FCC Part 24 Test Report
for
NPL-2

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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 3606 (April 14, 2000)

2 CUSTOMER INFORMATION

Client:	Nokia Corporation Lise-Meitner-Str. 10 D-89019 Ulm GERMANY Tel. + 49 (0) 731 1754 0 Fax. + 49 (0) 731 1754 6800
Contact person:	Tomi Vähätiitto
Receipt of EUT:	7.8.2002
Date of testing:	7-15.8 2002
Date of report:	20.8.2002

The tests listed in this report have been done to demonstrate compliance with the applicable FCC rules in CFR 47 Part 24.

Contents approved:

Hannu Kytömaa
Hannu Kytömaa EMC Team Leader

3 SUMMARY OF TEST RESULTS

Section in CFR 47		Result
§2.1046 (a)	Conducted RF output	X
§24.232 (b)	Radiated RF output	PASS
§2.1049 (h)	99% occupied bandwidth	X
§24.238 (a)	Band-edge compliance	PASS
§24.238 (a), §2.1051	Spurious emissions at antenna terminals	PASS
§24.238 (a), §2.1053	Field strength of spurious radiation	PASS
§24.235, §2.1055 (a)(1)(b)	Frequency stability, temperature variation	X
§24.235, §2.1055 (d)(1)(2)	Frequency stability, voltage variation	X

PASS The EUT passed that particular test
FAIL The EUT failed that particular test
X The measurement was done, but there is no applicable performance criteria
- Not done

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4 EUT INFORMATION

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

	Device	Type	FCCID	S/N	EUT number
EUT	GSM1900 mobile phone GSM1900 mobile phone	NPL-2 NPL-2	PPI-NPL-2 PPI-NPL-2	004400051701157 004400051714531	03229 03232
Accessories	Battery Dummy battery	BL-4C -	- -	067038610717228514	03230 03219

Notes: -

4.1 EUT description

The EUT is a triple band (900MHz/1800MHz/1900MHz) GSM mobile phone.

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 section 16.

6 APPLICABLE STANDARDS

The tests were performed in guidance of CFR 47 part 24, part 2 and ANSI C63.4-1992. 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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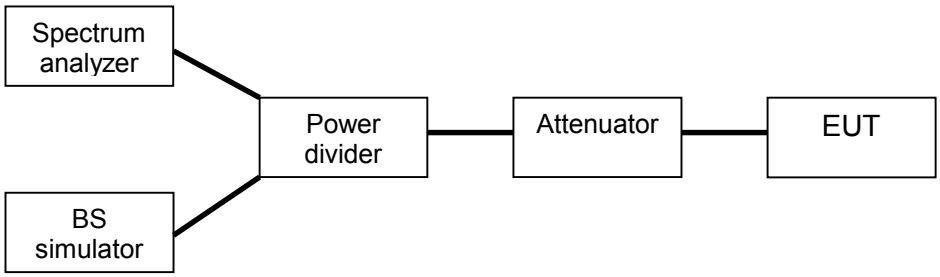
7 CONDUCTED RF OUTPUT POWER

EUT	03229		
Accessories	03230		
Temp, Humidity, Air Pressure	22ºC	56RH%	1017 mbar
Date of measurement	7.8.2002		
FCC rule part	§2.1046 (a)		
Measured by	Hannu Kytömaa		

7.1 Test setup

The test setup was as in the block diagram below. The BS simulator was used to set the TX channel and power level and modulate the TX signal with different bit patterns.



7.2 EUT operation mode

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

7.3 Results

The measured power values were corrected with the attenuation of the cables, attenuator and power divider. The following formula was used to convert the measured values to the reported ones:

$$P[W] = \frac{10^{(P_{Meas[dBm]} + L_{Cables[dB]} + L_{Attenuator[dB]} + L_{Divider[dB]})/10}}{1000}$$

EUT Channel	Measured value [dBm]	Cable loss [dB]	Attenuator loss [dB]	Divider loss [dB]	Output power [dBm]	Output power [W]
512	13.25	1.72	9.94	6.16	31.07	1.279
661	13.13	1.63	9.98	6.13	30.87	1.222
810	12.81	1.50	9.85	6.29	30.45	1.109

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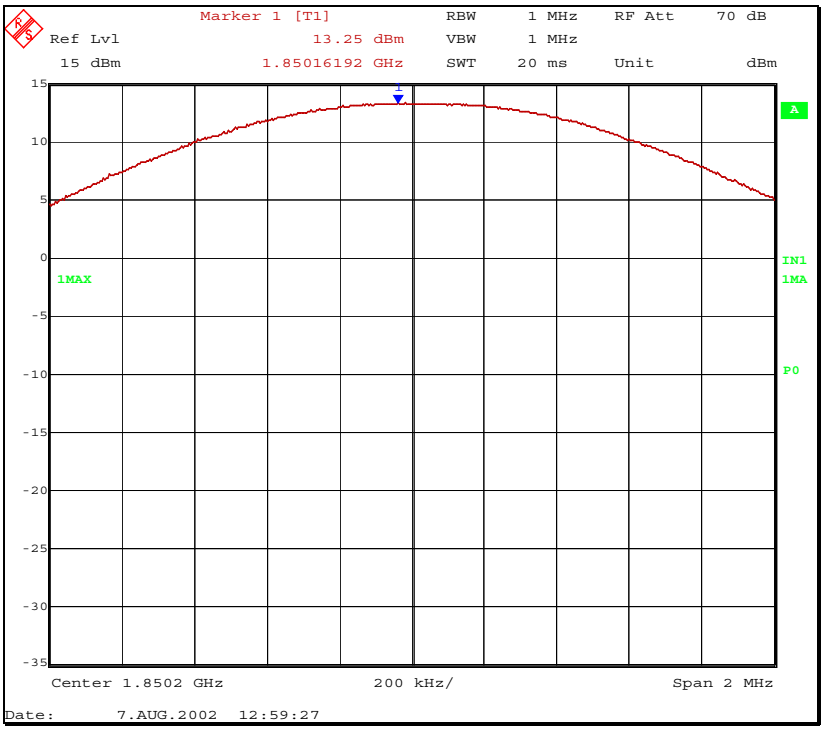
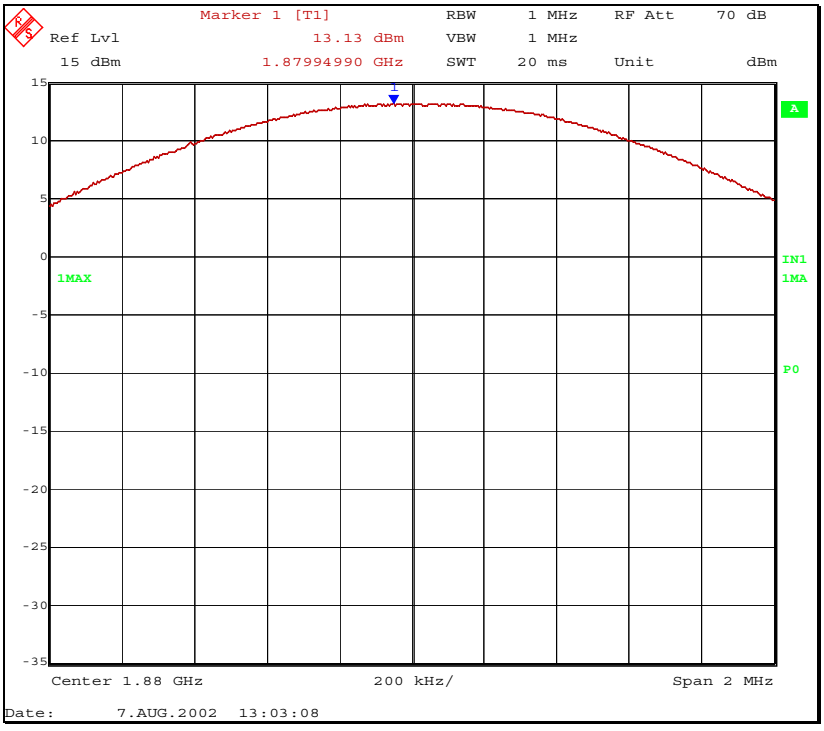
7.4 Screen shots



Picture 1. Conducted output power, channel 512



Picture 2. Conducted output power, channel 661

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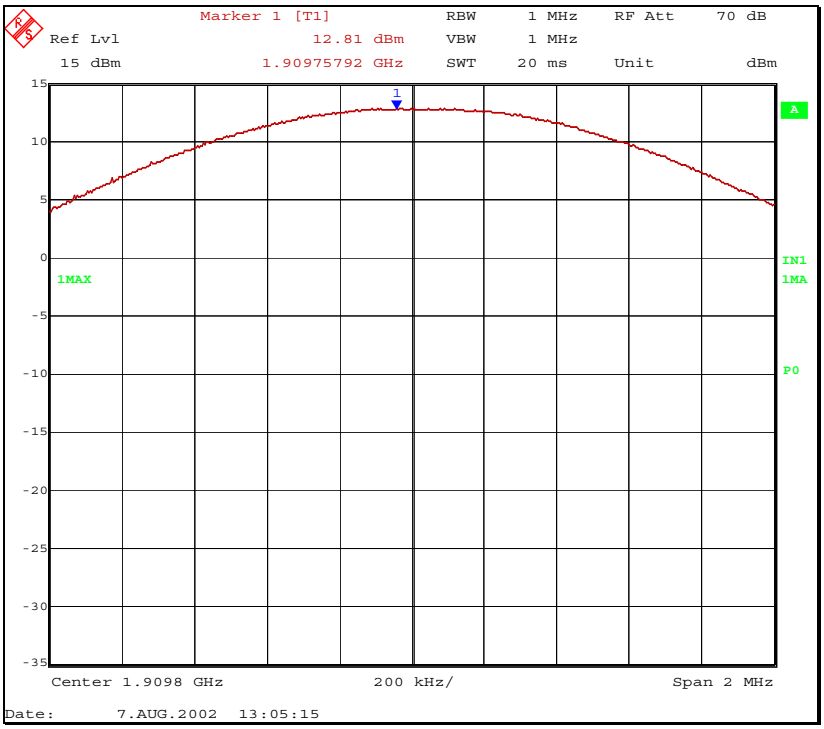

Picture 3. Conducted output power, channel 810

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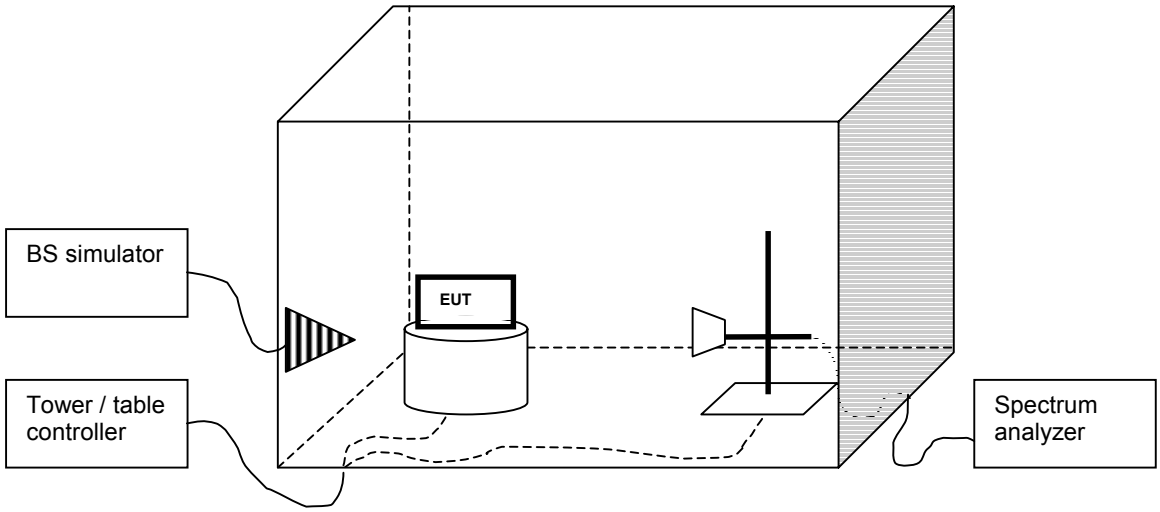
8 RADIATED RF OUTPUT POWER

EUT	03232		
Accessories	03230		
Temp, Humidity, Air Pressure	21ºC	58RH%	1010mbar
Date of measurement	13.8.2002		
FCC rule part	§24.232 (b)		
Measured by	Tero Huhtala		
Result	PASS		

8.1 Test setup

The test setup was as in the block diagram below. 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.



8.2 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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8.3 EUT operation mode

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

8.4 Limit

Watts, EIRP
≤ 2

8.5 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 8.2) from the EUT
$P_{Subst\_TX\ [dBm]}$	Power (from step c in 8.2) fed to the substituting antenna
$P_{Subst\_RX\ [dBm]}$	Power (from step c in 8.2) 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 substituting antenna and signal generator

EUT Channel	P_{EUT} [dBm]	$P_{Subst\ TX}$ [dBm]	$P_{Subst\ RX}$ [dBm]	L_{Cable} [dB]	Antenna gain [dBi]	Output power [dBm]	Output power [W]
512	-20.95	18.0	-29.28	5.88	8.80	29.25	0.841
661	-20.56	18.0	-30.09	6.16	8.70	30.07	1.016
810	-20.35	18.0	-29.93	5.86	8.70	30.42	1.102

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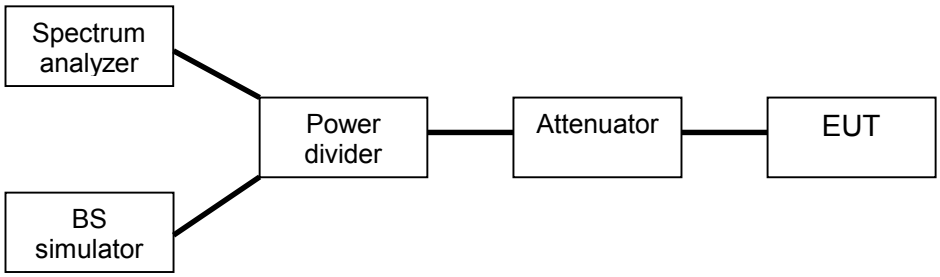
9 99% OCCUPIED BANDWIDTH

EUT	03229		
Accessories	03230		
Temp, Humidity, Air Pressure	22ºC	56RH%	1017mbar
Date of measurement	7.8.2002		
FCC rule part	§2.1049 (h)		
Measured by	Hannu Kytömaa		

9.1 Test setup

The test setup was as in the block diagram below. 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 modulation
EUT channel	512, 661, 810
EUT TX power level	0 (+30dBm)

9.3 Results

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

EUT Channel	99% occupied bandwidth [kHz]
512	242.48
661	240.48
810	242.48

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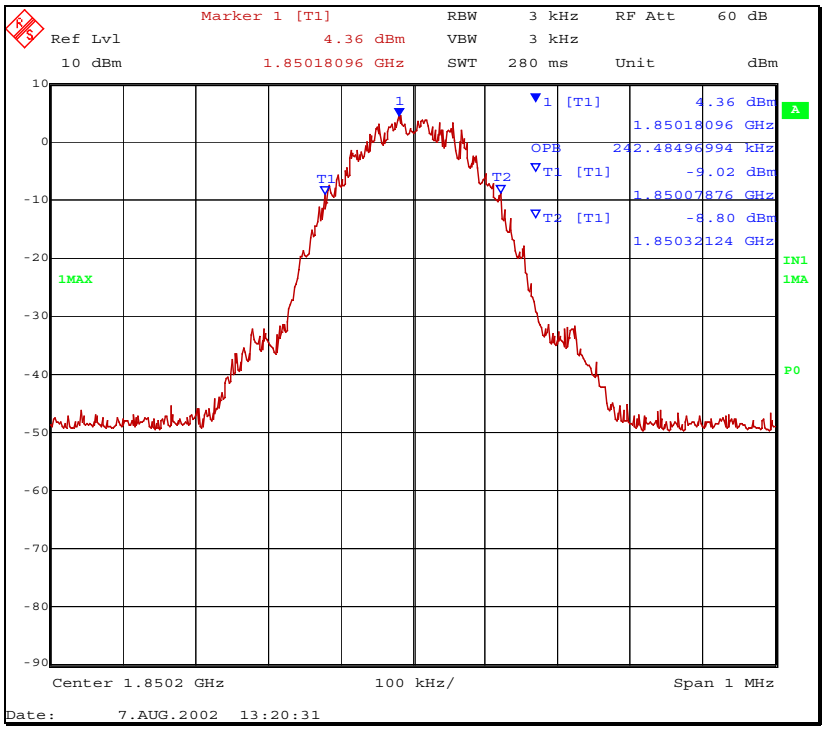
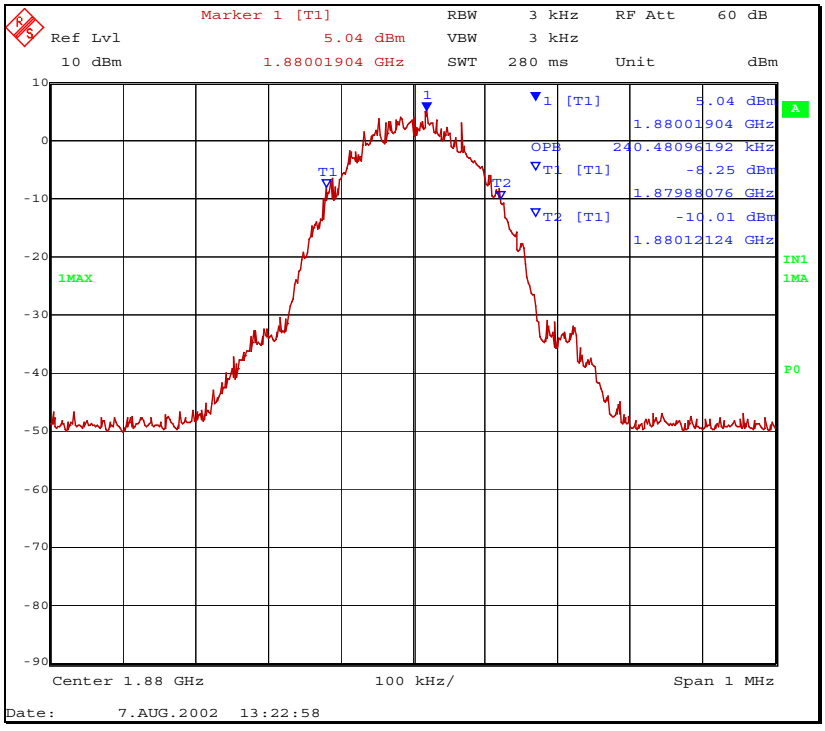
9.4 Screen shots



Picture 4. 99% occupied bandwidth, channel 512



Picture 5. 99% occupied bandwidth, channel 661

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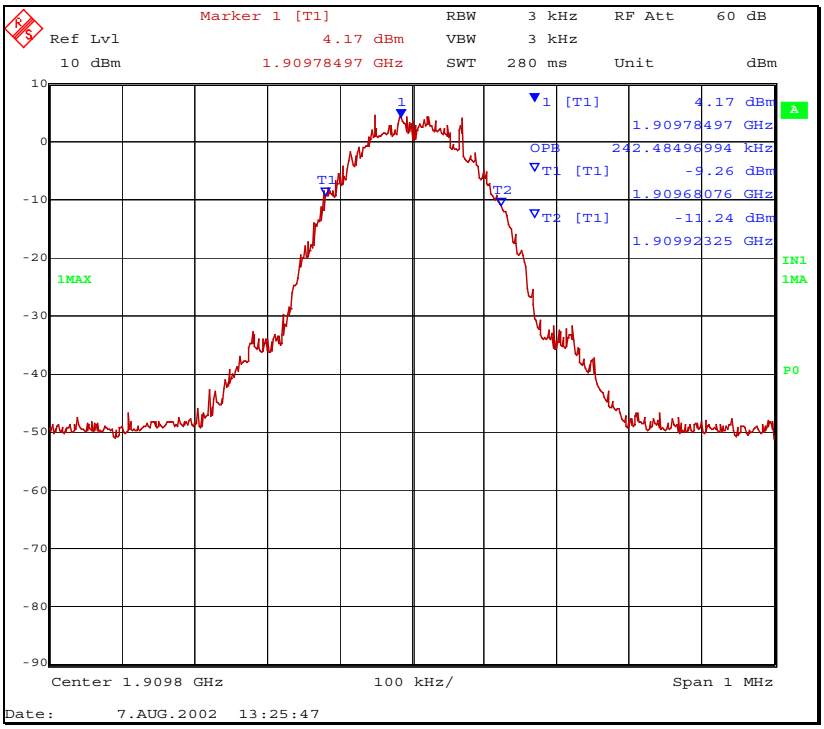

Picture 6. 99% occupied bandwidth, channel 810

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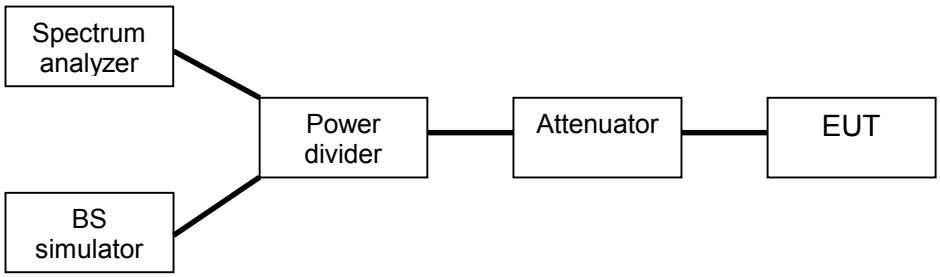
10 BAND-EDGE COMPLIANCE

EUT	03229		
Accessories	03230		
Temp, Humidity, Air Pressure	22ºC	56RH%	1017mbar
Date of measurement	7.8.2002		
FCC rule part	§24.238 (a)		
Measured by	Hannu Kytömaa		
Result	PASS		

10.1 Test setup

The test setup was as in the block diagram below. The BS simulator was used to set the TX channel and power level and modulate the TX signal with different bit patterns.



10.2 EUT operation mode

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

10.3 Limit

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

10.4 Results

The line in the screen shots is the -13dBm limit line. It's value has been corrected with the combined attenuation of cables, attenuator and divider, shown in the screen shots as "offset". The values used to offset the limit line were taken from 7.3.

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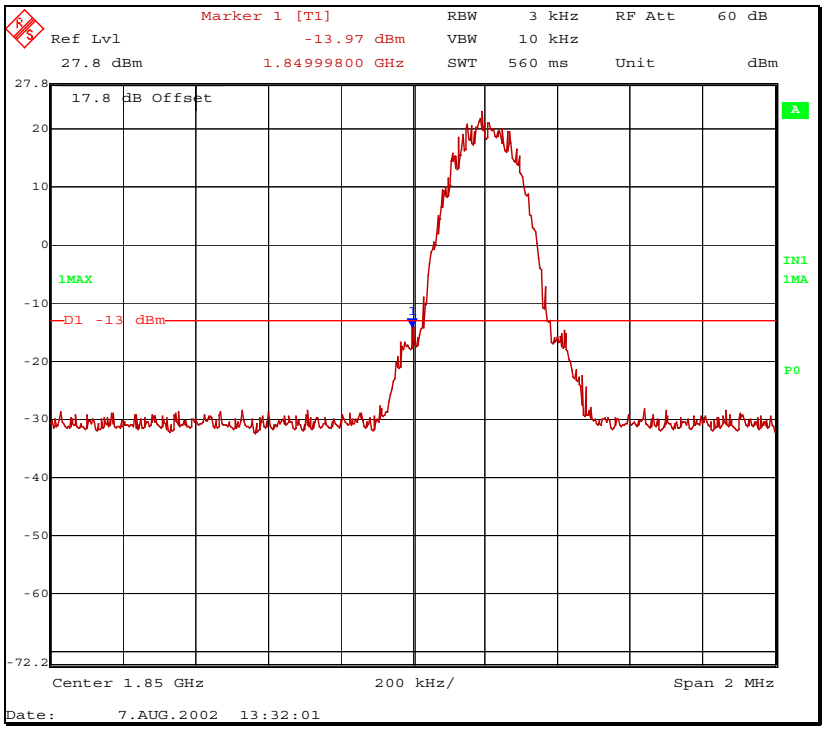
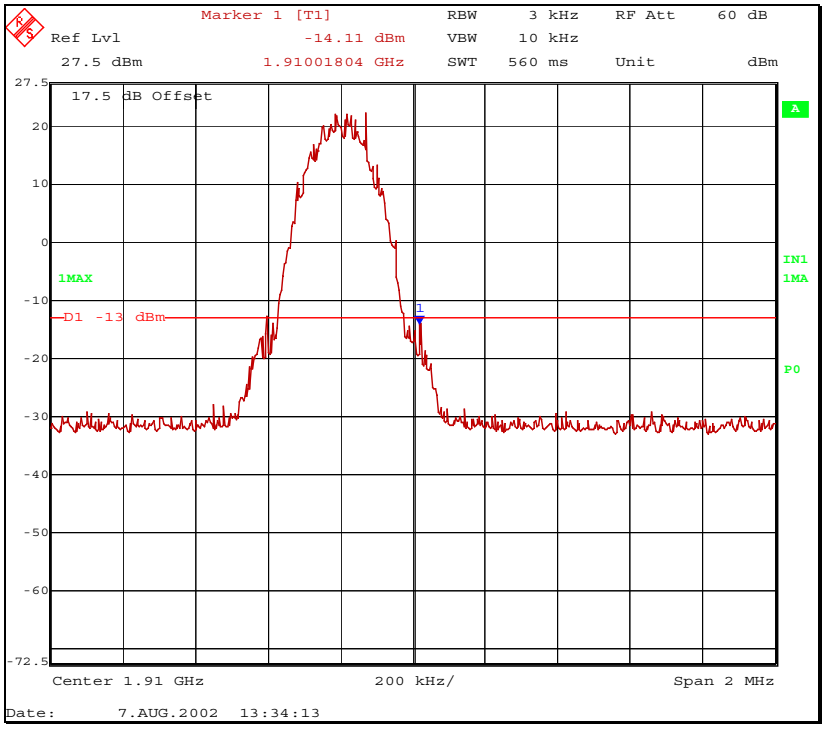
10.5 Screen shots



Picture 7. Lower band edge, channel 512



Picture 8. Higher band edge, channel 810

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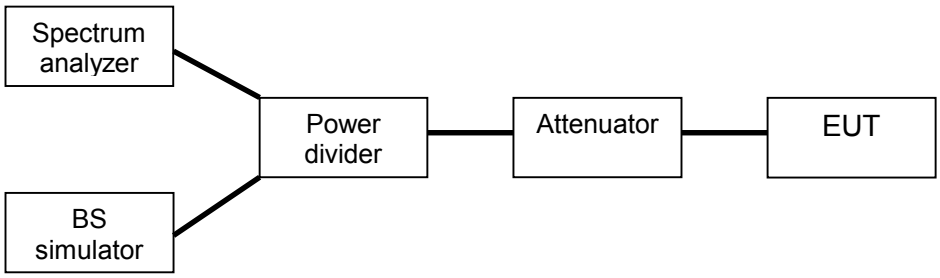
11 SPURIOUS EMISSIONS AT ANTENNA TERMINALS

EUT	03229		
Accessories	03230		
Temp, Humidity, Air Pressure	22ºC	56RH%	1017mbar
Date of measurement	7.8.2002		
FCC rule part	§24.238 (a), §2.1051		
Measured by	Hannu Kytömaa		
Result	PASS		

11.1 Test setup

The test setup was as in the block diagram below. The BS simulator was used to set the TX channel and power level and modulate the TX signal with different bit patterns.



11.2 Test method

The measured emission levels were corrected with the attenuation of the cables, attenuator and divider.

11.3 EUT operation mode

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

11.4 Limit

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

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11.5 Results

The highest emissions are reported in the tables below. If there were no emissions closer than 20dB below the limit line, then the emission levels were measured at the transmitter's harmonics.

Frequency [MHz]	Level [dBm]	Cable [dB]	Attenuator [dB]	Result [dBm]
3700,43	-51.67	1.78	15.47	-34.42
5550,67	-57.71	1.96	16.08	-39.67
7400,78	-60.01	2.75	15.03	-42.23

Table 9. Emission levels, channel 512

Frequency [MHz]	Level [dBm]	Cable [dB]	Attenuator [dB]	Result [dBm]
3760,19	-48.64	1.81	15.48	-31.35
5640,21	-50.61	2.21	15.94	-32.46
7520,24	-50.15	2.86	15.05	-32.24

Table 10. Emission levels, channel 661

Frequency [MHz]	Level [dBm]	Cable [dB]	Attenuator [dB]	Result [dBm]
3819,50	-47.90	1.85	15.51	-30.54
5729,43	-50.61	2.20	15.93	-32.48
7639,24	-50.45	2.88	15.13	-32.44

Table 11. Emission levels, channel 810

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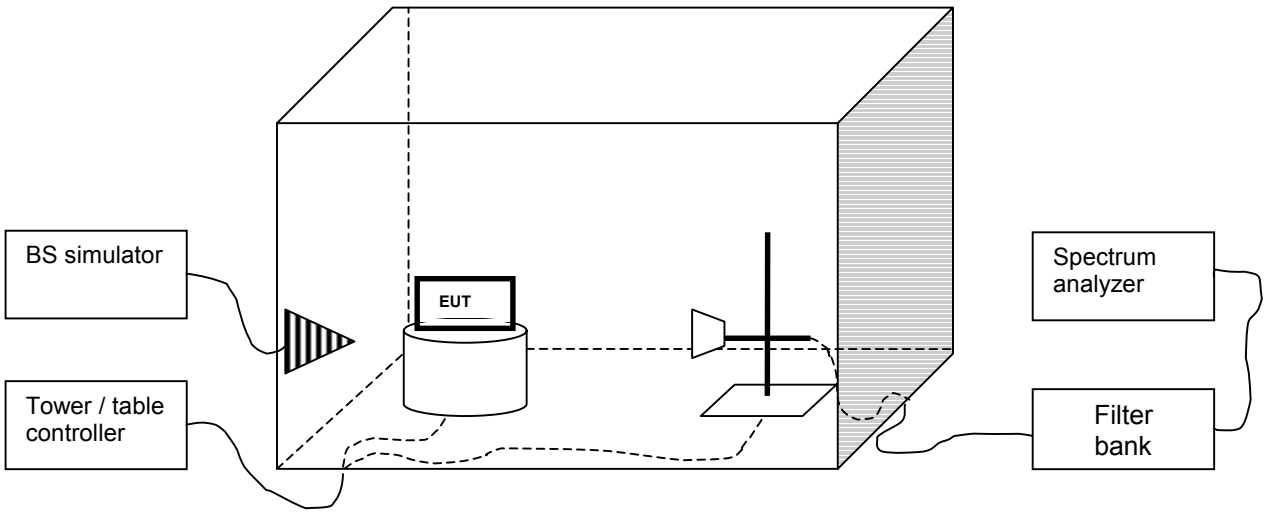
12 FIELD STRENGTH OF SPURIOUS RADIATION

EUT	03232		
Accessories	03230		
Temp, Humidity, Air Pressure	21ºC	58RH%	1013mbar
Date of measurement	14.8.2002		
FCC rule part	§24.238 (a), §2.1053		
Measured by	Tero Huhtala		
Result	PASS		

12.1 Test setup

The test setup was as in the block diagram below. 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.



12.2 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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12.3 EUT operation mode

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

12.4 Limit

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

12.5 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 12.2)

$P_{Subst\_TX\ [dBm]}$ Signal generator power (from step d in 12.2) fed to the substituting antenna

$L_{Cable\ [dB]}$ Loss of the cable between antenna and signal generator (from step d in 12.2)

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

Frequency [MHz]	$P_{Measured}$ [dBm]	$P_{Subst\ TX}$ [dBm]	L_{Cable} [dB]	$G_{Antenna}$ [dBi]	$P_{Emission}$ [dBm]
3700,40	-48.63	-28.5	8.68	8.80	-28.38
5550,60	-66.23	-43.5	10.71	10.20	-44.01
7400,80	-73.58	-43.16	12.57	9.80	-45.93

Table 12. Emission levels, channel 512

Frequency [MHz]	$P_{Measured}$ [dBm]	$P_{Subst\ TX}$ [dBm]	L_{Cable} [dB]	$G_{Antenna}$ [dBi]	$P_{Emission}$ [dBm]
3760,00	-52.92	-31.48	8.75	8.70	-31.53
5640,00	-67.72	-45.21	10.74	10.40	-45.55
7520,00	-71.96	-40.46	12.66	10.10	-43.02

Table 13. Emission levels, channel 661

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Frequency [MHz]	$P_{Measured}$ [dBm]	$P_{Subst\ TX}$ [dBm]	L_{Cable} [dB]	$G_{Antenna}$ [dBi]	$P_{Emission}$ [dBm]
3819,60	-57.39	-35.59	8.88	8.60	-35.87
5729,40	-68.32	-46.26	10.88	10.60	-46.54
7639,20	-74.37	-46.80	13.20	10.40	-49.60

Table 14. Emission levels, channel 810

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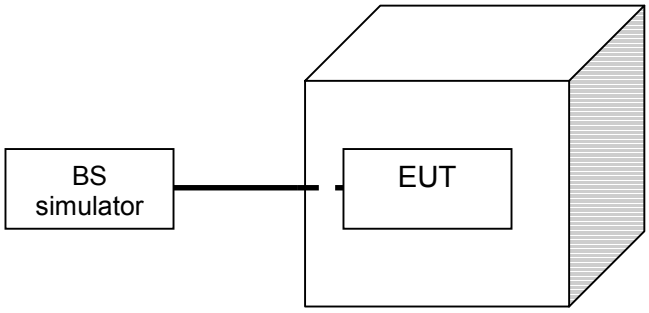
13 FREQUENCY STABILITY, TEMPERATURE VARIATION

EUT	03229		
Accessories	03230		
Temp, Humidity, Air Pressure	22ºC	57RH%	1017mbar
Date of measurement	9.8.2002		
FCC rule part	§24.235, §2.1055 (a)(1)(b)		
Measured by	Hannu Kytömaa		

13.1 Test setup

The test setup was as in the block diagram below. The BS simulator was used to set the TX channel and power level and modulate the TX signal with different bit patterns.



13.2 EUT operation mode

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

13.3 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 30 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

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13.4 Results

The measured values are reported in the table below.

Temperature [ºC]	Deviation [Hz]	ppm
-30	*)	*)
-20	0	0
-10	-5	-0.0027
0	9	0.0048
10	5	0.0027
20	0	0
30	-21	-0.0111
40	1	0.0053
50	15	0.0079

Table 15. Frequency deviation, temperature variation

NOTE! *) The mobile turns off during call to mobile in progress.

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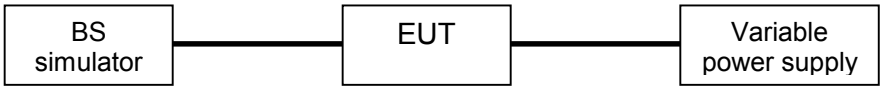
14 FREQUENCY STABILITY, VOLTAGE VARIATION

EUT	03229		
Accessories	03219		
Temp, Humidity, Air Pressure	22ºC	56RH%	1018mbar
Date of measurement	7.8.2002		
FCC rule part	§24.235, §2.1055 (d)(1)(2)		
Measured by	Hannu Kytömaa		

14.1 Test setup

The test setup was as in the block diagram below. The BS simulator was used to set the TX channel and power level and modulate the TX signal with different bit patterns.



14.2 EUT operation mode

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

14.3 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.

14.4 Results

The measured values are reported in the table below.

Level	Voltage [V]	Deviation [Hz]	ppm
Nominal	3.70	40	0.021
Battery cut-off point	3.20	26	0.013

Table 16. Frequency deviation, voltage variation

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15 TEST EQUIPMENT

Each test equipment is calibrated once a year.

15.1 Conducted measurements

Equipment	Manufacturer	Model
EMI receiver	Rohde & Schwarz	ESI 40
GSM MS Test Set	Hewlett-Packard	8922M
DCS/PCS MS Test Set	Hewlett-Packard	83220E
Digital radio test set	Racal	6103E
Radio communication tester	Rohde & Schwarz	CMU-200
Attenuator 10 dB	Huber+Suhner AG	6810.17.A
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
Temperature chamber	Vötsch	VT4002
DC power supply	Thurlby-Thandar	PL330QMD
Multimeter	Fluke	87

15.2 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

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Communication antenna	EMC Automation	LPA-8020
GSM MS Test Set	Hewlett-Packard	8922M
DCS/PCS MS Test Set	Hewlett-Packard	83220E
Digital radio test set	Racal	6103E
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
Temperature chamber	Vötsch	VT4002
DC power supply	Thurlby-Thandar	PL330QMD
Multimeter	Fluke	87

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16 TEST SETUP PHOTOGRAPHS

See "NPL2_test_setup_photographs.doc".

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