



Date: <u>ESPOO02.10.2013</u>	Page: <u>1 (29)</u>
	Appendices <u>-</u>
Number: No. 1 / 1	224568H
	Date of handing in: 23.11.2012
	Tested by:  Pekka Kälviäinen, Test Engineer
	Reviewed by:  Timo Leismala, Test Manager

SORT OF EQUIPMENT:

2.4 GHz Transceiver

TRADEMARK:

SCANRECO

TYPE:

G5 P1, G5 P2, G5 P3, G5 P4, G5 P, G5 P7, G5 P7, G5 P8

MANUFACTURER:

Scanreco Industri Elektronik AB

CLIENT:

Scanreco Industri Elektronik AB

ADDRESS:

Årsta Skolgränd 22, S – 100 74 Stockholm, Sweden

TEST LABORATORY:

Nemko Oy

FCC REG. NO.

359859 October 20, 2011

IC FILE NO.

2040F-1 November 22, 2012

SUMMARY:

Only the type of G5 P8A was tested since the electrical circuit design, layout, components used and internal wiring were identical for all types of the product.

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>Section in RSS-GEN or RSS-210, Issue 8</i>		<i>Result</i>
15.247 (b)(1)	A8.4 (2)	Conducted peak output power	PASS
15.247 (d)	A8.5	Band-edge compliance of RF emissions	PASS
15.247 (d)	A8.5	Spurious RF conducted emissions	PASS
15.247 (d) 15.209	A8.5	Spurious radiated emissions	PASS
15.207	7.2.2	AC power line conducted emissions	N.A.
15.247 (a)(1)	A8.1 (a)	20 dB bandwidth	X
15.247 (a)(1)	A8.1 (b)	Carrier frequency separation	PASS
15.247 (a)(1)(iii)	A8.1 (d)	Number of hopping frequencies	PASS
15.247 (a)(1)(iii)	A8.1 (d)	Time of occupancy	PASS

Explanations:

- PASS The EUT passed that particular test.
FAIL The EUT failed that particular test.
N.A. The test not applicable, battery operated equipment
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

2.4 GHz transceiver, Frequency hopping system, 16 channels
 Type: G5 P1, G5 P2, G5 P3, G5 P4, G5 P5, G5 P7, G5 P7, G5 P8.

1.2 EUT and accessories

	<i>unit</i>	<i>type</i>	<i>s/n</i>
<i>EUT1</i>	Transceiver	G5	7
<i>EUT2</i>	Transceiver with temporary antenna connector	G5	8
<i>EUT3</i>	Transceiver with temporary antenna connector	G5	6

Operating voltages

4.5 VDC 3 * AAA Battery

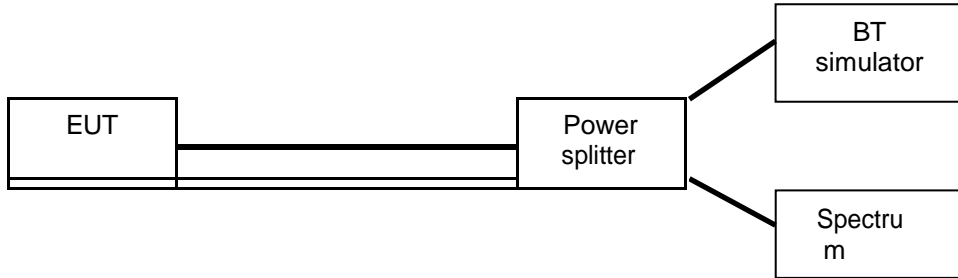
1.3 Additional information related to testing

Tested Technology:	Frequency Hopping System, 16 channels	
Antenna:	Integral, gain = 0dBi	
Type of Unit	Transmitter	
Modulation:	FHSS	
Power Supply Requirement:	Nominal	4.5V
Transmit Frequency Range	2400 MHz to 2483.5 MHz	
Transmit Channels Tested:	Channel Number	Channel Frequency (MHz)
	0	2405
	7	2440
	15	2480

2. Test setups

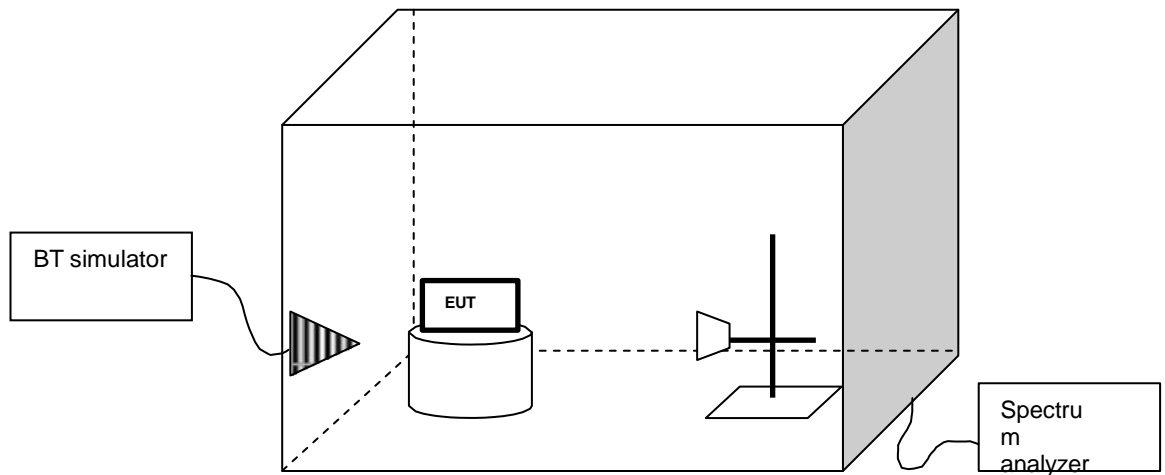
Setup 1 (Conducted measurements)

The test was performed inside a shielded room. A BT simulator was not used.



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. A BT simulator was not used.



3. Standards and measurement methods

The test were performed in guidance of the CFR 47, FCC Rules Part 15 Subpart C, ANSI C63.4 (2003), CISPR 22 Ed. 6.0, Public notice DA 00-705, ANSI C63.10 (2009), 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 / Perkaa
<i>FCC rule part</i>	§ 15.247 (b)(1)
<i>Section in RSS-210</i>	A8.4 (2)
<i>Date of testing</i>	30.09.2013
<i>Test equipment</i>	566
<i>Test conditions</i>	22 °C, 31 % RH

4.1.1 EUT operation mode

<i>EUT channel</i>	0, 7 and 15
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4.1.2 Test method and limit

The measurement is made according to Public notice DA 00-705 and IC standard RSS-210.

<i>Frequency range (MHz)</i>	<i>Limit (W)</i>	<i>Limit (dBm)</i>
2400 – 2483.5	≤ 1.0	≤ 30

4.1.3 Test results

<i>Channel / f (MHz)</i>	<i>P (dBm)</i>	<i>Result</i>
0 / 2405	19.99	PASS
7 / 2440	19.89	PASS
15 / 2480	17.93	PASS

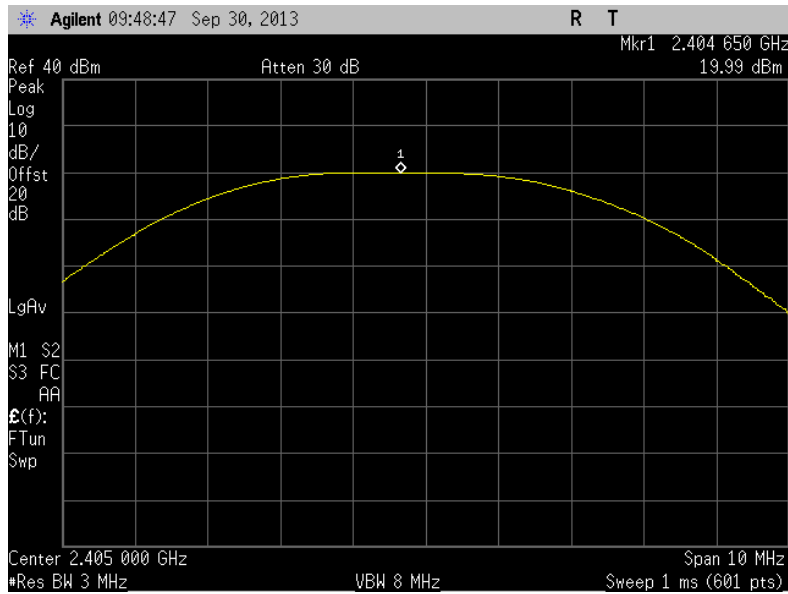


Figure 1. channel 0, conducted peak output power

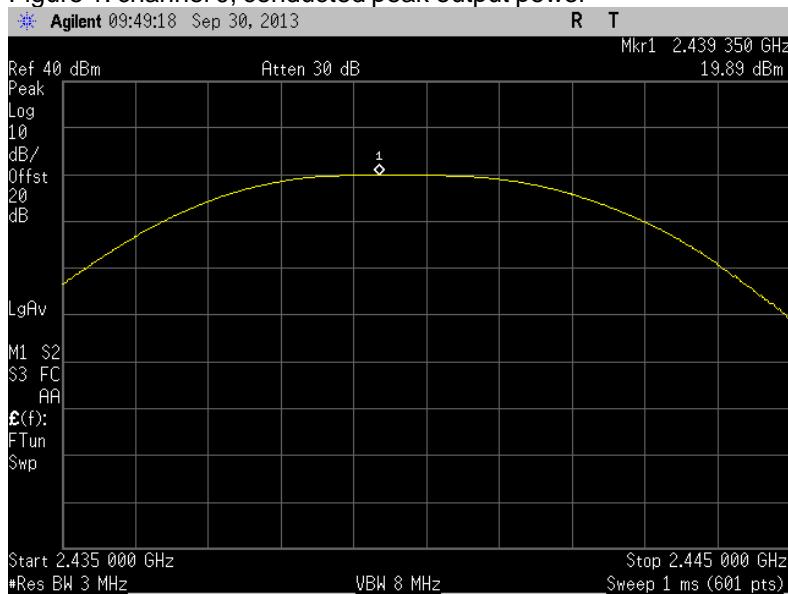


Figure 2. channel 7, conducted peak output power

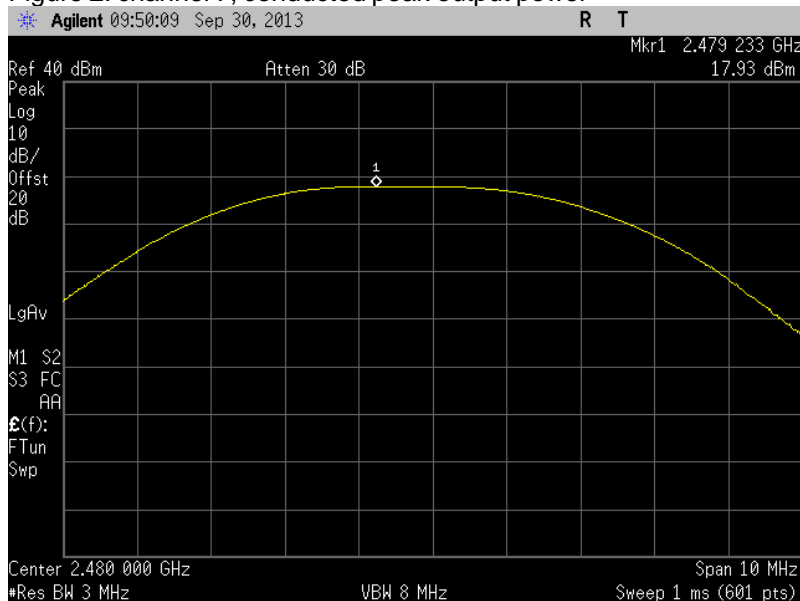


Figure 3. channel 15, conducted peak output power

4.2 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 / Perkkaa
<i>FCC rule part</i>	§ 15.247 (d)
<i>Section in RSS-210</i>	A8.5
<i>Date of testing</i>	02.05.2013
<i>Test equipment</i>	566, 525, 350
<i>Test conditions</i>	22 °C, 35 % RH
<i>Test result</i>	PASS

4.2.1 EUT operation mode

<i>EUT channel</i>	Hopping 0 and 15
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4.2.2 Test method and limit

The measurement is made according to Public notice DA 00-705 and IC standard RSS-210.

3m measurement distance

<i>Frequency range (MHz)</i>	<i>Limit Average (dBμV/m)</i>	<i>Limit Peak (dBμV/m)</i>
Below 2390 and above 2483.5	≤ 54	≤ 74

The measurement results were obtained as described below.

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

Where

U_{RX} receiver reading

A_{CABLE} attenuation of the cable

AF antenna factor

Duty Cycle correction factor(dB) -26.89 dB was used.

4.2.3 Test results

Hopping:

Below 2390 MHz:

<i>Detector (RBW: 1MHz)</i>	<i>E (dBμV/m)</i>	<i>Result</i>
Peak	62.08	PASS
Average	35.19	PASS

Hopping:

Above 2483.5 MHz:

<i>Detector (RBW: 1MHz)</i>	<i>E (dBμV/m)</i>	<i>Result</i>
Peak	69.73	PASS
Average	42.84	PASS

Channel 0:

Below 2390 MHz:

<i>Detector (RBW: 1MHz)</i>	<i>E (dBμV/m)</i>	<i>Result</i>
Peak	62.31	PASS
Average	35.42	PASS

Channel 15:

Above 2483.5 MHz:

<i>Detector (RBW: 1MHz)</i>	<i>E (dBμV/m)</i>	<i>Result</i>
Peak	70.88	PASS
Average	43.99	PASS

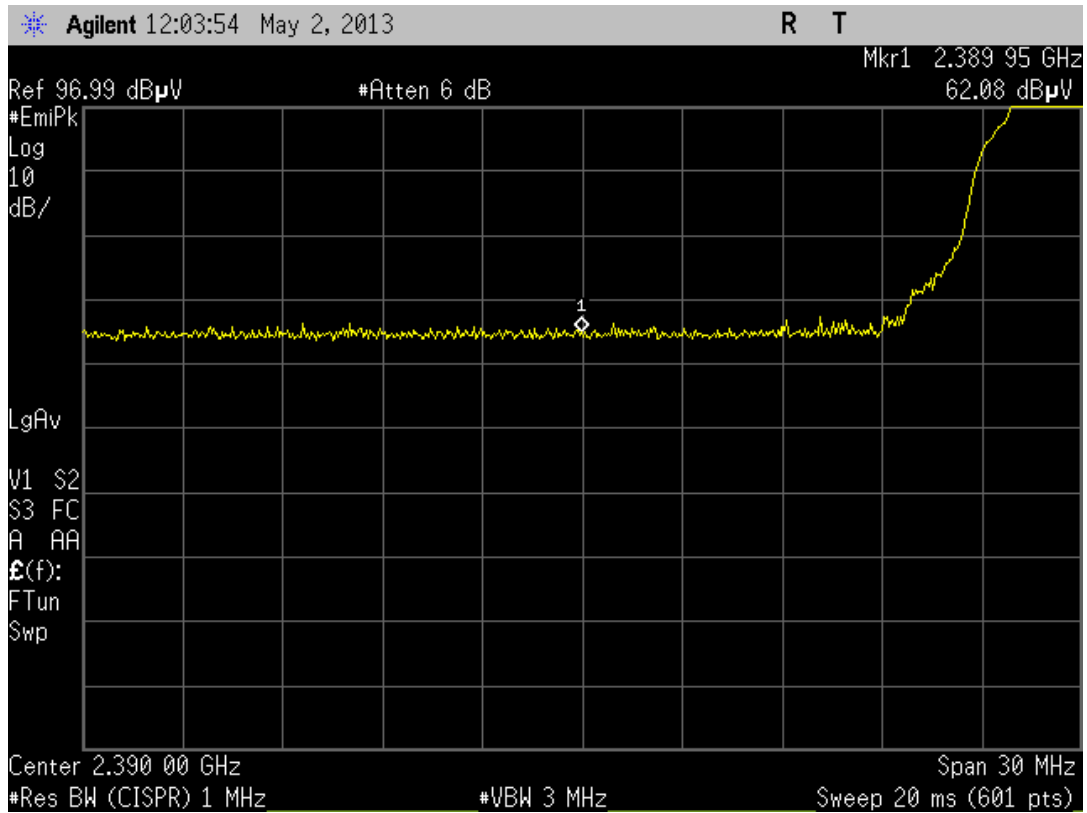


Figure 4. Hopping on, Band-edge compliance, low end

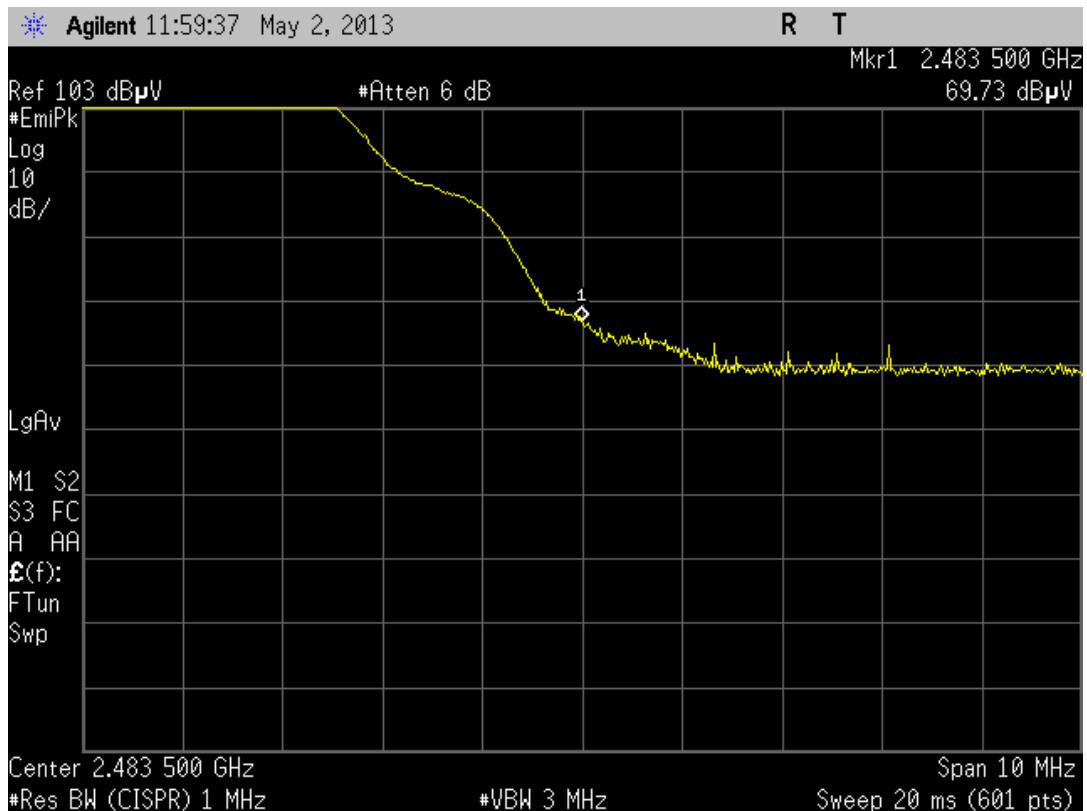


Figure 5. Hopping on, Band-edge compliance, high end

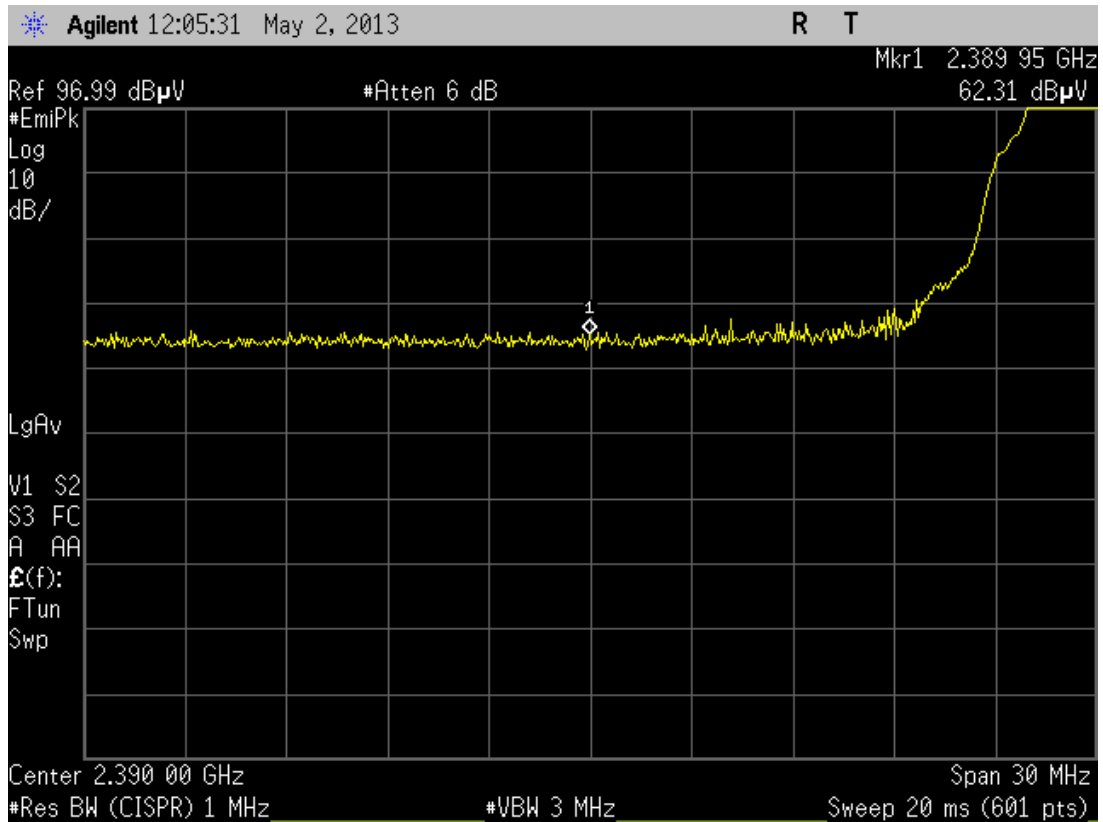


Figure 6. Hopping off, Channel 0, Band-edge compliance, low end

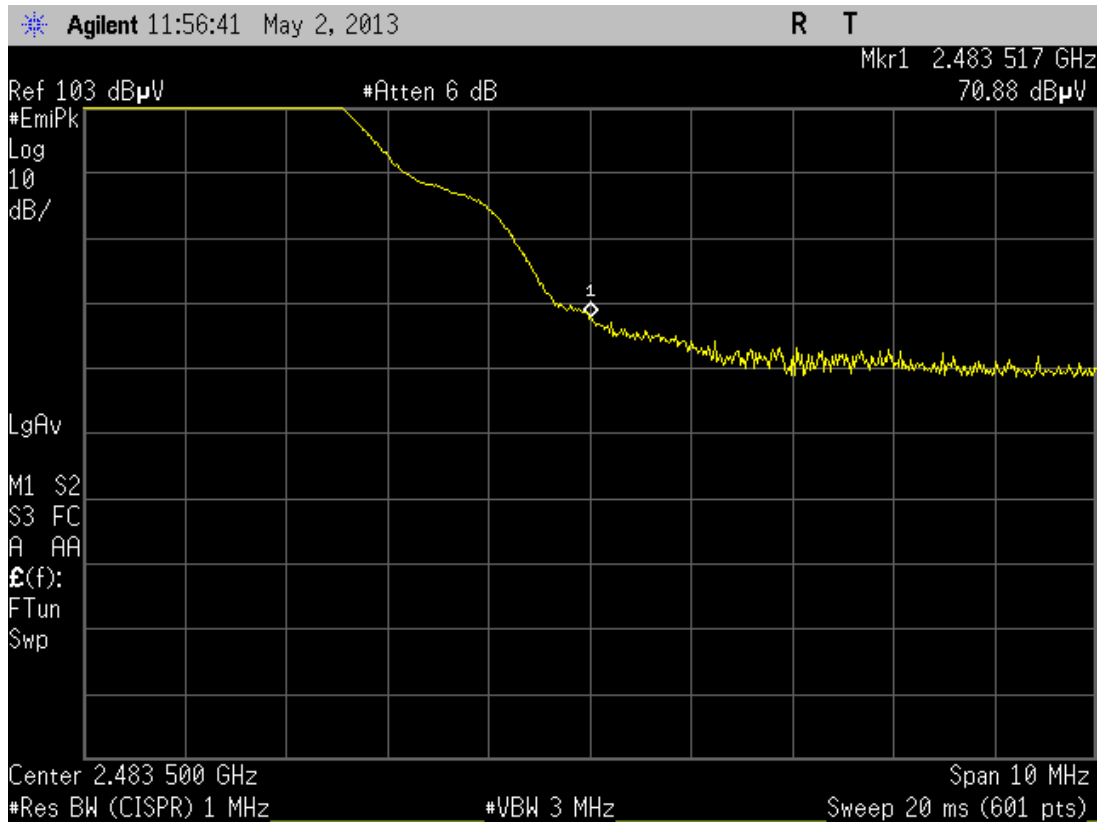


Figure 7. Hopping off, Channel 15, Band-edge compliance, high end

4.3 Spurious RF conducted emission

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 (d)
<i>Section in RSS-210</i>	6.2.2(o), e1
<i>Date of testing</i>	02.05.2013
<i>Test equipment</i>	566, 559
<i>Test conditions</i>	22 °C, 35 % RH

4.3.1 EUT operation mode

<i>EUT channel</i>	0, 7 and 15
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4.3.2 Test method and limit

The measurement is made according to Public notice DA 00-705 and IC standard RSS-210. The device was tested from 30 MHz to the tenth harmonic of the highest fundamental frequency.

<i>Frequency range (MHz)</i>	<i>Limit (dBc)</i>
≤ 25000	≤ -20

4.3.3 Test results

Channel 0 /2405 MHz

<i>Frequency (GHz)</i>	<i>P (dBc)</i>	<i>Result</i>
9.68	-50.95	PASS
12.02	-56.37	PASS

Channel 7 /2440 MHz

<i>Frequency (GHz)</i>	<i>P (dBc)</i>	<i>Result</i>
9.75	-53.78	PASS
12.20	-55.45	PASS

Channel 15 /2480 MHz

<i>Frequency (GHz)</i>	<i>P (dBc)</i>	<i>Result</i>
24.30	-53.17	PASS

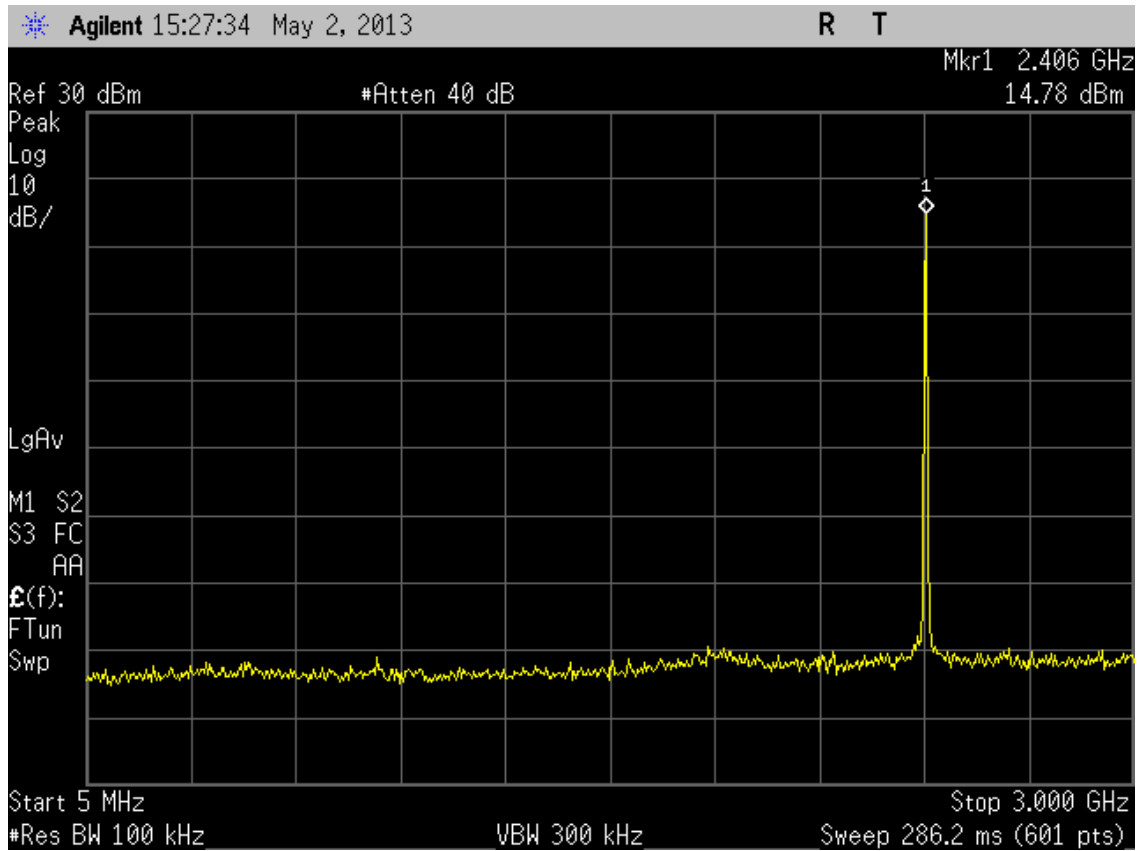


Figure 8. channel 0, spurious RF conducted emission

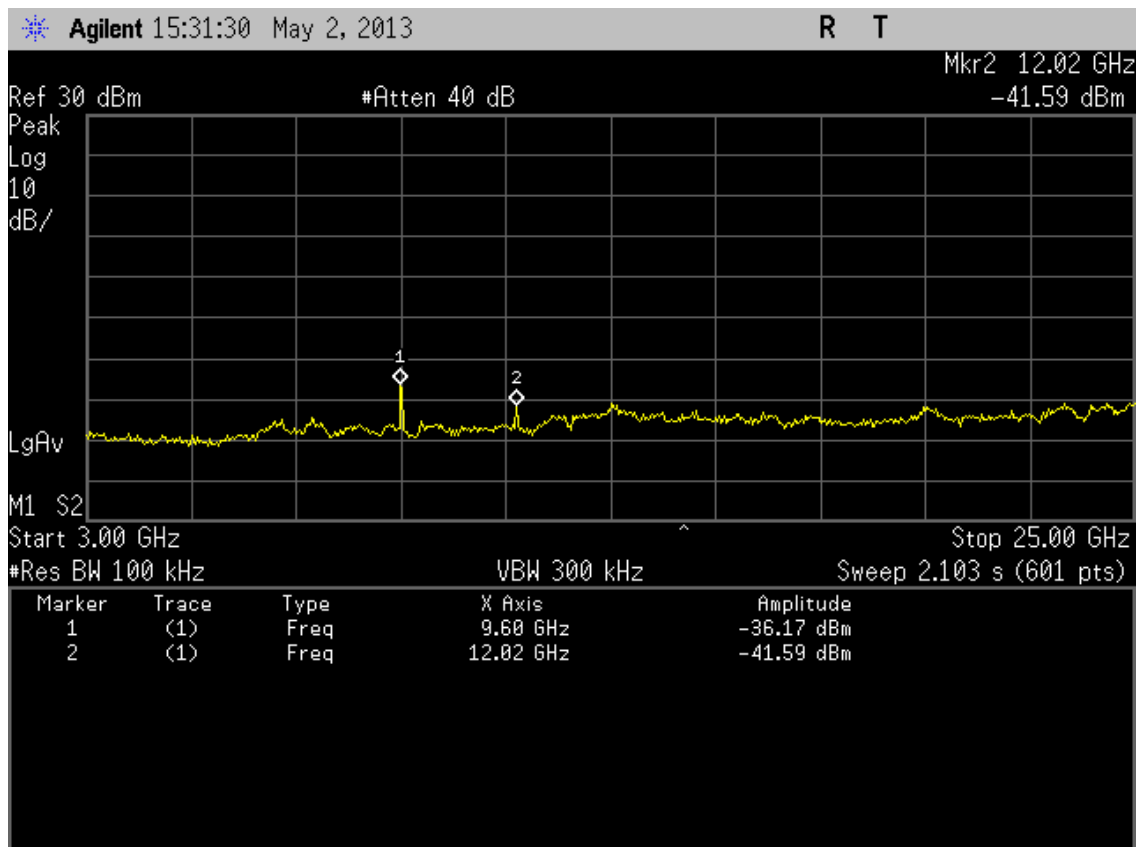
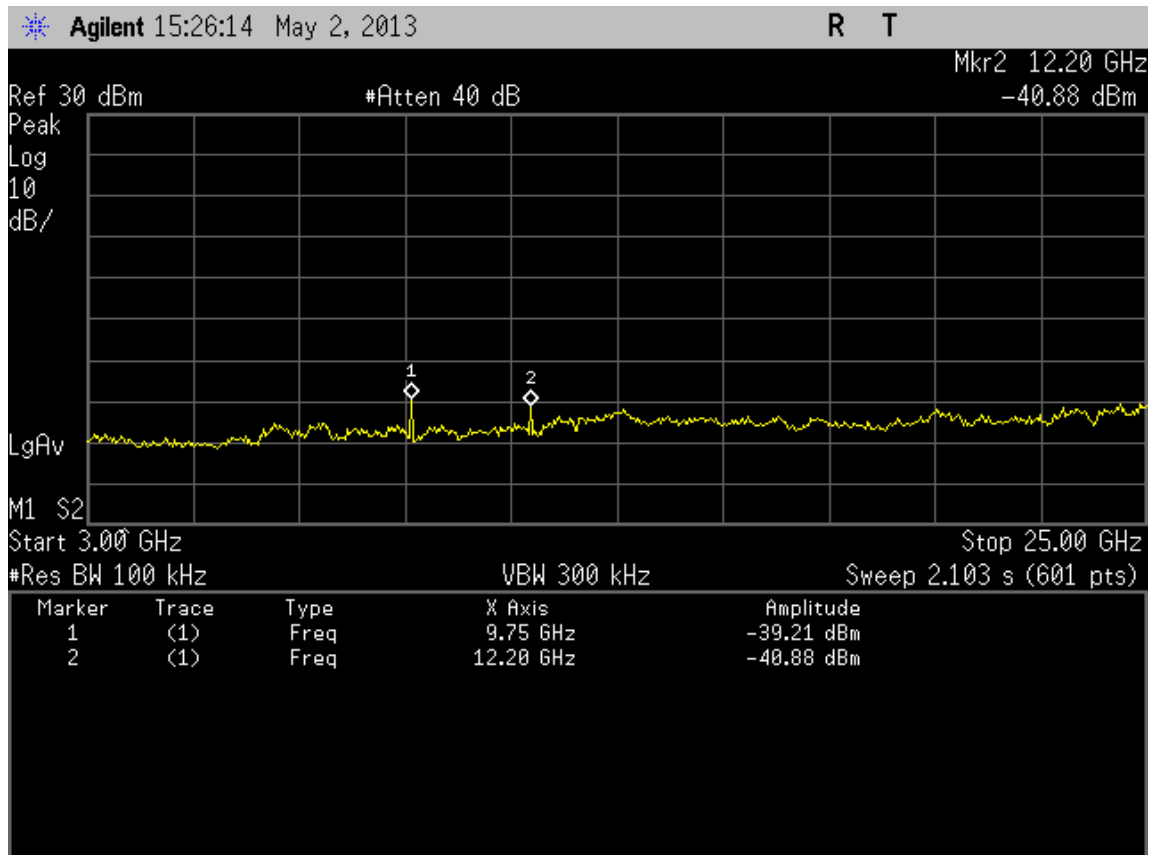
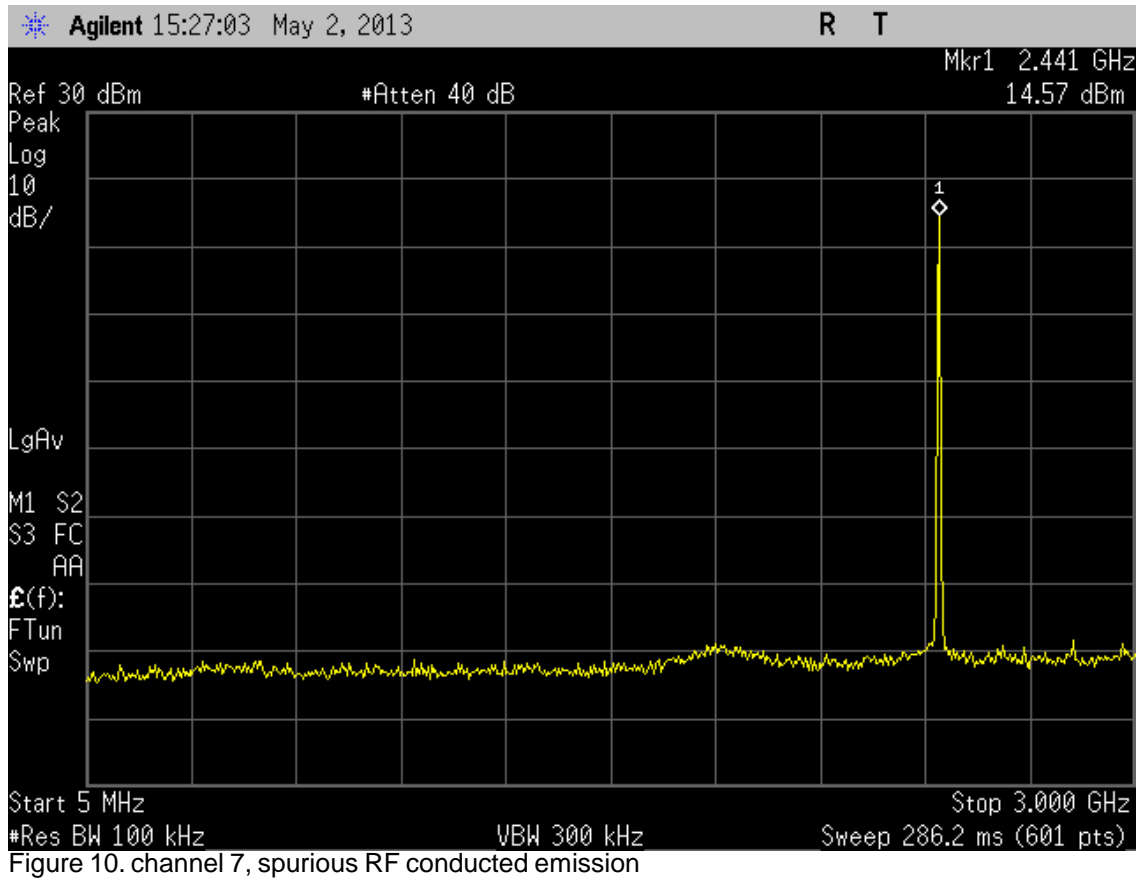


Figure 9. channel 0, spurious RF conducted emission



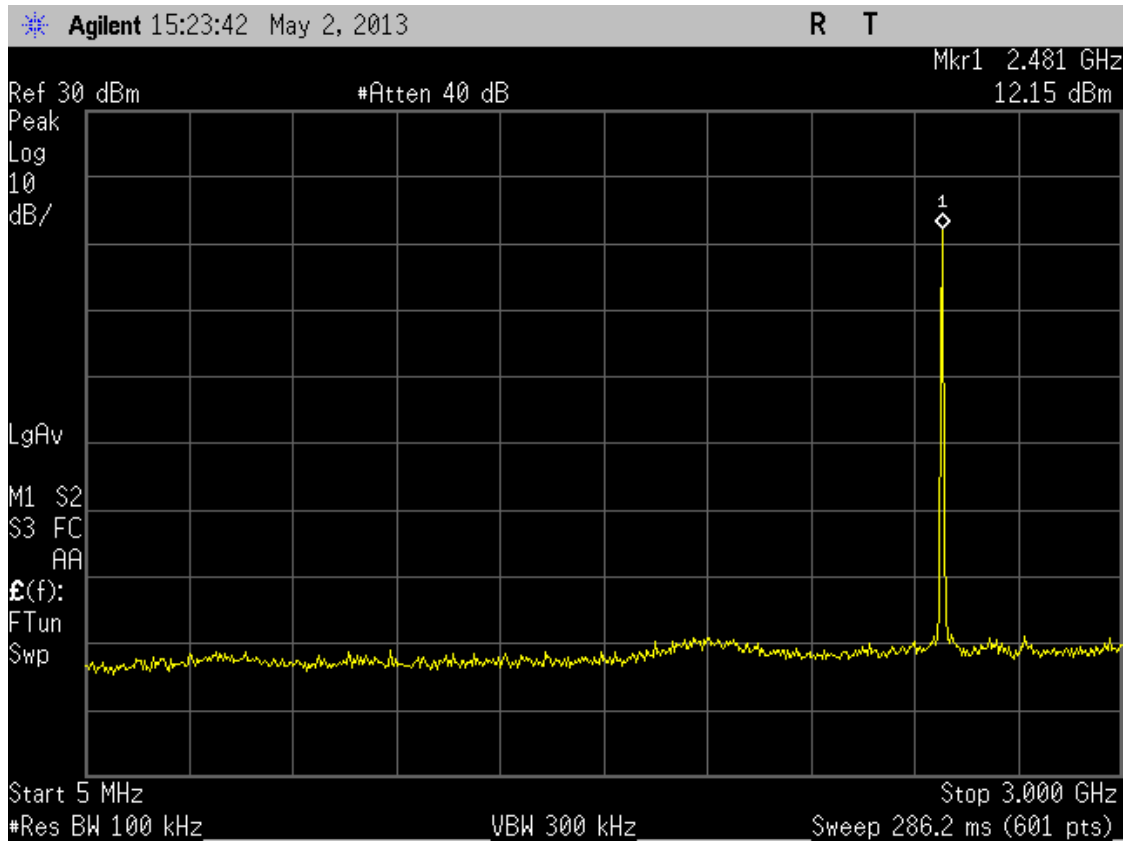


Figure 12. channel 15, spurious RF conducted emission

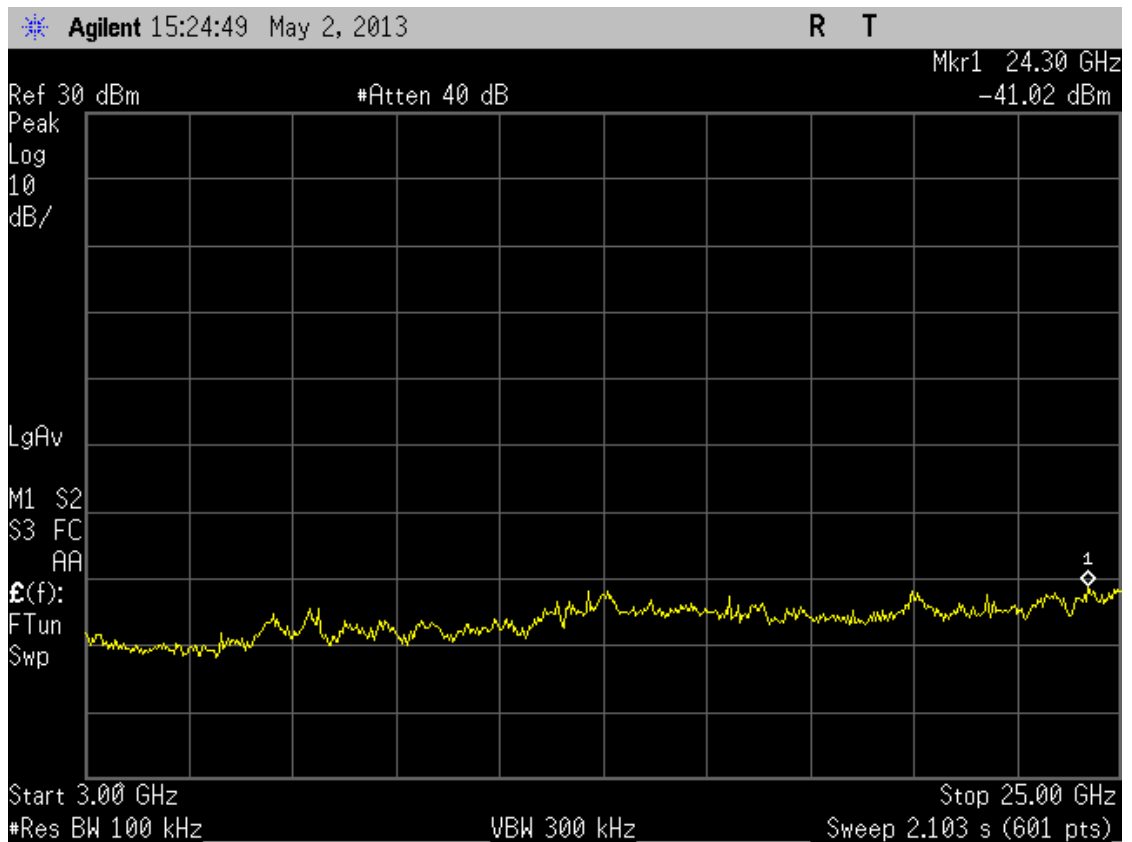


Figure 13. channel 15, spurious RF conducted emission

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 / Perkaa
<i>FCC rule part</i>	§ 15.247 (d), § 15.209
<i>Section in RSS-210</i>	A8.5
<i>Date of testing</i>	11.01.2013
<i>Test equipment</i>	566, 709, 564, 559, 525, 319, 544, 393, 350, 88, 710
<i>Test conditions</i>	22 °C, 31 % RH

4.4.1 EUT operation mode

<i>EUT channel</i>	Channel 0, 7 and 15
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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 was 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 – 25000 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. (below 1GHz: RBW 120kHz; above 1GHz: RBW 1MHz, VBW 3MHz)

3m measuring distance, FCC Part 15.209

<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 - 25000	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 axes.

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).

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: $[dB(\mu V/m)] = 20 \log[\mu V/m]$.

The measurement results were obtained as described below.

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

Where

U_{RX} receiver reading

A_{CABLE} attenuation of the cable

AF antenna factor

G_{PREAMP} gain of the preamplifier

Duty Cycle correction factor(dB) -26.89 dB was used.

4.4.3 Test results

Channel 0

<i>Frequency MHz</i>	<i>Peak dB(μV/m)</i>	<i>Limit dB(μV/m)</i>	<i>Margin dB</i>	<i>Result</i>
4810	65.3	74	8.7	PASS
12025	64.5	74	9.5	PASS

<i>Frequency MHz</i>	<i>Average dB(μV/m)</i>	<i>Limit dB(μV/m)</i>	<i>Margin dB</i>	<i>Result</i>
4810	38.4	54	15.6	PASS
12025	37.6	54	16.4	PASS

<i>Frequency MHz</i>	<i>Peak dBc</i>	<i>Limit dBc</i>	<i>Margin dB</i>	<i>Result</i>
7215	-40.0	-20	20.0	PASS
9620	-42.4	-20	22.4	PASS

Channel 7

<i>Frequency MHz</i>	<i>Peak dB(μV/m)</i>	<i>Limit dB(μV/m)</i>	<i>Margin dB</i>	<i>Result</i>
4880	60.6	74	13.4	PASS
7320	73.3	74	0.7	PASS
12200	53.9	74	20.1	PASS

<i>Frequency MHz</i>	<i>Average dB(μV/m)</i>	<i>Limit dB(μV/m)</i>	<i>Margin dB</i>	<i>Result</i>
4880	33.7	54	20.3	PASS
7320	46.4	54	7.6	PASS
12200	27.0	54	27.0	PASS

<i>Frequency MHz</i>	<i>Peak dBc</i>	<i>Limit dBc</i>	<i>Margin dB</i>	<i>Result</i>
9760	-48.2	-20	28.2	PASS

Channel 15

<i>Frequency MHz</i>	<i>Peak dB(μV/m)</i>	<i>Limit dB(μV/m)</i>	<i>Margin dB</i>	<i>Result</i>
4960	55.1	74	18.9	PASS
7440	63.6	74	10.4	PASS
12400	57.8	74	16.2	PASS

<i>Frequency MHz</i>	<i>Average dB(μV/m)</i>	<i>Limit dB(μV/m)</i>	<i>Margin dB</i>	<i>Result</i>
4960	28.2	54	25.8	PASS
7440	36.5	54	17.5	PASS
12400	30.9	54	23.1	PASS

<i>Frequency MHz</i>	<i>Peak dBc</i>	<i>Limit dBc</i>	<i>Margin dB</i>	<i>Result</i>
9920	-44.5	-20	24.5	PASS

4.5 20 dB bandwidth

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

<i>EUT</i>	EUT3, setup 1
<i>Site name</i>	Nemko Oy / Perkkaa
<i>FCC rule part</i>	§ 15.247 (a)(1)
<i>Section in RSS-210</i>	A8.1 (a)
<i>Date of testing</i>	13.03.2013
<i>Test equipment</i>	566
<i>Test conditions</i>	22 °C, 31 % RH

4.5.1 EUT operation mode

<i>EUT channel</i>	0, 7 and 15
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4.5.2 Test method and limit

The measurement is made according to Public notice DA 00-705 and IC standard RSS-210.

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

4.5.3 Test results

<i>EUT Channel / f (MHz)</i>	<i>20 dB bandwidth (MHz)</i>
0 / 2405	2.794
7 / 2440	2.813
15 / 2480	2.809



Figure 14. channel 0, 20 dB bandwidth



Figure 15. channel 7, 20 dB bandwidth

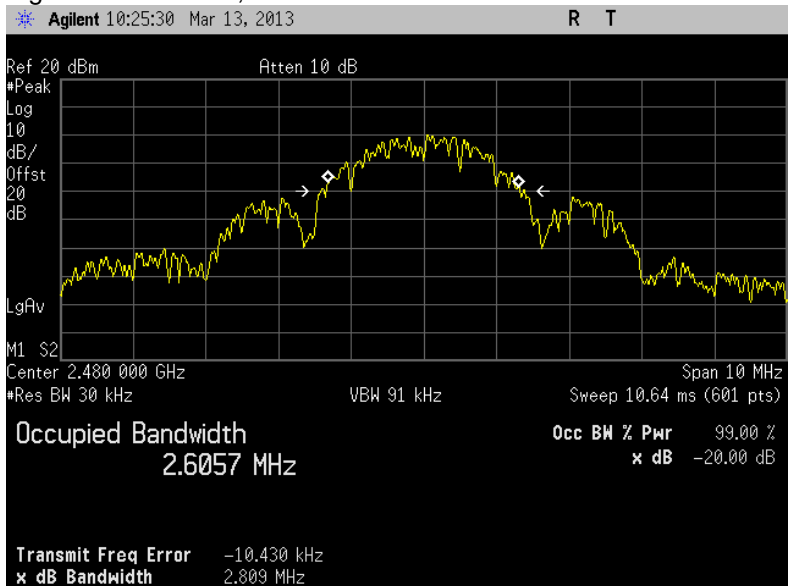


Figure 16. channel 15, 20 dB bandwidth

4.6 Carrier frequency separation

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

<i>EUT</i>	EUT3, setup 1
<i>Site name</i>	Nemko Oy / Perkkaa
<i>FCC rule part</i>	§ 15.247 (a)(1)
<i>Section in RSS-210</i>	A8.1 (b)
<i>Date of testing</i>	13.03.2013
<i>Test equipment</i>	566
<i>Test conditions</i>	22 °C, 31 % RH

4.6.1 EUT operation mode

<i>EUT channel</i>	Hopping
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4.6.2 Test method and limit and test results

The measurement is made according to Public notice DA 00-705 and IC standard RSS-210.

<i>Limit (MHz)</i>
≥ 0.025 or 2/3 of the 20 dB BW

4.6.3 Test results

Carrier frequency separation (MHz)	Result
5.000	PASS

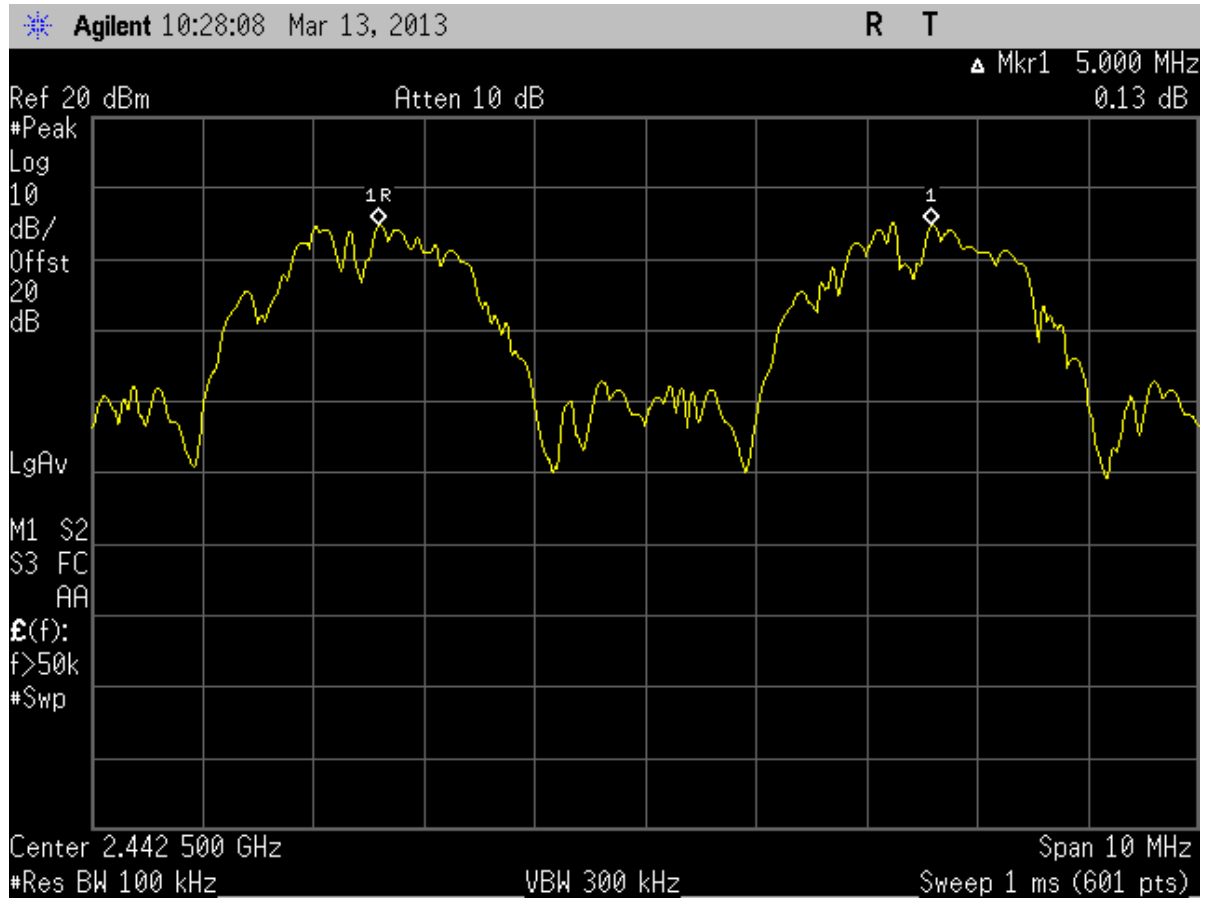


Figure 17. Hopping on, carrier frequency separation of channels 7 / 2440MHz and 8 / 2445MHz

4.7 Number of hopping frequencies

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

<i>EUT</i>	EUT3, setup 1
<i>Site name</i>	Nemko Oy / Perkkaa
<i>FCC rule part</i>	§ 15.247, (a)(1)(iii)
<i>Section in RSS-210</i>	A8.1 (d)
<i>Date of testing</i>	13.03.2013
<i>Test equipment</i>	566
<i>Test conditions</i>	22 °C, 31 % RH

4.7.1 EUT operation mode

<i>EUT channel</i>	Hopping
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4.7.2 Test method and limit

The measurement is made according to Public notice DA 00-705 and IC standard RSS-210.

<i>limit (Number)</i>
≥ 15

4.7.3 Test results

<i>Number of hopping frequencies</i>	<i>Result</i>
16	PASS

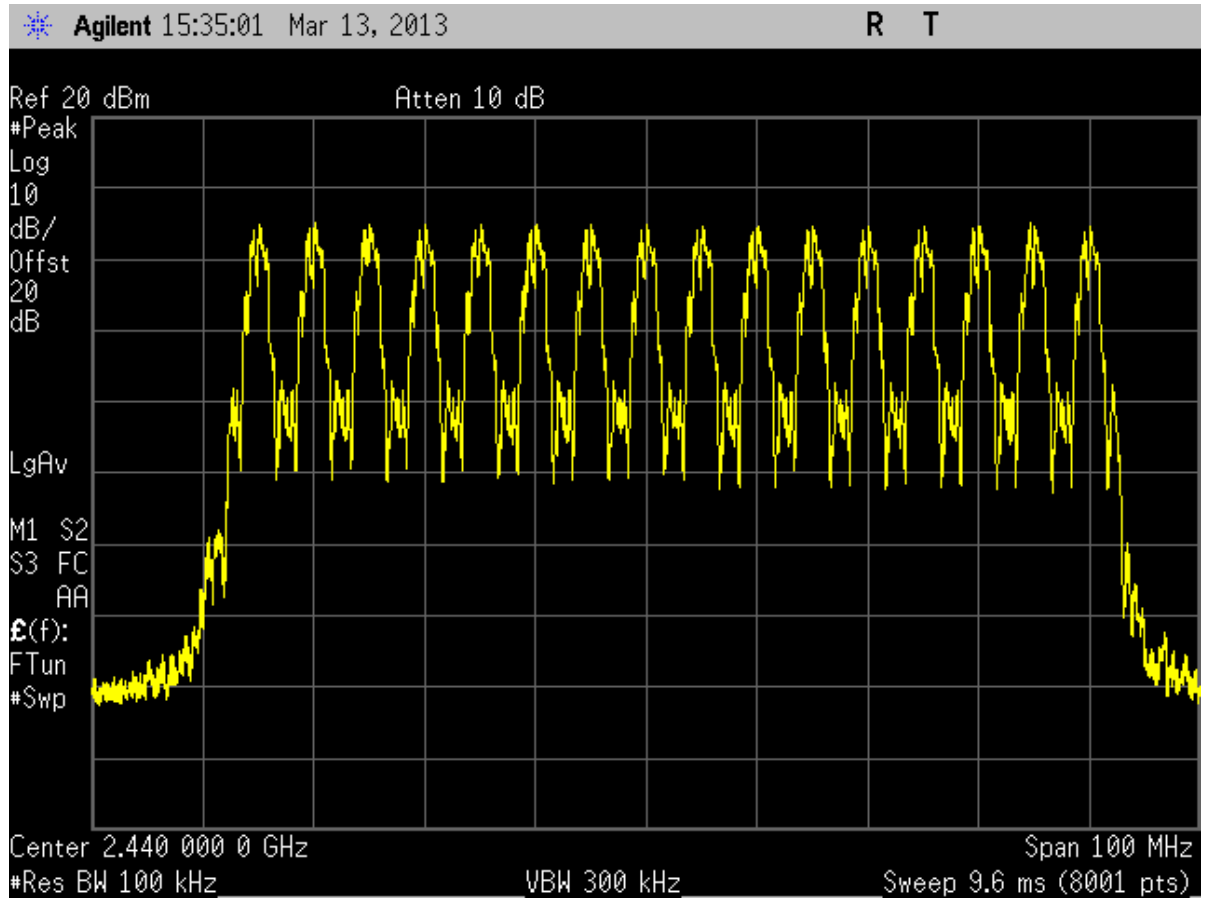


Figure 18. Hopping on, number of hopping frequencies

4.8 Time of occupancy

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

<i>EUT</i>	EUT3, setup 1
<i>Site name</i>	Nemko Oy / Perkkaa
<i>FCC rule part</i>	§ 15.247 (a)(1)(iii)
<i>Section in RSS-210</i>	A8.1 (d)
<i>Date of testing</i>	13.03.2013
<i>Test equipment</i>	566
<i>Test conditions</i>	22 °C, 31 % RH

4.8.1 EUT operation mode

<i>EUT channel</i>	Hopping
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4.8.2 Test method and limit

The measurement is made according to Public notice DA 00-705 and IC standard RSS-210 as follows:

The total time of occupancy is obtained by multiplying the measured number of transmissions occurred during 6.4 second period with the duration of one transmission.

<i>Limit (s)</i>
≤ 0.4

4.8.3 Test results

<i>Time of occupancy, t (s)</i>	<i>Result</i>
0.2894	PASS

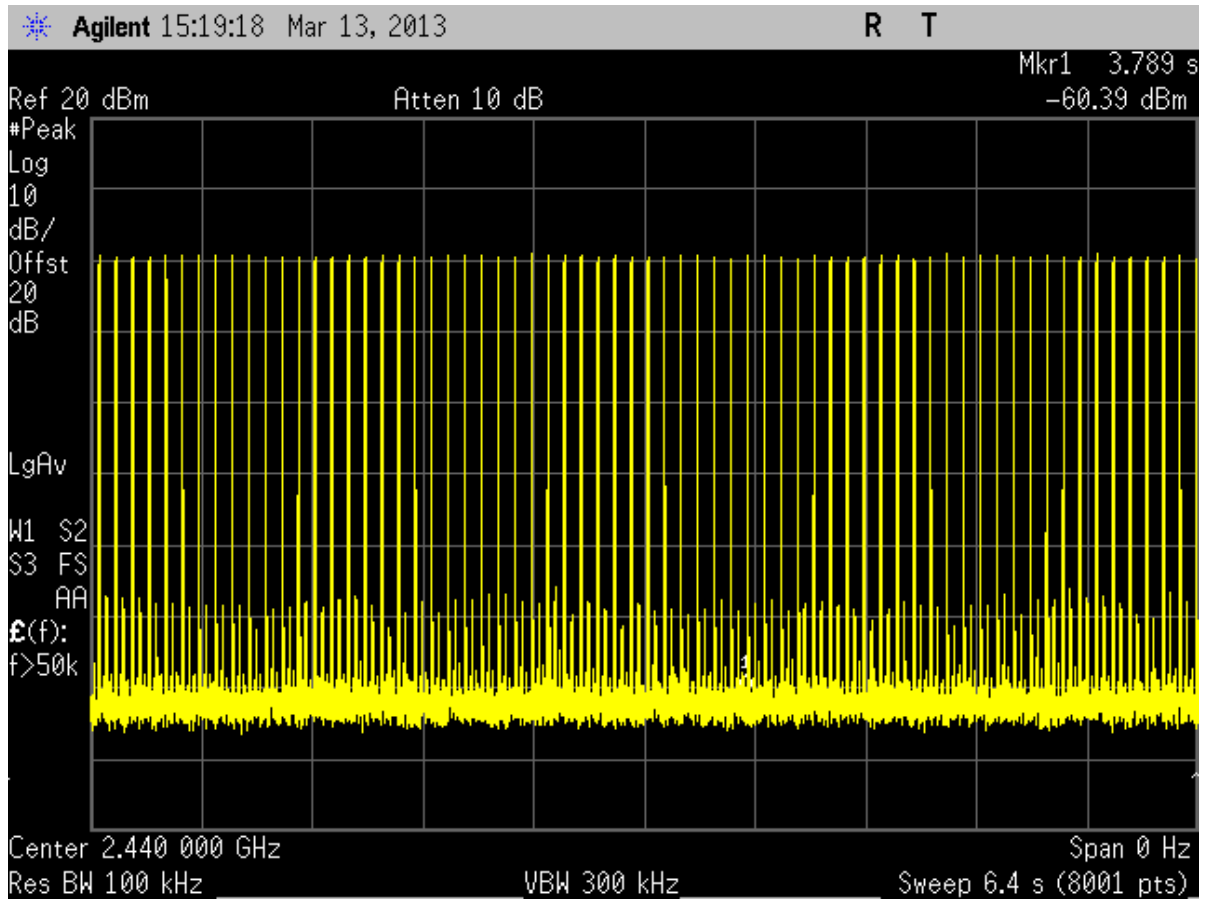


Figure 19. Hopping on, number of transmissions, channel 7 / 2440MHz, 67 transmissions

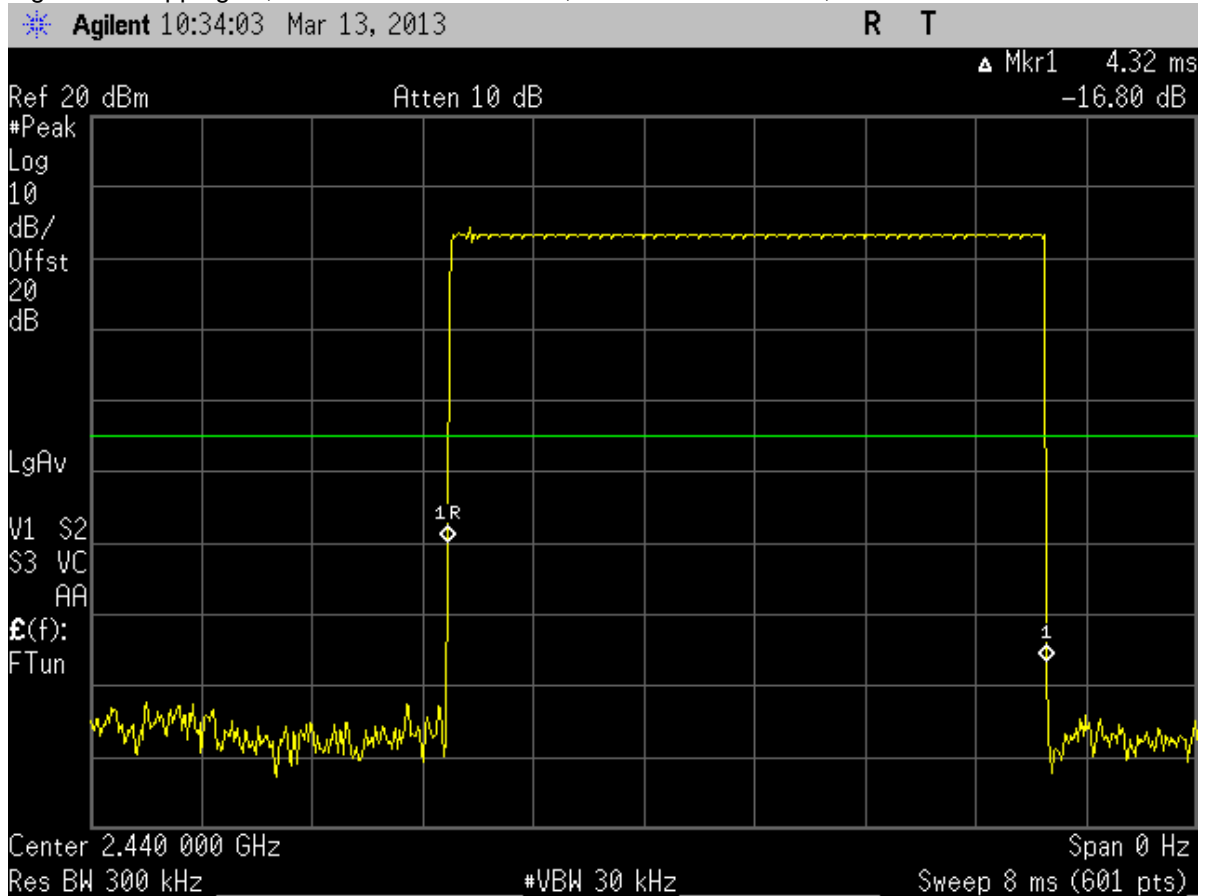


Figure 20. Hopping on, duration of one transmission, channel 7 / 2440Hz

4.9 Duty cycle correction factor

Spectrum analyzer with zero span was used to investigate spectrum.

15.35(c) Unless otherwise specified, e.g. § 15.255(b), when the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum value. The exact method of calculating the average field strength shall be submitted with any application for certification or shall be retained in the measurement data file for equipment subject to notification or verification.

ANSI C63.10-2009

The Duty Cycle Correction Factor δ , when expressed in dB, is calculated using the formula:
 $\delta(\text{dB})=20\log(\delta)$

$$\delta(\text{dB})=20*\log[\Sigma(n*t1+m*t2+...+\xi*tx)/T]$$

where

n is the number of pulses of duration t1

m is the number of pulses of duration t2

ξ is the number of pulses of duration tx

T is the period of the pulse train or 100 ms if the pulse train length is greater than 100 ms

4.9.2 Test data

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

Number of hopping channels 16

*Channel occupancy: During 0.4s*16=6.4s 67 hits at 2440 MHz. Assuming equal use of channels on average this is 67 x 16 / 6.4 = 167.5 hops per second. Pulse period (T) = 16 / 167.5 = 95.5 ms*

Pulse period (T) = 95.5ms

Length of one pulse (t1) = 4.32ms, n=1, m=0, $\xi=0$

$$\text{DutyCycleCorrectionFactor}=20*\log(T_{occ}/T)=20*\log(1*4.32/95.5)=-26.89\text{dB}$$

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	Cal date	Cal due
390	RF attenuator PAD	WA2-10	Weinschel	3784	10.12.2011	12.2013
694	EMI Test Receiver	ESPC	Rohde & Schwarz	842888/023	11.12.2012	12.2013
566	Spectrum analyzer	E4448A	Agilent	US42510236	17.4.2013	4.2014
709	EMI test receiver	ESU8	Rohde & Schwarz	100297	24.07.2013	7.2014
567	RF generator	E8257C	Agilent	MY43320736	25.2.2013	2.2014
544	RF-amplifier	ZFL-2000VH2	Mini-Circuits	QA0749010	9.1.2013	1.2014
564	RF amplifier	CA018-4010	CIAO Wireless	132	9.1.2013	1.2014
710	RF-amplifier	ALS 1826-41-12	ALC Microwave Inc.	0011	28.10.2011	10.2013
745	2-Line V-Network	ENV216	Rohde & Schwarz	101466	11.6.2013	06.2014
319	Antenna	CBL6112	Chase	2018	12.7.2012	1.2014
525	Double-Ridged Horn	3115	Emco	6691	10.10.2012	4.2014
542	Double-Ridged Horn	3115	Emco	00023905	10.10.2012	4.2014
559	Highpass filter	WHKX3.0/18G-10ss	Wainwright	1	7.12.2011	2.2013
88	Waveguide horn	638	Narda	8003	-	-
371	AC Power source	500i-400	California Instr.	HK 52064	23.5.2012	5.2013
350	Semianechoic shielded room	RFD-F-100	Euroshield Oy	1327	26.10.2012	10.2014

6. Photographs



Photograph 1: Test setup.