TEST REPORT

No.B23N00972-WLAN 2.4GHz

for

Robert Bosch GmbH

Virtual Cockpit Unit

Model Name: VCUNH1

with

Hardware Version: C3

Software Version: SQBR4-20

FCC ID: 2AUXS-VCUNH1

Issued Date: 2023-09-14

Designation Number: CN1210

Note:

The test results in this test report relate only to the devices specified in this report. This report shall not be reproduced except in full without the written approval of SAICT.

Test Laboratory:

SAICT, Shenzhen Academy of Information and Communications Technology

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REPORT HISTORY

Report Number	Revision	Description	Issue Date
B23N00972-WLAN 2.4GHz	Rev.0	1st edition	2023-09-14

Note: the latest revision of the test report supersedes all previous versions.

CONTENTS

1. Summary of Test Report

1.1. Test Items

Description	Virtual Cockpit Unit
Model Name	VCUNH1
Applicant's name	Robert Bosch GmbH
Manufacturer's Name	Robert Bosch GmbH

1.2. Test Standards

FCC Part15-2021; ANSI C63.10-2013; KDB 662911-V02r01.

1.3. Test Result

Pass

Please refer to "5.2. Test Results"

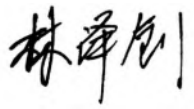
1.4. Testing Location

Address: Building G, Shenzhen International Innovation Center, No.1006 Shennan Road, Futian District, Shenzhen, Guangdong, P. R. China 518000

1.5. Project data

Testing Start Date:	2023-07-21
Testing End Date:	2023-09-11

1.6. Signature



Lin Zechuang

(Prepared this test report)

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(Reviewed this test report)

Zhang Bojun

(Approved this test report)

2. Client Information

2.1. Applicant Information

Company Name:	Robert Bosch GmbH
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Contact Person	Dirk Zamow
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2.2. Manufacturer Information

Company Name:	Robert Bosch GmbH
Address:	Robert-Bosch-Str. 200, 31139 Hildesheim, Germany
Contact Person	Dirk Zamow
E-Mail	Dirk.Zamow@de.bosch.com
Telephone:	+49 5121 49-2608
Fax:	/

3. Equipment Under Test (EUT) and Ancillary Equipment (AE)

3.1. About EUT

Description	Virtual Cockpit Unit
Model Name	VCUNH1
RF Protocol	IEEE 802.11b/g/n-HT20/ax-HE20
Operating Frequency	ISM 2412MHz~2462MHz
Type of Modulation	DSSS/CCK/OFDM/OFDMA
Antenna Type	Integrated antenna
Antenna Gain	SISO: Antenna 0: 5.2dBi; Antenna 1: 5.57dBi. Directional Gain: 8.4dBi (see Note1)
Power Supply	13.5V DC by External Power Supply
FCC ID	2AUXS-VCUNH1
IC	25847-VCUNH1
Condition of EUT as received	No abnormality in appearance

Note1: The device is connected with two antennas (RF0 and RF1).
Internal antenna(RF0) has no antenna connector. External antenna(RF1) uses a unique Single High-Speed FAKRA Mini 1 pin-Rosenberger connector. The internal antenna RF0 is shared with Wifi via Time Division Multiplexing. The antennas are used with the following frequencies.

- RF0(Ant0) is for internal antenna which supports BT and Wifi (2.4GHz and 5GHz).
- RF1(Ant1) is for external antenna which supports only Wifi (2.4GHz and 5GHz).

According to customer description, antenna gain calculation for WLAN modes as described in KDB 662911 D01, sub-clause F)2)d)(i).
Directional gain = 10log $[(10^{G1/20} + 10^{G2/20} + \ldots + 10^{GN/20})^2 /NANT]$dBi =10 log $[(10^{5.2/20} + 10^{5.57/20})^2 /2]$dBi = 8.4dBi.
Note2: Components list, please refer to documents of the manufacturer; it is also included in the original test record of Shenzhen Academy of Information and Communications Technology.

3.2. Internal Identification of EUT used during the test

EUT ID*	SN or IMEI	HW Version	SW Version	Date of Receipt
UT02aa	9000002	C3	SQBR4-20	2023-06-28
UT03aa	9000004	C3	SQBR4-20	2023-06-28

*EUT ID: is used to identify the test sample in the lab internally.
UT02aa is used for conduction test, UT03aa is used for radiation test.

3.1. Internal Identification of AE used during the test

AE No.	Description	AE ID*
AE1	DC power supply	Aa01a
AE2	Data Cable	Ca01a
AE3	Power Cable	Ba01a
AE4	OptoUSB-2.0 Transceiver	Ha01a

AE1

Model	PCR1000LA
Manufacturer	KIKUSUI

AE2

Model	J6 HSAL-II
Manufacturer	MOLEX

AE3

Model	J2 56 way STAK50H SYSTEM
Manufacturer	/

AE4

Model	OptoUSB-2.0
Manufacturer	Messtechnik

*AE ID and AE Label: is used to identify the test sample in the lab internally.

3.3. General Description

The Equipment under Test (EUT) is a model of Virtual Cockpit Unit with integrated antenna.
Manual and specifications of the EUT were provided to fulfil the test.
Samples undergoing test were selected by the client.

4. Reference Documents

4.1. Documents supplied by applicant

EUT feature information is supplied by the applicant or manufacturer, which is the basis of testing.

4.2. Reference Documents for testing

The following documents listed in this section are referred for testing.

Reference	Title	Version
FCC Part15	FCC CFR 47, Part 15, Subpart C: 15.205 Restricted bands of operation; 15.209 Radiated emission limits, general requirements; 15.247 Operation within the bands 902–928MHz, 2400–2483.5 MHz, and 5725–5850 MHz	2021
ANSI C63.10	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices	2013
KDB 662911	Emissions Testing of Transmitters with Multiple Outputs in the Same Band (e.g., MIMO, Smart Antenna, etc)	V02r01

5. Test Results

5.1. Testing Environment

Normal Temperature: 15~35℃

Relative Humidity: 20~75%

5.2. Test Results

No	Test cases	Sub-clause of Part 15C	Verdict
0	Antenna Requirement	15.203	**P**
1	Maximum Output Power	15.247 (b)	**P**
2	Peak Power Spectral Density	15.247 (e)	**P**
3	6dB Bandwidth	15.247 (a)	**P**
4	Band Edges Compliance	15.247 (d)	**P**
5	Conducted Emission	15.247 (d)	**P**
6	Radiated Emission	15.247, 15.205, 15.209	**P**

See **ANNEX A** for details.

5.3. Statements

SAICT has evaluated the test cases requested by the applicant/manufacturer as listed in section 5.2 of this report, for the EUT specified in section 3, according to the standards or reference documents listed in section 4.2.

Disclaimer:

A. After confirmation with the customer, the sample information provided by the customer may affect the validity of the measurement results in this report, and the impact and consequences arising therefrom shall be borne by the customer.

B. The samples in this report are provided by the customer, and the test results are only applicable to the samples received.

6. Test Equipments Utilized

Conducted test system

No.	Equipment	Model	Serial Number	Manufacturer	Calibration date	Calibration Period
1	Vector Signal Analyzer	FSV40	100903	Rohde & Schwarz	2022-12-29	1 year
2	Power Sensor	U2021XA	MY55430013	Keysight	2022-12-29	1 year
3	Data Acquisition	U2531A	TW55443507	Keysight	/	/
4	RF Control Unit	JS0806-2	21C8060398	Tonscend	2023-05-08	1 year
5	Shielding Room	S81	CT000986-1344	ETS-Lindgren	2021-09-13	5 years

Radiated test system

9K-30MHz, 30MHz-1GHz, 18GHz-26.5GHz:

No.	Equipment	Model	Serial Number	Manufacturer	Calibration date	Calibration Period
1	Test Receiver	ESR7	101676	Rohde & Schwarz	2022-11-24	1 year
2	Spectrum Analyzer	FSV40	101192	Rohde & Schwarz	2023-01-12	1 year
3	BiLog Antenna	3142E	0224831	ETS-Lindgren	2021-05-28	3years
4	Horn Antenna	3117	00066577	ETS-Lindgren	2022-04-18	3 years
5	Horn Antenna	QSH-SL-18-26 -S-20	17013	Q-par	2023-02-02	3 years
6	Horn Antenna	QSH-SL-18-40 -K-SG	15979	Q-par	2021-01-30	3 years
7	Anechoic Chamber	FACT3-2.0	1285	ETS-Lindgren	2023-05-29	2 years
8	Loop Antenna	HLA6120	35779	TESEQ	2022-05-13	3 years

1GHz-18GHz:

No.	Equipment	Model	Serial Number	Manufacturer	Calibration date	Calibration Period
1	Test Receiver	FSV40-N	101655	Rohde & Schwarz	2023-05-03	1 year
2	BiLog Antenna	VULB 9163	9163-330	Schwarzbeck	2021-03-23	3 year
3	Horn Antenna	3117	00227733	ETS-lindgren	2023-03-16	3 years
4	Anechoic Chamberr	SAC3-1.2	TJ2359-Q19 22	ETS-Lindgren	2022-09-05	2 years
5	Filter	HPF_3G18G-SMA	SKET	/	/	/
6	Filter	HPF_6.3G21G -SMA	SKET	/	/	/

Test software

No.	Equipment	Manufacturer	Version
1	JS1120-3	Tonscend	3.3
2	EMC32	Rohde & Schwarz	10.50.40

EUT is engineering software provided by the customer to control the transmitting signal.
The EUT was programmed to be in continuously transmitting mode.

7. Laboratory Environment

Shielded room

Temperature	Min. = 15 ˚C, Max. = 35 ˚C
Relative humidity	Min. = 20 %, Max. = 75 %
Shielding effectiveness	0.014MHz-1MHz> 60 dB; 1MHz-18000MHz>90 dB
Electrical insulation	> 2MΩ
Ground system resistance	< 4 Ω

Anechoic chamber (FACT3-2.0)

Temperature	Min. = 15 ˚C, Max. = 35 ˚C
Relative humidity	Min. = 20 %, Max. = 75 %
Shielding effectiveness	0.014MHz-1MHz> 60 dB; 1MHz-18000MHz>90 dB
Electrical insulation	> 2MΩ
Ground system resistance	< 4 Ω
Normalised site attenuation (NSA)	<±4 dB, 3 m distance, from 30 to 1000 MHz
Voltage Standing Wave Ratio (VSWR)	≤ 6 dB, from 1 to 18 GHz, 3m distance
Uniformity of field strength	Between 0 and 6 dB, from 80 to 6000 MHz

Anechoic chamber (SAC3-1.2)

Temperature	Min. = 15 ˚C, Max. = 35 ˚C
Relative humidity	Min. = 20 %, Max. = 75 %
Shielding effectiveness	0.014MHz-1MHz> 60 dB; 1MHz-18000MHz>90 dB
Electrical insulation	> 2MΩ
Ground system resistance	< 4 Ω
Voltage Standing Wave Ratio (VSWR)	≤ 6 dB, from 1 to 18 GHz, 3m distance
Uniformity of field strength	Between 0 and 6 dB, from 80 to 6000 MHz

8. Measurement Uncertainty

Test Name	Uncertainty (*k*=2)	
1. Maximum Peak Output Power	1.32dB	
2. Peak Power Spectral Density	1.32dB	
3. 6dB Bandwidth	4.56kHz	
4. Band Edges Compliance	1.92dB	
5. Transmitter Spurious Emission - Conducted	30MHz≤f<1GHz	1.41dB
	1GHz≤f<7GHz	1.92dB
	7GHz≤f<13GHz	2.31dB
	13GHz≤f≤26GHz	2.61dB
6. Transmitter Spurious Emission - Radiated	9kHz≤f<30MHz	1.70dB
	30MHz≤f<1GHz	4.80dB
	1GHz≤f<18GHz	4.88dB
	18GHz≤f≤40GHz	2.36dB

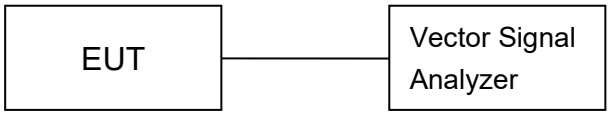
ANNEX A: Detailed Test Results

Test Configuration

The measurement is made according to ANSI C63.10.

1) Conducted Measurements

1. Connect the EUT to the test system correctly.
2. Set the EUT to the required work mode.
3. Set the EUT to the required channel.
4. Set the spectrum analyzer to start measurement.
5. Record the values.

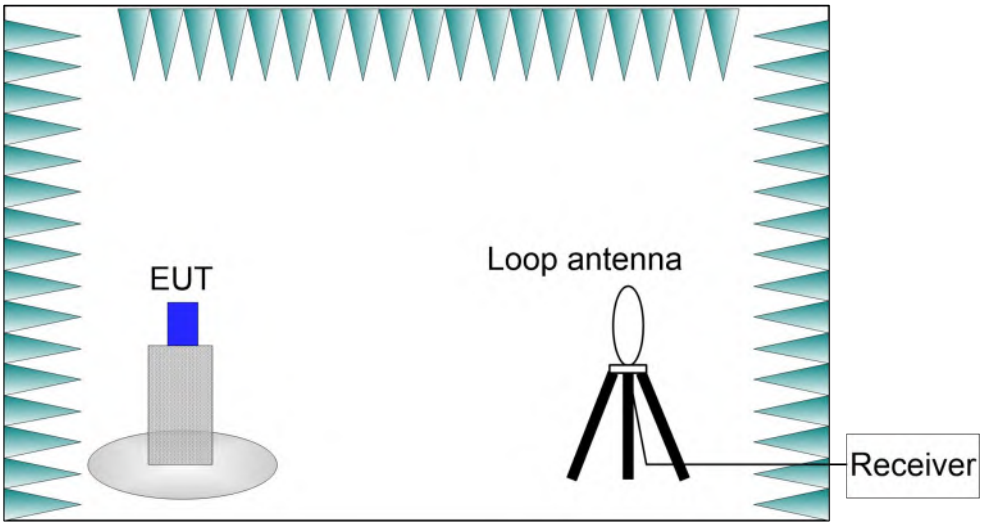


2) Radiated Measurements

Test setup:

9kHz-30MHz：

The EUT are measured in a anechoic chamber. The EUT is placed on a non-conductive stand of 80cm high, the External antenna of EUT and EUT are placed 50cm apart center to center on the same plane, and at a measurement distance of 3m from the receiving antenna. The center of the receiving loop antenna is 1.0 meter above the ground. The test setup refers to figure below. During the tests, Detected emissions were maximized at each frequency by rotating the EUT and adjusting the receiver antenna polarization.

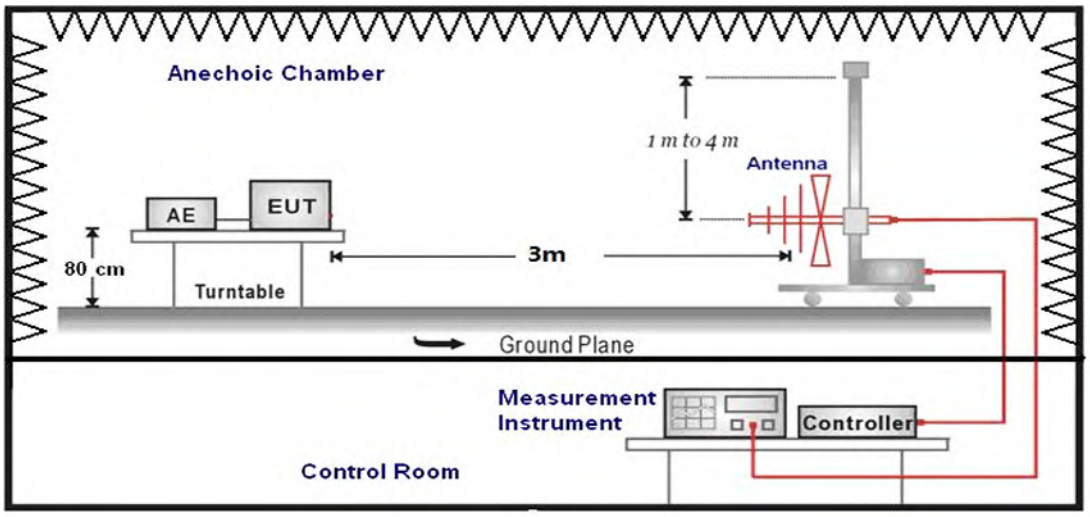


30MHz-1GHz:

The EUT are measured in a anechoic chamber. The EUT is placed on a non-conductive stand of 80cm high, the external antenna of EUT and EUT are placed 50cm apart center to center on the same plane, and at a measurement distance of 3m from the receiving antenna. The center of the

receiving antenna is 1.0 meter to 4.0 meter above the ground. The test setup refers to figure below. Detected emissions were maximized at each frequency by rotating the EUT and adjusting the receiver antenna polarization.

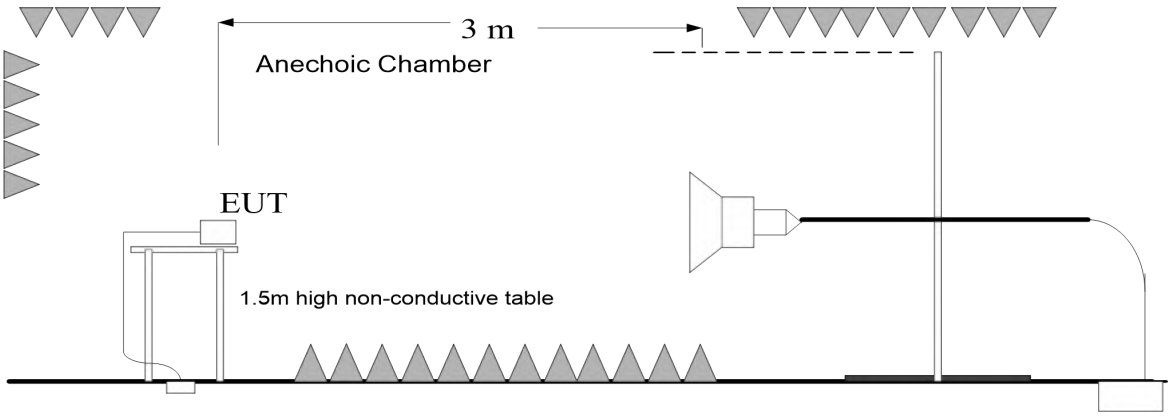
30MHz-1GHz:



1GHz-40GHz：

The EUT are measured in a anechoic chamber. The EUT is placed on a non-conductive stand of 1.5 meter high, the External antenna of EUT and EUT are placed 50cm apart center to center on the same plane, and at a measurement distance of 3m from the receiving antenna. The center of the receiving loop antenna is 1.5 meter above the ground. The test setup refers to figure below. During the tests, Detected emissions were maximized at each frequency by rotating the EUT and adjusting the receiver antenna polarization.

1GHz-40GHz:



A.0 Antenna requirement

Measurement Limit:

Standard	Requirement
FCC CRF Part 15.203	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 shall be considered sufficient to comply with the provisions of this section. 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. This requirement does not apply to carrier current devices or to devices operated under the provisions of §15.211, §15.213, §15.217, §15.219, or §15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

Conclusion: The Directional gains of antenna used for transmitting:

SISO: Antenna 0: 5.2dBi; Antenna 1: 5.57dBi.

Directional Gain: 8.4dBi.

The RF transmitter uses an integrate antenna without connector.

A.1 Maximum Output Power

Measurement of method: See ANSI C63.10-2013-Clause 11.9.2.3.2.

Method AVGPM-G is a measurement using a gated RF average power meter.

Alternatively, measurements may be performed using a wideband gated RF power meter provided that the gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Because the measurement is made only during the ON time of the transmitter, no duty cycle correction factor is required.

Measurement Limit:

Standard	Limit (dBm)
FCC CRF Part 15.247(b)	< 27.6

Note: The directional gain is greater than 6dBi, the limits need to be reduced as required.

Pout = Plimit − (GTx − 6) = Plimit - 2.4dB.

Measurement Results:

SISO:

Antenna 0:

Mode	RF output power (dBm)		
	2412MHz (CH1)	2437MHz (CH6)	2462MHz (CH11)
802.11b	20.07	19.68	19.98
802.11g	16.04	19.43	15.86
802.11n-HT20	15.39	19.97	14.73
802.11ax-HE20	14.02	18.92	13.81

Antenna 1:

Mode	RF output power (dBm)		
	2412MHz (CH1)	2437MHz (CH6)	2462MHz (CH11)
802.11b	17.62	17.69	17.62
802.11g	13.63	17.41	13.64
802.11n-HT20	12.98	17.80	12.49
802.11ax-HE20	11.49	16.82	11.60

MIMO:

Mode	RF output power (dBm)								
	2412MHz (CH1)			2437MHz (CH6)			2462MHz (CH11)		
	Ant0	Ant1	Sum	Ant0	Ant1	Sum	Ant0	Ant1	Sum
802.11n -HT20	15.32	12.87	17.28	19.92	17.61	21.93	14.76	12.34	16.73
802.11ax-HE20	14.01	11.53	15.95	19.04	16.68	21.03	13.93	11.40	15.86

Note: The data rate 1Mbps (11b mode), 6Mbps (11g mode), MCS0 (11n mode) and MCS0 (11ax mode) are selected as the Worst-Case. **Antenna 0** is selected as the worst condition (SISO). The following cases and test graphs are performed with this condition.The EUT was programmed to be in continuously transmitting mode and the transmit duty cycle is not less than 98%.

Conclusion: PASS

A.2 Peak Power Spectral Density

Method of Measurement: See ANSI C63.10-clause 11.10.2.

Measurement Limit:

Standard	Limit (dBm/3 kHz)
FCC CRF Part 15.247(e)	< 5.6

Note: The directional gain is greater than 6dBi, the limits need to be reduced as required.
Pout = Plimit − (GTx − 6) = Plimit - 2.4dB.

Measurement Results:

SISO-Ant0:

Mode	Frequency (MHz)	Test Results(dBm/10 kHz)		Conclusion
802.11b	2412(CH1)	Fig.1	-0.47	**P**
	2437(CH6)	Fig.2	-0.41	**P**
	2462(CH11)	Fig.3	-0.34	**P**
802.11g	2412(CH1)	Fig.4	-5.18	**P**
	2437(CH6)	Fig.5	-2.72	**P**
	2462(CH11)	Fig.6	-5.94	**P**
802.11n-HT20	2412(CH1)	Fig.7	-4.29	**P**
	2437(CH6)	Fig.8	-0.27	**P**
	2462(CH11)	Fig.9	-4.43	**P**
802.11ax-HE20	2412(CH1)	Fig.10	-7.74	**P**
	2437(CH6)	Fig.11	-2.72	**P**
	2462(CH11)	Fig.12	-8.24	**P**
802.11ax-HE20 (RU26)	2412(CH1)	Fig.13	-0.05	**P**
	2462(CH11)	Fig.14	-0.06	**P**

Note: **Ant0** is the port with the worst result in SISO.
According to the customer description, RU26 is the worst RU type of 802.11ax.

MIMO:

Mode	Frequency (MHz)	Test Results(dBm/10 kHz)	Conclusion
802.11n-HT20	2412(CH1)	-2.80	**P**
	2437(CH6)	2.54	**P**
	2462(CH11)	-3.34	**P**
802.11ax-HE20	2412(CH1)	-7.09	**P**
	2437(CH6)	-1.75	**P**
	2462(CH11)	-6.80	**P**

See below for test graphs.

Conclusion: PASS

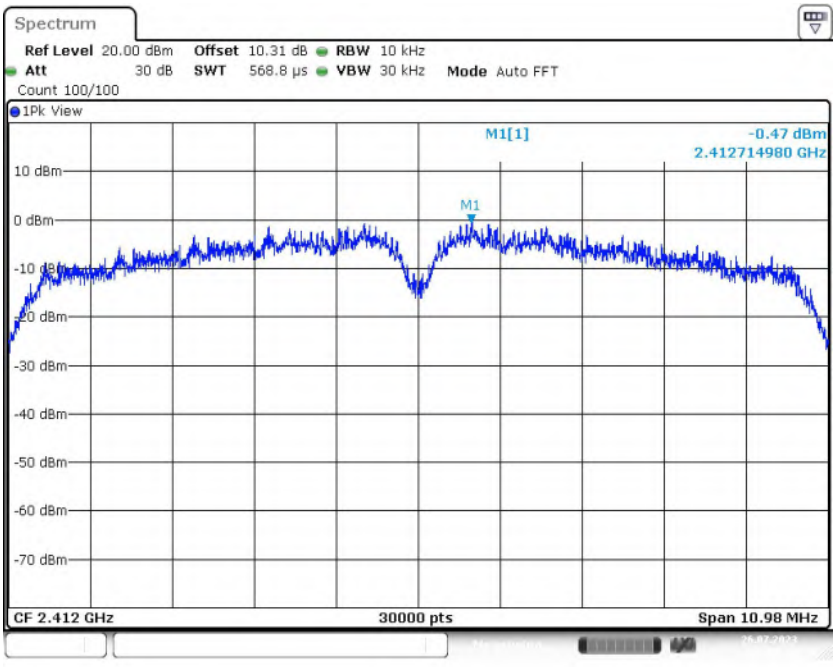


Fig.1 Power Spectral Density (802.11b, CH1)

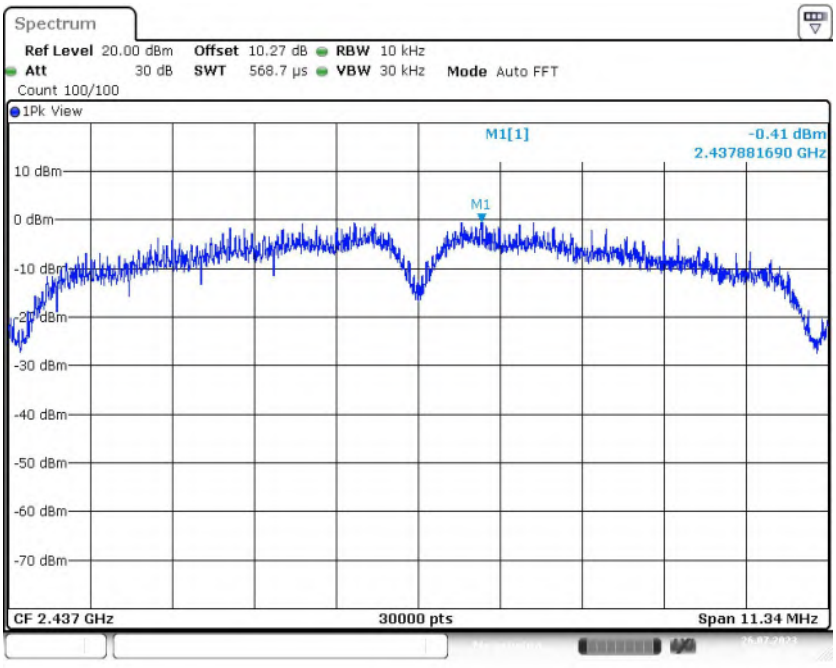


Fig.2 Power Spectral Density (802.11b, CH6)

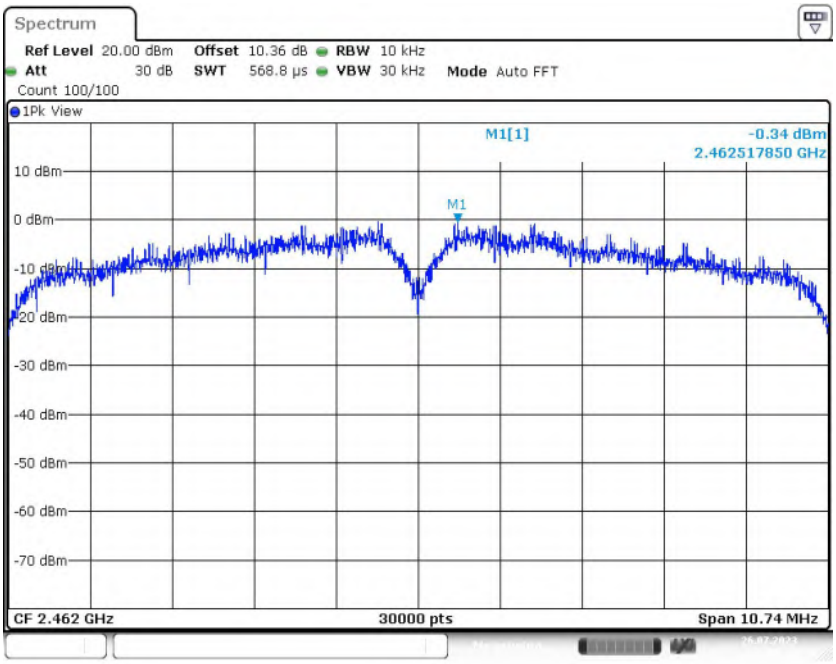


Fig.3 Power Spectral Density (802.11b, CH11)

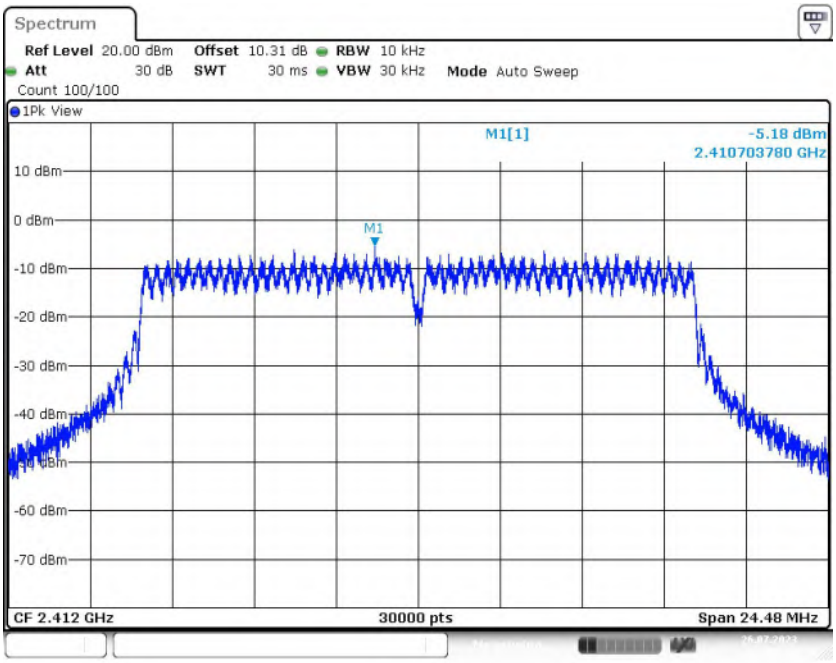


Fig.4 Power Spectral Density (802.11g, CH1)

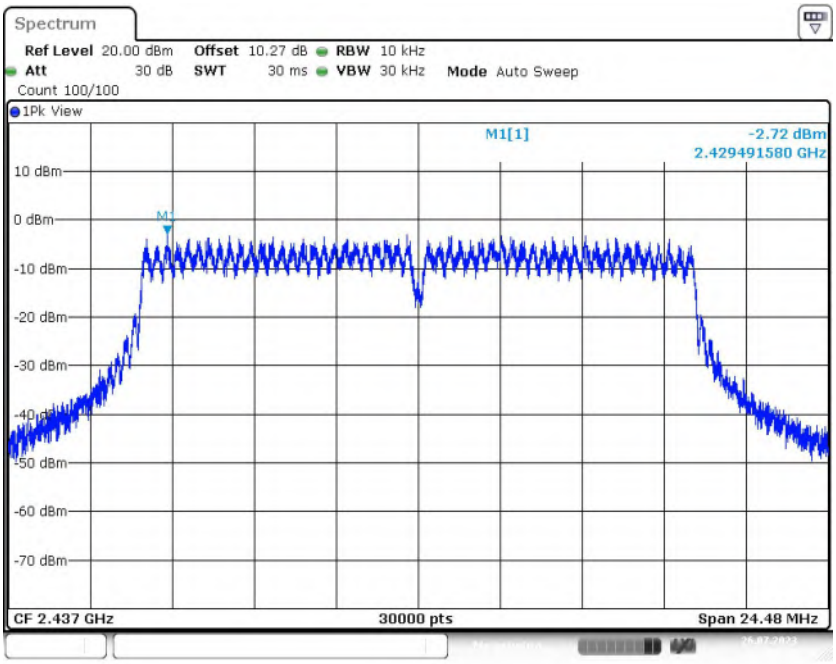


Fig.5 Power Spectral Density (802.11g, CH6)

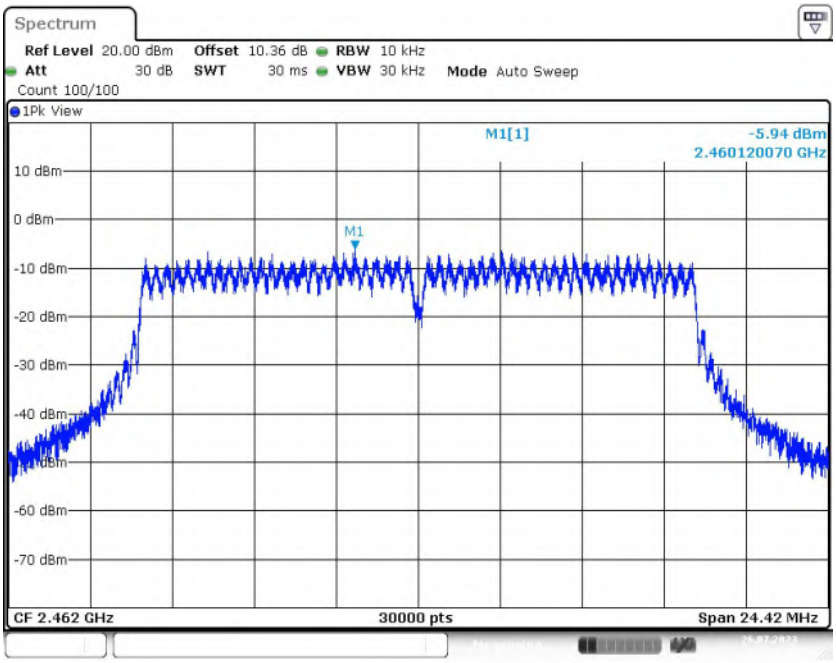


Fig.6 Power Spectral Density (802.11g, CH11)

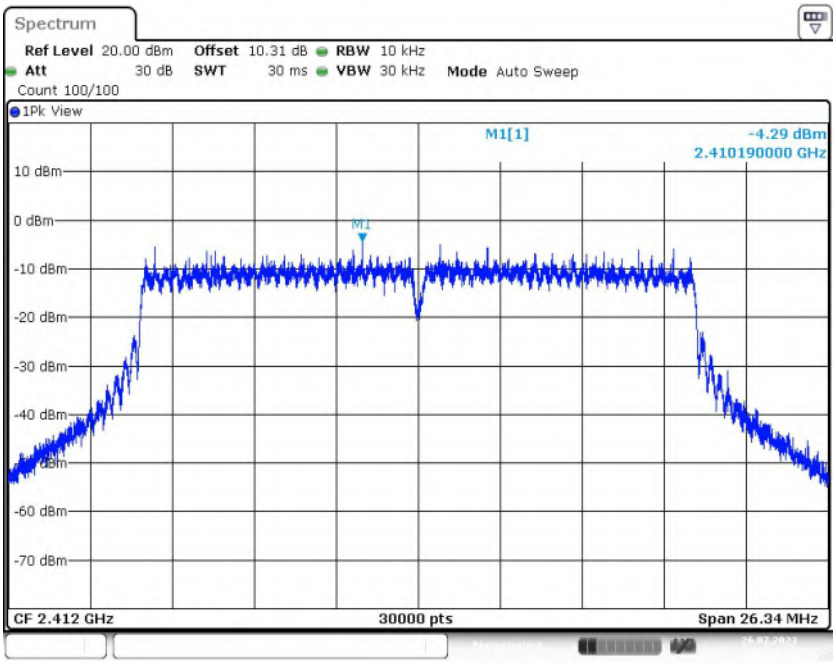


Fig.7 Power Spectral Density (802.11n-HT20, CH1)

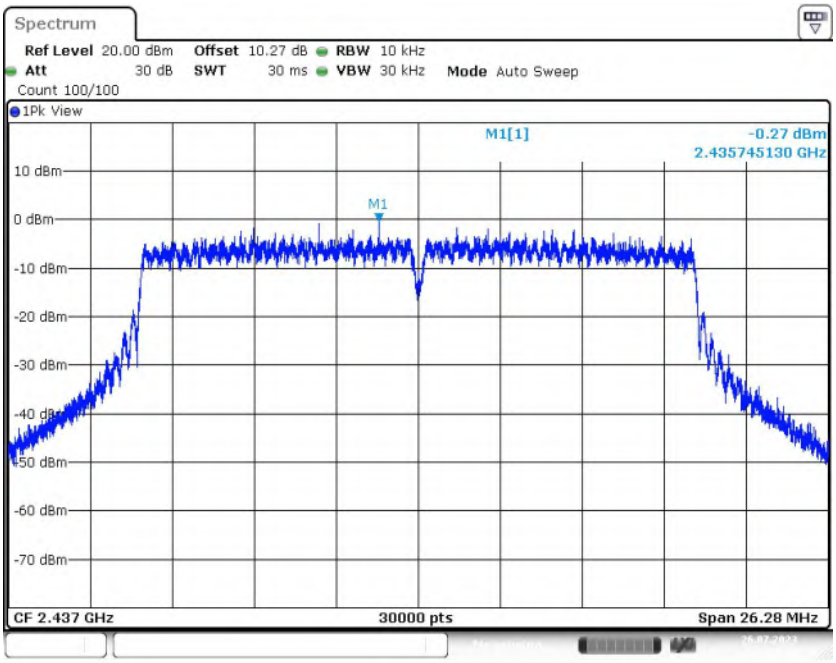


Fig.8 Power Spectral Density (802.11n-HT20, CH6)

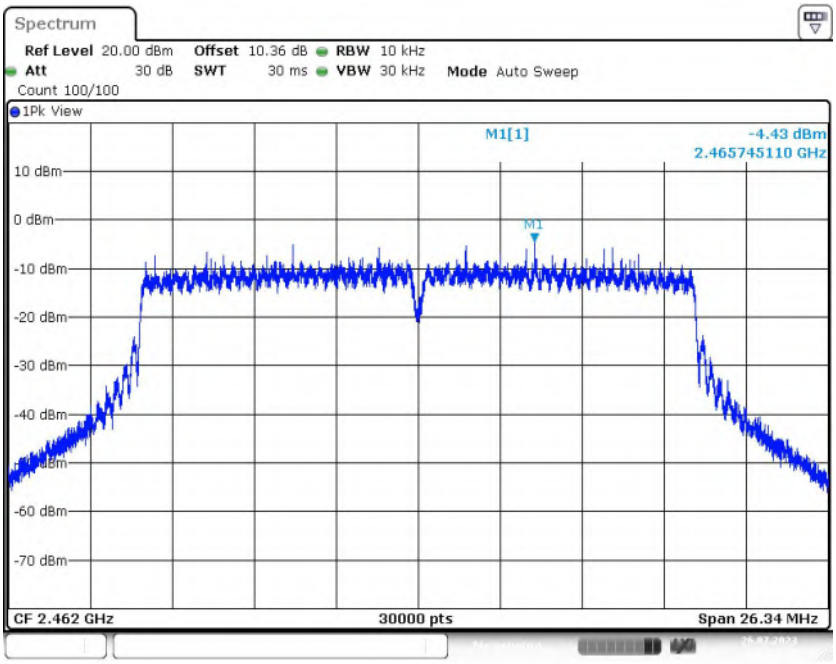


Fig.9 Power Spectral Density (802.11n-HT20, CH11)

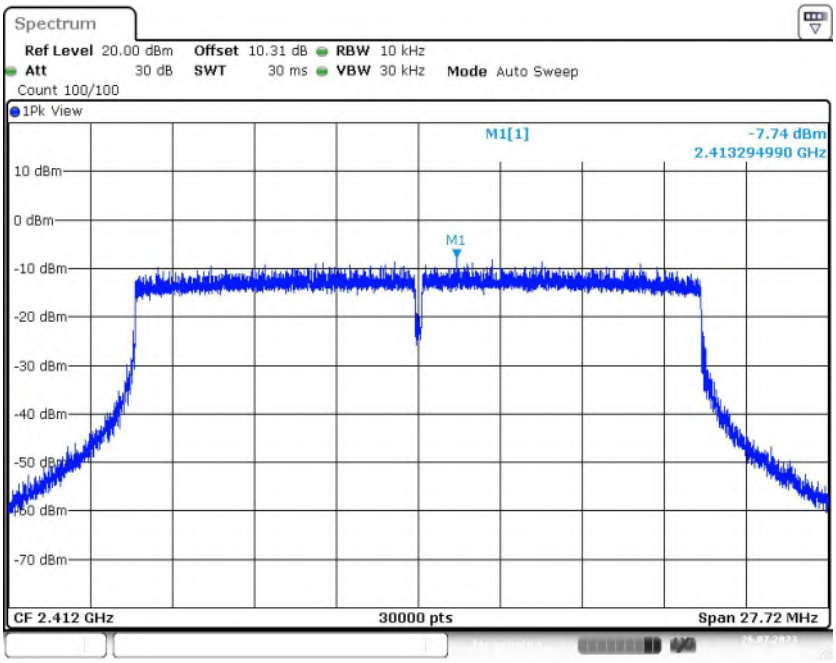


Fig.10 Power Spectral Density (802.11ax-HE20, CH1)

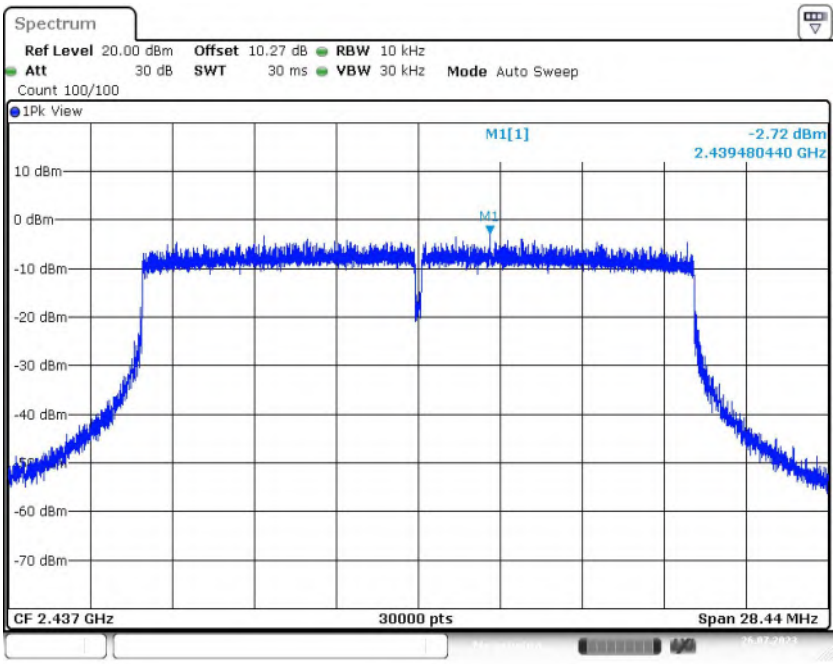


Fig.11 Power Spectral Density (802.11ax-HE20, CH6)

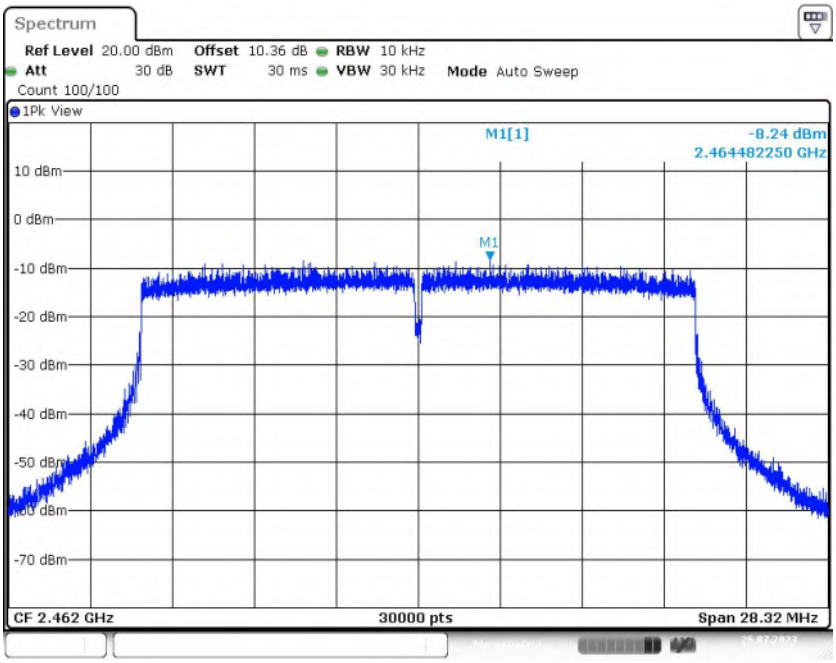


Fig.12 Power Spectral Density (802.11ax-HE20, CH11)

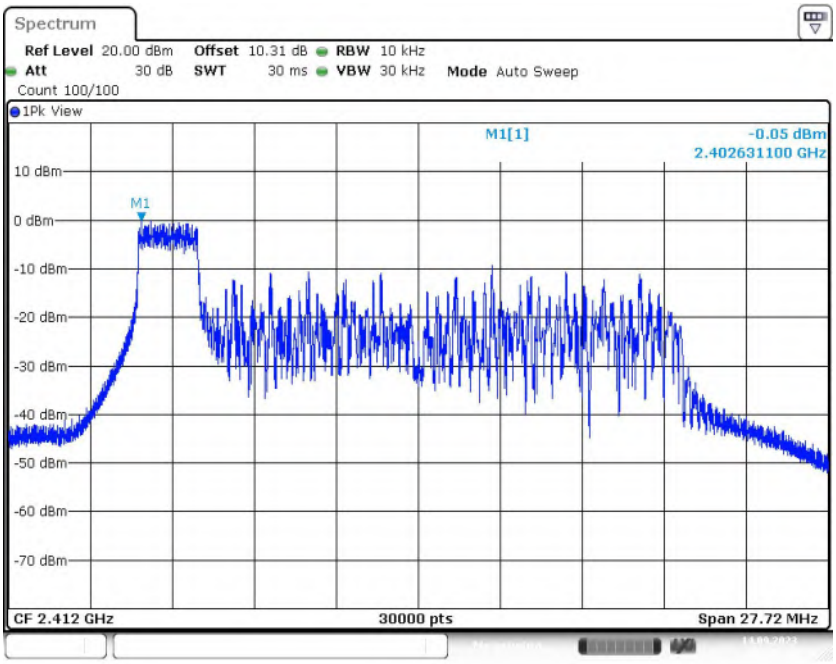


Fig.13 Power Spectral Density (802.11ax-HE20(RU26), CH1)

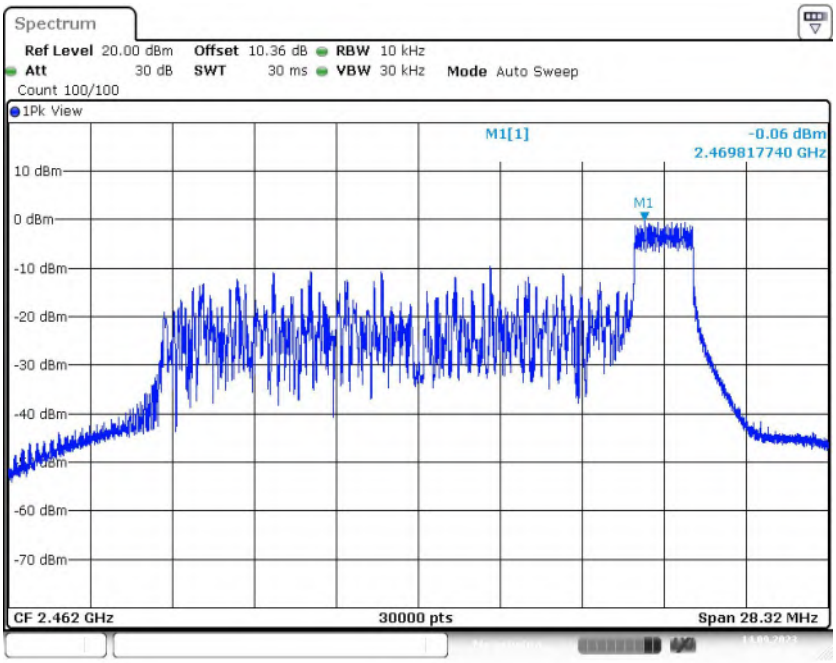


Fig.14 Power Spectral Density (802.11ax-HE20(RU26), CH11)

A.3 6dB Bandwidth

Method of Measurement: See ANSI C63.10-clause 11.8.

Measurement Limit:

Standard	Limit (MHz)
FCC 47 CFR Part 15.247 (a)	≥ 0.5

Measurement Result:

SISO-Ant0:

Mode	Frequency (MHz)	Test Results (MHz)		Conclusion
802.11b	2412(CH1)	Fig.15	7.32	**P**
	2437(CH6)	Fig.16	7.56	**P**
	2462(CH11)	Fig.17	7.16	**P**
802.11g	2412(CH1)	Fig.18	16.32	**P**
	2437(CH6)	Fig.19	16.32	**P**
	2462(CH11)	Fig.20	16.28	**P**
802.11n-HT20	2412(CH1)	Fig.21	17.56	**P**
	2437(CH6)	Fig.22	17.52	**P**
	2462(CH11)	Fig.23	17.56	**P**
802.11ax-HE20	2412(CH1)	Fig.24	18.48	**P**
	2437(CH6)	Fig.25	18.96	**P**
	2462(CH11)	Fig.26	18.88	**P**

See below for test graphs.

Conclusion: PASS

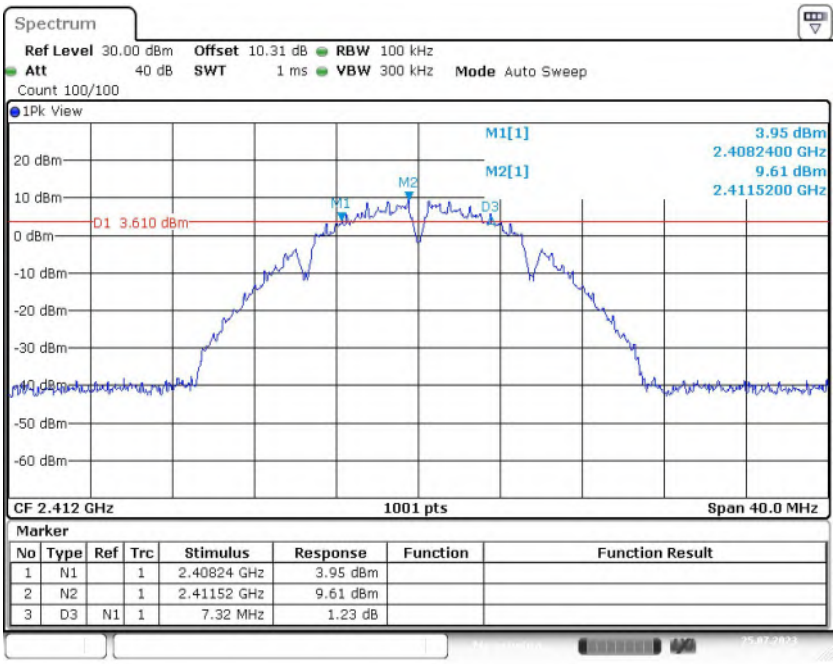


Fig.15 6dB Bandwidth (802.11b, CH1)

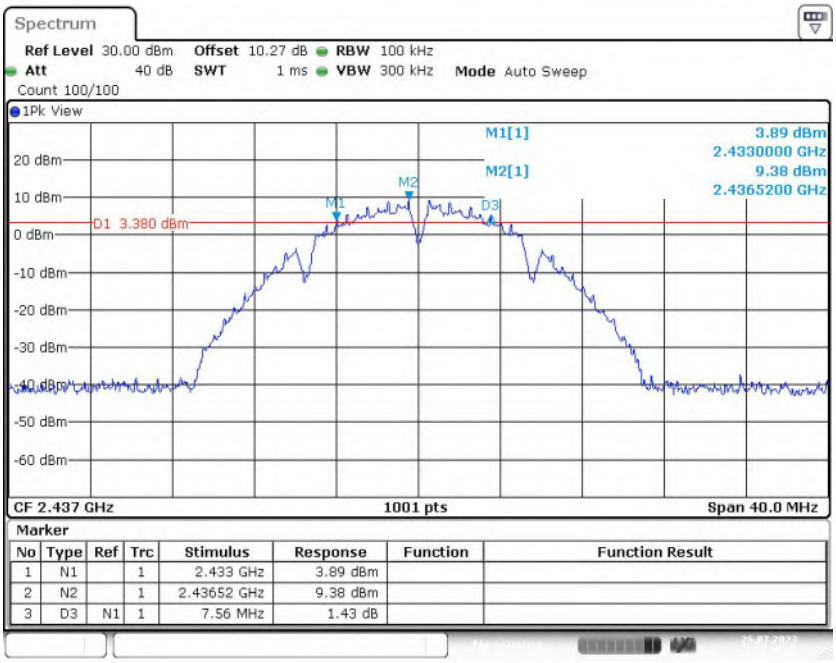


Fig.16 6dB Bandwidth (802.11b, CH6)

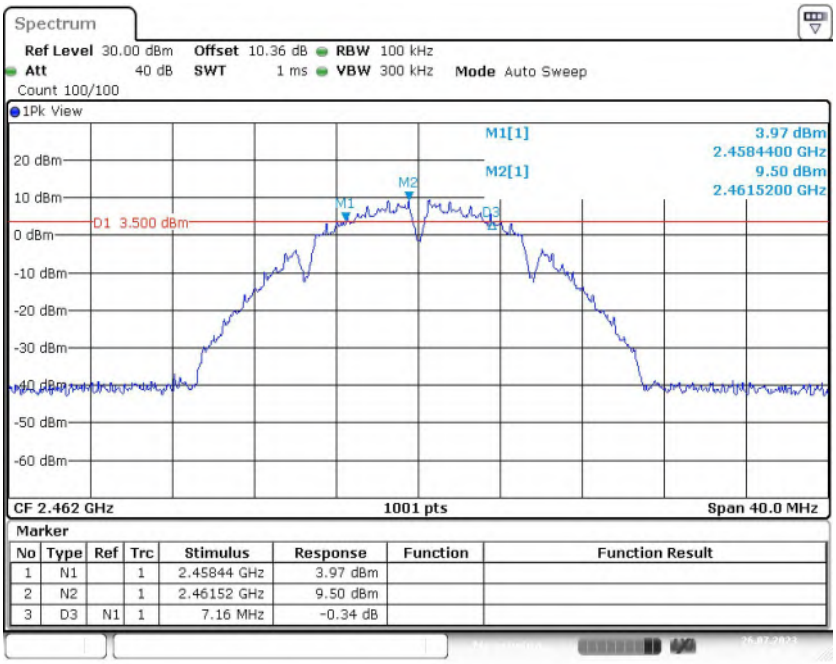


Fig.17 6dB Bandwidth (802.11b, CH11)

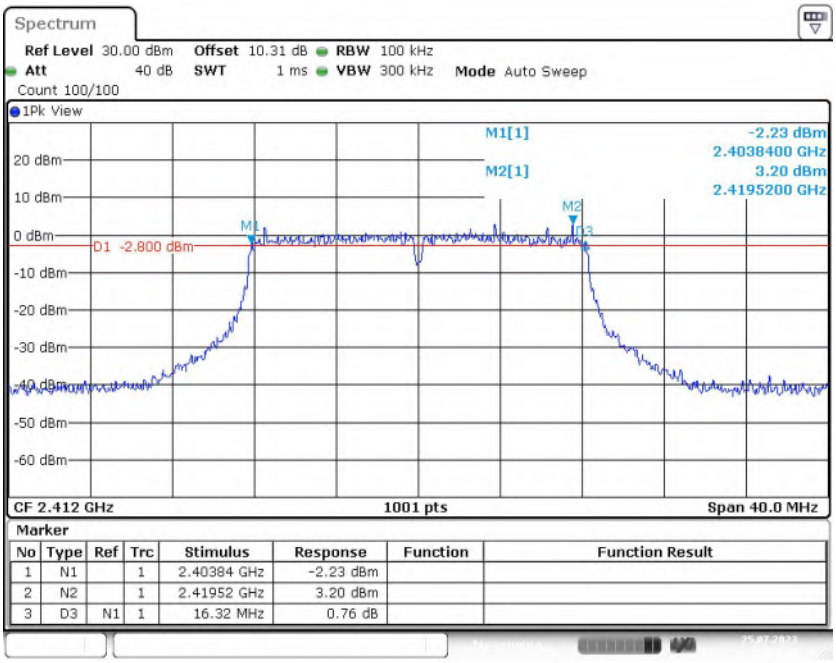


Fig.18 6dB Bandwidth (802.11g, CH1)

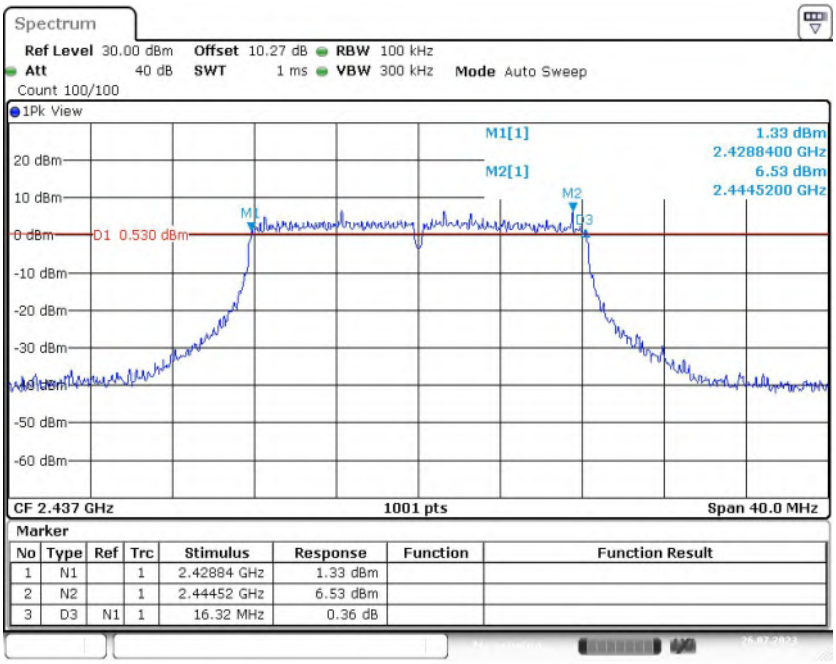


Fig.19 6dB Bandwidth (802.11g, CH6)

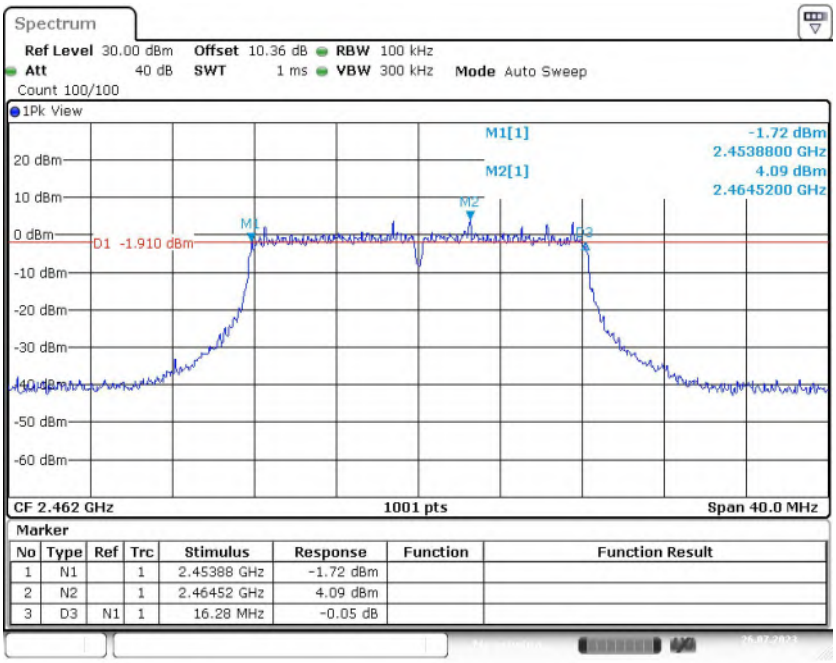


Fig.20 6dB Bandwidth (802.11g, CH11)

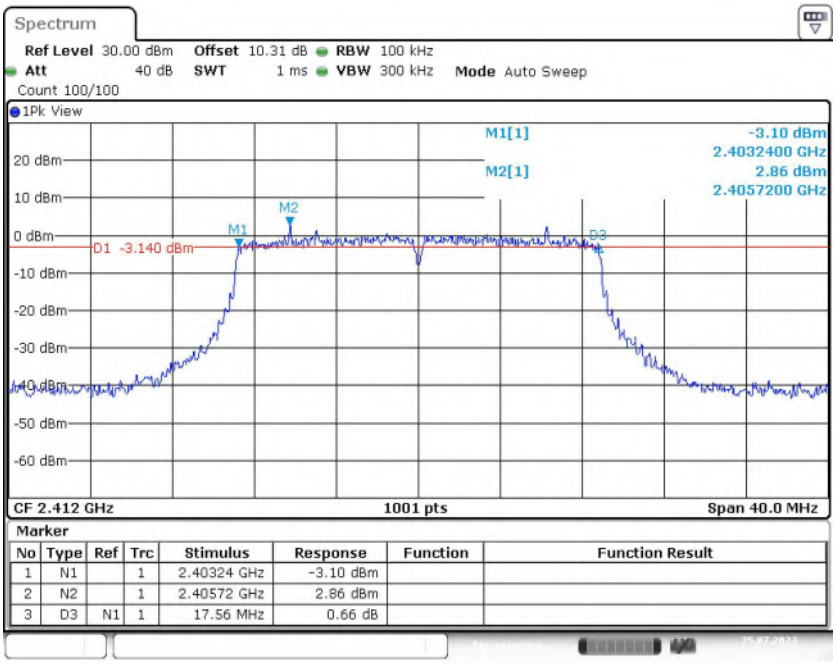


Fig.21 6dB Bandwidth (802.11n-HT20, CH1)

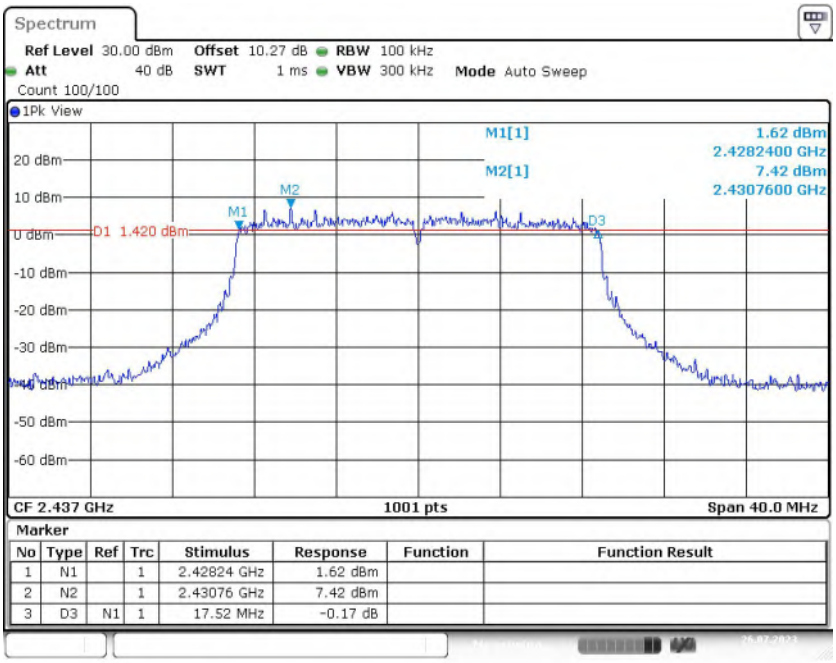


Fig.22 6dB Bandwidth (802.11n-HT20, CH6)

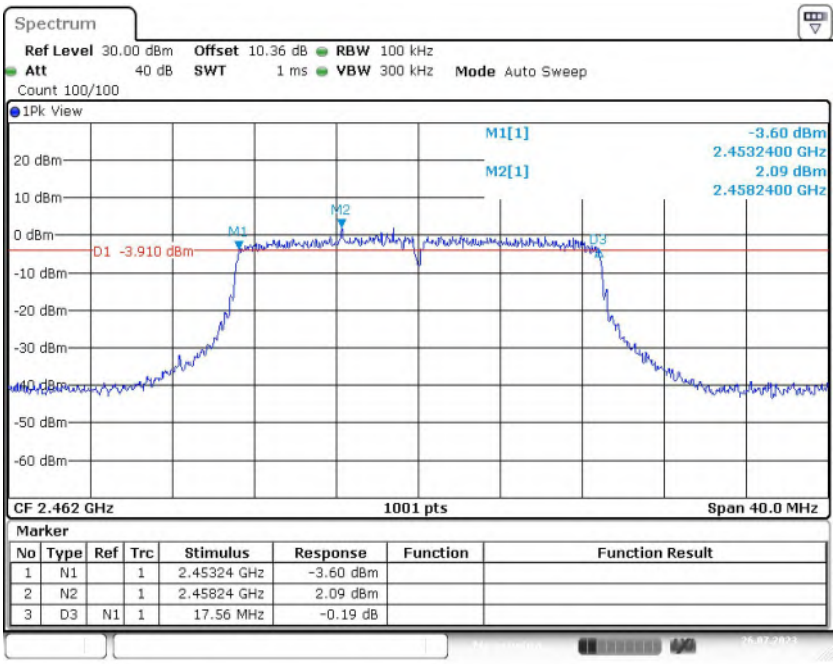


Fig.23 6dB Bandwidth (802.11n-HT20, CH11)

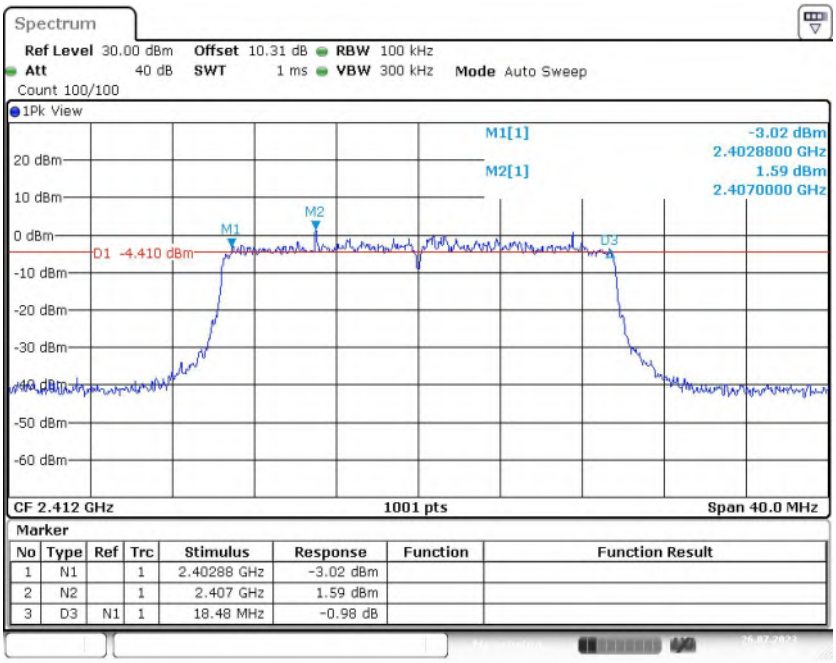


Fig.24 6dB Bandwidth (802.11ax-HE20, CH1)

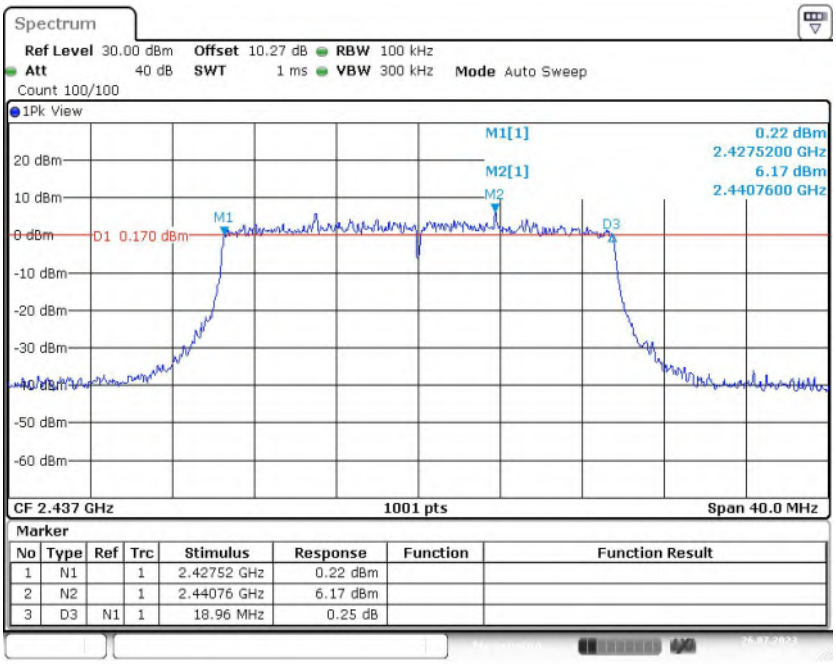


Fig.25 6dB Bandwidth (802.11ax-HE20, CH6)

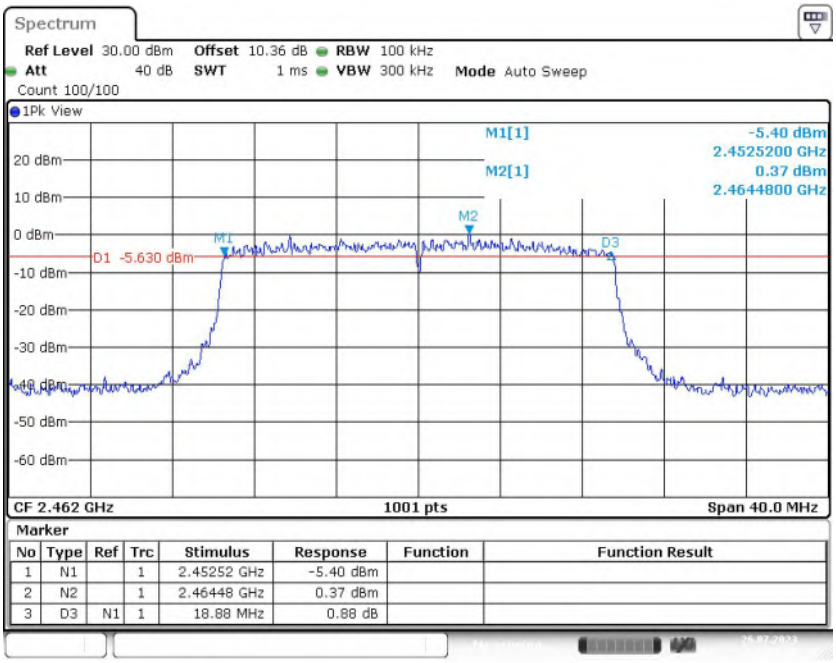


Fig.26 6dB Bandwidth (802.11ax-HE20, CH11)

A.4 Band Edges Compliance

Method of Measurement: See ANSI C63.10-clause 11.13.3.

Measurement Limit:

Standard	Limit (dBc)
FCC 47 CFR Part 15.247 (d)	> 30

Measurement Result:

SISO-Ant0:

Mode	Frequency (MHz)	Test Results (dBc)		Conclusion
802.11b	2412(CH1)	Fig.27	51.04	**P**
	2462(CH11)	Fig.28	55.13	**P**
802.11g	2412(CH1)	Fig.29	40.87	**P**
	2462(CH11)	Fig.30	50.50	**P**
802.11n-HT20	2412(CH1)	Fig.31	39.54	**P**
	2462(CH11)	Fig.32	48.44	**P**
802.11ax-HE20	2412(CH1)	Fig.33	40.55	**P**
	2462(CH11)	Fig.34	48.25	**P**

See below for test graphs.

Conclusion: PASS

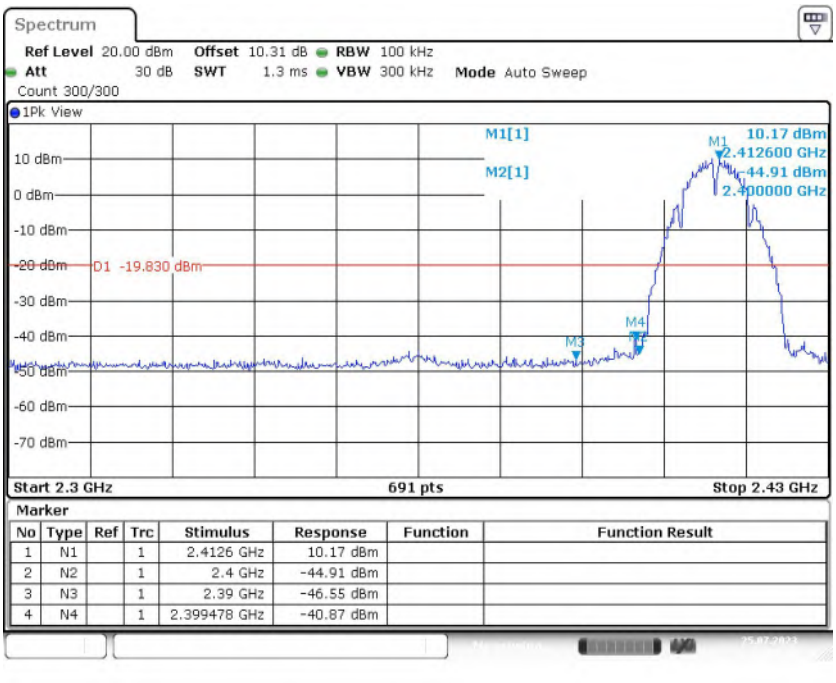


Fig.27 Band Edges (802.11b, CH1)

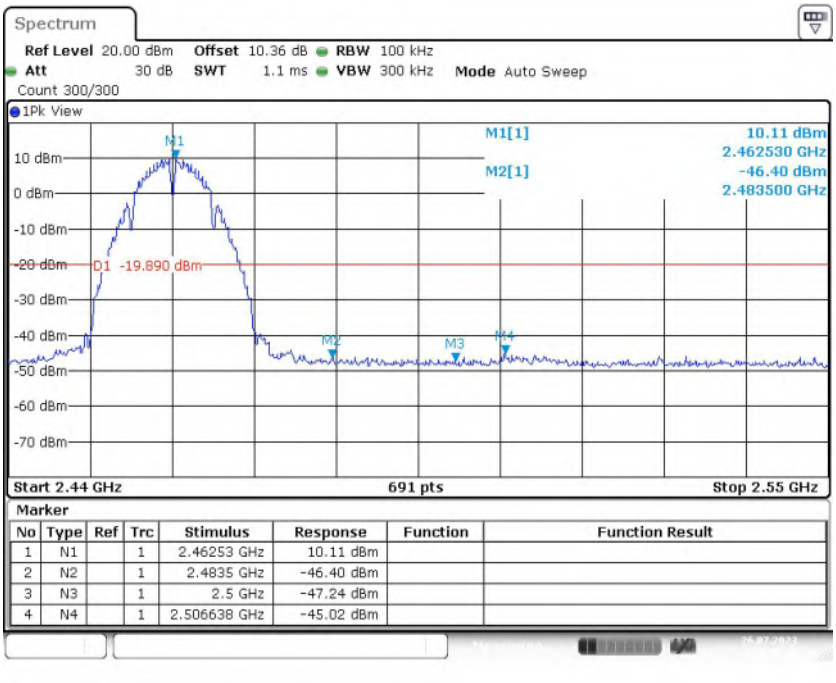


Fig.28 Band Edges (802.11b, CH11)

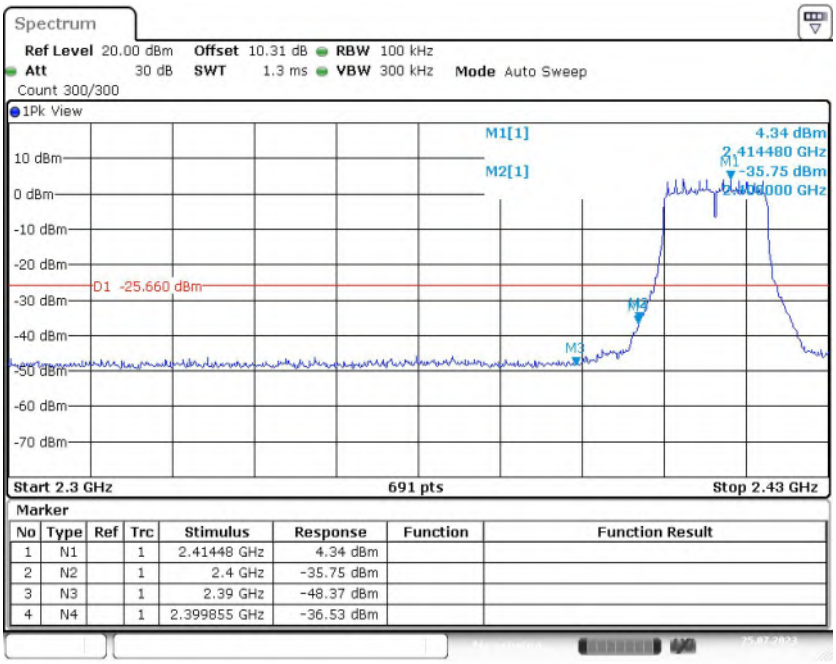


Fig.29 Band Edges (802.11g, CH1)

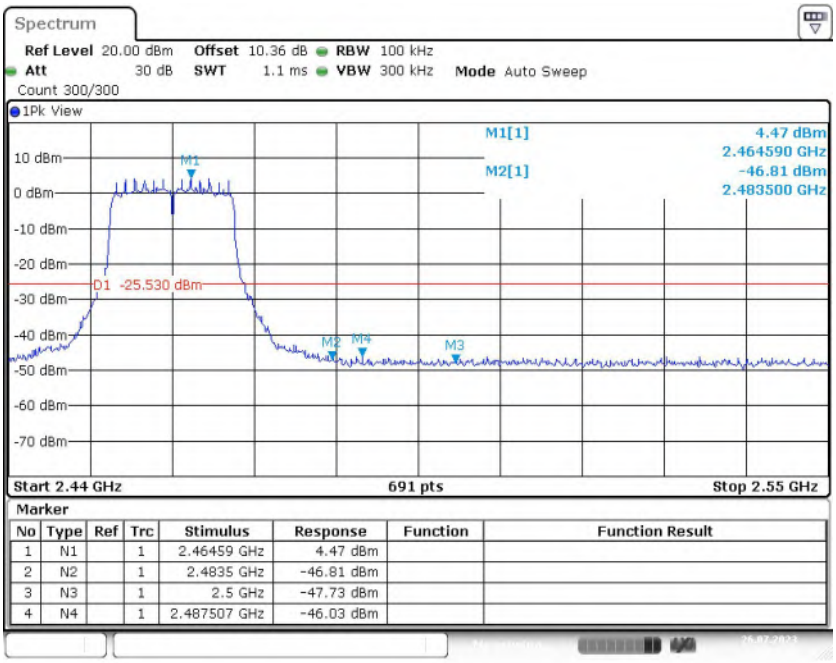


Fig.30 Band Edges (802.11g, CH11)

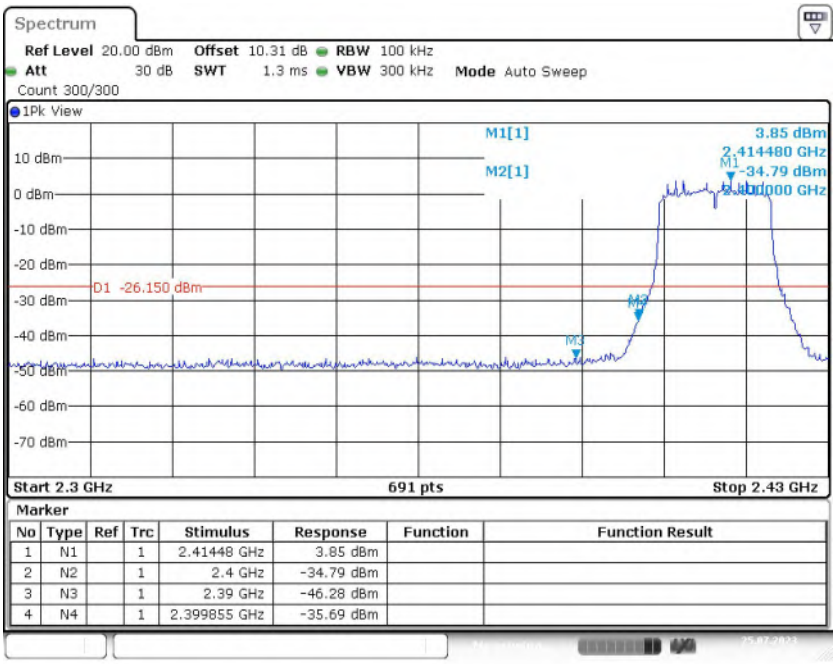


Fig.31 Band Edges (802.11n-HT20, CH1)

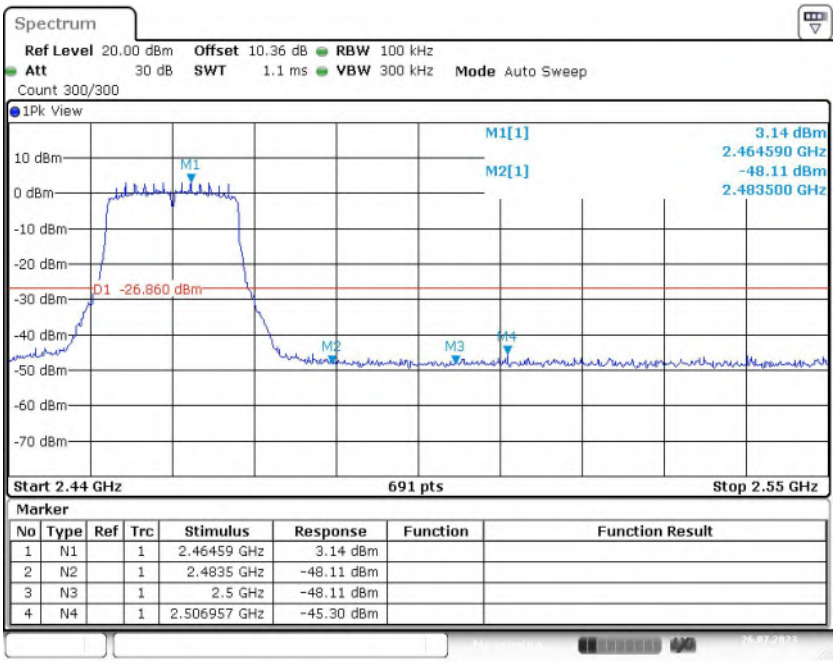


Fig.32 Band Edges (802.11n-HT20, CH11)

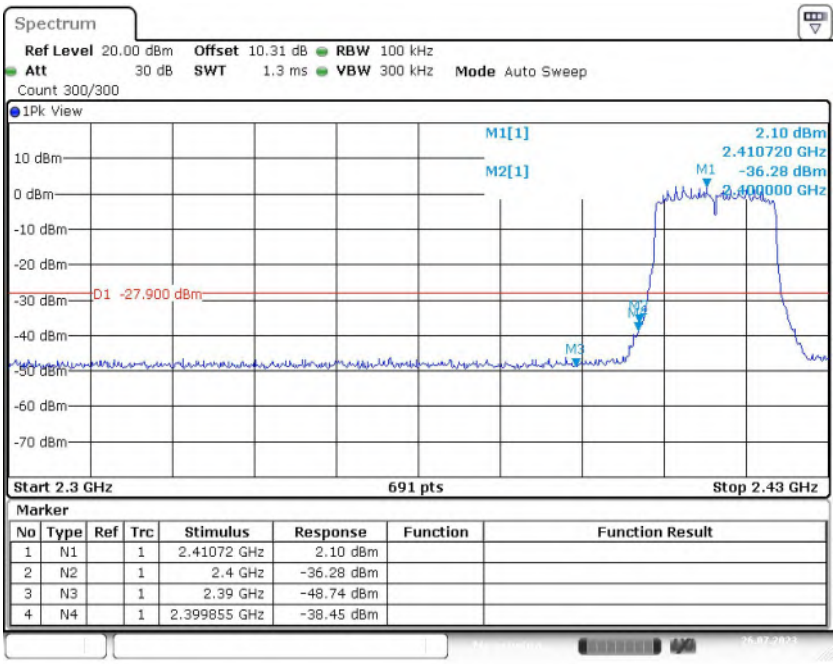


Fig.33 Band Edges (802.11ax-HE20, CH1)

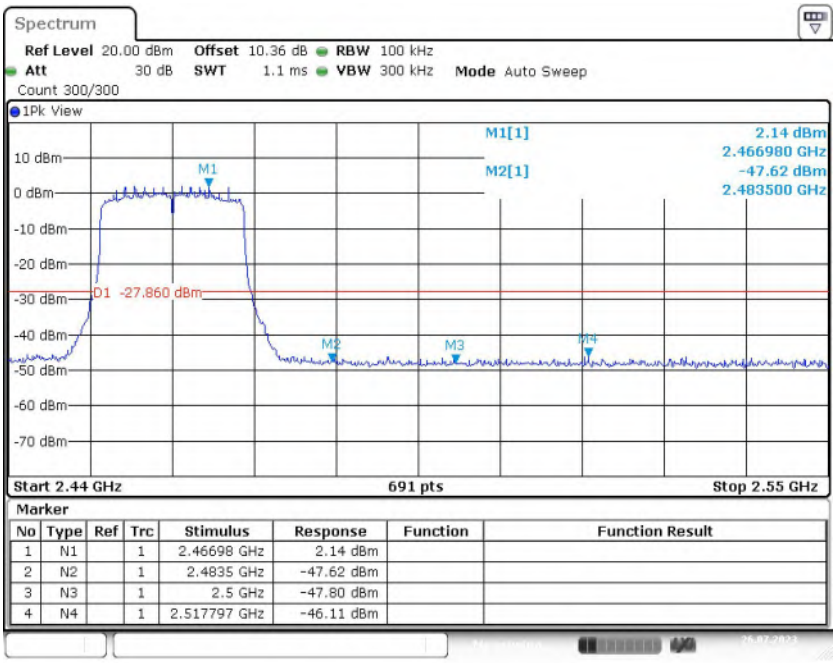


Fig.34 Band Edges (802.11ax-HE20, CH11)

A.5 Conducted Emission

Method of Measurement: See ANSI C63.10-clause 11.11.

Measurement Limit:

Standard	Limit (dBm)
FCC 47 CFR Part 15.247 (d)	30dBm below peak output power in 100kHz bandwidth

Measurement Results:

SISO-Ant0:

Mode	Frequency (MHz)	Frequency Range	Test Results	Conclusion
802.11b	2412(CH1)	1GHz-26.5GHz	Fig.35	P
	2437(CH6)	1GHz-26.5GHz	Fig.36	P
	2462(CH11)	1GHz-26.5GHz	Fig.37	P
802.11g	2412(CH1)	1GHz-26.5GHz	Fig.38	P
	2437(CH6)	1GHz-26.5GHz	Fig.39	P
	2462(CH11)	1GHz-26.5GHz	Fig.40	P
802.11n-HT20	2412(CH1)	1GHz-26.5GHz	Fig.41	P
	2437(CH6)	1GHz-26.5GHz	Fig.42	P
	2462(CH11)	1GHz-26.5GHz	Fig.43	P
802.11ax-HE20	2412(CH1)	1GHz-26.5GHz	Fig.44	P
	2437(CH6)	1GHz-26.5GHz	Fig.45	P
	2462(CH11)	1GHz-26.5GHz	Fig.46	P
802.11ax-HE20 (RU26)	2412(CH1)	1GHz-26.5GHz	Fig.47	P
	2462(CH11)	1GHz-26.5GHz	Fig.48	P
/	All channels	30MHz -1GHz	Fig.49	P

MIMO-Ant0:

Mode	Frequency (MHz)	Frequency Range	Test Results	Conclusion
802.11n-HT20	2412(CH1)	1GHz-26.5GHz	Fig.50	P
	2437(CH6)	1GHz-26.5GHz	Fig.51	P
	2462(CH11)	1GHz-26.5GHz	Fig.52	P
802.11ax-HE20	2412(CH1)	1GHz-26.5GHz	Fig.53	P
	2437(CH6)	1GHz-26.5GHz	Fig.54	P
	2462(CH11)	1GHz-26.5GHz	Fig.55	P
/	All channels	30MHz -1GHz	Fig.56	P

Note: The MIMO conduction test is tested separately for each RF port. Both RF ports were tested, and **Ant0** is the port with the worst result in SISO and MIMO.
According to the customer description, RU26 is the worst RU type of 802.11ax.

See below for test graphs.

Conclusion: PASS

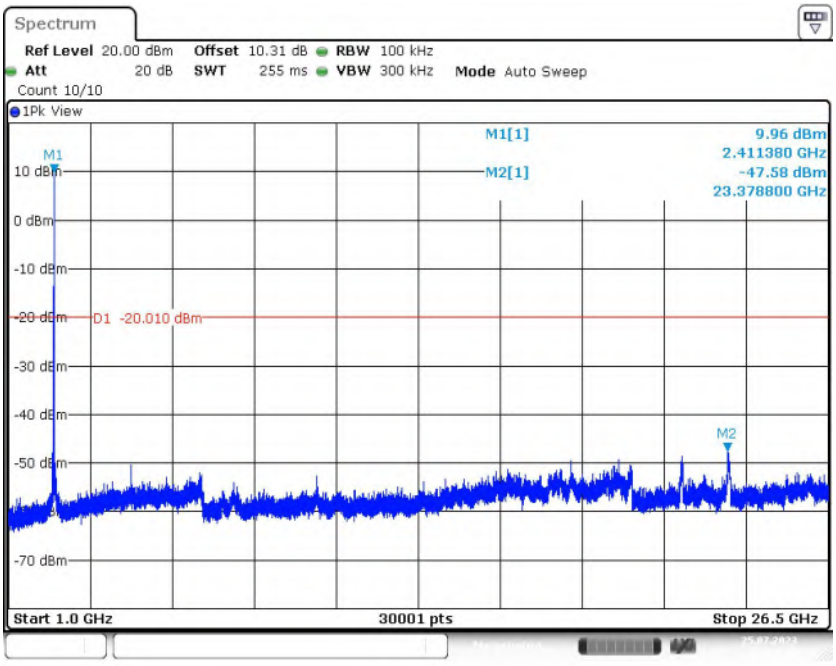


Fig.35 Conducted Spurious Emission (1GHz-26.5GHz, 802.11b, CH1)

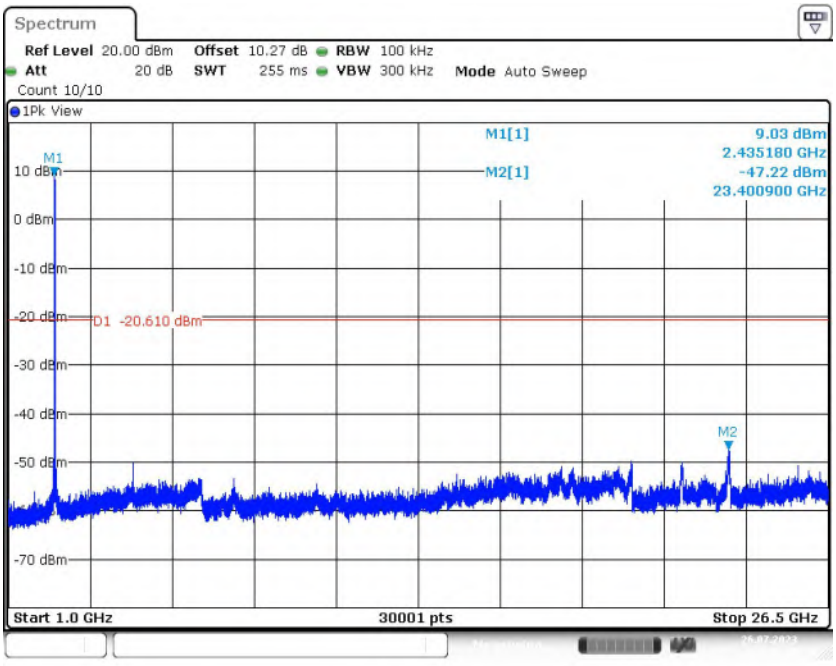


Fig.36 Conducted Spurious Emission (1GHz-26.5GHz, 802.11b, CH6)

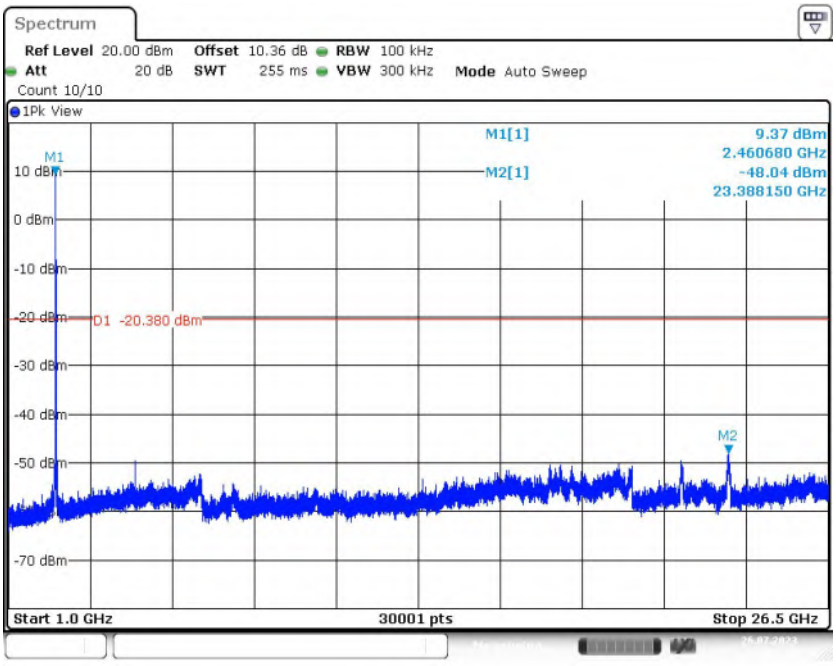


Fig.37 Conducted Spurious Emission (1GHz-26.5GHz, 802.11b, CH11)

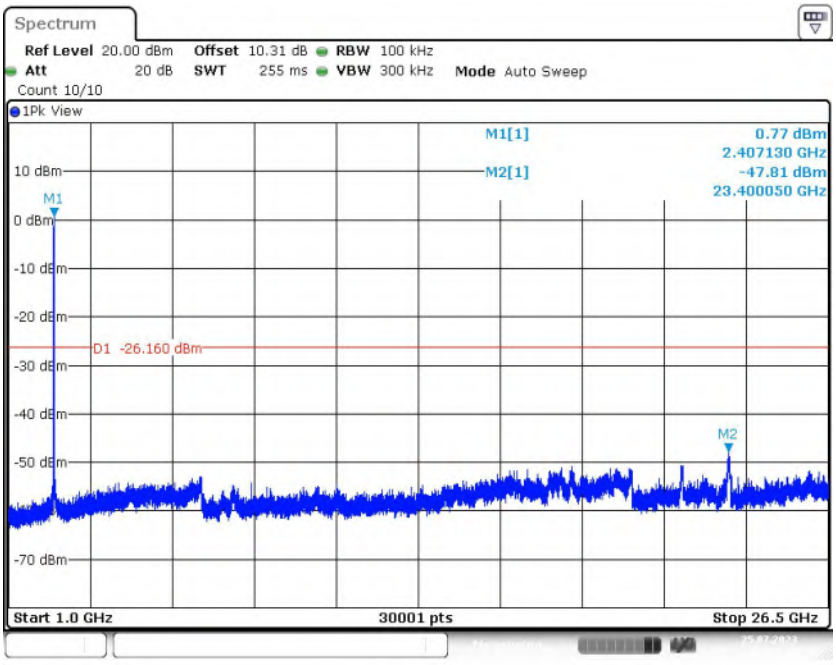


Fig.38 Conducted Spurious Emission (1GHz-26.5GHz, 802.11g, CH1)

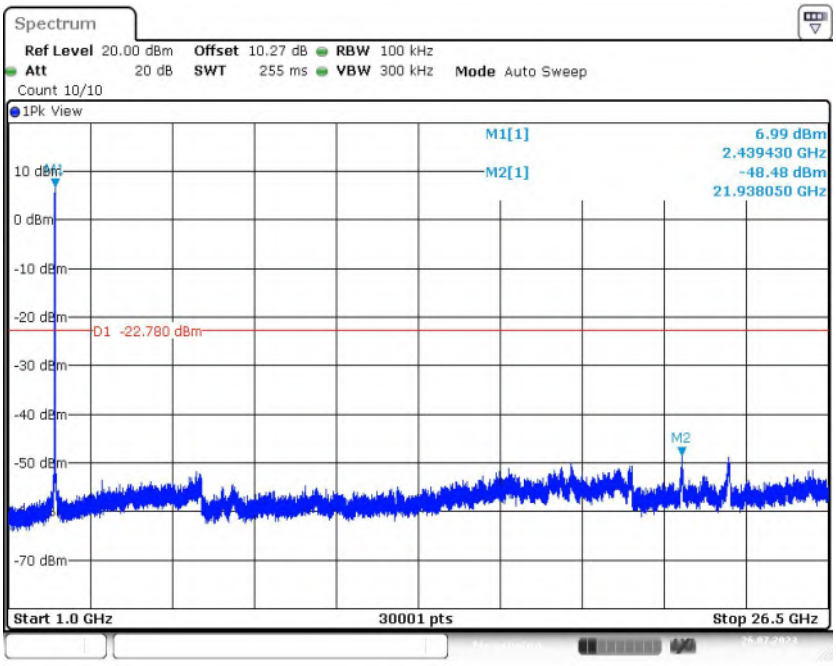


Fig.39 Conducted Spurious Emission (1GHz-26.5GHz, 802.11g, CH6)

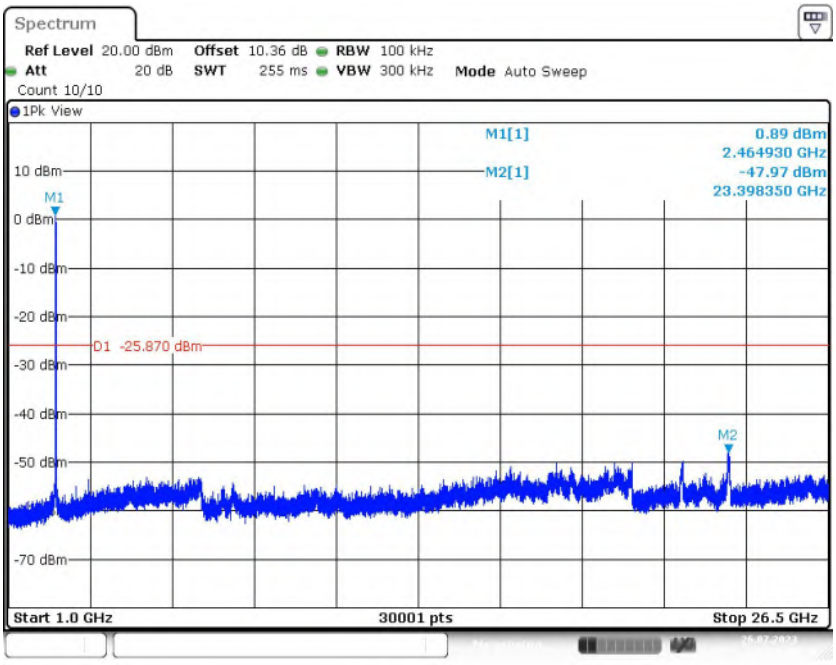


Fig.40 Conducted Spurious Emission (1GHz-26.5GHz, 802.11g, CH11)

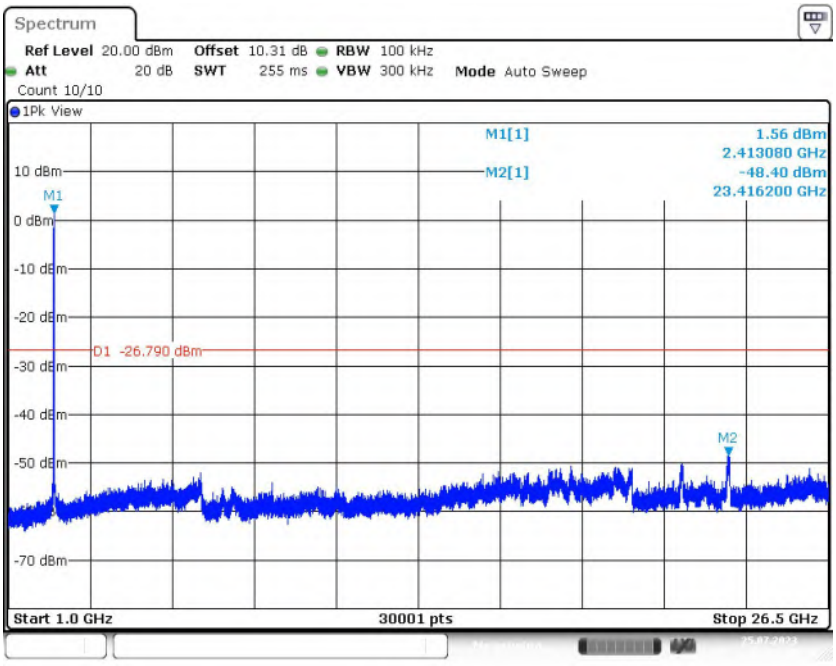


Fig.41 Conducted Spurious Emission (1GHz-26.5GHz, 802.11n-HT20, CH1)

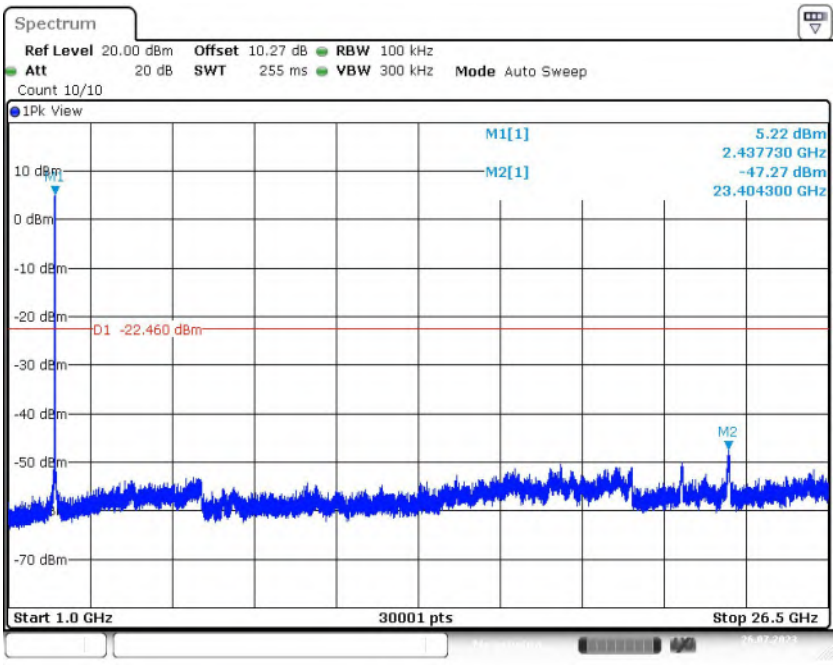


Fig.42 Conducted Spurious Emission (1GHz-26.5GHz, 802.11n-HT20, CH6)

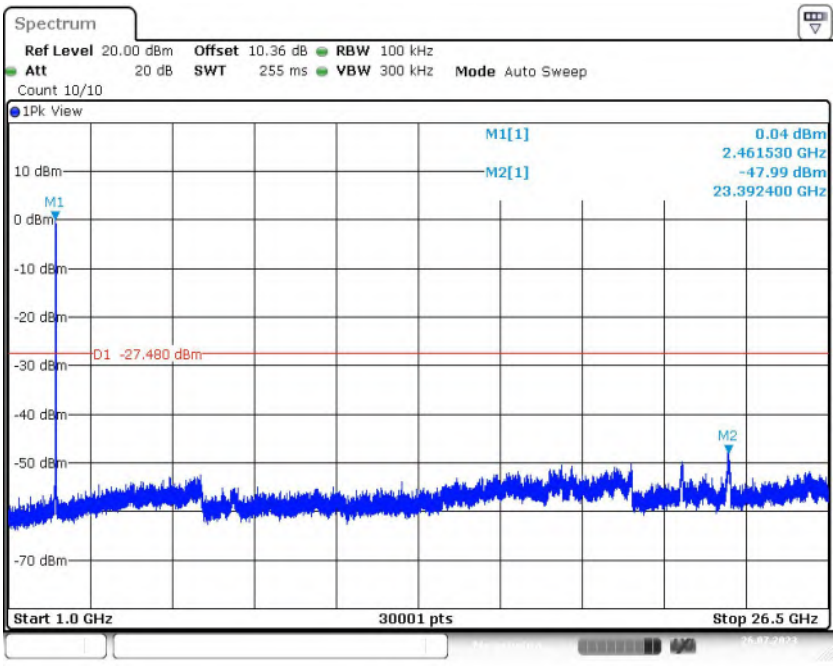


Fig.43 Conducted Spurious Emission (1GHz-26.5GHz, 802.11n-HT20, CH11)

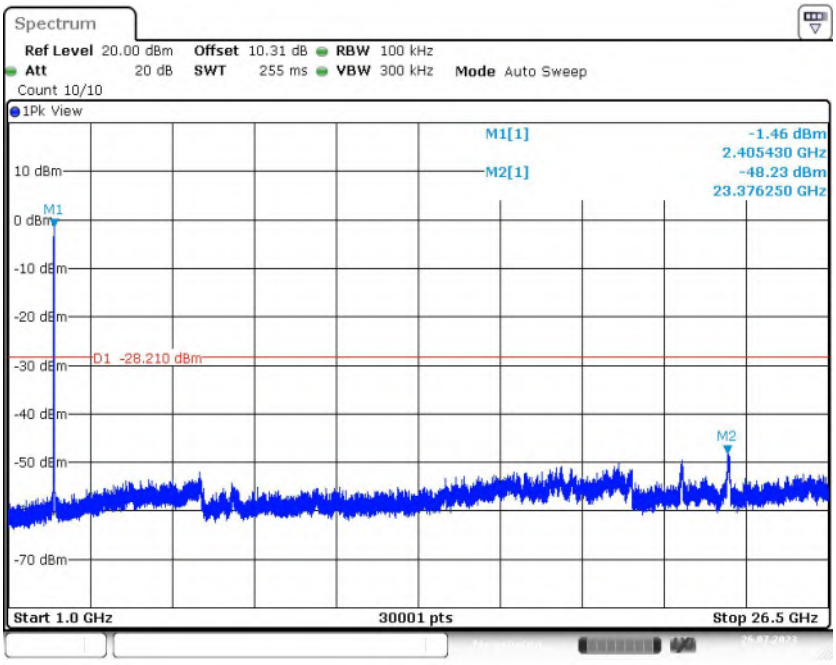


Fig.44 Conducted Spurious Emission (1GHz-26.5GHz, 802.11ax-HE20, CH1)

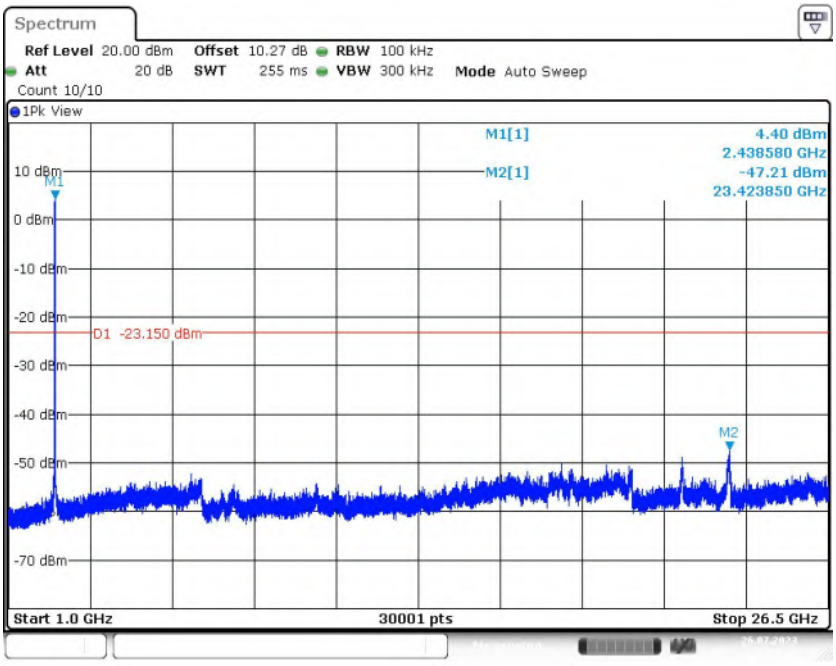


Fig.45 Conducted Spurious Emission (1GHz-26.5GHz, 802.11ax-HE20, CH6)

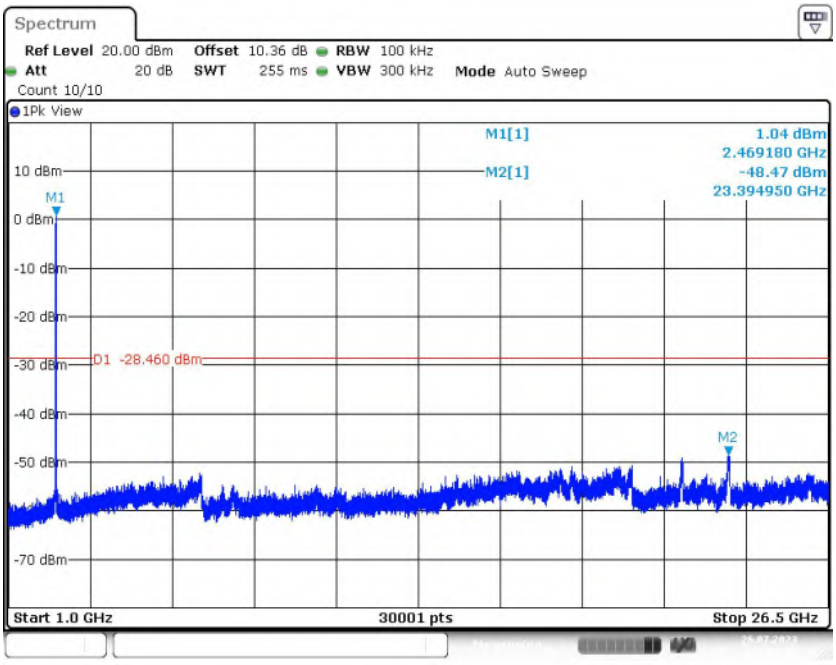


Fig.46 Conducted Spurious Emission (1GHz-26.5GHz, 802.11ax-HE20, CH11)

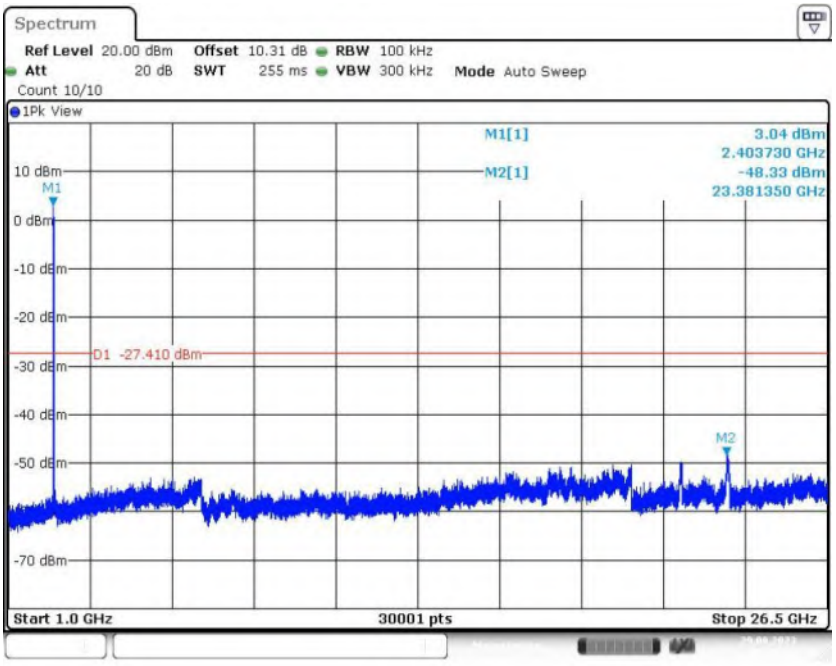


Fig.47 Conducted Spurious Emission (1GHz-26.5GHz, 802.11ax-HE20(RU26), CH1)

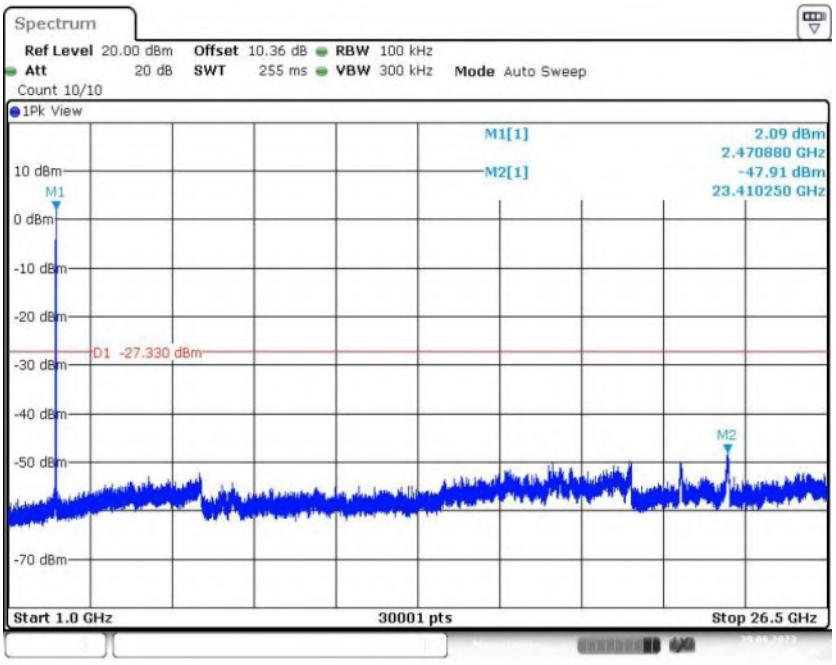


Fig.48 Conducted Spurious Emission (1GHz-26.5GHz, 802.11ax-HE20(RU26), CH11)

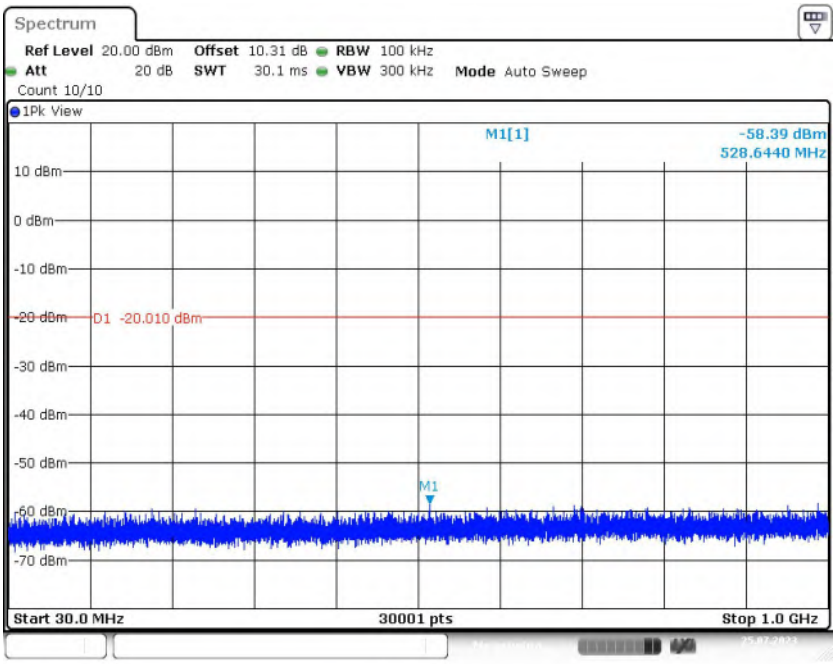


Fig.49 Conducted Spurious Emission (All Channels, 30MHz -1GHz)

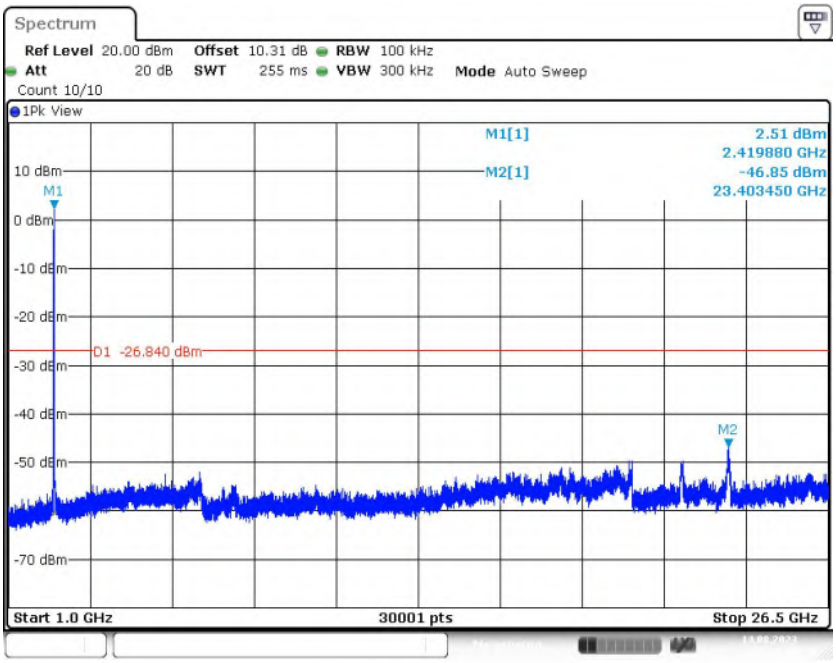


Fig.50 Conducted Spurious Emission (1GHz-26.5GHz, 802.11n-HT20, CH1), MIMO-Ant0

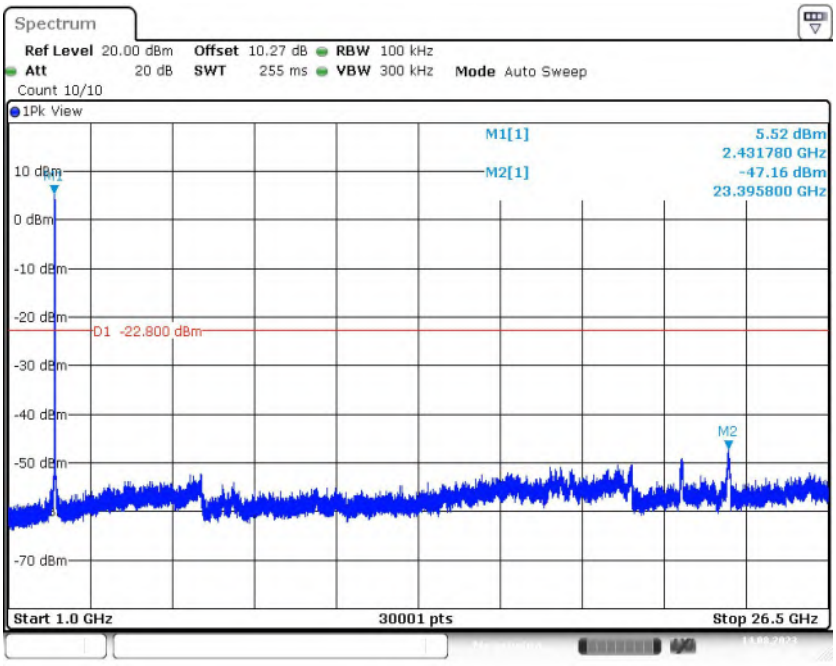


Fig.51 Conducted Spurious Emission (1GHz-26.5GHz, 802.11n-HT20, CH6), MIMO-Ant0

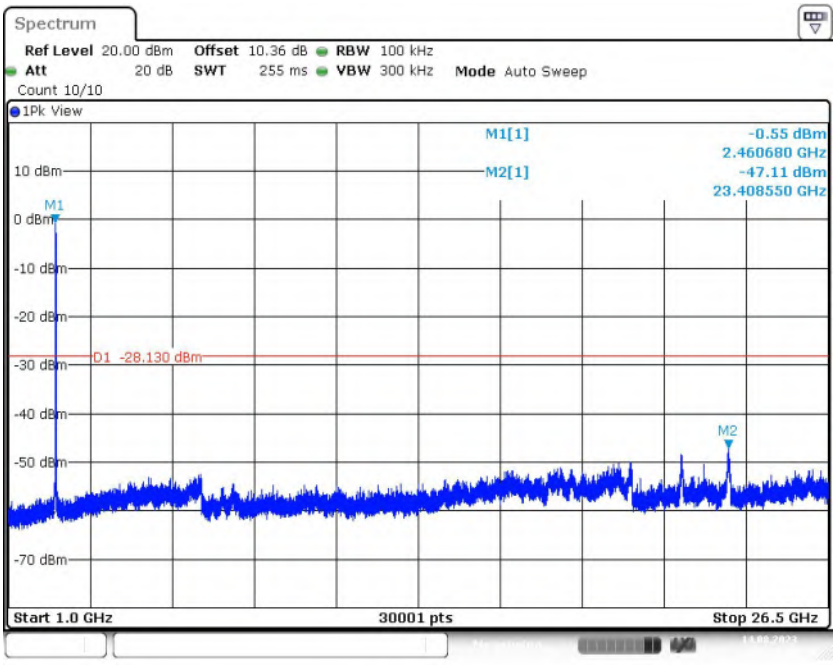


Fig.52 Conducted Spurious Emission (1GHz-26.5GHz, 802.11n-HT20, CH11), MIMO-Ant0

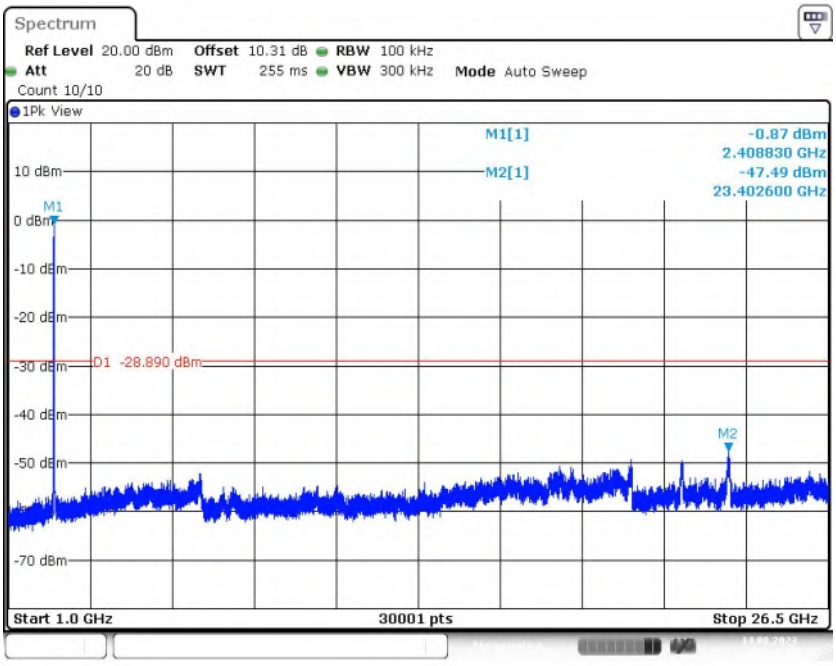


Fig.53 Conducted Spurious Emission (1GHz-26.5GHz, 802.11ax-HE20, CH1), MIMO-Ant0

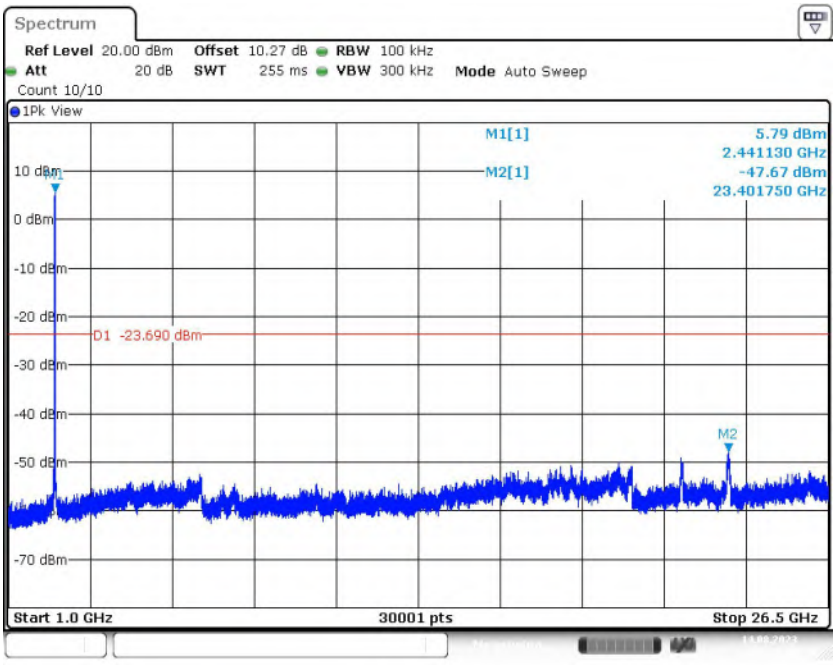


Fig.54 Conducted Spurious Emission (1GHz-26.5GHz, 802.11ax-HE20, CH6), MIMO-Ant0

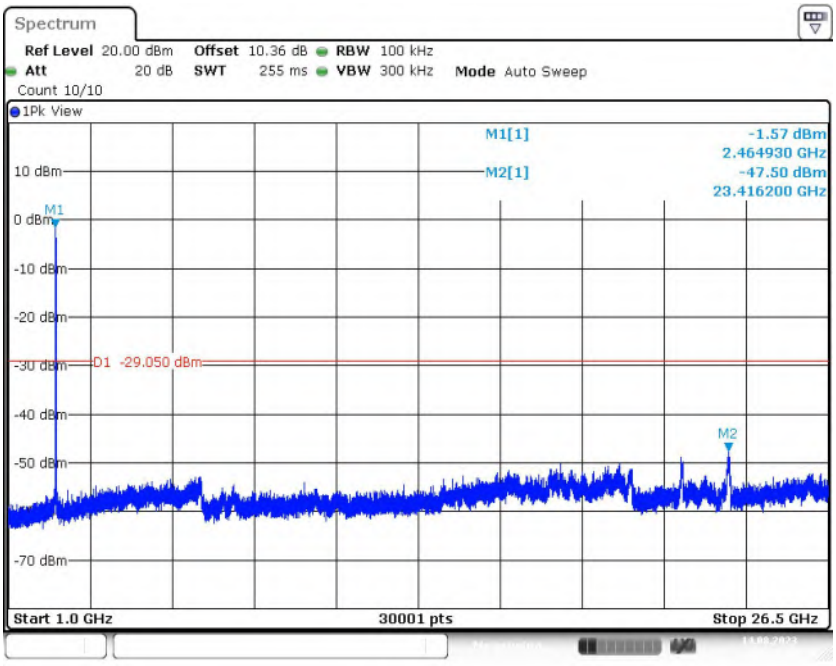


Fig.55 Conducted Spurious Emission (1GHz-26.5GHz, 802.11ax-HE20, CH11), MIMO-Ant0

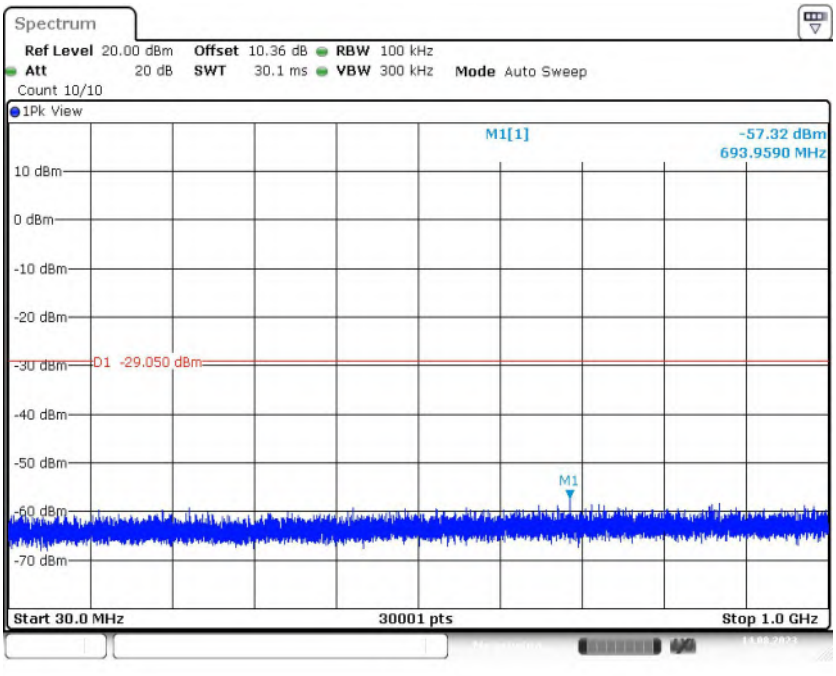


Fig.56 Conducted Spurious Emission (All Channels, 30MHz -1GHz), MIMO-Ant0

A.6 Radiated Emission

Method of Measurement: See ANSI C63.10-clause 11.11&11.12.

Measurement Limit:

Standard	Limit (dBm)
FCC 47 CFR Part 15.247, 15.205, 15.209	20dBm below peak output power

In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a) (see § 15.205(c)).

Limit in restricted band:

Frequency of emission (MHz)	Field strength(μV/m)	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

Test Condition:

The EUT was placed on a non-conductive table. The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the antenna height and the EUT azimuth were varied in order to identify the maximum level of emissions from the EUT. This maximization process was repeated with the EUT positioned in each of its three orthogonal orientations.

Frequency of emission (MHz)	RBW/VBW	Sweep Time(s)
30-1000	120kHz/300kHz	5
1000-4000	1MHz/3MHz	15
4000-18000	1MHz/3MHz	40
18000-26500	1MHz/3MHz	20

Note: According to the performance evaluation, the radiated emission margin of EUT is over 20dB in the band from 9kHz to 30MHz.Therefore, the measurement starts from 30MHz to tenth harmonic.

The measurement results include the horizontal polarization and vertical polarization measurements. For radiated measurement, pre-scanned in three orthogonal panels, X, Y, Z. The worst cases were recorded in this report.

Measurement Results:

SISO-Ant0:

Mode	Frequency (MHz)	Frequency Range	Test Results	Conclusion
802.11b	2412(CH1)	1 GHz ~18 GHz	Fig.57	P
	2437(CH6)	1 GHz ~18 GHz	Fig.58	P
	2462(CH11)	1 GHz ~18 GHz	Fig.59	P
	Restricted Band (CH1)	2.38 GHz ~ 2.45 GHz	Fig.60	P
	Restricted Band (CH11)	2.45 GHz ~ 2.5 GHz	Fig.61	P
802.11g	2412(CH1)	1 GHz ~18 GHz	Fig.62	P
	2437(CH6)	1 GHz ~18 GHz	Fig.63	P
	2462(CH11)	1 GHz ~18 GHz	Fig.64	P
	Restricted Band (CH1)	2.38 GHz ~ 2.45 GHz	Fig.65	P
	Restricted Band (CH11)	2.45 GHz ~ 2.5 GHz	Fig.66	P
802.11n -HT20	2412(CH1)	1 GHz ~18 GHz	Fig.67	P
	2437(CH6)	1 GHz ~18 GHz	Fig.68	P
	2462(CH11)	1 GHz ~18 GHz	Fig.69	P
	Restricted Band (CH1)	2.38 GHz ~ 2.45 GHz	Fig.70	P
	Restricted Band (CH11)	2.45 GHz ~ 2.5 GHz	Fig.71	P
802.11ax -HE20	2412(CH1)	1 GHz ~18 GHz	Fig.72	P
	2437(CH6)	1 GHz ~18 GHz	Fig.73	P
	2462(CH11)	1 GHz ~18 GHz	Fig.74	P
	Restricted Band (CH1)	2.38 GHz ~ 2.45 GHz	Fig.75	P
	Restricted Band (CH11)	2.45 GHz ~ 2.5 GHz	Fig.76	P
802.11ax -HE20 (RU26)	2412(CH1)	1 GHz ~18 GHz	Fig.77	P
	2462(CH11)	1 GHz ~18 GHz	Fig.78	P
	Restricted Band (CH1)	2.38 GHz ~ 2.45 GHz	Fig.79	P
	Restricted Band (CH11)	2.45 GHz ~ 2.5 GHz	Fig.80	P
/	All Channels	9 kHz ~30 MHz	Fig.81	P
		30 MHz ~1 GHz	Fig.82	P
		18 GHz ~26.5 GHz	Fig.83	P

MIMO:

Mode	Channel	Frequency Range	Test Results	Conclusion
802.11n-HT20	2412(CH1)	1 GHz ~ 18 GHz	Fig.84	P
	2437(CH6)	1 GHz ~ 18 GHz	Fig.85	P
	2462(CH11)	1 GHz ~ 18 GHz	Fig.86	P
	Restricted Band (CH1)	2.38 GHz ~ 2.45 GHz	Fig.87	P
	Restricted Band (CH11)	2.45 GHz ~ 2.5 GHz	Fig.88	P
802.11ax -HE20	2412(CH1)	1 GHz ~ 18 GHz	Fig.89	P
	2437(CH6)	1 GHz ~ 18 GHz	Fig.90	P
	2462(CH11)	1 GHz ~ 18 GHz	Fig.91	P
	Restricted Band (CH1)	2.38 GHz ~ 2.45 GHz	Fig.92	P
	Restricted Band (CH11)	2.45 GHz ~ 2.5 GHz	Fig.93	P
/	All Channels	9 kHz ~ 30 MHz	Fig.94	P

		30 MHz ~ 1 GHz	Fig.95	**P**
		18 GHz ~ 26.5 GHz	Fig.96	**P**

Note: Both RF ports were tested, and **Ant0** is the port with the worst result in SISO.
According to the customer description, RU26 is the worst RU type of 802.11ax.

Worst-Case Result:

SISO-Ant0:

802.11b CH1 (1-18GHz)

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Pol	Corr. (dB/m)
6750.000000	49.85	74.00	24.15	V	6.5
7901.571429	45.51	74.00	28.49	V	7.4
10320.428572	48.98	74.00	25.02	V	10.4
11865.428572	49.62	74.00	24.38	V	12.8
14901.428572	52.03	74.00	21.97	V	14.7
16762.714286	55.57	74.00	18.43	V	19.5

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Pol	Corr. (dB/m)
6750.000000	42.30	54.00	11.70	V	6.5
7901.571429	35.38	54.00	18.62	V	7.4
10320.428572	38.82	54.00	15.18	V	10.4
11865.428572	39.36	54.00	14.64	V	12.8
14901.428572	41.69	54.00	12.31	V	14.7
16762.714286	45.59	54.00	8.41	V	19.5

802.11g CH6 (1GHz-18GHz)

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Pol	Corr. (dB/m)
10471.285714	48.76	74.00	25.24	V	10.0
11865.000000	49.48	74.00	24.52	V	12.8
12876.857143	51.10	74.00	22.90	V	13.2
14947.714286	52.63	74.00	21.37	V	14.7
16581.428571	55.73	74.00	18.27	V	19.1
17922.857143	57.20	74.00	16.80	V	21.3

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Pol	Corr. (dB/m)
10471.285714	38.09	54.00	15.91	V	10.0
11865.000000	39.09	54.00	14.91	V	12.8
12876.857143	40.39	54.00	13.61	V	13.2
14947.714286	39.49	54.00	14.51	V	14.7
16581.428571	43.78	54.00	10.22	V	19.1
17922.857143	44.85	54.00	9.15	V	21.3

802.11n-HT20 CH6 (1GHz-18GHz)

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Pol	Corr. (dB/m)
10923.000000	49.71	74.00	24.29	V	10.9
11854.285714	50.60	74.00	23.40	V	12.7
12817.285714	50.79	74.00	23.21	V	13.1
14922.428572	51.40	74.00	22.60	V	14.7
16569.428571	56.05	74.00	17.95	V	19.0
17884.285714	57.33	74.00	16.67	V	21.5

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Pol	Corr. (dB/m)
10923.000000	36.61	54.00	17.39	V	10.9
11854.285714	37.28	54.00	16.72	V	12.7
12817.285714	37.74	54.00	16.26	V	13.1
14922.428572	39.55	54.00	14.45	V	14.7
16569.428571	43.79	54.00	10.21	V	19.0
17884.285714	44.63	54.00	9.37	V	21.5

802.11ax-HE20 CH6 (1GHz-18GHz)

Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Pol	Corr. (dB/m)
8922.428572	46.75	74.00	27.25	V	7.5
9829.285714	45.98	74.00	28.02	V	8.7
10870.714286	48.58	74.00	25.42	V	10.5
12925.285714	50.30	74.00	23.70	V	13.2
14933.571429	50.79	74.00	23.21	V	14.7
17917.285714	55.40	74.00	18.60	V	21.4

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Pol	Corr. (dB/m)
8922.428572	35.99	54.00	18.01	V	7.5
9829.285714	35.84	54.00	18.16	V	8.7
10870.714286	38.04	54.00	15.96	V	10.5
12925.285714	38.10	54.00	15.90	V	13.2
14933.571429	39.66	54.00	14.34	V	14.7
17917.285714	44.96	54.00	9.04	V	21.4

802.11ax-HE20(RU26) CH11 (1GHz-18GHz)

Frequency (MHz)	MaxPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Pol	Corr. (dB/m)
10481.571429	48.20	74.00	25.80	H	10.0
11871.857143	48.99	74.00	25.01	V	12.8
12896.571429	50.81	74.00	23.19	V	13.2
14846.571429	51.83	74.00	22.17	V	14.6
16546.714286	55.54	74.00	18.46	V	18.8
17952.000000	57.36	74.00	16.64	V	21.2

Frequency (MHz)	Average (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Pol	Corr. (dB/m)
10481.571429	35.96	54.00	18.04	H	10.0
11871.857143	36.91	54.00	17.09	V	12.8
12896.571429	38.46	54.00	15.54	V	13.2
14846.571429	38.91	54.00	15.09	V	14.6
16546.714286	43.06	54.00	10.94	V	18.8
17952.000000	44.57	54.00	9.43	V	21.2

MIMO:

802.11n-HT20 CH6 (1-18GHz)

Frequency (MHz)	MaxPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Pol	Corr. (dB)
10464.000000	48.57	74.00	25.43	V	10.0
11744.571429	49.65	74.00	24.35	V	12.2
12918.000000	51.19	74.00	22.81	V	13.2
14894.142857	51.64	74.00	22.36	V	14.7
16575.428571	56.11	74.00	17.89	V	19.1
17909.571429	57.29	74.00	16.71	V	21.4

Frequency (MHz)	Average (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Pol	Corr. (dB)
10464.000000	36.12	54.00	17.88	V	10.0
11744.571429	37.05	54.00	16.95	V	12.2
12918.000000	38.20	54.00	15.80	V	13.2
14894.142857	39.61	54.00	14.39	V	14.7
16575.428571	43.66	54.00	10.34	V	19.1
17909.571429	44.94	54.00	9.06	V	21.4

802.11ax-HE20 CH6 (1-18GHz)

Frequency (MHz)	MaxPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Pol	Corr. (dB)
9508.714286	46.71	74.00	27.29	V	8.1
10446.857143	48.94	74.00	25.06	V	10.0
11860.285714	49.28	74.00	24.72	V	12.8
12885.428572	51.26	74.00	22.74	V	13.2
14803.285714	51.98	74.00	22.02	V	14.6
16674.000000	55.68	74.00	18.32	V	19.6

Frequency (MHz)	Average (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Pol	Corr. (dB)
4532.400000	34.41	54.00	19.59	V	4.1
5862.900000	35.75	54.00	18.25	H	4.7
7589.571429	32.23	54.00	21.77	H	5.7
10470.000000	35.13	54.00	18.87	V	9.0
14849.571429	37.75	54.00	16.25	V	13.0
17892.428571	41.58	54.00	12.42	H	18.8

Note:

A "reference path loss" is established and the A_{Rpl} is the attenuation of “reference path loss”, and Antenna Factor, the gain of the preamplifier, the cable loss. P_{Mea} is the field strength recorded from the instrument. The measurement results are obtained as described below:

Result= P_{Mea} +Cable Loss +Antenna Factor-Gain of the preamplifier.

See below for test graphs.

Conclusion: PASS

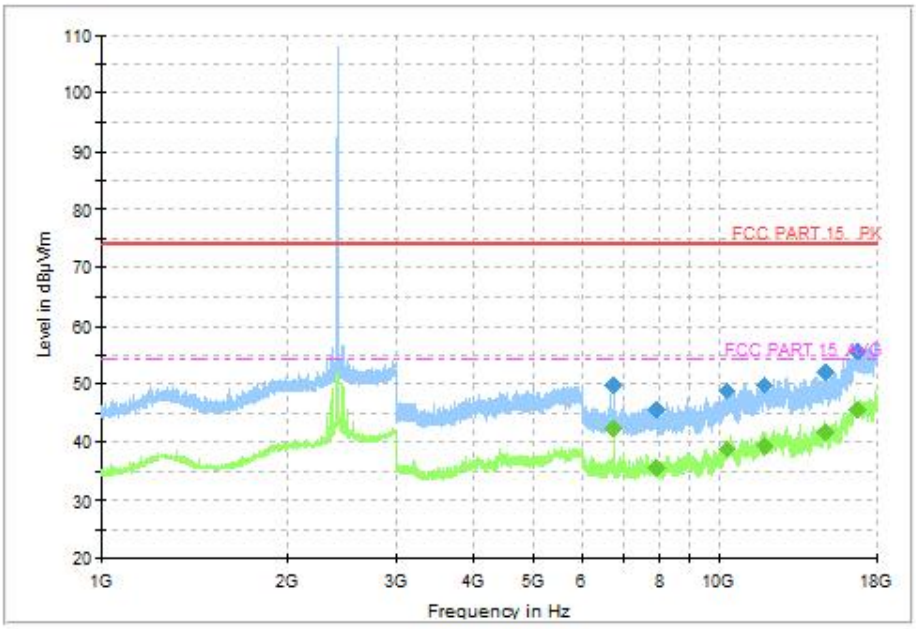


Fig.57 Radiated Spurious Emission (802.11b, CH1, 1GHz-18GHz)

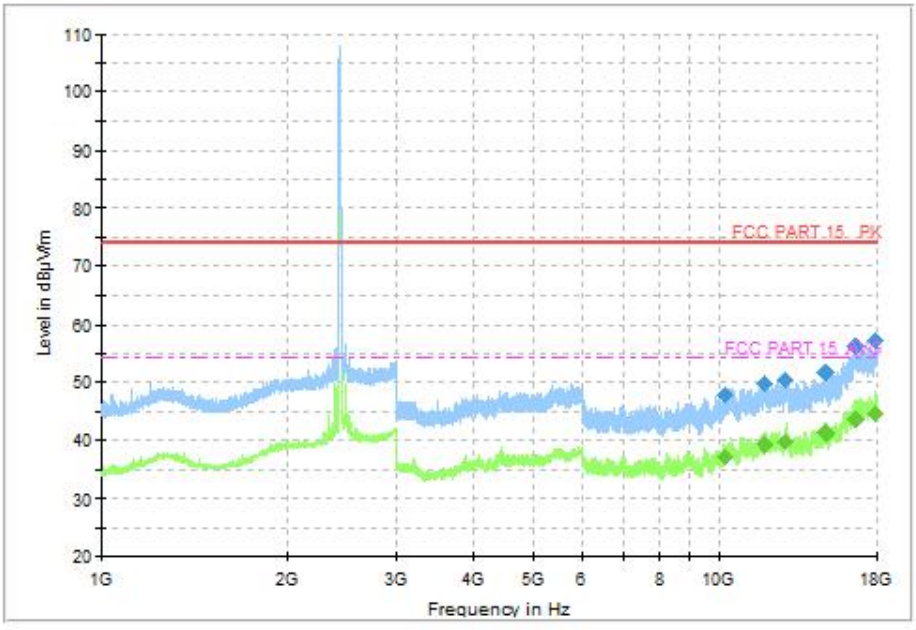


Fig.58 Radiated Spurious Emission (802.11b, CH6, 1GHz-18GHz)

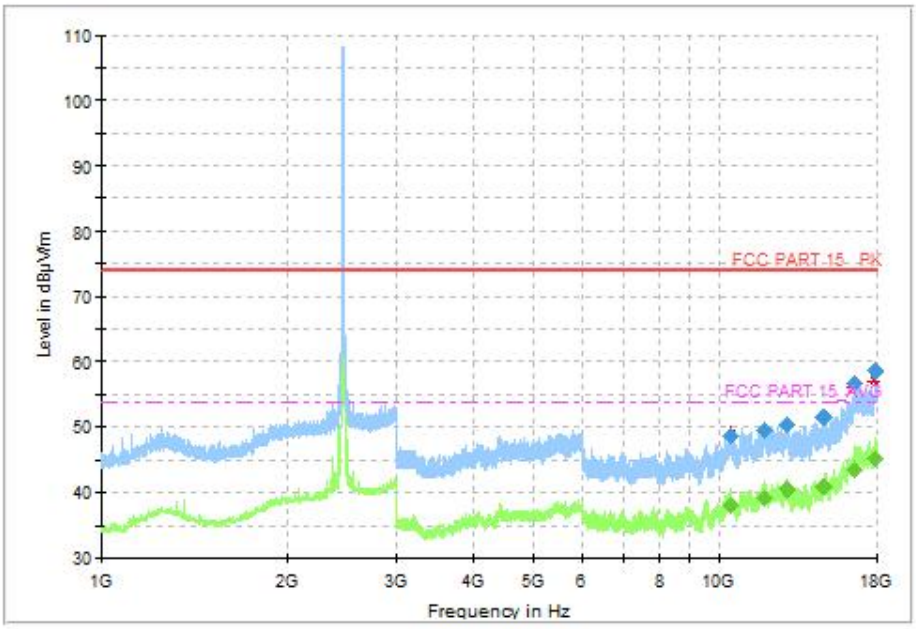


Fig.59 Radiated Spurious Emission (802.11b, CH11, 1GHz-18GHz)

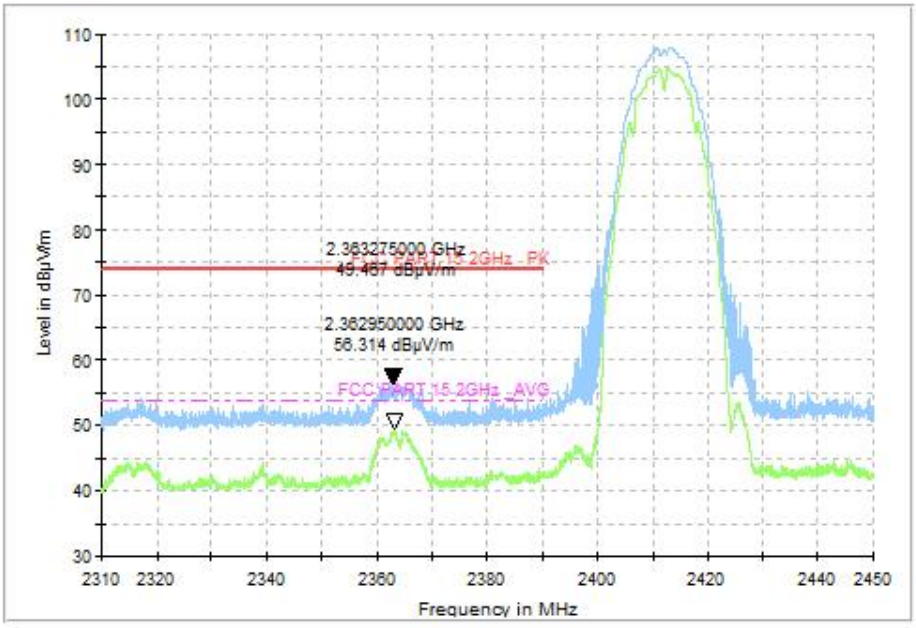


Fig.60 Radiated Restricted Band (802.11b, CH1, 2.38GHz~2.45GHz)

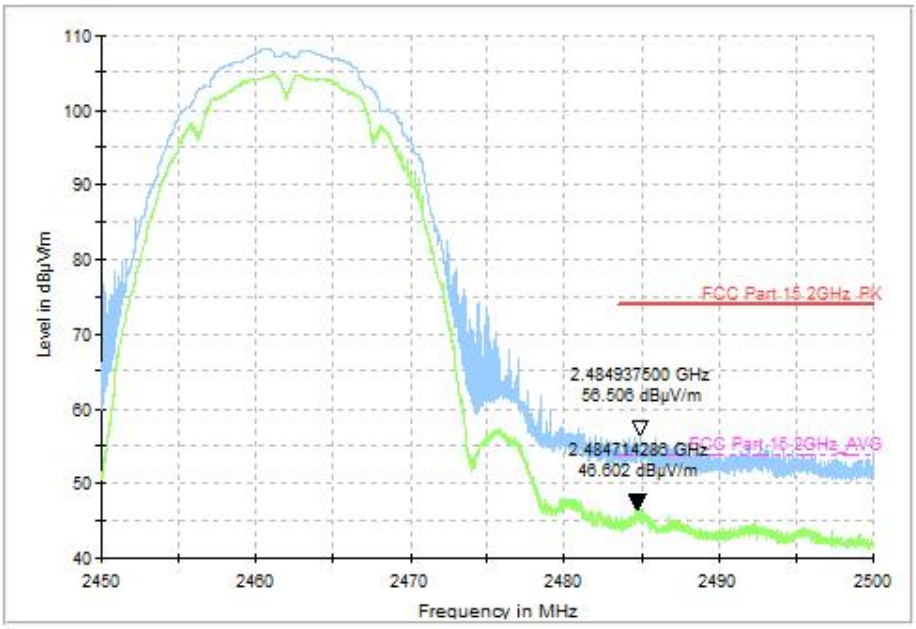


Fig.61 Radiated Restricted Band (802.11b, CH11, 2.45GHz~2.50GHz)

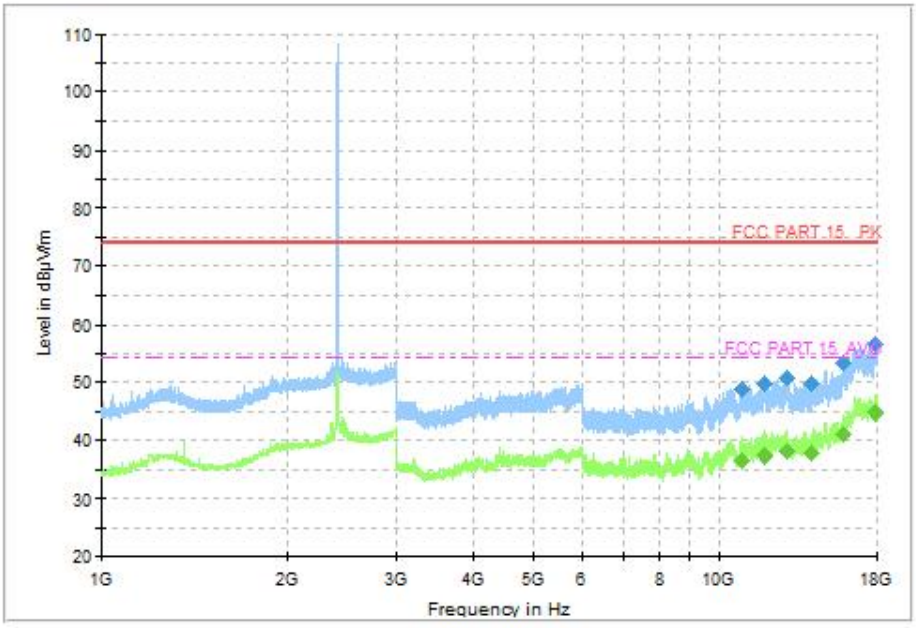


Fig.62 Radiated Spurious Emission (802.11g, CH1, 1GHz-18GHz)

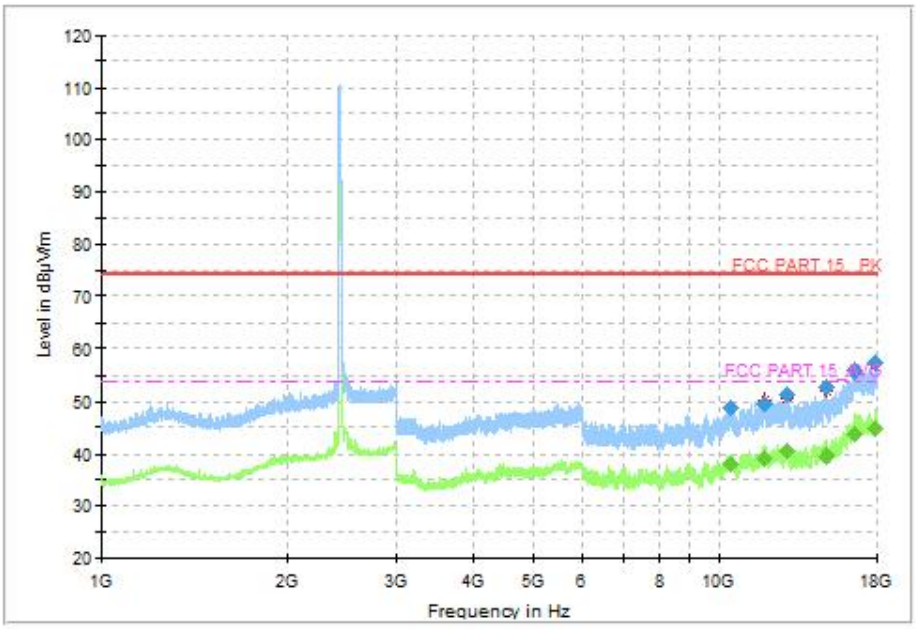


Fig.63 Radiated Spurious Emission (802.11g, CH6, 1GHz-18GHz)

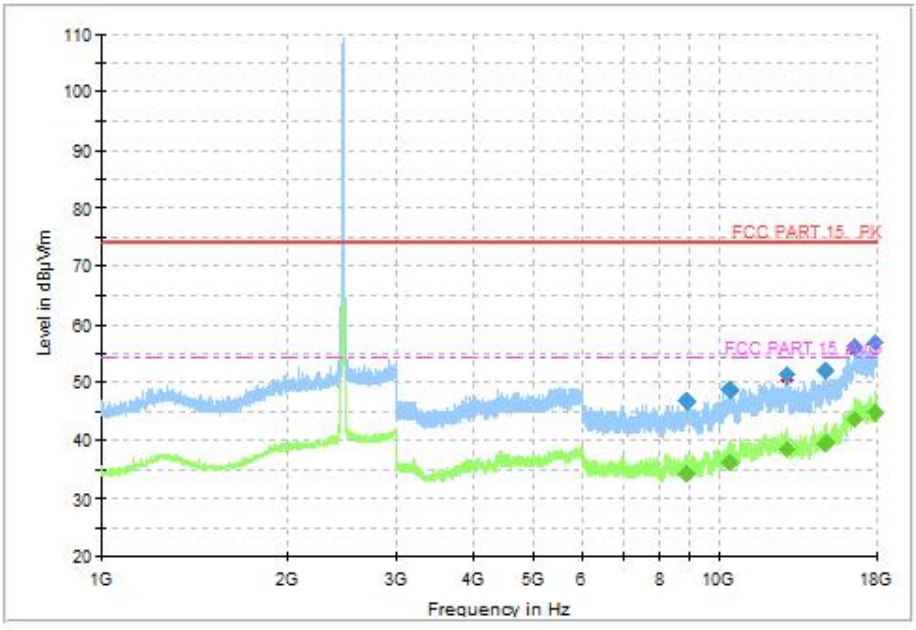


Fig.64 Radiated Spurious Emission (802.11g, CH11, 1GHz-18GHz)

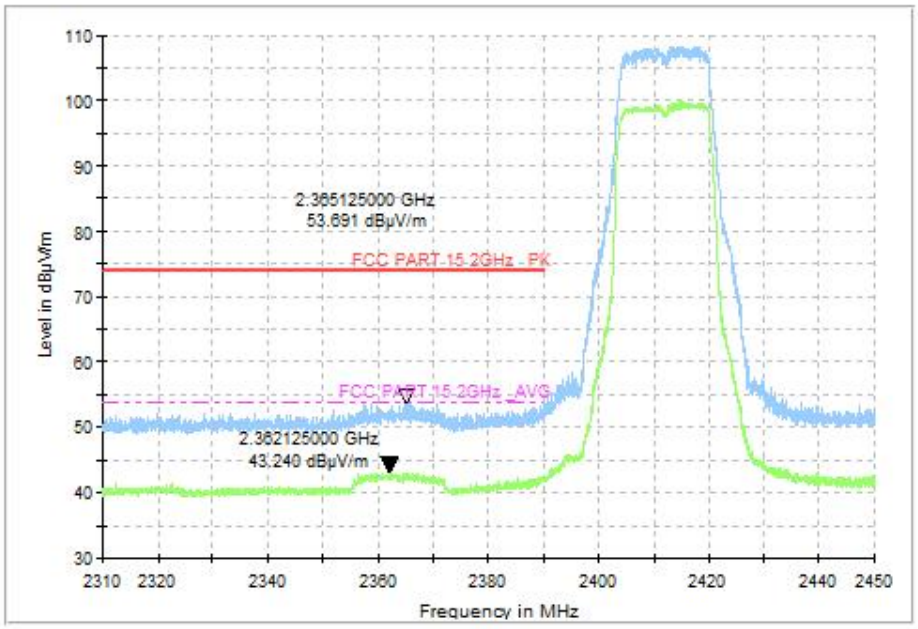


Fig.65 Radiated Restricted Band (802.11g, CH1, 2.38GHz~2.45GHz)

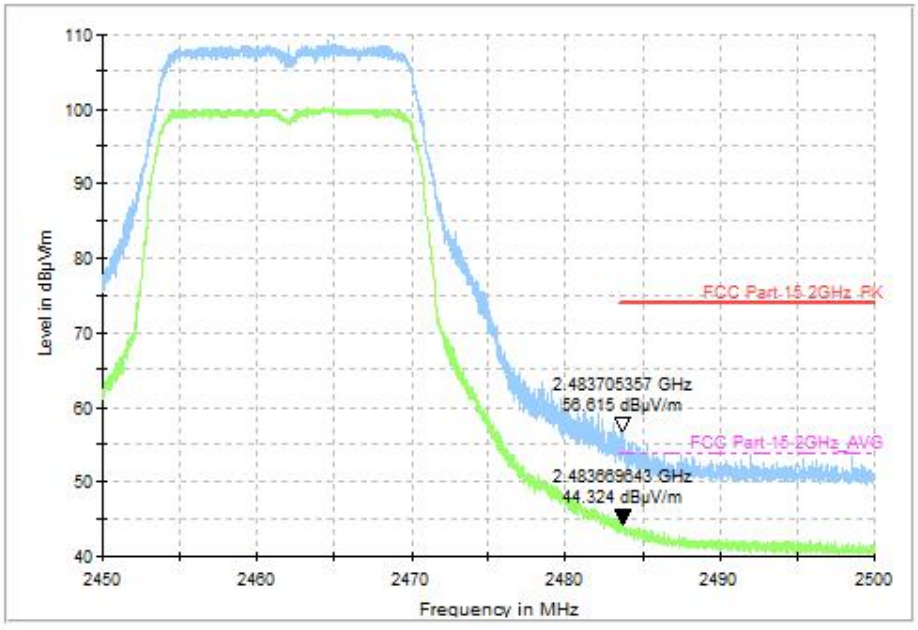


Fig.66 Radiated Restricted Band (802.11g, CH11, 2.45GHz~2.50GHz)

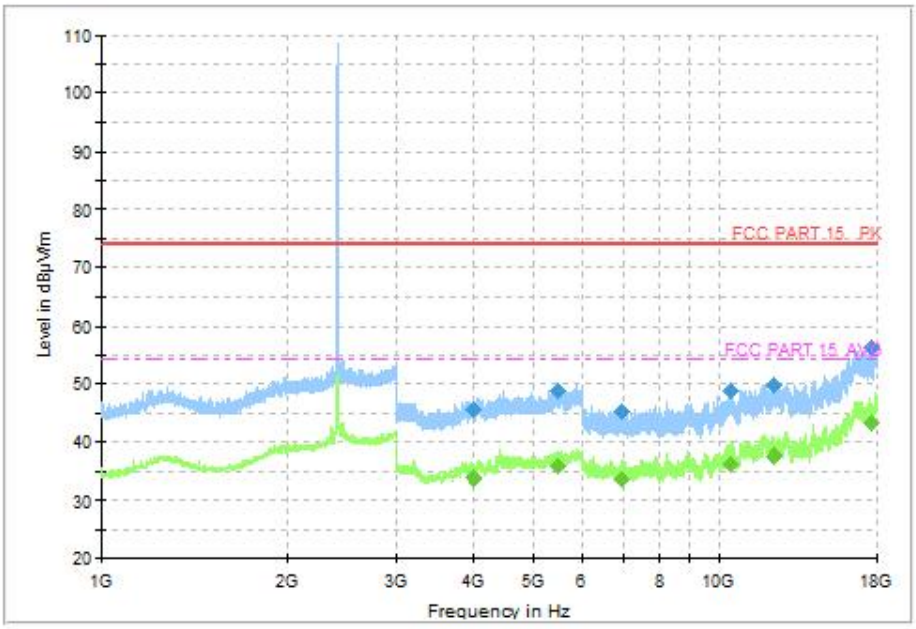


Fig.67 Radiated Spurious Emission (802.11n-HT20, CH1, 1GHz-18GHz)

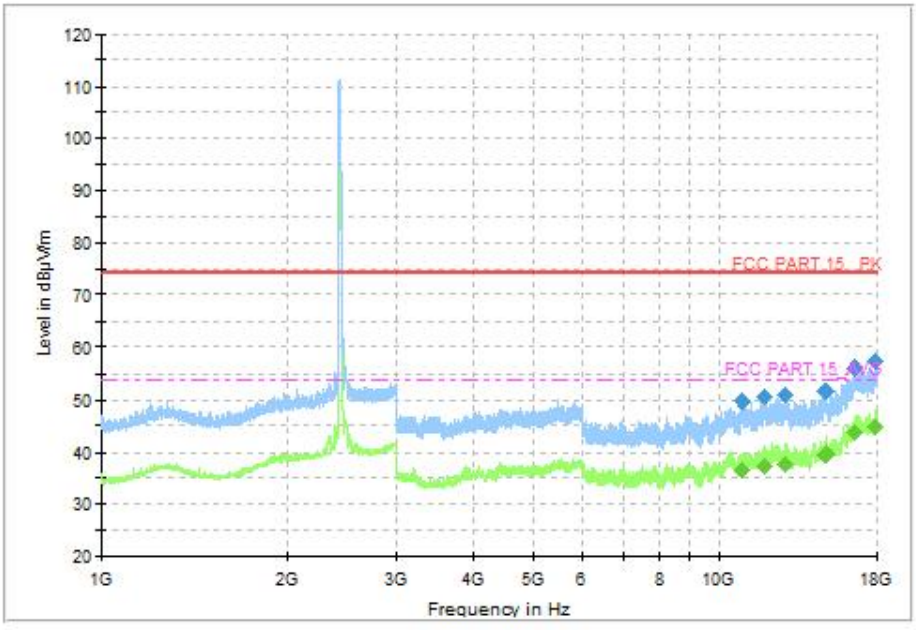


Fig.68 Radiated Spurious Emission (802.11n-HT20, CH6, 1GHz-18GHz)

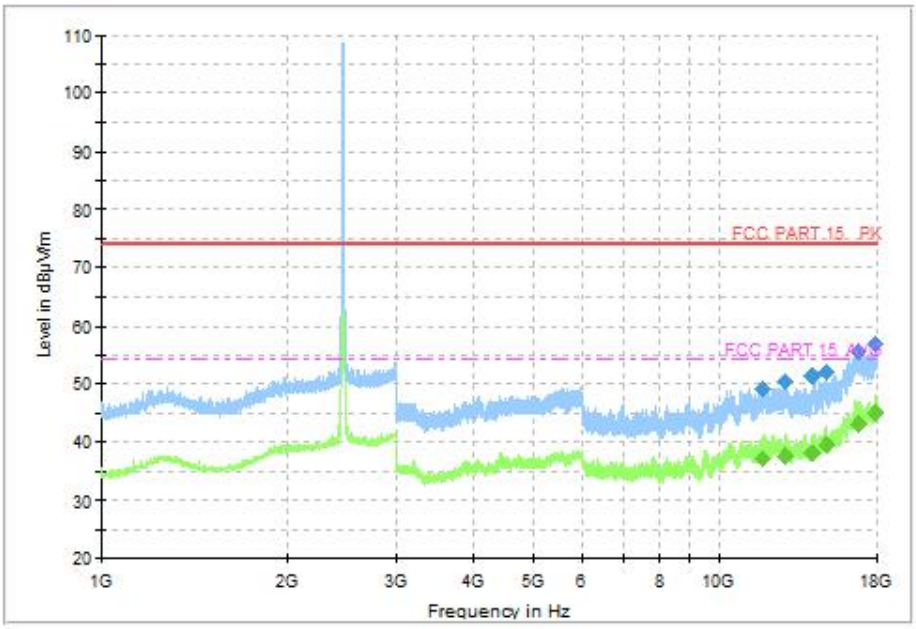


Fig.69 Radiated Spurious Emission (802.11n-HT20, CH11, 1GHz-18GHz)

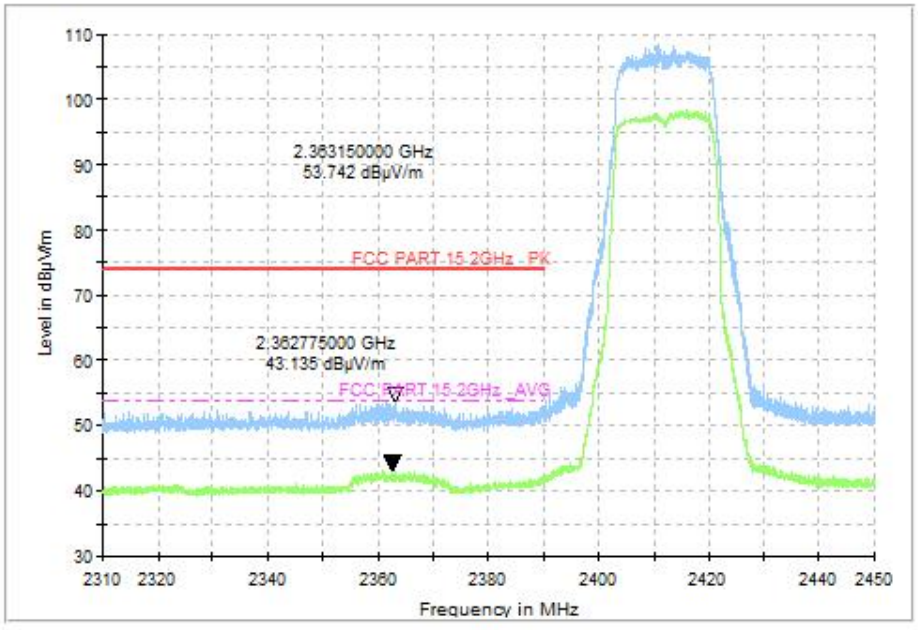


Fig.70 Radiated Restricted Band (802.11n-HT20, CH1, 2.38GHz~2.45GHz)

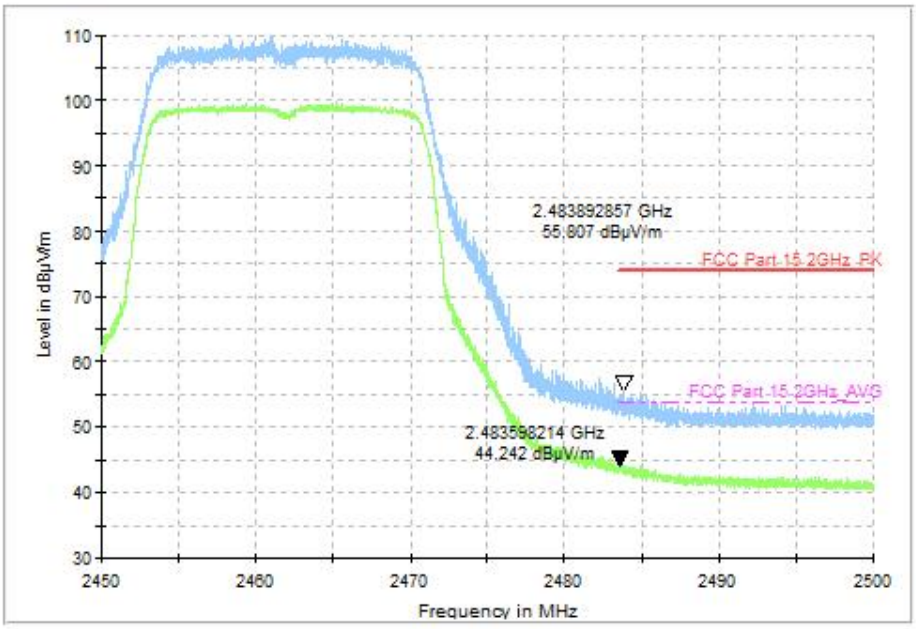


Fig.71 Radiated Spurious Emission (802.11n-HT20, CH11, 2.45GHz~2.50GHz)

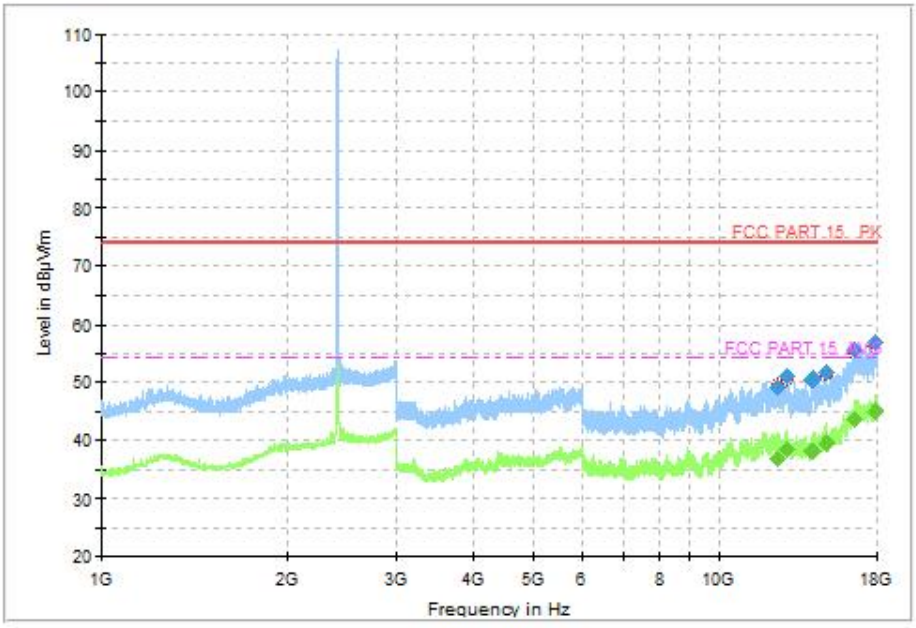


Fig.72 Radiated Spurious Emission (802.11ax-HE20, CH1, 1GHz-18GHz)

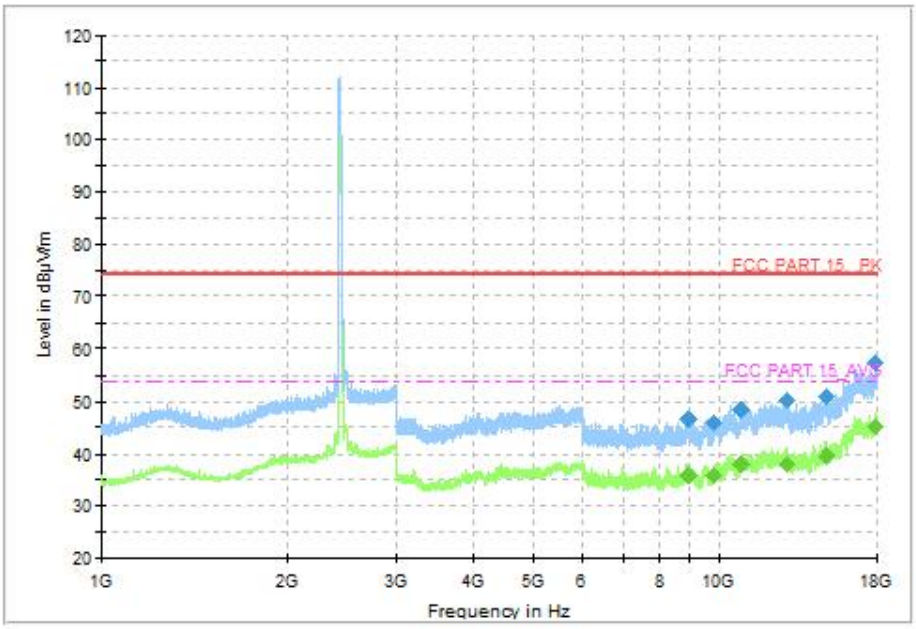


Fig.73 Radiated Spurious Emission (802.11ax-HE20, CH6, 1GHz-18GHz)

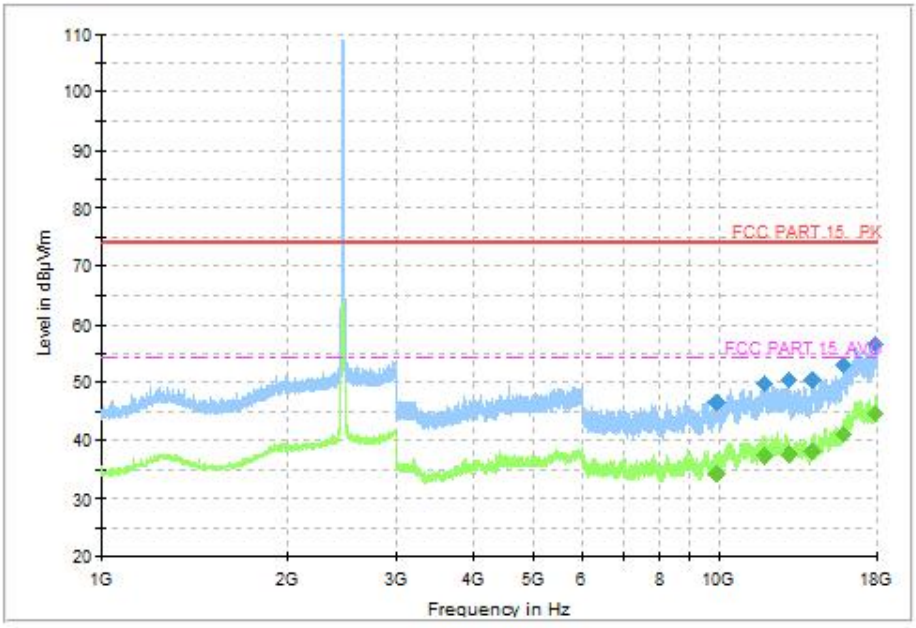


Fig.74 Radiated Spurious Emission (802.11ax-HE20, CH11, 1GHz-18GHz)

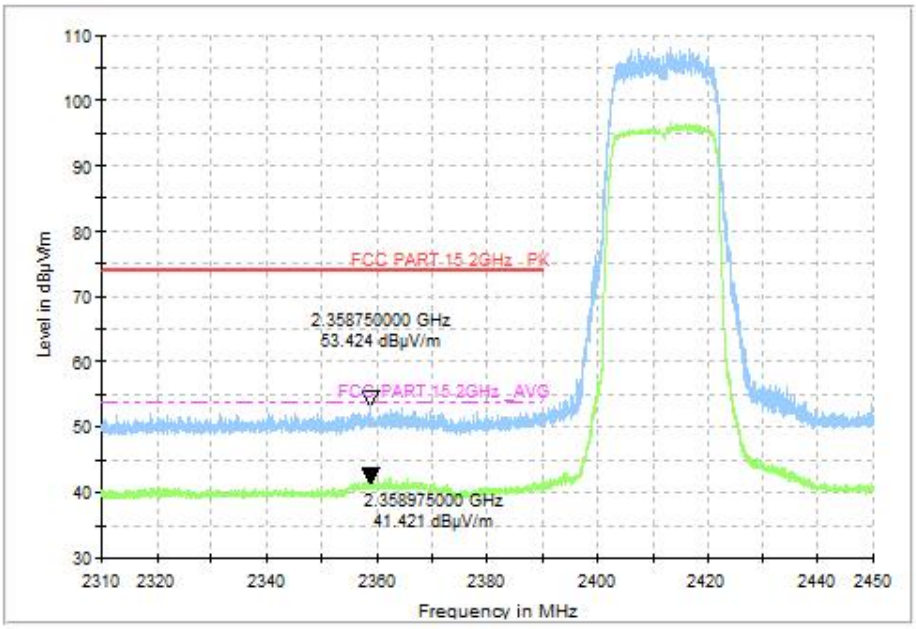


Fig.75 Radiated Restricted Band (802.11ax-HE20, CH1, 2.38GHz~2.45GHz)

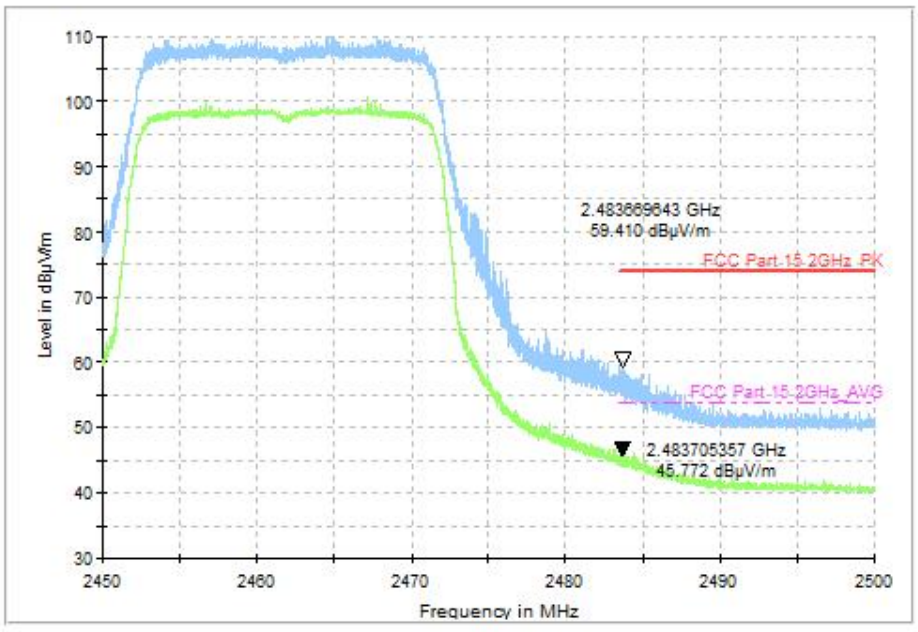


Fig.76 Radiated Spurious Emission (802.11ax-HE20, CH11, 2.45GHz~2.50GHz)

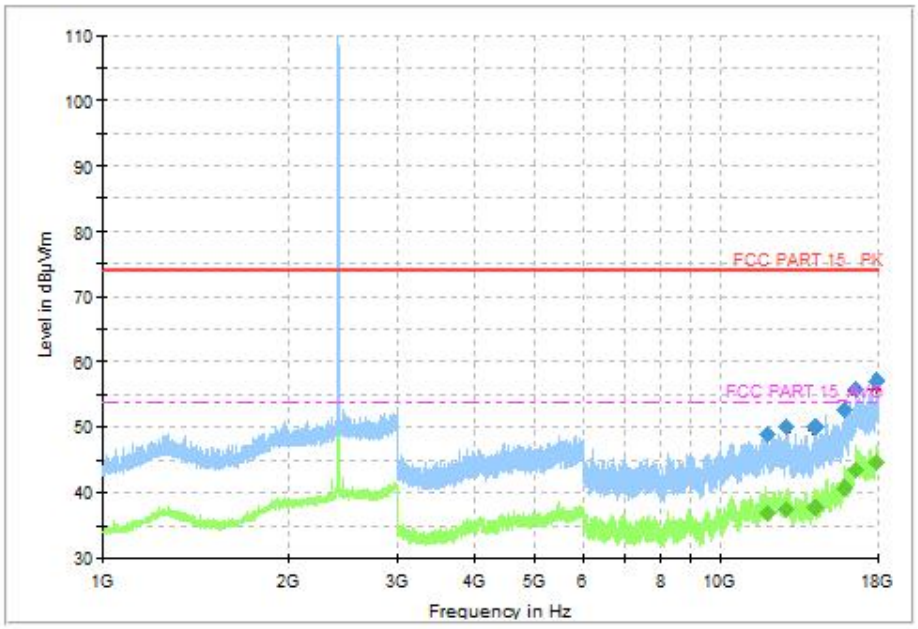


Fig.77 Radiated Spurious Emission (802.11ax-HE20(RU26), CH1, 1GHz-18GHz)

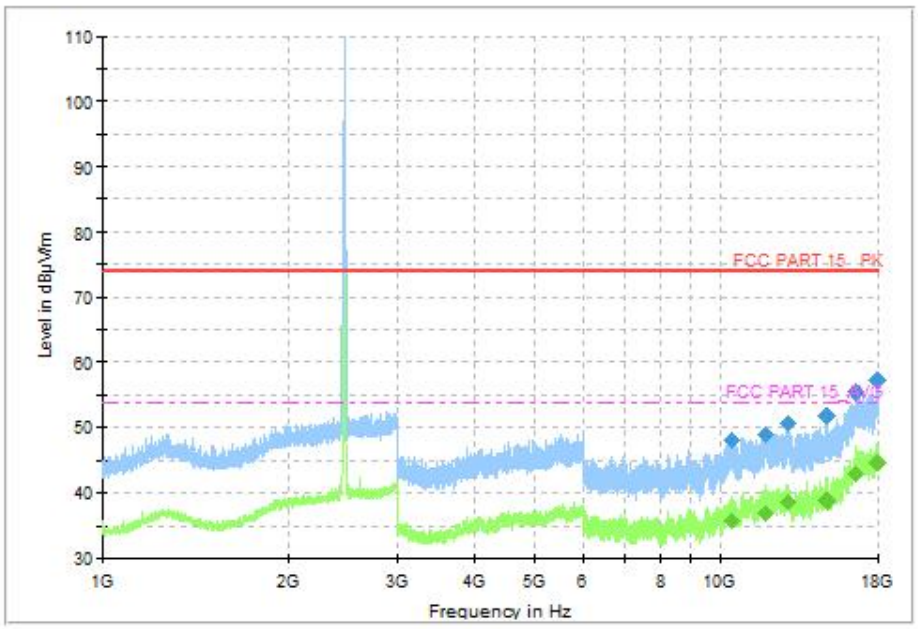


Fig.78 Radiated Spurious Emission (802.11ax-HE20(RU26), CH11, 1GHz-18GHz)

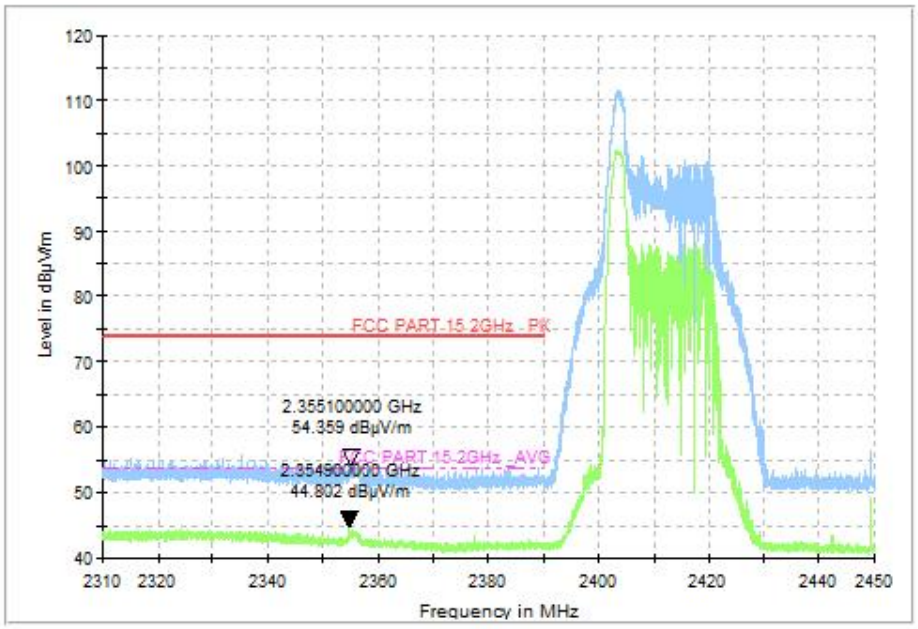


Fig.79 Radiated Restricted Band (802.11ax-HE20, CH1(RU26), 2.38GHz~2.45GHz)

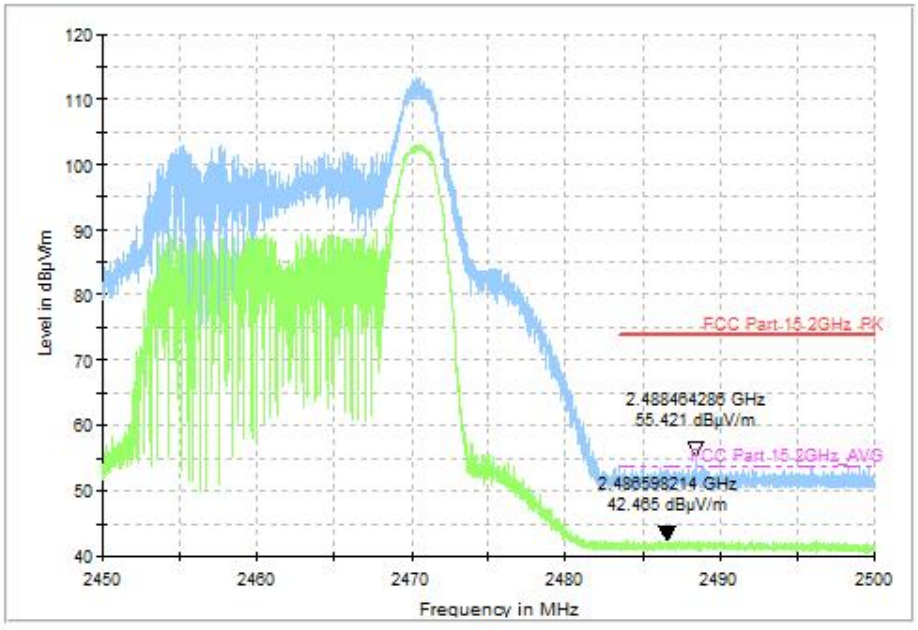


Fig.80 Radiated Spurious Emission (802.11ax-HE20, CH11(RU26), 2.45GHz~2.50GHz)

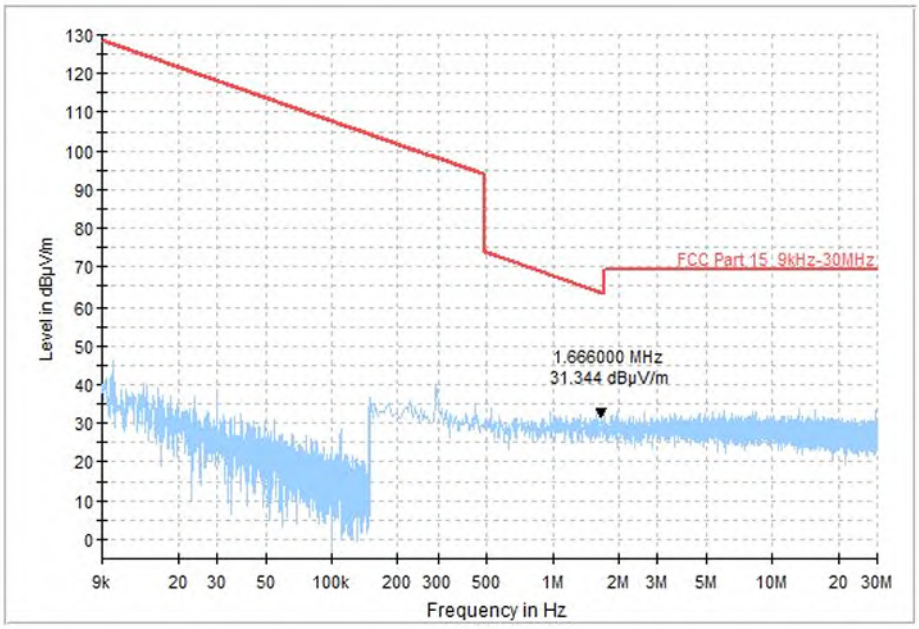


Fig.81 Radiated Spurious Emission (All channel, 9kHz~30MHz)

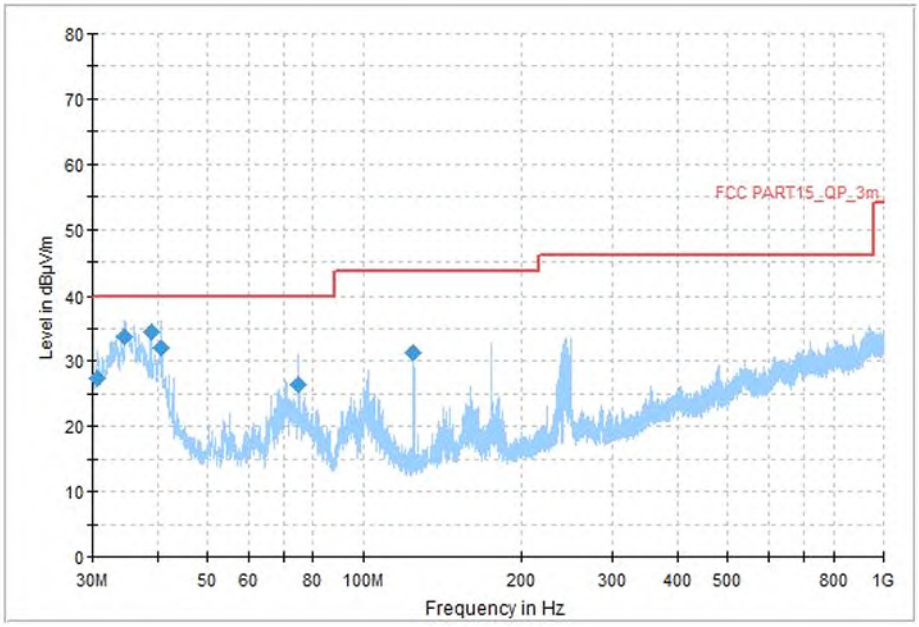


Fig.82 Radiated Spurious Emission (All channel, 30MHz~1GHz)

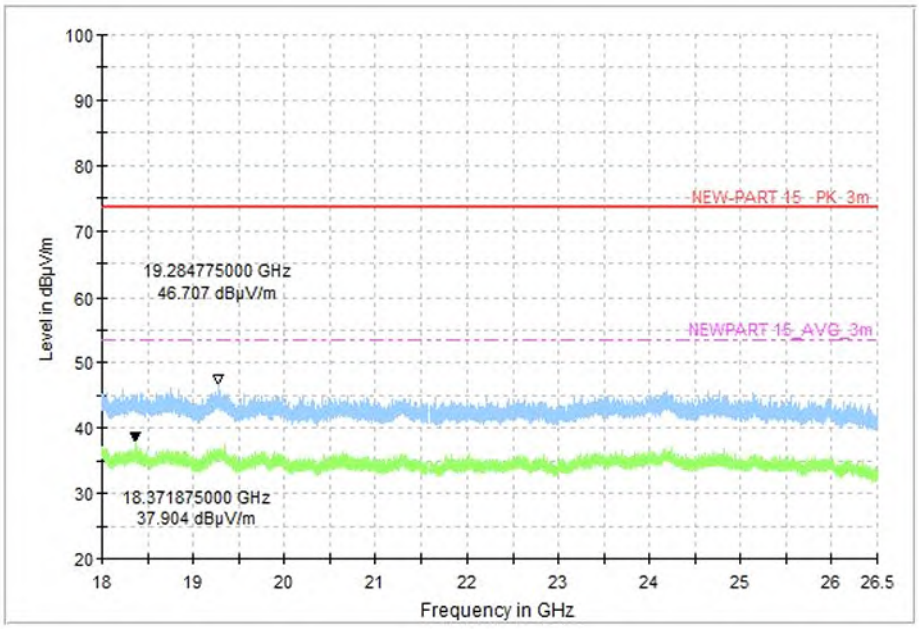


Fig.83 Radiated Spurious Emission (All channel, 18GHz~26.5GHz)

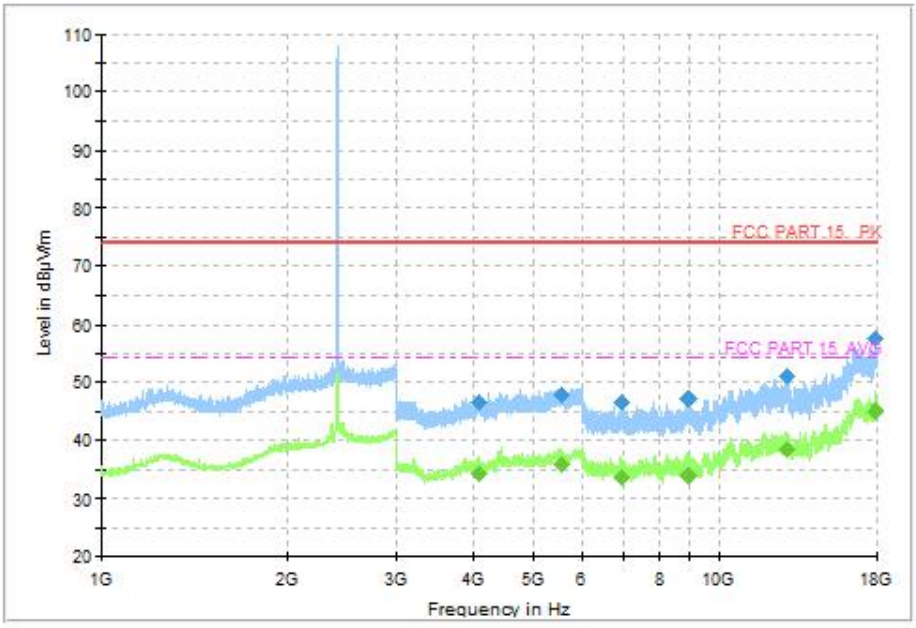


Fig.84 Radiated Spurious Emission (802.11n-HT20, CH1, 1GHz-18GHz),MIMO

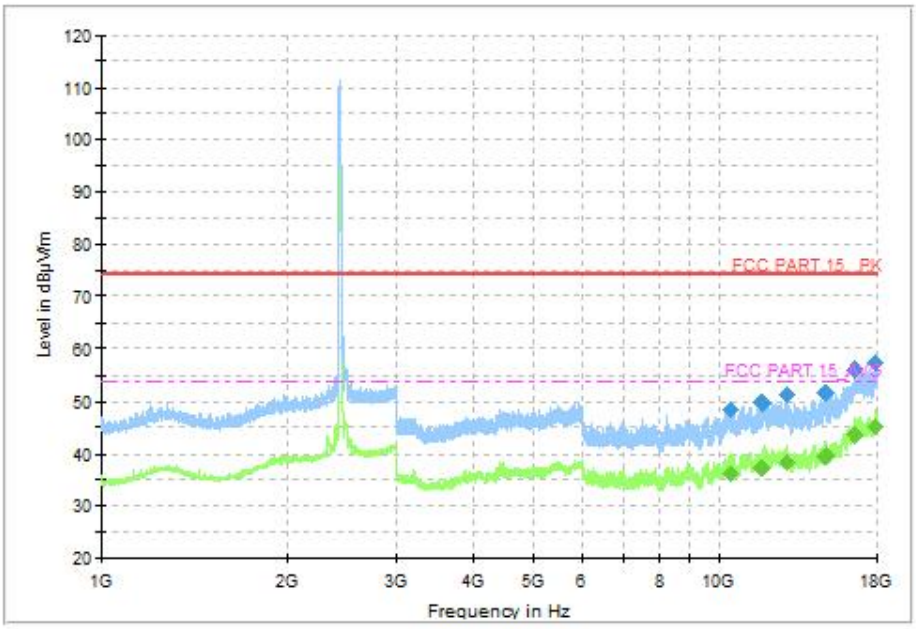


Fig.85 Radiated Spurious Emission (802.11n-HT20, CH6, 1GHz-18GHz),MIMO

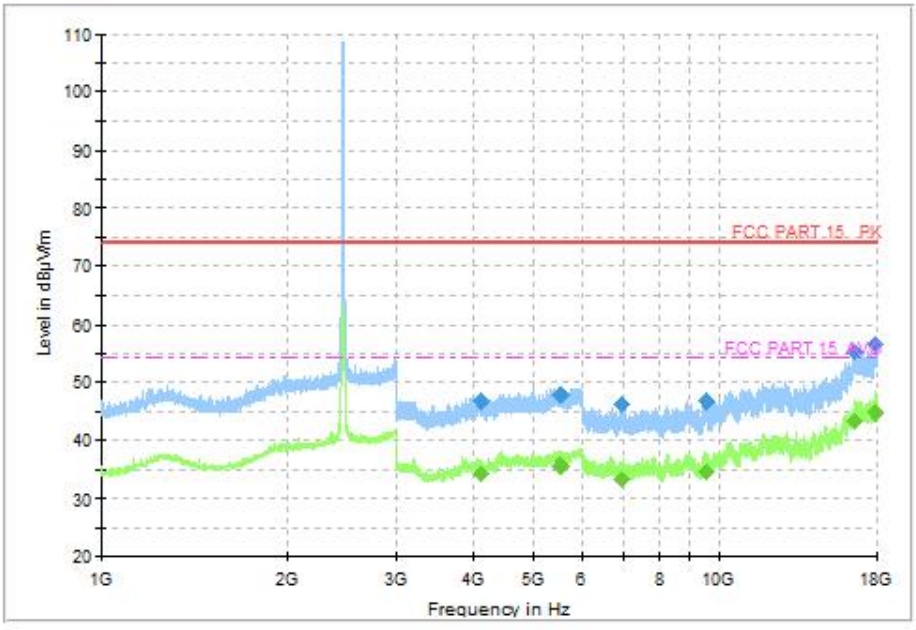


Fig.86 Radiated Spurious Emission (802.11n-HT20, CH11, 1GHz-18GHz),MIMO

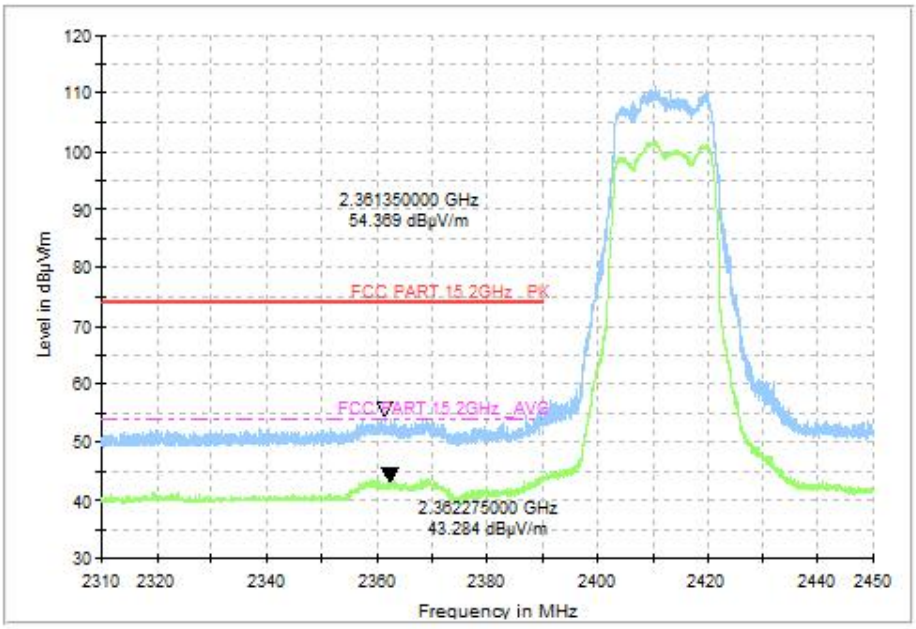


Fig.87 Radiated Restricted Band (802.11n-HT20, CH1, 2.38GHz~2.45GHz),MIMO

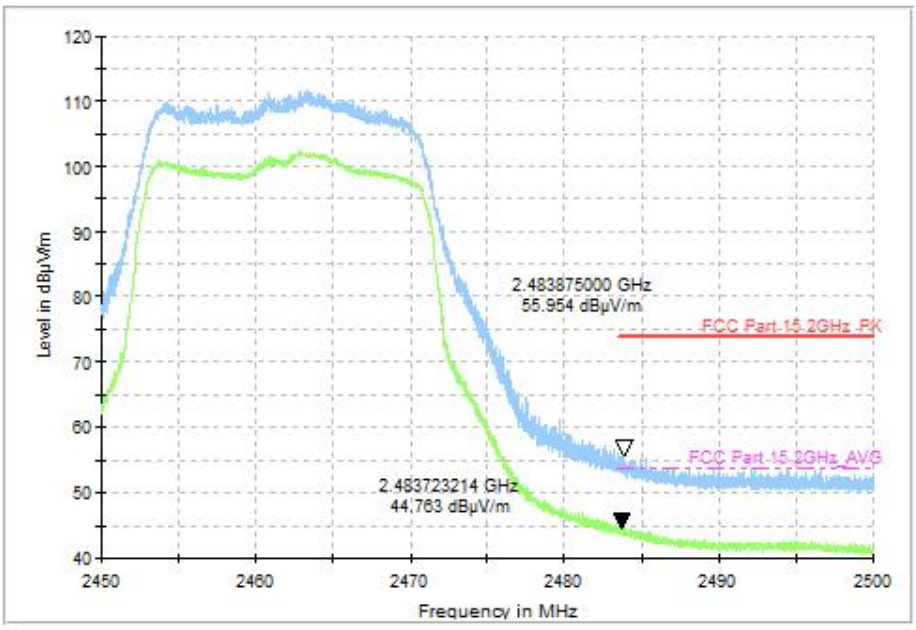


Fig.88 Radiated Spurious Emission (802.11n-HT20, CH11, 2.45GHz~2.50GHz),MIMO

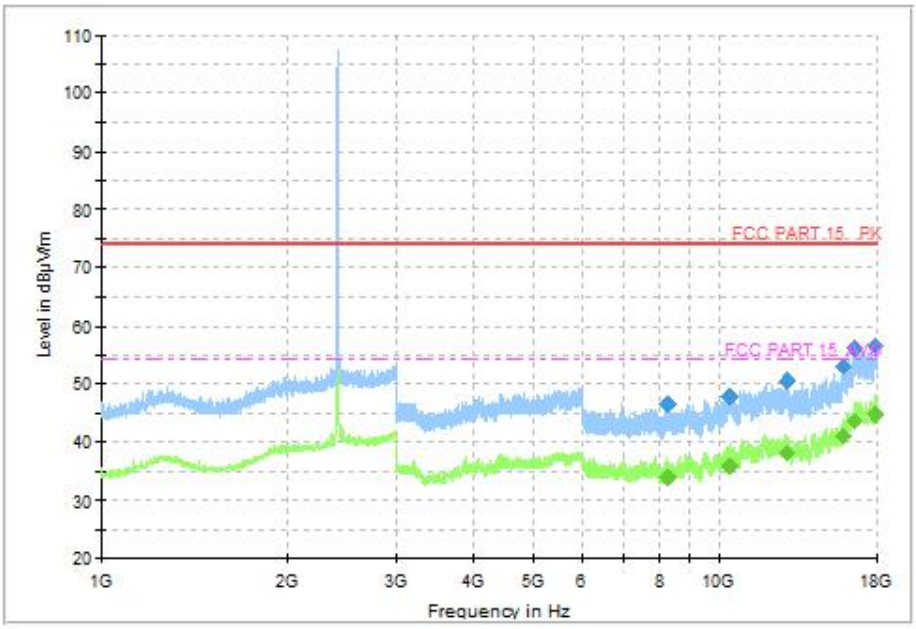


Fig.89 Radiated Spurious Emission (802.11ax-HE20, CH1, 1GHz-18GHz),MIMO

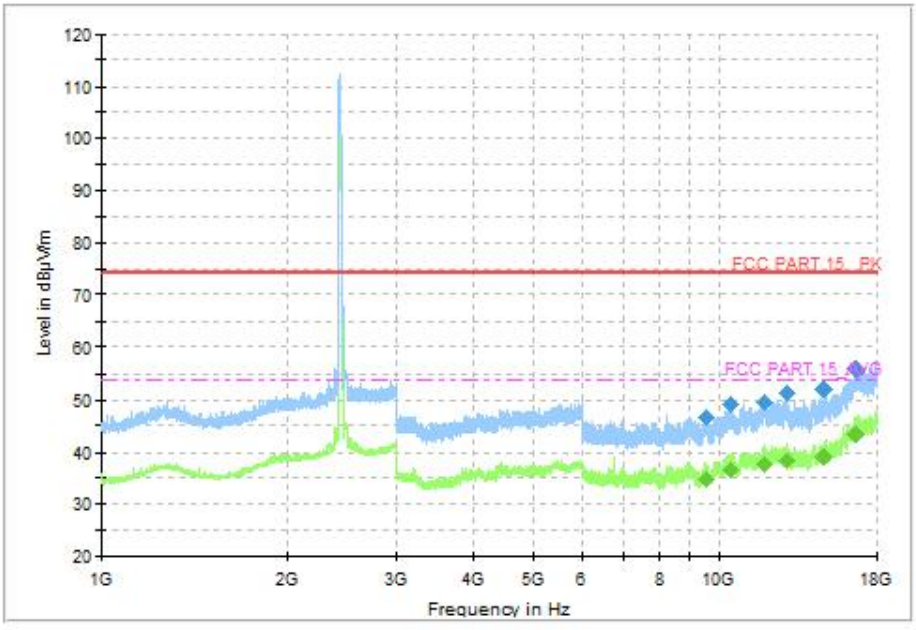


Fig.90 Radiated Spurious Emission (802.11ax-HE20, CH6, 1GHz-18GHz),MIMO

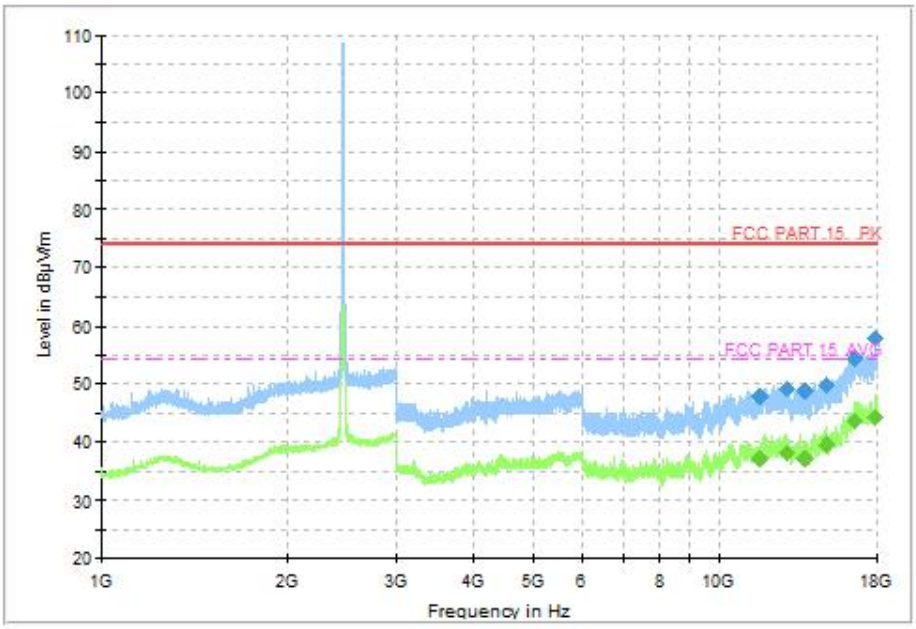


Fig.91 Radiated Spurious Emission (802.11ax-HE20, CH11, 1GHz-18GHz),MIMO

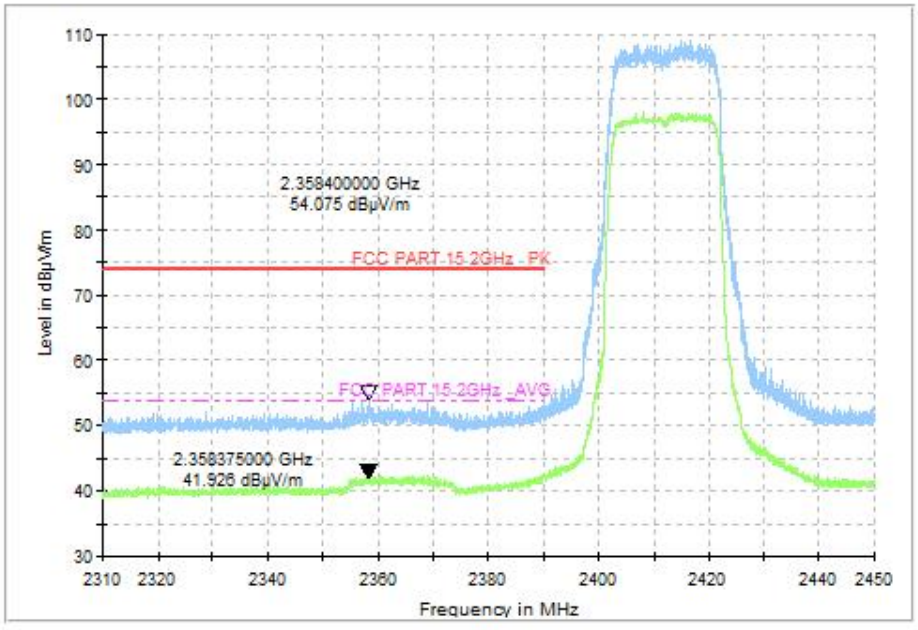


Fig.92 Radiated Restricted Band (802.11ax-HE20, CH1, 2.38GHz~2.45GHz),MIMO

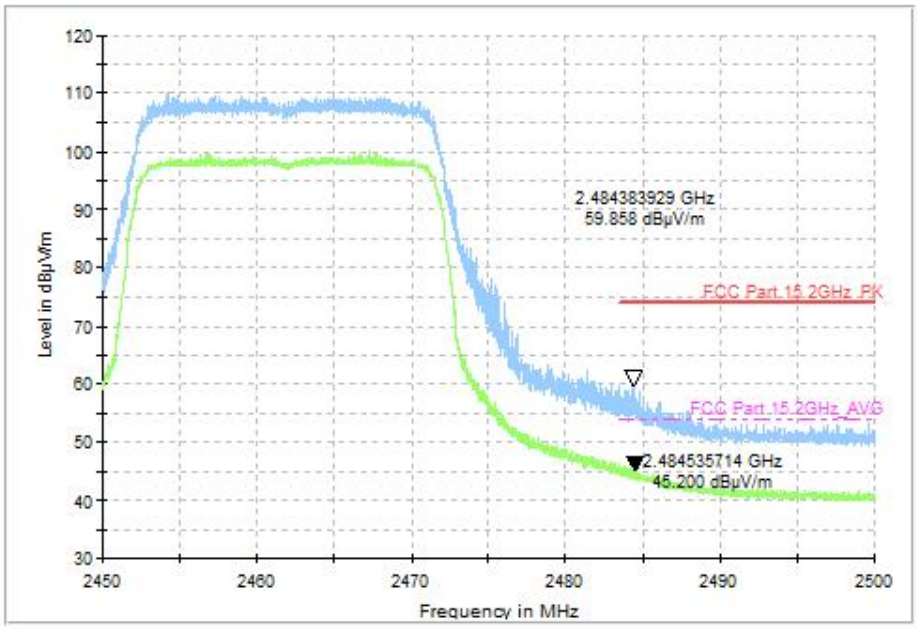


Fig.93 Radiated Spurious Emission (802.11ax-HE20, CH11, 2.45GHz~2.50GHz),MIMO

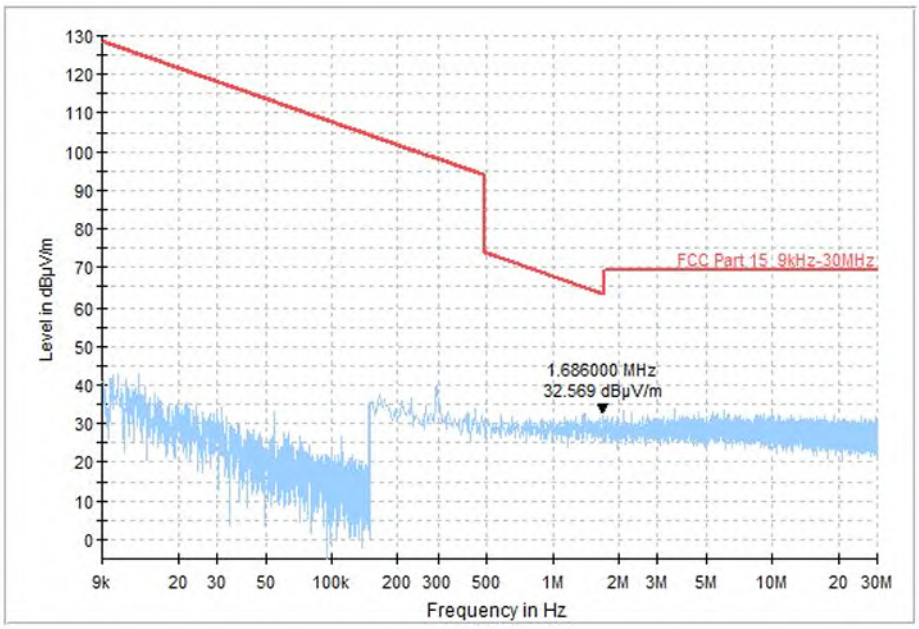


Fig.94 Radiated Spurious Emission (All channel, 9kHz~30MHz),MIMO

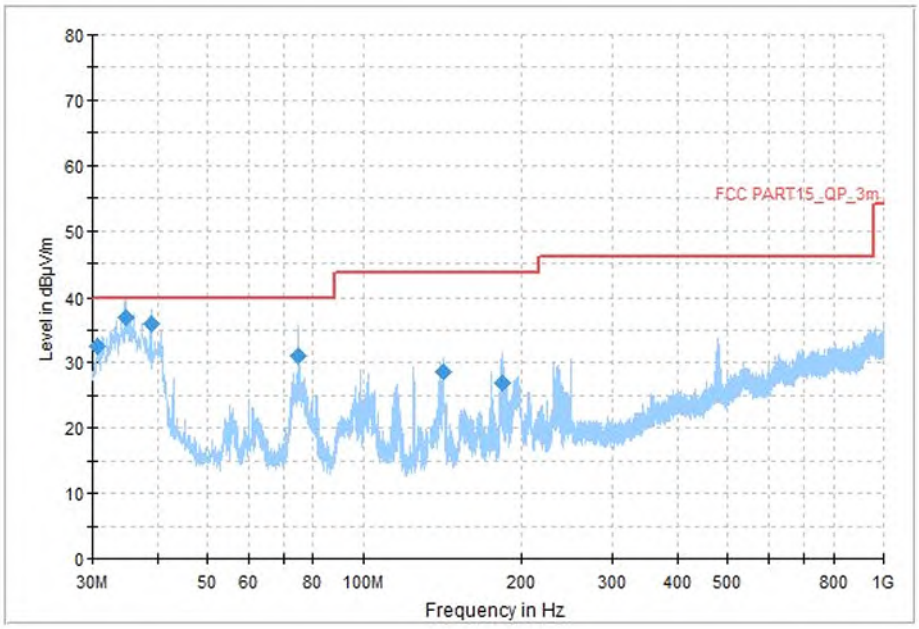


Fig.95 Radiated Spurious Emission (All channel, 30MHz~1GHz),MIMO

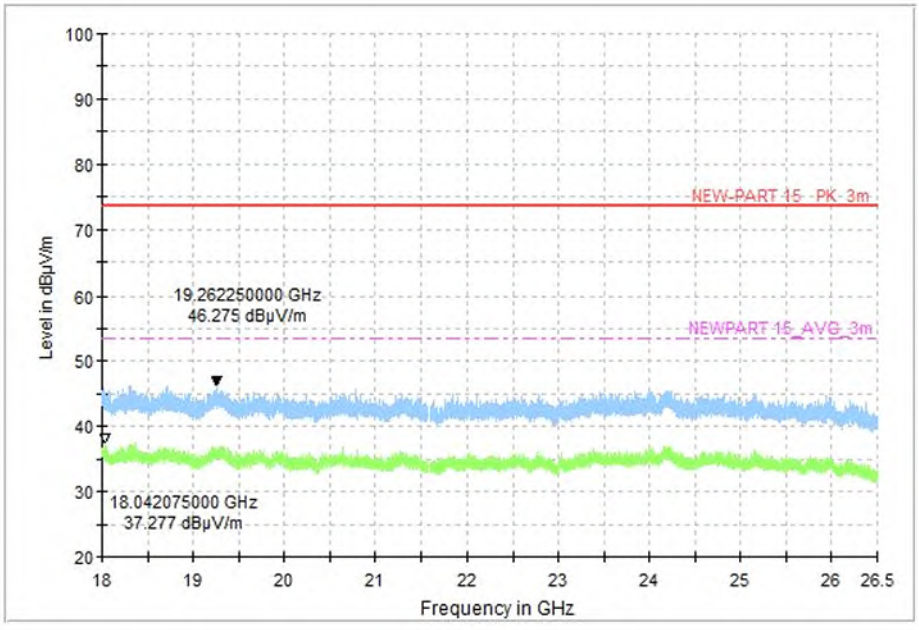


Fig.96 Radiated Spurious Emission (All channel, 18GHz~26.5GHz),MIMO

*****END OF REPORT*****