Nemko TEST REPORT

Date:	**ESPOO 16.08.2011**	Page:	**1 (50)**
		Appendices	–

Number: No. 1 / 1

183922B

Date of handing in: 17.01.2011

Tested by:

Timo Hietala, Test Engineer

Reviewed by:

Janne Nyman, Compliance Specialist

SORT OF EQUIPMENT: **7signal Sapphire Eye WLAN Unit 2.4/5GHz**

MARKETING NAME: ***7signal Sapphire Eye 802.11a/b/g/n***

TYPE: ***7signal Sapphire Eye APU3B-1101-000318***

MANUFACTURER: ***7signal Ltd.***

CLIENT: **7signal Ltd**

ADDRESS: **Panuntie 6, FI-00620 Helsinki, Finland**

TELEPHONE: **+358 45 1234020 /**

TEST LABORATORY: **Nemko Oy**

SUMMARY:

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

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Summary of performed tests and test results

Test	*Section in CFR 47*		*Result*
1	15.207	AC power line conducted emissions	**PASS**, margin 7.6 dB
2	15.209 / 15.407 (b)	Electric Field Strength Spurious Emissions, 30MHz ~ 40000MHz	**PASS**, margin 0.3 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 excurcion	**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.

Contents

1. EUT and Accessory Information

1.1 EUT description

The EUT is a 7signal Sapphire Eye WLAN unit.

Operating frequencies and channels:

	Channel	Frequency [MHz]
802.11a, 6Mbit/s	36	5180
	40	5200
	48	5240
	52	5260
	56	5280
	64	5320
	100	5500
	116	5580
	136	5680
	140	5700
	149	5745
	157	5785
	161	5805
802.11n, 20MHz bw MCS0	36	5180
	40	5200
	48	5240
	52	5260
	56	5280
	64	5320
	100	5500
	116	5580
	136	5680
	140	5700
	149	5745
	157	5785
	161	5805
802.11n, 40MHz bw MCS0	36/40	5190
	44/48	5230
	52/56	5270
	60/64	5310
	100/104	5510
	136/140	5690
	149/153	5755
	157/161	5795

Power supply: 48V DC, Power through Ethernet.

Antenna: 7 x Directional plane antenna, gain 7.5 dBi.

1.2 EUT and accessories

unit	*type*	*S/N*
7signal Sapphire Eye 802.11a/b/g/n	**APU3B-1101-000318**	**EMC B1**
Ethernet node	**D-link Model: DES-1008P**	**F3EX197000034**
AC power unit	**D-link Model: VAN90C-480B**	**1309200809-0D**

Cables:

From	To	Type	Length [m]
7signal Sapphire Eye	**Ethernet node**	unshielded	4.0 / 10.0
Ethernet node	**AC power unit**	unshielded	2.0
AC power unit	**AC mains**	unshielded	2.0

Operating voltage during the tests:
48V DC, PoE, (115V 60Hz)

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) 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:

Site name	Nemko Oy/ Perkkaa
Date of testing	28.03.2011
Test equipment	694, 168, 348, 371
Test conditions	22 °C, 30 % RH
Test result	**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.

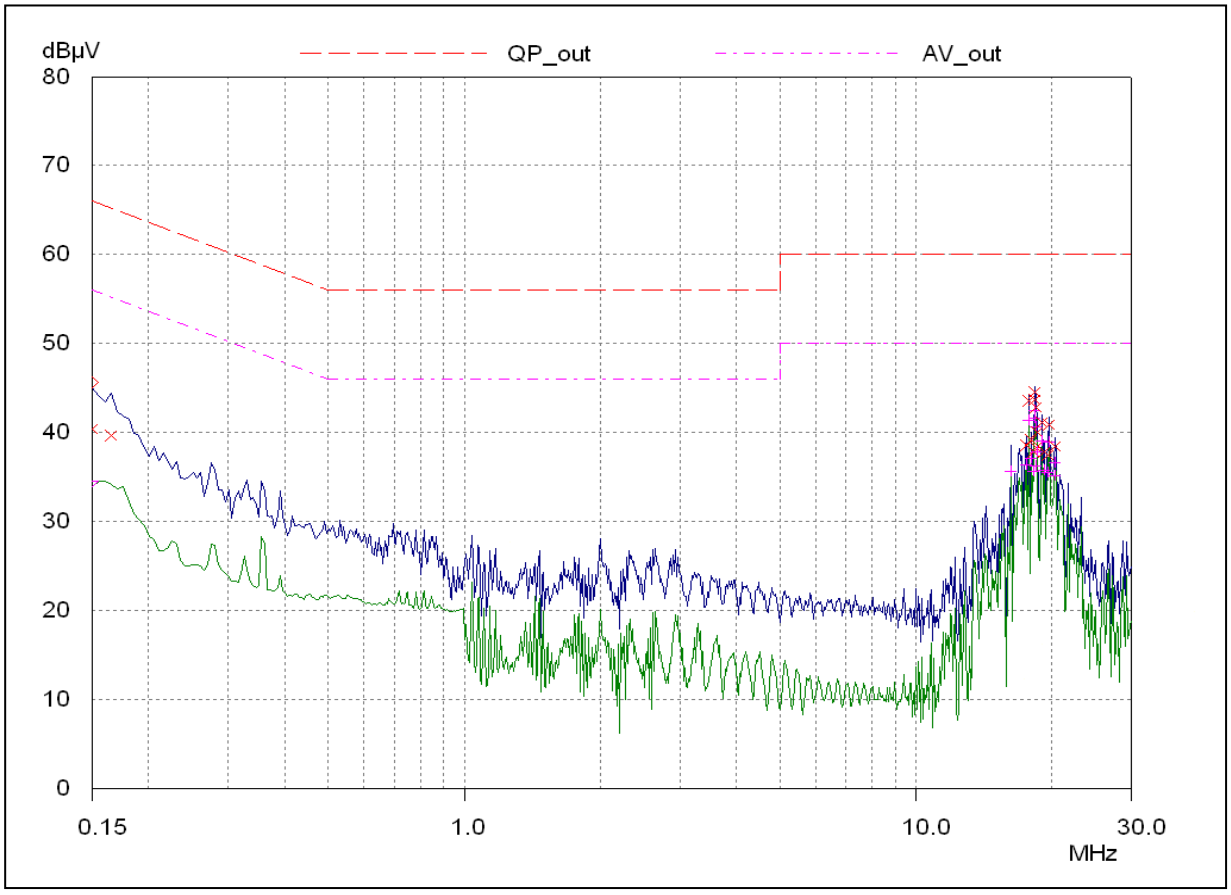
If not, then at the test frequencies concerned the measurement is performed also by using a quasi-peak detector. If the disturbance levels measured by using the quasi-peak detector are below the limit value defined for the measurement performed by using an average detector, then measurements by using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

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

2.1.2 Test results

802.11b, 1Mbit/s, channel 6, TXf=2437MHz

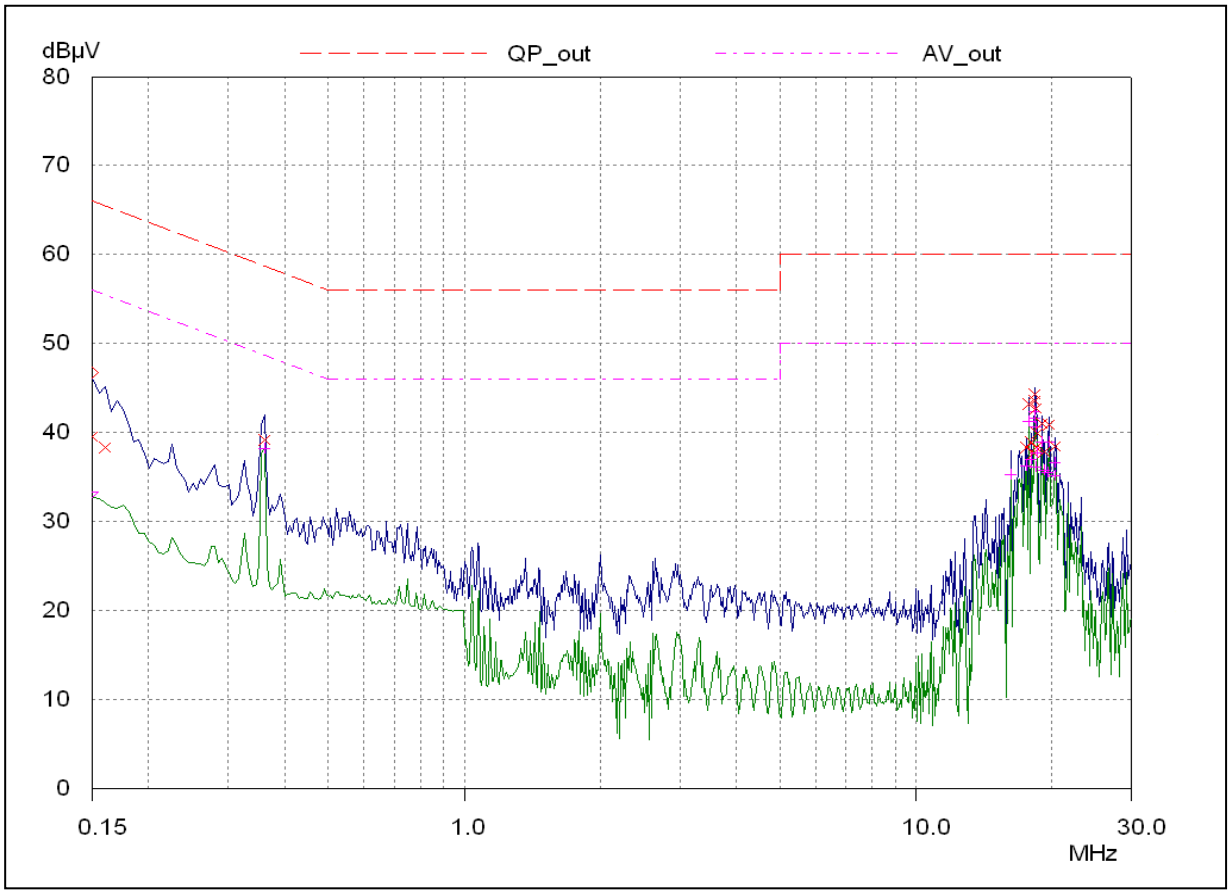
line N, Uin = 115V/60Hz



Final resuls:

QP				AVE			
Freq MHz	Level dBµV	Limit dBµV	Margin dB	Freq MHz	Level dBµV	Limit dBµV	Margin dB
0.15	40.42	66	25.58	16.23	35.62	50	14.38
0.165	39.69	65.21	25.52	17.57	36.36	50	13.64
17.57	38.53	60	21.47	17.695	41.42	50	8.58
17.695	43.5	60	16.50	17.94	37.11	50	12.89
17.94	39.21	60	20.79	18.18	35.57	50	14.43
18.18	37.81	60	22.19	18.245	42.45	50	7.55
18.245	44.48	60	15.52	18.305	41.62	50	8.38
18.305	43.74	60	16.26	18.365	40.69	50	9.31
18.365	42.84	60	17.16	18.425	36.18	50	13.82
18.425	38.35	60	21.65	18.485	37.8	50	12.20
18.485	39.98	60	20.02	18.915	39.03	50	10.97
18.915	41.12	60	18.88	19.16	35.8	50	14.20
19.16	37.81	60	22.19	19.585	35.49	50	14.51
19.585	37.49	60	22.51	19.71	38.94	50	11.06
19.71	40.86	60	19.14	20.26	36.63	50	13.37

line L, Uin = 115V/60Hz



Final resuls:

QP				AVE			
Freq MHz	Level dBµV	Limit dBµV	Margin dB	Freq MHz	Level dBµV	Limit dBµV	Margin dB
0.15	39.54	66	26.46	0.36	38.2	48.73	10.53
0.16	38.3	65.46	27.16	16.23	35.27	50	14.73
0.36	39.2	58.73	19.53	17.57	36.23	50	13.77
17.57	38.31	60	21.69	17.695	41.28	50	8.72
17.695	43.24	60	16.76	17.94	37	50	13.00
17.94	38.97	60	21.03	18.245	42.32	50	7.68
18.18	37.65	60	22.35	18.305	41.62	50	8.38
18.245	44.3	60	15.7	18.365	40.62	50	9.38
18.305	43.6	60	16.4	18.425	36.12	50	13.88
18.365	42.72	60	17.28	18.485	37.75	50	12.25
18.425	38.25	60	21.75	18.915	38.97	50	11.03
18.485	39.88	60	20.12	19.16	35.74	50	14.26
18.915	41.02	60	18.98	19.585	35.49	50	14.51
19.16	37.77	60	22.23	19.71	38.94	50	11.06
19.71	40.82	60	19.18	20.26	36.63	50	13.37

3. Test results

3.1 Radiated emissions

Site name	Nemko / Perkkaa
Date of testing	17.01, 09-12.08.2011
Test equipment	350, 338, 544, 319, 567, 564, 525, 542, 559, 371, 86, 87, 88, 521, 710
Test conditions	22-25 °C, 30-55 % 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 1000-6000 MHz the distance from the EUT to the measuring antenna was 3 m and in the frequency range 6000-40000 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 EUT was in 3 orthogonal positions.

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(µV/m)]=20log[µV/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) $E = \frac{1000000\sqrt{30P}}{d}$, $where\, E = \mu V/m$, $P = W[EIRP]$, $d = m[distance]$

3.1.2 Test results

30-1000MHz:

The measurement results were obtained as described below.

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

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).

802.11b, 1Mbit/s

Channel	*Frequency* MHz	*Result QP dBµV/m*	*Limit QP dBµV/m*	*Margin dB*	*Height cm*	*Azimuth deg*	*Polarisation*
6	56.00	32.8	40	7.2	102	337	VERTICAL
	101.92	35.6	40	4.4	151	105	VERTICAL
	200.00	36.4	43.5	7.1	102	56	VERTICAL
	600.88	38.8	46	7.2	102	107	VERTICAL
	872.42	45.7	46	0.3	286	259	HORIZONTAL
	999.36	46.9	54	7.1	100	243	HORIZONTAL

1-6 GHz:

The measurement results were obtained as described below.

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

Where

U_{RX}	receiver reading
A_{CABLE}	attenuation of the cable
AF	antenna factor
G_{PREAMP}	gain of the preamplifier

At the frequencies 1-6 GHz the measurements were performed with Peak detector (RBW: 1 MHz and VBW: 3 MHz) and with power average detector (RMS, RBW: 1 MHz and VBW: 1 MHz).

Above 6 GHz:

The measurement results were obtained as described below.

$$E\ [\mu V/m] = U_{RX} + A_{CABLE} + AF - G_{PREAMP} - 10$$

Where

U_{RX}	receiver reading
A_{CABLE}	attenuation of the cable
AF	antenna factor
G_{PREAMP}	gain of the preamplifier
10	correction factor 1m to 3m

At the frequencies above 6 GHz the measurements were performed with Peak detector (RBW: 1 MHz and VBW: 3 MHz) and with power average detector (RMS, RBW: 1 MHz and VBW: 1 MHz).

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	66.0	68.2	2.2	-	-	-
	15540	63.5	74	10.5	52.6	54	1.4
	20720	49.3	74	24.7	38.5	54	15.5
	25900	38.0	68.2	30.2	-	-	-
40	10400	64.6	68.2	3.6	-	-	-
	15600	61.6	74	12.4	46.0	54	8.0
	20800	49.0	74	25.0	37.8	54	16.2
	26000	38.9	68.2	29.3	-	-	-
48	10480	63.0	68.2	5.2	-	-	-
	15720	60.0	74	14.0	50.3	54	3.7
	20960	47.8	74	26.2	37.2	54	16.8
	26200	39.6	68.2	28.6	-	-	-
52	10520	64.3	68.2	3.9	-	-	-
	15780	63.0	74	11.0	53.3	54	0.7
	21040	55.1	74	18.9	44.9	54	9.1
	26300	45.5	68.2	22.7	-	-	-
56	10560	61.2	68.2	7.0	-	-	-
	15840	58.5	74	15.5	50.0	54	4.0
	21120	53.8	74	20.2	42.7	54	11.3
	26400	45.8	68.2	22.4	-	-	-
64	10640	56.4	68.2	11.8	48.8	54	5.2
	15960	56.6	74	17.4	48.2	54	5.8
	21280	50.2	74	23.8	40.0	54	14.0
	26600	45.1	68.2	23.1	-	-	-
100	11000	54.9	74	19.1	45.7	54	8.3
	16500	60.1	68.2	8.1	-	-	-
	22000	49.6	68.2	18.6	-	-	-
	27500	50.8	68.2	17.4	-	-	-
116	11160	53.8	74	20.2	42.8	54	11.2
	16740	57.6	68.2	10.6	-	-	-
	22320	43.3	74	30.7	34.4	54	19.6
	27900	51.6	68.2	16.6	-	-	-
140	11400	49.6	74	24.4	41.0	54	13.0
	17100	56.5	68.2	11.7	-	-	-
	22800	46.1	74	27.9	37.3	54	16.7
	28500	49.6	68.2	18.6	-	-	-
149	11490	49.8	74	24.2	43.8	54	10.2
	17235	59.3	68.2	8.9	-	-	-
	22980	50.0	74	24.0	41.3	54	12.7
	28725	49.1	68.2	19.1	-	-	-
157	11570	49.3	74	24.7	40.0	54	14.0
	17355	57.4	68.2	10.8	-	-	-
	23140	53.7	68.2	14.5	-	-	-
	28925	54.8	68.2	13.4	-	-	-
161	11610	50.4	74	23.6	41.1	54	12.9
	17415	57.1	68.2	11.1	-	-	-
	23220	50.0	68.2	18.2	-	-	-
	29025	55.8	68.2	12.4	-	-	-

802.11n, 20MHz bw, MCS0

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	66.0	68.2	2.2	-	-	-
	15540	64.2	74	9.8	51.8	54	2.2
	20720	49.4	74	24.6	38.1	54	15.9
	25900	39.2	68.2	29.0	-	-	-
40	10400	65.1	68.2	3.1	-	-	-
	15600	62.0	74	12.0	50.2	54	3.8
	20800	47.5	74	26.5	36.9	54	17.1
	26000	38.6	68.2	29.6	-	-	-
48	10480	63.4	68.2	4.8	-	-	-
	15720	59.6	74	14.4	48.6	54	5.4
	20960	49.1	74	24.9	37.0	54	17.0
	26200	39.8	68.2	28.4	-	-	-
52	10520	65.1	68.2	3.1	-	-	-
	15780	62.6	74	11.4	53.0	54	1.0
	21040	54.7	74	19.3	44.5	54	9.5
	26300	47.8	68.2	20.4	-	-	-
56	10560	61.7	68.2	6.5	-	-	-
	15840	58.9	74	15.1	50.0	54	4.0
	21120	54.1	74	19.9	41.7	54	12.3
	26400	46.9	68.2	21.3	-	-	-
64	10640	56.3	68.2	11.9	46.9	54	7.1
	15960	57.2	74	16.8	47.5	54	6.5
	21280	50.7	74	23.3	40.2	54	13.8
	26600	44.6	68.2	23.6	-	-	-
100	11000	55.0	74	19.0	44.4	54	9.6
	16500	58.9	68.2	9.3	-	-	-
	22000	50.7	68.2	17.5	-	-	-
	27500	54.0	68.2	14.2	-	-	-
116	11160	53.8	74	20.2	42.5	54	11.5
	16740	57.6	68.2	10.6	-	-	-
	22320	45.2	74	28.8	34.3	54	19.7
	27900	52.4	68.2	15.8	-	-	-
140	11400	50.2	74	23.8	42.0	54	12.0
	17100	56.6	68.2	11.6	-	-	-
	22800	48.2	74	25.8	36.7	54	17.3
	28500	50.2	68.2	18.0	-	-	-
149	11490	50.4	74	23.6	40.5	54	13.5
	17235	58.0	68.2	10.2	-	-	-
	22980	52.0	74	22.0	40.8	54	13.2
	28725	49.4	68.2	18.8	-	-	-
157	11570	48.6	74	25.4	39.3	54	14.7
	17355	57.6	68.2	10.6	-	-	-
	23140	53.3	68.2	14.9	-	-	-
	28925	54.9	68.2	13.3	-	-	-
161	11610	50.3	74	23.7	40.9	54	12.1
	17415	57.5	68.2	10.7	-	-	-
	23220	54.6	68.2	13.6	-	-	-
	29025	56.1	68.2	12.1	-	-	-

802.11n, 40MHz bw

Channel	*Frequency MHz*	*Result Peak dBµV/m*	*Limit Peak dBµV/m*	*Margin dB*	*Result Average dBµV/m*	*Limit Average dBµV/m*	*Margin dB*
36/40	10380	54.4	68.2	13.8	-	-	-
	15570	53.3	74	20.7	45.5	54	8.5
	20760	43.9	74	30.1	34.9	54	19.1
	25950	35.9	68.2	32.3	-	-	-
44/48	10460	57.8	68.2	10.4	-	-	-
	15690	55.6	74	18.4	46.2	54	7.8
	20920	43.7	74	30.3	33.9	54	20.1
	26150	36.7	68.2	31.5	-	-	-
52/56	10540	59.2	68.2	9.0	-	-	-
	15810	58.1	74	15.9	49.6	54	4.4
	21080	48.9	74	25.1	41.1	54	12.9
	26350	44.1	68.2	24.1	-	-	-
60/64	10620	56.3	74	17.7	48.9	54	5.1
	15930	56.1	74	17.9	47.2	54	6.8
	21240	46.4	74	27.6	37.3	54	16.7
	26550	41.2	68.2	27.0	-	-	-
100/104	11020	46.3	68.2	21.9	43.6	54	10.4
	16530	49.7	74	24.3	-	-	-
	22040	46.0	68.2	22.2	37.5	54	16.5
	27550	44.4	74	29.6	-	-	-
136/140	11400	43.6	74	30.4	40.1	54	13.9
	17100	54.0	68.2	14.2	-	-	-
	22800	44.1	74	29.9	35.9	54	18.1
	28500	43.3	68.2	24.9	-	-	-
149/153	11510	51.5	74	22.5	42.4	54	11.6
	17265	57.0	68.2	11.2		-	-
	23020	45.9	74	28.1	39.0	54	15.0
	28775	44.8	68.2	23.4		-	-
157/161	11590	43.1	74	30.9	39.4	54	14.6
	17385	49.9	68.2	18.3	-	-	-
	23180	49.8	68.2	18.4	-	-	-
	28975	50.9	68.2	17.3	-	-	-

3.2 Maximum conducted peak output power

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

Site name	Nemko Oy / Perkkaa
FCC rule part	§ 15.407
Date of testing	25-26.07, 15.08.2011
Test equipment	566
Test conditions	25 °C, 55-58 % RH
Test result	**PASS**

3.2.1 Test method and limit

Test method #1 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 7.5 dBi => limit = 17 dBm - (7.5-6) dB = 15.5 dBm

5250 – 5350 MHz:
Antenna gain 7.5 dBi => limit = 24 dBm - (7.5-6) dB = 22.5 dBm

5470 – 5725 MHz:
Antenna gain 7.5 dBi => limit = 24 dBm - (7.5-6) dB = 22.5 dBm

5725 – 5825 MHz:
Antenna gain 7.5 dBi => limit = 30 dBm - (7.5-6) dB = 28.5 dBm

3.2.2 Test results

802.11a, 6Mbit/s

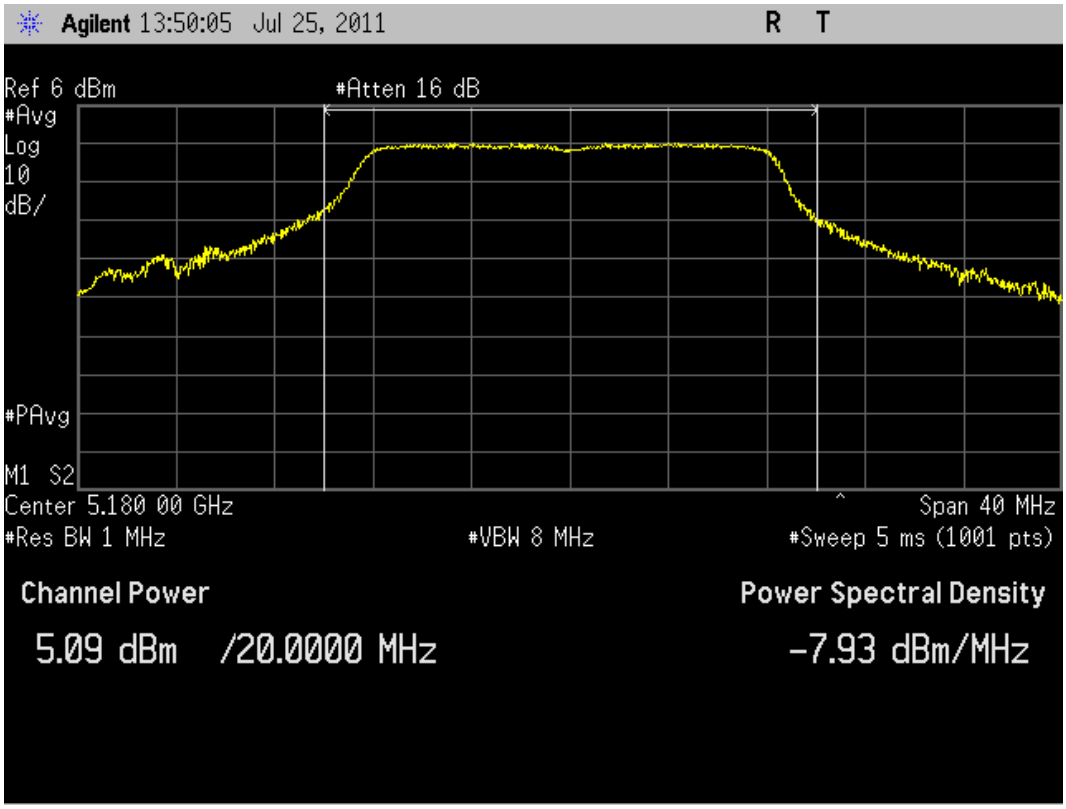
Channel	*Frequency MHz*	*Result dBm*	*Limit dBm*	*Margin dBm*
36	5180	5.1	15.5	10.4
40	5200	4.9	15.5	10.6
48	5240	4.7	15.5	10.8
52	5260	8.3	22.5	14.2
56	5280	7.8	22.5	14.7
64	5320	8.1	22.5	14.4
100	5500	6.4	22.5	16.1
116	5580	6.2	22.5	16.3
136	5680	6.5	22.5	16.0
140	5700	6.0	22.5	16.5
149	5745	6.4	28.5	22.1
157	5785	6.2	28.5	22.3
161	5805	6.0	28.5	22.5

802.11n, 20MHz bw, MCS0

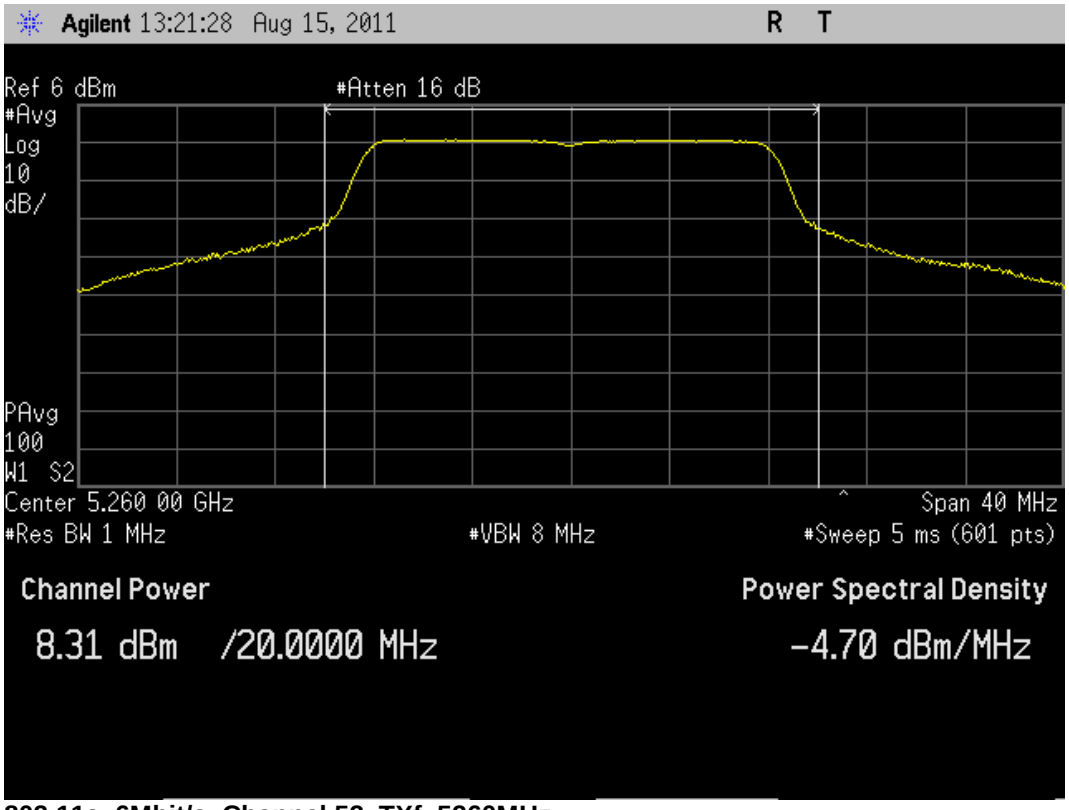
Channel	*Frequency MHz*	*Result dBm*	*Limit dBm*	*Margin dBm*
36	5180	5.0	15.5	10.5
40	5200	4.6	15.5	10.9
48	5240	5.0	15.5	10.5
52	5260	8.3	22.5	14.2
56	5280	7.9	22.5	14.6
64	5320	8.1	22.5	14.4
100	5500	6.3	22.5	16.2
116	5580	6.0	22.5	16.5
136	5680	6.2	22.5	16.3
140	5700	5.8	22.5	16.7
149	5745	6.1	28.5	22.4
157	5785	6.0	28.5	22.5
161	5805	6.1	28.5	22.4

802.11n, 40MHz bw, MCS0

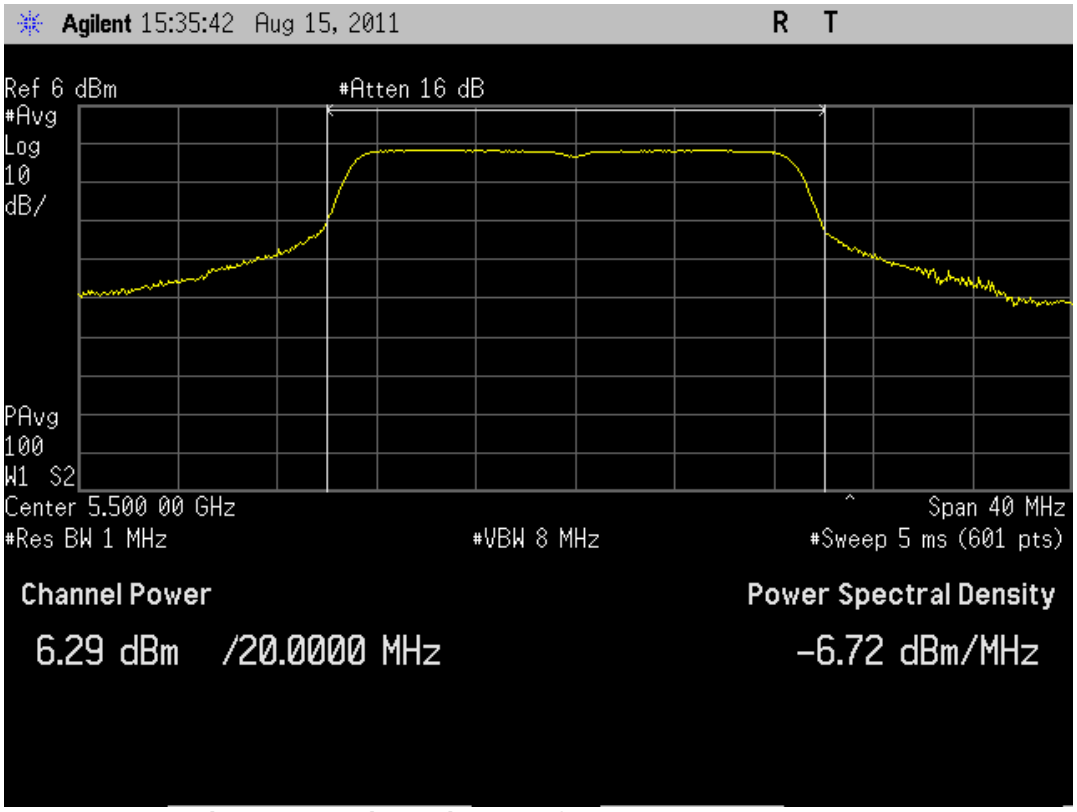
Channel	*Frequency MHz*	*Result dBm*	*Limit dBm*	*Margin dBm*
36/40	5190	4.0	15.5	11.5
44/48	5230	4.4	15.5	11.1
52/56	5270	8.2	22.5	14.3
60/64	5310	8.2	22.5	14.3
100/104	5510	5.1	22.5	17.4
136/140	5690	5.7	22.5	16.8
149/153	5755	5.1	28.5	23.4
157/161	5795	6.3	28.5	22.2



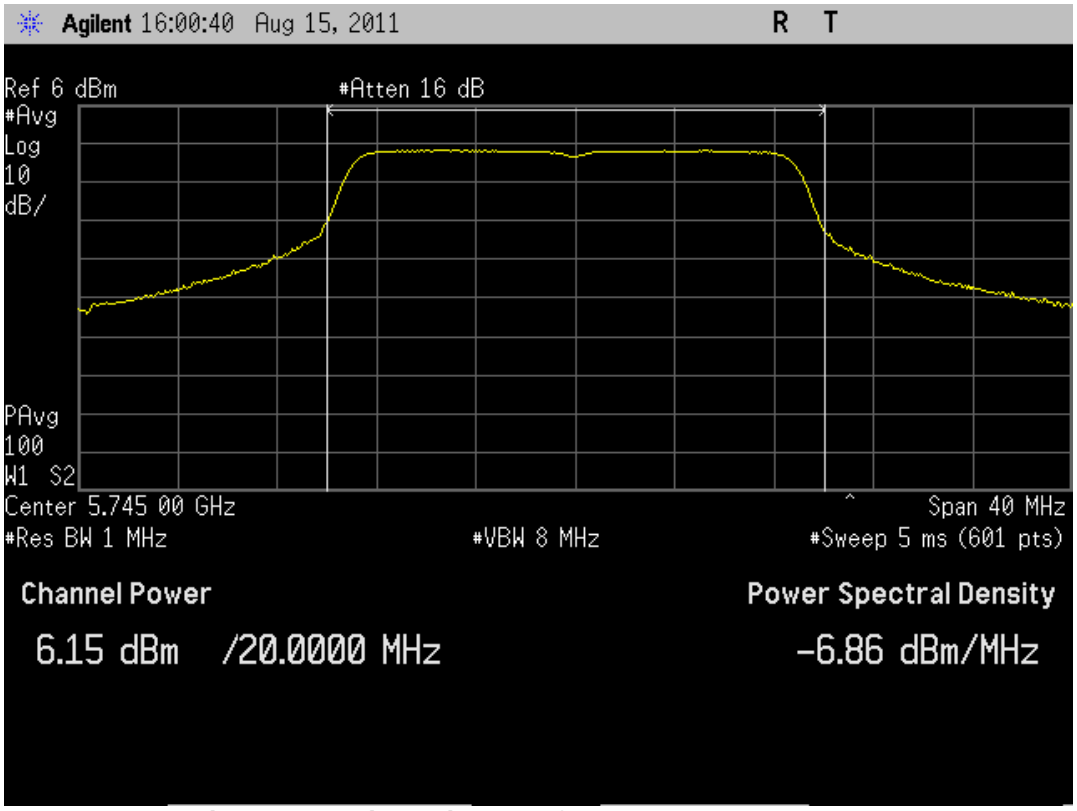
802.11a, 6Mbit/s, Channel 36, TXf=5180MHz



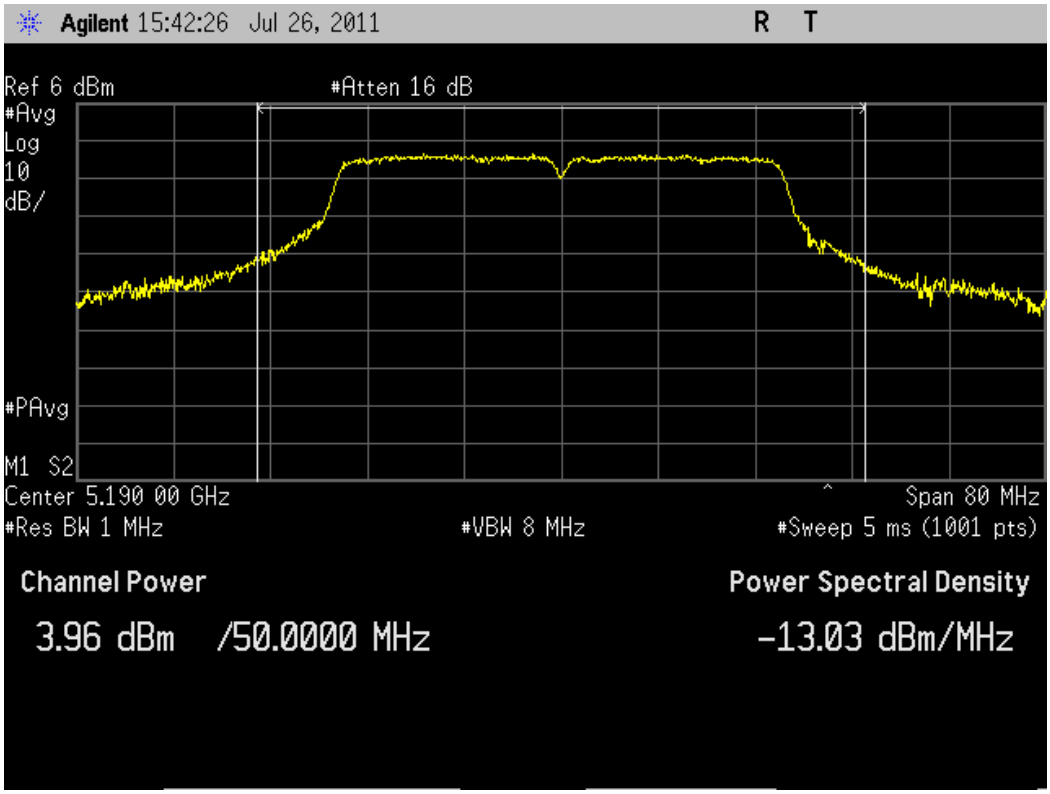
802.11a, 6Mbit/s, Channel 52, TXf=5260MHz



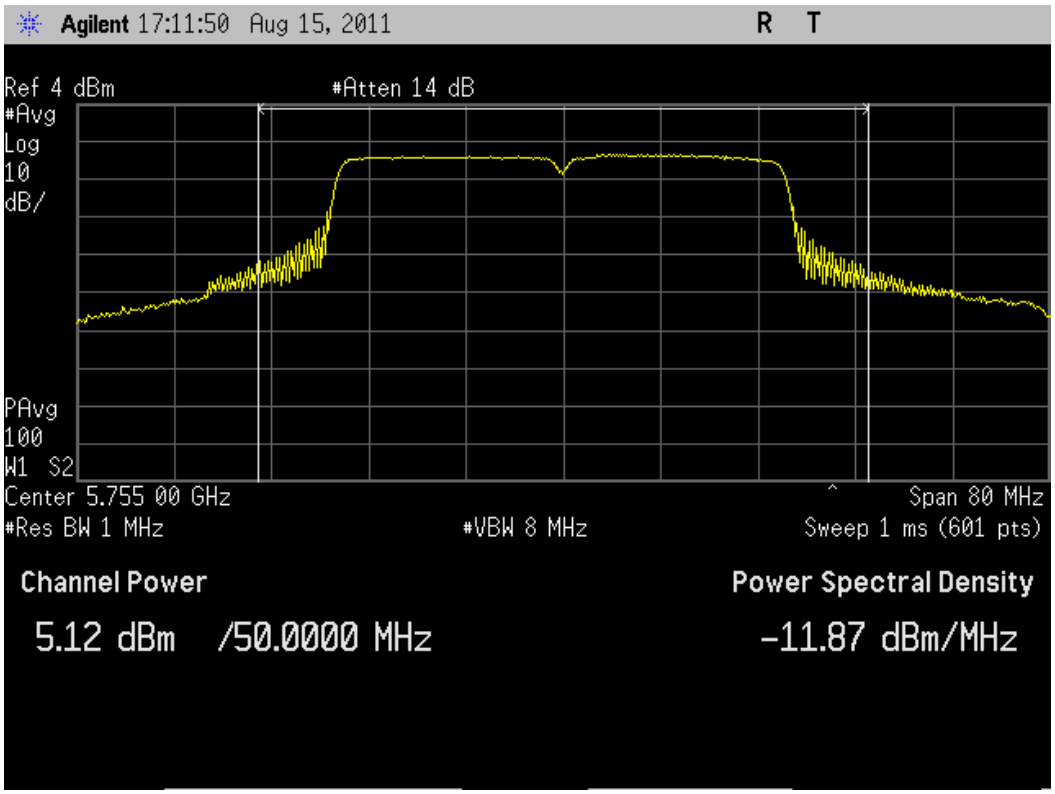
802.11n, 20MHz bw, MCS0, Channel 100, TXf=5500MHz



802.11n, 20MHz bw, MCS0, Channel 149, TXf=5745MHz



802.11n, 40MHz bw, MCS0, Channel 36/40, TXf=5190MHz



802.11n, 40MHz bw, MCS0, Channel 149/153, TXf=5755MHz

3.3 26dB Bandwidth

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

Site name	Nemko Oy / Perkkaa
FCC rule part	§ 15.407
Date of testing	25.7, 15.08.2011
Test equipment	566
Test conditions	25 °C, 55 % 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

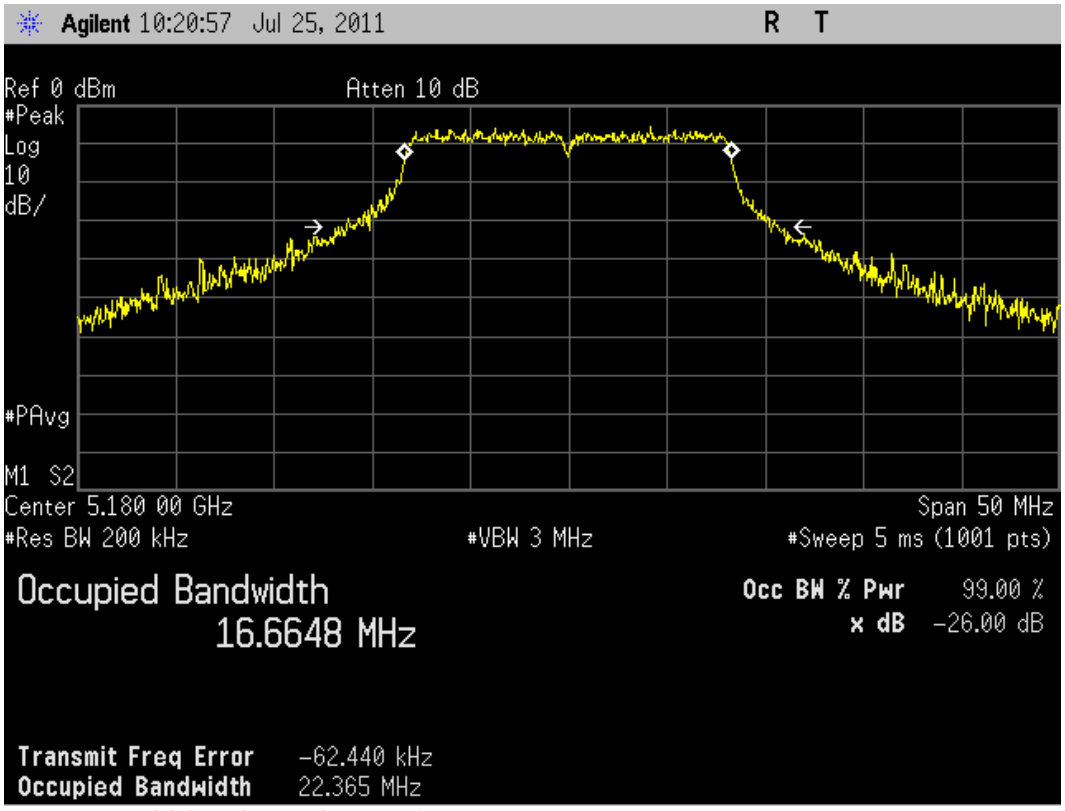
Channel	*Frequency MHz*	*99% bandwidth (MHz)*	*26 dB bandwidth (MHz)*
36	5180	16.7	22.4
40	5200	16.7	22.3
48	5240	16.7	23.3
52	5260	17.0	27.5
56	5280	16.9	25.1
64	5320	16.9	25.4
100	5500	16.8	26.8
116	5580	16.9	27.4
136	5680	16.8	25.4
140	5700	16.7	23.9
149	5745	16.8	23.6
157	5785	16.8	25.2
161	5805	16.8	26.2

802.11n, 20MHz bw, MCS0

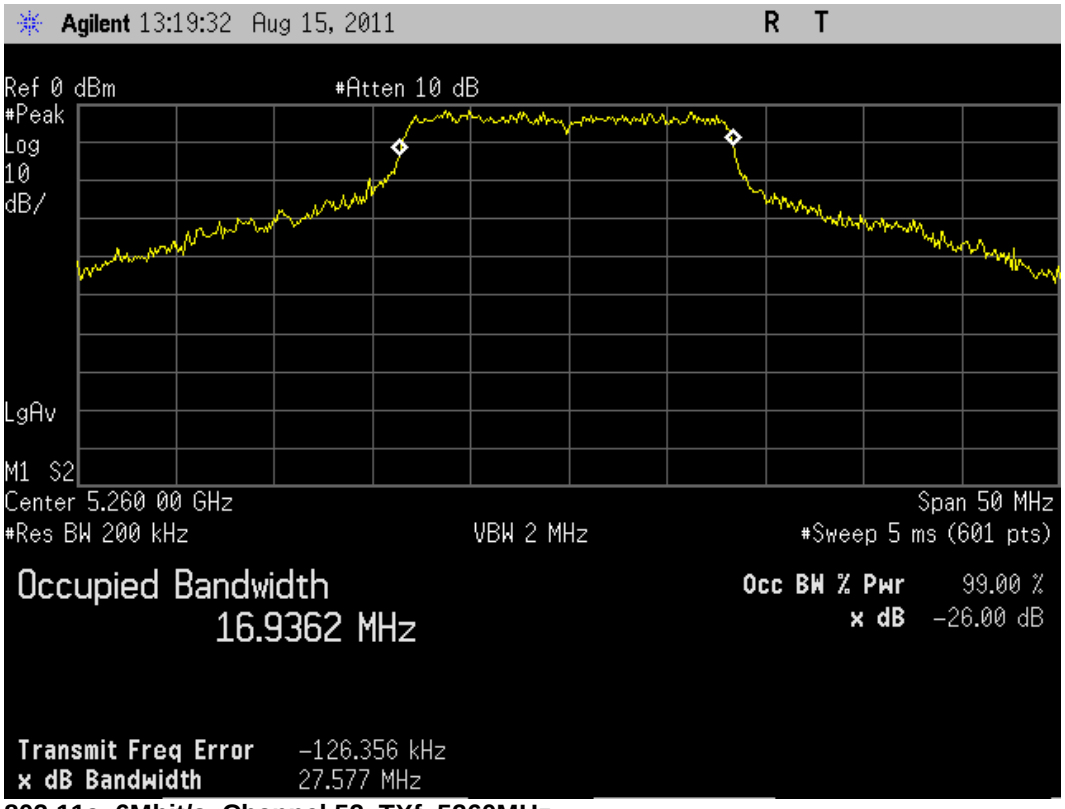
Channel	*Frequency MHz*	*99% bandwidth (MHz)*	*26 dB bandwidth (MHz)*
36	5180	17.9	23.3
40	5200	17.9	23.4
48	5240	17.9	23.3
52	5260	18.0	26.0
56	5280	18.0	26.4
64	5320	18.0	25.5
100	5500	18.0	25.8
116	5580	18.0	26.2
136	5680	18.0	24.7
140	5700	17.9	24.7
149	5745	17.9	24.2
157	5785	17.9	24.0
161	5805	17.9	24.8

802.11n, 40MHz bw, MCS0

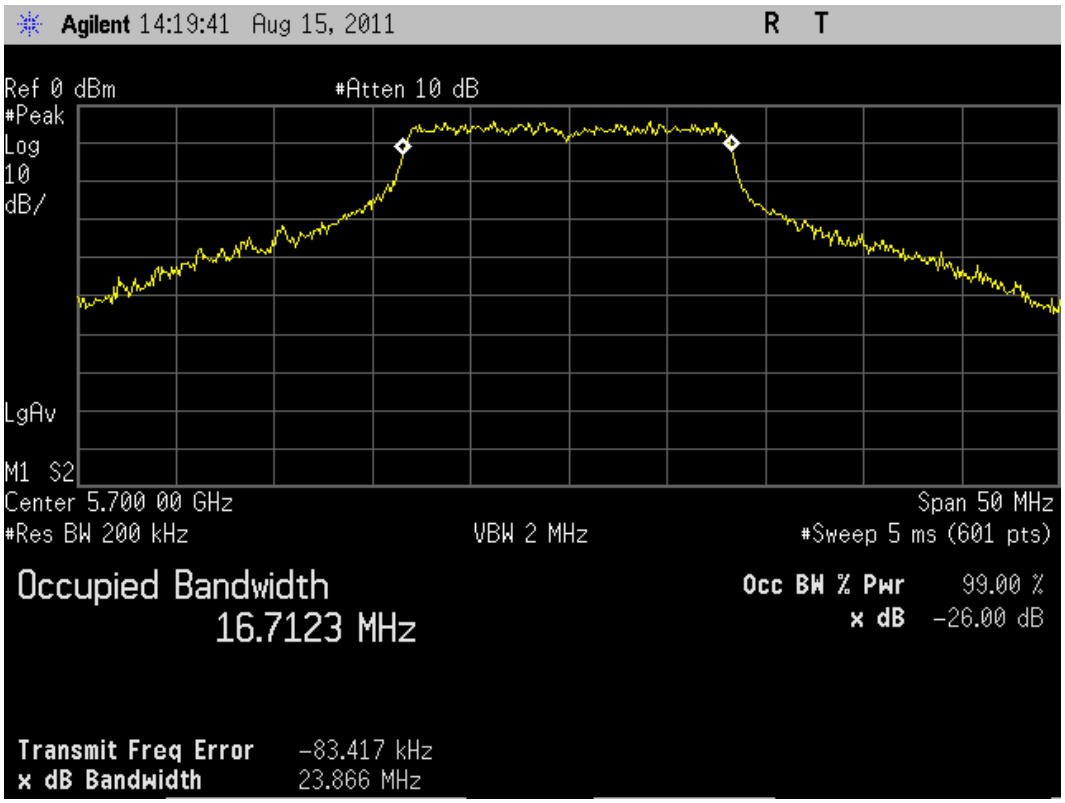
Channel	*Frequency MHz*	*99% bandwidth (MHz)*	*26 dB bandwidth (MHz)*
36/40	5190	36.6	46.5
44/48	5230	36.5	47.6
52/56	5270	36.9	56.3
60/64	5310	36.8	53.7
100/104	5510	36.6	48.2
136/140	5690	36.8	50.0
149/153	5755	36.6	48.2
157/161	5795	36.7	49.9



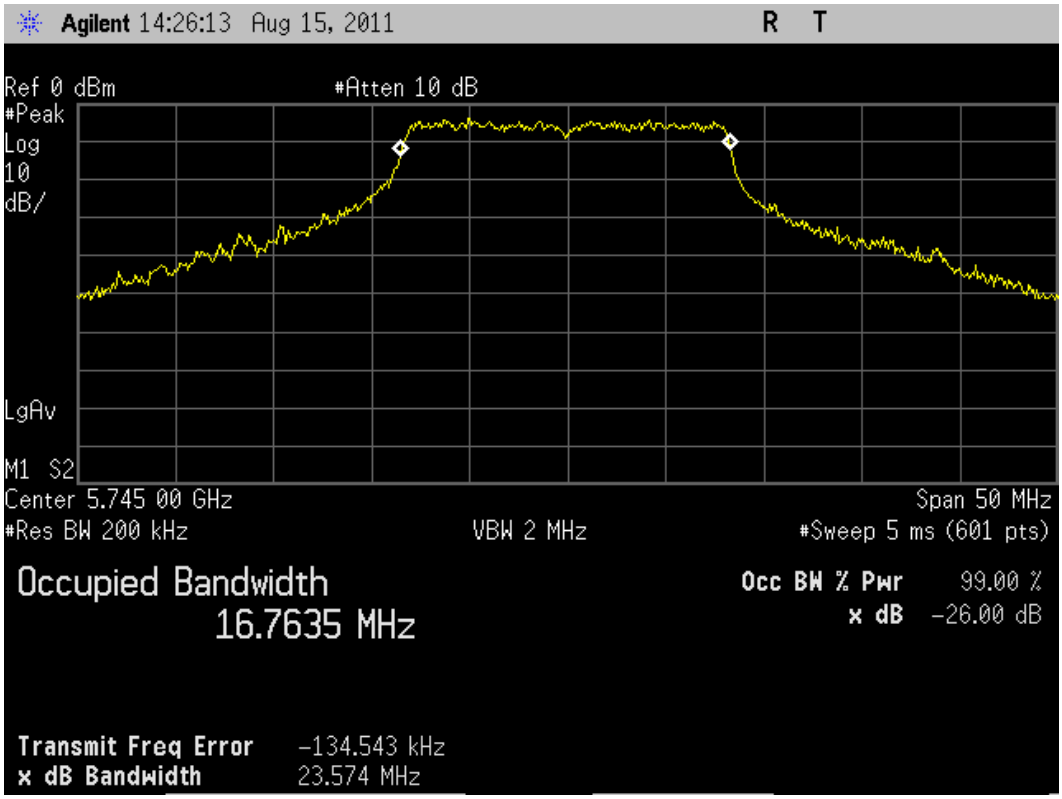
802.11a, 6Mbit/s, Channel 36, TXf=5180MHz



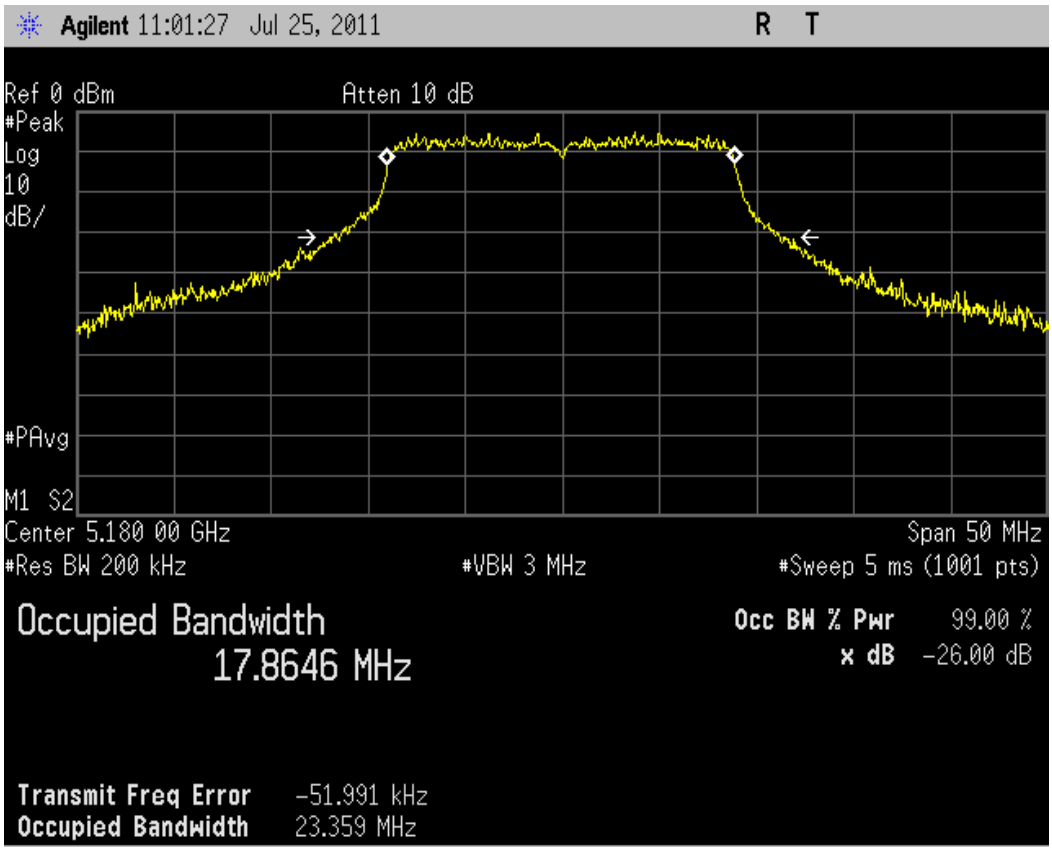
802.11a, 6Mbit/s, Channel 52, TXf=5260MHz



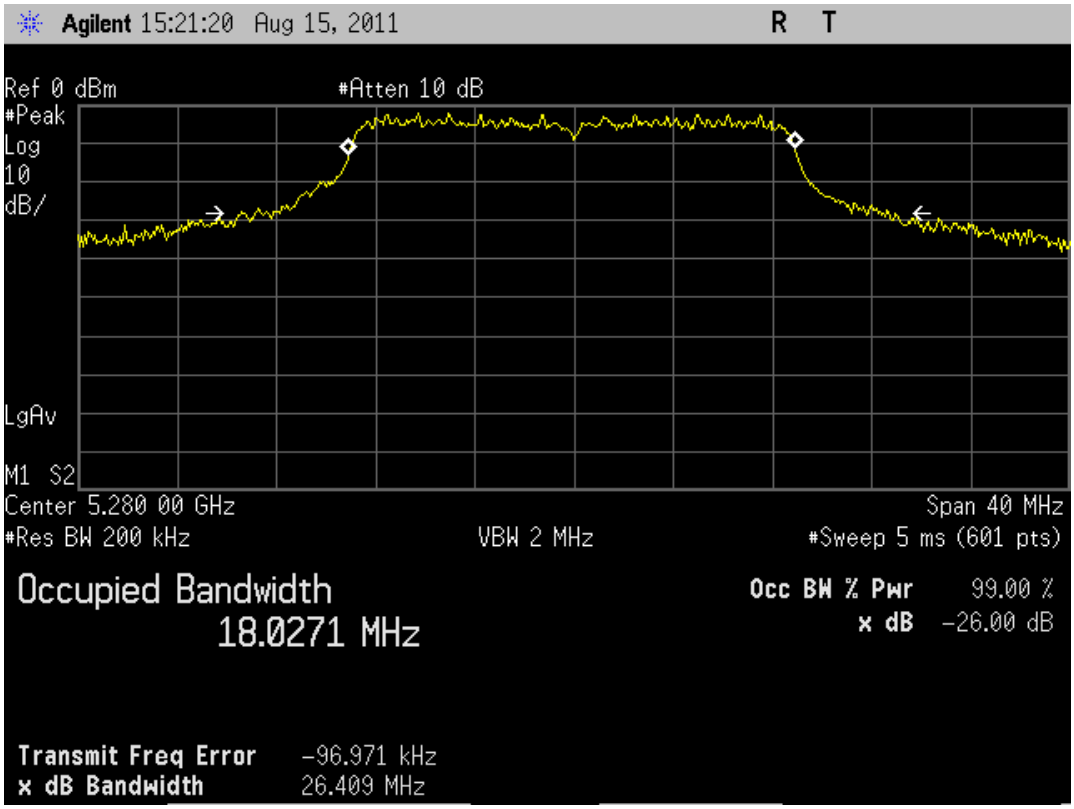
802.11a, 6Mbit/s, Channel 140, TXf=5700MHz



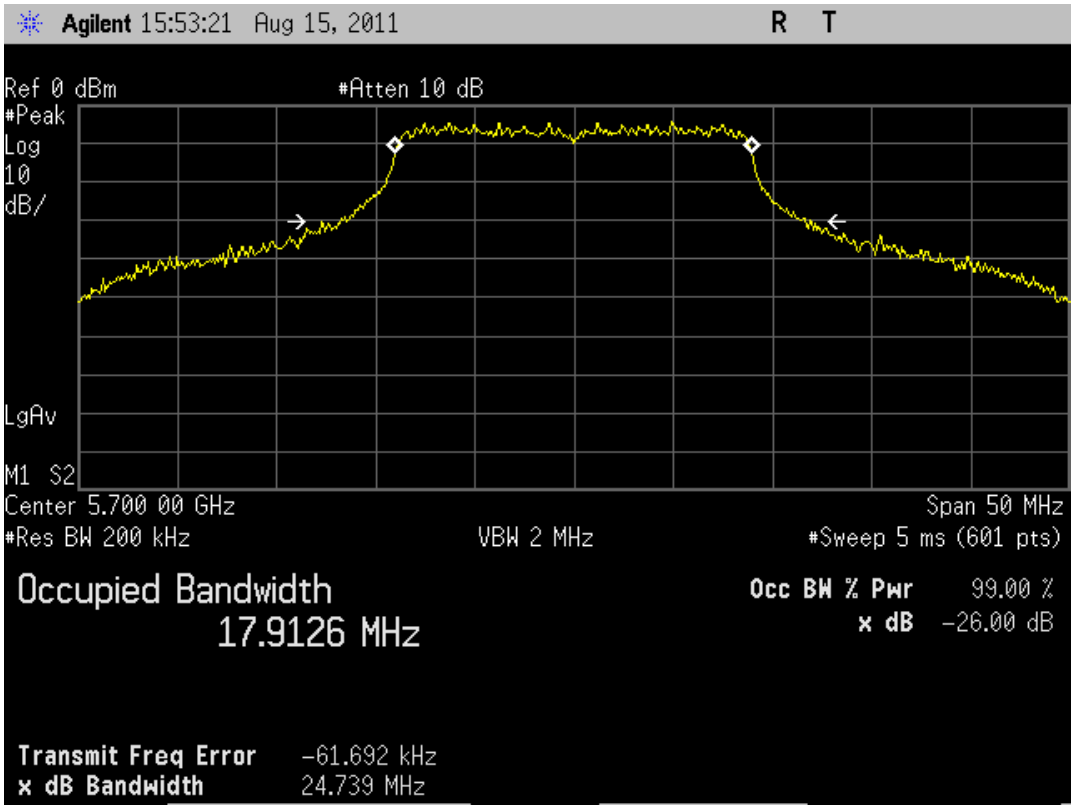
802.11a, 6Mbit/s, Channel 149, TXf=5745MHz



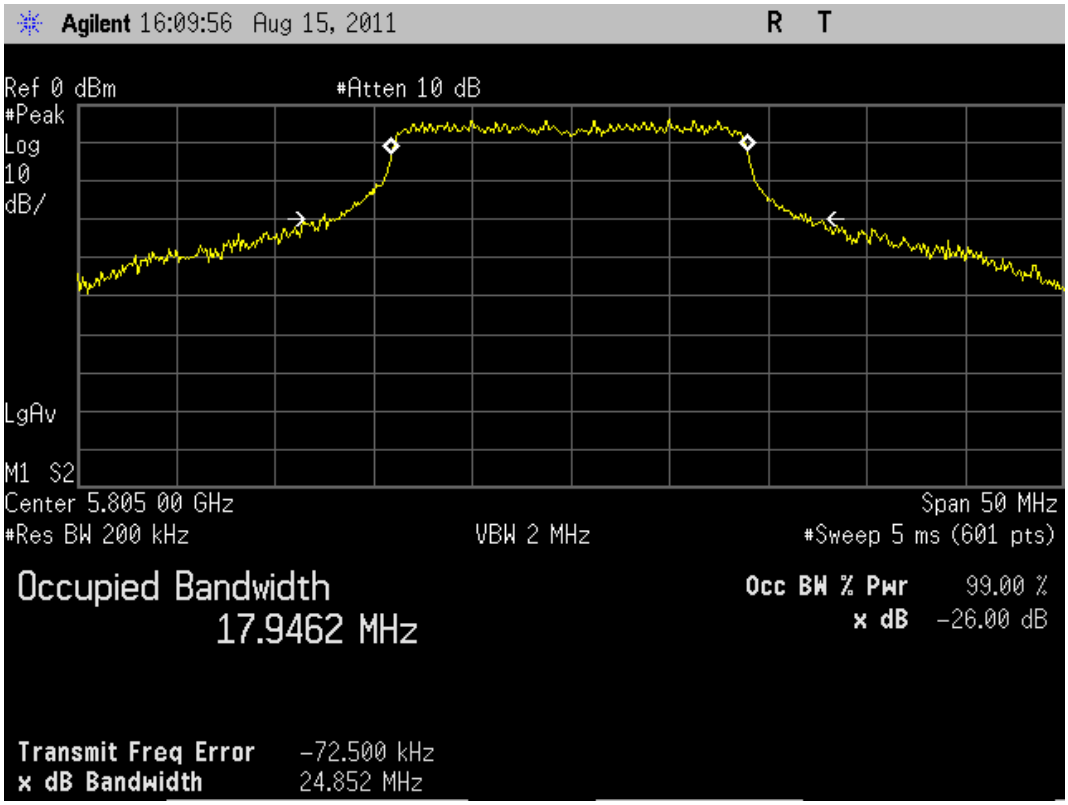
802.11n, 20MHz bw MCS0, TX on at channel 36, TXf=5180MHz



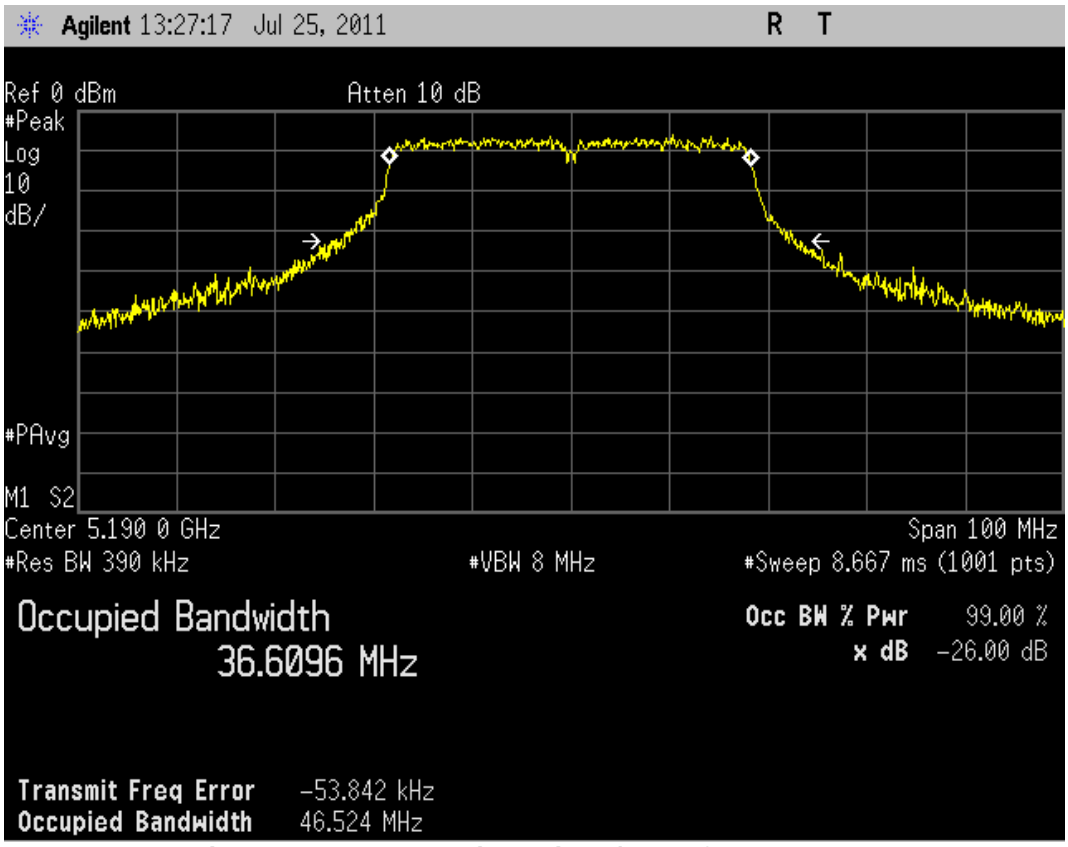
802.11n, 20MHz bw MCS0, TX on at channel 56, TXf=5280MHz



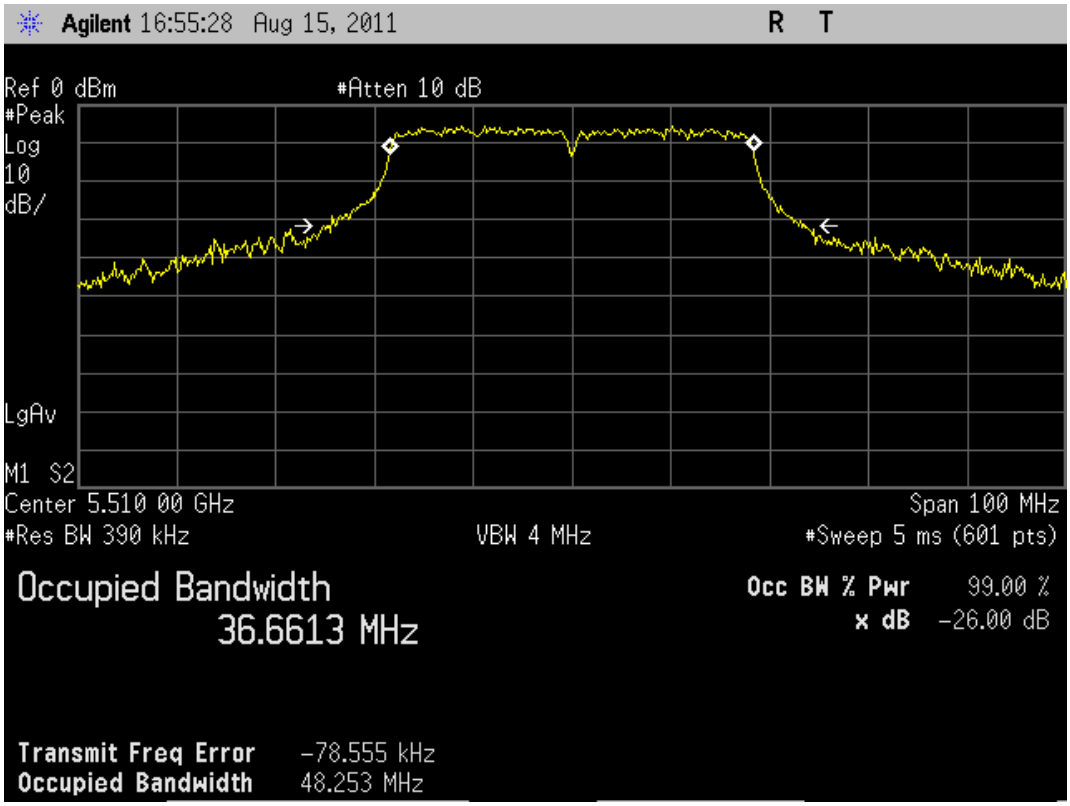
802.11n, 20MHz bw MCS0, TX on at channel 140, TXf=5700MHz



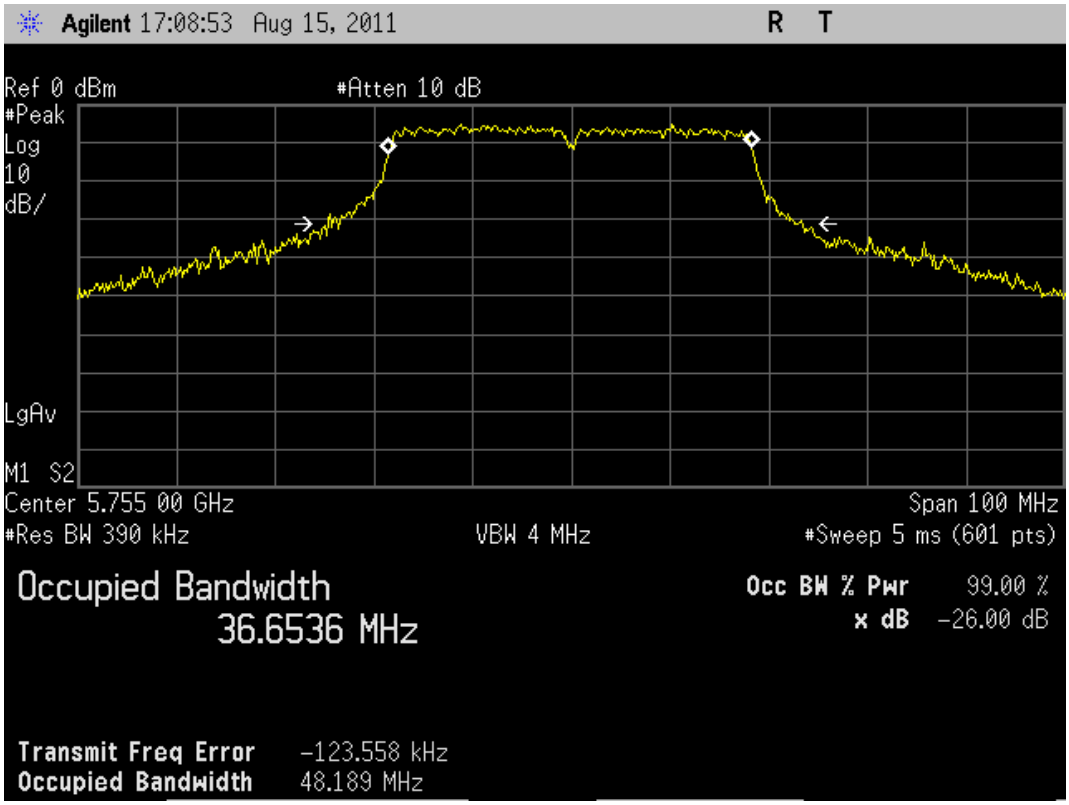
802.11n, 20MHz bw MCS0, TX on at channel 161, TXf=5805MHz



802.11n, 40MHz bw, MCS0, TX on at channels 36/40, TXf=5190MHz



802.11n, 40MHz bw, MCS0, TX on at channels 100/104, TXf=5510MHz



802.11n, 40MHz bw, MCS0, TX on at channels 149/153, TXf=5755MHz

3.4 Band-edge compliance

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

Site name	Nemko Oy / Perkkaa
FCC rule part	§ 15.407
Date of testing	09-10.8.2011
Test equipment	566, 542, 564
Test conditions	25 °C, 55-58 % 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.

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

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

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	54.9	74	19.1	38.1	54	15.9
48	5250	64.8	-	-	42.9	-	-
48	5350	50.1	74	23.9	36.8	54	17.2
52	5250	88.2	-	-	59.5	-	-
52	5150	51.6	74	18.4	39.0	54	15.0
64	5350	57.3	74	16.7	41.3	54	12.7
100	5470	57.6	68.2	10.6	-	-	-
116	5602.5[1]	68.2	-	-	-	-	-
136	5659.5[1]	68.2	-	-	-	-	-
140	5725	55.0	68.2	13.2	-	-	-
149	5725	65.0	78.2	13.2	-	-	-
149	5715	56.3	68.2	11.9	-	-	-
161	5825	67.8	78.2	10.4	-	-	-
161	5835	54.3	68.2	13.9	-	-	-

Note [1] Frequency where level is 68.2 dBµV/m

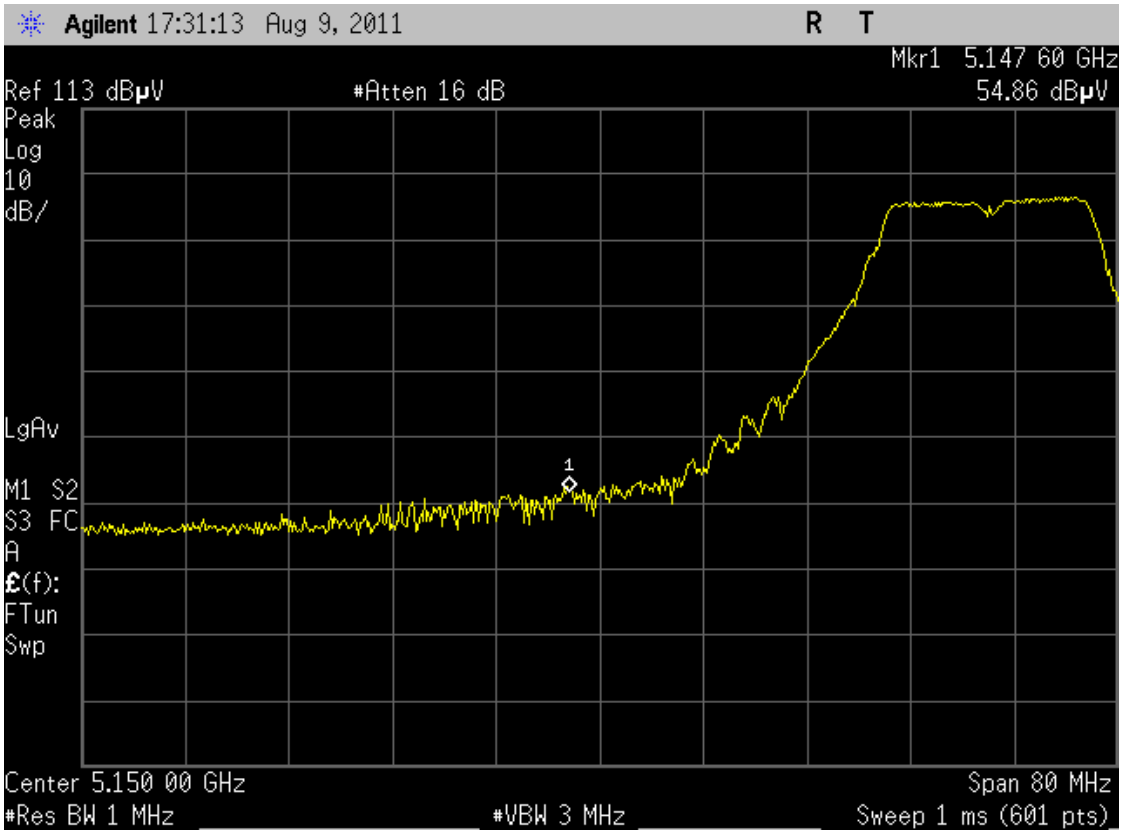
802.11n, 20MHz bw

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	55.2	74	18.8	38.2	54	15.9
48	5250	63.6	-	-	43.2	-	-
48	5350	50.1	74	23.9	36.8	54	17.2
52	5250	88.3	-	-	65.9	-	-
52	5150	52.0	74	18.0	39.0	54	15.0
64	5350	58.5	74	15.5	41.4	54	12.6
100	5470	57.9	68.2	10.3	-	-	-
116	5603.3[1]	68.2	-	-	-	-	-
136	5657.2[1]	68.2	-	-	-	-	-
140	5725	58.6	68.2	9.6	-	-	-
149	5725	70.0	78.2	8.2	-	-	-
149	5715	54.9	68.2	13.3	-	-	-
161	5825	71.6	78.2	6.6	-	-	-
161	5835	55.0	68.2	13.2	-	-	-

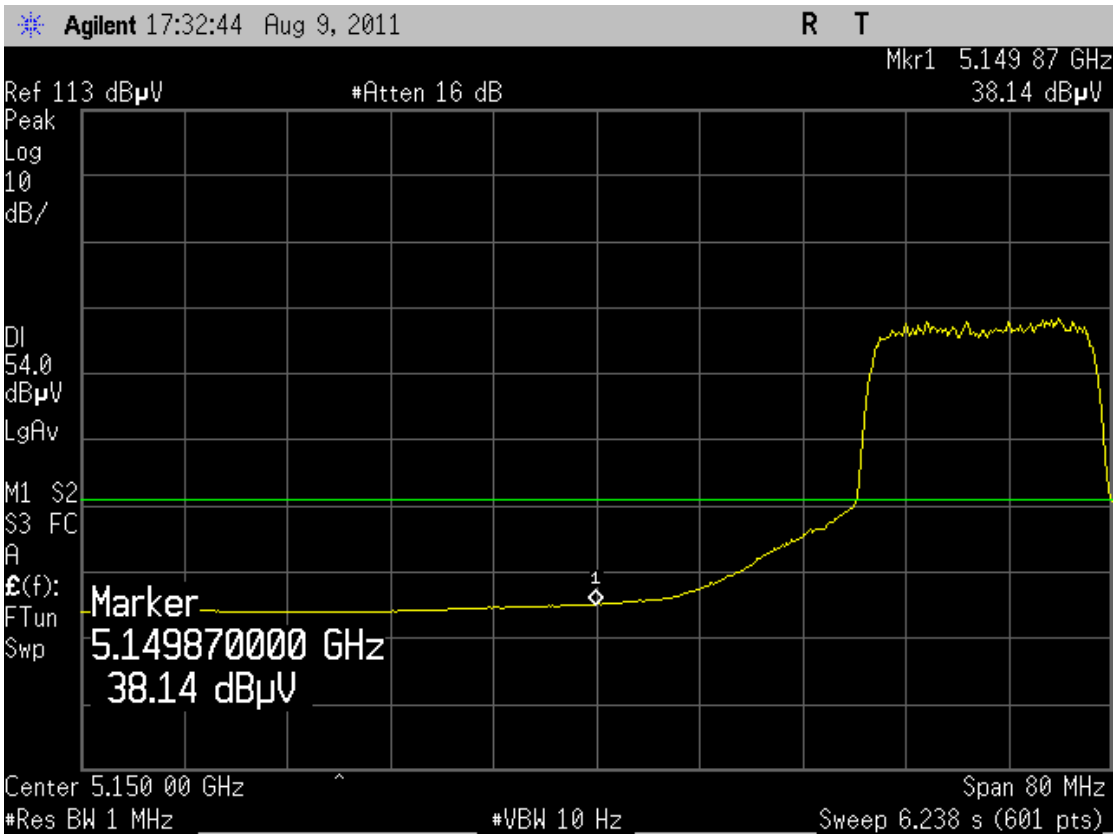
Note [1] Frequency where level is 68.2 dBµV/m

802.11n, 40MHz bw

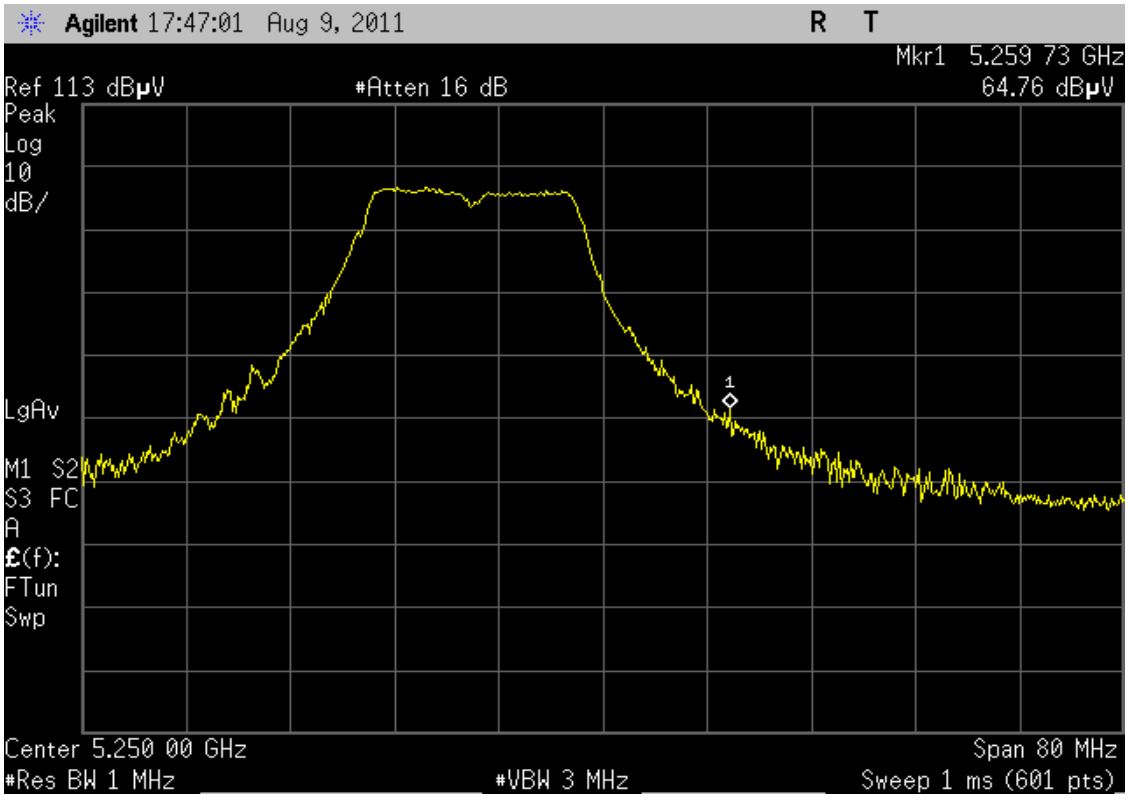
Channel	*Band Edge Frequency MHz*	*Result Peak dBµV/m*	*Limit Peak dBµV/m*	*Margin dB*	*Result Average dBµV/m*	*Limit Average dBµV/m*	*Margin dB*
36/40	5150	59.9	74	14.1	39.6	54	14.4
60/64	5350	68.6	74	5.4	47.9	54	6.1
100/104	5470	68.0	68.2	0.2	-	-	-
136/140	5725	68.2	68.2	0.0	-	-	-
149/153	5725	68.0	78.2	10.2	-	-	-
149/153	5715	62.4	68.2	5.8	-	-	-
157/161	5825	69.6	78.2	8.6	-	-	-
157/161	5835	65.0	68.2	3.2	-	-	-



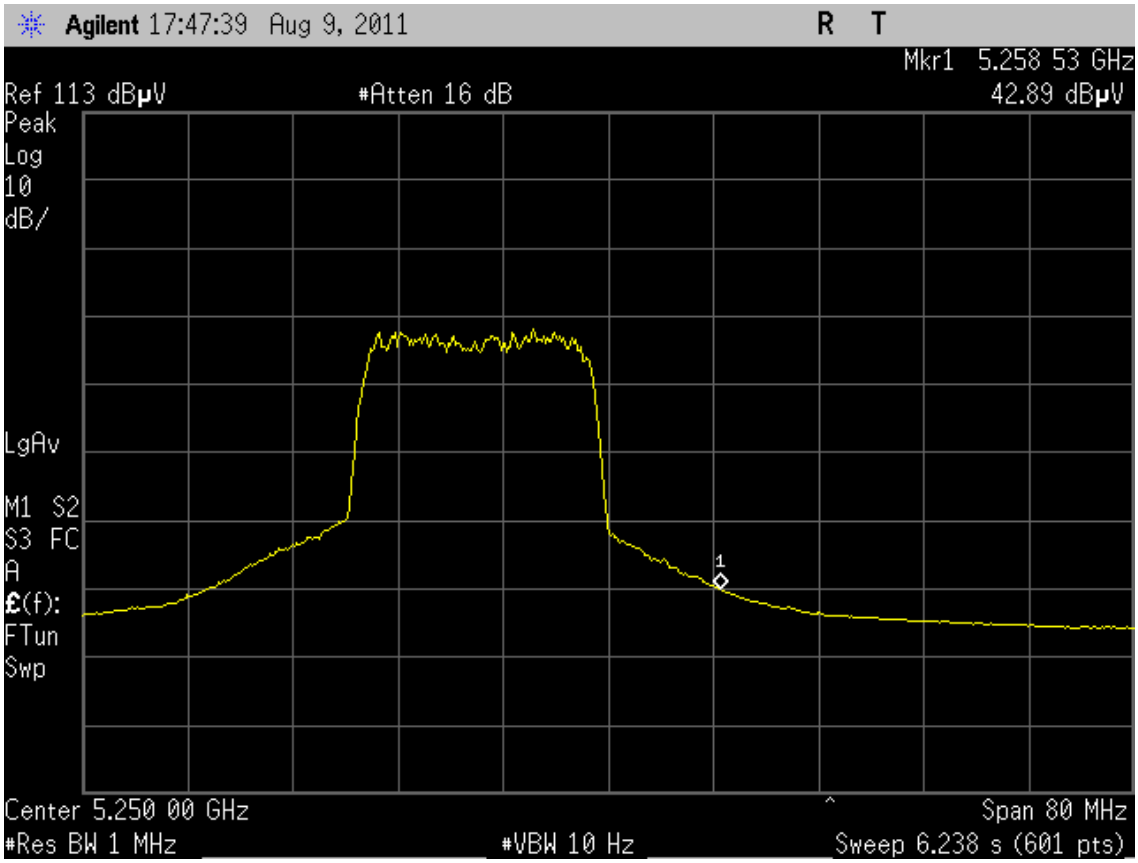
802.11a, 6Mbit/s, Channel 36, TXf=5180MHz, band edge 5150 MHz



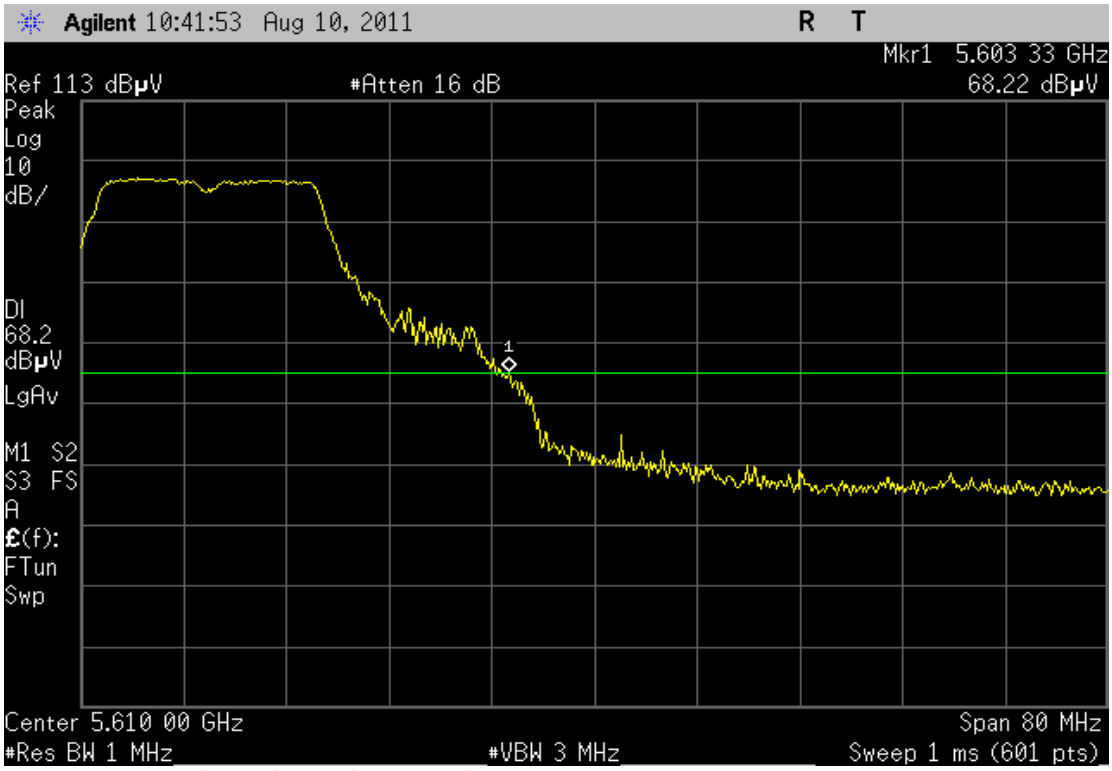
802.11a, 6Mbit/s, Channel 36, TXf=5180MHz, band edge 5150 MHz



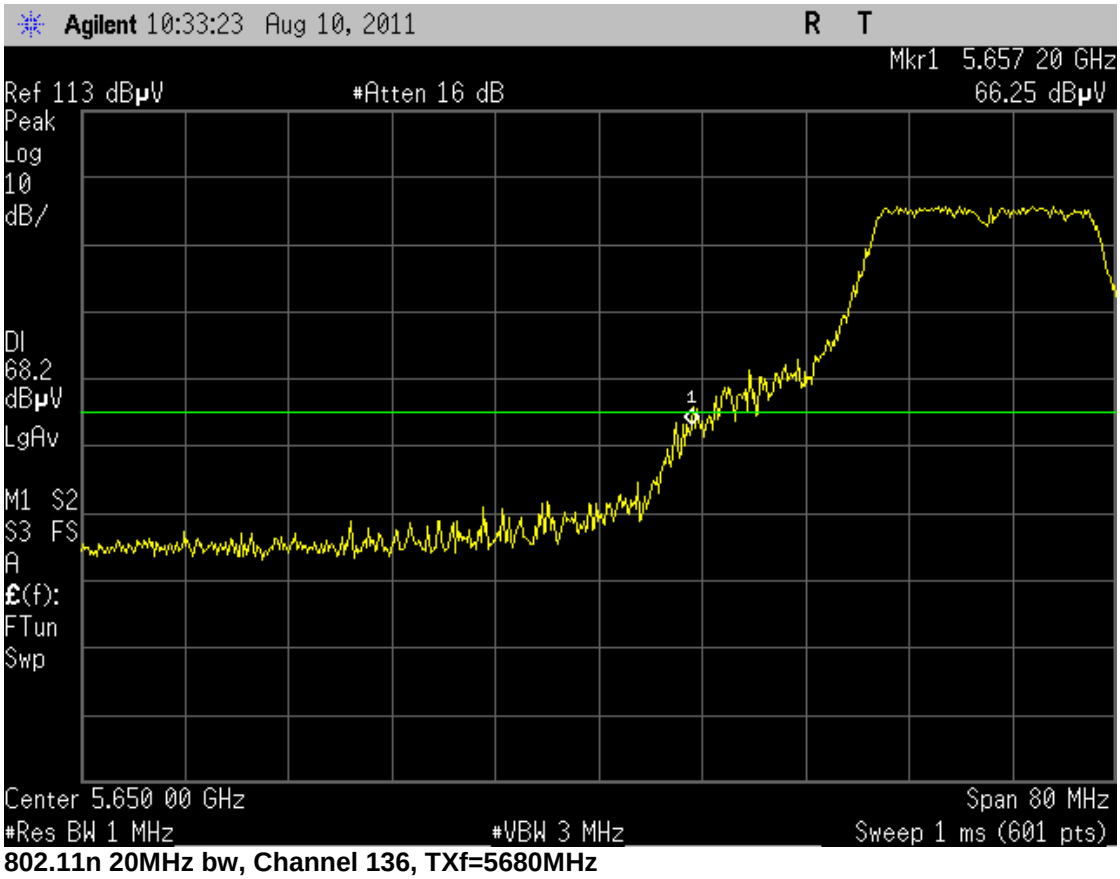
802.11a, 6Mbit/s, Channel 48, TXf=5240MHz, band edge 5250/5350 MHz



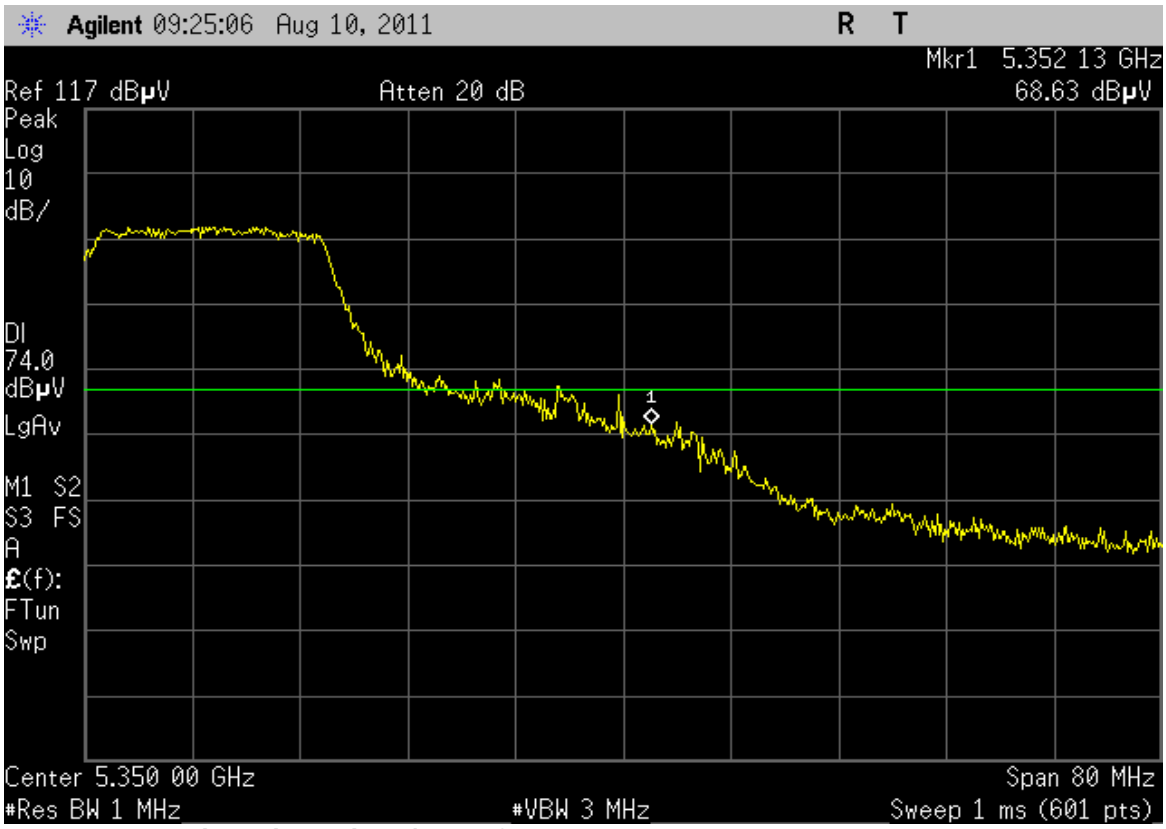
802.11a, 6Mbit/s, Channel 48, TXf=5240MHz, band edge 5250/5350 MHz



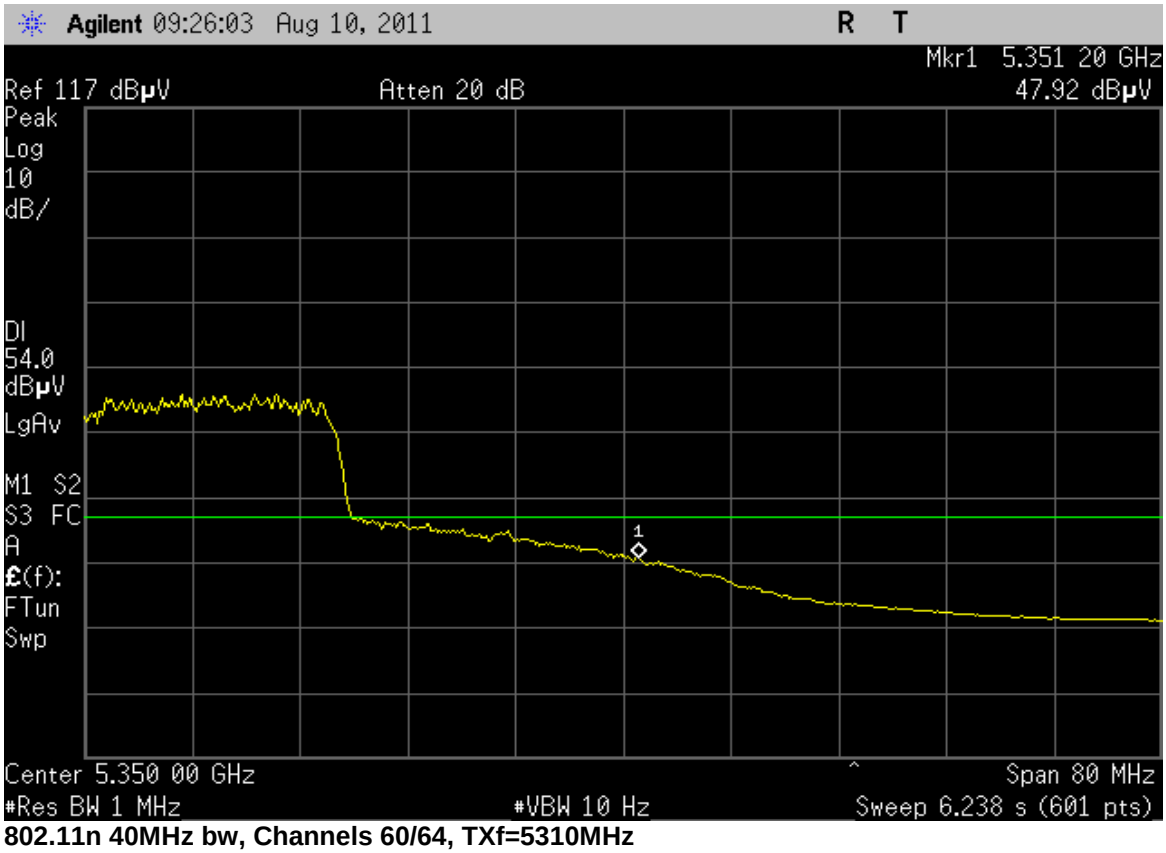
802.11n 20MHz bw, Channel 116, TXf=5580MHz



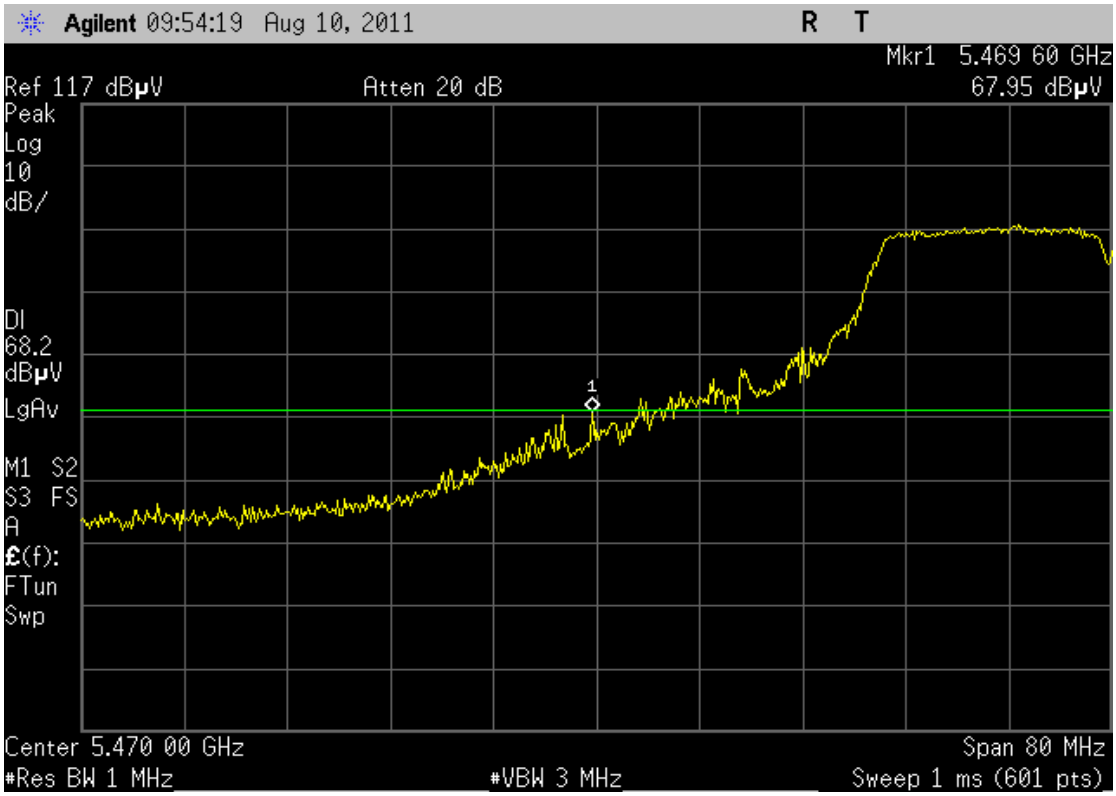
802.11n 20MHz bw, Channel 136, TXf=5680MHz



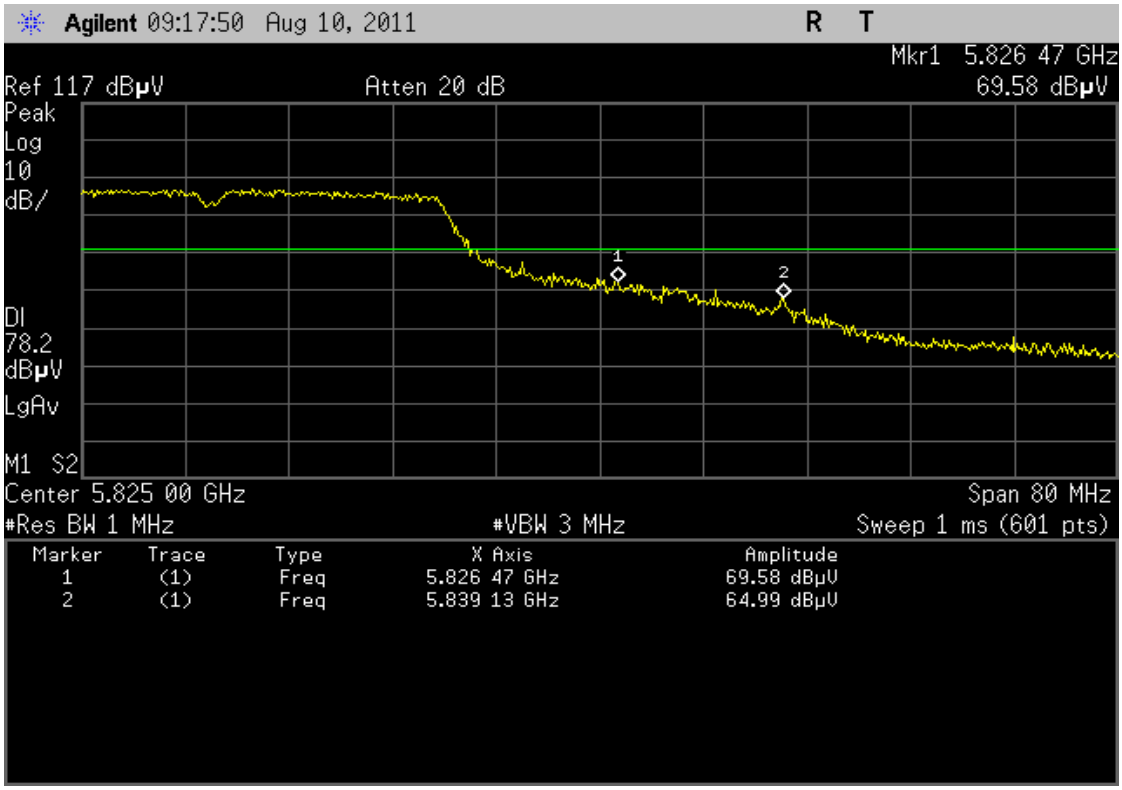
802.11n 40MHz bw, Channels 60/64, TXf=5310MHz



802.11n 40MHz bw, Channels 60/64, TXf=5310MHz



802.11n 40MHz bw, Channels 100/104, TXf=5510MHz



802.11n 40MHz bw, Channels 157/161, TXf=5755MHz

3.5 Peak power spectral density

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

Site name	Nemko Oy / Perkkaa
FCC rule part	§ 15.407
Date of testing	25-26.7.2011, 15.08.2011
Test equipment	566
Test conditions	25 °C, 55-58 % RH
Test result	**PASS**

3.5.1 Test method and limit

Test method #2 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 7.5 dBi => limit = 4 dBm - (7.5-6) dB = 2.5 dBm

5250 – 5350 MHz:
Antenna gain 7.5 dBi => limit = 11 dBm - (7.5-6) dB = 9.5 dBm

5470 – 5725 MHz:
Antenna gain 7.5 dBi => limit = 11 dBm - (7.5-6) dB = 9.5 dBm

5725 – 5825 MHz:
Antenna gain 7.5 dBi => limit = 17 dBm - (7.5-6) dB = 15.5 dBm

3.5.2 Test results

802.11a, 6Mbit/s

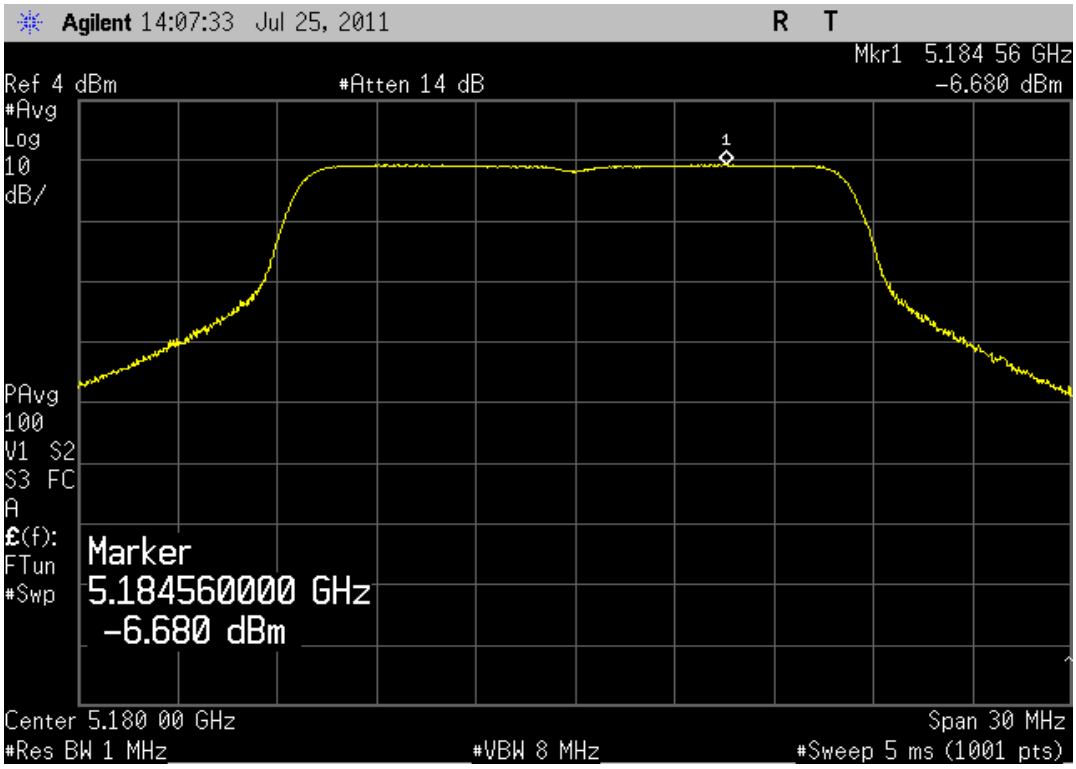
Channel	*Frequency MHz*	*Result dBm*	*Limit dBm*	*Margin dBm*
36	5180	-6.7	2.5	9.2
40	5200	-6.7	2.5	9.2
48	5240	-6.5	2.5	9.0
52	5260	-3.2	9.5	12.7
56	5280	-3.4	9.5	12.9
64	5320	-3.4	9.5	12.9
100	5500	-5.2	9.5	14.7
116	5580	-5.5	9.5	15.0
136	5680	-5.0	9.5	14.5
140	5700	-5.7	9.5	15.2
149	5745	-5.4	15.5	20.9
157	5785	-5.5	15.5	21.0
161	5805	-5.7	15.5	21.2

802.11n, 20MHz bw, MCS0

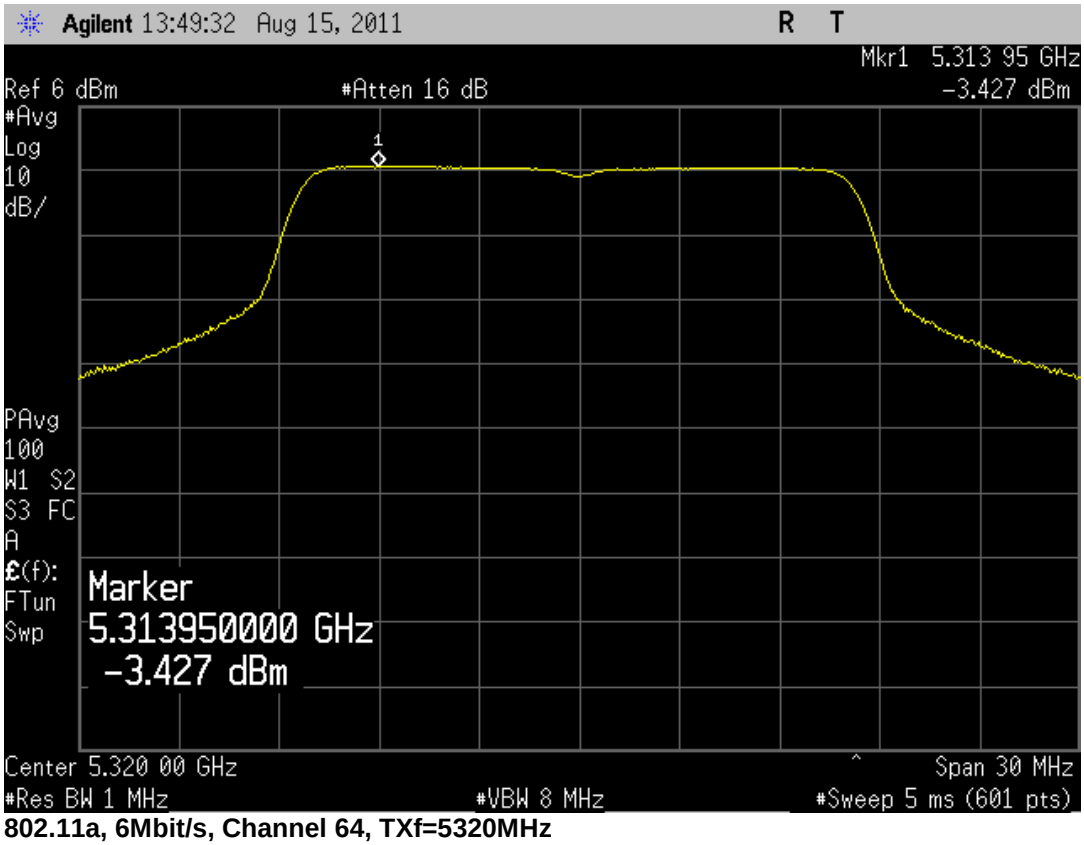
Channel	*Frequency MHz*	*Result dBm*	*Limit dBm*	*Margin dBm*
36	5180	-6.2	2.5	8.7
40	5200	-6.7	2.5	9.2
48	5240	-6.5	2.5	9.0
52	5260	-3.6	9.5	13.1
56	5280	-3.8	9.5	13.3
64	5320	-3.8	9.5	13.3
100	5500	-5.6	9.5	15.1
116	5580	-5.9	9.5	15.4
136	5680	-5.5	9.5	15.0
140	5700	-6.2	9.5	15.7
149	5745	-5.8	15.5	21.3
157	5785	-5.9	15.5	21.4
161	5805	-5.9	15.5	21.4

802.11n, 40MHz bw, MCS0

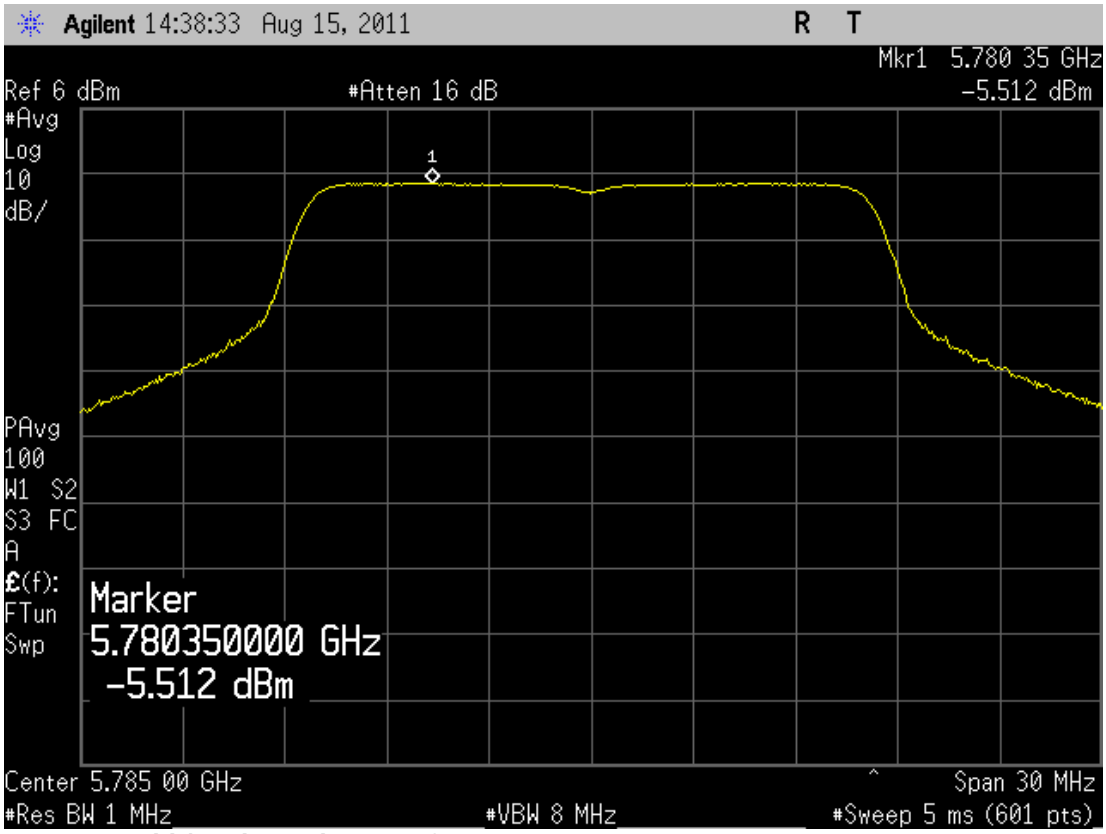
Channel	*Frequency MHz*	*Result dBm*	*Limit dBm*	*Margin dBm*
36/40	5190	-10.3	2.5	12.8
44/48	5230	-9.9	2.5	12.4
52/56	5270	-6.4	9.5	15.9
60/64	5310	-6.0	9.5	15.5
100/104	5510	-9.4	9.5	18.9
136/140	5690	-8.8	9.5	18.3
149/153	5755	-9.1	15.5	24.6
157/161	5795	-7.7	15.5	23.2



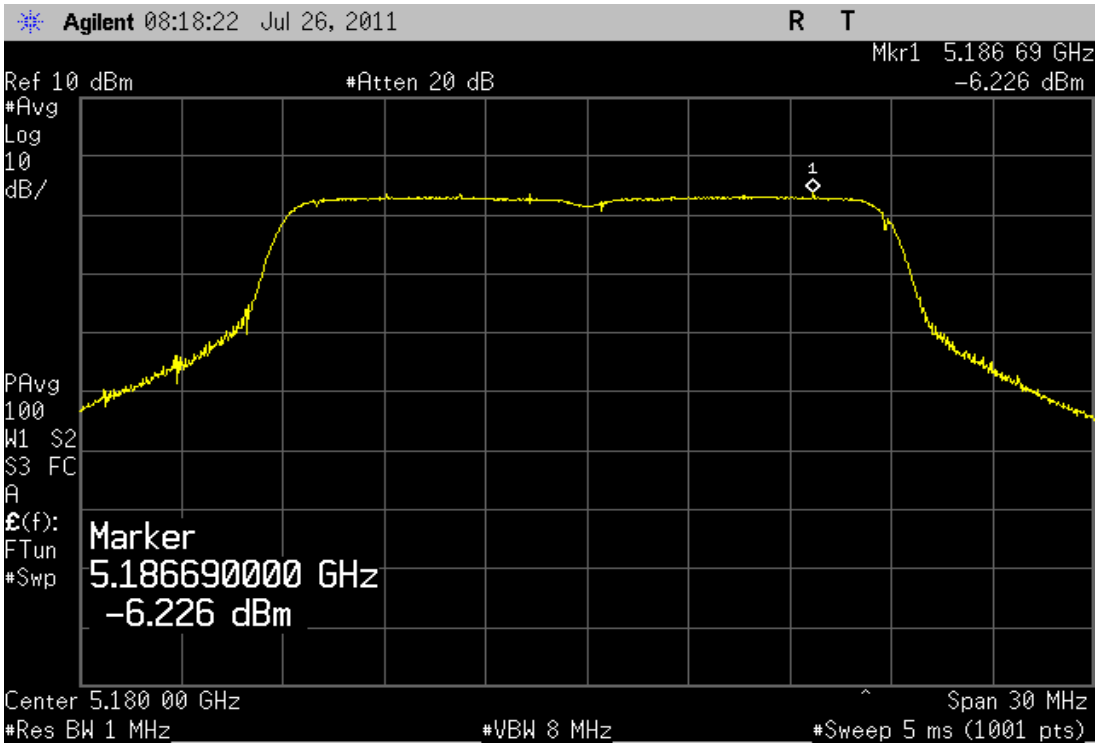
802.11a, 6Mbit/s, Channel 36, TXf=5180MHz



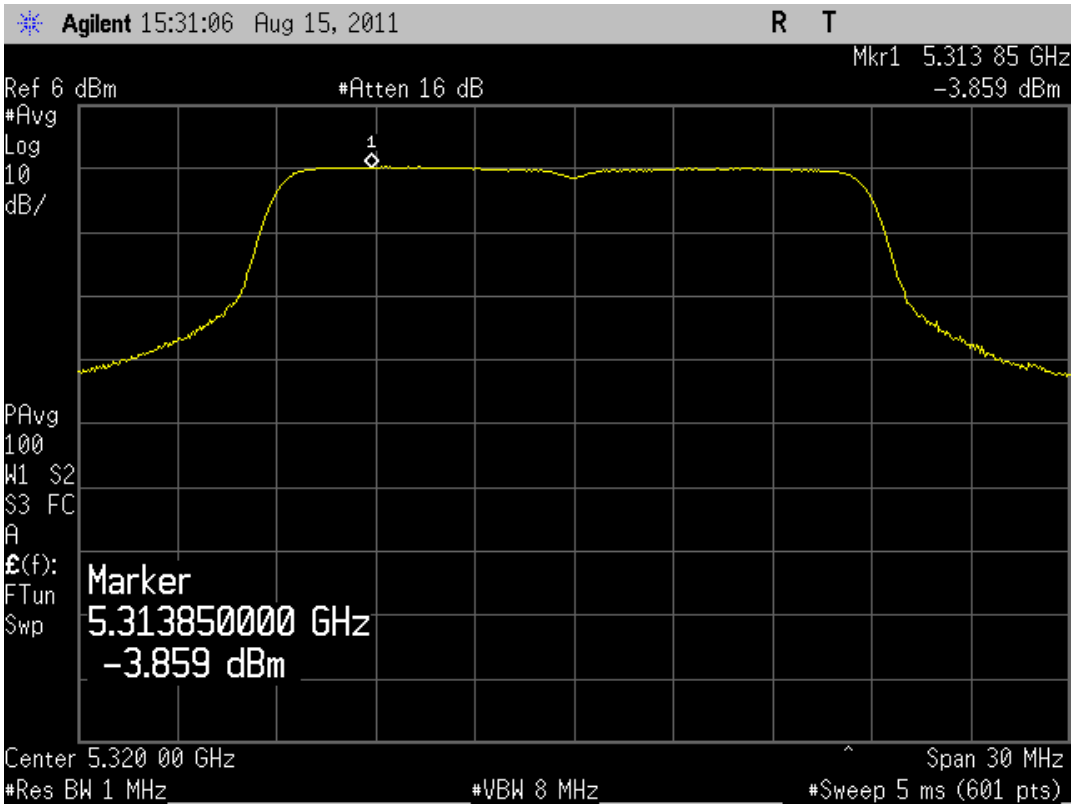
802.11a, 6Mbit/s, Channel 64, TXf=5320MHz



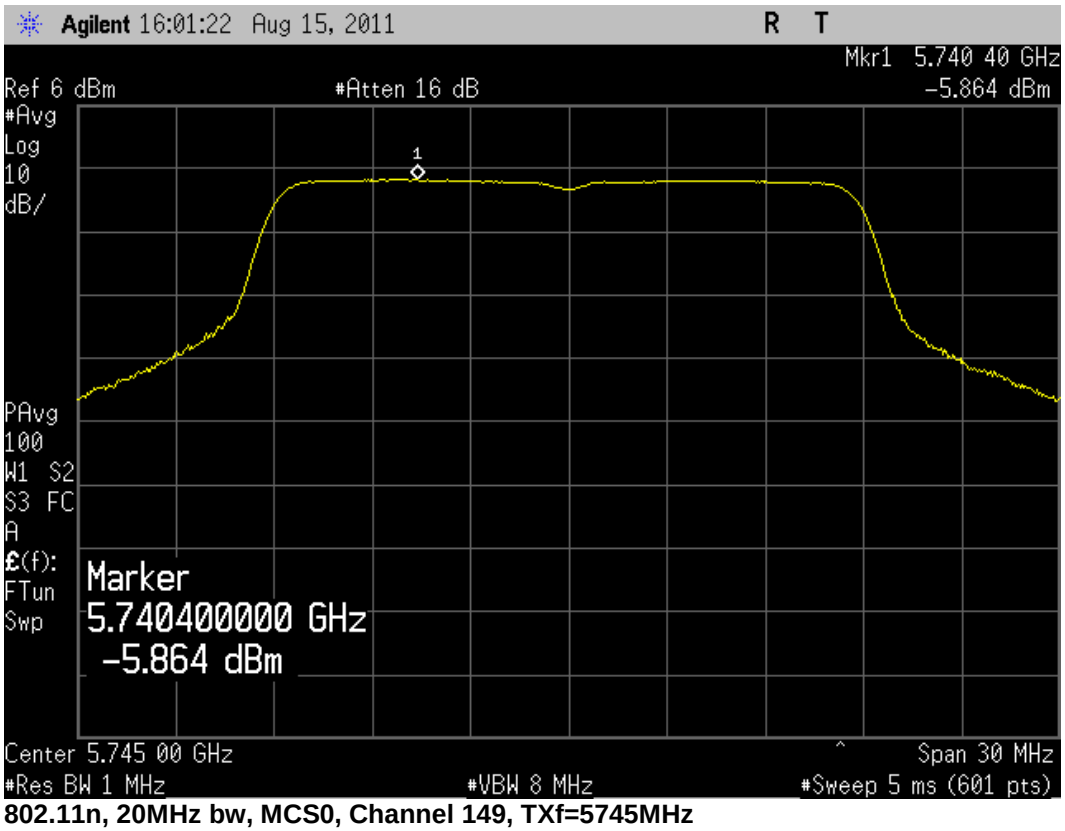
802.11a, 6Mbit/s, Channel 157, TXf=5785MHz



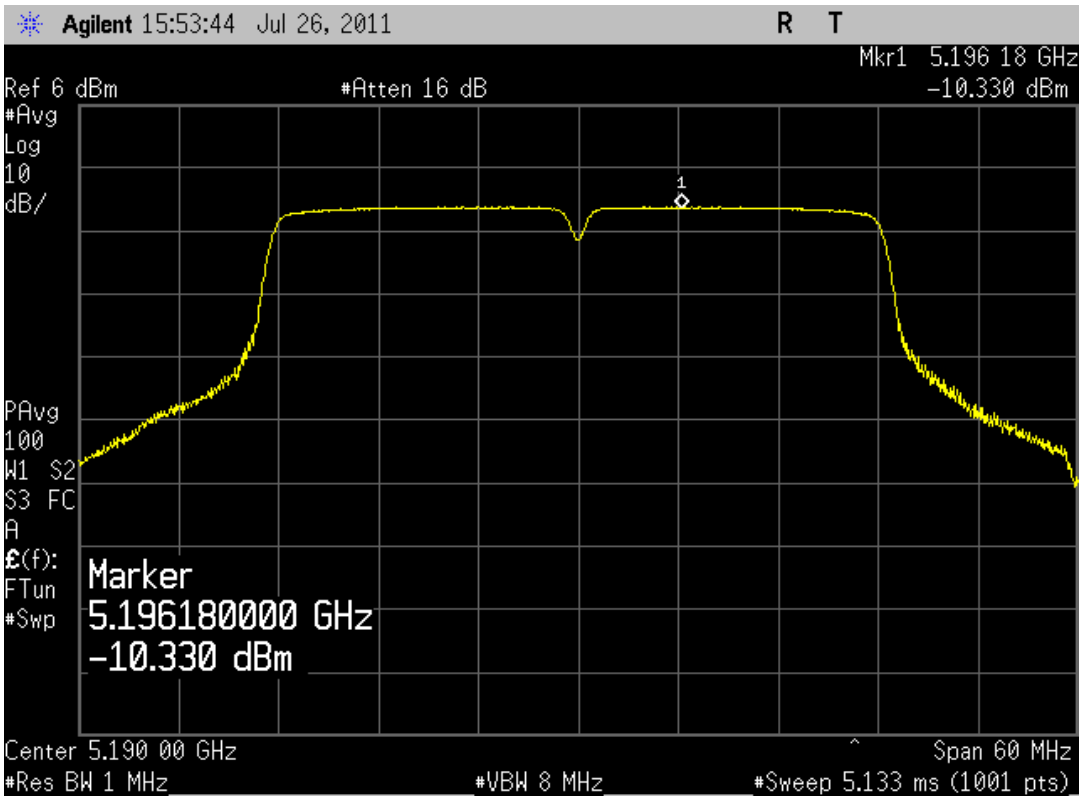
802.11n, 20MHz bw, MCS0, Channel 36, TXf=5180MHz



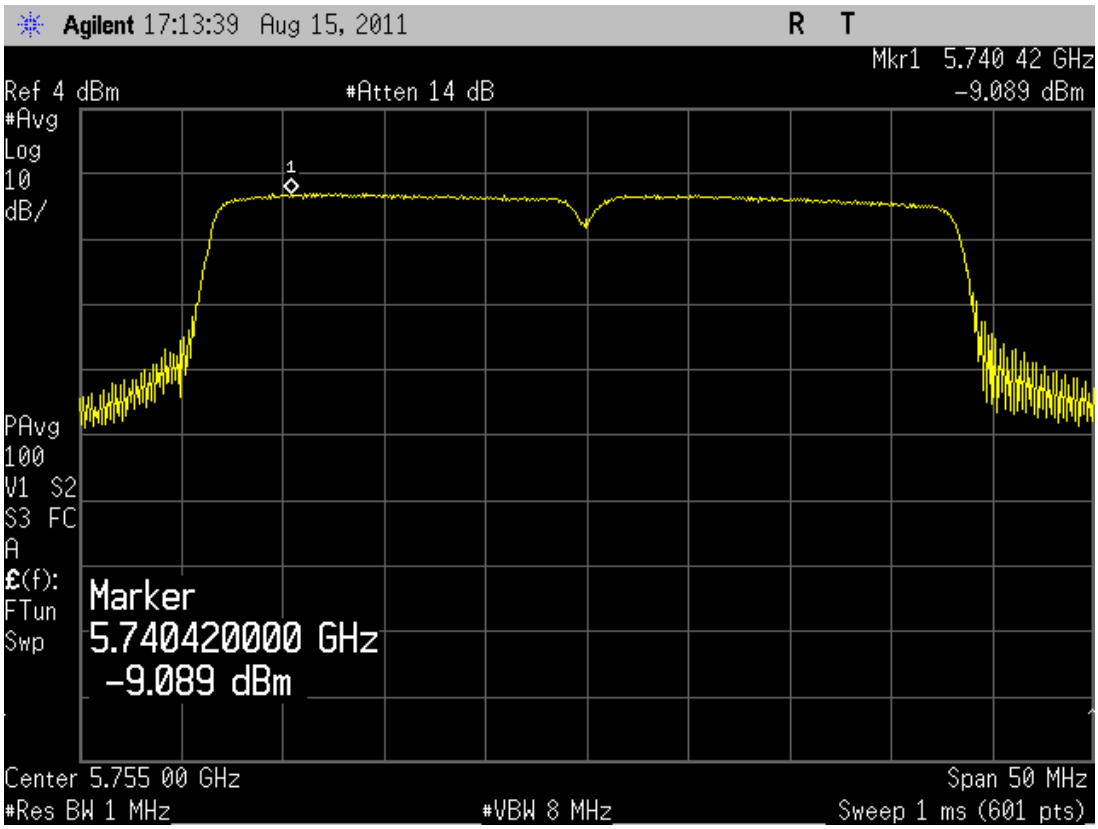
802.11n, 20MHz bw, MCS0, Channel 64, TXf=5320MHz



802.11n, 20MHz bw, MCS0, Channel 149, TXf=5745MHz



802.11n, 40MHz bw, MCS0 , Channels 36/40, TXf=5190MHz



802.11n, 40MHz bw, MCS0 , Channels 149/153, TXf=5755MHz

3.6 Peak power excursion

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

Site name	Nemko Oy / Perkkaa
FCC rule part	§ 15.407
Date of testing	25-26.7, 15.08.2011
Test equipment	566
Test conditions	25 °C, 55-58 % RH
Test result	**PASS**

3.6.1 Test method and limit

Trace 1
Test method #2 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.

Trace 1 and trace 2 was read to computer and subtracted.

Frequency band, MHz	**Limit**
5150-5250	***< 13 dB***
5250-5350	***< 13 dB***
5470-5725	***< 13 dB***
5725-5805	***< 13 dB***

3.6.2 Test results

802.11a, 6Mbit/s

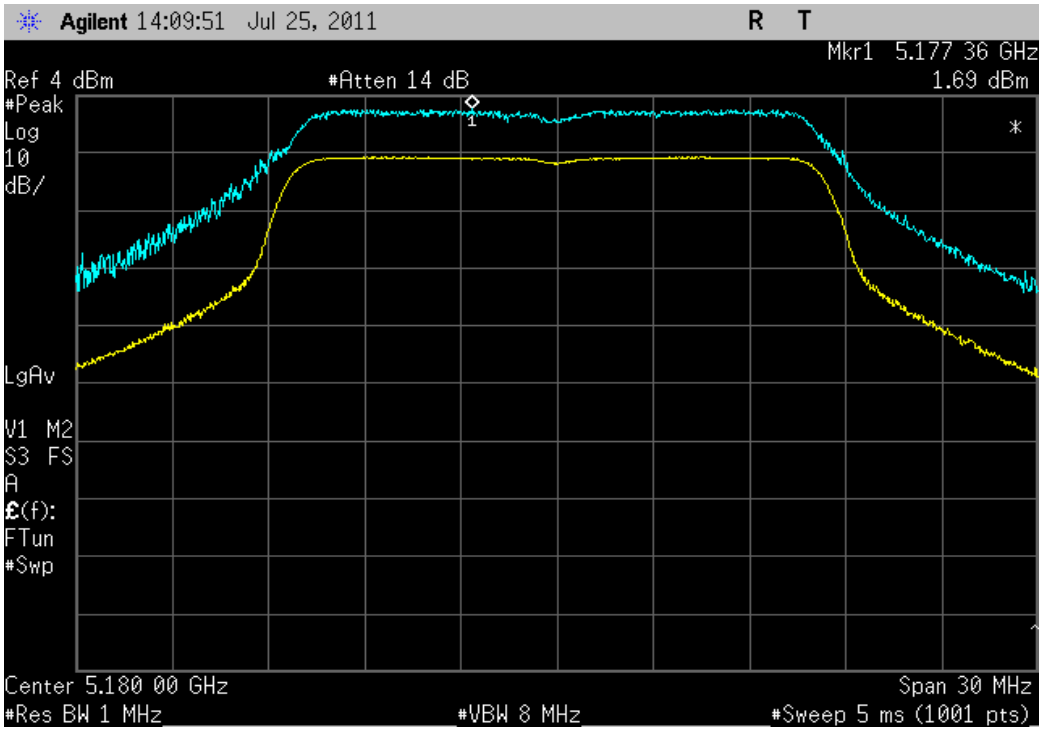
Channel	*Frequency MHz*	*Result dB*	*Limit dB*	*Margin dB*
36	5180	8.8	13	4.2
40	5200	8.8	13	4.2
48	5240	8.9	13	4.1
52	5260	8.9	13	4.1
56	5280	8.2	13	4.8
64	5320	8.2	13	4.8
100	5500	8.7	13	4.3
116	5580	8.6	13	4.4
136	5680	8.2	13	4.8
140	5700	8.2	13	4.8
149	5745	8.7	13	4.3
157	5785	8.4	13	4.6
161	5805	9.3	13	3

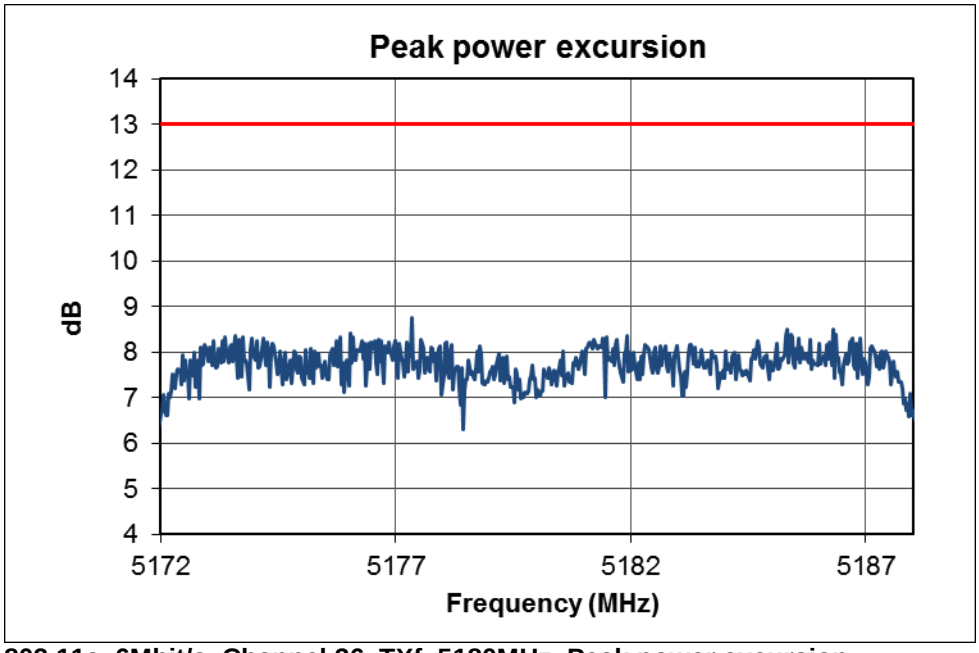
802.11n, 20MHz bw, MCS0

Channel	*Frequency MHz*	*Result dB*	*Limit dB*	*Margin dB*
36	5180	8.8	13	4.2
40	5200	8.6	13	4.4
48	5240	8.5	13	4.5
52	5260	8.4	13	4.6
56	5280	8.2	13	4.8
64	5320	8.6	13	4.4
100	5500	8.7	13	4.3
116	5580	8.5	13	4.5
136	5680	8.3	13	4.7
140	5700	8.4	13	4.6
149	5745	8.6	13	4.4
157	5785	8.6	13	4.4
161	5805	9.3	13	3.7

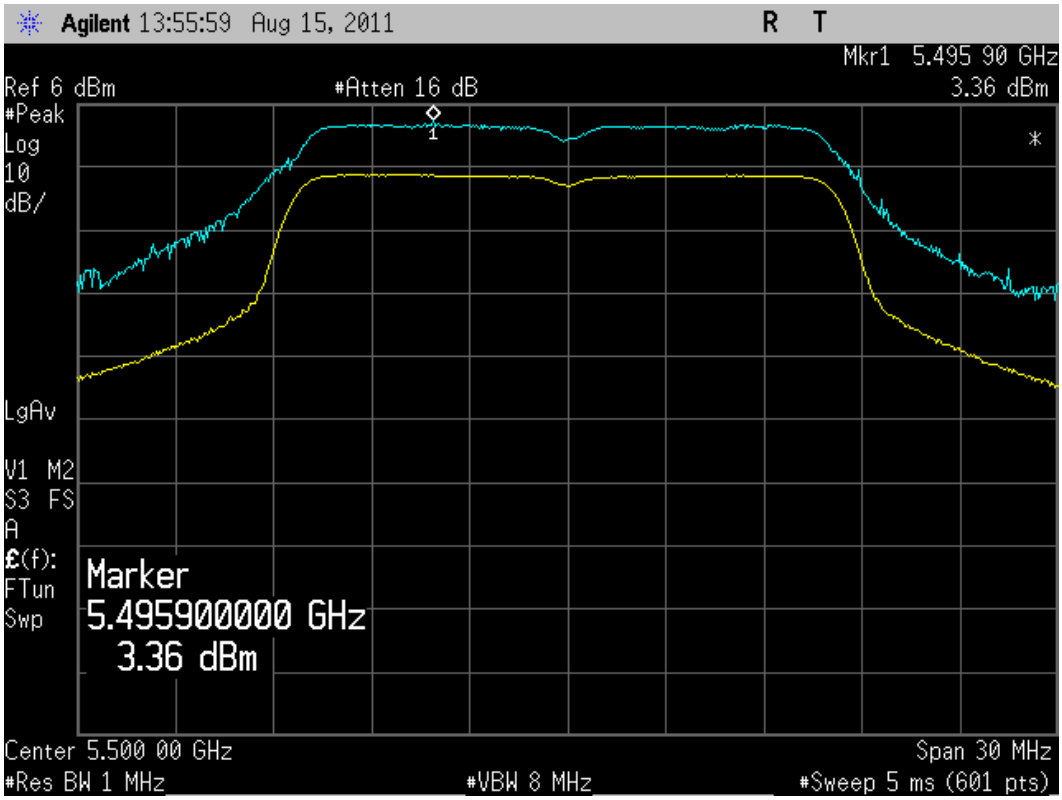
802.11n, 40MHz bw, MCS0

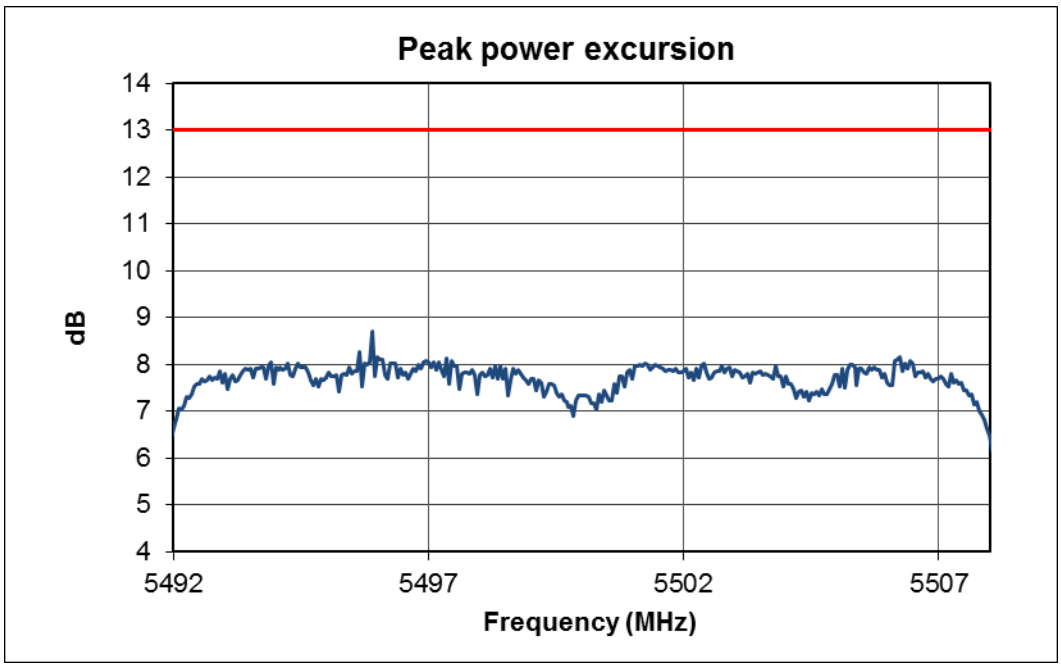
Channel	*F requency MHz*	*Result dB*	*Limit dB*	*Margin dB*
36/40	5190	9.7	13	3.3
44/48	5230	8.8	13	4.2
52/56	5270	8.7	13	4.3
60/64	5310	8.9	13	4.1
100/104	5510	9.2	13	3.8
136/140	5690	10.5	13	2.5
149/153	5755	9.7	13	3.3
157/161	5795	9.9	13	3.1



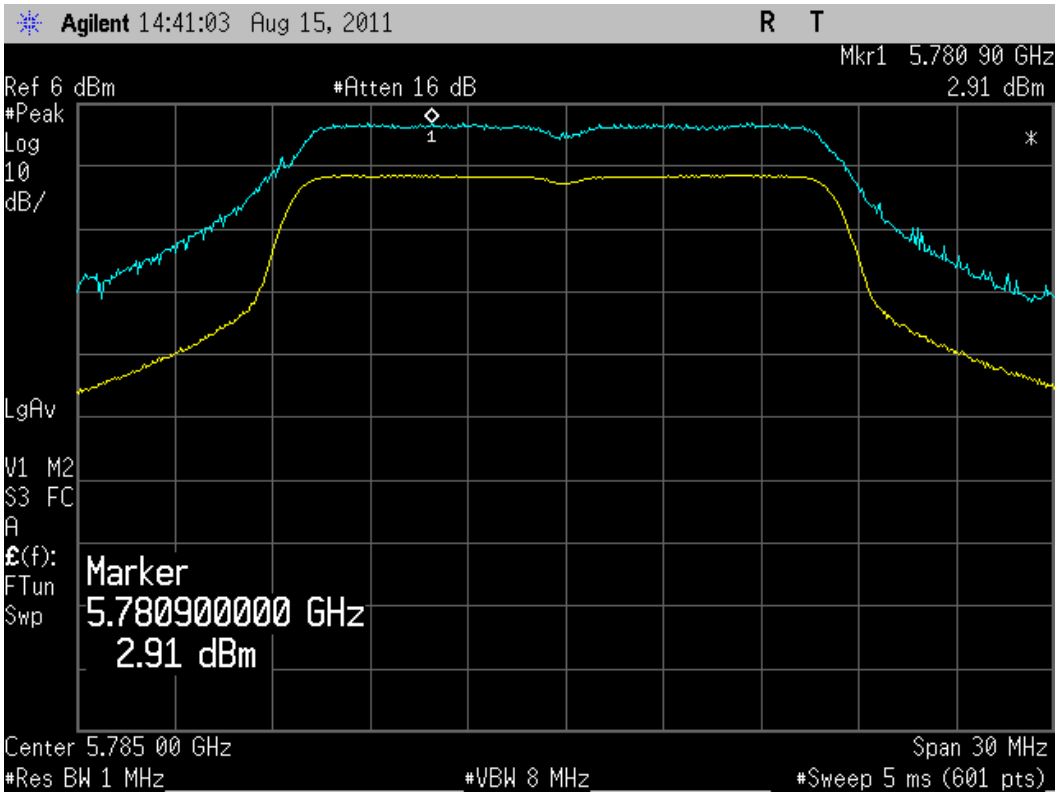


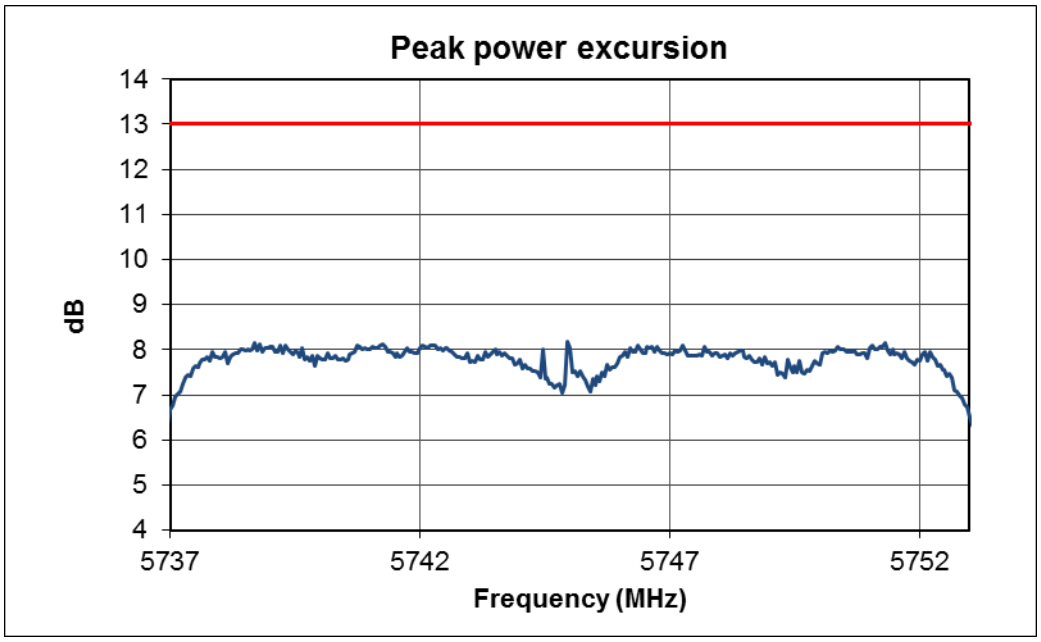
802.11a, 6Mbit/s, Channel 36, TXf=5180MHz, Peak power excursion



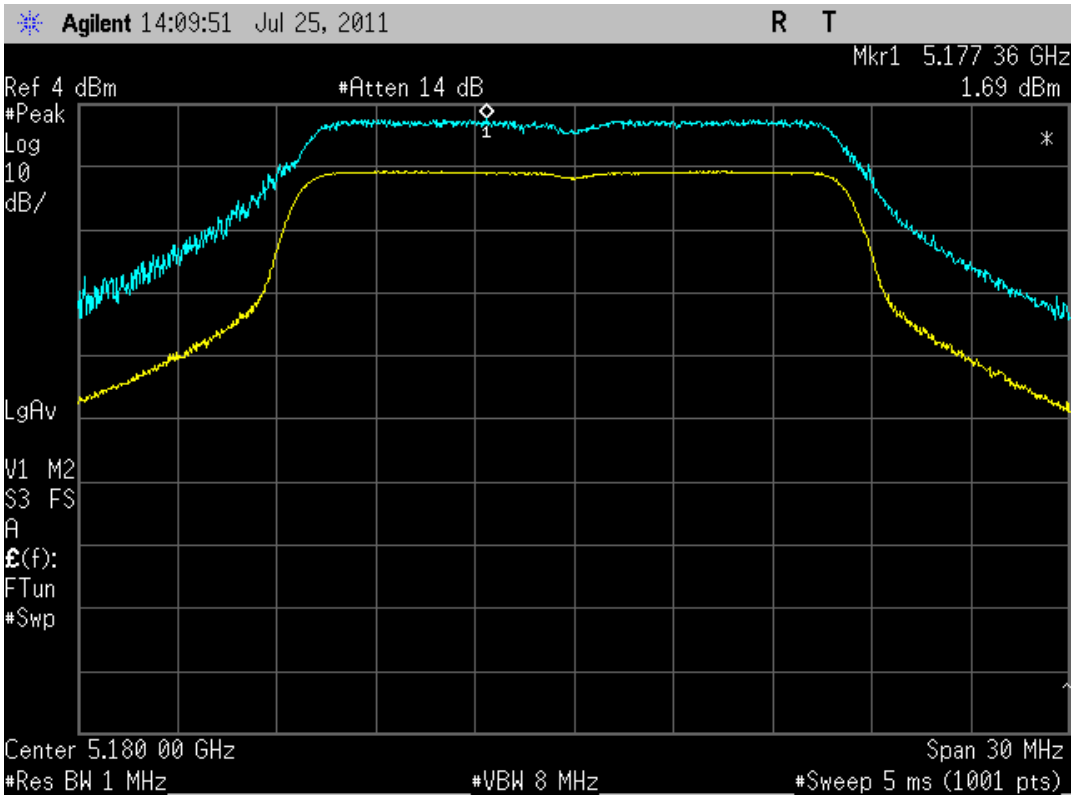


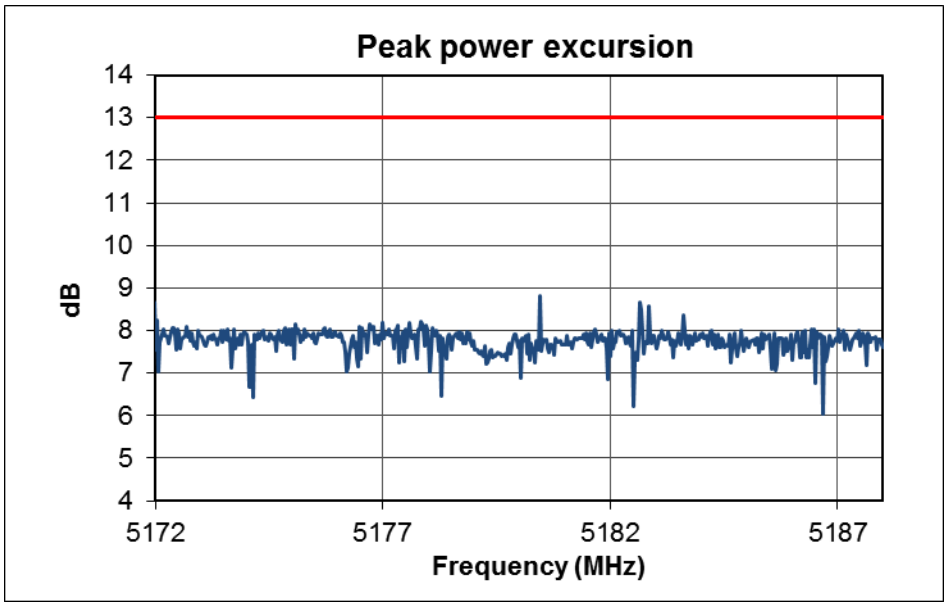
802.11a, 6Mbit/s, Channel 100, TXf=5500MHz, Peak power excursion



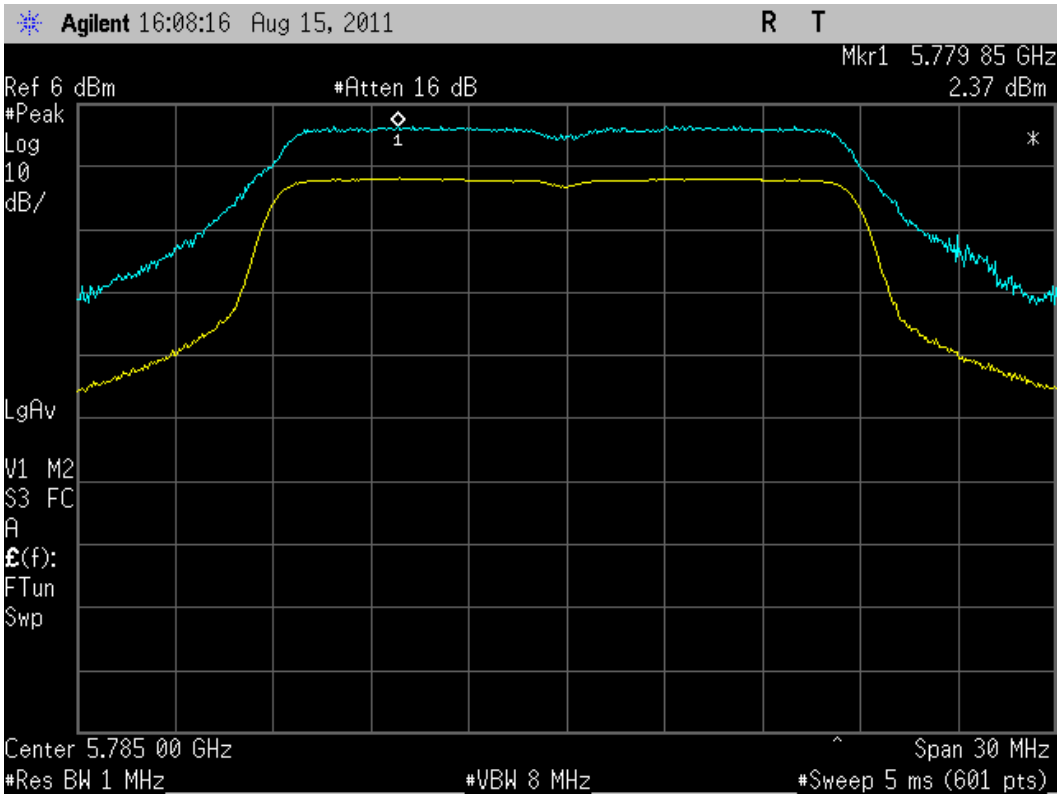


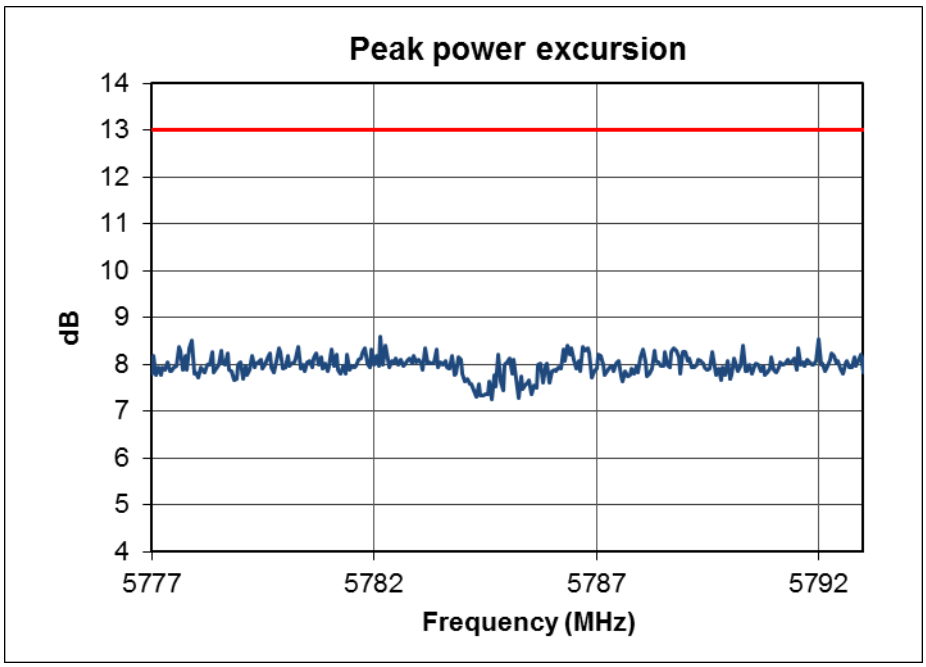
802.11a, 6Mbit/s, Channel 157, TXf=5745MHz, Peak power excursion



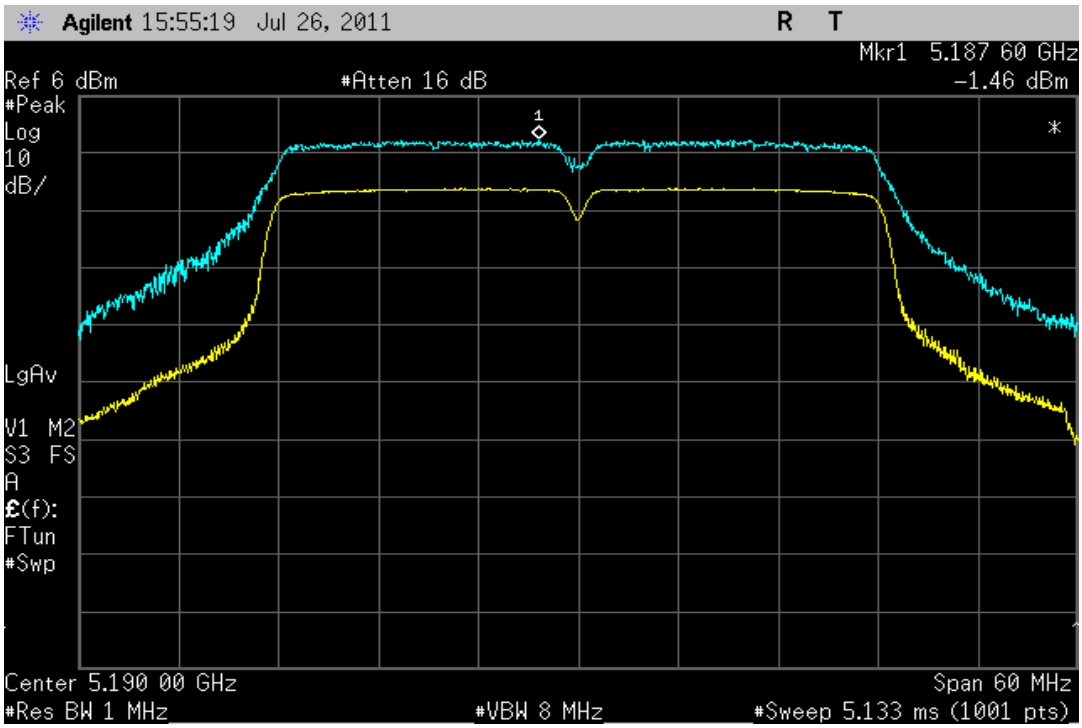


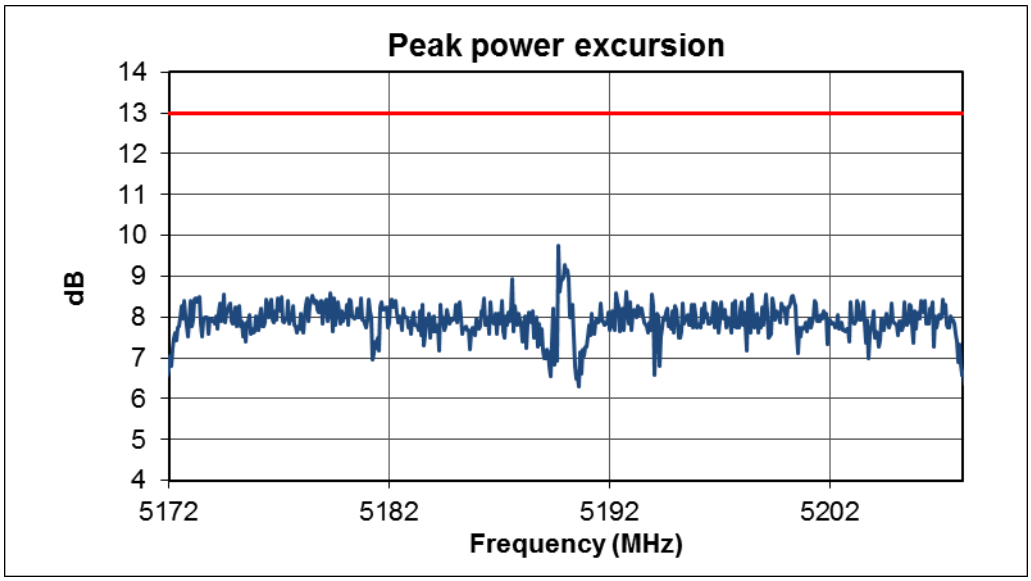
802.11n, 20MHz bw, MCS0, Channel 36, TXf=5180MHz, Peak power excursion



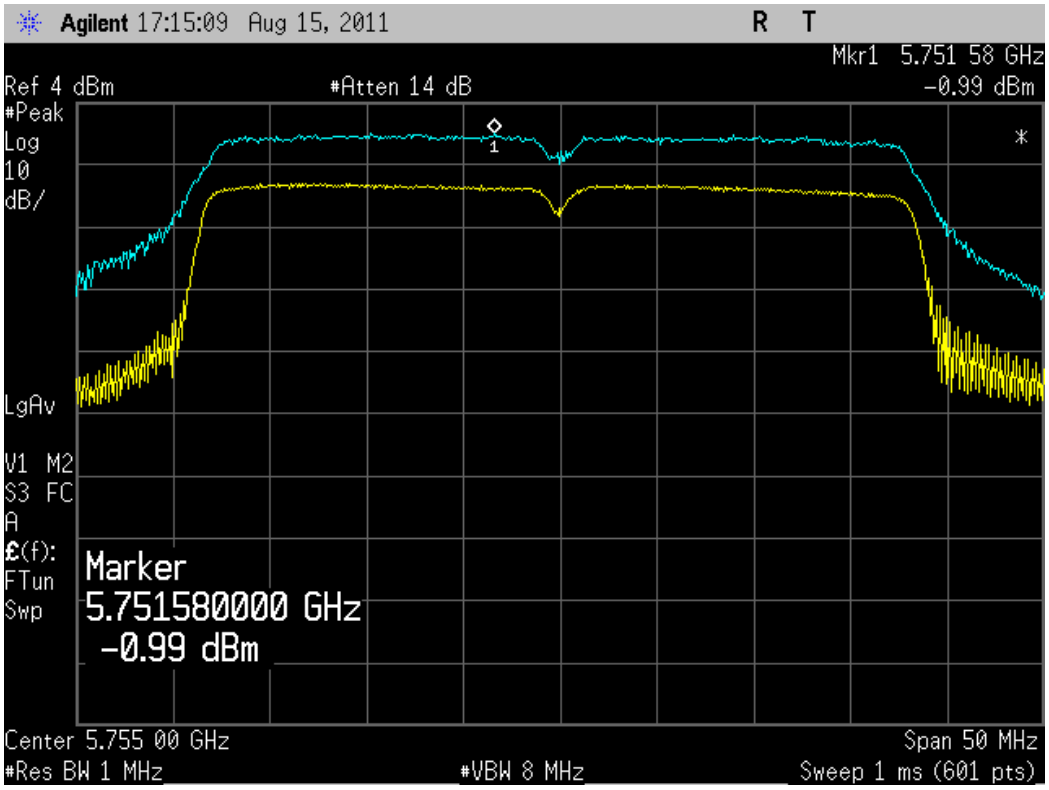


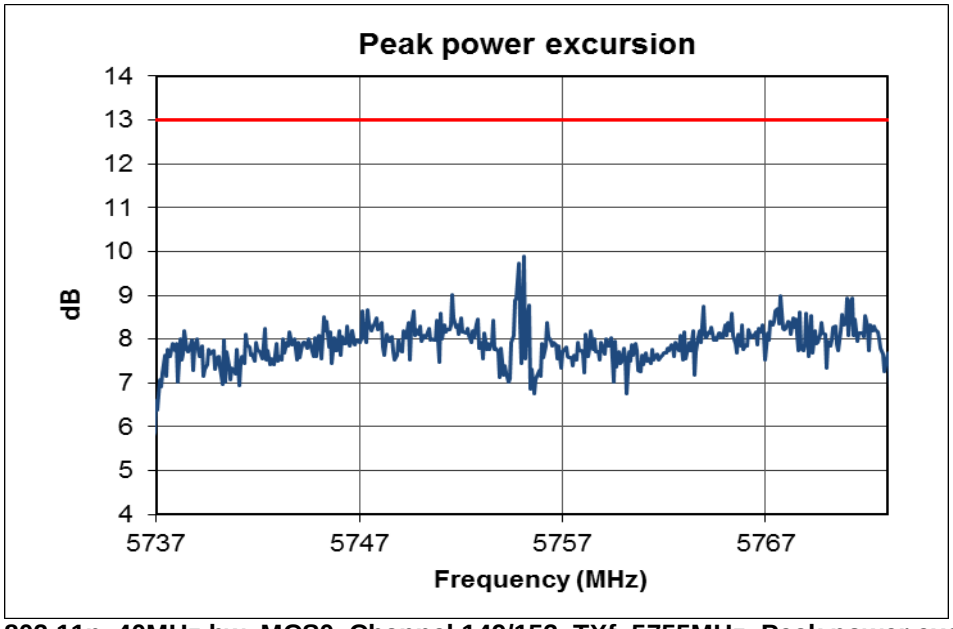
802.11n, 20MHz bw, MCS0, Channel 157, TXf=5785MHz, Peak power excursion





802.11n, 40MHz bw, MCS0, Channel 36/40, TXf=5190MHz, Peak power excursion





802.11n, 40MHz bw, MCS0, Channel 149/153, TXf=5755MHz, Peak power excursion

3.7 Frequency stability

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

Site name	Nemko Oy / Perkkaa
FCC rule part	§ 15.407
Date of testing	17.03.2011, 28.7.2011
Test equipment	566, 380, 157
Test conditions	22 °C, 30-58 % RH
Test result	**PASS (limit 0.02%)**

3.7.1 Test method

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

3.7.2 Test results

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

Temperature °C	Frequency error kHz	Error %	Limit %
50	**-98.0**	**-0.0019**	**0.02**
40	**-56.6**	**-0.0011**	**0.02**
30	**-151.6**	**-0.0029**	**0.02**
20	**-8.86**	**-0.0002**	**0.02**
10	**-141.4**	**-0.0027**	**0.02**
0	**-120.1**	**-0.0023**	**0.02**
-10	**-250.0**	**-0.0048**	**0.02**
-20	**-164.0**	**-0.0031**	**0.02**
-30	**-153.8**	**-0.0029**	**0.02**

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

DC voltage POE	Frequency error kHz	Error %	Limit %
48	**-33.9**	**-0.0006**	**0.02**
55	**-33.9**	**-0.0006**	**0.02**
35	**-33.9**	**-0.0006**	**0.02**

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
694	EMI Test Receiver	ESPC	Rohde & Schwarz	842888/023
338	Test receiver	ESS	Rohde & Schwarz	847151/009
566	Spectrum analyzer	E4448A	Agilent	US42510236
567	RF generator	E8257C	Agilent	MY43320736
544	RF-amplifier	ZFL-2000VH2	Mini-Circuits	D01080
564	RF amplifier	CA018-4010	CIAO Wireless	101
710	RF-amplifier	ALS 1826-41-12	ALC Microwave Inc.	0011
168	Artificial Mains	NSLK 8127	Schwartzbeck	8127162
380	RF attenuator PAD	771 C - 20 dB	Narda	-
559	Highpass filter	WHKX3.0/18G-10ss	Wainwright	1
319	Antenna	CBL6112	Chase	2018
525	Double-Ridged Horn	3115	Emco	6691
542	Double-Ridged Horn	3115	Emco	00023905
86	Waveguide horn	640	Narda	09
87	Waveguide horn	639	Narda	7909
88	Waveguide horn	638	Narda	8003
521	Waveguide horn	V637	Narda	9307
371	AC Power source	500i-400	California Instr.	HK 52064
348	Shielded room	RFSD-100	Euroshield Oy	1320
350	Semianechoic shielded room	RFD-F-100	Euroshield Oy	1327
176	Anechoic chamber	RFD-60	Euroshield	509
157	Temp. test chamber	VMT 04/240	Vötch	31884