ONE WORLD ○ OUR APPROVAL

Test report

400183-1R1TRFWL

Date of issue: July 28, 2020

Applicant:

Akerson Enterprises, LLC

Product:

Wearable Bluetooth Device for Breast Feeding

Model:

Kindred Bravely SmartBra Device

FCC ID: 2AWPX-KBSM1001

Specifications:

- FCC 47 CFR Part 15, Subpart C – §15.247
  Operation within the bands 902 – 928 MHz, 2400 – 2483.5 MHz, 5727 – 5850 MHz
- RSS-247, Issue 2, February 2017
  Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

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	James Cunningham, Wireless Supervisor
Reviewed by	Juan M Gonzalez, EMC & Wireless Divisions Manager
Review date	July 28, 2020
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	Akerson Enterprises, LLC
Address	4015 Avenida De la Plata, Suite 401
City	Oceanside
Province/State	CA
Postal/Zip code	92056
Country	United States

1.2 Manufacturer

Company name	Akerson Enterprises, LLC
Address	4015 Avenida De la Plata, Suite 401
City	Oceanside
Province/State	CA
Postal/Zip code	92056
Country	United States

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 15.247 Measurement Guidance v05r02	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
400183-1TRFWL	Original report issued
400183-1R1TRFWL	Corrected applicant/manufacturer

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
§15.31(e)	Variation of power source	Pass
§15.203	Antenna requirement	Pass

Notes: EUT is battery powered
The antenna is PCB trace antenna, maximum gain 0.49 dBi.

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	July 27, 2020
Nemko sample ID number	NEx: 400183

3.2 EUT information

Product name	Wearable Bluetooth Device for Breast Feeding
Model	Kindred Bravely SmartBra Device
Serial number	129 (Conducted port sample) 130 (Radiated sample)
Part number	N/A

3.3 Technical information

Used IC test site(s) reg. number	2040A
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)	-1.47 dBm e.i.r.p.
Maximum output power (dBm)	-1.20 dBm e.i.r.p.
Measured 6 dB bandwidth	2402 MHz: 719.3 kHz 2440 MHz: 719.3 kHz 2480 MHz: 715.3 kHz
Type of modulation	GFSK
Emission classification	F1D
Power requirements	3 VDC battery
Antenna information	0.49 dBi gain antenna on PCB

3.4 EUT exercise and monitoring details

The EUT is a nursing bra with sensors that detect the opening and closing of the bra cup flaps transmitting this via Bluetooth Low Energy to an app which tracks the nursing time.

The EUT was controlled via test software and commanded to transmit at full power on the required frequencies.

The EUT comprises 2 identical BLE radios. Testing was performed on one such radio.

Table 3.4-1: EUT sub assemblies

Description	Brand name	Model/Part number	Serial number	Rev.
Conducted antenna port sample	Wearable Bluetooth Device for Breast Feeding	Kindred Bravely SmartBra Device	129	N/A
Radiated sample	Wearable Bluetooth Device for Breast Feeding	Kindred Bravely SmartBra Device	130	N/A

Table 3.4-2: EUT interface ports

Description	Qty.
None	

Table 3.4-3: Support equipment

Description	Brand name	Model/Part number	Serial number	Rev.
None				

Table 3.4-4: Inter-connection cables

Cable description	From	To	Length (ft)
None			

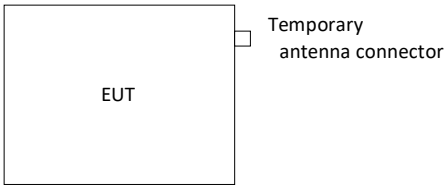

Figure 3.4-1: Test setup

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
Radiated spurious emissions	3.78
Powerline conducted emissions	1.38
All antenna port measurements	0.55
Conducted spurious emissions	1.13

Section 7 Test Equipment

Table 6.1-1: Test Equipment List

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
Signal and spectrum analyzer	Rohde & Schwarz	FSW	E1302	1 year	10 Jan 2021
EMI Test Receiver	Rohde & Schwarz	ESU40	E1121	1 year	25 Nov 2020
System Controller	Sunol Sciences	SC104V	E1129	NCR	NCR
Bilog Antenna	Schaffner	CBL6111C	1480	1 year	18 Oct 2020
DRG Horn	ETS-Lindgren	3117-PA	E1160	1 year	30 Oct 2020
Pre-Amp as part of DRG Horn	ETS-Lindgren	3117-PA	Part of E1160	1 year	30 Oct 2020
2.4 GHz notch filter	Micro-Tonics	HPM50110-01	E1142	VBU	VBU

Notes: VBU – verify before use
NCR – no calibration required

Table 6.1-2: Test Software

Manufacturer of Software	Details
Rohde & Schwarz	EMC 32 V10.60.15 (radiated emissions)

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 References

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	July 28, 2020	Temperature	22 °C
Test engineer	James Cunningham	Air pressure	1004 mbar
Test location	Wireless bench	Relative humidity	68 %

8.1.3 Notes

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

8.1.4 Setup details

EUT setup configuration	Tabletop
Test facility	Wireless bench
Measurement method	558074 D01 DTS Measurement Guidance §8.2 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	719.30	> 500	219.30
2440	719.30	> 500	219.30
2480	715.30	> 500	215.30

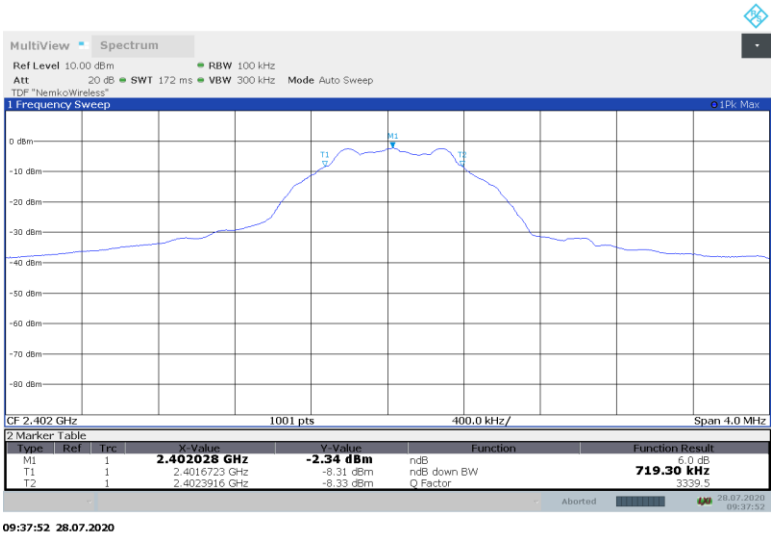

Figure 8.1-1: 6 dB occupied bandwidth, 2402 MHz

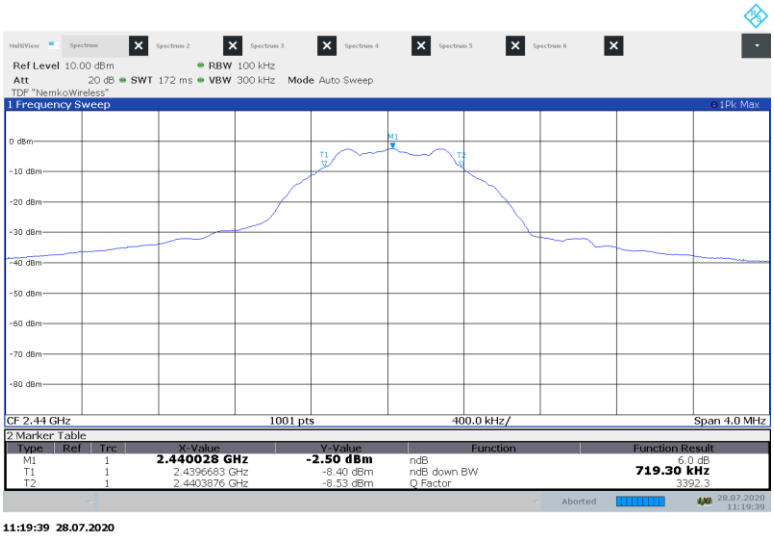

Figure 8.1-2: 6 dB occupied bandwidth, 2440 MHz

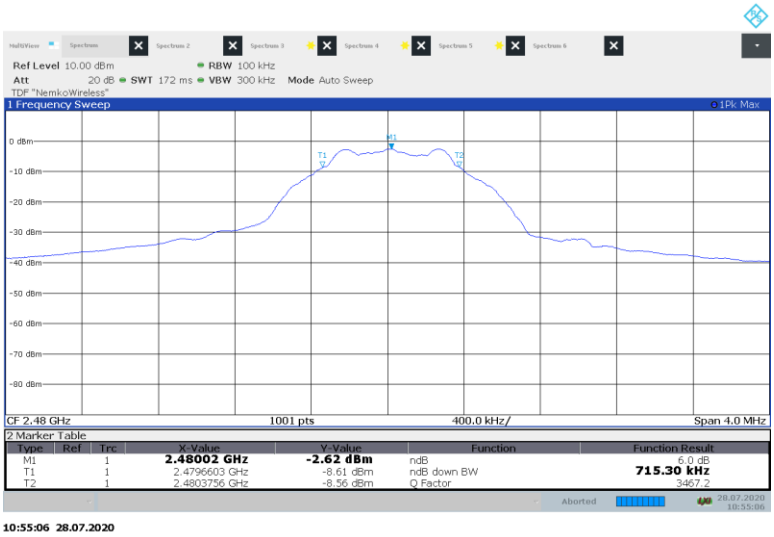

Figure 8.1-3: 6 dB occupied bandwidth, 2480 MHz

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	July 28, 2020	Temperature	22 °C
Test engineer	James Cunningham	Air pressure	1004 mbar
Test location	Wireless bench	Relative humidity	68 %

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 spectrum analyzer as a transducer factor.

The antenna gain is 0.49 dBi per client declaration.

EIRP = Conducted Power + Declared Antenna Gain

8.2.4 Setup details

EUT setup configuration	Tabletop
Test facility	Wireless bench
Measurement method	ANSI C63.10 §11.9.1.1 (RBW ≥ DTS bandwidth)

8.2.5 Test data

Table 8.2-1: Output power

Test Frequency (MHz)	Measured Conducted Power (dBm)	Conducted Limit (dBm)	Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	EIRP Margin (dB)
2402	-1.69	30.0	0.49	-1.20	36.0	37.20
2440	-1.82	30.0	0.49	-1.33	36.0	37.33
2480	-1.96	30.0	0.49	-1.47	36.0	37.47

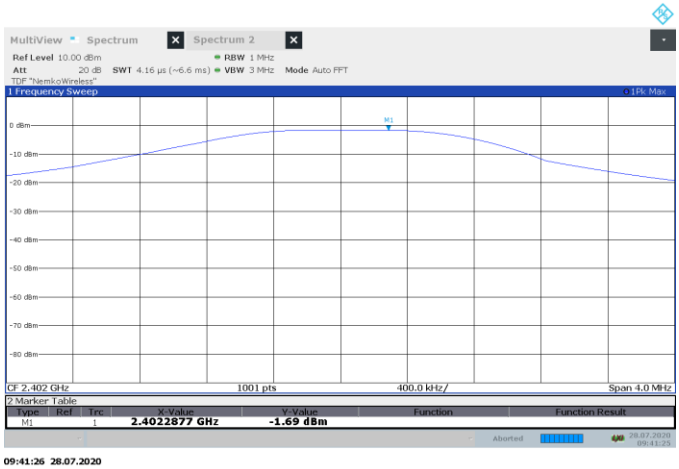

Figure 8.2-1: Output power, 2402 MHz

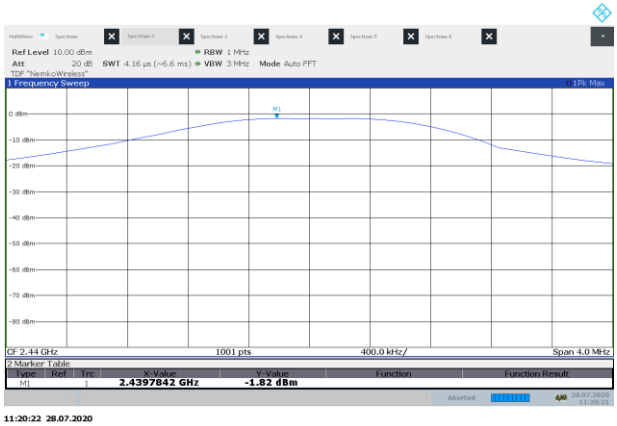

Figure 8.2-2: Output power, 2440 MHz

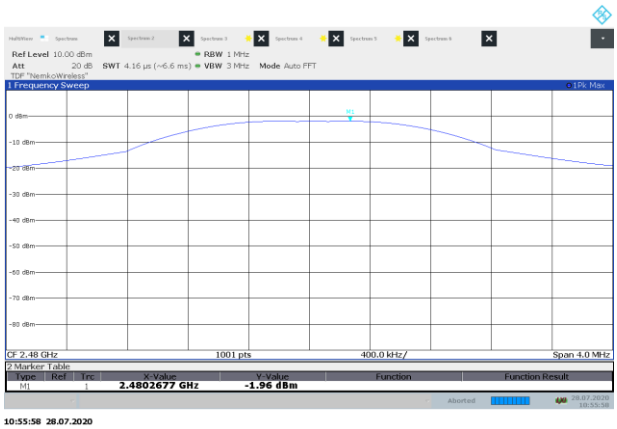

Figure 8.2-3: Output power, 2480 MHz

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	July 27, 2020 (Radiated) July 28, 2020 (Conducted)	Temperature	21 °C (Radiated) 21 °C (Conducted)
Test engineer	James Cunningham	Air pressure	1005 mbar (Radiated) 1004 mbar (Conducted)
Test location	Wireless bench (Conducted) 3m semi-anechoic chamber (Radiated)	Relative humidity	62 % (Radiated) 68 % (Conducted)

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 of 2480 MHz).

Radiated measurements were performed at a 3 m measurement distance.

For conducted measurements, the loss of the connected cable and attenuator was input into the spectrum analyzer as a transducer factor.

8.3.4 Setup details

EUT setup configuration	Tabletop
Test facility	Wireless bench
Measurement details	Conducted band edge measurement performed as per C63.10 §6.10.4 Conducted spurious emissions measurement performed as per C63.10 §11.11.3 Radiated spurious emissions measurement performed as per C63.10 §11.12

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

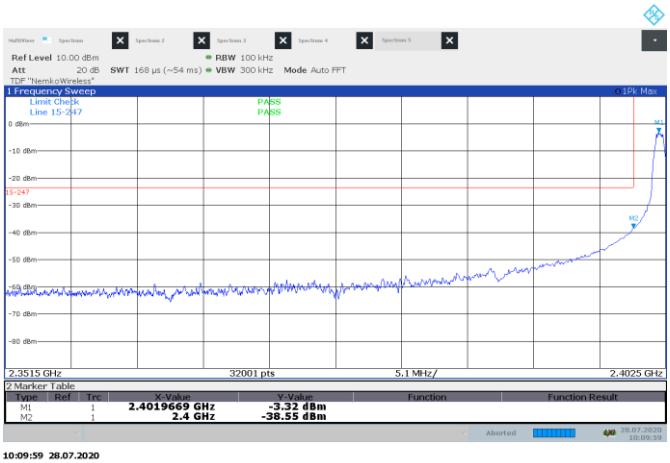

Figure 8.3-1: Band edge measurement, 2402 MHz

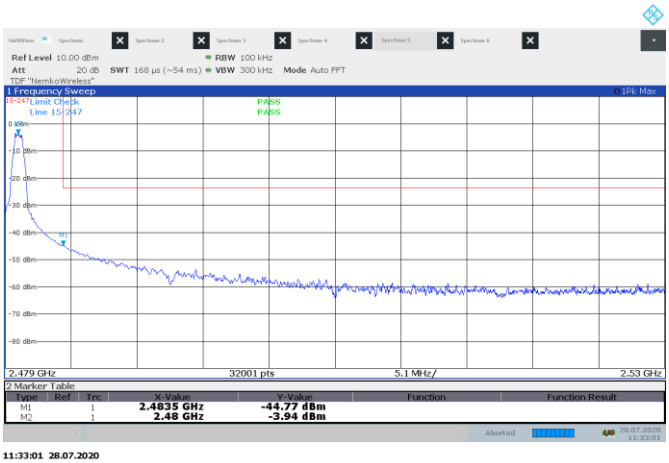

Figure 8.3-2: Band edge measurement, 2480 MHz

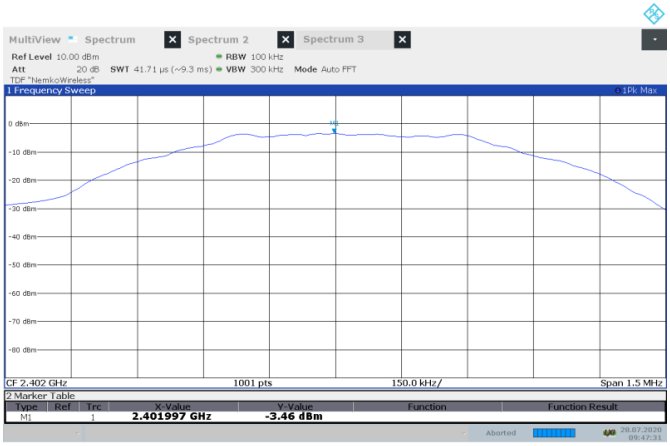

Figure 8.3-3: Reference level measurement (C63.10 §11.11.2), 2402 MHz

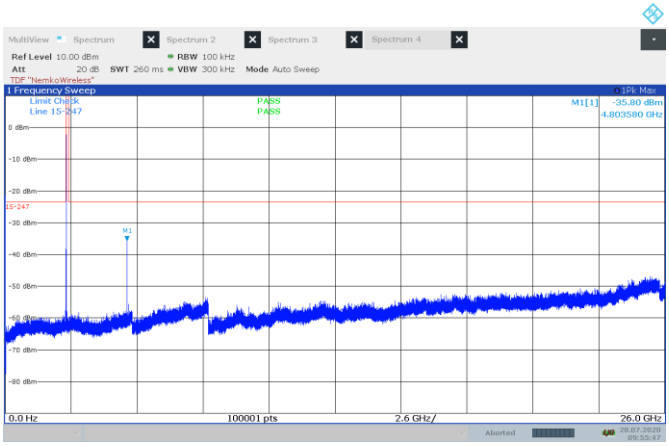

Figure 8.3-4: Conducted spurious emissions (C63.10 §11.11.3), 2402 MHz

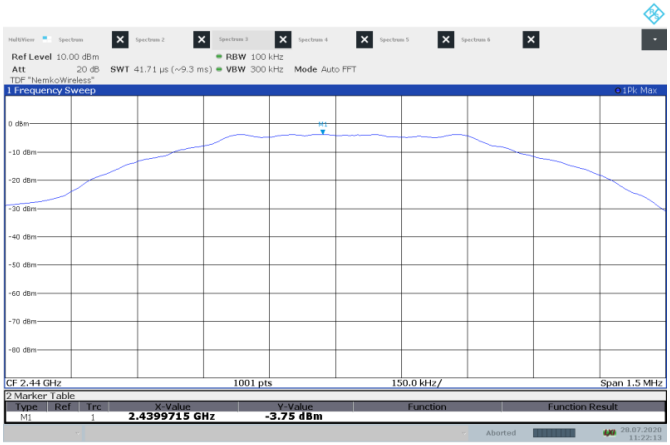

Figure 8.3-5: Reference level measurement (C63.10 §11.11.2), 2440 MHz

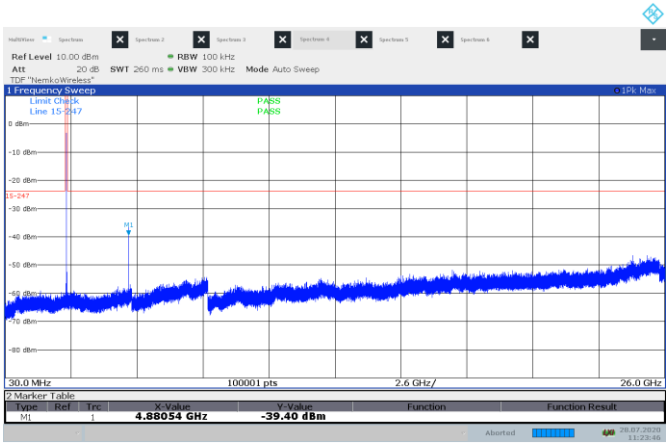

Figure 8.3-6: Conducted spurious emissions (C63.10 §11.11.3), 2440 MHz

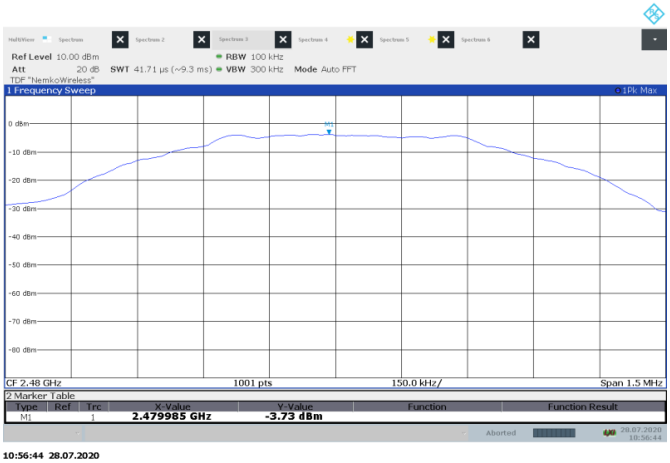

Figure 8.3-7: Reference level measurement (C63.10 §11.11.2), 2480 MHz

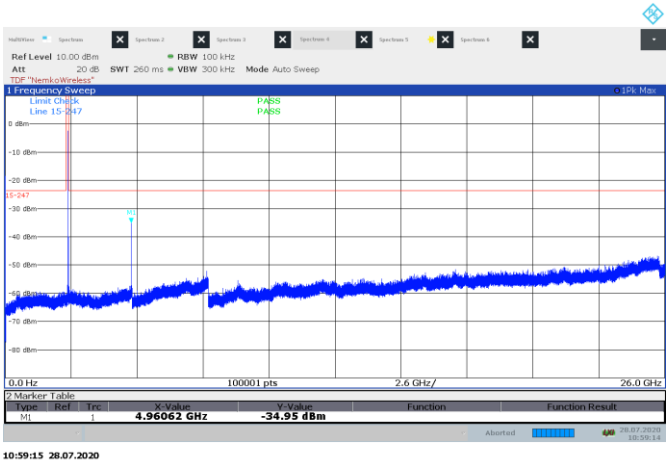

Figure 8.3-8: Conducted spurious emissions (C63.10 §11.11.3), 2480 MHz

Note: For conducted emissions plots above, peaks within 2400-2483.5MHz are transmitter fundamentals signals and are not evaluated against the relevant limits.

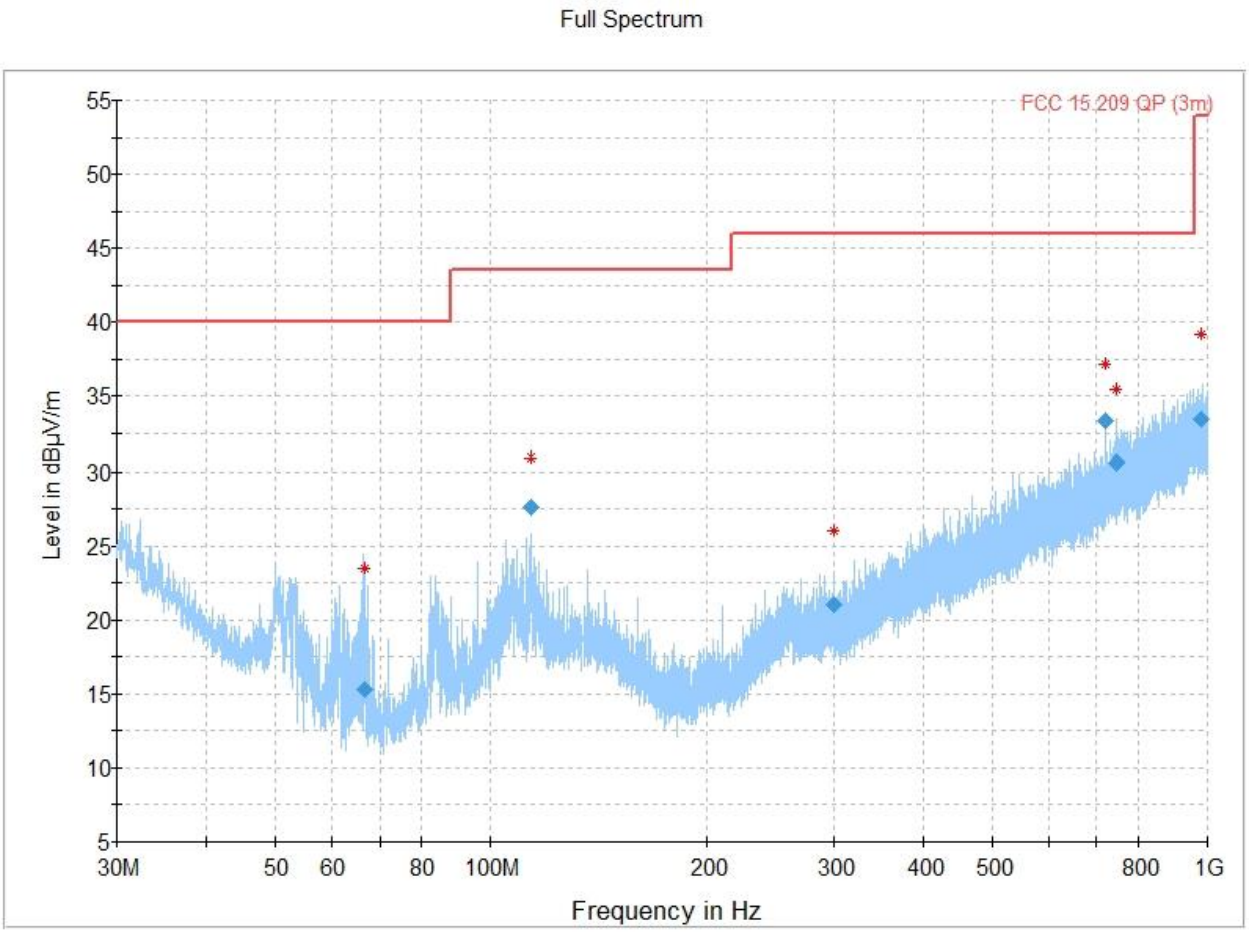

Figure 8.3-9: Radiated emissions, 2402 MHz, 30 – 1000 MHz

Table 8.3-2: Radiated emissions, 2402 MHz, 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)
66.812000	15.32	40.00	24.68	5000.0	120.000	114.0	V	104.0	13.0
113.634000	27.63	43.50	15.87	5000.0	120.000	391.0	V	0.0	18.8
300.003333	21.05	46.00	24.95	5000.0	120.000	129.0	V	237.0	21.6
720.005667	33.34	46.00	12.66	5000.0	120.000	139.0	H	212.0	30.2
746.338667	30.56	46.00	15.44	5000.0	120.000	353.0	V	224.0	30.9
982.424667	33.44	53.90	20.46	5000.0	120.000	361.0	V	11.0	33.7

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.

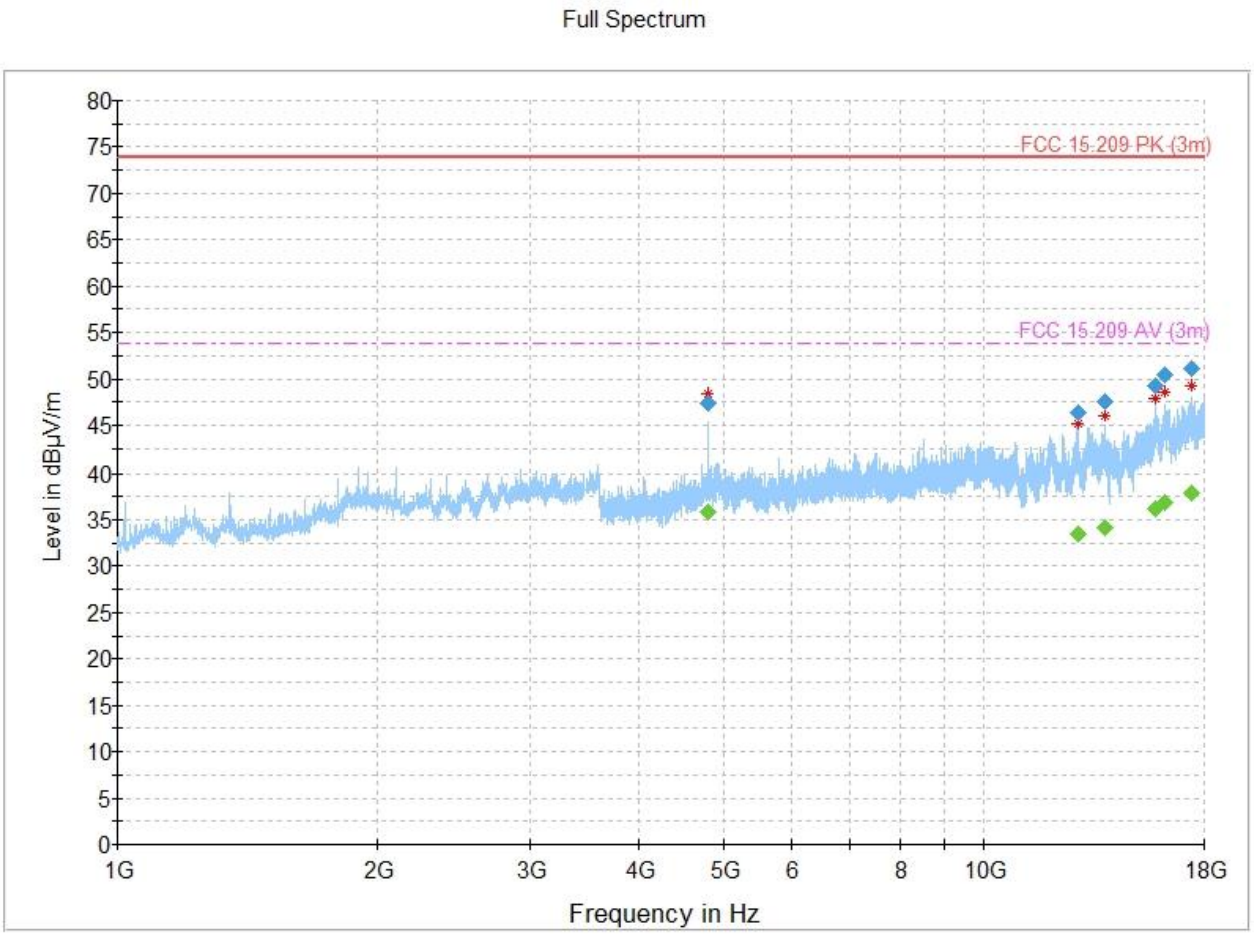

Figure 8.3-10: Radiated emissions, 2402 MHz, 1 - 18 GHz

Table 8.3-3: Radiated emissions, 2402 MHz, 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)
4803.669150	47.47	---	73.90	26.43	5000.0	1000.000	200.0	H	254.0	-2.6
4803.669150	---	35.82	53.90	18.08	5000.0	1000.000	200.0	H	254.0	-2.6
12851.316750	---	33.40	53.90	20.50	5000.0	1000.000	194.0	H	180.0	5.6
12851.316750	46.43	---	73.90	27.47	5000.0	1000.000	194.0	H	180.0	5.6
13807.013800	47.52	---	73.90	26.38	5000.0	1000.000	380.0	H	58.0	8.4
13807.013800	---	34.11	53.90	19.79	5000.0	1000.000	380.0	H	58.0	8.4
15786.976600	49.27	---	73.90	24.63	5000.0	1000.000	344.0	H	0.0	9.2
15786.976600	---	36.24	53.90	17.66	5000.0	1000.000	344.0	H	0.0	9.2
16202.063850	50.37	---	73.90	23.53	5000.0	1000.000	304.0	V	164.0	10.0
16202.063850	---	36.81	53.90	17.09	5000.0	1000.000	304.0	V	164.0	10.0
17378.766350	---	37.83	53.90	16.07	5000.0	1000.000	263.0	H	0.0	11.8
17378.766350	51.19	---	73.90	22.71	5000.0	1000.000	263.0	H	0.0	11.8

Notes: The marker highlights 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 notch filter was used to suppress the transmitter carrier

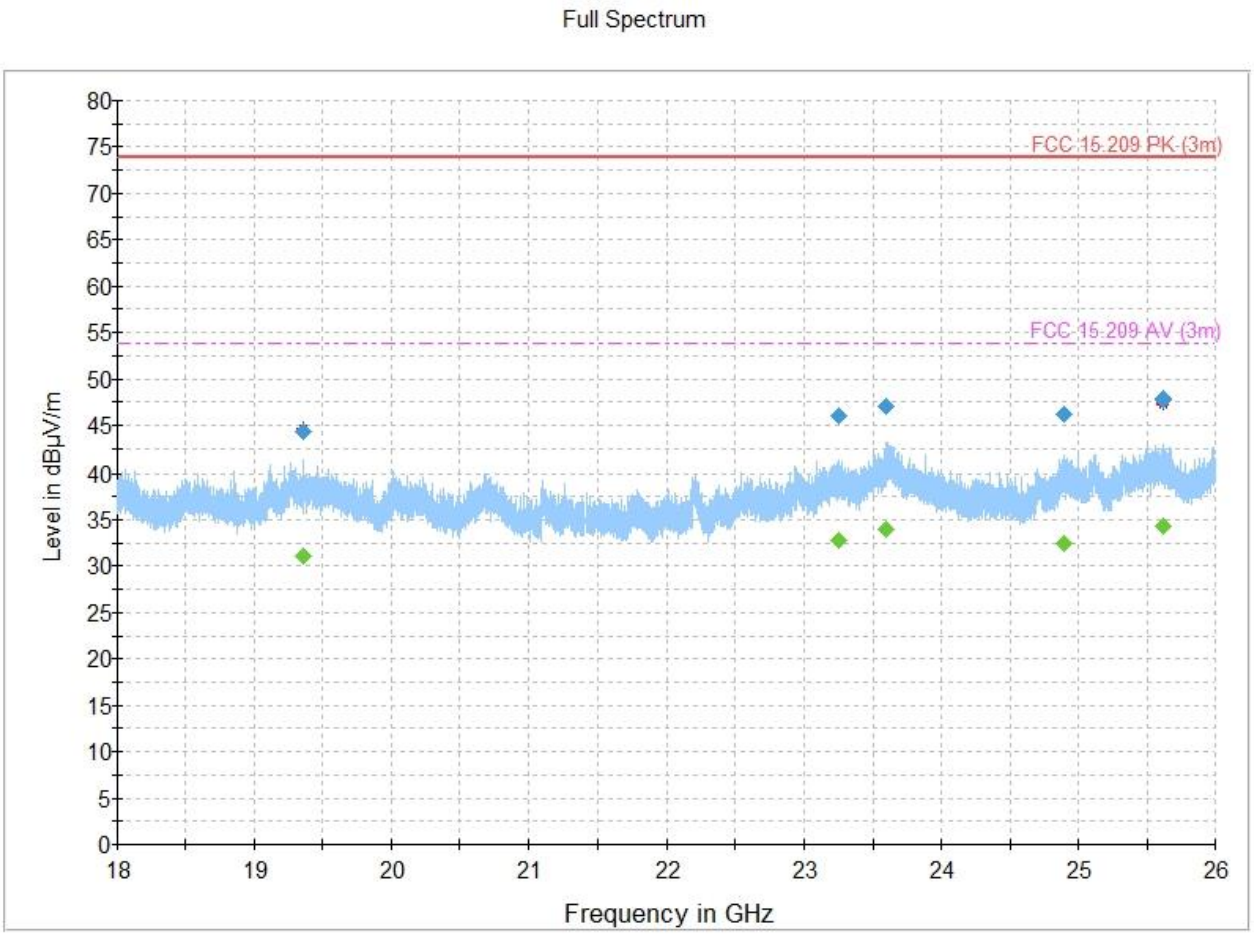

Figure 8.3-11: Radiated emissions, 2402 MHz, 18 - 26 GHz

Table 8.3-4: Radiated emissions, 2402 MHz, 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)
19350.900000	44.38	---	73.90	29.52	5000.0	1000.000	328.0	V	75.0	14.9
19350.900000	---	31.14	53.90	22.76	5000.0	1000.000	328.0	V	75.0	14.9
23256.766667	---	32.80	53.90	21.10	5000.0	1000.000	100.0	V	116.0	18.3
23256.766667	46.00	---	73.90	27.90	5000.0	1000.000	100.0	V	116.0	18.3
23599.966667	---	33.89	53.90	20.01	5000.0	1000.000	269.0	V	0.0	20.4
23599.966667	47.04	---	73.90	26.86	5000.0	1000.000	269.0	V	0.0	20.4
24895.966667	46.19	---	73.90	27.71	5000.0	1000.000	410.0	H	87.0	18.7
24895.966667	---	32.52	53.90	21.38	5000.0	1000.000	410.0	H	87.0	18.7
25619.833333	47.76	---	73.90	26.14	5000.0	1000.000	332.0	V	166.0	19.2
25619.833333	---	34.33	53.90	19.57	5000.0	1000.000	332.0	V	166.0	19.2
25625.433333	47.89	---	73.90	26.01	5000.0	1000.000	331.0	V	221.0	19.2
25625.433333	---	34.38	53.90	19.52	5000.0	1000.000	331.0	V	221.0	19.2

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.

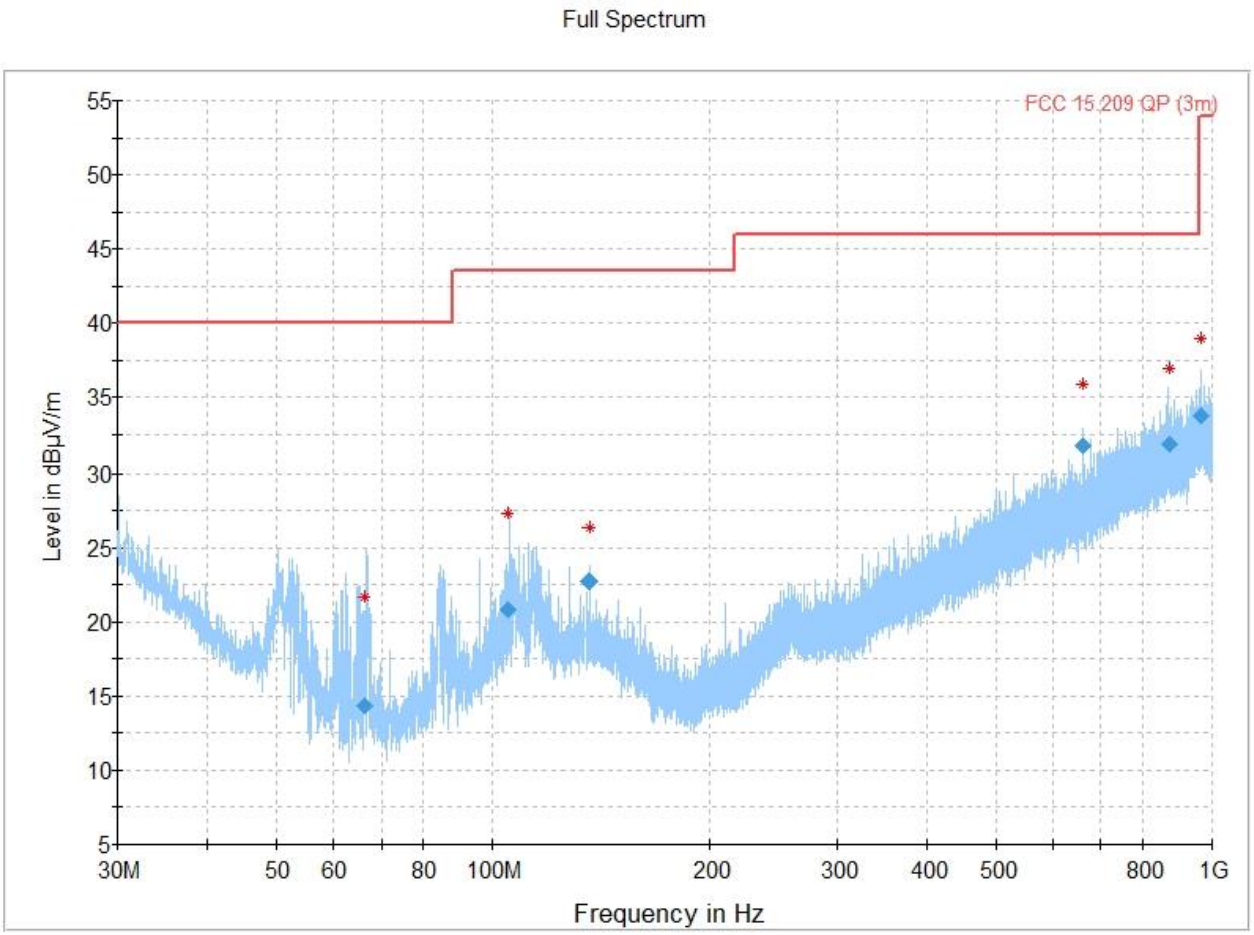

Figure 8.3-12: Radiated emissions, 2440 MHz, 30 – 1000 MHz

Table 8.3-5: Radiated emissions, 2440 MHz, 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)
66.335333	14.33	40.00	25.67	5000.0	120.000	100.0	V	117.0	12.9
105.247667	20.77	43.50	22.73	5000.0	120.000	330.0	V	33.0	18.1
135.993333	22.74	43.50	20.76	5000.0	120.000	367.0	V	104.0	19.4
659.995000	31.73	46.00	14.27	5000.0	120.000	312.0	V	312.0	29.2
870.512333	31.84	46.00	14.16	5000.0	120.000	281.0	V	80.0	32.4
967.674000	33.76	53.90	20.14	5000.0	120.000	203.0	H	252.0	34.1

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.

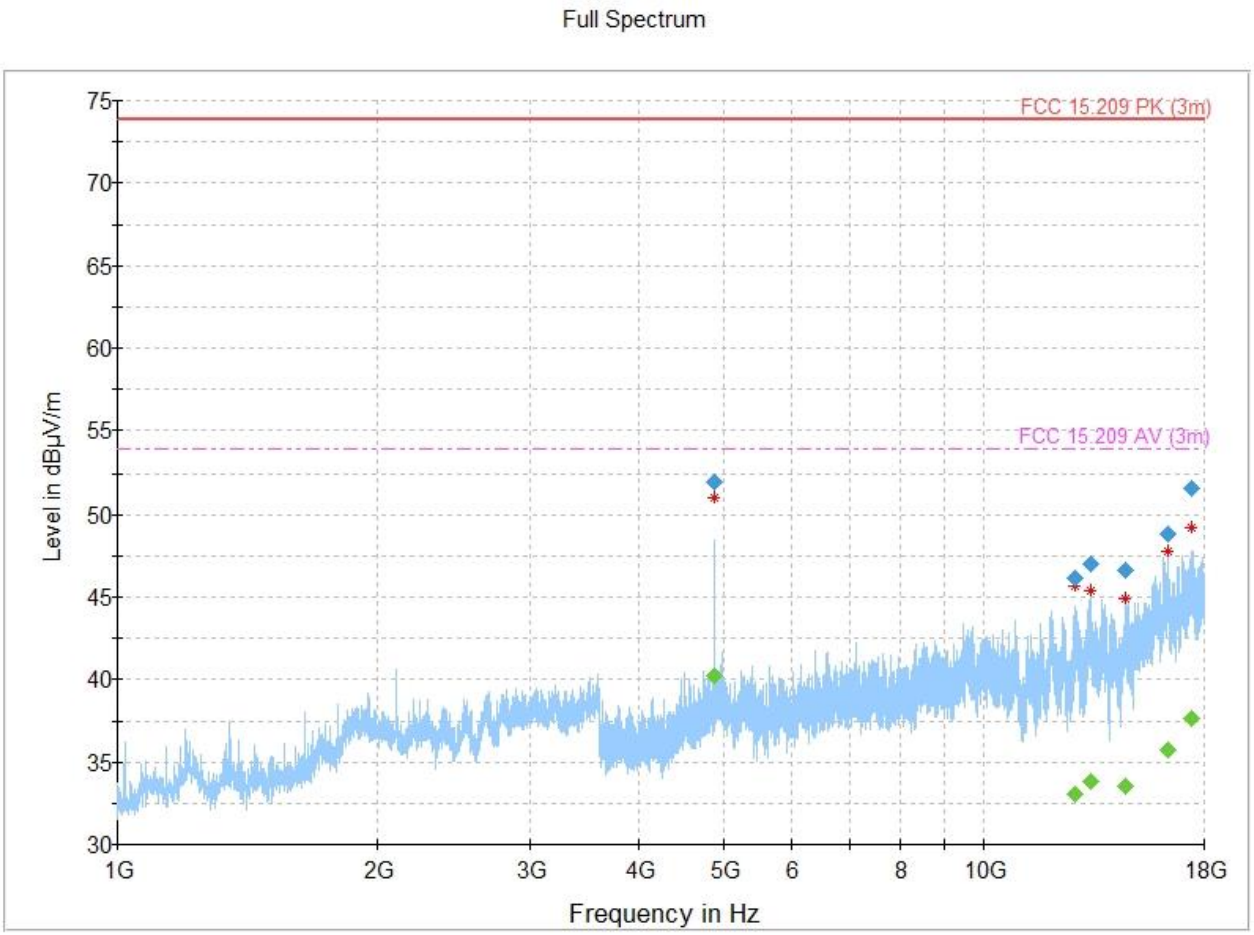

Figure 8.3-13: Radiated emissions, 2440 MHz, 1 - 18 GHz

Table 8.3-6: Radiated emissions, 2440 MHz, 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)
4880.577500	51.94	---	73.90	21.96	5000.0	1000.000	208.0	H	270.0	-2.8
4880.577500	---	40.18	53.90	13.72	5000.0	1000.000	208.0	H	270.0	-2.8
12783.557950	---	33.05	53.90	20.85	5000.0	1000.000	150.0	H	326.0	5.5
12783.557950	46.19	---	73.90	27.72	5000.0	1000.000	150.0	H	326.0	5.5
13288.044150	46.97	---	73.90	26.93	5000.0	1000.000	128.0	V	222.0	7.7
13288.044150	---	33.85	53.90	20.05	5000.0	1000.000	128.0	V	222.0	7.7
14581.927550	---	33.49	53.90	20.41	5000.0	1000.000	215.0	V	270.0	7.4
14581.927550	46.65	---	73.90	27.25	5000.0	1000.000	215.0	V	270.0	7.4
16334.117850	48.79	---	73.90	25.11	5000.0	1000.000	403.0	H	0.0	10.7
16334.117850	---	35.69	53.90	18.21	5000.0	1000.000	403.0	H	0.0	10.7
17424.173050	51.56	---	73.90	22.34	5000.0	1000.000	217.0	H	255.0	11.6
17424.173050	---	37.69	53.90	16.21	5000.0	1000.000	217.0	H	255.0	11.6

Notes:
The marker highlights 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 notch filter was used to suppress the transmitter carrier

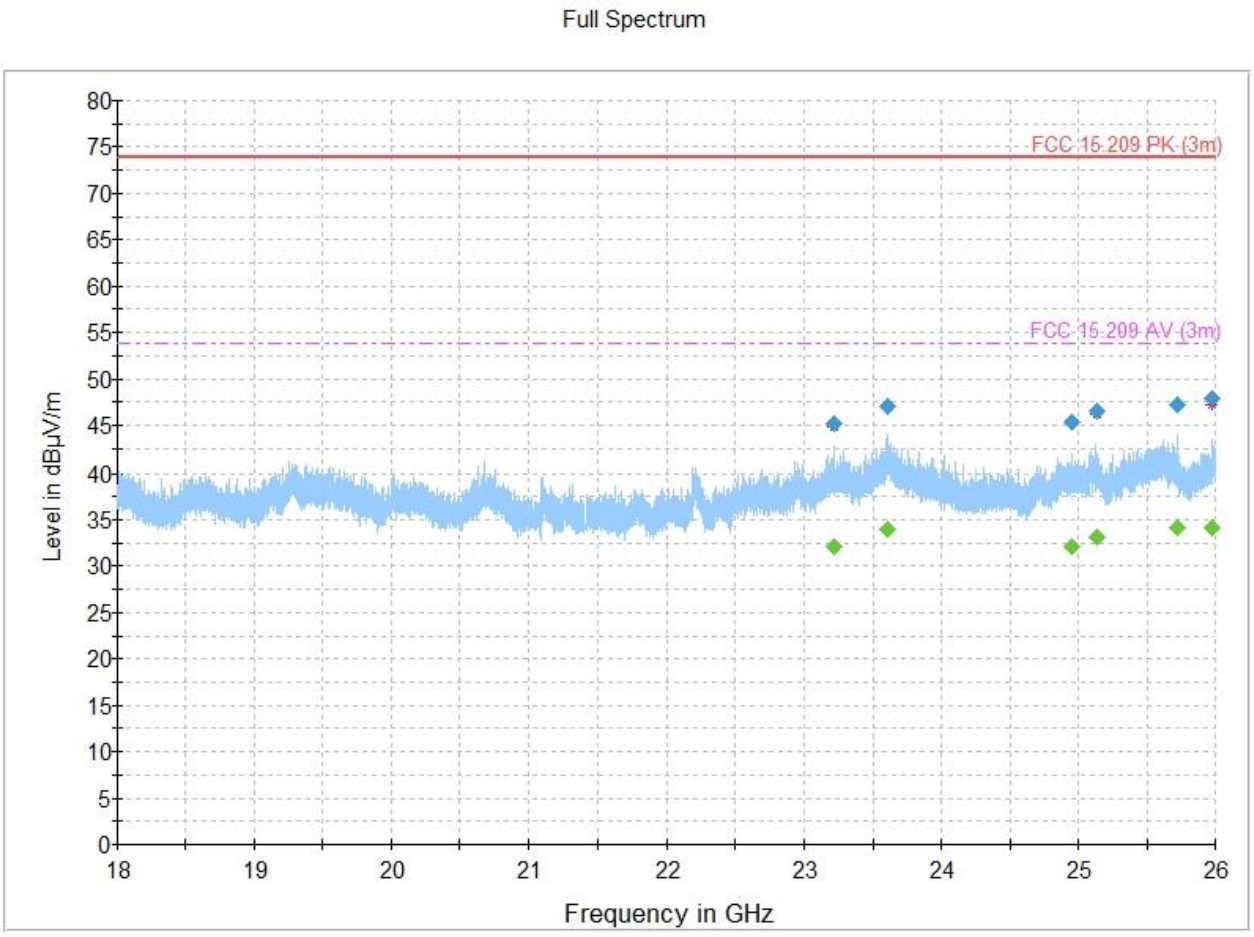

Figure 8.3-14: Radiated emissions, 2440 MHz, 18 - 26 GHz

Table 8.3-7: Radiated emissions, 2440 MHz, 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)
23215.366667	45.20	---	73.90	28.70	5000.0	1000.000	394.0	H	0.0	17.6
23215.366667	---	32.16	53.90	21.74	5000.0	1000.000	394.0	H	0.0	17.6
23613.233333	---	33.89	53.90	20.01	5000.0	1000.000	400.0	V	127.0	20.3
23613.233333	47.04	---	73.90	26.86	5000.0	1000.000	400.0	V	127.0	20.3
24954.500000	45.43	---	73.90	28.47	5000.0	1000.000	355.0	V	127.0	18.8
24954.500000	---	32.08	53.90	21.82	5000.0	1000.000	355.0	V	127.0	18.8
25134.033333	---	33.11	53.90	20.79	5000.0	1000.000	384.0	H	307.0	18.9
25134.033333	46.55	---	73.90	27.35	5000.0	1000.000	384.0	H	307.0	18.9
25718.633333	47.16	---	73.90	26.74	5000.0	1000.000	402.0	V	163.0	19.2
25718.633333	---	34.06	53.90	19.84	5000.0	1000.000	402.0	V	163.0	19.2
25975.966667	47.87	---	73.90	26.03	5000.0	1000.000	377.0	V	317.0	20.4
25975.966667	---	34.12	53.90	19.78	5000.0	1000.000	377.0	V	317.0	20.4

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.

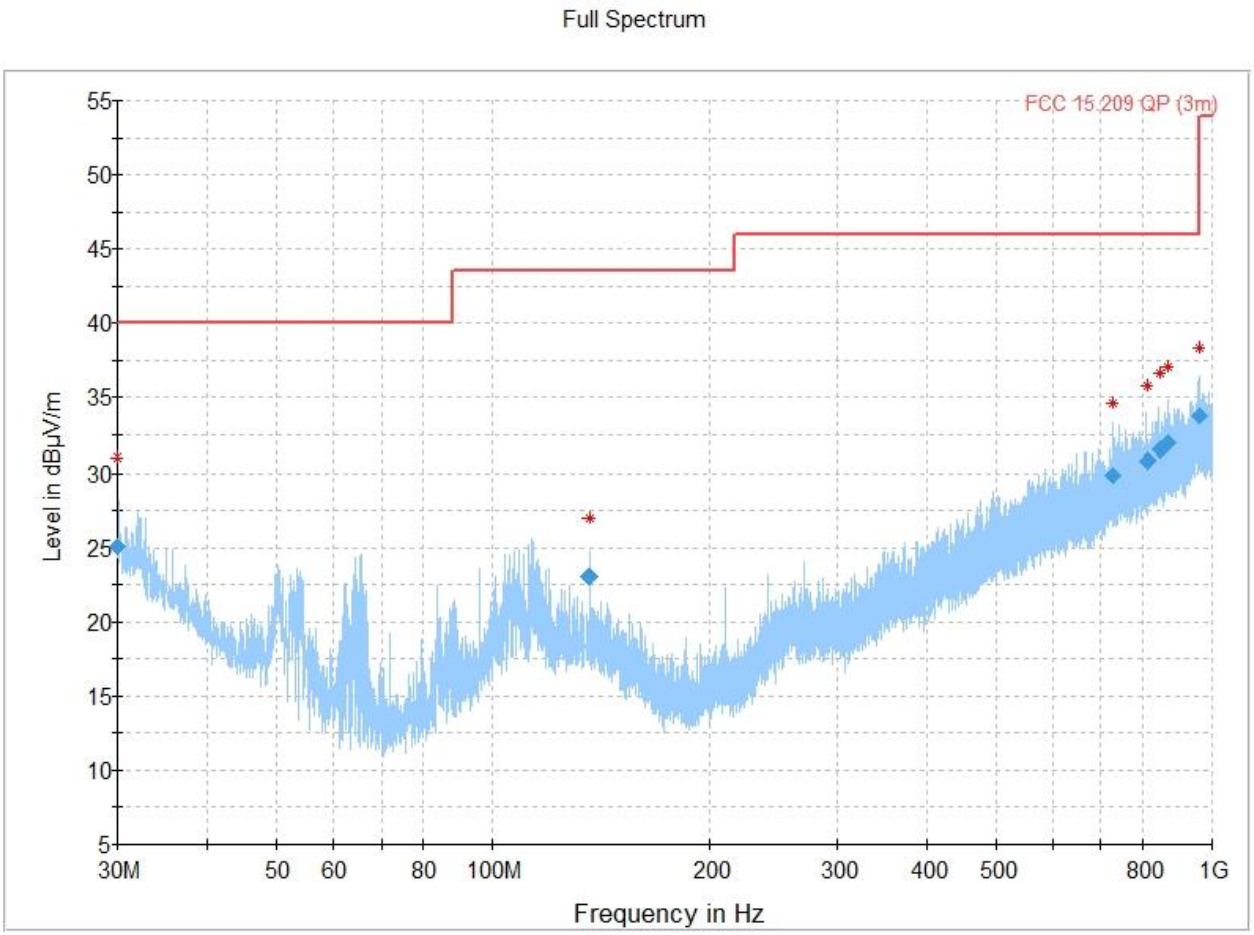

Figure 8.3-15: Radiated emissions, 2480 MHz, 30 – 1000 MHz

Table 8.3-8: Radiated emissions, 2480 MHz, 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)
30.060000	25.10	40.00	14.90	5000.0	120.000	182.0	V	128.0	26.4
136.048667	23.08	43.50	20.43	5000.0	120.000	401.0	V	333.0	19.4
727.238000	29.85	46.00	16.15	5000.0	120.000	402.0	V	356.0	30.4
810.979000	30.79	46.00	15.21	5000.0	120.000	240.0	V	132.0	31.3
844.750333	31.58	46.00	14.42	5000.0	120.000	267.0	V	126.0	32.2
867.912000	31.94	46.00	14.06	5000.0	120.000	322.0	V	224.0	32.5
958.057333	33.72	46.00	12.28	5000.0	120.000	128.0	H	330.0	34.1

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.

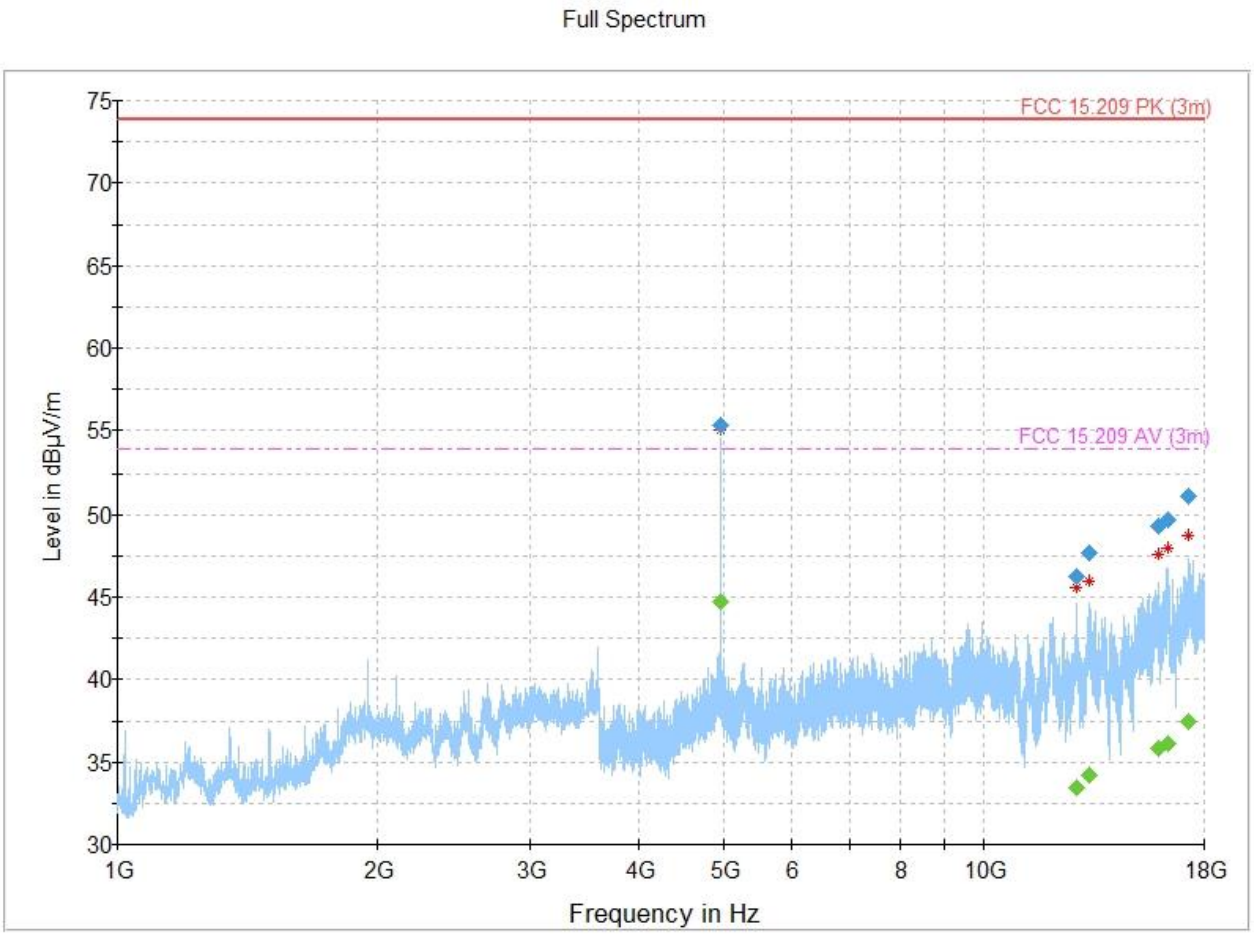

Figure 8.3-16: Radiated emissions, 2480 MHz, 1 - 18 GHz

Table 8.3-9: Radiated emissions, 2480 MHz, 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)
4959.456550	55.36	---	73.90	18.54	5000.0	1000.000	195.0	H	95.0	-3.0
4959.456550	---	44.72	53.90	9.18	5000.0	1000.000	195.0	H	95.0	-3.0
12805.274400	---	33.43	53.90	20.47	5000.0	1000.000	231.0	V	320.0	5.5
12805.274400	46.20	---	73.90	27.70	5000.0	1000.000	231.0	V	320.0	5.5
13253.365750	---	34.18	53.90	19.72	5000.0	1000.000	291.0	H	173.0	7.4
13253.365750	47.71	---	73.90	26.19	5000.0	1000.000	291.0	H	173.0	7.4
15926.446850	49.29	---	73.90	24.61	5000.0	1000.000	150.0	V	238.0	9.3
15926.446850	---	35.87	53.90	18.03	5000.0	1000.000	150.0	V	238.0	9.3
16312.972800	---	36.15	53.90	17.75	5000.0	1000.000	327.0	H	201.0	10.9
16312.972800	49.71	---	73.90	24.19	5000.0	1000.000	327.0	H	201.0	10.9
17287.024050	---	37.44	53.90	16.46	5000.0	1000.000	108.0	V	110.0	12.6
17287.024050	51.08	---	73.90	22.82	5000.0	1000.000	108.0	V	110.0	12.6

Notes:
The marker highlights 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 notch filter was used to suppress the transmitter carrier

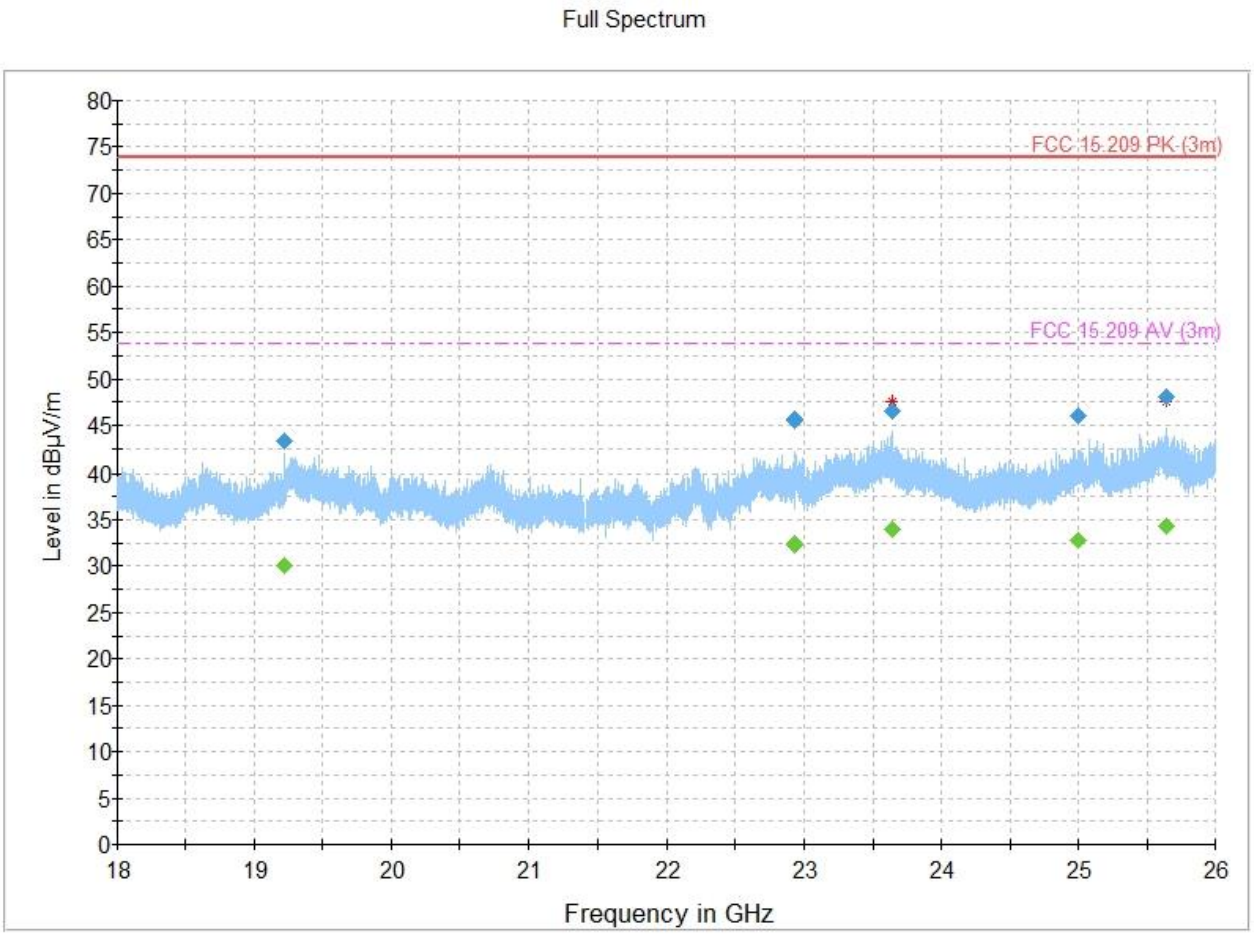

Figure 8.3-17: Radiated emissions, 2480 MHz, 18 - 26 GHz

Table 8.3-10: Radiated emissions, 2480 MHz, 18 - 26 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)
19222.766667	43.31	---	73.90	30.59	5000.0	1000.000	267.0	H	273.0	14.2
19222.766667	---	30.02	53.90	23.88	5000.0	1000.000	267.0	H	273.0	14.2
22930.633333	45.70	---	73.90	28.20	5000.0	1000.000	100.0	H	0.0	17.1
22930.633333	---	32.20	53.90	21.70	5000.0	1000.000	100.0	H	0.0	17.1
22935.233333	45.50	---	73.90	28.40	5000.0	1000.000	267.0	H	22.0	17.0
22935.233333	---	32.45	53.90	21.45	5000.0	1000.000	267.0	H	22.0	17.0
23640.100000	---	33.89	53.90	20.01	5000.0	1000.000	100.0	H	250.0	20.1
23640.100000	46.60	---	73.90	27.30	5000.0	1000.000	100.0	H	250.0	20.1
25003.366667	---	32.74	53.90	21.16	5000.0	1000.000	358.0	H	327.0	19.0
25003.366667	46.11	---	73.90	27.79	5000.0	1000.000	358.0	H	327.0	19.0
25642.100000	48.13	---	73.90	25.77	5000.0	1000.000	201.0	H	102.0	19.2
25642.100000	---	34.31	53.90	19.59	5000.0	1000.000	201.0	H	102.0	19.2

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 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)

(a) 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	July 28, 2020	Temperature	22 °C
Test engineer	James Cunningham	Air pressure	1004 mbar
Test location	Wireless bench	Relative humidity	68 %

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 and a suitable attenuator. The loss of this assembly was corrected for via a transducer factor 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	3 kHz
Video bandwidth	10 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/3 kHz)	Limit (dBm/3 kHz)	Margin (dB)
2402	-3.46	8.00	11.46
2440	-3.75	8.00	11.75
2480	-3.73	8.00	11.73

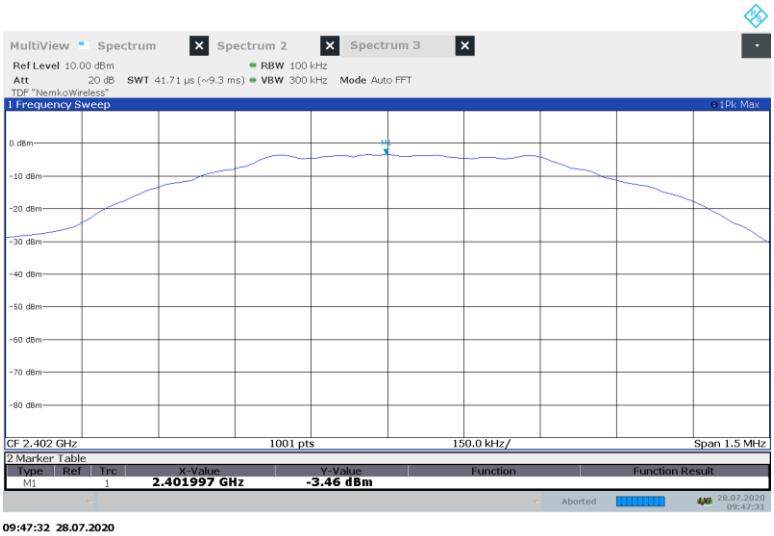

Figure 8.4-1: Power spectral density of digital transmission system, 2402 MHz

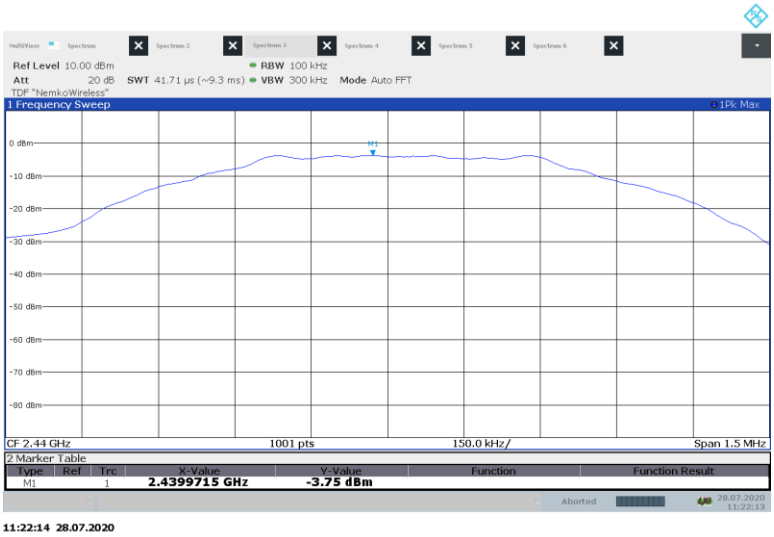

Figure 8.4-2: Power spectral density of digital transmission system, 2440 MHz

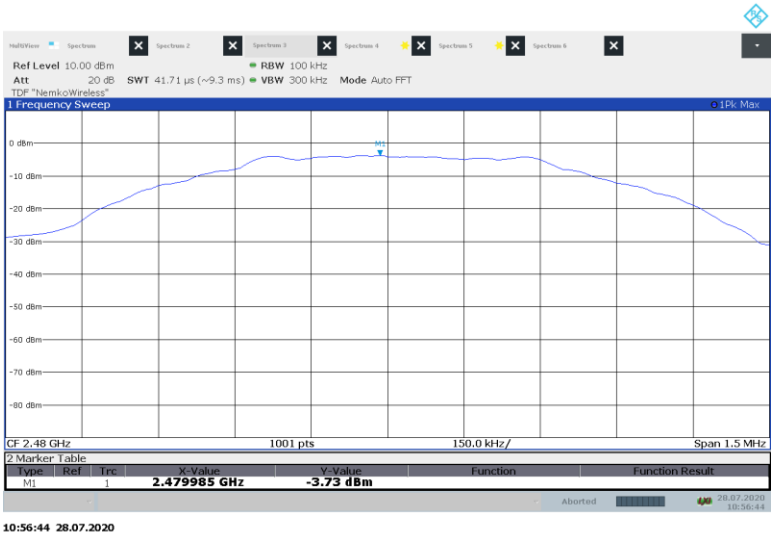

Figure 8.4-3: Power spectral density of digital transmission system, 2480 MHz

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	July 28, 2020	Temperature	22 °C
Test engineer	James Cunningham	Air pressure	1004 mbar
Test location	Wireless bench	Relative humidity	68 %

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	100 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 (MHz)
2402	1.1056
2440	1.1205
2480	1.1186

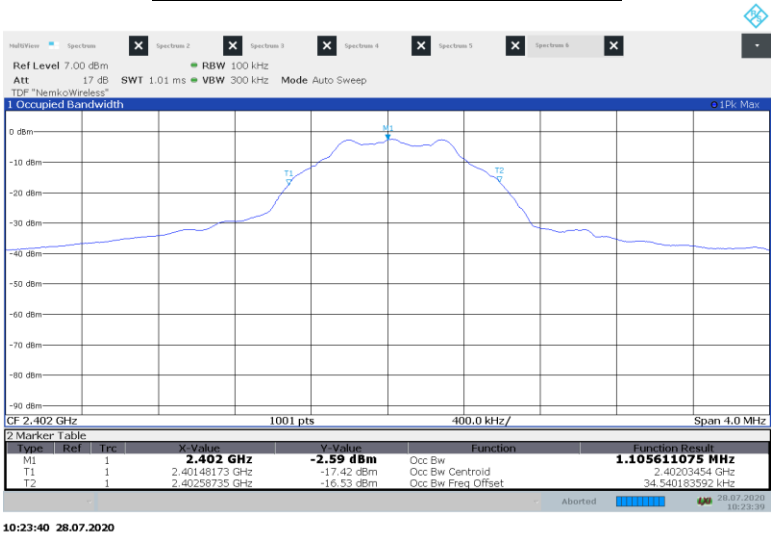

Figure 8.5-1: 99% bandwidth, 2402 MHz

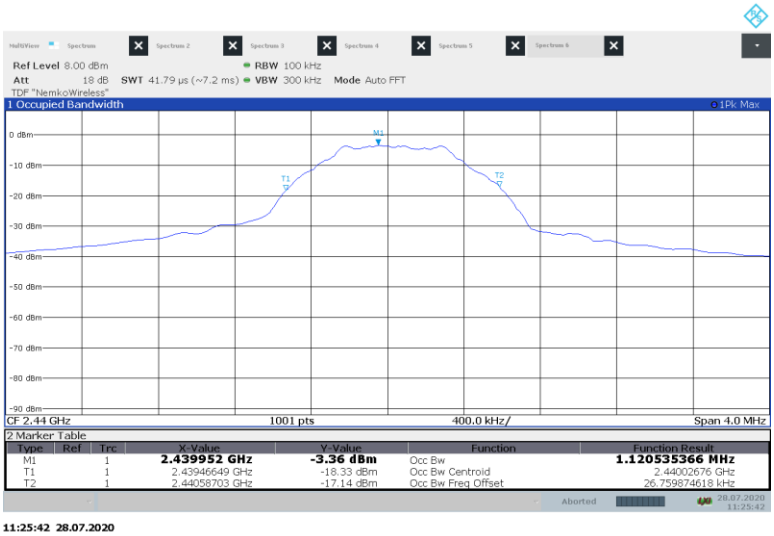

Figure 8.5-2: 99% bandwidth, 2440 MHz

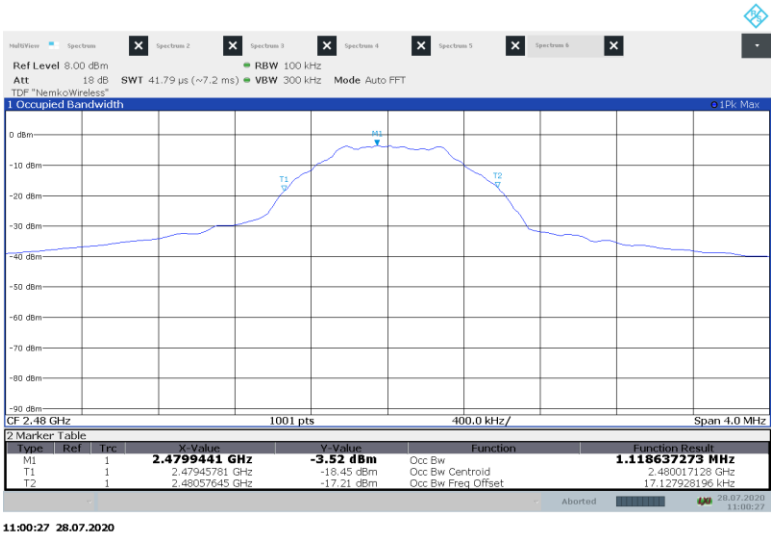

Figure 8.5-3: 99% bandwidth, 2480 MHz

Section 9 Block diagrams of test set-ups

9.1 Radiated emissions set-up

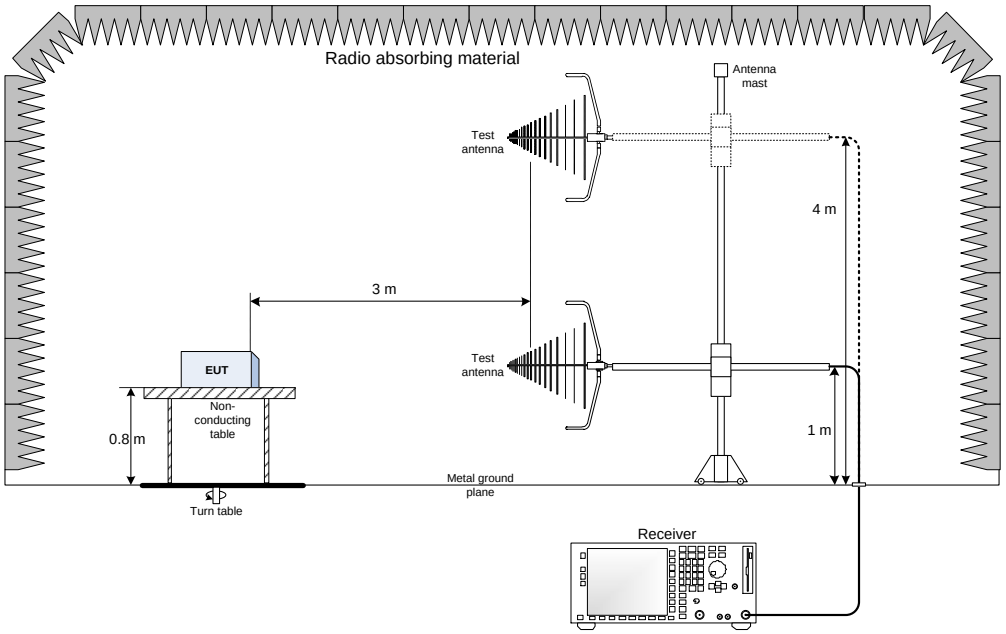

Figure 9.1-1 30 MHz - 1000 MHz Setup

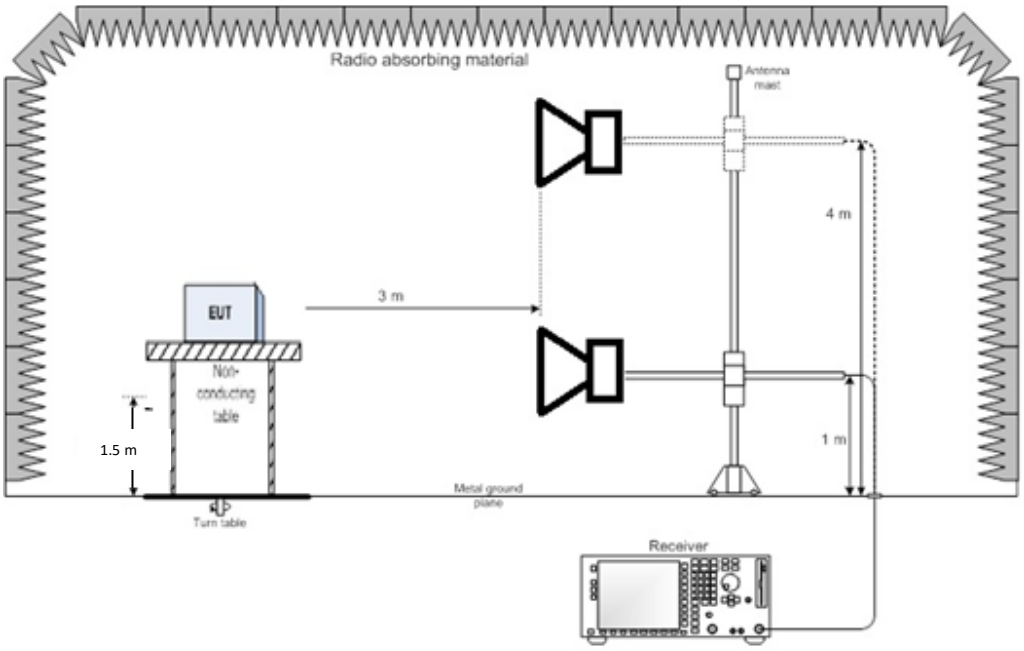

Figure 9.1-2 1 GHz - 26 GHz Setup

Thank you for choosing