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Test report

345868-1TRFWL

Date of issue: February 9, 2018

Applicant:

Edgewater Wireless Systems Inc

Product:

802.11a, miniPCI, 3-channel WiFi Radio Card

Model:

EWC5XGWFR1

FCC ID: ATX-EWC5XGWFR1

ISED Registration number: 10165A-EWC5XGWFR1

Specifications:

- FCC 47 CFR Part 15 Subpart E, §15.407
  Unlicensed National Information Infrastructure Devises
- RSS-247, Issue 2, Section 6, February 2017
  Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

Test location

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Toll free	+1 800 563 6336
Website	www.nemko.com
Site number	FCC: CA2040; ISED: 2040A-4 (3 m semi anechoic chamber)

Tested by	Andrey Adelberg, Senior Wireless/EMC Specialist
Reviewed by	Kevin Rose, Wireless/EMC Specialist
Review date	February 9, 2018
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 Canada's ISO/IEC 17025 accreditation.

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Section 1. Report summary

1.1 Applicant and manufacturer

Company name	Edgewater Wireless Systems Inc
Address	408 Churchill Ave, N
City	Ottawa
Province/State	Ontario
Postal/Zip code	K1Z 5C6
Country	Canada

1.2 Test specifications

FCC 47 CFR Part 15, Subpart E, Clause 15.407	Unlicensed National Information Infrastructure Devises
RSS-247, Issue 2, February 2017	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

1.3 Test methods

789033 D02 General U-NII Test Procedures New Rules v01r04	Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices Part 15, Subpart E
ANSI C63.10 v2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

1.4 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was completed 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.

1.5 Exclusions

None

1.6 Test report revision history

Revision #	Details of changes made to test report
TRF	Original report issued

Section 2. Summary of test results

2.1 FCC Part 15 Subpart C, general requirements test results

Part	Test description	Verdict
§15.31(e)	Variation of power source	Pass[1]
§15.203	Antenna requirement	Pass[2]

Notes: [1]Measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, was performed with the supply voltage varied between 85 % and 115 % of the nominal rated supply voltage. No noticeable output power variation was observed

[2]The Antennas ports have unique RF connections: u-FL located on the EUT board.

2.2 FCC Part 15 Subpart E, test results

Part	Test description	Verdict
§15.403(i)	Emission bandwidth	Pass
§15.407(a)(1)	Power and density limits within 5.15–5.25 GHz band	Pass
§15.407(a)(2)	Power and density limits within 5.25–5.35 GHz and 5.47–5.725 GHz bands	Not applicable
§15.407(a)(3)	Power and density limits within 5.725–5.85 GHz band	Not applicable
§15.407(b)(1)	Undesirable emission limits for 5.15–5.25 GHz band	Pass
§15.407(b)(2)	Undesirable emission limits for 5.25–5.35 GHz band	Not applicable
§15.407(b)(3)	Undesirable emission limits for 5.47–5.725 GHz bands	Not applicable
§15.407(b)(4)	Undesirable emission limits for 5.725–5.85 GHz band	Not applicable
§15.407(b)(6)	Conducted limits for U-NII devices using an AC power line	Pass
§15.407(e)	Minimum 6 dB bandwidth of U-NII devices within the 5.725-5.85 GHz band	Not applicable
§15.407(g)	Frequency stability	Pass
§15.407(h)(1)[1]	Transmit power control (TPC)	Not applicable
§15.407(h)(2)[1]	Dynamic Frequency Selection (DFS)	Not applicable

Note: [1]DFS and TPC requirements are only applicable to 5.25–5.35 GHz and 5.47–5.725 GHz bands

2.3 IC RSS-GEN, Issue 4, test results

Part	Test description	Verdict
6.6	Occupied Bandwidth	Pass
7.1.2[1]	Receiver radiated emission limits	Not applicable
7.1.3[1]	Receiver conducted emission limits	Not applicable
8.8	Power Line Conducted Emissions Limits for Licence-Exempt Radio Apparatus	Pass
8.11[2]	Frequency stability	Pass

Notes: [1]According to sections 5.2 and 5.3 of RSS-Gen, Issue 4: if EUT does not have a stand-alone receiver neither scanner receiver, then it exempt from receiver requirements.

[2]According to section 8.11 of RSS-Gen, Issue 4: if the frequency stability of the licence-exempt radio apparatus is not specified in the applicable standard (RSS), measurement of the frequency stability is not required

2.4 IC RSS-247, Issue 2, test results

Section	Test description	Verdict
6.1[1]	Types of Modulation	Pass
6.2.1.1	Power limits for 5150–5250 MHz band	Pass
6.2.2.1	Power limits for 5250–5350 MHz band	Not applicable
6.2.3.1	Power limits for 5470–5600 MHz and 5650–5725 MHz bands	Not applicable
6.2.4.1	Power limits for 5725–5850 MHz band	Not applicable
6.2.4.1	Minimum 6 dB bandwidth	Not applicable
6.2.1.2	Unwanted emission limits for 5150–5250 MHz band	Pass
6.2.2.2	Unwanted emission limits for 5250–5350 MHz band	Not applicable
6.2.2.2	TPC requirements for devices with a maximum e.i.r.p. greater than 500 mW	Not applicable
6.2.2.3	e.i.r.p. at different elevations restrictions for 5250–5350 MHz band	Not applicable
6.2.3.2	Unwanted emission limits for 5470–5600 MHz and 5650–5725 MHz bands	Not applicable
6.2.4.2	Unwanted emission limits for 5725–5850 MHz band	Not applicable
6.3	Dynamic Frequency Selection (DFS) for devices operating in the bands 5250–5350 MHz, 5470–5600 MHz and 5650–5725 MHz	Not applicable

Notes: [1] The EUT employs digital modulation: 802.11a

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	January 15, 2018
Nemko sample ID number	1

3.2 EUT information

Product name	802.11a, miniPCI, 3-channel WiFi Radio Card
Model	EWC5XGWFR1
Serial number	EWP161215A00159

3.3 Technical information

Applicant IC company number	10165A
IC UPN number	EWC5XGWFR1
All used IC test site(s) Reg. number	2040A-4
RSS number and Issue number	RSS-247 Issue 2, Section 6, February 2017
Frequency band	5150–5250 MHz
Frequency Min (MHz)	5180
Frequency Max (MHz)	5240
RF power Min (W)	N/A
RF power Max (W), Conducted	0.129 (21.09 dBm)
Field strength, Units @ distance	N/A
Measured BW (kHz) (26 dB)	19423 (per channel of operation)
Measured BW (kHz) (99%)	16474 (per channel of operation)
Calculated BW (kHz), as per TRC-43	N/A
Type of modulation	802.11a
Emission classification (F1D, G1D, D1D)	W7D
Transmitter spurious (dBµV/m) @ 3 m	43.72 (average at 5350 MHz)
Power requirements	48 V_{DC} from PoE power supply (120 V_{AC}, 60 Hz)
Antenna information	L-Com. Triple Element Dual Polarized Flat Panel Antenna, M/N: HG2458-14DP-3NF, Gain 14 dBi Laird Tech. Tri-band whip omnidirectional antenna, M/N: RD2458-5, Gain 5 dBi EUT contains two antenna ports: one for Transmission, one exclusively for Receiving. For Canada, only 5 dBi antenna is used. The EUT uses a unique antenna coupling/ non-detachable antenna to the intentional radiator.

3.4 Product description and theory of operation

The EWC5XGWFR1 is a wide-band, multi-channel, wireless LAN Mini-PCI module utilizing the Edgewater EWC3000 chip set. The EWC5XGWFR1 Module is compliant with IEEE802.11a (Wi-Fi) operating at 5150–5250 MHz U-NII-1 band and 5725–5850 MHz U-NII-3 band. Based on Edgewater's proprietary silicon technology the EWC5XGWFR1 simultaneously supports 3 autonomous IEEE 802.11a MAC protocols in a highly integrated chipset.

3.5 EUT exercise details

Low, mid and high channels of the EUT as well as power level were controlled from laptop using PuTTy session.
2-carrier operation is a simultaneous transmission from two adjacent non-overlapping channels.

- Tested at the bottom of the band and at the top of the band.

3-carrier operation is a simultaneous transmission from three adjacent non-overlapping channels.

- Tested at the bottom of the band and at the top of the band.

3.6 EUT setup diagram

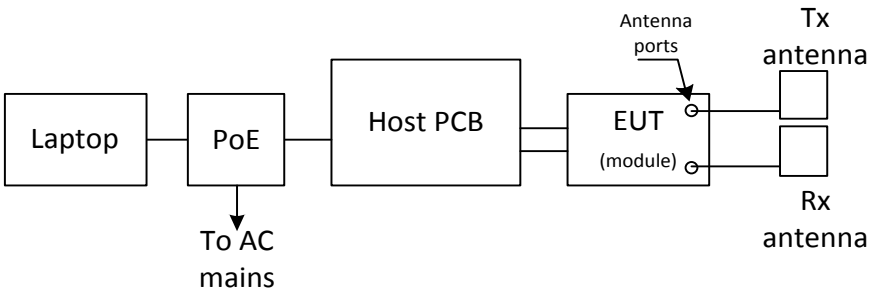


Figure 3.6-1: *Setup diagram*

3.7 EUT sub assemblies

Table 3.7-1: *EUT sub assemblies*

Description	Brand name	Model/Part number	Serial number
Laptop	Lenovo	x220i	4286CTO
PoE	Ubiquity	GP-C500-120G	1645-0003257
Host PCB	Gateworks	GW2388-4	694622

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	860–1060 mbar

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

5.2 Power supply range

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

Section 6. Measurement uncertainty

6.1 Uncertainty of measurement

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

Test name	Measurement uncertainty, dB
All antenna port measurements	0.55
Conducted spurious emissions	1.13
Radiated spurious emissions	3.78
AC power line conducted emissions	3.55

Section 7. Test equipment

7.1 Test equipment list

Table 7.1-1: *Equipment list*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
3 m EMI test chamber	TDK	SAC-3	FA002047	1 year	Dec. 09/18
Flush mount turntable	Sunol	FM2022	FA002082	—	NCR
Controller	Sunol	SC104V	FA002060	—	NCR
Antenna mast	Sunol	TLT2	FA002061	—	NCR
AC Power source	Chenwa	2700M-10k	FA002716	—	VOU
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 26	FA002043	1 year	Jan. 31/18
Spectrum analyzer	Rohde & Schwarz	FSU	FA001877	1 year	July 18/18
Horn antenna (1–18 GHz)	EMCO	3115	FA000825	1 year	June 21/18
Preamp (1–18 GHz)	ETS-Lindgren	124334	FA002877	1 year	Nov. 14/18
Horn antenna (18–40 GHz)	EMCO	3116	FA001847	1 year	June 27/18
Pre-amplifier (18–26 GHz)	Narda	BBS-1826N612	FA001550	—	VOU
Pre-amplifier (26–40 GHz)	Narda	DBL-2640N610	FA001556	—	VOU
LISN	Rohde & Schwarz	ENV216	FA002023	1 year	May 19/18
Temperature chamber	Thermotron	SM-16C	FA001030	1 year	NCR

Note: NCR - no calibration required, VOU - verify on use

Section 8. Testing data

8.1 FCC 15.403(i) Emission bandwidth

8.1.1 Definitions and limits

For purposes of this subpart the emission bandwidth shall be determined by measuring the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, that are 26 dB down relative to the maximum level of the modulated carrier. Determination of the emissions bandwidth is based on the use of measurement instrumentation employing a peak detector function with an instrument resolution bandwidth approximately equal to 1.0 percent of the emission bandwidth of the device under measurement.

8.1.2 Test summary

Test date	January 15, 2018
Test engineer	Andrey Adelberg

8.1.3 Observations, settings and special notes

Spectrum analyser settings:

Resolution bandwidth	approximately 1% of the emission bandwidth
Video bandwidth	> RBW
Detector mode	Peak
Trace mode	Max Hold

8.1.4 Test data

Table 8.1-1: *26 dB bandwidth results*

Application	Central frequency, MHz	26 dB bandwidth, MHz
1-carrier	5180	19.423
	5200	19.295
	5240	19.167
2-carrier	5190	40.545
	5230	40.064
3-carrier	5200	61.058
	5220	60.897

8.1.4 Test data, continued

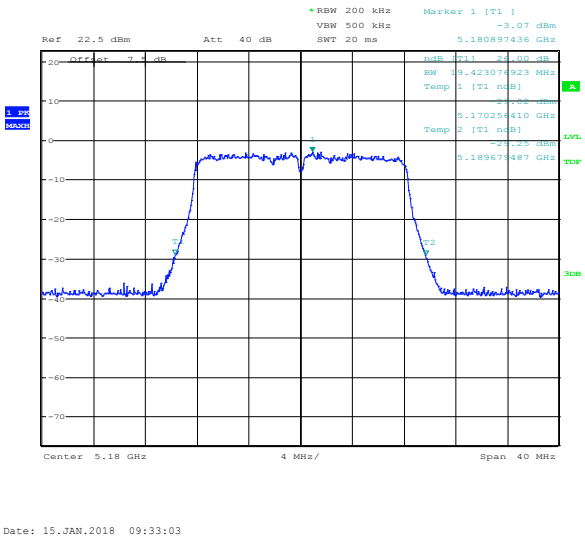


Figure 8.1-1: *26 dB bandwidth at low channel, 1-carrier operation*

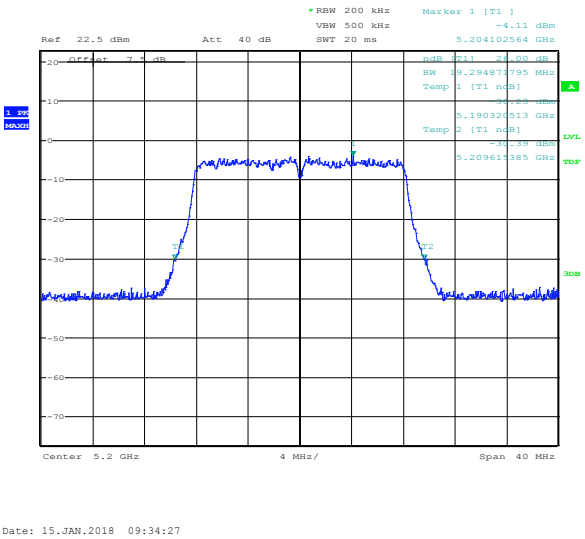


Figure 8.1-2: *26 dB bandwidth at mid channel, 1-carrier operation*

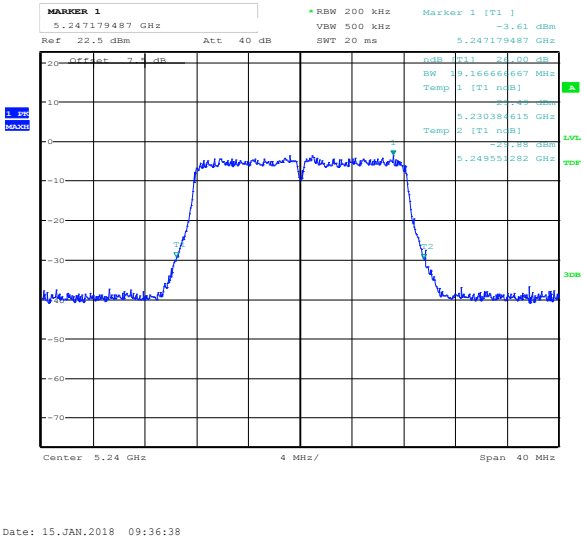
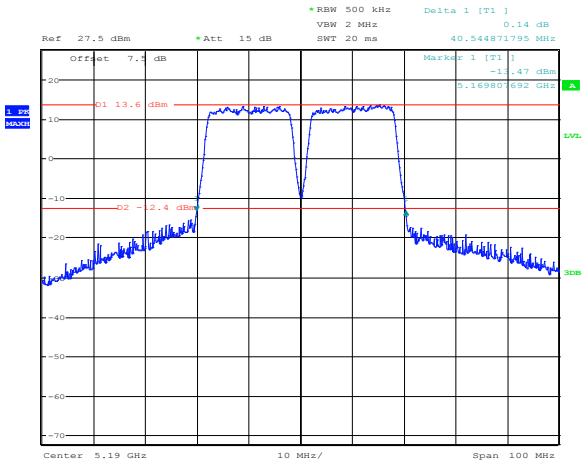
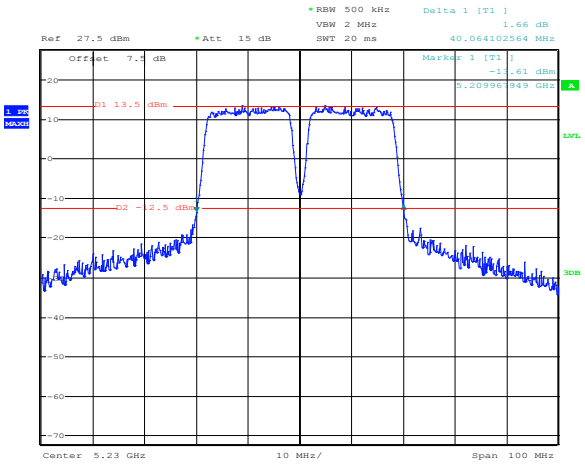


Figure 8.1-3: *26 dB bandwidth at high channel, 1-carrier operation*



Date: 16.JAN.2018 12:31:50

Figure 8.1-4: *26 dB bandwidth at bottom of the band, 2-carrier operation*



Date: 16.JAN.2018 13:42:06

Figure 8.1-5: *26 dB bandwidth at top of the band, 2-carrier operation*

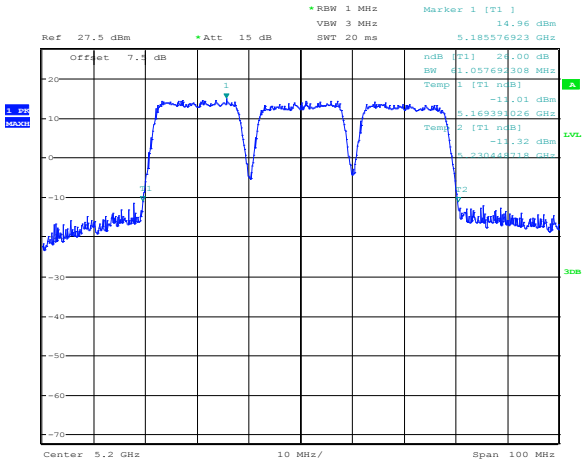


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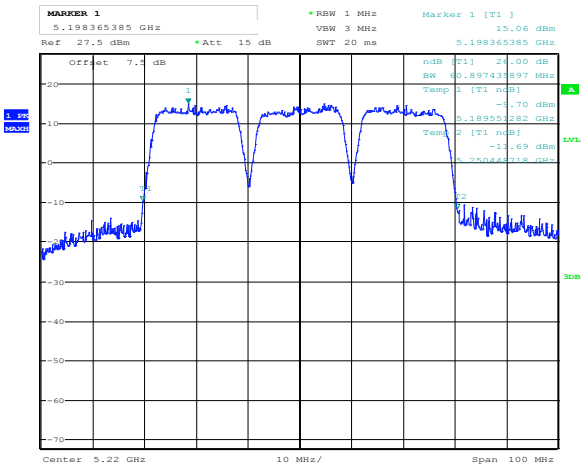
Figure 8.1-6: *26 dB bandwidth at bottom of the band, 3-carrier operation*



Date: 16.JAN.2018 14:06:28

Figure 8.1-7: *26 dB bandwidth at top of the band, 3-carrier operation*

8.2 RSS-Gen 6.6 Occupied bandwidth

8.2.1 Definitions and limits

The emission bandwidth (×dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated × dB below the maximum in-band spectral density of the modulated signal. Spectral density (power per unit bandwidth) is to be measured with a detector of resolution bandwidth in the range of 1% to 5% of the anticipated emission bandwidth, and a video bandwidth at least 3× the resolution bandwidth.

When the occupied bandwidth limit is not stated in the applicable RSS or reference measurement method, the transmitted signal bandwidth shall be reported as the 99% emission bandwidth, as calculated or measured.

8.2.2 Test summary

Test date:	January 15, 2018
Test engineer:	Andrey Adelberg

8.2.3 Observations, settings and special notes

Spectrum analyser settings:

Resolution bandwidth:	≥ 1 % of bandwidth
Video bandwidth:	≥3 × RBW
Detector mode:	Peak
Trace mode:	Max Hold

8.2.4 Test data

Table 8.2-1: *99 % bandwidth results*

Application	Central frequency, MHz	99 % occupied bandwidth, MHz
1-carrier	5180	16.474
	5200	16.474
	5240	16.474
2-carrier	5190	36.378
	5230	36.218
3-carrier	5200	56.571
	5220	56.731

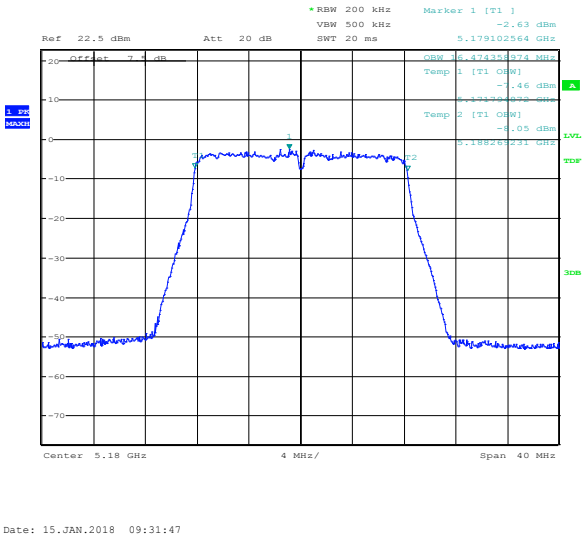


Figure 8.2-1: *99 % bandwidth at low channel, 1-carrier operation*

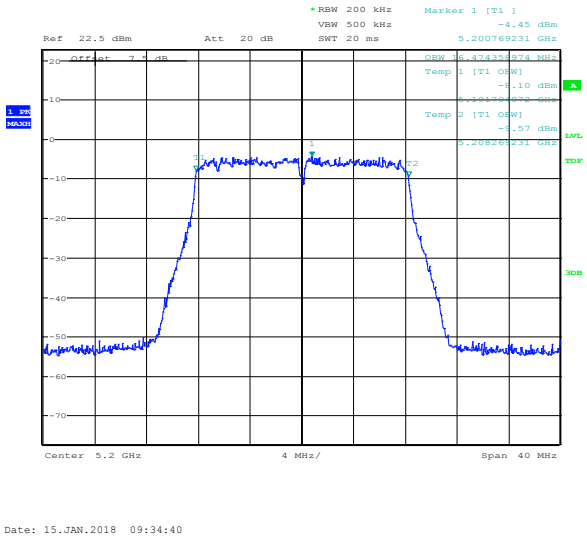


Figure 8.2-2: *99 % bandwidth at mid channel, 1-carrier operation*

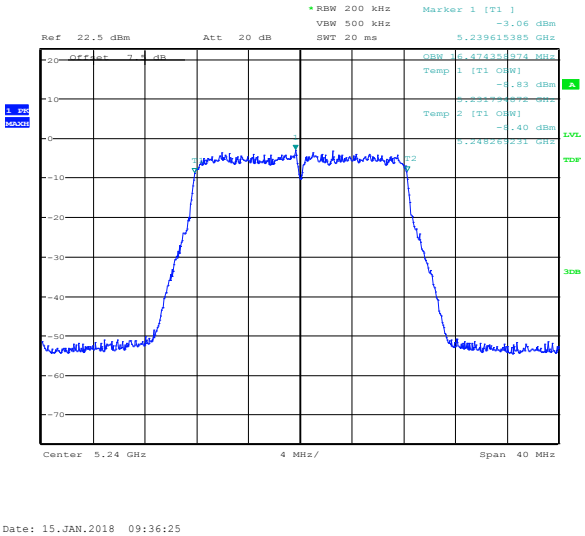


Figure 8.2-3: *99 % bandwidth at high channel, 1-carrier operation*

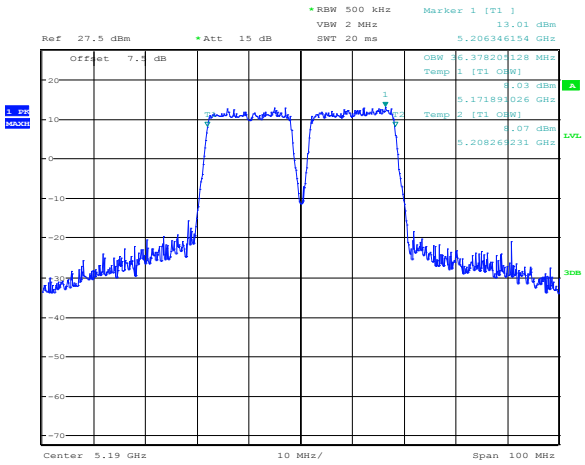


Figure 8.2-4: *99 % bandwidth at bottom of the band, 2-carrier operation*

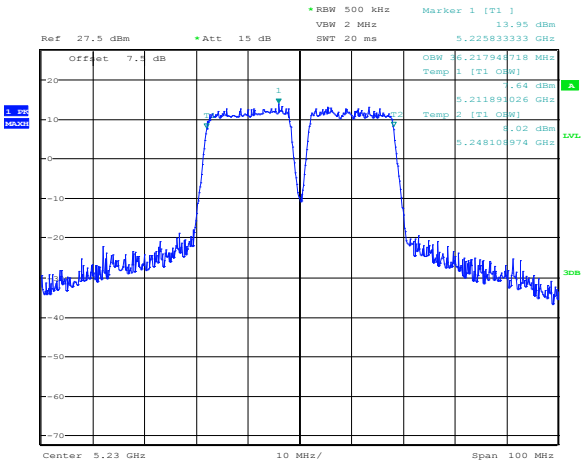


Figure 8.2-5: *99 % bandwidth at top of the band, 2-carrier operation*

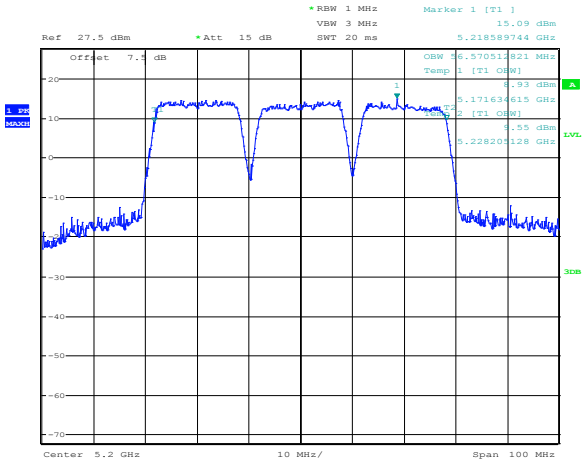


Figure 8.2-6: *99 % bandwidth at bottom of the band, 3-carrier operation*

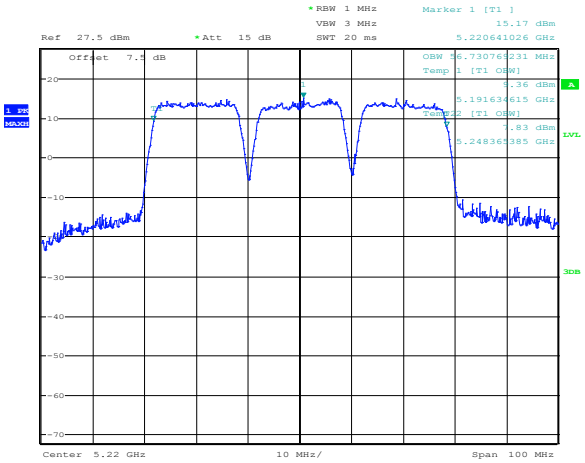


Figure 8.2-7: *99 % bandwidth at top of the band, 3-carrier operation*

8.3 FCC 15.407(a)(1) and RSS-247 6.2.1.1 5.15–5.25 GHz band output power and spectral density limits

8.3.1 Definitions and limits

FCC:

(i) For an outdoor access point operating in the band 5.15–5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W (30 dBm) provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).

(ii) For an indoor access point operating in the band 5.15–5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W (30 dBm) provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(iii) For fixed point-to-point access points operating in the band 5.15–5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W (30 dBm). In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. Fixed point-to-point U-NII devices may employ antennas with directional gain up to 23 dBi without any corresponding reduction in the maximum conducted output power or maximum power spectral density. For fixed point-to-point transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in maximum conducted output power and maximum power spectral density is required for each 1 dB of antenna gain in excess of 23 dBi. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

(iv) For mobile and portable client devices in the 5.15–5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW (24 dBm) provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

ISED:

LE-LAN devices are restricted to indoor operation only in the band 5150–5250 MHz.

The maximum e.i.r.p. shall not exceed 200 mW (23 dBm) or $10 + 10 \times \log_{10}(B)$, dBm, whichever power is less. B is the 99% emission bandwidth in megahertz. The e.i.r.p. spectral density shall not exceed 10 dBm in any 1.0 MHz band.

8.3.2 Test summary

Test date:	January 15, 2018
Test engineer:	Andrey Adelberg

8.3.3 Observations, settings and special notes

For antennas with the directional gain greater than 6 dBi, the maximum FCC output power limit was calculated as follows:

30 dBm – (Maximum antenna gain – 6 dBi)

Limit for 14 dBi antenna: 30 dBm – (12.5 dBi – 6 dBi) = 23.5 dBm

Minimum declared cable loss of 1.5 dB was reduced from the maximum antenna gain.

For antennas with the directional gain greater than 6 dBi, the maximum FCC power spectral density limit was calculated as follows:

17 dBm/MHz – (Maximum antenna gain – 6 dBi)

Limit for 14 dBi antenna: 17 dBm/MHz – (12.5 dBi – 6 dBi) = 10.5 dBm/MHz

Minimum declared cable loss of 1.5 dB was reduced from the maximum antenna gain.

The minimum 99 % measured occupied bandwidth was 16.474 MHz

ISED EIRP limit was calculated as follows: $10 + 10 \times \text{Log}_{10}$ (16.474 MHz) = 22.17 dBm < 23 dBm (200 mW)

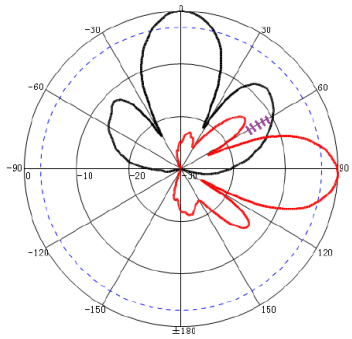
8.3.4 Test data

Table 8.3-1: *Output power measurements results for 14 dBi antenna (USA)*

Application	Central frequency, MHz	Conducted output power, dBm	Power limit, dBm	Margin, dB
1-carrier	5180	21.09	23.50	2.41
	5200	21.00	23.50	2.50
	5240	20.60	23.50	2.90
2-carrier	5190	20.05	23.50	3.45
	5230	19.93	23.50	3.57
3-carrier	5200	20.12	23.50	3.38
	5220	19.89	23.50	3.61

Table 8.3-2: *Output power measurements results for 14 dBi antenna at angles above 30° from the horizon (USA)*

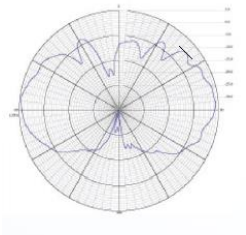
Application	Central frequency, MHz	Conducted output power, dBm	Antenna gain above 30°, dBi	EIRP, dBm	EIRP limit, dBm	Margin, dB
1-carrier	5180	21.09	-1.50	19.59	21.00	1.41
	5200	21.00	-1.50	19.50	21.00	1.50
	5240	20.60	-1.50	19.10	21.00	1.90
2-carrier	5190	20.05	-1.50	18.55	21.00	2.45
	5230	19.93	-1.50	18.43	21.00	2.57
3-carrier	5200	20.12	-1.50	18.62	21.00	2.38
	5220	19.89	-1.50	18.39	21.00	2.61



As per antenna (HG2458-14DP-3NF) pattern document (see red trace above), at the angles above 30° from the horizon the maximum antenna gain drop is 14 dB from 14 dBi to 0 dBi. Minimum declared cable loss of 1.5 dB was reduced from the maximum antenna gain. Antenna gain used for EIRP calculation was −1.5 dBi.

Table 8.3-3: *Output power measurements results for 5 dBi antenna (for USA) at angles above 30° from the horizon*

Application	Central frequency, MHz	Conducted output power, dBm	Antenna gain above 30°, dBi	EIRP, dBm	EIRP limit, dBm	Margin, dB
1-carrier	5180	21.09	-6.50	14.59	21.00	6.41
	5200	21.00	-6.50	14.50	21.00	6.50
	5240	20.60	-6.50	14.10	21.00	6.90
2-carrier	5190	20.05	-6.50	13.55	21.00	7.45
	5230	19.93	-6.50	13.43	21.00	7.57
3-carrier	5200	20.12	-6.50	13.62	21.00	7.38
	5220	19.89	-6.50	13.39	21.00	7.61



As per antenna (RD2458-5) pattern document (see above), at the angles above 30° from the horizon the maximum antenna gain drop is 5 dB from 5 dBi to 0 dBi. Minimum declared cable loss of 1.5 dB was reduced from the maximum antenna gain. Antenna gain used for EIRP calculation was −6.5 dBi
Canada power settings are much lower than those used for USA, therefore elevation pattern evaluation will comply with higher margins.

Table 8.3-4: *PPSD measurements results for 14 dBi antenna (USA)*

Application	Central frequency, MHz	PPSD, dBm/MHz	PPSD limit, dBm/MHz	Margin, dB
1-carrier	5180	10.01	10.50	0.49
	5200	9.93	10.50	0.57
	5240	9.54	10.50	0.96
2-carrier	5190	6.32	10.50	4.18
	5230	6.16	10.50	4.34
3-carrier	5200	4.88	10.50	5.62
	5220	4.38	10.50	6.12

Table 8.3-5: *Output power measurements results for 5 dBi antenna (Canada)*

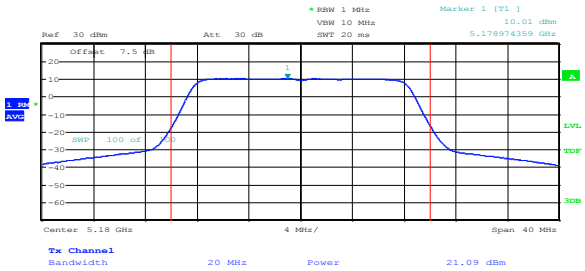
Application	Central frequency, MHz	Conducted output power, dBm	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
1-carrier	5180	15.82	3.50	19.32	22.17	2.85
	5200	16.04	3.50	19.54	22.17	2.63
	5240	15.59	3.50	19.09	22.17	3.08
2-carrier	5190	17.75	3.50	21.25	23.00	1.75
	5230	17.19	3.50	20.69	23.00	2.31
3-carrier	5200	17.39	3.50	20.89	23.00	2.11
	5220	17.21	3.50	20.71	23.00	2.29

Minimum declared cable loss of 1.5 dB was reduced from the maximum antenna gain.

Table 8.3-6: *PPSD measurements results for 5 dBi antenna (Canada)*

Application	Central frequency, MHz	PPSD, dBm/MHz	Antenna gain, dBi	EIRPSD, dBm/MHz	EIRPPSD limit, dBm/MHz	Margin, dB
1-carrier	5180	4.73	3.50	8.23	10.00	1.77
	5200	4.91	3.50	8.41	10.00	1.59
	5240	4.47	3.50	7.97	10.00	2.03
2-carrier	5190	3.81	3.50	7.31	10.00	2.69
	5230	3.43	3.50	6.93	10.00	3.07
3-carrier	5200	1.87	3.50	5.37	10.00	4.63
	5220	2.52	3.50	6.02	10.00	3.98

Minimum declared cable loss of 1.5 dB was reduced from the maximum antenna gain.



Date: 15.JAN.2018 10:09:30

Figure 8.3-1: *Conducted output power and PPSD at low channel, 1-carrier operation, USA*

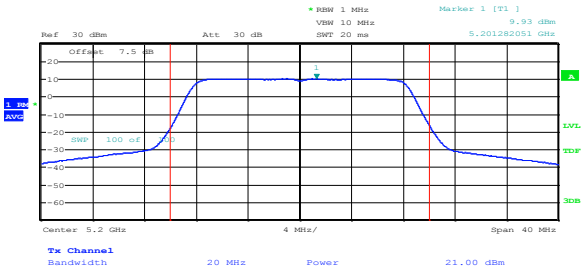


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Figure 8.3-2: *Conducted output power and PPSD at mid channel, 1-carrier operation, USA*

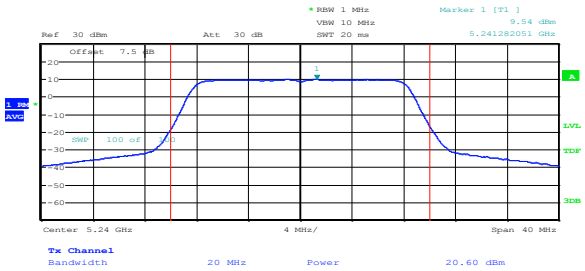

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Figure 8.3-3: *Conducted output power and PPSD at high channel, 1-carrier operation, USA*

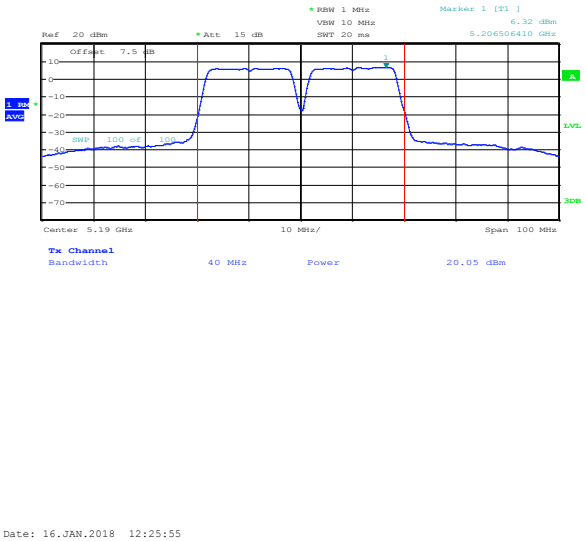


Figure 8.3-4: *Conducted output power and PPSD at the bottom of the band, 2-carrier operation, USA*

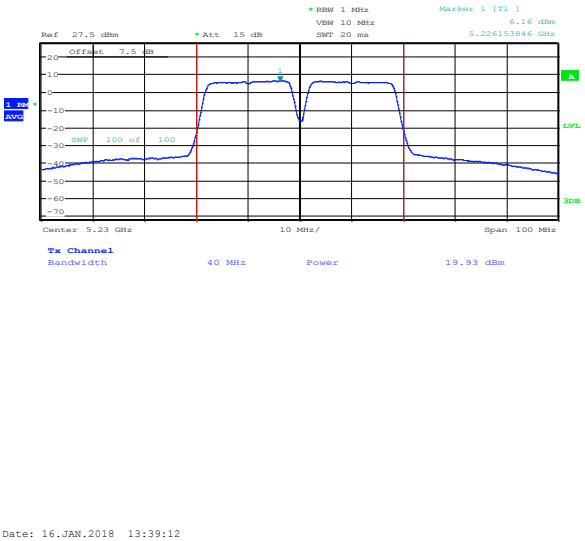


Figure 8.3-5: *Conducted output power and PPSD at the top of the band, 2-carrier operation, USA*

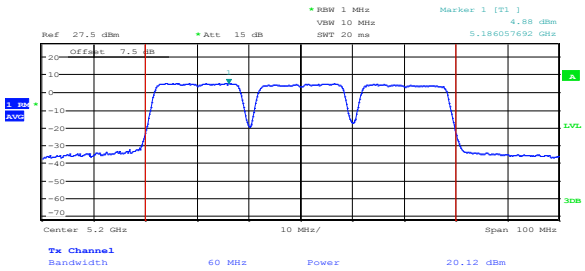


Figure 8.3-6: *Conducted output power and PPSD at the bottom of the band, 3-carrier operation, USA*

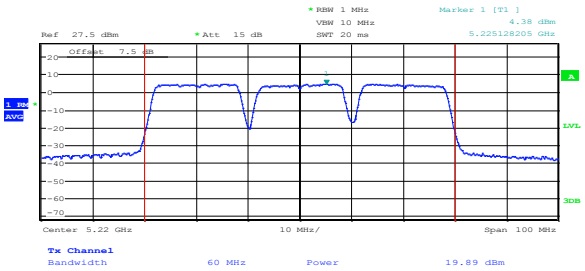
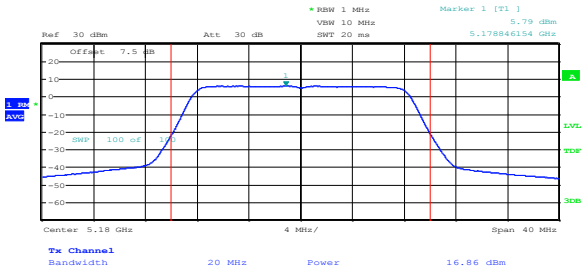
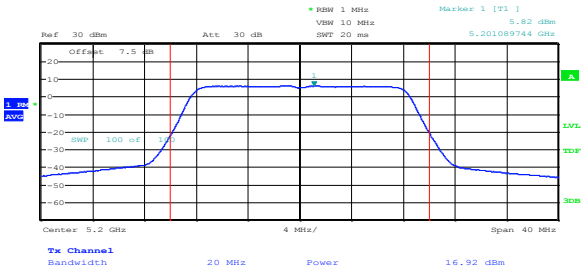


Figure 8.3-7: *Conducted output power and PPSD at the top of the band, 3-carrier operation, USA*



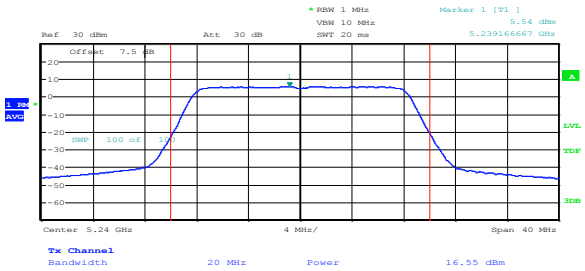
Date: 15.JAN.2018 10:11:31

Figure 8.3-8: *Conducted output power and PPSD at low channel, 1-carrier operation, Canada*



Date: 15.JAN.2018 10:00:36

Figure 8.3-9: *Conducted output power and PPSD at mid channel, 1-carrier operation, Canada*



Date: 15.JAN.2018 09:59:39

Figure 8.3-10: *Conducted output power and PPSD at high channel, 1-carrier operation, USA Canada*

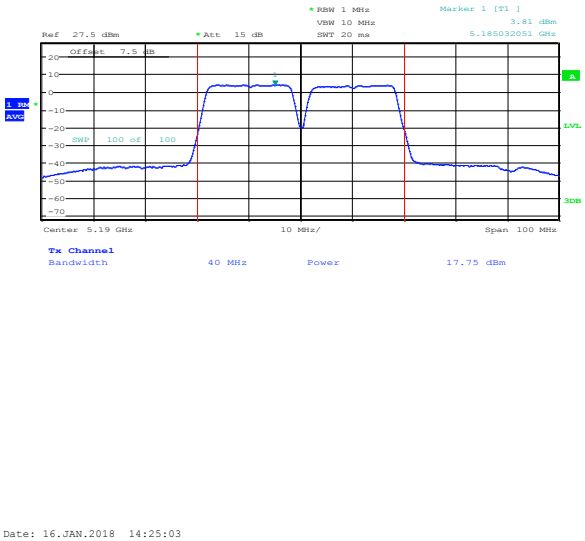


Figure 8.3-11: *Conducted output power and PPSD at the bottom of the band, 2-carrier operation, Canada*

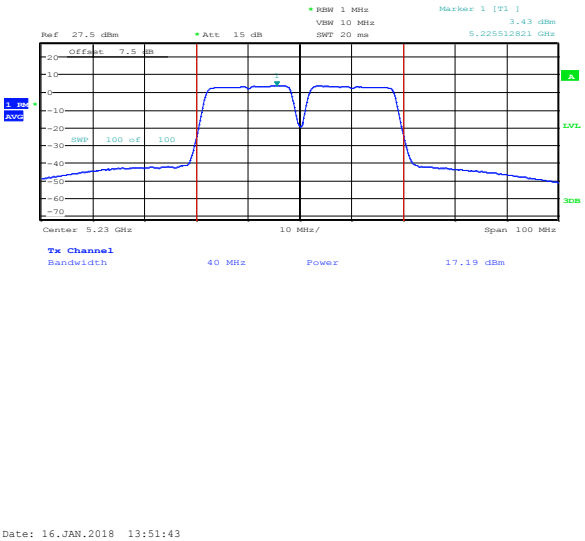


Figure 8.3-12: *Conducted output power and PPSD at the top of the band, 2-carrier operation, Canada*

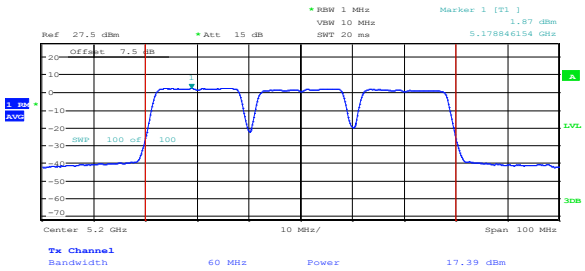


Figure 8.3-13: *Conducted output power and PPSD at the bottom of the band, 3-carrier operation, Canada*

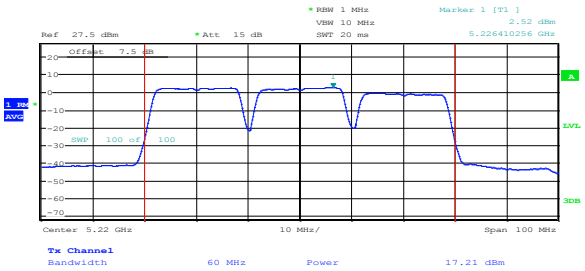


Figure 8.3-14: *Conducted output power and PPSD at the top of the band, 3-carrier operation, Canada*

8.4 FCC 15.407(b) and RSS-247 6.2.1.2 Undesirable (unwanted) emissions

8.4.1 Definitions and limits

FCC:
(1) For transmitters operating in the 5.15–5.25 GHz band: all emissions outside of the 5.15–5.35 GHz band shall not exceed an EIRP of −27 dBm/MHz.
(5) The emission measurements shall be performed using a minimum resolution bandwidth of 1 MHz. A lower resolution bandwidth may be employed near the band edge, when necessary, provided the measured energy is integrated to show the total power over 1 MHz.
(6) Unwanted emissions below 1 GHz must comply with the general field strength limits set forth in § 15.209.
(7) The provisions of § 15.205 apply to intentional radiators operating under this section.
(8) When measuring the emission limits, the nominal carrier frequency shall be adjusted as close to the upper and lower frequency block edges as the design of the equipment permits.

ISED:
For transmitters operating in the band 5150–5250 MHz, all emissions outside the band 5150–5350 MHz shall not exceed −27 dBm/MHz e.i.r.p. However, any unwanted emissions that fall into the band 5250–5350 MHz must be 26 dBc, when measured using a resolution bandwidth between 1 and 5% of the occupied bandwidth, above 5.25 GHz. Otherwise, the transmission is considered as intentional and the devices shall implement dynamic frequency selection (DFS) and transmitter power control (TPC) as per the requirements for the band 5250–5350 MHz.

RSS-Gen 8.10 Emissions falling within restricted frequency bands
Restricted bands, identified in Table 8.4-2, are designated primarily for safety-of-life services (distress calling and certain aeronautical bands), certain satellite downlinks, radio astronomy and some government uses. Except where otherwise indicated, the following restrictions apply:
(a) fundamental components of modulation of licence-exempt radio apparatus shall not fall within the restricted bands of below;
(b) unwanted emissions falling into restricted bands of below shall comply with the limits specified in RSS-Gen;
(c) unwanted emissions not falling within restricted frequency bands shall either comply with the limits specified in the applicable RSS, or with those specified in RSS-Gen.

Table 8.4-1: *FCC §15.209 and RSS-Gen – Radiated emission limits*

Frequency, MHz	Field strength of emissions µV/m	dBµV/m	Measurement distance, m
0.009–0.490	2400/F *(F in kHz)*	67.6 – 20 × $\log_{10}$(F) *(F in kHz)*	300
0.490–1.705	24000/F *(F in kHz)*	87.6 – 20 × $\log_{10}$(F) *(F in kHz)*	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

8.4.1 Definitions and limits, continued

Table 8.4-2: *ISED restricted frequency bands*

MHz	MHz	MHz	GHz
0.090–0.110	12.51975–12.52025	399.9–410	5.35–5.46
2.1735–2.1905	12.57675–12.57725	608–614	7.25–7.75
3.020–3.026	13.36–13.41	960–1427	8.025–8.5
4.125–4.128	16.42–16.423	1435–1626.5	9.0–9.2
4.17725–4.17775	16.69475–16.69525	1645.5–1646.5	9.3–9.5
4.20725–4.20775	16.80425–16.80475	1660–1710	10.6–12.7
5.677-5.683	25.5–25.67	1718.8–1722.2	13.25–13.4
6.215–6.218	37.5–38.25	2200–2300	14.47–14.5
6.26775–6.26825	73–74.6	2310–2390	15.35–16.2
6.31175–6.31225	74.8–75.2	2655–2900	17.7–21.4
8.291–8.294	108–138	3260–3267	22.01–23.12
8.362–8.366	156.52475–156.52525	3332–3339	23.6–24.0
8.37625–8.38675	156.7–156.9	3345.8–3358	31.2–31.8
8.41425–8.41475	240–285	3500–4400	36.43–36.5
12.29–12.293	322–335.4	4500–5150	Above 38.6

Note: Certain frequency bands listed in Table 8.4-2 and above 38.6 GHz are designated for low-power license-exempt applications. These frequency bands and the requirements that apply to the devices are set out in this Standard

Table 8.4-3: *FCC restricted frequency bands*

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

8.4.2 Test summary

Test date:	January 16, 2018
Test engineer:	Andrey Adelberg

8.4.3 Observations, settings and special notes

The spectrum was searched from 30 MHz to 40 GHz.
EUT was set to transmit with 100 % duty cycle.
Radiated measurements were performed at a distance of 3 m up to 18 GHz. Above 18 GHz measurements were performed at a distance of 1 m.

Spectrum analyser for peak conducted measurements within restricted bands below 1 GHz:

Resolution bandwidth:	100 kHz
Video bandwidth:	300 kHz
Detector mode:	Peak
Trace mode:	Max Hold

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

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

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

Resolution bandwidth:	1 MHz
Video bandwidth:	3 MHz
Detector mode:	RMS
Trace mode:	Averaging

Spectrum analyser for peak conducted measurements outside restricted bands:

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

8.4.4 Test data

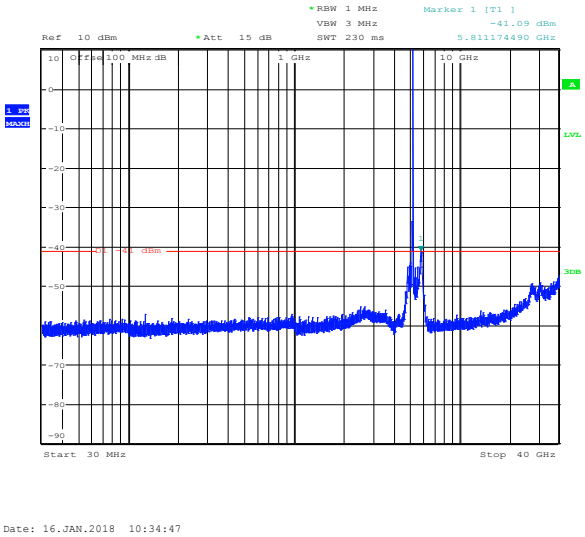


Figure 8.4-1: *Peak conducted spurious emissions outside restricted bands at low channel, 1-carrier operation*

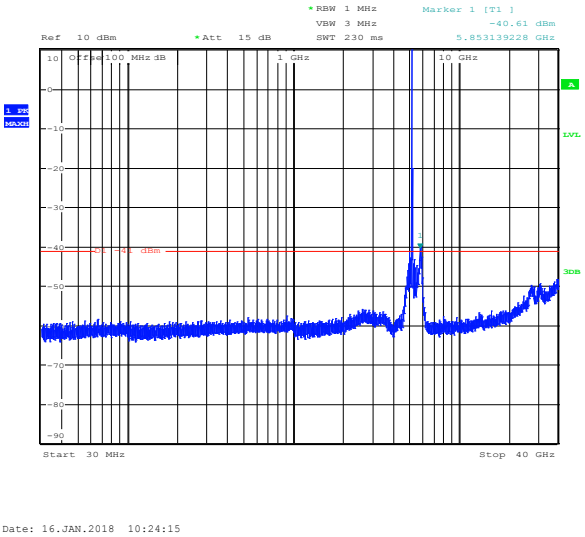


Figure 8.4-2: *Peak conducted spurious emissions outside restricted bands at mid channel, 1-carrier operation*

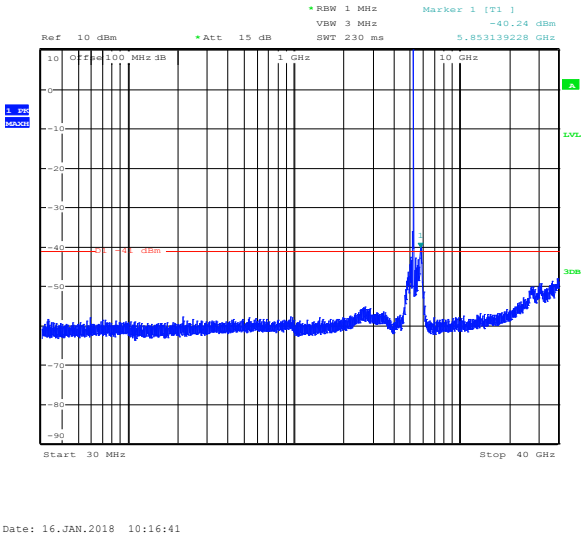


Figure 8.4-3: *Peak conducted spurious emissions outside restricted bands at high channel, 1-carrier operation*

Note: in the plots below, EIRP limit line was adjusted to include antenna gain.

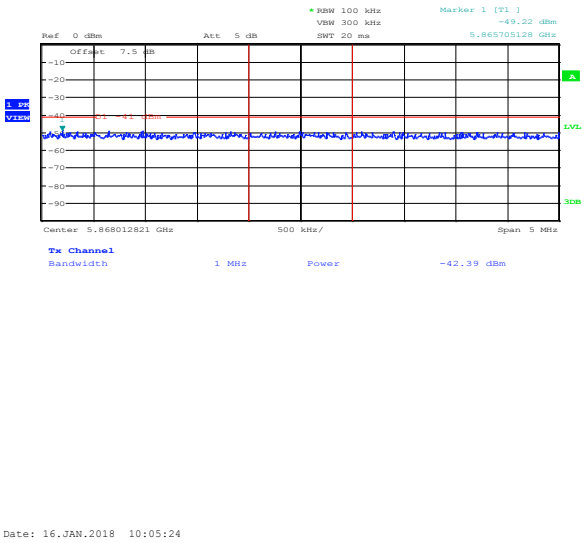


Figure 8.4-4: *Peak conducted spurious emissions at 5.86 GHz at low channel, 1-carrier operation*

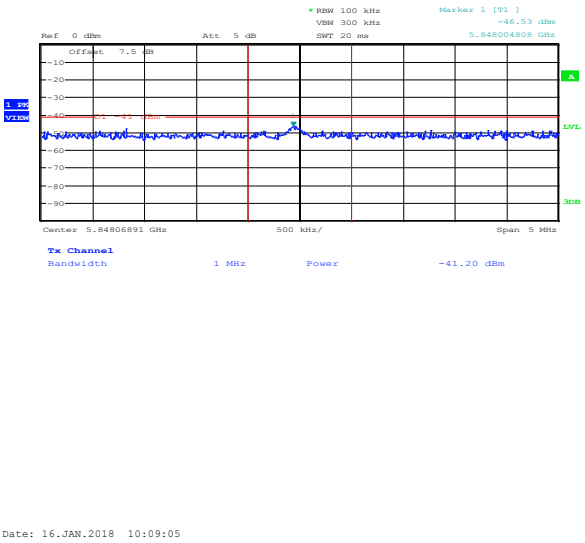


Figure 8.4-5: *Peak conducted spurious emissions at 5.85 GHz at mid channel, 1-carrier operation*

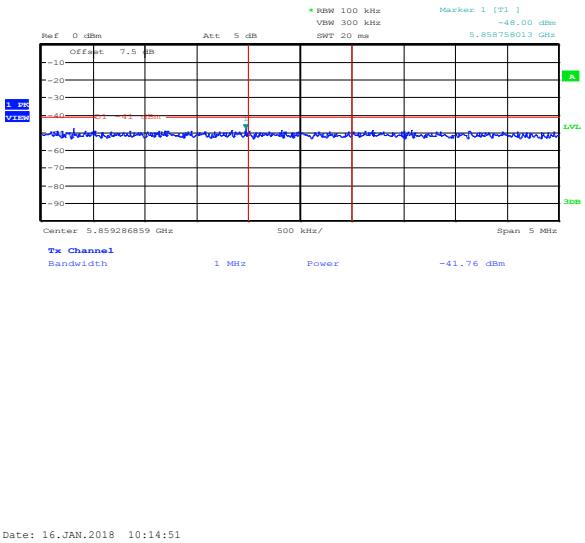


Figure 8.4-6: *Peak conducted spurious emissions at 5.86 GHz at high channel, 1-carrier operation*

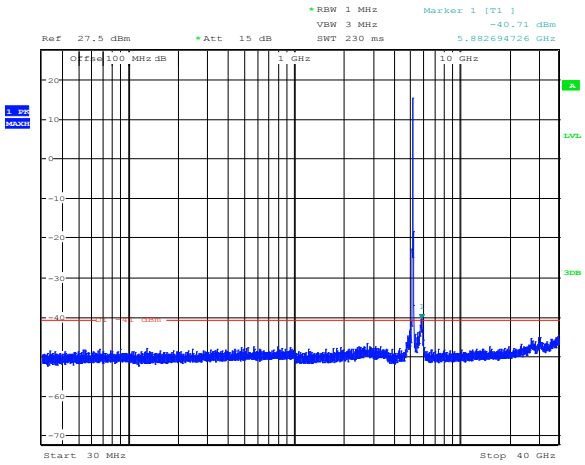


Figure 8.4-7: *Peak conducted spurious emissions outside restricted bands at the bottom of the band, 2-carrier operation*

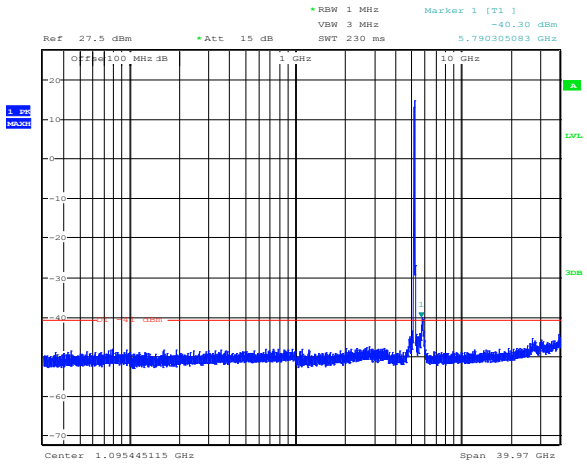


Figure 8.4-8: *Peak conducted spurious emissions outside restricted bands at the top of the band, 2-carrier operation*

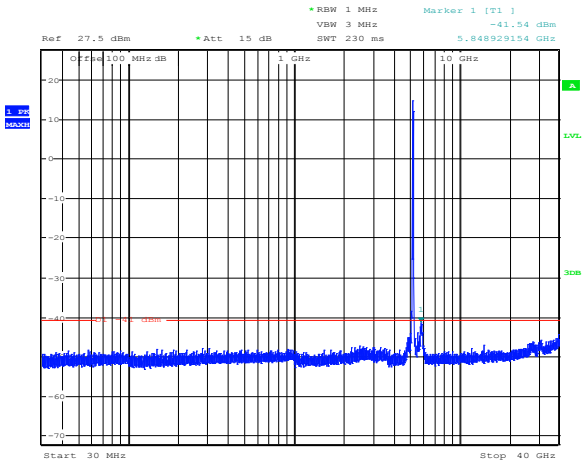


Figure 8.4-9: *Peak conducted spurious emissions outside restricted bands at the bottom of the band, 3-carrier operation*

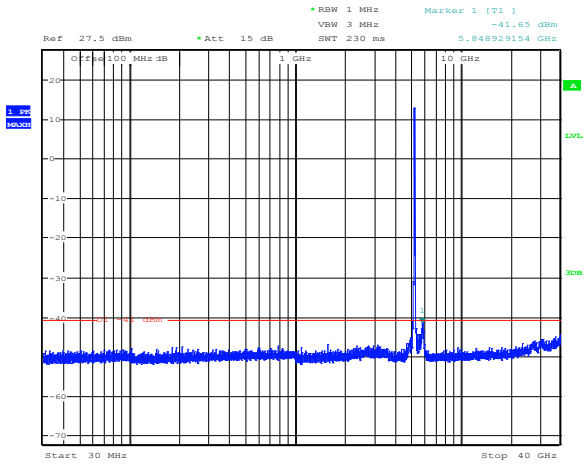


Figure 8.4-10: *Peak conducted spurious emissions outside restricted bands at the top of the band, 3-carrier operation*

Note: in the plots below, EIRP limit line was adjusted to include antenna gain.

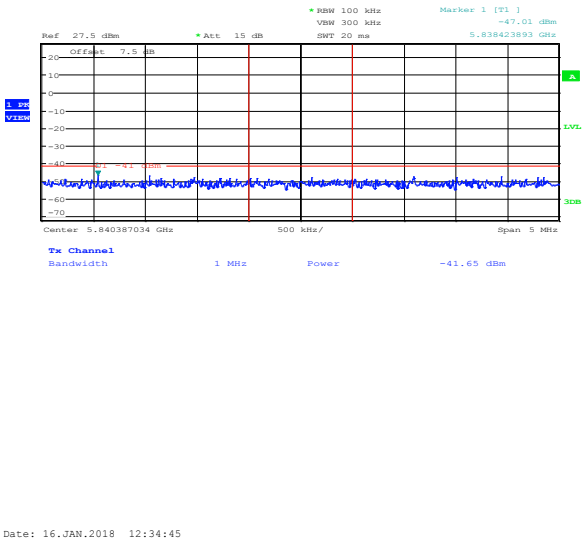


Figure 8.4-11: *Peak conducted spurious emissions at 5.86 GHz at the bottom of the band, 2-carrier operation*

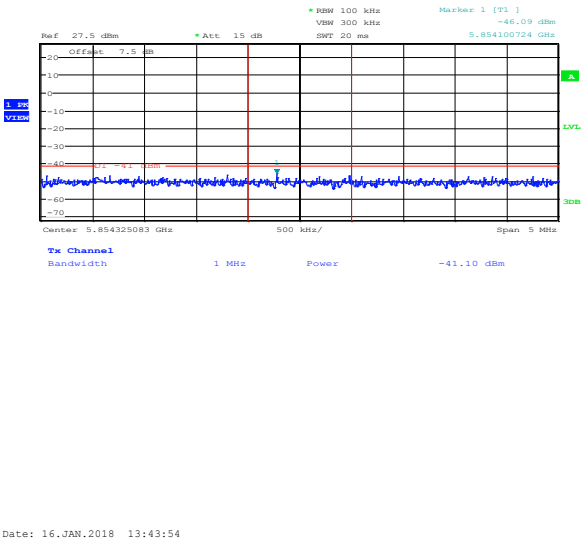


Figure 8.4-12: *Peak conducted spurious emissions at 5.85 GHz at the top of the band, 2-carrier operation*

In order to comply with the ISED band edge emissions requirements at 5.25 GHz, RBW was reduced to 1–5% of occupied bandwidth and 26 dB BW was measured to verify it contained below 5.25 GHz.

For 1-carrier operation (20 MHz total EBW), RBW was set to 200 kHz

For 2-carrier operation (40 MHz total EBW), RBW was set to 500 kHz

For 3-carrier operation (60 MHz total EBW), RBW was set to 1000 kHz

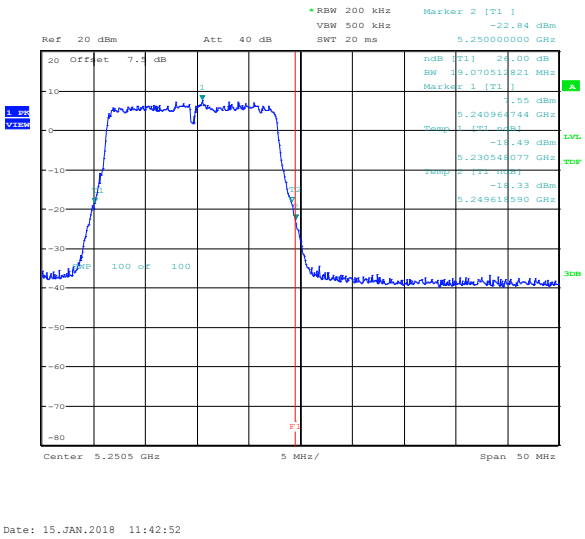


Figure 8.4-13: *Band edge emission for ISED at 5.25 GHz, high channel, 1-carrier operation*

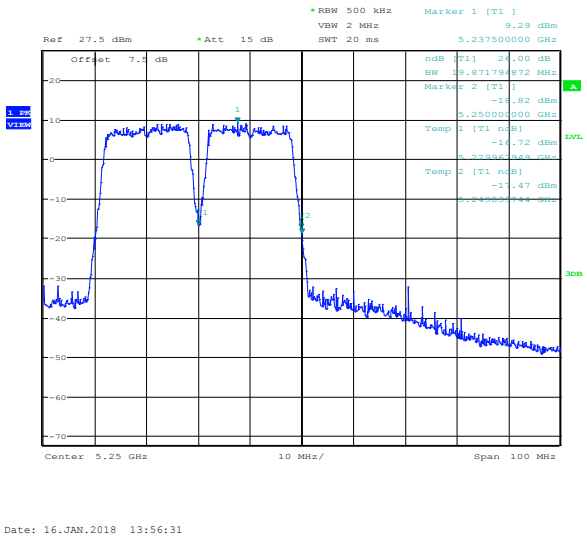


Figure 8.4-14: *Band edge emission for ISED at 5.25 GHz, top of the band, 2-carrier operation*

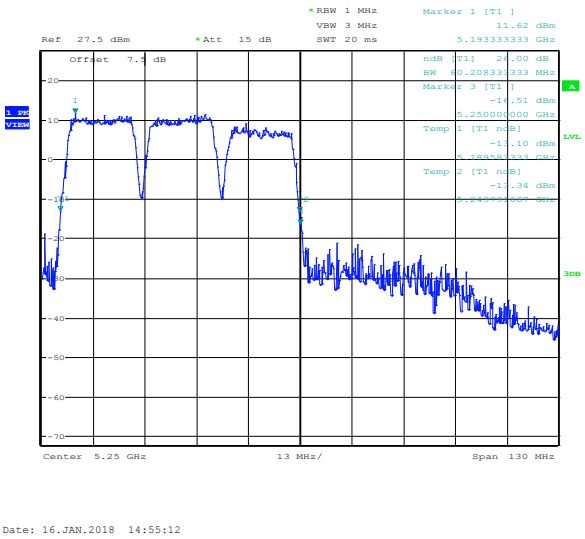


Figure 8.4-15: *Band edge emission for ISED at 5.25 GHz, high channel, 1-carrier operation*

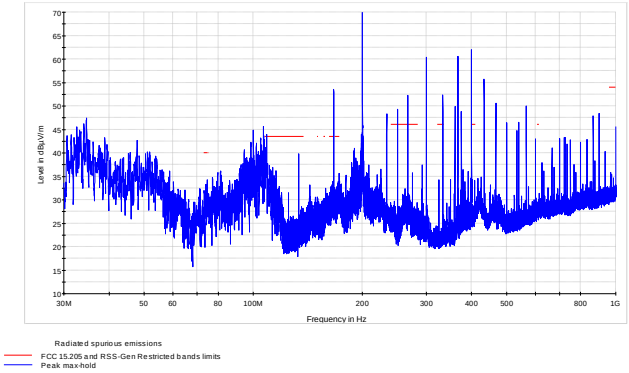


Figure 8.4-16: *Peak radiated spurious emissions within 30–1000 MHz within restricted bands, 1-carrier operation*

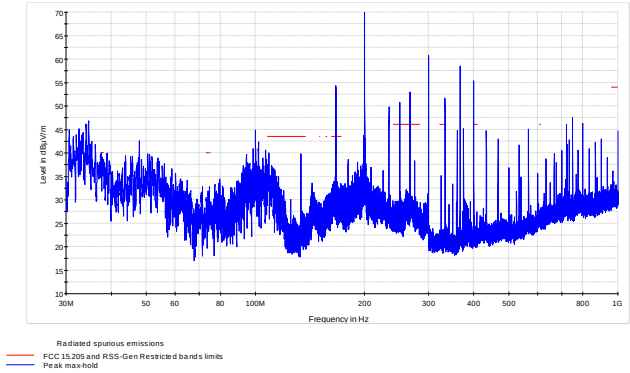


Figure 8.4-17: *Peak radiated spurious emissions within 30–1000 MHz within restricted bands, 2-carrier operation*

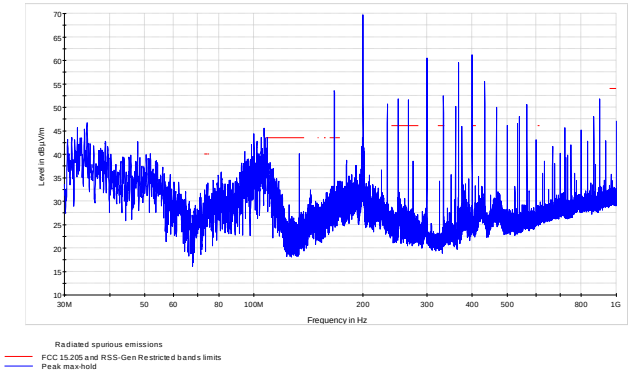


Figure 8.4-18: *Peak radiated spurious emissions within 30–1000 MHz within restricted bands, 3-carrier operation*

Note: on the plots above emissions exceeding the limit line were investigated and it was verified that they are originating from the digital circuitry of the supporting equipment.
No EUT spurious emissions from the RF components were detected near the limit lines.

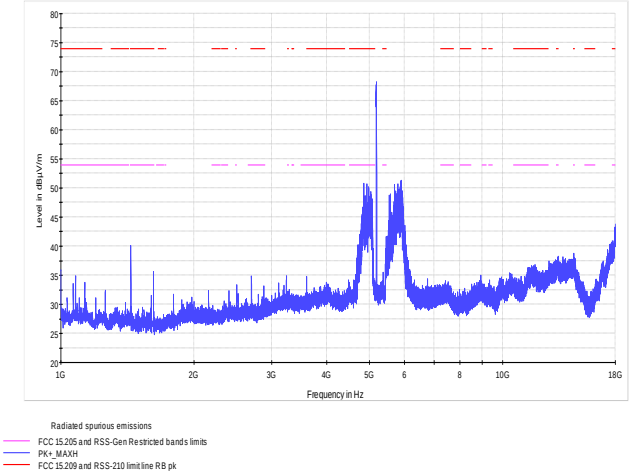


Figure 8.4-19: *Peak radiated spurious emissions within 1–18 GHz within restricted bands, low channel, 1-carrier operation*

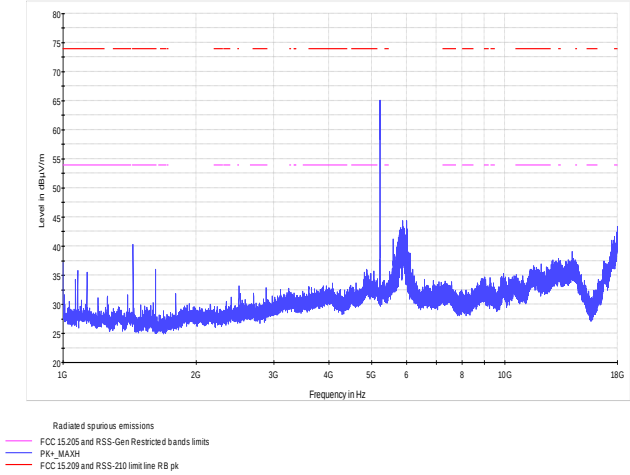


Figure 8.4-20: *Peak radiated spurious emissions within 1–18 GHz within restricted bands, mid channel, 1-carrier operation*

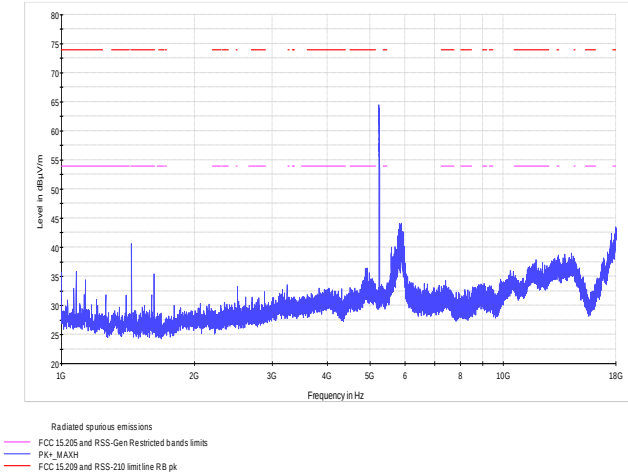


Figure 8.4-21: *Peak radiated spurious emissions within 1–18 GHz within restricted bands, high channel, 1-carrier operation*

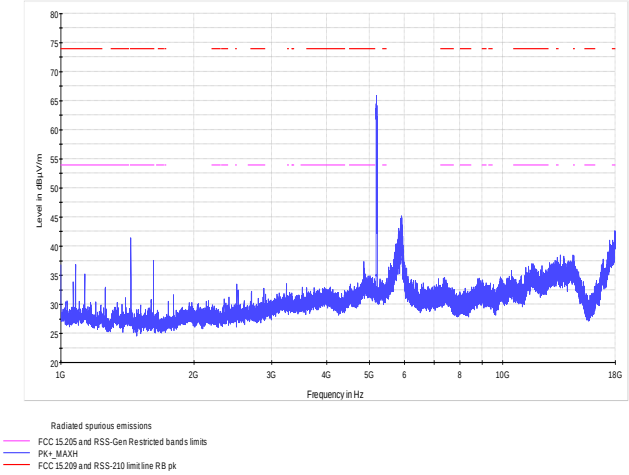


Figure 8.4-22: *Peak radiated spurious emissions within 1–18 GHz within restricted bands, bottom of the band, 2-carrier operation*

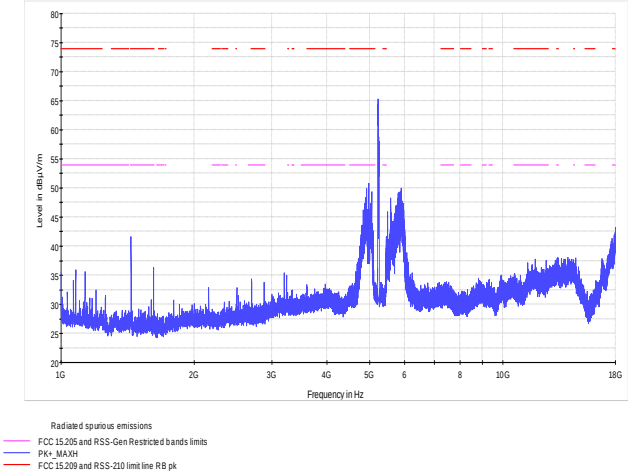


Figure 8.4-23: *Peak radiated spurious emissions within 1–18 GHz within restricted bands, top of the band, 2-carrier operation*

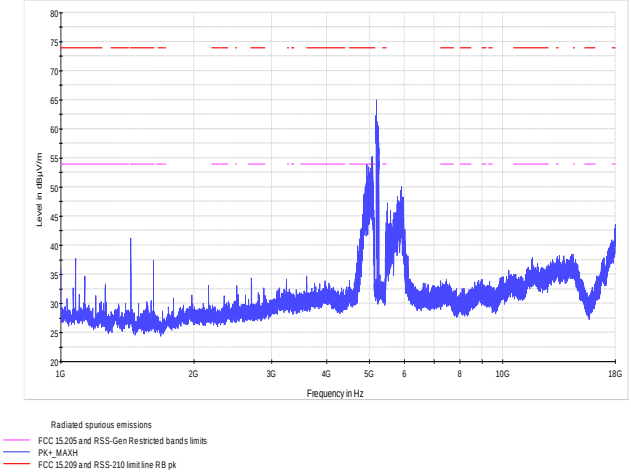


Figure 8.4-24: *Peak radiated spurious emissions within 1–18 GHz within restricted bands, bottom of the band, 3-carrier operation*

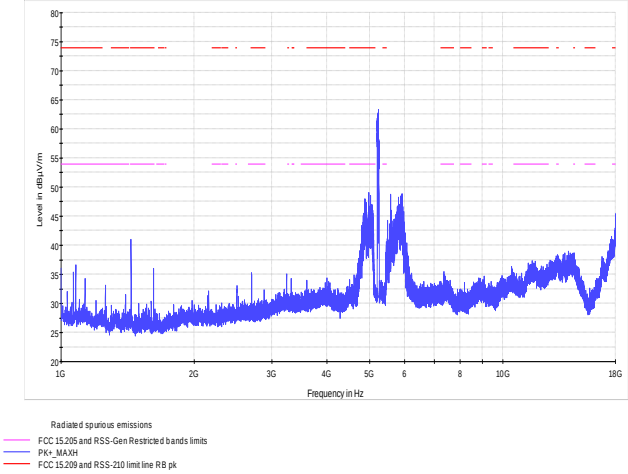
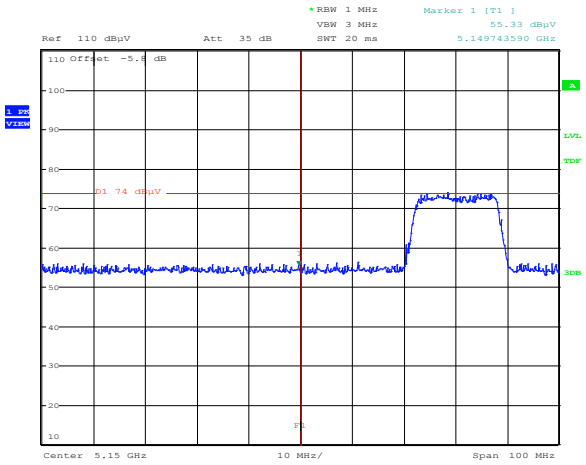
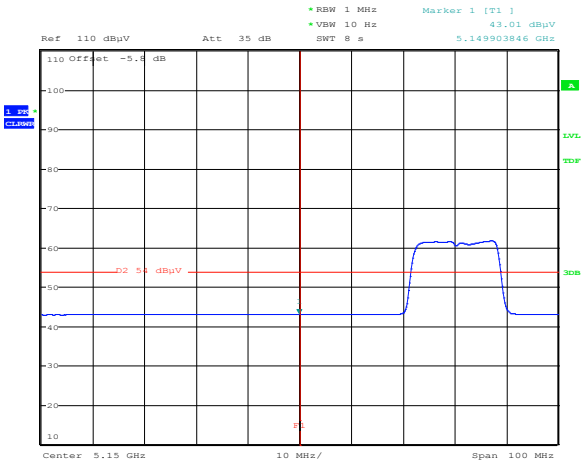


Figure 8.4-25: *Peak radiated spurious emissions within 1–18 GHz within restricted bands, top of the band, 3-carrier operation*



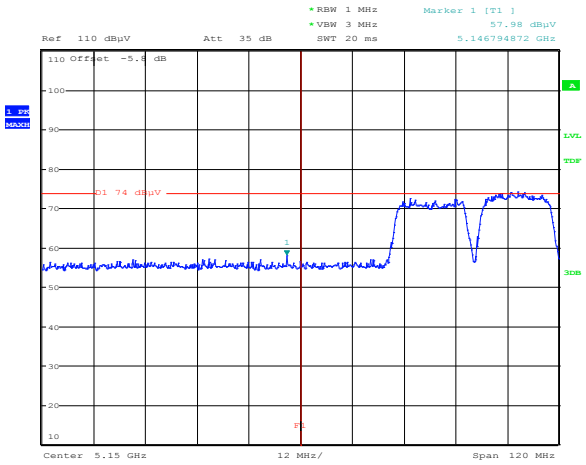
Date: 18.JAN.2018 14:34:46

Figure 8.4-26: *Peak radiated spurious band edge emissions at 5150 MHz within restricted bands, low channel, 1-carrier operation*



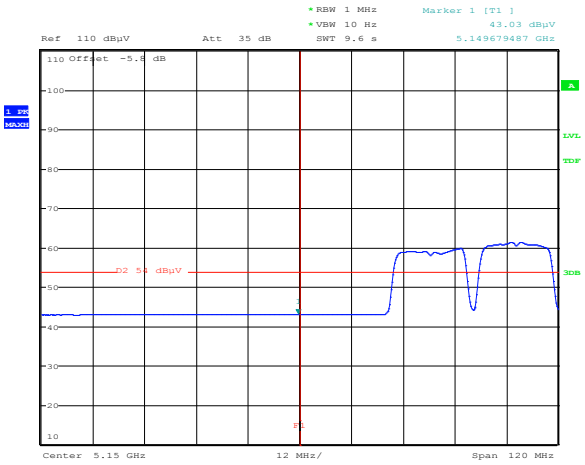
Date: 18.JAN.2018 14:35:52

Figure 8.4-27: *Average radiated spurious band edge emissions at 5150 MHz within restricted bands, low channel, 1-carrier operation*



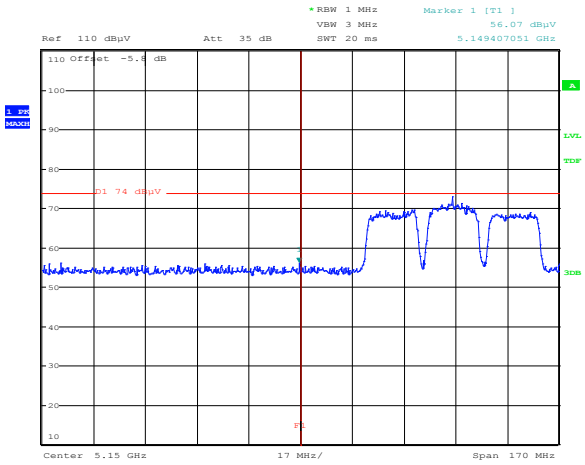
Date: 18.JAN.2018 14:45:37

Figure 8.4-28: *Peak radiated spurious band edge emissions at 5150 MHz within restricted bands, bottom of the band, 2-carrier operation*



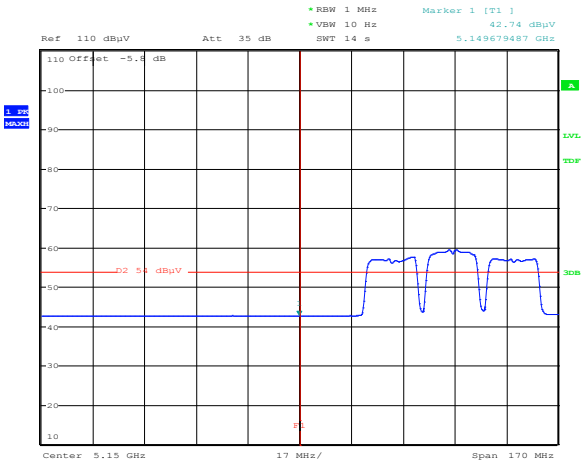
Date: 18.JAN.2018 14:46:03

Figure 8.4-29: *Average radiated spurious band edge emissions at 5150 MHz within restricted bands, bottom of the band, 2-carrier operation*



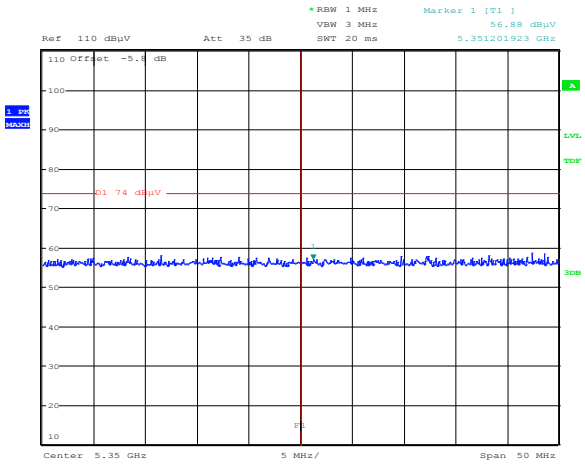
Date: 18.JAN.2018 14:56:20

Figure 8.4-30: *Peak radiated spurious band edge emissions at 5150 MHz within restricted bands, bottom of the band, 3-carrier operation*



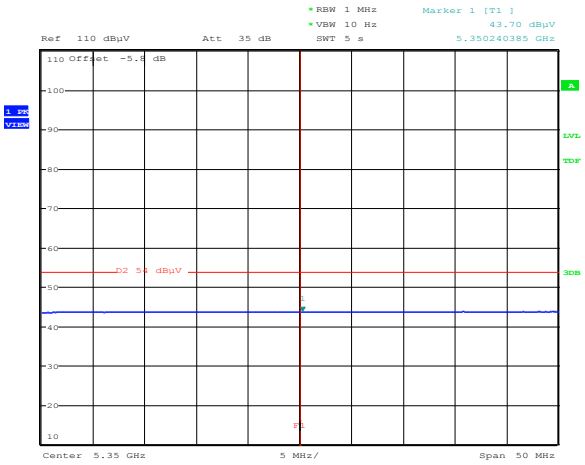
Date: 18.JAN.2018 14:56:56

Figure 8.4-31: *Average radiated spurious band edge emissions at 5150 MHz within restricted bands, bottom of the band, 3-carrier operation*



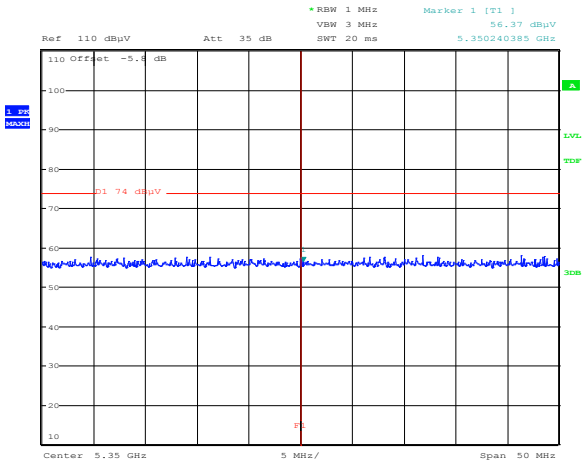
Date: 18.JAN.2018 15:13:04

Figure 8.4-32: *Peak radiated spurious band edge emissions at 5350 MHz within restricted bands, high channel, 1-carrier operation*



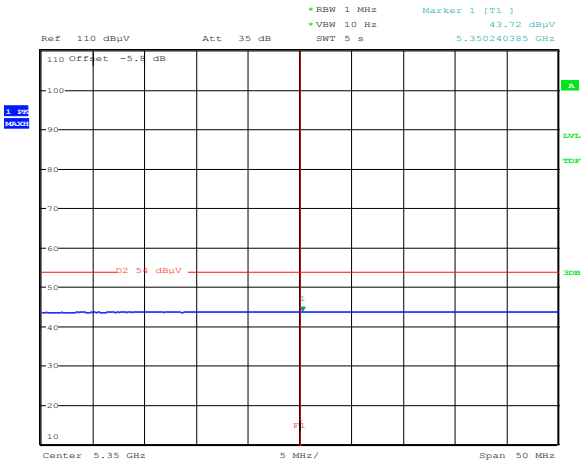
Date: 18.JAN.2018 15:12:38

Figure 8.4-33: *Average radiated spurious band edge emissions at 5350 MHz within restricted bands, high channel, 1-carrier operation*



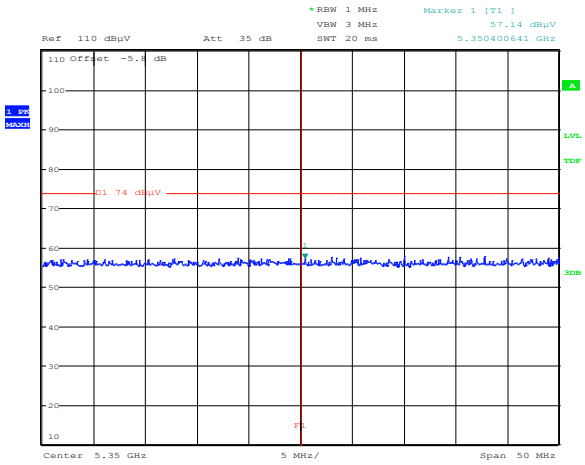
Date: 18.JAN.2018 15:07:50

Figure 8.4-34: *Peak radiated spurious band edge emissions at 5350 MHz within restricted bands, top of the band, 2-carrier operation*



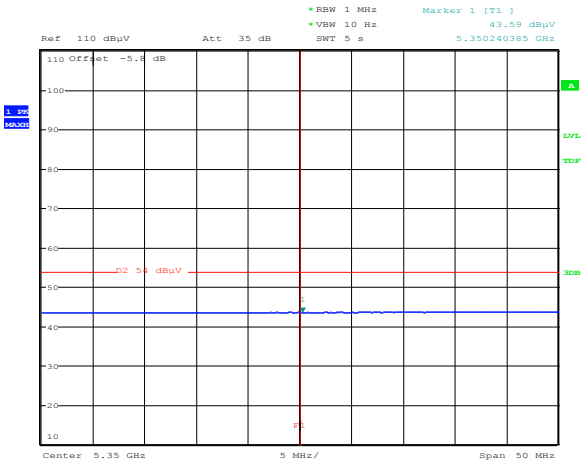
Date: 18.JAN.2018 15:08:19

Figure 8.4-35: *Average radiated spurious band edge emissions at 5350 MHz within restricted bands, top of the band, 2-carrier operation*



Date: 18.JAN.2018 15:01:32

Figure 8.4-36: *Peak radiated spurious band edge emissions at 5350 MHz within restricted bands, top of the band, 3-carrier operation*



Date: 18.JAN.2018 15:02:43

Figure 8.4-37: *Average radiated spurious band edge emissions at 5350 MHz within restricted bands, top of the band, 3-carrier operation*

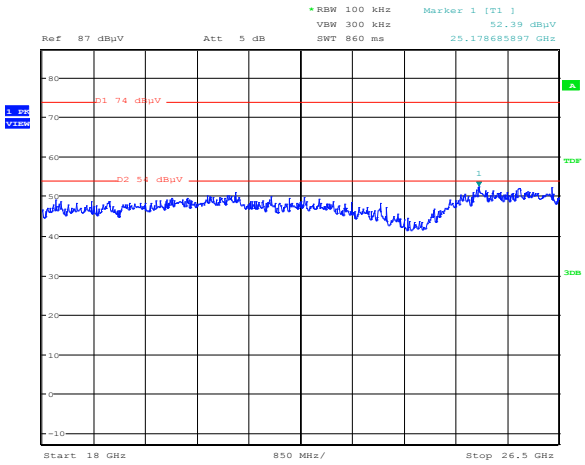


Figure 8.4-38: *Peak radiated spurious emissions within 18–26.5 GHz within restricted bands, 1-carrier operation*

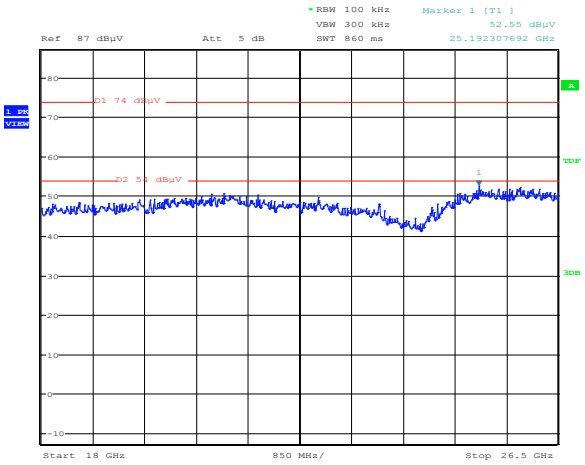


Figure 8.4-39: *Peak radiated spurious emissions within 18–26.5 GHz within restricted bands, 2-carrier operation*

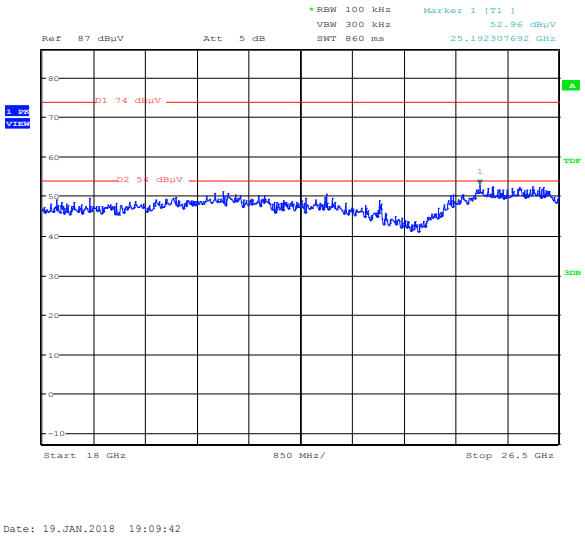


Figure 8.4-40: *Peak radiated spurious emissions within 18–26.5 GHz within restricted bands, 3-carrier operation*

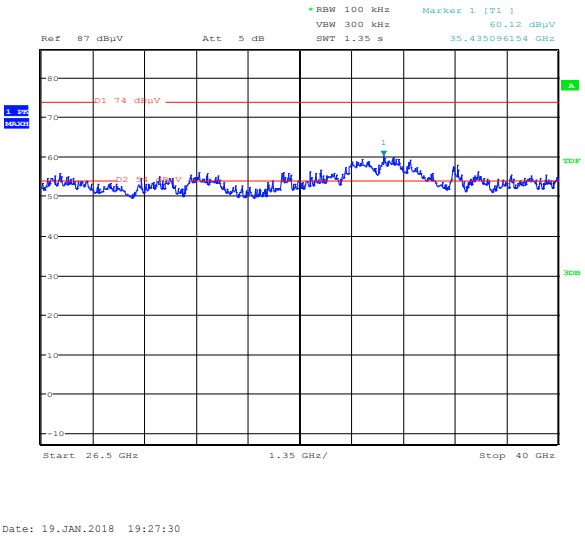


Figure 8.4-41: *Peak radiated spurious emissions within 26.5–40 GHz within restricted bands, 1-carrier operation*

Note: At frequencies above 26.5 GHz average level was verified where peak emissions exceeded average limit, no emissions radiated from the EUT were detected.

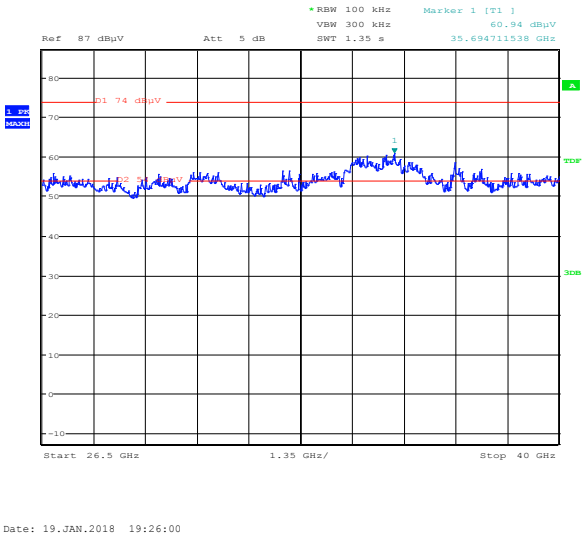


Figure 8.4-42: *Peak radiated spurious emissions within 26.5–40 GHz within restricted bands, 2-carrier operation*

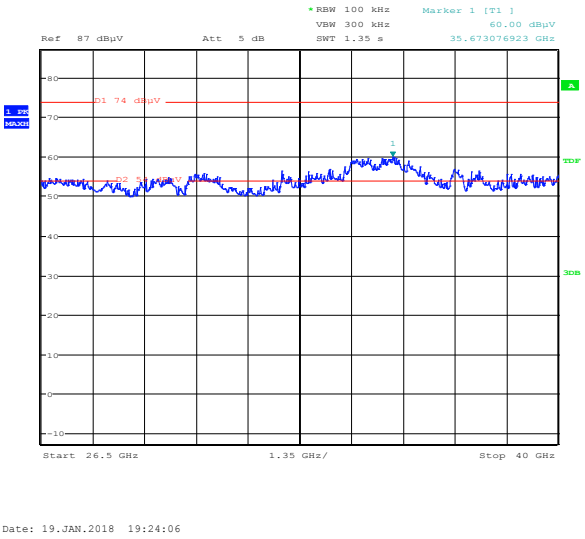


Figure 8.4-43: *Peak radiated spurious emissions within 26.5–40 GHz within restricted bands, 3-carrier operation*

8.5 FCC 15.207(a) and RSS-Gen 8.8 AC power line conducted emissions limits

8.5.1 Definitions and limits

FCC §15.407(6)(b):

Any U-NII devices using an AC power line are required to comply also with the conducted limits set forth in §15.207

FCC §15.207(a):
Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 µH/50 Ω line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

IC:
A radio apparatus that is designed to be connected to the public utility (AC) power line shall ensure that the radio frequency voltage, which is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz, shall not exceed the limits in table below.

Unless the requirements applicable to a given device state otherwise, for any radio apparatus equipped to operate from the public utility AC power supply either directly or indirectly (such as with a battery charger), the radio frequency voltage of emissions conducted back onto the AC power lines in the frequency range of 0.15 MHz to 30 MHz shall not exceed the limits shown in table below. The more stringent limit applies at the frequency range boundaries.

Table 8.5-1: *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: * - The level decreases linearly with the logarithm of the frequency.
** - A linear average detector is required.

8.5.2 Test summary

Test date	January 19, 2018
Test engineer	Andrey Adelberg

8.5.3 Observations, settings and special notes

The EUT was set up as tabletop configuration.

The spectral scan has been corrected with transducer factors (i.e. cable loss, LISN factors, and attenuators) for determination of compliance.

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.

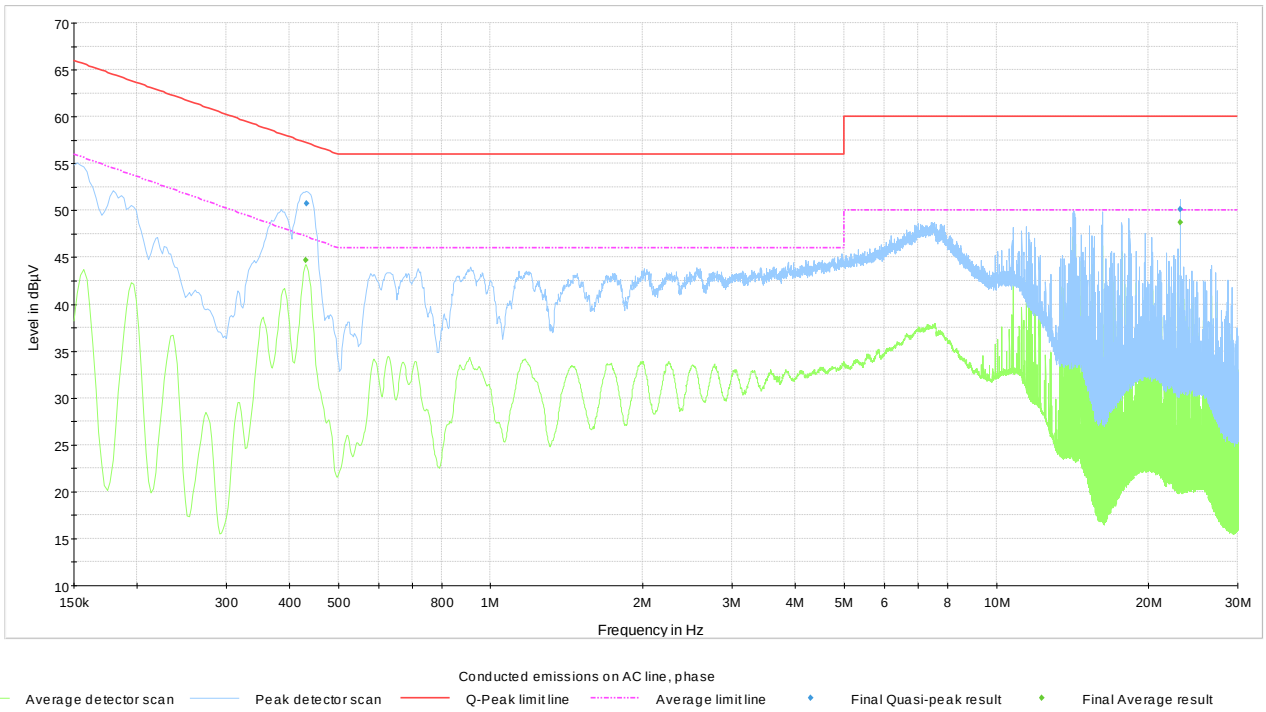
Receiver settings for preview measurements:

Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Detector mode	Peak and Average
Trace mode	Max Hold
Measurement time	100 ms

Receiver settings for final measurements:

Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Detector mode	Quasi-Peak and Average
Trace mode	Max Hold
Measurement time	100 ms

8.5.4 Test data



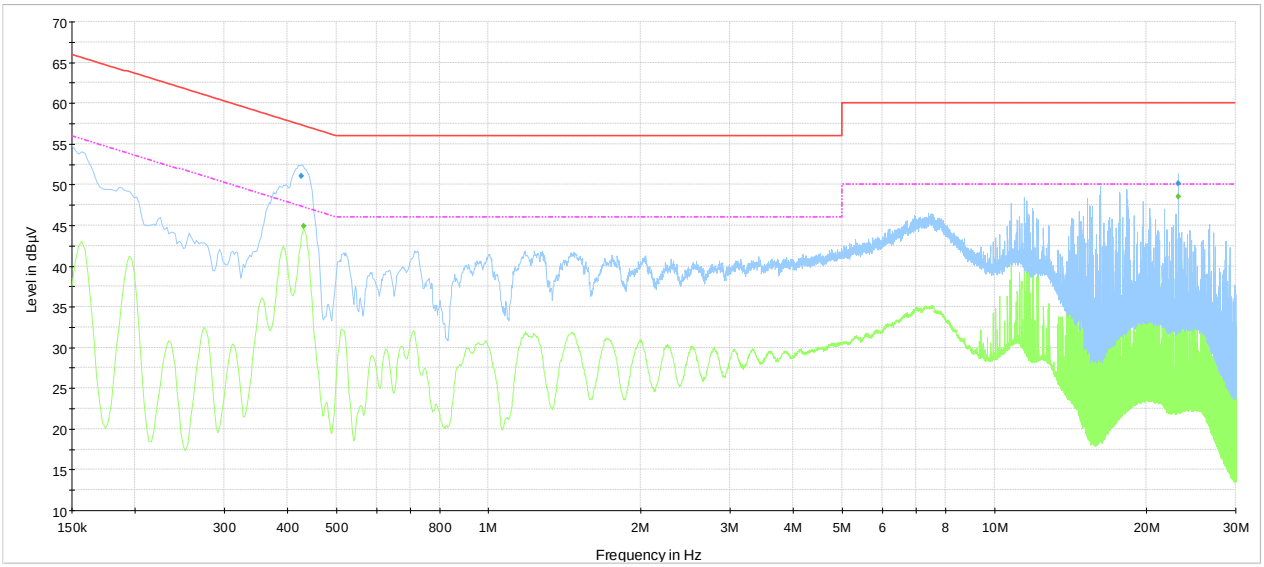
Plot 8.5-1: *Conducted emissions on phase line*

Table 8.5-2: *Quasi-Peak conducted emissions results on phase line*

Frequency, MHz	Q-Peak result, dBµV	Limit, dBµV	Margin, dB	Meas. Time, ms	Bandwidth, kHz	Line	Filter	Correction, dB
0.434	50.76	57.19	6.43	100	9	L1	ON	9.4
23.129	50.16	60.00	9.84	100	9	L1	ON	10.5

Table 8.5-3: *Average conducted emissions results on phase line*

Frequency, MHz	Average result, dBµV	Limit, dBµV	Margin, dB	Meas. Time, ms	Bandwidth, kHz	Line	Filter	Correction, dB
0.431	44.69	47.23	2.54	100	9	L1	ON	9.4
23.129	48.70	50.00	1.30	100	9	L1	ON	10.5



Conducted emissions on AC line, neutral
- Average detector scan
- Peak detector scan
- Q-Peak limit line
- Average limit line
- Final Quasi-peak result
- Final Average result

Plot 8.5-2: *Conducted emissions on neutral line*

Table 8.5-4: *Quasi-Peak conducted emissions results on neutral line*

Frequency, MHz	Q-Peak result, dBµV	Limit, dBµV	Margin, dB	Meas. Time, ms	Bandwidth, kHz	Line	Filter	Correction, dB
0.427	51.03	57.32	6.29	100	9	N	ON	9.4
23.129	50.16	60.00	9.84	100	9	N	ON	10.6

Table 8.5-5: *Average conducted emissions results on neutral line*

Frequency, MHz	Average result, dBµV	Limit, dBµV	Margin, dB	Meas. Time, ms	Bandwidth, kHz	Line	Filter	Correction, dB
0.431	44.92	47.23	2.31	100	9	N	ON	9.4
23.129	48.57	50.00	1.43	100	9	N	ON	10.6

8.6 FCC 15.407(g) and RSS-Gen 8.11 Frequency stability

8.6.1 Definitions and limits

Manufacturers of U-NII devices are responsible for ensuring frequency stability such that an emission is maintained within the band of operation under all conditions of normal operation as specified in the user's manual.

8.6.2 Test summary

Test date:	January 18, 2018
Test engineer:	Andrey Adelberg

8.6.3 Observations, settings and special notes

Spectrum analyser settings:

Resolution bandwidth:	500 Hz
Video bandwidth:	2 kHz
Detector mode:	Peak
Trace mode:	Max Hold

8.6.4 Test data

Table 8.6-1: *Frequency drift measurement*

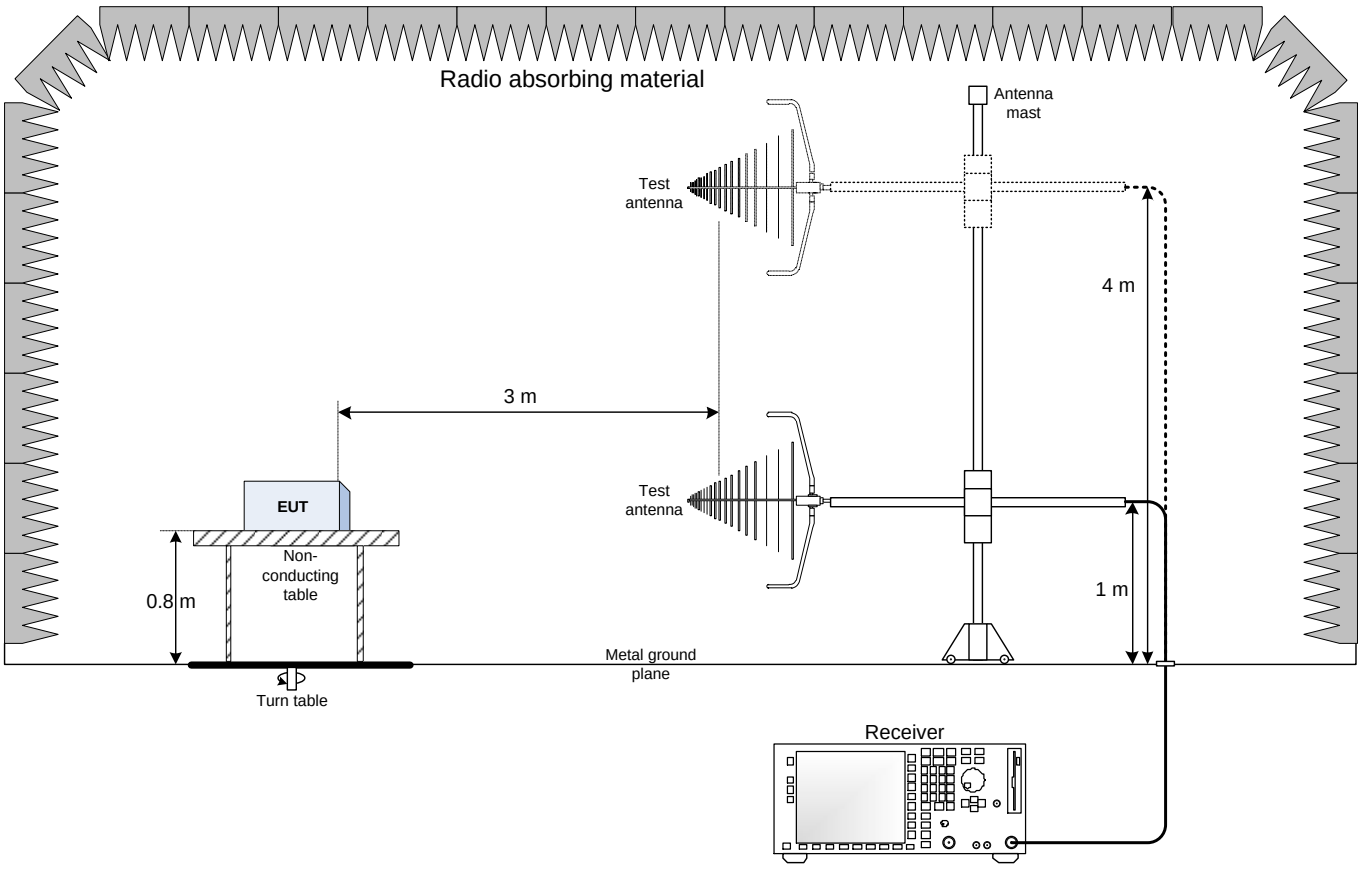
Test conditions	Frequency, Hz	Drift, Hz
+50 °C, Nominal	5200002244	-10096
+40 °C, Nominal	5199999840	-12500
+30 °C, Nominal	5200002885	-9455
+20 °C, +15 %	5200012019	-321
+20 °C, Nominal	5200012340	*Reference*
+20 °C, −15 %	5200012179	-161
+10 °C, Nominal	5200025321	12981
0 °C, Nominal	5200044712	32372
−10 °C, Nominal	5200054327	41987
−20 °C, Nominal	5200057372	45032
−30 °C, Nominal	5200051603	39263

Maximum negative drift measured is 12.5 kHz. Maximum positive drift measured is 45.032 kHz
26 dB BW frequency at the single low channel is slightly above 5170 MHz, which is more than 20 MHz from the band edge.
26 dB BW frequency at the single high channel is at above 5249.55 MHz, which is 49.5 kHz from the band edge.

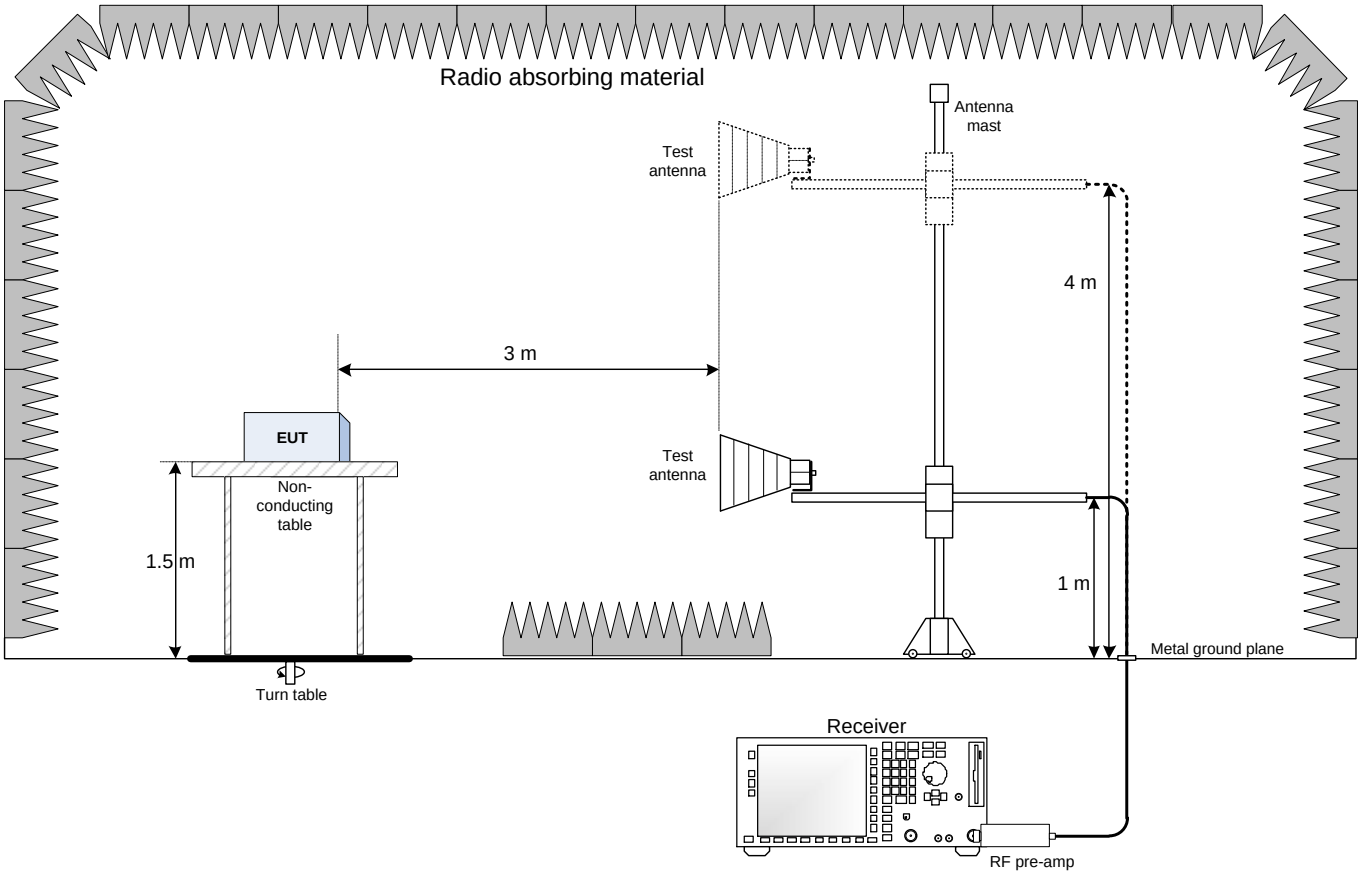
Emission is maintained within the band of operation during normal and extreme conditions.

Section 9. Block diagrams of test set-ups

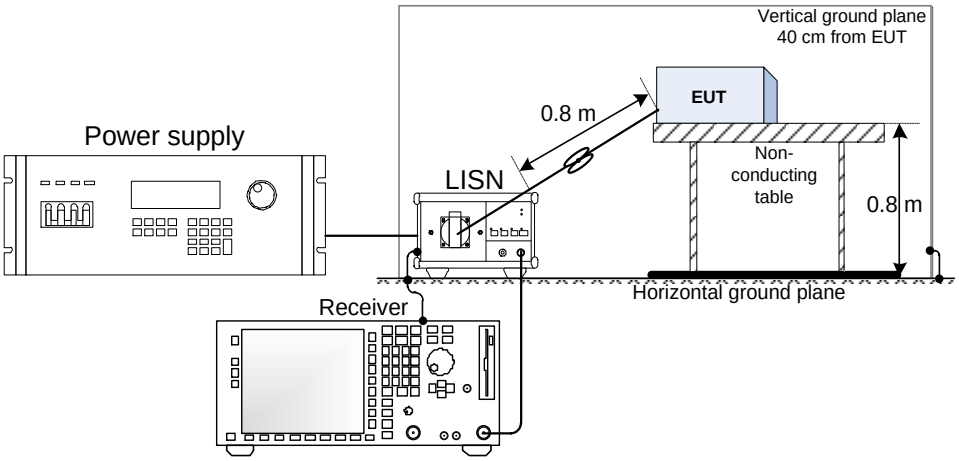
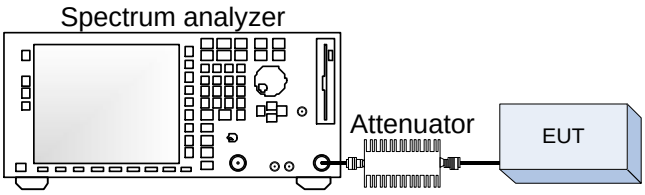
9.1 Radiated emissions set-up for frequencies below 1 GHz



9.2 Radiated emissions set-up for frequencies above 1 GHz



9.3 Conducted emissions set-up



9.4 Antenna-port measurements set-up