



FCC RADIO TEST REPORT

FCC ID : 2AFZZK1G
Equipment : Mobile Phone
Brand Name : Xiaomi
Model Name : M2102K1G
Applicant : Xiaomi Communications Co., Ltd.
#019, 9th Floor, Building 6, 33 Xi'erqi
Middle Road, Haidian District,
Beijing, China, 100085
Manufacturer : Xiaomi Communications Co., Ltd.
#019, 9th Floor, Building 6, 33 Xi'erqi
Middle Road, Haidian District,
Beijing, China, 100085
Standard : FCC Part 15 Subpart C §15.247

The product was received on Jan. 07, 2021 and testing was started from Jan. 10, 2021 and completed on Jan. 28, 2021. We, SPORTON INTERNATIONAL INC., EMC & Wireless Communications Laboratory, would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval of SPORTON INTERNATIONAL INC. EMC & Wireless Communications Laboratory, the test report shall not be reproduced except in full.

Louis Wu

Approved by: Louis Wu

SPORTON INTERNATIONAL INC. EMC & Wireless Communications Laboratory
No. 52, Huaya 1st Rd., Guishan Dist., Taoyuan City, Taiwan (R.O.C.)



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Summary of Test Result

Report Clause	Ref Std. Clause	Test Items	Result (PASS/FAIL)	Remark
3.1	15.247(a)(2)	6dB Bandwidth	Pass	-
3.1	2.1049	99% Occupied Bandwidth	Reporting only	-
3.2	15.247(b)	Power Output Measurement	Pass	-
3.3	15.247(e)	Power Spectral Density	Pass	-
3.4	15.247(d)	Conducted Band Edges	Pass	-
		Conducted Spurious Emission	Pass	-
3.5	15.247(d)	Radiated Band Edges and Radiated Spurious Emission	Pass	Under limit 5.35 dB at 2483.520 MHz
3.6	15.207	AC Conducted Emission	Pass	Under limit 13.35 dB at 4.934 MHz
3.7	15.203 & 15.247(b)	Antenna Requirement	Pass	-

Declaration of Conformity:

The test results with all measurement uncertainty excluded are presented in accordance with the regulation limits or requirements declared by manufacturers.

Comments and Explanations:

The declared of product specification for EUT presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.

Reviewed by: Wii Chang

Report Producer: Ruby Zou



1 General Description

1.1 Product Feature of Equipment Under Test

GSM/WCDMA/LTE/5G NR, Bluetooth, Wi-Fi 2.4GHz 802.11b/g/n/ax, Wi-Fi 5GHz 802.11a/n/ac/ax, Wi-Fi 6GHz 802.11ax, NFC, WPC/WPT, and GNSS.

Product Specification subjective to this standard		
Antenna Type	WWAN: PIFA Antenna WLAN 2.4GHz: <Ant. 5>: PIFA Antenna <Ant. 7>: PIFA Antenna WLAN 5GHz: <Ant. 11>: PIFA Antenna <Ant. 8>: PIFA Antenna WLAN 6GHz: <Ant. 11>: PIFA Antenna <Ant. 8>: PIFA Antenna Bluetooth: <Ant. 5>: PIFA Antenna <Ant. 7>: PIFA Antenna GPS / Glonass / Galileo / BDS: PIFA Antenna NFC: Planar Antenna WPC/WPT: Coil antenna	
Antenna information		
2400 MHz ~ 2483.5 MHz	Peak Gain (dBi)	Ant. 5: -2.46 Ant. 7: -2.58

Remark: The above EUT's information was declared by manufacturer. Please refer to Comments and Explanations in report summary.

1.2 Modification of EUT

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



1.3 Testing Location

Test Site	SPORTON INTERNATIONAL INC. EMC & Wireless Communications Laboratory
Test Site Location	No.52, Huaya 1st Rd., Guishan Dist., Taoyuan City, Taiwan (R.O.C.) TEL: +886-3-327-3456 FAX: +886-3-328-4978
Test Site No.	Sporton Site No. TH05-HY, CO05-HY

Note: The test site complies with ANSI C63.4 2014 requirement.

Test Site	SPORTON INTERNATIONAL INC. EMC & Wireless Communications Laboratory
Test Site Location	No.58, Aly. 75, Ln. 564, Wenhua 3rd, Rd., Guishan Dist., Taoyuan City, Taiwan (R.O.C.) TEL: +886-3-327-0868 FAX: +886-3-327-0855
Test Site No.	Sporton Site No. 03CH11-HY

Note: The test site complies with ANSI C63.4 2014 requirement.

FCC designation No.: TW1190 and TW0007

1.4 Applicable Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- ♦ FCC Part 15 Subpart C §15.247
- ♦ FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v05r02
- ♦ FCC KDB 414788 D01 Radiated Test Site v01r01.
- ♦ FCC KDB 662911 D01 Multiple Transmitter Output v02r01.
- ♦ ANSI C63.10-2013

Remark:

1. All test items were verified and recorded according to the standards and without any deviation during the test.
2. The TAF code is not including all the FCC KDB listed without accreditation.



2 Test Configuration of Equipment Under Test

- a. The EUT has been associated with peripherals and configuration operated in a manner tended to maximize its emission characteristics in a typical application. Frequency range investigated: conduction emission (150 kHz to 30 MHz), radiation emission (9 kHz to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower). For radiated measurement, pre-scanned in three orthogonal panels, X, Y, Z and WPC Charging Mode. The worst cases (Z plane and X Plane for WPC Charging Mode) were recorded in this report.

- b. AC power line Conducted Emission was tested under maximum output power.

2.1 Carrier Frequency and Channel

Frequency Band	Channel	Freq. (MHz)	Channel	Freq. (MHz)
2400-2483.5 MHz	1	2412	7	2442
	2	2417	8	2447
	3	2422	9	2452
	4	2427	10	2457
	5	2432	11	2462
	6	2437		



2.2 Test Mode

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

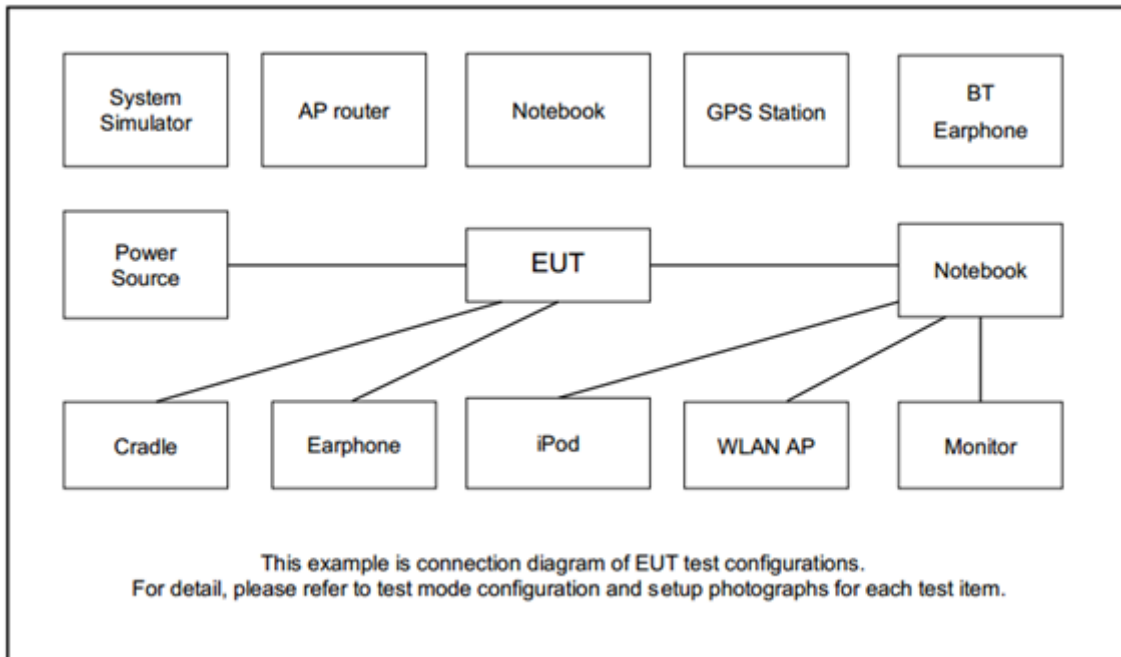
Modulation	Data Rate
802.11b	1 Mbps
802.11g	6 Mbps
802.11n HT20 (Covered by HE20)	MCS0
802.11n HT40 (Covered by HE40)	MCS0
802.11ax HE20	MCS0
802.11ax HE40	MCS0

Test Cases	
AC Conducted Emission	Mode 1 : Bluetooth Link + WLAN (2.4GHz) Link + MPEG 4 + USB Cable (Charging from Adapter)

Ch. #	2400-2483.5 MHz			
	802.11b	802.11g	802.11ax HE20	802.11ax HE40
Low	01	01	01	03
Middle	06	06	06	06
High	11	11	11	09

Remark: For radiation spurious emission, the final modulation and the worst data rate was reference the max RF conducted power.

2.3 Connection Diagram of Test System



2.4 Support Unit used in test configuration and system

Item	Equipment	Brand Name	Model Name	FCC ID	Data Cable	Power Cord
1.	Bluetooth Earphone	Sony Ericsson	MW600	PY7DDA-2029	N/A	N/A
2.	WLAN AP	ASUS	RT-AC66U	MSQ-RTAC66U	N/A	Unshielded, 1.8 m
3.	Notebook	Dell	Latitude 3400	FCC DoC	N/A	AC I/P: Unshielded, 1.2 m DC O/P: Shielded, 1.8 m
4.	Mobile Phone	Xiaomi	M2102K1G	2AFZZK1G	N/A	N/A



2.5 EUT Operation Test Setup

The RF test items make the EUT get into the engineering modes to provide channel selection, power level, data rate and the application type and for continuous transmitting signals.

2.6 Measurement Results Explanation Example

For all conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuator factor between EUT conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.

Example:

The spectrum analyzer offset is derived from RF cable loss and attenuator factor.

Offset = RF cable loss + attenuator factor.

Following shows an offset computation example with cable loss 4.2 dB and 10dB attenuator.

$$\begin{aligned} \text{Offset(dB)} &= \text{RF cable loss(dB)} + \text{attenuator factor(dB)}. \\ &= 4.2 + 10 = 14.2 \text{ (dB)} \end{aligned}$$

3 Test Result

3.1 6dB and 99% Bandwidth Measurement

3.1.1 Limit of 6dB and 99% Bandwidth

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

3.1.2 Measuring Instruments

See list of measuring equipment of this test report.

3.1.3 Test Procedures

1. The testing follows the ANSI C63.10 Section 6.9.3 (OBW) and 11.8.1 (6dB BW).
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 1-5% of the emission bandwidth and set the Video bandwidth (VBW) $\geq 3 * RBW$.
6. Measure and record the results in the test report.

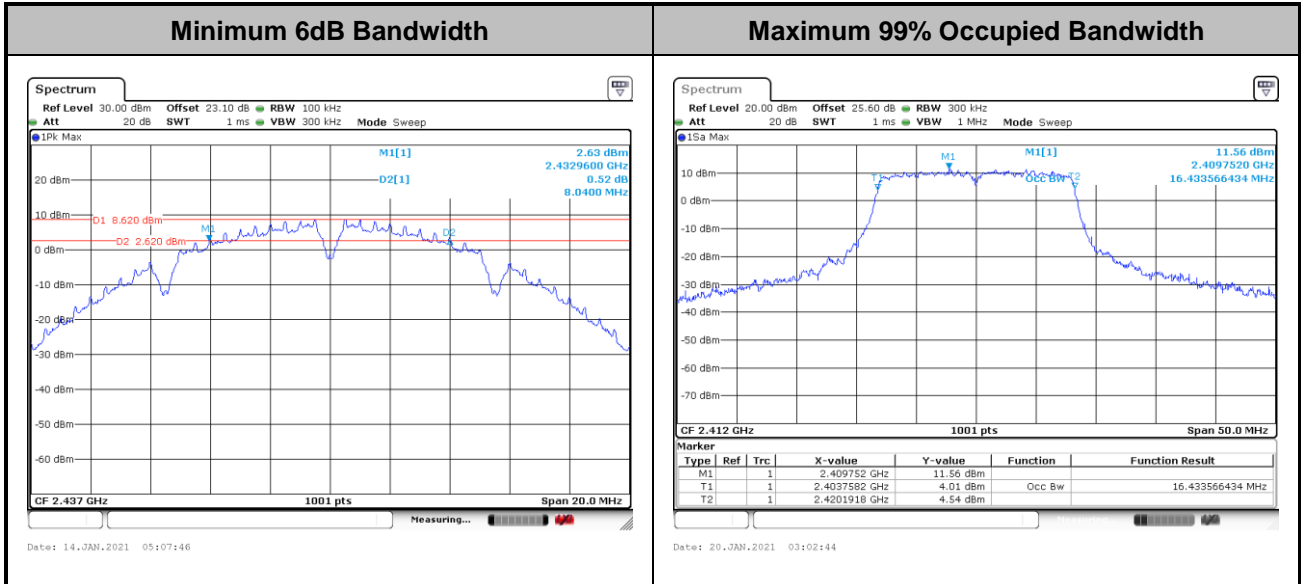
3.1.4 Test Setup





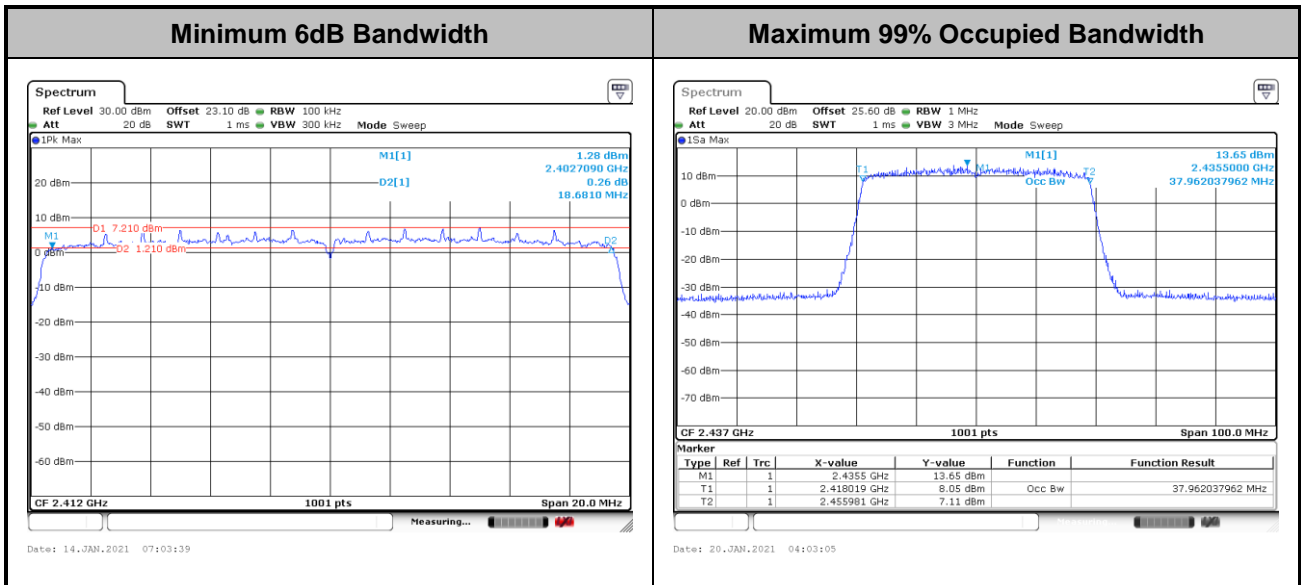
3.1.5 Test Result of 6dB and 99% Occupied Bandwidth

Please refer to Appendix A.



Note: The occupied channel bandwidth is maintained within the band of operation for all of the modulations.

<802.11ax Mode>



Note: The occupied channel bandwidth is maintained within the band of operation for all of the modulations.

3.2 Output Power Measurement

3.2.1 Limit of Output Power

For systems using digital modulation in the 2400-2483.5MHz, the limit for output power is 30dBm. If transmitting antenna with directional gain greater than 6dBi is used, the peak output power from the intentional radiator shall be reduced below the above stated value by the amount in dB that the directional gain of the antenna exceeds 6 dBi. In case of point-to-point operation, the limit has to be reduced by 1dB for every 3dB that the directional gain of the antenna exceeds 6dBi.

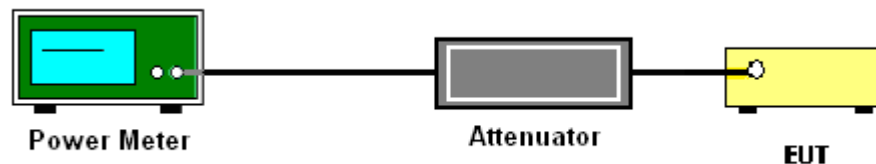
3.2.2 Measuring Instruments

See list of measuring equipment of this test report.

3.2.3 Test Procedures

1. For Average Power, the testing follows ANSI C63.10 Section 11.9.2.3.2 Method AVGPM-G
2. The RF output of EUT was connected to the power meter by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Measure the conducted output power and record the results in the test report.
5. For MIMO mode, calculation method follows FCC KDB 662911 D01 Multiple Transmitter Output v02r01.

3.2.4 Test Setup



3.2.5 Test Result of Average Output Power

Please refer to Appendix A.

3.3 Power Spectral Density Measurement

3.3.1 Limit of Power Spectral Density

The peak power spectral density shall not be greater than 8dBm in any 3kHz band at any time interval of continuous transmission.

3.3.2 Measuring Instruments

See list of measuring equipment of this test report.

3.3.3 Test Procedures

1. The testing follows the ANSI C63.10 Section 11.10.2 Method PKPSD.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 3 kHz. Video bandwidth VBW = 10 kHz In order to make an accurate measurement, set the span to 1.5 times DTS Channel Bandwidth. (6dB BW)
5. Detector = peak, Sweep time = auto couple, Trace mode = max hold, Allow trace to fully stabilize. Use the peak marker function to determine the maximum power level.
6. Measure and record the results in the test report.
7. For MIMO mode, calculation method follows FCC KDB 662911 D01 Multiple Transmitter Output v02r01.

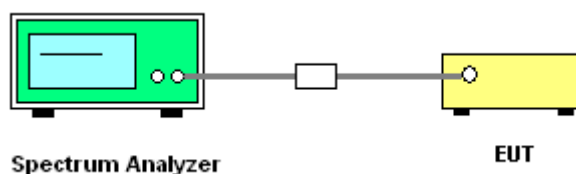
If measurements performed using method (2) plus $10 \log(N)$ exceeds the emission limit, the test should choose method (1) before declaring that the device fails the emission limit.

Method (1): Measure and sum the spectra across the outputs.

The total final Power Spectral Density is from a device with 2 transmitter outputs. The spectrum measurements of the individual outputs are all performed with the same span and number of points, the spectrum value in the first spectral bin of output 1 is summed with that in the first spectral bin of output 2 to obtain the value for the first frequency bin of the summed spectrum.

Method (2): Measure and add $10 \log(N)$ dB, where N is the number of outputs. (N=2)

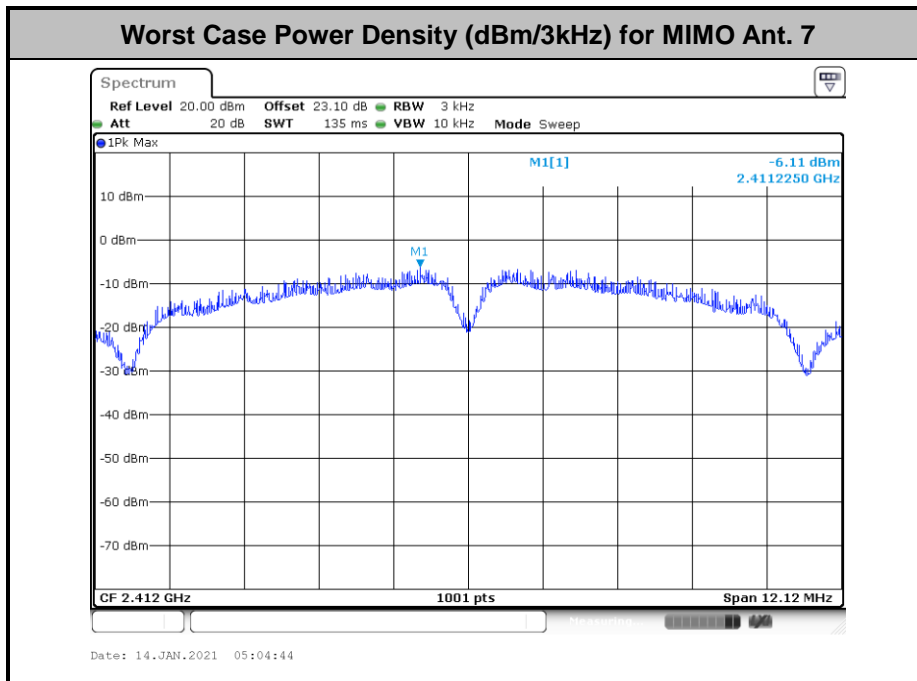
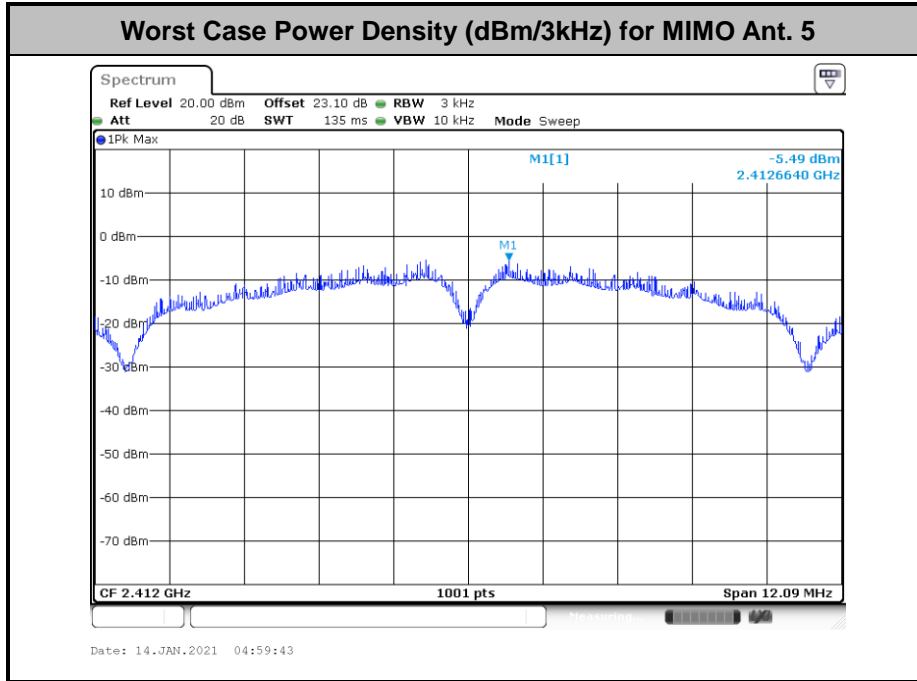
3.3.4 Test Setup





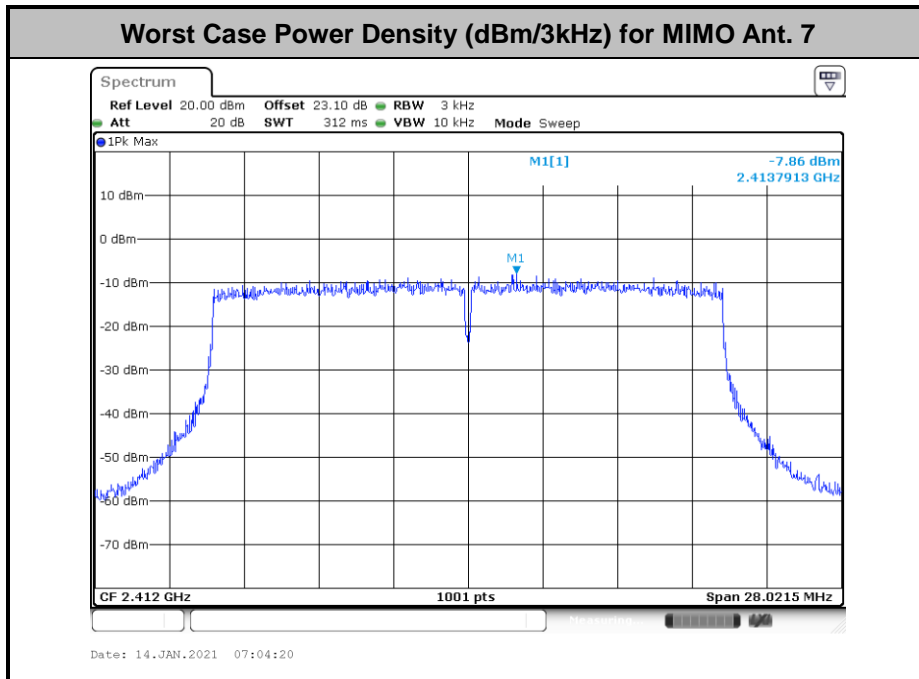
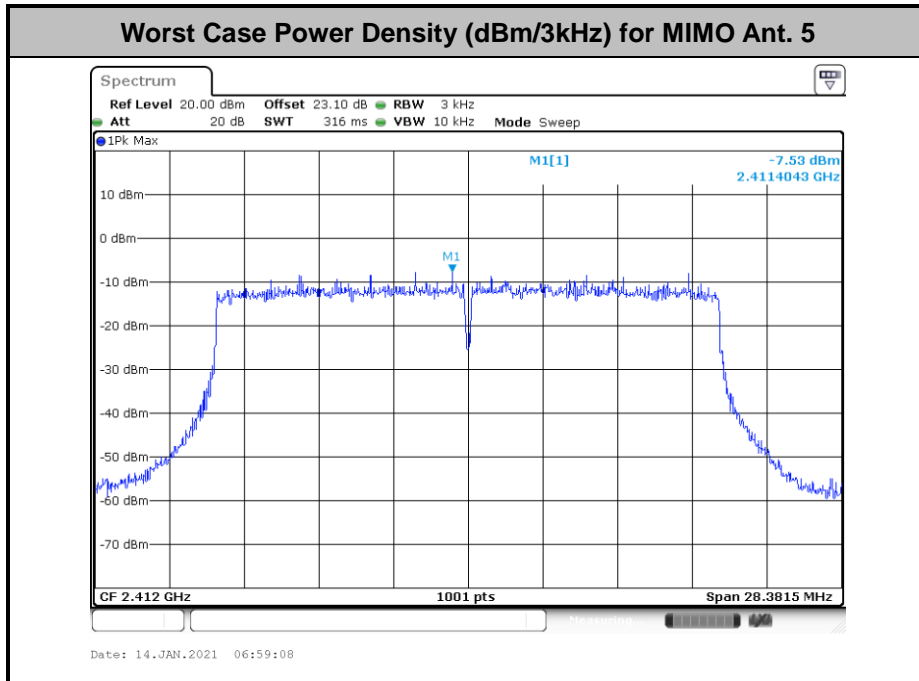
3.3.5 Test Result of Power Spectral Density

Please refer to Appendix A.





<802.11ax Mode>



3.4 Conducted Band Edges and Spurious Emission Measurement

3.4.1 Limit of Conducted Band Edges and Spurious Emission Measurement

In any 100 kHz bandwidth outside of the authorized frequency band, the emissions which fall in the non-restricted bands shall be attenuated at least 20 dB / 30dB relative to the maximum PSD level in 100 kHz by RF conducted measurement.

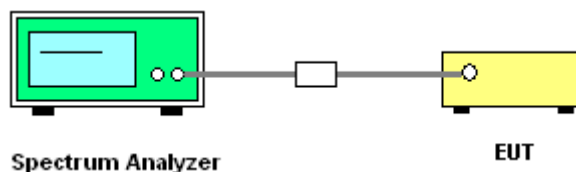
3.4.2 Measuring Instruments

See list of measuring equipment of this test report.

3.4.3 Test Procedures

1. The testing follows the ANSI C63.10 Section 11.11.3 Emission level measurement.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Set RBW = 100 kHz, VBW=300 kHz, Peak Detector. Unwanted Emissions measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz when maximum peak conducted output power procedure is used. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 dB instead of 20 dB per 15.247(d).
5. Measure and record the results in the test report.
6. The RF fundamental frequency should be excluded against the limit line in the operating frequency band.

3.4.4 Test Setup



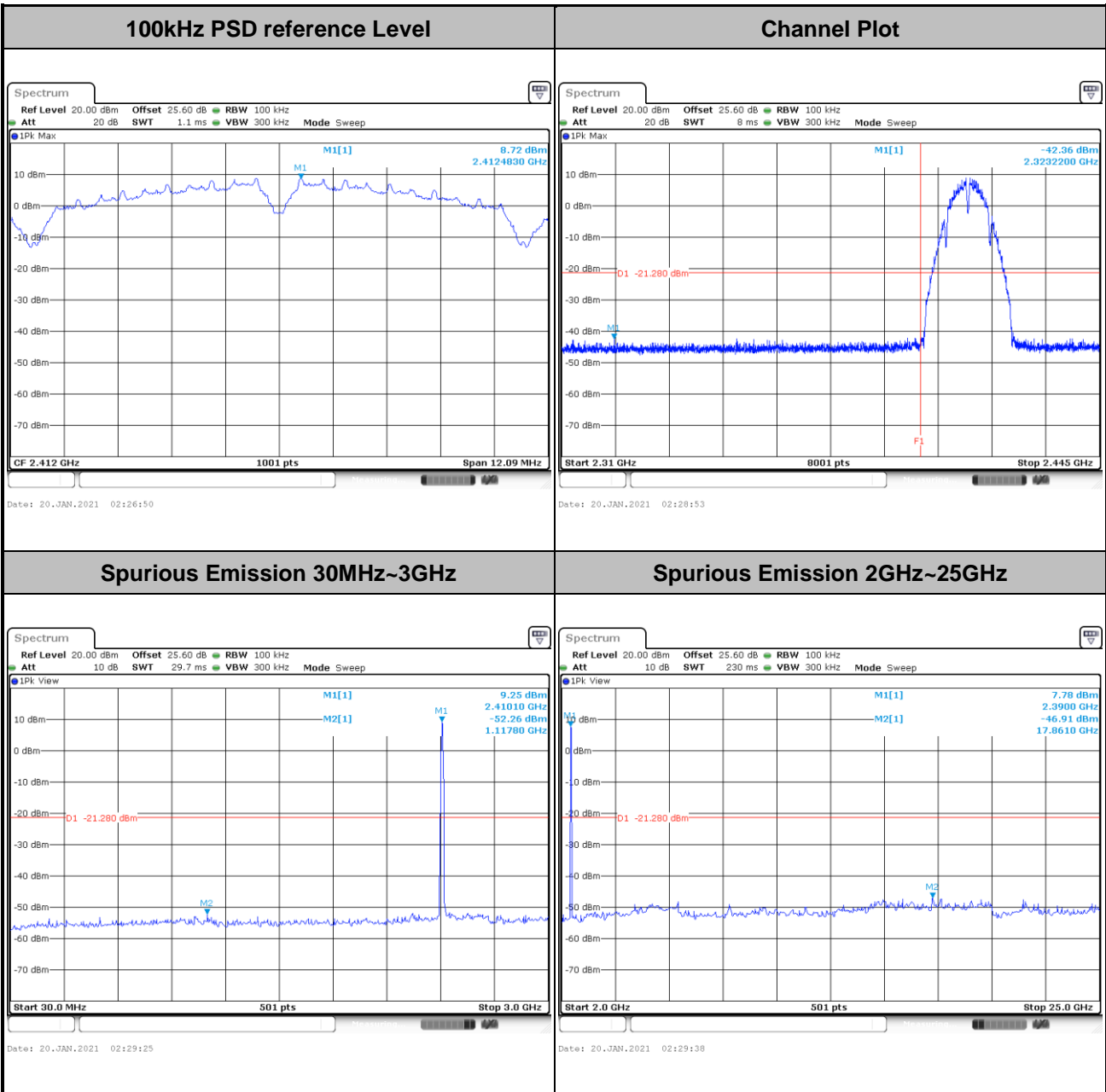


3.4.5 Test Result of Conducted Band Edges and Spurious Emission

Test Engineer : Jacob Yu	Temperature :	19.6~24.7°C
	Relative Humidity :	46.7~57.5%

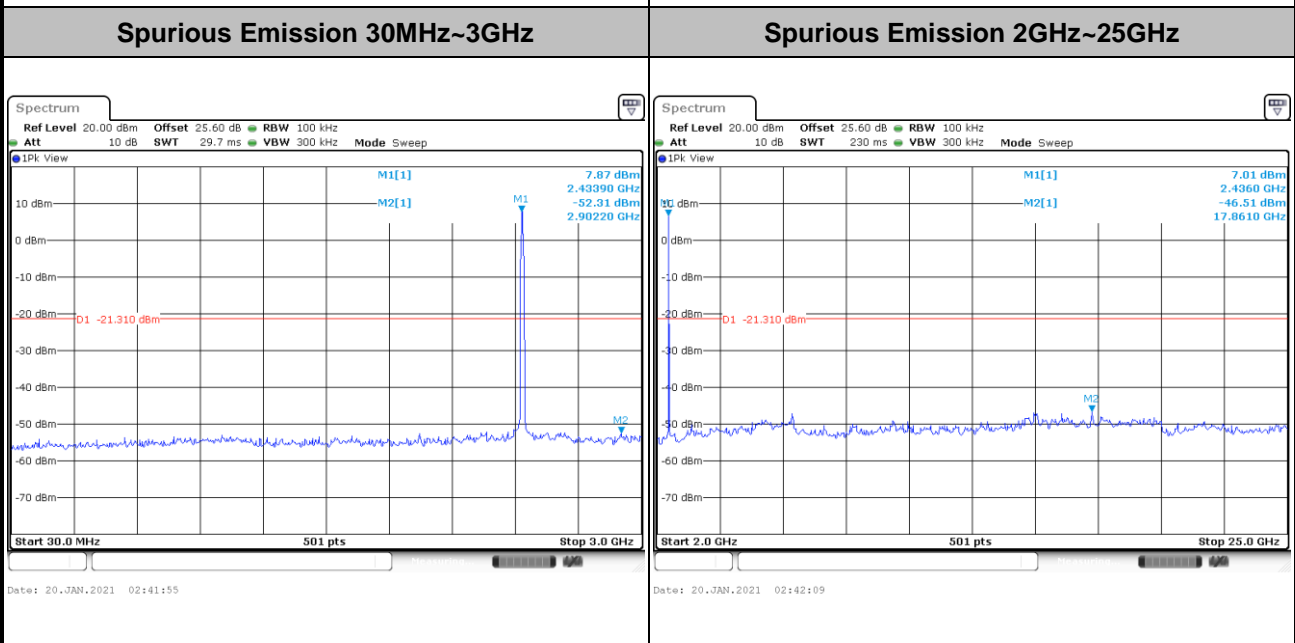
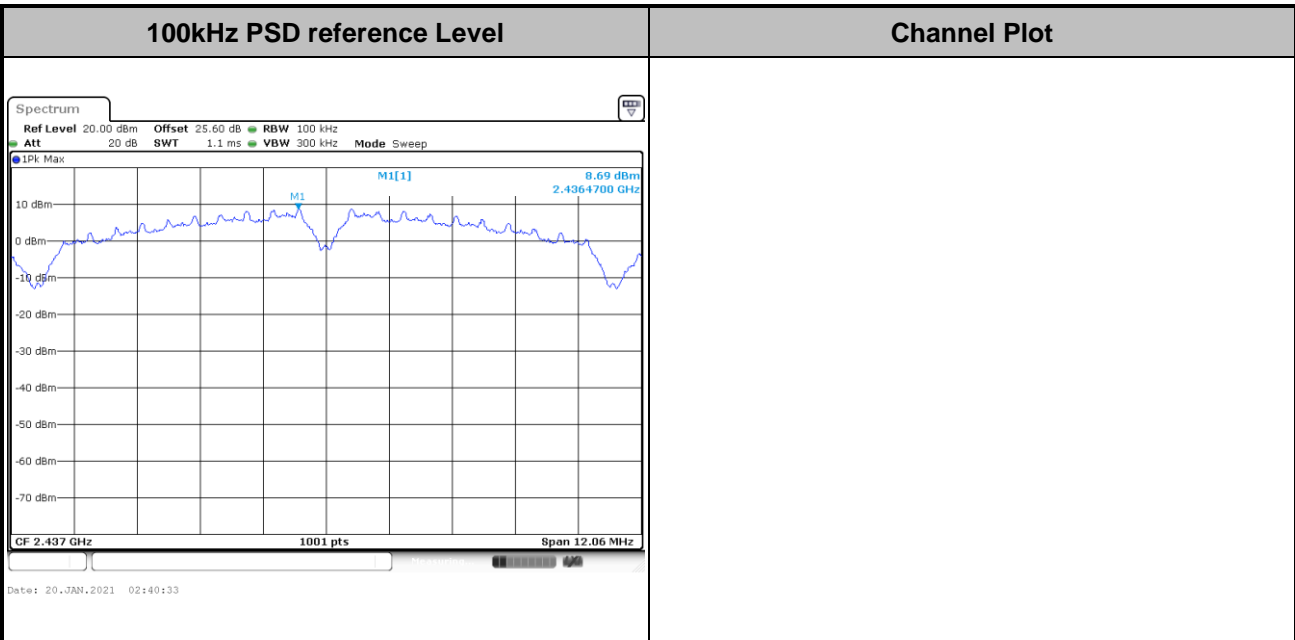
Number of TX = 2, Ant. 5 (Measured)

Test Mode :	802.11b	Test Channel :	01
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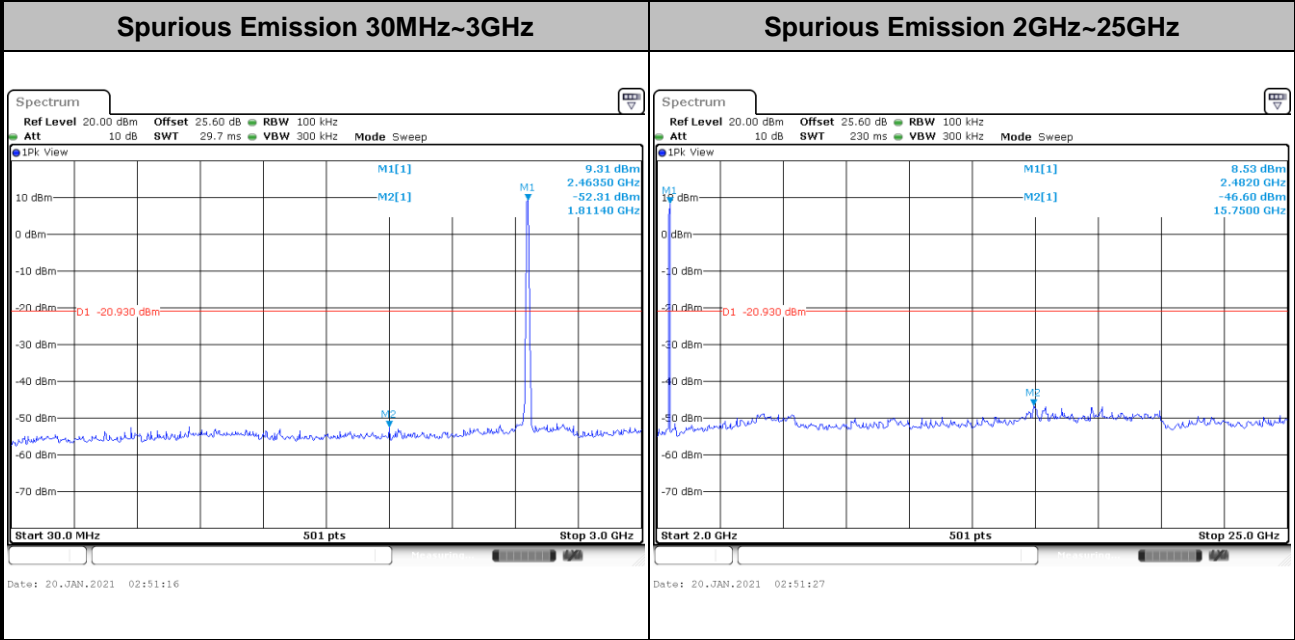
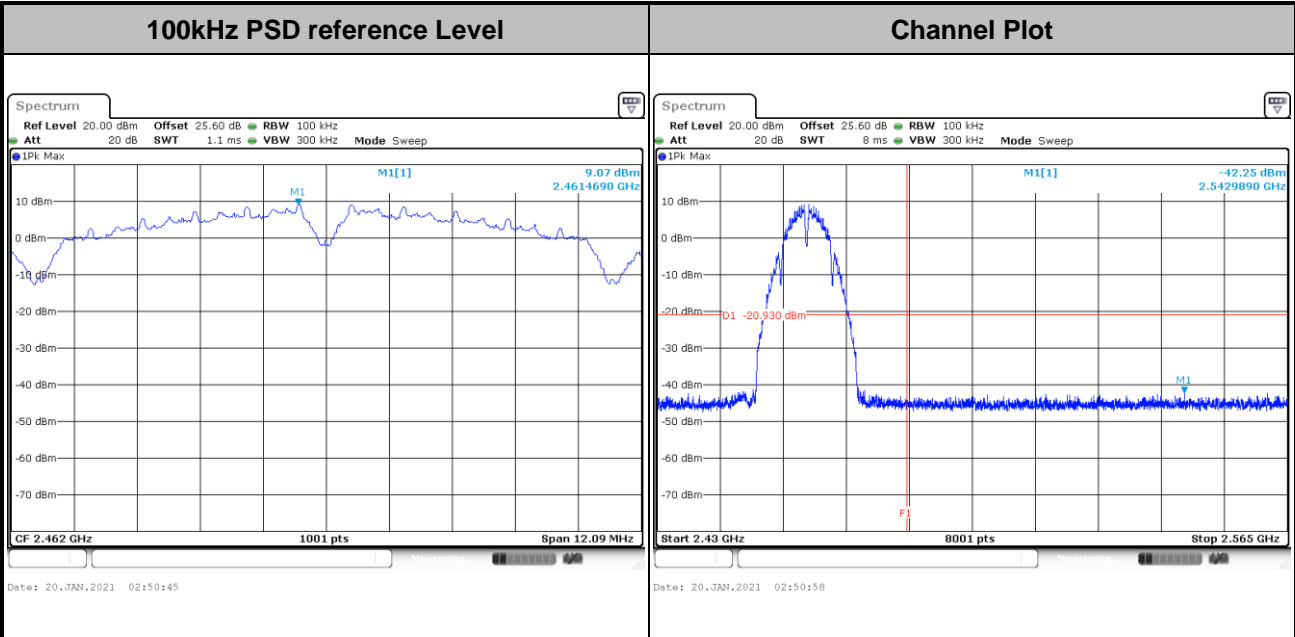


Test Mode :	802.11b	Test Channel :	06
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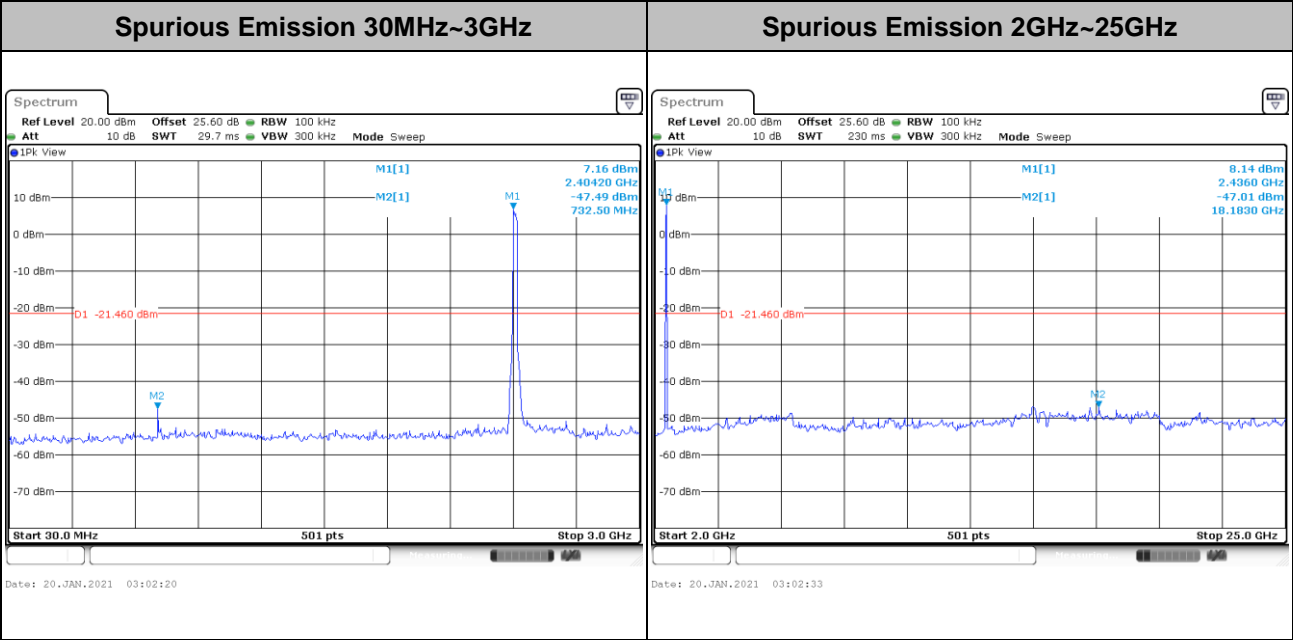
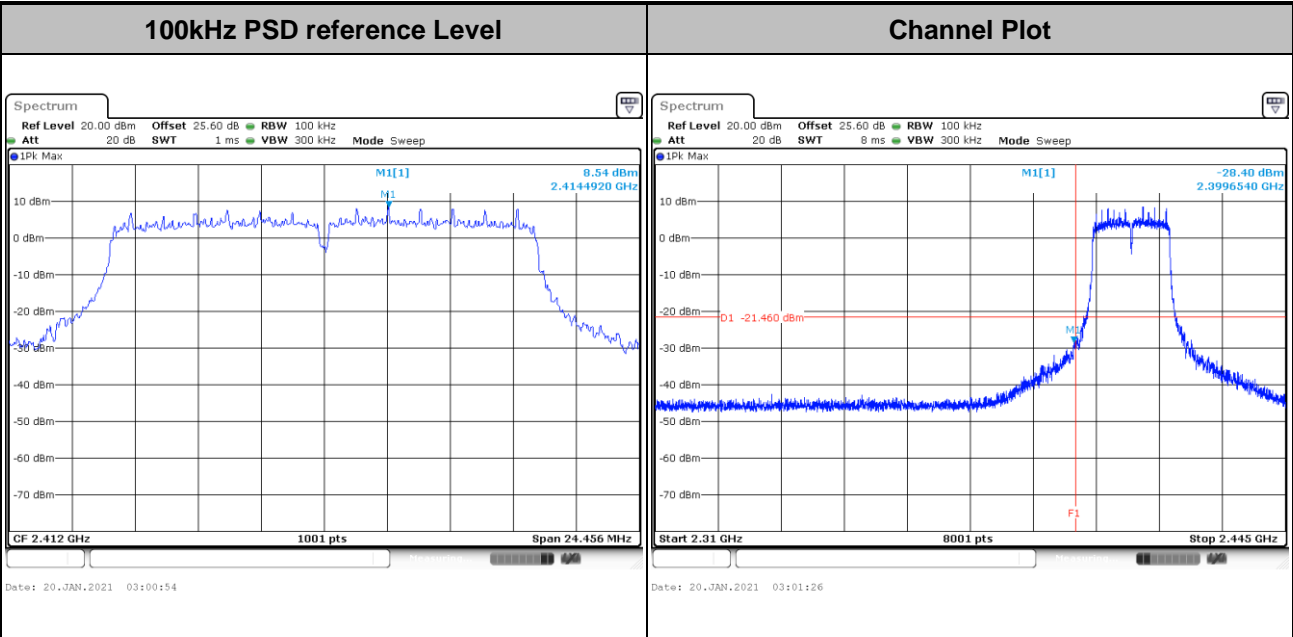


Test Mode :	802.11b	Test Channel :	11
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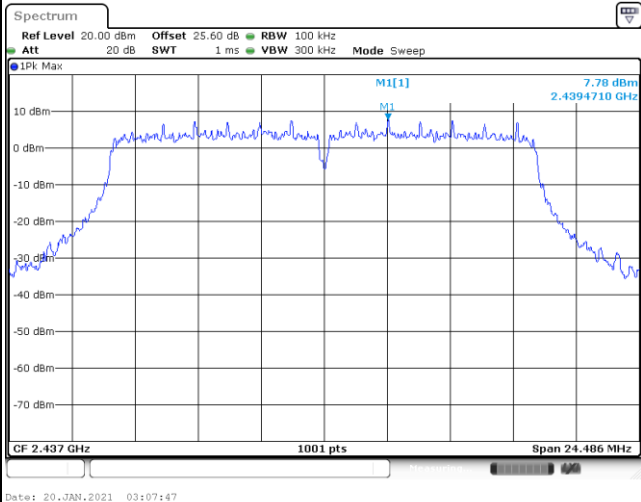
Test Mode : 802.11g Test Channel : 01





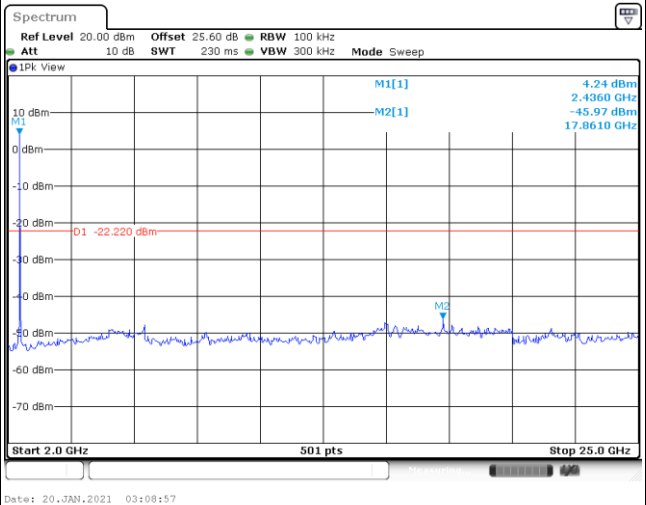
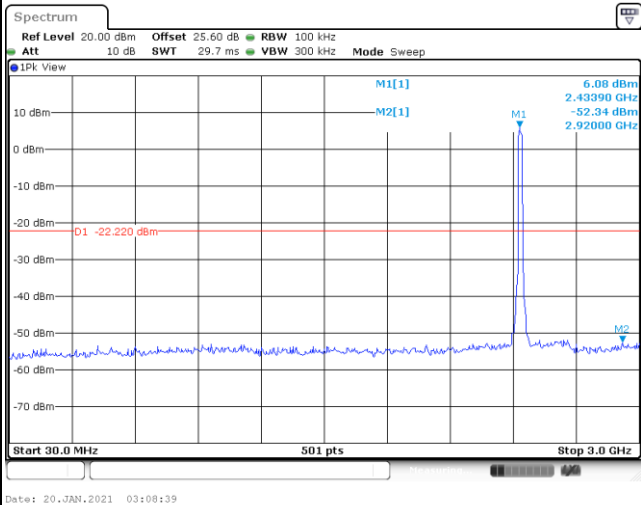
Test Mode :	802.11g	Test Channel :	06
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100kHz PSD reference Level	Channel Plot
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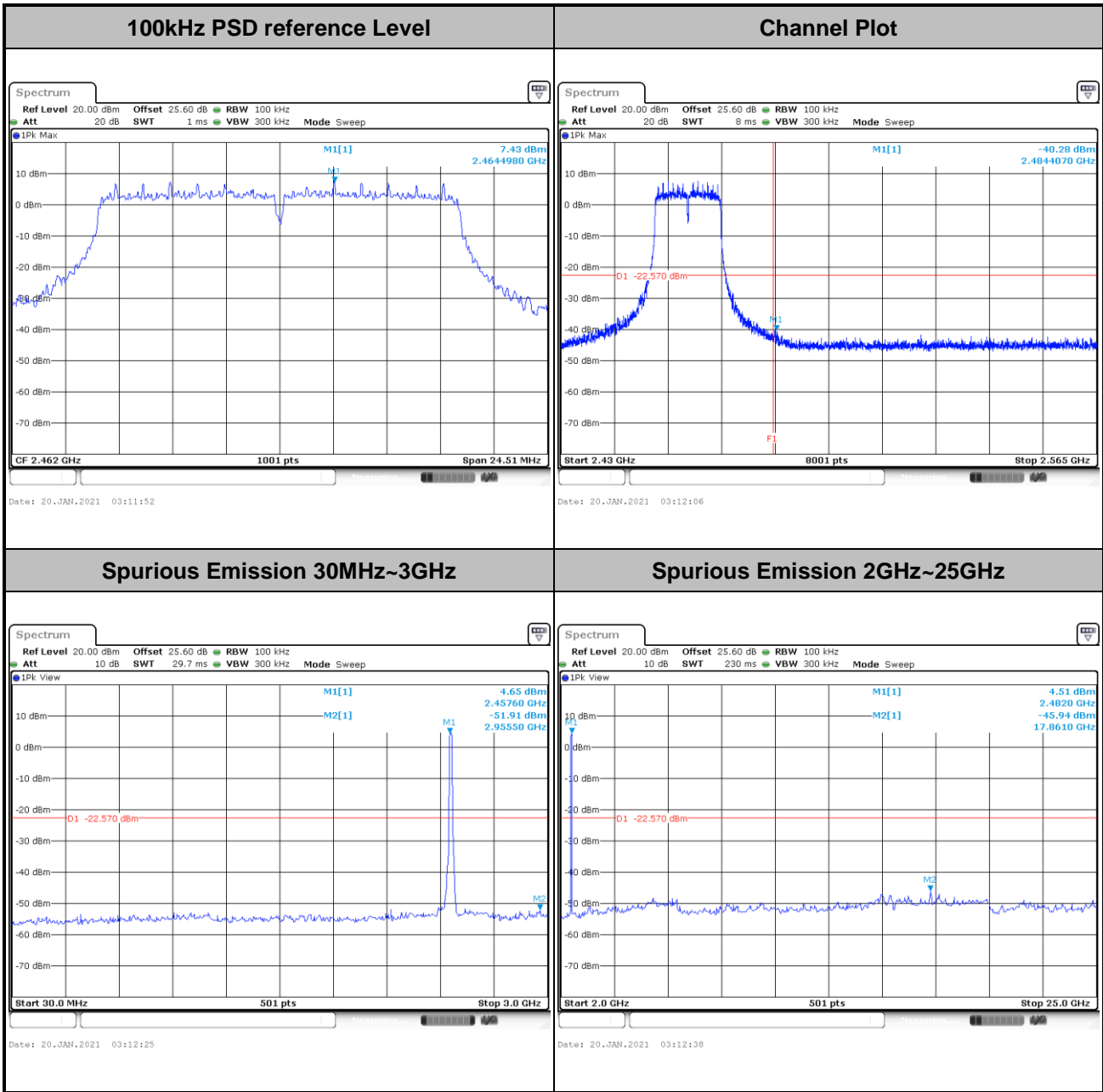
Spurious Emission 30MHz~3GHz

Spurious Emission 2GHz~25GHz



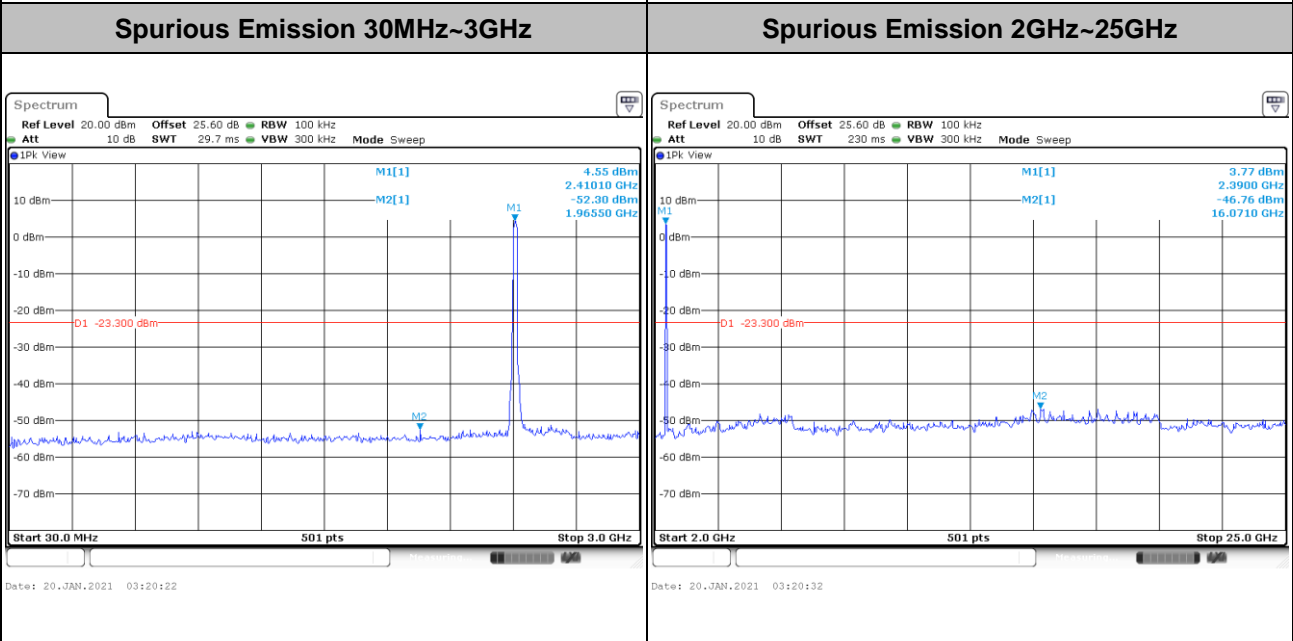
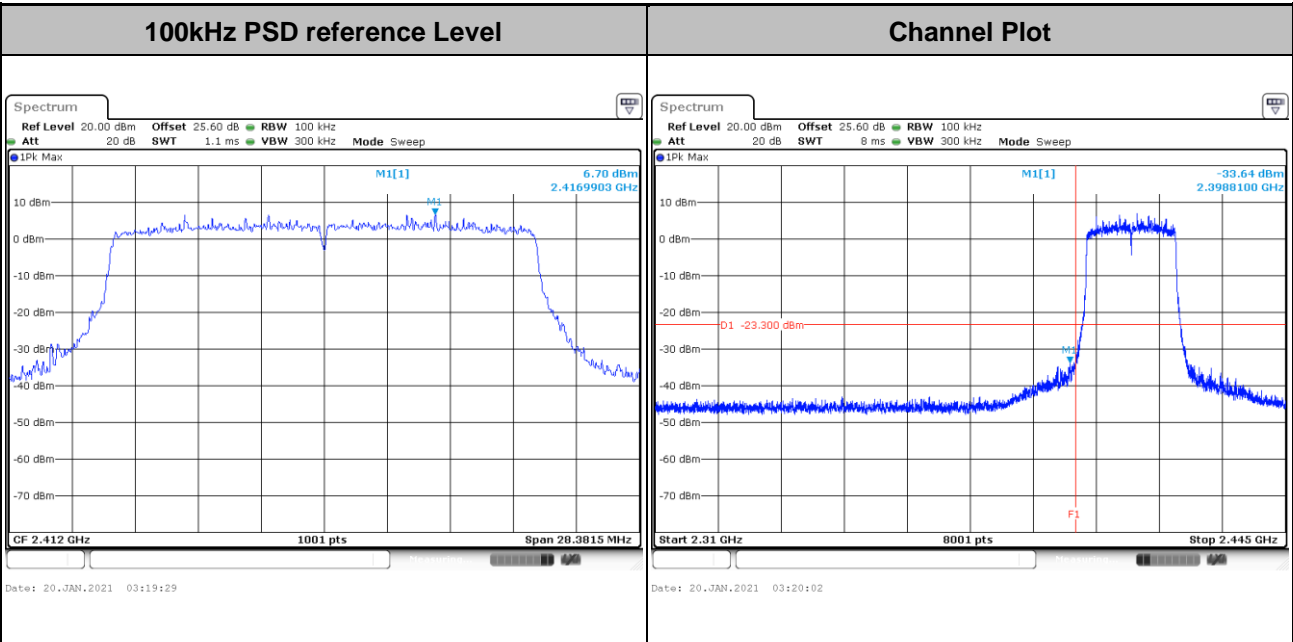


Test Mode :	802.11g	Test Channel :	11
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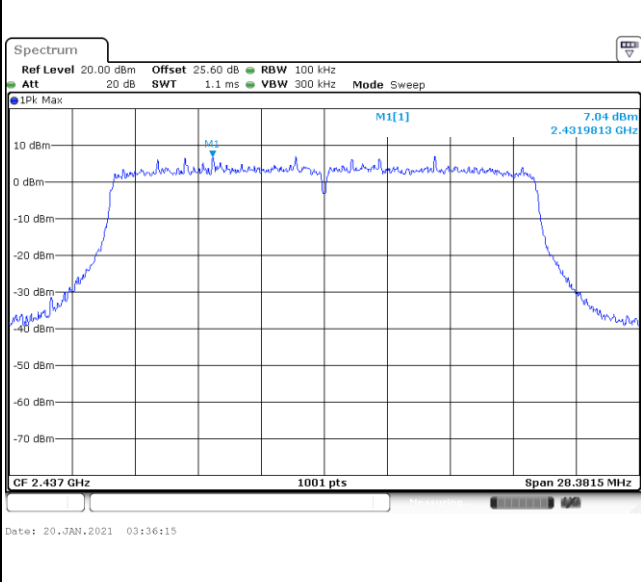
Test Mode : 802.11ax HE20	Test Channel : 01
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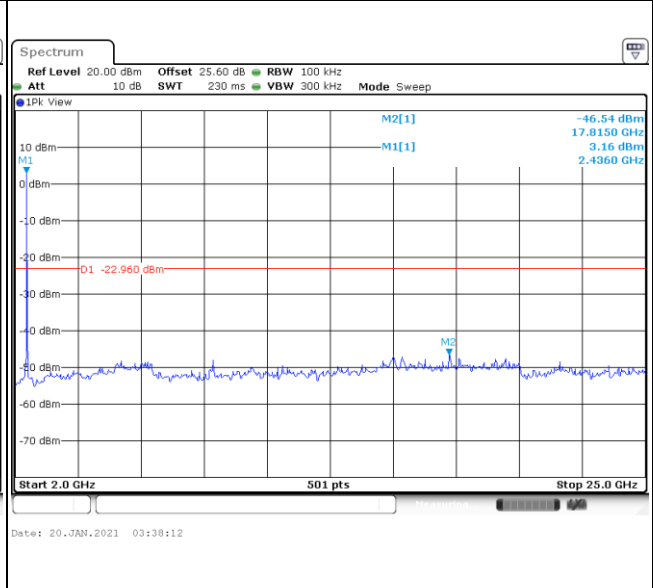
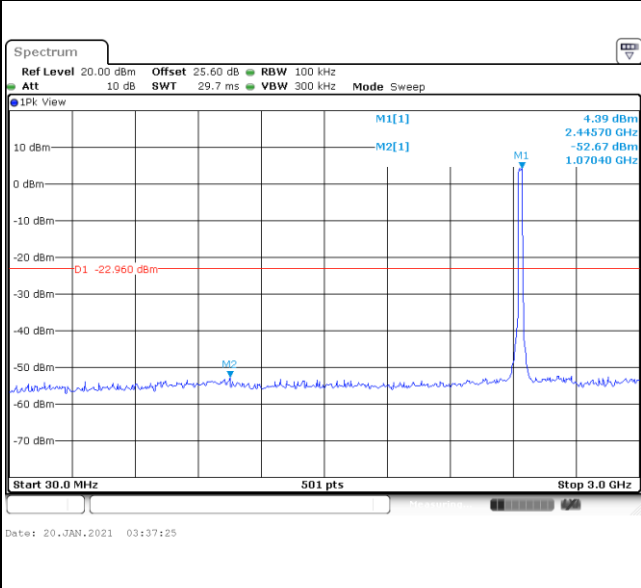


Test Mode :	802.11ax HE20	Test Channel :	06
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100kHz PSD reference Level	Channel Plot
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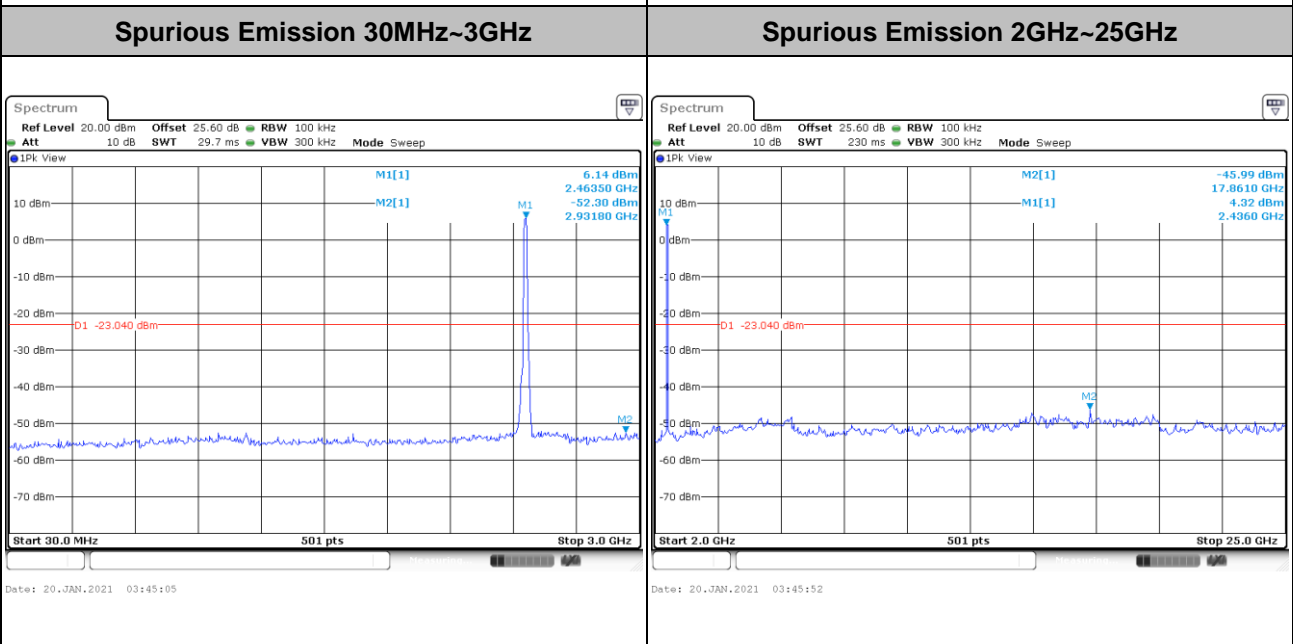
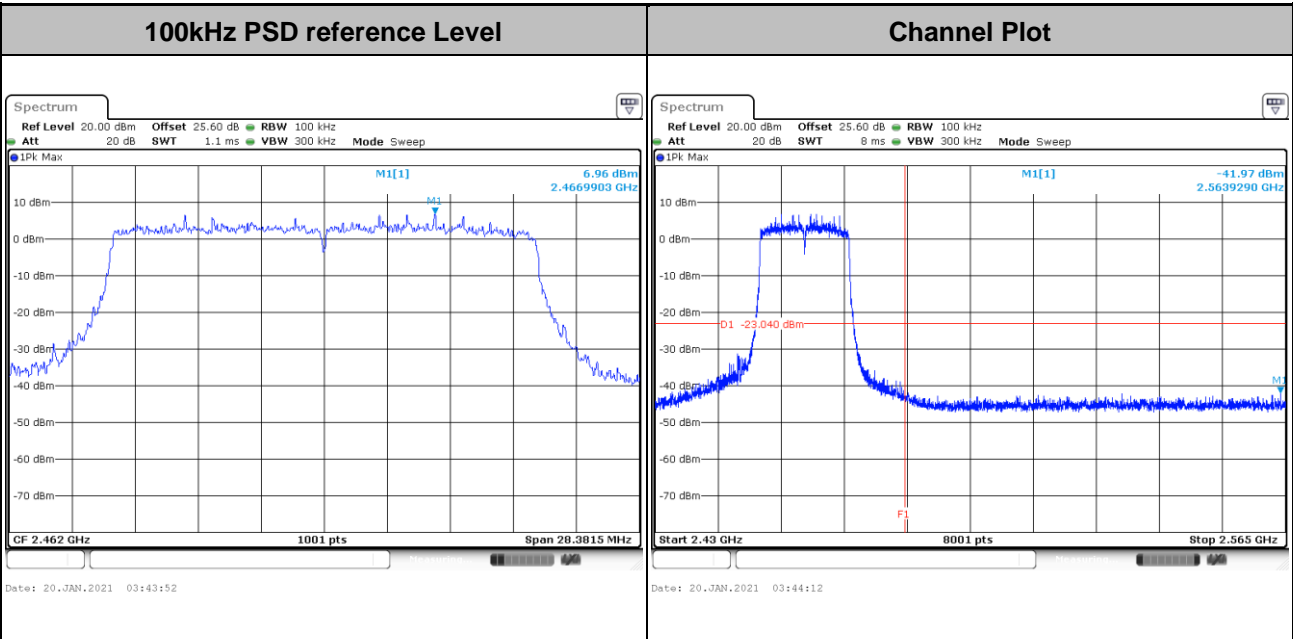


Spurious Emission 30MHz~3GHz	Spurious Emission 2GHz~25GHz
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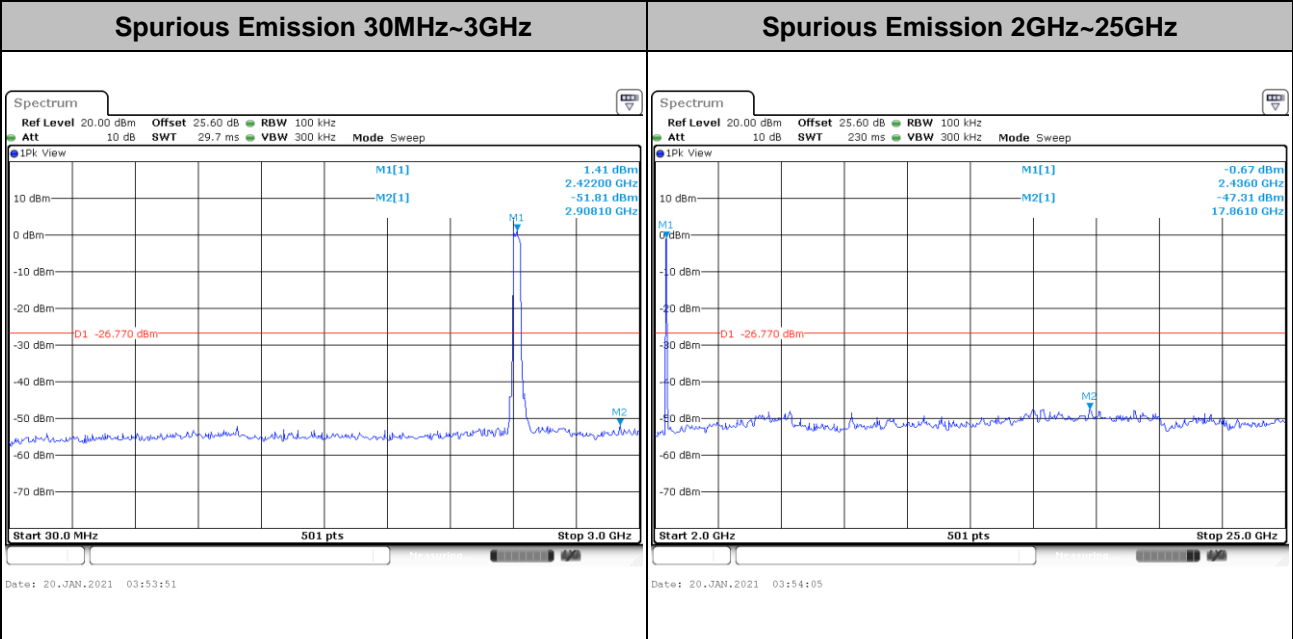
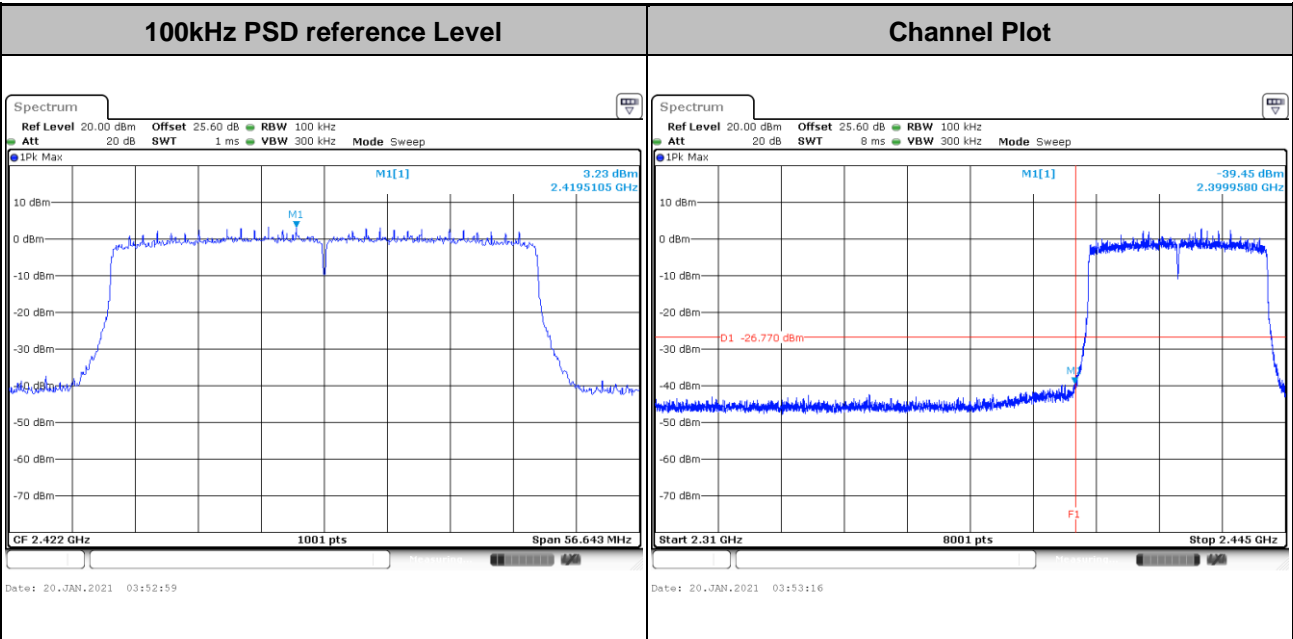


Test Mode :	802.11ax HE20	Test Channel :	11 Full RU
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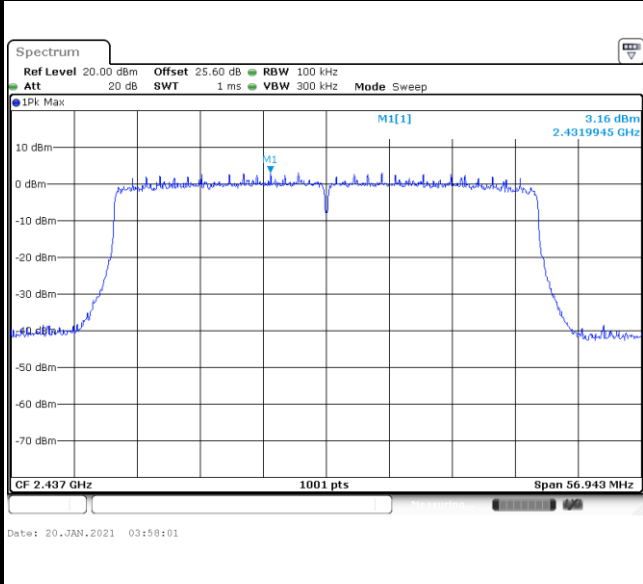
Test Mode : 802.11ax HE40	Test Channel : 03 Full RU
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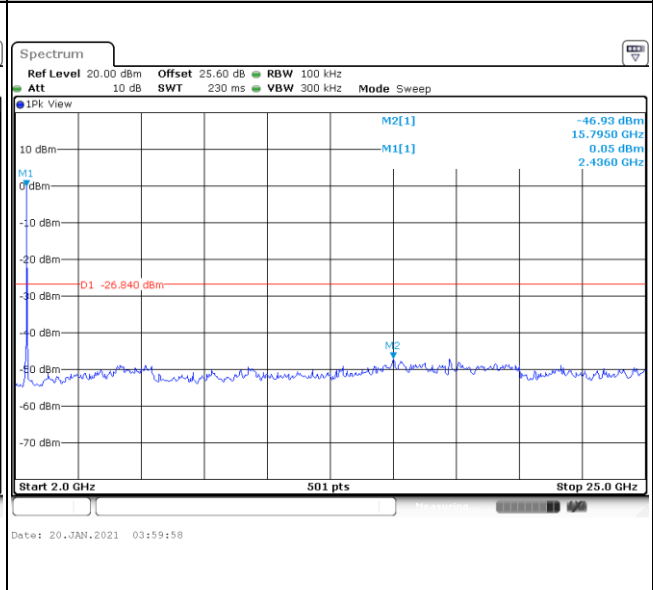
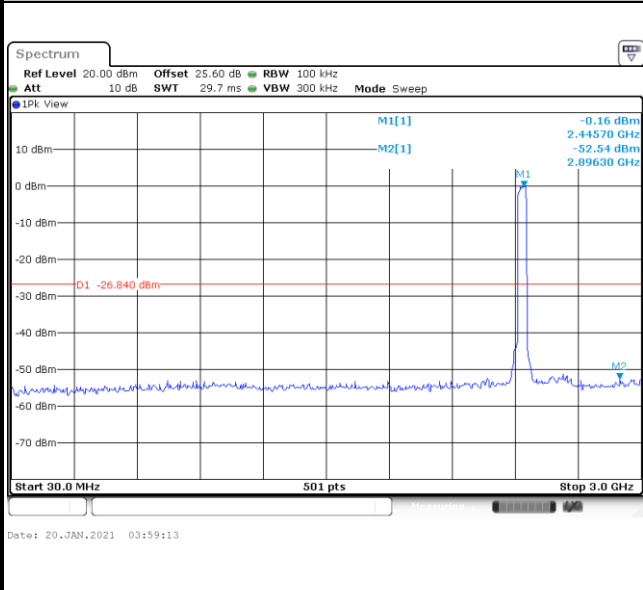


Test Mode :	802.11ax HE40	Test Channel :	06 Full RU
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100kHz PSD reference Level	Channel Plot
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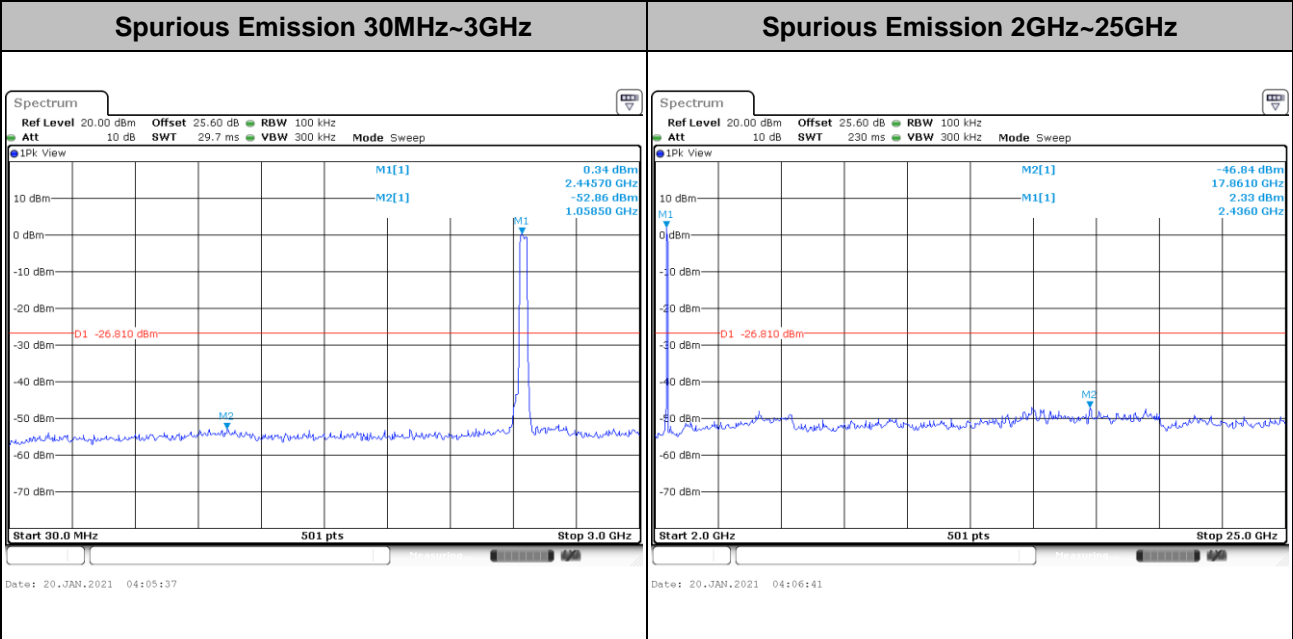
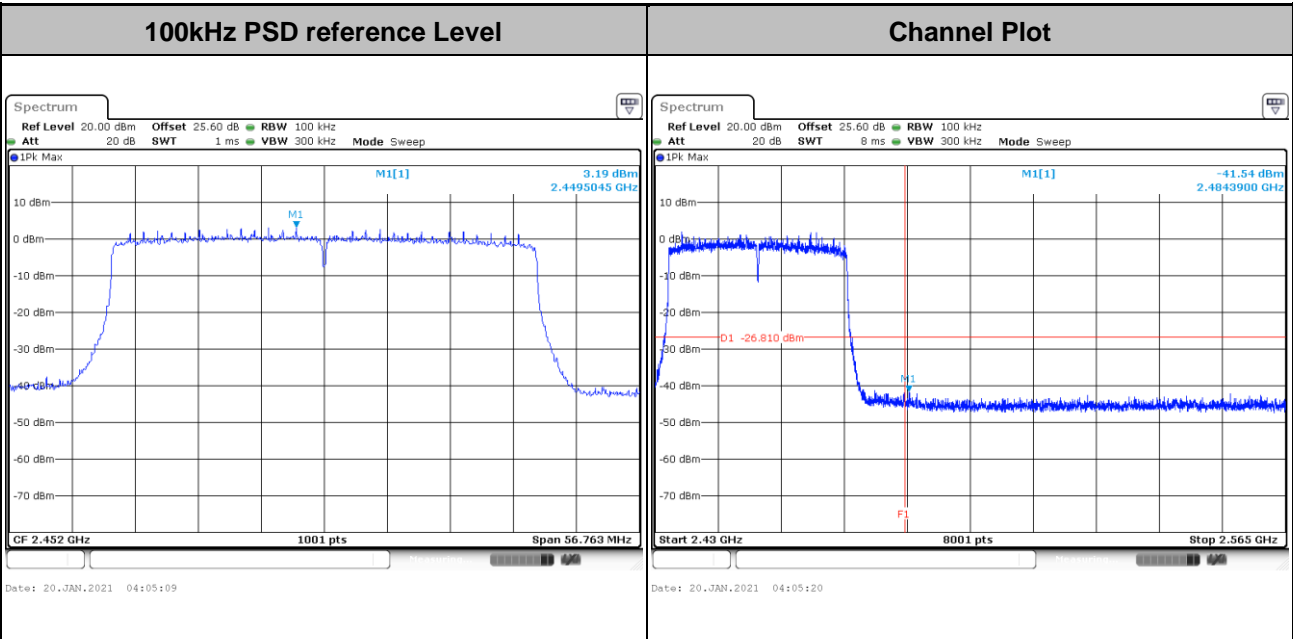


Spurious Emission 30MHz~3GHz	Spurious Emission 2GHz~25GHz
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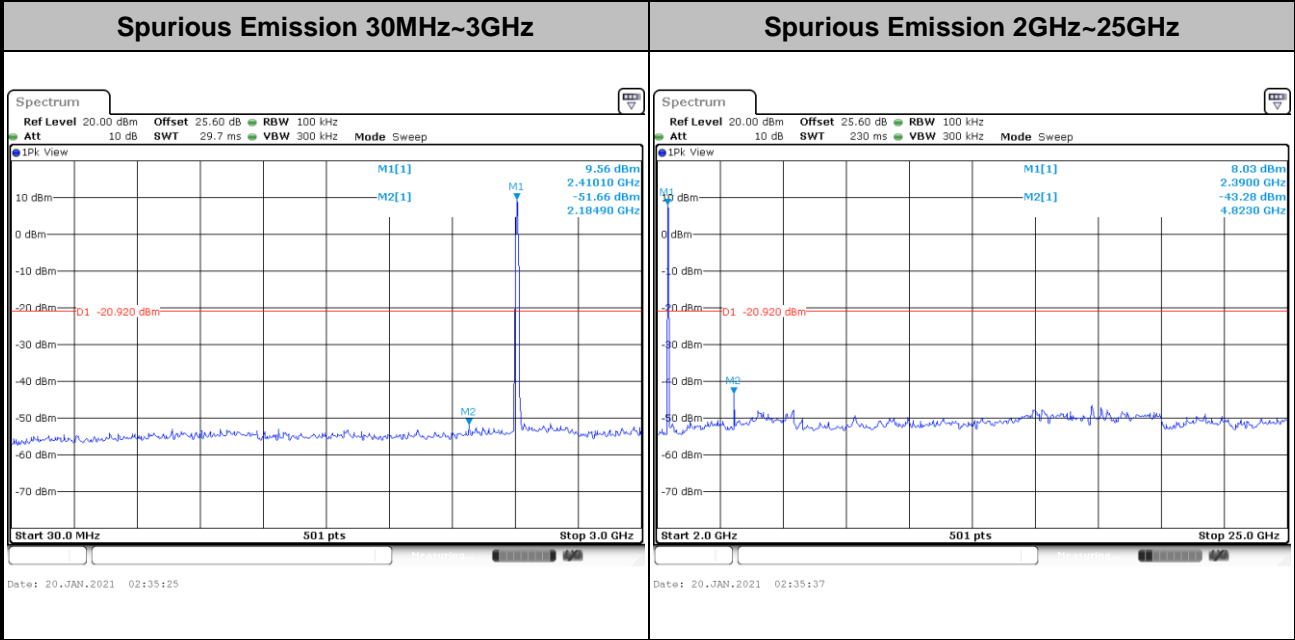
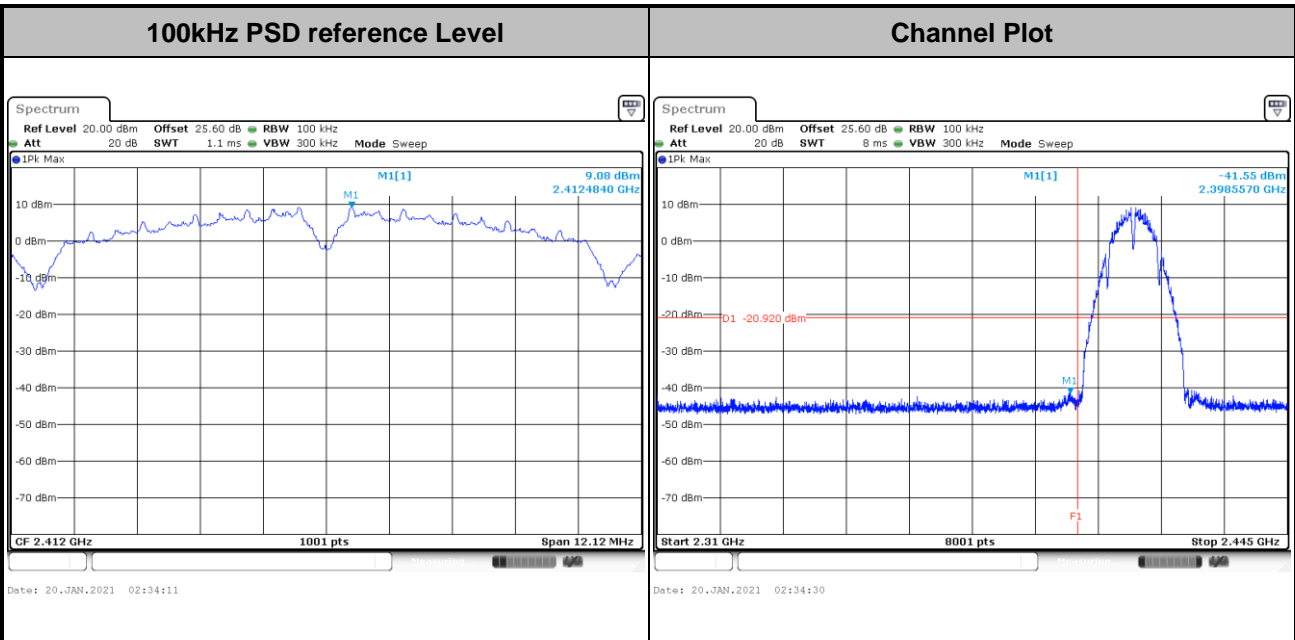
Test Mode : 802.11ax HE40 Test Channel : 09 Full RU





Number of TX = 2, Ant. 7 (Measured)

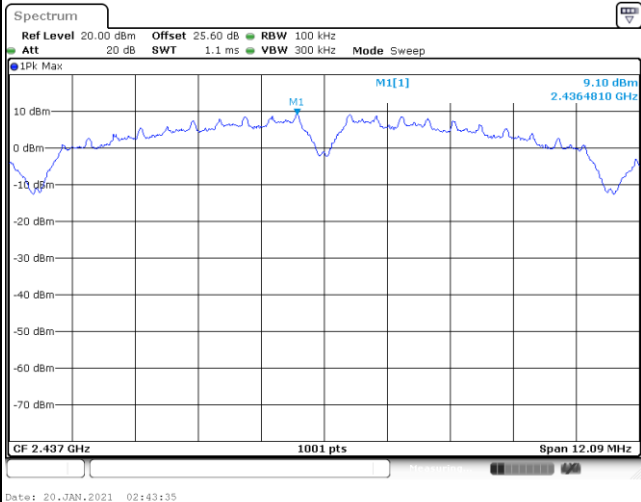
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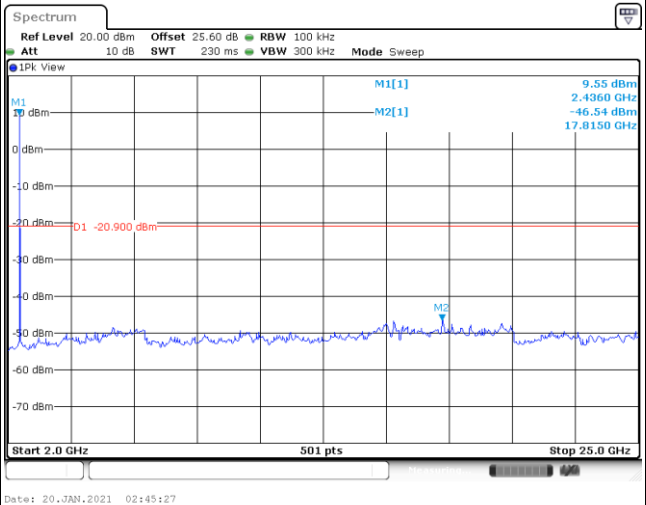
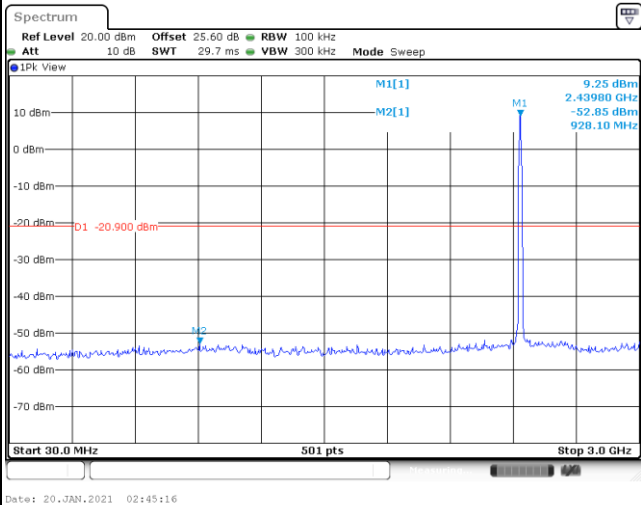
Test Mode :	802.11b	Test Channel :	06
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100kHz PSD reference Level	Channel Plot
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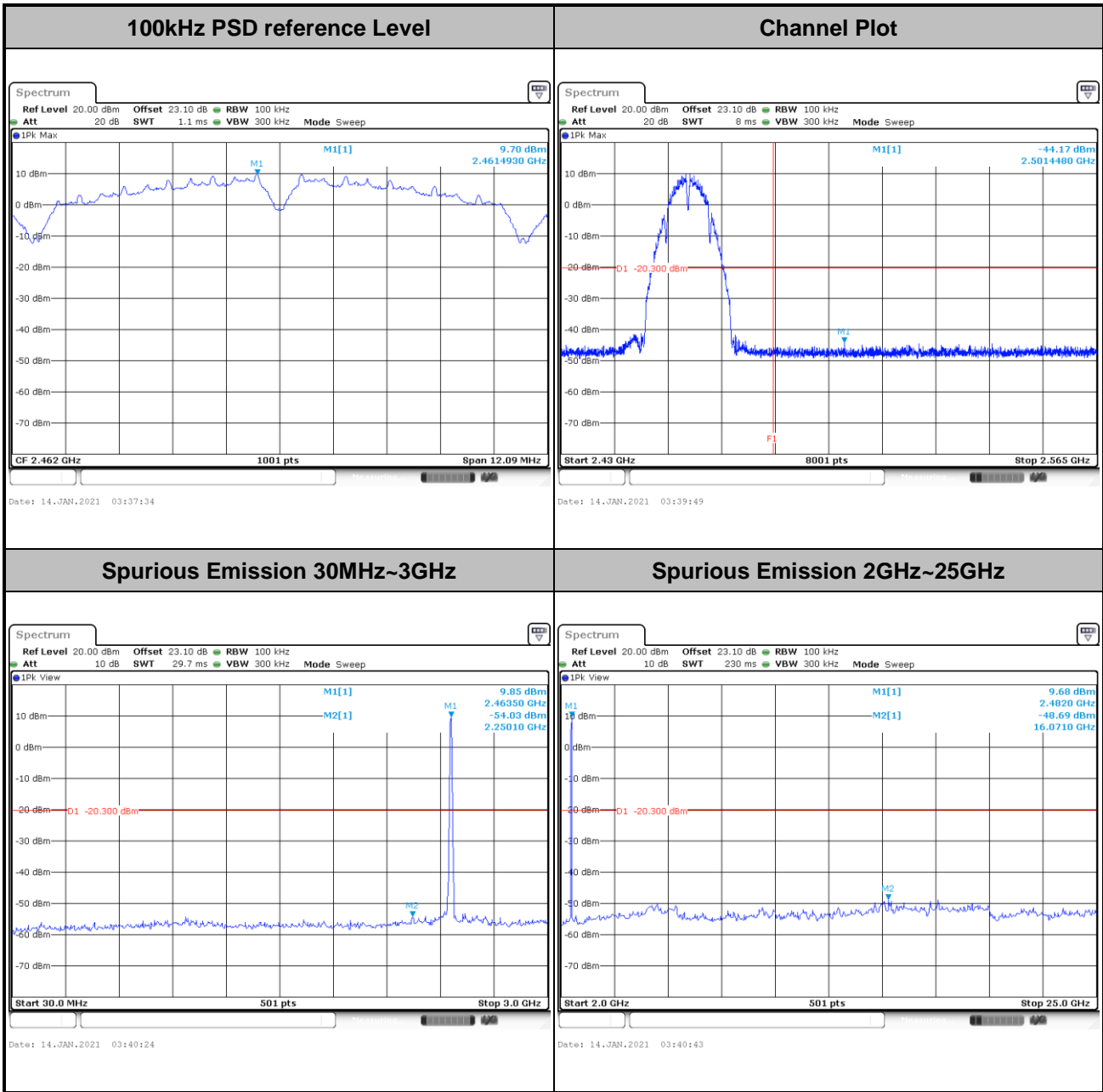
Spurious Emission 30MHz~3GHz

Spurious Emission 2GHz~25GHz



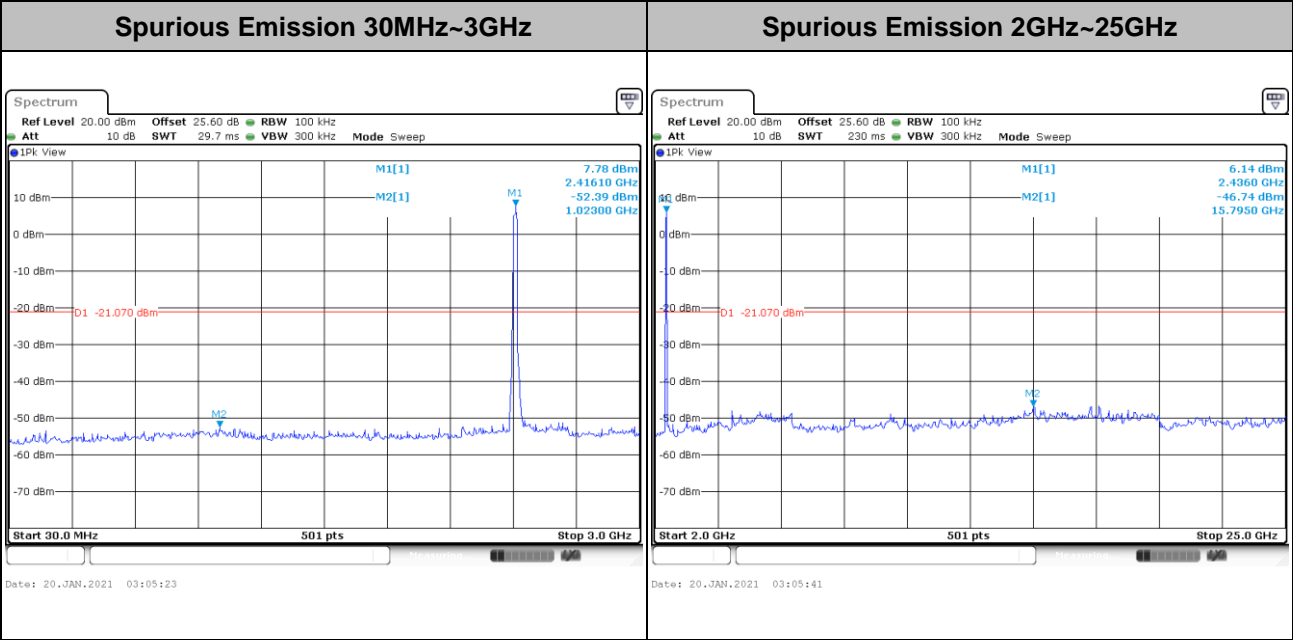
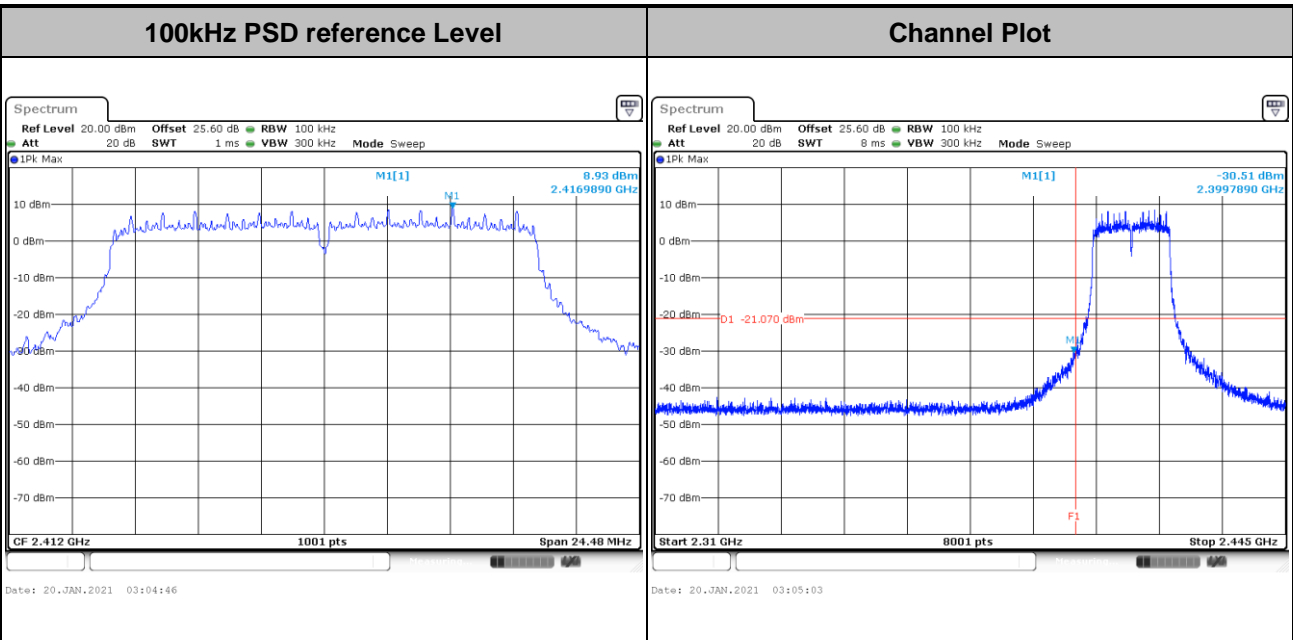


Test Mode :	802.11b	Test Channel :	11
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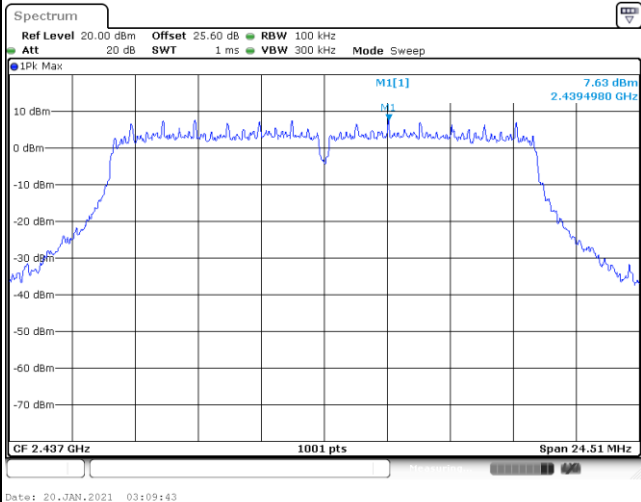
Test Mode :	802.11g	Test Channel :	01
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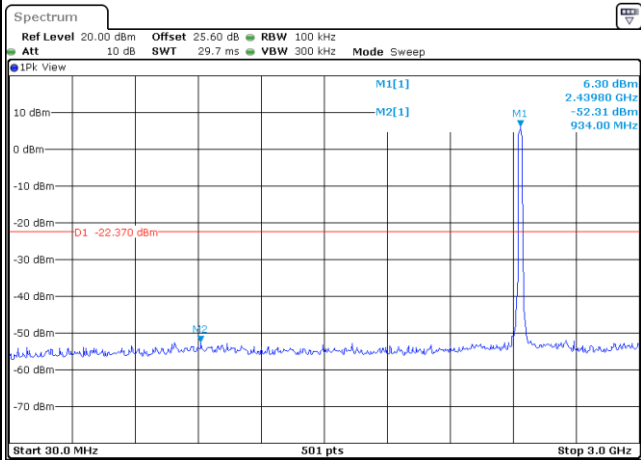
Test Mode :	802.11g	Test Channel :	06
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100kHz PSD reference Level	Channel Plot
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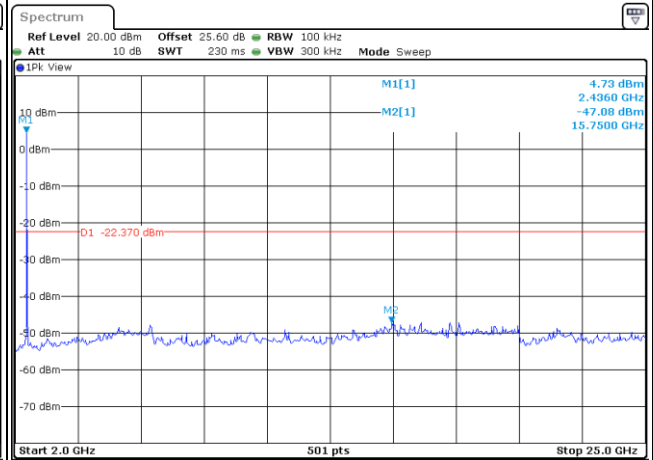


Date: 20.JAN.2021 03:09:43

Spurious Emission 30MHz~3GHz	Spurious Emission 2GHz~25GHz
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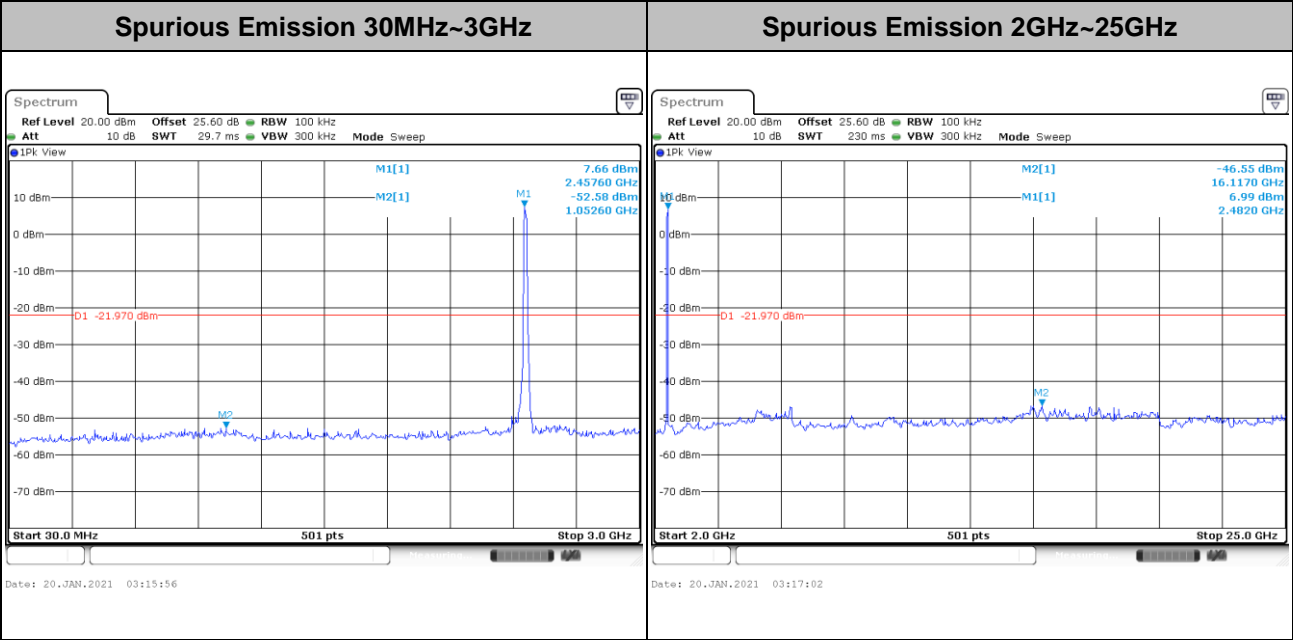
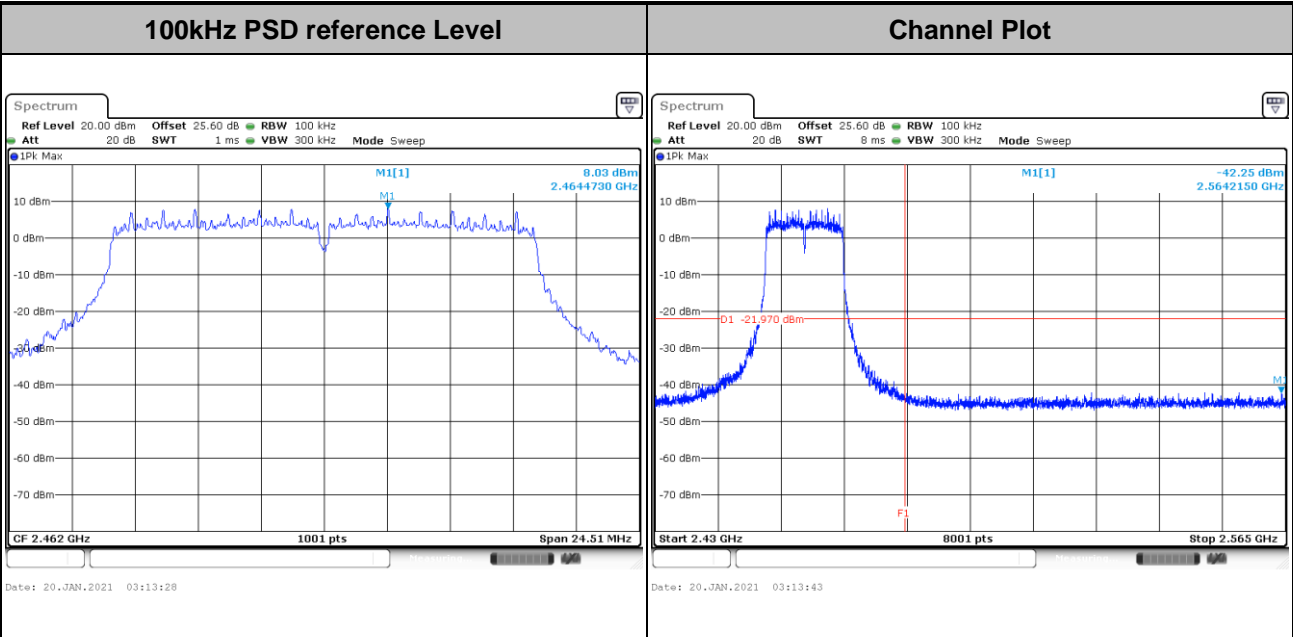
Date: 20.JAN.2021 03:10:01



Date: 20.JAN.2021 03:10:15

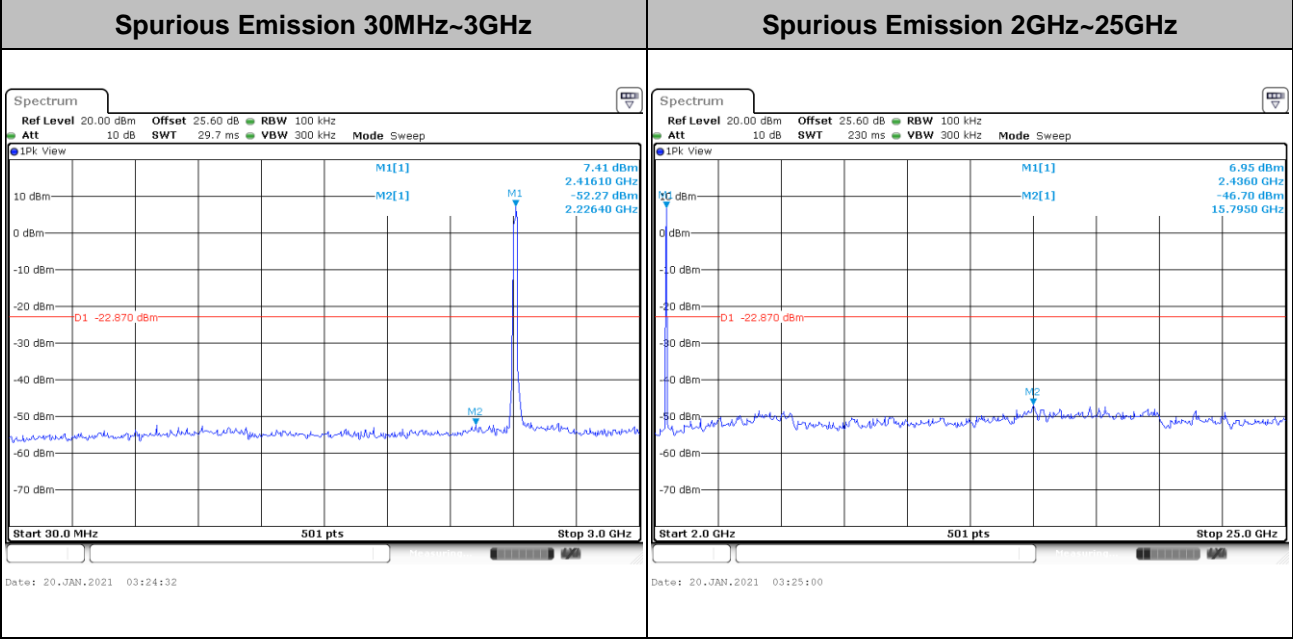
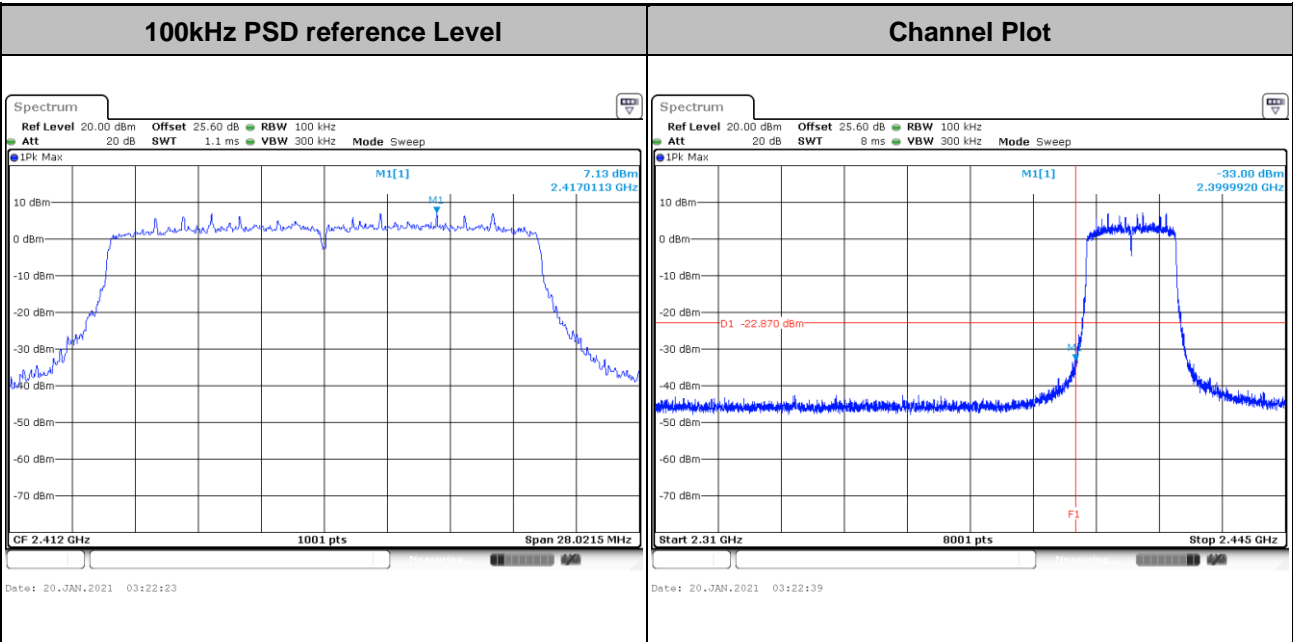


Test Mode :	802.11g	Test Channel :	11
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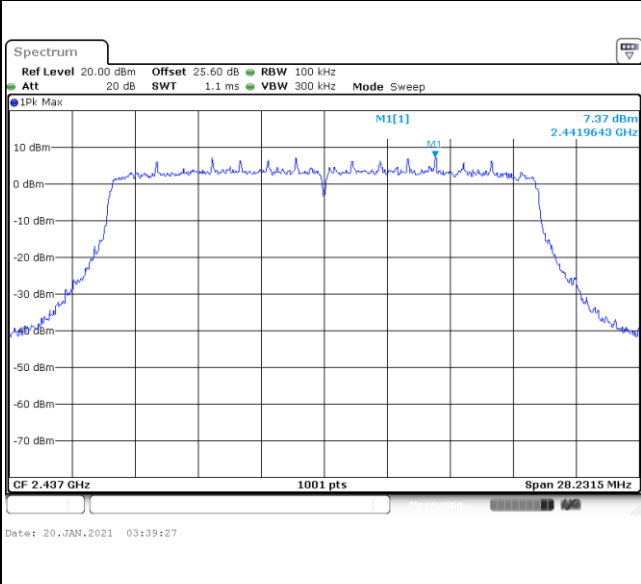
Test Mode : 802.11ax HE20 Test Channel : 01 Full RU



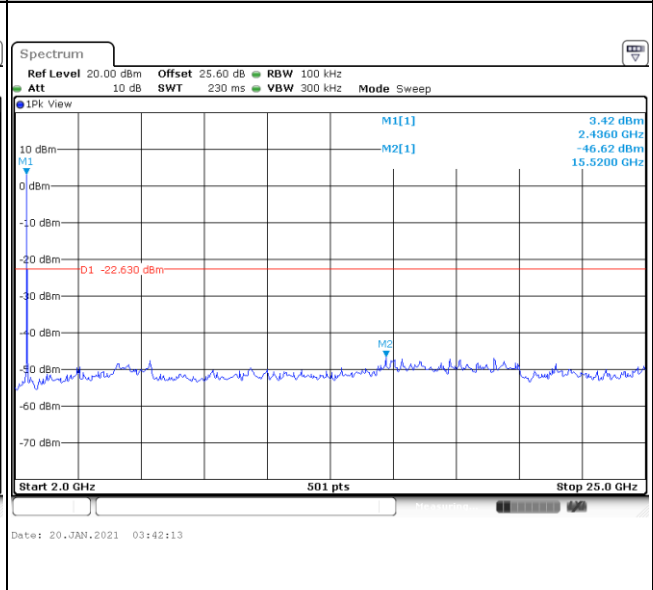
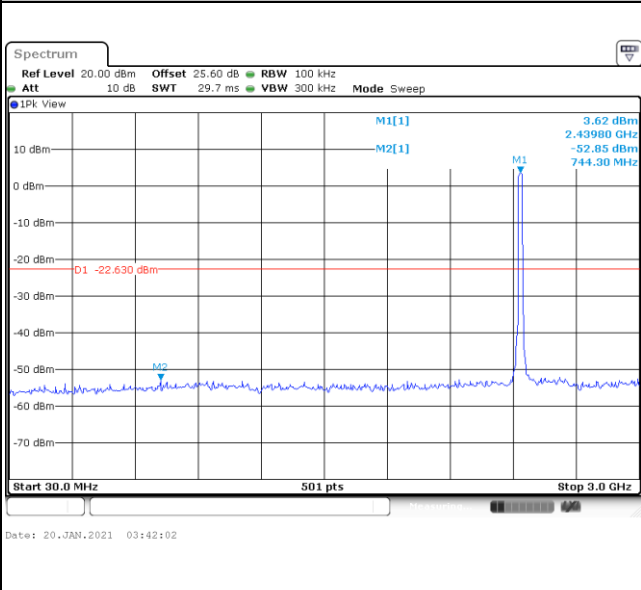


Test Mode :	802.11ax HE20	Test Channel :	06 Full RU
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100kHz PSD reference Level	Channel Plot
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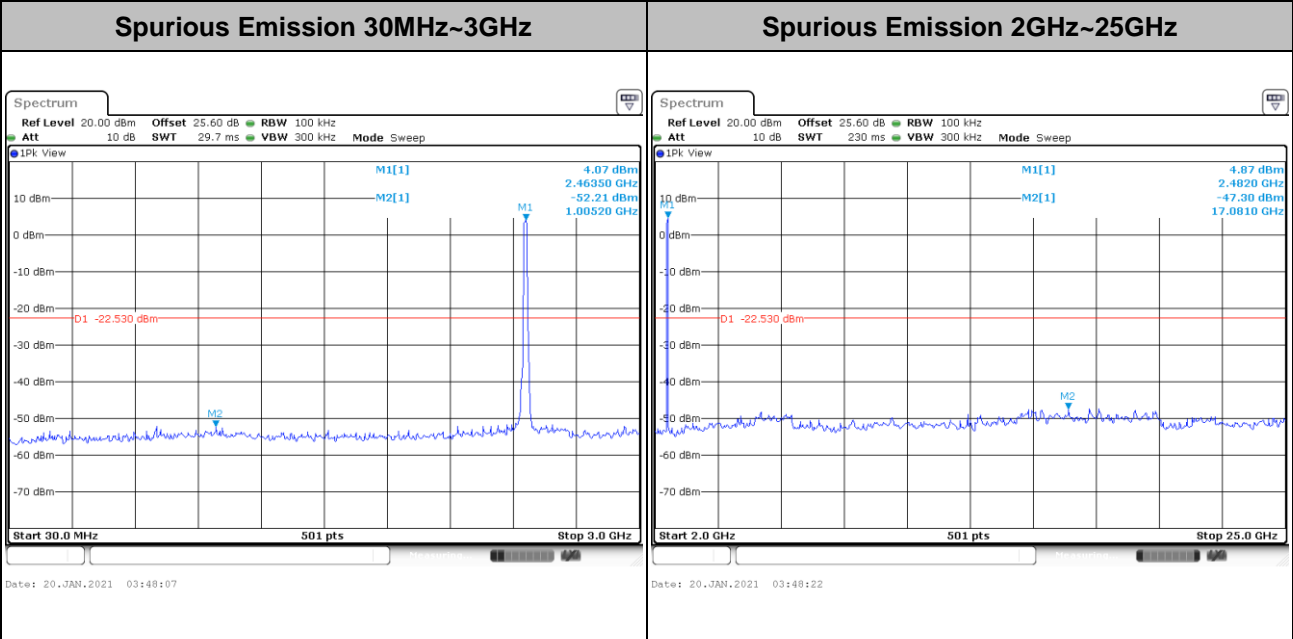
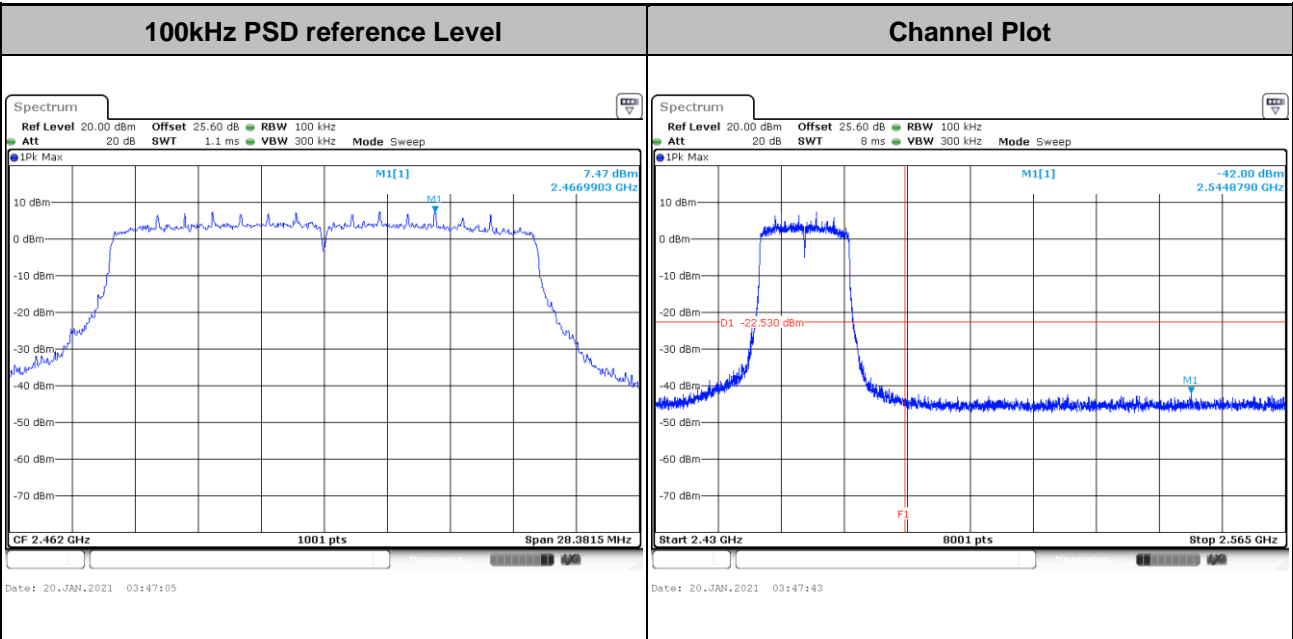


Spurious Emission 30MHz~3GHz	Spurious Emission 2GHz~25GHz
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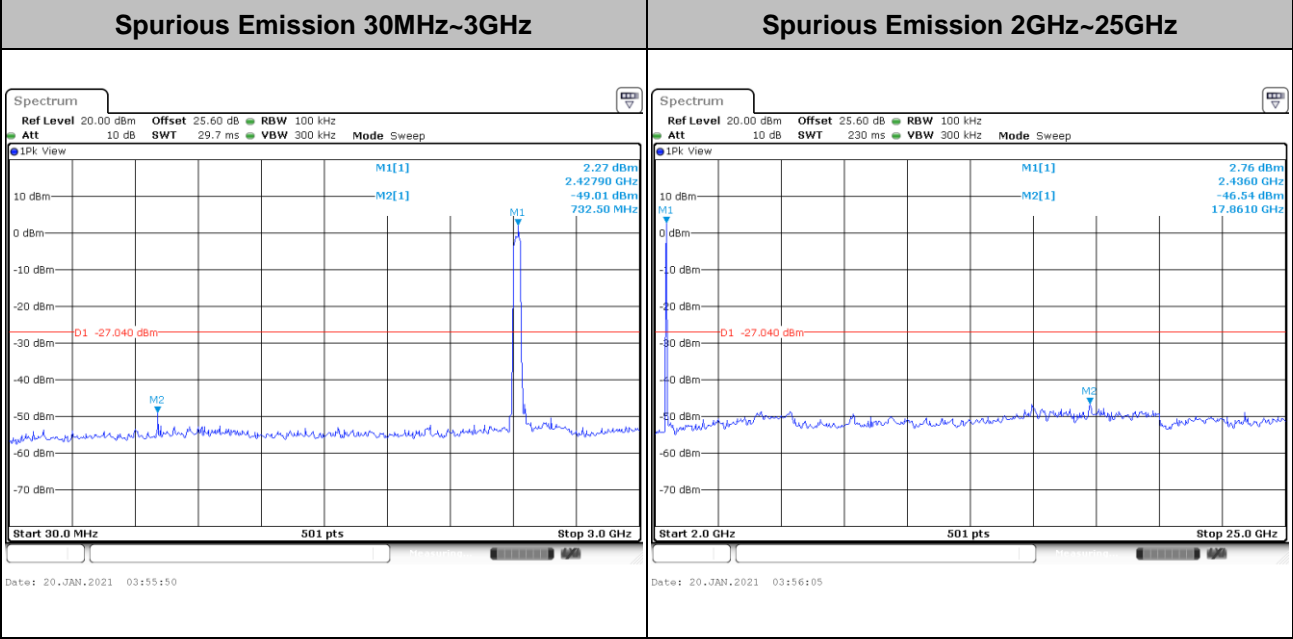
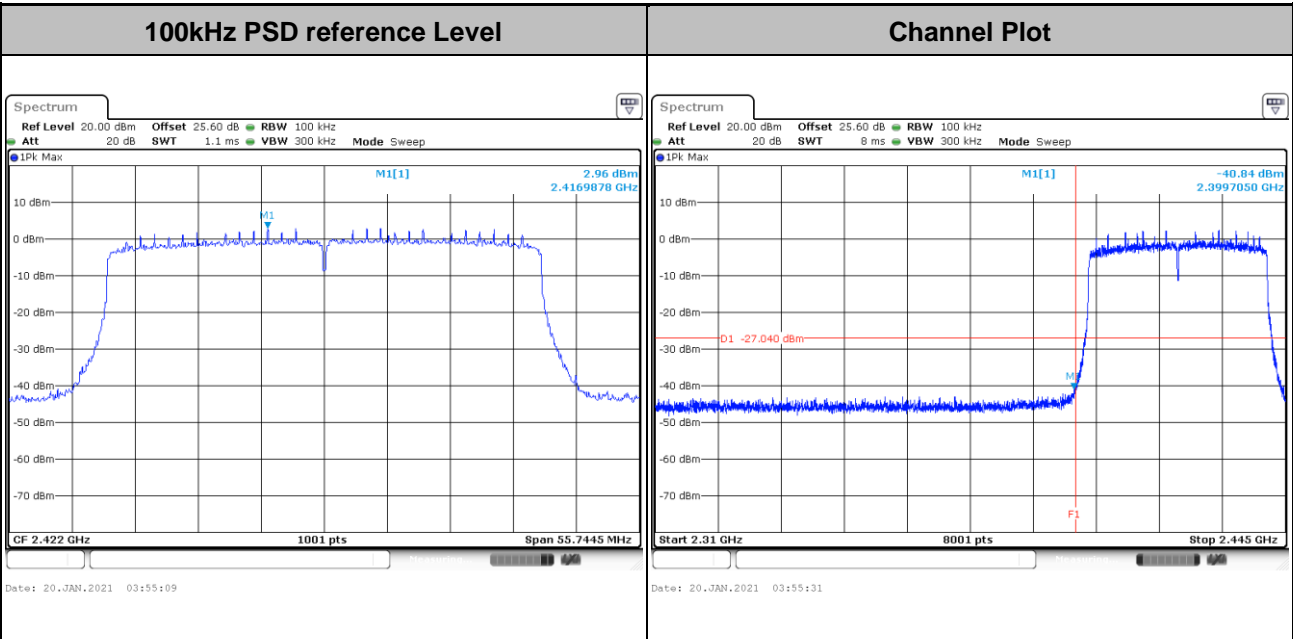


Test Mode : 802.11ax HE20	Test Channel : 11 Full RU
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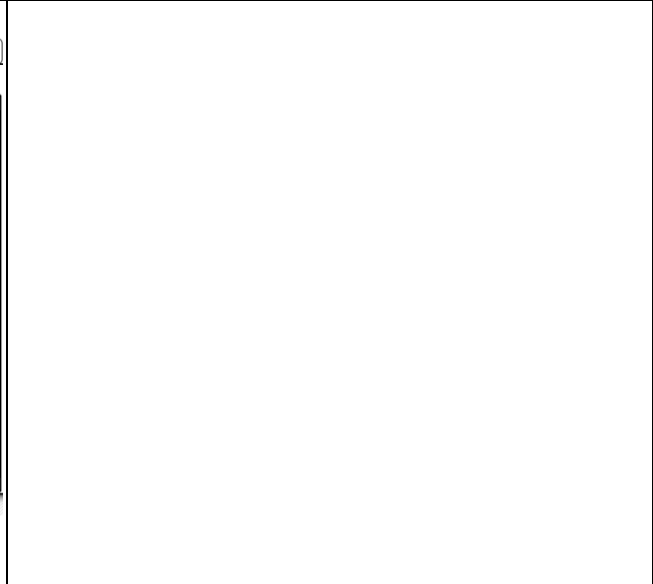
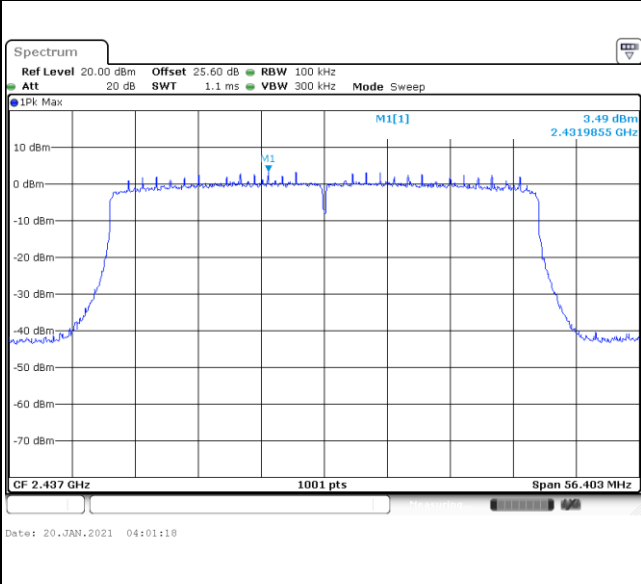
Test Mode : 802.11ax HE40 Test Channel : 03 Full RU



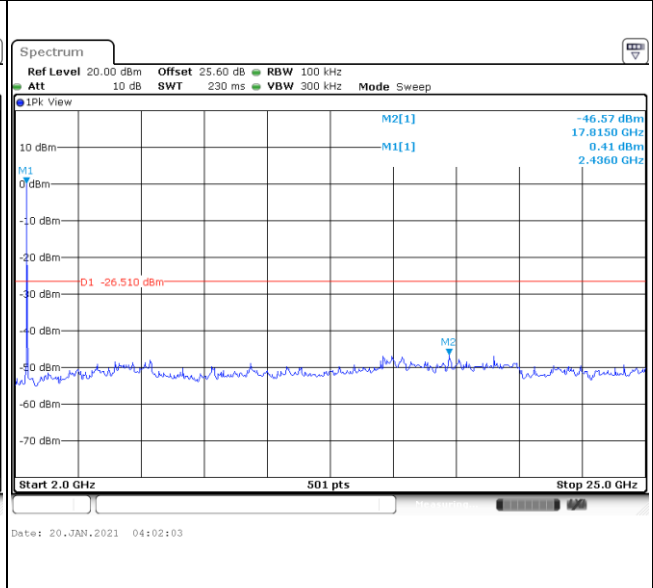
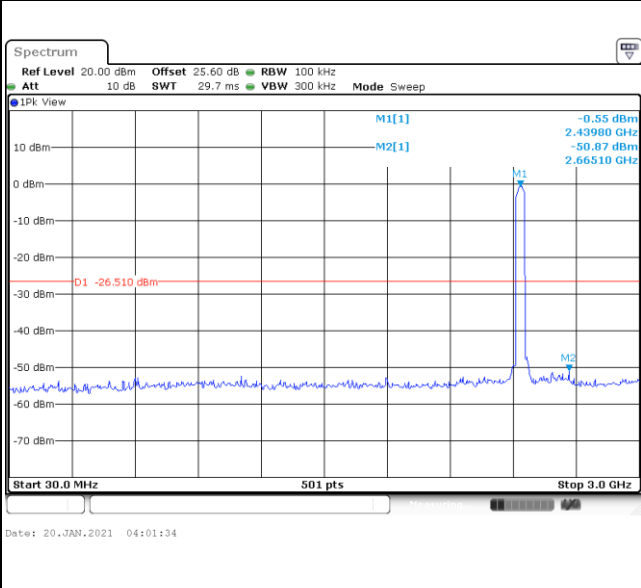


Test Mode :	802.11ax HE40	Test Channel :	06 Full RU
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100kHz PSD reference Level	Channel Plot
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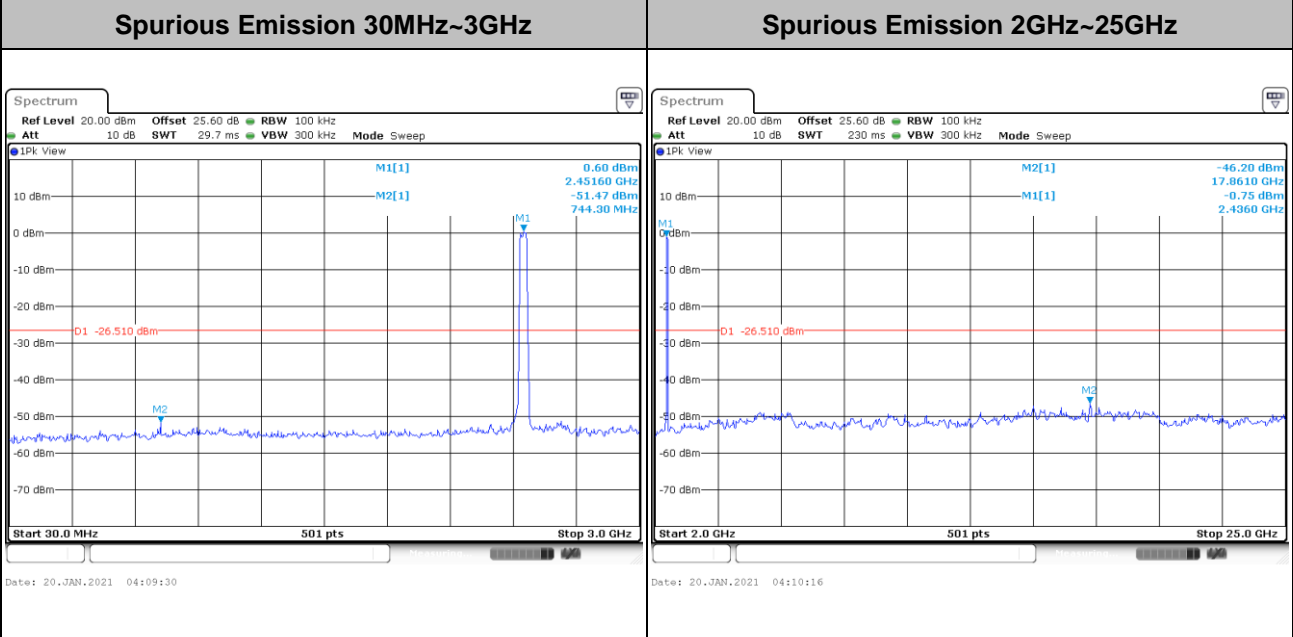
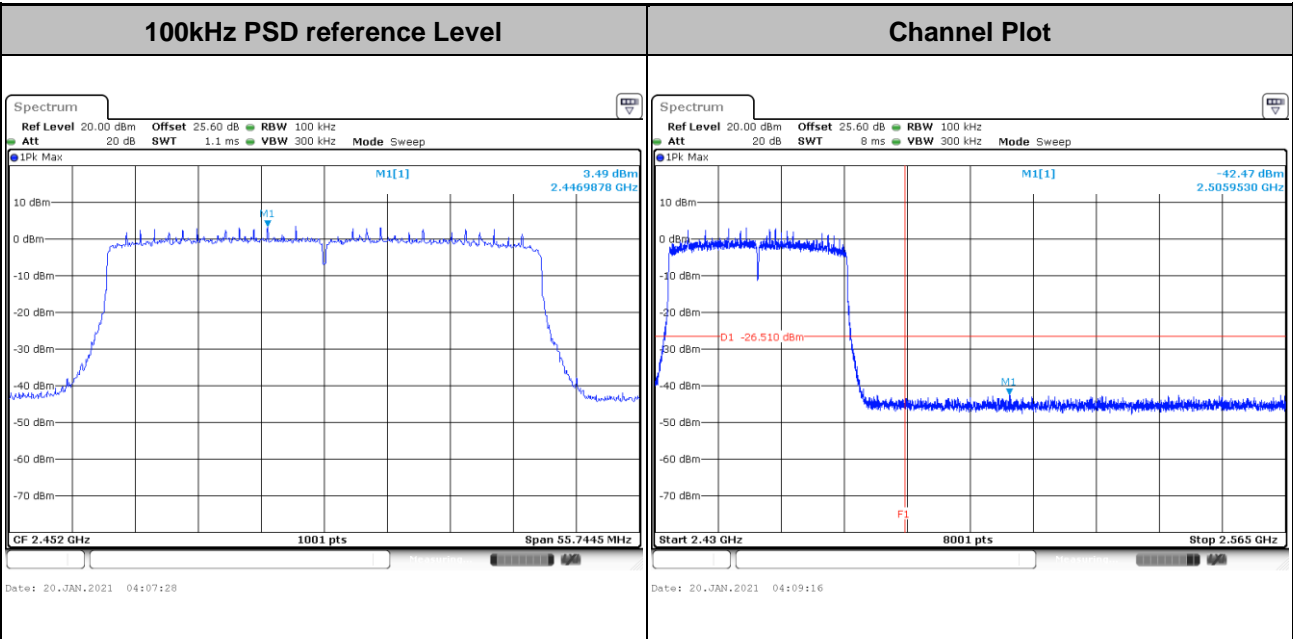


Spurious Emission 30MHz~3GHz	Spurious Emission 2GHz~25GHz
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Test Mode : 802.11ax HE40	Test Channel : 09 Full RU
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3.5 Radiated Band Edges and Spurious Emission Measurement

3.5.1 Limit of Radiated band edge and Spurious Emission Measurement

In any 100 kHz bandwidth outside the intentional radiator frequency band, all harmonics/spurious must be at least 20 dB below the highest emission level within the authorized band. If the output power of this device was measured by spectrum analyzer, the attenuation under this paragraph shall be 30 dB instead of 20 dB. In addition, radiated emissions which fall in the restricted bands must also comply with the limits as below.

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30.0	30	30
30 – 88	100	3
88 – 216	150	3
216 - 960	200	3
Above 960	500	3

3.5.2 Measuring Instruments

See list of measuring equipment of this test report.

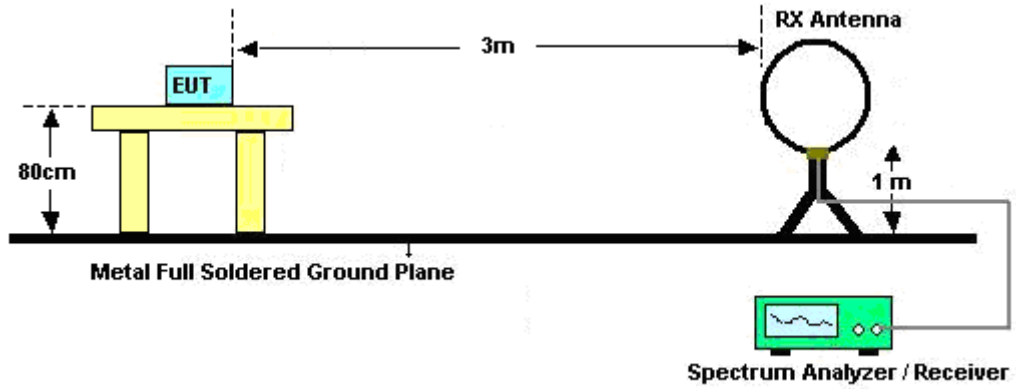


3.5.3 Test Procedures

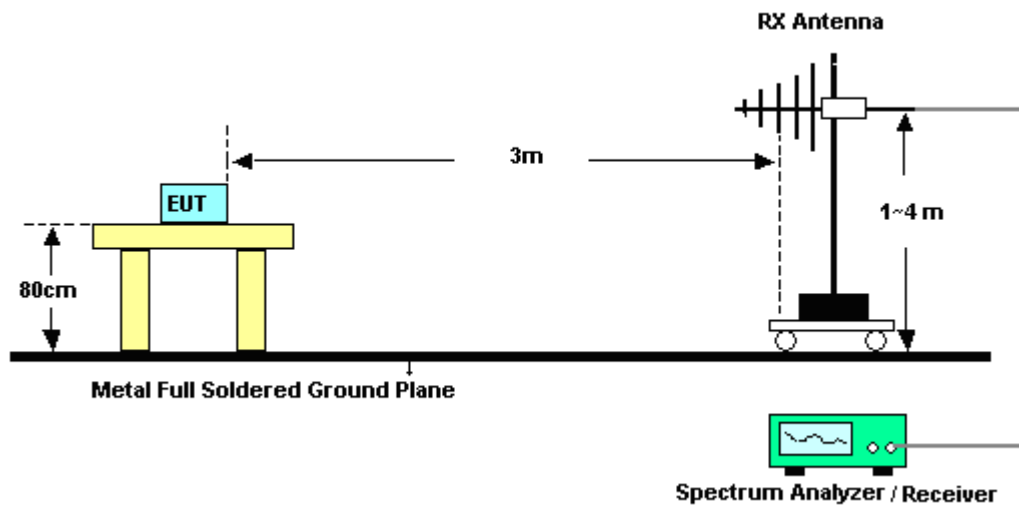
1. The testing follows the ANSI C63.10 Section 11.12.1 Radiated emission measurements.
2. The EUT was arranged to its worst case and then tune the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level.
3. The EUT was placed on a turntable with 0.8 meter for frequency below 1GHz and 1.5 meter for frequency above 1GHz respectively above ground.
4. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower.
5. Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level
6. For testing below 1GHz, if the emission level of the EUT in peak mode was 3 dB lower than the limit specified, then peak values of EUT will be reported, otherwise, the emissions will be repeated one by one using the CISPR quasi-peak method and reported.
7. For testing above 1GHz, the emission level of the EUT in peak mode was 20dB lower than average 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; $VBW \geq RBW$; Sweep = auto; Detector function = peak; Trace = max hold;
 - (3) Set RBW = 1 MHz, VBW= 3MHz for $f \geq 1$ GHz for peak measurement.
For average measurement:
 - $VBW = 10$ Hz, when duty cycle is no less than 98 percent.
 - $VBW \geq 1/T$, when duty cycle is less than 98 percent where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.

3.5.4 Test Setup

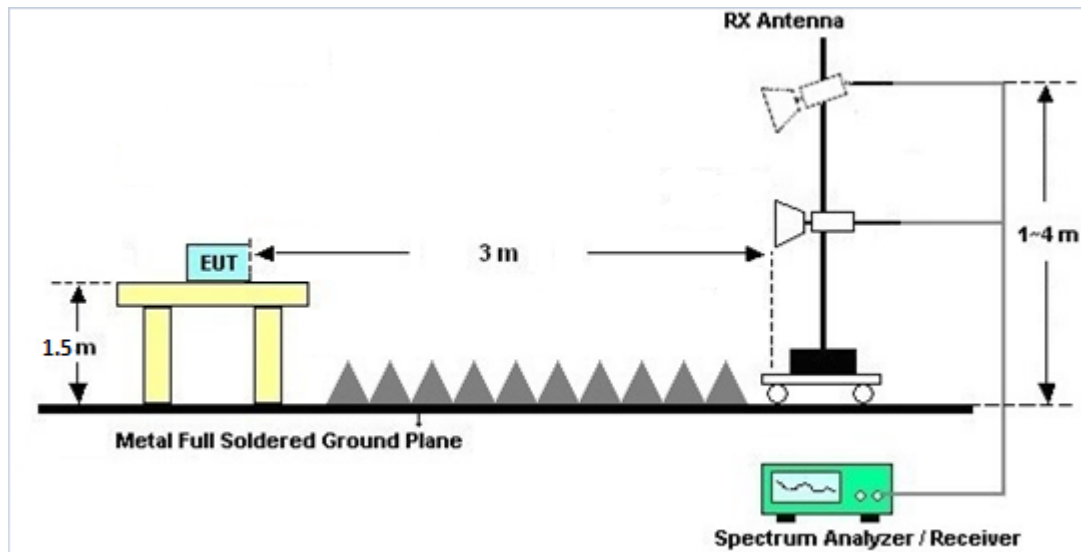
For radiated emissions below 30MHz



For radiated emissions from 30MHz to 1GHz



For radiated test above 1GHz



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

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit line was not reported.

There is a comparison data of both open-field test site and alternative test site - semi-Anechoic chamber according to 414788 D01 Radiated Test Site v01r01, and the result came out very similar.

3.5.6 Test Result of Radiated Spurious at Band Edges

Please refer to Appendix C and D.

3.5.7 Duty Cycle

Please refer to Appendix E.

3.5.8 Test Result of Radiated Spurious Emission (30MHz ~ 10th Harmonic)

Please refer to Appendix C and D.

3.6 AC Conducted Emission Measurement

3.6.1 Limit of AC Conducted Emission

For equipment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table.

Frequency of Emission (MHz)	Conducted Limit (dB μ V)	
	Quasi-Peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

*Decreases with the logarithm of the frequency.

3.6.2 Measuring Instruments

See list of measuring equipment of this test report.

3.6.3 Test Procedures

1. The EUT was placed 0.4 meter from the conducting wall of the shielding room, and it was kept at least 80 centimeters from any other grounded conducting surface.
2. Connect EUT to the power mains through a line impedance stabilization network (LISN).
3. All the support units are connecting to the other LISN.
4. The LISN provides 50 ohm coupling impedance for the measuring instrument.
5. The FCC states that a 50 ohm, 50 microhenry LISN should be used.
6. Both sides of AC line were checked for maximum conducted interference.
7. The frequency range from 150 kHz to 30 MHz was searched.
8. Set the test-receiver system to Peak Detect Function and specified bandwidth (IF bandwidth = 9kHz) with Maximum Hold Mode.

3.6.4 Test Setup



3.6.5 Test Result of AC Conducted Emission

Please refer to Appendix B.



3.7 Antenna Requirements

3.7.1 Standard Applicable

If directional gain of transmitting Antennas is greater than 6dBi, the power shall be reduced by the same level in dB comparing to gain minus 6dBi. The use of a permanently attached Antenna or of an Antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the rule.

3.7.2 Antenna Anti-Replacement Construction

An embedded-in antenna design is used.

3.7.3 Antenna Gain

<CDD Modes >

FCC KDB 662911 D01 Multiple Transmitter Output v02r01

For CDD transmissions, directional gain is calculated as

Directional gain = G_{ANT} + Array Gain, where Array Gain is as follows.

For power spectral density (PSD) measurements on all devices,

Array Gain = $10 \log(N_{ANT}/N_{SS}=1)$ dB.

For power measurements on IEEE 802.11 devices,

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

Directional gain may be calculated by using the formulas applicable to equal gain antennas with G_{ANT} set equal to the gain of the antenna having the highest gain;

The EUT supports CDD mode.

For power, the directional gain G_{ANT} is set equal to the antenna having the highest gain, i.e., F)2)f)i).

For PSD, the directional gain calculation is following F)2)f)ii) of KDB 662911 D01 v02r01.

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

The directional gain "DG" is calculated as following table.

<CDD Modes>						
			DG for Power (dBi)	DG for PSD (dBi)	Power Limit Reduction (dB)	PSD Limit Reduction (dB)
	Ant. 5 (dBi)	Ant. 7 (dBi)				
2.4 GHz	-2.46	-2.58	-2.46	0.49	0.00	0.00

$Power\ Limit\ Reduction = DG(Power) - 6dBi, (min = 0)$

$PSD\ Limit\ Reduction = DG(PSD) - 6dBi, (min = 0)$



4 List of Measuring Equipment

Instrument	Brand Name	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
Horn Antenna	SCHWARZBECK	BBHA 9120 D	9120D-1326	1GHz ~ 18GHz	Nov. 03, 2020	Jan. 10, 2021~ Jan. 28, 2021	Nov. 02, 2021	Radiation (03CH11-HY)
Loop Antenna	Rohde & Schwarz	HFH2-Z2	100488	9 kHz~30 MHz	Jul. 14, 2020	Jan. 10, 2021~ Jan. 28, 2021	Jul. 13, 2021	Radiation (03CH11-HY)
SHF-EHF Horn Antenna	SCHWARZBECK	BBHA 9170	00994	18GHz- 40GHz	Nov. 29, 2020	Jan. 10, 2021~ Jan. 28, 2021	Nov. 28, 2021	Radiation (03CH11-HY)
Bilog Antenna	TESEQ	CBL 6111D & N-6-06	35414 & AT-N0602	30MHz~1GHz	Oct. 11, 2020	Jan. 10, 2021~ Jan. 28, 2021	Oct. 10, 2021	Radiation (03CH11-HY)
Preamplifier	Keysight	83017A	MY53270080	1GHz~26.5GHz	Nov. 12, 2020	Jan. 10, 2021~ Jan. 28, 2021	Nov. 11, 2021	Radiation (03CH11-HY)
Preamplifier	EMEC	EM1G18G	060812	1GHz~18GHz	Oct. 27, 2020	Jan. 10, 2021~ Jan. 28, 2021	Oct. 26, 2021	Radiation (03CH11-HY)
Preamplifier	EMEC	EM18G40G	060801	18GHz~40GHz	Jun. 15, 2020	Jan. 10, 2021~ Jan. 28, 2021	Jun. 14, 2021	Radiation (03CH11-HY)
Amplifier	SONOMA	310N	187312	9kHz~1GHz	Dec. 02, 2020	Jan. 10, 2021~ Jan. 28, 2021	Dec. 01, 2021	Radiation (03CH11-HY)
Spectrum Analyzer	Keysight	N9010A	MY54200486	10Hz~44GHz	Oct. 23, 2020	Jan. 10, 2021~ Jan. 28, 2021	Oct. 22, 2021	Radiation (03CH11-HY)
EMI Test Receiver	Keysight	N9038A(MXE)	MY55420170	20MHz~8.4GHz	May 21, 2020	Jan. 10, 2021~ Jan. 28, 2021	May 20, 2021	Radiation (03CH11-HY)
Controller	EMEC	EM 1000	N/A	Control Turn table & Ant Mast	N/A	Jan. 10, 2021~ Jan. 28, 2021	N/A	Radiation (03CH11-HY)
Antenna Mast	EMEC	AM-BS-4500-B	N/A	1~4m	N/A	Jan. 10, 2021~ Jan. 28, 2021	N/A	Radiation (03CH11-HY)
Turn Table	EMEC	TT 2000	N/A	0~360 Degree	N/A	Jan. 10, 2021~ Jan. 28, 2021	N/A	Radiation (03CH11-HY)
Software	Audix	E3 6.2009-8-24	RK-001053	N/A	N/A	Jan. 10, 2021~ Jan. 28, 2021	N/A	Radiation (03CH11-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	MY9837/4 PE	9kHz-30MHz	Mar. 12, 2020	Jan. 10, 2021~ Jan. 28, 2021	Mar. 11, 2021	Radiation (03CH11-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	MY2859/2	30MHz-40GHz	Mar. 12, 2020	Jan. 10, 2021~ Jan. 28, 2021	Mar. 11, 2021	Radiation (03CH11-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	MY9837/4 PE	30M-18G	Mar. 12, 2020	Jan. 10, 2021~ Jan. 28, 2021	Mar. 11, 2021	Radiation (03CH11-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	MY4274/2	30MHz-40GHz	Mar. 12, 2020	Jan. 10, 2021~ Jan. 28, 2021	Mar. 11, 2021	Radiation (03CH11-HY)
Filter	Wainwright	WLK4-1000-1530-8000-40SS	SN11	1.53G Low Pass	Sep. 14, 2020	Jan. 10, 2021~ Jan. 28, 2021	Sep. 13, 2021	Radiation (03CH11-HY)
Filter	Wainwright	WHKX12-2700-3000-18000-60SS	SN3	3GHz High Pass Filter	Sep. 14, 2020	Jan. 10, 2021~ Jan. 28, 2021	Sep. 13, 2021	Radiation (03CH11-HY)
Hygrometer	TECPEL	DTM-303B	TP200880	QA-3-031	Oct. 22, 2020	Jan. 10, 2021~ Jan. 28, 2021	Oct. 21, 2021	Radiation (03CH11-HY)



Instrument	Brand Name	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
AC Power Source	ChainTek	APC-1000W	N/A	N/A	N/A	Jan. 21, 2021	N/A	Conduction (CO05-HY)
EMI Test Receiver	Rohde & Schwarz	ESR3	102317	9kHz~3.6GHz	Sep. 11, 2020	Jan. 21, 2021	Sep. 10, 2021	Conduction (CO05-HY)
Hygrometer	Testo	608-H1	34913912	N/A	Nov. 18, 2020	Jan. 21, 2021	Nov. 17, 2021	Conduction (CO05-HY)
LISN	Rohde & Schwarz	ENV216	100081	9kHz~30MHz	Nov. 16, 2020	Jan. 21, 2021	Nov. 15, 2021	Conduction (CO05-HY)
Software	Rohde & Schwarz	EMC32 V10.30	N/A	N/A	N/A	Jan. 21, 2021	N/A	Conduction (CO05-HY)
LISN Cable	MVE	RG-400	260260	N/A	Dec. 31, 2020	Jan. 21, 2021	Dec. 30, 2021	Conduction (CO05-HY)
Pulse Limiter	SCHWARZBECK	ESHVTS 9561-F N3-Z2	109561-F N0037308 51	9kHz-200MHz	Nov. 02, 2020	Jan. 21, 2021	Nov. 01, 2021	Conduction (CO05-HY)
Hygrometer	Testo	608-H1	34893241	N/A	Mar. 02, 2020	Jan. 13, 2021~ Jan. 23, 2021	Mar. 01, 2021	Conducted (TH05-HY)
Power Sensor	DARE	RPR3006W	16I00054S NO10	10MHz~6GHz	Dec. 09, 2020	Jan. 13, 2021~ Jan. 23, 2021	Dec. 08, 2021	Conducted (TH05-HY)
Signal Analyzer	Rohde & Schwarz	FSV40	101566	10Hz ~ 40GHz	Jul. 22, 2020	Jan. 13, 2021~ Jan. 23, 2021	Jul. 21, 2021	Conducted (TH05-HY)
Switch Box & RF Cable	EM Electronics	EMSW18SE	SW200302	N/A	Mar. 17, 2020	Jan. 13, 2021~ Jan. 23, 2021	Mar. 16, 2021	Conducted (TH05-HY)



5 Uncertainty of Evaluation

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

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	2.3
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Uncertainty of Radiated Emission Measurement (30 MHz ~ 1000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	4.4
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Uncertainty of Radiated Emission Measurement (1000 MHz ~ 18000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	5.2
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Uncertainty of Radiated Emission Measurement (18000 MHz ~ 40000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	5.1
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Appendix A. Test Result of Conducted Test Items

Test Engineer:	Jacob Yu	Temperature:	19.6~24.7	°C
Test Date:	2021/1/13-2021/1/23	Relative Humidity:	46.7~57.5	%

TEST RESULTS DATA
6dB and 99% Occupied Bandwidth

2.4GHz Band MIMO										
Mod.	Data Rate	N _{TX}	CH.	Freq. (MHz)	99% Occupied BW (MHz)		6dB BW (MHz)		6dB BW Limit (MHz)	Pass/Fail
					Ant5	Ant7	Ant5	Ant7		
11b	1Mbps	2	1	2412	13.09	13.14	8.06	8.08	0.50	Pass
11b	1Mbps	2	6	2437	13.04	13.09	8.04	8.06	0.50	Pass
11b	1Mbps	2	11	2462	13.09	13.09	8.06	8.06	0.50	Pass
11g	6Mbps	2	1	2412	16.43	16.38	16.30	16.32	0.50	Pass
11g	6Mbps	2	6	2437	16.43	16.38	16.32	16.34	0.50	Pass
11g	6Mbps	2	11	2462	16.43	16.33	16.34	16.34	0.50	Pass

TEST RESULTS DATA
Average Output Power

2.4GHz Band MIMO																
Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Average Conducted Power (dBm)			Conducted Power Limit (dBm)		DG (dBi)		EIRP Power (dBm)		EIRP Power Limit (dBm)		Pass /Fail
					Ant5	Ant7	SUM	Ant5	Ant7	Ant5	Ant7	Ant5	Ant7	Ant5	Ant7	
11b	1Mbps	2	6	2437	18.70	18.30	21.51	30.00		-2.46		19.05		36.00		Pass
11b	1Mbps	2	11	2462	18.90	18.60	21.76	30.00		-2.46		19.30		36.00		Pass
11g	6Mbps	2	1	2412	19.70	19.60	22.66	30.00		-2.46		20.20		36.00		Pass
11g	6Mbps	2	6	2437	19.50	19.50	22.51	30.00		-2.46		20.05		36.00		Pass
11g	6Mbps	2	11	2462	19.50	19.70	22.61	30.00		-2.46		20.15		36.00		Pass
HT20	MCS0	2	1	2412	18.50	18.30	21.41	30.00		-2.46		18.95		36.00		Pass
HT20	MCS0	2	6	2437	18.40	18.20	21.31	30.00		-2.46		18.85		36.00		Pass
HT20	MCS0	2	11	2462	18.40	18.50	21.46	30.00		-2.46		19.00		36.00		Pass
HT40	MCS0	2	3	2422	17.10	16.80	19.96	30.00		-2.46		17.50		36.00		Pass
HT40	MCS0	2	6	2437	17.00	17.10	20.06	30.00		-2.46		17.60		36.00		Pass
HT40	MCS0	2	9	2452	17.10	17.20	20.16	30.00		-2.46		17.70		36.00		Pass

Note: Measured power (dBm) has offset with cable loss.

TEST RESULTS DATA
Peak Power Spectral Density

2.4GHz Band MIMO												
Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Peak PSD (dBm/3kHz)			DG (dBi)		Peak PSD Limit (dBm/3kHz)		Pass/Fail
					Ant5	Ant7	Worse + 3.01	Ant5	Ant7	Ant5	Ant7	
11b	1Mbps	2	1	2412	-5.49	-6.11	-2.48	0.49		8.00		Pass
11b	1Mbps	2	6	2437	-6.07	-6.32	-3.06	0.49		8.00		Pass
11b	1Mbps	2	11	2462	-5.49	-5.73	-2.48	0.49		8.00		Pass
11g	6Mbps	2	1	2412	-7.53	-7.37	-4.36	0.49		8.00		Pass
11g	6Mbps	2	6	2437	-7.32	-7.29	-4.28	0.49		8.00		Pass
11g	6Mbps	2	11	2462	-7.29	-7.12	-4.11	0.49		8.00		Pass

Measured power density (dBm) has offset with cable loss.

TEST RESULTS DATA
6dB and 99% Occupied Bandwidth

2.4GHz Band MIMO											
Mod.	Data Rate	NTx	CH.	Freq. (MHz)	RU Config	99% Occupied BW (MHz)		6dB BW (MHz)		6dB BW Limit (MHz)	Pass/Fail
						Ant5	Ant7	Ant5	Ant7		
HE20	MCS0	2	1	2412	Full	18.98	18.93	18.92	18.68	0.50	Pass
HE20	MCS0	2	6	2437	Full	18.93	18.93	18.92	18.82	0.50	Pass
HE20	MCS0	2	11	2462	Full	18.93	18.93	18.92	18.80	0.50	Pass
HE40	MCS0	2	3	2422	Full	37.86	37.86	37.76	37.16	0.50	Pass
HE40	MCS0	2	6	2437	Full	37.86	37.96	37.96	37.60	0.50	Pass
HE40	MCS0	2	9	2452	Full	37.86	37.86	37.84	37.16	0.50	Pass

TEST RESULTS DATA
Average Output Power

2.4GHz Band MIMO																	
Mod.	Data Rate	NTx	CH.	Freq. (MHz)	RU Config	Average Conducted Power (dBm)			Conducted Power Limit (dBm)		DG (dBi)		EIRP Power (dBm)		EIRP Power Limit (dBm)		Pass /Fail
						Ant5	Ant7	SUM	Ant5	Ant7	Ant5	Ant7	Ant5	Ant7	Ant5	Ant7	
HE20	MCS0	2	1	2412	Full	18.60	18.40	21.51	30.00		-2.46	19.05		36.00		Pass	
HE20	MCS0	2	1	2412	26/0	9.30	9.00	12.16	30.00		-2.46	9.70		36.00		Pass	
HE20	MCS0	2	1	2412	52/37	11.70	11.40	14.56	30.00		-2.46	12.10		36.00		Pass	
HE20	MCS0	2	1	2412	106/53	15.20	15.10	18.16	30.00		-2.46	15.70		36.00		Pass	
HE20	MCS0	2	6	2437	Full	18.50	18.30	21.41	30.00		-2.46	18.95		36.00		Pass	
HE20	MCS0	2	6	2437	26/4	9.80	9.70	12.76	30.00		-2.46	10.30		36.00		Pass	
HE20	MCS0	2	6	2437	52/39	11.50	11.80	14.66	30.00		-2.46	12.20		36.00		Pass	
HE20	MCS0	2	6	2437	106/53	14.90	14.90	17.91	30.00		-2.46	15.45		36.00		Pass	
HE20	MCS0	2	11	2462	Full	18.50	18.60	21.56	30.00		-2.46	19.10		36.00		Pass	
HE20	MCS0	2	11	2462	26/8	8.80	9.20	12.01	30.00		-2.46	9.55		36.00		Pass	
HE20	MCS0	2	11	2462	52/40	11.80	12.30	15.07	30.00		-2.46	12.61		36.00		Pass	
HE20	MCS0	2	11	2462	106/54	15.00	15.20	18.11	30.00		-2.46	15.65		36.00		Pass	
HE40	MCS0	2	3	2422	Full	17.20	16.90	20.06	30.00		-2.46	17.60		36.00		Pass	
HE40	MCS0	2	3	2422	242/61	14.70	14.40	17.56	30.00		-2.46	15.10		36.00		Pass	
HE40	MCS0	2	6	2437	Full	17.10	17.20	20.16	30.00		-2.46	17.70		36.00		Pass	
HE40	MCS0	2	6	2437	242/61	13.90	14.10	17.01	30.00		-2.46	14.55		36.00		Pass	
HE40	MCS0	2	9	2452	Full	17.20	17.30	20.26	30.00		-2.46	17.80		36.00		Pass	
HE40	MCS0	2	9	2452	242/62	13.90	14.10	17.01	30.00		-2.46	14.55		36.00		Pass	

Note: Measured power (dBm) has offset with cable loss.

TEST RESULTS DATA
Peak Power Spectral Density

2.4GHz Band MIMO													
Mod.	Data Rate	Ntx	CH.	Freq. (MHz)	RU Config	Peak PSD (dBm/3kHz)			DG (dBi)		Peak PSD Limit (dBm/3kHz)		Pass/Fail
						Ant5	Ant7	Worse + 3.01	Ant5	Ant7	Ant5	Ant7	
HE20	MCS0	2	1	2412	Full	-7.53	-7.86	-4.52	0.49		8.00		Pass
HE20	MCS0	2	1	2412	26/0	-8.00	-8.27	-4.99	0.49		8.00		Pass
HE20	MCS0	2	1	2412	52/37	-7.92	-8.00	-4.91	0.49		8.00		Pass
HE20	MCS0	2	1	2412	106/53	-7.87	-7.93	-4.86	0.49		8.00		Pass
HE20	MCS0	2	6	2437	Full	-7.74	-8.20	-4.73	0.49		8.00		Pass
HE20	MCS0	2	6	2437	26/4	-7.97	-8.49	-4.96	0.49		8.00		Pass
HE20	MCS0	2	6	2437	52/39	-8.19	-8.28	-5.18	0.49		8.00		Pass
HE20	MCS0	2	6	2437	106/53	-7.88	-8.42	-4.87	0.49		8.00		Pass
HE20	MCS0	2	11	2462	Full	-8.00	-7.95	-4.94	0.49		8.00		Pass
HE20	MCS0	2	11	2462	26/8	-8.50	-8.04	-5.03	0.49		8.00		Pass
HE20	MCS0	2	11	2462	52/40	-8.73	-8.39	-5.38	0.49		8.00		Pass
HE20	MCS0	2	11	2462	106/54	-8.19	-7.99	-4.98	0.49		8.00		Pass
HE40	MCS0	2	3	2422	Full	-11.97	-12.54	-8.96	0.49		8.00		Pass
HE40	MCS0	2	3	2422	242/61	-12.30	-12.75	-9.29	0.49		8.00		Pass
HE40	MCS0	2	6	2437	Full	-12.11	-12.21	-9.10	0.49		8.00		Pass
HE40	MCS0	2	6	2437	242/61	-12.50	-12.45	-9.44	0.49		8.00		Pass
HE40	MCS0	2	9	2452	Full	-12.05	-11.89	-8.88	0.49		8.00		Pass
HE40	MCS0	2	9	2452	242/62	-12.35	-12.69	-9.34	0.49		8.00		Pass

Measured power density (dBm) has offset with cable loss.



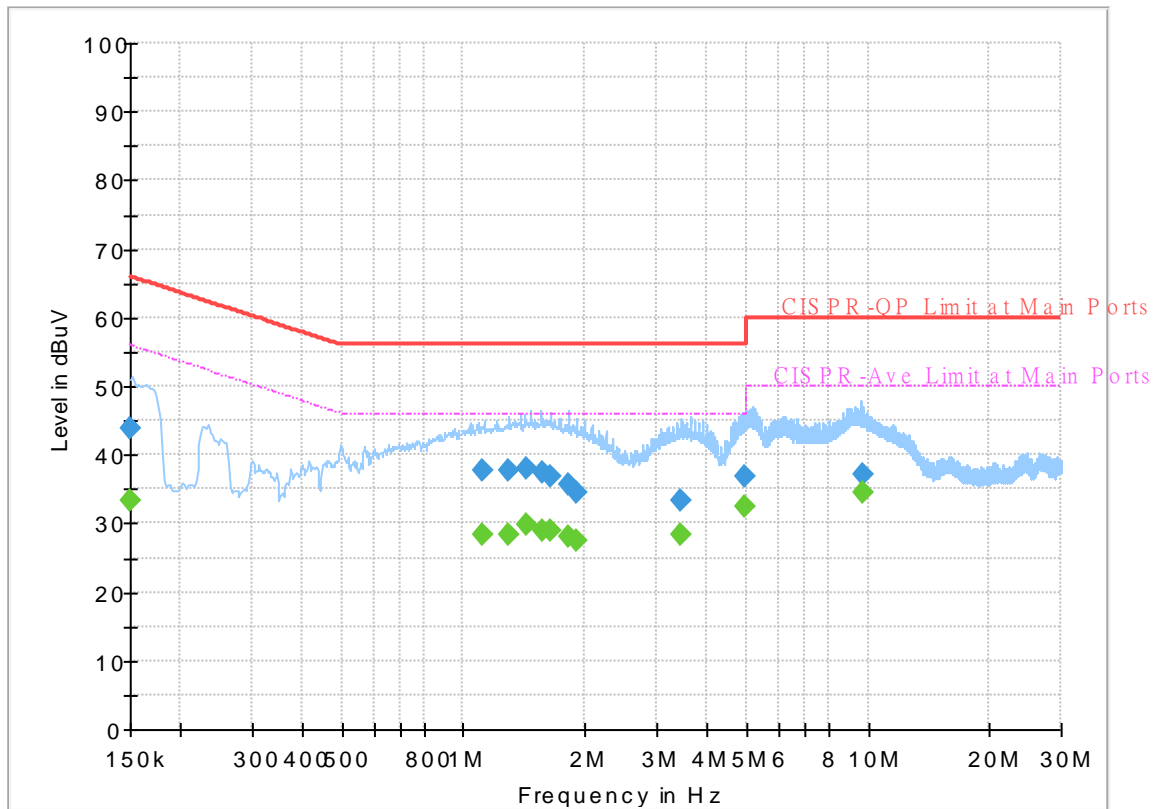
Appendix B. AC Conducted Emission Test Results

Test Engineer :	Howard Huang	Temperature :	23~26°C
		Relative Humidity :	40~50%

EUT Information

Report NO : 110703
 Test Mode : Mode 1
 Test Voltage : 120Vac/60Hz
 Phase : Line

Full Spectrum



Final_Result

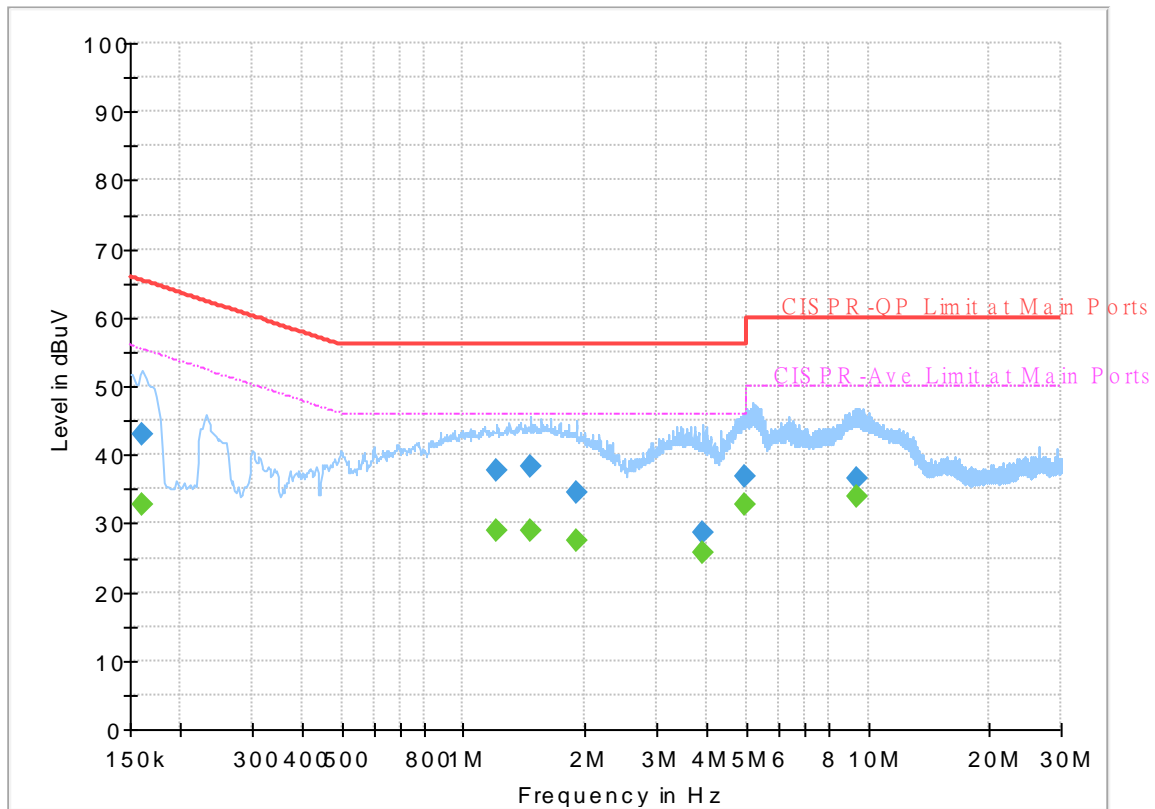
Frequency (MHz)	QuasiPeak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Line	Filter	Corr. (dB)
0.150203	---	33.37	55.99	22.62	L1	OFF	19.7
0.150203	43.96	---	65.99	22.03	L1	OFF	19.7
1.110750	---	28.35	46.00	17.65	L1	OFF	20.3
1.110750	37.61	---	56.00	18.39	L1	OFF	20.3
1.299300	---	28.41	46.00	17.59	L1	OFF	20.2
1.299300	37.79	---	56.00	18.21	L1	OFF	20.2
1.425750	---	29.84	46.00	16.16	L1	OFF	20.2
1.425750	38.15	---	56.00	17.85	L1	OFF	20.2
1.565340	---	29.09	46.00	16.91	L1	OFF	20.2
1.565340	37.35	---	56.00	18.65	L1	OFF	20.2
1.648500	---	28.94	46.00	17.06	L1	OFF	20.2
1.648500	36.86	---	56.00	19.14	L1	OFF	20.2
1.817250	---	28.17	46.00	17.83	L1	OFF	20.2
1.817250	35.62	---	56.00	20.38	L1	OFF	20.2
1.905000	---	27.51	46.00	18.49	L1	OFF	20.2
1.905000	34.47	---	56.00	21.53	L1	OFF	20.2
3.460200	---	28.46	46.00	17.54	L1	OFF	20.1
3.460200	33.32	---	56.00	22.68	L1	OFF	20.1
4.933500	---	32.49	46.00	13.51	L1	OFF	20.1
4.933500	36.86	---	56.00	19.14	L1	OFF	20.1
9.688380	---	34.60	50.00	15.40	L1	OFF	20.2

9.688380	37.24	---	60.00	22.76	L1	OFF	20.2
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EUT Information

Report NO : 110703
 Test Mode : Mode 1
 Test Voltage : 120Vac/60Hz
 Phase : Neutral

Full Spectrum



Final Result

Frequency (MHz)	QuasiPeak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Line	Filter	Corr. (dB)
0.161340	---	32.89	55.40	22.51	N	OFF	19.7
0.161340	43.11	---	65.40	22.29	N	OFF	19.7
1.208220	---	28.86	46.00	17.14	N	OFF	20.3
1.208220	37.86	---	56.00	18.14	N	OFF	20.3
1.466250	---	28.85	46.00	17.15	N	OFF	20.3
1.466250	38.26	---	56.00	17.74	N	OFF	20.3
1.911750	---	27.55	46.00	18.45	N	OFF	20.3
1.911750	34.48	---	56.00	21.52	N	OFF	20.3
3.887250	---	25.66	46.00	20.34	N	OFF	20.1
3.887250	28.65	---	56.00	27.35	N	OFF	20.1
4.933500	---	32.65	46.00	13.35	N	OFF	20.1
4.933500	36.96	---	56.00	19.04	N	OFF	20.1
9.431250	---	34.01	50.00	15.99	N	OFF	20.2
9.431250	36.60	---	60.00	23.40	N	OFF	20.2