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No. 1 / 1**223827B**

Date of handing in: 08.11.2012

Tested by:



Pekka Kälviäinen, Test Engineer

Reviewed by:



Timo Hietala, Test Engineer

SORT OF EQUIPMENT:

Digital hearing aid system

MARKETING NAME:

TYPE:

MANUFACTURER:

DM90**Comfort Audio AB**

CLIENT:

Comfort Audio AB

ADDRESS:

Box 154, SE-30105, Halmstad, Sweden

TELEPHONE:

+46 35 260 16 00

TEST LABORATORY:

Nemko Oy

FCC REG. NO.

359859 October 20, 2011

IC FILE NO.

2040F-1 November 22, 2012**SUMMARY:**

In regard to the performed tests the equipment under test fails 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>Section in RSS-GEN or RSS-210</i>		<i>Result</i>
15.247 (b)(3)	RSS-Gen 4.8 RSS-210 A8.4 (4)	Conducted peak output power	PASS
15.247 (e)	RSS-210 A8.2 (b)	Power Spectral Density	PASS
15.247 (d)	RSS-Gen 4.9 RSS-210 A8.5	Band-edge compliance of RF emissions	PASS
15.247 (d) 15.209 (a)	RSS-Gen 4.9 RSS-210 A8.5	Spurious radiated emissions	PASS
15.207	RSS-Gen 7.2.4	AC power line conducted emissions	PASS
15.247 (a)(2)	RSS-Gen 4.6.2 RSS-210 A8.2 (a)	6 dB bandwidth	PASS
2.1049	RSS-Gen 4.8/4.6.3	20 dB bandwidth	X

CISPR 22		<i>Radiated emissions 30-1000 MHz</i>	PASS, class B
CISPR 22		AC power line conducted emissions	PASS, class B

Explanations:

PASS The EUT passed that particular test.

FAIL The EUT failed that particular test.

X The measurement was done, but there is no applicable performance criteria.

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1. EUT and Accessory Information

1.1 EUT description

Digital hearing aid system.

1.2 EUT and accessories

	<i>unit</i>	<i>type</i>	<i>s/n</i>
<i>EUT1</i>	Digital hearing aid system	DM90	P27
	AC mains charger	FW7600/05	1108B
	External Microphone	-	-
	Neck Loop Cable (long)	K0807	-
<i>EUT2</i>	Digital hearing aid system (with temporary antenna connector)	DM90	P28

Operating voltages

EUT:

DM90: internal re-chargeable Li-ion Battery, 3.7V 650mAh
AC Charger: 115V 60Hz AC

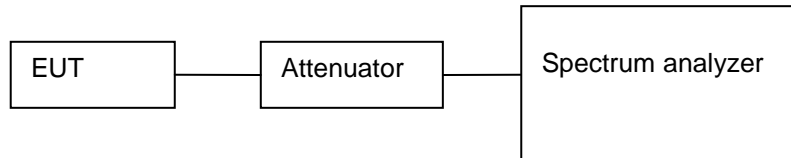
1.3 Additional information related to testing

Tested Technology:	Digital Transmissions system	
Type of Unit	Transmitter	
Modulation:	FSK	
Power Supply Requirement:	Nominal	3.7V
Transmit Frequency Range	902 MHz to 928 MHz	
Transmit Channels Tested:	Channel Number	Channel Frequency (MHz)
	1	904.65
	19	915.45
	38	926.85

2. Test setups

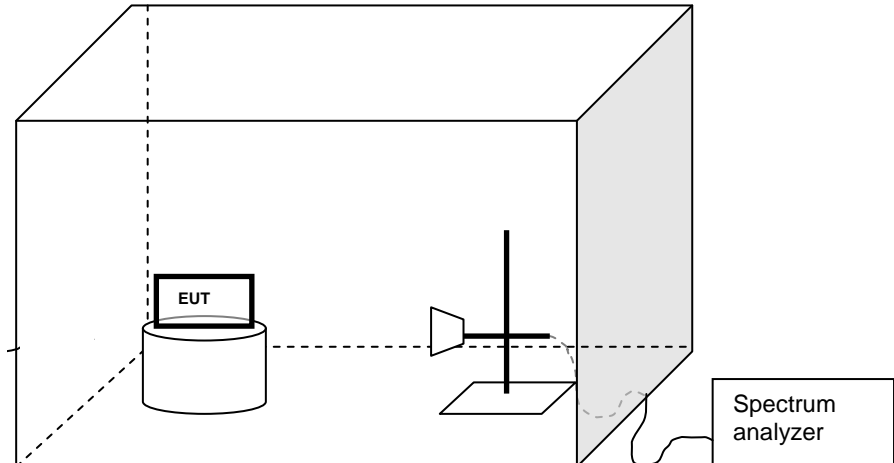
Setup 1 (Conducted measurements)

The test was performed inside a shielded room. The antenna port of the EUT was connected via an attenuator to the spectrum analyzer.



Setup 2 (Radiated measurements)

The test was performed inside a semi anechoic shielded room. For the duration of the test the EUT was placed on a non-conductive support 0.8 m high standing on the turntable. The tower and turn table were remotely controlled to turn the EUT and change the antenna polarization. The measured signal was routed from the measuring antenna to the spectrum analyzer.



3. Standards and measurement methods

The test were performed in guidance of the CFR 47, FCC Rules Part 15 Subpart C, CISPR 22 Ed. 6.0, ANSI C63.10 (2009), KDB 558074 D01 DTS Meas Guidance v02 "Digital Transmission Systems (DTS) Operating under Section 15.247" 10/4/2012, IC standards RSS-GEN (Issue 3, December 2010) and RSS-210 (Issue 8, December 2010).

4. Test results

4.1 Conducted peak output power

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

<i>EUT</i>	EUT2, setup 1
<i>Site name</i>	Nemko Oy / Perkkaa
<i>FCC rule part</i>	§ 15.247 (b)(3)
<i>Section in RSS-210</i>	A8.4 (4)
<i>Date of testing</i>	22.11.2012
<i>Test equipment</i>	566, 377
<i>Test conditions</i>	22 °C, 31 % RH

4.1.1 EUT operation mode

<i>EUT operation mode</i>	Transmitter on
<i>EUT channel</i>	1, 19 and 38

4.1.2 Test method and limit

The measurement is made according to ANSI C63.10 Section 6.10.1

<i>Frequency range (MHz)</i>	<i>Limit (W)</i>	<i>Limit (dBm)</i>
902 – 928	≤ 1.0	≤ 30

4.1.3 Test results

<i>Channel / f (MHz)</i>	<i>P (dBm)</i>	<i>Result</i>
1 / 904.65	-0.76	PASS
19 / 914.45	2.27	PASS
38 / 926.85	2.83	PASS

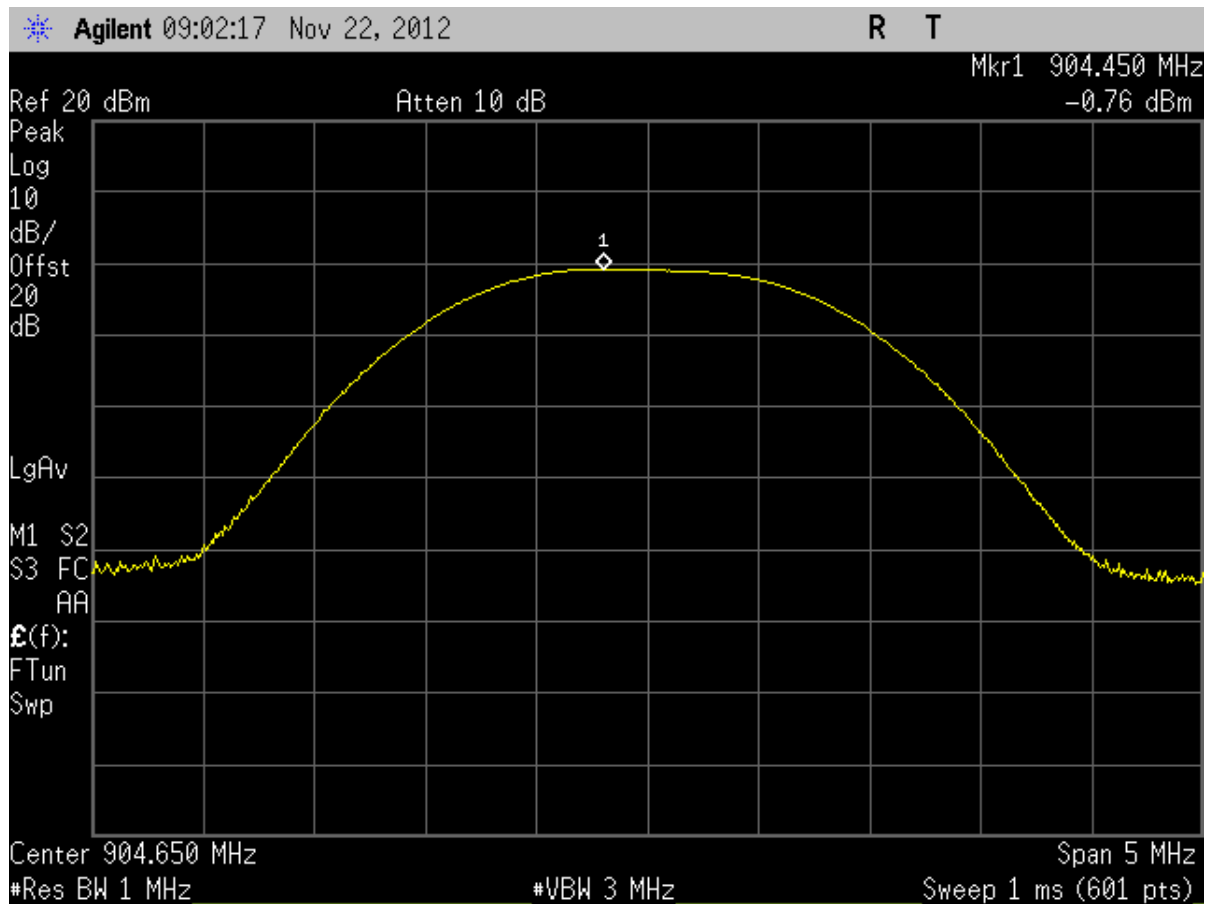


Figure 1. channel 1, conducted peak output power

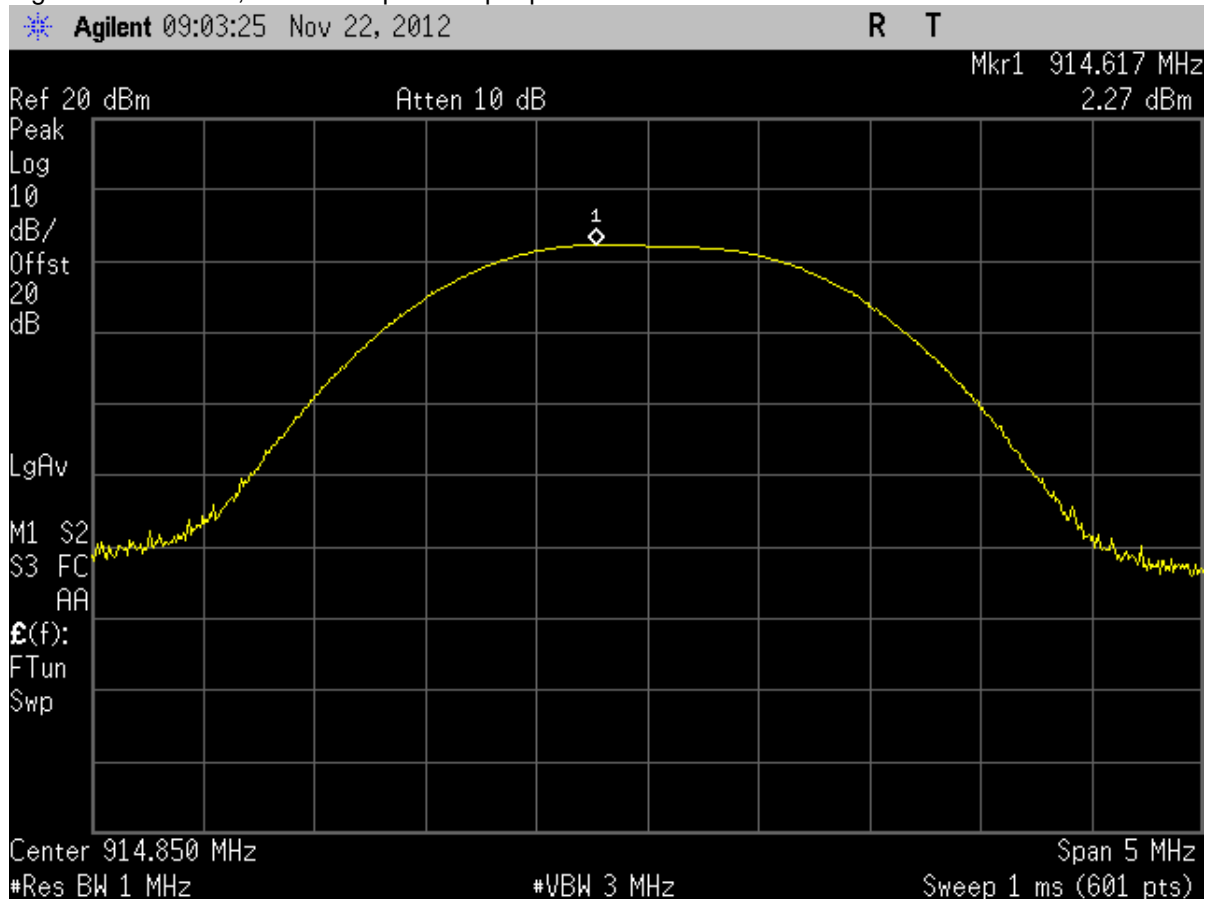
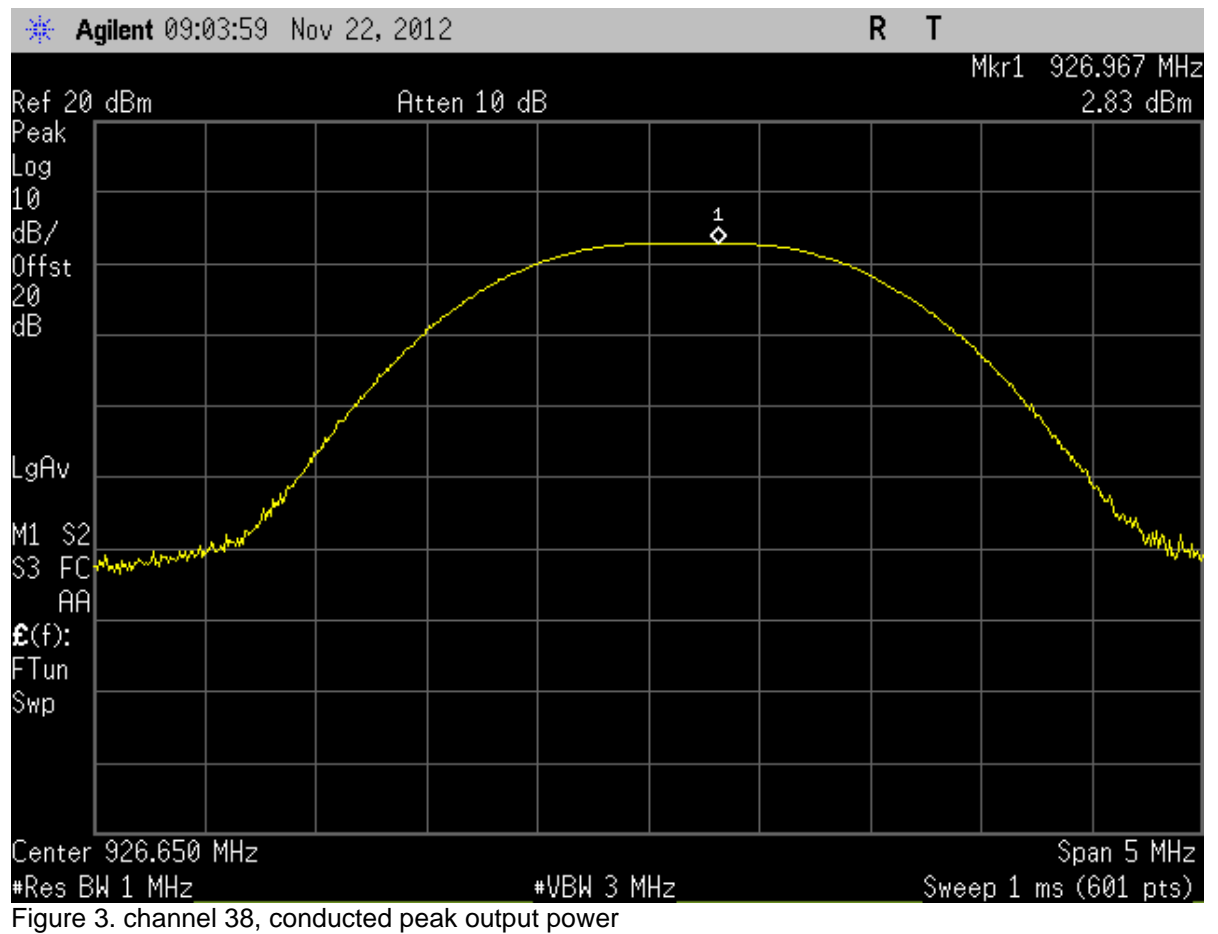


Figure 2. channel 19, conducted peak output power



4.2 Power Spectral Density

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

<i>EUT</i>	EUT2, setup 1
<i>Site name</i>	Nemko Oy / Perkkaa
<i>FCC rule part</i>	§ 15.247 (e)
<i>Date of testing</i>	13.12.2012
<i>Test equipment</i>	566, 377
<i>Test conditions</i>	22 °C, 31 % RH

4.2.1 EUT operation mode

<i>EUT operation mode</i>	Transmitter on
<i>EUT channel</i>	1, 19 and 38

4.2.2 Test method and limit

The measurement is made according to ANSI C63.10 Section 6.11.2

<i>Frequency range (MHz)</i>	<i>Limit (dBm/3kHz)</i>
902 – 928	≤ 8

4.2.3 Test results

<i>Channel / f (MHz)</i>	<i>P (dBm/3kHz)</i>	<i>Result</i>
1 / 904.65	-5.30	PASS
19 / 914.45	-2.37	PASS
38 / 926.85	-1.78	PASS

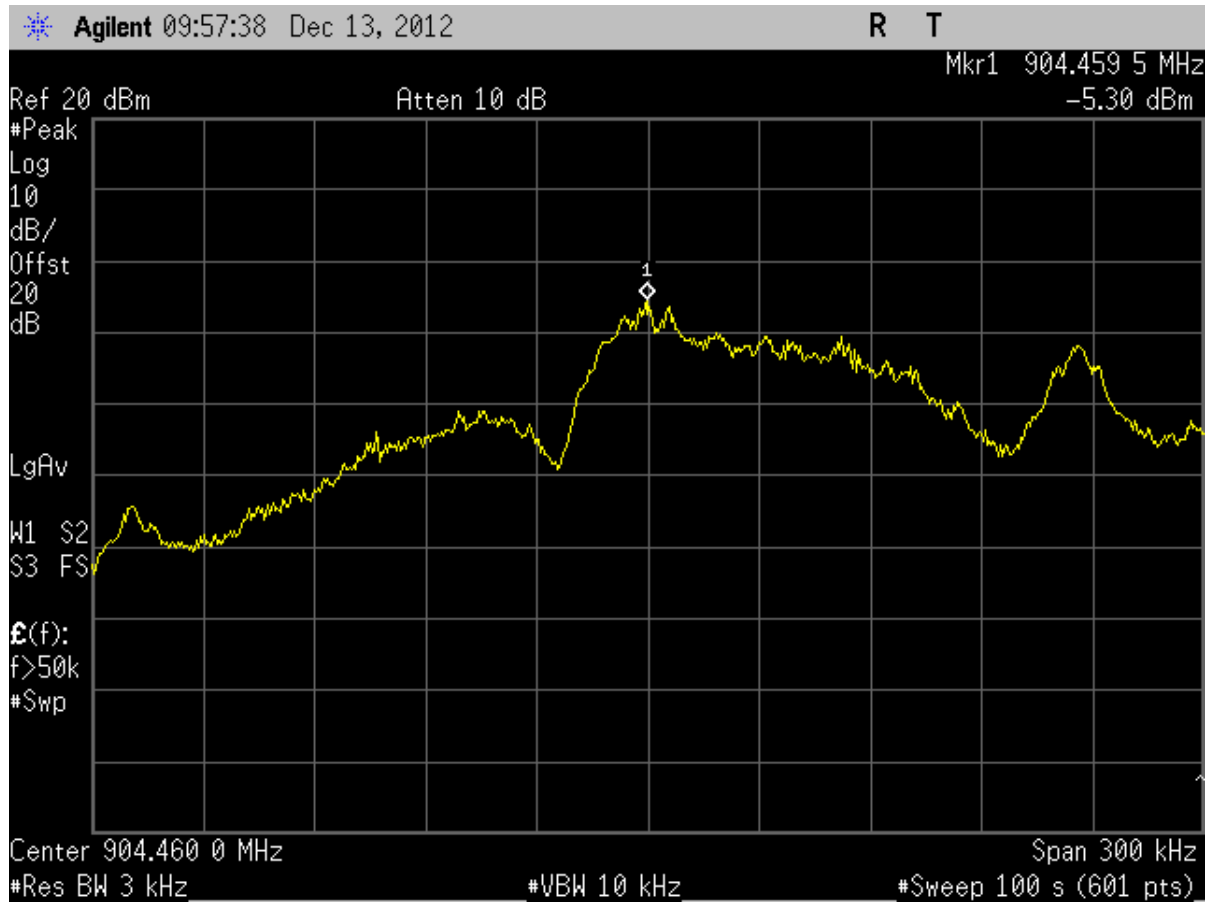


Figure 4. channel 1, power spectral density

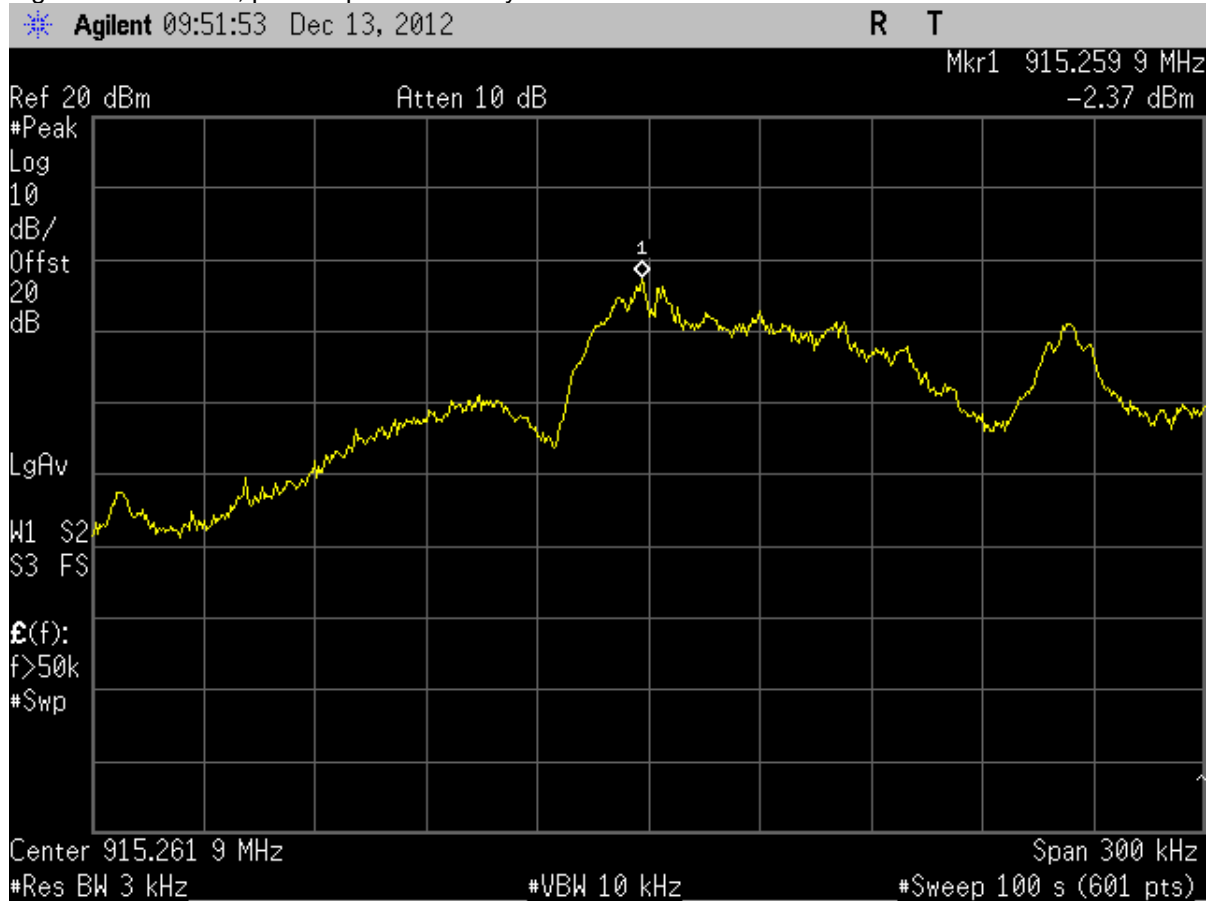


Figure 5. channel 19, power spectral density

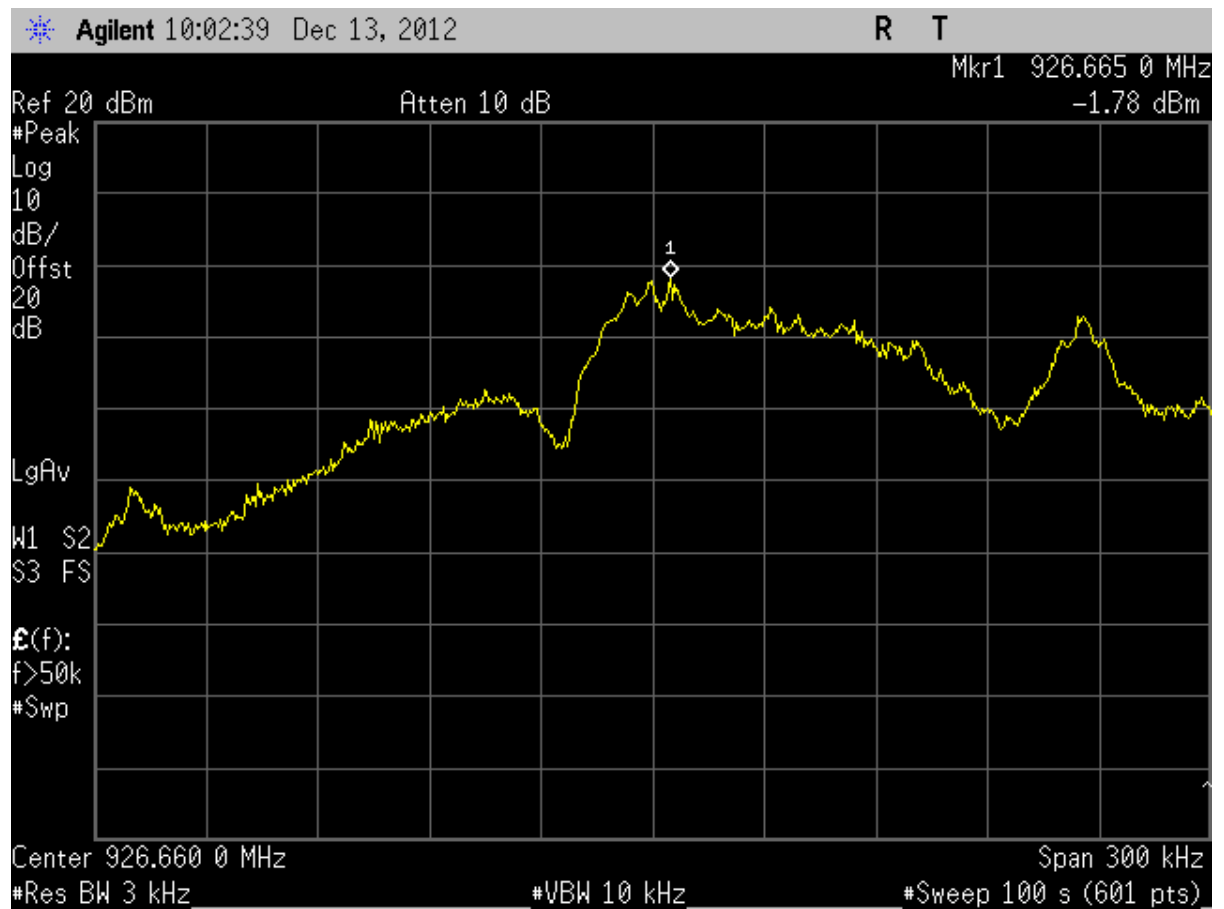


Figure 6. channel 38, power spectral density

4.3 Band-edge compliance of RF emissions

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

<i>EUT</i>	EUT1, setup 2
<i>Site name</i>	Nemko Oy / Perkkää
<i>FCC rule part</i>	§ 15.247 (d)
<i>Date of testing</i>	17.12.2012
<i>Test equipment</i>	566, 546, 525, 564, 350
<i>Test conditions</i>	22 °C, 30 % RH

4.3.1 EUT operation mode

<i>EUT operation mode</i>	Transmitter on
<i>EUT channel</i>	1 and 38

4.3.2 Test method and limit

The measurement is made according to ANSI C63.10 Section 6.9.2.

3m measurement distance

<i>Frequency range (MHz)</i>	<i>Limit (dBc)</i>
Below 902 and above 928	≤ -20

The measurement results were obtained as described below.

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

Where

U_{RX} receiver reading

A_{CABLE} attenuation of the cable

AF antenna factor

G_{PREAMP} gain of the preamplifier

4.3.3 Test results

Channel 1:

Below 902 MHz:

<i>Detector (RBW: 100kHz)</i>	<i>P (dBc)</i>	<i>Result</i>
Peak	-48.95	PASS

Channel 38:

Above 928 MHz:

<i>Detector (RBW: 100kHz)</i>	<i>P (dBc)</i>	<i>Result</i>
Peak	-41.49	PASS

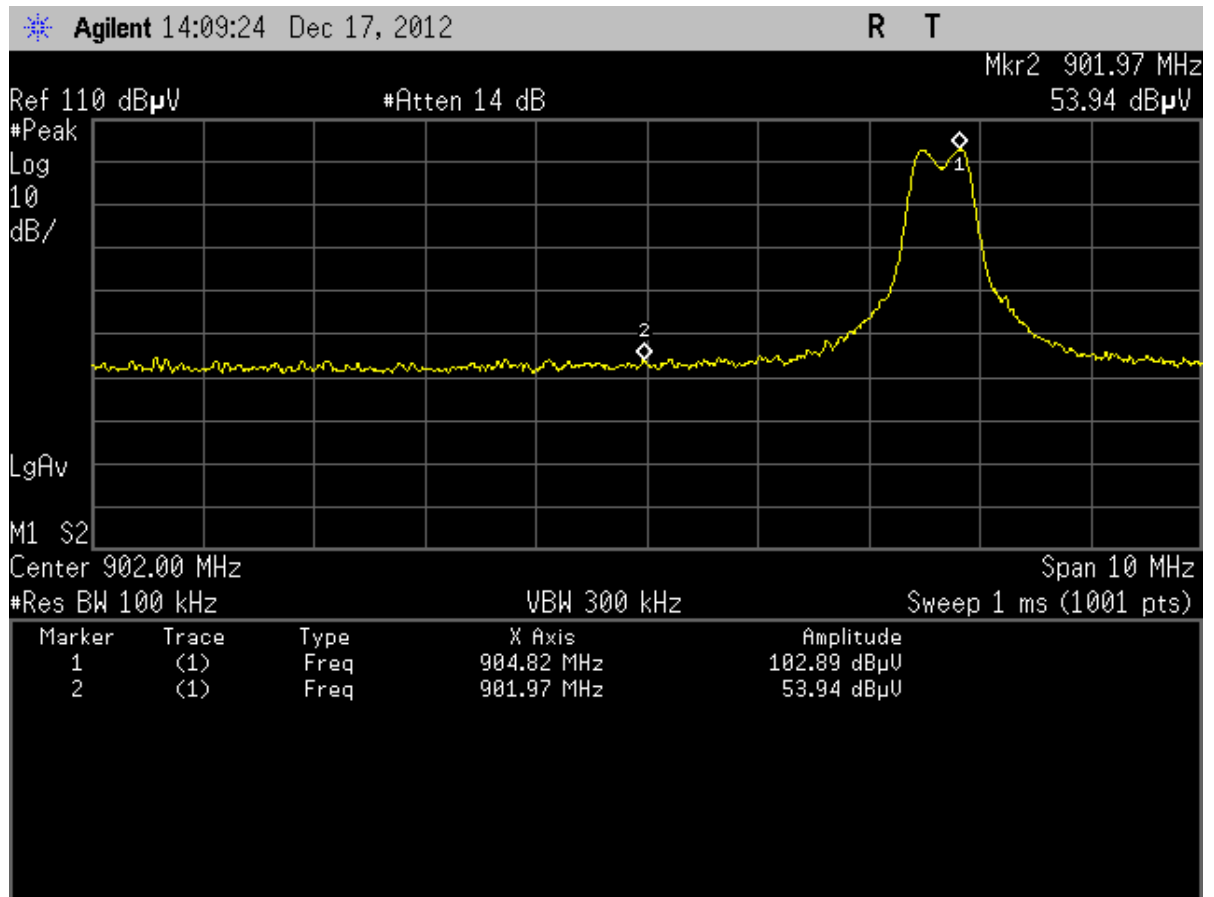


Figure 7. Channel 1, Band-edge compliance, low end

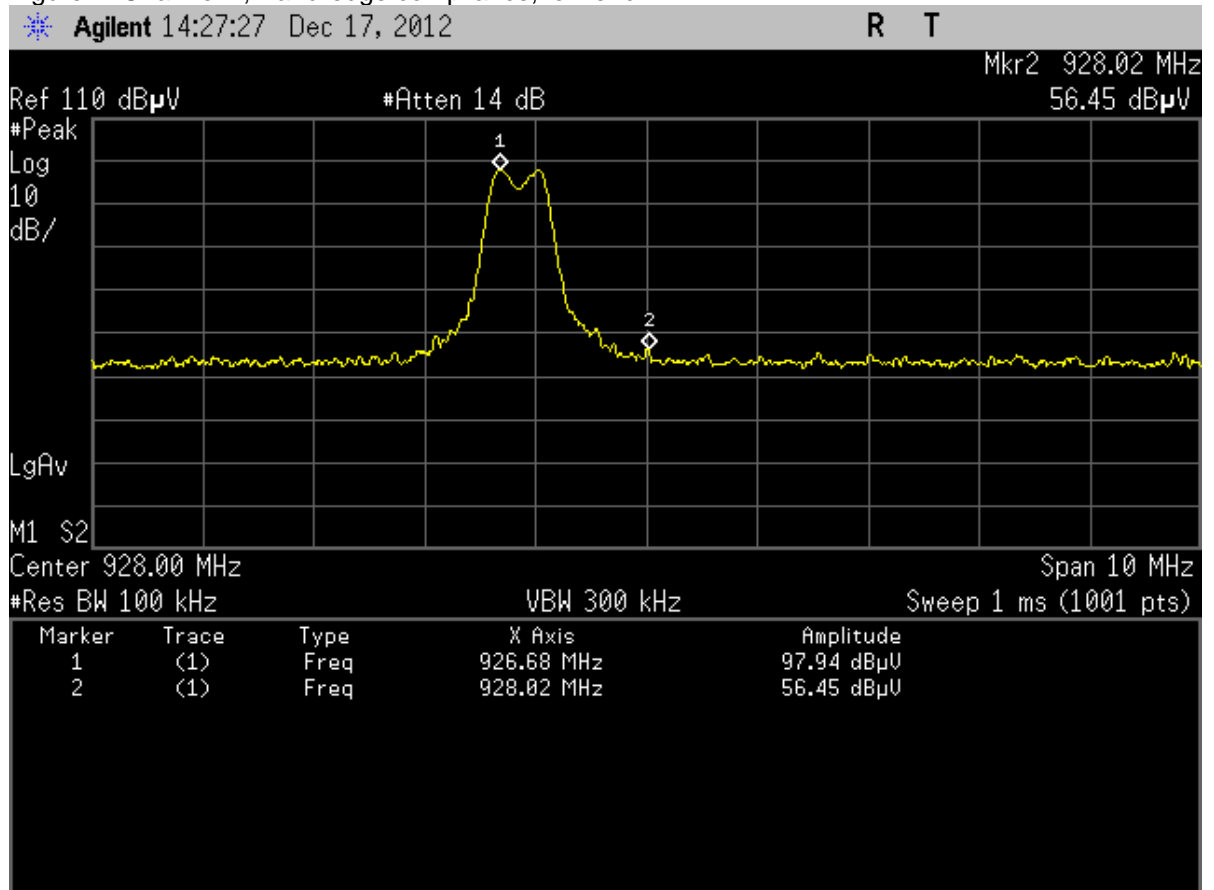


Figure 8. Channel 38, Band-edge compliance, high end

4.4 Spurious radiated emission

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

<i>EUT</i>	EUT1, setup 2
<i>Site name</i>	Nemko Oy / Perkkaa
<i>FCC rule part</i>	§ 15.247 (d), § 15.209 (a)
<i>Date of testing</i>	07.12.2012 and 18.12.2012
<i>Test equipment</i>	566, 709, 564, 572, 525, 319, 544, 393, 350
<i>Test conditions</i>	22 °C, 31 % RH

4.4.1 EUT operation mode

<i>EUT operation mode</i>	Transmitter on
<i>EUT channel</i>	Channel 1, 19 and 38
<i>EUT operation voltage</i>	115 V / 60 Hz

4.4.2 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 the distance from the EUT to the measuring antenna was 3 m. The excess length of the cables of the EUT were made into bundles 30-40 cm in length (see photograph 1). 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.

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

Vertical and horizontal polarizations in the frequency range 1000 – 9300 MHz was measured by using the peak detector. During the peak detector scan. the turntable was rotated from 0° to 360° with 15° step with the antenna heights 1.0 m, 1,5m, 2.0m, 2,5m and 3.0 m. The highest levels of the radiated interference field strength measured by using the average and peak detectors were recorded.

Minimum Standard: In any 100kHz bandwidth outside the frequency band in which the transmitter is operating, emissions shall be at least 20 dB below the fundamental emission or shall not exceed the following field strength limits:

Emissions falling in the restricted bands of 15.205 shall not exceed the limits shown in §15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in §15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in §15.209 shall be demonstrated based on the average value of the measured emissions.

3m measuring distance

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

<i>Frequency band MHz</i>	<i>limit, average detector dB(μV/m)</i>	<i>limit, peak detector dB(μV/m)</i>
1000 - 9300	54	74

3m measuring distance, CISPR 22, class B

<i>Frequency band MHz</i>	<i>limit, Quasi peak detector dB(μV/m)</i>
30 - 230	40
230 - 1000	47

The EUT was tested on three orthogonal axis.

The device was tested from 30 MHz to the tenth harmonic of the highest fundamental frequency per 15.33.

The device was tested on three channels per 15.31(l).

Duty Cycle Calculation:

Duty Cycle correction factor(dB) = 20 log (rf_{ON} in ms/100ms)
rf_{ON} > 100ms, correction factor was not used.

The CFR 47 Part 15. Subpart B. Class B limit of 500 μV/m has been calculated to correspond 54 dB(μV/m) as follows: [dB(μV/m)]=20log[μV/m].

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

4.4.3 Test results

Below 1GHz, Channel 19 (bw120kHz)

<i>Frequency MHz</i>	<i>Quasi peak dB(μV/m)</i>	<i>Limit dB(μV/m)</i>	<i>Margin dB</i>	<i>Result</i>
30.18	34.9	40	5.1	PASS
31.10	36.2	40	3.8	PASS
33.71	35.0	40	5.0	PASS
34.190	34.8	40	5.2	PASS

Above 1GHz, Channel 1

<i>Frequency GHz</i>	<i>Peak dB(μV/m)</i>	<i>Limit dB(μV/m)</i>	<i>Margin dB</i>	<i>Result</i>
1809.30	57.91	82.89*)	24.98	PASS
5427.90	49.58	74	24.42	PASS

*) -20dBc, fundamental on page 14, figure 7

Above 1GHz, Channel 1

<i>Frequency GHz</i>	<i>Average dB(μV/m)</i>	<i>Limit dB(μV/m)</i>	<i>Margin dB</i>	<i>Result</i>
5427.90	37.04	54	16.96	PASS

Above 1GHz, Channel 19

<i>Frequency GHz</i>	<i>Peak dB(μV/m)</i>	<i>Limit dB(μV/m)</i>	<i>Margin dB</i>	<i>Result</i>
1830.90	56.05	80.15**)	24.10	PASS
all others	-	74	>20	PASS

**) -20dBc, fundamental 100.15dB(μV/m)

Above 1GHz, Channel 19

<i>Frequency GHz</i>	<i>Average dB(μV/m)</i>	<i>Limit dB(μV/m)</i>	<i>Margin dB</i>	<i>Result</i>
all	-	54	>20	PASS

Above 1GHz, Channel 38

<i>Frequency GHz</i>	<i>Peak dB(μV/m)</i>	<i>Limit dB(μV/m)</i>	<i>Margin dB</i>	<i>Result</i>
1853.70	53.38	77.94 ***)	24.56	PASS
all others	-	74	>20	PASS

***) -20dBc, fundamental on page 14, figure 8

Above 1GHz, Channel 38

<i>Frequency GHz</i>	<i>Average dB(μV/m)</i>	<i>Limit dB(μV/m)</i>	<i>Margin dB</i>	<i>Result</i>
all	-	54	>20	PASS

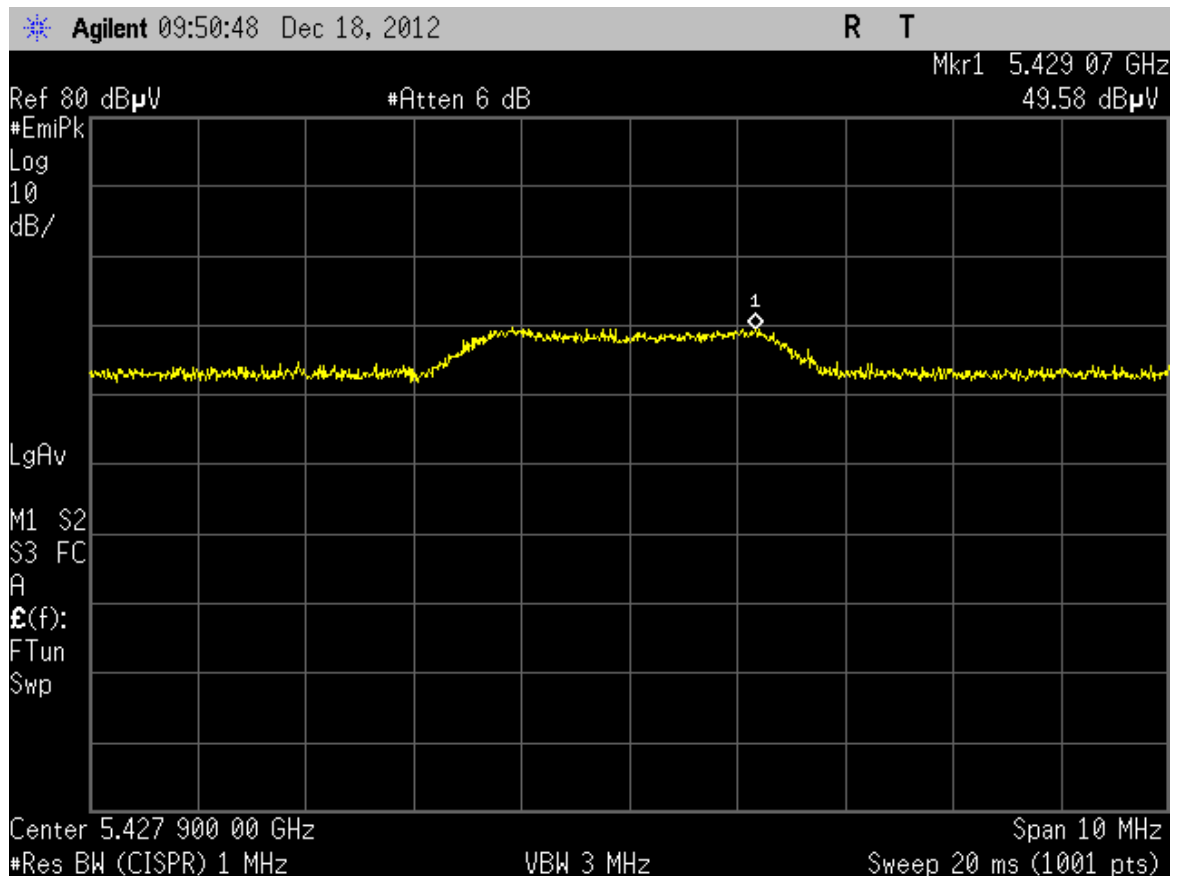


Figure 9. channel 1, spurious RF radiated emission, peak

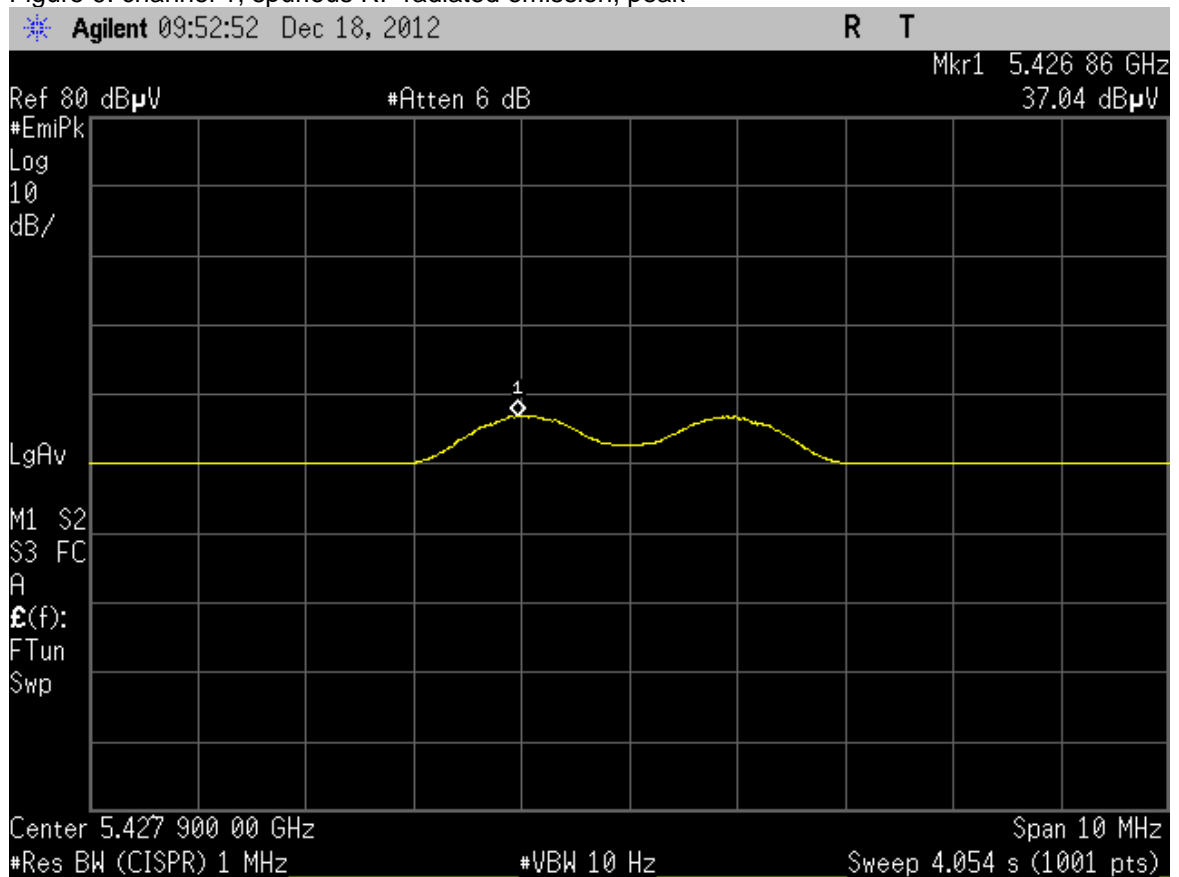


Figure 10. channel 1, spurious RF radiated emission, average

4.5 AC power line conducted emissions

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

<i>EUT</i>	EUT1, setup 2
<i>Site name</i>	Nemko / Perkkaa
<i>FCC rule part</i>	§ 15.207 / CISPR 22
<i>Date of testing</i>	07.12.2012
<i>Test equipment</i>	745, 348, 338
<i>Test conditions</i>	22 °C, 30 % RH

4.5.1 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 (see photograph 2). The excess length of the cables of the EUT were made into bundles 30-40 cm in length. 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.

CISPR 22, class B limits

<i>Frequency band MHz</i>	<i>Quasi-peak 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

4.5.2 EUT operation mode

<i>EUT operation mode</i>	Transmitter on
<i>EUT channel</i>	19
<i>EUT operation voltage</i>	115 V / 60 Hz

4.5.3 Test results

Line N

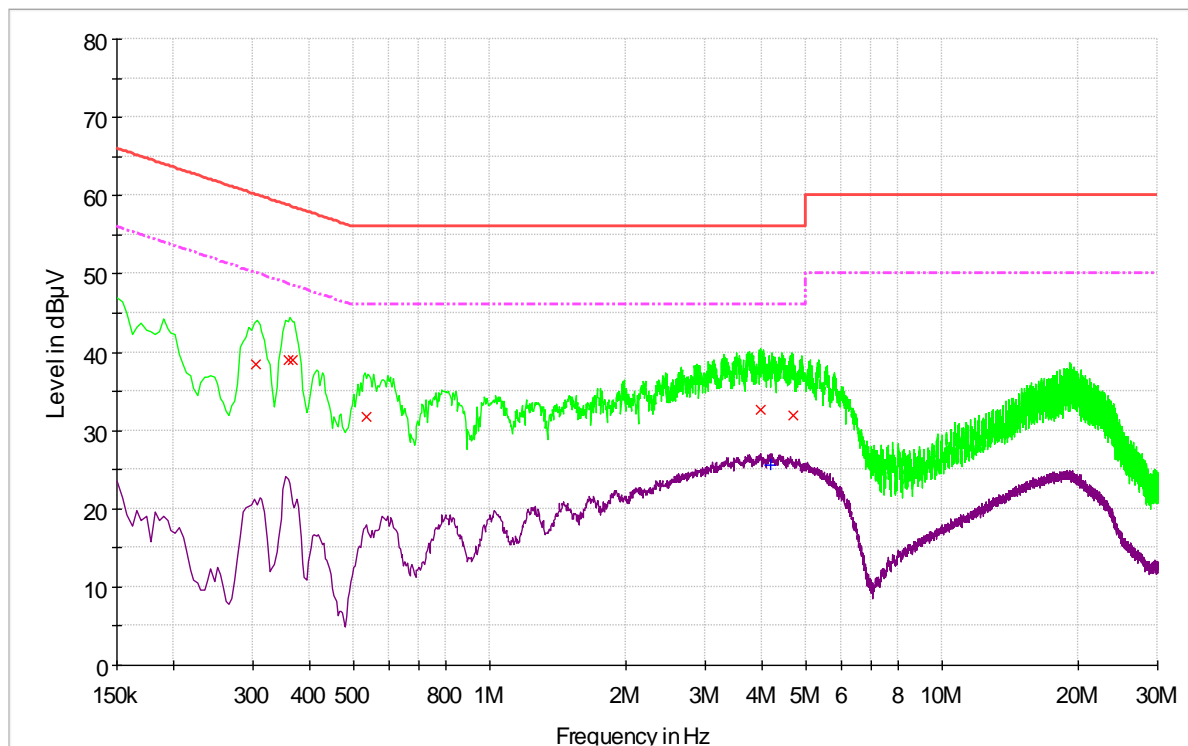


Figure 15. AC powerline emissions, Line N

Highest emissions (bw 10kHz):

Frequency MHz	Quasi-peak dB(μV)	Limit value dB(μV)	Margin dB	Result
0.3050	38.4	60.1	21.7	Pass
0.360	39.0	58.7	19.8	Pass
0.366	39.0	58.6	19.6	Pass
0.534	31.7	56.0	24.3	Pass
3.987	32.7	56.0	23.3	Pass
4.677	31.8	56.0	24.2	Pass

Frequency MHz	Average dB(μV)	Limit value dB(μV)	Margin dB	Result
4.193	25.5	46.0	20.5	Pass

Line L

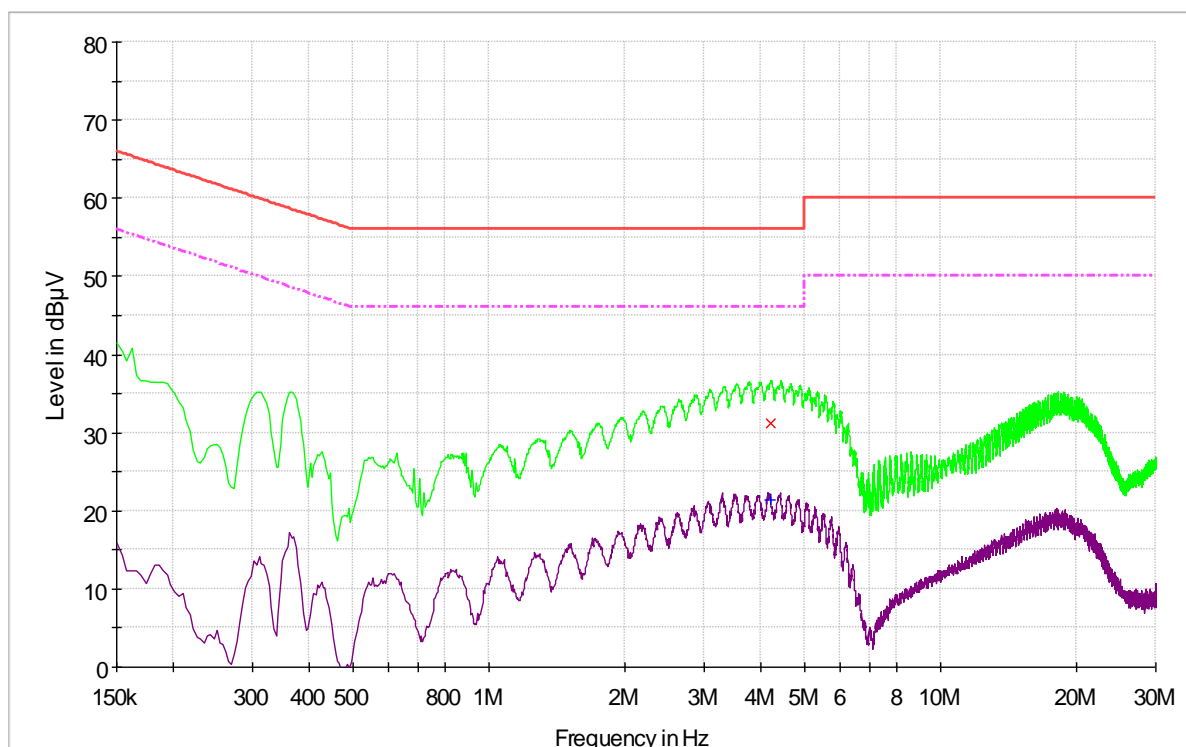


Figure 16. AC powerline emissions, Line L

Highest emissions (bw 10kHz):

Frequency MHz	Quasi-peak dB(μV)	Limit value dB(μV)	Margin dB	Result
4.218	31.2	56.0	24.8	Pass

Frequency MHz	Average dB(μV)	Limit value dB(μV)	Margin dB	Result
4.218	21.4	46.0	24.6	Pass

4.6 6 dB bandwidth

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

<i>EUT</i>	EUT2, setup 1
<i>Site name</i>	Nemko Oy / Perkkaa
<i>FCC rule part</i>	§ 15.247 (a)(2)
<i>Date of testing</i>	11.2.2013
<i>Test equipment</i>	566, 377
<i>Test conditions</i>	22 °C, 31 % RH

4.6.1 EUT operation mode

<i>EUT operation mode</i>	Transmitter on
<i>EUT channel</i>	1, 19 and 38

4.6.2 Test method and limit

The measurement is made according to ANSI C63.10 Section 6.9.1 referencing KDB 558074 D01 DTS Meas Guidance v02 "Digital Transmission Systems (DTS) Operating under Section 15.247" 10/4/2012, 7.2 option 2

<i>Limit (kHz)</i>
≥500

4.6.3 Test results

<i>EUT Channel / f (MHz)</i>	<i>6 dB bandwidth (kHz)</i>
1 / 904.65	510.170
19 / 915.45	509.882
38 / 926.85	510.066

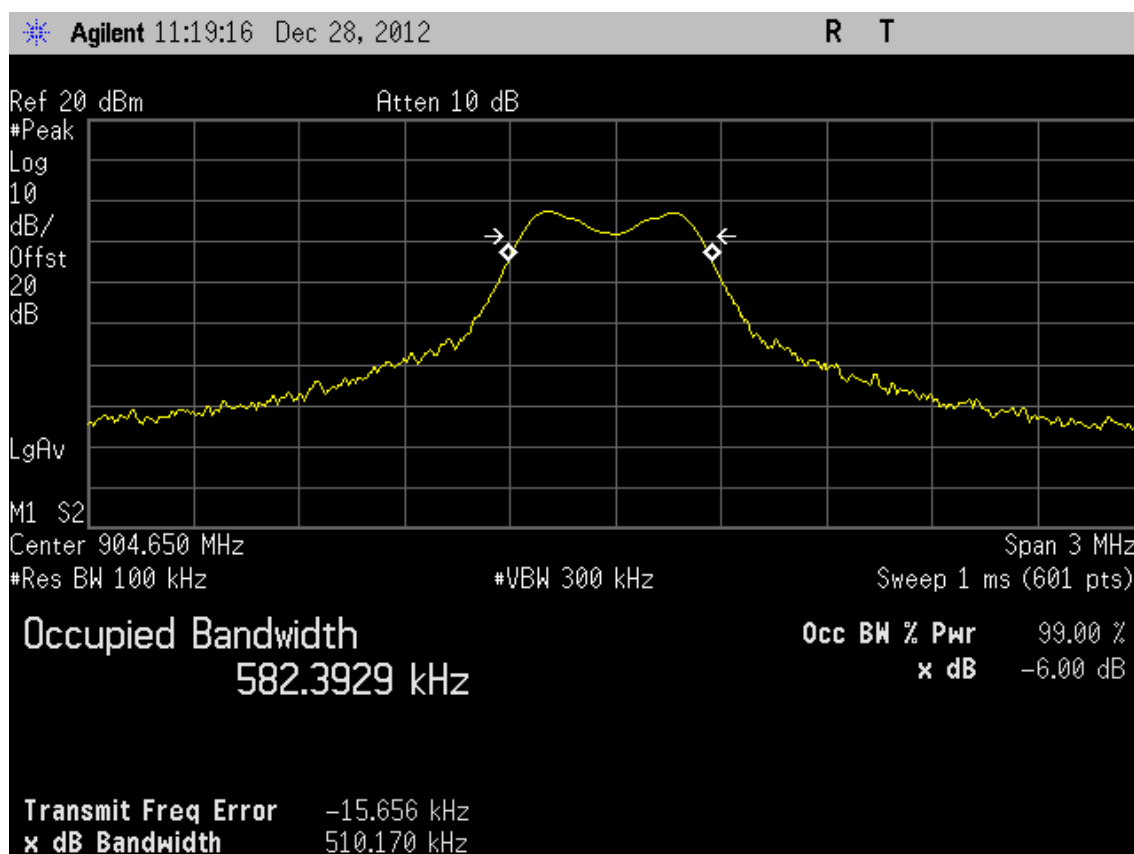


Figure 17. channel 1, 6 dB bandwidth

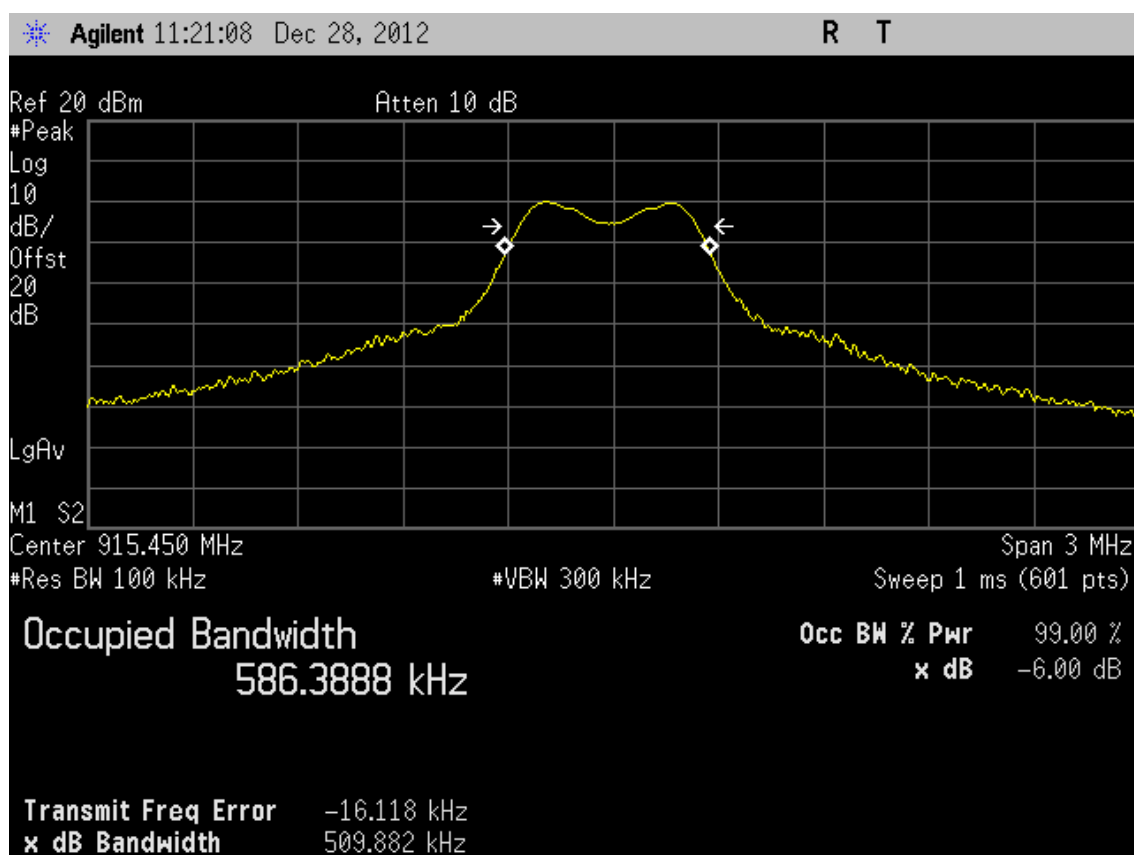


Figure 18. channel 19, 6 dB bandwidth

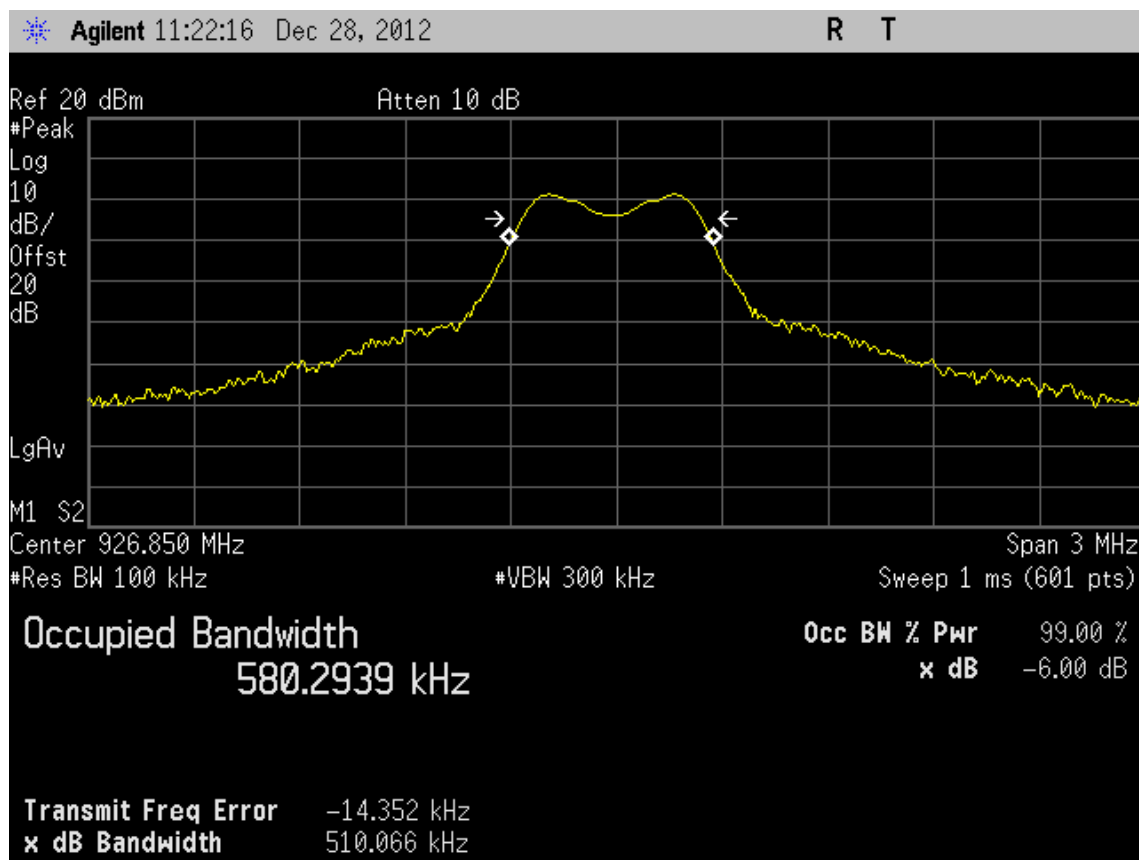


Figure 19. channel 38, 6 dB bandwidth

4.7 20 dB bandwidth

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

<i>EUT</i>	EUT2, setup 1
<i>Site name</i>	Nemko Oy / Perkkaa
<i>FCC rule part</i>	§ 2.1049
<i>Date of testing</i>	11.2.2013
<i>Test equipment</i>	566, 377
<i>Test conditions</i>	22 °C, 31 % RH

4.7.1 EUT operation mode

<i>EUT operation mode</i>	Transmitter on
<i>EUT channel</i>	1, 19 and 38

4.7.2 Test method and limit

The measurement is made according to ANSI C63.10 Section 6.9.1 referencing KDB 558074 D01 DTS Meas Guidance v02 "Digital Transmission Systems (DTS) Operating under Section 15.247" 10/4/2012, 7.2 option 2

<i>Limit (kHz)</i>
N/A

4.7.3 Test results

<i>EUT Channel / f (MHz)</i>	<i>20 dB bandwidth (kHz)</i>
1 / 904.65	527
19 / 915.45	523
38 / 926.85	520

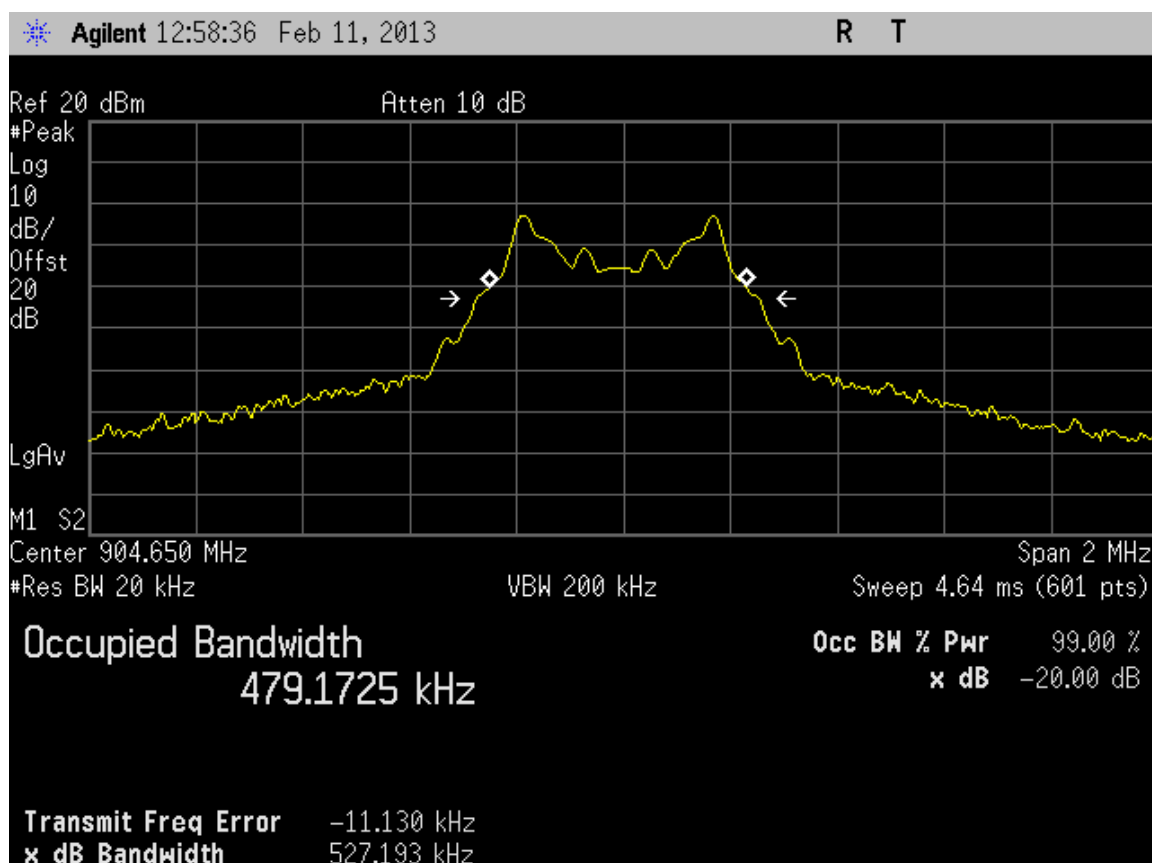


Figure 17. channel 1, 20 dB bandwidth

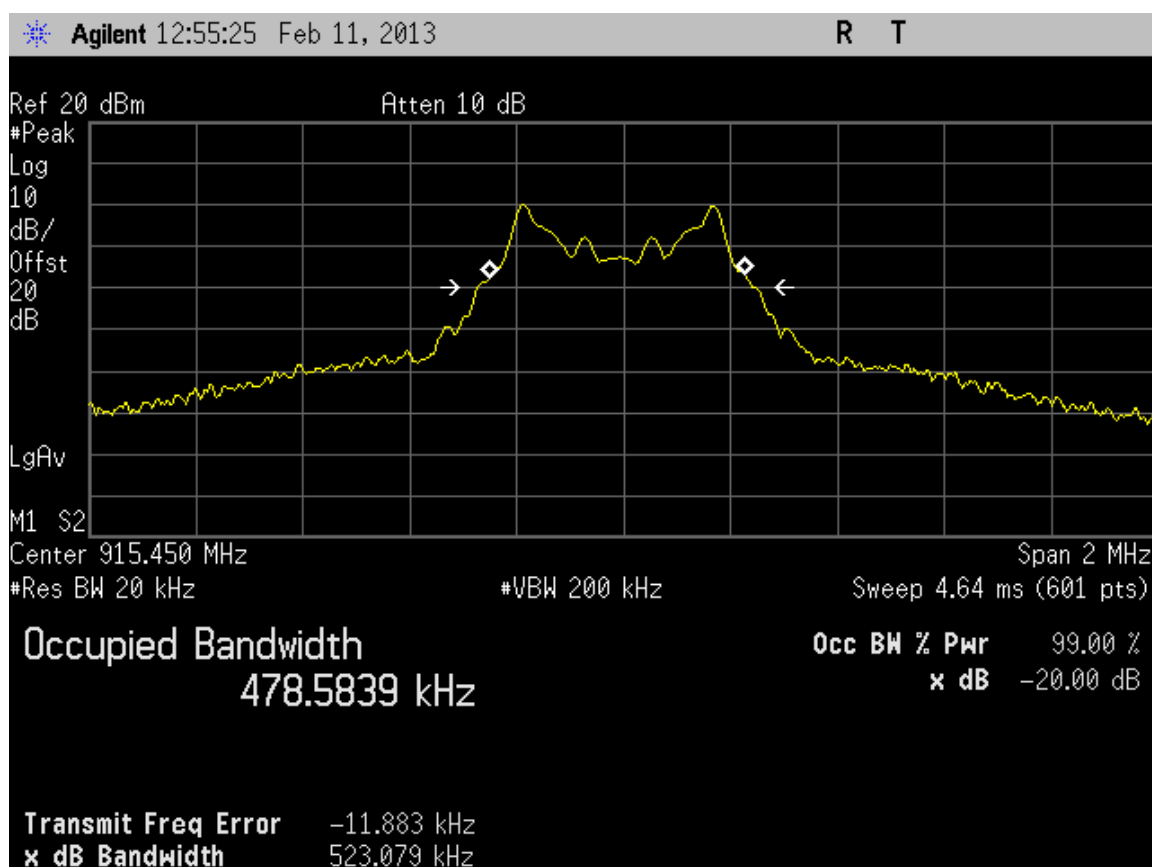


Figure 18. channel 19, 20 dB bandwidth

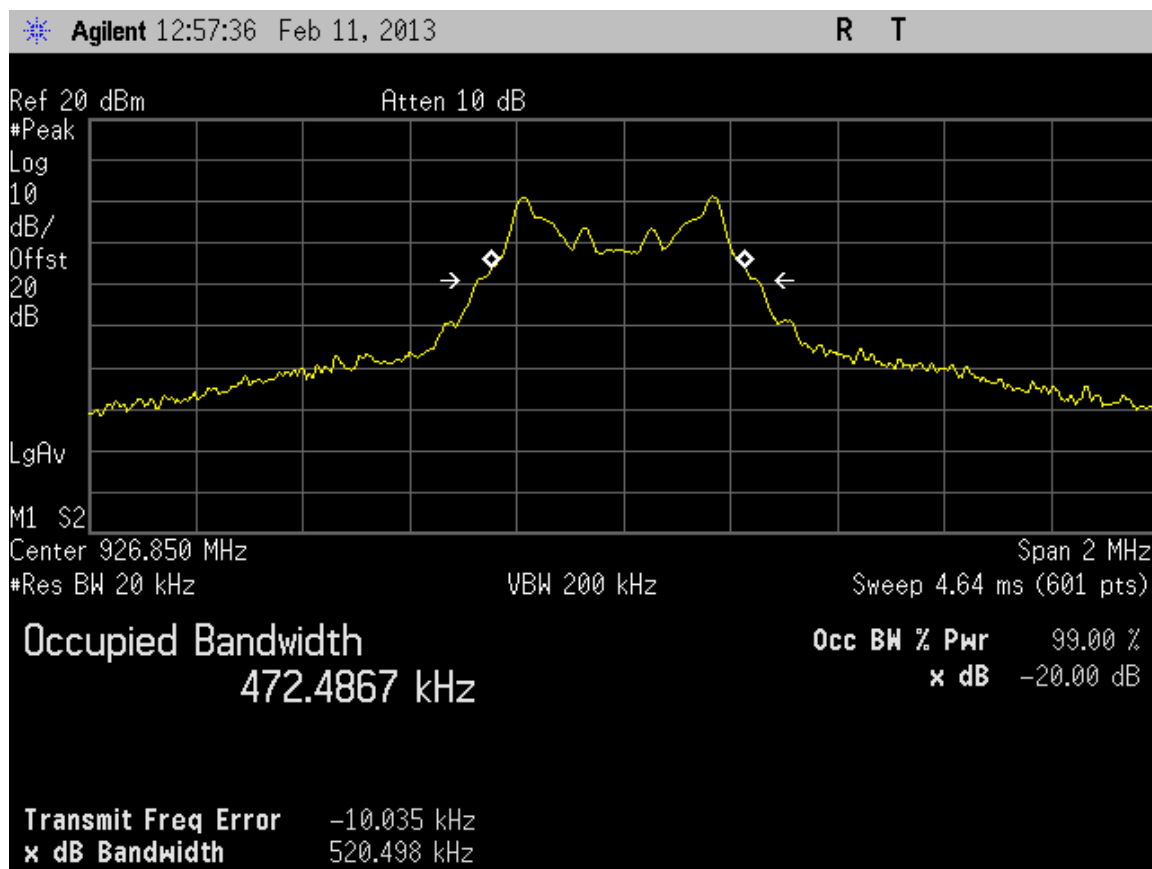


Figure 19. channel 38, 20 dB bandwidth

5. 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
88	Antenna	638	Narda	8003
745	2-Line V-Network	ENV216	Rohde & Schwarz	101466
319	Antenna	CBL6112	Chase	2018
348	Shielded room	RFSD-100	Euroshield Oy	1320
350	Semianechoic shielded room	RFD-F-100	Euroshield Oy	1327
393	RF attenuator PAD	1A (10dB)	Weinschel	
519	RF High-Power Attenuator	765-20	Narda	
525	Double-Ridged Horn	3115	Emco	6691
542	Double-Ridged Horn	3115	Emco	00023905
544	RF-amplifier	ZFL-1000VH2	Mini-Circuits	QA0749010
546	Bluetooth Test Set	MT8850A	Anritsu	6K00000092
559	Highpass Filter	WHKX3.0/18G-10SS	Wainwright Instruments	1
572	High Pass Filter	WHKX1.5/15G-12SS	Wainwright Instruments	4
564	RF amplifier	CA018-4010	CIAO Wireless	132
566	Spectrum analyzer	E4448A	Agilent	US42510236
567	RF generator	E8257C	Agilent	MY43320736
338	Test receiver	ESS	Rohde & Schwarz	847151/009
694	EMI Test Receiver	ESPC	Rohde & Schwarz	842888/023
709	EMI test receiver	ESU8	Rohde & Schwarz	100297
710	RF amplifier	ALS1826-41-12	ALC Microwave Inc.	0011
377	RF attenuator PAD	757 C - 20 dB	Narda	
383	Hybrid	3033B	Narda	01727
X1	Dual directional coupler	11692D	Hewlett Packard	1212A01868

6. Photographs

See document "223827_test_setup_photographs"