Certificate #5505.02

TEST REPORT FOR WLAN TESTING

Report No.: SRTC2023-9004(F)-23062102 (F)

Product Name: WIFI/BT Module

Product ID: MWH623S

Applicant: Qingdao Intelligent & Precise Electronics Co., Ltd.

Manufacturer: Qingdao Intelligent & Precise Electronics Co., Ltd.

Specification: FCC Part 15 Subpart C (2022)

FCC ID: 2AJVQ-MWH623S

The State Radio_monitoring_center Testing Center (SRTC)

15th Building, No.30 Shixing Street, Shijingshan District, Beijing, P.R.China

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1. GENERAL INFORMATION

1.1 Notes of the test report

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1.2 Information about the testing laboratory

Company:	The State Radio_monitoring_center Testing Center (SRTC)
Test Site 1:	15th Building, No.30 Shixing Street, Shijingshan District
Test Site 2:	No.80, Zhaojiachang, Beizang, Daxing District
City:	Beijing
Country or Region:	P.R.China
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Designation Number:	CN1267
Registration number:	239125

1.3 Applicant's details

Company:	Qingdao Intelligent & Precise Electronics Co., Ltd.
Address:	No.218 Qianwangang Road, Qingdao Economic & Technological Development Zone, Qingdao City, Shandong Province, P. R. China

1.4 Manufacturer's details

Company:	Qingdao Intelligent & Precise Electronics Co., Ltd.
Address:	No.218 Qianwangang Road, Qingdao Economic & Technological Development Zone, Qingdao City, Shandong Province, P. R. China

1.5 Test Environment

Date of Receipt of test sample at SRTC:	2023-06-21
Testing Start Date:	2023-06-22
Testing End Date:	2023-07-11

Environmental Data:	Temperature (°C)	Humidity (%)
Ambient	25	40
Maximum Extreme	70	---
Minimum Extreme	-10	---

Normal Supply Voltage (V d.c.):	3.30
Maximum Extreme Supply Voltage (V d.c.):	3.60
Minimum Extreme Supply Voltage (V d.c.):	3.00

2 DESCRIPTION OF THE DEVICE UNDER TEST

2.1Final Equipment Build Status

Frequency Band:	2.412GHz~2.462GHz
Number of Channel For 20MHz:	11
Number of Channel For 40MHz:	7
Modulation Type:	802.11b 802.11g 802.11n (HT20/HT40) 11ax (HE20/HE40)
Power Supply:	DC supply
Software Revision:	NA
Hardware Revision:	V1.00
Directional gain	For power：3.93dBi(Uncorrelated) For PSD： 3.93dBi(Uncorrelated)
IMEI:	NA
Antenna type:	Refer to Note
Antenna connector:	Refer to Note

Note: Antenna requirement (FCC part 15.203)

An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can 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 antenna(s) of the EUT are permanently attached.

•There are no provisions for connection to an external antenna.

Note: The antenna provides to the EUT, please refer to the following table:

Brand	Model	Antenna gain	Frequency band	Antenna type	Connecter Type
N/A	N/A	ANT0：3.93dBi ANT1：3.93dBi	2.4GHz~2.4835GHz	Ipex pulled-out	N/A

NOTE1：The antenna gain is provided by the customer and involved in the calculation and influence of the test results. Our laboratory takes the value declared by the customer as the criterion, and the customer is responsible for the antenna gain value. Manufacturers ensure that their designs will not be modified by the user or third party's arbitrary antenna parameters and performance.

NOTE2： Refer to section F of 662911 D01, Categorization as Correlated or Completely Uncorrelated:

Correlated signals include, but are not limited to, signals transmitted in any of the following modes:

- *Any transmit beamforming mode*, whether fixed or adaptive (*e.g.*, phased array modes, closed loop MIMO modes, Transmitter Adaptive Antenna modes, Maximum Ratio Transmission (MRT) modes, and Statistical Eigen Beamforming (EBF) modes).
- *Cyclic Delay Diversity (CDD) modes, also known as Cyclic Shift Diversity (CSD)* (including modes for 802.11n and later devices to communicate with legacy 802.11 devices). In CDD modes, the same digital data is carried by each transmit antenna, but with different cyclic delays. The signals are highly correlated at any one frequency, though not necessarily at zero time delay. In particular, correlations tend to be high over the bandwidths specified for in-band PSD measurements in FCC rule parts that require reductions in PSD when directional gain exceeds a threshold.

Completely uncorrelated signals include those transmitted in the following modes, if they are not combined with any correlated modes, such as beamforming:

- Space Time Block Codes (STBC) or Space Time Codes (STC) for which different digital data is carried by each transmit antenna during any symbol period (*e.g.*, WiMAX Matrix A [Alamouti coding]).
- Spatial Multiplexing MIMO (SM-MIMO), for which independent data streams are sent to each transmit antenna (*e.g.*, WiMAX Matrix B). WiMAX Matrix C, which adds diversity, also produces uncorrelated transmit signals.

EUT is STBC MODE。the output signals are Uncorrelated。

For CDD transmissions directional gain is calculated as：

a) For power, the directional gain calculation is following.

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

b) For PSD, the directional gain calculation is following.

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

2.2 Description of Test Modes

11 channels are provided to this EUT:

CHANNEL	FREQ. (MHz)	CHANNEL	FREQ. (MHz)
1	2412	7	2442
2	2417	8	2447
3	2422	9	2452
4	2427	10	2457
5	2432	11	2462
6	2437	---	---

2.2.1 Test Mode Applicability and Tested Channel Detail

EUT CONFIGURE MODE	APPLICABLE TO				DESCRIPTION
	RE ≥ 1G	RE<1G	PLC	APCM	-
-	√	√	√	√	-

Where
RE ≥ 1G: Radiated Emission above 1GHz
RE<1G: Radiated Emission below 1GHz
PLC: Power Line Conducted Emission
APCM: Antenna Port Conducted Measurement

Radiated Emission Test (Above 1GHz):

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

Following channel(s) was (were) selected for the final test as listed below.

AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TYPE	DATA RATE (Mbps)
1 to 11	1,6,11	802.11b	1
1 to 11	1,6,11	802.11g	6
1 to 11	1,6,11	802.11n 20	MCS0
3 to 9	3,6,9	802.11n 40	MCS0

Radiated Emission Test (Below 1GHz):

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

Following channel(s) was (were) selected for the final test as listed below.

AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TYPE	DATA RATE (Mbps)
1 to 11	1,6,11	802.11b	1
1 to 11	1,6,11	802.11g	6
1 to 11	1,6,11	802.11n 20	MCS0
3 to 9	3,6,9	802.11n 40	MCS0

Power Line Conducted Emission Test:

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

Following channel(s) was (were) selected for the final test as listed below.

AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TYPE	DATA RATE (Mbps)
1 to 11	6	802.11b	1

Antenna Port Conducted Measurement:

This item includes all test value of each mode, but only includes spectrum plot of worst value of each mode.

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

Following channel(s) was (were) selected for the final test as listed below.

AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TYPE	DATA RATE (Mbps)
1 to 11	1,6,11	802.11b	1
1 to 11	1,6,11	802.11g	6
1 to 11	1,6,11	802.11n 20	MCS0
3 to 9	3,6,9	802.11n 40	MCS0

2.3 EUT Operating conditions

The software provided by client to enable the EUT under transmission condition continuously at lowest, middle and highest channel frequencies individually.

2.4 Support Equipment

The following support equipment was used to exercise the DUT during testing:
N/A

3 REFERENCE SPECIFICATION

Specification	Version	Title
FCC part15 Subpart C	2022	Intentional radiators
ANSI C63.10	2013	Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
KDB 558074D01 V05R02	April 2, 2019	Guidance for compliance measurements on Digital transmission system, frequency hopping spread spectrum system, and hybrid system devices operating under section 15.247 of the FCC rules

4 KEY TO NOTES AND RESULT CODES

Code	Meaning
PASS	Test result shows that the requirements of the relevant specification have been met.
FAIL	Test result shows that the requirements of the relevant specification have not been met.
N/T	Test case is not tested.

5 RESULT SUMMARY

No.	Test case	Reference	Verdict	Test Site
1	Transmitter Output Power	15.247(b)(3)	Pass	1
2	6dB Bandwidth	15.247(a)(2)	Pass	1
3	Transmitter Power Spectral Density	15.247(e)	Pass	1
4	Conducted Out of band emission measurement	15.247(d)	Pass	1
5	Band Edge	15.247(d)	Pass	1
6	Antenna requirement	15.203	Pass(refer to section 2.1)	1

Test Site 1: 15th Building, No.30 Shixing Street, Shijingshan District

This Test Report Is Approved by: Mr. Peng Zhen	Review by: Mr. Li Bin
Tested and Issued by: Mr. Du Wei	Approved date: 20230711

No.	Test case	Reference	Verdict	Test Site
7	Spurious Radiated Emissions	15.205/15.209	Pass	2
8	AC Power line Conducted Emission	15.207	Pass	2

Test Site 2: No.80, Zhaojiachang, Beizang, Daxing District

This Test Report Is Approved by: Mr. Liu Wei	Review by: Mr. Guo Yu
Tested and Issued by: Mr. Dong Qifeng	Approved date: 20230711

6 TEST RESULT

6.1 Peak Power Output

6.2.1 Test limit

Part15.247 (b) (3)
The maximum permissible conducted output power is 1 Watt.

6.2.2 Test Procedure Used

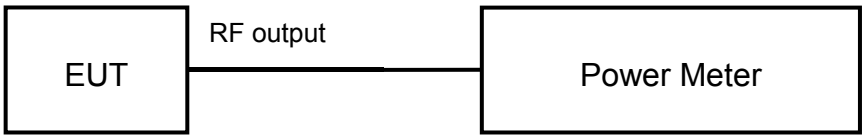
ANSI C63.10-2013 – Section 11.9.1.3
ANSI C63.10-2013 – Section 11.9.2.3.2
KDB 558074 D01 v05r02 – Section 8.3.1.3

6.2.3 Test Settings

Peak Power Measurement
The maximum peak conducted output power may be measured using a broadband peak RF power meter. The power meter shall have a video bandwidth that is greater than or equal to the DTS bandwidth and shall utilize a fast-responding diode detector.
Average Power Measurement
Average power measurements were performed only when the EUT was transmitting at its maximum power control level using a broadband power meter with a pulse sensor. The power meter implemented triggering and gating capabilities which were set up such that power measurements were recorded only during the ON time of the transmitter. The trace was averaged over 100 traces to obtain the final measured average power.

6.2.4 Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.



6.2.5 Test result

The test results are shown in Appendix A.

6.2 6dB Bandwidth

6.1.1 Test limit

Part15.247 (a) (2)
The minimum permissible 6dB bandwidth is 500 kHz

6.1.2 Test Procedure Used

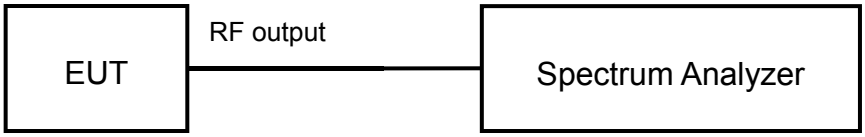
ANSI C63.10-2013 – Section 11.8.2 Option 2
KDB 558074 D01 v05r02 – Section 8.2

6.1.3 Test Settings

1. The signal analyzers' automatic bandwidth measurement capability of the spectrum analyzer was used to perform the 6dB bandwidth measurement. The "X" dB bandwidth parameter was set to X = 6. The bandwidth measurement was not influenced by any intermediate power nulls in the fundamental emission.
2. RBW = 100 kHz
3. VBW ≥ 3 x RBW
4. Detector = Peak
5. Trace mode = max hold
6. Sweep = auto couple
7. The trace was allowed to stabilize

6.1.4 Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.



6.1.5 Test result

The test results are shown in Appendix A.

6.3 Transmitter Power Spectral Density

6.3.1 Test limit

Part15.247 (e)
The maximum permissible power spectral density is 8.0dBm in any 3 kHz band.

6.3.2 Test Procedure Used

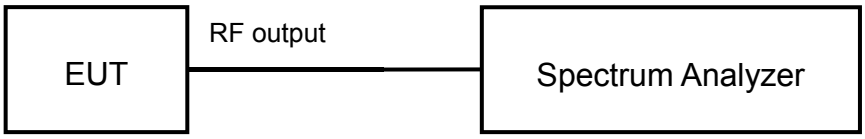
ANSI C63.10-2013 – Section 11.10.2 Method PKPSD
KDB 558074 D01 v05r02 – Section 8.4

6.3.3 Test Settings

1. Analyzer was set to the center frequency of the DTS channel under investigation
2. Span = 1.5 times the DTS channel bandwidth
3. RBW = 3 kHz
4. VBW = 10 kHz
5. Detector = peak
6. Sweep time = auto couple
7. Trace mode = max hold
8. Trace was allowed to stabilize

6.3.4 Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.



6.3.5 Test result

The test results are shown in Appendix A.

6.4 Conducted Out of band emission measurement

6.4.1 Test limit

Part 15.247(d): The limit for out-of-band spurious emissions at the band edge is 20dB below the fundamental emission level, as determined from the in-band power measurement of the DTS channel performed in a 100 kHz bandwidth.

6.4.2 Test Procedure Used

ANSI C63.10-2013 – Section 11.11.3
KDB 558074 D01 v05r02 – Section 8.5

6.4.3 Reference level measurement Settings

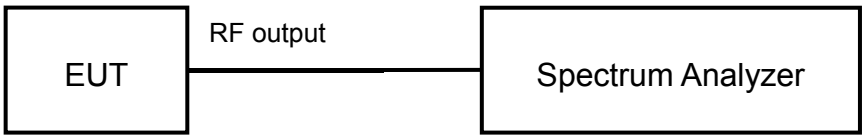
Establish a reference level by using the following procedure:
a) Set instrument center frequency to DTS channel center frequency.
b) Set the span to ≥ 1.5 MHz
c) Set the RBW = 100 kHz.
d) Set the VBW ≥ 300 kHz.
e) Detector = peak.
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum PSD level.

6.4.4 Test Settings

a) Set the center frequency and span to encompass frequency range to be measured.
b) Set the RBW = 100 kHz.
c) Set the VBW ≥ 300 kHz.
d) Detector = peak.
e) Set span to encompass the spectrum to be examined
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum amplitude level.

6.4.5 Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.



6.4.6 Test result

The spectrum plots are attached on the following pages. D1 line indicates the highest level, and D2 line indicates the 20dB offset below D1. It shows compliance with the requirement. The test results are shown in Appendix A.

6.5 Band-edge measurement

6.5.1 Test limit

Part 15.247(d): The limit for out-of-band spurious emissions at the band edge is 20dB below the fundamental emission level, as determined from the in-band power measurement of the DTS channel performed in a 100 kHz bandwidth.

6.5.2 Test Procedure Used

ANSI C63.10-2013 – Section 11.11.3
KDB 558074 D01 v05r02 – Section 8.7.2

6.5.3 Reference level measurement Settings

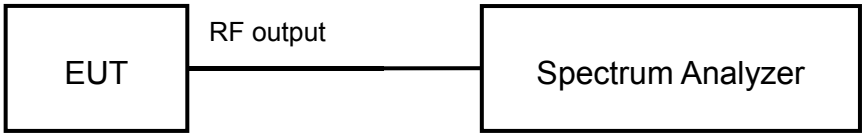
Establish a reference level by using the following procedure:
a) Set instrument center frequency to DTS channel center frequency.
b) Set the span to ≥ 1.5 MHz
c) Set the RBW = 100 kHz.
d) Set the VBW ≥ 300 kHz.
e) Detector = peak.
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum PSD level.

6.5.4 Test Settings

a) Set the center frequency and span to encompass frequency range to be measured.
b) Set the RBW = 100 kHz.
c) Set the VBW ≥ 300 kHz.
d) Detector = peak.
e) Set span to encompass the spectrum to be examined
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum amplitude level.

6.5.5 Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.



6.5.6 Test result

The spectrum plots are attached on the following pages. D1 line indicates the highest level, and D2 line indicates the 20dB offset below D1. It shows compliance with the requirement. The test results are shown in Appendix A.

6.6 Spurious Radiated Emissions

6.6.1 Test Description

All out of band radiated spurious emissions are measured with a spectrum analyzer connected to a receive antenna while the EUT is operating at maximum power and at the appropriate frequencies. Only the radiated emissions of the configuration that produced the worst case emissions are reported in this section.

6.6.2 Test limit

Part15.205, 15.209, 15.247(d)

All out of band emissions appearing in a restricted band as specified in Section 15.205 of the Title 47 CFR must not exceed the limits shown in below Table per Section 15.209. The spectrum shall be investigated from the lowest radio frequency signal generated in the device

Frequency [MHz]	Field strength [μV/m]	Measured 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

Radiated Limits

Part15.35(b):

There is also a limit on the radio frequency emissions, as measured using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit

Used conversion factor: Limit (dBμV/m) = 20 log (Limit (μV/m)/1μV/m)

Frequency [MHz]	Detector	Unit (dBμV/m)
30～88	Quasi-peak	40.0
88～216	Quasi-peak	43.5
216～960	Quasi-peak	46.0
960～1000	Quasi-peak	54.0
1000～5th harmonic of the highest frequency or 40GHz, whichever is lower	Average	54.0
	Peak	74.0

Conversion Radiated limits

6.6.3 Test Procedure Used

ANSI C63.10-2013

For Radiated emission below 30MHz

a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at chamber room. The table was rotated 360 degrees to determine the position of the highest radiation.
b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
c. Both X and Y axes of the antenna are set to make the measurement.
d. For each suspected emission, the EUT was arranged to its worst case and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
e. The test-receiver system was set to Quasi-Peak Detect Function and recorded the reading with Maximum Hold Mode.

NOTE:
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer complied the following setting:

Frequency	RBW
9-150kHz	200-300Hz
0.15-30MHz	9-10kHz

2. Signals below 30MHz are not recorded in the report because they are lower than the limits by more than 20dB.

For Radiated emission above 30MHz
a. The EUT was placed on the top of a rotating table 0.8 meters (for 30MHz ~ 1GHz) / 1.5 meters (for above 1GHz) above the ground in chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
c. The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
e. The test-receiver system was set to quasi-peak detect function and recorded the reading with Maximum Hold Mode when the test frequency is below 1 GHz.
f. The test-receiver system was set to peak and average detector and recorded the reading with Maximum Hold Mode when the test frequency is above 1 GHz. If the peak reading value also meets average limit, measurement with the average detector is unnecessary.

For the radiated emission test above 1GHz:

Place the measurement antenna away from each area of the EUT determined to be a source of emissions at the specified measurement distance, while keeping the measurement antenna aimed at the source of emissions at each frequency of significant emissions, with polarization oriented for maximum response. The measurement antenna may have to be higher or lower than the EUT, depending on the radiation pattern of the emission and staying aimed at the emission source for receiving the maximum signal. The final measurement antenna elevation shall be that which maximizes the emissions. The measurement antenna elevation for maximum emissions shall be restricted to a range of heights of from 1 m to 4 m above the ground or reference ground plane.

NOTE:
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz for Quasi-peak detection (QP) at frequency below 1GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Average detection (AV) at frequency above 1GHz. If duty cycle of test signal is < 98%, the duty factor need added to measured value.
4. All modes of operation were investigated and the worst-case emissions are reported.

6.6.4 Test Settings

Average Field Strength Measurements

Frequency	Detector
＜1000MHz	Quasi-peak
>1000MHz	Peak and average

Peak Field Strength Measurements

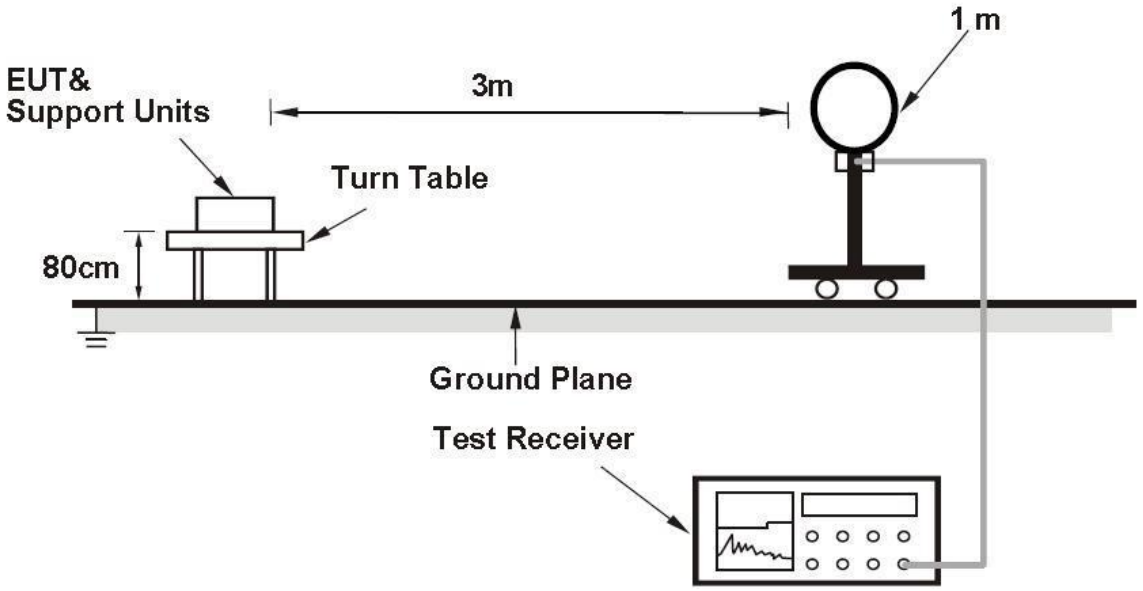
1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
2. RBW is set depending on measurement frequency, as specified in following table

Frequency	RBW
9-150kHz	200-300Hz
0.15-30MHz	9-10kHz
30-1000MHz	100-120kHz
>1000MHz	1MHz

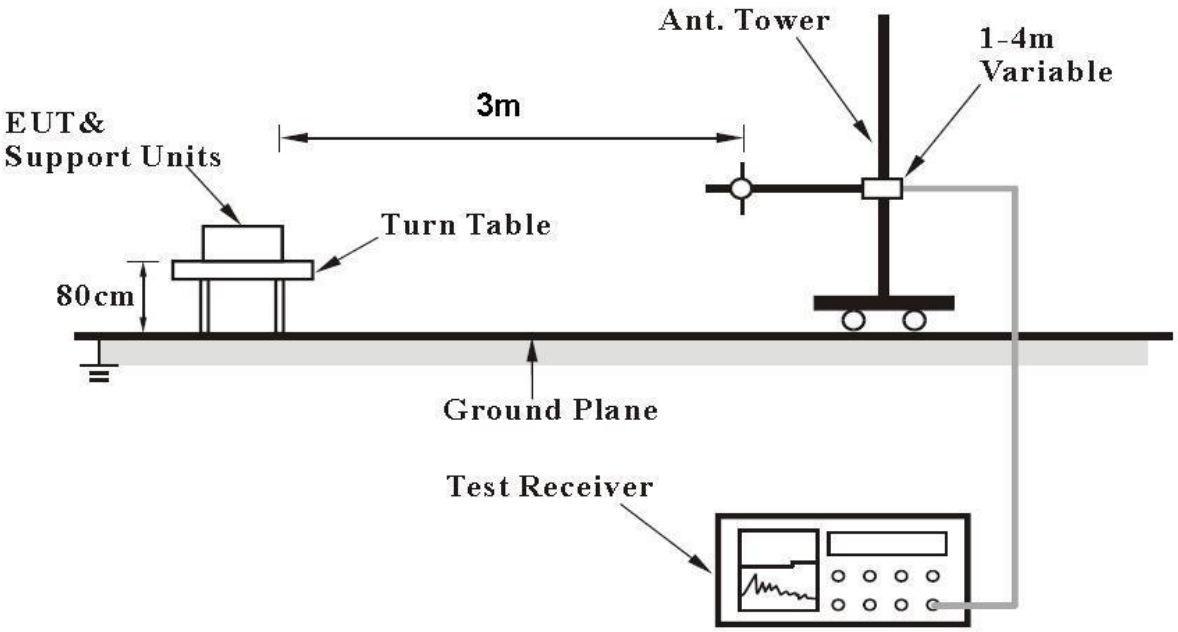
3. VBW = 3MHz
4. Detector = peak
5. Sweep time = auto couple
6. Trace mode = max hold
7. Trace was allowed to stabilize

6.6.5 Test Setup

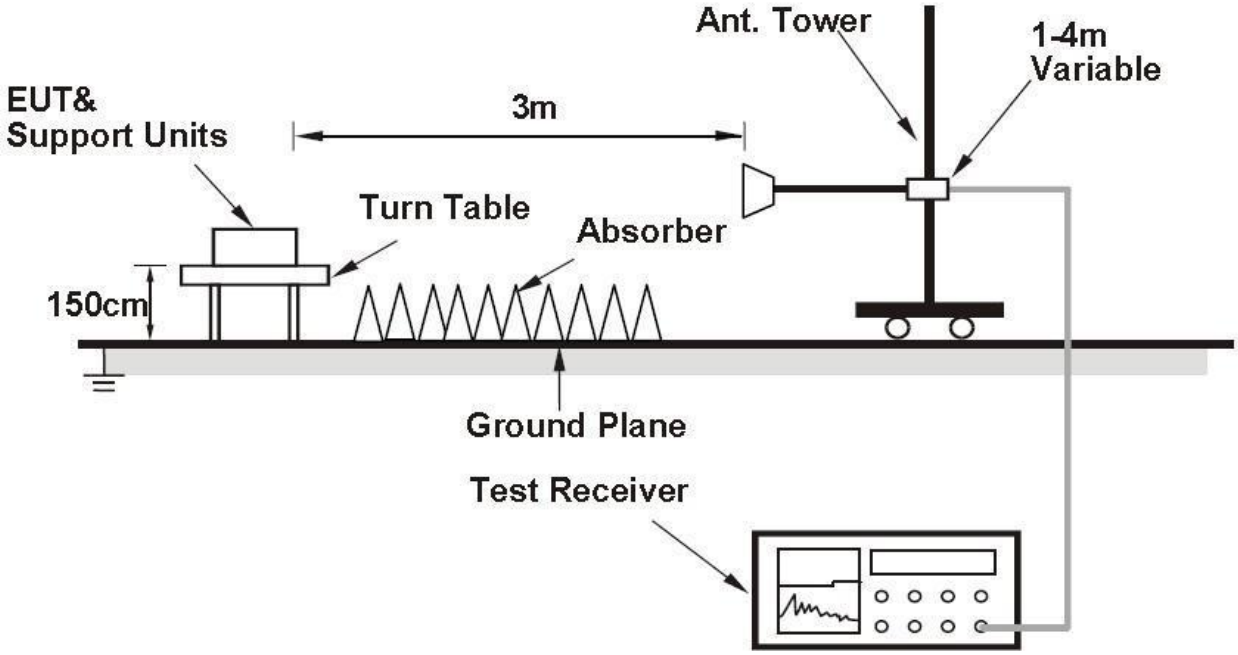
For Radiated emission below 30MHz



For Radiated emission 30MHz to 1GHz



For Radiated emission above 1GHz



6.6.6 Test result

The test results are shown in Appendix B.

6.7 AC Power line Conducted Emission

6.7.1 Test limit

FCC Part15.207

Frequency of Emission (MHz)	Conducted Limit (dBuV)	
	Quasi-peak	Average
0.15-0.5	66 to 56 *	56 to 46 *
0.5-5	56	46
5-30	60	50

* Decreases with the logarithm of the frequency.

The measurement is made according to ANSI C63.10-2013

6.7.2 Test Procedures

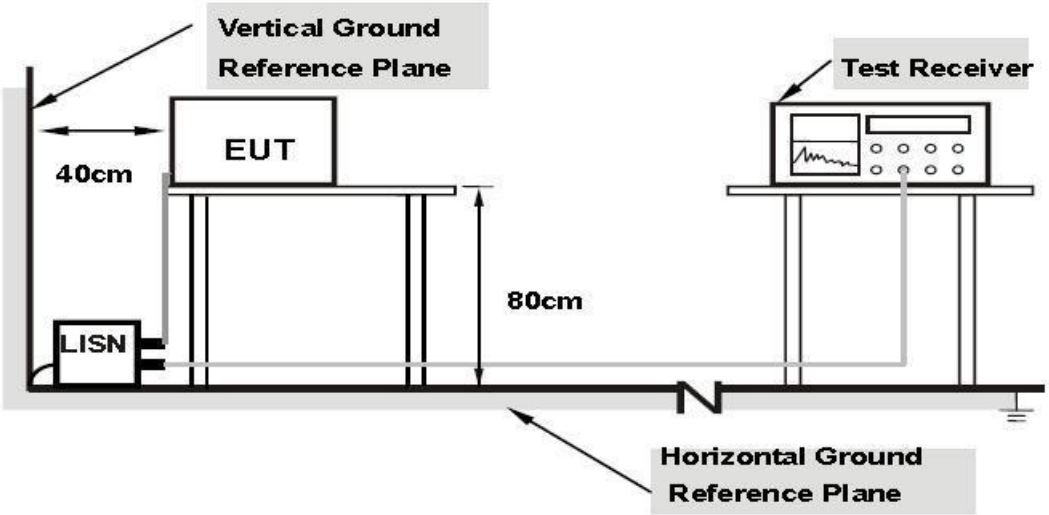
a. The EUT was placed 0.4 meters from the conducting wall of the shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). Other support units were connected to the power mains through another LISN. The two LISNs provide 50 ohm/ 50uH of coupling impedance for the measuring instrument.

b. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.

c. The frequency range from 150kHz to 30MHz was searched. Emission levels under (Limit -20dB) were not recorded.

NOTE: The resolution bandwidth and video bandwidth of test receiver is 9kHz for quasi-peak detection (QP) and average detection (AV) at frequency 0.15MHz-30MHz.
The EUT shall test under the power AC120V/240V/60Hz.

6.7.3 Test Setup



For the actual test configuration, please refer to the attached file (Test Setup Photo).

6.7.4 Test result

The test results are shown in Appendix B.

7 MEASUREMENT UNCERTAINTIES

Items	Uncertainty	
6dB Bandwidth	3kHz	
Peak power output	0.67dB	
Transmitter Power Spectral Density	0.75dB	
Band edge compliance	1.20dB	
Conducted Out of band emission measurement	30MHz～1GHz	2.83dB
	1GHz～12.75GHz	2.50dB
	12.75GHz～25GHz	2.75dB
Spurious Radiated Emissions	30MHz～200MHz	4.88dB
	200MHz～1GHz	4.87dB
	1GHz～18GHz	4.58dB
	18GHz~40GHz	4.35dB
AC Power line Conducted Emission	3.92dB	

8 TEST EQUIPMENTS

No.	Name/ Model	Manufacturer	S/N	Cal date	Cal Due date
1.	Spectrum Analyzer / FSV	ROHDE & SCHWARZ	101065	2023.06.21	2024.06.20
2.	Signal Analyzer / N9020A	Agilent	MY48010771	2023.03.06	2024.03.05
3.	Bluetooth Test Set / MT8852B	Anritsu	1329003	2023.06.21	2024.06.20
4.	Power Divider / 11667A	HP	19632	2023.06.21	2024.06.20
5.	Signal Generator / SMBV100A	R&S	260910	2023.06.21	2024.06.20
6.	Power Meter E4416A	Agilent	MY52370013	2023.03.06	2024.03.05
7.	Power Sensor E9323A	Agilent	MY52150008	2023.03.06	2024.03.05
8.	Temperature chamber / SH241	ESPEC	92013758	2023.06.21	2024.06.20
9.	Fully-Anechoic Chamber / 12.65m×8.03m×7.50m	FRANKONIA	-----	-----	-----
10.	Semi-Anechoic/Chamber / 23.18m×16.88m×9.60m	FRANKONIA	---	-----	-----
11.	Turn table Diameter:1m	FRANKONIA	-----	-----	-----
12.	Turn table Diameter:5m	FRANKONIA	-----	-----	-----
13.	Antenna master FAC(MA4.0)	MATURO	-----	-----	-----
14.	Antenna master SAC(MA4.0)	MATURO	-----	-----	-----
15.	Shielding room / 9.080m×5.255m×3.525m	FRANKONIA	-----	-----	-----
16.	Double-Ridged Waveguide Horn Antenna / HF 907	R&S	100512	2023.06.21	2024.06.20
17.	Double-Ridged Waveguide Horn Antenna / HF 907	R&S	100513	2023.06.21	2024.06.20
18.	Ultra log antenna / HL562	R&S	100016	2023.06.21	2024.06.20
19.	Receive antenna /3160-09	SCHWARZ-BECK	002058-002	2023.06.21	2024.06.20
20.	EMI test receiver / ESI 40	R&S	100015	2023.06.21	2024.06.20
21.	EMI test receiver / ESCS30	R&S	100029	2023.06.21	2024.06.20
22.	Receive antenna / HL562	R&S	100167	2023.06.21	2024.06.20
23.	AMN / ENV216	R&S	3560.6550.12	2023.06.21	2024.06.20
24.	WLAN AP WIA3300-20	SKSpruce	8152017060700339	---	---
25.	Notebook E470c	Lenovo	PF10UZW7	---	---
26.	Loop Antenna	R&S	100340	2022.08.21	2023.08.20
27.	FCC auto test system / RT9200BW-2	Radiosky	V2.05	/	/
28.	EMI test software / EMC32	R&S	V10.20.01	/	/

APPENDIX A – TEST DATA OF CONDUCTED EMISSION

Offset 1.2dB = Temporary antenna connector loss 0.2dB+ Cable loss 1.0dB

Duty Cycle

Modulation Type	Frequency (MHz)	Antenna	Plot	Duty Cycle	Correction Factor(dB)
802.11b	2412	Chain0	Fig.1	99.95%	0
802.11b	2412	Chain1	Fig.2	99.94%	0
802.11g	2412	Chain0	Fig.3	99.62%	0
802.11g	2412	Chain1	Fig.4	99.62%	0
802.11n HT20	2412	Chain0	Fig.5	99.57%	0
802.11n HT20	2412	Chain1	Fig.6	99.63%	0
802.11ax HE20	2412	Chain0	Fig.7	99.07%	0
802.11ax HE20	2412	Chain1	Fig.8	99.03%	0
802.11n HT40	2422	Chain0	Fig.9	99.38%	0
802.11n HT40	2422	Chain1	Fig.10	99.38%	0
802.11ax HE40	2422	Chain0	Fig.11	75.48%	1.22
802.11ax HE40	2422	Chain1	Fig.12	76.24%	1.18

Note: Correction Factor=10*log (1/Duty Cycle)

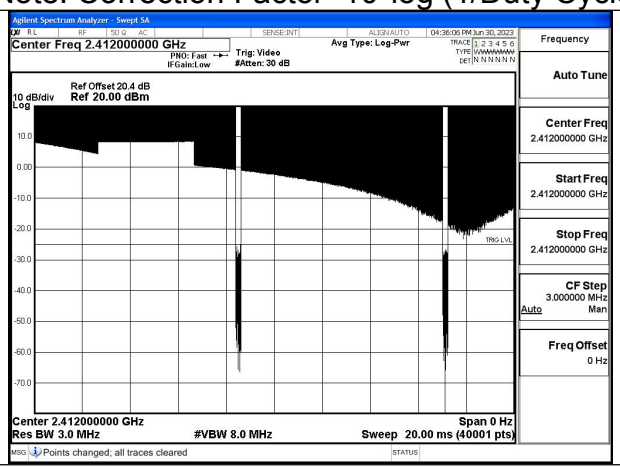


Fig.1

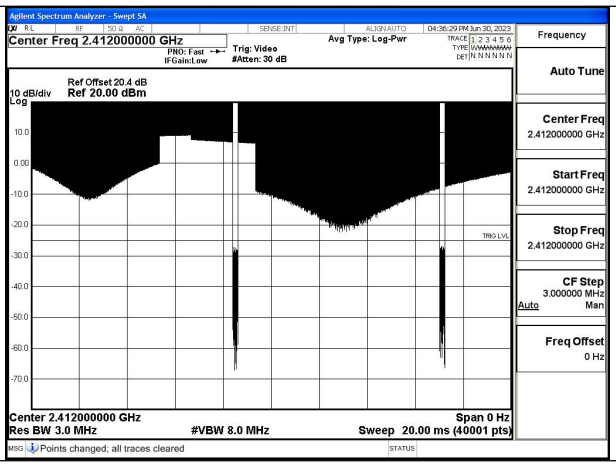


Fig.2

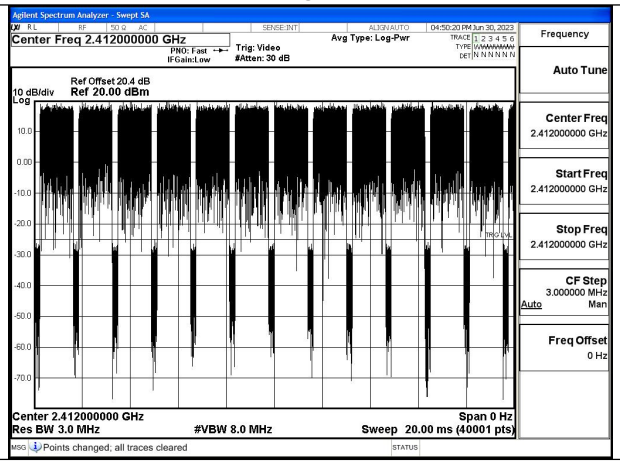


Fig.3

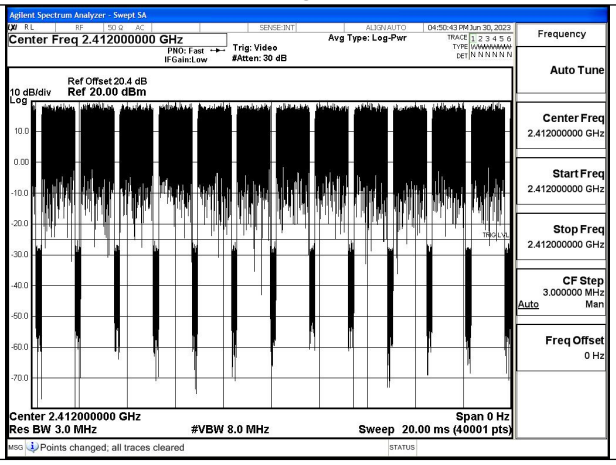


Fig.4

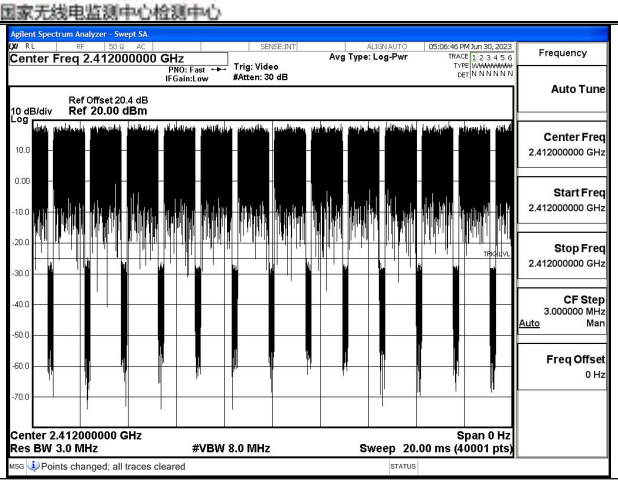


Fig.5

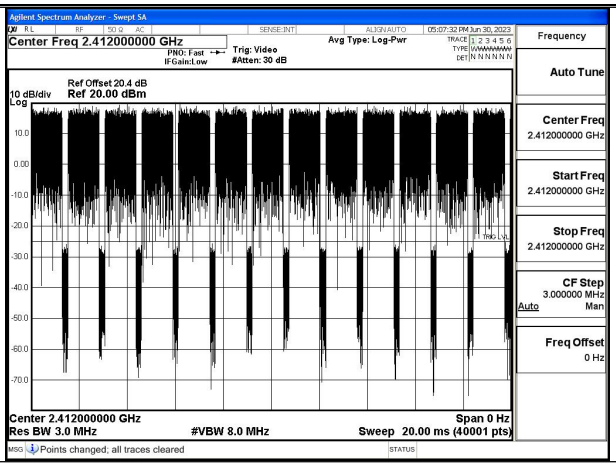


Fig.6

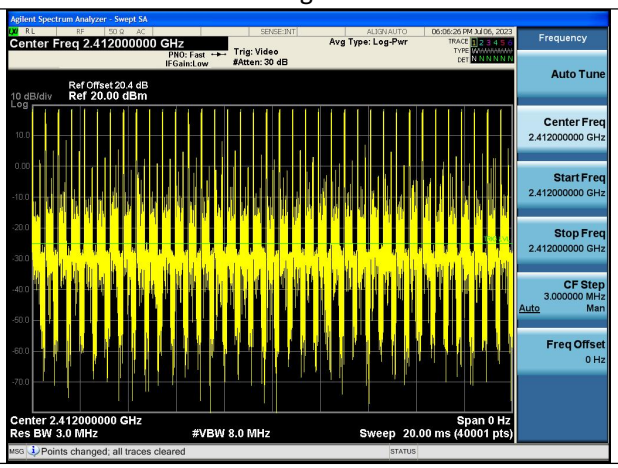


Fig.7

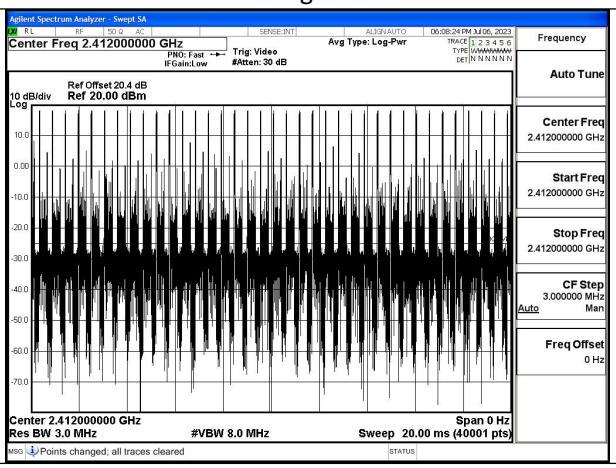


Fig.8

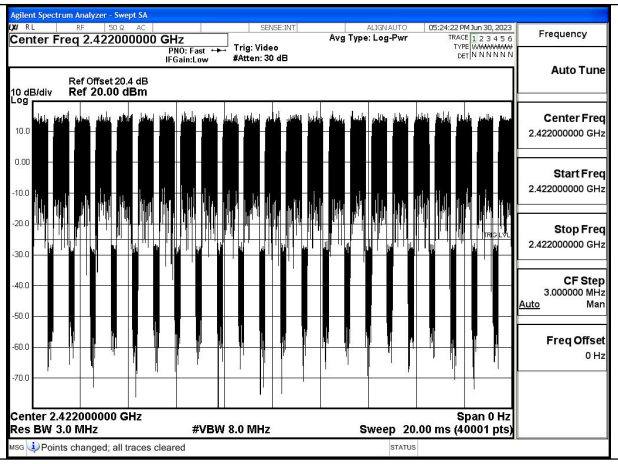


Fig.9

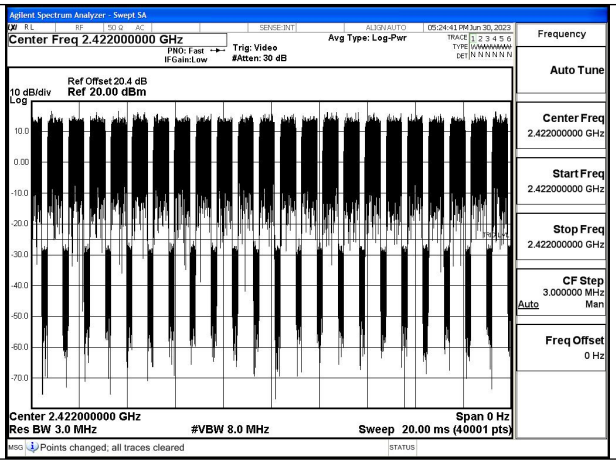
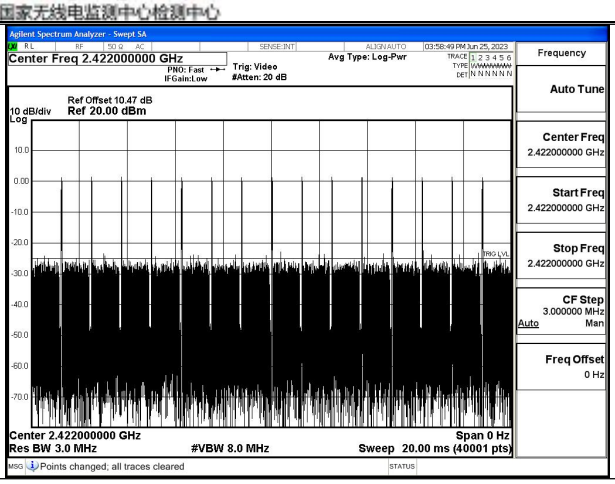


Fig.10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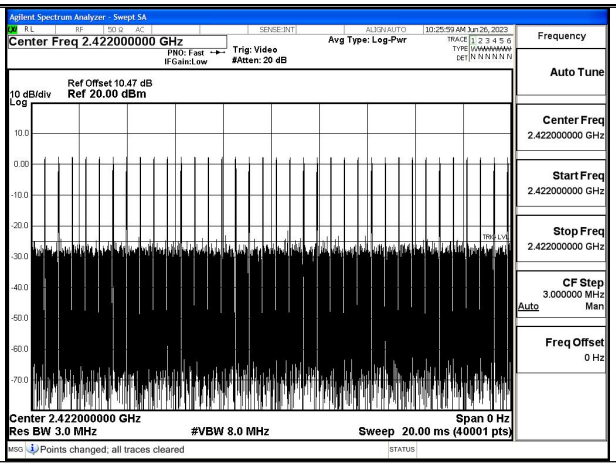
Center Freq 2.422000000 GHz
PNO: Fast
IFGain:Low
Trig: Video
#Atten: 20 dB
Avg Type: Log-Pwr
03:58:49 PM Jun 25, 2023
Ref Offset 10.47 dB
10 dB/div Ref 20.00 dBm
Log
Center 2.422000000 GHz
Res BW 3.0 MHz
#VBW 8.0 MHz
Span 0 Hz
Sweep 20.00 ms (40001 pts)
Frequency
Auto Tune
Center Freq 2.422000000 GHz
Start Freq 2.422000000 GHz
Stop Freq 2.422000000 GHz
CF Step 3.000000 MHz
Auto Man
Freq Offset 0 Hz
Points changed; all traces cleared

Fig.11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Center Freq 2.422000000 GHz
PNO: Fast
IFGain:Low
Trig: Video
#Atten: 20 dB
Avg Type: Log-Pwr
10:25:59 AM Jun 26, 2023
Ref Offset 10.47 dB
10 dB/div Ref 20.00 dBm
Log
Center 2.422000000 GHz
Res BW 3.0 MHz
#VBW 8.0 MHz
Span 0 Hz
Sweep 20.00 ms (40001 pts)
Frequency
Auto Tune
Center Freq 2.422000000 GHz
Start Freq 2.422000000 GHz
Stop Freq 2.422000000 GHz
CF Step 3.000000 MHz
Auto Man
Freq Offset 0 Hz
Points changed; all traces cleared

Fig.12

Conducted power

Test Mode	Tones/ RU Index	Frequency (MHz)	Antenna	Peak power output (dBm)	Average power output (dBm)
802.11b	NA	2412	Chain0	21.39	18.31
802.11b	NA	2412	Chain1	21.39	18.32
802.11b	NA	2437	Chain0	20.75	17.54
802.11b	NA	2437	Chain1	20.97	17.62
802.11b	NA	2462	Chain0	21.90	18.80
802.11b	NA	2462	Chain1	21.83	18.75
802.11g	NA	2412	Chain0	25.92	16.85
802.11g	NA	2412	Chain1	25.78	16.73
802.11g	NA	2437	Chain0	25.89	16.84
802.11g	NA	2437	Chain1	25.83	16.81
802.11g	NA	2462	Chain0	26.20	17.14
802.11g	NA	2462	Chain1	26.18	17.13
802.11n HT20	NA	2412	Chain0	25.12	16.10
802.11n HT20	NA	2412	Chain1	25.08	16.05
802.11n HT20	NA	2412	MIMO	28.11	19.09
802.11n HT20	NA	2437	Chain0	25.22	16.18
802.11n HT20	NA	2437	Chain1	25.18	16.16
802.11n HT20	NA	2437	MIMO	28.21	19.18
802.11n HT20	NA	2462	Chain0	25.47	16.43
802.11n HT20	NA	2462	Chain1	25.42	16.42
802.11n HT20	NA	2462	MIMO	28.46	19.44
802.11n HT40	NA	2422	Chain0	25.17	15.46
802.11n HT40	NA	2422	Chain1	25.10	15.42
802.11n HT40	NA	2422	MIMO	28.15	18.45
802.11n HT40	NA	2437	Chain0	25.21	15.51
802.11n HT40	NA	2437	Chain1	25.17	15.49
802.11n HT40	NA	2437	MIMO	28.20	18.51
802.11n HT40	NA	2452	Chain0	25.38	15.67
802.11n HT40	NA	2452	Chain1	25.35	15.63
802.11n HT40	NA	2452	MIMO	28.38	18.66

Test Mode	Tones/ RU Index	Frequency (MHz)	Antenna	Peak power output (dBm)	Average power output (dBm)
802.11ax HE20	26T+0	2412	Chain0	26.87	16.37
802.11ax HE20	26T+0	2412	Chain1	26.58	16.07
802.11ax HE20	26T+0	2412	MIMO	29.74	19.23
802.11ax HE20	26T+0	2437	Chain0	26.43	15.95
802.11ax HE20	26T+0	2437	Chain1	26.09	15.60
802.11ax HE20	26T+0	2437	MIMO	29.27	18.79
802.11ax HE20	26T+0	2462	Chain0	25.98	15.46
802.11ax HE20	26T+0	2462	Chain1	25.89	15.38
802.11ax HE20	26T+0	2462	MIMO	28.95	18.43

802.11ax HE20	26T+4	2412	Chain0	26.63	16.02
802.11ax HE20	26T+4	2412	Chain1	26.39	15.82
802.11ax HE20	26T+4	2412	MIMO	29.52	18.93
802.11ax HE20	26T+4	2437	Chain0	25.99	15.45
802.11ax HE20	26T+4	2437	Chain1	25.94	15.44
802.11ax HE20	26T+4	2437	MIMO	28.98	18.46
802.11ax HE20	26T+4	2462	Chain0	25.92	15.35
802.11ax HE20	26T+4	2462	Chain1	25.83	15.28
802.11ax HE20	26T+4	2462	MIMO	28.89	18.33
802.11ax HE20	26T+8	2412	Chain0	26.80	16.12
802.11ax HE20	26T+8	2412	Chain1	26.61	16.00
802.11ax HE20	26T+8	2412	MIMO	29.72	19.07
802.11ax HE20	26T+8	2437	Chain0	26.52	15.93
802.11ax HE20	26T+8	2437	Chain1	26.39	15.80
802.11ax HE20	26T+8	2437	MIMO	29.47	18.88
802.11ax HE20	26T+8	2462	Chain0	26.22	15.73
802.11ax HE20	26T+8	2462	Chain1	25.98	15.41
802.11ax HE20	26T+8	2462	MIMO	29.11	18.58
802.11ax HE20	52T+37	2412	Chain0	27.23	15.91
802.11ax HE20	52T+37	2412	Chain1	27.11	15.85
802.11ax HE20	52T+37	2412	MIMO	30.18	18.89
802.11ax HE20	52T+37	2437	Chain0	26.75	15.49
802.11ax HE20	52T+37	2437	Chain1	26.53	15.25
802.11ax HE20	52T+37	2437	MIMO	29.65	18.38
802.11ax HE20	52T+37	2462	Chain0	26.38	15.05
802.11ax HE20	52T+37	2462	Chain1	26.28	14.96
802.11ax HE20	52T+37	2462	MIMO	29.34	18.02
802.11ax HE20	52T+39	2412	Chain0	26.94	15.78
802.11ax HE20	52T+39	2412	Chain1	26.82	15.66
802.11ax HE20	52T+39	2412	MIMO	29.89	18.73
802.11ax HE20	52T+39	2437	Chain0	26.54	15.30
802.11ax HE20	52T+39	2437	Chain1	26.38	15.19
802.11ax HE20	52T+39	2437	MIMO	29.47	18.26
802.11ax HE20	52T+39	2462	Chain0	26.24	15.07
802.11ax HE20	52T+39	2462	Chain1	26.15	14.96
802.11ax HE20	52T+39	2462	MIMO	29.21	18.03
802.11ax HE20	52T+40	2412	Chain0	22.24	7.29
802.11ax HE20	52T+40	2412	Chain1	22.30	7.39
802.11ax HE20	52T+40	2412	MIMO	25.28	10.35
802.11ax HE20	52T+40	2437	Chain0	22.08	6.90
802.11ax HE20	52T+40	2437	Chain1	22.12	7.00
802.11ax HE20	52T+40	2437	MIMO	25.11	9.96
802.11ax HE20	52T+40	2462	Chain0	22.14	7.16
802.11ax HE20	52T+40	2462	Chain1	22.25	7.19
802.11ax HE20	52T+40	2462	MIMO	25.21	10.19

802.11ax HE20	106T+53	2412	Chain0	22.19	7.32
802.11ax HE20	106T+53	2412	Chain1	22.19	7.94
802.11ax HE20	106T+53	2412	MIMO	25.20	10.65
802.11ax HE20	106T+53	2437	Chain0	22.28	7.34
802.11ax HE20	106T+53	2437	Chain1	22.30	7.36
802.11ax HE20	106T+53	2437	MIMO	25.30	10.36
802.11ax HE20	106T+53	2462	Chain0	22.48	7.45
802.11ax HE20	106T+53	2462	Chain1	22.51	7.49
802.11ax HE20	106T+53	2462	MIMO	25.51	10.48
802.11ax HE20	106T+54	2412	Chain0	22.87	7.79
802.11ax HE20	106T+54	2412	Chain1	22.86	7.77
802.11ax HE20	106T+54	2412	MIMO	25.88	10.79
802.11ax HE20	106T+54	2437	Chain0	22.27	7.25
802.11ax HE20	106T+54	2437	Chain1	22.32	7.20
802.11ax HE20	106T+54	2437	MIMO	25.31	10.24
802.11ax HE20	106T+54	2462	Chain0	22.47	7.41
802.11ax HE20	106T+54	2462	Chain1	22.53	7.46
802.11ax HE20	106T+54	2462	MIMO	25.51	10.45
802.11ax HE20	242T+61	2412	Chain0	20.92	7.08
802.11ax HE20	242T+61	2412	Chain1	21.56	7.08
802.11ax HE20	242T+61	2412	MIMO	24.26	10.09
802.11ax HE20	242T+61	2437	Chain0	21.28	6.81
802.11ax HE20	242T+61	2437	Chain1	21.24	6.81
802.11ax HE20	242T+61	2437	MIMO	24.27	9.82
802.11ax HE20	242T+61	2462	Chain0	21.35	6.94
802.11ax HE20	242T+61	2462	Chain1	21.38	6.95
802.11ax HE20	242T+61	2462	MIMO	24.38	9.96
802.11ax HE40	26T+0	2422	Chain0	20.98	11.49
802.11ax HE40	26T+0	2422	Chain1	21.19	11.76
802.11ax HE40	26T+0	2422	MIMO	24.10	14.64
802.11ax HE40	26T+0	2437	Chain0	20.76	11.32
802.11ax HE40	26T+0	2437	Chain1	20.85	11.51
802.11ax HE40	26T+0	2437	MIMO	23.82	14.43
802.11ax HE40	26T+0	2452	Chain0	20.72	11.29
802.11ax HE40	26T+0	2452	Chain1	21.11	11.78
802.11ax HE40	26T+0	2452	MIMO	23.93	14.55
802.11ax HE40	26T+10	2422	Chain0	21.10	11.59
802.11ax HE40	26T+10	2422	Chain1	21.22	11.77
802.11ax HE40	26T+10	2422	MIMO	24.17	14.69
802.11ax HE40	26T+10	2437	Chain0	20.90	11.34
802.11ax HE40	26T+10	2437	Chain1	21.32	11.85
802.11ax HE40	26T+10	2437	MIMO	24.13	14.61
802.11ax HE40	26T+10	2452	Chain0	21.30	11.73
802.11ax HE40	26T+10	2452	Chain1	21.25	11.88
802.11ax HE40	26T+10	2452	MIMO	24.29	14.82

802.11ax HE40	26T+17	2422	Chain0	20.78	11.40
802.11ax HE40	26T+17	2422	Chain1	20.93	11.44
802.11ax HE40	26T+17	2422	MIMO	23.87	14.43
802.11ax HE40	26T+17	2437	Chain0	20.82	11.51
802.11ax HE40	26T+17	2437	Chain1	21.09	11.63
802.11ax HE40	26T+17	2437	MIMO	23.97	14.58
802.11ax HE40	26T+17	2452	Chain0	21.12	11.67
802.11ax HE40	26T+17	2452	Chain1	21.18	11.67
802.11ax HE40	26T+17	2452	MIMO	24.16	14.68
802.11ax HE40	52T+37	2422	Chain0	21.79	11.82
802.11ax HE40	52T+37	2422	Chain1	21.88	11.82
802.11ax HE40	52T+37	2422	MIMO	24.85	14.83
802.11ax HE40	52T+37	2437	Chain0	21.74	11.70
802.11ax HE40	52T+37	2437	Chain1	21.80	11.77
802.11ax HE40	52T+37	2437	MIMO	24.78	14.75
802.11ax HE40	52T+37	2452	Chain0	21.51	11.60
802.11ax HE40	52T+37	2452	Chain1	21.74	11.76
802.11ax HE40	52T+37	2452	MIMO	24.64	14.69
802.11ax HE40	52T+41	2422	Chain0	21.47	11.52
802.11ax HE40	52T+41	2422	Chain1	21.76	11.59
802.11ax HE40	52T+41	2422	MIMO	24.63	14.57
802.11ax HE40	52T+41	2437	Chain0	21.45	11.17
802.11ax HE40	52T+41	2437	Chain1	21.82	11.67
802.11ax HE40	52T+41	2437	MIMO	24.65	14.44
802.11ax HE40	52T+41	2452	Chain0	21.61	11.55
802.11ax HE40	52T+41	2452	Chain1	22.07	11.96
802.11ax HE40	52T+41	2452	MIMO	24.86	14.77
802.11ax HE40	52T+44	2422	Chain0	21.81	11.72
802.11ax HE40	52T+44	2422	Chain1	21.88	11.73
802.11ax HE40	52T+44	2422	MIMO	24.86	14.74
802.11ax HE40	52T+44	2437	Chain0	21.83	11.84
802.11ax HE40	52T+44	2437	Chain1	21.89	11.79
802.11ax HE40	52T+44	2437	MIMO	24.87	14.83
802.11ax HE40	52T+44	2452	Chain0	21.90	11.81
802.11ax HE40	52T+44	2452	Chain1	21.98	11.83
802.11ax HE40	52T+44	2452	MIMO	24.95	14.83
802.11ax HE40	106T+53	2422	Chain0	22.13	11.87
802.11ax HE40	106T+53	2422	Chain1	22.18	11.66
802.11ax HE40	106T+53	2422	MIMO	25.17	14.78
802.11ax HE40	106T+53	2437	Chain0	21.81	11.64
802.11ax HE40	106T+53	2437	Chain1	22.03	11.58
802.11ax HE40	106T+53	2437	MIMO	24.93	14.62
802.11ax HE40	106T+53	2452	Chain0	21.71	11.52
802.11ax HE40	106T+53	2452	Chain1	22.28	11.86
802.11ax HE40	106T+53	2452	MIMO	25.01	14.70

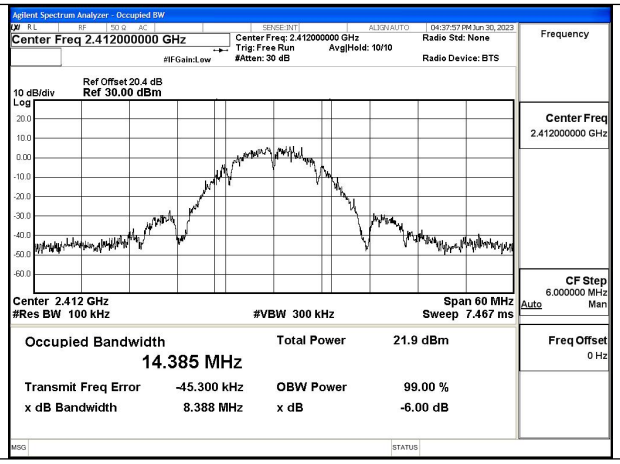
802.11ax HE40	106T+55	2422	Chain0	21.89	11.68
802.11ax HE40	106T+55	2422	Chain1	21.90	11.45
802.11ax HE40	106T+55	2422	MIMO	24.91	14.58
802.11ax HE40	106T+55	2437	Chain0	21.56	11.46
802.11ax HE40	106T+55	2437	Chain1	21.93	11.49
802.11ax HE40	106T+55	2437	MIMO	24.76	14.49
802.11ax HE40	106T+55	2452	Chain0	22.01	11.77
802.11ax HE40	106T+55	2452	Chain1	22.21	11.74
802.11ax HE40	106T+55	2452	MIMO	25.12	14.77
802.11ax HE40	106T+56	2422	Chain0	21.66	11.63
802.11ax HE40	106T+56	2422	Chain1	22.25	11.91
802.11ax HE40	106T+56	2422	MIMO	24.98	14.78
802.11ax HE40	106T+56	2437	Chain0	21.78	11.70
802.11ax HE40	106T+56	2437	Chain1	22.09	11.82
802.11ax HE40	106T+56	2437	MIMO	24.95	14.77
802.11ax HE40	106T+56	2452	Chain0	22.20	11.97
802.11ax HE40	106T+56	2452	Chain1	22.25	11.88
802.11ax HE40	106T+56	2452	MIMO	25.24	14.94
802.11ax HE40	242T+61	2422	Chain0	21.55	11.71
802.11ax HE40	242T+61	2422	Chain1	21.77	11.90
802.11ax HE40	242T+61	2422	MIMO	24.67	14.82
802.11ax HE40	242T+61	2437	Chain0	21.40	11.50
802.11ax HE40	242T+61	2437	Chain1	21.52	11.78
802.11ax HE40	242T+61	2437	MIMO	24.47	14.65
802.11ax HE40	242T+61	2452	Chain0	21.23	11.35
802.11ax HE40	242T+61	2452	Chain1	21.75	11.95
802.11ax HE40	242T+61	2452	MIMO	24.51	14.67
802.11ax HE40	242T+62	2422	Chain0	21.33	11.46
802.11ax HE40	242T+62	2422	Chain1	21.58	11.79
802.11ax HE40	242T+62	2422	MIMO	24.47	14.64
802.11ax HE40	242T+62	2437	Chain0	21.24	11.36
802.11ax HE40	242T+62	2437	Chain1	21.82	11.91
802.11ax HE40	242T+62	2437	MIMO	24.55	14.65
802.11ax HE40	242T+62	2452	Chain0	21.52	11.73
802.11ax HE40	242T+62	2452	Chain1	21.90	11.95
802.11ax HE40	242T+62	2452	MIMO	24.72	14.85
802.11ax HE40	484T+65	2422	Chain0	21.84	11.79
802.11ax HE40	484T+65	2422	Chain1	21.72	11.65
802.11ax HE40	484T+65	2422	MIMO	24.79	14.73
802.11ax HE40	484T+65	2437	Chain0	21.63	11.56
802.11ax HE40	484T+65	2437	Chain1	21.70	11.57
802.11ax HE40	484T+65	2437	MIMO	24.68	14.58
802.11ax HE40	484T+65	2452	Chain0	21.70	11.64
802.11ax HE40	484T+65	2452	Chain1	21.45	11.38
802.11ax HE40	484T+65	2452	MIMO	24.59	14.52

6dB Bandwidth

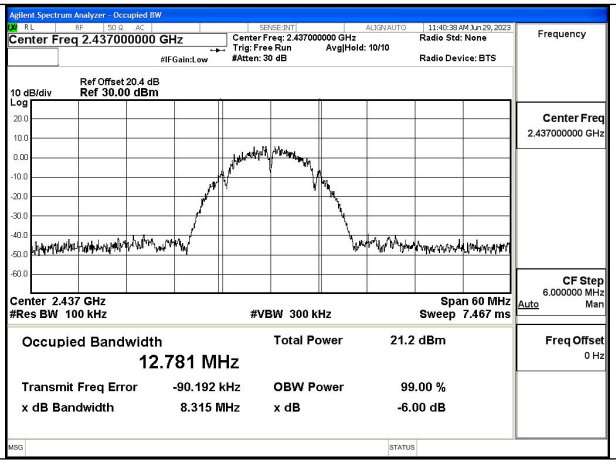
Test Mode	Antenna	6 dB bandwidth (MHz)		
		Channel No.1	Channel No.6	Channel No.11
		2412MHz	2437MHz	2462MHz
802.11b	Chain0	8.39	8.31	8.43
802.11b	Chain1	7.68	6.75	9.57
802.11g	Chain0	16.31	16.39	16.42
802.11g	Chain1	16.04	16.42	16.36
802.11n HT20	Chain0	17.68	17.66	17.67
802.11n HT20	Chain1	13.21	16.37	17.29
802.11ax HE20	Chain0	17.45	15.98	16.95
802.11ax HE20	Chain1	17.43	18.51	18.53

Test Mode	Antenna	6 dB bandwidth (MHz)		
		Channel No.3	Channel No.6	Channel No.9
		2422MHz	2437MHz	2452MHz
802.11n HT40	Chain0	33.23	35.03	34.86
802.11n HT40	Chain1	32.66	32.46	31.01
802.11ax HE40	Chain0	36.82	36.96	37.29
802.11ax HE40	Chain1	35.20	34.45	35.20

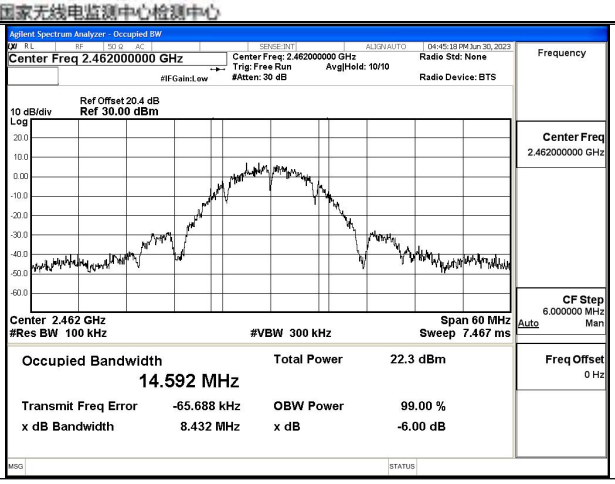
Test Mode: 802.11b



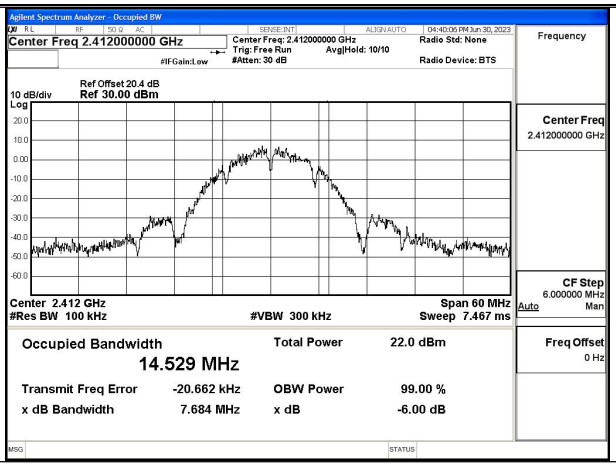
Mode:802.11b Frequency:2412MHz Ant:Chain0



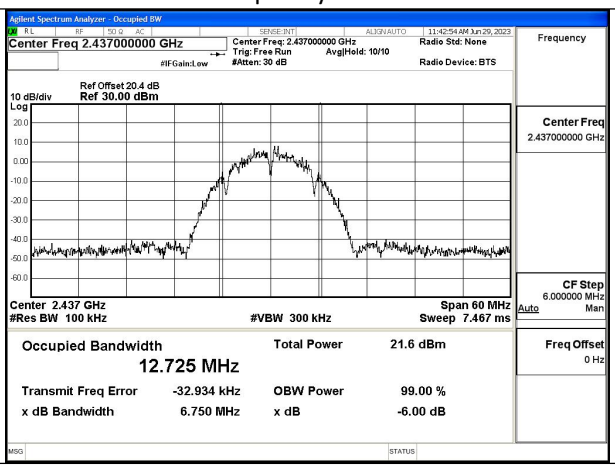
Mode:802.11b Frequency:2437MHz Ant:Chain0



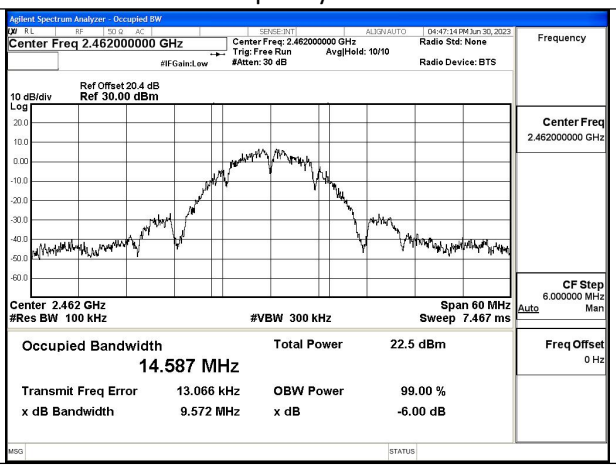
Mode:802.11b Frequency:2462MHz Ant:Chain0



Mode:802.11b Frequency:2412MHz Ant:Chain1

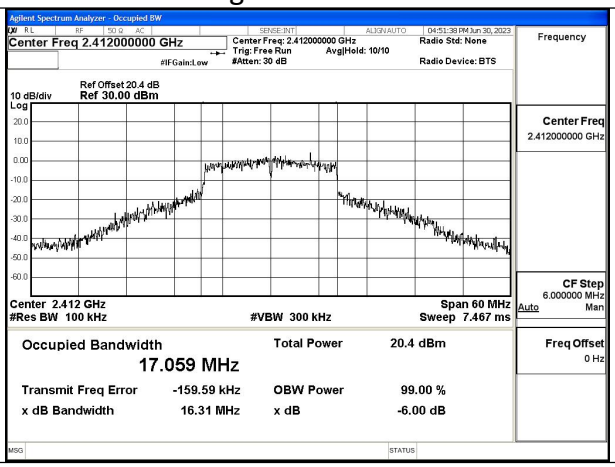


Mode:802.11b Frequency:2437MHz Ant:Chain1

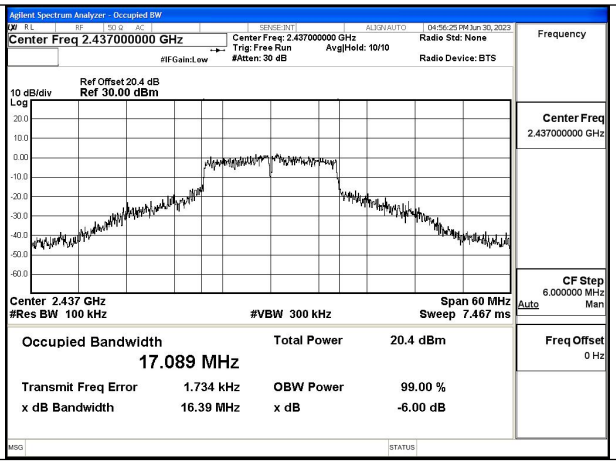


Mode:802.11b Frequency:2462MHz Ant:Chain1

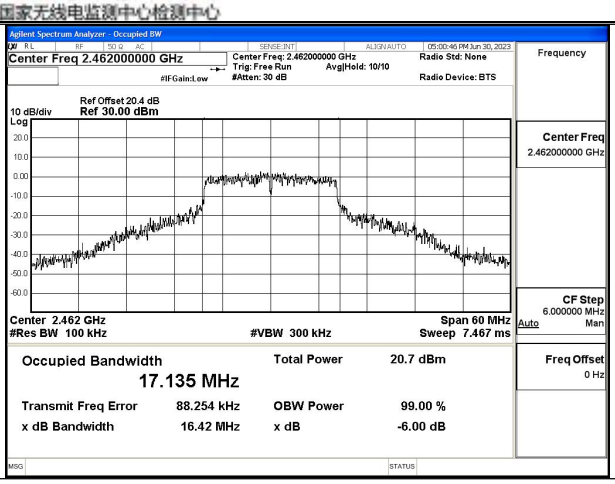
Test Mode: 802.11g



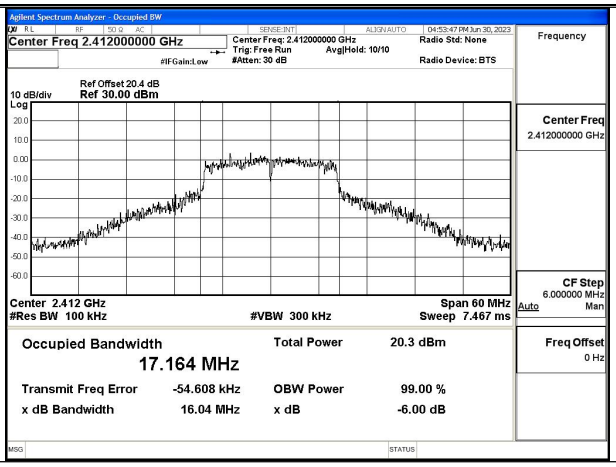
Mode:802.11g Frequency:2412MHz Ant:Chain0



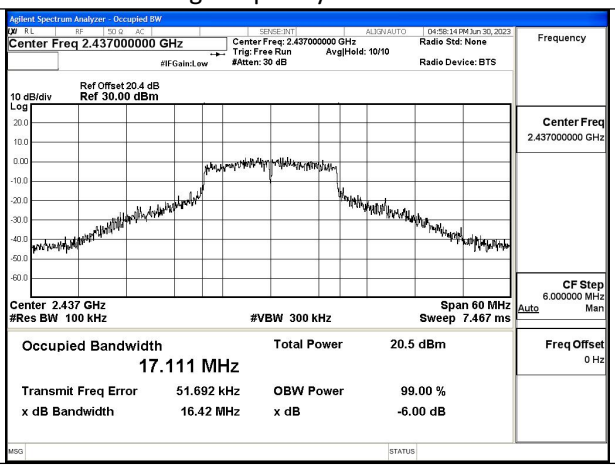
Mode:802.11g Frequency:2437MHz Ant:Chain0



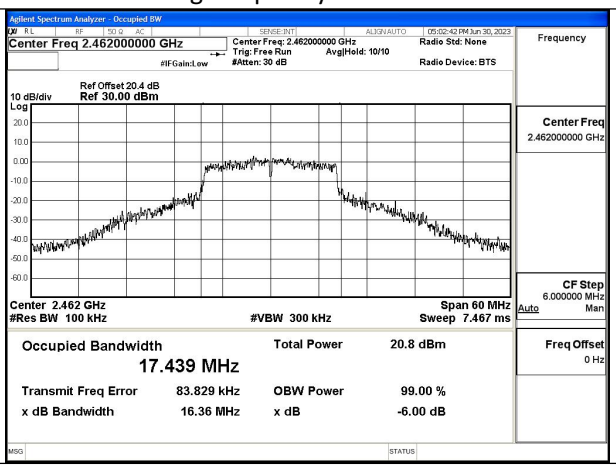
Mode:802.11g Frequency:2462MHz Ant:Chain0



Mode:802.11g Frequency:2412MHz Ant:Chain1

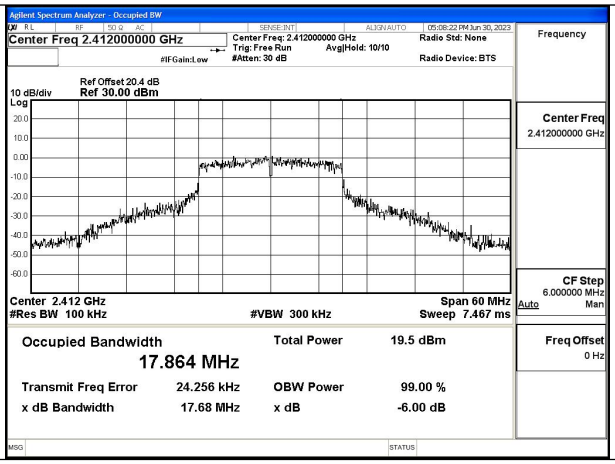


Mode:802.11g Frequency:2437MHz Ant:Chain1

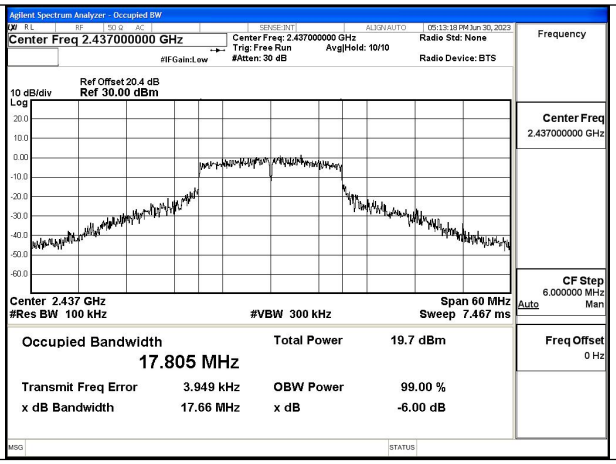


Mode:802.11g Frequency:2462MHz Ant:Chain1

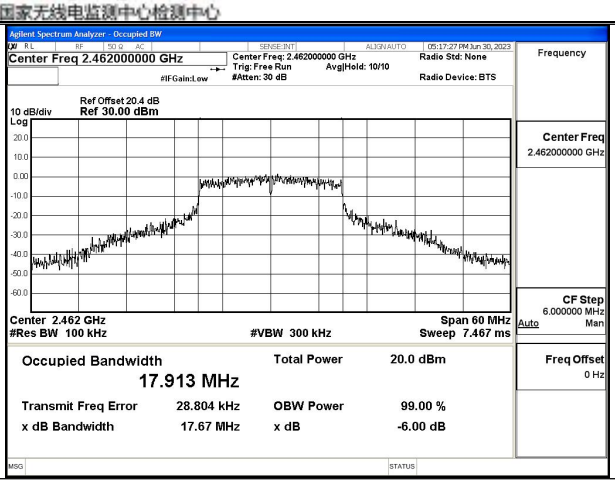
Test Mode: 802.11n HT20



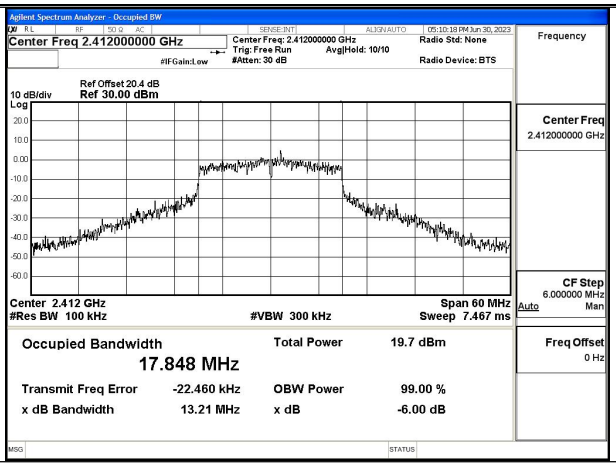
Mode:802.11n HT20 Frequency:2412MHz Ant:Chain0



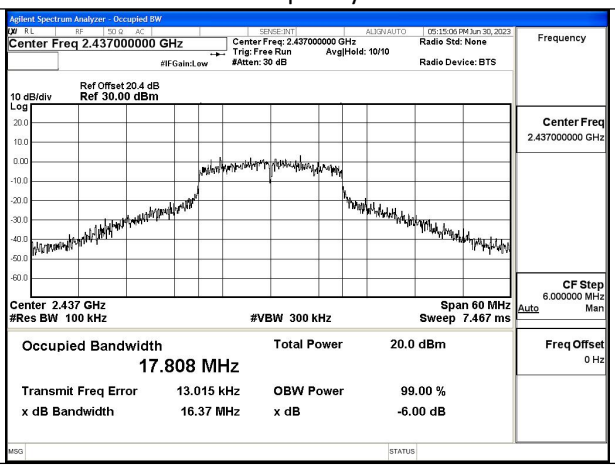
Mode:802.11n HT20 Frequency:2437MHz Ant:Chain0



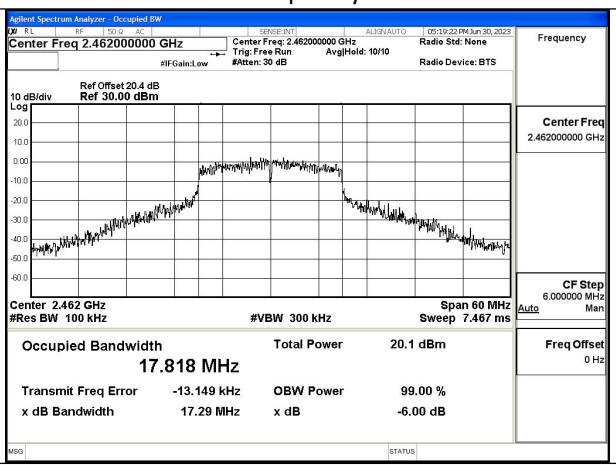
Mode:802.11n HT20 Frequency:2462MHz Ant:Chain0



Mode:802.11n HT20 Frequency:2412MHz Ant:Chain1

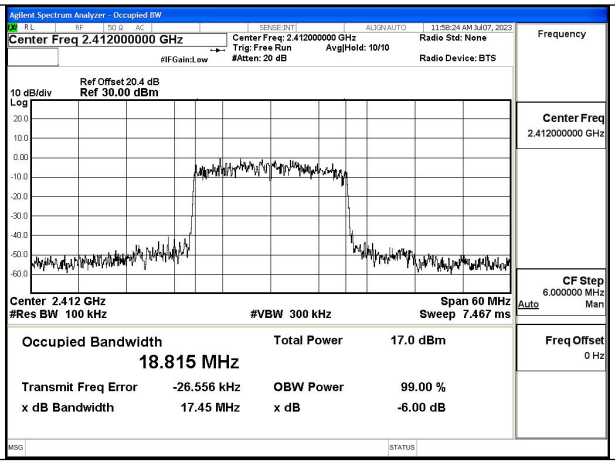


Mode:802.11n HT20 Frequency:2437MHz Ant:Chain1

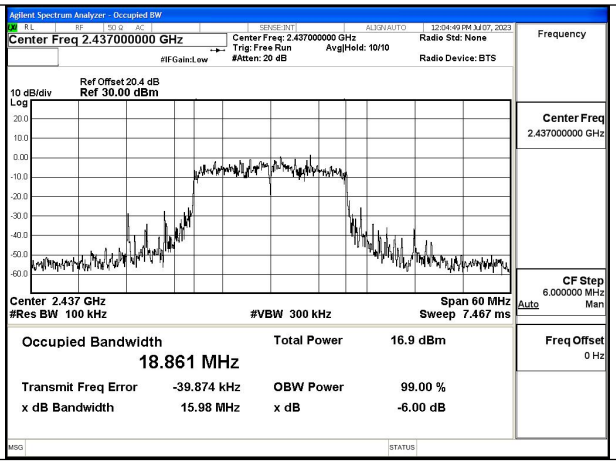


Mode:802.11n HT20 Frequency:2462MHz Ant:Chain1

Test Mode: 802.11ax HE20



Mode:802.11ax HE20 Tone:242T Frequency:2412MHz Ant:Chain0



Mode:802.11ax HE20 Tone:242T Frequency:2437MHz Ant:Chain0