

Date: ESPOO 16.08.2011Page: 1 (42)Appendices –Number:  
No. 1 / 1**183922A**

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.**

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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

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

### Summary of performed tests and test results

<i>Section in CFR 47</i>		<i>Result</i>
15.207	AC power line conducted emissions	<b>PASS</b> , margin 7.6 dB
15.209 / 15.247 (d)	Radiated Emissions, 30MHz ~ 40000MHz	<b>PASS</b> , margin 0.2 dB
15.247 (d)	Conducted Emissions at antenna port, 30MHz ~ 40000MHz	<b>PASS</b>
15.247 (b)	Maximum peak output power	<b>PASS</b>
15.247 (d)	Band Edge compliance	<b>PASS</b>
15.247	6dB Bandwidth	<b>PASS</b>
15.247	Peak Power Spectral Density	<b>PASS</b>

#### 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 a 7signal Sapphire Eye WLAN unit.

Operating frequencies and channels:

	Channel	Frequency [MHz]
802.11b, 1Mbit/s	1	2412
	6	2437
	11	2462
802.11g, 6Mbit/s	1	2412
	6	2437
	11	2462
802.11a, 6Mbit/s	149	5745
	157	5785
	165	5825
802.11n, 20MHz bw MCS0	149	5745
	157	5785
	165	5825
802.11n, 40MHz bw MCS0	1/5	2422
	7/11	2452
	149/153	5755
	161/165	5815

Power supply: 48V DC Power through Ethernet, (115VAC, 60 Hz).

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

**1.2 EUT and accessories**

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

Cables:

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

Operating voltage during the tests: 48 VDC PoE (115 VAC, 60 Hz)

## 2. Standards and measurement methods

The test were performed in guidance of the CFR 47 Part 15, Subpart B, Class B, ANSI C63.4 (2009), ANSI C63.10 (2009) and CISPR 22 Ed. 6.

## 3. Test results

### 3.1 AC power line conducted emissions

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

<i>Site name</i>	Nemko Oy/ Perkkaa
<i>Date of testing</i>	28.03.2011
<i>Test equipment</i>	694, 168, 348, 371
<i>Test conditions</i>	22 °C, 30 % RH
<i>Test result</i>	<b>PASS</b>

#### 3.1.1 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.

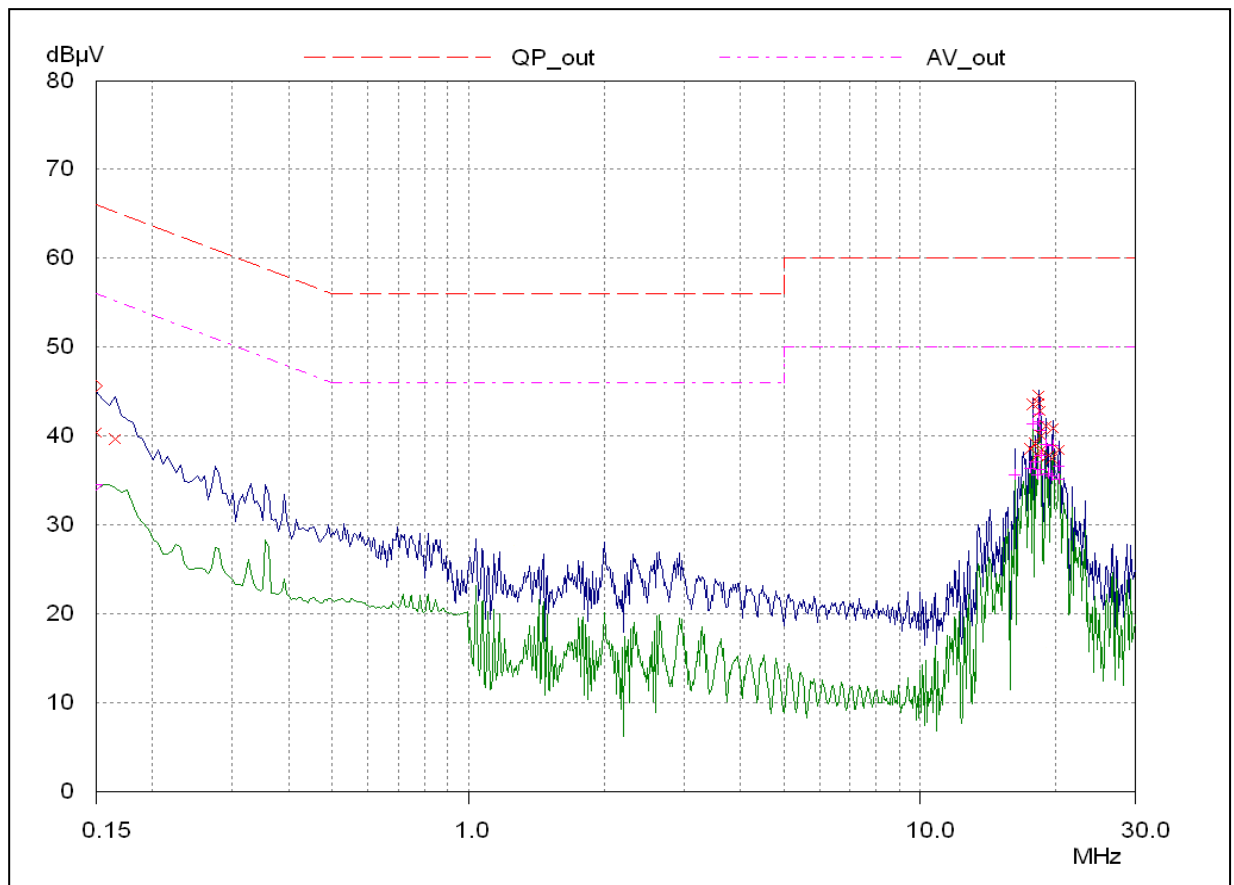
If not, then at the test frequencies concerned the measurement is performed also by using a quasi-peak detector. If the disturbance levels measured by using the quasi-peak detector are below the limit value defined for the measurement performed by using an average detector, then measurements by using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

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

### 3.1.2 Test results

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

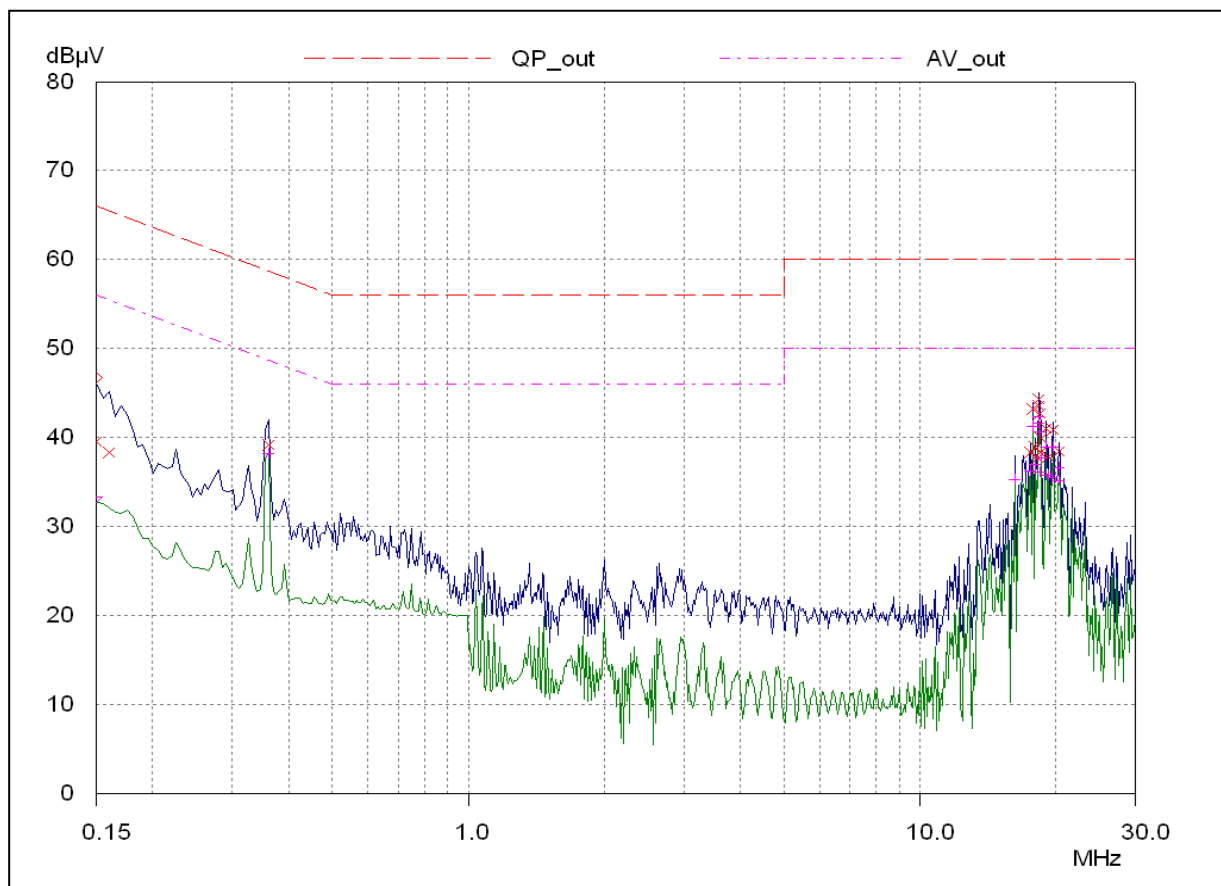
line N, Uin = 115V/60Hz



Final results:

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 results:

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



### 3.2 Radiated emissions

<i>Site name</i>	Nemko / Perkkaa
<i>Date of testing</i>	17.01, 09-10.08.2011
<i>Test equipment</i>	350, 338, 544, 319, 176, 567, 564, 525, 542, 559, 371, 86, 87, 88, 521, 710
<i>Test conditions</i>	22-25 °C, 30-50 % RH
<i>Test result</i>	<b>PASS</b>

#### 3.2.1 Test method and limit

The test was performed in a semi-anechoic shielded room. The EUT was placed on a non-conductive 0.8 m high table 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) and in the frequency range 1000-40000 MHz the distance from the EUT to the measuring antenna was 1 m (RF absorbers on the 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 (30-1000 MHz) 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.

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

<i>Frequency band MHz</i>	<i>Quasi-peak limit <math>\text{dB}(\mu\text{V/m})</math></i>
<b>30 - 88</b>	<b>40</b>
<b>88 - 216</b>	<b>43.5</b>
<b>216 - 960</b>	<b>46</b>
<b>960 - 1000</b>	<b>54</b>

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

<i>Frequency band MHz</i>	<i>Average limit <math>\text{dB}(\mu\text{V/m})</math></i>	<i>Peak limit <math>\text{dB}(\mu\text{V/m})</math></i>
<b>1000 - 40000</b>	<b>54</b>	<b>74</b>

### 3.2.2 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).

**802.11b, 1Mbit/s**

Channel	Frequency MHz	Result Peak dBμV/m	Limit Peak dBμV/m	Margin dB	Result Average dBμV/m	Limit Average dBμV/m	Margin dB
1	4824	55.9	74	18.1	53.5	54	0.5
	7236	41.3	74	32.7	35.3	54	18.7
	9648	44.8	74	29.2	39.8	54	14.2
	12060	40.7	74	33.3	32.5	54	21.5
	14472	43.2	74	30.8	33.8	54	20.2
	16884	43.3	74	30.7	33.8	54	20.2
6	4874	56.5	74	17.5	53.3	54	0.7
	7311	44.9	74	29.1	39.6	54	14.4
	9748	45.9	74	28.1	42.9	54	11.1
	12185	41.1	74	32.9	33.7	54	20.3
	14622	42.8	74	31.2	35.0	54	19.0
	17059	43.3	74	30.7	34.3	54	19.7
11	4924	56.3	74	17.7	53.8	54	0.2
	7386	61.7	74	12.3	39.4	54	14.6
	9848	56.6	74	17.4	47.7	54	6.3
	12310	48.6	74	25.4	28.5	54	25.5
	14772	46.7	74	27.3	35.6	54	18.4
	17234	43.9	74	30.1	29.3	54	24.7

**802.11g, 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
1	4824	58.1	74	15.9	50.3	54	3.7
	7236	53.8	74	20.2	42.5	54	11.5
	9648	49.4	74	24.6	39.0	54	15.0
	12060	51.4	74	22.6	37.3	54	16.7
	14472	43.1	74	30.9	33.9	54	20.1
	16884	42.7	74	31.3	34.1	54	19.9
6	4874	57.5	74	16.5	49.7	54	4.3
	7311	57.5	74	16.5	47.0	54	7.0
	9748	51.1	74	22.9	40.7	54	13.3
	12185	46.3	74	27.7	33.5	54	20.5
	14622	43.0	74	31.0	33.6	54	20.4
	17059	43.5	74	30.5	34.3	54	19.7
11	4924	56.3	74	17.7	41.4	54	12.6
	7386	61.7	74	12.3	42.7	54	11.3
	9848	56.6	74	17.4	38.2	54	15.8
	12310	48.6	74	25.4	30.8	54	23.2
	14772	46.7	74	27.3	30.0	54	24.0
	17234	43.9	74	30.1	29.3	54	24.7

**802.11a, 6Mbit/s**

<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>
149	11490	49.8	74	24.2	43.8	54	10.2
	17235	59.3	74	14.7	48.5	54	5.5
	22980	50.0	74	24.0	41.3	54	12.7
	28725	49.1	74	24.9	36.9	54	17.1
157	11570	49.3	74	24.7	40.0	54	14.0
	17355	57.4	74	16.6	47.8	54	6.2
	23140	53.7	74	20.3	42.9	54	11.1
	28925	54.8	74	19.2	41.6	54	12.4
165	11650	54.0	74	20.0	43.3	54	10.7
	17475	61.1	74	12.9	49.4	54	4.6
	23300	57.4	74	16.6	46.6	54	7.4
	29125	56.6	74	17.4	46.3	54	7.7

**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>
149	11490	50.4	74	23.6	40.5	54	13.5
	17235	58.0	74	16.0	48.1	54	5.9
	22980	52.0	74	22.0	40.8	54	13.2
	28725	49.4	74	24.6	36.2	54	17.8
157	11570	48.6	74	25.4	39.3	54	14.7
	17355	57.6	74	16.4	47.8	54	6.2
	23140	53.3	74	20.7	42.6	54	11.4
	28925	54.9	74	19.1	42.5	54	11.5
165	11650	50.8	74	23.2	42.9	54	11.1
	17475	59.7	74	14.3	47.6	54	6.4
	23300	55.8	74	18.2	46.3	54	7.7
	29125	57.9	74	16.1	45.9	54	8.1

**802.11n, 40MHz bw, MCS0**

<i>Channel</i>	<i>Frequency MHz</i>	<i>Result Peak dB<math>\mu</math>V/m</i>	<i>Limit Peak dB<math>\mu</math>V/m</i>	<i>Margin dB</i>	<i>Result Average dB<math>\mu</math>V/m</i>	<i>Limit Average dB<math>\mu</math>V/m</i>	<i>Margin dB</i>
1/5	4844	53.8	74	20.2	46.8	54	7.2
	7266	51.9	74	22.1	40.3	54	13.7
	9688	46.9	74	27.1	37.5	54	16.5
	12110	43.6	74	30.4	33.5	54	20.5
	14532	43.7	74	30.3	34.5	54	19.5
	16954	43.1	74	30.9	34.3	54	19.7
7/11	4904	53.7	74	20.3	47.3	54	6.7
	7356	53.8	74	20.2	44.2	54	9.8
	9808	49.7	74	24.3	40.5	54	13.5
	12260	42.5	74	31.5	33.1	54	20.9
	14712	44.6	74	29.4	35.3	54	18.7
	17164	44.1	74	29.9	35.0	54	19.0
149/153	11510	51.5	74	22.5	42.4	54	11.6
	17265	57.0	74	17.0	47.6	54	6.4
	23020	45.9	74	28.1	39.0	54	15.0
	28775	44.8	74	29.2	34.7	54	19.3
161/165	11630	50.2	74	23.8	43.5	54	10.5
	17445	57.0	74	17.0	47.3	54	6.7
	23260	49.5	74	24.5	41.4	54	12.6
	29075	52.1	74	21.9	42.1	54	11.9

### 3.3 Conducted emissions at antenna port

<i>Site name</i>	Nemko / Perkkaa
<i>Date of testing</i>	07.03-05.05.2011, 15.08.2011
<i>Test equipment</i>	566
<i>Test conditions</i>	22-25 °C, 30-55 % RH
<i>Test result</i>	<b>PASS</b>

#### 3.3.1 Test method and limit

The measurements were performed with peak-detector (RBW: 100 kHz).

<i>Operating Frequency MHz</i>	<i>Frequency band MHz</i>	<i>Limit dBc</i>
<b>2400-2483.5</b>	<b>30 - 25000</b>	<b>-20</b>
<b>5725-5850</b>	<b>30 - 40000</b>	<b>-20</b>

#### 3.3.2 Test results

##### 802.11b, 1Mbit/s

<i>Channel</i>	<i>Frequency MHz</i>	<i>Result dBc</i>	<i>Limit dBc</i>	<i>Margin dB</i>
1	4824	-34.6	-20	14.6
1	7236	<-50	-20	>30
6	4874	-35.3	-20	15.3
6	7311	<-50	-20	>30
11	4924	-36.9	-20	16.9
11	7386	-59.7	-20	39.7

##### 802.11g, 6Mbit/s

<i>Channel</i>	<i>Frequency MHz</i>	<i>Result dBc</i>	<i>Limit dBc</i>	<i>Margin dB</i>
1	4824	-40.9	-20	20.9
1	7236	-50.5	-20	30.5
6	4874	-40.6	-20	20.6
6	7311	-52.3	-20	32.3
11	4924	-44.0	-20	24.0
11	7386	-54.9	-20	34.9

**802.11a, 6Mbit/s**

<i>Channel</i>	<i>Frequency MHz</i>	<i>Result dBc</i>	<i>Limit dBc</i>	<i>Margin dB</i>
149	30-25000	<-40	-20	>20
	25000-40000	<-30	-20	>10
157	30-25000	<-40	-20	>20
	25000-40000	<-30	-20	>10
165	30-25000	<-40	-20	>20
	25000-40000	<-30	-20	>10

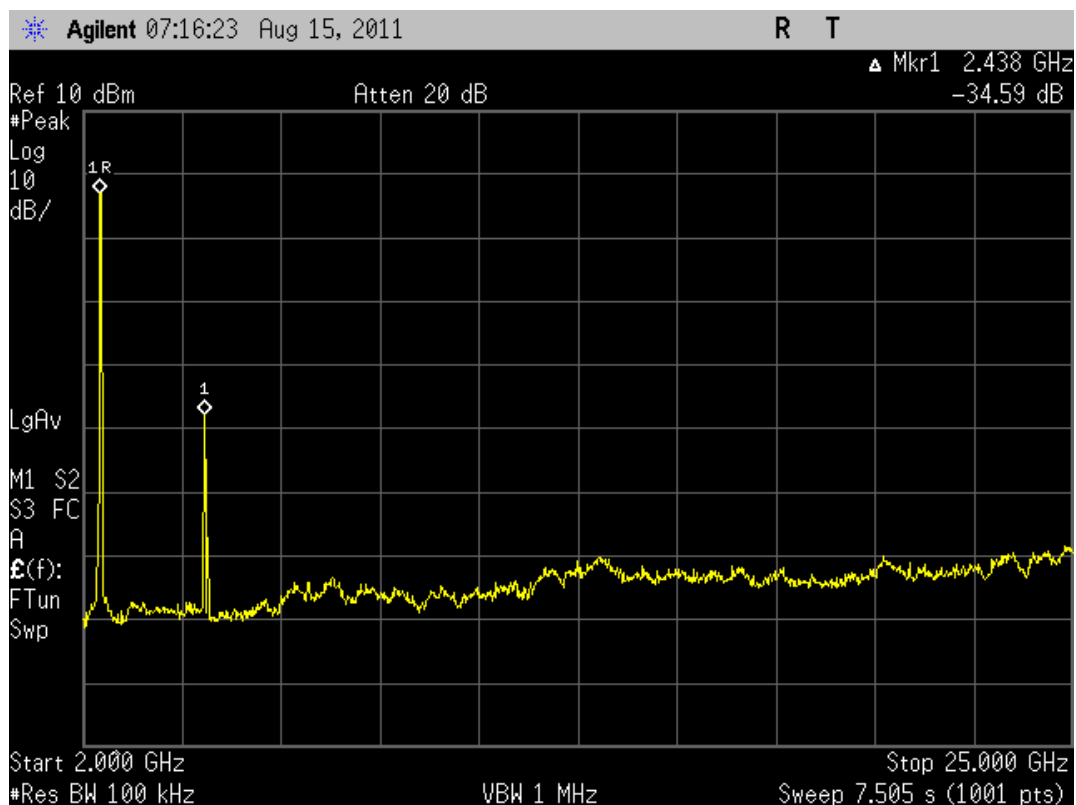
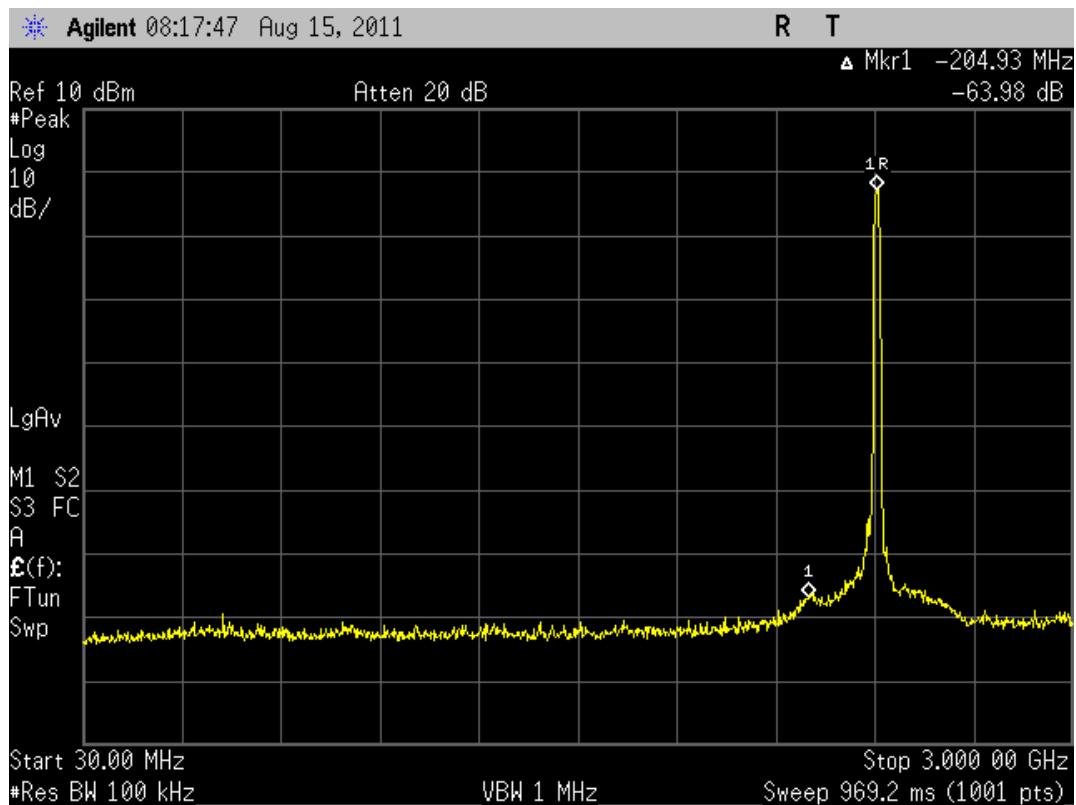
**802.11n, 20MHz bw**

<i>Channel</i>	<i>Frequency MHz</i>	<i>Result dBc</i>	<i>Limit dBc</i>	<i>Margin dB</i>
149	30-25000	<-40	-20	>20
	25000-40000	<-30	-20	>10
157	30-25000	<-40	-20	>20
	25000-40000	<-30	-20	>10
165	30-25000	<-40	-20	>20
	25000-40000	<-30	-20	>10

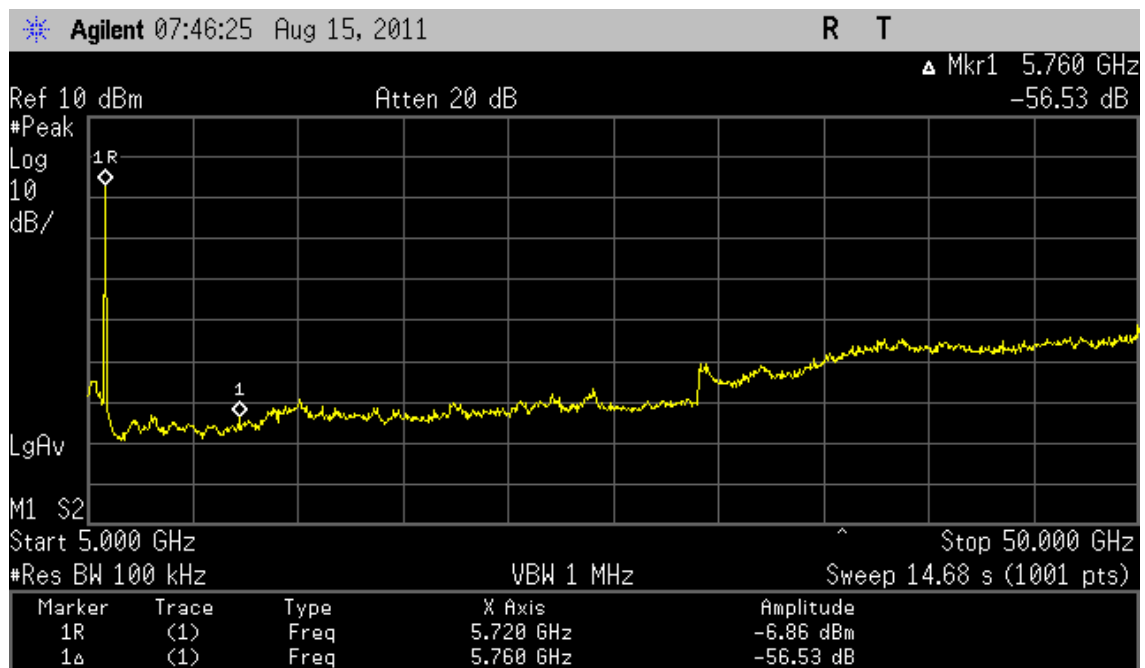
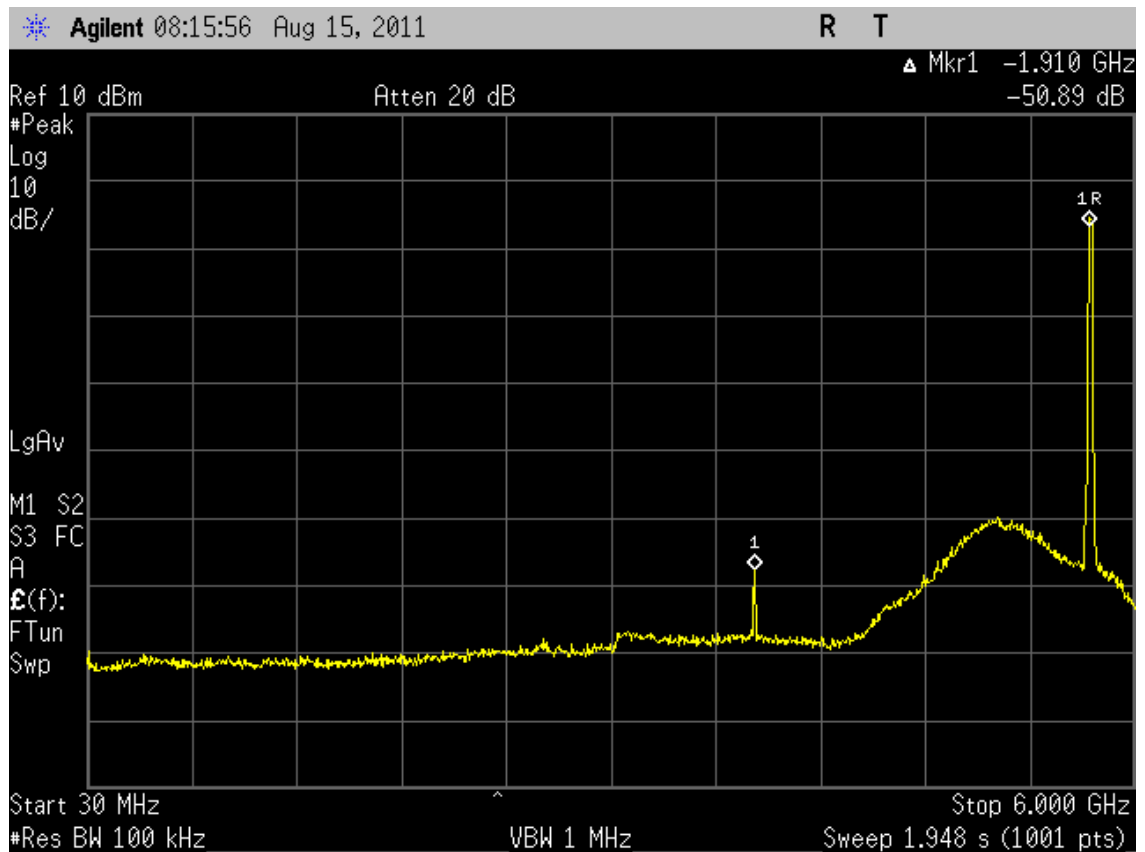
**802.11n, 40MHz bw**

<i>Channel</i>	<i>Frequency MHz</i>	<i>Result dBc</i>	<i>Limit dBc</i>	<i>Margin dB</i>
1/5	4844	-41.6	-20	21.6
	7266	-54.8	-20	34.8
7/11	4904	-39.9	-20	19.9
	7356	-56.5	-20	36.5
149/153	30-25000	<-40	-20	>20
	25000-40000	<-30	-20	>10
161/165	30-25000	<-40	-20	>20
	25000-40000	<-30	-20	>10





802.11b, 1Mbit/s, Channel 1, TXf=2412MHz



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

### 3.4 Maximum peak output power

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

<i>Site name</i>	Nemko Oy / Perkkaa
<i>FCC rule part</i>	§ 15.247
<i>Date of testing</i>	15.08.2011
<i>Test equipment</i>	566
<i>Test conditions</i>	25 °C, 55 % RH
<i>Test result</i>	<b>PASS</b>

#### 3.4.1 Test method and limit

Test method #2 was used. RBW=8MHz and VBW=50MHz. Peak detector was used. Gated sweep was used in order not to have periods OFF included in the result. 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 external antenna port of the EUT was connected to the spectrum analyzer.

Antenna gain 7.5 dBi => limit = 30 dBm - (7.5-6) dB = 28.5 dBm

### 3.4.2 Test data

#### 802.11b, 1Mbit/s

<i>Channel</i>	<i>Frequency MHz</i>	<i>Result dBm</i>	<i>Limit dBm</i>	<i>Margin dBm</i>
1	2412	12.6	28.5	15.9
6	2437	12.9	28.5	15.6
11	2462	12.6	28.5	15.9

#### 802.11g, 6Mbit/s

<i>Channel</i>	<i>Frequency MHz</i>	<i>Result dBm</i>	<i>Limit dBm</i>	<i>Margin dBm</i>
1	2412	15.8	28.5	12.7
6	2437	16.2	28.5	12.3
11	2462	15.9	28.5	12.6

#### 802.11a, 6Mbit/s

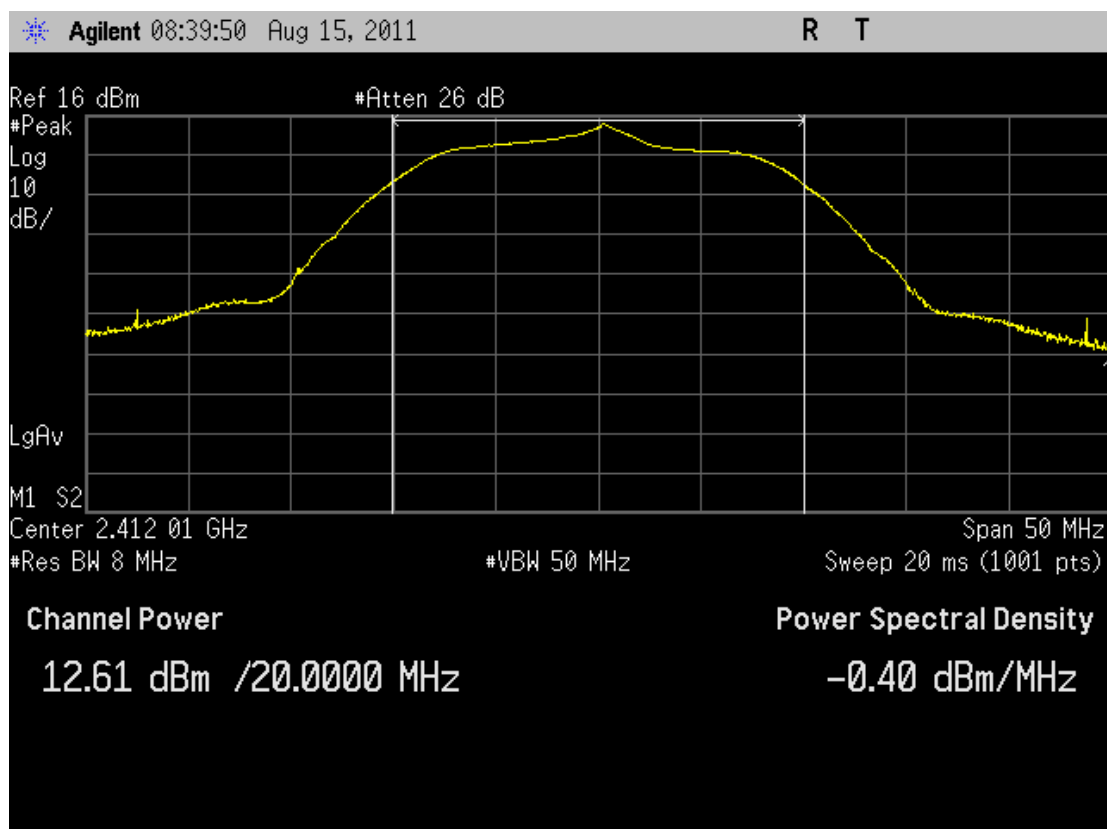
<i>Channel</i>	<i>Frequency MHz</i>	<i>Result dBm</i>	<i>Limit dBm</i>	<i>Margin dBm</i>
149	5745	12.0	28.5	16.5
157	5785	12.5	28.5	16.0
165	5825	12.8	28.5	15.7

#### 802.11n, 20MHz bw, MCS0

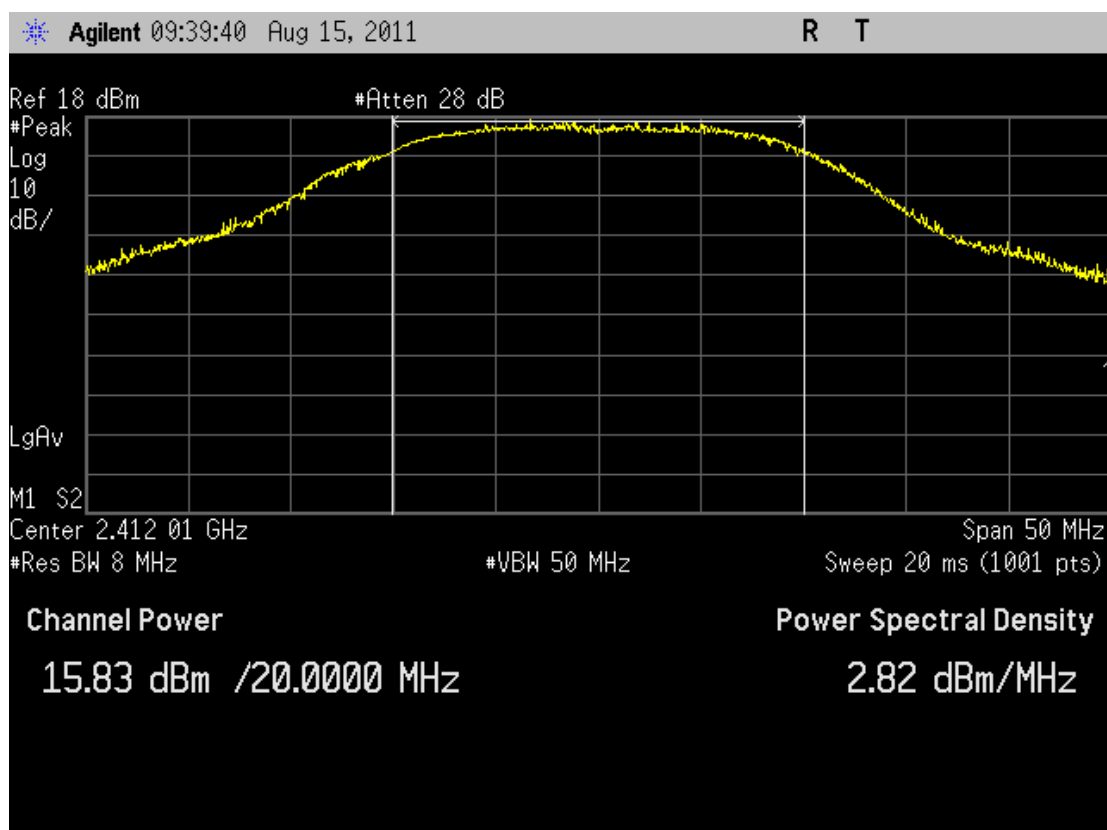
<i>Channel</i>	<i>Frequency MHz</i>	<i>Result dBm</i>	<i>Limit dBm</i>	<i>Margin dBm</i>
149	5745	12.4	28.5	16.1
157	5785	12.2	28.5	16.3
165	5825	13.0	28.5	15.5

#### 802.11n, 40MHz bw, MCS0

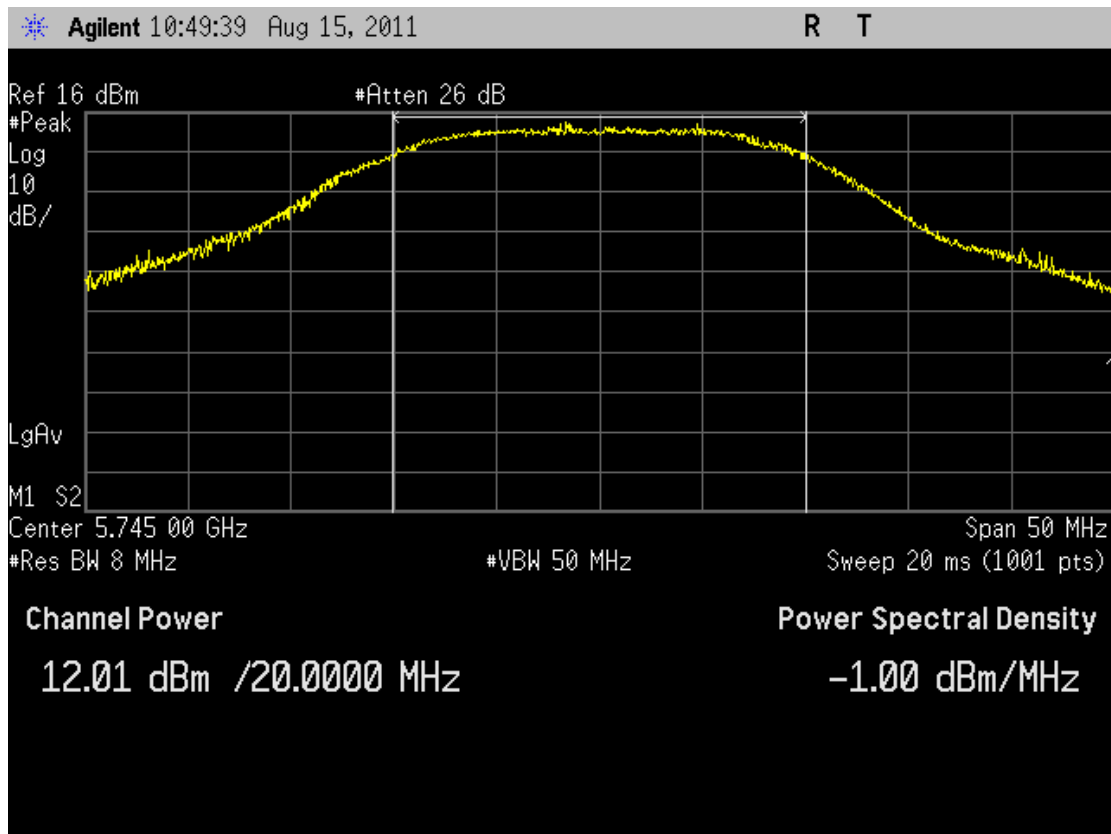
<i>Channel</i>	<i>Frequency MHz</i>	<i>Result dBm</i>	<i>Limit dBm</i>	<i>Margin dBm</i>
1/5	2422	15.2	28.5	13.3
7/11	2452	15.1	28.5	13.4
149/153	5755	11.2	28.5	17.3
161/165	5815	11.9	28.5	16.6



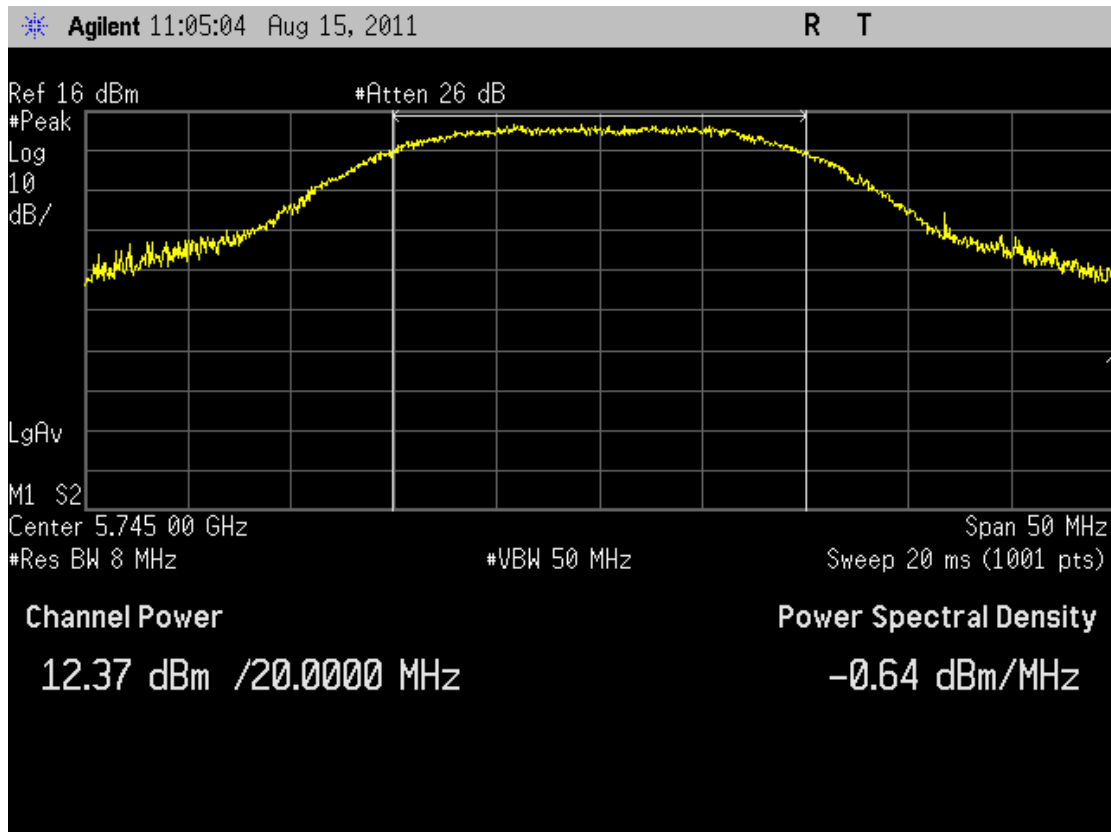
802.11b, 1Mbit/s, Channel 1, TXf=2412MHz



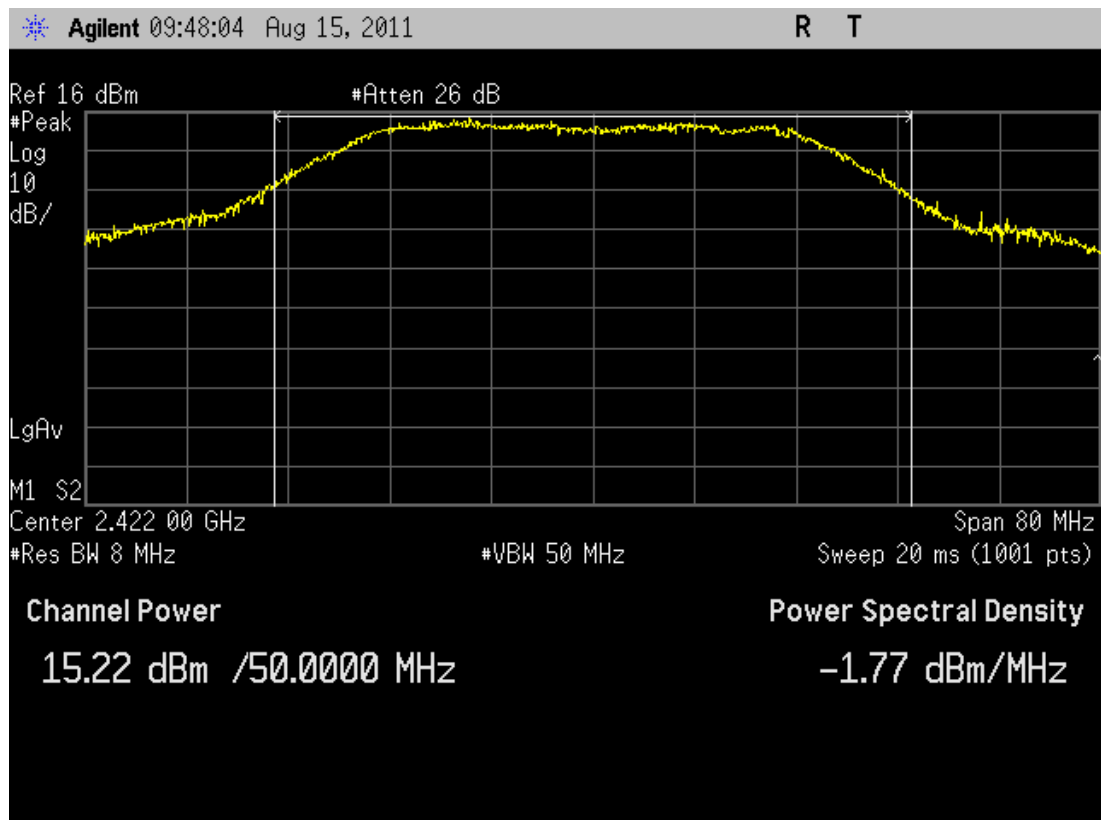
802.11g, 6Mbit/s, Channel 1, TXf=2412MHz



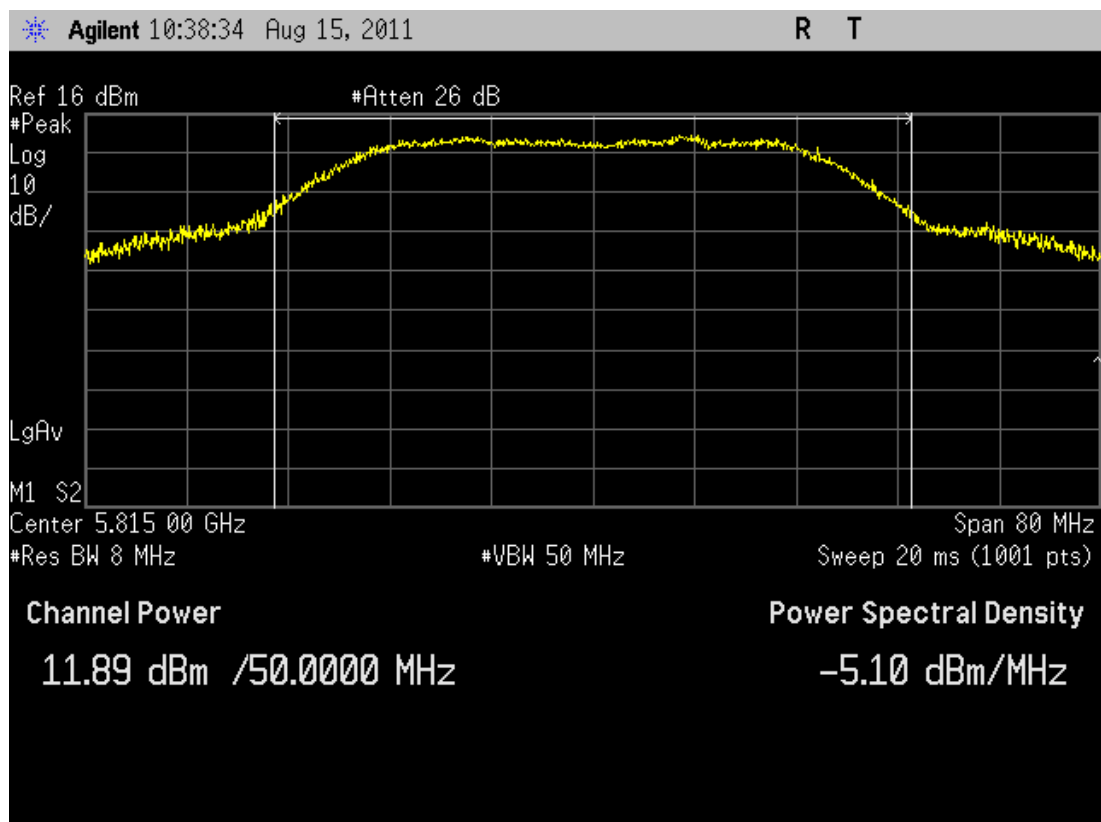
802.11a 6M, Channel 149, TXf=5745MHz



802.11n, 20MHz bw, MCS0, Channel 165, TXf=5825MHz



802.11n, 40MHz bw, MCS0, TX on at channels 1/5, TXf=2422MHz



802.11n, 40MHz bw, MCS0 , TX on at channels 161/165, TXf=5815MHz

### 3.5 Band-edge compliance

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

<i>Site name</i>	Nemko Oy / Perkkaa
<i>FCC rule part</i>	§ 15.247
<i>Date of testing</i>	09-10.08.2011
<i>Test equipment</i>	566, 542, 564
<i>Test conditions</i>	23 °C, 50 % RH
<i>Test result</i>	<b>PASS</b> limit: -20dBc out of restricted bands limit: 54 dBµV/m AVE 74 dBµV/m peak in restricted bands

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

The measurements -20dBc out of restricted bands were performed with peak-detector (RBW: 100 kHz, VBW: 300 kHz).

The test in restricted bands was performed with settings (RBW: 1 MHz, VBW: 3MHz and 10 Hz)

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



### 3.5.1 Test results

#### 802.11b, 1Mbit/s

Channel	Band Frequency MHz	Result dBc	Limit dBc	Margin dB
1	2400	-32.3	-20	12.3

Channel	Band Frequency MHz	Result Peak dBμV/m	Limit Peak dBμV/m	Margin dB	Result Average dBμV/m	Limit Average dBμV/m	Margin dB
11	2483.5	48.2	74	26.8	39.9	54	14.1

#### 802.11g, 6Mbit/s

Channel	Band Frequency MHz	Result dBc	Limit dBc	Margin dB
1	2400	-26.4	-20	6.4

Channel	Band Frequency MHz	Result Peak dBμV/m	Limit Peak dBμV/m	Margin dB	Result Average dBμV/m	Limit Average dBμV/m	Margin dB
11	2483.5	73.2	74	0.8	48.4	54	5.6

#### 802.11a, 6Mbit/s

Channel	Band Frequency MHz	Result dBc	Limit dBc	Margin dB
149	5725	-35.6	-20	15.6
165	5850	-42.2	-20	22.2

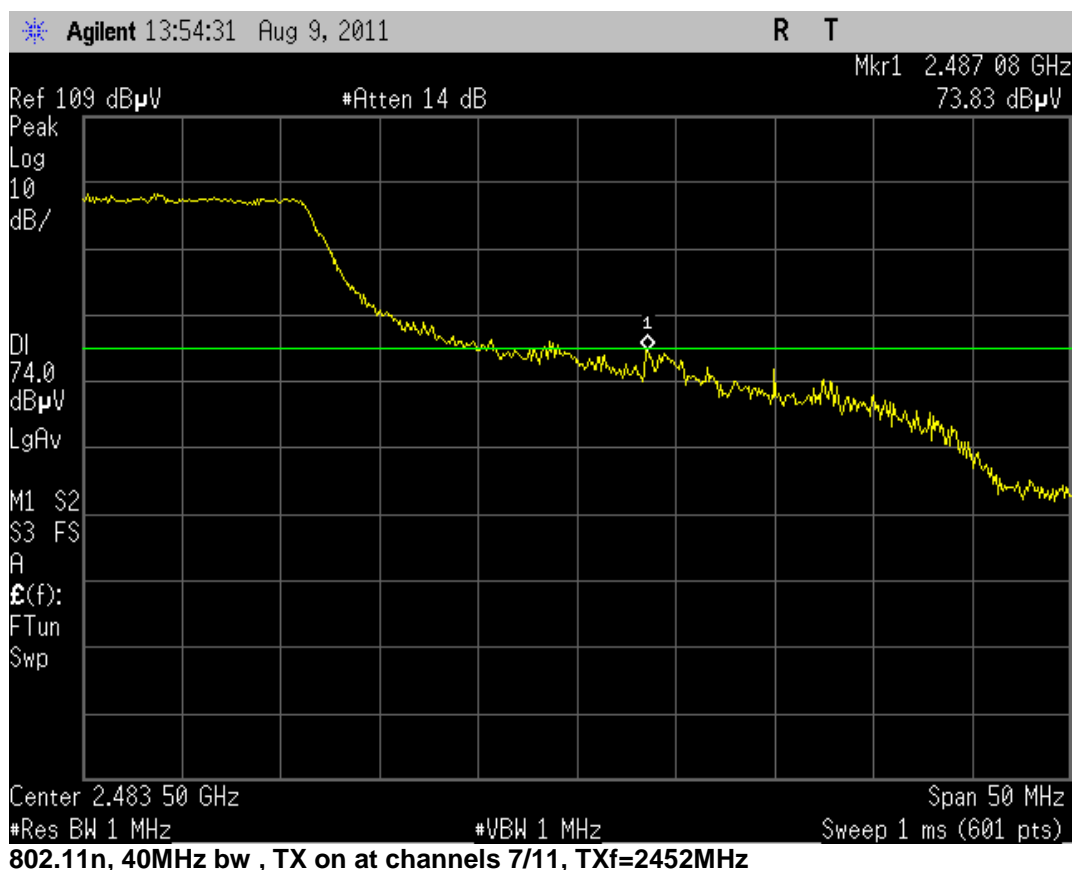
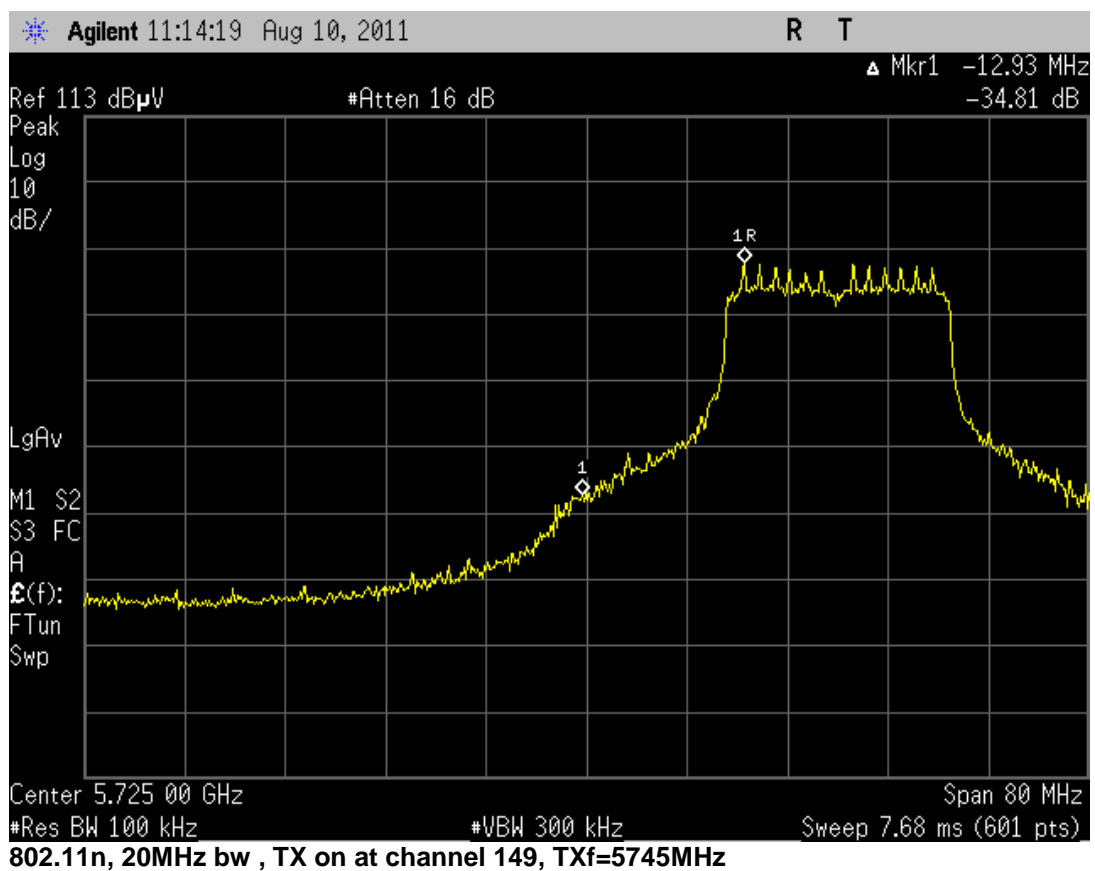
#### 802.11n, 20MHz bw

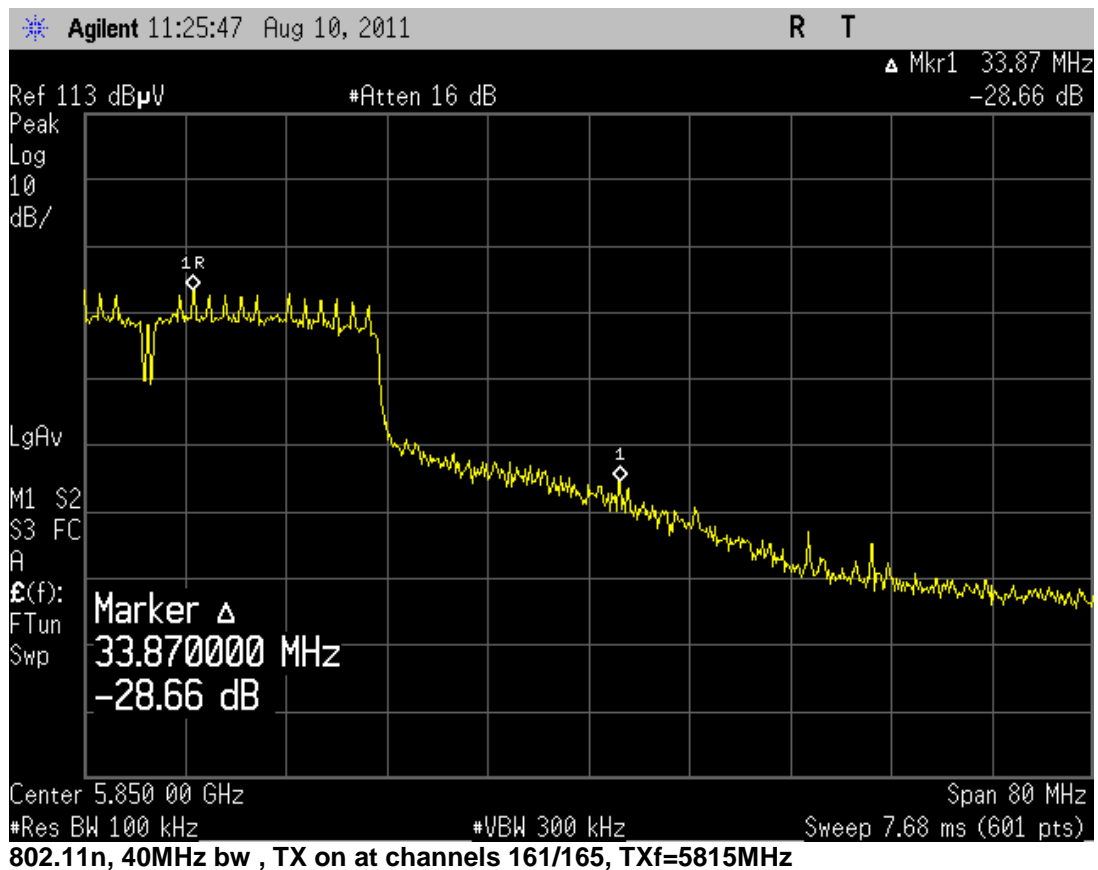
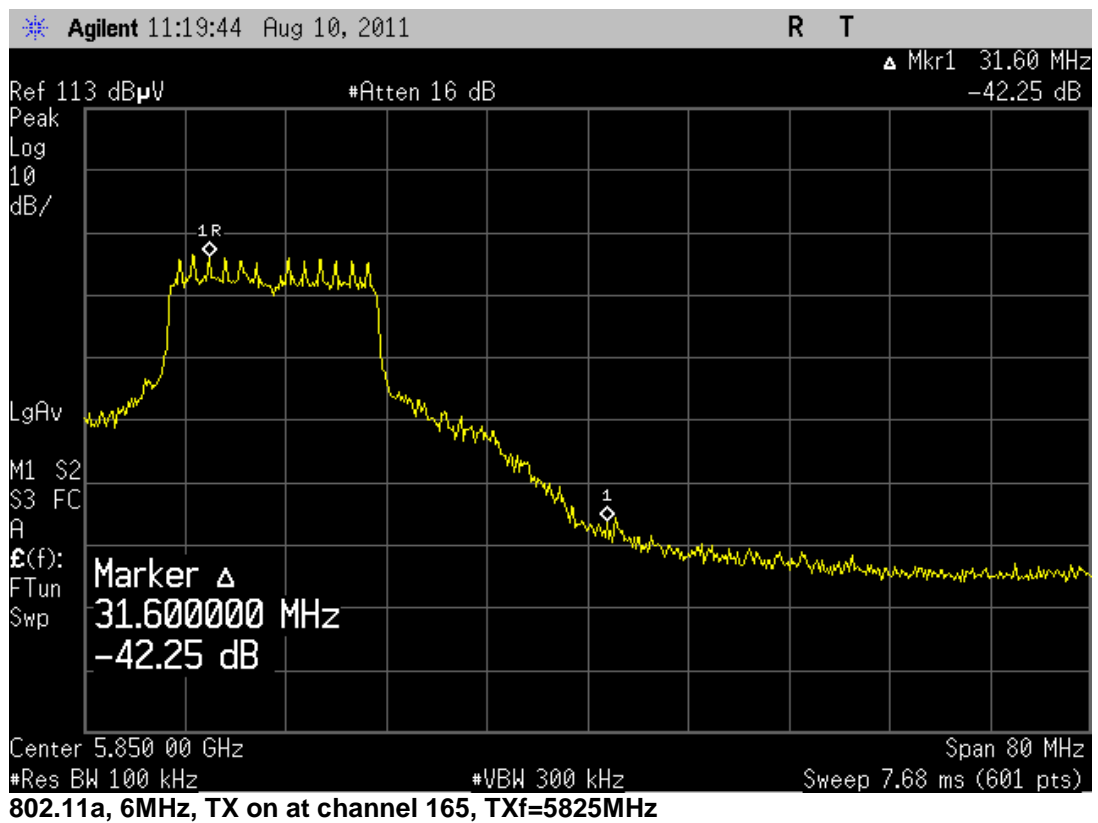
Channel	Band Frequency MHz	Result dBc	Limit dBc	Margin dB
149	5725	-34.8	-20	14.8
165	5850	-41.8	-20	21.8

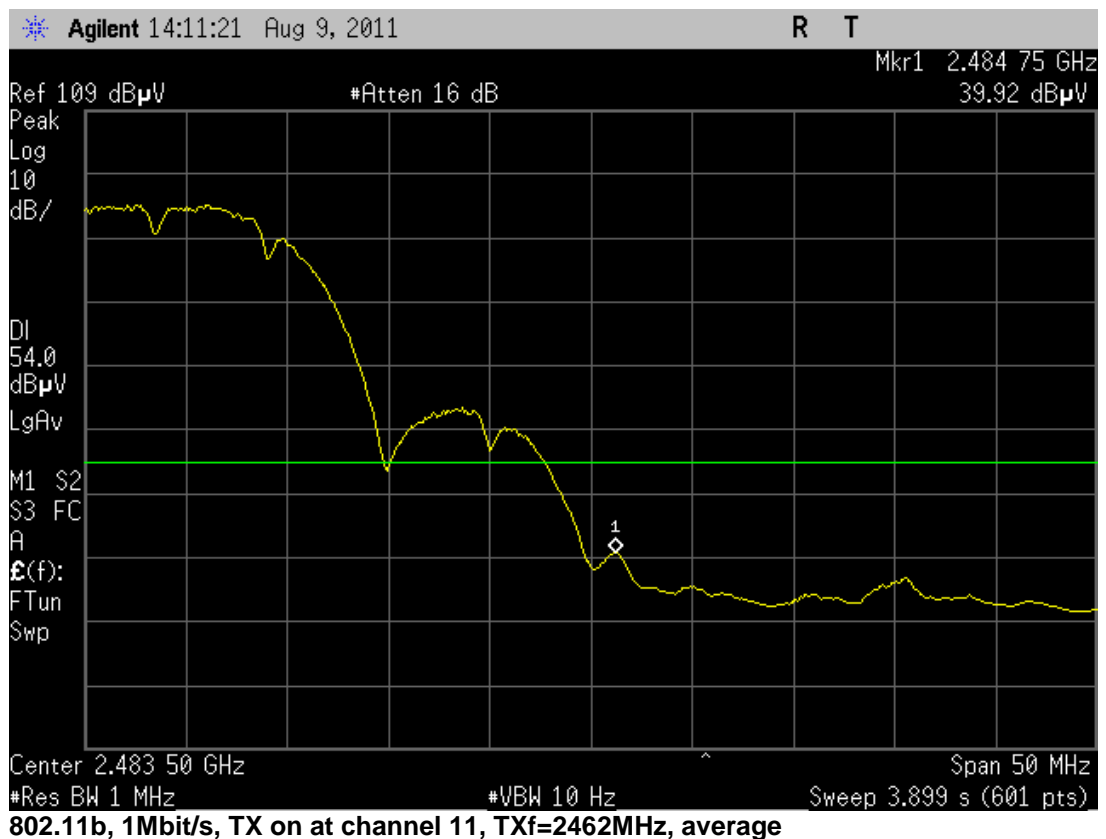
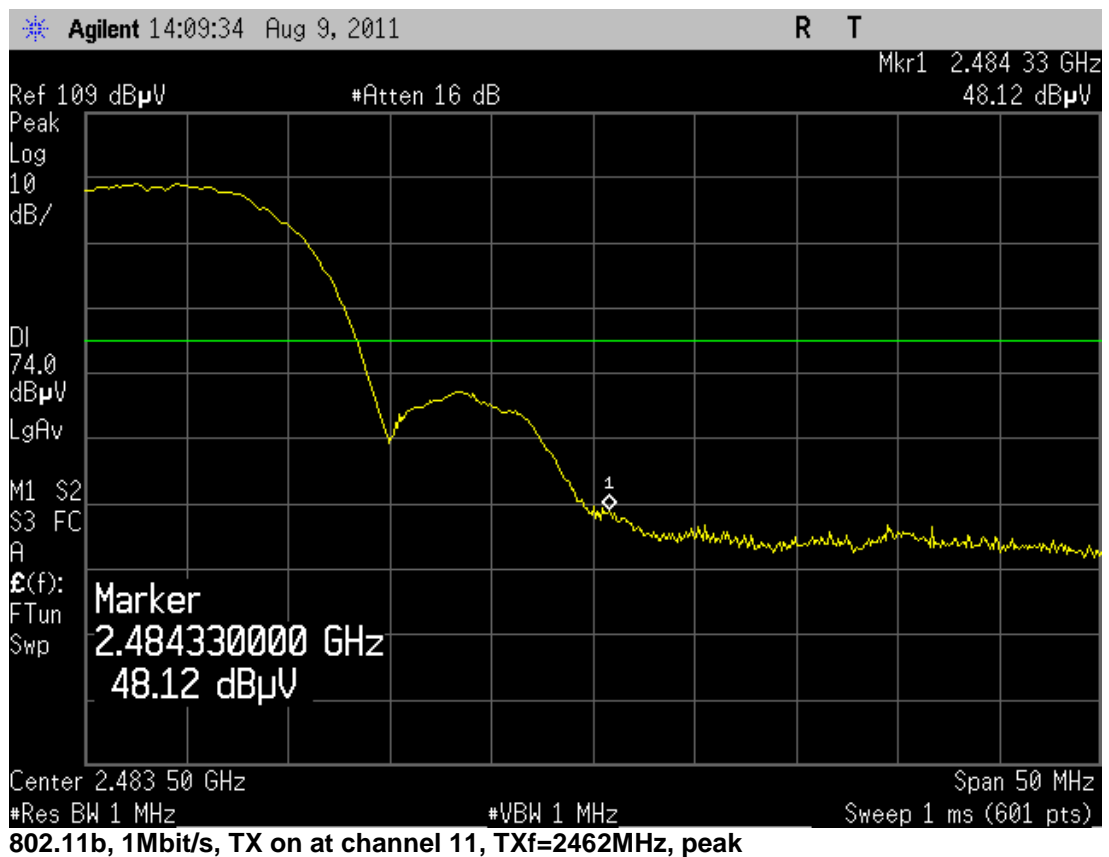
#### 802.11n, 40MHz bw

Channel	Band Frequency MHz	Result dBc	Limit dBc	Margin dB
1/5	2400	-22.8	-20	2.8
149/153	5725	-30.0	-20	10.0
161/165	5850	-28.7	-20	8.7

Channel	Band Frequency MHz	Result Peak dBμV/m	Limit Peak dBμV/m	Margin dB	Result Average dBμV/m	Limit Average dBμV/m	Margin dB
7/11	2483.5	73.8	74	0.2	49.8	54	4.2







### 3.1 6dB Bandwidth

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

Site name	Nemko Oy / Perkkaa
FCC rule part	§ 15.247
Date of testing	15.8.2011
Test equipment	566
Test conditions	22-25 °C, 30-55 % RH
Test result	<b>PASS (Limit: min 500 kHz)</b>

#### 3.1.1 Test method

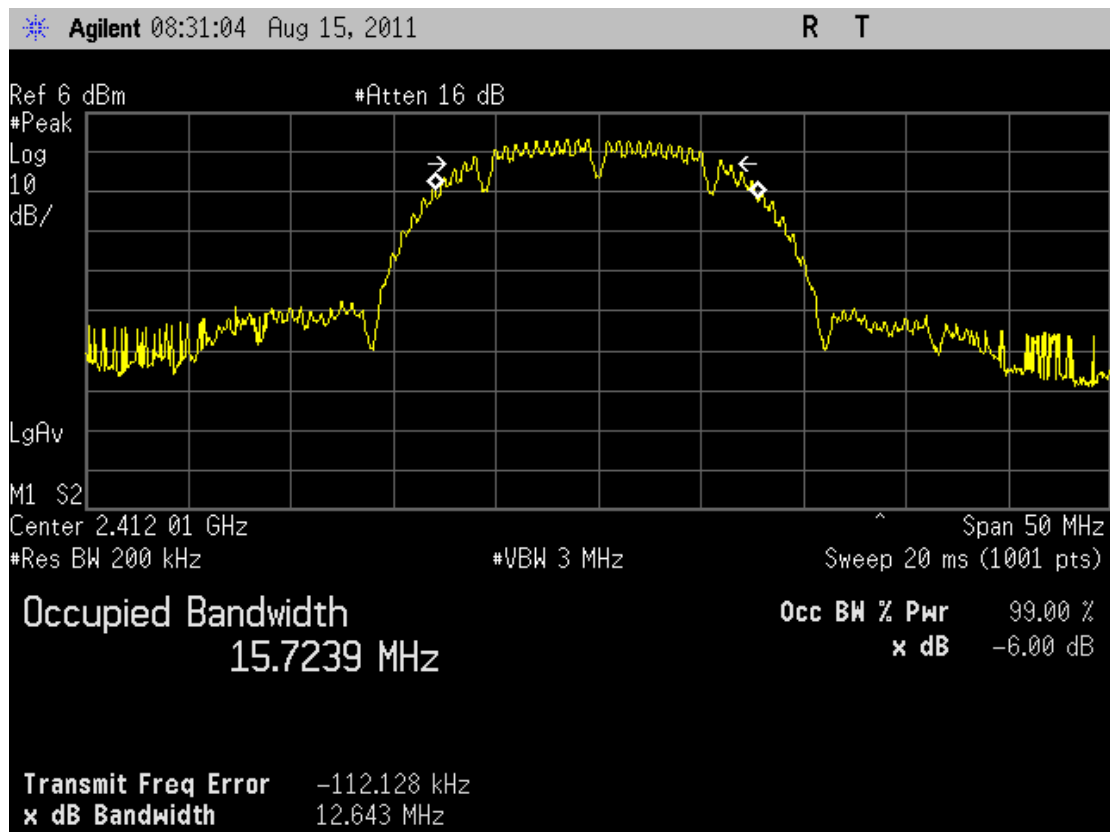
The external antenna port of the EUT was connected to the spectrum analyzer.

#### 3.1.2 EUT operation mode

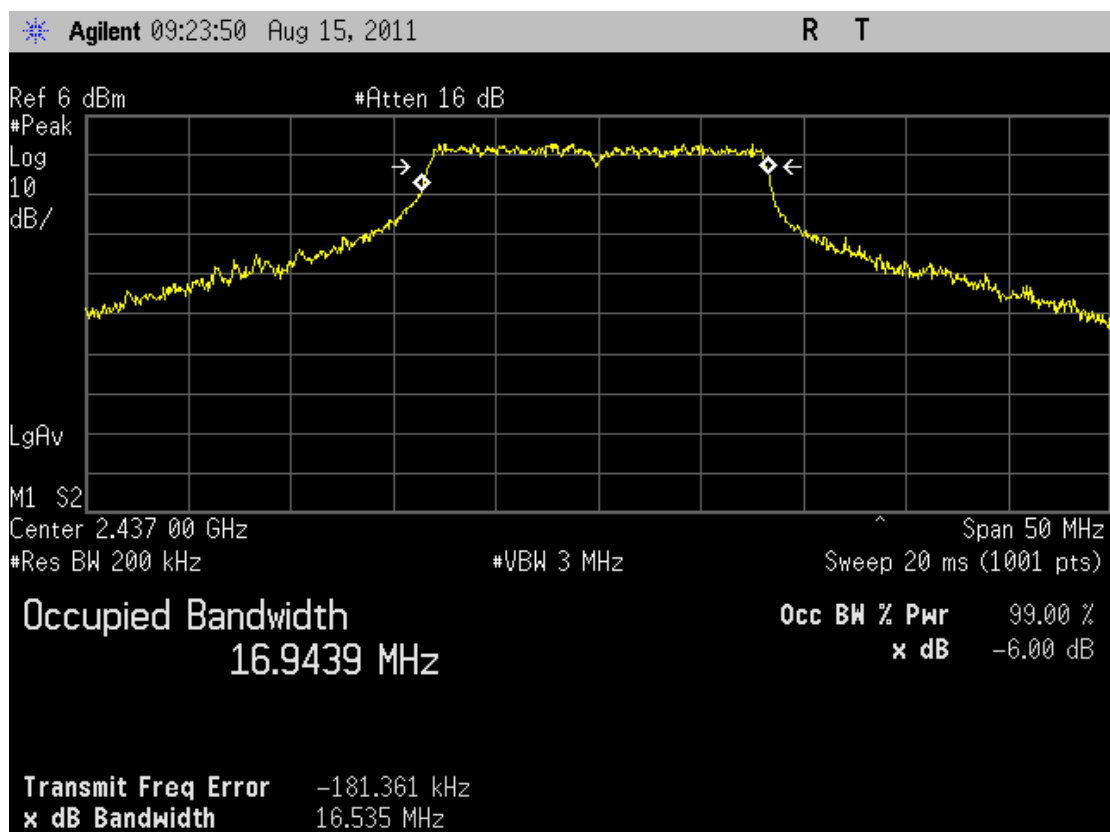
EUT operation mode	802.11b, 1Mbit/s, TX on at channels 1, 6, 11
	802.11g, 6Mbit/s, TX on at channels 1, 6, 11
	802.11a, 6Mbit/s, TX on at channels 149, 157, 165
	802.11n, 20MHz bw MSC0, TX on at channels 149, 157, 165
	802.11n, 40MHz bw MSC0, TX on at channels 1/5, 7/11, 149/153, 161/165

#### 3.1.2 Test data

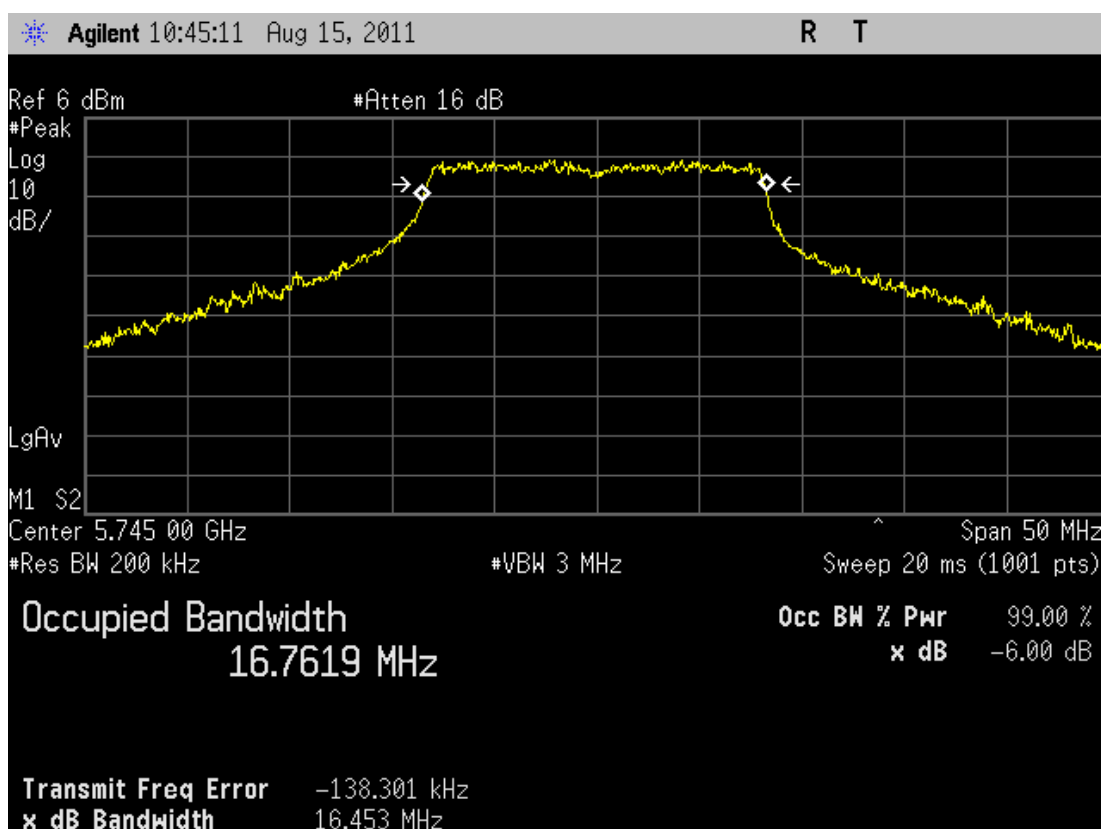
EUT operation mode	Result MHz
802.11b, 1Mbit/s, TX on at channel 1, TXf=2412MHz	12.6
802.11b, 1Mbit/s, TX on at channel 6, TXf=2437MHz	12.6
802.11b, 1Mbit/s, TX on at channel 11, TXf=2462MHz	13.0
802.11g, 6Mbit/s, TX on at channel 1, TXf=2412MHz	16.5
802.11g, 6Mbit/s, TX on at channel 6, TXf=2437MHz	16.5
802.11g, 6Mbit/s, TX on at channel 11, TXf=2462MHz	16.5
802.11a, 6Mbit/s, TX on at channels 149, TXf=5745MHz	16.4
802.11a, 6Mbit/s, TX on at channels 157, TXf=5785MHz	16.4
802.11a, 6Mbit/s, TX on at channels 165, TXf=5825MHz	16.5
802.11n, 20MHz bw MSC0, TX on at channels 149, TXf=5745MHz	17.6
802.11n, 20MHz bw MSC0, TX on at channels 157, TXf=5785MHz	17.6
802.11n, 20MHz bw MSC0, TX on at channels 165, TXf=5825MHz	17.7
802.11n, 40MHz bw MSC0, TX on at channels 1/5, TXf=2422MHz	36.4
802.11n, 40MHz bw MSC0, TX on at channels 7/11, TXf=2452MHz	36.6
802.11n, 40MHz bw MSC0, TX on at channels 149/153, TXf=5745MHz	36.4
802.11n, 40MHz bw MSC0, TX on at channels 161/165, TXf=5825MHz	36.4



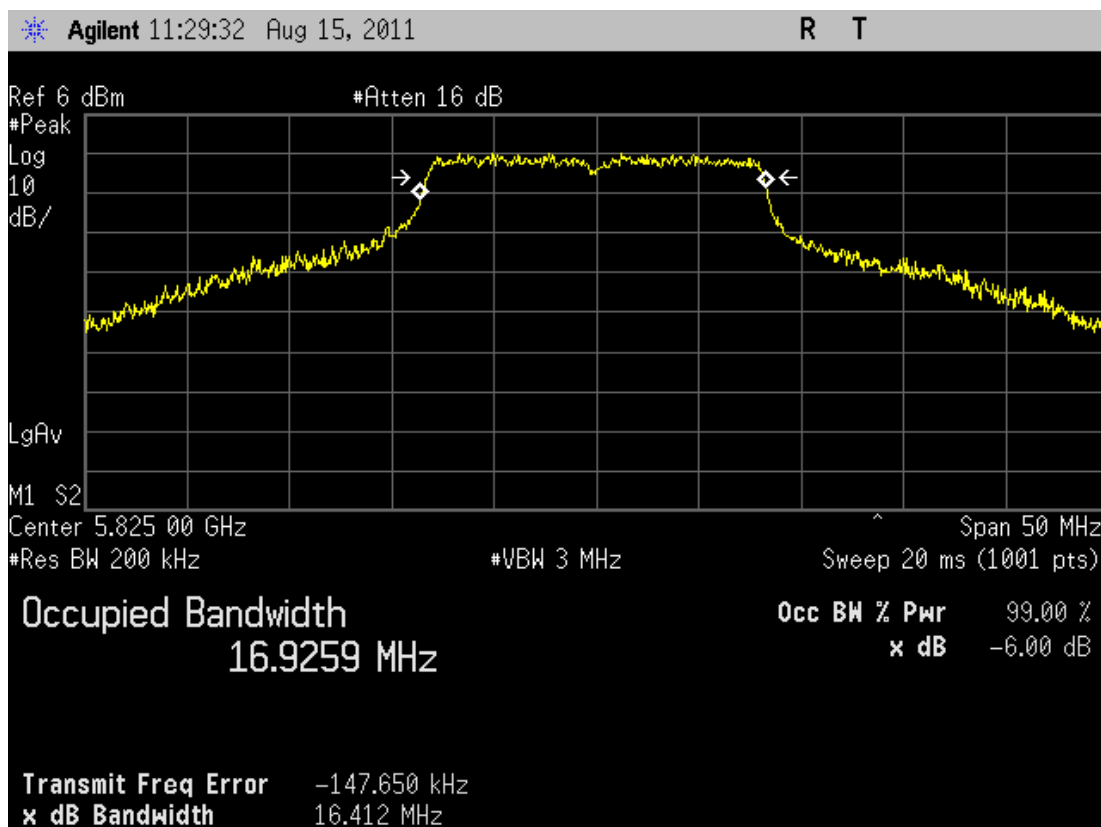
802.11b, 1Mbit/s, TX on at channel 1, TXf=2412MHz



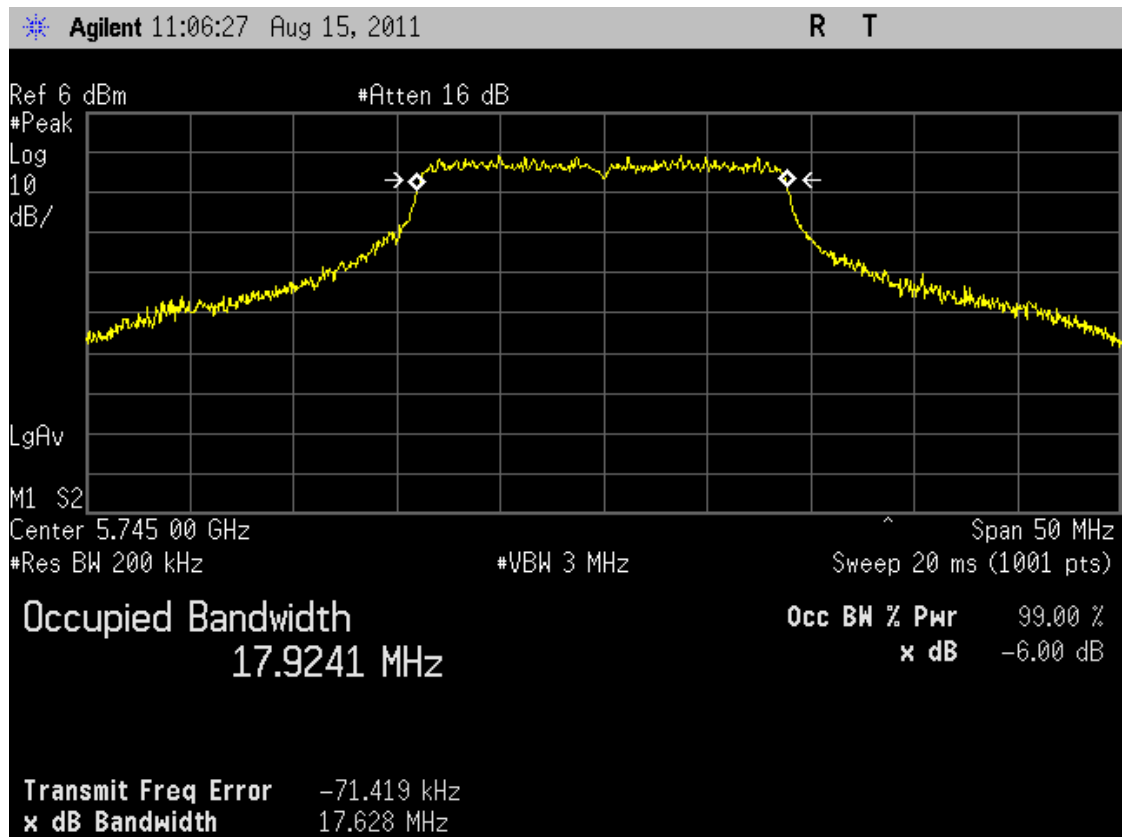
802.11g, 6Mbit/s, TX on at channel 6, TXf=2437MHz



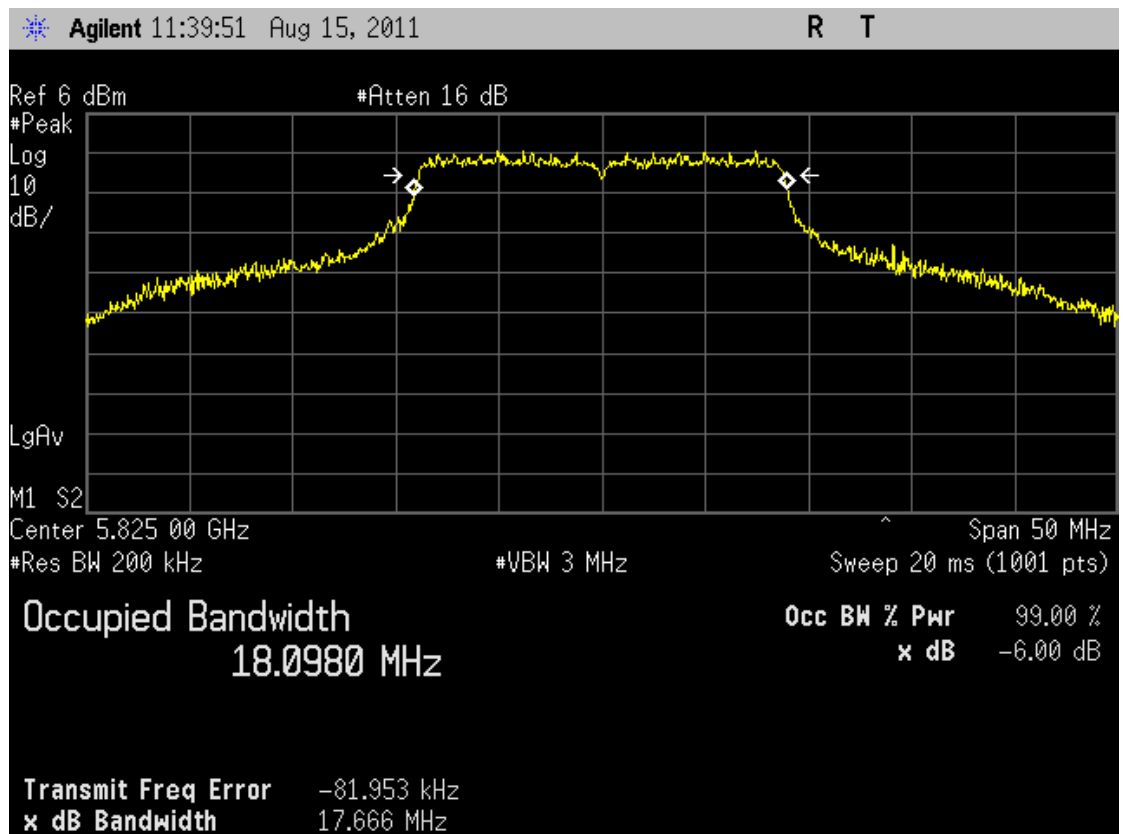
802.11a, 6Mbit/s, TX on at channels 149, TXf=5745MHz



802.11a, 6Mbit/s, TX on at channels 165, TXf=5825MHz

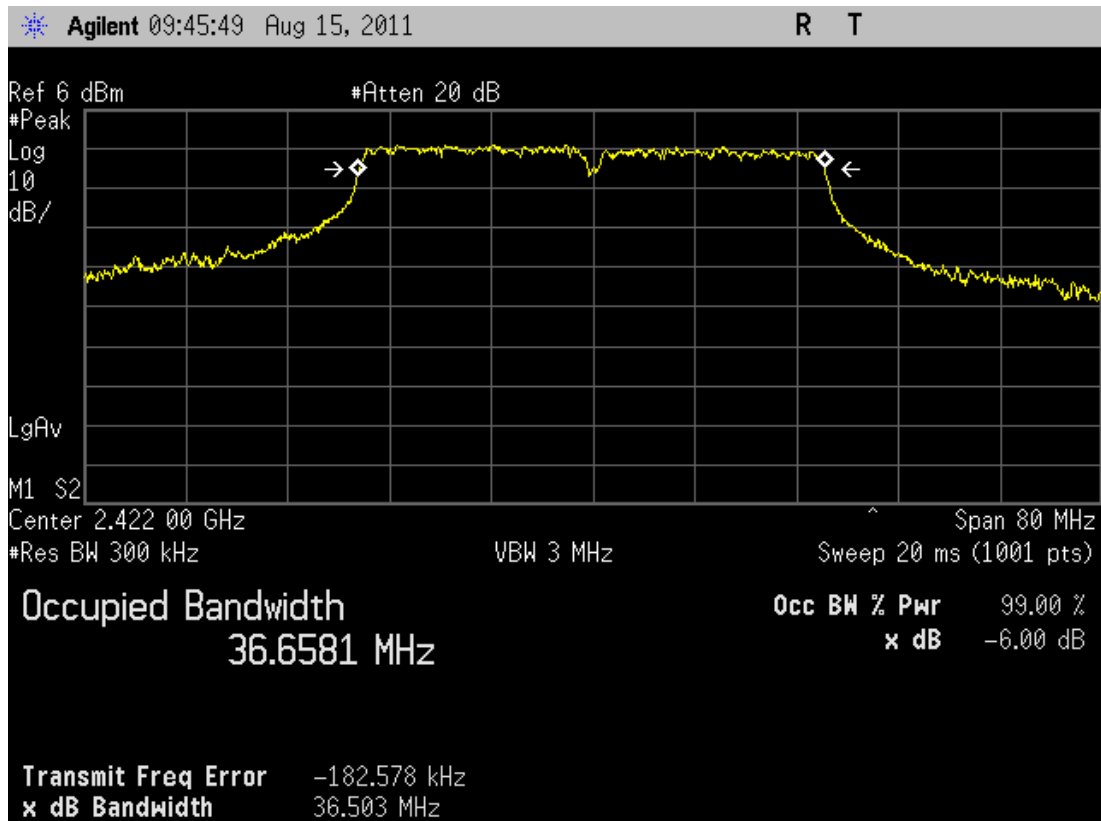


802.11n, 20MHz bw MCS0, TX on at channels 149, TXf=5745MHz

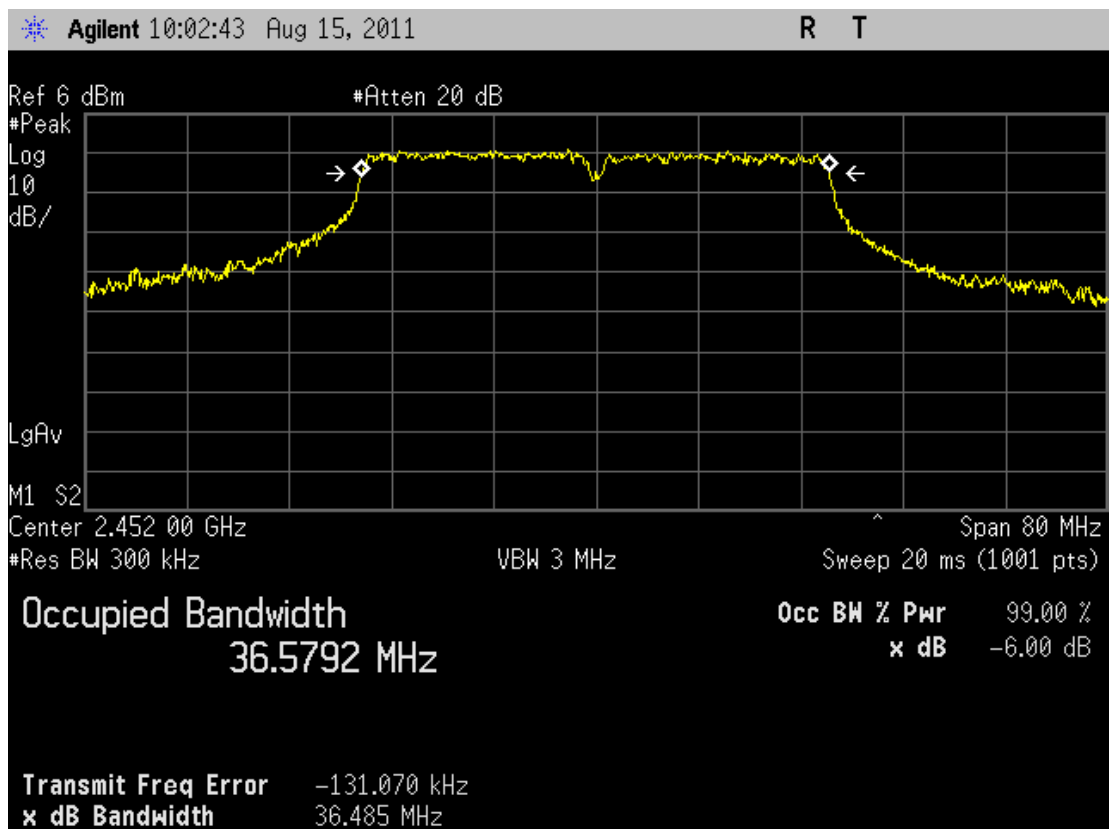


802.11n, 20MHz bw MCS0, TX on at channels 165, TXf=5825MHz

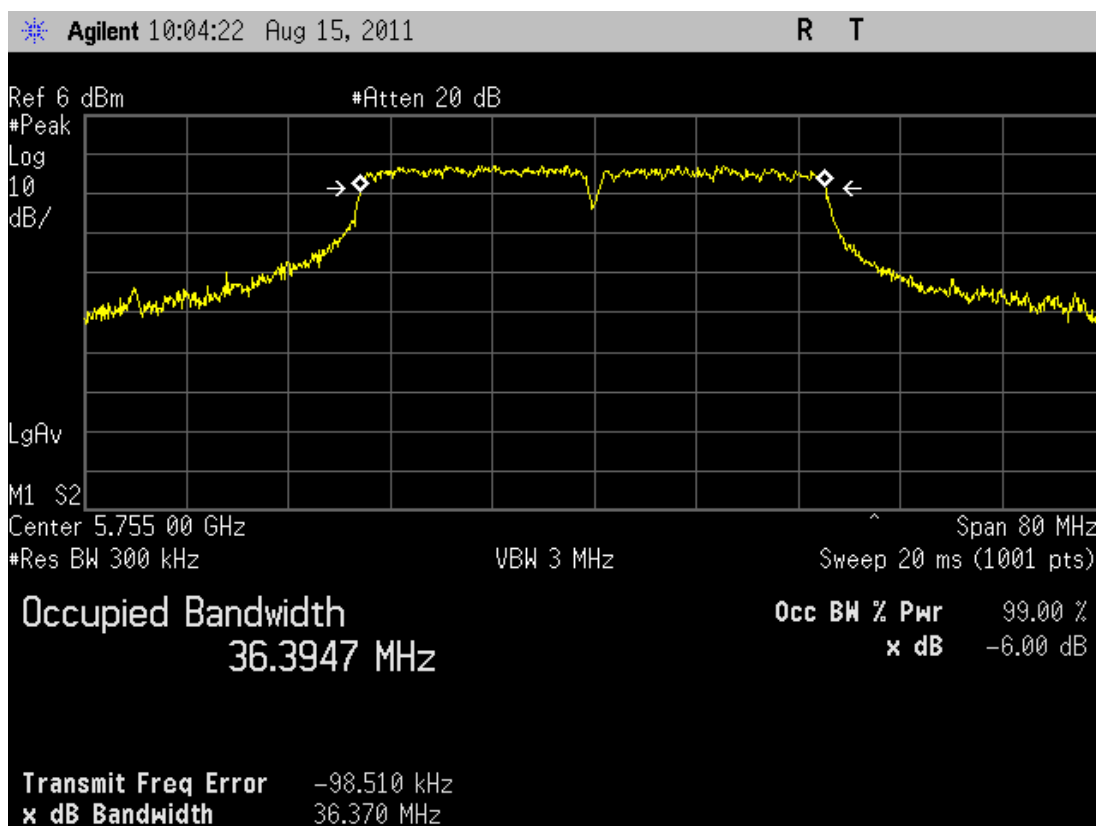




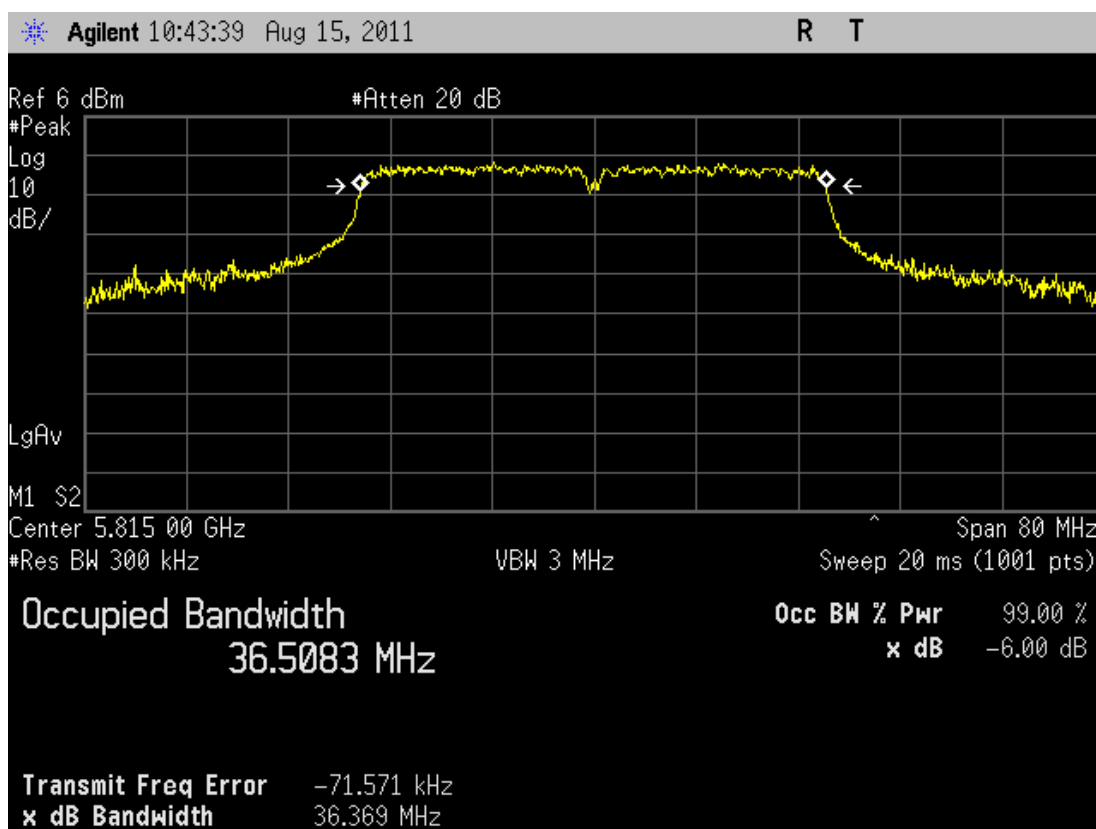
802.11n, 40MHz bw MCS0, TX on at channels 1/5, TXf=2422MHz



802.11n, 40MHz bw MCS0, TX on at channels 7/11, TXf=2452MHz



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



802.11n, 40MHz bw MCS0, TX on at channels 161/165, TXf=5815MHz

### 3.2 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	§ 15.247
Date of testing	15.8.2011
Test equipment	566
Test conditions	25 °C, 55 % RH
Test result	<b>PASS</b>

#### 3.2.1 Test method and limit

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

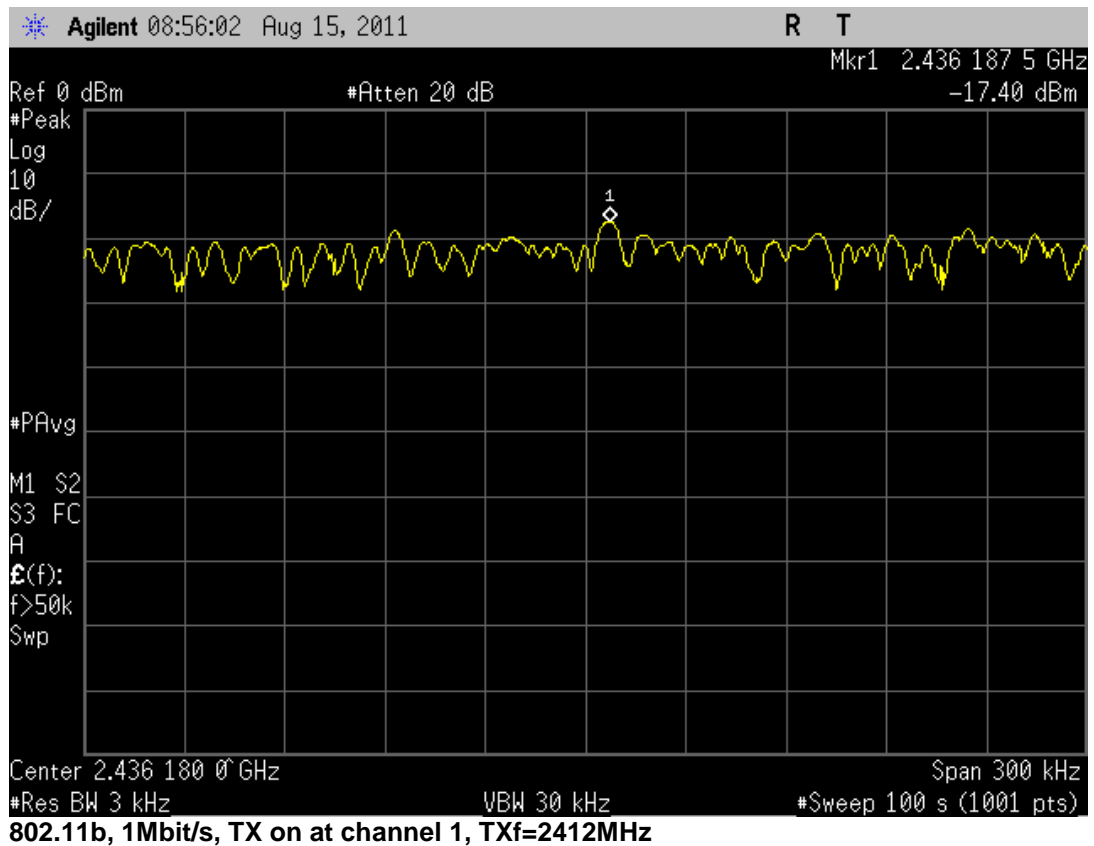
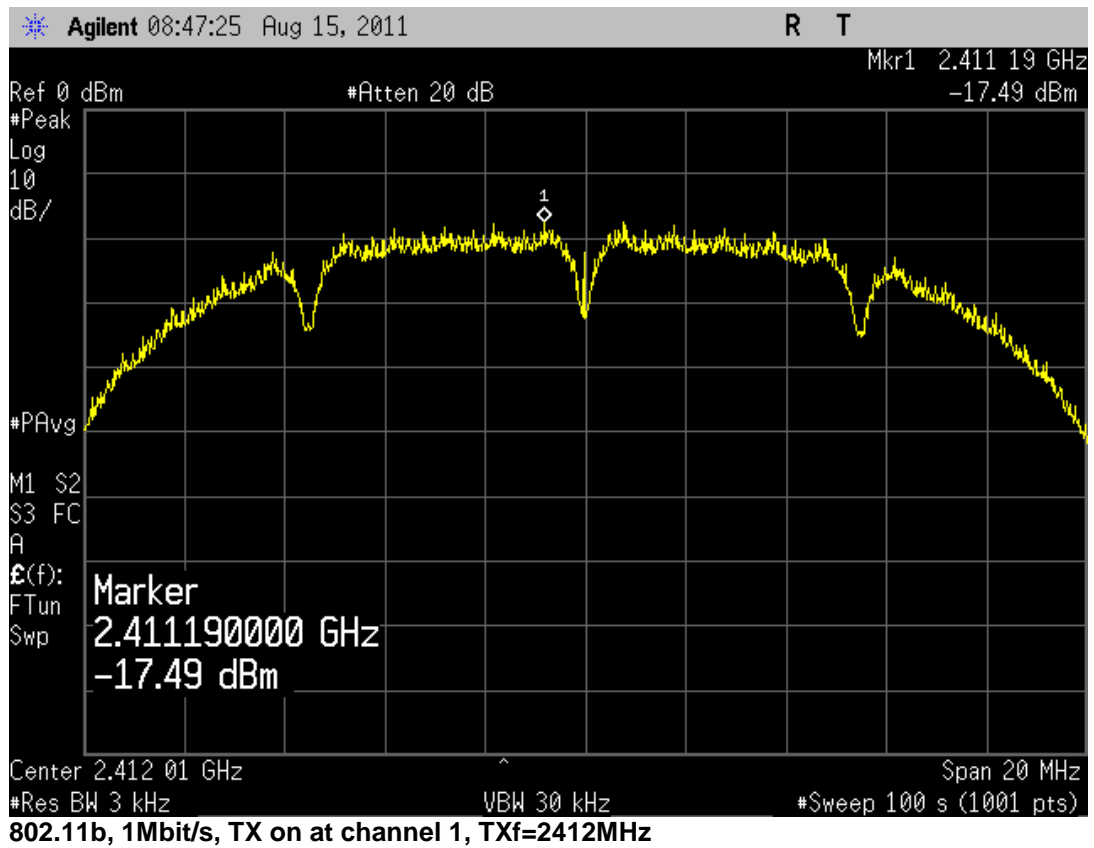
Antenna gain 7.5 dBi => limit = 8 dBm - (7.5-6) dB = 6.5 dBm

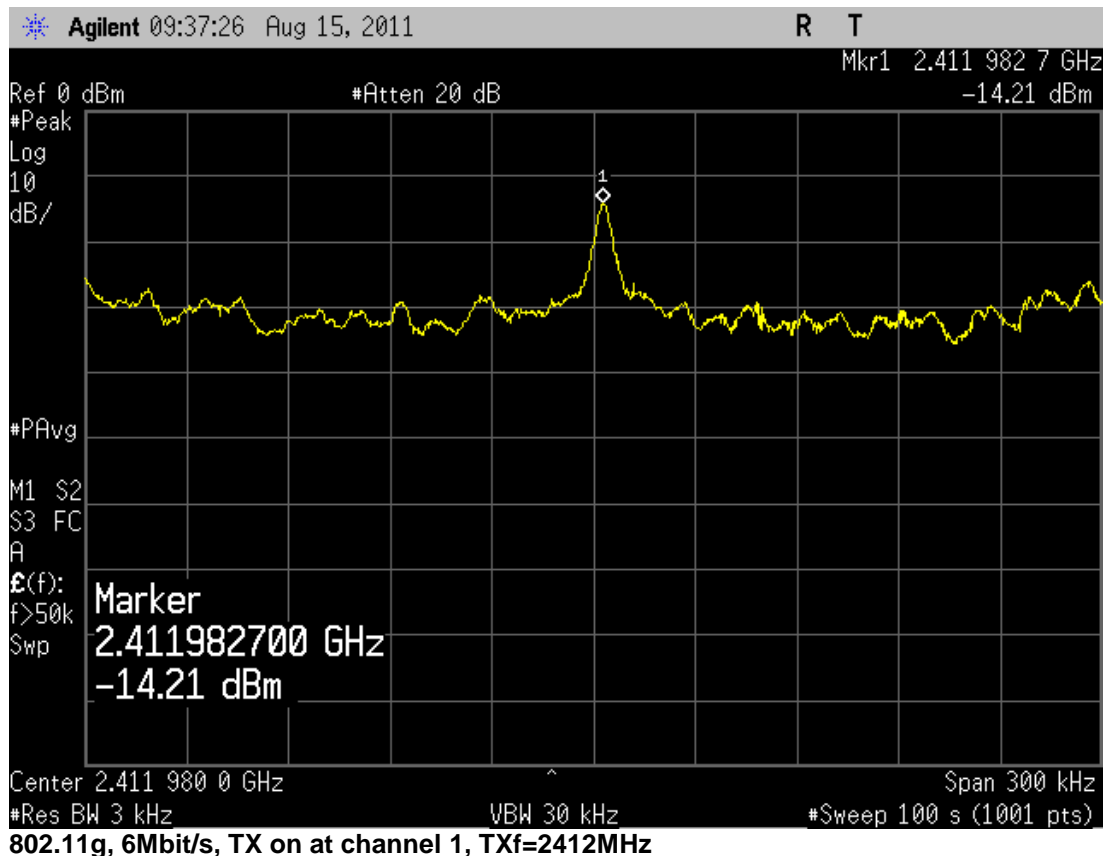
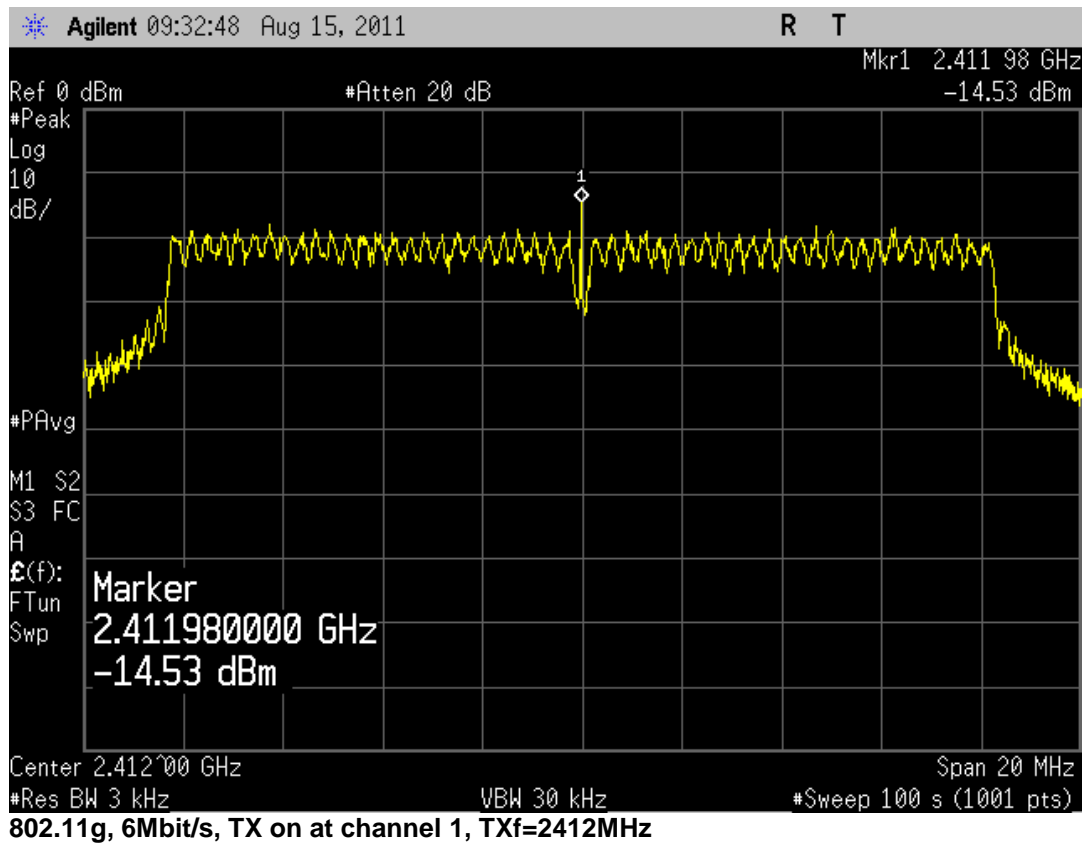
#### 3.2.2 EUT operation mode

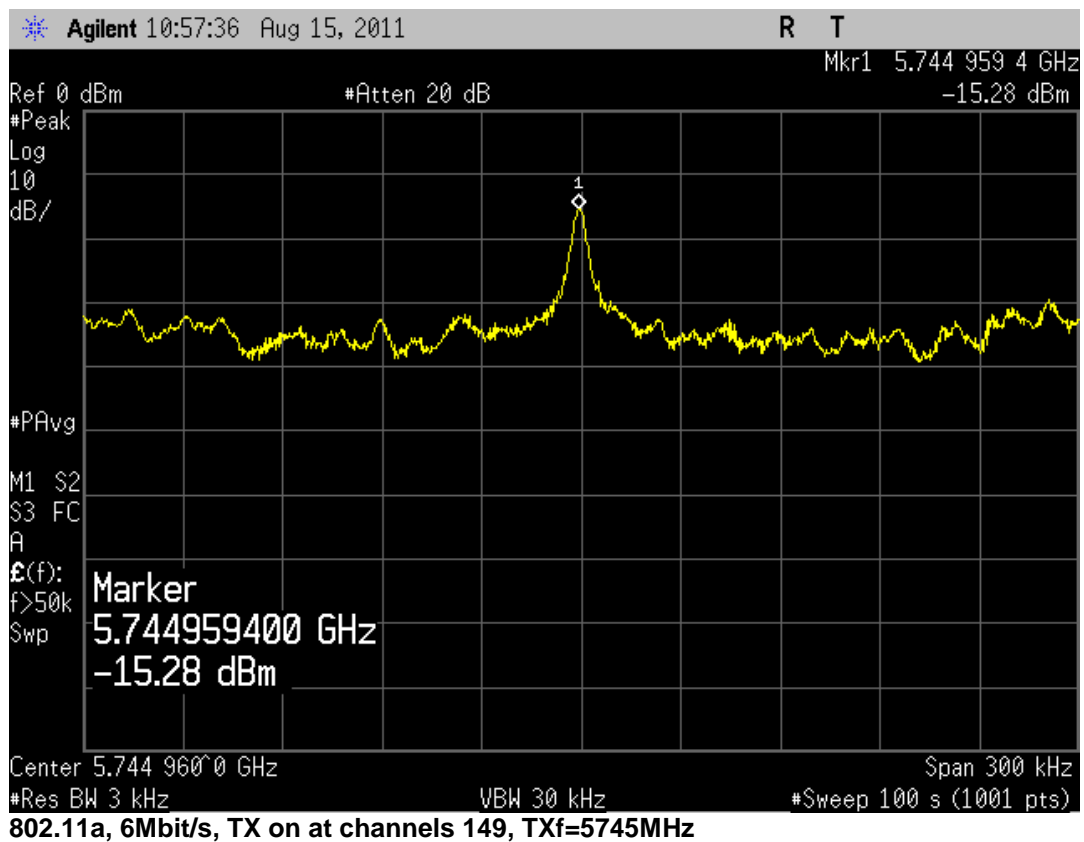
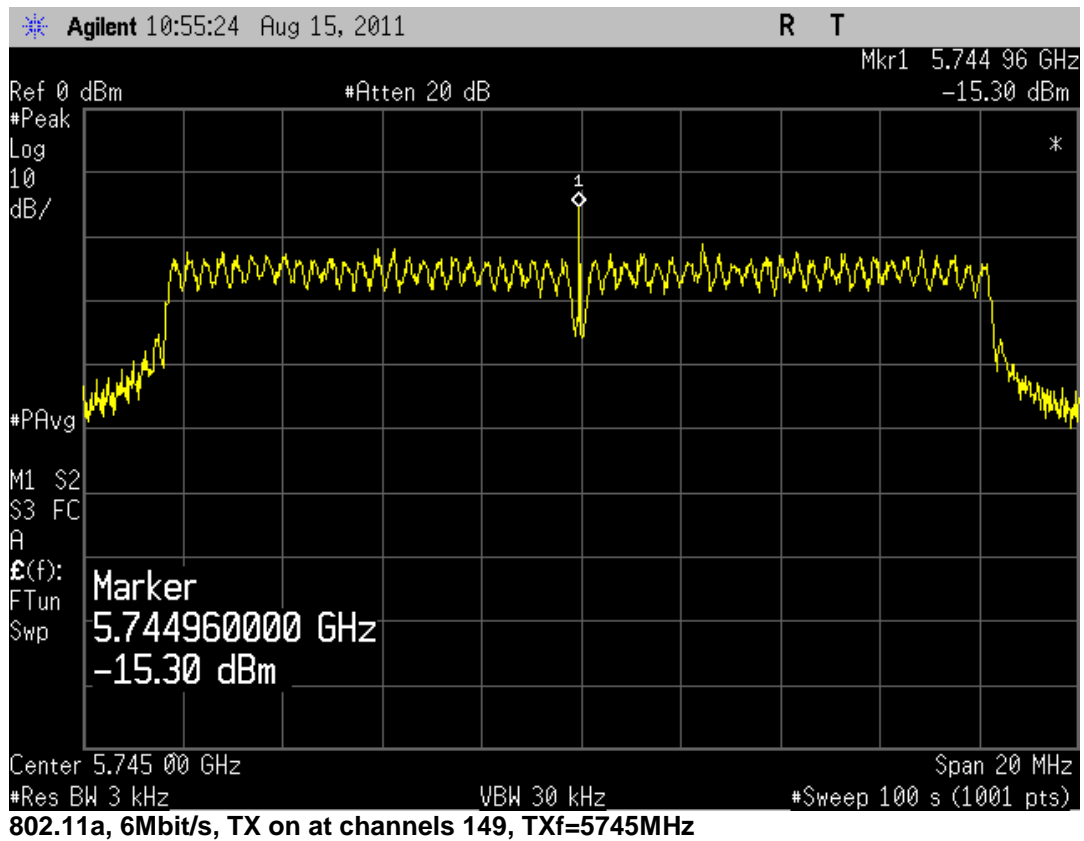
EUT operation mode	802.11b, 1Mbit/s, TX on at channels 1, 6, 11
	802.11g, 6Mbit/s, TX on at channels 1, 6, 11
	802.11a, 6Mbit/s, TX on at channels 149, 157, 165
	802.11n, 20MHz bw MCS0, TX on at channels 149, 157, 165
	802.11n, 40MHz bw MCS0, TX on at channels 1/5, 7/11, 149/153, 161/165

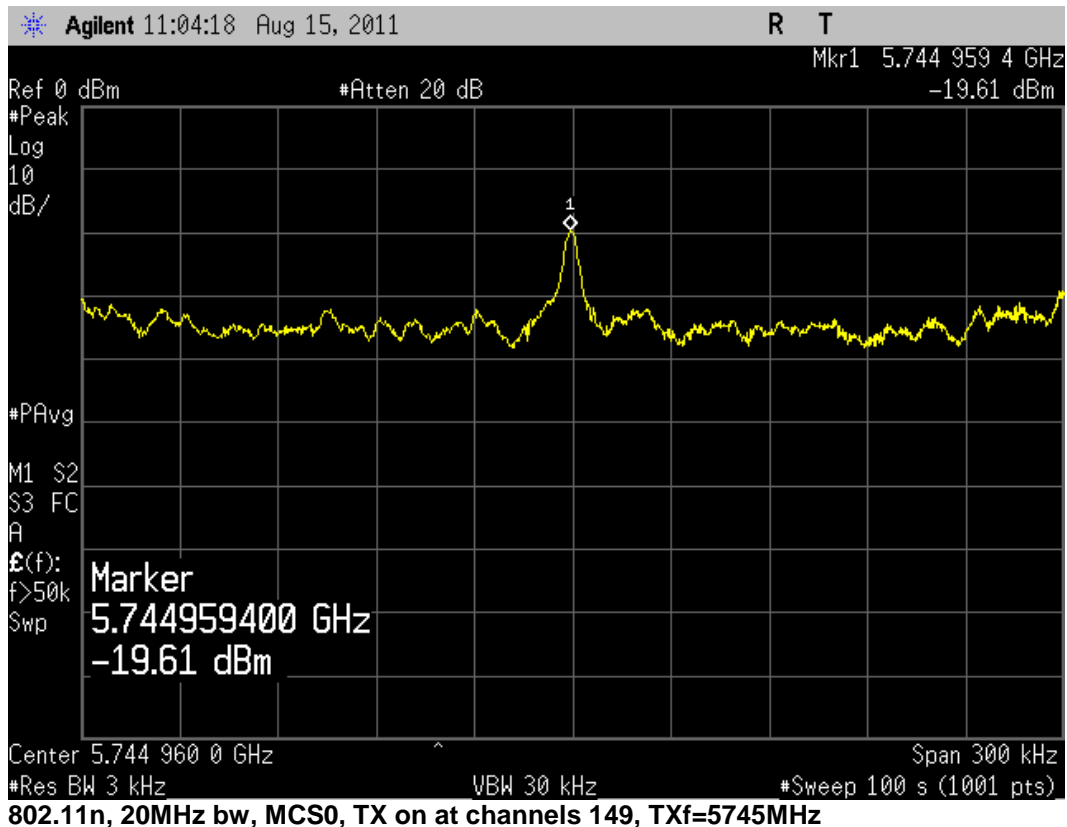
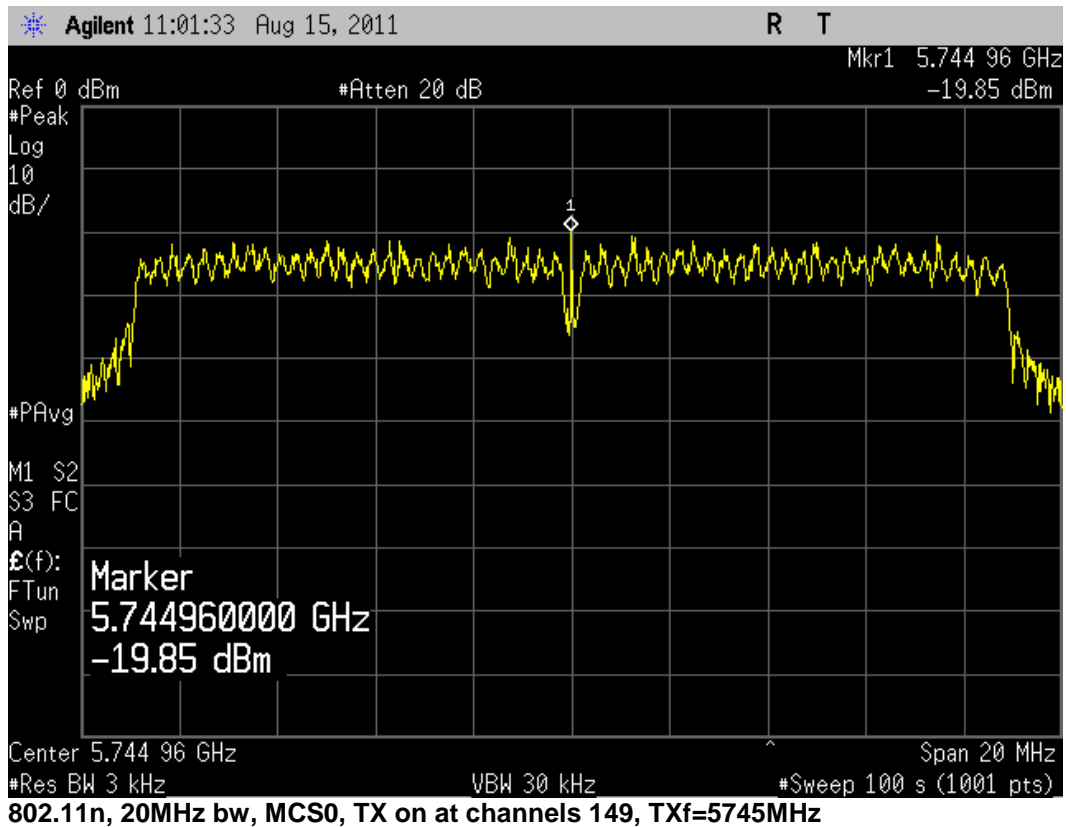
#### 3.2.2 Test data

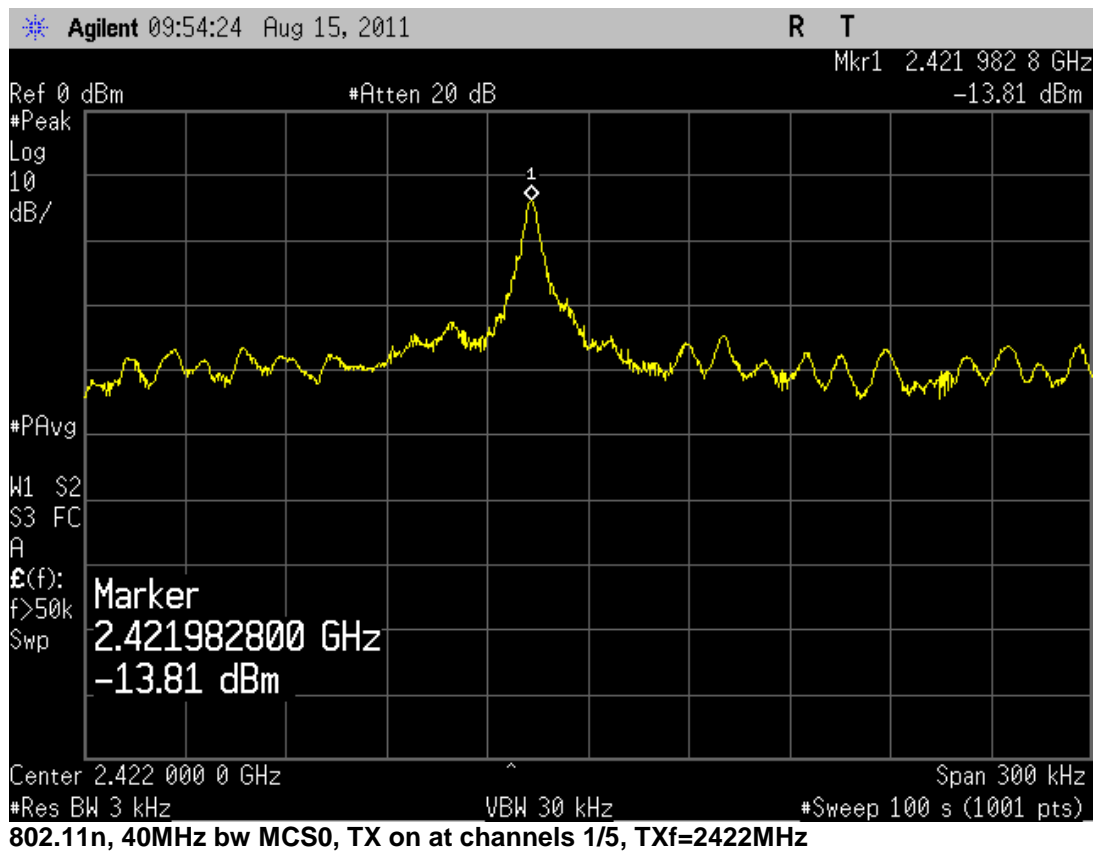
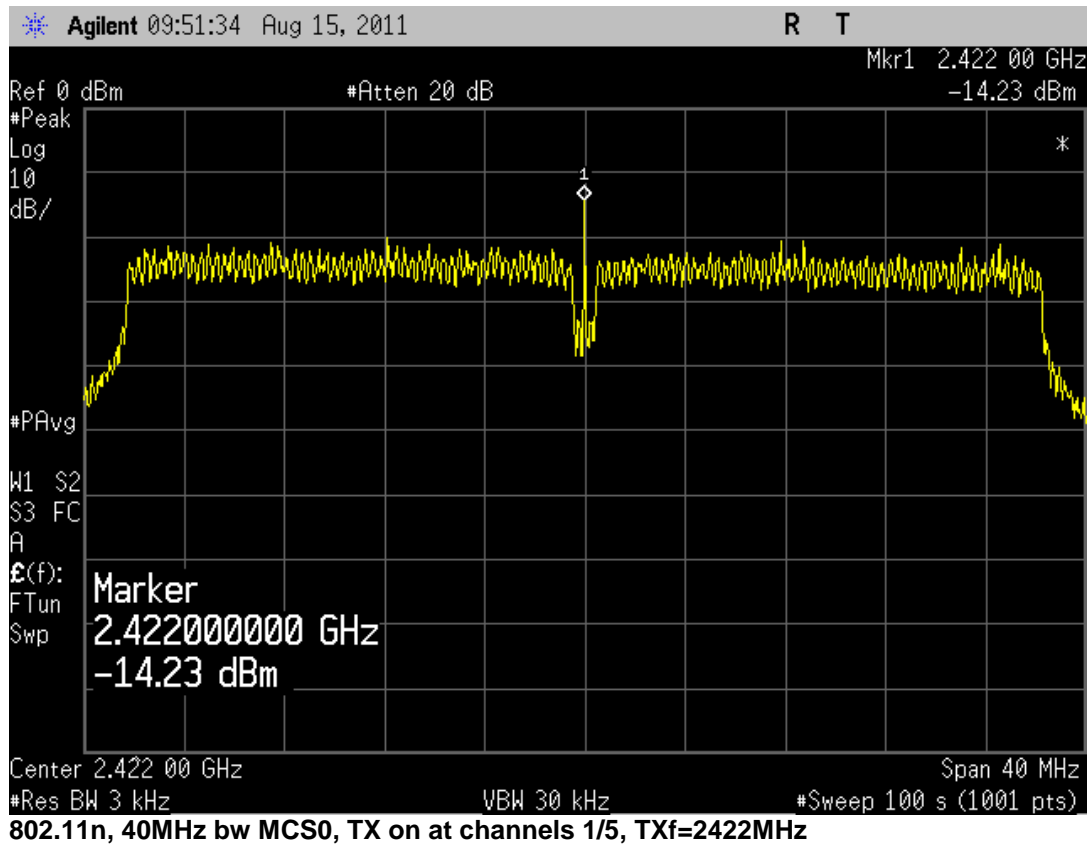
EUT operation mode	Result dBm	Limit dBm	Margin dB
802.11b, 1Mbit/s, TX on at channel 1, TXf=2412MHz	-17.4	6.5	23.9
802.11b, 1Mbit/s, TX on at channel 6, TXf=2437MHz	-17.4	6.5	23.9
802.11b, 1Mbit/s, TX on at channel 11, TXf=2462MHz	-17.3	6.5	23.8
802.11g, 6Mbit/s, TX on at channel 1, TXf=2412MHz	-14.2	6.5	20.7
802.11g, 6Mbit/s, TX on at channel 6, TXf=2437MHz	-17.1	6.5	23.6
802.11g, 6Mbit/s, TX on at channel 11, TXf=2462MHz	-18.9	6.5	16.7
802.11a, 6Mbit/s, TX on at channels 149, TXf=5745MHz	-15.2	6.5	21.7
802.11a, 6Mbit/s, TX on at channels 157, TXf=5785MHz	-17.9	6.5	24.4
802.11a, 6Mbit/s, TX on at channels 165, TXf=5825MHz	-18.7	6.5	25.2
802.11n, 20MHz MCS0, TX on at channels 149, TXf=5745MHz	-19.9	6.5	26.1
802.11n, 20MHz MCS0, TX on at channels 157, TXf=5785MHz	-17.9	6.5	24.4
802.11n, 20MHz MCS0, TX on at channels 165, TXf=5825MHz	-20.1	6.5	26.6
802.11n, 40MHz MCS0, TX on at channels 1/5, TXf=2422MHz	-13.8	6.5	20.3
802.11n, 40MHz MCS0, TX on at channels 7/11, TXf=2452MHz	-16.4	6.5	22.9
802.11n, 40MHz MCS0, TX on at channels 149/153, TXf=5755MHz	-23.7	6.5	30.2
802.11n, 40MHz MCS0, TX on at channels 161/165, TXf=5815MHz	-15.9	6.5	22.4



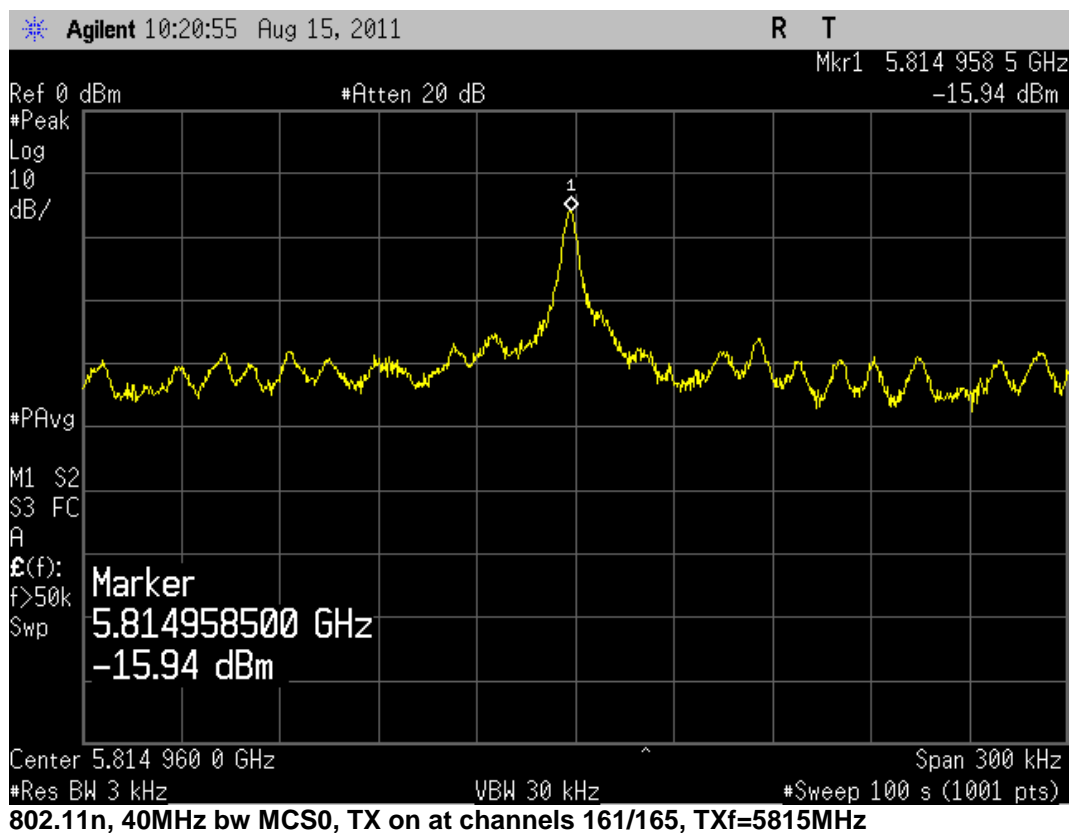
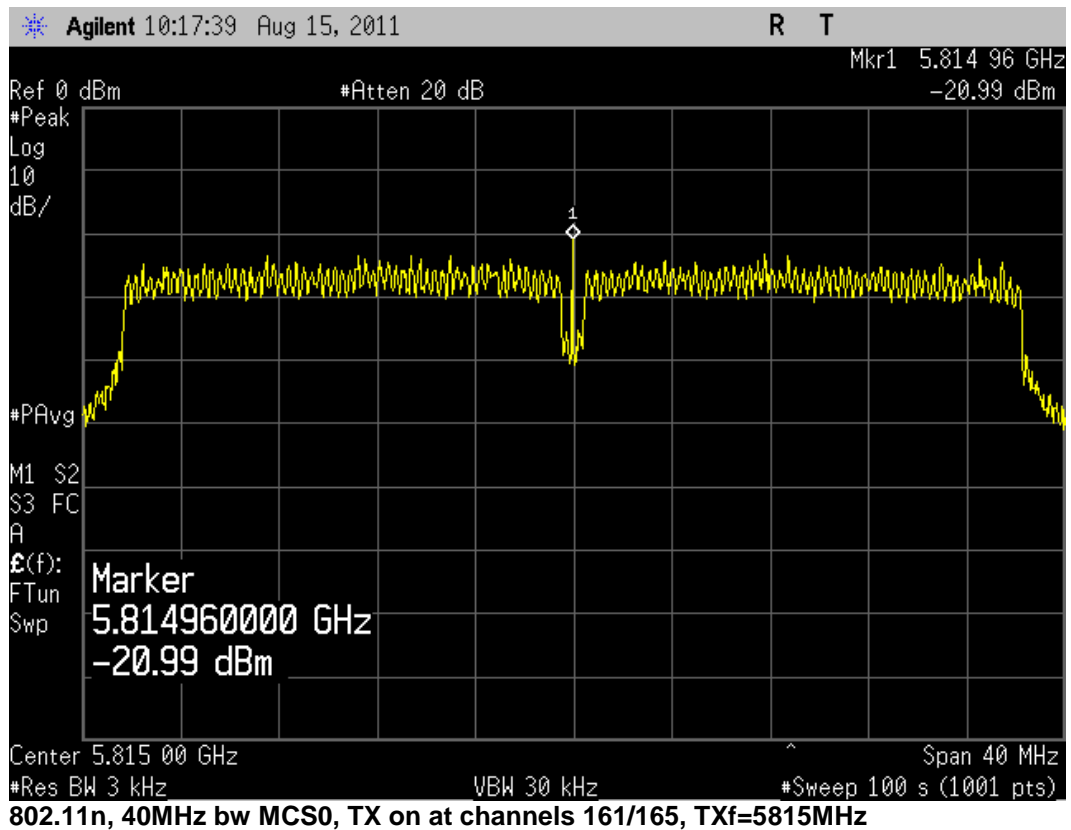












#### 4. List of test equipment

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	Vötsch	31884