

Test Report for NEM-4

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1 LABORATORY INFORMATION

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FCC registration number:	94436 (June 14, 2002)
IC file number:	IC 3608 (March 5, 2003)

2 CUSTOMER INFORMATION

Client:	Nokia Corporation 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:	12-21.5.2003
Date of report:	2.6.2003

The tests listed in this report have been done to demonstrate compliance to the FCC rules section §15.247 and IC standard RSS-210.

Contents approved:


Asko Välimäki Quality Manager



3 SUMMARY OF TEST RESULTS

Rule part in CFR 47	Section in RSS-210		Result
15.247, a1	6.2.2 (o), a1	Carrier frequency separation	PASS
15.247, a1ii	6.2.2 (o), a3	Number of hopping frequencies	PASS
15.247, a1ii, 15.247, f	6.2.2 (o), a3	Time of occupancy	PASS
15.247, a	6.2.2 (o), a1	20dB bandwidth	PASS
15.247, b1	6.2.2 (o), a3	Peak output power	PASS
15.247, c	6.2.2 (o), e1	Band-edge compliance of RF emissions	PASS
15.207	6.6	AC powerline conducted emissions	PASS
15.247, c	6.2.2 (o), e1	Spurious RF conducted emissions	PASS
15.247, c	6.2.2 (o), e1	Spurious radiated emissions	PASS

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.

	Name	Type	S/N	EUT number
EUT	GSM Phone	NEM-4	004400/21/170127/9	03319
	GSM Phone	NEM-4	004400/21/172746/4	03320
Accessories	Battery	BL-5C	067040063807310131	03304
	Charger	ACP-12E	394349J363220572088	03308

Notes: -

4.1 EUT description

The EUT is a triple band (900MHz/1800MHz/1900MHz) GSM mobile phone with Bluetooth and FM radio.

5 EUT TEST SETUPS

For each test the EUT was exercised to find out the worst case of operation modes and device configuration.

The EUT was not modified during the tests.

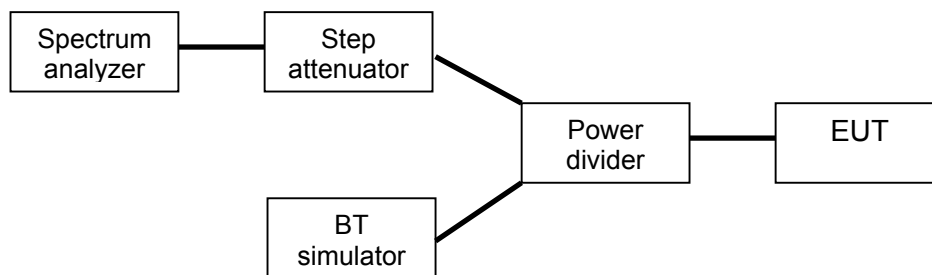
Two different test setups were used: one for conducted measurements, another for radiated measurements. One EUT was equipped with an external antenna connector for conductive measurements.

5.1 Setup A (conducted measurements)

This setup was used in conducted measurements. The test setup was as in the block diagram below. The Bluetooth simulator was used to control the following:

- set the EUT channel (0 – 78)
- set the number of EUT TX slots (1, 3, 5)
- set the EUT to TX, RX and TX/RX mode
- enable/disable frequency hopping
- select between several different test modulation patterns

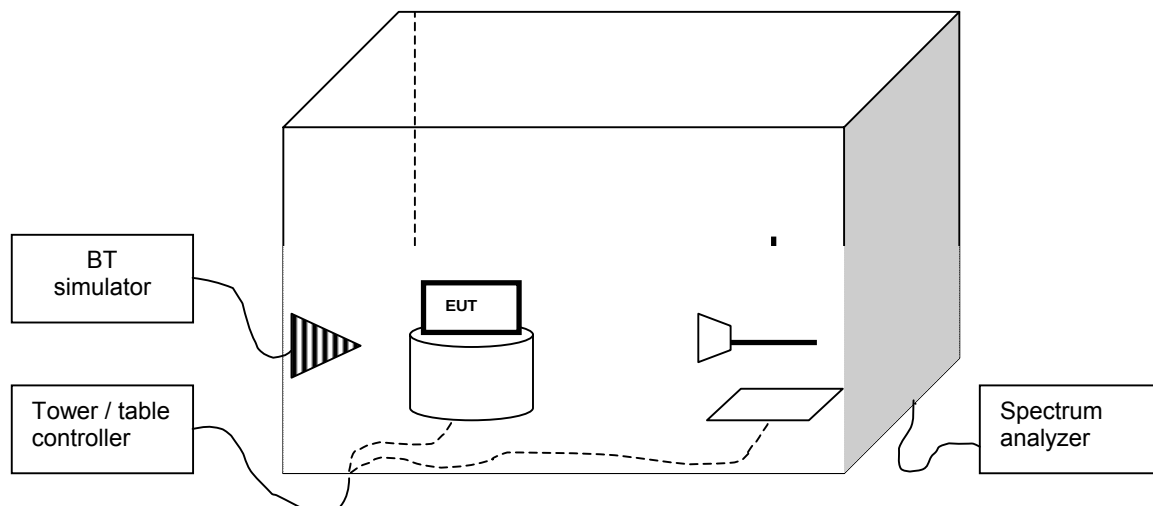
In tests, where absolute level reporting were required, the results were corrected with all applicable factors as detailed in the result section of each measurement.



5.2 Setup B (radiated measurements)

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 BT 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 Bluetooth simulator was used to the same as in conducted measurements.

In tests, where absolute level reporting were required, the results were corrected with all applicable factors as detailed in the result section of each measurement.



6 STANDARDS AND MEASUREMENT METHODS

The tests were performed in guidance of CFR 47 section 15.247, Part 2, FCC public notice DA 00-705 (March 30, 2000), ANSI C63.4 (1992) and RSS-210. Deviations, modifications or clarifications (if any) to above mentioned documents are written in each section under "Test method".

7 CARRIER FREQUENCY SEPARATION

EUT	03320
Accessories	03304
Test setup	A
Temp, Humidity, Air Pressure	22°C 48%RH 1006mbar
Date of measurement	14.5.2003
FCC rule part	§15.247 (a) (1)
RSS-210 section	6.2.2 (o), a1
Measured by	Tero Huhtala
Result	PASS

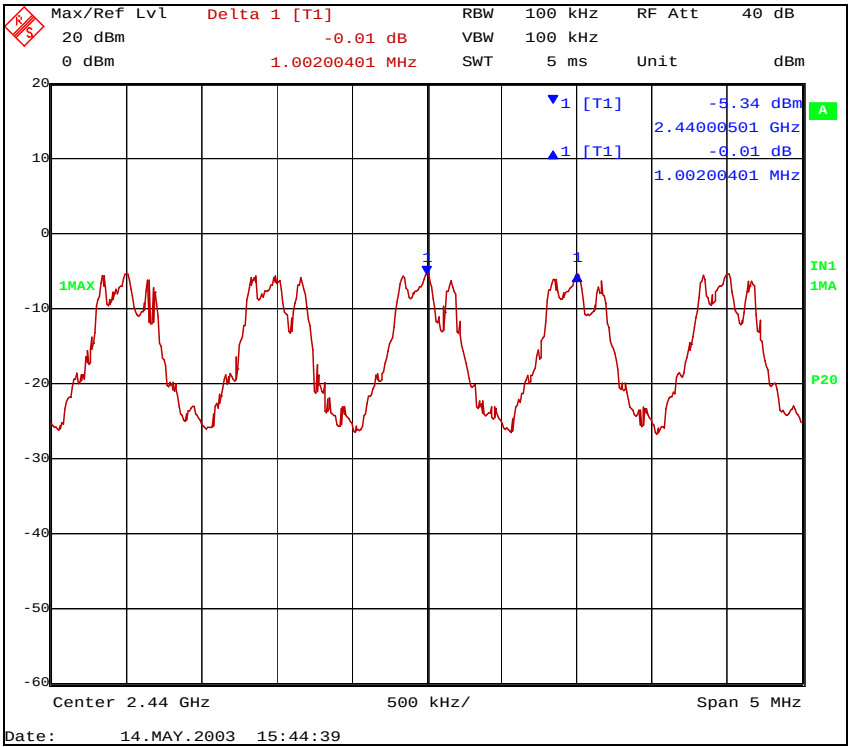
7.1 EUT operation mode

EUT operation mode	Connection, DM5, Static PRBS
EUT channel	Hopping
EUT TX power level	Nominal

7.2 Limits and results

Limit (MHz)	Result (MHz)
≥ 0.025 or 20dB BW	1.002

7.3 Screen shot



Picture 1. Carrier frequency separation of channels 38 and 39

8 NUMBER OF HOPPING FREQUENCIES

EUT	03320
Accessories	03304
Test setup	A
Temp, Humidity, Air Pressure	22 °C 48%RH 1006mbar
Date of measurement	14.5.2003
FCC rule part	§15.247(a) (2)
RSS-210 section	6.2.2 (o), a3
Measured by	Tero Huhtala
Result	PASS

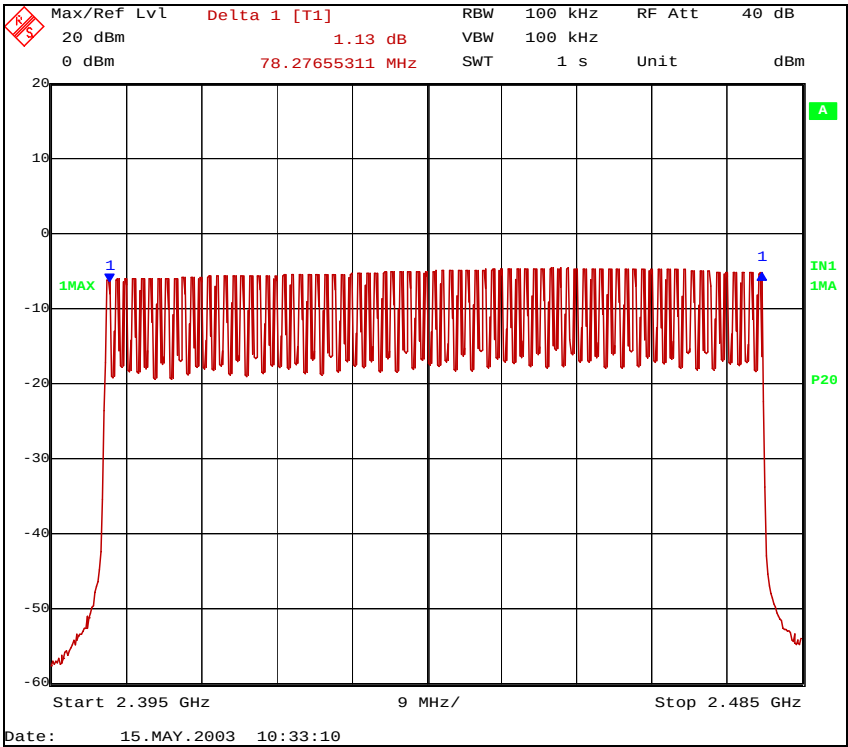
8.1 EUT operation mode

EUT operation mode	Connection, DM5, Static PRBS
EUT channel	Hopping
EUT TX power level	Nominal

8.2 Limits and results

Number	Measured value
≥ 75	79

8.3 Screen shot



Picture 2. Number of hopping frequencies

9 TIME OF OCCUPANCY

EUT	03320
Accessories	03304
Test setup	A
Temp, Humidity, Air Pressure	20°C 47%RH 1009mbar
Date of measurement	19.5.2003
FCC rule part	§15.247 (a) (3)
RSS-210 section	6.2.2 (o), a3
Measured by	Tero Huhtala
Result	PASS

9.1 Page mode

9.1.1 EUT operation mode

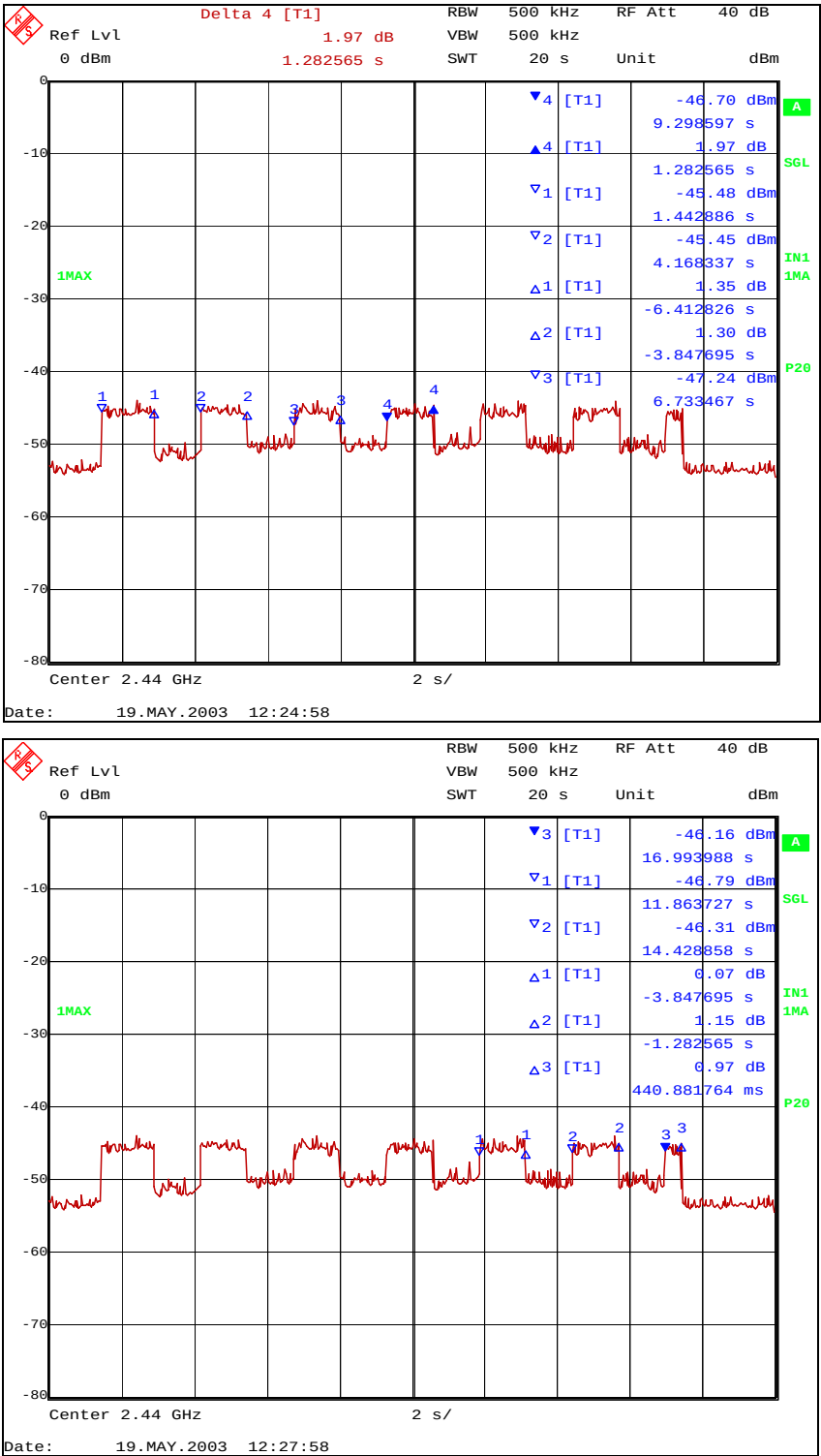
EUT operation mode	Page
EUT channel	Hopping
EUT TX power level	Nominal

9.2 Limits and results

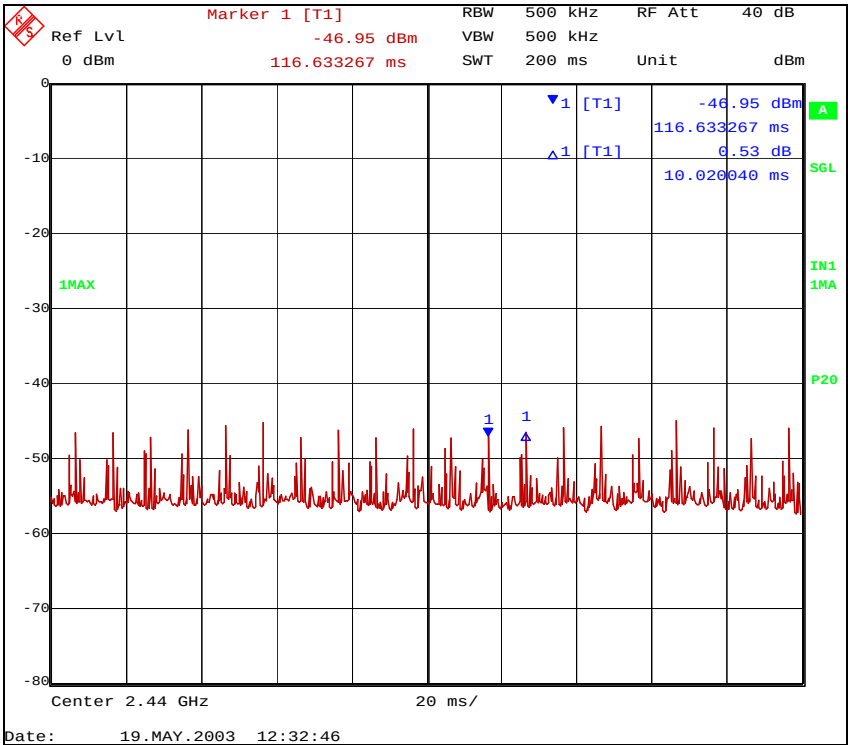
Limit (s)	Measured value (s)
≤ 0.4	0.131

The page consisted of seven separate cycles, lengths 1.44 s, 1.28 s, 1.28 s, 1.28 s, 1.28 s, 1.28 s and 0.44 s. The complete page cycle took 8.28 s, during which the transmitter operated at every 10.02ms. The duration of one transmission was 0.16112ms. $(8.28s / 0.0102s) * 0.16112ms = 130.79ms$

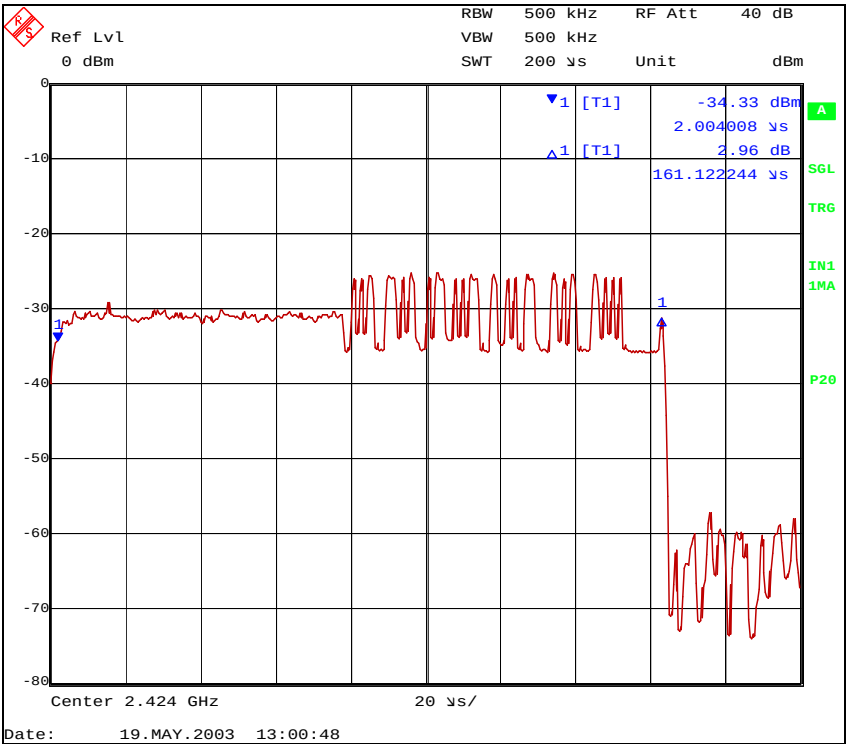
9.3 Screen shots



Picture 3. Complete paging cycle, channel 38



Picture 4. Paging repetition frequency, channel 38



Picture 5. Duration of one transmission, channel 22

9.4 Inquiry mode

9.4.1 EUT operation mode

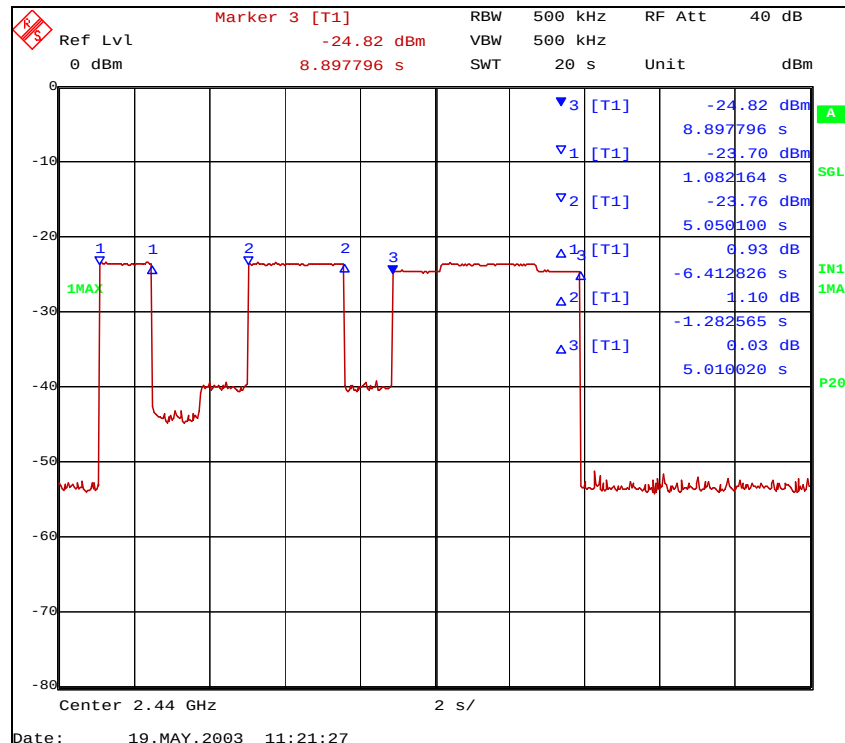
EUT operation mode	Inquiry
EUT channel	Hopping
EUT TX power level	Nominal

9.5 Limits and results

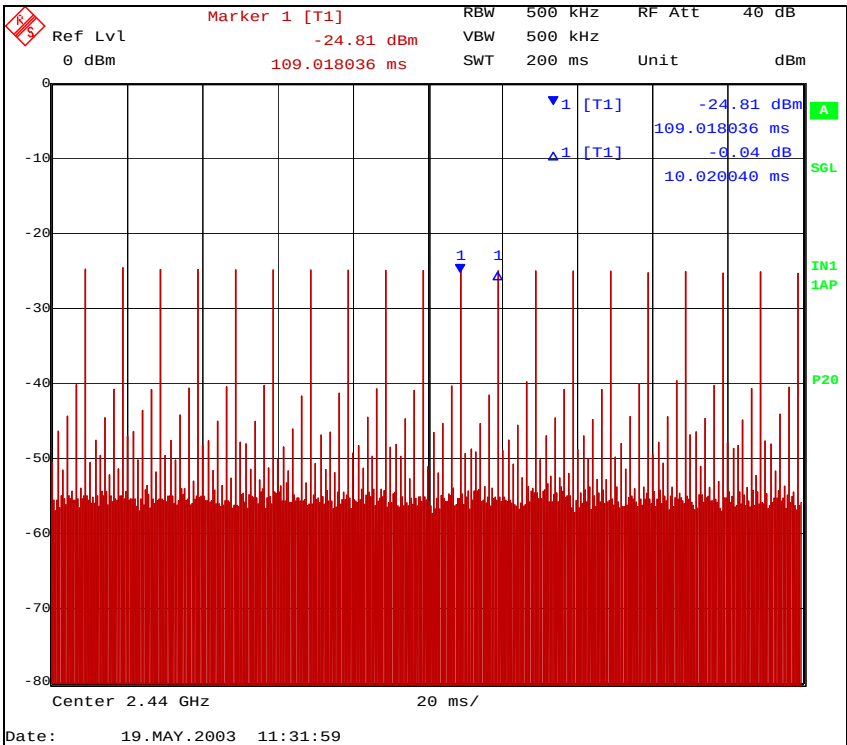
Limit (s)	Measured value (s)
≤ 0.4	0.141

The inquiry consisted of three separate cycles, lengths 1.40 s, 2.56 s and 5.01 s. The complete inquiry cycle took 8.97s, during which the transmitter operated at every 10.02ms. The duration of one transmission was 0.16090ms. $(8.97s / 0.0102s) * 0.16090ms = 141.4974ms$

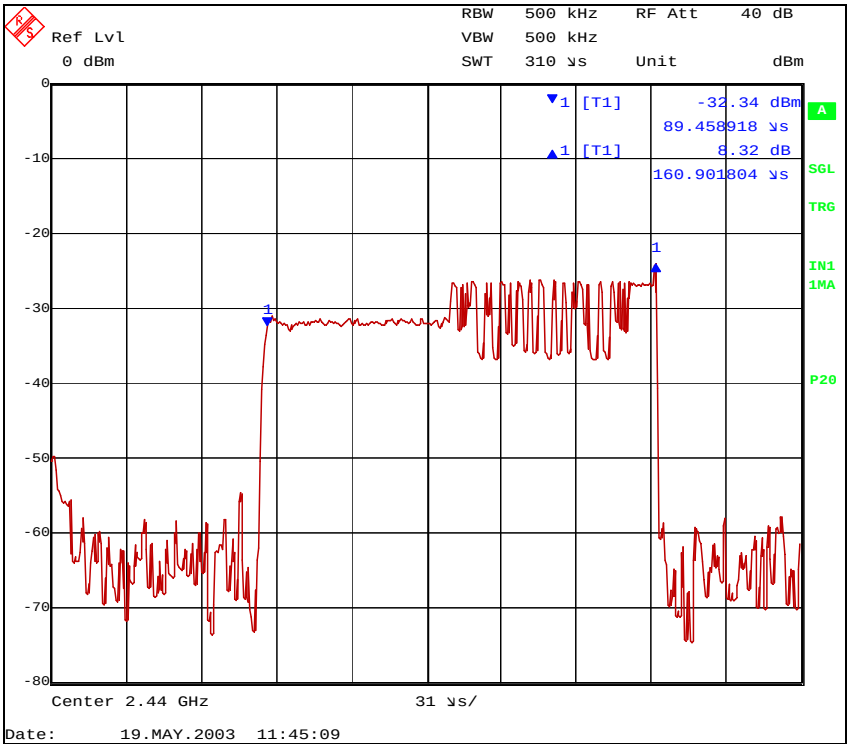
9.6 Screen shots



Picture 6. Complete inquiry cycle, channel 38



Picture 7. Inquiry repetition frequency, channel 38



Picture 8. Duration of one transmission, channel 38

9.7 Connection mode

9.7.1 EUT operation mode

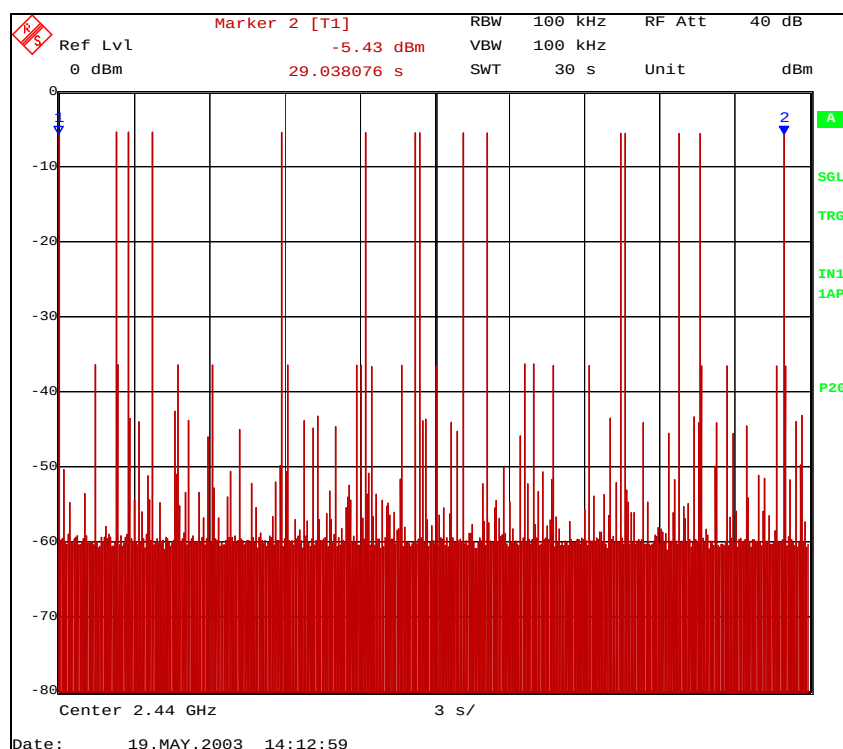
EUT operation mode	Connection, DH5, PRBS
EUT channel	Hopping
EUT TX power level	Nominal

9.8 Limits and results

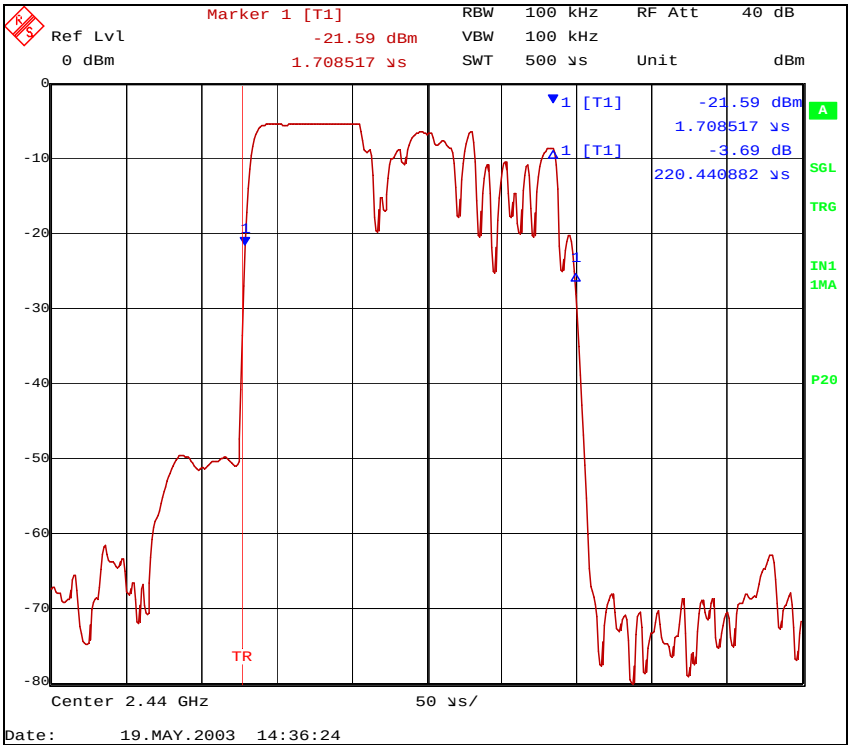
Limit (s)	Measured value (s)
≤ 0.4	0.003

In measurement time of 30s, total of 15 transmissions occurred. The duration of one transmission was 0.220 ms. $15 * 0.220\text{ms} = 3.3\text{ms}$

9.9 Screen shots



Picture 9. Number of transmissions, channel 38



Picture 10. Duration of one transmission, channel 38

10 20dB BANDWIDTH

EUT	03320
Accessories	03304
Test setup	A
Temp, Humidity, Air Pressure	22 °C 48%RH 1019mbar
Date of measurement	15.5.2003
FCC rule part	§15.247 (a) (1)
RSS-210 section	6.2.2 (o), a1
Measured by	Tero Huhtala
Result	PASS

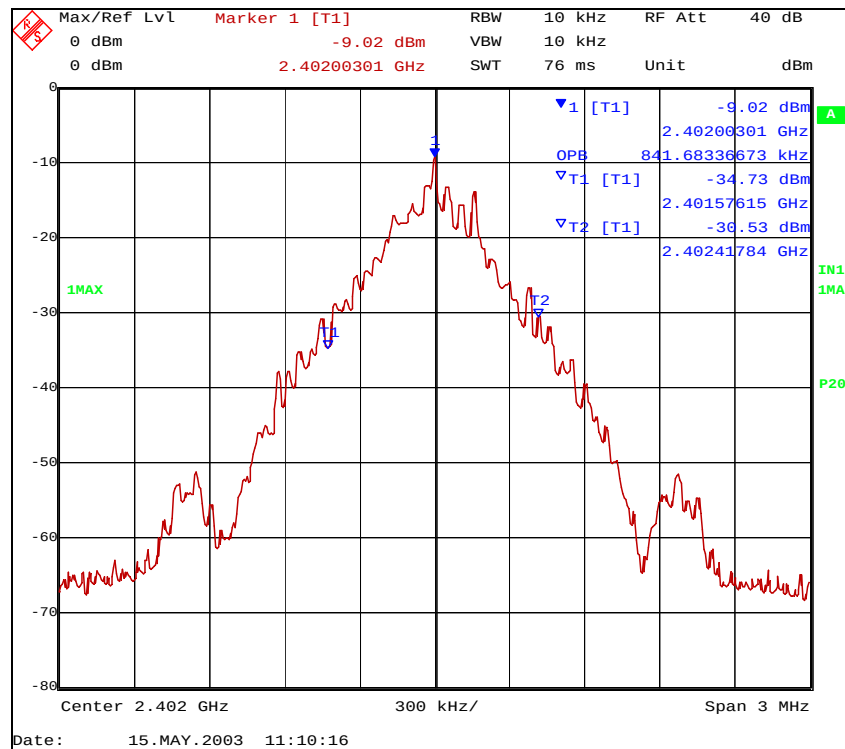
10.1 EUT operation mode

EUT operation mode	Connection, DM5, Static PRBS
EUT channel	0 (2402 MHz), 38 (2440 MHz), 78 (2480MHz)
EUT TX power level	Nominal

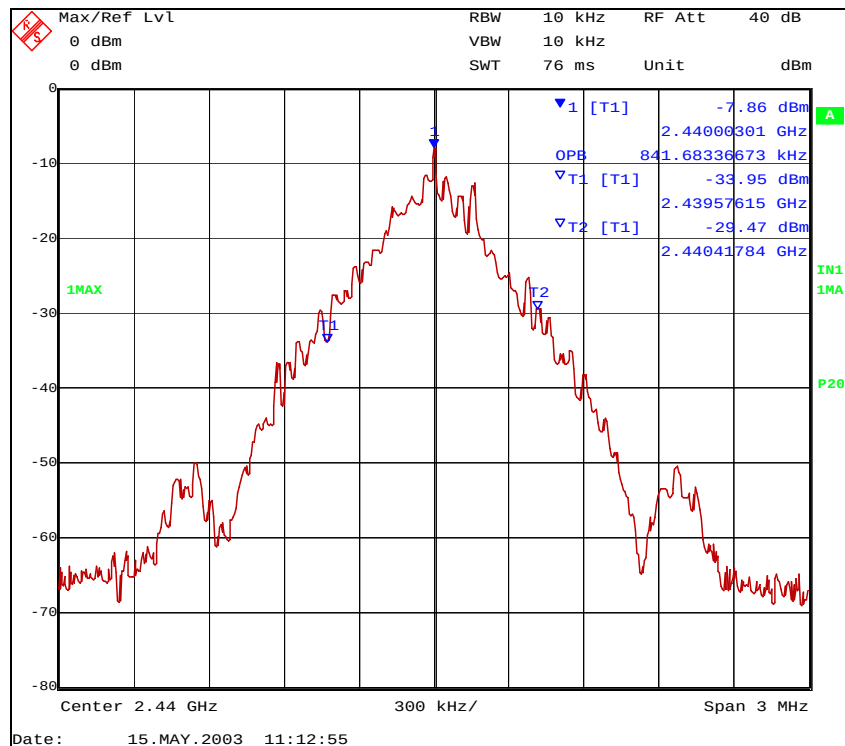
10.2 Limits and results

EUT Channel	Limit (MHz)	Measured value (MHz)
0	≤1.0	0.8417
38		0.8417
78		0.8597

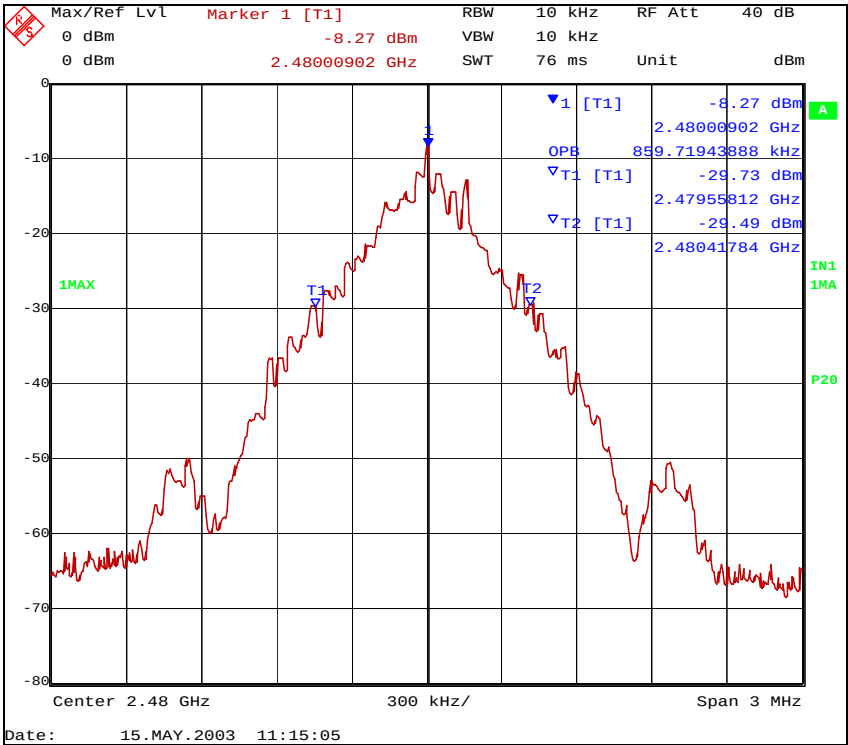
10.3 Screen shots



Picture 11. 20dB bandwidth, channel 0



Picture 12. 20dB bandwidth, channel 38



Picture 13. 20dB bandwidth, channel 78

11 PEAK OUTPUT POWER

EUT	03320
Accessories	03304
Test setup	A
Temp, Humidity, Air Pressure	22°C 48%RH 1006mbar
Date of measurement	14.5.2003
FCC rule part	§15.247 (b) (1)
RSS-210 section	6.2.2 (o), a3
Measured by	Tero Huhtala
Result	PASS

11.1 EUT operation mode

EUT operation mode	Connection, DM5, Static PRBS
EUT channel	0 (2402 MHz), 38 (2440 MHz), 78 (2480MHz)
EUT TX power level	Nominal
EUT antenna gain [dBi]	-2

11.2 Limits and results

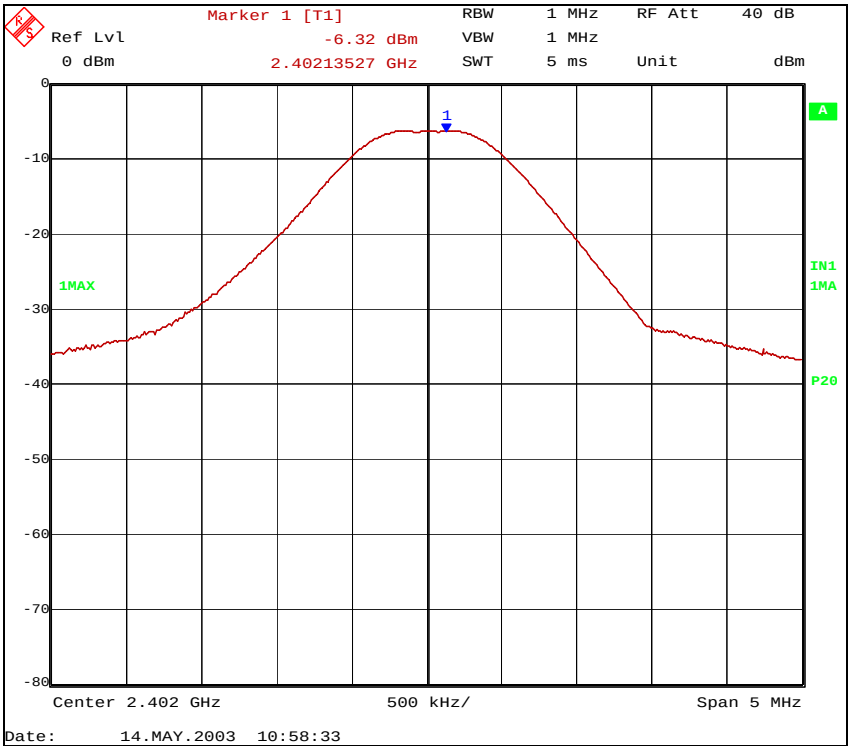
EUT Channel	Limit (W)	Test result (W)
0	≤ 1	0.00119
38		0.00166
78		0.00160

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:

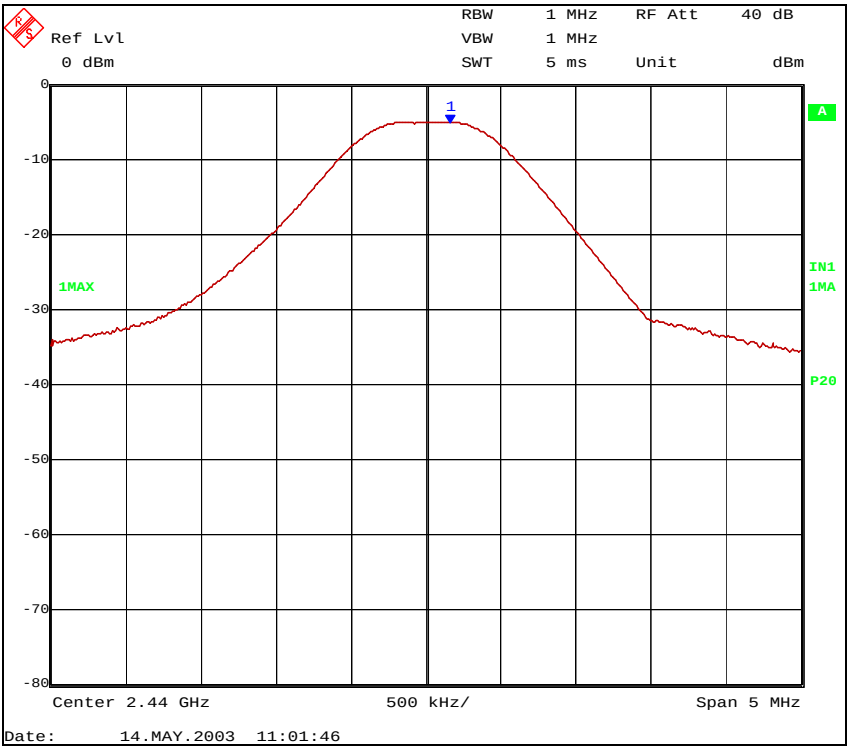
$$P[W] = \frac{10^{(P_{Meas}[dBm] + L_{Cables}[dB] + L_{Attenuator}[dB] + L_{Divider}[dB])}}{1000}$$

EUT Channel	Measured value [dBm]	Cable loss [dB]	Attenuator loss [dB]	Divider loss [dB]	Peak output power [dBm]	Peak output power [W]
0	-6.32	1.06	0	6	0.74	0.00119
38	-5.05	1.26	0	6	2.21	0.00166
78	-5.18	1.21	0	6	2.03	0.00160

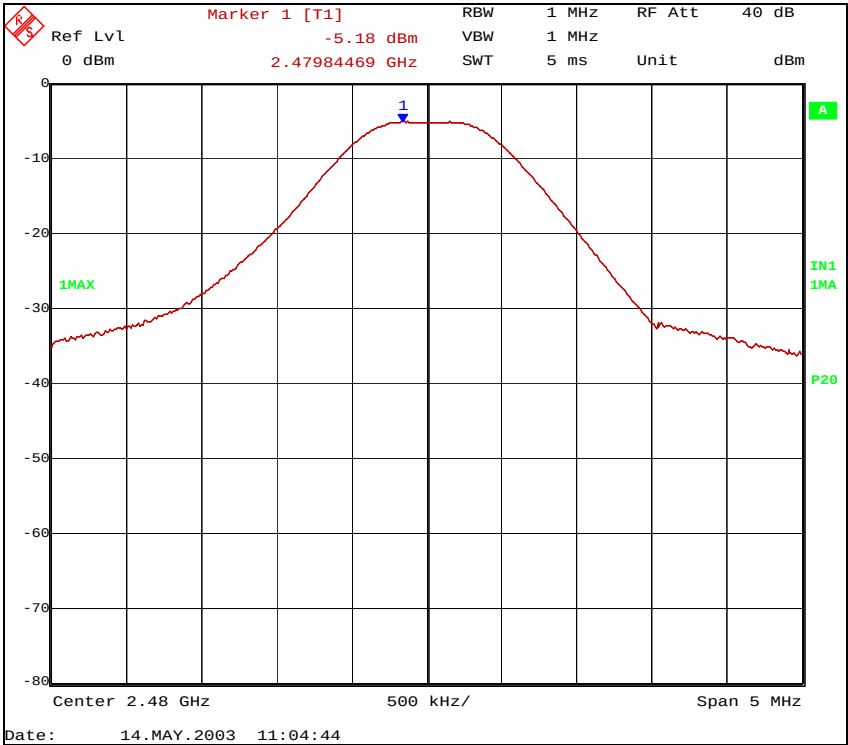
11.3 Screen shots



Picture 14. Peak output power on channel 0



Picture 15. Peak output power on channel 38



Picture 16. Peak output power on channel 78

12 BAND-EDGE COMPLIANCE OF RF CONDUCTED EMISSIONS

12.1 Hopping enabled

EUT	03320		
Accessories	03304		
Test setup	A		
Temp, Humidity, Air Pressure	20°C	47%RH	1009mbar
Date of measurement	19.5.2003		
FCC rule part	§15.247 (c) (1)		
RSS-210 section	6.2.2 (o), e1		
Measured by	Tero Huhtala		
Result	PASS		

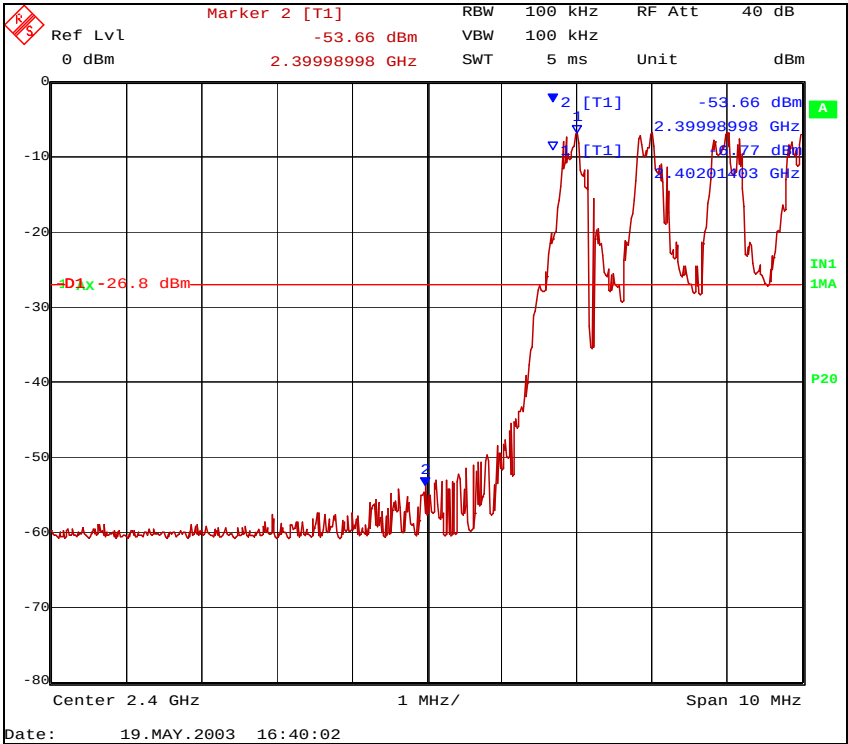
12.1.1 EUT operation mode

EUT operation mode	Connection, DH5, PRBS
EUT channel	Hopping
EUT TX power level	Nominal

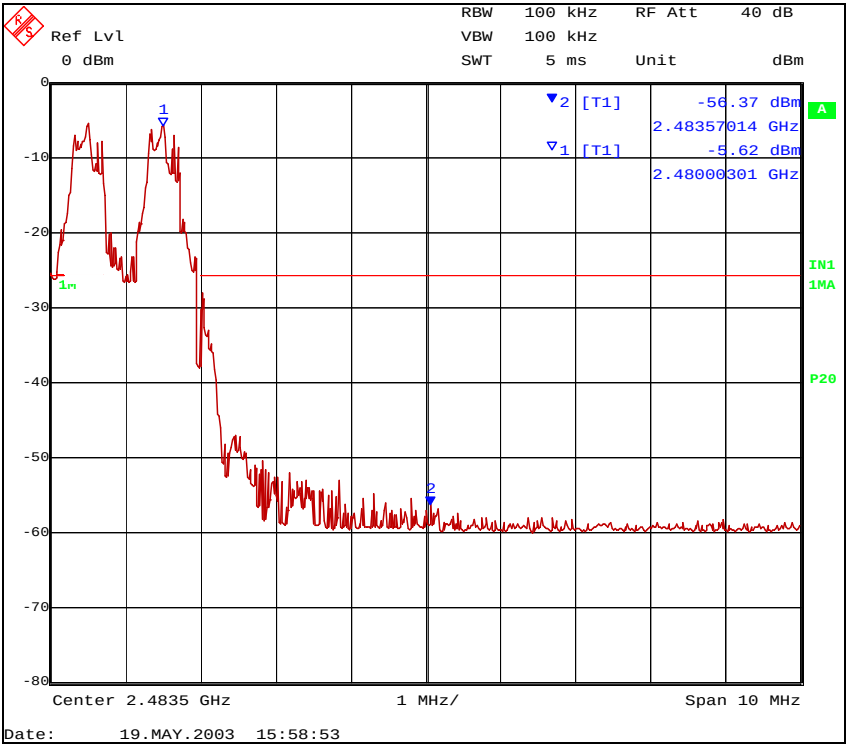
12.1.2 Limits and results

Channel	Limit (dBc)	Result (dBc)
0	≤ -20	-46.9 dBc
78		-50.8 dBc

12.1.3 Screen shots



Picture 20. Bandedge compliance, low end



Picture 21. Bandedge compliance, high end

12.2 Hopping disabled

EUT	03320		
Accessories	03304		
Test setup	A		
Temp, Humidity, Air Pressure	20°C	47%RH	1009mbar
Date of measurement	19.5.2003		
FCC rule part	§15.247 (c) (1)		
RSS-210 section	6.2.2 (o), e1		
Measured by	Tero Huhtala		
Result	PASS		

12.2.1 Test method

The test is made according to ANSI C63.4 (1992).

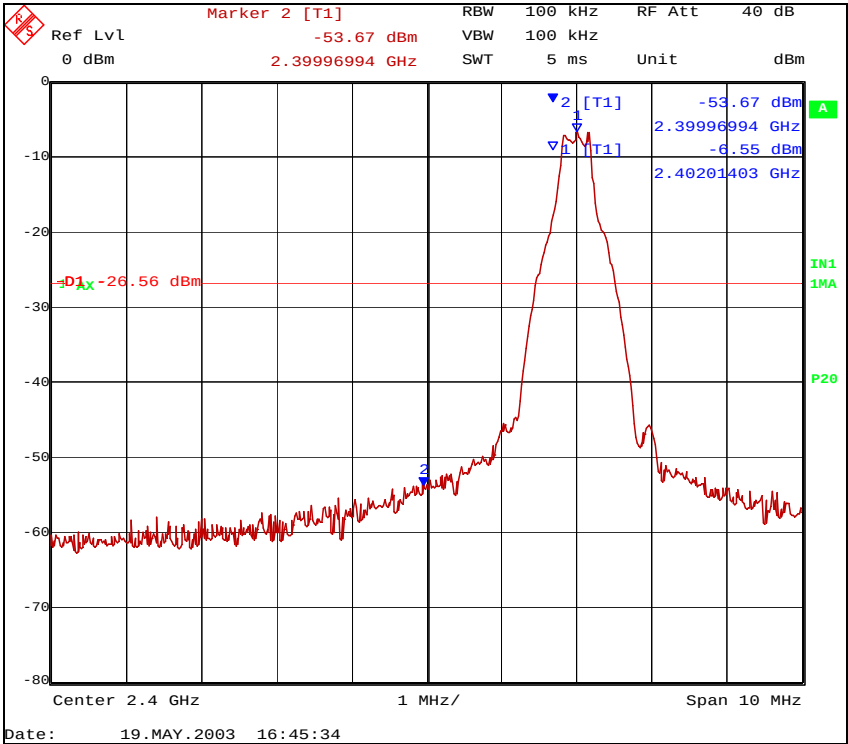
12.2.2 EUT operation mode

EUT operation mode	Connection, DM5, Static PRBS
EUT channel	0 (2402 MHz), 78 (2480MHz)
EUT TX power level	Nominal

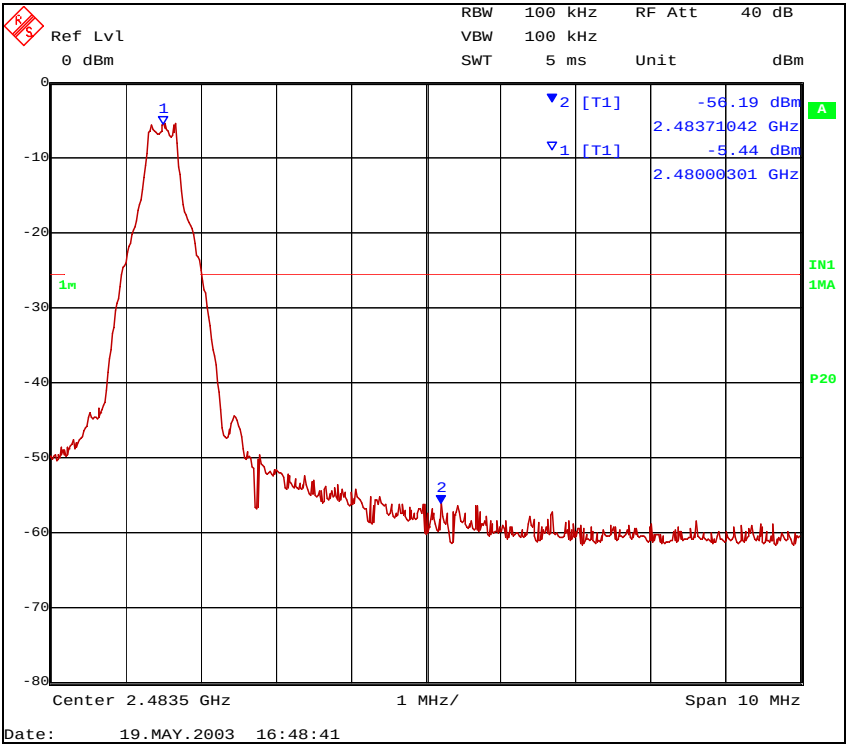
12.2.3 Limits and results

Channel	Limit (dBc)	Result (dBc)
0	≤ -20	-47.1 dBc
78		-50.8 dBc

12.2.4 Screen shots



Picture 22. Bandedge compliance, low end



Picture 23. Bandedge compliance, high end

13 AC POWERLINE CONDUCTED EMISSIONS

EUT	03319
Accessories	03304, 03308
Test setup	A
Temp, Humidity, Air Pressure	22 °C 47%RH 1013mbar
Date of measurement	21.5.2003
FCC rule part	§15.207
RSS-210 section	6.6
Measured by	Tero Huhtala
Result	PASS

13.1 Test setup

The EUT was set according to ANSI C63.4-1992. Test setup photographs are in section 17.

13.2 EUT operation mode

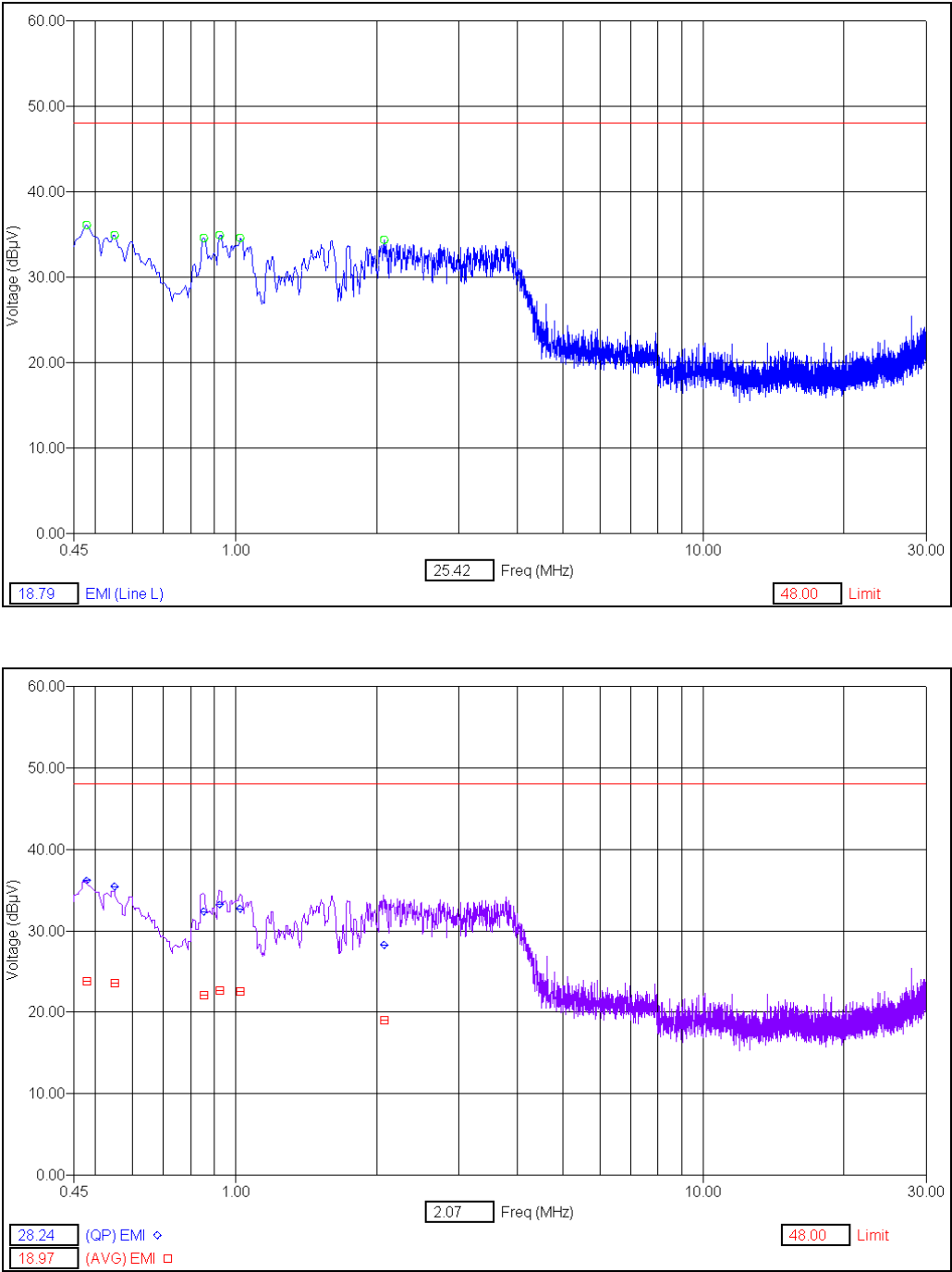
EUT operation mode	Connection, DH5, PRBS
EUT channel	Hopping
EUT TX power level	Nominal
EUT operation voltage	115VAC/60Hz

13.3 Limit

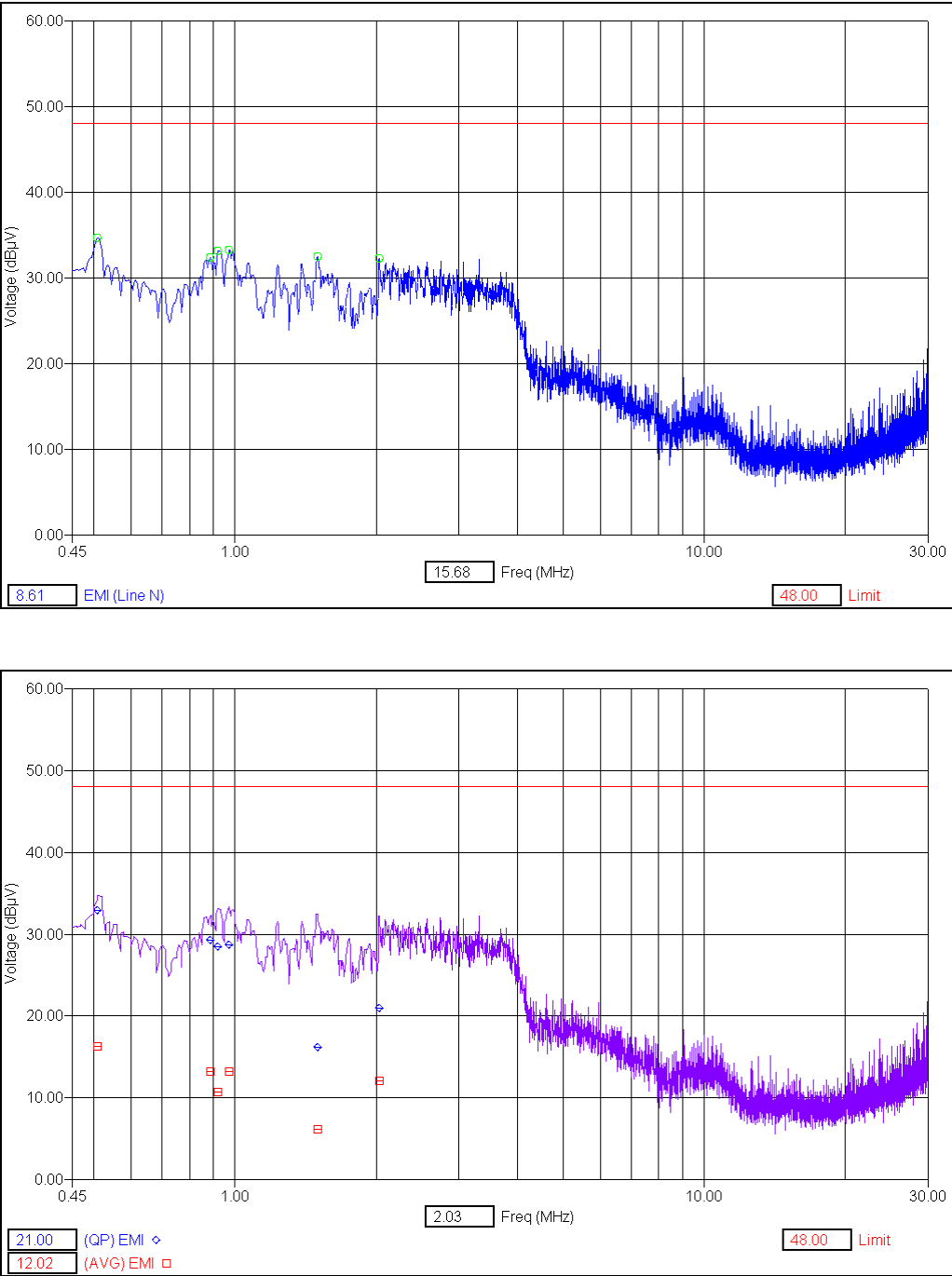
Frequency band (MHz)	Quasi-peak (μV)	Quasi-peak (dBμV)
0.45 - 30	250	48.0

13.4 Results

The measurement results were adjusted with the attenuation of the cable between the LISN and receiver by the computer controlling the test system.



Picture 24. AC powerline emissions, line L



Picture 25. AC powerline emissions, line N

Freq (Max) (MHz)	[QP] EMI (dBμV)	[AVG] EMI (dBμV)	Limit (dBμV)	[QP] Margin (dB)	[AVG] Margin (dB)
0.47	36.26	23.83	48.00	-11.74	-24.17
0.54	35.40	23.54	48.00	-12.60	-24.46
0.86	32.36	22.13	48.00	-15.64	-25.87
0.92	33.28	22.61	48.00	-14.72	-25.39
1.01	32.70	22.59	48.00	-15.30	-25.41
2.07	28.24	18.97	48.00	-19.76	-29.03

Table 26. Highest emissions, line L

Freq (Max) (MHz)	[QP] EMI (dBμV)	[AVG] EMI (dBμV)	Limit (dBμV)	[QP] Margin (dB)	[AVG] Margin (dB)
0.50	32.94	16.32	48.00	-15.06	-31.68
0.88	29.23	13.19	48.00	-18.77	-34.81
0.92	28.48	10.74	48.00	-19.52	-37.26
0.96	28.67	13.20	48.00	-19.33	-34.80
1.51	16.12	6.17	48.00	-31.88	-41.83
2.03	21.00	12.02	48.00	-27.00	-35.98

Table 27. Highest emissions, line N

14 SPURIOUS RF CONDUCTED EMISSIONS

EUT	03320
Accessories	03304
Test setup	A
Temp, Humidity, Air Pressure	21°C 47%RH 1009mbar
Date of measurement	20.5.2003
FCC rule part	§15.247 (c) (2)
RSS-210 section	6.2.2 (o), e1
Measured by	Tero Huhtala
Result	PASS

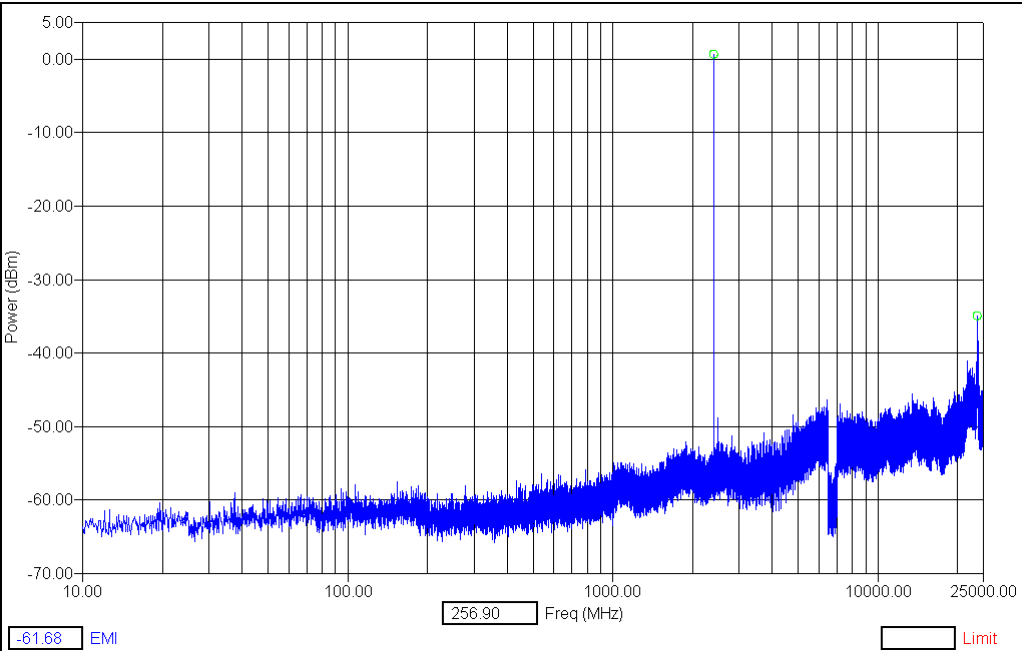
14.1 EUT operation mode

EUT operation mode	Connection, DM5, Static PRBS
EUT channel	0 (2402 MHz), 38 (2440 MHz), 78 (2480MHz)
EUT TX power level	Nominal

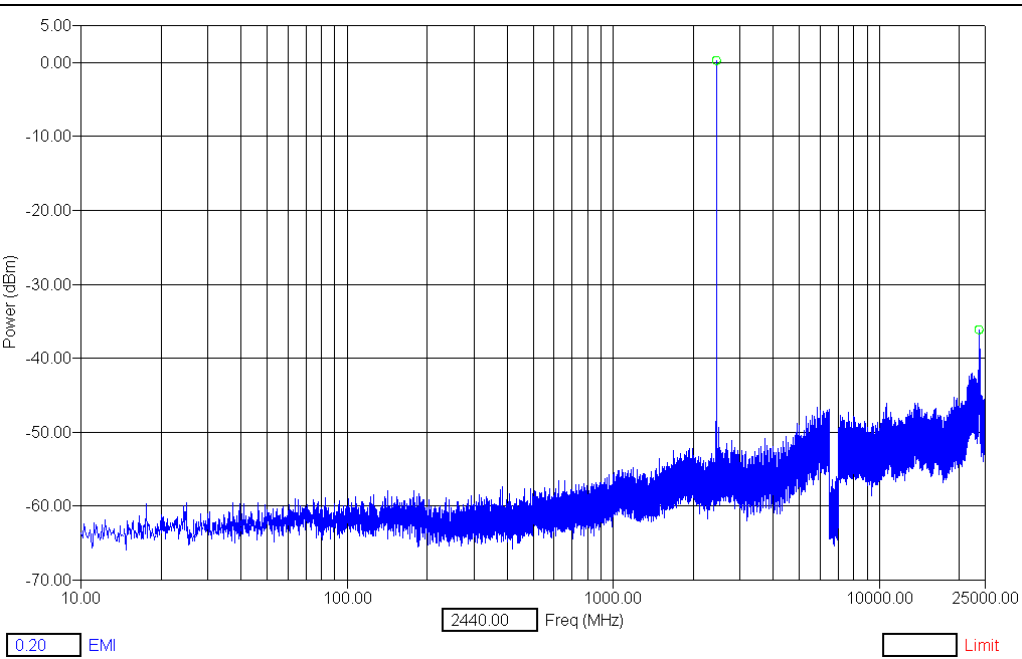
14.2 Limits and results

EUT Channel	Limit (dBc)	Result (dBc)
0	≤ -20	-35.61
38		-36.33
78		-36.63

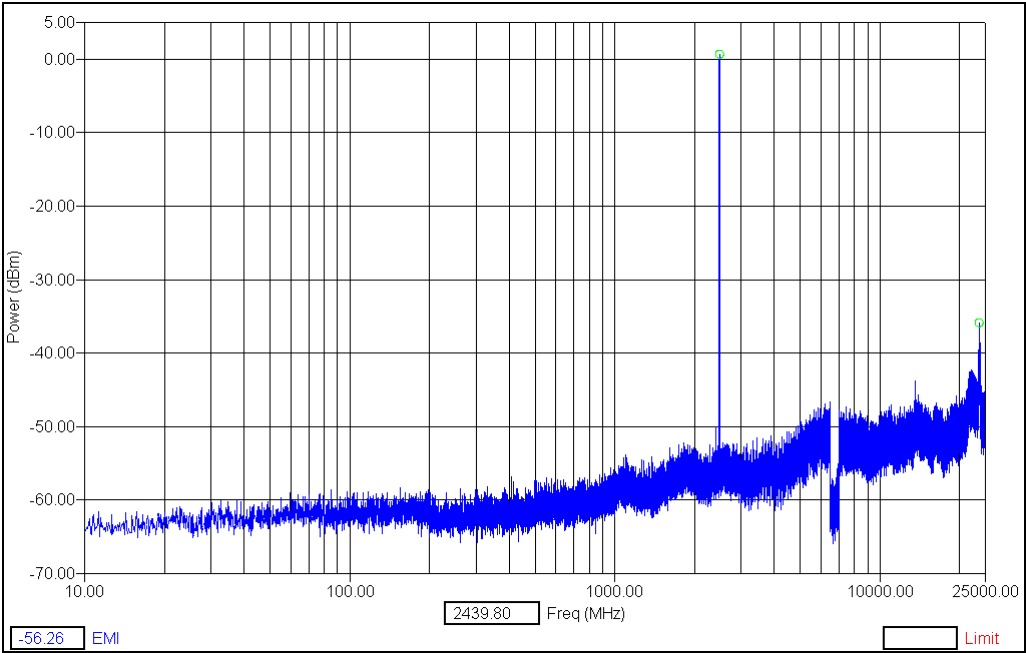
14.3 Screen shots



Picture 28. Spurious RF conducted emissions, TX on channel 0



Picture 29. Spurious RF conducted emissions, TX on channel 38



Picture 30. Spurious RF conducted emissions, TX on channel 78

15 SPURIOUS RADIATED EMISSIONS

EUT	03319
Accessories	03304, 03308
Test setup	B
Temp, Humidity, Air Pressure	22°C 48%RH 1025mbar
Date of measurement	12.5.2003
FCC rule part	§15.247 (c) (1)
RSS-210 section	6.2.2 (o), e1
Measured by	Tero Huhtala
Result	PASS

15.1 Test method

- The spectrum analyzer with peak detector was used to find all the emissions generated by the EUT.
- All suspicious frequencies with emission levels were recorded.
- The test was repeated with the EUT in three orthogonal orientations.
- For each frequency detected in (b), the emissions were maximized by moving the turn table and measuring antenna and manipulating the EUT.
- The maximized emissions were measured and reported.

15.2 EUT operation mode

EUT operation mode	Connection, DM5, Static PRBS
EUT channel	0 (2402 MHz), 38 (2440 MHz), 78 (2480MHz)
EUT TX power level	Nominal
EUT operation voltage	115VAC/60Hz

15.3 Limits, 3m measuring distance

Frequency band (MHz)	Limit (μV/m)	Limit (dBμV/m)	Detector
30 – 88	100	40	QP
88 -216	150	43.5	QP
216 - 960	200	46	QP
960 - 1000	500	54.0	QP
1000 - 18000	500	74.0 / 54.0	PK / AV

As default, all emissions were compared against the general limits. If any emission exceeded that limit, it was further checked, if it was outside the restricted band thus complying with the -20dBc requirement.

15.4 Results

The results were corrected with the cable and filter losses, preamplifier gain, antenna factor and measurement distance.

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

Freq. [MHz]	U_{RX} dBuV	Pol.	Det.	A_{CABLE} (dB)	G_{PREAMP} (dB)	AF dB(1/m)	Limit [dBuV/m]	$C_{DISTANCE}$	Result [dBuV/m]
4804	42.13	V	PK	14.26	29.70	33.62	74	9.54	50.77
4804	27.41	V	AV	14.26	29.70	33.62	54	9.54	36.05
7206	40.56	V	PK	17.30	27.64	37.03	74	9.54	57.71
7206	27.24	V	AV	17.30	27.64	37.03	54	9.54	44.39
9608	39.52	V	PK	20.41	25.01	38.41	74	9.54	63.79
9608	25.97	V	AV	20.41	25.01	38.41	54	9.54	50.24
12010	39.78	V	PK	23.00	26.34	39.19	74	9.54	66.09
12010	26.56	V	AV	23.00	26.34	39.19	54	9.54	52.87

Table 31. Emission levels, TX on channel 0

Freq. [MHz]	U _{RX} dBuV	Pol.	Det.	A _{CABLE} (dB)	G _{PREAMP} (dB)	AF dB(1/m)	Limit [dBuV/m]	C _{DISTANCE}	Result [dBuV/m]
4880	41.97	V	PK	14.52	29.60	34.00	74	9.54	51.35
4880	28.95	V	AV	14.52	29.60	34.00	54	9.54	38.33
7320	40.73	V	PK	15.43	27.36	37.52	74	9.54	56.78
7320	27.03	V	AV	15.43	27.36	37.52	54	9.54	43.08
9760	39.24	V	PK	20.41	25.27	38.62	74	9.54	63.46
9760	25.93	V	AV	20.41	25.27	38.62	54	9.54	50.15
12200	43.80	V	PK	23.26	26.19	39.16	74	9.54	70.49
12200	27.12	V	AV	23.26	26.19	39.16	54	9.54	53.81

Table 32. Emission levels, TX on channel 38

Freq. [MHz]	U _{RX} dBuV	Pol.	Det.	A _{CABLE} (dB)	G _{PREAMP} (dB)	AF dB(1/m)	Limit [dBuV/m]	C _{DISTANCE}	Result [dBuV/m]
4960	42.87	V	PK	14.73	29.43	34.22	74	9.54	52.85
4960	29.44	V	AV	14.73	29.43	34.22	54	9.54	39.42
7440	40.15	V	PK	17.64	27.18	37.56	74	9.54	58.63
7440	26.62	V	AV	17.64	27.18	37.56	54	9.54	45.10
9920	38.64	V	PK	20.21	25.20	38.82	74	9.54	62.93
9920	25.82	V	AV	20.21	25.20	38.82	54	9.54	50.11
12400	39.53	V	PK	23.36	25.50	39.10	74	9.54	66.95
12400	26.51	V	AV	23.36	25.50	39.10	54	9.54	53.93

Table 33. Emission levels, TX on channel 78

16 TEST EQUIPMENT

Each test equipment is calibrated once a year.

16.1 Conducted measurements

Equipment	Manufacturer	Model
EMI receiver	Rohde & Schwarz	ESI 40
Radio communication tester	Rohde & Schwarz	CMU-200
Step attenuator 110dB	Hewlett-Packard	8496A
Power splitter	Hewlett-Packard	11667A
High pass filter	Trilithic	4HC3000/18000-3-KK
Band stop filter	Wainwright	WRCA 2400/2500-0.2-10SS

16.2 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
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	4HC3000/18000-3-KK
Band stop filter	Wainwright	WRCA 2400/2500-0.2-10SS
Antenna/turntable controller	Deisel	HD-100
Antenna mast	Deisel	MA240
Turntable	Deisel	DS412

17 TEST SETUP PHOTOGRAPHS

See "NEM4_test_setup_photographs.doc".