

Test report

268950-5TRFWL

Date of issue: March 23, 2015

Applicant:

TableTop Media

Product:

ZIOSK

Model:

Z400

FCC ID:

XOX-Z400

Specifications:

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

Unlicensed National Information Infrastructure Devices

Test location

Company name	Nemko Canada Inc.
Address	303 River Road
City	Ottawa
Province	Ontario
Postal code	K1V 1H2
Country	Canada
Telephone	+1 613 737 9680
Facsimile	+1 613 737 9691
Toll free	+1 800 563 6336
Website	www.nemko.com
Site number	FCC: 176392 (3 m semi anechoic chamber)

Tested by	Andrey Adelberg, Senior Wireless/EMC Specialist
Reviewed by	Kevin Rose, Wireless/EMC Specialist
Date	March 23, 2015
Signature of the reviewer	

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	TableTop Media
Address	12404 Park Central Drive Ste 350
City	Dallas
Province/State	TX
Postal/Zip code	75251
Country	United States

1.2 Test specifications

FCC 47 CFR Part 15, Subpart E, Clause 15.407	Unlicensed National Information Infrastructure Devices
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1.3 Test methods

789033 D02 General UNII Test Procedures New Rules v01	Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices Part 15, Subpart E
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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
§15.207(a)	Conducted limits	Not applicable ¹
§15.31(e)	Variation of power source	Pass ²
§15.203	Antenna requirement	Pass ³

Notes: ¹The EUT is a battery powered device

²The tests were performed with fully charged batteries

³The 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	Pass
§15.407(a)(1)	5.15–5.25 GHz band power and density limits	Not applicable
§15.407(a)(2)	5.25–5.35 GHz and 5.47–5.725 GHz bands power and density limits	Not applicable
§15.407(a)(3)	5.725–5.85 GHz band power and density limits	Pass
§15.407(b)(1)	5.15–5.25 GHz band undesired emission limits	Not applicable
§15.407(b)(2)	5.25–5.35 GHz band undesired emission limits	Not applicable
§15.407(b)(3)	5.47–5.725 GHz band undesired emission limits	Not applicable
§15.407(b)(4)	5.725–5.85 GHz band undesired emission limits	Pass
§15.407(e)	Minimum 6 dB bandwidth within the 5.725–5.85 GHz bandh	Pass
§15.407(g)	Frequency stability	Pass
§15.407(h)(1)	Transmit power control (TPC) for 5.25–5.35 GHz and 5.47–5.725 GHz bands	Not applicable
§15.407(h)(2)	Dynamic Frequency Selection (DFS) for 5.25–5.35 GHz and 5.47–5.725 GHz bands	Not applicable

Note: None

Section 3. Equipment under test (EUT) details

3.1 Sample information

Receipt date	September 15, 2014
Nemko sample ID number	1

3.2 EUT information

Product name	ZIOSK
Model	Z400
Serial number	001EC0890C7C

3.3 Technical information

Operating band	5725–5850 MHz
Operating frequencies	20 MHz channels: 5745–5825 MHz; 40 MHz channels: 5755–5795 MHz; 80 MHz channel: 5755 MHz
Modulation type	802.11a: 6–54 Mbps; 802.11n HT20: MCS 0–7; 802.11n HT40: MCS 0–7; 802.11ac VHT40: MCS 0–9; 802.11ac VHT80: MCS 0–9
Occupied bandwidth (99 %)	17.31 MHz (802.11a); 18.37 MHz (802.11n HT20); 36.62 MHz (802.11n HT40); 36.70 MHz (802.11ac VHT40); 75.96 MHz (802.11ac VHT80)
Emission designator	W7D
Power requirements	7.4 V _{DC} Lithium battery
Antenna information	1.94 dBi The EUT uses a unique antenna coupling/ non-detachable antenna to the intentional radiator.

3.4 Product description and theory of operation

The Ziosk is a wireless, battery operated touch screen device with a 7" LCD display, used for pay-at-the-table applications in casual dining restaurants. The device can display menu items, specials, entertainment and local area information; it can also process credit card payments and print receipts.

3.5 EUT exercise details

EUT was connected to Laptop via internal (not user accessible) USB connector and Android shell commands were used to control channel, modulation and data rate settings.

3.6 EUT setup diagram

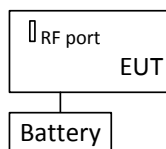


Figure 3.6-1: Setup diagram

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

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 $\pm 5\%$, for which the equipment was designed.

Section 6. Measurement uncertainty

6.1 Uncertainty of measurement

Nemko Canada Inc. has calculated measurement uncertainty and is documented in EMC/MUC/001 "Uncertainty in EMC measurements." Measurement uncertainty was calculated using the methods described in CISPR 16-4 Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: Uncertainty in EMC measurements; as well as described in UKAS LAB34: The expression of Uncertainty in EMC Testing. Measurement uncertainty calculations assume a coverage factor of $K=2$ with 95% certainty.

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	Mar. 18/15
Flush mount turntable	Sunol	FM2022	FA002082	—	NCR
Controller	Sunol	SC104V	FA002060	—	NCR
Antenna mast	Sunol	TLT2	FA002061	—	NCR
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 26	FA002043	1 year	Oct. 24/14
Bilog antenna (20–3000 MHz)	Sunol	JB3	FA002108	1 year	Mar. 12/15
Horn antenna (1–18 GHz)	EMCO	3115	FA000825	1 year	Mar. 10/15
Pre-amplifier (1–18 GHz)	JCA	JCA118-503	FA002091	1 year	June 23/15
Spectrum analyzer	Rohde & Schwarz	FSU	FA001877	1 year	Jan. 27/15
Temperature chamber	Thermotron	SM-16C	FA001030	1 year	NCR
Multimeter	Fluke	16	FA001831	1 year	Feb. 04/15

Note: NCR - no calibration required

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	October 22, 2014	Temperature	21 °C
Test engineer	Andrey Adelberg	Air pressure	1007 mbar
Verdict	Pass	Relative humidity	31 %

8.1.3 Observations, settings and special notes

Spectrum analyser settings:

Resolution bandwidth for 26 dB BW test	300 kHz for channels up to 40 MHz; 1 MHz for 80 MHz channel
Resolution bandwidth for 99% OBW test	300 kHz for 20 MHz channel; 500 kHz for 40 MHz channel; 1 MHz for 80 MHz channel
Video bandwidth	$\geq 3 \times \text{RBW}$
Frequency span for 26 dB BW test	30 MHz for 20 MHz channel; 60 MHz for 40 MHz channel; 100 MHz for 80 MHz channel
Frequency span for 99% OBW test	30 MHz for 20 MHz channel; 50 MHz for 40 MHz channel; 100 MHz for 80 MHz channel
Detector mode	Peak
Trace mode	Max Hold

8.1.4 Test data

Table 8.1-1: Emission bandwidth results for 802.11a

Frequency, MHz	Data rate	26 dB bandwidth, MHz	99 % Occupied bandwidth, MHz
5745	6 Mbps	21.88	17.31
5745	54 Mbps	21.35	16.78
5785	6 Mbps	21.88	17.26
5785	54 Mbps	21.30	16.83
5825	6 Mbps	21.92	17.31
5825	54 Mbps	21.35	16.78

Table 8.1-2: Emission bandwidth results for 802.11n HT20

Frequency, MHz	Data rate	26 dB bandwidth, MHz	99 % Occupied bandwidth, MHz
5745	MCS 0	22.12	18.32
5745	MCS 7	21.73	18.08
5785	MCS 0	22.16	18.37
5785	MCS 7	21.78	18.13
5825	MCS 0	22.26	18.37
5825	MCS 7	21.59	18.13

Table 8.1-3: Emission bandwidth results for 802.11n HT40

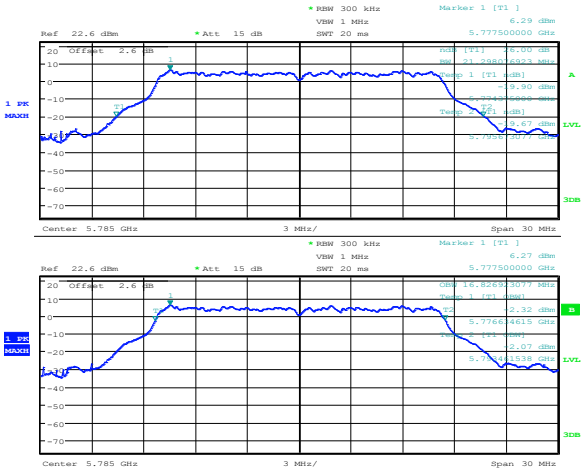
Frequency, MHz	Data rate	26 dB bandwidth, MHz	99 % Occupied bandwidth, MHz
5755	MCS 0	39.90	36.62
5755	MCS 7	39.52	36.46
5795	MCS 0	40.39	36.62
5795	MCS 7	39.42	36.54

Table 8.1-4: Emission bandwidth results for 802.11ac VHT40

Frequency, MHz	Data rate	26 dB bandwidth, MHz	99 % Occupied bandwidth, MHz
5755	MCS 0	40.10	36.62
5755	MCS 9	39.71	36.54
5795	MCS 0	40.19	36.70
5795	MCS 9	39.71	36.70

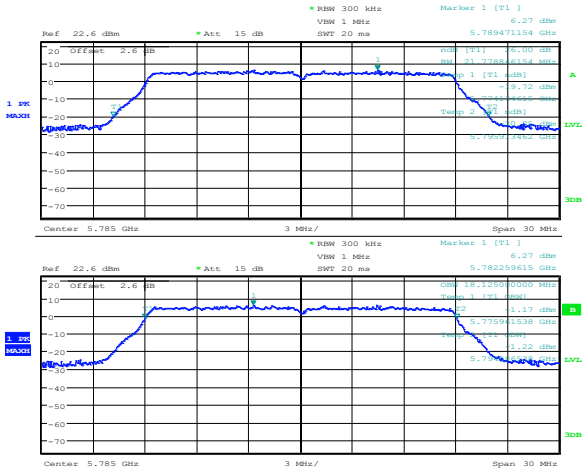
Table 8.1-5: Emission bandwidth results for 802.11ac VHT80

Frequency, MHz	Data rate	26 dB bandwidth, MHz	99 % Occupied bandwidth, MHz
5775	MCS 0	82.85	75.96
5775	MCS 9	82.21	75.96



Date: 22.OCT.2014 13:53:56

Figure 8.1-1: 26 dB and 99% occupied bandwidth on 802.11a, sample plot

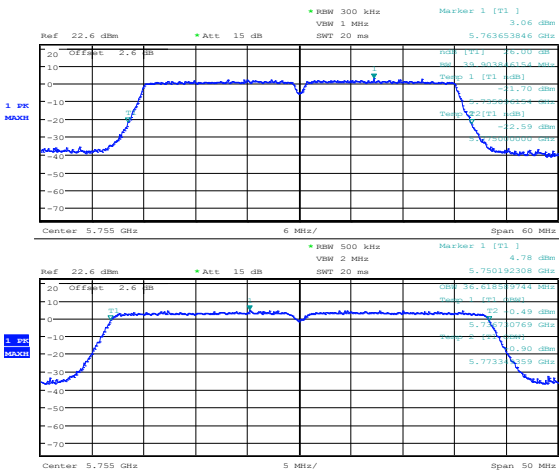


Date: 22.OCT.2014 13:59:37

Figure 8.1-2: 26 dB and 99% occupied bandwidth on 802.11n HT20, sample plot

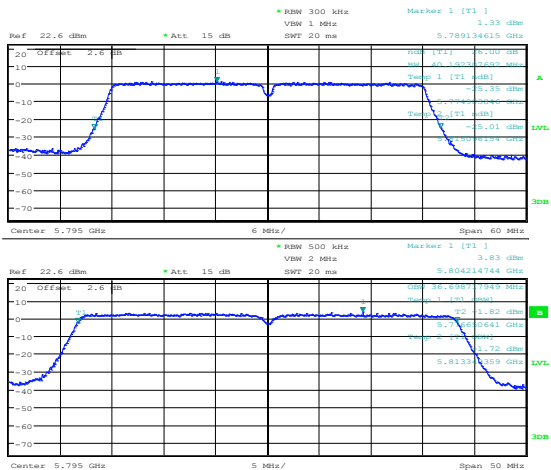
Section 8
Test name
Specification

Testing data
FCC 15.403(i) Emission bandwidth
FCC 15 Subpart E



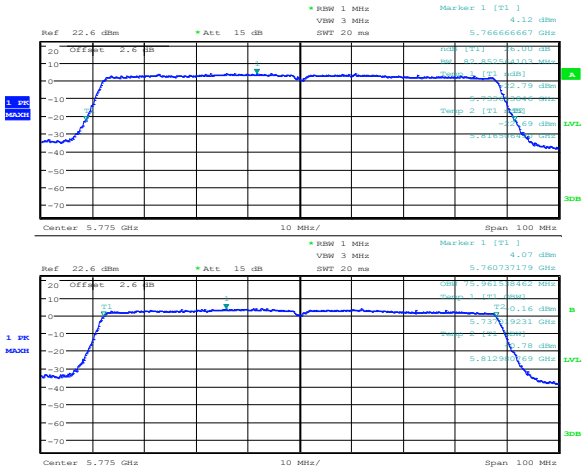
Date: 22.OCT.2014 14:18:48

Figure 8.1-3: 26 dB bandwidth and 99% occupied on 802.11n HT40, sample plot



Date: 22.OCT.2014 14:27:57

Figure 8.1-4: 26 dB bandwidth and 99% occupied on 802.11ac VHT40, sample plot



Date: 22.OCT.2014 14:33:38

Figure 8.1-5: 26 dB bandwidth and 99% occupied on 802.11ac VHT80, sample plot

8.2 FCC 15.407(e) Minimum 6 dB bandwidth

8.2.1 Definitions and limits

Within the 5.725–5.85 GHz band, the minimum 6 dB bandwidth of U-NII devices shall be at least 500 kHz.

8.2.2 Test summary

Test date	October 23, 2014	Temperature	22 °C
Test engineer	Andrey Adelberg	Air pressure	1004 mbar
Verdict	Pass	Relative humidity	30 %

8.2.3 Observations, settings and special notes

Spectrum analyser settings:

Resolution bandwidth	100 kHz
Video bandwidth	$\geq 3 \times \text{RBW}$
Detector mode	Peak
Trace mode	Max Hold

8.2.4 Test data

Table 8.2-1: 6 dB bandwidth results for 802.11a

Frequency, MHz	Data rate	6 dB bandwidth, MHz	Minimum limit, MHz	Margin, MHz
5745	6 Mbps	16.42	0.50	15.92
5745	54 Mbps	16.48	0.50	15.98
5785	6 Mbps	16.40	0.50	15.90
5785	54 Mbps	16.44	0.50	15.94
5825	6 Mbps	16.40	0.50	15.90
5825	54 Mbps	16.46	0.50	15.96

Table 8.2-2: 6 dB bandwidth results for 802.11n HT20

Frequency, MHz	Data rate	6 dB bandwidth, MHz	Minimum limit, MHz	Margin, MHz
5745	MCS 0	17.62	0.50	17.12
5745	MCS 7	17.74	0.50	17.24
5785	MCS 0	17.66	0.50	17.16
5785	MCS 7	17.76	0.50	17.26
5825	MCS 0	17.62	0.50	17.12
5825	MCS 7	17.74	0.50	17.24

Table 8.2-3: 6 dB bandwidth results for 802.11n HT40

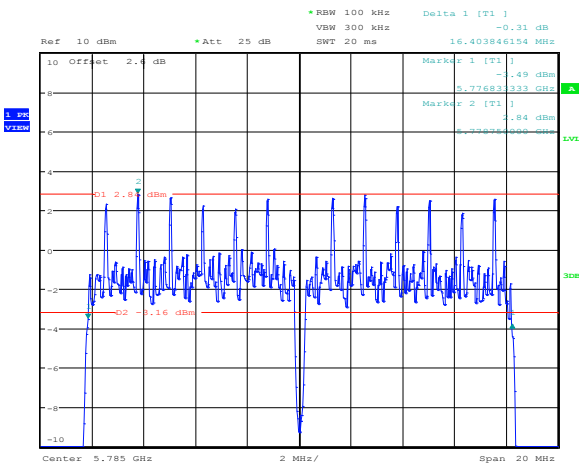
Frequency, MHz	Data rate	6 dB bandwidth, MHz	Minimum limit, MHz	Margin, MHz
5775	MCS 0	36.33	0.50	35.83
5775	MCS 7	36.59	0.50	36.09
5795	MCS 0	36.45	0.50	35.95
5795	MCS 7	36.51	0.50	36.01

Table 8.2-4: 6 dB bandwidth results for 802.11ac VHT40

Frequency, MHz	Data rate	6 dB bandwidth, MHz	Minimum limit, MHz	Margin, MHz
5775	MCS 0	36.47	0.50	35.97
5775	MCS 9	36.60	0.50	36.10
5795	MCS 0	36.45	0.50	35.95
5795	MCS 9	36.58	0.50	36.08

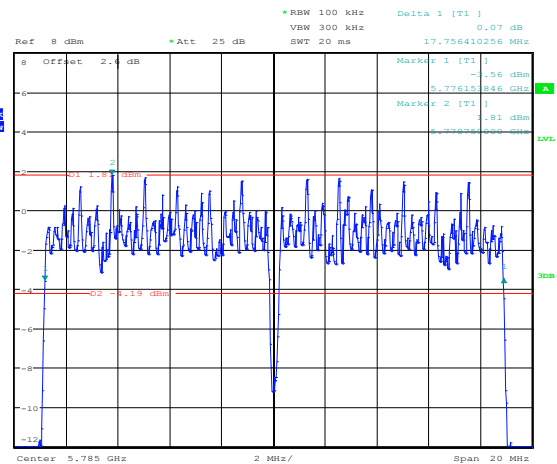
Table 8.2-5: 6 dB bandwidth results for 802.11ac VHT80

Frequency, MHz	Data rate	6 dB bandwidth, MHz	Minimum limit, MHz	Margin, MHz
5775	MCS 0	76.22	0.50	75.72
5775	MCS 9	76.47	0.50	75.97



Date: 23.OCT.2014 10:11:05

Figure 8.2-1: 6 dB bandwidth on 802.11a, sample plot

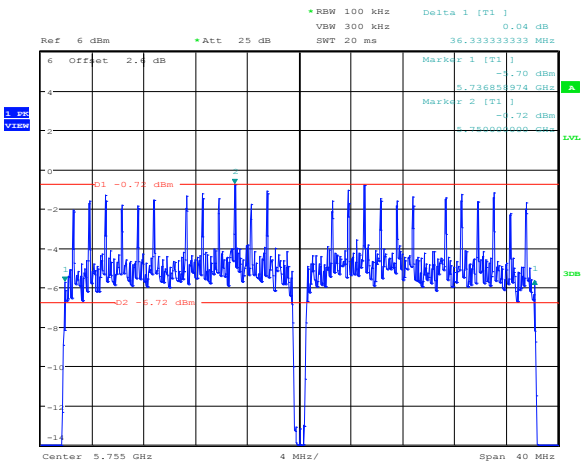


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Figure 8.2-2: 6 dB bandwidth on 802.11n HT20, sample plot

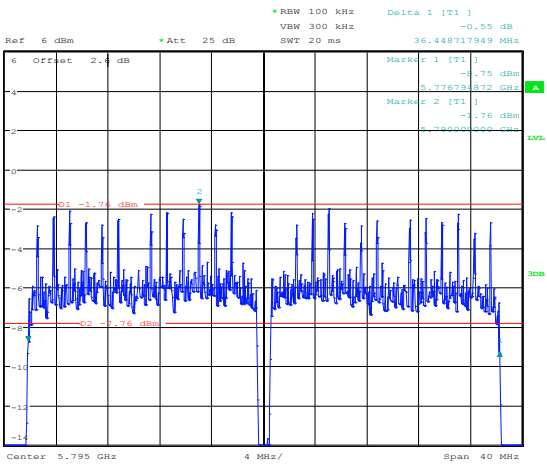
Section 8
Test name
Specification

Testing data
FCC 15.407(e) Minimum 6 dB bandwidth
FCC 15 Subpart E



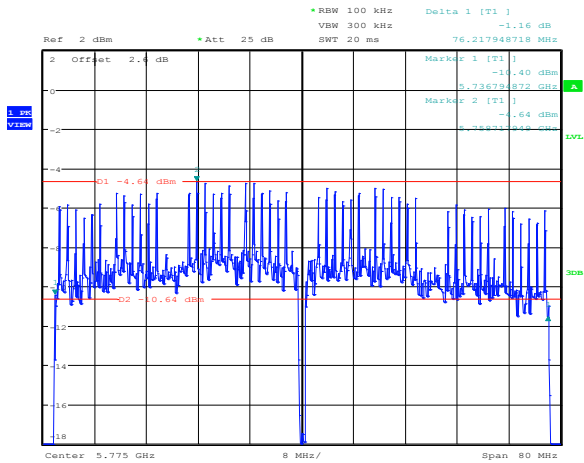
Date: 23.OCT.2014 10:29:09

Figure 8.2-3: 6 dB bandwidth on 802.11n HT40, sample plot



Date: 23.OCT.2014 10:39:58

Figure 8.2-4: 6 dB bandwidth on 802.11ac VHT40, sample plot



Date: 23.OCT.2014 10:45:54

Figure 8.2-5: 6 dB bandwidth on 802.11ac VHT80, sample plot

8.3 FCC 15.407(a)(3) 5.725–5.85 GHz band output power, EIRP and spectral density limits

8.3.1 Definitions and limits

(3) For the band 5.725–5.85 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 30 dBm in any 500-kHz 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. However, fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter conducted power. 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.

8.3.2 Test summary

Test date	October 22, 2014	Temperature	21 °C
Test engineer	Andrey Adelberg	Air pressure	1007 mbar
Verdict	Pass	Relative humidity	31 %

8.3.3 Observations, settings and special notes

The test was performed according to 789033 D02 General UNII Test Procedures New Rules v01 section E) 2) b) Method SA-1 (trace averaging with the EUT transmitting at full power throughout each sweep).

Spectrum analyser settings:

Resolution bandwidth	1 MHz
Video bandwidth	10 MHz
Frequency span	30 MHz for 20 MHz channel; 50 MHz for 40 MHz channel; 100 MHz for 80 MHz channel
Detector mode	RMS
Trace mode	Triggered power averaging over 100 sweeps with EBW integration for power measurement

8.3.4 Test data

Table 8.3-1: Output power measurements results for 802.11a

Frequency, MHz	Data rate	Output power level, dBm	Power limit, dBm	Margin, dB
5745	6 Mbps	13.89	30.00	16.11
5745	54 Mbps	14.01	30.00	15.99
5785	6 Mbps	13.96	30.00	16.04
5785	54 Mbps	14.13	30.00	15.87
5825	6 Mbps	13.64	30.00	16.36
5825	54 Mbps	13.67	30.00	16.33

Table 8.3-2: Output power measurements results for 802.11n HT20

Frequency, MHz	Data rate	Output power level, dBm	Power limit, dBm	Margin, dB
5745	MCS 0	12.93	30.00	17.07
5745	MCS 7	13.04	30.00	16.96
5785	MCS 0	12.80	30.00	17.20
5785	MCS 7	13.13	30.00	16.87
5825	MCS 0	12.48	30.00	17.52
5825	MCS 7	12.98	30.00	17.02

Table 8.3-3: FCC Output power measurements results for 802.11n HT40

Frequency, MHz	Data rate	Output power level, dBm	Power limit, dBm	Margin, dB
5755	MCS 0	13.37	30.00	16.63
5755	MCS 7	13.47	30.00	16.53
5795	MCS 0	13.18	30.00	16.82
5795	MCS 7	13.33	30.00	16.67

Table 8.3-4: Output power measurements results for 802.11ac VHT40

Frequency, MHz	Data rate	Output power level, dBm	Power limit, dBm	Margin, dB
5755	MCS 0	12.31	30.00	17.69
5755	MCS 9	12.57	30.00	17.43
5795	MCS 0	11.98	30.00	18.02
5795	MCS 9	12.28	30.00	17.72

Table 8.3-5: Output power measurements results for 802.11ac VHT80

Frequency, MHz	Data rate	Output power level, dBm	Power limit, dBm	Margin, dB
5775	MCS 0	11.68	30.00	18.32
5775	MCS 9	12.02	30.00	17.98

Table 8.3-6: Power spectral density measurements results for 802.11a

Frequency, MHz	Data rate	PSD level, dBm/MHz	PSD limit, dBm/500 kHz	Margin, dB
5745	6 Mbps	2.70	30.00	27.30
5745	54 Mbps	3.44	30.00	26.56
5785	6 Mbps	2.97	30.00	27.03
5785	54 Mbps	3.33	30.00	26.67
5825	6 Mbps	2.54	30.00	27.46
5825	54 Mbps	3.02	30.00	26.98

Table 8.3-7: Power spectral density measurements results for 802.11n HT20

Frequency, MHz	Data rate	PSD level, dBm/MHz	PSD limit, dBm/500 kHz	Margin, dB
5745	MCS 0	1.29	30.00	28.71
5745	MCS 7	1.46	30.00	28.54
5785	MCS 0	1.20	30.00	28.80
5785	MCS 7	1.62	30.00	28.38
5825	MCS 0	0.91	30.00	29.09
5825	MCS 7	1.38	30.00	28.62

Table 8.3-8: Power spectral density measurements results for 802.11n HT40

Frequency, MHz	Data rate	PSD level, dBm/MHz	PSD limit, dBm/500 kHz	Margin, dB
5755	MCS 0	-1.11	30.00	31.11
5755	MCS 7	-1.03	30.00	31.03
5795	MCS 0	-1.41	30.00	31.41
5795	MCS 7	-1.23	30.00	31.23

Table 8.3-9: Power spectral density measurements results for 802.11ac VHT40

Frequency, MHz	Data rate	PSD level, dBm/MHz	PSD limit, dBm/500 kHz	Margin, dB
5755	MCS 0	-2.21	30.00	32.21
5755	MCS 9	-1.87	30.00	31.87
5795	MCS 0	-2.61	30.00	32.61
5795	MCS 9	-2.26	30.00	32.26

Table 8.3-10: Power spectral density measurements results for 802.11ac VHT80

Frequency, MHz	Data rate	PSD level, dBm/MHz	PSD limit, dBm/500 kHz	Margin, dB
5775	MCS 0	-5.58	30.00	35.58
5775	MCS 9	-5.21	30.00	35.21

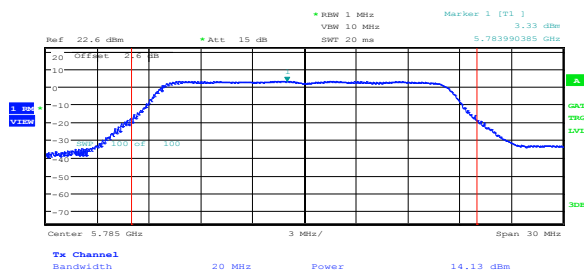


Figure 8.3-1: Sample plot for power and PSD on 802.11a

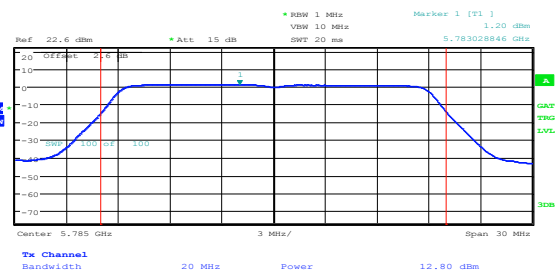


Figure 8.3-2: Sample plot for power and PSD on 802.11n HT20

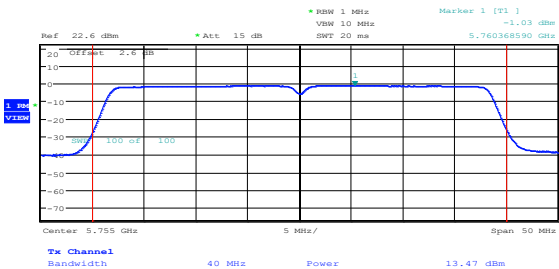


Figure 8.3-3: Sample plot for power and PSD on 802.11n HT40

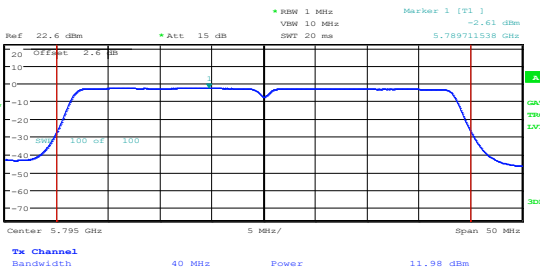


Figure 8.3-4: Sample plot for power and PSD on 802.11ac VHT40

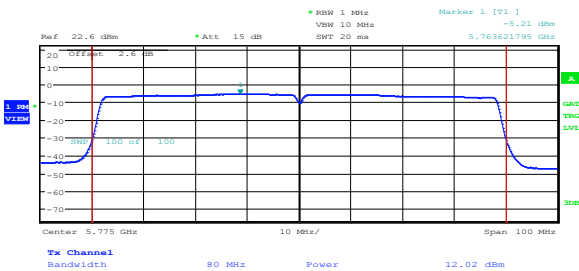


Figure 8.3-5: Sample plot for power and PSD on 802.11ac VHT80

Output power summary

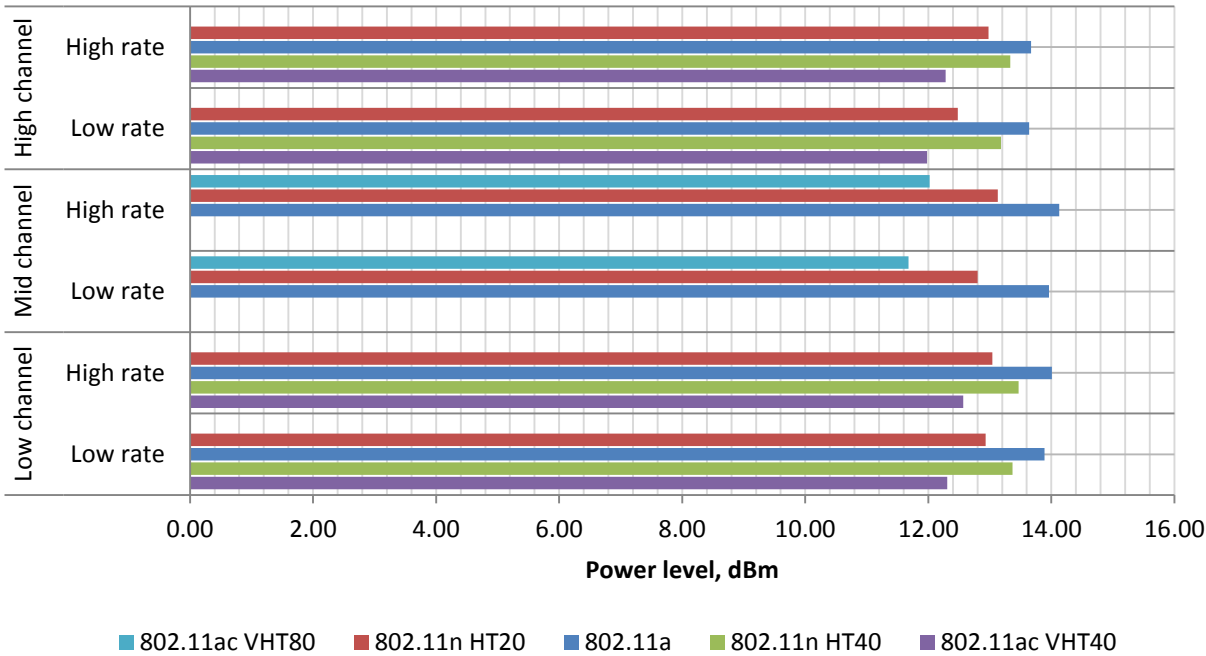


Figure 8.3-6: Output power summary

8.4 FCC 15.407(b) Spurious (out-of-band) emissions

8.4.1 Definitions and limits

- (4) For transmitters operating in the 5.725–5.85 GHz band: All emissions within the frequency range from the band edge to 10 MHz above or below the band edge shall not exceed an e.i.r.p. of –17 dBm/MHz; for frequencies 10 MHz or greater above or below the band edge, emissions shall not exceed an e.i.r.p. 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.

Table 8.4-1: FCC §15.209 – Radiated emission limits

Frequency, MHz	Field strength of emissions		Measurement distance, m
	µV/m	dBµV/m	
0.009–0.490	2400/F	$67.6 - 20 \times \log_{10}(F)$	300
0.490–1.705	24000/F	$87.6 - 20 \times \log_{10}(F)$	30
1.705–30.0	30	29.5	30
30–88	100	40.0	3
88–216	150	43.5	3
216–960	200	46.0	3
above 960	500	54.0	3

Notes: In the emission table above, the tighter limit applies at the band edges.

For frequencies above 1 GHz the limit on peak RF emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test

Table 8.4-2: FCC restricted frequency bands

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

8.4.2 Test summary

Test date	October 22, 2014	Temperature	21 °C
Test engineer	Andrey Adelberg	Air pressure	1007 mbar
Verdict	Pass	Relative humidity	31 %

8.4.3 Observations, settings and special notes

The spectrum was searched from 30 MHz to 40 GHz.
 Cabinet radiation measurements were performed at a distance of 3 m while antenna connector was terminated with 50 Ω load.

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: $54 \text{ dB}\mu\text{V/m} - 95.23 \text{ dB} - 1.94 \text{ dBi} - 4.7 \text{ dB} = -47.87 \text{ dBm}$

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: $54 \text{ dB}\mu\text{V/m} - 95.23 \text{ dB} - 1.94 \text{ dBi} = -43.17 \text{ dBm/MHz}$

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: $-43.17 \text{ dBm/MHz} + 20 \text{ dB} = -23.17 \text{ dBm/MHz}$

Spectrum analyser for peak conducted measurements outside restricted bands:

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

The limit was adjusted to include antenna directional gain of 1.94 dBi: $-27 \text{ dBm/MHz} - 1.94 \text{ dBi} = -28.94 \text{ dBm/MHz}$ and $-17 \text{ dBm/MHz} - 1.94 \text{ dBi} = -18.94 \text{ dBm/MHz}$

As per 789033 D02 General UNII Test Procedures New Rule sv01: If an out-of-band emission complies with both the peak and average limits of §15.209 it is not required to satisfy the -27 dBm/MHz or -17 dBm/MHz maximum emission limit.

All limit lines on the plots are lower by 0.53 dB than the ones calculated above, due to wrong initial antenna gain.

Every margin depicted on the plots is 0.53 dB higher.

8.4.4 Test data

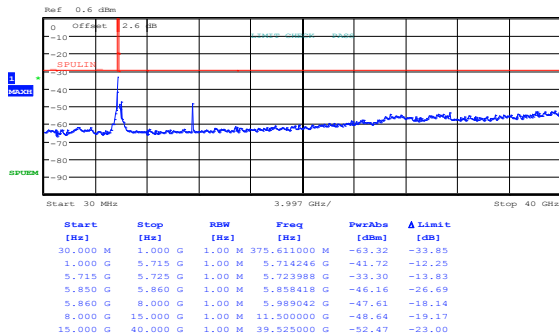


Figure 8.4-1: Spurious emissions outside restricted bands at low channel, 802.11a, 6 Mbps

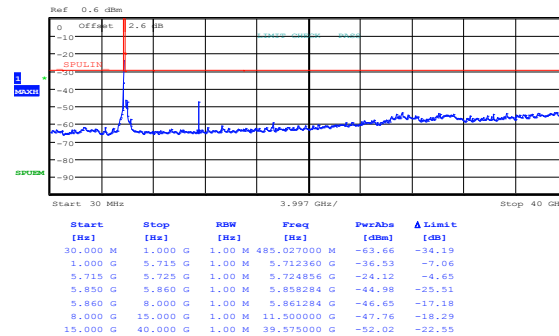


Figure 8.4-2: Spurious emissions outside restricted bands at low channel, 802.11a, 54 Mbps

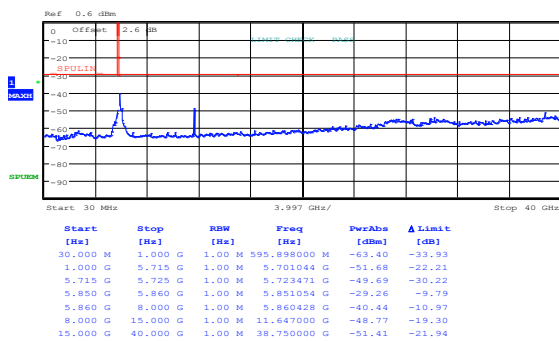


Figure 8.4-3: Spurious emissions outside restricted bands at high channel, 802.11a, 6 Mbps

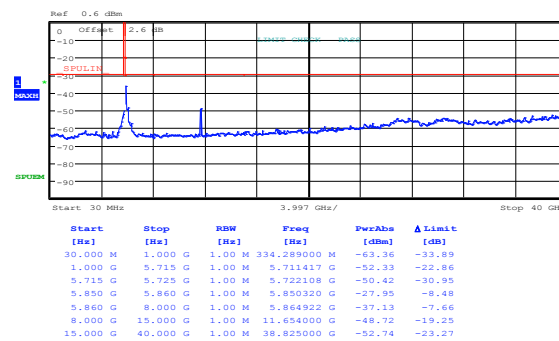


Figure 8.4-4: Spurious emissions outside restricted bands at high channel, 802.11a, 54 Mbps

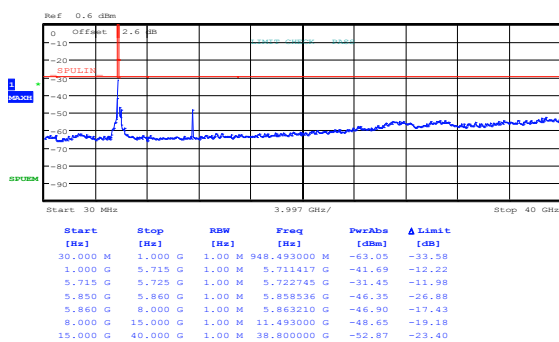


Figure 8.4-5: Spurious emissions outside restricted bands at low channel, 802.11n HT20, MCS 0

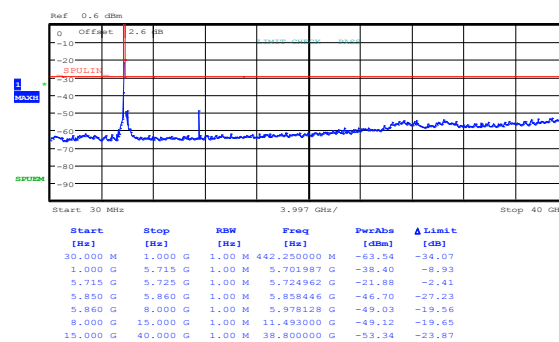


Figure 8.4-6: Spurious emissions outside restricted bands at low channel, 802.11n HT20, MCS 7

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FCC 15.407(b) Spurious (out-of-band) emissions
FCC Part 15 Subpart E

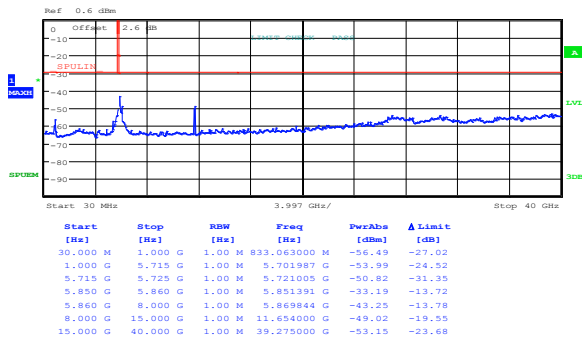


Figure 8.4-7: Spurious emissions outside restricted bands at high channel, 802.11n HT20, MCS 0

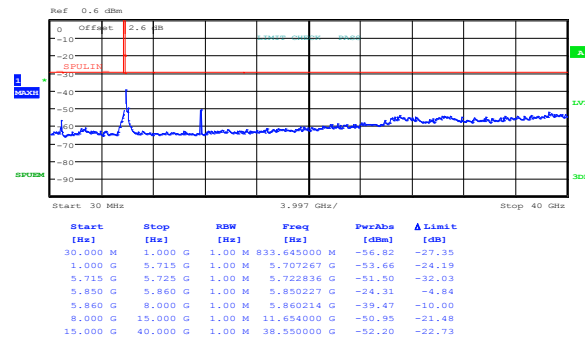


Figure 8.4-8: Spurious emissions outside restricted bands at high channel, 802.11n HT20, MCS 7

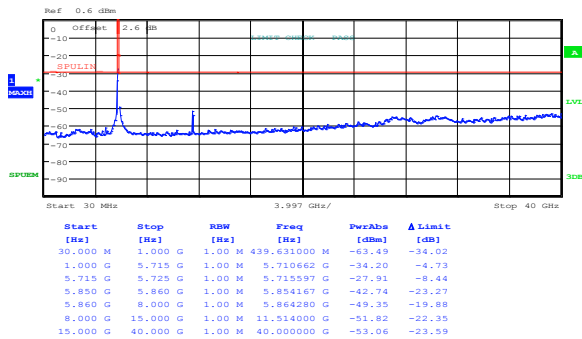


Figure 8.4-9: Spurious emissions outside restricted bands at low channel, 802.11n HT40, MCS 0

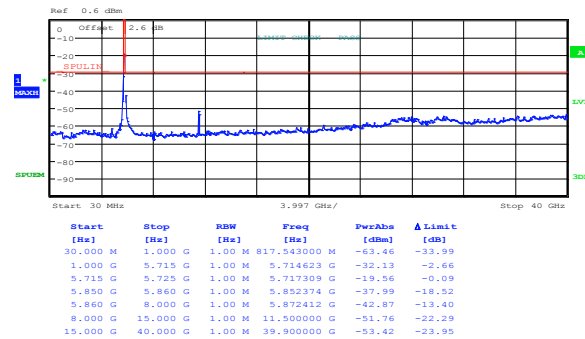


Figure 8.4-10: Spurious emissions outside restricted bands at low channel, 802.11n HT40, MCS 7

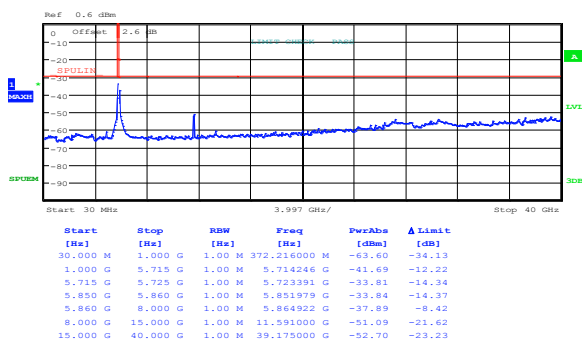


Figure 8.4-11: Spurious emissions outside restricted bands at high channel, 802.11n HT40, MCS 0

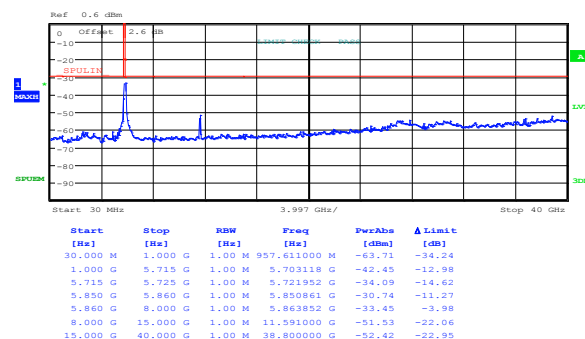


Figure 8.4-12: Spurious emissions outside restricted bands at high channel, 802.11n HT40, MCS 7

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Test name
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FCC 15.407(b) Spurious (out-of-band) emissions
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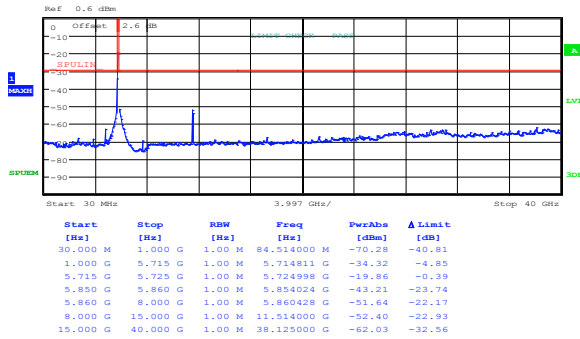


Figure 8.4-13: Spurious emissions outside restricted bands at low channel, 802.11ac VHT40, MCS 0

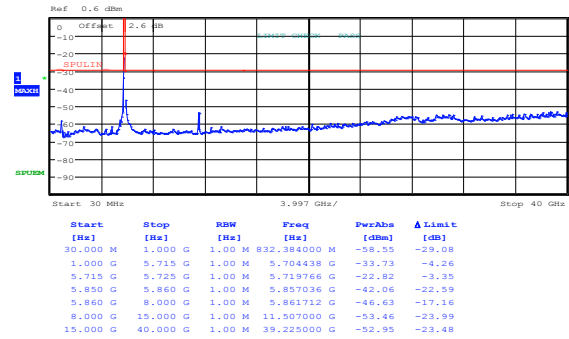


Figure 8.4-14: Spurious emissions outside restricted bands at low channel, 802.11ac VHT40, MCS 9

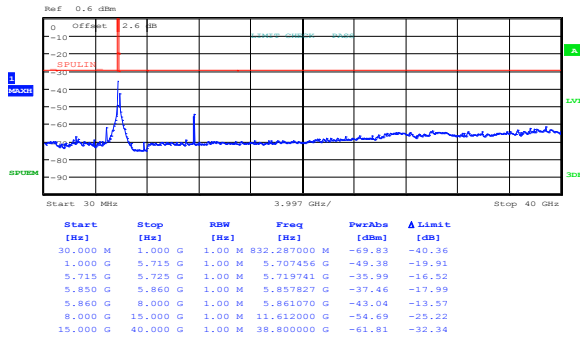


Figure 8.4-15: Spurious emissions outside restricted bands at high channel, 802.11ac VHT40, MCS 0

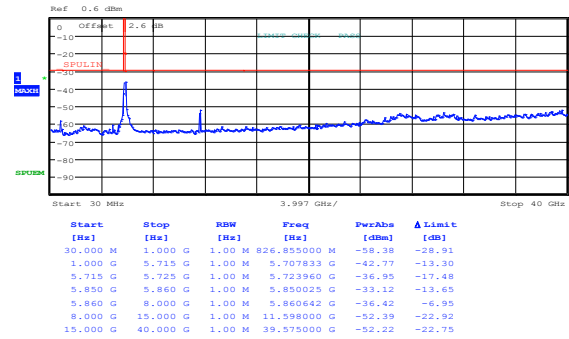


Figure 8.4-16: Spurious emissions outside restricted bands at high channel, 802.11ac VHT40, MCS 9

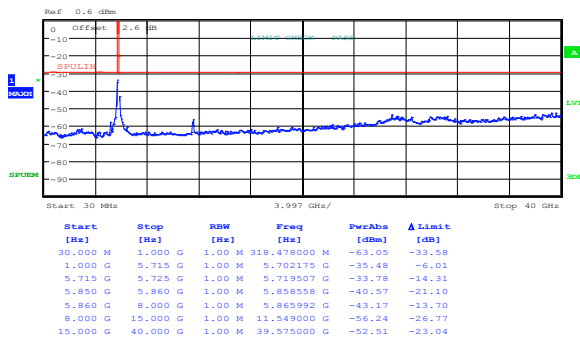


Figure 8.4-17: Spurious emissions outside restricted bands, 802.11ac VHT80, MCS 0

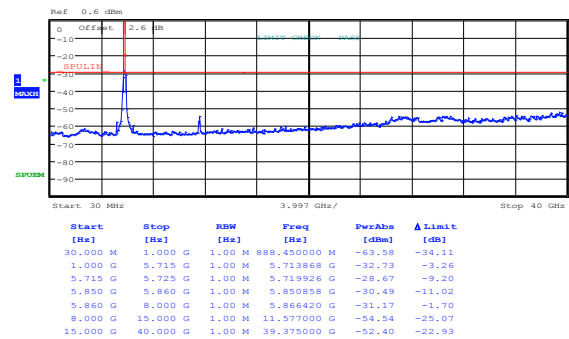


Figure 8.4-18: Spurious emissions outside restricted bands, 802.11ac VHT80, MCS 9

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FCC 15.407(b) Spurious (out-of-band) emissions
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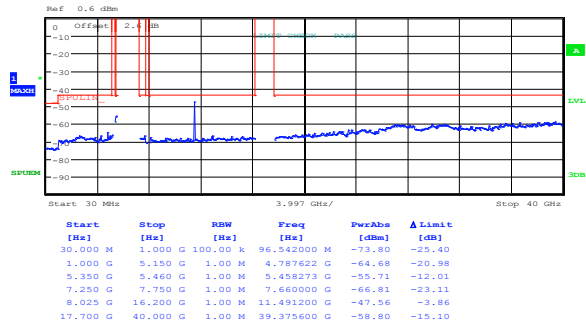


Figure 8.4-19: Spurious emissions within restricted bands at low channel, 802.11a, 6 Mbps

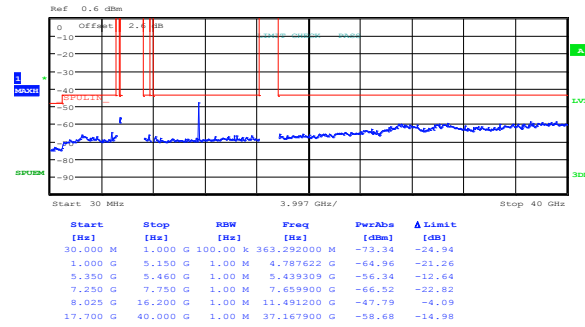


Figure 8.4-20: Spurious emissions within restricted bands at low channel, 802.11a, 54 Mbps

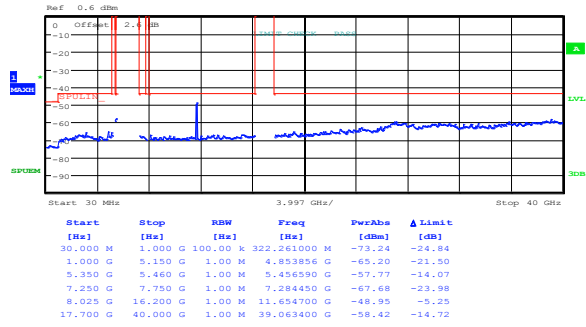


Figure 8.4-21: Spurious emissions within restricted bands at high channel, 802.11a, 6 Mbps

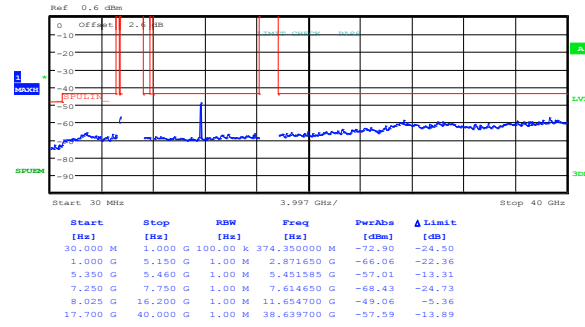


Figure 8.4-22: Spurious emissions within restricted bands at high channel, 802.11a, 54 Mbps

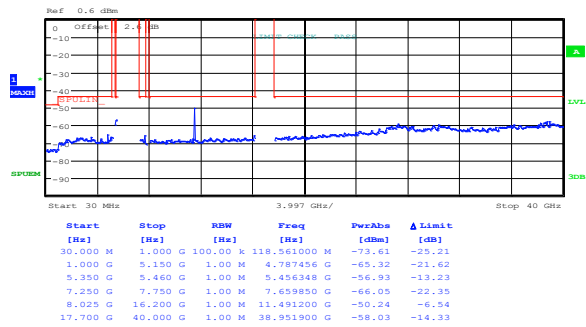


Figure 8.4-23: Spurious emissions within restricted bands at low channel, 802.11n HT20, MCS 0

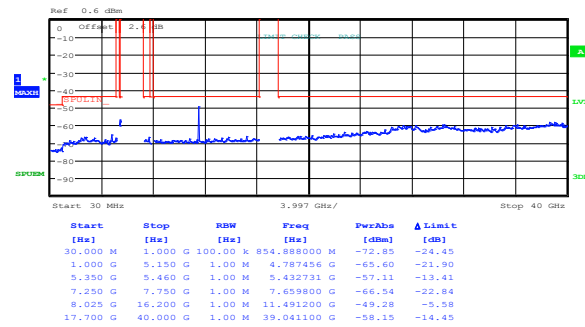


Figure 8.4-24: Spurious emissions within restricted bands at low channel, 802.11n HT20, MCS 7

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FCC 15.407(b) Spurious (out-of-band) emissions
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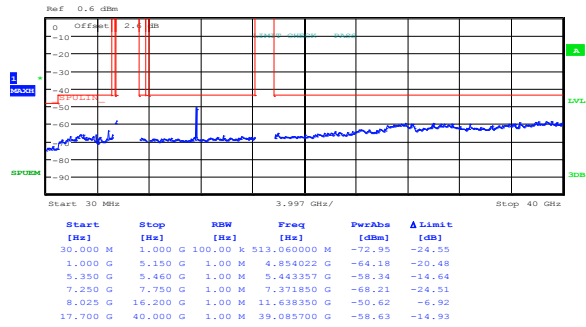


Figure 8.4-25: Spurious emissions within restricted bands at high channel, 802.11n HT20, MCS 0

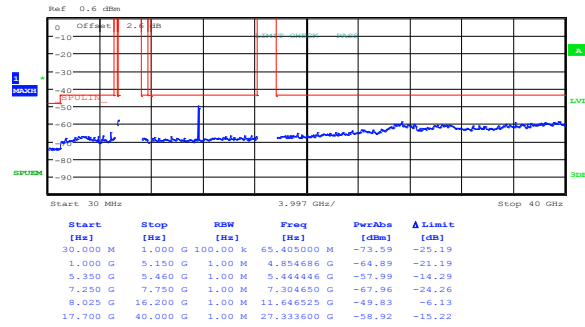


Figure 8.4-26: Spurious emissions within restricted bands at high channel, 802.11n HT20, MCS 7

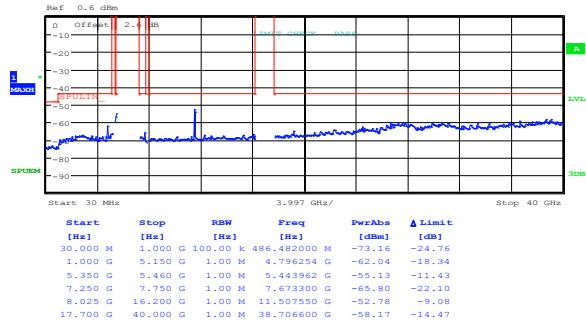


Figure 8.4-27: Spurious emissions within restricted bands at low channel, 802.11n HT40, MCS 0

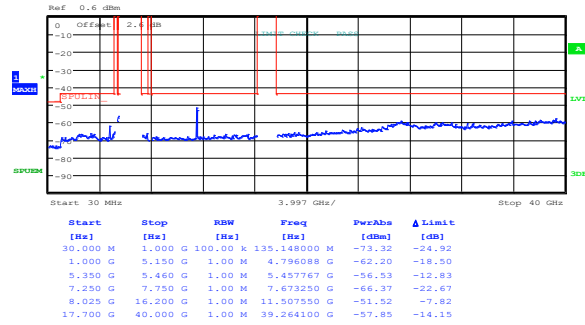


Figure 8.4-28: Spurious emissions within restricted bands at low channel, 802.11n HT40, MCS 7

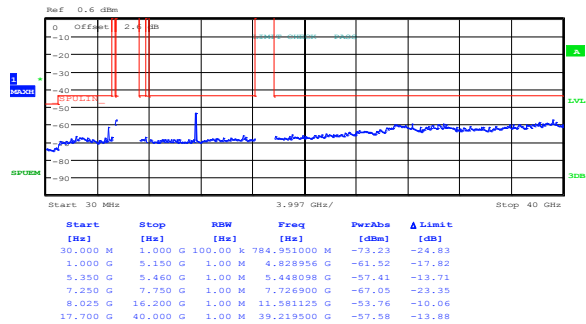


Figure 8.4-29: Spurious emissions within restricted bands at high channel, 802.11n HT40, MCS 0

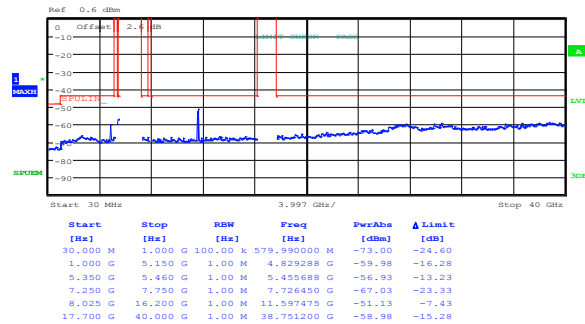


Figure 8.4-30: Spurious emissions within restricted bands at high channel, 802.11n HT40, MCS 7

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FCC 15.407(b) Spurious (out-of-band) emissions
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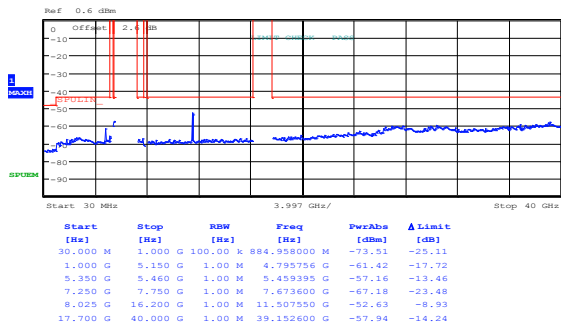


Figure 8.4-31: Spurious emissions within restricted bands at low channel, 802.11ac VHT40, MCS 0

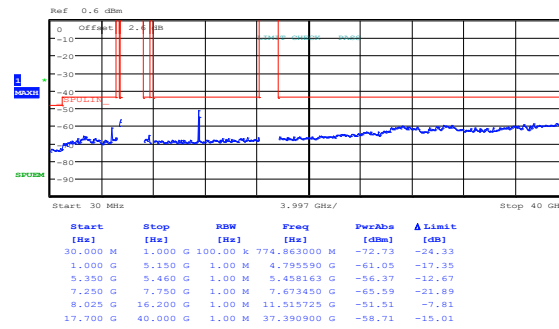


Figure 8.4-32: Spurious emissions within restricted bands at low channel, 802.11ac VHT40, MCS 9

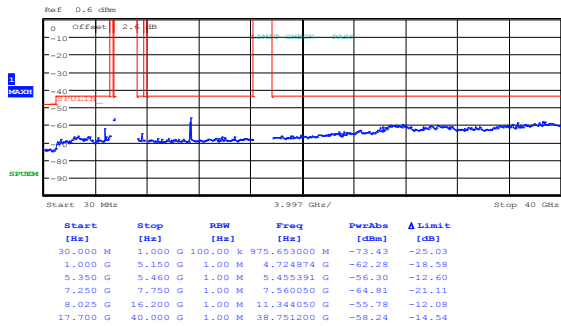


Figure 8.4-33: Spurious emissions within restricted bands at low channel, 802.11ac VHT40, MCS 0

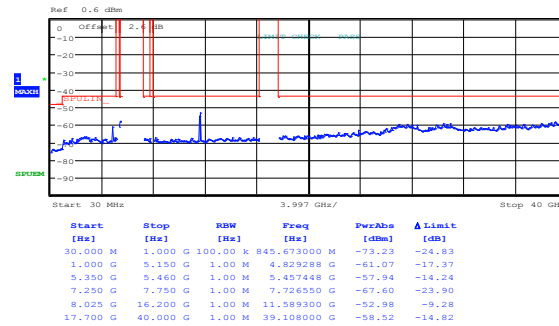


Figure 8.4-34: Spurious emissions within restricted bands at high channel, 802.11ac VHT40, MCS 9

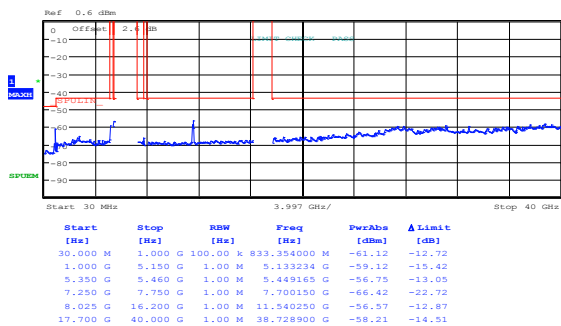


Figure 8.4-35: Spurious emissions within restricted bands, 802.11ac VHT80, MCS 0

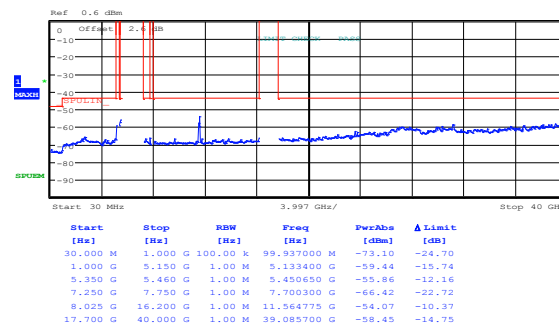
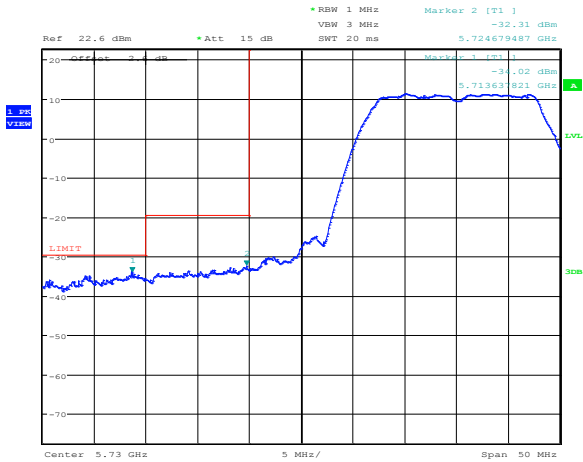


Figure 8.4-36: Spurious emissions within restricted bands, 802.11ac VHT80, MCS 9

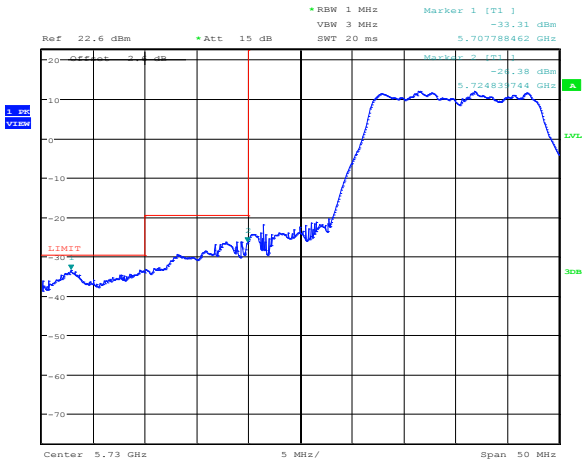
Section 8
Test name
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Testing data
FCC 15.407(b) Spurious (out-of-band) emissions
FCC Part 15 Subpart E



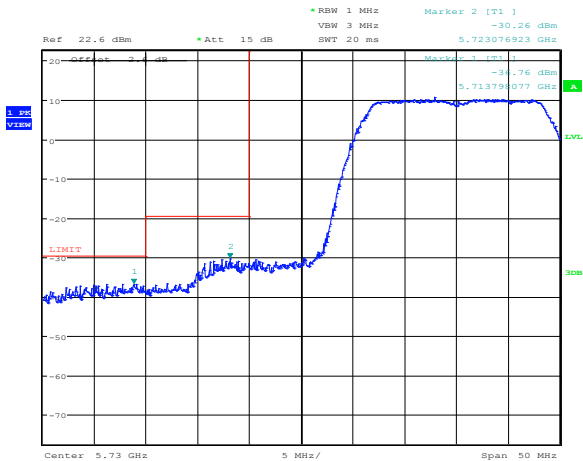
Date: 22.OCT.2014 15:02:38

Figure 8.4-37: Lower band edge emission for 802.11a with 6 Mbps



Date: 22.OCT.2014 15:03:21

Figure 8.4-38: Lower band edge emission for 802.11a with 54 Mbps



Date: 22.OCT.2014 15:04:42

Figure 8.4-39: Lower band edge emission for 802.11n HT20 with MCS 0

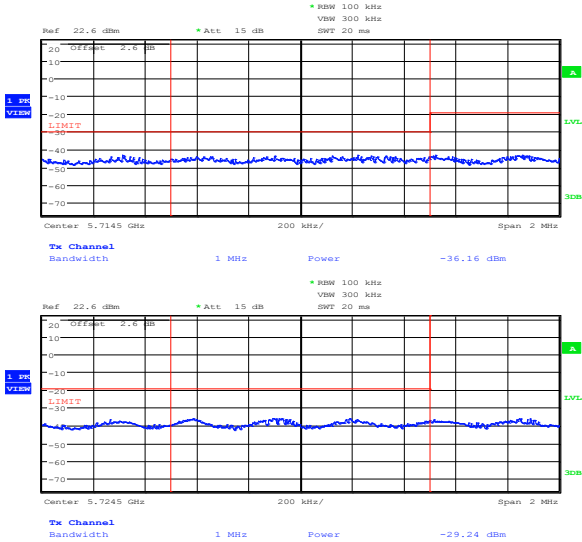


Figure 8.4-40: Lower band edges emissions for 802.11n HT20 with MCS 7

Section 8
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FCC 15.407(b) Spurious (out-of-band) emissions
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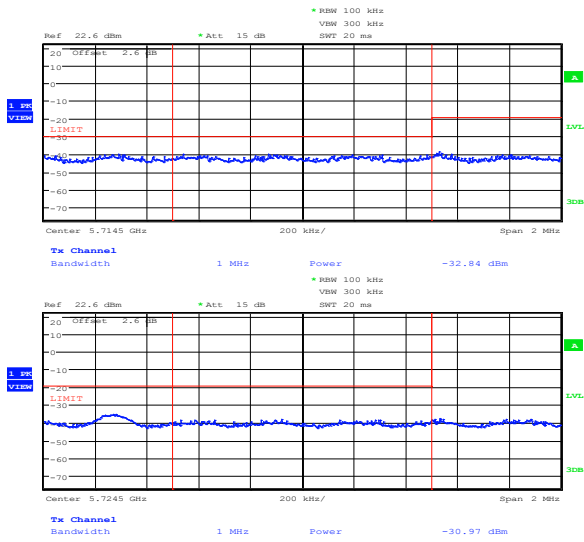


Figure 8.4-41: Lower band edges emissions for 802.11n HT40 with MCS 0

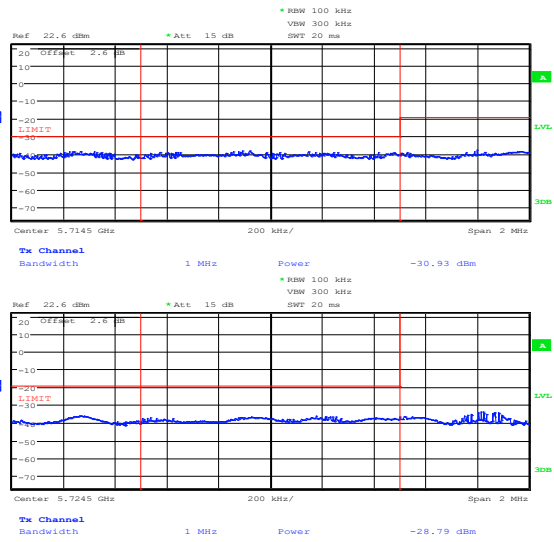


Figure 8.4-42: Lower band edge emission for 802.11n HT40 with MCS 7

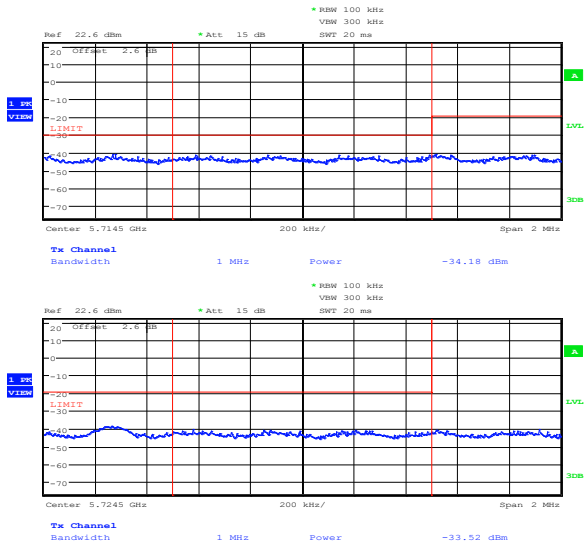


Figure 8.4-43: Lower band edge emission for 802.11ac VHT40 with MCS 0

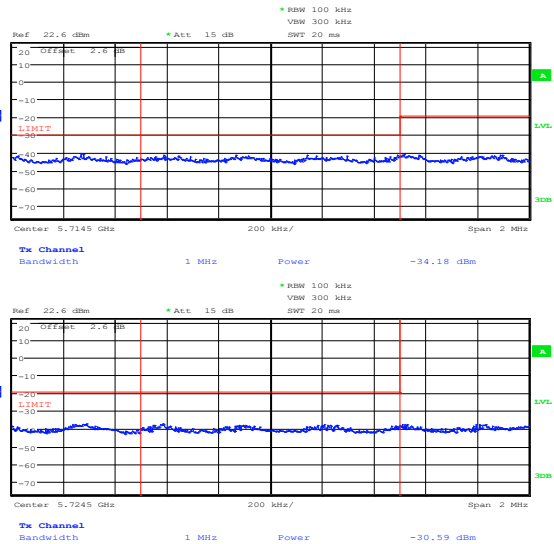
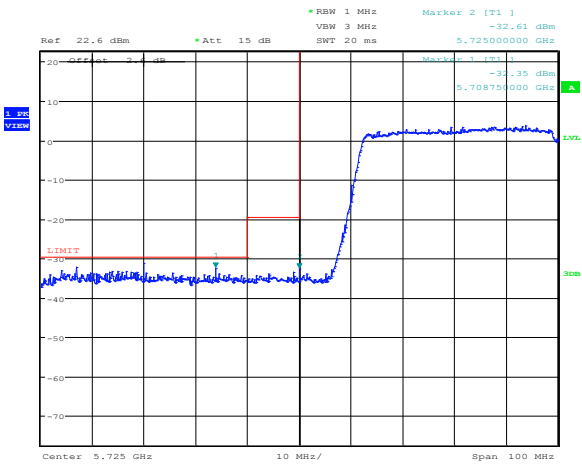


Figure 8.4-44: Lower band edge emission for 802.11ac VHT40 with MCS 9

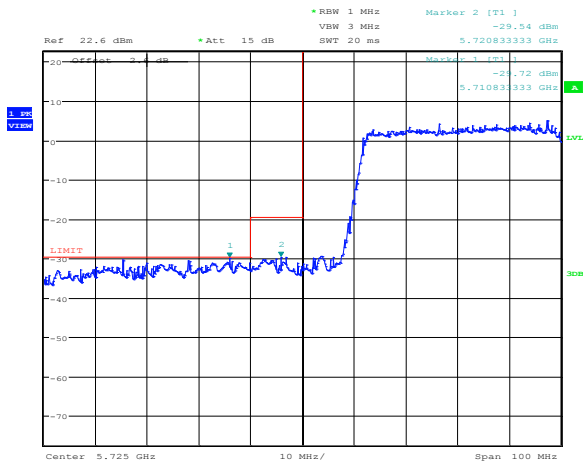
Section 8
Test name
Specification

Testing data
FCC 15.407(b) Spurious (out-of-band) emissions
FCC Part 15 Subpart E



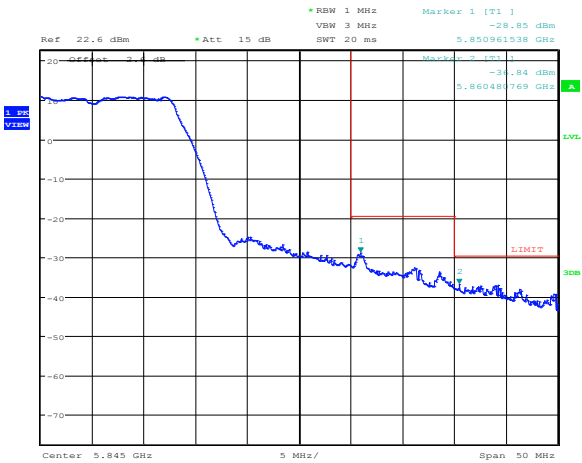
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Figure 8.4-45: Lower band edge emission for 802.11ac VHT80 with MCS 0



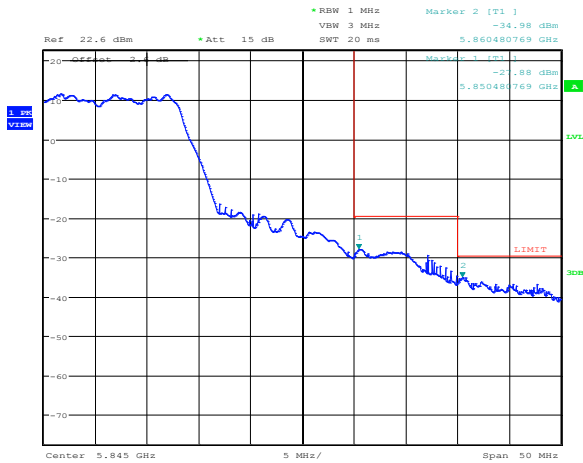
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Figure 8.4-46: Lower band edge emission for 802.11ac VHT80 with MCS 9



Date: 22.OCT.2014 14:59:58

Figure 8.4-47: Upper band edge emission for 802.11a with 6 Mbps

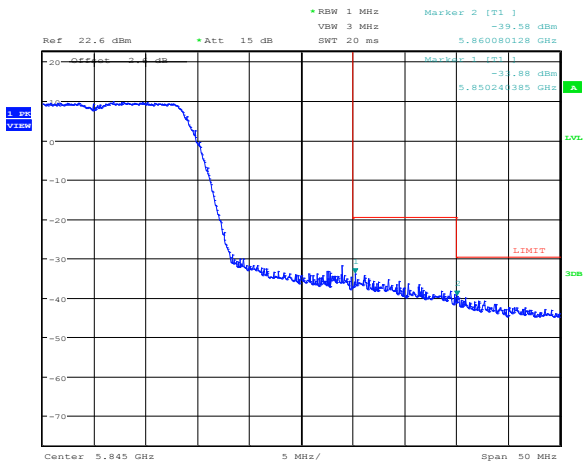


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Figure 8.4-48: Upper band edge emission for 802.11a with 54 Mbps

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FCC 15.407(b) Spurious (out-of-band) emissions
FCC Part 15 Subpart E



Date: 22.OCT.2014 15:10:34

Figure 8.4-49: Upper band edge emission for 802.11n HT20 with MCS 0

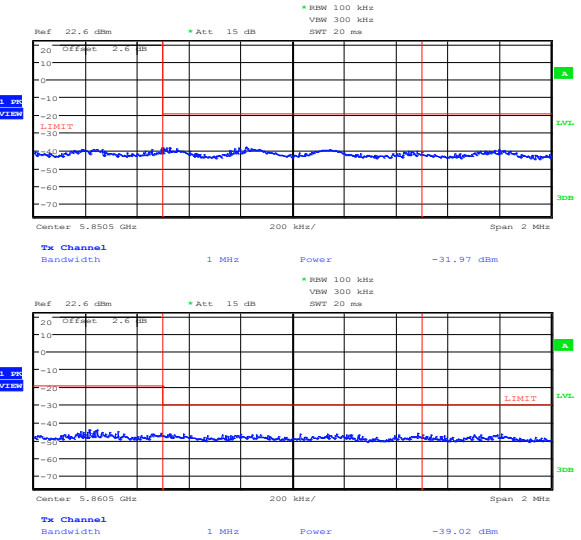
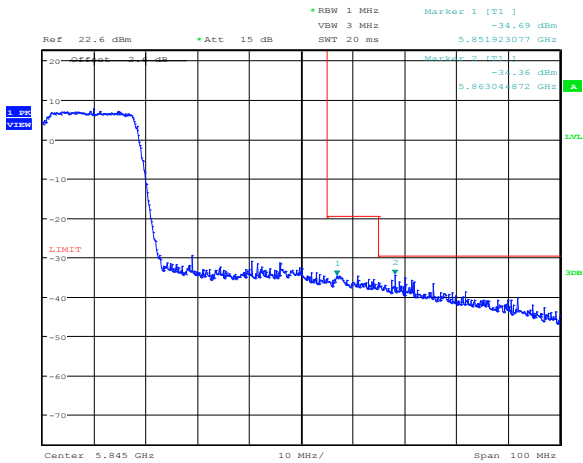
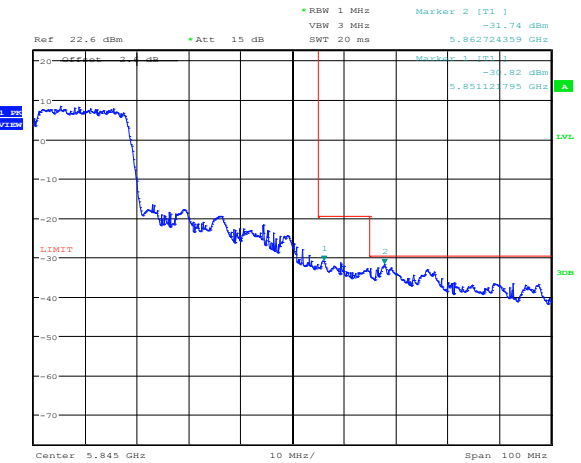


Figure 8.4-50: Upper band edge emission 802.11n HT20 with MCS 7



Date: 22.OCT.2014 15:13:17

Figure 8.4-51: Upper band edge emission for 802.11n HT40 with MCS 0

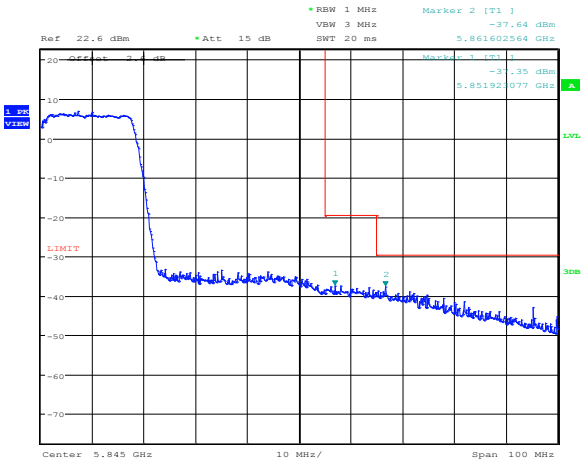


Date: 22.OCT.2014 15:14:01

Figure 8.4-52: Upper band edge emission 802.11n HT40 with MCS 9

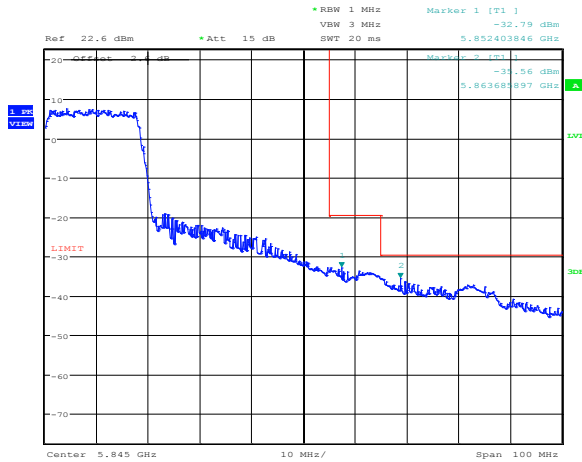
Section 8
Test name
Specification

Testing data
FCC 15.407(b) Spurious (out-of-band) emissions
FCC Part 15 Subpart E



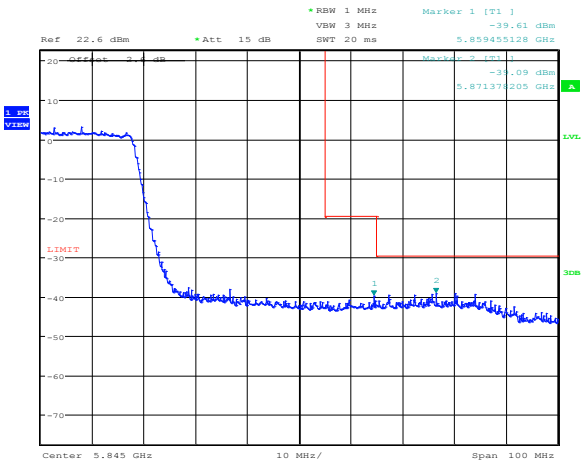
Date: 22.OCT.2014 15:21:58

Figure 8.4-53: Upper band edge emission for 802.11ac VHT40 with MCS 0



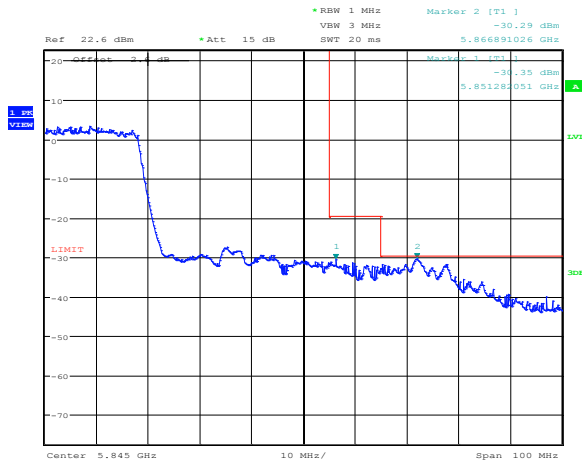
Date: 22.OCT.2014 15:22:43

Figure 8.4-54: Upper band edge emission for 802.11ac VHT40 with MCS 9



Date: 22.OCT.2014 15:29:59

Figure 8.4-55: Upper band edge emission for 802.11ac VHT80 with MCS 0



Date: 22.OCT.2014 15:29:09

Figure 8.4-56: Upper band edge emission for 802.11ac VHT80 with MCS 9

8.5 FCC 15.407(g) Frequency stability

8.5.1 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.

8.5.2 Test summary

Test date	October 22, 2014	Temperature	21 °C
Test engineer	Andrey Adelberg	Air pressure	1007 mbar
Verdict	Pass	Relative humidity	31 %

8.5.3 Observations, settings and special notes

As per manufacturer specification the temperature operational range is 5–30 °C. Spectrum analyser settings:

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

8.5.4 Test data

Table 8.5-1: Frequency drift measurement

Test conditions	Frequency, GHz	Drift, Hz
+30 °C, Nominal	5.7850801285	-9936
+20 °C, +15 %	5.7850900645	0
+20 °C, Nominal	5.7850900645	Reference
+20 °C, -15 %	5.7850900645	0
+10 °C, Nominal	5.7851201925	30128
+5 °C, Nominal	5.7851201925	30128

Table 8.5-2: Lower band edge drift calculation

Modulation	-26 dBc lower cross point, GHz	Max negative drift, Hz	Drifted lower cross point, GHz	Band edge, GHz	Margin, kHz
802.11a	5.725018463	9936	5.72500853	5.725	8.527
802.11n HT20	5.725020769	9936	5.72501083	5.725	10.833
802.11n HT40	5.725096154	9936	5.72508622	5.725	86.218
802.11ac VHT40	5.735000000	9936	5.73499006	5.725	9990.064
802.11ac VHT80	5.733053846	9936	5.73304391	5.725	8043.910

Notes: Drifted lower cross point = -26 dBc lower cross point – max negative drift.



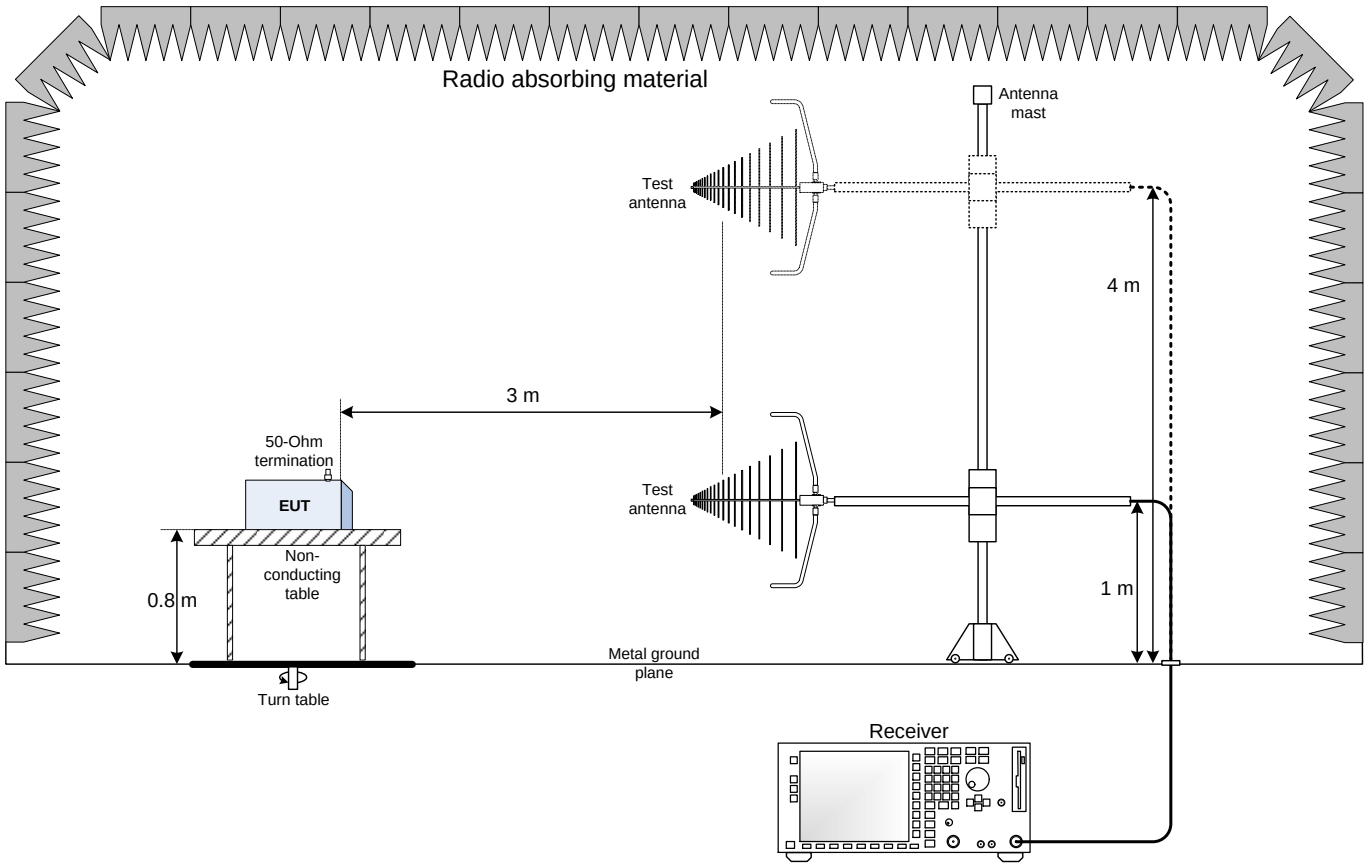
Table 8.5-3: Upper band edge drift calculation

Modulation	-26 dBc upper cross point, GHz	Max positive drift, Hz	Drifted upper cross point, GHz	Band edge, GHz	Margin, kHz
802.11a	5.835913462	30128	5.83594359	5.85	14056.410
802.11n HT20	5.836153846	30128	5.83618397	5.85	13816.026
802.11n HT40	5.815192308	30128	5.81522244	5.85	34777.564
802.11ac VHT40	5.815096154	30128	5.81512628	5.85	34873.718
802.11ac VHT80	5.816506410	30128	5.81653654	5.85	33463.462

Notes: Drifted upper cross point = -26 dBc upper cross point + max positive drift.

Section 9. Block diagrams of test set-ups

9.1 Radiated emissions set-up



9.2 Antenna terminal set-up

