Test Report
for
NEM-4

TCC Tampere
Box 68
FIN-33721 TAMPERE
FINLAND

Tel. +358 7180 46800
Fax. +358 7180 46880

CONTENTS

TCC Tampere
Box 68
FIN-33721 TAMPERE
FINLAND

Tel. +358 7180 46800
Fax. +358 7180 46880

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 Oyj Sinitaival 5 FIN-33720 TAMPERE Tel. +358 7180 46800 Fax. +358 7180 46880
Contact person:	Juha Soininen
Receipt of EUT:	3.4.2003
Date of testing:	3-17.4.2003
Date of report:	2.6.2003

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

TCC Tampere
Box 68
FIN-33721 TAMPERE
FINLAND

Tel. +358 7180 46800
Fax. +358 7180 46880

3 SUMMARY OF TEST RESULTS

Section in CFR 47	Section in RSS-133		Result
§2.146 (a)	6.2	Conducted RF output	-
§24.232 (b)	6.2	Radiated RF output	PASS
§2.1049 (h)	5.6	99% occupied bandwidth	X
§24.238 (a)	6.3	Band-edge compliance	PASS
§24.238 (a), §2.1051	6.3	Spurious emissions at antenna terminals	-
§24.238 (a), §2.1053	6.3	Spurious radiated emissions	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 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

TCC Tampere
Box 68
FIN-33721 TAMPERE
FINLAND

Tel. +358 7180 46800
Fax. +358 7180 46880

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	S/N	EUT number
EUT	GSM 1900 Mobile Phone	NEM-4	004400/21/170112/1	03300
	GSM 1900 Mobile Phone	NEM-4	004400/21/170121/2	03303
	GSM 1900 Mobile Phone	NEM-4	004400/21/170132/9	03305
Accessories	Battery	BL-5C	067040063807310131	03301
	Battery	BL-5C	067040063807310131	03304
	Battery	BL-5C	067040063807310131	03306
	Dummy Battery			03307

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 14.

6 APPLICABLE STANDARDS

The tests were performed in guidance of CFR 47 part 24, part 2, ANSI C63.4-1992 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.

TCC Tampere
Box 68
FIN-33721 TAMPERE
FINLAND

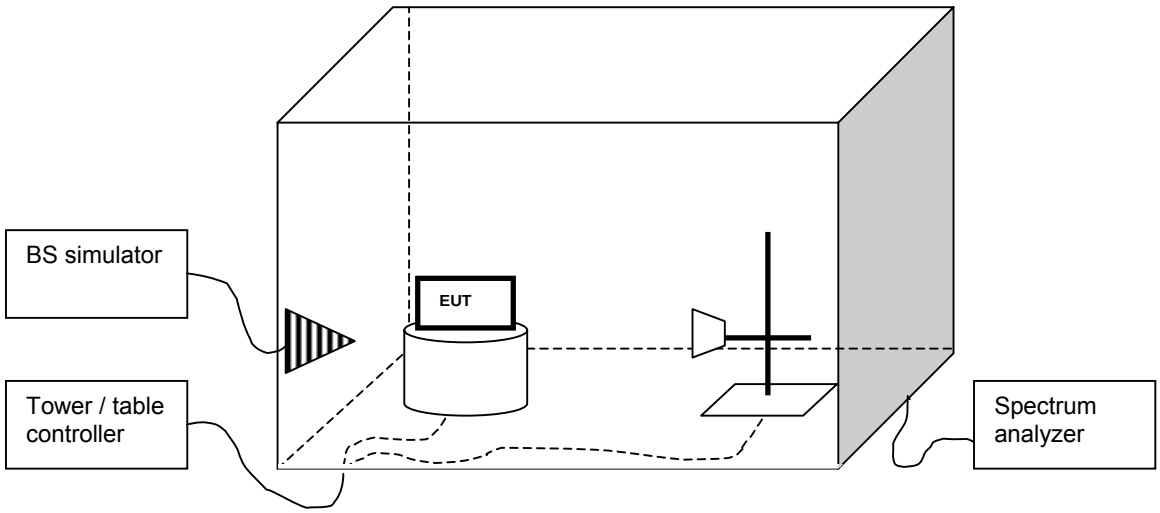
Tel. +358 7180 46800
Fax. +358 7180 46880

7 RADIATED RF OUTPUT POWER

EUT	03300		
Accessories	03301		
Temp, Humidity, Air Pressure	23ºC	49RH%	1001mbar
Date of measurement	3.4.2003		
FCC rule part	§24.232 (b)		
RSS-133 section	6.2		
Measured by	Tero Huhtala		
Result	PASS		

7.1 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.



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.

TCC Tampere
Box 68
FIN-33721 TAMPERE
FINLAND

Tel. +358 7180 46800
Fax. +358 7180 46880

7.3 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)

7.4 Limit

Watts, EIRP
≤ 2

7.5 Results

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

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

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
$L_{Cable\ [dB]}$	Cable attenuation from generator to substituting antenna.

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	-19.60	18.00	-27.92	5.71	8.75	29.36	0.863
661	-20.46	18.00	-29.02	5.89	8.76	29.43	0.877
810	-20.08	18.00	-28.48	5.65	8.78	29.53	0.897

TCC Tampere
Box 68
FIN-33721 TAMPERE
FINLAND

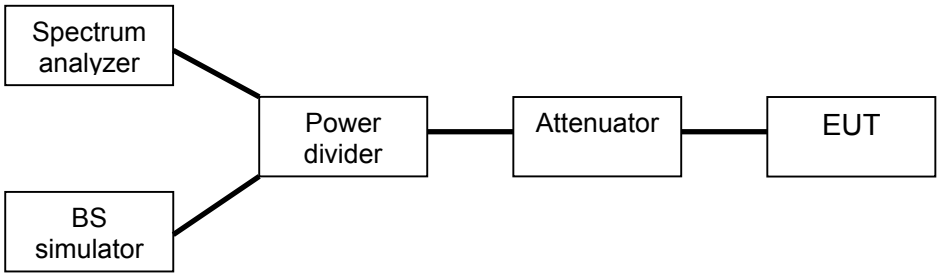
Tel. +358 7180 46800
Fax. +358 7180 46880

8 99% OCCUPIED BANDWIDTH

EUT	03305		
Accessories	03306		
Temp, Humidity, Air Pressure	20ºC	50RH%	1031mbar
Date of measurement	16.4.2003		
FCC rule part	§2.1049 (h)		
RSS-133 section	5.6		
Measured by	Tero Huhtala		

8.1 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.



8.2 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)

8.3 Results

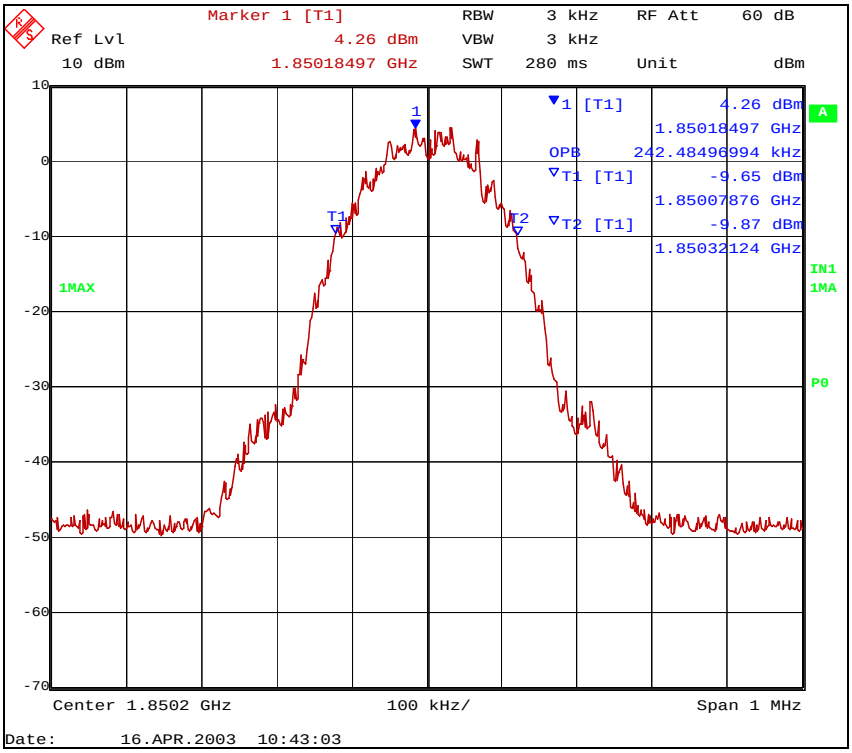
The 99% occupied bandwidth was measured using the in-built function of the spectrum analyzer.

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

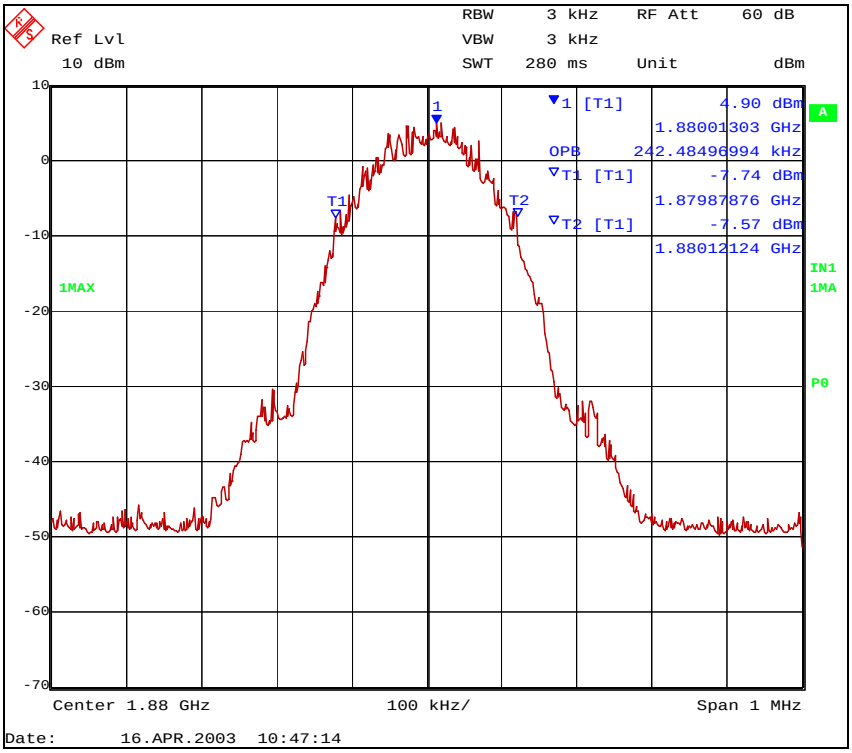
TCC Tampere
Box 68
FIN-33721 TAMPERE
FINLAND

Tel. +358 7180 46800
Fax. +358 7180 46880

8.4 Screen shots



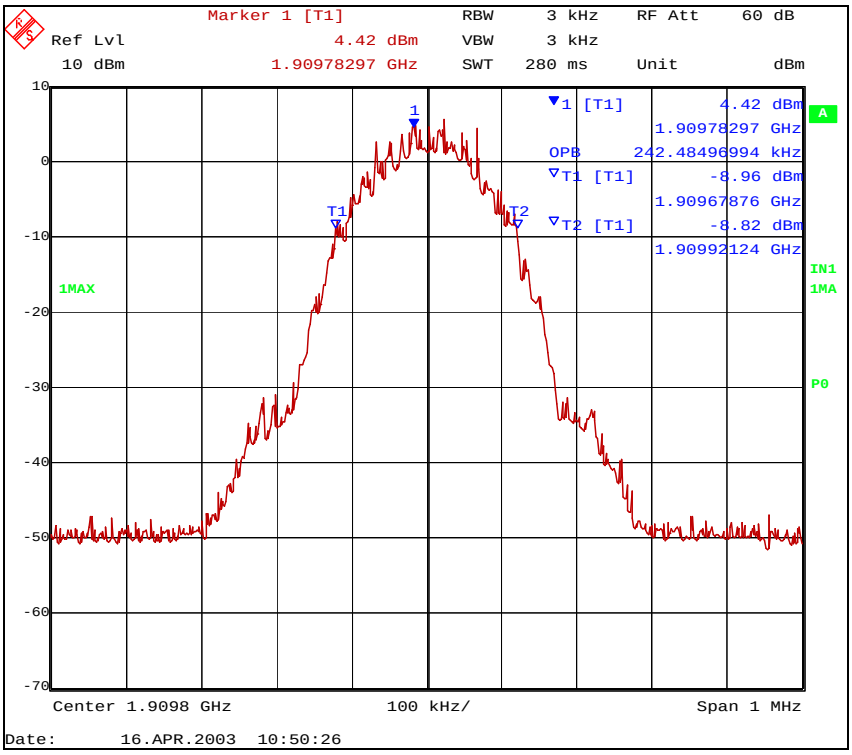
Picture 4. 99% occupied bandwidth, channel 512



Picture 5. 99% occupied bandwidth, channel 661

TCC Tampere
Box 68
FIN-33721 TAMPERE
FINLAND

Tel. +358 7180 46800
Fax. +358 7180 46880



Picture 6. 99% occupied bandwidth, channel 810

TCC Tampere
Box 68
FIN-33721 TAMPERE
FINLAND

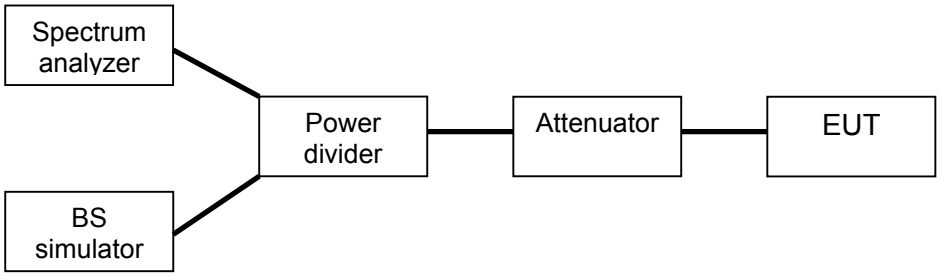
Tel. +358 7180 46800
Fax. +358 7180 46880

9 BAND-EDGE COMPLIANCE

EUT	03305		
Accessories	03306		
Temp, Humidity, Air Pressure	20ºC	50RH%	1031mbar
Date of measurement	16.4.2003		
FCC rule part	§24.238 (a)		
RSS-133 section	6.3		
Measured by	Tero Huhtala		
Result	PASS		

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 Limit

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

9.4 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 table 9.5

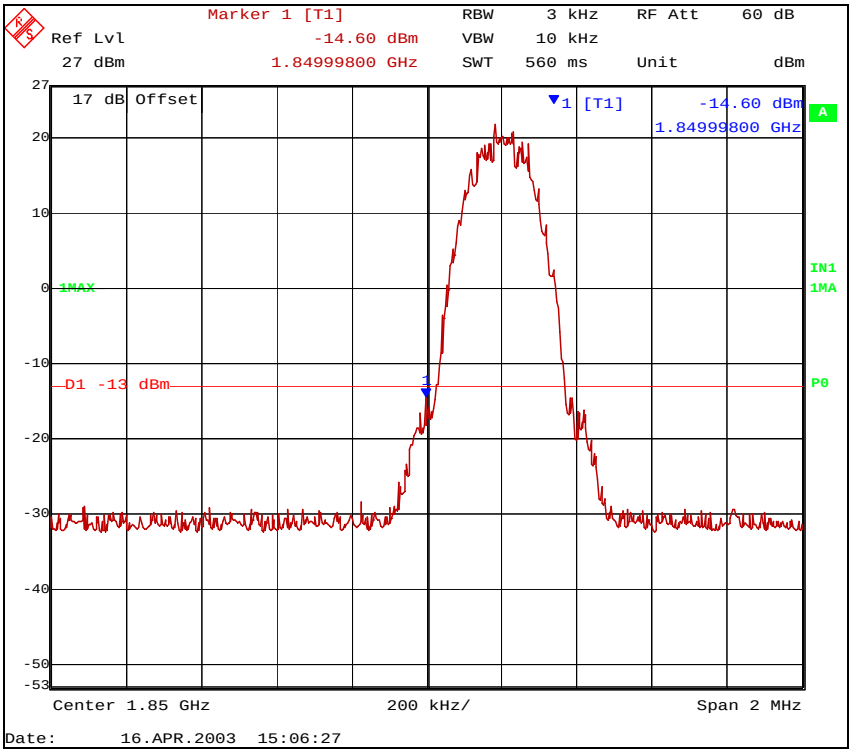
TCC Tampere
Box 68
FIN-33721 TAMPERE
FINLAND

Tel. +358 7180 46800
Fax. +358 7180 46880

9.5 Table

EUT Channel	Signal path loss [dB]
512	17.00
810	17.22

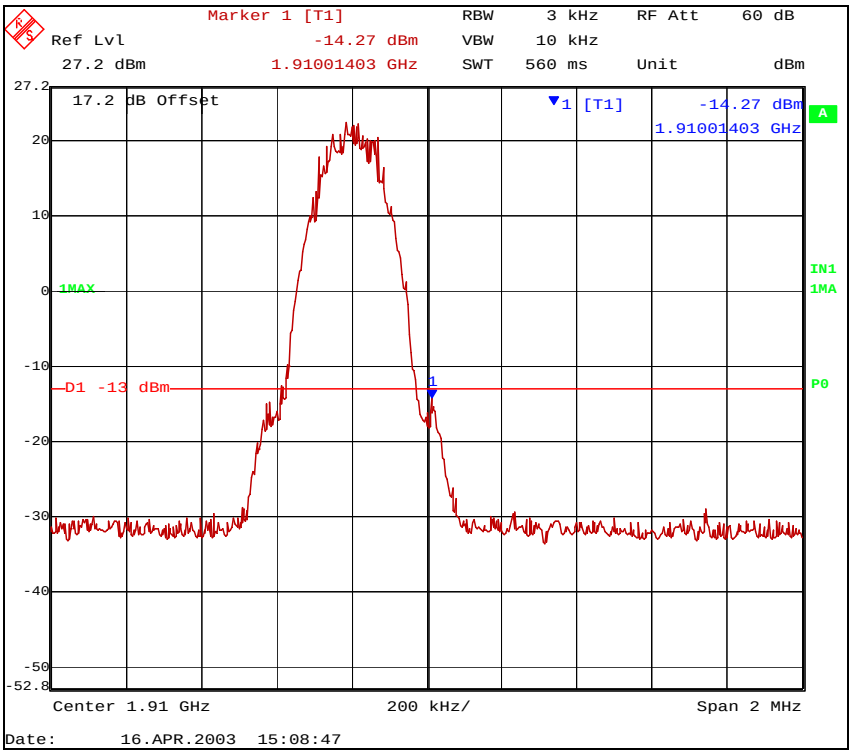
9.6 Screen shots



Picture 7. Lower band edge, channel 512

TCC Tampere
Box 68
FIN-33721 TAMPERE
FINLAND

Tel. +358 7180 46800
Fax. +358 7180 46880



Picture 8. Higher band edge, channel 810

TCC Tampere
Box 68
FIN-33721 TAMPERE
FINLAND

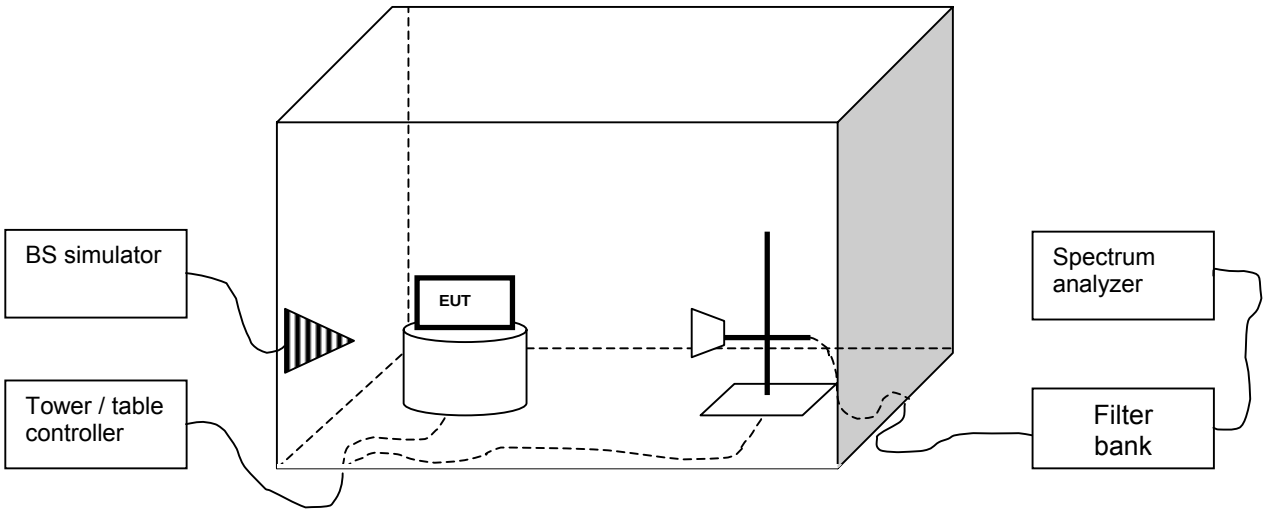
Tel. +358 7180 46800
Fax. +358 7180 46880

10 SPURIOUS RADIATED EMISSIONS

EUT	03303		
Accessories	03304		
Temp, Humidity, Air Pressure	21ºC	50RH%	1035mbar
Date of measurement	15.4.2003		
FCC rule part	§24.238 (a), §2.1053		
RSS-133 section	6.3		
Measured by	Tero Huhtala		
Result	PASS		

10.1 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.



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.

TCC Tampere
Box 68
FIN-33721 TAMPERE
FINLAND

Tel. +358 7180 46800
Fax. +358 7180 46880

10.3 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)

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

Frequency [MHz]	$P_{Measured}$ [dBm]	P_{Subst_TX} [dBm]	L_{Cable} [dB]	$G_{Antenna}$ [dBi]	$P_{Emission}$ [dBm]
3700.4	-64.54	-44.30	8.76	9.6	-43.46
5550.6	-70.55	-45.90	10.32	11.15	-45.07

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	-63.80	-41.60	8.34	9.5	-40.44
5640	-70.43	-45.70	10.21	11.35	-44.56

Table 13. Emission levels, channel 661

TCC Tampere
Box 68
FIN-33721 TAMPERE
FINLAND

Tel. +358 7180 46800
Fax. +358 7180 46880

Frequency [MHz]	$P_{Measured}$ [dBm]	P_{Subst_TX} [dBm]	L_{Cable} [dB]	$G_{Antenna}$ [dBi]	$P_{Emission}$ [dBm]
3819.6	-62.52	-38.50	8.62	9.4	-37.72
5729.4	-68.21	-41.00	10.26	11.5	-39.76

Table 14. Emission levels, channel 810

TCC Tampere
Box 68
FIN-33721 TAMPERE
FINLAND

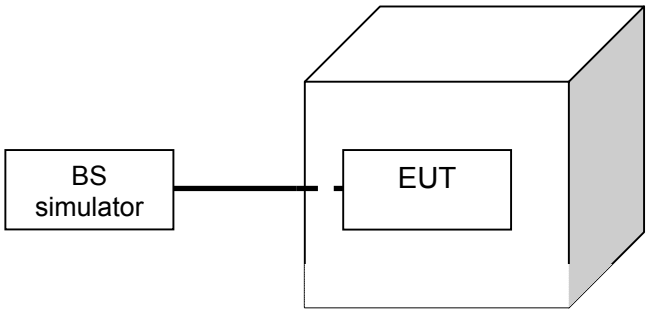
Tel. +358 7180 46800
Fax. +358 7180 46880

11 FREQUENCY STABILITY, TEMPERATURE VARIATION

EUT	03305		
Accessories	03306		
Temp, Humidity, Air Pressure	21ºC	49RH%	1035mbar
Date of measurement	17.4.2003		
FCC rule part	§24.235, §2.1055 (a)(1)(b)		
RSS-133 section	7		
Measured by	Tero Huhtala		
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 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)

11.3 Limit

ppm
± 2.5

11.4 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

TCC Tampere
Box 68
FIN-33721 TAMPERE
FINLAND

Tel. +358 7180 46800
Fax. +358 7180 46880

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

11.5 Results

The measured values are reported in the table below.

Temperature [ºC]	Deviation [Hz]	ppm
-30	- *	-
-20	-9	0.0048
-10	-7	0.0037
0	0	0
10	+4	0.0021
20	+4	0.0021
30	+6	0.0032
40	+11	0.0059
50	+18	0.0096

Table 15. Frequency deviation, temperature variation

Note: * Phone not work in this temperature.

TCC Tampere
Box 68
FIN-33721 TAMPERE
FINLAND

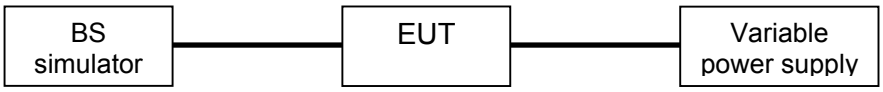
Tel. +358 7180 46800
Fax. +358 7180 46880

12 FREQUENCY STABILITY, VOLTAGE VARIATION

EUT	03305		
Accessories	03307		
Temp, Humidity, Air Pressure	21ºC	49RH%	1035mbar
Date of measurement	17.4.2003		
FCC rule part	§24.235, §2.1055 (d)(1)(2)		
RSS-133 section	7		
Measured by	Tero Huhtala		
Result	PASS		

12.1 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.



12.2 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)

12.3 Limit

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

The measured values are reported in the table below.

Level	Voltage [V]	Deviation [Hz]	ppm
Nominal	4.2	53	0.028
Battery cut-off point	3.57	53	0.028

Table 16. Frequency deviation, voltage variation

TCC Tampere
Box 68
FIN-33721 TAMPERE
FINLAND

Tel. +358 7180 46800
Fax. +358 7180 46880

13 TEST EQUIPMENT

Each test equipment is calibrated once a year.

13.1 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

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

TCC Tampere
Box 68
FIN-33721 TAMPERE
FINLAND

Tel. +358 7180 46800
Fax. +358 7180 46880

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

TCC Tampere
Box 68
FIN-33721 TAMPERE
FINLAND

Tel. +358 7180 46800
Fax. +358 7180 46880

14 TEST SETUP PHOTOGRAPHS

See "NEM4_test_setup_photographs.doc".

TCC Tampere
Box 68
FIN-33721 TAMPERE
FINLAND

Tel. +358 7180 46800
Fax. +358 7180 46880