

RADIO TEST REPORT

Report ID:

REP040752

Project number:

PRJ0048354

Type of assessment:

Class II Permissive Change

Applicant:

EXFO Inc.

Product name:

Communication Module

Model (HVIN):

1YN

FCC ID:

2AYQH-LB1DX

ISED certification number:

IC: 26882-LB1DX

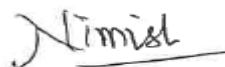
Specifications:

- ◆ FCC 47 CFR Part 15 Subpart C, §15.247
- ◆ RSS-247, Issue 3, August 2023, Section 5

Date of issue: December 5, 2024

Nimish Kapoor, EMC/RF Specialist

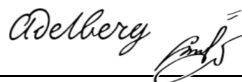
Tested by



Signature

Andrey Adelberg, Senior EMC/RF test specialist

Reviewed by



Signature

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ANAB File Number: AT-3195 (Ottawa/Almonte); AT-3193 (Pointe-Claire); AT-3194 (Cambridge)

Lab locations

Company name	Nemko Canada Inc.			
Facilities	<div> <div> <i>Ottawa site:</i> 303 River Road Ottawa, Ontario Canada K1V 1H2 Tel: +1 613 737 9680 Fax: +1 613 737 9691 </div> <div> <i>Montréal site:</i> 292 Labrosse Avenue Pointe-Claire, Québec Canada H9R 5L8 Tel: +1 514 694 2684 Fax: +1 514 694 3528 </div> <div> <i>Cambridge site:</i> 1-130 Saltsman Drive Cambridge, Ontario Canada N3E 0B2 Tel: +1 519 650 4811 </div> </div>			
Test site identifier	Organization	Ottawa	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.

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Section 1 Report summary

1.1 Test specifications

FCC 47 CFR Part 15, Subpart C, Clause 15.247 (85 FR 18149, Apr. 1, 2020)	Operation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz
RSS-247, Issue 3, August 2023, 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.
662911 D01 Multiple Transmitter Output v02r01 (October 31, 2013)	Emissions Testing of Transmitters with Multiple Outputs in the Same Band
DA 00-705, Released March 30, 2000	Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems
KDB 996369 D04 Module Integration Guide v02	Modular transmitter integration guide, guidance for host product manufacturers
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)
RSS-Gen, Issue 5 April 2018 + A1:2019 + A2:2021	General Requirements for Compliance of Radio Apparatus

1.3 Exclusions

Partial testing was performed on the product with the transmitter operating to confirm that the host product meets the FCC requirements. This investigation of the final product was done by spot checking emissions from the device while operating the host as a composite system. This testing was performed with the host product configured in typical operational modes to check the spurious emissions for compliance with all the applicable rules.

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

Report ID	Date of issue	Details of changes made to test report
REP040752	July 18, 2024	Original report issued
REP040752	December 5, 2024	Updated to Issue 3 of RSS-247

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 Model variant declaration

There were no model variants declared by the applicant.

2.4 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 $\pm 5\%$, for which the equipment was designed.

Section 4 Information provided by the applicant

4.1 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.

4.2 Applicant/Manufacturer

Name	EXFO Inc
Address	400 Godin Avenue Quebec City, QC, Canada, G1M 2K2

4.3 EUT information

Product	Communication Module
Model number (HVIN)	1YN
Host model number (HMN)	FIP-200 Series
Part number	LBEE5KL1YN-814
Power supply requirements	3.6 VDC VBAT and 3.3 VDC VDDIO
Product description and theory of operation	The EUT is a small and high-performance module based on Infineon CYW4343W combo chipset to support Wi-Fi and BLE.

4.4 Radio technical information

Category of Wideband Data Transmission equipment	<input type="checkbox"/> Frequency Hopping Spread Spectrum (FHSS) equipment <input checked="" type="checkbox"/> Other types of Wideband Data Transmission equipment (e.g. DSSS, OFDM, etc.).
Frequency band	2400–2483.5 MHz
Frequency Min (MHz)	2402 for BLE 2412 for Wi-Fi
Frequency Max (MHz)	2480 for BLE 2462 for Wi-Fi
Type of modulation	BLE: GFSK Wi-Fi: DSSS (CCK, DQPSK, DBPSK), OFDM (QPSK, BPSK, 16-QAM, 64-QAM)
Antenna	Manufacturer: Pulse, Type: Chip antenna, Gain: 2.2 dBi, Part number: W3006

4.5 EUT setup details

4.5.1 Radio exercise details

Operating conditions	“MobaXterm_Personal 20.6.exe” software was used to control the Module. The following scripts are used to control. Wi-Fi: “./Murata_IFX_RF_Test_Tool.py” BLE: “./cyw_ble-test.sh”
Transmitter state	Transmitter set in to continuous mode. <ol style="list-style-type: none"> Bluetooth Low Energy (BLE) mode: Middle Channel (2442 MHz) Wi-Fi mode: Low Channel (2412 MHz) with 1 Mbps Data Rate, packet interval: 30, packet length: 1024 and 20 MHz bandwidth with 17 dBm output power.

4.5.2 EUT setup configuration

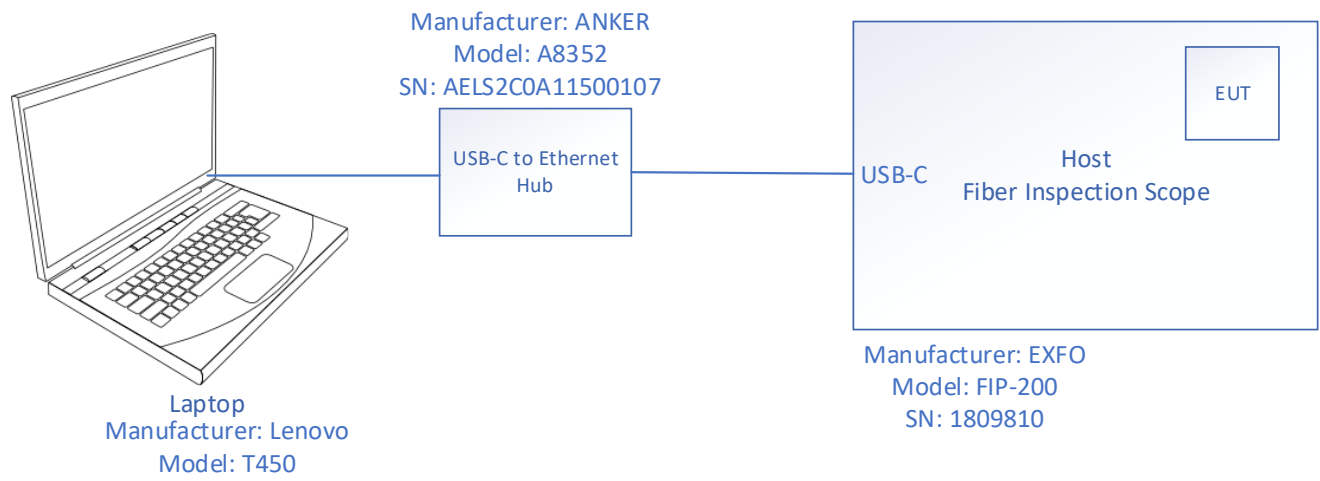


Figure 4.5-1: Block diagram (for Configuration)

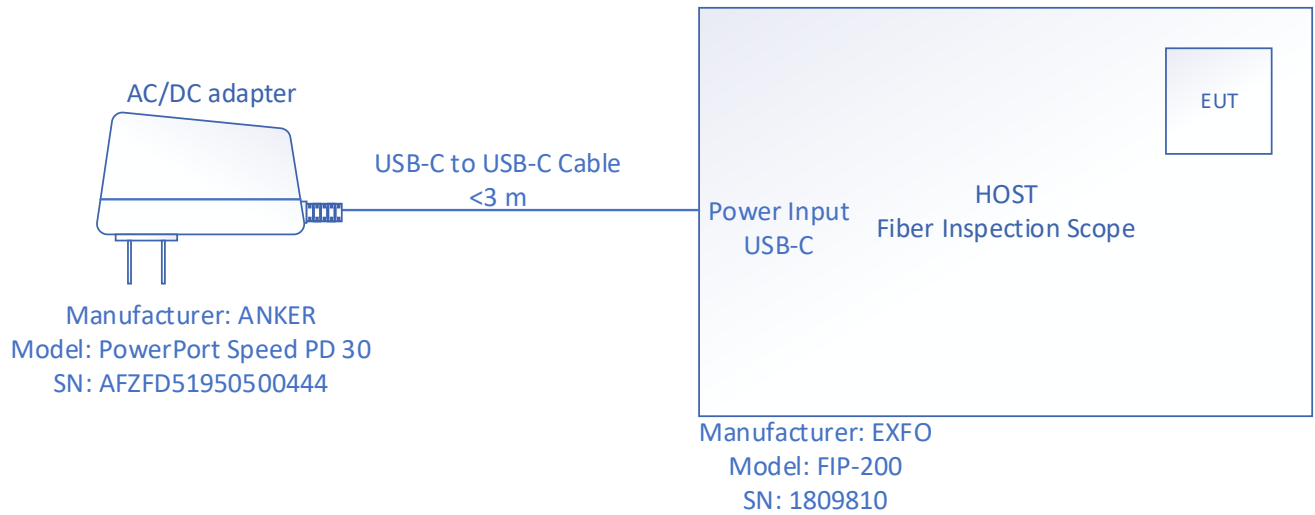


Figure 4.5-2: Block diagram (For testing)

Section 5 Summary of test results

5.1 Testing period

Test start date	May 8, 2024	Test end date	May 8, 2024
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5.2 Sample information

Receipt date	May 6, 2024	Nemko sample ID number(s)	PRJ00483540001
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5.3 FCC Part 15, Test results

Table 5.3-1: FCC requirements results

Part	Test description	Verdict
§15.207(a)	Conducted limits	Pass
§15.247(d)	Spurious emissions	Pass

Notes: None

5.4 ISED RSS-Gen/ ISED RSS-247, Test results

Table 5.4-1: RSS-Gen/ ISED RSS-247 requirements results

Part	Test description	Verdict
ISED RSS-Gen, 7.3	Receiver radiated emission limits	Not applicable
ISED RSS-Gen, 8.8	AC power-line conducted emissions limits	Pass
ISED RSS-247, 5.5	Unwanted emissions	Pass

Notes: ¹According 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.

Section 6 Test equipment

6.1 Test equipment list

Table 6.1-1: Equipment list

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
3 m EMI test chamber	TDK	SAC-3	FA002047	1 year	January 18, 2025
Flush mount turntable	Sunol	FM2022	FA002082	—	NCR
Controller	Sunol	SC104V	FA002060	—	NCR
Antenna mast	Sunol	TLT2	FA002061	—	NCR
61505 AC/DC programmable source	Chroma	61509	FA003036	—	NCR
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 40	FA002071	1 year	March 7, 2025
Horn (1–18 GHz)	ETS Lindgren	3117	FA002840	1 year	March 8, 2025
Preamplifier (1–18 GHz)	ETS Lindgren	124334	FA002877	1 year	November 24, 2024
Bilog antenna (20–3000 MHz)	Sunol	JB3	FA002108	1 year	March 27, 2025
50 Ω coax cable	Carlisle	WHU18-1818-072	FA002391	1 year	October 17, 2024
50 Ω coax cable	Huber+Suhner	104B11NX2/11000	FA003441	1 year	October 17, 2024
LISN	Rohde & Schwarz	ENV216	FA002023	1 year	January 5, 2025
LISN	Rohde & Schwarz	ENV216	FA002515	1 year	February 1, 2025
50 Ω coax cable	Huber + Suhner	None	FA001652	1 year	April 4, 2025

Notes: NCR - no calibration required,
All equipment related to the contribution of measurement has been included in this list. Such items include, but are not limited to, cables, attenuators, directional couplers, and pre-amps.

Table 6.1-2: Automation software details

Test description	Manufacturer of Software	Details
Radiated emissions as of April 4, 2023	Rohde & Schwarz	EMC32, Software for EMC Measurements, Version 11.20.00
Conducted emissions as of April 4, 2023	Rohde & Schwarz	EMC32, Software for EMC Measurements, Version 11.20.00

Table 6.1-3: Measurement uncertainty calculations based on equipment list

Measurement	Measurement uncertainty, ±dB
AC power line conducted emissions	3.42
Radiated spurious emissions (30 MHz to 1 GHz)	4.16
Radiated spurious emissions (1 GHz to 6 GHz)	4.67
Radiated spurious emissions (6 GHz to 18 GHz)	4.95

Notes: UKAS Lab 34, TIA-603 and ETSI TR 100 028-1&2 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 calculations assume a coverage factor of K = 2 with 95% certainty.

Section 7 Testing data

7.1 AC power line conducted emissions limits

7.1.1 References, definitions and limits

FCC §15.207:

- (a) 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 μ H/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, Clause 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.

RSS-Gen, Clause 8.8:

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 7.1-1: Conducted emissions limit

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

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

7.1.2 Test summary

Verdict	Pass		
Test date	May 8, 2024	Temperature	23 °C
Tested by	Nimish Kapoor	Air pressure	1015 mbar
Test location	Ottawa	Relative humidity	58 %

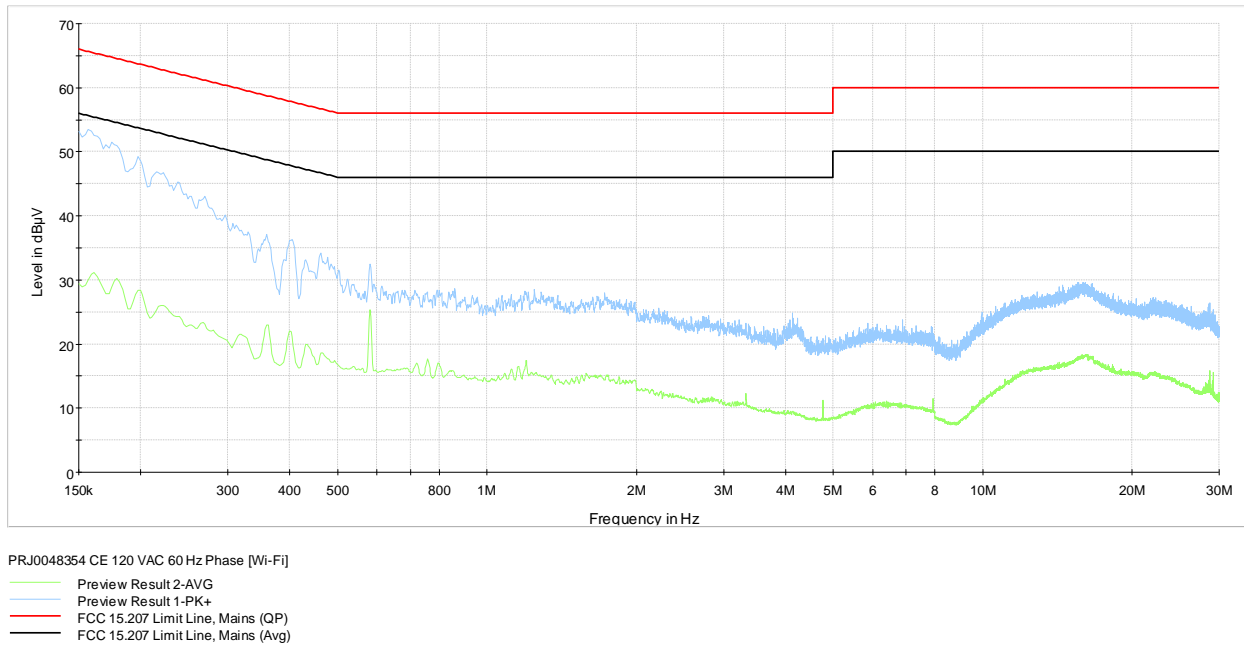
7.1.3 Observations, settings and special notes

Port under test – Coupling device	AC Input of AC/DC Adapter – Artificial Mains Network (AMN)
EUT power input during test	120 V _{AC} , 60 Hz; 5 V _{DC} USB Powered
EUT setup configuration	Table top
Measurement details	A preview measurement was generated with the receiver in continuous scan mode. Emissions detected within 10 dB or above the limit were re-measured with the appropriate detector against the correlating limit and recorded as the final measurement.
Additional notes:	<ul style="list-style-type: none"> – 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. Correction factor (dB) = LISN factor IL (dB) + cable loss (dB) + attenuator (dB) – 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.

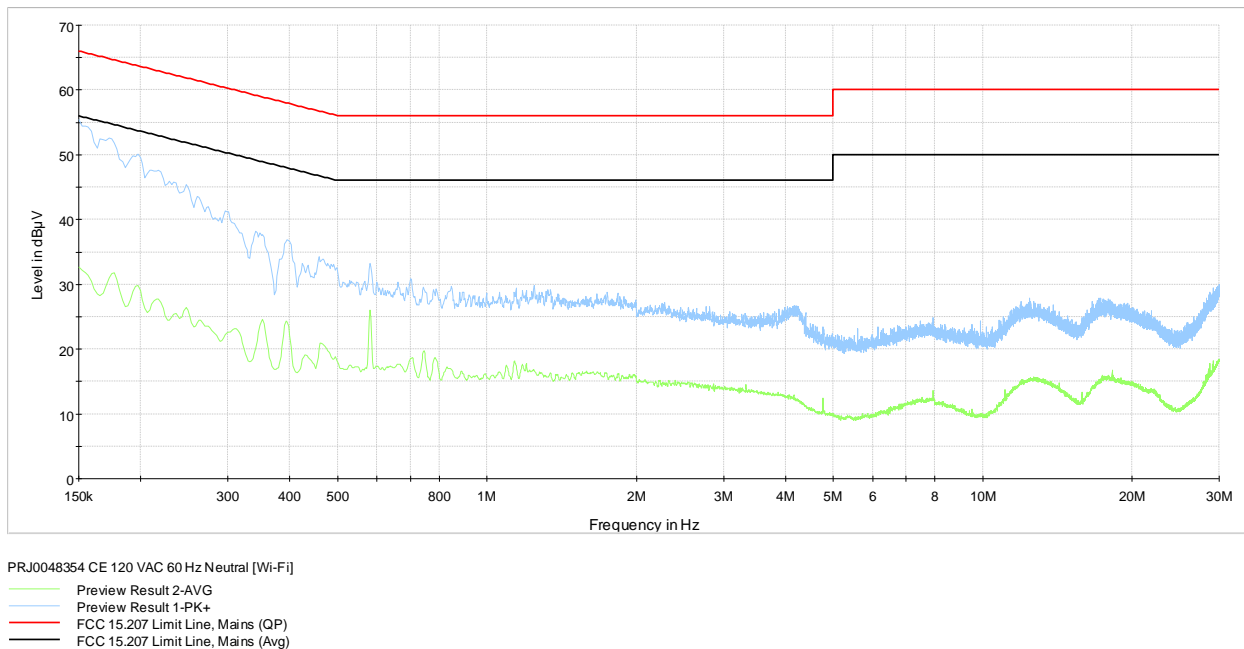
Receiver settings:

Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Detector mode	Peak and Average (Preview), Quasi-peak and CAverage (Final)
Trace mode	Max Hold
Measurement time	100 ms (Preview), 160 ms (Final)

7.1.4 Test data

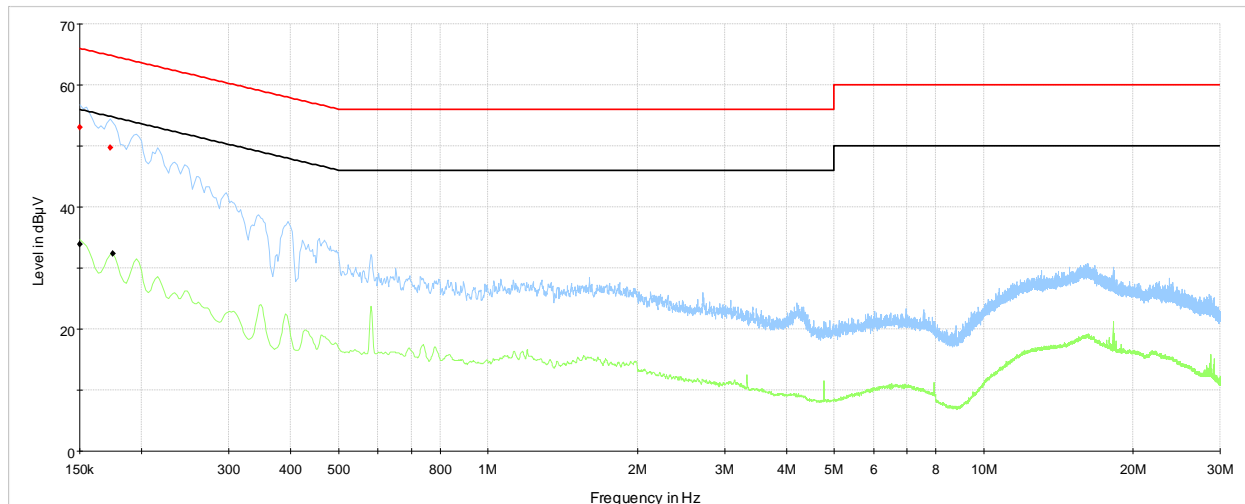


Plot 7.1-1: Conducted emissions on phase line [Wi-Fi]



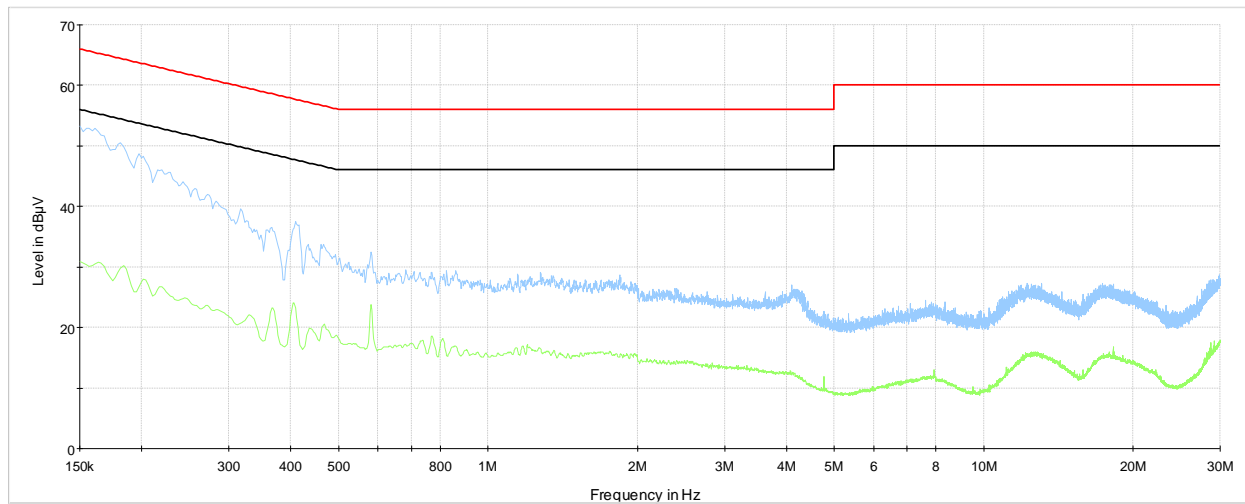
Plot 7.1-2: Conducted emissions on neutral line [Wi-Fi]

Test data, continued



PRJ0048354 CE 120 VAC 60 Hz Phase [BLE]
 Preview Result 2-AVG
 Preview Result 1-PK+
 FCC 15.207 Limit Line, Mains (QP)
 FCC 15.207 Limit Line, Mains (Avg)
 Final_Result QPK
 Final_Result CAV

Plot 7.1-3: Conducted emissions on phase line [BLE]



PRJ0048354 CE 120 VAC 60 Hz Neutral [BLE]
 Preview Result 2-AVG
 Preview Result 1-PK+
 FCC 15.207 Limit Line, Mains (QP)
 FCC 15.207 Limit Line, Mains (Avg)

Plot 7.1-4: Conducted emissions on neutral line [BLE]

7.1.5 Setup photos

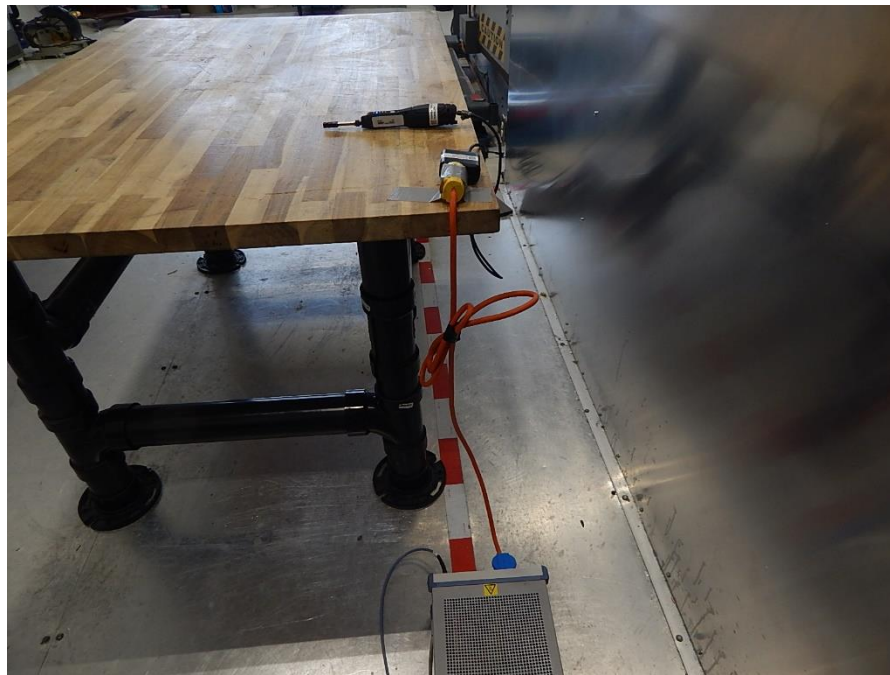


Figure 7.1-5: Conducted emissions – from AC mains power ports setup photo



Figure 7.1-6: Conducted emissions – from AC mains power ports setup photo

7.2 Spurious (out-of-band) unwanted emissions

7.2.1 References, definitions and limits

FCC §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, Clause 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.

RSS-Gen:

- 8.9 Except where otherwise indicated in the applicable RSS, radiated emissions shall comply with the field strength limits shown in table below.
- 8.10 Restricted frequency bands are designated primarily for safety-of-life services (distress calling and certain aeronautical activities), certain satellite downlinks, radio astronomy and some government uses. The following conditions related to the restricted frequency bands apply:
- a The transmit frequency, including fundamental components of modulation, of licence-exempt radio apparatus shall not fall within the restricted frequency bands.
 - b Unwanted emissions that fall into restricted frequency bands listed in table 7 shall comply with the limits specified in table below.
 - c Unwanted emissions that do not fall within the restricted frequency bands shall comply either with the limits specified in the applicable RSS or with those specified in table below.

Table 7.2-1: FCC §15.209 and RSS-Gen – Radiated emission limits

Frequency, MHz	Field strength of emissions		Measurement distance, m
	μV/m	dBμV/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.

References, definitions and limits, continued

Table 7.2-2: 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	
8.41425–8.41475	167.72–173.2	3500–4400	
12.29–12.293	240–285	4500–5150	Above 38.6
12.51975–12.52025	322–335.4	5350–5460	

Note: Certain frequency bands listed in Table 7.2-2 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 7.2-3: 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			

7.2.2 Test summary

Verdict	Pass		
Test date	May 8, 2024	Temperature	23 °C
Tested by	Nimish Kapoor	Air pressure	1015 mbar
Test location	Ottawa	Relative humidity	58 %

7.2.3 Observations, settings and special notes

- Only radiated spurious emissions within restricted bands were evaluated.
- 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 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 (Measurements within restricted bands)

Resolution bandwidth:	Measurements below 1 GHz: 100 kHz Peak or 120 kHz Q-Peak, Measurements above 1 GHz: 1 MHz
Video bandwidth:	Measurements below 1 GHz: 300 kHz, Measurements above 1 GHz: 3 MHz
Detector mode:	Peak or Q-Peak
Trace mode:	Max Hold

7.2.4 Test data

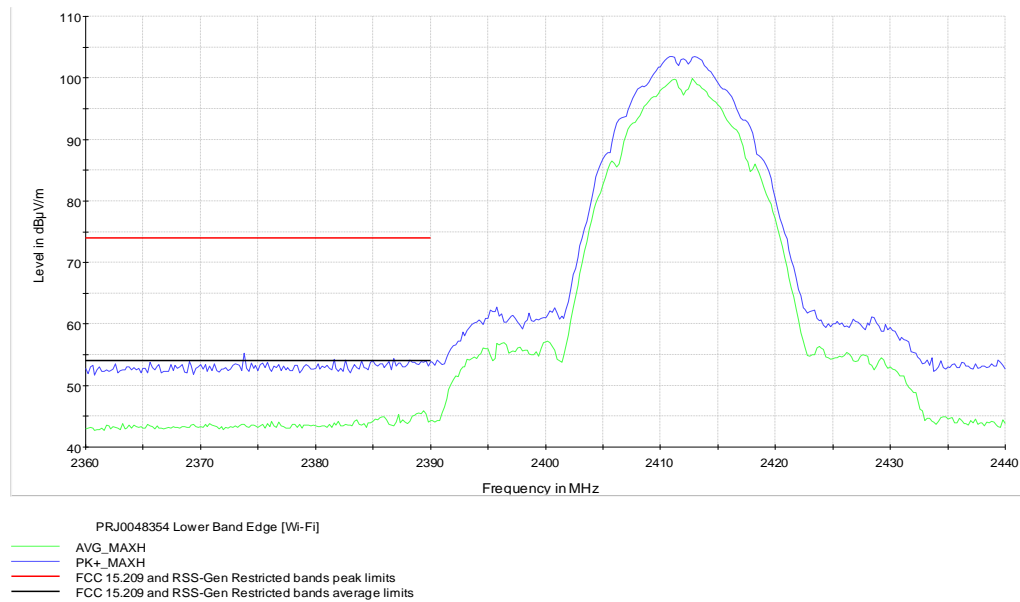


Figure 7.2-1: Radiated spurious emissions on lower band edge [Wi-Fi]

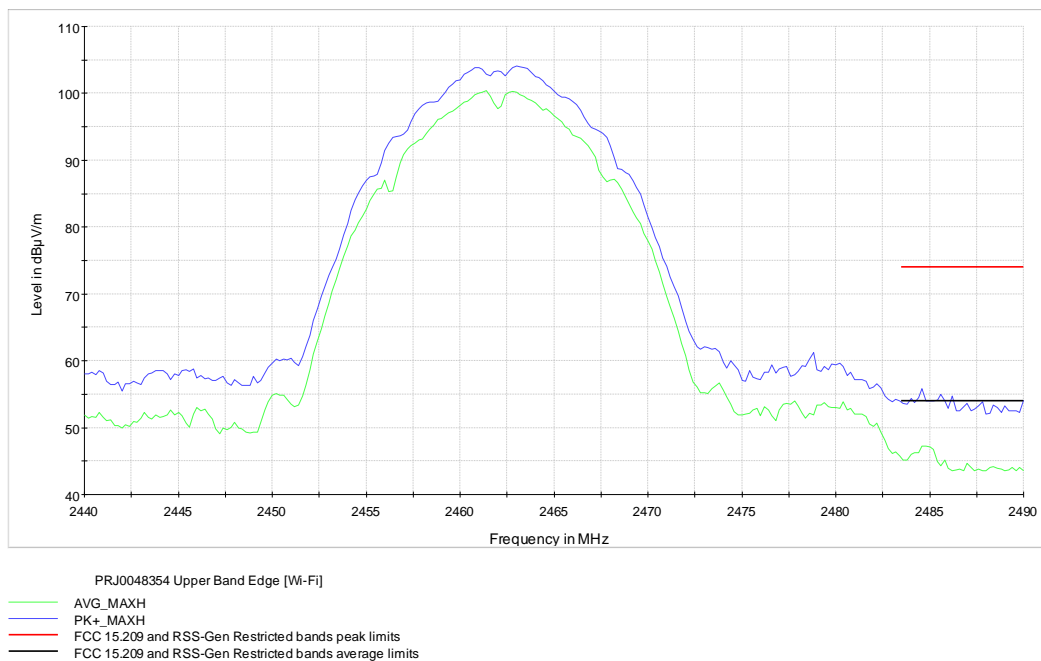


Figure 7.2-2: Radiated spurious emissions on upper band edge [Wi-Fi]

Test data, continued

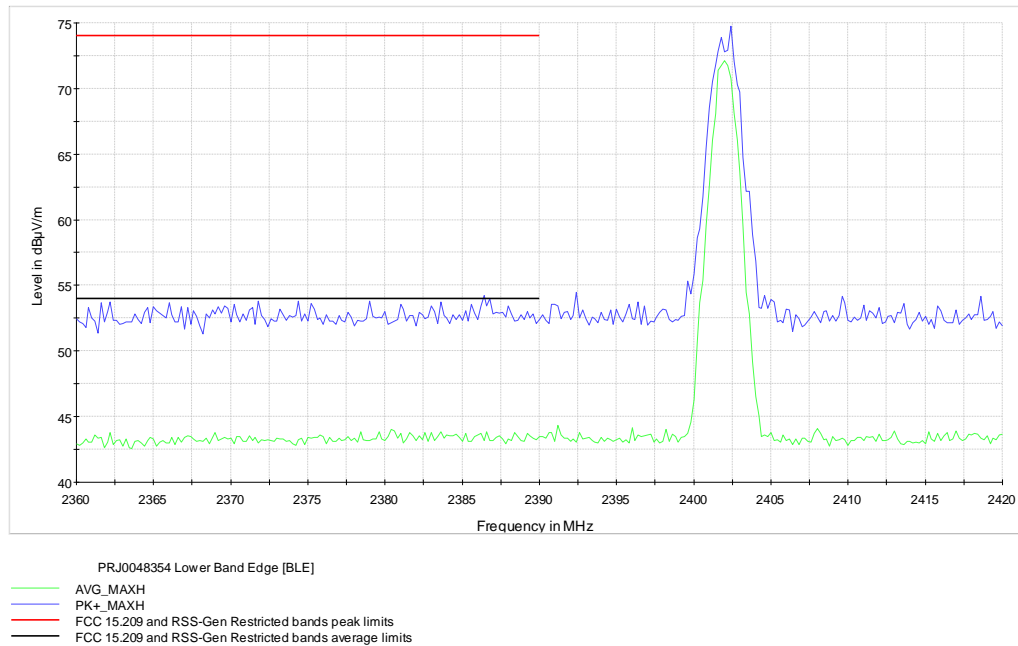


Figure 7.2-3: Radiated spurious emissions on lower band edge [BLE]

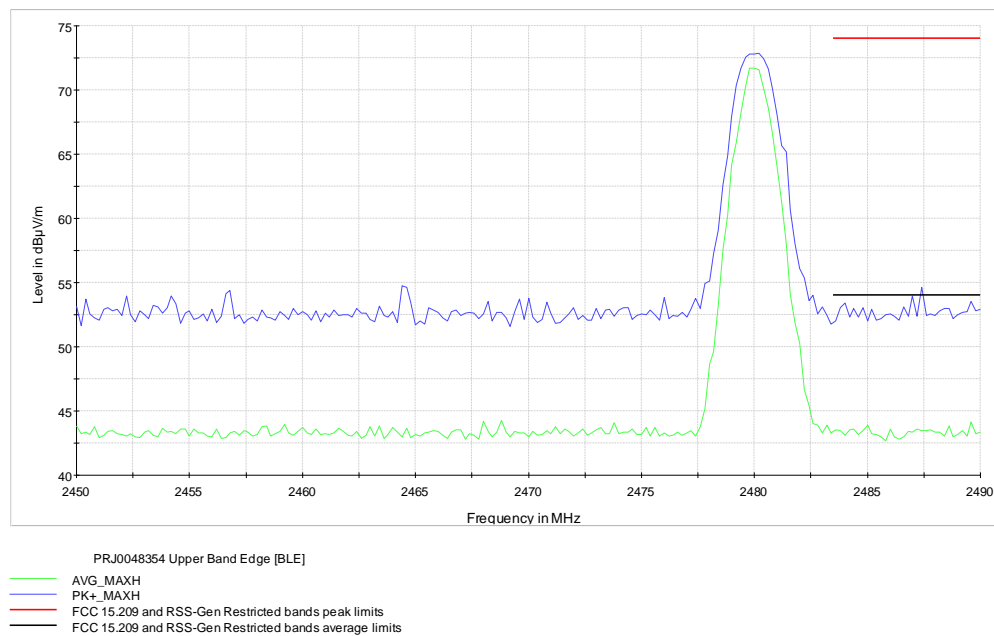


Figure 7.2-4: Radiated spurious emissions on upper band edge [BLE]

Test data, continued

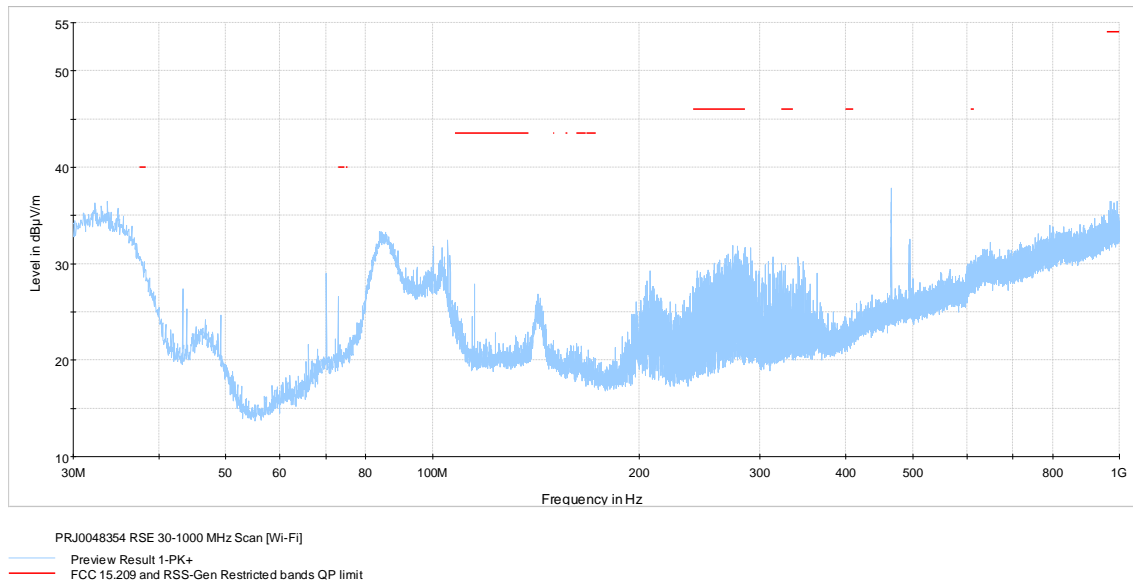


Figure 7.2-5: Radiated spurious emissions 30-1000 MHz Scan [Wi-Fi]

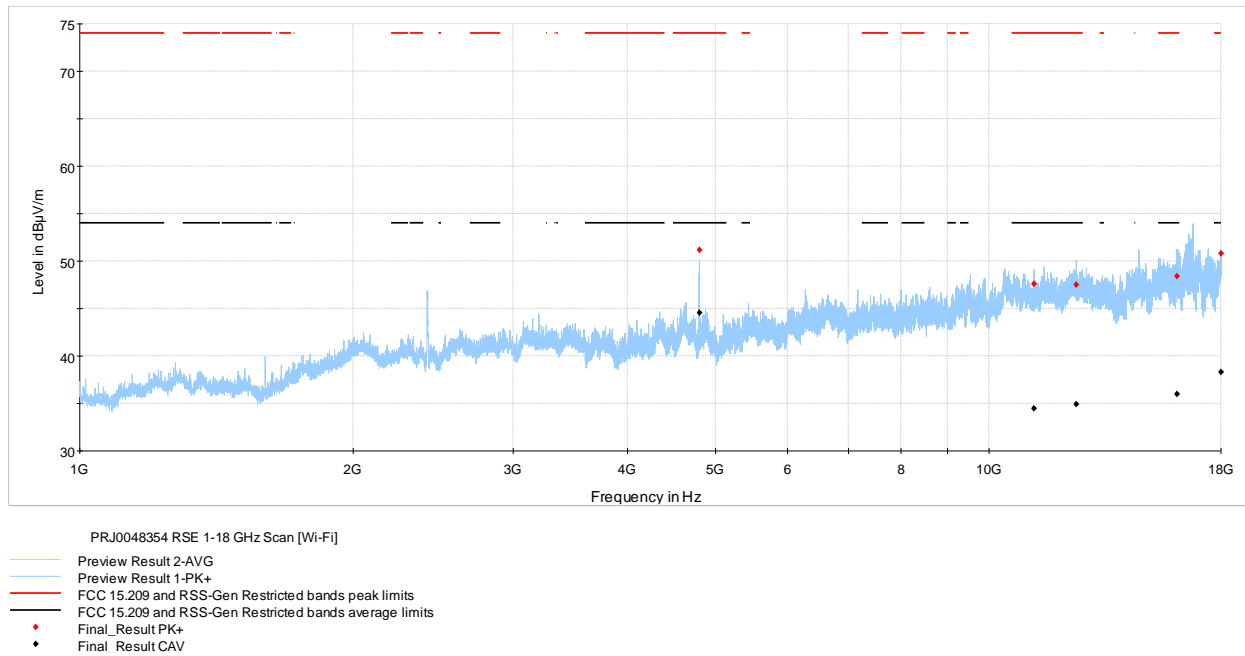


Figure 7.2-6: Radiated spurious emissions 1-18 GHz Scan [Wi-Fi]

Test data, continued

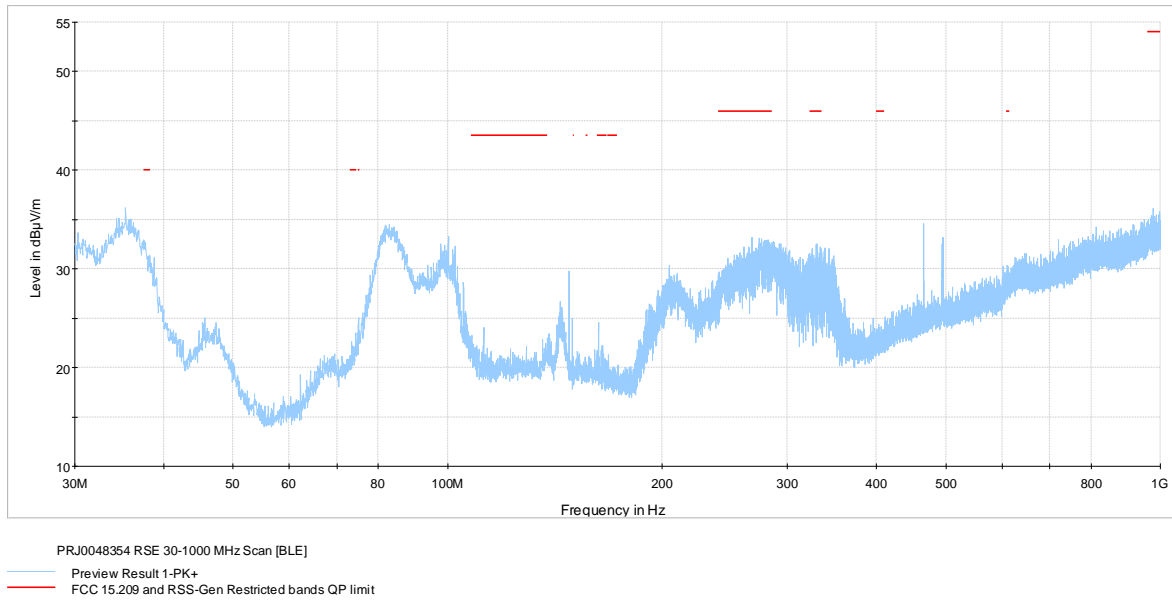


Figure 7.2-7: Radiated spurious emissions 30-1000 MHz Scan [BLE]

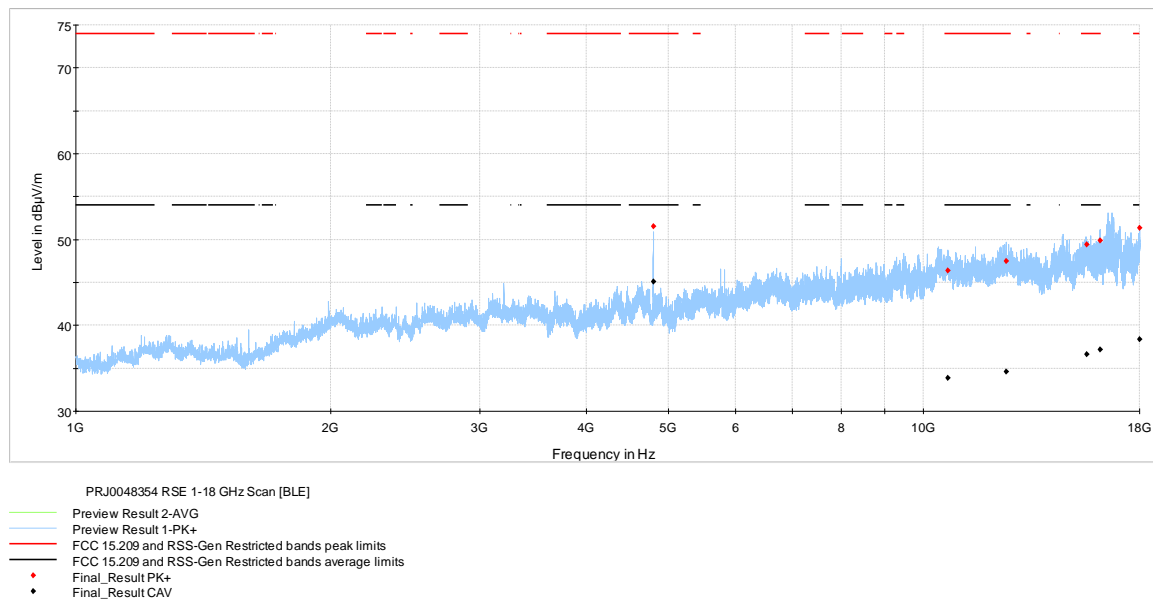


Figure 7.2-8: Radiated spurious emissions 1-18 GHz Scan [BLE]

7.2.5 Setup photos

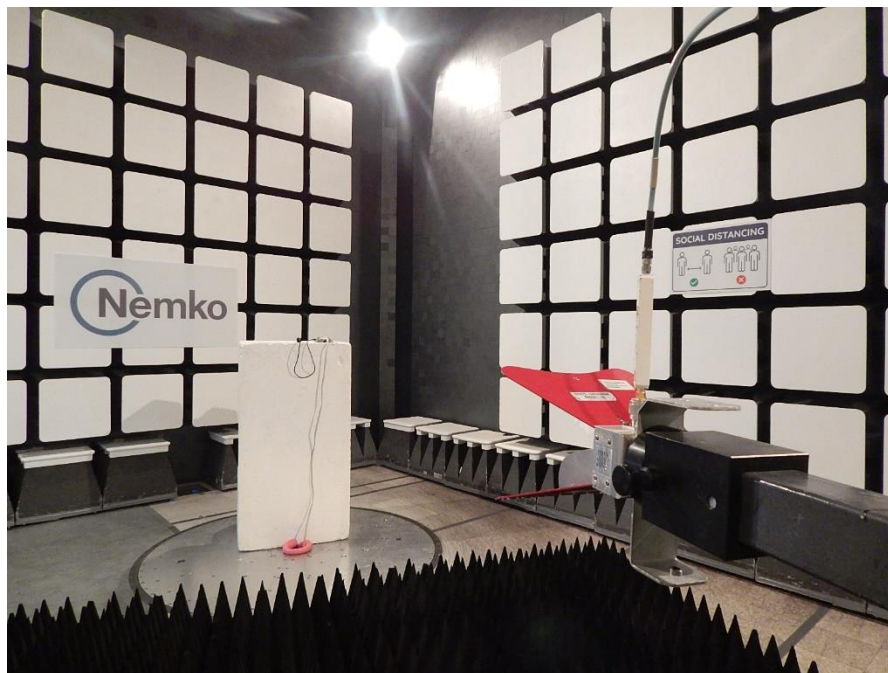


Figure 7.2-9: Radiated spurious emissions – below 1 GHz



Figure 7.2-10: Radiated spurious emissions – above 1 GHz

Section 8 Host photos

8.1 External photos of the host



Figure 8.1-1: Front and top view photo



Figure 8.1-2: Rear view photo



Figure 8.1-3: Side and top view photo



Figure 8.1-4: Side and bottom view photo

End of the test report