COMLAB
Accredited Testing and Certification
EMC, Radio and Telecommunications

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Nemko Comlab AS

Office address: Gåsevikveien 8, Kjeller
Postal address: P.O.Box 96, N-2027 Kjeller
Telephone: +47 64 84 57 00
Facsimile: +47 64 84 57 05
E-mail: post@comlab.no
http://www.comlab.no
Enterprise no: NO 984 592 418 MVA

Test report : 03/606/5

Item tested : RFM

Type of equipment : Frequency Hopping Transmitter

FCC ID : RTN-BCC-RFMV04

Client : BlueChip Communication AS

Tested according to :

FCC part 15, subpart C
Frequency Hopping Transmitter

RSS-210, Issue 5
Low Power License-Exempt Radiocommunication Devices

Date of issue : 18 MARCH 2004

Authorized by :

Kjell G. Haga
Managing Director

Frode Sveinsen
Technical Supervisor

CONTENTS

1 GENERAL INFORMATION

1.1 Testhouse Info

Name : Nemko Comlab AS

Address : Gåsevikveien 8, Box 96
N-2027 Kjeller, NORWAY

Telephone : +47 64 84 57 00

Fax : +47 64 84 57 05

E-mail: mailto:post@comlab.no

Managing Director: Kjell G. Haga

FCC test firm registration number : 994405

Industry Canada OATS registration number : 4443

1.2 Client Information

Name : BlueChip Communication AS

Address : Strandveien 13, 1366 Lysaker, Norway

Telephone : +47 67 83 08 00

Fax : +47 67 83 08 10

Contact:

Name : Ståle Pettersen

Telephone : +47 67 83 08 00

E-mail : staale.pettersen@bluechip.no

1.3 Manufacturer

Name : BlueChip Communication AS

Address : Strandveien 13, 1366 Lysaker, Norway

Telephone : +47 67 83 08 00

Fax : +47 67 83 08 10

E-mail : staale.pettersen@bluechip.no

2 Test Information

2.1 Tested Item

Name :	RFM (Radio Frequency networking Module)
FCC ID :	RTN-BCC-RFMV04
Model/version :	V0.4
Serial number :	Detachable antenna: 30303030, Integral antenna: 30303031
Hardware identity and/or version:	V0.4
Software identity and/or version :	0D4
Frequency Range :	905.2 – 924.7 MHz
Tunable Bands :	1
Number of Channels :	25[1]
Modulation :	FSK
Emissions Designator :	1MF1D
User Frequency Adjustment :	None, Software controlled.
Rated Output Power :	2 mW

1) 25 channels in use.

Theory of Operation

In normal use the total system consists of a master Home hub or countertop device as well as up to 8 household appliances. The master is connected to the Internet through normal dial up or broadband services and accesses a dedicated web server called the Beyond information server. It further links to the household appliances through the means of this RF module.

Example of applications and appliances are normal household appliances: microwave own, bread maker and coffee maker. This RF module use the communication link with the master e.g. to update user selectable cooking parameters.

2.2 Test Environment

2.2.1 Normal test condition

Temperature:	20 - 23 °C
Relative humidity:	30 - 50 %
Normal test voltage:	5.0 V DC

The values are the limit registered during the test period.

2.3 Test Period

Item received date: 2004-02-02

Test period : from 2004-02-09 to 2004-03-18

3 TEST REPORT SUMMARY

3.1 General

Manufacturer: BlueChip Communication AS

Model No.: RFM

Serial No.: Unit with detachable antenna: 30303030,
Unit with integral antenna: 30303031

All measurements are traceable to national standards.

The tests were conducted for the purpose of demonstrating compliance with FCC Part 15, Subpart C, paragraph 15.247 for Frequency Hopping Spread Spectrum devices and Industry Canada RSS-210 Frequency Hopping Spread Spectrum.

Radiated tests were conducted in accordance with ANSI C63.4-1992. The radiated tests were made in a semi-anechoic chamber at measuring distances of 3 and 10 meters.

☒ 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: 03/606/5

TESTED BY: _____ DATE: **18 MARCH 2004**

G.Suhanthakumar, Test engineer

3.2 Test Summary

Name of test	FCC Part 15 reference	RSS-210 reference	Result
Supply voltage variations	15.31 (e)		Complies
Number of operating frequencies	15.31 (m)		Complies
Conducted Emission (Receiver)	15.107(a)		ref. 15.207(a)
Radiated Emission limits (receiver)	15.109(a)		ref. 15.209(a)
Antenna requirement	15.203		Complies
Radiated emissions limits for restricted bands	15.205(a)		Complies
Power line Conducted Emission	15.207(a)	7.4, 9	Complies
Channel Separation	15.247(a)(1)(i)	6.2.2(o)(a1)	Complies
Pseudorandom Hopping Algorithm	15.247(a)(1)	6.2.2(o)(a1)	Complies
Time of Occupancy	15.247(a)(1)(i)	Amendment, paragraph I (ii)	Complies
Occupied Bandwidth	15.247(a)(1)(i)	Amendment, paragraph I (ii)	Complies
Peak Power Output	15.247(b)(2)	6.2.2 (o)(a3)	Complies
Spurious Emissions (Antenna Conducted)	15.247(c)	6.2.2 (o)(e1)	Complies[1]
Spurious Emissions (Radiated)	15.247(c), 15.209(a)	6.2.2 (o)(e1)	Complies

[1] The antenna connector is a reversed SMA connector.

3.3 Description of modification for Modification Filing

Not Applicable.

3.4 Comments

The channels are selected with a laptop PC connected to the EUT. The laptop and the software for communication/test mode is delivered for testing by the manufacturer. The laptop is only used for selection of channels. The measurements are performed at channels near top ch 0, near middle ch 12 and near bottom ch 24. The EUT complies at these channels.

3.5 Family List Rational

RFM module with detachable antenna and module with integral antenna.

The only difference between the two modules is the antenna connector. During testing the integral antenna has been disconnected with the help of a capacitor.

4 TEST RESULTS

4.1 Powerline Conducted Emissions

Para. No.: 15.207 (a)

Test Performed By: G.Suhanthakumar	**Date of Test: 10 February 2004**

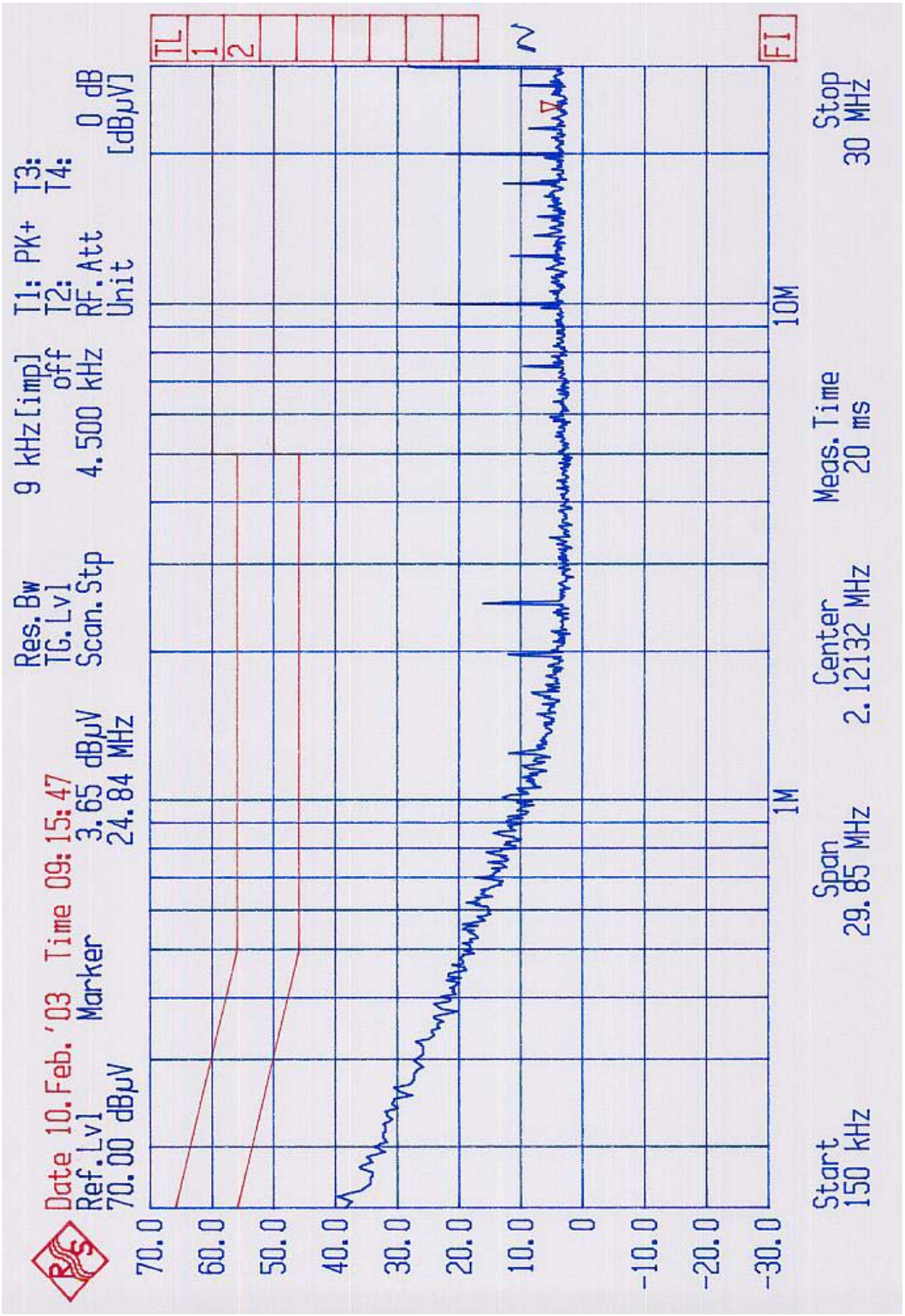
Measurement procedure: CISPR 22 1997 Clause 5.1 Class B ITE using 50 μH/50 ohms LISN.

Test Results: **Complies.**

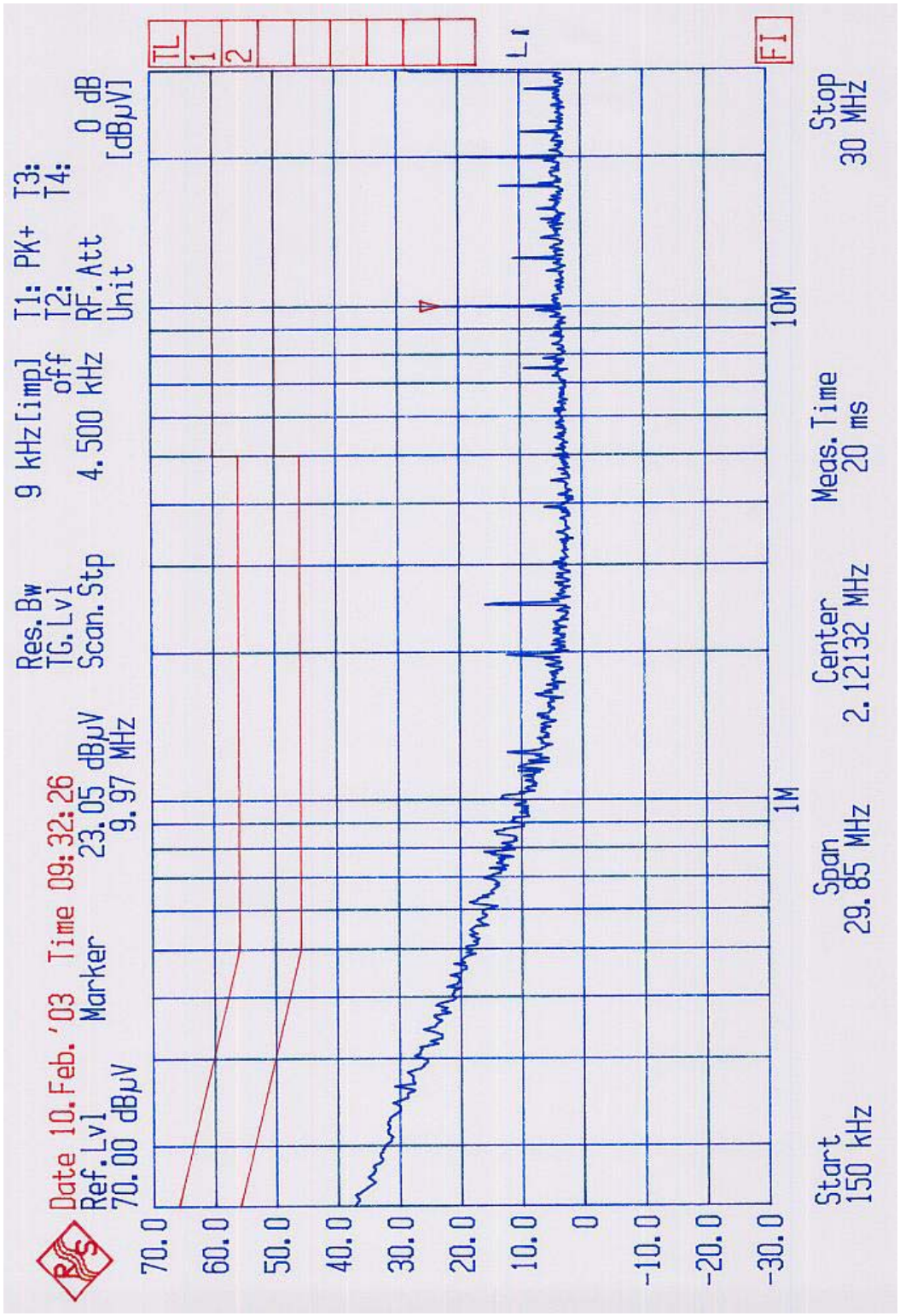
Measurement Data: **See attached graph, (Peak detector).**

Highest measured value:

Frequency	Line	Detector	Measured value	Limit	Margin
MHz	L1/ N	Peak/QP/AV	dBμV	dBμV	dB
1.953	N	QP	10,15	56	
1.953	N	AV	9.23	46	
2.486	N	QP	14.82	56	
2.486	N	AV	13.5	46	
9.97	N	QP	23.48	60	
9.97	N	AV	22.6	50	
12.47	N	QP	10.9	60	
12.47	N	AV	21.04	50	
19.98	N	QP	21.04	60	
19.98	N	AV	20.96	50	
30	N	QP	27.87	60	
30	N	AV	26.7	50	
2.486	L1	QP	14.94	56	
2.486	L1	AV	13.6	46	
9.97	L1	QP	22.36	60	
9.97	L1	AV	20.6	50	
19.98	L1	QP	21.50	60	
19.98	L1	AV	20.2	50	
30	L1	QP	28.25	60	
30	L1	AV	26.8	50	



Mains phase N



Mains phase L1

4.2 Channel Separation

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

Test Performed By: G.Suhanthakumar	**Date of Test: 02 MARCH 2004**

Test Results: **Complies**

Measurement Data: Channel Separation: Max : >900kHz ; Min: 383.47 kHz

20 dB Bandwidth of hopping channel: 282.055kHz

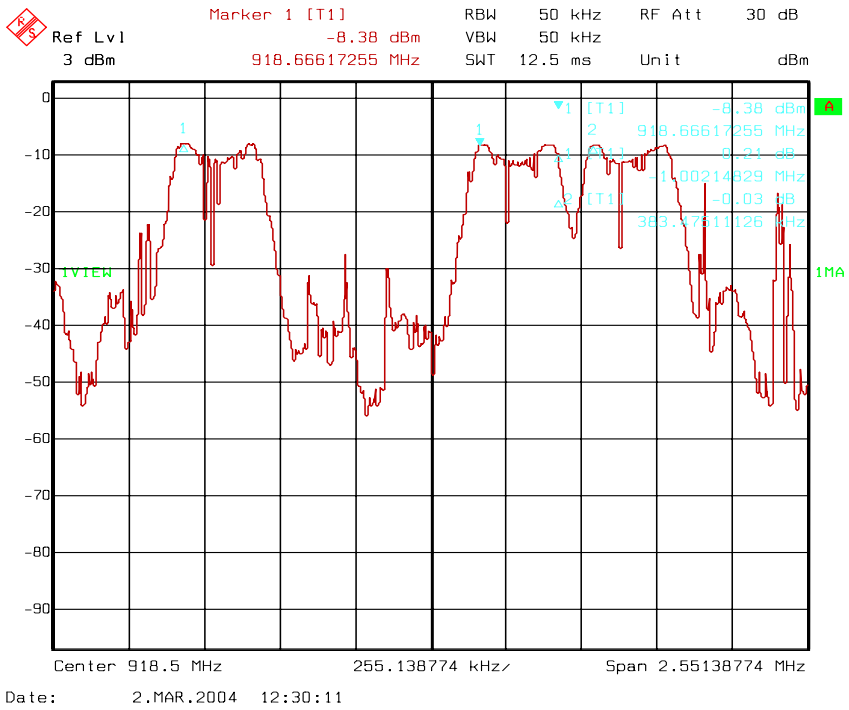
RF channel (1 to 25) has no influence on 20 dB bandwidth.

See attached graph

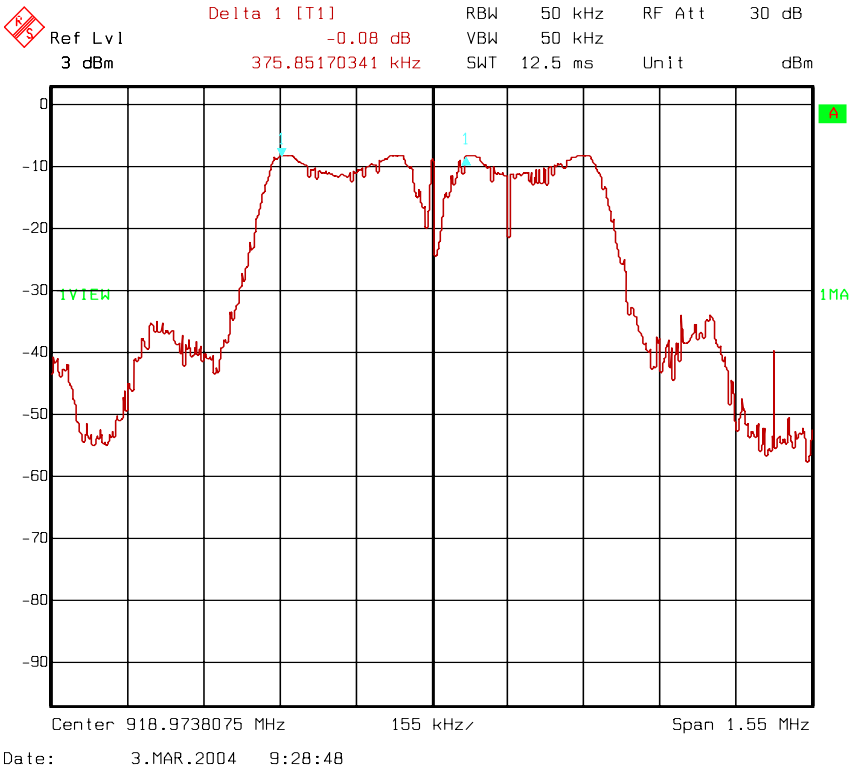
Channel Separation average value: 811.4 kHz.

Requirement:

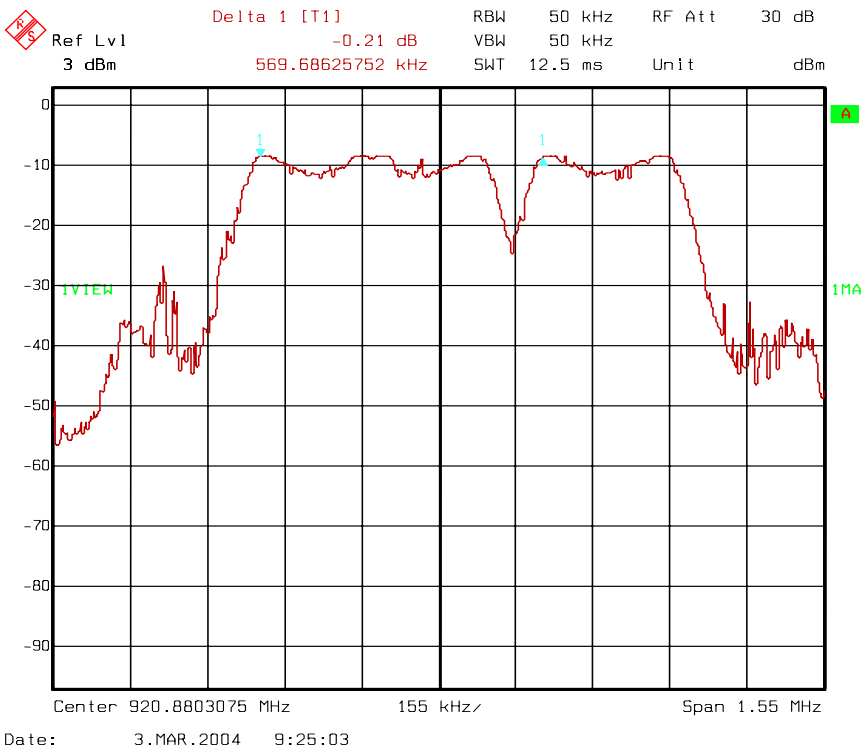
Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.



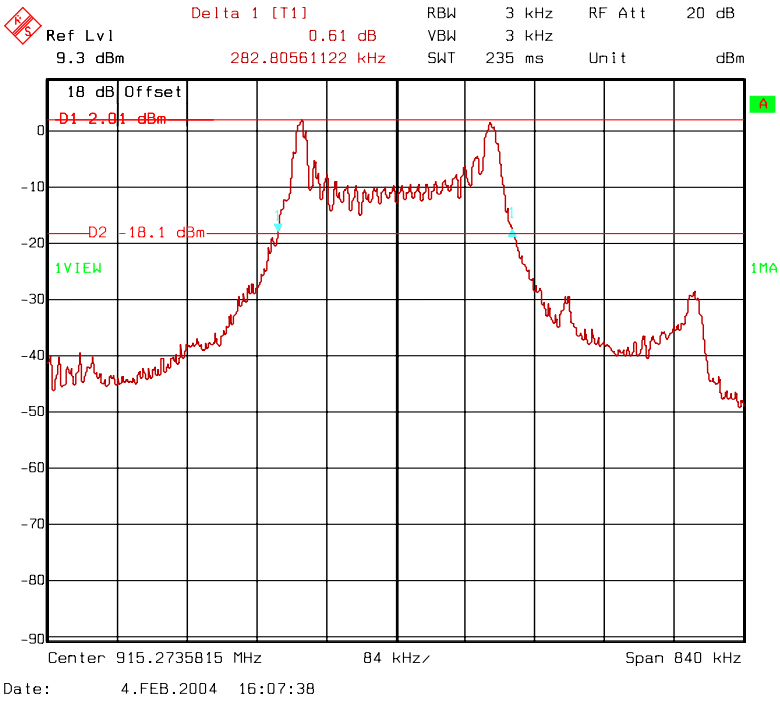
Channel separation Maximum >900kHz and minimum 383.47 kHz



Channel separation for Channel 17 & 18



Channel separation for Channel 19 & 20



Occupied Bandwidth

4.3 Pseudorandom Hopping Algorithm

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

Test Performed By: G.Suhanthakumar	**Date of Test: 09 February 2004**

Test Results: Complies

Basic Hopping Sequence (see FHSS documentation)

The sequence is 25 hops long.
25 different frequencies are used. They are called f00...f24.

f00...f24 are randomly organized in a list. This list is called FreqList.

When a new frequency should be entered, a counter called FreqCounter is incremented. It counts from 0 to 24, and then rolls over to 0. When FreqCounter rolls over to 0, another counter, called FreqTable is incremented. The value of FreqTable determines how the 25 frequencies are organized.

This results in the following:

All 25 frequencies are used in a random order. ("are used" means: receive mode or transmit mode at the frequency is entered). Then all 25 freqs are used again, but this time in another random order. Then all 25 freqs are used again, the order is changed again. And so on.

The index in FreqList:

Index = ((FreqTable* FreqCounter) mod 25) + FreqTable
If Index >=25: Index = 25

FreqTable: Legal values are 1,2,3,4,9,6,7,8. Changed when FreqCounter changes from 25 -> 1: Incremented with 8 lsb of master-address.
FreqCounter: 1,2,3,...24, 25. Updated every 104msec

Requirements:

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

4.4 Occupancy Time

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

Test Performed By: G.Suhanthakumar	**Date of Test: 09 February 2004**

Test Results: Complies

Measurement Data: Number of RF channel: 25

RF burst pr channel: 45.99ms

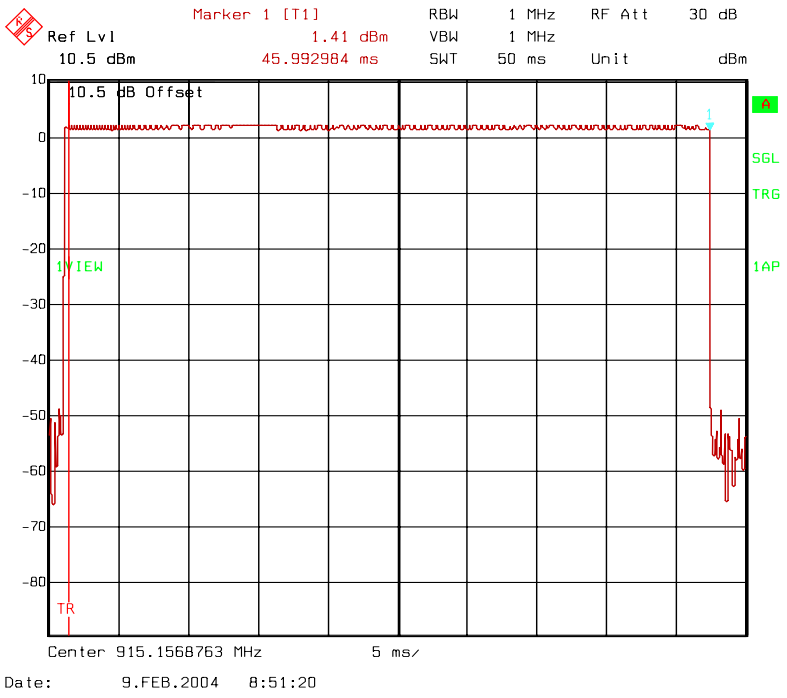
Time between each RF burst on same RF channel: 2.625 s

Time of occupancy: (45.99ms/2.625s)*0,4 sec*25 = 0.1752 s

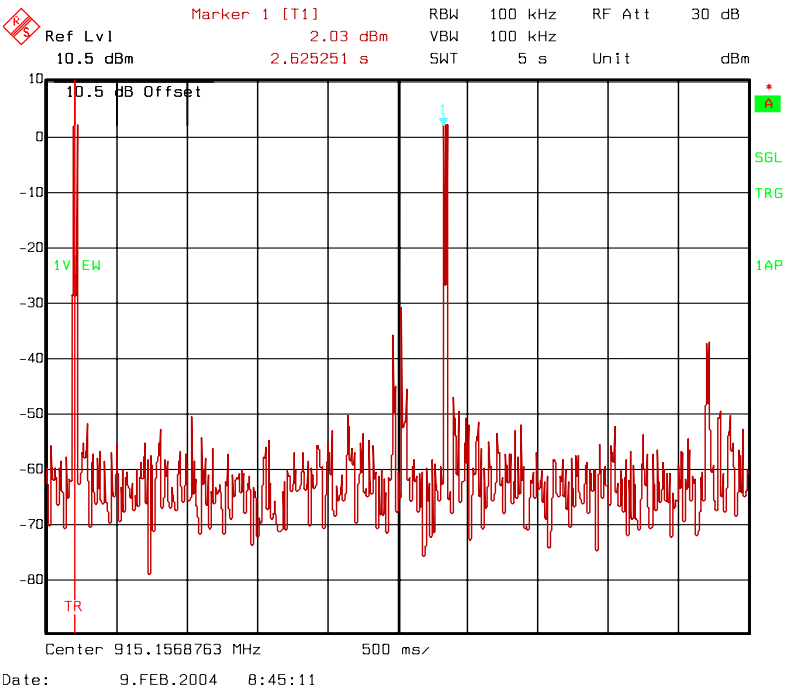
See attached graph.

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.



RF burst



Time between RF burst on same RF channel

4.5 Occupied Bandwidth

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

Test Performed By: G.Suhanthakumar	**Date of Test: 06 February 2004**

Test Results: Complies

Measurement Data: 25 RF channels in use

See attached graph.

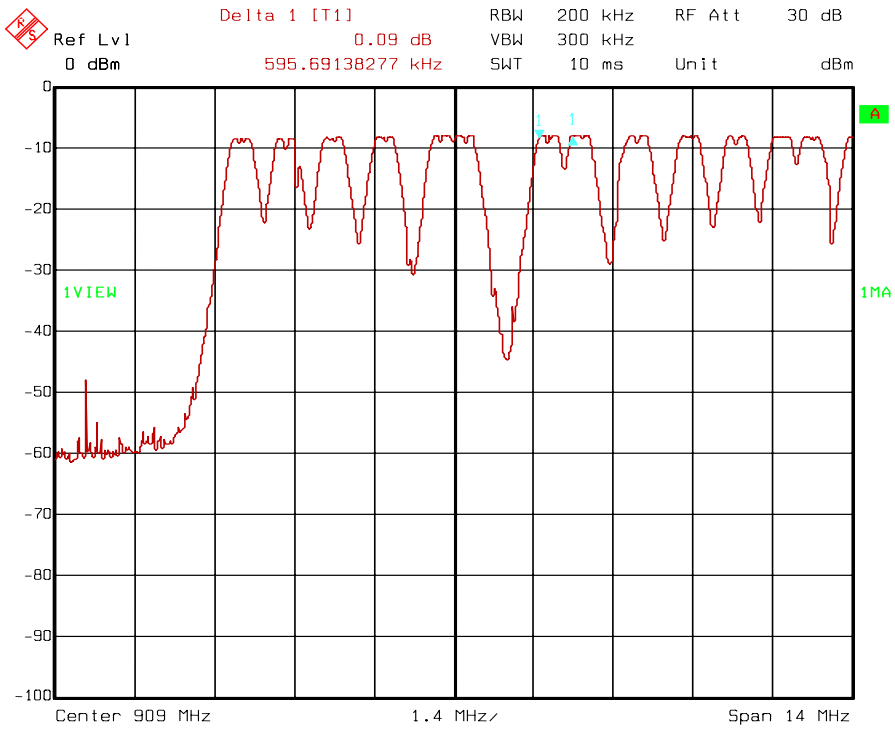
Requirements:

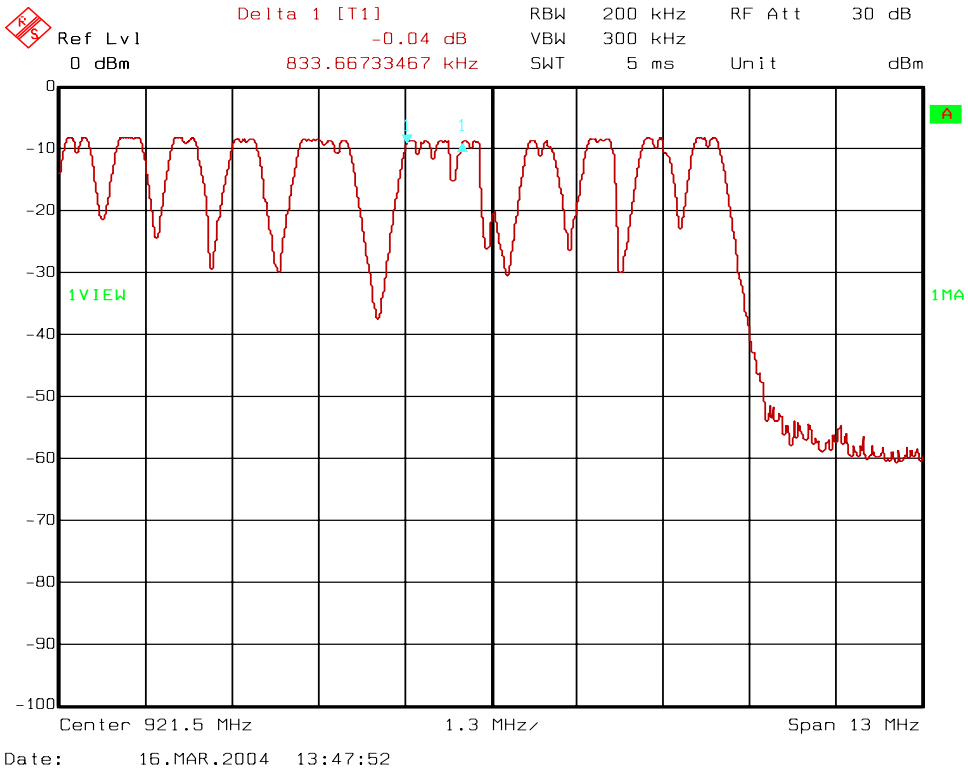
Frequency hopping systems in the 902 - 928 MHz band shall use at least 15 non-overlapping channels. No requirements for bandwidth for this frequency band.

Channel Centre Frequencies

The following table lists the 25 channel centre frequencies. The values are in MHz. Each of the 25 channels are used at a time.

Channel number	Center frequency	Channel number	Center frequency
0	905.263158	13	916.052632
1	906.052632	14	916.875000
2	906.875000	15	917.777778
3	907.777778	16	918.787879
4	908.787879	17	919.166667
5	909.166667	18	920.384616
6	910.645161	19	920.833333
7	911.212121	20	921.212121
8	912.222222	21	922.222222
9	913.125000	22	923.125000
10	913.947368	23	923.947368
11	914.736842	24	924.736842
12	915.263158		





RF channels in use

4.6 Peak Power Output

Para. No.: 15.247 (b)(2)

Test Performed By: G.Suhanthakumar	**Date of Test: 09 February 2004 & 17 MARCH 2004**

Test Results: Complies

Measurement Data:

Maximum Conducted Peak Output Power, mW

RF channel	0	12	24
Conducted	1.574	1.675	1.625

Maximum EIRP, mW

RF channel	0	12	24
Unit with integrated antenna	0.209	0.257	0.186
Antenna gain for integrated antenna dBi	-8.77	-8.14	-9.41
Unit with detachable antenna	2.34	2.29	2.24
Antenna gain for detachable antenna dBi	1.72	1.36	1.39

Antenna gain = 10*log(EIRP/Conducted power) dBi

EIRP is measured by substitution method defined by ETSI.

See attached graph.

Detachable antenna? ☒ Yes ☐ No

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

Antenna connector on the unit with detachable antenna is reversed SMA.

Power supply variation within 85 % to 115% of nominal value has no influence on measured values.

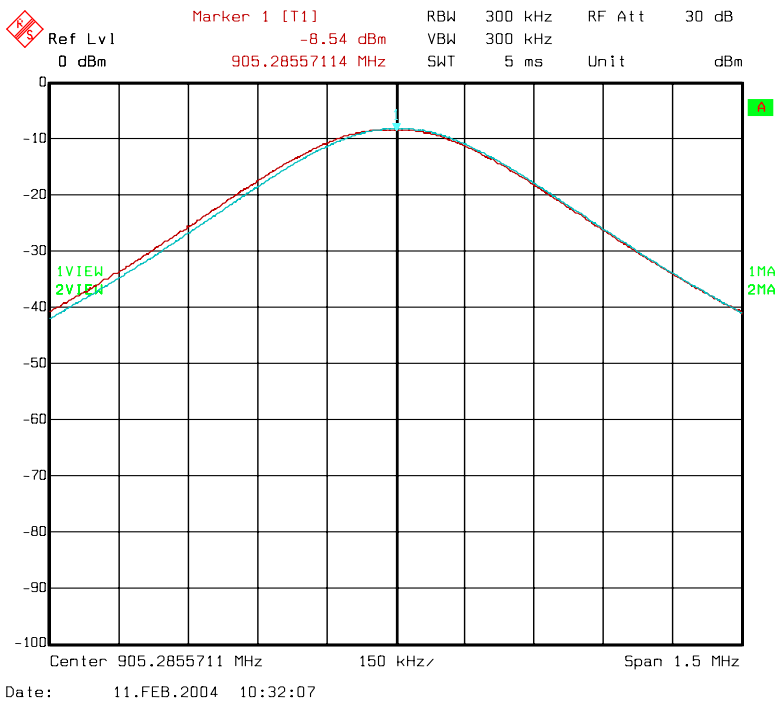
Voltages – Min : 4.25Vdc , Nominal: 5Vdc , Max: 5.75 Vdc (regulated with external power supply)

Requirements:

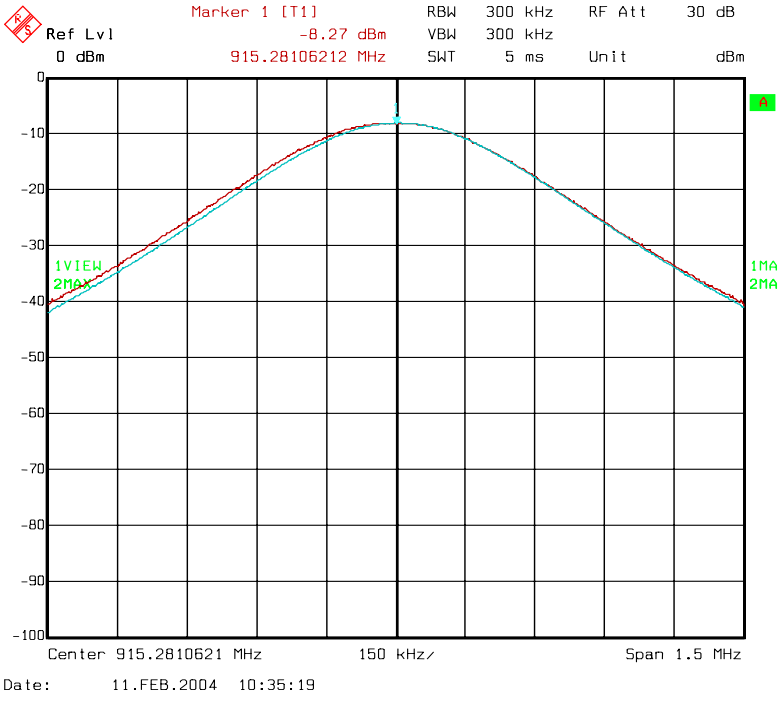
The maximum peak output power for frequency hopping systems shall not exceed the following limits:

For systems employing at least 25 hopping channels: 0.25 watt

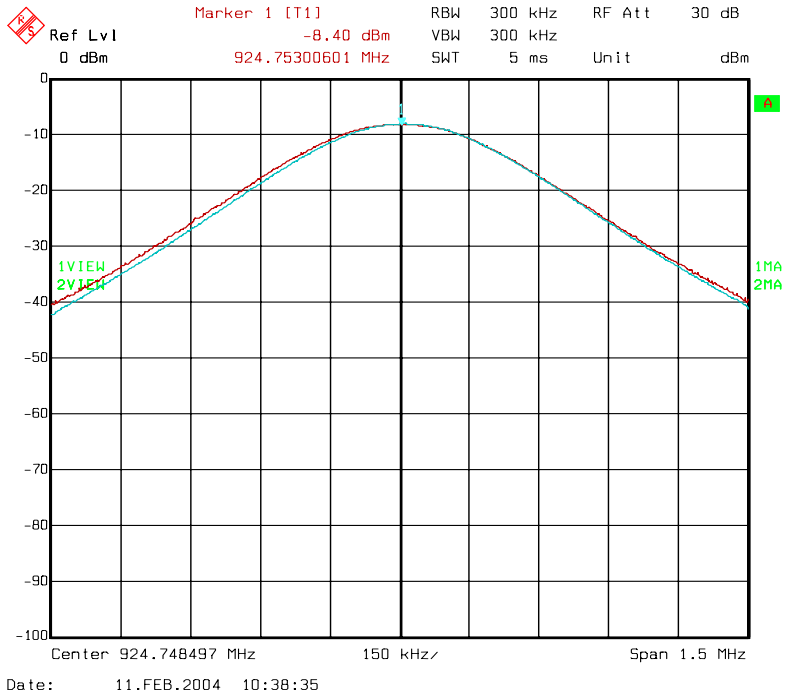
For systems employing at least 50 hopping channels: 1 watt



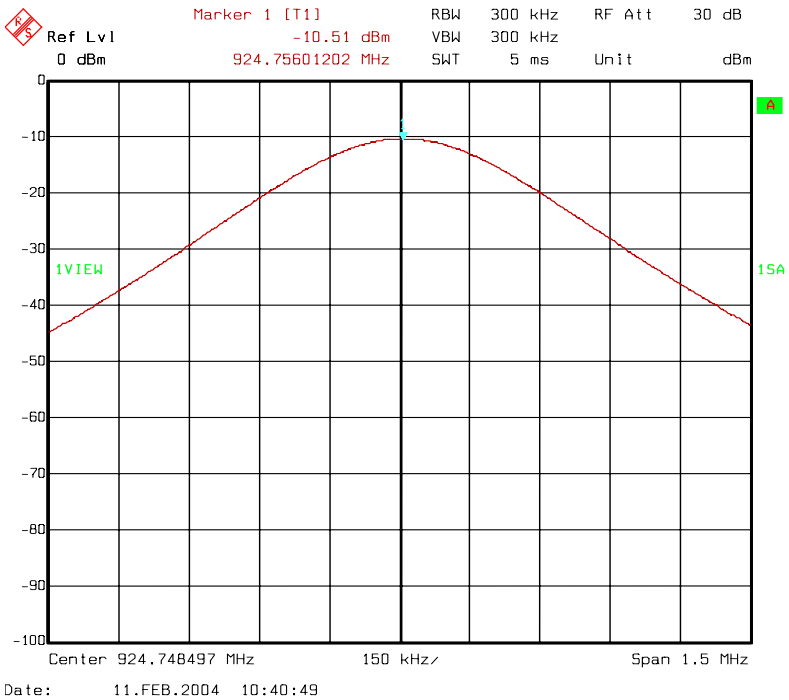
RF conducted channel 0



RF conducted channel 12



RF conducted channel 24



10 dB Attenuator + cable loss

4.7 Spurious Emissions (Radiated)

Para. No.: 15.247 (c)

Test Performed By: G.Suhanthakumar	**Date of Test: 10 February 2004 –18.MARCH 2004**

Test Results: Complies

Measurement Data:

RF conducted power to 10 GHz see attached graph.

Maximum RF level outside operating band:

RF ch 0: -52.06 dB/C, margin 32.06 dB, 2.715 GHz

RF ch 12: -54.77 dB/C, margin 34.77 dB, 2.745GHz

RF ch 24: -56.35 dB/C, margin 36.35 dB, 2.774GHz

Radiated emission (Integrated ant), 1-10 GHz, see attached table.

Highest value RF Ch 0: Peak 50.97 dBμV/m, average 44.23 dBμV/m, 1.810 GHz

Ch 12: Peak 50.18 dBμV/m, average 43.44 dBμV/m, 1.830 GHz

Ch 24: Peak 49.52 dBμV/m, average 42.78 dBμV/m, 1.849 GHz

Radiated emission (detachable ant), 1-10 GHz, see attached table.

Highest value RF Ch 0: Peak 51.02 dBμV/m, average 44.28 dBμV/m, 1.810 GHz

Ch 12: Peak 53.72dBμV/m, average 46.98 dBμV/m, 1.830 GHz

Ch 24: Peak 52.77 dBμV/m, average 46.03 dBμV/m, 1.849 GHz

Duty Cycle Calculation:

See also Para 4.4 Occupancy Time.

RF duty cycle: Calculation according to RF burst Para 15.35 (c)

20*log (45.99ms/100ms) = - 6.74 dB

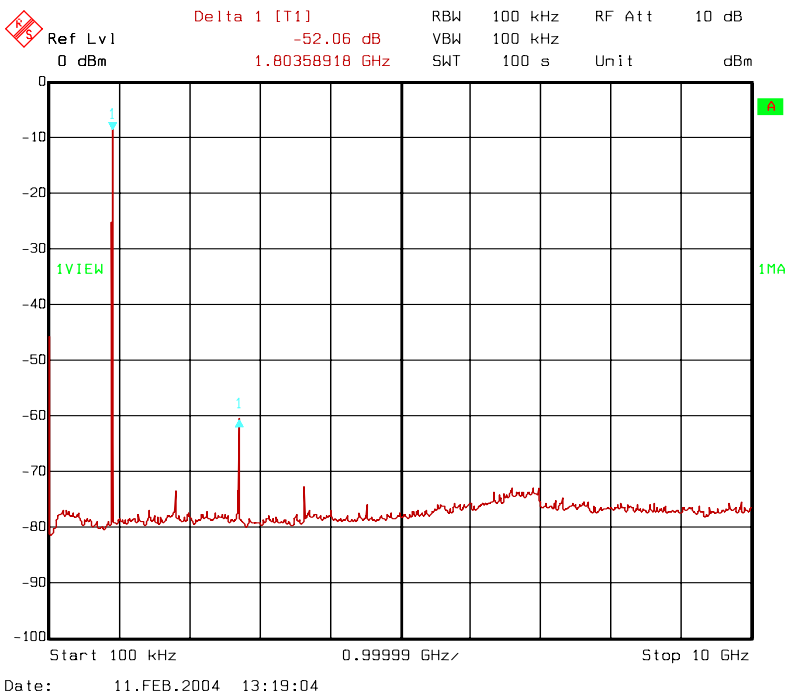
Maximum duty cycle according to Para 15.35 (b): -20 dB

No components above 2.7 GHz detected

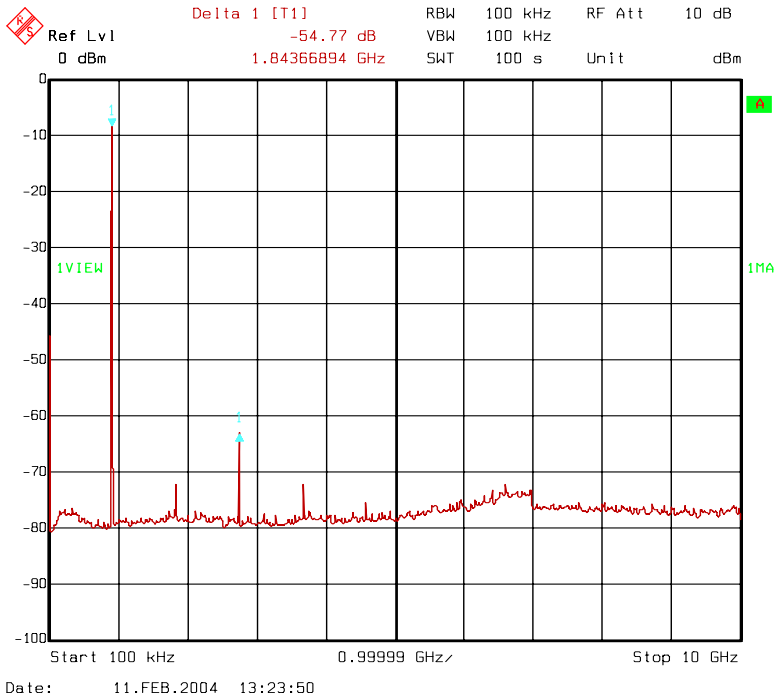
This value is used when measuring average field strength above 1 GHz with Peak Detector function employed on spectrum analyzer.

Example of frequency graph of radiated emission is also attached.

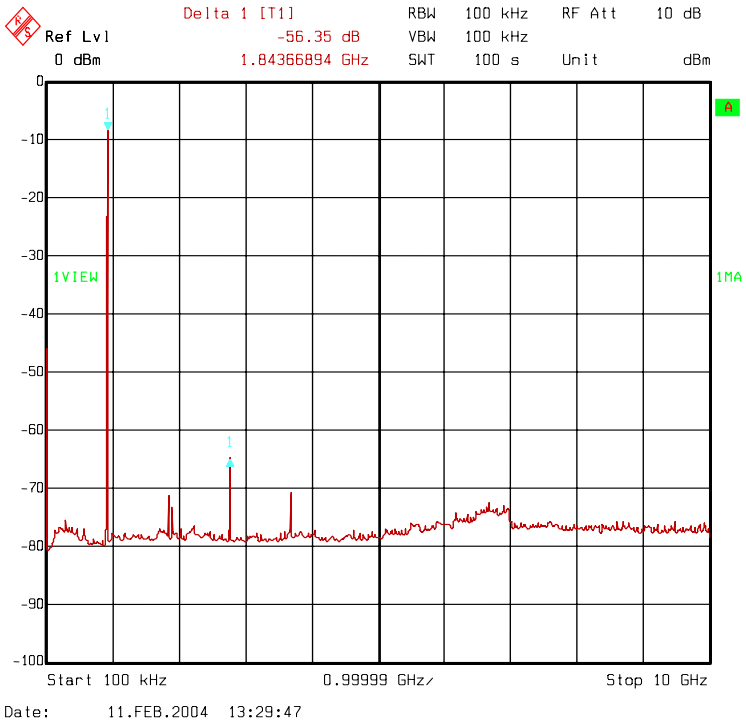
Antenna factor, amplifier gain and cable loss are included in spectrum analyzer “Transducer factor”.



RF conducted power ch 0



RF conducted power ch 12



RF conducted power ch 24

Radiated Emission 1 – 25 GHz, Peak (for detachable antenna)

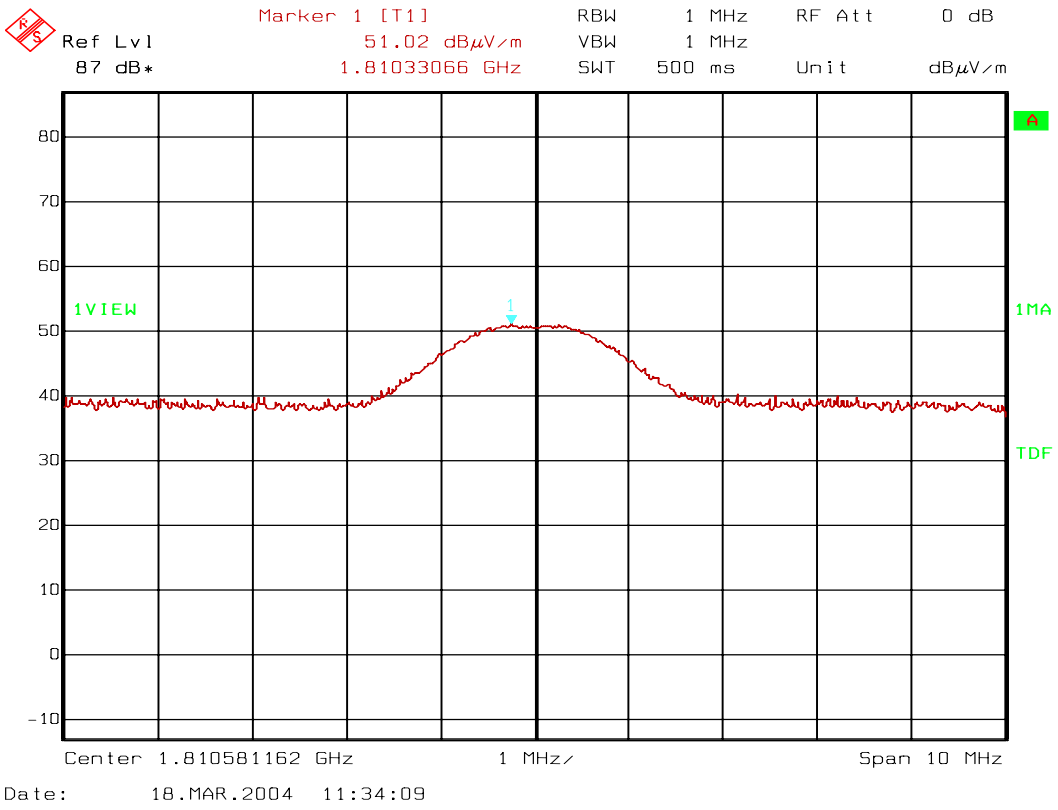
Measured with Peak Detector

Frequency	RF channel	Dist. corr. factor	Field strength, Peak, 3 metres	Duty cycle	Limit	Margin
GHz	0-24	dB	dBμV/m	dB	dBμV/m	dB
1.810	0	0	51.02		74	22.98
1.830	12	0	53.72		74	20.28
1.849	24	0	52.77		74	21.23
2.715	0	0	50.43		74	23.57
2.745	12	0	50.12		74	23.88
2.774	24	0	49.78		74	24.22
3.620	0	0	None detected		74	
3.66	12	0	None detected		74	
3.69	24	0	None detected		74	
4.526	0	0	46.27		74	27.73
4.576	12	0	45.62		74	28.38
4.623	24	0	45.69		74	28.31
5.431	0	0	None detected		74	
5.491	12	0	None detected		74	
5.548	24	0	None detected		74	

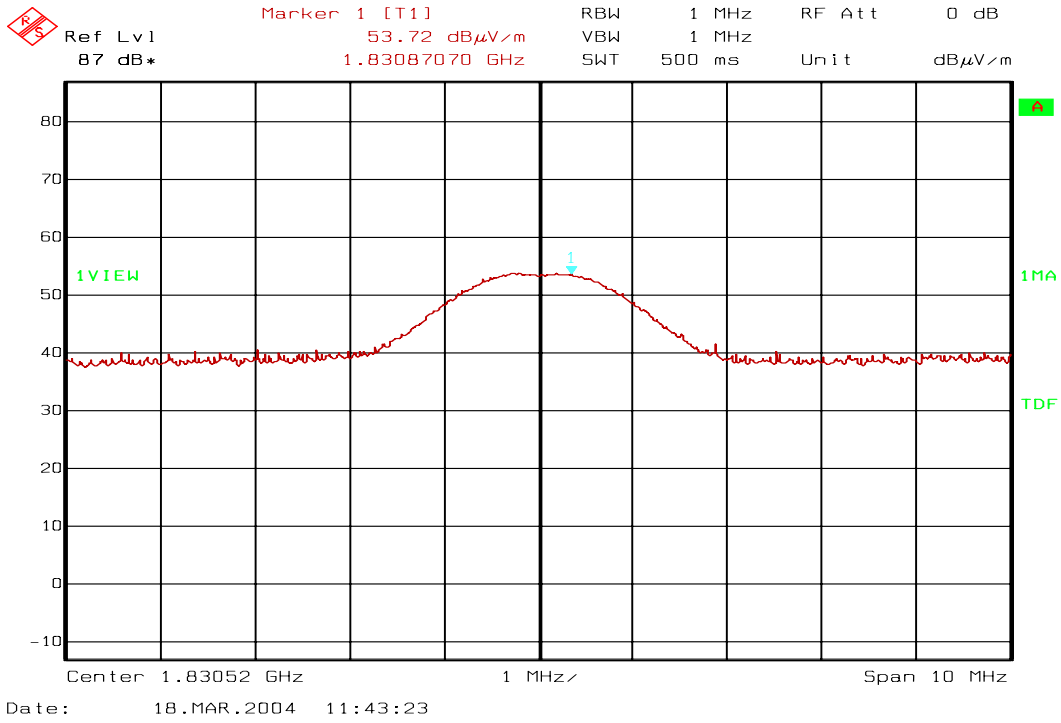
Radiated emission 1- 25 GHz, Average (for detachable antenna)

Measured with Peak Detector

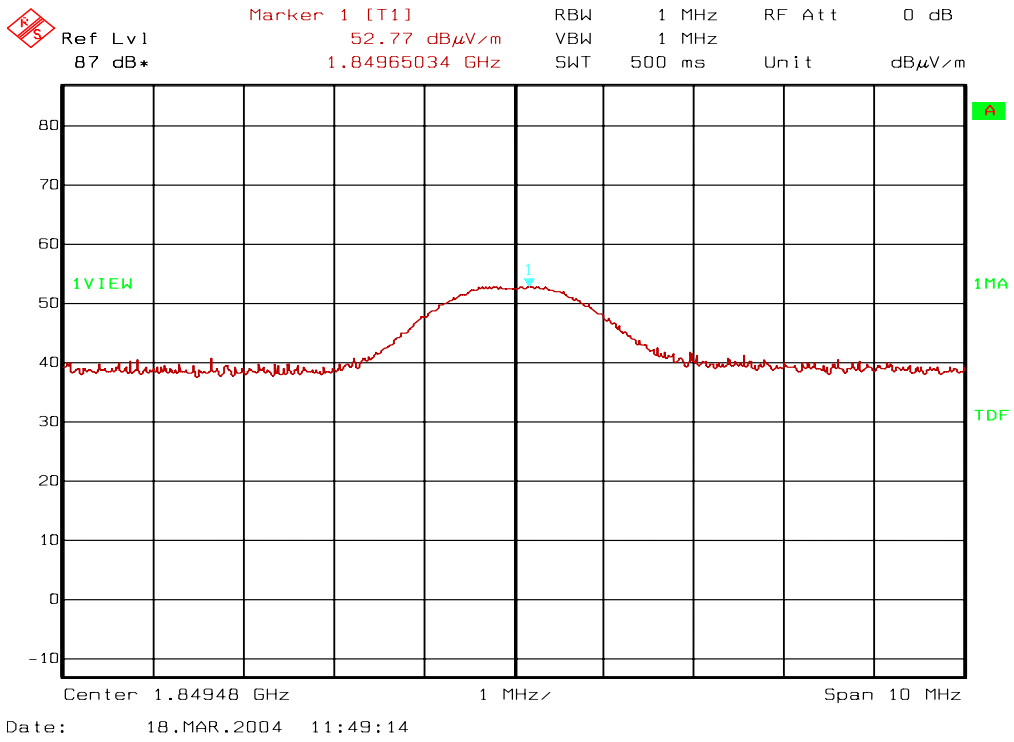
Frequency	RF channel	Dist. corr. factor	Field strength, Peak, 3 metres	Duty cycle	Limit	Margin
GHz	0-24	dB	dBμV/m	dB	dBμV/m	dB
1.810	0	0	51.02	-6.74	54	9.72
1.830	12	0	53.72	-6.74	54	7.02
1.849	24	0	52.77	-6.74	54	7.97
2.715	0	0	50.43	-6.74	54	10.31
2.745	12	0	50.12	-6.74	54	10.62
2.774	24	0	49.78	-6.74	54	10.96
3.620	0	0	None detected	-6.74	54	
3.66	12	0	None detected	-6.74	54	
3.69	24	0	None detected	-6.74	54	
4.526	0	0	46.27	-6.74	54	14.47
4.576	12	0	45.62	-6.74	54	15.12
4.623	24	0	45.69	-6.74	54	15.05
5.431	0	0	None detected	-6.74	54	
5.491	12	0	None detected	-6.74	54	
5.548	24	0	None detected	-6.74	54	



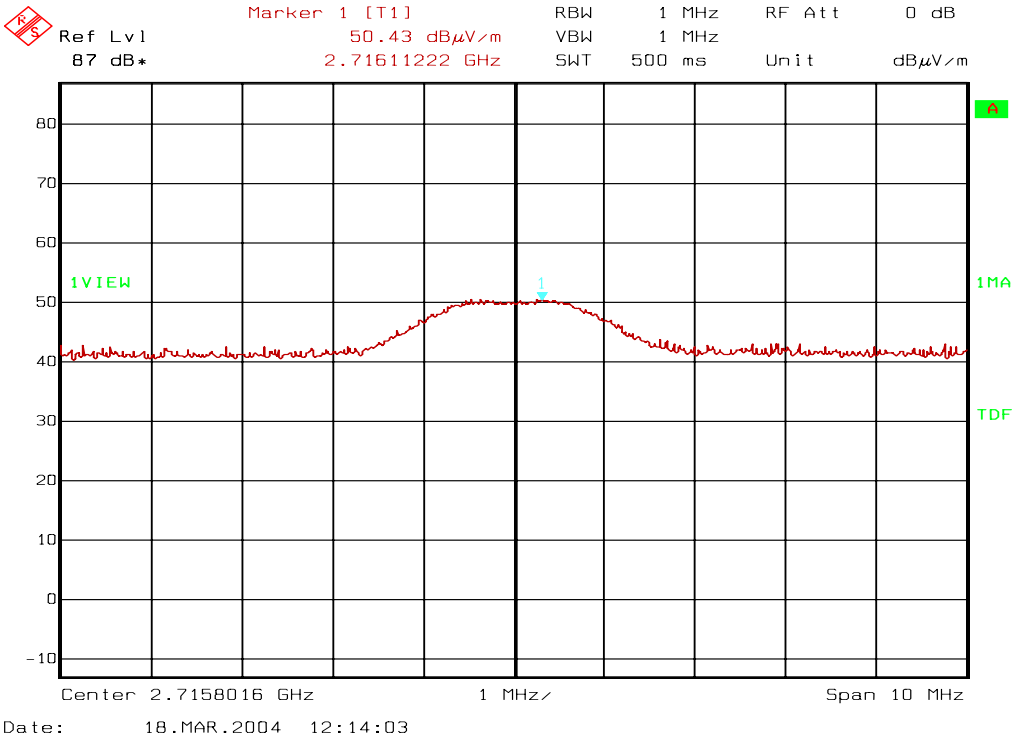
Max field strength – radiated emission(detachable ant) 2nd Harmonic , ch 0



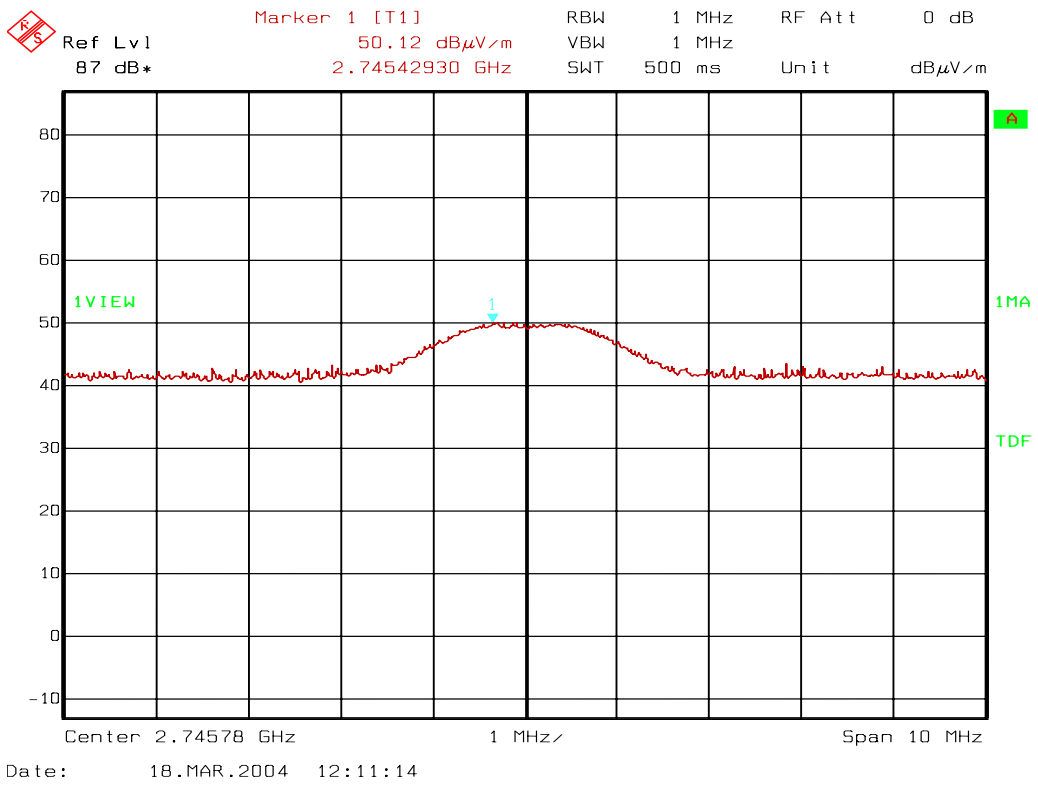
Max field strength – radiated emission(detachable ant) 2nd Harmonic , ch 12



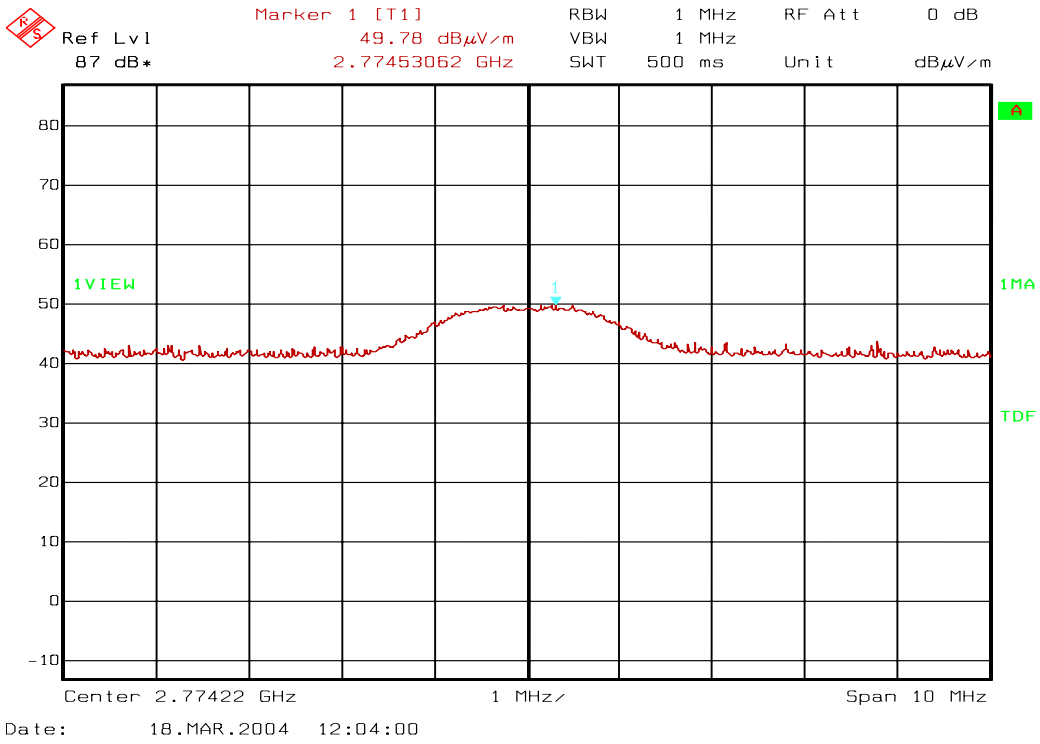
Max field strength –radiated emission(detachable ant) 2nd Harmonic , ch 24



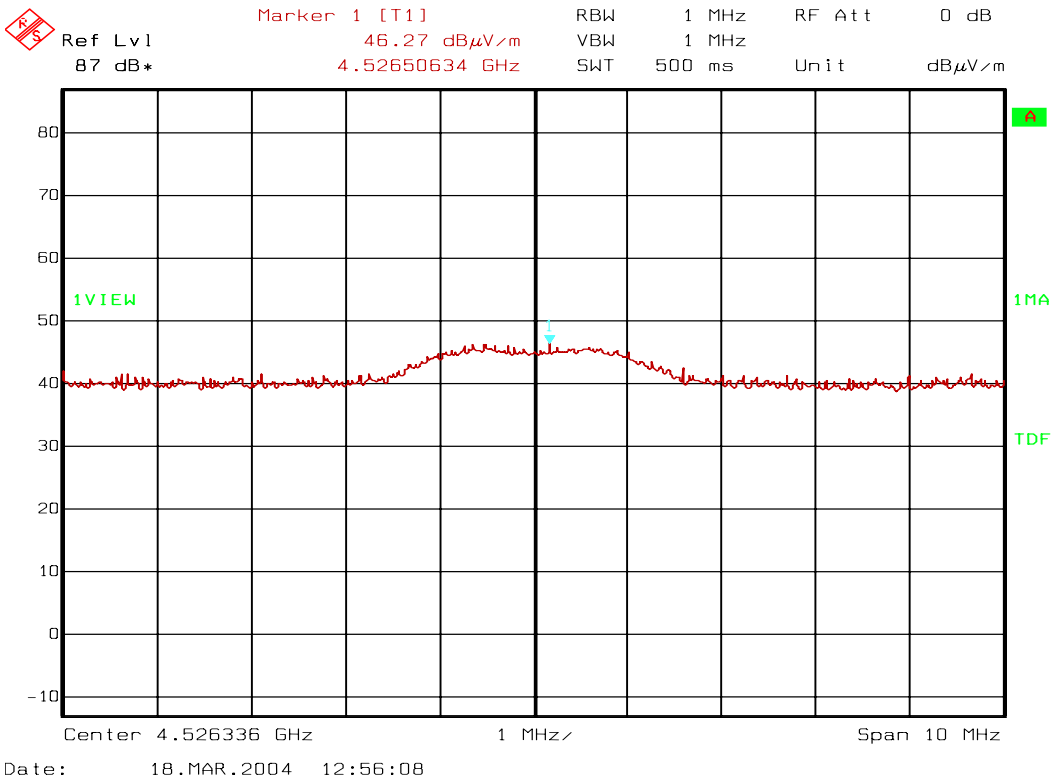
Max field strength –radiated emission(detachable ant) 3rd Harmonic , ch 0.



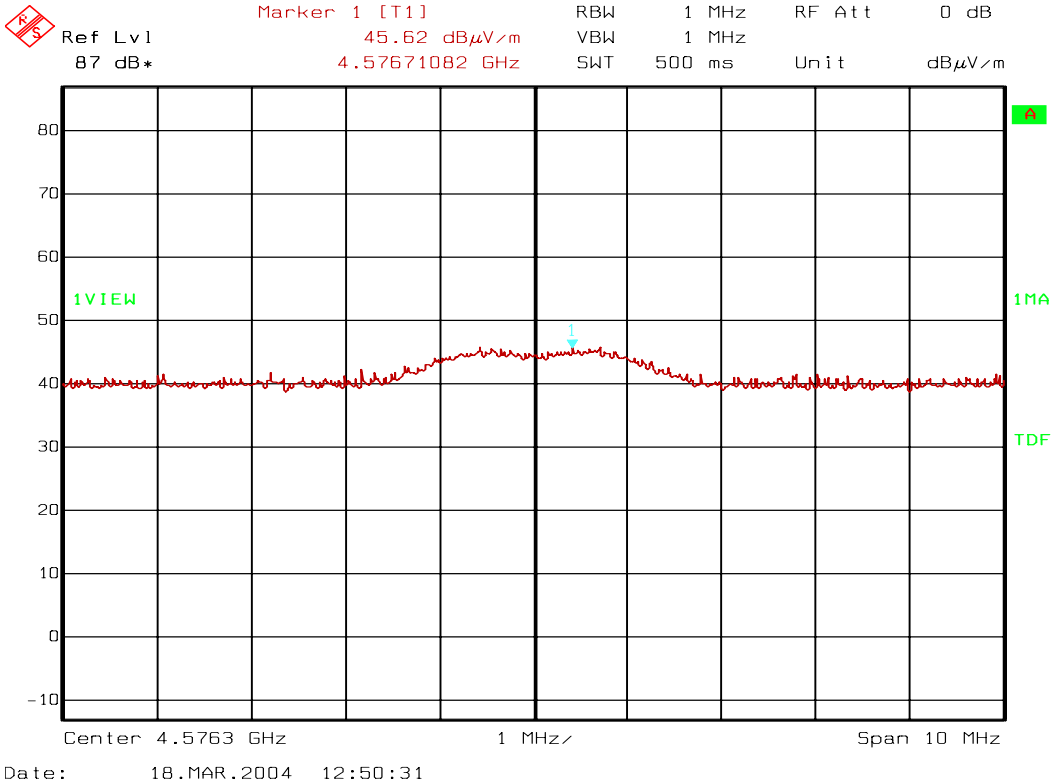
Max field strength –radiated emission(detachable ant) 3rd Harmonic , ch 12



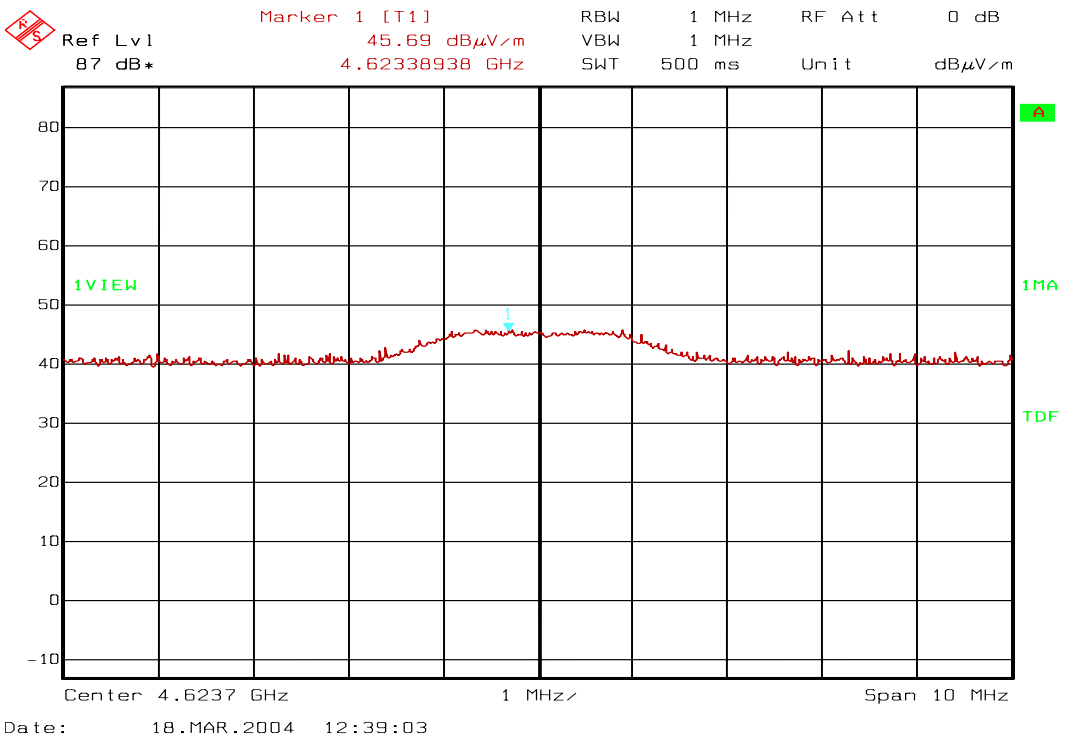
Max field strength –radiated emission(detachable ant) 3rd Harmonic , ch 24



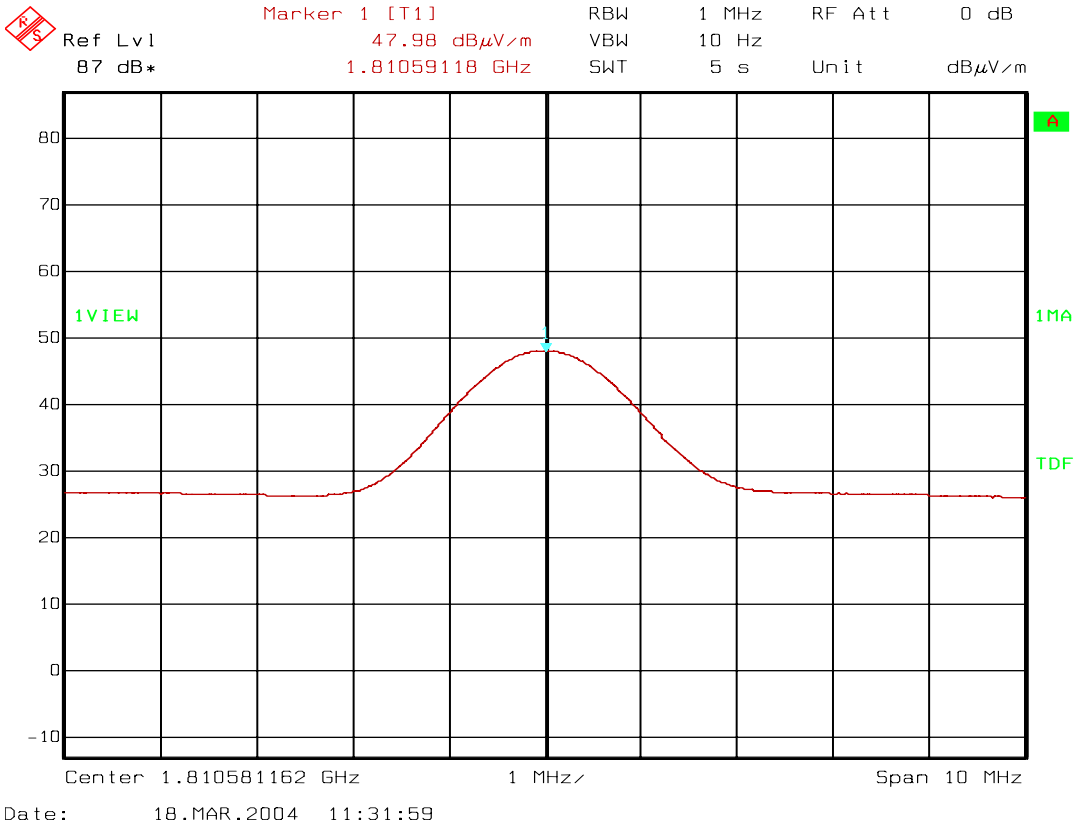
Max field strength –radiated emission(detachable ant) 5th Harmonic , ch 0



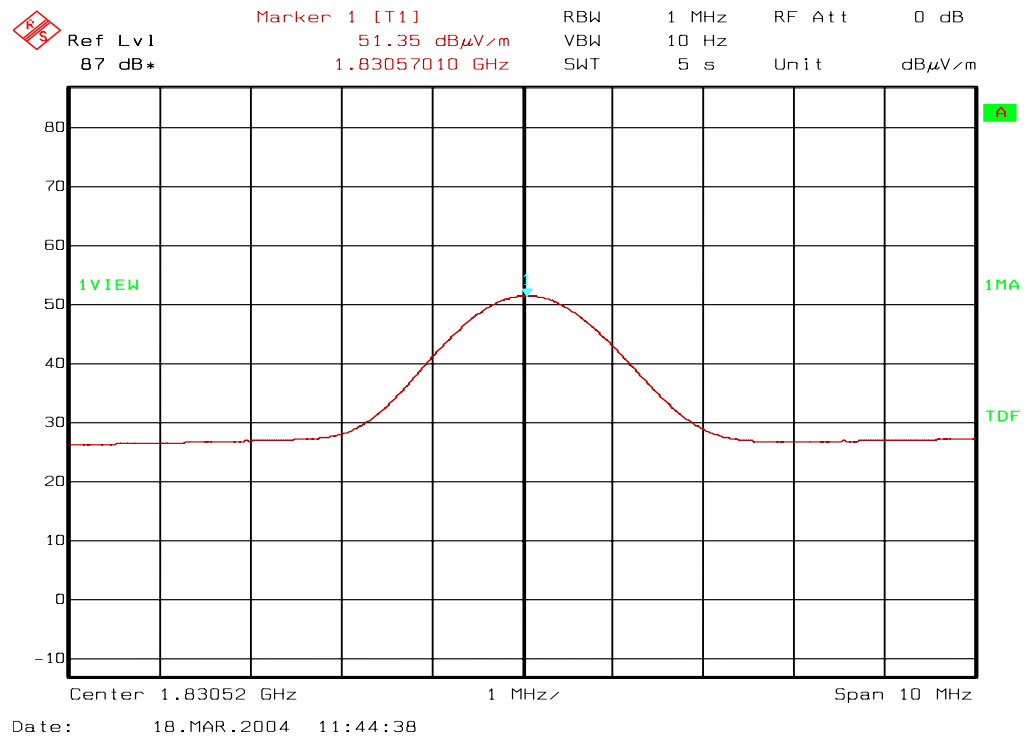
Max field strength –radiated emission(detachable ant) 5th Harmonic , ch 12



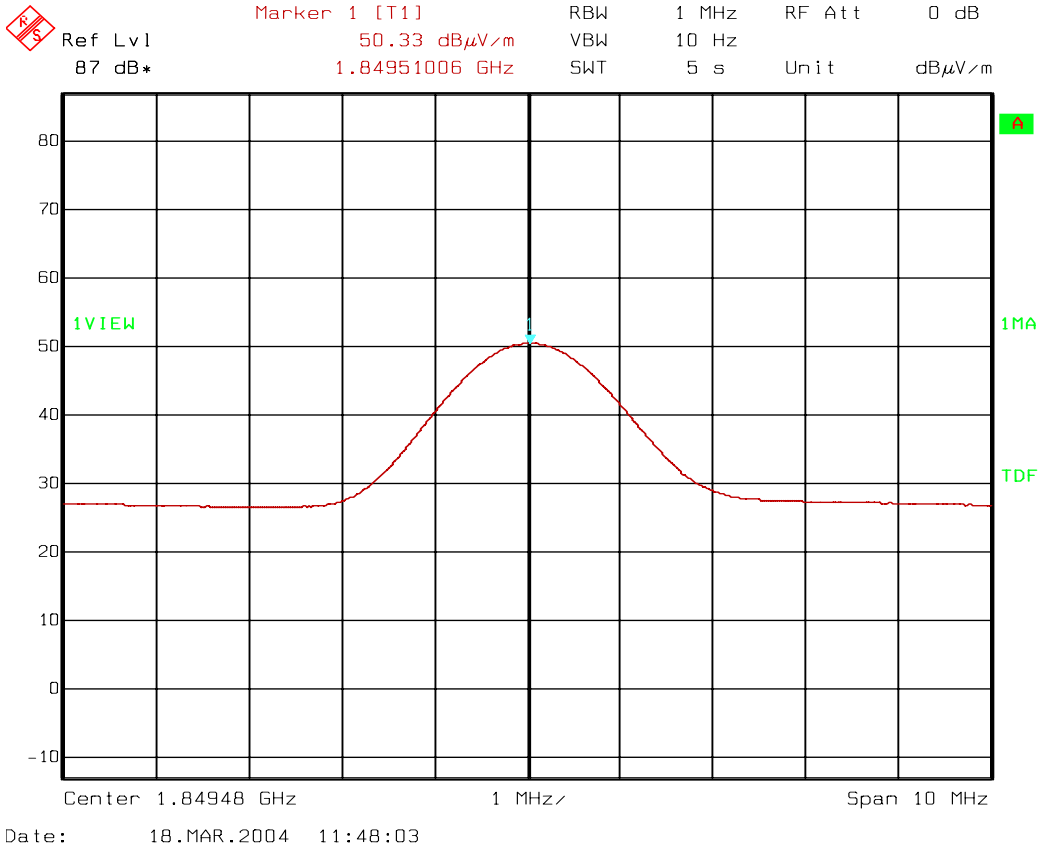
Max field strength –radiated emission(detachable ant) 5th Harmonic , ch 24



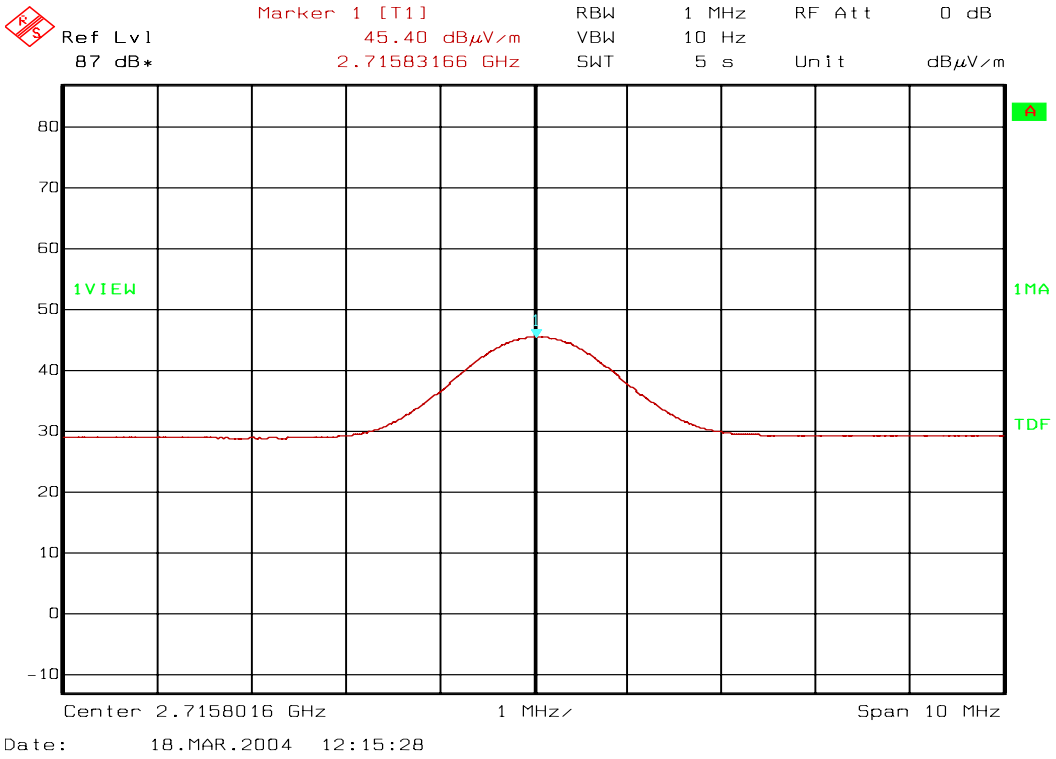
Max field strength (10Hz VBW) –radiated emission(detachable ant) 2nd Harmonic , ch 0



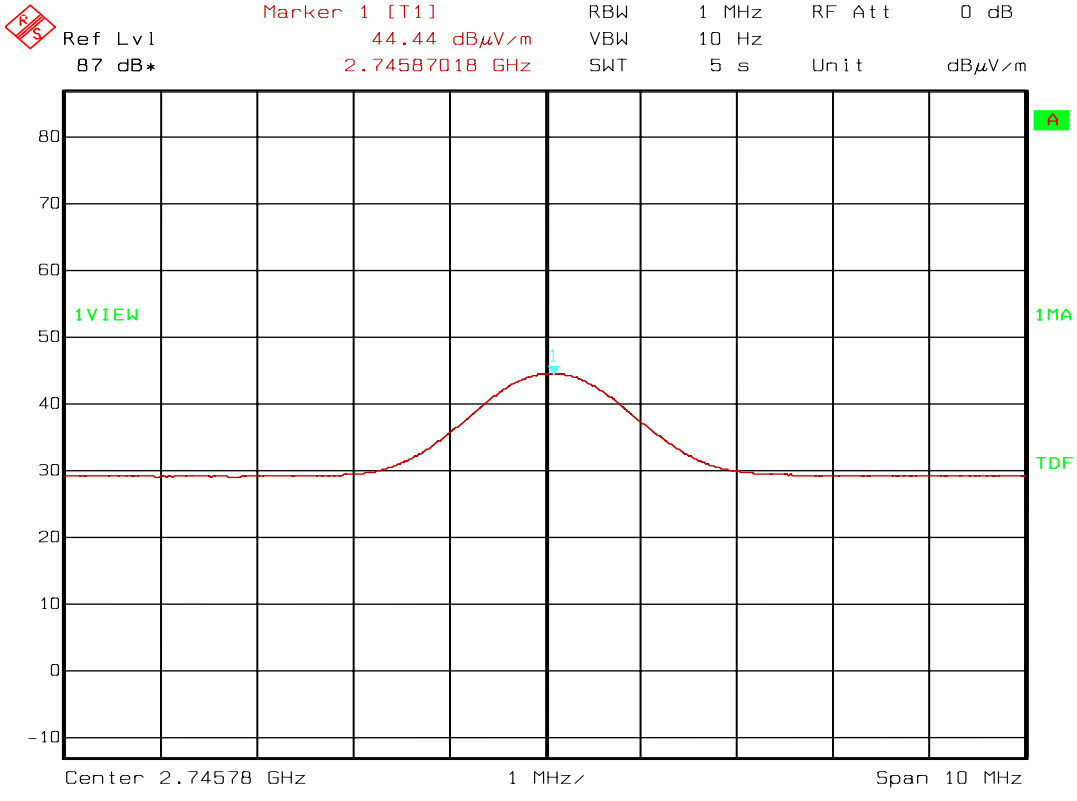
Max field strength(10HzVBW) –radiated emission(detachable ant) 2nd Harmonic , ch 12



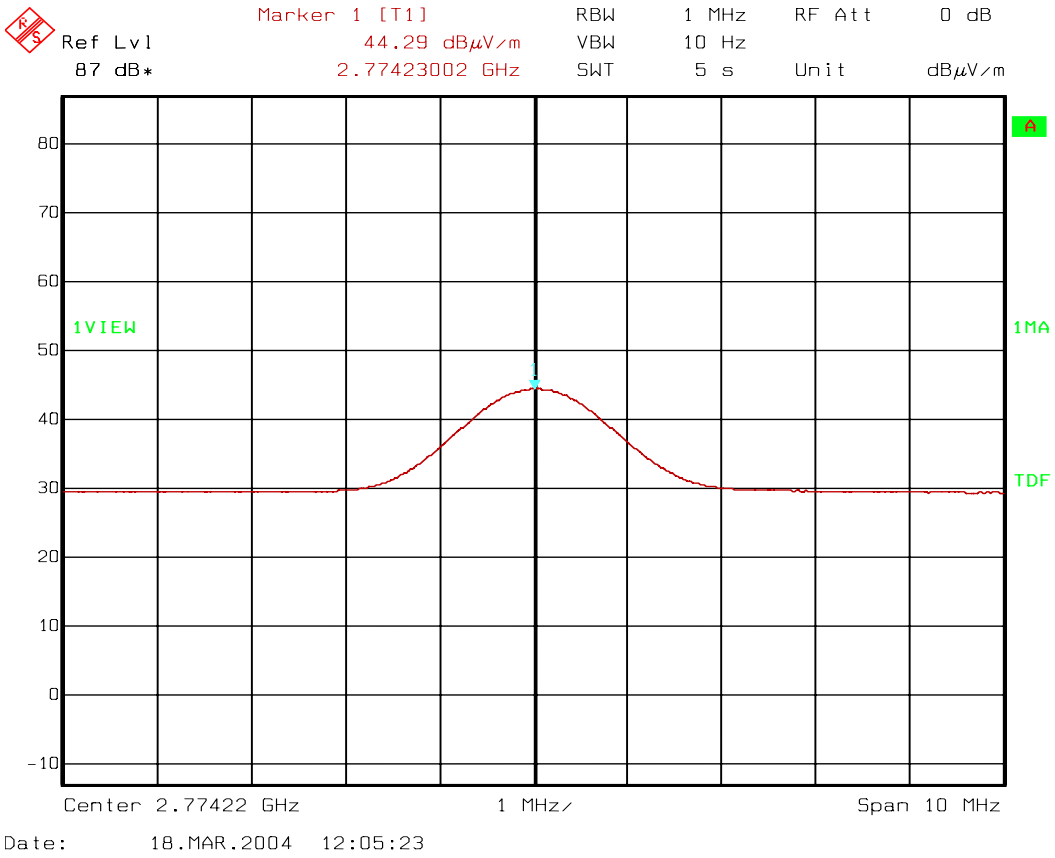
Max field strength(10HzVBW) –radiated emission(detachable ant) 2nd Harmonic , ch 24



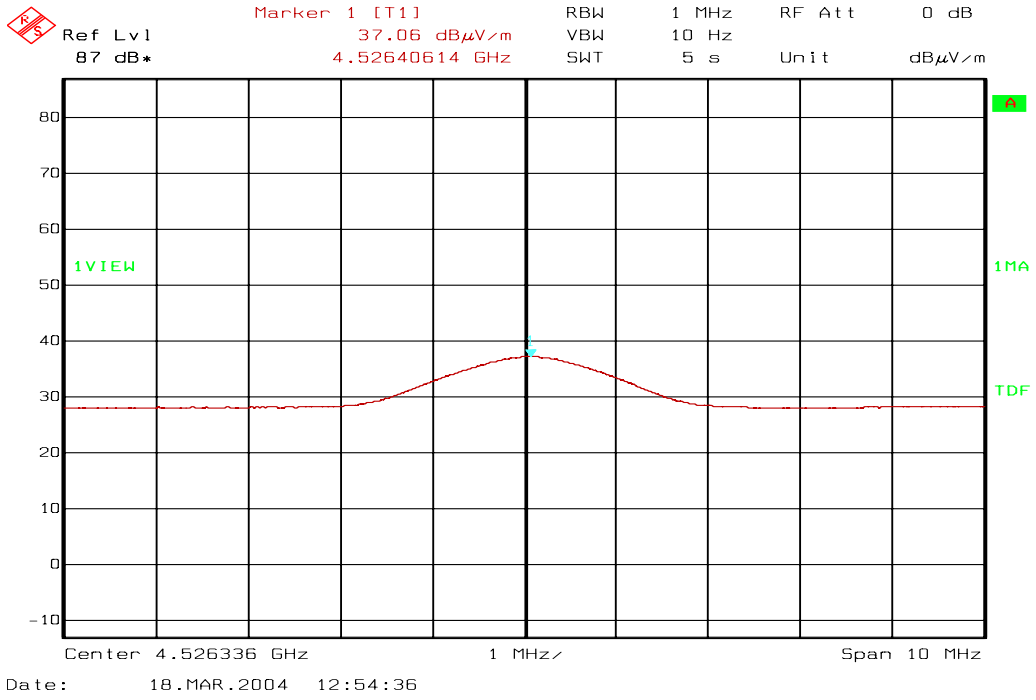
Max field strength(10HzVBW) –radiated emission(detachable ant) 3rd Harmonic , ch 0



Max field strength(10HzVBW) –radiated emission(detachable ant) 3rd Harmonic , ch 12



Max field strength(10HzVBW) –radiated emission(detachable ant) 3rd Harmonic , ch 24



Max field strength(10HzVBW) –radiated emission(detachable ant) 5th Harmonic , ch 0