

**REPORT: FCC / IC Radio Frequency (RF) test report**

This report replaces the old test report: T08-762A-RF

**PRODUCT:**

Test item description:	Laser Barcode scanner
Trade Mark:	Nordic ID Morphic
Model/Type reference:	HTB00001
Serial number:	-
Customer:	Nordic ID Myllyojankatu 2.A 24100 Salo FINLAND
Contact person:	Hannu Heino
Manufacturer:	Nordic ID Myllyojankatu 2.A 24100 Salo FINLAND

**ORIGINAL DATE:** 19.12.2008

**CORRECTED DATE:** 6.2.2009

**TESTED BY:**



Simo Ojanen ; Test engineer

**APPROVED BY:**



Tuomo Hahl ; Test engineer

## CONTENTS

<b>1</b>	<b>LABORATORY INFORMATION</b> .....	<b>5</b>
<b>2</b>	<b>CUSTOMER INFORMATION</b> .....	<b>5</b>
<b>3</b>	<b>SUMMARY OF TEST RESULTS</b> .....	<b>6</b>
<b>4</b>	<b>EUT INFORMATION</b> .....	<b>7</b>
4.1	EUT description .....	7
<b>5</b>	<b>EUT TEST SETUPS</b> .....	<b>8</b>
<b>6</b>	<b>APPLICABLE STANDARDS</b> .....	<b>9</b>
<b>7</b>	<b>CARRIER FREQUENCY SEPARATION</b> .....	<b>10</b>
7.1	Test setup and testing method .....	10
7.2	EUT operation mode .....	10
7.3	Bluetooth Results .....	10
7.4	Screen shots .....	11
<b>8</b>	<b>NUMBER OF HOPPING FREQUENCIES</b> .....	<b>12</b>
8.1	Test setup .....	12
8.2	EUT operation mode .....	12
8.3	Bluetooth Results .....	12
8.4	Screen shots .....	13
<b>9</b>	<b>TIME OF OCCUPANCY</b> .....	<b>14</b>
9.1	Test setup and testing method .....	14
9.2	EUT operation mode .....	14
9.3	Bluetooth Results .....	15
9.3.1	Screen shots.....	15
<b>10</b>	<b>20 dB BANDWIDTH</b> .....	<b>17</b>
10.1	Test setup and measurement method .....	17
10.2	EUT operation mode .....	17
10.3	Bluetooth Results .....	18
10.4	Screen shots .....	18
<b>11</b>	<b>PEAK OUTPUT POWER</b> .....	<b>20</b>
11.1	Test setup and measurement method .....	20
11.2	EUT operation mode .....	20
11.3	Bluetooth Results .....	21
11.4	Screen shots .....	21
<b>12</b>	<b>BAND-EDGE COMPLIANCE OF RF CONDUCTED EMISSIONS</b> .....	<b>23</b>
12.1	Test setup and measurement method .....	23
12.2	Hopping enabled .....	23
12.2.1	EUT operation mode .....	23
12.2.2	Bluetooth Results.....	23
12.2.3	Screen shots.....	24
12.3	Hopping disabled .....	25
12.3.1	EUT operation mode .....	25
12.3.2	Bluetooth Results.....	25
12.3.3	Screen shots.....	25
<b>13</b>	<b>99 % BANDWIDTH</b> .....	<b>27</b>

Test results are valid for the tested unit only.

The report may be copied only in its entirety

13.1	Test setup and measurement method .....	27
13.2	EUT operation mode .....	27
13.3	Bluetooth Results .....	28
13.4	Screen shots .....	28
<b>14</b>	<b>SPURIOUS RF CONDUCTED EMISSIONS.....</b>	<b>29</b>
14.1	Test setup and measurement method .....	29
14.2	EUT operation mode .....	29
14.3	Limit.....	30
14.4	Bluetooth Results .....	30
<b>15</b>	<b>RADIATED SPURIOUS EMISSIONS .....</b>	<b>32</b>
15.1	Test setup .....	32
15.2	Test method.....	33
15.3	EUT operation mode .....	33
15.4	Limit.....	33
15.5	Bluetooth Results .....	34
<b>16</b>	<b>6 dB BANDWIDTH.....</b>	<b>36</b>
16.1	Test setup and measurement method .....	36
16.2	EUT operation mode .....	36
16.3	WLAN Results.....	37
16.4	Screen shots .....	37
<b>17</b>	<b>PEAK OUTPUT POWER .....</b>	<b>39</b>
17.1	Test setup and measurement method .....	39
17.2	EUT operation mode .....	39
17.3	WLAN Results.....	40
17.4	Screen shots .....	40
<b>18</b>	<b>BAND-EDGE COMPLIANCE OF RF CONDUCTED EMISSIONS.....</b>	<b>42</b>
18.1	Test setup and measurement method .....	42
18.2	EUT operation mode .....	43
18.3	WLAN Results.....	43
18.4	Screen shots .....	43
<b>19</b>	<b>POWER SPECTRAL DENSITY .....</b>	<b>45</b>
19.1	Test setup and measurement method .....	45
19.2	EUT operation mode .....	46
19.3	WLAN Results.....	46
19.4	Screen shots .....	46
<b>20</b>	<b>99 % BANDWIDTH.....</b>	<b>48</b>
20.1	Test setup and measurement method .....	48
20.2	EUT operation mode .....	48
20.3	WLAN Results.....	49
20.4	Screen shots .....	49
<b>21</b>	<b>SPURIOUS RF CONDUCTED EMISSIONS.....</b>	<b>50</b>
21.1	Test setup and measurement method .....	50
21.2	EUT operation mode .....	50
21.3	Limit.....	51
21.4	WLAN Results.....	51
<b>22</b>	<b>RADIATED SPURIOUS EMISSIONS .....</b>	<b>53</b>
22.1	Test setup .....	53
22.2	Test method.....	54
22.3	EUT operation mode .....	54

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22.4	Limit.....	54
22.5	WLAN Results.....	55
<b>23</b>	<b>CONDUCTED EMISSIONS TO AC-MAINS.....</b>	<b>57</b>
23.1	Test setup.....	57
23.2	EUT operation mode.....	57
23.3	Limits.....	57
23.4	Results.....	58
23.5	Screen shots.....	59
<b>24</b>	<b>RECEIVER RADIATED EMISSION.....</b>	<b>60</b>
24.1	Test setup.....	60
24.2	Test method.....	61
24.3	EUT operation mode.....	61
24.4	Limit.....	61
24.5	Results.....	62
<b>25</b>	<b>TEST EQUIPMENT.....</b>	<b>64</b>
25.1	Conducted measurements.....	64
25.2	Radiated measurements.....	64
<b>26</b>	<b>TEST SETUP PHOTOGRAPHS.....</b>	<b>65</b>

## 1 LABORATORY INFORMATION

<b>Test Laboratory</b>	Intertek ETL Semko OY EMC Laboratory Koneenkatu 12 / K17 05830 Hyvinkää FINLAND  Tel: +358 10 424 6200 Fax: +358 10 424 6201 e-mail: firstname.surname@intertek.com
<b>FCC registration number:</b> <b>IC file number:</b>	910391 (January 27, 2003) IC 2042C-1 (May 14, 2003)

## 2 CUSTOMER INFORMATION

<b>Client</b>	Nordic ID Myllyojankatu 2.A 24100 Salo FINLAND
<b>Contact person:</b>	Hannu Heino Nordic ID Myllyojankatu 2.A 24100 Salo FINLAND
<b>Receipt of EUT:</b>	August 13, 2008
<b>Testing date:</b>	December 03, 2008 – February 05, 2009
<b>Report date:</b>	February 06, 2009

The tests listed in this report have been done to demonstrate compliance to the FCC rules section §15.107, §15.109, §15.247 and IC standard RSS-GEN / RSS-210.

### 3 SUMMARY OF TEST RESULTS

#### Bluetooth Transmitter measurements

Section in CFR 47	Section in RSS-210	Test	Result
15.247, a 1	A8.1 (2)	Carrier frequency separation	PASS
15.247, a 1 iii	A8.1 (4)	Number of hopping frequencies	PASS
15.247, a 1 iii	A8.1 (4)	Time of occupancy	PASS
15.247, a	A8.1 (1)	20dB bandwidth	PASS
15.247, b 1	A8.4 (2)	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	A8.5	Spurious radiated emissions	PASS
	RSS-GEN 4.4.1	99% bandwidth	PASS

#### WLAN Transmitter measurements

Section in CFR 47	Section in RSS-210	Test	Result
15.247, a	A8.2 (1)	6dB bandwidth	PASS
15.247, e	A8.2 (1)	Power spectral density	PASS
15.247, b 1	A8.4 (4)	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	A8.5	Spurious radiated emissions	PASS
	RSS-GEN 4.4.1	99% bandwidth	PASS

#### Receiver measurements

Section in CFR 47	Section in RSS-GEN	Section in ICES-003	Test	Result
§15.107	7.2.2	5.3	Conducted emissions to AC-power lines	PASS
§15.109	7.2.3	5.5	Radiated emissions	PASS

PASS Pass

FAIL Fail

X Measured, but there is no applicable performance criteria

- Not done

## 4 EUT INFORMATION

The EUT and accessories used in the tests are listed below. Later in this report only EUT numbers are used as reference.

	Device	Type	S/N	EUT number
<b>EUT</b>	Barcode reader	HTB00001	-	1
	Barcode reader	HTB00001	K083300148	2 *
<b>Accessories</b>	Desktop charger	ACN00069	K084100120	3
	Power supply Nordic Power	SA115C-05	-	4
	Battery Varta Easypack	#66380 711 099	-	5
	Laptop Pc	Dell	-	6
	Printer	HP	-	7
	Mouse	Logitec	-	8

Notes:

\* Antennas replaced with SMA-connectors

### 4.1 EUT description

EUT is battery powered Laser barcode scanner equipped with Wlan and Bluetooth transceivers.

The EUT was equipped with rf-shield on rf-chips.

## 5 EUT TEST SETUPS

For each test the EUT was exercised to find out the worst case of operation modes and device configuration.

Two different test setups were used: one for conducted measurements, another for radiated measurements. One EUT was equipped with an external antenna connector for conductive measurements.

Different operation modes were done with Morphic radiotest software:

Bluetooth TX mode:

Control = Transmit

Test type = 4 pseudo random

Hopping = 0 (off) or 1 (ON)

Freq = 2402 MHz, 2441 MHz or 2480 MHz

Bluetooth RX mode:

Control = Receive

Test type = 4 pseudo random

Hopping = 0 (off) or 1 (ON)

Freq = 2402 MHz, 2441 MHz or 2480 MHz

WLAN TX mode:

Control = TX Burst

CH = 1, 7 or 13

Rate = 11

# packets = 0

BB scaling = 16384

LF att = 3

RF att = 3

WLAN RX mode:

Control = RX continuous

CH = 1, 7 or 13

Type = SINGLETONE\_100kHz

The test setup photographs are in the document referenced in last section.



## 6 APPLICABLE STANDARDS

The tests were performed in guidance of:

CFR 47 Part:

§15.107

§15.109

§15.209

§15.247

ANSI C63.4 (2003)

IC standard:

RSS-GEN, Issue 1

RSS-210, Issue 7

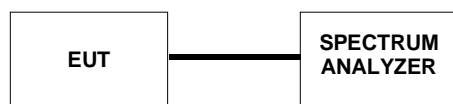
CISPR 22, 2002

Deviations, modifications or clarifications (if any) to above mentioned documents are written in each section under "Test method" for each test case.

## 7 CARRIER FREQUENCY SEPARATION

<b>EUT</b>	2		
<b>Accessories</b>	3,4,5		
<b>Temp, Humidity, Air Pressure</b>	22 °C	31 RH%	986 hPa
<b>Date of measurement</b>	December 3, 2008		
<b>FCC rule part</b>	15.247, a 1		
<b>RSS-210 section</b>	A8.1 (2)		
<b>Measured by</b>	Simo Ojanen		

### 7.1 Test setup and testing method



Picture 1: Test setup for carrier frequency separation measurement

Spectrum analyzer was set to sweep the Bluetooth operating band 2,40 – 2,483 GHz. 30 kHz resolution bandwidth and maximum hold function was used to measure the EUT transmission over sufficient time. Carrier frequency separation was read from the screen.

### 7.2 EUT operation mode

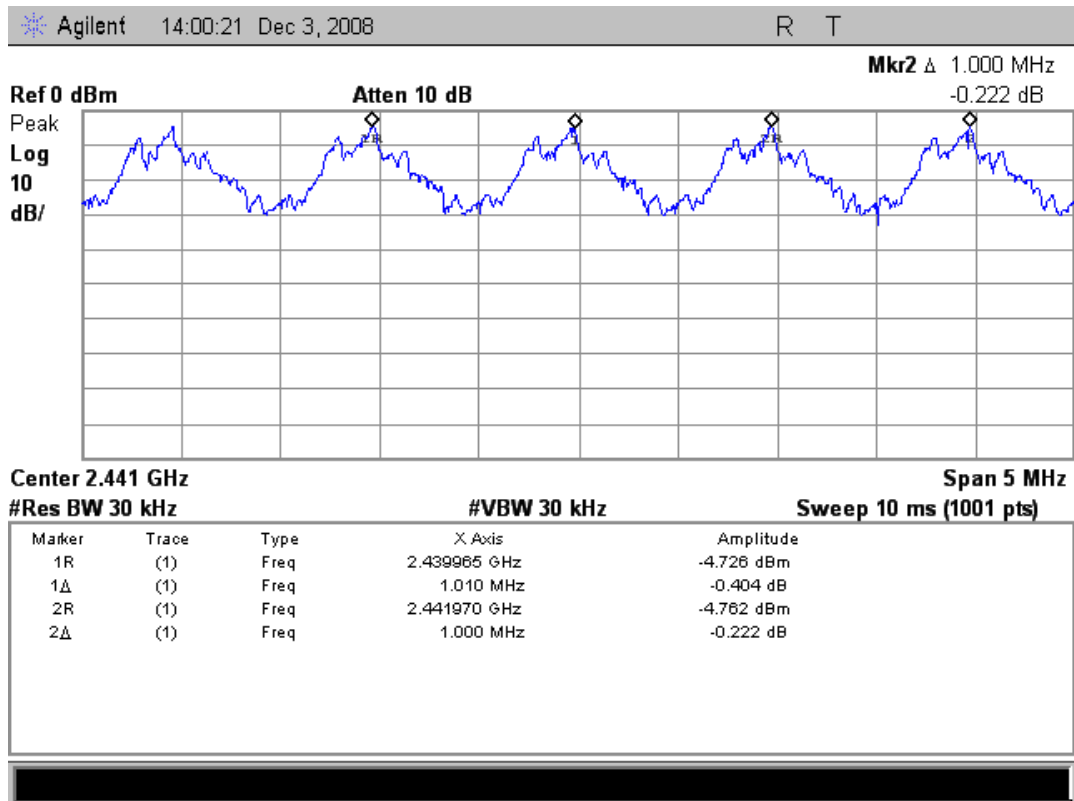
<b>EUT operation mode</b>	Connection, GFSK modulation, PRBS packet type
<b>EUT channel</b>	Hopping
<b>EUT TX power level</b>	max

### 7.3 Bluetooth Results

Table 1: Carrier frequency separation measurement results

Limit	Result
$2/3 * 20\text{dB bandwidth}$	1,00 MHz

7.4 Screen shots

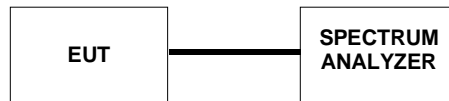


Picture 2: Carrier frequency separation, Channels 38 and 39

## 8 NUMBER OF HOPPING FREQUENCIES

<b>EUT</b>	2		
<b>Accessories</b>	3,4,5		
<b>Temp, Humidity, Air Pressure</b>	22 °C	31 RH%	986 hPa
<b>Date of measurement</b>	December 3, 2008		
<b>FCC rule part</b>	15.247, a 1 iii		
<b>RSS-210 section</b>	A8.1 (4)		
<b>Measured by</b>	Simo Ojanen		

### 8.1 Test setup



Picture 3: Test setup for measurement of number of hopping frequencies

Spectrum analyzer was set to sweep the Bluetooth operating band 2,40 – 2,483 GHz. 300 kHz resolution bandwidth and maximum hold function was used to measure the EUT transmission over sufficient time. Number of hopping frequencies was calculated from the screen.

### 8.2 EUT operation mode

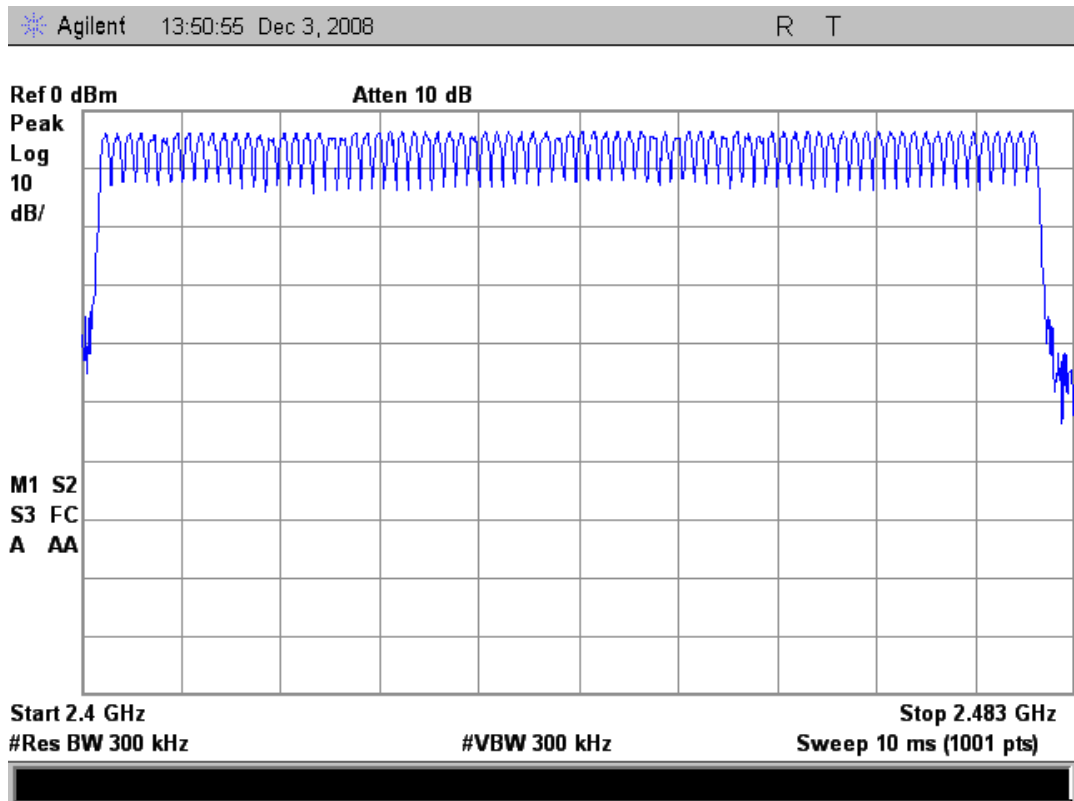
<b>EUT operation mode</b>	Connection, GFSK modulation, PRBS packet type
<b>EUT channel</b>	Hopping
<b>EUT TX power level</b>	max

### 8.3 Bluetooth Results

Table 2: Number of hopping frequencies measurement results

Limit	Result
$\geq 75$	79

### 8.4 Screen shots

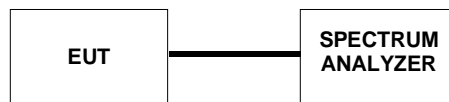


Picture 4: Number of hopping frequencies measurement

## 9 TIME OF OCCUPANCY

<b>EUT</b>	2		
<b>Accessories</b>	3,4,5		
<b>Temp, Humidity, Air Pressure</b>	22 °C	31 RH%	986 hPa
<b>Date of measurement</b>	December 03, 2008		
<b>FCC rule part</b>	15.247, a 1 iii		
<b>RSS-210 section</b>	A8.1 (4)		
<b>Measured by</b>	Simo Ojanen		

### 9.1 Test setup and testing method



Picture 5: Test setup for conducted RF output power measurement

Spectrum analyzer with single sweep and 0 Hz span was used to monitor the transmitter operation over time.

### 9.2 EUT operation mode

<b>EUT operation mode</b>	Connection, GFSK modulation, PRBS packet type
<b>EUT channel</b>	Hopping
<b>EUT TX power level</b>	max

### 9.3 Bluetooth Results

Table 3: Time of occupancy during connection mode measurement results

Limit	Result
≤ 0,4 s over 31,6 s period	0,0344 s

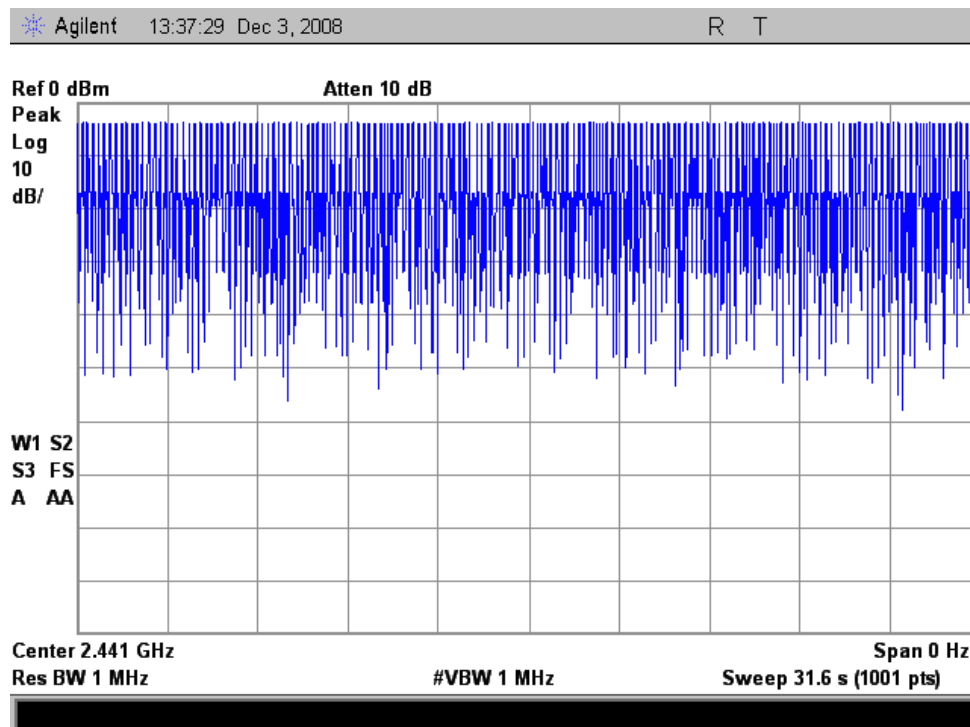
**Limit:**

In the connection mode Bluetooth uses 79 channels. As defined in 15.247, a 1 iii, the limit for time of occupancy is 0.4s over time of number of channels multiplied with 0,4s ( $79 * 0,4s = 31,6 s$ ).

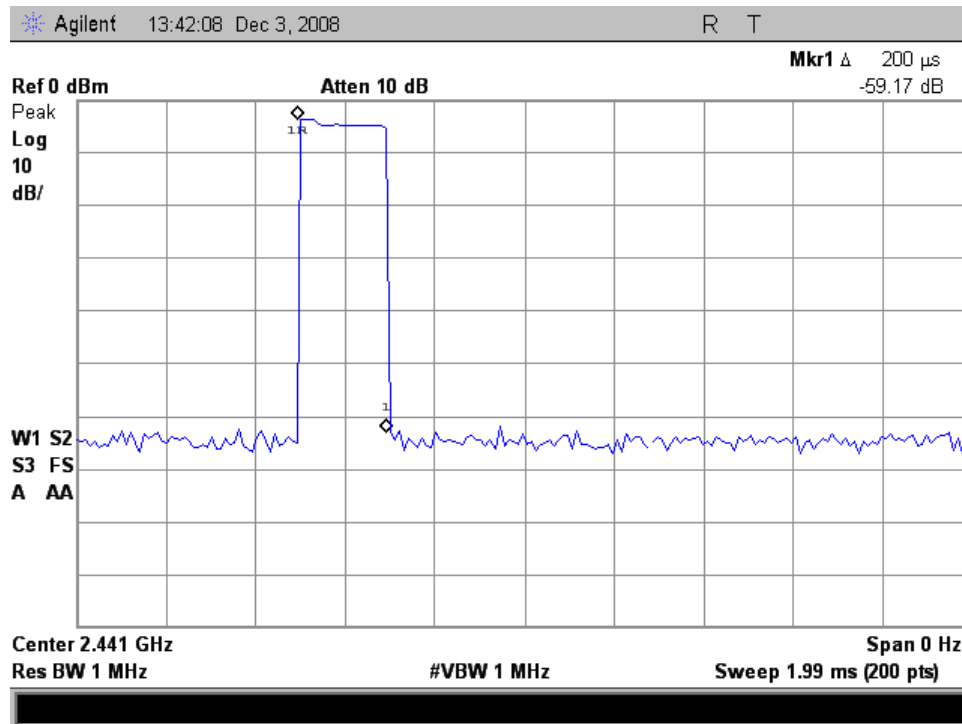
**Results:**

In measurement time of 31,6 s, total of 172 transmissions occurred. The duration of one transmission was 0,2 ms. Based on these measurements the transmitter operated  $172 * 0,2 ms = 0,0344 s$  during the 31,6 s period

#### 9.3.1 Screen shots



Picture 6: Number of transmissions on connection state, channel 39



Picture 7: Duration of one transmission on connection state, channel 39



## 10 20 dB BANDWIDTH

<b>EUT</b>	2		
<b>Accessories</b>	3,4,5		
<b>Temp, Humidity, Air Pressure</b>	22 °C	31 RH%	986 hPa
<b>Date of measurement</b>	December 3, 2008		
<b>FCC rule part</b>	15.247, a		
<b>RSS-210 section</b>	A8.1 (1)		
<b>Measured by</b>	Simo Ojanen		

### 10.1 Test setup and measurement method



Picture 8: Test setup for 20 dB BW measurement

The 20dB bandwidth was measured using 10 kHz resolution bandwidth and maximum hold function of the spectrum analyzer. 20dB bandwidth was defined by measuring the maximum level on the measured channel and by placing delta markers 20 dB below this value and read the value.

### 10.2 EUT operation mode

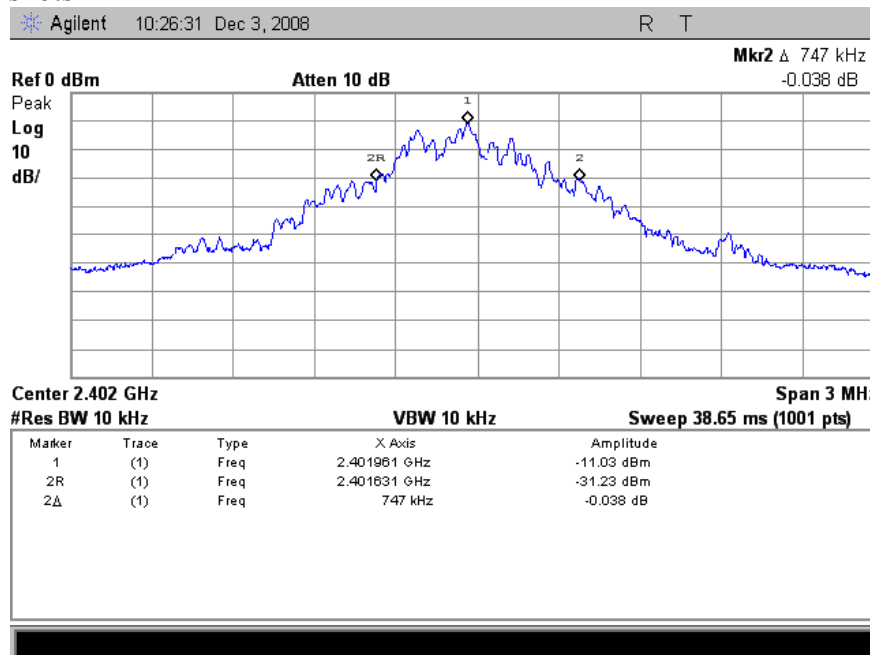
<b>EUT operation mode</b>	Connection, GFSK modulation, PRBS packet type
<b>EUT channel</b>	0, 39 and 78
<b>EUT TX power level</b>	max

### 10.3 Bluetooth Results

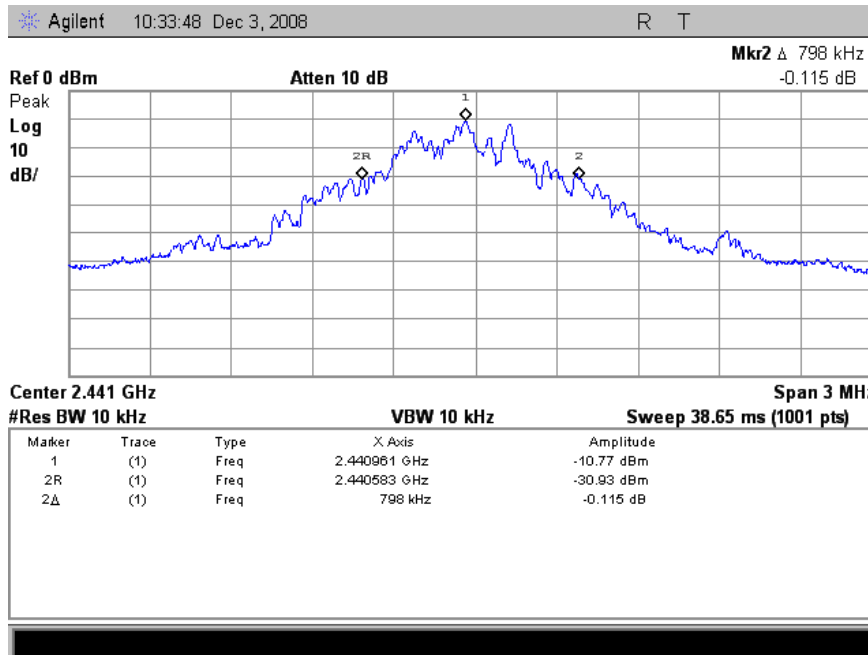
Table 4: 20dB bandwidth measurement results

EUT Channel	Limit (MHz)	Measured value (MHz)
0	≤ 1,0	0,747
39		0,798
78		0,753

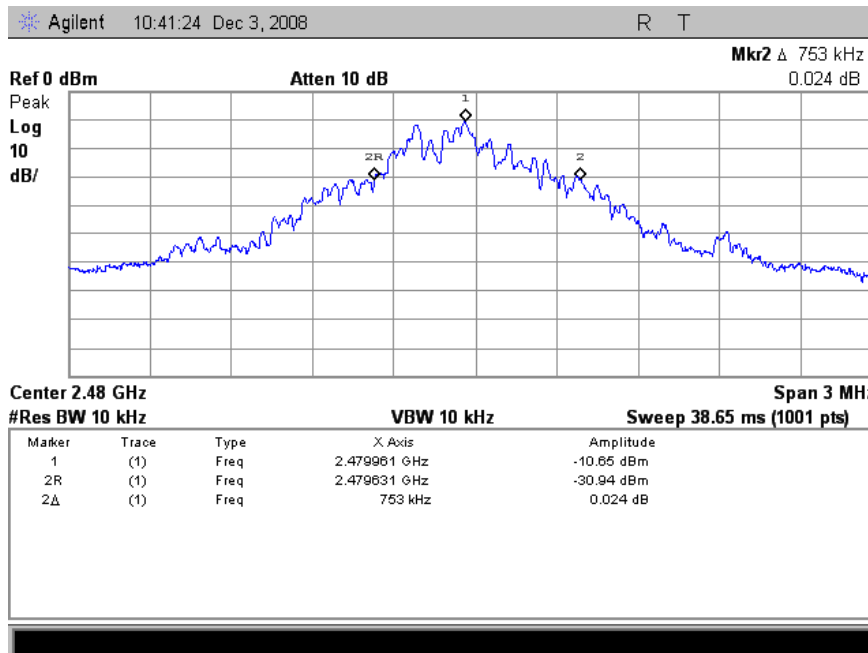
### 10.4 Screen shots



Picture 9: 20dB Bandwidth measurement result, Channel 0



Picture 10: 20dB Bandwidth measurement result, Channel 39



Picture 11: 20dB Bandwidth measurement result, Channel 78

## 11 PEAK OUTPUT POWER

<b>EUT</b>	2		
<b>Accessories</b>	3,4,5		
<b>Temp, Humidity, Air Pressure</b>	22 °C	31 RH%	986 hPa
<b>Date of measurement</b>	December 3, 2008		
<b>FCC rule part</b>	15.247, b 1		
<b>RSS-210 section</b>	A8.4 (2)		
<b>Measured by</b>	Simo Ojanen		

### 11.1 Test setup and measurement method



Picture 12: Test setup for peak output power measurement

In the peak output power measurement the power cable attenuation was measured prior to the power measurement and set as parameter for cable loss in the spectrum analyzer to correct the reading of the peak output power. Spectrum analyzer subtracts the set attenuation value from the measured reading.

The measurement was made using 3 MHz resolution bandwidth and 3 MHz video bandwidth and maximum hold function to record the maximum peak output power.

### 11.2 EUT operation mode

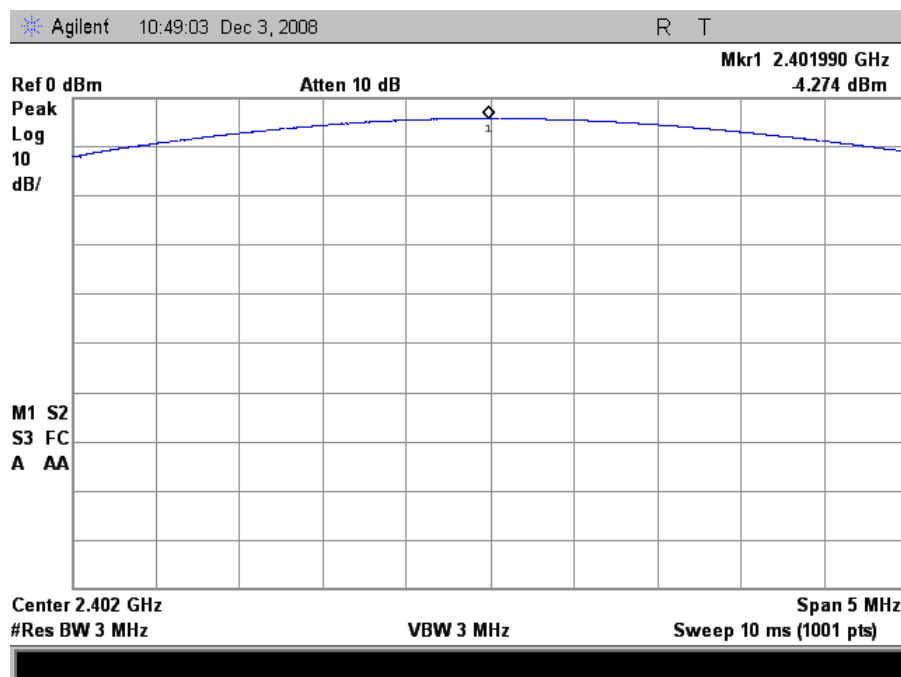
<b>EUT operation mode</b>	Connection, GFSK modulation, PRBS packet type
<b>EUT channel</b>	0, 39 and 78
<b>EUT TX power level</b>	max

### 11.3 Bluetooth Results

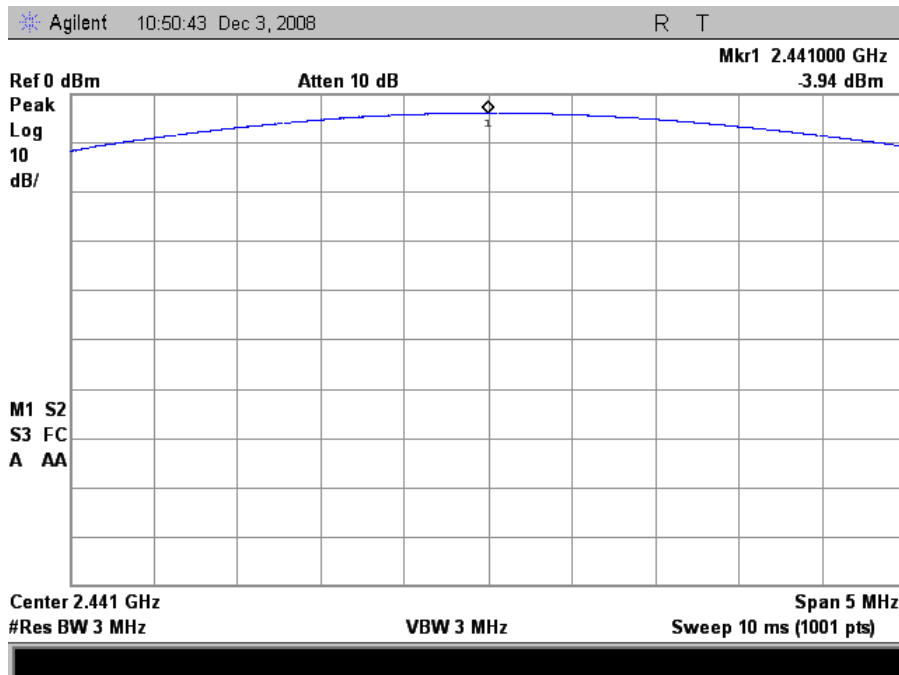
Table 5: Peak output power measurement results

EUT Channel	Limit (W)	Test result (W)	Limit (dBm)	Test result (dBm)
0	≤ 1	0,00037	≤ 30	-4,3
39		0,00040		-3,9
78		0,00040		-4,0

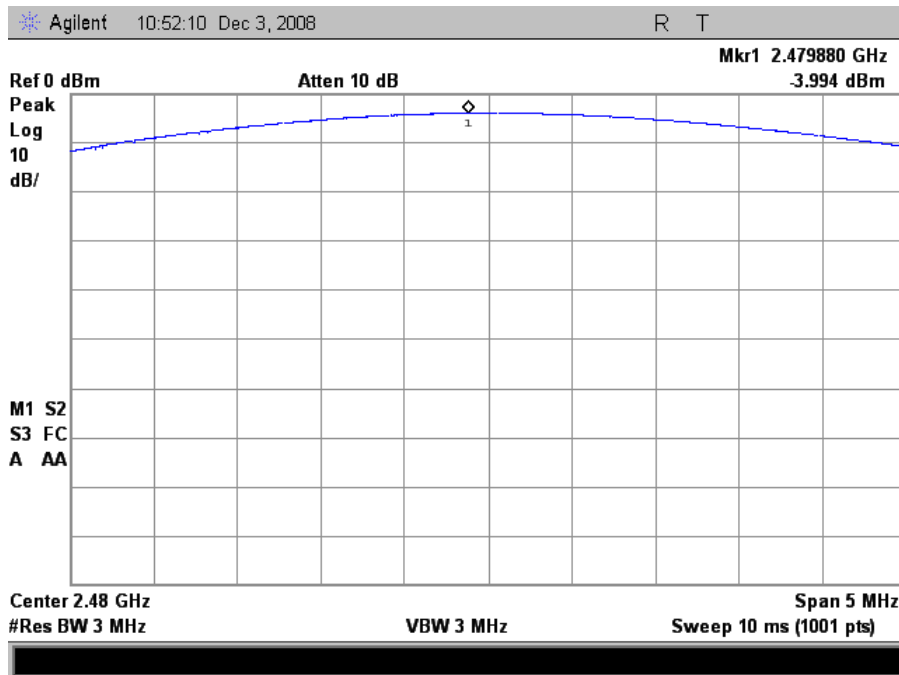
### 11.4 Screen shots



Picture 13: Peak output power, channel 0



Picture 14: Peak output power, channel 39

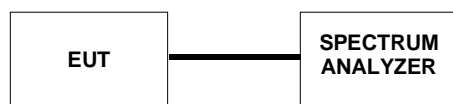


Picture 15: Peak output power, channel 78

## 12 BAND-EDGE COMPLIANCE OF RF CONDUCTED EMISSIONS

<b>EUT</b>	2		
<b>Accessories</b>	3,4,5		
<b>Temp, Humidity, Air Pressure</b>	22 °C	31 RH%	986 hPa
<b>Date of measurement</b>	December 3, 2008		
<b>FCC rule part</b>	15.247, d		
<b>RSS-210 section</b>	A8.5		
<b>Measured by</b>	Simo Ojanen		

### 12.1 Test setup and measurement method



Picture 16: Test setup for band edge compliance measurement

Band edge compliance of RF-conducted emissions was measured by setting the band edge as center frequency in the spectrum analyzer and measuring the power on the transmission on channels 0 and 79. The measured power and power on the band edge was then compared.

### 12.2 Hopping enabled

#### 12.2.1 EUT operation mode

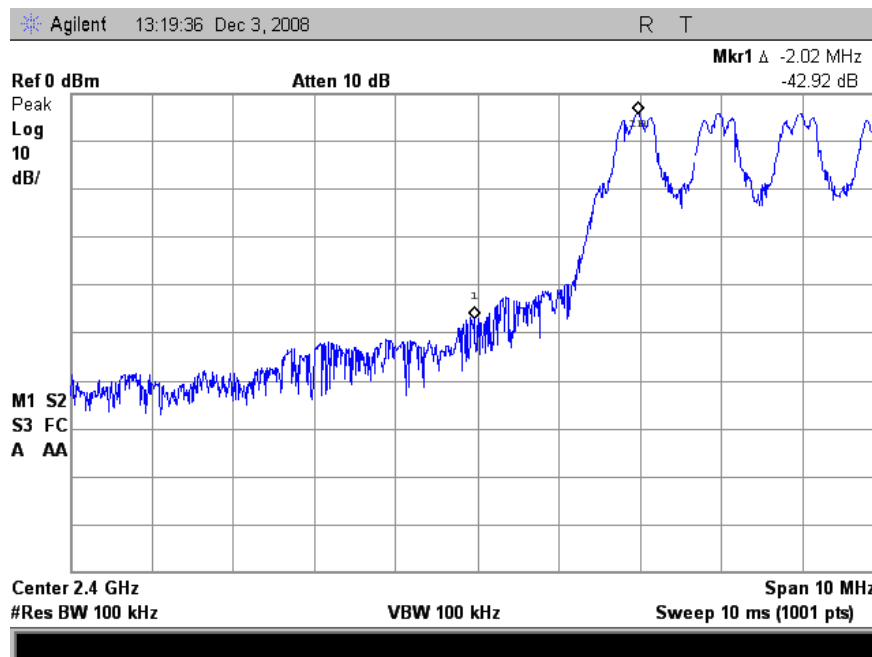
<b>EUT operation mode</b>	Connection, GFSK modulation, PRBS packet type
<b>EUT channel</b>	Hopping
<b>EUT TX power level</b>	max

#### 12.2.2 Bluetooth Results

Table 6: Number of hopping frequencies measurement results

<b>EUT Channel</b>	<b>Limit (dBc)</b>	<b>Test result (dBc)</b>
0	≤ -20	-42,9
78		-46,3

12.2.3 Screen shots



Picture 17: Band edge compliance, channel 0, hopping enabled



Picture 18: Band edge compliance, channel 78, hopping enabled



### 12.3 Hopping disabled

#### 12.3.1 EUT operation mode

<b>EUT operation mode</b>	Connection, GFSK modulation, PRBS packet type
<b>EUT channel</b>	0 (2402 MHz), 78 (2480 MHz)
<b>EUT TX power level</b>	max

#### 12.3.2 Bluetooth Results

Table 7: Band edge compliance measurement results

EUT Channel	Limit (dBc)	Test result (dBc)
0	≤ -20	-42,7
78		-46,2

#### 12.3.3 Screen shots



Picture 19: Band edge compliance, channel 0, hopping disabled

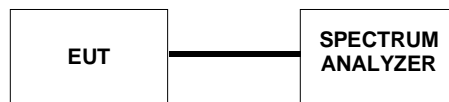


Picture 20: Band edge compliance, channel 78, hopping disabled

### 13 99 % BANDWIDTH

<b>EUT</b>	2		
<b>Accessories</b>	3,4,5		
<b>Temp, Humidity, Air Pressure</b>	22 °C	31 RH%	986 hPa
<b>Date of measurement</b>	December 3, 2008		
<b>FCC rule part</b>			
<b>RSS-GEN section</b>	4.4.1		
<b>Measured by</b>	Simo Ojanen		

#### 13.1 Test setup and measurement method



Picture 21: Test setup for 99% BW measurement

The 99% occupied bandwidth was calculated from spectrum analyzer measurements. The measurement data was read from the analyzer to computer. Software in computer calculated the total power from the measurement data and defined the frequency band containing 99% of the total power. Markers in the spectrum analyzer were then placed between the calculated frequencies to show the calculated 99% power band in the screenshots.

#### 13.2 EUT operation mode

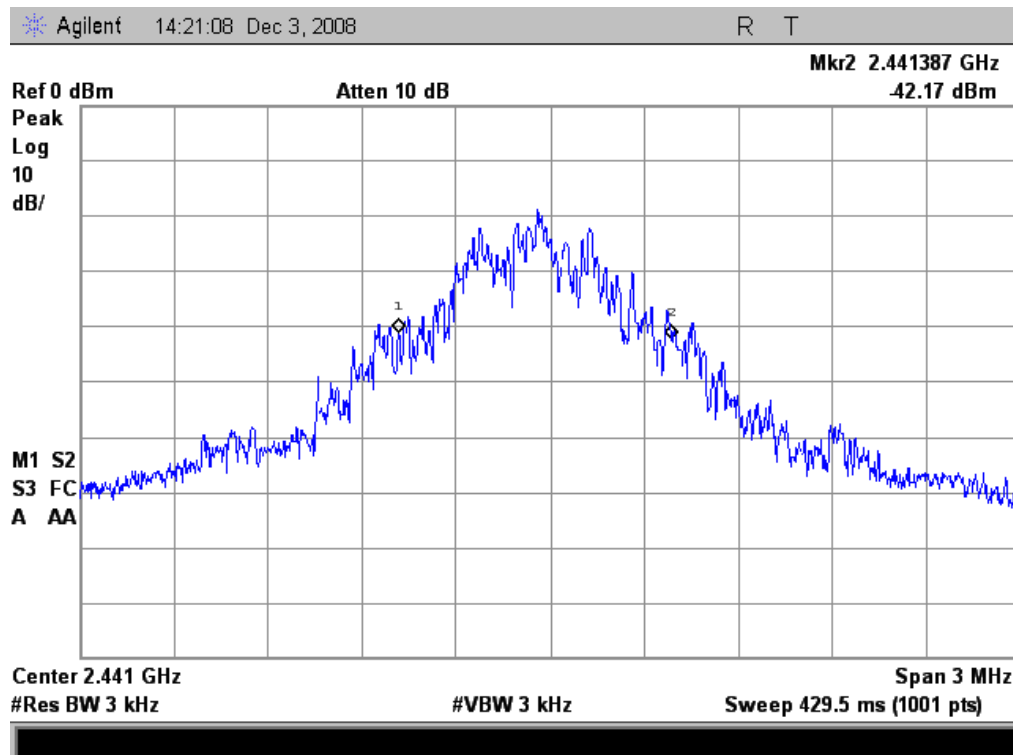
<b>EUT operation mode</b>	Continuous transmission
<b>EUT frequency</b>	2441 MHz
<b>EUT TX power level</b>	Max. (Software configuration)

### 13.3 Bluetooth Results

Table 8: 99% bandwidth measurement results

EUT Frequency MHz	Limit MHz	Measured value MHz
2441	-	0,87

### 13.4 Screen shots



Picture 22: 99% Bandwidth measurement result

## 14 SPURIOUS RF CONDUCTED EMISSIONS

<b>EUT</b>	2		
<b>Accessories</b>	3,4,5		
<b>Temp, Humidity, Air Pressure</b>	23 °C	26 RH%	983 hPa
<b>Date of measurement</b>	December 4, 2008		
<b>FCC rule part</b>	15.247, d		
<b>RSS-210 section</b>	A8.5		
<b>Measured by</b>	Simo Ojanen		

### 14.1 Test setup and measurement method



Picture 23: Test setup for spurious RF conducted emission measurement

Spectrum analyzer and automated software were used to record conducted spurious emissions on frequency range 30 MHz – 25 GHz. Frequency range was scanned using 100 kHz resolution bandwidth and 50 kHz steps.

Spurious emissions levels relative to the carrier level were read from the measured results.

### 14.2 EUT operation mode

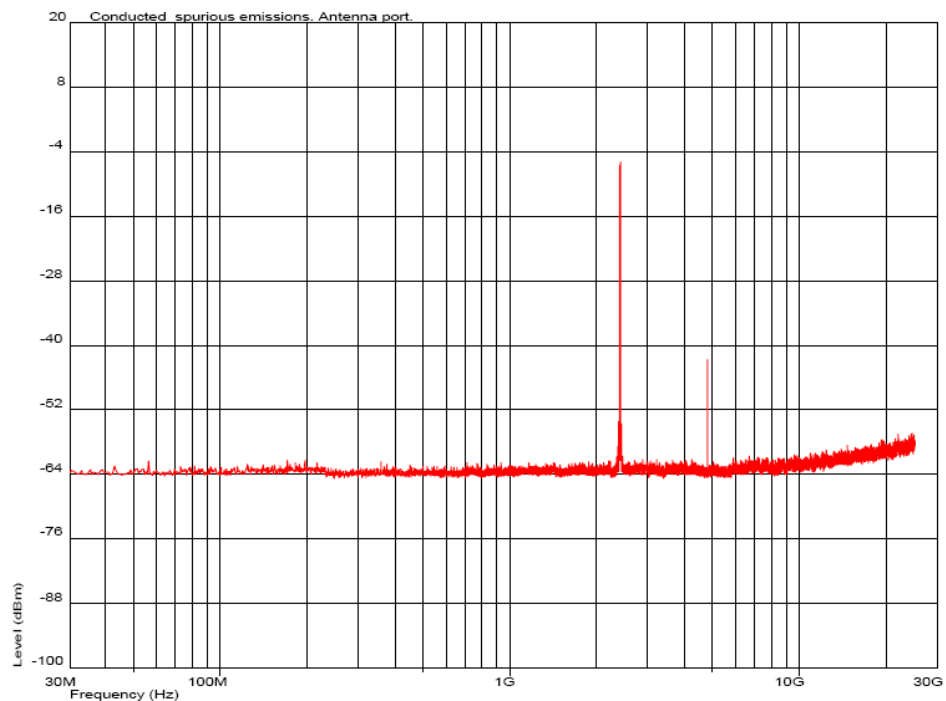
<b>EUT operation mode</b>	Connection, GFSK modulation, PRBS packet type
<b>EUT channel</b>	0 (2402 MHz), 39 (2441 MHz) and 78 (2480 MHz)
<b>EUT TX power level</b>	max

### 14.3 Limit

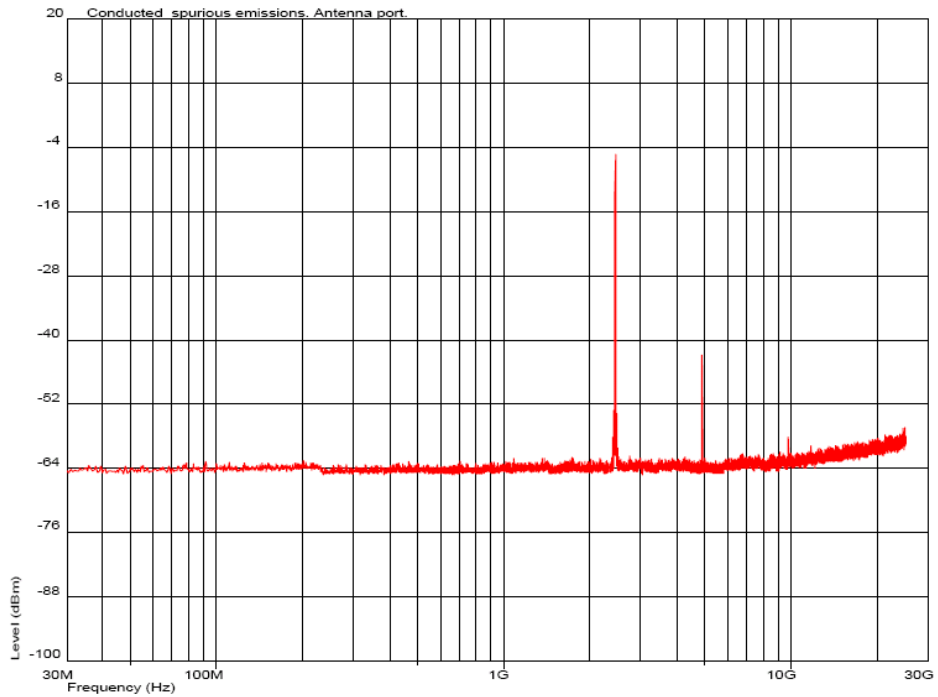
EUT Channel	Limit (dBc)
0	≤ -20
39	
78	

### 14.4 Bluetooth Results

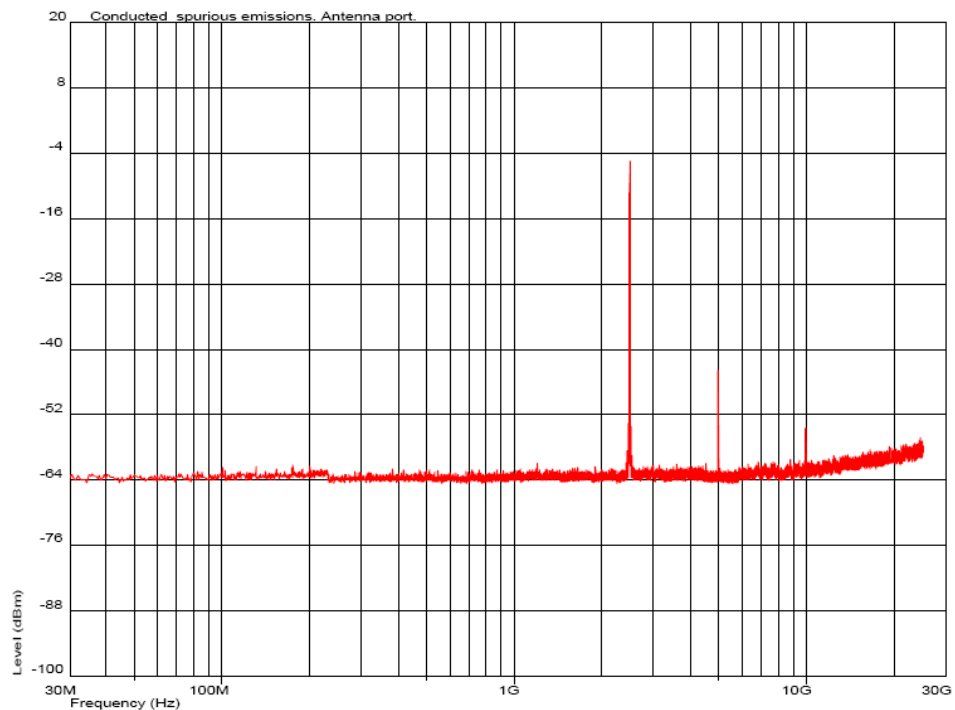
All spurious emissions measured were at least 35 dB below the carrier level.



Picture 24: Conducted spurious emissions on antenna port, Channel 0



Picture 25: Conducted spurious emissions on antenna port, Channel 39



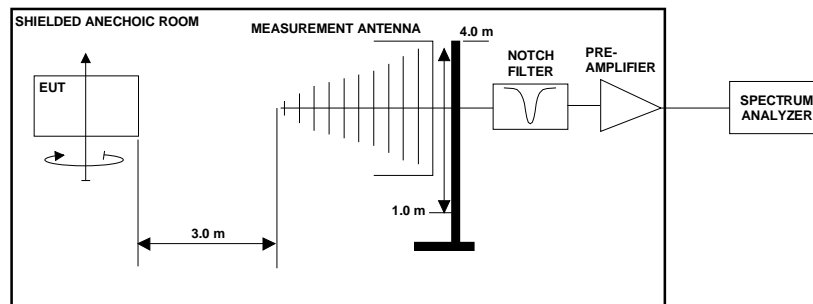
Picture 26: Conducted spurious emissions on antenna port, Channel 78

## 15 RADIATED SPURIOUS EMISSIONS

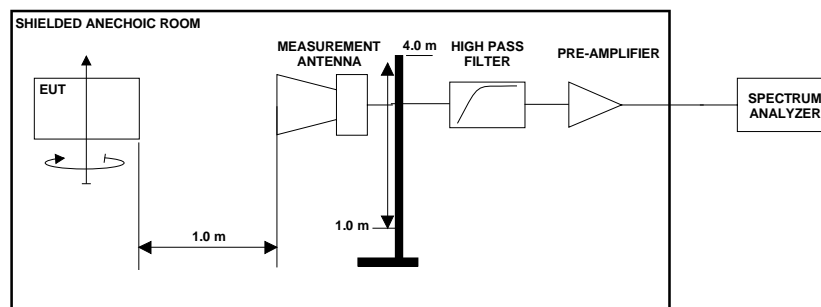
<b>EUT</b>	1		
<b>Accessories</b>	3,4,5		
<b>Temp, Humidity, Air Pressure</b>	23 °C	26 RH%	983 hPa
<b>Date of measurement</b>	December 4 – December 5, 2008		
<b>FCC rule part</b>	15.247, d		
<b>RSS-210 section</b>	A8.5		
<b>Measured by</b>	Simo Ojanen		

### 15.1 Test setup

The test was done using an automated test system, where a computer controlled the measurement equipment.



Picture 27: Test setup for radiated spurious emissions measurement  
30 MHz - 3 GHz frequencies



Picture 28: Test setup for radiated spurious emissions measurement  
3 GHz – 25 GHz frequencies



## 15.2 Test method

1. The emissions were searched and maximized by moving the turntable, changing the measuring antenna polarization and height and manipulating the EUT.
2. Levels of suspicious signals and levels of EUT transmitter harmonics were recorded.
3. The recorded levels were corrected in the automated test system with the measurement antenna factor, cable attenuations and filter attenuation.
4. The corrected values, giving the EUT radiated spurious emission levels as dB $\mu$ V/m at 3 m distance, are reported.

## 15.3 EUT operation mode

<b>EUT operation mode</b>	Connection, GFSK modulation, PRBS packet type
<b>EUT channel</b>	0 (2402 MHz), 39 (2441 MHz) and 78 (2480 MHz)
<b>EUT TX power level</b>	max

## 15.4 Limit

Table 9: Radiated spurious emission limits at measurement distance 3m

<b>Frequency band (MHz)</b>	<b>3m Limit (<math>\mu</math>V/m)</b>	<b>3m Limit (dB<math>\mu</math>V/m)</b>	<b>Detector</b>
30 – 88	100	40	QP
88 -216	150	43,5	QP
216 - 960	200	46	QP
960 - 1000	500	54,0	QP
1000 - 25000	500	54,0	AVG
1000 - 25000	5000	74,0	PEAK

As default, all emissions were compared against the general limits. If any emission exceeded that limit, it was further checked, if it was outside the restricted band thus complying with the -20dBc requirement.

## 15.5 Bluetooth Results

Measurement system noise level was at least 15 dB below the spurious emission limit. Only levels of suspicious signals and transmitter harmonic frequencies, which were above the measurement system noise, are reported.

Table 10: Emission levels PEAK (QP) detector, BT channel 0

Freq MHz	Measured Value dBuV	Correction Factor dB	Result dBuV/m	Marginal dB	EUT Position	Ant Pol.	Ant height
720,06	43,5	1,50	45,0	0,9	Pos 1	Ver	1,5
960,06	39,2	5,46	44,7	9,3	Pos 1	Ver	1,6
4804	48,5	-15,89	32,6	41,3	Pos 1	Ver	1,5

Table 11: Emission levels PEAK (QP) detector, BT channel 39

Freq MHz	Measured Value dBuV	Correction Factor dB	Result dBuV/m	Marginal dB	EUT Position	Ant Pol.	Ant height
720,06	41,5	1,50	43,0	2,9	Pos 1	Ver	1,6
960,06	39,3	5,46	44,8	9,2	Pos 1	Ver	1
4882	47,8	-15,68	32,2	41,7	Pos 1	Hor	1,45
4934	51,4	-15,54	35,9	38,0	Pos 1	Hor	1

Table 12: Emission levels PEAK (QP) detector, BT channel 78

Freq MHz	Measured Value dBuV	Correction Factor dB	Result dBuV/m	Marginal dB	EUT Position	Ant Pol.	Ant height
720,06	43,4	1,50	44,9	1,0	Pos 1	Ver	1,5
960,06	38,8	5,46	44,2	9,7	Pos 1	Ver	1,7
4934	47,9	-15,54	32,3	41,6	Pos 1	Hor	1,5
4960	48,8	-15,47	33,4	40,5	Pos 1	Ver	1,05

Table 13: Emission levels AVERAGE detector, BT channel 0

Freq MHz	Measured Value dBuV	Correction Factor dB	Result dBuV/m	Marginal dB	EUT Position	Ant Pol.	Ant height
4804	34,7	-15,8	18,8	35,1	Pos 1	Ver	1,5

Table 14: Emission levels AVERAGE detector, BT channel 39

Freq MHz	Measured Value dBuV	Correction Factor dB	Result dBuV/m	Marginal dB	EUT Position	Ant Pol.	Ant height
4882	33,9	-15,6	18,3	35,7	Pos 1	Hor	1,45
4934	44,8	-15,5	29,2	24,7	Pos 1	Hor	1

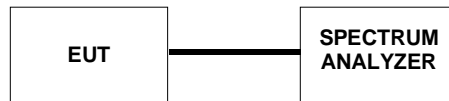
Table 15: Emission levels AVERAGE detector, BT channel 78

Freq MHz	Measured Value dBuV	Correction Factor dB	Result dBuV/m	Marginal dB	EUT Position	Ant Pol.	Ant height
4934	35,4	-15,54	19,9	34,0	Pos 1	Hor	1,5
4960	34,5	-15,47	19,0	34,9	Pos 1	Ver	1,05

## 16 6 dB BANDWIDTH

<b>EUT</b>	2		
<b>Accessories</b>	3,4,5		
<b>Temp, Humidity, Air Pressure</b>	22 °C	31 RH%	986 hPa
<b>Date of measurement</b>	December 3, 2008 & February 6, 2009		
<b>FCC rule part</b>	15.247, a		
<b>RSS-210 section</b>	A8.2 (1)		
<b>Measured by</b>	Simo Ojanen / Matti Virkki		

### 16.1 Test setup and measurement method



Picture 29: Test setup for conducted RF output measurement

The 6 dB bandwidth was measured using 100 kHz resolution bandwidth and maximum hold function of the spectrum analyzer. 6 dB bandwidth was defined by measuring the maximum level on the measured channel and by placing delta markers 6 dB below this value and by reading the bandwidth from the marker.

### 16.2 EUT operation mode

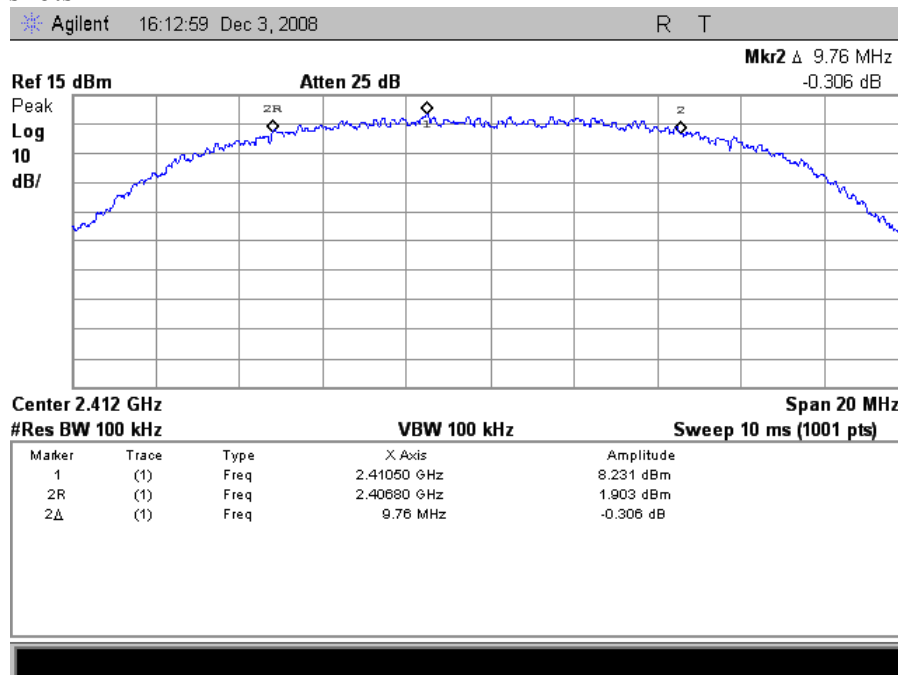
<b>EUT operation mode</b>	DSSS mode, BPSK modulation, 11 Mbps data rate
<b>EUT channel</b>	1, 7 and 11
<b>EUT TX power level</b>	max

### 16.3 WLAN Results

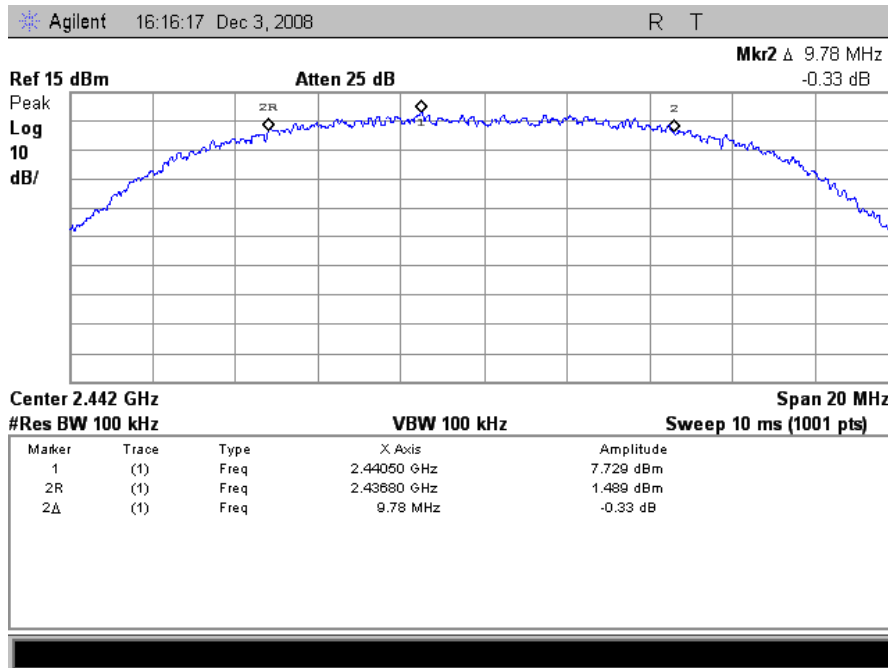
Table 16: 6 dB bandwidth measurement results

EUT Channel	Limit (MHz)	Measured value (MHz)
1	≥ 0,5	9,7
7		9,7
11		9,7

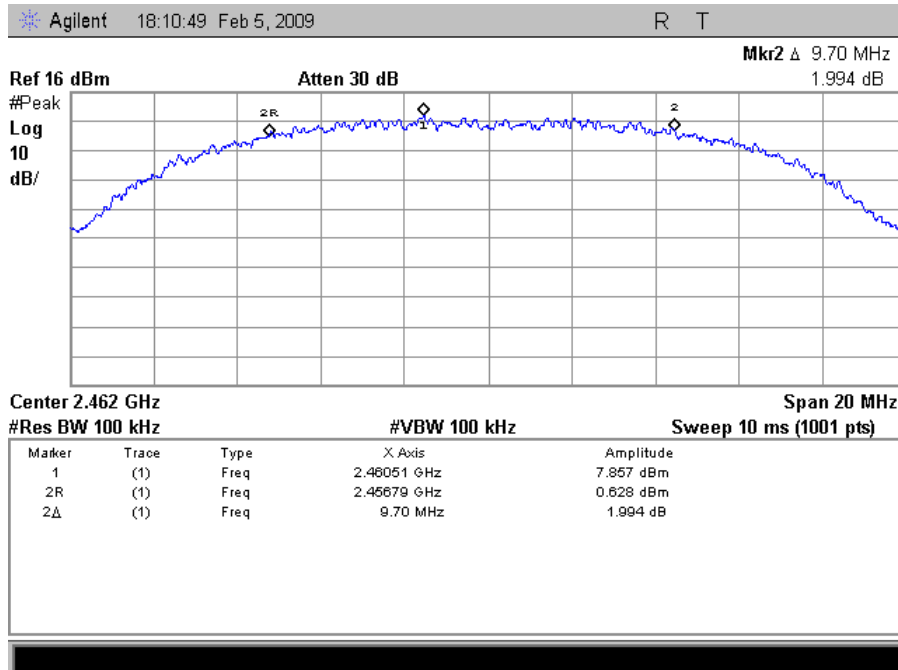
### 16.4 Screen shots



Picture 30: 6dB Bandwidth measurement result, Channel 1



Picture 31: 6dB Bandwidth measurement result, Channel 7



Picture 32: 6dB Bandwidth measurement result, Channel 11

## 17 PEAK OUTPUT POWER

<b>EUT</b>	2		
<b>Accessories</b>	3,4,5		
<b>Temp, Humidity, Air Pressure</b>	22 °C	31 RH%	986 hPa
<b>Date of measurement</b>	February 5, 2008		
<b>FCC rule part</b>	15.247, b 1		
<b>RSS-210 section</b>	A8.4 (2)		
<b>Measured by</b>	Matti Virkki		

### 17.1 Test setup and measurement method



Picture 33: Test setup for conducted RF output power measurement

In the peak output power measurement the cable attenuations were measured prior to the power measurement and set as parameter for cable in the spectrum analyzer to correct the reading of the peak output power. Spectrum analyzer subtracts the set cable loss value from the measured reading.

The measurement was made using spectrum analyzer's band power measurement function.

### 17.2 EUT operation mode

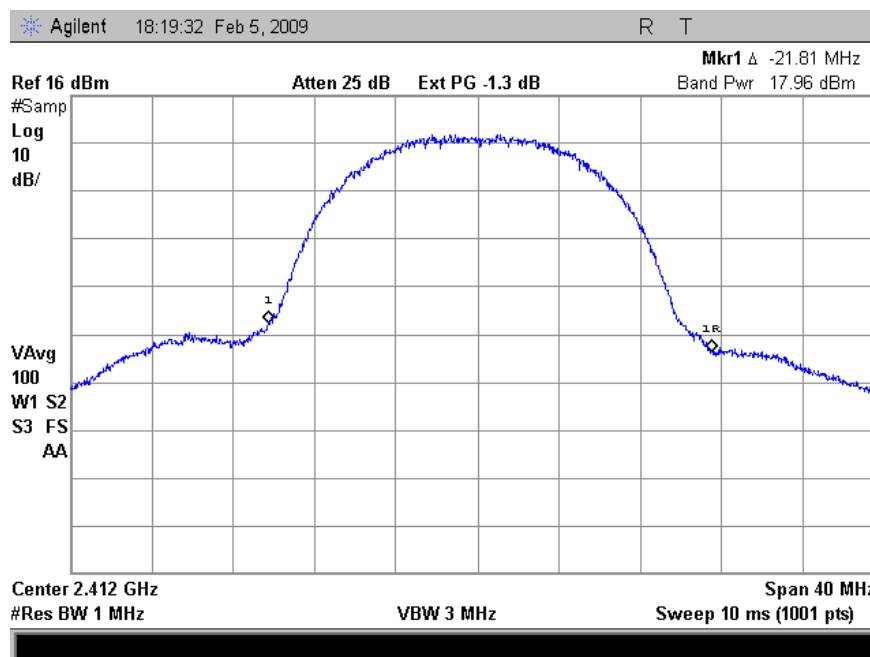
<b>EUT operation mode</b>	DSSS mode, BPSK modulation, 11 Mbps data rate
<b>EUT channel</b>	1, 7 and 11
<b>EUT TX power level</b>	max

### 17.3 WLAN Results

Table 17: Peak output power measurement results

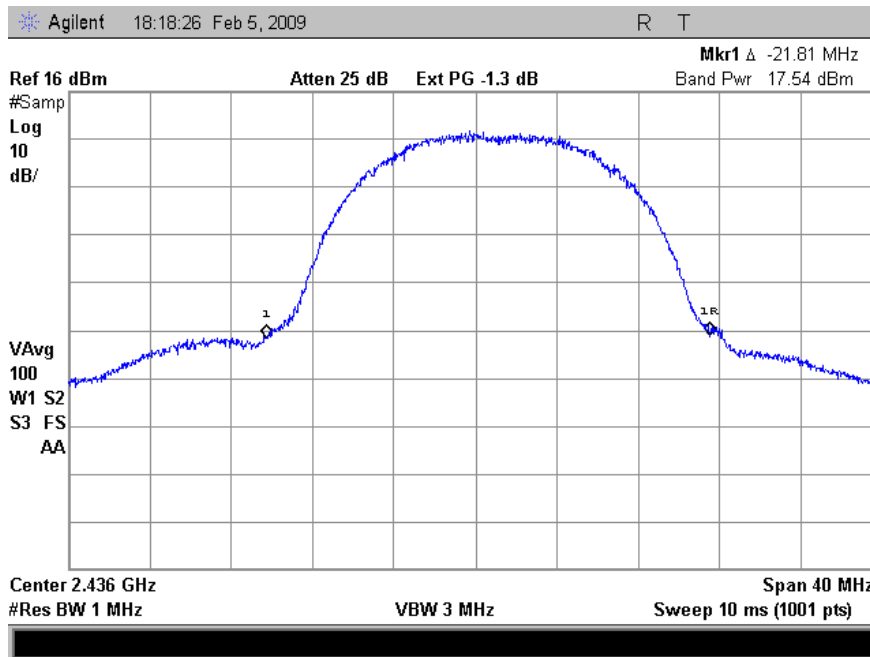
EUT Channel	Limit (W)	Test result (W)	Limit (dBm)	Test result (dBm)
1	≤ 1	0,063	≤ 30	18,0
7		0,056		17,5
11		0,050		17,0

### 17.4 Screen shots

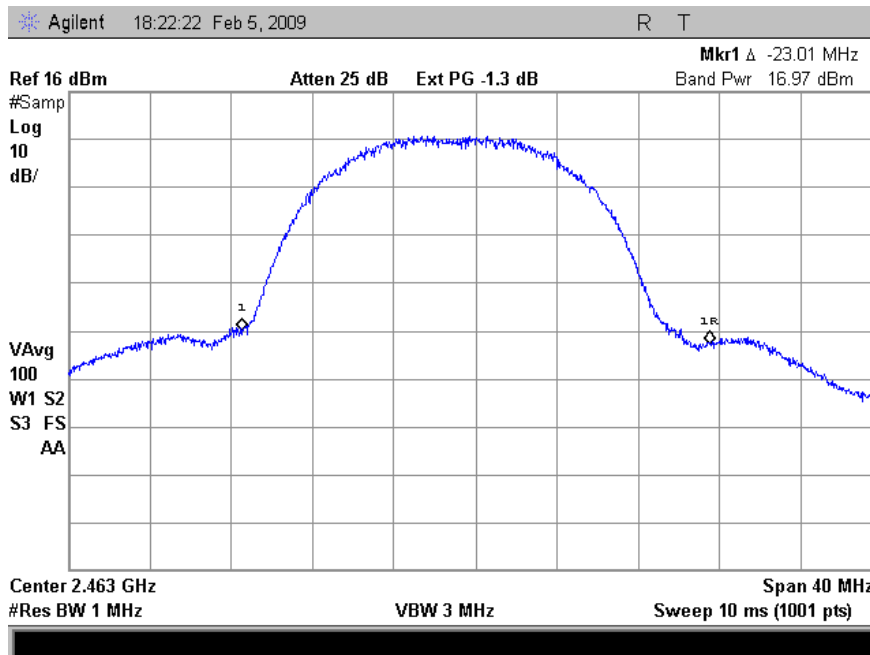


Picture 34: Peak output power, channel 1





Picture 35: Peak output power, channel 7

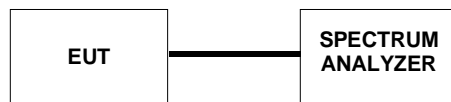


Picture 36: Peak output power, channel 11

## 18 BAND-EDGE COMPLIANCE OF RF CONDUCTED EMISSIONS

<b>EUT</b>	2		
<b>Accessories</b>	3,4,5		
<b>Temp, Humidity, Air Pressure</b>	22 °C	31 RH%	986 hPa
<b>Date of measurement</b>	December 3, 2008 & February 6, 2009		
<b>FCC rule part</b>	15.247, d		
<b>RSS-210 section</b>	A8.5		
<b>Measured by</b>	Simo Ojanen / Matti Virkki		

### 18.1 Test setup and measurement method



Picture 37: Test setup for band edge compliance measurement

Band edge compliance of RF-conducted emissions was measured by setting the band edge as center frequency in the spectrum analyzer and measuring the power on the transmission on channels 1 and 11. The measured power and power on the band edge was then compared.

## 18.2 EUT operation mode

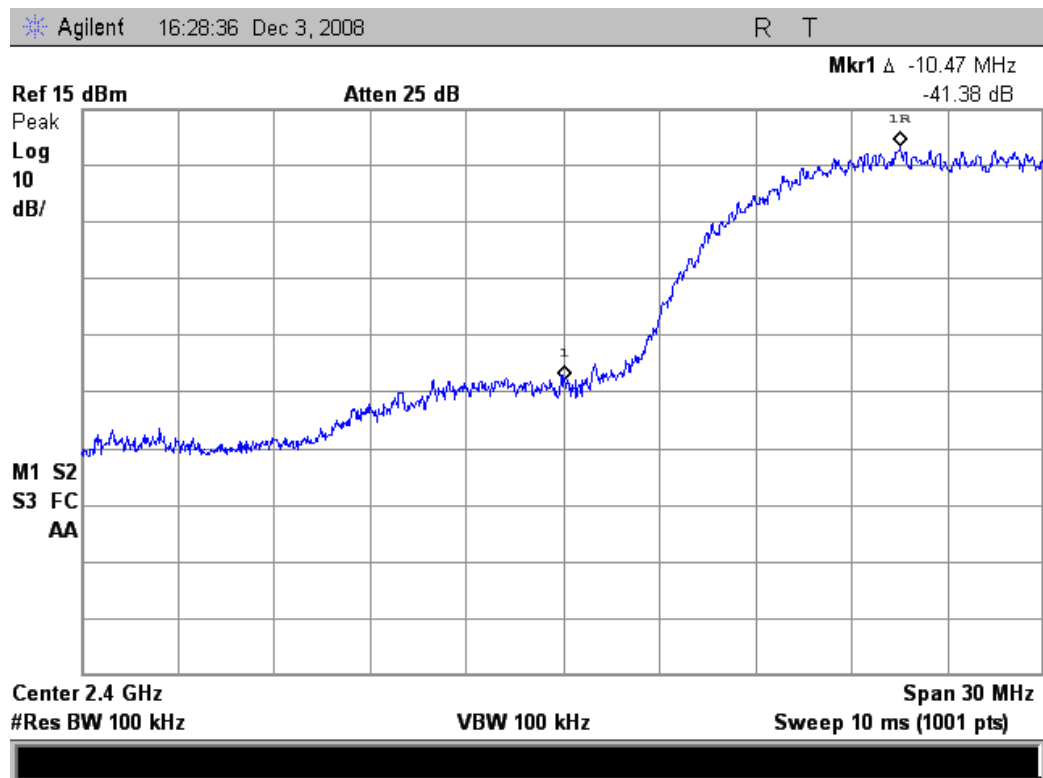
<b>EUT operation mode</b>	DSSS mode, BPSK modulation, 11 Mbps data rate
<b>EUT channel</b>	1 and 11
<b>EUT TX power level</b>	max

## 18.3 WLAN Results

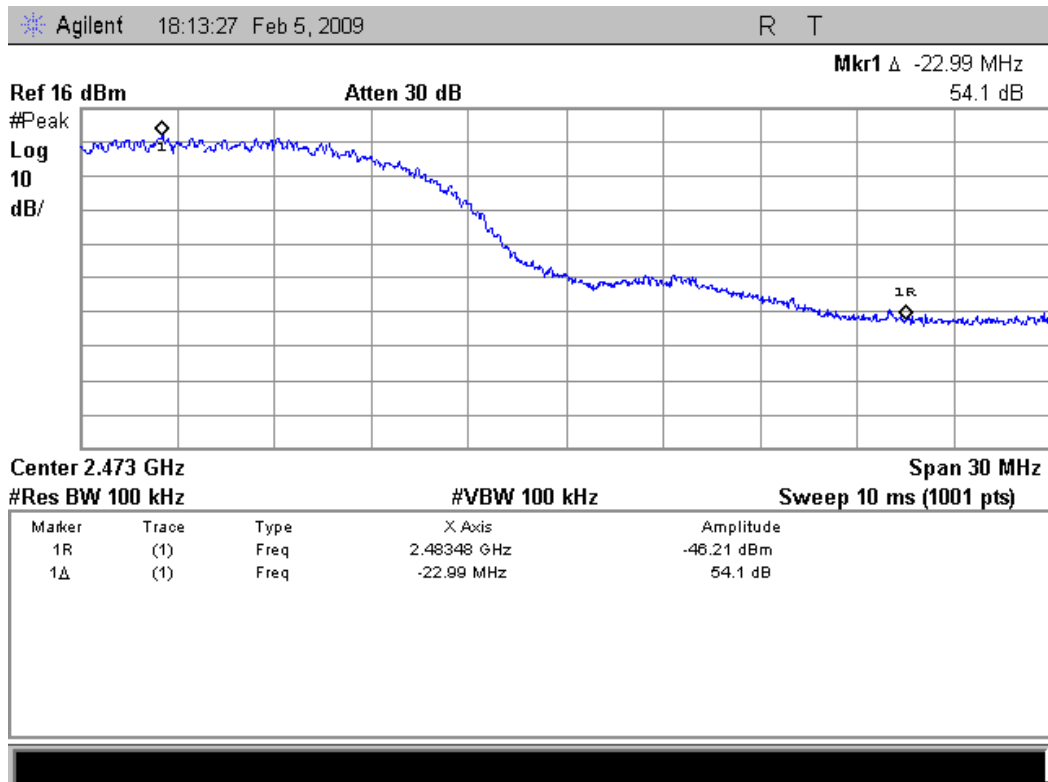
Table 18: Number of hopping frequencies measurement results

EUT Channel	Limit (dBc)	Test result (dBc)
1	≤ -20	-41,3
11		-54,1

## 18.4 Screen shots



Picture 38: Band edge compliance, channel 1

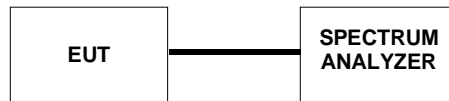


Picture 39: Band edge compliance, channel 11

## 19 POWER SPECTRAL DENSITY

<b>EUT</b>	2		
<b>Accessories</b>	3,4,5		
<b>Temp, Humidity, Air Pressure</b>	22 °C	31 RH%	986 hPa
<b>Date of measurement</b>	December 3, 2008 & February 6, 2009		
<b>FCC rule part</b>	15.247, e		
<b>RSS-210 section</b>	A8.2 (2)		
<b>Measured by</b>	Simo Ojanen / Matti Virkki		

### 19.1 Test setup and measurement method



Picture 40: Test setup for conducted RF output power measurement

In the peak output power measurement the cable attenuations were measured prior to the power measurement and set as parameter for cable in the spectrum analyzer to correct the reading of the peak output power. Spectrum analyzer subtracts the set cable loss value from the measured reading.

The measurement was made by first finding the maximum of emission with wide enough measurement span to cover the whole transmitter spectrum. The maximum was centered to spectrum analyzer display. RBW was set to 3 kHz and VBW to 10kHz. Power spectral density was measured with peak detector, free run trigger and trace average 100 traces.

## 19.2 EUT operation mode

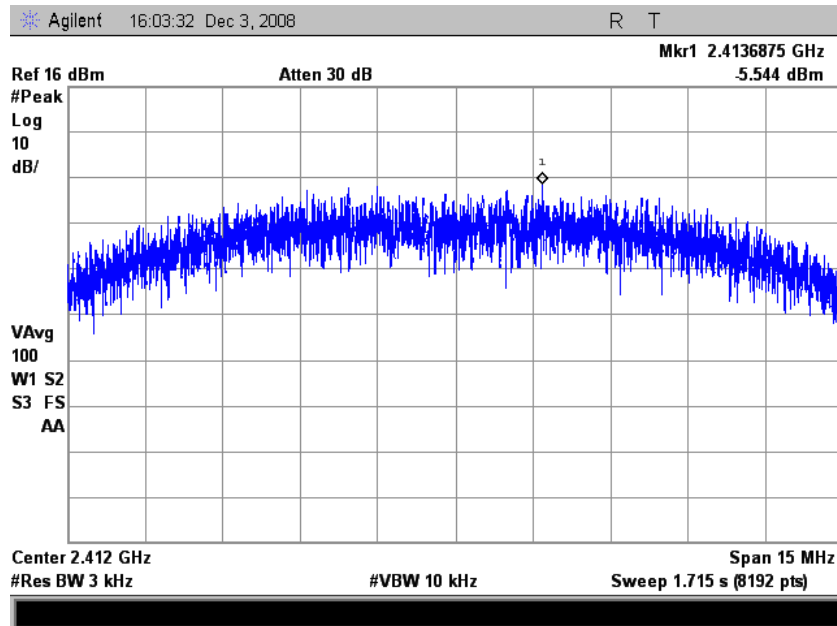
<b>EUT operation mode</b>	DSSS mode, BPSK modulation, 11 Mbps data rate
<b>EUT channel</b>	1, 7 and 11
<b>EUT TX power level</b>	max

## 19.3 WLAN Results

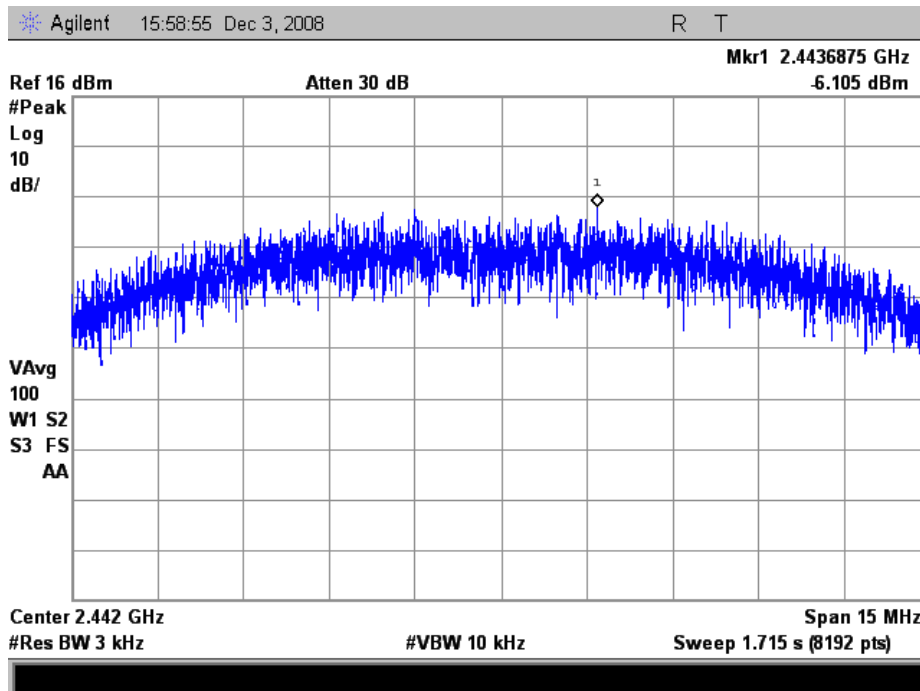
Table 19: Power spectral density results

EUT Channel	Limit (dBm @ 3kHz)	Test result (dBm)
1	$\leq 8$	-5,5
7		-6,1
11		-4,4

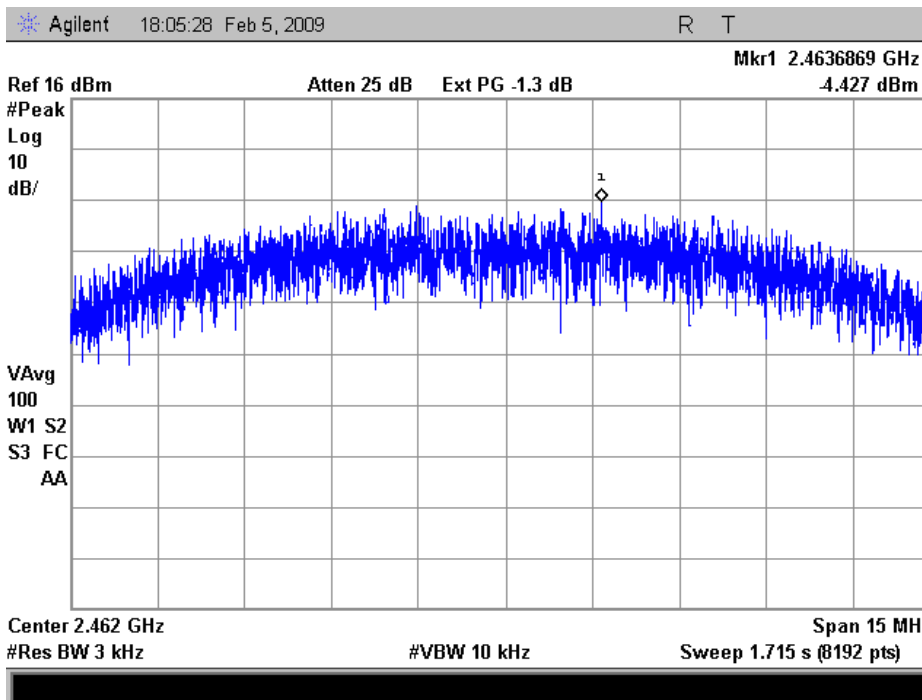
## 19.4 Screen shots



Picture 41: Power spectral density, channel 1



Picture 42: Power spectral density, channel 7



Picture 43: Power spectral density, channel 11

## 20 99 % BANDWIDTH

<b>EUT</b>	2		
<b>Accessories</b>	3,4,5		
<b>Temp, Humidity, Air Pressure</b>	22 °C	31 RH%	986 hPa
<b>Date of measurement</b>	December 3, 2008		
<b>FCC rule part</b>			
<b>RSS-GEN section</b>	4.4.1		
<b>Measured by</b>	Simo Ojanen		

### 20.1 Test setup and measurement method

The 99% occupied bandwidth was calculated from spectrum analyzer measurements. The measurement data was read from the analyzer to computer. Software in computer calculated the total power from the measurement data and defined the frequency band containing 99% of the total power. Markers in the spectrum analyzer were then placed between the calculated frequencies to show the calculated 99% power band in the screenshots.

### 20.2 EUT operation mode

<b>EUT operation mode</b>	DSSS mode, BPSK modulation, 11 Mbps data rate
<b>EUT frequency</b>	2442
<b>EUT TX power level</b>	Max. (Software configuration)

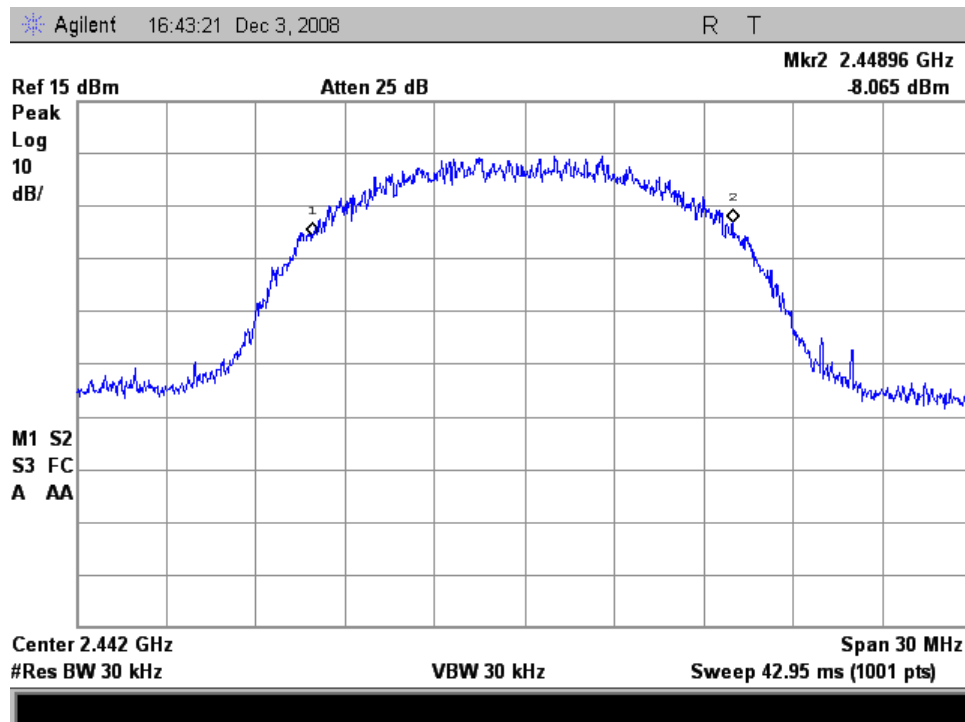


### 20.3 WLAN Results

Table 20: 99% bandwidth measurement results

EUT Frequency MHz	Limit MHz	Measured value MHz
2442	-	14,04

### 20.4 Screen shots

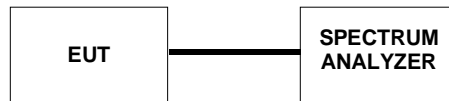


Picture 44: 99% Bandwidth measurement result

## 21 SPURIOUS RF CONDUCTED EMISSIONS

<b>EUT</b>	2		
<b>Accessories</b>	3,4,5		
<b>Temp, Humidity, Air Pressure</b>	23 °C	26 RH%	983 hPa
<b>Date of measurement</b>	December 4, 2008		
<b>FCC rule part</b>	15.247, d		
<b>RSS-210 section</b>	A8.5		
<b>Measured by</b>	Simo Ojanen		

### 21.1 Test setup and measurement method



Picture 45: Test setup for band edge compliance measurement

Spectrum analyzer and automated software were used to record conducted spurious emissions on frequency range 30 MHz – 25 GHz. Frequency range was scanned using 100 kHz resolution bandwidth and 50 kHz steps.

Spurious emissions levels relative to the carrier level were read from the measured results.

### 21.2 EUT operation mode

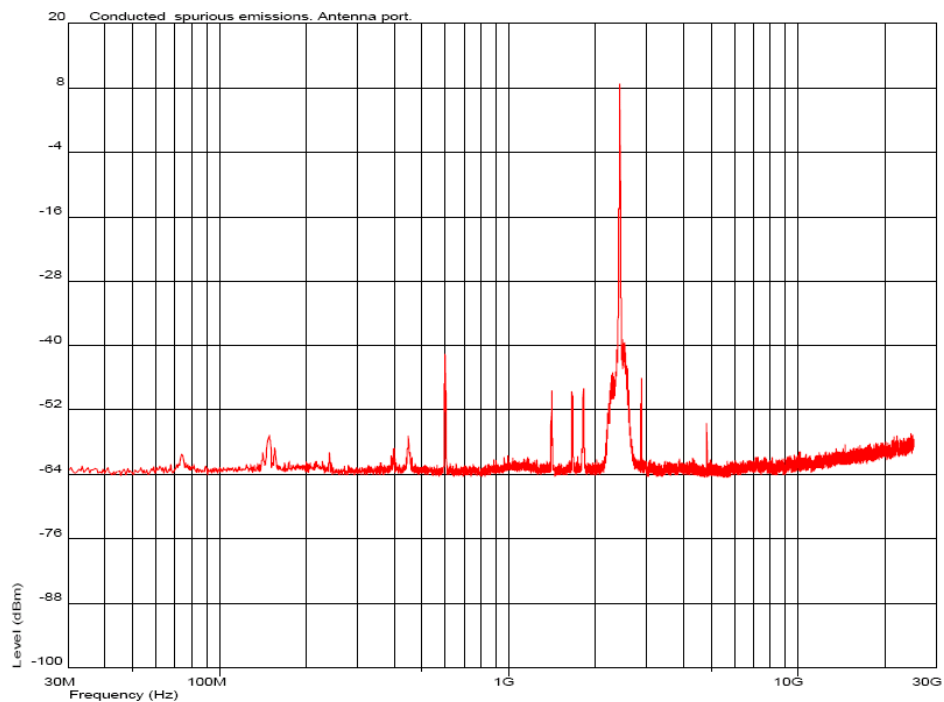
<b>EUT operation mode</b>	DSSS mode, BPSK modulation, 11 Mbps data rate
<b>EUT channel</b>	1, 7 and 13
<b>EUT TX power level</b>	max

### 21.3 Limit

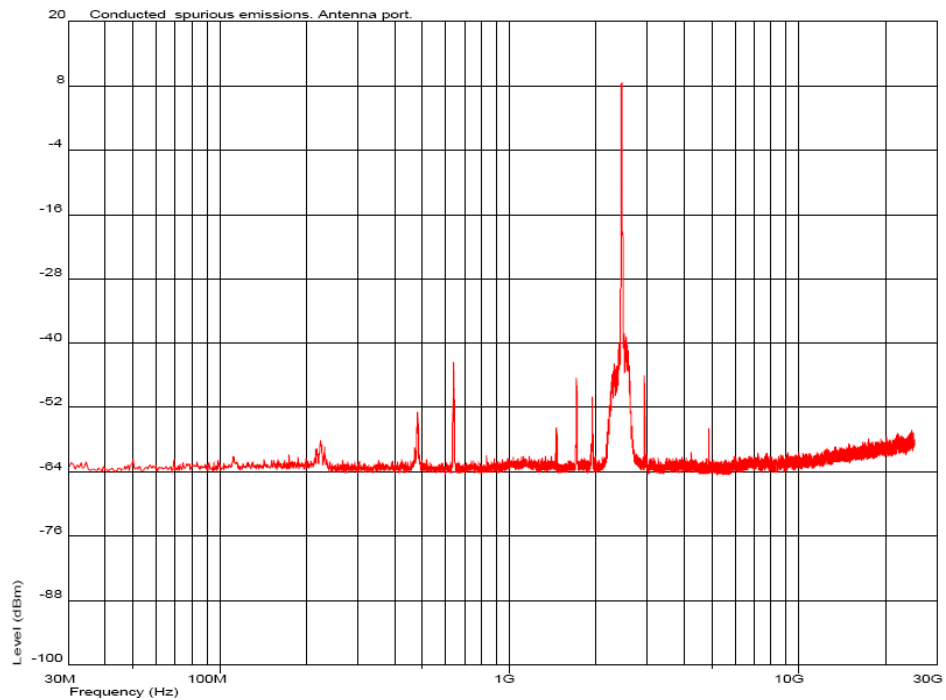
EUT Channel	Limit (dBc)
1	≤ -20
7	
13	

### 21.4 WLAN Results

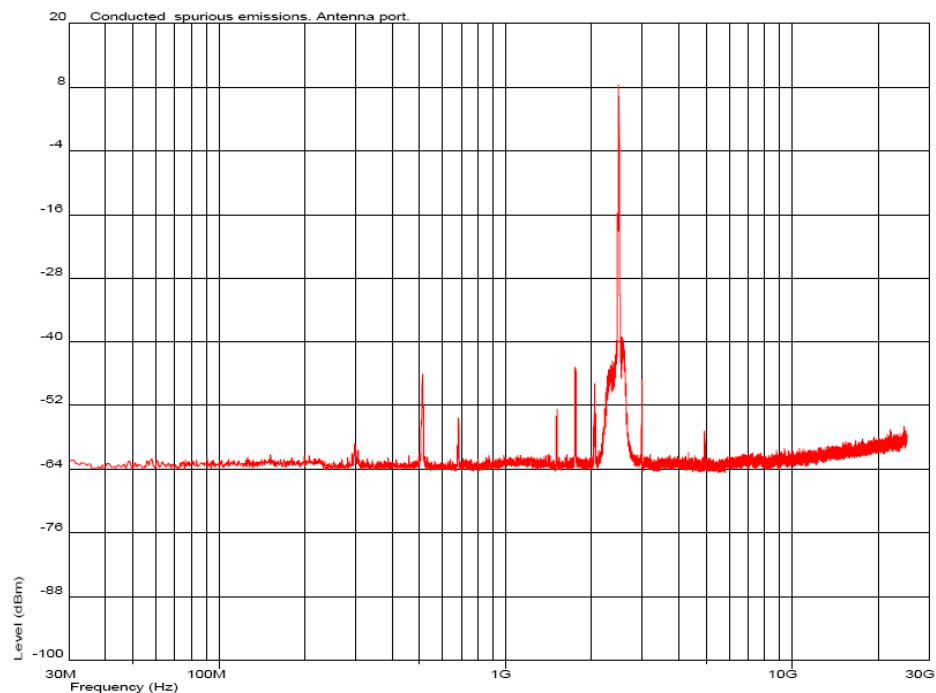
All spurious emissions measured were least 45 dB below the carrier level.



Picture 46: Conducted spurious emissions on antenna port, Channel 1



Picture 47: Conducted spurious emissions on antenna port, Channel 7



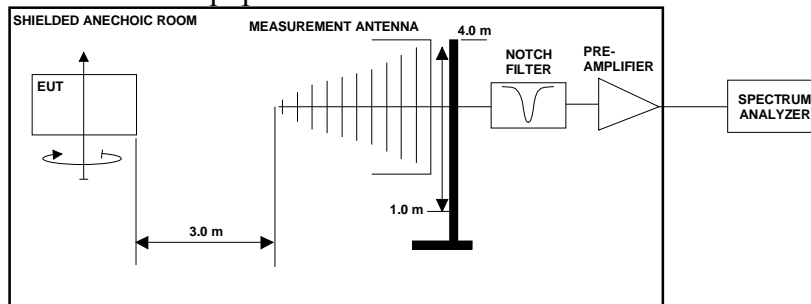
Picture 48: Conducted spurious emissions on antenna port, Channel 13

## 22 RADIATED SPURIOUS EMISSIONS

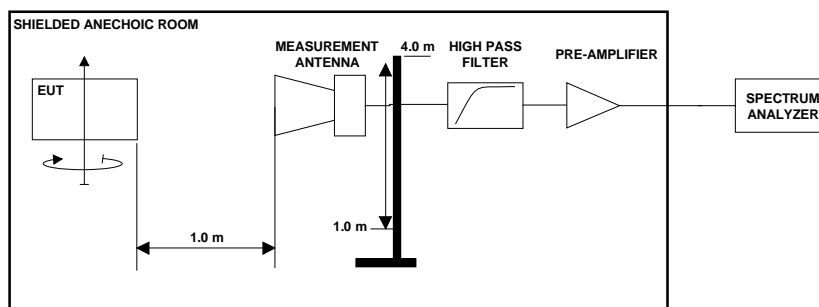
<b>EUT</b>	1		
<b>Accessories</b>	3,4,5		
<b>Temp, Humidity, Air Pressure</b>	23 °C	26 RH%	983 hPa
<b>Date of measurement</b>	December 4 – December 5, 2008		
<b>FCC rule part</b>	15.247, d		
<b>RSS-210 section</b>	A8.5		
<b>Measured by</b>	Simo Ojanen		

### 22.1 Test setup

The test was done using an automated test system, where a computer controlled the measurement equipment.



Picture 49: Test setup for radiated spurious emissions measurement  
30 MHz - 3 GHz frequencies



Picture 50: Test setup for radiated spurious emissions measurement  
3 GHz – 25 GHz frequencies

## 22.2 Test method

5. The emissions were searched and maximized by moving the turntable, changing the measuring antenna polarization and height and manipulating the EUT.
6. Levels of suspicious signals and levels of EUT transmitter harmonics were recorded.
7. The recorded levels were corrected in the automated test system with the measurement antenna factor, cable attenuations and filter attenuation.
8. The corrected values, giving the EUT radiated spurious emission levels as dB $\mu$ V/m at 3 m distance, are reported.

## 22.3 EUT operation mode

<b>EUT operation mode</b>	DSSS mode, BPSK modulation, 11 Mbps data rate
<b>EUT channel</b>	1, 7 and 13
<b>EUT TX power level</b>	max

## 22.4 Limit

Table 21: Radiated spurious emission limits at measurement distance 3m

Frequency band (MHz)	3m Limit ( $\mu$ V/m)	3m Limit (dB $\mu$ V/m)	Detector
30 – 88	100	40	QP
88 -216	150	43,5	QP
216 - 960	200	46	QP
960 - 1000	500	54,0	QP
1000 - 25000	500	54,0	AVG
1000 - 25000	5000	74,0	PEAK

As default, all emissions were compared against the general limits. If any emission exceeded that limit, it was further checked, if it was outside the restricted band thus complying with the -20dBc requirement.

## 22.5 WLAN Results

Measurement system noise level was at least 15 dB below the spurious emission limit. Only levels of suspicious signals and transmitter harmonic frequencies, which were above the measurement system noise, are reported.

Table 22: Emission levels PEAK (QP) detector, WLAN channel 1

Freq MHz	Measured Value dBuV	Correction Factor dB	Result dBuV/m	Marginal dB	EUT Position	Ant Pol.	Ant height
54,30	28,3	-10,50	17,8	22,1	Pos 1	Ver	1,3
720,06	43,7	1,50	45,2	0,7	Pos 1	Ver	1,5
960,06	39,9	5,46	45,4	8,5	Pos 1	Ver	1,6
4824	52,4	-15,83	36,5	37,4	Pos 1	Hor	1,15
9648	53,0	-5,62	47,4	26,5	Pos 1	Hor	1

Table 23: Emission levels PEAK (QP) detector, WLAN channel 7

Freq MHz	Measured Value dBuV	Correction Factor dB	Result dBuV/m	Marginal dB	EUT Position	Ant Pol.	Ant height
720,06	43,8	1,50	45,3	0,6	Pos 1	Ver	1,5
960,06	39,9	5,46	45,4	8,5	Pos 1	Ver	1,6
4884	53,0	-15,67	37,3	36,6	Pos 1	Hor	1,05
9768	51,7	-5,48	46,2	27,7	Pos 1	Hor	1,45

Table 24: Emission levels PEAK (QP) detector, WLAN channel 13

Freq MHz	Measured Value dBuV	Correction Factor dB	Result dBuV/m	Marginal dB	EUT Position	Ant Pol.	Ant height
720,06	44,0	1,50	45,5	0,5	Pos 1	Ver	1,5
960,06	39,9	5,46	45,4	8,5	Pos 1	Ver	1,6
4944	51,9	-15,51	36,4	37,5	Pos 1	Hor	1,05
7884	45,3	-5,03	40,3	33,6	Pos 1	Ver	1,3
9888	54,5	-5,14	49,4	24,5	Pos 1	Hor	1,05

Table 25: Emission levels AVERAGE detector, WLAN channel 1

Freq MHz	Measured Value dBuV	Correction Factor dB	Result dBuV/m	Marginal dB	EUT Position	Ant Pol.	Ant height
4824	45,5	-15,83	29,7	24,2	Pos 1	Hor	1,15
9648	49,3	-5,62	43,7	10,2	Pos 1	Hor	1

Table 26: Emission levels AVERAGE detector, WLAN channel 7

Freq MHz	Measured Value dBuV	Correction Factor dB	Result dBuV/m	Marginal dB	EUT Position	Ant Pol.	Ant height
4884	44,8	-15,67	29,1	24,8	Pos 1	Hor	1,05
9768	47,2	-5,48	41,7	12,2	Pos 1	Hor	1,45

Table 27: Emission levels AVERAGE detector, WLAN channel 13

Freq MHz	Measured Value dBuV	Correction Factor dB	Result dBuV/m	Marginal dB	EUT Position	Ant Pol.	Ant height
4944	44,7	-15,51	29,2	24,7	Pos 1	Hor	1,05
7884	29,6	-5,03	24,6	29,3	Pos 1	Ver	1,3
9888	51,1	-5,14	46,0	7,9	Pos 1	Hor	1,05



## 23 CONDUCTED EMISSIONS TO AC-MAINS

<b>EUT</b>	1		
<b>Accessories</b>	3,4,5,6,7,8		
<b>Temp, Humidity, Air Pressure</b>	23 °C	31 RH%	1009 hPa
<b>Date of measurement</b>	December 3, 2008		
<b>FCC rule part</b>	§15.107		
<b>RSS-GEN section</b>	7.2.2		
<b>ICES-003 section</b>	5.3		
<b>Measured by</b>	Simo Ojanen		

### 23.1 Test setup

Charger was connected to line impedance stabilization network and conducted emissions to AC-mains were measured using measurement receiver. Laptop was connected to chargers USB interface.

### 23.2 EUT operation mode

EUT was at idle mode.

### 23.3 Limits

Frequency of emission [MHz]	FCC / IC	
	Limit [dBµV] Quasi peak	Limit [dBµV] Average
0,15 – 0,50	66 – 56*	56 – 46*
0,50 – 5	56	46
5 – 30	60	50

\* The limit decreases linearly with the logarithm of the frequency

## 23.4 Results

The measured interference values using peak and average detectors are shown in the Picture 51 and Picture 52 below.

All signals closer than 6 dB to the limit have been measured using quasi peak and average detectors and reported in tables 28 - 25.

Table 28: Quasi peak detector measurement results, AC live

Frequency [MHz]	Measured value [dB $\mu$ V]	Limit [dB $\mu$ V]	Margin to limit [dB]
0,193	54,9	63,9	9,0

Table 29: Average detector measurement results, AC live

Frequency [MHz]	Measured value [dB $\mu$ V]	Limit [dB $\mu$ V]	Margin to limit [dB]
N/A			

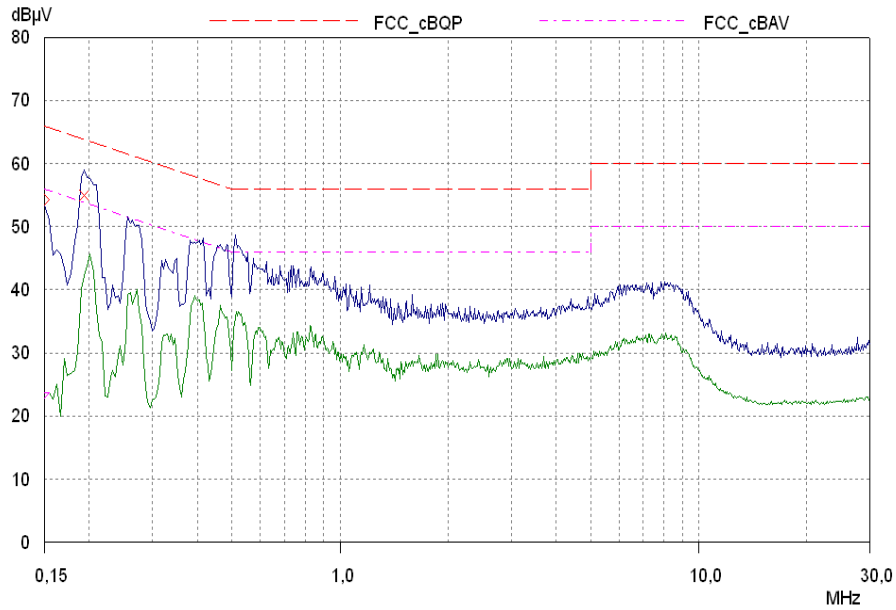
Table 30: Quasi peak detector measurement results, AC neutral

Frequency [MHz]	Measured value [dB $\mu$ V]	Limit [dB $\mu$ V]	Margin to limit [dB]
N/A			

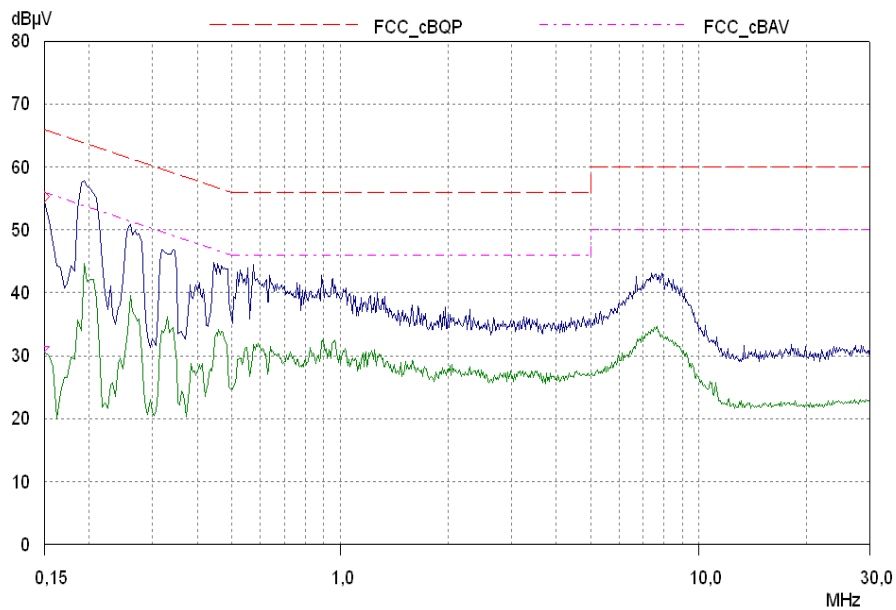
Table 31: Average detector measurement results, AC neutral

Frequency [MHz]	Measured value [dB $\mu$ V]	Limit [dB $\mu$ V]	Margin to limit [dB]
N/A			

### 23.5 Screen shots



Picture 51: AC-mains conducted emission measurement results, AC live



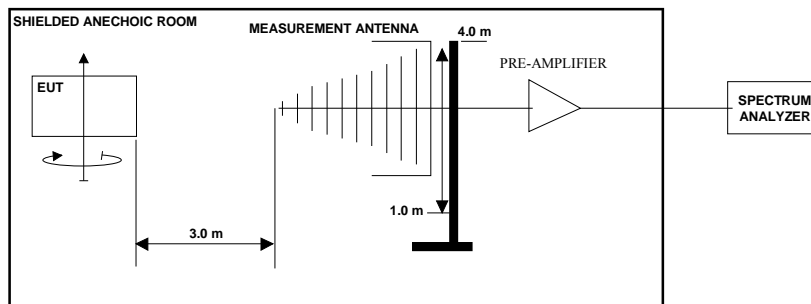
Picture 52: AC-mains conducted emission measurement results, AC neutral

## 24 RECEIVER RADIATED EMISSION

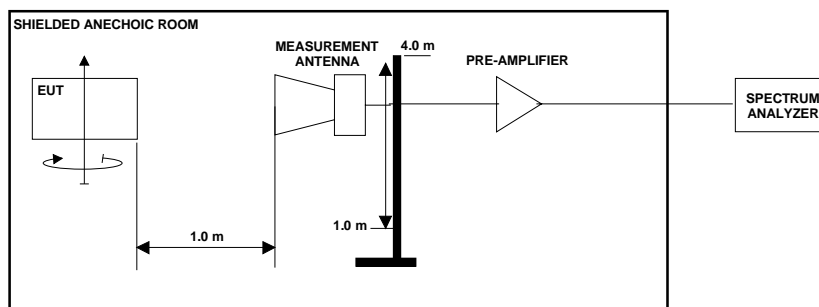
<b>EUT</b>	1		
<b>Accessories</b>	3,4,5,6,7,8		
<b>Temp, Humidity, Air Pressure</b>	22 °C	42 RH%	1004 hPa
<b>Date of measurement</b>	December 5, 2008		
<b>FCC rule part</b>	§15.109		
<b>RSS-GEN section</b>	7.2.3		
<b>ICES-003 section</b>	5.5		
<b>Measured by</b>	Simo Ojanen		

### 24.1 Test setup

The test was done using an automated test system, where a computer controlled the measurement equipments.



Picture 53: Test setup for radiated spurious emissions measurement  
30 MHz - 1 GHz frequencies



Picture 54: Test setup for radiated spurious emissions measurement  
1 GHz – 12,4 GHz frequencies

## 24.2 Test method

1. The emissions were searched and maximized by moving the turntable, changing the measuring antenna polarization and height and manipulating the EUT.
2. Levels of suspicious signals and levels of EUT transmitter harmonics were recorded.
3. The recorded levels were corrected in the automated test system with the measurement antenna factor, cable attenuations and filter attenuation.
4. The corrected values, giving the EUT radiated spurious emission levels as dB $\mu$ V/m at 3 m distance, are reported.

## 24.3 EUT operation mode

<b>EUT operation mode</b>	Receiver mode (BT & WLAN)
<b>EUT frequency</b>	Na
<b>EUT TX power level</b>	Na

## 24.4 Limit

Table 32: Radiated spurious emission limits at measurement distance 3m

<b>Frequency band (MHz)</b>	<b>3m Limit (<math>\mu</math>V/m)</b>	<b>3m Limit (dB<math>\mu</math>V/m)</b>	<b>Detector</b>
30 – 88	100	40	QP
88 -216	150	43,5	QP
216 - 960	200	46	QP
960 - 1000	500	54,0	QP
1000 - 12400	500	54,0	AVG
1000 - 12400	5000	74,0	PEAK

As default, all emissions were compared against the general limits. If any emission exceeded that limit, it was further checked, if it was outside the restricted band thus complying with the -20dBc requirement.

## 24.5 Results

The measured interference values using Quasi peak and average detectors are shown in the pictures below.

All signals closer than 6 dB to the limit below 1 GHz have been measured using quasi peak or average detector and reported in the table 33, 34 and 35.

Table 33: Radiated emissions using Quasi peak detector

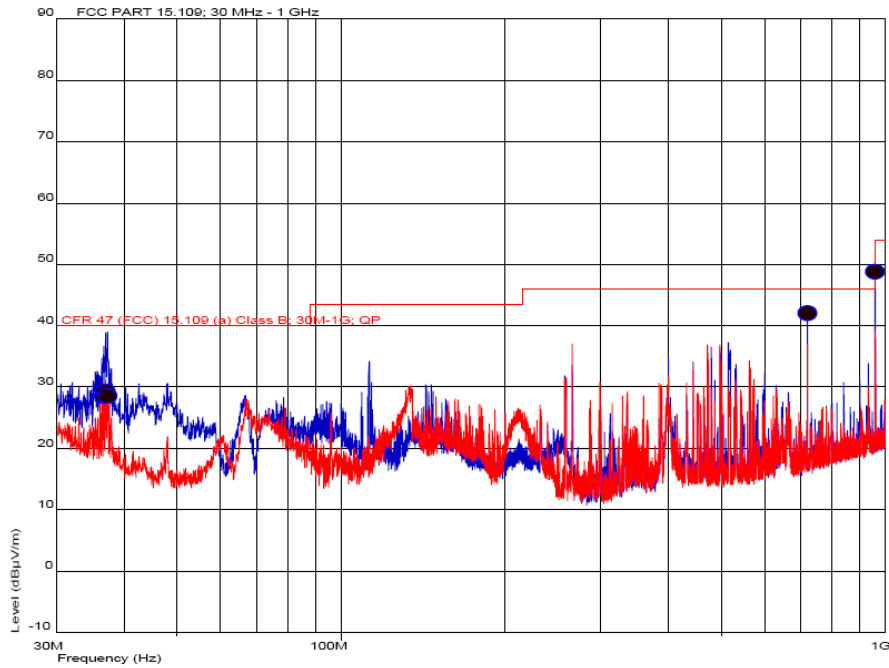
Freq MHz	Measured Value dBuV	Correction Factor dB	Result dBuV/m	Marginal dB	EUT Position	Ant Pol.	Ant height	TT angle
36,6	31,5	-2,95	28,6	11,4	Pos 1	Ver	1	240
36,9	32,3	-3,10	29,3	10,7	Pos 1	Ver	1	246
37,2	31,8	-3,25	28,6	11,4	Pos 1	Ver	1	259
720,06	41,3	0,68	42,0	4,0	Pos 1	Ver	1,5	192
960,06	44,5	4,30	48,9	5,1	Pos 1	Ver	1	178

Table 34: Radiated emissions using Peak detector

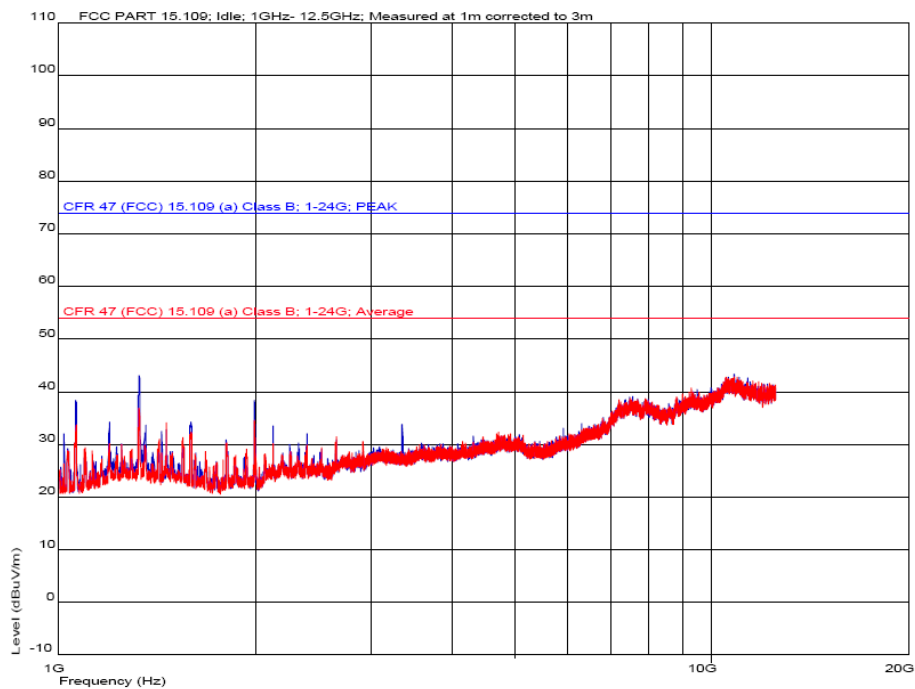
Freq MHz	Measured Value dBuV	Correction Factor dB	Result dBuV/m	Marginal dB	EUT Position	Ant Pol.	Ant height	TT angle
N/A								

Table 35: Radiated emissions using Average detector

Freq MHz	Measured Value dBuV	Correction Factor dB	Result dBuV/m	Marginal dB	EUT Position	Ant Pol.	Ant height	TT angle
N/A								



Picture 55: radiated emission results, 30 – 1000 MHz,  
Red= horizontal polarization, blue = vertical polarization



Picture 56: radiated emission results, 1 – 12,5 GHz,  
Red= horizontal polarization, blue = vertical polarization

## 25 TEST EQUIPMENT

All testing and measurement equipment has been calibrated once a year, except the antennas which are calibrated every two years.

### 25.1 Conducted measurements

Equipment	Manufacturer	Model
Spectrum Analyzer	Agilent	E7405A
Measurement receiver	Rohde & Schwarz	ESCS 30
Transient limiter / 10 dB attenuator	Chase	CFL 9206
Line Impedance Stabilization Network (LISN)	Rohde & Schwarz	ESH 3-Z5

### 25.2 Radiated measurements

Equipment	Manufacturer	Model
Spectrum Analyzer	Agilent	E7405A
Antenna	Chase	CBL 6141
Antenna	Schwarzbeck	BBHA 9120D
Antenna	Schwarzbeck	BBHA 9170
Band reject filter	Wainwright Instruments	WRCT2400/2483
High pass filter	Wainwright Instruments	WHK3.0/18GST
Pre-amplifier	Agilent	87405B
Pre-amplifier	JCA	118-400
Pre-amplifier	Miteq	AMF-6F-18002650-25-10P
Turn table / antenna mast controller	EMCO	2090
Antenna mast	EMCO	2075-2



## 26 TEST SETUP PHOTOGRAPHS

Test setup photograph can be found in a separate document

T08-762B-RF\_PHOTOS.doc