
Bluetooth test report for NHL-12

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1 LABORATORY INFORMATION

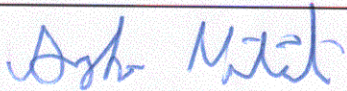
Test laboratory:	TCC Tampere Sinitaival 5 FIN-33720 TAMPERE Tel. +358 7180 46800 Fax. +358 7180 46880
FCC registration number:	94436 (June 14, 2002)
IC file number:	IC 3608 (March 5, 2003)

2 CUSTOMER INFORMATION

Client:	Nokia Corporation Multimedia Imaging BU Mattilanniemi 6-8 FIN-40100 JYVÄSKYLÄ FINLAND Tel. +358-71-8008000 Fax. +358-71-8078000
Contact person:	Mikael Honkanen
Receipt of EUT:	7.1.2004
Date of testing:	12-27.2.2004
Date of report:	3.3.2004

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

PASS Pass
FAIL Fail
X Measured, but there is no applicable performance criteria
- Not done

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	NHL-12	004400231357006	3389
	GSM Phone	NHL-12	004400231657089	3396
	GSM Phone	NHL-12	004400231656875	3390
Accessories	Battery	BL-5C	-	3394
	Memory Card	DTS-32	A200EJ85221	3393
	Memory Card	DTS-32	-	3377
	Battery	BL-5C	-	3378
	Charger	ACP-12U	399791K30510014877	3395

Notes: -

4.1 EUT description

The EUT is a triple band (850 MHz/1800 MHz/1900 MHz) E-GPRS (Edge) GSM mobile phone with bluetooth.

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.

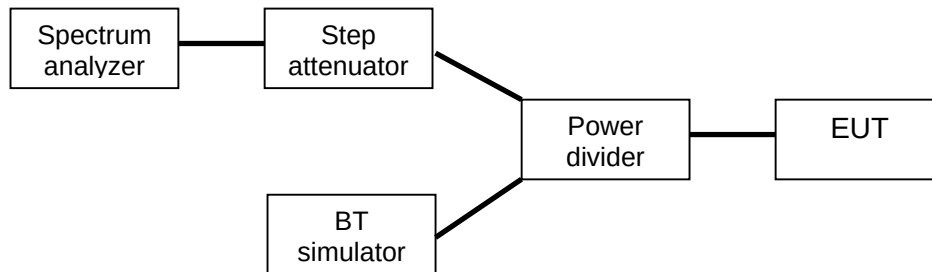
Two different test setups were used: one for conducted measurements, another for radiated measurements. One EUT was equipped with an external antenna connector for conductive measurements.

5.1 Setup A (conducted measurements)

This setup was used in conducted measurements. The 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

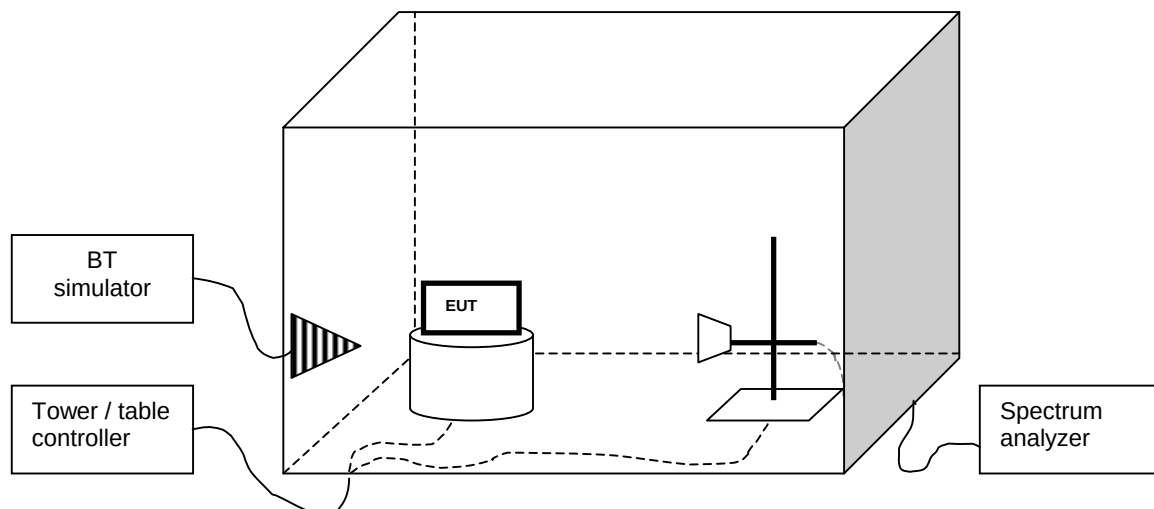
In tests, where absolute level reporting were required, the results were corrected with all applicable factors as detailed in the result section of each measurement.



5.2 Setup B (radiated measurements)

The 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 Part 15.247, Part 2, FCC public notice DA 00-705 (March 30, 2000), ANSI C63.4 (1992), RSS-210 (Issue 5, November 2001) and CISPR-22. Deviations, modifications or clarifications (if any) to above mentioned documents are written in each section under "Test method".

7 CARRIER FREQUENCY SEPARATION

EUT	03389		
Accessories	03377, 03386		
Test setup	A		
Temp, Humidity, Air Pressure	20°C	45%RH	1026 mbar
Date of measurement	12.2.2004		
FCC rule part	§15.247 (a) (1)		
RSS-210 section	6.2.2 (o), a1		
Measured by	Jan-Erik Lilja		
Result	PASS		

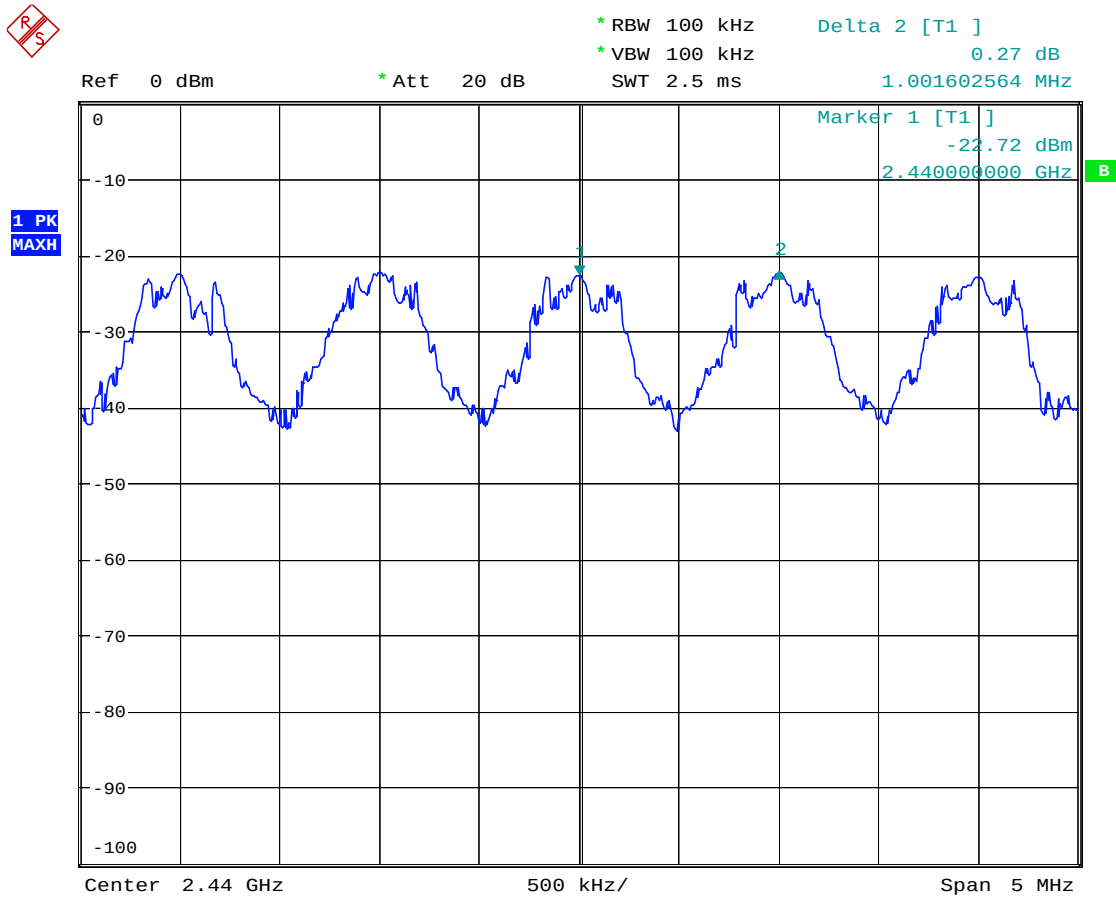
7.1 EUT operation mode

EUT operation mode	Connection, Static PRBS, DH5 packet type
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



Date: 12.FEB.2004 15:39:23

Figure 1 Carrier frequency separation of channels 40 and 41

8 NUMBER OF HOPPING FREQUENCIES

EUT	03389		
Accessories	03377, 03386		
Test setup	A		
Temp, Humidity, Air Pressure	20 °C	45 %RH	1026 mbar
Date of measurement	12.2.2004		
FCC rule part	§15.247(a) (2)		
RSS-210 section	6.2.2 (o), a3		
Measured by	Jan-Erik Lilja		
Result	PASS		

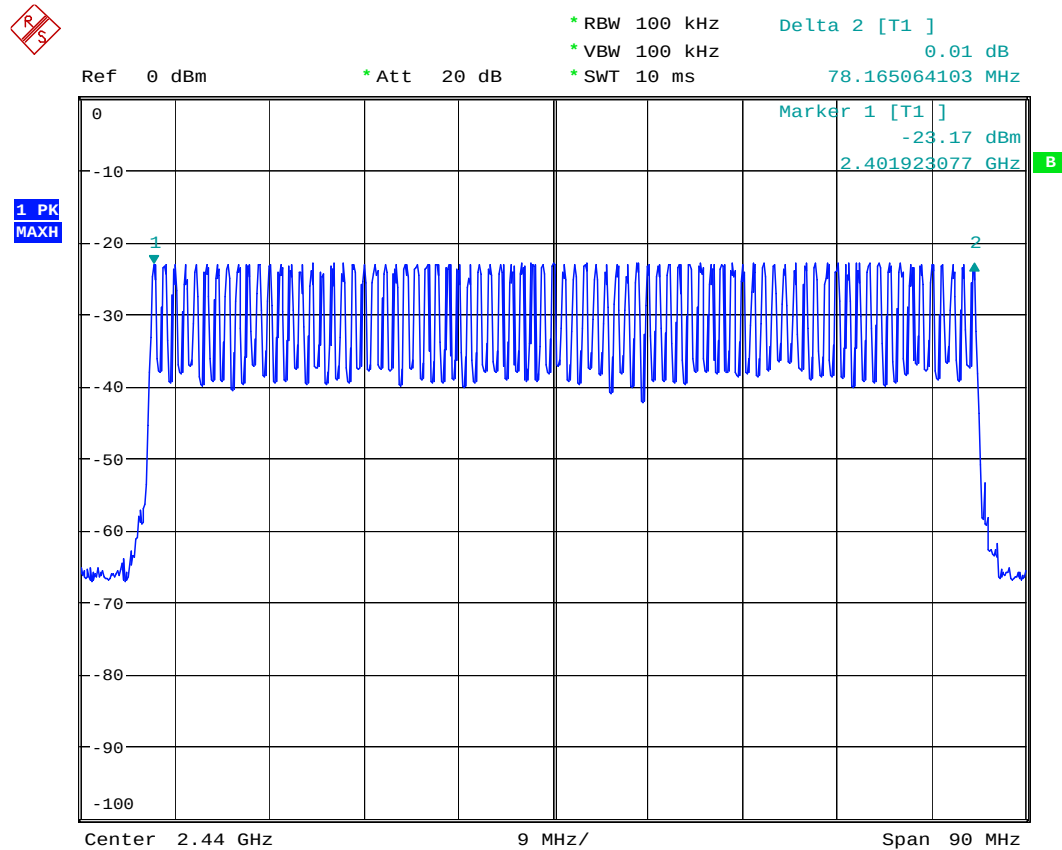
8.1 EUT operation mode

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

8.2 Limits and results

Number	Measured value
≥ 75	79

8.3 Screen shot



Date: 12.FEB.2004 16:35:47

Figure 2 Number of hopping frequencies

9 TIME OF OCCUPANCY

EUT	3396, 3389		
Accessories	3377, 3386		
Test setup	A		
Temp, Humidity, Air Pressure	20-21 °C	45-47 %RH	1006-1028 mbar
Date of measurement	16-23.2.2004		
FCC rule part	§15.247 (a) (3)		
RSS-210 section	6.2.2 (o), a3		
Measured by	Jan-Erik Lilja		
Result	PASS		

9.1 Page mode

9.1.1 EUT operation mode

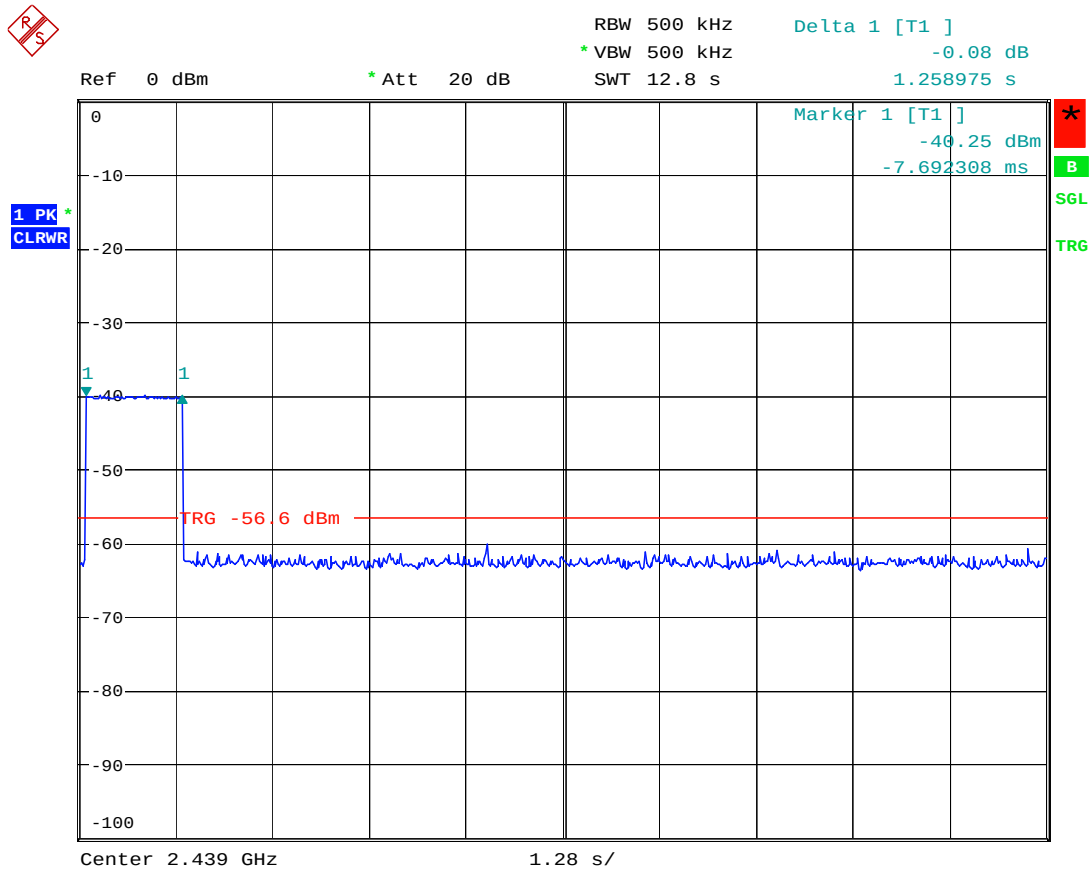
EUT operation mode	Page
EUT channel	Hopping
EUT TX power level	Nominal

9.2 Limits and results

Limit (s)	Measured value (s)
≤ 0.4	0.017

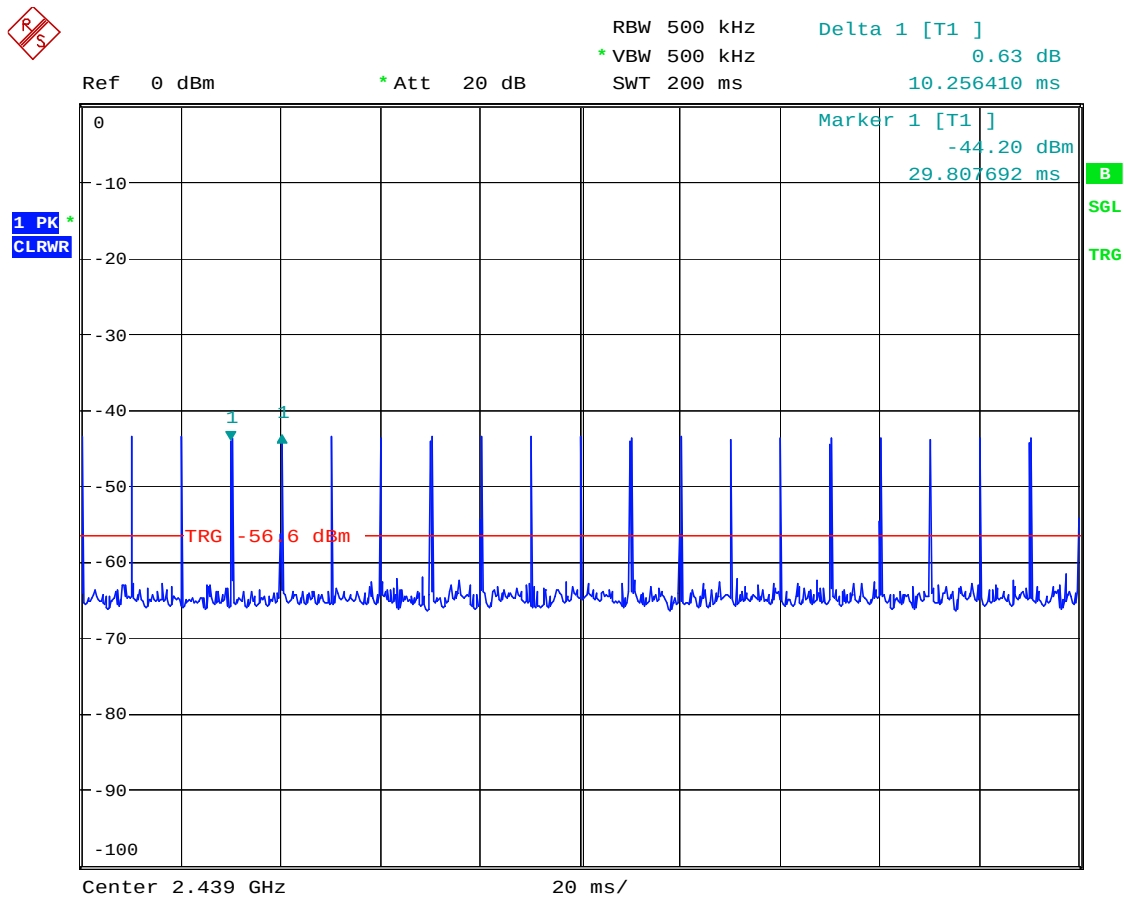
The complete paging cycle took 1.26 s, during which the transmitter operated at every 10.26 ms. The duration of one transmission was 141.026 µs. $(1.26 \text{ s} / 0.01026 \text{ s}) * 0.141026 \text{ ms} = 17.31 \text{ ms}$.

9.3 Screen shots



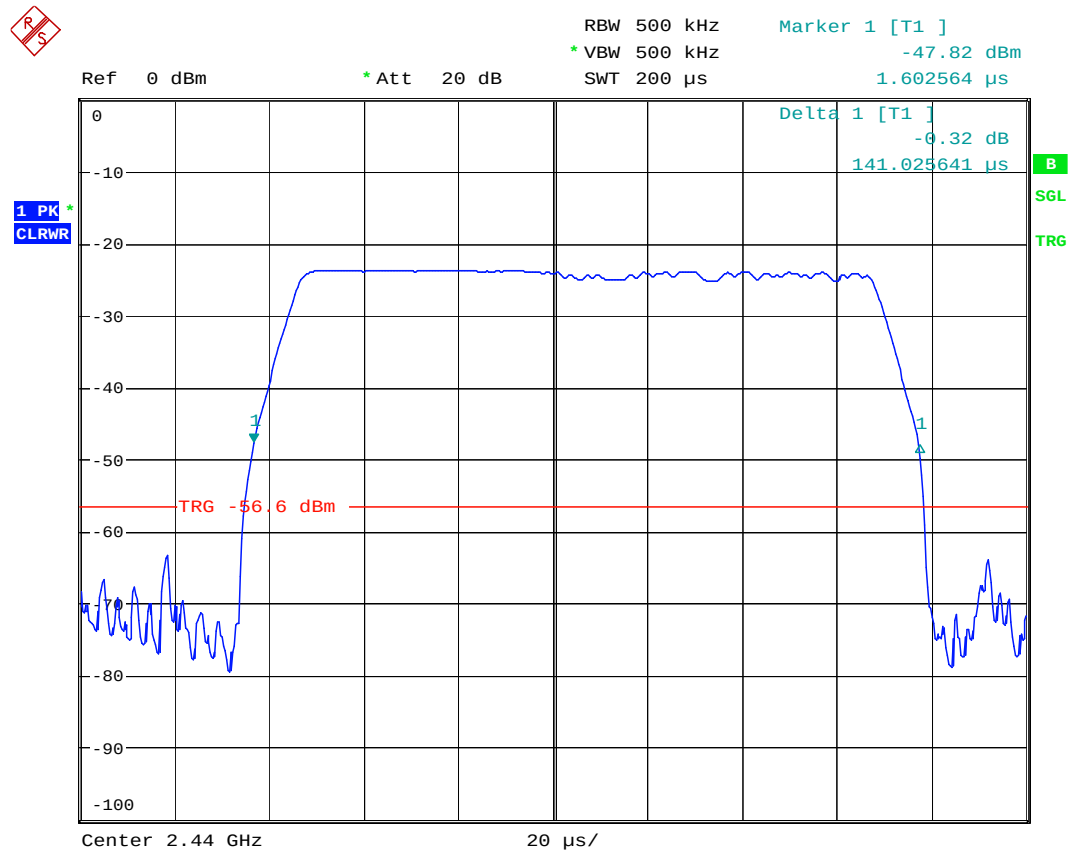
Date: 19.FEB.2004 19:20:17

Figure 3 Complete paging cycle, channel 37



Date: 20.FEB.2004 12:00:31

Figure 4 Paging repetition frequency, channel 37



Date: 20.FEB.2004 12:11:37

Figure 5 Duration of one transmission, channel 38

9.4 Inquiry mode

9.4.1 EUT operation mode

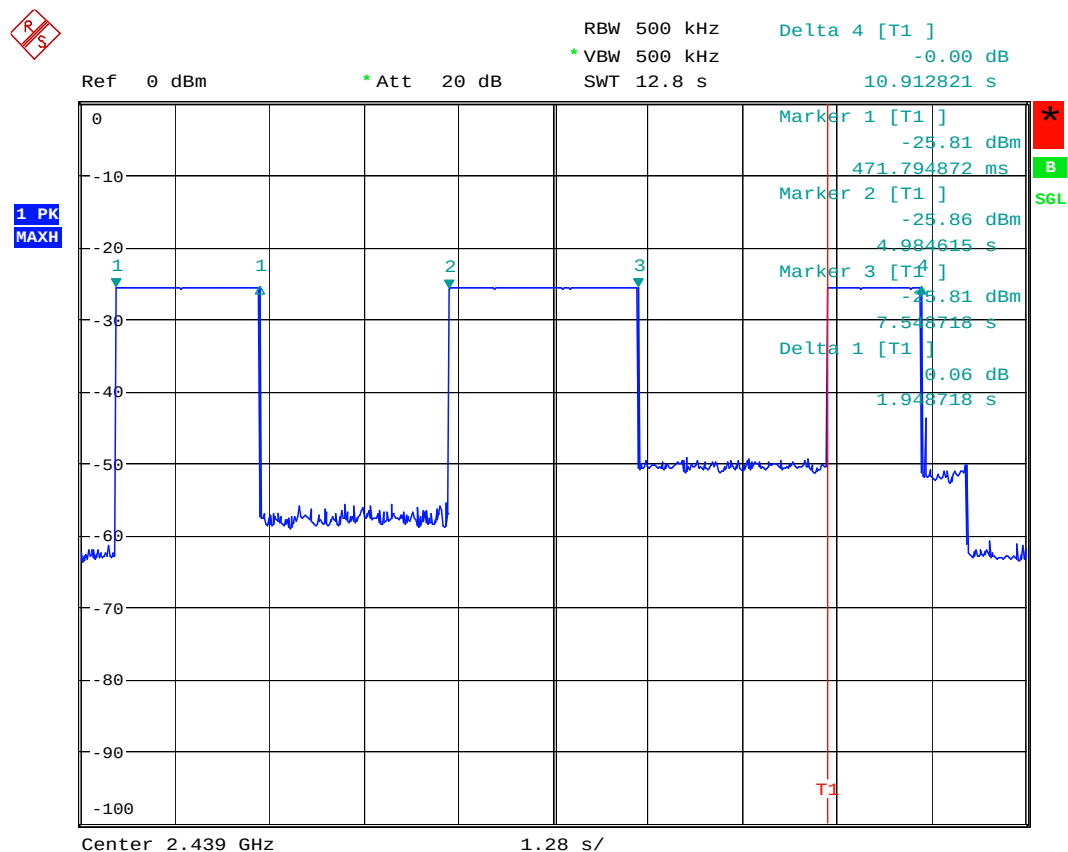
EUT operation mode	Inquiry
EUT channel	Hopping
EUT TX power level	Nominal

9.5 Limits and results

Limit (s)	Measured value (s)
≤ 0.4	0.056

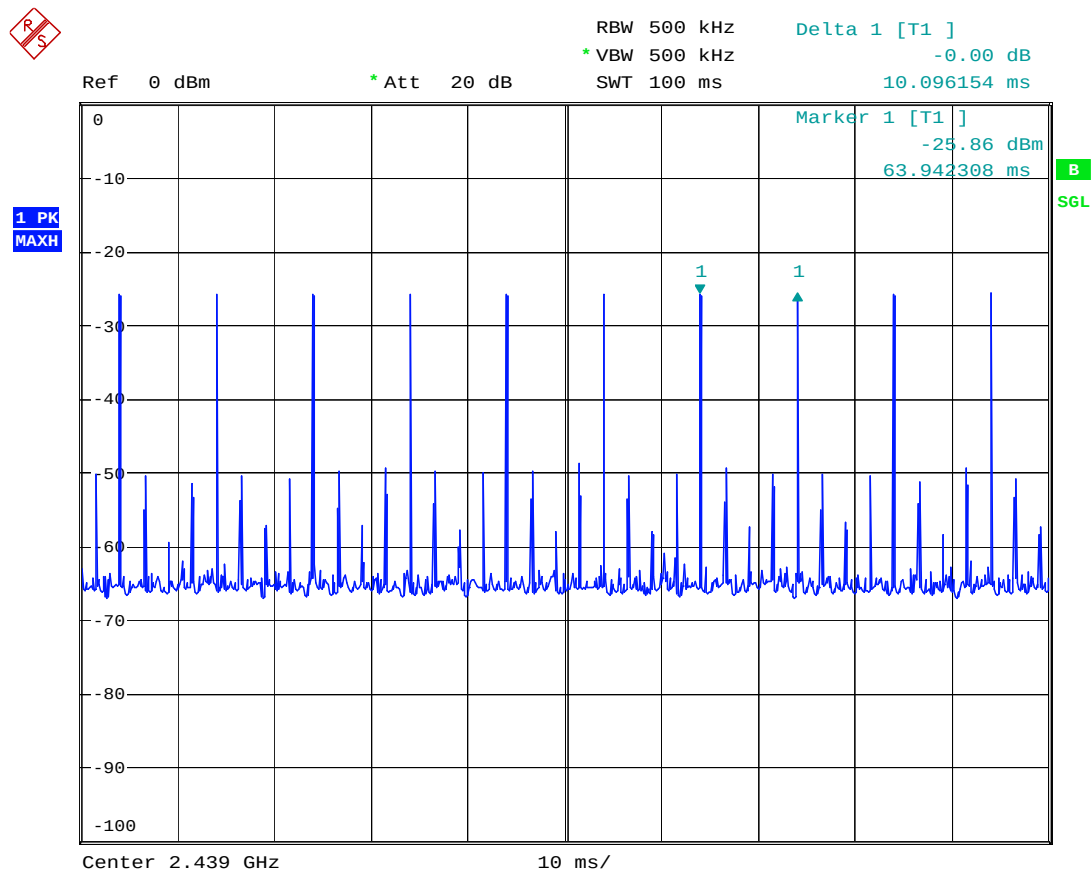
The complete inquiry cycle took 5.785 s, during which the transmitter operated at every 10.10 ms. The duration of one transmission was 97.76 μ s. $(5.785 \text{ s} / 0.0101 \text{ s}) * 0.09776 \text{ ms} = 56.01 \text{ ms}$.

9.6 Screen shots



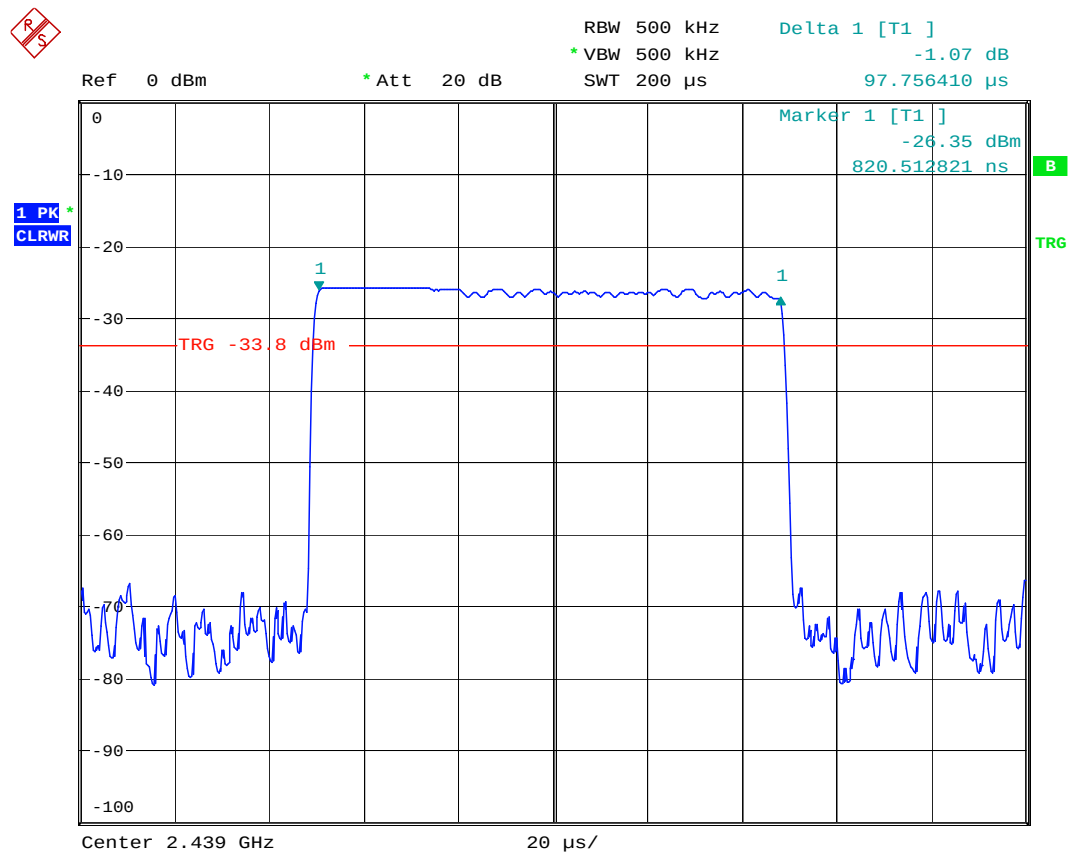
Date: 16.FEB.2004 15:39:27

Figure 6 Complete inquiry cycle, channel 37



Date: 16.FEB.2004 15:53:52

Figure 7 Paging repetition frequency, channel 37



Date: 16.FEB.2004 16:26:45

Figure 8 Duration of one transmission, channel 37

9.7 Connection mode

9.7.1 EUT operation mode

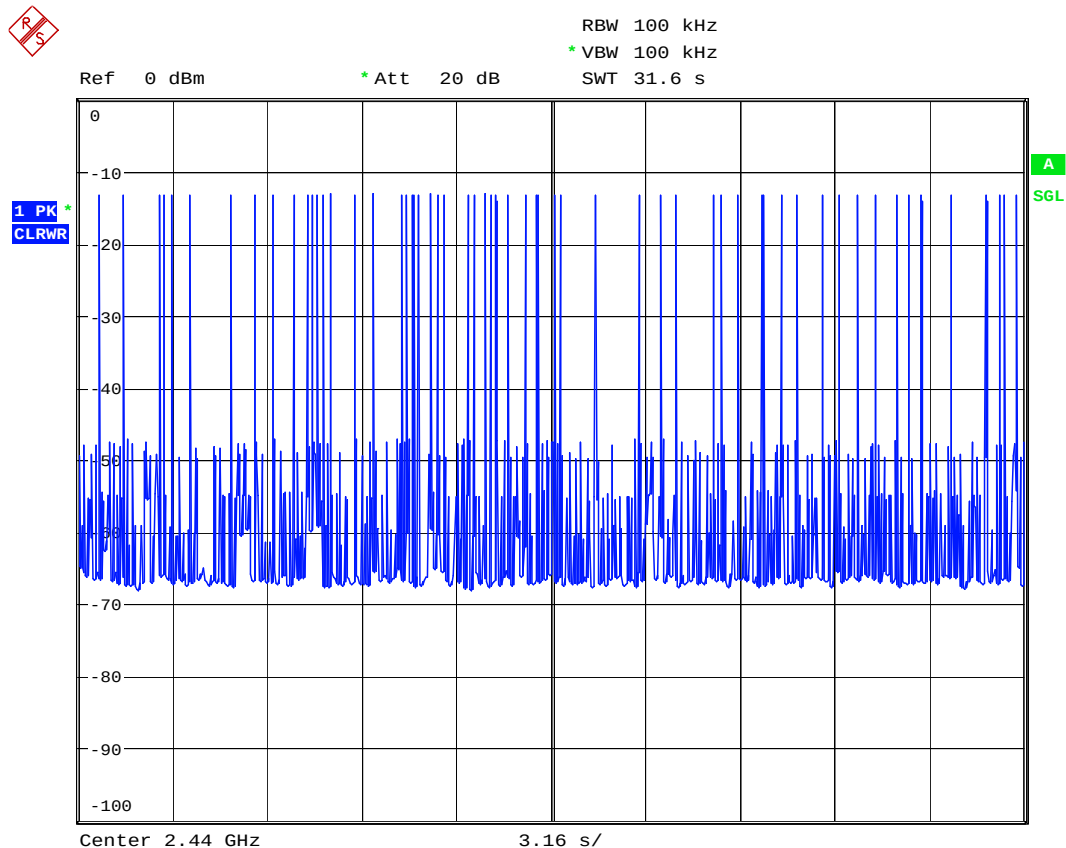
EUT operation mode	Connection, Static PRBS, DH5 packet type
EUT channel	Hopping
EUT TX power level	Nominal

9.7.2 Limits and results

Limit (s)	Measured value (s)
≤ 0.4	0.183

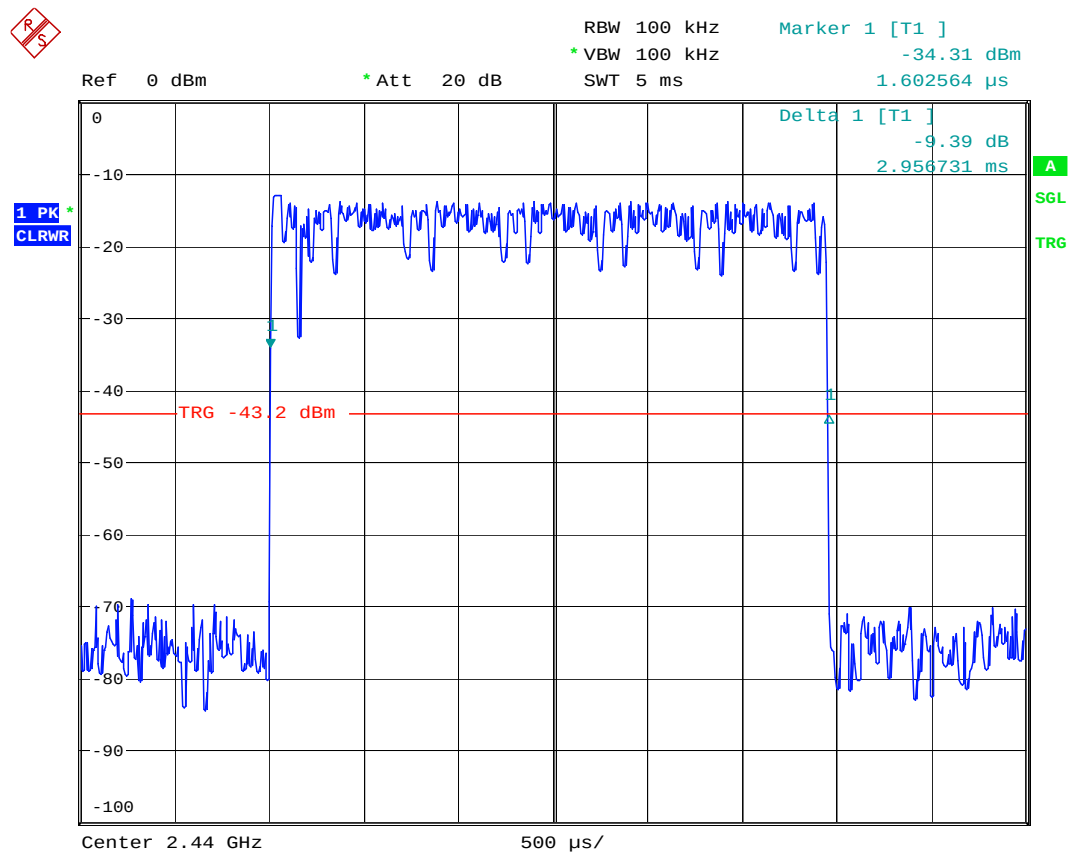
In measurement time of 31.6 s, total of 62 transmissions occurred. The duration of one transmission was 2.957 ms. $2.957 \cdot 62 = 183.32$ ms.

Screen shots



Date: 23.FEB.2004 14:41:46

Figure 9 Number of transmissions, channel 38



Date: 23.FEB.2004 14:01:47

Figure 10 Duration of one transmission, channel 38

10 20dB BANDWIDTH

EUT	3396		
Accessories	3377, 3386		
Test setup	A		
Temp, Humidity, Air Pressure	20°C	45%RH	1020 mbar
Date of measurement	17.2.2004		
FCC rule part	§15.247 (a) (1)		
RSS-210 section	6.2.2 (o), a1		
Measured by	Jan-Erik Lilja		
Result	PASS		

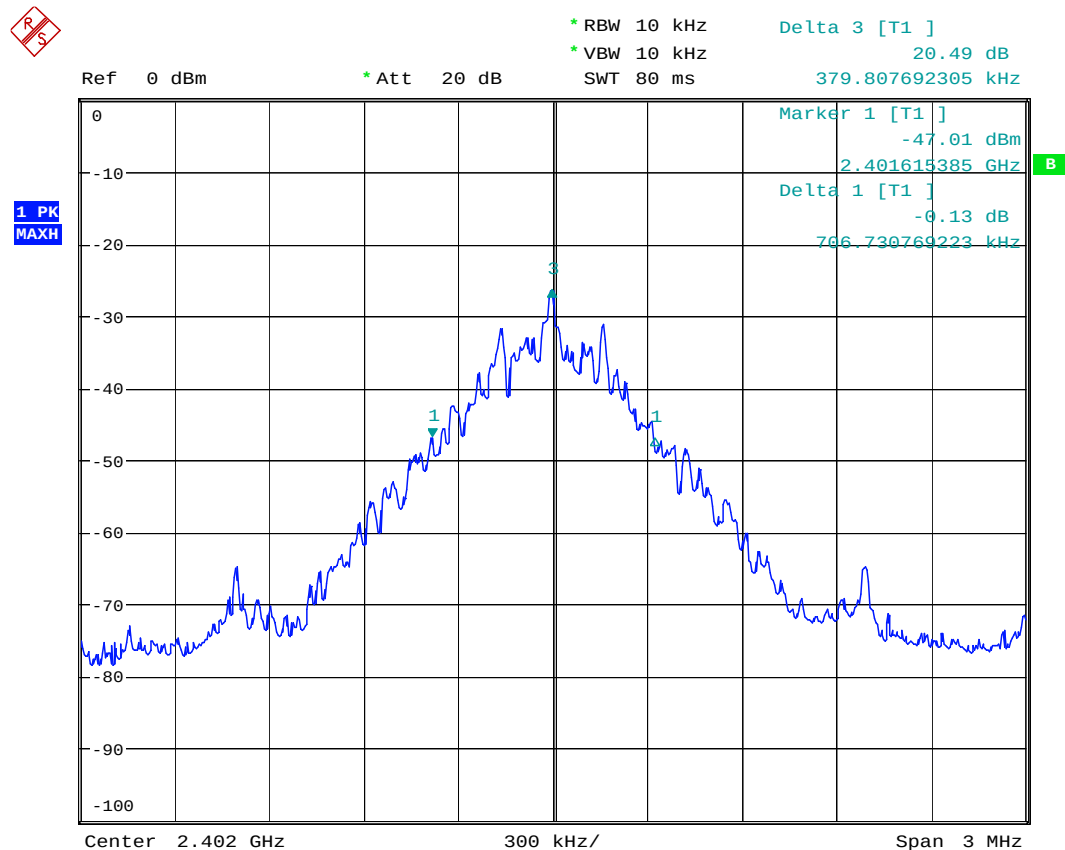
10.1 EUT operation mode

EUT operation mode	Connetction, Static PRBS, DH5 packet type
EUT channel	0, 38 and 78
EUT TX power level	Nominal

10.2 Limits and results

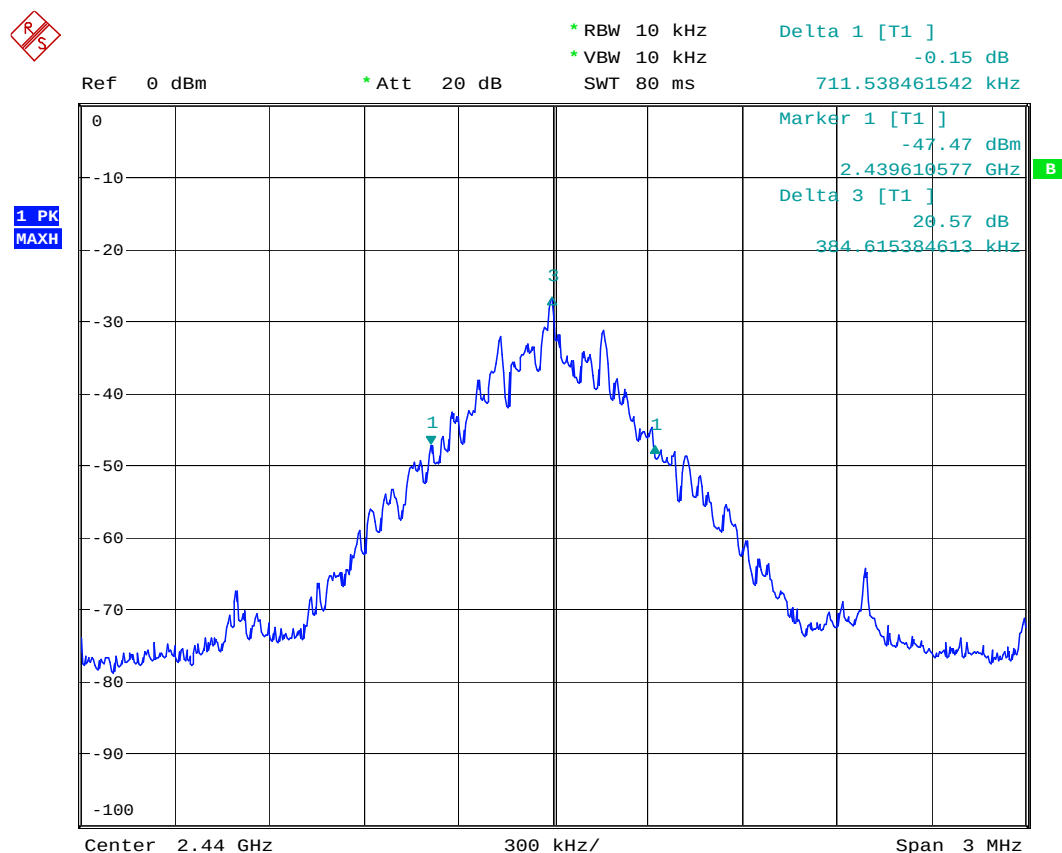
EUT Channel	Limit (MHz)	Measured value (MHz)
0	≤1.0	0.7067
38		0.7115
78		0.7356

10.3 Screen shots



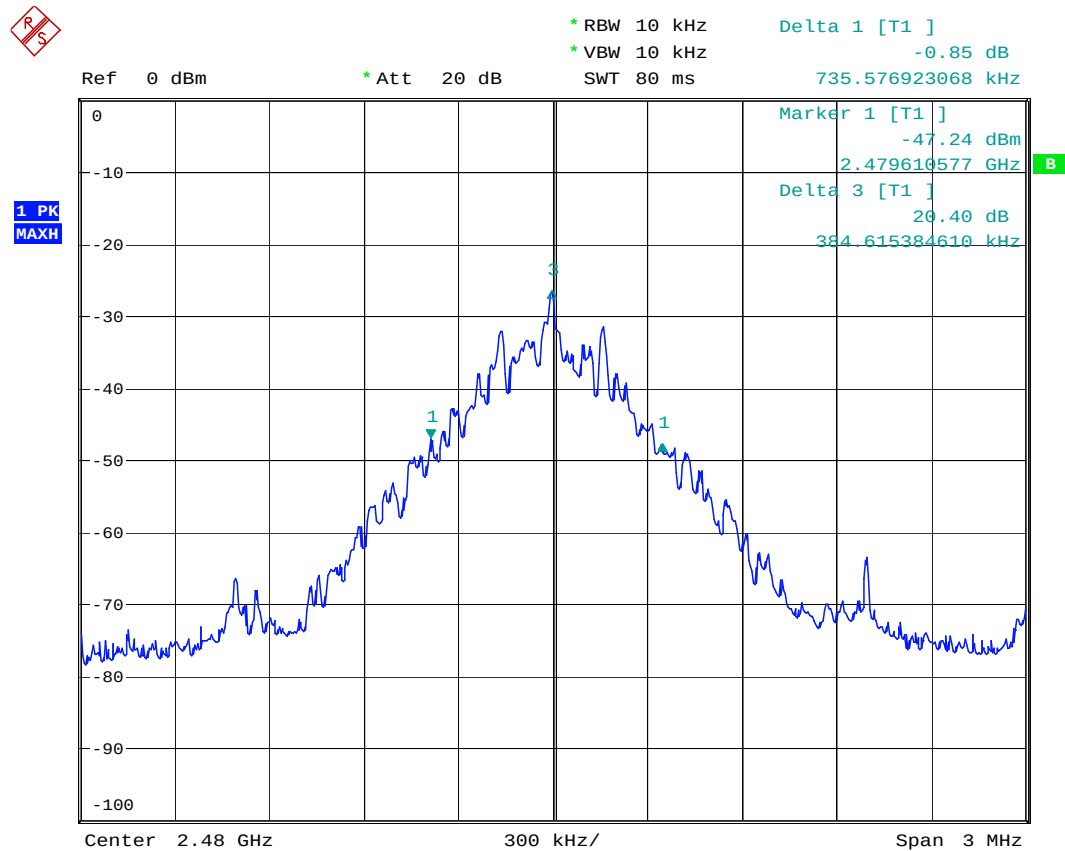
Date: 17.FEB.2004 12:23:40

Figure 11 20 dB bandwidth, channel 0



Date: 17.FEB.2004 12:26:13

Figure 12 20 dB bandwidth, channel 38



Date: 17.FEB.2004 12:28:47

Figure 13 20 dB bandwidth, channel 78

11 PEAK OUTPUT POWER

EUT	3396
Accessories	3377, 3386
Test setup	A
Temp, Humidity, Air Pressure	20°C 45%RH 1020 mbar
Date of measurement	17.2.2004
FCC rule part	§15.247 (b) (1)
RSS-210 section	6.2.2 (o), a3
Measured by	Jan-Erik Lilja
Result	Pass

11.1 EUT operation mode

EUT operation mode	Connection, Static PRBS, DH5 packet type
EUT channel	2, 40 and 80
EUT TX power level	Nominal

11.2 Limits and results

EUT Channel	Limit (W)	Test result (W)
0	≤ 1	0.000723
38		0.000741
78		0.000794

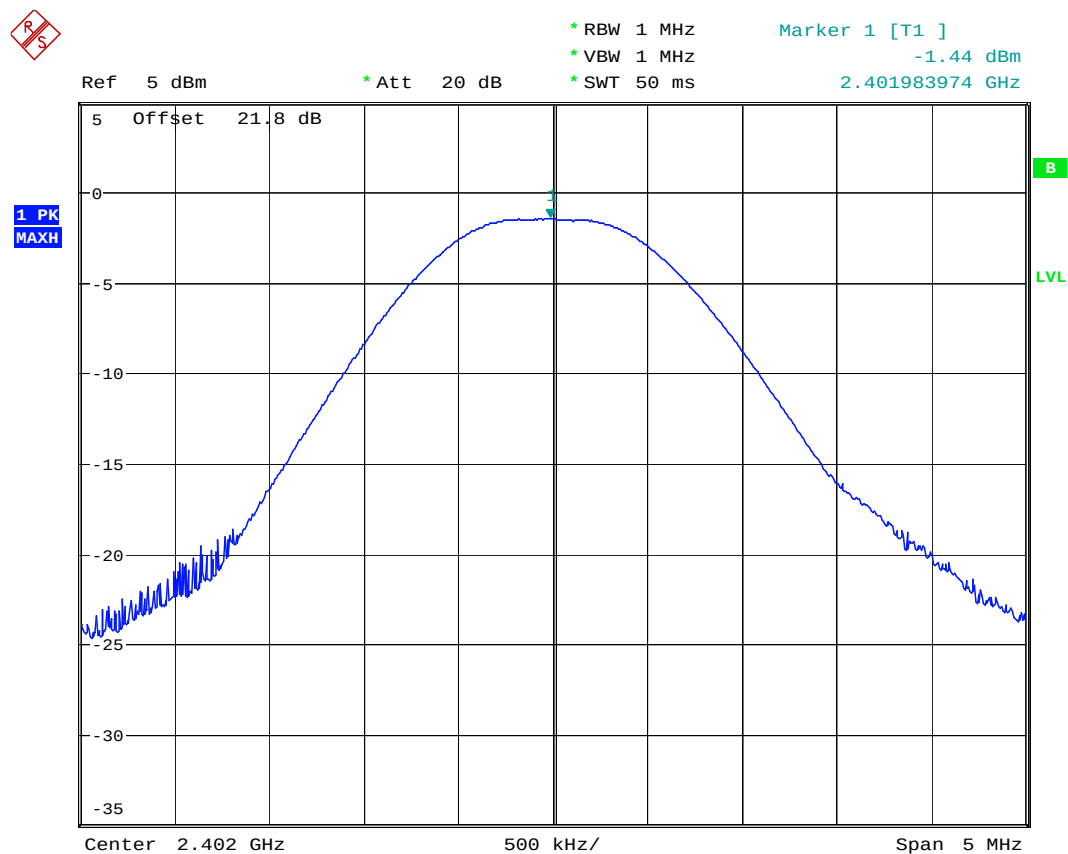
The measured power values were corrected with the attenuation of the cables, attenuator and power divider using the formula:

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

Table 1 Conducted peak output power

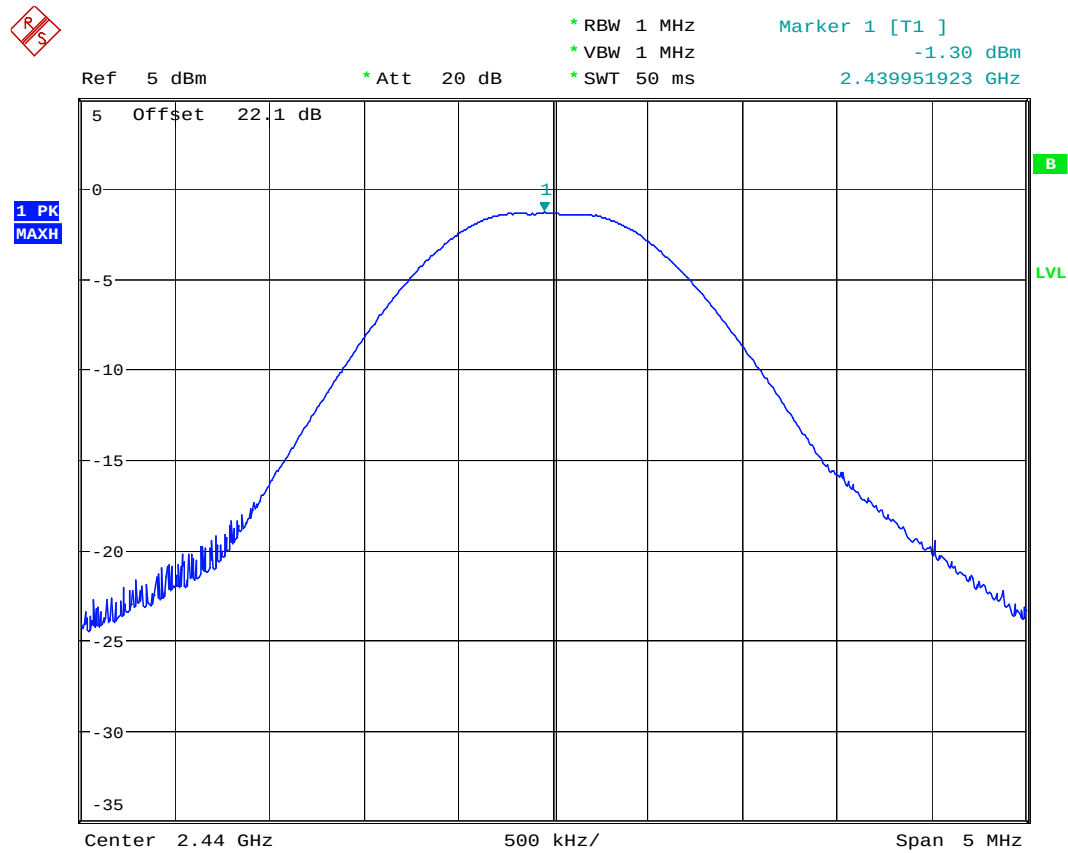
EUT Channel	Measured value [dBm]	Signal path loss [dB]	Peak output power [dBm]	Peak output power [W]
0	-23.24	21.83	-1.41	0.000723
38	-23.40	22.10	-1.30	0.000741
78	-22.98	21.98	-1.0	0.000794

11.3 Screen shots



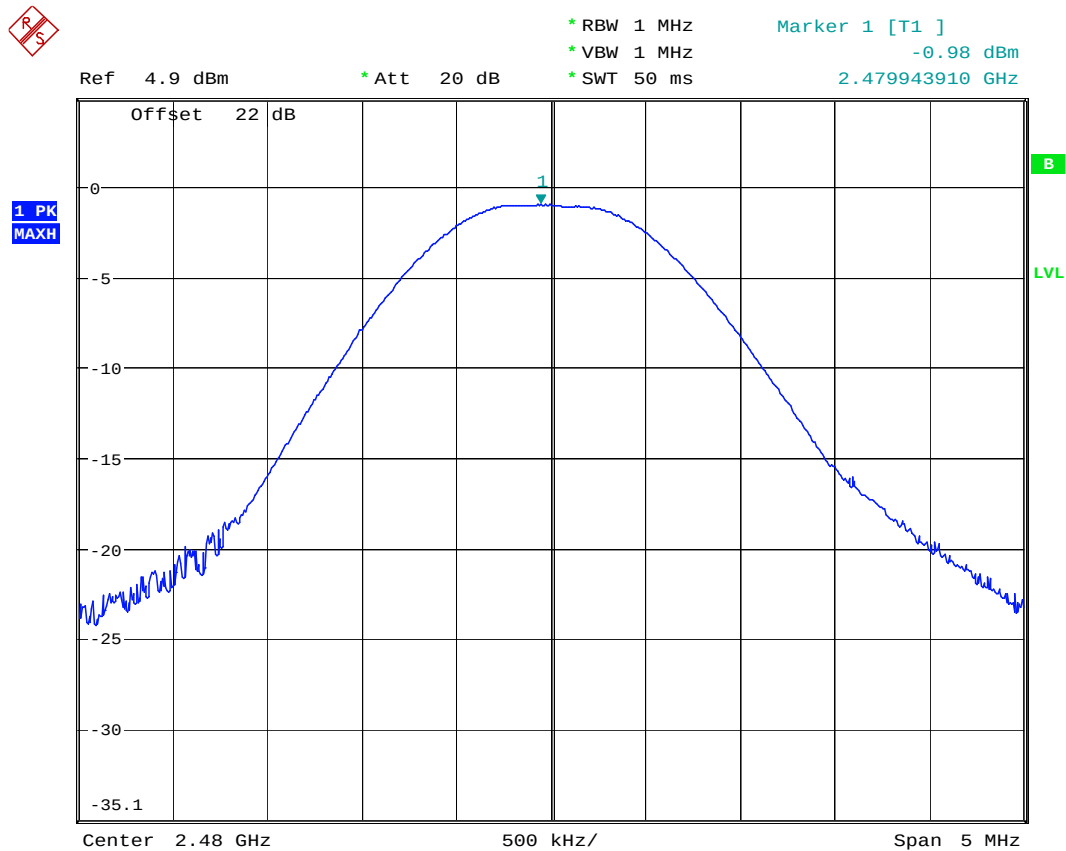
Date: 17.FEB.2004 12:16:05

Figure 14 Peak output power on channel 0



Date: 17.FEB.2004 12:11:38

Figure 15 Peak output power on channel 38



Date: 17.FEB.2004 12:14:06

Figure 16 Peak output power on channel 78

12 BAND-EDGE COMPLIANCE OF RF CONDUCTED EMISSIONS

12.1 Hopping enabled

EUT	3389		
Accessories	3377, 3386		
Test setup	A		
Temp, Humidity, Air Pressure	20°C	45 %RH	1026 mbar
Date of measurement	13.2.2004		
FCC rule part	§15.247 (c) (1)		
RSS-210 section	6.2.2 (o), e1		
Measured by	Jan-Erik Lilja		
Result	PASS		

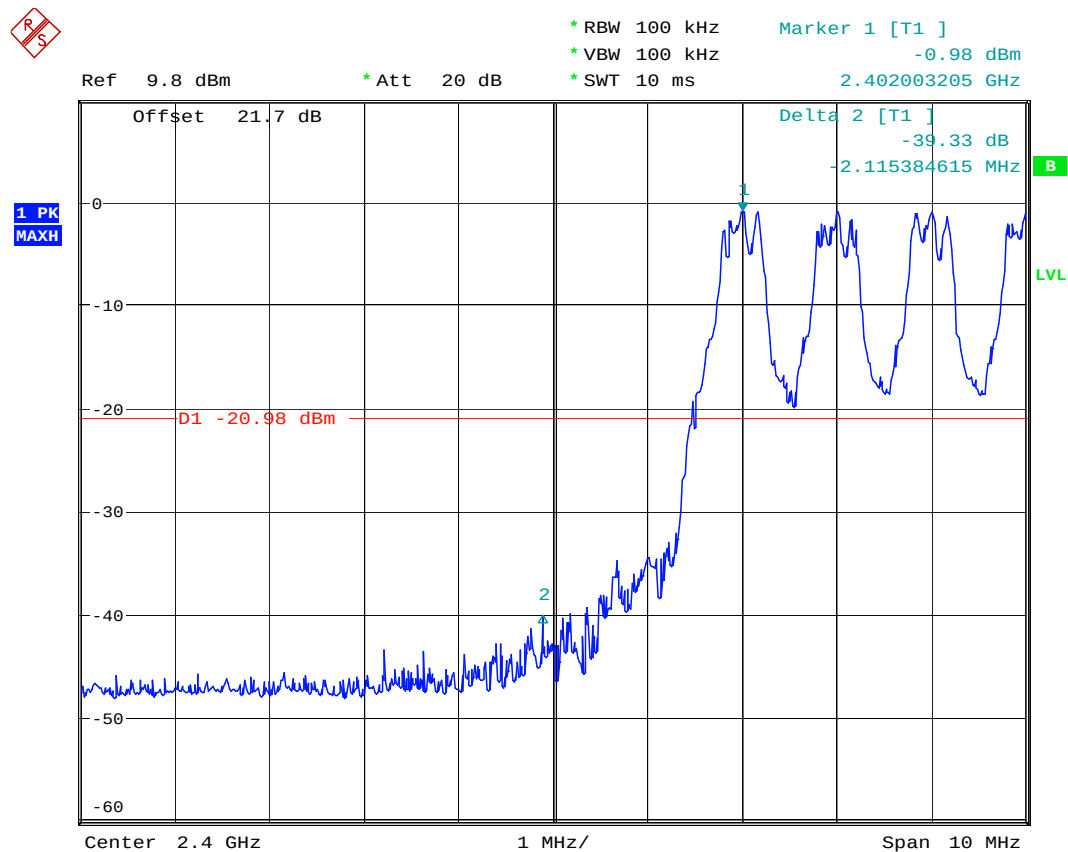
12.1.1 EUT operation mode

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

12.1.2 Limits and results

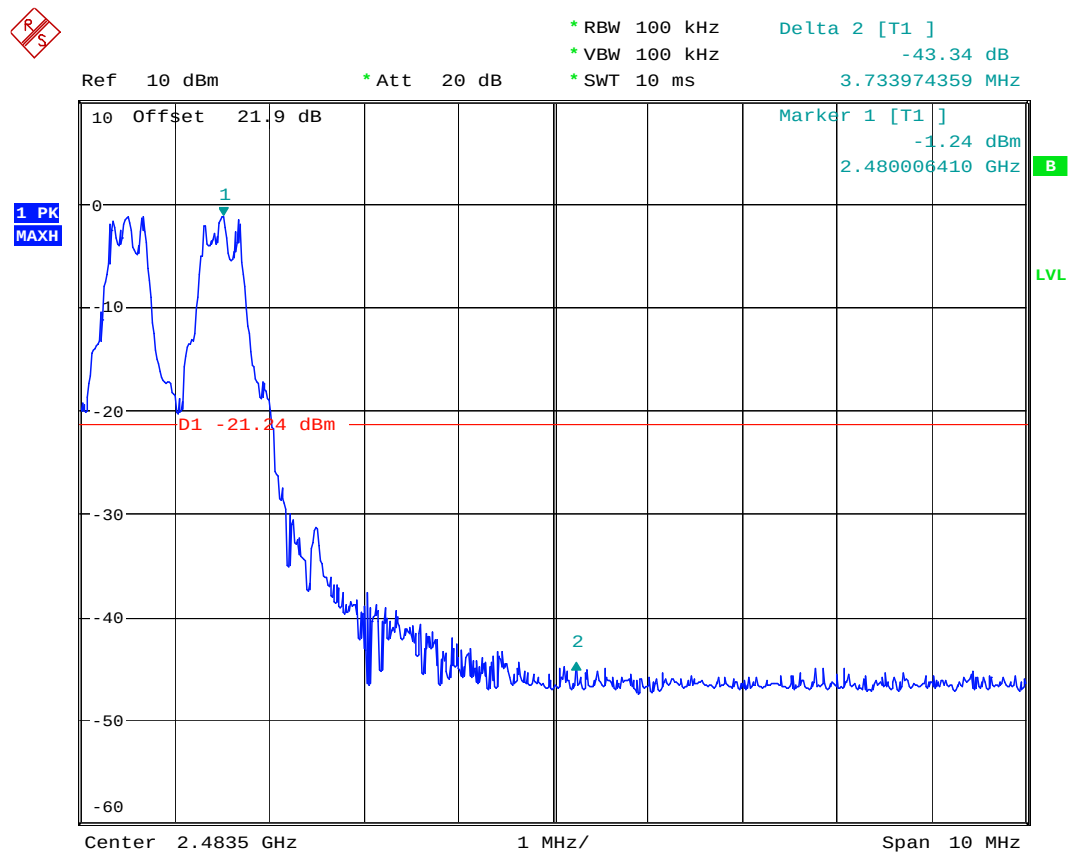
Channel	Limit (dBc)	Result (dBc)
0	≤ -20	-39.33
78		-43.34

12.1.3 Screen shots



Date: 13.FEB.2004 13:09:12

Figure 17 Bandedge compliance, low end



Date: 13.FEB.2004 13:02:03

Figure 18 Bandedge compliance, high end

12.2 Hopping disabled

EUT	3396		
Accessories	3377, 3386		
Test setup	A		
Temp, Humidity, Air Pressure	20 °C	45%RH	1017 mbar
Date of measurement	16.2.2004		
FCC rule part	§15.247 (c) (1)		
RSS-210 section	6.2.2 (o), e1		
Measured by	Jan-Erik Lilja		
Result	PASS		

12.2.1 Test method

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

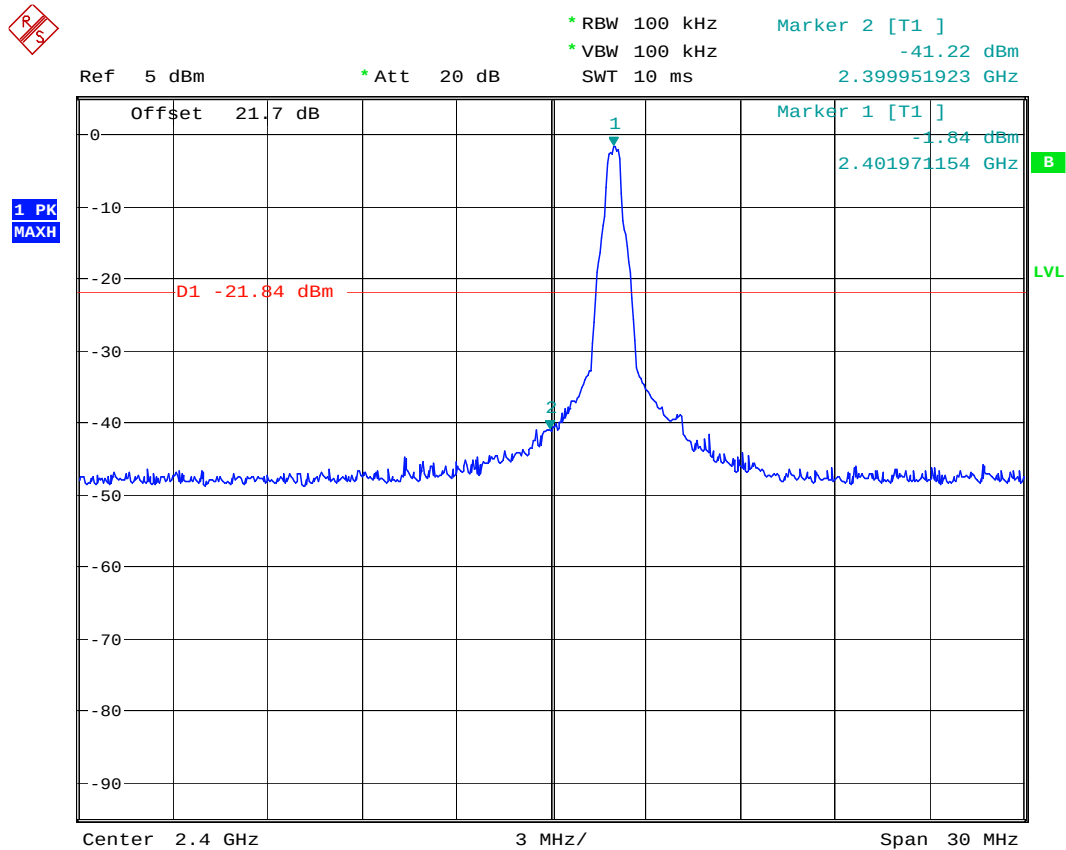
12.2.2 EUT operation mode

EUT operation mode	Connection, Static PRBS, DH5 packet type
EUT channel	0 and 78
EUT TX power level	Nominal

12.2.3 Limits and results

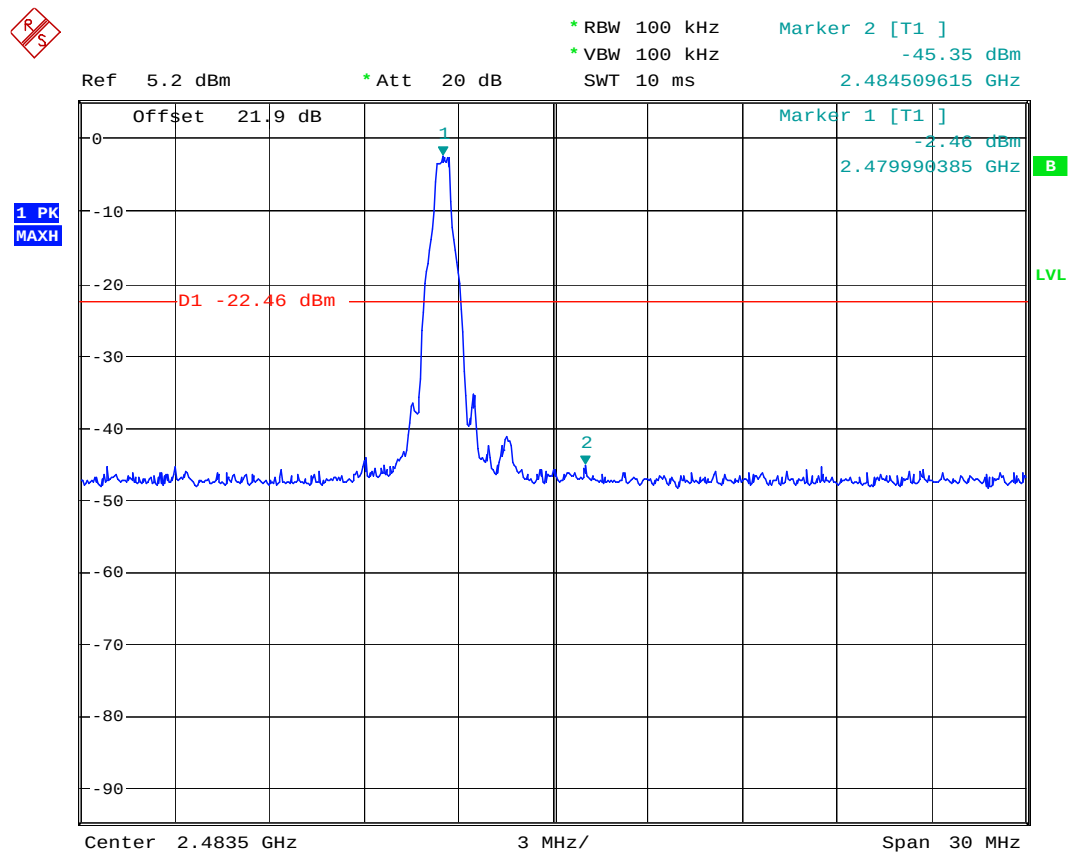
Channel	Limit (dBc)	Result (dBc)
0	≤ -20	-39.98
78		-42.89

12.2.4 Screen shots



Date: 16.FEB.2004 13:07:54

Figure 19 Bandedge compliance, low end



Date: 16.FEB.2004 13:15:31

Figure 20 Bandedge compliance, high end

13 AC POWERLINE CONDUCTED EMISSIONS

EUT	3390
Accessories	3377, 3378, 3395
Test setup	-
Temp, Humidity, Air Pressure	18 °C 52 %RH 990 mbar
Date of measurement	26.2.2004
FCC rule part	§15.207
RSS-210 section	6.6
Measured by	Jan-Erik Lilja, Jari Jantunen
Result	PASS

13.1 Test setup

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

13.2 EUT operation mode

EUT operation mode	BT Connection, Static PRBS, DH5 packet type
EUT channel	38
EUT TX power level	Nominal
EUT operation voltage	115VAC/60Hz

13.3 Limit

Frequency band (MHz)	Quasi-peak limit (dB μ V)	Average limit (dB μ V)
0.15 – 0.5	66 – 56	56 – 46
0.5 – 5	56	46
5 – 30	60	50

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.

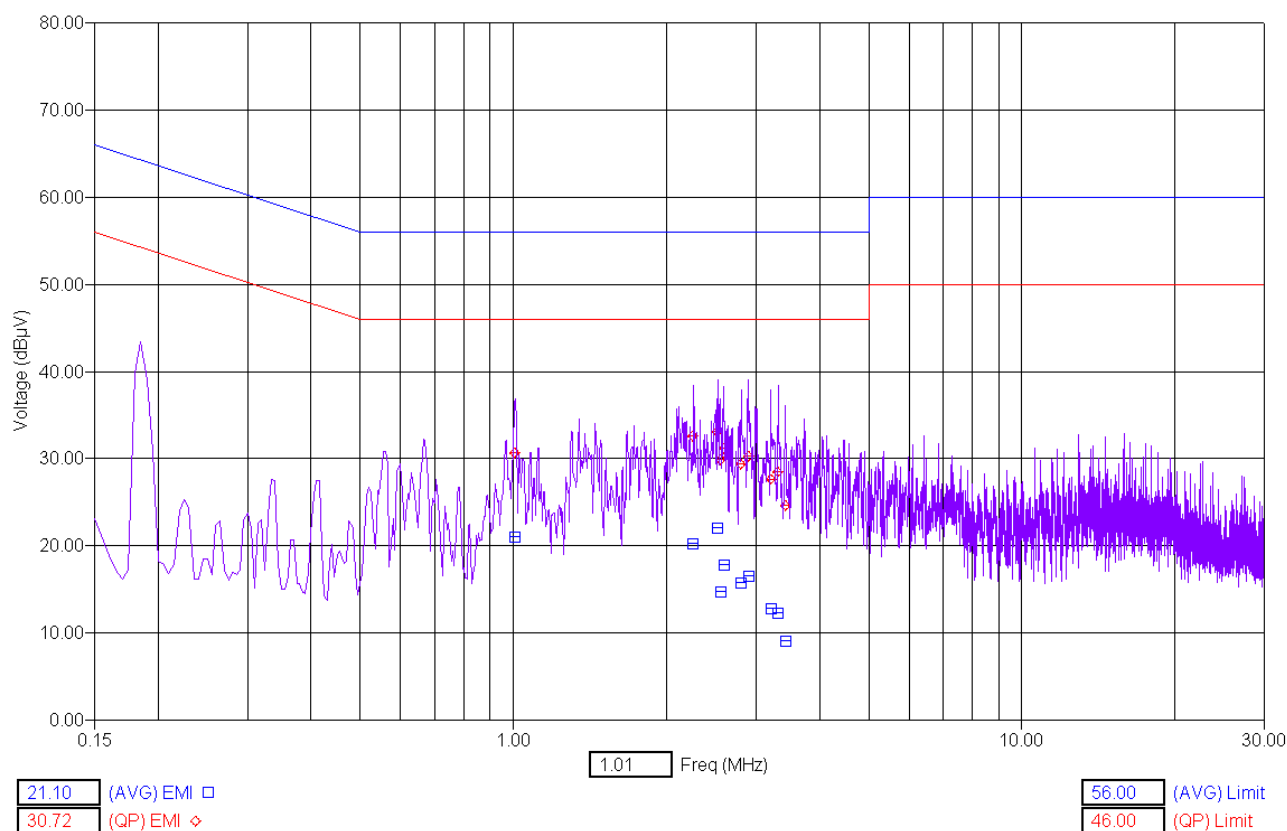


Figure 21 AC powerline emissions, line L

Table 2 Highest emissions, line L

Freq (Max) (MHz)	[QP] EMI (dBμV)	[AVG] EMI (dBμV)	Limit (dBμV)	[QP] Margin (dB)	[AVG] Margin (dB)
1.01	16.76	0.84	48.00	-31.24	-47.16
2.26	19.15	2.58	48.00	-28.85	-45.42
2.53	19.74	2.71	48.00	-28.26	-45.29
2.55	19.79	2.79	48.00	-28.21	-45.21
2.59	19.79	2.78	48.00	-28.21	-45.22
2.81	15.39	1.21	48.00	-32.61	-46.79
2.89	31.71	17.27	48.00	-16.29	-30.73
3.20	31.11	23.21	48.00	-16.89	-24.79
3.33	29.85	18.77	48.00	-18.15	-29.23
3.42	28.12	13.47	48.00	-19.88	-34.53

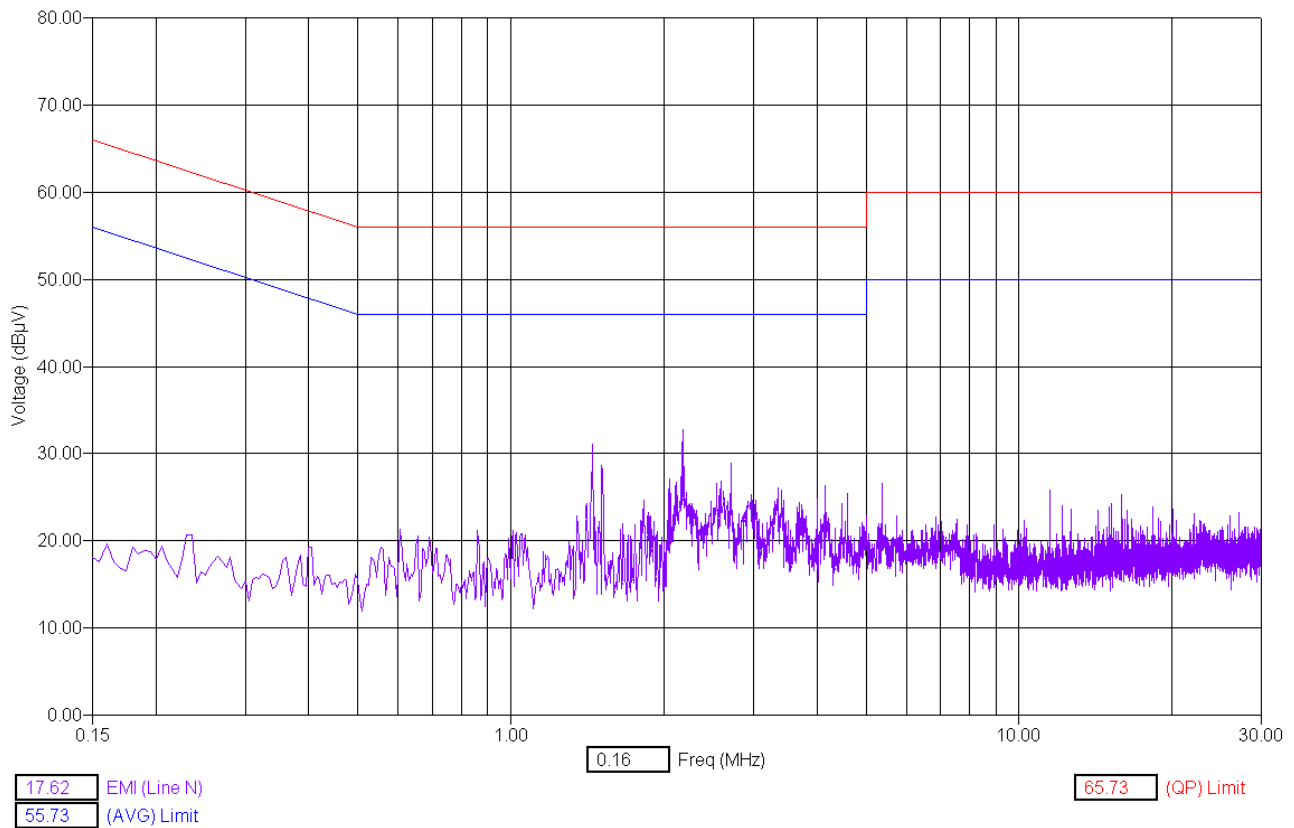


Figure 22 AC powerline emissions, line N

14 SPURIOUS RF CONDUCTED EMISSIONS

EUT	3396		
Accessories	3394, 3393		
Test setup	A		
Temp, Humidity, Air Pressure	22°C	42 %RH	999mbar
Date of measurement	27.2.2004		
FCC rule part	§15.247 (c) (2)		
RSS-210 section	6.2.2 (o), e1		
Measured by	Jan-Erik Lilja		
Result	PASS		

14.1 EUT operation mode

EUT operation mode	BT Connection, Static PRBS, DH5 packet type
EUT channel	0, 38 and 78
EUT TX power level	Nominal

14.2 Limits and results

EUT Channel	Limit (dBc)	Result (dBc)
0	≤ -20	-44.25
38		-48.88
78		-40.00

Tampere

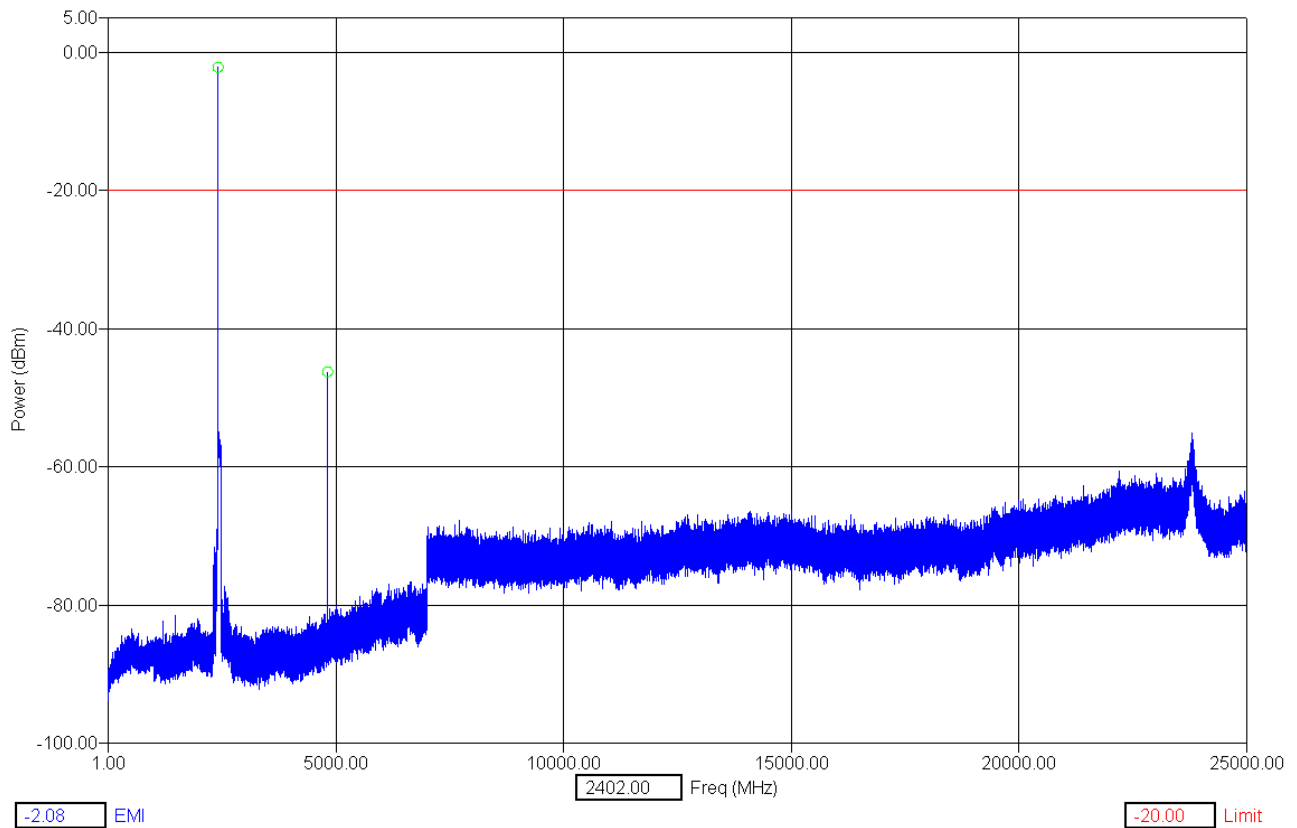


Figure 23 Spurious RF conducted emissions, TX on channel 0

Tampere

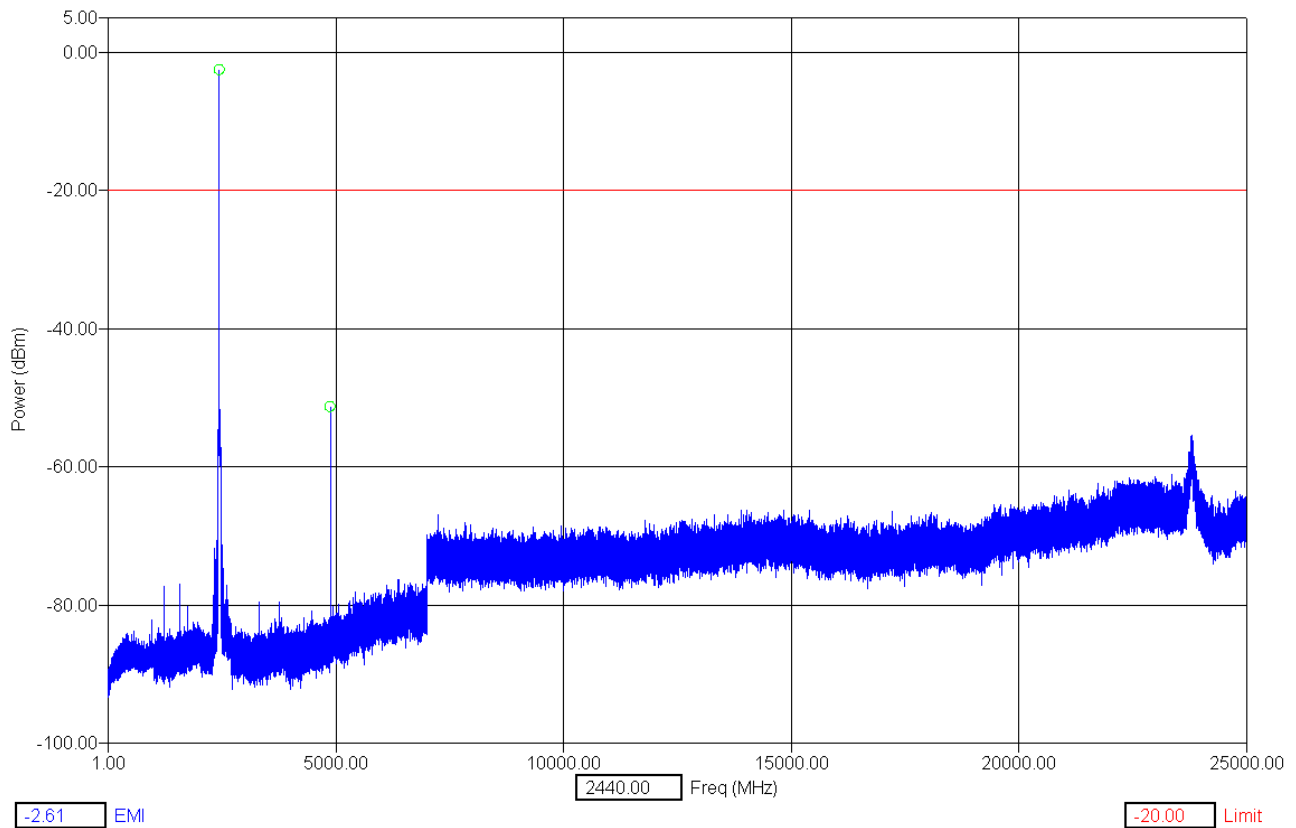


Figure 24 Spurious RF conducted emissions, TX on channel 38

Tampere

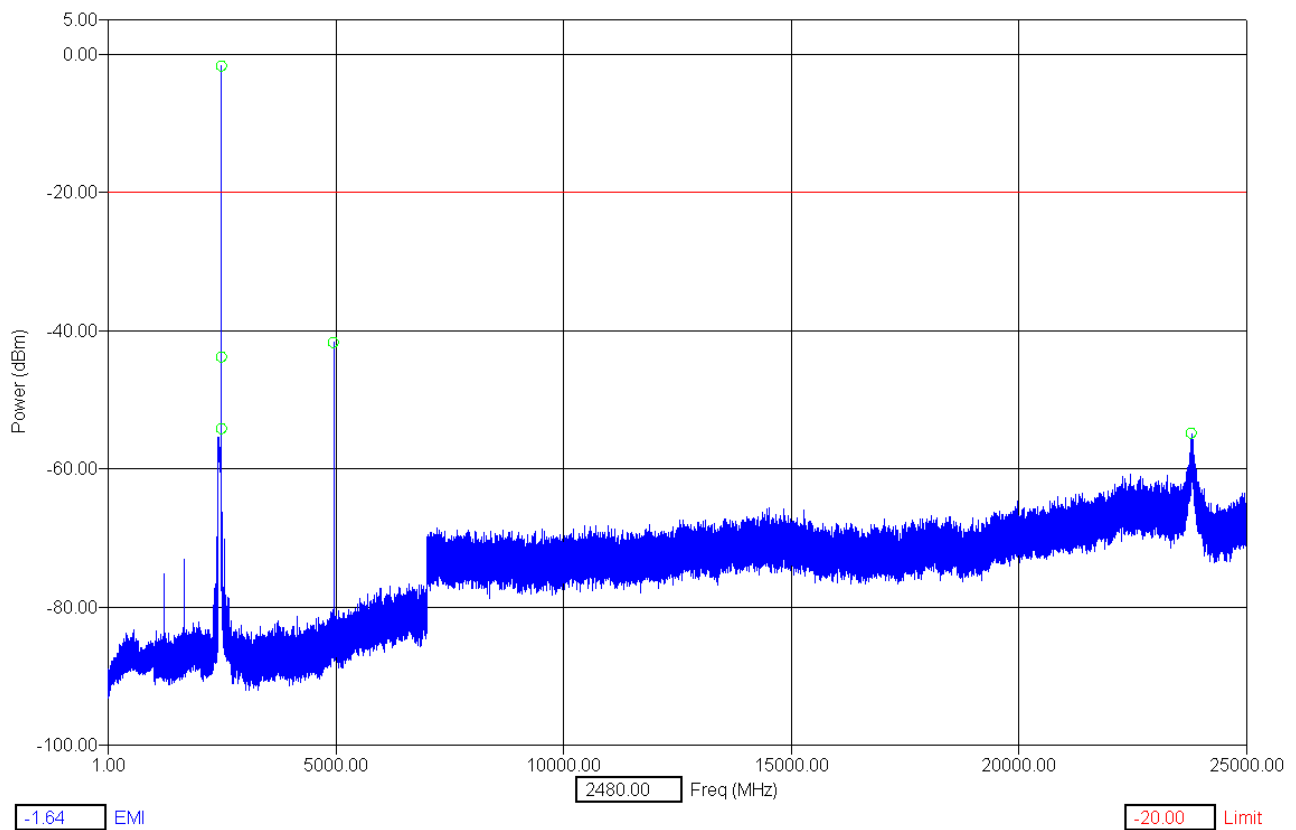


Figure 25 Spurious RF conducted emissions, TX on channel 78

15 SPURIOUS RADIATED EMISSIONS

EUT	3390
Accessories	3395,3377, 3378
Test setup	B
Temp, Humidity, Air Pressure	19 °C 45 %RH 1006 mbar
Date of measurement	23.2.2004
FCC rule part	§15.247 (c) (1)
RSS-210 section	6.2.2 (o), e1
Measured by	Jari Jantunen
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.
- 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	BT Connection, Static PRBS, DH5 packet type
EUT channel	0, 38 and 78
EUT TX power level	Nominal
EUT operation voltage	115 V

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 - 25000	500	54.0	Av
1000 - 25000	5000	74.0	Pk

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

Table 3 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]
4804	41.32	V	PK	19.27	29.96	33.39	74	9.54	54.48
4804	27.10	V	AV	19.27	29.96	33.39	54	9.54	40.26
7206	42.53	V	PK	23.48	28.72	36.95	74	9.54	65.70
7206	27.28	V	AV	23.48	28.72	36.95	54	9.54	49.45

Table 4 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]
4880	42.25	V	PK	19.53	30.02	33.82	74	9.54	56.04
4880	28.06	V	AV	19.53	30.02	33.82	54	9.54	41.85
7320	40.84	V	PK	23.45	27.36	37.34	74	9.54	64.73
7320	26.90	V	AV	23.45	27.36	37.34	54	9.54	50.79

Table 5 Emission levels, TX on channel 78

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	43.56	V	PK	19.66	29.81	34.15	74	9.54	58.02
4960	29.08	V	AV	19.66	29.81	34.15	54	9.54	43.54
7440	40.71	V	PK	23.61	28.33	37.45	74	9.54	63.90
7440	26.49	V	AV	23.61	28.33	37.45	54	9.54	49.68

16 TEST EQUIPMENT

Each test equipment is calibrated once a year.

16.1 Conducted measurements

Equipment	Manufacturer	Model
EMI receiver	Rohde & Schwarz	FSU26
Radio communication tester	Rohde & Schwarz	CMU-200
Attenuator 10 dB	Huber+Suhner AG	6251.17.A
Power splitter	Hewlett-Packard	11667A
Temperature chamber	Vötsch	VT4002
DC power supply	Hewlett&Packard	6632A
Multimeter	Hewlett&Packard	34401A

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

For test setup photographs, see " NHL-12 Test setup photographs.doc ".