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Appendices **–**

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249312B

Date of handing in: 31.10.2013

Tested by:



Timo Hietala, Test Specialist

Reviewed by:



Timo Leismala, Test Manager

SORT OF EQUIPMENT:

Vital signs monitor

MARKETING NAME:

VC150 Vital Signs Monitor

TYPE:

VC150

MANUFACTURER:

Innokas Medical

CLIENT:

Innokas Medical

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TEST LABORATORY:

Nemko Oy

FCC REG. NO.

359859 October 25, 2013

IC FILE NO.

2040F-1 November 22, 2012

SUMMARY:

In regard to the performed tests the equipment under test fulfils the requirements defined in the test specifications, see page 2 for details

The test results are valid for the tested unit only. Without a written permission of SGS Fimko EMC Oy it is allowed to copy this report as a whole, but not partially.

Summary of performed tests and test results

Test	Section in CFR 47		Result
1	15.207	AC power line conducted emissions	PASS , margin 3.5 dB
2	15.209 / 15.407 (b)	Electric Field Strength Spurious Emissions, 30MHz ~ 40000MHz	PASS , margin 3.3 dB
3	15.407 (a)	26dB Bandwidth	PASS
4	15.407 (a)	Maximum peak output power	PASS
5	15.407 (a)	Peak Power Spectral Density	PASS
6	15.407 (a)	Peak excursion	PASS
7	15.407 (b)	Band Edge compliance	PASS
8	15.407 (g)	Frequency Stability	PASS

Explanations:

PASS The EUT passed that particular test.
FAIL The EUT failed that particular test.

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1. EUT and Accessory Information

1.1 EUT description

The EUT is VC150 Vital Signs Monitor with WLAN.

Operating frequencies and channels:

	Channel	Frequency [MHz]
802.11a, 6Mbit/s, 9 Mbit/s, 12 Mbit/s 18Mbit/s, 24 Mbit/s 36Mbit/s, 48Mbit/s 54 Mbit/s	36	5180
	40	5200
	48	5240
	52	5260
	56	5280
	64	5320
	100	5500
	116	5580
	136	5680
	140	5700
802.11n, 20MHz BW MCS0, MCS1, MCS2, MCS3, MCS4, MCS5, MCS6, MCS7	36	5180
	40	5200
	48	5240
	52	5260
	56	5280
	64	5320
	100	5500
	116	5580
	136	5680
	140	5700

Power supply: 11.1V DC, (power supply rated 100-240 VAC, 1.1A, 50-60 Hz, output 24VDC 2.0A).

Antenna: PCB, gain <2dBi.

Preliminary tests were performed in different data rates and modulation methods to find the worst case emissions. Following test modes were selected for final tests:

Mode 802.11a: 6Mbps

Mode 802.11n: MCS0, 7.2Mbps

1.2 EUT and accessories

<i>unit</i>	<i>type</i>	<i>S/N</i>
Monitor (EUT1, radiated tests)	VC150, application version v13.6, MSP sw 0.34	SK513340005YP
Monitor (EUT2, conducted tests)	VC150, application version v13.6, MSP sw 0.34	SK513340001YP
AC power unit	XP Power, AFM45US24	1315-00971
Infrared Thermometer (USB)	Exergen TAT-50005-USB-GE	-
SpO₂	TS-F4-GE	-
Bar code reader (USB)	JDK-2083	130301-003
Temperature probe	Welch Allyn, PN 02692-100	-

Cables:

From	To	Type	Length [m]
AC mains	AC power unit	unshielded	2.0
AC power unit	EUT	unshielded	2.0
SpO₂	EUT	shielded	4.2
Infrared Thermometer	EUT	shielded, (USB)	2.7
Bar code reader	EUT	shielded, (USB)	1.3
Temperature probe	EUT	shielded	3.0

Operating voltage during the tests: 11.1 VDC (115VAC, 60 Hz).

2. Standards and measurement methods

The tests were performed in guidance of the CFR 47 Part 15, Subpart E, ANSI C63.4 (2009), ANSI C63.10 (2009), KDB 789033 D01 General UNII Test Procedures v01r03 and CISPR 22 Ed. 6.

2.1 AC power line conducted emissions

The test was performed as a compliance test. The test parameters concerned were as follows:

<i>Site name</i>	SGS Fimko EMC Oy/ Perkkaa
<i>Date of testing</i>	6.11.2013
<i>Test equipment</i>	694, 745, 348
<i>Test conditions</i>	23 °C, 35 % RH
<i>Test result</i>	PASS

2.1.1 Test method and limit

The test was performed inside a shielded room where the floor and one of the walls of the test site comprised the reference ground plane (RGP). For the duration of the test the EUT was placed on a non-conductive table 0.8 m high standing on the reference ground plane. The power input cable of the EUT was connected to an artificial mains network. The test was performed separately on the phase and also on the neutral wire.

The disturbances were first examined by performing a spectrum scan by using a peak detector. The general procedure in the conducted disturbance emission test is that no further measurements are necessary if the disturbance levels measured by using the peak detector are below the limit value defined for the measurement performed by using an average detector.

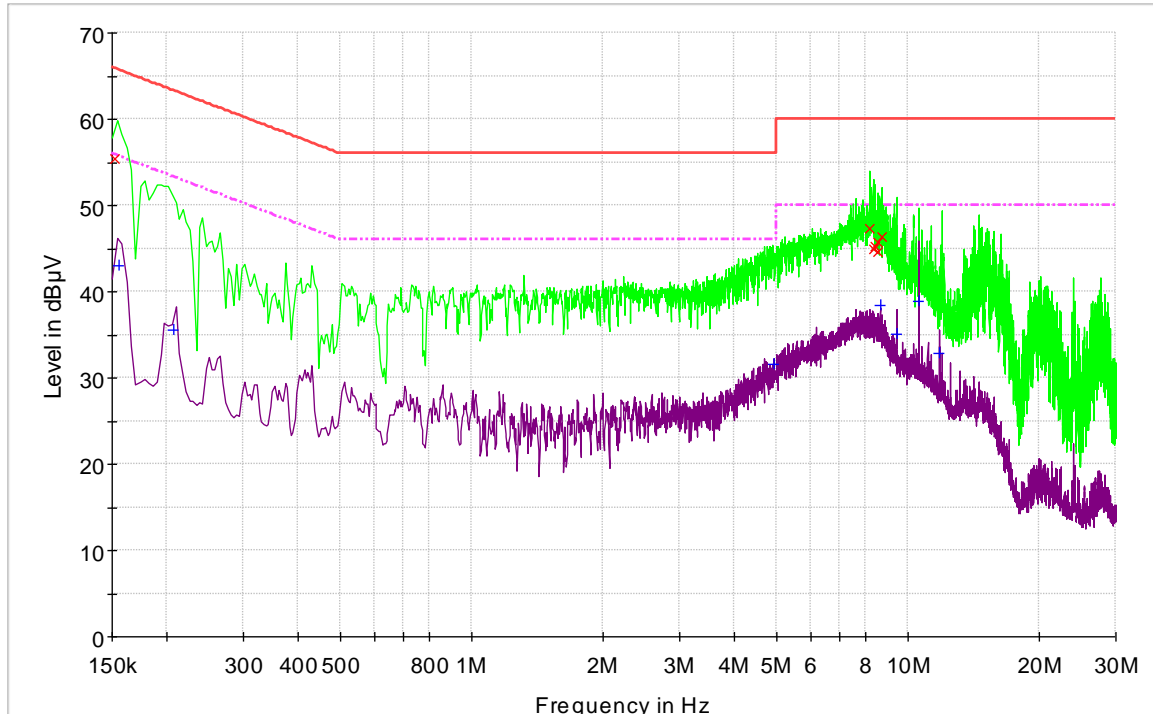
If not, then at the test frequencies concerned the measurement is performed also by using a quasi-peak detector. If the disturbance levels measured by using the quasi-peak detector are below the limit value defined for the measurement performed by using an average detector, then measurements by using the average detector are not necessary.

<i>Frequency band MHz</i>	<i>Quasi-peak limit dB(μV)</i>	<i>Average limit dB(μV)</i>
0.15 – 0.5	66 – 56	56 – 46
0.5 – 5	56	46
5 - 30	60	50

2.1.2 Test results

802.11a, 6Mbit/s

line N, $U_{in} = 115V/60Hz$



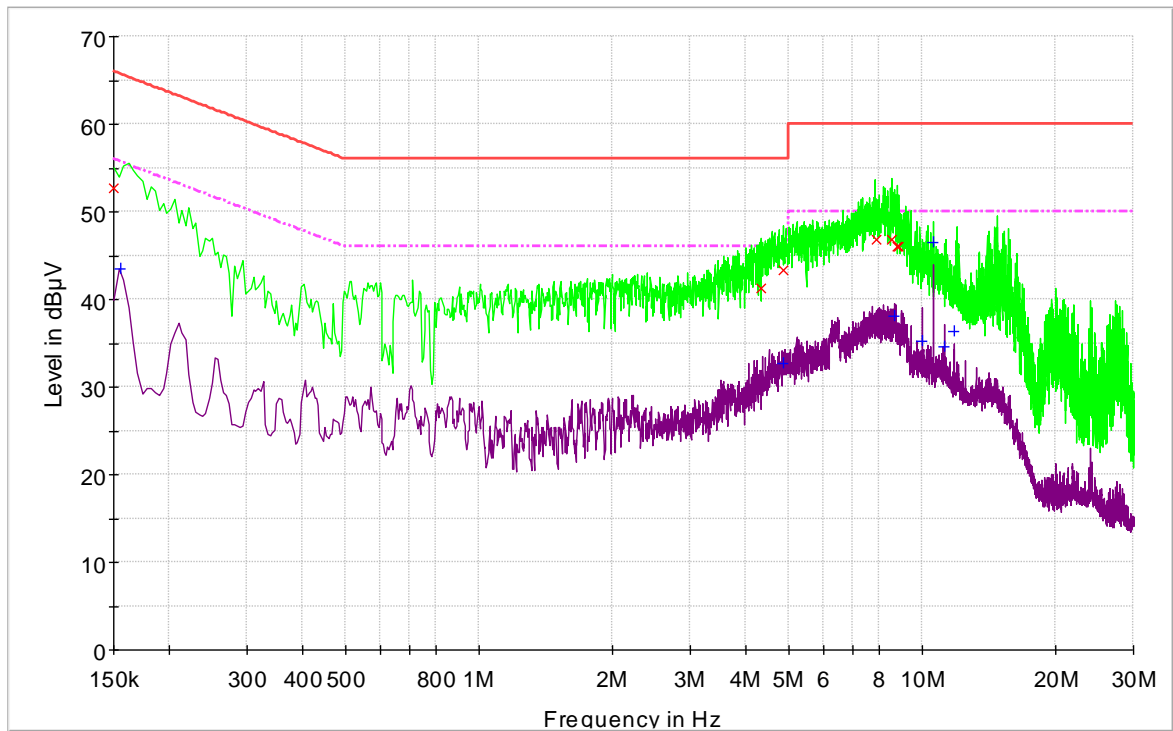
Measurement results (QP):

Frequency MHz	Level dBμV	Limit dBμV	Margin dB	Line	Conclusion Pass/Fail
0.152	55.4	65.9	10.5	N	Pass
8.189	47.3	60.0	12.7	N	Pass
8.347	45.0	60.0	15.0	N	Pass
8.408	45.2	60.0	14.8	N	Pass
8.522	45.7	60.0	14.3	N	Pass
8.550	44.6	60.0	15.4	N	Pass
8.749	46.4	60.0	13.6	N	Pass

Measurement results (Average):

Frequency MHz	Level dBμV	Limit dBμV	Margin dB	Line	Conclusion Pass/Fail
0.156	43.0	55.7	12.7	N	Pass
0.208	35.5	53.3	17.8	N	Pass
4.920	31.6	46.0	14.4	N	Pass
8.643	38.4	50.0	11.6	N	Pass
9.439	35.1	50.0	14.9	N	Pass
10.618	38.9	50.0	11.1	N	Pass
11.795	32.9	50.0	17.1	N	Pass

line L, $U_{in} = 115V/60Hz$



Measurement results (QP):

Frequency MHz	Level dB μ V	Limit dB μ V	Margin dB	Line	Conclusion Pass/Fail
0.150	52.7	66.0	13.3	L	Pass
4.345	41.3	56.0	14.7	L	Pass
4.879	43.4	56.0	12.6	L	Pass
7.873	46.8	60.0	13.2	L	Pass
8.524	46.8	60.0	13.2	L	Pass
8.776	46.1	60.0	13.9	L	Pass
8.855	46.0	60.0	14.0	L	Pass

Measurement results (Average):

Frequency MHz	Level dB μ V	Limit dB μ V	Margin dB	Line	Conclusion Pass/Fail
0.156	43.5	55.7	12.1	L	Pass
4.876	32.7	46.0	13.3	L	Pass
8.649	38.1	50.0	11.9	L	Pass
10.029	35.3	50.0	14.7	L	Pass
10.617	46.5	50.0	3.5	L	Pass
11.212	34.6	50.0	15.4	L	Pass
11.796	36.3	50.0	13.7	L	Pass

3. Test results

3.1 Radiated emissions

Site name	SGS Fimko EMC Oy/ Perkkää
Date of testing	4.11.2013
Test equipment	350, 709, 544, 319, 567, 564, 525, 542, 88, 521, 710
Test conditions	23 °C, 35 % RH
Test result	PASS

3.1.1 Test method and limit

The test 30-1000 MHz was performed in a semi-anechoic shielded room. The EUT was placed on a non-conductive table 0.8 m high standing on the turntable. During the test in the frequency range 30-1000 MHz the distance from the EUT to the measuring antenna was 3 m (with conducting ground plane). The excess length of the cables of the EUT was made into bundles 30-40 cm in length. In order to find the maximum levels of the disturbance radiation the angle of the turntable, the height of the measuring antenna and the lay-out of the EUT cables were varied during the tests. The test was performed with the measuring antenna being both in horizontal and vertical polarizations.

In the frequency range 1000-40000 MHz the test was performed in the absorber lined fully-anechoic room. During the test in the frequency range 1000-18000 MHz the distance from the EUT to the measuring antenna was 3 m and in the frequency range 18000-40000 MHz the distance from the EUT to the measuring antenna was 1 m. The test was performed with the measuring antenna being both in horizontal and vertical polarizations.

The CFR 47 Part 15, Section 15.209(a) limit of 500 µV/m has been calculated to correspond 54 dB(µV/m) as follows: $[dB(\mu V/m)] = 20 \log[\mu V/m]$.

Frequency band MHz	Quasi-peak limit dB(µV/m)
30 - 88	40
88 - 216	43.5
216 - 960	46
960 - 1000	54

The CFR 47 Part 15, Section 15.209(a) limit values for radiated emissions which fall in the restricted bands (3m measuring distance)

Frequency band MHz	Average limit dB(µV/m)	Peak limit dB(µV/m)
1000 - 40000	54	74

The CFR 47 Part 15, Section 15.407 limit values for radiated emissions of UNWANTED EMISSION OUT OF THE RESTRICTED BANDS (3m measuring distance, calculated from -27 dBm limit ¹⁾)

Frequency band MHz	Average limit dB(µV/m)	Peak limit dB(µV/m)
1000 - 40000	-	68.2

$$^1) E = \frac{1000000 \sqrt{30P}}{d}, \text{ where } E = \mu V/m, P = W[EIRP], d = m[\text{distance}]$$

As specified in 15.407(b), emissions above 1000 MHz that are outside of the restricted bands are subject to a peak emission limit of -27 dBm/MHz (or -17 dBm/MHz as specified in 15.407(b)(4)). However, an out-of-band emission that complies with both the average and peak limits of 15.209 is not required to satisfy the -27 dBm/MHz or -17 dBm/MHz peak emission limit.

15.205 Restricted Bands			
MHz	MHz	MHz	GHz
0.09-0.110	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
6.125-6.218	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			

3.1.2 Test results

The measurement results were obtained as described below.

$$E \text{ [dB}\mu\text{V/m]} = U_{RX} + A_{CABLE} + AF - G_{PREAMP}$$

Where

U_{RX} receiver reading

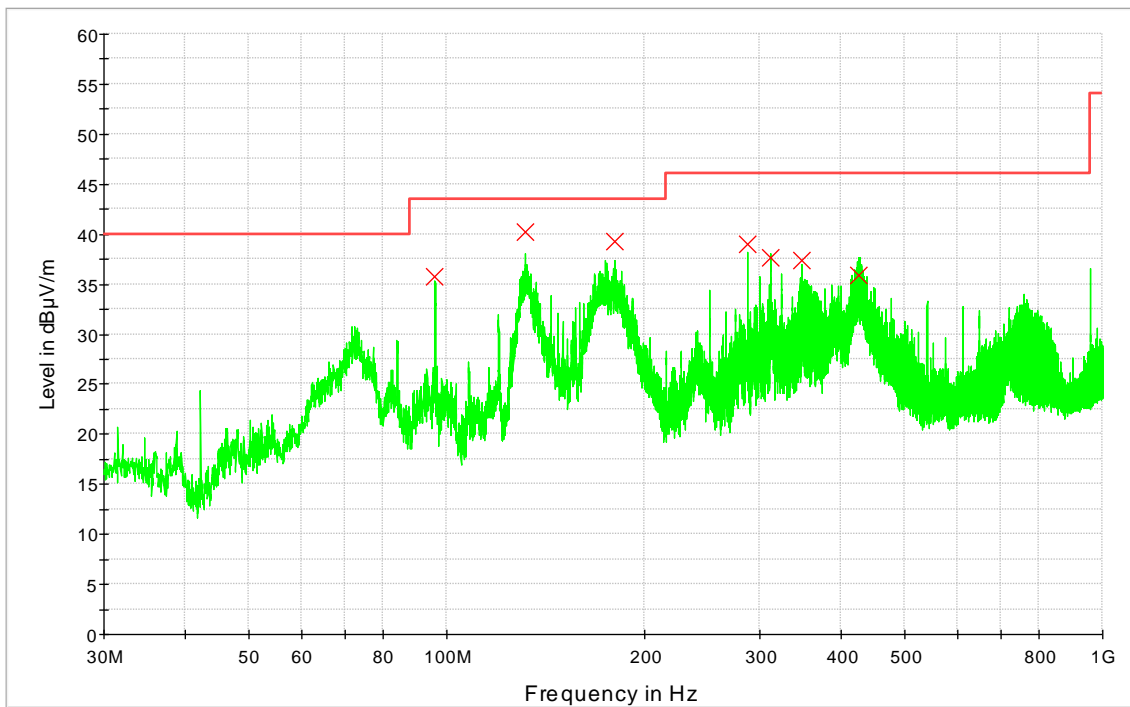
A_{CABLE} attenuation of the cable

AF antenna factor

G_{PREAMP} gain of the preamplifier

At the frequencies 30-1000 MHz the measurements were performed with QP-detector (RBW: 120 kHz) and at the frequencies above 1 GHz with Peak detector (RBW: 1 MHz and VBW: 3 MHz) and with power average detector (RMS, RBW: 1 MHz and VBW: 3 MHz).

30-1000MHz
Ch 149, 802.11a, 6Mbit/s



Vertical and horizontal polarizations in the frequency range 30 – 1000 MHz measured by using the peak detector. During the peak detector scan, the turntable was rotated from 0° to 360° with 30° step with the antenna heights 1.0 m and 3.0 m. The highest levels of the radiated interference field strength measured by using the quasi-peak detector were recorded.

Measurement results (Quasi-Peak):

Frequency MHz	Level dBμV/m	Limit dBμV/m	Margin dB	Height cm	Polarization Hor/Ver	Azimuth degrees
95.970	35.7	43.5	7.8	141	V	325
131.970	40.2	43.5	3.3	100	V	249
179.990	39.3	43.5	4.2	100	V	258
288.020	39.0	46.0	7.0	137	H	357
311.880	37.7	46.0	8.3	133	H	4
347.750	37.3	46.0	8.7	100	H	110
424.050	35.9	46.0	10.1	134	H	46

3.1.1 Test results

802.11a, 6Mbit/s

Channel	Frequency MHz	Result Peak dBμV/m	Limit Peak dBμV/m	Margin dB	Result Average dBμV/m	Limit Average dBμV/m	Margin dB
36	10360 ¹⁾	43.1	68.2	25.1	-	-	-
	15540	59.3	74.0	14.7	45.2	54.0	8.8
	20720	51.8	74.0	22.2	46.1	54.0	7.9
40	10400 ¹⁾	43.6	68.2	24.6	-	-	-
	15600	56.1	74.0	17.9	44.7	54.0	9.3
	20800	51.0	74.0	23.0	47.3	54.0	6.7
48	10480 ¹⁾	45.3	68.2	22.9	-	-	-
	15720	58.1	74.0	15.9	43.8	54.0	10.2
	20960	49.1	74.0	24.9	41.0	54.0	13.0
52	10520 ¹⁾	46.8	68.2	21.4	-	-	-
	15780	59.4	74.0	14.6	46.5	54.0	7.5
	21040	47.5	74.0	26.5	41.5	54.0	12.5
56	10560 ¹⁾	48.1	68.2	20.1	-	-	-
	15840	57.0	74.0	17.0	42.6	54.0	11.4
	21120	49.6	74.0	24.4	41.7	54.0	12.3
64	10640 ¹⁾	45.6	68.2	22.6	33.5	54.0	20.5
	15960	54.3	74.0	19.7	42.1	54.0	11.9
	21280	51.8	74.0	22.2	47.2	54.0	6.8
100	11000	45.8	74.0	28.2	32.9	54.0	21.1
	16500 ¹⁾	52.0	68.2	16.2	-	-	-
	22010	50.0	74.0	24.0	39.9	54.0	14.1
116	11160	48.5	74.0	25.5	38.2	54.0	15.8
	16740 ¹⁾	52.5	68.2	15.7	-	-	-
	22320	53.0	74.0	21.0	43.3	54.0	10.7
140	11400	49.4	74.0	24.6	36.3	54.0	17.7
	17100 ¹⁾	55.3	68.2	12.9	-	-	-
	22800	52.1	74.0	21.9	47.7	54.0	6.3

Note ¹⁾ Limit -27dBm/MHz (Pk) or 74 dBμV/m(Pk)/54 dBμV/m(AV)

802.11n, 20MHz BW, MCS0

<i>Channel</i>	<i>Frequency MHz</i>	<i>Result Peak dBμV/m</i>	<i>Limit Peak dBμV/m</i>	<i>Margin dB</i>	<i>Result Average dBμV/m</i>	<i>Limit Average dBμV/m</i>	<i>Margin dB</i>
36	10360 ¹⁾	43.1	68.2	25.1	-	-	-
	15540	59.3	74.0	14.7	45.2	54.0	8.8
	20720	51.8	74.0	22.2	46.1	54.0	7.9
40	10400 ¹⁾	43.6	68.2	24.6	-	-	-
	15600	56.1	74.0	17.9	44.7	54.0	9.3
	20800	51.0	74.0	23.0	47.3	54.0	6.7
48	10480 ¹⁾	45.3	68.2	22.9	-	-	-
	15720	58.1	74.0	15.9	43.8	54.0	10.2
	20960	49.1	74.0	24.9	41.0	54.0	13.0
52	10520 ¹⁾	46.8	68.2	21.4	-	-	-
	15780	59.4	74.0	14.6	46.5	54.0	7.5
	21040	47.5	74.0	26.5	41.5	54.0	12.5
56	10560 ¹⁾	48.1	68.2	20.1	-	-	-
	15840	57.0	74.0	17.0	42.6	54.0	11.4
	21120	49.6	74.0	24.4	41.7	54.0	12.3
64	10640 ¹⁾	45.6	68.2	22.6	33.5	54.0	20.5
	15960	54.3	74.0	19.7	42.1	54.0	11.9
	21280	51.8	74.0	22.2	47.2	54.0	6.8
100	11000	45.8	74.0	28.2	32.9	54.0	21.1
	16500 ¹⁾	52.0	68.2	16.2	-	-	-
	22000 ¹⁾	50.0	74.0	24.0	39.9	54.0	14.1
116	11160	48.5	74.0	25.5	38.2	54.0	15.8
	16740 ¹⁾	52.5	68.2	15.7	-	-	-
	22320	53.0	74.0	21.0	43.3	54.0	10.7
140	11400	49.4	74.0	24.6	36.3	54.0	17.7
	17100 ¹⁾	55.3	68.2	12.9	-	-	-
	23220 ¹⁾	52.1	74.0	21.9	47.7	54.0	6.3

Note ¹⁾ Limit -27dBm/MHz (Pk) or 74 dBμV/m(Pk)/54 dBμV/m(AV)

3.2 Maximum conducted peak output power

The test was performed as a compliance test. The test parameters concerned were as follows:

<i>Site name</i>	SGS Fimko EMC Oy/ Perkkaa
<i>FCC rule part</i>	§ 15.407
<i>Date of testing</i>	1.11.2013
<i>Test equipment</i>	566, X1
<i>Test conditions</i>	23 °C, 35 % RH
<i>Test result</i>	PASS

3.2.1 Test method and limit

Test method E SA-1 789033 D01 General UNII Test Procedures v01r03 was used. RBW=1MHz and VBW=8MHz. Trace average 100 traces in power averaging mode was used. Gated sweep was used in order not to have periods OFF included in the average. Compute power by integrating the spectrum across the 26 dB EBW of the signal. The integration was performed using the spectrum analyzer's band power measurement function.

The antenna port of the EUT was connected to the spectrum analyzer.

5150 – 5250 MHz:

Antenna gain <2 dBi => limit = 17 dBm

5250 – 5350 MHz:

Antenna gain <2 dBi => limit = 24 dBm

5470 – 5725 MHz:

Antenna gain <2 dBi => limit = 24 dBm

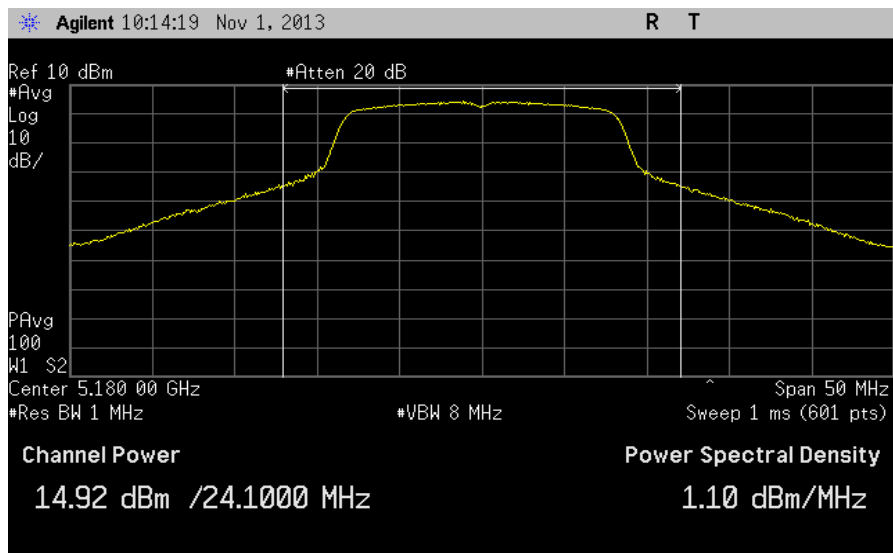
3.2.2 Test results

802.11a, 6Mbit/s

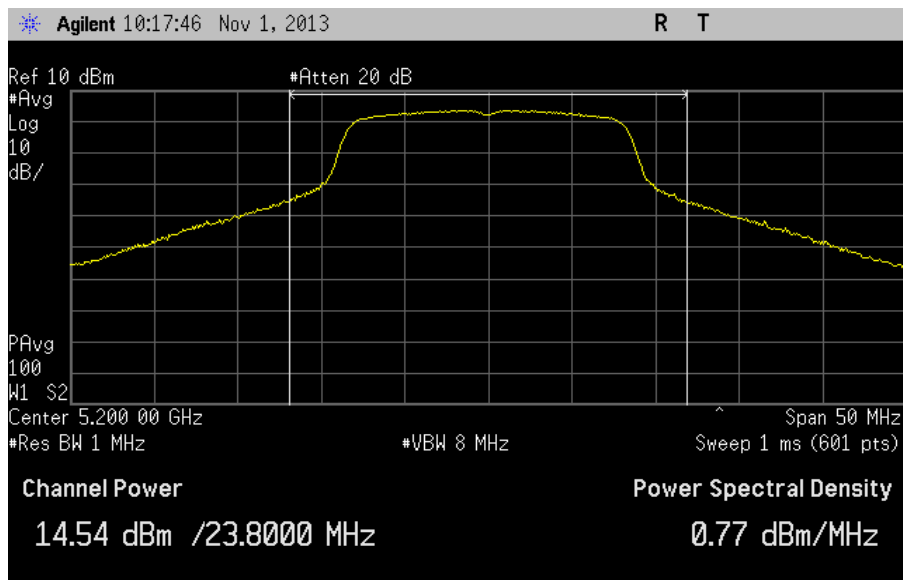
<i>Channel</i>	<i>Frequency MHz</i>	<i>Result dBm</i>	<i>Limit dBm</i>	<i>Margin dBm</i>
36	5180	14.92	17.0	2.08
40	5200	14.54	17.0	2.46
48	5240	14.38	17.0	2.62
52	5260	14.47	24.0	9.53
56	5280	14.05	24.0	9.95
64	5320	14.46	24.0	9.54
100	5500	12.80	24.0	11.20
116	5580	12.98	24.0	11.02
140	5700	13.10	24.0	10.90

802.11n, 20MHz BW, MCS0

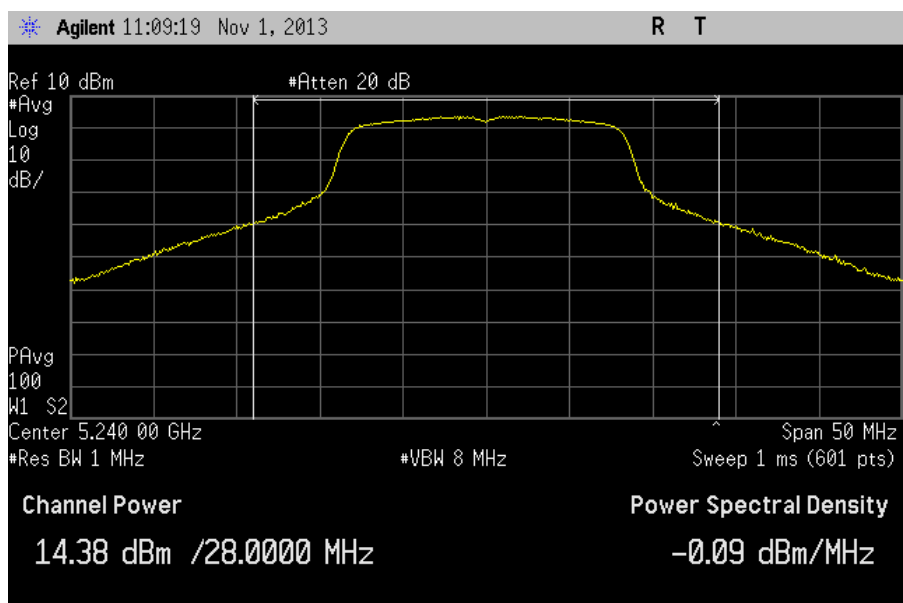
<i>Channel</i>	<i>Frequency MHz</i>	<i>Result dBm</i>	<i>Limit dBm</i>	<i>Margin dBm</i>
36	5180	14.88	17.0	2.12
40	5200	14.54	17.0	2.46
48	5240	13.99	17.0	3.01
52	5260	14.64	24.0	9.36
56	5280	13.98	24.0	10.02
64	5320	14.41	24.0	9.59
100	5500	12.74	24.0	11.26
116	5580	12.68	24.0	11.32
140	5700	12.95	24.0	11.05



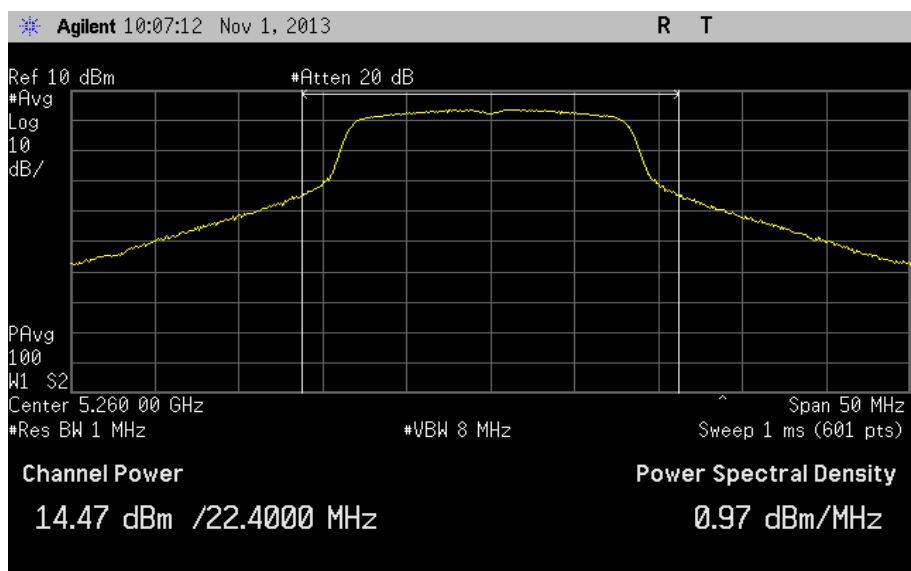
802.11a, 6Mbit/s, Channel 36, TXf=5180MHz



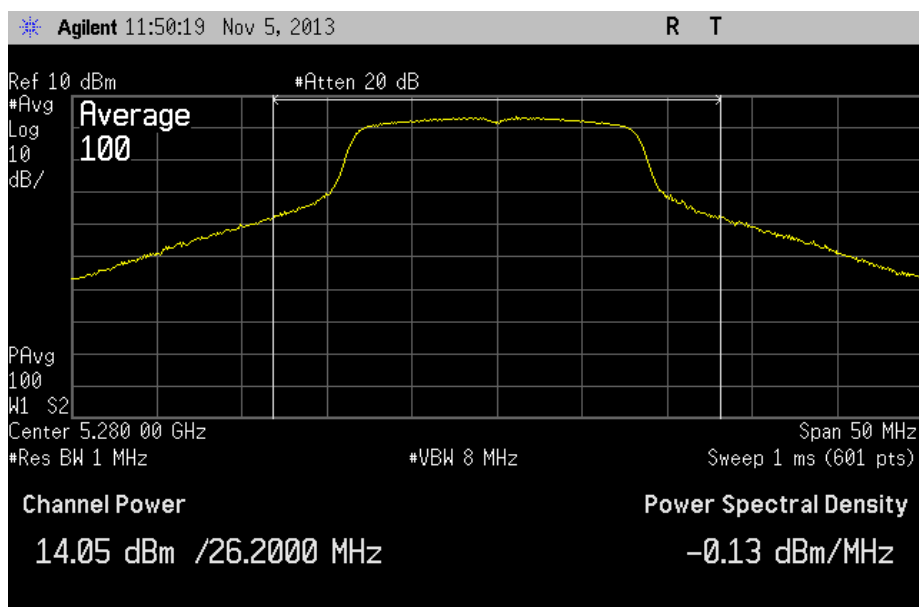
802.11a, 6Mbit/s, Channel 40, TXf=5200MHz



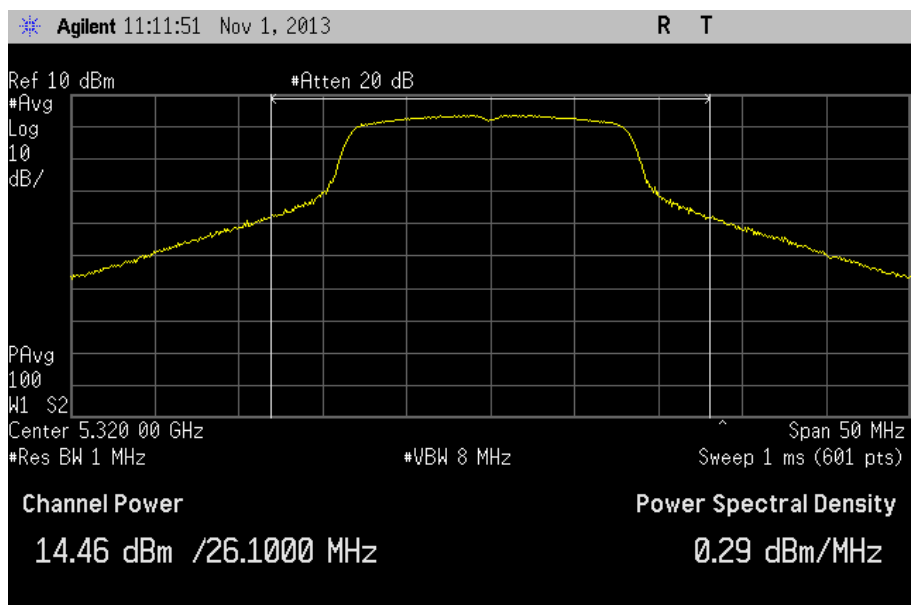
802.11a, 6Mbit/s, Channel 48, TXf=5240MHz



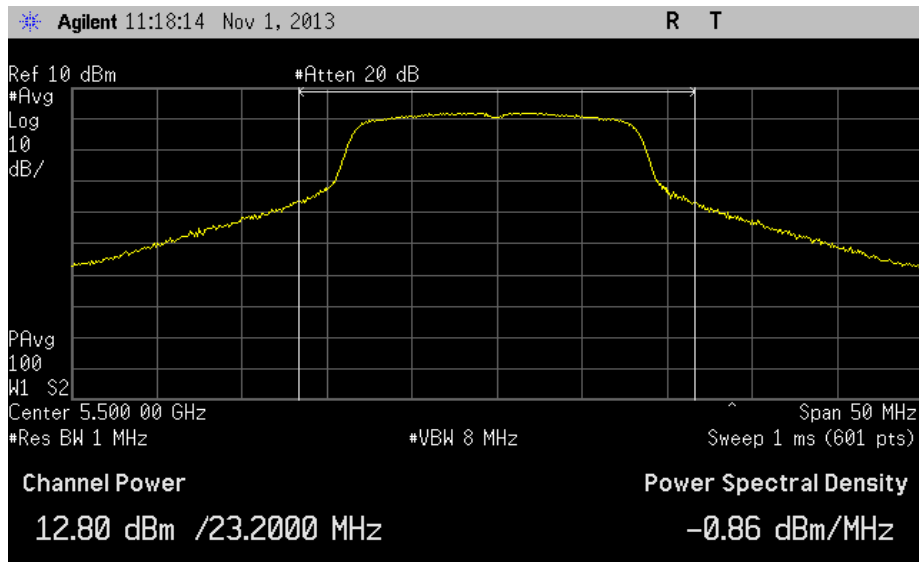
802.11a, 6Mbit/s, Channel 52, TXf=5260MHz



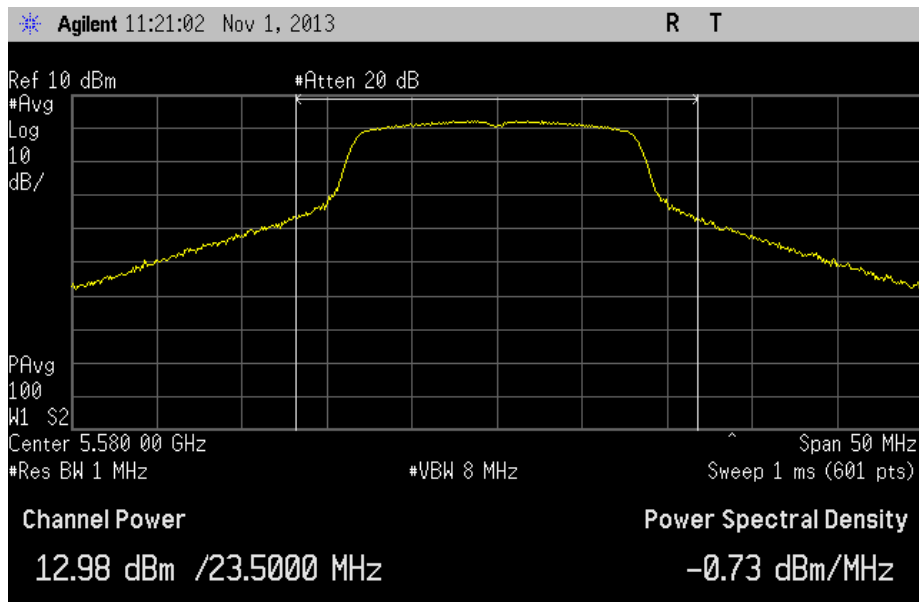
802.11a, 6Mbit/s, Channel 56, TXf=5280MHz



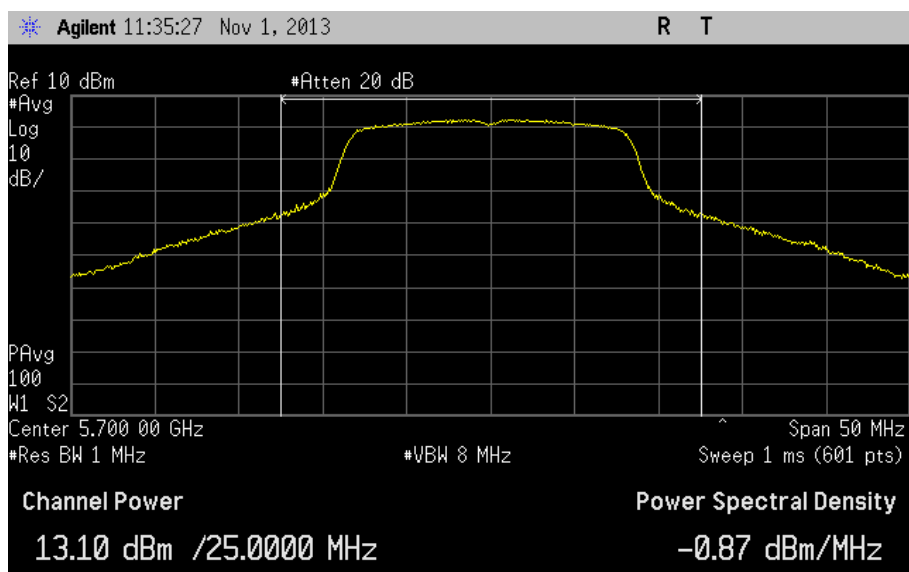
802.11a, 6Mbit/s, Channel 64, TXf=5320MHz



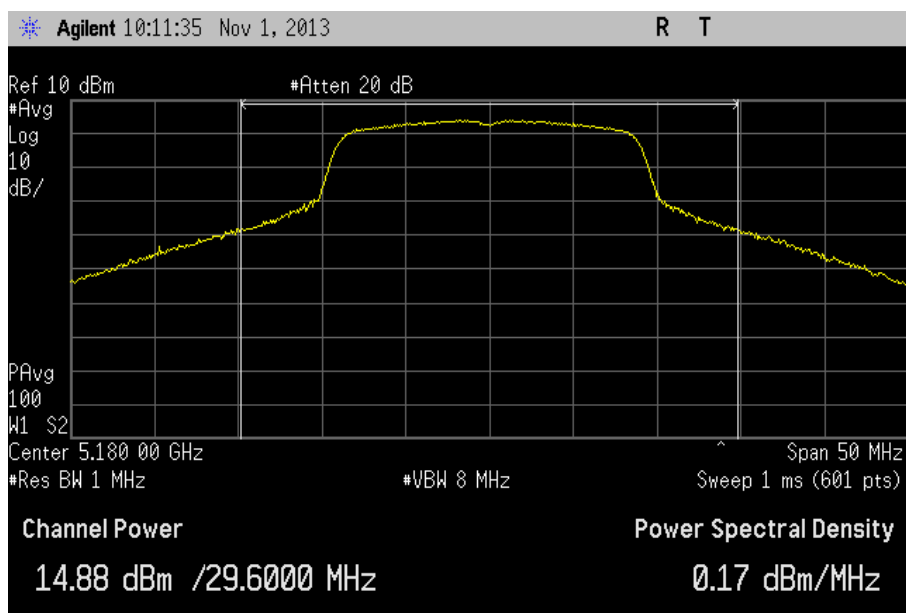
802.11a, 6Mbit/s, Channel 100, TXf=5500MHz



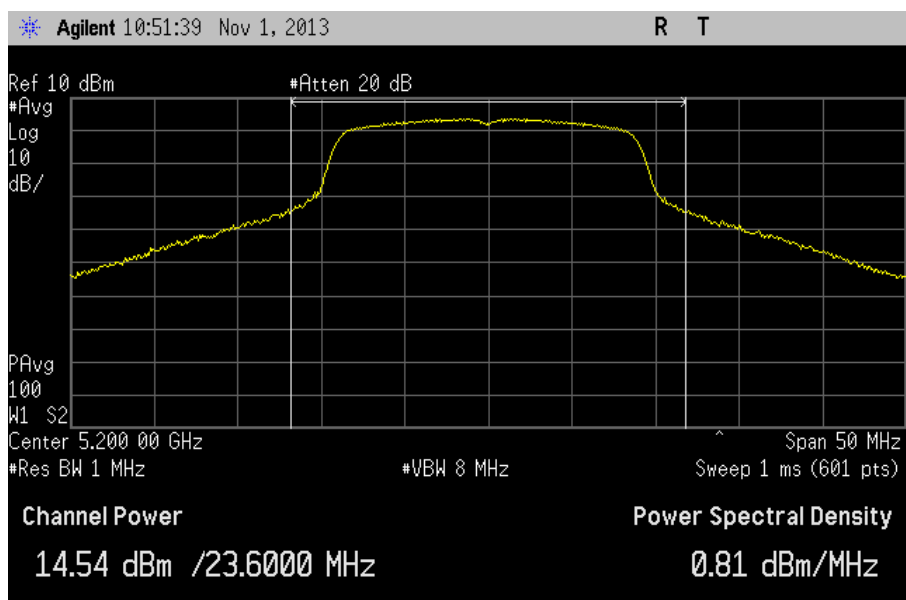
802.11a, 6Mbit/s, Channel 116, TXf=5580MHz



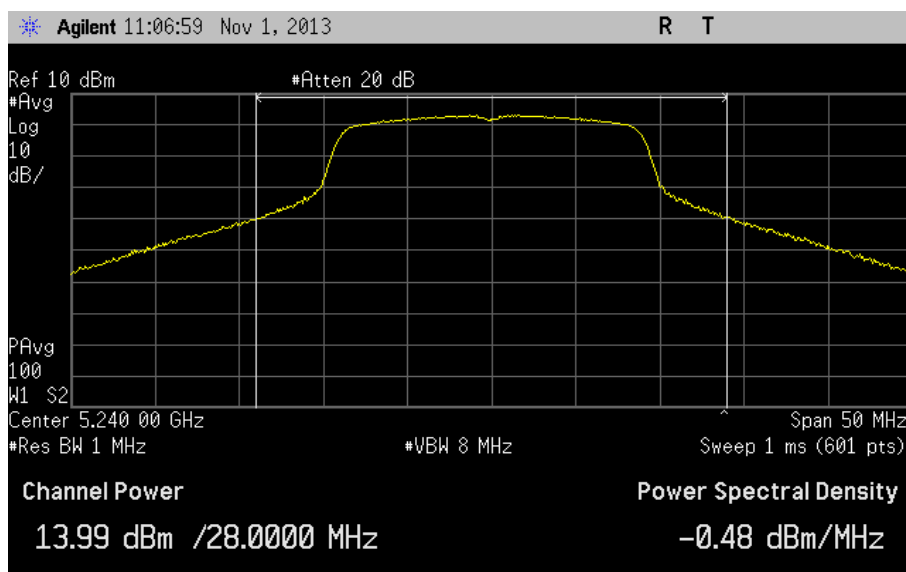
802.11a, 6Mbit/s, Channel 140, TXf=5700MHz



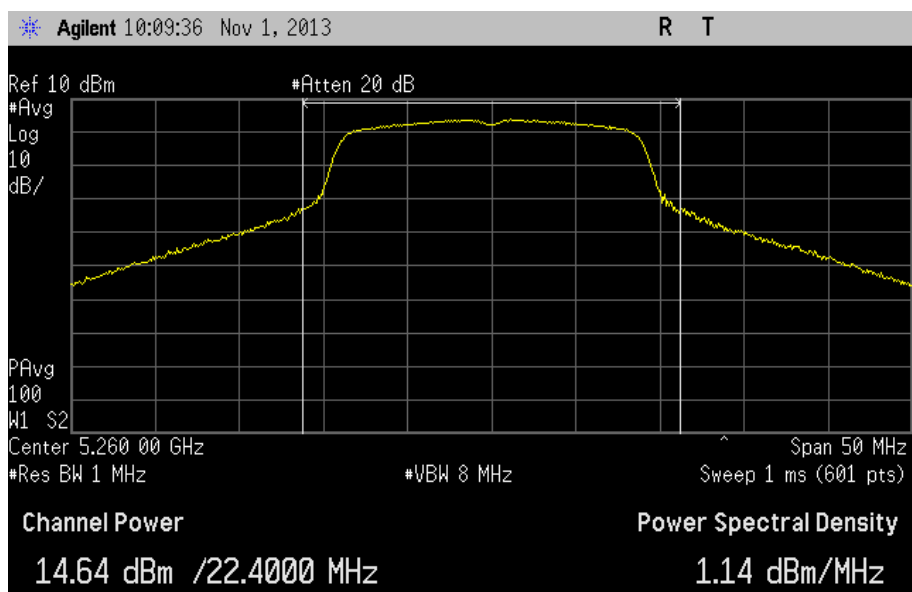
802.11n, 20MHz BW MCS0, TX on at channel 36, TXf=5180MHz



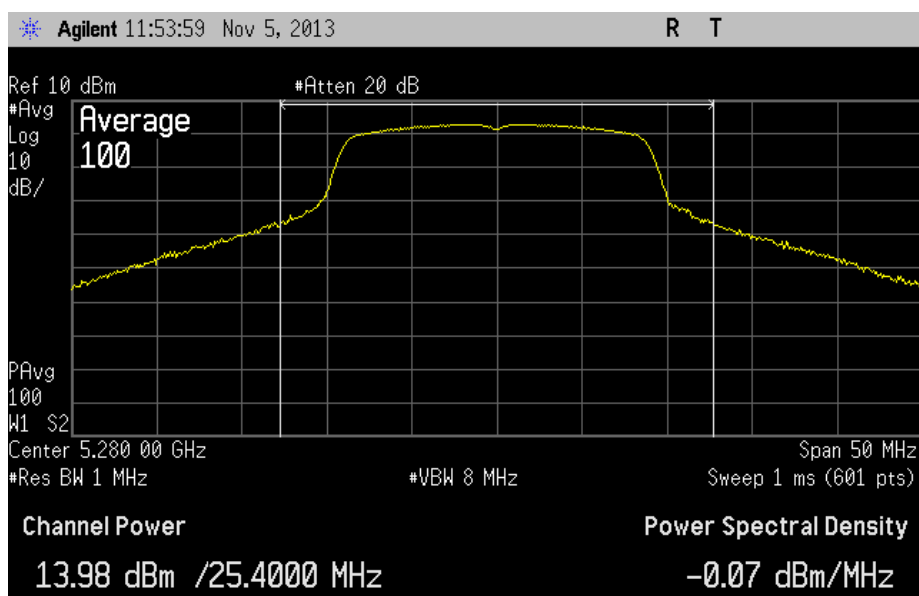
802.11n, 20MHz BW MCS0, TX on at channel 40, TXf=5200MHz



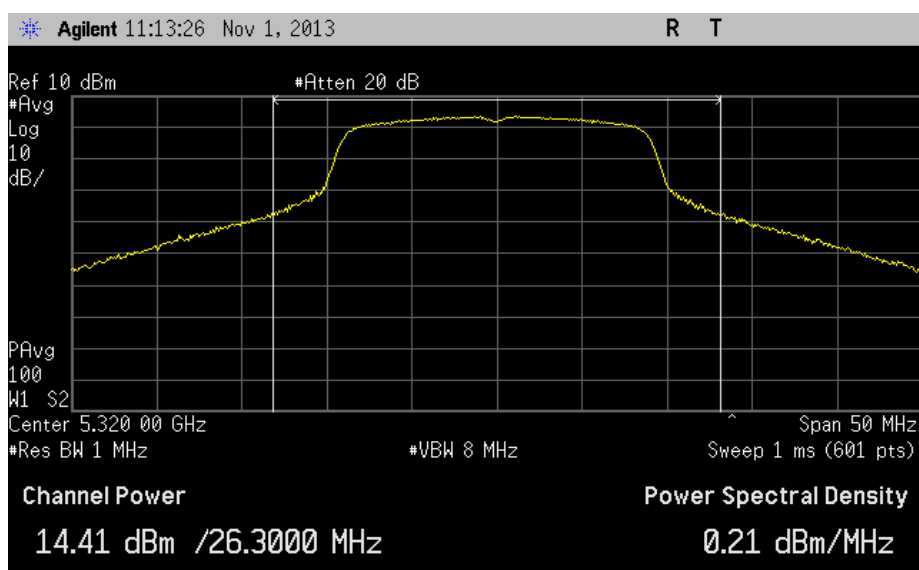
802.11n, 20MHz BW MCS0, TX on at channel 48, TXf=5240MHz



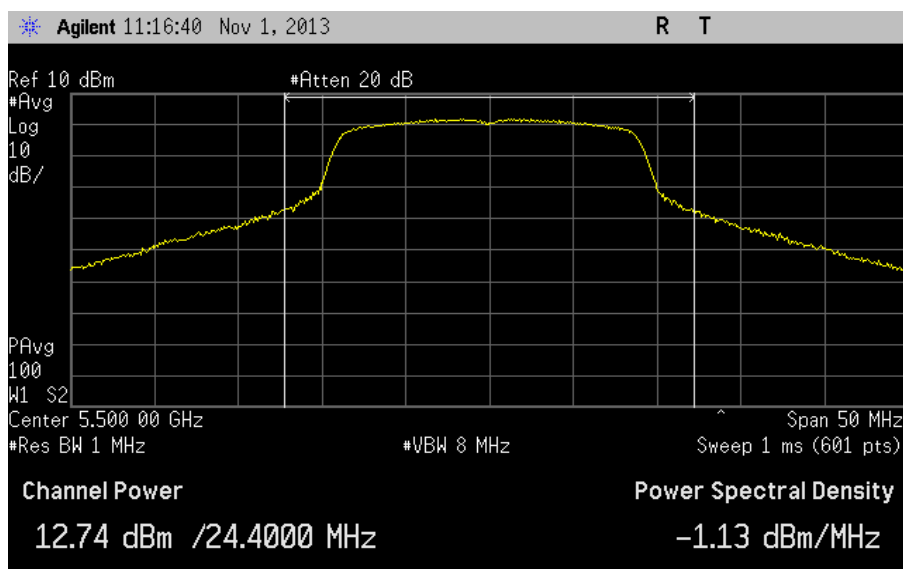
802.11n, 20MHz BW MCS0, TX on at channel 52, TXf=5260MHz



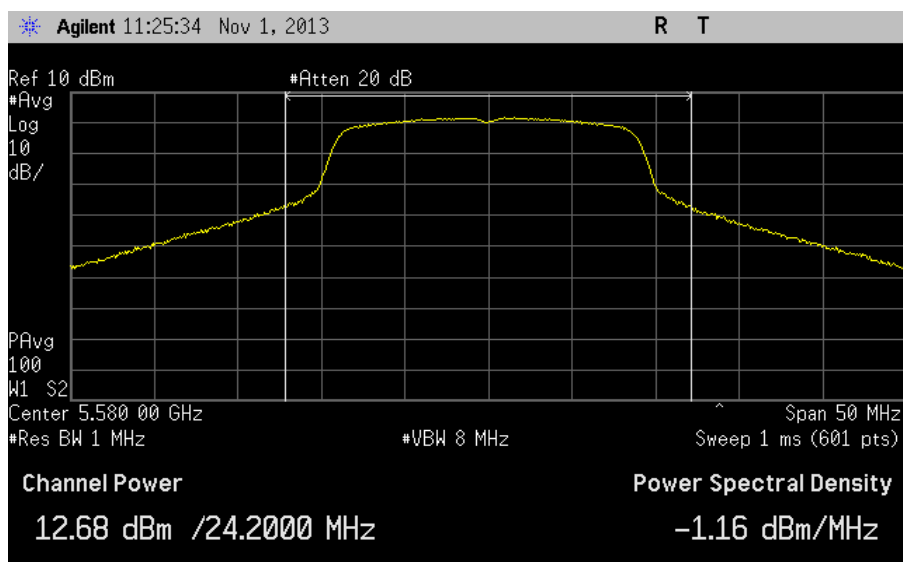
802.11n, 20MHz BW MCS0, TX on at channel 56, TXf=5280MHz



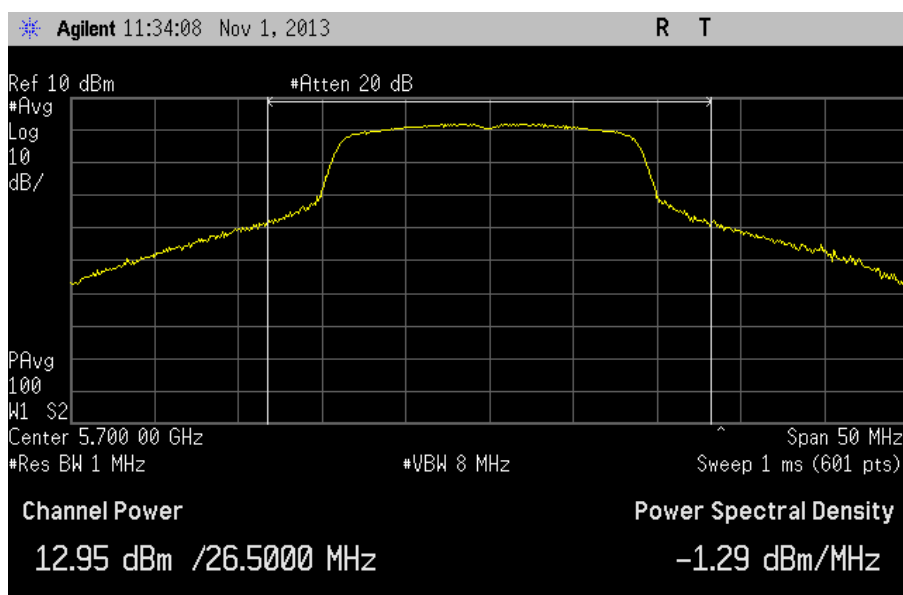
802.11n, 20MHz BW MCS0, TX on at channel 64, TXf=5320MHz



802.11n, 20MHz BW MCS0, TX on at channel 100, TXf=5500MHz



802.11n, 20MHz BW MCS0, TX on at channel 116, TXf=5580MHz



802.11n, 20MHz BW MCS0, TX on at channel 140, TXf=5700MHz

3.3 26dB Bandwidth

The test was performed as a compliance test. The test parameters concerned were as follows:

Site name	SGS Fimko EMC Oy/ Perkkaa
FCC rule part	§ 15.407
Date of testing	31.10.-5.11.2013
Test equipment	566, X1
Test conditions	23 °C, 35 % RH
Test result	PASS (Limit: min 500 kHz)

3.3.1 Test method

The antenna port of the EUT was connected to the spectrum analyzer.

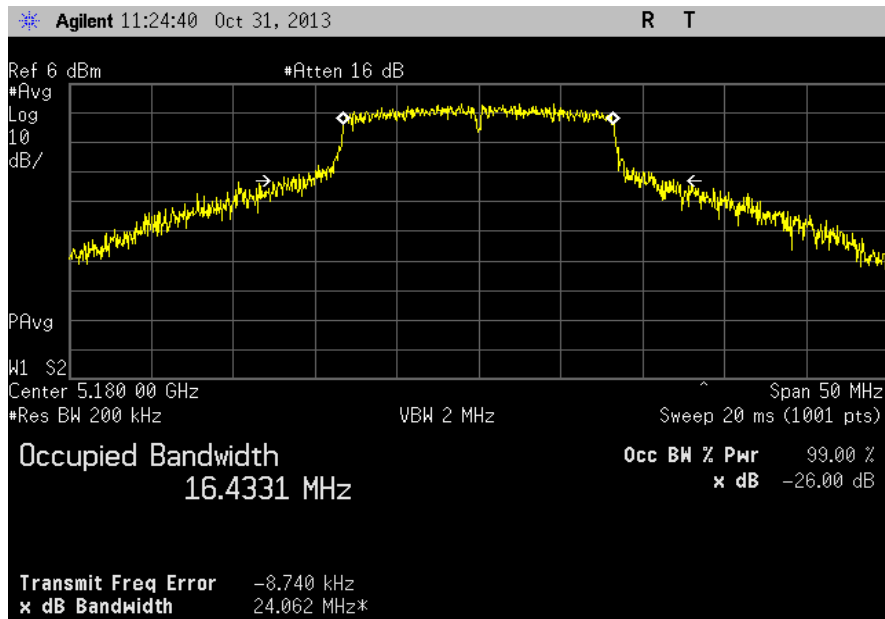
3.3.2 Test results

802.11a, 6Mbit/s

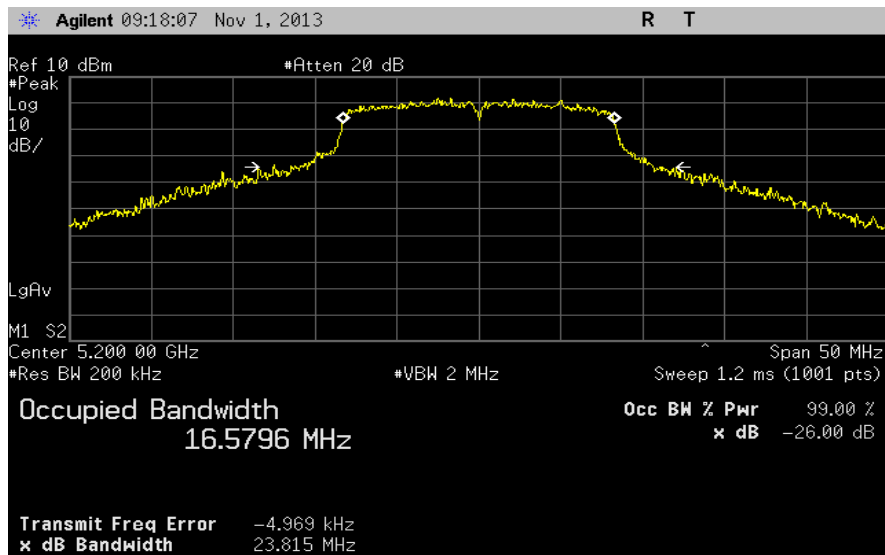
Channel	Frequency MHz	99% bandwidth (MHz)	26 dB bandwidth (MHz)
36	5180	16.4	24.1
40	5200	16.6	23.8
48	5240	16.9	28.8
52	5260	16.6	22.4
56	5280	16.7	26.2
64	5320	16.8	26.1
100	5500	16.6	23.2
116	5580	16.6	23.5
140	5700	16.6	25.0

802.11n, 20MHz BW, MCS0

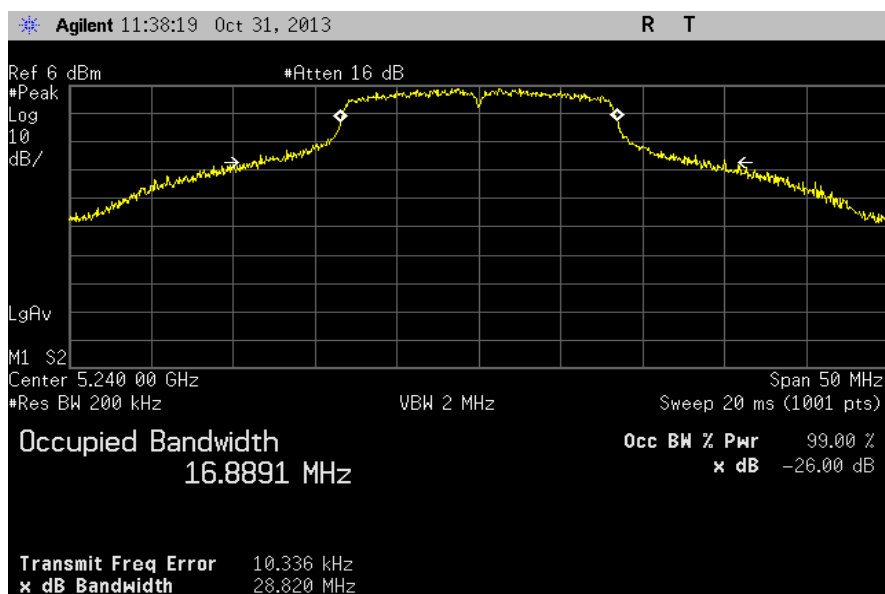
Channel	Frequency MHz	99% bandwidth (MHz)	26 dB bandwidth (MHz)
36	5180	18.1	29.6
40	5200	17.7	23.6
48	5240	17.9	28.0
52	5260	17.7	25.3
56	5280	17.8	25.4
64	5320	17.8	26.3
100	5500	17.8	24.4
116	5580	17.7	24.2
140	5700	17.8	26.5



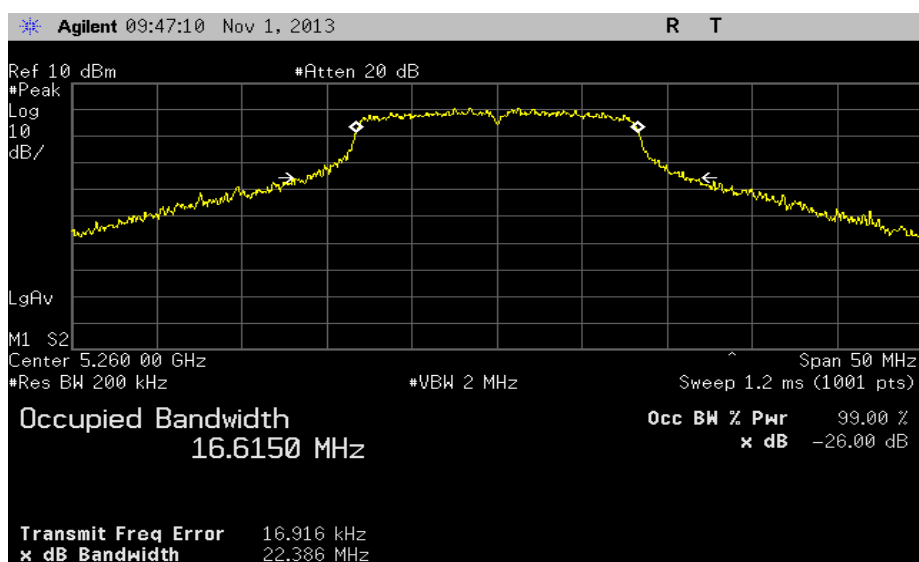
802.11a, 6Mbit/s, Channel 36, TXf=5180MHz



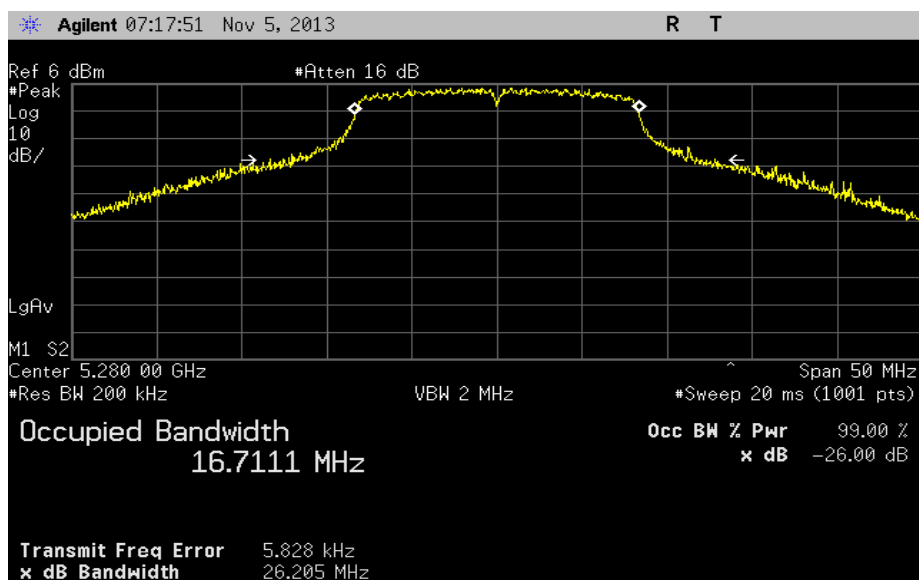
802.11a, 6Mbit/s, Channel 40, TXf=5200MHz



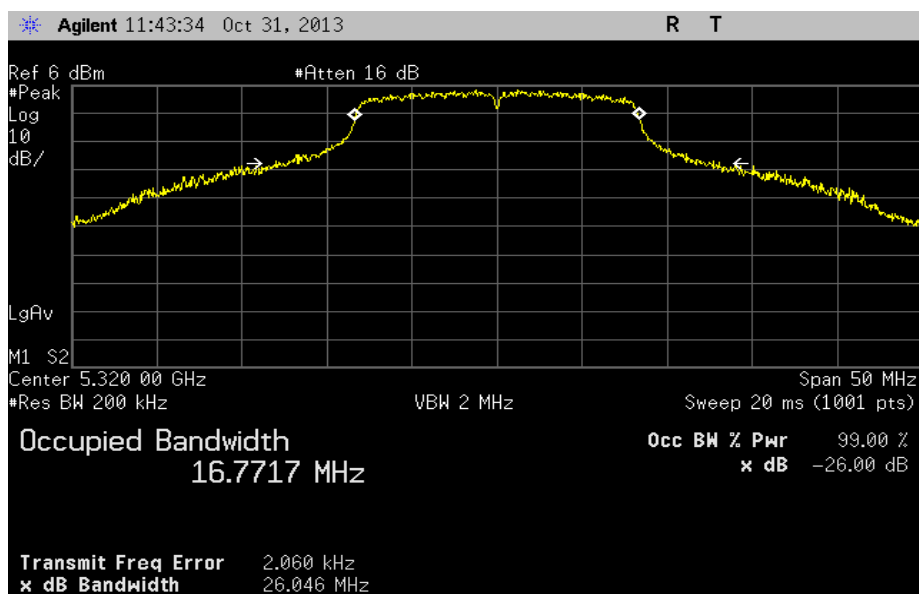
802.11a, 6Mbit/s, Channel 48, TXf=5240MHz



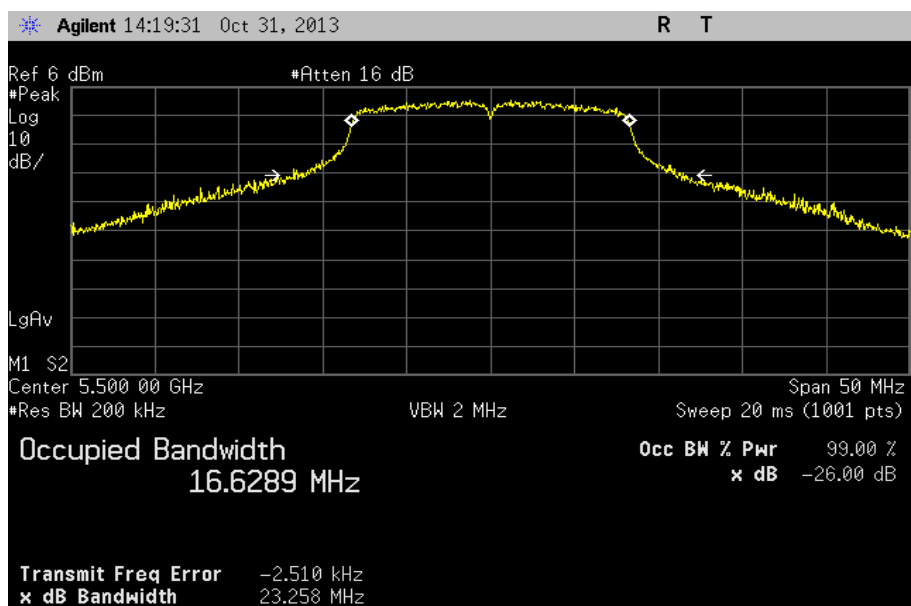
802.11a, 6Mbit/s, Channel 52, TXf=5260MHz



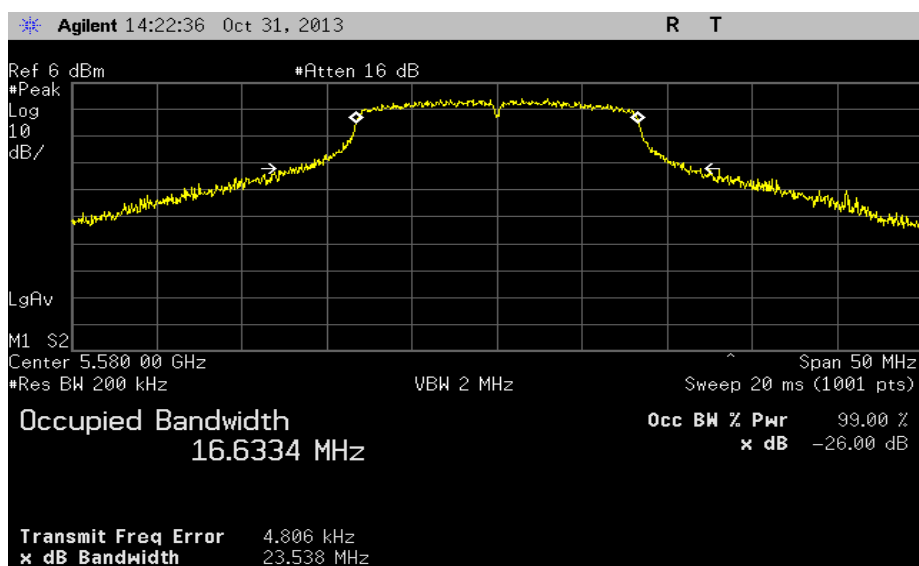
802.11a, 6Mbit/s, Channel 56, TXf=5280MHz



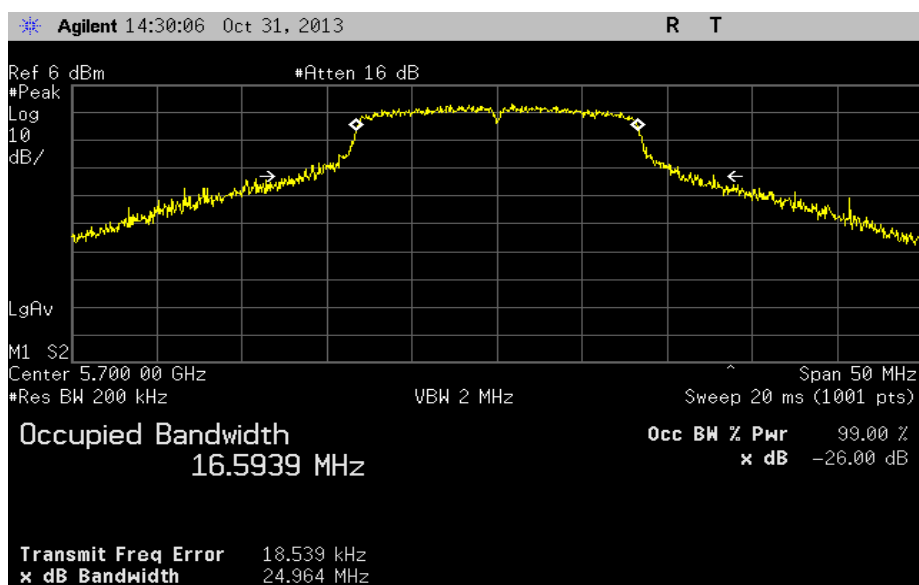
802.11a, 6Mbit/s, Channel 64, TXf=5320MHz



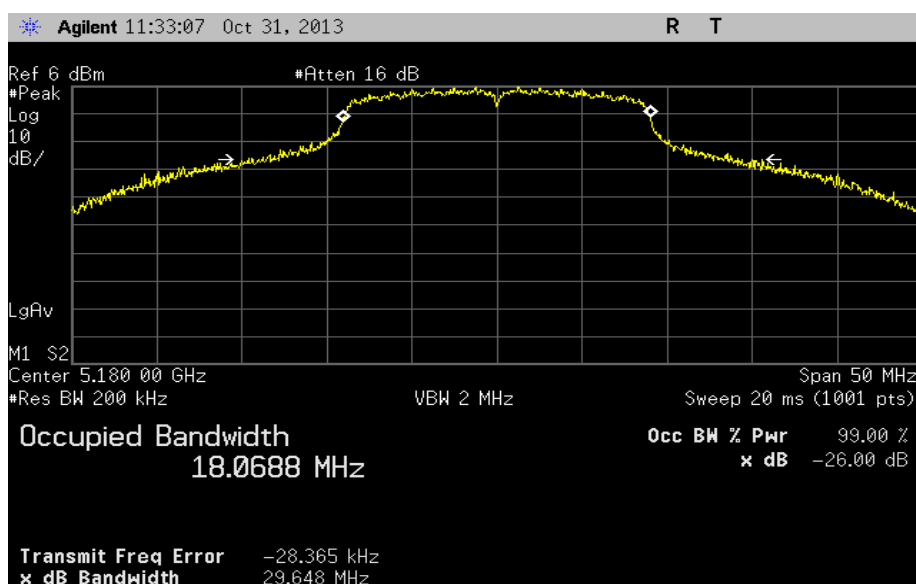
802.11a, 6Mbit/s, Channel 100, TXf=5500MHz



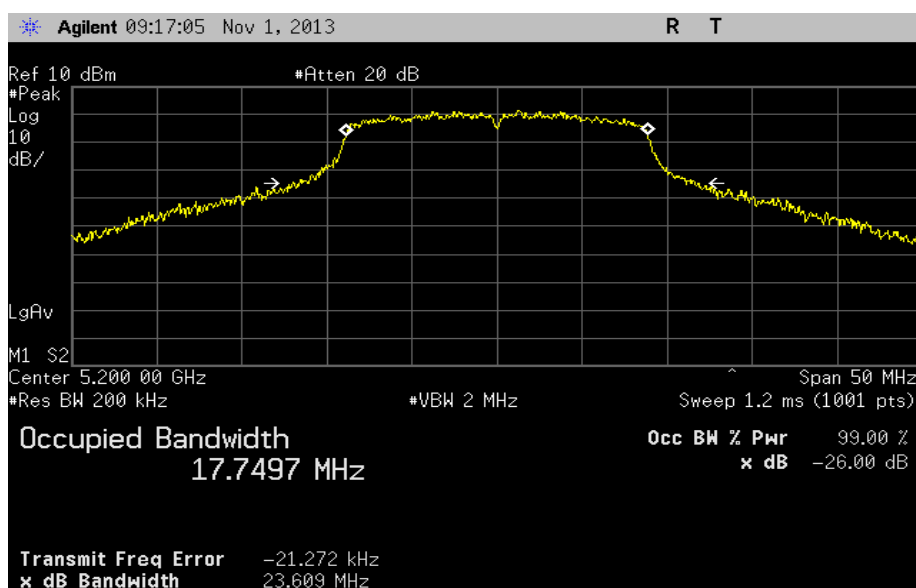
802.11a, 6Mbit/s, Channel 116, TXf=5580MHz



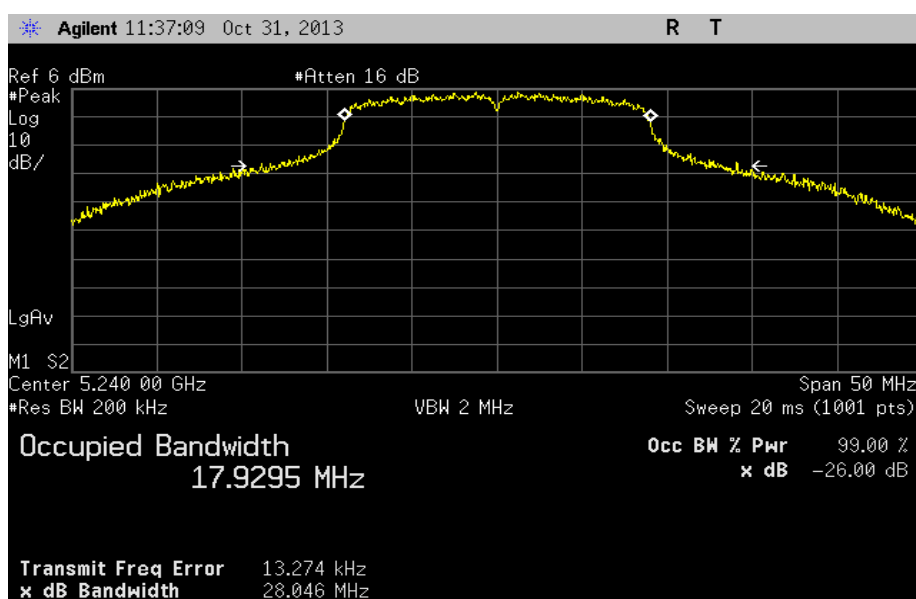
802.11a, 6Mbit/s, Channel 140, TXf=5700MHz



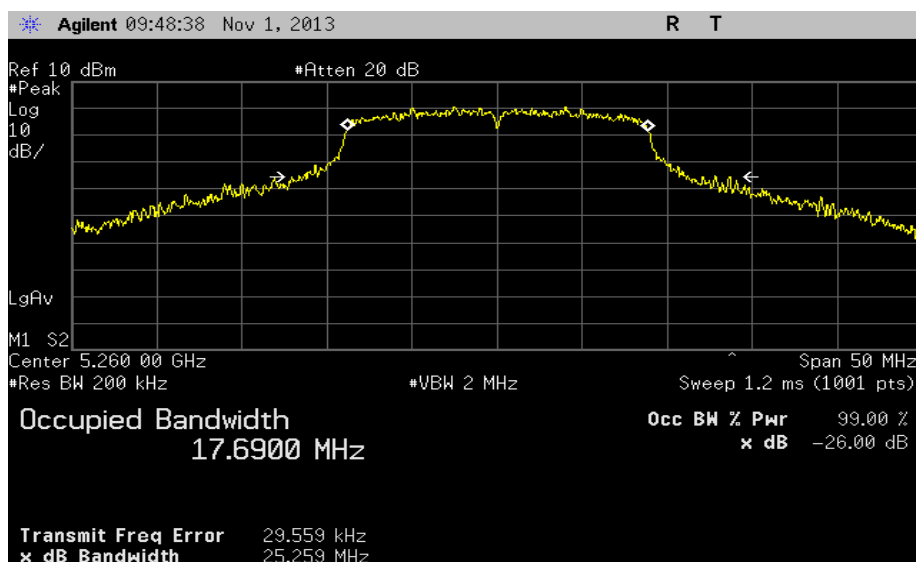
802.11n, 20MHz BW MCS0, TX on at channel 36, TXf=5180MHz



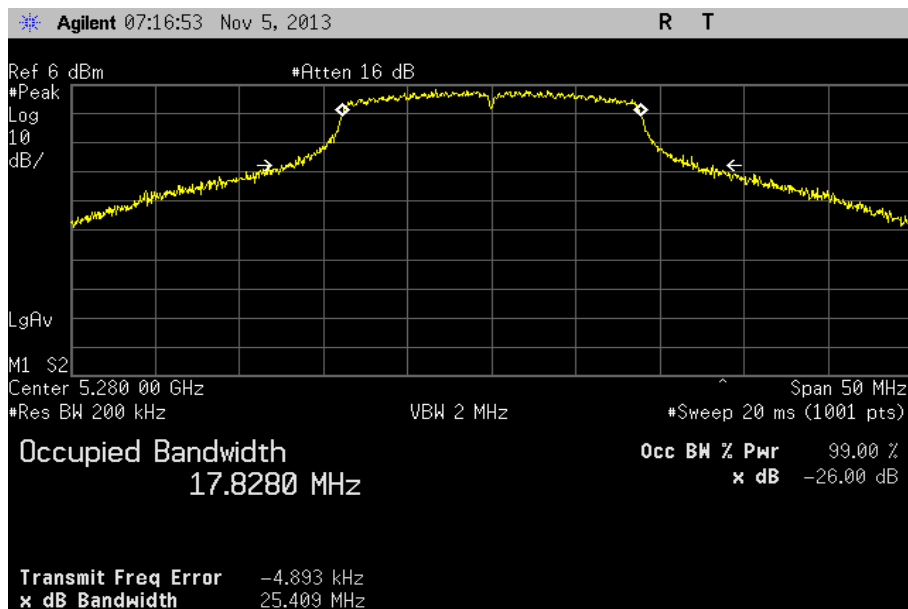
802.11n, 20MHz BW MCS0, TX on at channel 40, TXf=5200MHz



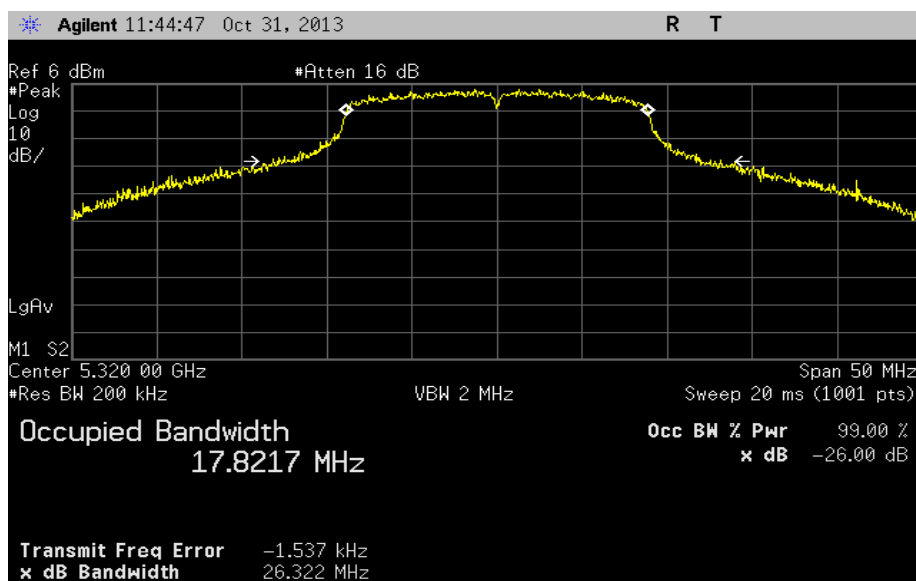
802.11n, 20MHz BW MCS0, TX on at channel 48, TXf=5240MHz



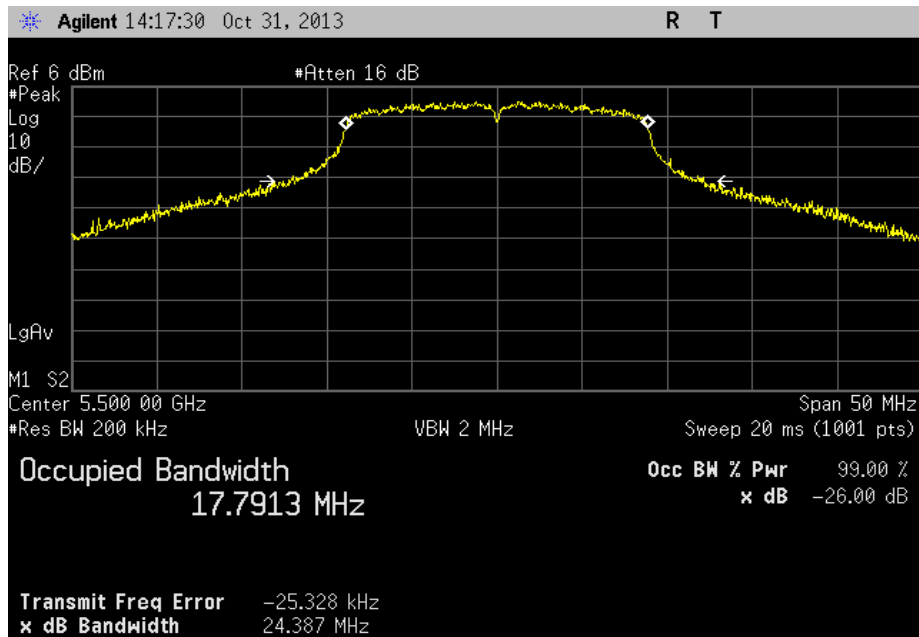
802.11n, 20MHz BW MCS0, TX on at channel 52, TXf=5260MHz



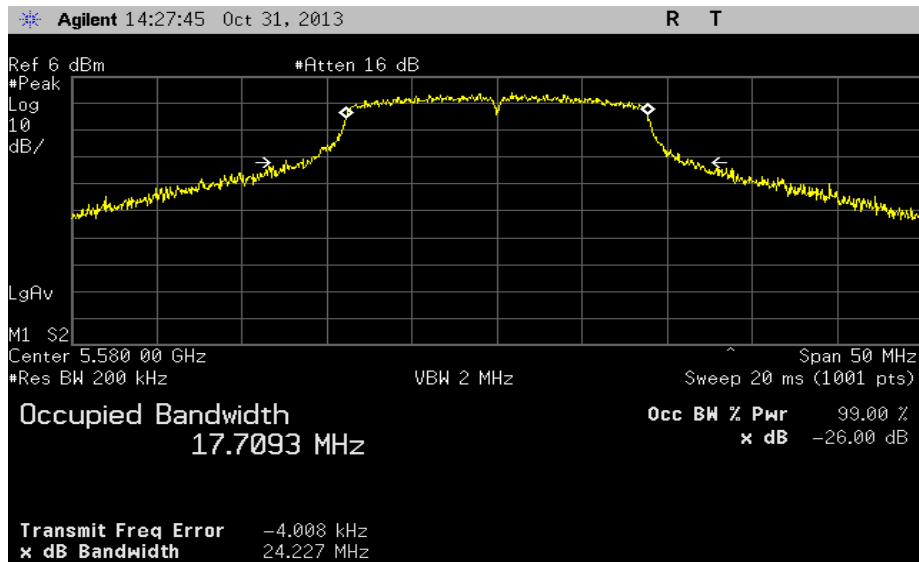
802.11n, 20MHz BW MCS0, TX on at channel 56, TXf=5280MHz



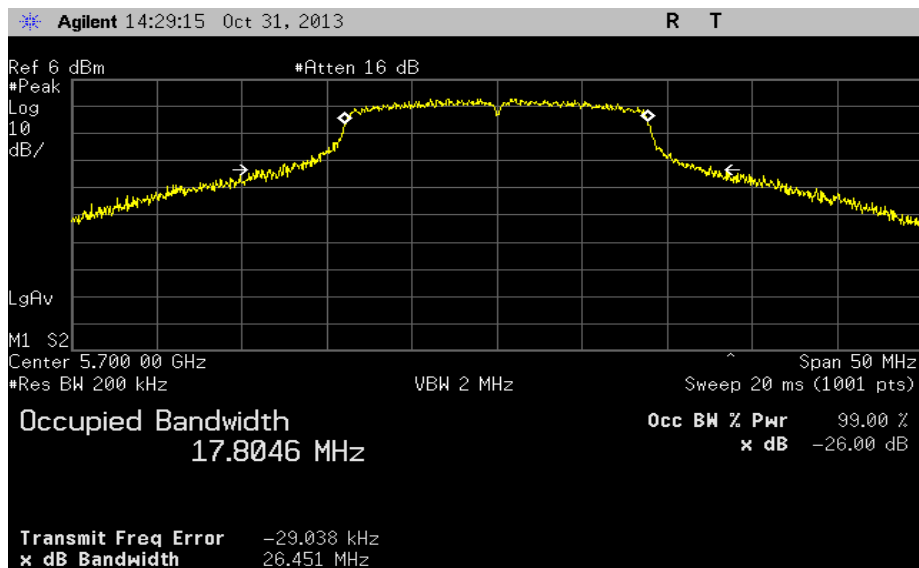
802.11n, 20MHz BW MCS0, TX on at channel 64, TXf=5320MHz



802.11n, 20MHz BW MCS0, TX on at channel 100, TXf=5500MHz



802.11n, 20MHz BW MCS0, TX on at channel 116, TXf=5580MHz



802.11n, 20MHz BW MCS0, TX on at channel 140, TXf=5700MHz

3.4 Band-edge compliance

The test was performed as a compliance test. The test parameters concerned were as follows:

Site name	SGS Fimko EMC Oy/ Perkkaa
FCC rule part	§ 15.407
Date of testing	07.11.2013
Test equipment	566, 542, 564
Test conditions	23 °C, 35 % RH
Test result	PASS (limit: EIRP -27 dBm/MHz/-17dBm/MHz out of restricted bands, 54 dBμV/m AVE, 74 dBμV/m peak in restricted bands)

3.4.1 Test method

The test was performed in a fully anechoic shielded room. The EUT was placed on a non-conductive table 0.8 m high standing on the turntable.

The measurement results were obtained as described below.

$$E [\text{dB}\mu\text{V/m}] = U_{RX} + A_{CABLE} + AF - G_{PREAMP}$$

Where

U_{RX} receiver reading

A_{CABLE} attenuation of the cable

AF antenna factor

G_{PREAMP} gain of the preamplifier

The CFR 47 Part 15, Section 15.407 limit values for radiated emissions of UNWANTED EMISSION OUT OF THE RESTRICTED BANDS (3m measuring distance, calculated from -27 dBm and -17 dBm limits ¹⁾)

$$^1) E = \frac{1000000\sqrt{30P}}{d}, \text{ where } E = \mu\text{V/m}, P = W[EIRP], d = m[\text{distance}]$$

Calculated limit values:

-27 dBm => 68.2 dBμV/m

-17 dBm => 78.2 dBμV/m

3.4.2 Test results

802.11a, 6Mbit/s

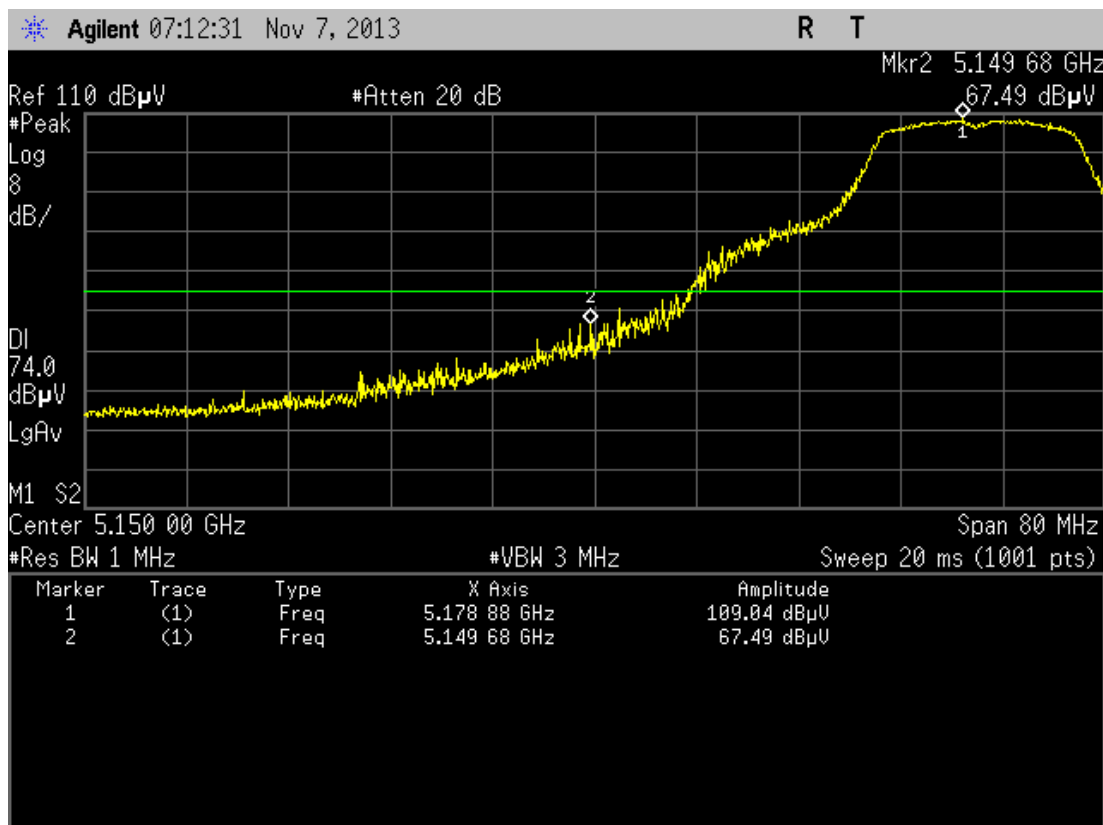
Channel	Band Edge Frequency MHz	Result Peak dBμV/m	Limit Peak dBμV/m	Margin dB	Result Average dBμV/m	Limit Average dBμV/m	Margin dB
36	5150	67.4	74	6.6	44.3	54	9.7
48	5250	95.1	-	-	-	-	-
48	5350	58.1	74	15.9	38.2	54	15.8
52	5250	94.4	-	-	-	-	-
52	5150	56.1	74	17.9	38.2	54	15.8
64	5350	72.8	74	1.2	47.8	54	6.2
100	5460	61.2	74	12.8	40.1	54	13.9
100	5470	66.1	68.2	2.1	-	-	-
116	5608.5 ¹⁾	68.2	-	-	-	-	-
132	5630.9 ¹⁾	68.2	-	-	-	-	-
140	5725	66.7	68.2	1.5	-	-	-

Note ¹⁾ Frequency where level is 68.2 dBμV/m (-27dBm/MHz)

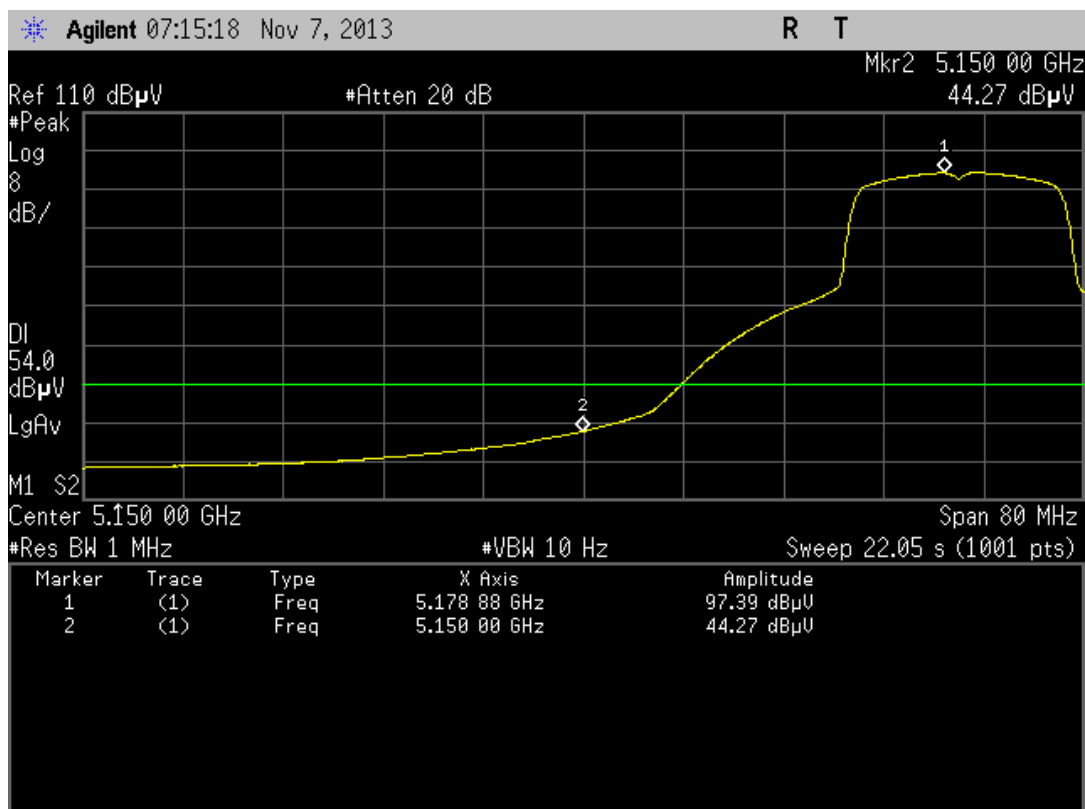
802.11n, 20MHz BW

Channel	Band Edge Frequency MHz	Result Peak dBμV/m	Limit Peak dBμV/m	Margin dB	Result Average dBμV/m	Limit Average dBμV/m	Margin dB
36	5150	70.7	74	3.3	48.8	54	5.2
48	5250	95.5	-	-	-	-	-
48	5350	57.6	74	16.4	38.2	54	15.8
52	5250	98.5	-	-	-	-	-
52	5150	57.8	74	16.2	38.2	54	15.8
64	5350	70.3	74	3.7	47.8	54	6.2
100	5460	61.6	74	12.4	40.1	54	13.9
100	5470	64.7	68.2	3.5	-	-	-
116	5609.3 ¹⁾	68.2	-	-	-	-	-
132	5631.5 ¹⁾	68.2	-	-	-	-	-
140	5725	67.1	68.2	1.1	-	-	-

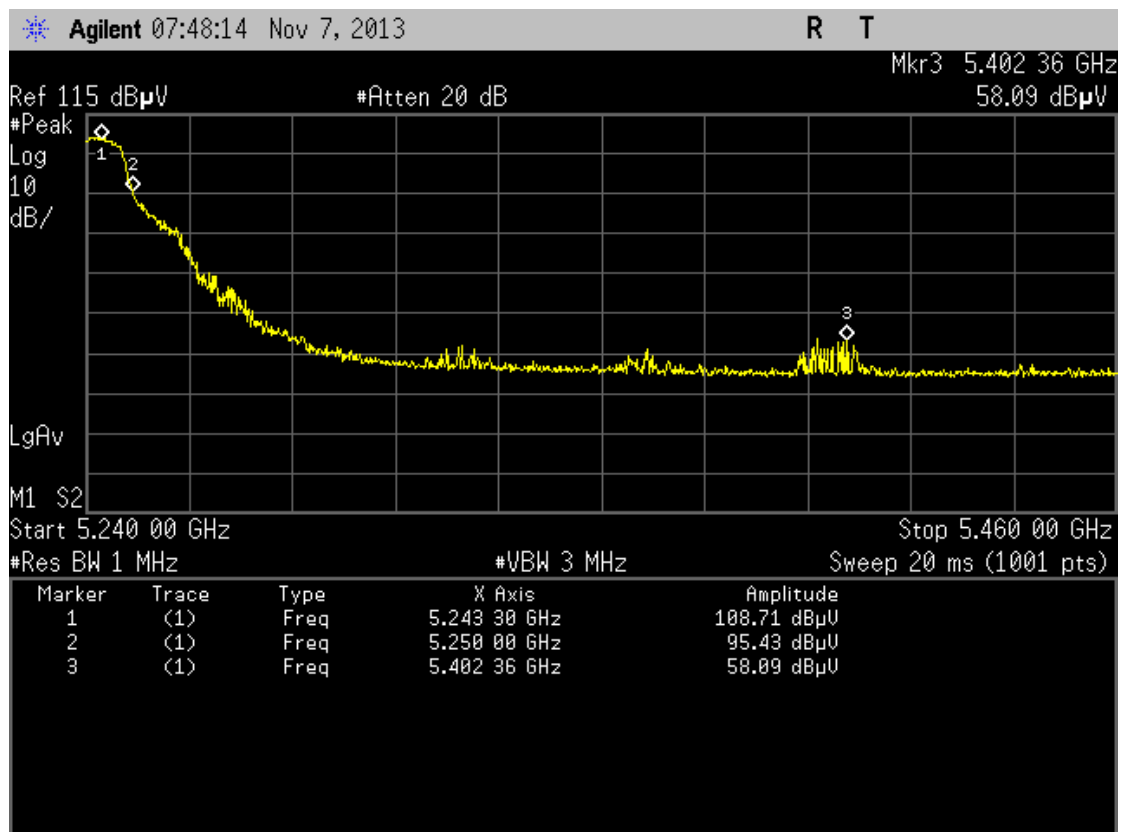
Note ¹⁾ Frequency where level is 68.2 dBμV/m (-27dBm/MHz)



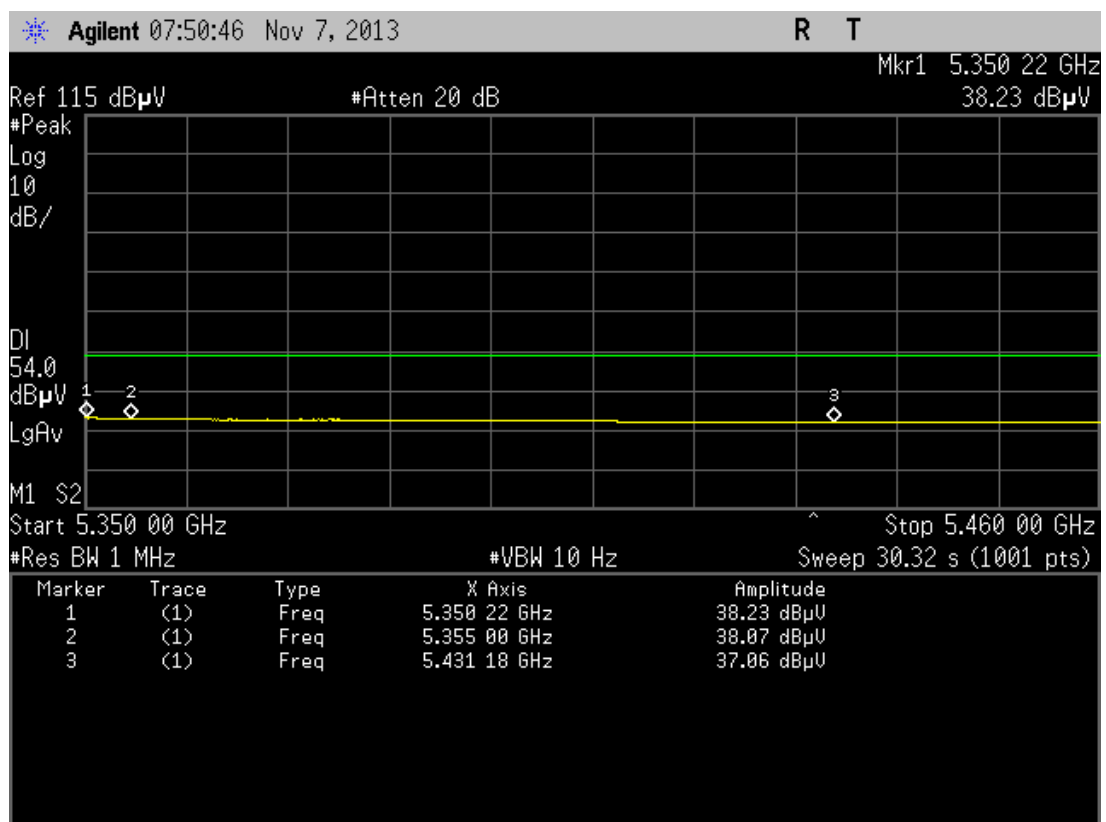
802.11a, 6Mbit/s, Channel 36, TXf=5180MHz, band edge 5150 MHz



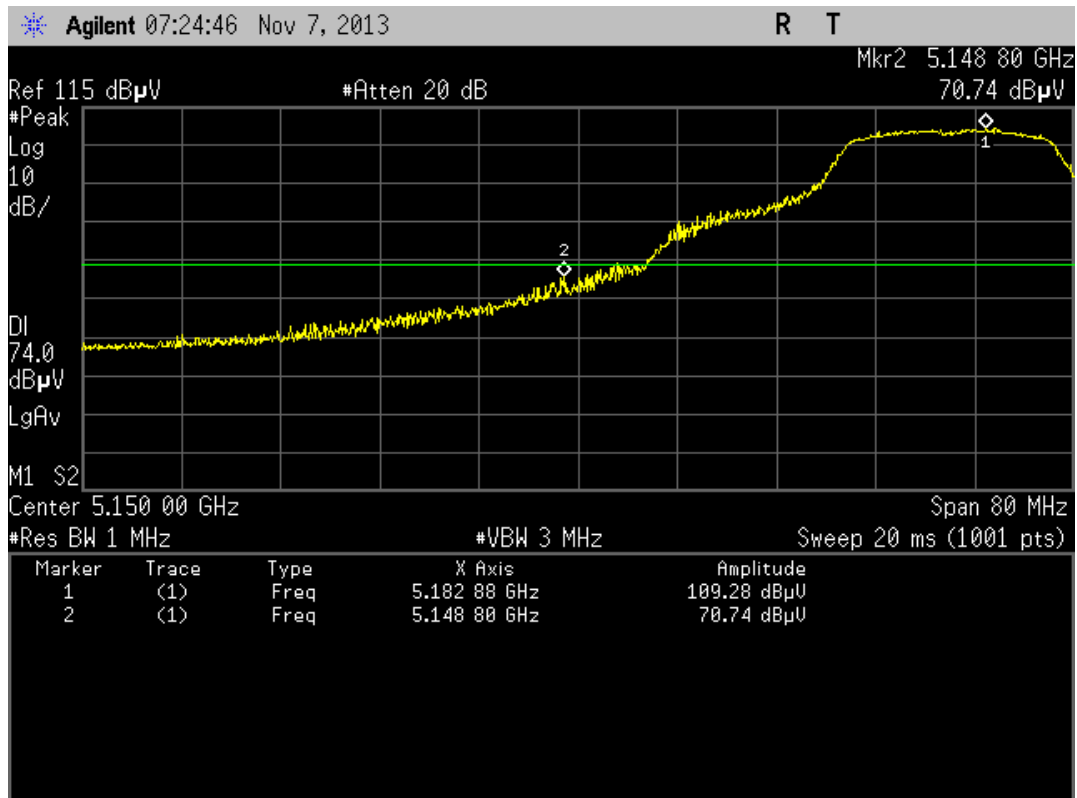
802.11a, 6Mbit/s, Channel 36, TXf=5180MHz, band edge 5150 MHz



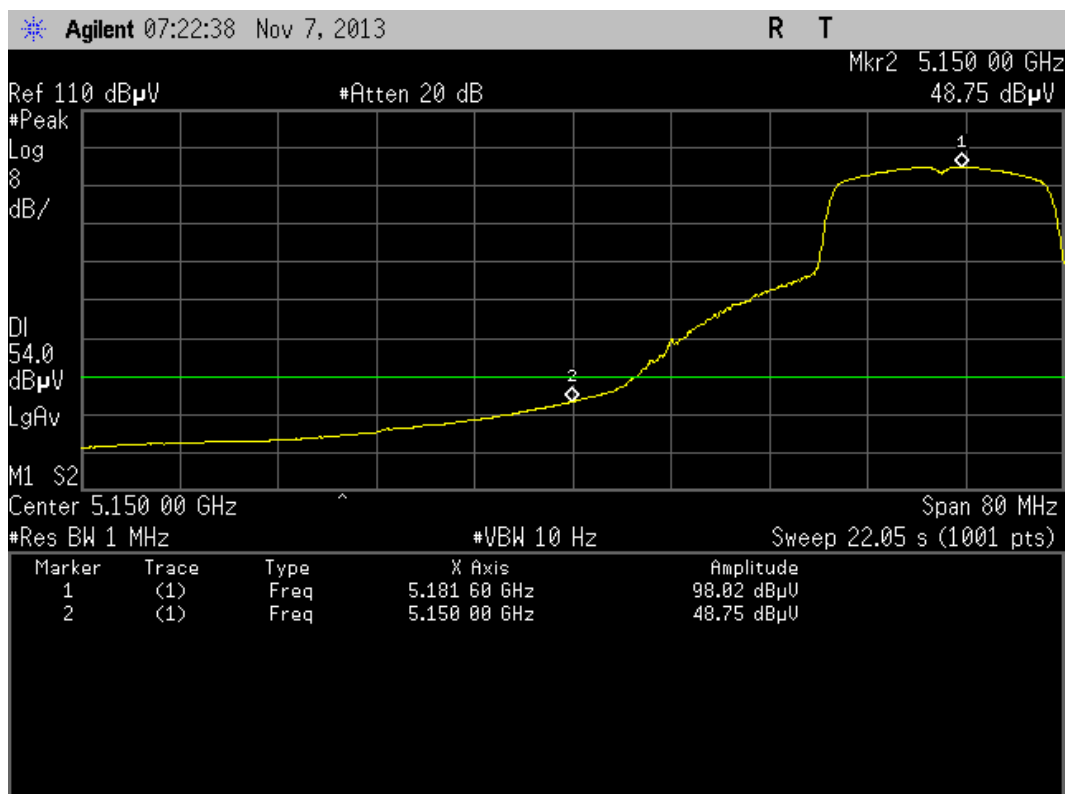
802.11a, 6Mbit/s, Channel 48, TXf=5240MHz, band edge 5250/5350 MHz



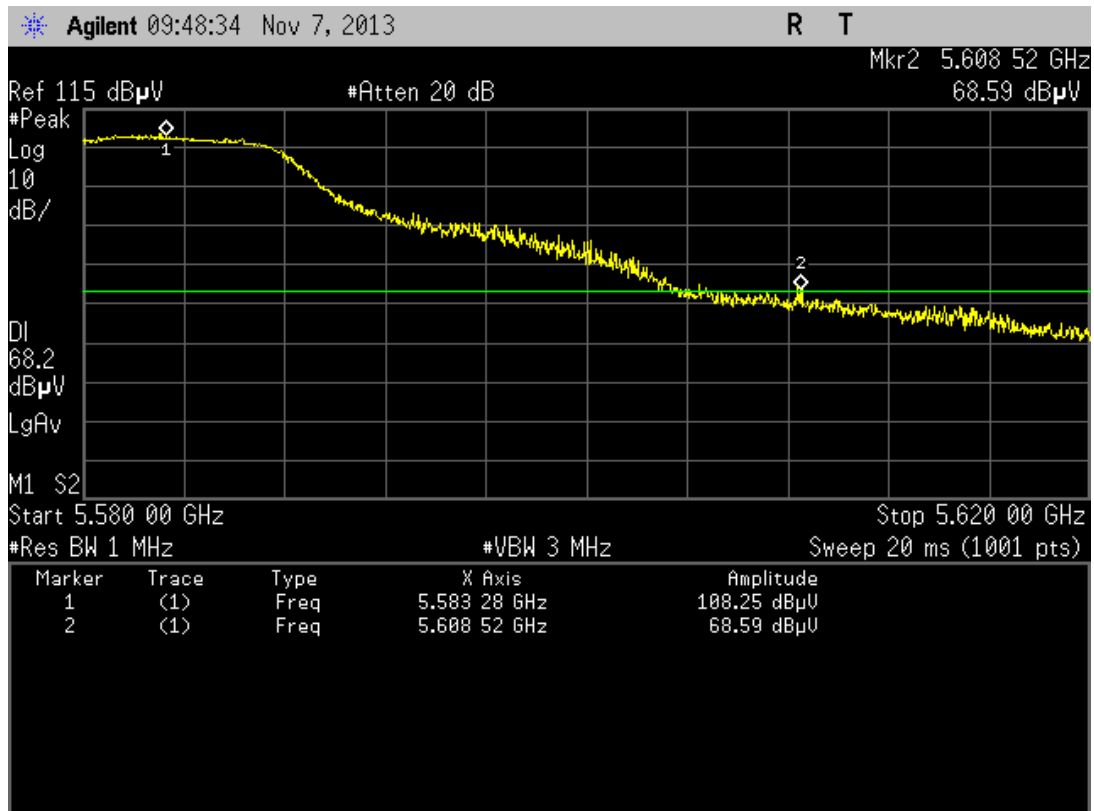
802.11a, 6Mbit/s, Channel 48, TXf=5240MHz, band edge 5250/5350 MHz



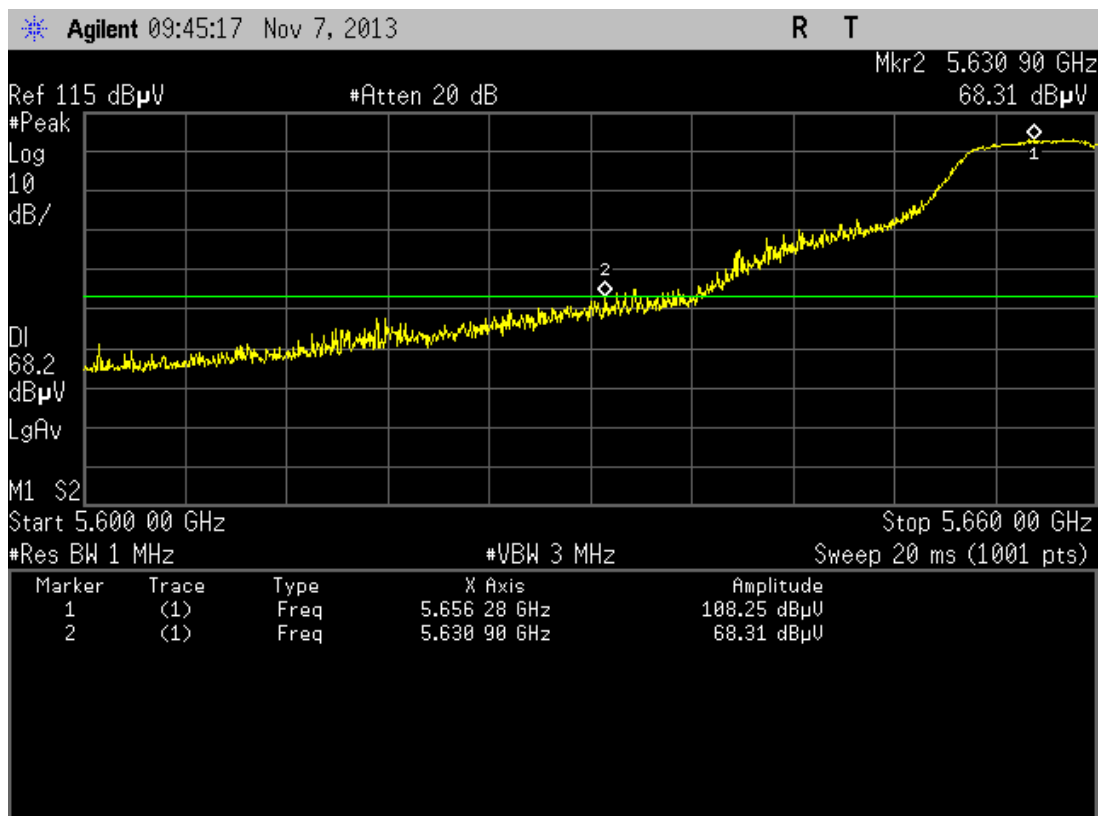
802.11 n 20MHz BW, Channel 36, TXf=5180MHz, band edge 5150 MHz



802.11 n 20MHz BW, Channel 36, TXf=5180MHz, band edge 5150 MHz



802.11n 20MHz BW, Channel 116, TXf=5580MHz



802.11n 20MHz BW, Channel 132, TXf=5660MHz

3.5 Peak power spectral density

The test was performed as a compliance test. The test parameters concerned were as follows:

<i>Site name</i>	SGS Fimko EMC Oy/ Perkkaa
<i>FCC rule part</i>	§ 15.407
<i>Date of testing</i>	4.11.2013
<i>Test equipment</i>	566, X1
<i>Test conditions</i>	25 °C, 35 % RH
<i>Test result</i>	PASS

3.5.1 Test method and limit

Test method F (E SA-1) 789033 D01 General UNII Test Procedures v01r03 was used.
SA RBW=1MHz and VBW=8MHz. Trace average 100 traces in power averaging mode was used.
Gated sweep was used in order not to have periods OFF included in the average. Peak search was used to find maximum level on the display.

The antenna port of the EUT was connected to the spectrum analyzer.

5150 – 5250 MHz:

Antenna gain <2 dBi => limit = 4 dBm

5250 – 5350 MHz:

Antenna gain <2 dBi => limit = 11 dBm

5470 – 5725 MHz:

Antenna gain <2 dBi => limit = 11 dBm

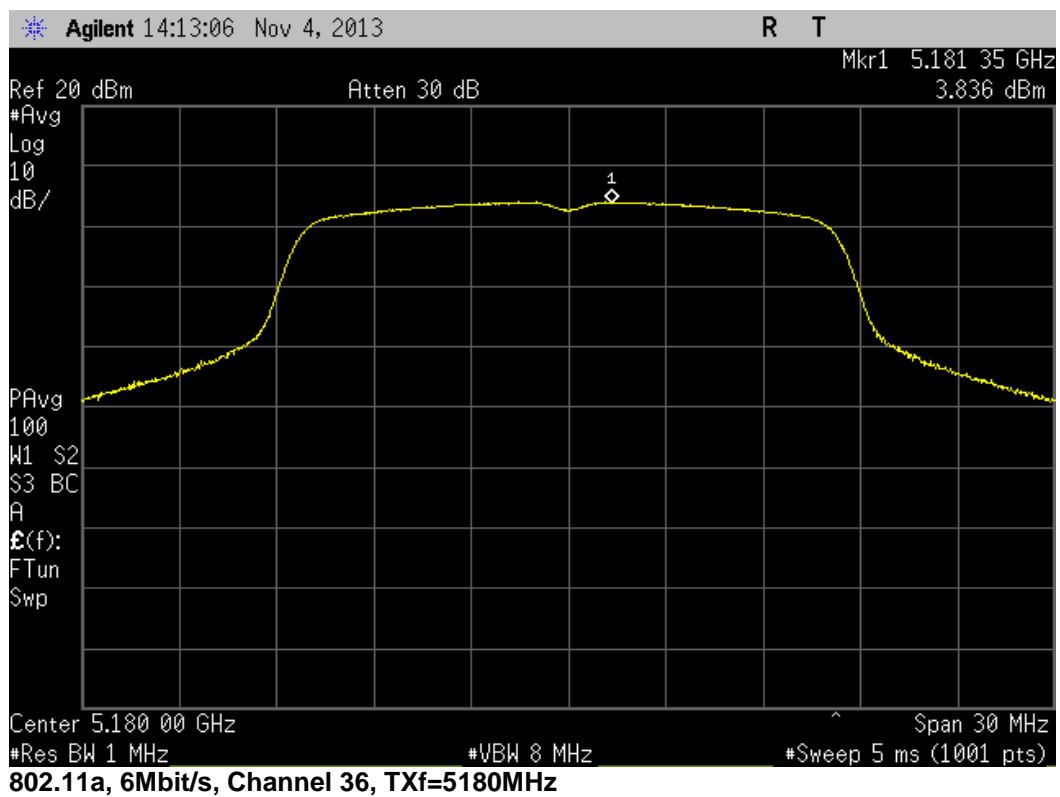
3.5.2 Test results

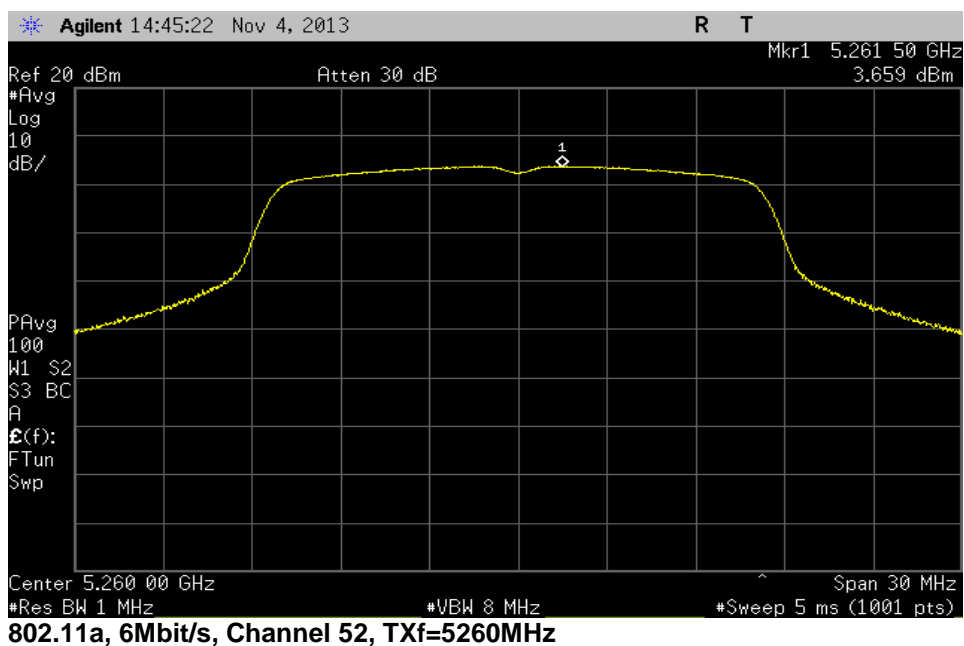
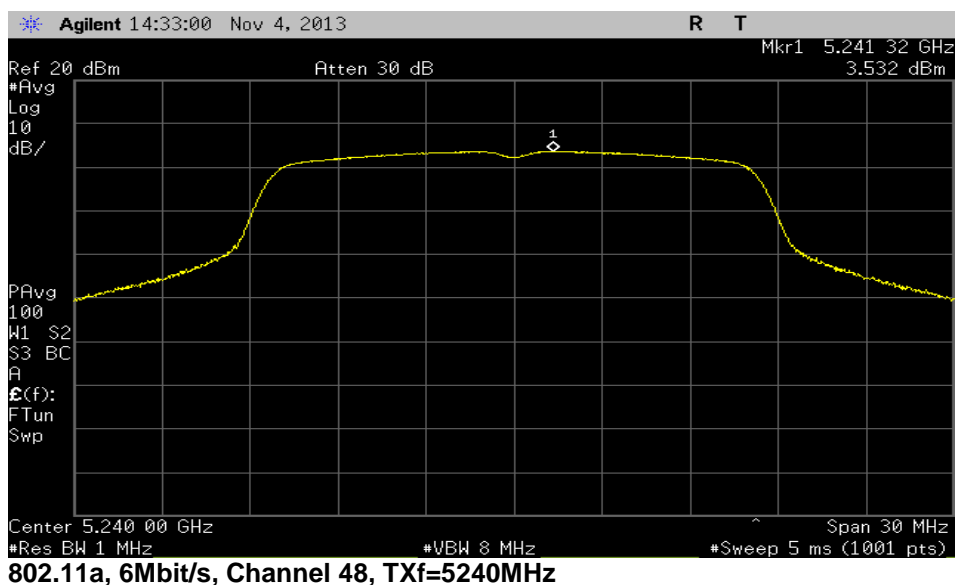
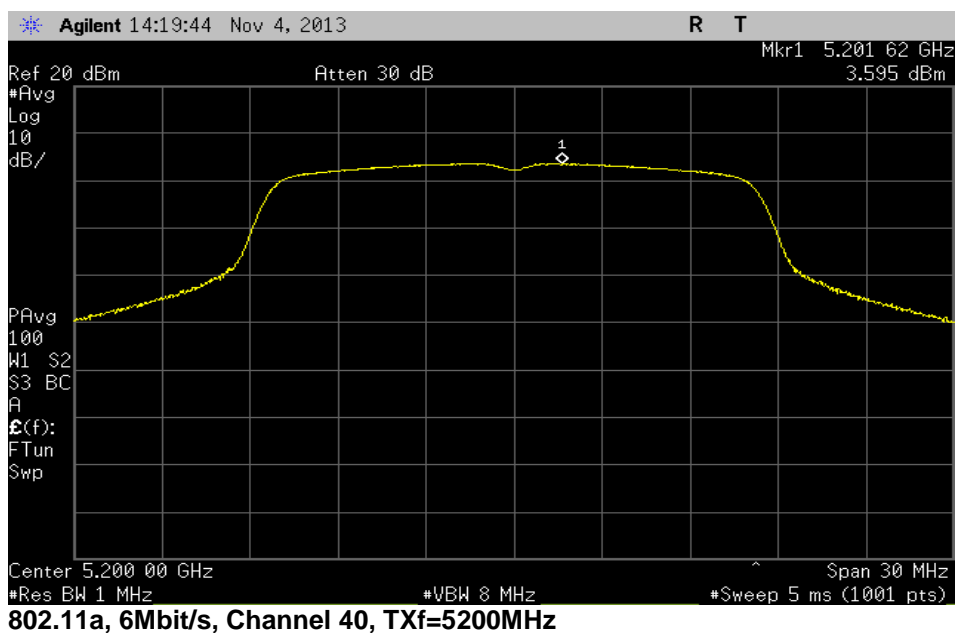
802.11a, 6Mbit/s

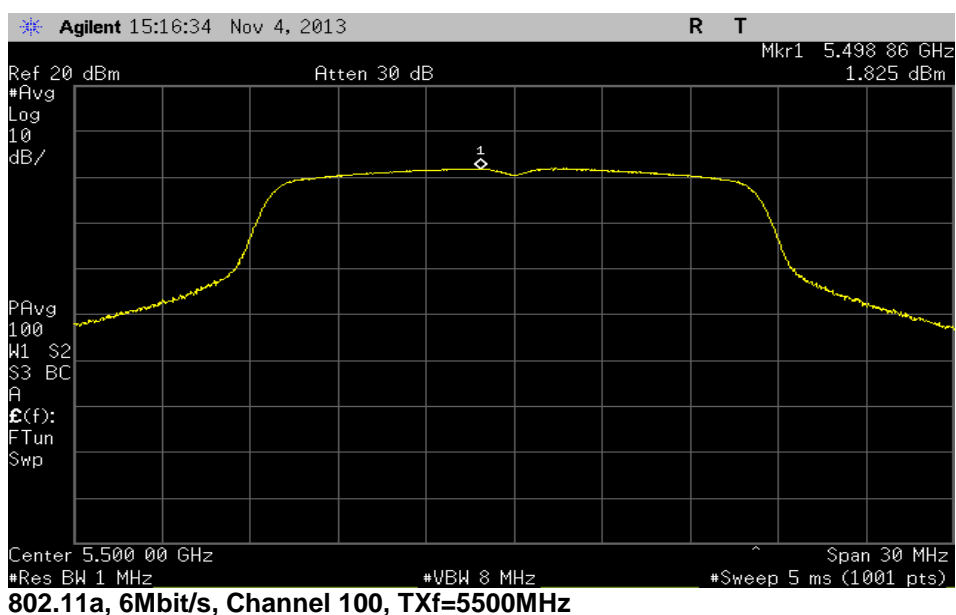
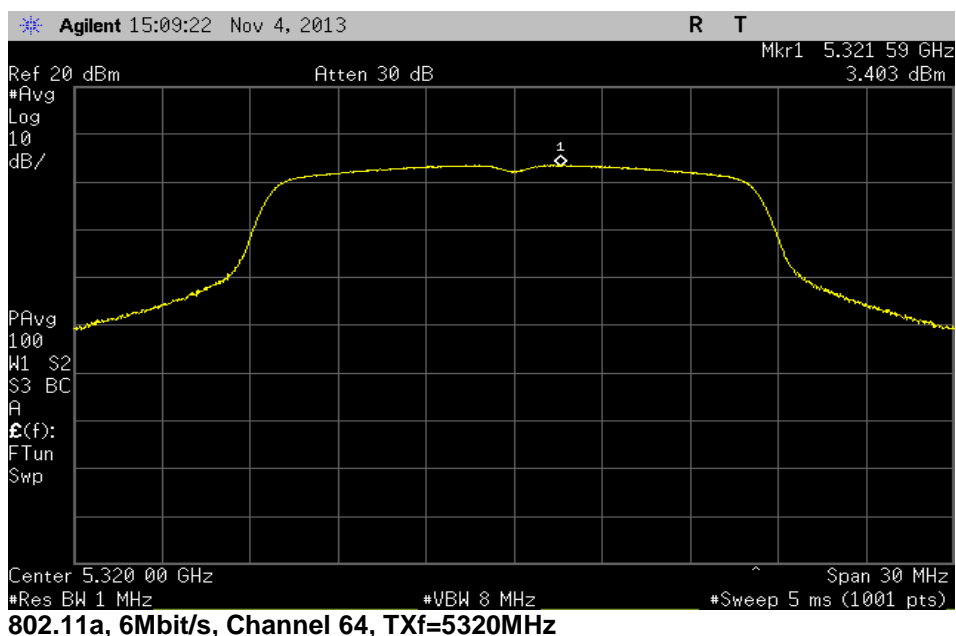
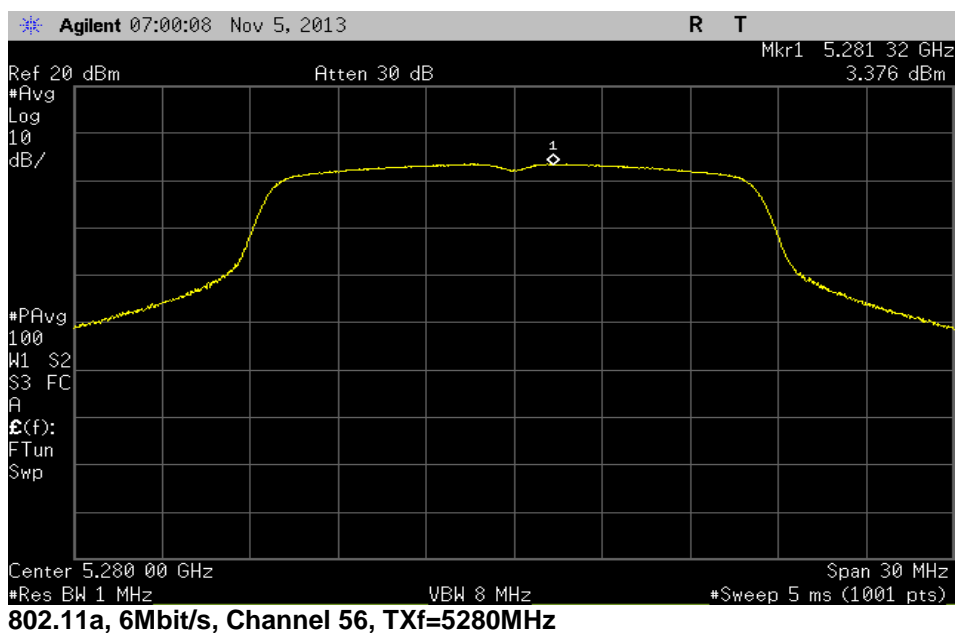
<i>Channel</i>	<i>Frequency MHz</i>	<i>Result dBm</i>	<i>Limit dBm</i>	<i>Margin dBm</i>
36	5180	3.83	4.0	0.17
40	5200	3.59	4.0	0.41
48	5240	3.53	4.0	0.47
52	5260	3.66	11.0	7.34
56	5280	3.37	11.0	7.63
64	5320	3.40	11.0	7.60
100	5500	1.82	11.0	9.18
116	5580	2.04	11.0	8.96
140	5700	1.92	11.0	9.08

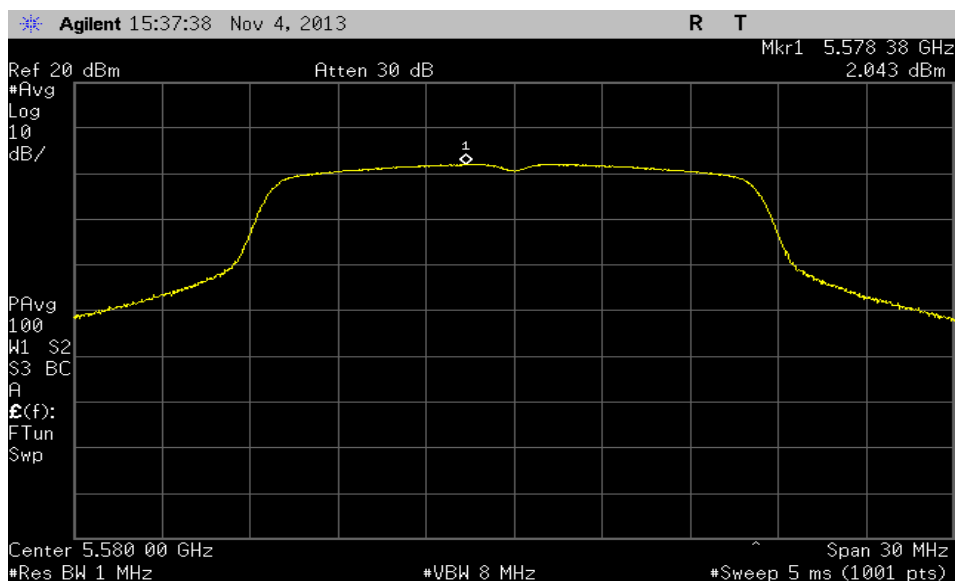
802.11n, 20MHz BW, MCS0

Channel	Frequency MHz	Result dBm	Limit dBm	Margin dBm
36	5180	3.61	4.0	0.39
40	5200	3.34	4.0	0.66
48	5240	3.06	4.0	0.94
52	5260	3.38	11.0	7.62
56	5280	3.21	11.0	7.79
64	5320	3.06	11.0	7.94
100	5500	1.53	11.0	9.47
116	5580	1.36	11.0	9.64
140	5700	1.96	11.0	9.04

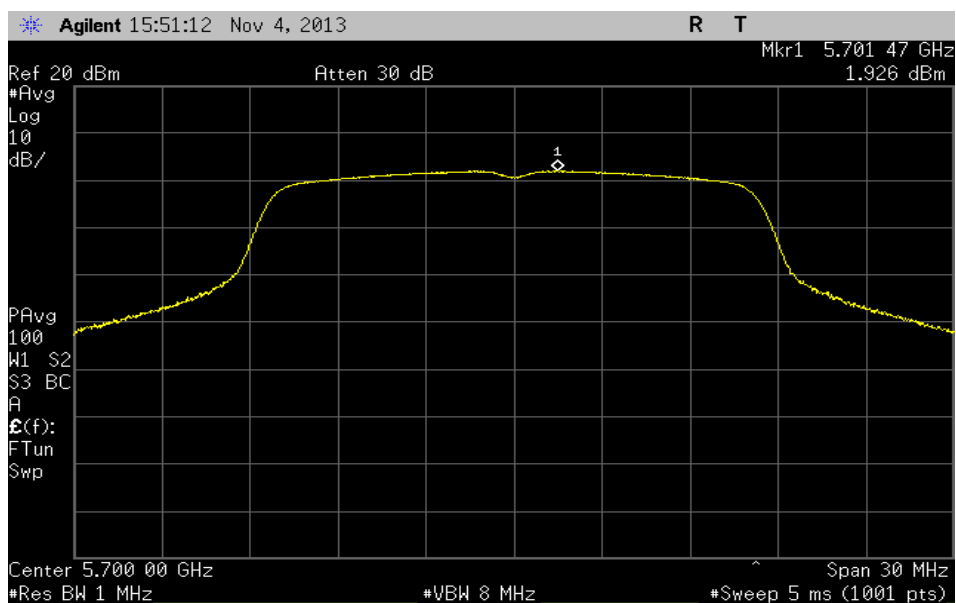




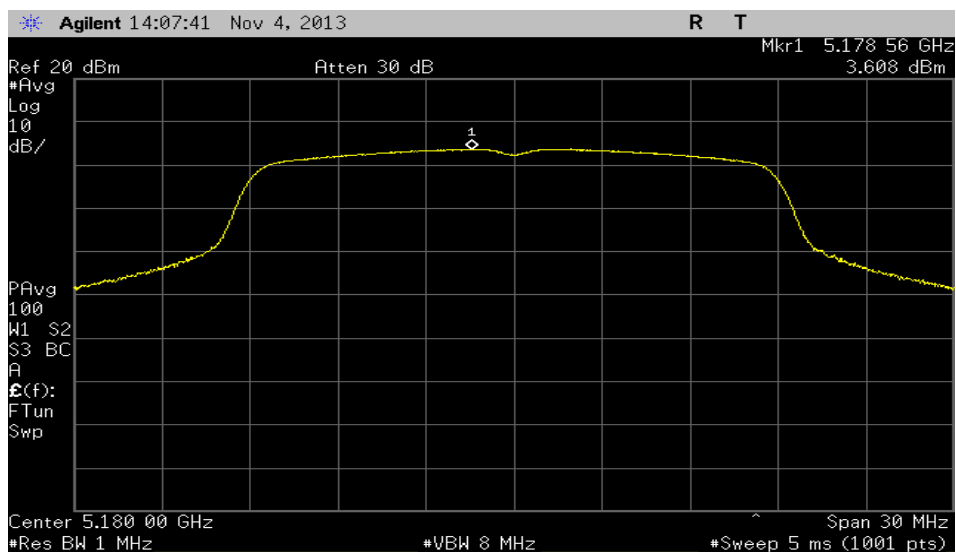




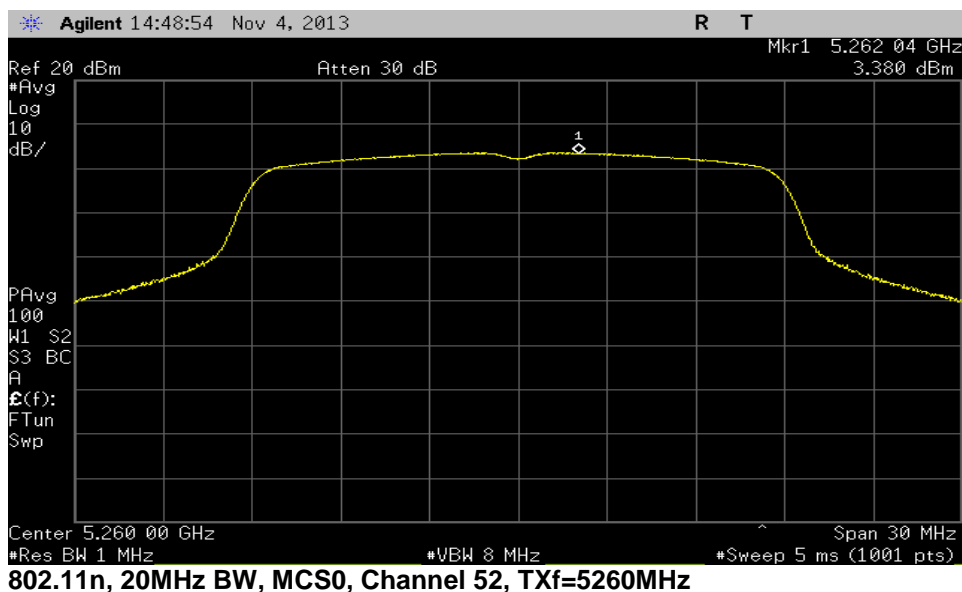
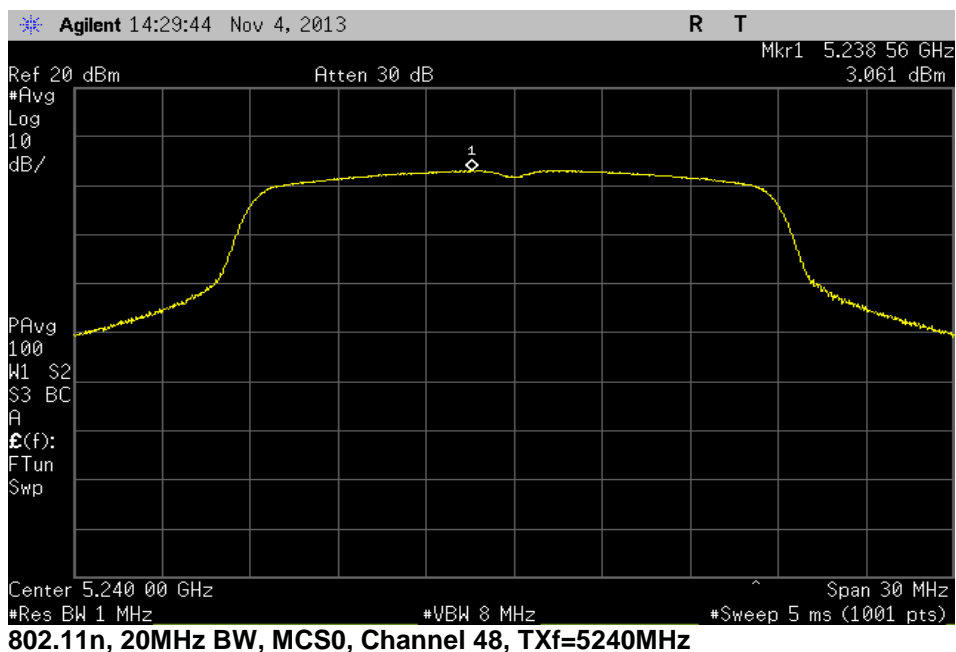
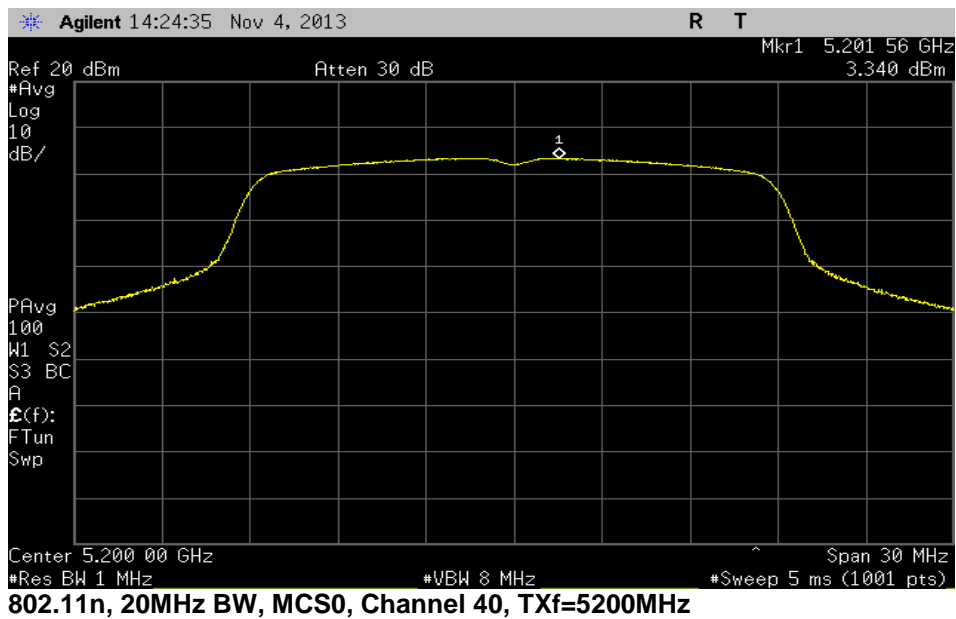
802.11a, 6Mbit/s, Channel 116, TXf=5580MHz

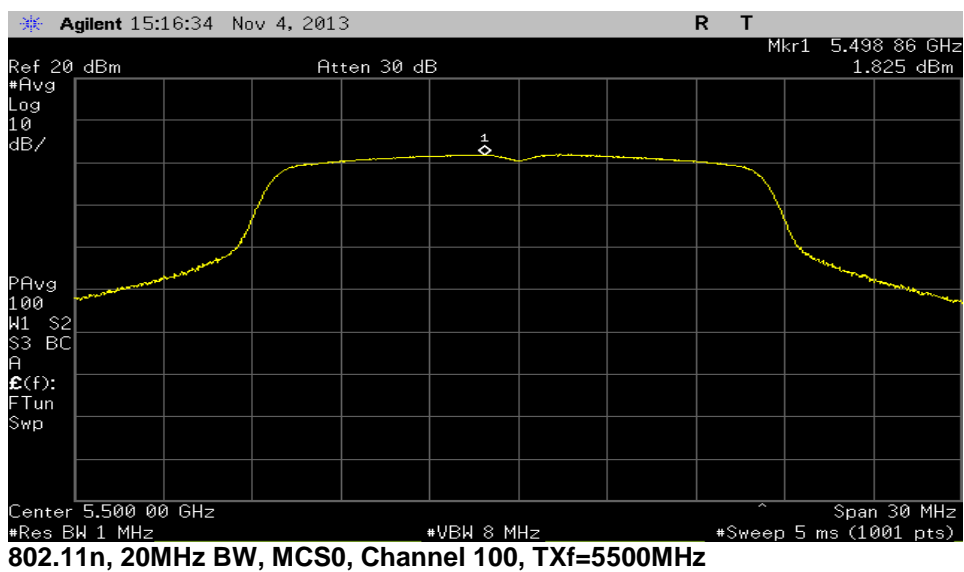
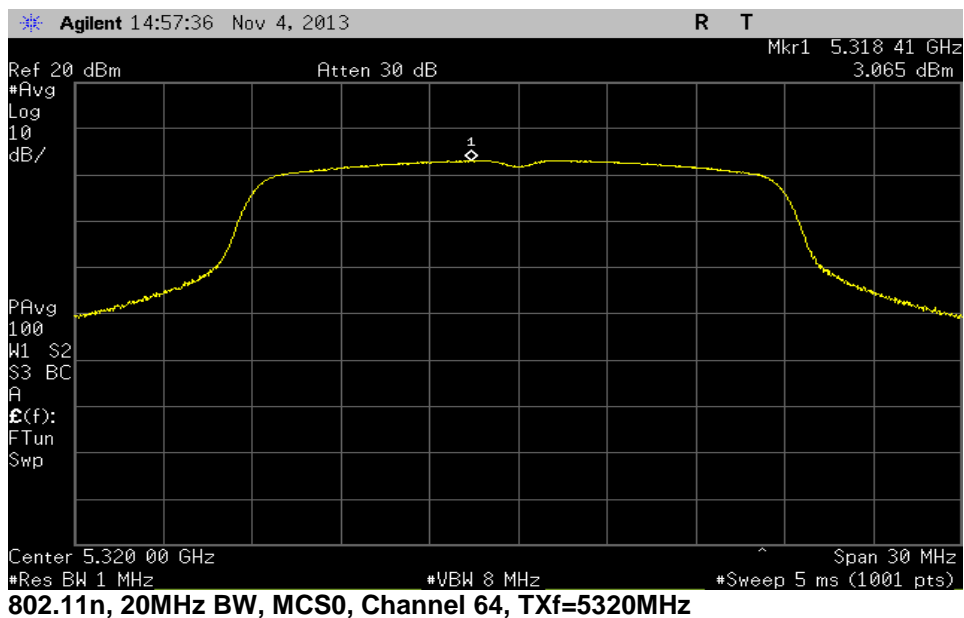
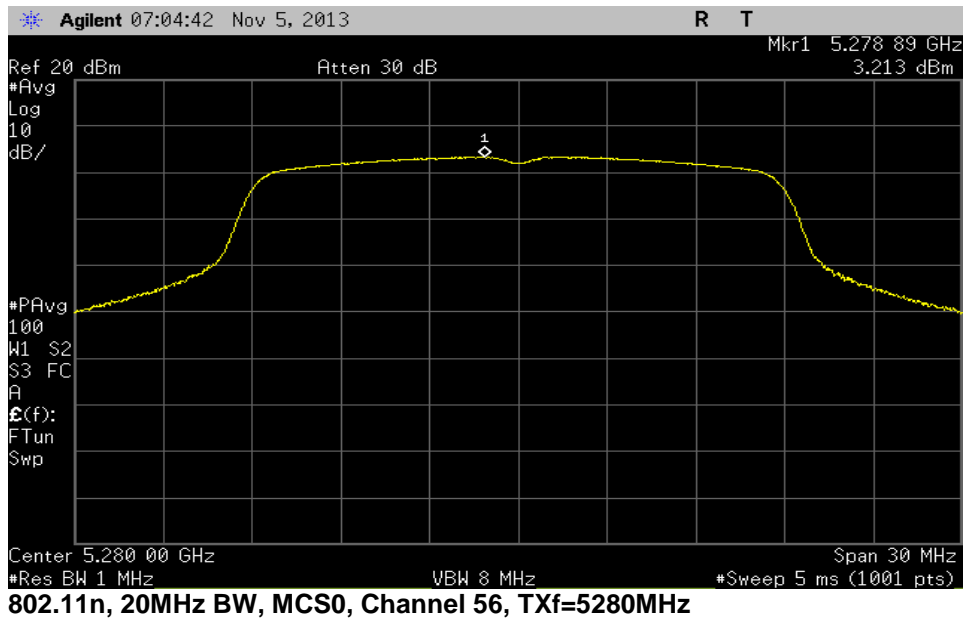


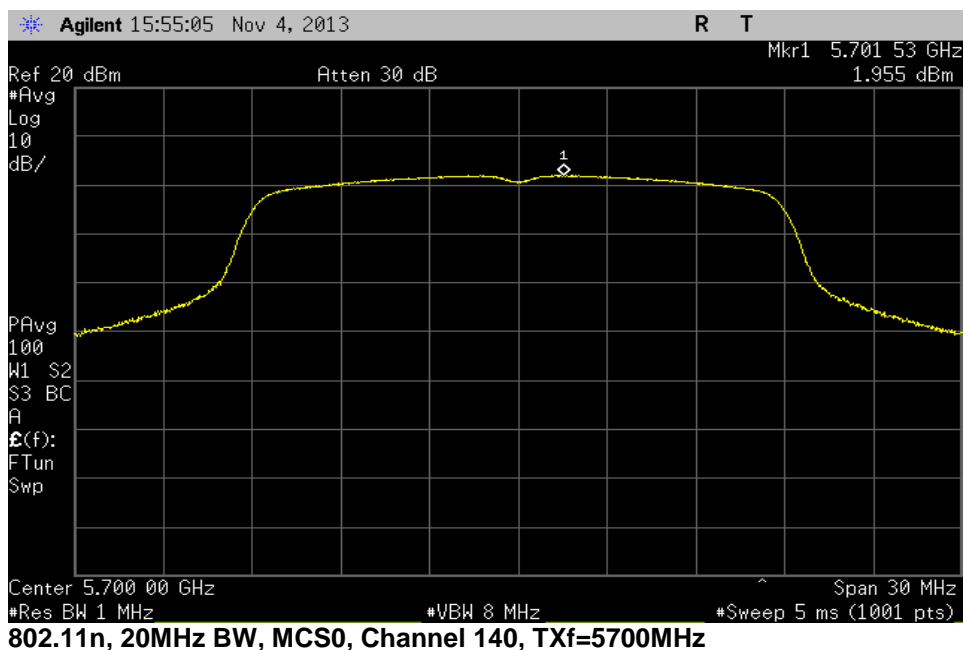
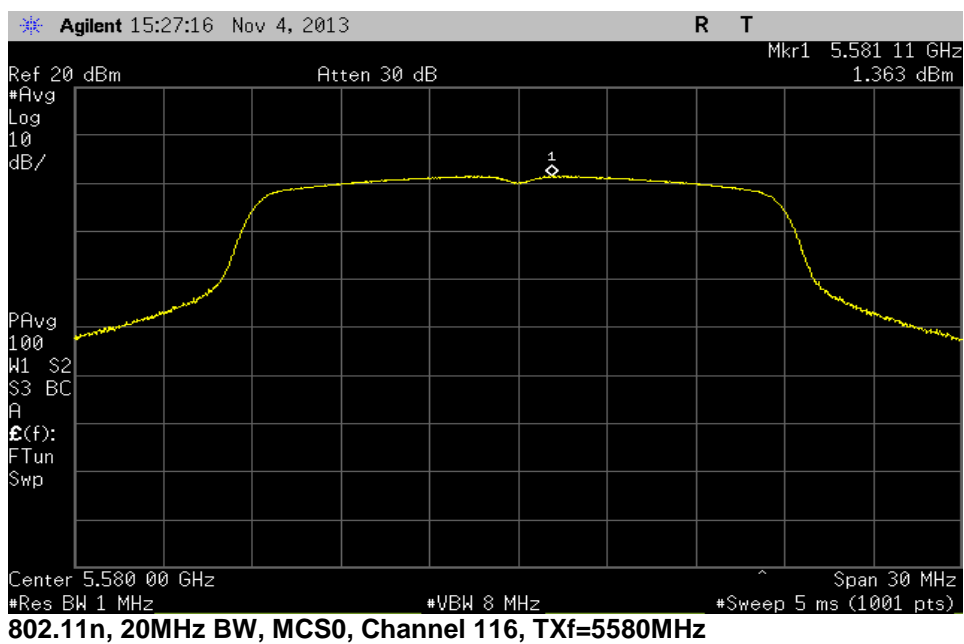
802.11a, 6Mbit/s, Channel 140, TXf=5700MHz



802.11n, 20MHz BW, MCS0, Channel 36, TXf=5180MHz







3.6 Peak power excursion

The test was performed as a compliance test. The test parameters concerned were as follows:

<i>Site name</i>	SGS Fimko EMC Oy/ Perkkaa
<i>FCC rule part</i>	§ 15.407
<i>Date of testing</i>	20.11.2013
<i>Test equipment</i>	566, X1
<i>Test conditions</i>	23 °C, 35 % RH
<i>Test result</i>	PASS

3.6.1 Test method and limit

Test method G 789033 D01 General UNII Test Procedures v01r03 was used.

Trace 1

Test method E SA-1 789033 D01 General UNII Test Procedures v01r03 was used. RBW=1MHz and VBW=8MHz. Trace average 100 traces in power averaging mode was used. Gated sweep was used in order not to have periods OFF included in the average.

Trace 2

RBW=1MHz and VBW=8MHz. Peak detector, trace MAX HOLD.

Maximum of traces 1 and trace 2 was read and subtracted.

<i>Frequency band, MHz</i>	Limit
5150-5250	< 13 dB
5250-5350	< 13 dB
5470-5725	< 13 dB

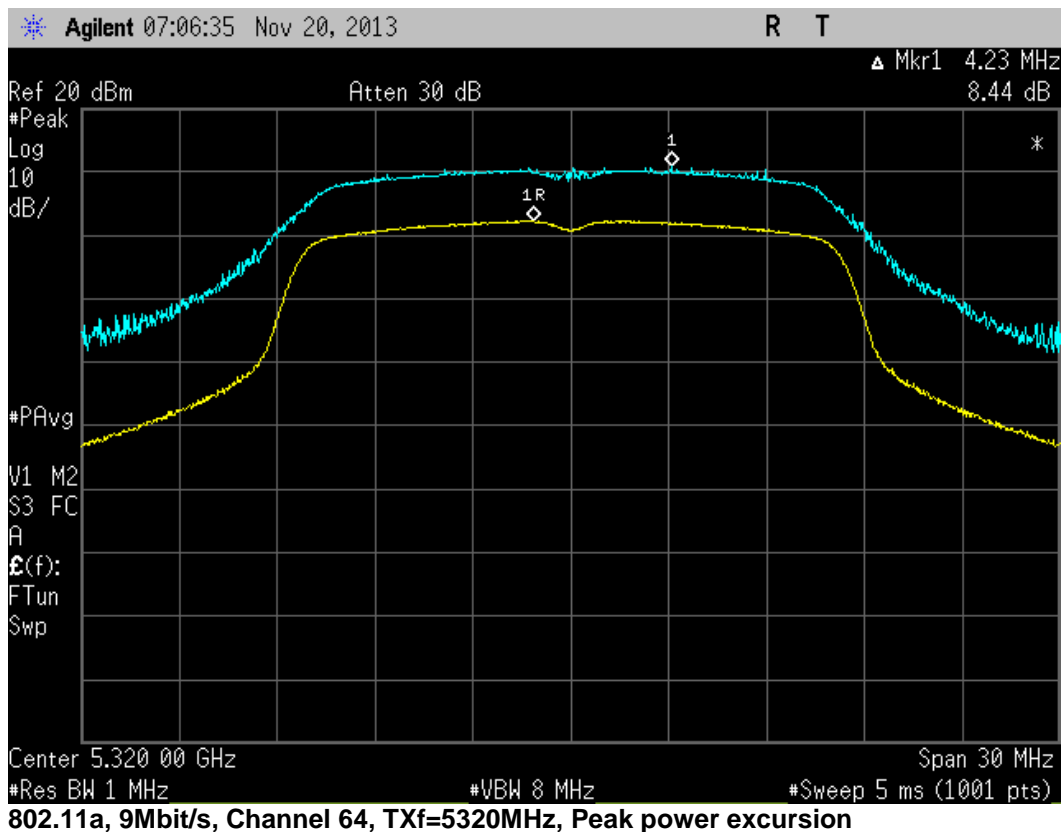
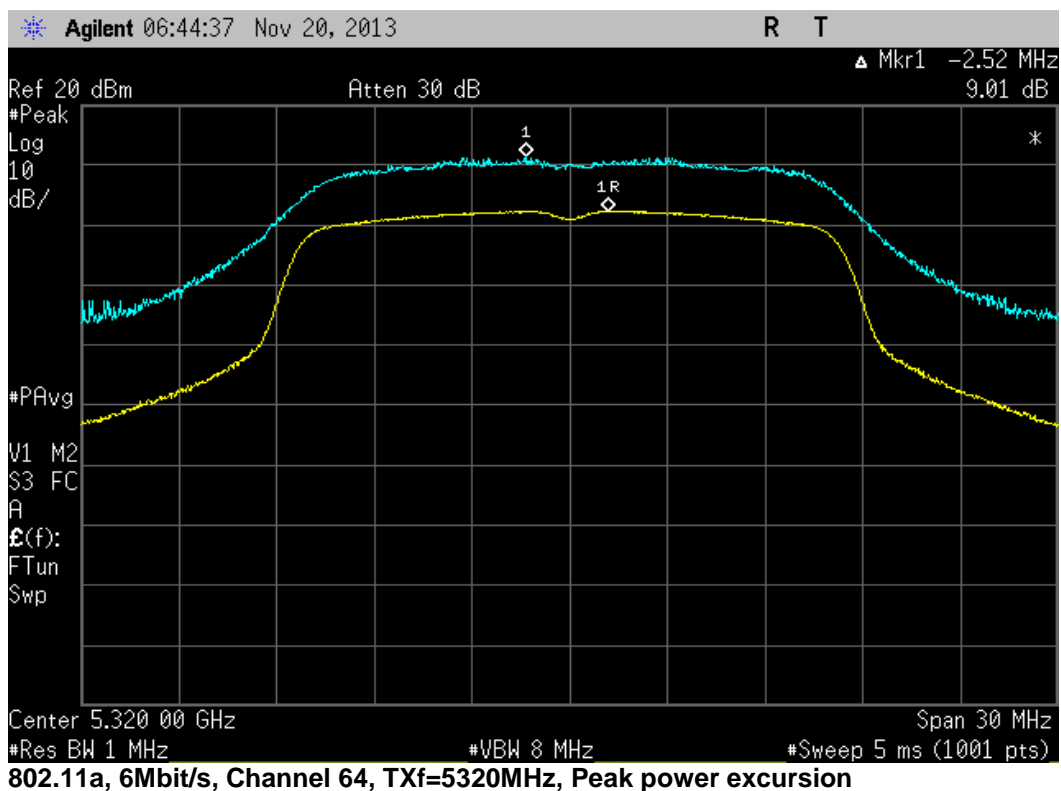
3.6.2 Test results

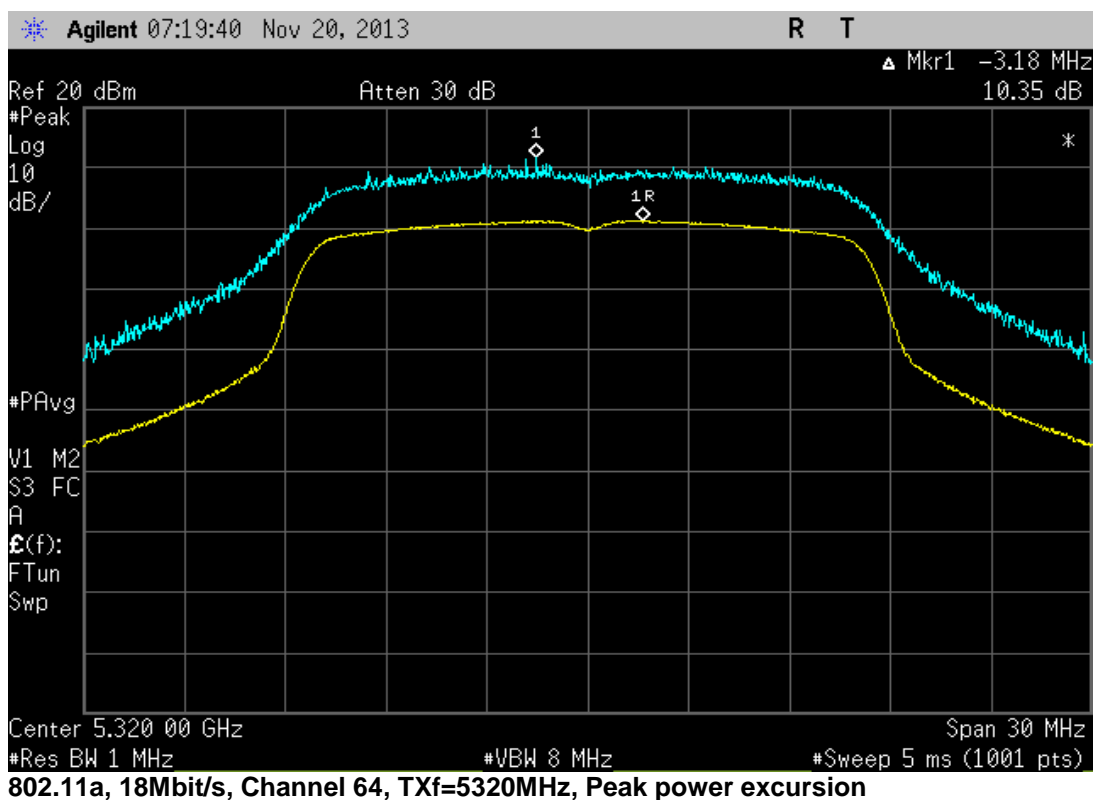
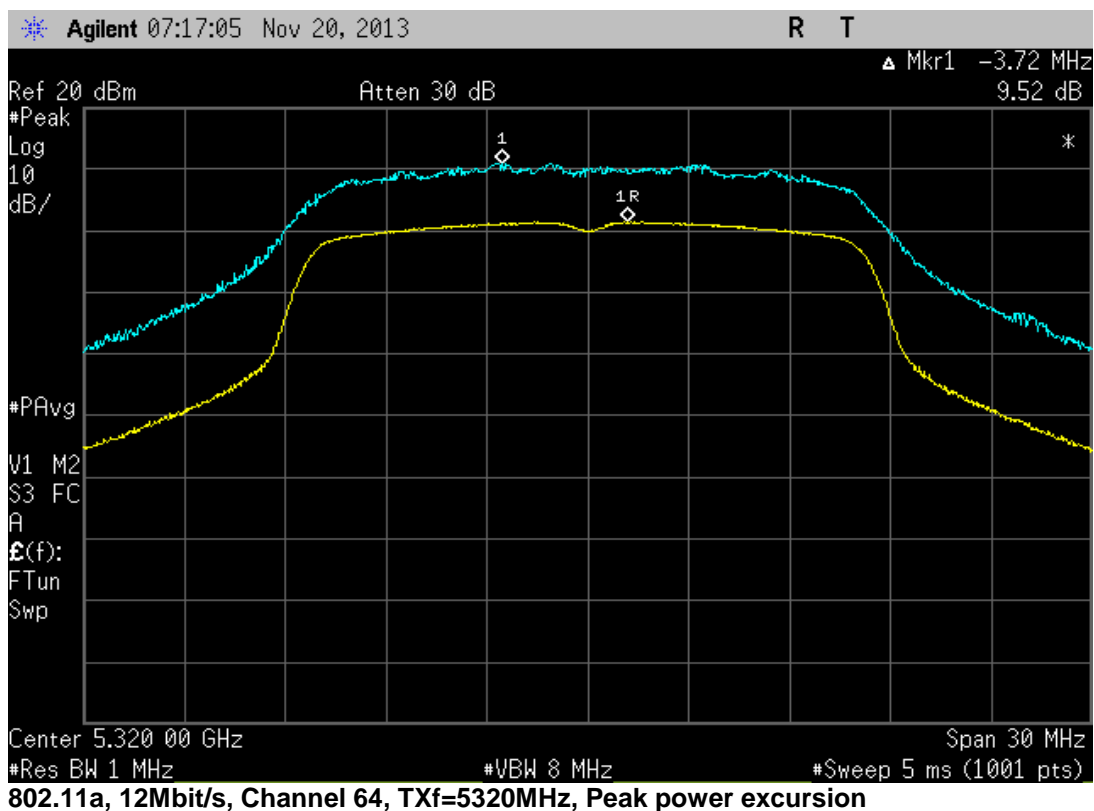
802.11a, Channel 64 5320MHz

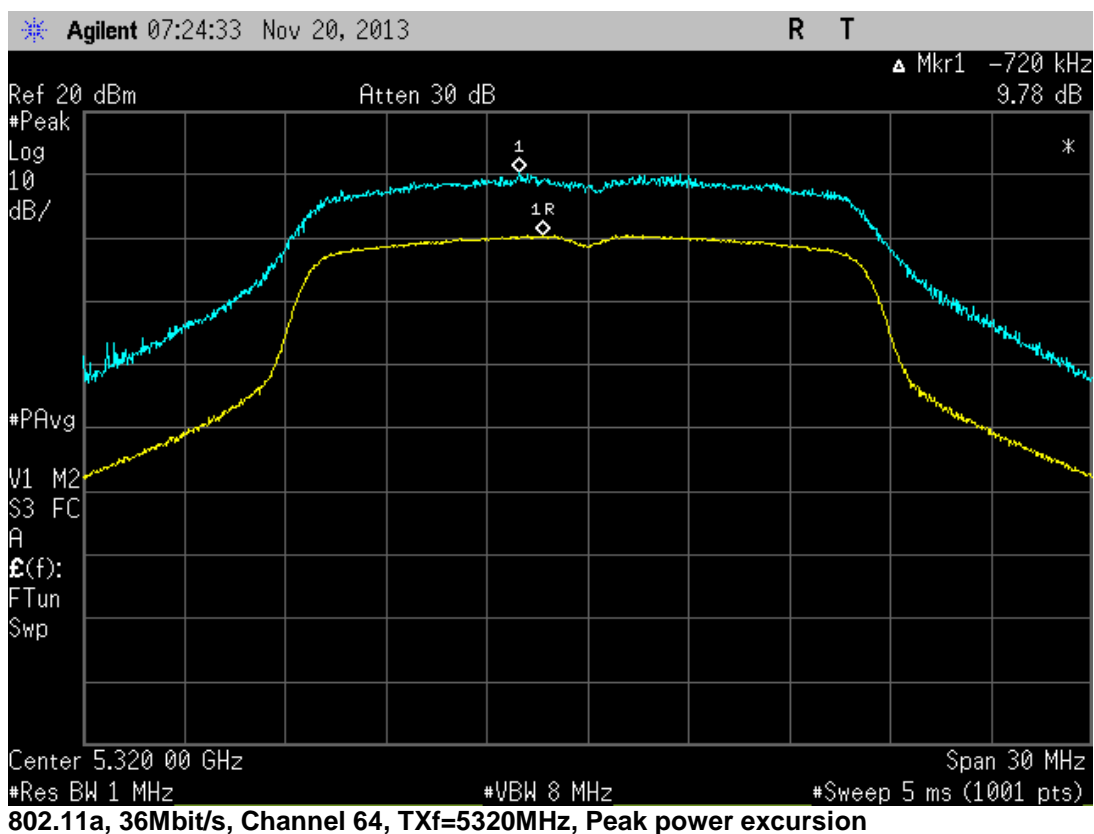
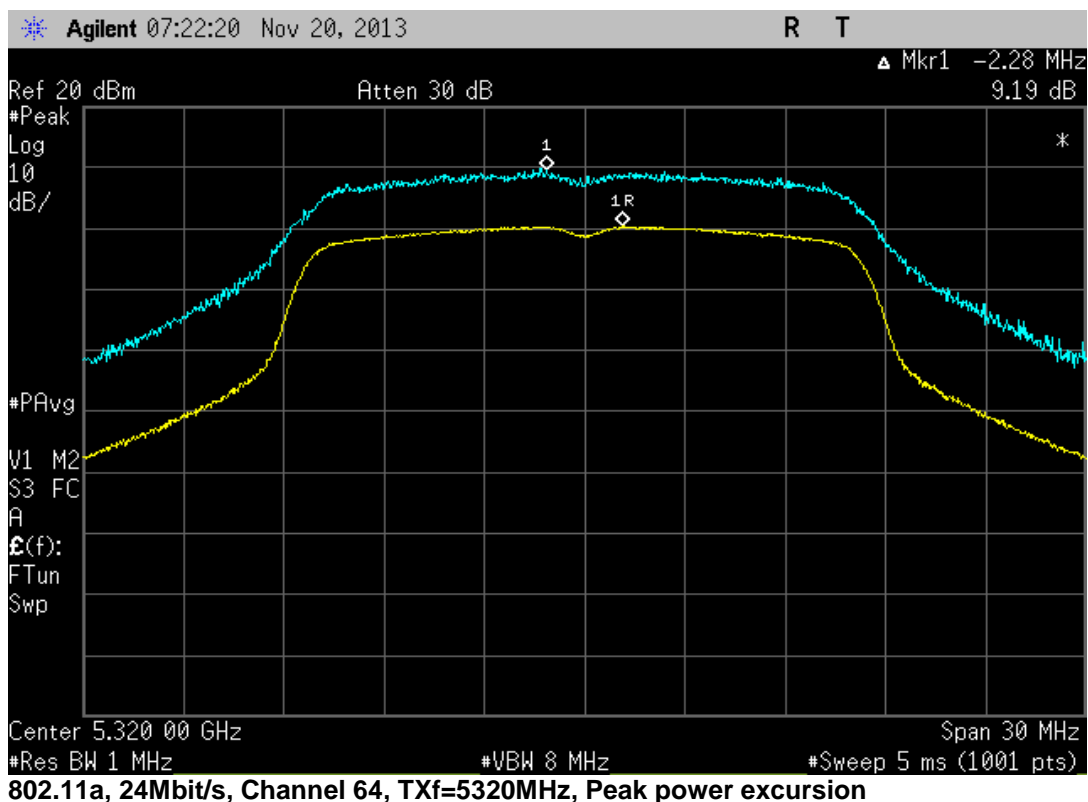
<i>Frequency MHz</i>	<i>Mbps</i>	<i>Result dB</i>	<i>Limit dB</i>	<i>Margin dB</i>
5320	6	9.01	13	3.99
5320	9	8.44	13	4.56
5320	12	9.52	13	3.48
5320	18	10.35	13	2.65
5320	24	9.19	13	3.81
5320	36	9.78	13	3.22
5320	48	9.42	13	3.58
5320	54	10.06	13	2.94

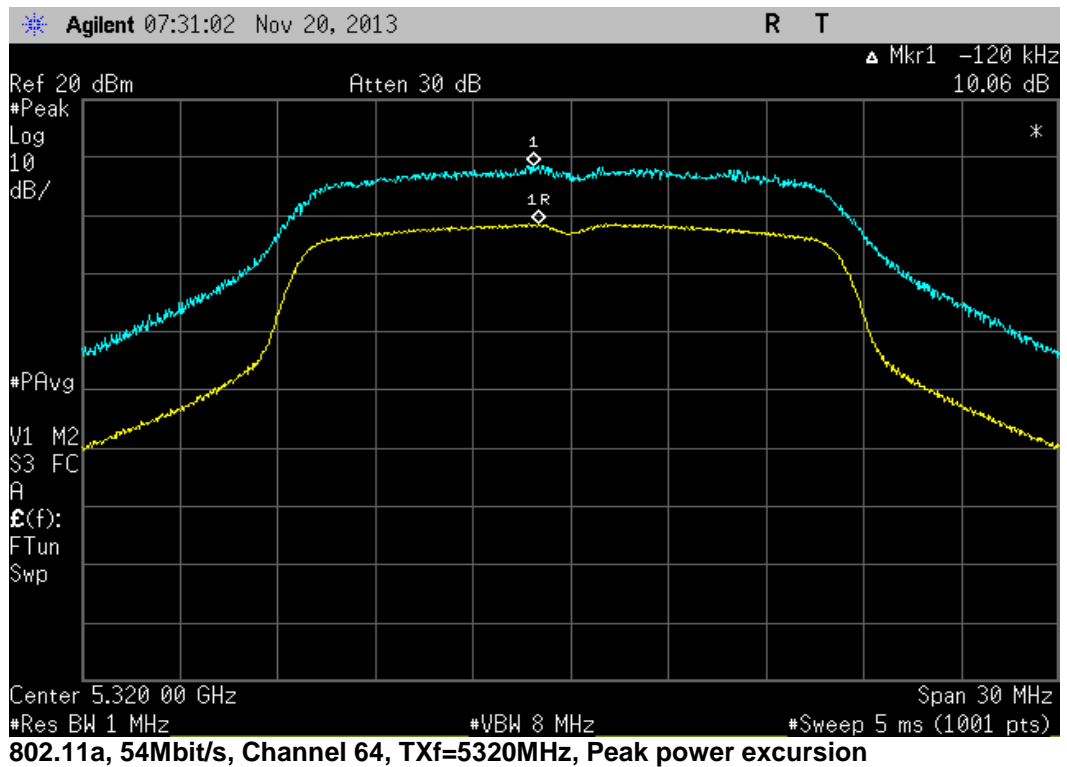
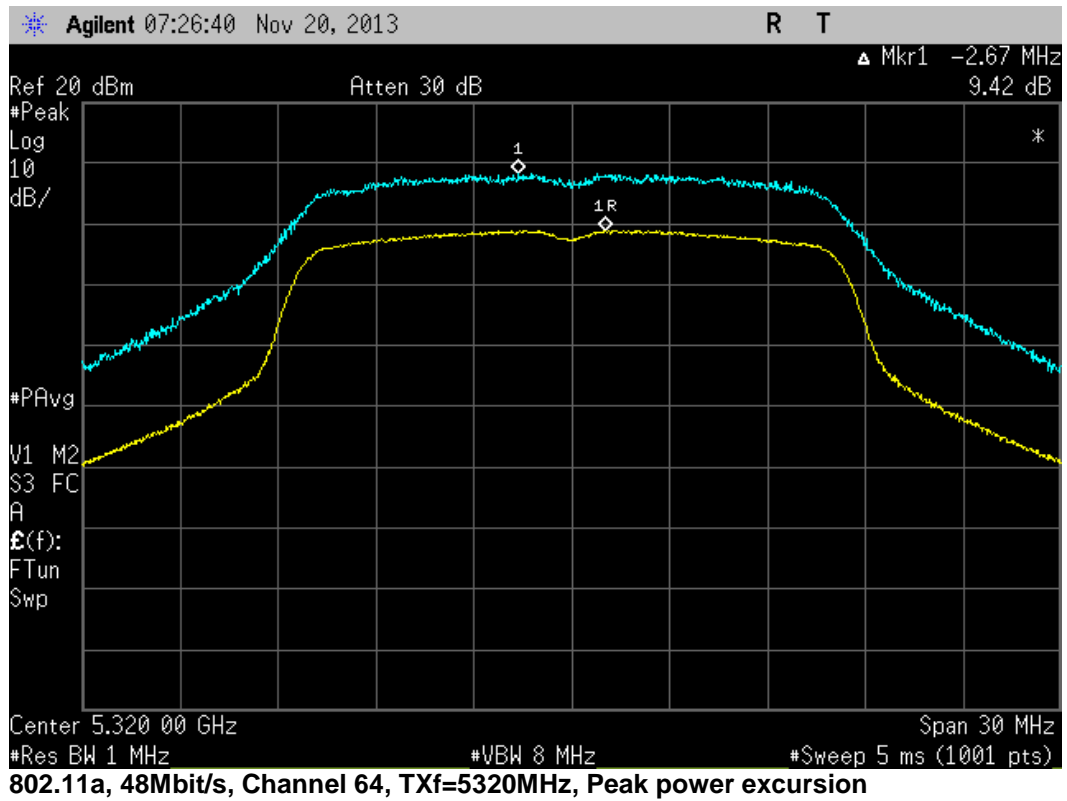
802.11n, 20MHz BW, Channel 64 5320MHz

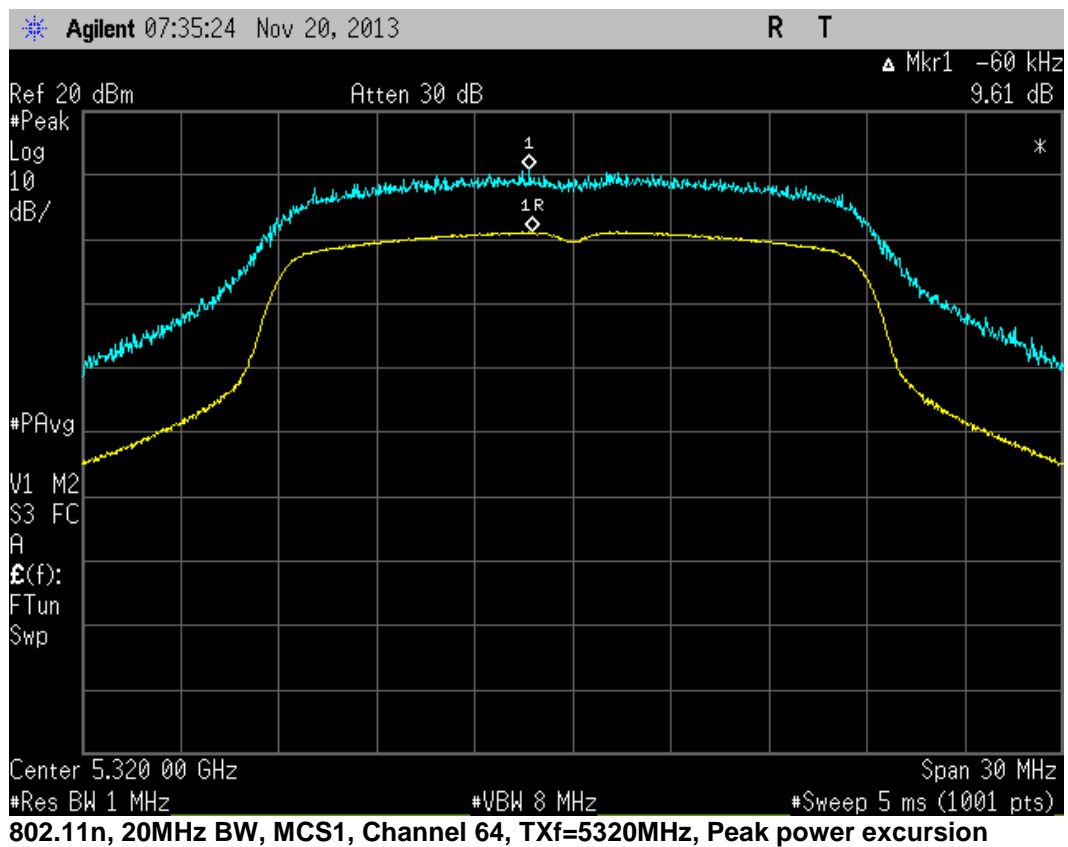
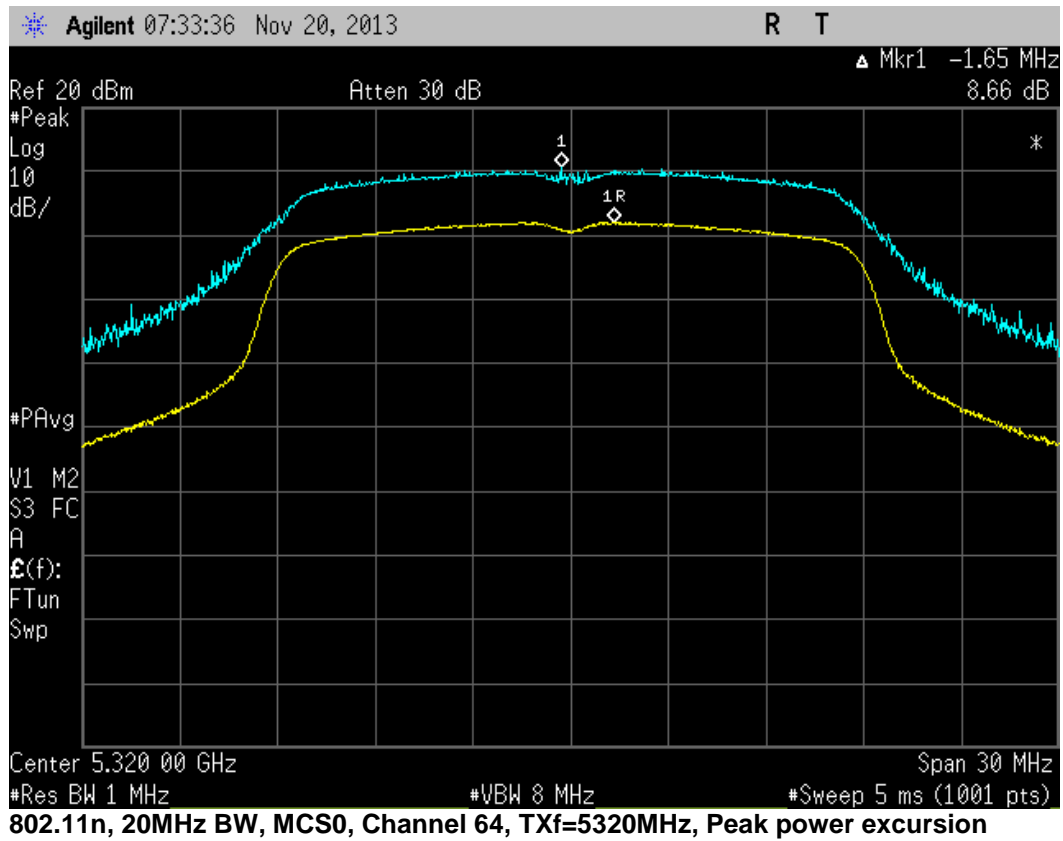
<i>Frequency MHz</i>	<i>MCS index</i>	<i>Modulation</i>	<i>Result dB</i>	<i>Limit dB</i>	<i>Margin dB</i>
5320	MCS0	BPSK	8.66	13	4.34
5320	MCS2	QPSK	9.61	13	3.39
5320	MCS3	16-QAM	10.38	13	2.62
5320	MCS6	64-QAM	9.88	13	3.12

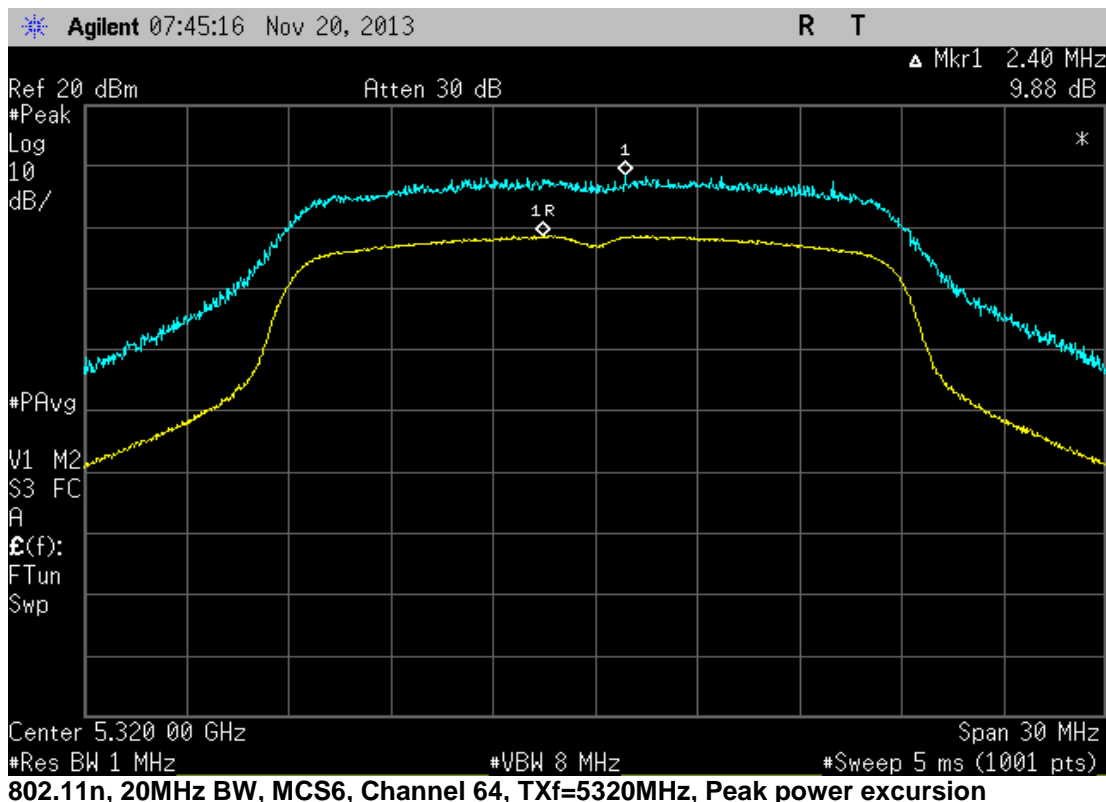
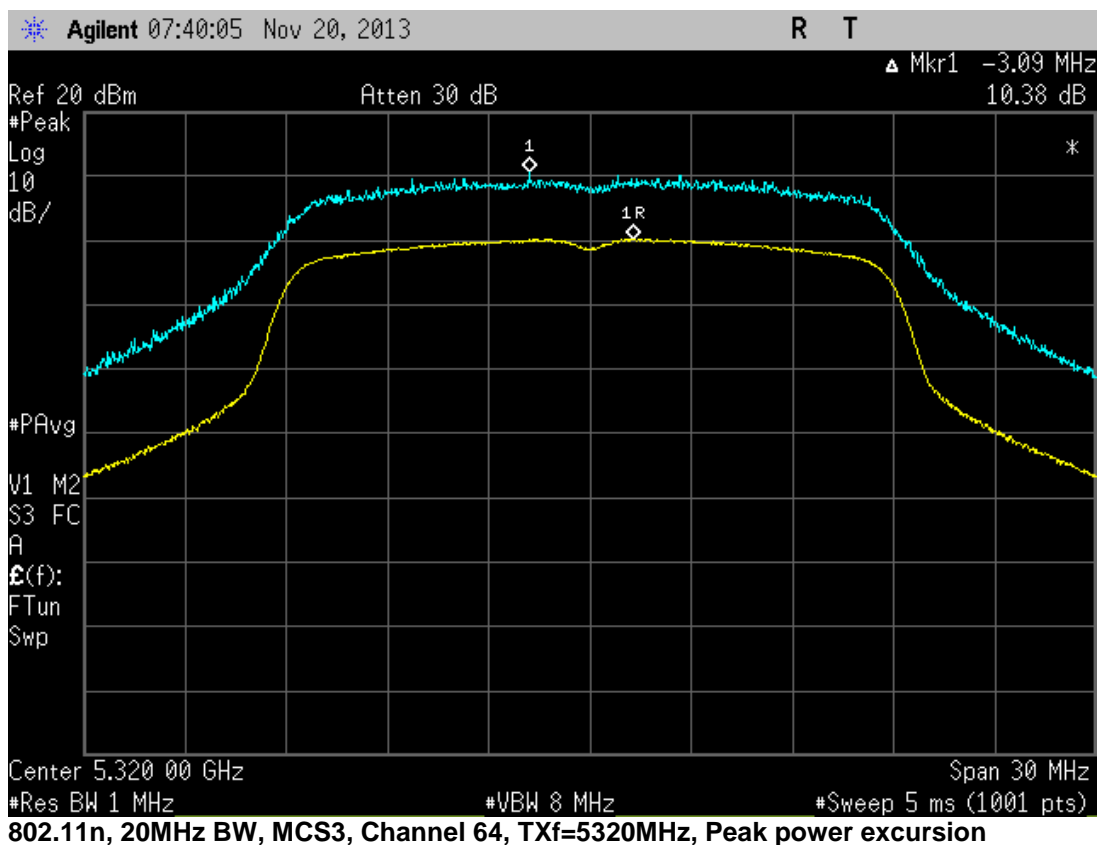












3.7 Frequency stability

The test was performed as a compliance test. The test parameters concerned were as follows:

Site name	SGS Fimko EMC Oy/ Perkaa
FCC rule part	§ 15.407
Date of testing	07.11.2013
Test equipment	566, X1, 307, 563
Test conditions	22 °C, 35 % RH
Test result	PASS

3.7.1 Test method and limit

The antenna port of the EUT was connected to the spectrum analyzer.

The frequency tolerance of the carrier signal shall be maintained within the band of operation frequency over a temperature variation of -30 degrees to +50 degrees at normal supply voltage, and for a variation in the supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C.

3.7.2 Test results

Frequency stability versus temperature

802.11a, 6Mbit/s, Channel 149, TXf=5745MHz

Temperature °C	Frequency error kHz	Error %
50	2.65	0.0000461
40	2.25	0.0000392
30	1.85	0.0000322
20	1.65	0.0000287
10	1.45	0.0000252
0	0.85	0.0000148
-10	1.85	0.0000322
-20	2.65	0.0000461
-30	2.45	0.0000426

Frequency stability versus operating voltage

802.11a, 6Mbit/s, Channel 149, TXf=5745MHz

DC voltage	Frequency error kHz	Error %
12.7	1.65	0.0000287
11.1	1.65	0.0000287
9.0	1.65	0.0000287

4. List of test equipment

Each active test equipment is calibrated once a year, antennas every 18 months and other passive equipment every 24 months.

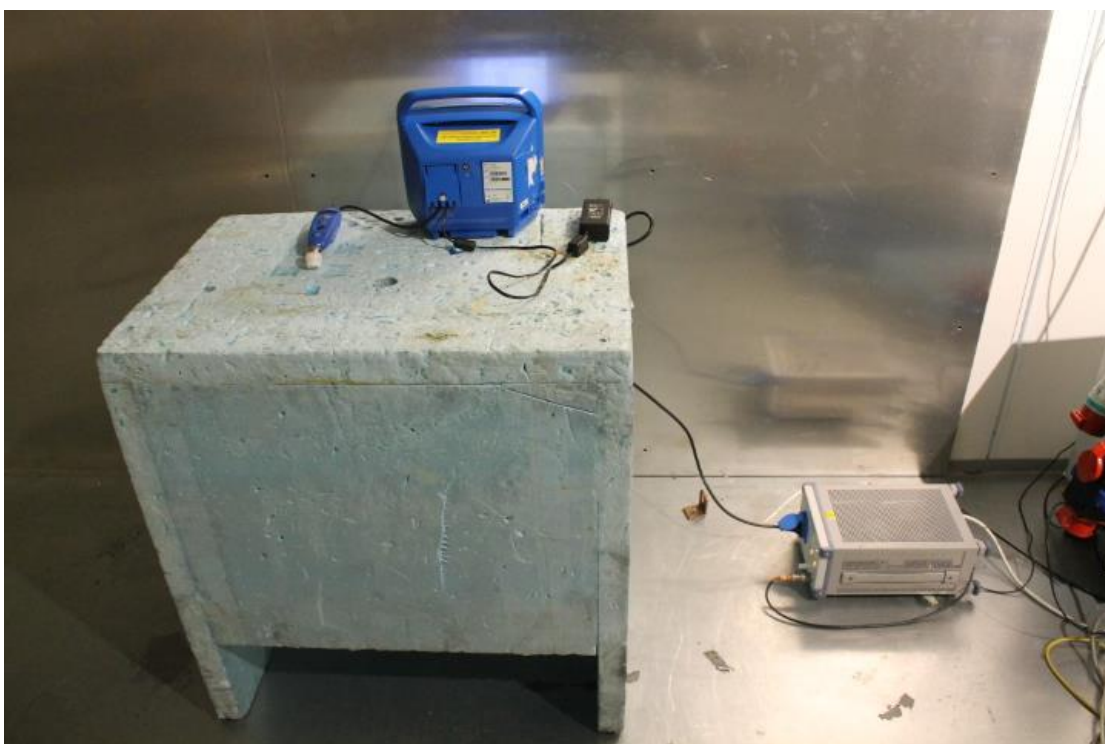
Nr.	Equipment	Type	Manufacturer	Serial number	Cal date	Cal due
694	EMI Test Receiver	ESPC	Rohde & Schwarz	842888/023	11.12.2012	12.2013
566	Spectrum analyzer	E4448A	Agilent	US42510236	17.4.2013	4.2014
709	EMI test receiver	ESU8	Rohde & Schwarz	100297	24.07.2013	7.2014
567	RF generator	E8257C	Agilent	MY43320736	25.2.2013	2.2014
544	RF-amplifier	ZFL-2000VH2	Mini-Circuits	QA0749010	9.1.2013	1.2014
564	RF amplifier	CA018-4010	CIAO Wireless	132	9.1.2013	1.2014
710	RF-amplifier	ALS 1826-41-12	ALC Microwave Inc.	0011	4.4.2014	4.2015
745	2-Line V-Network	ENV216	Rohde & Schwarz	101466	11.6.2013	06.2014
319	Antenna	CBL6112	Chase	2018	12.7.2012	1.2014
525	Double-Ridged Horn	3115	Emco	6691	10.10.2012	4.2014
542	Double-Ridged Horn	3115	Emco	00023905	10.10.2012	4.2014
87	Waveguide horn	639	Narda	7909	10.10.2012	4.2014
88	Waveguide horn	638	Narda	8003	10.10.2012	4.2014
521	Waveguide horn	V637	Narda	9307	10.10.2012	4.2014
350	Semianechoic shielded room	RFD-F-100	Euroshield Oy	1327	26.10.2012	10.2014
307	Temp. test chamber	VMT 04/140	Heraeus Vötsch	27045	1)	1)
563	Thermometer	52 II	Fluke	19300005	2.4.2013	4.2014
X1	Attenuator pad	8493B	Hewlett-PackardP	04228	2.12.2011	12.2013

Note 1): temperatre measured with calibrated thermometer

5. Photographs



Photograph 1. Radiated disturbance emission test.



Photograph 2. Conducted emissions at mains ports emission test.