

Date: ESPOO 12.04.2011Page: 1 (31)Appendices -Number:
No. 1 / 1**166069 NII**

Date of handing in: 05.01.2011

Tested by:



Pekka Kälviäinen, Test Engineer

Reviewed by:



Janne Nyman, Compliance Specialist

SORT OF EQUIPMENT:

7signal Sapphire Eye WLAN Unit

MARKETING NAME:

7signal Sapphire Eye

TYPE:

7signal Sapphire Eye (ver. 2.0)

MANUFACTURER:

7signal Ltd

CLIENT:

7signal Ltd

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TEST LABORATORY:

Nemko Oy

FCC REG. NO.

ID 359859 November 26, 2008**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	PASS , margin 9.1 dB
15.209 / 15.407 (b)	Electric Field Strength Spurious Emissions, 30MHz ~ 40000MHz	PASS , margin 0.5 dB
15.407 (a)	99% occupied bandwidth measurement	PASS
15.407 (a)	Maximum conducted output power	PASS
15.407 (a)	Power Spectral Density	PASS
15.407 (a)	Peak excursion	PASS
15.407 (b)	Band Edge emissions	PASS
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 a 7signal Sapphire Eye WLAN unit, S/N: 10220005.

FCC ID: YLF-ABG-EYE-APU2

Operating frequencies and channels:

Channel No.	Frequency [MHz]	Test performed
36	5180	All tests
40	5200	
44	5220	
48	5240	All tests except AC power line conducted emissions
52	5260	Max output power, 99%BW, SPD, peak excursion
56	5280	
60	5300	
64	5320	All tests except AC power line conducted emissions
149	5745	All tests except AC power line conducted emissions
153	5765	-
157	5785	All tests except AC power line conducted emissions
161	5805	All tests except AC power line conducted emissions

Modulation: OFDM

Transfer rate: 802.11a: 54 Mbps, no turbo mode available

Channel spacing: 20 MHz

Power supply: Power through Ethernet in all tests except frequency stability test: 13.2 VDC (+/- 15%), from laboratory power

Antenna: Directional plane antenna

1.2 EUT and accessories

	<i>unit</i>	<i>type</i>	<i>S/N</i>
EUT	7signal Sapphire Eye	7signal Sapphire Eye (ver. 2.0)	ED2 / 10.1.19.52
	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

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.

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>	23.12.2010
<i>Test equipment</i>	694, 168, 348, 371
<i>Test conditions</i>	22 °C, 35 % RH
<i>Test result</i>	PASS

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.

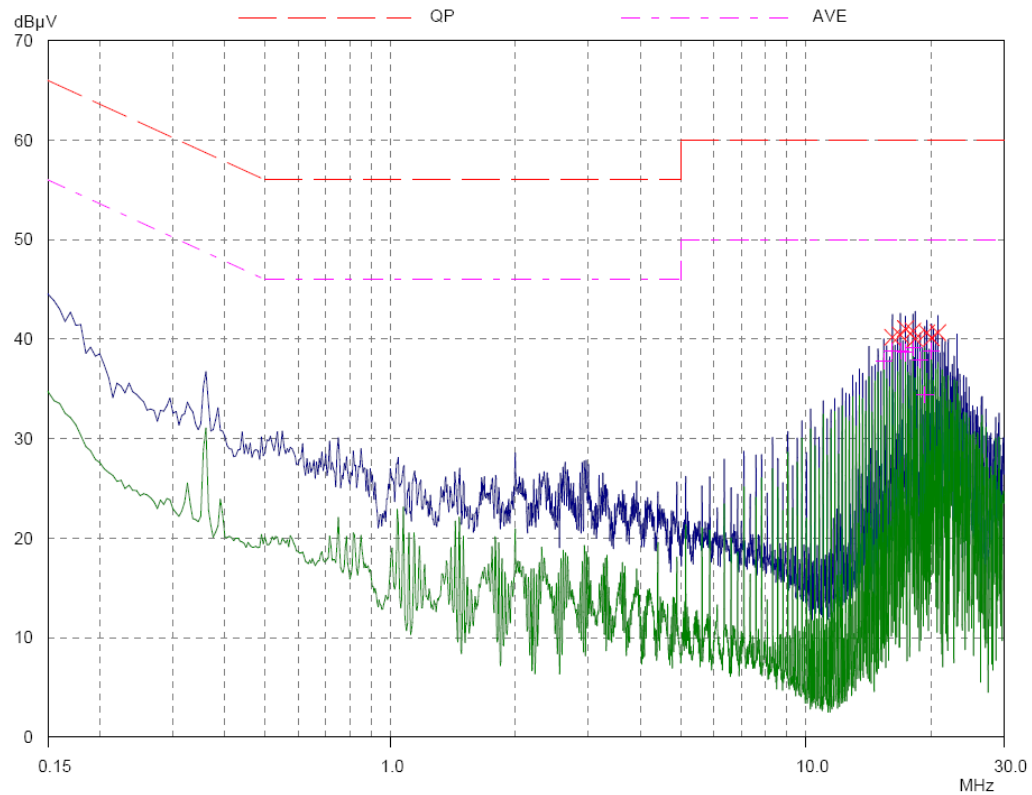
<i>Frequency band MHz</i>	<i>Quasi-peak limit dB(μV)</i>	<i>Average limit dB(μV)</i>
0.15 – 0.5	66 – 56	56 – 46
0.5 – 5	56	46
5 - 30	60	50

3.1.2 EUT operation mode

<i>EUT operation mode</i>	TX on channel 36 (5180 MHz)
<i>EUT operation voltage</i>	115 V / 60 Hz

3.1.3 Test data

line N

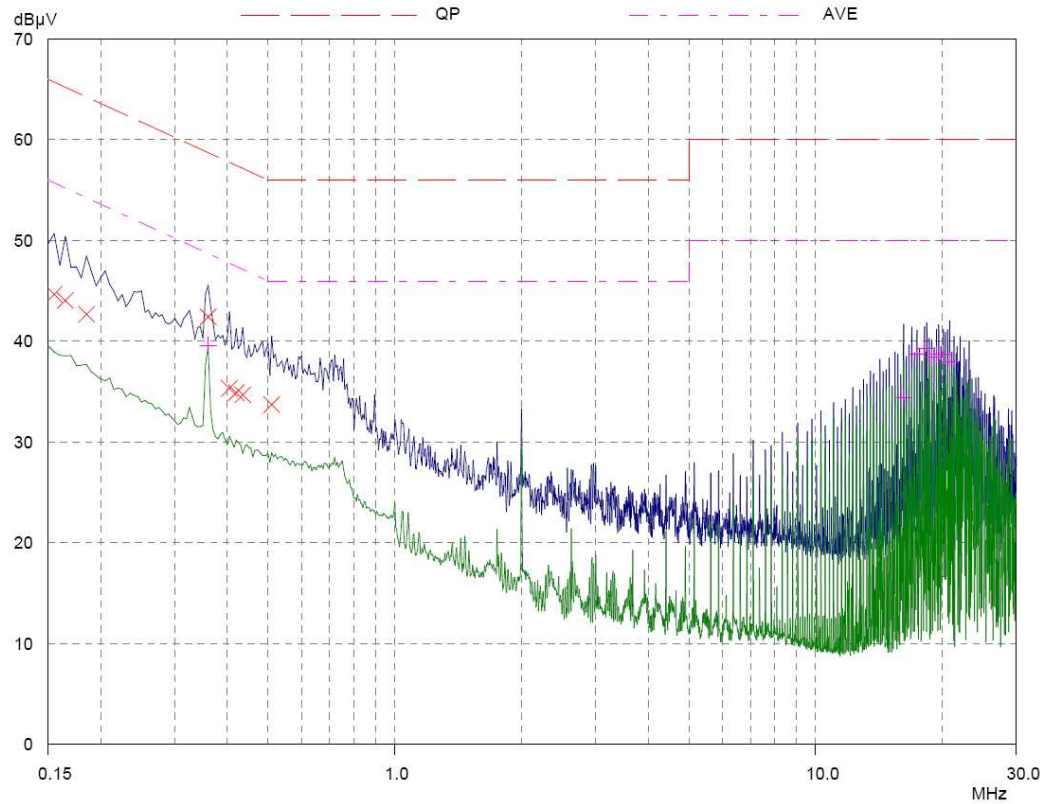


Final Measurement Results

Frequency MHz	QP Level dBμV	QP Limit dBμV	QP Delta dB
16.165	40.19	60.00	19.81
16.9	40.41	60.00	19.59
17.39	41.06	60.00	18.94
18.125	40.82	60.00	19.18
18.37	40.03	60.00	19.97
19.59	40.64	60.00	19.36
20.08	40.13	60.00	19.87
20.815	40.66	60.00	19.34

Frequency MHz	AV Level dBμV	AV Limit dBμV	AV Delta dB
15.43	37.79	50.00	12.21
16.165	38.83	50.00	11.17
16.9	38.80	50.00	11.20
17.39	38.67	50.00	11.33
18.125	39.15	50.00	10.85
18.86	37.89	50.00	12.11
19.35	34.44	50.00	15.56
20.08	38.82	50.00	11.18

line L



Final Measurement Results

Frequency MHz	QP Level dBμV	QP Limit dBμV	QP Delta dB
0.155	44.67	65.73	21.06
0.165	44.05	65.21	21.16
0.185	42.68	64.26	21.58
0.36	42.42	58.73	16.31
0.405	35.33	57.75	22.42
0.42	34.91	57.45	22.54
0.435	34.70	57.16	22.46
0.51	33.72	56.00	22.28

Frequency MHz	AV Level dBμV	AV Limit dBμV	AV Delta dB
0.36	39.60	48.73	9.13
16.165	34.45	50.00	15.55
17.385	38.72	50.00	11.28
18.12	39.30	50.00	10.70
18.855	38.45	50.00	11.55
19.345	38.71	50.00	11.29
20.08	38.73	50.00	11.27
20.815	37.98	50.00	12.02

3.2 Radiated emissions

Site name	Nemko / Perkkaa
Date of testing	10.11.2010, 20.12.2010 and 05.01.2011, 11-12.04.2011
Test equipment	350, 338, 566, 544, 564, 319, 525, 559, 371, 88, 521, 66, 710
Test conditions	22 °C, 30 % RH
Test result	PASS

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 1000-18000 MHz the distance from the EUT to the measuring antenna was 3 m (RF absorbers on the conducting ground plane) and in the frequency range 18000-40000 MHz the distance from the EUT to the measuring antenna was 2 m or closer at frequencies above 26 GHz (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 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 - 18000	-	68.2

The CFR 47 Part 15, Section 15.407 limit values for radiated emissions of UNWANTED EMISSION OUT OF THE RESTRICTED BANDS (2m measuring distance, calculated from -27 dBm limit ¹⁾)

Frequency band MHz	Average limit dB(µV/m)	Peak limit dB(µV/m)
18000 - 40000	-	71.7

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

3.2.2 EUT operation mode

EUT operation mode	TX on at channels 36, 48, 64, 149, 157, 161
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3.2.3 Test data

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).

Highest emissions (Quasipeak):

Frequency MHz	Level dBμV/m	Limit dBμV/m	Margin dB	Height cm	Azimuth deg	Polarisation
198.90	34.30	43.50	9.20	102.0	170.00	VERTICAL
200.20	41.10	43.50	2.40	100.0	224.00	VERTICAL
201.12	39.10	43.50	4.40	102.0	337.00	VERTICAL
201.24	41.40	43.50	2.10	100.0	65.00	VERTICAL
206.94	32.70	43.50	10.80	102.0	357.00	VERTICAL
634.14	44.50	46.00	1.50	102.0	178.00	VERTICAL

Highest emissions (Peak in channels 157 / 161, channel 157 was the worst case):

Frequency MHz	Level dBμV/m	Limit dBμV/m	Margin dB	Height cm	Azimuth deg	Polarisation
17349	67.7	68.2	0.5	100	30	VERTICAL
17412	57.0	68.2	11.2	100	30	HORIZONTAL

Restricted bands

Highest emissions (Peak in channels 157 / 161, channel 161 was the worst case):

Frequency MHz	Level dBμV/m	Limit dBμV/m	Margin dB	Height cm	Azimuth deg	Polarisation
11569	58.0	74	16	100	90	VERTICAL
11607	61.5	74	13.5	100	0	VERTICAL

Highest emissions (Average in channels 157 / 161, channel 157 was the worst case):

Frequency MHz	Level dBμV/m	Limit dBμV/m	Margin dB	Height cm	Azimuth deg	Polarisation
11569	49.0	54	5.0	100	90	VERTICAL
11607	48.5	54	5.5	100	0	VERTICAL

3.3 Band-edge compliance

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

<i>Site name</i>	Nemko Oy / Perkkää
<i>FCC rule part</i>	§ 15.407
<i>Date of testing</i>	11-12.4.2011
<i>Test equipment</i>	350, 566, 525
<i>Test conditions</i>	23 °C, 35 % RH
<i>Test result</i>	PASS (limit: EIRP -27 dBm/MHz/-17dBm/MHz out of restricted bands, 54 dBµV/m AVE 74 dBµV/m peak in restricted bands)

3.3.1 EUT operation mode

<i>EUT operation mode</i>	Transmitting
<i>EUT channel</i>	36, 64, 149, 161
<i>EUT TX power level</i>	Nominal

3.3.2 Test method

RF radiated test method as described in the chapter 3.2 was used to measure band edge compliance. 1 m measuring distance was used and the results were converted to 3 m measuring distance by using 20 dB / decade conversion factor.

3.3.3 Test data

Restricted bands TX on channel 36

Highest emissions (Peak)

Frequency MHz	Level dBµV/m	Limit dBµV/m	Margin dB
5150	66.9	74	7.1

Highest emissions (Average)

Frequency MHz	Level dBµV/m	Limit dBµV/m	Margin dB
5150	44.2	54	9.8

Restricted bands TX on channel 64

Highest emissions (Peak)

Frequency MHz	Level dBµV/m	Limit dBµV/m	Margin dB
5350	65.6	74	7.4

Highest emissions (Average)

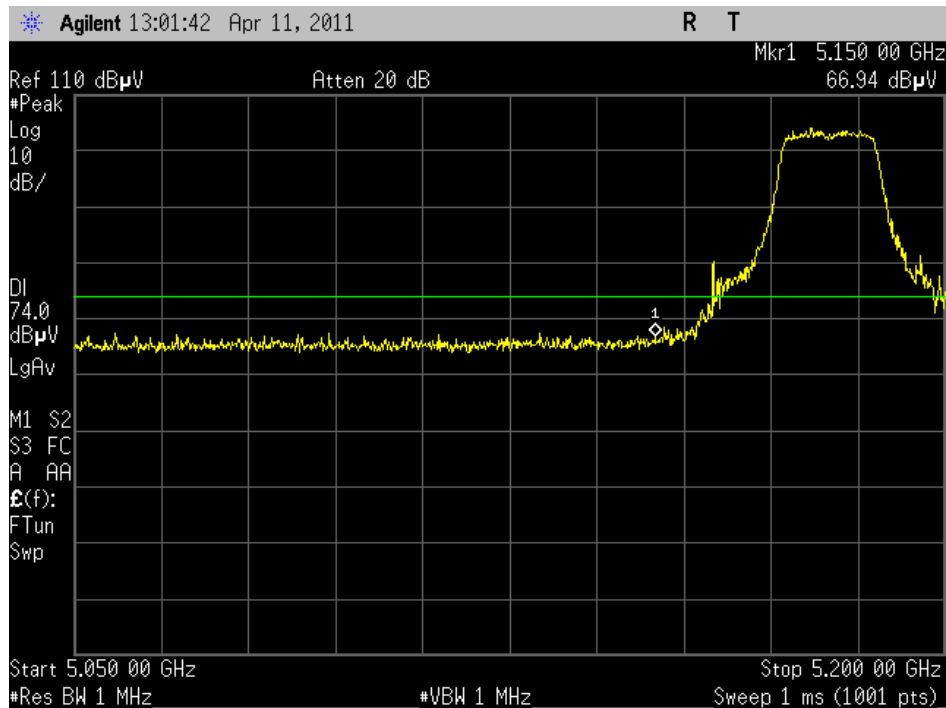
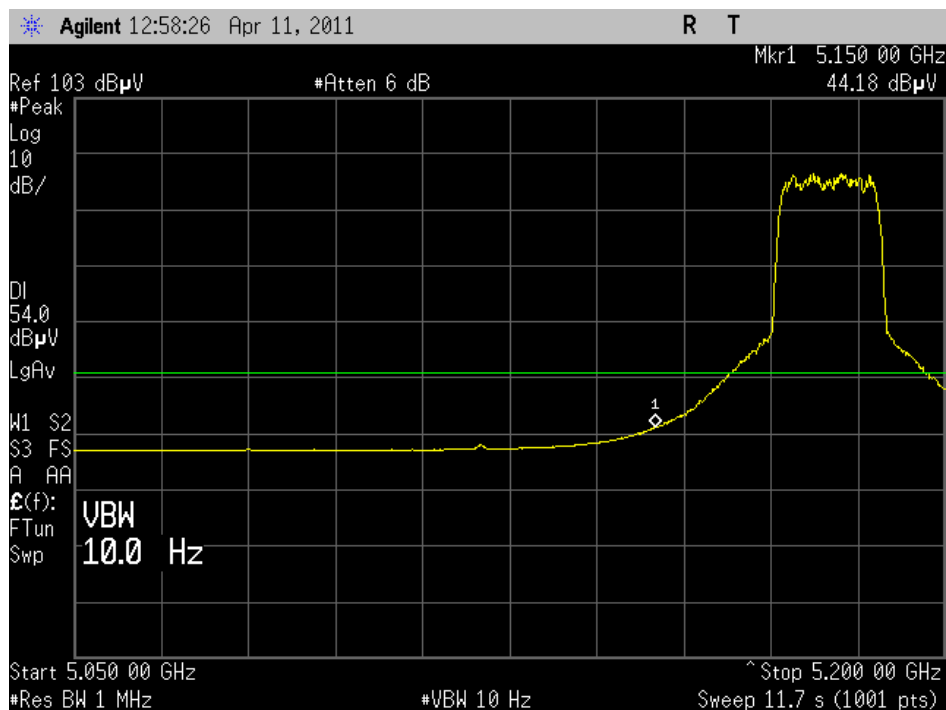
Frequency MHz	Level dBµV/m	Limit dBµV/m	Margin dB
5350	43.9	54	10.1

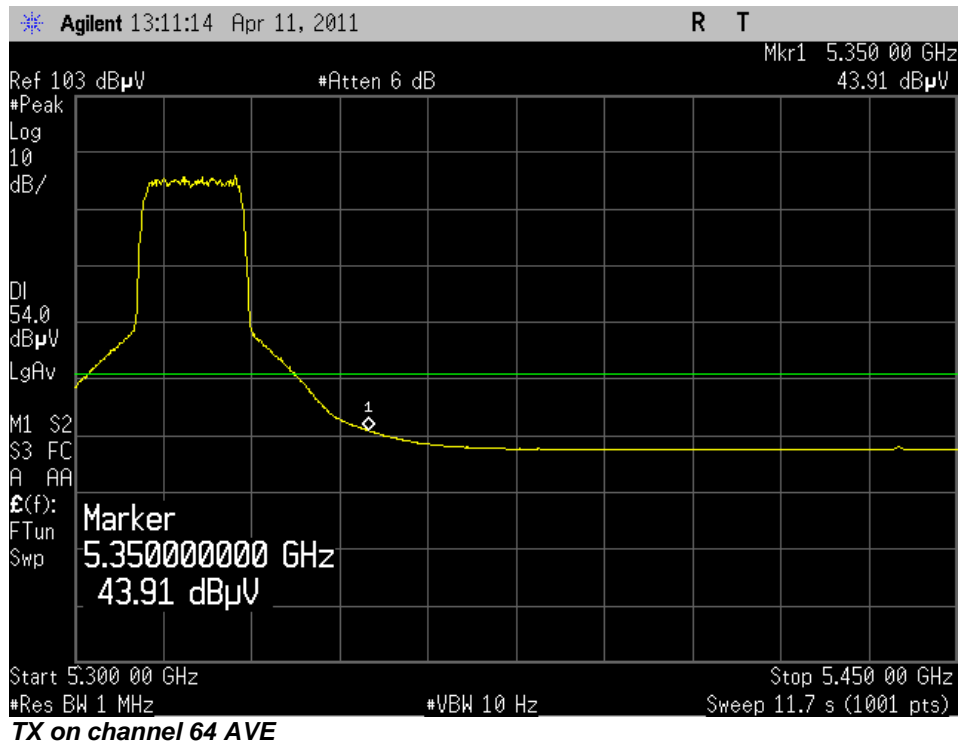
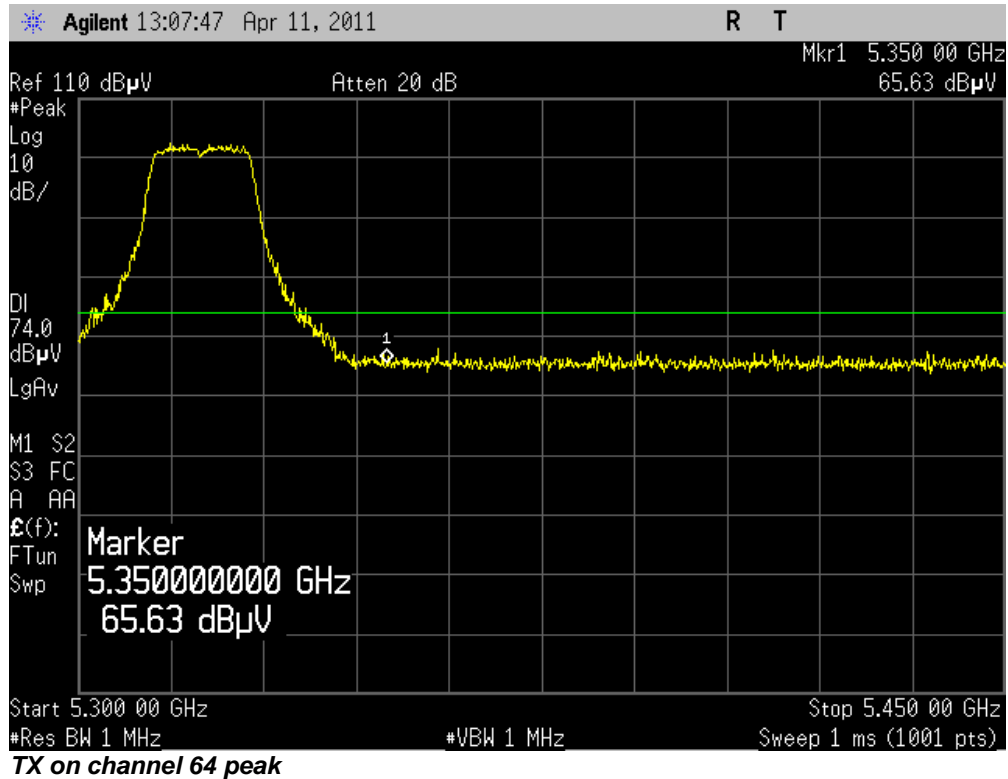
Out of restricted bands TX on channel 149

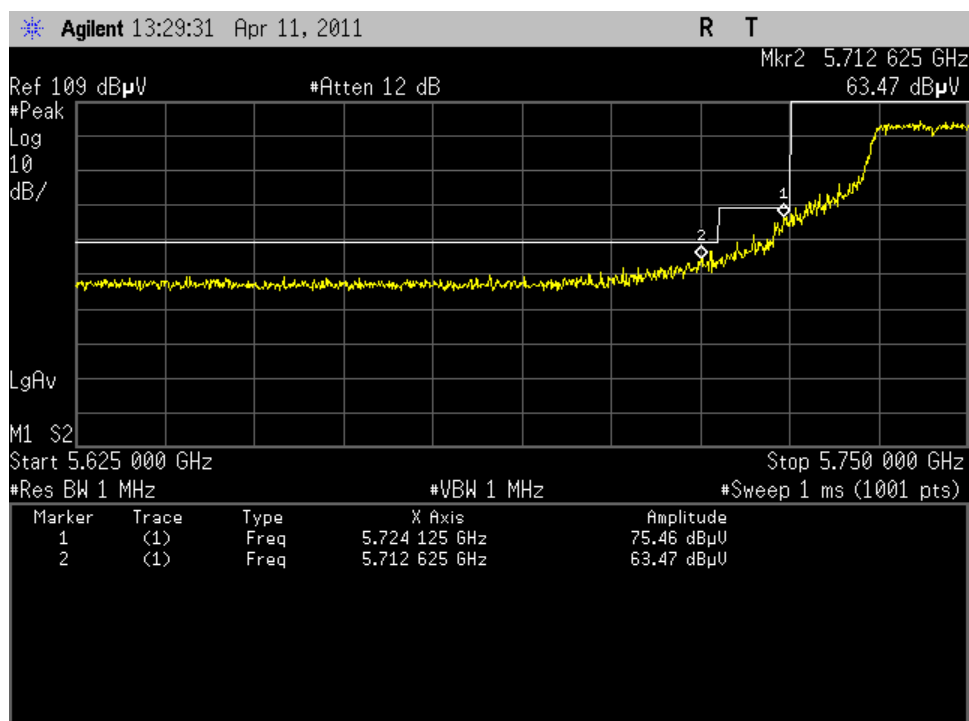
Frequency MHz	Result dBm	Limit dBm	Margin dB
5724.1	-19.8	-17	2.8
5712.6	-31.8	-27	4.8

TX on channel 161

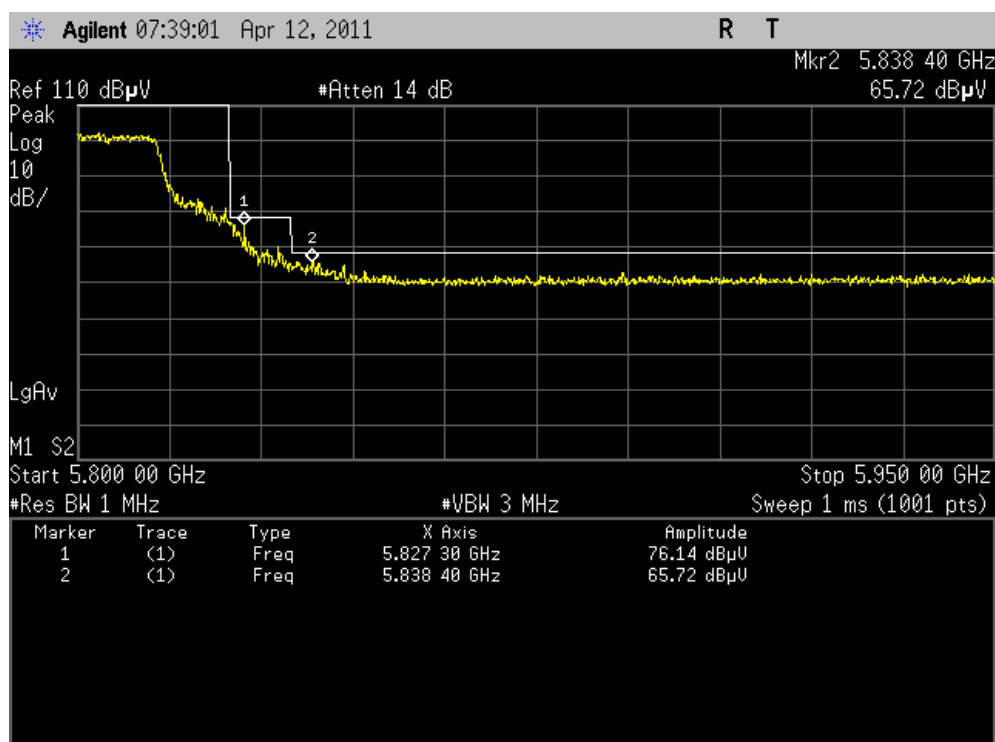
Frequency MHz	Result dBm	Limit dBm	Margin dB
5827.3	-19.2	-17	2.3
5838.4	-29.6	-27	2.6


TX on channel 36 peak

TX on channel 36 AVE





TX on channel 149



TX on channel 161

3.4 Maximum conducted 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>	§ 15.407
<i>Date of testing</i>	08-12.04.2011
<i>Test equipment</i>	567, 42, 2047, 392, 567
<i>Test conditions</i>	23 °C, 35 % RH
<i>Test result</i>	PASS

3.4.1 EUT operation mode

<i>EUT operation mode</i>	Transmitting
<i>EUT channel</i>	36, 48, 52, 64, 149, 157, 161
<i>EUT TX power level</i>	Nominal
<i>EUT bit rate (Mbps)</i>	54

3.4.2 Test method and limit

Test method #1 was used. EUT continuous transmission time without power OFF is 1.3ms. RBW=1MHz and VBW=8MHz. Trace average 100 traces in power averaging mode was used. External trigger was used in order to not 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.

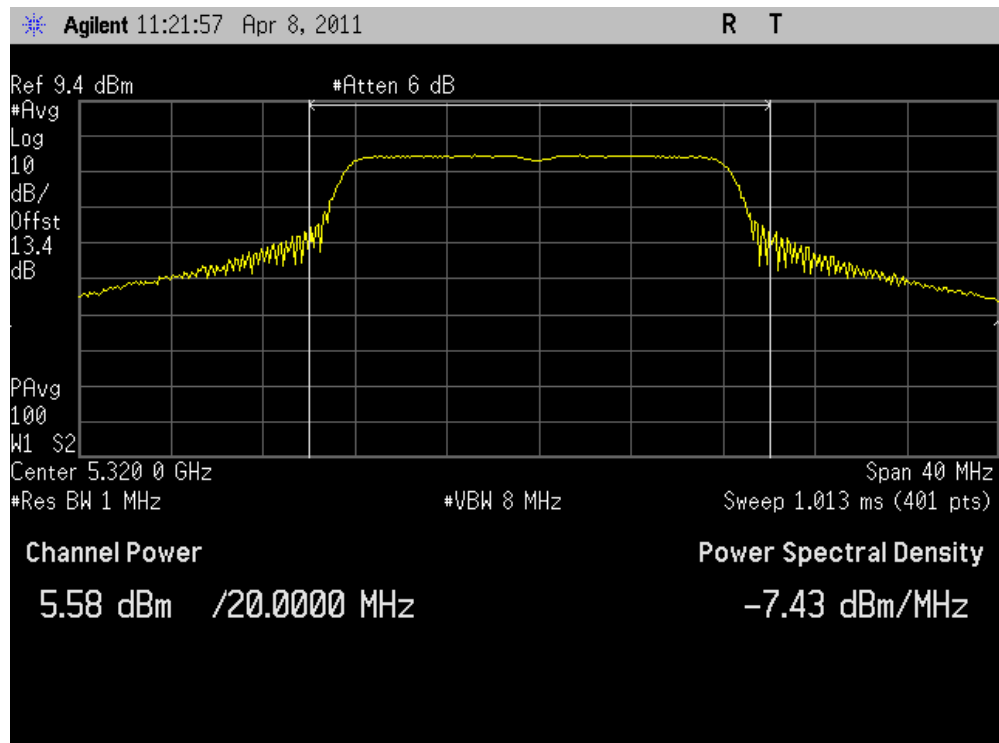
Limit values

<i>FCC Rule Part</i>	<i>Frequency band MHz</i>	<i>Peak dBm</i>
15.407	5150 – 5250	17 or 4+10logB
15.407	5250 – 5350	23 or 11+10logB
15.407	5725 – 5825	30 or 17+10logB

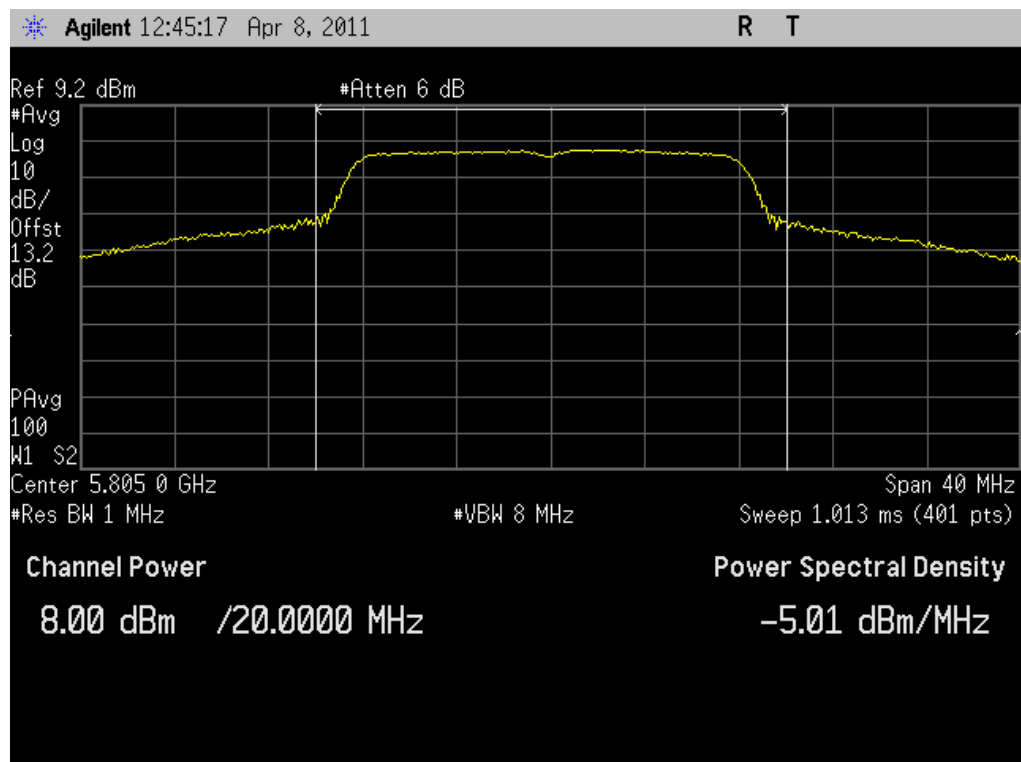
3.4.3 Test results

TX on at channels 36, 48, 52, 64, 149, 157, 161

<i>Channel</i>	<i>Frequency MHz</i>	<i>Result dBm</i>	<i>Limit dBm</i>	<i>Margin dB</i>
36	5180	6.9	17	10.1
48	5240	4.1	17	12.9
52	5260	4.8	24	19.2
64	5320	5.6	24	18.4
149	5745	8.9	30	21.1
157	5785	8.5	30	21.5
161	5805	8.0	30	22.0



Channel 64 (5320MHz)



Channel 161 (5805MHz)

3.4.4 99%, 6dB and 26 dB Bandwidth

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

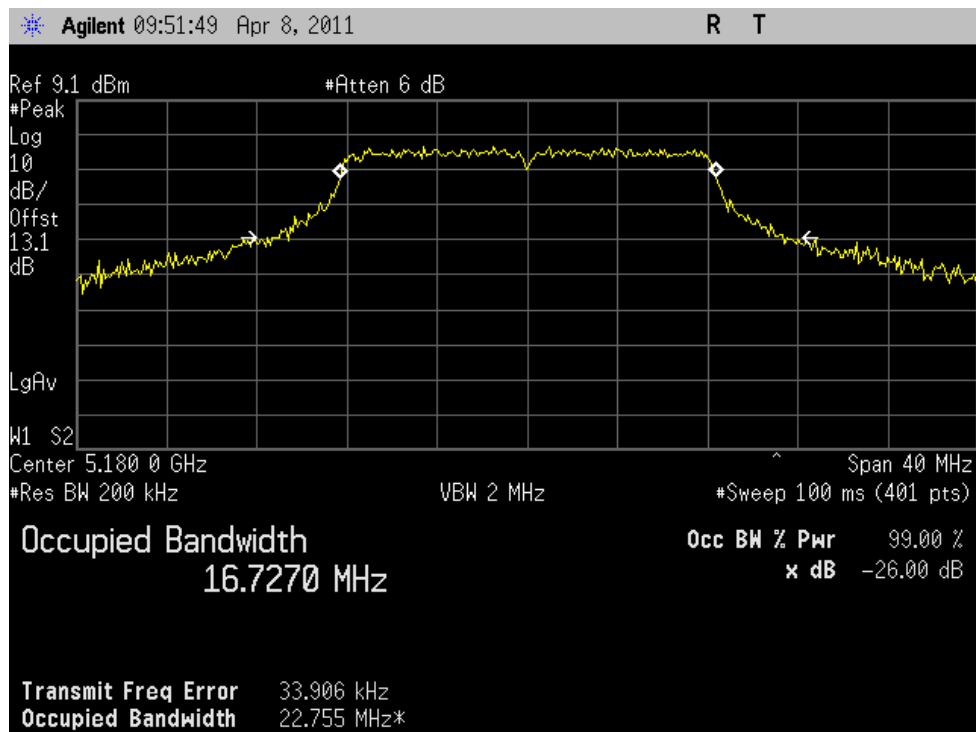
Site name	Nemko Oy / Perkkaa
FCC rule part	§ 15.407
Date of testing	08-12.04.2011
Test equipment	566, 2047, 392
Test conditions	23 °C, 35 % RH
Test result	PASS (Limit: min 500 kHz)

3.4.5 EUT operation mode

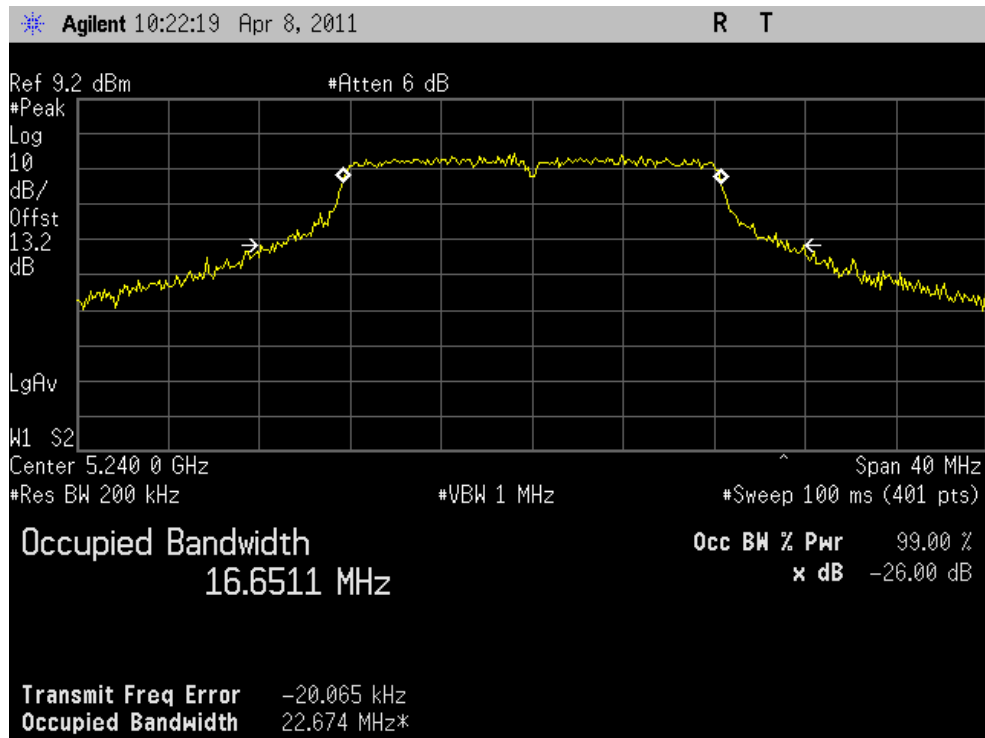
EUT operation mode	Transmitting
EUT channel	36, 48, 52, 64, 149, 157, 161
EUT TX power level	Nominal
EUT bit rate (Mbps)	54

3.4.2 Test data

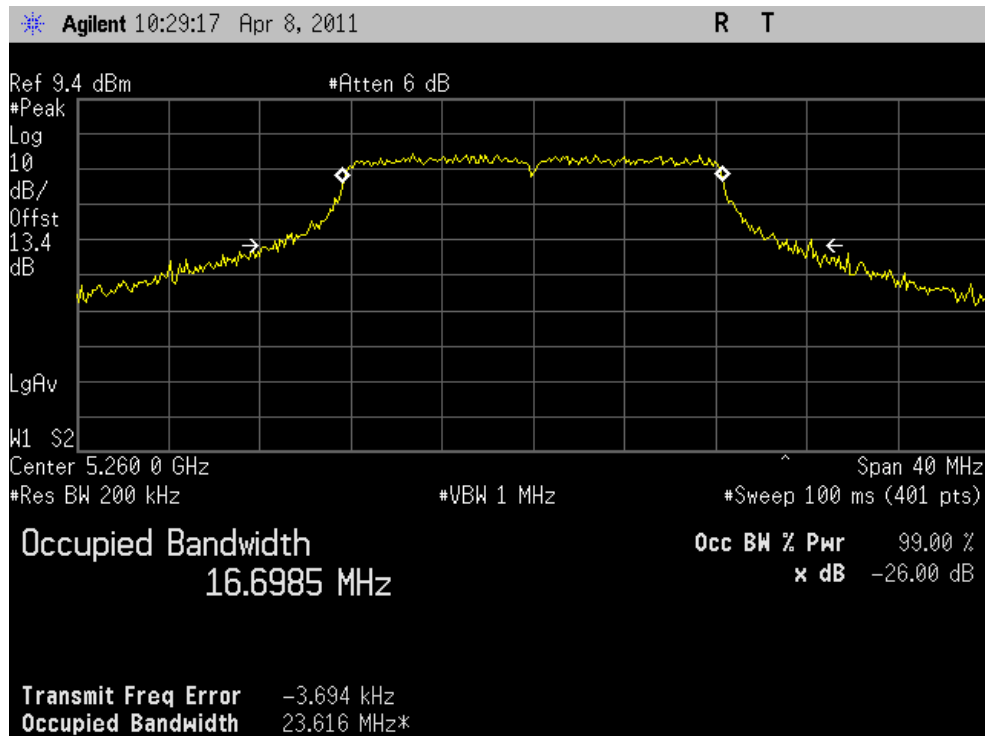
EUT Channel	99% bandwidth (MHz)	6 dB bandwidth (MHz)	26 dB bandwidth (MHz)
36	16.7	16.4	22.7
48	16.6	16.5	22.7
52	16.7	16.5	23.6
64	16.7	16.5	23.3
149	17.4	16.6	35.6
157	17.4	16.5	32.7
161	16.7	16.6	31.2



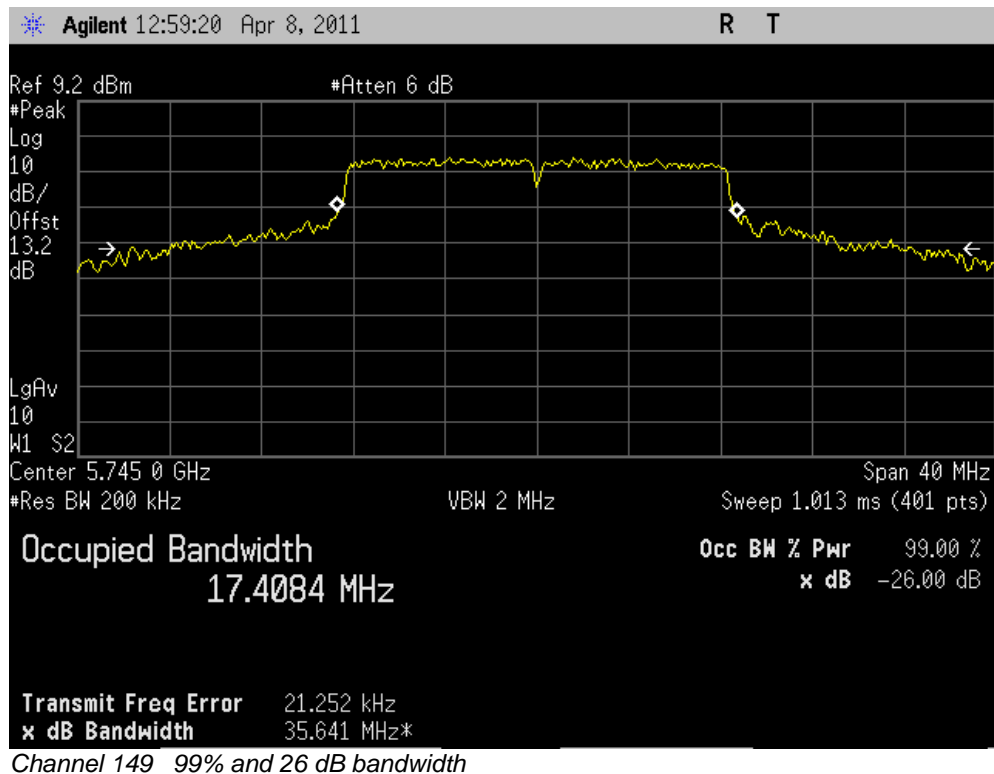
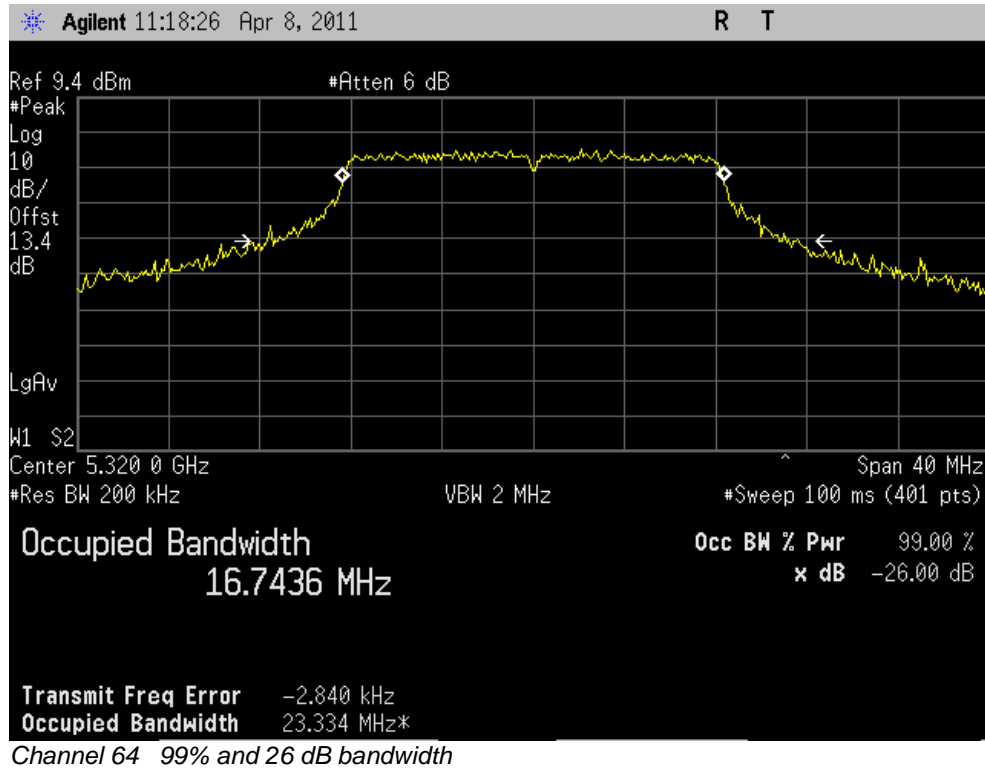
Channel 36 99% and 26 dB bandwidth

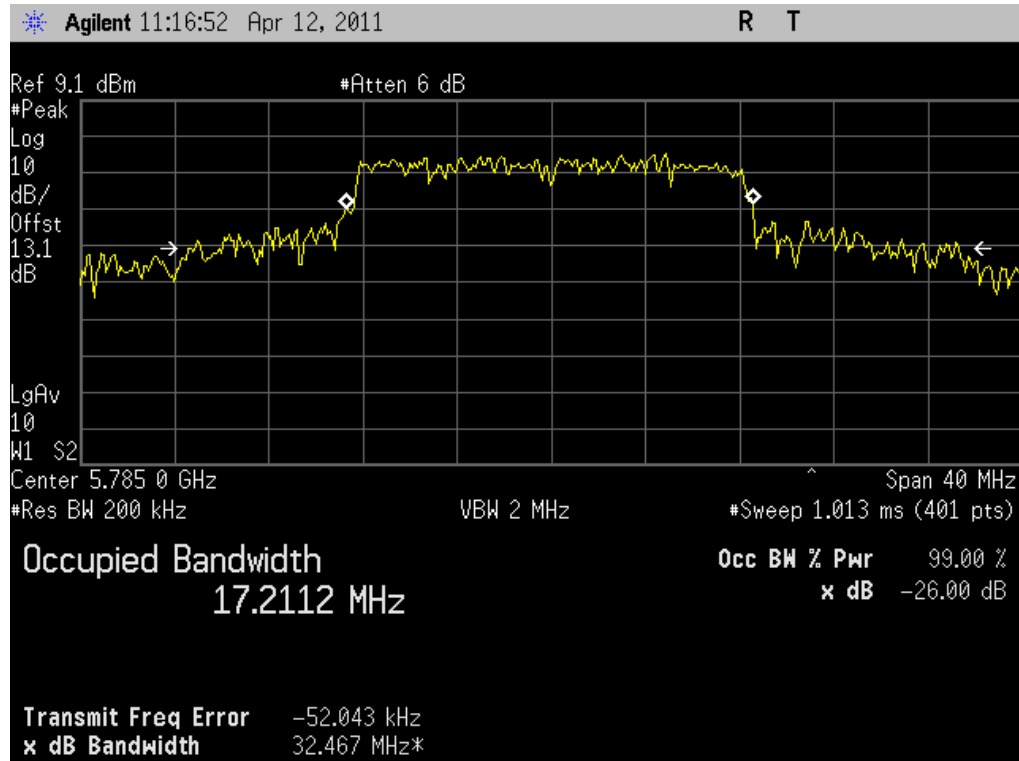


Channel 48 99% and 26 dB bandwidth

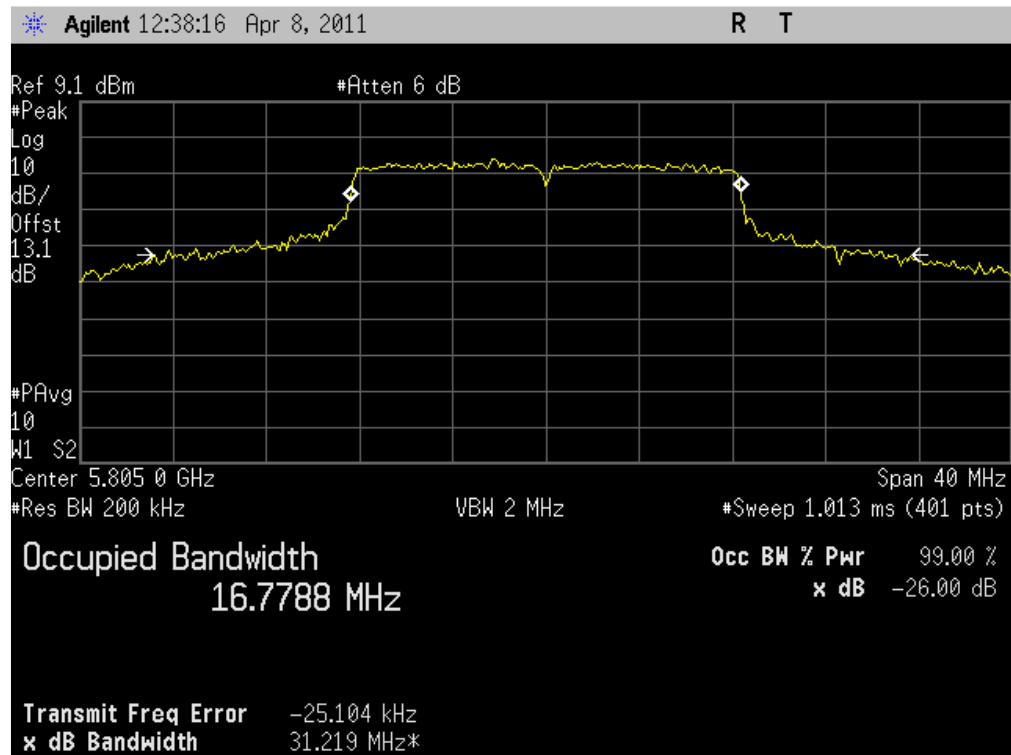


Channel 52 99% and 26 dB bandwidth





Channel 157 99% and 26 dB bandwidth



Channel 161 99% and 26 dB bandwidth

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>	Nemko Oy / Perkkää
<i>FCC rule part</i>	§ 15.407
<i>Date of testing</i>	08-12.04.2011
<i>Test equipment</i>	566, 2047, 392
<i>Test conditions</i>	23 °C, 35 % RH
<i>Test result</i>	PASS

3.5.1 EUT operation mode

<i>EUT operation mode</i>	Transmitting
<i>EUT channel</i>	36, 48, 52, 64, 149, 157, 161
<i>EUT TX power level</i>	Nominal
<i>EUT bit rate (Mbps)</i>	54

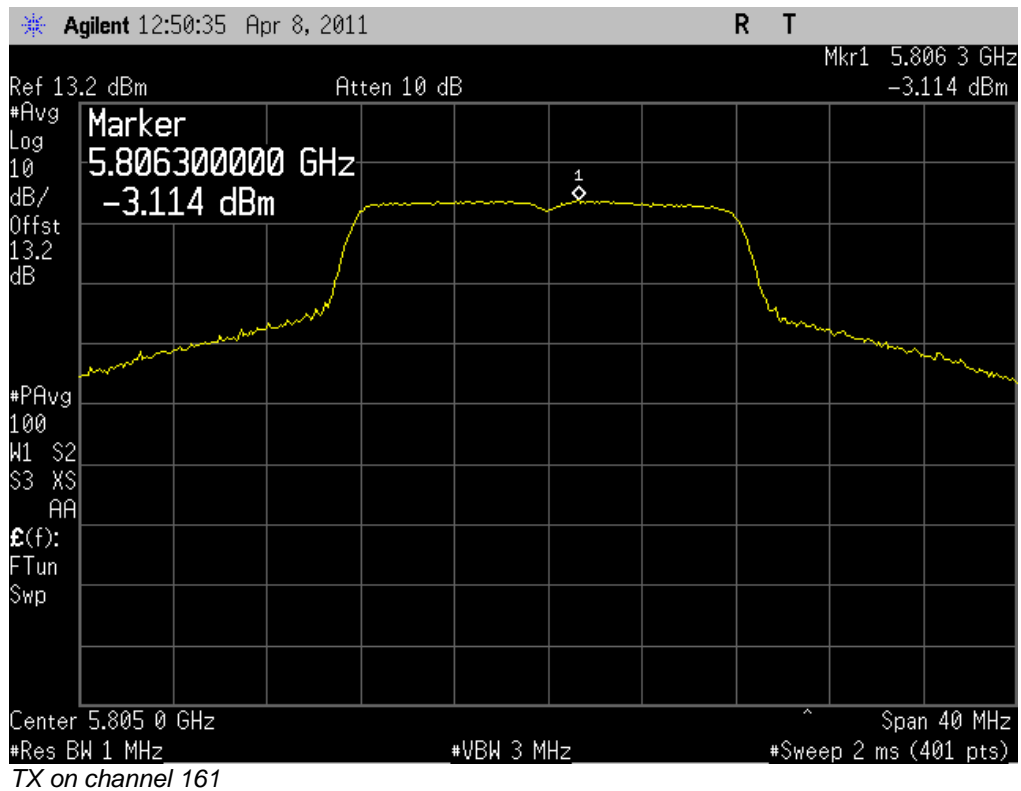
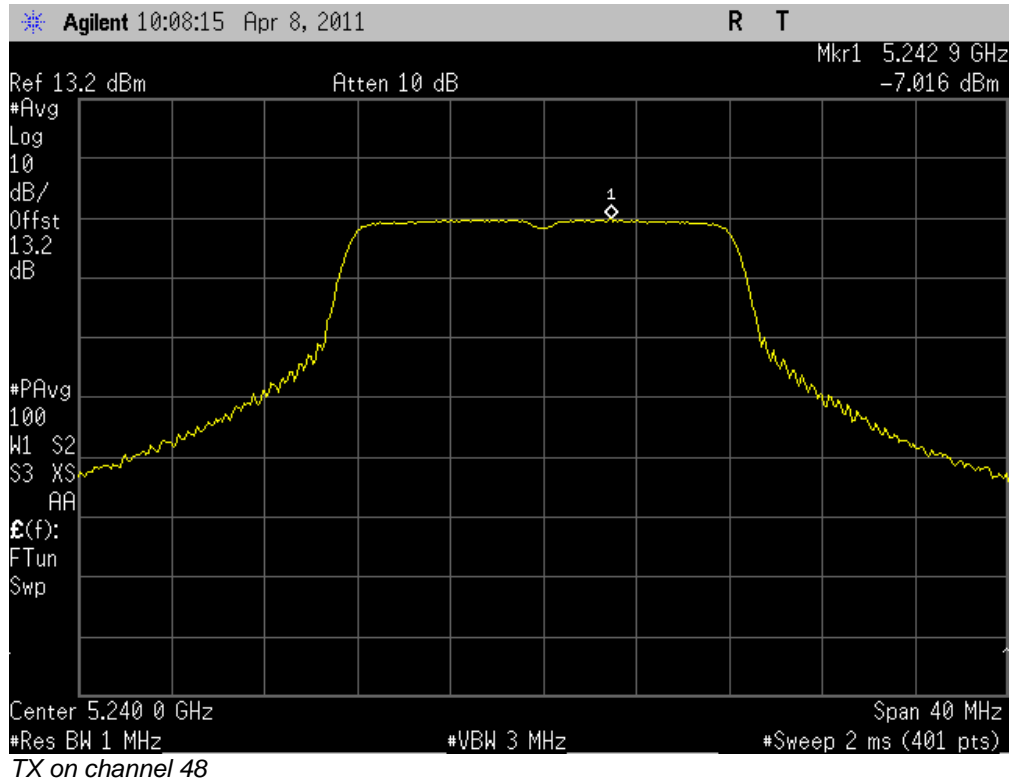
3.5.2 Test method and limit

Test method #2 was used. EUT continuous transmission time without power OFF is 1.3ms. RBW=1MHz and VBW=3MHz. Trace average 100 traces in power averaging mode was used. External trigger and 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.

<i>Frequency band, MHz</i>	Limit
5150-5250	4 dBm
5250-5350	11 dBm
5725-5825	17 dBm

3.5.2 Test data

<i>Frequency MHz</i>	<i>Result dBm</i>	<i>Limit dBm</i>	<i>Margin dB</i>
5180	-4.8	4	8.8
5240	-7.0	4	11
5260	-6.2	11	17.2
5320	-5.8	11	16.8
5745	-1.9	17	18.9
5785	-2.2	17	19.2
5805	-3.1	17	20.1



3.6 Peak excursion

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>	§ 15.407
<i>Date of testing</i>	08-12.04.2011
<i>Test equipment</i>	566, 2047, 392
<i>Test conditions</i>	23 °C, 35 % RH
<i>Test result</i>	PASS

3.6.1 EUT operation mode

<i>EUT operation mode</i>	Transmitting
<i>EUT channel</i>	36, 48, 52, 64, 149, 157, 161
<i>EUT TX power level</i>	Nominal
<i>EUT bit rate (Mbps)</i>	54

3.6.2 Test method and limit

Trace 1

Test method #2 was used. EUT continuous transmission time without power OFF is 1.3ms.
RBW=1MHz and VBW=3MHz. Trace average 100 traces in power averaging mode was used.
External trigger and gated sweep was used in order not to have periods OFF included in the average.

Trace 2

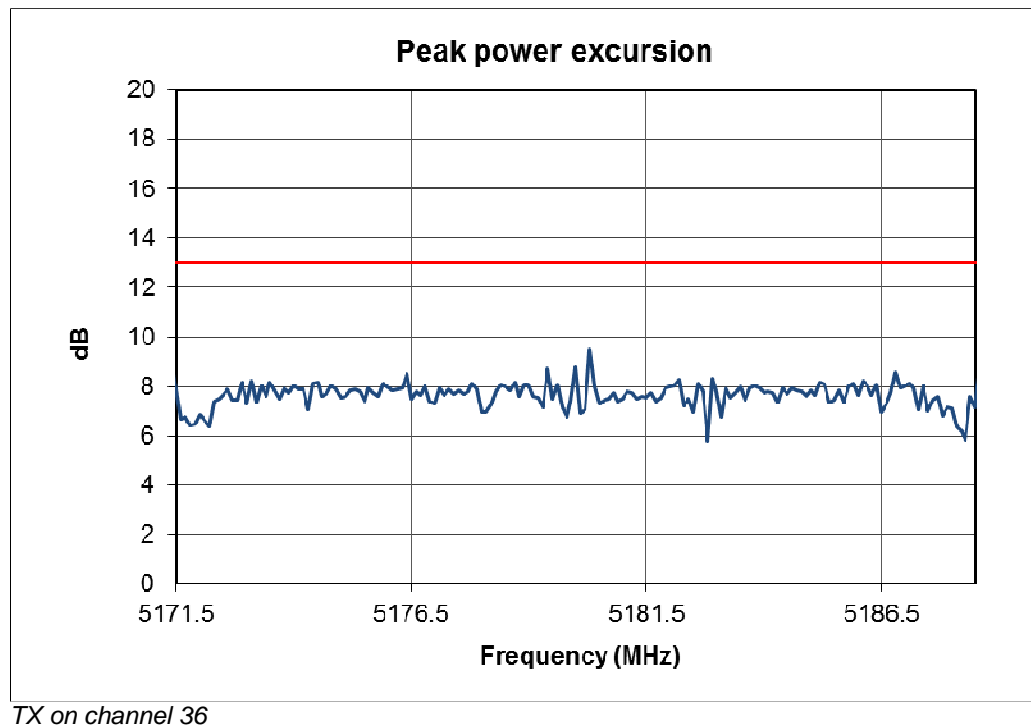
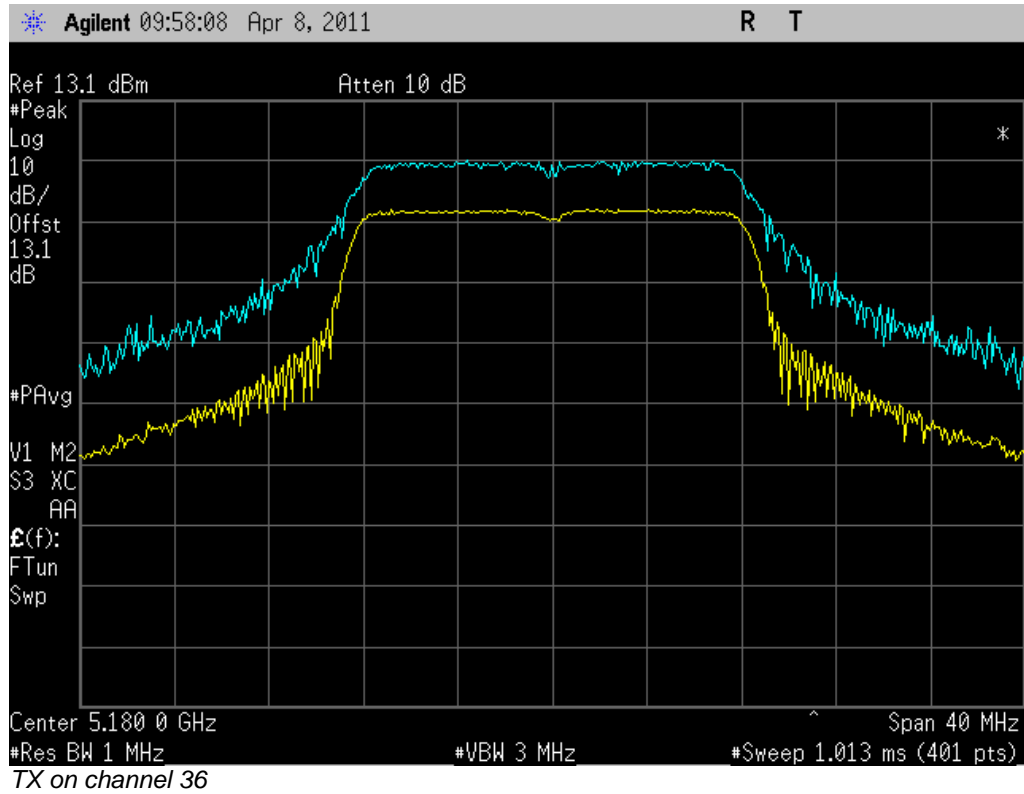
RBW=1MHz and VBW=3MHz. Peak detector, trace MAX HOLD.

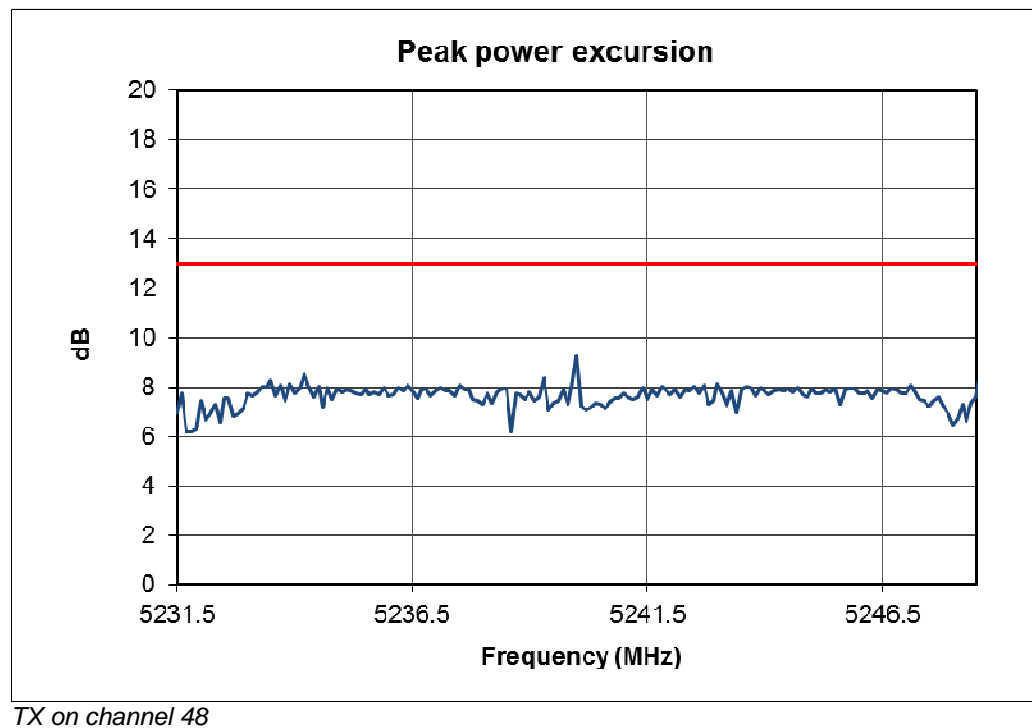
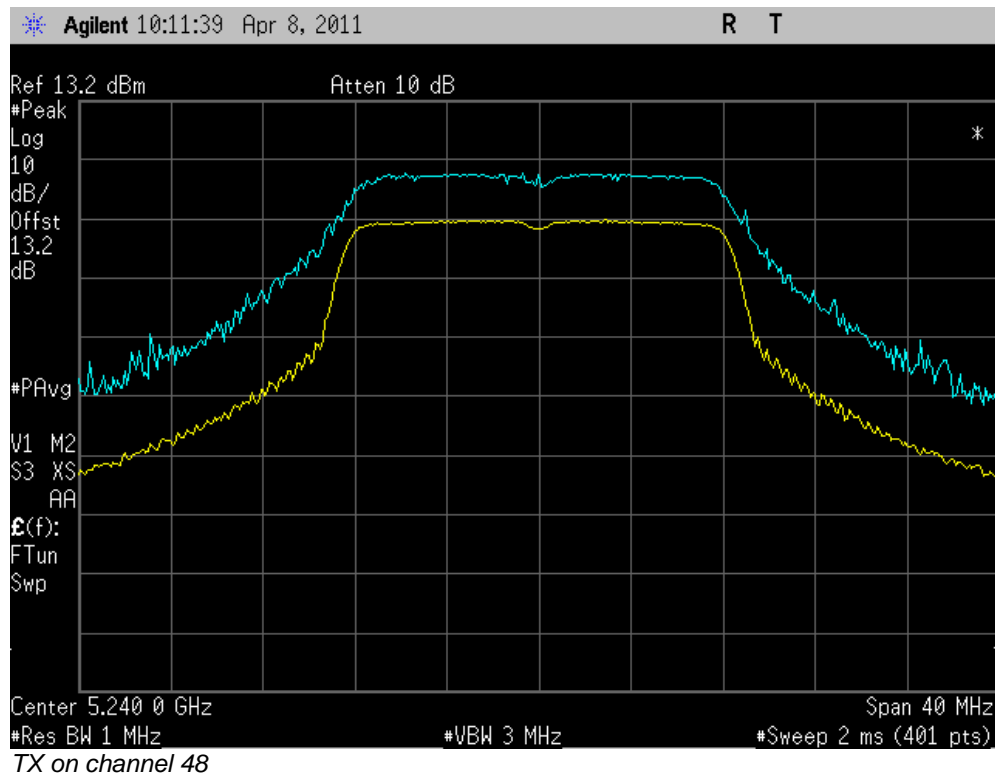
Trace 1 and trace 2 was read to computer and subtracted.

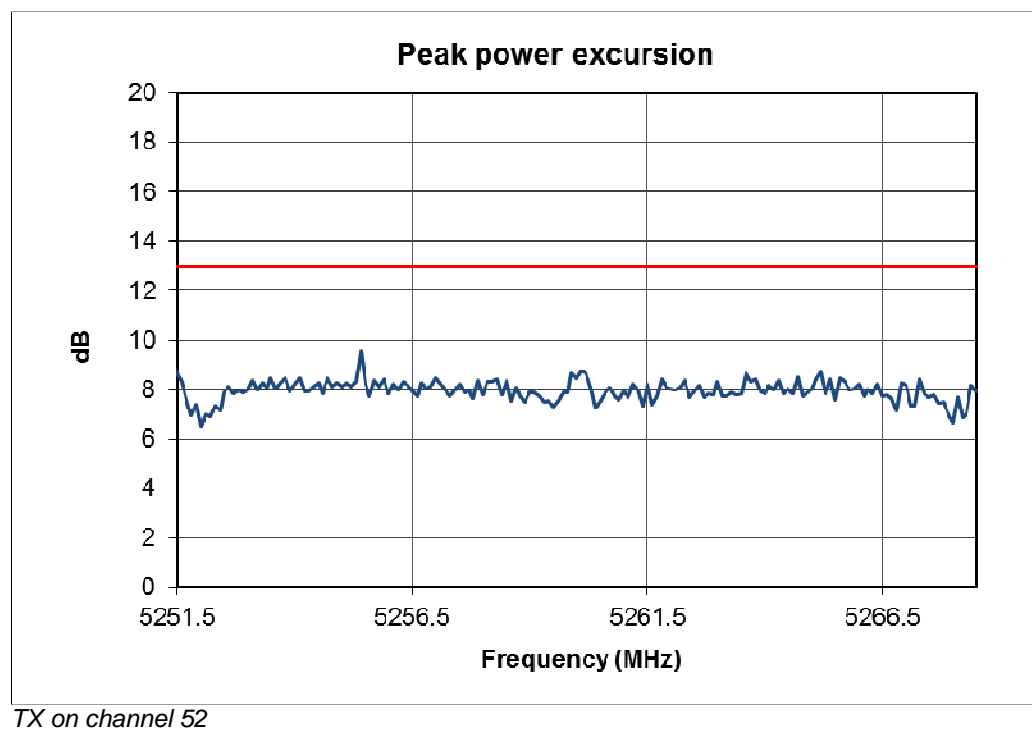
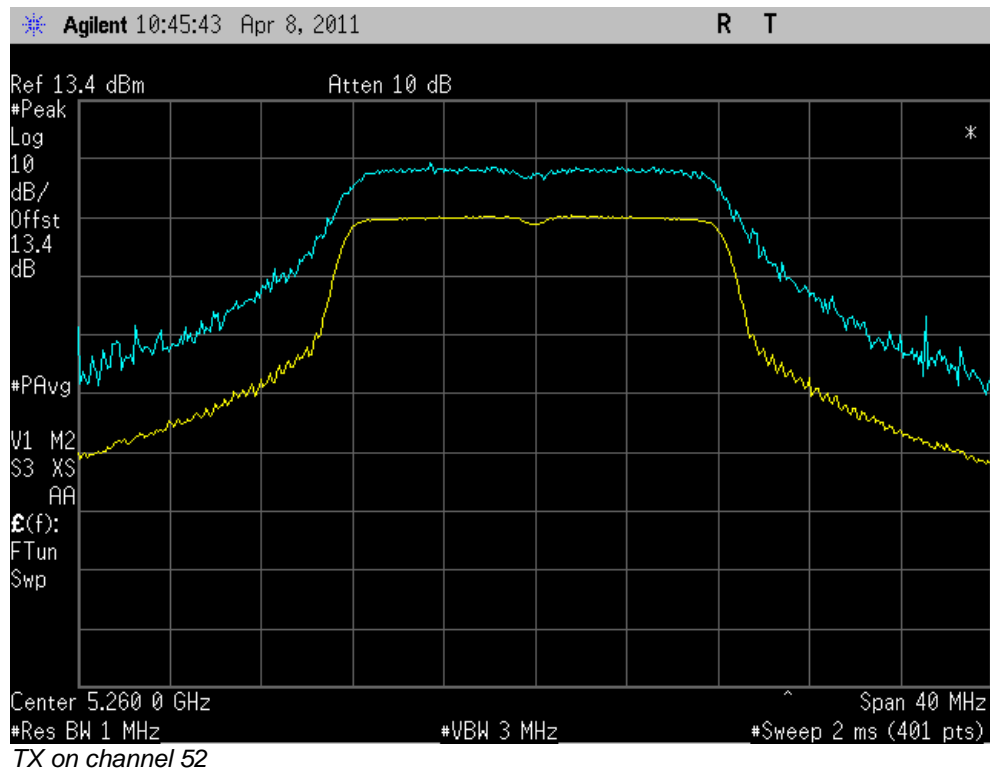
<i>Frequency band, MHz</i>	Limit
5150-5250	< 13 dB
5250-5350	< 13 dB
5725-5805	< 13 dB

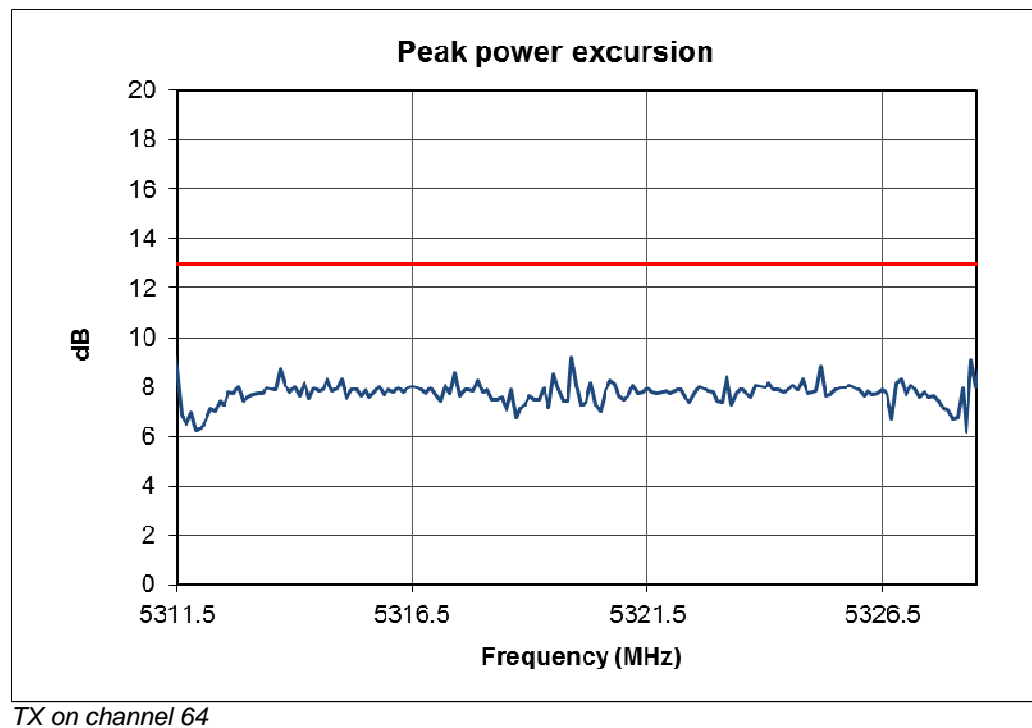
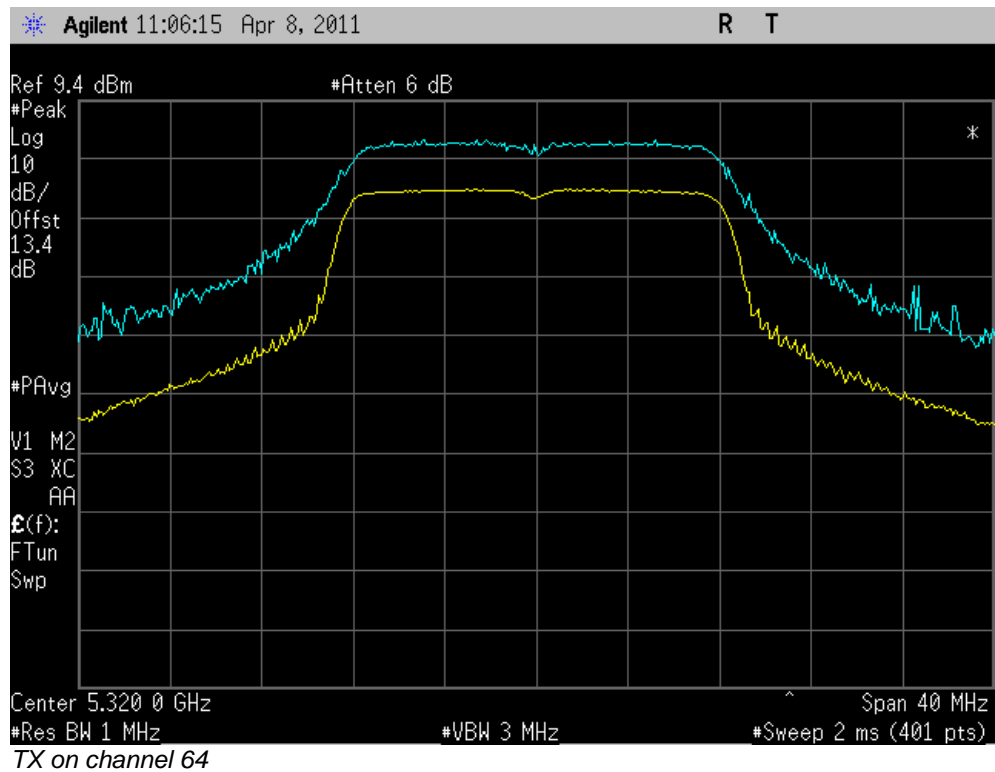
3.6.3 Test data

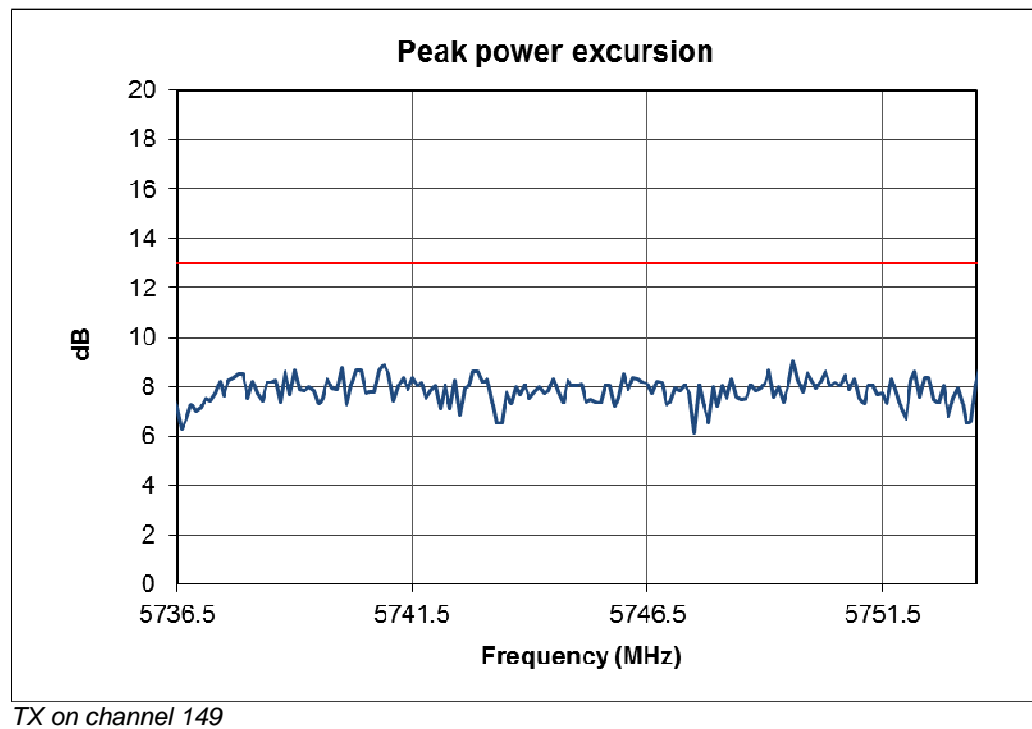
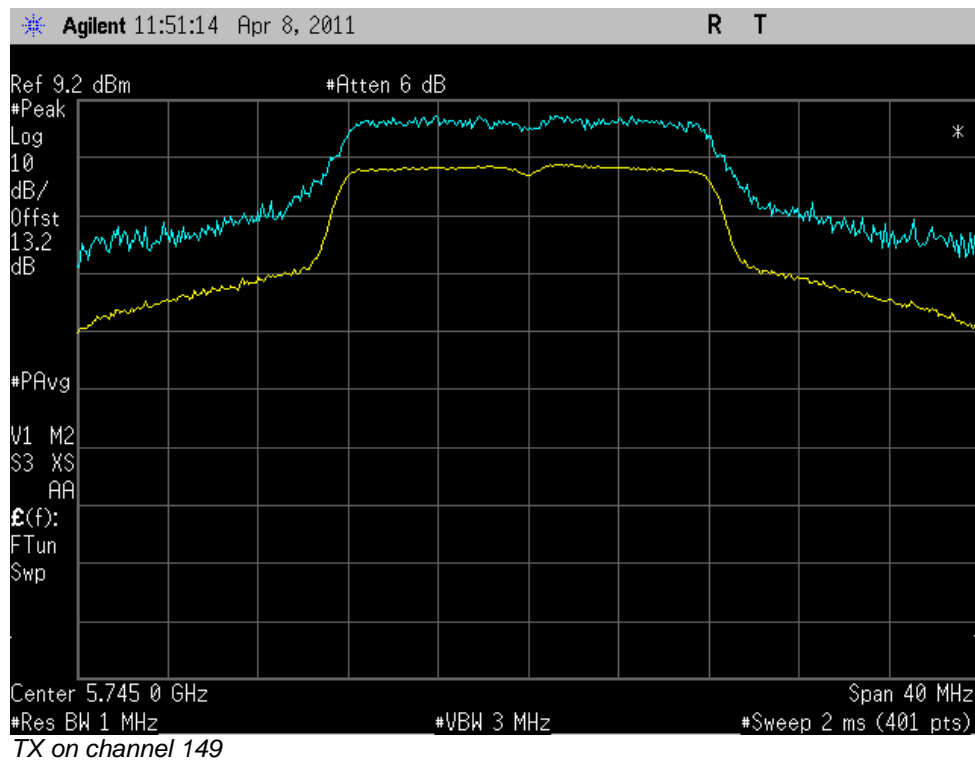
<i>Frequency MHz</i>	<i>Result dB</i>	<i>Limit dB</i>	<i>Margin dB</i>
5180	9.5	13	3.5
5240	9.3	13	3.7
5260	9.5	13	3.5
5320	9.2	13	3.8
5745	8.5	13	4.5
5785	9.5	13	3.5
5805	9.5	13	3.5

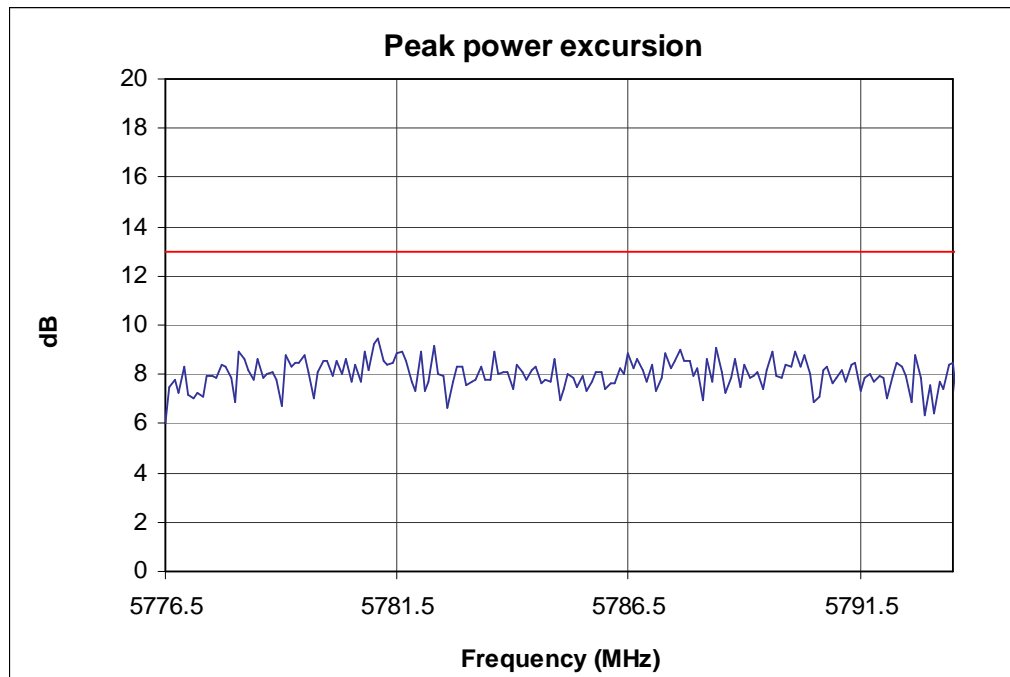
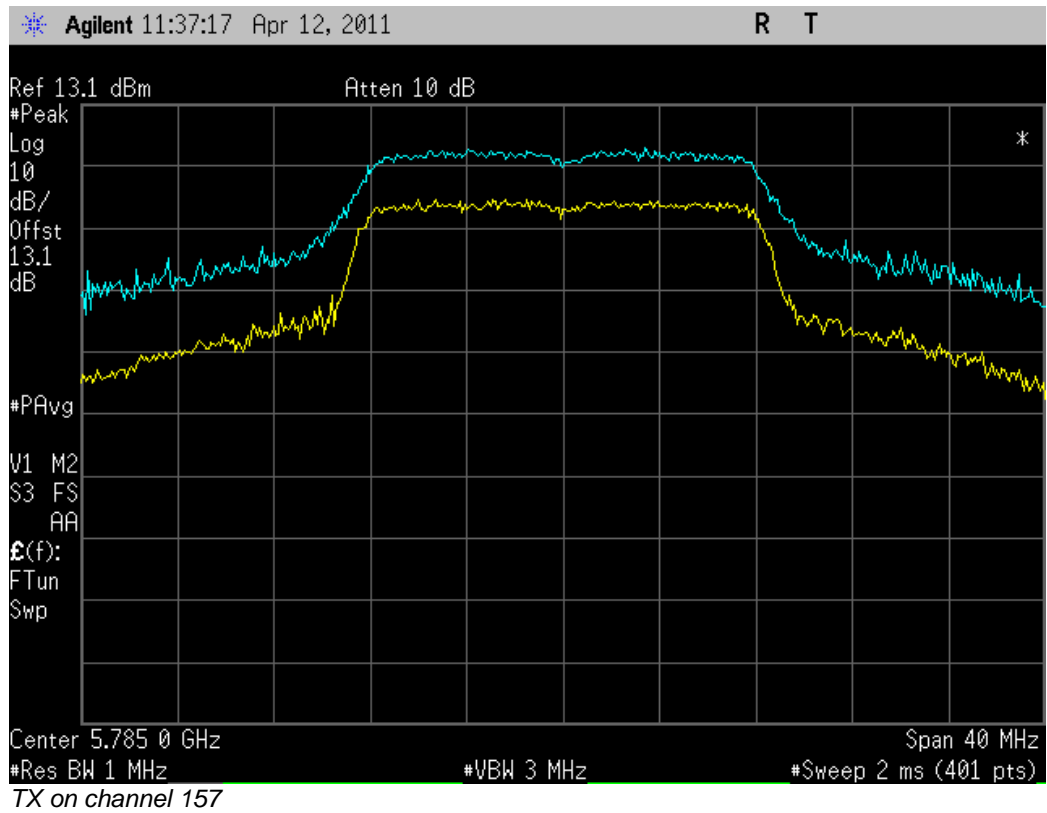




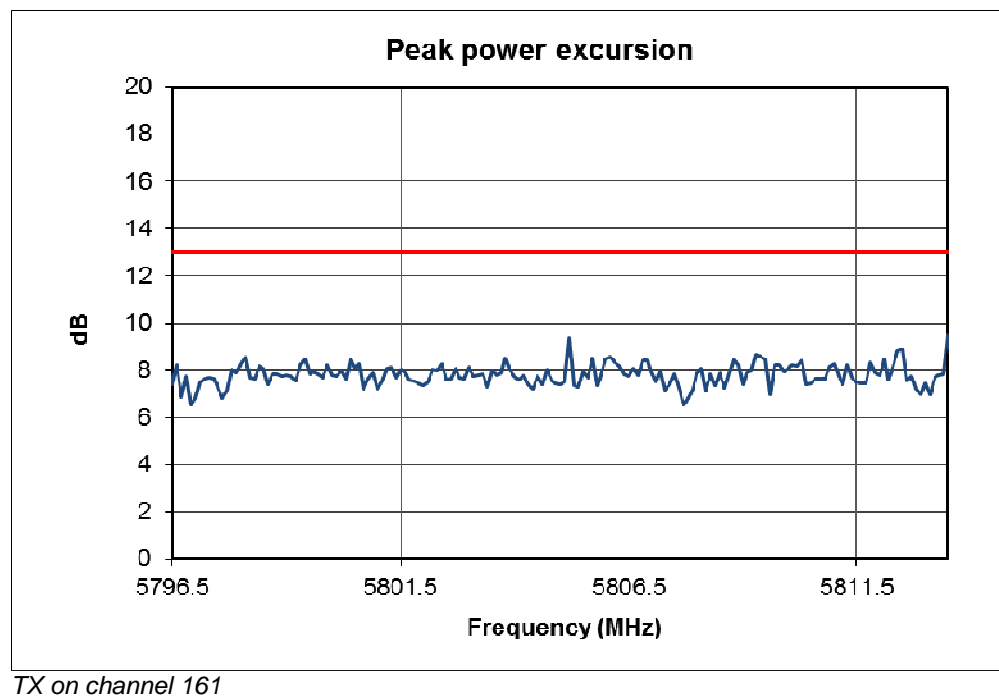
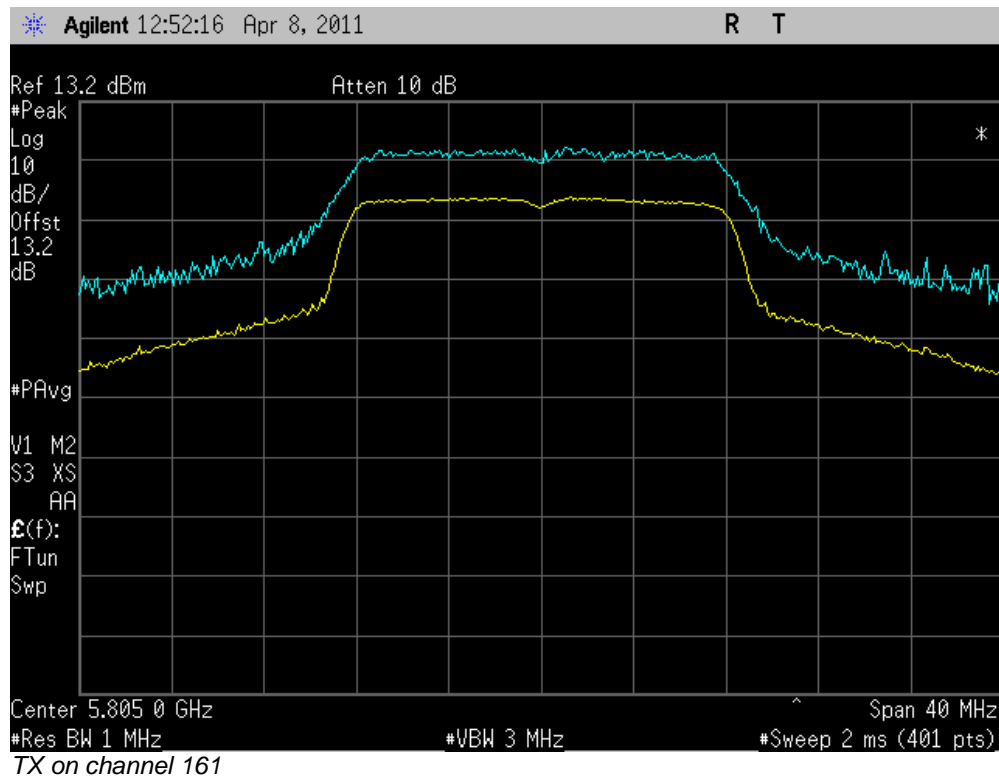








TX on channel 157



3.7 Frequency stability**NAME OF TEST: Frequency Stability****FCC rule part 15.407****TESTED BY: Pekka Kälviäinen****DATE: 03/01/2011****Test Results:** Complies.**Limit:** 0.02%

Test performed at transmitter frequency 5240.0 MHz, channel 48.

Test Data:**a) Frequency stability vs. voltage variations**

Temperature °C	Voltage V	Frequency MHz	Error %	Limit %
20	11.22	5240.033	0.00063	0.02
20	13.20	5240.000	0	0.02
20	15.18	5240.067	0.001279	0.02

b) Frequency stability vs. temperature variations

Temperature °C	Voltage V	Frequency MHz	Error %	Limit %
50	13.2	5240.017	0,000324427	0.02
40	13.2	5240.000	0	0.02
30	13.2	5239.967	0,000629771	0.02
20	13.2	5239.917	0,001583969	0.02
10	13.2	5239.983	0,000324427	0.02
0	13.2	5239.917	0,001583969	0.02
-10	13.2	5240.067	0,001278626	0.02
-20	13.2	5239.967	0,000629771	0.02
-30	13.2	5240	0	0.02

Equipment used: 2046**Measurement
Uncertainty:** ± 0.7 dB.**Temperature:** 23 °C.**Relative
Humidity:** 45 %.

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
66	RF amplifier	5325-507N	Watkins-Johnson	
42	Spectrum analyzer	8566B	Hewlett Packard	2637A04102
338	Test receiver	ESS	Rohde & Schwarz	847151/009
566	Spectrum analyzer	E4448A	Agilent	US42510236
544	RF-amplifier	ZFL-2000VH2	Mini-Circuits	D01080
564	RF amplifier	CA018-4010	CIAO Wireless	101
168	Artificial Mains	NSLK 8127	Schwartzbeck	8127162
559	Highpass filter	WHKX3.0/18G-10ss	Wainwright	1
319	Antenna	CBL6112	Chase	2018
525	Double-Ridged Horn	3115	Emco	6691
348	Shielded room	RFSD-100	Euroshield Oy	1320
350	Semianechoic shielded room	RFD-F-100	Euroshield Oy	1327
371	AC Power source	500i-400	California Instr.	HK 52064
2046	Counter	5351B	Hewlett Packard	2844U00220
2047	Power splitter		Weinschel	
392	RF attenuator PAD	1A (6dB)	Weinschel	-
84	Antenna	643	Narda	7911
88	Antenna	638	Narda	8003
521	Waveguide horn	V637	Narda	9307
710	RF-amplifier	ALS 1826-41-12	ALC Microwave Inc.	0011