

Test report

312742-2TRFWL

Date of issue: November 24, 2016

Applicant:

Seiko Epson Corporation

Product:

Smart Glasses

Model:

H756A (BT-300)

FCC ID:

SKSH756A

IC Registration number:

1052D-H756A

Specifications:

◆ **FCC 47 CFR Part 15 Subpart E, §15.407**

Unlicensed National Information Infrastructure Devices

◆ **RSS-247, Issue 1, Section 6, May 2015**

Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

Test location

Company name	Nemko Canada Inc.
Address	292 Labrosse Avenue
City	Pointe-Claire
Province	QC
Postal code	H9R 5L8
Country	Canada
Telephone	+1 514 694 2684
Facsimile	+1 514 694 3528
Toll free	+1 800 563 6336
Website	www.nemko.com
Site number	FCC: 722545; IC: 2040G-5 (3 m semi anechoic chamber)

Tested by	Yong Huang, Wireless/EMC Specialist
Reviewed by	Andrey Adelberg, Senior Wireless/EMC Specialist
Review date	November 24, 2016
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	Seiko Epson Corporation
Address	6925 Tazawa, Toyoshina, Azumino-shi, Nagano 399-8285 Japan

1.2 Test specifications

FCC 47 CFR Part 15, Subpart E, Clause 15.407	Unlicensed National Information Infrastructure Devices
RSS-247, Issue 1, May 2015	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 v01r03 (August 22, 2016)	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: ¹Measurements 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

²The Antennas are located within the enclosure of EUT and not user accessible.

2.2 FCC Part 15 Subpart E, test results

Part	Test description	Verdict
§15.403(i)	Emission bandwidth	Not applicable
§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	Not applicable
§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: ¹DFS 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: ¹According 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.

²According 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 1, test results

Section	Test description	Verdict
6.1 (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 modulations, such as: 802.11a, 802.11n and 802.11ac

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	October 4, 2016
Nemko sample ID number	133-003152 (Conducted sample) and 133-003139 (Radiated sample)

3.2 EUT information

Product name	Smart Glasses
Model	H756A (BT-300)
Model variant	N/A
Serial number	TCW27560112

3.3 Technical information

Applicant IC company number	1052D
IC UPN number	H756A
All used IC test site(s) Reg. number	2040G-5
RSS number and Issue number	RSS-247 Issue 1, Section 6, May 2015
Frequency band	5150–5250 MHz
Frequency Min (MHz)	5180(802.11a, 802.11n HT20 and 802.11ac VHT20) 5190(802.11n HT40 and 802.11ac VHT40) 5210(802.11ac VHT80)
Frequency Max (MHz)	5240(802.11a, 802.11n HT20 and 802.11ac VHT20) 5230(802.11n HT40 and 802.11ac VHT40) 5210(802.11ac VHT80)
RF power Min (W),	N/A
RF power Max (W), Conducted	0.0089(9.48 dBm , 802.11a) 0.0097(9.41 dBm, 802.11n. HT20) 0.0093(8.59 dBm, 802.11n.HT40) 0.0098(9.44 dBm, 802.11ac.VHT20) 0.0091(8.63 dBm, 802.11ac.VHT40) 0.0093(8.50 dBm,802.11ac VHT80)
Field strength, Units @ distance	N/A
Measured BW (kHz) (99% dB)	16650(802.11a) 17970(802.11n. HT20) 36130(802.11n.HT40) 17900(802.11ac.VHT20) 36190(802.11ac.VHT40) 75520 (802.11ac VHT80)
Calculated BW (kHz), as per TRC-43	N/A
Type of modulation	802.11a/n/ac
Emission classification (F1D, G1D, D1D)	W7D
Transmitter spurious, Units @ distance	44.3 dBμV/m @3m, Quasi-peak
Power requirements	5 VDC (Powered via external AC-DC adapter 100–240 VAC 50–60 Hz) and via battery
Antenna information	The EUT uses a non-detachable antenna to the intentional radiator. As per customer the antenna gain is 2.4 dBi at 5 GHz band

3.4 Product description and theory of operation

EUT is a smart glass with see-through lenses, which allows to overlay images on actual view. The virtual images were provided by a controller.

3.5 EUT exercise details

EUT was set to test modes during tests, by software drivers provided by customer.

3.6 EUT setup diagram

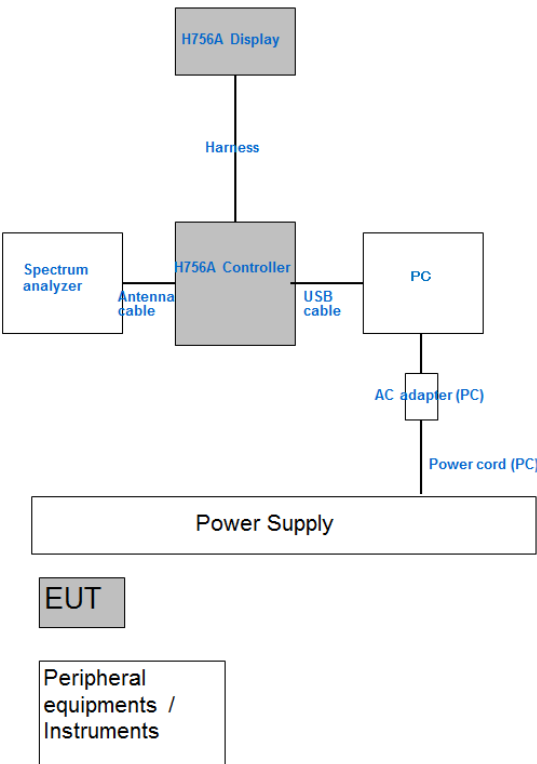


Figure 3.6-1: Setup diagram

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

EUT could be configured to different data rates. From preliminary investigation, the following was chosen to be worst case to present in this report: 6 Mbps in 802.11a, MCS0 in 802.11n and MCS0 in 802.11ac.

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 $\pm 5\%$, 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	FA002532	2 year	May 25/17
Flush mount turntable	Sunol	FM2022	FA002550	—	NCR
Controller	Sunol	SC104V	FA002551	—	NCR
Antenna mast	Sunol	TLT2	FA002552	—	NCR
spectrum analyzer	Rohde & Schwarz	FSV 40	FA002731	1 year	Apr 06/17
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 40	FA002071	1 year	March 23/17
Biconical antenna (30–300 MHz)	Sunol	BC2	FA002078	1 year	March 4/17
Log periodic antenna (200–5000 MHz)	Sunol	LP5	FA002077	1 year	March 14/17
Horn antenna (1–18 GHz)	EMCO	RGA-60	FA002577	1 year	April 5/17
Horn antenna (18–40 GHz)	EMCO	3116	FA002487	2 year	Aug. 16/17
Pre-amplifier (0.5–18 GHz)	COM-POWER	PAM-118A	FA002561	1 year	May 6/17
Pre-amplifier (18–40 GHz)	COM-POWER	PAM-840	FA002508	1 year	May 6/17
50 Ω coax cable	C.C.A.	None	FA002603	—	VOU
50 Ω coax cable	C.C.A.	None	FA002605	—	VOU
50 Ω coax cable	C.C.A.	None	FA002607	—	VOU
Signal generator	Rohde & Schwarz	SMR 40	FA002698	1 year	May 10/17
Power Sensor	Rohde & Schwarz	NRP18S	FA002730	1 year	Mar. 14/17
Environmental Chamber	ESPEC	EPX-4H	FA002736	1 year	Jan. 18/17
LISN	Rohde & Schwarz	ENV216	FA002514	1 year	Nov. 20/16
Power source	California Instruments	5001ix	FA002494	1 year	Apr 29/17

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	November 3, 2016 to November 4, 2016	Temperature	25 °C
Test engineer	Yong Huang	Air pressure	1015 mbar
Verdict	Pass	Relative humidity	30 %

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

Modulation	Frequency, MHz	26 dB bandwidth, MHz
802.11a	5180	21.35
	5200	21.40
	5240	21.40
802.11n HT20	5180	21.62
	5200	21.65
	5240	21.52
802.11n HT40	5190	39.41
	5230	39.65
	5180	21.63
802.11ac VHT20	5200	21.90
	5240	21.80
802.11ac VHT40	5190	39.39
	5230	39.47
802.11ac VHT80	5210	79.68

8.1.4 Test data, continued

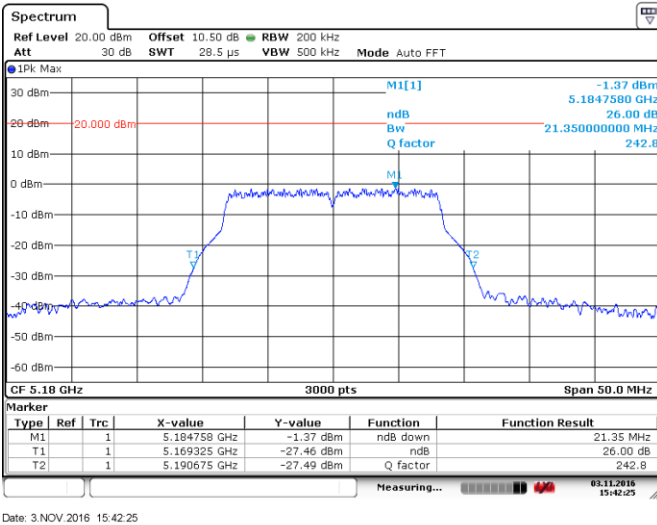


Figure 8.1-1: 26 dB bandwidth on 802.11a, sample plot

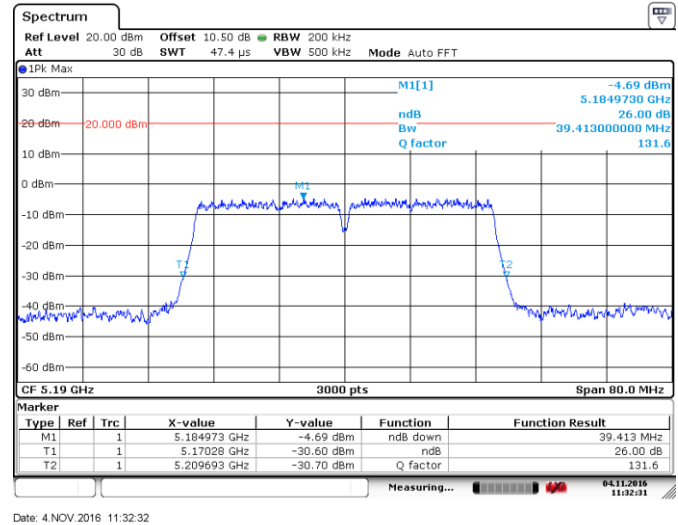


Figure 8.1-2: 26 dB bandwidth on 802.11n HT40, sample plot

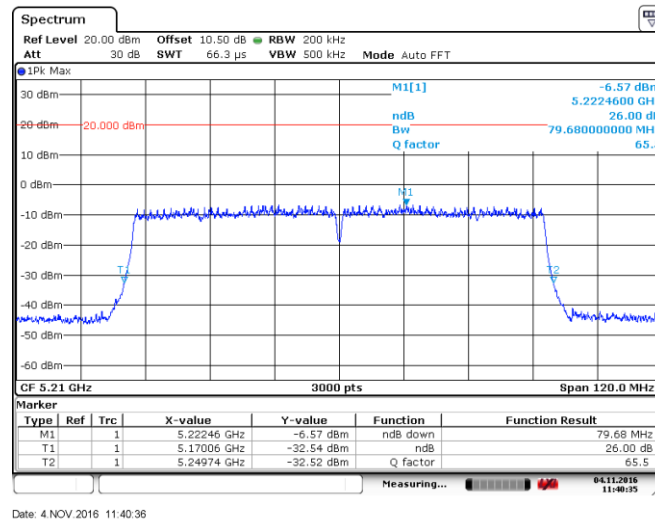


Figure 8.1-3: 26 dB bandwidth on 802.11ac VHT80, sample plot

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	November 4, 2016	Temperature	25 °C
Test engineer	Yong Huang	Air pressure	1015 mbar
Verdict	Pass	Relative humidity	30 %

8.2.3 Observations, settings and special notes

Spectrum analyser settings:

Resolution bandwidth:	1 % to 5 % of the OBW
Video bandwidth:	≥3 × RBW
Detector mode:	Peak
Trace mode:	Max Hold

8.2.4 Test data

Table 8.2-1: 99 % bandwidth results

Modulation	Frequency, MHz	99 % bandwidth, MHz
802.11a	5180	16.65
	5200	16.63
	5240	16.61
802.11n HT20	5180	17.97
	5200	17.83
	5240	17.90
802.11n HT40	5190	36.11
	5230	36.13
	5180	17.90
802.11ac VHT20	5200	17.85
	5240	17.88
	5190	36.19
802.11ac VHT40	5230	36.13
	5210	75.52

8.2.4 Test data, continued

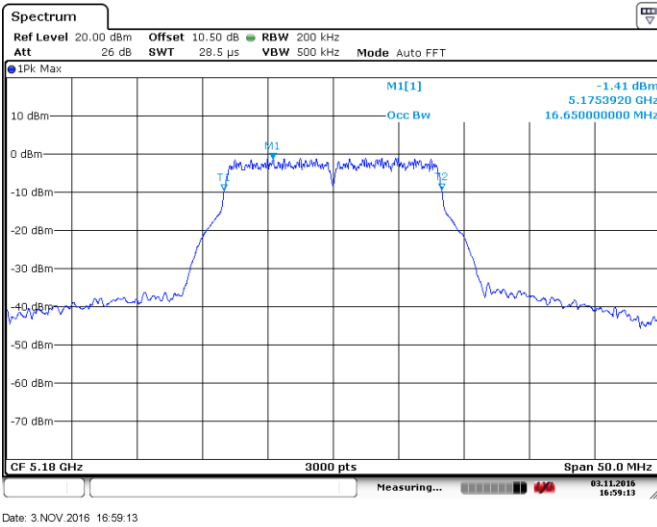


Figure 8.2-1: 99 % bandwidth on 802.11a, sample plot

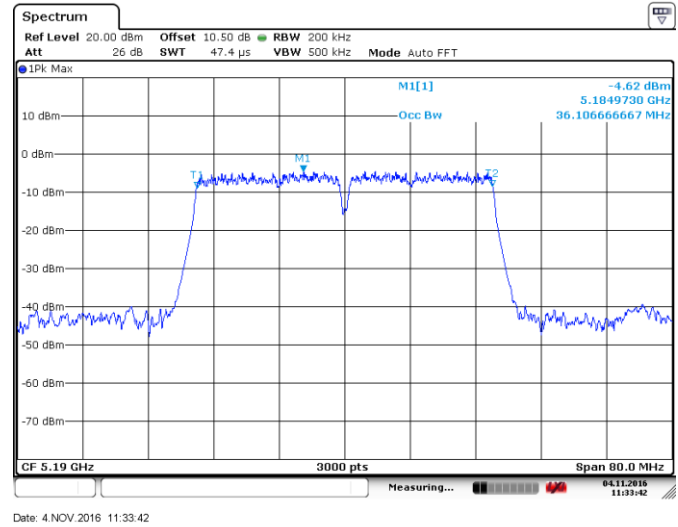


Figure 8.2-2: 99 % bandwidth on 802.11n HT40, sample plot

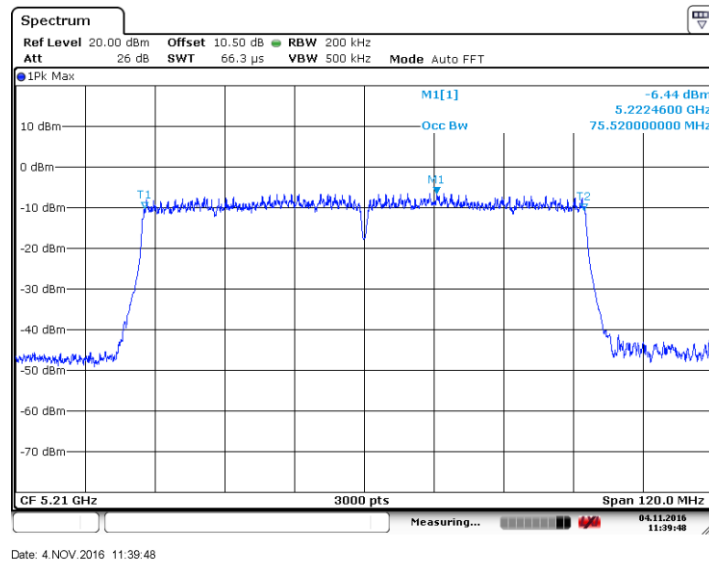


Figure 8.2-3: 99 % bandwidth on 802.11ac VHT80, sample plot

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.

IC:

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	November 3, 2016 to November 4, 2016	Temperature	25 °C
Test engineer	Yong Huang	Air pressure	1015 mbar
Verdict	Pass	Relative humidity	30 %

8.3.3 Observations, settings and special notes

As 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)

The 99 % measured occupied bandwidth for 802.11a was 16.65 MHz, for 802.11n HT20 was 17.97 MHz, for 802.11n HT40 was 36.13 MHz, for 802.11ac VHT20 was 17.90 MHz, for 802.11ac VHT40 was 36.19 MHz and for 802.11ac VHT80 was 75.52 MHz

IC EIRP limit for 802.11a was calculated as follows: $10 + 10 \times \text{Log}_{10}(16.65) = 22.21 \text{ dBm} < 23 \text{ dBm}$

IC EIRP limit for 802.11n HT20 was calculated as follows: $10 + 10 \times \text{Log}_{10}(17.97) = 22.55 \text{ dBm} < 23 \text{ dBm}$

IC EIRP limit for 802.11n HT40 was calculated as follows: $10 + 10 \times \text{Log}_{10}(36.13) = 25.58 \text{ dBm} > 23 \text{ dBm}$, therefore the limit is 23 dBm

IC EIRP limit for 802.11ac VHT20 was calculated as follows: $10 + 10 \times \text{Log}_{10}(17.90) = 22.53 \text{ dBm} < 23 \text{ dBm}$

IC EIRP limit for 802.11ac VHT40 was calculated as follows: $10 + 10 \times \text{Log}_{10}(36.19) = 25.59 \text{ dBm} > 23 \text{ dBm}$, therefore the limit is 23 dBm

IC EIRP limit for 802.11ac VHT80 was calculated as follows: $10 + 10 \times \text{Log}_{10}(75.52) = 28.78 \text{ dBm} > 23 \text{ dBm}$, therefore the limit is 23 dBm

8.3.4 Test data

Table 8.3-1: Output power measurements results for FCC

Modulation	Frequency, MHz	Conducted output power, dBm	Power limit, dBm	Margin, dB
802.11a	5180	9.05	24	14.95
	5200	9.20	24	14.80
	5240	9.48	24	14.52
802.11n HT20	5180	8.98	24	15.02
	5200	9.10	24	14.90
	5240	9.41	24	14.59
802.11n HT40	5190	8.33	24	15.67
	5230	8.59	24	15.41
	5180	5.50	24	18.50
802.11ac VHT20	5200	7.13	24	16.87
	5240	9.44	24	14.56
	5190	8.41	24	15.59
802.11ac VHT40	5230	8.63	24	15.37
	5210	8.50	24	15.50

Table 8.3-2: PPSD measurements results for FCC

Modulation	Frequency, MHz	PPSD, dBm/MHz	PPSD limit, dBm/MHz	Margin, dB
802.11a	5180	-1.64	11	12.64
	5200	-1.53	11	12.53
	5240	-1.19	11	12.19
802.11n HT20	5180	-2.09	11	13.09
	5200	-1.87	11	12.87
	5240	-1.66	11	12.66
802.11n HT40	5190	-5.43	11	16.43
	5230	-5.43	11	16.43
	5180	-5.61	11	16.61
802.11ac VHT20	5200	-4.06	11	15.06
	5240	-1.78	11	12.78
	5190	-5.73	11	16.73
802.11ac VHT40	5230	-5.58	11	16.58
	5210	-8.27	11	19.27

Section 8

Testing data

Test name

FCC 15.407(a)(1) and RSS-247 6.2.1(1) 5.15–5.25 GHz band output power and spectral density limits

Specification

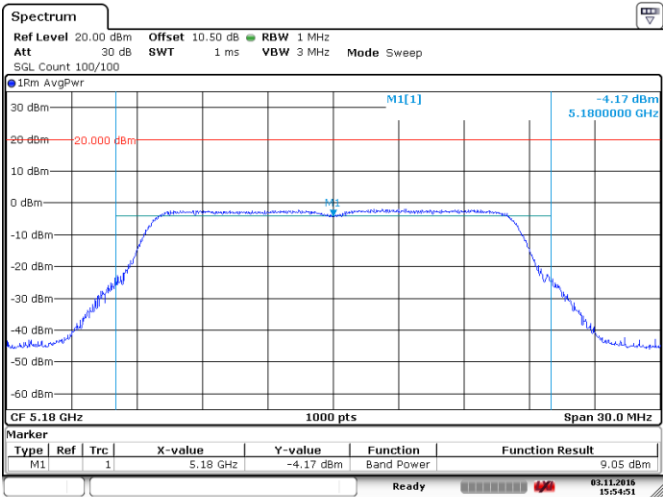
FCC Part 15 Subpart E and RSS-247, Issue 1


Table 8.3-3: Output power measurements and EIRP calculations results for IC

Modulation	Frequency, MHz	Conducted output power, dBm	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	Margin, dB
802.11a	5180	9.05	2.4	11.45	22.21	10.76
	5200	9.20	2.4	11.60	22.21	10.61
	5240	9.48	2.4	11.88	22.21	10.33
802.11n HT20	5180	8.98	2.4	11.38	22.55	11.17
	5200	9.10	2.4	11.50	22.55	11.05
	5240	9.41	2.4	11.81	22.55	10.74
802.11n HT40	5190	8.33	2.4	10.73	23.00	12.27
	5230	8.59	2.4	10.99	23.00	12.01
	5180	5.50	2.4	7.90	22.53	14.63
802.11ac VHT20	5200	7.13	2.4	9.53	22.53	13.00
	5240	9.44	2.4	11.84	22.53	10.69
	5190	8.41	2.4	10.81	23.00	12.19
802.11ac VHT40	5230	8.63	2.4	11.03	23.00	11.97
	5210	8.50	2.4	10.90	23.00	12.10

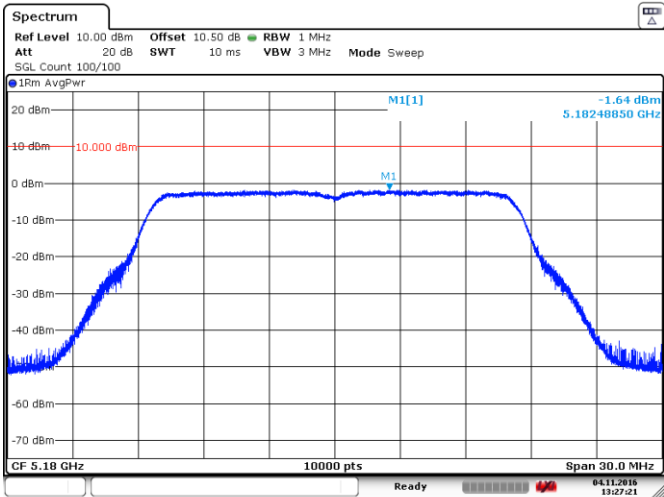
Table 8.3-4: PSD measurements results for IC

Modulation	Frequency, MHz	PSD, dBm/MHz	Antenna gain, dBi	EIRP PSD, dBm/MHz	EIRP PSD limit, dBm/MHz	Margin, dB
802.11a	5180	-1.64	2.4	0.76	10	9.24
	5200	-1.53	2.4	0.87	10	9.13
	5240	-1.19	2.4	1.21	10	8.79
802.11n HT20	5180	-2.09	2.4	0.31	10	9.69
	5200	-1.87	2.4	0.53	10	9.47
	5240	-1.66	2.4	0.74	10	9.26
802.11n HT40	5190	-5.43	2.4	-3.03	10	13.03
	5230	-5.43	2.4	-3.03	10	13.03
	5180	-5.61	2.4	-3.21	10	13.21
802.11ac VHT20	5200	-4.06	2.4	-1.66	10	11.66
	5240	-1.78	2.4	0.62	10	9.38
	5190	-5.73	2.4	-3.33	10	13.33
802.11ac VHT40	5230	-5.58	2.4	-3.18	10	13.18
	5210	-8.27	2.4	-5.87	10	15.87



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Figure 8.3-1: Sample plot for power measurement



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Figure 8.3-2: Sample plot for PPSD measurement

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.

IC:

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		Measurement distance, m
	µV/m	dBµV/m	
0.009–0.490	2400/F (<i>F in kHz</i>)	67.6 – 20 × log ₁₀ (F) (<i>F in kHz</i>)	300
0.490–1.705	24000/F (<i>F in kHz</i>)	87.6 – 20 × log ₁₀ (F) (<i>F in kHz</i>)	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: IC 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	October 7, 2016 to November 5, 2016	Temperature	25 °C
Test engineer	Yong Huang	Air pressure	1015 mbar
Verdict	Pass	Relative humidity	30 %

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. Radiated emissions were performed while antenna connectors were terminated with 50 Ω load.

Antenna gain of 2.4 dBi was included as offset in conducted measurement.

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

Average limit line was set as follows: 54 dB μ V/m – 95.23 dB – 4.7 dB = -45.93 dBm

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

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

Average limit line was set as follows: 54 dB μ V/m – 95.23 dB = -41.23 dBm/MHz

Spectrum analyser for average conducted measurements within restricted bands above 1 GHz for frequencies where peak results were above the average limit:

Resolution bandwidth:	1 MHz
Video bandwidth:	10 MHz
Detector mode:	RMS
Trace mode:	Power average
Number of averaging traces:	100

Peak limit is 20 dB higher than the average limit: -41.23 dBm/MHz + 20 dB = -21.23 dBm/MHz

Spectrum analyser for peak conducted measurements outside restricted bands:

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

Conducted emissions measurements outside restricted bands were performed on antenna port. The limit was: -27 dBm/MHz

8.4.4 Test data

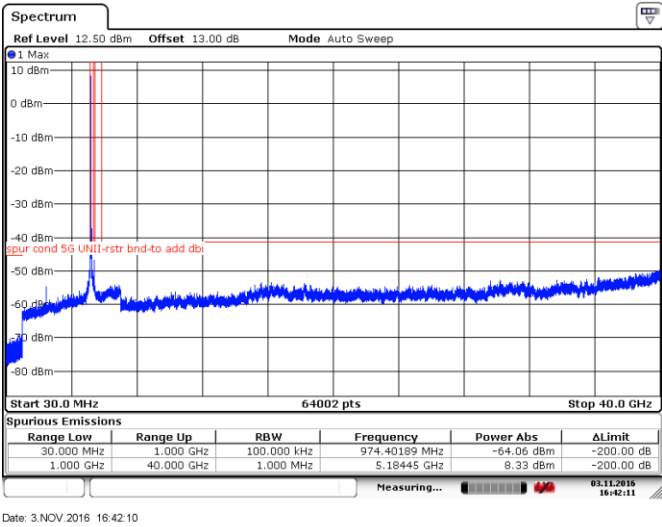


Figure 8.4-1: Conducted peak spurious emissions within restricted bands at low channel, 802.11a

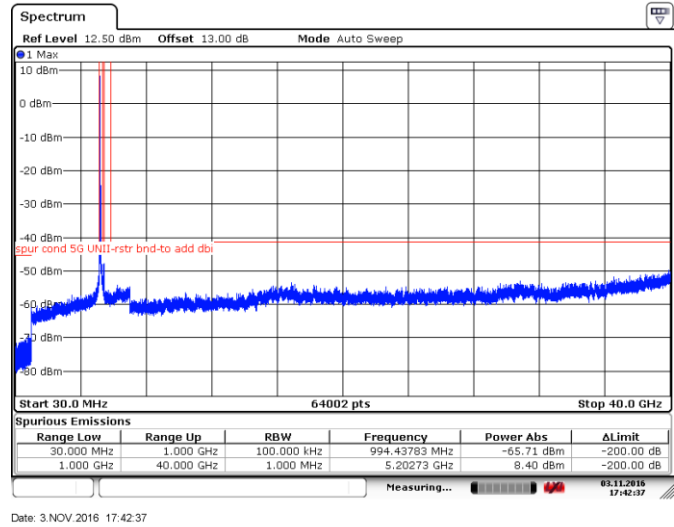


Figure 8.4-2: Conducted peak spurious emissions within restricted bands at mid channel, 802.11a

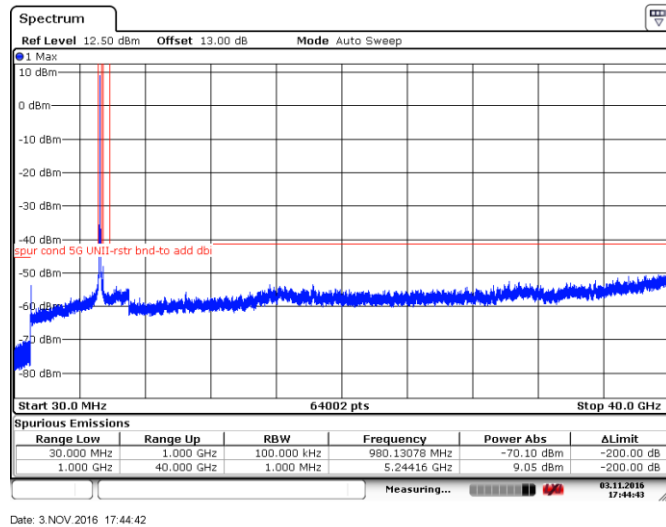
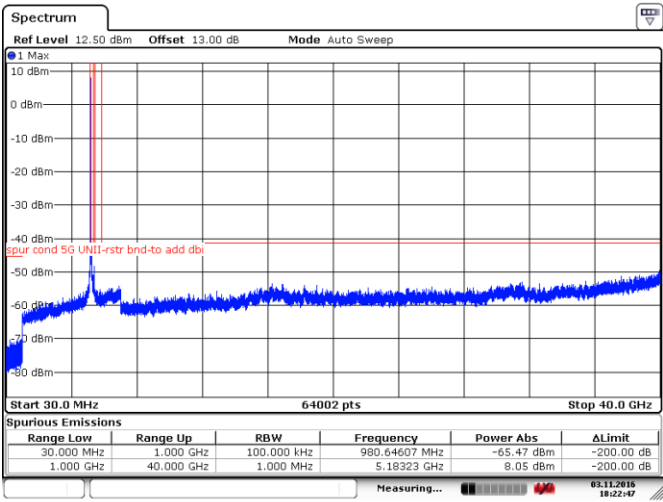


Figure 8.4-3: Conducted peak spurious emissions within restricted bands at high channel, 802.11a

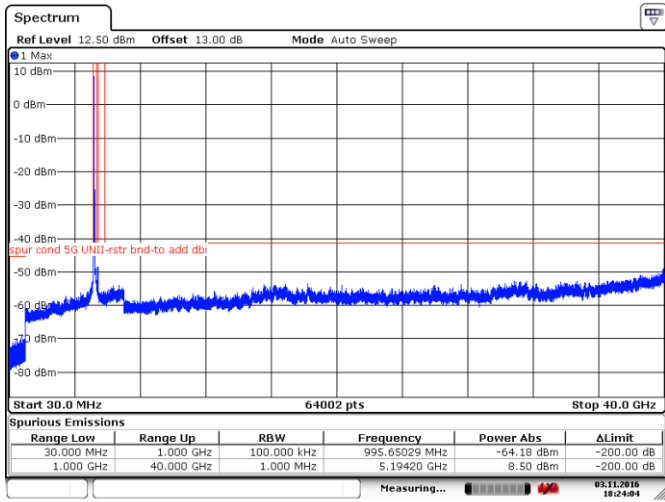
Section 8
Test name
Specification

Testing data
FCC 15.407(b) and RSS-247 6.2.1(2) Undesirable (unwanted) emissions
FCC Part 15 Subpart E and RSS-247, Issue 1



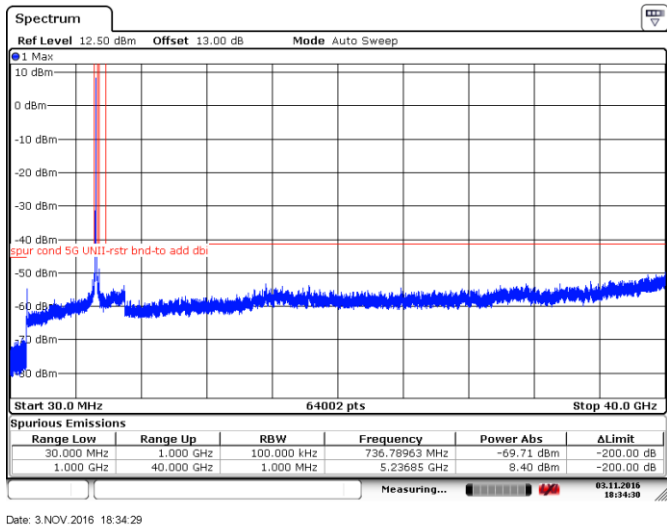
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Figure 8.4-4: Conducted peak spurious emissions within restricted bands at low channel, 802.11n-HT20



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Figure 8.4-5: Conducted peak spurious emissions within restricted bands at mid channel, 802.11n-HT20



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Figure 8.4-6: Conducted peak spurious emissions within restricted bands at high channel, 802.11n-HT20

Section 8
Test name
Specification

Testing data
FCC 15.407(b) and RSS-247 6.2.1(2) Undesirable (unwanted) emissions
FCC Part 15 Subpart E and RSS-247, Issue 1

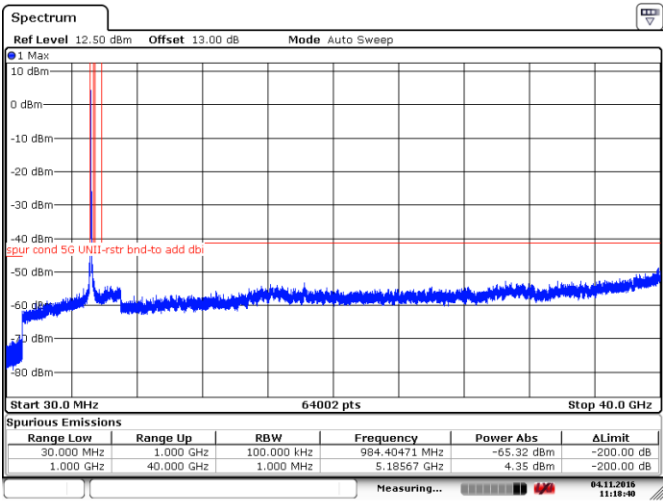


Figure 8.4-7: Conducted peak spurious emissions within restricted bands at low channel, 802.11n-HT40

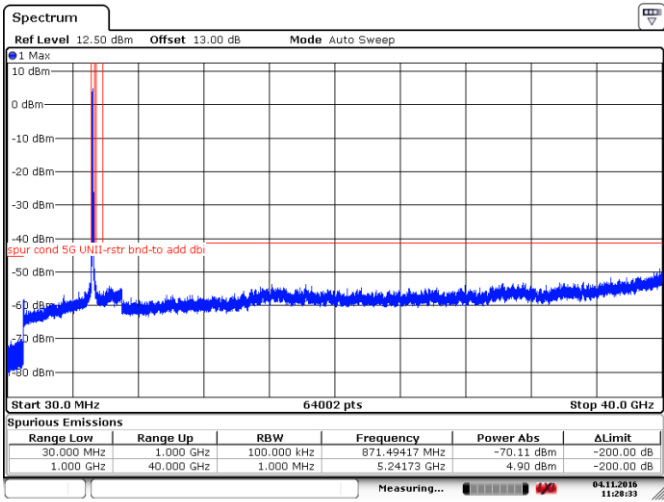


Figure 8.4-8: Conducted peak spurious emissions within restricted bands at high channel, 802.11n-HT40

Test name
Specification



Figure 8.4-9: Conducted peak spurious emissions within restricted bands at low channel, 802.11ac-VHT20



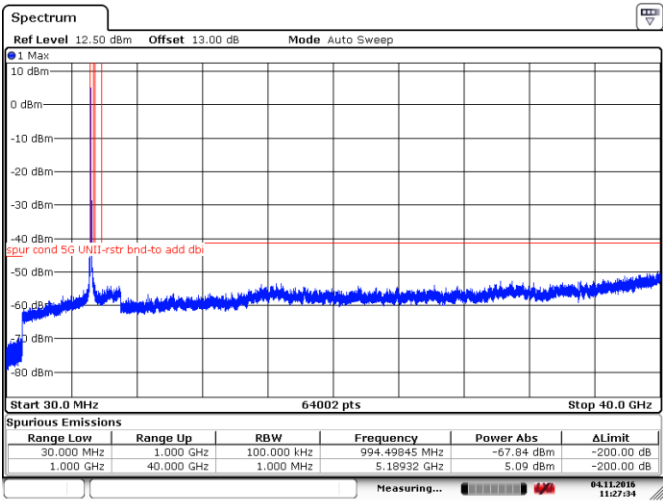
Figure 8.4-10: Conducted peak spurious emissions within restricted bands at mid channel, 802.11ac-VHT20



Figure 8.4-11: Conducted peak spurious emissions within restricted bands at high channel, 802.11ac-VHT20

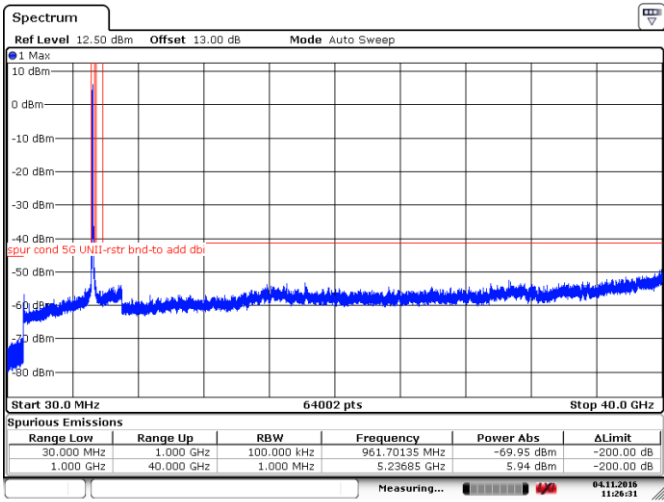
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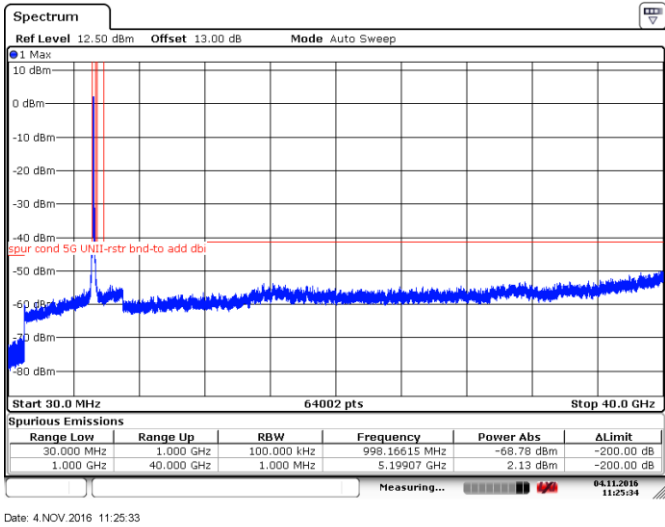
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Figure 8.4-12: Conducted peak spurious emissions within restricted bands at low channel, 802.11ac-VHT40



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Figure 8.4-13: Conducted peak spurious emissions within restricted bands at high channel, 802.11ac-VHT40

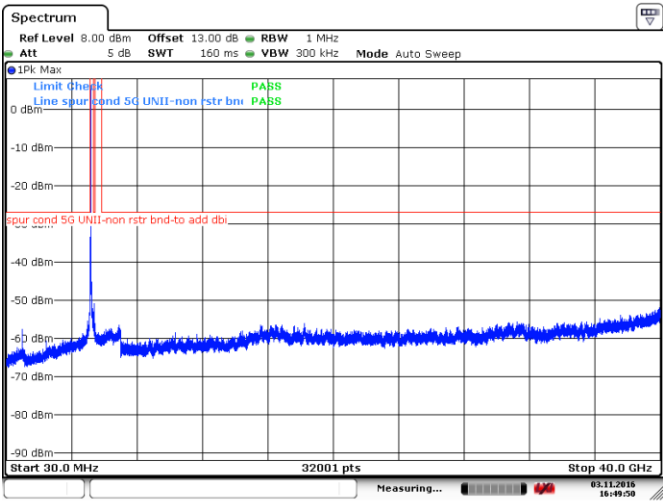


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Figure 8.4-14: Conducted peak spurious emissions within restricted bands, 802.11ac-VHT80

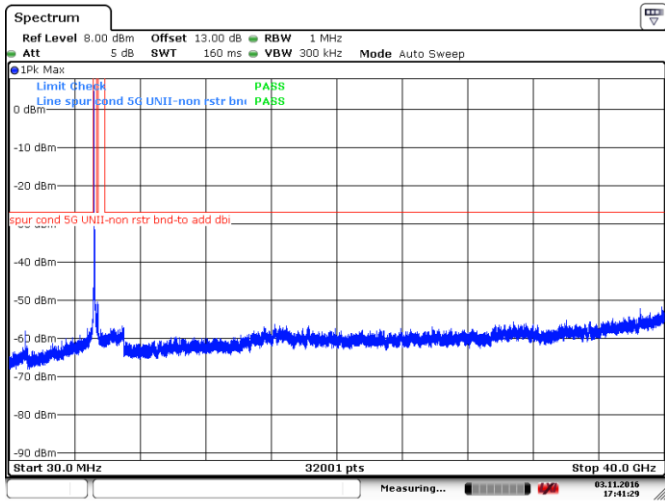
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Testing data
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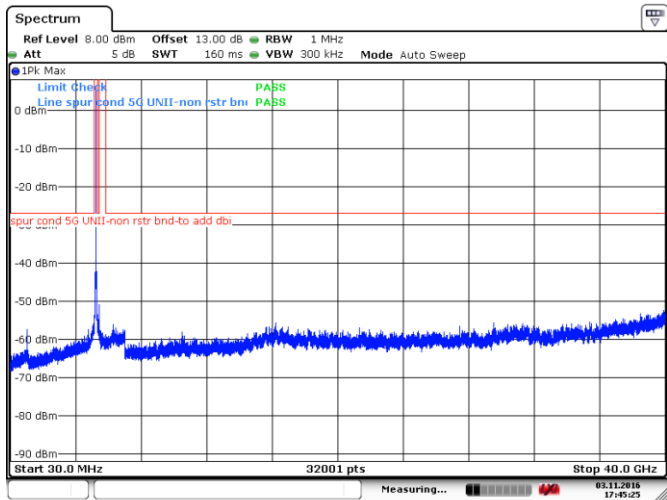
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Figure 8.4-15: Conducted peak spurious emissions outside restricted bands at low channel, 802.11a



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Figure 8.4-16: Conducted peak spurious emissions outside restricted bands at mid channel, 802.11a

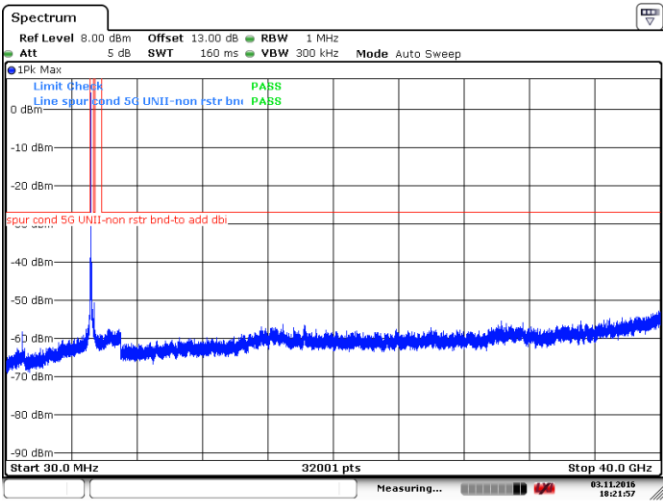


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Figure 8.4-17: Conducted peak spurious emissions outside restricted bands at high channel, 802.11a

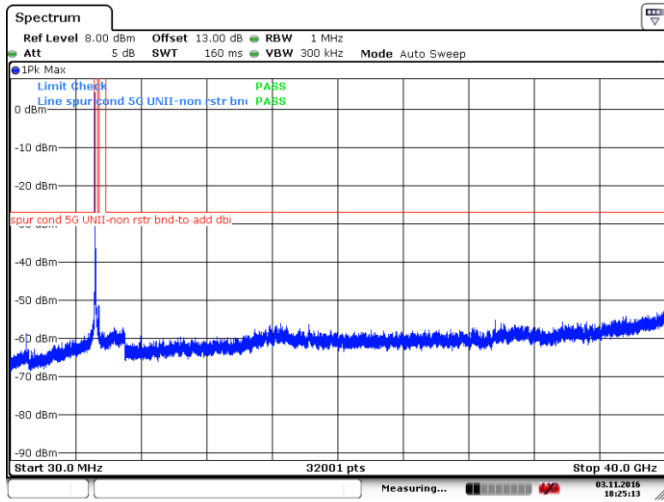
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Testing data
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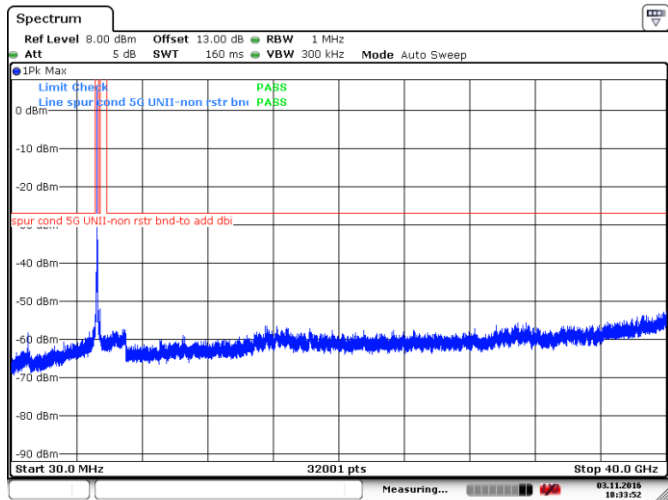
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Figure 8.4-18: Conducted peak spurious emissions outside restricted bands at low channel, 802.11n-HT20



Date: 3.NOV.2016 18:25:13

Figure 8.4-19: Conducted peak spurious emissions outside restricted bands at mid channel, 802.11n-HT20



Date: 3.NOV.2016 18:33:52

Figure 8.4-20: Conducted peak spurious emissions outside restricted bands at high channel, 802.11a, 802.11n-HT20

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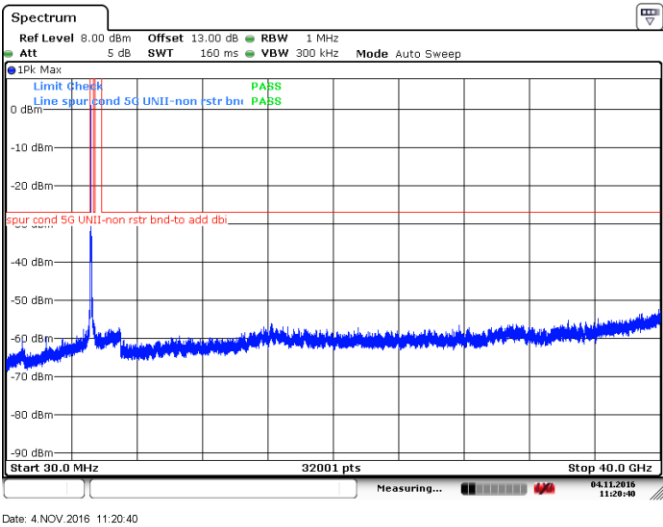


Figure 8.4-21: Conducted peak spurious emissions outside restricted bands at low channel, 802.11n-HT40

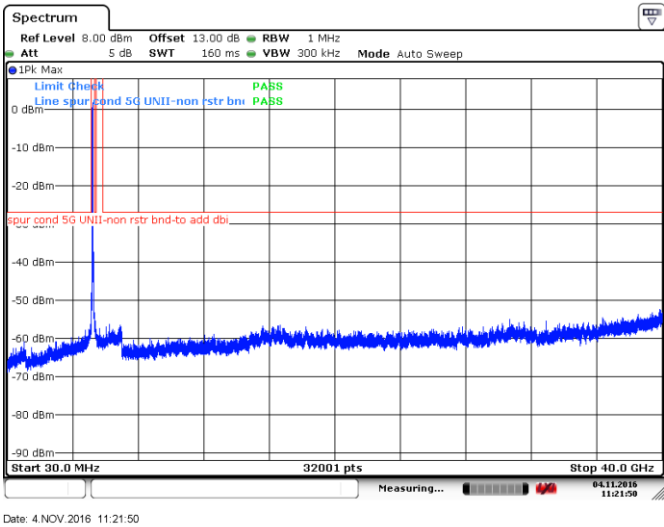


Figure 8.4-22: Conducted peak spurious emissions outside restricted bands at high channel, 802.11n-HT40

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Test name
Specification

Testing data
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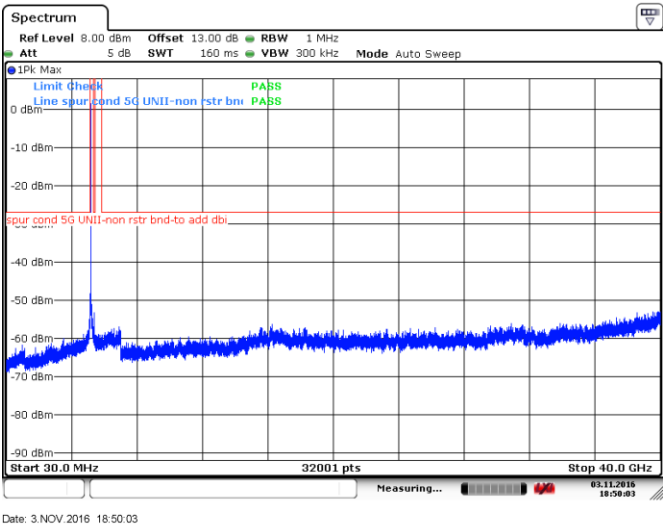


Figure 8.4-23: Conducted peak spurious emissions outside restricted bands at low channel, 802.11ac-VHT20

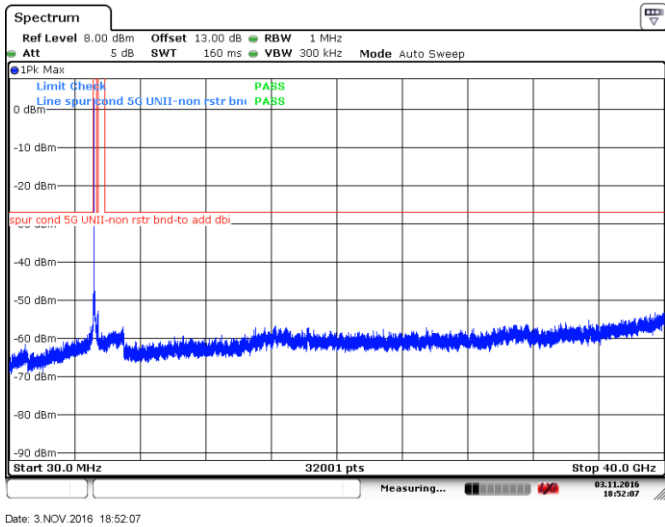


Figure 8.4-24: Conducted peak spurious emissions outside restricted bands at mid channel, 802.11ac-VHT20

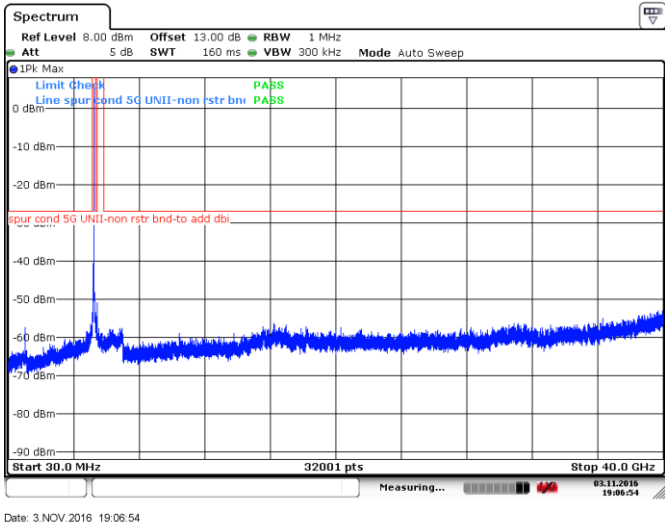
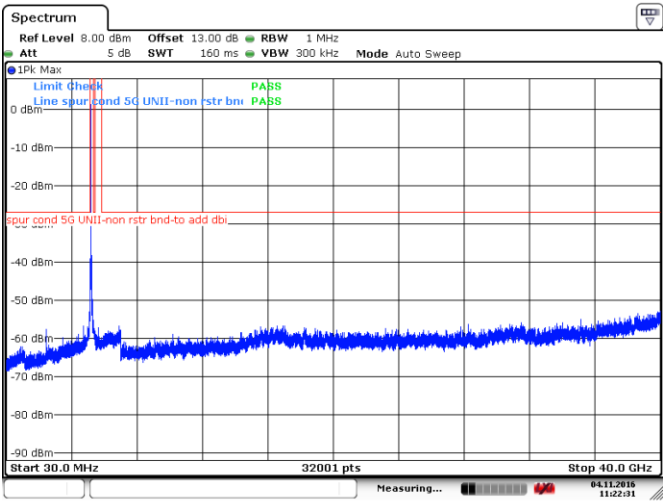


Figure 8.4-25: Conducted peak spurious emissions outside restricted bands at high channel, 802.11ac-VHT20

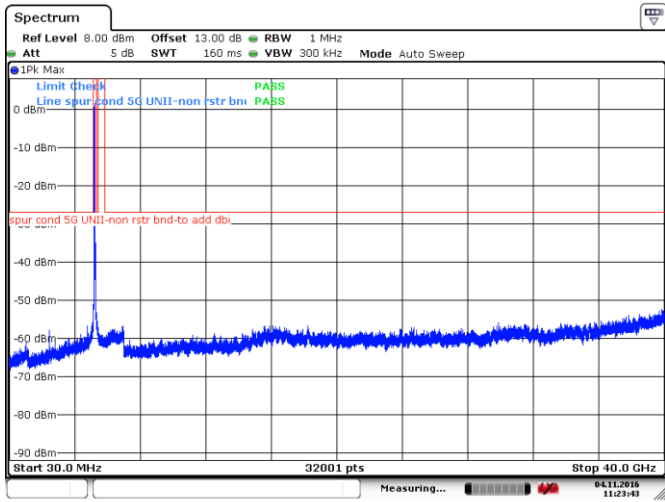
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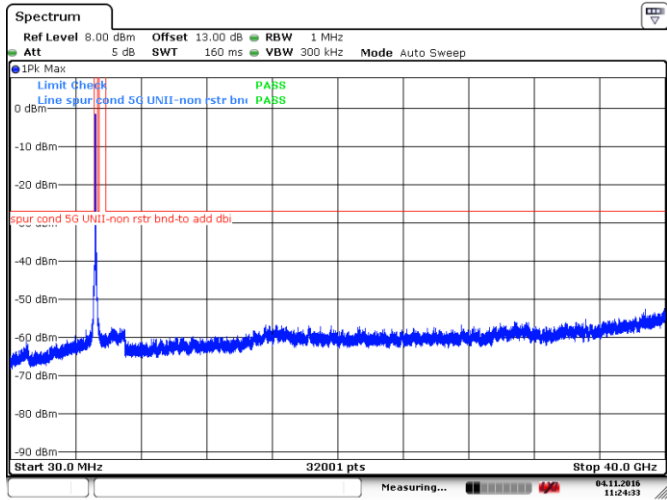
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Figure 8.4-26: Conducted peak spurious emissions outside restricted bands at low channel, 802.11ac-VHT40



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Figure 8.4-27: Conducted peak spurious emissions outside restricted bands at high channel, 802.11ac-VHT40

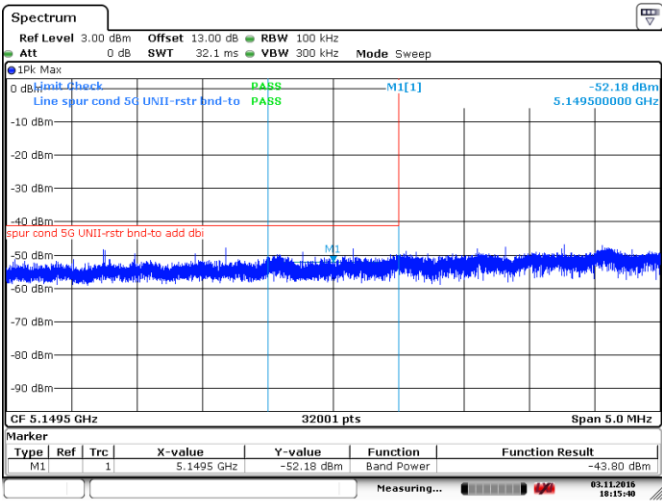


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Figure 8.4-28: Conducted peak spurious emissions outside restricted bands, 802.11ac-VHT80

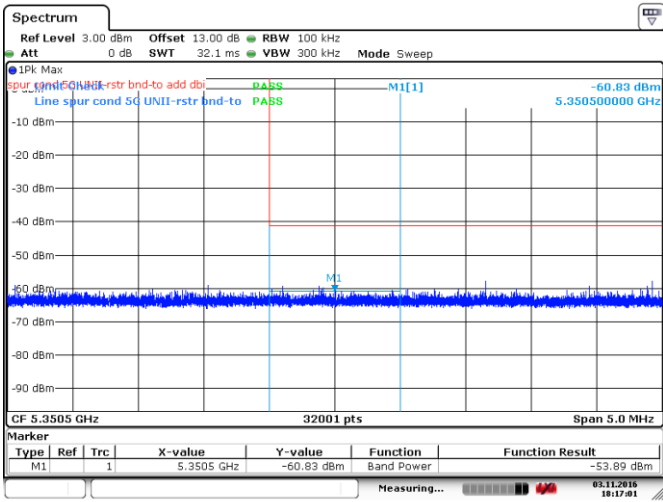
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Specification

Testing data
FCC 15.407(b) and RSS-247 6.2.1(2) Undesirable (unwanted) emissions
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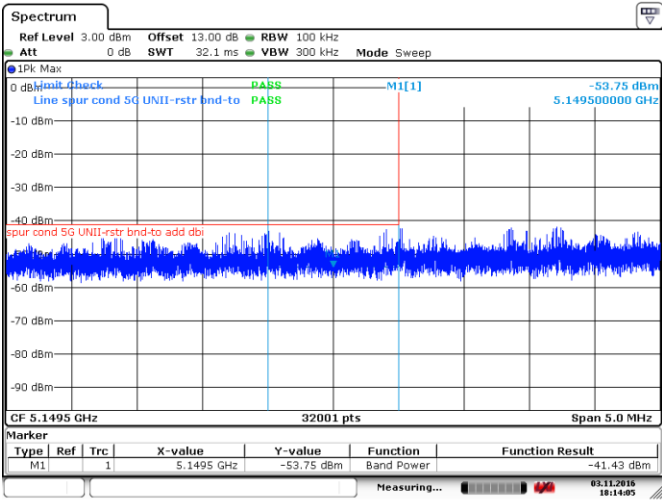
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Figure 8.4-29: Lower band edge emission, 802.11a



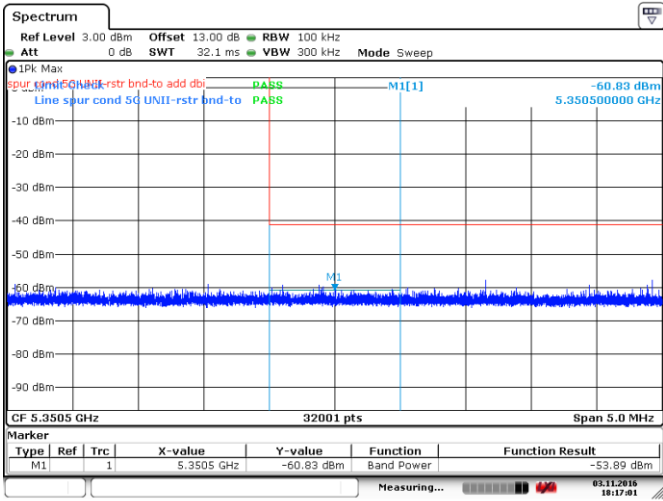
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Figure 8.4-30: Upper band edge emission, 802.11a



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Figure 8.4-31: Lower band edge emission, 802.11n-HT20

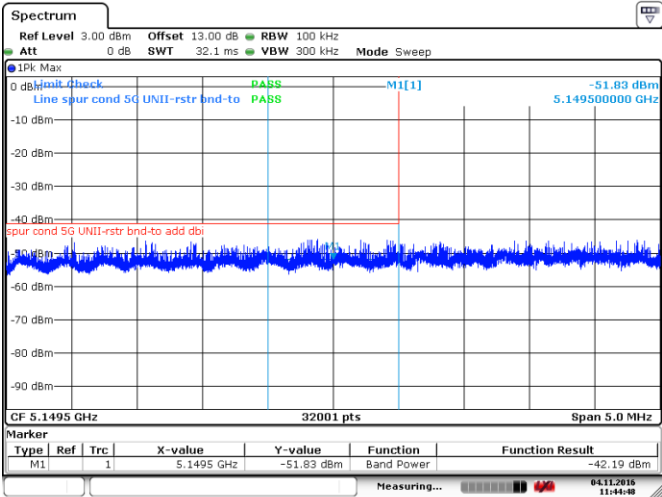


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Figure 8.4-32: Upper band edge emission, 802.11n-HT20

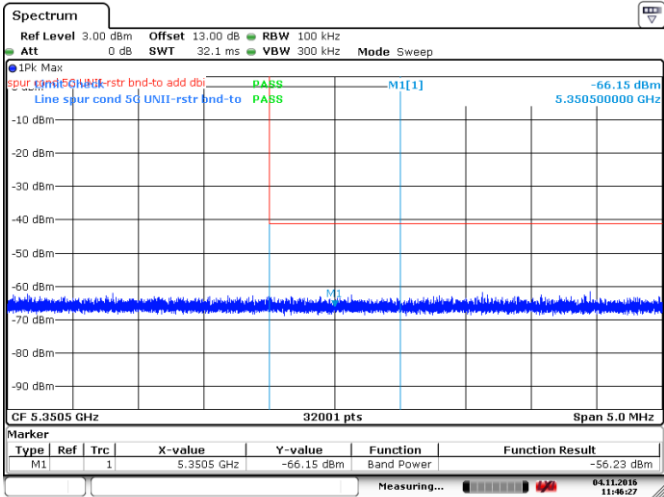
Section 8
Test name
Specification

Testing data
FCC 15.407(b) and RSS-247 6.2.1(2) Undesirable (unwanted) emissions
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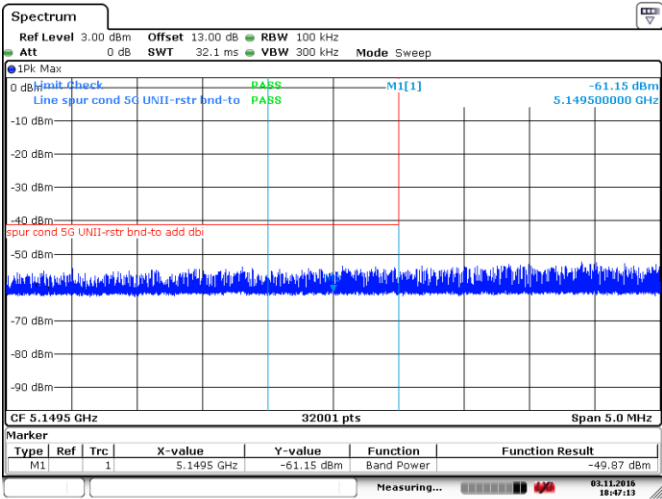
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Figure 8.4-33: Lower band edge emission, 802.11n-HT40



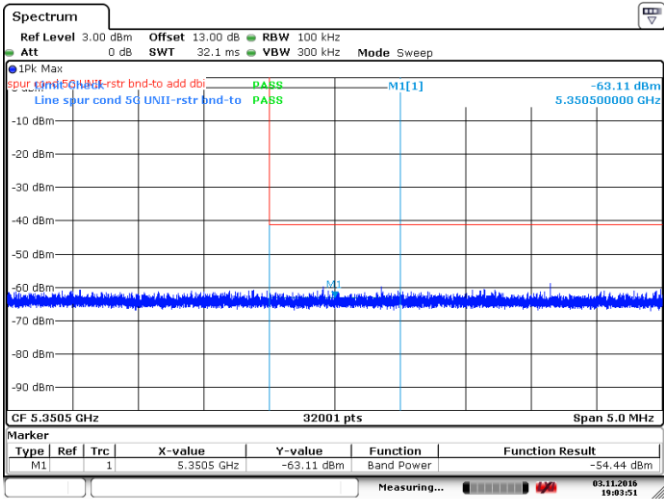
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Figure 8.4-34: Upper band edge emission, 802.11n-HT40



Date: 3.NOV.2016 18:47:13

Figure 8.4-35: Lower band edge emission, 802.11ac-VHT20



Date: 3.NOV.2016 19:03:51

Figure 8.4-36: Upper band edge emission, 802.11ac-VHT20

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FCC 15.407(b) and RSS-247 6.2.1(2) Undesirable (unwanted) emissions
FCC Part 15 Subpart E and RSS-247, Issue 1

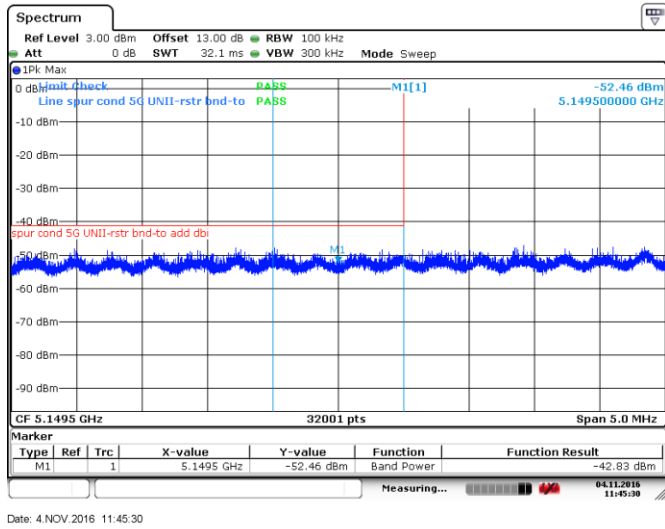


Figure 8.4-37: Lower band edge emission, 802.11ac-VHT40

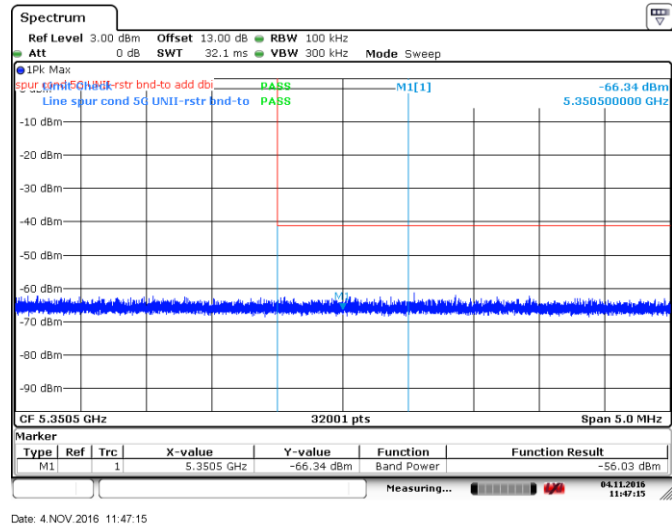


Figure 8.4-38: Upper band edge emission, 802.11ac-VHT40

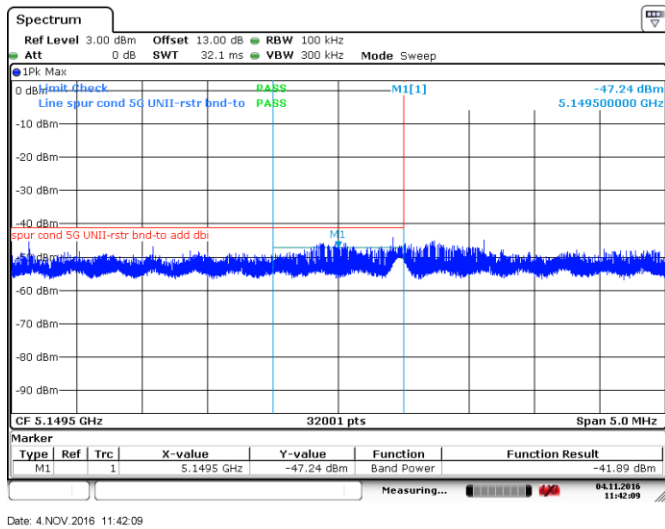


Figure 8.4-39: Lower band edge emission, 802.11ac-VHT80

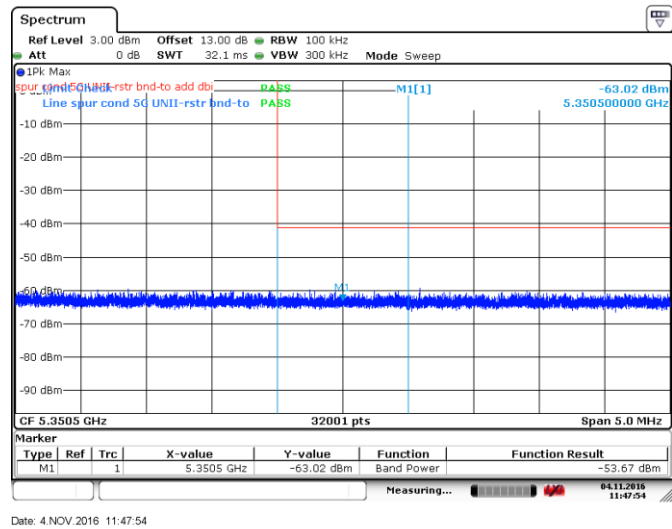


Figure 8.4-40: Upper band edge emission, 802.11ac-VHT80

Table 8.4-4: Upper band edge (5250 MHz) measurements results for ISFD

Modulation	Frequency, MHz	Band edge attenuation, dBc	Minimum limit, dBc	Margin, dB
802.11a	5240	40.02	26	14.02
802.11n HT20	5240	38.04	26	12.04
802.11n HT40	5230	50.86	26	24.86
802.11ac VHT20	5240	37.97	26	11.97
802.11ac VHT40	5230	51.05	26	25.05
802.11ac VHT80	5210	50.33	26	24.33

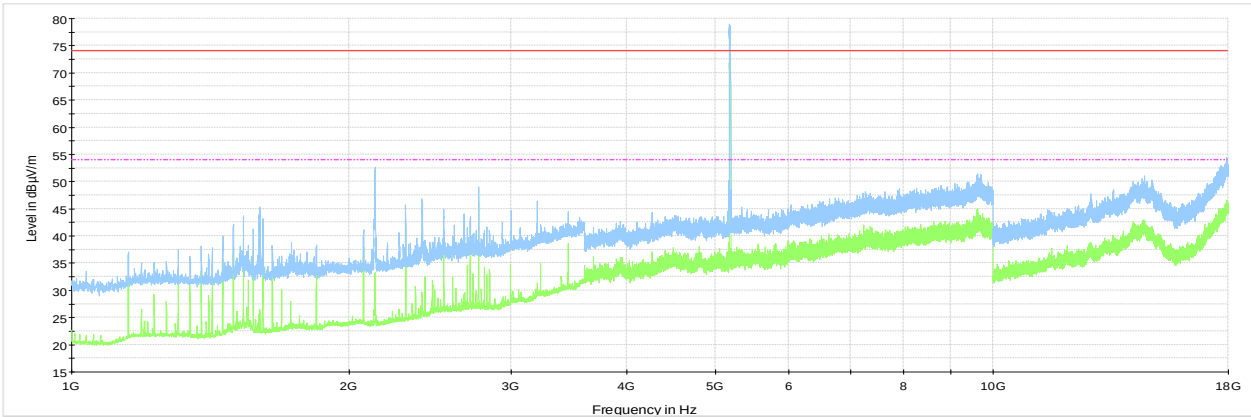


Figure 8.4-41: Cabinet Radiated spurious emission 1 to 18 GHz sample plot, low channel

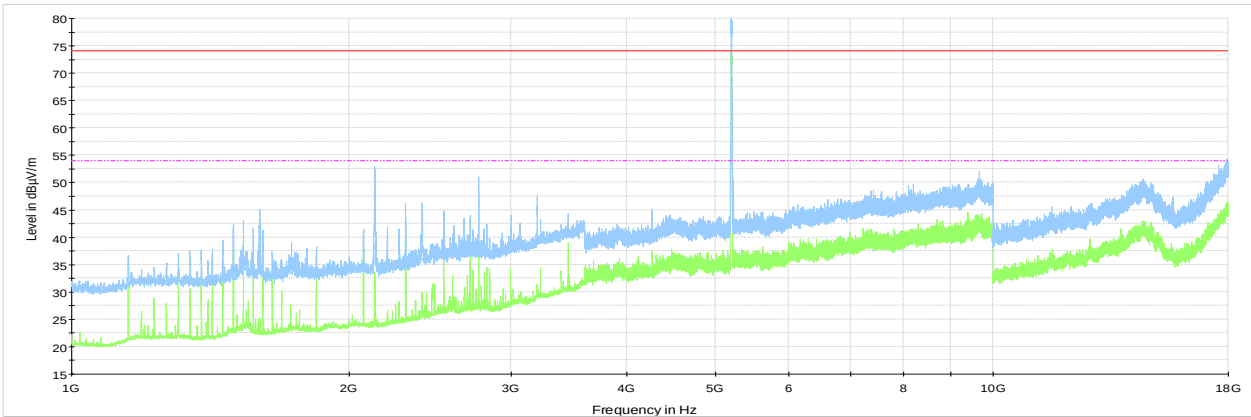


Figure 8.4-42: Cabinet Radiated spurious emission 1 to 18 GHz sample plot, mid channel

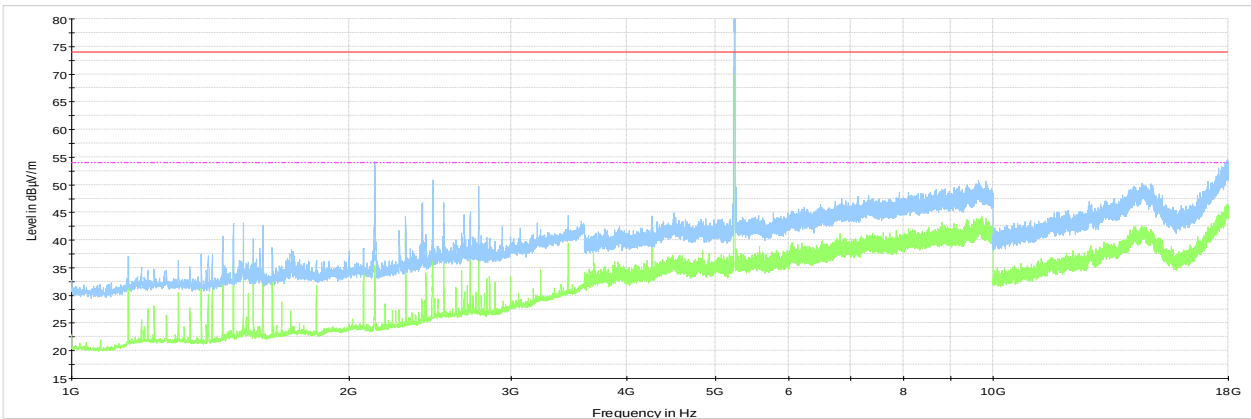


Figure 8.4-43: Cabinet Radiated spurious emission 1 to 18 GHz sample plot, high channel

Note: Spectrum were investigated from 30 MHz to 25 GHz, no emission were detected above 18 GHz within 10 dB below the limit.
EUT was investigated in 802.11a/802.11n/802.11ac modes, only worst case was presented.

Table 8.4-5: Radiated field strength measurement results below 1 GHz

Frequency, MHz	Peak Field strength, dB μ V/m	Limit, dB μ V/m	Margin, dB
30.2	32.1	40.0	7.9
246.4	44.1	46.0	1.9
584.0	44.3	46.0	1.7

Notes: Field strength includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.

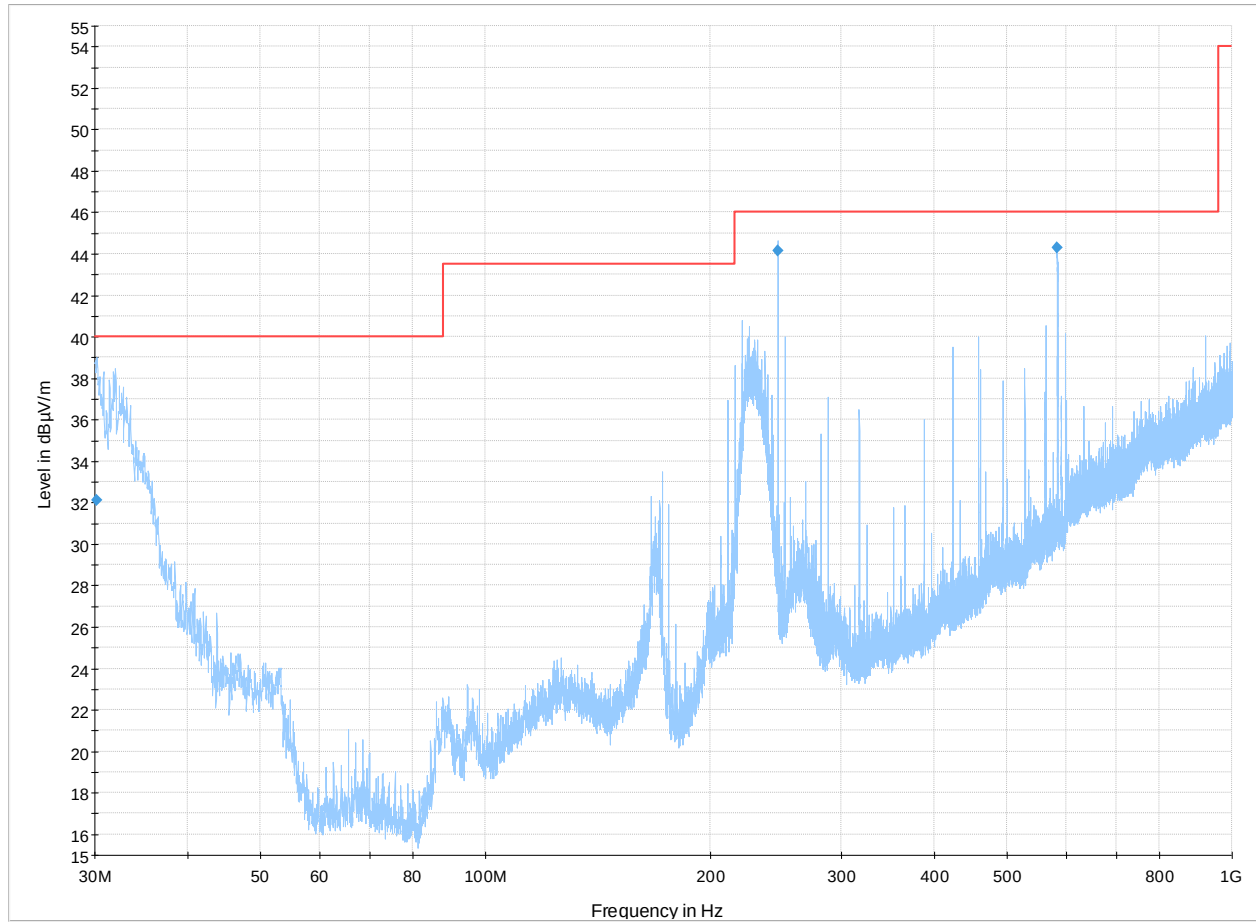


Figure 8.4-44: Radiated spurious emission below 1 GHz sample plot

Note: EUT was investigated in 802.11b/802.11G/802.11n modes, only the worst case was presented.

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 μ H/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 (dB μ V)	
	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	October 6, 2016	Temperature	25 °C
Test engineer	Yong Huang	Air pressure	1009 mbar
Verdict	Pass	Relative humidity	40 %

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.

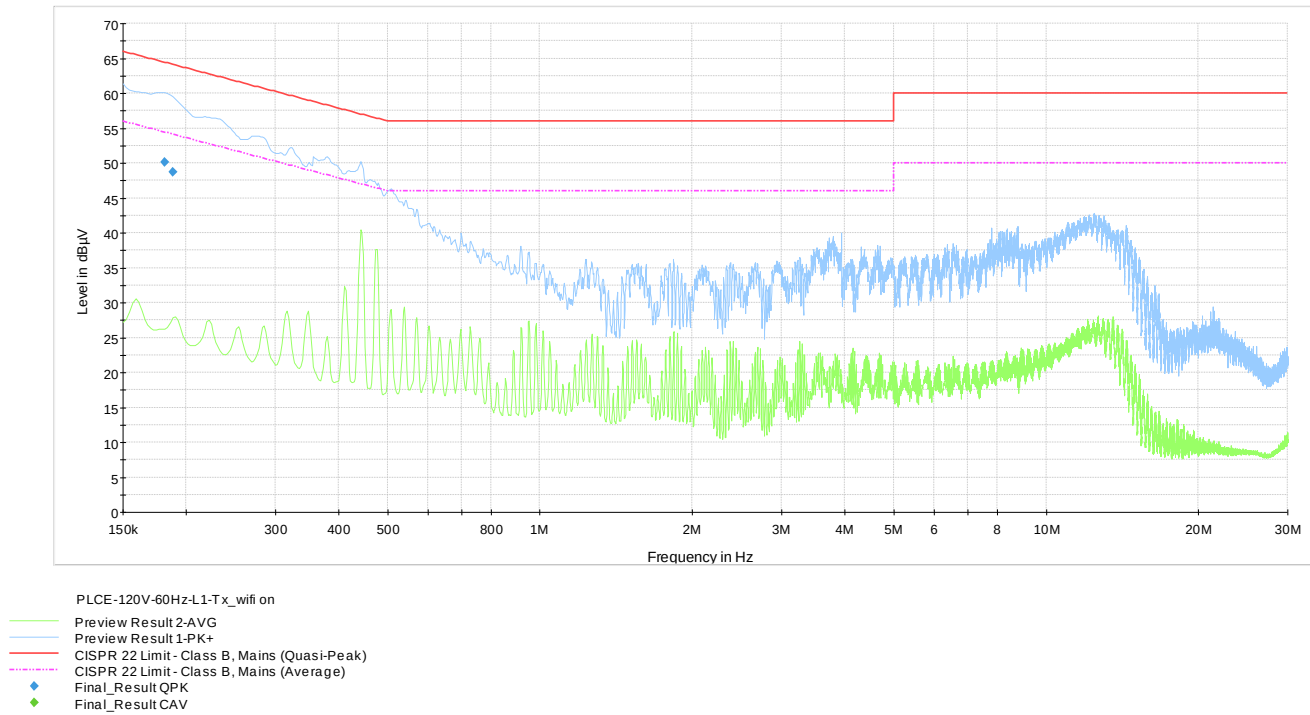
Receiver settings for preview measurements:

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 results AC power line conducted emissions limits – phase line

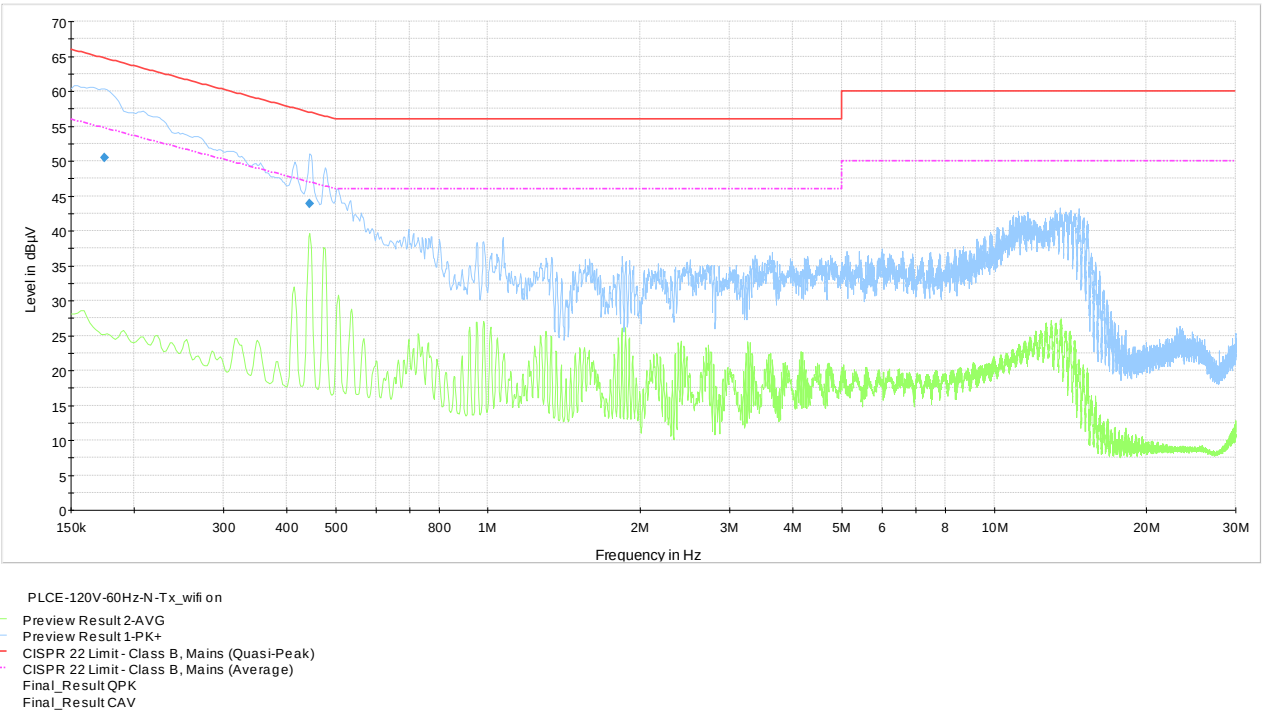
Frequency (MHz)	Quasi-Peak result ^{1 and 3} (dBµV)	Quasi-Peak limit (dBµV)	Margin (dB)	Measurement time (ms)	Bandwidth (kHz)	Conductor	Filter	Correction factor ² (dB)
0.181500	50.1	64.4	14.3	100.0	9	L1	ON	10.2
0.188250	48.8	64.1	15.4	100.0	9	L1	ON	10.2

Notes: ¹ Result (dBµV) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)

² Correction factor (dB) = LISN factor IL (dB) + cable loss (dB) + attenuator (dB)

³ The maximum measured value observed over a period of 15 seconds was recorded.

Sample calculation: 53.4 dBµV (result) = 43.3 dBµV (receiver reading) + 9.9 dB (Correction factor)



Plot 8.5-2: Conducted emissions on neutral line

Table 8.5-3: Quasi-Peak results AC power line conducted emissions limits – neutral line

Frequency (MHz)	Quasi-Peak result ¹ and ³ (dBµV)	Quasi-Peak limit (dBµV)	Margin (dB)	Measurement time (ms)	Bandwidth (kHz)	Conductor	Filter	Correction factor ² (dB)
0.174750	50.4	64.7	14.3	100.0	9	N	ON	10.2
0.444750	43.9	57.0	13.1	100.0	9	N	ON	10.0

Notes: ¹ Result (dBµV) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)

² Correction factor (dB) = LISN factor IL (dB) + cable loss (dB) + attenuator (dB)

³ The maximum measured value observed over a period of 15 seconds was recorded.

Sample calculation: 53.4 dBµV (result) = 43.3 dBµV (receiver reading) + 9.9 dB (Correction factor)

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:	November 10, 2016	Temperature:	24 °C
Test engineer:	Yong Huang	Air pressure:	1009 mbar
Verdict:	Pass	Relative humidity:	37 %

8.6.3 Observations, settings and special notes

Spectrum analyser settings:

Resolution bandwidth:	10 Hz
Video bandwidth:	10 Hz
Detector mode:	Peak
Trace mode:	Max Hold

8.6.4 Test data

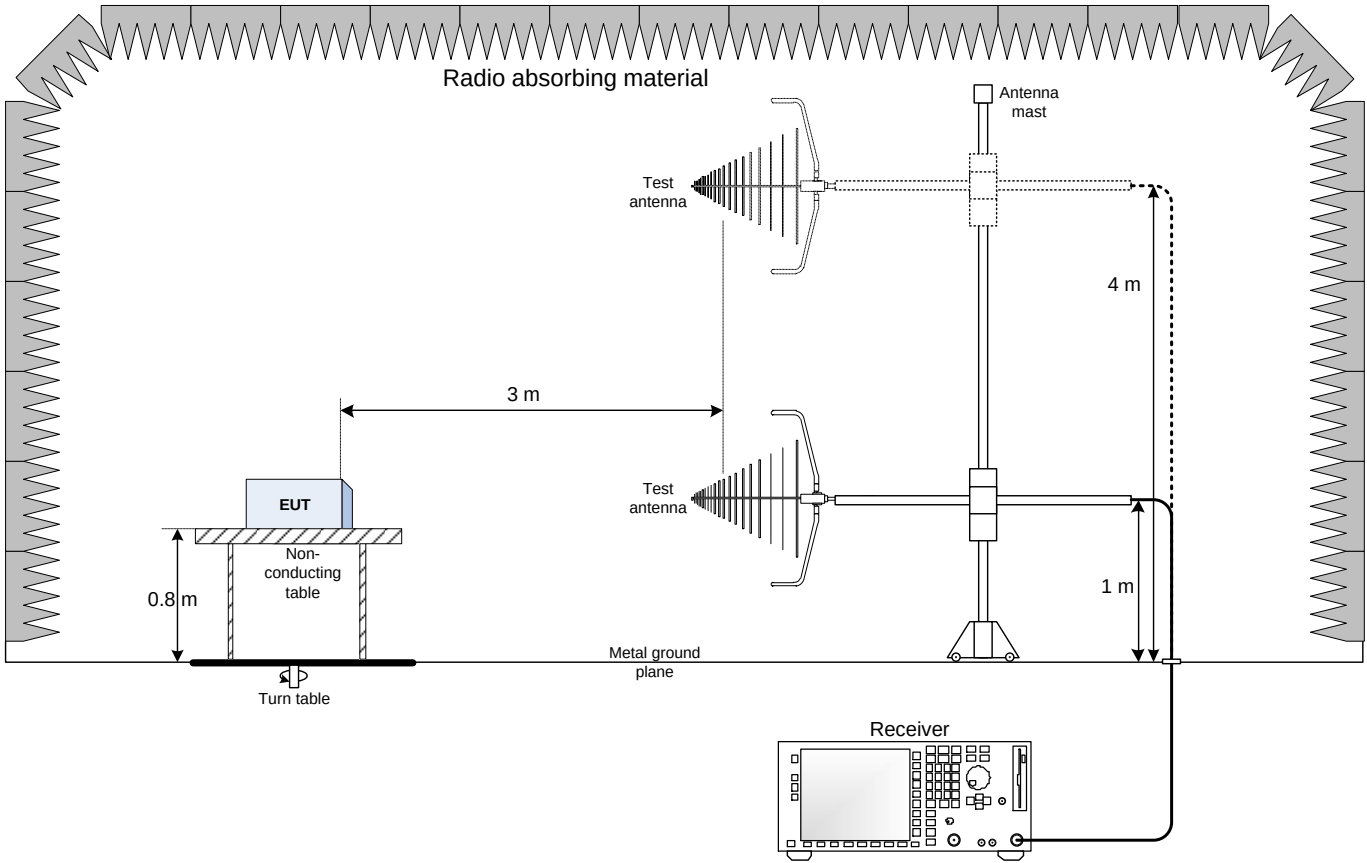
Table 8.6-1: Frequency drift measurement

Test conditions	Frequency, GHz	Drift, Hz
+35 °C, Nominal	5.179968776	-5565
+30 °C, Nominal	5.179974096	-244
+20 °C, +15 %	5.17997434	0
+20 °C, Nominal	5.17997434	Reference
+20 °C, -15 %	5.17997434	0
+10 °C, Nominal	5.179990763	16423
+5 °C, Nominal	5.180007217	32876

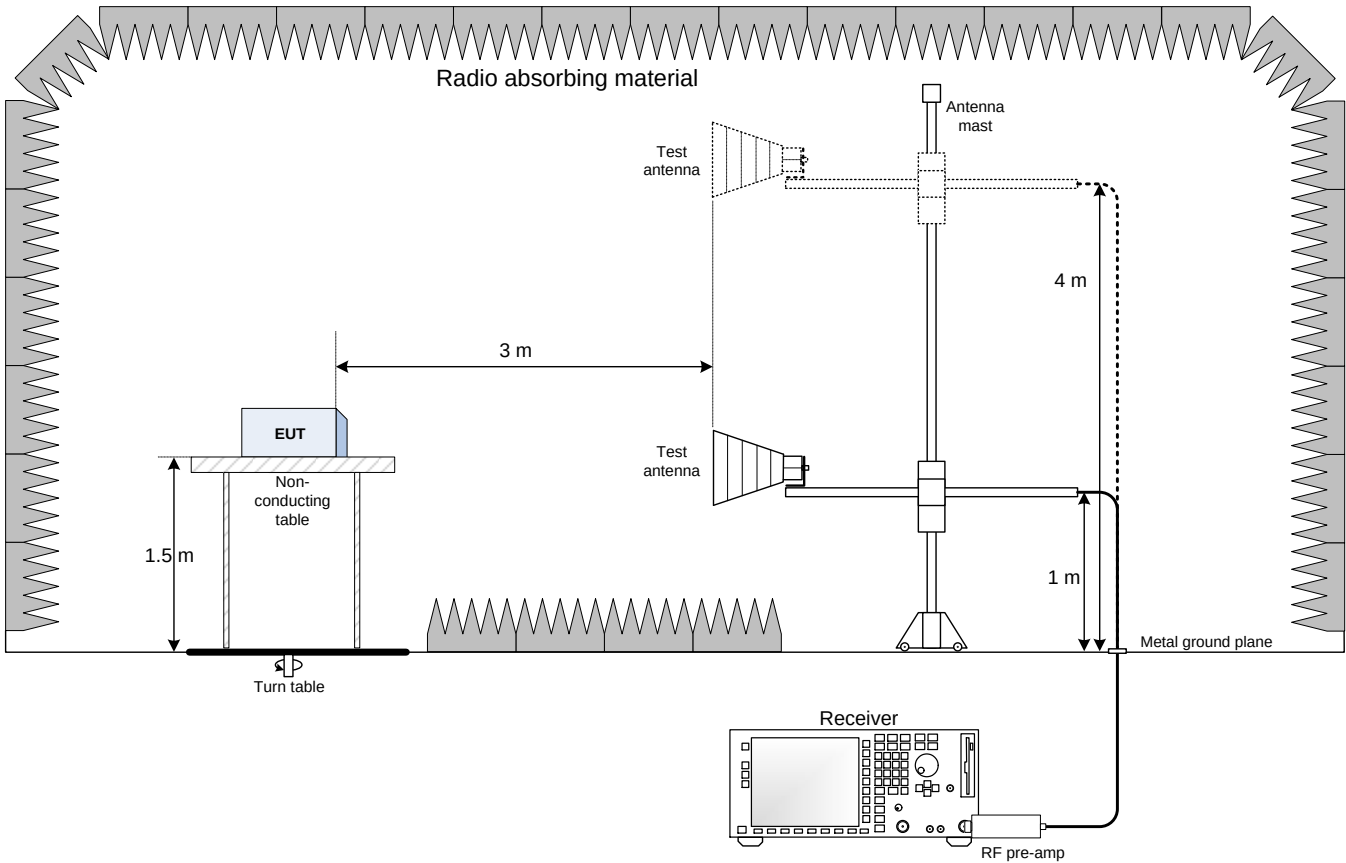
Note: Frequency stability was assessed between two +5 °C and +35 °C, as per client's manual.
Maximum recorded frequency drift was 33 kHz, which is 6 ppm

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

