Test Report
for

DTL-1 and FLA-15

TAC Tampere
Nokia Mobile Phones Ltd.
Box 68
FIN-33721 TAMPERE
FINLAND

Tel. +358 10 505 6800
Fax. +358 10 505 6880

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TAC Tampere
Nokia Mobile Phones Ltd.
Box 68
FIN-33721 TAMPERE
FINLAND
Tel. +358 10 505 6800
Fax. +358 10 505 6880

1 CUSTOMER INFORMATION

Test laboratory: FCA registration number	TAC Tampere Nokia Mobile Phones Ltd. Sinitaival 5 33720 TAMPERE FINLAND Tel. +358 10 505 6800 Fax. +358 10 505 6880 94436 (July 09, 1999)
Customer: 	Nokia Mobile Phones Ltd. Sinitaival 5 33720 TAMPERE FINLAND Tel. +358 10 505 6800 Fax. +358 10 505 6880
Contact person:	Pasi Vainio
Receipt of EUT:	11.9.2000
Test plan reference:	-
Date of testing:	26.9. - 12.10.2000
Date of report:	17.10.2000

The tests listed in this report have been done to demonstrate compliance to the CFR 47, Section 15, Subpart B - Unintentional Radiators.

Contents approved:

Markku Niemi Manager, TAC Tampere	Asko Välimäki EMC Testing

2 EUT AND ACCESSORY INFORMATION

2.1 EUT description

The EUT is a Connectivity Card (DTL-1) operating on the 2.4GHz – 2.4835GHz band using Bluetooth technology. It comes with a separate PC Card adapter (FLA-15) which allows inserting it to a computer with a PCMCIA slot. The EUT has an integral antenna and no external connections or controls. The EUT is in control of the software delivered with the EUT.

2.2 EUT and accessories

The table below lists all EUTs and accessories used in the tests. Later in this test report, only numbers in the last column are used to refer to the devices in each test.

2.3 Software

The computers were equipped with test software provided by the customer. The software was used to control the EUT in the tests.

	Name	Type	S/N	Number
EUT	Connectivity Card	DTL-1		03011
	Connectivity Card	DTL-1		03013
	Connectivity Card	DTL-1		03025
	Connectivity Card	DTL-1		03026
	PC Card Adapter	FLA-15		03012
	PC Card Adapter	FLA-15		03014
Accessories	Laptop computer	Dell Latitude Cpi D300XT	0009321C-12800-924-1175	03015
	Charger	Dell AA 20031	16291-91V-0859	03016
	Charger AC cable	(203cm)		
	Laptop computer	Toshiba PA1270E YXCD	98037322	03017
	Charger	Toshiba PA 2450U	9905C2264522	03018
	Charger AC cable	(199cm)		
	Printer	Lexmark 4091-001	0049006, FCCID: IYL 2030	03033
	Power supply	Lexmark AD-2030L	97010328647	03034
	Printer cable	(179cm)		03035
	Digital camera	Fuji DS-7	7102516	03036
	Camera cable	(209cm)		03037
Software	LinkMas.exe			
	LinkSla.exe			

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3 SUMMARY OF TEST RESULTS

Section in CFR 47		Result
15.107, a	AC powerline conducted emissions	PASS
15.109, a	Radiated emissions	PASS

PASS The EUT passed that particular test.
FAIL The EUT failed that particular test.

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4 STANDARDS AND MEASUREMENT METHODS

The tests were performed in guidance of CFR 47 Part 15, Subpart B and ANSI C63.4 (1992). Deviations, modifications or clarifications (if any) to above mentioned documents are written in each section under "Test method". For the test equipment, see device list in the end of this test report.

4.1 Selection of operation mode for tests

Before tests, several operation modes, TX slot lengths and modulation patterns were tried. The worst case was selected for each test and those results reported.

5 TEST SETUP

5.1 Operational description

The setup was used in all measurements with hopping function enabled. The master was inserted in a laptop PC equipped with a software, which could communicate with the slave.

5.2 Block diagram

The slave was placed far enough from the EUT not to disturb the measurements but still to allow communication with the master.

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6 TEST RESULTS

6.1 AC powerline conducted emissions (§15.107)

EUT	03012, 03025		
Accessories	03017, 03018, 03033, 03034, 03035, 03036, 03037		
Temp, Humidity, Air Pressure	18 ºC	45 %RH	mbar
Date of measurement	4.10.2000		
Measured by	Asko Välimäki		
Result	**PASS**		

6.1.1 Limit

Classs B limit

Frequency band (MHz)	Quasi-peak (µV)
0.45 - 30	250

6.1.2 EUT operation mode

EUT operation mode	Data transmission, DM5
EUT channel	Hopping
EUT TX power level	Nominal
EUT operation voltage	110V/60Hz

6.1.3 EUT test setup

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

Picture 1. AC conducted emission measurement setup.

TAC Tampere
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6.1.4 Emission measurement data

The measurement results were adjusted with the attenuation of the cable between the LISN and receiver.

Line N

Freq [MHz]	Pk [uV]	QP [uV]	Av [uV]
2.758	85.7	52.6	27.0
3.01	67.4	54.8	27.4
1.082	56.4	52.6	38.7
1.478	63.2	56.7	51.8
2.462	62.2	55.1	39.7
2.166	65.2	56.3	47.3

LINE L

Freq [MHz]	Pk [uV]	QP [uV]	Av [uV]
2.462	62.2	54.1	38.3
2.266	60.3	49.4	39.6
2.858	52.8	51.1	43.2
2.562	61.2	52.5	47.8
1.478	64.2	57.4	51.3
3.154	51.9	44.3	32.5

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6.2 Radiated emissions (§15.109)

EUT	03012, 03025		
Accessories	03015, 03016		
Temp, Humidity, Air Pressure	22 °C	42 %RH	mbar
Date of measurement	11. - 12.10.2000		
Measured by	Asko Välimäki		
Result	**PASS (Note)**		

Note: At 422.76MHz there is a spike exceeding the limit line by 0.85dB. The measurement was repeated with another computer hosting the EUT. In that comparison measurement the spike had disappeared. It is obvious, that the emission came from the computer, not the EUT itself. For that reason the EUT passes the test.

6.2.1 Test method and level, 30MHz - 1GHz

The test was made according to ANSI C63.4 (1992) with following execptions and additions:
1) The measurement was made in semi-anechoic chamber at measurement distance of 3m. The chamber had ferrite and absorber lining in all walls and ceiling, the floor was metal covered.
2) The measurement was divided in two parts; prescan and final measurement.

6.2.1.1 Prescan

a) The EUT was set on the turntable and measuring antenna in horizontal polarization at 1m.
b) The turntable was set to 0 degrees.
c) The receiver was set to record the maximum level using peak detector.
d) The antenna was raised from 1m to 4m in 1 meter steps.
e) For each antenna height the table was rotated full turn in 45 degree steps.
f) Antenna polarization was changed to vertical and phases b - e repeated.
g) All suspect frequencies were recorded in a file.
h) At every suspect frequency the turntable was rotated around, antenna scanned and the polarization changed to find the maximum levels.
i) If there were any emissions closer than 10dB to the limit line, the final measurement was done.

6.2.1.2 Final measurement

a) The final measurement was run at suspect frequencies only using quasi-peak detector.
b) The turntable was rotated full turn to find out the worst azimuth.
c) On those azimuths obtained in b, the antenna was scanned from 1m to 4m to find out the worst elevation.
d) Phases b and c were repeated with another antenna polarization.
e) Obtained quasi-peak values were reported

6.2.2 Test method and level, 1GHz - 18GHz

The test was made according to ANSI C63.4 (1992) with following execptions and additions:
3) The measurement was made in semi-anechoic chamber at measurement distance of 1m. The chamber had ferrite and absorber lining in all walls and ceiling, the floor was metal covered.
4) The measurement was divided in two parts; prescan and final measurement.

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6.2.2.1 Prescan

j) The EUT was set on the turntable and measuring antenna in horizontal polarization at 1m.
k) The turntable was set to 0 degrees.
l) The receiver was set to record the maximum level using peak detector.
m) The table was rotated full turn.
n) Antenna polarization was changed to vertical and phases k - m repeated.
o) All suspect frequencies were recorded in a file.

6.2.2.2 Final measurement

f) The final measurement was run at suspect frequencies only with antenna in horizontal polarization.
p) The receiver was set to record the maximum level using peak detector.
g) At every suspect frequency (or frequency band), the turntable was rotated full turn to find out the worst azimuth.
h) Phase g was repeated with vertical antenna polarization.
i) Obtained values were recorded.

Class B limit (3m measuring distance)

Frequency band (MHz)	Limit (µV/m)	Detector
30 – 88	100	QP
88-216	150	QP
230-960	200	QP
960-1000	500	QP
1000-18000	500	Av

6.2.3 EUT operation mode

EUT operation mode	Data transmission, DM5
EUT channel	Hopping
EUT TX power level	Nominal
EUT operation voltage	110V/60Hz

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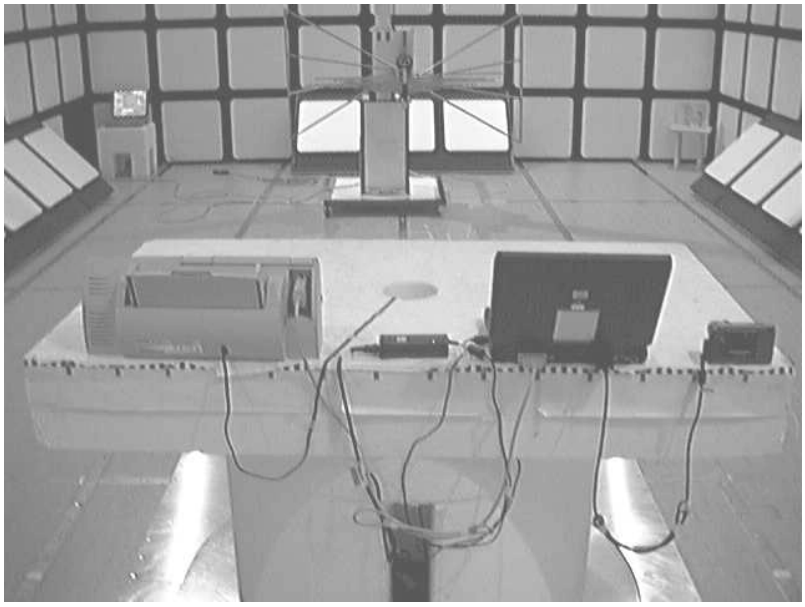
6.2.4 EUT test setup



Picture 19. Radiated emission measurement setup

Note: The setup in picture 19 was used in radiated emission measurement between 30MHz and 1GHz. For measurements above 1GHz all accessories were removed, only the PC and EUT were left on the table. The charger was placed at the floor level on the turntable. That was to allow the EUT to radiate it's maximum power without being attenuated or blocked by the surrounding accessories.

6.2.5 Emission measurement data, 30MHz - 1GHz

The measurement results were obtained as described below.

$$E[uV/m] = U_{RX} + A_{CABLE} + AF - G_{PREAMP}$$

Where

U_{RX}	receiver reading
A_{CABLE}	Attenuation of the cable
AF	Antenna factor
G_{PREAMP}	Gain of the preamplifier

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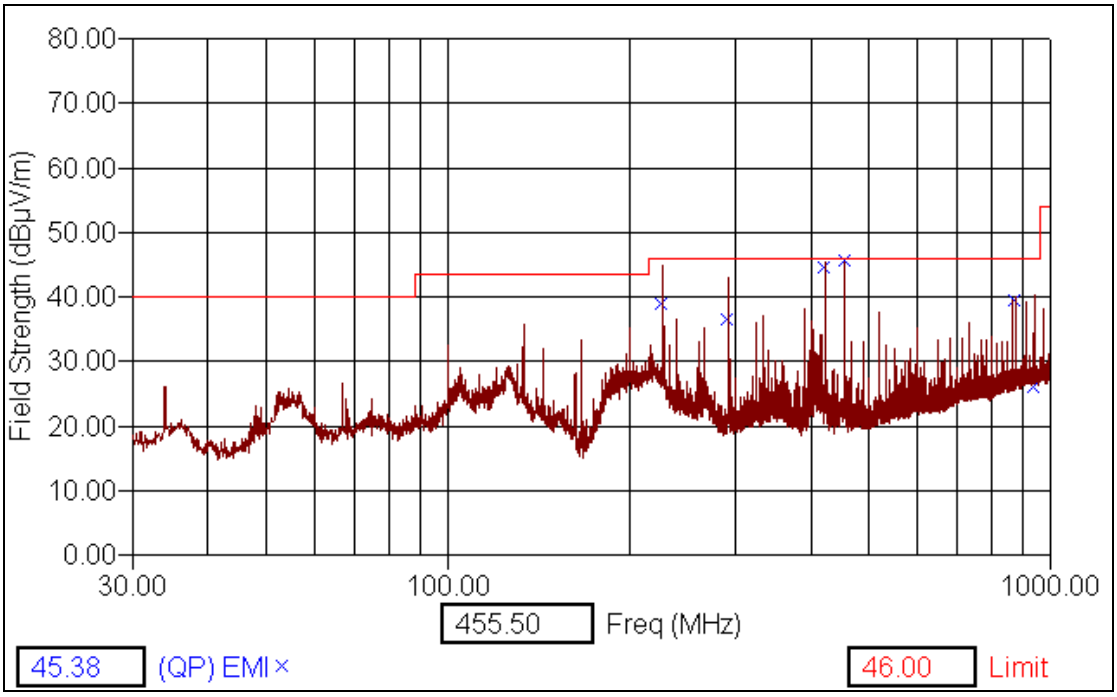

Picture 20. Radiated emissions, horizontal polarization

Freq (Max) (MHz)	(QP) EMI (dBµV/m)	Limit (dBµV/m)	(QP) Marg (dB)	Ttbl Agl (deg)	Twr Ht (cm)	Pol.
227.65	38.67	46.00	-7.33	98.00	135.00	H
292.70	36.34	46.00	-9.66	297.00	101.00	H
422.79	44.40	46.00	-1.60	285.00	185.00	H
455.30	45.38	46.00	-0.62	154.00	185.00	H
878.10	39.45	46.00	-6.55	276.00	175.00	H
943.43	25.70	46.00	-20.30	183.00	115.00	H

Table 1. Highest emissions, horizontal polarization

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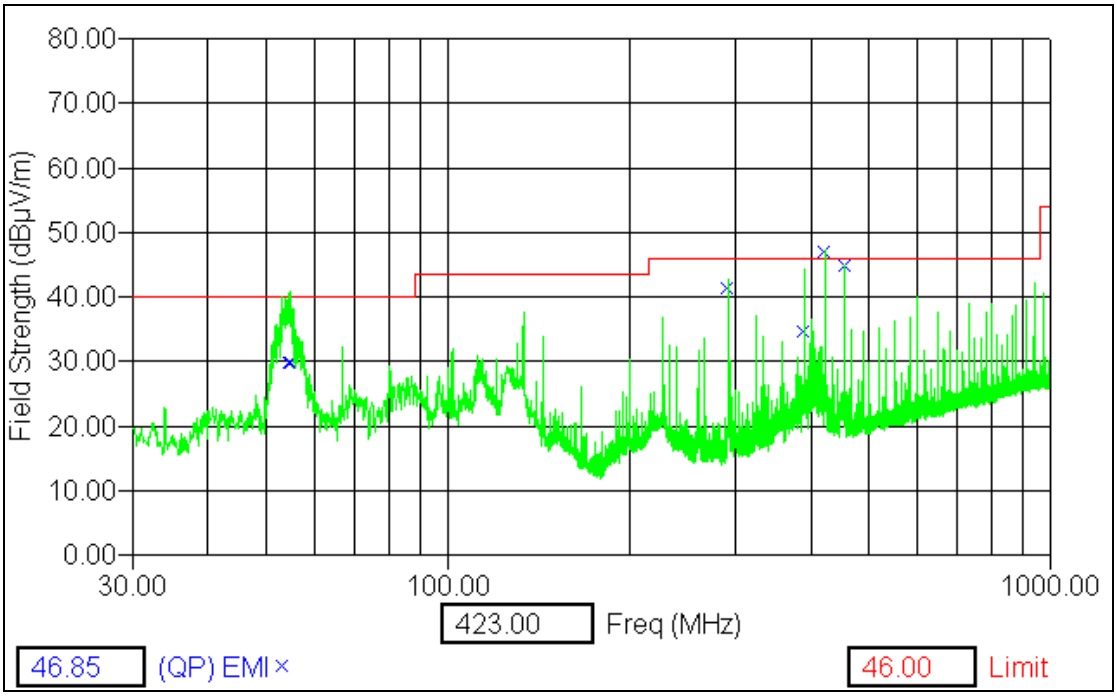

Picture 21. Radiated emissions, vertical polarization

Freq (Max) (MHz)	(QP) EMI (dBµV/m)	Limit (dBµV/m)	(QP) Margin (dB)	Ttbl Agl (deg)	Twr Ht (cm)
54.47	29.77	40.00	-10.23	1.00	163.00
55.23	29.73	40.00	-10.27	9.00	152.00
292.71	40.97	46.00	-5.03	314.00	171.00
390.26	34.59	46.00	-11.41	101.00	145.00
422.76	46.85	46.00	0.85	197.00	143.00
455.30	44.56	46.00	-1.44	190.00	200.00

Table 2. Highest emissions, vertical polarization

6.2.6 Emission measurement data, 1GHz - 18GHz

The measurement results were obtained as described below.

$$E[uV/m] = U_{RX} + A_{CABLE} + AF - G_{PREAMP} - C_{DISTANCE}$$

Where

U_{RX}	receiver reading
A_{CABLE}	Attenuation of the cable
AF	Antenna factor
G_{PREAMP}	Gain of the preamplifier
$C_{DISTANCE}$	Conversion factor from 3m to 1m measurement distance

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Box 68
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Freq [GHz]	U_{RX} [dBuV]	A_{CABLE} [dB]	AF [1/m]	G_{PREAMP} [dB]	$C_{DISTANCE}$ [dB]	E [dBuV/]	E [uV/m]	Limit [uV/m]
Restricted bands								
17.776500	21.99	5.88	44.60	31.60	9.54	31.33	36.86	500
1.681000	44.43	0.56	26.10	37.10	9.54	24.45	16.69	500
1.645533	44.88	0.56	25.60	37.10	9.54	24.40	16.60	500
Harmonics								
4.852400	54.71	1.44	33.20	34.10	9.54	45.71	192.97	500
4.848400	54.10	1.44	33.20	34.10	9.54	45.10	179.89	500
4.844600	53.82	1.44	33.20	34.10	9.54	44.82	174.18	500
Band edge								
2.389300	63.17	1.10	28.30	35.30	9.54	47.73	243.50	500
2.485530	66.76	1.10	28.30	35.30	9.54	51.32	368.13	500
Fundamental								
2.402000	110.56	1.10	28.30	35.30	9.54	95.12	57016.43	
2.440000	110.41	1.10	28.30	35.30	9.54	94.97	56040.24	
2.480000	108.54	1.10	28.30	35.30	9.54	93.10	45185.59	

Notes: For the measurements above 1GHz, following arrangements were done:

1) Only peak detector was used

2) The measurement bandwidth was decreased to 3kHz to make it possible to find the emissions.

3) All spikes visibly out of the noise floor were recorded and later maximized by the procedure described in 6.9.2.

4) The highest fundamentals, harmonics, restricted band emissions and spurious emissions were reported.

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7 TEST EQUIPMENT

15.109 (Radiated emissions, 30MHz-1GHz)

Equipment	Type	Manufacturer	Device number
3m semi-anechoic Chamber		TDK	30599
EMI Receiver	8546A	HP	26518
RF Filter Section	85460A	HP	26517
Biconilog antenna	3142	EMCO	26502
Preamplifier	8447F	HP	26503
Computer, equipped with: - Standard emission software - GPIB interface card	ErgoPro STD_EMI v6.20 NI_TNT_GPIB	Fujitsu-ICL EA NI	25610
System Interface, including: - Remote switch interface - Remote switch module - RF coaxial switch set	SI200 P196X2-SW RSM-01 ISM-01	EA EA EA EA	26506
Mast/turntable controller	HD-100	Deisel	30642
Antenna Mast	MA240	Deisel	26501
Turndisk	DS412	Deisel	26500

15.109 (Radiated emissions above 1GHz)

Equipment	Type	Manufacturer	Device number
3m semi-anechoic Chamber		TDK	30599
Spectrum analyzer	8593EM	HP	24778
Horn antenna	3115	EMCO	26497
Preamplifier	8449B	HP	26504
Mast/turntable controller	HD-100	Deisel	30642
Turndisk	DS412	Deisel	26500
Coaxial cable	SMA male/N male	Own	C
Coaxial cable	SMA male/N male	Own	B

15.107 (AC powerline conducted emissions)

Equipment	Type	Manufacturer	Device number
EMI receiver	ESI 40	Rohde&Schwarz	38845
LISN	L2-16	PMM	30636
LISN	L2-16	PMM	30637
Coaxial cable	N male/N male	Own	FCC LISN

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