Test report

PRJ0015832-4TRFWL

Date of issue: November 23, 2022

Applicant:

Eko Devices

Product:

Combination ECG / Auscultation Device

Model:	Variant(s):
DUO3	None

FCC ID: 2ANB3-E8

IC ID: 23063-E8

Specifications:

- FCC 47 CFR Part 15, Subpart C – §15.247
  Operation within the bands 902 – 928 MHz, 2400 – 2483.5 MHz, 5725 – 5850 MHz
- Industry Canada 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	Lan Sayasane, EMC Test Engineer
Reviewed by	James Cunningham, EMC/MIL/WL Supervisor
Review date	November 23, 2022
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

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Section 1 Report summary

1.1 Test specifications

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

1.2 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

1.3 Exclusions

None.

1.4 Statement of compliance

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

Results obtained indicate that the product under test complies in full with the tested requirements.

The test results relate only to the item(s) tested.

See “Section 2 Summary of test results” for full details.

1.5 Test report revision history

Table 1.5-1: *Test report revision history*

Revision #	Issue Date	Details of changes made to test report
PRJ0015832-4TRFWL	November 23, 2022	Original report issued

Section 2 Summary of test results

2.1 FCC Part 15, Subpart C, general requirements

Part	Test description	Verdict
§15.207(a)	Conducted limits	Pass [1]
§15.31(e)	Variation of power source	Pass
§15.203	Antenna requirement	Pass [2]
§15.215(c)	20 dB bandwidth	Pass

Note 1: The EUT is AC powered
Note 2: The antenna is integral to the EUT and cannot be removed

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 5275 – 5850 MHz bands	Pass
§15.247(b)(4)	Transmitting antennas of directional gain greater than 6 dBi	Not applicable
§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 (a)	Bandwidth of a frequency hopping channel	Not applicable
5.1 (b)	Minimum channel spacing for frequency hopping systems	Not applicable
5.1 (c)	Frequency hopping systems operating in the 902–928 MHz band	Not applicable
5.1 (d)	Frequency hopping systems operating in the 2400–2483.5 MHz band	Not applicable
5.1 (e)	Frequency hopping systems operating in the 5725–5850 MHz band	Not applicable
5.2 (a)	Minimum 6 dB bandwidth	Pass
5.2 (b)	Maximum power spectral density	Pass
5.3 (a)	Digital modulation turned off	Not applicable
5.3 (b)	Frequency hopping turned off	Not applicable
5.4 (a)	Frequency hopping systems operating in the 902–928 MHz band	Not applicable
5.4 (b)	Frequency hopping systems operating in the 2400–2483.5 MHz band	Not applicable
5.4 (c)	Frequency hopping systems operating in the 5725–5850 MHz	Not applicable
5.4 (d)	Systems employing digital modulation techniques	Pass
5.4 (e)	Point-to-point systems in 2400–2483.5 MHz and 5725–5850 MHz band	Not applicable
5.4 (f)	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
6.7	99% Occupied bandwidth	Pass
7.3	Receiver radiated emission limits	Not applicable [1]
7.4	Receiver conducted emission limits	Not applicable [2]
8.8	Power Line Conducted Emissions Limits for License-Exempt Radio Apparatus	Pass [3]

Note 1: EUT is neither a stand-alone receiver nor a scanning receiver.
Note 2: The EUT is AC powered

Section 3 Equipment under test (EUT) details

3.1 Disclaimer

This section contains information provided by the applicant and has been utilized to support the test plan. Inaccurate information provided by the applicant can affect the validity of the results within this test report. Nemko accepts no responsibility for the information contained within this section and the impact it may have on the test plan and resulting measurements.

3.2 Sample information

Receipt date	23-Sep-22
Nemko sample ID number	PRj0015832

3.3 Applicant

Company name	Eko Devices
Address	1212 Broadway, Suite 100
City	Oakland
State	CA
Postal/Zip code	94612
Country	USA

3.4 Manufacturer

Company name	Eko Devices
Address	1212 Broadway, Suite 100
City	Oakland
State	CA
Postal/Zip code	94612
Country	USA

3.5 EUT information

Product name	Combination ECG / Auscultation Device
Model	DUO3
Variant(s)	None
Serial number	FF076 (Conducted) / FF079 (Radiated)
Part number	N/A
Power requirements	3.7V Lithium Ion Battery; 5Vdc (USB-C) cable
Description/theory of operation	The Eko DUO3 s a Class II medical device that provides the ability to capture, store, and share heart sounds and ECG readings. It consists of a hardware component with detachable earpieces and a mobile App. The device can be used as an electronic stethoscope using the device's face as a stethoscope diaphragm, allowing the user to auscultate organs, record the sounds, adjust playback volume, and share the recordings. In addition, DUO3 features a three leads ECG that can read and display the electrical activity of the heart in conjunction with the heart sounds. With the mobile App, recordings and notes can be shared with healthcare professionals. The user interface is a screen and three tactile switches. There is also a capacitive sensing electrode that causes the device to turn on when it is held in a user's hand.
Operational frequencies	2.4 GHz (Bluetooth)
Software details	Eko DUO3 Embedded FW Version 0.0.7
Operating band	2400 – 2483.5 MHz
Test frequencies	2402 MHz, 2440 MHz, 2480 MHz
Modulation type(s)	GFSK
Antenna type	Integrated
Antenna gain (declared)	1.80 dBi
Nominal channel spacing	2 MHz

3.6 EUT exercise and monitoring details

EUT description of the methods used to exercise the EUT and all relevant ports:

- The EUT always operates in Data Collection Mode when the USB-C port is not connected. In Data Collection mode the EUT samples data from ECG sensors and an Audio sensor. The two data streams are transmitted via Bluetooth to a mobile device such as an IPhone. ECG data is displayed on the included screen and Audio is played out of the TRS jack. The device is always in Charging Mode when connected to a USB-C port providing 5V power.

EUT setup/configuration rationale:

- The EUT setup in a configuration that was expected to produce the highest amplitude emissions relative to the limit and that satisfy normal operation/installation practice by the end user.
- The type and construction of cables used in the measurement set-up were consistent with normal or typical use. Cables with mitigation features (for example, screening, tighter/more twists per length, ferrite beads) have been noted below:
  - None
- The EUT was setup in a manner that was consistent with its typical arrangement and use. The measurement arrangement of the EUT, local ancillary equipment and associated cabling was representative of normal practice. Any deviations from typical arrangements have been noted below:
  - None

3.7 EUT setup details

Table 3.7-1: *EUT sub assemblies*

Description	Brand name	Model/Part number	Serial number	Rev.
Combination ECG / Auscultation Device	Eko Devices	DUO3	FF076 (Conducted) / FF079 (Radiated)	--

Table 3.7-2: *EUT interface ports*

Description	Qty.
USB-C port	1

Table 3.7-3: *Support equipment*

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

Table 3.7-4: *Inter-connection cables*

Cable description	From	To	Length (m)
USB-C Cable	USB-C port	AC/DC Adapter	1

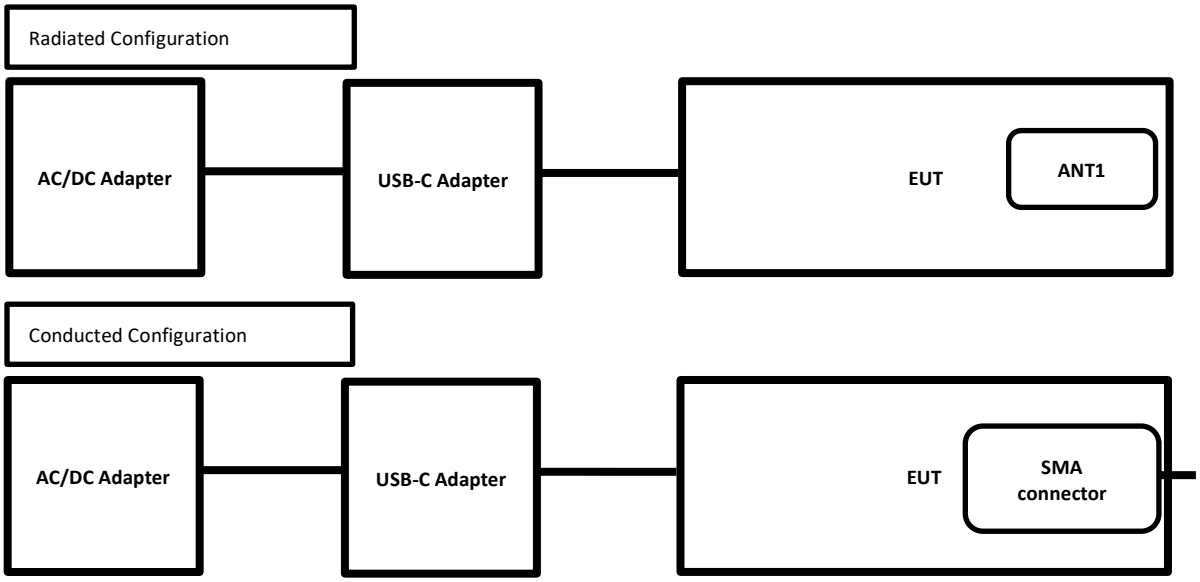

Figure 3.7-1: Test setup diagram

Section 4 Engineering considerations

4.1 Modifications incorporated in the EUT

None.

4.2 Technical judgement

None.

4.3 Deviations from laboratory test procedures

None.

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

Nemko USA Inc. has calculated measurement uncertainty and is documented in EMC/MUC/001 “Uncertainty in EMC measurements.” Measurement uncertainty was calculated using the methods described in CISPR 16-4-2 Specification for radio disturbance and immunity measuring apparatus and methods – Part 4-2: Uncertainties, statistics, and limit modelling – Measurement instrumentation uncertainty. The expression of Uncertainty in EMC testing. Measurement uncertainty calculations assume a coverage factor of K=2 with 95% certainty.

Table 6.1-1: *Measurement uncertainty calculations*

Measurement		**U_{cispr} dB**	**U_{lab} dB**
Conducted disturbance at AC mains and other port power using a V-AMN	9 kHz to 150 kHz	3.8	2.9
	150 kHz to 30 MHz	3.4	2.3
Conducted disturbance at telecommunication port using AAN	150 kHz to 30 MHz	5.0	4.3
Conducted disturbance at telecommunication port using CVP	150 kHz to 30 MHz	3.9	2.9
Conducted disturbance at telecommunication port using CP	150 kHz to 30 MHz	2.9	1.4
Conducted disturbance at telecommunication port using CP and CVP	150 kHz to 30 MHz	4.0	3.1
Radiated disturbance (electric field strength in a SAC)	30 MHz to 1 GHz	6.3	5.5
Radiated disturbance (electric field strength in a FAR)	1 GHz to 6 GHz	5.2	4.7
Radiated disturbance (electric field strength in a FAR)	6 GHz to 18 GHz	5.5	5.0

Notes: Compliance assessment:

If U_{lab} is less than or equal to U_{cispr} then:

- compliance is deemed to occur is no measured disturbance level exceeds the disturbance limit;
- non-compliance is deemed to occur if any measured disturbance level exceeds the disturbance limit

If U_{lab} is greater than U_{cispr} then:

- compliance is deemed to occur is no measured disturbance level, increased by (U_{lab} - U_{cispr}), exceeds the disturbance limit;
- non-compliance is deemed to occur if any measured disturbance level, increased by (U_{lab} - U_{cispr}), exceeds the disturbance limit

V-AMN: V type artificial mains network
AAN: Asymmetric artificial network
CP: Current probe
CVP: Capacitive voltage probe
SAC: Semi-anechoic chamber
FAR: Fully anechoic room

Section 7 Test equipment

Table 6.1-1: *Test equipment list*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
Signal Generator	Rohde & Schwarz	SMB100A	E1128	1 year	23-Dec-2022
Signal & Spectrum Analyzer	Rohde & Schwarz	FSW43	E1302	1 year	08-Nov-2022
Power Sensor	ETS-Lindgren	7002-006	E1062	1 year	01-Nov-2022
Attenuator, 20dB	Centric RF	C407-20	E1200	VOU	VOU
EMI Test Receiver	Rohde & Schwarz	ESU	E1121	1 year	31-May-2023
System Controller	Sunol Sciences	SC104V	E1191	NCR	NCR
Antenna, Bilog	Schaffner-Chase	CBL 6111D	1763	2 years	01-Apr-2024
Antenna, DRG Horn	ETS-Lindgren	3117-PA	E1139	2 years	19-Apr-2023
Antenna, Recyangular Gain Horn	SAGE	SAR-2309-42-S2	E1143	2 years	13-Nov-2022
Notch Filter, 2.4 GHz	Micro-Tonics	BRM50702-02	E1142	NCR	NCR
EMI Test Receiver	Rohde & Schwarz	ESCI 7	E1026	1 year	22-Mar-2023
Transient Limiter (10 dB pad)	Hewlett Packard	11947A	E1159	1 year	18-Feb-2023
Two Line V-Network	Rohde & Schwarz	ENV216	E1020	1 year	17-Jan-2023

Notes: N/A – not applicable
NCR – no calibration required
VOU – verify on use

Table 6.1-2: ***T****est software details*

Manufacturer of Software	Details
Rohde & Schwarz	EMC 32 V10.60.10 (Conducted) / EMC 32 V10.60.15 (Radiated)

Notes: None

Section 8 Testing data

8.1 AC power line conducted emissions

8.1.1 References and limits

- FCC 47 CFR Part 15, Subpart C: §15.207
- RSS-Gen: 8.8
- Test method: ANSI C63.10-2014 §6.2

Table 8.1-1: *AC power line conducted emissions limit*

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

Note: * - Decreases with the logarithm of the frequency.

8.1.2 Test summary

Verdict	Pass		
Test date	October 7, 2022	Temperature	22 °C
Test engineer	Lan Sayasane, EMC Test Engineer	Air pressure	1008.0 mbar
Test location	☒ Ground plane ☐ Other:	Relative humidity	68 %

8.1.3 Notes

Testing was performed with the transmitter operating on a fixed channel at full power. Low, middle and high channels were tested.

8.1.4 Setup details

Port under test	AC power input (USB-C port) – AMN
EUT power input during test	120 Vac/60 Hz
EUT setup configuration	☒ Table-top ☐ Floor standing ☐ Other:
Measurement details	A preview measurement was generated with the receiver in continuous scan mode. Emissions detected within 6 dB or above limit were re-measured with the appropriate detector against the correlating limit and recorded as the final measurement.

Receiver settings:

Resolution bandwidth	9 kHz
Detector mode	– Peak (Preview measurement) – Quasi-peak and average (Final measurement)
Trace mode	Max Hold
Measurement time	– 100 ms (Peak preview measurement) – 5000 ms (Quasi-peak and average final measurement)

8.1.5 Test data

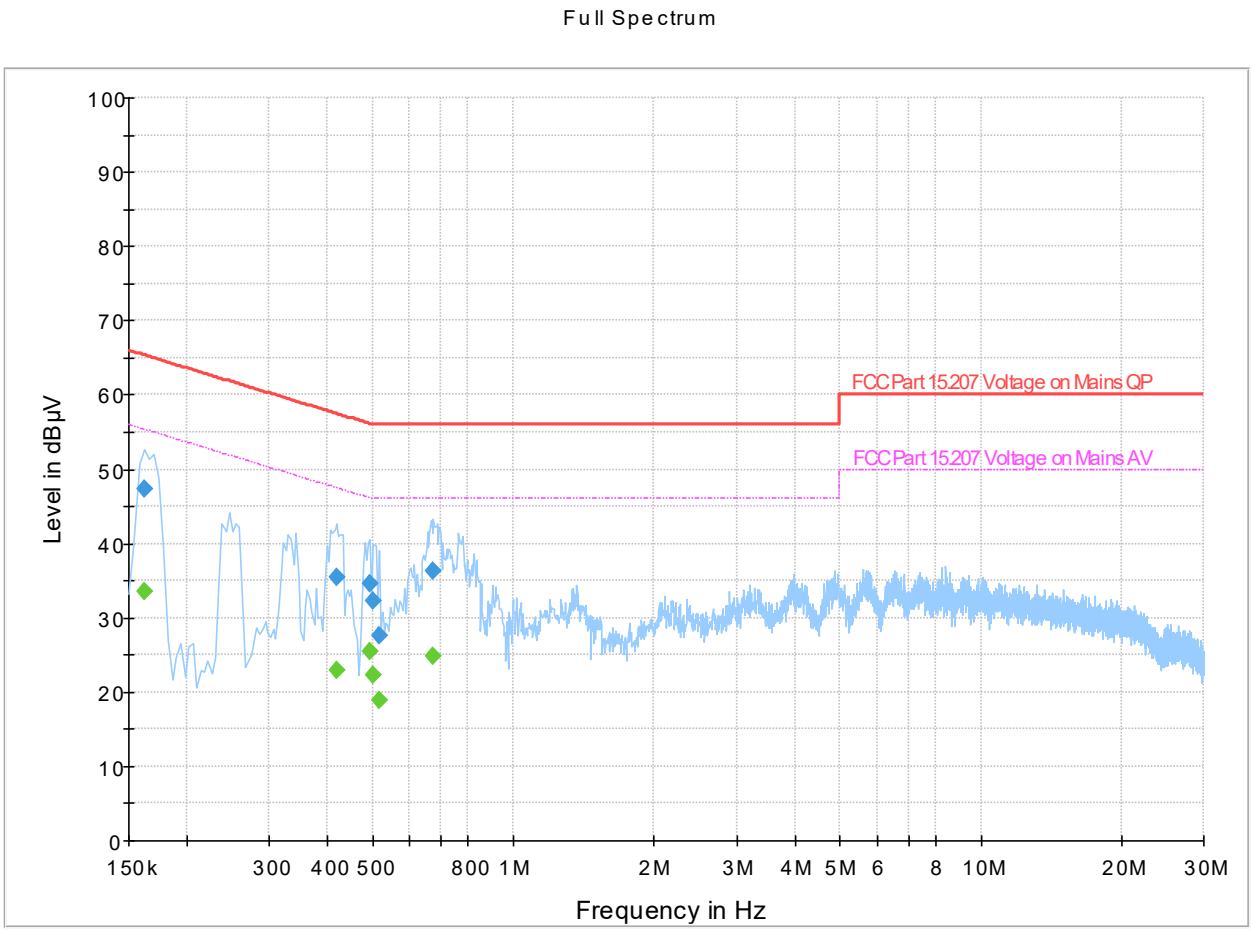

Figure 8.1-1: *Conducted emissions at mains port spectral plot (150 kHz - 30 MHz)*

Table 8.1-2*: Conducted emissions at mains port results*

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.162000	---	33.51	55.36	21.85	5000.0	9.000	L1	ON	19.7
0.162000	47.37	---	65.36	17.99	5000.0	9.000	L1	ON	19.7
0.418000	---	22.90	47.49	24.59	5000.0	9.000	L1	ON	19.5
0.418000	35.54	---	57.49	21.94	5000.0	9.000	L1	ON	19.5
0.494000	---	25.49	46.10	20.61	5000.0	9.000	L1	ON	19.5
0.494000	34.57	---	56.10	21.53	5000.0	9.000	L1	ON	19.5
0.502000	---	22.30	46.00	23.70	5000.0	9.000	L1	ON	19.5
0.502000	32.33	---	56.00	23.67	5000.0	9.000	L1	ON	19.5
0.514000	---	18.87	46.00	27.13	5000.0	9.000	L1	ON	19.5
0.514000	27.70	---	56.00	28.30	5000.0	9.000	L1	ON	19.5
0.674000	---	24.85	46.00	21.15	5000.0	9.000	L1	ON	19.5
0.674000	36.33	---	56.00	19.67	5000.0	9.000	L1	ON	19.5

Notes:
[1] Result (dBµV) = receiver analyzer value (dBµV) + correction factor (dB).
[2] Correction factors = LISN factor IL (dB) + cable loss (dB) + transient limiter (dB)
[3] Emissions that were continuously present for a minimum of 1 second and occurred more than once for every 15 seconds observation period were considered valid emissions. The maximum value of valid emissions has been recorded.

8.2 20 dB bandwidth

8.2.1 References and limits

- FCC 47 CFR Part 15, Subpart B: §15.215(c)
- Test method: ANSI C63.4-2014: §6.9.2

§15.215:
(c) Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§ 15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated.

8.2.2 Test summary

Verdict	Pass		
Test date	September 23, 2022	Temperature	22.87 °C
Test engineer	Lan Sayasane, EMC Test Engineer	Air pressure	1004.82 mbar
Test location	☒ Wireless bench ☐ Other:	Relative humidity	47.9 %

8.2.3 Notes

Testing was performed with the transmitter operating on a fixed channel at full power. Low, middle and high channels were tested.

8.2.4 Setup details

EUT power input during test	120 Vac/60 Hz
EUT setup configuration	☒ Table-top ☐ Floor standing ☐ Other:

Receiver settings:

Resolution bandwidth	20 kHz
Video bandwidth	100 kHz
Detector mode	Peak
Trace mode	Max Hold
Measurement time	Long enough for trace to stabilize

8.2.5 Test data

Table 8.2-1: *20 dB occupied bandwidth test data*

Test frequency (MHz)	Bandwidth (MHz)	Measured f_c (MHz)	Measured f_L (MHz)	Measured f_H (MHz)	Limit
2402	1.055	2401.992	2401.485	2402.540	f_H and f_L within 2400 – 2483.5 MHz
2440	1.055	2439.992	2439.485	2440.540	f_H and f_L within 2400 – 2483.5 MHz
2480	1.055	2479.992	2479.485	2480.540	f_H and f_L within 2400 – 2483.5 MHz

Figure 8.2-1: *20 dB occupied bandwidth, 2402 MHz*

Figure 8.2-2: *20 dB occupied bandwidth, 2440 MHz*

Figure 8.2-3: *20 dB occupied bandwidth, 2480 MHz*

8.3 Minimum 6 dB bandwidth for systems using digital modulation techniques

8.3.1 References and limits

- FCC 47 CFR Part 15, Subpart B: §15.247(a)(2)
- RSS-247: §5.2(a)
- Test method: 558074 D01 DTS Measurement Guidance §8.2 and ANSI C63.10 §11.8.2 (using built-in marker function of the spectrum analyzer)

§15.247:

(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.

RSS-247:

5.2 DTSs include systems that employ digital modulation techniques resulting in spectral characteristics similar to direct sequence systems. The following applies to the bands 902-928 MHz and 2400-2483.5 MHz:

(a) The minimum 6 dB bandwidth shall be 500 kHz.

8.3.2 Test summary

Verdict	Pass		
Test date	September 23, 2022	Temperature	22.87 °C
Test engineer	Lan Sayasane, EMC Test Engineer	Air pressure	1004.82 mbar
Test location	☒ Wireless bench ☐ Other:	Relative humidity	47.9 %

8.3.3 Notes

Testing was performed with the transmitter operating on a fixed channel at full power. Low, middle and high channels were tested.

8.3.4 Setup details

EUT power input during test	120 Vac/60 Hz
EUT setup configuration	☒ Table-top ☐ Floor standing ☐ Other:

Receiver settings:

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

8.3.5 Test data

Table 8.3-1: *6 dB DTS bandwidth test data*

Test frequency (MHz)	Bandwidth (kHz)	Limit
2402	655.300	≥ 500 kHz
2440	659.300	≥ 500 kHz
2480	663.300	≥ 500 kHz

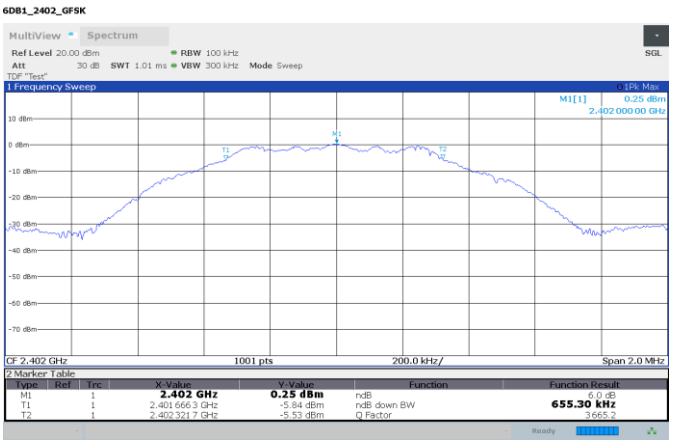

Figure 8.3-1: *6 dB DTS bandwidth, 2402 MHz*

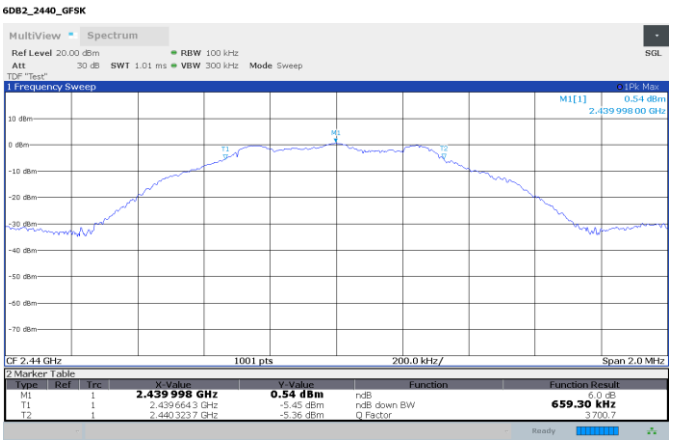

Figure 8.3-2: *6 dB DTS bandwidth, 2440 MHz*

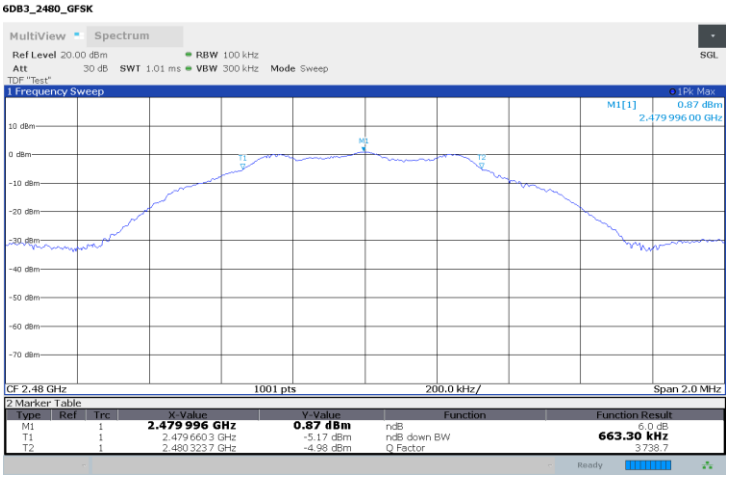

Figure 8.3-3: *6 dB DTS bandwidth, 2480 MHz*

8.4 Transmitter output power and EIRP requirements

8.4.1 References and limits

- FCC 47 CFR Part 15, Subpart B: §15.247(b)(3)
- RSS-247: §5.4(d)
- Test method: 558074 D01 DTS Measurement Guidance §8.3.1.1 and ANSI C63.10 §11.9.1.1 (RBW ≥ DTS bandwidth)

§15.247:

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

(3) For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. 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.

RSS-247:

5.4 Devices shall comply with the following requirements, where applicable:

(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 EIRP shall not exceed 4 W, except as provided in RSS 247 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.

8.4.2 Test summary

Verdict	Pass		
Test date	September 23, 2022	Temperature	22.87 °C
Test engineer	Lan Sayasane, EMC Test Engineer	Air pressure	1004.82 mbar
Test location	☒ Wireless bench ☐ Other:	Relative humidity	47.9 %

8.4.3 Notes

Testing was performed with the transmitter operating on a fixed channel at full power. Low, middle and high channels were tested. EIRP = conducted power + declared antenna gain.

8.4.4 Setup details

EUT power input during test	120 Vac/60 Hz
EUT setup configuration	☒ Table-top ☐ Floor standing ☐ Other:

Receiver settings:

Resolution bandwidth	2 MHz
Video bandwidth	5 MHz
Detector mode	Peak
Trace mode	Max Hold
Measurement time	Long enough for trace to stabilize

8.4.5 Test data

Table 8.4-1: *Transmitter output power and EIRP test data*

Test frequency (MHz)	Peak conducted output power (dBm)	Conducted limit (dBm)	Antenna Gain (declared) (dBi)	EIRP (dBm)	EIRP limit (dBm)
2402	0.31	30.0	1.8	2.11	36.0
2440	0.85	30.0	1.8	2.65	36.0
2480	1.02	30.0	1.8	2.82	36.0

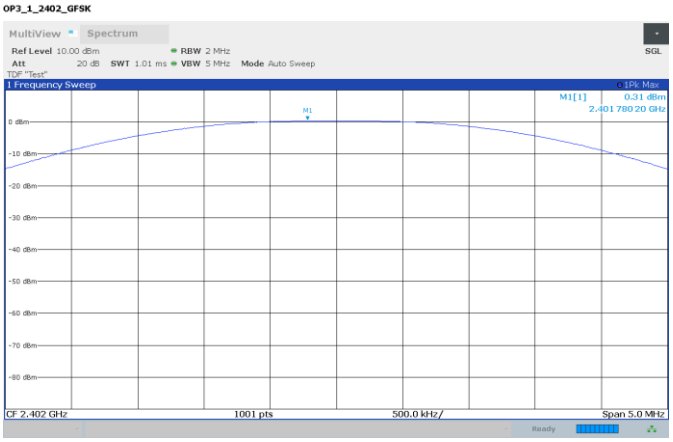

Figure 8.4-1: *Conducted output power, 2402 MHz*

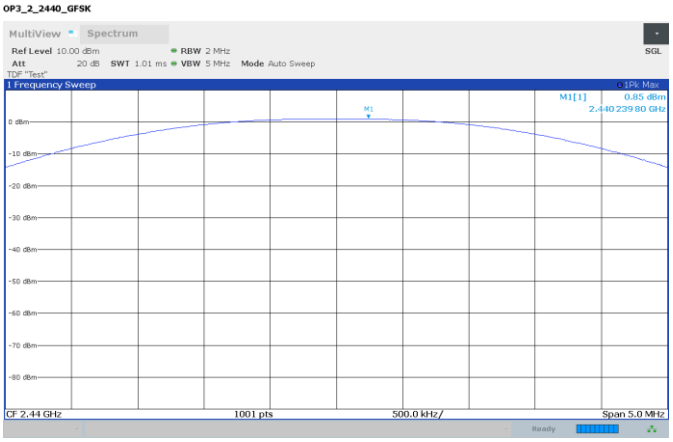

Figure 8.4-2: *Conducted output power, 2440 MHz*

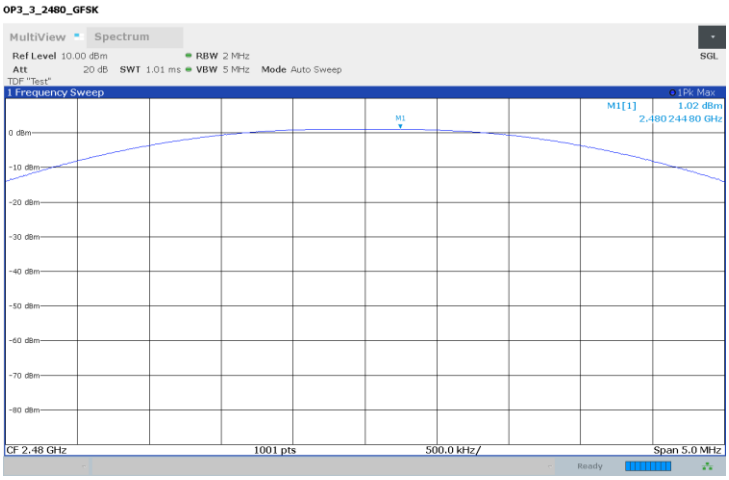

Figure 8.4-3: *Conducted output power, 2480 MHz*

8.5 Spurious emissions

8.5.1 References and limits

- FCC 47 CFR Part 15, Subpart B: §15.247(d)
- RSS-247: §5.5
- Test method: ANSI C63.10-2014 §6.10.4 (authorized band edge)
- Test method: ANSI C63.10-2014 §6.7 (antenna port conducted spurious emissions)
- Test method: ANSI C63.10-2014 §11.13 (radiated restricted band edge)
- Test method: ANSI C63.10-2014 §6.5, 6.6 (radiated emissions in restricted bands)

§15.247:

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

RSS-247:

5.4 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 8.5-1: *FCC §15.209– Radiated emission limits*

Frequency, MHz	Field strength of emissions µV/m	Field strength of emissions dBµV/m	Measurement distance, 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 8.5-2: *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			

8.5.2 Test summary

Verdict	Pass		
Test date	September 23, 2022	Temperature	22.95 °C
Test engineer	Lan Sayasane, EMC Test Engineer	Air pressure	1005.11 mbar
Test location	☐ Wireless bench ☐ 10 m semi-anechoic chamber ☒ 3 m semi-anechoic chamber ☐ Other:	Relative humidity	48.2 %

8.5.3 Notes

Testing was performed with the transmitter operating on a fixed channel at full power. Low, middle and high channels were tested. The spectrum was searched from 30 MHz to 26 GHz (above the 10th harmonic of the highest transmit frequency).

For radiated measurements, the EUT was investigated to identify the worst case orientation with respect to the fundamental transmitter power. All measurements were performed with the EUT in that worst-case orientation.

8.5.4 Setup details

EUT power input during test	120 Vac/60 Hz
EUT setup configuration	☒ Table-top ☐ Floor standing ☐ Other:

Spectrum analyzer settings (conducted 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)

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

Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Detector mode	Peak (preview measurements) Peak and average (final measurements)

8.5.5 Test data

Authorized band edge conducted emissions

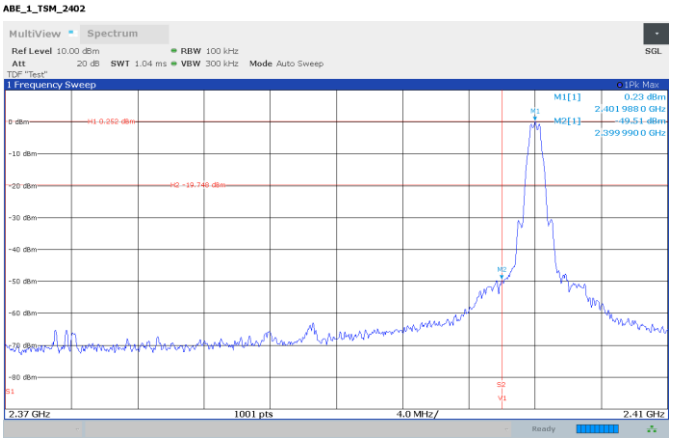

Figure 8.5-1: *Authorized band edge emissions, 2402 MHz*

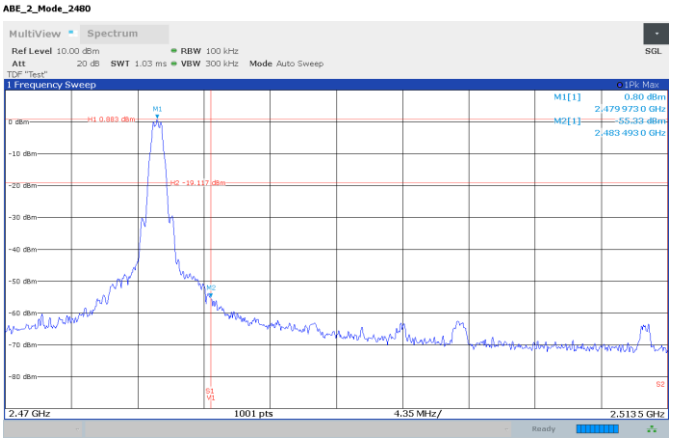

Figure 8.5-2: *Authorized band edge emissions, 2480 MHz*

Antenna port conducted spurious emissions

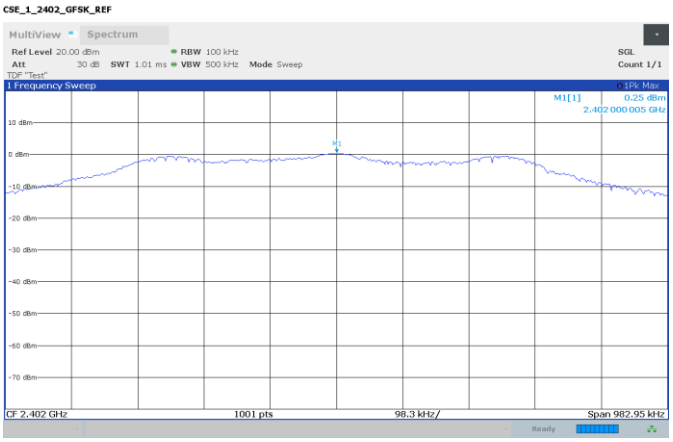

Figure 8.5-3: *Conducted power spectral density reference level, 2402 MHz*

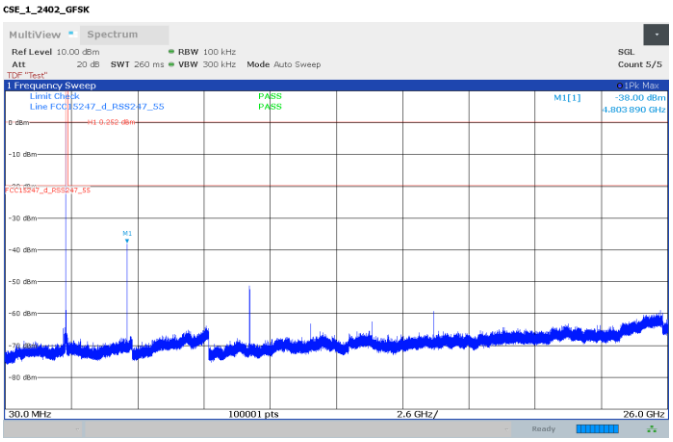

Figure 8.5-4: *Antenna port conducted spurious emissions, 2402 MHz*

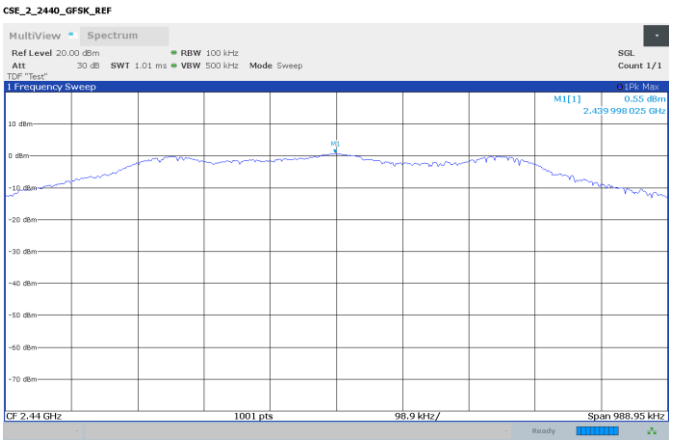

Figure 8.5-5: *Conducted power spectral density reference level, 2440 MHz*

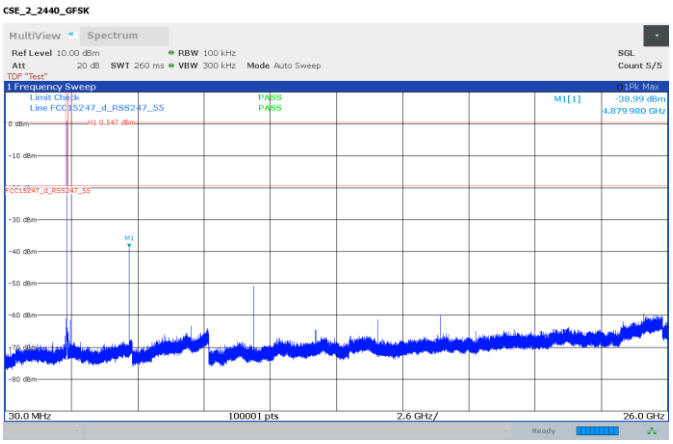

Figure 8.5-6: *Antenna port conducted spurious emissions, 2440 MHz*

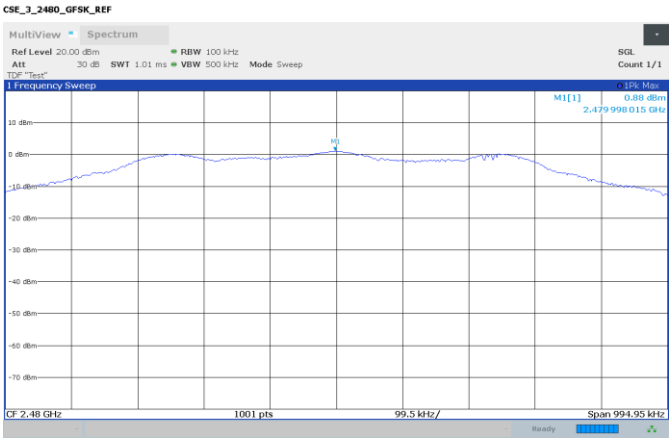

Figure 8.5-7: *Conducted power spectral density reference level, 2480 MHz*

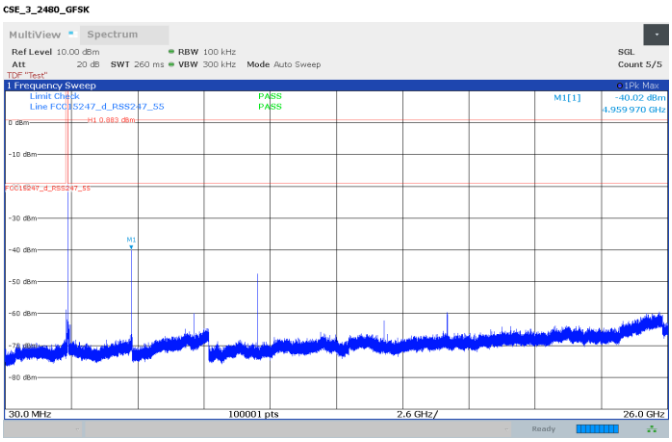

Figure 8.5-8: *Antenna port conducted spurious emissions, 2480 MHz*

Radiated restricted band edge emissions

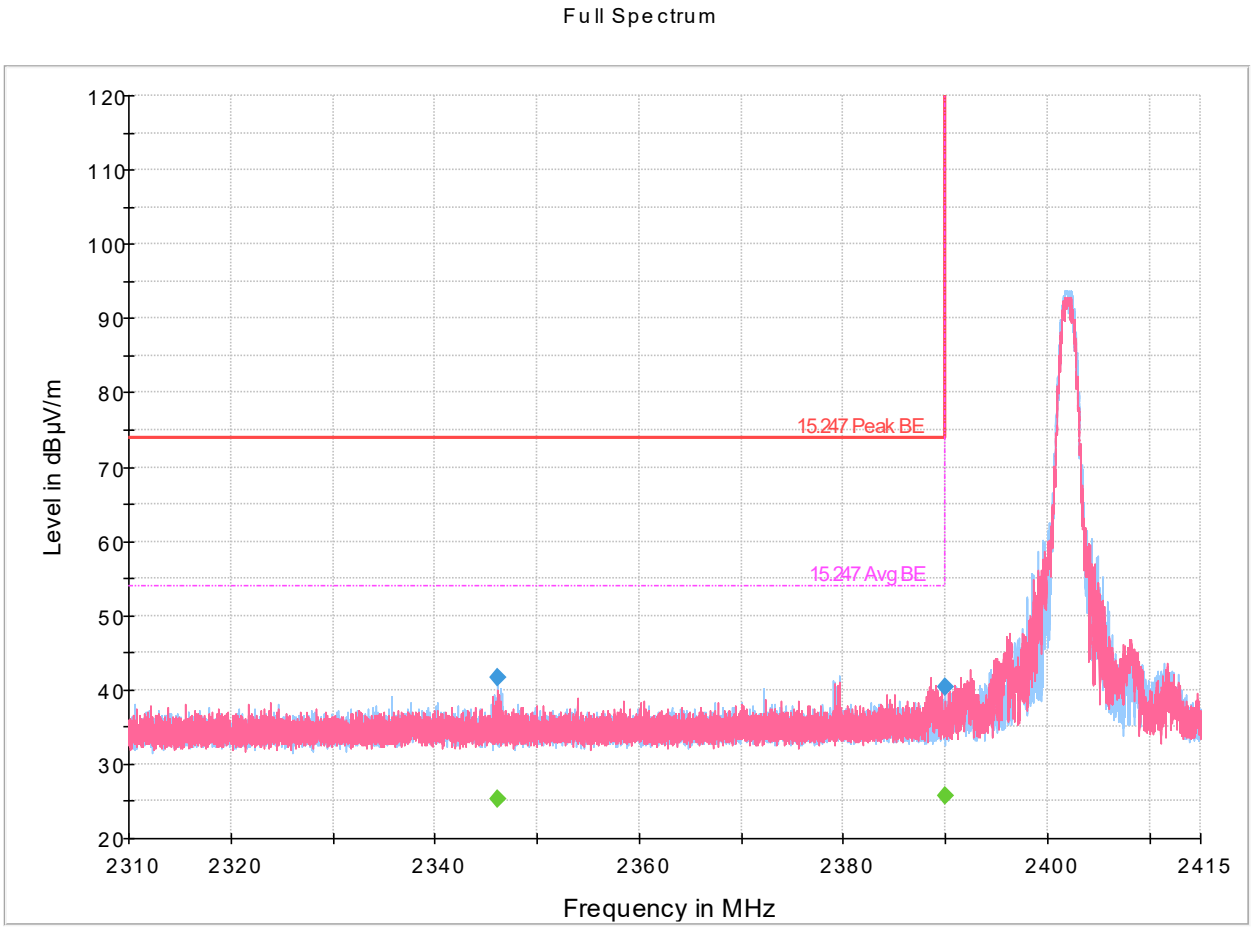

Figure 8.5-9: *Radiated emissions spectral plot (2.31 GHz - 2.415 GHz)*

Table 8.5-2*: Radiated emissions results*

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)
2346.165500	---	25.31	53.90	28.59	5000.0	1000.000	374.0	V	0.0	-10.2
2346.165500	41.76	---	73.90	32.14	5000.0	1000.000	374.0	V	0.0	-10.2
2390.000000	---	25.84	53.90	28.06	5000.0	1000.000	400.0	V	350.0	-10.0
2390.000000	40.42	---	73.90	33.48	5000.0	1000.000	400.0	V	350.0	-10.0

Notes: [1] Field strength (dB V/m) = receiver/spectrum analyzer value (dB V) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB)
[3] Emissions that were continuously present for a minimum of 1 second and occurred more than once for every 15 seconds observation period were considered valid emissions. The maximum value of valid emissions has been recorded.

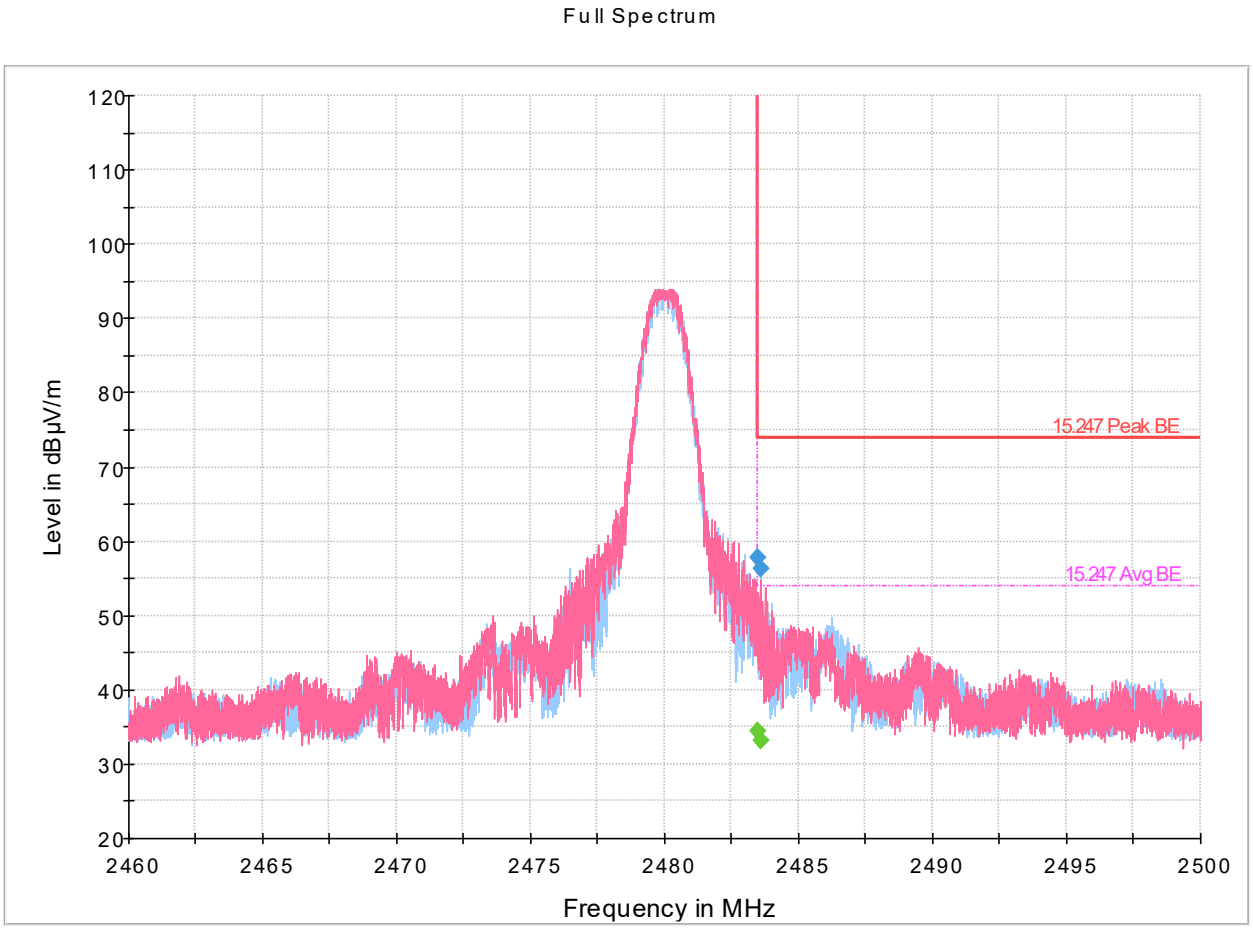

Figure 8.5-10: *Radiated emissions spectral plot (2.46 GHz - 2.5 GHz)*

Table 8.5-3*: Radiated emissions results*

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	---	34.42	53.90	19.48	5000.0	1000.000	142.0	H	278.0	-9.7
2483.500000	57.82	---	73.90	16.08	5000.0	1000.000	142.0	H	278.0	-9.7
2483.576000	---	33.09	53.90	20.81	5000.0	1000.000	139.0	H	271.0	-9.7
2483.576000	56.35	---	73.90	17.55	5000.0	1000.000	139.0	H	271.0	-9.7

Notes: [1] Field strength (dB V/m) = receiver/spectrum analyzer value (dB V) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB)
[3] Emissions that were continuously present for a minimum of 1 second and occurred more than once for every 15 seconds observation period were considered valid emissions. The maximum value of valid emissions has been recorded.

Radiated emissions in restricted bands

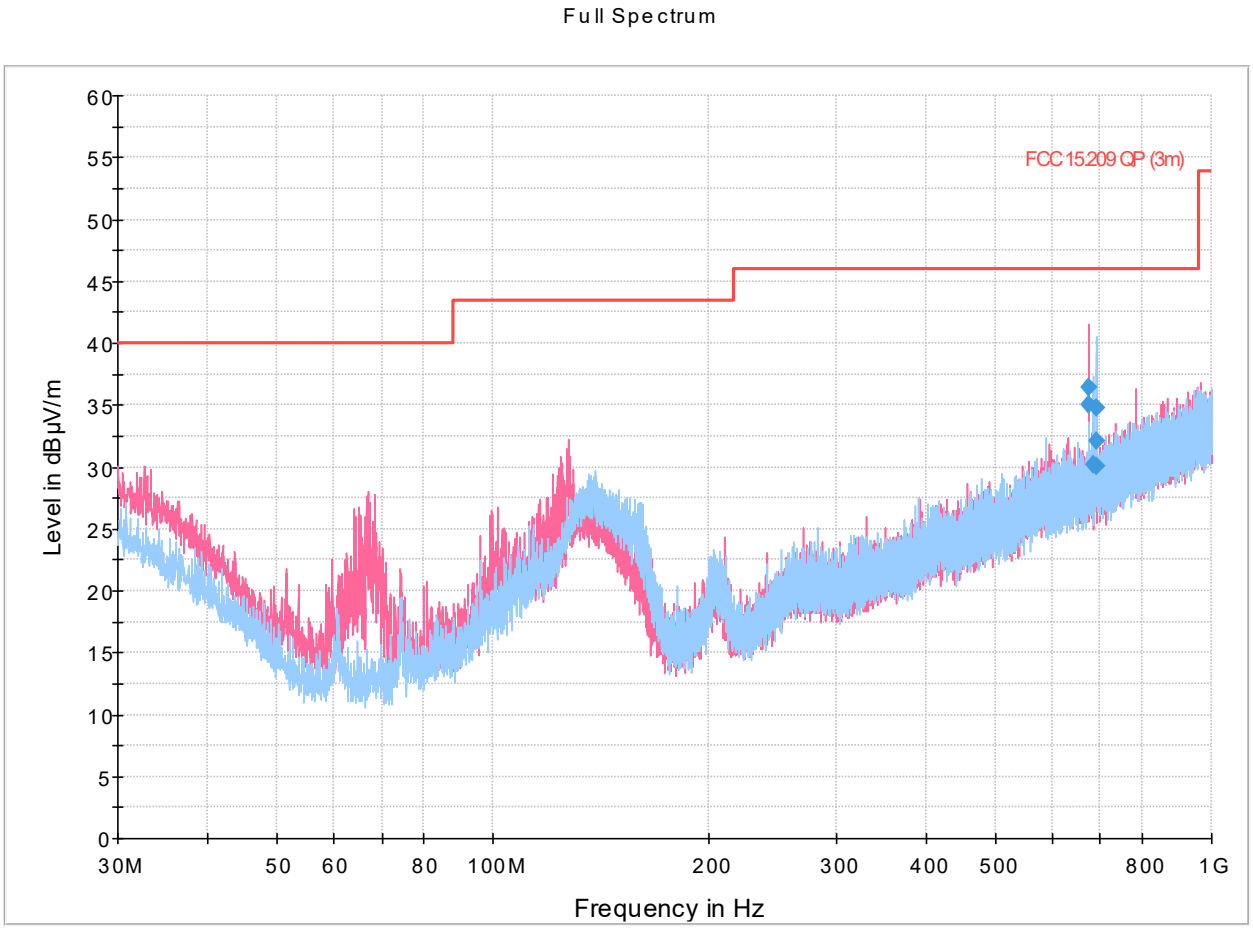

Figure 8.5-11: *Radiated emissions spectral plot (30 MHz - 1 GHz) – channel 2402 MHz*

Table 8.5-4*: Radiated emissions results*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
673.863333	34.99	46.00	11.01	5000.0	120.000	284.0	V	232.0	30.1
673.934000	36.48	46.00	9.52	5000.0	120.000	124.0	V	314.0	30.1
684.146333	30.15	46.00	15.85	5000.0	120.000	170.0	H	54.0	30.6
689.974667	32.12	46.00	13.88	5000.0	120.000	171.0	V	315.0	30.5
691.144000	30.12	46.00	15.88	5000.0	120.000	100.0	V	170.0	30.5
692.452667	34.80	46.00	11.20	5000.0	120.000	375.0	H	228.0	30.5

Notes: [1] Field strength (dB V/m) = receiver/spectrum analyzer value (dB V) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB)
[3] Emissions that were continuously present for a minimum of 1 second and occurred more than once for every 15 seconds observation period were considered valid emissions. The maximum value of valid emissions has been recorded.

Full Spectrum

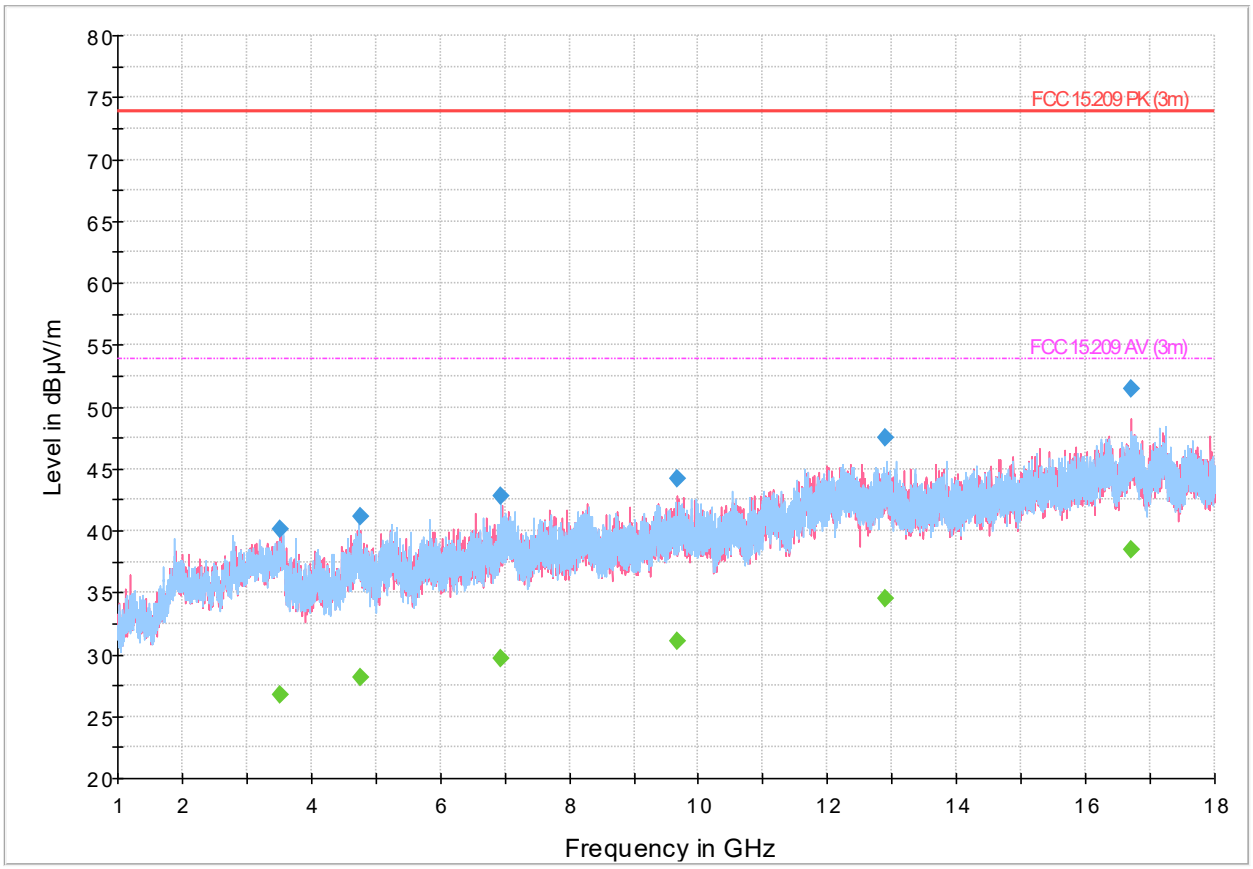

Figure 8.5-12: *Radiated emissions spectral plot (1 GHz - 18 GHz) – channel 2402 MHz*

Table 8.5-5*: Radiated emissions results*

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)
3525.250000	40.15	---	73.90	33.75	5000.0	1000.000	203.0	V	216.0	-6.2
3525.250000	---	26.77	53.90	27.13	5000.0	1000.000	203.0	V	216.0	-6.2
4750.850000	41.13	---	73.90	32.77	5000.0	1000.000	219.0	H	71.0	-2.2
4750.850000	---	28.17	53.90	25.74	5000.0	1000.000	219.0	H	71.0	-2.2
6931.150000	---	29.69	53.90	24.21	5000.0	1000.000	262.0	H	323.0	0.7
6931.150000	42.76	---	73.90	31.14	5000.0	1000.000	262.0	H	323.0	0.7
9669.100000	---	31.08	53.90	22.82	5000.0	1000.000	115.0	V	70.0	3.6
9669.100000	44.27	---	73.90	29.63	5000.0	1000.000	115.0	V	70.0	3.6
12906.050000	---	34.51	53.90	19.39	5000.0	1000.000	315.0	H	121.0	8.6
12906.050000	47.49	---	73.90	26.41	5000.0	1000.000	315.0	H	121.0	8.6
16714.500000	---	38.49	53.90	15.41	5000.0	1000.000	400.0	V	357.0	14.7
16714.500000	51.42	---	73.90	22.48	5000.0	1000.000	400.0	V	357.0	14.7

Notes: [1] Field strength (dB V/m) = receiver/spectrum analyzer value (dB V) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB)
[3] Emissions that were continuously present for a minimum of 1 second and occurred more than once for every 15 seconds observation period were considered valid emissions. The maximum value of valid emissions has been recorded.

Full Spectrum

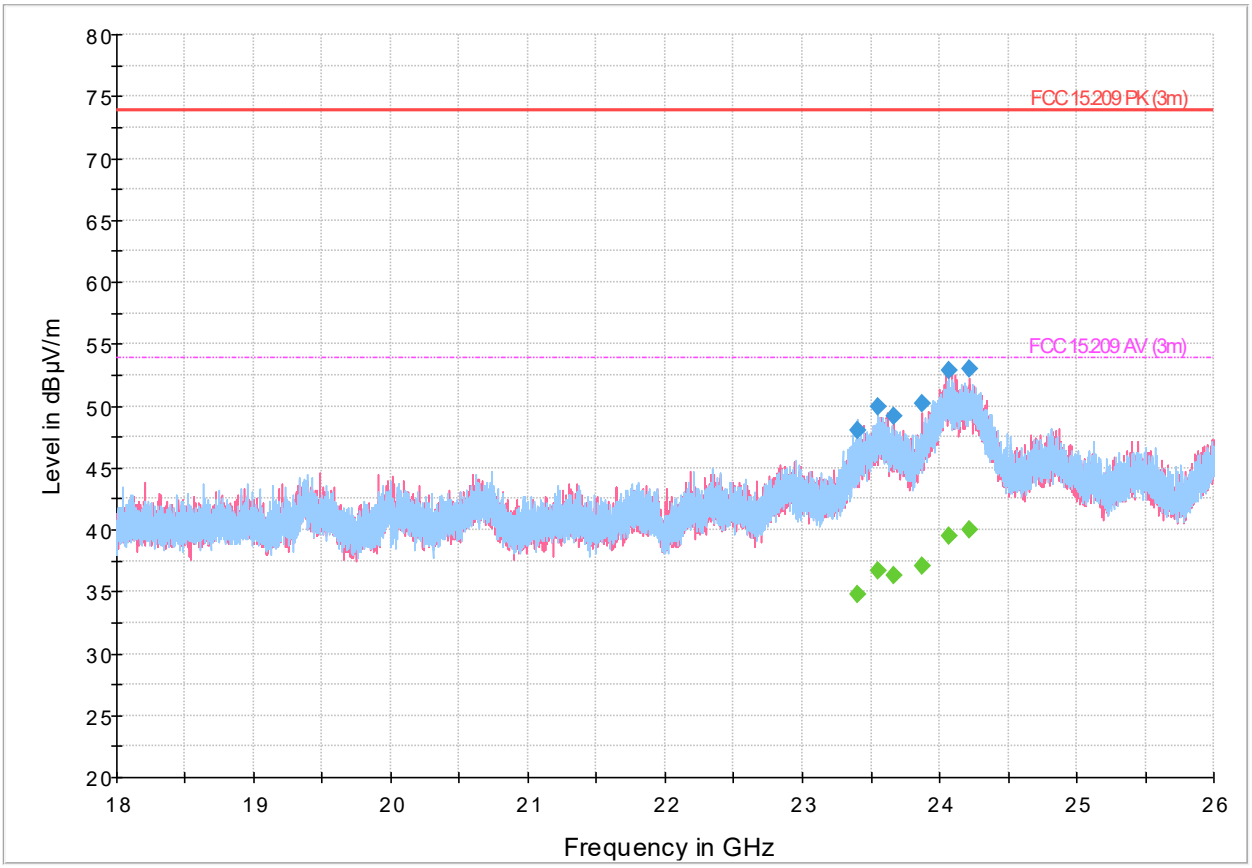

Figure 8.5-13: *Radiated emissions spectral plot (18 GHz - 26 GHz) – channel 2402 MHz*

Table 8.5-6*: Radiated emissions results*

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)
23401.500000	48.06	---	73.90	25.84	5000.0	1000.000	363.0	H	66.0	24.2
23401.500000	---	34.76	53.90	19.14	5000.0	1000.000	363.0	H	66.0	24.2
23553.300000	---	36.70	53.90	17.20	5000.0	1000.000	264.0	V	300.0	25.7
23553.300000	49.90	---	73.90	24.00	5000.0	1000.000	264.0	V	300.0	25.7
23668.500000	---	36.33	53.90	17.57	5000.0	1000.000	268.0	V	226.0	25.6
23668.500000	49.21	---	73.90	24.69	5000.0	1000.000	268.0	V	226.0	25.6
23876.500000	50.14	---	73.90	23.76	5000.0	1000.000	132.0	V	342.0	26.9
23876.500000	---	37.13	53.90	16.77	5000.0	1000.000	132.0	V	342.0	26.9
24069.700000	52.88	---	73.90	21.02	5000.0	1000.000	391.0	H	250.0	29.7
24069.700000	---	39.51	53.90	14.39	5000.0	1000.000	391.0	H	250.0	29.7
24224.100000	53.06	---	73.90	20.84	5000.0	1000.000	117.0	V	352.0	29.1
24224.100000	---	39.99	53.90	13.91	5000.0	1000.000	117.0	V	352.0	29.1

Notes: [1] Field strength (dB V/m) = receiver/spectrum analyzer value (dB V) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB)
[3] Emissions that were continuously present for a minimum of 1 second and occurred more than once for every 15 seconds observation period were considered valid emissions. The maximum value of valid emissions has been recorded.

Full Spectrum

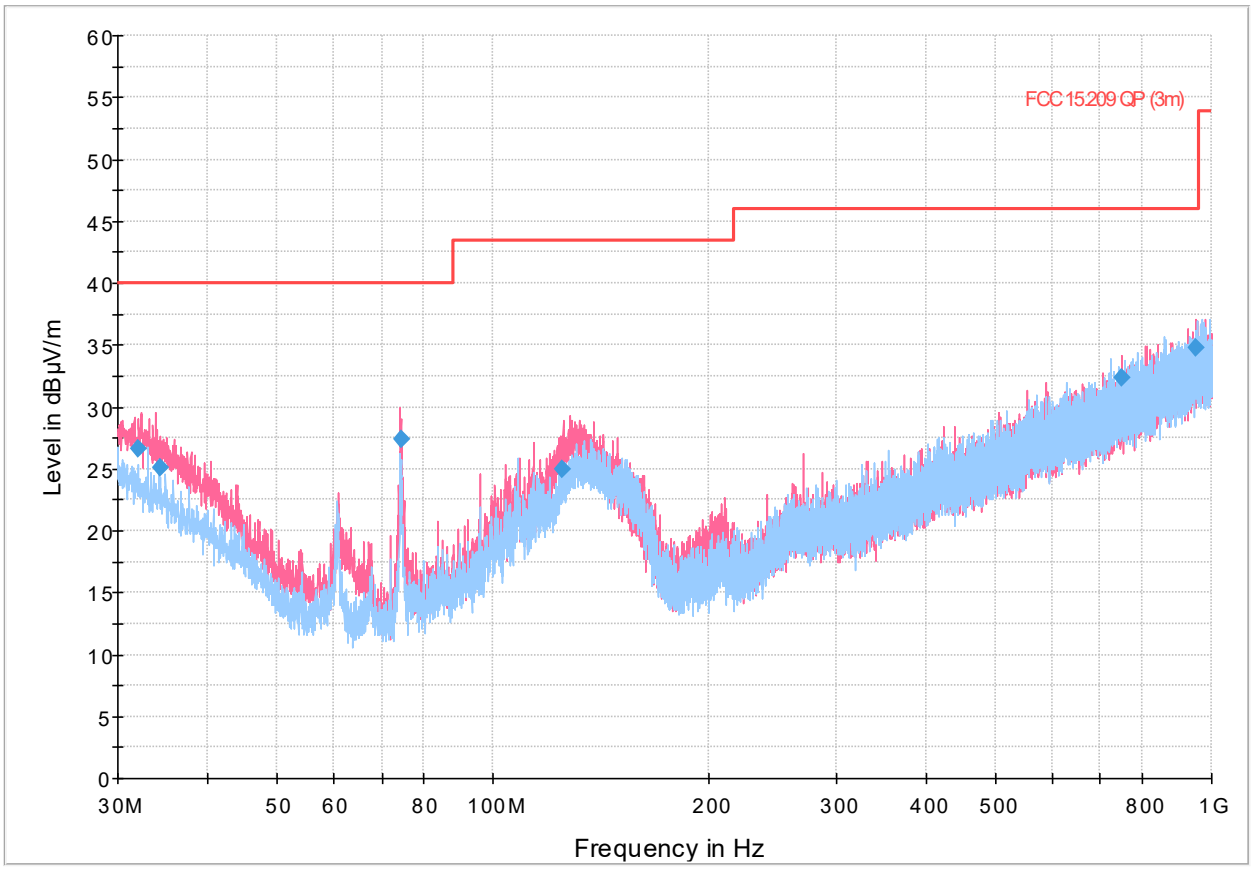

Figure 8.5-14: *Radiated emissions spectral plot (30 MHz - 1 GHz) – channel 2440 MHz*

Table 8.5-7*: Radiated emissions results*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
31.995667	26.60	40.00	13.40	5000.0	120.000	117.0	V	276.0	25.5
34.355333	25.07	40.00	14.93	5000.0	120.000	111.0	V	128.0	24.2
74.364333	27.45	40.00	12.55	5000.0	120.000	100.0	V	322.0	14.4
124.640000	25.03	43.50	18.47	5000.0	120.000	138.0	V	208.0	19.7
749.984667	32.36	46.00	13.64	5000.0	120.000	270.0	V	328.0	31.7
952.495000	34.79	46.00	11.21	5000.0	120.000	161.0	V	10.0	35.0

Notes:
[1] Field strength (dB V/m) = receiver/spectrum analyzer value (dB V) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB)
[3] Emissions that were continuously present for a minimum of 1 second and occurred more than once for every 15 seconds observation period were considered valid emissions. The maximum value of valid emissions has been recorded.

Full Spectrum

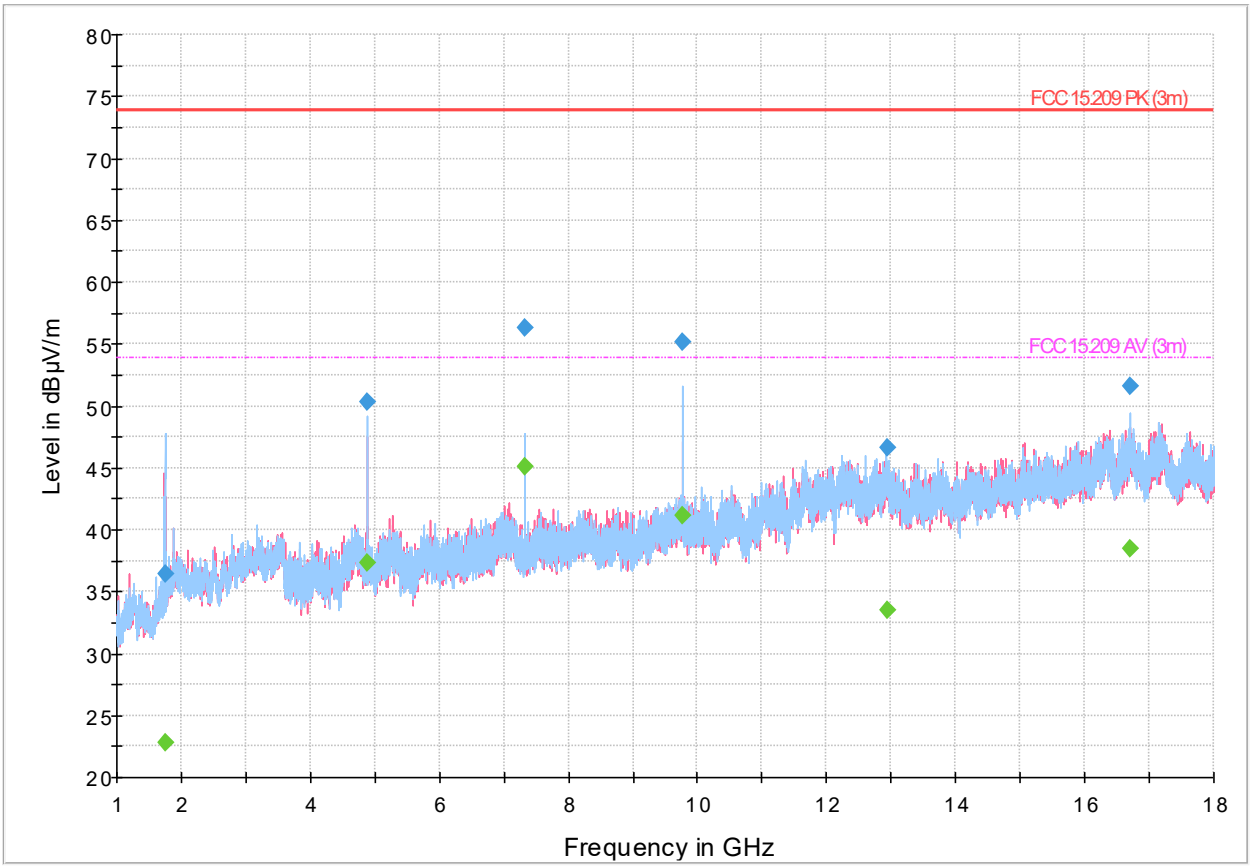

Figure 8.5-15: *Radiated emissions spectral plot (1 GHz - 18 GHz) – channel 2440 MHz*

Table 8.5-8*: Radiated emissions results*

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)
1749.200000	36.46	---	73.90	37.44	5000.0	1000.000	341.0	H	352.0	-12.6
1749.200000	---	22.85	53.90	31.05	5000.0	1000.000	341.0	H	352.0	-12.6
4880.650000	---	37.31	53.90	16.59	5000.0	1000.000	266.0	H	195.0	-2.3
4880.650000	50.35	---	73.90	23.55	5000.0	1000.000	266.0	H	195.0	-2.3
7320.050000	---	45.14	53.90	8.76	5000.0	1000.000	243.0	H	10.0	0.6
7320.050000	56.24	---	73.90	17.66	5000.0	1000.000	243.0	H	10.0	0.6
9760.000000	---	41.18	53.90	12.72	5000.0	1000.000	230.0	H	10.0	3.6
9760.000000	55.11	---	73.90	18.79	5000.0	1000.000	230.0	H	10.0	3.6
12934.250000	---	33.52	53.90	20.38	5000.0	1000.000	351.0	H	284.0	8.6
12934.250000	46.67	---	73.90	27.23	5000.0	1000.000	351.0	H	284.0	8.6
16708.900000	51.61	---	73.90	22.29	5000.0	1000.000	142.0	H	152.0	14.7
16708.900000	---	38.46	53.90	15.44	5000.0	1000.000	142.0	H	152.0	14.7

Notes: [1] Field strength (dB V/m) = receiver/spectrum analyzer value (dB V) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB)
[3] Emissions that were continuously present for a minimum of 1 second and occurred more than once for every 15 seconds observation period were considered valid emissions. The maximum value of valid emissions has been recorded.

Full Spectrum

Figure 8.5-16: *Radiated emissions spectral plot (18 GHz - 26 GHz) – channel 2440 MHz*

Table 8.5-9*: Radiated emissions results*

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)
22871.700000	45.93	---	73.90	27.97	5000.0	1000.000	273.0	H	285.0	21.2
22871.700000	---	32.03	53.90	21.87	5000.0	1000.000	273.0	H	285.0	21.2
23578.700000	48.32	---	73.90	25.58	5000.0	1000.000	366.0	H	100.0	25.9
23578.700000	---	35.39	53.90	18.51	5000.0	1000.000	366.0	H	100.0	25.9
24040.900000	---	39.78	53.90	14.12	5000.0	1000.000	250.0	H	293.0	29.7
24040.900000	52.75	---	73.90	21.15	5000.0	1000.000	250.0	H	293.0	29.7
24124.100000	52.56	---	73.90	21.34	5000.0	1000.000	357.0	H	20.0	29.5
24124.100000	---	39.55	53.90	14.35	5000.0	1000.000	357.0	H	20.0	29.5
24210.700000	---	39.72	53.90	14.18	5000.0	1000.000	316.0	H	0.0	29.1
24210.700000	53.02	---	73.90	20.88	5000.0	1000.000	316.0	H	0.0	29.1
25871.700000	47.86	---	73.90	26.04	5000.0	1000.000	109.0	H	260.0	24.5
25871.700000	---	33.80	53.90	20.10	5000.0	1000.000	109.0	H	260.0	24.5

Notes: [1] Field strength (dB V/m) = receiver/spectrum analyzer value (dB V) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB)
[3] Emissions that were continuously present for a minimum of 1 second and occurred more than once for every 15 seconds observation period were considered valid emissions. The maximum value of valid emissions has been recorded.

Full Spectrum

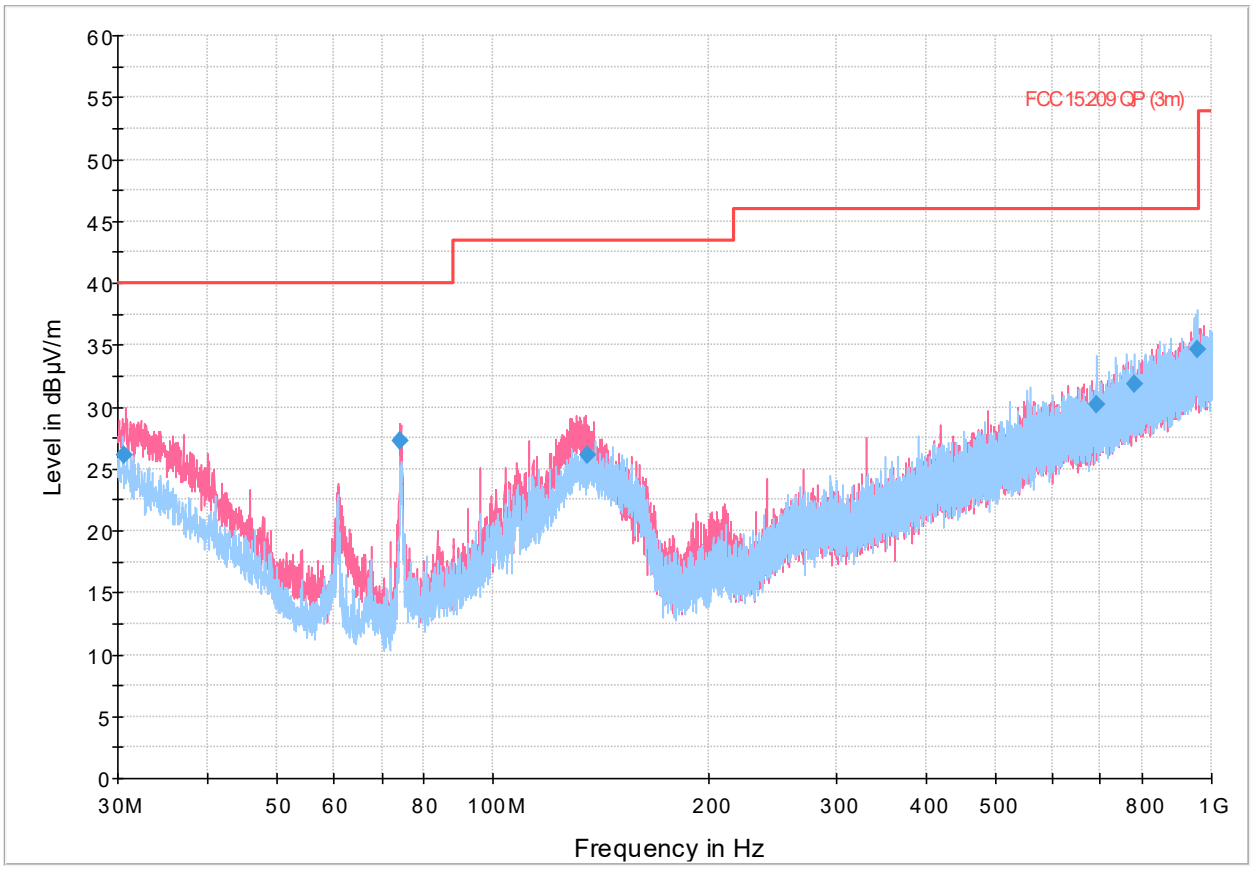

Figure 8.5-17: *Radiated emissions spectral plot (30 MHz - 1 GHz) – channel 2480 MHz*

Table 8.5-10*: Radiated emissions results*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
30.556000	26.17	40.00	13.83	5000.0	120.000	137.0	V	118.0	26.3
74.259667	27.26	40.00	12.74	5000.0	120.000	114.0	V	330.0	14.4
134.913667	26.13	43.50	17.37	5000.0	120.000	114.0	V	230.0	19.8
692.428000	30.14	46.00	15.86	5000.0	120.000	263.0	H	238.0	30.5
782.536667	31.83	46.00	14.17	5000.0	120.000	400.0	H	347.0	32.0
956.036333	34.69	46.00	11.31	5000.0	120.000	258.0	H	66.0	34.9

Notes:
[1] Field strength (dB V/m) = receiver/spectrum analyzer value (dB V) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB)
[3] Emissions that were continuously present for a minimum of 1 second and occurred more than once for every 15 seconds observation period were considered valid emissions. The maximum value of valid emissions has been recorded.

Full Spectrum

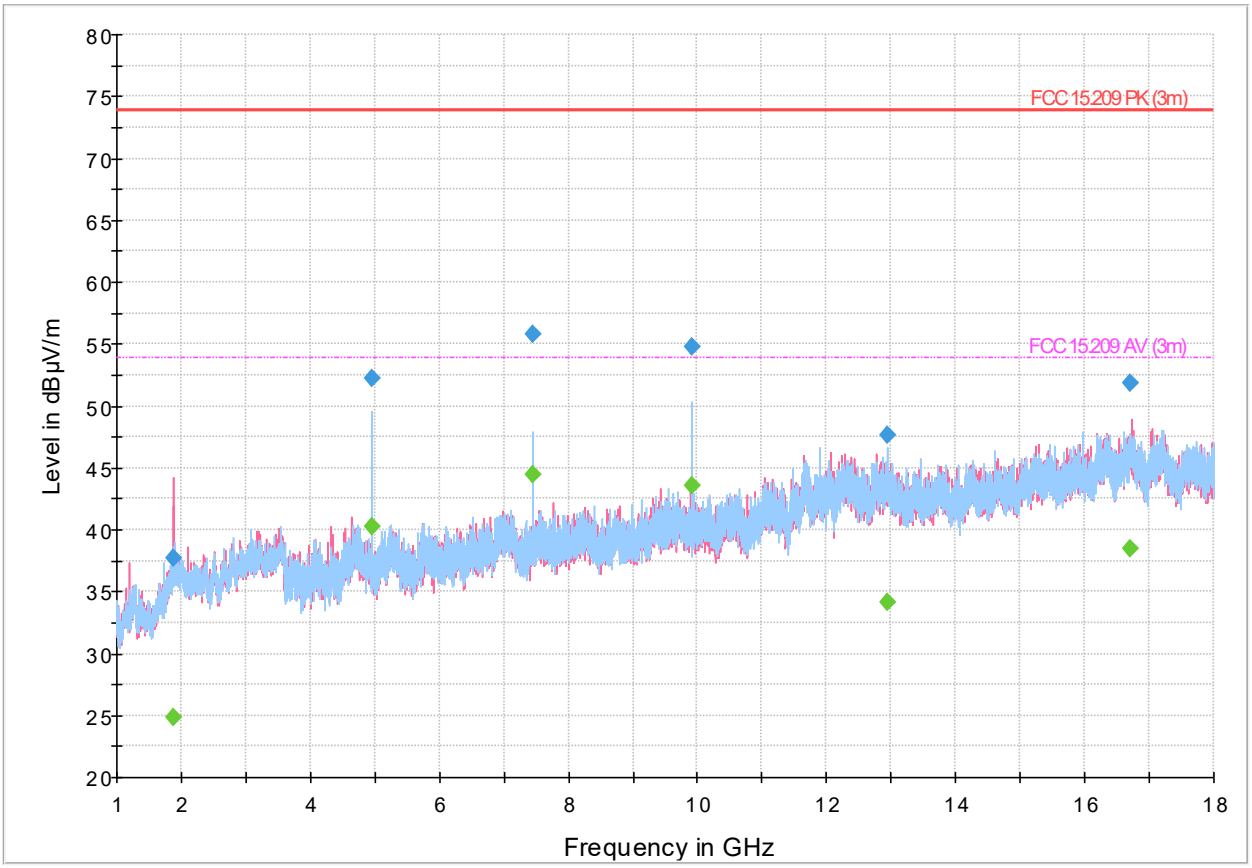

Figure 8.5-18: *Radiated emissions spectral plot (1 GHz - 18 GHz) – channel 2480 MHz*

Table 8.5-11*: Radiated emissions results*

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)
1869.050000	---	24.81	53.90	29.09	5000.0	1000.000	147.0	V	10.0	-10.9
1869.050000	37.73	---	73.90	36.17	5000.0	1000.000	147.0	V	10.0	-10.9
4960.550000	---	40.32	53.90	13.58	5000.0	1000.000	277.0	H	196.0	-2.4
4960.550000	52.24	---	73.90	21.66	5000.0	1000.000	277.0	H	196.0	-2.4
7439.950000	55.75	---	73.90	18.15	5000.0	1000.000	248.0	H	10.0	1.2
7439.950000	---	44.42	53.90	9.48	5000.0	1000.000	248.0	H	10.0	1.2
9919.050000	54.77	---	73.90	19.13	5000.0	1000.000	241.0	H	10.0	3.3
9919.050000	---	43.52	53.90	10.38	5000.0	1000.000	241.0	H	10.0	3.3
12934.150000	47.71	---	73.90	26.19	5000.0	1000.000	377.0	H	289.0	8.6
12934.150000	---	34.08	53.90	19.82	5000.0	1000.000	377.0	H	289.0	8.6
16715.550000	51.82	---	73.90	22.08	5000.0	1000.000	182.0	V	347.0	14.7
16715.550000	---	38.48	53.90	15.42	5000.0	1000.000	182.0	V	347.0	14.7

Notes: [1] Field strength (dB V/m) = receiver/spectrum analyzer value (dB V) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB)
[3] Emissions that were continuously present for a minimum of 1 second and occurred more than once for every 15 seconds observation period were considered valid emissions. The maximum value of valid emissions has been recorded.

Full Spectrum

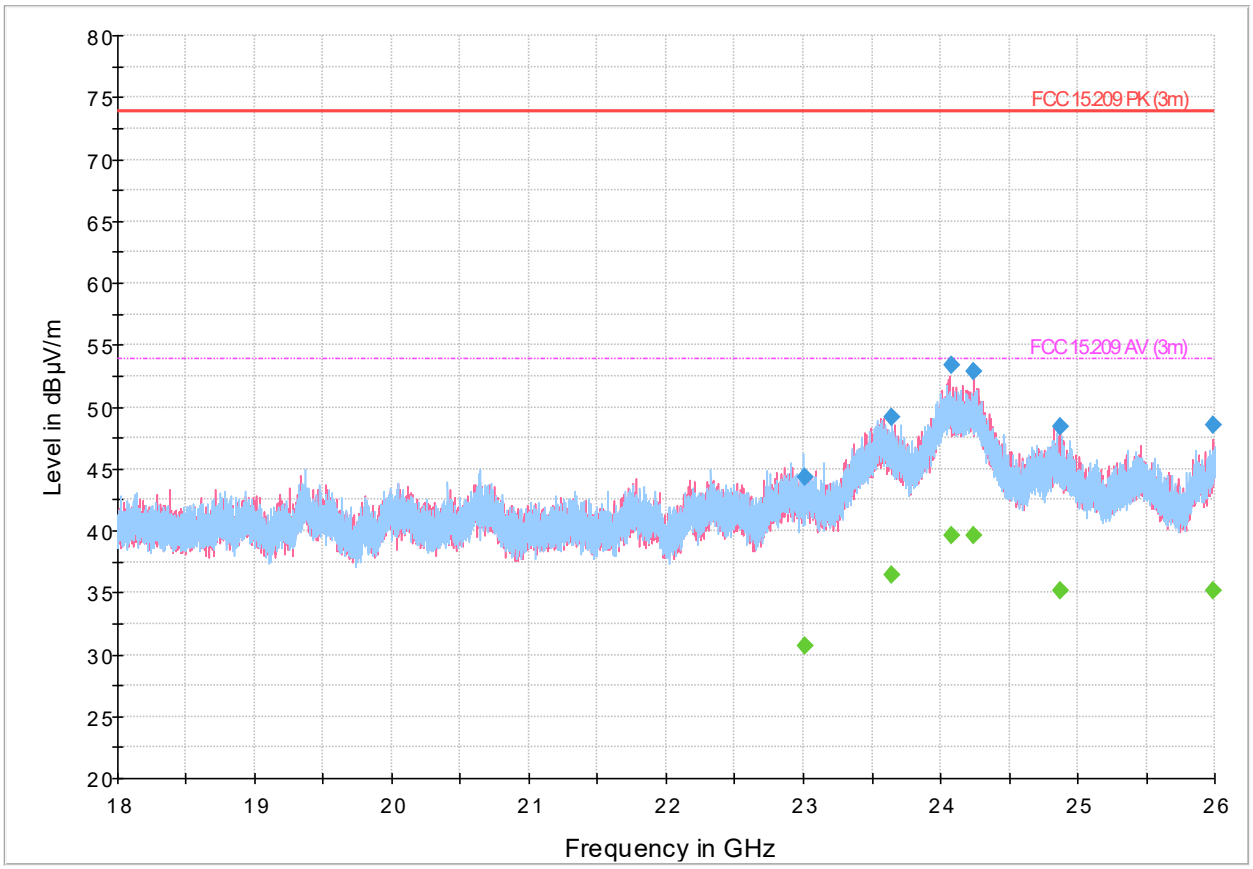

Figure 8.5-19: *Radiated emissions spectral plot (18 GHz - 26 GHz) – channel 2480 MHz*

Table 8.5-12*: Radiated emissions results*

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)
23007.300000	---	30.66	53.90	23.24	5000.0	1000.000	115.0	H	100.0	20.9
23007.300000	44.34	---	73.90	29.56	5000.0	1000.000	115.0	H	100.0	20.9
23646.100000	49.23	---	73.90	24.67	5000.0	1000.000	364.0	V	311.0	25.7
23646.100000	---	36.40	53.90	17.50	5000.0	1000.000	364.0	V	311.0	25.7
24074.900000	---	39.63	53.90	14.27	5000.0	1000.000	241.0	V	125.0	29.7
24074.900000	53.31	---	73.90	20.59	5000.0	1000.000	241.0	V	125.0	29.7
24238.100000	---	39.59	53.90	14.31	5000.0	1000.000	194.0	V	0.0	29.0
24238.100000	52.88	---	73.90	21.02	5000.0	1000.000	194.0	V	0.0	29.0
24874.500000	---	35.20	53.90	18.70	5000.0	1000.000	400.0	V	0.0	24.7
24874.500000	48.40	---	73.90	25.50	5000.0	1000.000	400.0	V	0.0	24.7
25990.500000	48.59	---	73.90	25.31	5000.0	1000.000	225.0	V	228.0	25.4
25990.500000	---	35.11	53.90	18.79	5000.0	1000.000	225.0	V	228.0	25.4

Notes: [1] Field strength (dB V/m) = receiver/spectrum analyzer value (dB V) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB)
[3] Emissions that were continuously present for a minimum of 1 second and occurred more than once for every 15 seconds observation period were considered valid emissions. The maximum value of valid emissions has been recorded.

8.6 Power spectral density

8.6.1 References and limits

- FCC 47 CFR Part 15, Subpart B: §15.247(e)
- RSS-247: §5.2(b)
- Test method: ANSI C63.10 §11.10.2.1 (Method PKPSD)

§15.247:

(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:

5.4 DTSs include systems that employ digital modulation techniques resulting in spectral characteristics similar to direct sequence systems. The following applies to the bands 902-928 MHz and 2400-2483.5 MHz:

(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(d), (i.e., the power spectral density shall be determined using the same method as is used to determine the conducted output power).

8.6.2 Test summary

Verdict	Pass		
Test date	September 23, 2022	Temperature	22.87 °C
Test engineer	Lan Sayasane, EMC Test Engineer	Air pressure	1004.82 mbar
Test location	☒ Wireless bench ☐ Other:	Relative humidity	47.9 %

8.6.3 Notes

Testing was performed with the transmitter operating on a fixed channel at full power. Low, middle and high channels were tested.

8.6.4 Setup details

EUT power input during test	120 Vac/60 Hz
EUT setup configuration	☒ Table-top ☐ Floor standing ☐ Other:

Spectrum analyzer settings:

Resolution bandwidth	3 kHz
Video bandwidth	10 kHz
Detector mode	Peak
Trace mode	Max Hold
Measurement time	Long enough for trace to stabilize

8.6.5 Test data

Table 8.6-1: *Power spectral density test data*

Test frequency (MHz)	Measured power spectral density (dBm/3kHz)	Limit (dBm/3kHz)
2402	-13.84	≤8.0
2440	-13.50	≤8.0
2480	-13.12	≤8.0

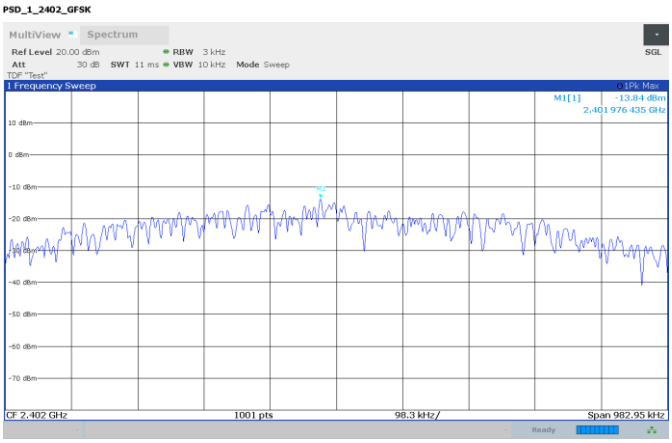

Figure 8.6-1: *Power spectral density, 2402 MHz*

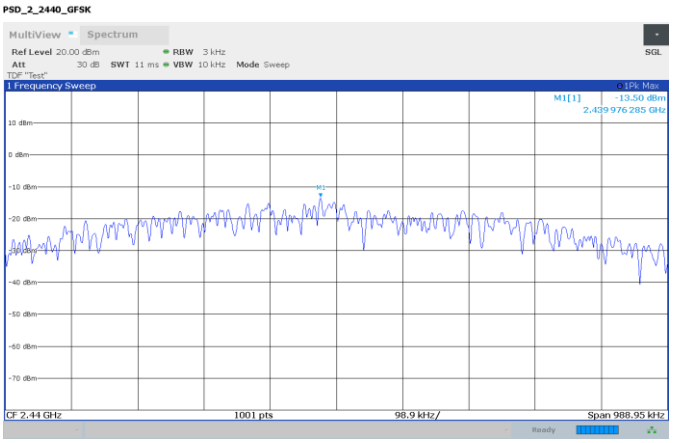

Figure 8.6-2: *Power spectral density, 2440 MHz*

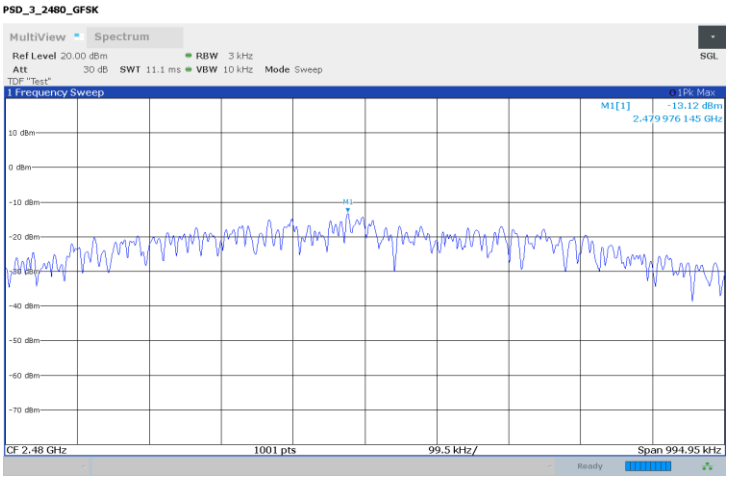

Figure 8.6-3: *Power spectral density, 2480 MHz*

8.7 99 % occupied bandwidth

8.7.1 References and limits

- RSS-Gen: §6.7
- Test method: ANSI C63.4-2014: §6.9.2

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.

8.7.2 Test summary

Verdict	Pass		
Test date	September 29, 2022	Temperature	22.96 °C
Test engineer	Lan Sayasane, EMC Test Engineer	Air pressure	1004.68 mbar
Test location	☒ Wireless bench ☐ Other:	Relative humidity	49.6 %

8.7.3 Notes

Testing was performed with the transmitter operating on a fixed channel at full power. Low, middle and high channels were tested.

8.7.4 Setup details

EUT power input during test	120 Vac/60 Hz
EUT setup configuration	☒ Table-top ☐ Floor standing ☐ Other:

Receiver settings:

Resolution bandwidth	20 kHz
Video bandwidth	100 kHz
Detector mode	Peak
Trace mode	Max Hold
Measurement time	Long enough for trace to stabilize

8.7.5 Test data

Table 8.7-1: *99 % occupied bandwidth test data*

Test frequency (MHz)	Bandwidth (MHz)	Measured f_c (MHz)	Measured f_L (MHz)	Measured f_H (MHz)	Limit
2402	1.019	2401.992	2401.498	2402.517	f_H and f_L within 2400 – 2483.5 MHz
2440	1.016	2439.992	2439.498	2440.514	f_H and f_L within 2400 – 2483.5 MHz
2480	1.021	2479.992	2479.496	2480.517	f_H and f_L within 2400 – 2483.5 MHz

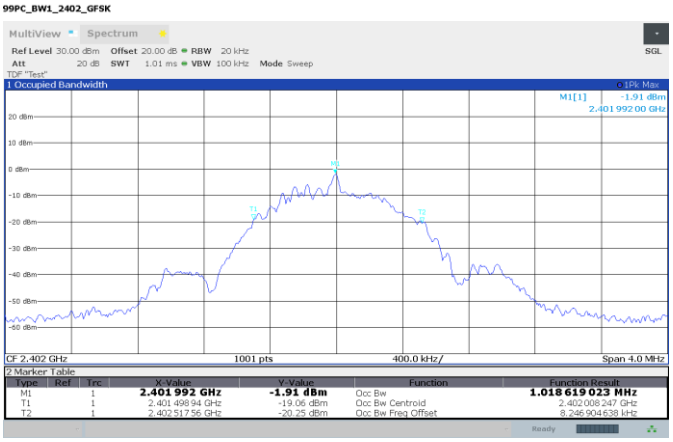

Figure 8.7-1: *99 % occupied bandwidth, 2402 MHz*

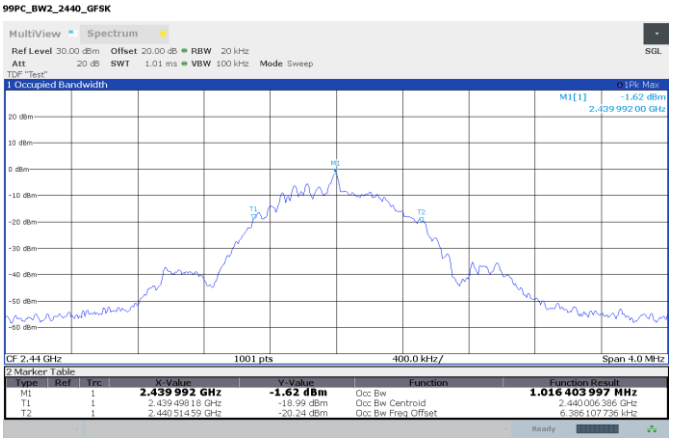

Figure 8.7-2: *99 % occupied bandwidth, 2440 MHz*

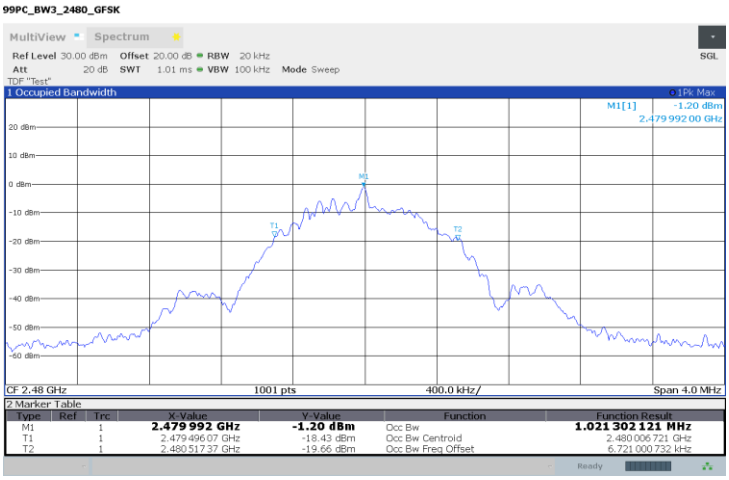

Figure 8.7-3: *99 % occupied bandwidth, 2480 MHz*

Section 9 Block diagrams of test setup

9.1 Radiated emission setup

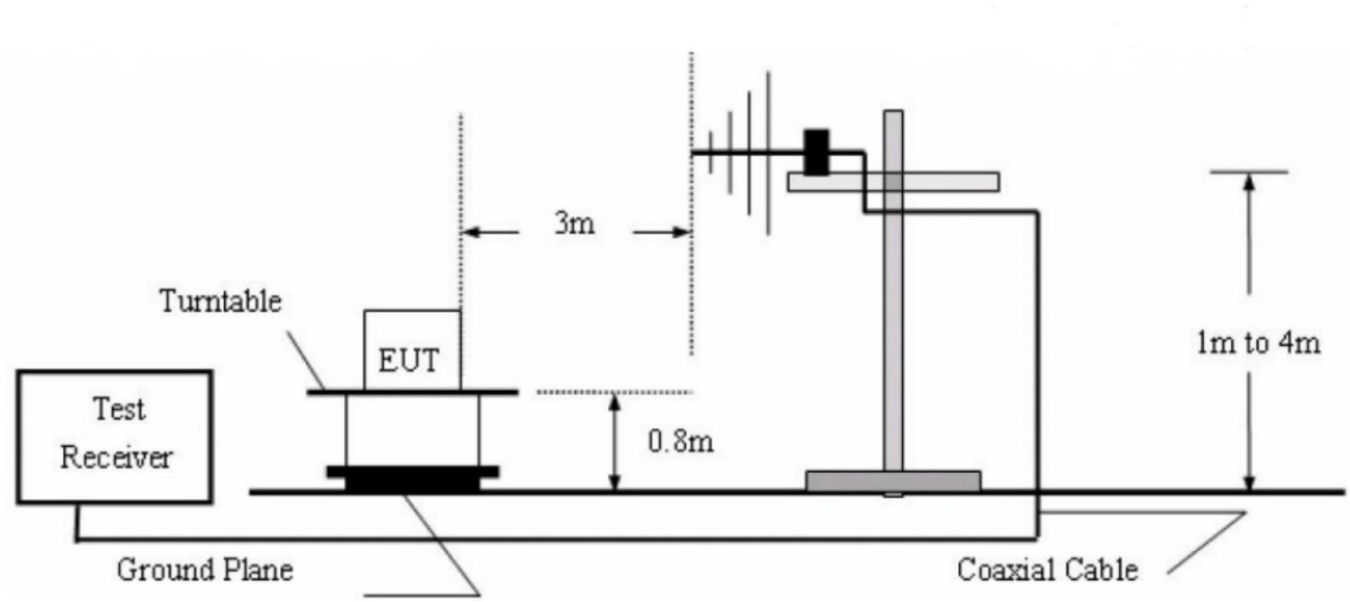

Figure 9.1-1: *Radiated emissions < 1 GHz*

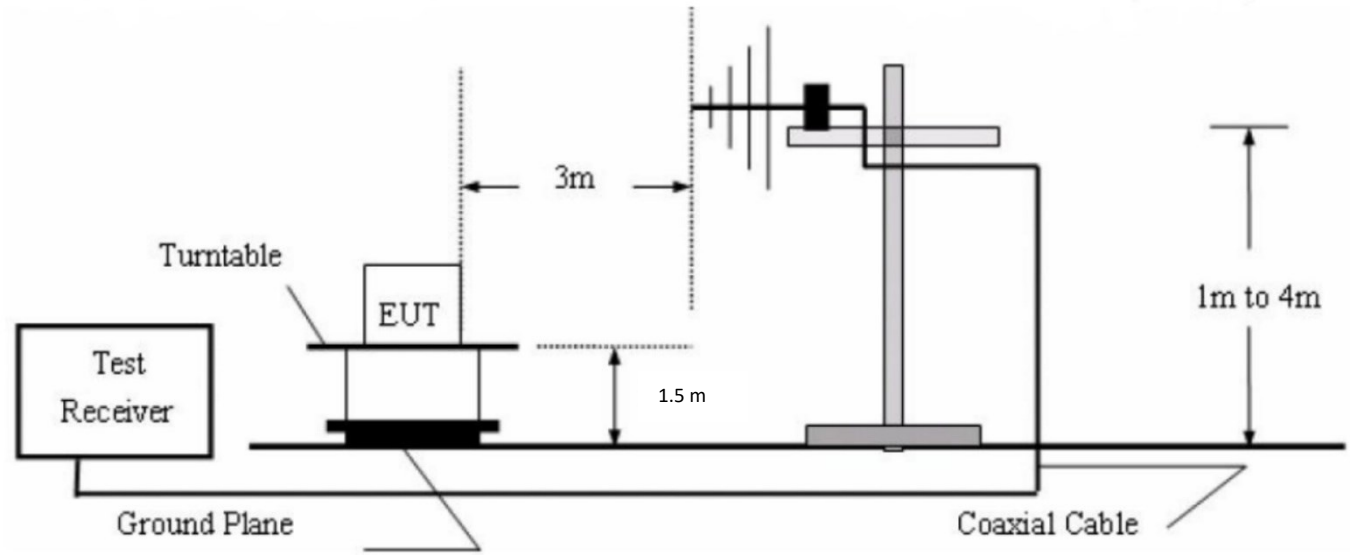

Figure 9.1-2: *Radiated emissions > 1 GHz*

9.2 AC conducted emissions test setup

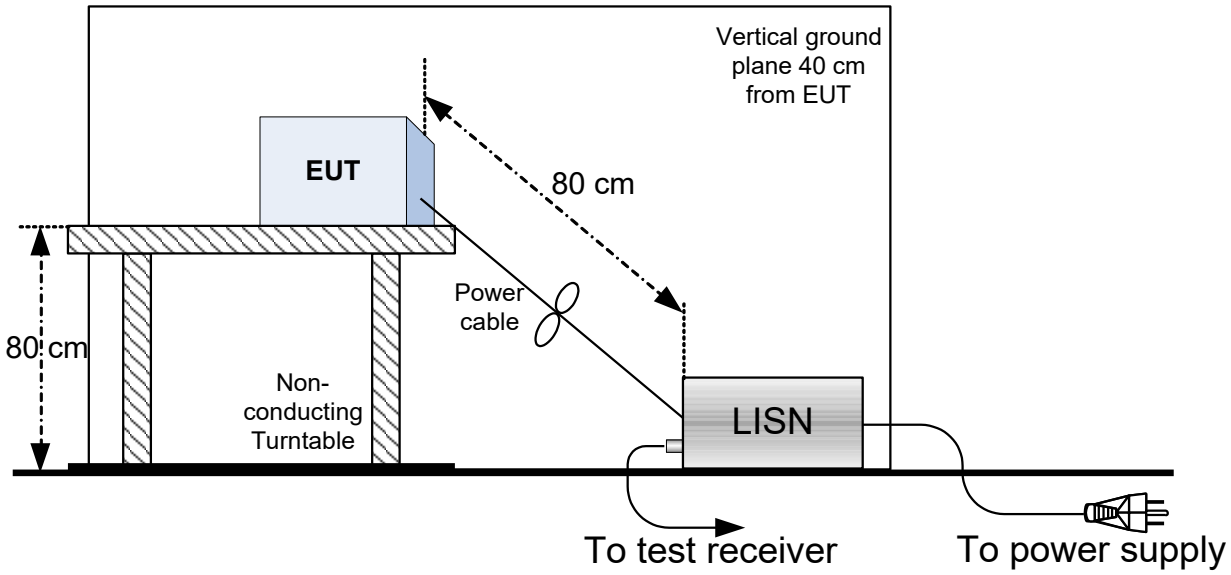

Figure 9.2-1: *AC conducted emissions setup*

End of report