

Bluetooth test report for **AD-5B**

Report Date: February 26, 2004

Signatures:

Tested by: 

Marko Turkkila Testing Engineer

Contents approved: 

Tomi Nyberg Laboratory Manager

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1 LABORATORY INFORMATION

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FCC registration number: IC file number:	910391 (January 27, 2003) IC 4616 (May 14, 2003)

2 CUSTOMER INFORMATION

Client	Nokia Corporation Keilalahdentie 2-4 02150 Espoo PL 226 00045 NOKIA GROUP Tel: 07180 08000
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Receipt of EUT:	February 20, 2004
Testing date:	February 23 – February 25, 2004
Report date:	February 26, 2004

The tests listed in this report have been done to demonstrate compliance to the FCC rules section §15.247, §15.207 and IC standard RSS-210.

3 SUMMARY OF TEST RESULTS

Section in CFR 47	Section in RSS-210	Test	Result
15.247, a1	6.2.2 (o), a1	Carrier frequency separation	PASS
15.247, a1ii	6.2.2 (o), a3	Number of hopping frequencies	PASS
15.247, a1iii	6.2.2 (o), a3	Time of occupancy	PASS
15.247, a	6.2.2 (o), a1	20dB bandwidth	PASS
15.247, b1	6.2.2 (o), a3	Peak output power	PASS
15.247, c	6.2.2 (o), e1	Band-edge compliance of RF emissions	PASS
15.207	6.6	AC power line conducted emissions	PASS
15.247, c	6.2.2 (o), e1	Spurious RF conducted emissions	PASS
15.247, c	6.2.2 (o), e1	Spurious 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
EUT	Bluetooth module	AD-5B	HW:0.7 MV:0.15 SW:BT test mode SN:1208	16001
	Bluetooth module	AD-5B	HW:0.7 MV:0.15 SW: 0.13U9 SN:1303	16002
	Bluetooth module	AD-5B	HW:0.7 MV:0.15 SW: 0.13U9 SN:2075	16003
	Bluetooth module	AD-5B	HW:0.7 MV:0.15 SW:BT test mode SN:-	16004
Accessories	GSM mobile phone	NPL-2	351451/20/000012/3	16005
	Charger	ACP-12U		16006
	Charger	ACP-12E		16007
	Charger	ACP-8E		16008
	ACI prommer	FPH-1	0770401	16009
	BT headset	HS-3W	MAYX03484	16010

Notes: EUTs 16003 and 16004 were equipped with antenna connector for conducted measurements

4.1 EUT description

EUT is auxiliary equipment for connecting GSM mobile phone and Bluetooth headset.

The EUT was not modified during the tests.

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.

The test setup photographs are in the document referenced in section 17.

6 APPLICABLE STANDARDS

The tests were performed in guidance of CFR 47 Part 15.247 and 15.207, Part 2, FCC public notice DA 00-705 (March 30, 2000), ANSI C63.4 (1992), RSS-210 (Issue 5, November 2001) and CISPR-22.

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

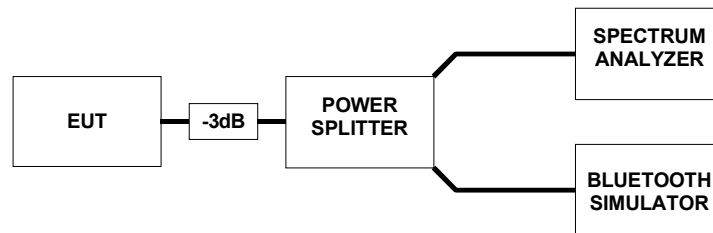
7 CARRIER FREQUENCY SEPARATION

EUT	16004		
Accessories	16005, 16007, 16008, 16009		
Temp, Humidity, Air Pressure	22 °C	36 RH%	1005 hPa
Date of measurement	February 23, 2004		
FCC rule part	§15.247 (a) (1)		
RSS-210 section	6.2.2 (o), a1		
Measured by	Marko Turkkila		

7.1 Test setup and testing method

The Bluetooth simulator was used to:

- set the EUT channel (0 – 78)
- set the number of EUT TX slots (1, 3, 5)
- set the EUT to TX, RX and TX/RX mode
- enable/disable frequency hopping
- select between several different test modulation patterns



Picture 1: Test setup for carrier frequency separation measurement

Spectrum analyzer was set to sweep the Bluetooth operating band 2.40 – 2.483 GHz.

100 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

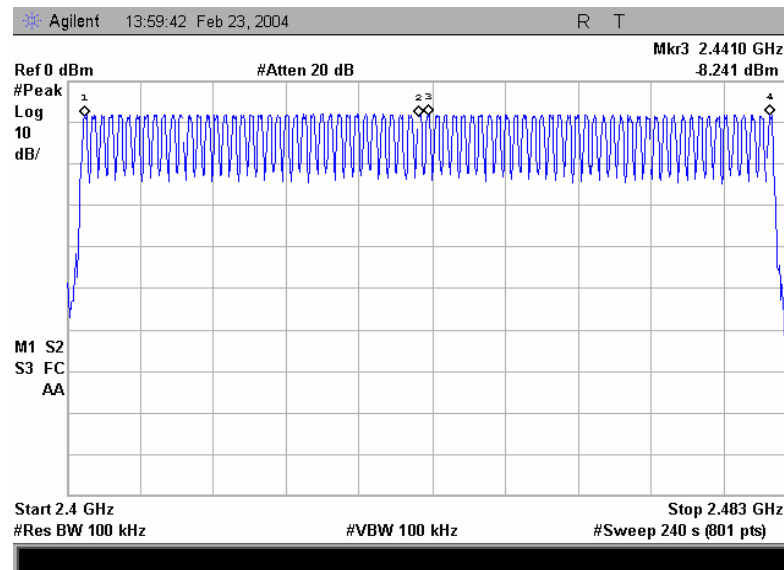
EUT operation mode	Connection, DM5, PRBS
EUT channel	Hopping
EUT TX power level	0 dBm

7.3 Results

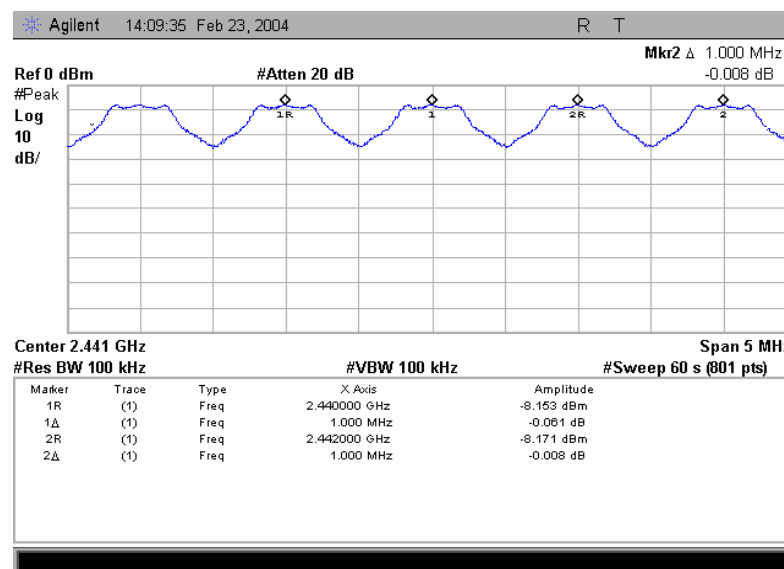
Table 1: Carrier frequency separation measurement results

Limit	Result
≥ 0.025 or 20dB BW	1.00 MHz

7.4 Screen shots



Picture 2: Carrier frequency separation, General overview of the spectrum



Picture 3: Carrier frequency separation, Channels 38 and 39

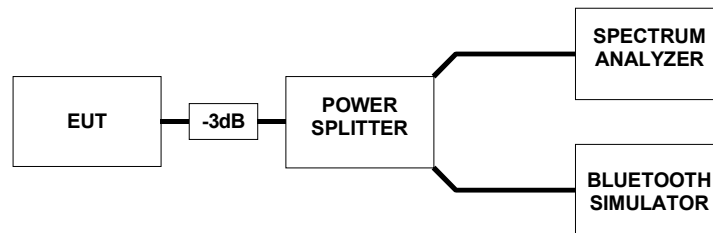
8 NUMBER OF HOPPING FREQUENCIES

EUT	16004		
Accessories	16005, 16007, 16008, 16009		
Temp, Humidity, Air Pressure	22 °C	36 RH%	1005 hPa
Date of measurement	February 23, 2004		
FCC rule part	§15.247(a) (2)		
RSS-210 section	6.2.2 (o), a3		
Measured by	Marko Turkkila		

8.1 Test setup

The Bluetooth simulator was used to:

- set the EUT channel (0 – 78)
- set the number of EUT TX slots (1, 3, 5)
- set the EUT to TX, RX and TX/RX mode
- enable/disable frequency hopping
- select between several different test modulation patterns



Picture 4: Test setup for measurement of number of hopping frequencies

Spectrum analyzer was set to sweep the Bluetooth operating band 2.40 – 2.483 GHz.

100 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

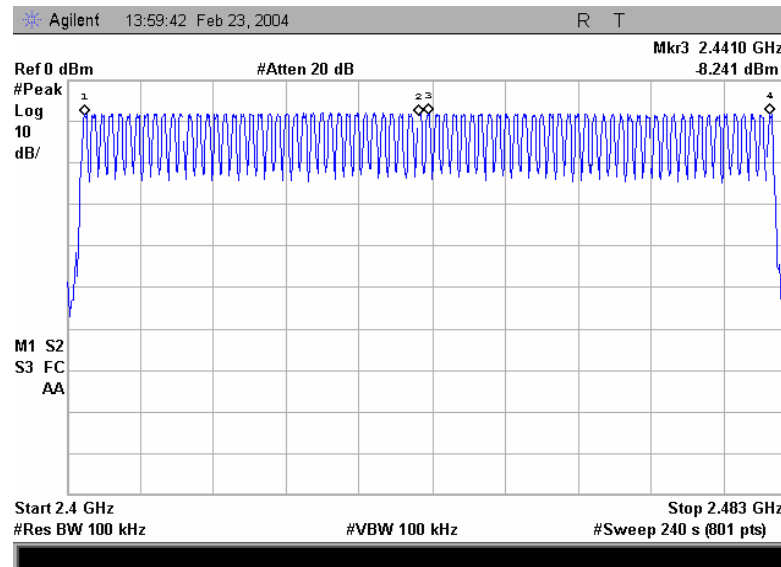
EUT operation mode	Connection, DM5, PRBS
EUT channel	Hopping
EUT TX power level	0 dBm

8.3 Results

Table 2: Number of hopping frequencies measurement results

Limit	Result
≥ 75	79

8.4 Screen shots



Picture 5: Number of hopping frequencies measurement

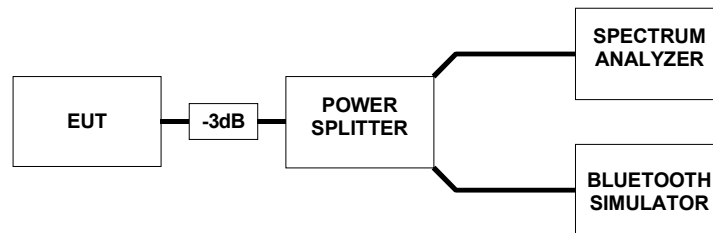
9 TIME OF OCCUPANCY

EUT	16003 (Inquiry mode), 16004		
Accessories	16005, 16007, 16008, 16009, 16010		
Temp, Humidity, Air Pressure	22 °C	36 RH%	1005 hPa
Date of measurement	February 23, 2004		
FCC rule part	§15.247 (a) (1) iii		
RSS-210 section	6.2.2 (o), a3		
Measured by	Marko Turkkila		

9.1 Test setup and testing method

The Bluetooth simulator was used to:

- set the EUT channel (0 – 78)
- set the number of EUT TX slots (1, 3, 5)
- set the EUT to TX, RX and TX/RX mode
- enable/disable frequency hopping
- select between several different test modulation patterns



Picture 6: 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 Inquiry mode

9.2.1 EUT operation mode

EUT operation mode	Inquiry
EUT channel	Hopping
EUT TX power level	0 dBm

9.2.2 Results

Table 3: Time of occupancy during inquiring mode measurement results

Limit	Result
≤ 0.4 s over 12.8 s period	0.092 s

Limit:

In the inquiry mode Bluetooth uses a reduced hopping pattern (32 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 ($32 * 0.4\text{s} = 12.8\text{ s}$).

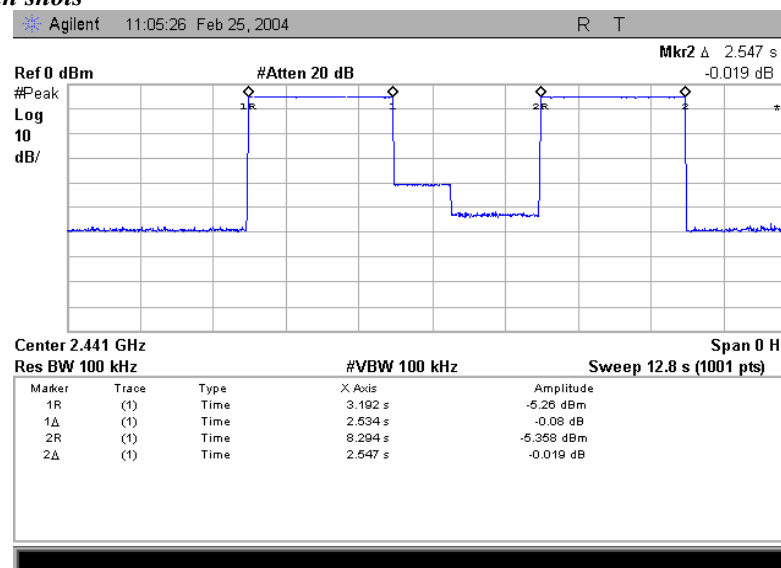
Results:

The complete inquiry cycle took $2.547 + 2.534 = 5.081$ s, during which the transmitter operated at every 10.0 ms.

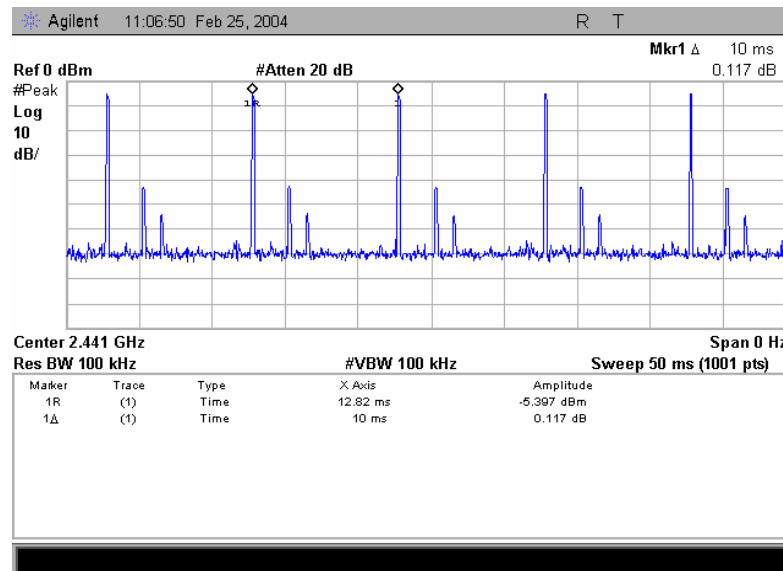
The duration of one transmission was 181.8 μs .

Based on these measurements, one channel was occupied $(5.081\text{ s} / 10.0\text{ ms}) * 181.8\text{ }\mu\text{s} = 0.092\text{ s}$ during the 12.8 s period.

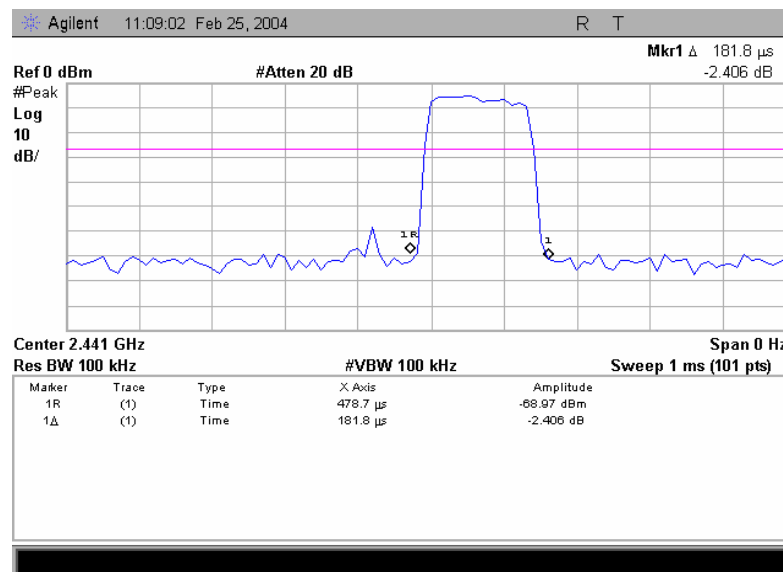
9.2.3 Screen shots



Picture 7: Complete inquiry cycle, channel 39



Picture 8: Transmission interval during inquiry cycle, channel 39



Picture 9: Duration of one transmission during inquiry, channel 39

9.3 Connection mode

9.3.1 EUT operation mode

EUT operation mode	Connection, DH5, PRBS
EUT channel	Hopping
EUT TX power level	0 dBm

9.3.2 Results

Table 4: Time of occupancy during connection mode measurement results

Limit	Result
≤ 0.4 s over 31.6 s period	0.165 s

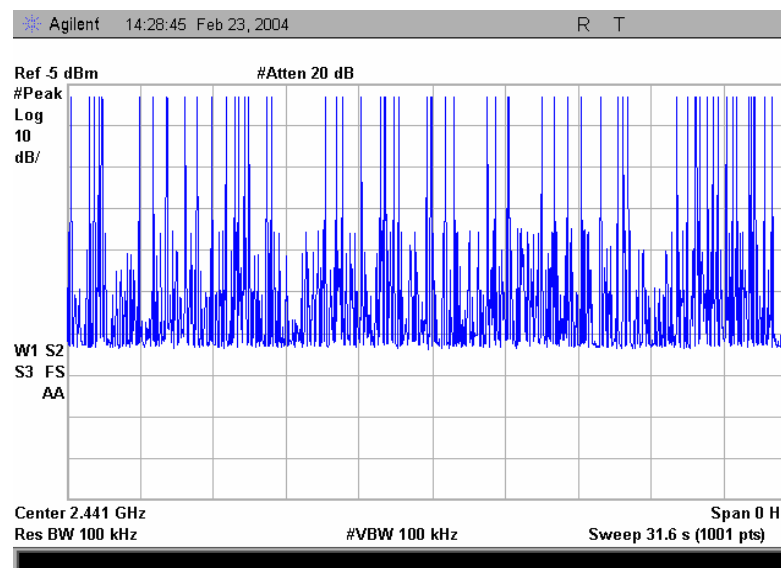
Limit:

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).

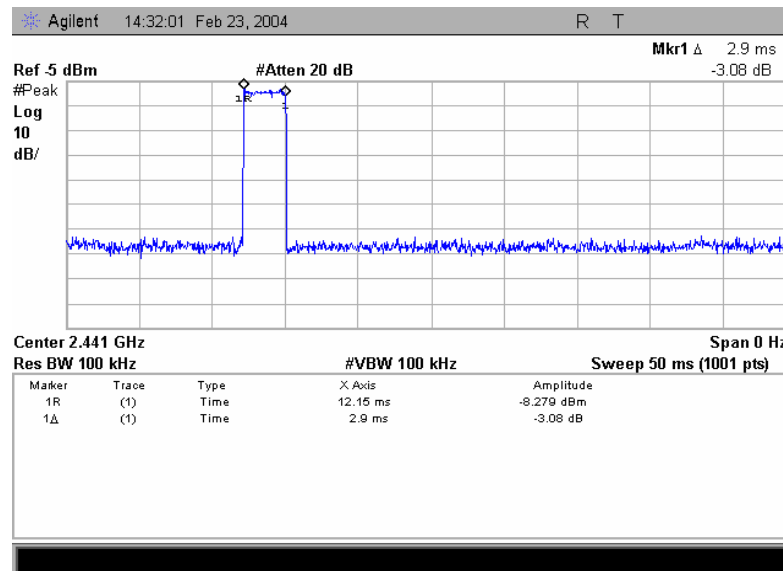
Results:

In measurement time of 31.6 s, total of 57 transmissions occurred. The duration of one transmission was 2.9ms. Based on these measurements the transmitter operated $57 * 2.9$ ms = 0.165 s during the 31.6 s period

9.3.3 Screen shots



Picture 10: Number of transmissions on connection state, channel 39



Picture 11: Duration of one transmission on connection state, channel 39

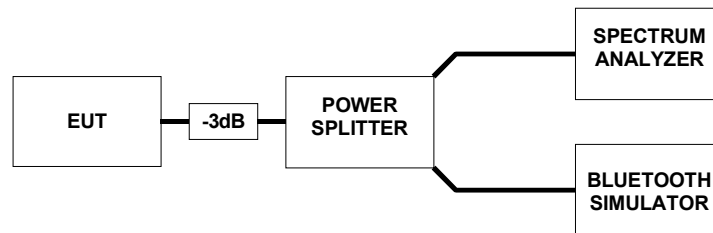
10 20 dB BANDWIDTH

EUT	16004		
Accessories	16005, 16007, 16008, 16009		
Temp, Humidity, Air Pressure	22 °C	36 RH%	1005 hPa
Date of measurement	February 23, 2004		
FCC rule part	§15.247 (a) (1)		
RSS-210 section	6.2.2 (o), a1		
Measured by	Marko Turkkila		

10.1 Test setup and measurement method

The Bluetooth simulator was used to:

- set the EUT channel (0 – 78)
- set the number of EUT TX slots (1, 3, 5)
- set the EUT to TX, RX and TX/RX mode
- enable/disable frequency hopping
- select between several different test modulation patterns



Picture 12: Test setup for conducted RF output power 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 display line 20 dB below this value and by reading the bandwidth from the intersection of the measured trace and display line.

10.2 EUT operation mode

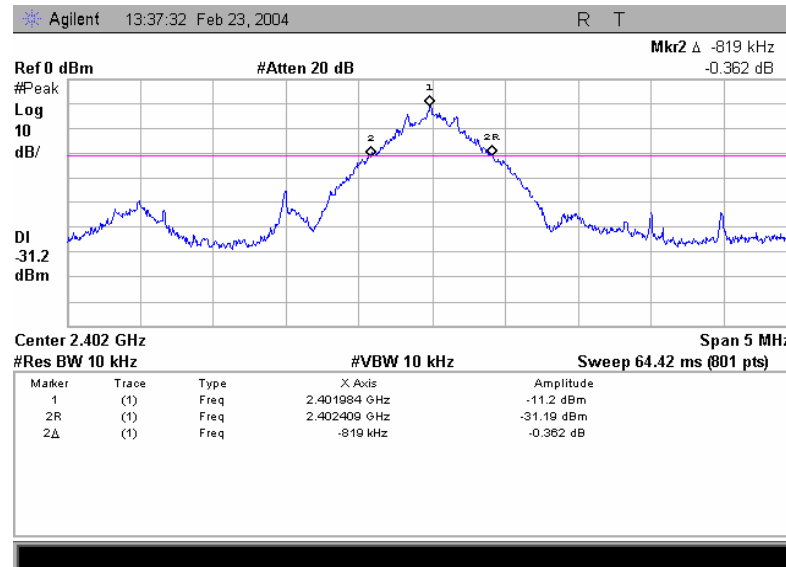
EUT operation mode	Connection, DM5, PRBS
EUT channel	0, 39 and 78
EUT TX power level	0 dBm

10.3 Results

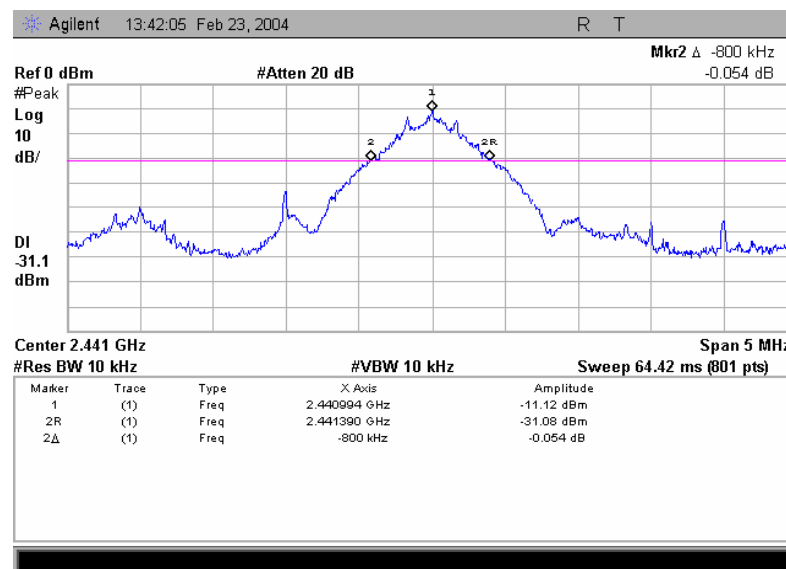
Table 5: 20dB bandwidth measurement results

EUT Channel	Limit (MHz)	Measured value (MHz)
0	≤ 1.0	0.819
39		0.800
78		0.819

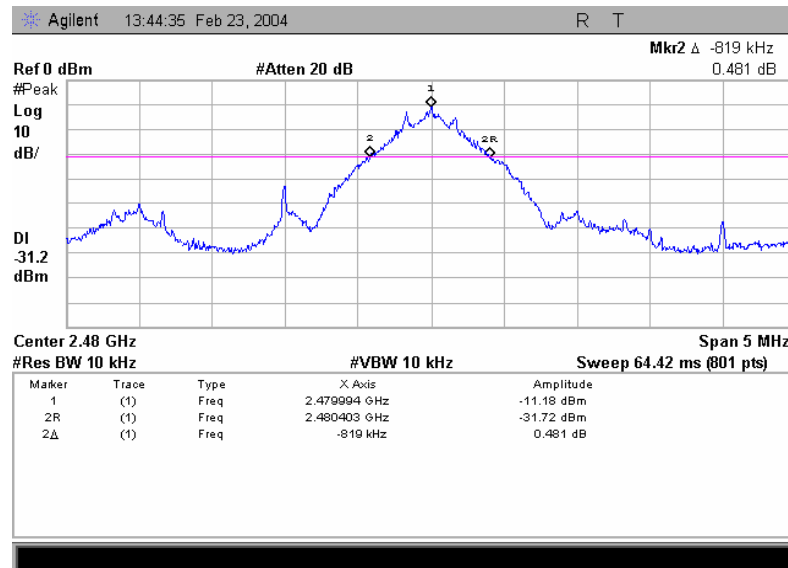
10.4 Screen shots



Picture 13: 20dB Bandwidth measurement result, Channel 0



Picture 14: 20dB Bandwidth measurement result, Channel 39



Picture 15: 20dB Bandwidth measurement result, Channel 78

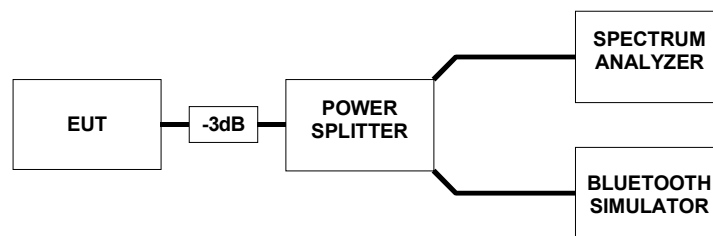
11 PEAK OUTPUT POWER

EUT	16004		
Accessories	16005, 16007, 16008, 16009		
Temp, Humidity, Air Pressure	22 °C	36 RH%	1005 hPa
Date of measurement	February 23, 2004		
FCC rule part	§15.247 (b) (1)		
RSS-210 section	6.2.2 (o), a3		
Measured by	Marko Turkkila		

11.1 Test setup and measurement method

The Bluetooth simulator was used to:

- set the EUT channel (0 – 78)
- set the number of EUT TX slots (1, 3, 5)
- set the EUT to TX, RX and TX/RX mode
- enable/disable frequency hopping
- select between several different test modulation patterns



Picture 16: Test setup for conducted RF output power measurement

In the peak output power measurement the power splitter, attenuator and cable attenuations were measured prior to the power measurement and set as parameter for external preamplifier gain in the spectrum analyzer to correct the reading of the peak output power. Spectrum analyzer subtracts the set PG value shown in the screenshots from the measured reading.

The measurement was made using 1 MHz resolution bandwidth and 1 MHz video bandwidth and maximum hold function to record the maximum peak output power.

11.2 EUT operation mode

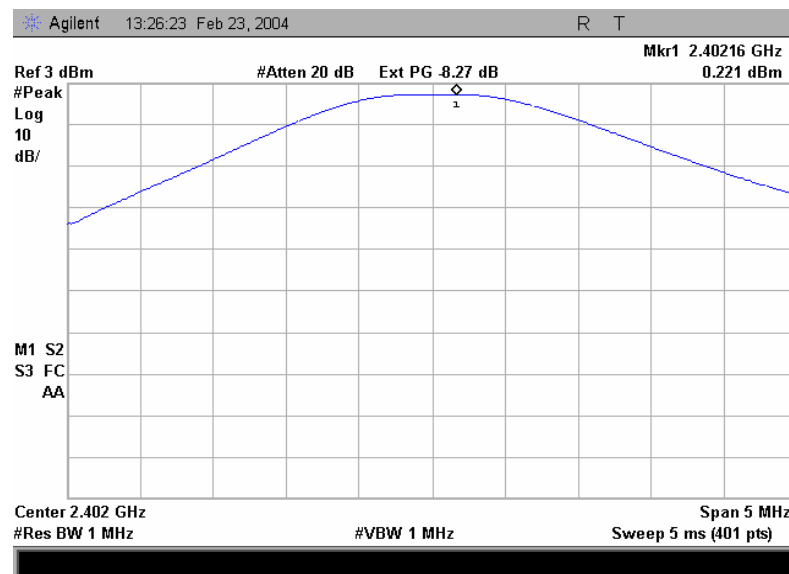
EUT operation mode	Connection, DM5, PRBS
EUT channel	0, 39 and 78
EUT TX power level	0 dBm

11.3 Results

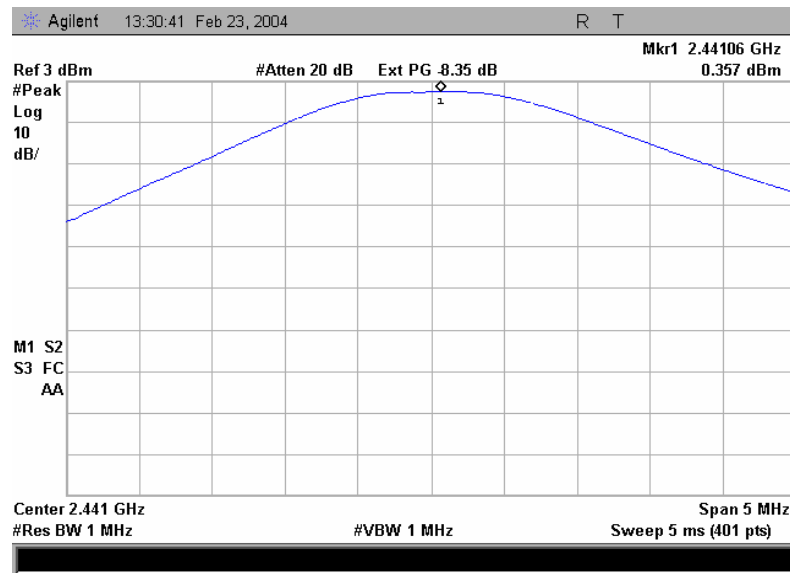
Table 6: Peak output power measurement results

EUT Channel	Limit (W)	Test result (W)	Limit (dBm)	Test result (dBm)
0	≤ 1	0.0010	≤ 30	0.221
39		0.0011		0.357
78		0.0011		0.385

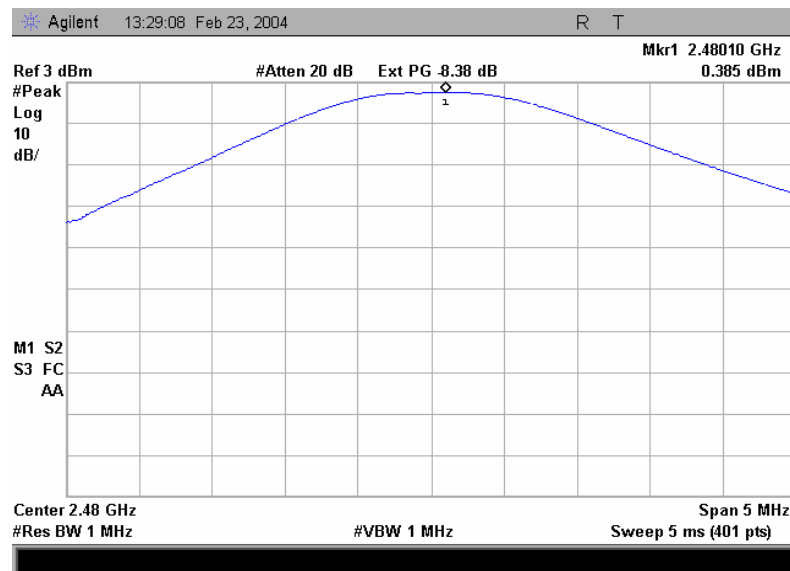
11.4 Screen shots



Picture 17: Peak output power, channel 0



Picture 18: Peak output power, channel 39



Picture 19: Peak output power, channel 78

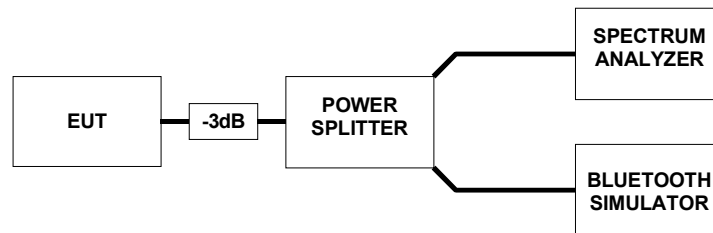
12 BAND-EDGE COMPLIANCE OF RF CONDUCTED EMISSIONS

EUT	16004		
Accessories	16005, 16007, 16008, 16009		
Temp, Humidity, Air Pressure	22 °C	36 RH%	1005 hPa
Date of measurement	February 26, 2004		
FCC rule part	§15.247 (c) (1)		
RSS-210 section	6.2.2 (o), e1		
Measured by	Marko Turkkila		

12.1 Test setup and measurement method

The Bluetooth simulator was used to:

- set the EUT channel (0 – 78)
- set the number of EUT TX slots (1, 3, 5)
- set the EUT to TX, RX and TX/RX mode
- enable/disable frequency hopping
- select between several different test modulation patterns



Picture 20: 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

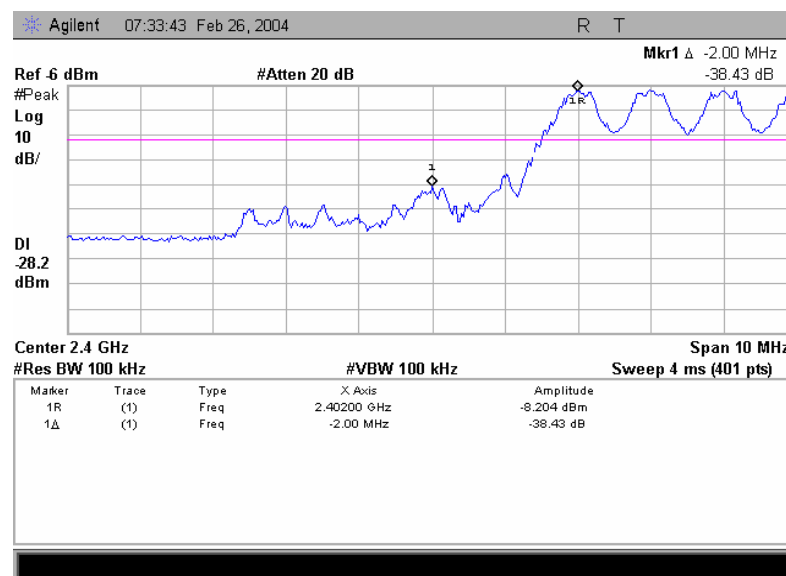
EUT operation mode	Connection, DH5, PRBS
EUT channel	Hopping
EUT TX power level	0 dBm

12.2.2 Results

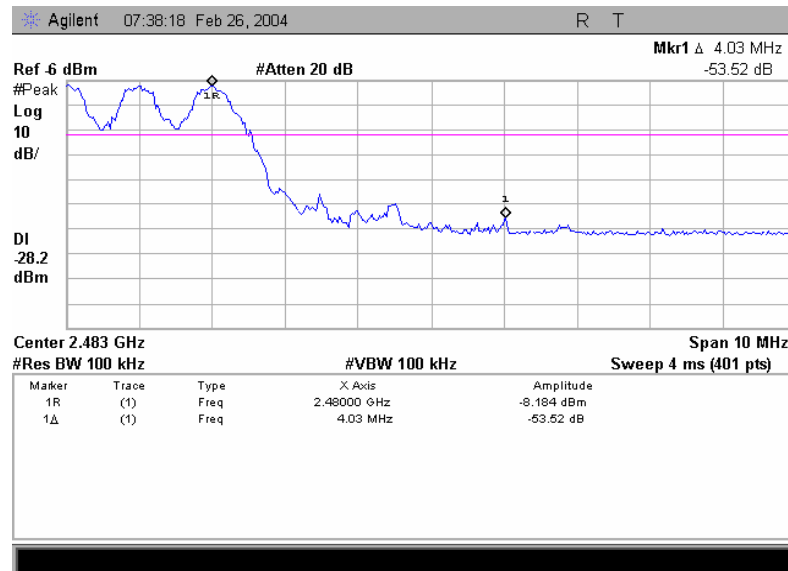
Table 7: Number of hopping frequencies measurement results

EUT Channel	Limit (dBc)	Test result (dBc)
0	≤ -20	-38.4
78		-53.5

12.2.3 Screen shots



Picture 21: Band edge compliance, channel 0, hopping enabled



Picture 22: Band edge compliance, channel 78, hopping enabled

12.3 Hopping disabled

12.3.1 EUT operation mode

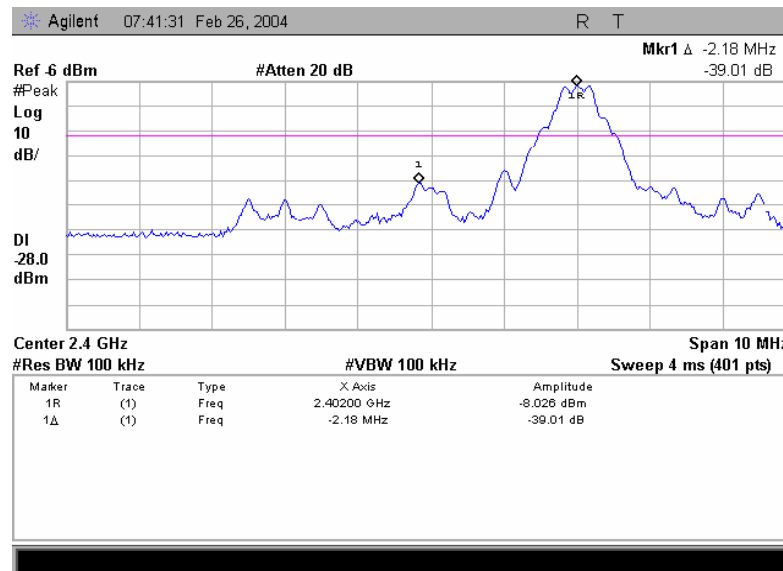
EUT operation mode	Connection, DM5, PRBS
EUT channel	0 (2402 MHz), 78 (2480 MHz)
EUT TX power level	0 dBm

12.3.2 Results

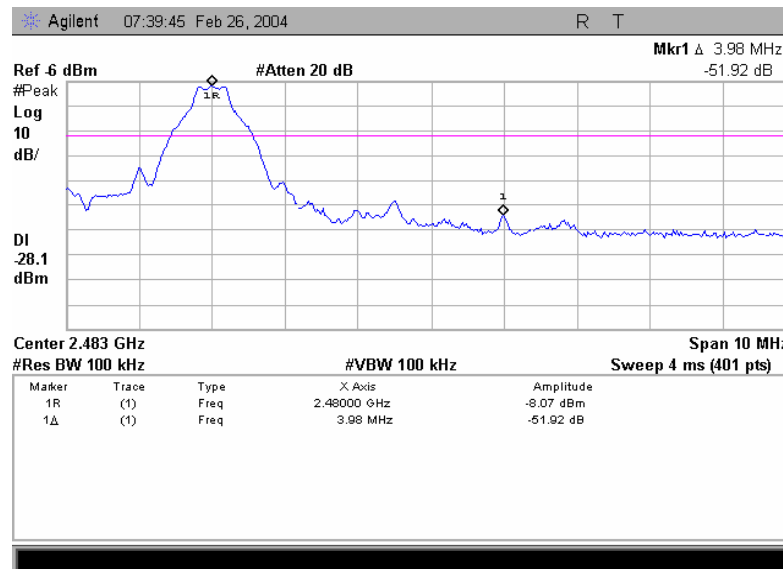
Table 8: Band edge compliance measurement results

EUT Channel	Limit (dBc)	Test result (dBc)
0	≤ -20	-39.0
79		-51.9

12.3.3 Screen shots



Picture 23: Band edge compliance, channel 0, hopping disabled



Picture 24: Band edge compliance, channel 78, hopping disabled

13 AC POWERLINE CONDUCTED EMISSIONS

EUT	16002		
Accessories	16005, 16006, 16010		
Temp, Humidity, Air Pressure	22 °C	41 RH%	1014 hPa
Date of measurement	February 26, 2004		
FCC rule part	§15.207		
RSS-210 section	6.6		
Measured by	Marko Turkkila		

13.1 Test setup and measurement method

The EUT was set according to ANSI C63.4-1992, figure 9a

EUT was in normal operation mode, connected to Bluetooth headset.

13.2 EUT operation mode

EUT operation mode	Connection, DH5, PRBS
EUT channel	Hopping
EUT TX power level	0 dBm
EUT operation voltage	110 VAC / 60 Hz

13.3 Limits

Table 9: AC power line conducted emission measurement results

Frequency band (MHz)	Quasi-peak limit (dBμV)	Average limit (dBμV)
0.15 – 0.5	66 – 56*	56 – 46*
0.5 – 5	56	46
5 – 30	60	50

* The limit decreases linearly with the logarithm of the frequency

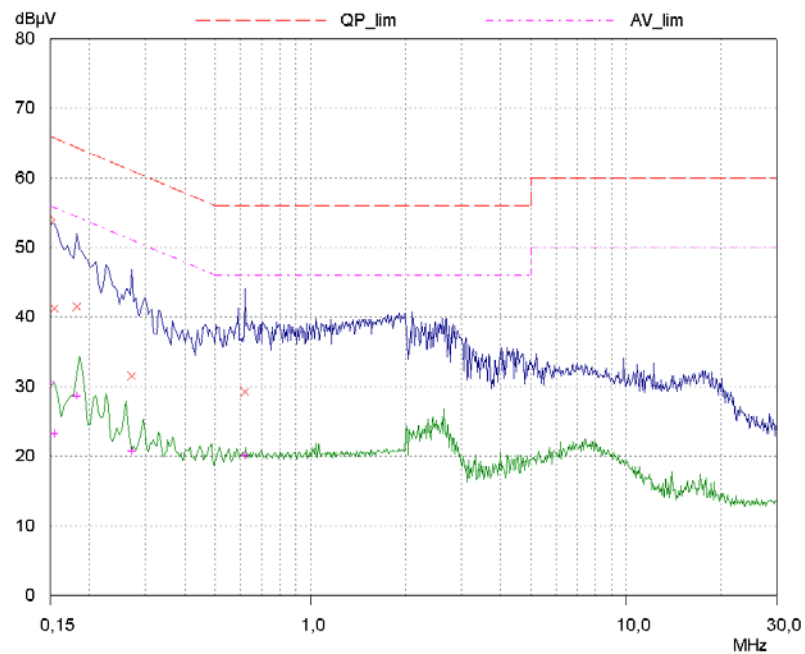
13.4 Results

The measurement results were adjusted with the attenuation of the cable between the LISN and receiver by the computer controlling the test system

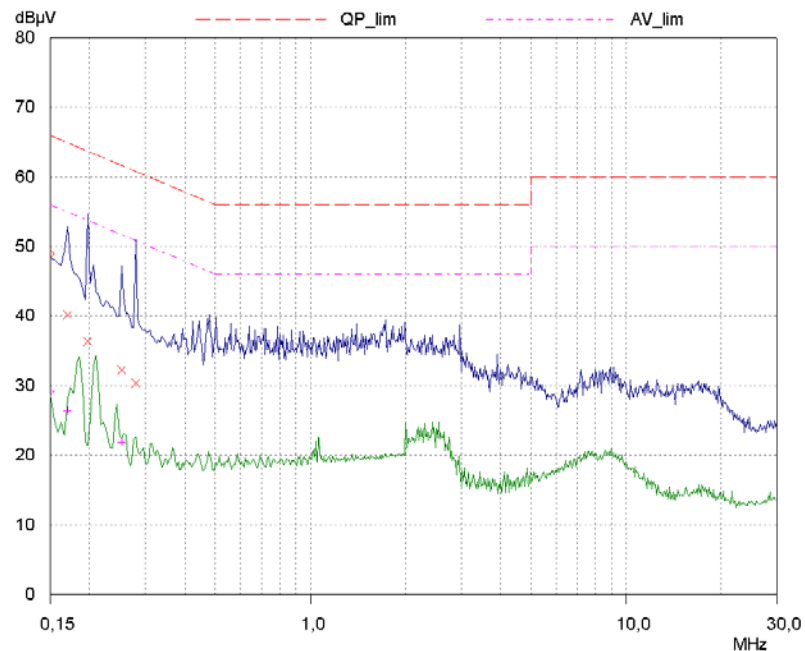
Peaks closer than 6 dB to the quasi peak limit were measured using quasi-peak detector. These values have been listed in Table 10 and Table 11.

Blue curve: Peak detector.

Green curve: Average detector



Picture 25: AC power line emissions, line L.



Picture 26: AC power line emissions, line N

Table 10: Highest emissions, line L

Frequency (MHz)	QP (dB μ V)	Limit (dB μ V)	Margin (dB)
0,15	41,3	65,8	24,5
0,18	41,5	64,4	22,9
0,27	31,6	61,1	29,5
0,62	29,2	56,0	26,8

Table 11: Highest emissions, line N

Frequency (MHz)	QP (dB μ V)	Limit (dB μ V)	Margin (dB)
0,17	40,1	65,0	24,9
0,20	36,3	63,7	27,4
0,25	32,3	61,7	29,4
0,28	30,4	60,9	30,5

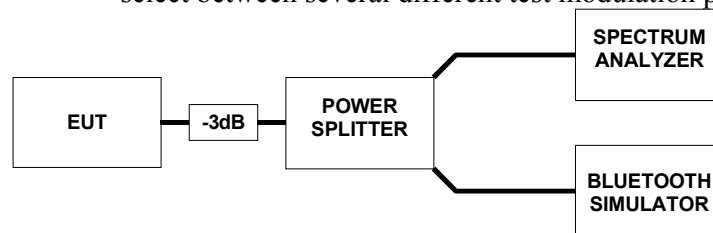
14 SPURIOUS RF CONDUCTED EMISSIONS

EUT	16004		
Accessories	16005, 16007, 16008, 16009		
Temp, Humidity, Air Pressure	22 °C	36 RH%	1005 hPa
Date of measurement	February 25, 2004		
FCC rule part	§15.247 (c) (2)		
RSS-210 section	6.2.2 (o), e1		
Measured by	Marko Turkkila		

14.1 Test setup and measurement method

The Bluetooth simulator was used to:

- set the EUT channel (0 – 78)
- set the number of EUT TX slots (1, 3, 5)
- set the EUT to TX, RX and TX/RX mode
- enable/disable frequency hopping
- select between several different test modulation patterns



Picture 27: 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.

14.2 EUT operation mode

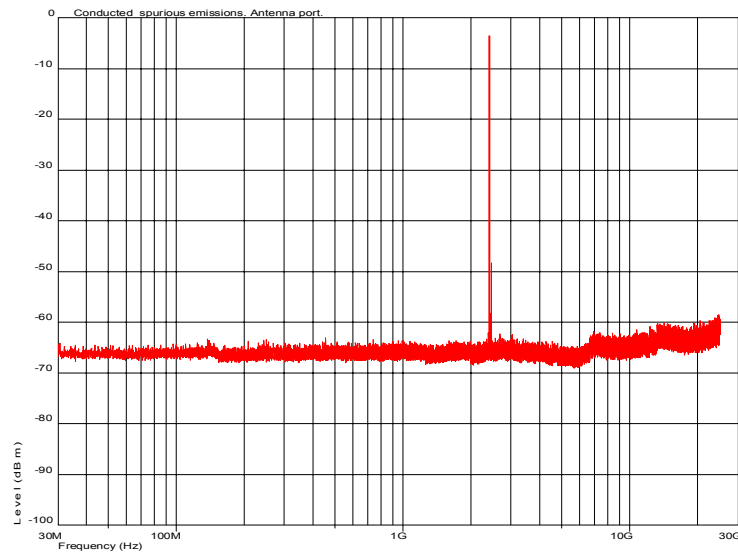
EUT operation mode	Connection, DM5, PRBS
EUT channel	0, 39 and 78
EUT TX power level	0 dBm

14.3 Limit

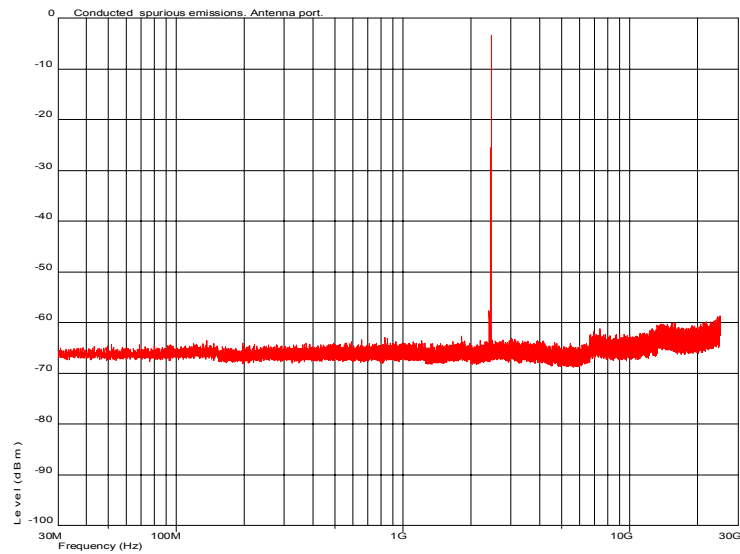
EUT Channel	Limit (dBc)
0	≤ -20
39	
78	

14.4 Results

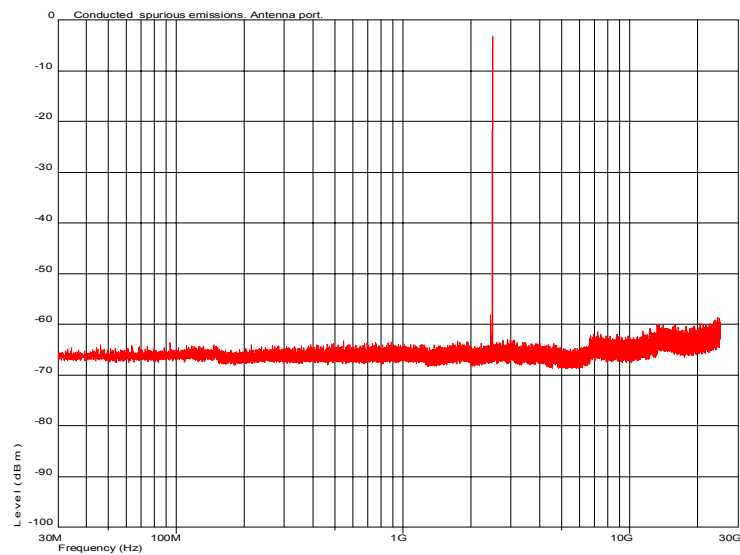
All spurious emissions measured were at least 45 dB below the carrier level.



Picture 28: Conducted spurious emissions on antenna port, Channel 0



Picture 29: Conducted spurious emissions on antenna port, Channel 39



Picture 30: Conducted spurious emissions on antenna port, Channel 78

15 RADIATED SPURIOUS EMISSIONS

EUT	16001		
Accessories	16005, 16007, 16008, 16009		
Temp, Humidity, Air Pressure	22 °C	36 RH%	1005 hPa
Date of measurement	February 24 - 25, 2004		
FCC rule part	§15.247 (c) (1)		
RSS-210 section	6.2.2 (o), e1		
Measured by	Marko Turkkila, Kimmo Aarnio		

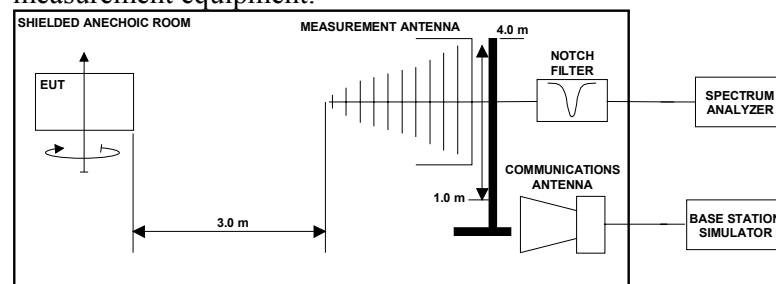
15.1 Test setup

The Bluetooth simulator was used to:

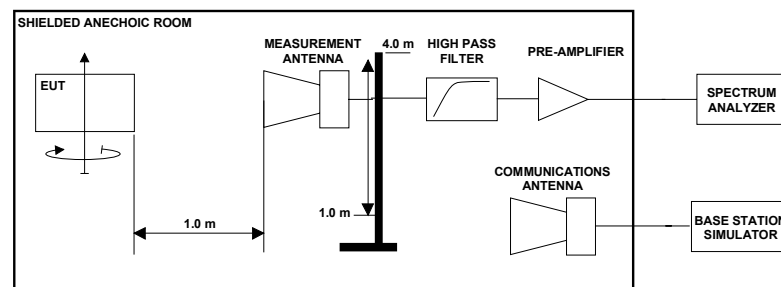
- set the EUT channel (0 – 78)
- set the number of EUT TX slots (1, 3, 5)
- set the EUT to TX, RX and TX/RX mode
- enable/disable frequency hopping

select between several different test modulation patterns

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



Picture 31: Test setup for radiated spurious emissions measurement on below 3 GHz frequencies



Picture 32: Test setup for radiated spurious emissions measurement on above 3 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. The worst EUT orientation was searched EUT in middle channel. The lowest and highest channels were measured in that orientation.
3. Levels of suspicious signals and levels of EUT transmitter harmonics were recorded.
4. The recorded levels were corrected in the automated test system with the measurement antenna factor, cable attenuations and filter attenuation.
5. The corrected values, giving the EUT radiated spurious emission levels as dB μ V/m at 3 m (1m over 3GHz) distance, are reported.

15.3 EUT operation mode

EUT operation mode	Connection mode, DM5, PRBS
EUT channel	0 (2402 MHz), 39 (2441 MHz) and 78 (2480 MHz)
EUT TX power level	0 dBm

15.4 Limit

Table 12: Radiated spurious emission limits at measurement distance 3m

Frequency band (MHz)	3m Limit (μV/m)	3m Limit (dBμV/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

Table 13: Radiated spurious emission limits at measurement distance 1m

Frequency of emission (MHz)	1m Limit (μV / m)	1m Limit (dBμV/m)	Measurement detector type
Above 1000	1500	63.5	Average
Above 1000	15000	83.5	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 Results

Measurement system noise level was 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 14: Emission levels PEAK detector, channel 0

Freq MHz	Measured Value dBuV	Correction Factor dB	Result dBuV/m	EUT orientation	Antenna Pol.	Antenna height	Turntable angle
4804	52.16	-8.47	43.69	Ver	Hor	1.1	14
7206	42.99	1.57	44.56	Ver	Ver	1.9	88
9608	50.49	2.06	52.55	Ver	Ver	1	0

Table 15: Emission levels PEAK detector, channel 39

Freq MHz	Measured Value dBuV	Correction Factor dB	Result dBuV/m	EUT orientation	Antenna Pol.	Antenna height	Turntable angle
4882	54.68	-7.82	46.86	Ver	Ver	1	62
7323	42.99	2.11	45.1	Ver	Hor	1.15	4
9764	48.12	2.21	50.33	Ver	Hor	1	130

Table 16: Emission levels PEAK detector, channel 78

Freq MHz	Measured Value dBuV	Correction Factor dB	Result dBuV/m	EUT orientation	Antenna Pol.	Antenna height	Turntable angle
4960	51.04	-7.36	43.68	Ver	Ver	1.3	37
7440	43.45	2.29	45.74	Ver	Ver	1.05	223
9920	48.33	2.19	50.52	Ver	Hor	1	141

Table 17: Emission levels AVERAGE detector, channel 0

Freq MHz	Measured Value dBuV	Correction Factor dB	Result dBuV/m	EUT orientation	Antenna Pol.	Antenna height	Turntable angle
4804	39.72	-8.47	31.25	Ver	Hor	1.1	14
7206	28.63	1.57	30.2	Ver	Ver	1.9	88
9608	34.9	2.06	36.96	Ver	Ver	1	0

Table 18: Emission levels AVERAGE detector, channel 39

Freq MHz	Measured Value dBuV	Correction Factor dB	Result dBuV/m	EUT orientation	Antenna Pol.	Antenna height	Turntable angle
4882	42.85	-7.82	35.03	Ver	Ver	1	62
7323	28.63	2.11	30.74	Ver	Hor	1.15	4
9764	33.38	2.21	35.59	Ver	Hor	1	130

Table 19: Emission levels AVERAGE detector, channel 78

Freq MHz	Measured Value dBuV	Correction Factor dB	Result dBuV/m	EUT orientation	Antenna Pol.	Antenna height	Turntable angle
4960	37.96	-7.36	30.6	Ver	Ver	1.3	37
7440	28.88	2.29	31.17	Ver	Ver	1.05	223
9920	32.51	2.19	34.7	Ver	Hor	1	141

16 TEST EQUIPMENT

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

16.1 Conducted measurements

Equipment	Manufacturer	Model
Spectrum Analyzer	Agilent	E7405A
Measurement receiver	Rohde & Schwarz	ESCS 30
Attenuator 3 dB	Narda	779-3
Power splitter	Mini Circuits	ZFSC-2-4
Power splitter	Narda	4426-2
Bluetooth Simulator	Anritsu	MT 8850A
Transient limiter / 10 dB attenuator	Chase	CFL 9206
Line Impedance Stabilization Network (LISN)	Rohde & Schwarz	ESH 3-Z5

16.2 Radiated measurements

Equipment	Manufacturer	Model
Spectrum Analyzer	Agilent	E7405A
Antenna	Chase	CBL 6140
Antenna	Schwarzbeck	BBHA 9120D
High pass filter	Wainwright Instruments	WHK3.0/18GST
Pre-amplifier	JCA	118-400
Turn table / antenna mast controller	EMCO	2090
Antenna mast	EMCO	2075-2
Bluetooth simulator	Anritsu	MT 8850A

17 TEST SETUP PHOTOGRAPHS

Test setup photograph can be found in a separate document

T04-016A-EMC_PHOTOS.doc