Radio Communication Tester	ROHDE&SCHWARZ	CMW500	SUWI-01-16-05	2022/02/14	2023/02/13
				2023/02/06	2024/02/05
DC Power Supply	HYELEC	HY3005B	SUWI-01-18-01	2022/02/15	2023/02/14
				2023/02/06	2024/02/05
Power meter	Anritsu	ML2495A	SUWI-01-31-01	2022/11/23	2023/11/22
Pulse power sensor	Anritsu	MA2411B	SUWI-01-32-01	2022/11/23	2023/11/22
MXG Vector signal genitor	KEYSIGHT	N5182B	SUWI-01-38-01	2022/02/14	2023/02/13
				2023/02/06	2024/02/05
Temperature Chamber	ESPEC	SU-242	SUWI-01-13-01	2022/02/15	2023/02/14
				2023/02/06	2024/02/05



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Report No.: SEWA2301000005RG03

Rev.: 01

Page: 30 of 259

CE Test System					
Test Equipment	Manufacturer	Model No.	Inventory No.	Cal. date (yyyy/mm/dd)	Cal.Due date (yyyy/mm/dd)
Shielding Room	Brilliant-emc	N/A	SUWI-04-03-01	2021/05/08	2024/05/07
Test receiver	ROHDE&SCHWARZ	ESR7	SUWI-01-10-01	2022/02/19	2023/02/18
				2023/02/08	2024/02/07
Temperature and humidity meter	MingGao	TH101B	SUWI-01-01-06	2022/02/16	2023/02/15
				2023/02/07	2024/02/06
Artificial network	ROHDE&SCHWARZ	ENV216	SUWI-01-19-01	2022/02/19	2023/02/18
				2023/02/08	2024/02/07
Artificial network	ROHDE&SCHWARZ	ENV216	SUWI-01-19-02	2022/02/19	2023/02/18
				2023/02/08	2024/02/07
Measurement Software	Tonscend	JS32-CE 4.0.0.2	SUWI-02-09-05	NCR	NCR



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Report No.: SEWA2301000005RG03

Rev.: 01

Page: 31 of 259

RSE Test System					
Test Equipment	Manufacturer	Model No.	Inventory No.	Cal. date (yyyy/mm/dd)	Cal.Due date (yyyy/mm/dd)
Semi-Anechoic Chamber	Brilliant-emc	N/A	SUWI-04-02-02	2021/11/25	2024/11/24
Temperature and humidity meter*	MingGao	TH101B	SUWI-01-01-13	2023/02/07	2024/02/06
Signal Analyzer	ROHDE&SCHWARZ	FSW43	SUWI-01-02-04	2022/05/28	2023/05/27
Signal Analyzer	KEYSIGHT	N9020A	SUWI-01-02-06	2022/11/23	2023/11/22
Test receiver	ROHDE&SCHWARZ	ESR7	SUWI-01-10-01	2022/02/19	2023/02/18
				2023/02/08	2024/02/07
Receiving antenna	SCHWRZBECK MESS-ELEKTRONIK	VULB 9163	SUWI-01-11-04	2021/12/05	2023/12/04
Receiving antenna	SCHWRZBECK MESS-ELEKTRONIK	BBHA 9120D	SUWI-01-11-05	2021/12/05	2023/12/04
Receiving antenna	SCHWRZBECK MESS-ELEKTRONIK	BBHA 9170	SUWI-01-11-03	2021/05/14	2023/05/13
Active Loop Antenna	SCHWRZBECK MESS-ELEKTRONIK	FMZB 1519B	SUWI-01-21-01	2021/06/10	2023/06/09
Amplifier	Tonscend	TAP9K3G32	SUWI-01-14-06	2022/11/23	2023/11/22
Amplifier	Tonscend	TAP01018050	SUWI-01-14-04	2022/11/23	2023/11/22
Amplifier	Tonscend	TAP30M7G30	SUWI-01-14-05	2022/11/23	2023/11/22
Measurement Software	Tonscend	JS32-RE V4.0.0.0	SUWI-02-09-04	NCR	NCR

\*Note: This equipment is not used for testing before 2023/02/07.



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Report No.: SEWA2301000005RG03

Rev.: 01

Page: 32 of 259

## 7 Photographs - Setup Photos

Refer to Appendix A.2 WLAN Setup Photos.



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Page: 33 of 259

# Appendix



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Report No.: SEWA2301000005RG03

Rev.: 01

Page: 34 of 259

## DTS Bandwidth Test Result

TestMode	Antenna	Frequency[MHz]	DTS BW [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
11b	Ant1	2412	7.20	2407.88	2415.08	≥0.5	PASS
		2437	8.12	2432.92	2441.04	≥0.5	PASS
		2462	8.12	2457.92	2466.04	≥0.5	PASS
11g-CDD	Ant0	2412	16.36	2403.80	2420.16	≥0.5	PASS
	Ant1	2412	16.40	2403.76	2420.16	≥0.5	PASS
	Ant0	2417	16.40	2408.76	2425.16	≥0.5	PASS
	Ant1	2417	16.12	2408.76	2424.88	≥0.5	PASS
	Ant0	2437	15.16	2428.76	2443.92	≥0.5	PASS
	Ant1	2437	15.52	2429.36	2444.88	≥0.5	PASS
	Ant0	2457	15.48	2449.04	2464.52	≥0.5	PASS
	Ant1	2457	16.40	2448.76	2465.16	≥0.5	PASS
	Ant0	2462	16.40	2453.76	2470.16	≥0.5	PASS
	Ant1	2462	14.52	2455.64	2470.16	≥0.5	PASS
11n20MIMO	Ant0	2412	17.48	2403.16	2420.64	≥0.5	PASS
	Ant1	2412	17.24	2403.40	2420.64	≥0.5	PASS
	Ant0	2417	16.76	2408.44	2425.20	≥0.5	PASS
	Ant1	2417	17.20	2408.44	2425.64	≥0.5	PASS
	Ant0	2437	16.40	2428.12	2444.52	≥0.5	PASS
	Ant1	2437	16.00	2429.36	2445.36	≥0.5	PASS
	Ant0	2452	17.36	2443.44	2460.80	≥0.5	PASS
	Ant1	2452	17.48	2443.32	2460.80	≥0.5	PASS
	Ant0	2457	16.52	2448.44	2464.96	≥0.5	PASS
	Ant1	2457	16.80	2448.44	2465.24	≥0.5	PASS
	Ant0	2462	16.76	2453.44	2470.20	≥0.5	PASS
	Ant1	2462	17.24	2453.40	2470.64	≥0.5	PASS
11n40MIMO	Ant0	2422	35.36	2404.32	2439.68	≥0.5	PASS
	Ant1	2422	36.64	2403.60	2440.24	≥0.5	PASS
	Ant0	2427	36.00	2409.00	2445.00	≥0.5	PASS
	Ant1	2427	35.68	2409.32	2445.00	≥0.5	PASS
	Ant0	2432	36.32	2413.68	2450.00	≥0.5	PASS
	Ant1	2432	35.92	2413.68	2449.60	≥0.5	PASS
	Ant0	2437	35.52	2419.08	2454.60	≥0.5	PASS
	Ant1	2437	35.68	2418.92	2454.60	≥0.5	PASS
	Ant0	2442	36.56	2423.68	2460.24	≥0.5	PASS
	Ant1	2442	35.68	2423.92	2459.60	≥0.5	PASS
	Ant0	2447	36.24	2428.92	2465.16	≥0.5	PASS
	Ant1	2447	36.08	2428.92	2465.00	≥0.5	PASS
	Ant0	2452	36.08	2433.92	2470.00	≥0.5	PASS
	Ant1	2452	35.92	2433.68	2469.60	≥0.5	PASS



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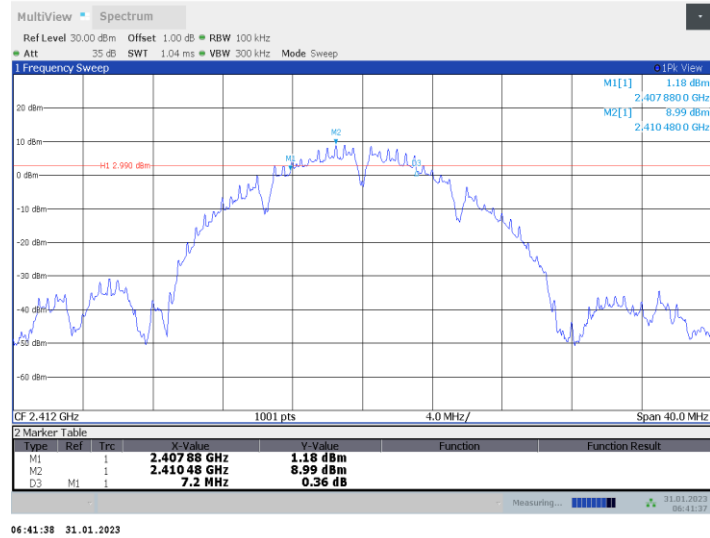
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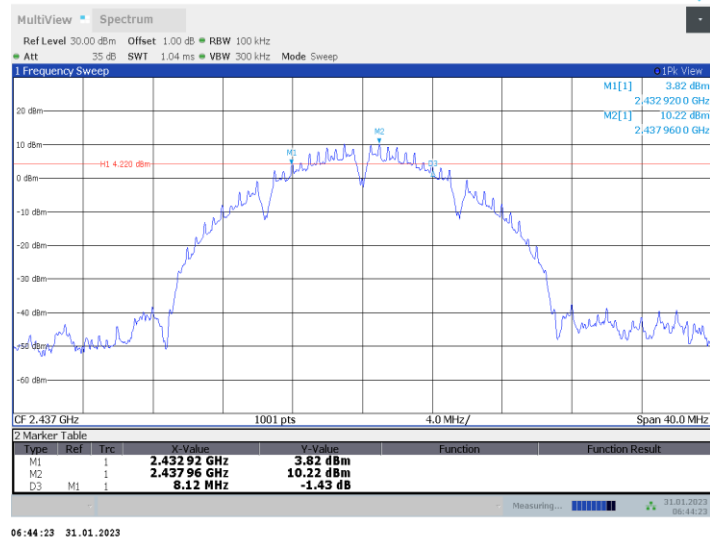
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### Test Graphs

11b\_Ant1\_2412



11b\_Ant1\_2437



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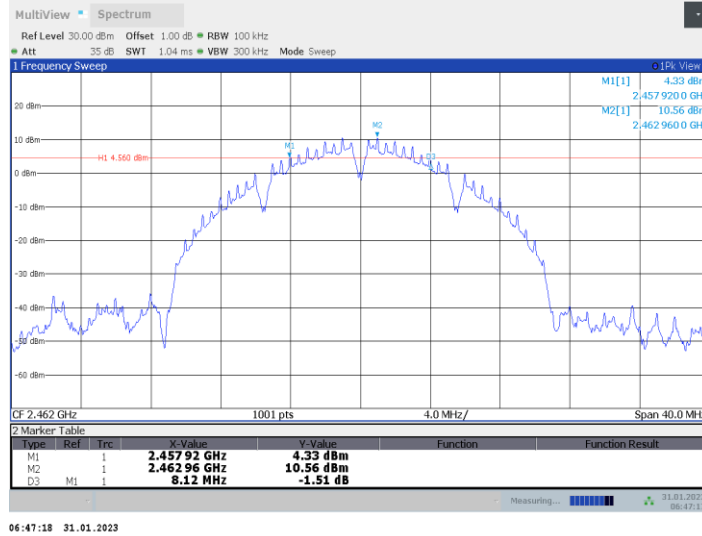
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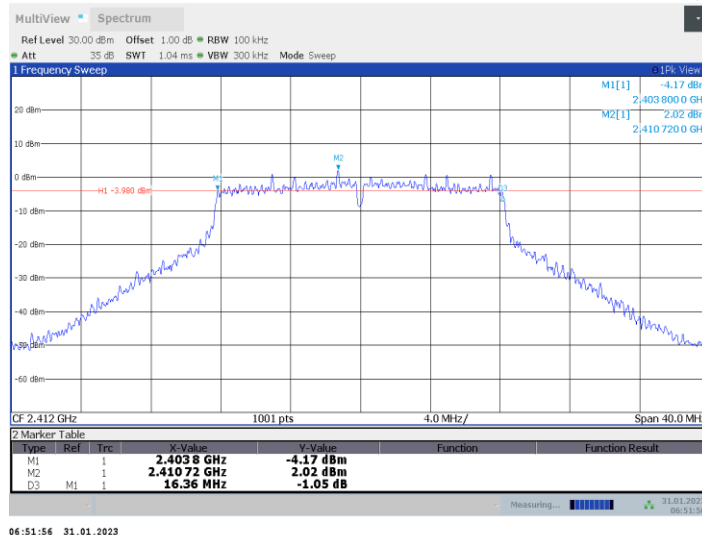
Page: 36 of 259

### 11b\_Ant1\_2462



06:47:18 31.01.2023

### 11g-CDD\_Ant0\_2412



06:51:56 31.01.2023



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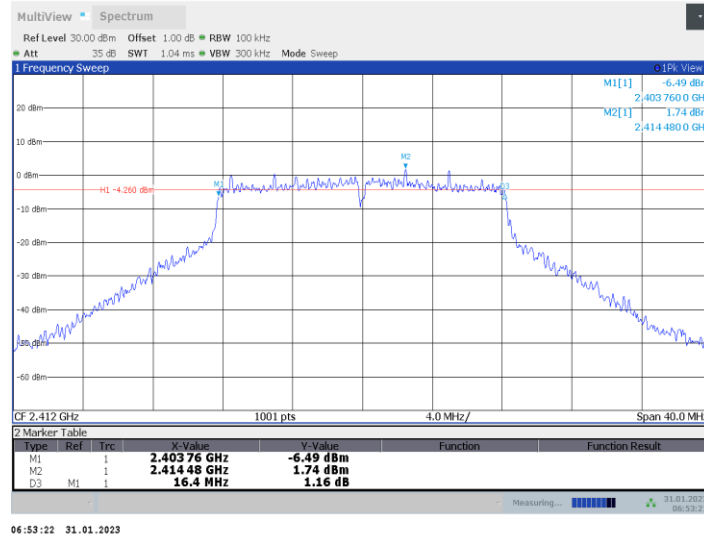
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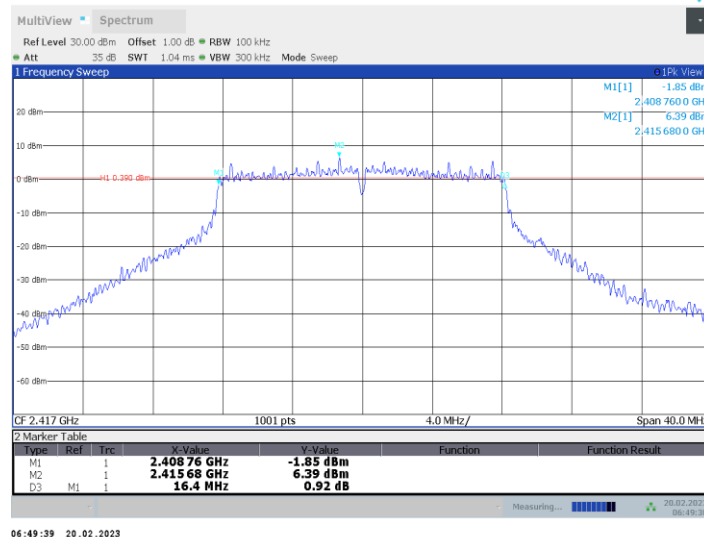
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### 11g-CDD\_Ant1\_2412



### 11g-CDD\_Ant0\_2417



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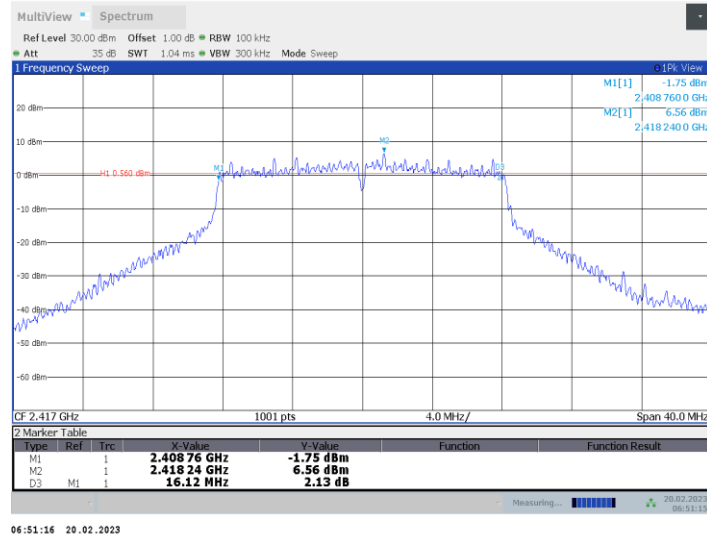
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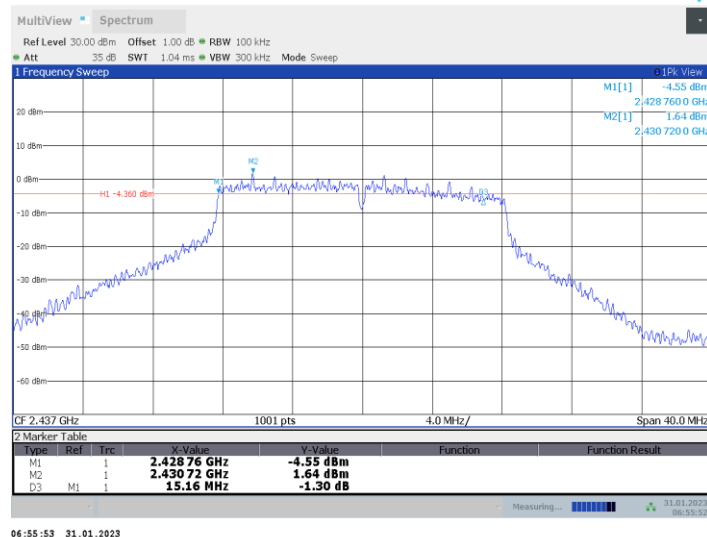
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### 11g-CDD\_Ant0\_2437



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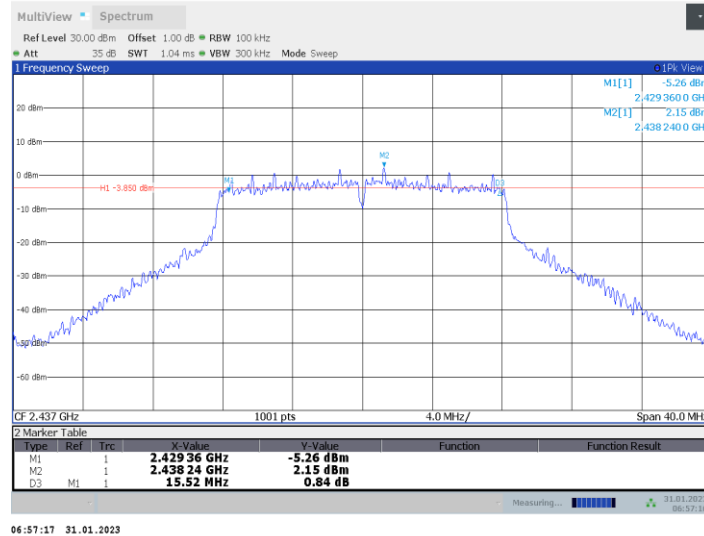


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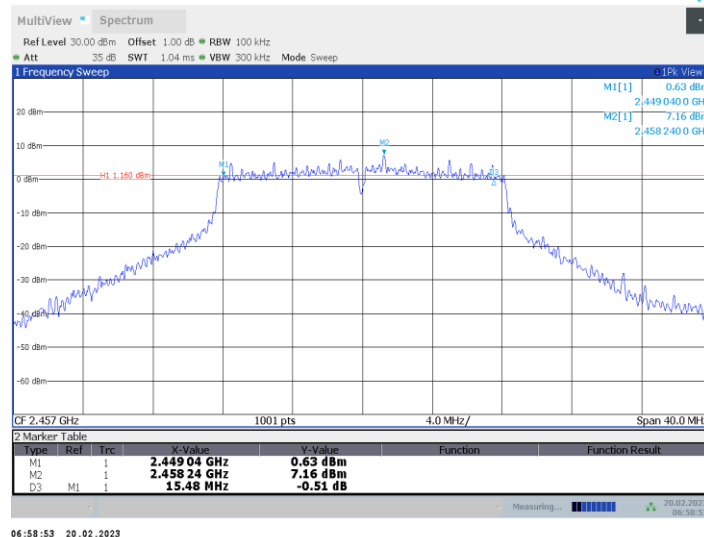
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06:57:17 31.01.2023

### 11g-CDD\_Ant0\_2457



06:58:53 20.02.2023



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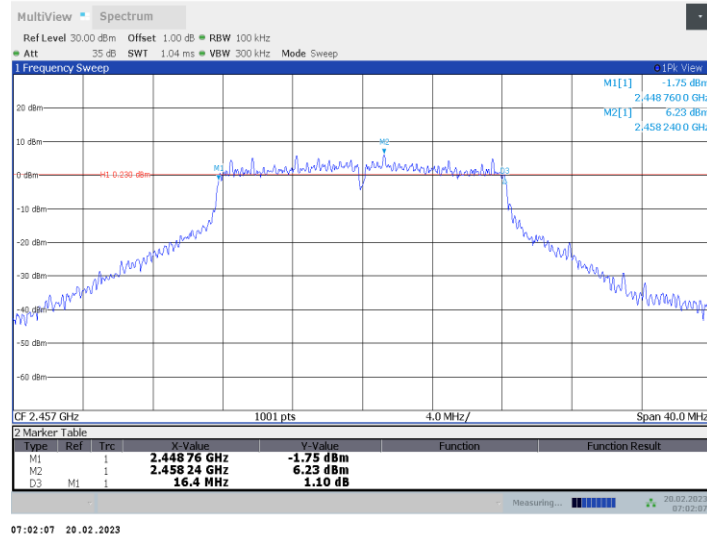
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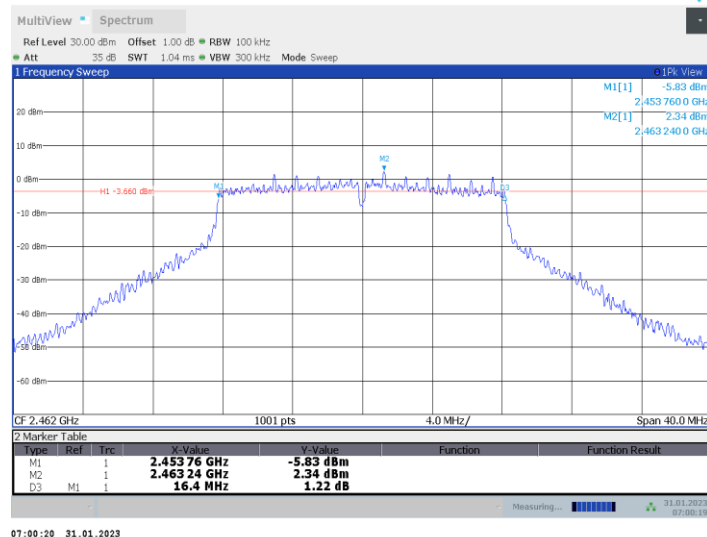
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### 11g-CDD\_Ant0\_2462



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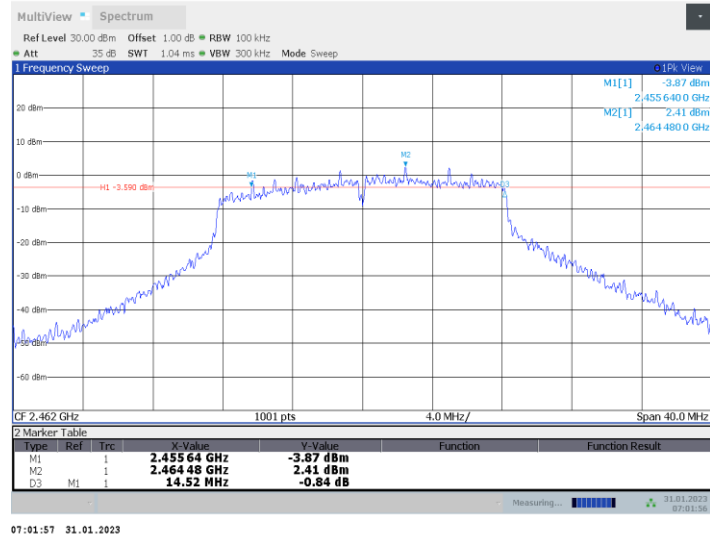
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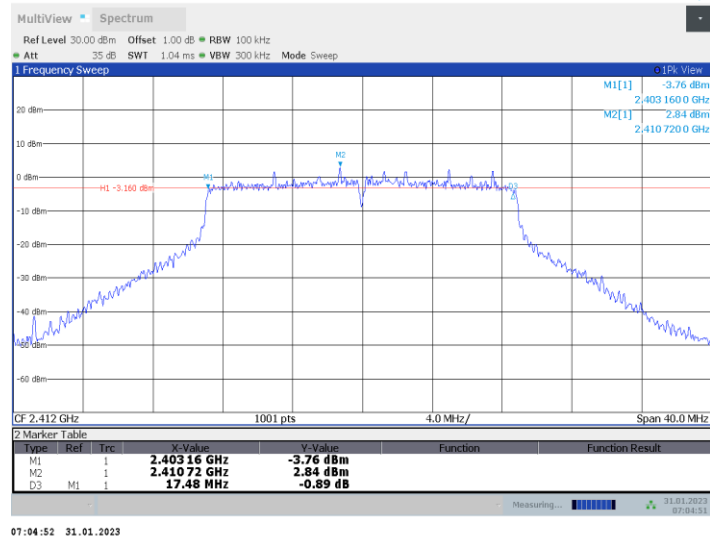
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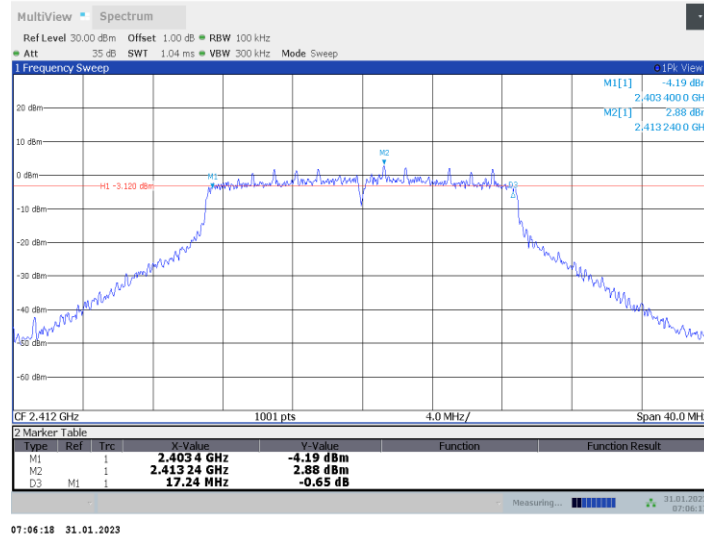


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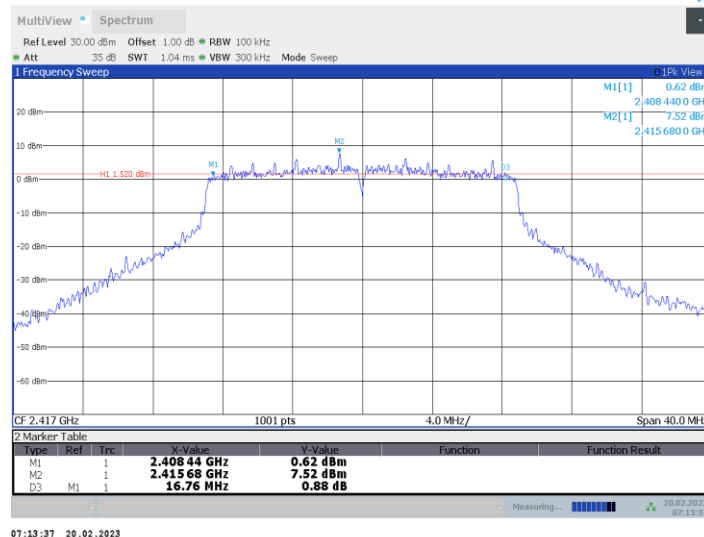
Page: 42 of 259

### 11n20MIMO\_Ant1\_2412



07:06:18 31.01.2023

### 11n20MIMO\_Ant0\_2417



07:13:37 20.02.2023



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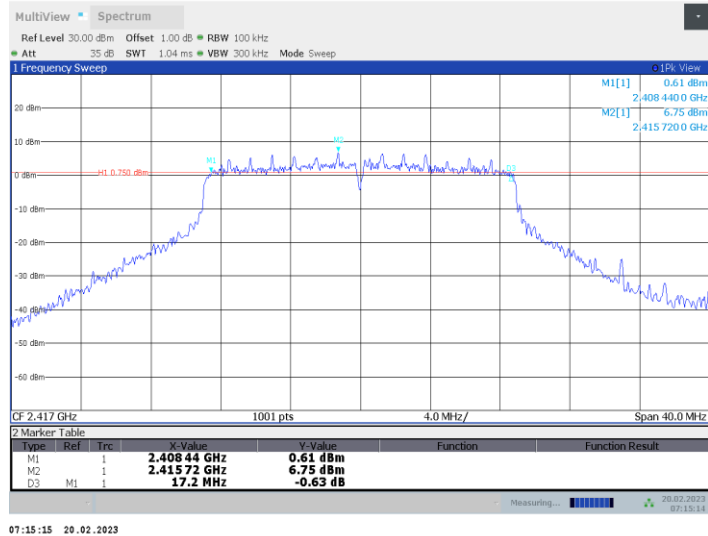
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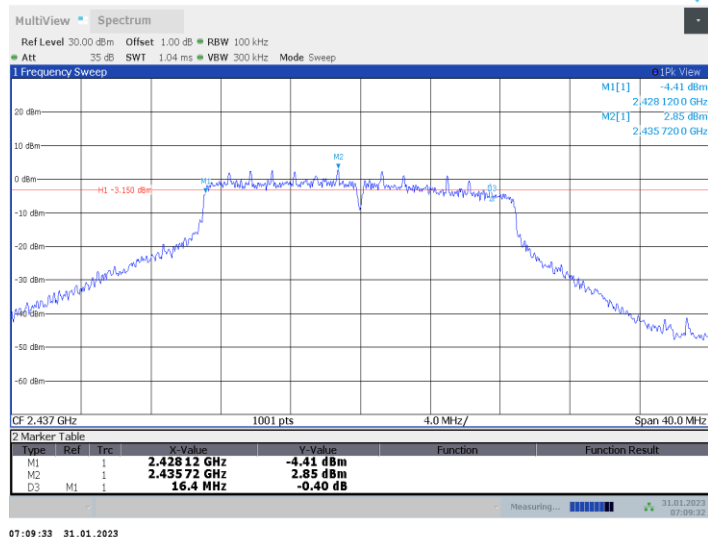
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### 11n20MIMO\_Ant1\_2417



### 11n20MIMO\_Ant0\_2437



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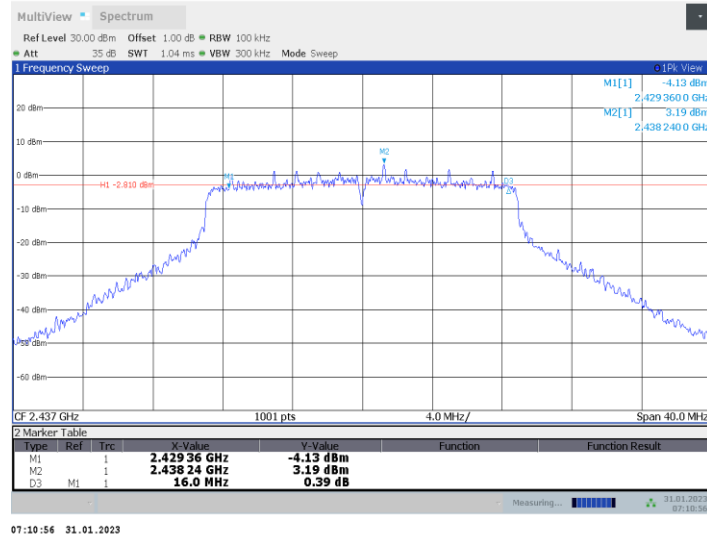


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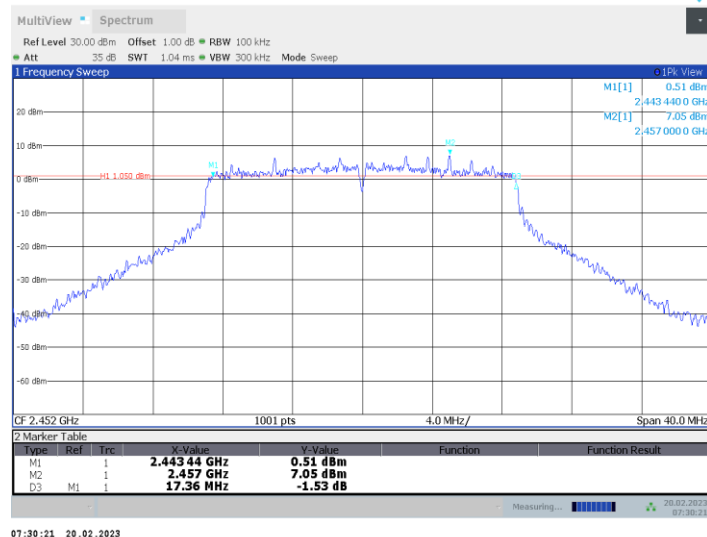
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## 11n20MIMO\_Ant1\_2437



## 11n20MIMO\_Ant0\_2452

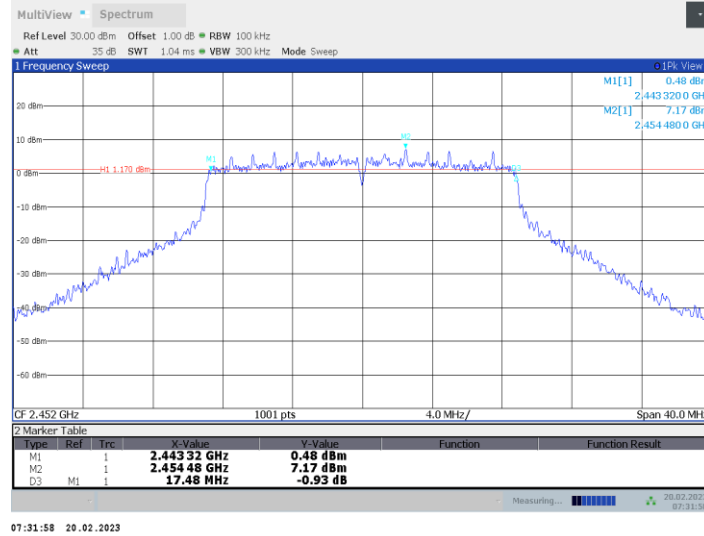


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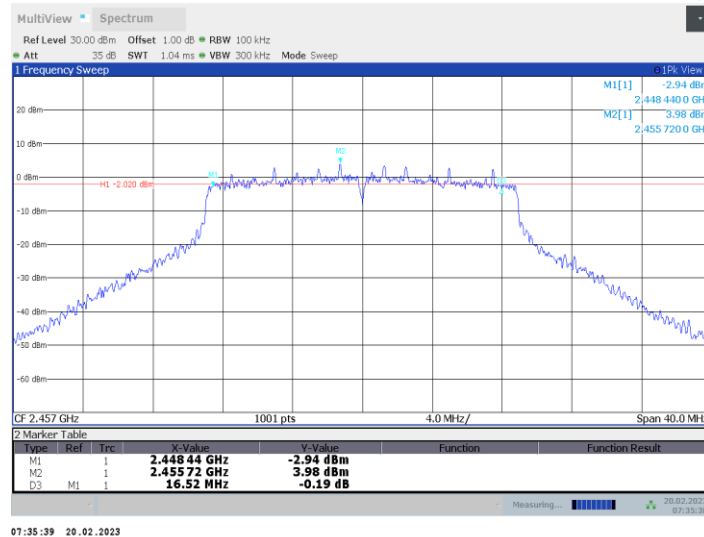
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### 11n20MIMO\_Ant1\_2452



### 11n20MIMO\_Ant0\_2457



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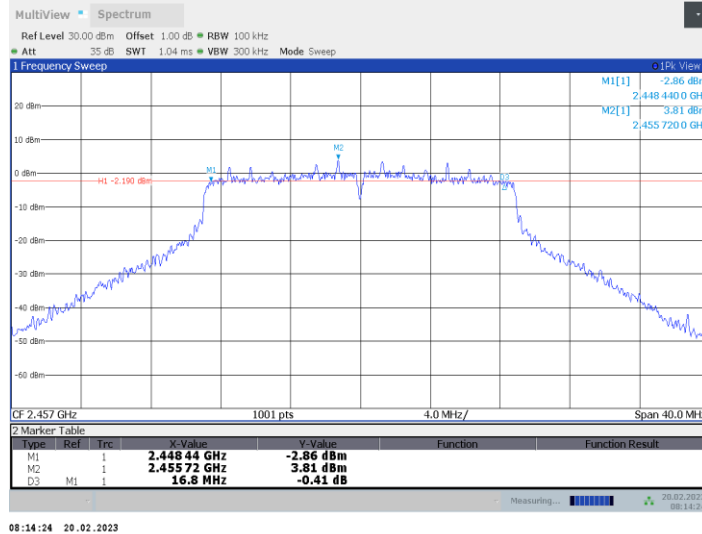
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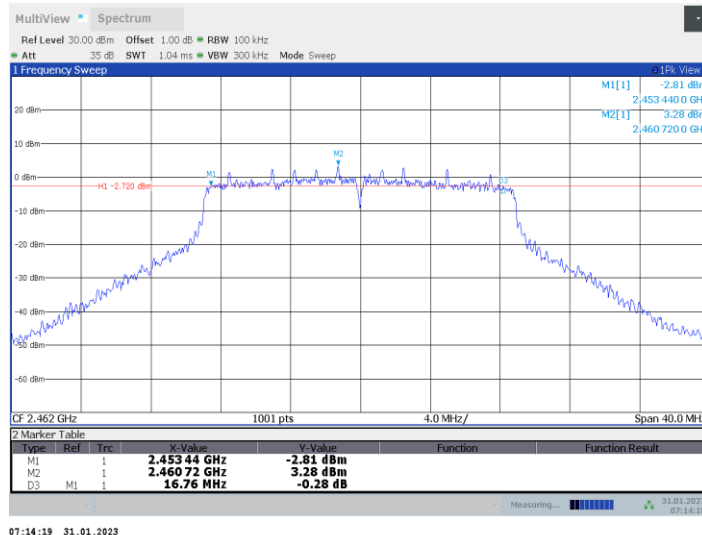
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### 11n20MIMO\_Ant1\_2457



### 11n20MIMO\_Ant0\_2462



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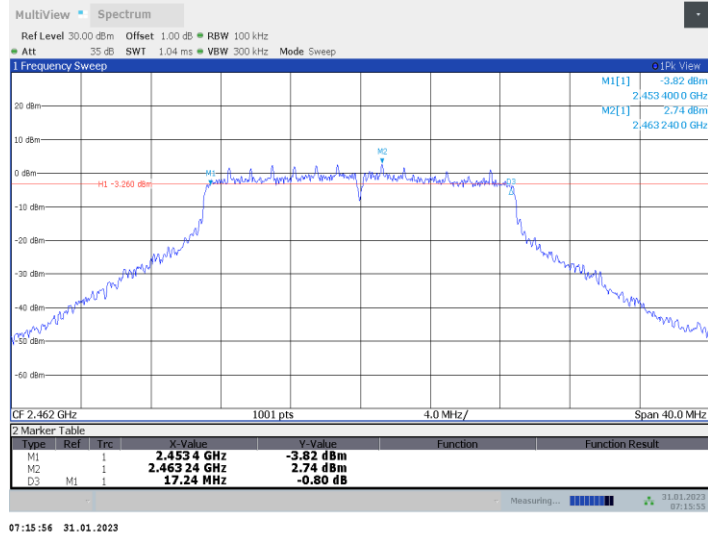
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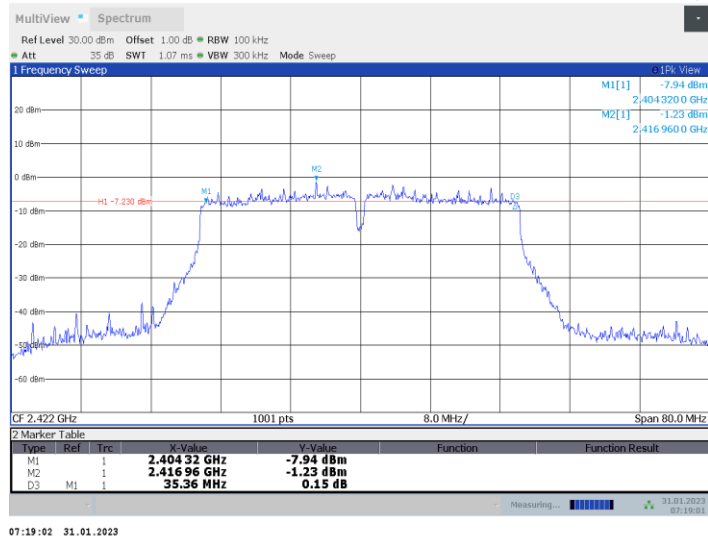
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### 11n20MIMO\_Ant1\_2462



### 11n40MIMO\_Ant0\_2422



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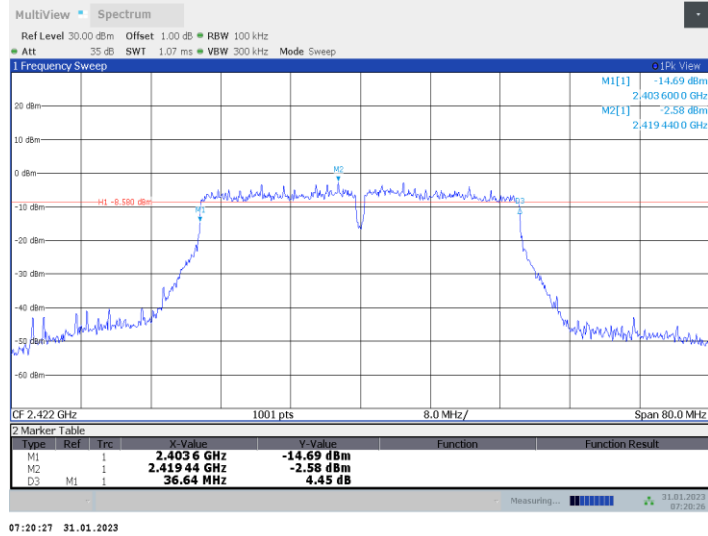
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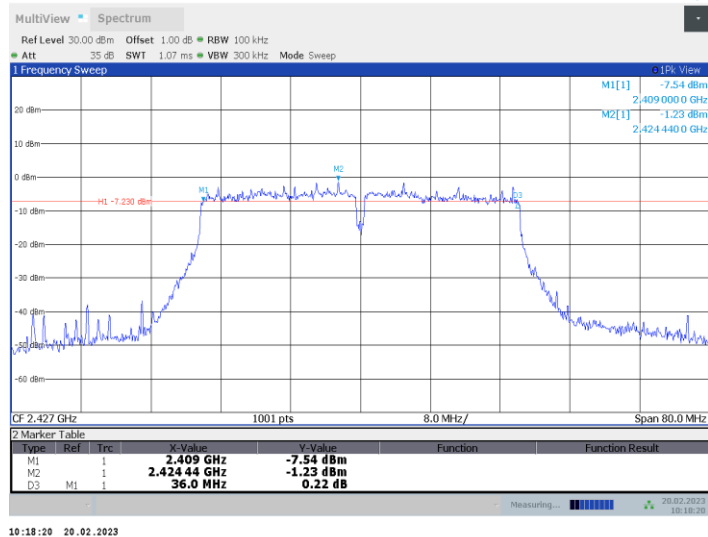
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### 11n40MIMO\_Ant1\_2422



### 11n40MIMO\_Ant0\_2427



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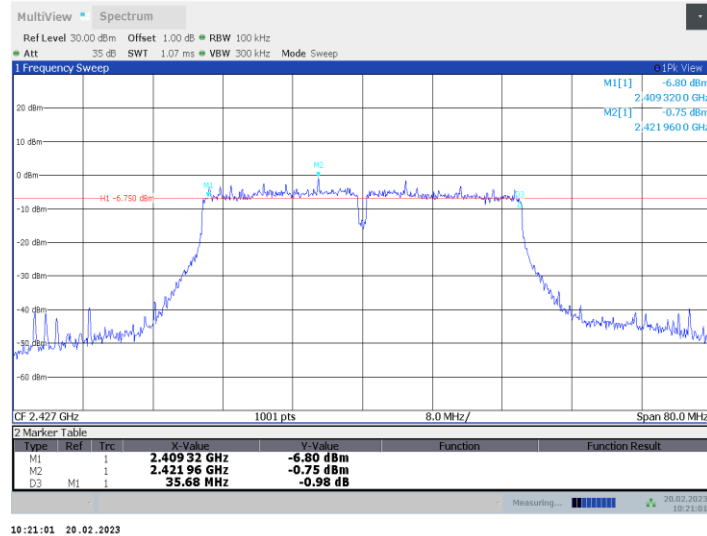


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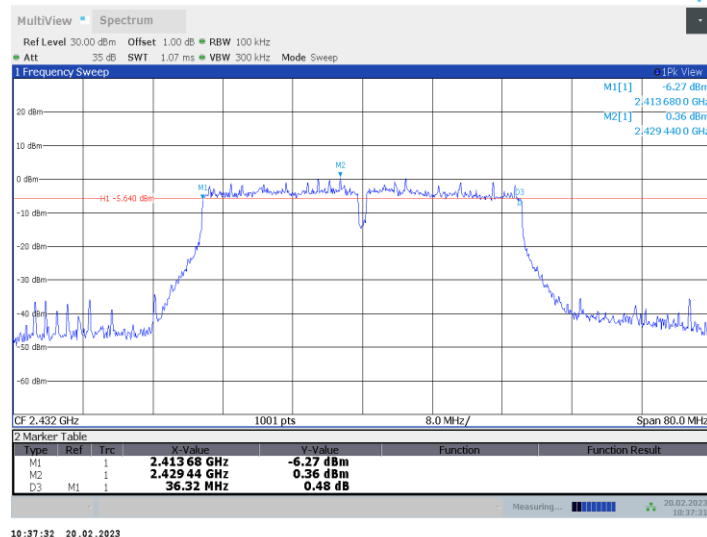
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## 11n40MIMO\_Ant1\_2427



## 11n40MIMO\_Ant0\_2432

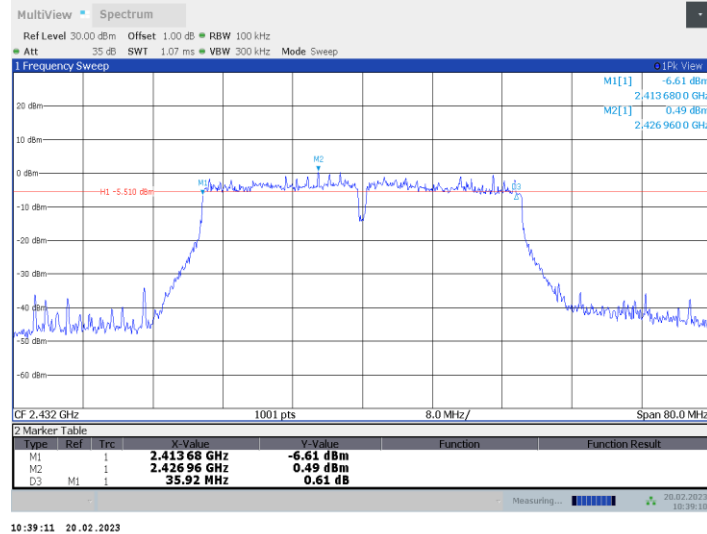


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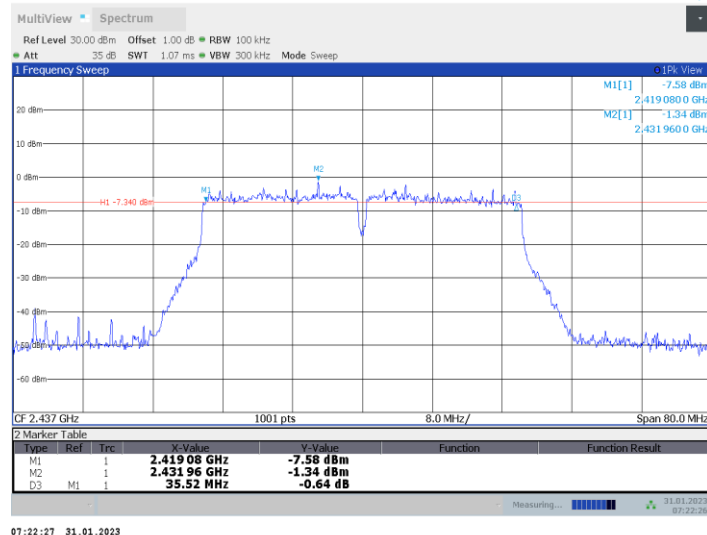
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### 11n40MIMO\_Ant1\_2432



10:39:11 20.02.2023

### 11n40MIMO\_Ant0\_2437



07:22:27 31.01.2023



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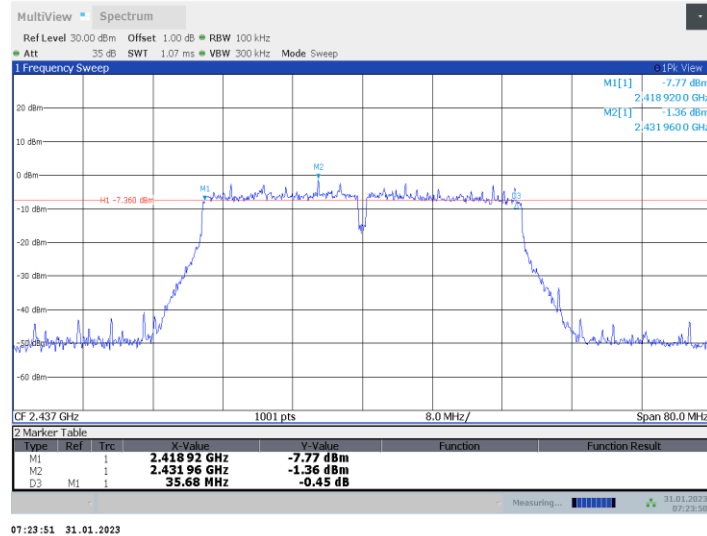
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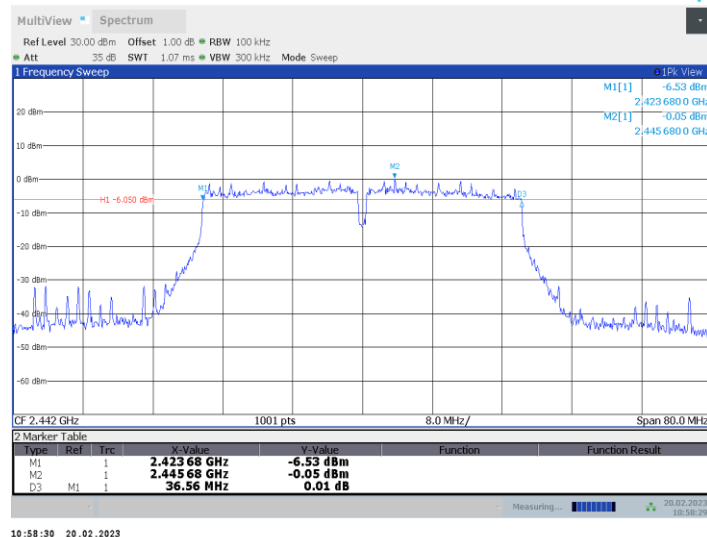
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### 11n40MIMO\_Ant0\_2442



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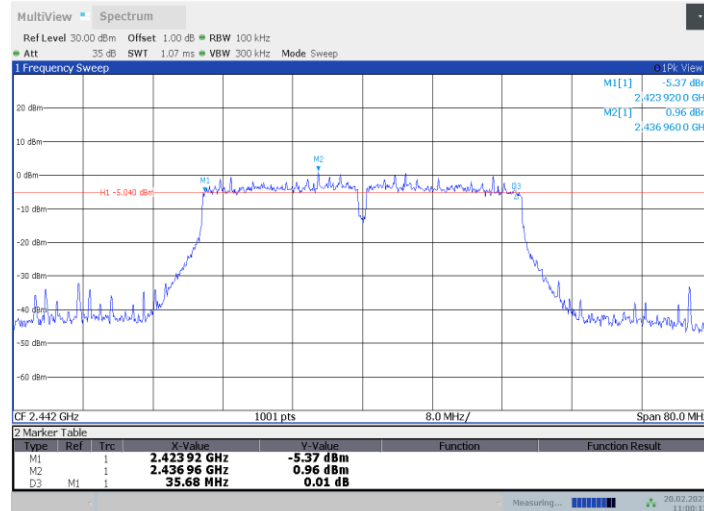
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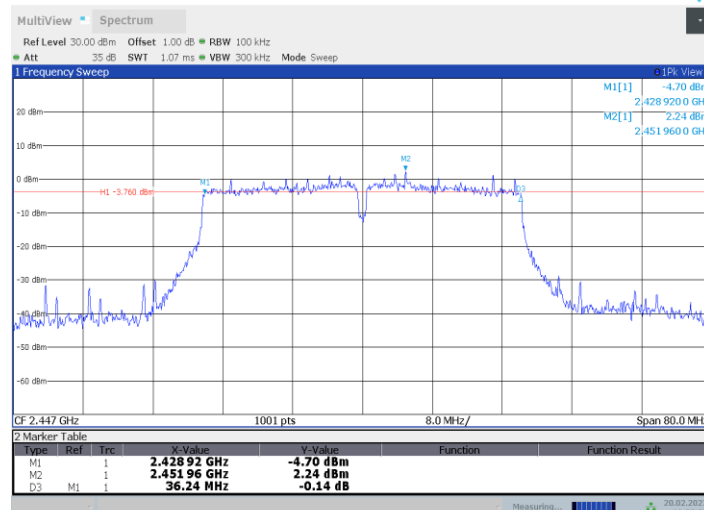
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11:00:13 20.02.2023

### 11n40MIMO\_Ant0\_2447



11:02:24 20.02.2023



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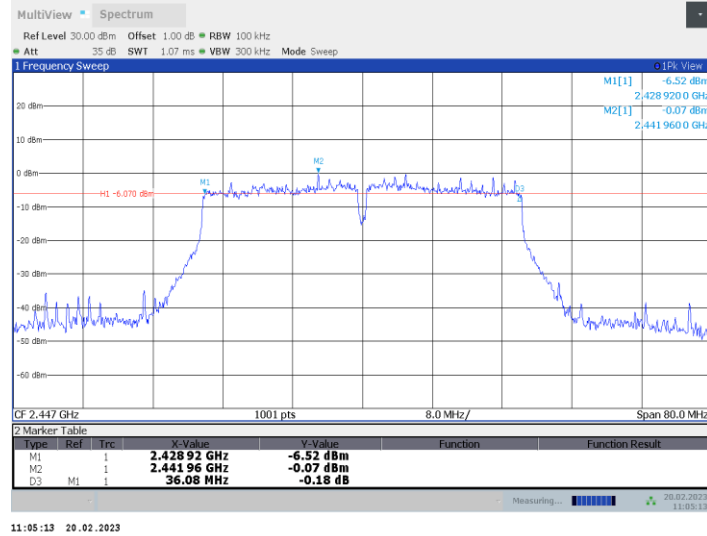
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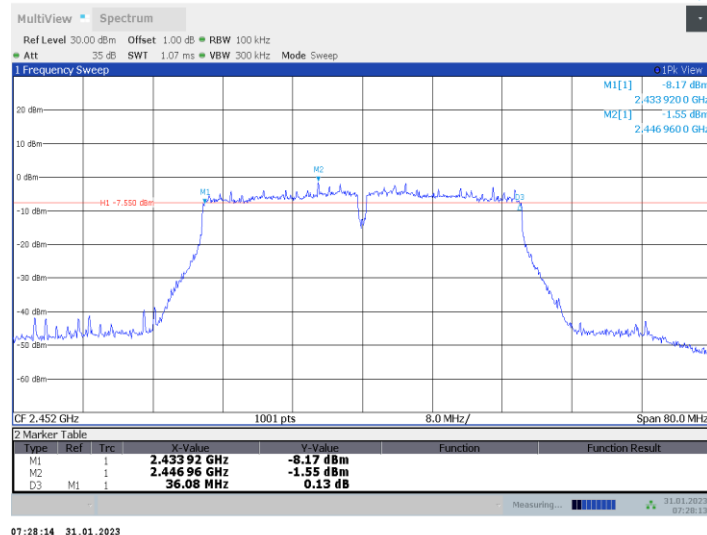
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11:05:13 20.02.2023

### 11n40MIMO\_Ant0\_2452



07:28:14 31.01.2023



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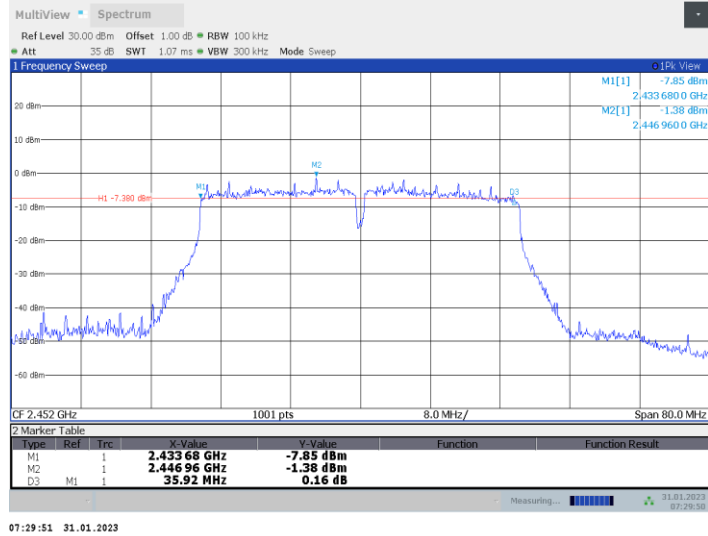


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Page: 55 of 259

## Occupied Channel Bandwidth Test Result

TestMode	Antenna	Channel Frequency[MHz]	OCB [MHz]	FL[MHz]	FH[MHz]	Verdict
11b	Ant1	2412	14.355	2404.381	2418.736	Reporting only
		2437	14.262	2429.847	2444.108	
		2462	14.330	2454.751	2469.081	
11g-CDD	Ant0	2412	16.840	2403.542	2420.382	
	Ant1	2412	17.049	2403.325	2420.374	
	Ant0	2417	16.804	2408.558	2425.362	
	Ant1	2417	16.780	2408.579	2425.359	
	Ant0	2437	16.980	2428.217	2445.197	
	Ant1	2437	16.909	2428.539	2445.448	
	Ant0	2457	16.800	2448.555	2465.355	
	Ant1	2457	16.790	2448.549	2465.339	
	Ant0	2462	16.795	2453.546	2470.341	
11n20MIMO	Ant1	2462	16.849	2453.800	2470.649	
	Ant0	2412	18.051	2402.954	2421.004	
	Ant1	2412	18.061	2402.928	2420.988	
	Ant0	2417	18.013	2407.959	2425.973	
	Ant1	2417	17.985	2407.997	2425.982	
	Ant0	2437	18.127	2427.631	2445.758	
	Ant1	2437	18.019	2428.023	2446.042	
	Ant0	2452	18.012	2442.989	2461.001	
	Ant1	2452	18.040	2443.007	2461.047	
	Ant0	2457	18.009	2447.940	2465.949	
	Ant1	2457	18.069	2447.952	2466.021	
11n40MIMO	Ant0	2462	17.971	2452.951	2470.921	
	Ant1	2462	18.048	2452.939	2470.986	
	Ant0	2422	36.524	2403.710	2440.234	
	Ant1	2422	36.640	2403.599	2440.239	
	Ant0	2427	36.571	2408.651	2445.222	
	Ant1	2427	36.490	2408.716	2445.206	
	Ant0	2432	36.609	2413.581	2450.189	
	Ant1	2432	36.615	2413.547	2450.162	
	Ant0	2437	36.584	2418.590	2455.173	
	Ant1	2437	36.701	2418.532	2455.233	
	Ant0	2442	36.587	2423.607	2460.194	
	Ant1	2442	36.641	2423.595	2460.235	
	Ant0	2447	36.624	2428.643	2465.266	
	Ant1	2447	36.525	2428.695	2465.220	
	Ant0	2452	36.521	2433.684	2470.205	
	Ant1	2452	36.470	2433.631	2470.101	



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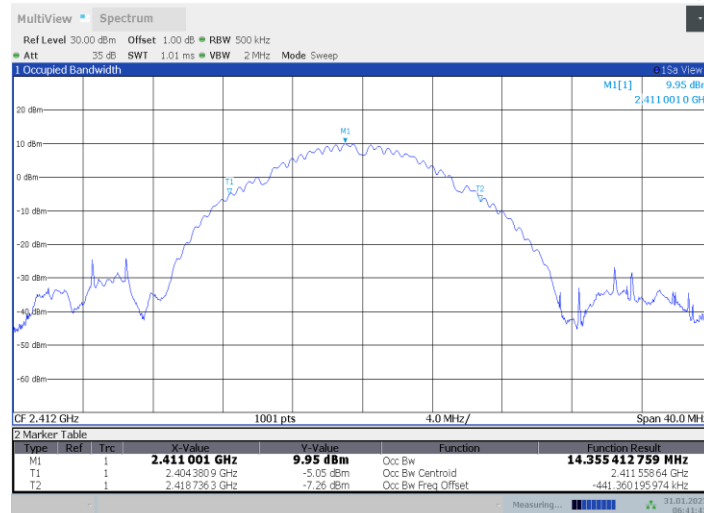
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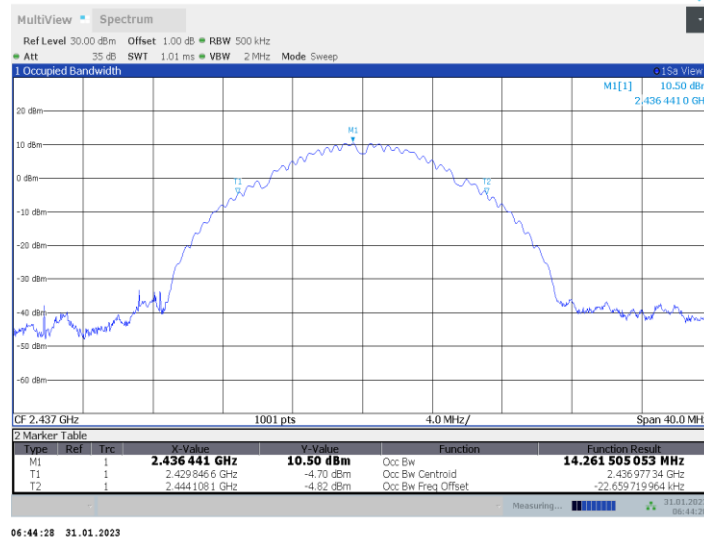
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### Test Graphs

11b\_Ant1\_2412



11b\_Ant1\_2437



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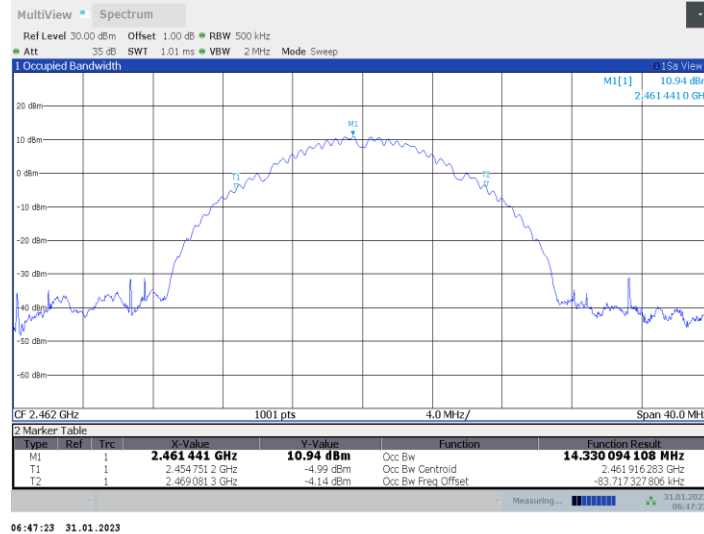
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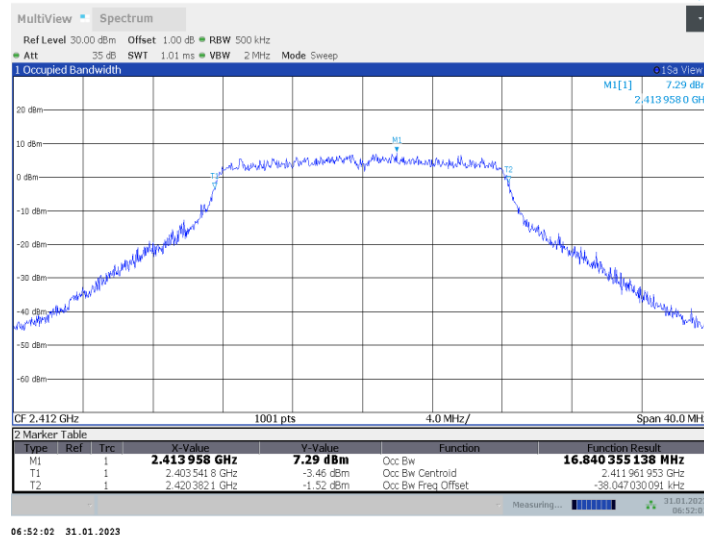
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### 11b\_Ant1\_2462



### 11g-CDD\_Ant0\_2412



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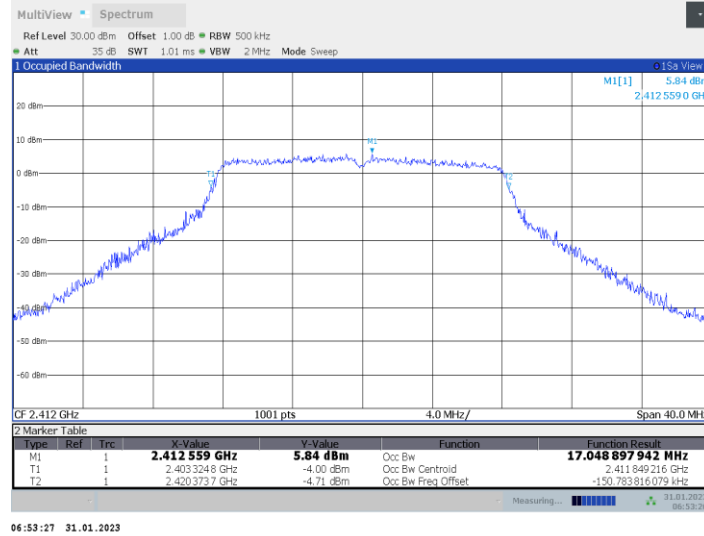
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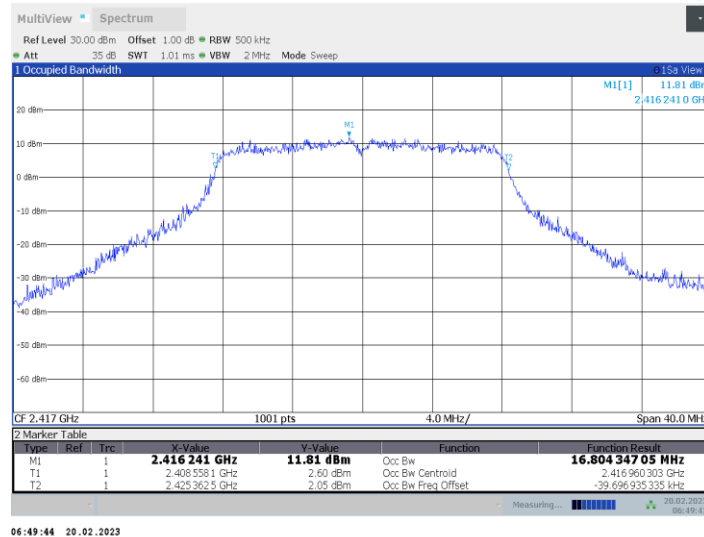
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### 11g-CDD\_Ant1\_2412



### 11g-CDD\_Ant0\_2417



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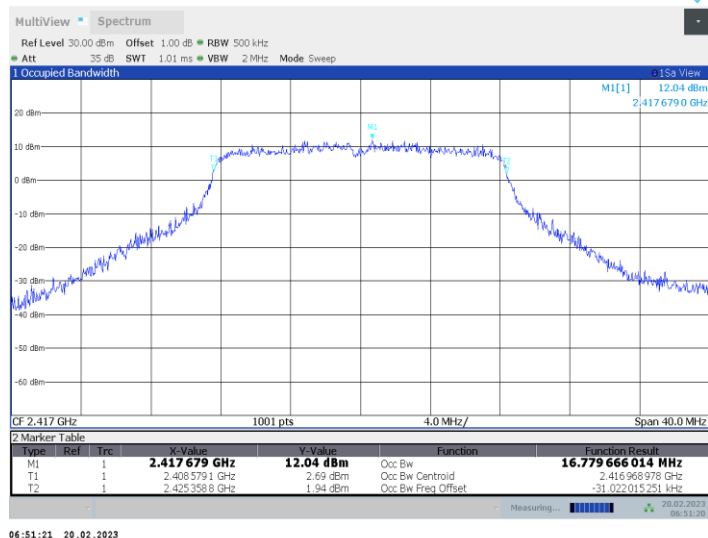


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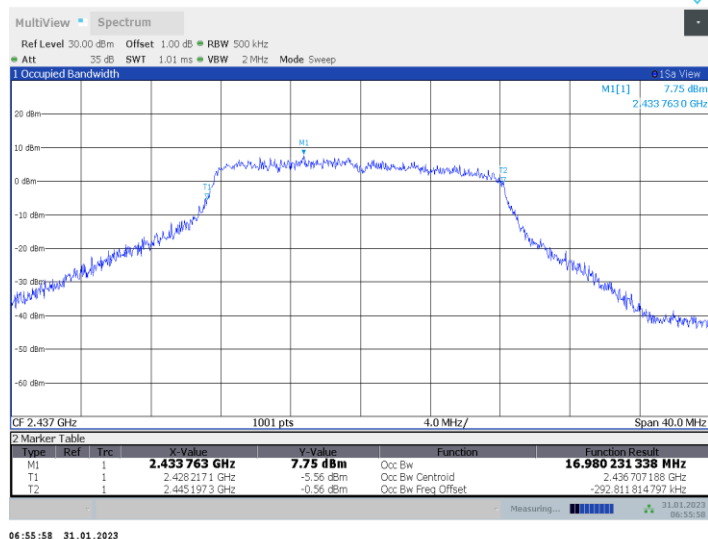
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### 11g-CDD\_Ant1\_2417



### 11g-CDD\_Ant0\_2437



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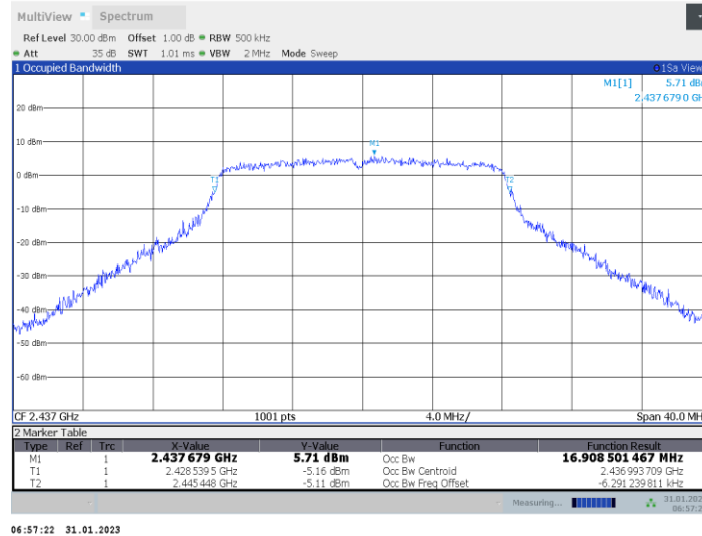
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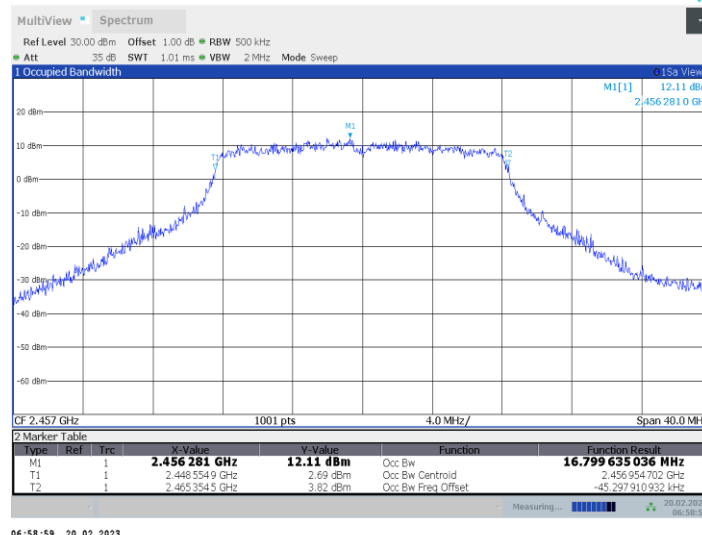
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### 11g-CDD\_Ant1\_2437



06:57:22 31.01.2023

### 11g-CDD\_Ant0\_2457



06:58:59 20.02.2023



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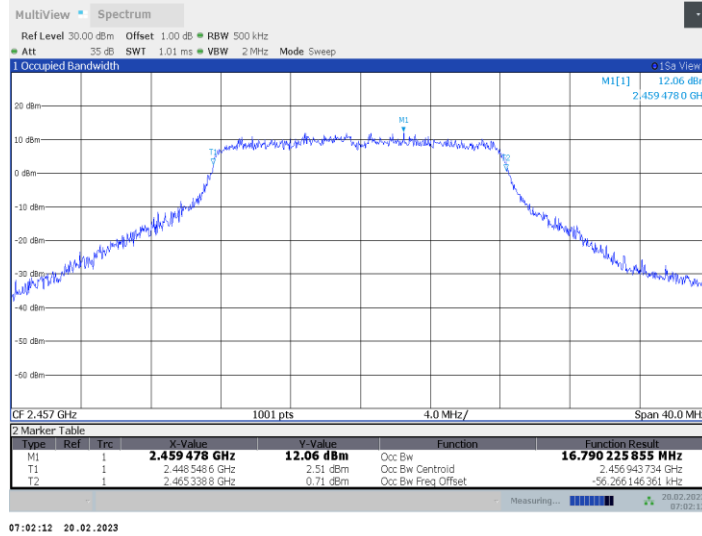
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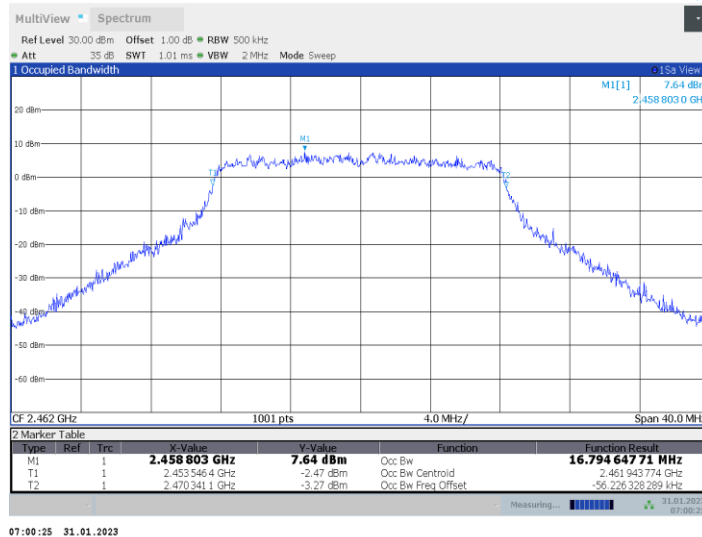
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### 11g-CDD\_Ant0\_2462



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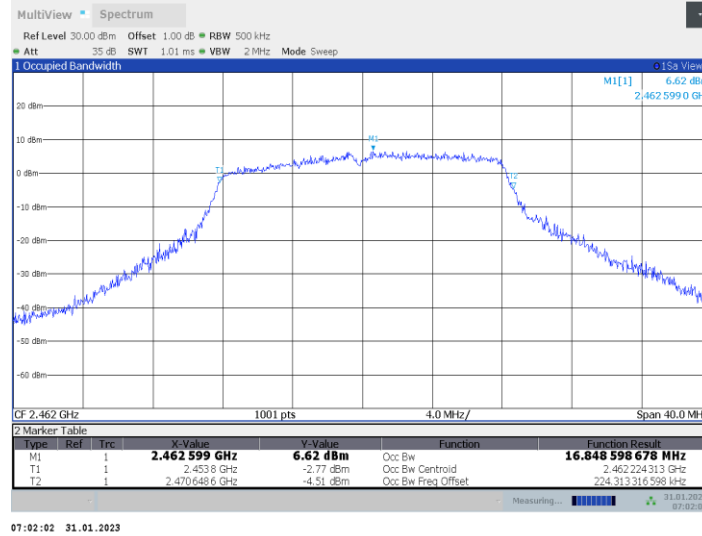
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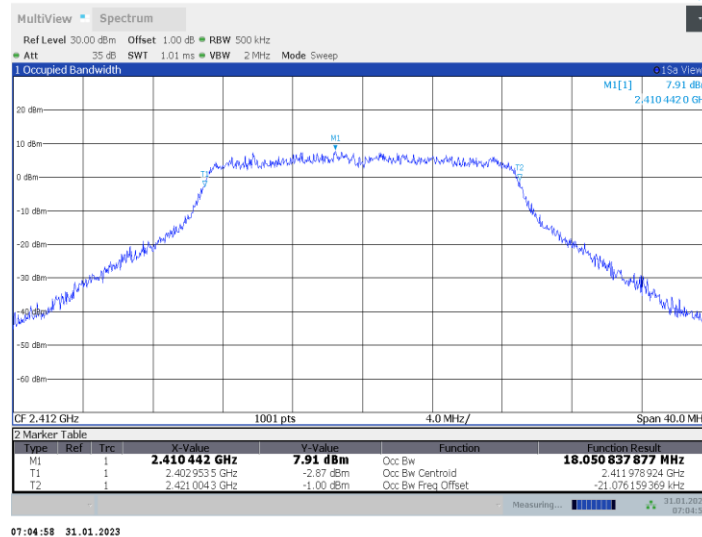
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### 11n20MIMO\_Ant0\_2412



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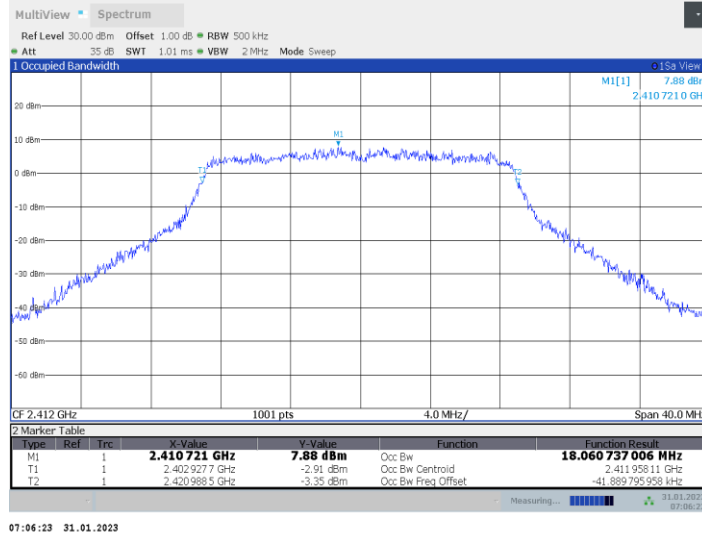
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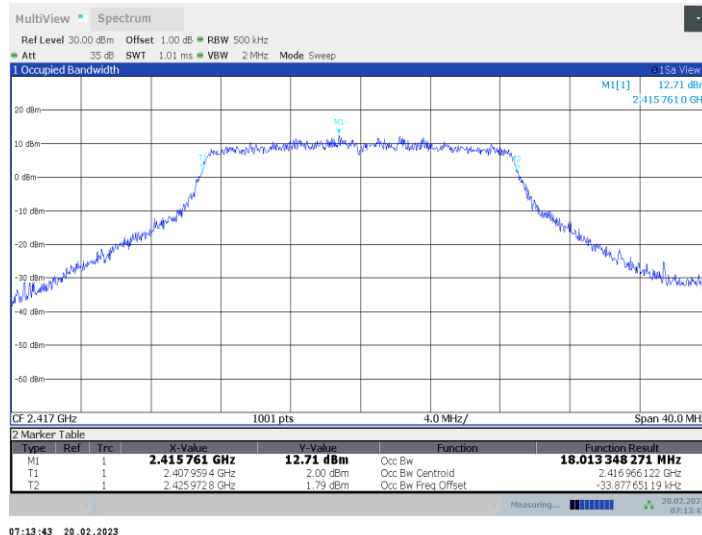
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## 11n20MIMO\_Ant0\_2417



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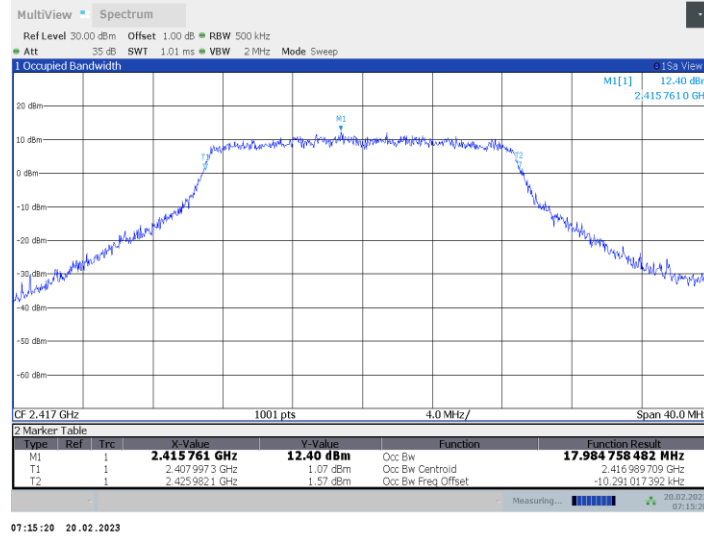


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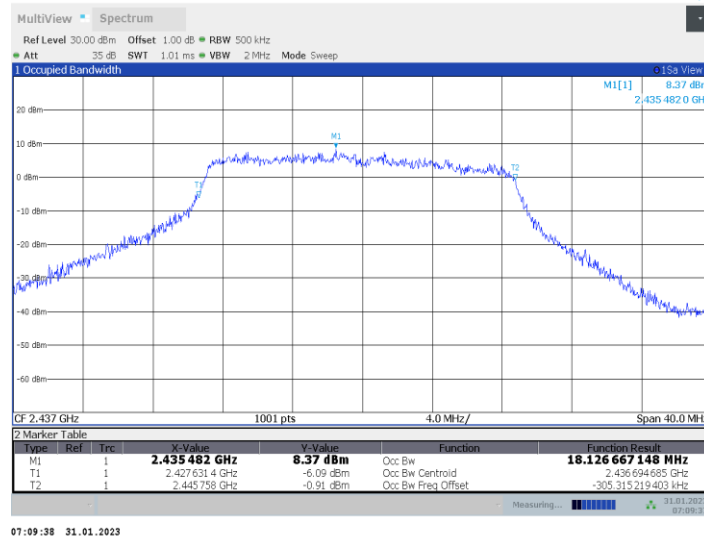
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### 11n20MIMO\_Ant1\_2417



### 11n20MIMO\_Ant0\_2437



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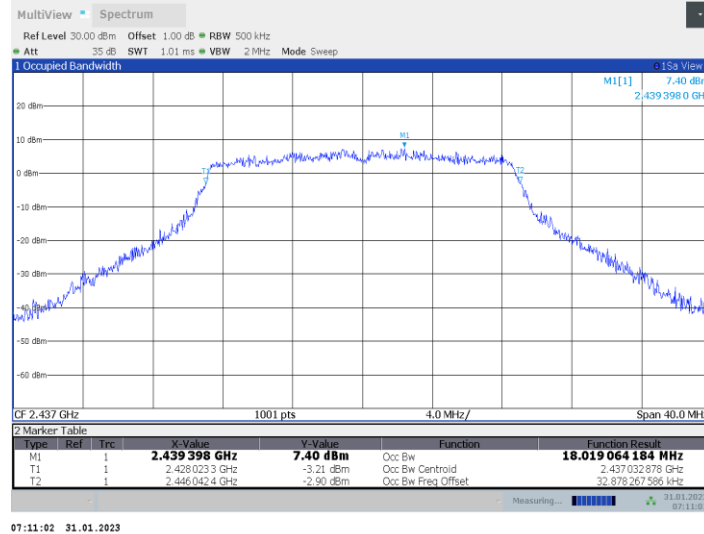
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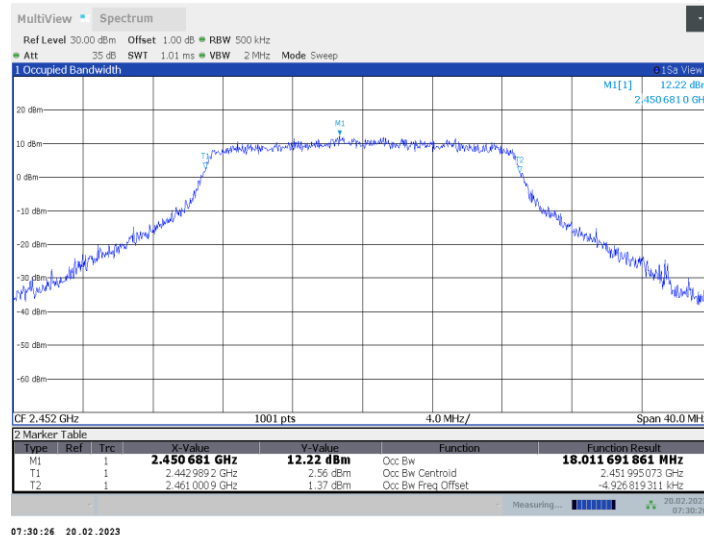
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### 11n20MIMO\_Ant1\_2437



### 11n20MIMO\_Ant0\_2452



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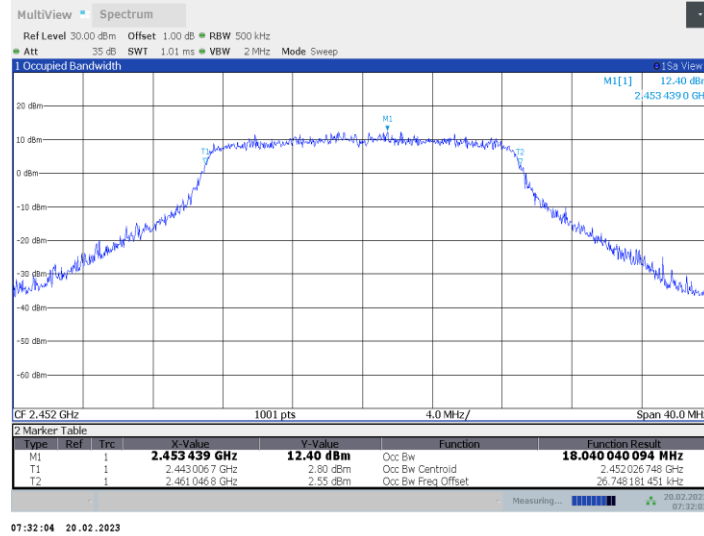
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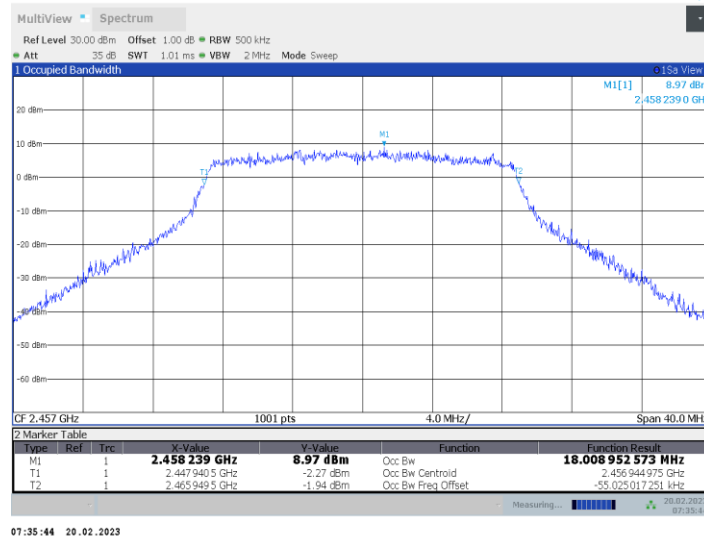
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Page: 66 of 259

### 11n20MIMO\_Ant1\_2452



### 11n20MIMO\_Ant0\_2457



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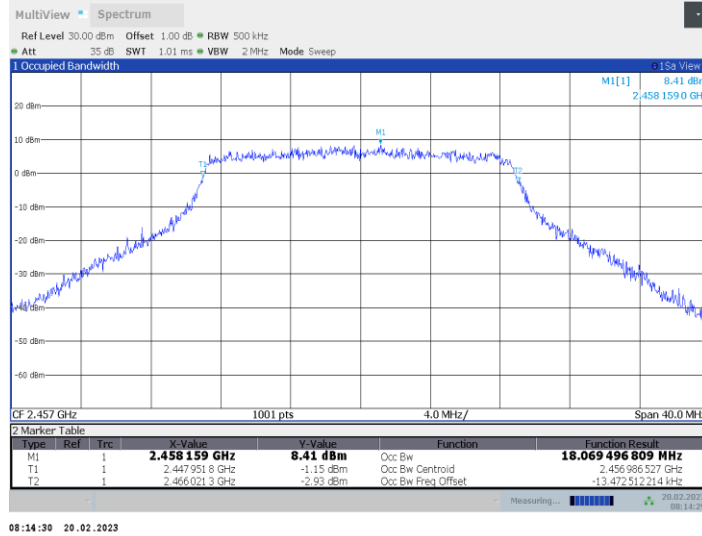
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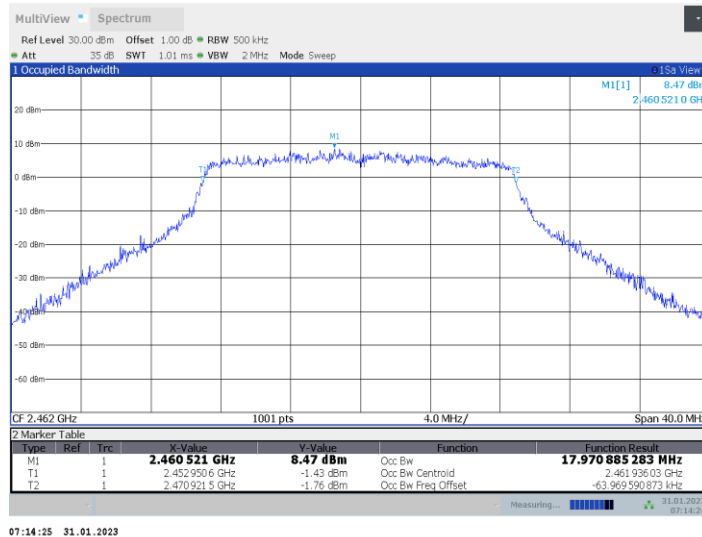
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Page: 67 of 259

### 11n20MIMO\_Ant1\_2457



### 11n20MIMO\_Ant0\_2462



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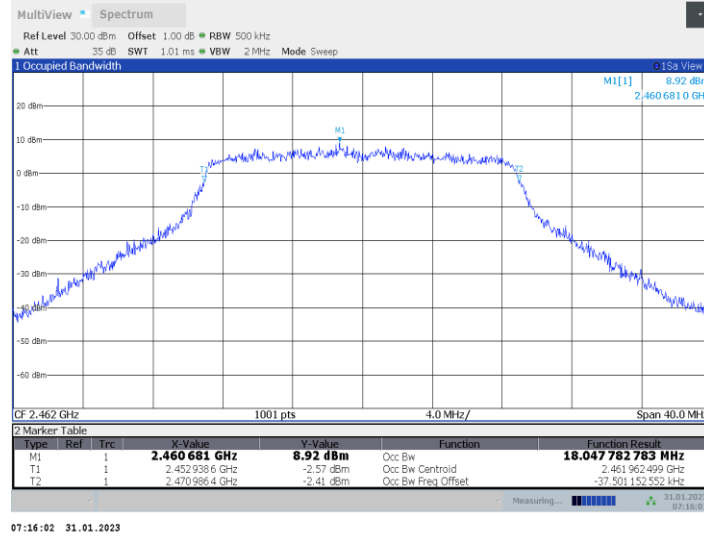
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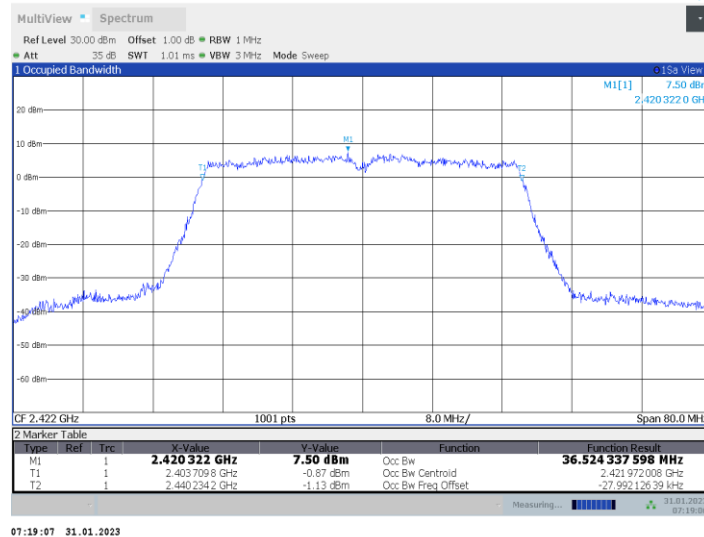
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### 11n20MIMO\_Ant1\_2462



### 11n40MIMO\_Ant0\_2422



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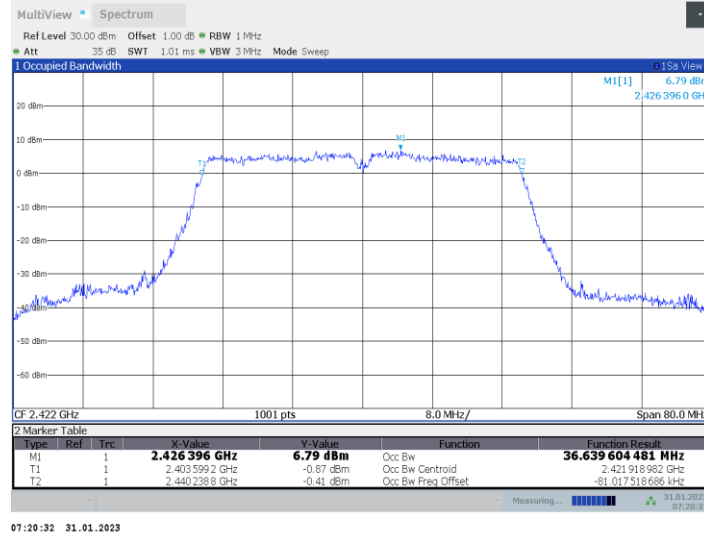


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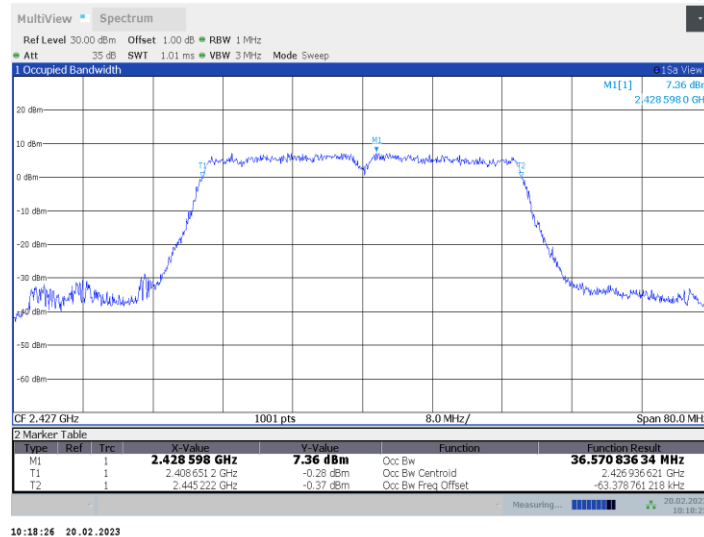
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### 11n40MIMO\_Ant1\_2422



### 11n40MIMO\_Ant0\_2427



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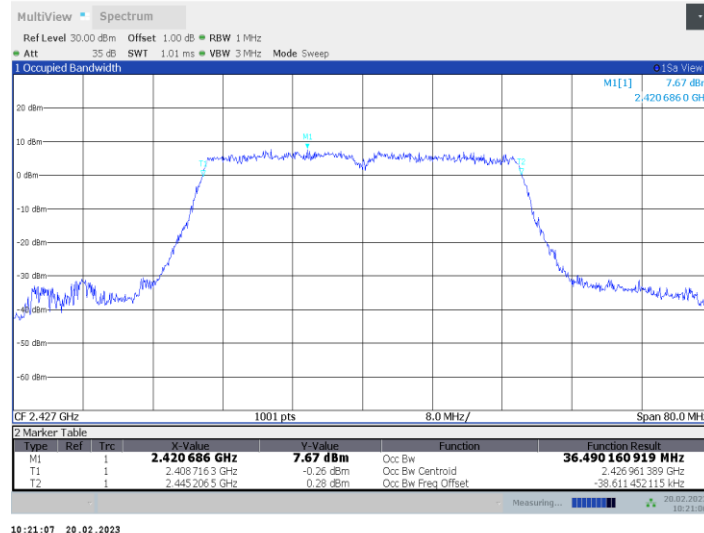
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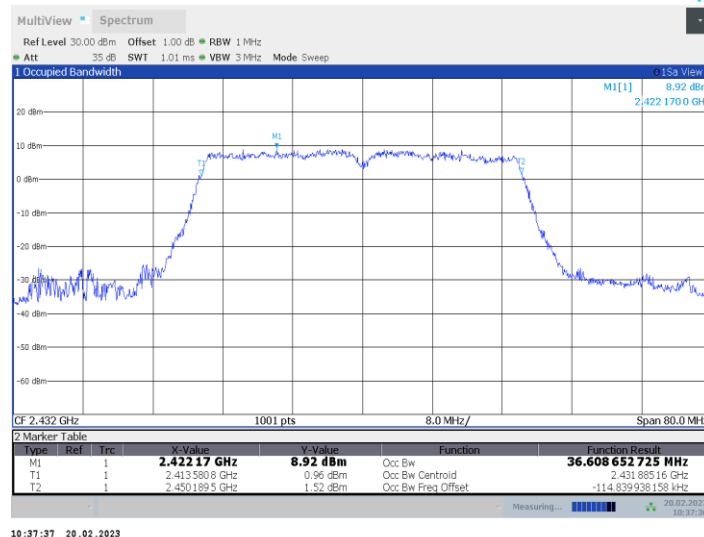
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### 11n40MIMO\_Ant1\_2427



### 11n40MIMO\_Ant0\_2432



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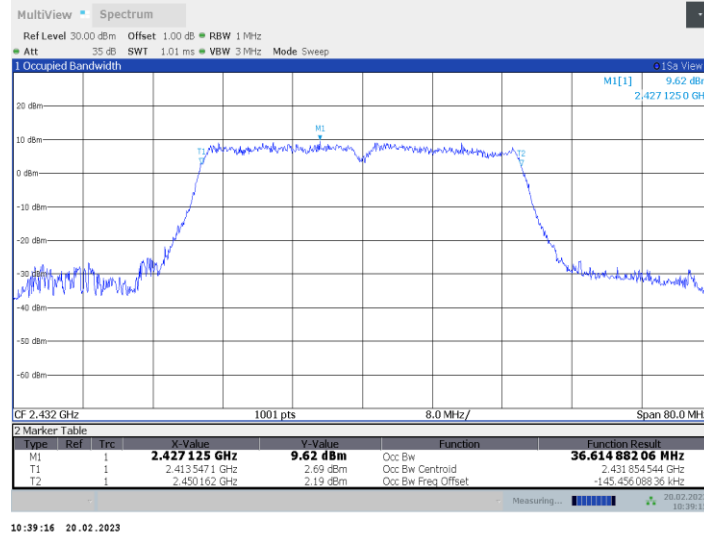
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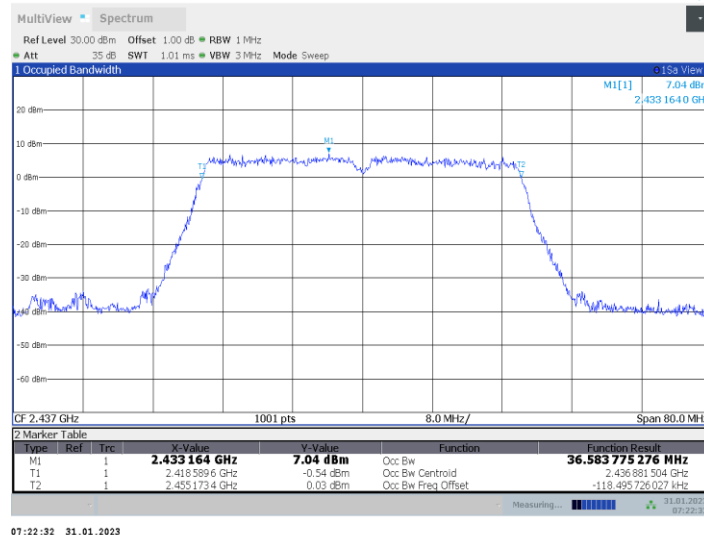
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### 11n40MIMO\_Ant1\_2432



### 11n40MIMO\_Ant0\_2437



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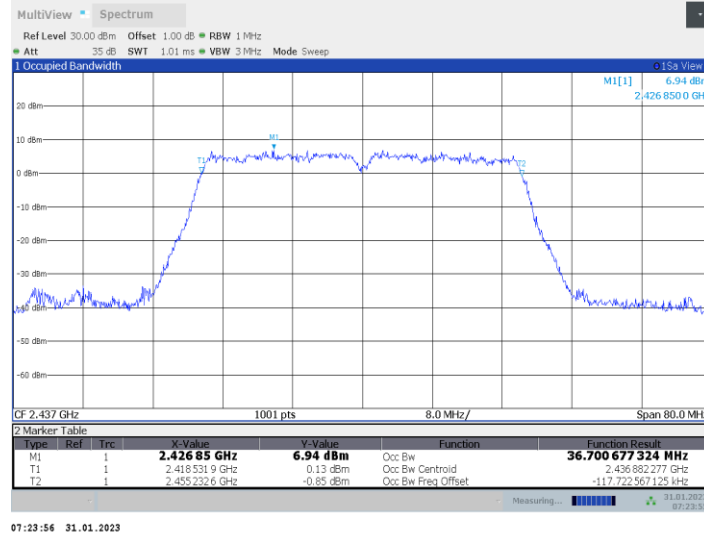
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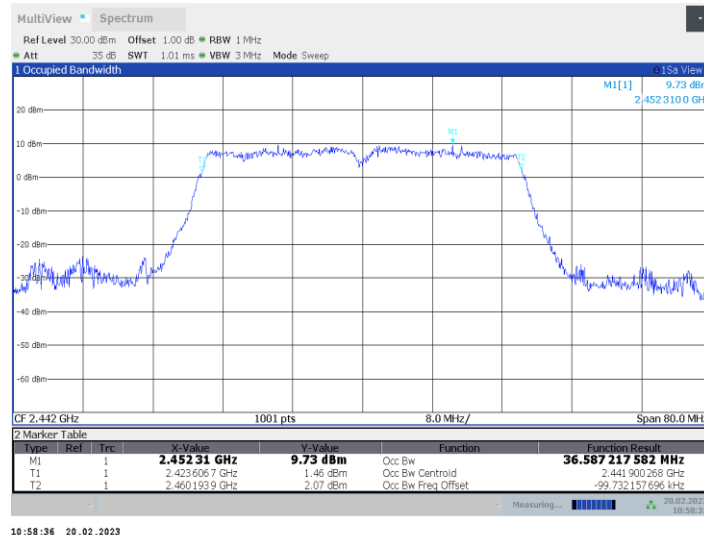
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### 11n40MIMO\_Ant1\_2437



### 11n40MIMO\_Ant0\_2442



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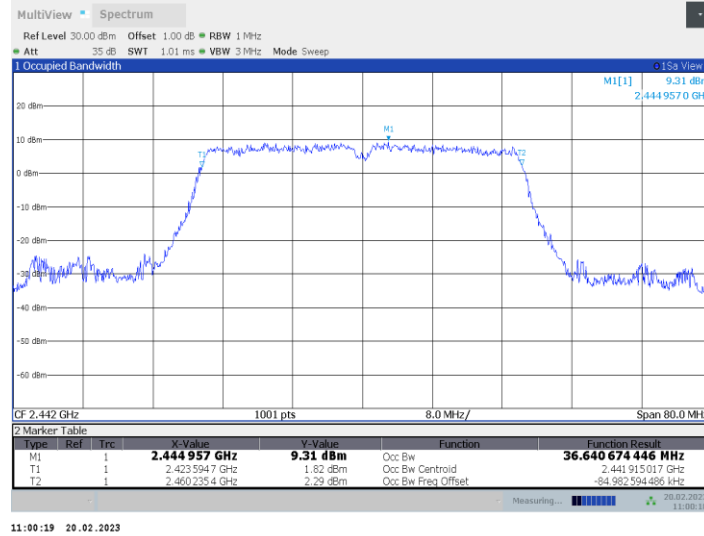
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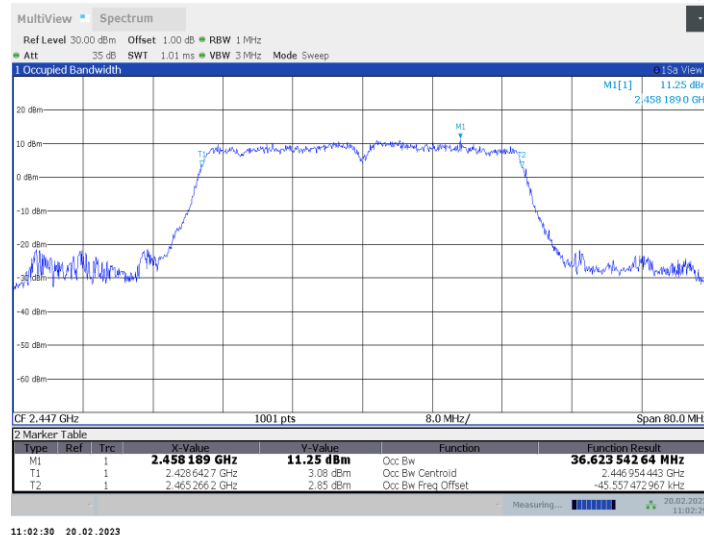
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### 11n40MIMO\_Ant1\_2442



11:00:19 20.02.2023

### 11n40MIMO\_Ant0\_2447



11:02:30 20.02.2023



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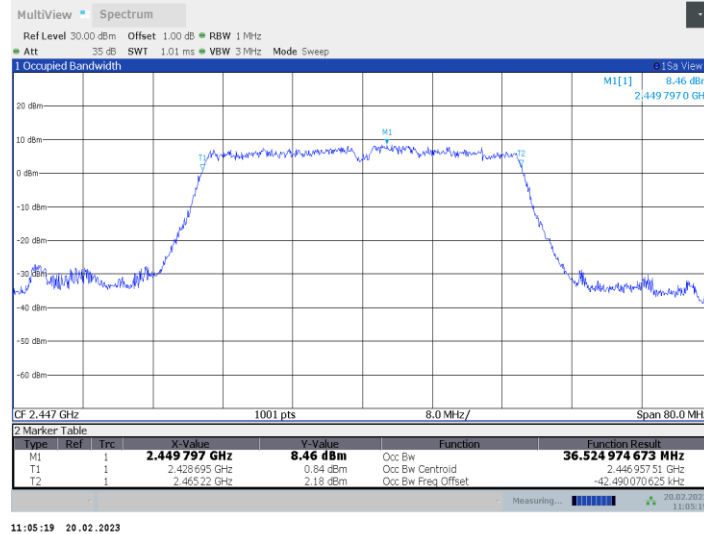


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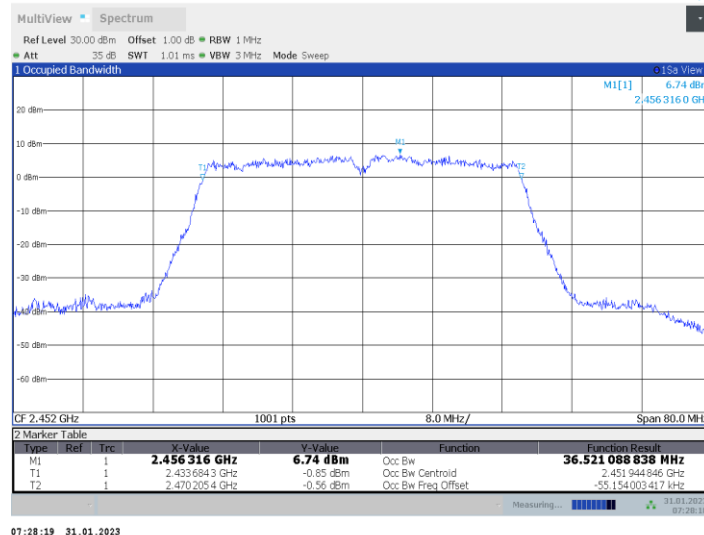
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### 11n40MIMO\_Ant1\_2447



11:05:19 20.02.2023

### 11n40MIMO\_Ant0\_2452



07:28:19 31.01.2023



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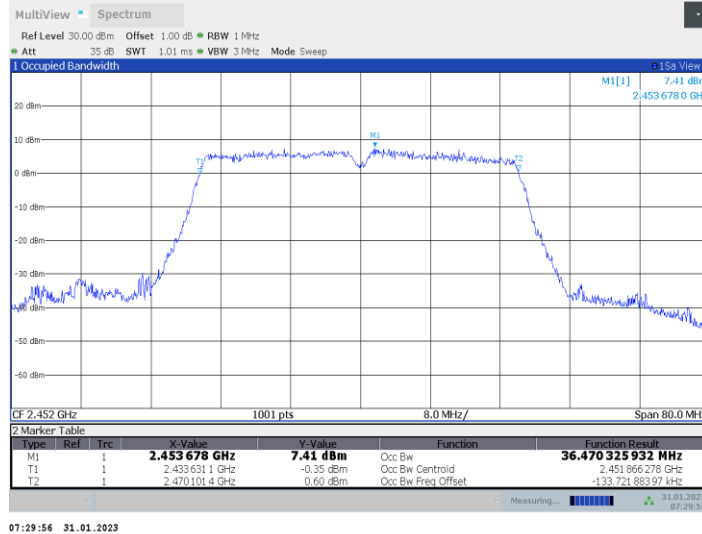
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Rev.: 01

Page: 76 of 259

## Maximum conducted output power

### Test Result Peak

TestMode	Antenna	Frequency[MHz]	Peak Power[dBm]	Conducted Limit[dBm]	Verdict
11b	Ant0	2412	21.01	≤30.00	PASS
		2437	21.23	≤30.00	PASS
		2462	21.12	≤30.00	PASS
11b	Ant1	2412	21.06	≤30.00	PASS
		2437	21.46	≤30.00	PASS
		2462	21.09	≤30.00	PASS
11g-CDD	Ant0	2412	21.10	≤30.00	PASS
	Ant1	2412	21.13	≤30.00	PASS
	total	2412	24.13	≤30.00	PASS
	Ant0	2417	22.03	≤30.00	PASS
	Ant1	2417	22.10	≤30.00	PASS
	total	2417	25.08	≤30.00	PASS
	Ant0	2437	22.11	≤30.00	PASS
	Ant1	2437	22.13	≤30.00	PASS
	total	2437	25.13	≤30.00	PASS
	Ant0	2457	21.98	≤30.00	PASS
	Ant1	2457	22.03	≤30.00	PASS
	total	2457	25.02	≤30.00	PASS
	Ant0	2462	18.10	≤30.00	PASS
	Ant1	2462	18.61	≤30.00	PASS
	total	2462	21.37	≤30.00	PASS
11n20MIMO	Ant0	2412	17.83	≤30.00	PASS
	Ant1	2412	17.86	≤30.00	PASS
	total	2412	20.86	≤30.00	PASS
	Ant0	2417	22.32	≤30.00	PASS
	Ant1	2417	22.39	≤30.00	PASS
	total	2417	25.37	≤30.00	PASS
	Ant0	2437	22.39	≤30.00	PASS
	Ant1	2437	22.41	≤30.00	PASS
	total	2437	25.41	≤30.00	PASS
	Ant0	2452	22.51	≤30.00	PASS
	Ant1	2452	22.61	≤30.00	PASS
	total	2452	25.57	≤30.00	PASS
	Ant0	2457	19.01	≤30.00	PASS
	Ant1	2457	19.21	≤30.00	PASS
	total	2457	22.12	≤30.00	PASS
11n40MIMO	Ant0	2462	18.71	≤30.00	PASS
	Ant1	2462	18.43	≤30.00	PASS
	total	2462	21.58	≤30.00	PASS
	Ant0	2422	19.03	≤30.00	PASS
	Ant1	2422	18.65	≤30.00	PASS
	total	2422	21.85	≤30.00	PASS
	Ant0	2427	19.45	≤30.00	PASS
	Ant1	2427	19.43	≤30.00	PASS
	total	2427	22.45	≤30.00	PASS
	Ant0	2432	21.03	≤30.00	PASS
	Ant1	2432	21.06	≤30.00	PASS
	total	2432	24.06	≤30.00	PASS
	Ant0	2437	22.46	≤30.00	PASS



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