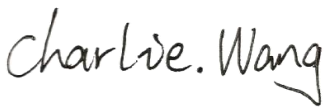
RF Test Report

Applicant:	Quectel Wireless Solutions Co., Ltd.
Address:	Building 5, Shanghai Business Park Phase III (Area B), No.1016 Tianlin Road, Minhang District, Shanghai, China, 200233
Product:	Smart Module
Model No.:	SG560D-WF
Brand Name:	QUECTEL
FCC ID:	XMR2023SG560DWF
Standards:	FCC CFR47 Part 15C
Report No.:	PD20230213RF03
Issue Date:	2024/01/15
Test Result:	PASS *

* **The above equipment has been tested and compliance with the requirement of the relative standards by Hefei Panwin Technology Co., Ltd.**



Reviewed By: Charlie Wang **Approved By:** Alec Yang

Hefei Panwin Technology Co., Ltd.

Floor 1, Zone E, Plant 2#, Mingzhu Industrial Park, No.106 Chuangxin Avenue, High-tech Zone, Hefei City, Anhui Province,China

TEL: +86-0551-63811775

Revision History

Report No.	Version	Description	Issue Date	Note
PD20230213RF03	1	Initial Report	2024/01/15	Valid

Remark:

The customer claimed that the clocking scheme of the module's WiFi unit had been updated, and the old clock scheme continues to provide the clock signal for the entire system except WiFi. After the update, the module is the same everywhere except for the difference in the clock scheme of WiFi. The new XO solution has no RF impact.Therefore, this report verifies the 6dB and 99% Bandwidth and Radiated Band Edges and Radiated Spurious Emission, and other data can be referred to in the original report(Report No.: SEWA2303000041RG03) released by SGS on 2023/05/24.

CONTENTS

Test Summary

No.	Test Case	FCC Rules	Verdict
1	6dB and 99% Bandwidth Measurement	15.247(a)(2)	PASS
2	Radiated Band Edges and Spurious Emission Measurement	15.247(d)	PASS
3	Antenna Requirements	15.203 & 15.247(b)	PASS
Date of Testing:2023/12/07 to 2024/01/11 Date of Sample Received: 2023/12/04			
• We, Hefei Panwin Technology Co., Ltd., would like to declare that the tested sample has been evaluated in accordance with the procedures given in applied standard(s) in **Section 2.3** of this report and shown compliance with the applicable technical standards. • All indications of PASS/FAIL in this report are based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only.			

1 General Information

1.1 Notes of the Test Report

This report is invalid without signature of auditor and approver or with any alterations. The report shall not be partially reproduced without written approval of the testing company. Entrusted test results are only responsible for incoming samples. If there is any objection to the testing report, it shall be raised to the testing company within 15 days from the date of receiving the report. In the test results, "NA" means "not applicable", and the test items marked with "Δ" are subcontracted projects.

1.2 Test Facility

FCC (Designation number: CN1361, Test Firm Registration Number: 473156)

Hefei Panwin Technology Co., Ltd. has been listed on the US Federal Communications Commission list of test facilities recognized to perform measurements.

A2LA (Certificate Number: 6849.01)

Hefei Panwin Technology Co., Ltd. has been listed by American Association for Laboratory Accreditation to perform measurement.

1.3 Testing Laboratory

Company Name	Hefei Panwin Technology Co., Ltd.
Address	Floor 1, Zone E, Plant 2#, Mingzhu Industrial Park, No.106 Chuangxin Avenue, High-tech Zone, Hefei City, Anhui Province,China
Telephone	+86-0551-63811775
Post Code	230031

2 General Description of Equipment under Test

2.1 Details of Application

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

2.2 General Information

Product	Smart Module
Model	SG560D-WF
SN	1. P1Y23141B000037 2. P1Y23123V000012
Hardware Version	R1.1
Software Version	SG560DWFPARO2A04
Antenna Type	External Antenna
Antenna Gain	0.47dBi
Additional Beamforming Gain	NA
Operating voltage range	Typical 4.0Vdc
Type of Modulation	WLAN 802.11b/g/n/ax: DSSS,OFDM,OFDMA
Operating Frequency Range(s)	WLAN 802.11b/g/n HT20/ax HE20: 2412MHz to 2462MHz WLAN 802.11n HT40/ax HE40: 2422MHz to 2452MHz
Note: The declared of product specification for EUT and/or Antenna presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.	

2.3 Applicable Standard(s)

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
- ANSI C63.10-2013

3 Test Condition

3.1 Test Configuration

Test mode

Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture). The worst cases were recorded in this report.

Radiated measurements are performed by rotating the EUT in three different orthogonal test planes (Z, X, Y axis), receiver antenna polarization (horizontal and vertical), the worst emission was found in Z position and the worst case was recorded.

Test Mode	Data Rate(Mbps)
802.11b_CDD	1
802.11g_CDD	6
802.11n HT20_MIMO	MCS0
802.11ax HE20_MIMO	MCS0
802.11n HT40_MIMO	MCS0
802.11ax HE40_MIMO	MCS0

3.2 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	/	/

3.3 Equipment List

Instrument	Manufacturer	Model	Asset No.	Cal. Interval	Cal. Due Date
EMI Test Receiver	R&S	ESR7	PWB0023	1 Year	2024/10/11
Spectrum Analyzer	R&S	FSV3044	PWB0024	1 Year	2024/10/11
Loop Antenna	R&S	HFH2-Z2E	PWB0026	1 Year	2024/10/21
TRILOG Broadband Antenna	Schwarzbeck	VULB9162	PWB0029	1 Year	2024/10/14
Double-Ridged Guide Antenna	ETS-Lindgren	3117	PWB0031	1 Year	2024/10/12
k Type Horn Antenna	Steatite Antennas	QMS-00880	PWB0035	1 Year	2024/10/17
Spectrum Analyzer	KEYSIGHT	N9020B	PWC0055	1 Year	2024/10/11
DC Power	KEYSIGHT	E3640A	PWC0046	1 Year	2024/10/11
Anechoic Chamber	ETS.LINDGREN	Fact 3-2m	PWB0003	3 Years	2024/08/28
Shielded Chamber	Maorui	MR543	PWC0041	3 Years	2026/08/26
Pre-Amplifier	R&S	SCU18F	PWB0034	1 Year	2024/10/11
Pre-Amplifier	R&S	SCU40F1	PWB0036	1 Year	2024/10/11
Pre-Amplifier	COM-MW	DLNA8	PWB0094	1 Year	2024/11/08
Test Software	Tonseced	JS1120-3 V3.2.22	/	/	/
Test Software	R&S	ELEKTRA V4.20.2	/	/	/

3.4 Support Equipment List

Equipment	Manufacturer	Description	Model	Serial Number
EVB	QUECTEL	/	/	/
USB Cable	/	/	/	/
Adapter	Xiamen Xinsenhai Electronics Co., Ltd	Output:12V 60W	P60EB120500	/

3.5 Test Uncertainty

No.	Parameter	Uncertainty
1	DTS Bandwidth	1.9 %
2	Occupied channel bandwidth	1.9 %
3	Unwanted Emissions In Non-restricted Frequency Bands	9kHz-7GHz: 1.21 dB 7GHz-40GHz: 3.31 dB
4	Radiated Spurious Emission	4.46 dB
5	Temperature	3 °C
6	Humidity	1.3 %
7	Supply Voltages	0.006 V

4 Test Items Description

Ambient condition

Shielded Chamber

Temperature [°C]	20.4 to 25.6
Humidity [%RH]	29 to 40
Pressure [kPa]	100.8 to 102.7

Anechoic Chamber

Temperature [°C]	20.1 to 27.1
Humidity [%RH]	30 to 49
Pressure [kPa]	100.8 to 104.1

4.1 6dB and 99% Bandwidth Measurement

4.1.1 Limit of 6dB and 99% Bandwidth

The minimum 6 dB bandwidth shall be at least 500 kHz

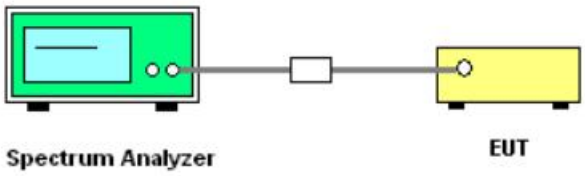
4.1.2 Measuring Instruments

The section 3.3 of List of Measuring Equipment of this test report is used for test.

4.1.3 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) is set 1% to 5% of the 99% OBW and the VBW is set to 3 times of the RBW.
6. Measure and record the results in the test report.

4.1.4 Test Setup



4.1.5 Test Results

See Appendix A.1.

4.2 Radiated Band Edges and Spurious Emission Measurement

4.2.1 Limit of Radiated Band Edges and Spurious Emission

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

4.2.2 Measuring Instruments

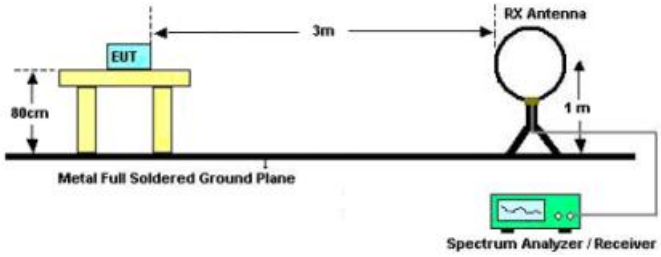
The section 3.3 of List of Measuring Equipment of this test report is used for test.

4.2.3 Test Procedures

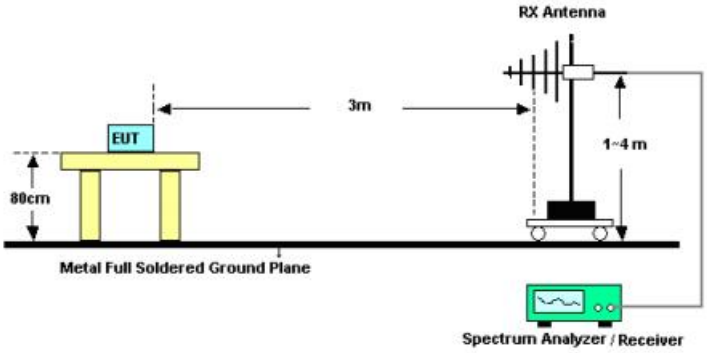
1. The testing follows ANSI C63.10-2013 clause 11.11 & 11.12
2. The EUT was arranged to its worst case and then tune the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better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

4.2.4 Test Setup

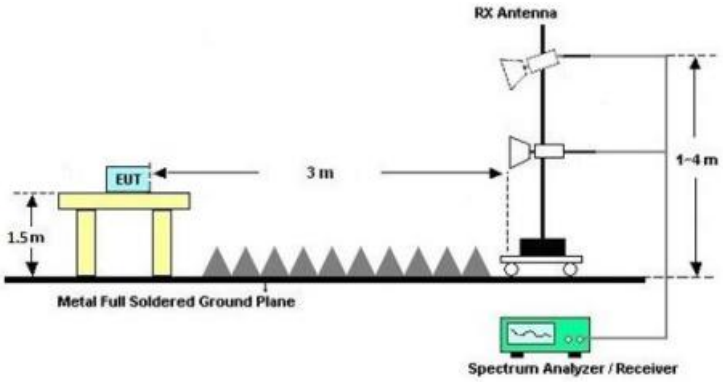
For radiated emissions below 30MHz



For radiated emissions from 30MHz to 1GHz



For radiated emissions above 1GHz



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

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.

4.2.6 Test Result of Radiated Spurious at Band Edges

Please refer to Appendix B.1.

4.2.7 Test Result of Radiated Spurious Emission (30MHz ~ 10th Harmonic or 40GHzwhichever is lower)

Please refer to Appendix B.1.

4.3 Antenna Requirements

4.3.1 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.

4.3.2 Antenna Anti-Replacement Construction

An embedded-in antenna design is used.

4.3.3 Antenna Gain

The antenna peak gain of EUT is less than 6 dBi. Therefore, it is not necessary to reduce maximum peak output power limit.

Appendix A – Test Results of Conducted Test

A.1 6dB and 99% Bandwidth

Test Result 6dB Bandwidth

Test Mode	Antenna	Frequency[MHz]	DTS BW [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
11B-CDD	Ant1	2412	8.400	2407.960	2416.360	0.5	PASS
11B-CDD	Ant2	2412	8.400	2407.960	2416.360	0.5	PASS
11B-CDD	Ant1	2437	8.080	2432.960	2441.040	0.5	PASS
11B-CDD	Ant2	2437	8.080	2432.960	2441.040	0.5	PASS
11B-CDD	Ant1	2462	8.400	2457.600	2466.000	0.5	PASS
11B-CDD	Ant2	2462	8.400	2457.640	2466.040	0.5	PASS
11G-CDD	Ant1	2412	16.480	2403.760	2420.240	0.5	PASS
11G-CDD	Ant2	2412	16.480	2403.760	2420.240	0.5	PASS
11G-CDD	Ant1	2437	16.520	2428.720	2445.240	0.5	PASS
11G-CDD	Ant2	2437	16.480	2428.760	2445.240	0.5	PASS
11G-CDD	Ant1	2462	16.480	2453.720	2470.200	0.5	PASS
11G-CDD	Ant2	2462	16.520	2453.720	2470.240	0.5	PASS
11N20MIMO	Ant1	2412	17.760	2403.120	2420.880	0.5	PASS
11N20MIMO	Ant2	2412	17.760	2403.120	2420.880	0.5	PASS
11N20MIMO	Ant1	2437	17.760	2428.120	2445.880	0.5	PASS
11N20MIMO	Ant2	2437	17.720	2428.120	2445.840	0.5	PASS
11N20MIMO	Ant1	2462	17.680	2453.120	2470.800	0.5	PASS
11N20MIMO	Ant2	2462	17.720	2453.120	2470.840	0.5	PASS
11N40MIMO	Ant1	2422	36.080	2403.840	2439.920	0.5	PASS
11N40MIMO	Ant2	2422	36.080	2404.080	2440.160	0.5	PASS
11N40MIMO	Ant1	2437	35.920	2418.840	2454.760	0.5	PASS
11N40MIMO	Ant2	2437	36.080	2419.080	2455.160	0.5	PASS
11N40MIMO	Ant1	2452	35.680	2433.840	2469.520	0.5	PASS
11N40MIMO	Ant2	2452	35.920	2433.840	2469.760	0.5	PASS
11AX20MIMO	Ant1	2412	18.880	2402.600	2421.480	0.5	PASS
11AX20MIMO	Ant2	2412	18.880	2402.560	2421.440	0.5	PASS
11AX20MIMO	Ant1	2437	18.920	2427.520	2446.440	0.5	PASS
11AX20MIMO	Ant2	2437	18.880	2427.520	2446.400	0.5	PASS
11AX20MIMO	Ant1	2462	18.720	2452.480	2471.200	0.5	PASS
11AX20MIMO	Ant2	2462	18.680	2452.600	2471.280	0.5	PASS
11AX40MIMO	Ant1	2422	37.440	2403.040	2440.480	0.5	PASS
11AX40MIMO	Ant2	2422	37.760	2403.200	2440.960	0.5	PASS

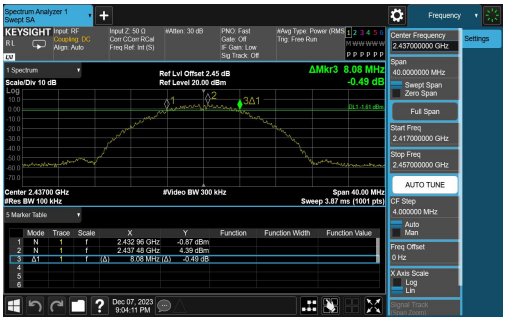
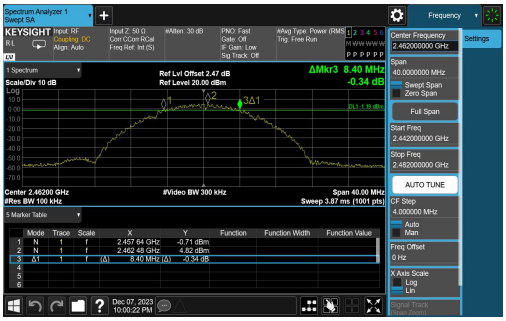
11AX40MIMO	Ant1	2437	37.520	2418.120	2455.640	0.5	PASS
11AX40MIMO	Ant2	2437	37.440	2418.280	2455.720	0.5	PASS
11AX40MIMO	Ant1	2452	37.360	2433.040	2470.400	0.5	PASS
11AX40MIMO	Ant2	2452	37.840	2433.040	2470.880	0.5	PASS

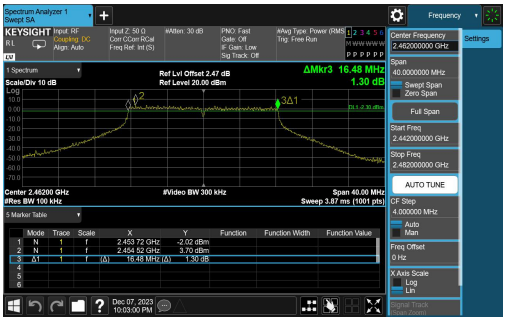
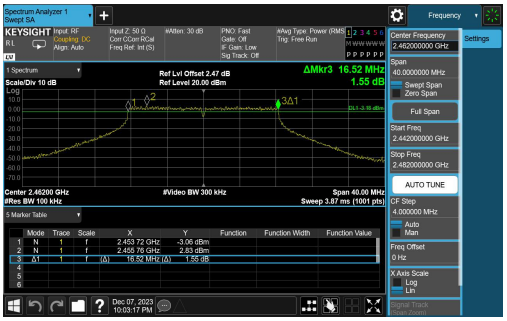
Test Result 99% Bandwidth

Test Mode	Antenna	Channel Frequency[MHz]	OCB [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
11B-CDD	Ant1	2412	13.004	2405.4928	2418.4968	---	---
11B-CDD	Ant2	2412	13.169	2405.4323	2418.6013	---	---
11B-CDD	Ant1	2437	13.013	2430.4264	2443.4394	---	---
11B-CDD	Ant2	2437	12.953	2430.4639	2443.4169	---	---
11B-CDD	Ant1	2462	13.102	2455.3183	2468.4203	---	---
11B-CDD	Ant2	2462	13.156	2455.3739	2468.5299	---	---
11G-CDD	Ant1	2412	16.939	2403.5515	2420.4905	---	---
11G-CDD	Ant2	2412	16.938	2403.5570	2420.4950	---	---
11G-CDD	Ant1	2437	17.005	2428.4838	2445.4888	---	---
11G-CDD	Ant2	2437	16.975	2428.5113	2445.4863	---	---
11G-CDD	Ant1	2462	16.971	2453.4310	2470.4020	---	---
11G-CDD	Ant2	2462	16.960	2453.4772	2470.4372	---	---
11N20MIMO	Ant1	2412	18.097	2402.9776	2421.0746	---	---
11N20MIMO	Ant2	2412	18.151	2402.9657	2421.1167	---	---
11N20MIMO	Ant1	2437	18.185	2427.8903	2446.0753	---	---
11N20MIMO	Ant2	2437	18.131	2427.9529	2446.0839	---	---
11N20MIMO	Ant1	2462	18.115	2452.8631	2470.9781	---	---
11N20MIMO	Ant2	2462	18.124	2452.9058	2471.0298	---	---
11N40MIMO	Ant1	2422	36.053	2403.9518	2440.0048	---	---
11N40MIMO	Ant2	2422	36.162	2403.9884	2440.1504	---	---
11N40MIMO	Ant1	2437	36.181	2418.8647	2455.0457	---	---
11N40MIMO	Ant2	2437	36.177	2418.9226	2455.0996	---	---
11N40MIMO	Ant1	2452	36.077	2433.8616	2469.9386	---	---
11N40MIMO	Ant2	2452	36.152	2433.8977	2470.0497	---	---
11AX20MIMO	Ant1	2412	18.947	2402.5383	2421.4853	---	---
11AX20MIMO	Ant2	2412	18.993	2402.5215	2421.5145	---	---
11AX20MIMO	Ant1	2437	18.996	2427.4796	2446.4756	---	---
11AX20MIMO	Ant2	2437	18.990	2427.4905	2446.4805	---	---
11AX20MIMO	Ant1	2462	18.973	2452.4673	2471.4403	---	---
11AX20MIMO	Ant2	2462	18.959	2452.4912	2471.4502	---	---
11AX40MIMO	Ant1	2422	37.806	2403.0975	2440.9035	---	---

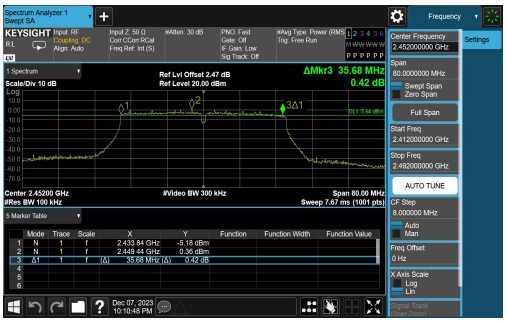
11AX40MIMO	Ant2	2422	37.761	2403.1526	2440.9136	---	---
11AX40MIMO	Ant1	2437	37.882	2418.0166	2455.8986	---	---
11AX40MIMO	Ant2	2437	37.820	2418.0899	2455.9099	---	---
11AX40MIMO	Ant1	2452	37.745	2433.0467	2470.7917	---	---
11AX40MIMO	Ant2	2452	37.822	2433.0520	2470.8740	---	---

Test Graphs_6dB Bandwidth

11B-CDD-Ant1-2412-PASS	11B-CDD-Ant2-2412-PASS
	
11B-CDD-Ant1-2437-PASS	11B-CDD-Ant2-2437-PASS
	
11B-CDD-Ant1-2462-PASS	11B-CDD-Ant2-2462-PASS
	

11G-CDD-Ant1-2412-PASS	11G-CDD-Ant2-2412-PASS
	
11G-CDD-Ant1-2437-PASS	11G-CDD-Ant2-2437-PASS
	
11G-CDD-Ant1-2462-PASS	11G-CDD-Ant2-2462-PASS
	
11N20MIMO-Ant1-2412-PASS	11N20MIMO-Ant2-2412-PASS
	

11N20MIMO-Ant1-2437-PASS	11N20MIMO-Ant2-2437-PASS
	
11N20MIMO-Ant1-2462-PASS	**11N20MIMO-Ant2-2462-PASS**
	
11N40MIMO-Ant1-2422-PASS	**11N40MIMO-Ant2-2422-PASS**
	
11N40MIMO-Ant1-2437-PASS	**11N40MIMO-Ant2-2437-PASS**
	

11N40MIMO-Ant1-2452-PASS	11N40MIMO-Ant2-2452-PASS
	
11AX20MIMO-Ant1-2412-PASS	11AX20MIMO-Ant2-2412-PASS
	
11AX20MIMO-Ant1-2437-PASS	11AX20MIMO-Ant2-2437-PASS
	
11AX20MIMO-Ant1-2462-PASS	11AX20MIMO-Ant2-2462-PASS