Elliott

EMC Test Data

Client:	Nokia	Job Number:	T36596
Model:	2.4GHz FHSS Wireless 10/100	T-Log Number:	T38016
		Proj Eng:	Mark Briggs
Contact:	Ivar Sanders		
Emissions Spec:	FCC	Class:	B
Immunity Spec:		Environment:	N/A

EMC Test Data

For The

Nokia

Model

2.4GHz FHSS Wireless 10/100

Elliott

EMC Test Data

Client:	Nokia	Job Number:	T36596
Model:	2.4GHz FHSS Wireless 10/100	T-Log Number:	T38016
		Proj Eng:	Mark Briggs
Contact:	Ivar Sanders		
Emissions Spec:	FCC	Class:	B
Immunity Spec:		Environment:	N/A

TEST SUMMARY

Date	Test Performed	Level	Results	Comments
06/15/2000	Spurious Emissions In Restricted Bands - Omni Antenna	FCC Part 15.209 / 15.247(c)	Pass	-13.3dB @ 7202.91MHz
06/15/2000	Spurious Emissions In Restricted Bands - Panel Antenna	FCC Part 15.209 / 15.247(c)	Pass	-14.8dB @ 7202.91MHz
06/15/2000	Spurious Emissions In Restricted Bands - Sector Antenna	FCC Part 15.209 / 15.247(c)	Pass	-6.9dB @ 7202.91MHz
06/19/2000	Antenna Conducted Spurious Emissions	FCC Part 15.209 /	Pass	> 20dB
06/19/2000	Output Power	15.247(b)	Pass	24.4dBm
06/19/2000	Channel Occupancy / Separation / Number of Channels	15.247(a)	Pass	
06/22/2000	CE, AC Power 120V/60Hz	FCC 15.207(a)	Pass	Required modification

Abbreviations Used: RE - Radiated Emissions, CE- Conducted Emissions, RI - Radiated Immunity, CI - Conducted Immunity, ESD - Electrostatic Discharge, EFT - Electrical Fast Transients, VDI - Voltage Dips and Interrupts

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EMC Test Data

Client:	Nokia	Job Number:	T36596
Model:	2.4GHz FHSS Wireless 10/100	T-Log Number:	T38016
		Proj Eng:	Mark Briggs
Contact:	Ivar Sanders		
Emissions Spec:	FCC	Class:	B
Immunity Spec:		Environment:	N/A

EUT INFORMATION

General Description

The EUT is a 2.4 – 2.4835 GHz frequency-hopping spread spectrum (FHSS) transceiver that is designed for multipoint operation. Normally, the EUT would be placed on a table top during operation. The EUT was, therefore, placed in this position during testing to simulate the end user environment.

Equipment Under Test

Manufacturer	Model	Description	Serial Number	FCC ID
Nokia		PCB	792924	
Nokia		Radio	0G3UH3	

EUT Enclosure

It measures approximately 13.7 cm wide by 11.4 cm deep by 3.4 cm high. It is primarily constructed of plastic with an internal conductive coating. The amplifier and dc injector are mounted in die-cast metal boxes.

Modification History

Mod. #	Test	Date	Modificaiton
1			
2			
3			

Client:	Nokia	Job Number:	T36596
Model:	2.4GHz FHSS Wireless 10/100	T-Log Number:	T38016
		Proj Eng:	Mark Briggs
Contact:	Ivar Sanders		
Emissions Spec:	FCC	Class:	B
Immunity Spec:		Environment:	N/A

Test Configuration Information (1)

Local Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
Maxrad	MFB24010	10 dBi Omni Antenna	N/A	
Til-Tek	TA-2408	17dBi Panel Antenna	N/A	
Til-Tek	TA-2304	12 dBi Sector Antenna	N/A	

Note: Antennas used for radiated spurious emissions tests.

Remote Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
IBM		Laptop	78-LZ070	
IBM		AC Adapter	J15JR533PB4	

Note: The laptop was only used to configure the EUT prior to testing. It was not connected during testing.

EUT Interface Ports

		Cable(s)		
EUT Port	Connected To	Description	Shielded or Unshielded	Length(m)
Antenna Output	Antenna	Coax (Andrew)	Shielded	1.5

EUT Operation During Emissions

EUT was set to transmit continously on a single channel for radiated emissions, power and bandwidth tests. For Channel occupancy measurements the EUT was set to transmit in hopping mode.

Client:	Nokia	Job Number:	T36596
Model:	2.4GHz FHSS Wireless 10/100	T-Log Number:	T38016
		Proj Eng:	Mark Briggs
Contact:	Ivar Sanders		
Spec:	FCC	Class:	N/A

Radiated Emissions

Test Specifics

Objective: The objective of this test session is to perform final qualification testing the EUT relative to the specification defined above.

Date of Test: 06/15/2000
Test Engineer: Mehran Birgani
Test Location: OATS #1

Config. Used: 1
Config Change: None
EUT Voltage: 120V /60Hz

General Test Configuration

The EUT and all local support equipment were located on the turntable for radiated spurious emissions testing.

For radiated emissions testing the measurement antenna was located 3 meters from the EUT.

Unless stated otherwise the EUT was operating such that it constantly hopped on either the low, center or high channels.

Ambient Conditions:

Temperature: 17°C
Rel. Humidity: 93%

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	Spurious Emissions In Restricted Bands - Omni Antenna	FCC Part 15.209 / 15.247(c)	Pass	-13.3dB @ 7202.91MHz
2	Spurious Emissions In Restricted Bands - Panel Antenna	FCC Part 15.209 / 15.247(c)	Pass	-14.8dB @ 7202.91MHz
3	Spurious Emissions In Restricted Bands - Sector Antenna	FCC Part 15.209 / 15.247(c)	Pass	-6.9dB @ 7202.91MHz

Modifications Made During Testing: None

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EMC Test Data

Client:	Nokia	Job Number:	T36596
Model:	2.4GHz FHSS Wireless 10/100	T-Log Number:	T38016
		Proj Eng:	Mark Briggs
Contact:	Ivar Sanders		
Spec:	FCC	Class:	N/A

Run #1a: Radiated Spurious Emissions, 2400-24000 MHz. Low Channel @ 2401 MHz
UNIT: 10 dBi OMNI

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	V/H	Limit	Margin	Pk/QP/Avg	degrees	meters	
7202.910	40.7	H	54.0	-13.3	Avg	186	1.8	
7202.910	37.5	V	54.0	-16.5	Avg	260	1.2	
4801.910	36.6	H	54.0	-17.4	Avg	28	1.2	
7202.910	52.2	H	74.0	-21.8	Pk	186	1.8	
7202.910	48.0	V	74.0	-26.0	Pk	260	1.2	
4801.910	47.4	H	74.0	-26.6	Pk	28	1.2	

Run #1b: Radiated Spurious Emissions, 2400-24000 MHz. Center Channel @ 2439 MHz
UNIT: 10 dBi OMNI

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
7317.000	39.8	V	54.0	-14.2	Avg	164	1.4	
7317.000	38.0	H	54.0	-16.0	Avg	128	1.0	
4878.000	37.9	V	54.0	-16.1	Avg	270	2.0	
7317.000	51.5	V	74.0	-22.5	Pk	164	1.4	
7317.000	50.7	H	74.0	-23.3	Pk	128	1.0	
4878.000	47.3	V	74.0	-26.7	Pk	270	2.0	

Run #1c: Radiated Spurious Emissions, 2400-24000 MHz. High Channel @ 2479 MHz
UNIT: 10 dBi OMNI

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
7436.910	38.5	V	54.0	-15.5	Avg	15	2.0	
7436.910	37.0	H	54.0	-17.0	Avg	251	1.0	
4957.940	34.7	V	54.0	-19.3	Avg	209	1.4	
7436.910	52.3	V	74.0	-21.7	Pk	15	2.0	
7436.910	49.3	H	74.0	-24.7	Pk	251	1.0	
4957.940	46.2	V	74.0	-27.8	Pk	209	1.4	

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EMC Test Data

Client:	Nokia	Job Number:	T36596
Model:	2.4GHz FHSS Wireless 10/100	T-Log Number:	T38016
		Proj Eng:	Mark Briggs
Contact:	Ivar Sanders		
Spec:	FCC	Class:	N/A

Run #2a: Radiated Spurious Emissions, 2400-24000 MHz. Low Channel @ 2401 MHz

UNIT: 17 dBi Panel

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	V/H	Limit	Margin	Pk/QP/Avg	degrees	meters	
7202.910	39.2	V	54.0	-14.8	Avg	312	1.2	
4801.910	38.6	V	54.0	-15.4	Avg	83	1.0	
7202.910	38.3	H	54.0	-15.7	Avg	320	1.5	
7202.910	51.3	V	74.0	-22.7	Pk	312	1.2	
7202.910	50.6	H	74.0	-23.4	Pk	320	1.5	
4801.910	47.5	V	74.0	-26.5	Pk	83	1.0	

Run #2b: Radiated Spurious Emissions, 2400-24000 MHz. Center Channel @ 2439 MHz

UNIT: 17 dBi Panel

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
7317.000	37.7	H	54.0	-16.3	Avg	123	1.0	
7317.000	37.6	V	54.0	-16.4	Avg	8	1.6	
4878.000	35.5	H	54.0	-18.5	Avg	320	2.2	
7317.000	51.0	V	74.0	-23.0	Pk	8	1.6	
7317.000	50.4	H	74.0	-23.6	Pk	123	1.0	
4878.000	46.3	H	74.0	-27.7	Pk	320	2.2	

Run #2c: Radiated Spurious Emissions, 2400-24000 MHz. High Channel @ 2479 MHz

UNIT: 17 dBi Panel

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
7436.910	38.1	H	54.0	-15.9	Avg	185	1.5	
7436.910	37.7	V	54.0	-16.3	Avg	163	1.3	
4957.940	33.2	V	54.0	-20.8	Avg	335	1.3	
4957.940	32.7	H	54.0	-21.3	Avg	60	1.4	
7436.910	50.4	H	74.0	-23.6	Pk	185	1.5	
7436.910	50.0	V	74.0	-24.0	Pk	163	1.3	
4957.940	46.0	V	74.0	-28.0	Pk	335	1.3	
4957.940	46.0	H	74.0	-28.0	Pk	60	1.4	

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EMC Test Data

Client:	Nokia	Job Number:	T36596
Model:	2.4GHz FHSS Wireless 10/100	T-Log Number:	T38016
		Proj Eng:	Mark Briggs
Contact:	Ivar Sanders		
Spec:	FCC	Class:	N/A

Run #3a: Radiated Spurious Emissions, 2400-24000 MHz. Low Channel @ 2401 MHz

UNIT: 12 dBi Sector

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	V/H	Limit	Margin	Pk/QP/Avg	degrees	meters	
7202.910	47.1	V	54.0	-6.9	Avg	203	1.0	
7202.910	43.1	H	54.0	-10.9	Avg	135	1.2	
4801.910	41.2	V	54.0	-12.8	Avg	120	1.0	
7202.910	54.8	V	74.0	-19.2	Pk	203	1.0	
7202.910	53.1	H	74.0	-20.9	Pk	135	1.2	
4801.910	49.3	V	74.0	-24.7	Pk	120	1.0	

Run #3b: Radiated Spurious Emissions, 2400-24000 MHz. Center Channel @ 2439 MHz

UNIT: 12 dBi Sector

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
7317.000	45.6	V	54.0	-8.4	Avg	180	1.9	
4878.000	45.0	V	54.0	-9.0	Avg	180	1.3	
7317.000	41.5	H	54.0	-12.5	Avg	140	1.0	
7317.000	54.1	V	74.0	-19.9	Pk	180	1.9	
7317.000	52.0	H	74.0	-22.0	Pk	140	1.0	
4878.000	51.0	V	74.0	-23.0	Pk	180	1.3	

Run #3c: Radiated Spurious Emissions, 2400-24000 MHz. High Channel @ 2479 MHz

UNIT: 12 dBi Sector

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
7436.910	39.5	V	54.0	-14.5	Avg	330	1.3	
4957.940	39.1	V	54.0	-14.9	Avg	248	1.3	
4957.940	37.9	H	54.0	-16.1	Avg	225	2.1	
7436.910	51.6	V	74.0	-22.4	Pk	330	1.3	
7436.910	50.1	H	74.0	-23.9	Pk	140	1.5	
4957.940	48.1	H	74.0	-25.9	Pk	225	2.1	

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EMC Test Data

Client:	Nokia	Job Number:	T36596
Model:	2.4GHz FHSS Wireless 10/100	T-Log Number:	T38016
		Proj Eng:	Mark Briggs
Contact:	Ivar Sanders		
Spec:	FCC	Class:	N/A

Antenna Conducted Emissions

Test Specifics

Objective: The objective of this test session is to perform final qualification testing the EUT relative to the specification) defined above.

Date of Test: 06/19/2000
Test Engineer: Vishal Narayan
Test Location: SVOATS 2

Config. Used: 1
Config Change: None
EUT Voltage: 120V/60Hz

General Test Configuration

When measuring the conducted emissions from the EUT's antenna port, the antenna port of the EUT was connected to the spectrum analyzer via a suitable attenuator to prevent overloading the measurement system. All measurements are corrected to allow for the external attenuators used.

Unless stated otherwise the EUT was operating such that it constantly hopped on either the low, center or high channels.

Ambient Conditions:

Temperature: 25.6°C
Rel. Humidity: 55%

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	Antenna Conducted Spurious Emissions	FCC Part 15.209 / 15.247(c)	Pass	> 20dB
3	Output Power	15.247(b)	Pass	24.4dBm
4	Channel Occupancy / Separation / Number of Channels	15.247(a)	Pass	

Modifications Made During Testing: None

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EMC Test Data

Client:	Nokia	Job Number:	T36596
Model:	2.4GHz FHSS Wireless 10/100	T-Log Number:	T38016
		Proj Eng:	Mark Briggs
Contact:	Ivar Sanders		
Spec:	FCC	Class:	N/A

Run #1: Radiated Spurious Emissions, 30-2484 MHz. Low Channel @ 2401 MHz

Channel	Graph reference #s	Comments
Low	T38016/101-104	All out-of-band emissions more than 20dB below the highest in-band signal level
Mid	T38016/105-108	
High	T38016/109-113	

Run #2: Signal Bandwidth

Channel	Frequency (MHz)	Resolution Bandwidth	20dB Signal Bandwidth	Graph reference #
Low	2401	30 kHz	To be measured on the configuration with the amplifier.	
Mid	2439	30 kHz		
High	2479	30 kHz		

Run #3: Output Power

Channel	Frequency (MHz)	Res BW	Output Power	Graph reference #
Low	2401	2 MHz	24.2	T38016/301
Mid	2439	2 MHz	24.4	T38016/302
High	2479	2 MHz	23.4	T38016/303

Run #4: Number of Channels, Channel Occupancy And Spacing

There were 79 channels (refer to graph T38016/401), giving a channel spacing of 1000kHz.
The channel occupancy was measured with the radio transmitting normally (i.e. In hopping mode)

The dwell time on a particular channel was:	130	ms
The period between successive transmissions on a channel was:	10	s
Period of occupancy in 30 seconds was, therefore:	390	ms

Refer to graphs numbered T384016/401 and 402

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EMC Test Data

Client:	Nokia	Job Number:	T36596
Model:	2.4GHz FHSS Wireless 10/100	T-Log Number:	T38016
		Proj Eng:	Mark Briggs
Contact:	Ivar Sanders		
Spec:	FCC	Class:	B

Conducted Emissions

Test Specifics

Objective: The objectiveThe objective of this test session is to perform final qualification testing the EUT relative to the specification(s) defined above.

Date of Test: 06/22/2000
Test Engineer: David W. Bare
Test Location: CCA#1

Config. Used: 1
Config Change:
EUT Voltage: 230V/50 Hz or 120V/60Hz or 208V/60 Hz

General Test Configuration

For tabletop equipment, the EUT was located on a wooden table, 40 cm from a vertical coupling plane. The LISN was located 80 cm from the EUT.

Ambient Conditions:

Temperature: 21°C
Rel. Humidity: 45%

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	CE, AC Power 120V/60Hz	FCC 15.207(a)	Fail	
2	CE, AC Power 120V/60Hz	FCC 15.207(a)	Pass	

Modifications Made During Testing:

Added copper foil tape to edge of radio module inside EUT

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EMC Test Data

Client:	Nokia	Job Number:	T36596
Model:	2.4GHz FHSS Wireless 10/100	T-Log Number:	T38016
		Proj Eng:	Mark Briggs
Contact:	Ivar Sanders		
Spec:	FCC	Class:	B

Run #1: AC Power Port Conducted Emissions, 0.45 - 30 MHz 120 V / 60 Hz

Frequency	Level	Power	FCC 15.207(a)		Detector	Comments
MHz	dBµV	Lead	Limit	Margin	QP/Ave	
19.996	57.1	Line1	48.0	9.1	QP	
19.996	51.6	Line1	48.0	3.6	Avg	Note 1
2.090	43.5	Line1	48.0	-4.5	QP	
21.790	45.5	Line1	48.0	-2.5	QP	
19.996	42.3	Line1	48.0	-5.7	QP	Note 2
19.996	36.8	Line1	48.0	-11.2	QP	Note 3

Note 1:	Average less than 6 dB below the QP, so emission is narrowband
Note 2:	Removed Ethernet cable
Note 3:	Added copper tape to end of radio module

Run #2: AC Power Port Conducted Emissions, 0.45 - 30 MHz 120 V / 60 Hz with modification

Frequency	Level	Power	FCC 15.207(a)		Detector	Comments
MHz	dBµV	Lead	Limit	Margin	QP/Ave	
28.227	42.4	Line1	48.0	-5.6	QP	
1.254	34.0	Line1	48.0	-14.0	QP	Note 1
1.254	37.4	Line1	48.0	-10.6	Avg	Note 1
2.398	33.0	Line1	48.0	-15.0	QP	Note 1
2.398	34.9	Line1	48.0	-13.1	Avg	Note 1
28.226	39.5	Neutral	48.0	-8.5	QP	
2.398	41.6	Neutral	48.0	-6.4	QP	
1.177	42.2	Neutral	48.0	-5.8	QP	

Note 1:	Emisssion considered broadband so 13 dB was subtracted from the Quasi peak amplitude

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EMC Test Data

Client:	Nokia	Job Number:	T36596
Model:	2.4GHz FHSS Wireless 10/100	T-Log Number:	T38016
		Proj Eng:	Mark Briggs
Contact:	Ivar Sanders		
Spec:	FCC	Class:	B

Conducted Emissions

Test Specifics

Objective: The objective of this test session is to perform final qualification testing the EUT relative to the specification(s) defined above.

Date of Test: 07/20/2000
Test Engineer: Pamela Galvan
Test Location: SVOATS #3

Config. Used: 1
Config Change: None
EUT Voltage: 120V/60Hz

General Test Configuration

For tabletop equipment, the EUT was located on a wooden table, 40 cm from a vertical coupling plane. The LISN was located 80 cm from the EUT. A second LISN was used for all local support equipment. Remote support equipment was located approximately 30 meters from the EUT with all I/O connections running on top of the groundplane.

Ambient Conditions:

Temperature: ??°C
Rel. Humidity:

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	CE, AC Power 120V/60Hz	FCC 15.207(a)	Pass	

Modifications Made During Testing: None

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EMC Test Data

Client:	Nokia	Job Number:	T36596
Model:	2.4GHz FHSS Wireless 10/100	T-Log Number:	T38016
		Proj Eng:	Mark Briggs
Contact:	Ivar Sanders		
Spec:	FCC	Class:	B

Run #1: AC Power Port Conducted Emissions, 0.45 - 30 MHz 120 V / 60 Hz

Transmit 75% / Receive 20 %mode

Frequency	Level	Power	FCC 15.207(a)		Detector	Comments
MHz	dBµV	Lead	Limit	Margin	QP/Ave	
0.5219	35.7	Line	48.0	-12.3	QP	Signal is broadband, QP reading corrected by -13dB
0.6714	30.1	Line	48.0	-17.9	QP	Signal is broadband, QP reading corrected by -13dB
0.9266	33.9	Line	48.0	-14.1	QP	
		Neutral	0.0	0.0	QP	
		Neutral	0.0	0.0	QP	
		Neutral	0.0	0.0	QP	