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Test report	**: 03/417/3**
Item tested	**: BeoCom 1/BeoLine**
Type of equipment	**: Frequency Hopping Transmitter**
Client	**: Bang & Olufsen Telecom A/S**

Tested according to : **FCC part 15, subpart C**
Frequency Hopping Transmitters
2400 - 2483.5 MHz

Date of issue : 30 September 2002

Authorised by : .....
Kjell G. Haga
Managing Director

.....
Frode Sveinsen
Technical Supervisor

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1 GENERAL INFORMATION

1.1 Testhouse Info

Name :	Nemko Comlab AS
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Managing Director:	Kjell G. Haga

1.2 Client Information

Name :	Bang & Olufsen Telecom A/S
Address :	Kjeldmarksvej 1, DK-2600 STRUER, DENMARK
Telephone :	+45 9684 4400
Fax :	+45 9684 4401

Contact:

Name :	Lars Nielsen
Telephone :	+45 9684 4612
E-mail :	lne@bang-olufsen.dk

1.3 Manufacturer

Name :	Bang & Olufsen Telecom A/S
Address :	Kjeldmarksvej 1, DK-2600 STRUER, DENMARK
Telephone :	+ 45 9684 4400
Fax :	+ 45 9684 4401
E-mail :	lne@bang-olufsen.dk

2 Test Information

2.1 Tested Item

Name :	Bang & Olufsen
FCC ID :	BV5BEOCOM1
Model/version :	Fixed part: BeoLine, Portable part: BeoCom 1
Serial number :	Portable Part: 17390807, Fixed Part: 10
Hardware identity and/or version:	26.06
Software identity and/or version :	None
Frequency Range :	2400 - 2483.5 MHz
Tunable Bands :	1
Number of Channels :	79[1]
Modulation :	GFSK
Emissions Designator :	1MF1D
User Frequency Adjustment :	None, Software controlled.
Rated Output Power :	250 mW

1) 75 channels in use.

Theory of Operation

The EUT is based on DECT the ETSI standards EN 300 175-1 to EN 300 175-8. The system is improved by implementing extra features to combat interference at 2.4 GHz. The system is implemented with unique IDs and encryption based on DECT, EN 300 175-6 V1.7.0.

2.2 Test Environment

2.2.1 Normal test condition

Temperature:	20 - 23 °C
Relative humidity:	30 - 50 %
Normal test voltage:	115 V AC

The values are the limit registered during the test period.

2.3 Test Period

Item received date: 2003-05-27

Test period : from 2003-06-16 to 2003-09-29

3 TEST REPORT SUMMARY

3.1 General

Manufacturer: Bang & Olufsen

Model No.: BeoCom 1

Serial No.: None

All measurements are tracable to national standards.

The tests were conducted for the purpose of demonstrating compliance with Part 15, Subpart C, Paragraph 15.247 for Frequency Hopping Spread Spectrum devices. Radiated tests were conducted in accordance with ANSI C63.4-1992. Radiated tests were made in a semi-anechoic chamber at measuring distances of 3 and 10 metres. A description of the test site is on file with the FCC (FCC ID: 994405).

☒ New Submission ☒ Production Unit

☐ Class II Permissive Change ☐ Pre-production Unit

DSS Equipment Code ☐ Family Listing

THIS TEST REPORT RELATES ONLY TO THE ITEM (S) TESTED.

Deviations from, additions to, or exclusions from the test specifications are described in "Summary of Test Data".

COMLAB

NEMKO COMLAB REF: 03/417/3

TESTED BY: Egil Hauger, Test engineer DATE: 30 September 2003

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3.2 Test Summary

Name of test	Paragraph #	Result
Powerline Conducted Emission	15.207(a)	Complies
Channel Separation	15.247(a)(1)	Complies
Pseudorandom Hopping Algorithm	15.247(a)(1)	Complies
Time of Occupancy	15.247(a)(1)(iii)	Complies
Occupied Bandwidth	15.247(a)(1)	Complies
Peak Power Output	15.247(b)	Complies
Spurious Emissions (Antenna Conducted)	15.247(c)	N/A[1]
Spurious Emissions (Radiated)	15.247(c)	Complies

[1] The tested equipment has integrated antennas only.

3.3 Description of modification for Modification Filing

Not Applicable.

3.4 Family List Rational

Not Applicable.

4 TEST RESULTS

4.1 Powerline Conducted Emissions

Para. No.: 15.207 (a)

Test Performed By: Egil Hauger	**Date of Test: 14-15 July 2003**

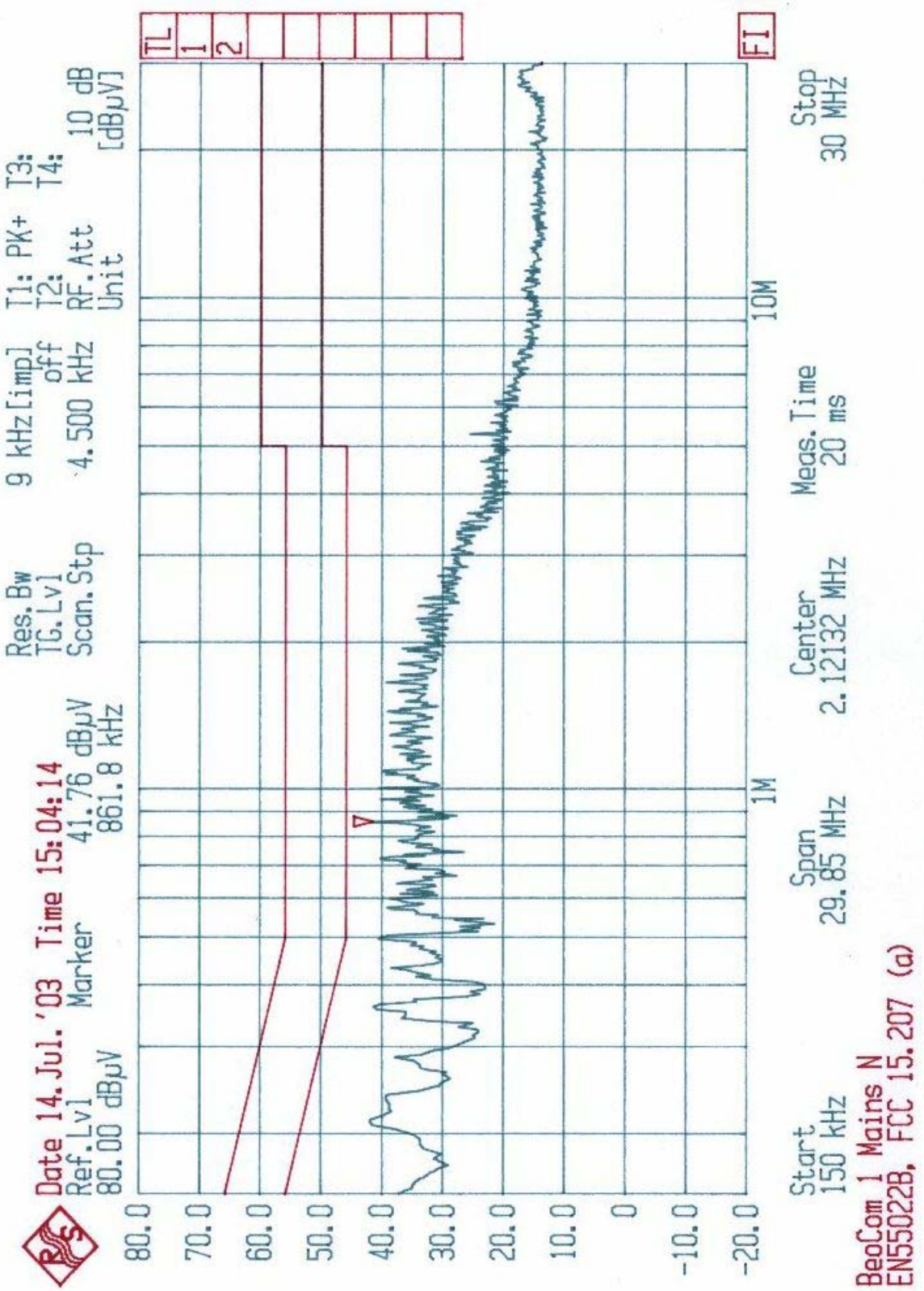
Measurement procedure: CISPR 22 1997 Clause 5.1 Class B ITE.

Test Results: **Complies.**

Measurement Data: **See attached graph, (Peak detector).**

Highest measured value:

Frequency	EUT	Line	Detector	Measured value	Limit	Margin
KHz	Portable/ Fixed	L1/ N	Peak/QP/AV	dBμV	dBμV	dB
861,8	Portable	N	Peak	41,7		
			QP	33,2	56	22,8
			AV	22,3	46	23,7
935	Portable	L1	Peak	45,8		
			QP	43,1	56	12,9
			Av	35,3	46	10,7
190,9	Fixed	N	Peak	44,8		
			QP	42,5	63,9	21,4
			Av	35,0	53,9	18,9
2650	Fixed	L1	Peak	41,6		
			QP	31,9	56	24,1
			AV	19,0	46	27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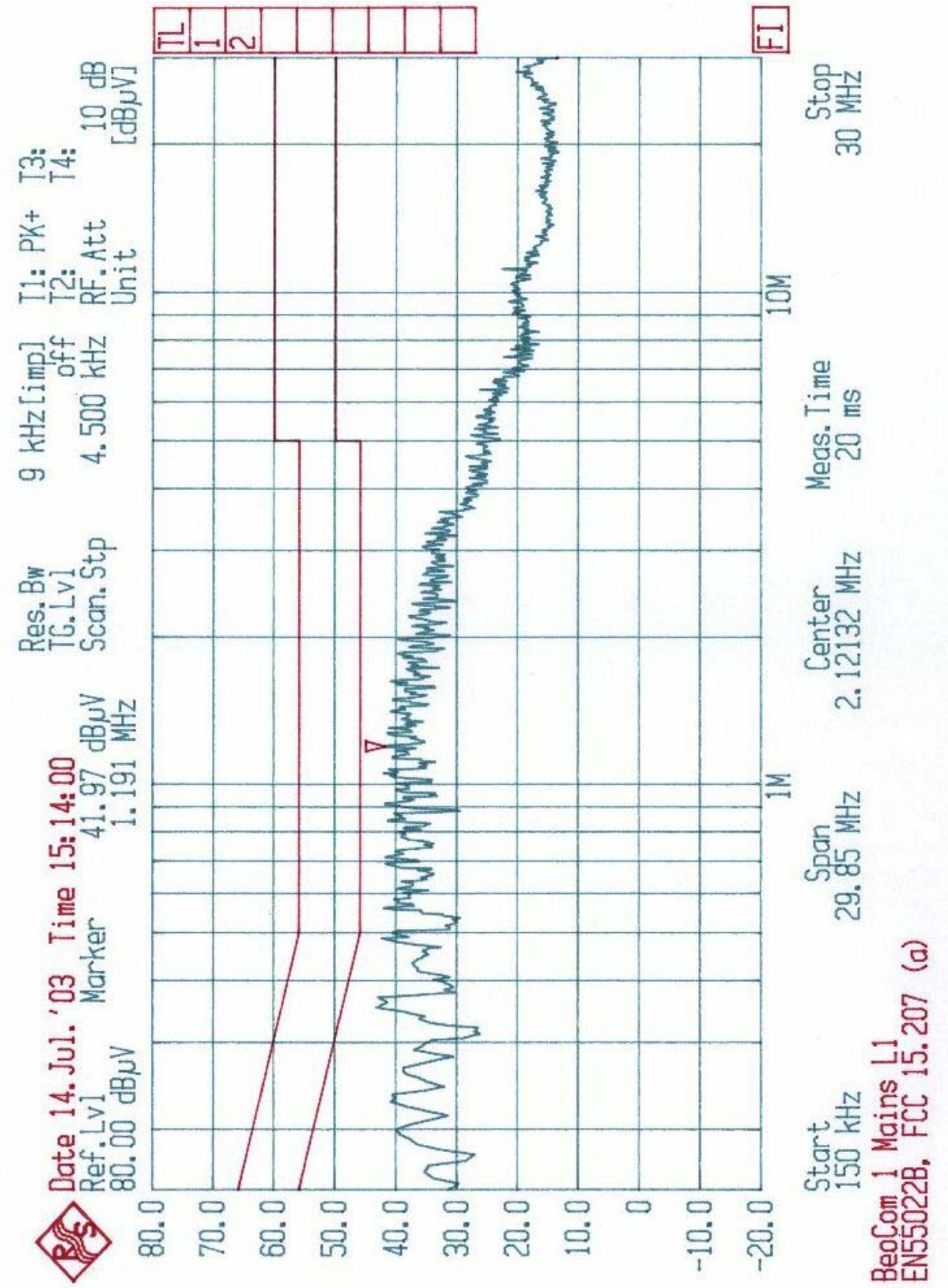
Ref.Lvl 80.00 dBµV
Marker 41.76 dBµV 861.8 kHz
Res.Bw 9 kHz[imp]
TG.Lvl off
Scan.Stp 4.500 kHz
T1: PK+
T2:
RF.Att
Unit
T3:
T4:
10 dB
[dBµV]
TL
1
2
FI
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
-10.0
-20.0
Start 150 kHz
1M
10M
Stop 30 MHz
Span 29.85 MHz
Center 2.12132 MHz
Meas.Time 20 ms
BeoCom 1 Mains N
EN55022B, FCC 15.207 (a)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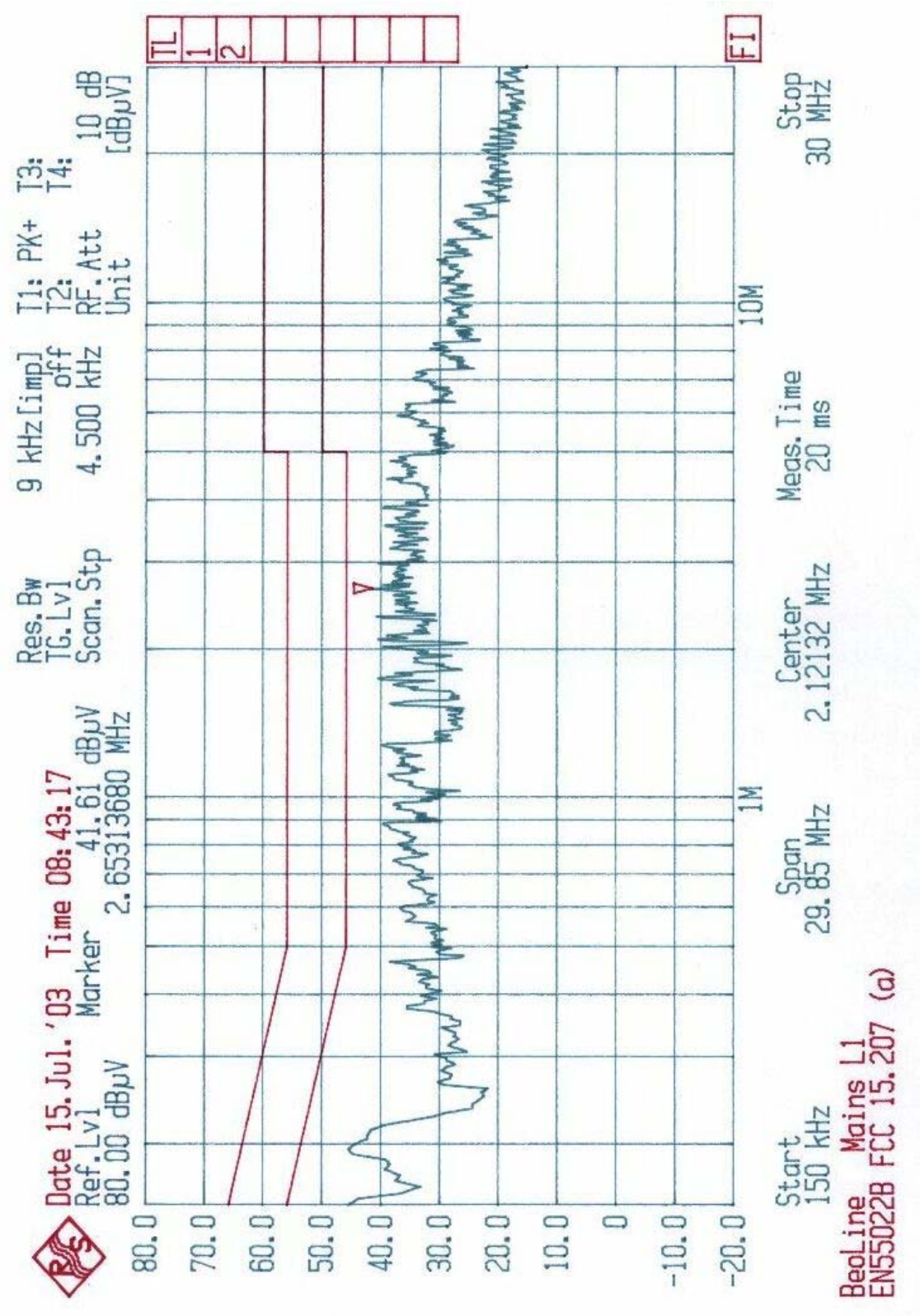
Ref.Lvl 80.00 dBµV
Marker 41.97 dBµV 1.191 MHz
Res.Bw 9 kHz[imp]
TG.Lvl off
Scan.Stp 4.500 kHz
T1: PK+
T2:
RF.Att 10 dB
Unit [dBµV]
T3:
T4:
TL
1
2
FI
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
-10.0
-20.0
1M
10M
Start 150 kHz
Span 29.85 MHz
Center 2.12132 MHz
Meas.Time 20 ms
Stop 30 MHz
BeoCom 1 Mains L1
EN55022B, FCC 15.207 (a)


Date 15.Jul.'03 Time 08:43:17
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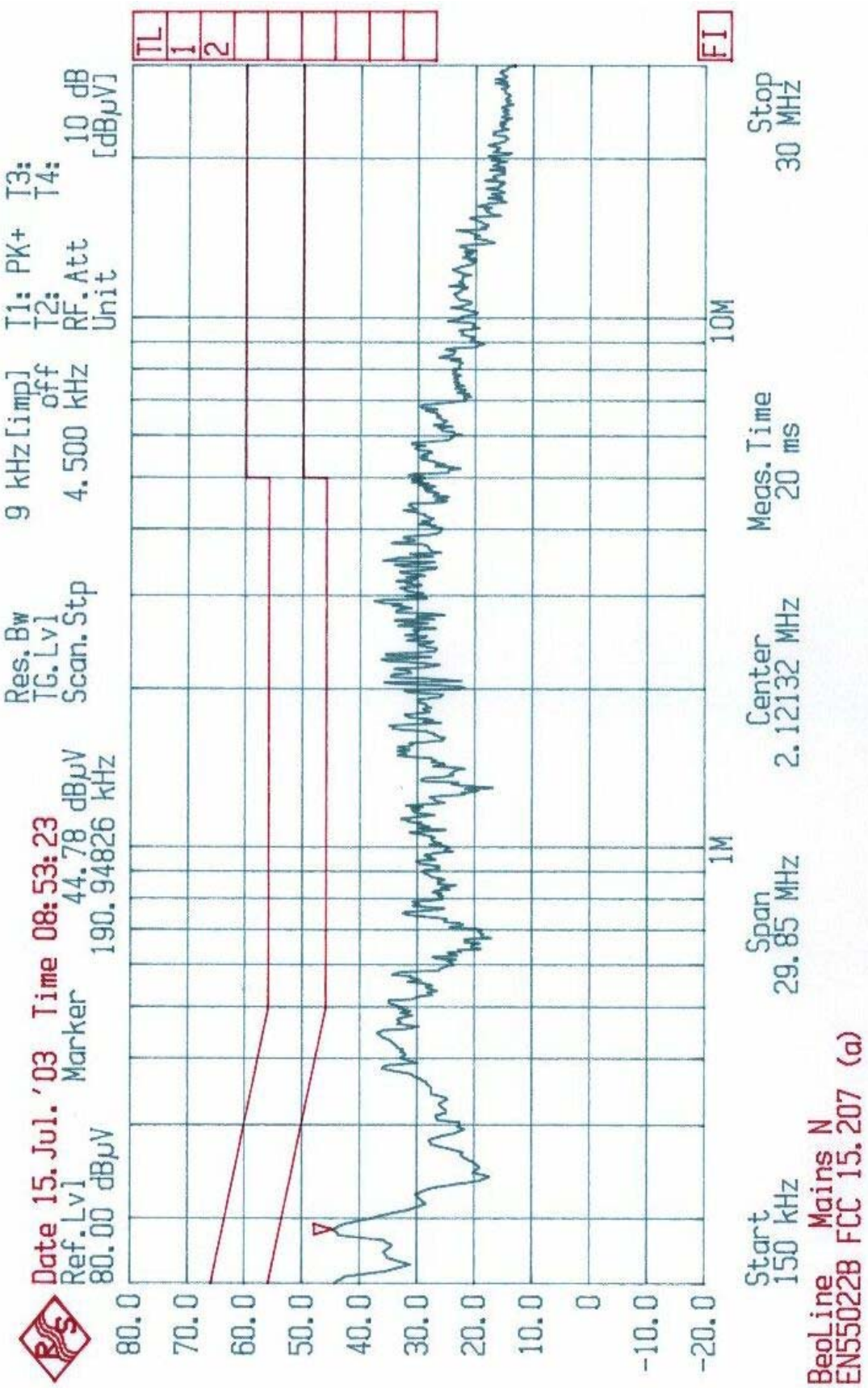
Marker 41.61 dBµV
2.65313680 MHz
Res.Bw 9 kHz [imp]
TG.Lvl off
Scan.Stp 4.500 kHz
T1: PK+
T2:
RF.Att 10 dB
Unit [dBµV]
T3:
T4:
TL
1
2
FI
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
-10.0
-20.0
Start 150 kHz
1M
10M
Stop 30 MHz
Span 29.85 MHz
Center 2.12132 MHz
Meas.Time 20 ms
BeoLine Mains L1
EN55022B FCC 15.207 (a)


Date 15.Jul.'03 Time 08:53:23
Ref.Lvl 80.00 dBµV
Marker 190.94826 kHz 44.78 dBµV
Res.Bw 9 kHz [imp]
TG.Lvl off
Scan.Stp 4.500 kHz
T1: PK+
T2: RF.Att 10 dB
Unit [dBµV]
T3:
T4:
TL 1 2
FI
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0
-10.0
-20.0
Start 150 kHz
1M
10M
Stop 30 MHz
Span 29.85 MHz
Center 2.12132 MHz
Meas.Time 20 ms
BeoLine Mains N
EN55022B FCC 15.207 (a)

4.2 Channel Separation

Para. No.: 15.247 (a)(1)

Test Performed By: Egil Hauger	**Date of Test: 22 September 2003**

Test Results: **Complies**

Measurement Data:

Channel Separation: 1,0249 MHz

20 dB Bandwidth of hopping channel: Fixed part: 986 MHz

Portable part: 970 MHz

RF channel (1 to 79) has no influence on 20 dB bandwidth.

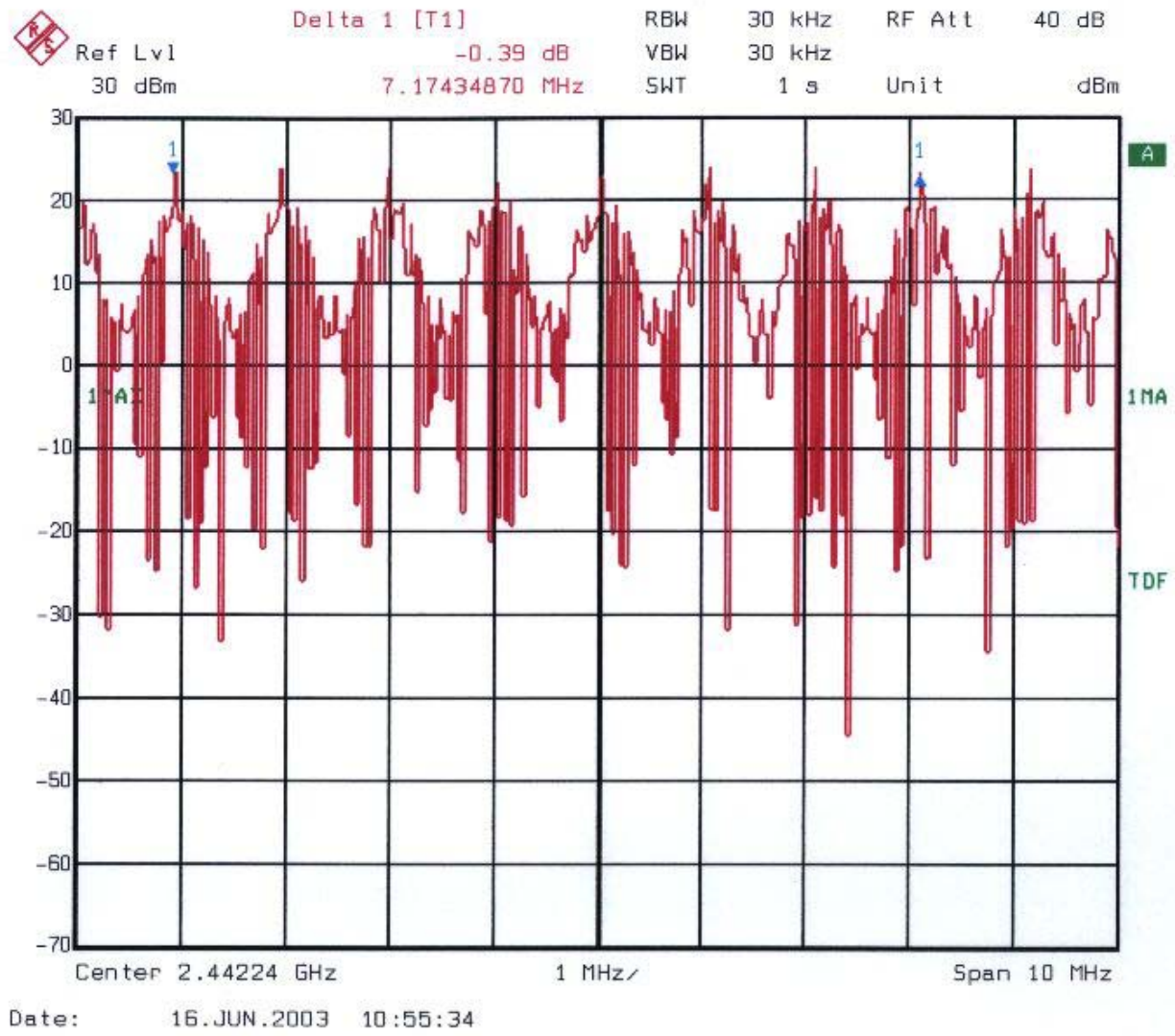
Comment: *In order to comply with the 20 dB BW requirement, the bitpattern in the synchronization field has been changed from 010101… to a pseudo-random pattern in the final version.*

See attached graph

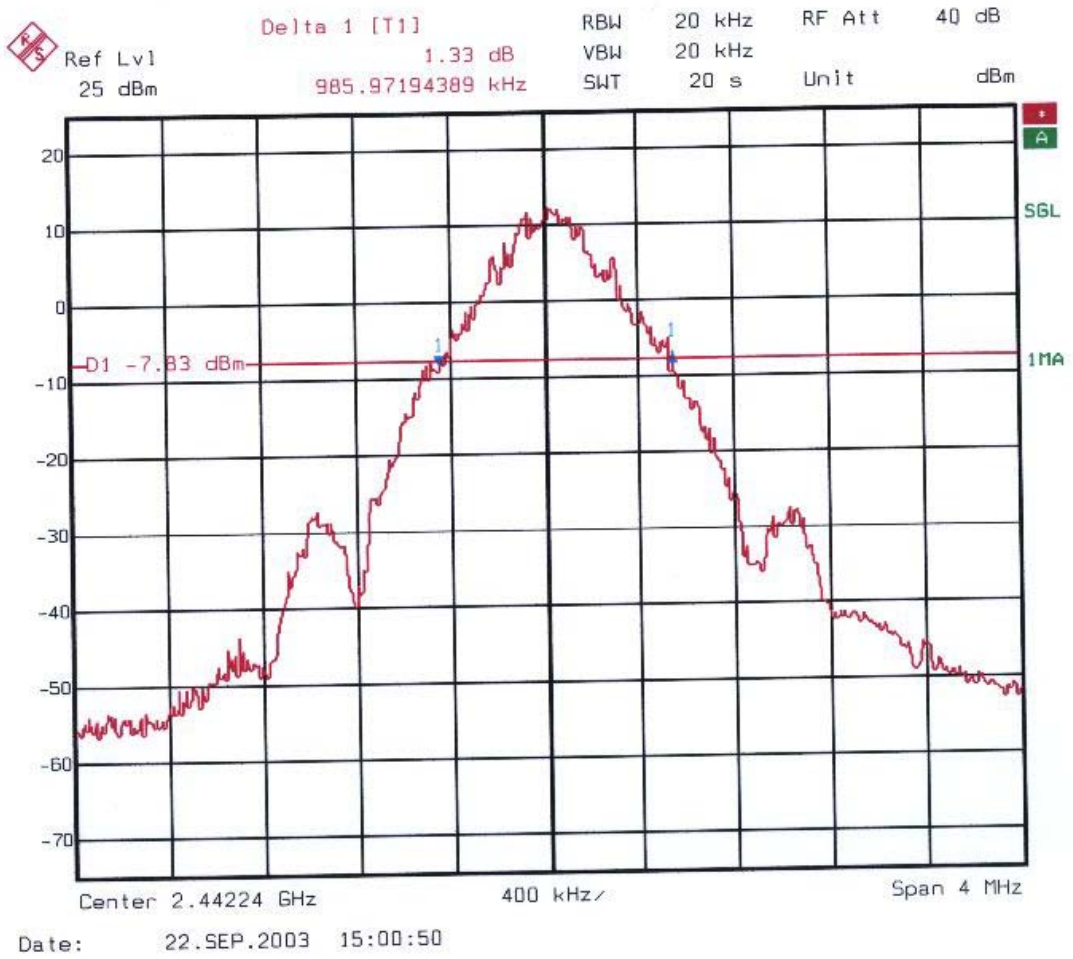
Channel Separation nominal value: 1,024 MHz.

Requirement:

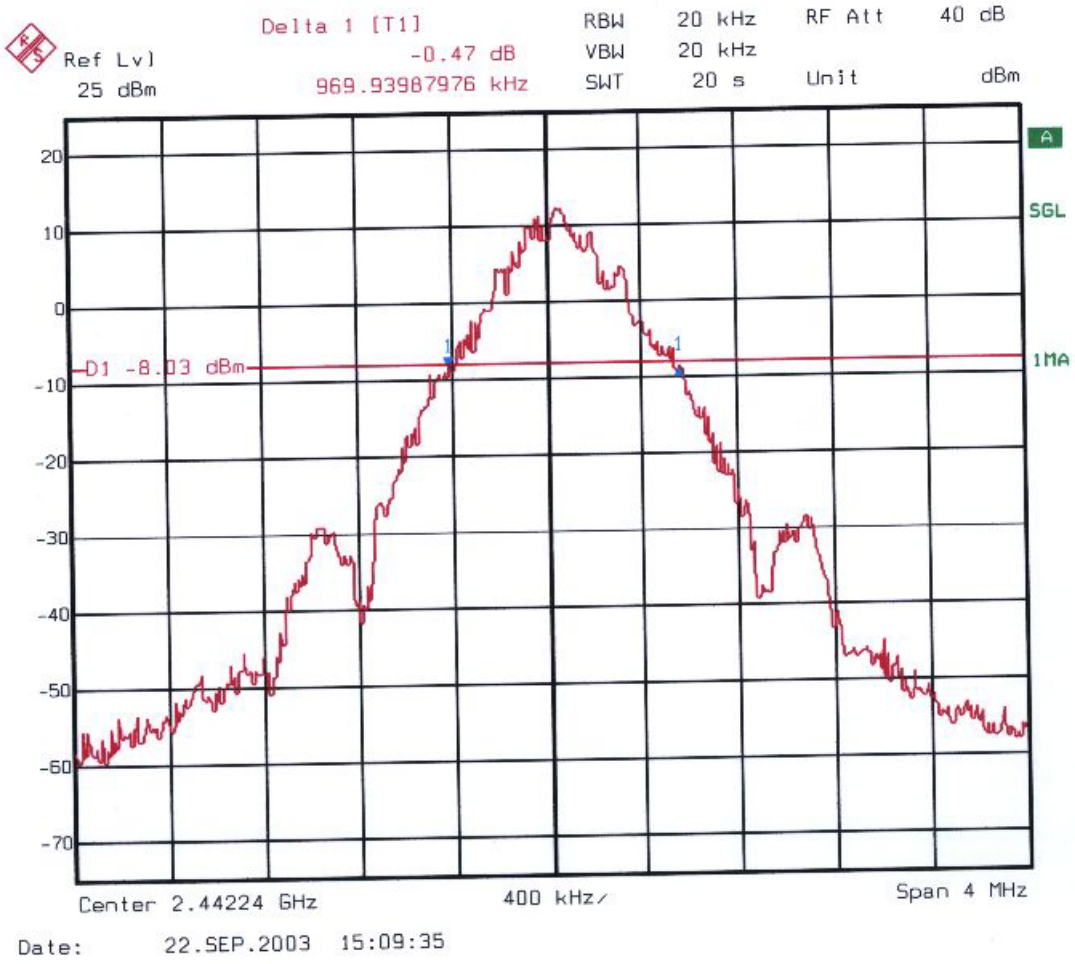
Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.



Channel separation



Occupied Bandwidth, Fixed part



Occupied Bandwidth, Portable part

4.3 Pseudorandom Hopping Algorithm

Para. No.: 15.247 (a)(1)

Test Performed By: Egil Hauger	**Date of Test: 29 September 2003**

Test Results: Complies

Measurement Data:

Requirements:

The channel frequencies shall be selected from a pseudorandom ordered list of hopping frequencies. Each frequency must be used equally by the transmitter.

Base Table Hopping Sequence

The following table, arranged as an 8 × 10 grid, is the base table for the hopping sequence. The sequence is 75 hops long.

	0	1	2	3	4	5	6	7	8	9
0	0	27	38	14	26	49	13	33	73	55
10	16	1	11	54	8	64	2	48	28	61
20	4	40	65	6	23	67	57	42	12	29
30	62	36	47	5	71	43	32	56	21	59
40	39	15	53	18	45	37	74	63	46	3
50	51	31	72	58	9	70	35	69	25	34
60	50	60	68	22	52	24	41	7	17	30
70	19	10	20	66	44					

4.4 Occupancy Time

Para. No.: 15.247 (a)(1)(iii)

Test Performed By: Egil Hauger	**Date of Test: 29 September 2003**

Test Results: Complies

Measurement Data: Number of RF channel: 75

RF burst pr channel: 444,9 µs

Time between each RF burst on same RF channel: 751,5 ms

Portable part: Time of occupancy: (444,9 µs/751,5 ms)*0,4*75 sec = 0,0177 s

Fixed part with one line OFF-HOOK: (444,9 µs/751,5 ms)*0,4*75 sec= 0,0177 s

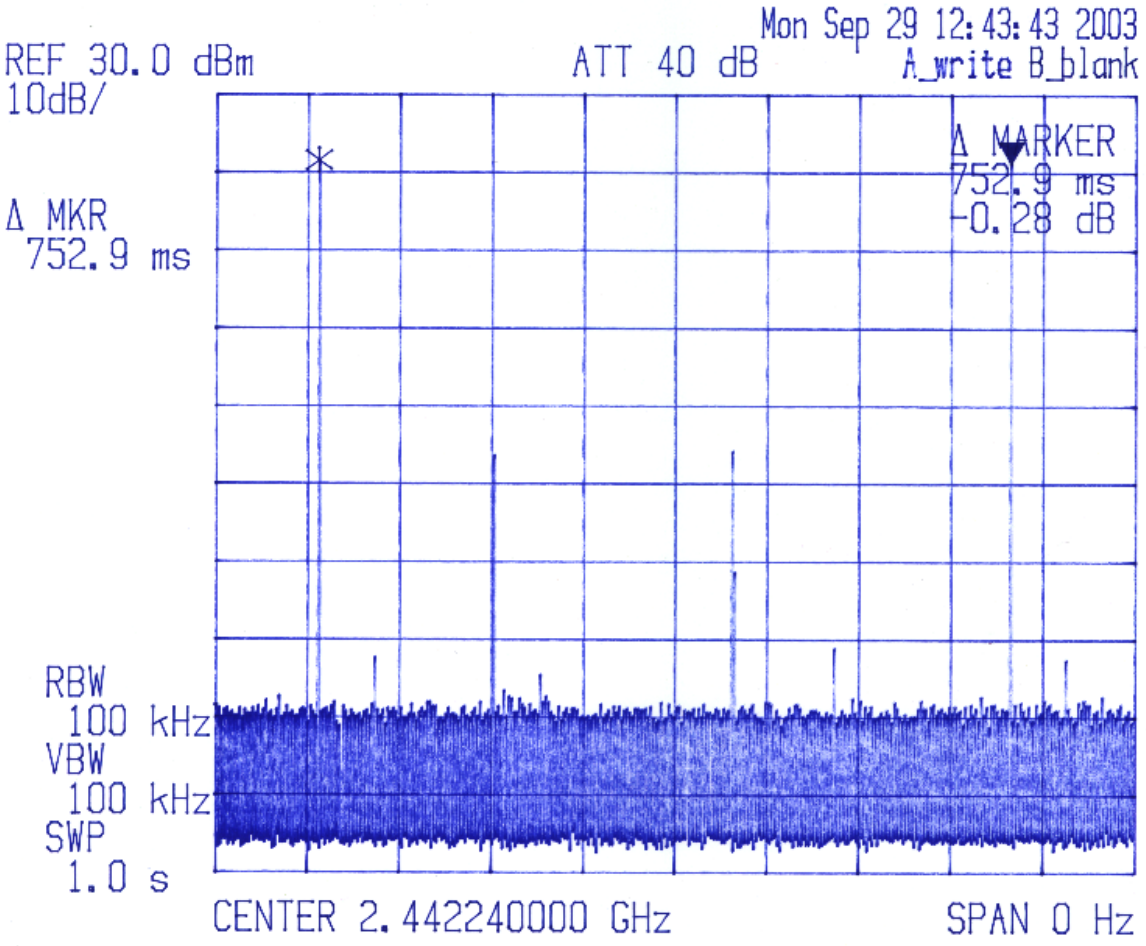
Fixed part with four line OFF-HOOK: (4*444,9 µs/751,5 ms)*0,4*75 sec= 0,071 s

The maximum number of lines fixed part can handle is four.

See attached graph.

Requirements:

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.


Mon Sep 29 12:43:43 2003
REF 30.0 dBm
10dB/
ATT 40 dB
A_write B_blank
Δ MARKER
752.9 ms
-0.28 dB
Δ MKR
752.9 ms
RBW
100 kHz
VBW
100 kHz
SWP
1.0 s
CENTER 2.442240000 GHz
SPAN 0 Hz

4.5 Occupied Bandwidth

Para. No.: 15.247 (a)(1)(iii)

Test Performed By: Egil Hauger	**Date of Test: 29. September 2003**

Test Results: Complies

Measurement Data: 75 RF channels in use

See attached graph.

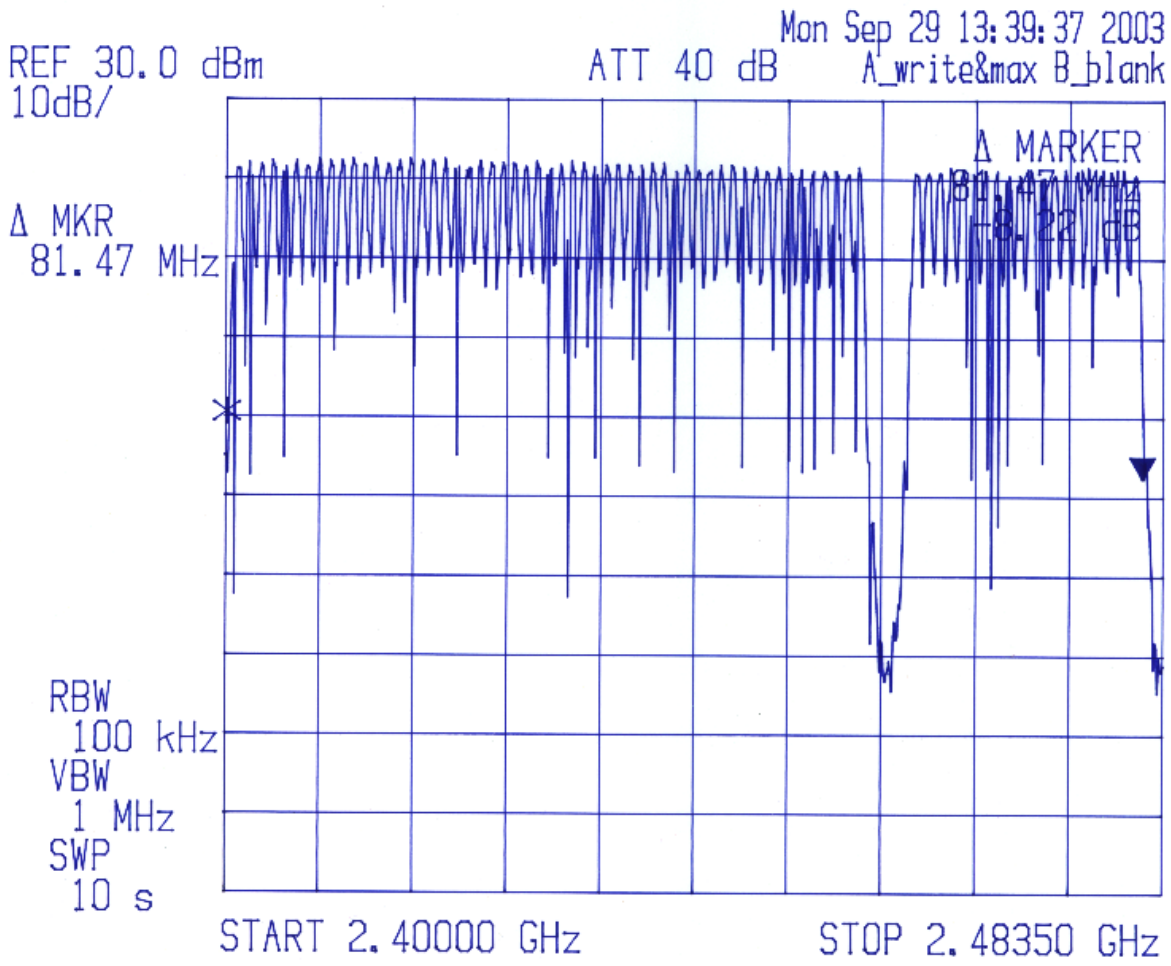
Requirements:

Frequency hopping systems in the 2400 - 2483.5 MHz band shall use at least 15 non-overlapping channels. No requirements for bandwidth for this frequency band.

Channel Centre Frequencies

The following table, arranged as a 10 × 8 grid, lists the 79 channel centre frequencies. The values are in MHz. Only 75 of the 79 are used at a time.

	0	1	2	3	4	5	6	7	8
0	2401,28000	2402,30400	2403,32800	2404,35200	2405,37600	2406,40000	2407,42400	2408,44800	2409,47200
1	2411,52000	2412,54400	2413,56800	2414,59200	2415,61600	2416,64000	2417,66400	2418,68800	2419,71200
2	2421,76000	2422,78400	2423,80800	2424,83200	2425,85600	2426,88000	2427,90400	2428,92800	2429,95200
3	2432,00000	2433,02400	2434,04800	2435,07200	2436,09600	2437,12000	2438,14400	2439,16800	2440,19200
4	2442,24000	2443,26400	2444,28800	2445,31200	2446,33600	2447,36000	2448,38400	2449,40800	2450,43200
5	2452,48000	2453,50400	2454,52800	2455,55200	2456,57600	2457,60000	2458,62400	2459,64800	2460,67200
6	2462,72000	2463,74400	2464,76800	2465,79200	2466,81600	2467,84000	2468,86400	2469,88800	2470,91200
7	2472,96000	2473,98400	2475,00800	2476,03200	2477,05600	2478,08000	2479,10400	2480,12800	2481,15200


Mon Sep 29 13:39:37 2003
REF 30.0 dBm
10dB/
ATT 40 dB
A_write&max B_blank
Δ MARKER
Δ MKR
81.47 MHz
RBW
100 kHz
VBW
1 MHz
SWP
10 s
START 2.40000 GHz
STOP 2.48350 GHz

4.6 Peak Power Output

Para. No.: 15.247 (b)

Test Performed By: Egil Hauger	**Date of Test: 29 September 2003**

Test Results: Complies

Measurement Data:

Maximum Conducted Peak Output Power, Watts

RF channel	1	41	79
Fixed part antenna 1	0,257	0,324	0,263
Fixed part antenna 2	0,200	0,277	0,204
Portable part	0,234	0,185	0,187

Power supply variation within 85 to 115 % of nominal value has no influence on Peak Output Power from fixed part.

See attached graph.

Detachable antenna? ☐ Yes ☒ No

If detachable, is the antenna connector non-standard? ☐ Yes ☐ No

Requirements:

The maximum peak output power for frequency hopping systems shall not exceed the following limits:

For systems employing at least 75 hopping channels: 1 watt

For all other frequency hopping systems in the 2400 - 2483.5 MHz band: 0.125 watts

If transmitting antennas of directional gain greater than 6 dBi are used, the peak output power from the intentional radiator shall be reduced below the stated value above by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Maximum Field Strength of Fundamental, Peak, mV/m.

Measuring distance: 3 m.

RF channel	1	41	79
Fixed part antenna 1	1195	1470	1586
Fixed part antenna 2	1140	1344	1145
Portable part	1144	1149	1154

Calculated maximum EIRP using free field formula:

Fixed part channel 79 antenna 1

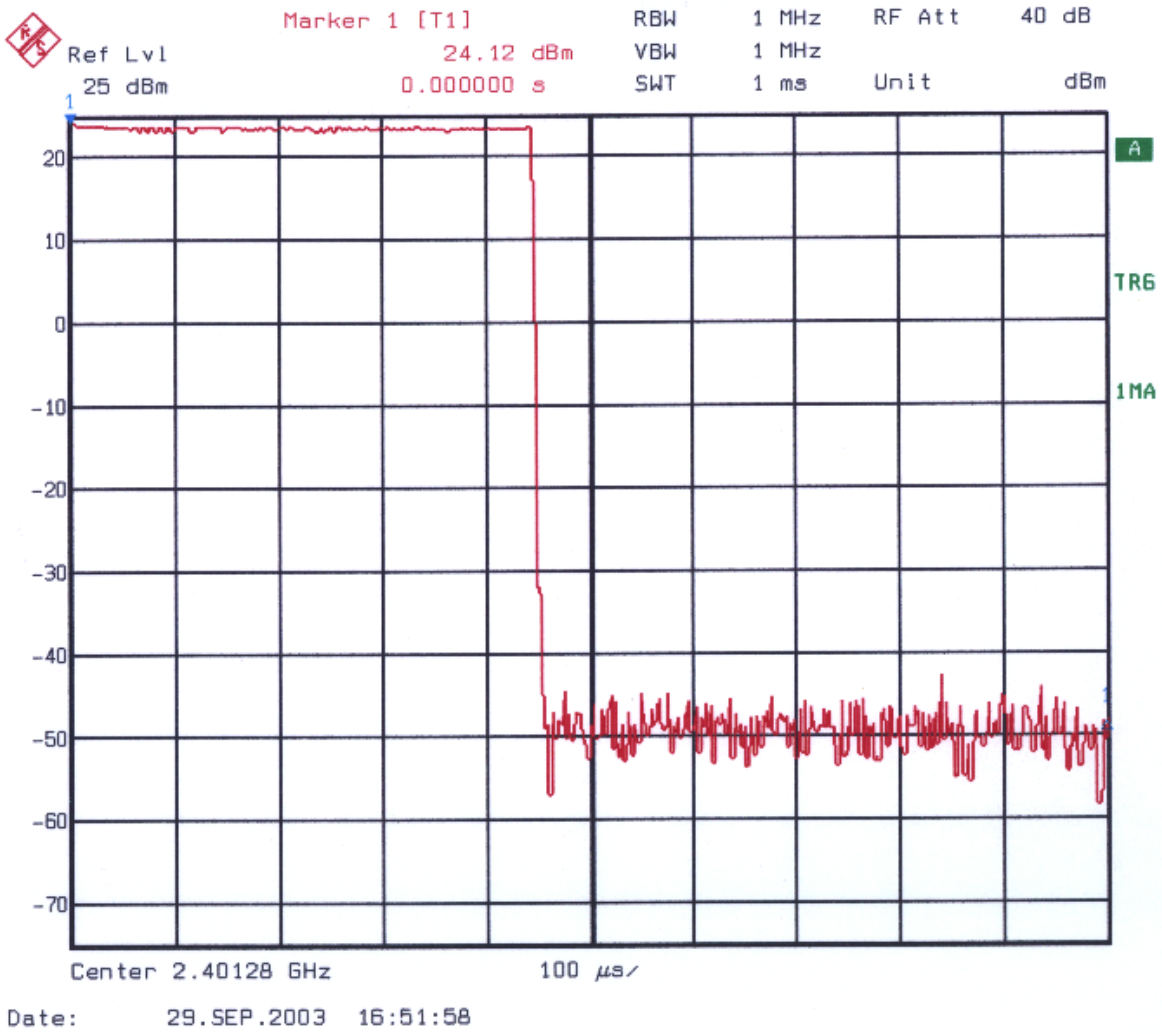
P (EIRP) watts = $(3*1,586)^2/30$ = 0,754 watts.

Portable part channel 79:

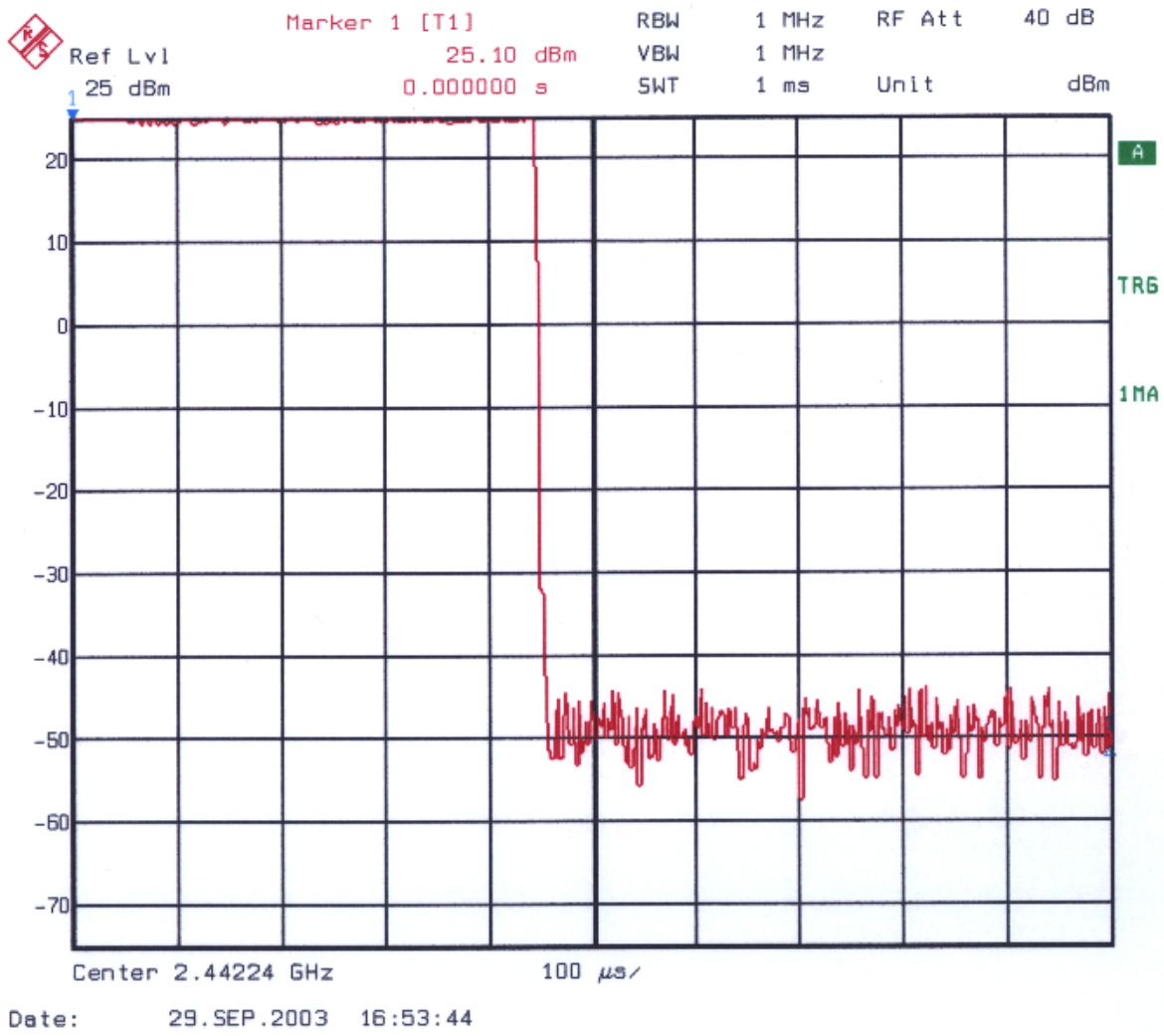
P (EIRP) watts = $(3*1,154)^2/30$ = 0,399 watts.

Antenna gain Fixed part: 10*log(0,754/0,263) = 4,6 dBi

Antenna gain Portable part: 10*log(0,399/0,187) = 3,3 dBi



Fixed part ch. 1 ant.1



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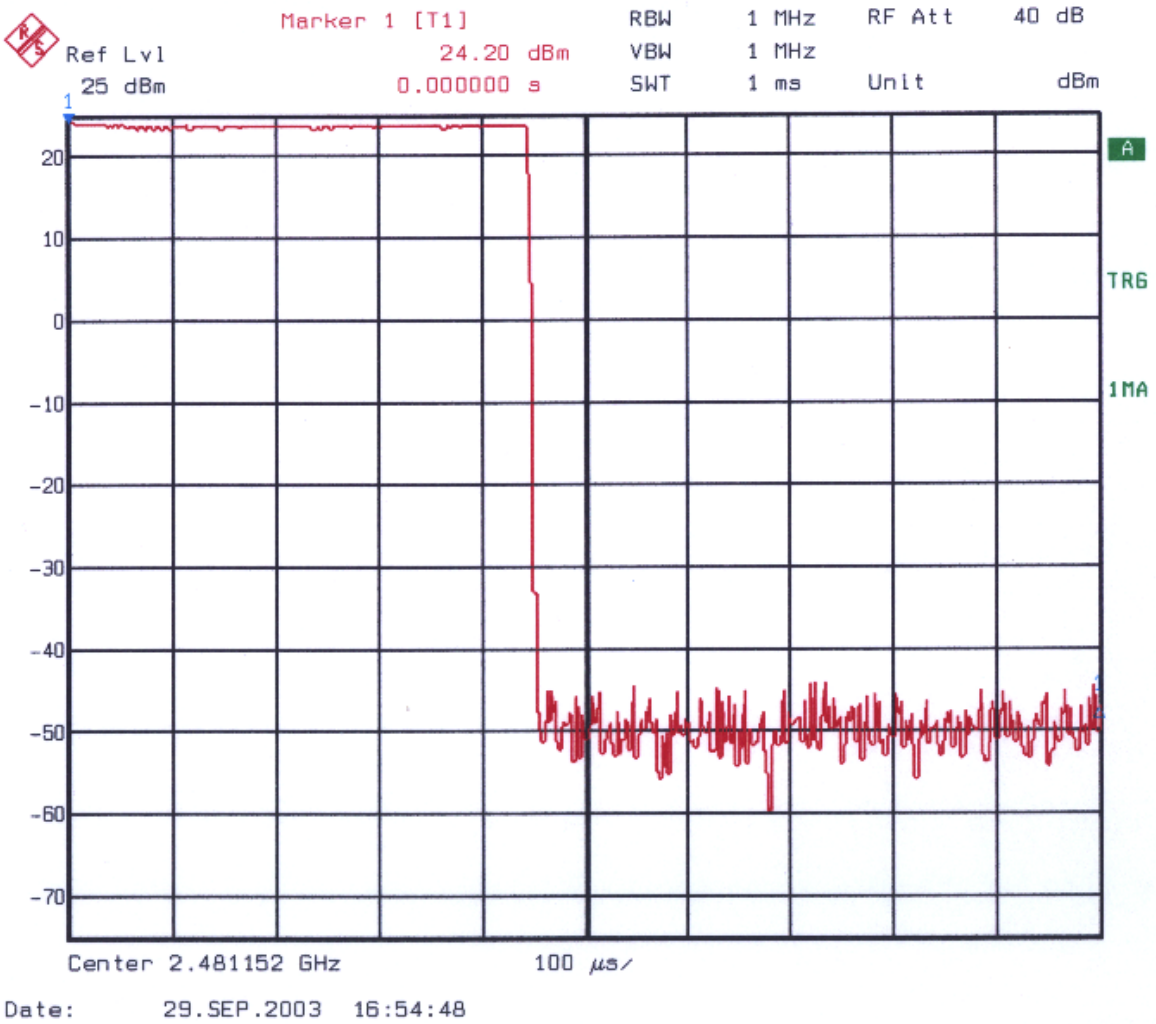

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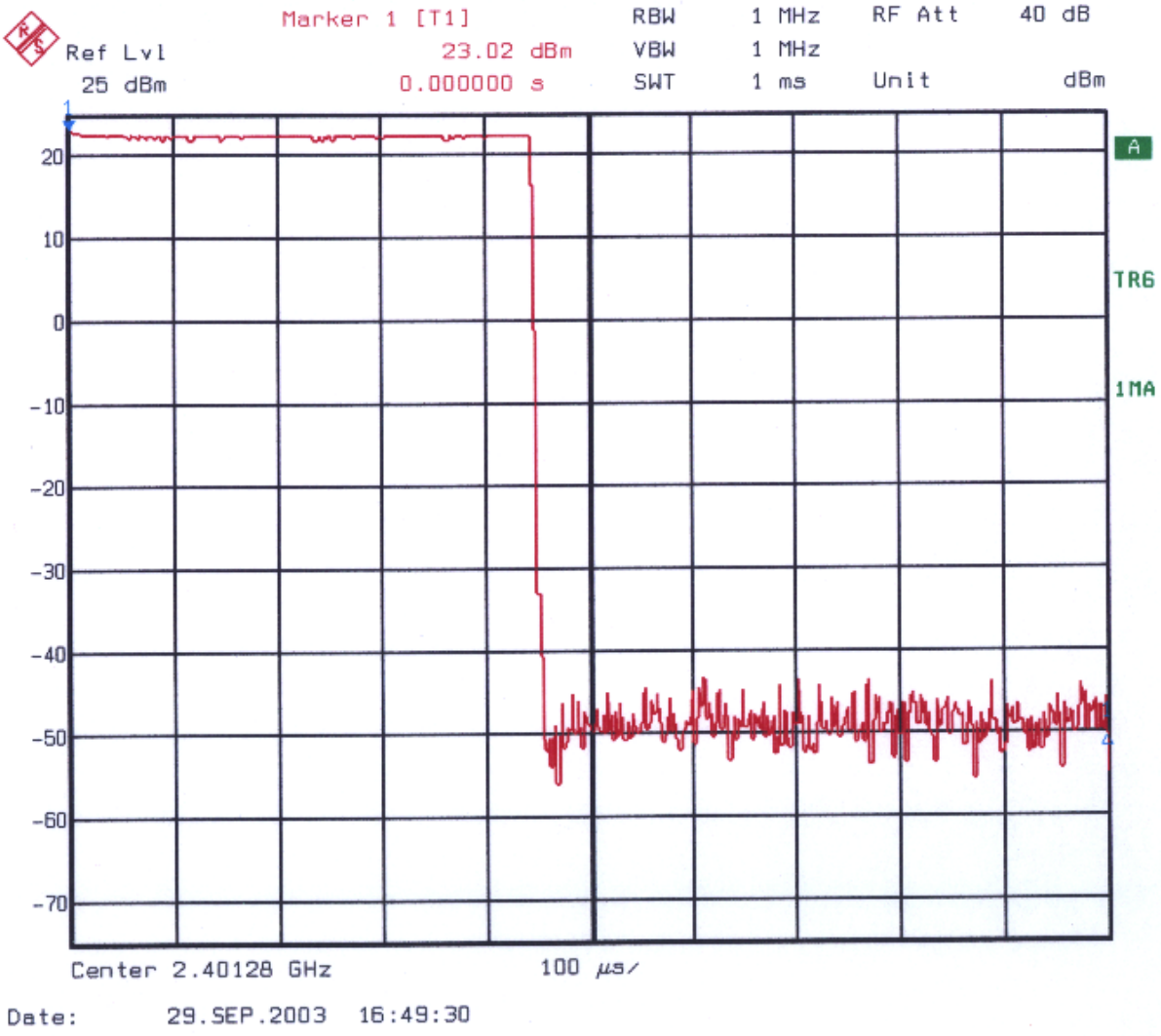

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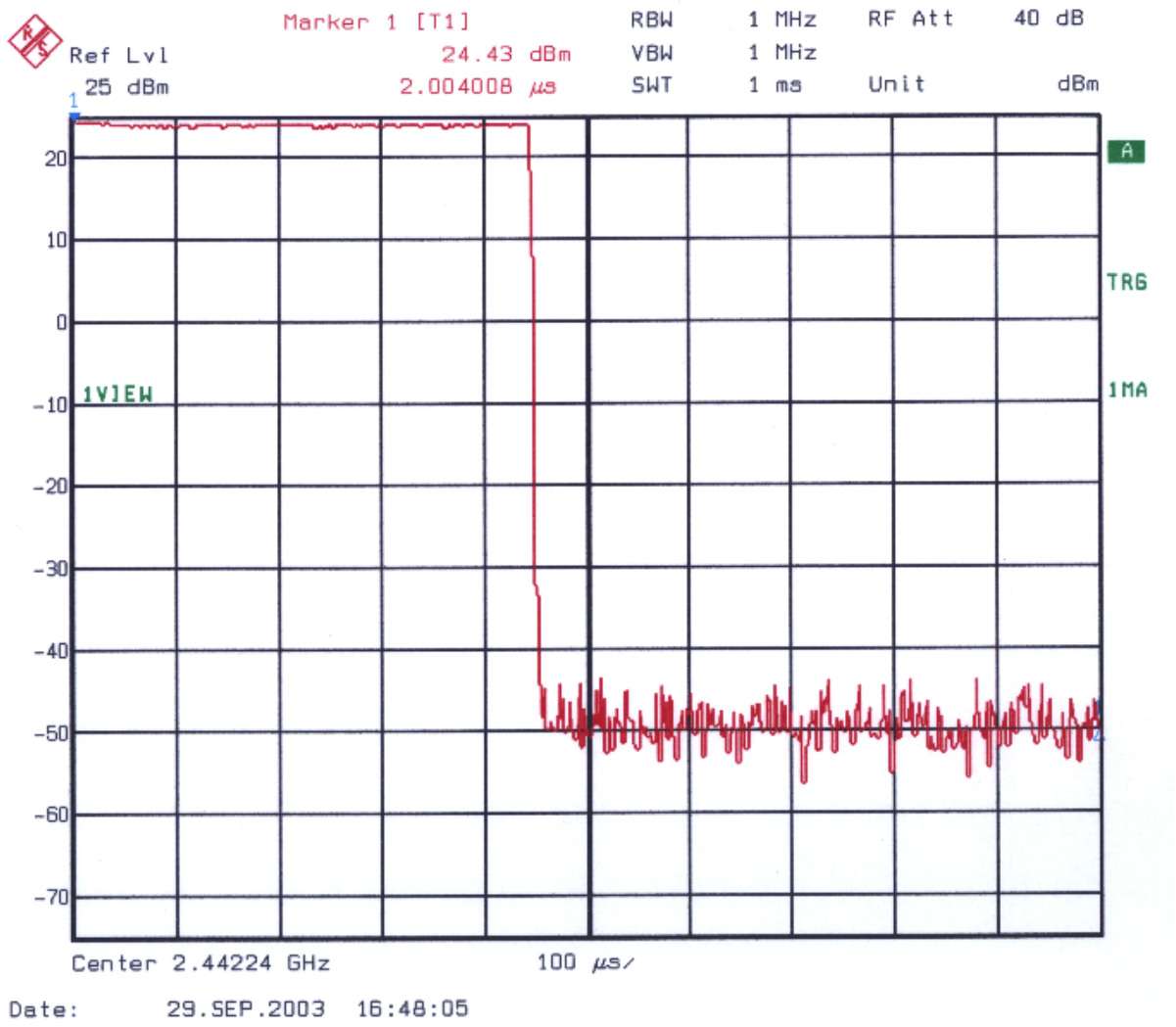

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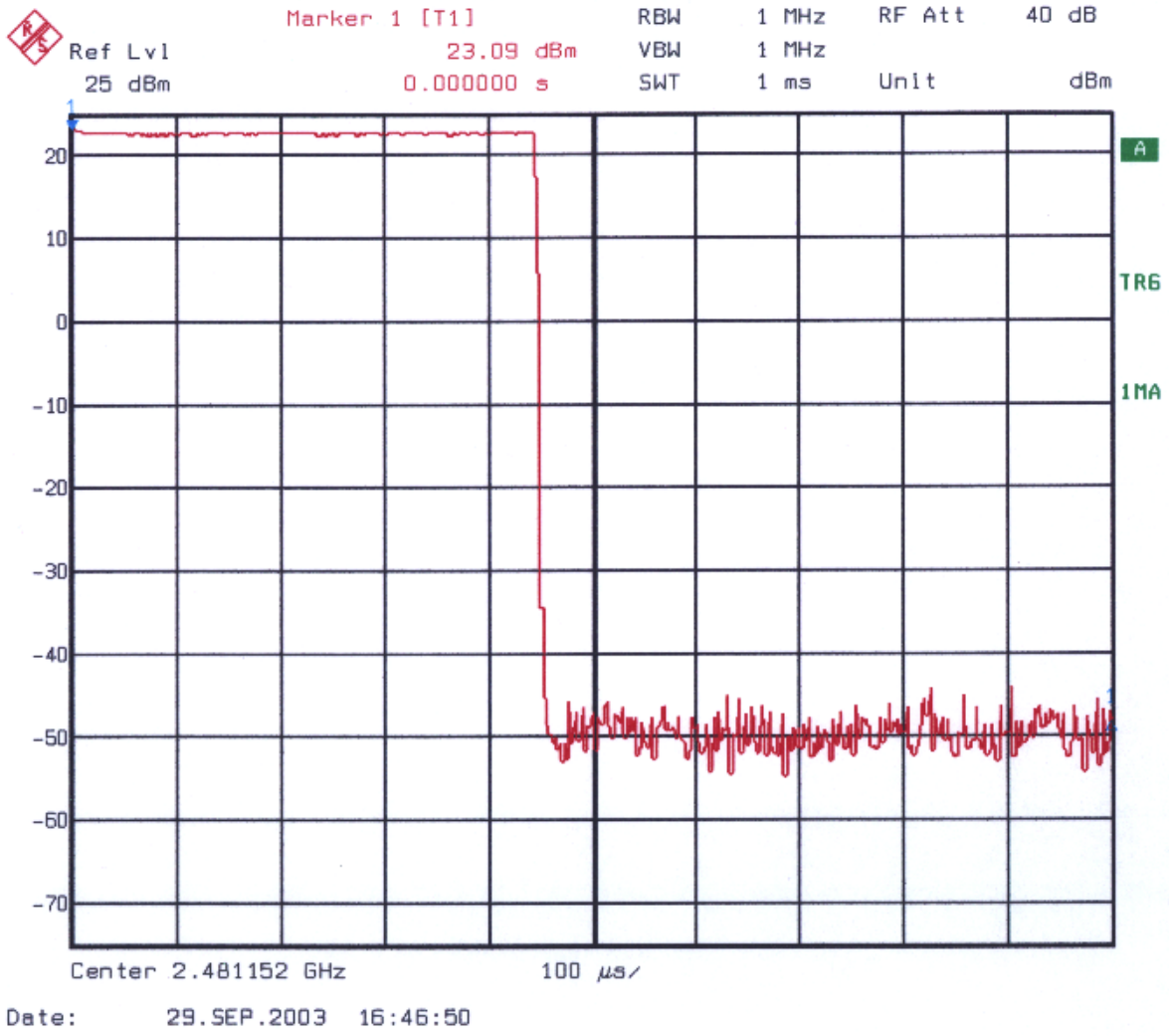

Fixed part ant. 2 ch. 79