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Test report

419922-1R1TRFWL

Date of issue: March 23, 2021

Applicant:

Cuepath Innovation Inc.

Product:

Gateway

Model:

PREMO7V1.0

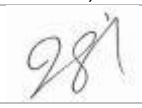
FCC ID: 2AY4L-CUESTICKER **IC: 27029-CUESTICKER**

Specifications:

- FCC 47 CFR Part 15, Subpart C – §15.247
- Industry Canada RSS-247, Issue 2

Lab and test locations

Company name	Nemko USA Inc.
Address	2210 Faraday Ave, Suite 150
City	Carlsbad
State	California
Postal code	92008
Country	USA
Telephone	+1 760 444 3500
Website	www.nemko.com
FCC Site Number	Test Firm Registration Number: 392943 Designation Number: US5058
ISED Test Site	2040B-3

Tested by	Martha Espinoza, Wireless Test Engineer
Reviewed by	James Cunningham, Wireless Supervisor
Review date	March 23, 2021
Reviewer signature	

Limits of responsibility

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

Copyright notification

Table of Contents

Section 1 Report summary

1.1 Applicant

Company name	Cuepath Innovation Inc.
Address	1200-555 West Hastings Street
City	Vancouver
Province/State	BC
Postal/Zip code	V6B4N6
Country	Canada

1.2 Manufacturer

Company name	Thirdwayv, Inc
Address	20 Pacifica Suite 420
City	Irvine
Province/State	CA
Postal/Zip code	92618
Country	USA

1.3 Test specifications

FCC 47 CFR Part 15, Subpart C – §15.247 IC RSS-247 Issue 2	Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

1.4 Test methods

ANSI C63.10-2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
558074 D01 DTS Measurement Guidance v03r02 (June 5, 2014)	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247

1.5 Exclusions

None

1.6 Statement of compliance

In the configuration tested, the EUT was found compliant.

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

1.7 Test report revision history

Table 1.7-1: *Test report revision history*

Revision #	Details of changes made to test report
419922-1R1TRFWL	Original report issued
419922-1R1TRFWL	Address and applicant name were changed by client request

Notes:

Section 2 Summary of test results

2.1 FCC Part 15 Subpart C, general requirements

Part	Test description	Verdict
§15.207(a)	Conducted limits	Not applicable[1]
§15.31(e)	Variation of power source	Pass
§15.203	Antenna requirement	Not applicable[2]

Notes: [1]EUT is battery power only
[2]EUT has an integrate antenna and it is not user accessible.

2.2 FCC Part 15.247

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

2.3 IC RSS-247, Issue 2

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

2.4 IC RSS-GEN, Issue 5

Part	Test description	Verdict
7.3	Receiver radiated emission limits	Pass
7.4	Receiver conducted emission limits	Not applicable
8.8	Power Line Conducted Emissions Limits for License-Exempt Radio Apparatus	Not applicable

Section 3 Equipment under test (EUT) details

3.1 Sample information

Receipt date	January 19, 2021
Nemko sample ID number	NEx: 419922

3.2 EUT information

Product name	Gateway
Model	PREMO7V1.0
Serial number	N/A
Part number	N/A

3.3 Technical information

Used IC test site(s) reg. number	N/A
RSS number and issue	RSS-247 issue 2 (February 2017)
Frequency band	2400 – 2483.5 MHz
Minimum frequency (MHz)	2402
Maximum frequency (MHz)	2480
Minimum output power (dBm)	1.77 dBm EIRP
Maximum output power (dBm)	1.84 dBm EIRP
Measured 6 dB bandwidth	2402 MHz: 695.76 kHz 2441 MHz: 707.634 kHz 2480 MHz: 714.275 kHz
Type of modulation	GFSK
Emission classification	N/A
Power requirements	Battery package (3 VDC)
Antenna information	0 dBi maximum antenna gain

3.4 EUT exercise and monitoring details

Conducted and radiated sample were configured through Tera Term terminal, where the fixed channel and max power were configured for each case: three channels, low, middle, and high. An UART interface was used to communicate the sample with the USB port.

3.5 EUT setup details

Table 3.5-1: *EUT sub assemblies*

Description	Brand name	Model/Part number	Serial number	Rev.
N/A	N/A	N/A	N/A	N/A

Table 3.5-2: *EUT interface ports*

Description	Qty.
N/A	--

3.5 EUT setup details continued

Table 3.5-1: *Support equipment*

Description	Brand name	Model/Part number	Serial number	Rev.
Laptop	Asus	UX305U	N/A	---
Switching adapter	N/A	SK90190237	N/A	--
FTDI Basic	Sparkfun	N/A	N/A	---

Table 3.5-2: *Inter-connection cables*

Cable description	From	To	Length (m)
USB Cable	Laptop	FTDI	1
Data and power cables	FTDI	EUT	0.20

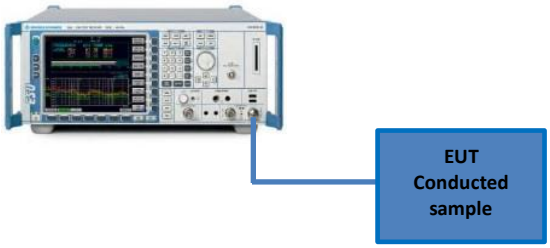


Figure 3.5-1: *Test conducted setup.*

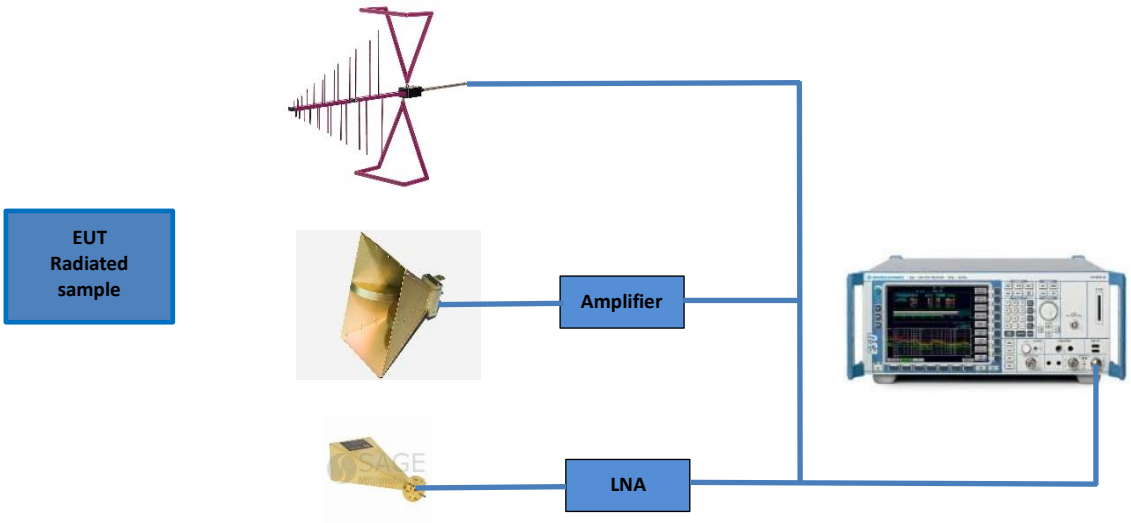


Figure 3.5-2: *Test radiated setup*

Section 4 Engineering considerations

4.1 Modifications incorporated in the EUT

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

4.2 Technical judgment

None

4.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures

Section 5 Test conditions

5.1 Atmospheric conditions

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

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

5.2 Power supply range

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

Section 6 Measurement uncertainty

6.1 Uncertainty of measurement

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

Test name	Measurement uncertainty, dB
All antenna port measurements/ including OBW	0.55
Conducted spurious emissions	1.13
Radiated spurious emissions	3.78
AC power line conducted emissions	1.38
Supply Voltages	0.05%
Time	2.09%

Table 6.1-1: *Measurement uncertainty.*

Important note: All testing in this document were done using the maximum radiation pattern from transmitter antenna for covering the worst case in all the measurements.

Section 7 Test Equipment

Table 7.1-1: *Test Equipment List*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
EMI Test Receiver	Rohde & Schwarz	ESU40	E1121	01 Dec 2020	01 Dec 2021
Spectrum analyzer	Rohde & Schwarz	FSV	E1120	19 Dec 2020	19 Dec 2021
System controller	Sunol sciences	SC104V	E1191	NCR	NCR
Power sensor	ETS Lindgren	7002-006	E1062	29 Oct 2020	29 Oct 2021
DRG Horn	ETS-Lindgren	3117-PA	E1139	21 March 2019	21 March 2021
Bilog Antenna	Schaffner	CBL6111C	1763	18 Feb 2020	18 Feb 2022
Antenna Horn	Sage	SAR-2309-42-S2	E1143	13 Nov 2020	13 Nov 2022
Low Noise Amplifier	Sage	SBL-1834034030-KFKF	E1228	NCR	NCR

Table 7.1-2: *Test Software*

Manufacturer of Software	Details
Rohde & Schwarz	EMC 32 V10.60.15

Section 8 Testing data

8.1 FCC 15.247(a)(2) and RSS-247 5.2(1) Minimum 6 dB bandwidth for systems using digital modulation techniques

8.1.1 Definition and limits

Title 47 → Chapter I → Subchapter A → Part 15 → Subpart C → §15.247(a)(2)
RSS-247 → §5.2(a)

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

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

8.1.2 Test summary

Verdict	Pass		
Test date	January 19, 2021	Temperature	21 °C
Test engineer	Martha Espinoza	Air pressure	1001 mbar
Test location	Wireless bench	Relative humidity	49 %

8.1.3 Notes

Testing was performed in BLE mode and the EUT transmitting on a fixed channel at full power. Cable losses where compensated using an offset of 2.0 dB.

8.1.4 Setup details

EUT setup configuration	Tabletop
Test facility	Wireless bench
Measurement method	ANSI C63.10 §11.8.1 using built-in marker function of the spectrum analyzer

Receiver/spectrum analyzer settings:

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

8.1.5 Test data

Table 8.1-1: *6 dB occupied bandwidth test data*

Test Frequency (MHz)	Bandwidth (kHz)	Limit (kHz)	Margin (kHz)
2402	695.760	> 500	195.760
2440	707.634	> 500	207.634
2480	714.275	> 500	214.275

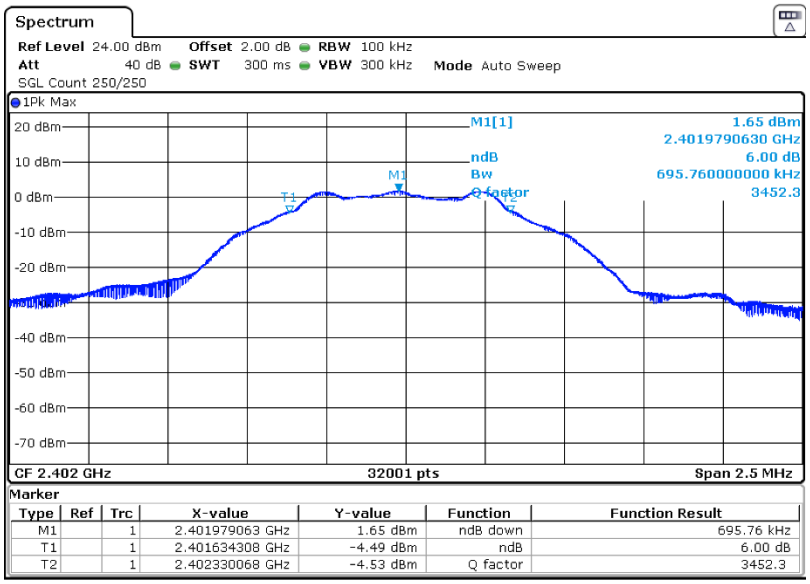


Figure 8.1-1: *6 dB occupied bandwidth, 2402 MHz*

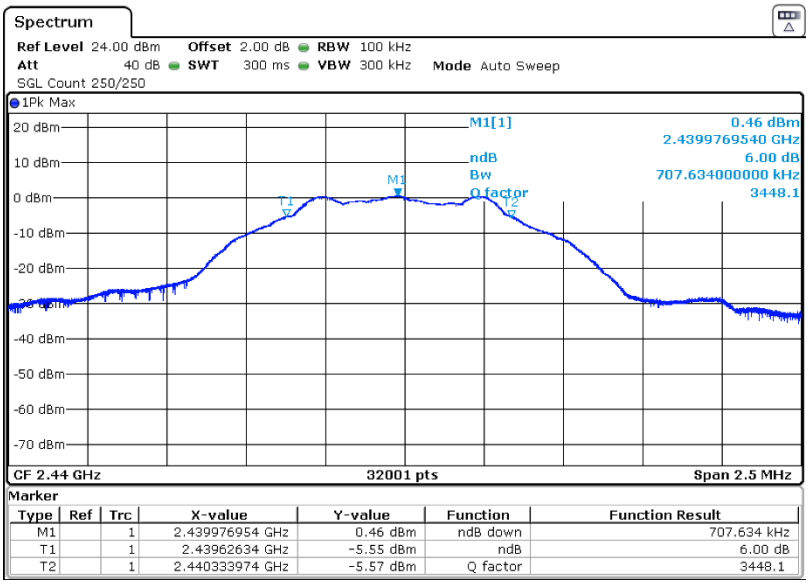


Figure 8.1-2: *6 dB occupied bandwidth, 2440 MHz*

FCC 15.247(a)(2) and RSS-247 5.2(1) Minimum 6 dB bandwidth for systems using digital modulation techniques

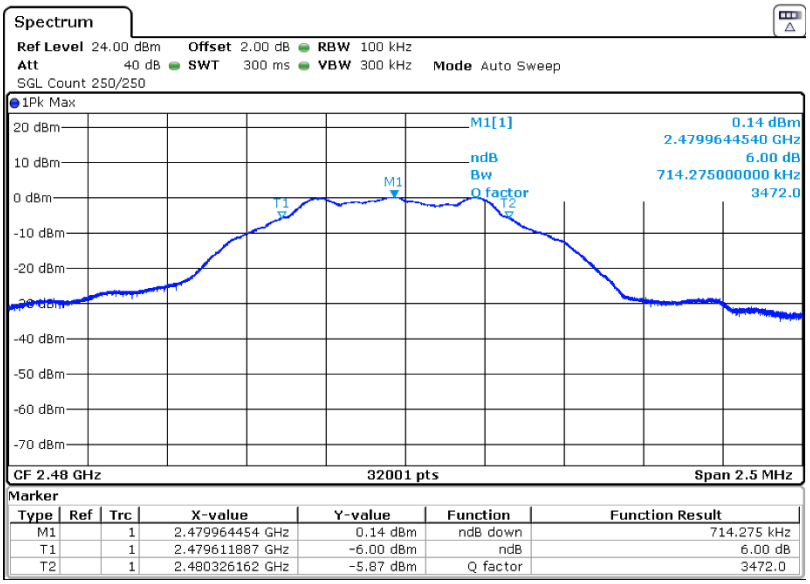


Figure 8.1-3: *6 dB occupied bandwidth, 2480 MHz*

8.2 FCC 15.247(b) and RSS-247 5.4 (4) Transmitter output power and E.I.R.P. requirements

8.2.1 Definition and limits

Title 47 → Chapter I → Subchapter A → Part 15 → Subpart C → §15.247(b)(2) / (3)

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

(3) For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 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.

(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 peak 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.

RSS-247 → §5.4(d)

(d) For DTSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1 W. The 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.

8.2.2 Test summary

Verdict	Pass		
Test date	January 19, 2021	Temperature	21 °C
Test engineer	Martha Espinoza	Air pressure	1001 mbar
Test location	Wireless bench	Relative humidity	49 %

8.2.3 Notes

Testing was performed in BLE mode and the EUT transmitting on a fixed channel at full power.
The antenna gain is 0 dBi per client declaration.

8.2.4 Setup details

EUT setup configuration	Tabletop
Test facility	Wireless bench
Measurement method	ANSI C63.10 §11.9.1.3

8.2.5 Test data

Table 8.2-1: *Output power*

Test Frequency (MHz)	Conducted Power (dBm)	Cable losses (dB)	Total conducted power (dBm)	Conducted Limit (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)
2402	1.27	0.5	1.77	30.0	0[1]	1.77	36.0
2441	1.34	0.5	1.84	30.0	0[1]	1.84	36.0
2480	1.29	0.5	1.79	30.0	0[1]	1.79	36.0

Note [1]: Maximum antenna gain declared by manufacturer (worst case).

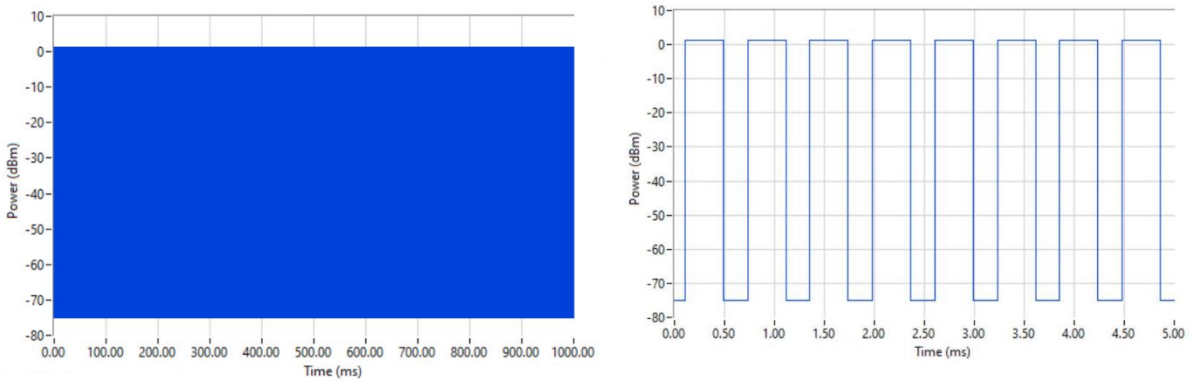


Figure 8.2-1: *Output power, 2402 MHz*

Maximum output power (dBm)	Medium Utilization (%)	Duty Cycle (%)
1.27	0.815	61.229

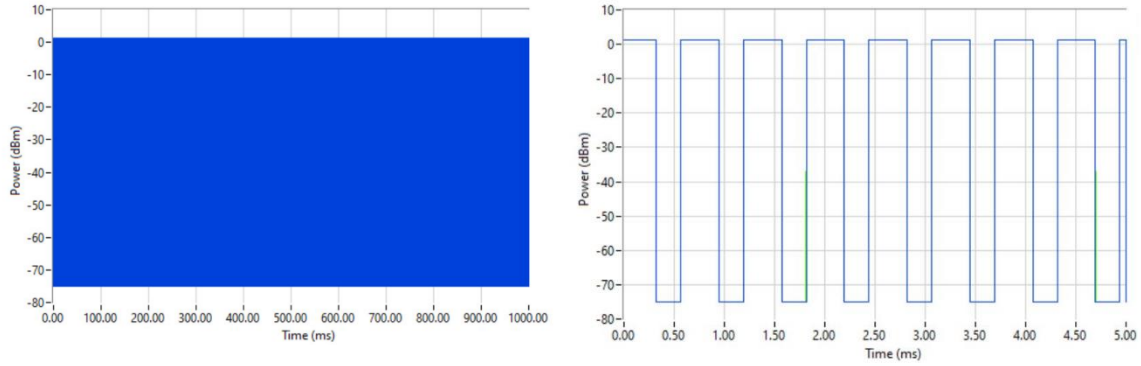


Figure 8.2-2: *Output power, 2440 MHz*

Maximum output power (dBm)	Medium Utilization (%)	Duty Cycle (%)
1.34	0.827	61.231

FCC 15.247(b) and RSS-247 5.4 (4) Transmitter output power and E.I.R.P. requirements

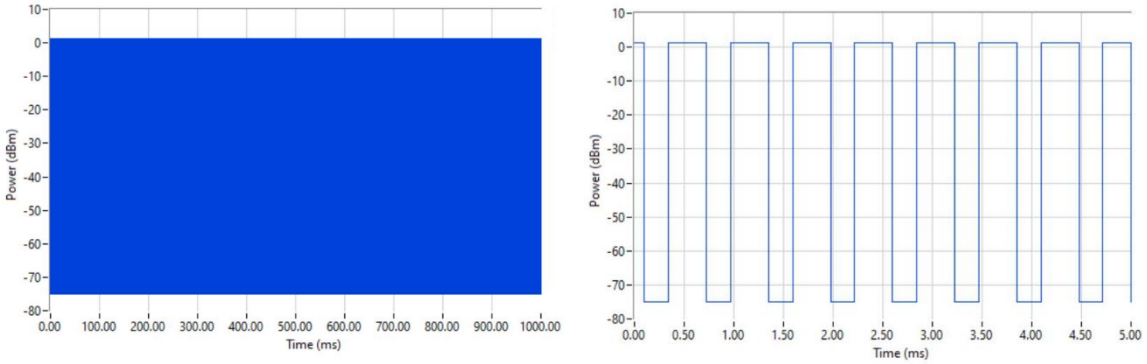


Figure 8.2-3: *Output power, 2480 MHz*

Maximum output power (dBm)	Medium Utilization (%)	Duty Cycle (%)
1.29	0.818	61.229

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

8.3.1 Definition and limits

Title 47 → Chapter I → Subchapter A → Part 15 → Subpart C → §15.247(d)

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

RSS-247 → §5.5

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

Table 8.3-1: *FCC §15.209– 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.

Table 8.3-2: *FCC restricted frequency bands*

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

8.3.2 Test summary

Verdict	Pass		
Test date	January 19, 2021 (conducted) November 20,21,22 2020 (radiated)	Temperature	21°C 22°C; 20°C; 23°C
Test engineer	Martha Espinoza	Air pressure	1001; 1003; 1000 mbar
Test location	Wireless bench 3m semi-anechoic chamber	Relative humidity	49; 50; 51 %

8.3.3 Notes

The EUT was configured to transmit continuously on the lowest, middle and highest channels.
The spectrum was search from 30 MHz to 26 GHz (above the 10th harmonic of the highest transmit frequency).
Radiated measurements were performed at a 3 m measurement distance.
For conducted measurements, the loss of the connected cable was input into the spectrum analyzer as 2.0 dB offset. The limit was calculated by subtracting 20 dB from the power spectral density measurements reported.
FCC 15.209 Limits are equivalent to FCC 15.247 Limits.

8.3.4 Setup details

EUT setup configuration	Tabletop
Test facility	Wireless bench
Measurement details	Measurement performed as per C63.10 §11.11

Spectrum analyzer settings for conducted spurious emissions:

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

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

Resolution bandwidth	120 kHz
Video bandwidth	300 kHz
Detector mode	Peak (preview measurements) Quasi-Peak (final measurements)
Trace mode	Max Hold
Measurement time	5 s (final measurements)

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

Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Detector mode	Average and peak (final measurements)
Trace mode	Max Hold
Measurement time	5 s (final measurements)

8.3.5 Test data

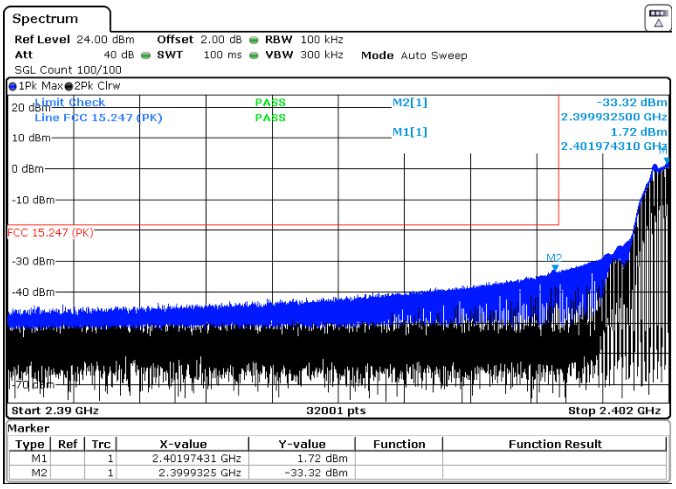


Figure 8.3-1: *Band edge measurement, low channel*

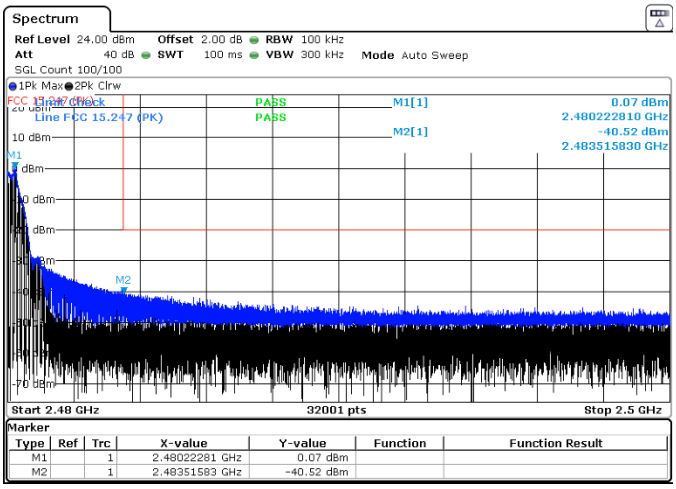


Figure 8.3-2: *Band edge measurement, high channel*

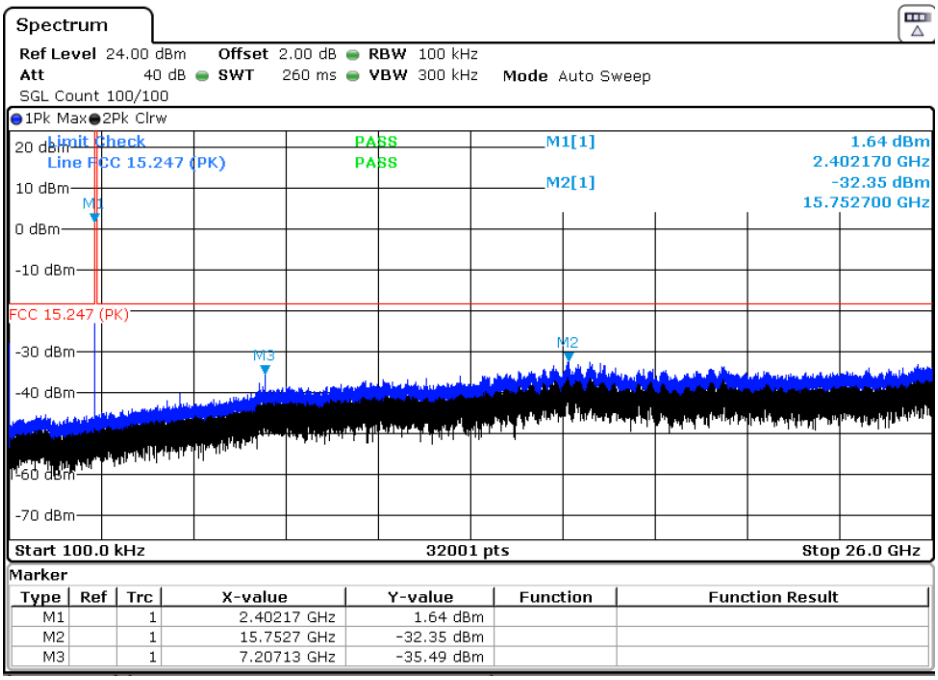


Figure 8.3-3: *Conducted spurious emissions, low channel (2402 MHz)*

Note: Peaks within 2400-2483.5MHz are transmitter fundamentals.

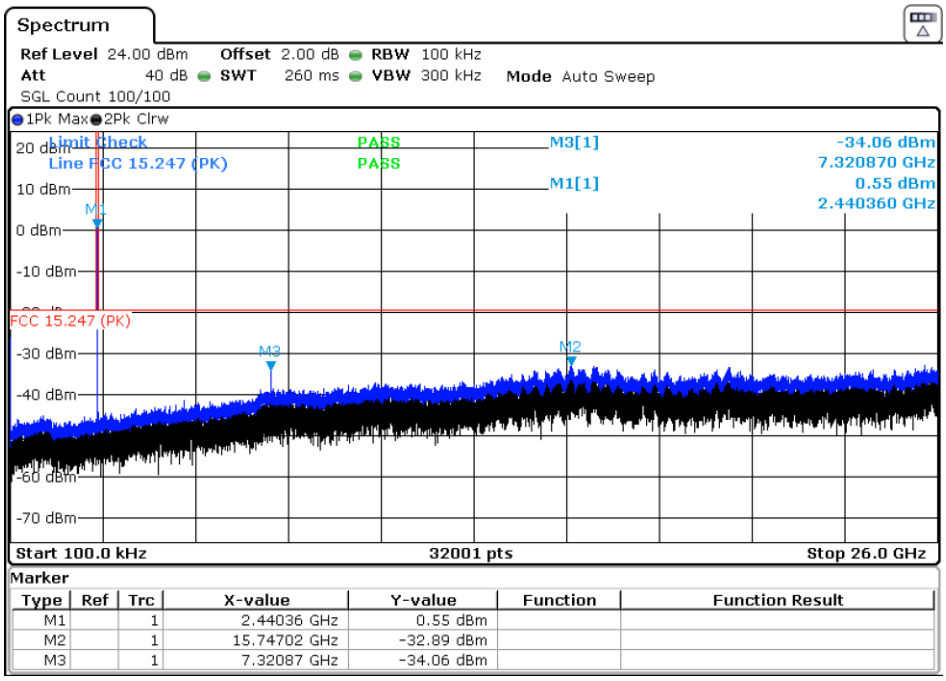


Figure 8.3-4: *Conducted spurious emissions, middle channel (2440 MHz)*

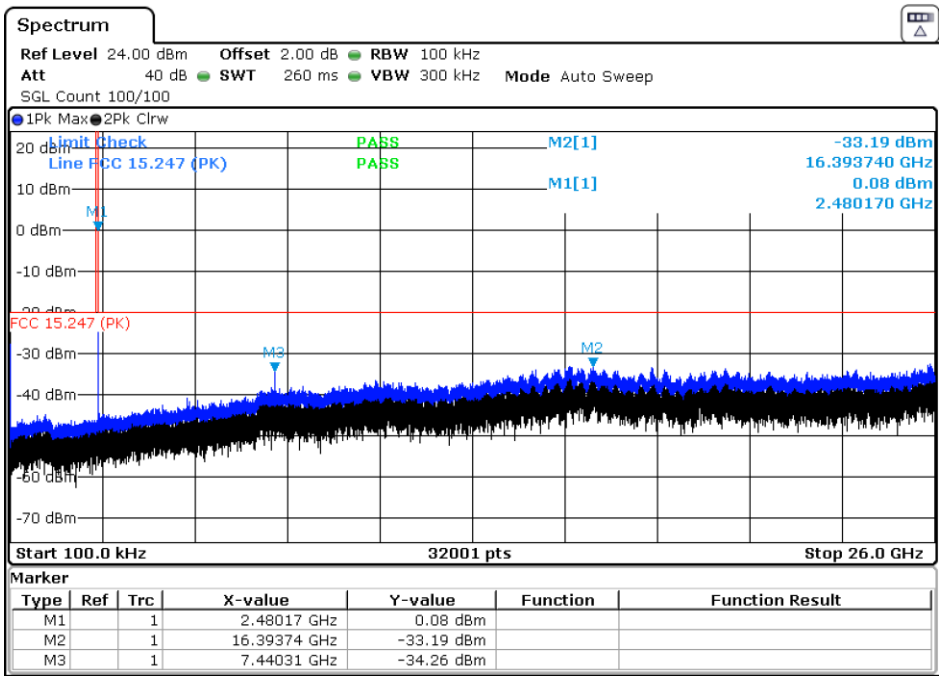


Figure 8.3-5: *Conducted spurious emissions, high channel (2480 MHz)*

Note: Peaks within 2400-2483.5MHz are transmitter fundamentals.

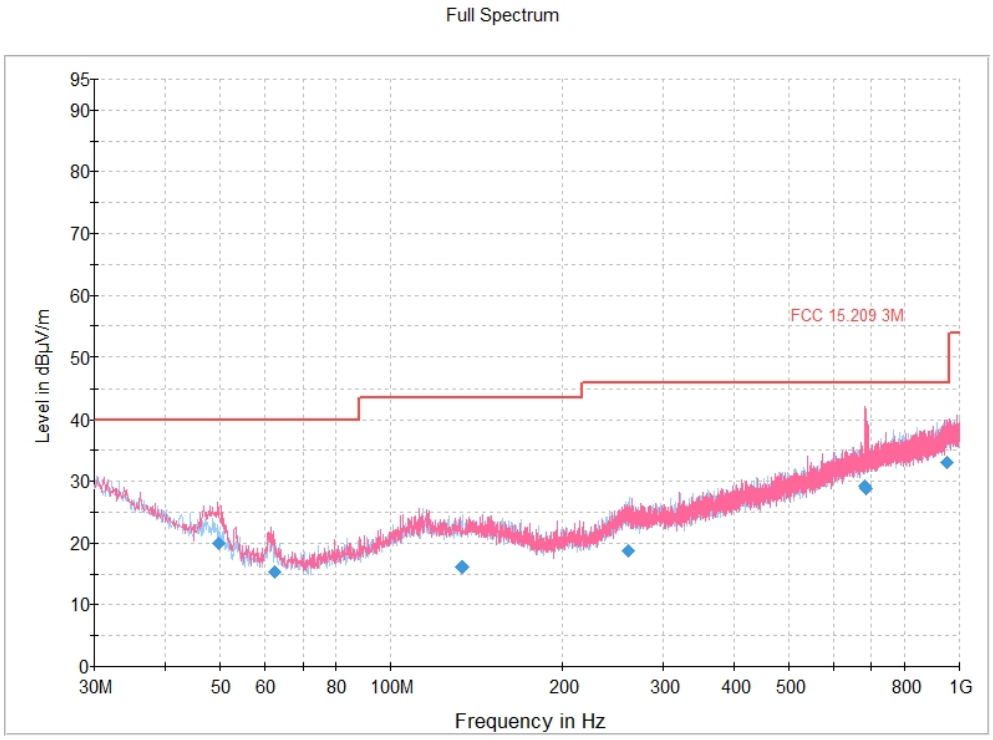


Figure 8.3-3: *Radiated emissions, low channel, 30 – 1000 MHz*

Table 8.3-3: *Radiated emissions, low channel, 30 – 1000 MHz*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
49.641250	19.90	40.00	20.10	5000.0	120.000	122.0	V	296.0	16.1
62.292500	15.30	40.00	24.70	5000.0	120.000	217.0	H	109.0	12.7
133.147500	16.14	43.50	27.36	5000.0	120.000	351.0	H	192.0	19.6
261.237500	18.83	46.00	27.17	5000.0	120.000	127.0	H	100.0	22.1
679.981250	29.26	46.00	16.74	5000.0	120.000	370.0	V	11.0	30.0
685.270000	28.81	46.00	17.19	5000.0	120.000	225.0	V	358.0	30.2
950.742500	32.99	46.00	13.01	5000.0	120.000	177.0	V	277.0	34.6

Notes:
Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB) Correction factors = antenna factor ACF (dB) + cable loss (dB).
Limits converted to dBµV/m and an inverse proportionality factor of 20 dB per decade has been used to normalize the specification limit to a measurement distance of 3 meters to determine compliance.

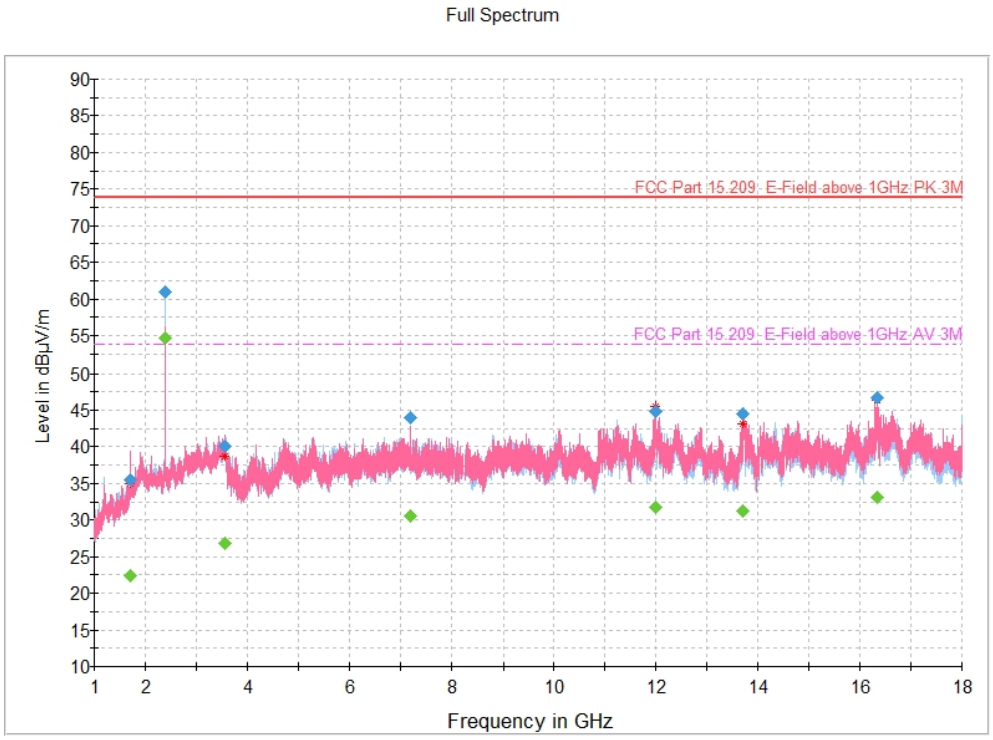


Figure 8.3-4: *Radiated emissions, low channel, 1 – 18 GHz*

Table 8.3-4: *Radiated emissions, low channel, 1 - 18 GHz*

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1718.066667	35.45	---	73.90	38.45	5000.0	1000.000	201.0	V	0.0	-12.7
1718.066667	---	22.40	53.90	31.50	5000.0	1000.000	201.0	V	0.0	-12.7
2401.766667	Low channel fundamental									
2401.766667	Low channel fundamental									
3575.333333	---	26.78	53.90	27.12	5000.0	1000.000	402.0	V	52.0	-5.4
3575.333333	40.15	---	73.90	33.75	5000.0	1000.000	402.0	V	52.0	-5.4
7206.766667	43.92	---	73.90	29.98	5000.0	1000.000	116.0	V	234.0	0.7
7206.766667	---	30.48	53.90	23.42	5000.0	1000.000	116.0	V	234.0	0.7
11982.266667	---	31.77	53.90	22.13	5000.0	1000.000	107.0	H	189.0	6.0
11982.266667	44.75	---	73.90	29.15	5000.0	1000.000	107.0	H	189.0	6.0
13712.100000	---	31.30	53.90	22.60	5000.0	1000.000	164.0	H	131.0	10.2
13712.100000	44.49	---	73.90	29.41	5000.0	1000.000	164.0	H	131.0	10.2
16347.466667	46.62	---	73.90	27.28	5000.0	1000.000	268.0	V	0.0	13.3
16347.466667	---	33.02	53.90	20.88	5000.0	1000.000	268.0	V	0.0	13.3

Notes:
The marked row as low channel fundamental is the wanted frequency of the transmitter and is not evaluated against the limits.
Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
Correction factors = antenna factor ACF (dB) + cable loss (dB)
Limits converted to dBµV/m and an inverse proportionality factor of 20 dB per decade has been used to normalize the specification limit to a measurement distance of 3 meters to determine compliance.
A 2.4 GHz filter was used to protect the receiver system.

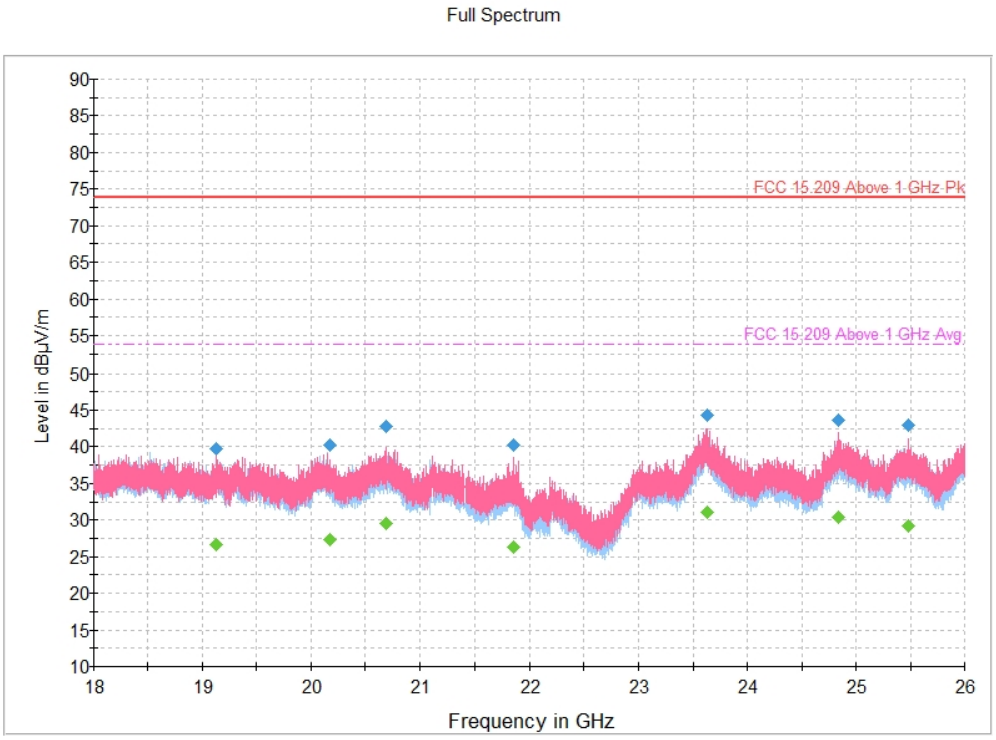


Figure 8.3-5: *Radiated emissions, low channel, 18 - 26 GHz*

Table 8.3-5: *Radiated emissions, low channel, 18 - 26 GHz*

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
19125.666667	39.75	---	73.90	34.15	5000.0	1000.000	394.0	V	180.0	17.7
19125.666667	---	26.64	53.90	27.26	5000.0	1000.000	394.0	V	180.0	17.7
20167.933333	40.29	---	73.90	33.61	5000.0	1000.000	137.0	H	273.0	18.0
20167.933333	---	27.29	53.90	26.61	5000.0	1000.000	137.0	H	273.0	18.0
20687.266667	---	29.57	53.90	24.33	5000.0	1000.000	288.0	V	98.0	20.5
20687.266667	42.84	---	73.90	31.06	5000.0	1000.000	288.0	V	98.0	20.5
21853.800000	40.27	---	73.90	33.63	5000.0	1000.000	139.0	V	354.0	19.4
21853.800000	---	26.35	53.90	27.55	5000.0	1000.000	139.0	V	354.0	19.4
23636.066667	---	30.98	53.90	22.92	5000.0	1000.000	327.0	V	350.0	23.6
23636.066667	44.26	---	73.90	29.64	5000.0	1000.000	327.0	V	350.0	23.6
24837.666667	43.71	---	73.90	30.19	5000.0	1000.000	366.0	V	0.0	22.6
24837.666667	---	30.37	53.90	23.53	5000.0	1000.000	366.0	V	0.0	22.6
25479.666667	---	29.28	53.90	24.62	5000.0	1000.000	98.0	V	258.0	22.4
25479.666667	42.90	---	73.90	31.00	5000.0	1000.000	98.0	V	258.0	22.4

Notes:
Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
Correction factors = antenna factor ACF (dB) + cable loss (dB)
Limits converted to dBµV/m and an inverse proportionality factor of 20 dB per decade has been used to normalize the specification limit to a measurement distance of 3 meters to determine compliance.

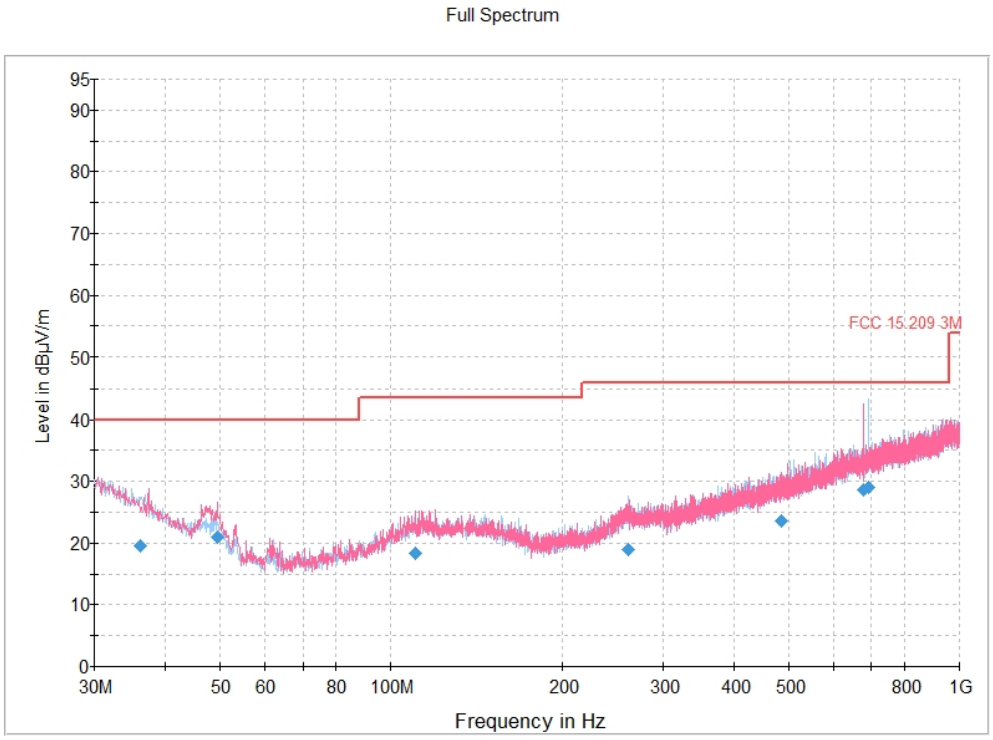


Figure 8.3-6: *Radiated emissions, middle channel, 30 – 1000 MHz*

Table 8.3-6: *Radiated emissions, middle channel, 30 – 1000 MHz*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
36.076250	19.57	40.00	20.43	5000.0	120.000	232.0	V	358.0	23.2
49.560000	21.00	40.00	19.00	5000.0	120.000	100.0	V	92.0	16.1
110.347500	18.39	43.50	25.11	5000.0	120.000	257.0	H	70.0	18.8
260.655000	18.92	46.00	27.08	5000.0	120.000	410.0	H	100.0	22.1
486.347500	23.55	46.00	22.45	5000.0	120.000	241.0	V	245.0	26.9
678.365000	28.62	46.00	17.38	5000.0	120.000	226.0	V	203.0	29.9
692.668750	29.09	46.00	16.91	5000.0	120.000	233.0	H	315.0	30.4

Notes:
Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
Correction factors = antenna factor ACF (dB) + cable loss (dB)
Limits converted to dBµV/m and an inverse proportionality factor of 20 dB per decade has been used to normalize the specification limit to a measurement distance of 3 meters to determine compliance.

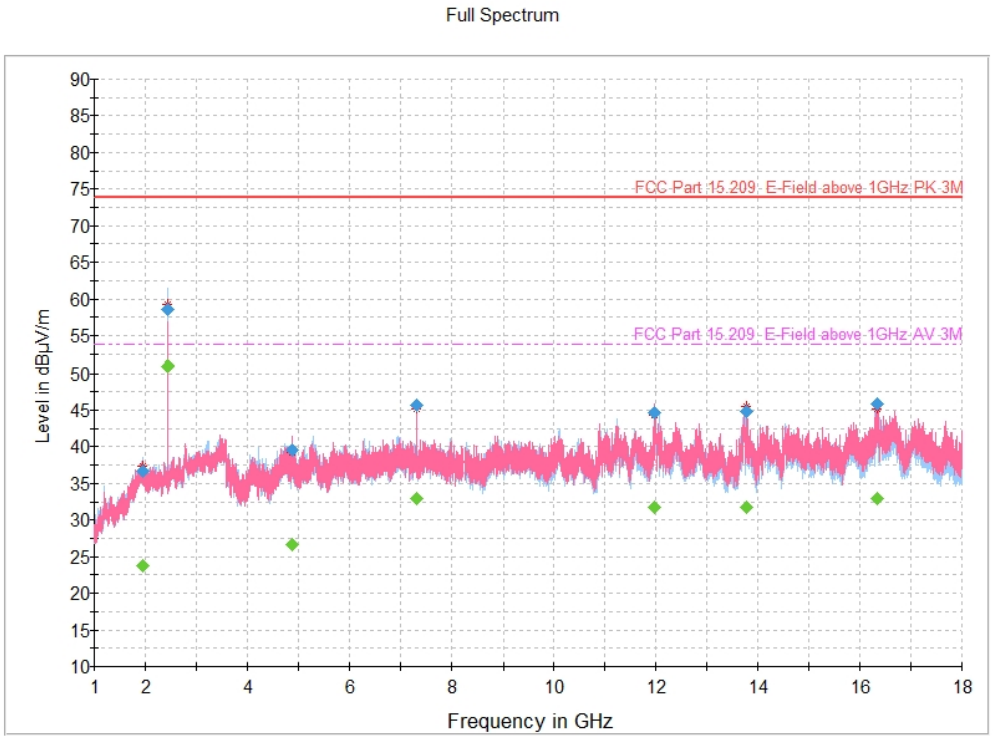


Figure 8.3-7: *Radiated emissions, middle channel, 1 - 18 GHz*

Table 8.3-7: *Radiated emissions, middle channel, 1 - 18 GHz*

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1950.133333	36.74	---	73.90	37.16	5000.0	1000.000	293.0	H	329.0	-10.5
1950.133333	---	23.79	53.90	30.11	5000.0	1000.000	293.0	H	329.0	-10.5
2440.300000	Middle channel fundamental									
2440.300000	Middle channel fundamental									
4877.400000	---	26.64	53.90	27.26	5000.0	1000.000	116.0	V	317.0	-1.9
4877.400000	39.52	---	73.90	34.38	5000.0	1000.000	116.0	V	317.0	-1.9
7320.666667	---	32.87	53.90	21.03	5000.0	1000.000	136.0	V	240.0	0.8
7320.666667	45.73	---	73.90	28.17	5000.0	1000.000	136.0	V	240.0	0.8
11976.000000	44.61	---	73.90	29.29	5000.0	1000.000	135.0	V	101.0	6.0
11976.000000	---	31.68	53.90	22.22	5000.0	1000.000	135.0	V	101.0	6.0
13782.400000	44.80	---	73.90	29.10	5000.0	1000.000	185.0	V	209.0	10.7
13782.400000	---	31.75	53.90	22.15	5000.0	1000.000	185.0	V	209.0	10.7
16348.300000	---	32.92	53.90	20.98	5000.0	1000.000	402.0	V	253.0	13.3
16348.300000	45.86	---	73.90	28.04	5000.0	1000.000	402.0	V	253.0	13.3

Notes:
The marked row as middle channel fundamental is the wanted frequency of the transmitter and is not evaluated against the limits.
Field strength (dB⍰V/m) = receiver/spectrum analyzer value (dB⍰V) + correction factor (dB)
Correction factors = antenna factor ACF (dB) + cable loss (dB)
Limits converted to dBµV/m and an inverse proportionality factor of 20 dB per decade has been used to normalize the specification limit to a measurement distance of 3 meters to determine compliance.
A 2.4 GHz filter was used to protect the receiver system.

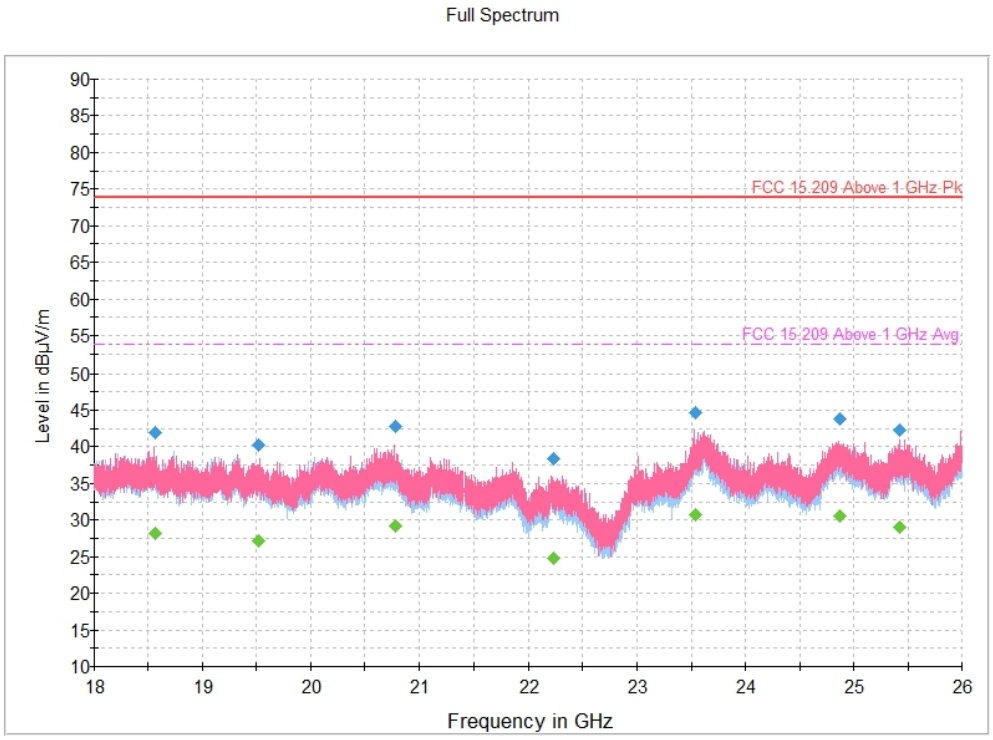


Figure 8.3-8: *Radiated emissions, middle channel, 18 - 26 GHz*

Table 8.3-8: *Radiated emissions, middle channel, 18 - 26 GHz*

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
18561.400000	41.92	---	73.90	31.98	5000.0	1000.000	284.0	V	170.0	18.3
18561.400000	---	28.11	53.90	25.79	5000.0	1000.000	284.0	V	170.0	18.3
19514.733333	40.16	---	73.90	33.74	5000.0	1000.000	216.0	V	11.0	17.6
19514.733333	---	27.17	53.90	26.73	5000.0	1000.000	216.0	V	11.0	17.6
20778.200000	---	29.26	53.90	24.64	5000.0	1000.000	402.0	V	53.0	20.0
20778.200000	42.84	---	73.90	31.06	5000.0	1000.000	402.0	V	53.0	20.0
22234.600000	38.41	---	73.90	35.49	5000.0	1000.000	391.0	H	320.0	19.5
22234.600000	---	24.71	53.90	29.19	5000.0	1000.000	391.0	H	320.0	19.5
23535.400000	44.61	---	73.90	29.29	5000.0	1000.000	220.0	V	348.0	23.7
23535.400000	---	30.68	53.90	23.22	5000.0	1000.000	220.0	V	348.0	23.7
24873.933333	43.73	---	73.90	30.17	5000.0	1000.000	356.0	V	338.0	22.7
24873.933333	---	30.54	53.90	23.36	5000.0	1000.000	356.0	V	338.0	22.7
25426.466667	42.27	---	73.90	31.63	5000.0	1000.000	402.0	V	225.0	22.2
25426.466667	---	29.08	53.90	24.82	5000.0	1000.000	402.0	V	225.0	22.2

Notes:
Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
Correction factors = antenna factor ACF (dB) + cable loss (dB)
Limits converted to dBµV/m and an inverse proportionality factor of 20 dB per decade has been used to normalize the specification limit to a measurement distance of 3 meters to determine compliance.

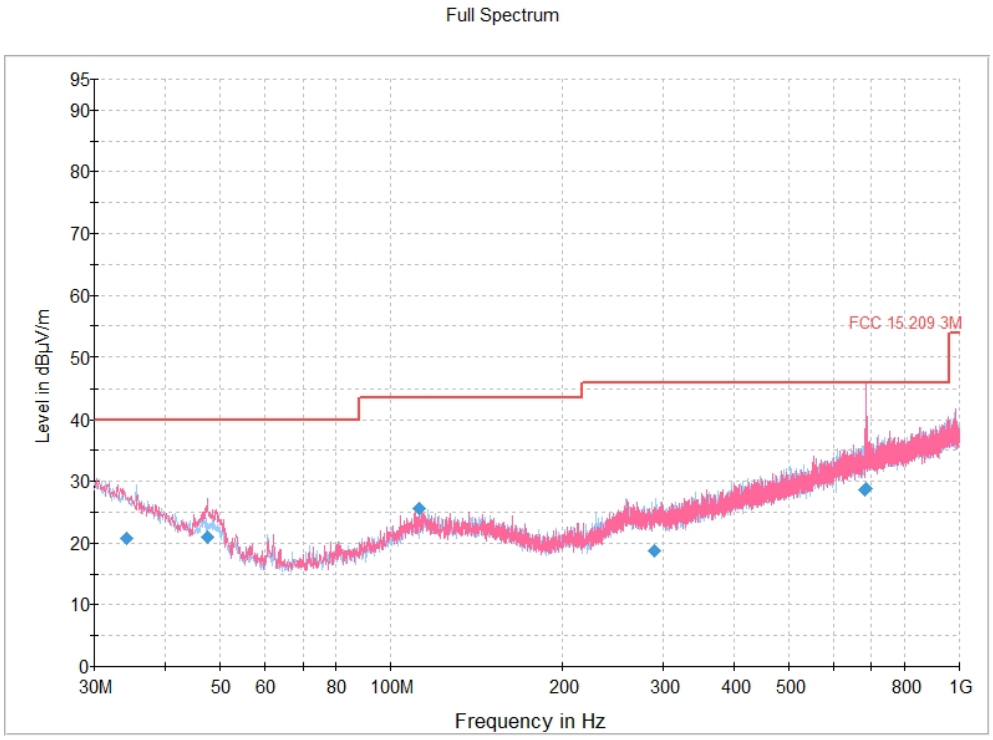


Figure 8.3-9: *Radiated emissions, high channel, 30 – 1000 MHz*

Table 8.3-9: *Radiated emissions, high channel, 30 – 1000 MHz*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
34.297500	20.74	40.00	19.26	5000.0	120.000	274.0	H	356.0	24.1
47.460000	20.90	40.00	19.10	5000.0	120.000	119.0	V	39.0	17.1
112.005000	25.55	43.50	17.95	5000.0	120.000	402.0	V	196.0	18.9
289.408750	18.69	46.00	27.31	5000.0	120.000	303.0	H	166.0	21.6
681.691250	28.71	46.00	17.29	5000.0	120.000	344.0	V	174.0	30.0
683.948750	28.78	46.00	17.22	5000.0	120.000	373.0	V	138.0	30.2

Notes:
Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
Correction factors = antenna factor ACF (dB) + cable loss (dB)
Limits converted to dBµV/m and an inverse proportionality factor of 20 dB per decade has been used to normalize the specification limit to a measurement distance of 3 meters to determine compliance.

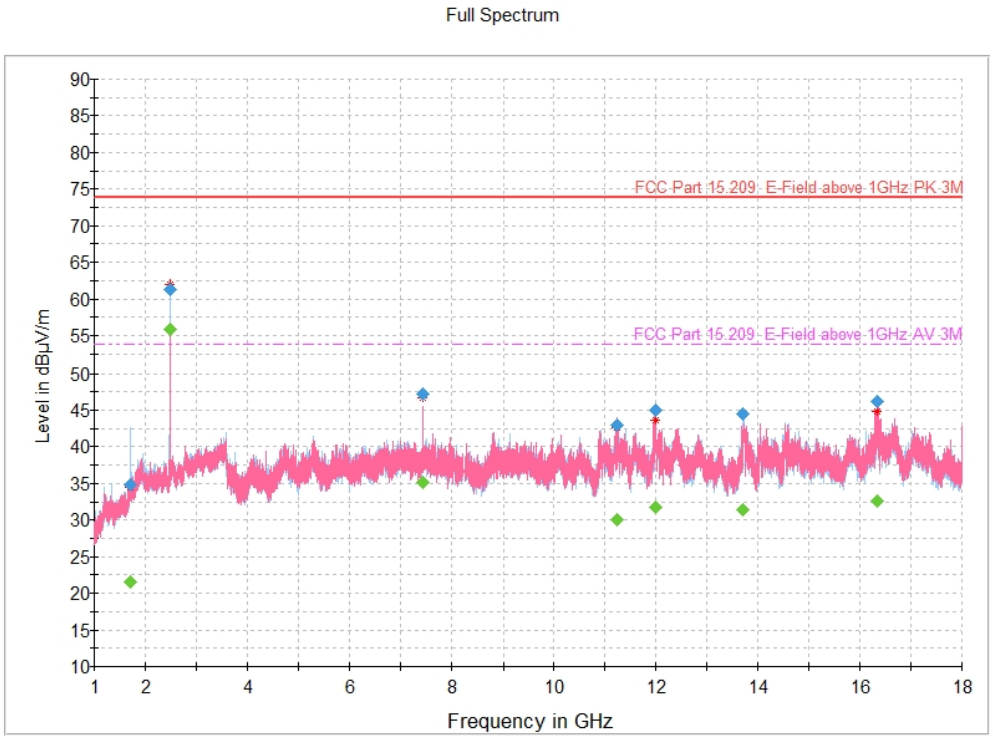


Figure 8.3-10: *Radiated emissions, high channel, 1 - 18 GHz*

Table 8.3-10: *Radiated emissions, high channel, 1 - 18 GHz*

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1710.366667	---	21.52	53.90	32.38	5000.0	1000.000	311.0	H	343.0	-12.8
1710.366667	34.73	---	73.90	39.17	5000.0	1000.000	311.0	H	343.0	-12.8
2479.966667	High channel fundamental									
2479.966667	High channel fundamental									
7439.200000	47.12	---	73.90	26.78	5000.0	1000.000	145.0	V	240.0	1.3
7439.200000	---	35.15	53.90	18.75	5000.0	1000.000	145.0	V	240.0	1.3
11239.566667	---	30.05	53.90	23.85	5000.0	1000.000	243.0	V	0.0	4.6
11239.566667	42.92	---	73.90	30.98	5000.0	1000.000	243.0	V	0.0	4.6
11979.566667	---	31.67	53.90	22.23	5000.0	1000.000	410.0	H	0.0	6.0
11979.566667	44.91	---	73.90	28.99	5000.0	1000.000	410.0	H	0.0	6.0
13701.500000	---	31.36	53.90	22.54	5000.0	1000.000	305.0	H	131.0	10.1
13701.500000	44.46	---	73.90	29.44	5000.0	1000.000	305.0	H	131.0	10.1
16348.900000	---	32.62	53.90	21.28	5000.0	1000.000	116.0	V	68.0	13.3
16348.900000	46.14	---	73.90	27.76	5000.0	1000.000	116.0	V	68.0	13.3

Notes:

The marked row as high channel fundamental is the wanted frequency of the transmitter and is not evaluated against the limits.
Field strength (dB⍰V/m) = receiver/spectrum analyzer value (dB⍰V) + correction factor (dB)
Correction factors = antenna factor ACF (dB) + cable loss (dB)
Limits converted to dBµV/m and an inverse proportionality factor of 20 dB per decade has been used to normalize the specification limit to a measurement distance of 3 meters to determine compliance.
A 2.4 GHz filter was used to protect the receiver system.

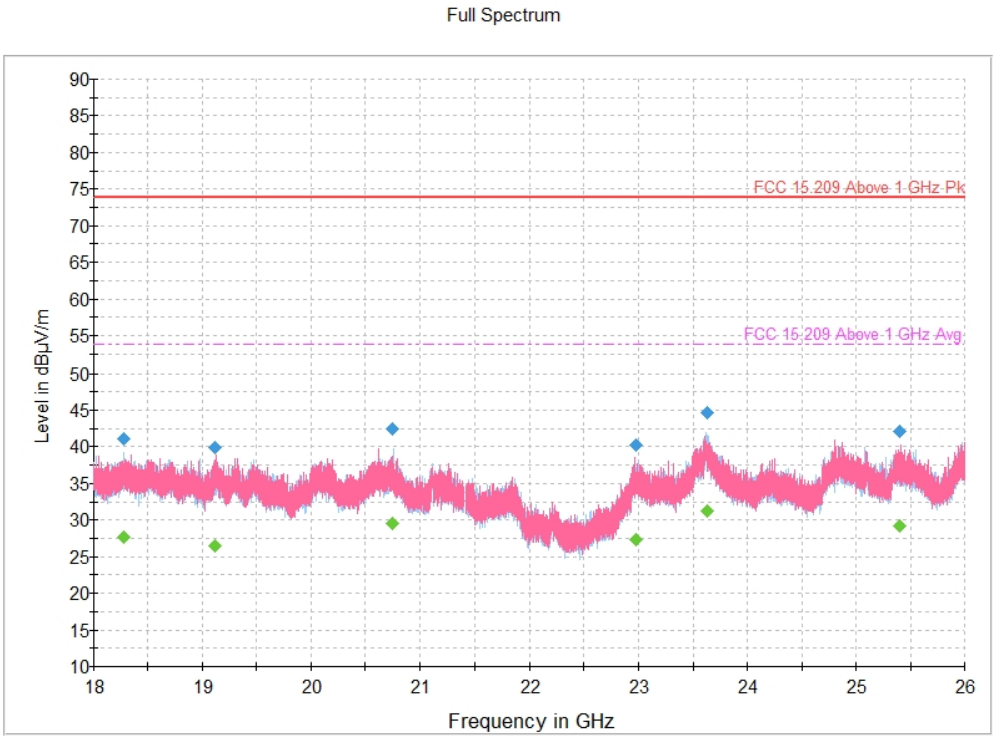


Figure 8.3-11: *Radiated emissions, high channel, 18 - 26 GHz*

Table 8.3-11: *Radiated emissions, high channel, 18 - 26 GHz*

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
18277.933333	---	27.74	53.90	26.16	5000.0	1000.000	410.0	H	53.0	17.0
18277.933333	41.15	---	73.90	32.75	5000.0	1000.000	410.0	H	53.0	17.0
19115.666667	---	26.47	53.90	27.43	5000.0	1000.000	332.0	V	116.0	17.7
19115.666667	39.82	---	73.90	34.08	5000.0	1000.000	332.0	V	116.0	17.7
20747.133333	---	29.51	53.90	24.39	5000.0	1000.000	195.0	H	39.0	20.3
20747.133333	42.49	---	73.90	31.41	5000.0	1000.000	195.0	H	39.0	20.3
22971.533333	---	27.25	53.90	26.65	5000.0	1000.000	187.0	V	285.0	20.6
22971.533333	40.23	---	73.90	33.67	5000.0	1000.000	187.0	V	285.0	20.6
23628.066667	---	31.30	53.90	22.60	5000.0	1000.000	136.0	H	200.0	23.6
23628.066667	44.70	---	73.90	29.20	5000.0	1000.000	136.0	H	200.0	23.6
25404.066667	---	29.11	53.90	24.79	5000.0	1000.000	254.0	V	0.0	22.2
25404.066667	42.11	---	73.90	31.79	5000.0	1000.000	254.0	V	0.0	22.2

Notes:
Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
Correction factors = antenna factor ACF (dB) + cable loss (dB)
Limits converted to dBµV/m and an inverse proportionality factor of 20 dB per decade has been used to normalize the specification limit to a measurement distance of 3 meters to determine compliance.

8.4 FCC 15.247(e) and RSS-247 5.2(b) Power spectral density of digital transmission system

8.4.1 Definition and limits

Title 47 → Chapter I → Subchapter A → Part 15 → Subpart C → §15.247(e) / ANSI C63.10: 2013

(e) For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this Section. The same method of determining the conducted output power shall be used to determine the power spectral density.

RSS-247 → §5.2(b)

(b) The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of Section 5.4(4), (i.e. the power spectral density shall be determined using the same method as is used to determine the conducted output power).

8.4.2 Test summary

Verdict	Pass		
Test date	January 19, 2021	Temperature	21 °C
Test engineer	Martha Espinoza	Air pressure	1001 mbar
Test location	Wireless bench	Relative humidity	49 %

8.4.3 Notes

Testing was performed in BLE mode and the EUT transmitting on a fixed channel at full power.
The EUT antenna port was connected to the spectrum analyzer via low loss cable. The cable loss was corrected for 1.5 dB offset in the spectrum analyzer.

8.4.4 Setup details

EUT setup configuration	Tabletop
Test facility	Wireless bench
Measurement details	Measurement performed as per C63.10 §11.10.2 (Method PKPSD)

Receiver/spectrum analyzer settings:

Resolution bandwidth	100 kHz (3 kHz ≤ RBW ≤ 100 kHz) (Worst case)
Video bandwidth	300 kHz (≥ 3 x RBW)
Frequency span	1.5 x DTS bandwidth
Detector mode	Peak
Trace mode	Max hold

8.4.5 Test data

Table 8.4-1: *Power spectral density of DTS*

Transmitter Frequency (MHz)	Measured Level (dBm/100 kHz)	Limit (dBm/3 kHz)	Margin (dB)
2400	1.67	8.00	6.33
2440	0.48	8.00	7.52
2480	0.17	8.00	7.83

Notes: None

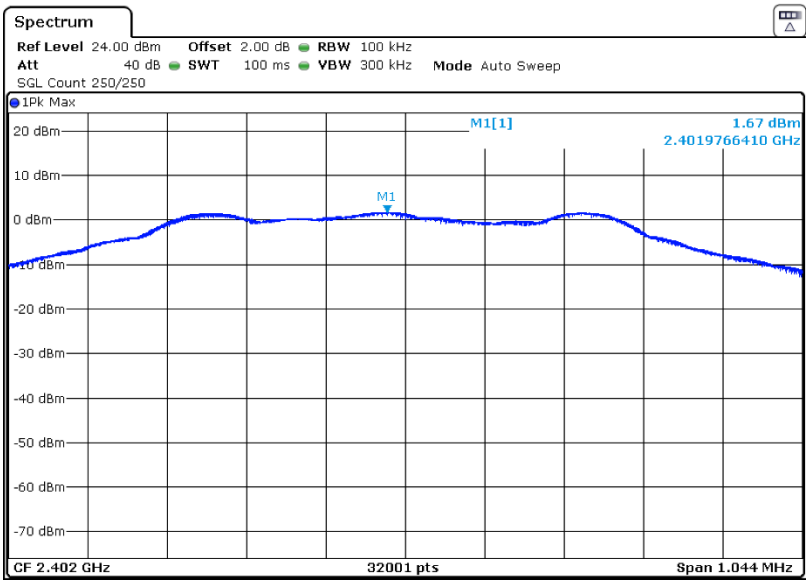


Figure 8.4-1: *Power spectral density of digital transmission system, 2402 MHz*

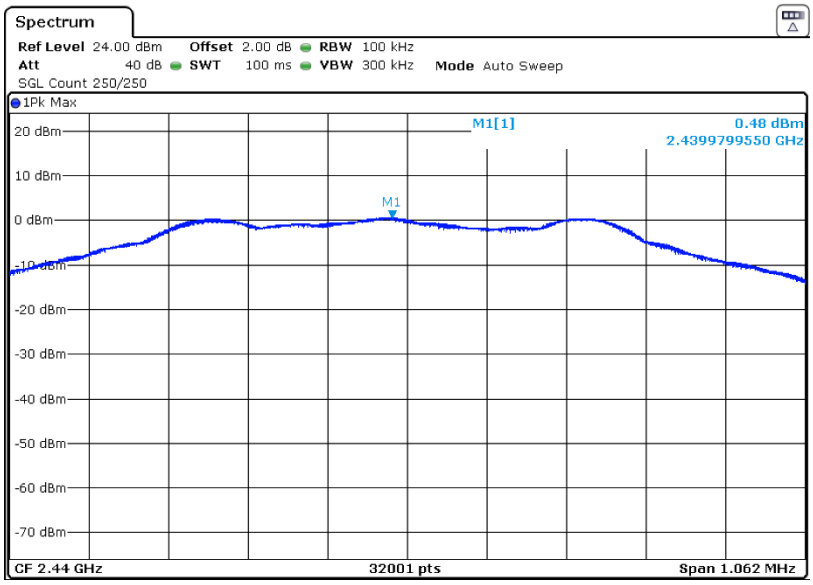


Figure 8.4-2: *Power spectral density of digital transmission system, 2440 MHz*

FCC 15.247(e) and RSS-247 5.2(b) Power spectral density of digital transmission system

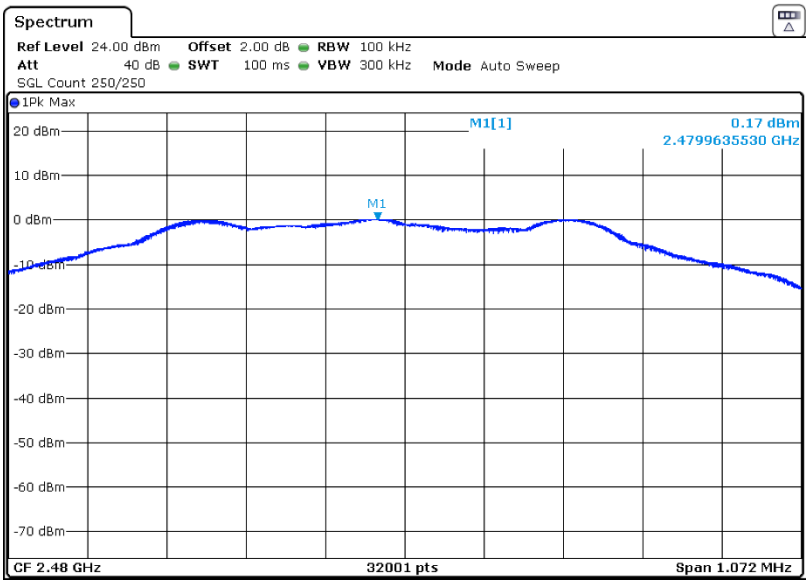


Figure 8.4-3: *Power spectral density of digital transmission system, 2480 MHz*

8.5 RSS-GEN 6.7 Occupied bandwidth (or 99% emission bandwidth)

8.5.1 References

RSS-Gen → §6.7

The occupied bandwidth or the "99% emission bandwidth" is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

8.5.2 Test summary

Verdict	Pass		
Test date	January 19, 2021	Temperature	21 °C
Test engineer	Martha Espinoza	Air pressure	1001 mbar
Test location	Wireless bench	Relative humidity	49 %

8.5.3 Notes

Testing was performed in BLE mode and the EUT transmitting on a fixed channel at full power.

8.5.4 Setup details

EUT setup configuration	Tabletop
Test facility	Wireless bench
Measurement details	Measurement performed as per C63.10 §6.9.3 using the built-in function of the spectrum analyzer

Receiver/spectrum analyzer settings:

Resolution bandwidth	50 kHz
Video bandwidth	300 kHz
Detector mode	Peak
Trace mode	Max Hold
Measurement time	Long enough for trace to stabilize

8.5.5 Test data

Test Frequency (MHz)	99%Bandwidth
2402	1.0567
2440	1.0562
2480	1.0562

Table 8.5-1: *99% bandwidth*

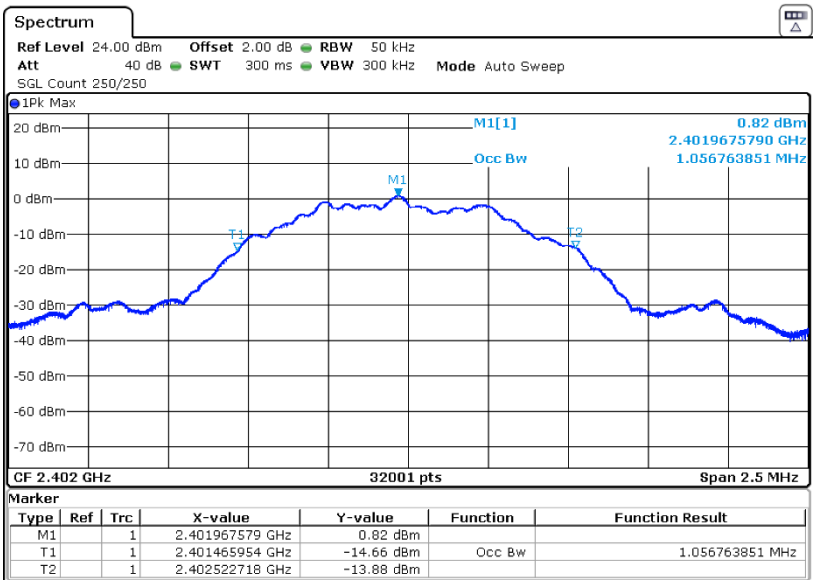


Figure 8.5-1: *99% bandwidth, 2402 MHz*

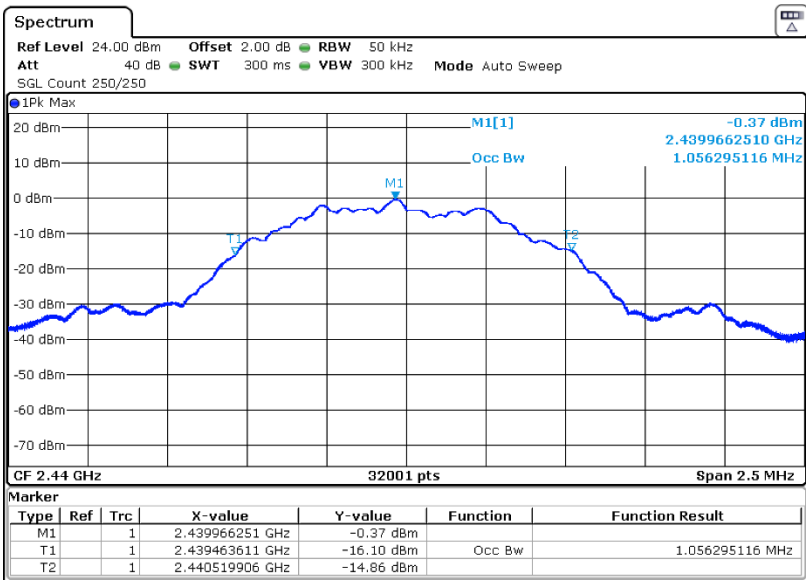


Figure 8.5-2: *99% bandwidth, 2440 MHz*

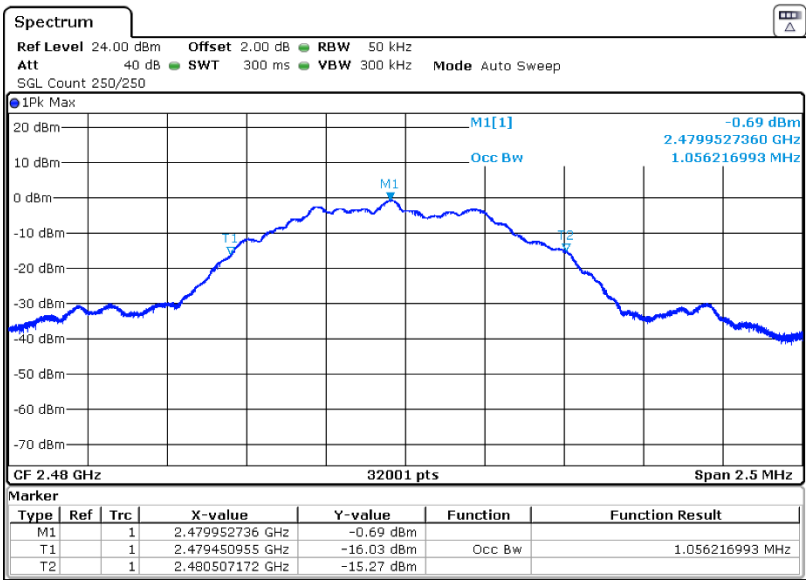


Figure 8.5-2: *99% bandwidth, 2480 MHz*

Section 9 Block diagrams of test set-ups

9.1 Radiated emissions set-up

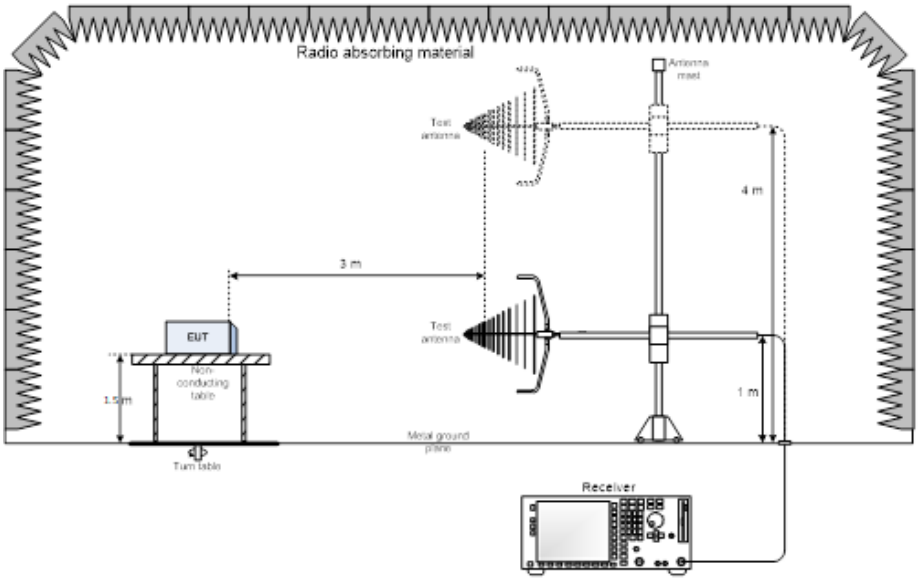


Figure 9.1-1: 30 MHz - 1000 MHz Setup

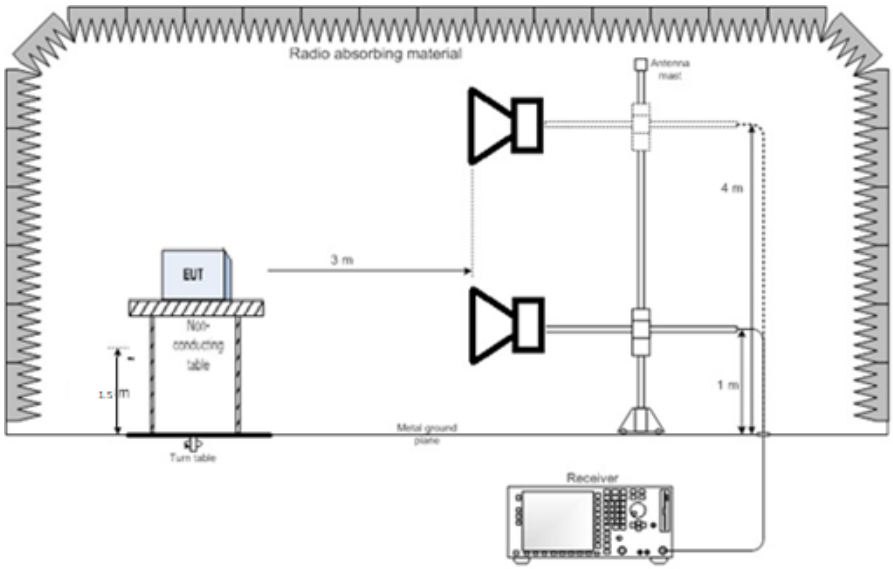


Figure 9.1-2: 1 GHz - 26 GHz Setup

Thank you for choosing