GSM1900 test report
for
NHL-12

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1 LABORATORY INFORMATION

Test laboratory:	TCC Tampere Sinitaival 5 FIN-33720 TAMPERE Tel. +358 7180 46800 Fax. +358 7180 46880
FCC registration number: IC file number:	94436 (June 14, 2002) IC 3608 (March 5, 2003)

2 CUSTOMER INFORMATION

Client:	Nokia Corporation Multimedia Imaging BU Mattilanniemi 6-8 FIN-40100 JYVÄSKYLÄ FINLAND Tel. +358-71-8008000 Fax. +358-71-8078000
Contact person:	Mikael Honkanen
Receipt of EUT:	7.1.2004
Date of testing:	7.1-12.2.2004
Date of report:	26.2.2004

The tests listed in this report have been done to demonstrate compliance with the applicable requirements in FCC rules Part 24 and IC standard RSS-133.

Contents approved:

Asko Välimäki Quality Manager

3 SUMMARY OF TEST RESULTS

Section in CFR 47	Section in RSS-133		Result
§2.1046 (a)	6.2	Conducted RF output	-
§24.232 (b)	6.2	Radiated RF output	PASS
§2.1049 (h)	5.6	99% occupied bandwidth	PASS
§24.238 (a)	6.3	Bandedge compliance	PASS
§24.238 (a), §2.1051	6.3	Spurious emissions at antenna terminals	-
§24.238 (a), §2.1053	6.3	Spurious radiated emission	PASS
§24.235, §2.1055 (a)(1)(b)	7	Frequency stability, temperature variation	PASS
§24.235, §2.1055 (d)(1)(2)	7	Frequency stability, voltage variation	PASS

PASS Pass
FAIL Fail
X Measured, but there is no applicable performance criteria
- Not done

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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	GSM Phone	NHL-12	004400231656917	3376
	GSM Phone	NHL-12	004400231656834	3392
Accessories	Battery	BL-5C	067040063563311211	3394
	Battery	BL-5C	067039880257341411	3386
	Memory card	DTS-32	A200EJ85221	3377
	Memory card	DTS-32	-	3393
	Dummy battery	-	-	3343

Notes: -

4.1 EUT description

The EUT is a triple band (850 MHz/1800 MHz/1900 MHz) E-GPRS (Edge) GSM mobile phone with bluetooth.

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.

The test setup photographs are in the document referenced in section 14.

6 APPLICABLE STANDARDS

The tests were performed in guidance of CFR 47 part 24, part 2, ANSI/TIA/EIA-603-A and RSS-133. Deviations, modifications or clarifications (if any) to above mentioned documents are written in each section under "Test method" for each test case.

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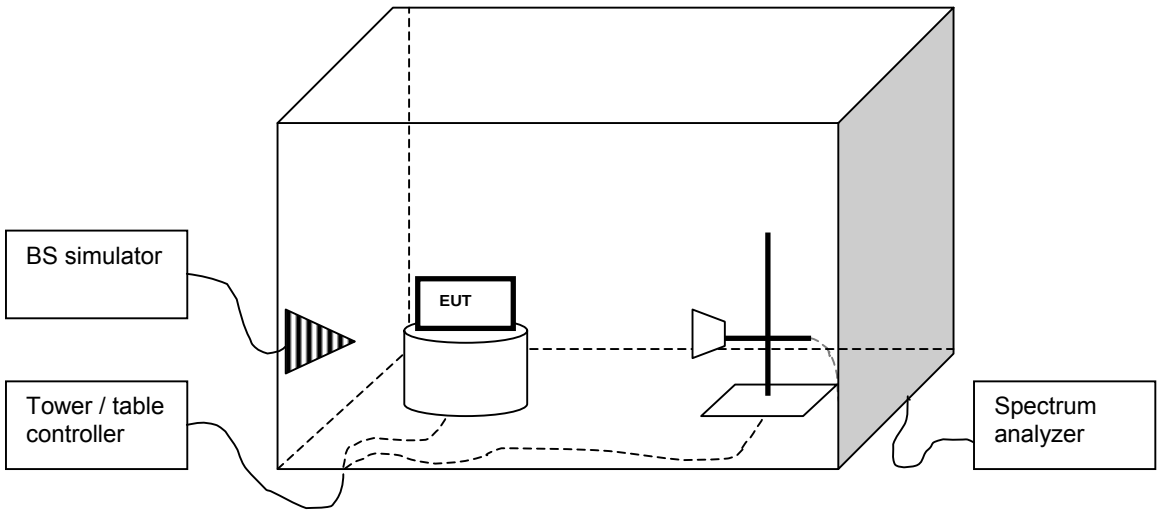
7 RADIATED RF OUTPUT POWER

EUT	3392		
Accessories	3393, 3394		
Temp, Humidity, Air Pressure	21 ºC	45 RH%	997 mbar
Date of measurement	7.2.2004		
FCC rule part	§24.232 (b)		
RSS-133 section	6.2		
Measured by	Jari Jantunen		
Result	PASS		

7.1 Test setup

The EUT was set on a non-conductive turn table in a semi anechoic chamber. In the corner of the chamber there was a communication antenna, which was connected to the BS simulator located outside the chamber. The radiated power from the EUT was measured with an antenna fixed to a antenna tower. 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. The BS simulator was used to set the TX channel and power level and modulate the TX signal with different bit patterns.



7.2 Test method

a) The maximum power level was searched by moving the turn table and measuring antenna and manipulating the EUT. This level (P_{EUT}) was recorded.

b) The EUT was replaced with a substituting antenna.

c) The substituting antenna was fed with the power (P_{Subst_TX}) giving a convenient reading on the spectrum analyzer. That reading (P_{Subst_RX}) on spectrum analyzer was recorded.

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7.3 EUT operation mode

EUT operation mode	TX on, 1 time slot transmission, PRBS 2E9-1 audio modulation, GMSK modulation
EUT channel	512, 661, 810
EUT TX power level	0 (+30dBm)

7.4 Limit

EIRP [W]
≤ 2

7.5 Results

The formula below was used to calculate the EIRP of the EUT.

$$P_{EIRP[W]} = \frac{10^{(P_{Subst\_TX[dBm]}+(P_{EUT[dBm]}-P_{Subst\_RX[dBm]})+G_{Substitute\_antenna[dBi]}-L_{Cable[dB]})/10}}{1000}$$

where the variables are as follows:

$P_{EUT\ [dBm]}$ Measured power level (from step a in 7.2) from the EUT

$P_{Subst\_TX\ [dBm]}$ Power (from step c in 7.2) fed to the substituting antenna

$P_{Subst\_RX\ [dBm]}$ Power (from step c in 7.2) received with the spectrum analyzer

$G_{Substitute\_antenna\ [dBi]}$ Gain of the substitutive antenna over isotropic radiator

$L_{Cable\ [dB]}$ Loss of the cable between signal generator and the substituting antenna

Table 1 Radiated output power

EUT Channel	P_{EUT} [dBm]	$P_{Subst\ TX}$ [dBm]	$P_{Subst\ RX}$ [dBm]	Cable loss [dB]	Antenna gain [dBi]	EIRP [dBm]	EIRP [W]
512	-15.17	+10	-40.33	6.27	0.2	29.09	0.8110
661	-15.68	+10	-40.12	6.19	-0.5	27.75	0.5957
810	-18.17	+10	-40.59	6.10	-0.8	25.52	0.3565

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7.6 EUT operation mode

EUT operation mode	TX on, 1 time slot transmission, PRBS 2E9-1 audio modulation, 8PSK modulation
EUT channel	512, 661, 810
EUT TX power level	0 (+30dBm)

7.7 Limit

EIRP [W]
≤ 2

7.8 Results

The formula below was used to calculate the EIRP of the EUT.

$$P_{EIRP[W]} = \frac{10^{(P_{Subst\_TX[dBm]}+(P_{EUT[dBm]}-P_{Subst\_RX[dBm]})+G_{Substitute\_antenna[dBi]}-L_{Cable[dB]})/10}}{1000}$$

where the variables are as follows:

$P_{EUT\ [dBm]}$ Measured power level (from step a in 7.2) from the EUT

$P_{Subst\_TX\ [dBm]}$ Power (from step c in 7.2) fed to the substituting antenna

$P_{Subst\_RX\ [dBm]}$ Power (from step c in 7.2) received with the spectrum analyzer

$G_{Substitute\_antenna\ [dBi]}$ Gain of the substitutive antenna over isotropic radiator

$L_{Cable\ [dB]}$ Loss of the cable between signal generator and the substituting antenna

Table 2 Radiated output power

EUT Channel	P_{EUT} [dBm]	$P_{Subst\ TX}$ [dBm]	$P_{Subst\ RX}$ [dBm]	Cable loss [dB]	Antenna gain [dBi]	EIRP [dBm]	EIRP [W]
512	-17.23	+10	-40.33	6.27	0.2	27.03	0.5047
661	-17.29	+10	-40.12	6.19	-0.5	26.14	0.4112
810	-20.32	+10	-40.59	6.10	-0.8	23.37	0.2173

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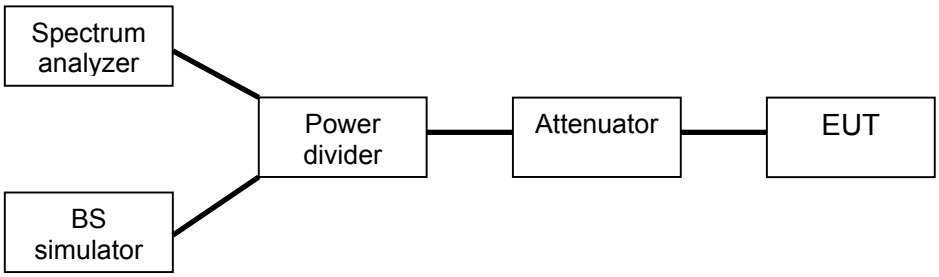
8 99% OCCUPIED BANDWIDTH

EUT	3376		
Accessories	3377, 3386		
Temp, Humidity, Air Pressure	20ºC	55RH%	999 mbar
Date of measurement	9.2.2004		
FCC rule part	§2.1049 (h)		
RSS-133 section	5.6		
Measured by	Jan-Erik Lilja		

8.1 Test setup

The BS simulator was used to set the TX channel and power level and modulate the TX signal with different bit patterns.



8.2 EUT operation mode

EUT operation mode	TX on, 1 time slot transmission, PRBS 2E9-1 audio modulation, GMSK modulation
EUT channel	661
EUT TX power level	0 (+30dBm)

8.3 Results

The 99% occupied bandwidth was measured using the in-built function of the spectrum analyzer.

Table 3 99% Occupied bandwidth

EUT Channel	99% occupied bandwidth [kHz]
661	238.782

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8.4 Screen shot

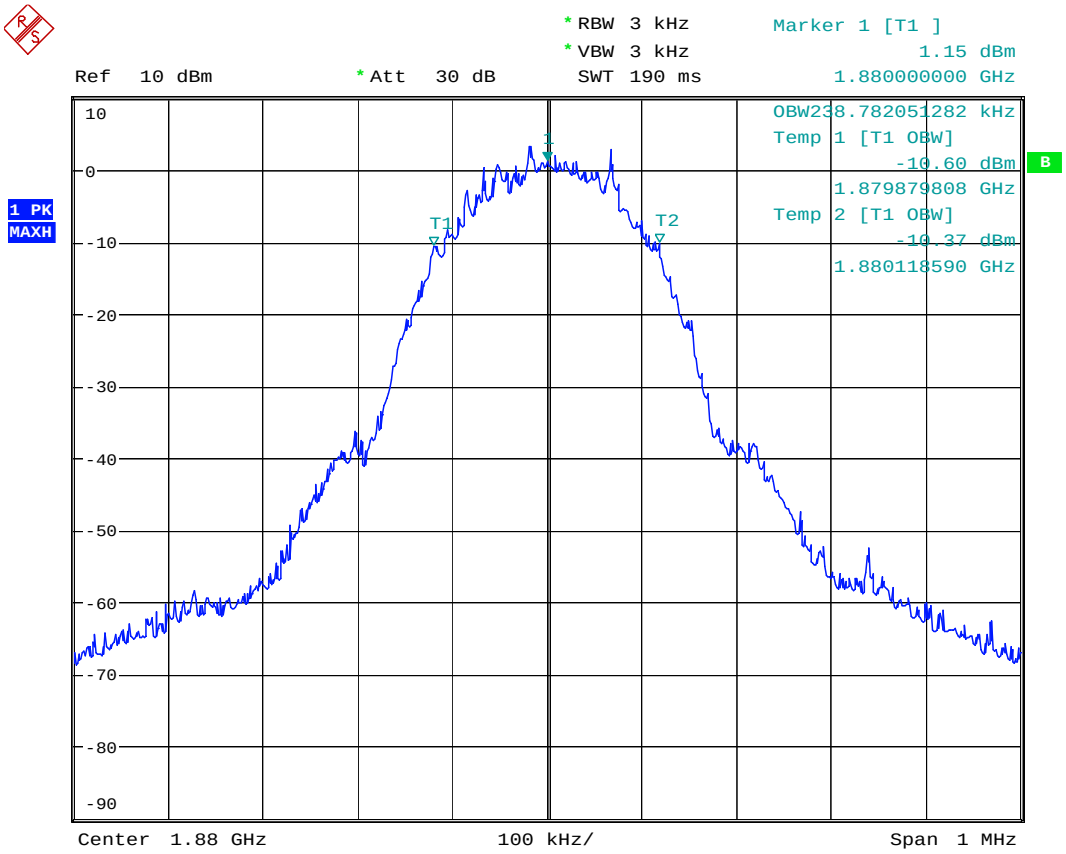

Figure 1 99% occupied bandwidth, channel 661 GMSK modulation

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8.5 EUT operation mode

EUT operation mode	TX on, 1 time slot transmission, PRBS 2E9-1 audio modulation, 8PSK modulation (EDGE)
EUT channel	661
EUT TX power level	0 (+30dBm)

8.6 Results

The 99% occupied bandwidth was measured using the in-built function of the spectrum analyzer.

Table 4 99% Occupied bandwidth

EUT Channel	99% occupied bandwidth [kHz]
661	240.385

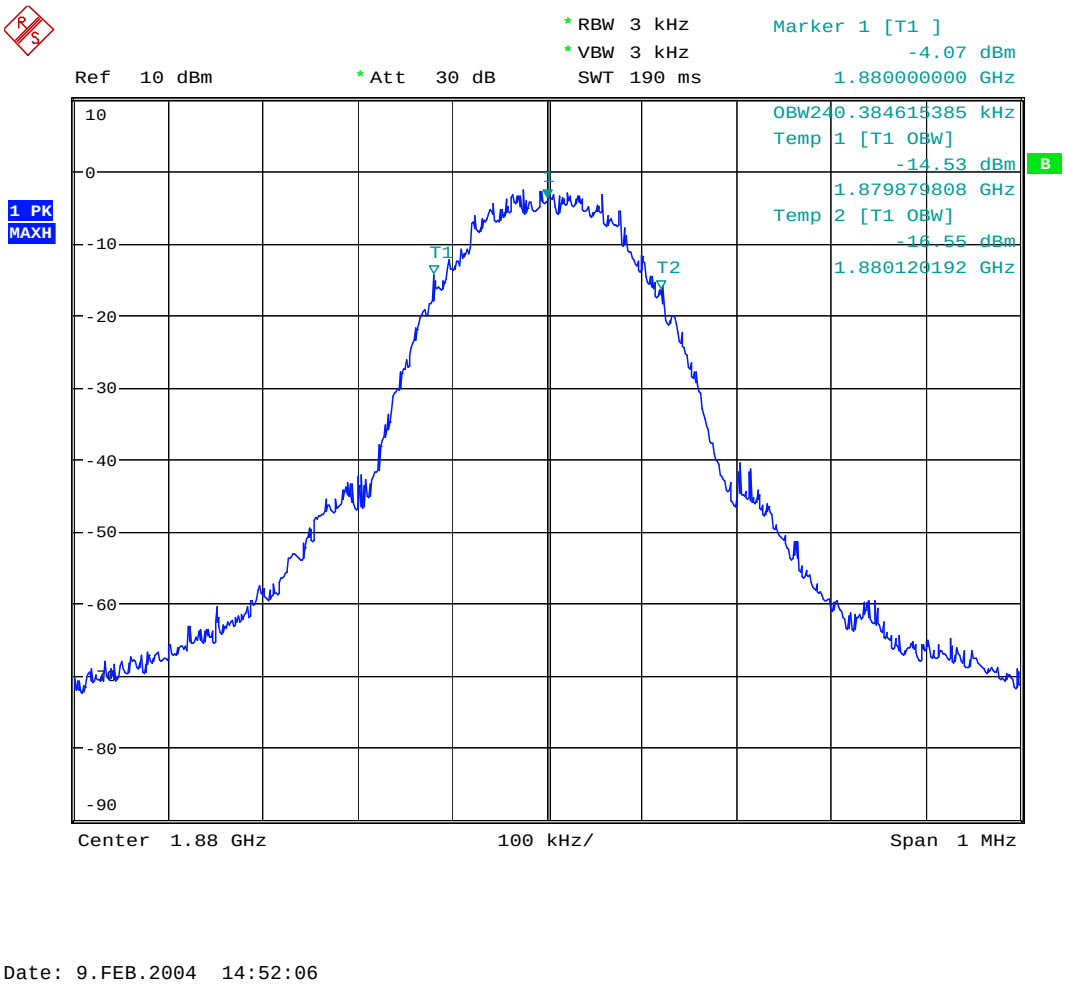

Figure 2 99% occupied bandwidth, channel 661 8PSK modulation

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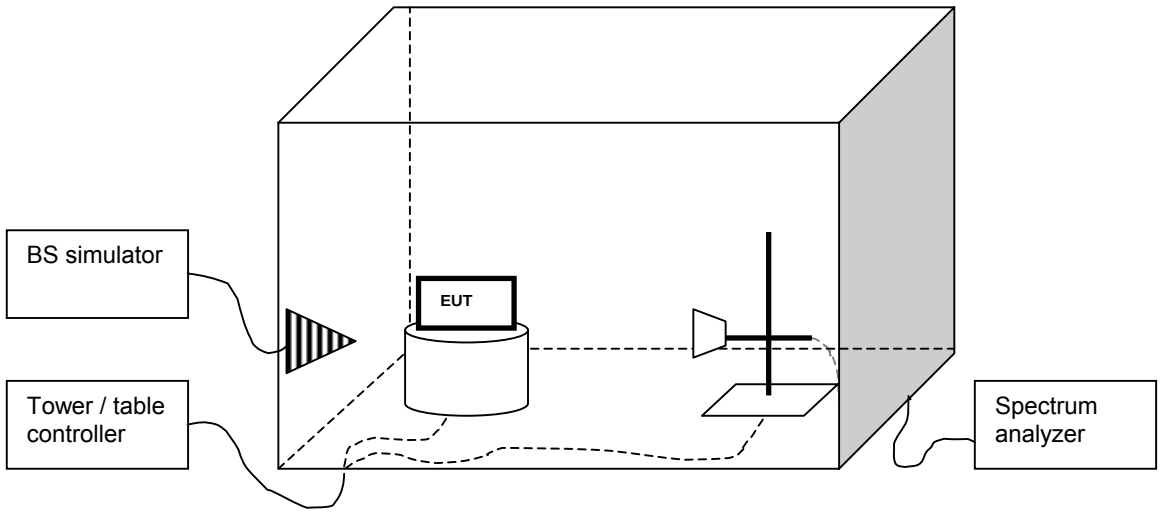
9 BANDEDGE COMPLIANCE

EUT	3392		
Accessories	3393, 3394		
Temp, Humidity, Air Pressure	22 ºC	45 RH%	1007 mbar
Date of measurement	9.2.2004		
FCC rule part	§24.238 (a)		
RSS-133 section	6.3		
Measured by	Jari Jantunen		
Result	PASS		

9.1 Test setup

This measurement was performed in conjuction of the ERP measurement.

The BS simulator was used to set the TX channel and power level and modulate the TX signal with different bit patterns.



9.2 EUT operation mode

EUT operation mode	TX on, 1 time slot transmission, PRBS 2E9-1 audio modulation, GMSK modulation
EUT channel	See section 9.4
EUT TX power level	0 (+30dBm)

9.3 Limit

Frequency [MHz]	Level [dBm]
<1850 or 1910<	-13

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9.4 Results

The line in the screen shots is the -13dBm limit line. The results were corrected with measurement path loss set as “offset” in the spectrum analyzer.

Table 5 Lower and upper bandedge

EUT Channel	Level [dBm]
512	-17.76
810	-22.45

9.5 Screen shots

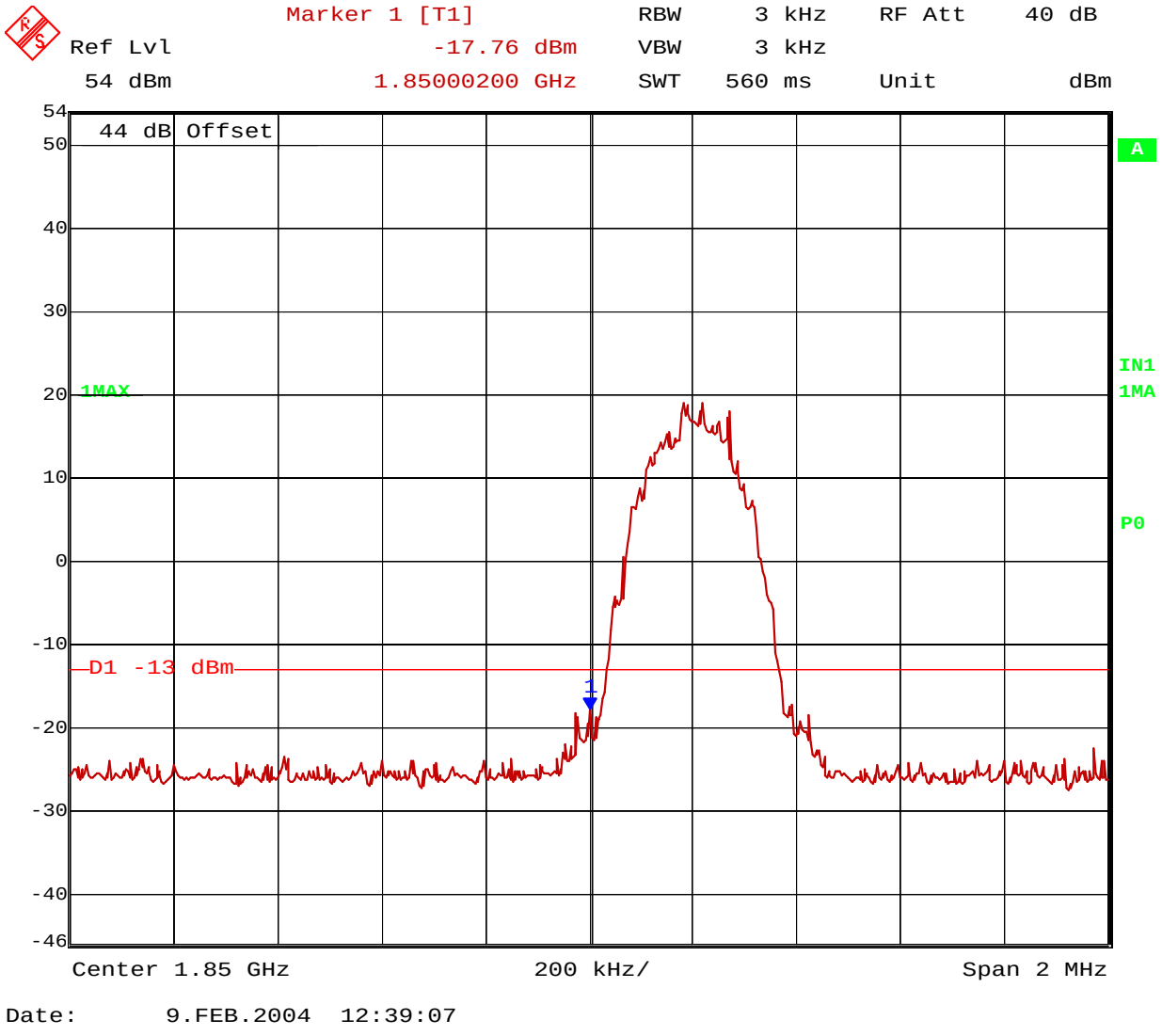

Figure 3 Lower bandedge, channel 512

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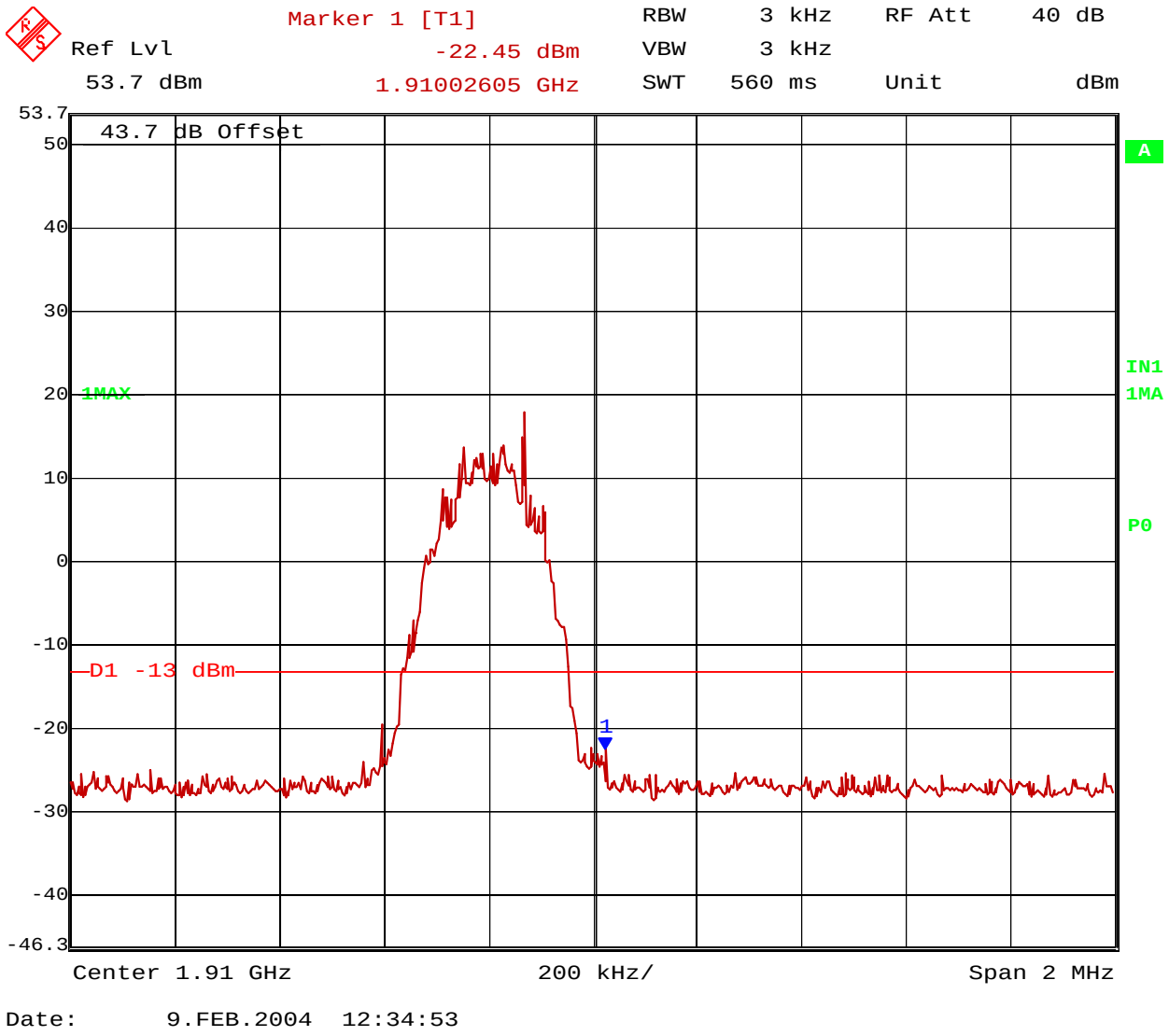

Figure 4 Upper bandedge, channel 810

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9.6 EUT operation mode

EUT operation mode	TX on, 1 time slot transmission, PRBS 2E9-1 audio modulation, 8PSK modulation
EUT channel	See section 9.4
EUT TX power level	0 (+30dBm)

9.7 Limit

Frequency [MHz]	Level [dBm]
<1850 or 1910<	-13

9.8 Results

The line in the screen shots is the -13dBm limit line. The results were corrected with measurement path loss set as “offset” in the spectrum analyzer.

Table 6 Lower and upper bandedge

EUT Channel	Level [dBm]
512	-22.79
810	-22.32

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9.9 Screen shots

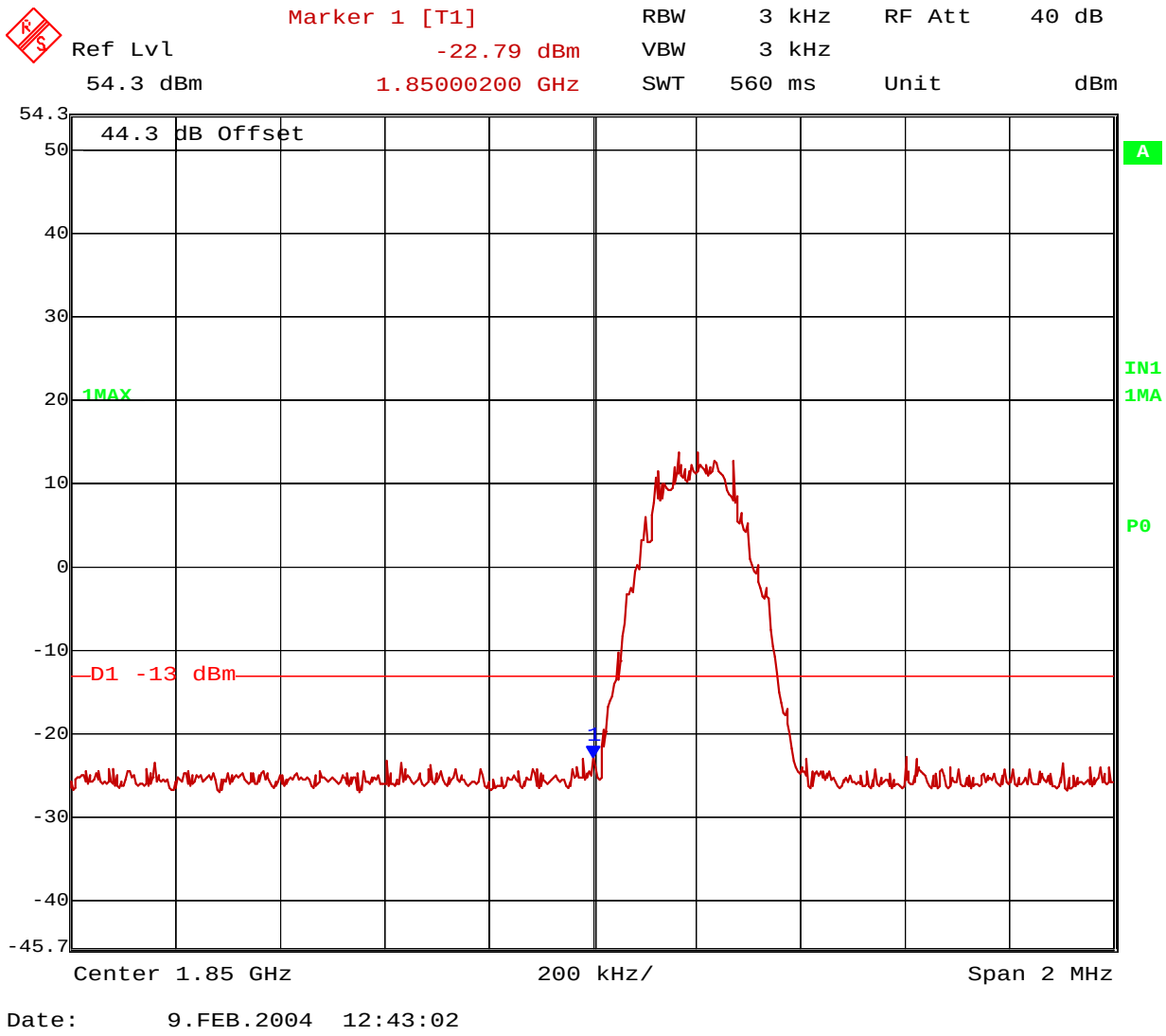

Figure 5 Lower bandedge, channel 512

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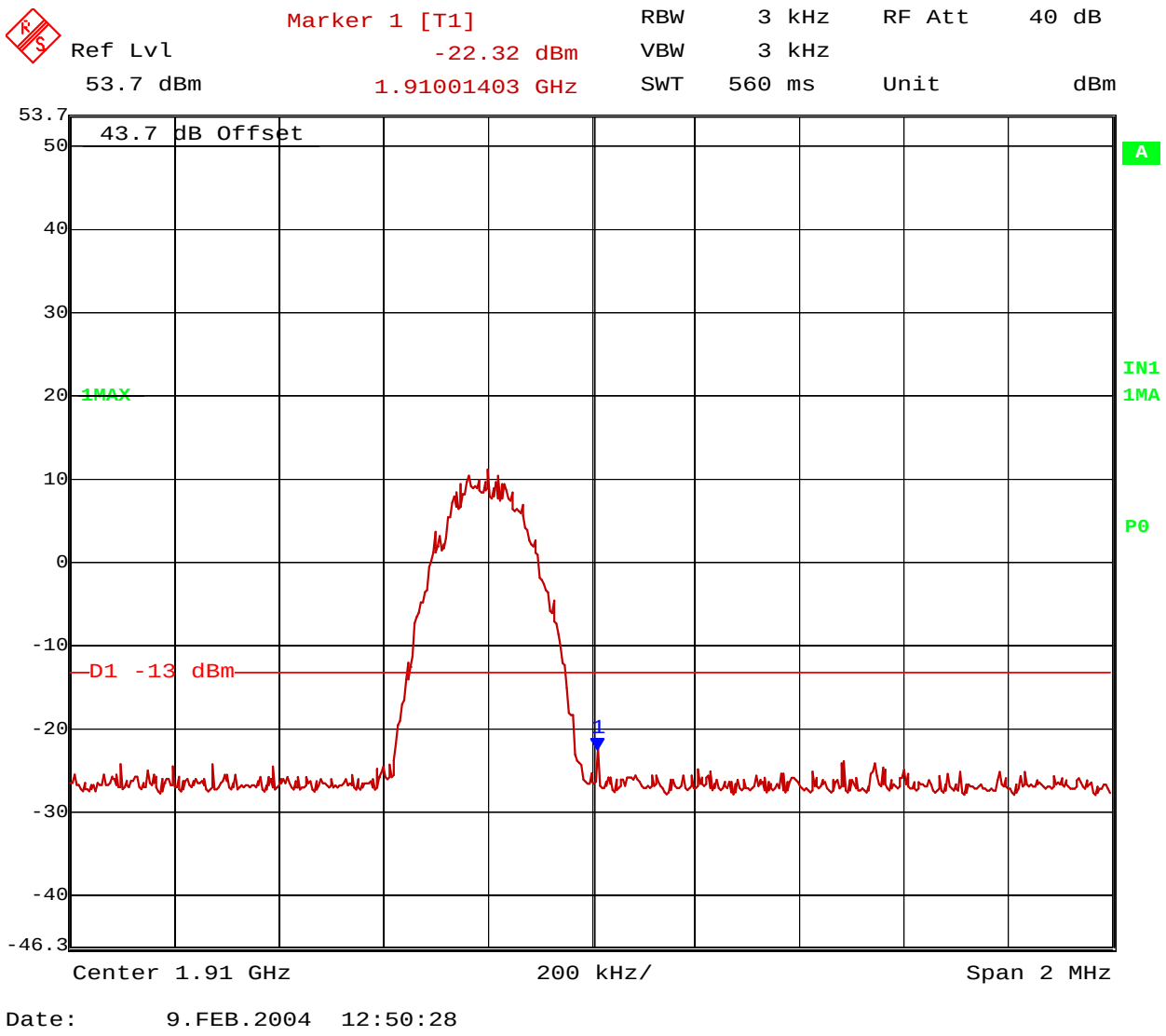

Figure 6 Upper bandedge, channel 810

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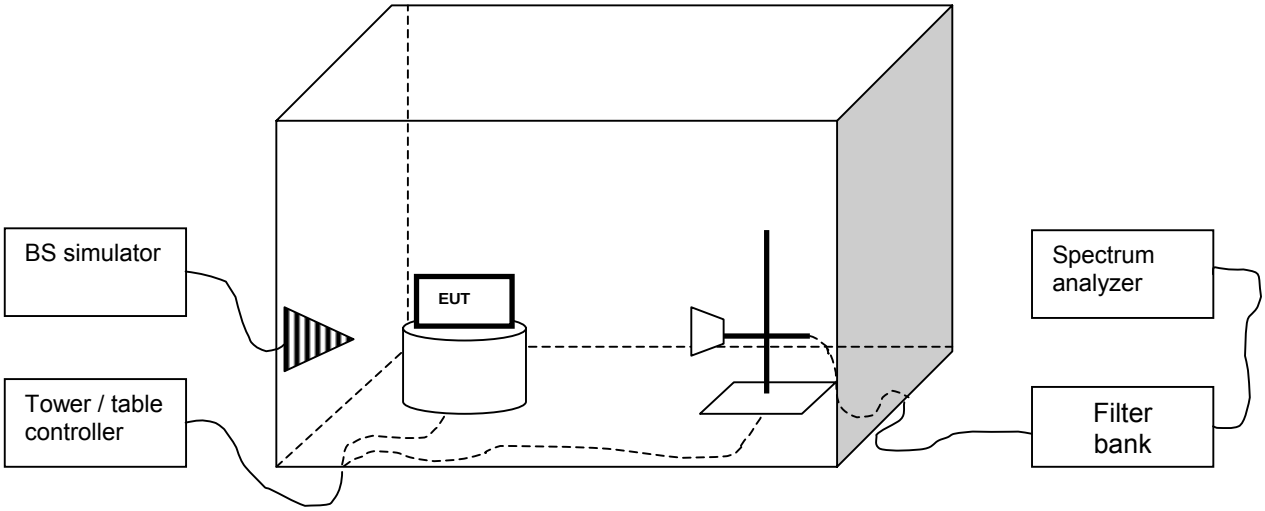
10 SPURIOUS RADIATED EMISSION

EUT	3376		
Accessories	3377,3378		
Temp, Humidity, Air Pressure	20 ºC	45 RH%	1026 mbar
Date of measurement	12.2.2004		
FCC rule part	§24.238 (a), §2.1053		
RSS-133 section	6.3		
Measured by	Jari Jantunen		
Result	PASS		

10.1 Test setup

A set of LP/HP/BS filters was used to prevent overloading the spectrum analyzer. The BS simulator was used to set the TX channel and power level and modulate the TX signal with different bit patterns. The test was done using an automated test system, where the measurement devices were controlled by a computer.



10.2 Test method

a) The emissions were searched and maximized by moving the turn table and measuring antenna and manipulating the EUT.

b) All suspicious frequencies with emission levels were recorded.

c) The EUT was replaced with a substituting antenna.

d) For each frequency recorded, the substituting antenna was fed with the power (from signal generator) giving the same reading as in (b). These power levels were reported.

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10.3 EUT operation mode

EUT operation mode	TX on, 1 time slot transmission, PRBS 2E9-1 audio modulation, GMSK modulation
EUT channel	661
EUT TX power level	0 (+30dBm)

10.4 Limit

Frequency [MHz]	Level [dBm]
30 – 19100	-13

10.5 Results

The formula below was used to calculate the EIRP of the spurious emissions. If there were no emissions closer than 20dB below the limit line, then the emission levels were measured at the transmitter's harmonics.

$$P_{Emission[dBm]} = P_{SubstTX[dBm]} - L_{Cable[dB]} + G_{Antenna[dBi]}$$

where the variables are as follows:

$P_{Measured\ [dBm]}$	Measured emission level (from step b in 10.2)
$P_{Subst\_TX\ [dBm]}$	Signal generator power (from step d in 10.2) fed to the substituting antenna
$L_{Cable\ [dB]}$	Loss of the cable between antenna and signal generator (from step d in 10.2)
$G_{Antenna\ [dBi]}$	Gain of the substitutive antenna over isotropic radiator

Table 7 Emission levels, channel 661

Frequency [MHz]	$P_{Measured}$ [dBm]	P_{Subst_TX} [dBm]	L_{Cable} [dB]	$G_{Antenna}$ [dBi]	$P_{Emission}$ [dBm]
3760,00	-57.80	-42.50	8.10	8.47	-42.13
4230.3	-58.32	-43.20	8.10	9.81	-41.49

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10.6 EUT operation mode

EUT operation mode	TX on, 1 time slot transmission, PRBS 2E9-1 audio modulation, 8PSK modulation
EUT channel	661
EUT TX power level	0 (+30dBm)

10.7 Limit

Frequency [MHz]	Level [dBm]
30 – 19100	-13

10.8 Results

The formula below was used to calculate the EIRP of the spurious emissions. If there were no emissions closer than 20dB below the limit line, then the emission levels were measured at the transmitter's harmonics.

$$P_{Emission[dBm]} = P_{SubstTX[dBm]} - L_{Cable[dB]} + G_{Antenna[dBi]}$$

where the variables are as follows:

$P_{Measured\ [dBm]}$	Measured emission level (from step b in 10.2)
$P_{Subst\_TX\ [dBm]}$	Signal generator power (from step d in 10.2) fed to the substituting antenna
$L_{Cable\ [dB]}$	Loss of the cable between antenna and signal generator (from step d in 10.2)
$G_{Antenna\ [dBi]}$	Gain of the substitutive antenna over isotropic radiator

Table 8 Emission levels, channel 661

Frequency [MHz]	$P_{Measured}$ [dBm]	P_{Subst_TX} [dBm]	L_{Cable} [dB]	$G_{Antenna}$ [dBi]	$P_{Emission}$ [dBm]
3760,00	-60.82	-47.50	8.10	8.47	-47.13
4230.1	-63.64	-45.10	8.10	9.81	-43.39

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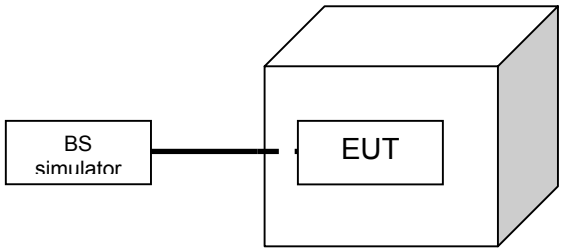
11 FREQUENCY STABILITY, TEMPERATURE VARIATION

EUT	3392		
Accessories	3393, 3343		
Temp, Humidity, Air Pressure	20ºC	50RH%	1008mbar
Date of measurement	10-11.2.2004		
FCC rule part	§24.235, §2.1055 (a)(1)(b)		
RSS-133 section	7		
Measured by	Jan-Erik Lilja		
Result	PASS		

11.1 Test setup

The BS simulator was used to set the TX channel and power level and modulate the TX signal with different bit patterns.



11.2 Limit

Frequency deviation [ppm]
± 2.5

11.3 Test method

a) The climate chamber temperature was set to the minimum value and the temperature was allowed to stabilize.

b) The EUT was placed in the chamber

c) The EUT was set in idle mode for 45 minutes.

d) The EUT was set to transmit.

e) The transmit frequency error was measured immediately

f) The steps c - e were repeated for each temperature

11.4 EUT operation mode

EUT operation mode	TX on, 1 time slot transmission, PRBS 2E9-1 audio modulation, GMSK modulation
EUT channel	661
EUT TX power level	0 (+30dBm)

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11.5 Results

Table 9 Frequency deviation, temperature variation

Temperature [ºC]	Deviation [Hz]	Deviation [ppm]
-30	*)	*)
-20	*)	*)
-10	38	0.0202
0	33	0.0176
10	31	0.0165
20	33	0.0176
30	25	0.0133
40	24	0.0128
50	24	0.0128

Note: *) Phone did not worked at this temperature

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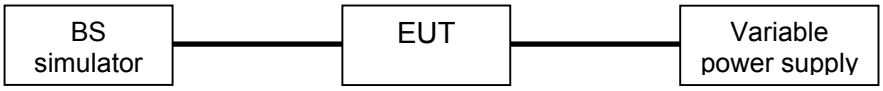
12 FREQUENCY STABILITY, VOLTAGE VARIATION

EUT	3392		
Accessories	3393, 3343		
Temp, Humidity, Air Pressure	20 ºC	45RH%	1026 mbar
Date of measurement	12.2.2004		
FCC rule part	§24.235, §2.1055 (d)(1)(2)		
RSS-133 section	7		
Measured by	Jan-Erik Lilja		
Result	PASS		

12.1 Test setup

The BS simulator was used to set the TX channel and power level and modulate the TX signal with different bit patterns.



12.2 EUT operation mode

EUT operation mode	TX on, 1 time slot transmission, PRBS 2E9-1 audio modulation. GMSK modulation
EUT channel	661
EUT TX power level	0 (+30dBm)

12.3 Limit

Frequency deviation [ppm]
± 2.5

12.4 Test method

The EUT battery was replaced with an adjustable power supply. The frequency stability was measured at nominal voltage and at the battery cut-off point.

12.5 Results

Table 10 Frequency deviation, voltage variation

Level	Voltage [V]	Deviation [Hz]	Deviation [ppm]
Nominal	3.9	28	0.0335
Battery cut-off point	3.1	26	0.0311

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13 TEST EQUIPMENT

Each test equipment is calibrated once a year.

13.1 Conducted measurements

Equipment	Manufacturer	Model
EMI receiver	Rohde & Schwarz	FSU26
Radio communication tester	Rohde & Schwarz	CMU-200
Attenuator 10 dB	Huber+Suhner AG	6251.17.A
Power splitter	Hewlett-Packard	11667A
Temperature chamber	Vötsch	VT4002
DC power supply	Hewlett&Packard	6632A
Multimeter	Hewlett&Packard	34401A

13.2 Radiated measurements

Equipment	Manufacturer	Model
3m semi-anechoic chamber	TDK	
EMI receiver	Rohde & Schwarz	ESI 40
Preamplifier	Hewlett-Packard	8447F
Preamplifier	Hewlett-Packard	8449B
Biconilog antenna	EMCO	3142
Double ridged waveguide antenna	EMCO	3115
Double ridged waveguide antenna	EMCO	3115
Horn antenna	EMCO	3116
Reference dipole set	Schwarzbeck	UHAP/VHAP
Fixed dipole	EMCO	3125-1880
Communication antenna	EMC Automation	LPA-8020
Radio communication tester	Rohde & Schwarz	CMU-200
Signal generator	Hewlett-Packard	83640L
Step attenuator 110dB	Hewlett-Packard	8496A
Power splitter	Hewlett-Packard	11667A
High pass filter	Trilithic	WHK2010-10SS
Low pass filter	Trilithic	WLK1750-10SS
Tunable notch filter	Wainwright	WRCD1850/1910-0.2/40
Antenna/turntable controller	Deisel	HD-100
Antenna mast	Deisel	MA240
Turntable	Deisel	DS412

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14 TEST SETUP PHOTOGRAPHS

See " NHL-12 Test setup photographs.doc ".

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