Test report

REP010975-1TRFWL

Date of issue: May 30, 2024

Applicant:

Space Exploration Technologies Corporation

Product description:

Wireless Module

Model:	Product marketing name(s):
UTW-231	N/A
FCC ID:	ISED certification number:
2AWHPW231	26207-UTW231

Specifications:

- FCC 47 CFR Part 15, Subpart C – §15.247
  Operation within the bands 902 – 928 MHz, 2400 – 2483.5 MHz, 5727 – 5850 MHz
- Industry Canada RSS-247, Issue 3
  Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

Lab and test locations

Company name	Nemko USA Inc.
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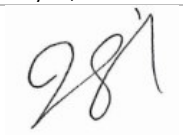
City	Carlsbad
State	California
Postal code	92008
Country	USA
Telephone	+1 760 444 3500
Website	www.nemko.com
FCC Site Number	Test Firm Registration Number: 392943; Designation Number: US5058
ISED Test Site	2040B-3

Tested by	Lan Sayasane, EMC Test Engineer Chenhao Ma, Wireless Test Technician
Reviewed by	James Cunningham, EMC/WL Manager
Review date	May 30, 2024
Reviewer signature	

Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.
This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contain in this report are within Nemko USA's ISO/IEC 17025 accreditation.
This report must not be used by the client to claim product certification, approval, or endorsement by ANAB, NIST, or any agency of the U.S. Government.

Copyright notification

Table of Contents

Section 1 Report summary

1.1 Test specifications

FCC 47 CFR Part 15, Subpart C – §15.247	Operation within the bands 902 – 928 MHz, 2400 – 2483.5 MHz, 5727 – 5850 MHz
Industry Canada RSS-247, Issue 3	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

1.2 Exclusions

None.

1.3 Statement of compliance

Testing was performed against all relevant requirements of the test standard(s).

Results obtained indicate that the product under test complies in full with the tested requirements.

The test results relate only to the item(s) tested.

See “Section 2 Summary of test results” for full details.

1.4 Test report revision history

Table 1.4-1: *Test report revision history*

Revision #	Issue Date	Details of changes made to test report
REP010975-1TRFEMC	May 30, 2024	Original report issued

Section 2 Summary of test results

2.1 Sample information

Receipt date	26-Feb-24
Nemko sample ID number	REP010975

2.2 Testing period

Test start date	26-Feb-24
Test end date	26-Apr-24

2.3 Test results

Table 2.3-1: *FCC 47 CFR Part 15, Subpart B & C, general requirements*

Part	Test description	Verdict
§15.207(a)	Conducted limits	Pass [1]
§15.31(e)	Variation of power source	Pass
§15.203	Antenna requirement	Pass

Notes: [1] EUT is directly or indirectly powered via AC mains

Table 2.3-2: *FCC 47 CFR Part 15, Subpart C, §15.247 requirements*

Part	Test description	Verdict
§15.247(a)(1)(i)	Frequency hopping systems operating in the 902–928 MHz band	Not applicable
§15.247(a)(1)(ii)	Frequency hopping systems operating in the 5725–5850 MHz band	Not applicable
§15.247(a)(1)(iii)	Frequency hopping systems operating in the 2400–2483.5 MHz band	Not applicable
§15.247(a)(2)	Minimum 6 dB bandwidth for systems using digital modulation techniques	Pass
§15.247(b)(1)	Maximum peak output power of frequency hopping systems operating in the 2400–2483.5 MHz band and 5725–5850 MHz band	Not applicable
§15.247(b)(2)	Maximum peak output power of Frequency hopping systems operating in the 902–928 MHz band	Not applicable
§15.247(b)(3)	Maximum peak output power of systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands	Pass
§15.247(b)(4)	Transmitting antennas of directional gain greater than 6 dBi	Not applicable
§15.247(c)(1)	Fixed point-to-point operation with directional antenna gains greater than 6 dBi	Not applicable
§15.247(c)(2)	Transmitters operating in the 2400–2483.5 MHz band that emit multiple directional beams	Not applicable
§15.247(d)	Spurious emissions	Pass
§15.247(e)	Power spectral density for digitally modulated devices	Pass
§15.247(f)	Time of occupancy for hybrid systems	Not applicable

Table 2.3-3: *ISED RSS-247 requirements*

Part	Test description	Verdict
5.1 (a)	Bandwidth of a frequency hopping channel	Not applicable
5.1 (b)	Minimum channel spacing for frequency hopping systems	Not applicable
5.1 (c)	Frequency hopping systems operating in the 902–928 MHz band	Not applicable
5.1 (d)	Frequency hopping systems operating in the 2400–2483.5 MHz band	Not applicable
5.1 (e)	Frequency hopping systems operating in the 5725–5850 MHz band	Not applicable
5.2 (a)	Minimum 6 dB bandwidth	Pass
5.2 (b)	Maximum power spectral density	Pass
5.3 (a)	Digital modulation turned off	Not applicable
5.3 (b)	Frequency hopping turned off	Not applicable
5.4 (a)	Frequency hopping systems operating in the 902–928 MHz band	Not applicable
5.4 (b)	Frequency hopping systems operating in the 2400–2483.5 MHz band	Not applicable
5.4 (c)	Frequency hopping systems operating in the 5725–5850 MHz	Not applicable
5.4 (d)	Systems employing digital modulation techniques	Pass
5.4 (e)	Point-to-point systems in 2400–2483.5 MHz and 5725–5850 MHz band	Not applicable
5.4 (f)	Transmitters which operate in the 2400–2483.5 MHz band with multiple directional beams	Not applicable
5.5	Out-of-band emissions	Pass

Table 2.3-4: *ISED RSS-GEN requirements*

Part	Test description	Verdict
6.7	Occupied bandwidth (99%)	Pass
7.3	Receiver radiated emission limits	Not applicable [1]
7.4	Receiver conducted emission limits	Not applicable [1]
8.8	Power Line Conducted Emissions Limits for Licence-Exempt Radio Apparatus	Pass

Notes: [1] Only applicable to scanner receivers or stand-alone receivers operating in the band 30-960 MHz

Section 3 Equipment under test (EUT) details

3.1 Disclaimer

This section contains information provided by the applicant and has been utilized to support the test plan. Inaccurate information provided by the applicant can affect the validity of the results within this test report. Nemko accepts no responsibility for the information contained within this section and the impact it may have on the test plan and resulting measurements.

3.2 Applicant

Company name	Space Exploration Technologies Corporation
Address	1 Rocket Road
City	Hawthorne
State	CA
Postal/Zip code	90240
Country	United States

3.3 Manufacturer

Company name	Space Exploration Technologies Corporation
Address	1 Rocket Road
City	Hawthorne
State	CA
Postal/Zip code	90240
Country	United States

3.4 EUT information

Product name	Wireless Module
Model	UTW-231
Variant(s)	N/A
Serial number	N/A
Part number	N/A
Power requirements	30 V DC / 2 A via 100-240 V AC/DC Adaptor
Description/theory of operation	Wi-Fi router supporting IEEE 802.11b/g/n/ax
Operational frequencies	2400 - 2483.5 MHz
Software details	N/A

3.5 Transmitter Information

Frequency band	2400 – 2483.5 MHz
Transmitter type	☐ Frequency hopping spread spectrum (FHSS) ☒ Digital transmission system (DTS) ☐ Hybrid FHSS / DTS
Minimum frequency (MHz)	2412
Maximum frequency (MHz)	2462
Type of modulation	IEEE 802.11b: DSSS-BPSK, DSSS-DQPSK, CCK-DQPSK, CCK-DQPSK IEEE 802.11g: OFDM-BPSK, OFDM-QPSK, OFDM-16QAM, OFDM-64QAM IEEE 802.11n: OFDM-BPSK, OFDM-QPSK, OFDM-16QAM, OFDM-64QAM
Data rate	IEEE 802.11b: Up to 11 Mbps IEEE 802.11g: Up to 54 Mbps IEEE 802.11n (HT20): Up to 195 Mbps IEEE 802.11n (HT40): Up to 405 Mbps
Antenna information	EUT includes 3 antenna ports (denoted ANT1, ANT2, ANT3). Maximum gain of each antenna in the operating band: ANT1: 5.11 dBi ANT2: 5.03 dBi ANT3: 4.56 dBi Maximum directional gain (for beamforming modes): 9.67 dBi Calculated using equation 40 from ANSI C63.10:2020: $\text{Directional gain} = 10\log\left[\left(10^{G_1/20}+10^{G_2/20}+\ldots+10^{G_N/20}\right)^2 / N_{\text{ANT}}\right]\ \text{dBi}$ (40)
Number of channels:	IEEE 802.11b, IEEE 802.11g, IEEE 802.11n (HT20): 11 IEEE 802.11n (HT40): 7
MIMO operation	IEEE 802.11n (HT20) and (HT40) support beamforming and cyclic delay diversity (CDD) modes of operation IEEE 802.11b and g only support CDD mode

3.6 Channel list

11 channels are available for IEEE 802.11b, IEEE 802.11g and IEEE 802.11n (HT20) operational modes:

Channel	Frequency	Channel	Frequency
1	2412 MHz	7	2442 MHz
2	2417 MHz	8	2447 MHz
3	2422 MHz	9	2452 MHz
4	2427 MHz	10	2457 MHz
5	2432MHz	11	2462 MHz
6	2437 MHz		

7 channels are available for IEEE 802.11n (HT40) operational mode:

Channel	Frequency	Channel	Frequency
3	2422 MHz	7	2442 MHz
4	2427 MHz	8	2447 MHz
5	2432 MHz	9	2452 MHz
6	2437 MHz		

3.7 Operating modes

Pre-scanning was performed to identify:

a. Worst-case spatial orientation for maximum emission

b. Worst-case modulation/data rate settings for a given IEEE 802.11x operating mode

Based on this pre-scanning, the following channels/modes were selected for testing:

Test Item	Mode	Signal mode	Tested channel(s)	Modulation / data rate
RF output power	IEEE 802.11b	CDD	1, 6, 11	CCK-DQPSK (5.5 Mbps)
	IEEE 802.11g	CDD	1, 7, 11	OFDM-64QAM (54 Mbps)
	IEEE 802.11n (HT20)	CDD and beamforming	1, 7, 11	OFDM-64QAM_MCS23 (195 Mbps)
	IEEE 802.11n (HT40)	CDD and beamforming	3, 6, 9	OFDM-64QAM_MCS22 (175.5 Mbps)
Power spectral density	IEEE 802.11b	CDD	1, 7, 11	CCK-DQPSK (5.5 Mbps)
DTS bandwidth	IEEE 802.11g	CDD	1, 7, 11	OFDM-64QAM (54 Mbps)
Conducted spurious	IEEE 802.11n (HT20)	CDD	1, 7, 11	OFDM-64QAM_MCS23 (195 Mbps)
emissions	IEEE 802.11n (HT40)	CDD	3, 6, 9	OFDM-64QAM_MCS22 (175.5 Mbps)
AC power line conducted emissions	IEEE 802.11n (HT40)	CDD	7	OFDM-64QAM_MCS22 (175.5 Mbps)
Radiated emissions < 1 GHz	IEEE 802.11n (HT40)	CDD	7	OFDM-64QAM_MCS22 (175.5 Mbps)
Radiated emissions > 1 GHz	IEEE 802.11b	CDD	1, 7, 11	CCK-DQPSK (5.5 Mbps)
	IEEE 802.11g	CDD	1, 7, 11	OFDM-64QAM (54 Mbps)
	IEEE 802.11n (HT20)	CDD	1, 7, 11	OFDM-64QAM_MCS23 (195 Mbps)
	IEEE 802.11 (HT40)	CDD	3, 6, 9	OFDM-64QAM_MCS22 (175.5 Mbps)

3.8 Transmitter power settings

Power levels of the transmitter were set to the levels below using proprietary software. The levels below were used for all testing.

Table 3.8-1: *EUT transmitter power levels*

Operational Mode	Channel	Frequency	Power Level in Tool
IEEE 802.11b	1	2412	0x28
	7	2442	0x28
	11	2462	0x27
IEEE 802.11g	1	2412	0x1A
	7	2442	0x28
	11	2462	0x1D
IEEE 802.11n (HT20), CDD	1	2412	0x17
	7	2442	0x17
	11	2462	0x17
IEEE 802.11n (HT40), CDD	3	2422	0x0C
	6	2437	0x2E
	9	2465	0x17
IEEE 802.11n (HT20), Beamforming	1	2412	0x25
	7	2442	0x25
	11	2462	0x25
IEEE 802.11n (HT40), Beamforming	3	2422	0x24
	6	2437	0x24
	9	2465	0x24

3.9 EUT setup details

Table 3.9-1: *EUT sub assemblies*

Description	Brand name	Model/Part number	Serial number	Rev.
Wireless router	Starlink	UTR-232	UTA232W-CON-DUT-2	N/A
AC/DC adaptor	Starlink	UTP-231L	PMLV241080000674	N/A

Table 3.9-2: *EUT interface ports*

Description	Qty.
DC power input	1
Ethernet	1

Table 3.9-3: *Support equipment*

Description	Brand name	Model/Part number	Serial number	Rev.
Laptop PC				

Table 3.9-4: *Inter-connection cables*

Cable description	From	To	Length (m)
Ethernet	Laptop PC	Wireless router (EUT)	1
AC power	Facility power	AC/DC adaptor	1

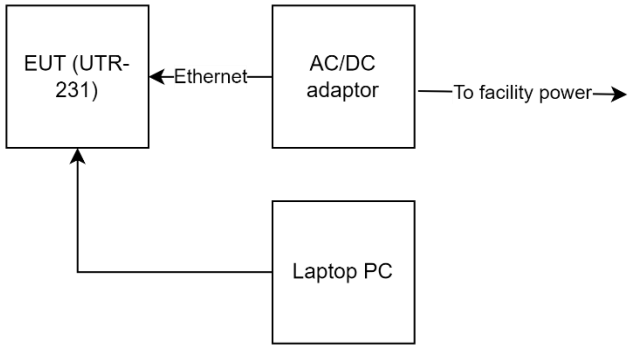


Figure 3.9-1: Test setup diagram

Section 4 Engineering considerations

4.1 Modifications incorporated in the EUT

None.

4.2 Technical judgement

None.

4.3 Deviations from laboratory test procedures

None.

Section 5 Test conditions

5.1 Atmospheric conditions

Temperature	15–30 °C
Relative humidity	20–75 %
Air pressure	86–106 kPa

When it is impracticable to carry out tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests shall be recorded and stated.

5.2 Power supply range

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage, or any of the declared voltages ±5 %, for which the equipment was designed.

Section 6 Measurement uncertainty

6.1 Uncertainty of measurement

Nemko USA Inc. has calculated measurement uncertainty and is documented in EMC/MUC/001 “Uncertainty in EMC measurements.” Measurement uncertainty was calculated using the methods described in CISPR 16-4-2 Specification for radio disturbance and immunity measuring apparatus and methods – Part 4-2: Uncertainties, statistics, and limit modelling – Measurement instrumentation uncertainty. The expression of Uncertainty in EMC testing. Measurement uncertainty calculations assume a coverage factor of K=2 with 95% certainty.

Table 6.1-1: *Measurement uncertainty calculations*

Measurement		**U_{cispr} dB**	**U_{lab} dB**
Conducted disturbance at AC mains and other port power using a V-AMN	9 kHz to 150 kHz	3.8	2.9
	150 kHz to 30 MHz	3.4	2.3
Conducted disturbance at telecommunication port using AAN	150 kHz to 30 MHz	5.0	4.3
Conducted disturbance at telecommunication port using CVP	150 kHz to 30 MHz	3.9	2.9
Conducted disturbance at telecommunication port using CP	150 kHz to 30 MHz	2.9	1.4
Conducted disturbance at telecommunication port using CP and CVP	150 kHz to 30 MHz	4.0	3.1
Radiated disturbance (electric field strength in a SAC)	30 MHz to 1 GHz	6.3	5.5
Radiated disturbance (electric field strength in a FAR)	1 GHz to 6 GHz	5.2	4.7
Radiated disturbance (electric field strength in a FAR)	6 GHz to 18 GHz	5.5	5.0

Notes: Compliance assessment:

If U_{lab} is less than or equal to U_{cispr} then:

- compliance is deemed to occur is no measured disturbance level exceeds the disturbance limit;
- non-compliance is deemed to occur if any measured disturbance level exceeds the disturbance limit

If U_{lab} is greater than U_{cispr} then:

- compliance is deemed to occur is no measured disturbance level, increased by (U_{lab} - U_{cispr}), exceeds the disturbance limit;
- non-compliance is deemed to occur if any measured disturbance level, increased by (U_{lab} - U_{cispr}), exceeds the disturbance limit

V-AMN: V type artificial mains network
AAN: Asymmetric artificial network
CP: Current probe
CVP: Capacitive voltage probe
SAC: Semi-anechoic chamber
FAR: Fully anechoic room

Section 7 Test equipment

7.1 Test equipment list

Table 7.1-1: *Test Equipment List*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
Two Line V-Network	Rohde & Schwarz	ENV216	E1019	1 year	03-Oct-2024
EMI Test Receiver 9kHz to 7GHz	Rohde & Schwarz	ESCI 7	E1026	1 year	18-Apr-2025
Antenna, Bilog	Schaffner	CBL 6111D	1763	2 years	01-Jul-2024
Power Sensor	ETS-Lindgren	7002-006	E1061	1 year	27-Jul-2024
Power Sensor	ETS-Lindgren	7002-006	E1062	1 year	27-Jul-2024
Power Sensor	ETS-Lindgren	7002-006	EW110	1 year	14-Apr-2025
EMI Test Receiver	Rohde & Schwarz	ESU 40	E1121	1 year	23-Aug-2024
Transient Limiter	HP	11947A	E1159	1 year	28-Feb-2025
DRG Horn (medium)	ETS-Lindgren	3117-PA	E1160	2 years	13-Feb-2025
Signal & Spectrum Analyzer 2Hz / 43.5 GHz	Rohde & Schwarz	FSW43	E1302	1 year	22-Jan-2025

Notes: NCR: no calibration required
VBU: verify before use

7.2 Test software list

Table 7.2-1: *Test Software*

Manufacturer	Details
Rohde & Schwarz	EMC 32 V10.60.10 (AC conducted emissions)
Rohde & Schwarz	EMC 32 V10.60.15 (radiated emissions)

Section 8 Testing data

8.1 Duty cycle of test signal

8.1.1 References and limits

For information only.

8.1.2 Test summary

Verdict	For information		
Test date	February 26, 2024	Temperature	20 °C
Test engineer	Lan Sayasane, EMC Test Engineer	Air pressure	1007 mbar
Test location	☐ 10m semi anechoic chamber ☐ 3m semi anechoic chamber ☒ Wireless bench: ☐ Other:	Relative humidity	49 %

8.1.3 Notes

None

8.1.4 Setup details

EUT power input during test	120 VAC / 60 Hz
EUT setup configuration	☒ Table-top ☐ Floor standing ☐ Other:

Measurements were performed with an RF power meter with built-in duty cycle and transmission duration measurement.

8.1.5 Test data

IEEE 802.11b operation:

Table 8.1-1: *Duty cycle of test signal test data*

Duty Cycle (%)	Transmission Duration (ms)
99.295	8.416

IEEE 802.11g operation:

Table 8.1-2: *Duty cycle of test signal test data*

Duty Cycle (%)	Transmission Duration (ms)
95.856	1.396

IEEE 802.11n (HT20) operation:

Table 8.1-3: *Duty cycle of test signal test data*

Duty Cycle (%)	Transmission Duration (ms)
91.769	0.672

IEEE 802.11n (HT40) operation:

Table 8.1-4: *Duty cycle of test signal test data*

Duty Cycle (%)	Transmission Duration (ms)
91.541	0.648

8.2 Conducted limits / power line conducted emissions limits for licence-exempt radio apparatus

8.2.1 References and limits

- FCC 47 CFR Part 15, Subpart C: §15.207
- ISED: RSS-GEN §6.8
- Test method: ANSI C63.10-2020 §6.2

Table 8.2-1: *Conducted emissions limit*

Frequency of emission, MHz	Conducted limit, dBµV	
	Quasi-peak	Average
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

Note: * Decreases with the logarithm of the frequency.

8.2.2 Test summary

Verdict	Pass		
Test date	March 8, 2024	Temperature	18 °C
Test engineer	Chenhao Ma, Wireless Test Technician	Air pressure	1006 mbar
Test location	☐ 10m semi anechoic chamber ☐ 3m semi anechoic chamber ☒ Other: Ground plane	Relative humidity	1005 %

8.2.3 Notes

Testing was performed with the transmitter operating on a fixed channel (lowest, middle, and highest) at maximum output power.

The spectral plots within this section have been corrected with all relevant transducer factors.

For EUT's supporting multiple modulation schemes and/or data rates, testing is performed with the modulation and data rate that produces the highest transmitter output power.

8.2.4 Setup details

Port under test	AC power input
EUT power input during test	120 VAC / 60 Hz
EUT setup configuration	☒ Table-top ☐ Floor standing ☐ Other:
Measurement details	A preview measurement was generated with the receiver in continuous scan mode. Emissions detected within 6 dB or above limit were re-measured with the appropriate detector against the correlating limit and recorded as the final measurement.
Modulation scheme / data rate tested	IEEE 802.11n HT40, middle channel (Other operational modes investigated – only this worst-case mode reported)

Receiver settings:

Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Detector mode	– Peak (Preview measurement) – Quasi-peak and CAverage (Final measurement)
Trace mode	Max Hold
Measurement time	– 100 ms (Peak and Average preview measurement) – 5000 ms (Quasi-peak final measurement) – 5000 ms (CAverage final measurement)

8.2.5 Test data

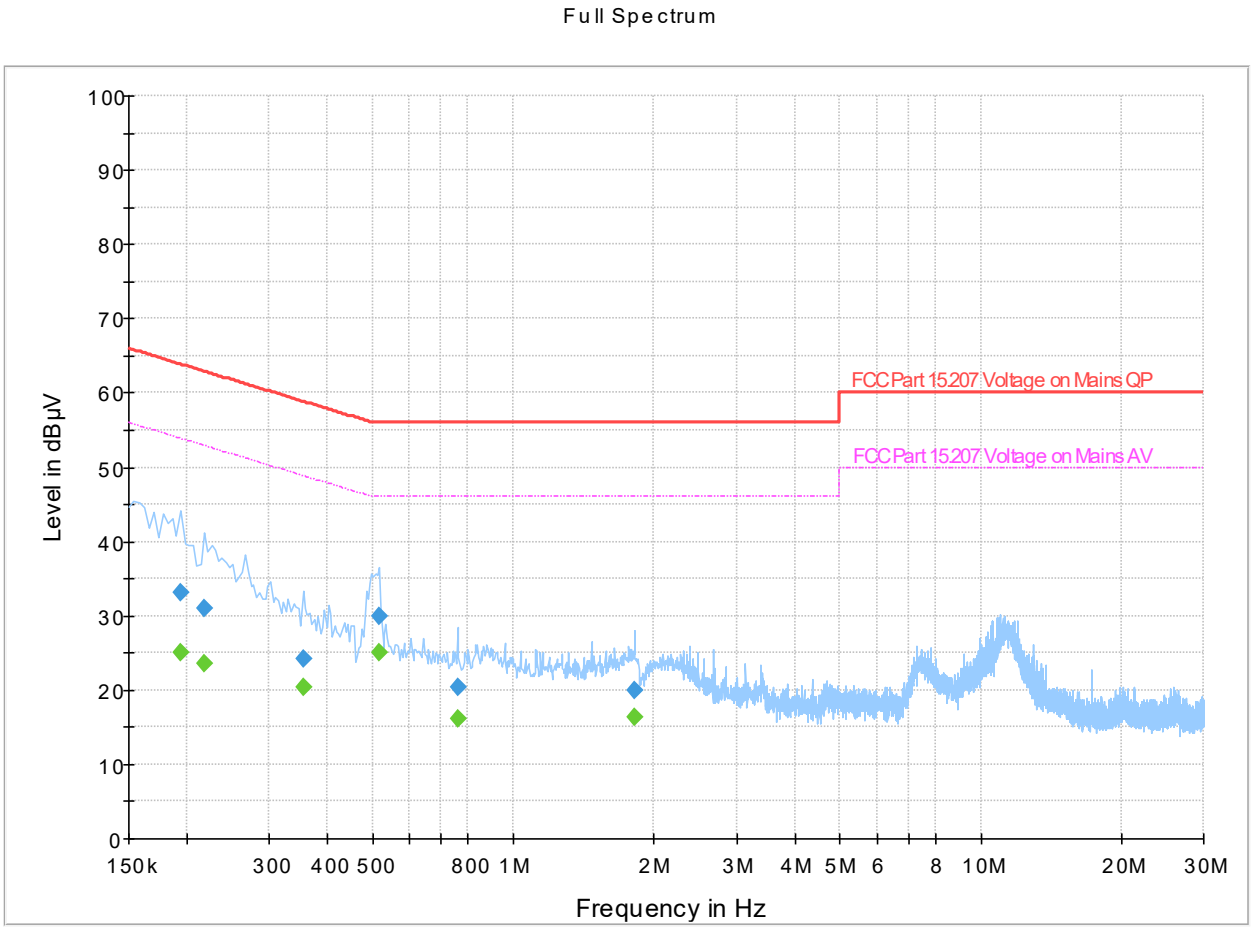


Figure 8.2-1: *Conducted emissions at mains port spectral plot (150 kHz - 30 MHz)*

Table 8.2-2*: Conducted emissions at mains port results*

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.194000	33.07	---	63.86	30.79	5000.0	9.000	N	ON	19.6
0.194000	---	25.14	53.86	28.72	5000.0	9.000	N	ON	19.6
0.218000	---	23.63	52.90	29.27	5000.0	9.000	N	ON	19.7
0.218000	31.10	---	62.90	31.79	5000.0	9.000	N	ON	19.7
0.354000	24.24	---	58.87	34.63	5000.0	9.000	N	ON	19.7
0.354000	---	20.42	48.87	28.45	5000.0	9.000	N	ON	19.7
0.514000	---	25.02	46.00	20.98	5000.0	9.000	L1	ON	19.7
0.514000	30.04	---	56.00	25.96	5000.0	9.000	L1	ON	19.7
0.758000	---	16.13	46.00	29.87	5000.0	9.000	N	ON	19.7
0.758000	20.36	---	56.00	35.64	5000.0	9.000	N	ON	19.7
1.818000	---	16.43	46.00	29.57	5000.0	9.000	N	ON	19.8
1.818000	20.02	---	56.00	35.98	5000.0	9.000	N	ON	19.8

Notes:
[1] Result (dBµV) = receiver analyzer value (dBµV) + correction factor (dB).
[2] Correction factors = LISN factor IL (dB) + cable loss (dB) + transient limiter (dB)
[3] Emissions that were continuously present for a minimum of 1 second and occurred more than once for every 15 seconds observation period were considered valid emissions. The maximum value of valid emissions has been recorded.

8.3 Variation of power source

8.3.1 References and limits

- FCC 47 CFR Part 15, Subpart A: §15.31(e)
- Test method: ANSI C63.10-2020 §5.13

§15.31(e):
For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. For battery operated equipment, the equipment tests shall be performed using a new battery.

8.3.2 Test summary

Verdict	Pass		
Test date	March 1, 2024	Temperature	21 °C
Test engineer	Lan Sayasane, EMC Test Engineer	Air pressure	1006 mbar
Test location	☒ Wireless bench ☐ Other:	Relative humidity	54 %

8.3.3 Notes

Testing was performed with the transmitter operating on a fixed channel (middle) at maximum output power.

8.3.4 Setup details

EUT power input during test	120 VAC / 60 Hz

8.3.5 Test data

☐	EUT is battery operated. Therefore, all tests performed with a new fully charged battery
☒	EUT power supply voltage varied across supported range. No variation in transmitter output power observed therefore all tests performed at nominal power supply voltage.
☐	EUT power supply voltage varied across supported range. Transmitter output power variation was observed. All tests performed with the EUT operated at the worst-case operating voltage with respect to transmitter output power: V.

8.4 Antenna requirement

8.4.1 References and limits

- FCC 47 CFR Part 15, Subpart C: §15.203

§15.203:
An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. Test summary

Verdict	Pass		
Test date	March 25, 2024	Temperature	20 °C
Test engineer	Chenhao Ma, Wireless Test Technician	Air pressure	1006 mbar
Test location	☒ Wireless bench ☐ Other:	Relative humidity	55 %

8.4.2 Notes

None

8.4.3 Test data

Antenna part number:	Not provided
Technical description:	Not provided
Peak gain (dBi):	ANT1: 5.11 dBi ANT2: 5.03 dBi ANT3: 4.56 dBi
Source of gain data:	☐ Declared by client ☐ Antenna data sheet or specification. Document name: ☒ Antenna gain test report. Document name: Test Summary_P24010066_WNC_Spacex mini desh_Gain_20240202.xls

8.5 Minimum 6 dB bandwidth

8.5.1 References and limits

- FCC 47 CFR Part 15, Subpart C: §15.247(a)(2)
- ISED: RSS-247 5.2(a)
- Test method: ANSI C63.10-2020 §11.8.1

§15.247:

(a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

(2) Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

RSS-247:

5.2 DTSs include systems that employ digital modulation techniques resulting in spectral characteristics similar to direct sequence systems. The following applies to the bands 902-928 MHz and 2400-2483.5 MHz:

(a) The minimum 6 dB bandwidth shall be 500 kHz.

8.5.2 Test summary

Verdict	Pass		
Test date	February 29, 2024	Temperature	20 °C
Test engineer	Lan Sayasane, EMC Test Engineer	Air pressure	1008 mbar
Test location	☒ Wireless bench ☐ Other:	Relative humidity	55 %

8.5.3 Notes

Testing was performed with the transmitter operating on a fixed channel (lowest, middle, and highest) at maximum output power.

The spectral plots within this section have been corrected with all relevant transducer factors.

8.5.4 Setup details

EUT power input during test	120 VAC / 60 Hz
EUT setup configuration	☒ Table-top ☐ Floor standing ☐ Other:

Receiver/spectrum analyzer settings:

Resolution bandwidth	1 – 5 % of nominal bandwidth, minimum of 100 kHz
Video bandwidth	3 x resolution bandwidth
Detector mode	Peak
Trace mode	Max Hold
Measurement time	Long enough for trace to stabilize

8.5.5 Test data

8.5.5.1 IEEE 802.11b (CDD) mode:

Table 8.5-1: *Minimum 6 dB bandwidth test data, IEEE 802.11b (CDD) mode*

Channel	Frequency (MHz)	Modulation	DTS Bandwidth (kHz)			Limit (kHz)
			ANT1	ANT2	ANT3	
1	2412	CCK-DQPSK (5.5 Mbps)	7691.040	**7913.745**	7667.765	≥ 500
7	2442		7890.960	8308.440	7957.600	
11	2462		7946.820	8278.550	7890.225	

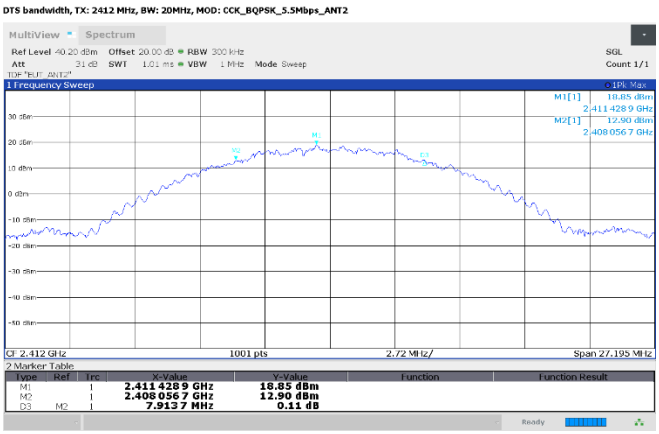


Figure 8.5-1: *Minimum 6 dB bandwidth, IEEE 802.11b (CDD mode), minimum measured DTS bandwidth*

8.5.5.2 IEEE 802.11g (CDD) mode:

Table 8.5-2: *Minimum 6 dB bandwidth test data, IEEE 802.11g (CDD) mode*

Channel	Frequency (MHz)	Modulation	DTS Bandwidth (kHz)			Limit (kHz)
			ANT1	ANT2	ANT3	
1	2412	OFDM-64QAM (54 Mbps)	16310.000	16170.000	15820.000	≥ 500
7	2442		**15610.000**	15610.000	16030.000	
11	2462		16170.000	16240.000	15750.000	

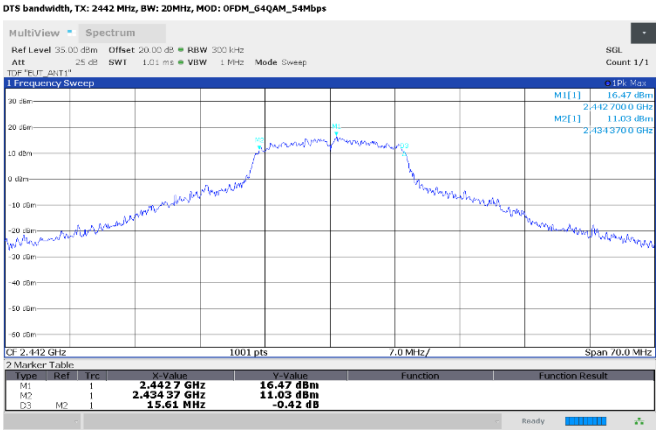


Figure 8.5-2: *Minimum 6 dB bandwidth, IEEE 802.11g (CDD mode), minimum measured DTS bandwidth*

8.5.5.3 IEEE 802.11n HT20 (CDD) mode:

Table 8.5-3: *Minimum 6 dB bandwidth test data, IEEE 802.11n HT20 (CDD) mode*

Channel	Frequency (MHz)	Modulation	DTS Bandwidth (kHz)			Limit (kHz)
			ANT1	ANT2	ANT3	
1	2412	OFDM-64QAM_MCS23 (195 Mbps)	16940.000	17430.000	17360.000	≥ 500
7	2442		**16100.000**	16940.000	17220.000	
11	2462		17430.000	16170.000	17150.000	

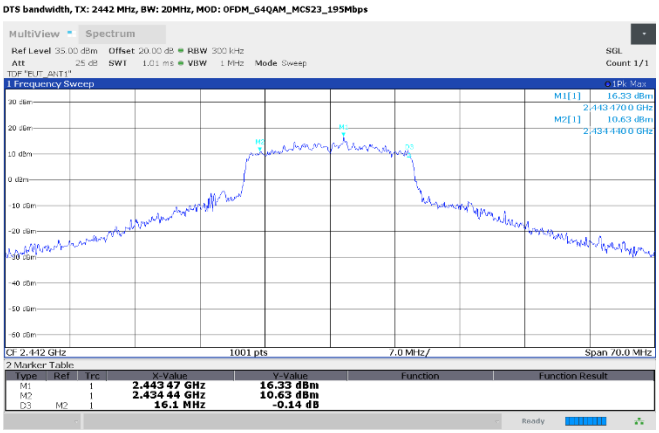


Figure 8.5-3: *Minimum 6 dB bandwidth, IEEE 802.11n HT20 (CDD mode), minimum measured DTS bandwidth*

8.5.5.4 IEEE 802.11n HT40 (CDD) mode:

Table 8.5-4: *Minimum 6 dB bandwidth test data, IEEE 802.11n HT40 (CDD) mode*

Channel	Frequency (MHz)	Modulation	DTS Bandwidth (kHz)			Limit (kHz)
			ANT1	ANT2	ANT3	
3	2422	OFDM-64QAM_MCS22 (175.5 Mbps)	35280.000	35700.000	35560.000	≥ 500
6	2437		**34860.000**	35980.000	35700.000	
9	2452		34720.000	35840.000	35980.000	

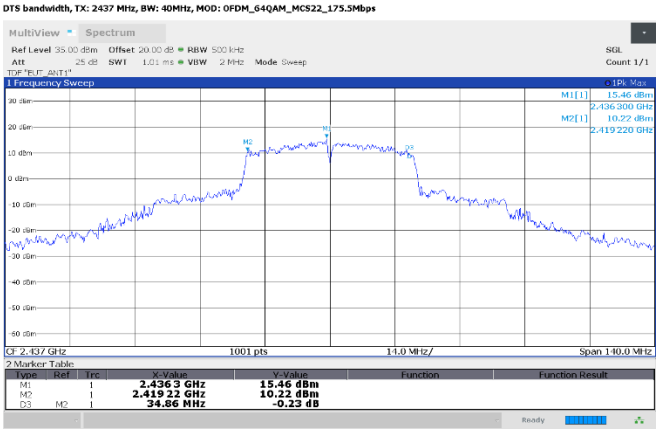


Figure 8.5-4: *Minimum 6 dB bandwidth, IEEE 802.11n HT40 (CDD mode), minimum measured DTS bandwidth*

8.6 Maximum peak output power

8.6.1 References and limits

- FCC 47 CFR Part 15, Subpart C: §15.247(b)(3)
- ISED: RSS-247 5.4(d)
- Test method: ANSI C63.10-2020 §11.9.2.3.1 (Average power method AVGPM)

§15.247:

(b) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

(3) For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one-Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

RSS-247:

5.4 Devices shall comply with the following requirements, where applicable:

(d) For DTSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1 W. The EIRP shall not exceed 4 W, except as provided in RSS 247 section 5.4(e).

As an alternative to a peak power measurement, compliance can be based on a measurement of the maximum conducted output power. The maximum conducted output power is the total transmit power delivered to all antennas and antenna elements, averaged across all symbols in the signalling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or transmitting at a reduced power level. If multiple modes of operation are implemented, the maximum conducted output power is the highest total transmit power occurring in any mode.

8.6.2 Test summary

Verdict	Pass		
Test date	February 29, 2024	Temperature	20 °C
Test engineer	Lan Sayasane, EMC Test Engineer	Air pressure	1008 mbar
Test location	☒ Wireless bench ☐ Other:	Relative humidity	55 %

8.6.3 Notes

Testing was performed with the transmitter operating on a fixed channel (lowest, middle, and highest) at maximum output power.

The spectral plots within this section have been corrected with all relevant transducer factors.

8.6.4 Setup details

EUT power input during test	120 VAC, 60 Hz
EUT setup configuration	☒ Table-top ☐ Floor standing ☐ Other:

8.6.5 Test data

8.6.5.1 IEEE 802.11b (CDD) mode

Table 8.6-1: *Maximum peak output power test data*

Channel	Frequency (MHz)	Modulation	Average power (dBm)			Total power (mw)	Total power (dBm)	Power Limit (dBm)	EIRP (ISED) (dBm)
			ANT1	ANT2	ANT3				
1	2412	CCK-DQPSK (5.5 Mbps)	24.75	23.90	25.18	873.619	29.41	30.00	34.52
7	2442		24.82	24.01	25.43	904.297	29.56	30.00	34.67
11	2462		24.92	24.10	25.36	911.053	29.60	30.00	34.71

EIRP reported per ISED requirements and calculated by adding highest (worst-case) antenna gain (5.11 dBi) to total conducted power.
The maximum gain is 5.11 dBi < 6 dBi, so the output power limit shall not be reduced.

8.6.5.2 IEEE 802.11g (CDD) mode

Table 8.6-2: *Maximum peak output power test data*

Channel	Frequency (MHz)	Modulation	Average power (dBm)			Total power (mw)	Total power (dBm)	Power Limit (dBm)	EIRP (ISED) (dBm)
			ANT1	ANT2	ANT3				
1	2412	OFDM-64QAM (54 Mbps)	25.03	24.27	25.62	950.474	29.78	30.00	34.89
7	2442		25.12	24.45	25.73	977.810	29.90	30.00	35.01
11	2462		25.28	24.46	25.83	998.724	29.99	30.00	25.10

EIRP reported per ISED requirements and calculated by adding highest (worst-case) antenna gain (5.11 dBi) to total conducted power.
The maximum gain is 5.11 dBi < 6 dBi, so the output power limit shall not be reduced.

8.6.5.3 IEEE 802.11n HT20 (CDD) mode

Table 8.6-3: *Maximum peak output power test data*

Channel	Frequency (MHz)	Modulation	Average power (dBm)			Total power (mw)	Total power (dBm)	Power Limit (dBm)	EIRP (ISED) (dBm)
			ANT1	ANT2	ANT3				
1	2412	OFDM-64QAM_MCS23 (195 Mbps)	23.33	22.52	23.74	630.519	28.00	30.00	33.11
7	2442		23.44	22.63	23.95	652.345	28.14	30.00	33.25
11	2462		25.20	24.56	25.82	998.834	29.99	30.00	35.10

EIRP reported per ISED requirements and calculated by adding highest (worst-case) antenna gain (5.11 dBi) to total conducted power.
The maximum gain is 5.11 dBi < 6 dBi, so the output power limit shall not be reduced.

8.6.5.4 IEEE 802.11n HT40 (CDD) mode

Table 8.6-4: *Maximum peak output power test data*

Channel	Frequency (MHz)	Modulation	Average power (dBm)			Total power (mw)	Total power (dBm)	Power Limit (dBm)	EIRP (ISED) (dBm)
			ANT1	ANT2	ANT3				
3	2422	OFDM-64QAM_MCS22 (175.5 Mbps)	19.75	19.39	21.21	313.432	24.96	30.00	30.07
6	2437		19.70	19.31	21.23	311.375	24.93	30.00	30.04
9	2452		19.80	19.33	21.29	315.789	24.99	30.00	30.10

EIRP reported per ISED requirements and calculated by adding highest (worst-case) antenna gain (5.11 dBi) to total conducted power.
The maximum gain is 5.11 dBi < 6 dBi, so the output power limit shall not be reduced.

8.6.5.5 IEEE 802.11n HT20 (beamforming) mode

Table 8.6-5: *Maximum peak output power test data*

Channel	Frequency (MHz)	Modulation	Average power (dBm)			Total power (mw)	Total power (dBm)	Power Limit (dBm)	EIRP (ISED) (dBm)
			ANT1	ANT2	ANT3				
1	2412	OFDM-64QAM_MCS23 (195 Mbps)	19.76	19.48	20.89	306.083	24.86	26.33	34.53
7	2442		19.45	19.09	20.63	284.812	24.55	26.33	34.22
11	2462		19.46	19.11	20.78	289.452	24.62	30.00	34.29

Directional gain is 9.67 dBi which is greater than 6 dBi. Therefore, conducted power limit is reduced by 9.67 – 6 = 3.67 dB.
EIRP reported per ISED requirements and calculated by adding highest directional gain (9.67 dBi) to total conducted power.

8.6.5.6 IEEE 802.11n HT40 (beamforming) mode

Table 8.6-6: *Maximum peak output power test data*

Channel	Frequency (MHz)	Modulation	Average power (dBm)			Total power (mw)	Total power (dBm)	Power Limit (dBm)	EIRP (ISED) (dBm)
			ANT1	ANT2	ANT3				
3	2422	OFDM-64QAM_MCS22 (175.5 Mbps)	21.19	20.69	22.45	424.534	26.28	26.33	35.95
6	2437		21.27	20.83	22.40	428.808	26.33	26.33	35.99
9	2452		21.25	20.81	22.42	428.438	26.32	26.33	35.99

Directional gain is 9.67 dBi which is greater than 6 dBi. Therefore, conducted power limit is reduced by 9.67 – 6 = 3.67 dB.
EIRP reported per ISED requirements and calculated by adding highest directional gain (9.67 dBi) to total conducted power.

8.7 Spurious emissions

8.7.1 References and limits

- FCC 47 CFR Part 15, Subpart C: §15.247(d)
- RSS-247: §5.5
- Test method: ANSI C63.10-2020 §6.10.4 (authorized band edge)
- Test method: ANSI C63.10-2020 §11.11 (antenna port conducted spurious emissions)
- Test method: ANSI C63.10-2020 §11.12.3 (radiated restricted band edge)
- Test method: ANSI C63.10-2020 §6.5, 6.6 (radiated emissions in restricted bands)

§15.247:

(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a) (see § 15.205(c)).

RSS-247:

5.5 In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

Table 8.7-1: *FCC §15.209 / RSS-GEN §8.9– Radiated emission limits*

Frequency, MHz	Field strength of emissions µV/m	Field strength of emissions dBµV/m	Measurement distance, m
0.009–0.490	2400/F	$67.6 - 20 \times \log_{10}(F)$	300
0.490–1.705	24000/F	$87.6 - 20 \times \log_{10}(F)$	30
1.705–30.0	30	29.5	30
30–88	100	40.0	3
88–216	150	43.5	3
216–960	200	46.0	3
above 960	500	54.0	3

Notes: In the emission table above, the tighter limit applies at the band edges.
For frequencies above 1 GHz the limit on peak RF emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test.

Table 8.7-2: *FCC restricted frequency bands*

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
0.495–0.505	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225	123–138	2200–2300	14.47–14.5
8.291–8.294	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675	156.7–156.9	2690–2900	22.01–23.12
8.41425–8.41475	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025	240–285	3345.8–3358	36.43–36.5
12.57675–12.57725	322–335.4	3600–4400	Above 38.6
13.36–13.41			

Table 8.7-3: *ISED RSS-GEN restricted frequency bands*

MHz	MHz	GHz
090 - 0.110	149.9 - 150.05	9.0 - 9.2
0.495 - 0.505	156.52475 - 156.52525	9.3 - 9.5
2.1735 - 2.1905	156.7 - 156.9	10.6 - 12.7
3.020 - 3.026	162.0125 - 167.17	13.25 - 13.4
4.125 - 4.128	167.72 - 173.2	14.47 - 14.5
4.17725 - 4.17775	240 – 285	15.35 - 16.2
4.20725 - 4.20775	322 - 335.4	17.7 - 21.4
5.677 - 5.683	399.9 - 410	22.01 - 23.12
6.215 - 6.218	608 - 614	23.6 - 24.0
6.26775 - 6.26825	960 - 1427	31.2 - 31.8
6.31175 - 6.31225	1435 - 1626.5	36.43 - 36.5
8.291 - 8.294	1645.5 - 1646.5	Above 38.6
8.362 - 8.366	1660 - 1710	
8.37625 - 8.38675	1718.8 - 1722.2	
8.41425 - 8.41475	2200 - 2300	
12.29 - 12.293	2310 - 2390	
12.51975 - 12.52025	2483.5 - 2500	
12.57675 - 12.57725	2655 - 2900	
13.36 - 13.41	3260 – 3267	
16.42 - 16.423	3332 - 3339	
16.69475 - 16.69525	3345.8 - 3358	
16.80425 - 16.80475	3500 - 4400	
25.5 - 25.67	4500 - 5150	
37.5 - 38.25	5350 - 5460	
73 - 74.6	7250 - 7750	
74.8 - 75.2	8025 – 8500	
108 – 138		

8.7.2 Test summary

Verdict	Pass		
Test date	March 1, 2024	Temperature	21 °C
Test engineer	Chenhao Ma, Wireless Test Technician	Air pressure	1005 mbar
Test location	☒ Wireless bench (conducted tests) ☐ 10 m semi-anechoic chamber (radiated tests) ☒ 3 m semi-anechoic chamber (radiated tests) ☐ Other:	Relative humidity	59 %

8.7.3 Notes

Testing was performed with the transmitter operating on a fixed channel at full power. Low, middle, and high channels were tested. The spectrum was searched from 30 MHz to 26 GHz (above the 10th harmonic of the highest transmit frequency).

The spectral plots within this section have been corrected with all relevant transducer factors.

8.7.4 Setup details

EUT power input during test	120 VAC / 60 Hz
EUT setup configuration	☒ Table-top ☐ Floor standing ☐ Other:

Spectrum analyzer settings (conducted emissions):

Resolution bandwidth	100 kHz
Video bandwidth	300 kHz
Detector mode	Peak
Trace mode	Max Hold
Measurement time	Long enough for trace to stabilize

Receiver settings for radiated measurements within restricted bands below 1 GHz:

Resolution bandwidth	120 kHz
Video bandwidth	300 kHz
Detector mode	Peak (preview measurements) Quasi-Peak (final measurements)

Receiver settings for radiated measurements within restricted bands above 1 GHz:

Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Detector mode	Peak (preview measurements) Peak and average (final measurements)

8.7.5 Test data – Conducted out-of-band emissions, authorized band edge

8.7.5.1 IEEE 802.11b (CDD) mode

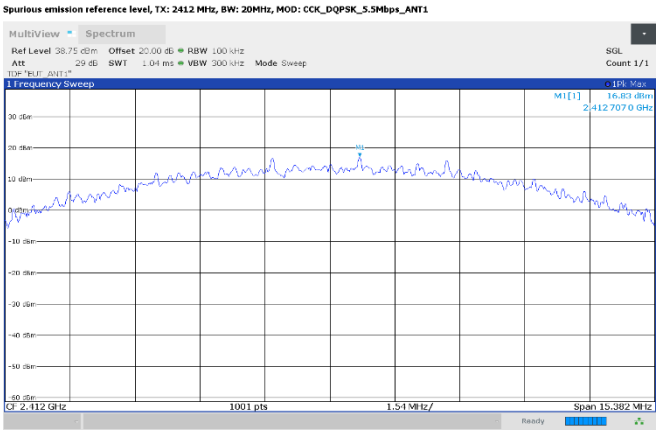


Figure 8.7-1: *Authorized band-edge emissions, reference level, 2412 MHz, Antenna 1*

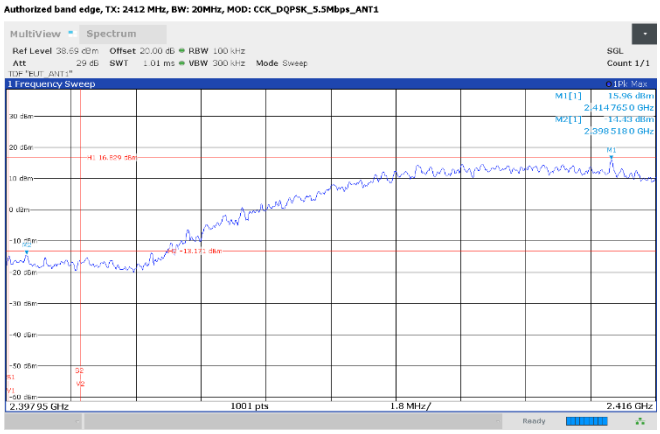


Figure 8.7-2: *Authorized band-edge emissions, 2412 MHz, Antenna 1*

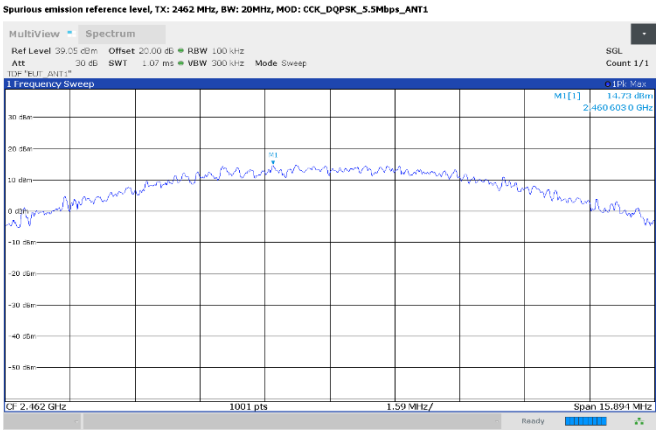


Figure 8.7-3: *Authorized band-edge emissions, reference level, 2462 MHz, Antenna 1*

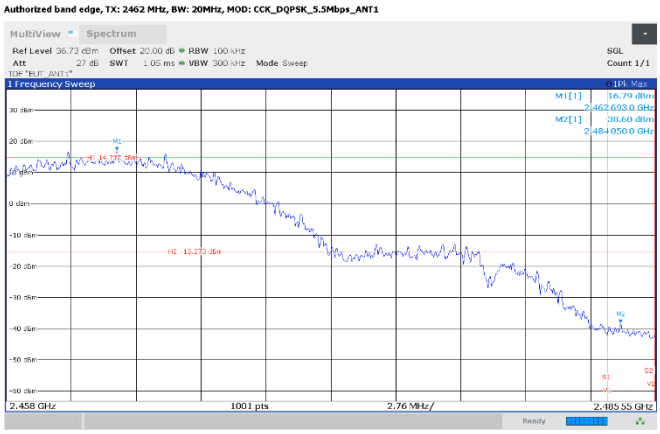


Figure 8.7-4: *Authorized band-edge emissions, 2462 MHz, Antenna 1*

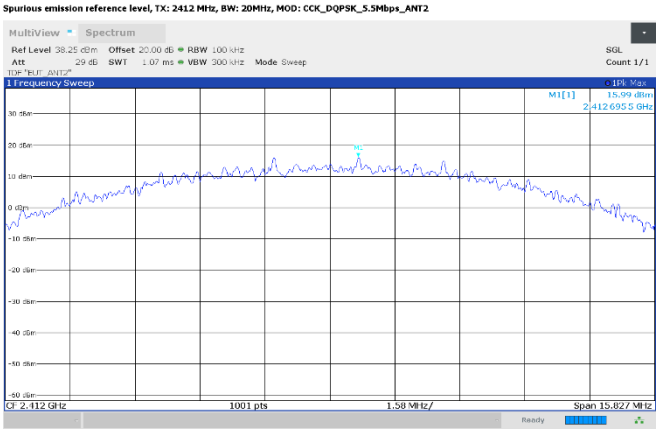


Figure 8.7-5: *Authorized band-edge emissions, reference level, 2412 MHz, Antenna 2*

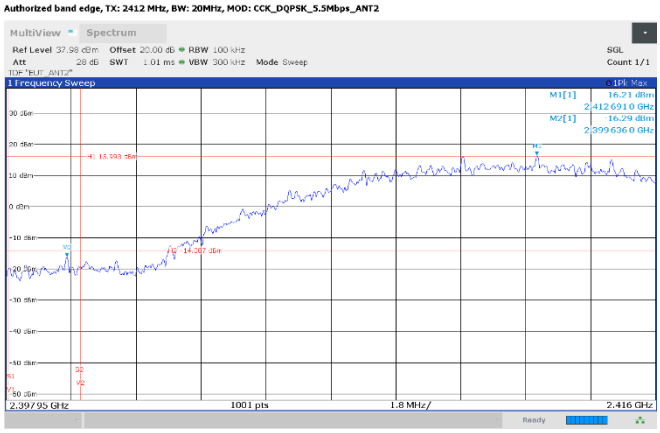


Figure 8.7-6: *Authorized band-edge emissions, 2412 MHz, Antenna 2*

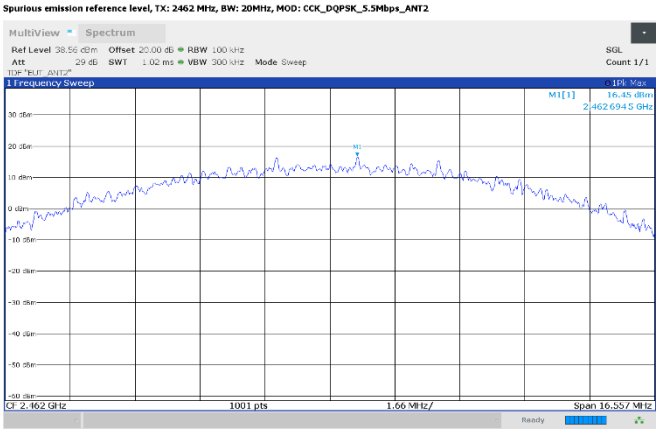


Figure 8.7-7: *Authorized band-edge emissions, reference level, 2462 MHz, Antenna 2*

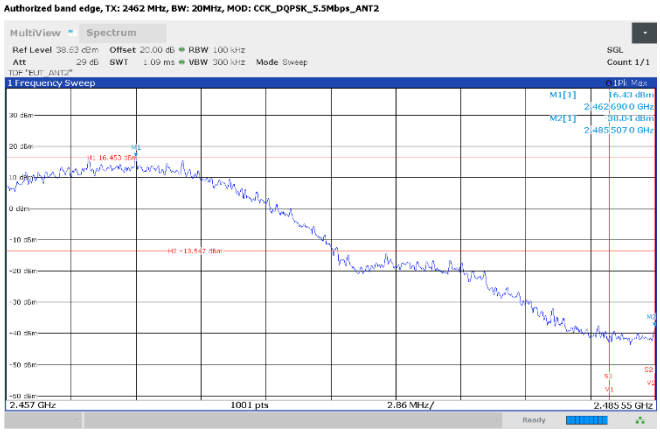


Figure 8.7-8: *Authorized band-edge emissions, 2462 MHz, Antenna 2*

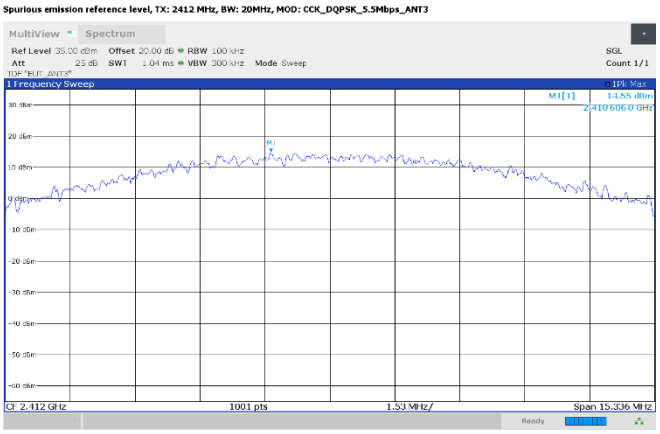


Figure 8.7-9: *Authorized band-edge emissions, reference level, 2412 MHz, Antenna 3*

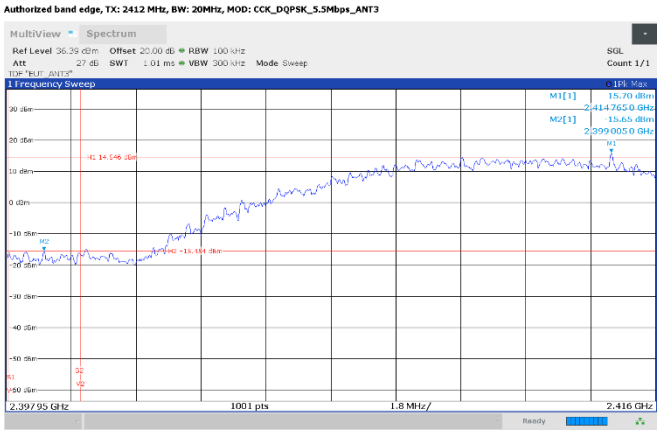


Figure 8.7-10: *Authorized band-edge emissions, 2412 MHz, Antenna 3*

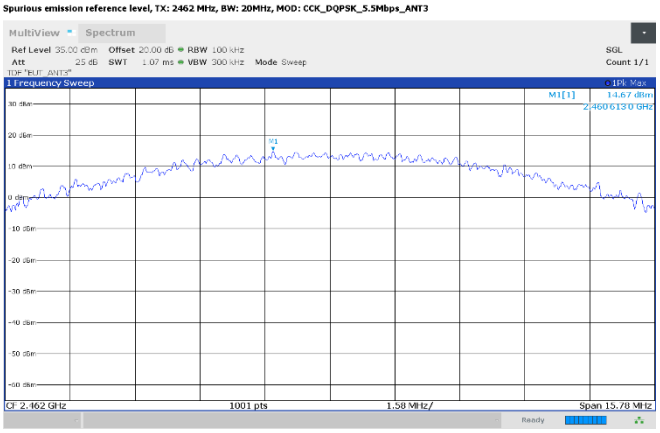


Figure 8.7-11: *Authorized band-edge emissions, reference level, 2462 MHz, Antenna 3*

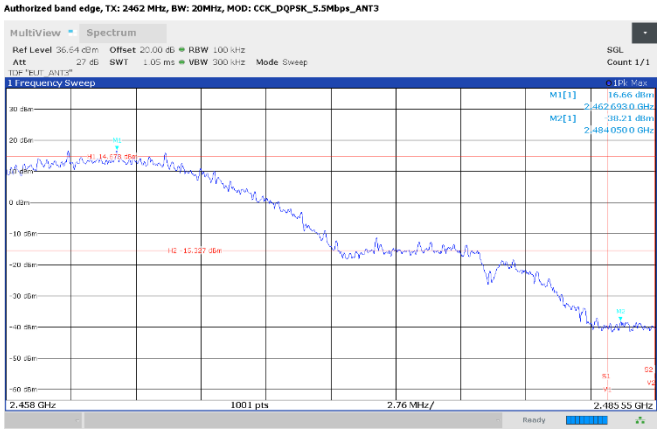


Figure 8.7-12: *Authorized band-edge emissions, 2462 MHz, Antenna 3*

8.7.5.2 IEEE 802.11g (CDD) mode

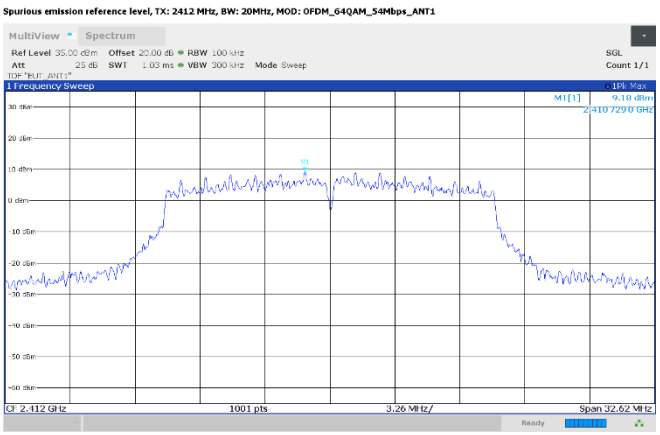


Figure 8.7-13: *Authorized band-edge emissions, reference level, 2412 MHz, Antenna 1*

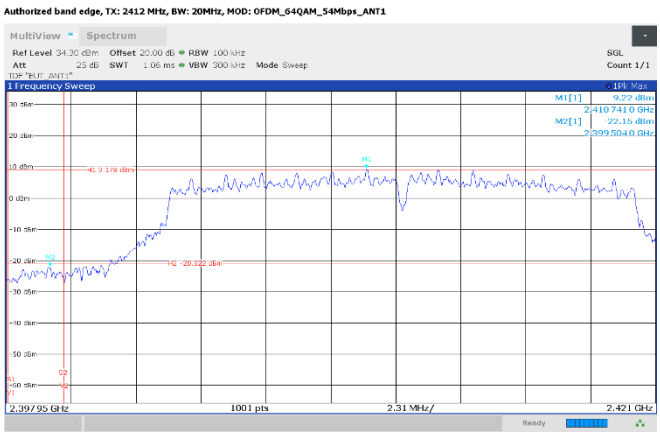


Figure 8.7-14: *Authorized band-edge emissions, 2412 MHz, Antenna 1*

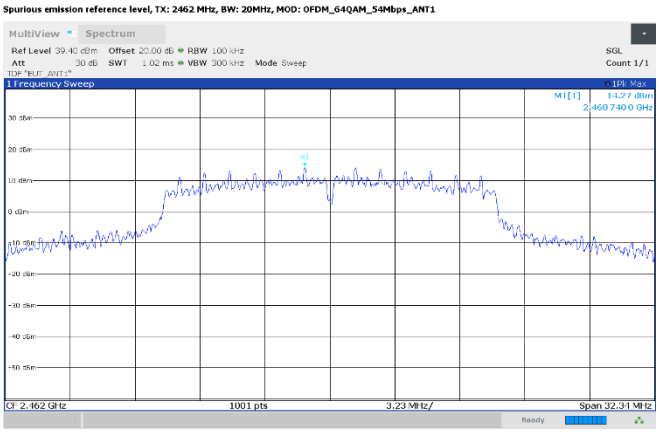


Figure 8.7-15: *Authorized band-edge emissions, reference level, 2462 MHz, Antenna 1*

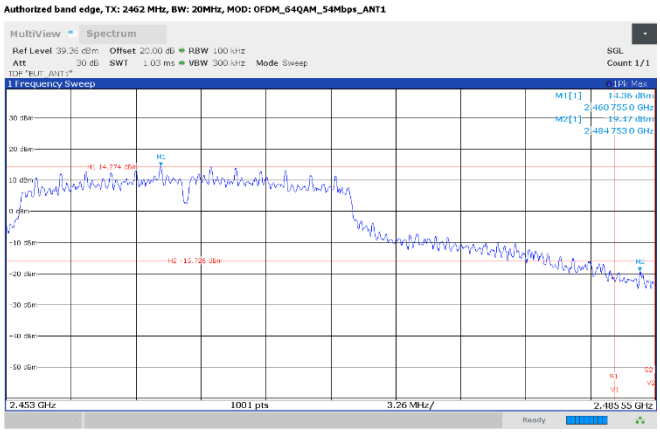


Figure 8.7-16: *Authorized band-edge emissions, 2462 MHz, Antenna 1*

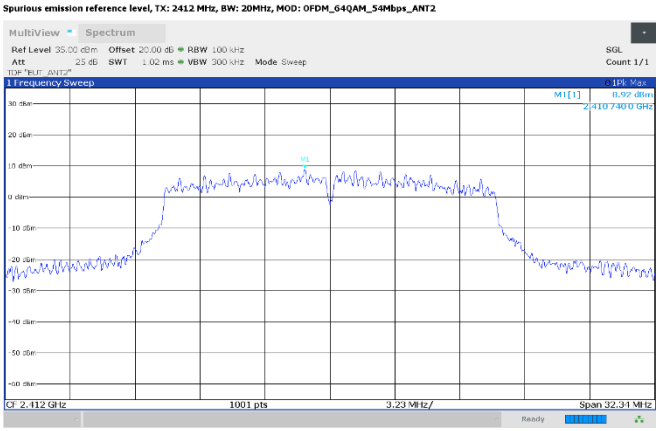


Figure 8.7-17: *Authorized band-edge emissions, reference level, 2412 MHz, Antenna 2*

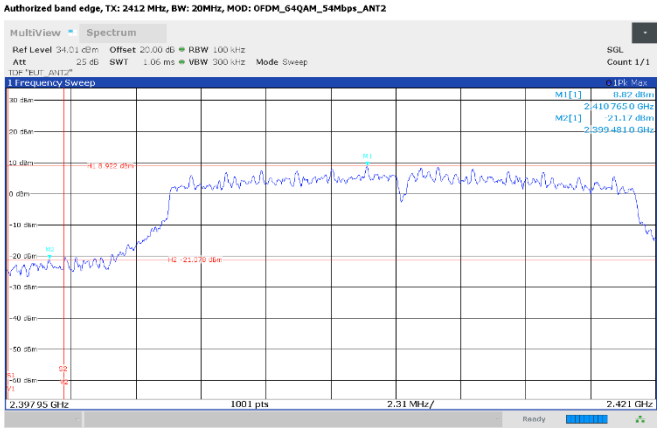


Figure 8.7-18: *Authorized band-edge emissions, 2412 MHz, Antenna 2*

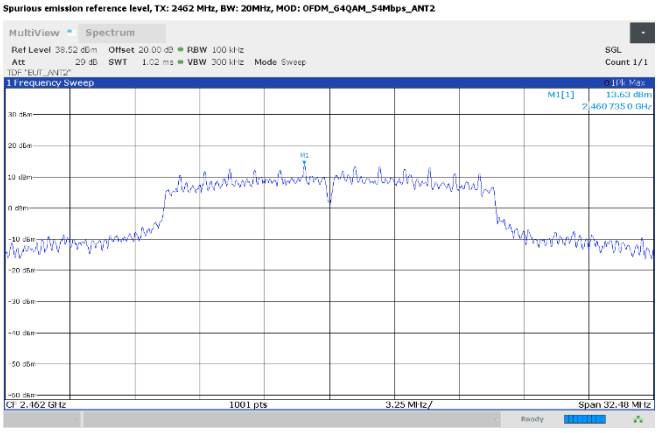


Figure 8.7-19: *Authorized band-edge emissions, reference level, 2462 MHz, Antenna 2*

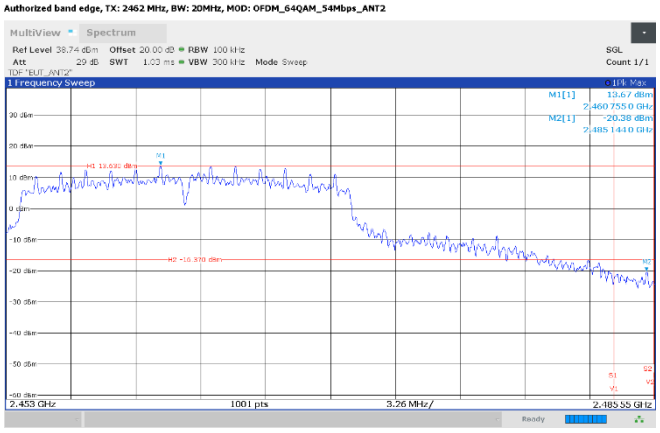


Figure 8.7-20: *Authorized band-edge emissions, 2462 MHz, Antenna 2*

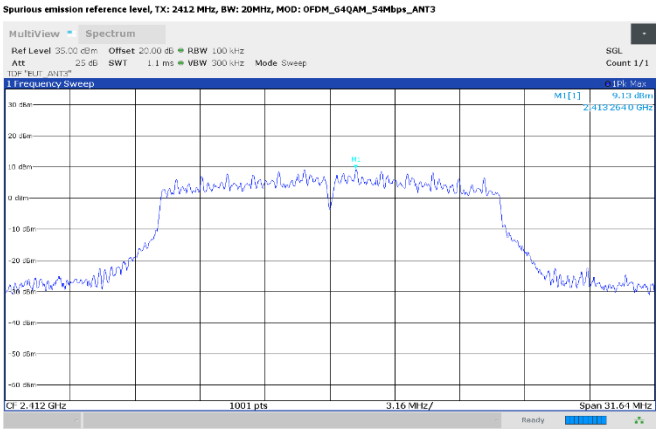


Figure 8.7-21: *Authorized band-edge emissions, reference level, 2412 MHz, Antenna 3*

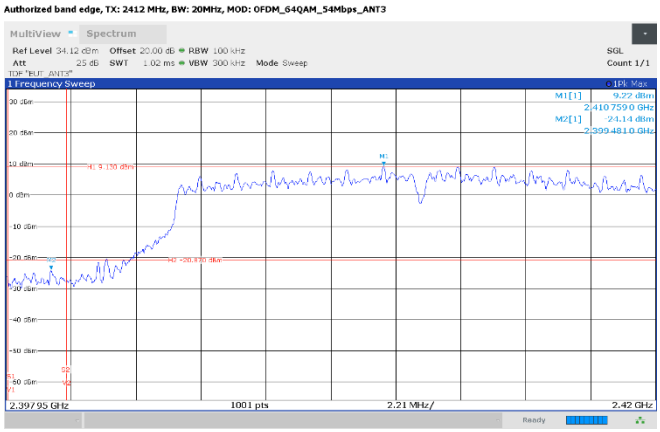


Figure 8.7-22: *Authorized band-edge emissions, 2412 MHz, Antenna 3*

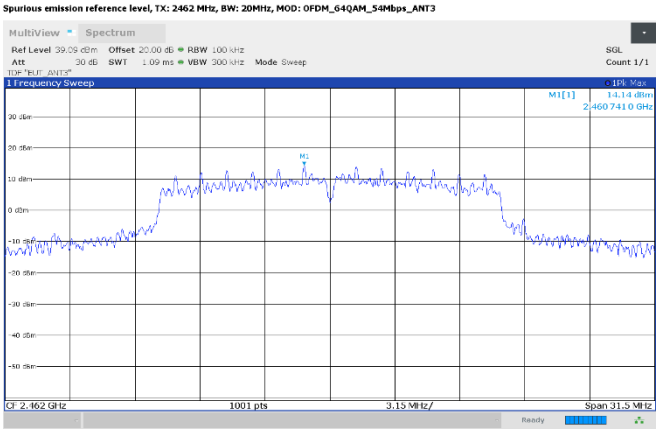


Figure 8.7-23: *Authorized band-edge emissions, reference level, 2462 MHz, Antenna 3*

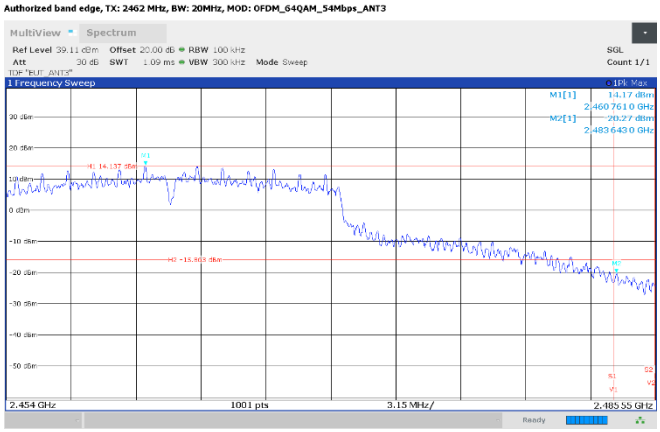


Figure 8.7-24: *Authorized band-edge emissions, 2462 MHz, Antenna 3*

8.7.5.3 IEEE 802.11n HT20 (CDD) mode

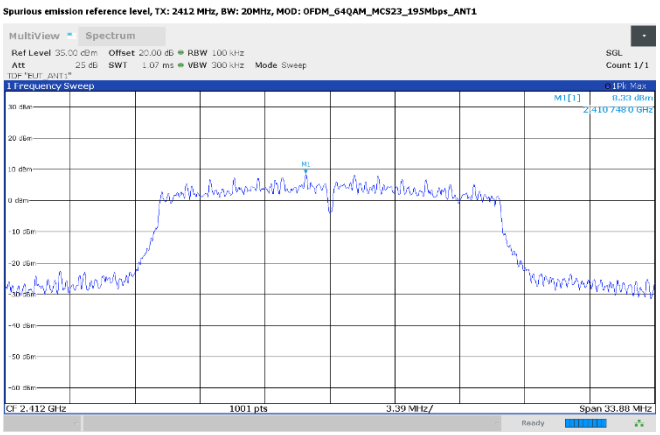


Figure 8.7-25: *Authorized band-edge emissions, reference level, 2412 MHz, Antenna 1*

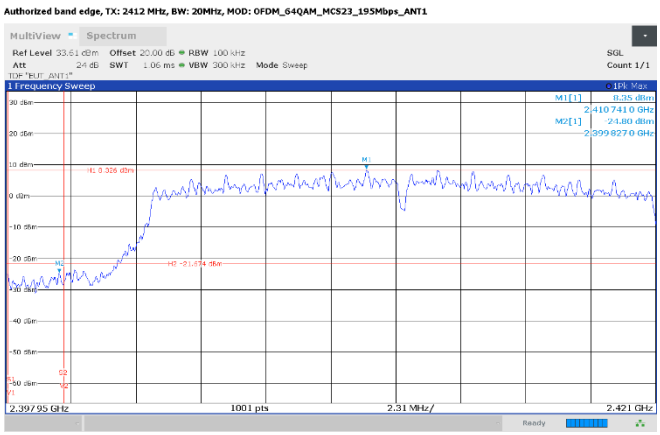


Figure 8.7-26: *Authorized band-edge emissions, 2412 MHz, Antenna 1*

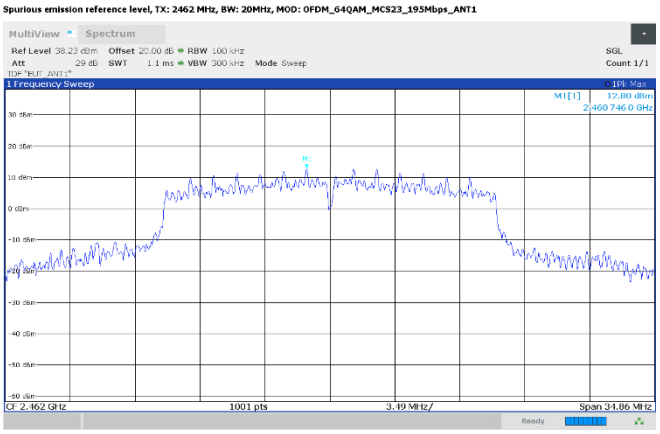


Figure 8.7-27: *Authorized band-edge emissions, reference level, 2462 MHz, Antenna 1*

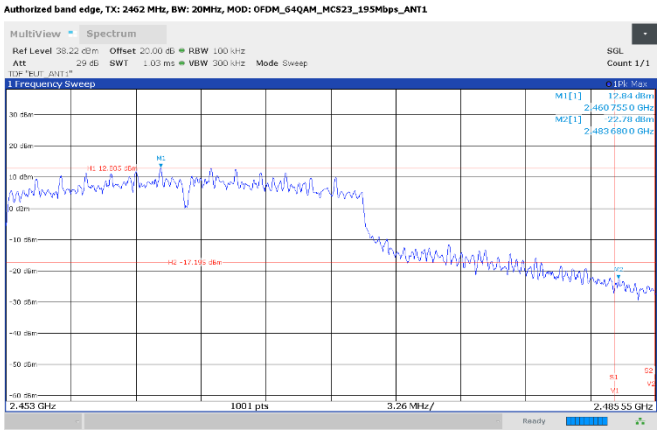


Figure 8.7-28: *Authorized band-edge emissions, 2462 MHz, Antenna 1*

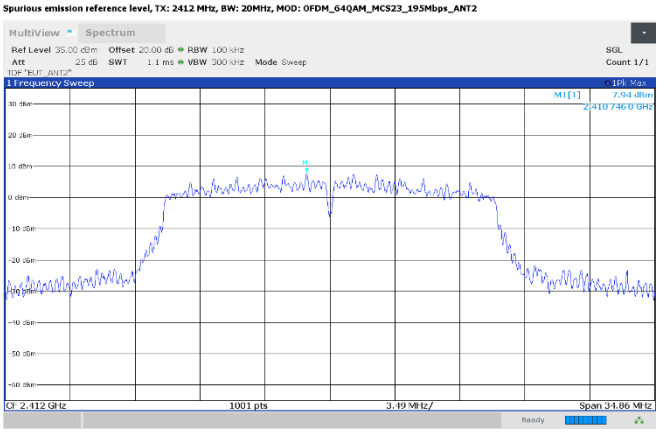


Figure 8.7-29: *Authorized band-edge emissions, reference level, 2412 MHz, Antenna 2*

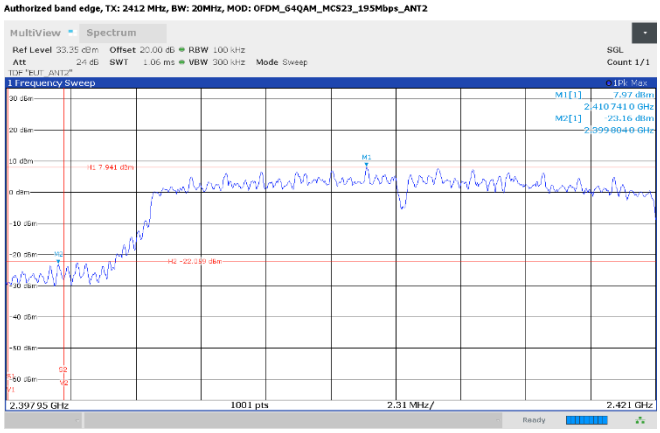


Figure 8.7-30: *Authorized band-edge emissions, 2412 MHz, Antenna 2*

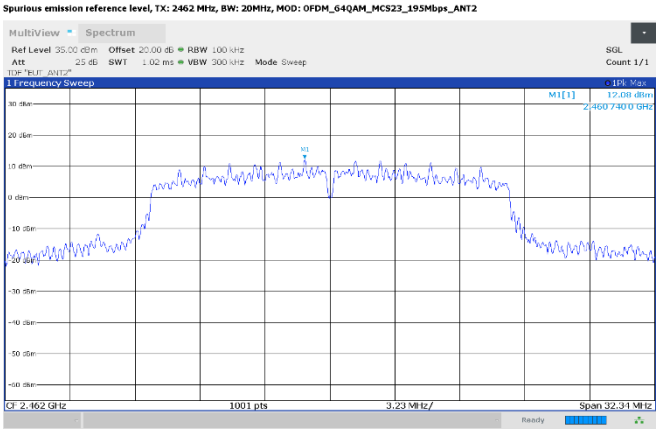


Figure 8.7-31: *Authorized band-edge emissions, reference level, 2462 MHz, Antenna 2*

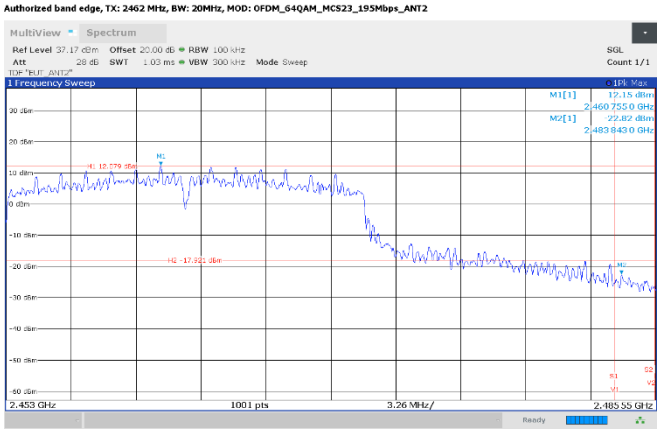


Figure 8.7-32: *Authorized band-edge emissions, 2462 MHz, Antenna 2*

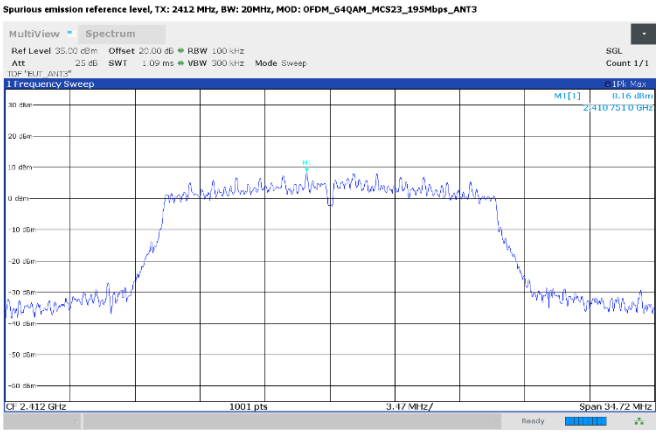


Figure 8.7-33: *Authorized band-edge emissions, reference level, 2412 MHz, Antenna 3*

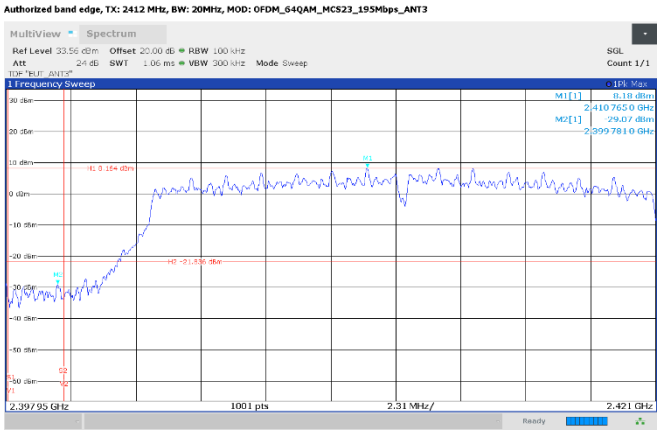


Figure 8.7-34: *Authorized band-edge emissions, 2412 MHz, Antenna 3*

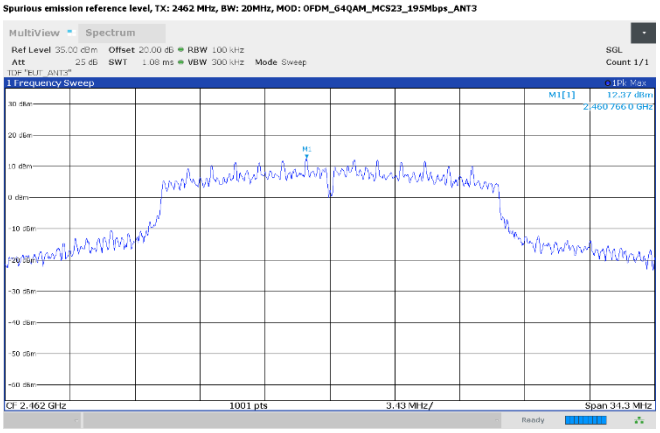


Figure 8.7-35: *Authorized band-edge emissions, reference level, 2462 MHz, Antenna 3*

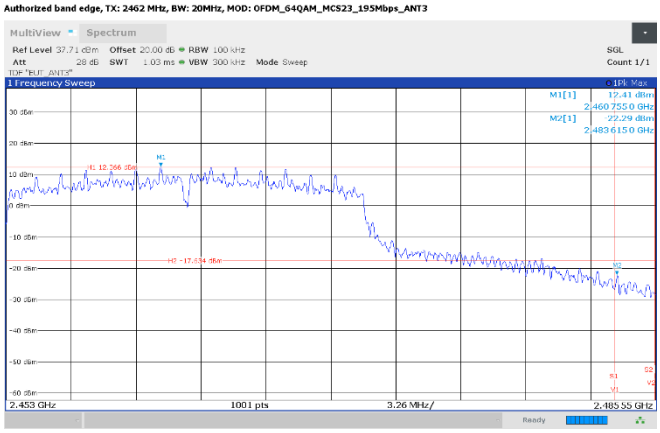


Figure 8.7-36: *Authorized band-edge emissions, 2462 MHz, Antenna 3*

8.7.5.4 IEEE 802.11n HT40 (CDD) mode

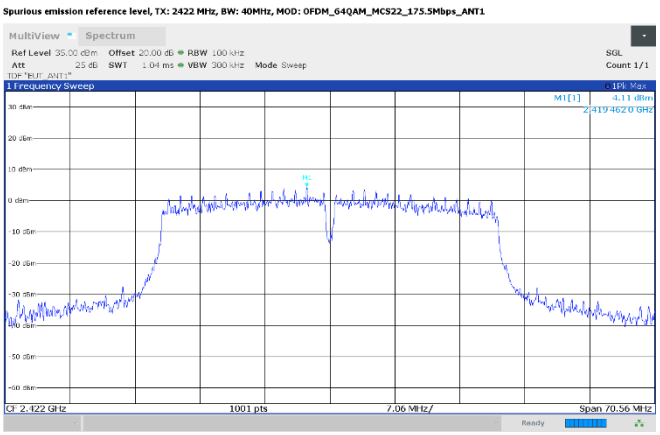


Figure 8.7-37: *Authorized band-edge emissions, reference level, 2422 MHz, Antenna 1*

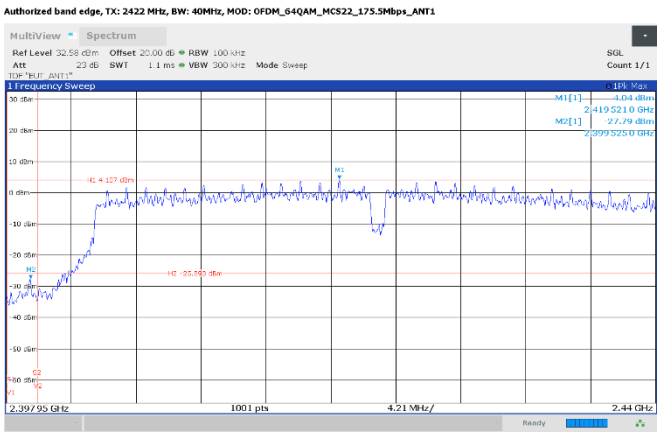


Figure 8.7-38: *Authorized band-edge emissions, 2422 MHz, Antenna 1*

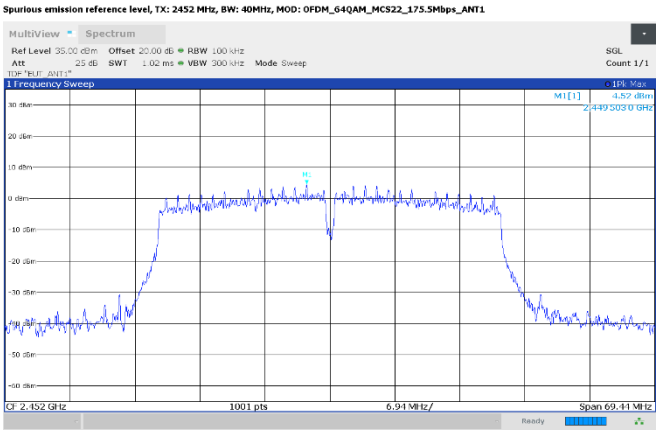


Figure 8.7-39: *Authorized band-edge emissions, reference level, 2452 MHz, Antenna 1*

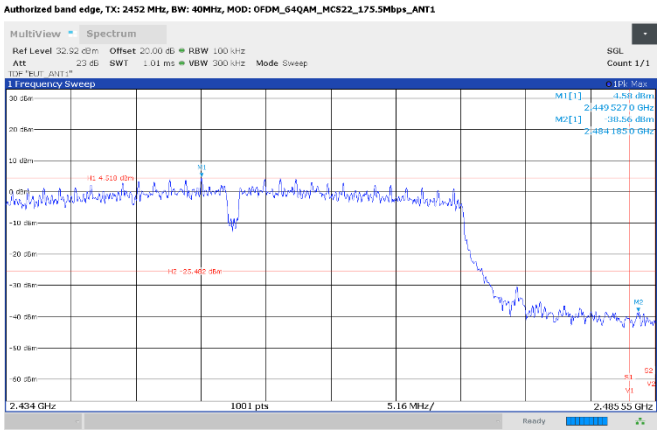


Figure 8.7-40: *Authorized band-edge emissions, 2452 MHz, Antenna 1*

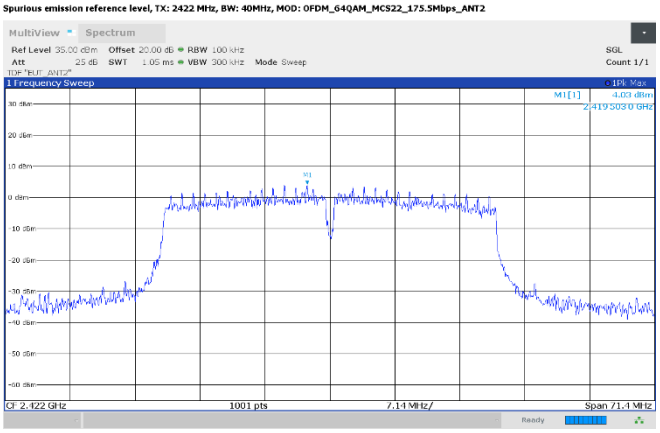


Figure 8.7-41: *Authorized band-edge emissions, reference level, 2422 MHz, Antenna 2*

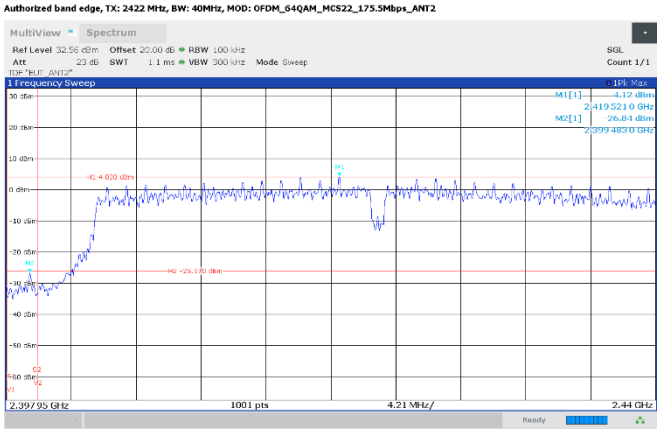


Figure 8.7-42: *Authorized band-edge emissions, 2422 MHz, Antenna 2*

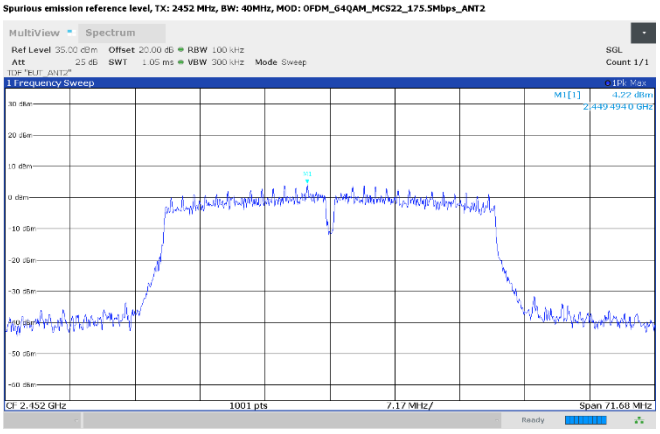


Figure 8.7-43: *Authorized band-edge emissions, reference level, 2452 MHz, Antenna 2*

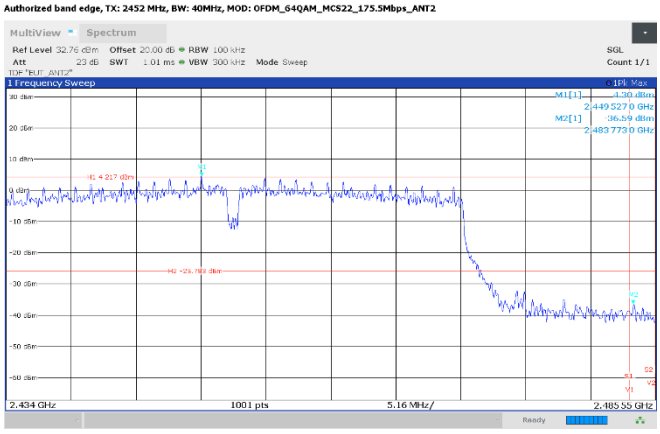


Figure 8.7-44: *Authorized band-edge emissions, 2452 MHz, Antenna 2*

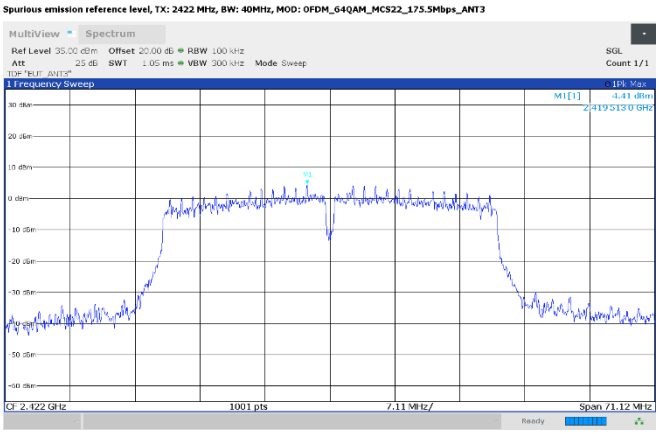


Figure 8.7-45: *Authorized band-edge emissions, reference level, 2422 MHz, Antenna 3*

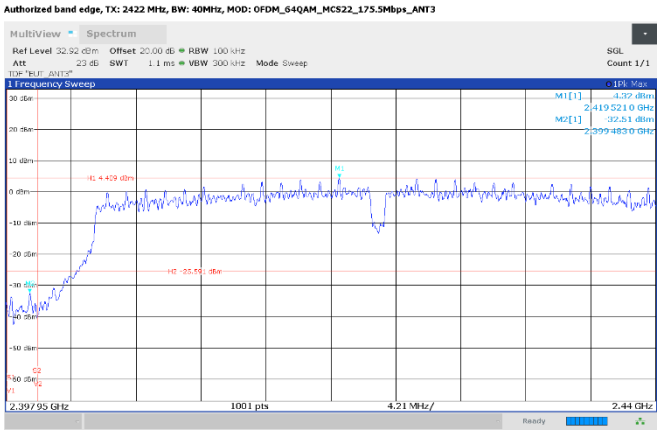


Figure 8.7-46: *Authorized band-edge emissions, 2422 MHz, Antenna 3*

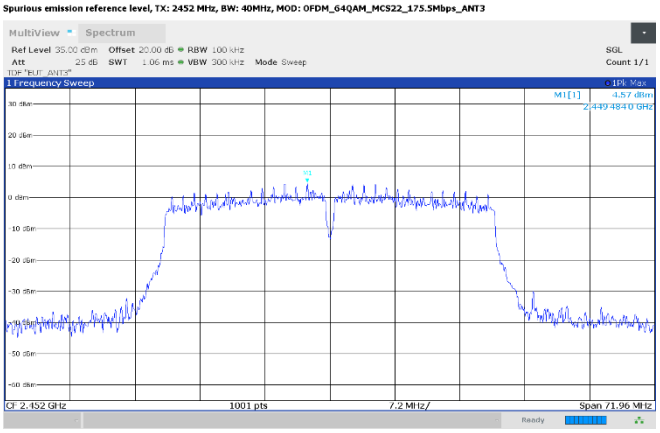


Figure 8.7-47: *Authorized band-edge emissions, reference level, 2452 MHz, Antenna 3*

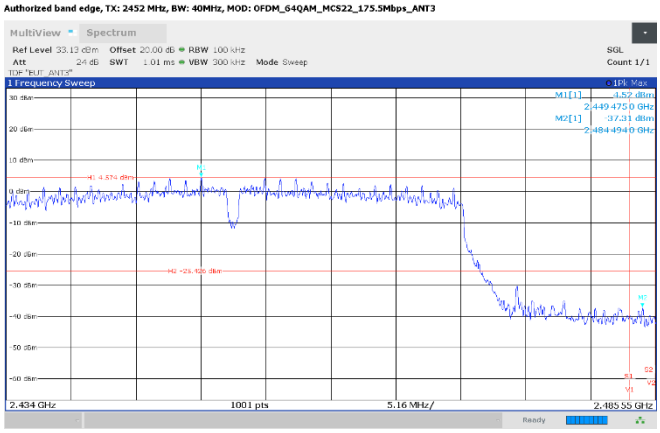


Figure 8.7-48: *Authorized band-edge emissions, 2452 MHz, Antenna 3*

8.7.6 Test data – Conducted antenna port spurious emissions

8.7.6.1 IEEE 802.11b (CDD) mode

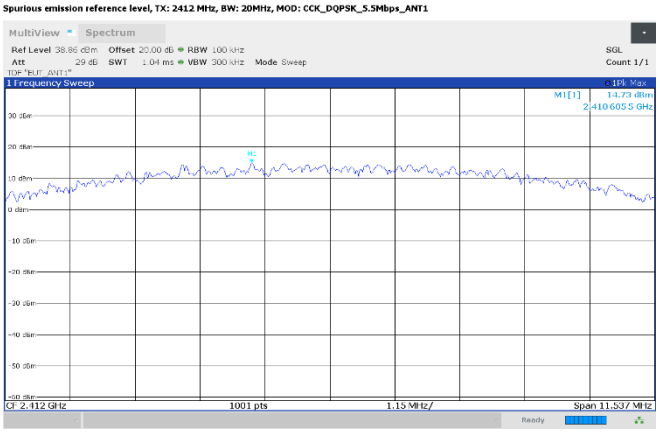


Figure 8.7-49: *Conducted antenna port spurious emissions, reference level, 2412 MHz, Antenna 1*

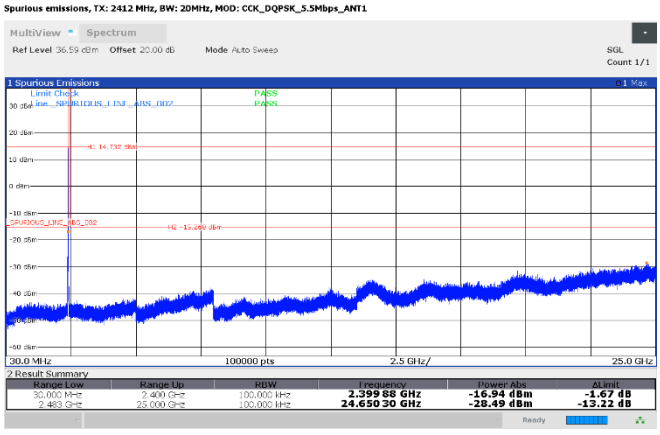


Figure 8.7-50: *Conducted antenna port spurious emissions, 2412 MHz, Antenna 1*

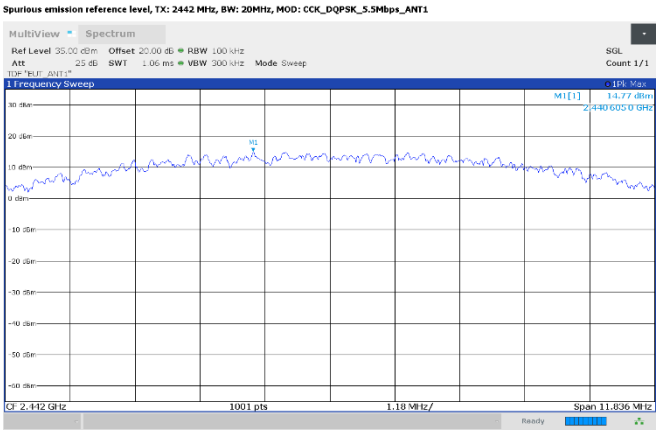


Figure 8.7-51: *Conducted antenna port spurious emissions, reference level, 2442 MHz, Antenna 1*

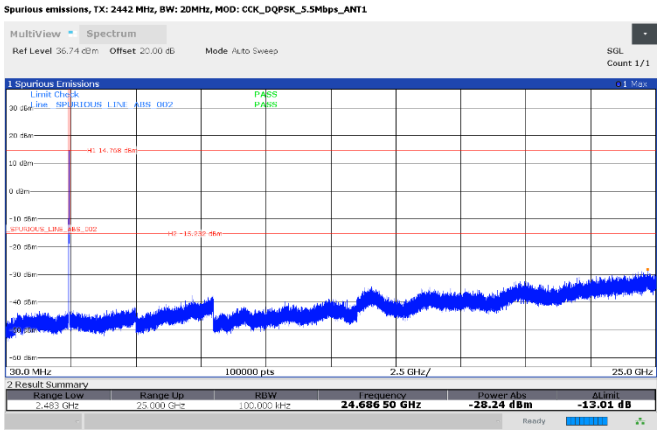


Figure 8.7-52: *Conducted antenna port spurious emissions, 2442 MHz, Antenna 1*

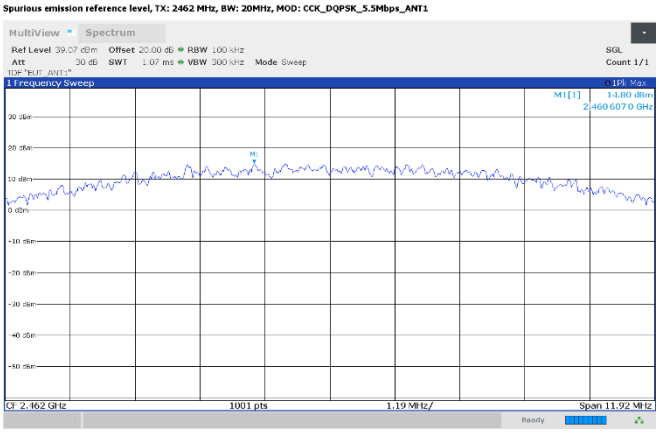


Figure 8.7-53: *Conducted antenna port spurious emissions, reference level, 2462 MHz, Antenna 1*

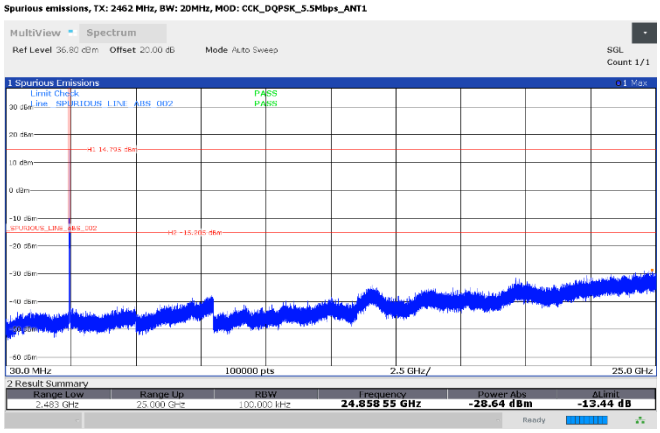


Figure 8.7-54: *Conducted antenna port spurious emissions, 2462 MHz, Antenna 1*

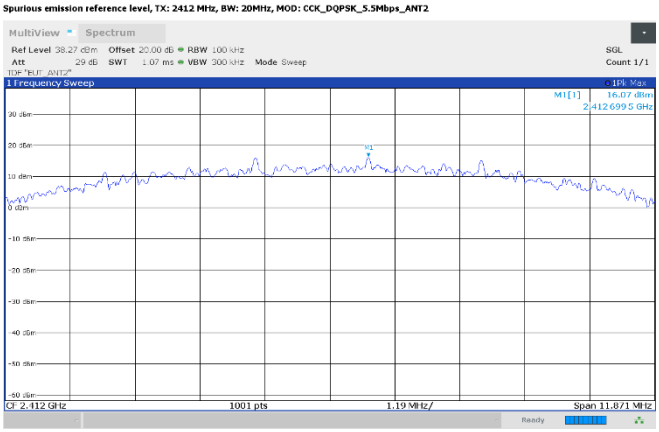


Figure 8.7-55: *Conducted antenna port spurious emissions, reference level, 2412 MHz, Antenna 2*

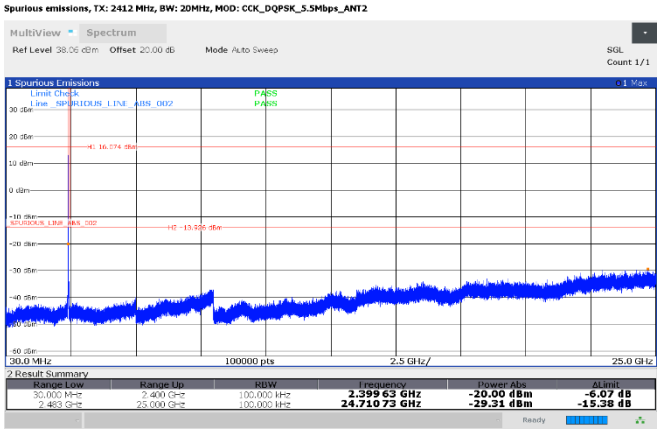


Figure 8.7-56: *Conducted antenna port spurious emissions, 2412 MHz, Antenna 2*

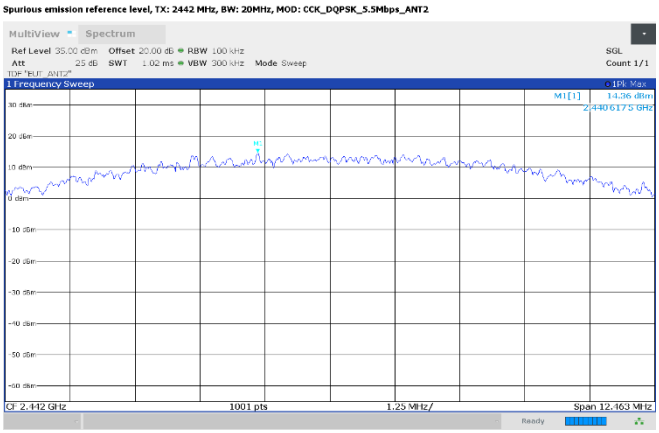


Figure 8.7-57: *Conducted antenna port spurious emissions, reference level, 2442 MHz, Antenna 2*

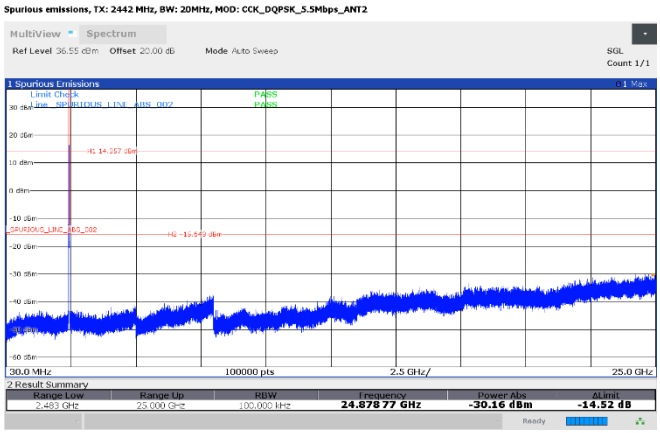


Figure 8.7-58: *Conducted antenna port spurious emissions, 2442 MHz, Antenna 2*

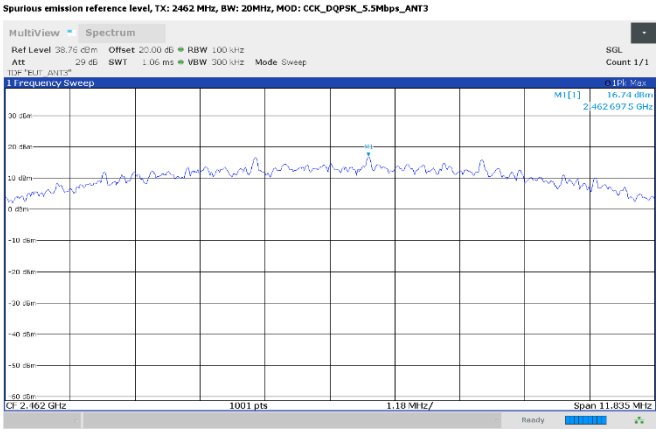


Figure 8.7-59: *Conducted antenna port spurious emissions, reference level, 2462 MHz, Antenna 2*

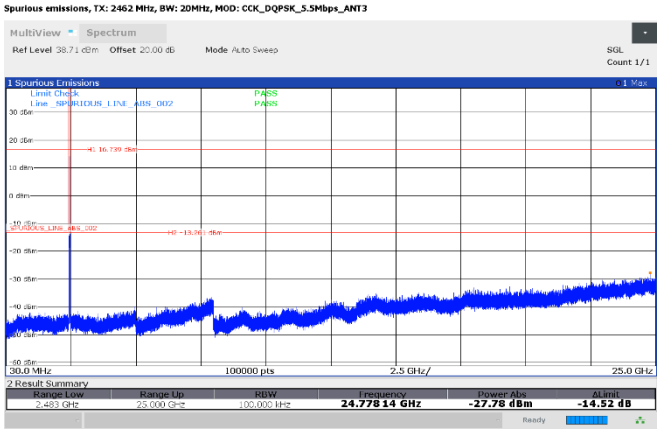


Figure 8.7-60: *Conducted antenna port spurious emissions, 2462 MHz, Antenna 2*

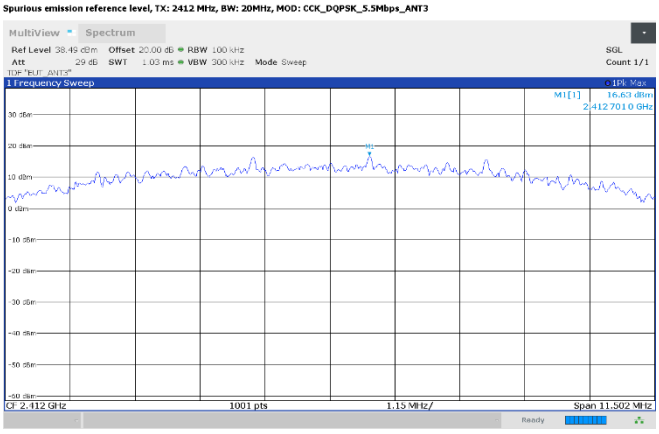


Figure 8.7-61: *Conducted antenna port spurious emissions, reference level, 2412 MHz, Antenna 3*

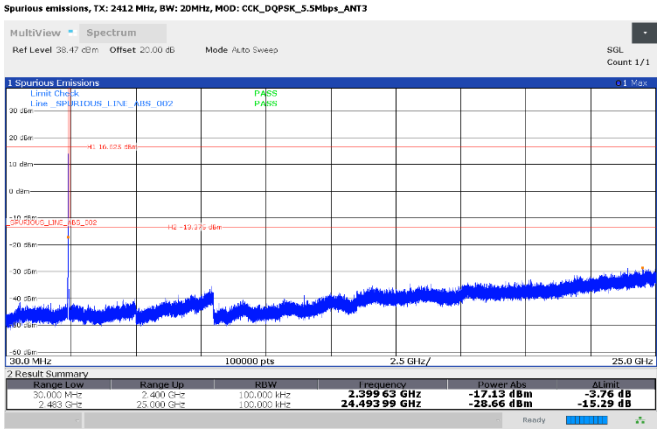


Figure 8.7-62: *Conducted antenna port spurious emissions, 2412 MHz, Antenna 3*

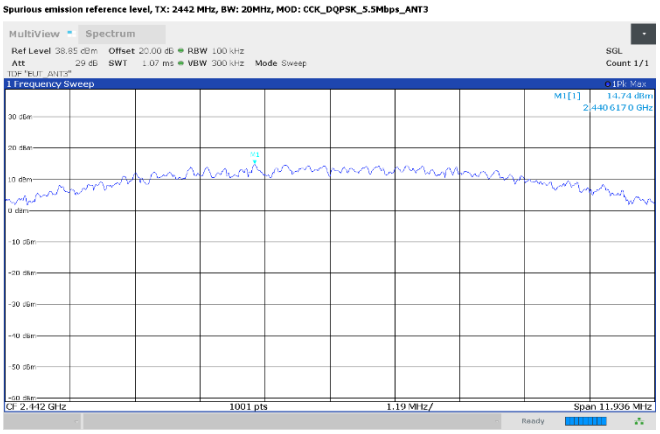


Figure 8.7-63: *Conducted antenna port spurious emissions, reference level, 2442 MHz, Antenna 3*

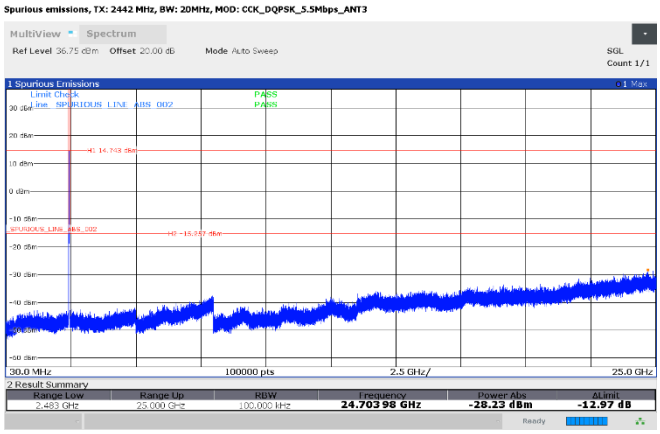


Figure 8.7-64: *Conducted antenna port spurious emissions, 2442 MHz, Antenna 3*

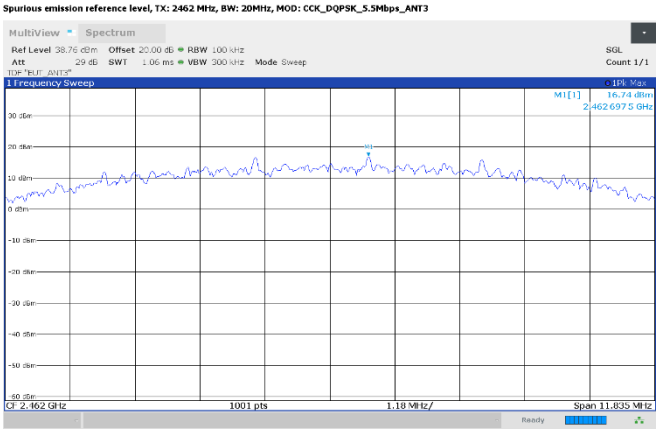


Figure 8.7-65: *Conducted antenna port spurious emissions, reference level, 2462 MHz, Antenna 3*

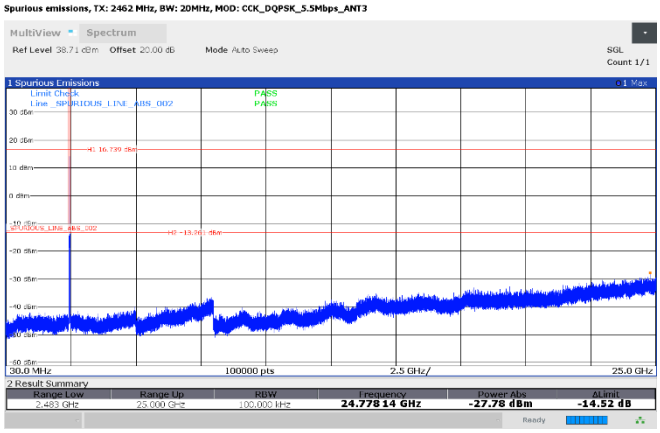


Figure 8.7-66: *Conducted antenna port spurious emissions, 2462 MHz, Antenna 3*

8.7.6.2 IEEE 802.11g (CDD) mode

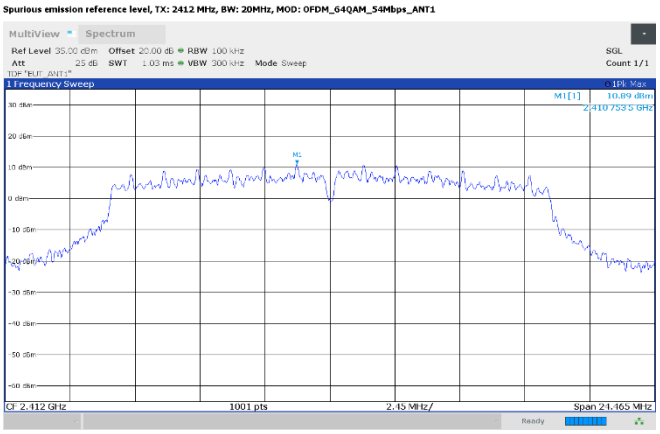


Figure 8.7-67: *Conducted antenna port spurious emissions, reference level, 2412 MHz, Antenna 1*

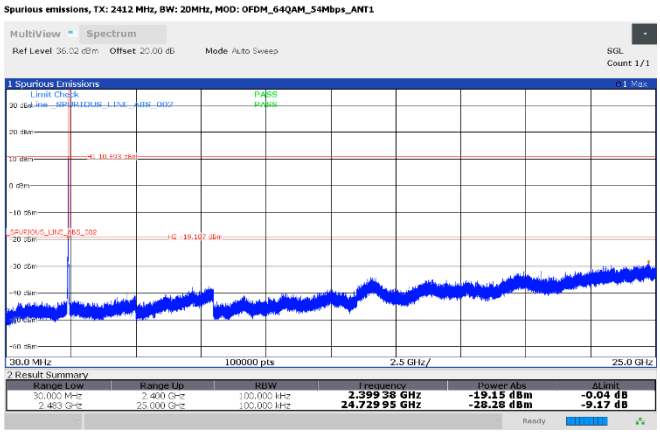


Figure 8.7-68: *Conducted antenna port spurious emissions, 2412 MHz, Antenna 1*

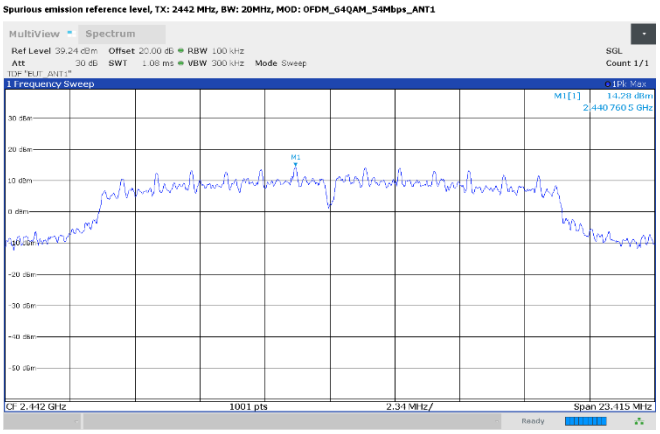


Figure 8.7-69: *Conducted antenna port spurious emissions, reference level, 2442 MHz, Antenna 1*

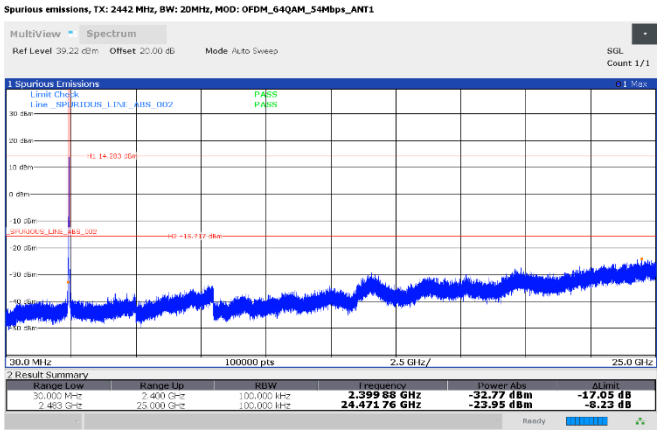


Figure 8.7-70: *Conducted antenna port spurious emissions, 2442 MHz, Antenna 1*

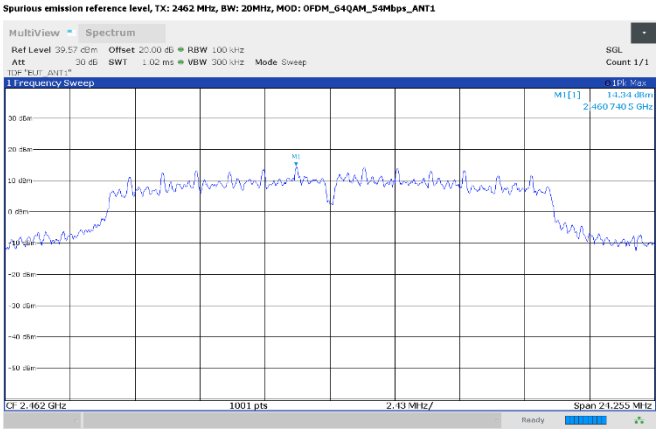


Figure 8.7-71: *Conducted antenna port spurious emissions, reference level, 2462 MHz, Antenna 1*

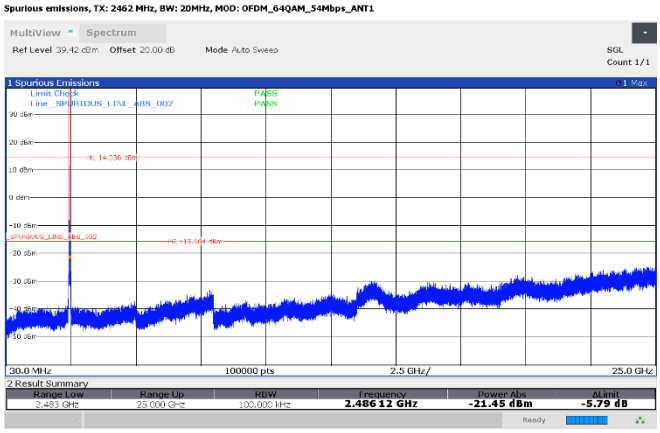


Figure 8.7-72: *Conducted antenna port spurious emissions, 2462 MHz, Antenna 1*

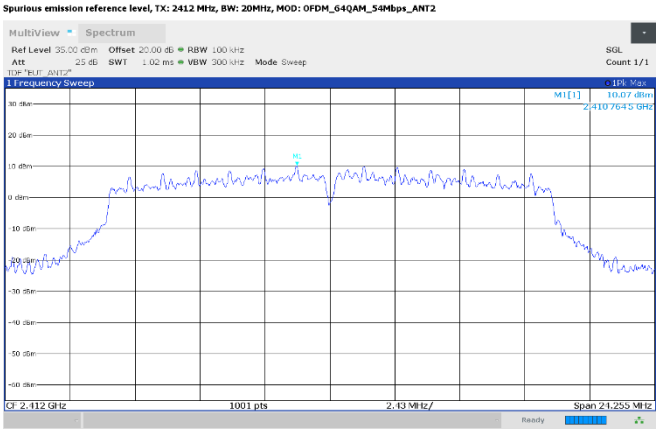


Figure 8.7-73: *Conducted antenna port spurious emissions, reference level, 2412 MHz, Antenna 2*

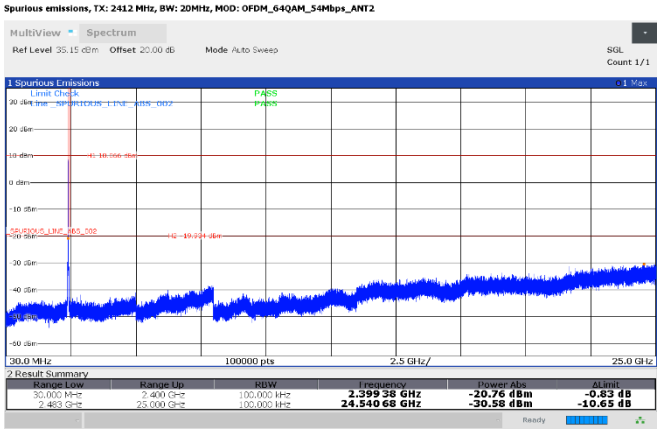


Figure 8.7-74: *Conducted antenna port spurious emissions, 2412 MHz, Antenna 2*

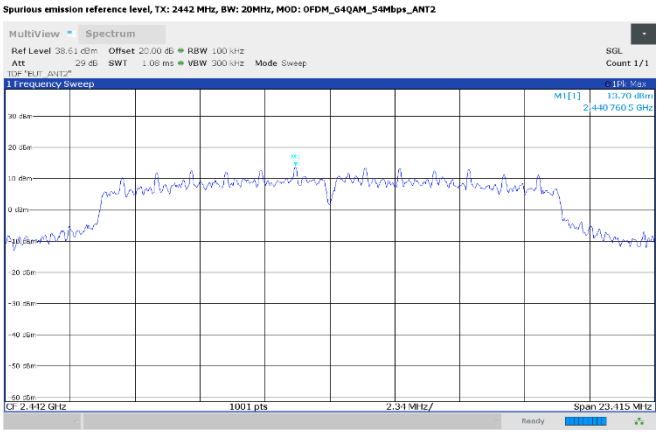


Figure 8.7-75: *Conducted antenna port spurious emissions, reference level, 2442 MHz, Antenna 2*

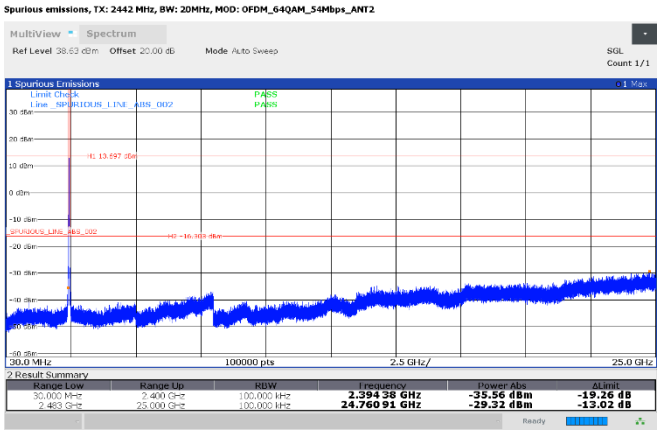


Figure 8.7-76: *Conducted antenna port spurious emissions, 2442 MHz, Antenna 2*

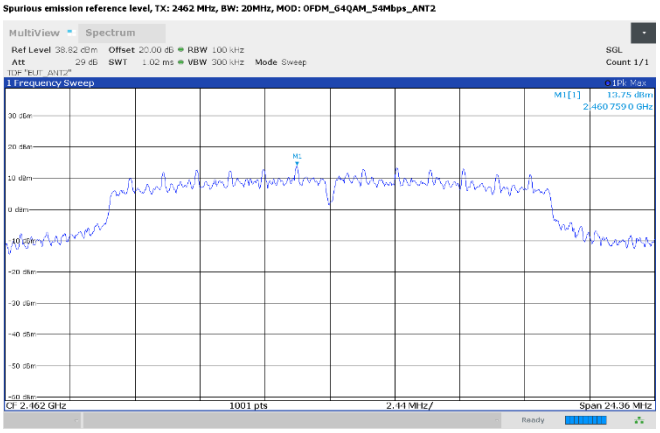


Figure 8.7-77: *Conducted antenna port spurious emissions, reference level, 2462 MHz, Antenna 2*

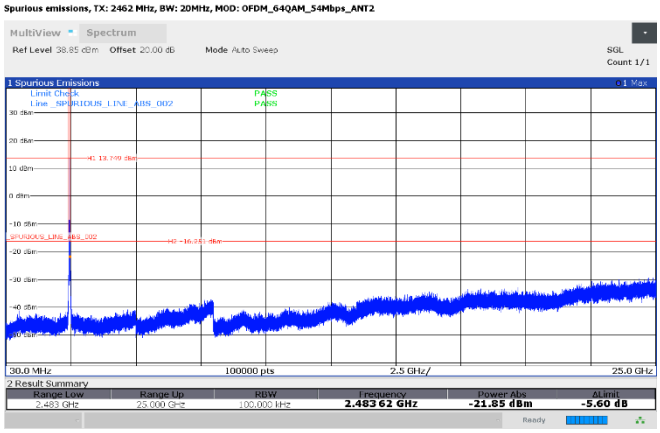


Figure 8.7-78: *Conducted antenna port spurious emissions, 2462 MHz, Antenna 2*

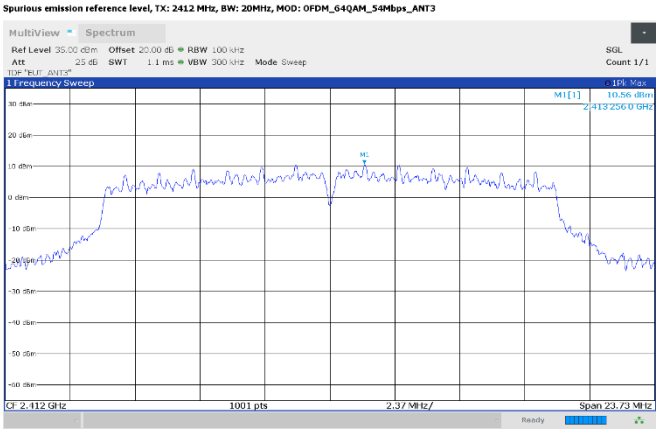


Figure 8.7-79: *Conducted antenna port spurious emissions, reference level, 2412 MHz, Antenna 3*

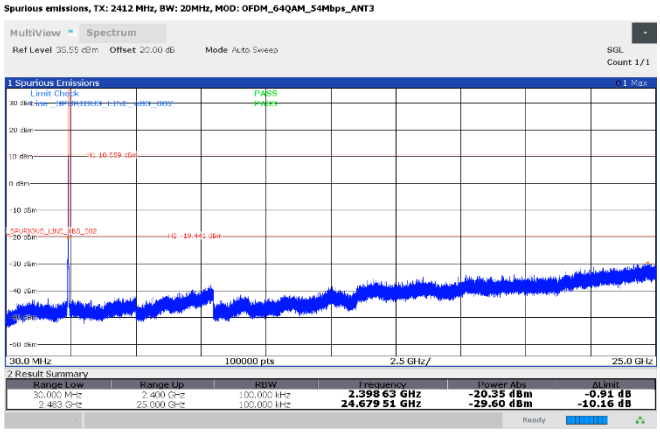


Figure 8.7-80: *Conducted antenna port spurious emissions, 2412 MHz, Antenna 3*

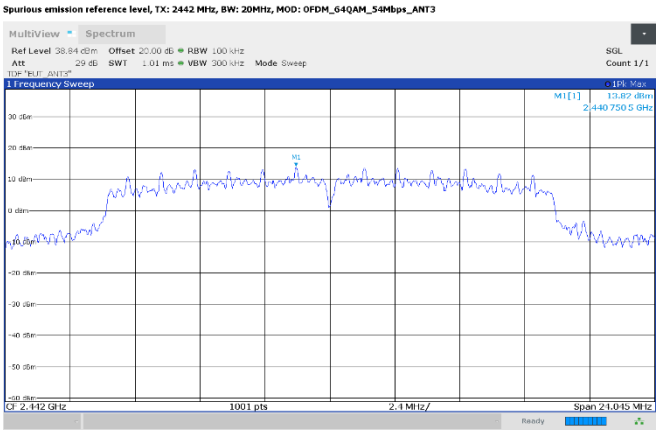


Figure 8.7-81: *Conducted antenna port spurious emissions, reference level, 2442 MHz, Antenna 3*

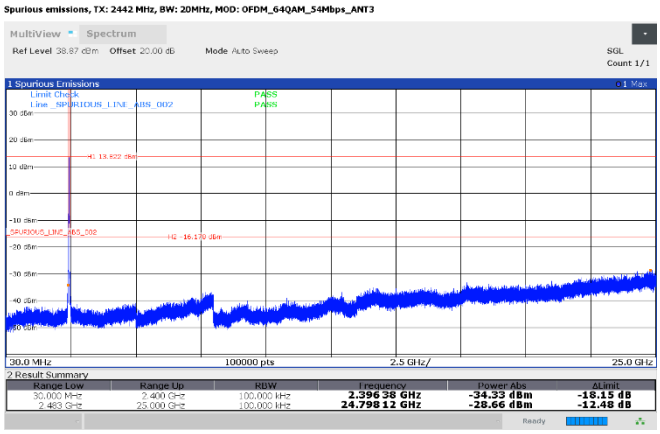


Figure 8.7-82: *Conducted antenna port spurious emissions, 2442 MHz, Antenna 3*

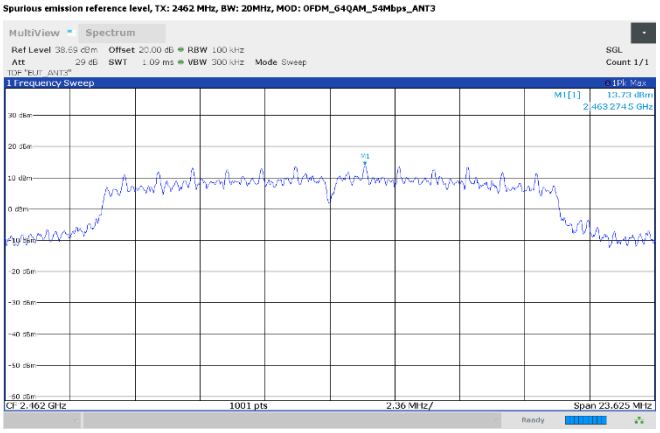


Figure 8.7-83: *Conducted antenna port spurious emissions, reference level, 2462 MHz, Antenna 3*

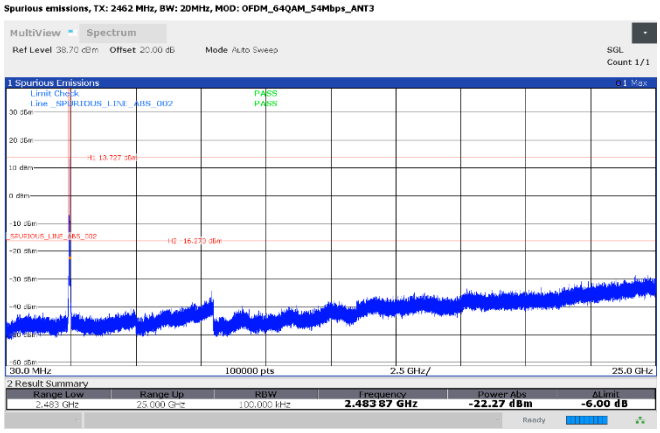


Figure 8.7-84: *Conducted antenna port spurious emissions, 2462 MHz, Antenna 3*

8.7.6.3 IEEE 802.11n HT20 (CDD) mode

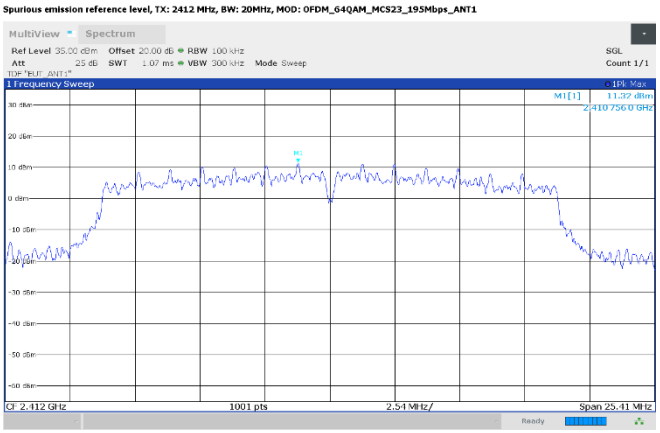


Figure 8.7-85: *Conducted antenna port spurious emissions, reference level, 2412 MHz, Antenna 1*

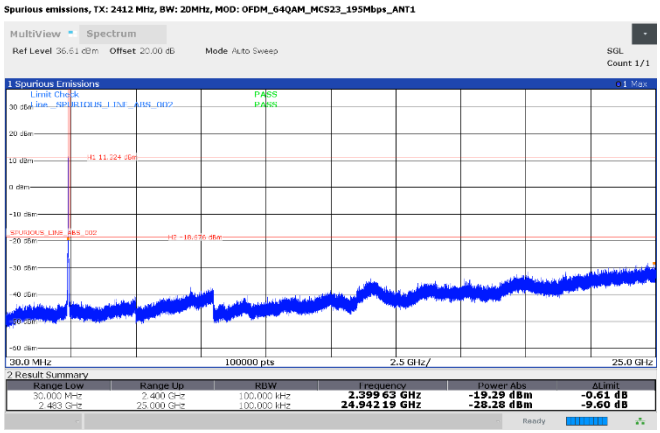


Figure 8.7-86: *Conducted antenna port spurious emissions, 2412 MHz, Antenna 1*

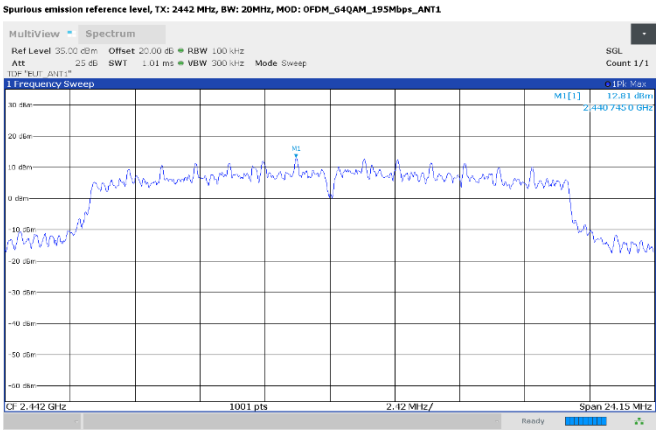


Figure 8.7-87: *Conducted antenna port spurious emissions, reference level, 2442 MHz, Antenna 1*

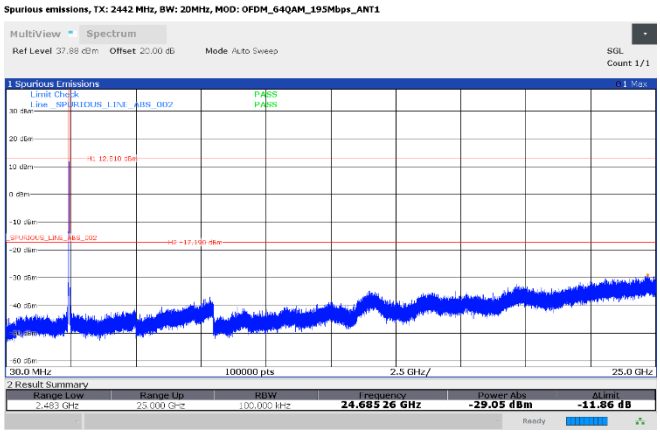


Figure 8.7-88: *Conducted antenna port spurious emissions, 2442 MHz, Antenna 1*

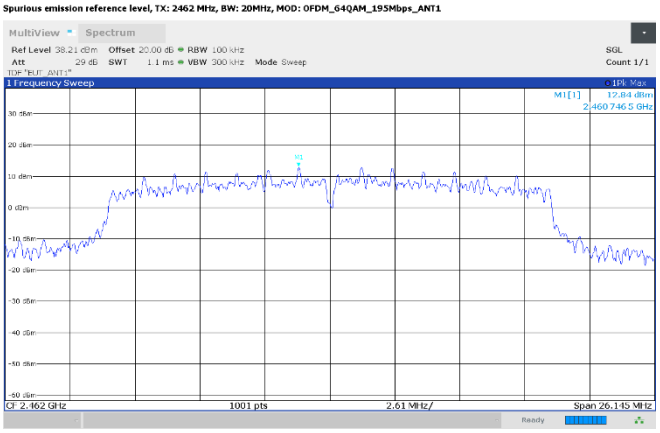


Figure 8.7-89: *Conducted antenna port spurious emissions, reference level, 2462 MHz, Antenna 1*

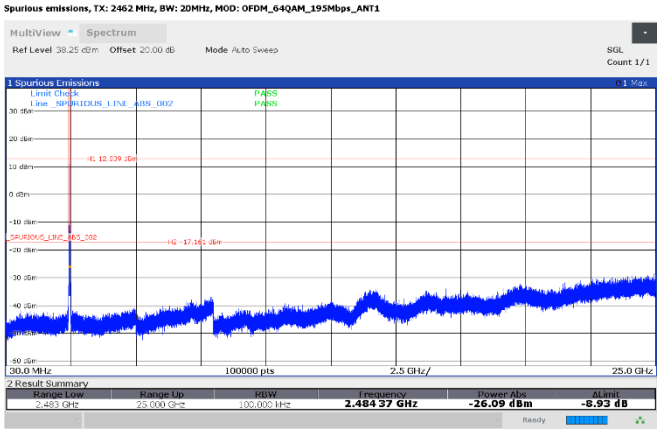


Figure 8.7-90: *Conducted antenna port spurious emissions, 2462 MHz, Antenna 1*

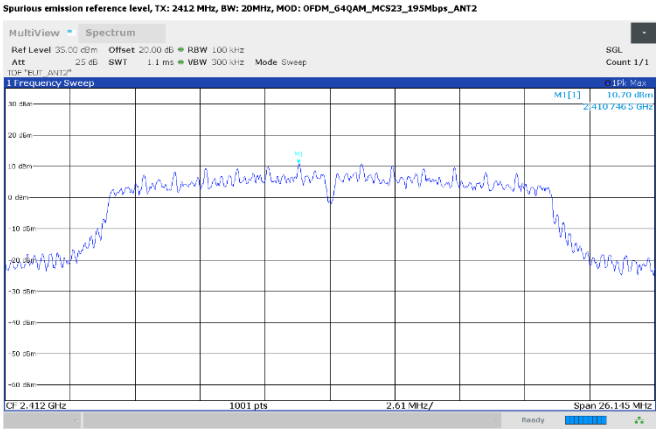


Figure 8.7-91: *Conducted antenna port spurious emissions, reference level, 2412 MHz, Antenna 2*

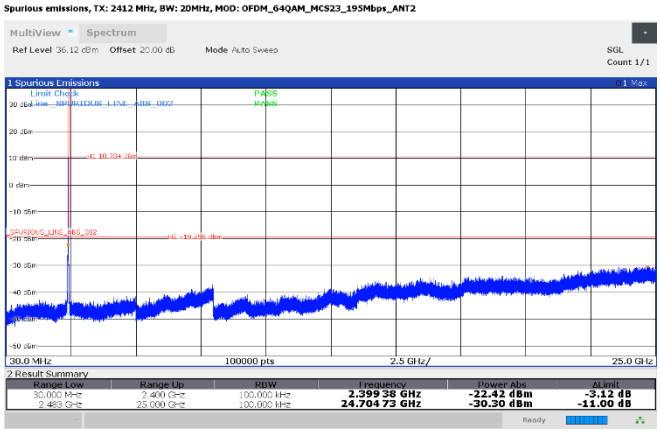


Figure 8.7-92: *Conducted antenna port spurious emissions, 2412 MHz, Antenna 2*

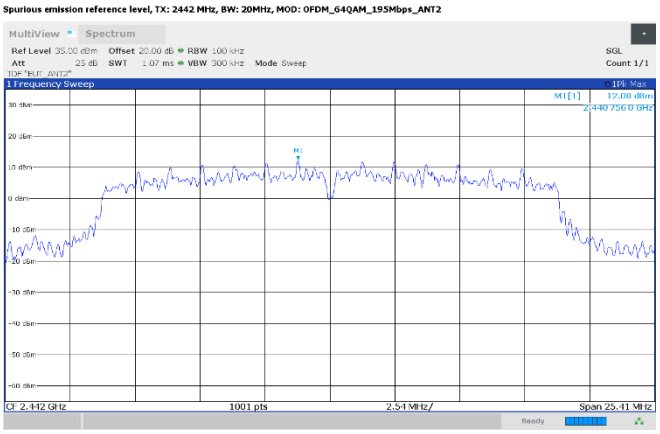


Figure 8.7-93: *Conducted antenna port spurious emissions, reference level, 2442 MHz, Antenna 2*

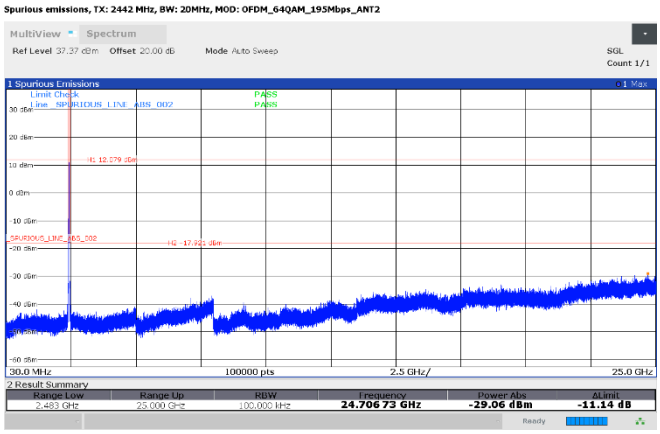


Figure 8.7-94: *Conducted antenna port spurious emissions, 2442 MHz, Antenna 2*

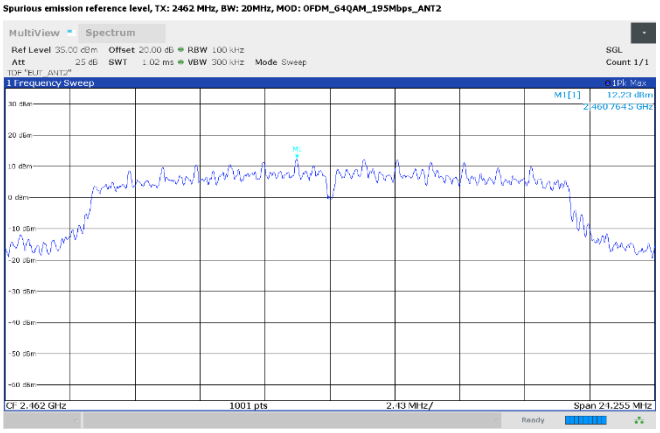


Figure 8.7-95: *Conducted antenna port spurious emissions, reference level, 2462 MHz, Antenna 2*

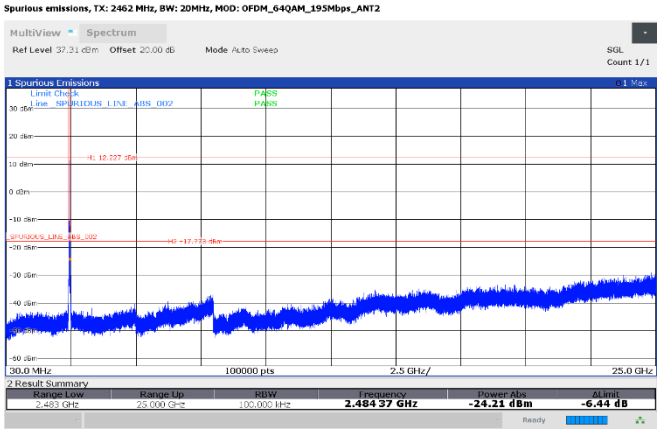


Figure 8.7-96: *Conducted antenna port spurious emissions, 2462 MHz, Antenna 2*

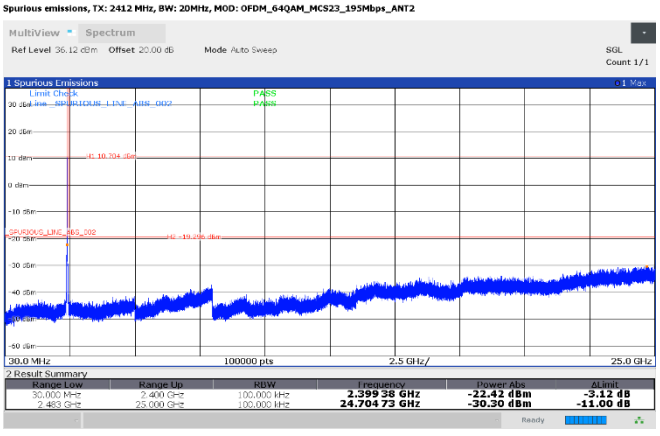


Figure 8.7-97: *Conducted antenna port spurious emissions, reference level, 2412 MHz, Antenna 3*

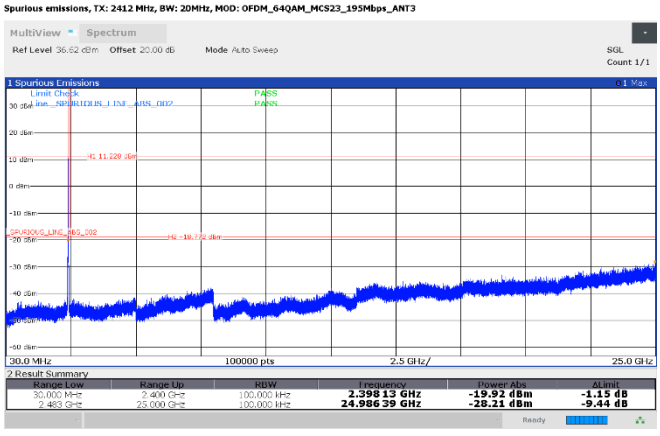


Figure 8.7-98: *Conducted antenna port spurious emissions, 2412 MHz, Antenna 3*

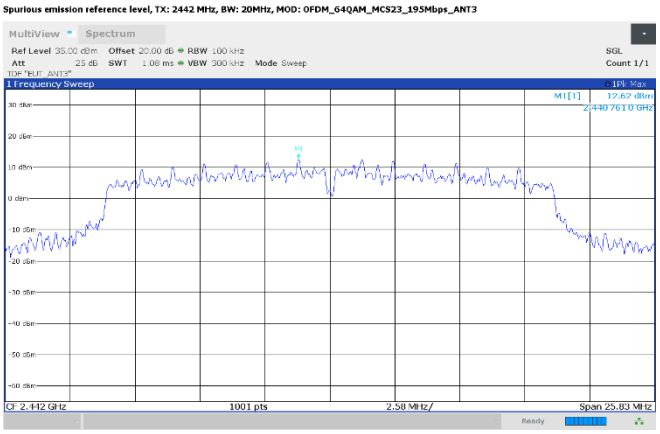


Figure 8.7-99: *Conducted antenna port spurious emissions, reference level, 2442 MHz, Antenna 3*

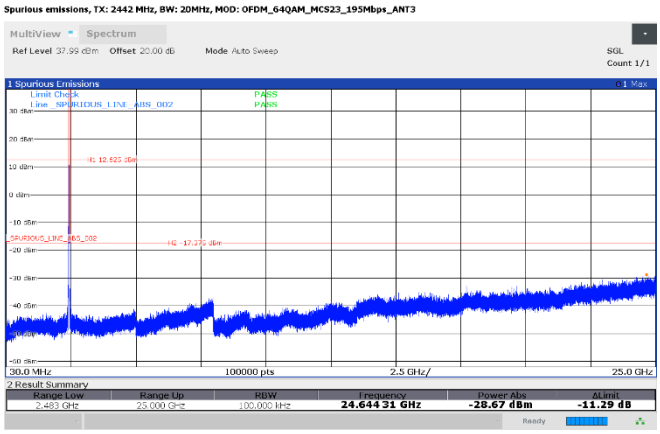


Figure 8.7-100: *Conducted antenna port spurious emissions, 2442 MHz, Antenna 3*

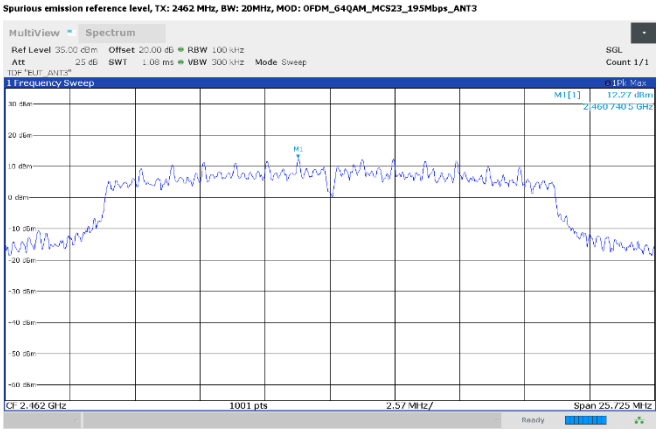


Figure 8.7-101: *Conducted antenna port spurious emissions, reference level, 2462 MHz, Antenna 3*

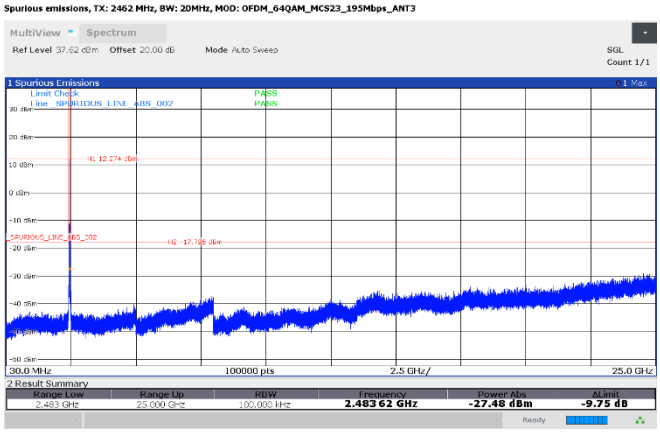


Figure 8.7-102: *Conducted antenna port spurious emissions, 2462 MHz, Antenna 3*

8.7.6.4 IEEE 802.11n HT40 (CDD) mode

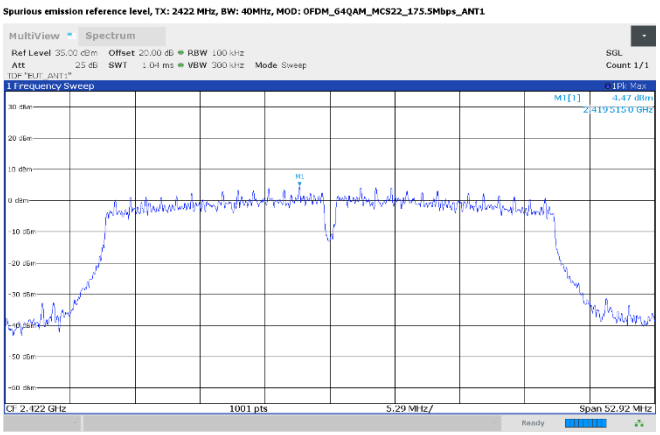


Figure 8.7-103: *Conducted antenna port spurious emissions, reference level, 2422 MHz, Antenna 1*

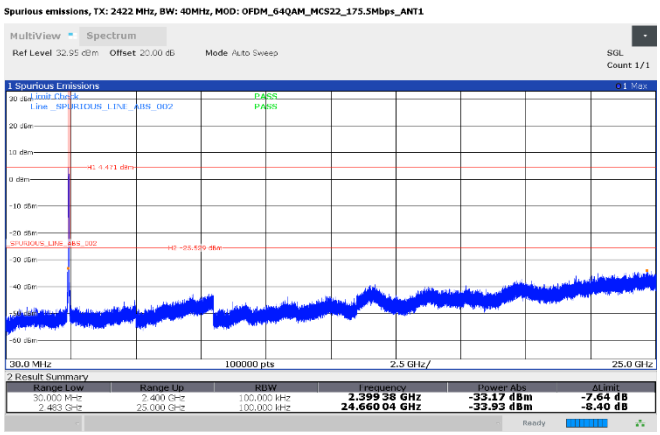


Figure 8.7-104: *Conducted antenna port spurious emissions, 2422 MHz, Antenna 1*

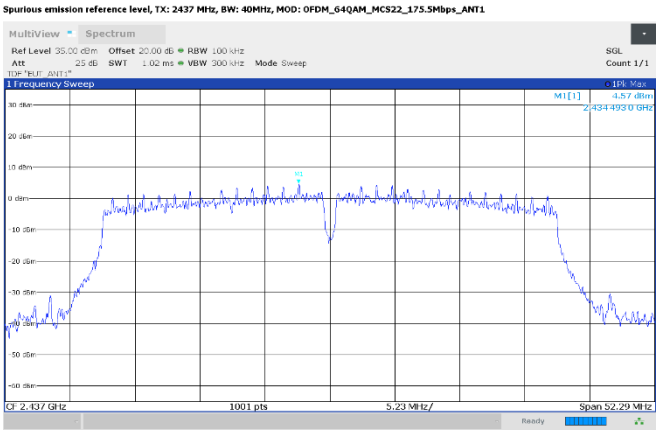


Figure 8.7-105: *Conducted antenna port spurious emissions, reference level, 2437 MHz, Antenna 1*

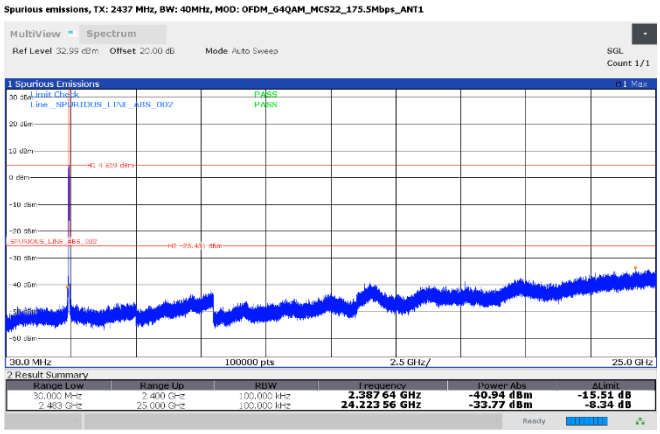


Figure 8.7-106: *Conducted antenna port spurious emissions, 2437 MHz, Antenna 1*

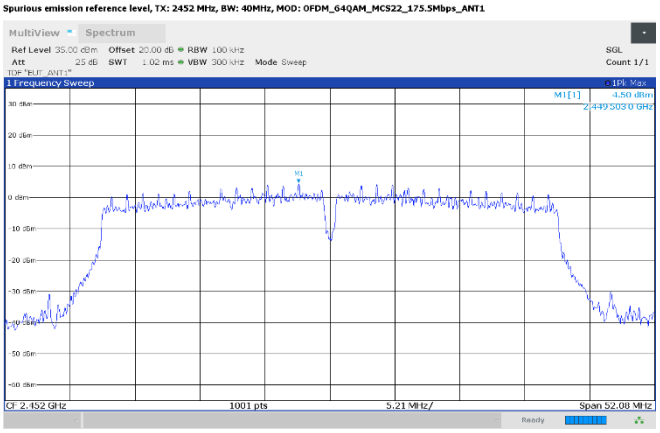


Figure 8.7-107: *Conducted antenna port spurious emissions, reference level, 2452 MHz, Antenna 1*

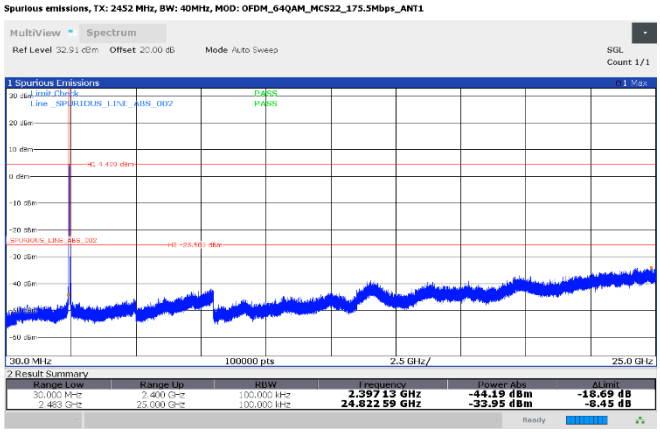


Figure 8.7-108: *Conducted antenna port spurious emissions, 2452 MHz, Antenna 1*

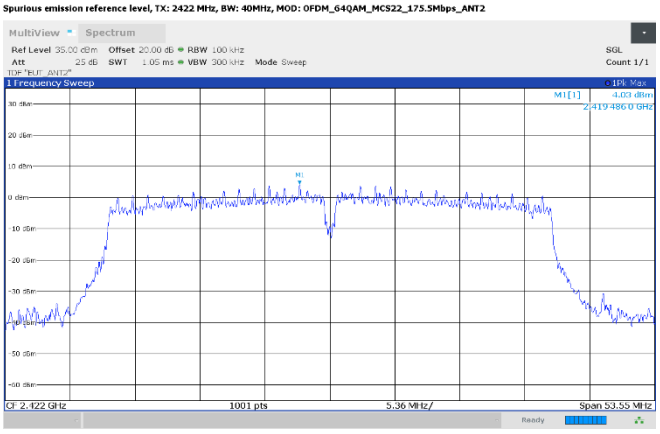


Figure 8.7-109: *Conducted antenna port spurious emissions, reference level, 2422 MHz, Antenna 2*

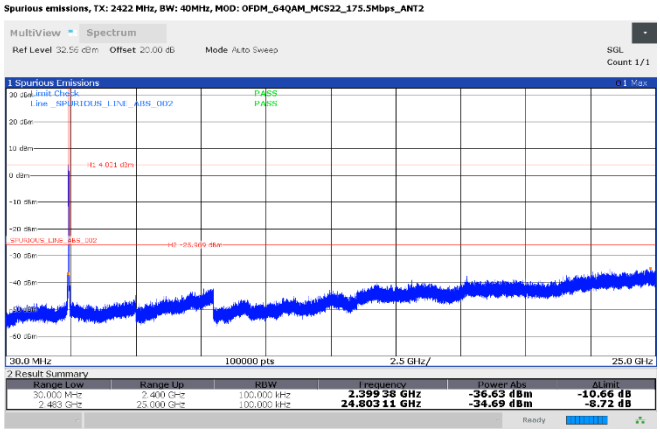


Figure 8.7-110: *Conducted antenna port spurious emissions, 2422 MHz, Antenna 2*

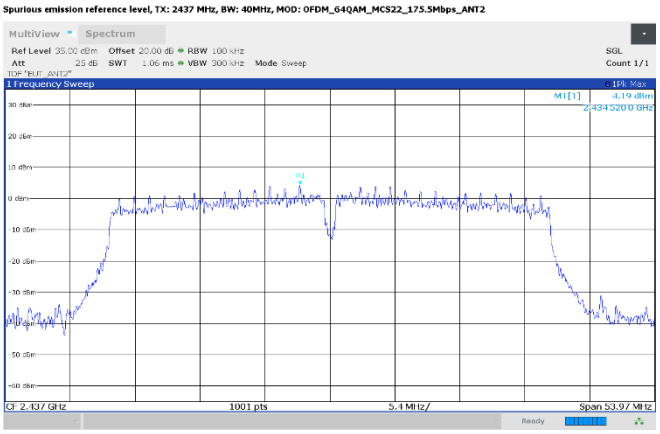


Figure 8.7-111: *Conducted antenna port spurious emissions, reference level, 2437 MHz, Antenna 2*

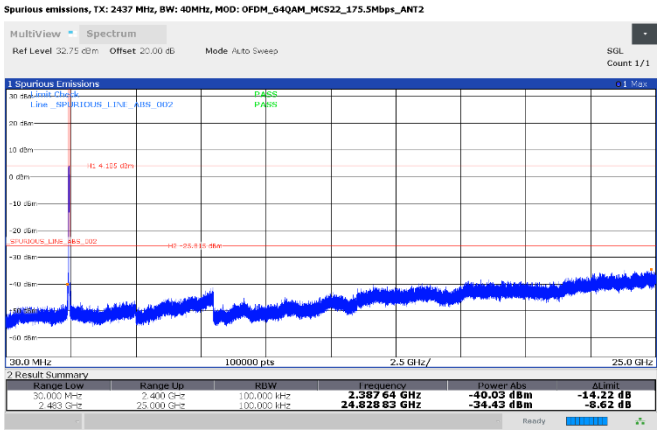


Figure 8.7-112: *Conducted antenna port spurious emissions, 2437 MHz, Antenna 2*

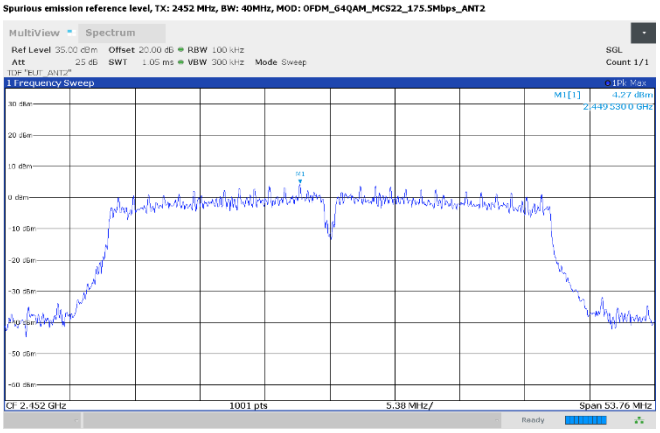


Figure 8.7-113: *Conducted antenna port spurious emissions, reference level, 2452 MHz, Antenna 2*

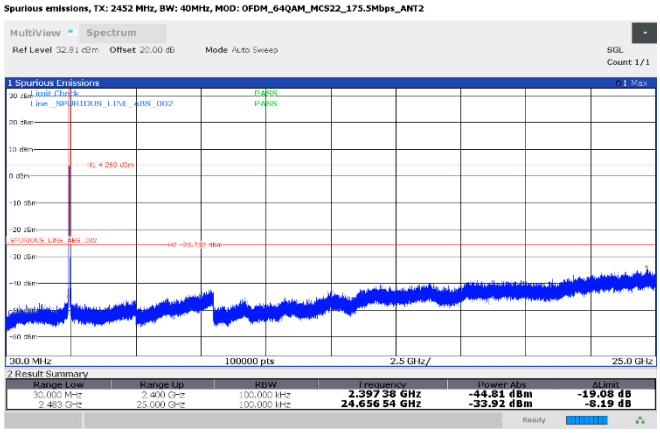


Figure 8.7-114: *Conducted antenna port spurious emissions, 2452 MHz, Antenna 2*

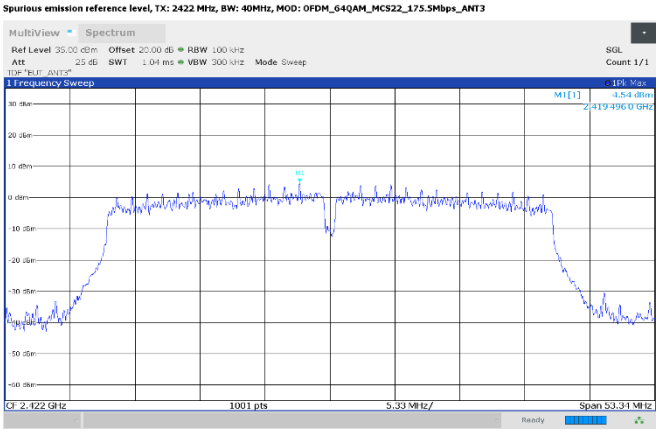


Figure 8.7-115: *Conducted antenna port spurious emissions, reference level, 2422 MHz, Antenna 3*

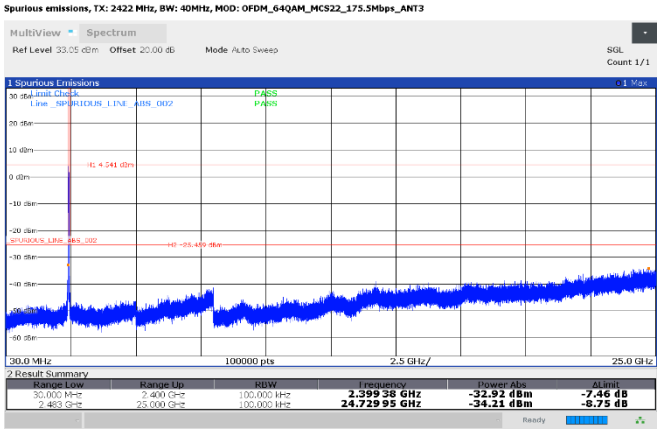


Figure 8.7-116: *Conducted antenna port spurious emissions, 2422 MHz, Antenna 3*

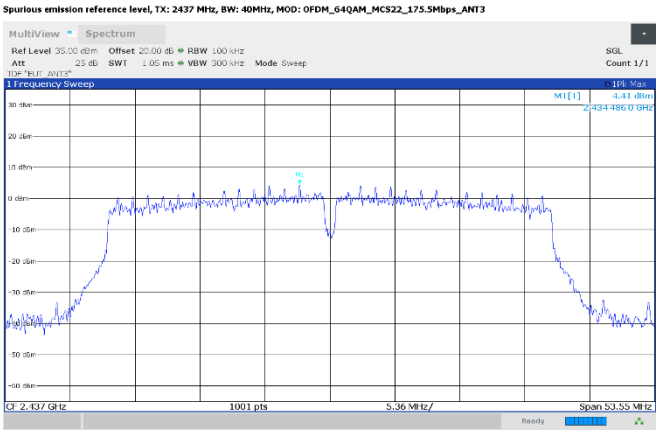


Figure 8.7-117: *Conducted antenna port spurious emissions, reference level, 2437 MHz, Antenna 3*

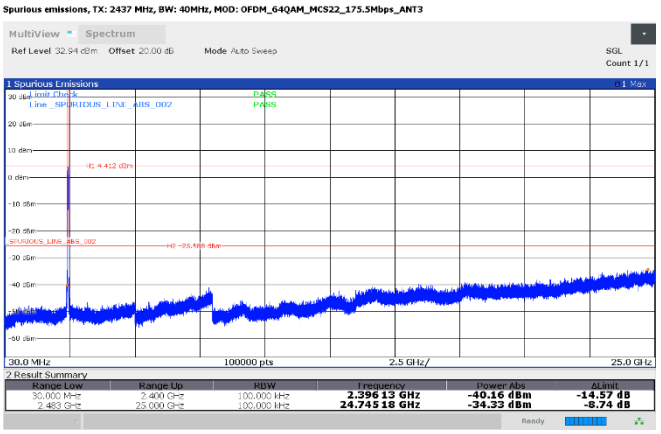


Figure 8.7-118: *Conducted antenna port spurious emissions, 2437 MHz, Antenna 3*

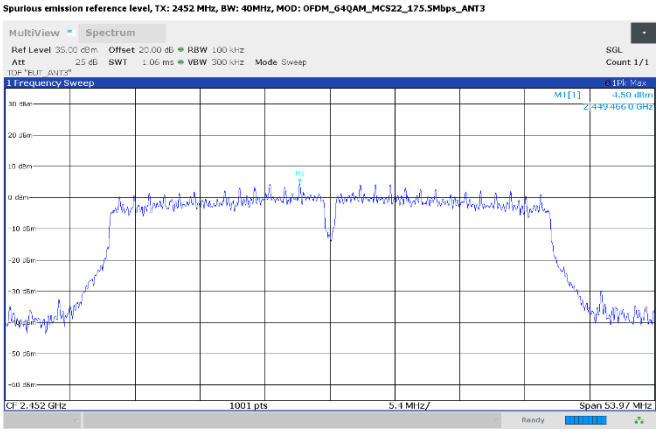


Figure 8.7-119: *Conducted antenna port spurious emissions, reference level, 2452 MHz, Antenna 3*

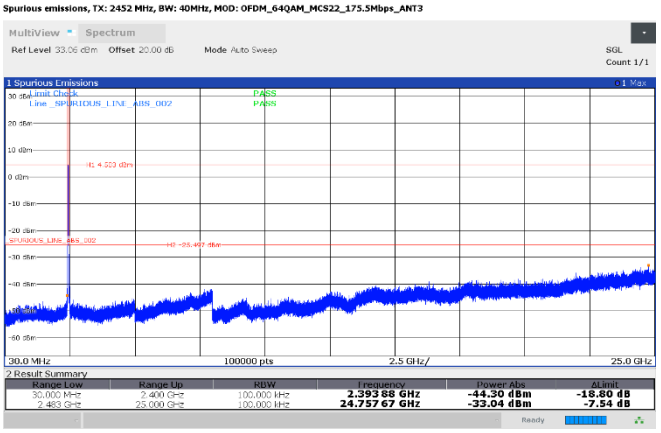


Figure 8.7-120: *Conducted antenna port spurious emissions, 2452 MHz, Antenna 3*

8.7.7 Test data – Radiated emissions – restricted band edge

8.7.7.1 IEEE 802.11b (CDD) mode

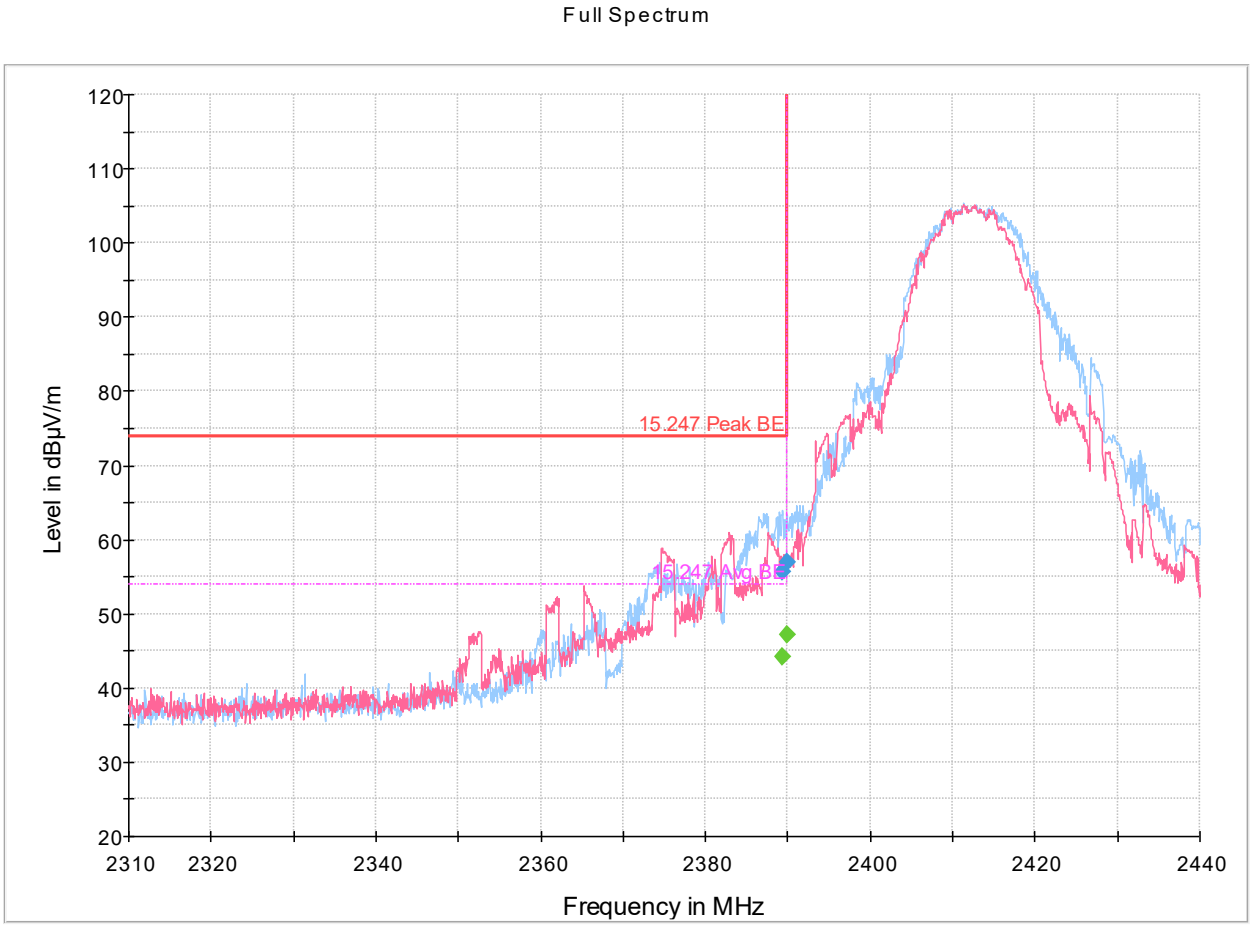


Figure 8.7-121: *Radiated emissions spectral plot (2.31 GHz - 2.44 GHz)*

Table 8.7-4*: Radiated emissions results*

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2389.365000	55.57	---	73.90	18.33	5000.0	1000.000	104.0	V	128.0	-4.4
2389.365000	---	44.12	53.90	9.78	5000.0	1000.000	104.0	V	128.0	-4.4
2390.000000	56.88	---	73.90	17.02	5000.0	1000.000	339.0	H	0.0	-4.4
2390.000000	---	47.22	53.90	6.68	5000.0	1000.000	339.0	H	0.0	-4.4

Notes: [1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB)
[3] Emissions that were continuously present for a minimum of 1 second and occurred more than once for every 15 seconds observation period were considered valid emissions. The maximum value of valid emissions has been recorded.

Full Spectrum

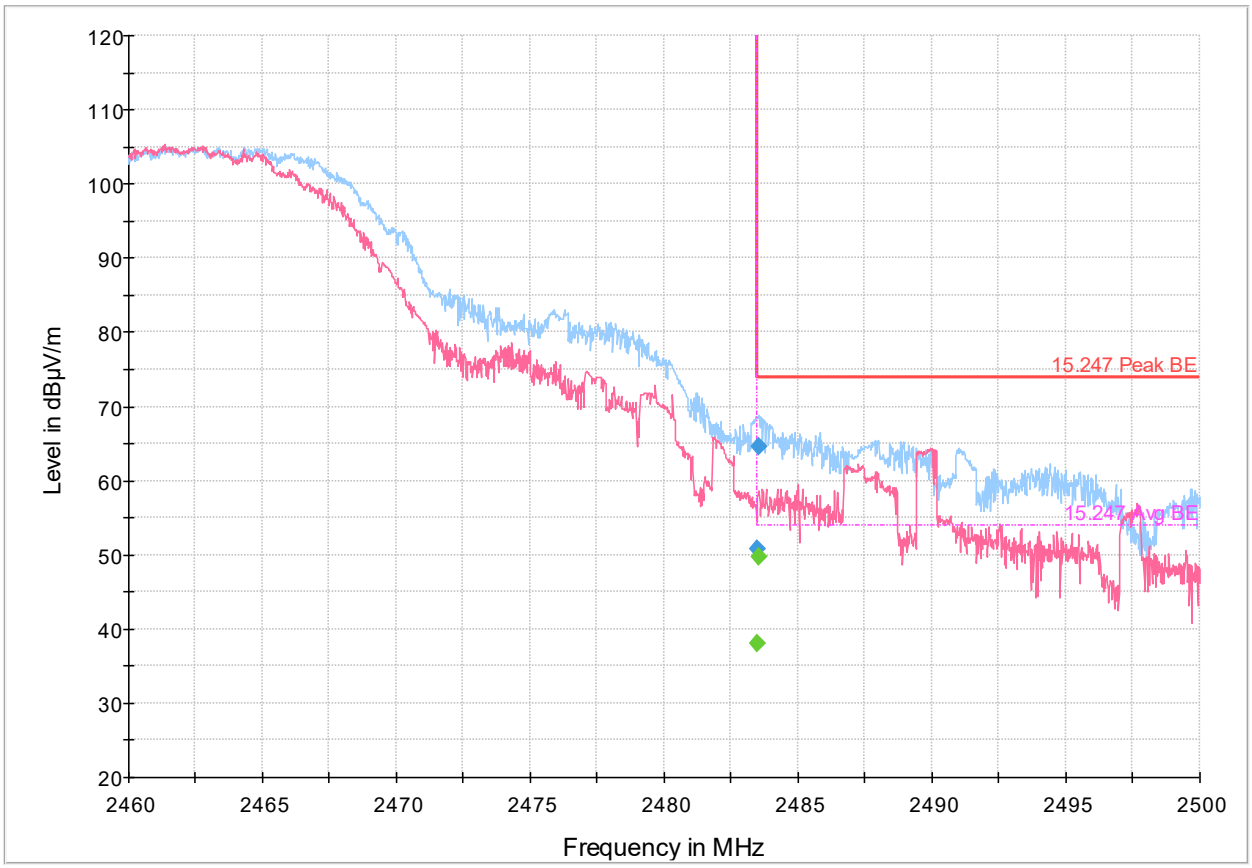


Figure 8.7-122: *Radiated emissions spectral plot (2.46 GHz - 2.5 GHz)*

Table 8.7-5*: Radiated emissions results*

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2483.500000	50.84	---	73.90	23.06	5000.0	1000.000	304.0	V	313.0	-4.0
2483.500000	---	38.07	53.90	15.83	5000.0	1000.000	304.0	V	313.0	-4.0
2483.540000	64.50	---	73.90	9.40	5000.0	1000.000	116.0	H	289.0	-4.0
2483.540000	---	49.76	53.90	4.14	5000.0	1000.000	116.0	H	289.0	-4.0

Notes: [1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB)
[3] Emissions that were continuously present for a minimum of 1 second and occurred more than once for every 15 seconds observation period were considered valid emissions. The maximum value of valid emissions has been recorded.