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Test report

408216-8R1TRFWL

Date of issue: February 12, 2021

Applicant:

Garmin International, Inc.

Product:

Battery Cradle + Battery (BLE)

Model:

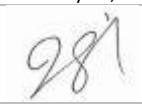
A04118

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	February 12, 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.

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Section 1 Report summary

1.1 Applicant

Company name	Garmin International, Inc.
Address	1200 E. 151st street
City	Olathe
Province/State	KS
Postal/Zip code	66062
Country	USA

1.2 Manufacturer

Company name	Garmin International, Inc.
Address	1200 E. 151st street
City	Olathe
Province/State	KS
Postal/Zip code	66062
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
408216-8TRFWL	Original report issued
408216-8R1TRFWL	Revised product and support equipment names

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	Pass[2]

Notes: [1]EUT is battery power only
[2]EUT has an integrated 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	Not applicable
7.4	Receiver conducted emission limits	Not applicable
8.8	Power Line Conducted Emissions Limits for License-Exempt Radio Apparatus	Pass

Section 3 Equipment under test (EUT) details

3.1 Sample information

Receipt date	November 9, 2020
Nemko sample ID number	NEx: 408216

3.2 EUT information

Product name	Battery Cradle + Battery
Model	A04118
Serial number	Conducted sample (50212): 3345709192 Radiated sample (30926): 3345709262
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)	8.31 dBm EIRP
Maximum output power (dBm)	8.79 dBm EIRP
Measured 6 dB bandwidth	2402 MHz: 689.603 kHz 2441 MHz: 690.822 kHz 2480 MHz: 693.072 kHz
Type of modulation	GFSK
Emission classification	N/A
Power requirements	Battery package
Antenna information	3.8 dBi maximum antenna gain

3.4 EUT exercise and monitoring details

Conducted and radiated sample were configured through a tool named “RF State Setter” where different parameters can be configured such as, channel frequency, continuous wave signal, modulated signal, ANT, BLE, etc., depending on the test requirement.

3.5 EUT setup details

Table 3.5-1: EUT sub assemblies

Description	Brand name	Model/Part number	Serial number	Rev.
Battery cradle	Garmin	A04118	3345709192	---
Battery	Garmin	A04119	3345708884	---

Table 3.5-2: EUT interface ports

Description	Qty.
Field disturbance sensor port	1
Field disturbance sensor display port	1
Battery port	1

Table 3.5-3: Support equipment

Description	Brand name	Model/Part number	Serial number	Rev.
Laptop	Dell	Latitude	N/A	---
ANT USB	Dynastream	ANTUSB-m	203-JN6016	---

Table 3.5-4: Inter-connection cables

Cable description	From	To	Length (ft)
N/A	N/A	N/A	N/A

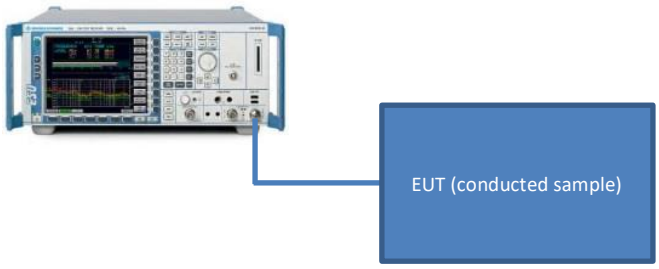

Figure 3.5-1: Test conducted setup.

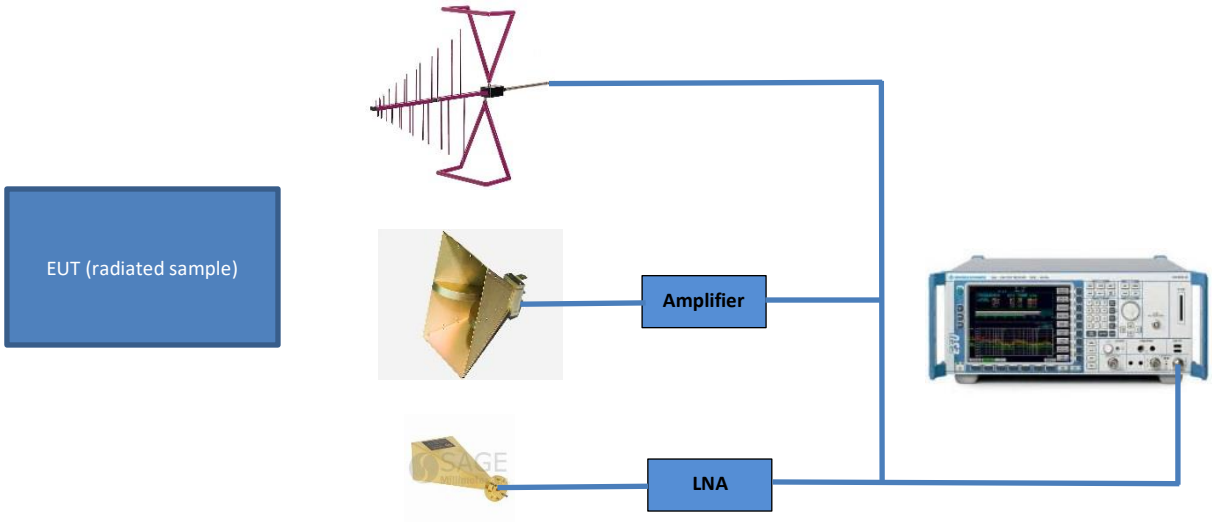

Figure 3.5-2: Test radiated setup

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

7.1 Test equipment list

Table 7.1-1: Test Equipment List

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
EMI Test Receiver	Rohde & Schwarz	ESU40	E1131	1 year	03 Dec 2021
EMI Test Receiver	Rohde & Schwarz	ESU40	E1121	1 year	01 Dec 2021
Spectrum analyzer	Rohde & Schwarz	FSW	E1302	1 year	18 Sep 2021
Spectrum analyzer	Rohde & Schwarz	FSV	E1120	1 year	19 Dec 2021
System controller	Sunol sciences	SC104V	E1191	NCR	NCR
Power sensor	ETS Lindgren	7002-006	E1062	1 year	29 Oct 2021
DRG Horn	ETS-Lindgren	3117-PA	E1139	2 years	21 March 2021
Bilog Antenna	Schaffner	CBL6111C	1763	2 years	18 Feb 2022
Antenna Horn	Sage	SAR-2309-42-S2	E1143	2 years	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	November 10, 2020	Temperature	22 °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. Calibrated cable losses were included using an offset of 1.5 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	689.603	> 500	189.603
2440	690.822	> 500	190.822
2480	693.072	> 500	193.072

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

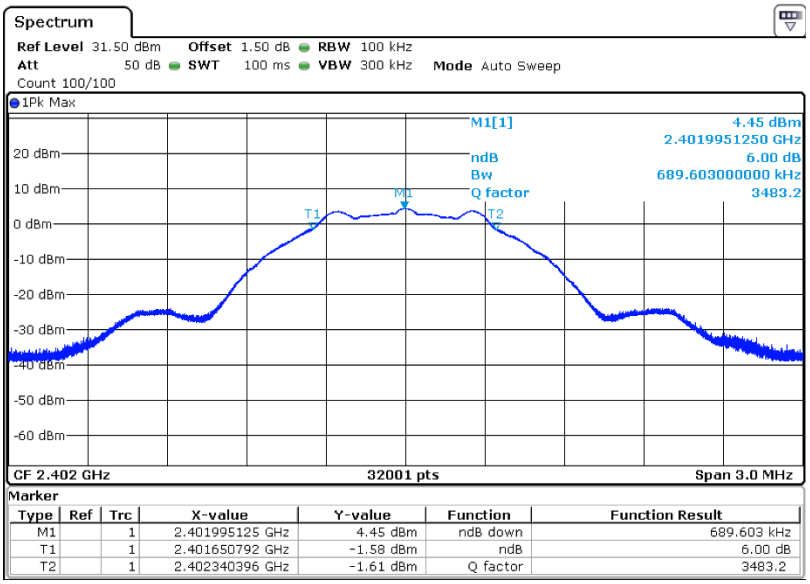

Figure 8.1-1: 6 dB occupied bandwidth, 2402 MHz

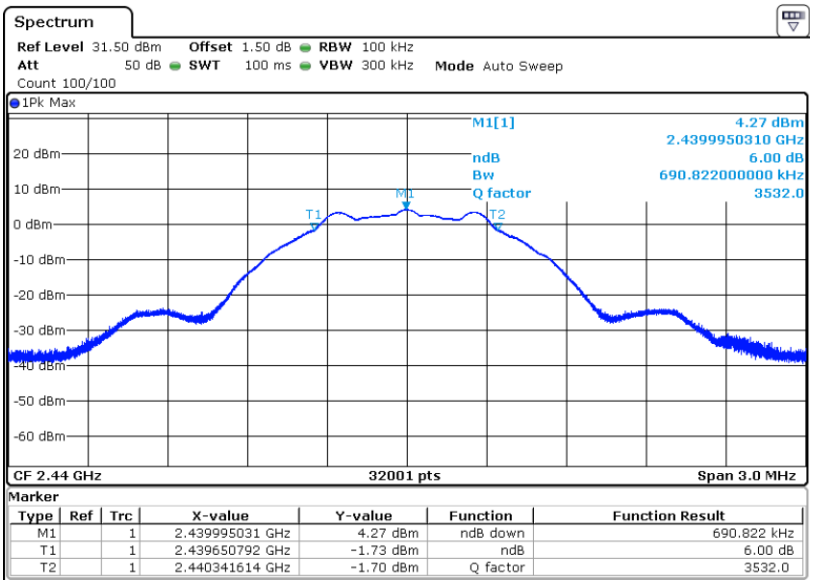

Figure 8.1-2: 6 dB occupied bandwidth, 2440 MHz

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

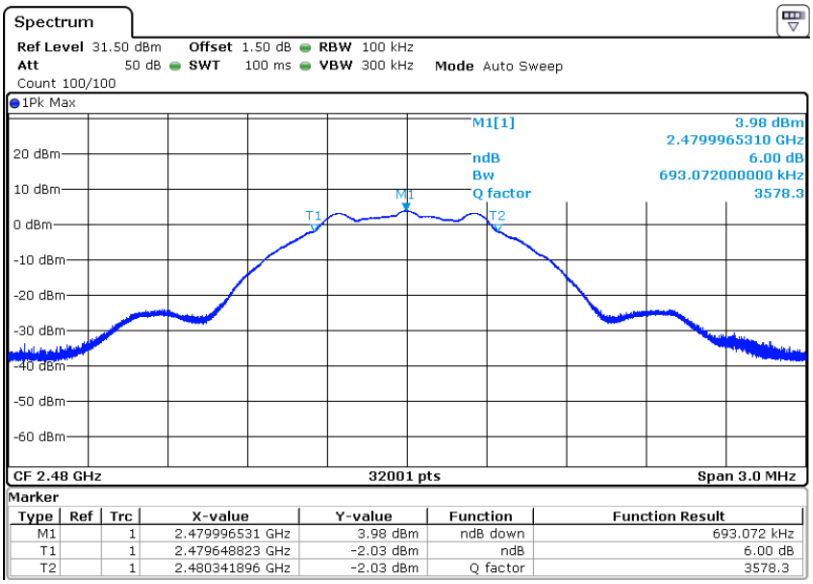

Figure 8.1-3: 6 dB occupied bandwidth, 2480 MHz

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	November 10, 2020	Temperature	22 °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 attenuation of the interconnecting cable was included in the power meter software as a correction factor. Calibrated cable losses were included using an offset of 1.5 dB.

The antenna gain is 3.8 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)	Peak Conducted Power (dBm)	Cable losses (dB)	Total conducted power (dBm)	Conducted Limit (dBm)	Antenna Gain (dBi)	Peak EIRP (dBm)	EIRP Limit (dBm)
2402	3.49	1.5	4.99	30.0	3.8[1]	8.79	36.0
2441	3.29	1.5	4.79	30.0	3.8[1]	8.59	36.0
2480	3.01	1.5	4.51	30.0	3.8[1]	8.31	36.0

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

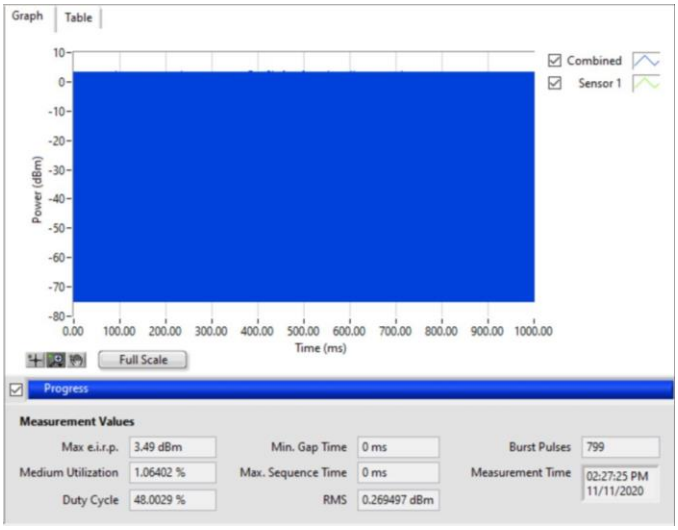

Figure 8.2-1: Output power, 2402 MHz

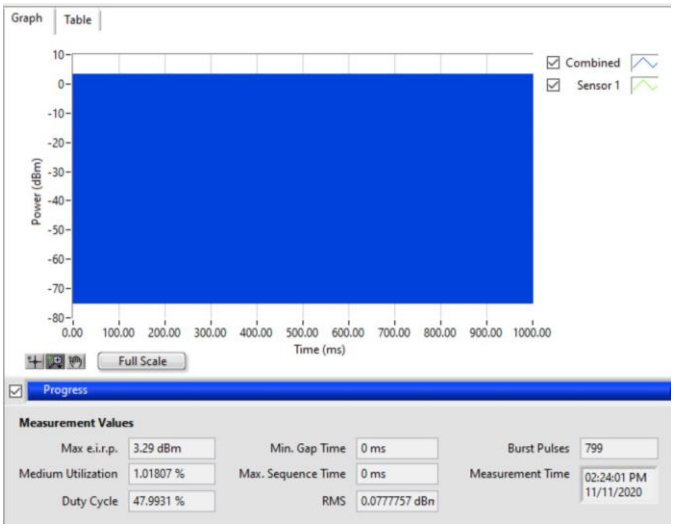

Figure 8.2-2: Output power, 2440 MHz

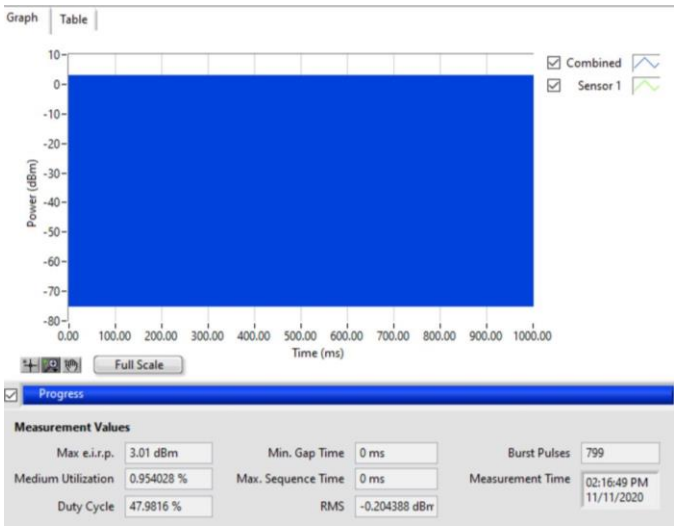

Figure 8.2-3: Output power, 2480 MHz

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	November 12, 2020 (conducted) November 16,17,19 2020 (radiated)	Temperature	21°C 21°C; 20°C; 23°C
Test engineer	Martha Espinoza	Air pressure	1005; 1001; 1000 mbar
Test location	Wireless bench 3m semi-anechoic chamber	Relative humidity	48; 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 1.5 dB offset.

For conducted measurements, the limit was established at a level 20 dB down from the peak fundamental power as measured in 100 kHz RBW.

8.3.4 Setup details

EUT setup configuration	Tabletop
Test facility	Wireless bench 3 m semi anechoic chamber
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

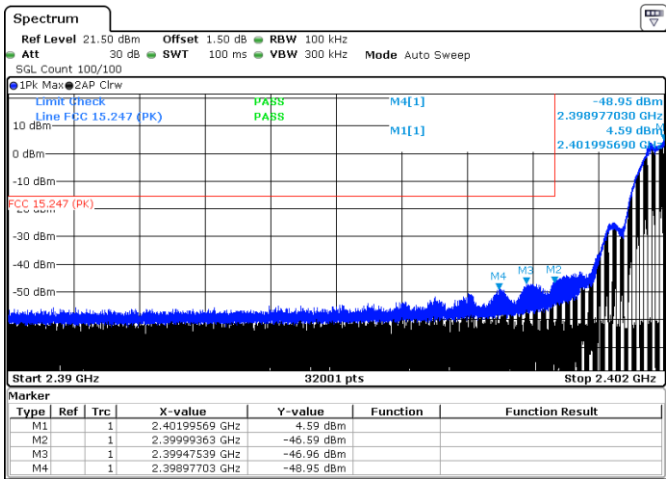

Figure 8.3-1: Band edge measurement, low channel

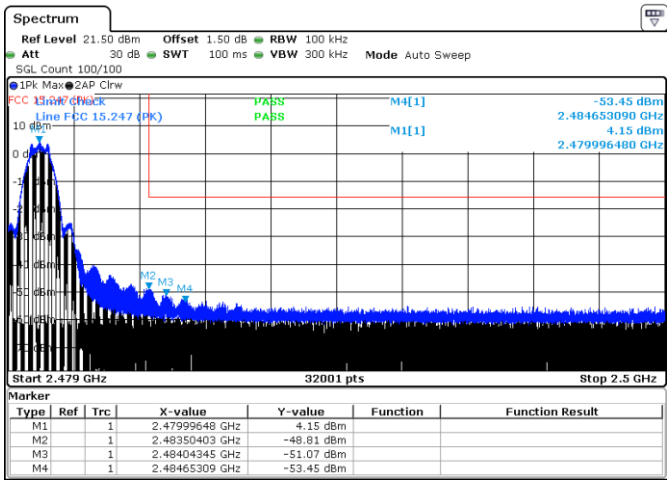

Figure 8.3-2: Band edge measurement, high channel

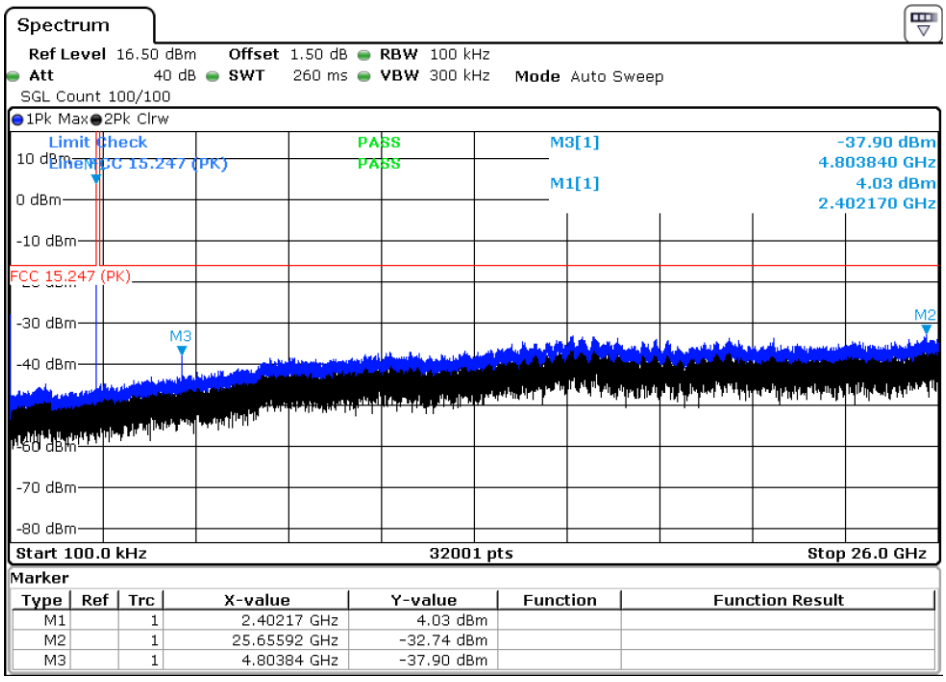

Figure 8.3-3: Conducted spurious emissions, low channel

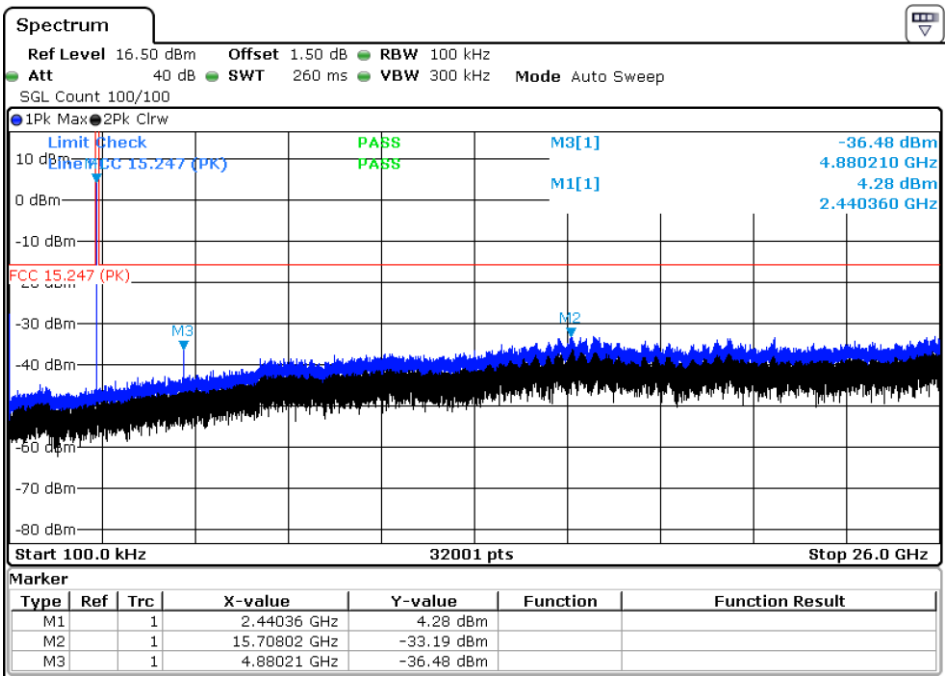

Figure 8.3-4: Conducted spurious emissions, middle channel

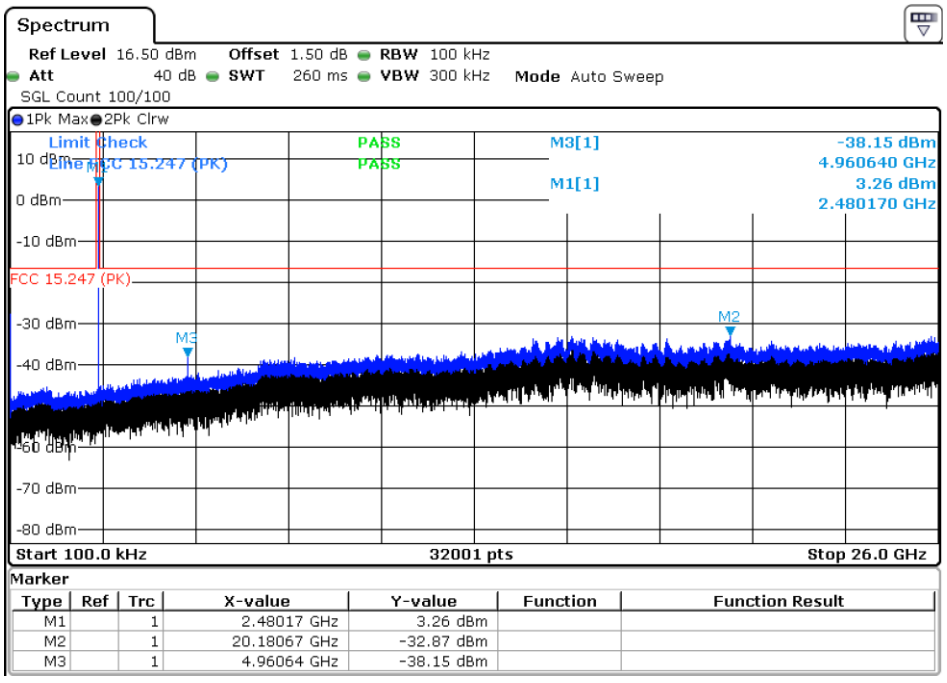

Figure 8.3-5: Conducted spurious emissions, high channel

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

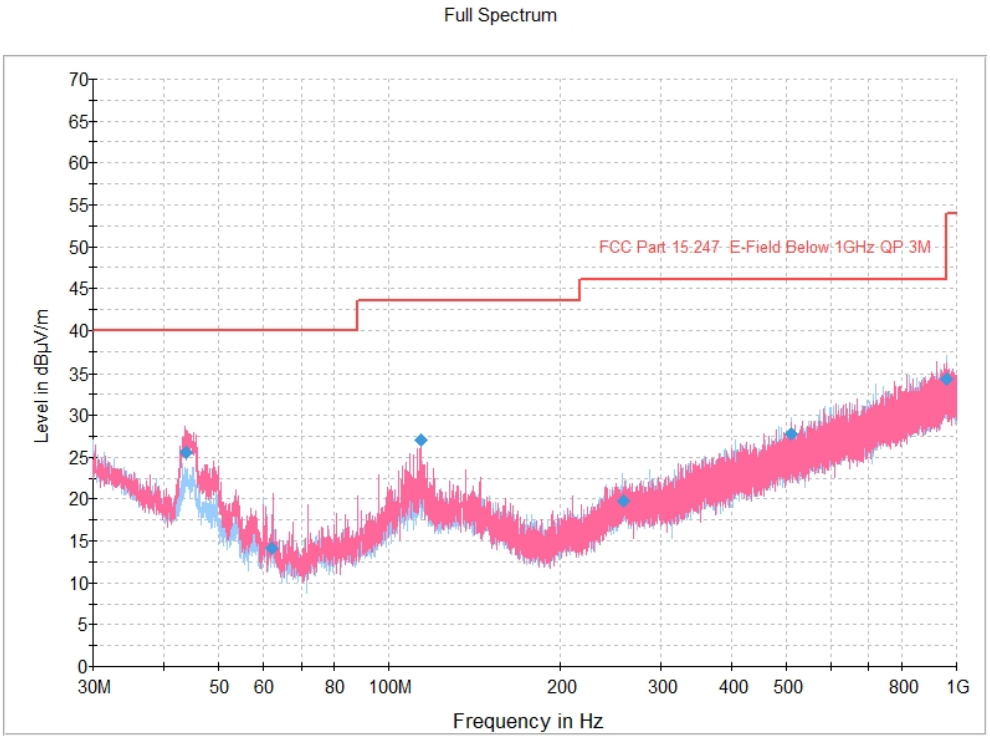

Figure 8.3-3: Radiated emissions, low channel, 30 – 1000 MHz

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)
43.932333	25.60	40.00	14.40	5000.0	120.000	98.0	V	10.0	19.0
62.205667	14.15	40.00	25.85	5000.0	120.000	98.0	V	40.0	12.7
113.654000	27.12	43.50	16.38	5000.0	120.000	379.0	V	333.0	19.1
258.277000	19.70	46.00	26.30	5000.0	120.000	410.0	H	71.0	21.9
510.028333	27.78	46.00	18.22	5000.0	120.000	98.0	H	285.0	27.3
960.774333	34.29	53.90	19.61	5000.0	120.000	201.0	H	11.0	34.7

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.

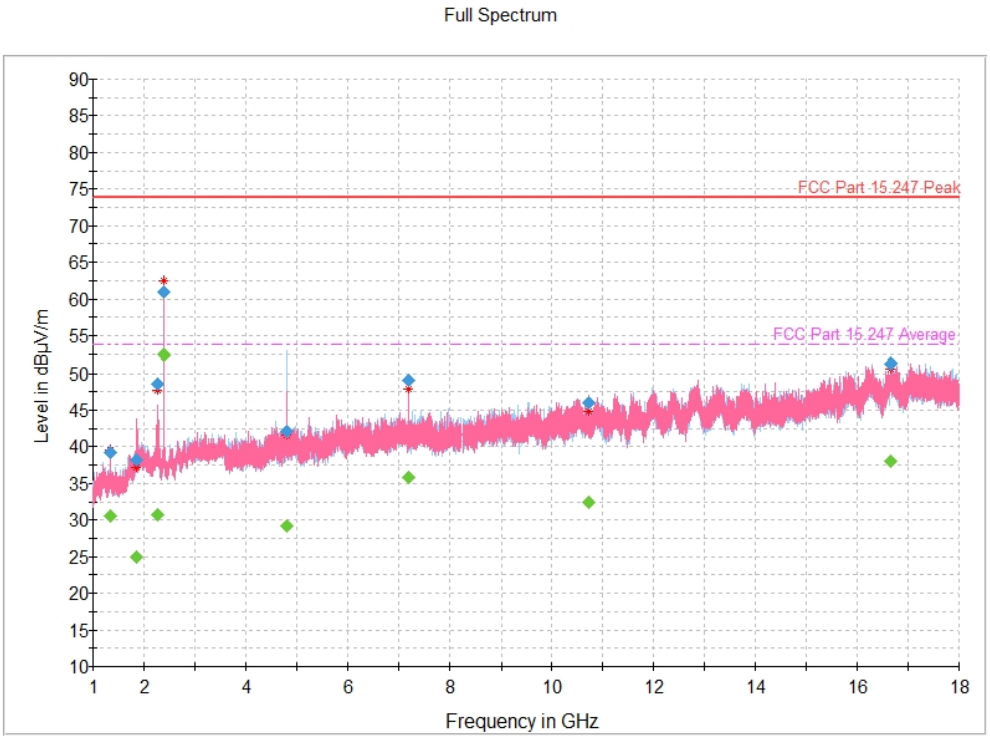

Figure 8.3-4: Radiated emissions, low channel, 1 – 18 GHz

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)
1350.033333	39.22	---	73.90	34.68	5000.0	1000.000	193.0	V	0.0	-14.4
1350.033333	---	30.56	53.90	23.34	5000.0	1000.000	193.0	V	0.0	-14.4
1865.633333	---	25.00	53.90	28.90	5000.0	1000.000	191.0	V	356.0	-11.2
1865.633333	38.18	---	73.90	35.72	5000.0	1000.000	191.0	V	356.0	-11.2
2273.700000	---	30.72	53.90	23.18	5000.0	1000.000	100.0	V	0.0	-10.4
2273.700000	48.50	---	73.90	25.40	5000.0	1000.000	100.0	V	0.0	-10.4
2401.766667	Low channel fundamental									
2401.766667	Low channel fundamental									
4806.833333	---	29.16	53.90	24.74	5000.0	1000.000	287.0	H	154.0	-1.7
4806.833333	42.15	---	73.90	31.75	5000.0	1000.000	287.0	H	154.0	-1.7
7206.700000	49.11	---	73.90	24.79	5000.0	1000.000	202.0	H	213.0	0.7
7206.700000	---	35.79	53.90	18.11	5000.0	1000.000	202.0	H	213.0	0.7
10717.266667	---	32.35	53.90	21.55	5000.0	1000.000	342.0	V	242.0	4.1
10717.266667	45.95	---	73.90	27.95	5000.0	1000.000	342.0	V	242.0	4.1
16654.200000	51.27	---	73.90	22.63	5000.0	1000.000	162.0	V	206.0	13.9
16654.200000	---	38.08	53.90	15.82	5000.0	1000.000	162.0	V	206.0	13.9

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)
18731.666667	50.61	---	73.90	23.29	3000.0	1000.000	297.0	V	11.0	18.0
18731.666667	---	37.70	53.90	16.20	3000.0	1000.000	297.0	V	11.0	18.0
19878.600000	---	37.44	53.90	16.46	3000.0	1000.000	179.0	V	190.0	17.8
19878.600000	50.60	---	73.90	23.30	3000.0	1000.000	179.0	V	190.0	17.8
20721.666667	53.53	---	73.90	20.37	3000.0	1000.000	149.0	H	0.0	20.6
20721.666667	---	40.09	53.90	13.81	3000.0	1000.000	149.0	H	0.0	20.6
22082.333333	53.40	---	73.90	20.50	3000.0	1000.000	368.0	H	57.0	19.2
22082.333333	---	39.89	53.90	14.01	3000.0	1000.000	368.0	H	57.0	19.2
23369.533333	56.91	---	73.90	16.99	3000.0	1000.000	327.0	H	173.0	23.0
23369.533333	---	43.45	53.90	10.45	3000.0	1000.000	327.0	H	173.0	23.0
25025.533333	---	44.74	53.90	9.16	3000.0	1000.000	402.0	V	57.0	23.2
25025.533333	57.59	---	73.90	16.31	3000.0	1000.000	402.0	V	57.0	23.2

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.

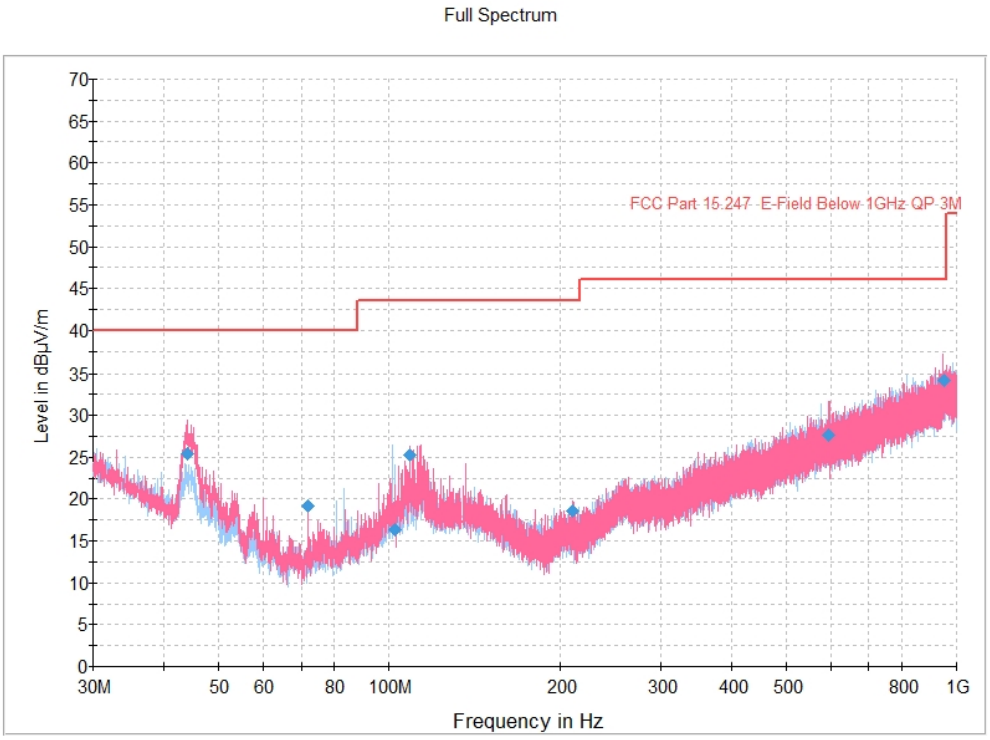

Figure 8.3-6: Radiated emissions, middle channel, 30 – 1000 MHz

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)
44.008000	25.34	40.00	14.66	5000.0	120.000	98.0	V	286.0	18.9
72.001000	19.21	40.00	20.79	5000.0	120.000	378.0	V	11.0	13.9
102.506000	16.31	43.50	27.19	5000.0	120.000	262.0	H	182.0	18.1
108.804000	25.23	43.50	18.27	5000.0	120.000	402.0	V	76.0	18.7
209.959667	18.61	43.50	24.89	5000.0	120.000	188.0	V	292.0	18.2
595.181667	27.62	46.00	18.38	5000.0	120.000	210.0	V	0.0	29.0
948.700000	34.21	46.00	11.79	5000.0	120.000	113.0	V	0.0	34.5

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.

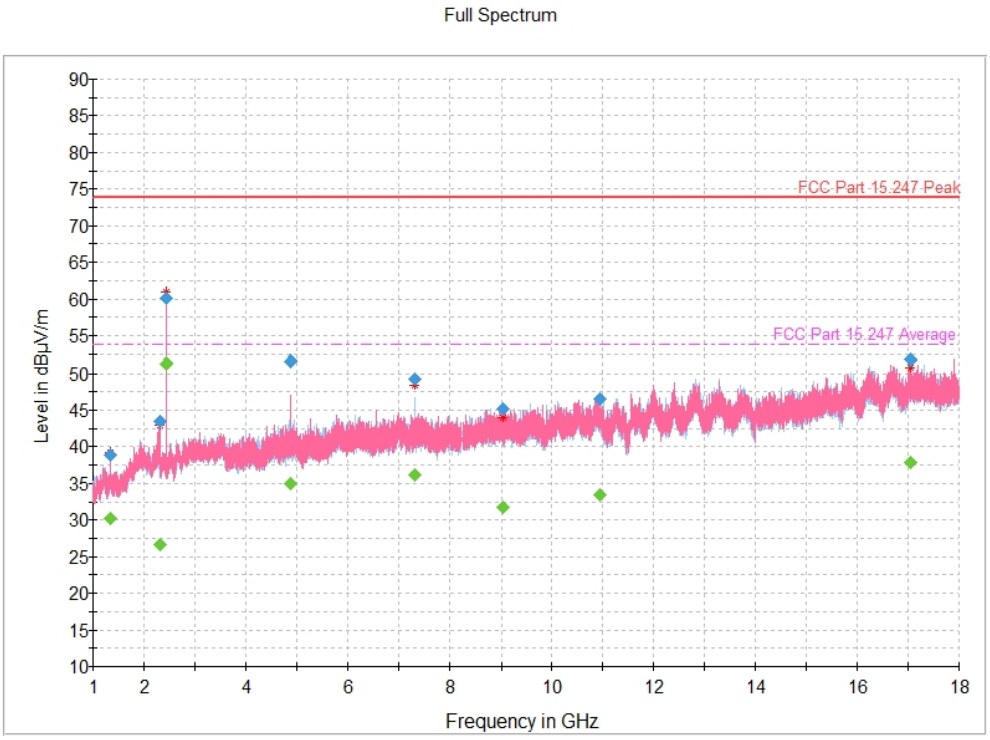

Figure 8.3-7: Radiated emissions, middle channel, 1 - 18 GHz

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

Frequency (MHz)	QuasiPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
1350.033333	---	30.28	53.90	23.62	5000.0	1000.000	195.0	V	212.0	-14.4
1350.033333	38.93	---	73.90	34.97	5000.0	1000.000	195.0	V	212.0	-14.4
2311.433333	---	26.68	53.90	27.22	5000.0	1000.000	128.0	V	0.0	-10.5
2311.433333	43.55	---	73.90	30.35	5000.0	1000.000	128.0	V	0.0	-10.5
2439.733333	Middle channel fundamental									
2439.733333	Middle channel fundamental									
4879.966667	51.58	---	73.90	22.32	5000.0	1000.000	108.0	V	76.0	-2.0
4879.966667	---	35.04	53.90	18.86	5000.0	1000.000	108.0	V	76.0	-2.0
7319.400000	---	36.19	53.90	17.71	5000.0	1000.000	215.0	H	222.0	0.8
7319.400000	49.32	---	73.90	24.58	5000.0	1000.000	215.0	H	222.0	0.8
9026.000000	---	31.82	53.90	22.08	5000.0	1000.000	397.0	H	0.0	2.9
9026.000000	45.13	---	73.90	28.77	5000.0	1000.000	397.0	H	0.0	2.9
10952.100000	---	33.43	53.90	20.47	5000.0	1000.000	227.0	H	344.0	4.6
10952.100000	46.55	---	73.90	27.35	5000.0	1000.000	227.0	H	344.0	4.6
17048.500000	51.72	---	73.90	22.18	5000.0	1000.000	402.0	V	174.0	12.9
17048.500000	---	37.93	53.90	15.97	5000.0	1000.000	402.0	V	174.0	12.9

Notes: The marked row as middle 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.

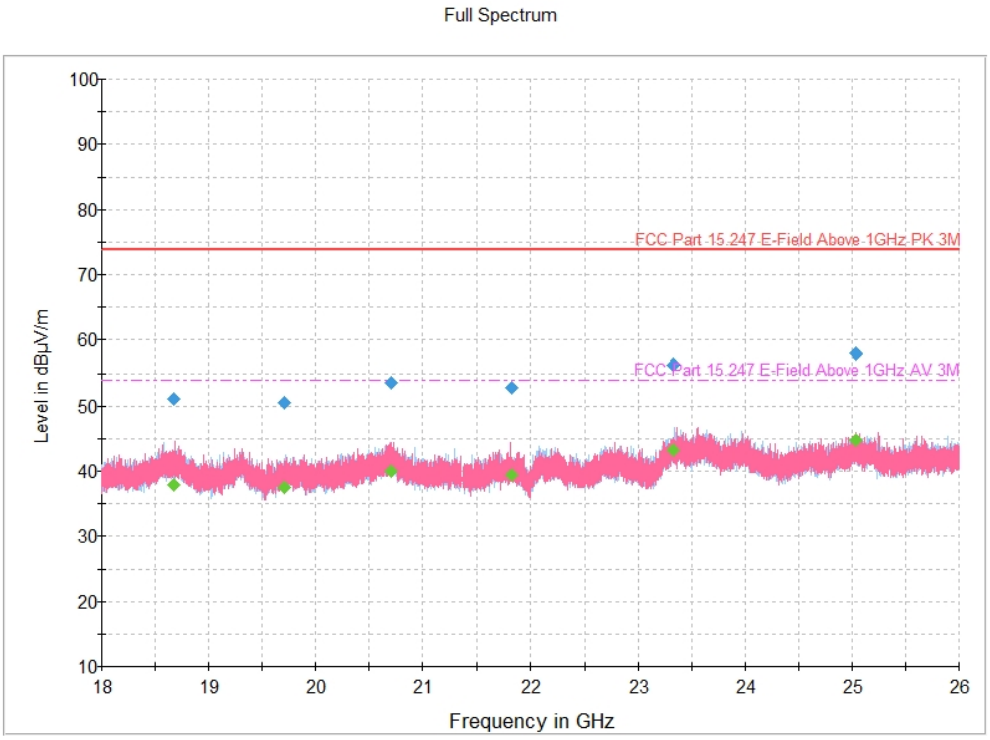

Figure 8.3-8: Radiated emissions, middle channel, 18 - 26 GHz

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)
18678.066667	51.14	---	73.90	22.76	3000.0	1000.000	200.0	V	11.0	18.1
18678.066667	---	37.95	53.90	15.95	3000.0	1000.000	200.0	V	11.0	18.1
19707.000000	---	37.54	53.90	16.36	3000.0	1000.000	410.0	H	58.0	17.8
19707.000000	50.55	---	73.90	23.35	3000.0	1000.000	410.0	H	58.0	17.8
20701.933333	---	40.02	53.90	13.88	3000.0	1000.000	297.0	H	56.0	20.6
20701.933333	53.50	---	73.90	20.40	3000.0	1000.000	297.0	H	56.0	20.6
21814.333333	---	39.37	53.90	14.53	3000.0	1000.000	226.0	V	72.0	19.5
21814.333333	52.87	---	73.90	21.03	3000.0	1000.000	226.0	V	72.0	19.5
23326.200000	56.21	---	73.90	17.69	3000.0	1000.000	410.0	H	72.0	22.7
23326.200000	---	43.33	53.90	10.57	3000.0	1000.000	410.0	H	72.0	22.7
25033.400000	---	44.77	53.90	9.13	3000.0	1000.000	284.0	V	0.0	23.1
25033.400000	57.93	---	73.90	15.97	3000.0	1000.000	284.0	V	0.0	23.1

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.

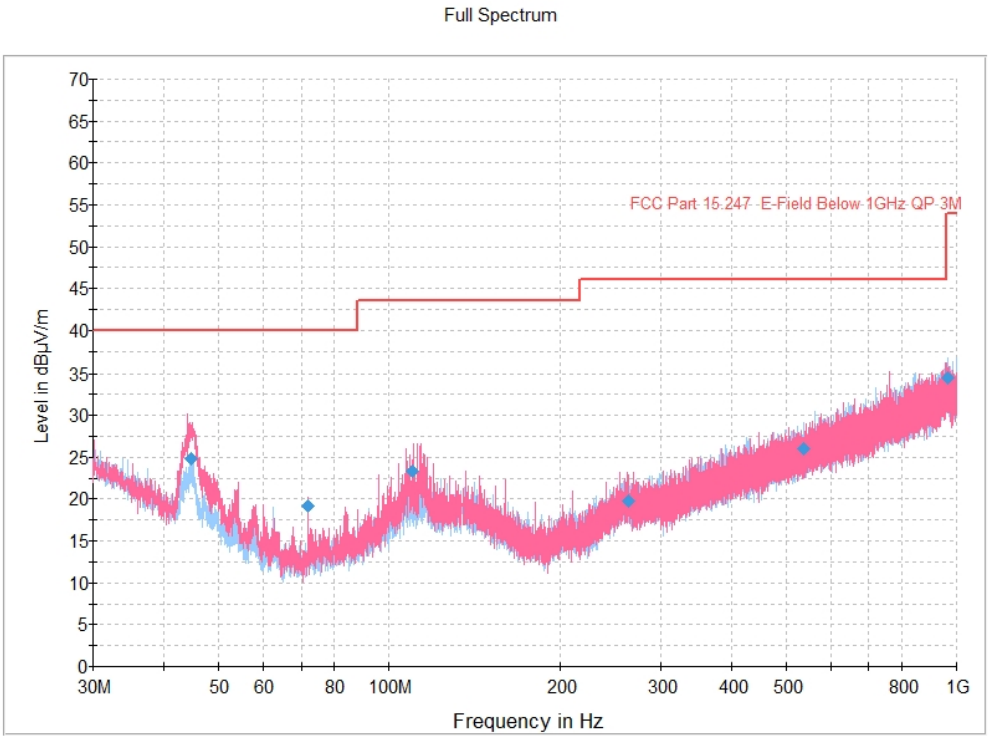

Figure 8.3-9: Radiated emissions, high channel, 30 – 1000 MHz

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)
44.800333	24.84	40.00	15.16	5000.0	120.000	111.0	V	237.0	18.5
72.001000	19.10	40.00	20.90	5000.0	120.000	392.0	V	171.0	13.9
109.853000	23.33	43.50	20.17	5000.0	120.000	386.0	V	256.0	18.8
262.787333	19.72	46.00	26.28	5000.0	120.000	410.0	H	273.0	21.9
536.876667	25.98	46.00	20.02	5000.0	120.000	250.0	H	0.0	27.7
963.983333	34.41	53.90	19.49	5000.0	120.000	249.0	H	0.0	34.7

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.

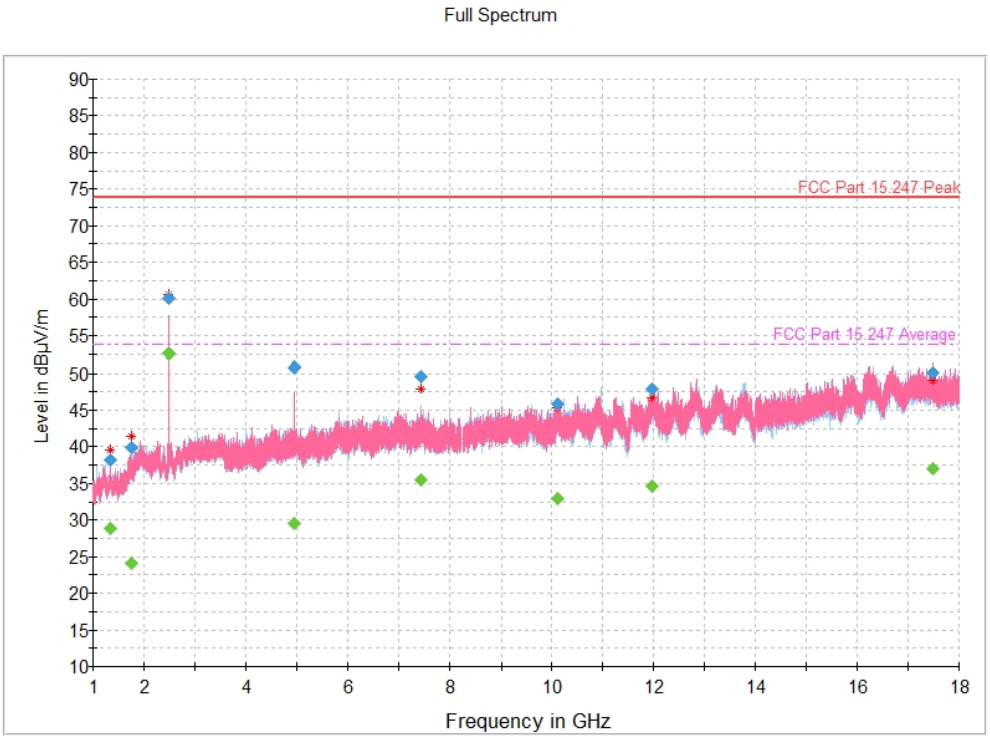

Figure 8.3-10: Radiated emissions, high channel, 1 - 18 GHz

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)
1350.033333	38.24	---	73.90	35.66	5000.0	1000.000	234.0	V	10.0	-14.4
1350.033333	---	28.84	53.90	25.06	5000.0	1000.000	234.0	V	10.0	-14.4
1754.066667	39.93	---	73.90	33.97	5000.0	1000.000	223.0	H	10.0	-12.2
1754.066667	---	24.02	53.90	29.88	5000.0	1000.000	223.0	H	10.0	-12.2
2479.966667	High channel fundamental									
2479.966667	High channel fundamental									
4960.033333	50.81	---	73.90	23.09	5000.0	1000.000	254.0	H	257.0	-2.1
4960.033333	---	29.61	53.90	24.29	5000.0	1000.000	254.0	H	257.0	-2.1
7439.933333	49.54	---	73.90	24.36	5000.0	1000.000	214.0	H	241.0	1.3
7439.933333	---	35.56	53.90	18.34	5000.0	1000.000	214.0	H	241.0	1.3
10108.500000	---	32.90	53.90	21.00	5000.0	1000.000	402.0	V	310.0	4.4
10108.500000	45.91	---	73.90	27.99	5000.0	1000.000	402.0	V	310.0	4.4
11964.633333	---	34.66	53.90	19.24	5000.0	1000.000	410.0	H	165.0	6.0
11964.633333	47.84	---	73.90	26.06	5000.0	1000.000	410.0	H	165.0	6.0
17491.600000	50.06	---	73.90	23.84	5000.0	1000.000	267.0	V	156.0	13.0
17491.600000	---	37.08	53.90	16.82	5000.0	1000.000	267.0	V	156.0	13.0

Notes: The marked row as high 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 8.3-11: 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)
18643.266667	---	38.12	53.90	15.78	3000.0	1000.000	402.0	V	291.0	18.1
18643.266667	51.23	---	73.90	22.67	3000.0	1000.000	402.0	V	291.0	18.1
20750.333333	52.81	---	73.90	21.09	3000.0	1000.000	300.0	V	76.0	20.3
20750.333333	---	39.70	53.90	14.20	3000.0	1000.000	300.0	V	76.0	20.3
22099.933333	53.01	---	73.90	20.89	3000.0	1000.000	377.0	H	172.0	19.2
22099.933333	---	39.88	53.90	14.02	3000.0	1000.000	377.0	H	172.0	19.2
23663.800000	56.34	---	73.90	17.56	3000.0	1000.000	233.0	H	175.0	23.4
23663.800000	---	43.30	53.90	10.60	3000.0	1000.000	233.0	H	175.0	23.4
24631.533333	---	42.93	53.90	10.97	3000.0	1000.000	140.0	V	0.0	22.1
24631.533333	56.34	---	73.90	17.56	3000.0	1000.000	140.0	V	0.0	22.1
25613.133333	57.22	---	73.90	16.68	3000.0	1000.000	402.0	V	214.0	22.7
25613.133333	---	44.42	53.90	9.48	3000.0	1000.000	402.0	V	214.0	22.7

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.

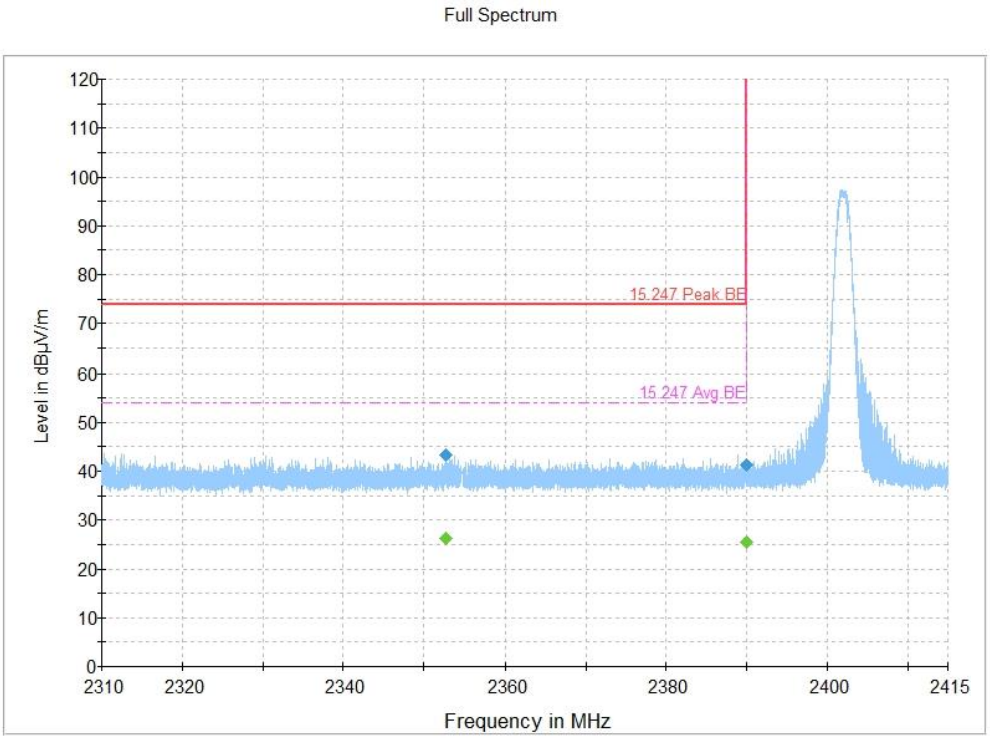

Figure 8.3-12: Radiated emissions, restricted band edge, low

Table 8.3-11: Radiated emissions, restricted band edge, low

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)
2352.833000	43.40	---	73.90	30.50	5000.0	1000.000	98.0	V	148.0	-10.3
2352.833000	---	26.13	53.90	27.77	5000.0	1000.000	98.0	V	148.0	-10.3
2390.000000	41.29	---	73.90	32.61	5000.0	1000.000	175.0	H	310.0	-10.1
2390.000000	---	25.56	53.90	28.34	5000.0	1000.000	175.0	H	310.0	-10.1

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.

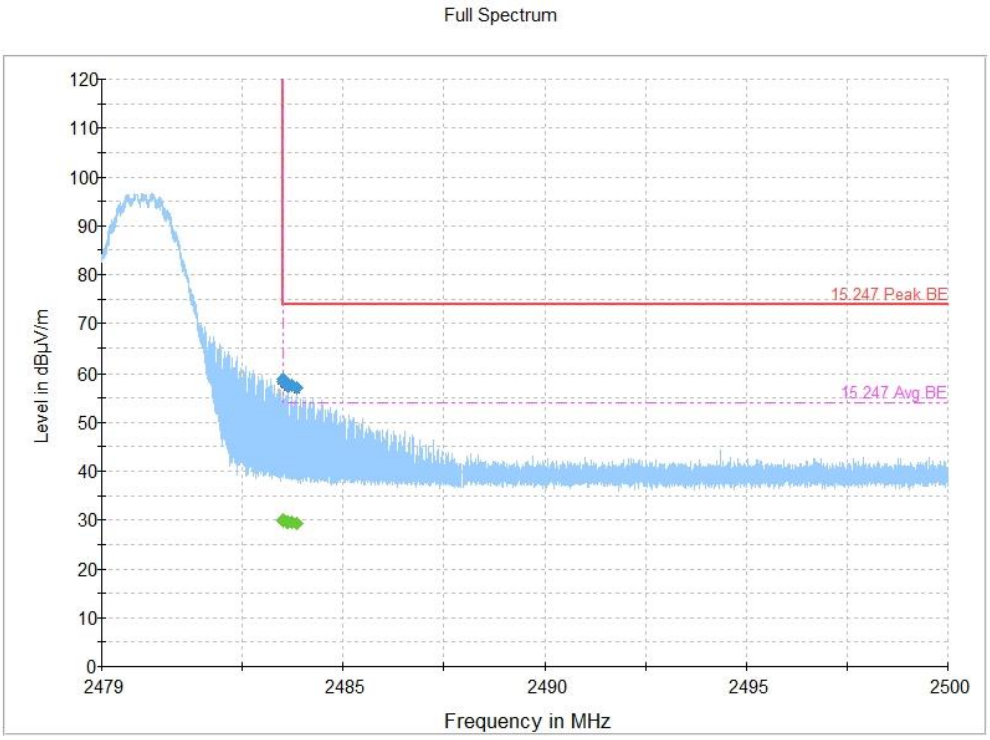

Figure 8.3-13: Radiated emissions, restricted band edge, high

Table 8.3-11: Radiated emissions, restricted band edge, high

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2483.500000	---	30.17	53.90	23.73	5000.0	1000.000	146.0	H	21.0	-9.5
2483.500000	58.74	---	73.90	15.16	5000.0	1000.000	146.0	H	21.0	-9.5
2483.517800	---	29.91	53.90	23.99	5000.0	1000.000	102.0	H	10.0	-9.5
2483.517800	58.23	---	73.90	15.67	5000.0	1000.000	102.0	H	10.0	-9.5
2483.611600	---	29.49	53.90	24.41	5000.0	1000.000	116.0	H	10.0	-9.5
2483.611600	57.51	---	73.90	16.39	5000.0	1000.000	116.0	H	10.0	-9.5
2483.622100	---	29.68	53.90	24.22	5000.0	1000.000	117.0	H	20.0	-9.5
2483.622100	57.65	---	73.90	16.25	5000.0	1000.000	117.0	H	20.0	-9.5
2483.645200	---	29.48	53.90	24.42	5000.0	1000.000	117.0	H	10.0	-9.5
2483.645200	57.32	---	73.90	16.58	5000.0	1000.000	117.0	H	10.0	-9.5
2483.729200	---	29.66	53.90	24.24	5000.0	1000.000	102.0	H	10.0	-9.5
2483.729200	57.52	---	73.90	16.38	5000.0	1000.000	102.0	H	10.0	-9.5
2483.834200	---	29.37	53.90	24.53	5000.0	1000.000	101.0	H	10.0	-9.5
2483.834200	57.03	---	73.90	16.87	5000.0	1000.000	101.0	H	10.0	-9.5

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 References

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	November 12, 2020	Temperature	221°C
Test engineer	Martha Espinoza	Air pressure	1005 mbar
Test location	Wireless bench	Relative humidity	48 %

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 §11.10.3 (Method AVGPSD-1)

Receiver/spectrum analyzer settings:

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

8.4.5 Test data

Table 8.4-1: Power spectral density of DTS

Transmitter Frequency (MHz)	Measured Level (dBm/3 kHz)	Limit (dBm/3 kHz)	Margin (dB)
2402	-10.66	8.00	18.66
2440	-10.76	8.00	18.76
2480	-11.11	8.00	19.11

Notes: None

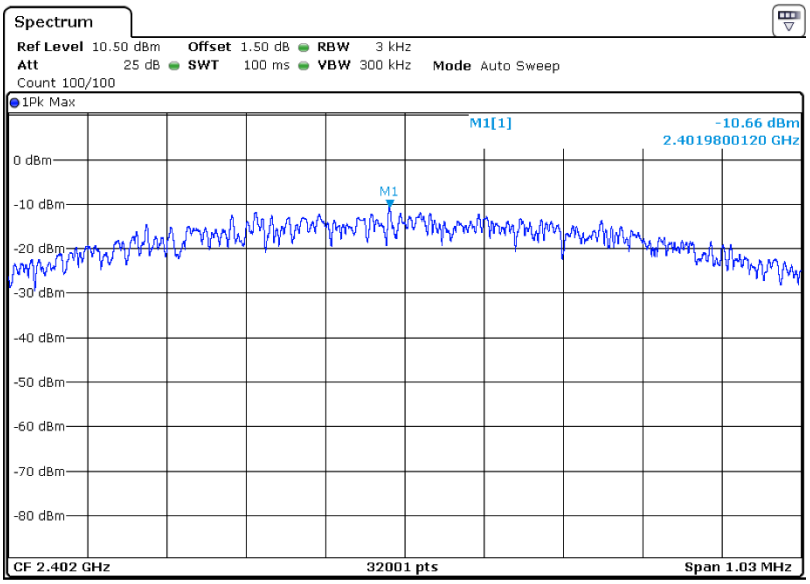

Figure 8.4-1: Power spectral density of digital transmission system, 2402 MHz

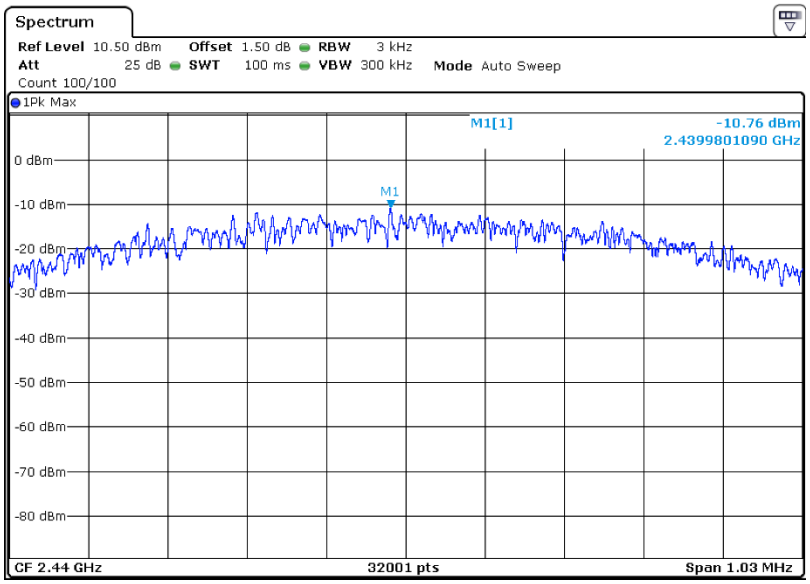

Figure 8.4-2: Power spectral density of digital transmission system, 2440 MHz

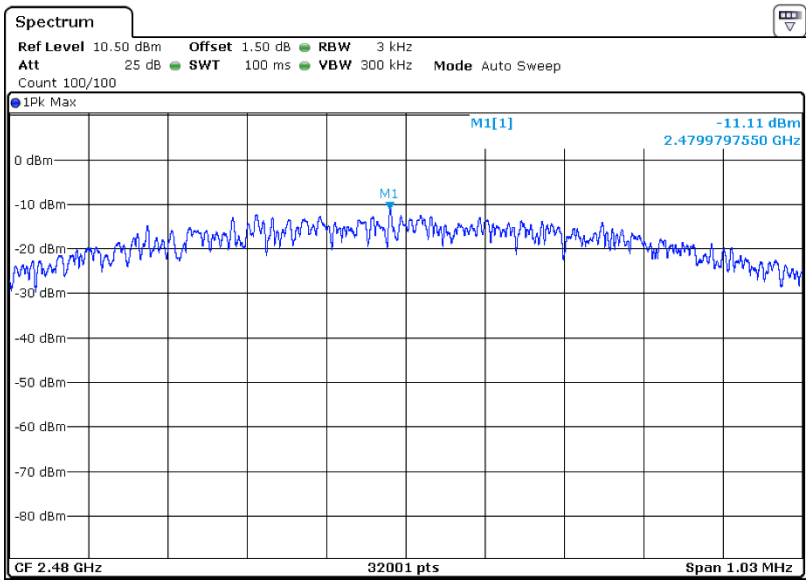

Figure 8.4-3: Power spectral density of digital transmission system, 2480 MHz

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	November 11, 2020	Temperature	22 °C
Test engineer	Martha Espinoza	Air pressure	1002 mbar
Test location	Wireless bench	Relative humidity	50 %

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

Table 8.5-1: 99% occupied bandwidth test data

Test Frequency (MHz)	99%Bandwidth
2402	1.0523
2440	1.0543
2480	1.0565

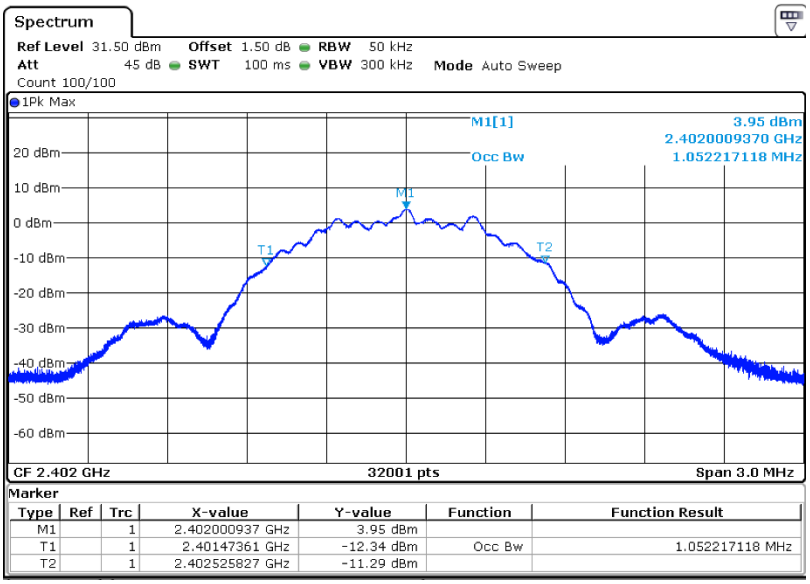

Figure 8.5-1: 99% bandwidth, 2402 MHz

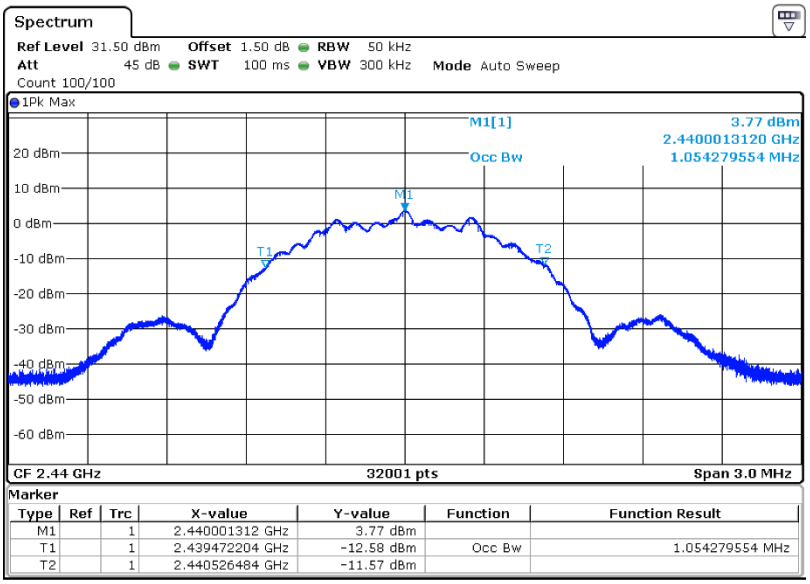

Figure 8.5-2: 99% bandwidth, 2440 MHz

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

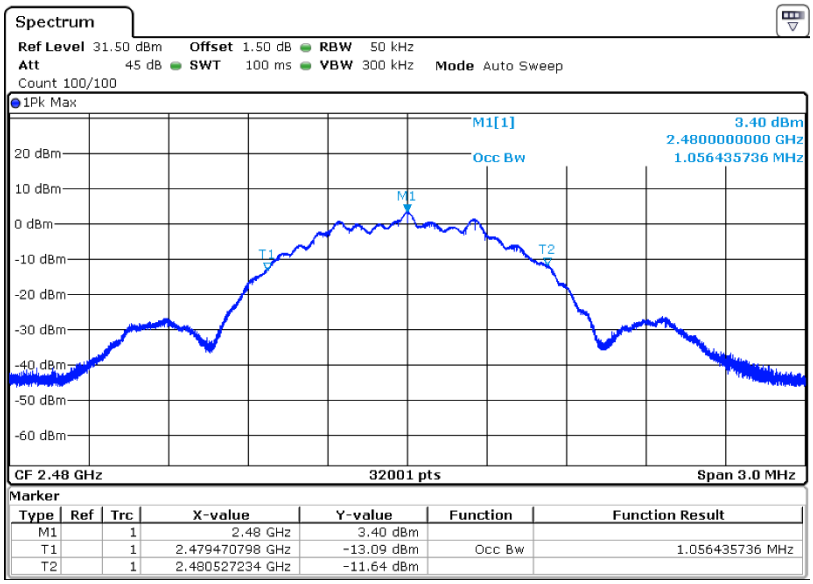

Figure 8.5-3: 99% bandwidth, 2480 MHz

Section 9 Block diagrams of test set-ups

9.1 Radiated emissions set-up

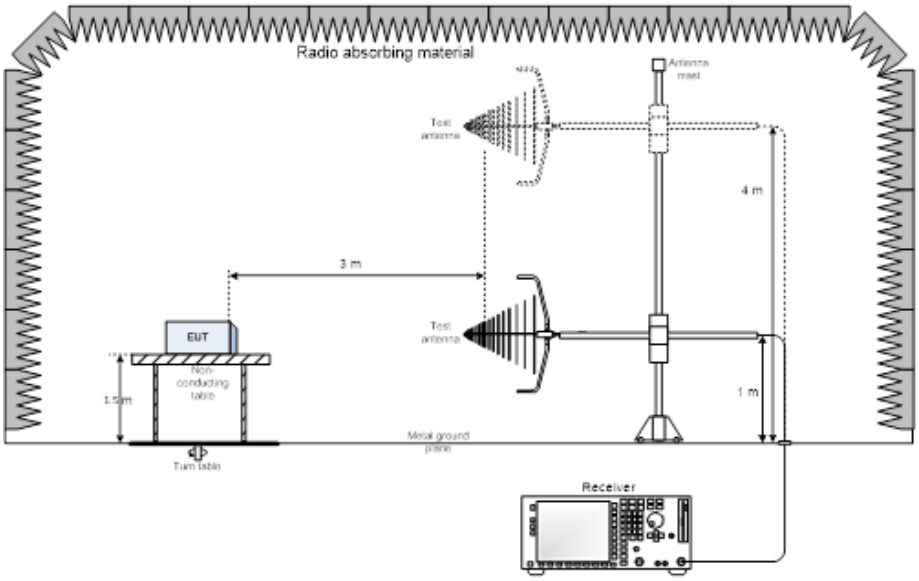

Figure 9.1-1 30 MHz - 1000 MHz Setup

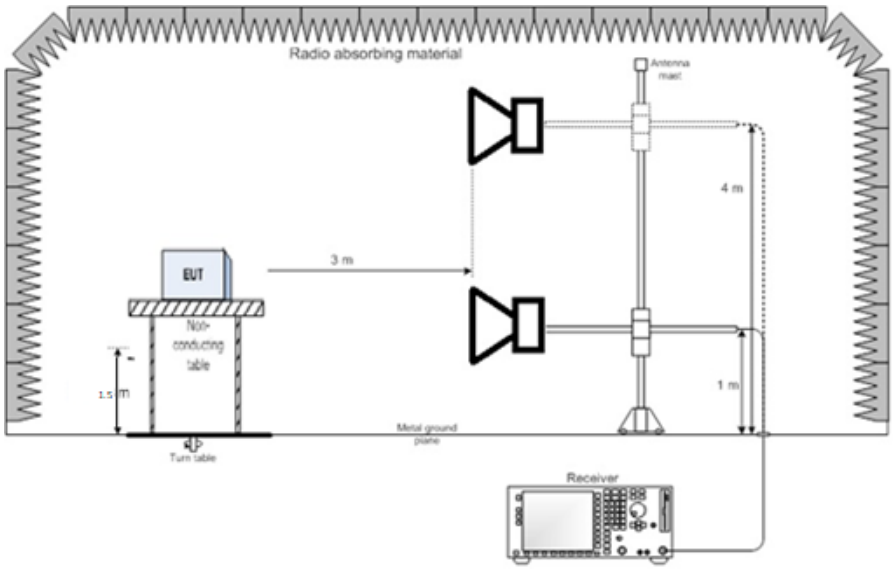

Figure 9.1-2 1 GHz - 26 GHz Setup

Thank you for choosing