

FCC/ISED - TEST REPORTReport Number : **68.710.24.0268.01** Date of Issue: 2024-09-05Model/HVIN : **Q10**

Product Type : Robot Vacuum Cleaner

Applicant : Shenzhen Tunnu Innovation Co., Ltd.

Address : 4 Floor, Tsinghua University Research Institute, Yuehai Street,

NanShan district, 518000 Shenzhen, Guangdong Province,PEOPLE'S REPUBLIC OF CHINA

Manufacturer : Shenzhen Tunnu Innovation Co., Ltd.

Address : 4 Floor, Tsinghua University Research Institute, Yuehai Street,

NanShan district, 518000 Shenzhen, Guangdong Province,PEOPLE'S REPUBLIC OF CHINATest Result : ☒ **Positive** ☐ **Negative**Total pages including
Appendices : **55**

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2 Details about the Test Laboratory

Details about the Test Laboratory

Test Site 1

Company name: TÜV SÜD Certification and Testing (China) Co., Ltd. Shenzhen Branch
Building 12 & 13, Zhiheng Wisdomland Business Park, Guankou Erlu, Nantou, Nanshan District, Shenzhen, Guangdong, China

Telephone: 86 755 8828 6998

Fax: 86 755 8828 5299

FCC Registration No.: 514049

FCC Designation Number: CN5009

ISED CAB identifier: CN0077

IC Registration No.: 10320A

3 Description of the Equipment Under Test

Product:	Robot Vacuum Cleaner
Model no.:	Q10
Product Marketing Name (PMN):	Robot Vacuum Cleaner
Hardware Version Identification No. (HVIN):	Q10
FCC ID:	2BELS-Q10
IC:	32336-Q10
Options and accessories:	Base station Manufacturer: Shenzhen Topband Co., Ltd. Model: Q10-S Input: 120VAC, 60Hz, 24W for Charging, 80W for Drying, 800W for Heating water, 1000W for Collecting dust Output: DC23.65V, 2.5A
Ratings:	Input: DC23.65V, 2.5A (for charging only) Battery: 14.4V, 5000mAh
RF Transmission Frequency:	2412MHz - 2462MHz for 2.4GHz Wi-Fi
No. of Operated Channel:	11 for 802.11b, 802.11n (HT20) 9 for 802.11n (HT40)
Modulation:	802.11b: BPSK, QPSK, CCK 802.11g: BPSK, QPSK, 16-QAM, 64-QAM 802.11n: BPSK, QPSK, 16-QAM, 64-QAM
Antenna Type:	Integrated FPC antenna
Antenna Gain:	4.2 dBi for 2.4GHz Wi-Fi
Description of the EUT:	The EUT is a Robot Vacuum Cleaner supports Wi-Fi and Bluetooth functions: 2412MHz - 2462MHz for 2.4GHz Wi-Fi; 2402MHz - 2480MHz for BLE (1Mbps); 2402MHz - 2480MHz for BR/EDR.
Remark:	This report is only for 2.4GHz Wi-Fi.

NOTE 1: The above EUT's information is declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.

4 Summary of Test Standards

Test Standards	
FCC Part 15 Subpart C 10-1-2023 Edition	PART 15 - RADIO FREQUENCY DEVICES Subpart C - Intentional Radiators
RSS-Gen Issue 5 April 2018 + Amendment 1 March 2019 + Amendment 2 February 2021	General Requirements for Compliance of Radio Apparatus
RSS-247 Issue 3 August 2023	Digital Transmission Systems (DTSS), Frequency Hopping Systems (FHSS) and License-Exempt Local Area Network (LE-LAN) Devices

All the test methods were according to KDB 558074 D01 15.247 Meas Guidance v05r02 Measurement Guidance and ANSI C63.10-2020.

5 Summary of Test Results

Technical Requirements						
FCC Part 15 Subpart C/ RSS-247 Issue 3/RSS-Gen Issue 5						
Test Condition		Test Site	Test Result			Test Environment
			Pass	Fail	N/A	
§15.207 & RSS-GEN 8.8	Conducted emission AC power port	N/A	☐	☐	☒	--
§15.247 (b) (3) & RSS-247 5.4(d)	Conducted peak output power	Site 1	☒	☐	☐	T: 22.4°C H: 53.2%
RSS-247 5.4(d)	Equivalent Isotropic Radiated Power	Site 1	☒	☐	☐	T: 23.2°C H: 51.5%
§15.247(a)(2) & RSS-247 5.2(a) & RSS-GEN 6.7	6dB bandwidth and 99% Occupied Bandwidth	Site 1	☒	☐	☐	T: 23.2°C H: 51.5%
§15.247(e) & RSS-247 5.2(b)	Power spectral density	Site 1	☒	☐	☐	T: 23.2°C H: 51.5%
§15.247(d) & RSS-247 5.5	Spurious RF conducted emissions	Site 1	☒	☐	☐	T: 23.2°C H: 51.5%
§15.247(d) & RSS-247 5.5	Band edge	Site 1	☒	☐	☐	T: 23.2°C H: 51.5%
§15.247(d) & §15.209 & §15.205 & RSS-247 5.5 & RSS-Gen 6.13	Spurious radiated emissions for transmitter	Site 1	☒	☐	☐	T: 24.7°C H: 49.3%
§15.203 & RSS-Gen 6.8	Antenna requirement	See note 2	☒	☐	☐	--

Note 1: N/A=Not Applicable.

Note 2: The EUT uses an Integrated FPC antenna, which gains are 4.2dBi for 2.4GHz WIFI. In accordance with §15.203 and RSS-Gen 6.8, it is considered sufficiently to comply with the provisions of this section.

Note 3: T: Temperature, H: Humidity.

6 General Remarks

The conducted emissions of Q10 were tested with a Base station, and the input voltage is 120VAC/60Hz; The RF tests of Q10 were tested with battery operation, the battery voltage is 14.4VDC.

This submittal(s) (test report) is intended for FCC ID: 2BELS-Q10, complies with Section 15.207, 15.209, 15.205, 15.247 of the FCC Part 15, Subpart C rules.

This submittal(s) (test report) is intended for IC: 32336-Q10, complies with RSS-247 and RSS-Gen.

SUMMARY:

All tests according to the regulations cited on page 5 were

■ - Performed

□ - **Not** Performed

The Equipment under Test

■ - **Fulfills** the general approval requirements.

□ - **Does not** fulfill the general approval requirements.

Sample Received Date: 2024-07-09

Testing Start Date: 2024-07-17

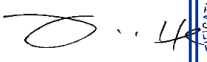
Testing End Date: 2024-08-09

- TÜV SÜD Certification and Testing (China) Co., Ltd. Shenzhen Branch –

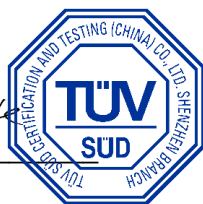
Reviewed by:

Prepared by:

Tested by:



Jessie He
Project Manager





Myron Yu
Project Engineer

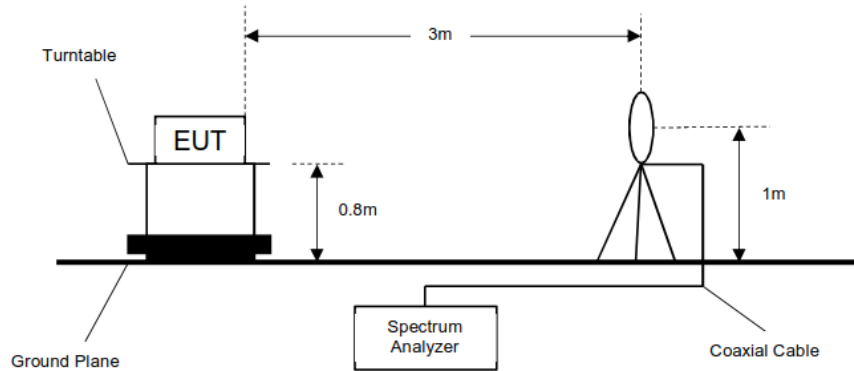


Carry Cai
Test Engineer

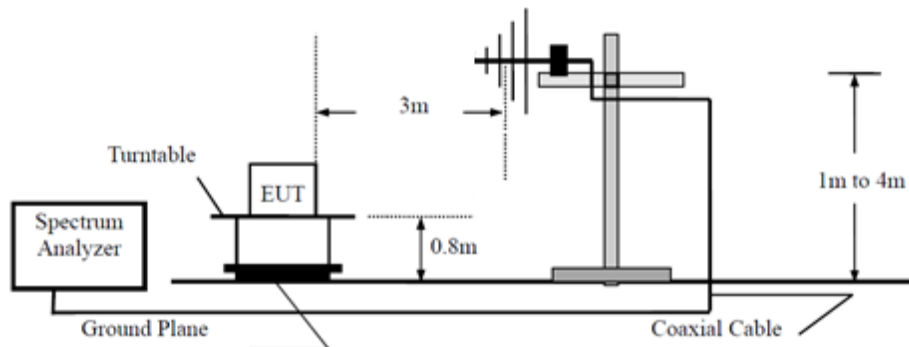
7 Test Setups

7.1 Radiated test setups

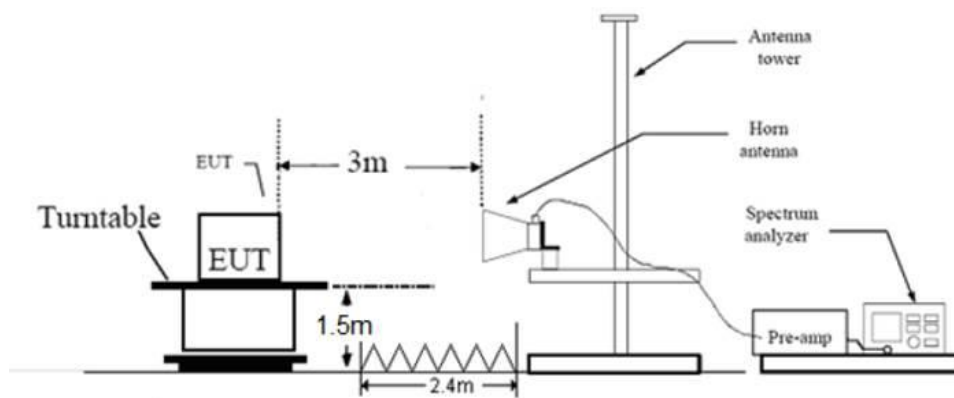
9kHz - 30MHz



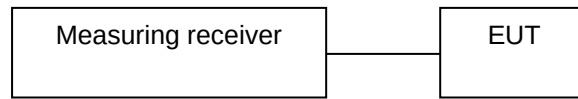
Below 1GHz



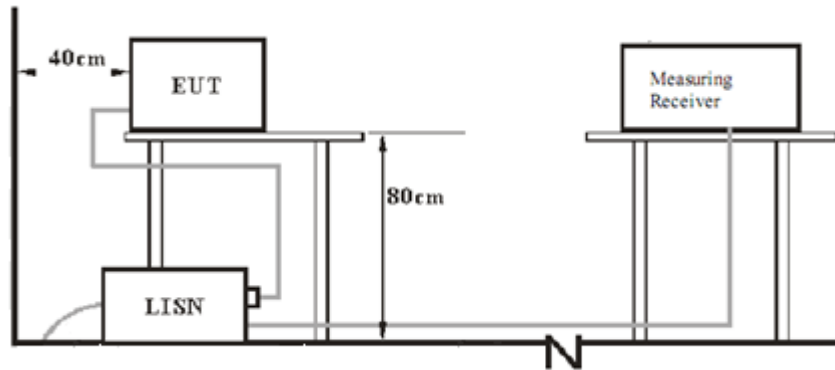
Above 1GHz



7.2 Conducted RF test setups



7.3 AC Power Line Conducted Emission test setups



8 Systems test configuration

Auxiliary Equipment Used during Test:

DESCRIPTION	MODEL NO.	MANUFACTURER	S/N
Laptop	X220	ThinkPad	EMC-158

Test Software Information:

Test Software Version	Adb tool	
Mode	Setting TX Power	Data Rate
802.11b	Default parameters	11b 1 Mbps
802.11g	Default parameters	11g 6 Mbps
802.11n HT20	Default parameters	MCS0 6.5 Mbps
802.11n HT40	Default parameters	MCS0 13.5 Mbps

The system was configured to channel 1, 6, and 11 for 802.11b/802.11g/802.11n-HT20:

Test mode	Channel	Frequency(MHz)
TX	1	2412
TX	6	2437
TX	11	2462

The system was configured to channel 3, 6, and 9 for 802.11n-HT40:

Test mode	Channel	Frequency(MHz)
TX	3	2422
TX	6	2437
TX	9	2452

9 Technical Requirement

9.1 Conducted Emission

Test Method

1. The EUT was placed 0.4 meter from the conducting wall of the shielding room 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. Both sides of AC line were checked for maximum conducted interference.
6. The frequency range from 150 kHz to 30 MHz was searched.
7. Set the test-receiver system to Peak Detect Function and specified bandwidth (IF Bandwidth = 9kHz) with Maximum Hold Mode. Then measurement is also conducted by Average Detector and Quasi-Peak Detector Function respectively.

Limit

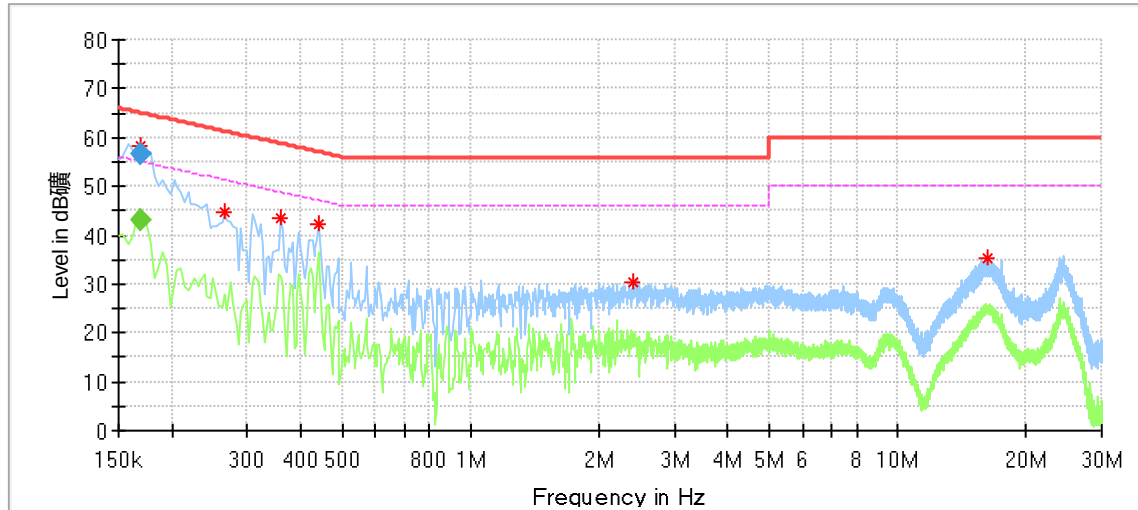
According to §15.207 & RSS-GEN 8.8, conducted emissions limit as below:

Frequency MHz	QP Limit dB μ V	AV Limit dB μ V
0.150-0.500	66-56*	56-46*
0.500-5	56	46
5-30	60	50

Remark: “*” Decreasing linearly with logarithm of the frequency

Conducted Emission

Product Type : Robot Vacuum Cleaner
 M/N : Q10
 Operating Condition : Charging + WIFI communication mode
 Test Specification : L
 Comment : AC 120V/60Hz



Critical_Freqs

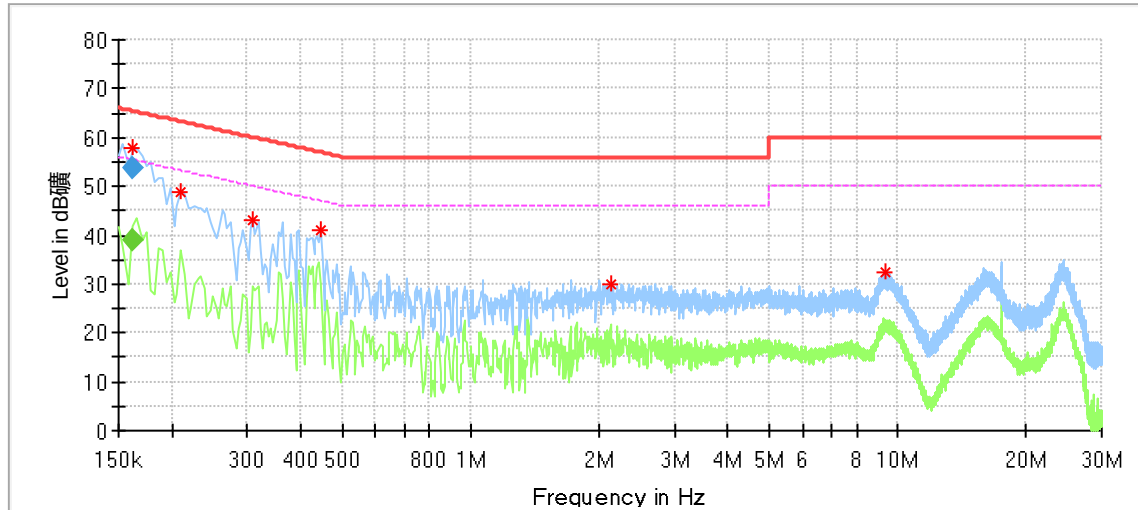
Frequency (MHz)	MaxPeak (dBμV)	Average (dBμV)	Limit (dBμV)	Margin (dB)	Line	Corr. (dB)
0.169500	58.44	---	64.96	6.52	L1	9.67
0.266000	44.73	---	61.24	16.51	L1	9.67
0.358000	43.60	---	58.78	15.18	L1	9.67
0.442000	42.18	---	57.02	14.84	L1	9.68
2.398000	30.48	---	56.00	25.52	L1	9.75
16.150000	35.42	---	60.00	24.58	L1	9.99

Final_Result

Frequency (MHz)	QuasiPeak (dBμV)	Average (dBμV)	Limit (dBμV)	Margin (dB)	Line	Corr. (dB)
0.169500	---	43.24	54.99	11.75	L1	9.67
0.169500	56.66	---	64.99	8.32	L1	9.67

Conducted Emission

Product Type : Robot Vacuum Cleaner
 M/N : Q10
 Operating Condition : Charging + WIFI communication mode
 Test Specification : N
 Comment : AC 120V/60Hz



Critical_Freqs

Frequency (MHz)	MaxPeak (dBμV)	Average (dBμV)	Limit (dBμV)	Margin (dB)	Line	Corr. (dB)
0.161500	57.96	---	65.16	7.19	N	9.67
0.210000	48.98	---	63.21	14.23	N	9.67
0.310000	43.15	---	59.97	16.82	N	9.67
0.446000	40.87	---	56.95	16.08	N	9.67
2.122000	30.12	---	56.00	25.88	N	9.71
9.362000	32.47	---	60.00	27.53	N	9.90

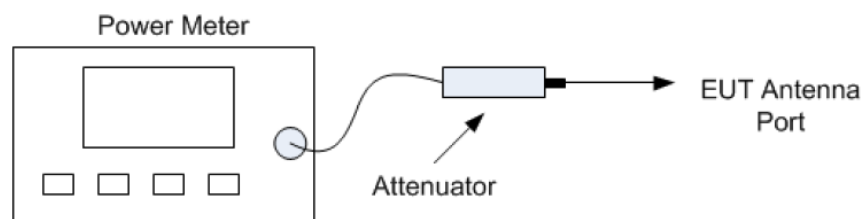
Final_Result

Frequency (MHz)	QuasiPeak (dBμV)	Average (dBμV)	Limit (dBμV)	Margin (dB)	Line	Corr. (dB)
0.161500	---	38.96	55.39	16.43	N	9.67
0.161500	53.93	---	65.39	11.46	N	9.67

9.2 Conducted Output Power & EIRP

Test Method

- 1) The EUT is configured to transmit continuously, or to transmit with a constant duty cycle.
- 2) At all times when the EUT is transmitting, it shall be transmitting at its maximum power control level.
- 3) The integration period of the power meter exceeds the repetition period of the transmitted signal by at least a factor of five.
- 4) Measure the peak power of the transmitter. This measurement is a peak over both the ON and OFF periods of the transmitter.



Power meter conducted test setup

Limit

According to §15.247 (b) (3) & RSS-247 5.4(d), conducted output power limit as below:

Frequency Range MHz	Limit W	Limit dBm
2400-2483.5	≤1	≤30

According to & RSS-247 5.4(d), EIRP limit as below:

Frequency Range MHz	Limit W	Limit dBm
2400-2483.5	≤4	≤36

Test Results

Mode	Frequency (MHz)	Gain (dBi)	Conducted Output Power (dBm)	EIRP (dBm)	Conducted Output Power Limit (dBm)	EIRP Limit (dBm)	Verdict
802.11b	2412	4.2	12.61	16.81	≤30	≤36	Pass
	2437	4.2	13.25	17.45	≤30	≤36	Pass
	2462	4.2	13.18	17.38	≤30	≤36	Pass
802.11g	2412	4.2	12.10	16.30	≤30	≤36	Pass
	2437	4.2	12.92	17.12	≤30	≤36	Pass
	2462	4.2	13.12	17.32	≤30	≤36	Pass
802.11n (HT20)	2412	4.2	11.03	15.23	≤30	≤36	Pass
	2437	4.2	11.80	16.00	≤30	≤36	Pass
	2462	4.2	11.05	15.25	≤30	≤36	Pass
802.11n (HT40)	2422	4.2	11.99	16.19	≤30	≤36	Pass
	2437	4.2	12.50	16.70	≤30	≤36	Pass
	2452	4.2	12.73	16.93	≤30	≤36	Pass

Note1: E.I.R.P = Measured Power + Antenna Gain

9.3 6 dB and 99% Bandwidth

Test Method for 6 dB Bandwidth

1. The RF output of EUT was connected to the spectrum analyzer. The path loss was compensated to the results for each measurement.
2. Set to the maximum power setting, the instrument center frequency is set to the nominal EUT channel center frequency enable the EUT transmit continuously.
3. Use the following spectrum analyzer settings:
RBW=100KHz, VBW $\geq$ 3RBW, Sweep = auto, Detector function = peak, Trace = max hold
4. Use the automatic bandwidth measurement capability of an instrument, use the X dB bandwidth mode with X set to 6 dB.
5. Allow the trace to stabilize, record the 6 dB Bandwidth value.

Test Method for 99 % Bandwidth

1. Connect EUT test port to spectrum analyzer.
Use the following spectrum analyzer settings:
RBW=1% to 5% of the actual occupied, VBW $\geq$ 3RBW, Sweep = auto,
Detector function = peak, Trace = max hold
2. Use the occupied bandwidth measurement capability of test receiver.
3. Allow the trace to stabilize, record the occupied bandwidth value.

Limit

6dB bandwidth Limit [kHz]	99% bandwidth Limit [kHz]
≥ 500	--

Test result

6dB bandwidth

Mode	Frequency (MHz)	6dB Bandwidth (MHz)		Verdict
		Result	Limit	
802.11b	2412	9.552	≥ 0.5	Pass
	2437	9.841	≥ 0.5	Pass
	2462	9.853	≥ 0.5	Pass
802.11g	2412	16.627	≥ 0.5	Pass
	2437	16.669	≥ 0.5	Pass
	2462	16.557	≥ 0.5	Pass
802.11n (HT20)	2412	17.719	≥ 0.5	Pass
	2437	17.777	≥ 0.5	Pass
	2462	17.596	≥ 0.5	Pass
802.11n (HT40)	2422	35.873	≥ 0.5	Pass
	2437	36.233	≥ 0.5	Pass
	2452	36.092	≥ 0.5	Pass

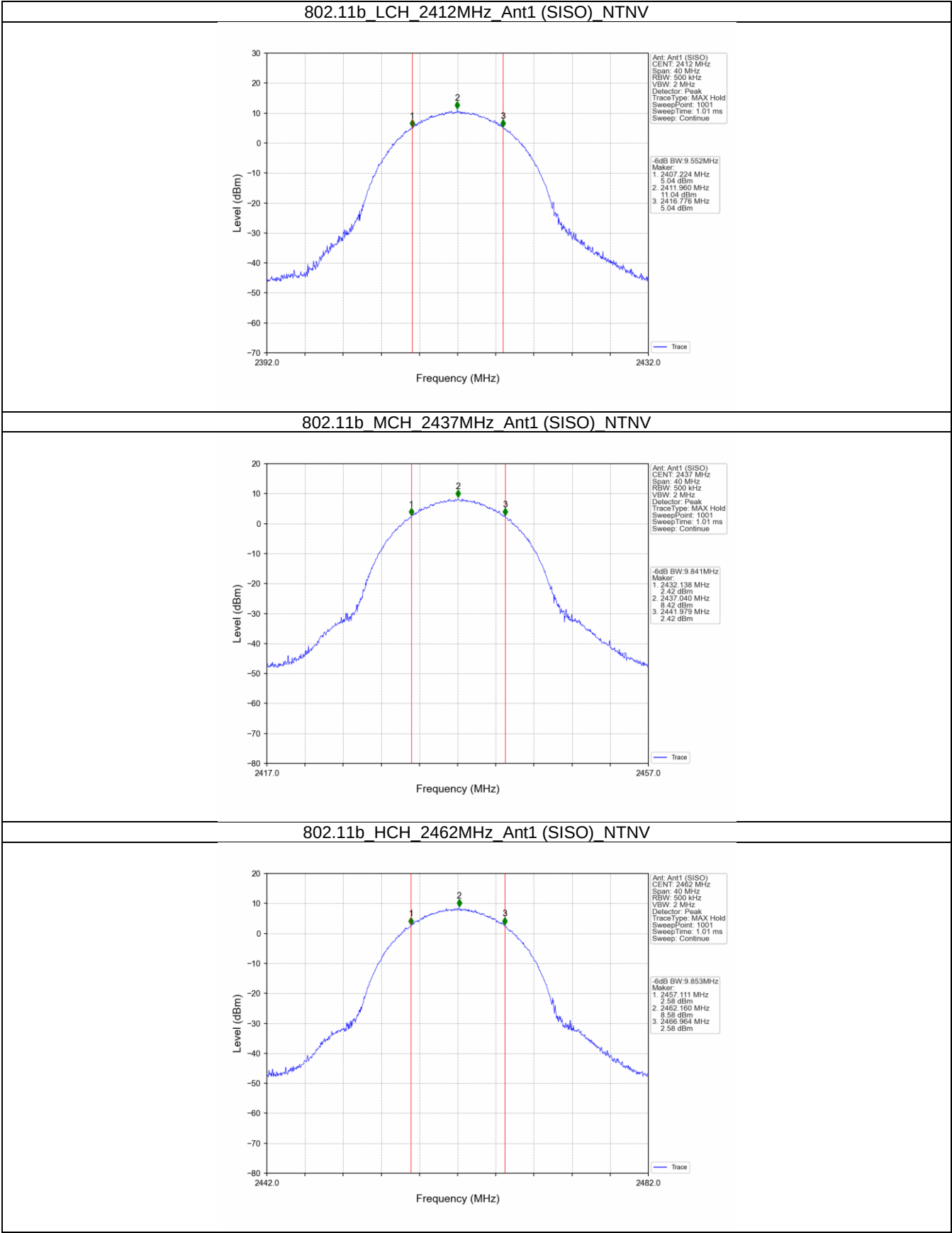
99% bandwidth

Mode	Frequency (MHz)	99% Occupied Bandwidth (MHz)		Verdict
		Result	Limit	
802.11b	2412	14.633	/	Pass
	2437	14.671	/	Pass
	2462	14.669	/	Pass
802.11g	2412	17.368	/	Pass
	2437	17.352	/	Pass
	2462	16.994	/	Pass
802.11n (HT20)	2412	18.100	/	Pass
	2437	18.140	/	Pass
	2462	18.123	/	Pass
802.11n (HT40)	2412	36.185	/	Pass
	2437	36.324	/	Pass
	2462	36.133	/	Pass

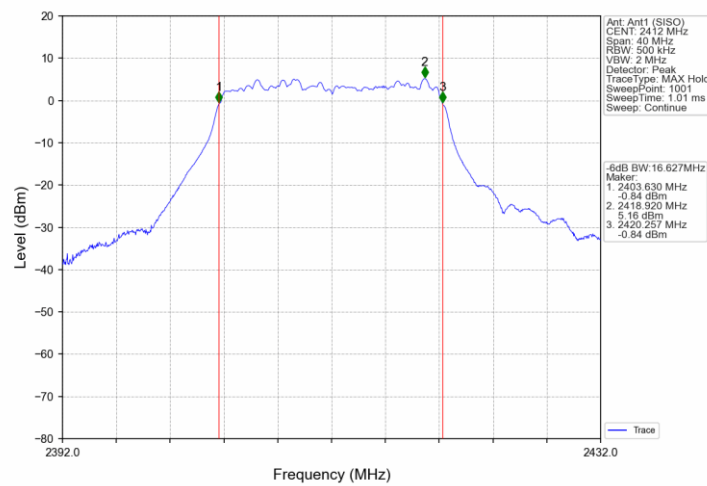


Test Graphs

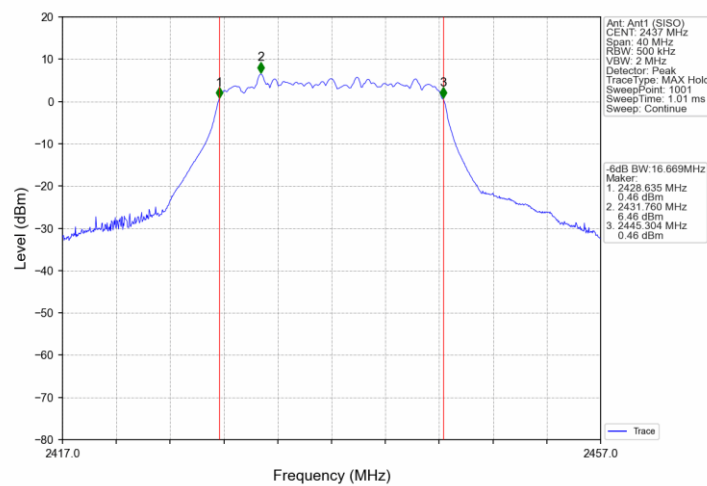
6dB bandwidth



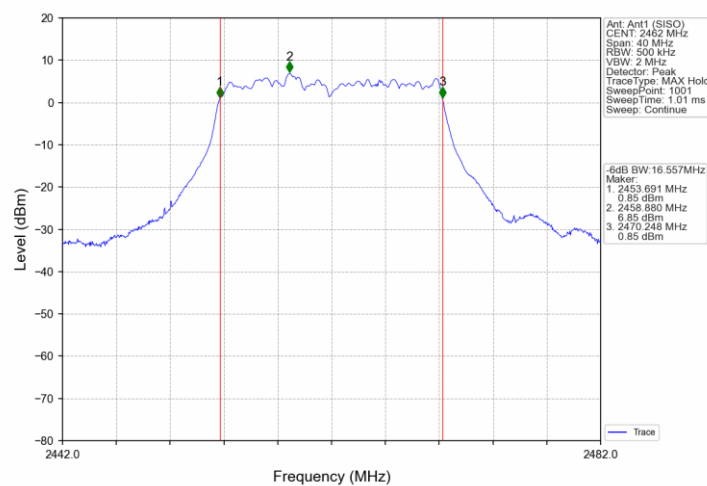
802.11g_LCH_2412MHz_Ant1 (SISO)_NTNV



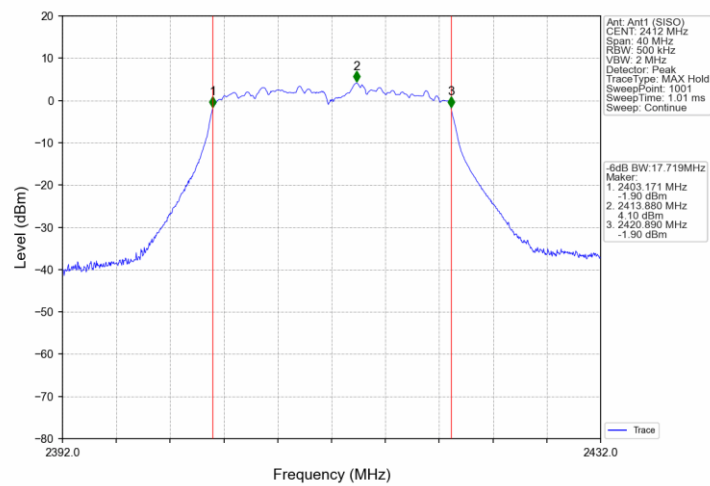
802.11g_MCH_2437MHz_Ant1 (SISO)_NTNV



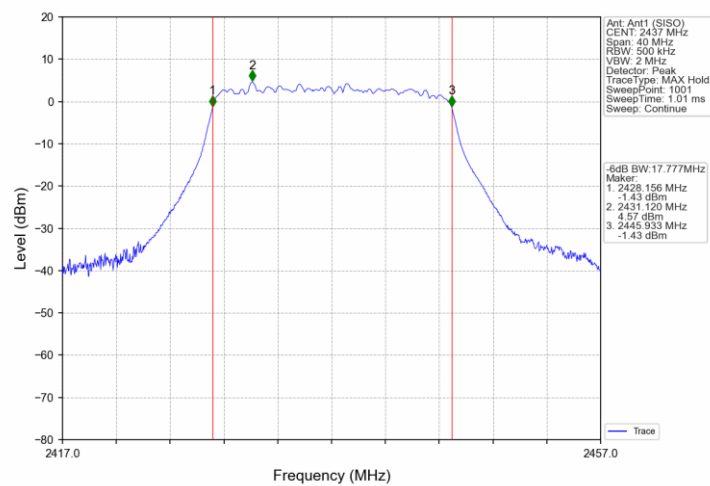
802.11g_HCH_2462MHz_Ant1 (SISO)_NTNV



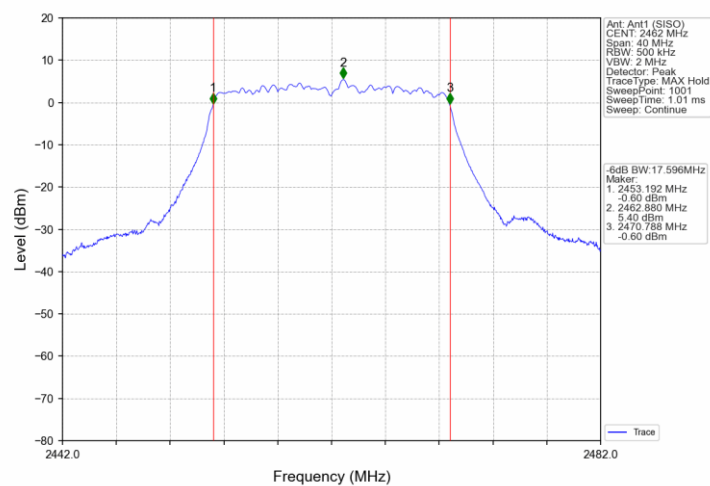
802.11n(HT20)_LCH_2412MHz_Ant1 (SISO)_NTNV



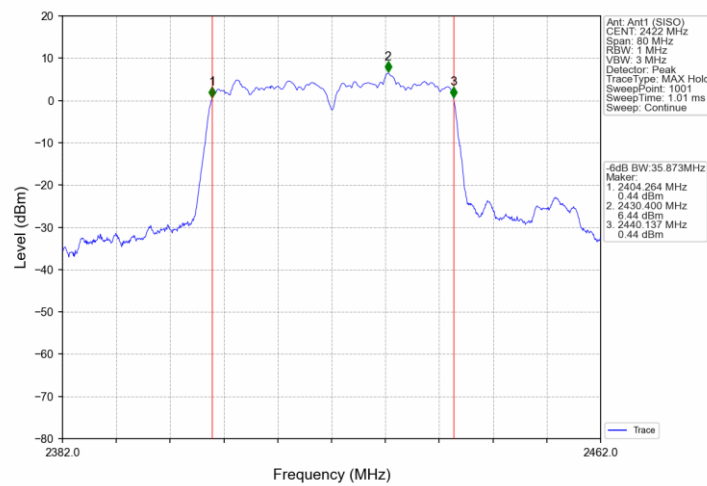
802.11n(HT20)_MCH_2437MHz_Ant1 (SISO)_NTNV



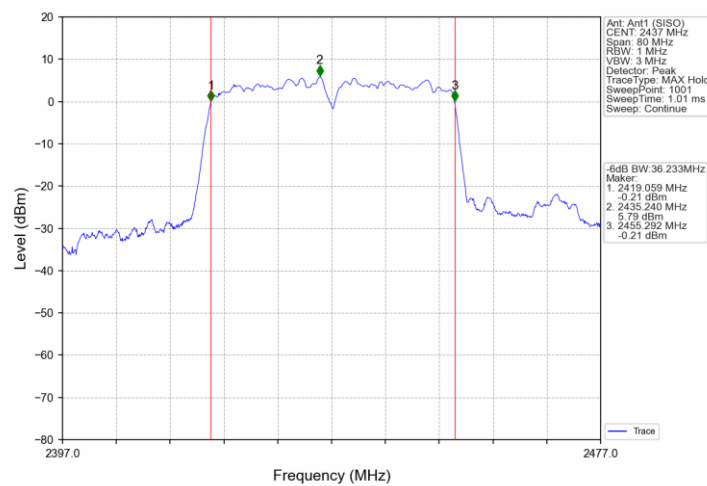
802.11n(HT20)_HCH_2462MHz_Ant1 (SISO)_NTNV



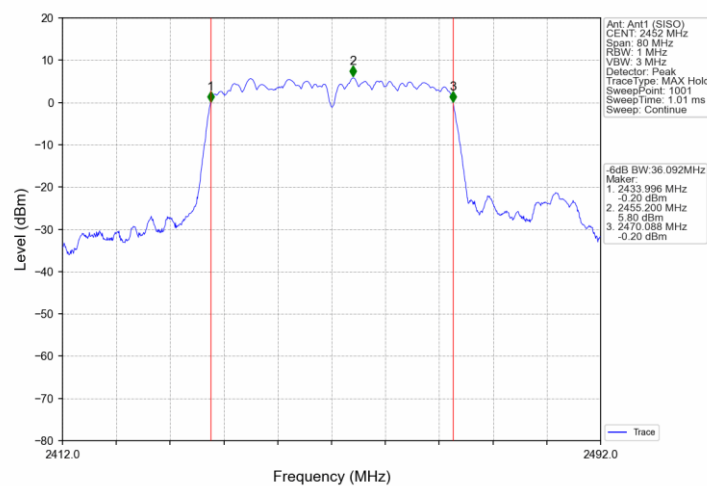
802.11n(HT40)_LCH_2422MHz_Ant1 (SISO)_NTNV



802.11n(HT40)_MCH_2437MHz_Ant1 (SISO)_NTNV

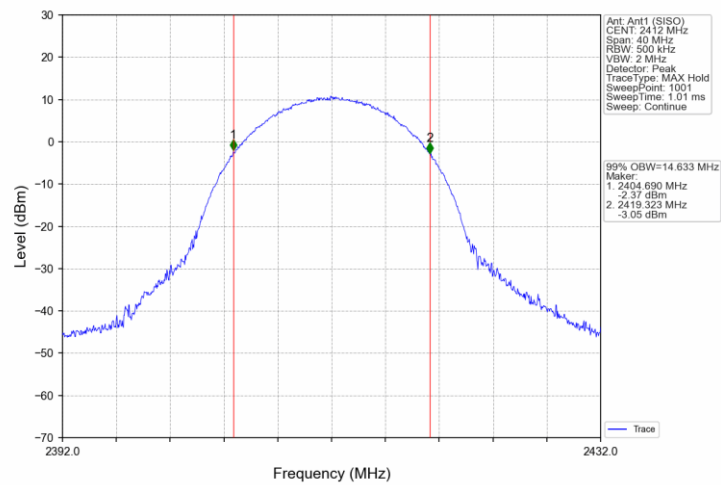


802.11n(HT40)_HCH_2452MHz_Ant1 (SISO)_NTNV

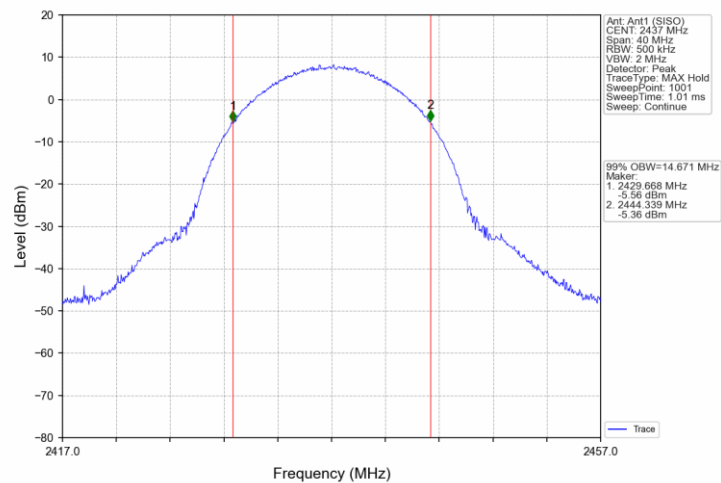


99% bandwidth

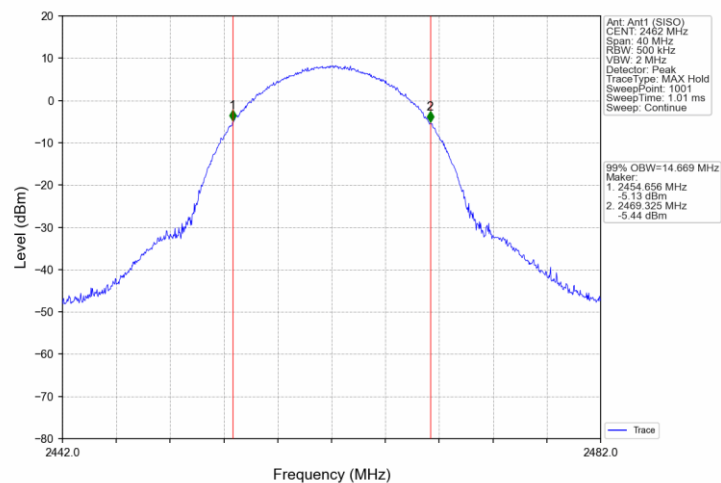
802.11b LCH 2412MHz Ant1 (SISO) NTNV



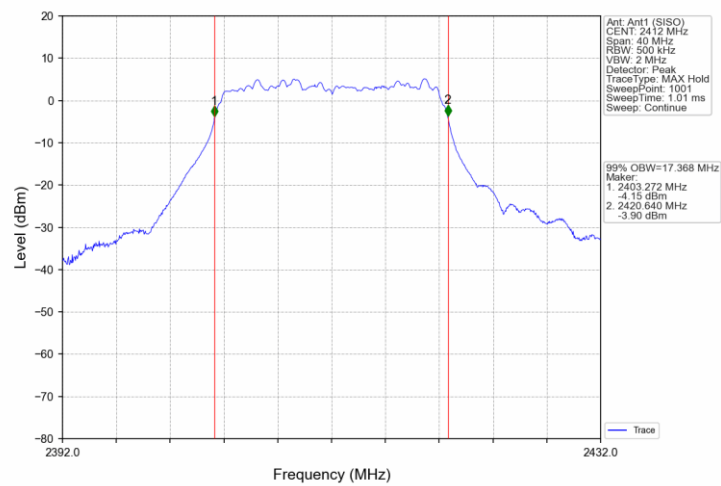
802.11b MCH 2437MHz Ant1 (SISO) NTNV



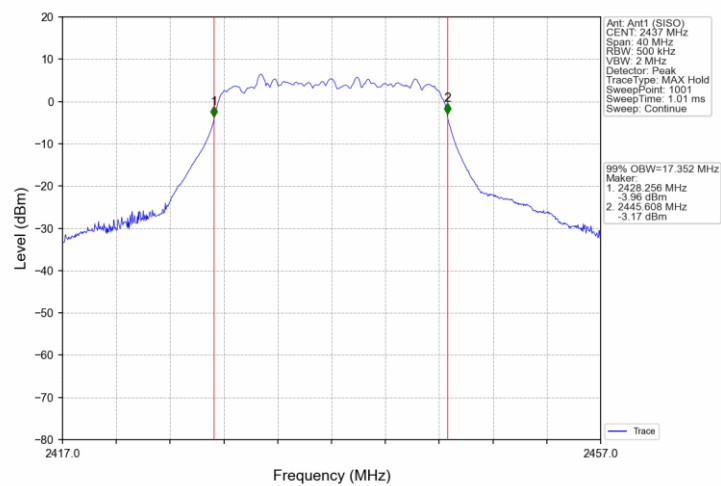
802.11b HCH 2462MHz Ant1 (SISO) NTNV



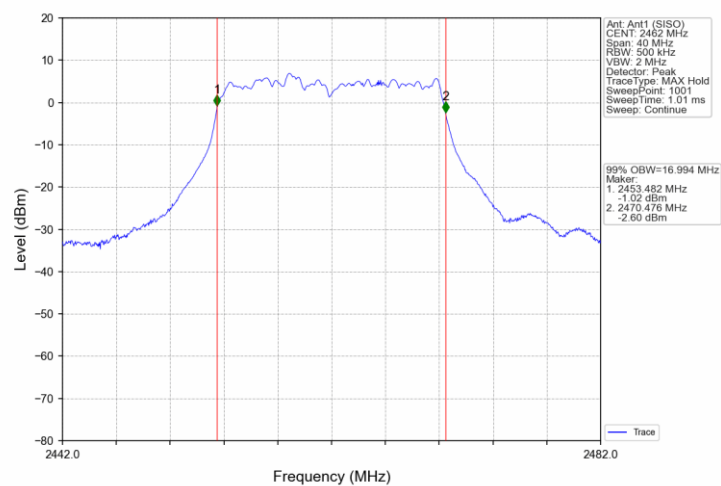
802.11g_LCH_2412MHz_Ant1 (SISO)_NTNV



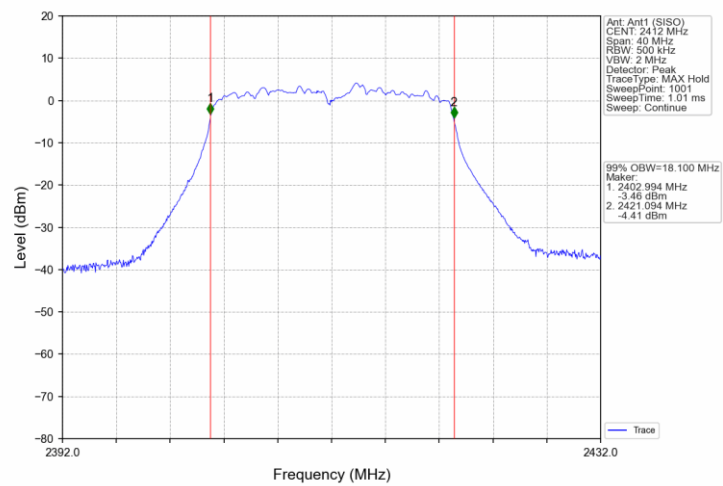
802.11g_MCH_2437MHz_Ant1 (SISO)_NTNV



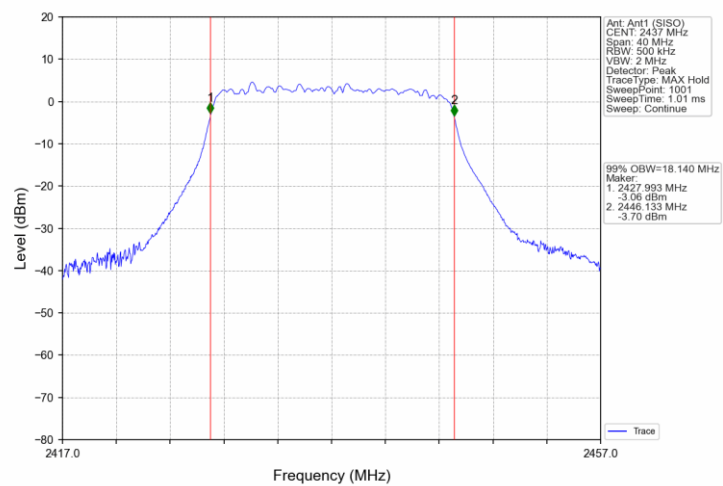
802.11g_HCH_2462MHz_Ant1 (SISO)_NTNV



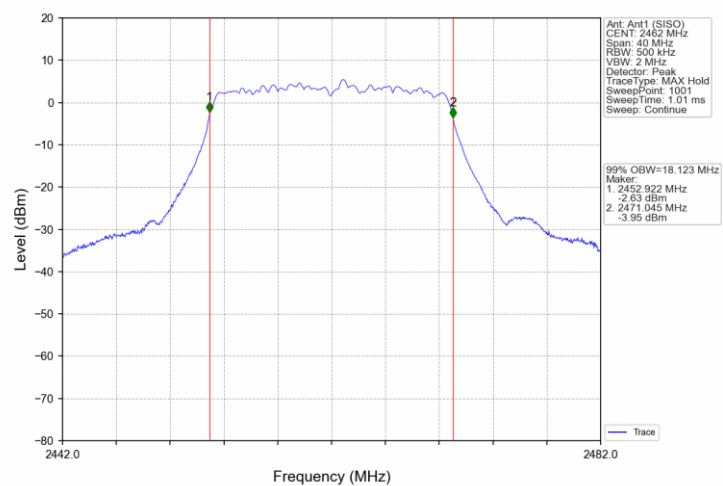
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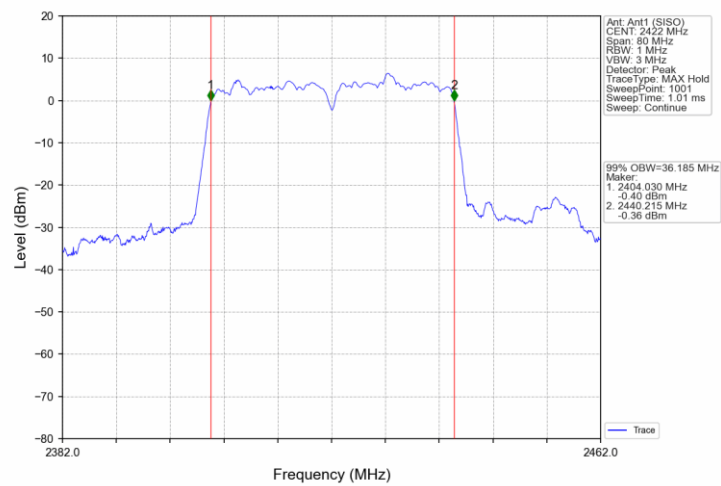
802.11n(HT20)_MCH_2437MHz_Ant1 (SISO)_NTNV



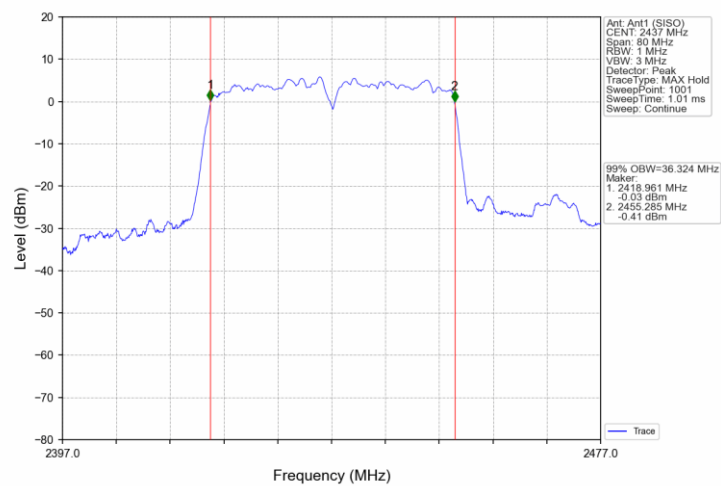
802.11n(HT20)_HCH_2462MHz_Ant1 (SISO)_NTNV



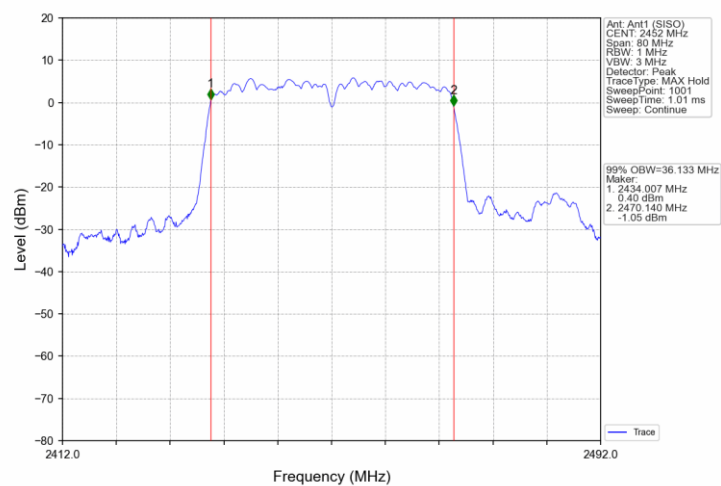
802.11n(HT40)_LCH_2422MHz_Ant1 (SISO)_NTNV



802.11n(HT40)_MCH_2437MHz_Ant1 (SISO)_NTNV



802.11n(HT40)_HCH_2452MHz_Ant1 (SISO)_NTNV



9.4 Power spectral density

Test Method

This procedure shall be used if maximum peak conducted output power was used to demonstrate compliance:

1. The RF output of EUT was connected to the spectrum analyzer. The path loss was compensated to the results for each measurement.
2. Set to the maximum power setting, the instrument center frequency is set to the nominal EUT channel center frequency enable the EUT transmit continuously.
3. Use the following spectrum analyzer settings:
4. Set analyzer center frequency to DTS channel center frequency. RBW=3kHz, VBW $\geq$ 3RBW, Span=1.5 times DTS bandwidth, Detector=Peak, Sweep=auto, Trace= max hold.
5. Allow trace to fully stabilize, use the peak marker function to determine the maximum amplitude level within the RBW.
6. Repeat above procedures until other frequencies measured were completed.

Limit

Limit [dBm/3kHz]

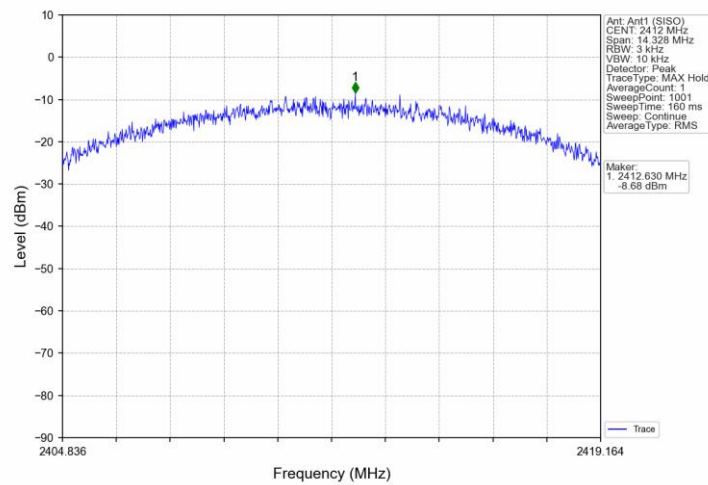
≤ 8

Test Results

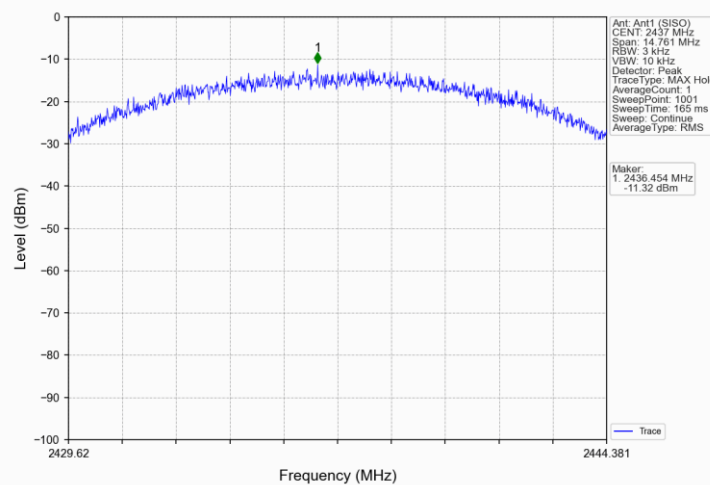
Mode	Frequency (MHz)	Maximum PSD (dBm/3kHz)		Verdict
		Result	Limit	
802.11b	2412	-8.68	≤ 8	Pass
	2437	-11.32	≤ 8	Pass
	2462	-11.66	≤ 8	Pass
802.11g	2412	-15.01	≤ 8	Pass
	2437	-14.75	≤ 8	Pass
	2462	-13.84	≤ 8	Pass
802.11n (HT20)	2412	-17.06	≤ 8	Pass
	2437	-15.98	≤ 8	Pass
	2462	-15.85	≤ 8	Pass
802.11n (HT20)	2422	-16.09	≤ 8	Pass
	2437	-17.48	≤ 8	Pass
	2452	-14.78	≤ 8	Pass

Test Graphs

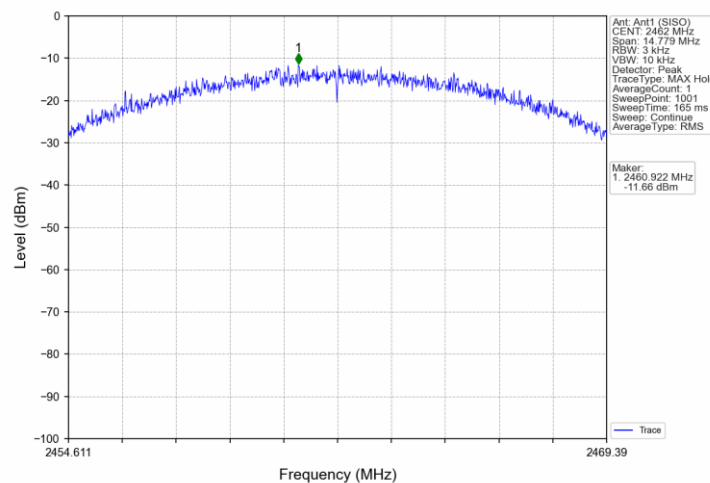
802.11b_LCH_2412MHz_Ant1 (SISO)_NTNV



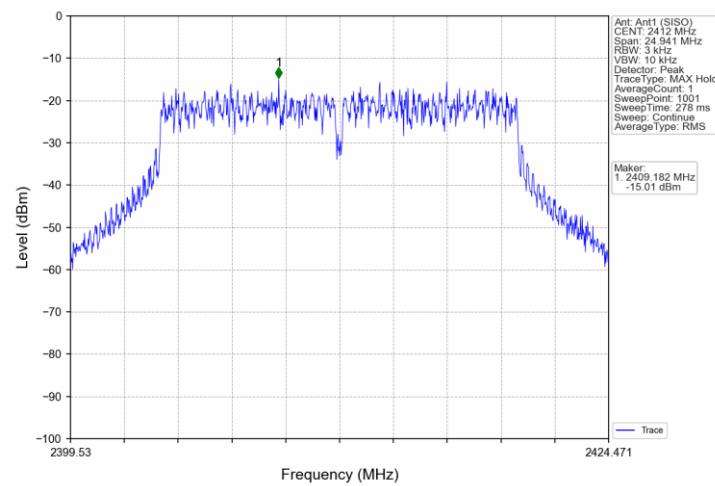
802.11b_MCH_2437MHz_Ant1 (SISO)_NTNV



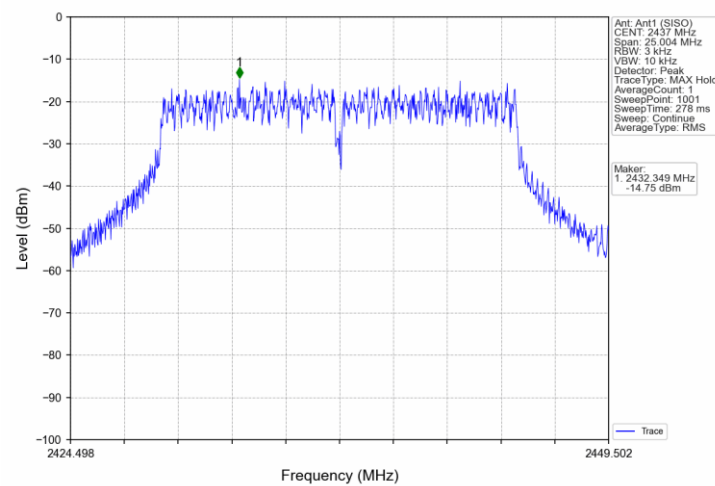
802.11b_HCH_2462MHz_Ant1 (SISO)_NTNV



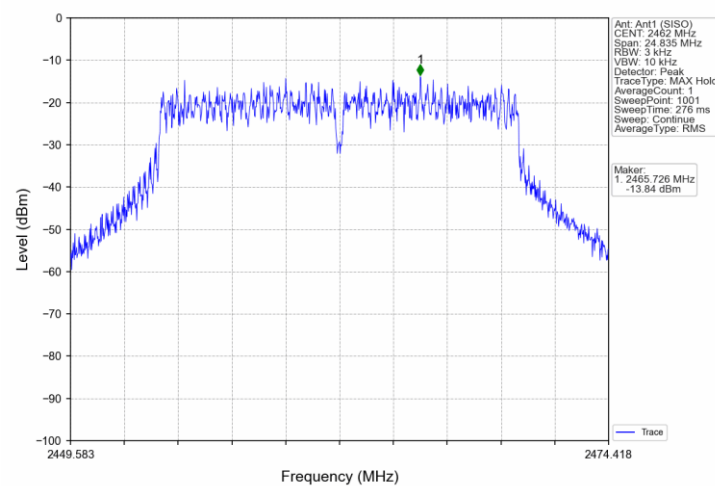
802.11g_LCH_2412MHz_Ant1 (SISO)_NTNV



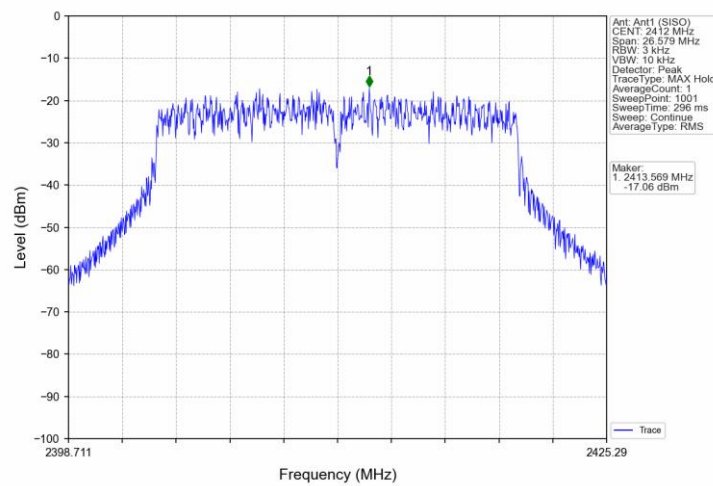
802.11g_MCH_2437MHz_Ant1 (SISO)_NTNV



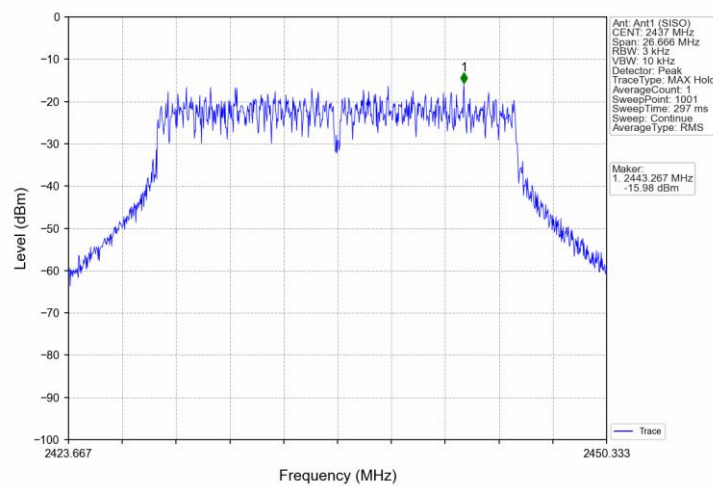
802.11g_HCH_2462MHz_Ant1 (SISO)_NTNV



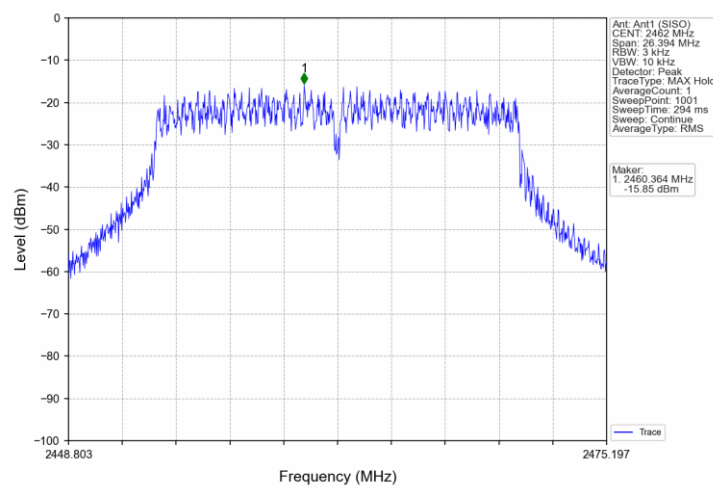
802.11n(HT20)_LCH_2412MHz_Ant1 (SISO)_NTNV



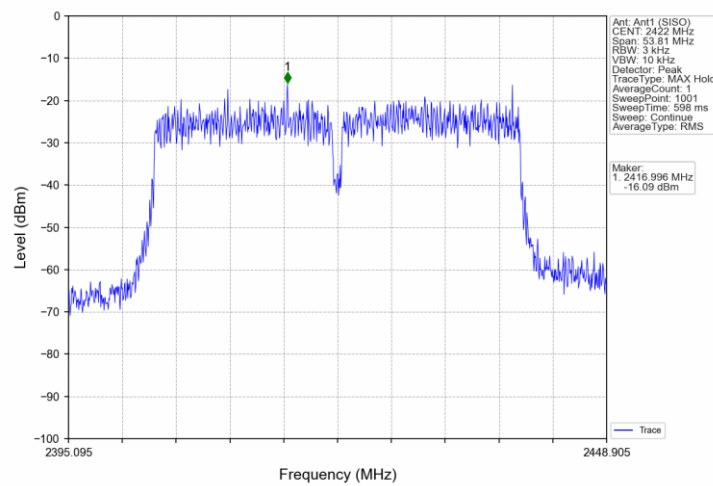
802.11n(HT20)_MCH_2437MHz_Ant1 (SISO)_NTNV



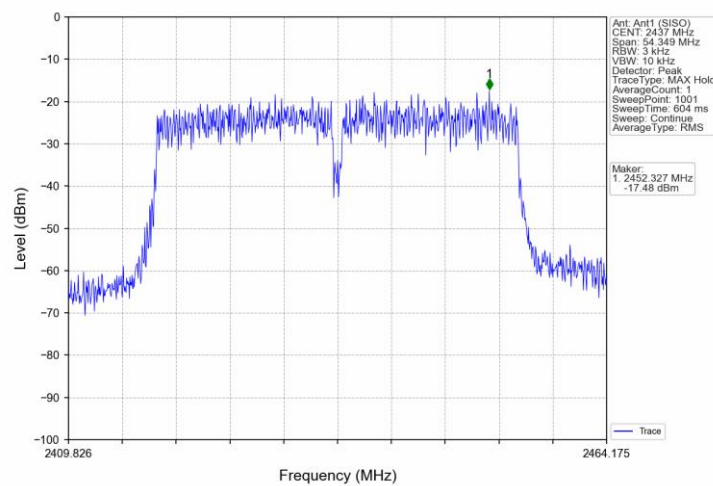
802.11n(HT20)_HCH_2462MHz_Ant1 (SISO)_NTNV



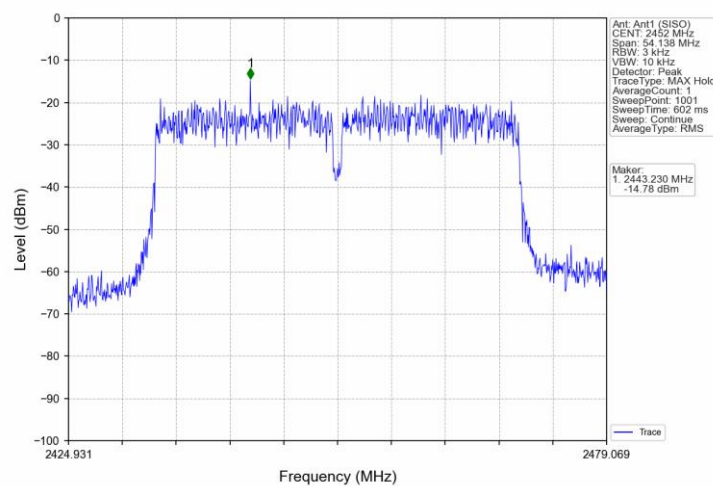
802.11n(HT40)_LCH_2422MHz_Ant1 (SISO)_NTNV



802.11n(HT40)_MCH_2437MHz_Ant1 (SISO)_NTNV



802.11n(HT40)_HCH_2452MHz_Ant1 (SISO)_NTNV



9.5 Spurious RF conducted emissions

Test Method

1. The RF output of EUT was connected to the spectrum analyzer by RF cable. The path loss was compensated to the results for each measurement.
2. Set to the maximum power setting, the instrument center frequency is set to the nominal EUT channel center frequency enable the EUT transmit continuously.
3. Use the following spectrum analyzer settings:
Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span.
RBW = 100 kHz, VBW $\geq$ 3RBW, Sweep = auto, Detector function = peak, Trace = max hold
4. Allow the trace to stabilize. Set the marker on the peak of any spurious emission recorded.
5. The level displayed must comply with the limit specified in this Section. Submit these plots.
6. Repeat above procedures until all frequencies measured were complete.

Limit

Frequency Range MHz	Limit (dBc)
30-25000	-20

Test Result

Mode	Frequency (MHz)	Level of Reference (dBm)	Limit (dBm)	Verdict
802.11b	2412	5.35	-14.65	Pass
	2437	3.39	-16.61	Pass
	2462	3.06	-16.94	Pass
802.11g	2412	-0.46	-20.46	Pass
	2437	0.22	-19.78	Pass
	2462	0.66	-19.34	Pass
802.11n (HT20)	2412	-1.57	-21.57	Pass
	2437	-0.74	-20.74	Pass
	2462	-0.30	-20.30	Pass
802.11n (HT40)	2422	-3.03	-23.03	Pass
	2437	-2.63	-22.63	Pass
	2452	-2.12	-22.12	Pass
Note1: Refer to FCC Part 15.247 (d) and ANSI C63.10-2020, the channel contains the maximum PSD level was used to establish the reference level.				