

RADIO TEST REPORT

Report ID
REP007204

Project ID
PRJ0030377

Type of assessment:
C2PC – antenna update and host integration

Applicant:
GSI Electronics Inc.

Model (HVIN):
ESP32-S3-WROOM-1U

Host name (HMN):
Vision Connect WiFi

FCC ID:
2AFLZSPS3WROOM1U

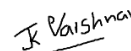
ISED Certification number:
11880A-ESPS3WROOMU

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

Date of issue: May 18, 2023

Jagrut Vaishnav, EMC/RF Specialist

Tested by



Signature

Kevin Rose, EMC/RF Specialist

Reviewed by



Signature

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





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	Test site identifier	Organization	Ottawa/Almonte	Montreal
	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	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 (DTSSs), 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

Partial testing was performed on the product with the transmitter operating to confirm that the host product meets the FCC/ISED 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. This is a Class 2 Permissive Change assessment with the new antenna of 5 dBi and the limited modular approval.

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
REP007204	May 18, 2023	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

Only radiated spurious emissions test with the new antenna and the product integrated within a representative host was performed.

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 $\pm 5\%$, 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

Test name	Measurement uncertainty, \pm dB
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/Manufacture

Applicant name	GSI Electronics
Applicant address	5200 Armand-Frappier, St-Hubert, QC, J3Z 1G5, Canada
Manufacture name	Same as applicant
Manufacture address	Same as applicant

5.3 EUT information

Host name	Vision Connect WiFi
WiFi radio Model (HVIN)	ESP32-S3-WROOM-1U
WiFi Part number	064-11532
Power supply requirements	DC: 12 V
Product description and theory of operation	RF WiFi module on vision connect host which provides WiFi connectivity of legacy GSI products.

5.4 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)	2412
Frequency Max (MHz)	2462
Channel numbers	1–11
Antenna information	Abracon AEACAD460065-S698, Linear Polarization, 5 dBi Gain

5.5 EUT setup details

5.5.1 Radio exercise details

Operating conditions	The EUT was powered with 12V DC supply through 100–240 V _{AC} 50/60 Hz PSU. It was then set to continuous transmission using RealTerm software.
Transmitter state	Transmitter set into continuous mode.

5.5.2 EUT setup configuration

Table 5.5-1: EUT sub assemblies

Description	Brand name	Model, Part number, Serial number, Revision level
AC/DC Adapter	Omron	SN: (21)1611524929, MN:S8FS-G05012CD

Table 5.5-2: EUT interface ports

Description	Qty.
Debug Port	1
3-Pin Supply connector	1

Table 5.5-3: Support equipment

Description	Brand name	Model, Part number, Serial number, Revision level
GSIE Debug Board	AGCO	MN: PCB399-RP04-300-00323, SN: AA2041M1142900028
Laptop	Dell	SN: 6776506622, MN: Precision 7530
Antenna	Abracon	PN: 833-00037, MN: AEACAD460065-S698

Table 5.5-4: Inter-connection cables

Cable description	From	To	Length (m)
DC Cable (2C 18-24 AWG Wire)	AC/DC PSU	DC input on EUT	5
AC Cord (3C 18 AWG Wire)	AC Mains	AC/DC PSU	2
Antenna Cable (RG-174)	EUT	Antenna	4.6

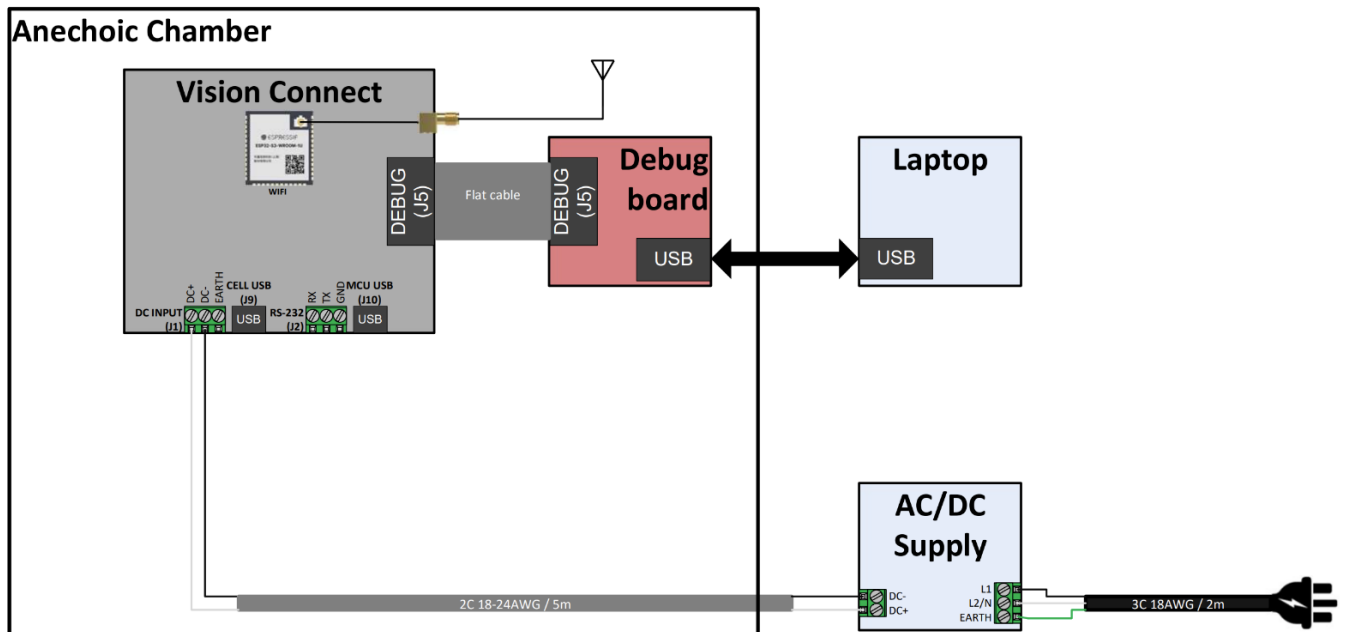


Figure 5.5-1: Radiated testing block diagram

Section 6 Summary of test results

6.1 Testing location

Test location (s)	Montreal
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6.2 Testing period

Test start date	February 22, 2023	Test end date	February 27, 2023
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6.3 Sample information

Receipt date	February 21, 2023	Nemko sample ID number(s)	PRJ00303770001
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6.4 FCC Part §15.247 test results

Table 6.4-1: FCC requirements results

Part	Test description	Verdict
§15.247(d)	Spurious emissions	Pass

Notes: All other specification's requirements are not applicable for this type of assessment, therefore were removed from the table.

6.5 ISED RSS-247, Issue 2, test results

Table 6.5-1: ISED requirements results

Part	Test description	Verdict
5.5	Unwanted emissions	Pass

Notes: All other specification's requirements are not applicable for this type of assessment, therefore were removed from the table.

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 (Emissions)	TDK	SAC-3	FA002532e	1 year	April 1, 2023
Flush mount turntable	Sunol	FM2022	FA002550	—	NCR
Antenna mast	Sunol	TLT2	FA002552	—	NCR
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 40	FA002071	1 year	March 3, 2023
Bilog antenna (20–2000 MHz)	Sunol	JB1	FA002517	1 year	March 24, 2023
Horn antenna (1–18 GHz)	EMCO	3115	FA001451	1 year	March 10, 2023
Pre-amplifier (0.5–18 GHz)	Com-Power	PAM-118A	FA002561	—	August 10, 2023

Notes: NCR - no calibration required

Section 8 Testing data

8.1 Spurious (out-of-band) unwanted emissions

8.1.1 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.

Table 8.1-1: 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 × log ₁₀ (F)	300
0.490–1.705	24000/F	87.6 – 20 × 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 8.1-2: 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	Above 38.6
12.29–12.293	240–285	4500–5150	
12.51975–12.52025	322–335.4	5350–5460	

Note: Certain frequency bands listed in Table 8.1-2 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 8.1-3: 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			

8.1.2 Test summary

Verdict	Pass		
Test date	February 28, 2023	Temperature	23 °C
Tested by	Jagrut Vaishnav	Air pressure	1015 mbar
Test location	Montreal	Relative humidity	30 %

8.1.3 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 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:	1 MHz
Video bandwidth:	3 MHz
Detector mode:	Peak
Trace mode:	Max Hold

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

Resolution bandwidth:	1 MHz
Video bandwidth:	10 Hz
Detector mode:	Peak
Trace mode:	Max Hold

8.1.4 Test data

Table 8.1-4: Output power results with the new antenna (worst case modulation results)

Channel	Frequency, MHz	Output power, dBm		Margin, dB	Antenna gain, dBi	EIRP, dBm		Margin, dB
		Measured	Limit			Measured	Limit	
Low	2412	23.28	30.0	6.7	5.0	28.3	36.0	7.7
Mid	2437	25.11	30.0	4.9	5.0	30.1	36.0	5.9
High	2462	23.78	30.0	6.2	5.0	28.8	36.0	7.2

Notes: The modulation that resulted in the highest output power was 802.11g with 6 Mbps, so it was the basis for the EIRP calculation.

Table 8.1-5: Radiated field strength measurement results

Channel	Frequency, MHz	Peak Field strength, dBμV/m		Margin, dB	Average Field strength, dBμV/m		Margin, dB
		Measured	Limit		Measured	Limit	
Low	2400.0*	42.0	74.0	32.0	42.0	54.0	12.0
Low	4824.0	50.0	74.0	24.0	47.0	54.0	7.0
Mid	4874.0	49.0	74.0	25.0	46.0	54.0	8.0
High	2483.5*	45.9	74.0	28.1	45.9	54.0	8.1
High	4924.0	48.0	74.0	26.0	48.0	54.0	6.0

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

* - peak levels were below the average limit, therefore those frequencies weren't tested with average detector.

Test data, Continued

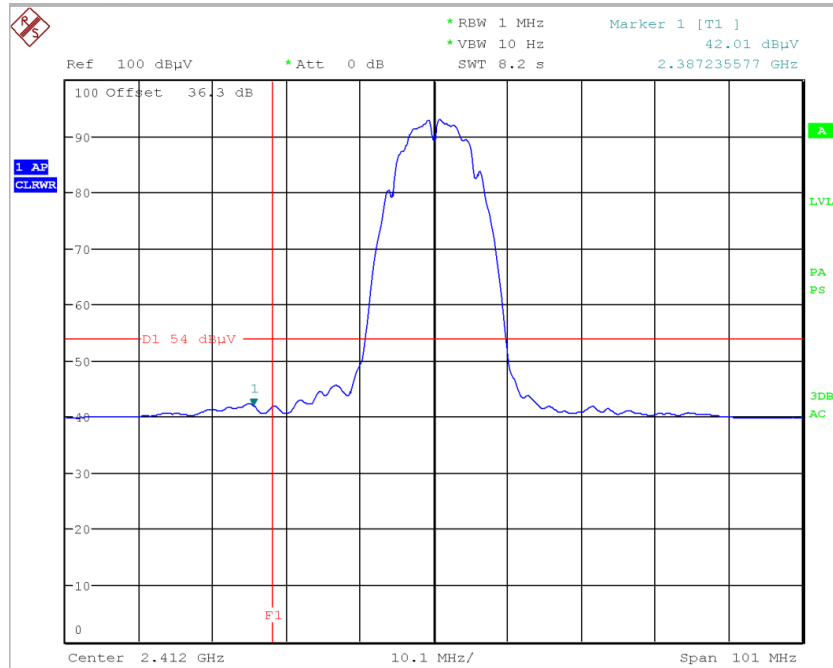


Figure 8.2 1: Band edge spurious emissions at 2400 MHz

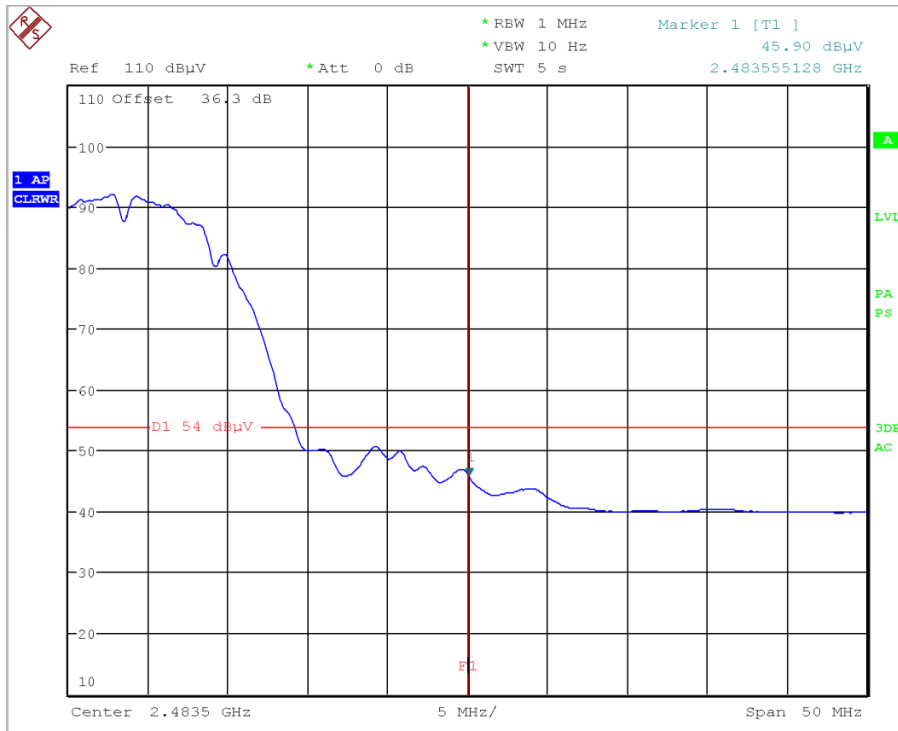
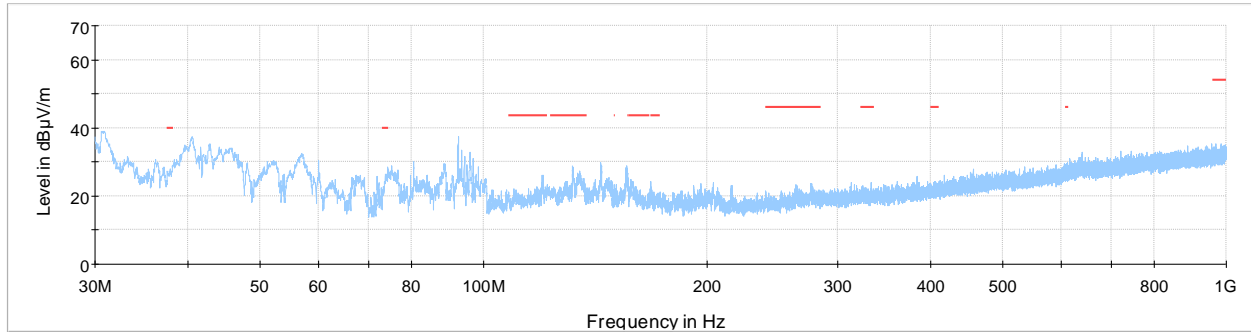


Figure 8.2 2: Band edge spurious emissions at 2483.5 MHz

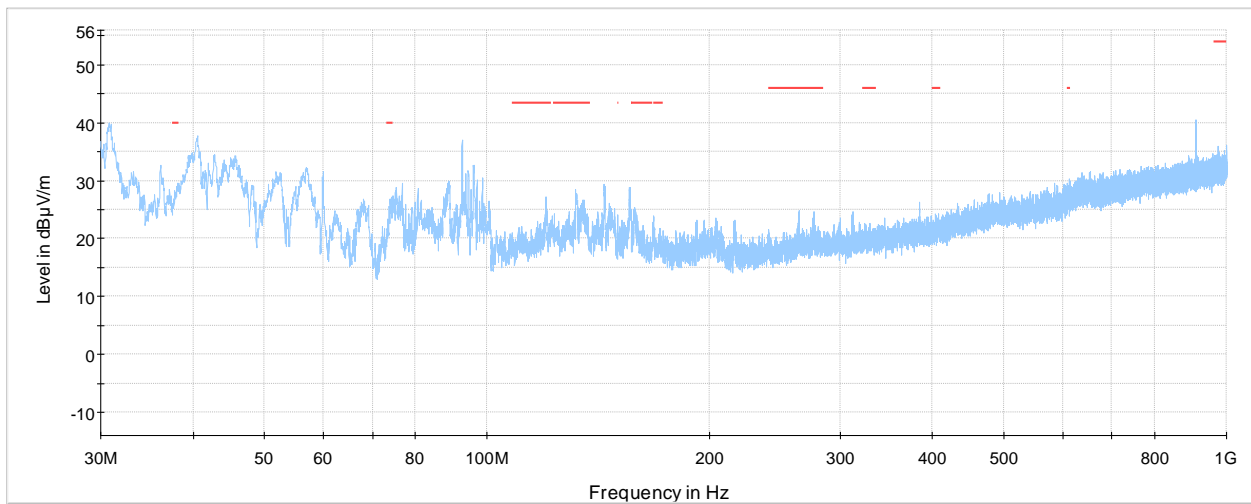
Test data, Continued



PRJ0030377 RE scan 30-1000 MHz 802_11b Low channel

- Preview Result 1-PK+
- ◆ Critical_Freqs PK+
- FCC 15.209 and RSS-210 limit line RstrB
- ◆ Final_Result QPK

Figure 8.2.3: Radiated spurious emissions on 30 MHz to 1 GHz (low channel)

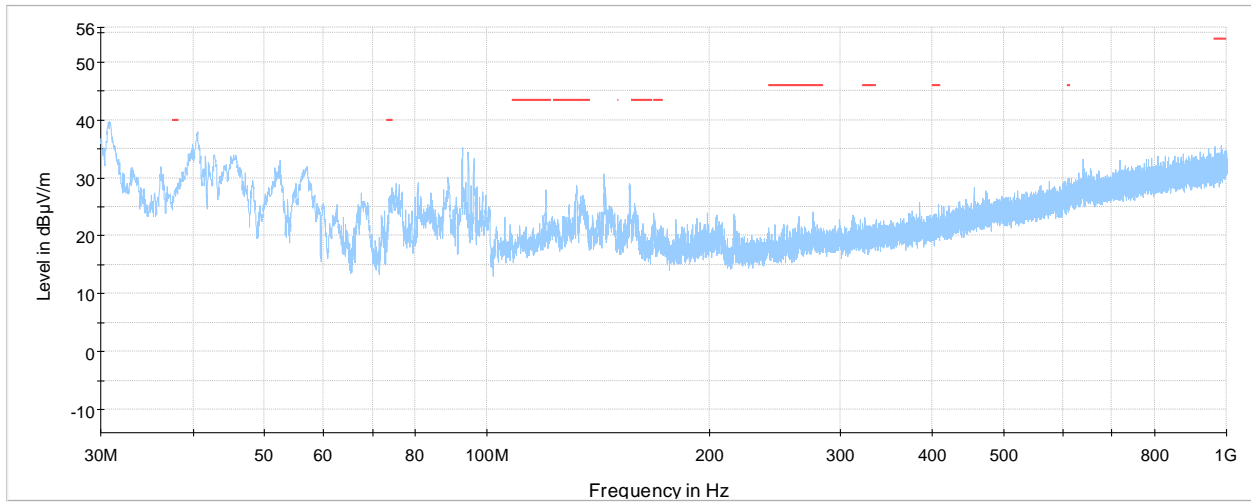


PRJ0030377 RE scan 30-1000 MHz 802_11b mid channel

- Preview Result 1-PK+
- ◆ PK+
- FCC 15.209 and RSS-210 limit line RstrB
- ◆ Final_Result QPK

Figure 8.2.4: Radiated spurious emissions on 30 MHz to 1 GHz (mid channel)

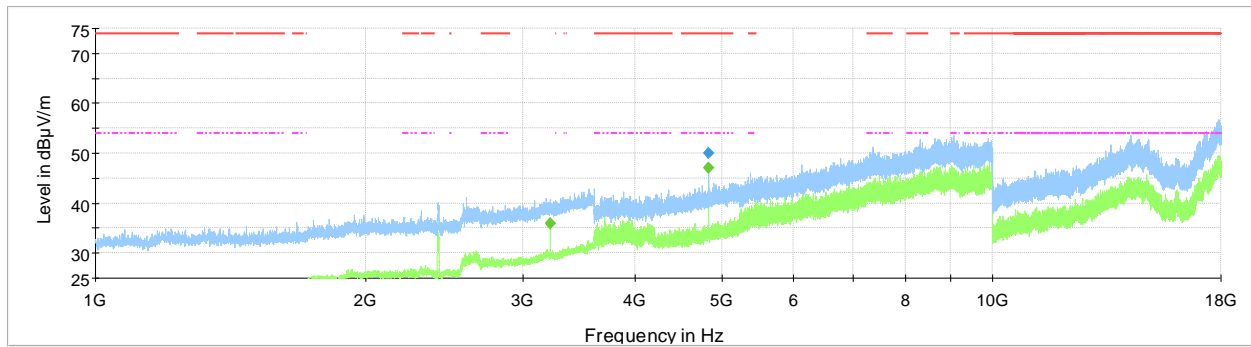
Test data, Continued



PRJ0030377 RE scan 30-1000 MHz 802_11b high channel

- Preview Result 1-PK+
- ◆ PK+
- FCC 15.209 and RSS-210 limit line RstrB
- ◆ Final_Result QPK

Figure 8.2.5: Radiated spurious emissions on 30 MHz to 1 GHz (high channel)

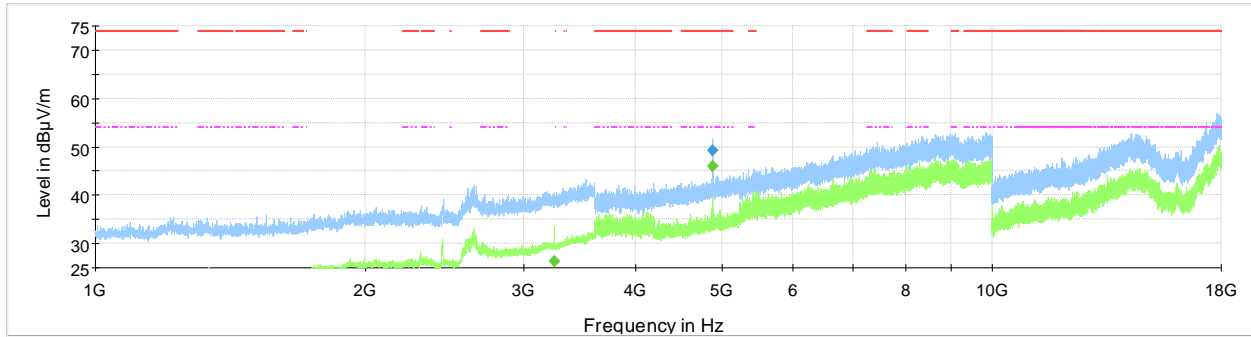


PRJ0030377 RE 1 GHz to 18 GHz scan 802_11b low channel

- Preview Result 2-AVG
- Preview Result 1-PK+
- FCC 15.209 and RSS-210 limit line RstrB pk
- FCC 15.209 and RSS-210 limit line RstrB
- ◆ Final_Result PK+
- ◆ Final_Result CAV

Figure 8.2.6: Radiated spurious emissions on 1-18 GHz (low channel)

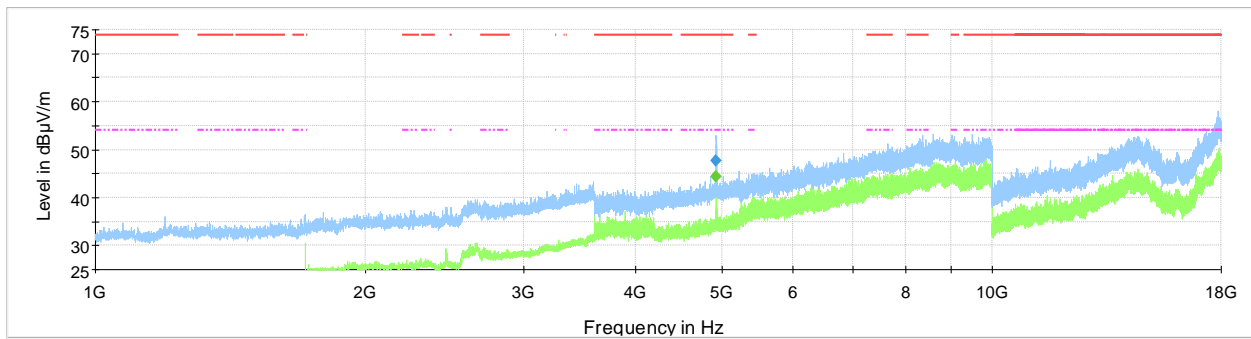
Test data, Continued



PRJ0030377 RE 1 GHz to 18 GHz scan 802_11b mid channel

- Preview Result 2-AVG
- Preview Result 1-PK+
- FCC 15.209 and RSS-210 limit line RstrB pk
- FCC 15.209 and RSS-210 limit line RstrB
- ◆ Final_Result PK+
- ◆ Final_Result CAV

Figure 8.2 7: Radiated spurious emissions on 1–18 GHz (mid channel)



PRJ0030377 RE 1 GHz to 18 GHz scan 802_11b high channel

- Preview Result 2-AVG
- Preview Result 1-PK+
- FCC 15.209 and RSS-210 limit line RstrB pk
- FCC 15.209 and RSS-210 limit line RstrB
- ◆ Final_Result PK+
- ◆ Final_Result CAV

Figure 8.2 8: Radiated spurious emissions on 1–18 GHz (high channel)

Test data, Continued

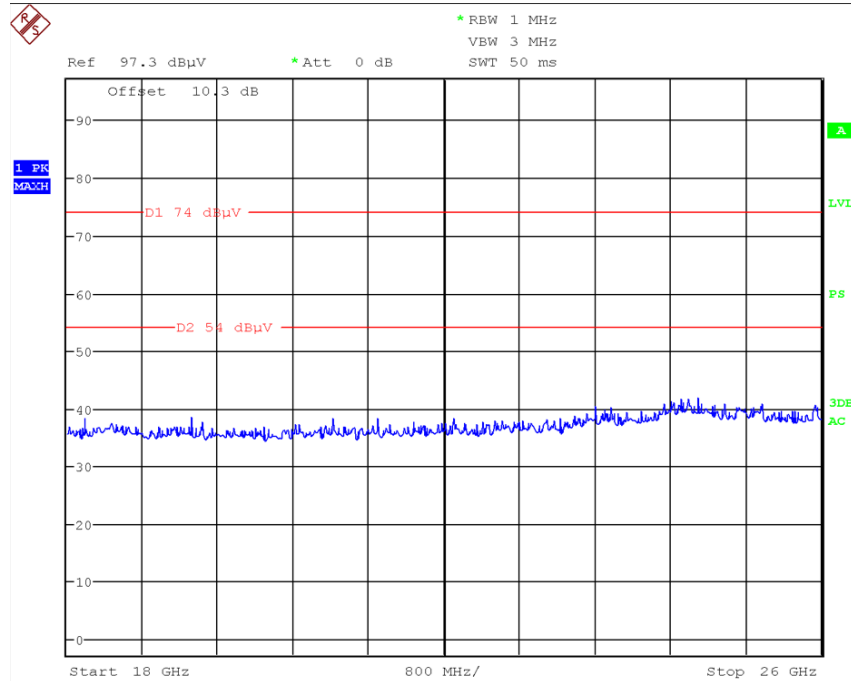


Figure 8.2.9: Radiated spurious emissions on 18–26 GHz (low channel)

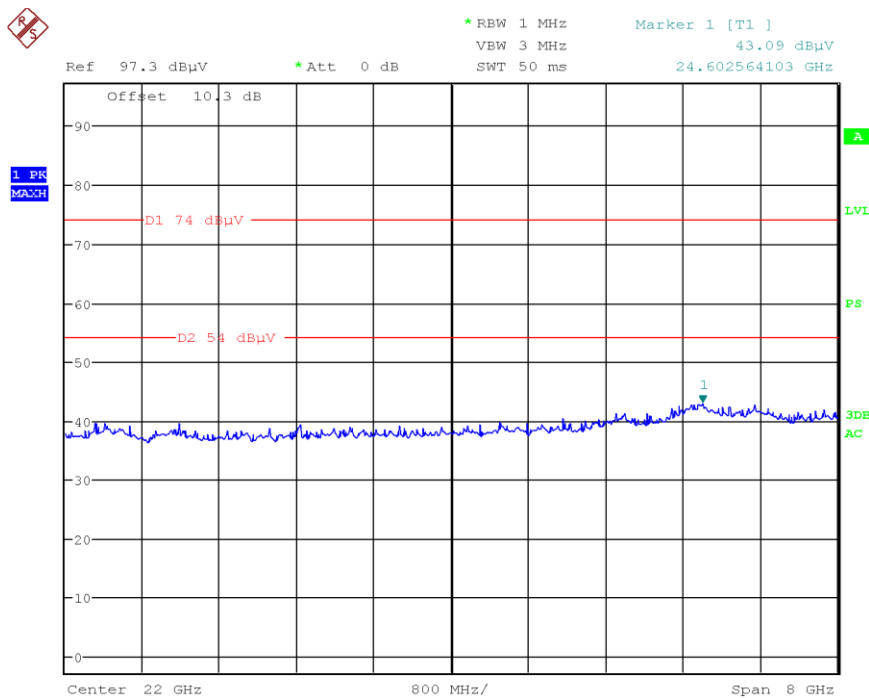
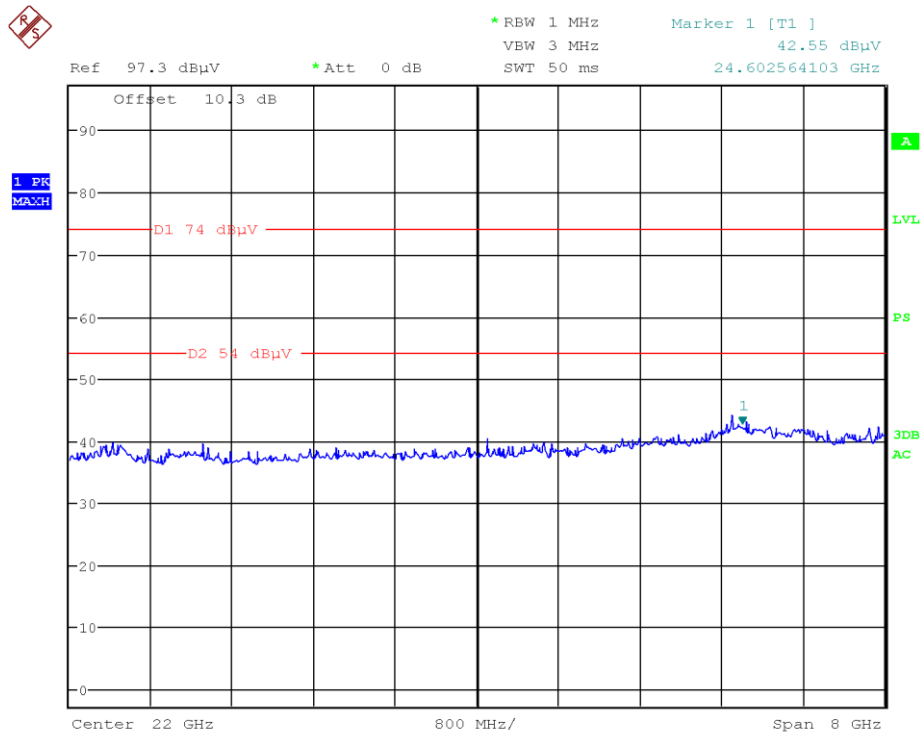


Figure 8.2.10: Radiated spurious emissions on 18–26 GHz (mid channel)

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Test data, Continued

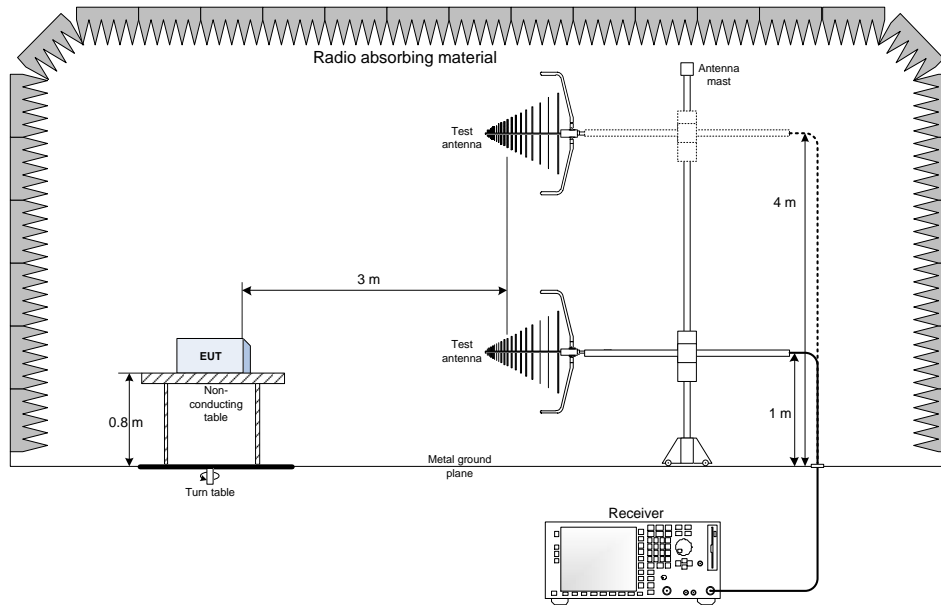


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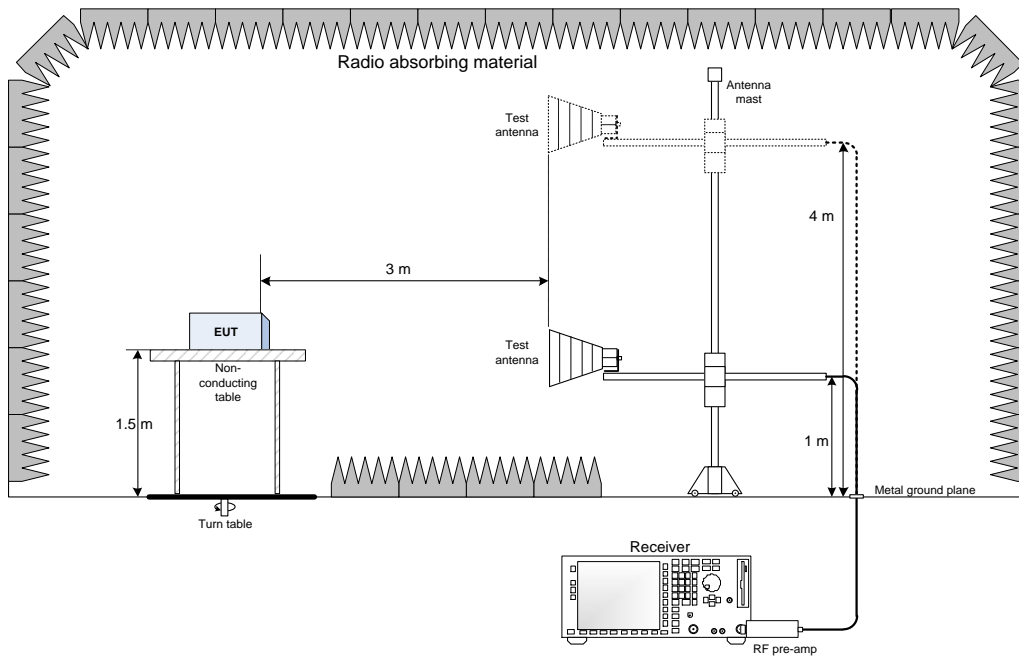
Figure 8.2 11: Radiated spurious emissions on 18–26 GHz (high channel)

Section 9 EUT setup diagrams

9.1 Radiated emissions set-up for frequencies below 1 GHz



9.2 Radiated emissions set-up for frequencies above 1 GHz



End of the test report