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RADIO TEST REPORT – 464493-2TRFWL

Type of assessment:

Final product testing

Applicant:

OtO Inc.

Product name (PMN):

OtO Lawn

Model (HVIN):

6014-F

Product description:

Smart Lawn Sprinkler

FCC ID:

2A6P5-6014F

IC Registration number:

28550-6014F

Specifications:

- FCC 47 CFR Part 15 Subpart C, §15.247
- RSS-247, Issue 2, Feb 2017, Section 5

Date of issue: June 3, 2022

Fahar Abdul Sukkoor, EMC/RF Specialist

Tested by

Signature

Tarek Elkholy, EMC/RF Specialist

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Lab locations

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Test site identifier	**Organization**	**Ottawa/Almonte**	**Montreal**	**Cambridge**
	FCC:	CA2040	CA2041	CA0101
	ISED:	2040A-4	2040G-5	24676
Website	www.nemko.com			

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 contained in this report are within Nemko Canada's ISO/IEC 17025 accreditation.

Copyright notification

Table of Contents

Section 1 Report summary

1.1 Test specifications

FCC 47 CFR Part 15, Subpart C, Clause 15.247	Operation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–585 MHz
RSS-247, Issue 2, Feb 2017, Section 5	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

1.2 Test methods

558074 D01 15.247 Meas Guidance v05r02 (April 2, 2019)	Guidance for compliance measurements on digital transmission system, frequency hopping spread spectrum system, and hybrid system devices operating under section 15.247 of the FCC rules.
ANSI C63.10 v2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
RSS-102, Issue 5, March 19, 2015	Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)

1.3 Exclusions

None

1.4 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was performed against all relevant requirements of the test standard except as noted in section 1.3 above. Results obtained indicate that the product under test complies In full with the requirements tested. The test results relate only to the items tested.

See "Summary of test results" for full details.

1.5 Test report revision history

Table 1.5-1: Test report revision history

Revision #	Date of issue	Details of changes made to test report
TRF	June 3, 2022	Original report issued

Section 2 Engineering considerations

2.1 Modifications incorporated in the EUT for compliance

There were no modifications performed to the EUT during this assessment.

2.2 Technical judgment

None

2.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 3 Test conditions

3.1 Atmospheric conditions

Temperature	15 °C – 35 °C
Relative humidity	20 % – 75 %
Air pressure	86 kPa (860 mbar) – 106 kPa (1060 mbar)

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.

3.2 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 4 Measurement uncertainty

4.1 Uncertainty of measurement

UKAS Lab 34 and TIA-603-B have been used as guidance for measurement uncertainty reasonable estimations with regards to previous experience and validation of data. Nemko Canada, Inc. follows these test methods in order to satisfy ISO/IEC 17025 requirements for estimation of uncertainty of measurement for wireless products.

Measurement uncertainty budgets for the tests are detailed below. Measurement uncertainty calculations assume a coverage factor of K = 2 with 95% certainty.

Table 4.1-1: Measurement uncertainty calculations for Radio

Test name	Measurement uncertainty, ±dB
All antenna port measurements	0.55
Occupied bandwidth	4.45
Conducted spurious emissions	1.13
Radiated spurious emissions	3.78
AC power line conducted emissions	3.55

Section 5 Information provided by the applicant

5.1 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 contained 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.

5.2 Applicant

Company name	Oto Inc.
Address	150 Courtland Ave, Concord, ON L4K 3T6

5.3 Manufacturer

Company name	OtO Inc.
Address	150 Courtland Ave, Concord, ON L4K 3T6

5.4 EUT information

Product name (PMN)	OtO Lawn
Equipment description	Smart Lawn Sprinkler
Model (HVIN)	6014-F
Serial number	MLB3.4-00018
Operating conditions	EUT transmits Wi-Fi 2.4 GHz signal using ESP RF tool kit. Hardware version: D Software version: V2
Product description and theory of operation	EUT is a smart sprinkler that will water and apply fertilizer on a schedule and to a particular part of their garden/lawn as defined by the customer in the accompanying mobile app for an automated lawncare solution

5.5 Technical information

Applicant IC company number	28550
IC UPN number	-6014F
All used IC test site(s) Reg. number	24676
RSS number and Issue number	RSS-247 Issue 2, Feb 2017
Category of Wideband Data Transmission equipment	☐ Frequency Hopping Spread Spectrum (FHSS) equipment ☒ Other types of Wideband Data Transmission equipment (e.g. DSSS, OFDM, etc.).
Frequency band	2400–2483.5 MHz
Frequency Min (MHz)	2412 (20 MHz) 2422 (40 MHz)
Frequency Max (MHz)	2462 (20 MHz) 2452 (40 MHz)
Channel numbers	1–11
RF power Max (W), Conducted	0.02 (13.2 dBm)
Field strength, dBμV/m @ 3 m	N/A
Measured BW (kHz), 99% OBW	17.43(20 MHz) 34.57 (40 MHz)
Type of modulation	OFDM
Emission classification	W7D
Transmitter spurious, dBμV/m @ 3 m	61.10 (pk) and 48.01(avg) on 2390 MHz @ LOW CHANNEL
Power supply requirements	12 V_{DC} (via external 100–240 V_{AC}, 50/60 Hz power adapter)
Antenna information	Antenna gain: 2 dBi Antenna type: Internal Embedded Antenna Antenna Manufacturer: Laird Connectivity Inc. Model number: MAF94045

5.6 EUT setup details

5.6.1 EUT Exercise and monitoring

Methods used to exercise the EUT and all relevant ports:

- EUT is powered on and transmit Wi-Fi signal using ESP RF Test Tool kit EUT runs at 100% duty cycle.

Configuration details:

- The EUT setup in a configuration that was expected to produce the highest amplitude emissions relative to the limit and that satisfy normal operation/installation practice by the end user.
- The type and construction of cables used in the measurement set-up were consistent with normal or typical use. Cables with mitigation features (for example, screening, tighter/more twists per length, ferrite beads) have been noted below:
  - The following deviations were:
  - None
- The EUT was setup in a manner that was consistent with its typical arrangement and use. The measurement arrangement of the EUT, local AE and associated cabling was representative of normal practice. Any deviations from typical arrangements have been noted below:
  - The following deviations were:
  - None

5.6 EUT setup details, continued

5.6.2 EUT test configuration

Table 5.6-1: EUT interface ports

Description	Qty.
DC power port	1

Table 5.6-2: Support equipment

Description	Brand name	Model, Part number, Serial number, Revision level
Laptop	Dell	MN: Latitude5420
AC/DC Adaptor	Xing Yuan Electronics co. Ltd.	MN: XY06J-1200500L-U0

Table 5.6-3: Inter-connection cables

Cable description	From	To	Length (m)
AC power port	AC mains	Power adaptor	<1
DC power port	Power adaptor	EUT	

5.6 EUT setup details, continued

5.6.2 EUT test configuration, continued

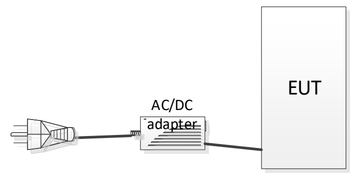


Figure 5.6-1: Radiated testing block diagram

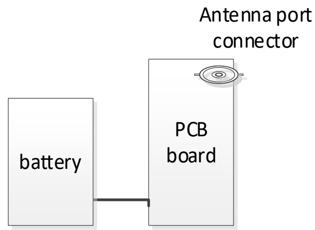


Figure 5.6-2: Antenna port testing block diagram

Section 6 Summary of test results

6.1 Testing location

Test location (s)	Cambridge

6.2 Testing period

Test start date	April 19, 2022	Test end date	April 27, 2022

6.3 Sample information

Receipt date	April 19, 2022	Nemko sample ID number(s)	1

6.4 FCC Part 15 Subpart C, general requirements test results

Table 6.4-1: FCC general requirements results

Part	Test description	Verdict
§15.207(a)	Conducted limits	Pass
§15.31I	Variation of power source	Pass
§15.31(m)	Number of tested frequencies	Pass
§15.203	Antenna requirement	Pass

Notes: EUT is DC powered via AC/DC power adaptor .

6.5 FCC Part 15 Subpart C, intentional radiators test results for digital transmission systems (DTS)

Table 6.5-1: FCC 15.247 results for DTS

Part	Test description	Verdict
§15.247(a)(2)	Minimum 6 dB bandwidth	Pass
§15.247(b)(3)	Maximum peak output power in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands	Pass
§15.247I(1)	Fixed point-to-point operation with directional antenna gains greater than 6 dBi	Not applicable
§15.247I(2)	Transmitters operating in the 2400–2483.5 MHz band that emit multiple directional beams	Not applicable
§15.247(d)	Spurious emissions	Pass
§15.247I	Power spectral density	Pass
§15.247(f)	Time of occupancy for hybrid systems	Not applicable
§15.247(i)	Radiofrequency radiation exposure evaluation	Pass

6.6 ISED RSS-Gen, Issue 5, test results

Table 6.6-1: RSS-Gen results

Part	Test description	Verdict
7.3	Receiver radiated emission limits	Not applicable
7.4	Receiver conducted emission limits	Not applicable
6.9	Operating bands and selection of test frequencies	Pass
8.8	AC power-line conducted emissions limits	Pass
RSS-102, 252	Exemption Limits for Routine Evaluation — RF Exposure Evaluation	Fail

Notes: [1] According to sections 5.2 and 5.3 of RSS-Gen, Issue 5 the EUT does not have a stand-alone receiver neither scanner receiver, therefore exempt from receiver requirements.
EUT is an DC powered device via AC/DC power adaptor .

6.7 ISED RSS-247, Issue 2, test results for digital transmission systems (DTS)

Table 6.7-1: RSS-247 results for DTS

Part	Test description	Verdict
5.2 (a)	Minimum 6 dB bandwidth	Pass
5.2 (b)	Maximum power spectral density	Pass
5.3	Hybrid Systems	
5.3 (a)	Digital modulation turned off	Not applicable
5.3 (b)	Frequency hopping turned off	Not applicable
5.4	Transmitter output power and e.i.r.p. requirements	
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	Unwanted emissions	Pass

Section 7 Test equipment

7.1 Test equipment list

Table 7.1-1: Equipment list

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
3 m EMI test chamber	TDK	SAC-3	FA003012	1 year	February 7, 2023
Flush mount turntable	SUNAR	FM2022	FA003006	—	NCR
Controller	SUNAR	SC110V	FA002976	—	NCR
Antenna mast	SUNAR	TLT2	FA003007	—	NCR
AC Power source	Chroma	0	FA003020	—	NCR
Receiver/spectrum analyzer	Rohde & Schwarz	ESR26	FA002969	1 year	November 30,2022
Spectrum analyzer	Rohde & Schwarz	FSW43	FA002971	1 year	December 31, 2022
Horn antenna (1–18 GHz)	ETS Lindgren	3117	FA002911	1 year	May 21, 2022
Preamp (1–18 GHz)	ETS Lindgren	124334	FA002956	1 year	March 30, 2023
Bilog antenna (20–2000 MHz)	Sun AR	JB1	FA003009	1 year	January 31, 2023
Horn antenna (18–40 GHz)	EMCO	3116B	FA002948	1 year	January 23, 2023
50 Ω coax cable	Huber + Suhner	None	FA003047	1 year	July 13, 2022
50 Ω coax cable	Huber + Suhner	None	FA003043	1 year	July 13, 2022
Two-line v-network	Rohde & Schwarz	ENV216	FA002964	1 year	November 30,2022
50 Ω coax cable	Rohde & Schwarz	None	FA003074	1 year	July 13, 2022
Pre amp (18-40 GHz)	Nemko	None	FA003323	1 year	March 30 2023

Note: NCR - no calibration required, VOU - verify on use

Section 8 Testing data

8.1 FCC 15.247(i) and 2.1093 Radiofrequency radiation exposure evaluation: portable devices

8.1.1 References, definitions and limits

§15.247(i) Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines. See §1.1307(b)(1) of this chapter.
§1.1307(b)(1) The appropriate exposure limits in §§1.1310 and 2.1093 of this chapter are generally applicable to all facilities, operations and transmitters regulated by the Commission.
§1.1310 Radiofrequency radiation exposure limits.
(e) Table below sets forth limits for Maximum Permissible Exposure (MPE) to radiofrequency electromagnetic fields.

Table 8.1-1: Limits for Maximum Permissible Exposure (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm²)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposure				
0.3–3.0	614	1.63	*100	6
3.0–30	1842/f	4.89/f	*900/f^2	6
30–300	61.4	0.163	1.0	6
300–1.500			f/300	6
1.500–100.000			5.0	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3–1.34	614	1.63	*100	30
1.34–30	824/f	2.19/f	*180/f^2	30
30–300	27.5	0.073	0.2	30
300–1.500			f/1500	30
1.500–100.000			1.0	30

*Notes: f = frequency in MHz; * = Plane-wave equivalent power density*

(1) Occupational/controlled exposure limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when a person is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure. The phrase fully aware in the context of applying these exposure limits means that an exposed person has received written and/or verbal information fully explaining the potential for RF exposure resulting from his or her employment. With the exception of transient persons, this phrase also means that an exposed person has received appropriate training regarding work practices relating to controlling or mitigating his or her exposure. Such training is not required for transient persons, but they must receive written and/or verbal information and notification (for example, using signs) concerning their exposure potential and appropriate means available to mitigate their exposure. The phrase exercise control means that an exposed person is allowed to and knows how to reduce or avoid exposure by administrative or engineering controls and work practices, such as use of personal protective equipment or time averaging of exposure.

(2) General population/uncontrolled exposure limits apply in situations in which the general public may be exposed, or in which persons who are exposed as a consequence of their employment may not be fully aware of the potential for exposure or cannot exercise control over their exposure.

8.1.2 Test summary

Verdict	Pass		
Tested by	Fahar Abdul Sukkoor	Test date	April 21, 2022

8.1.3 Observations, settings and special notes

Since the fundamental frequency is within 1.5–100 GHz range only Power Density limits apply.

Calculation of the power density at predicted distance was done using an equation from page 18 of OET Bulletin 65, Edition 97-01: $S = \frac{PG}{4\pi R^2}$

Were S: power density [mW/cm^2]; P: power input to the antenna [mW]; G: power gain of the antenna in the direction of interest relative to an isotropic radiator [numeric (linear scale)]; R: distance to the center of radiation of the antenna [cm].

8.1.4 Test data

Table 8.1-2: Maximum Permissible Exposure (MPE) calculations

Frequency (MHz)	Output power (dBm)	Antenna gain (dBi)	Prediction distance (R) (cm)	Power density (S) (mW/cm^2)	Power density limit (mW/cm^2)
2412	13.2	2.0	20	0.013	1.00
2437	11.9	2.0	20	0.009	1.00
2462	11.3	2.0	20	0.008	1.00

$$S = \frac{PG}{4\pi R^2}$$

P (mw) = $10^{\text{Output power (dBm) / 10}}$

G (*numeric*) = $10^{\text{Antenna gain (dBi) / 10}}$

8.2 RSS-102 Section 2.5.2 Exemption Limits for Routine Evaluation — RF Exposure Evaluation

8.2.1 References, definitions and limits

RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates as follows:

- below 20 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1 W (adjusted for tune-up tolerance);
- at or above 20 MHz and below 48 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $22.48/f^{0.5}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 48 MHz and below 300 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 0.6 W (adjusted for tune-up tolerance);
- at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $1.31 \times 10^{-2} f^{0.6834}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 5 W (adjusted for tune-up tolerance).

In these cases, the information contained in the RF exposure technical brief may be limited to information that demonstrates how the e.i.r.p. was derived.

8.2.2 Test summary

Verdict	Pass		
Tested by	Fahar Abdul Sukkoor	Test date	April 27, 2022

8.2.3 Observations, settings and special notes

Since the fundamental frequency is within 300–6000 MHz range: $1.31 \times 10^{-2} f^{0.6834}$ [W] MPE Exemption limit applies.

8.2.4 Test data

Table 8.2-1: Maximum EIRP calculations for MPE exemption

Frequency (MHz)	Output power (dBm)	Antenna gain (dBi)	EIRP (dBm)	EIRP (W)	MPE Exemption limit (W)	Margin for compliance (W)
2412	13.2	2.0	15.2	0.03	2.67	2.64
2437	11.9	2.0	13.9	0.02	2.70	2.68
2462	11.3	2.0	13.3	0.02	2.72	2.70

8.3 FCC 15.31(e) Variation of power source

8.3.1 References, definitions and limits

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		
Tested by	Fahar Abdul Sukkoor	Test date	April 22, 2022

8.3.3 Observations, settings and special notes

The testing was performed as per ANSI C63.10 Section 5.13.

a) Where the device is intended to be powered from an external power adapter, the voltage variations shall be applied to the input of the adapter provided with the device at the time of sale. If the device is not marketed or sold with a specific adapter, then a typical power adapter shall be used.
b) For devices, where operating at a supply voltage deviating ±15% from the nominal rated value may cause damages or loss of intended function, test to minimum and maximum allowable voltage per manufacturer's specification and document in the report.
c) For devices with wide range of rated supply voltage, test at 15% below the lowest and 15% above the highest declared nominal rated supply voltage.
d) For devices obtaining power from an input/output (I/O) port (USB, firewire, etc.), a test jig is necessary to apply voltage variation to the device from a support power supply, while maintaining the functionalities of the device.

For battery-operated equipment, the equipment tests shall be performed using a variable power supply.

8.3.4 Test data

EUT Power requirements:	☒ AC	☐ DC	☐ Battery
If EUT is an AC or a DC powered, was the noticeable output power variation observed?	☐ YES	☒ NO	☐ N/A
If EUT is battery operated, was the testing performed using fresh batteries?	☐ YES	☐ NO	☒ N/A
If EUT is rechargeable battery operated, was the testing performed using fully charged batteries?	☐ YES	☐ NO	☒ N/A

8.4 FCC 15.31(m) and RSS-Gen 6.9 Number of frequencies

8.4.1 References, definitions and limits

FCC:
Measurements on intentional radiators or receivers shall be performed and, if required, reported for each band in which the device can be operated with the device operating at the number of frequencies in each band specified in the following table.

ISED:
Except where otherwise specified, measurements shall be performed for each frequency band of operation for which the radio apparatus is to be certified, with the device operating at the frequencies in each band of operation shown in table below. The frequencies selected for measurements shall be reported in the test report.

Table 8.4-1: Frequency Range of Operation

Frequency range over which the device operates (in each band)	Number of test frequencies required	Location of measurement frequency inside the operating frequency range
1 MHz or less	1	Center (middle of the band)
1–10 MHz	2	1 near high end, 1 near low end
Greater than 10 MHz	3	1 near high end, 1 near center and 1 near low end

Note: "near" means as close as possible to or at the centre / low end / high end of the frequency range over which the device operates.

8.4.2 Test summary

Verdict	Pass		
Tested by	Fahar Abdul Sukkoor	Test date	April 22, 2022

8.4.3 Observations, settings and special notes

Per ANSI C63.10 Subclause 5.6.2.1:
The number of channels tested can be reduced by measuring the center channel bandwidth first and then applying the following relaxations as appropriate:

a) For each operating mode, if the measured channel bandwidth on the middle channel is at least 150% of the minimum permitted bandwidth, then it is not necessary to measure the bandwidth on the high and low channels.
b) For multiple-input multiple-output (MIMO) systems, if the measured channel bandwidth on testing the middle channel exceeds the minimum permitted bandwidth by more than 50% on one transmit chain, then it is not necessary to repeat testing on the other chains.
c) If the measured channel bandwidth on the middle channel is less than 50% of the maximum permitted bandwidth, then it is not necessary to measure the bandwidth on the high and low channels.

Per ANSI C63.10 Subclause 5.6.2.2:
For devices with multiple operating modes, measurements on the middle channel can be used to determine the worst-case mode(s). The worst-case modes are as follows:

a) Band edge requirements—Measurements on the mode with the widest bandwidth can be used to cover the same channel (center frequency) on modes with narrower bandwidth that have the same or lower output power for each modulation family (e.g., OFDM and direct sequence spread spectrum).
b) Spurious emissions—Measure the mode with the highest output power and the mode with the highest output power spectral density for each modulation family (e.g., OFDM and direct sequence spread spectrum).
c) In-band PSD—Measurements on the mode with the narrowest bandwidth can be used to cover all modes within the same modulation family of an equal or lower output power provided the result is less than 50% of the limit.

8.4.4 Test data

Table 8.4-2: Test channels selection for 20 MHz

Start of Frequency range, MHz	End of Frequency range, MHz	Frequency range bandwidth, MHz	Low channel, MHz	Mid channel, MHz	High channel, MHz
2400	2483.5	83.5	2412	2437	2462

Table 8.4-3: Test channels selection for 40 MHz

Start of Frequency range, MHz	End of Frequency range, MHz	Frequency range bandwidth, MHz	Low channel, MHz	Mid channel, MHz	High channel, MHz
2400	2483.5	83.5	2422	2437	2452

8.5 FCC 15.203 and RSS-Gen, section 6.8 Antenna requirement

8.5.1 References, definitions and limits

FCC:
An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.
FCC 15.247(b)(4)
The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

ISED:
The applicant for equipment certification shall provide a list of all antenna types that may be used with the transmitter, where applicable (i.e. for transmitters with detachable antenna), indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna. The test report shall demonstrate the compliance of the transmitter with the limit for maximum equivalent isotropically radiated power (e.i.r.p.) specified in the applicable RSS, when the transmitter is equipped with any antenna type, selected from this list.

For expediting the testing, measurements may be performed using only the antenna with highest gain of each combination of transmitter and antenna type, with the transmitter output power set at the maximum level. However, the transmitter shall comply with the applicable requirements under all operational conditions and when in combination with any type of antenna from the list provided in the test report.

8.5.2 Test summary

Verdict	Pass		
Tested by	Fahar Abdul Sukkoor	Test date	April 22, 2022

8.5.3 Observations, settings and special notes

None

8.5.4 Test data

Must the EUT be professionally installed?	☐ YES	☒ NO	
Does the EUT have detachable antenna(s)?	☐ YES	☒ NO	
If detachable, is the antenna connector(s) non-standard?	☐ YES	☐ NO	☒ N/A

Table 8.5-1: Antenna information

Antenna type	Manufacturer	Model number	Maximum gain	Connector type
Internal Embedded Antenna	Laird Connectivity	MAF94045	2	MHF

8.6 FCC 15.207(a) and RSS-Gen 8.8 AC power line conducted emissions limits

8.6.1 References, definitions and limits

FCC:
Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 µH/50 Ω line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

ANSI: C63.10 subclause 6.2
If the EUT normally receives power from another device that in turn connects to the public utility ac power lines, measurements shall be made on that device with the EUT in operation to demonstrate that the device continues to comply with the appropriate limits while providing the EUT with power. If the EUT is
operated only from internal or dedicated batteries, with no provisions for connection to the public utility ac power lines (600 VAC or less) to operate the EUT (such as an adapter), then ac power-line conducted measurements are not required.
For direct current (dc) powered devices where the ac power adapter is not supplied with the device, an "off-the-shelf" unmodified ac power adapter shall be used. If the device is supposed to be installed in a host (e.g., the device is a module or PC card), then it is tested in a typical compliant host.

IC:
A radio apparatus that is designed to be connected to the public utility (AC) power line shall ensure that the radio frequency voltage, which is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz, shall not exceed the limits in table below.

Unless the requirements applicable to a given device state otherwise, for any radio apparatus equipped to operate from the public utility AC power supply either directly or indirectly (such as with a battery charger), the radio frequency voltage of emissions conducted back onto the AC power lines in the frequency range of 0.15 MHz to 30 MHz shall not exceed the limits shown in table below. The more stringent limit applies at the frequency range boundaries.

Table 8.6-1: 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: * - The level decreases linearly with the logarithm of the frequency.
** - A linear average detector is required.

8.6.2 Test summary

Verdict	Pass		
Tested by	Fahar Abdul Sukkoor	Test date	April 25, 2022

8.6.3 Observations, settings and special notes

The EUT was set up as tabletop configuration per ANSI C63.10-2013 measurement procedure.

The spectral scan has been corrected with transducer factors (i.e. cable loss, LISN factors, and attenuators) for determination of compliance.

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.

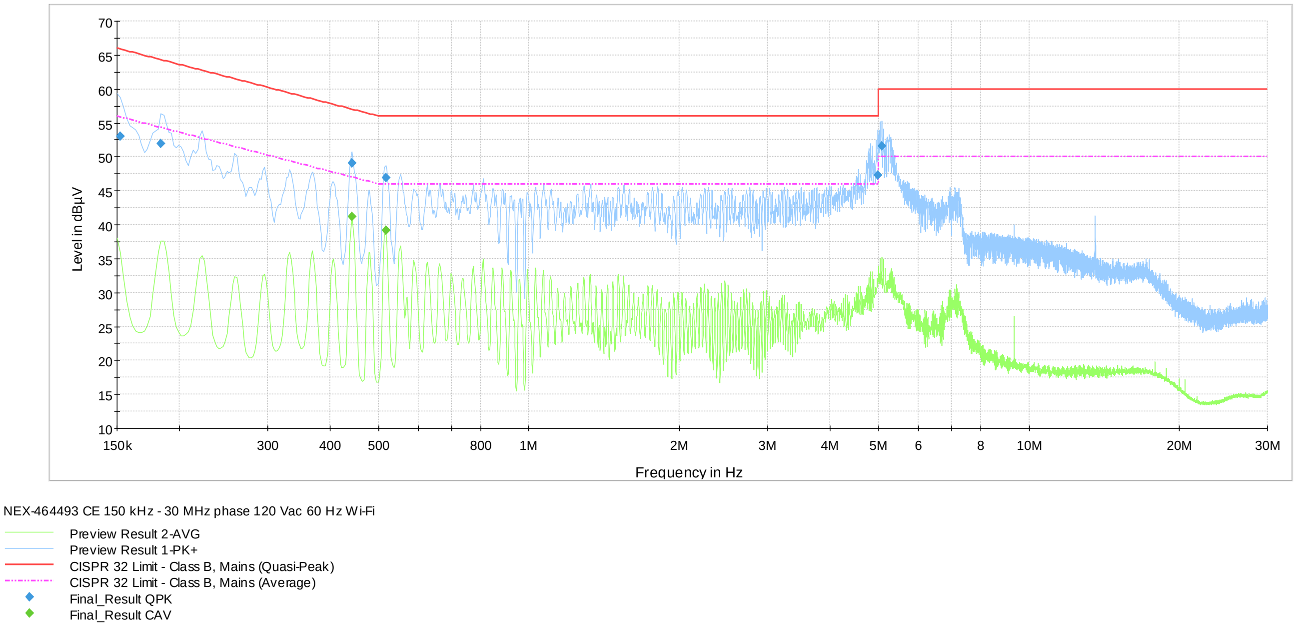
EMI Receiver settings for preview measurements:

Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Detector mode	Peak and Average
Trace mode	Max Hold
Measurement time	1000 ms

Receiver settings for final measurements:

Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Detector mode	Quasi-Peak and Average
Trace mode	Max Hold
Measurement time	1000 ms

8.6.4 Test data



Plot 8.6-1: Conducted emissions on phase line

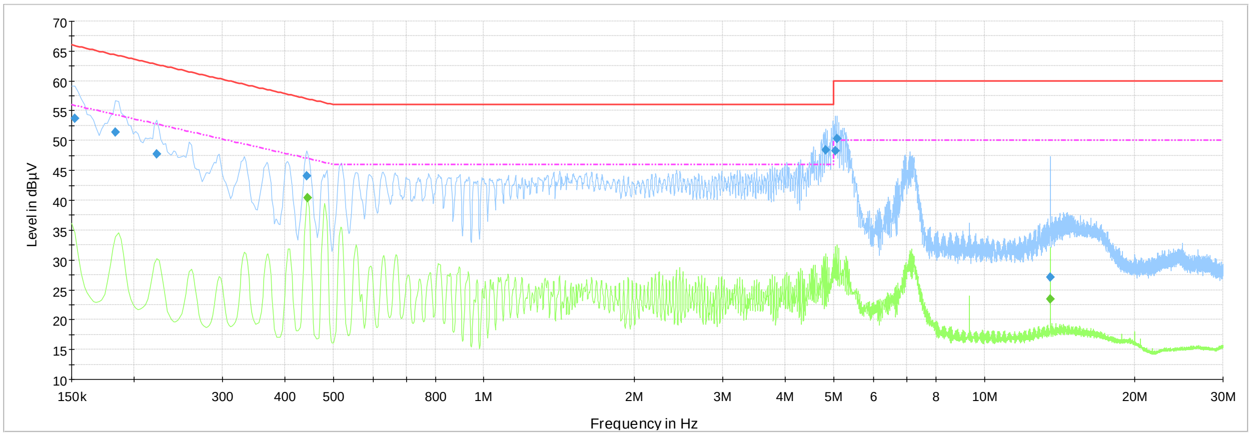
Table 8.6-2: Quasi-Peak conducted emissions results on phase line

Frequency, MHz	Q-Peak result, dBµV	Limit, dBµV	Margin, dB	Correction, dB
0.15	53.1	65.9	12.8	15.7
0.18	51.9	64.3	12.4	15.6
0.44	49.1	57.0	7.9	15.7
0.52	47.0	56.0	9.0	15.8
4.98	47.2	56.0	8.8	15.7
5.08	51.7	60.0	8.3	15.7

Note: 43.5 dBµV = 23.2 dBµV (receiver reading) + 10.1 dB (LISN factor IL) + 0.2 dB (cable loss) + 10 dB (attenuator)

Table 8.6-3: Average conducted emissions results on phase line

Frequency, MHz	Average result, dBµV	Limit, dBµV	Margin, dB	Correction, dB
0.44	41.2	47.0	5.8	15.7
0.52	39.2	46.0	6.8	15.8



Plot 8.6-2: Conducted emissions on neutral line

Table 8.6-4: Quasi-Peak conducted emissions results on neutral line

Frequency, MHz	Q-Peak result, dBµV	Limit, dBµV	Margin, dB	Correction, dB
0.15	53.7	65.9	12.2	15.7
0.18	51.3	64.3	13.0	15.6
0.22	47.8	62.7	14.9	15.6
0.44	44.1	57.0	12.9	15.7
4.82	48.4	56.0	7.6	15.7
5.04	48.3	60.0	11.7	15.7
5.08	50.3	60.0	9.7	15.7
13.56	27.1	60.0	32.9	15.8

Note: 43.5 dBµV = 23.2 dBµV (receiver reading) + 10.1 dB (LISN factor IL) + 0.2 dB (cable loss) + 10 dB (attenuator)

Table 8.6-5: Average conducted emissions results on neutral line

Frequency, MHz	Average result, dBµV	Limit, dBµV	Margin, dB	Correction, dB
0.44	40.4	47.0	6.6	15.7
13.56	23.5	50.0	26.5	15.8

8.7 FCC 15.247(a)(2) and RSS-247 5.2(a) Minimum 6 dB bandwidth for DTS systems

8.7.1 References, definitions and limits

FCC:
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.

ISED:
The minimum 6 dB bandwidth shall be 500 kHz.
RSS-GEN, Section 6.7:
6 dB bandwidth is defined as the frequency range between two points, one at the lowest frequency below and one at the highest frequency above the carrier frequency, at which the maximum power level of the transmitted emission is attenuated 6 dB below the maximum in-band power level of the modulated signal, where the two points are on the outskirts of the in-band emission.
For the 99% emission bandwidth, the trace data points are recovered and directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached, and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded. The difference between the two recorded frequencies is the occupied bandwidth (or the 99% emission bandwidth).

8.7.2 Test summary

Verdict	Pass		
Tested by	Fahar Abdul Sukkoor	Test date	April 21, 2022

8.7.3 Observations, settings and special notes

The test was performed as per KDB 558074, section 8.2 with reference to ANSI C63.10 subclause 11.8.
Spectrum analyser settings:

Resolution bandwidth	100 kHz for 6dB, 1-5% OBW for 99% bandwidth
Video bandwidth	≥3 × RBW
Frequency span	30 MHz for 20 MHz channel; 70 MHz for 40 MHz channel
Detector mode	Peak
Trace mode	Max Hold

8.7.4 Test data

Table 8.7-1: 99% occupied bandwidth results

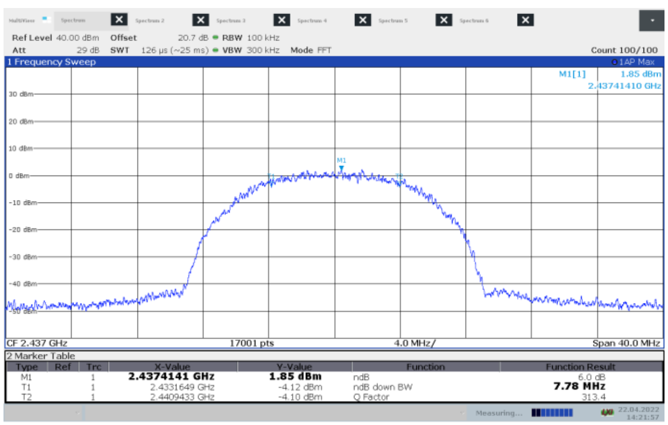
Modulation	Frequency, MHz	99% occupied bandwidth, MHz
802.11b	2412	13.05
	2437	13.06
	2462	13.05
802.11g	2412	16.53
	2437	16.52
	2462	16.53
802.11n HT20	2412	17.43
	2437	17.39
	2462	17.43
802.11n HT40	2422	34.53
	2437	34.57
	2452	34.50

Note: there is no 99% occupied bandwidth limit in the standard’s requirements, the measurement results provided for information purposes only.

8.7.1 Test data

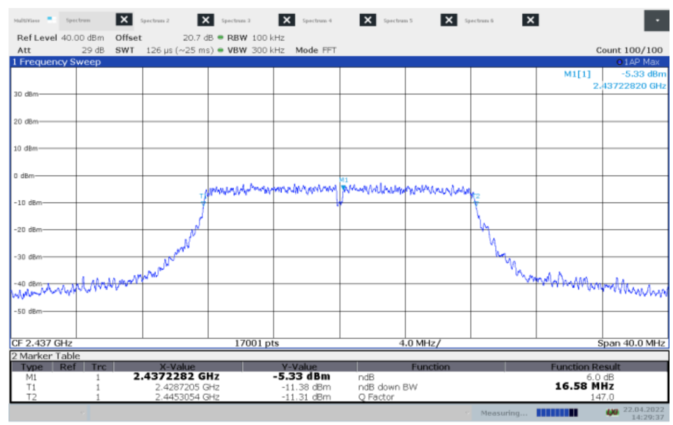
Table 8.7-2: 6 dB bandwidth results

Modulation	Frequency, MHz	6 dB bandwidth, MHz	Minimum limit, MHz	Margin, MHz
802.11b	2412	7.80	0.50	7.30
	2437	7.78	0.50	7.28
	2462	9.34	0.50	8.84
802.11g	2412	16.62	0.50	16.12
	2437	16.58	0.50	16.08
	2462	16.60	0.50	16.10
802.11n HT20	2412	17.63	0.50	17.13
	2437	17.64	0.50	17.14
	2462	17.63	0.50	17.13
802.11n HT40	2422	36.52	0.50	36.02
	2437	36.39	0.50	35.89
	2452	36.50	0.50	36.00



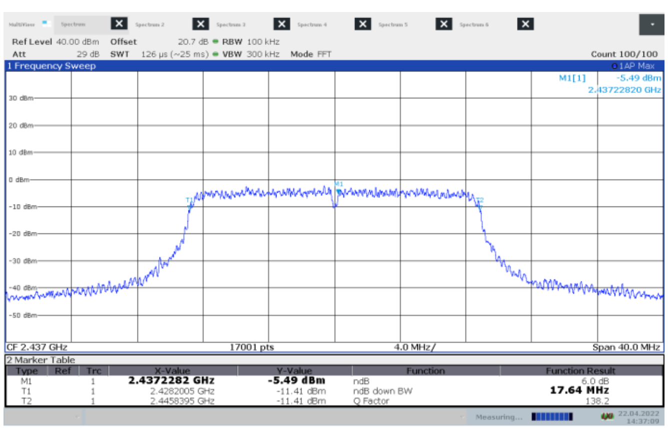
14:21:58 22.04.2022

Figure 8.7-1: 6 dB bandwidth on 802.11b, sample plot



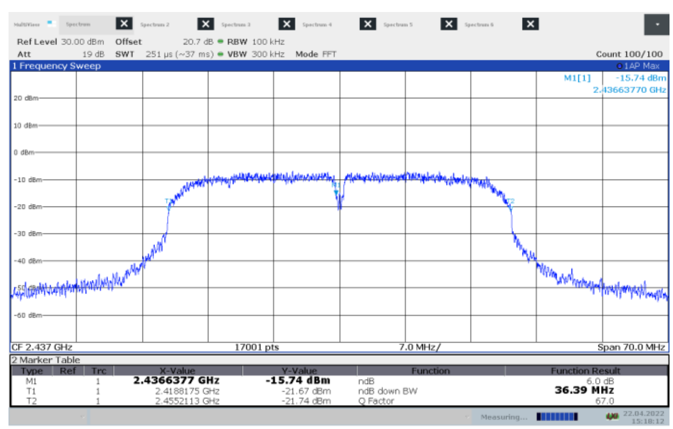
14:29:37 22.04.2022

Figure 8.7-2: 6 dB bandwidth on 802.11g, sample plot



14:37:09 22.04.2022

Figure 8.7-3: 6 dB bandwidth on 802.11n HT20, sample plot



15:18:12 22.04.2022

Figure 8.7-4: 6 dB bandwidth on 802.11n HT40, sample plot

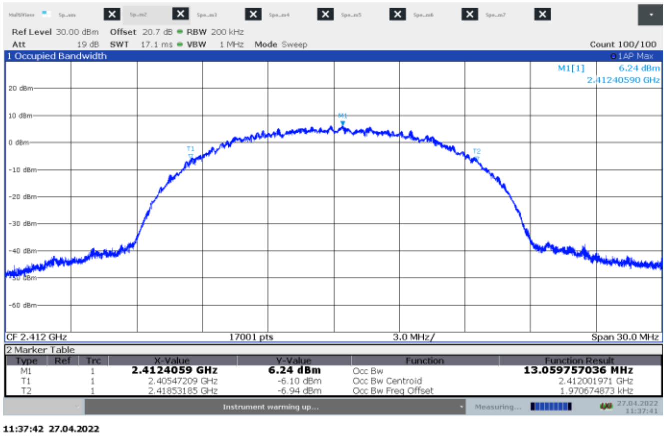


Figure 8.7-5: 99% occupied bandwidth on 802.11b, sample plot

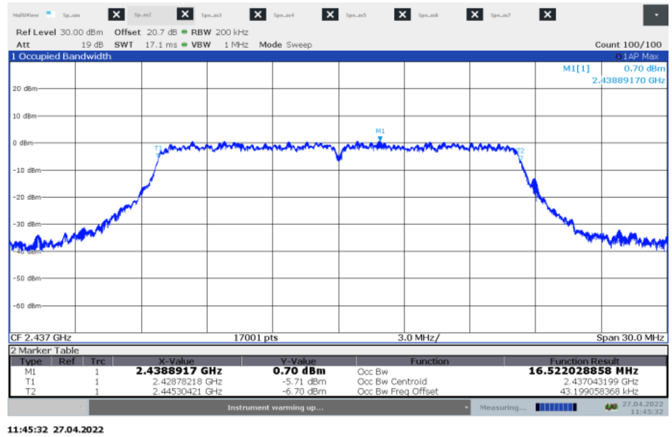


Figure 8.7-6: 99% occupied bandwidth on 802.11g, sample plot

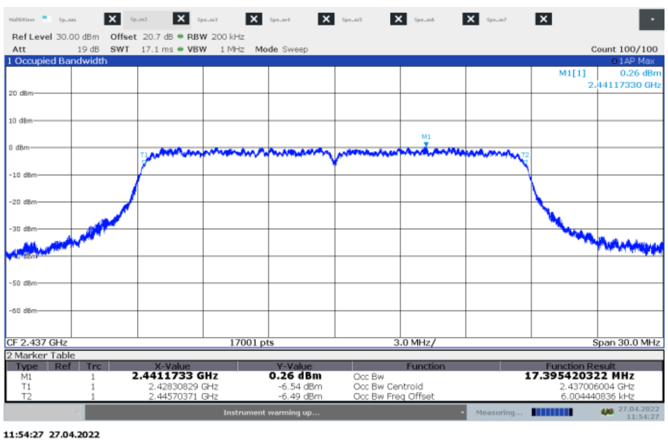


Figure 8.7-7: 99% occupied bandwidth on 802.11n HT20, sample plot

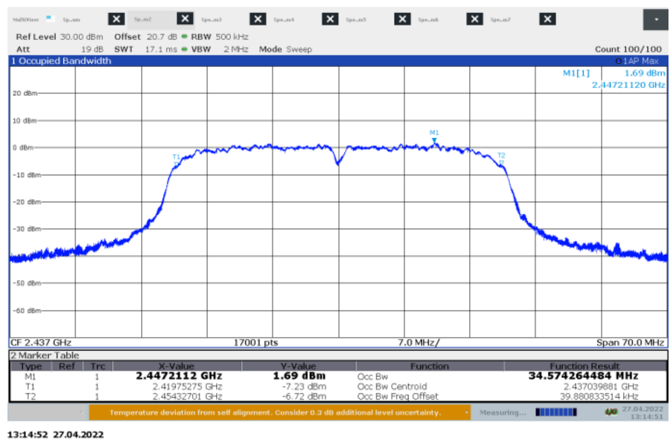


Figure 8.7-8: 99% occupied bandwidth on 802.11n HT40, sample plot

8.8 FCC 15.247(b) and RSS-247 5.4(d) Transmitter output power and e.i.r.p. requirements for DTS in 2.4 GHz

8.8.1 References, definitions and limits

FCC:

(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:

(3) For systems using digital modulation in the 2400–2483.5 MHz band: 1 W (30 dBm). 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.

(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(c) Operation with directional antenna gains greater than 6 dBi.

(1) Fixed point-to-point operation:

(i) Systems operating in the 2400–2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum conducted output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

(iii) Fixed, point-to-point operation, as used in paragraphs (c)(1)(i) and (c)(1)(ii) of this section, excludes the use of point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum or digitally modulated intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the intentional radiator shall contain language in the installation instructions informing the operator and the installer of this responsibility.

(2) In addition to the provisions in paragraphs (b)(1), (b)(3), (b)(4) and (c)(1)(i) of this section, transmitters operating in the 2400–2483.5 MHz band that emit multiple directional beams, simultaneously or sequentially, for the purpose of directing signals to individual receivers or to groups of receivers provided the emissions comply with the following:

(i) Different information must be transmitted to each receiver.

(ii) If the transmitter employs an antenna system that emits multiple directional beams but does not do emit multiple directional beams simultaneously, the total output power conducted to the array or arrays that comprise the device, i.e., the sum of the power supplied to all antennas, antenna elements, staves, etc. and summed across all carriers or frequency channels, shall not exceed the limit specified in paragraph (b)(1) or (b)(3) of this section, as applicable. However, the total conducted output power shall be reduced by 1 dB below the specified limits for each 3 dB that the directional gain of the antenna/antenna array exceeds 6 dBi. The directional antenna gain shall be computed as follows:

(A) The directional gain shall be calculated as the sum of 10 log (number of array elements or staves) plus the directional gain of the element or stave having the highest gain.

(B) A lower value for the directional gain than that calculated in paragraph (c)(2)(ii)(A) of this section will be accepted if sufficient evidence is presented, e.g., due to shading of the array or coherence loss in the beamforming.

(iii) If a transmitter employs an antenna that operates simultaneously on multiple directional beams using the same or different frequency channels, the power supplied to each emission beam is subject to the power limit specified in paragraph (c)(2)(ii) of this section. If transmitted beams overlap, the power shall be reduced to ensure that their aggregate power does not exceed the limit specified in paragraph (c)(2)(ii) of this section. In addition, the aggregate power transmitted simultaneously on all beams shall not exceed the limit specified in paragraph (c)(2)(ii) of this section by more than 8 dB.

(iv) Transmitters that emit a single directional beam shall operate under the provisions of paragraph (c)(1) of this section.

ISED:
d. For DTSs employing digital modulation techniques operating in the 2400–2483.5 MHz band, the maximum peak conducted output power shall not exceed 1 W. The e.i.r.p. shall not exceed 4 W, except as provided in 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.
e. Fixed point-to-point systems in the 2400–2483.5 MHz band are permitted to have an e.i.r.p. higher than 4 W provided that the higher e.i.r.p. is achieved by employing higher gain directional antennas and not higher transmitter output powers. Point-to-multipoint systems, omnidirectional applications and multiple co-located transmitters transmitting the same information are prohibited from exceeding an e.i.r.p. of 4 W.
f. Transmitters operating in the band 2400–2483.5 MHz, may employ antenna systems that emit multiple directional beams simultaneously or sequentially, for the purpose of directing signals to individual receivers or to groups of receivers, provided that the emissions comply with the following:

i Different information must be transmitted to each receiver.
ii If the transmitter employs an antenna system that emits multiple directional beams, but does not emit multiple directional beams simultaneously, the total output power conducted to the array or arrays that comprise the device (i.e. the sum of the power supplied to all antennas, antenna elements, staves, etc., and summed across all carriers or frequency channels) shall not exceed the applicable output power limit specified in sections 5.4(b) and 5.4(d). However, the total conducted output power shall be reduced by 1 dB below the specified limits for each 3 dB that the directional gain of the antenna/antenna array exceeds 6 dBi. The directional antenna gain shall be computed as the sum of 10 log (number of array elements or staves) plus the directional gain of the element or stave having the highest gain.
iii If a transmitter employs an antenna that operates simultaneously on multiple directional beams using the same or different frequency channels, the power supplied to each emission beam is subject to the applicable power limit specified in sections 5.4(b) and 5.4(d). If transmitted beams overlap, the power shall be reduced to ensure that their aggregate power does not exceed the applicable limit specified in sections 5.4(b) and 5.4(d). In addition, the aggregate power transmitted simultaneously on all beams shall not exceed the applicable limit specified in sections 5.4(b) and 5.4(d) by more than 8 dB.
iv Transmitters that transmit a single directional beam shall operate under the provisions of sections 5.4(b), 5.4(d) and 5.4(e).

8.8.2 Test summary

Verdict	Pass		
Tested by	Fahar Abdul Sukkoor	Test date	April 21, 2022

8.8.3 Observations, settings and special notes

The test was performed as per KDB 558074, section 8.3 with reference to ANSI C63.10 subclause 11.9.2 (average power) using method AVGSA-1 (trace averaging with the EUT transmitting at full power throughout each sweep).
Spectrum analyser settings:

Resolution bandwidth	1-5% OBW
Video bandwidth	≥3 × RBW
Frequency span	30 MHz for 20 MHz channel; 70 MHz for 40 MHz channel
Detector mode	RMS
Trace mode	Average (power aggregation over DTS bandwidth for 100 sweep counts)

8.8.4 Test data

Table 8.8-1: Output power and EIRP results (antenna port measurement)- 802.11b modulation

Frequency, MHz	Conducted output power, dBm	Output power limit, dBm	Output power margin, dB	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
2412	13.2	30.0	16.8	2.0	15.2	36.0	20.8
2437	11.9	30.0	18.1	2.0	13.9	36.0	22.1
2462	11.3	30.0	18.7	2.0	13.3	36.0	22.7

Note: EIRP [dBm] = Conducted output power [dBm] + Antenna gain [dBi]

Table 8.8-2: Output power and EIRP results (antenna port measurement)- 802.11g modulation

Frequency, MHz	Conducted output power, dBm	Output power limit, dBm	Output power margin, dB	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
2412	11.4	30.0	18.6	2.0	13.4	36.0	22.6
2437	10.5	30.0	19.5	2.0	12.5	36.0	23.5
2462	10.2	30.0	19.8	2.0	12.2	36.0	23.8

Note: EIRP [dBm] = Conducted output power [dBm] + Antenna gain [dBi]

Table 8.8-3: Output power and EIRP results (antenna port measurement)- 802.11n HT20 modulation

Frequency, MHz	Conducted output power, dBm	Output power limit, dBm	Output power margin, dB	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
2412	11.2	30.0	18.8	2.0	13.2	36.0	22.8
2437	10.3	30.0	19.7	2.0	12.3	36.0	23.7
2462	10.0	30.0	20.0	2.0	12.0	36.0	24.0

Note: EIRP [dBm] = Conducted output power [dBm] + Antenna gain [dBi]

Table 8.8-4: Output power and EIRP results (antenna port measurement)- 802.11n HT40 modulation

Frequency, MHz	Conducted output power, dBm	Output power limit, dBm	Output power margin, dB	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
2412	10.5	30.0	19.5	2.0	12.5	36.0	23.5
2437	9.8	30.0	20.2	2.0	11.8	36.0	24.2
2452	9.6	30.0	20.4	2.0	11.6	36.0	24.4

Note: EIRP [dBm] = Conducted output power [dBm] + Antenna gain [dBi]

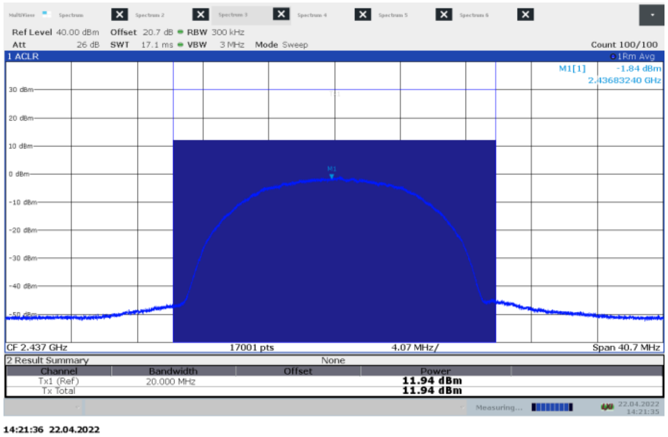


Figure 8.8-1: Output power 802.11b sample plot

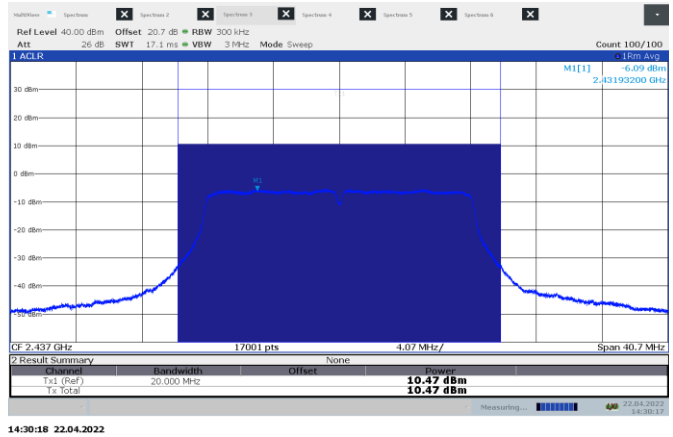


Figure 8.8-2: Output power on 802.11g sample plot

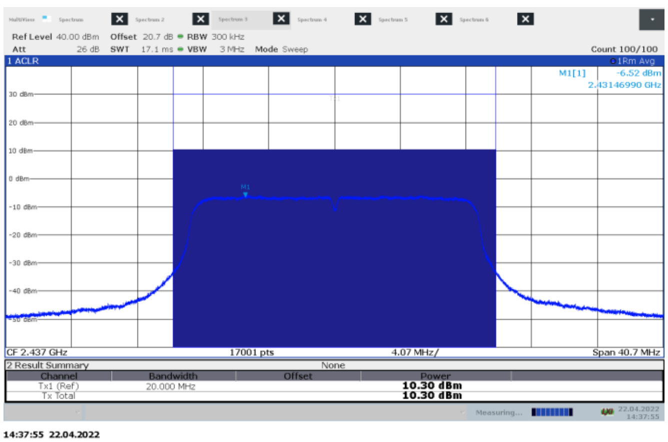


Figure 8.8-3: Output power 802.11n HT20 sample plot

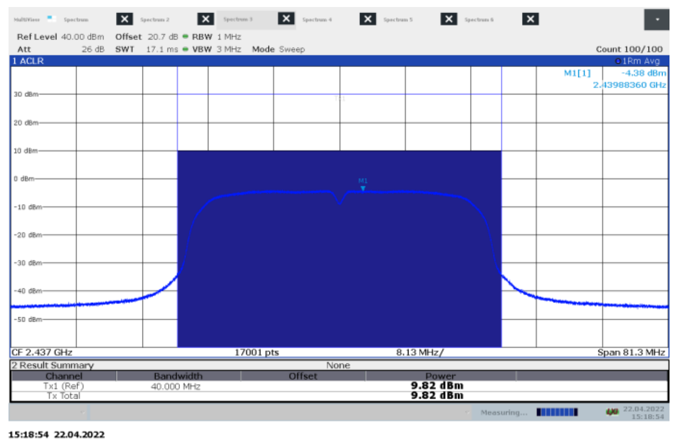


Figure 8.8-4: Output power 802.11n HT40 sample plot

8.9 FCC 15.247(d) and RSS-247 5.5 Spurious (out-of-band) unwanted emissions

8.9.1 References, definitions and limits

FCC:
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)).

ISED:
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 8.9-1: FCC §15.209 and RSS-Gen – 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 8.9-2: ISED restricted frequency bands

MHz	MHz	MHz	GHz
0.090–0.110	12.57675–12.57725	399.9–410	7.25–7.75
0.495–0.505	13.36–13.41	608–614	8.025–8.5
2.1735–2.1905	16.42–16.423	960–1427	9.0–9.2
3.020–3.026	16.69475–16.69525	1435–1626.5	9.3–9.5
4.125–4.128	16.80425–16.80475	1645.5–1646.5	10.6–12.7
4.17725–4.17775	25.5–25.67	1660–1710	13.25–13.4
4.20725–4.20775	37.5–38.25	1718.8–1722.2	14.47–14.5
5.677–5.683	73–74.6	2200–2300	15.35–16.2
6.215–6.218	74.8–75.2	2310–2390	17.7–21.4
6.26775–6.26825	108–138	2483.5–2500	22.01–23.12
6.31175–6.31225	149.9–150.05	2655–2900	23.6–24.0
8.291–8.294	156.52475–156.52525	3260–3267	31.2–31.8
8.362–8.366	156.7–156.9	3332–3339	36.43–36.5
8.37625–8.38675	162.0125–167.17	3345.8–3358	Above 38.6
8.41425–8.41475	167.72–173.2	3500–4400	
12.29–12.293	240–285	4500–5150	
12.51975–12.52025	322–335.4	5350–5460	

Note: Certain frequency bands listed in Table 8.9-2 and above 38.6 GHz are designated for licence-exempt applications. These frequency bands and the requirements that apply to related devices are set out in the 200 and 300 series of RSSs.

Table 8.9-3: 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			

8.9.2 Test summary

Verdict	Pass		
Tested by	Fahar Abdul Sukkoor	Test date	April 21, 2022

8.9.3 Observations, settings and special notes

As part of the current assessment, the test range of 9 kHz to 10th harmonic has been fully considered and compared to the actual frequencies utilized within the EUT. Since the EUT contains a transmitter in the GHz range, the EUT has been deemed compliant without formal testing in the 9 kHz to 30 MHz test range, therefore formal test results (tabular data and/or plots) are not provided within this test report.
EUT was set to transmit with 100 % duty cycle
Radiated measurements were performed at a distance of 3 m.
DTS emissions in non-restricted frequency bands test was performed as per KDB 558074, section 8.5 with reference to ANSI C63.10 subclause 11.11.
Since fundamental power was tested using Choose an item.
DTS emissions in restricted frequency bands test was performed as per KDB 558074, section 8.6 with reference to ANSI C63.10 subclause 11.12.
DTS band-edge emission measurements test was performed as per KDB 558074, section 8.7 with reference to ANSI C63.10 subclause 11.13.

Spectrum analyser settings for radiated measurements within restricted bands below 1 GHz:

Resolution bandwidth:	100 kHz
Video bandwidth:	300 kHz
Detector mode:	Peak
Trace mode:	Max Hold

Spectrum analyser settings for peak radiated measurements within restricted bands above 1 GHz:

Resolution bandwidth:	100 kHz
Video bandwidth:	300 kHz
Detector mode:	Peak
Trace mode:	Max Hold

Spectrum analyser settings for average radiated measurements within restricted bands above 1 GHz:

Resolution bandwidth:	100 kHz
Video bandwidth:	300 kHz
Detector mode:	Peak
Trace mode:	Max hold (Power integration over 1 MHz bandwidth)

Spectrum analyser settings for conducted spurious emissions measurements:

Resolution bandwidth:	100 kHz
Video bandwidth:	300 kHz
Detector mode:	Peak
Trace mode:	Max Hold

8.9.4 Test data

Table 8.9-4: Radiated field strength measurement results

Modulation	Channel	Frequency, MHz	Peak Field strength, dBµV/m		Margin, dB	Average Field strength, dBµV/m		Margin, dB
			Measured	Limit		Measured	Limit	
802.11b	Low	2390.0	60.35	74.00	13.65	43.68	54.00	10.32
	High	2483.5	59.94	74.00	14.06	43.63	54.00	10.37
802.11g	Low	2390.0	60.56	74.00	13.44	47.65	54.00	6.35
	High	2483.5	60.18	74.00	13.82	44.95	54.00	9.05
802.11n HT20	Low	2390.0	61.10	74.00	12.9	48.01	54.00	5.99
	High	2483.5	59.99	74.00	14.01	45.50	54.00	8.50
802.11n HT40	Low	2390.0	60.86	74.00	13.14	48.14	54.00	5.86
	High	2483.5	60.51	74.00	13.49	46.58	54.00	7.42

Note: Field strength includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.

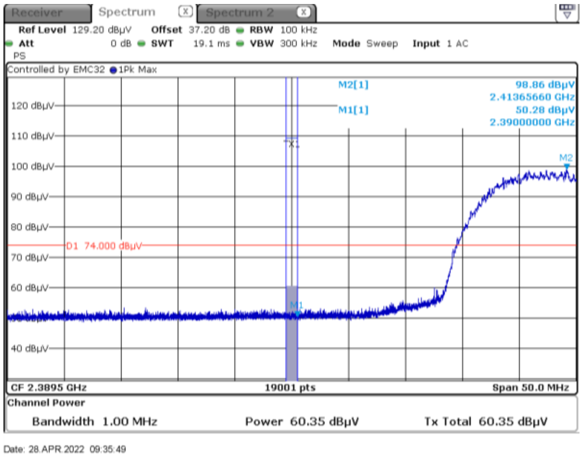


Figure 8.9-1:Radiated Band edge, peak at low channel,802.11b

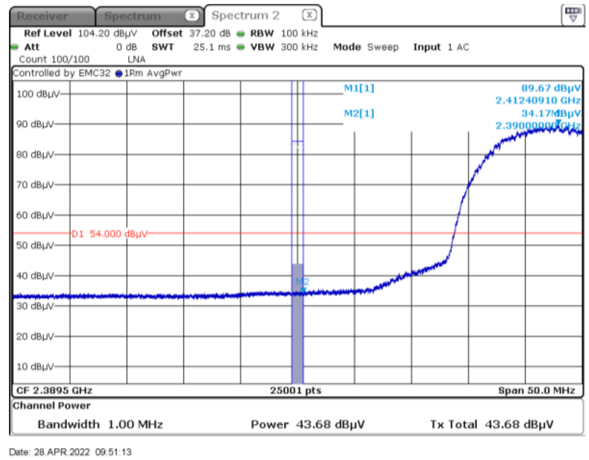


Figure 8.9-2: Radiated Band edge, average at low channel,802.11b

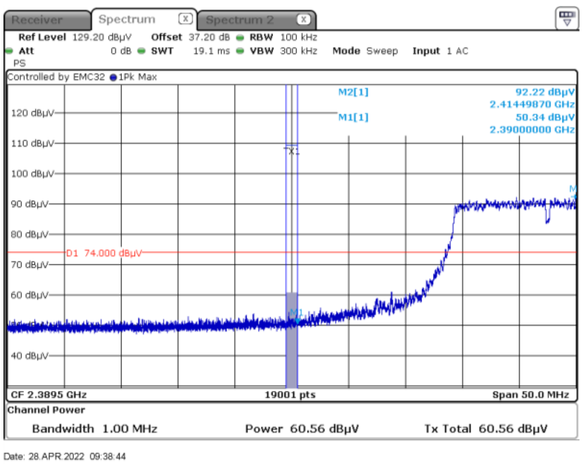


Figure 8.9-3: Radiated Band edge, peak at low channel,802.11g

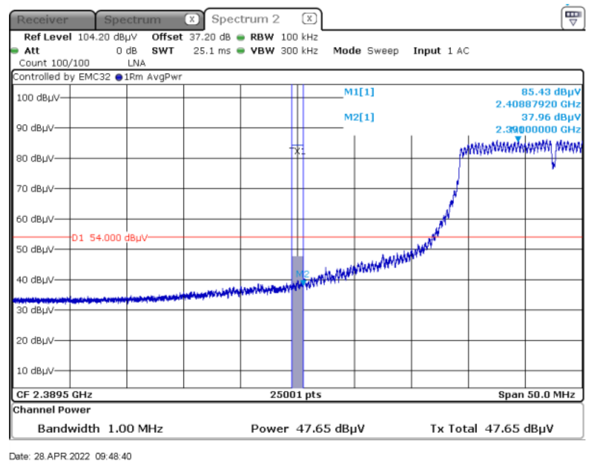


Figure 8.9-4: Radiated Band edge, average at low channel,802.11g

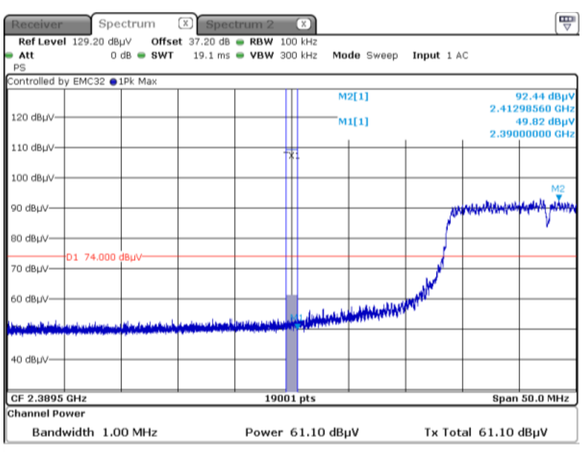


Figure 8.9-5: Radiated Band edge, peak at low channel,802.11n HT20

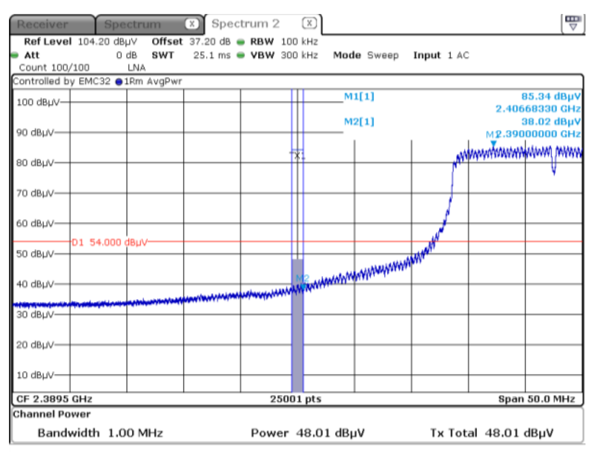


Figure 8.9-6: Radiated Band edge, ***average*** *at low channel,802.11n HT20*

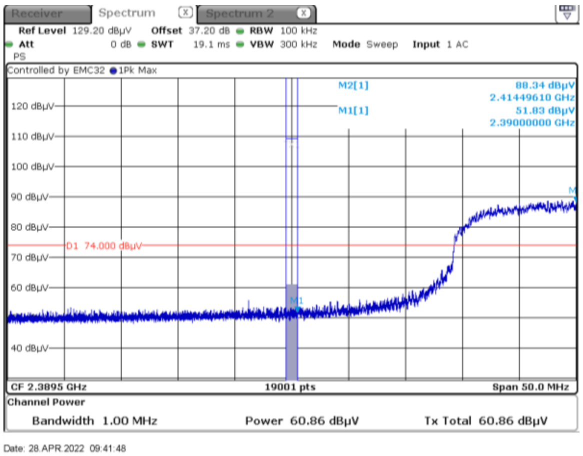


Figure 8.9-7: Radiated Band edge, peak at low channel,802.11n HT40

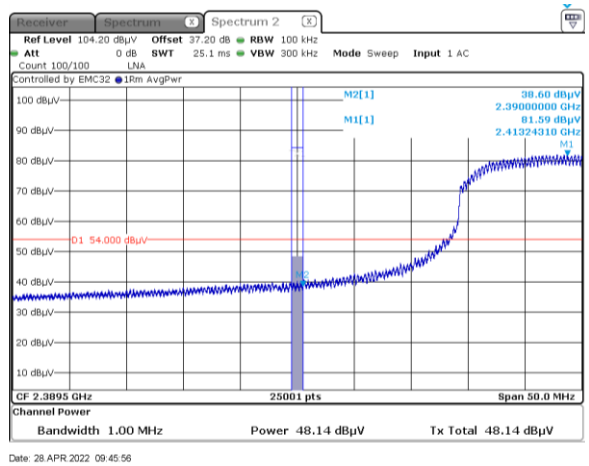


*Figure 8.9-8: Radiated Band edge, **average** at low channel,802.11n HT40*

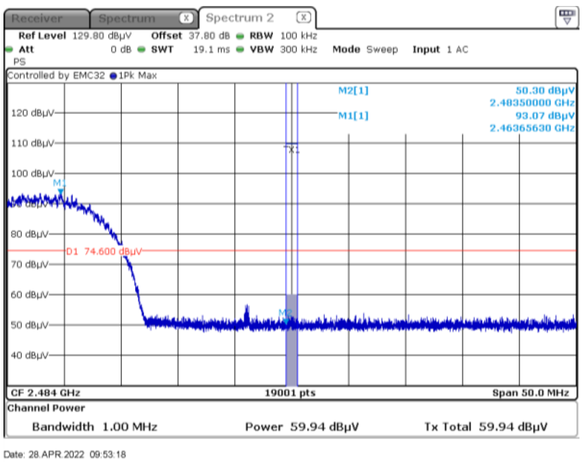


*Figure 8.9-9:Radiated Band edge, peak at **high** channel,802.11b*

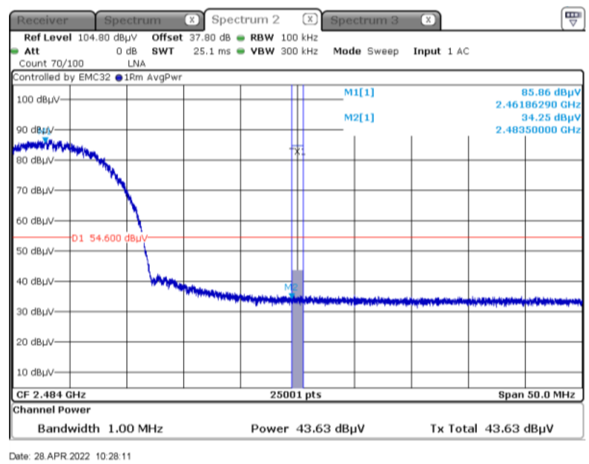


*Figure 8.9-10: Radiated Band edge, average at **high** channel,802.11b*

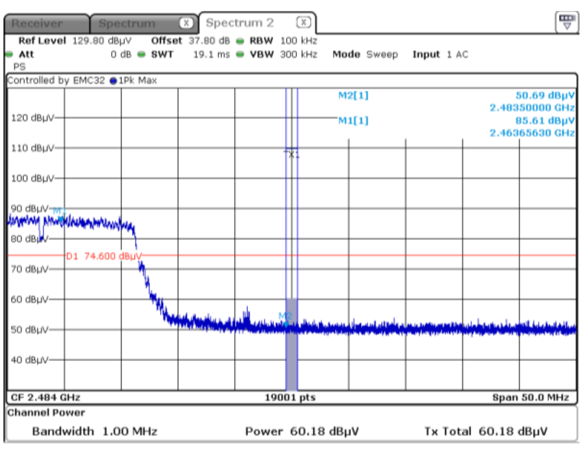


*Figure 8.9-11: Radiated Band edge, peak at **high** channel,802.11g*

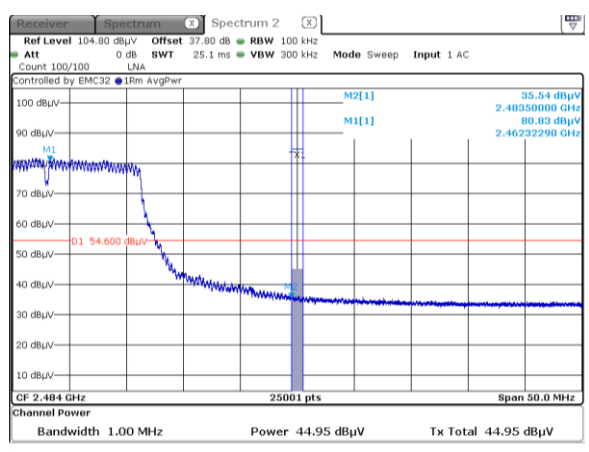


*Figure 8.9-12: Radiated Band edge, average at **high** channel,802.11g*

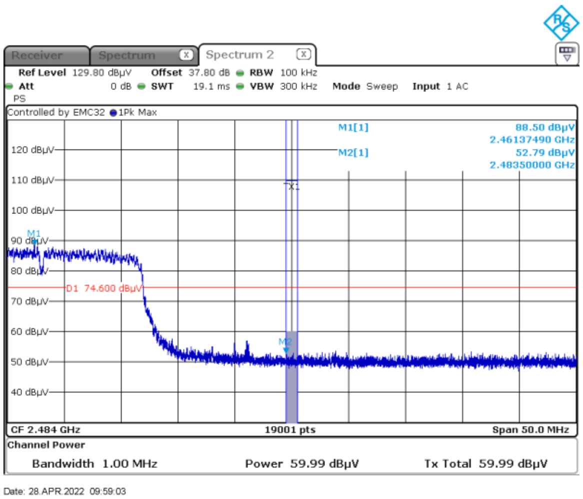


*Figure 8.9-13: Radiated Band edge, peak at **high** channel,802.11n HT20*

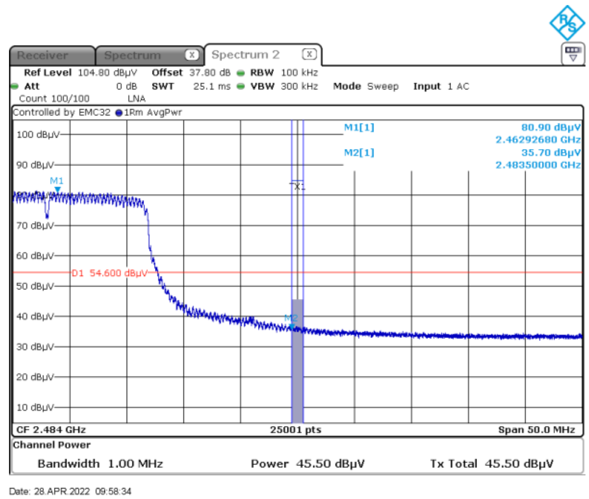


*Figure 8.9-14: Radiated Band edge, **average** at **high** channel,802.11n HT20*

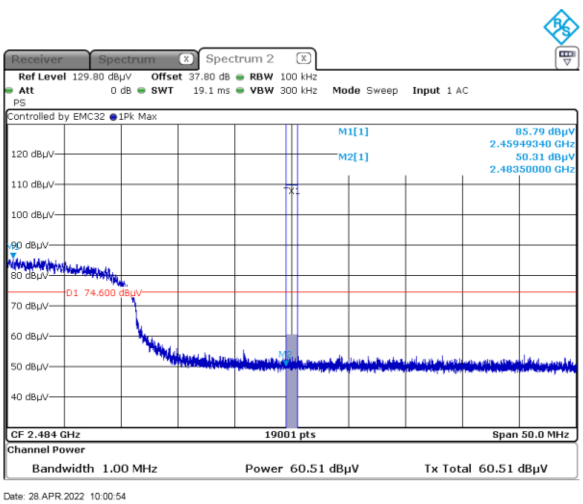


*Figure 8.9-15: Radiated Band edge, peak at **high** channel,802.11n HT40*

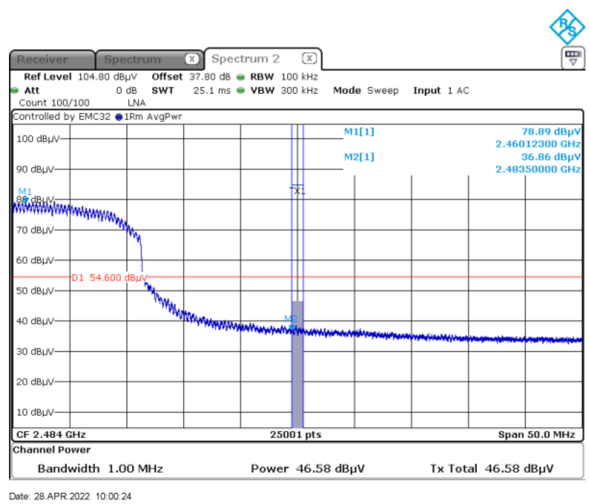
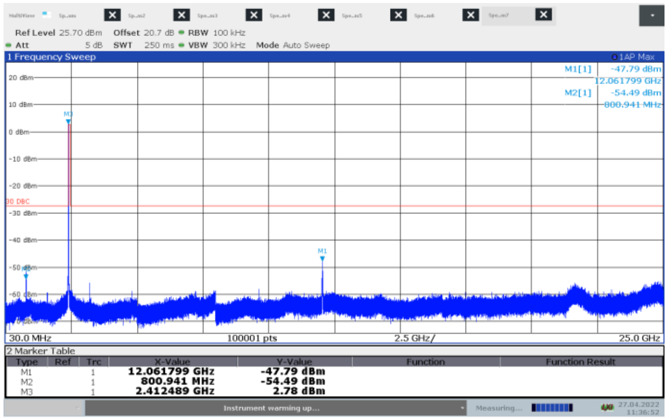
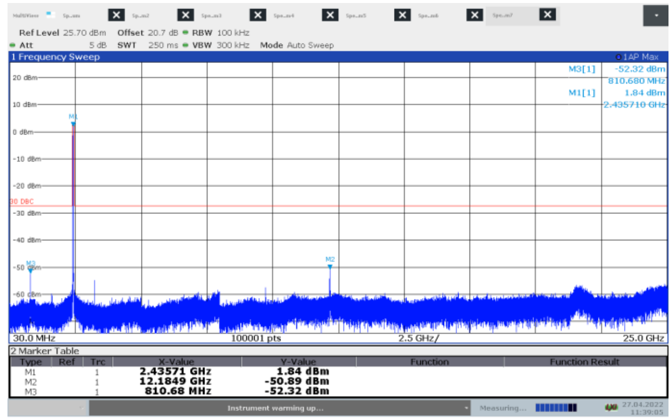


*Figure 8.9-16: Radiated Band edge, **average** at **high** channel,802.11n HT40*



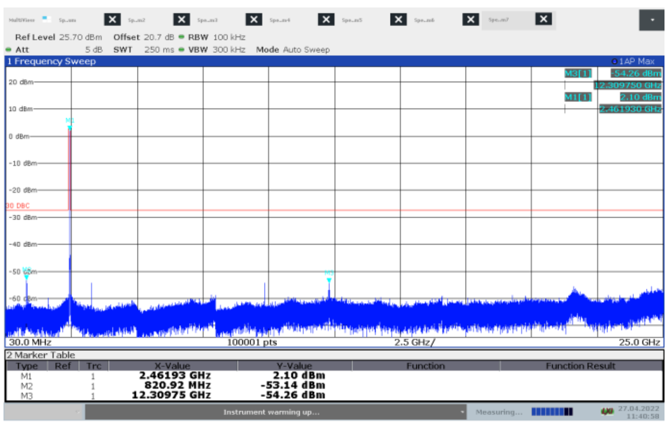
11:36:52 27.04.2022

Figure 8.9-17: Conducted spurious emissions, low channel 802.11b



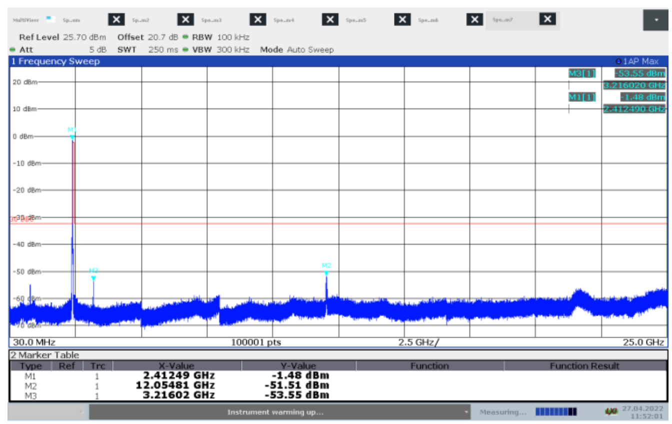
11:39:06 27.04.2022

Figure 8.9-18: Conducted spurious emissions, mid channel 802.11b



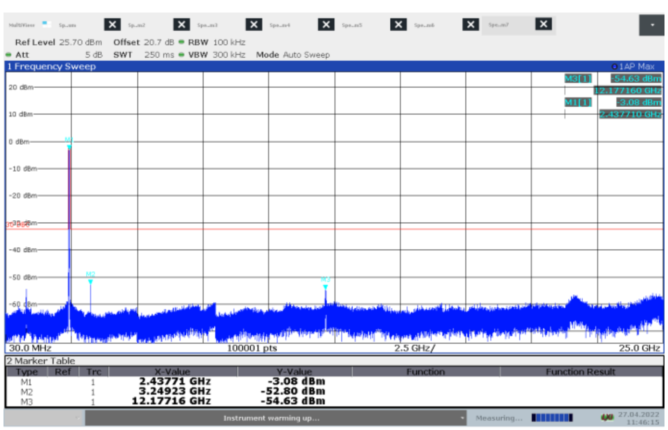
11:40:59 27.04.2022

Figure 8.9-19: Conducted spurious emissions, high channel 802.11b



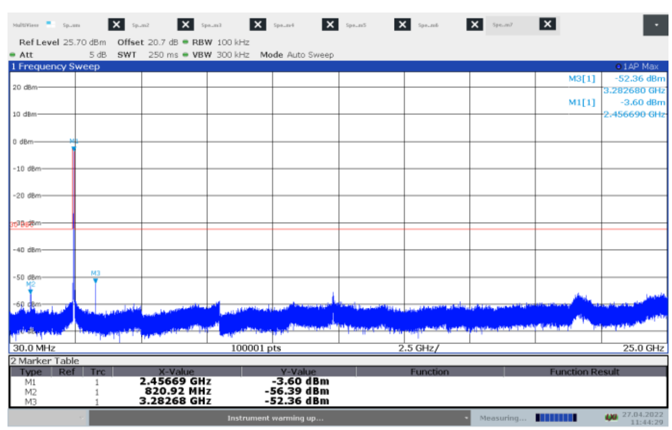
11:52:02 27.04.2022

Figure 8.9-20: Conducted spurious emissions, low channel 802.11g



11:46:16 27.04.2022

Figure 8.9-21: Conducted spurious emissions, mid channel 802.11g



11:44:29 27.04.2022

Figure 8.9-22: Conducted spurious emissions, high channel 802.11g

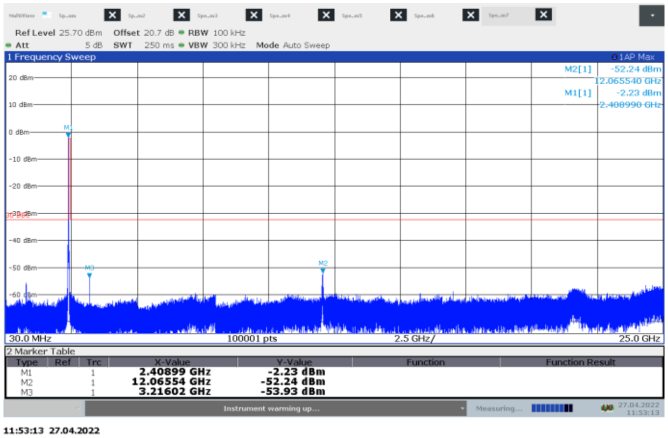


Figure 8.9-23: Conducted spurious emissions, low channel 802.11n HT20

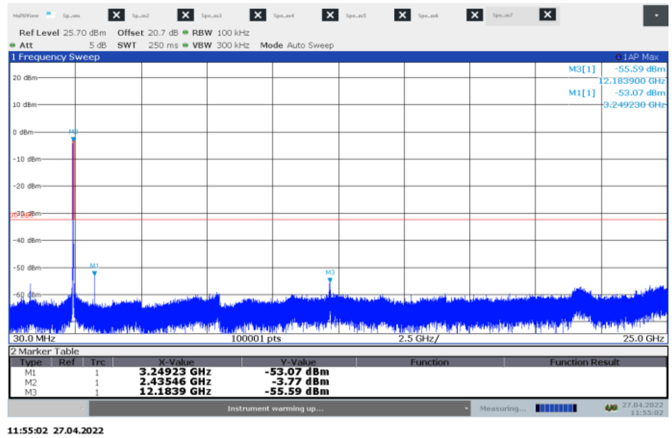


Figure 8.9-24: Conducted spurious emissions, mid channel 802.11n HT20

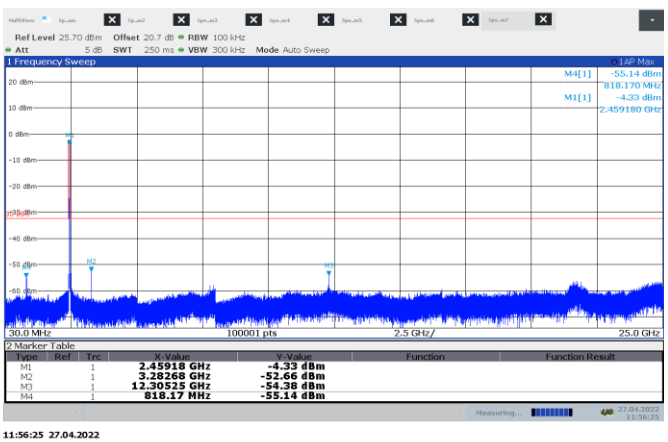


Figure 8.9-25: Conducted spurious emissions, high channel 802.11n HT20

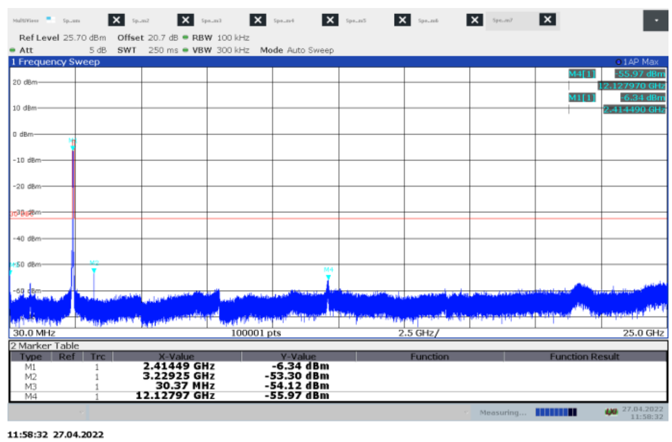


Figure 8.9-26: Conducted spurious emissions, low channel 802.11n HT40

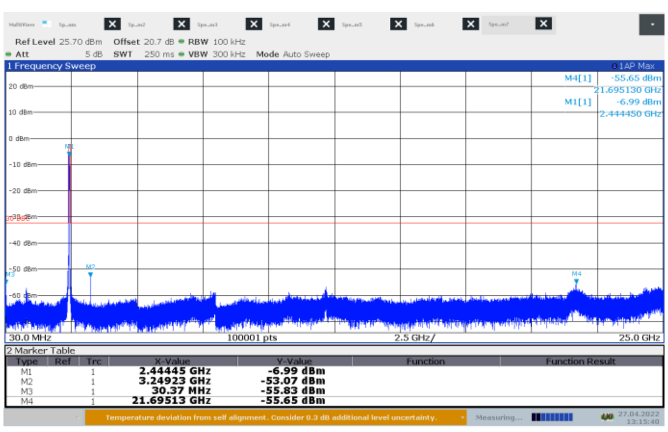


Figure 8.9-27: Conducted spurious emissions, mid channel 802.11n HT40

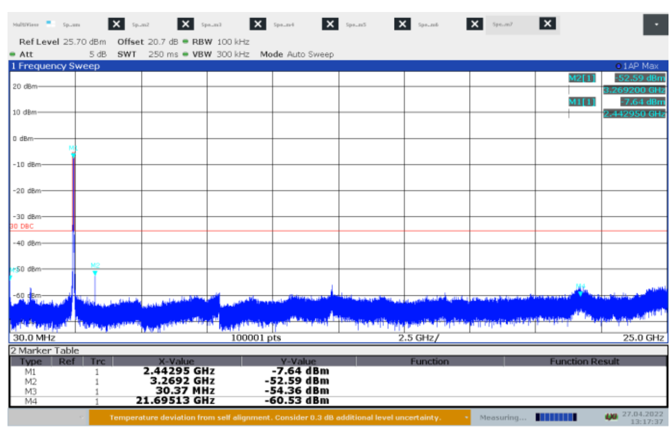


Figure 8.9-28: Conducted spurious emissions, high channel 802.11n HT40

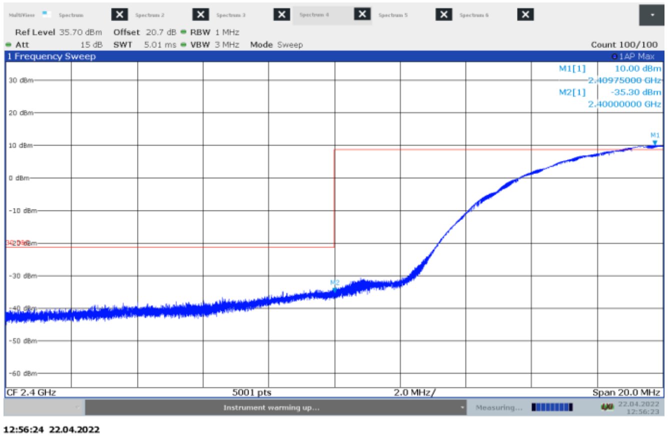


Figure 8.9-29:Conducted Band edge at low channel,802.11b

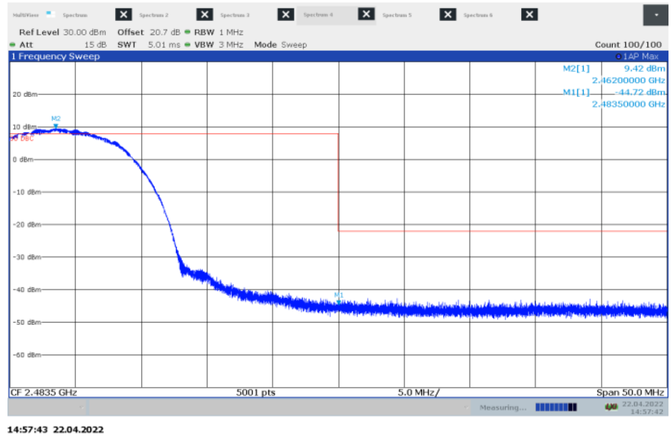


Figure 8.9-30: Conducted Band edge at high channel,802.11b

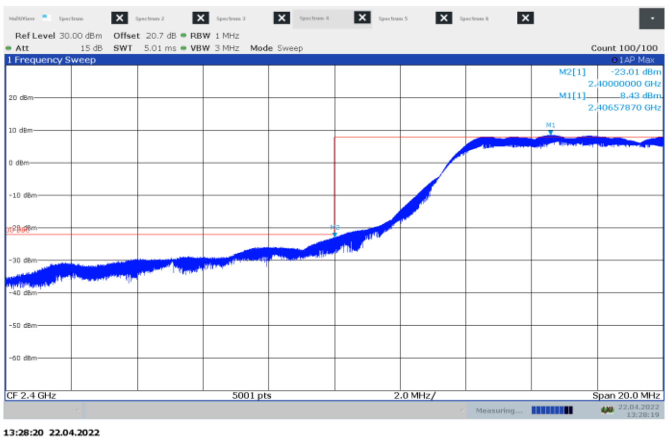


Figure 8.9-31: Conducted Band edge at low channel,802.11g

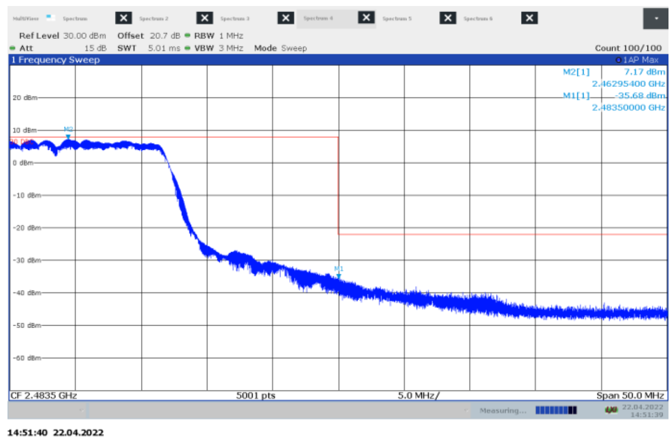


Figure 8.9-32: Conducted Band edge at high channel,802.11g

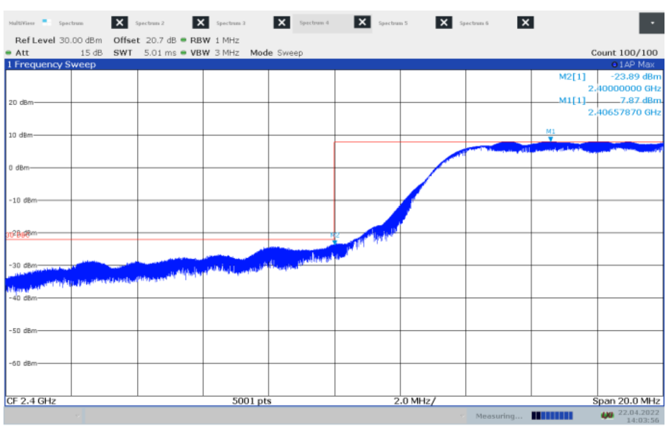


Figure 8.9-33: Conducted Band edge at low channel,802.11n HT20

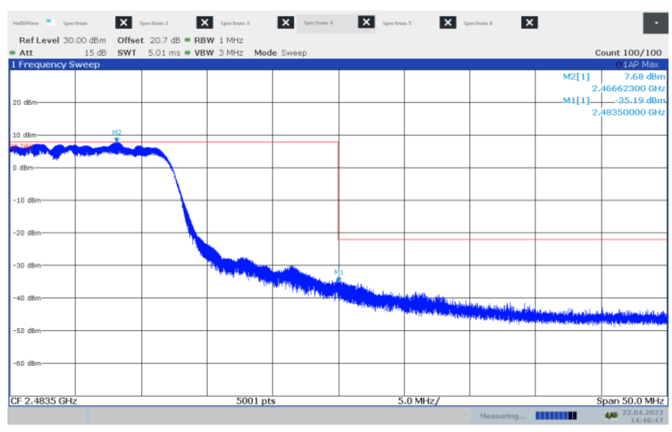


Figure 8.9-34: Conducted Band edge at high channel,802.11n HT20

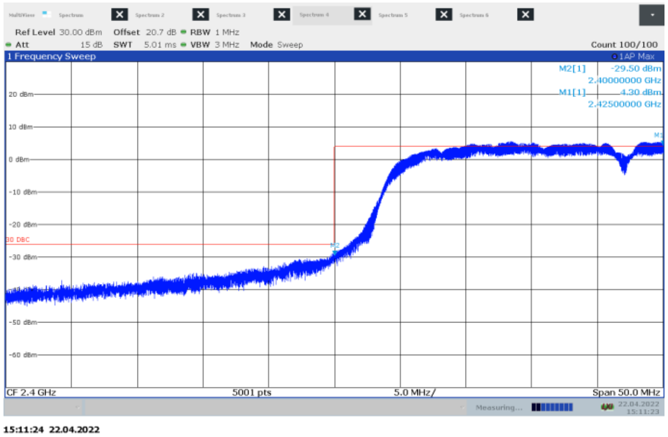


Figure 8.9-35: Conducted Band edge at low channel,802.11n HT40

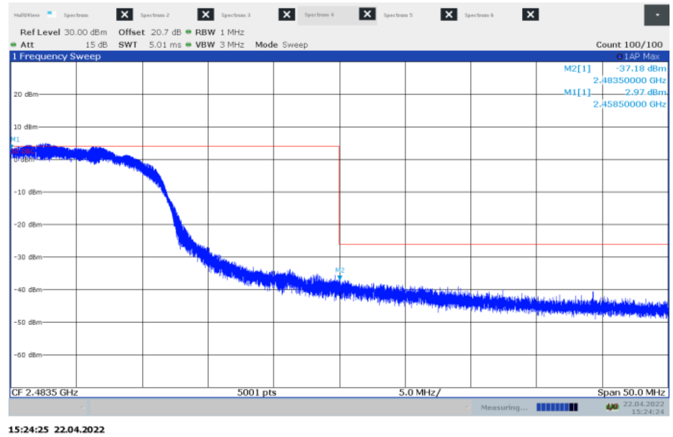


Figure 8.9-36: Conducted Band edge at high channel,802.11n HT40

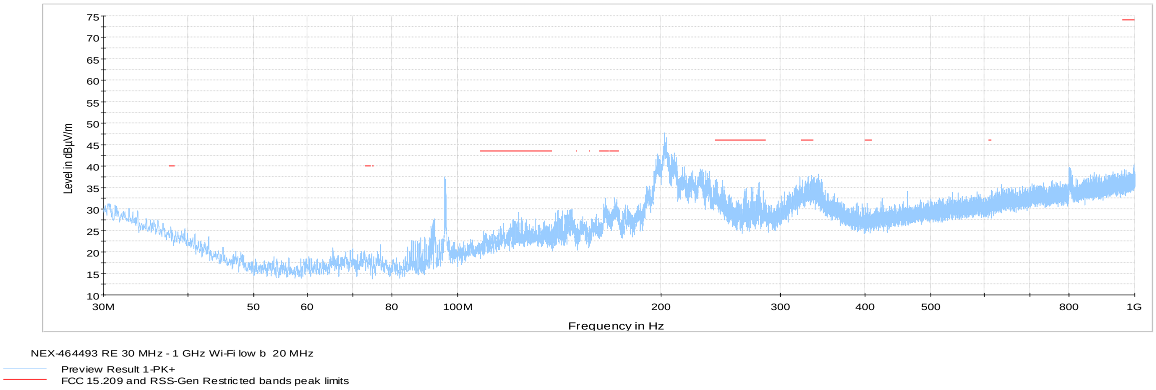


Figure 8.9-37: Radiated spurious emissions below 1 GHz low channel, 802.11b

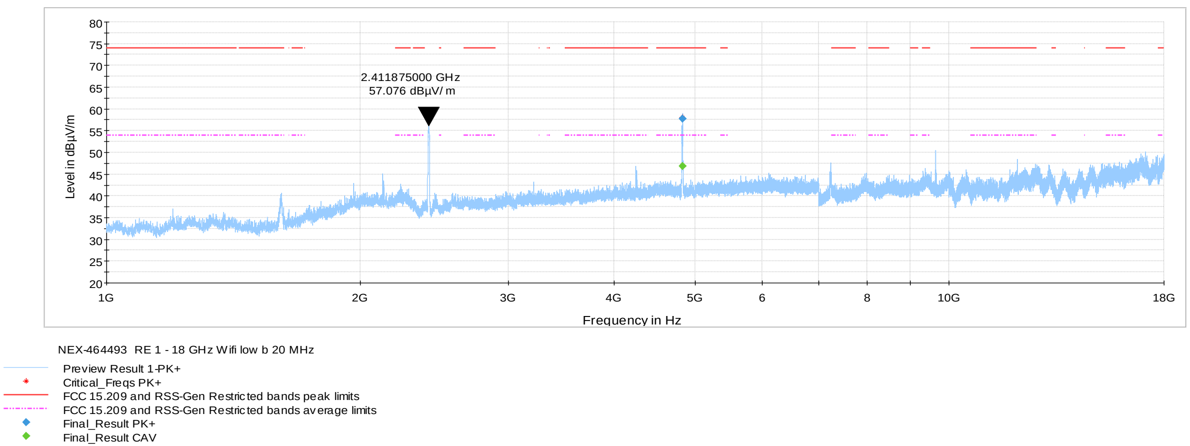


Figure 8.9-38: Radiated spurious emissions 1 -18 GHz low channel, 802.11b

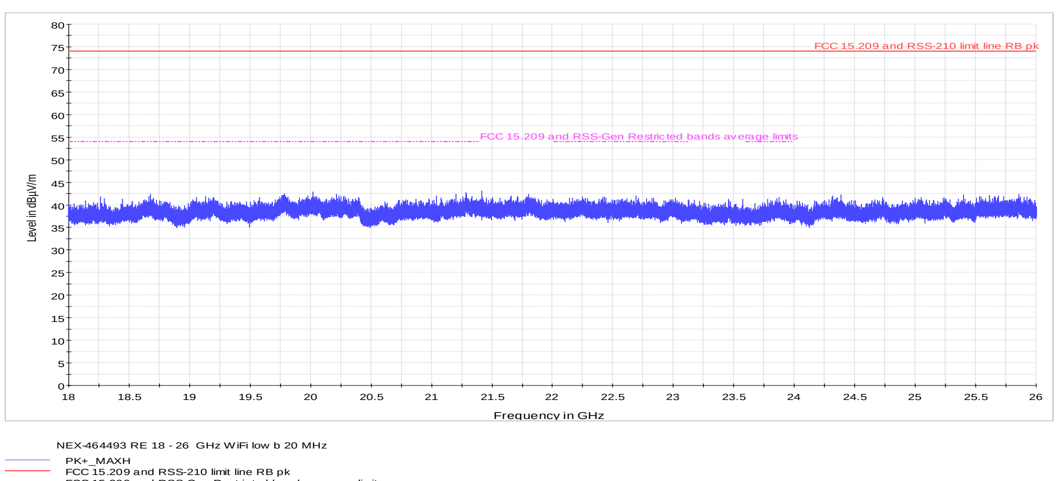


Figure 8.9-39: Radiated spurious emissions 18-26 GHz low channel, 802.11b

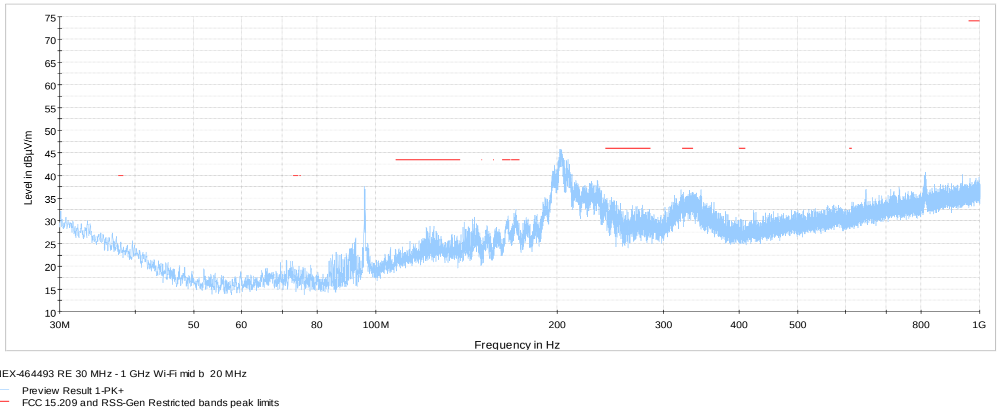


Figure 8.9-40: Radiated spurious emissions below 1 GHz mid channel, 802.11b

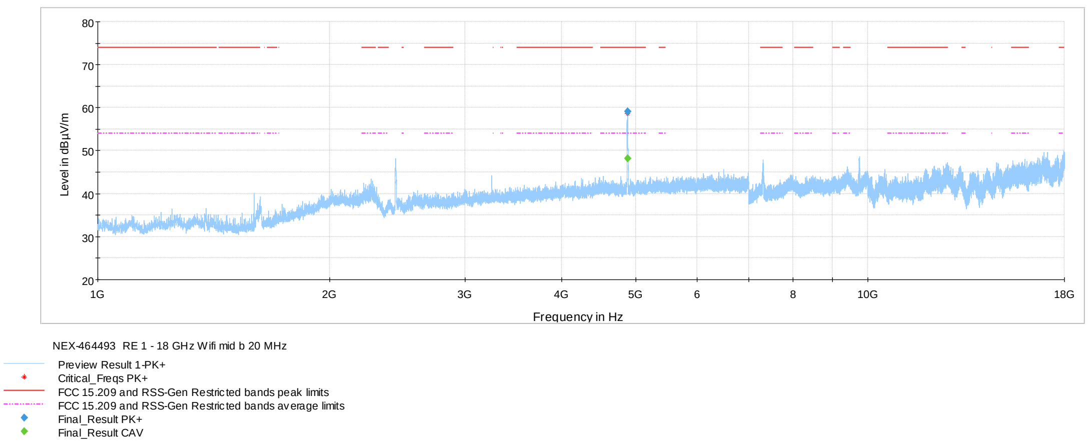


Figure 8.9-41: Radiated spurious emissions 1 -18 GHz mid channel, 802.11b

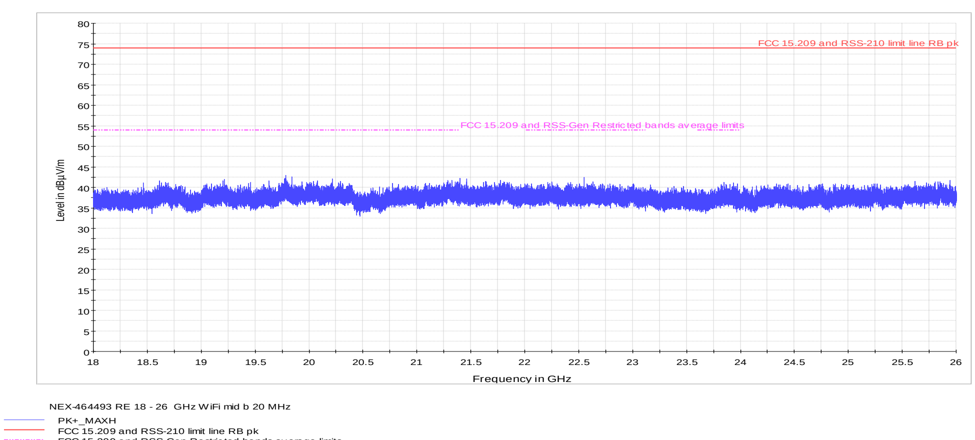


Figure 8.9-42: Radiated spurious emissions 18-26 GHz mid channel, 802.11b

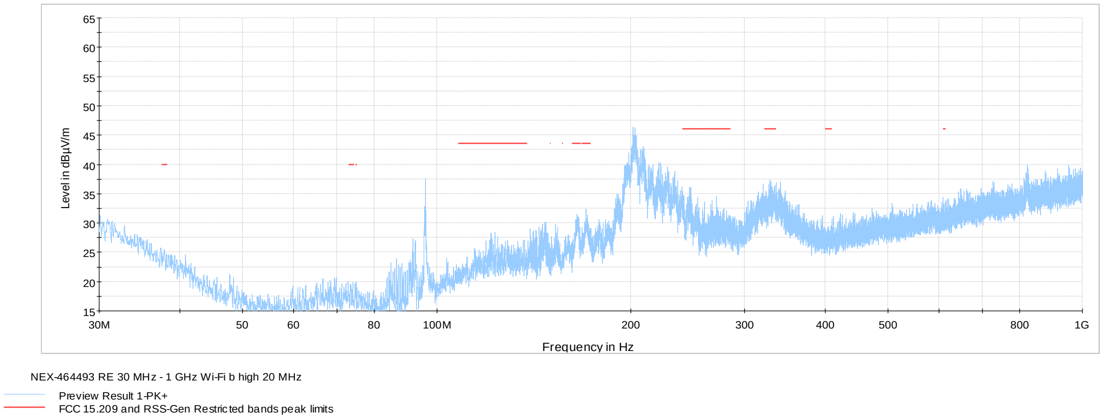


Figure 8.9-43: Radiated spurious emissions below 1 GHz high channel, 802.11b

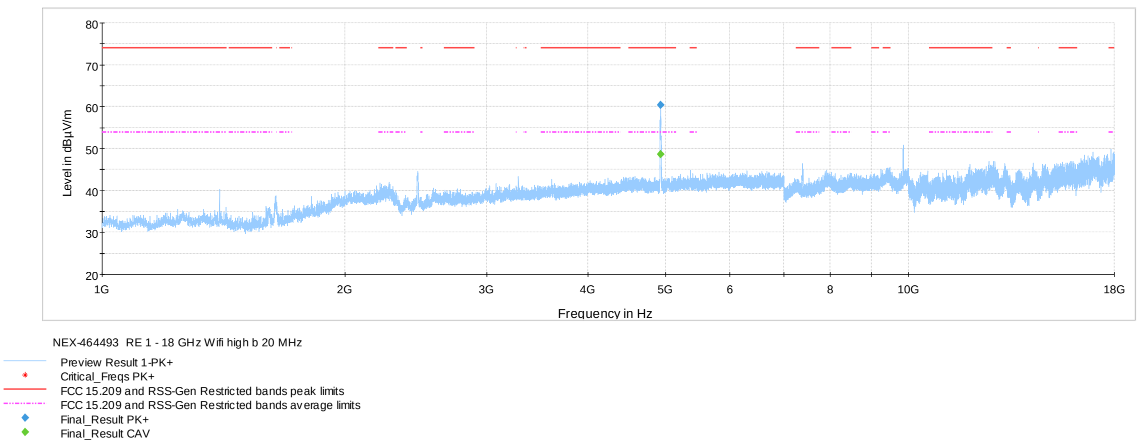


Figure 8.9-44: Radiated spurious emissions 1 -18 GHz high channel, 802.11b

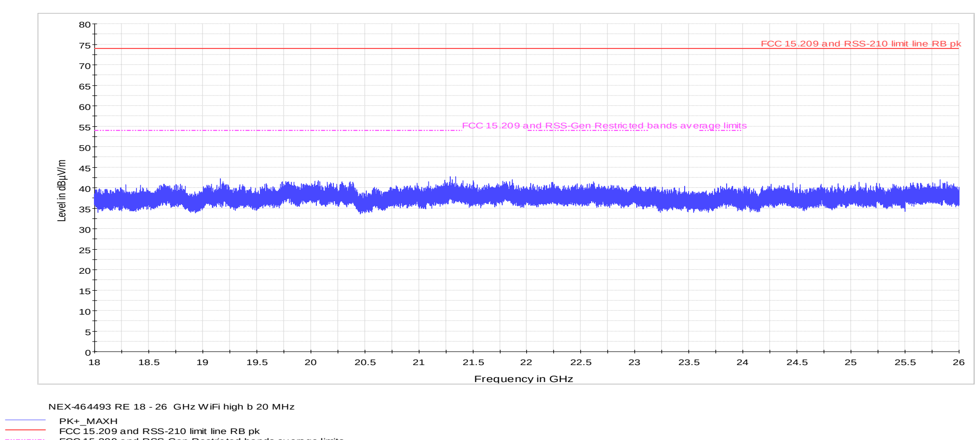


Figure 8.9-45: Radiated spurious emissions 18-26 GHz high channel, 802.11b

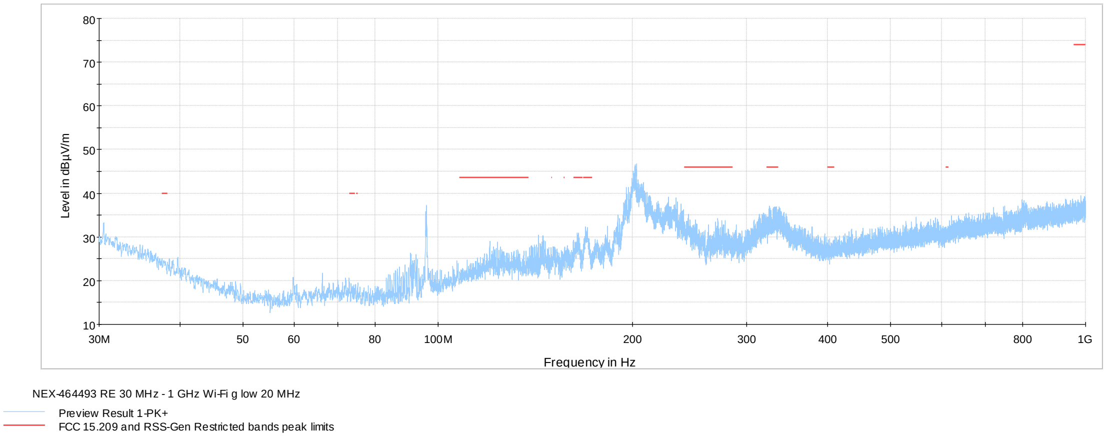


Figure 8.9-46: Radiated spurious emissions below 1 GHz low channel, 802.11g

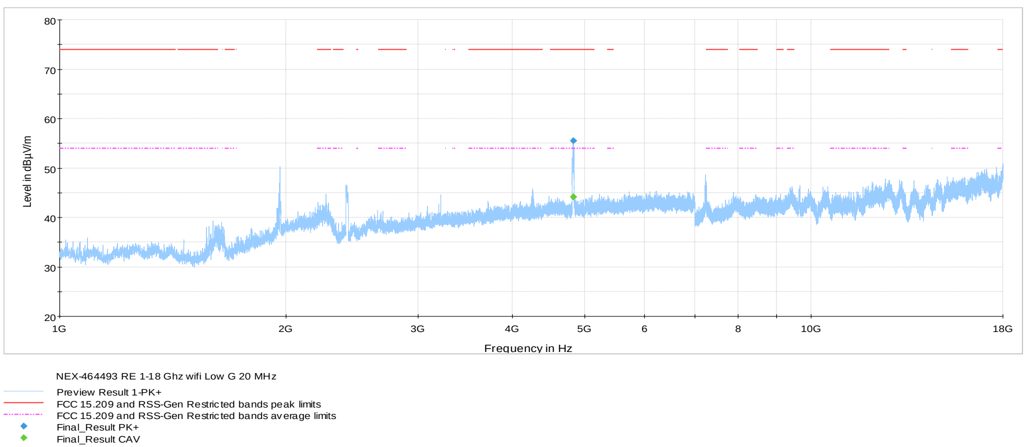


Figure 8.9-47: Radiated spurious emissions 1 -18 GHz low channel, 802.11g

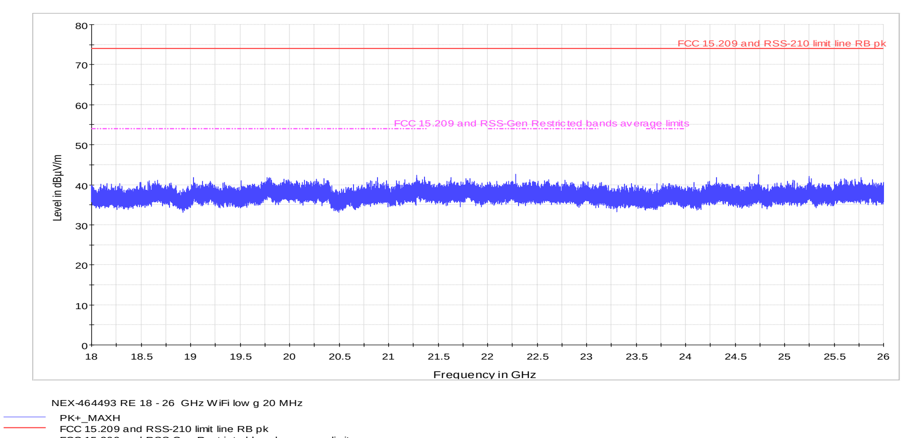


Figure 8.9-48: Radiated spurious emissions 18-26 GHz low channel, 802.11g

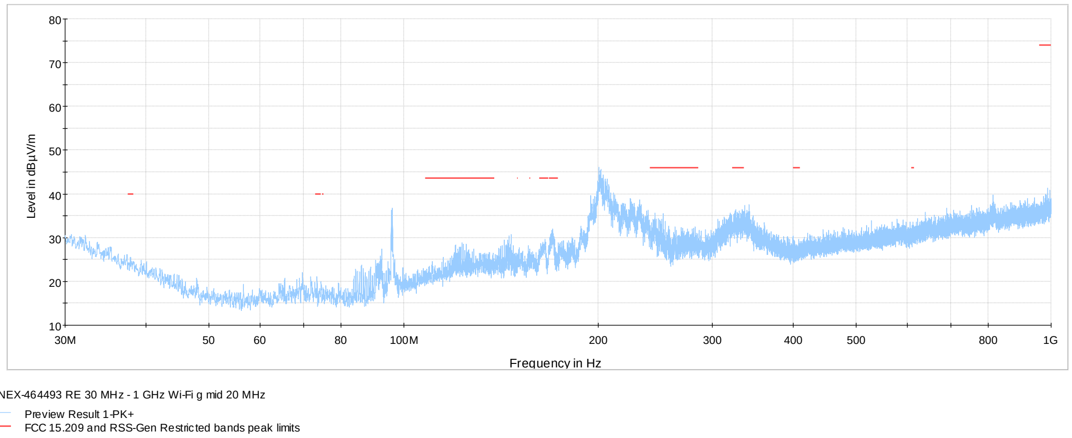


Figure 8.9-49: Radiated spurious emissions below 1 GHz mid channel, 802.11g

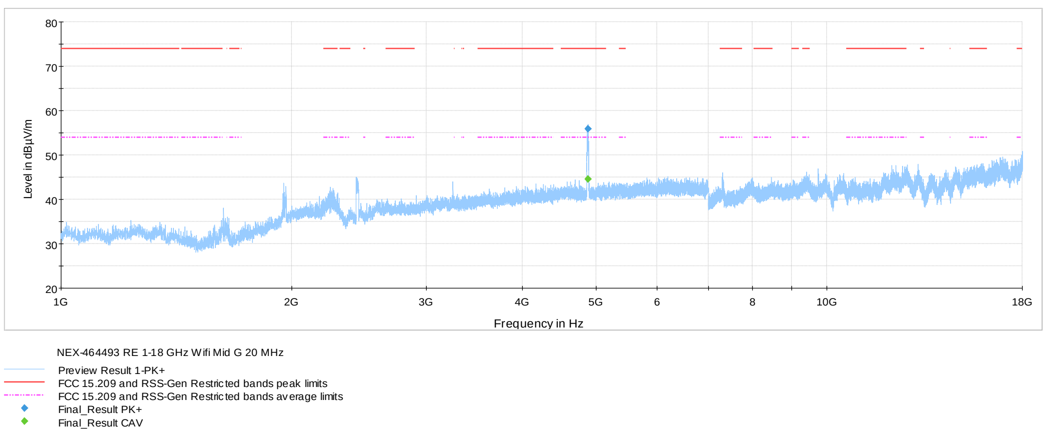


Figure 8.9-50: Radiated spurious emissions 1 -18 GHz mid channel , 802.11g

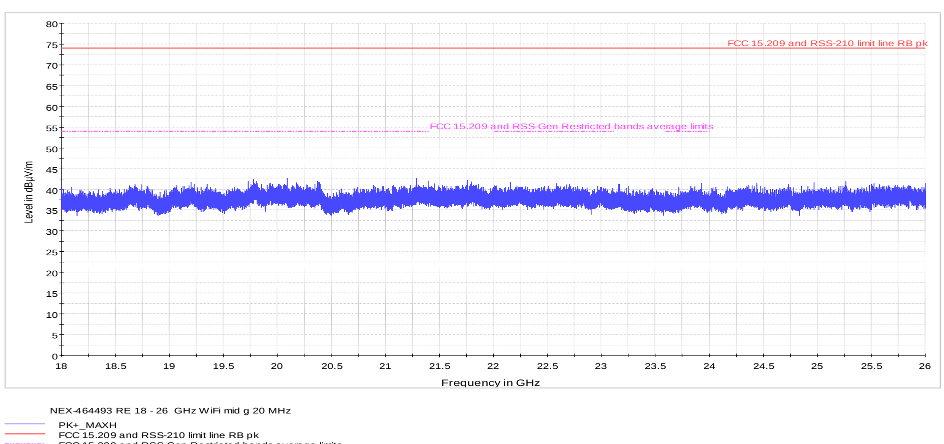


Figure 8.9-51: Radiated spurious emissions 18-26 GHz mid channel, 802.11g