

Test report no. : 77118/3

**Item tested : nRD24V1-Headset Reference
Design**

Type of equipment : 2.4GHz Evaluation Module

FCC ID : --

Client : Nordic Semiconductor ASA

**FCC Part 15.247
Digital Transmission System**

27 February 2007

Authorized by : 

Frode Sveinsen
Technical Verificator

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1 GENERAL INFORMATION

1.1 Testhouse Info

Name : Nemko Comlab
Address : Gåsevikveien 8, Box 96
N-2027 Kjeller, NORWAY
Telephone : +47 64 84 57 00
Fax : +47 64 84 57 05
E-mail: post@comlab.no
FCC test firm registration # : 994405
IC OATS registration # : 4443
Total Number of Pages: 45

1.2 Client Information

Name : Nordic Semiconductor ASA
Address : Vestre Rosten 81, N-7075 Tiller, Norway
Telephone : +47 7289 89 00
Fax : +47 72 89 89 89

Contact:

Name : Endre Rindalsholt
E-mail : endre.rindalsholt@nordicsemi.no

1.3 Manufacturer

Name : Nordic Semiconductor ASA
Address : Vestre Rosten 81, N-7075 Tiller, Norway
Telephone : +47 7289 89 00
Fax : +47 72 89 89 89
E-mail : /

2 Test Information

2.1 Test Item

Name :	nRD24V1-Headset Reference Design
FCC ID :	-
Model/version :	A
Serial number :	
Hardware identity and/or version:	nRD24V1-USBDONGLE-A and nRD24V1-APPBOARD-A with nRD24V1-RFMODULE-A
Software identity and/or version :	-
Frequency Range :	2402 – 2481 MHz
Tunable Bands :	1
Number of Channels :	79 ¹
Operating Modes :	TX & RX
Type of Modulation :	GFSK
Emissions Designator :	G1D
User Frequency Adjustment :	None, Software controlled
Rated Output Power :	0dBm
Type of Power Supply :	USB & battery
Antenna Connector :	Integral antenna and SMA connector
Antenna Diversity Supported :	None

1) 80 channels in use.

2.2 Test Environment

2.2.1 Normal test condition

Temperature: 20 - 22 °C

Relative humidity: 20 - 40 %

Normal test voltage: 2,5 V DC

The values are the limit registered during the test period.

2.3 Test Period

Item received date: 2006-12-11

Test period : from 2006-12-11 to 2006-12-12

3 TEST REPORT SUMMARY

3.1 General

Manufacturer: Nordic Semiconductor

Model No.: nRD24V1

Serial No.:

All measurements are traceable to national standards.

The tests were conducted for the purpose of demonstrating compliance with FCC CFR 47 Part 15.247 and Industry Canada RSS-210 Issue 6.

Radiated tests were conducted in accordance with ANSI C63.4-2003. 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

DTS Equipment Code

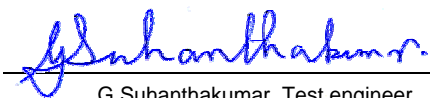
☐ Family Listing

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".



TEST REPORT #: 77118/3

TESTED BY: 
G.Suhanthakumar, Test engineer

DATE: 21.02.2007

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This test report applies only to the items and configurations tested.

3.2 Test Summary

Name of test	Paragraph #	Result
Supply voltage variations	15.31 (e)	Complies ²
Number of operating frequencies	15.31 (m)	Complies
Power Line Conducted Emissions (Receiver)	15.107(a)	N/A
Radiated Emissions limits (receiver)	15.109(a)	Complies
Antenna requirement	15.203	Complies ¹
Radiated emissions limits for restricted bands	15.205(a)	Complies
Power Line Conducted Emissions	15.207(a)	N/A
Radiated emission limits	15.209(a)	Complies
Bandwidth	15.247(a)(2)	Non- Compliant ³
Peak Power Output	15.247(b)(3)	Complies
Power Spectral Density	15.247(d)	Complies
Out-of-band emissions (Antenna Conducted)	15.247(c)	Complies
Out-of-band emissions (Radiated)	15.247(c)	Complies
Upper band edge radiated emission	15.247(c)	Complies

¹ Integral antenna only

² The manufacturer specified voltage range is 2.5 V dc \pm 1%

³ The bandwidth was measured with incorrect test modulation. Please see the corresponding document for the *nRD24H1-Remote Control Reference Design* for the correct measurements. The radio will be the same in both designs, hence the bandwidth requirements will be compliant in both cases.

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 is only used for power supply. The measurements are performed at channels near top Ch 81, near middle Ch 42 and near bottom Ch 02. The output level is set to maximum in the software.

All ports were populated during spurious emission measurements.

A temporary antenna connector is used only for making conducted RF measurements for evaluation purposes.

3.5 Family List Rationale

Not Applicable.

4 TEST RESULTS

4.1 Power-line Conducted Emissions

Para. No.: 15.207 (a)

Test Performed By: G.Suwanthakumar

Date of Test: -

Measurement procedure: ANSI C63.4-2003 using 50 μ H/50 ohms LISN.

Test Results: N/A

Measurement Data: -

Battery operated device.

4.2 Minimum 6 dB Bandwidth

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

Test Performed By: G.Suwanthakumar

Date of Test: 11.12.2006

Test Results: No-Compliant¹

Measurement Data:

nRD24V1-RFMODULE:

6 dB Bandwidth (kHz)		
Ch 02 2402MHz	Ch 42 2442MHz	Ch 81 2481MHz
400.8	380.8	400.8

nRD24V1-USBDONGLE:

6 dB Bandwidth (kHz)		
Ch 02 2402MHz	Ch 42 2442MHz	Ch 81 2481MHz
340.7	340.7	340.7

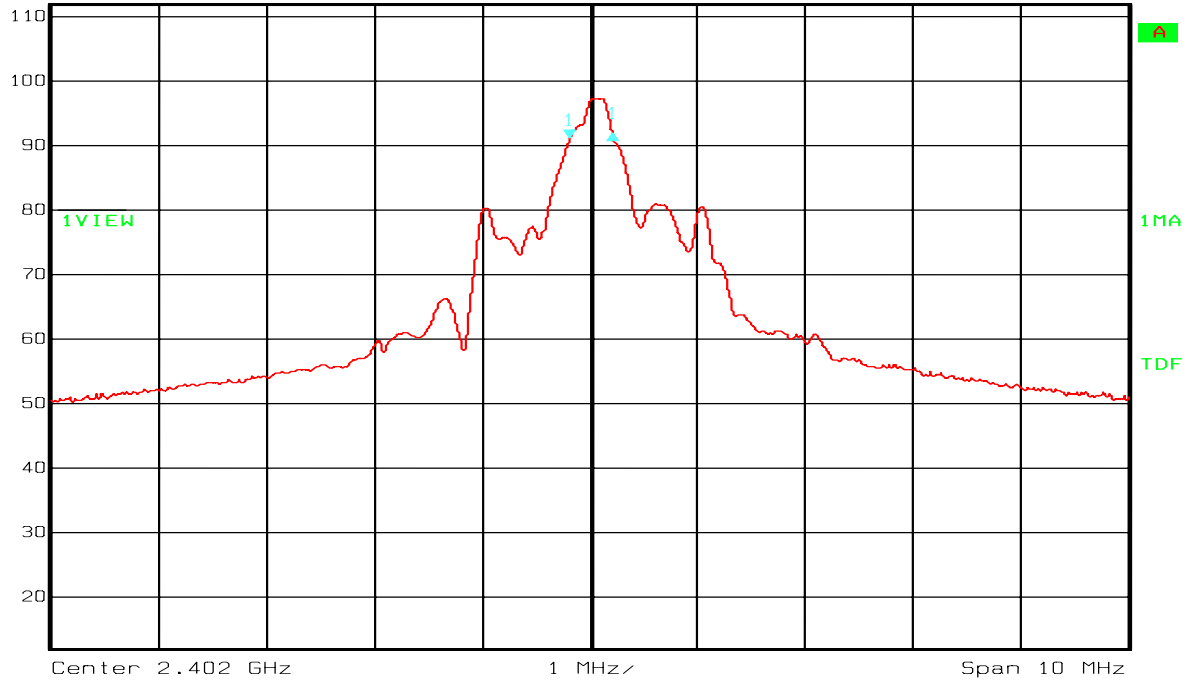
Power supply variation within manufacturer specified range has no influence on measured value.

Requirements:

For Digital Transmission Systems in the 2400-2483.5 MHz band the minimum 6 dB bandwidth shall be at least 500 KHz.

¹ The bandwidth was measured with incorrect test modulation. Please see the corresponding document for the **nRD24H1-Remote Control Reference Design** for the correct measurements. The radio will be the same in both designs, hence the bandwidth requirements will be compliant in both cases.

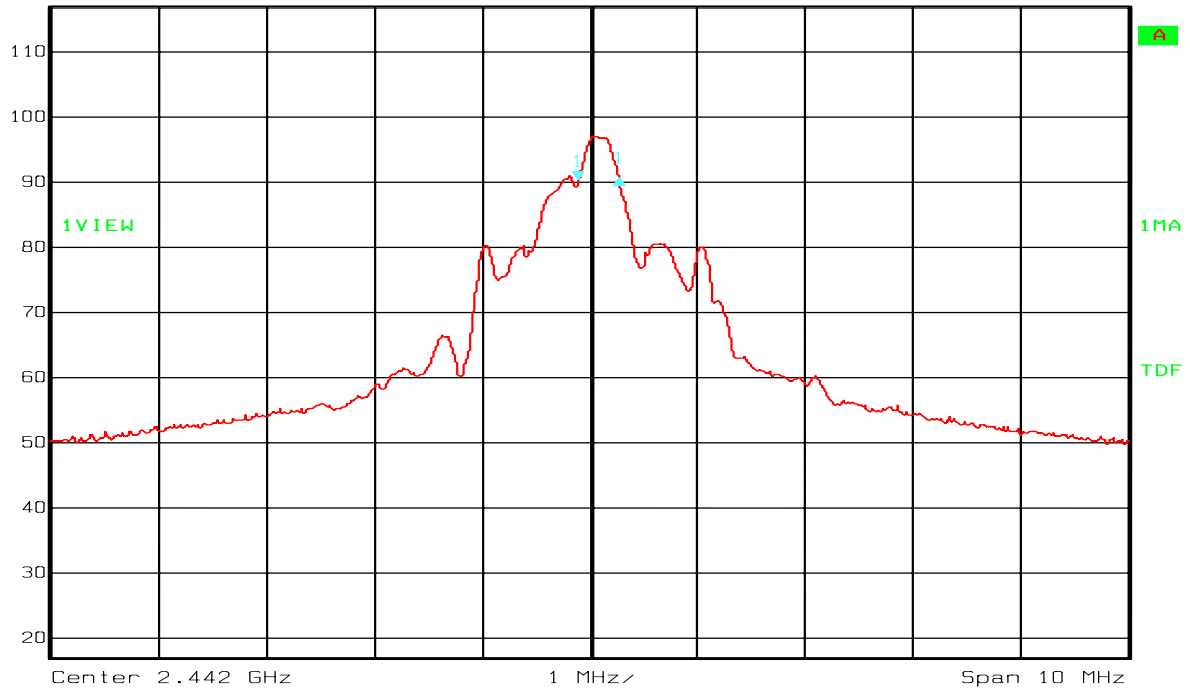
Delta 1 [T1] RBW 100 kHz RF Att 20 dB
 Ref Lvl 112 dB* 1.01 dB VBW 100 kHz
 400.80160321 kHz SWT 200 ms Unit dB μ V/m



Date: 11.DEC.2006 11:48:10

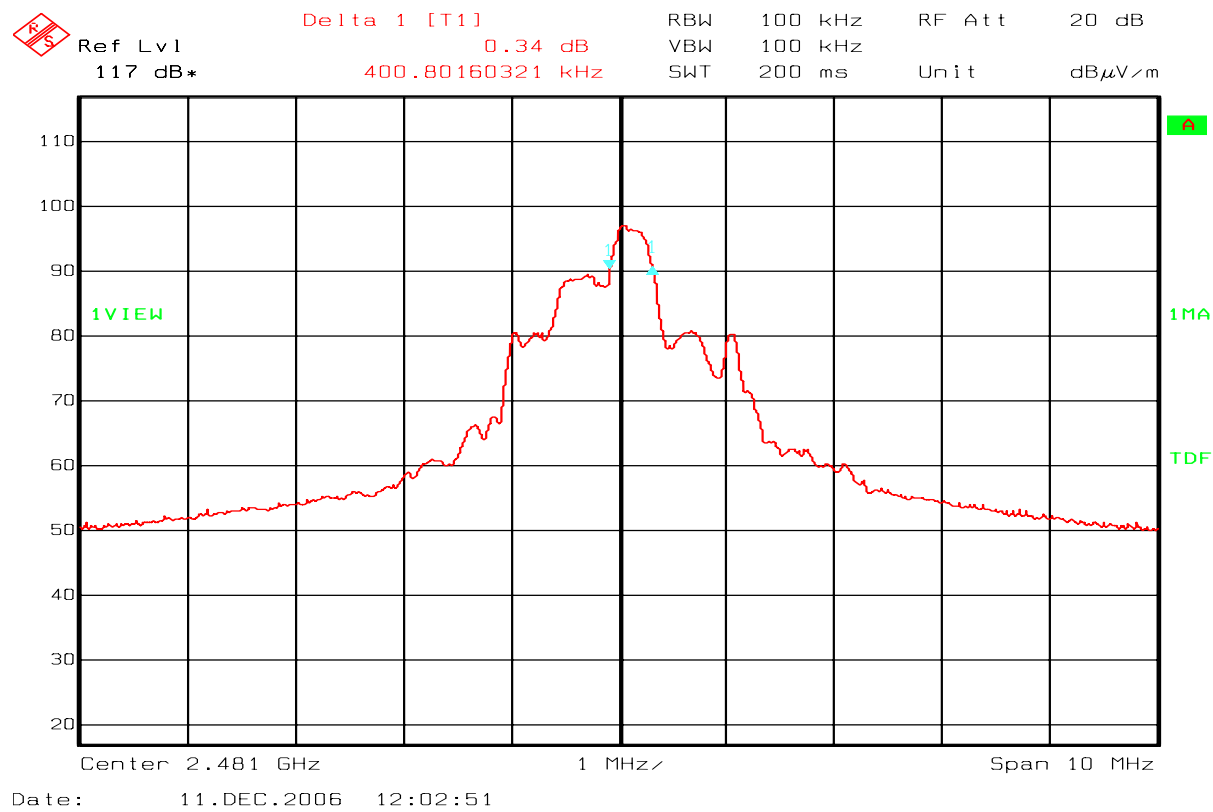
nRD24V1-RFMODULE Ch02 – 6 dB bandwidth – 400.8 kHz

Delta 1 [T1] RBW 100 kHz RF Att 20 dB
 Ref Lvl 117 dB* 0.56 dB VBW 100 kHz
 380.76152305 kHz SWT 200 ms Unit dB μ V/m



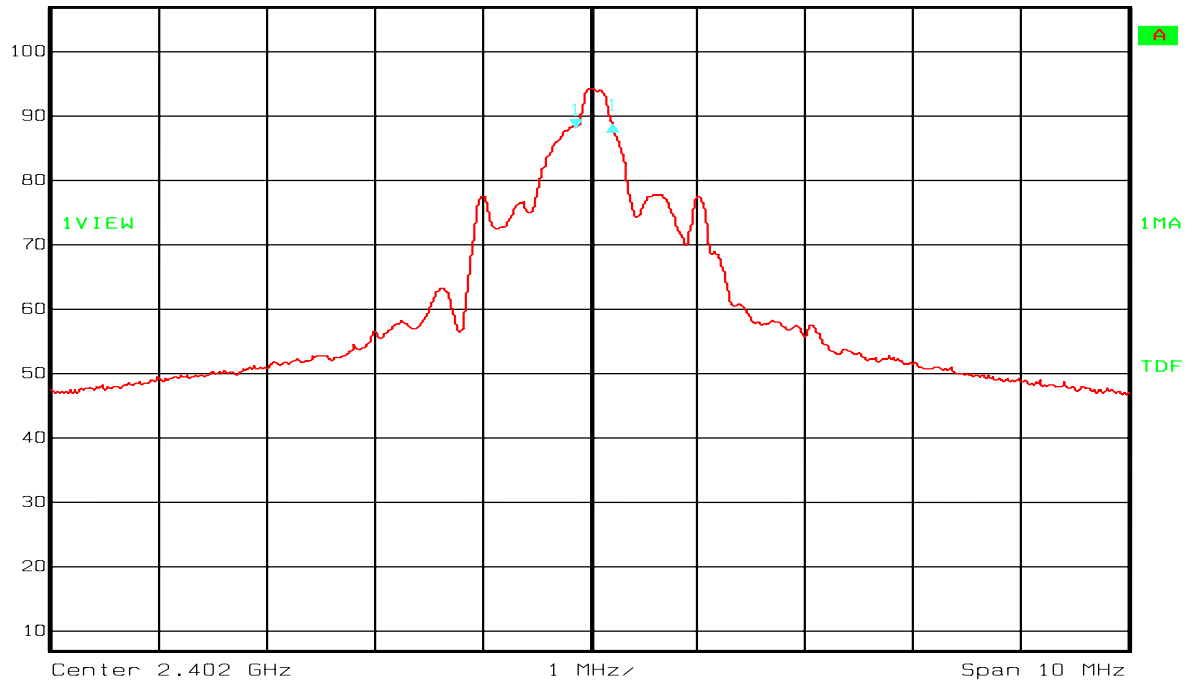
Date: 11.DEC.2006 12:00:36

nRD24V1-RFMODULE- Ch42 – 6 dB bandwidth – 380.76kHz



nRD24V1-RFMODULE -CH81 – 6 dB bandwidth – 400.8kHz

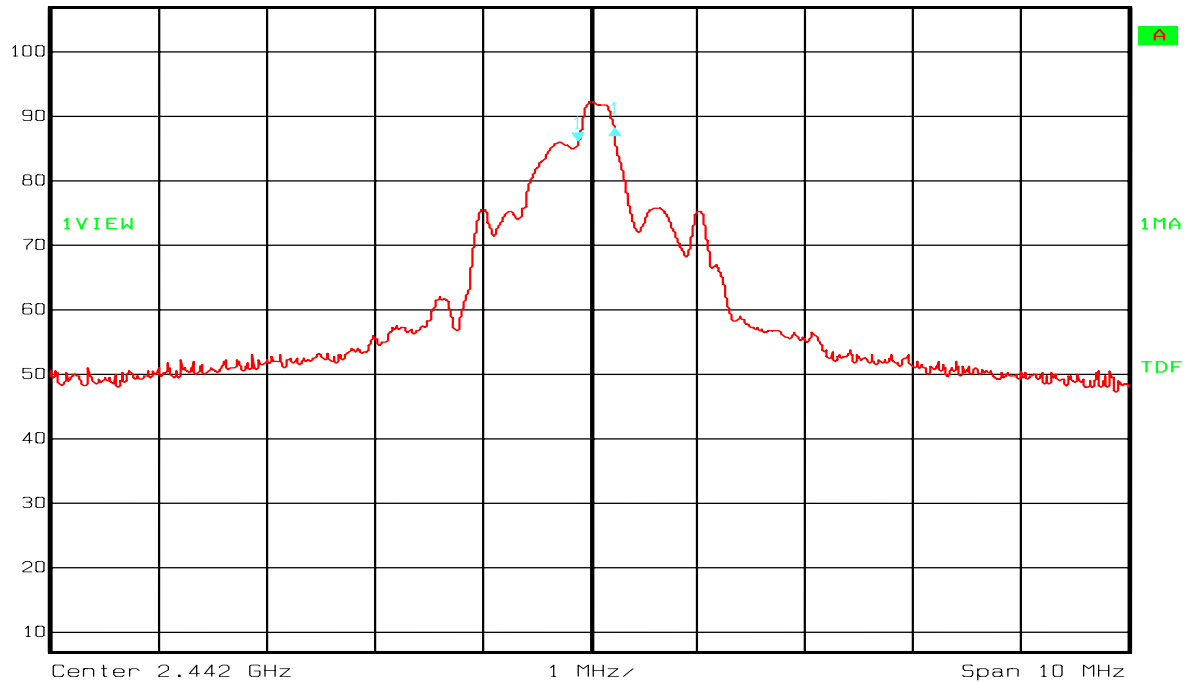
Delta 1 [T1] RBW 100 kHz RF Att 10 dB
 Ref Lvl 0.54 dB VBW 100 kHz
 107 dB* 340.68136273 kHz SWT 200 ms Unit dB μ V/m



Date: 11.DEC.2006 12:42:53

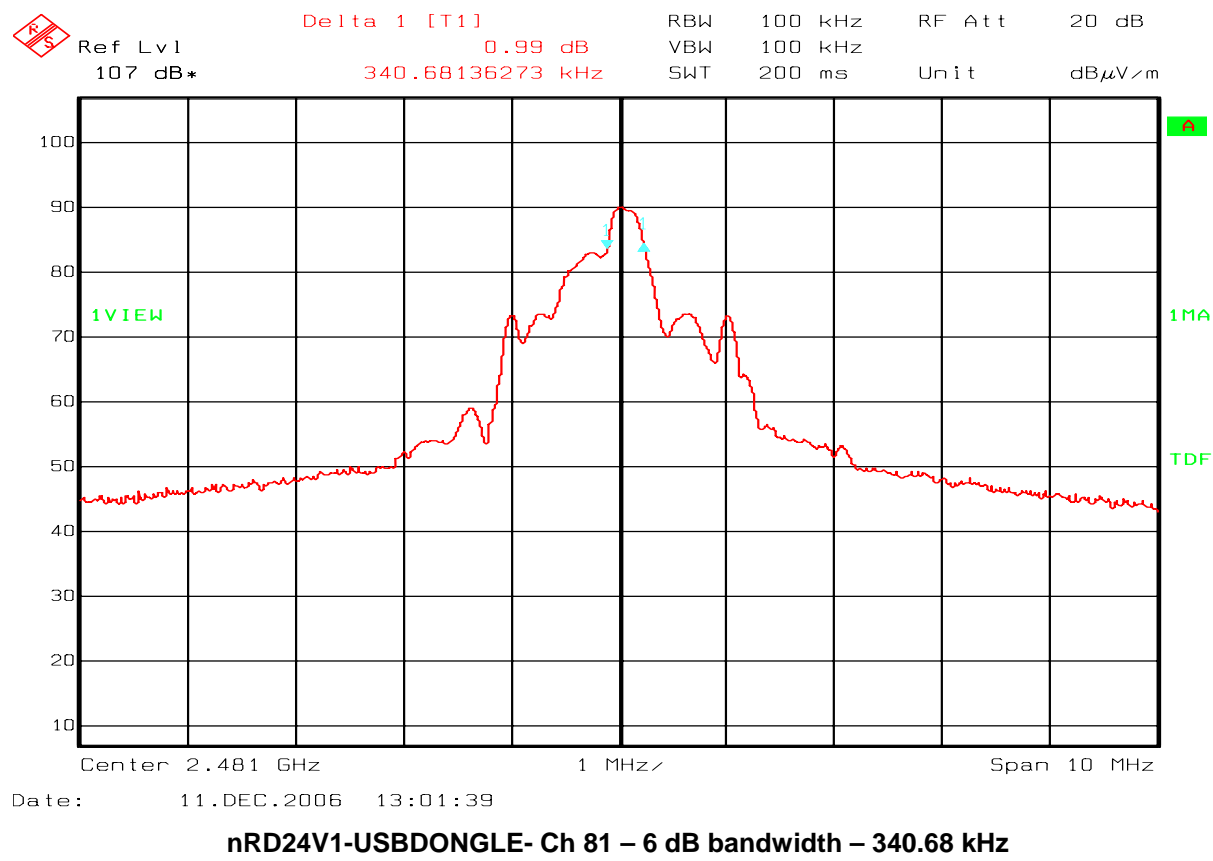
nRD24V1-USBDONGLE USB- Ch02 – 6 dB bandwidth – 340.68kHz

Delta 1 [T1] RBW 100 kHz RF Att 30 dB
 Ref Lvl 2.13 dB VBW 100 kHz
 107 dB* 340.68136273 kHz SWT 200 ms Unit dB μ V/m



Date: 11.DEC.2006 12:54:25

nRD24V1-USBDONGLE- Ch42 – 6 dB bandwidth – 340.68kHz



1VIEW

1MA

TDF

4.3 Peak Power Output - nRD24V1-RFMODULE

Para. No.: 15.247 (b)

Test Performed By: G.Suhandhakumar

Date of Test: 12.12.2006

Test Results: Complies

Measurement Data:

Maximum Conducted Peak Output Power

RF channel	Ch02	Ch40	Ch81
Measured value (mW)	0.79	0.84	0.82

Maximum EIRP

RF channel	Ch02	Ch40	Ch 81
Measured EIRP (mW)	1.15	1.04	0.82
Antenna gain dBi	1.63	0.93	0

Antenna gain = $10 \cdot \log(\text{EIRP} / \text{Conducted power})$ dBi

The EIRP is measured using substitution method.

Detachable antenna?

☐ Yes ☒ No

If detachable, is the antenna connector non-standard?

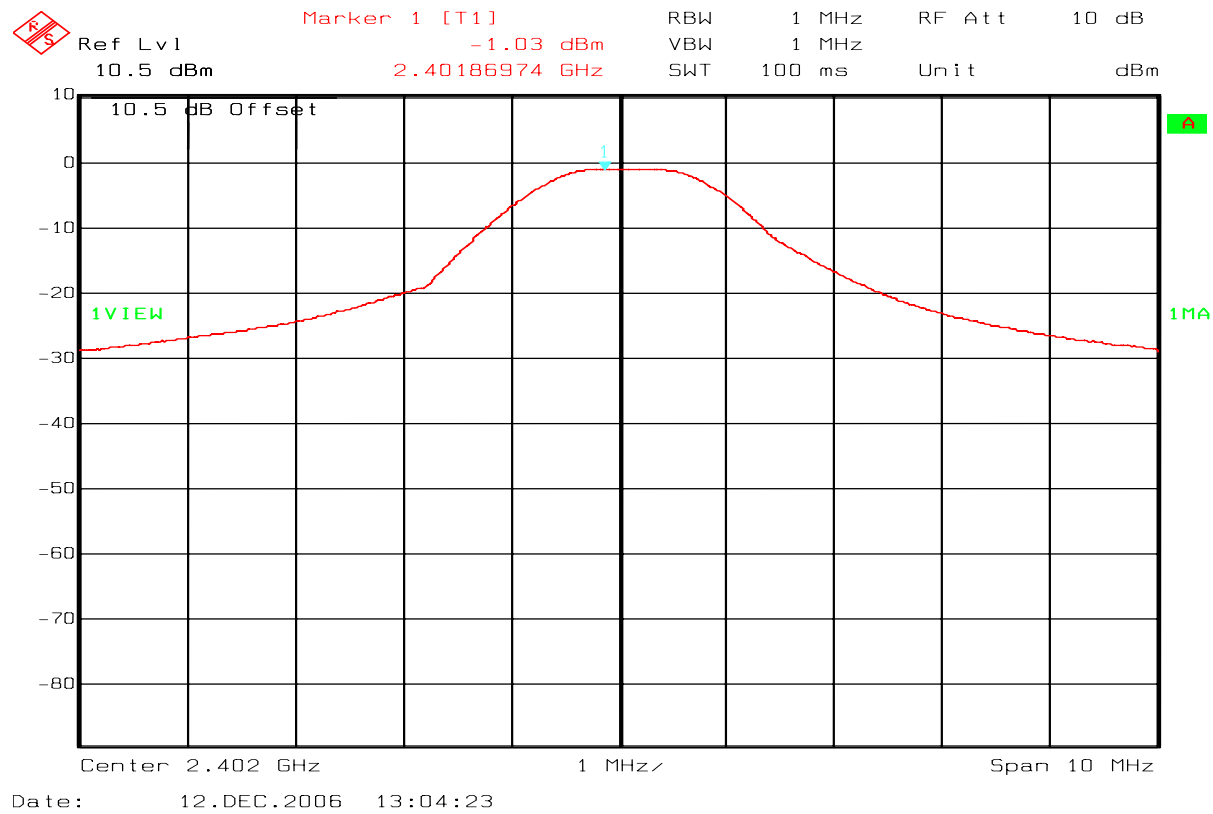
☐ Yes ☐ No

Requirements:

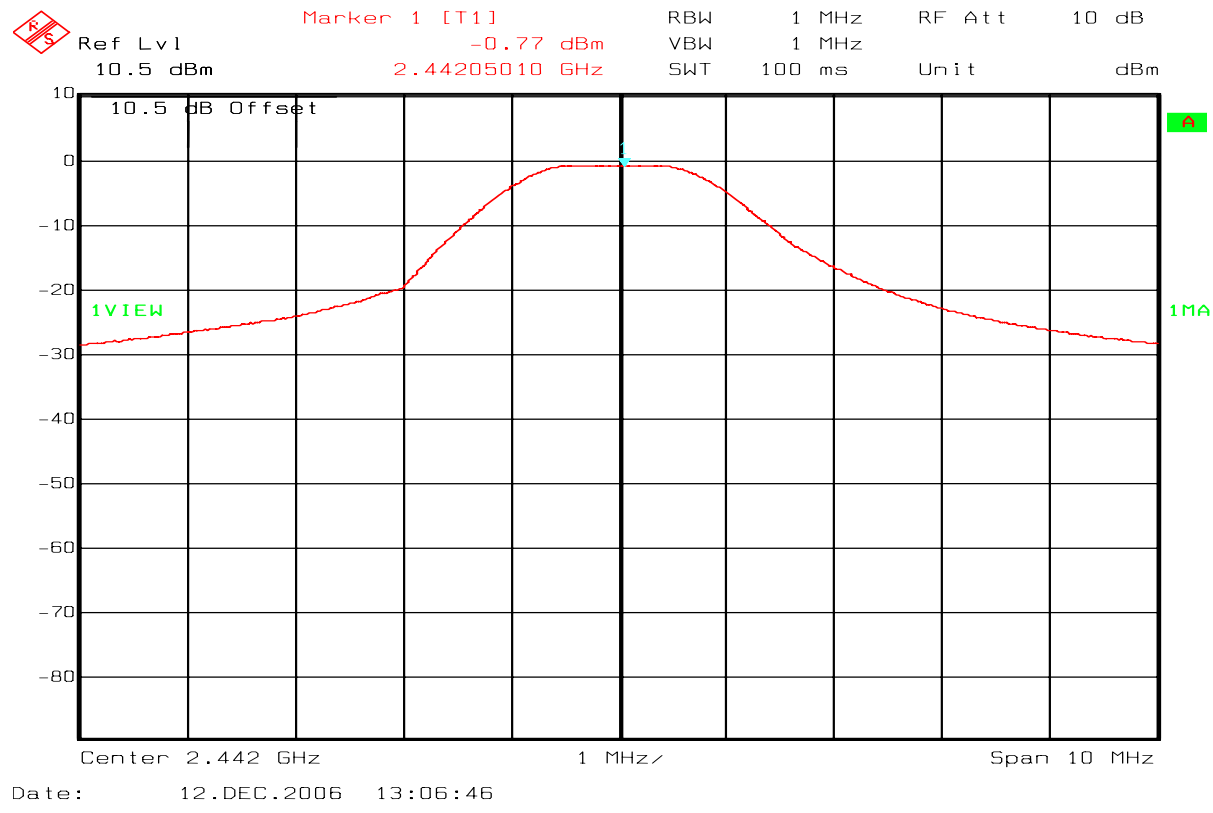
The maximum peak output power shall not exceed the following limits:

For Digital Transmission Systems in the 2400 - 2483.5 MHz band: 1 Watt

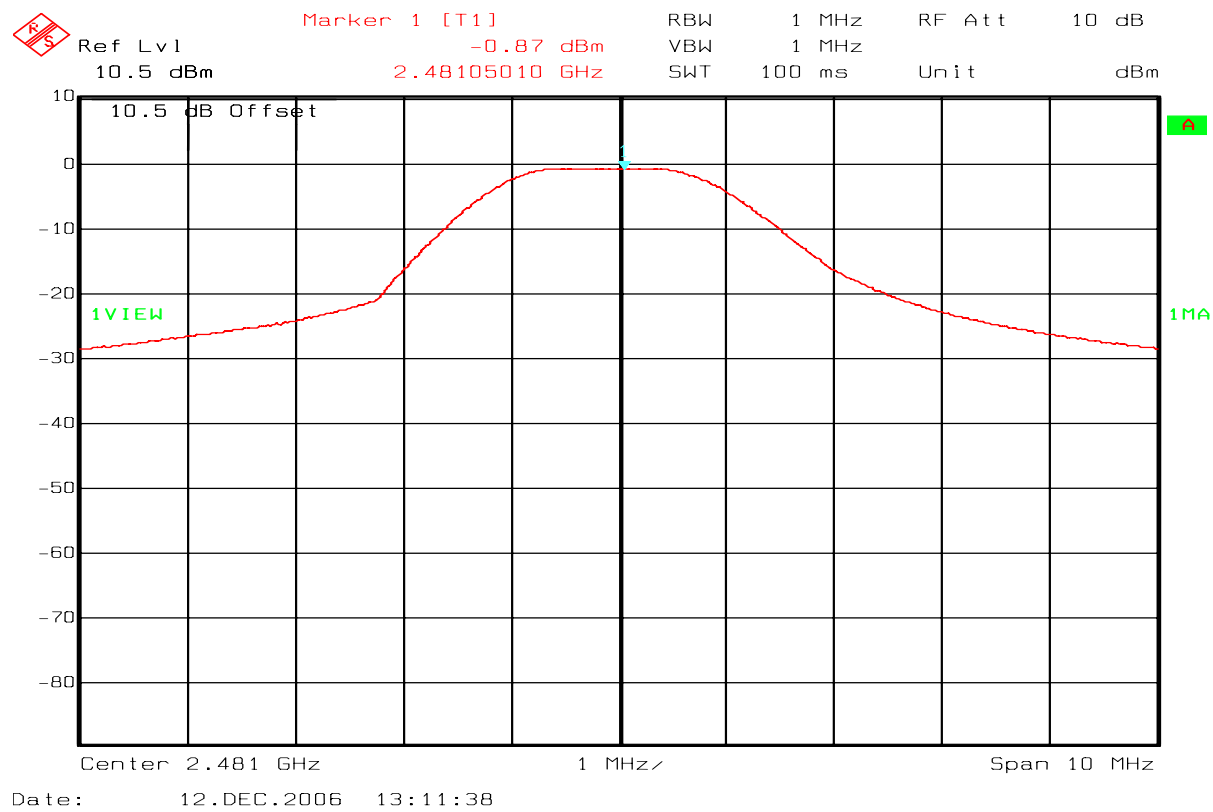
If transmitting antennas of directional gain greater than 6 dBi are used, the peak output power from the intentional radiator shall be reduced below the stated value above by the amount in dB that the directional gain of the antenna exceeds 6 dBi.



nRD24V1-RFMODULE - Ch02 – Conducted Peak Output Power



nRD24V1-RFMODULE - Ch40 – Conducted Peak Output Power



nRD24V1-RFMODULE - Ch81 – Conducted Peak Output Power

4.4 Peak Power Output – nRD24V1-USBDONGLE

Para. No.: 15.247 (b)

Test Performed By: G.Suinthakumar

Date of Test: 12.12.2006

Test Results: Complies

Measurement Data:

Maximum Conducted Peak Output Power

RF channel	Ch02	Ch40	Ch81
Measured value (mW)	1.04	0.91	0.72

Maximum EIRP

RF channel	Ch02	Ch40	Ch 81
Measured EIRP (mW)	0.35	0.21	0.16
Antenna gain dBi	-4.7	-6.4	-6.5

Antenna gain = $10 \cdot \log(\text{EIRP} / \text{Conducted power})$ dBi

The EIRP is measured using substitution method.

Detachable antenna?

☐ Yes ☒ No

If detachable, is the antenna connector non-standard?

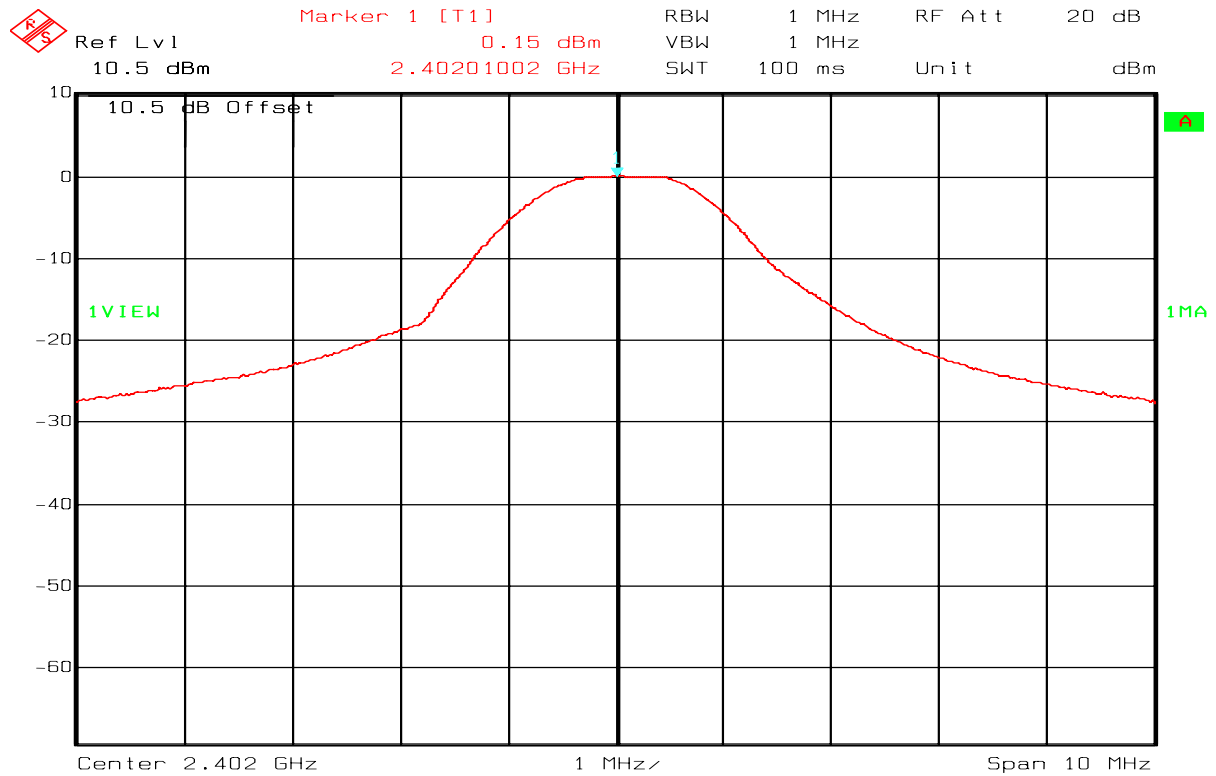
☐ Yes ☐ No

Requirements:

The maximum peak output power shall not exceed the following limits:

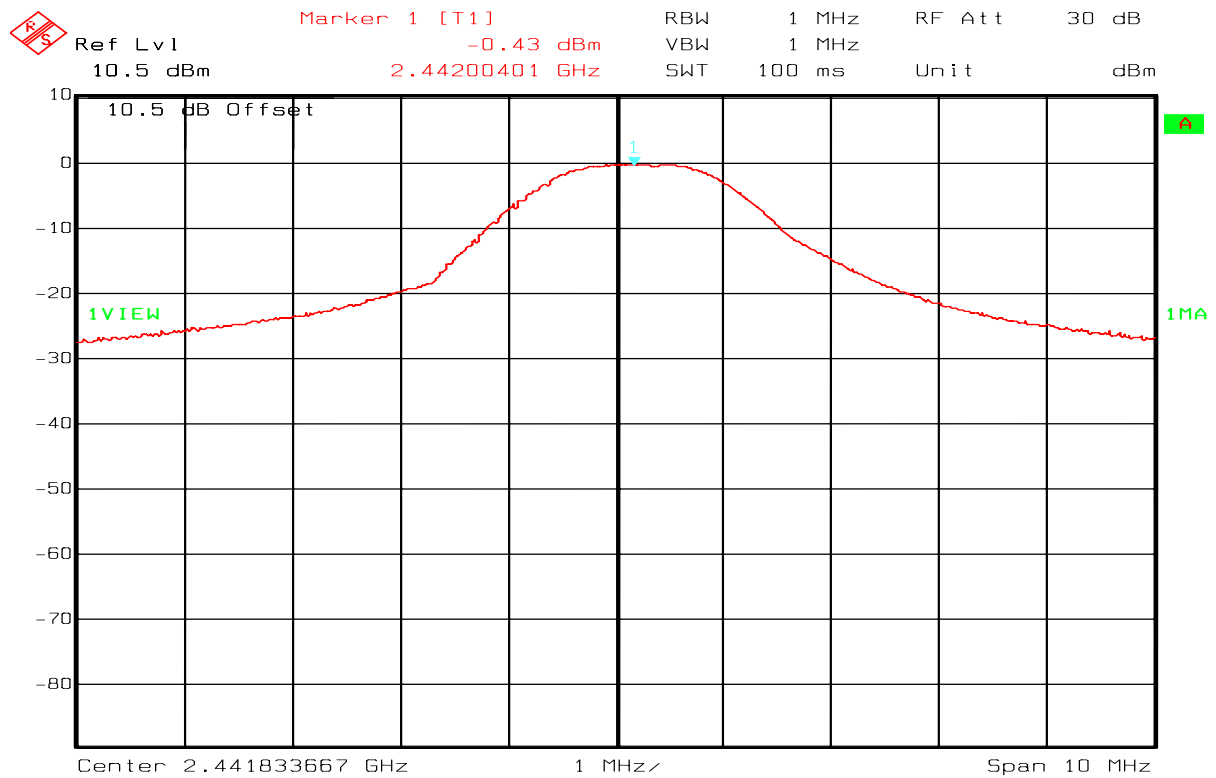
For Digital Transmission Systems in the 2400 - 2483.5 MHz band: 1 Watt

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.



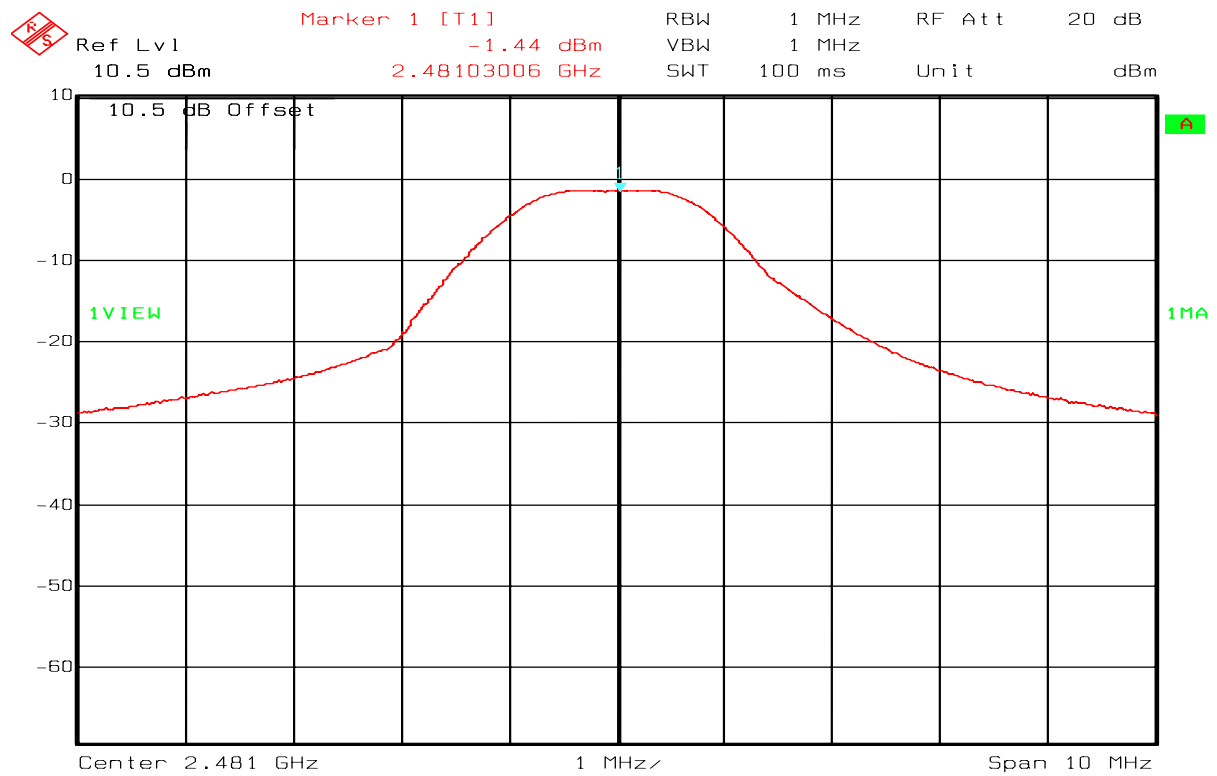
Date: 12.DEC.2006 12:54:38

nRD24V1-USBDONGLE – Ch02 – Conducted Peak Output Power



Date: 12.DEC.2006 12:24:25

nRD24V1-USBDONGLE – Ch42 – Conducted Peak Output Power



Date: 12.DEC.2006 12:56:20

nRD24V1-USBDONGLE - Ch81 – Conducted Peak Output Power

4.5 Spurious Emissions (Radiated)- nRD24V1-RFMODULE

Para. No.: 15.247 (c)

Test Performed By: G.Suwanthakumar

Date of Test: 11.12.2006

Test Results: Complies

Measurement Data:

Lower Band-edge radiated measurements

Frequency	Power below nearest channel, dB		Limit	Margin
GHz	RF ch 02	DSS	dB	dB
2.4	32.6		-16	16.6

Band-edge field strength 2.4 GHz.

Marker Delta 100kHz RBW: 32.6dB

Peak Field Strength $97.2 - 32.6 = 64.6$ dB μ V/m

Average Field Strength: 64.6 dB μ V/m $- 16.0$ dB = 48.6 dB μ V/m

Upper Band-edge radiated measurements

Frequency	Power below nearest channel, dB		Limit	Margin
GHz	RF ch 81	DSS	dB	dB
2.4835	40.5		-16	24.3

Band-edge field strength 2.4835 GHz.

Marker Delta 100kHz RBW: 40.5dB

Peak Field Strength $95.99 - 40.5 = 55.49$ dB μ V/m

Average Field Strength: 55.49 dB μ V/m $- 16$ dB = 39.49 dB μ V/m

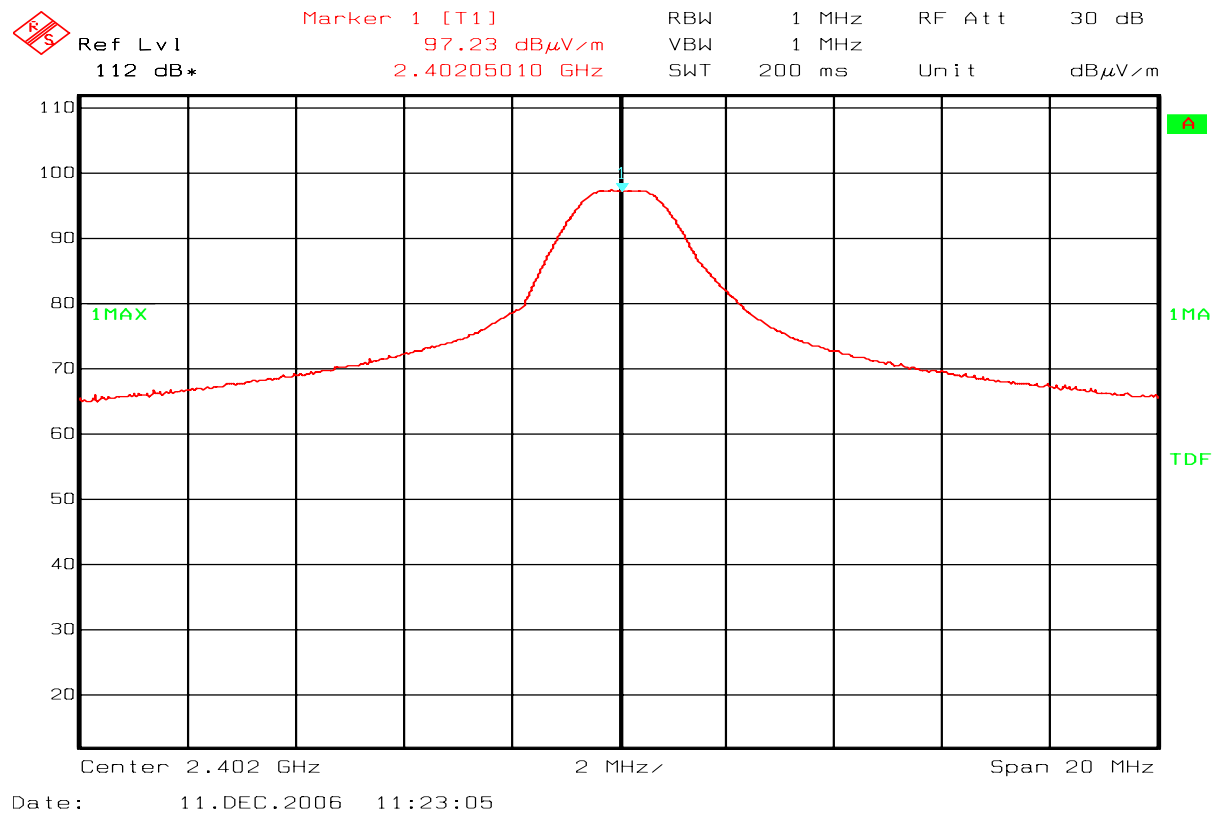
RF conducted emissions to 25 GHz

Maximum RF level outside operating band:

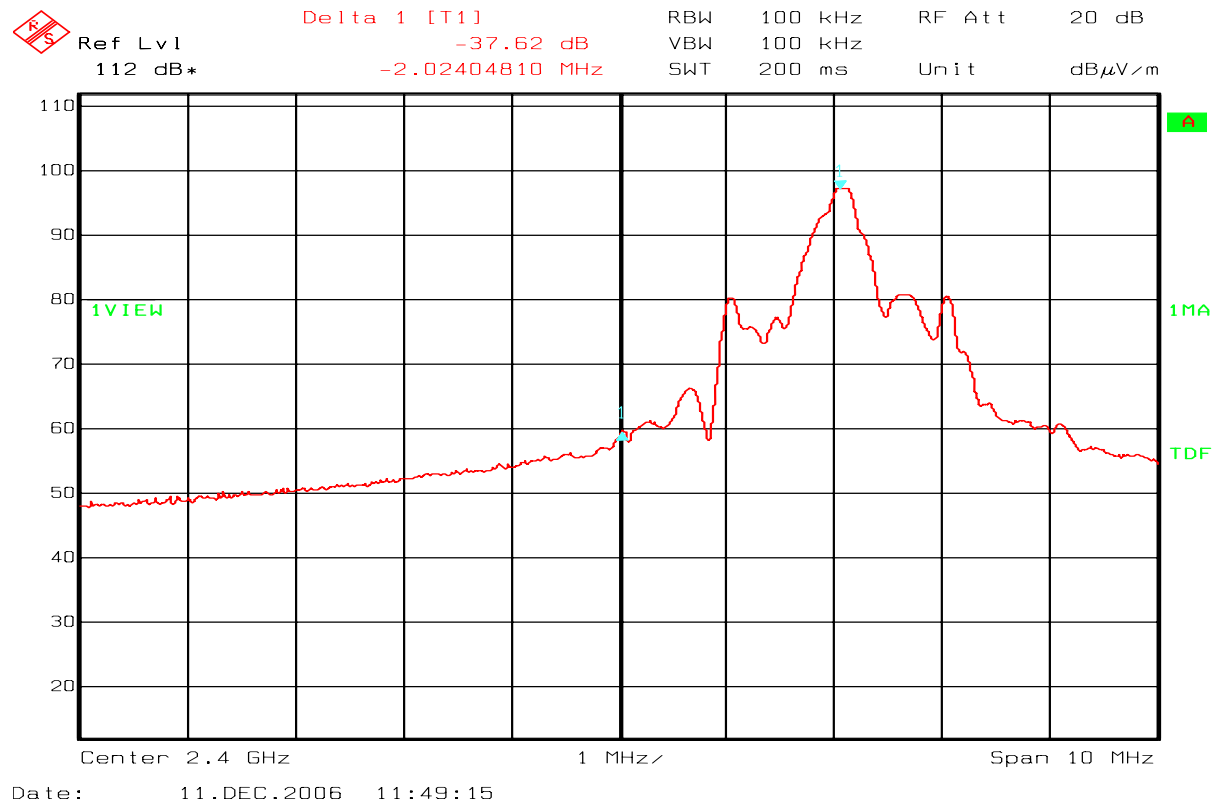
RF ch 11: 50 dB/C, margin > 20 dB

RF ch 18: 50 dB/C, margin > 20 dB

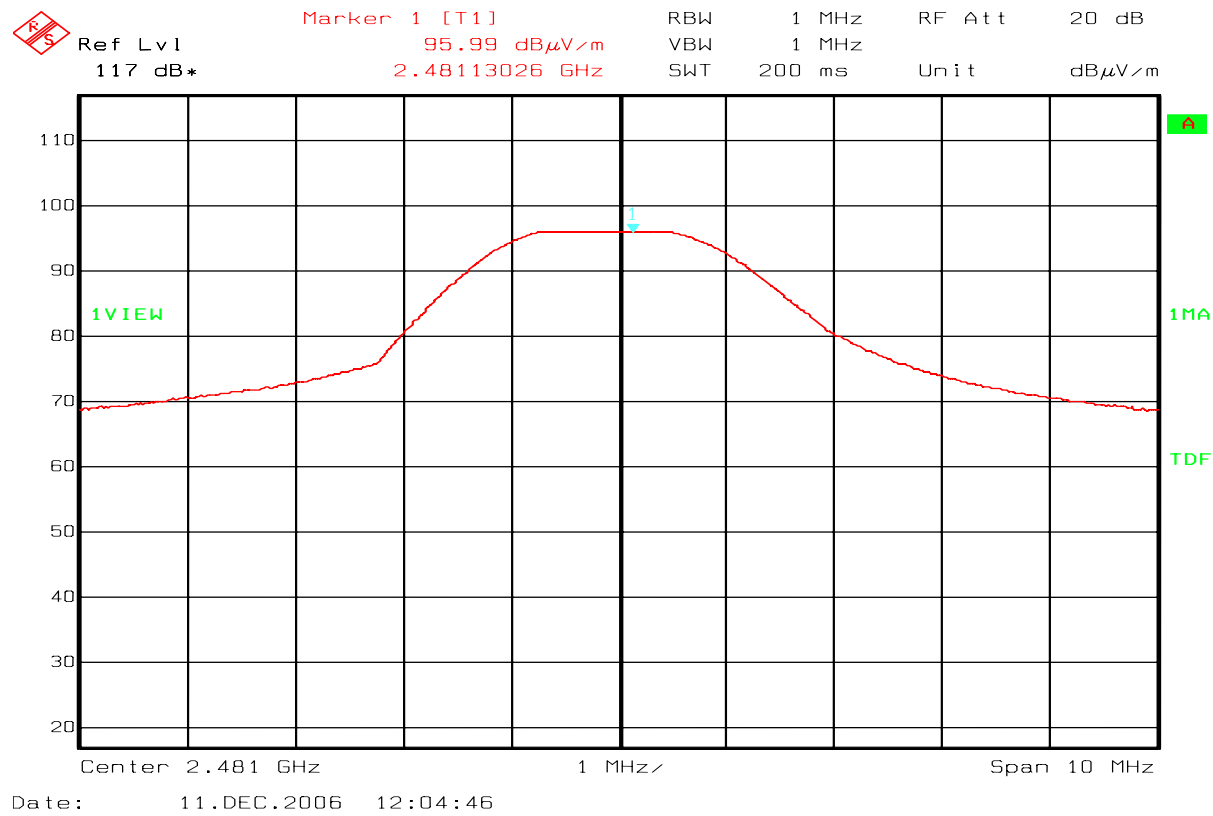
RF ch 26: 49 dB/C, margin > 20 dB



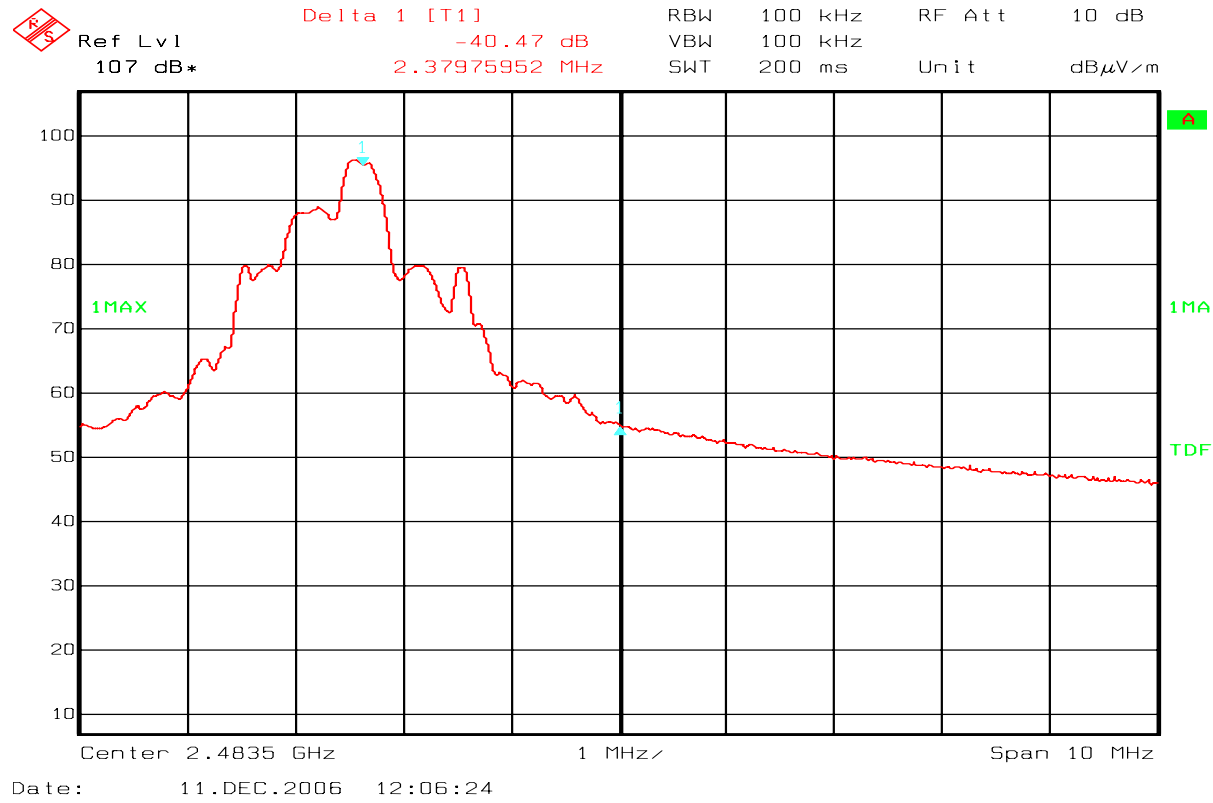
nRD24V1-RFMODULE - Ch02 - lower-band -field strength



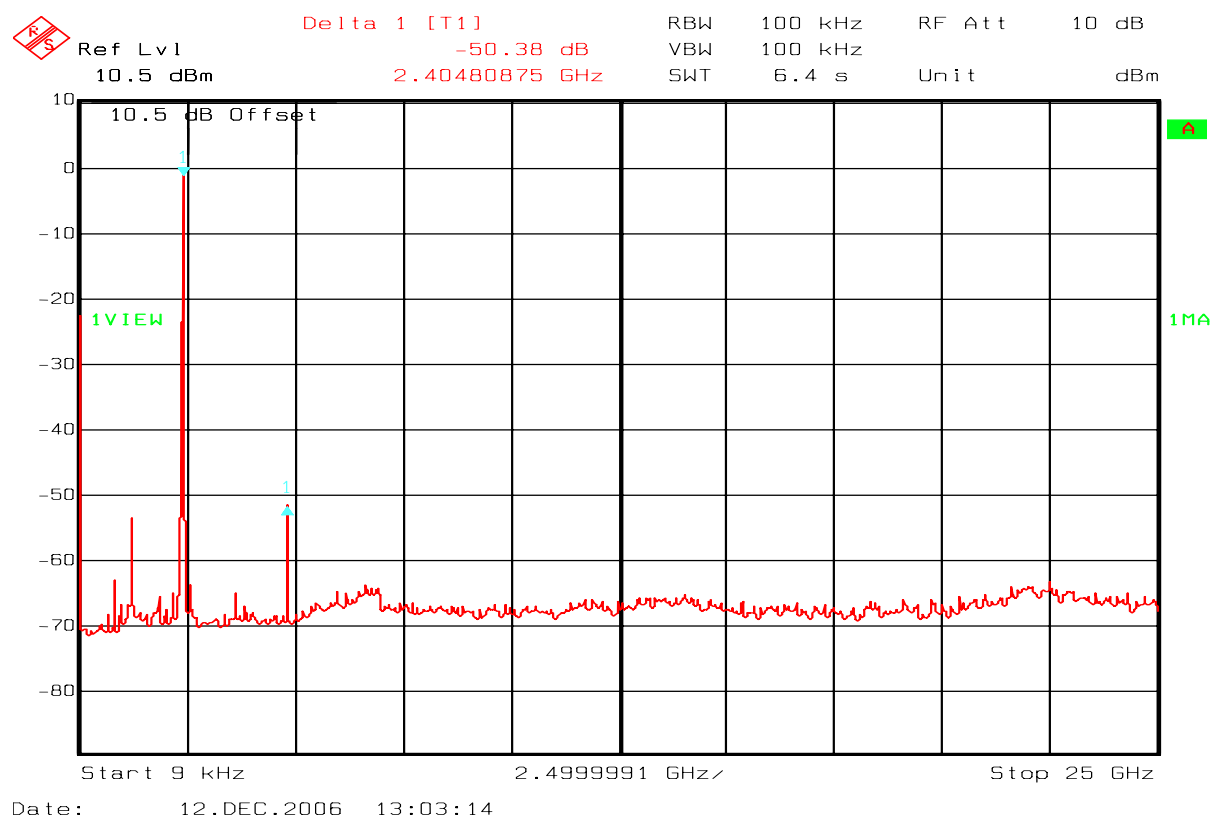
nRD24V1-RFMODULE - Ch02 - Lower-band-edge - Delta-marker



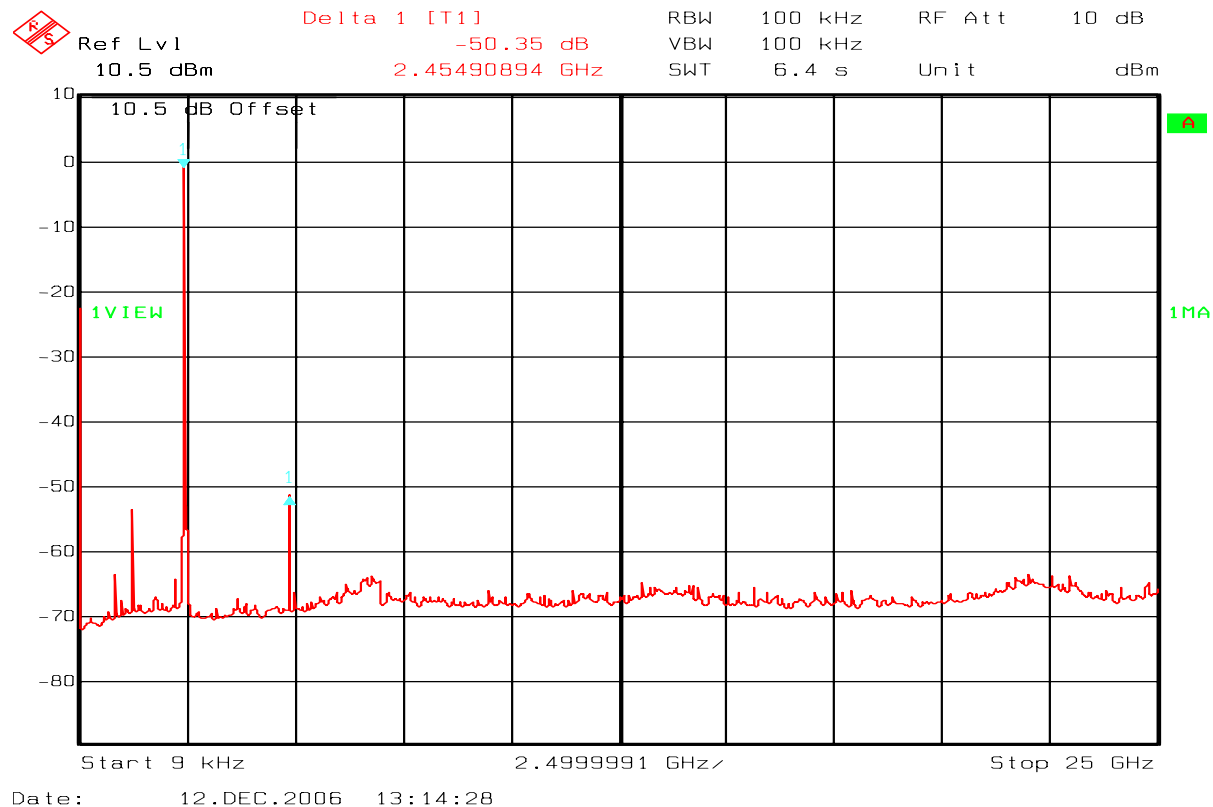
nRD24V1-RFMODULE – Ch81 – upper-band –field strength



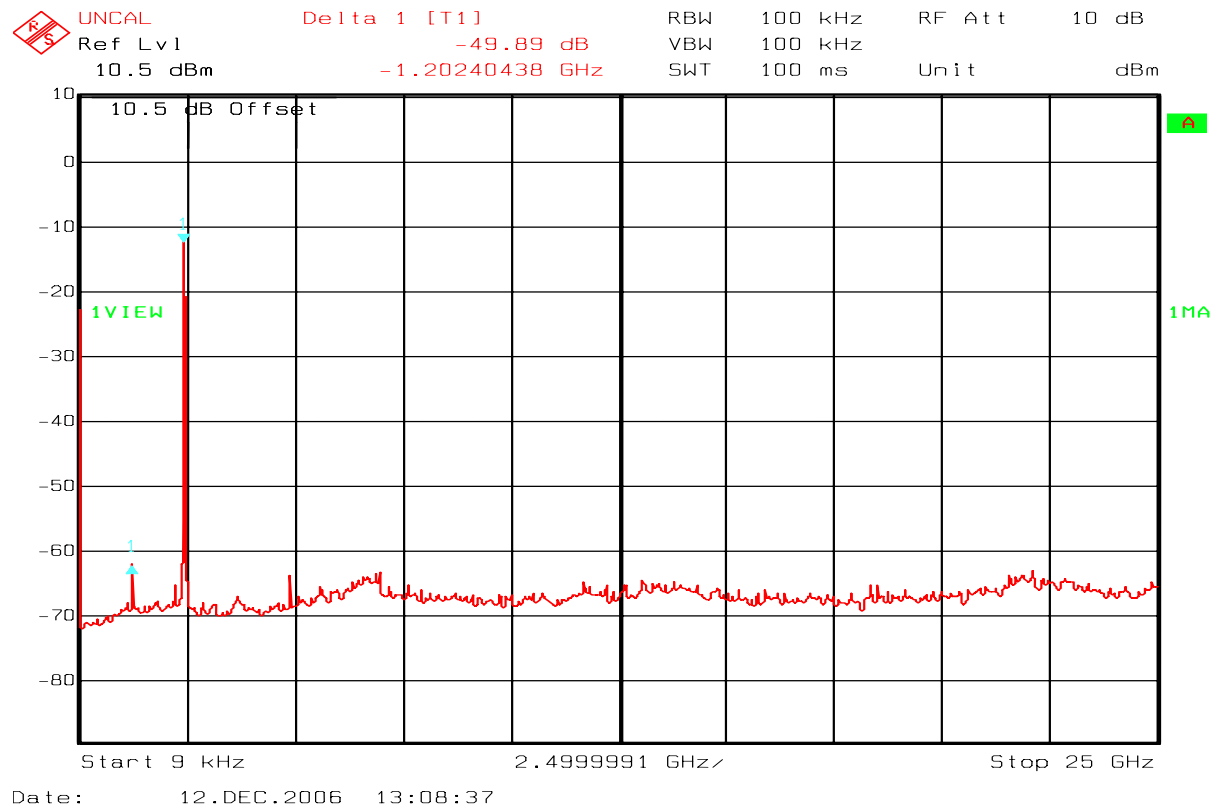
nRD24V1-RFMODULE Ch81 – Upper-band-edge – Delta-marker



nRD24V1-RFMODULE - Ch02 – Conducted Spurious – 9kHz – 25GHz



nRD24V1-RFMODULE -Ch40 – Conducted Spurious – 9kHz – 25GHz



nRD24V1-RFMODULE- Ch81 – Conducted Spurious – 9kHz – 25GHz

4.6 Spurious Emissions (Radiated)- nRD24V1-USBDONGLE

Para. No.: 15.247 (c)

Test Performed By: G.Suinthakumar

Date of Test: 11.12.2006

Test Results: Complies

Measurement Data:

Lower Band-edge radiated measurements

Frequency	Power below nearest channel, dB	Limit	Margin
GHz	RF ch 02 DSS	dB	dB
2.4	37.9	-16	21.9

Band-edge field strength 2.4 GHz.

Marker Delta 100kHz RBW: 37.9dB

Peak Field Strength $94.3 - 37.9 = 56.4$ dB μ V/m

Average Field Strength: 56.4 dB μ V/m $- 16.0$ dB = 40.4 dB μ V/m

Upper Band-edge radiated measurements

Frequency	Power below nearest channel, dB	Limit	Margin
GHz	RF ch 81 DSS	dB	dB
2.4835	37.9	-16	21.9

Band-edge field strength 2.4835 GHz.

Marker Delta 100kHz RBW: 37.9dB

Peak Field Strength $89.87 - 37.9 = 51.97$ dB μ V/m

Average Field Strength: 51.97 dB μ V/m $- 16$ dB = 35.9 dB μ V/m

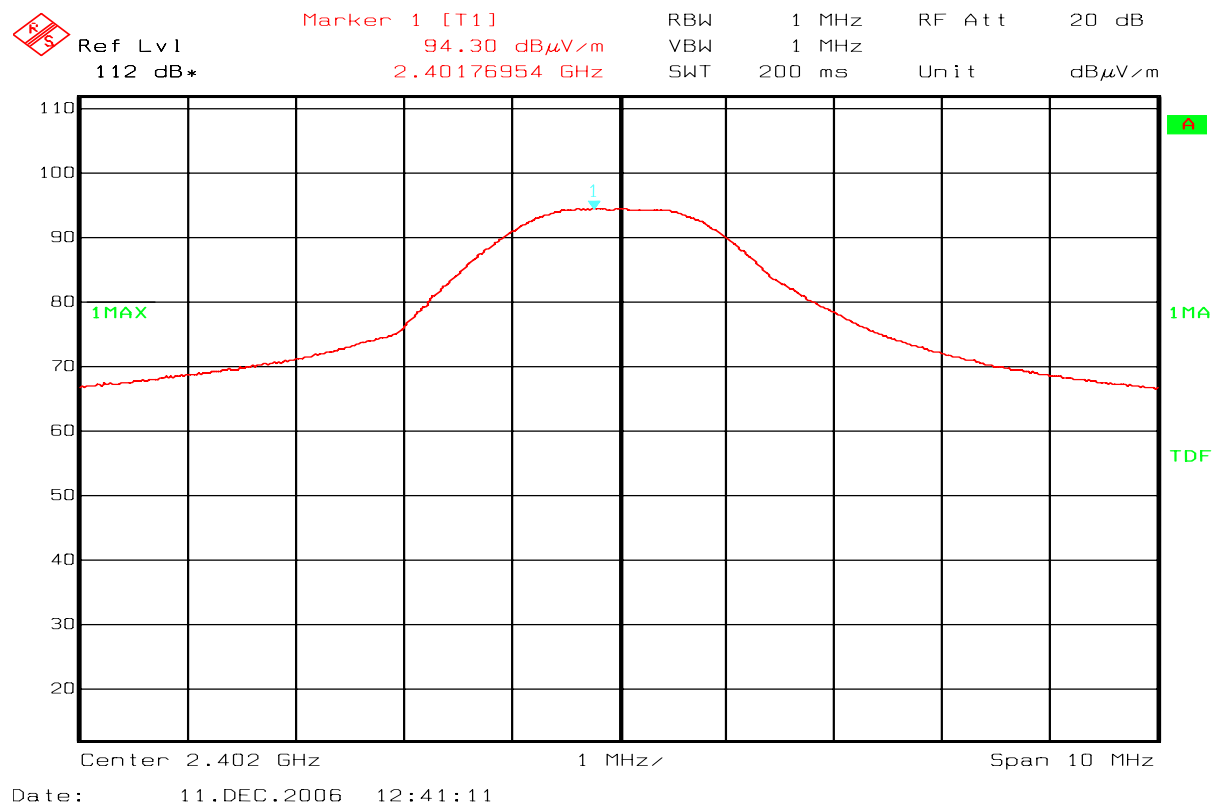
RF conducted emissions to 25 GHz

Maximum RF level outside operating band:

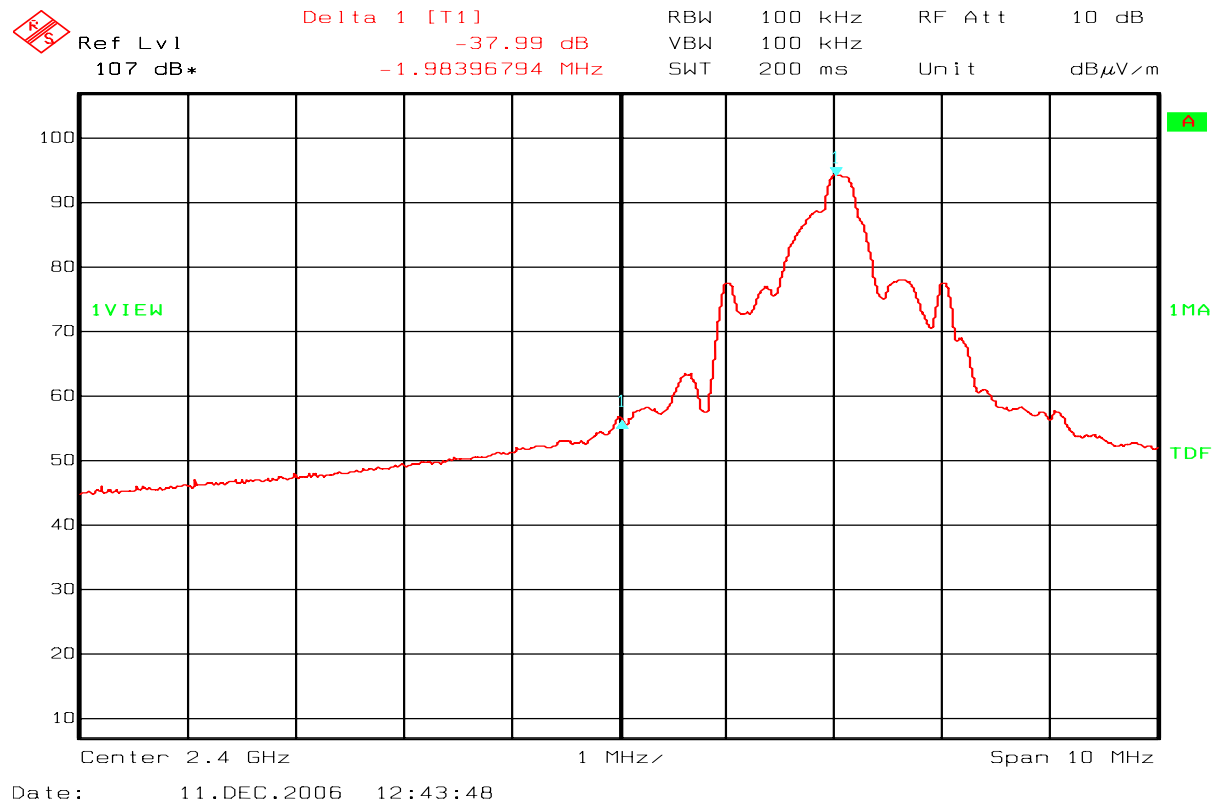
RF ch 11: 43 dB/C, margin > 20 dB

RF ch 18: 43 dB/C, margin > 20 dB

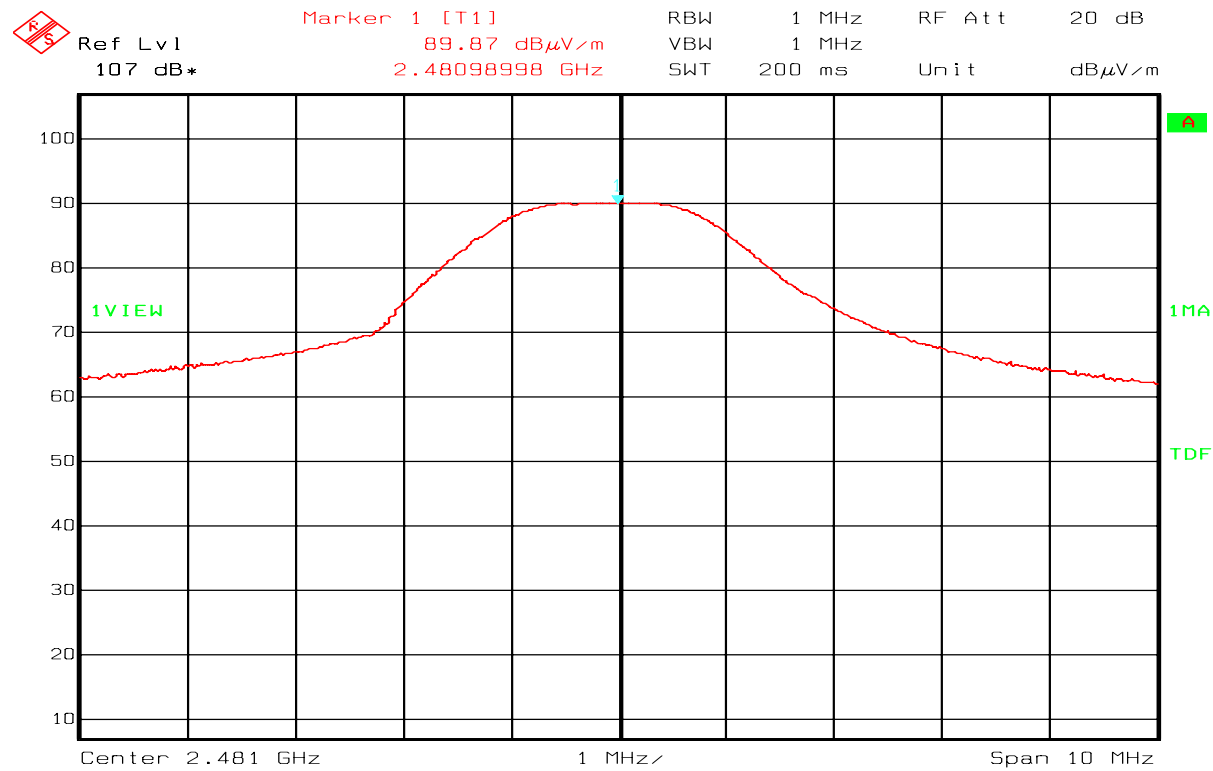
RF ch 26: 44 dB/C, margin > 20 dB



nRD24V1-USBDONGLE - Ch 02 – lower band – Field strength

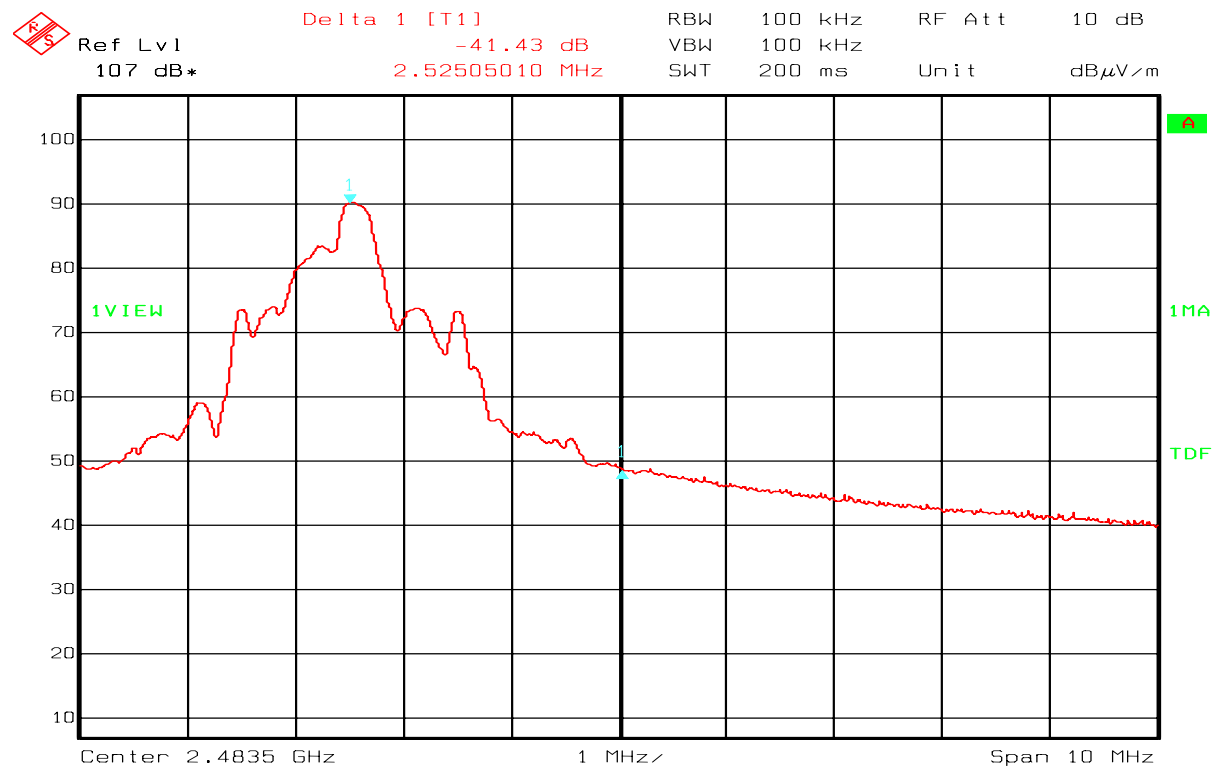


nRD24V1-USBDONGLE - Ch 02 – lower band – marker delta



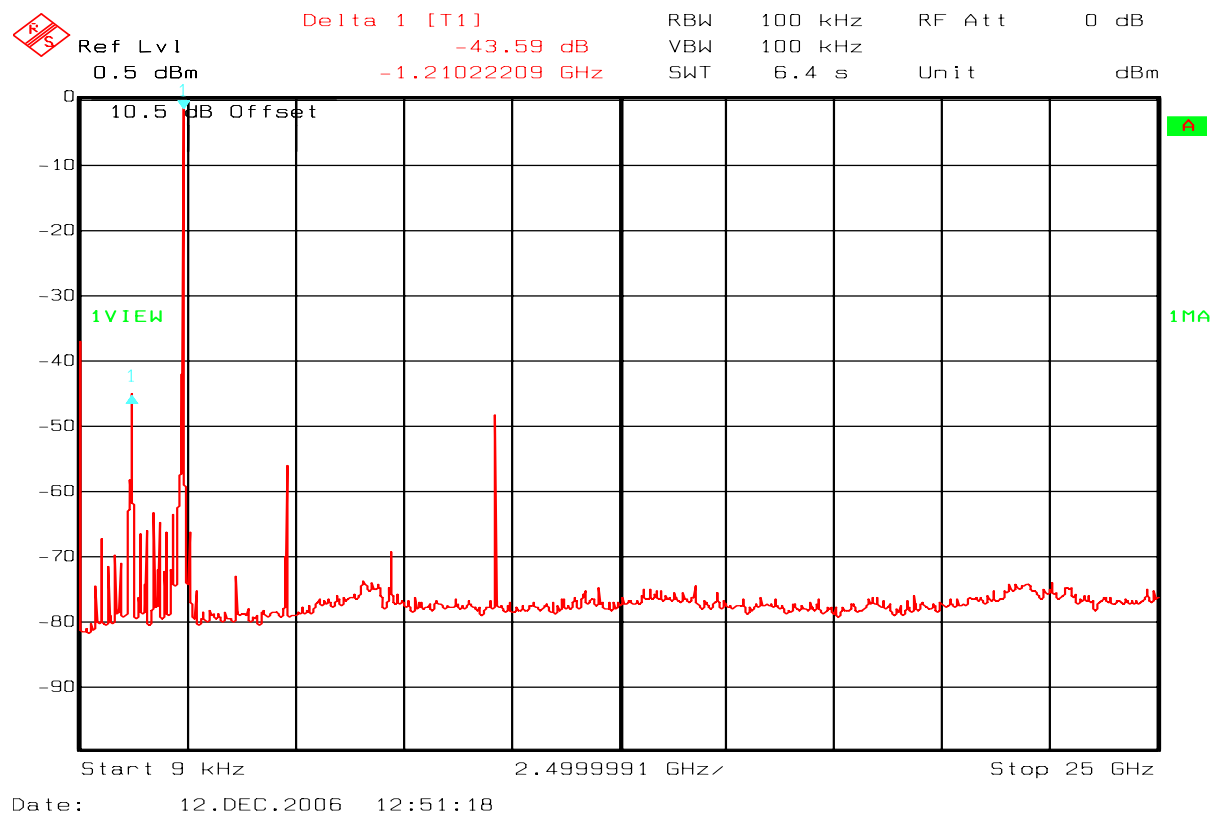
Date: 11.DEC.2006 13:00:37

nRD24V1-USBDONGLE - Ch 81 – upper band – Field strength

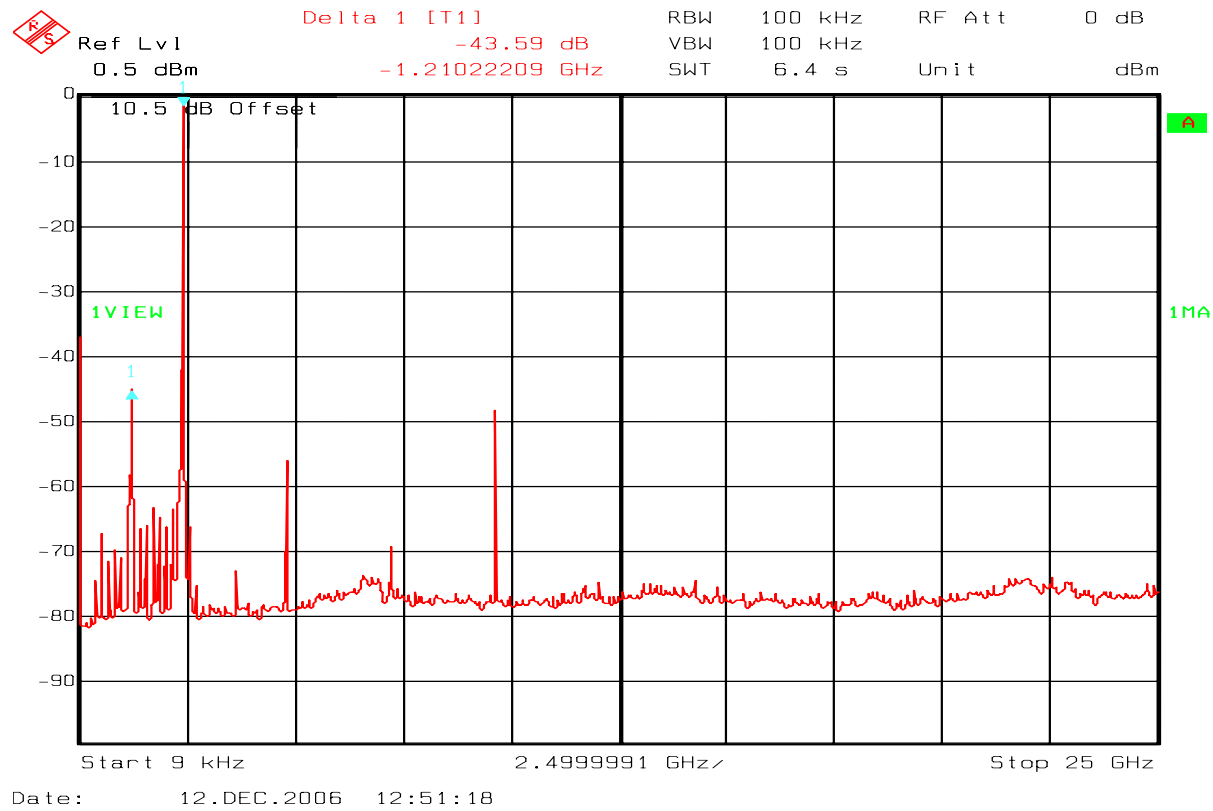


Date: 11.DEC.2006 13:02:40

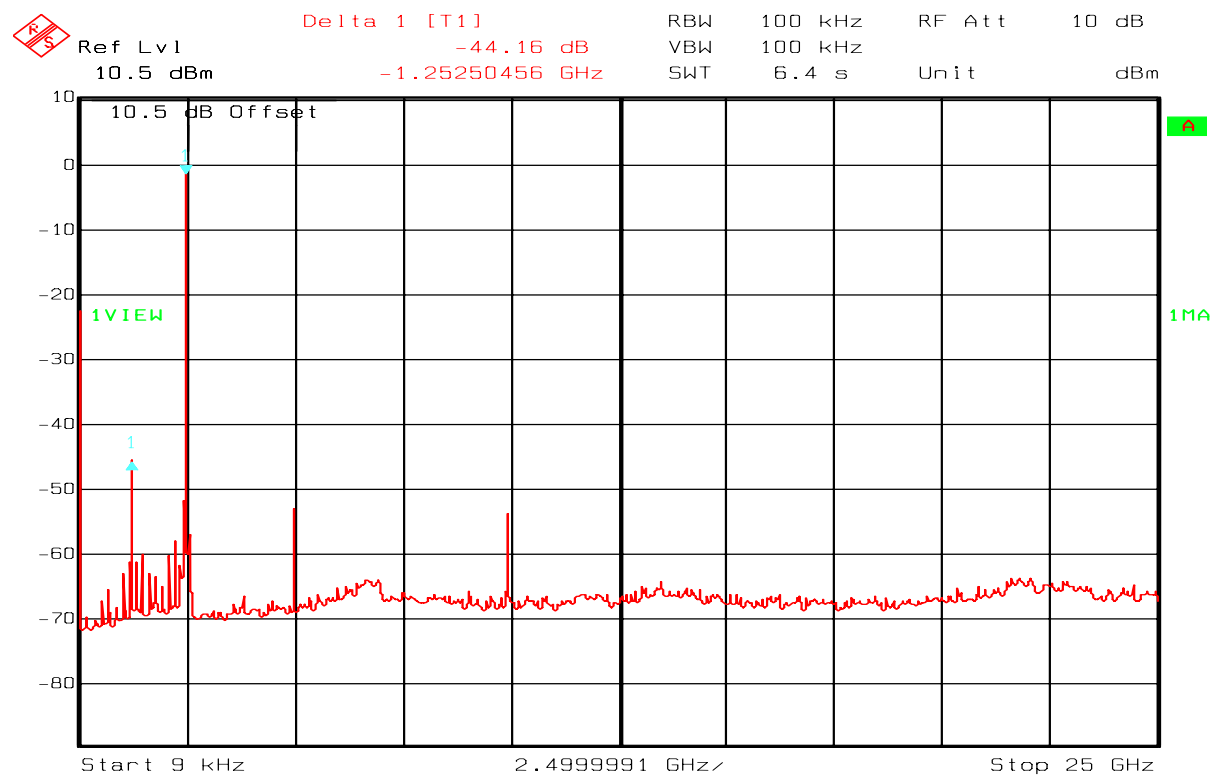
nRD24V1-USBDONGLE - Ch 81 – upper band – marker delta



nRD24V1-USBDONGLE- Ch02 – Conducted Spurious – 9kHz – 25GHz



nRD24V1-USBDONGLE- Ch42 – Conducted Spurious – 9kHz – 25GHz



Date: 12.DEC.2006 13:00:09

nRD24V1-USBDONGLE- Ch81 – Conducted Spurious – 9kHz – 25GHz

Duty Cycle Calculation:

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

$$-20 \cdot \log(565\text{us}/3750\text{us}) = \mathbf{16.4\text{ dB}}$$

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

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

Duty Cycle – ON-time = 564us

Duty Cycle – OFF time+ONtime = 3750us

Radiated Emissions, 1-25 GHz - nRD24V1-RFMODULE

1-18 GHz measured at a distance of 3m, 18-25 GHz measured at 1m.

No radiated spurious emissions detected with 50 ohm load.

Radiated Emission 1 – 25 GHz, Peak

Measured with Peak Detector

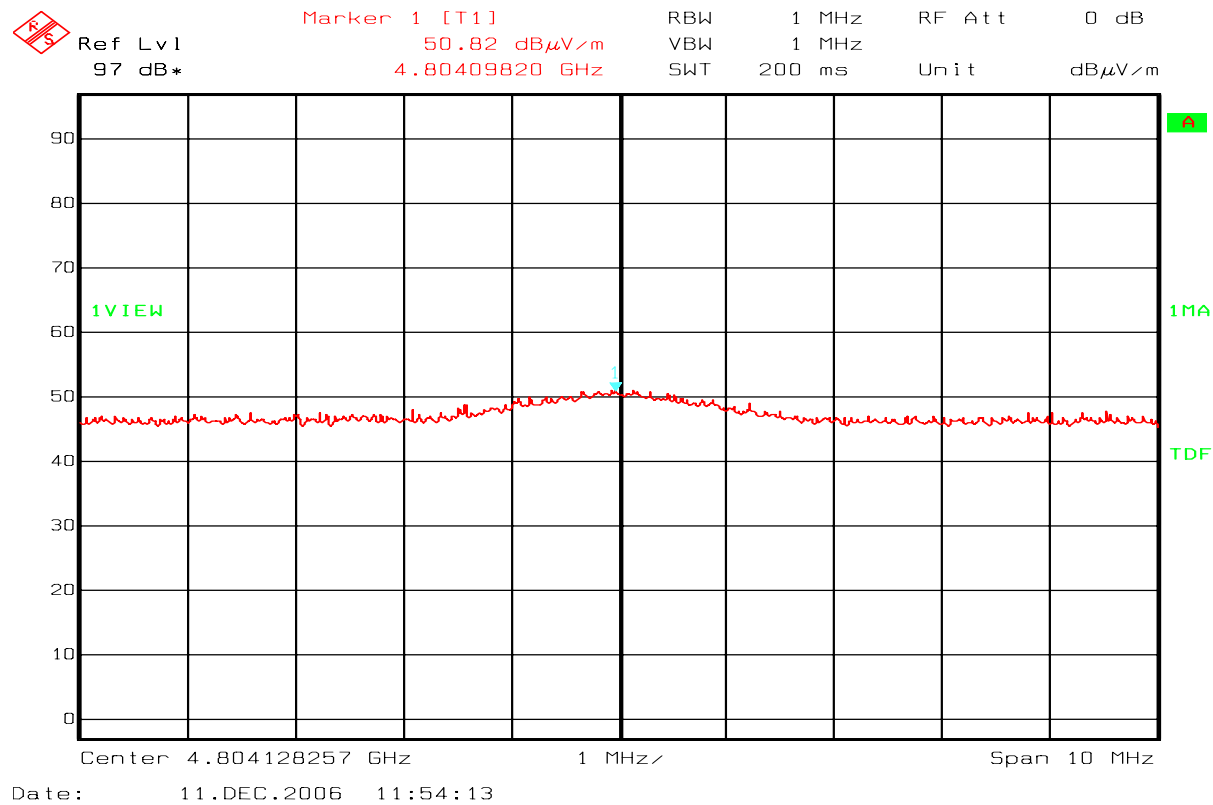
Frequency	RF channel	Dist. corr. factor	Field strength, Peak, 3m	Duty cycle corr. factor	Limit	Margin
GHz	02-81	dB	dB μ V/m	dB	dB μ V/m	dB
4.802	02	0	50.82	-	74	23.2
4.880	40	0	48.55	-	74	25.45
4.962	81	0	49.58	-	74	24.42
5 - 25	02,40,81	0	None detected	-	-	-

Radiated emission 1- 25 GHz, Average

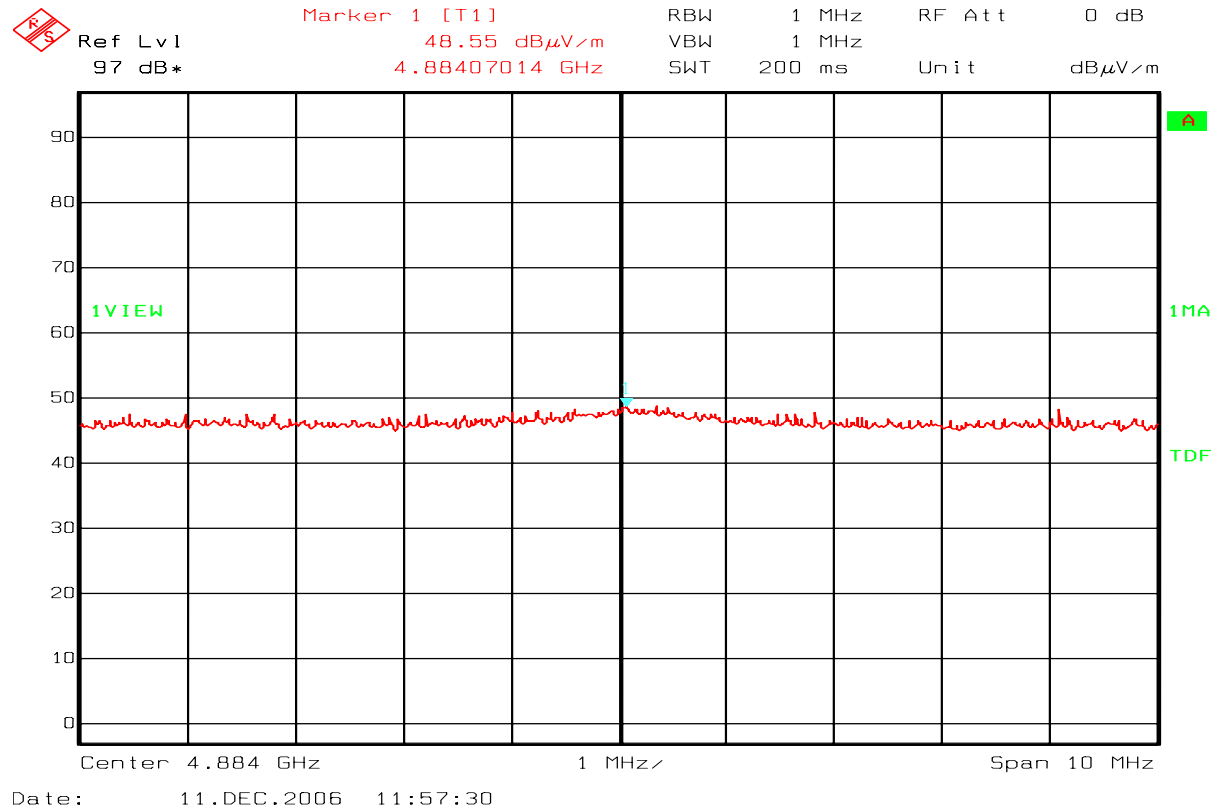
Calculated value from Peak Detector

Frequency	RF channel	Dist. corr. factor	Field strength, Peak, 3 meters	Duty cycle corr. factor	Limit	Margin
GHz	11-26	dB	dB μ V/m	dB	dB μ V/m	dB
4.802	02	0	50.82	-16	54	19.2
4.880	40	0	48.55	-16	54	21.5
4.962	81	0	49.58	-16	54	20.4
5 - 25	02,40,81	0	None detected	-	54	-

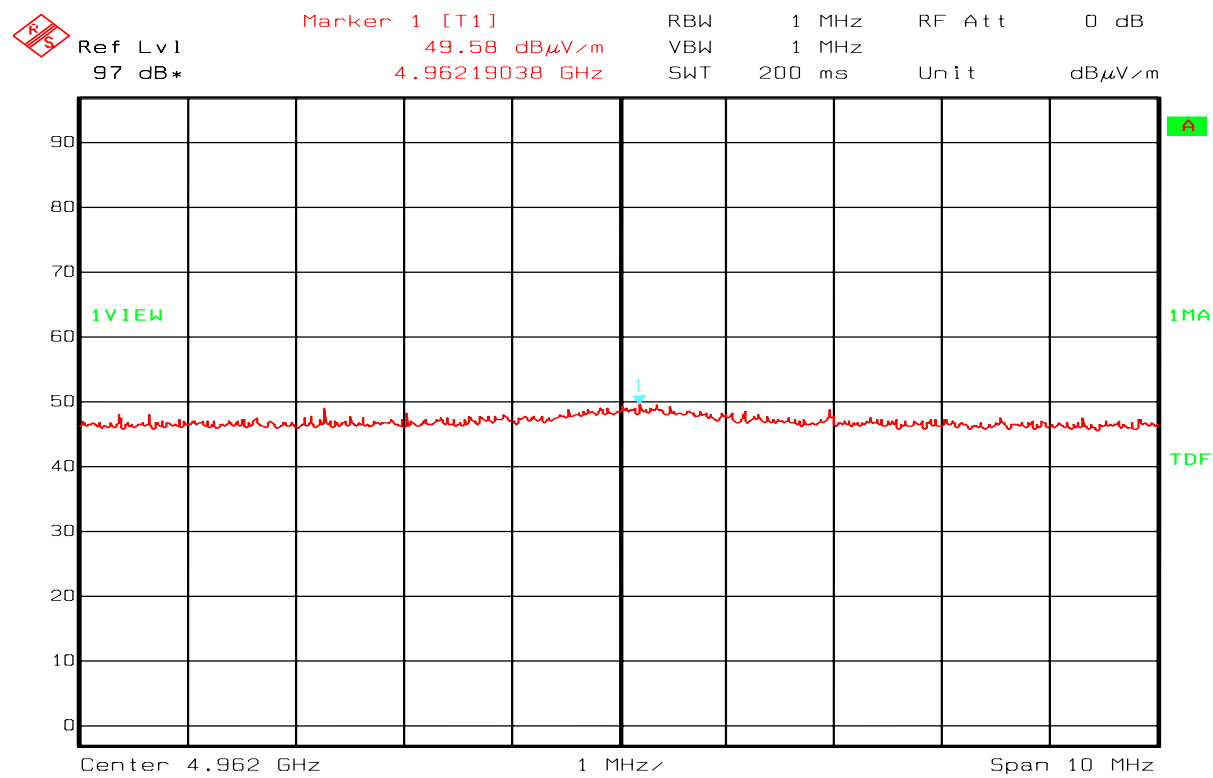
Antenna factor, amplifier gain and cable loss are included in spectrum analyzer "Transducer factor".



nRD24V1-RFMODULE - Ch02 - 2nd harmonic



nRD24V1-RFMODULE CH42 - 2nd Harmonic



Date: 11.DEC.2006 12:16:08

nRD24V1-RFMODULE CH81 – 2nd Harmonic

Radiated Emissions, 1-25 GHz - nRD24V1-USBDONGLE

1-18 GHz measured at a distance of 3m, 18-25 GHz measured at 1m.

No radiated spurious emissions detected with 50 ohm load.

Radiated Emission 1 – 25 GHz, Peak
Measured with Peak Detector

Frequency	RF channel	Dist. corr. factor	Field strength, Peak, 3m	Duty cycle corr. factor	Limit	Margin
GHz	02-81	dB	dB μ V/m	dB	dB μ V/m	dB
4.802	02	0	None detected	-	74	-
4.880	40	0	None detected	-	74	-
4.960	81	0	None detected	-	74	-
5 - 25	02,40,81	0	None detected	-	-	-

Radiated emission 1- 25 GHz, Average
Calculated value from Peak Detector

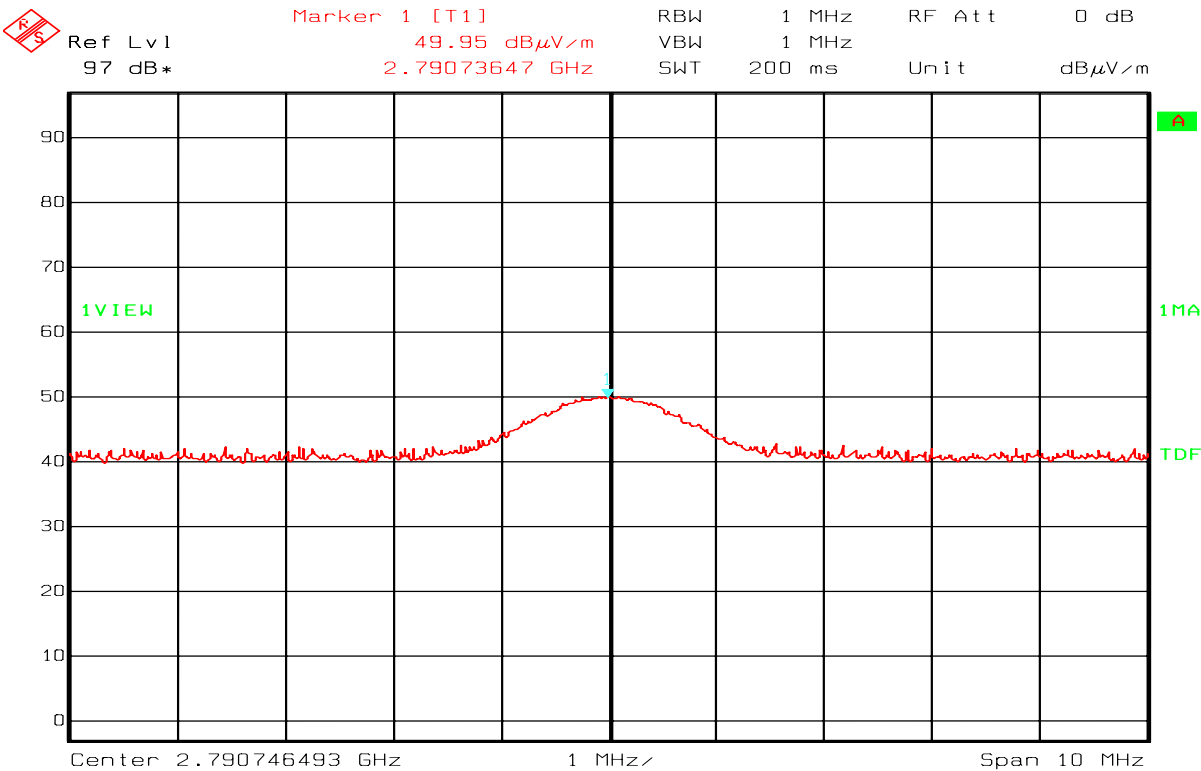
Frequency	RF channel	Dist. corr. factor	Field strength, Peak, 3 meters	Duty cycle corr. factor	Limit	Margin
GHz	11-26	dB	dB μ V/m	DB	dB μ V/m	dB
4.802	02	0	None detected	-16	54	-
4.880	40	0	None detected	-16	54	-
4.960	81	0	None detected	-16	54	-
5 - 25	02,40,81	0	None detected	-	54	-

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

Radiated Emissions, receiver mode - nRD24V1-USBDONGLE

Measured with Peak Detector

Frequency	RF channel	Dist. corr. factor	Field strength, Peak, 3m	Duty cycle corr. factor	Limit	Margin
GHz	02-81	dB	dBµV/m	dB	dBµV/m	dB
2.79	42	0	49.95	-	74	24.05



Date: 11.DEC.2006 13:13:32

Ch42 – RX - Harmonic

Radiated emissions 30 – 1000 MHz.

Detector: Quasi-Peak

Measuring distance 3 m.

Tested in active mode.

Frequency	Operational condition	Field strength	Measuring distance	Limit FCC15.209	Margin
MHz		dB μ V/m	metres	dB μ V/m	dB
30 -200	TX ON/RX	< 30	3	40	>10
200 -1000	TX on/RX	< 30	3	40	>10

Nemko Comlab

11. Dec 06 16:36

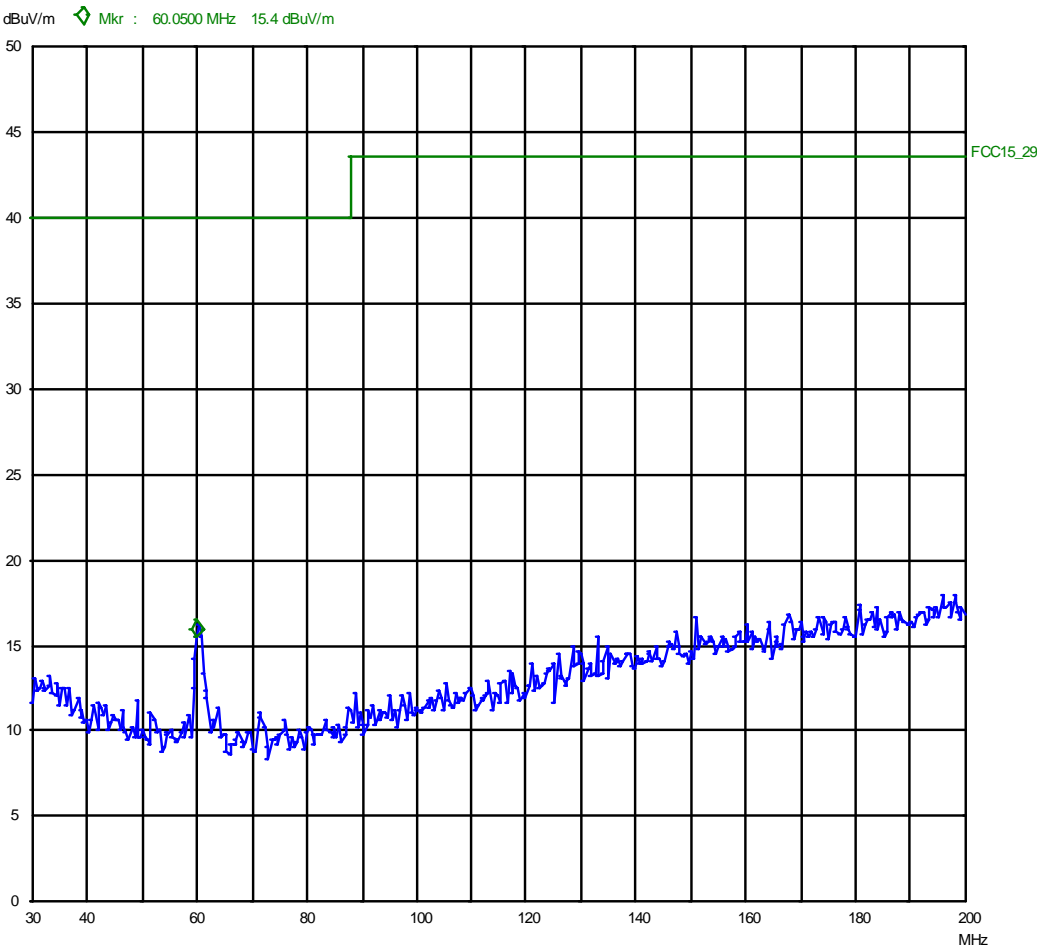
Peak

Manuf: Nordic semi
Op Cond: hp 4m
Operator: gns
Test Spec: FCC

Scan Settings (1 Range)

----- Frequencies -----||----- Receiver Settings -----|
Start Stop Step IF BW Detector M-Time Atten Preamp OpRge
30M 200M 50k 120k PK 50ms AUTO LN ON 60dB

Transducer No. Start Stop Name
20 30M 200M HK116



HP – 30 – 200 MHz

Nemko Comlab

11. Dec 06 16:31

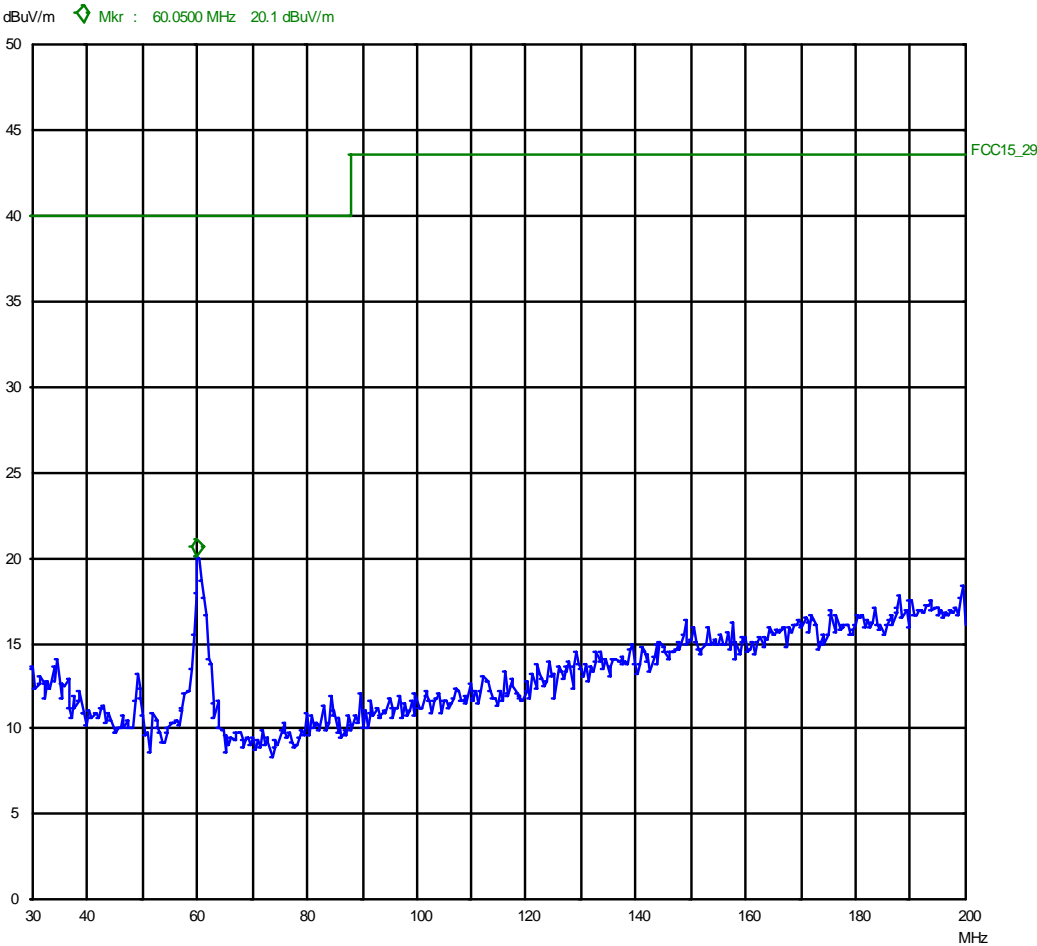
Peak

Manuf: Nordic semi
Op Cond: vp 1m
Operator: gns
Test Spec: FCC

Scan Settings (1 Range)

----- Frequencies -----||----- Receiver Settings -----|
Start Stop Step IF BW Detector M-Time Atten Preamp OpRge
30M 200M 50k 120k PK 50ms AUTO LN ON 60dB

Transducer No. Start Stop Name
20 30M 200M HK116



VP – 30 – 200MHz

Nemko Comlab

11. Dec 06 16:08

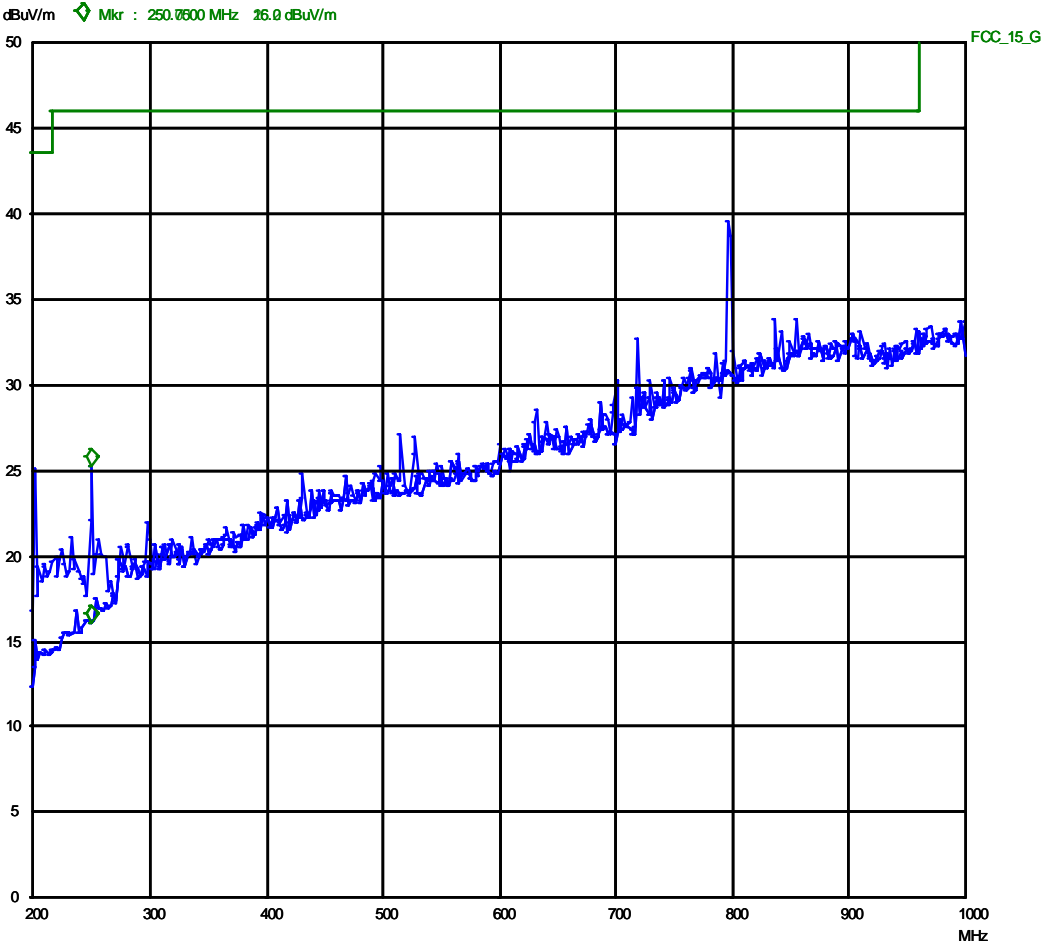
Peak

EUT: Heredestomol
Manuf: Nordic semi
Op Cond: vp 1m
Operator: gns
Test Spec: FCC

Scan Settings (1 Range)

----- Frequencies -----||----- Receiver Settings -----|
Start Stop Step IF BW Detector M-Time Atten Preamp OpRge
200M 1000M 50k 120k PK 50ms AUTO LN ON 60dB

Transducer No. Start Stop Name
21 200M 1000M HL223



VP – 200 – 1000GHz

Radiated emission 10 kHz-30 MHz.

Measuring distance 10 m, measured with Peak detector.

No component detected, see attached graph.

Limit is converted to 10 m using 40 dB/decade according to 15.31 (f) (2).

4.7 Power Spectral Density (PSD)

Para. No.: 15.247 (d)

Test Performed By: G.Suwanthakumar	Date of Test: 12.12.2006
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Test Results: Passed

Measured and Calculated Data:

Measured Conducted Values:

nRD24V1-RFMODULE Ch42 - Middle Channel:

PSD = - 4.11 dBm

nRD24V1-USBDONGLE Ch42 - Middle Channel:

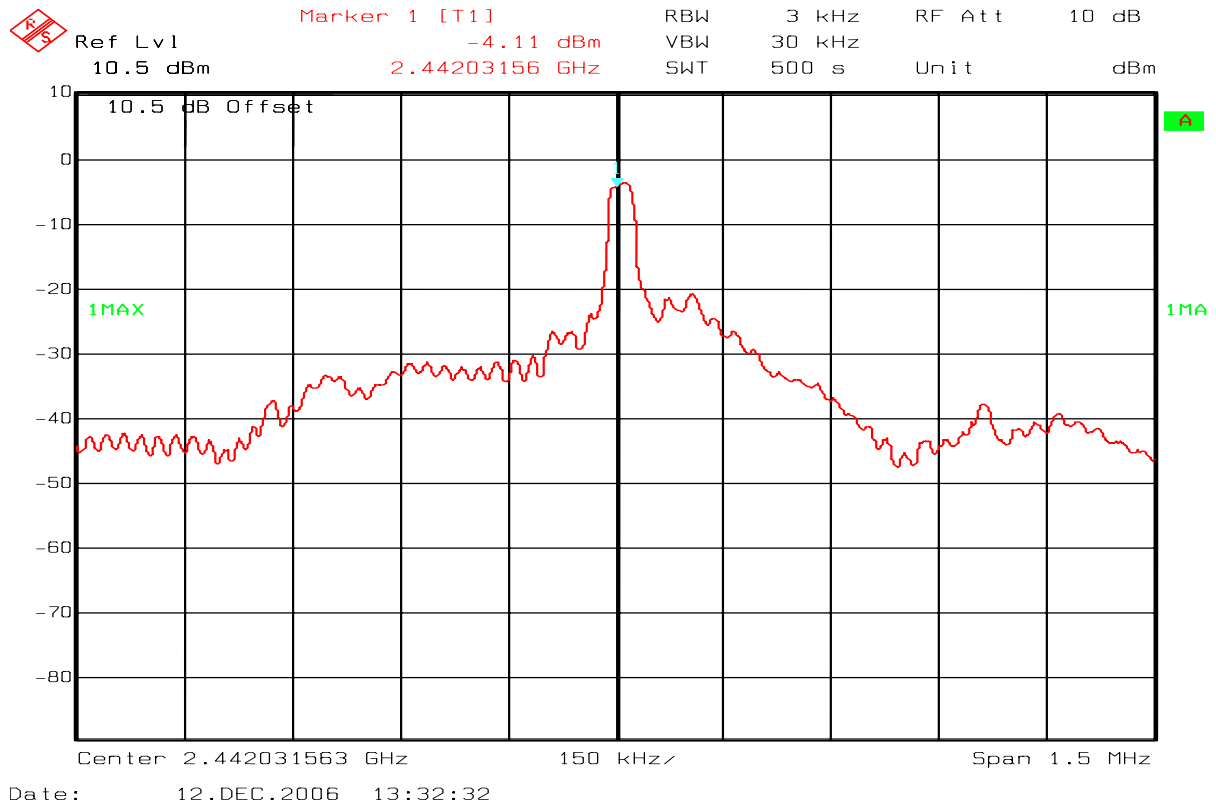
PSD = - 3.41 dBm

The spectrum line spacing is less than 3kHz, therefore used noise power density and corrected 35 dB for 3kHz

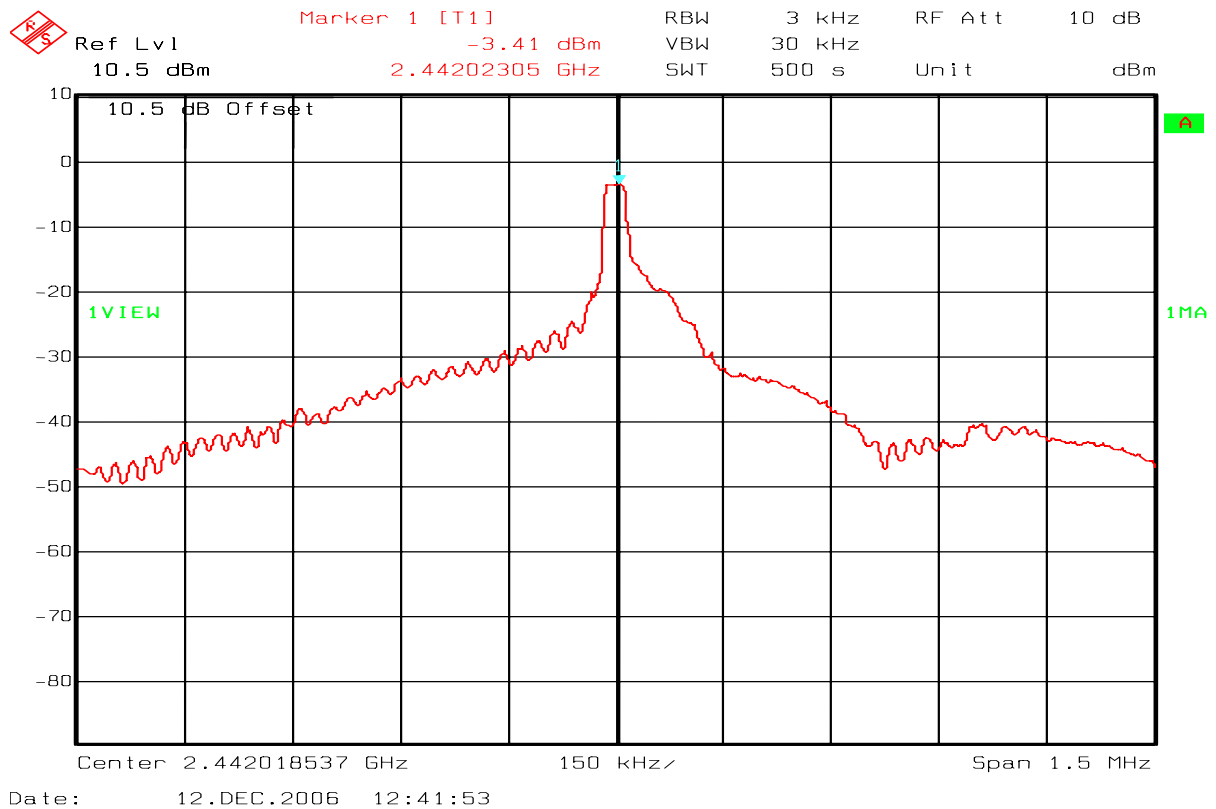
Requirements:

The Power Spectral Density of a Digital Transmission System shall be no greater than +8 dBm in any 3kHz band

No requirements for Frequency Hopping Systems.



nRD24V1-RFMODULE Ch42 – Power Density – Conducted measurement



nRD24V1-USB Dongle Ch42 – Power Density – Conducted measurement

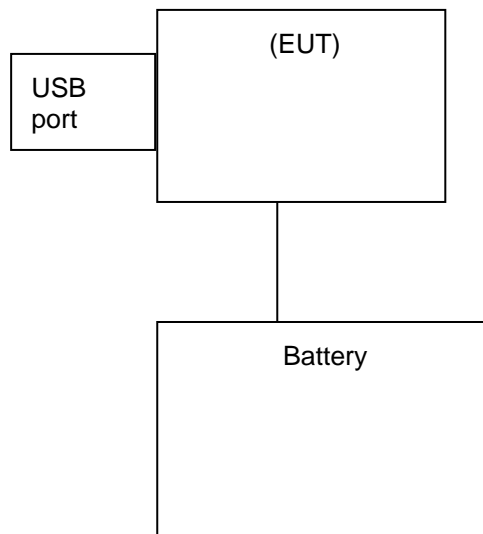
5 LIST OF TEST EQUIPMENT

To facilitate inclusion on each page of the test equipment used for related tests, each item of test equipment and ancillaries are identified (numbered) by the Test Laboratory.

No.	Instrument/ancillary	Type of instrument/ancillary	Manufacturer	Ref. no.
1	FSEK	Spectrum Analyzer	Rohde & Schwarz	LR 1337
2	ESN	EMI Receiver	Rohde & Schwarz	LR 1237
3	3115	Antenna horn	EMCO	LR 1330
4	643	Antenna horn	Narda	LR 093
5	642	Antenna horn	Narda	LR 220
6	PM7320X	Antenna horn	Siverts lab	LR 103
7	DBF-520-20	Antenna horn	Systron Donner	LR 101
8	638	Antenna horn	Narda	LR 098
9	Sucoflex 102E	Cable microwave	Sunher	LR 1370
10	6032A	Power supply	HP	LR 1062
11	ESH3-Z3	LISN	Rohde & Schwarz	LR 1076
12	8449B	Amplifier	Hewlett Packard	LR 1322
13	959C	Printer	Hewlett Packard	LR 1414
14	HFH2-Z2	Antenna loop	Rohde and Schwarz	LR 285
15	10855A	Amplifier	Hewlett Packard	LR 1445
16	HL223	Antenna log.per	Rohde & Schwarz	LR 1261
17	HK116	Antenna biconic	Rohde & Schwarz	LR 1260
18	ESVS 30	Test Receiver	Rohde & Schwarz	LR 1101
19	R3271	Spectrum Analyzer	Advantest	LR 1123
20	B32-10R	Power supply	Oltronix	LR 126
21	FSU26	EMI receiver	R&S	LR 1504

6 BLOCK DIAGRAM

6.1 System set up



6.2 Test Site Radiated Emission

