Test report no. : 204001-5

Item tested : MI201M01 / MI202M01

Type of equipment : 2.4GHz Transceiver

FCC ID : OG3MI201M01
OG3MI202M01

Client : GRUNDFOS Holding A/S

FCC Part 15.247
Digital Transmission System

RSS-210, Issue 8
Low Power Licence-Exempt
Radiocommunication Devices

26 July 2013

Authorized by : .....
Frode Sveinsen
Technical Verificator

CONTENTS

1 GENERAL INFORMATION

1.1 Testhouse Info

Name :	Nemko AS
Address :	Nemko Kjeller Instituttveien 6, Box 96 NO-2027 Kjeller, NORWAY
Telephone :	+47 64 84 57 00
Fax :	+47 64 84 57 05
E-mail:	comlab@nemko.com
FCC test firm :	994405
IC OATS :	2040D-1
Total Number of Pages:	38

1.2 Client Information

Name :	GRUNDFOS Holding A/S
Address :	Poul Due Jensens Vej 7
	DK-8850 Bjerringbro, Denmark

Contact:

Name :	Nikolaj Haahr Korshoej
Telephone :	+45 87 50 43 87
E-mail :	nkorshoej@grundfos.com

1.3 Responsible Manufacturer (If other than client)

Same as client.

2 Test Information

2.1 Test Item

Name :	R10000 Apple Dongle
Model/version :	MI201M01 MI202M01
FCC ID:	OG3MI201M01 OG3MI202M01
IC :	10447A-MI201M01 10447A-MI202M01
Serial number :	/
Hardware identity and/or version:	/
Software identity and/or version :	/
Frequency Range :	2405 – 2480 MHz
Number of Channels :	16
Type of Modulation :	DSSS (QPSK)
Conducted Output Power:	0.00088 W (Peak)
Data rate:	250kbps
User Frequency Adjustment :	None
Type of Power Supply :	Power from Iphone
Antenna Connector :	PCB antenna
Antenna Diversity Supported :	No
Desktop Charger :	/

Description of Test Item

The tested EUT is a 2.4GHz remote control for pumps.

The Models MI201M01 and MI202M01 are identical except for the plastic housing.

2.2 Exposure Evaluation

The EUT is designed for handheld use. Test separation distance is assumed to be ≥ 5 mm.

SAR is not required for the tested device according to FCC KDB 497498 D01 v05 Annex A, since Output Power is less than SAR Exclusion Threshold (clause 4.3.1):

(1 mW / 5 mm) x (√2.48 GHz) = 0.32 < 3.0 (Exclusion Threshold)

The EUT is exempted from RF Exposure Evaluation to Industry Canada requirements since the output power complies with the power levels of section 2.5.1 of RSS-102 Issue 4.

2.3 Test Environment

2.3.1 Normal test condition

Temperature:	20 – 23.7 °C
Relative humidity:	28.5 – 42.1 %
Normal test voltage:	3.7 Vdc (Powered from host Iphone)

The radiated emissions tests were performed with the EUT powered from an Iphone. The Iphone was fully charged during all tests.

The values are the limit registered during the test period.

2.4 Test Period

Item received date:	2012-03-27
Test period :	from 2012-04-18 to 2012-04-25 and 11-13 June 2013

3 TEST REPORT SUMMARY

3.1 General

All measurements are tracable to national standards.

The tests were conducted for the purpose of demonstrating compliance with FCC CFR 47 Part 15, paragraph 15.247 and Industry Canada RSS-210 Issue 8.

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 3m and 10m.

☒ New Submission ☒ Production Unit

☐ Class II Permissive Change ☐ Pre-production Unit

DTS Equipment Code ☐ Family Listing

THIS TEST REPORT APPLIES ONLY TO THE ITEM(S) AND CONFIGURATIONS TESTED.

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

TEST REPORT #: 204001-5

TESTED BY: _____ DATE: 2013-06-14

G.Suhanthakumar, Test engineer

3.2 Test Summary

Name of test	FCC Part 15 reference	RSS-210 Issue 8 reference	Result
Antenna Requirement	15.203	7.1.2 (RSS-GEN)	Pass
Power Line Conducted Emission	15.107(a) 15.207(a)	7.2.4 (RSS-GEN)	Pass*
Minimum 6 dB Bandwidth	15.247(a)(2)	A8.2	Pass
Peak Power Output	15.247(b)	A8.4	Pass
Power Spectral Density	15.247(e)	A8.2	Pass
Spurious Emissions (Antenna Conducted)	15.247(d)	A8.5	Pass
Spurious Emissions (Radiated)	15.247(d) 15.205(c) 15.209(a)	A8.5	Pass

*EUT is operated by battery driven Iphone.

3.3 Description of modification for Modification Filing

Not applicable.

3.4 Comments

All ports were populated during spurious emission measurements.

3.5 Family List Rational

Not Applicable.

4 TEST RESULTS

4.1 Power-line Conducted Emissions

Para. No.: 15.207 (a)

Test Performed By: G.Suhanthakumar	**Date of Test: 25 Apr 2012**

Measurement procedure: **ANSI C63.4-2009 using 50 μH/50 ohms LISN.**

Test Results: **Complies.**

Measurement Data: **Peak detector was used.**

EUT is connected at the USB port only for charging the iPHONE.

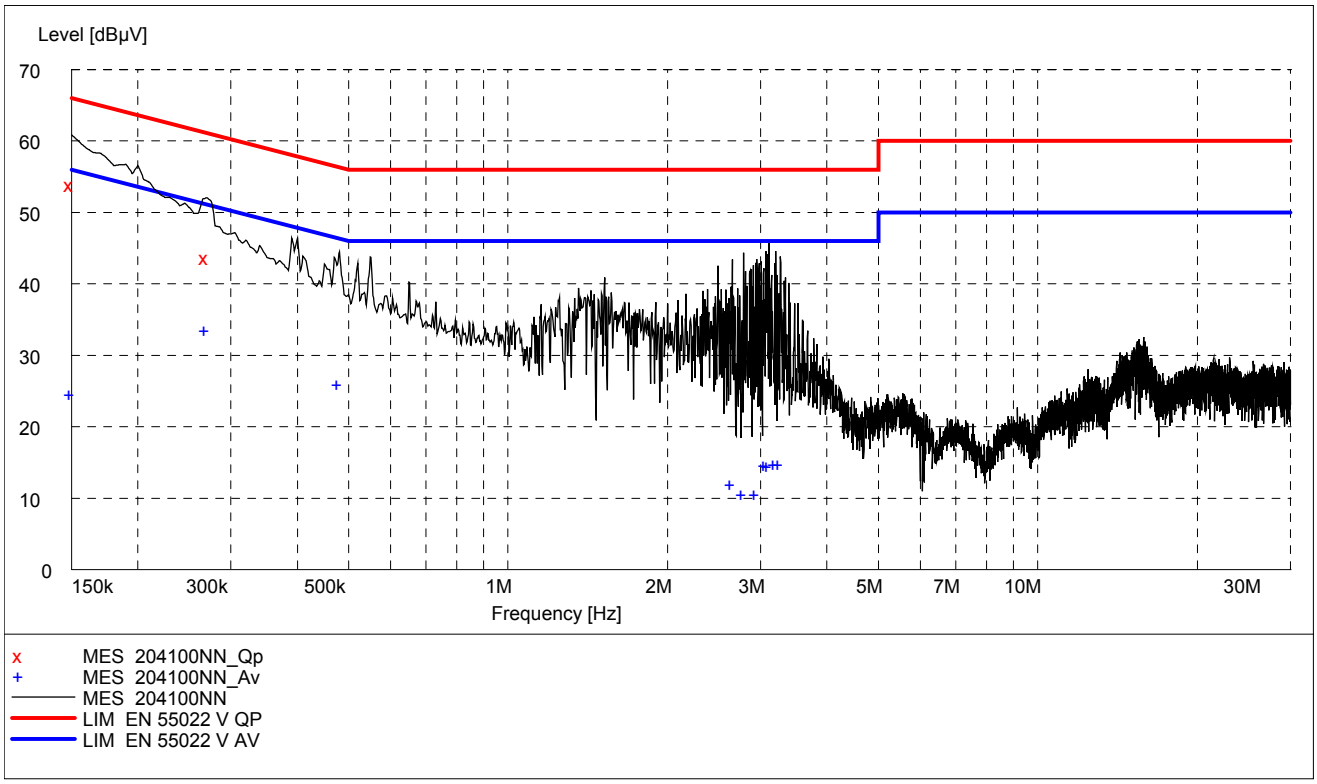
The graph shows peak scan and highest values. The QP and AV values are given in the table below.

Measured at AC mains 120V AC, 60Hz.

Model:Dell Latitude D610 and AC/DC adapter model:ADP-65JB B

Highest measured value (L and N):

See the attached plot for peak scan.



Frequency [MHz]	Level [dBuV]	Af [dB]	Limit [dBuV]	Margin [dB]	Det	Position	Verdict [Pass/Fail]
0.150000	54.10	10.10	66.00	11.90	QP	N	Pass
0.270000	43.80	10.10	61.10	17.30	QP	L1	Pass

Frequency [MHz]	Level [dBuV]	Af [dB]	Limit [dBuV]	Margin [dB]	Det	Position	Verdict [Pass/Fail]
0.150000	24.70	10.10	56.00	31.30	AV	N	Pass
0.270000	33.60	10.10	51.10	17.50	AV	L1	Pass
0.480000	26.00	10.20	46.30	20.30	AV	N	Pass
2.650000	12.10	10.30	46.00	33.90	AV	L1	Pass
2.785000	10.70	10.30	46.00	35.30	AV	L1	Pass
2.950000	10.70	10.30	46.00	35.30	AV	N	Pass
3.065000	14.70	10.30	46.00	31.30	AV	L1	Pass
3.110000	14.60	10.30	46.00	31.40	AV	L1	Pass
3.205000	14.80	10.30	46.00	31.20	AV	N	Pass
3.265000	14.90	10.30	46.00	31.10	AV	L1	Pass

4.2 Minimum 6 dB Bandwidth

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

Test Performed By: G.Suhanthakumar	Date of Test: 11 June 2013

Test Results: Complies

Measurement Data:

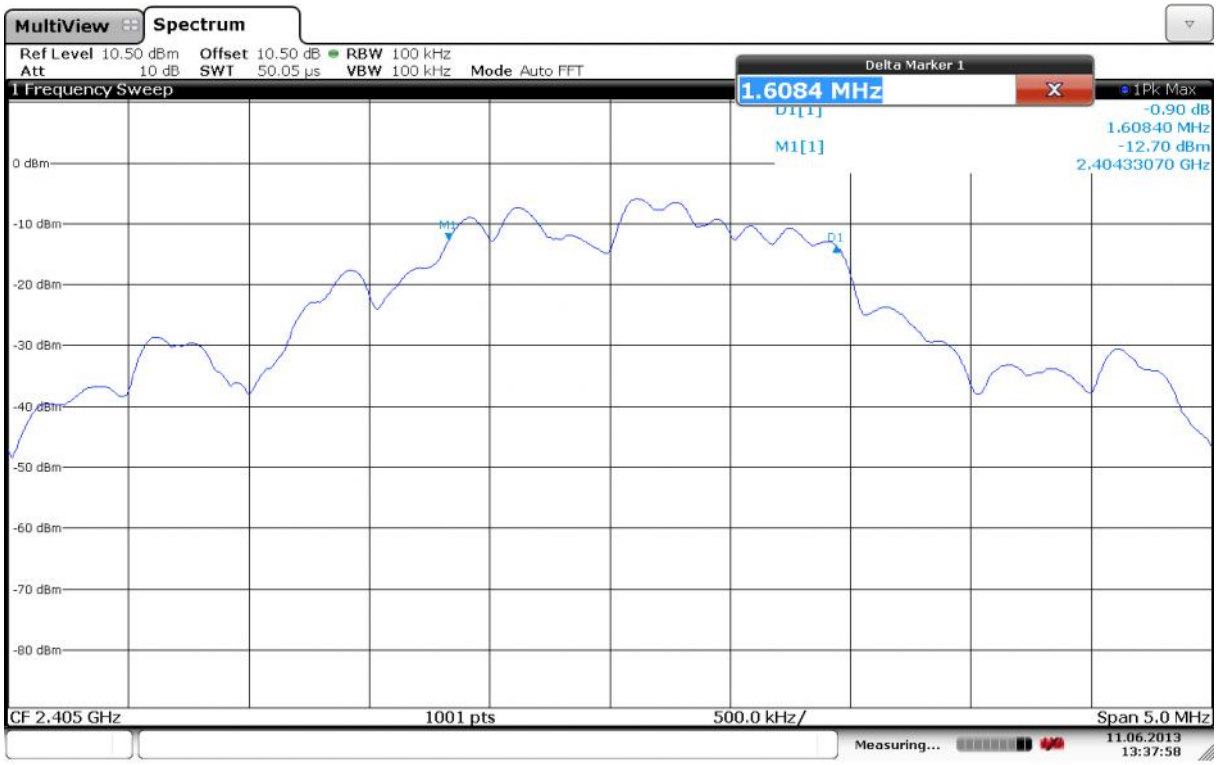
Measured 6 dB Bandwidth (MHz)		
2405MHz	**2440 MHz**	**2480MHz**
1.6	1.6	1.6

Conducted measurements

Tested according to KDB 558074 D01 DTS Meas Guidance v02, Section 7.1.

Requirements:

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



2397.500MHZ
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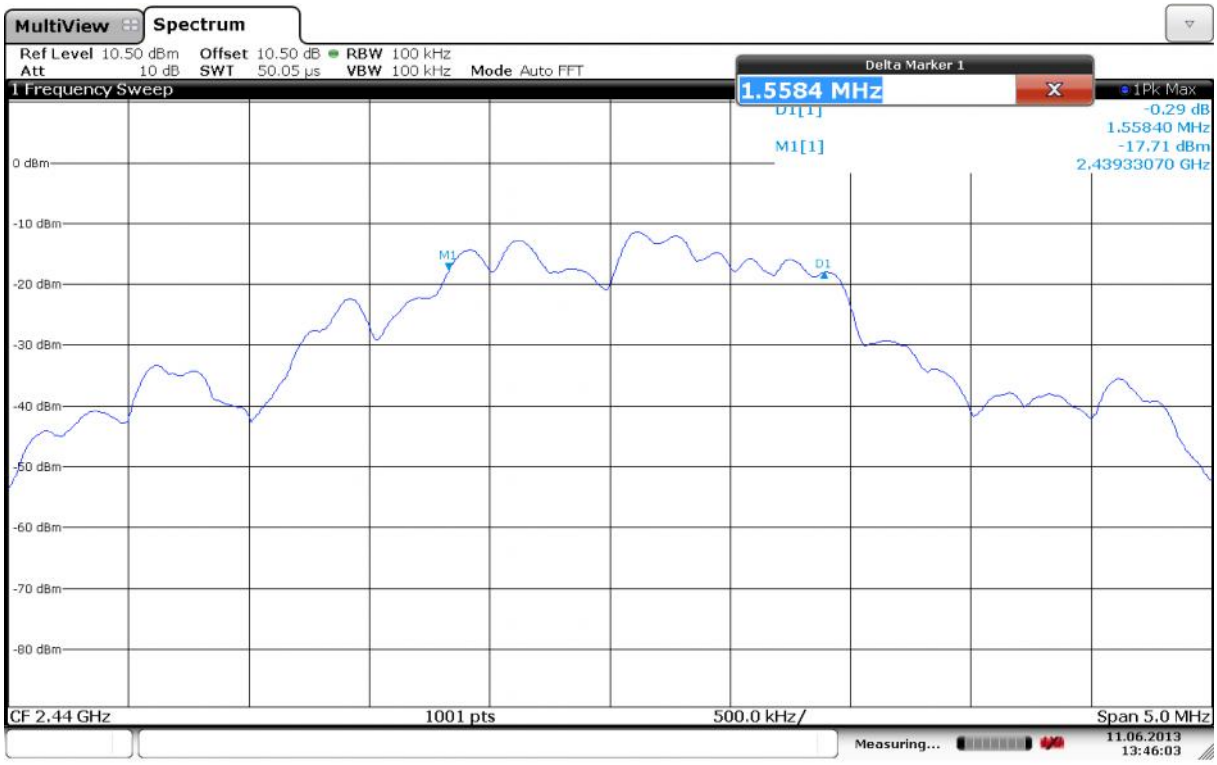
6 dB Bandwidth at 2405 MHz



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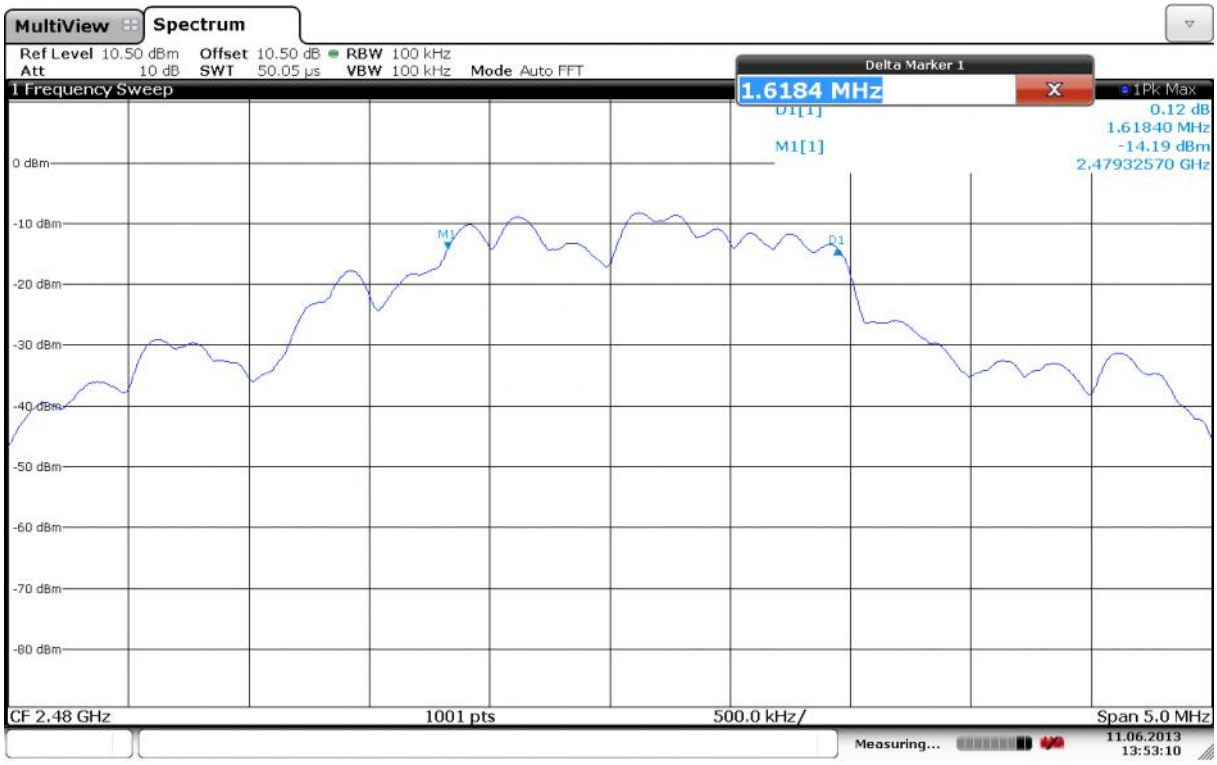
6 dB Bandwidth at 2440 MHz



2397.500MHZ
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6 dB Bandwidth at 2480 MHz

4.3 20 dB Bandwidth

Test Performed By: G.Suhanthakumar	Date of Test: 12 June 2013

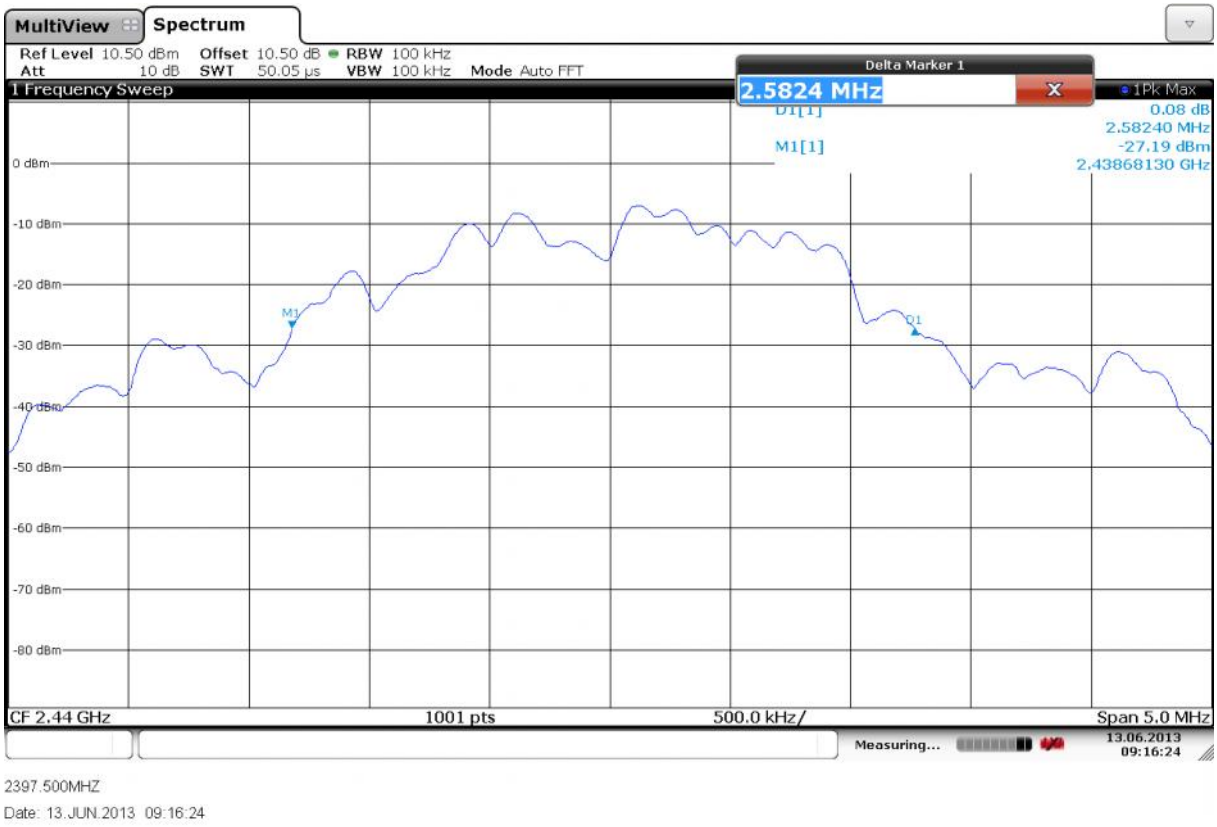
Measurement Data:

Measured 20 dB Bandwidth (MHz)		
2405MHz	**2440 MHz**	**2480MHz**
-	2.58	-

Conducted measurements

Requirements:

No requirements. Reported for information only.



20 dB Bandwidth at 2440 MHz

4.4 Peak Power Output

Para. No.: 15.247 (b)

Test Results: Complies

Measurement Data:

RF channel	2405 MHz	2440 MHz	2480 MHz
Conducted Power (dBm)	-0.55	-1.14	-2.01
Conducted Power (mW)	0.88	0.77	0.63
Measured Maxium Field strength (dBµV/m) –VP	94.23	89.73	86.47
Radiated Power (dBm)	-0.99	-5.49	-8.76
Antenna Gain (dB)	-0.44	-4.35	-6.75

Tested according to KDB 558074 D01 DTS Meas Guidance v02, Section 8.1.1.

EIRP is calculated according to KDB 558074 D01 DTS Meas Guidance v02, Section 10.2.2.1

The maximum field strength is obtained in XY plane and vertical polarization.Peak detector is used.

See attached graph.

Detachable antenna? ☐ Yes ☒ No

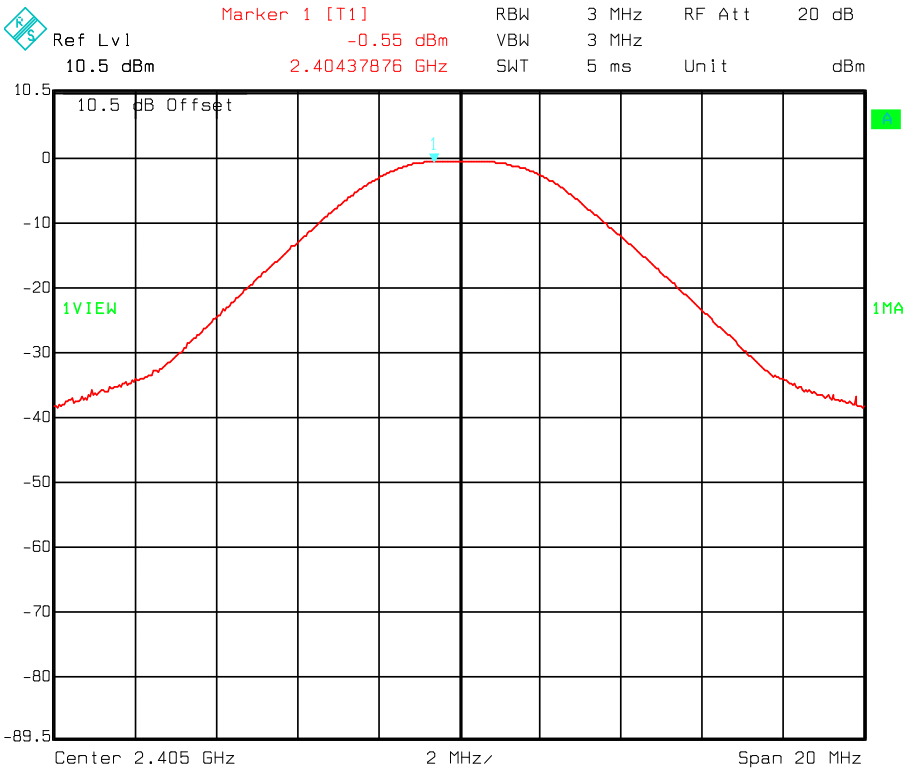
If detachable, is the antenna connector non-standard? ☐ Yes ☐ No

Requirements:

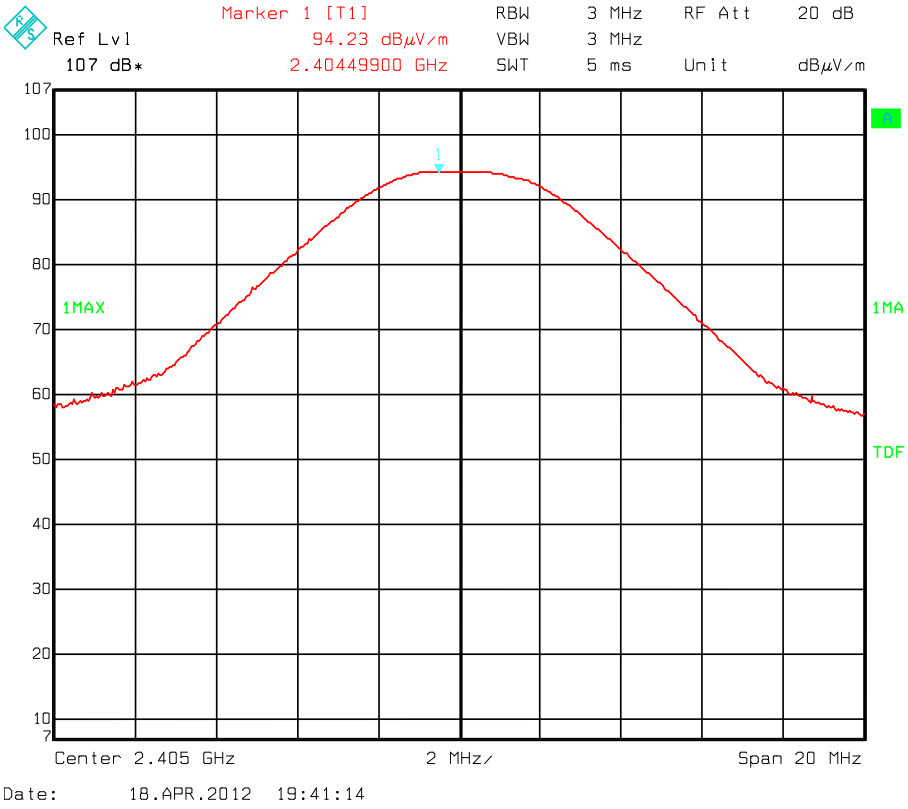
The maximum peak output power shall not exceed the following limits:

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

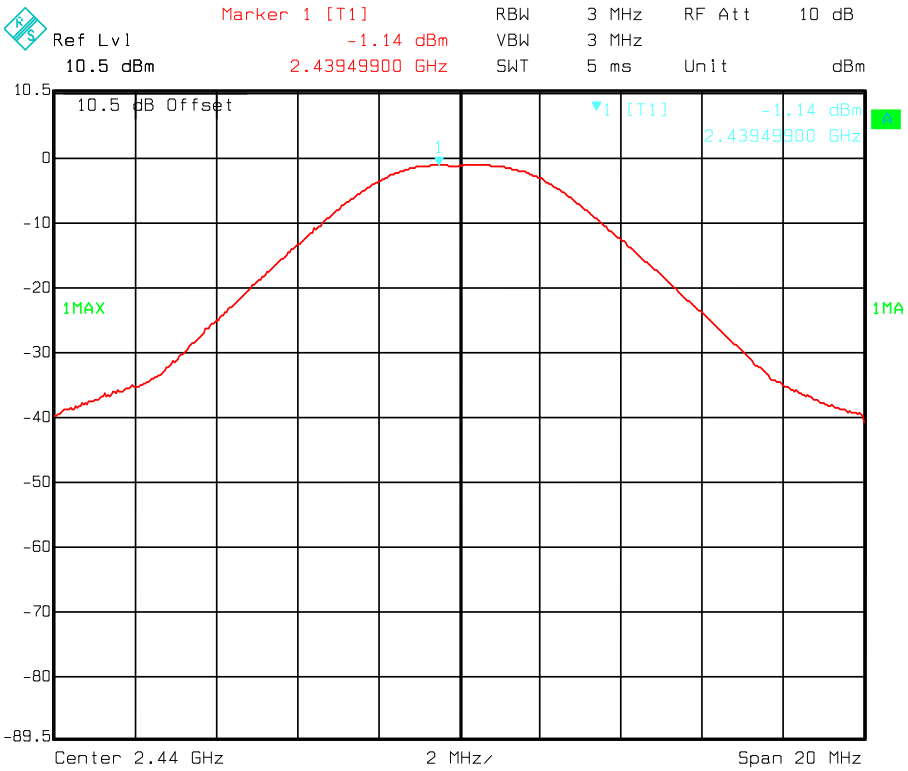
If transmitting antennas of directional gain greater than 6 dBi are used, the peak output power from the intentional radiator shall be reduced below the stated value above by the amount in dB that the directional gain of the antenna exceeds 6 dBi.



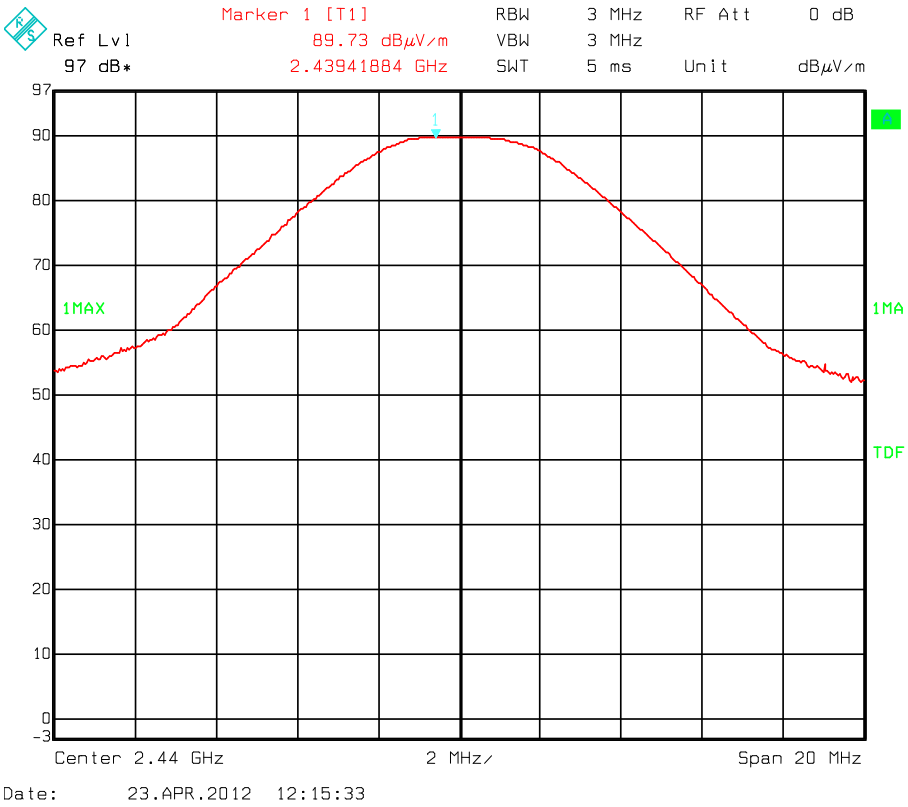
Conducted Power, 2405 MHz, peak detector



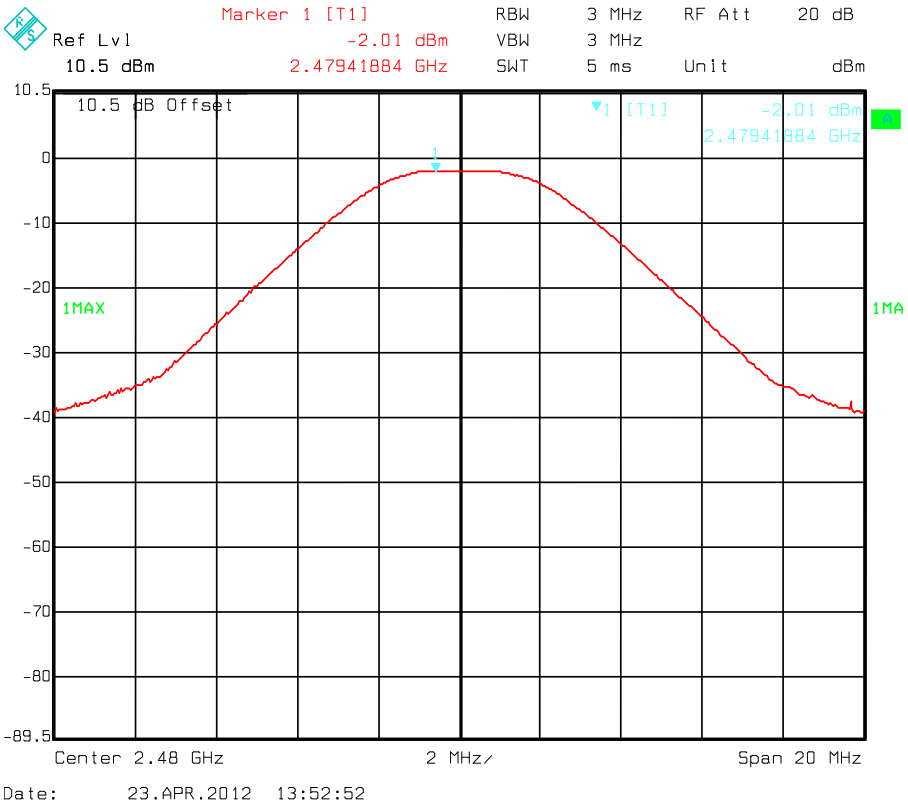
Radiated Field strength,VP , 2405 MHz



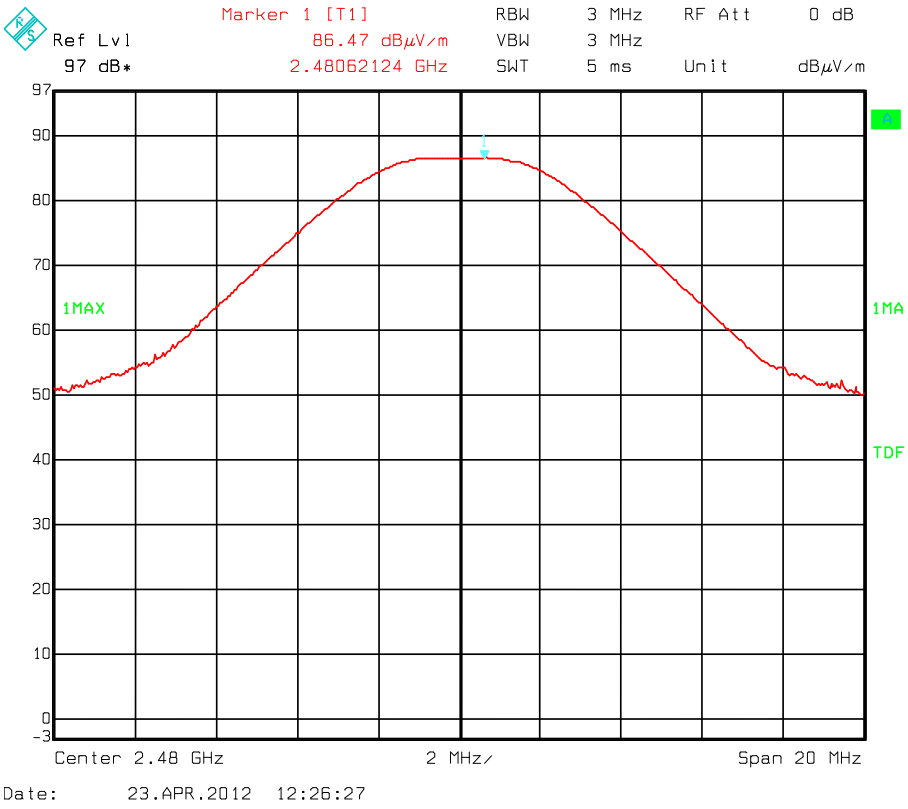
Conducted Power, 2440 MHz,peak detector



Radiated field strength,VP, 2440 MHz



Conducted Power, 2480 MHz, peak detector



Radiated field strength, 2480 MHz

4.5 Spurious Emissions (Radiated)

Para. No.: 15.247 (c)

Test Performed By: G.Suhanthakumar	**Date of Test: 18 - 23 Apr 2012**

Test Results: Complies

Measurement Data:

Band-edge, @3m

Frequency	Measured Field Strength @3m, dBµV/m	Detector	Limit dBµV/m	Margin dB
2.39 GHz	34.6	AV	54	19.4
	37.1	PK	74	36.9
2.4835 GHz	51.3	AV	54	2.7
	56.0	PK	74	18.0

See attached plots.

Tested according to KDB 913591.

Marker Delta Calculation:

Lower Band:

Measured emission at 2.39GHz : -57.73 dBm – Peak

Measured emission at 2.39GHz : -60.62 dBm – AV

Electric field strength is calculated according to KDB 558074 D01 DTS Meas Guidance v02, Section 10.2.2.1 and corrected with antenna gain.

Band Edge Field Strength, Peak: 37.08 dBµV/m

Band Edge Field Strength, AV: 34.6 dBµV/m

Upper Band:

Electric field strength is calculated according to KDB 558074 D01 DTS Meas Guidance v02, Section 10.2.2.1 and corrected with antenna gain.

Measured emission at 2.4835GHz : -32.46 dBm – Peak

Band Edge Field Strength, Peak: 56.0 dBµV/m

Max: 85.78 dBµV/m

Delta : 34.48 – AV

Band Edge Field Strength, AV: 85.78 – 34.48 dBµV/m = 51.26 dBµV/m

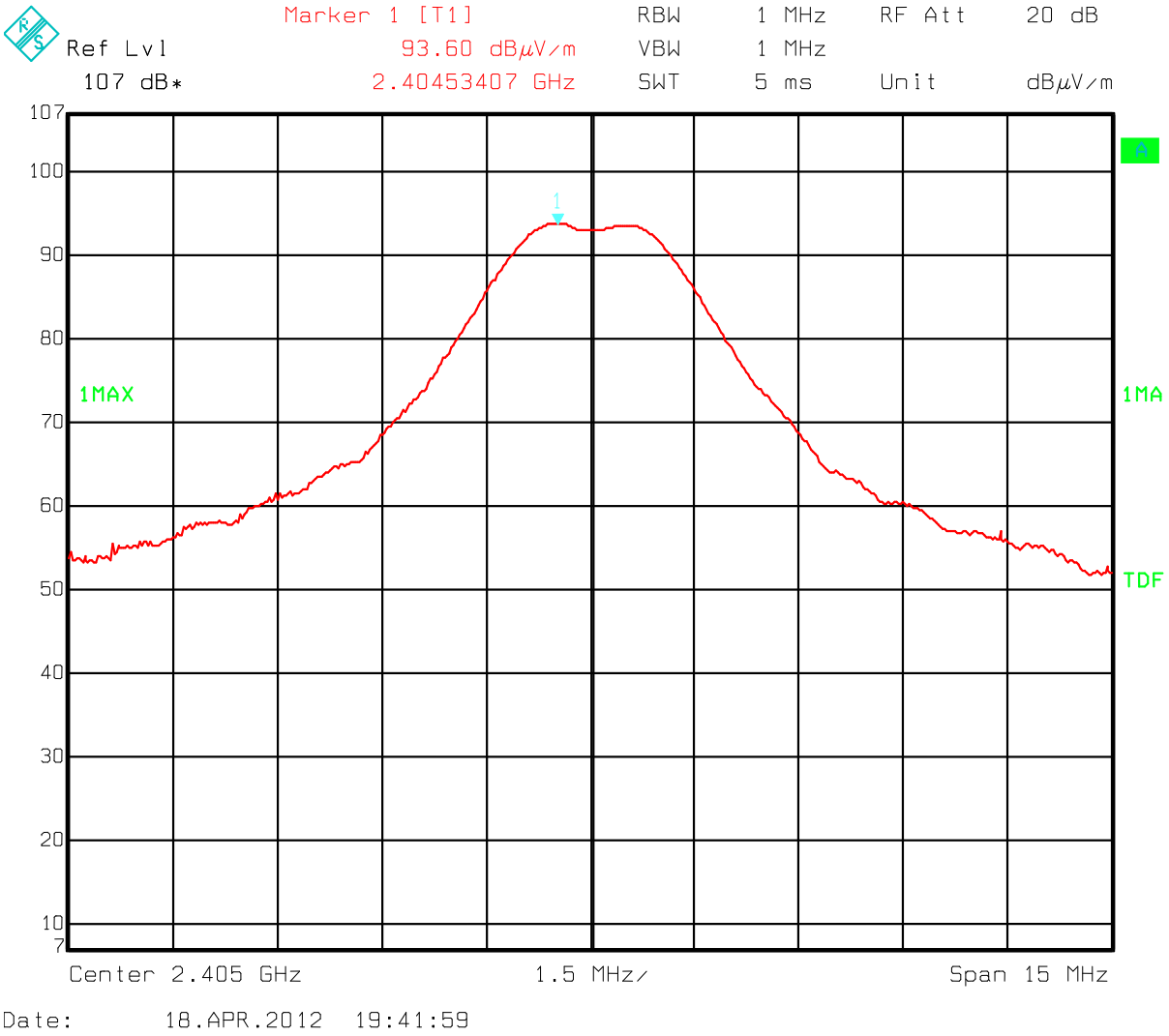
RF conducted power

Tested according to KDB 558074 D01 DTS Meas Guidance v02, Section 10.1.1 & 10.1.2.

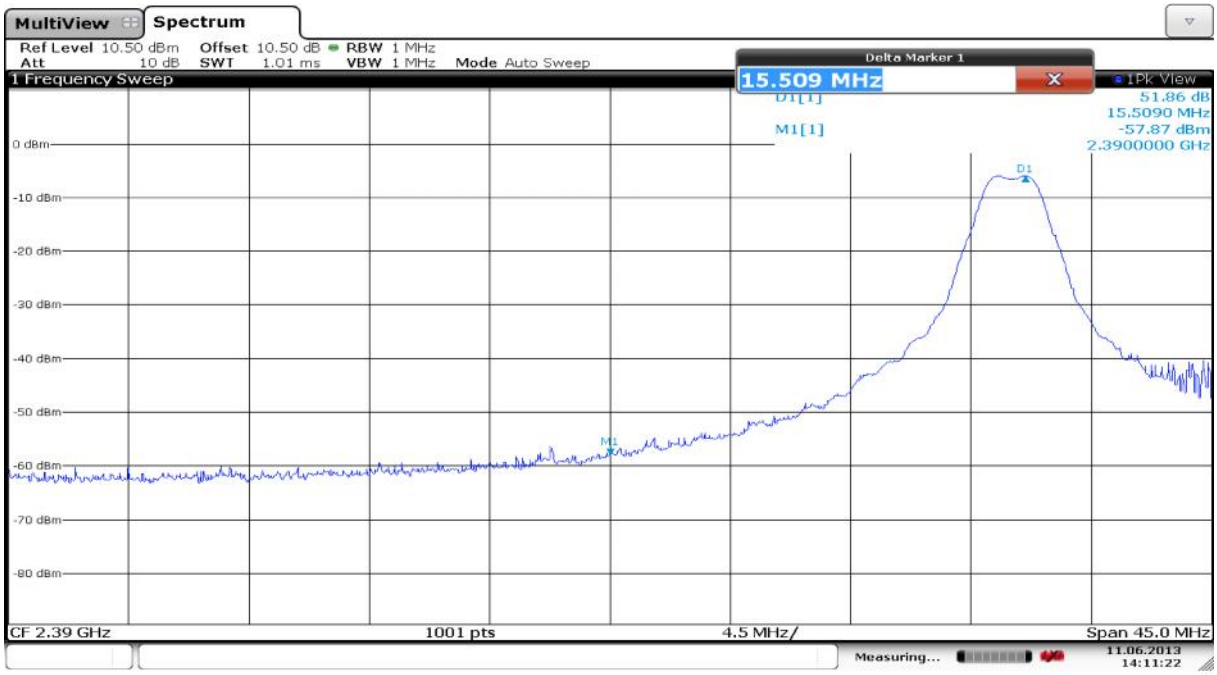
Test performed with 100 kHz Bandwidth from 9kHz to 25 GHz.

All emissions are more than 20dB below carrier.

See plots.

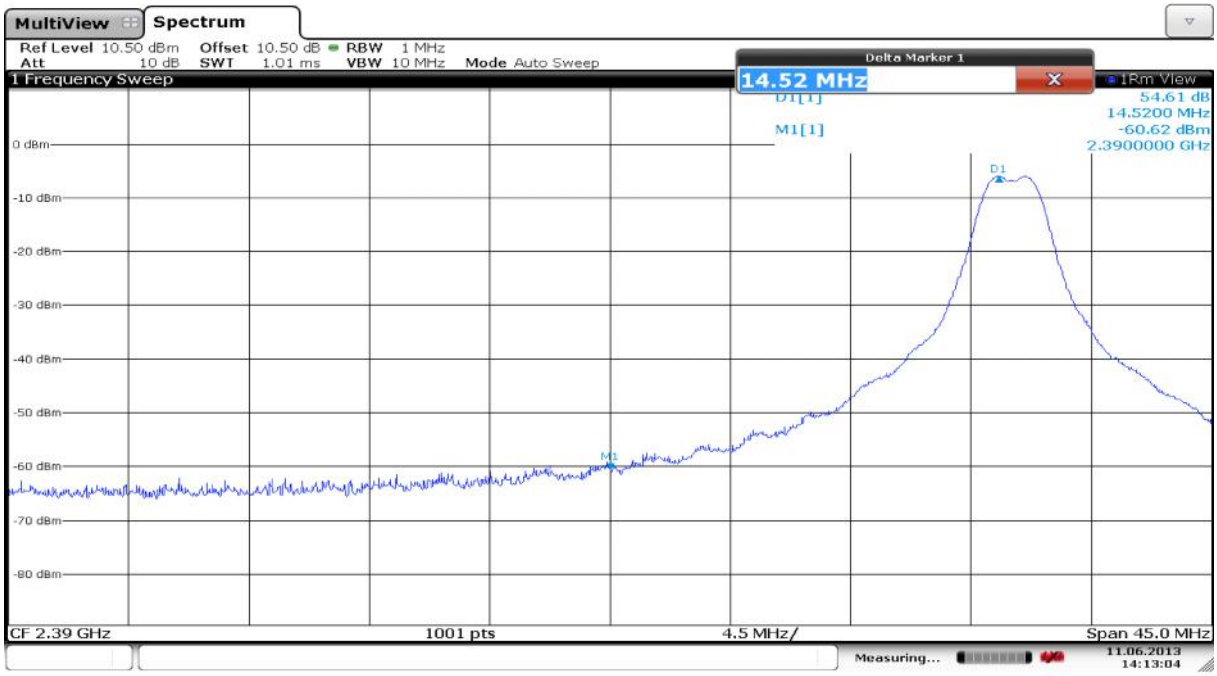


Field strength, 2405MHz



2397.500MHZ
Date: 11.JUN.2013 14:11:22

Band Edge, 2390 MHz, Peak Detector



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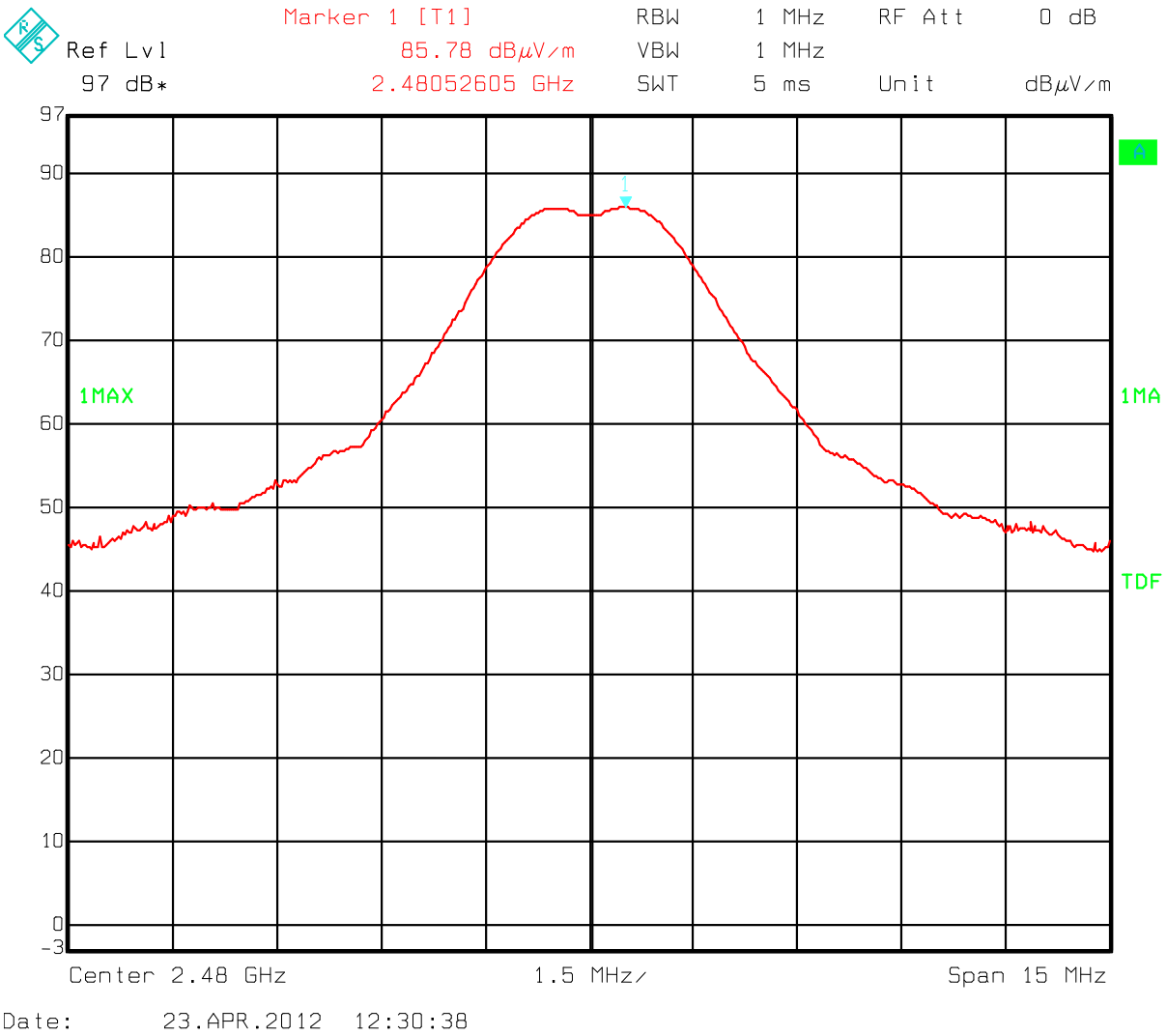
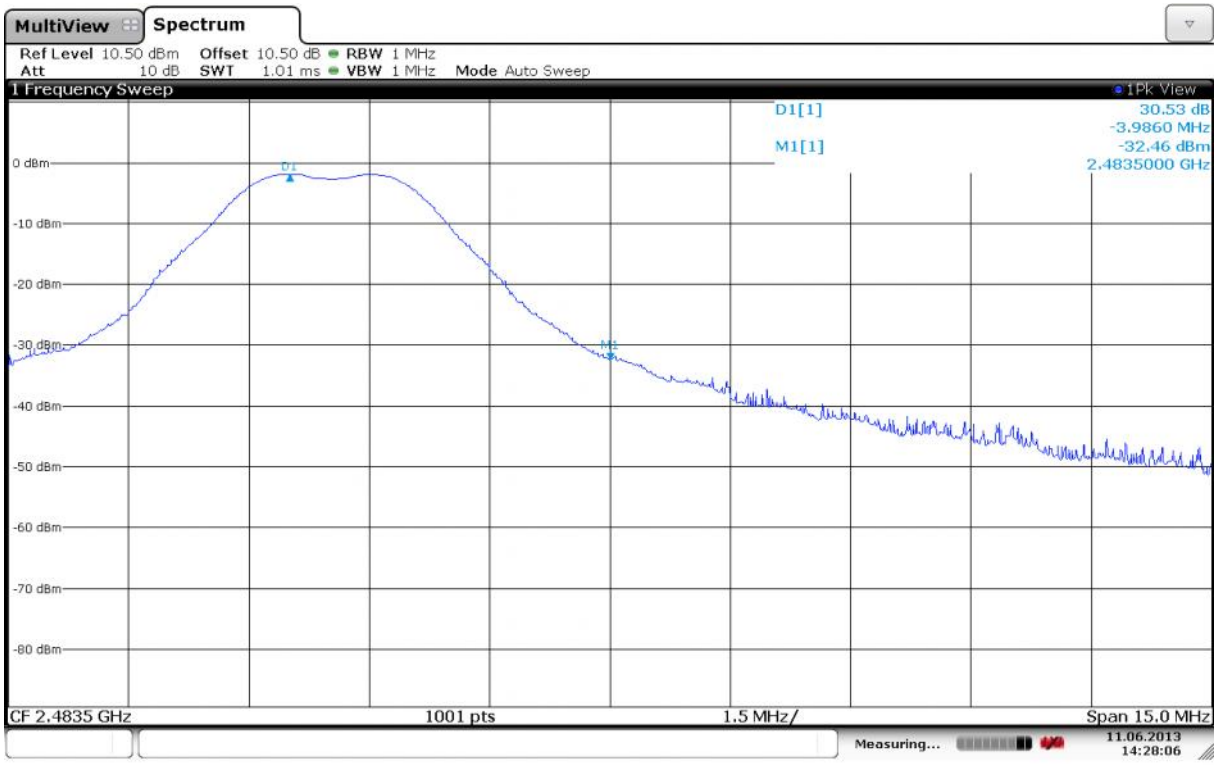
Band Edge, 2390 MHz, AV Detector



Field strength, 2483.5MHz, Pk Detector



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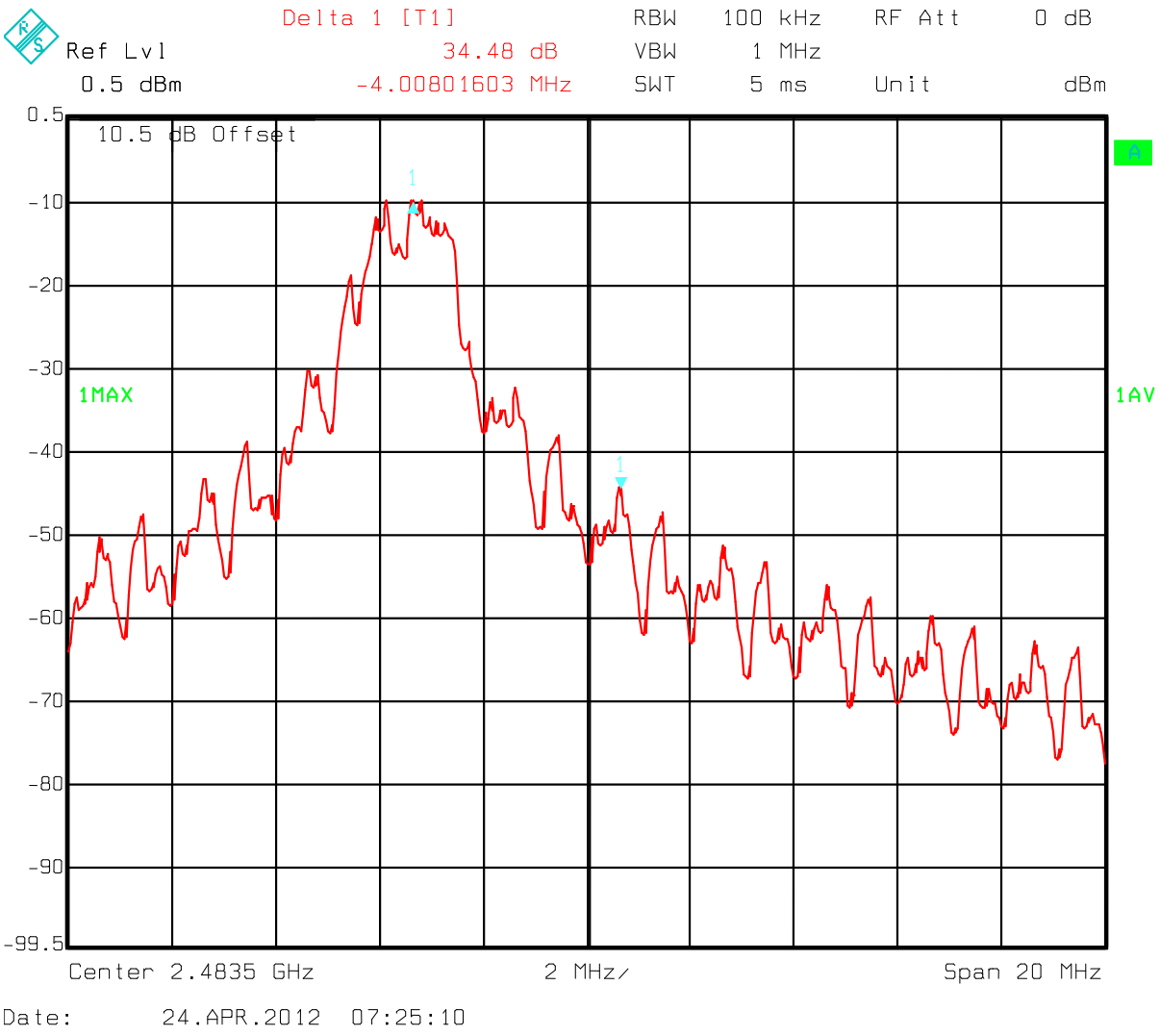
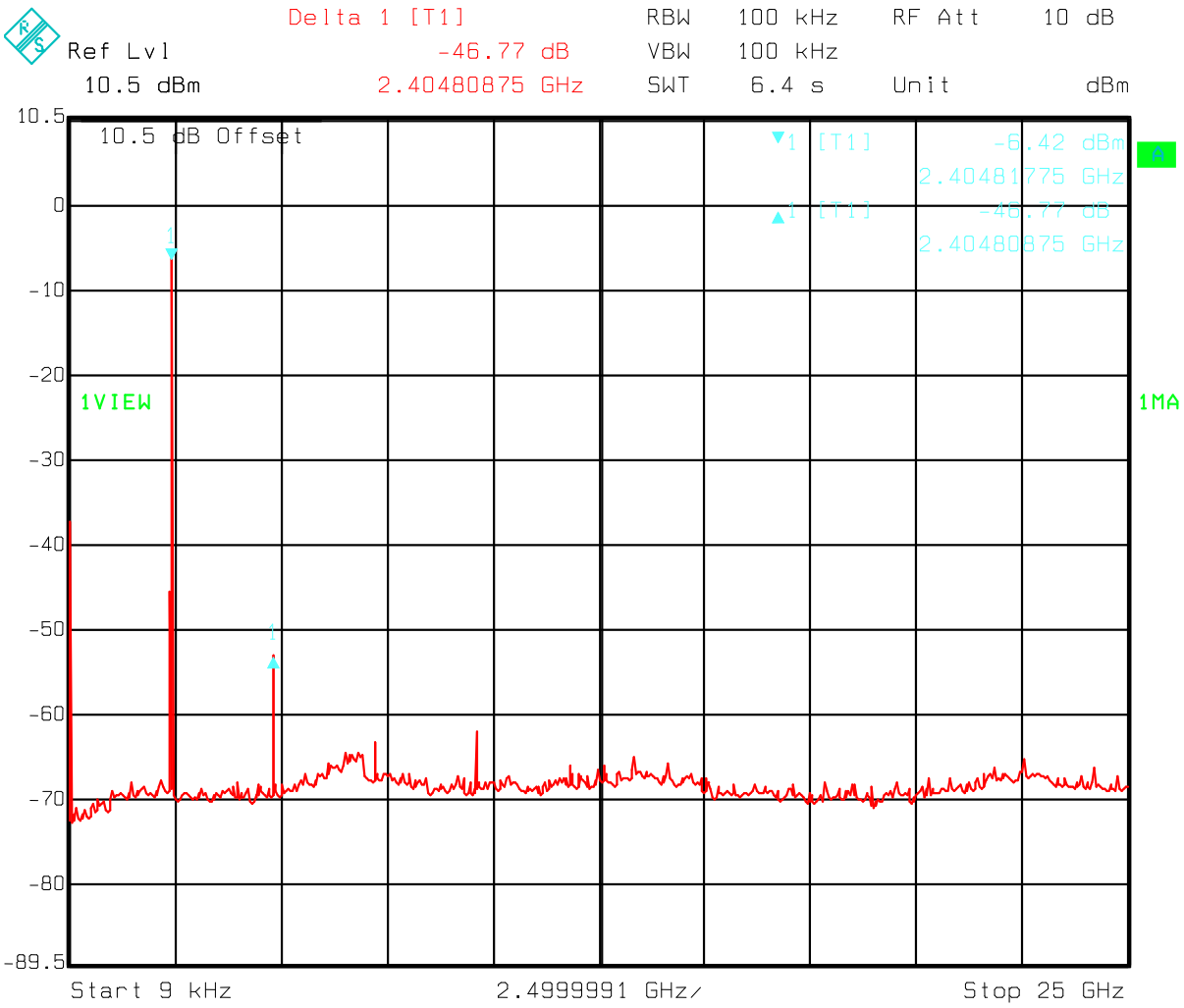
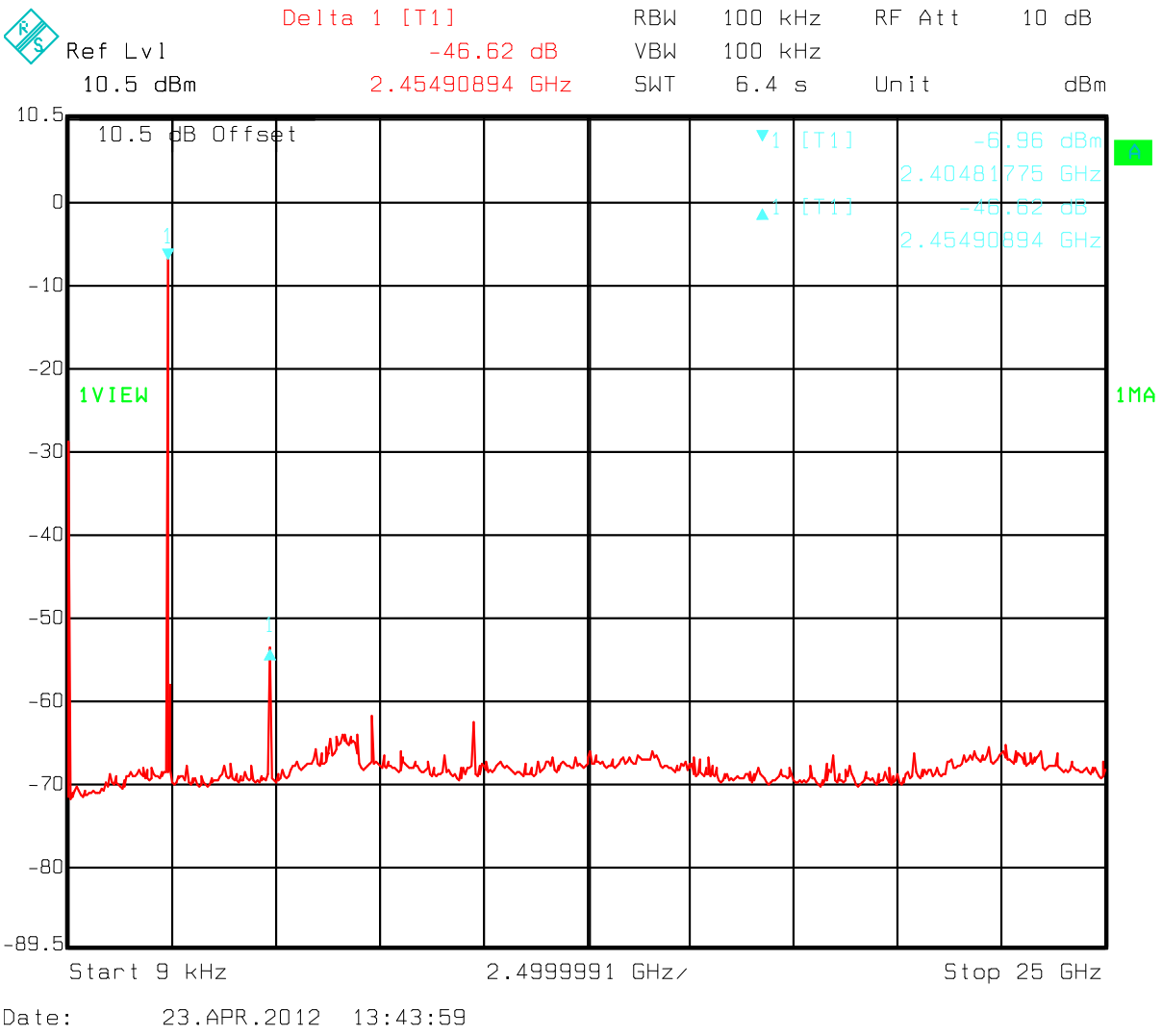
Band Edge, 2483.5 MHz, Peak detector



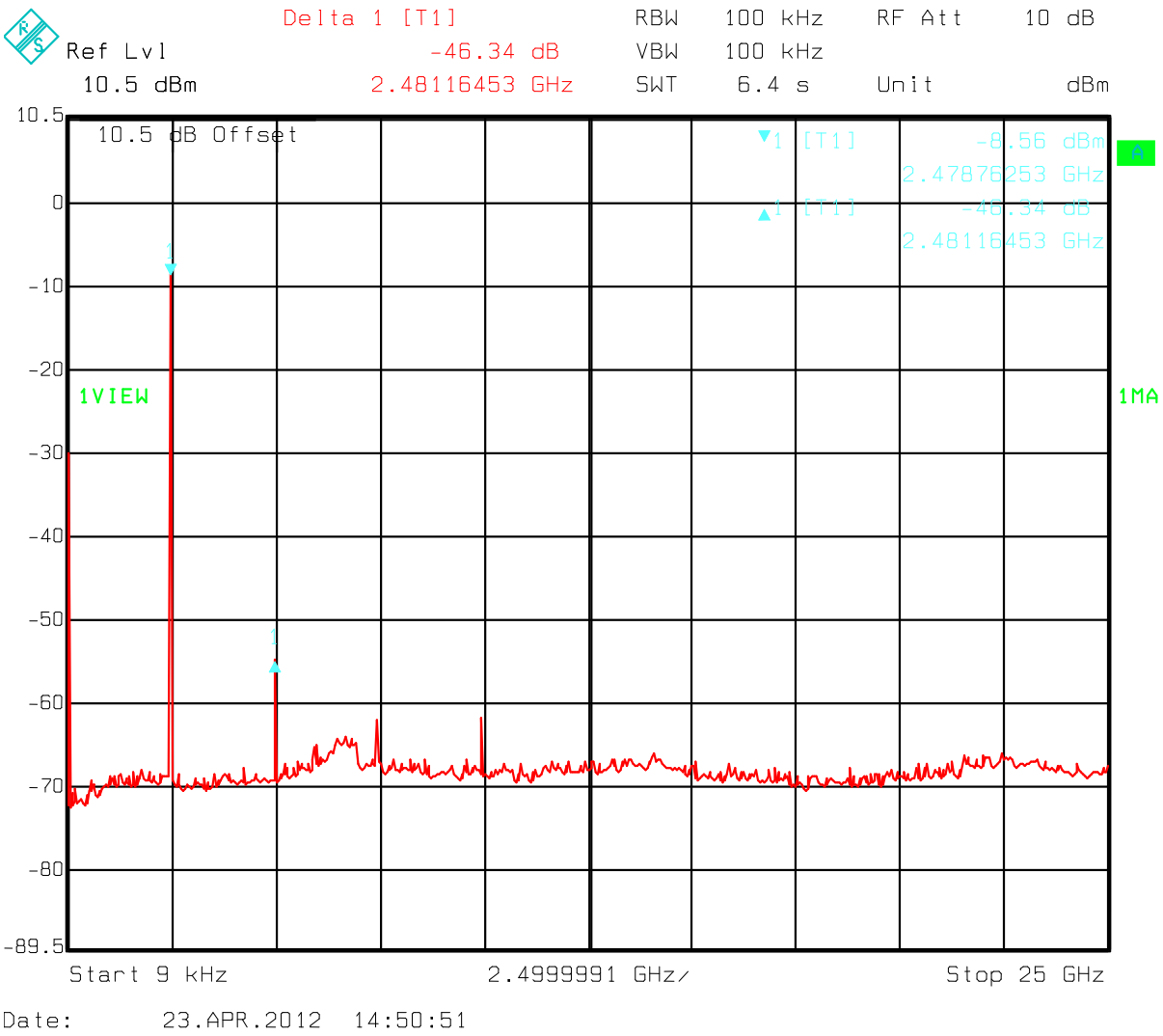
Band Edge, 2483.5 MHz, Marker Delta, Av detector



2405MHz - Conducted Emissions, 9kHz – 25GHz, peak detector



2440MHz - Conducted Emissions, 9kHz – 25GHz, peak detector



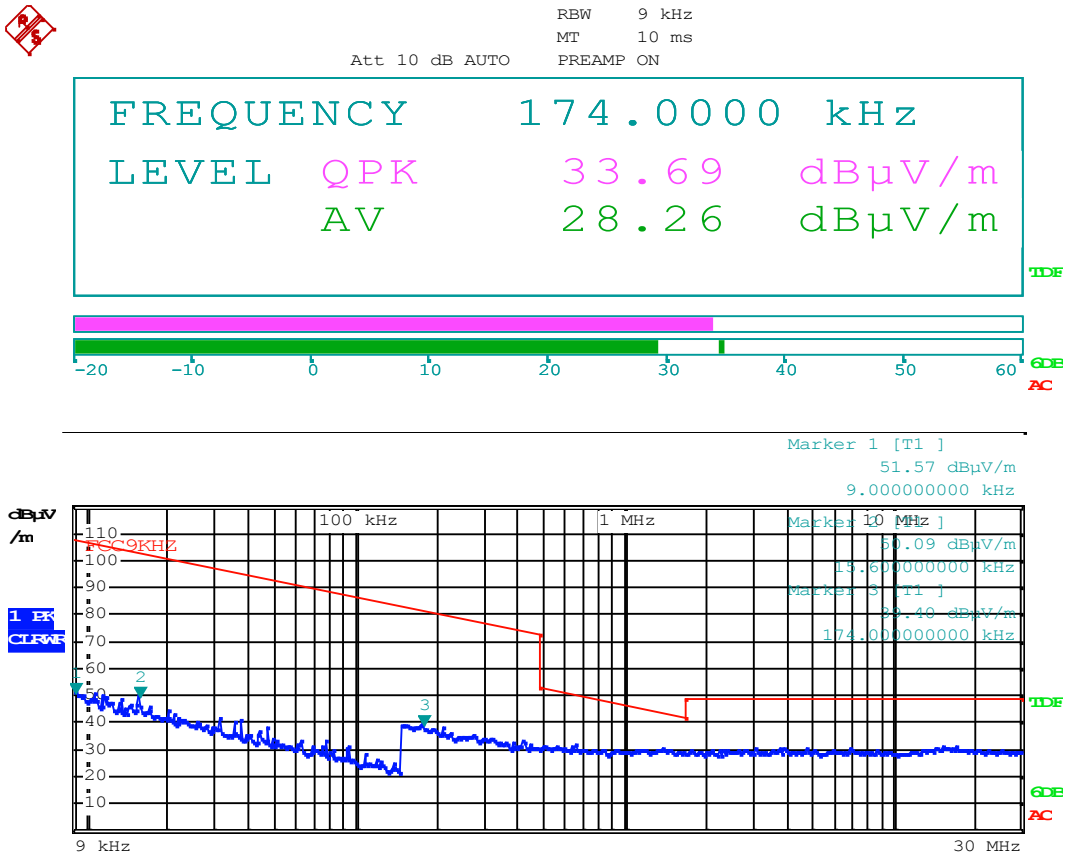
2480MHz - Conducted Emissions, 9kHz – 25GHz, peak detector

Radiated emissions 9kHz - 30 MHz.

Detector: Quasi-Peak

Measuring distance 10 m.

Frequency	Operational condition	Field strength	Measuring distance	Limit FCC15.209	Margin
MHz		dBµV/m	m	dBµV/m	dB
0.174	TX on	33.69	10	81.87	48.2



Date: 18.APR.2012 17:13:10

9kHz - 30MHz

Radiated emission 30 – 1000 MHz.

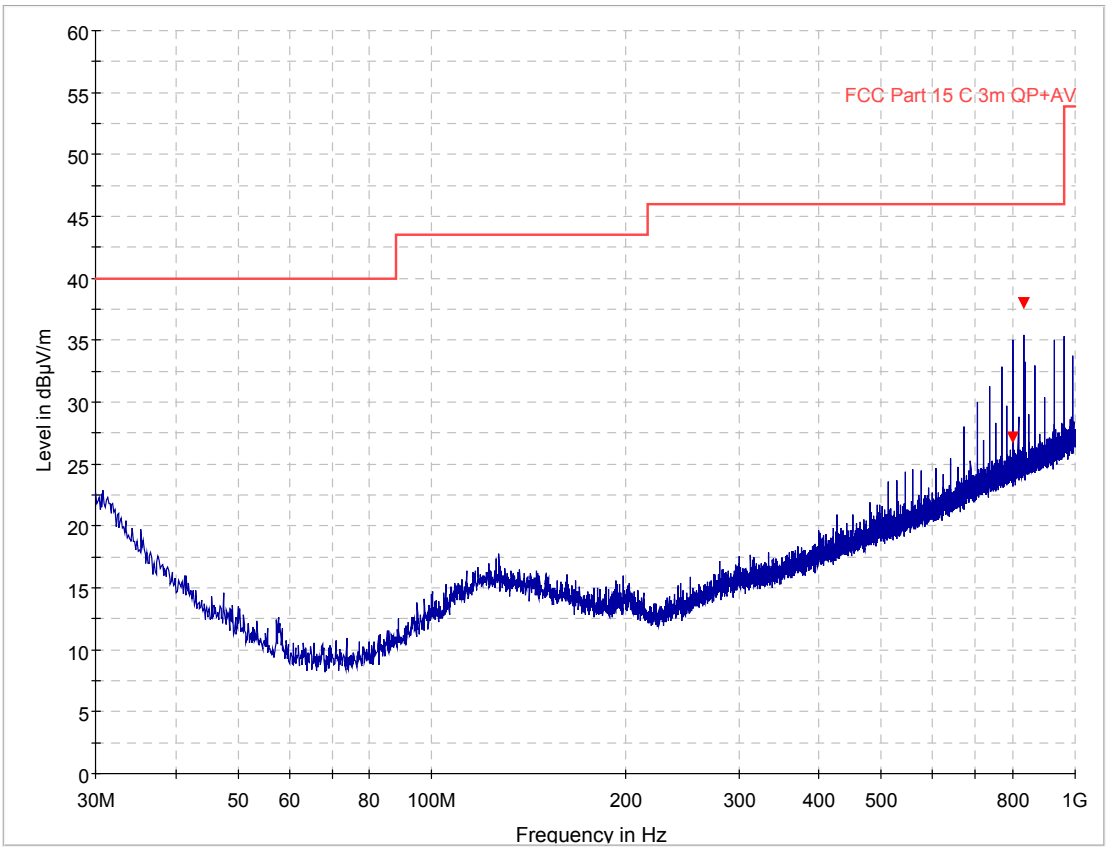
Detector: Peak

Measuring distance 3m.

All values are below the limit even when measured with Peak Detector.

RBW: 100kHz , VBW: 300kHz

See attached plot.



Radiated Emissions, 30 – 1000 MHz, VP and HP, @3m

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
800.090542	27.2	1000.0	120.000	127.0	V	297.0	0.6	18.8	46.0	
832.027192	38.0	1000.0	120.000	115.0	V	288.0	1.0	8.0	46.0	

Radiated Emissions, 1-25 GHz

1-3 GHz measured at a distance of 3 m

3 - 18 GHz measured at 1m

Prescan performed from 18 to 25 GHz.

PK-detector

Channel	Frequency MHz	Field strength @3m dBµV/m	Detector	Limit dBµV/m	Margin dB
Ch 2405	4809	50.10	Pk	74	23.90
Ch 2440	4880	46.16	Pk	74	27.84
Ch 2480	4960	46.37	Pk	74	27.63

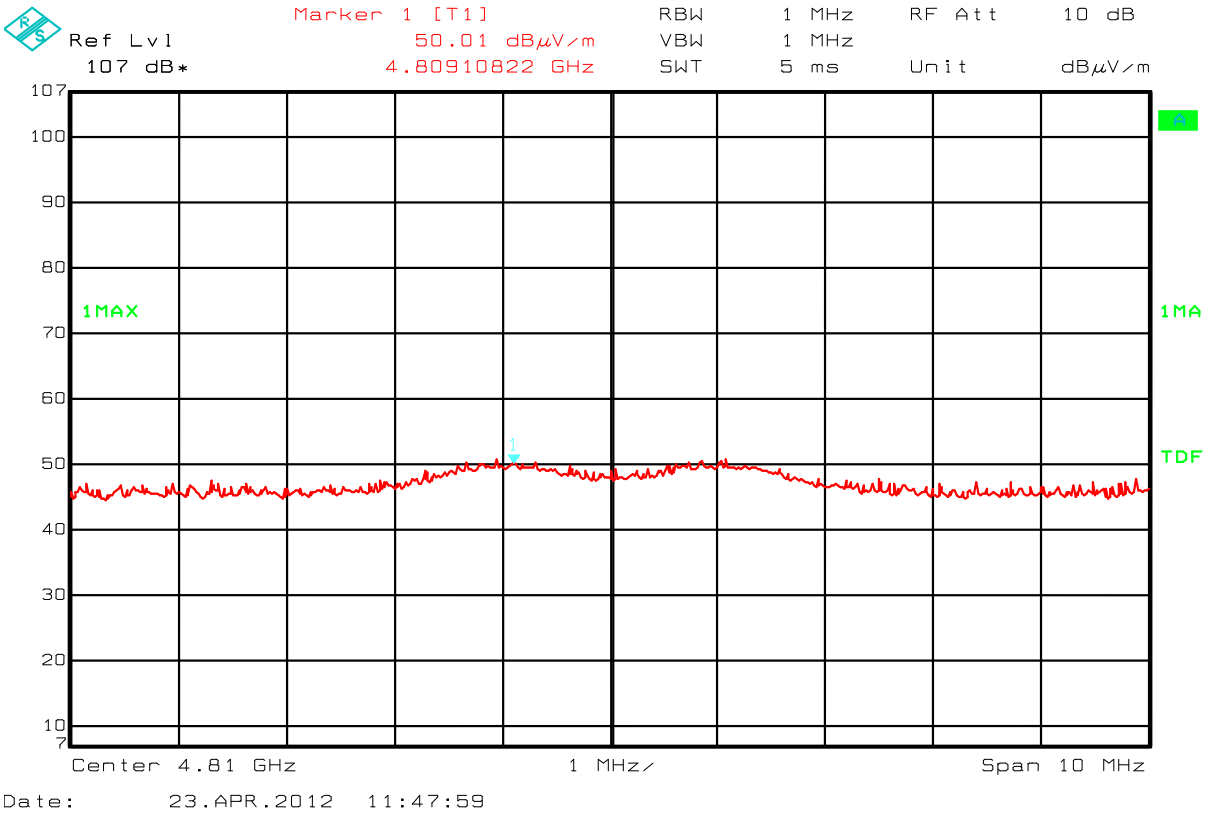
AV-detector

Channel	Frequency MHz	Field strength @3m dBµV/m	Detector	Limit dBµV/m	Margin dB
Ch 2405	4809	40.26	AV	54	13.74
Ch 2440	4880	41.02	AV	54	12.98
Ch 2480	4960	38.95	AV	54	15.05

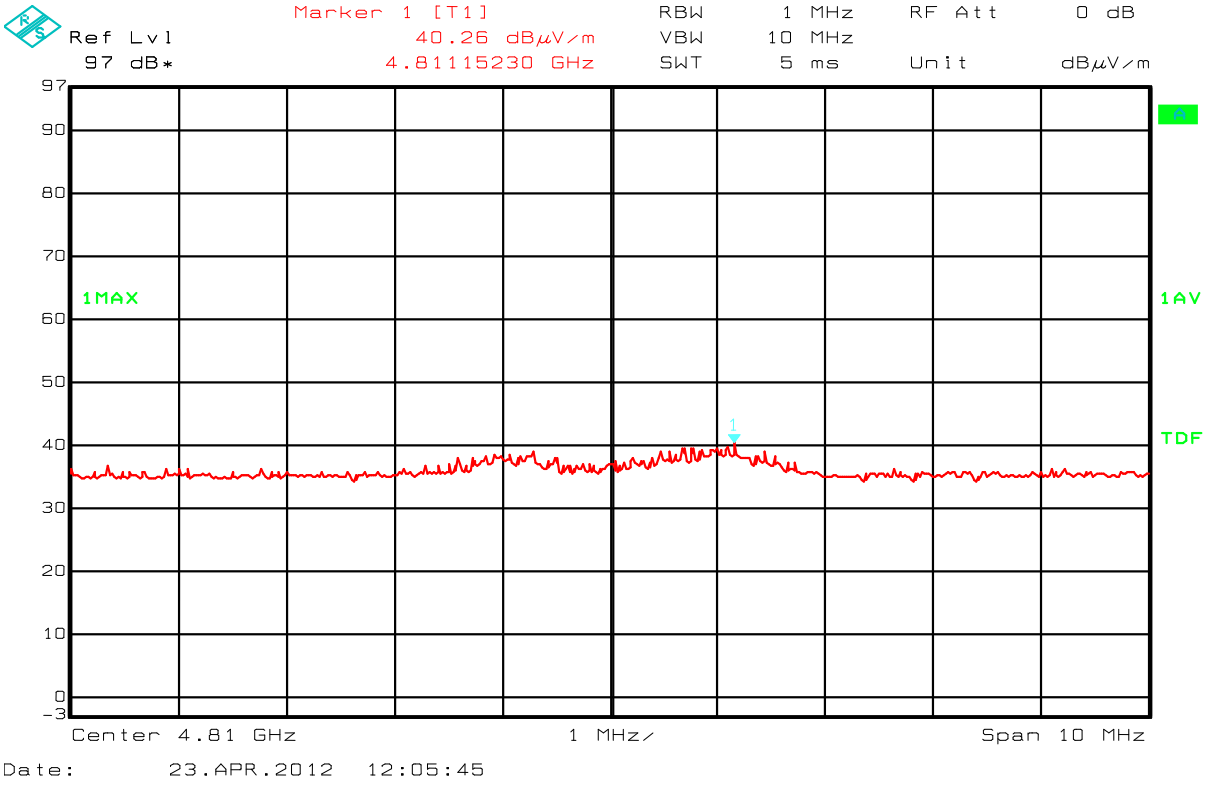
All emissions are below the Average Limit, even when measured with Peak Detector.

Antenna factor, amplifier gain and cable loss are included in Spectrum Analyzer "Transducer factor".

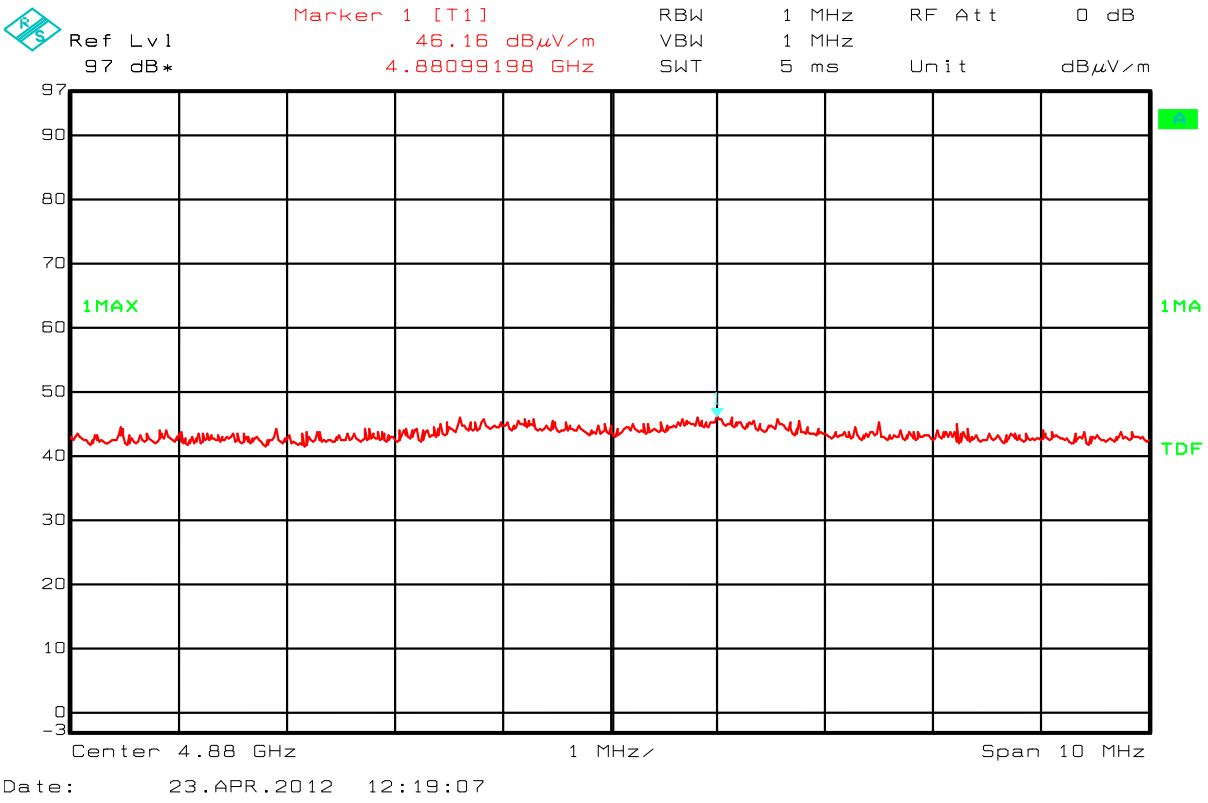
See attached graphs.



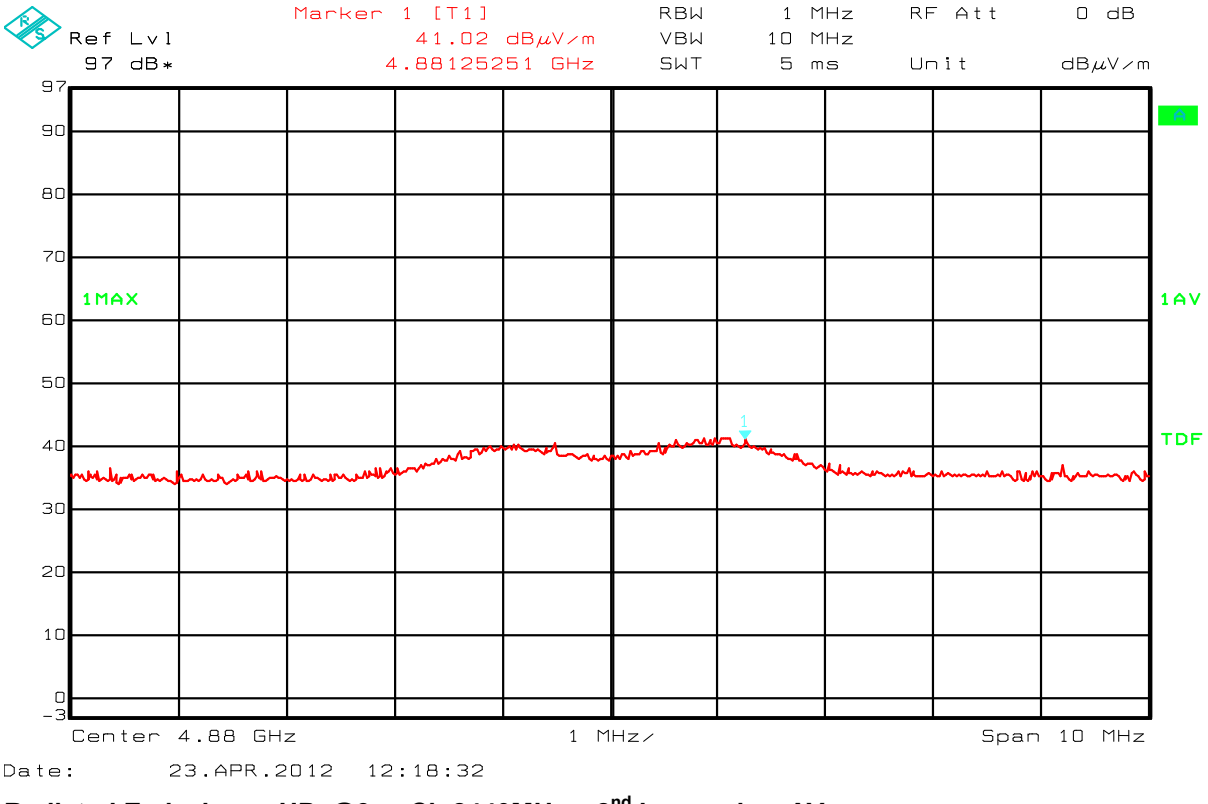
Radiated Emissions, HP, @3m, ch 2405MHz – 2nd harmonic - Max PK det



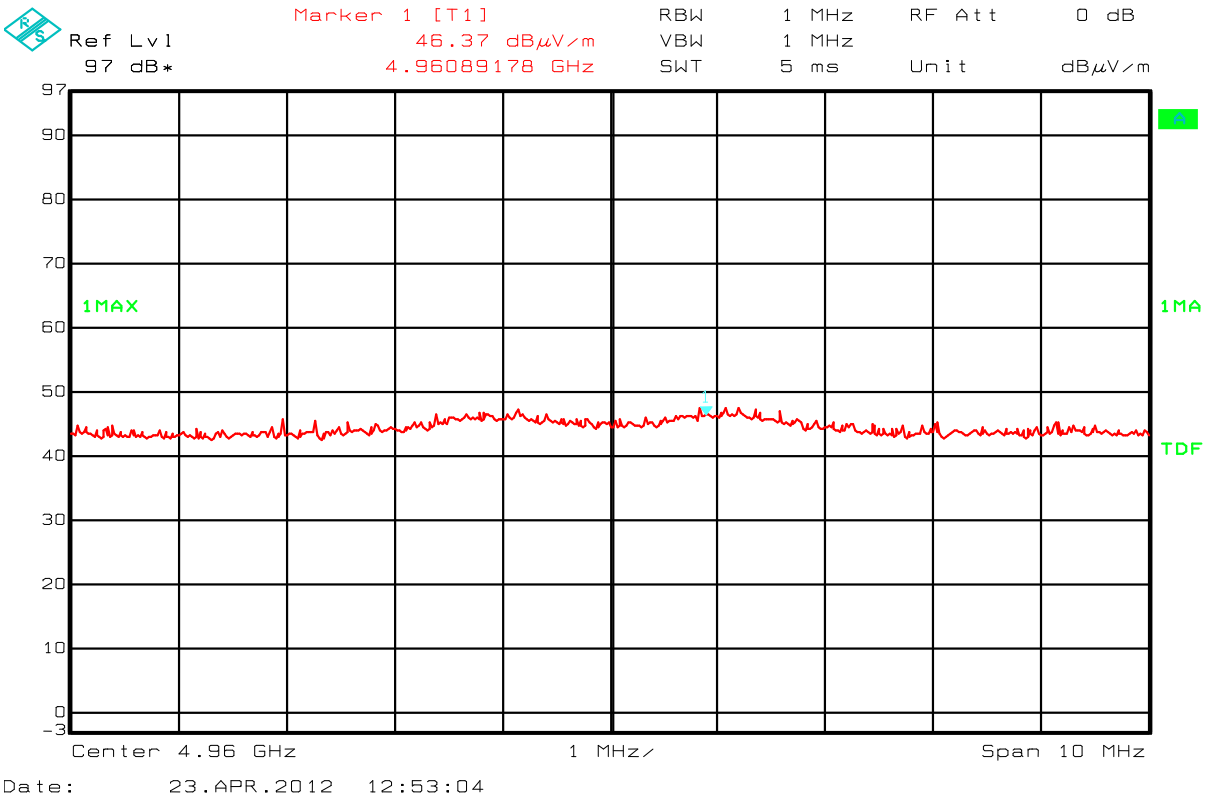
Radiated Emissions, HP, @3m, ch 2405MHz – 2nd harmonic - AV det



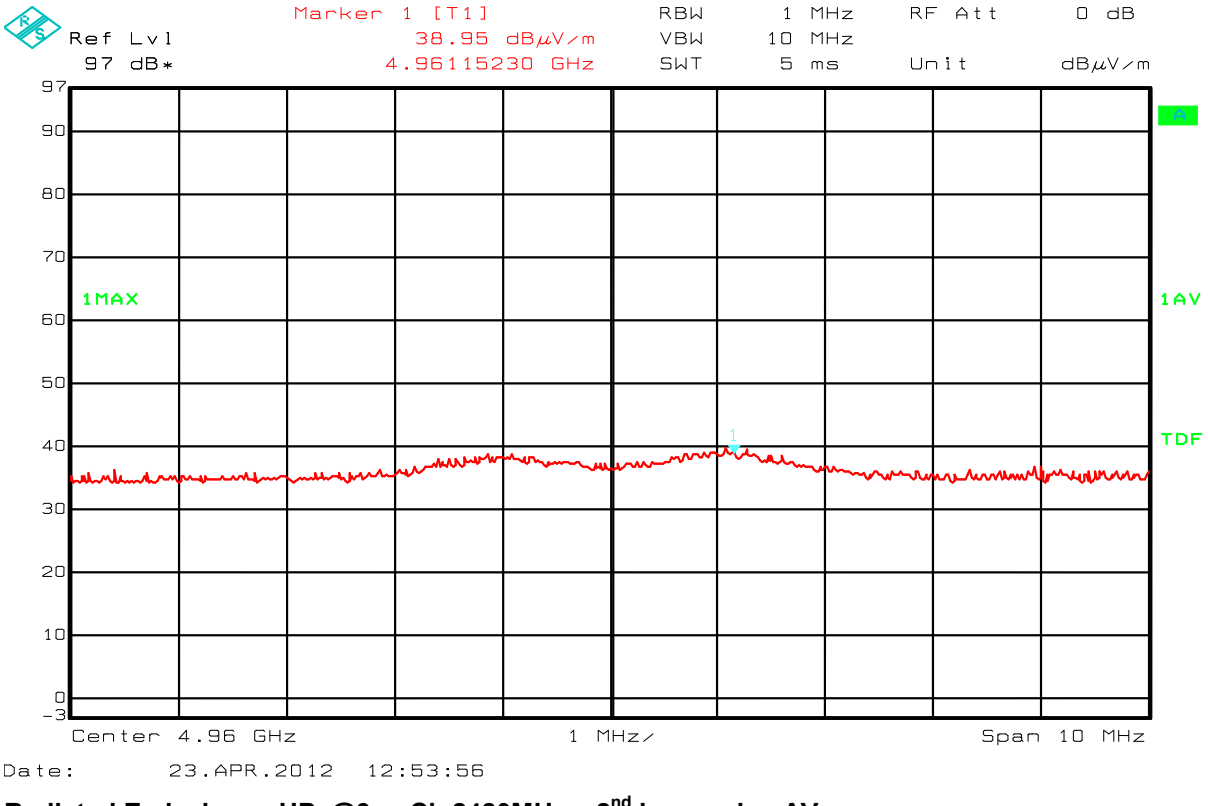
Radiated Emissions, HP, @3m, Ch 2440MHz – 2nd harmonic - PK



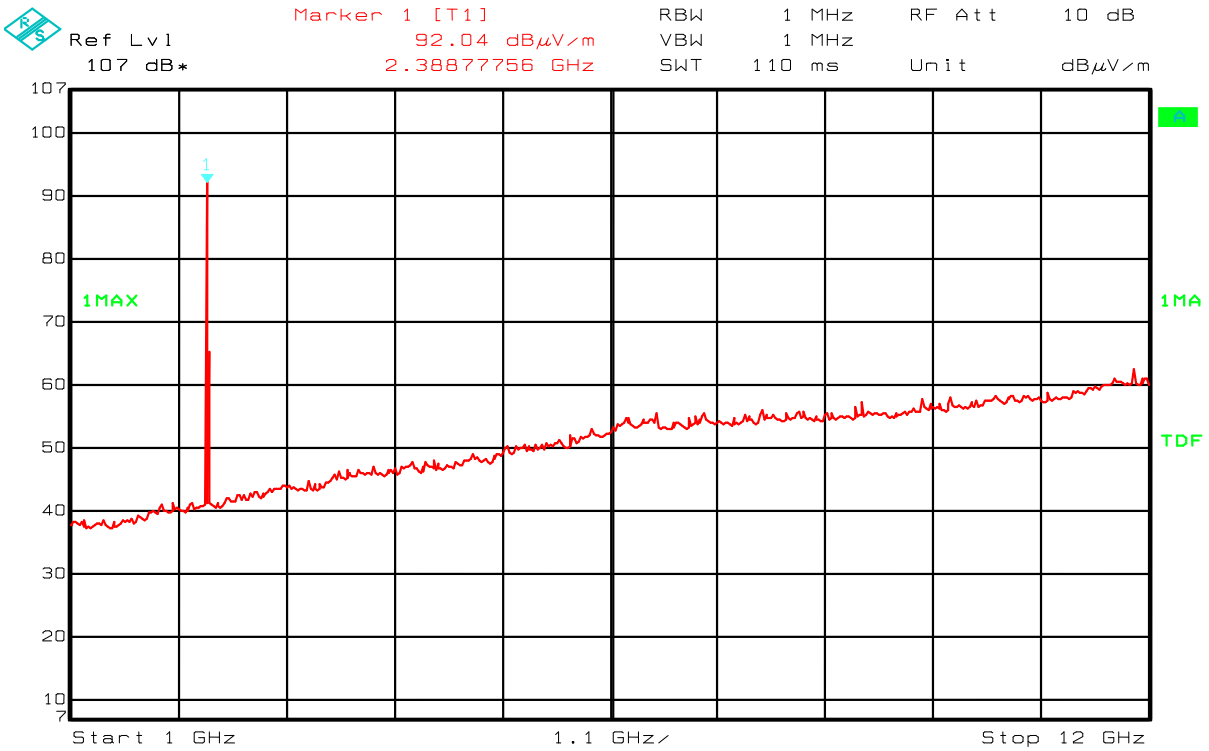
Radiated Emissions, HP, @3m, Ch 2440MHz – 2nd harmonic – AV



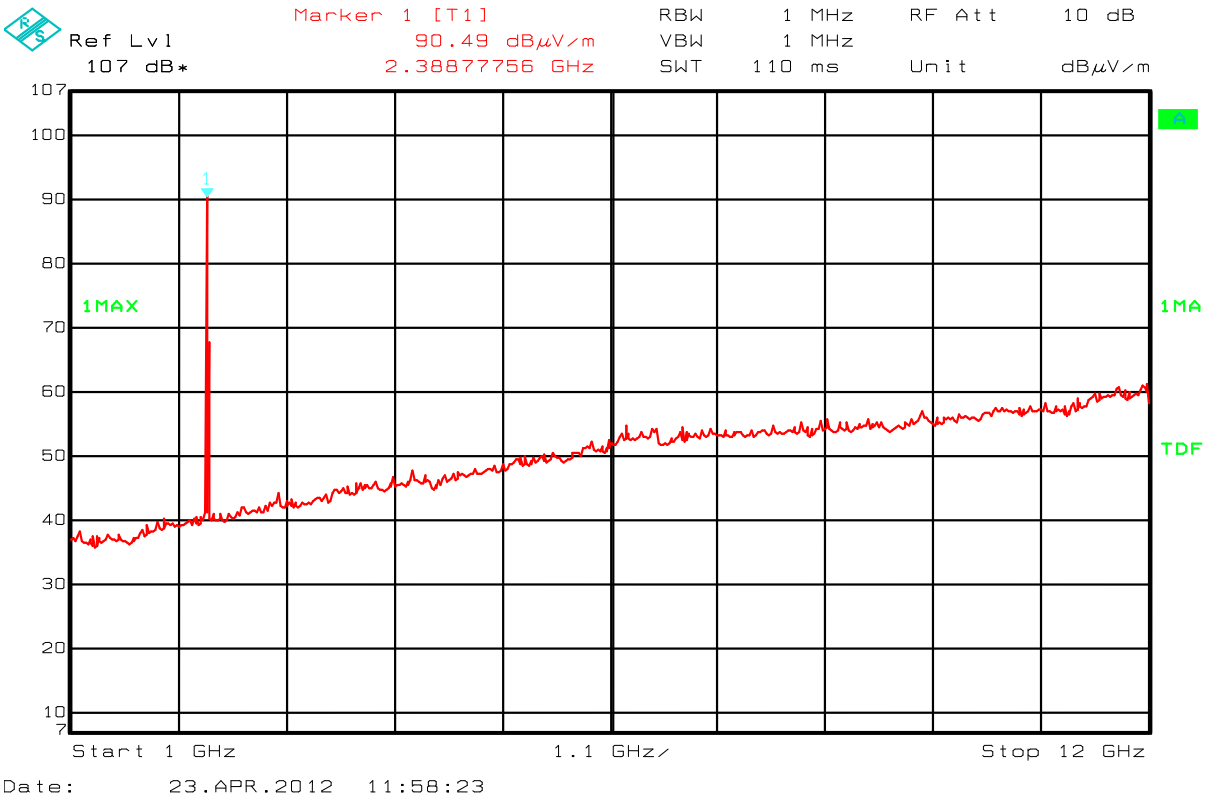
Radiated Emissions, HP, @3m, Ch 2480MHz – 2nd harmonic – PK



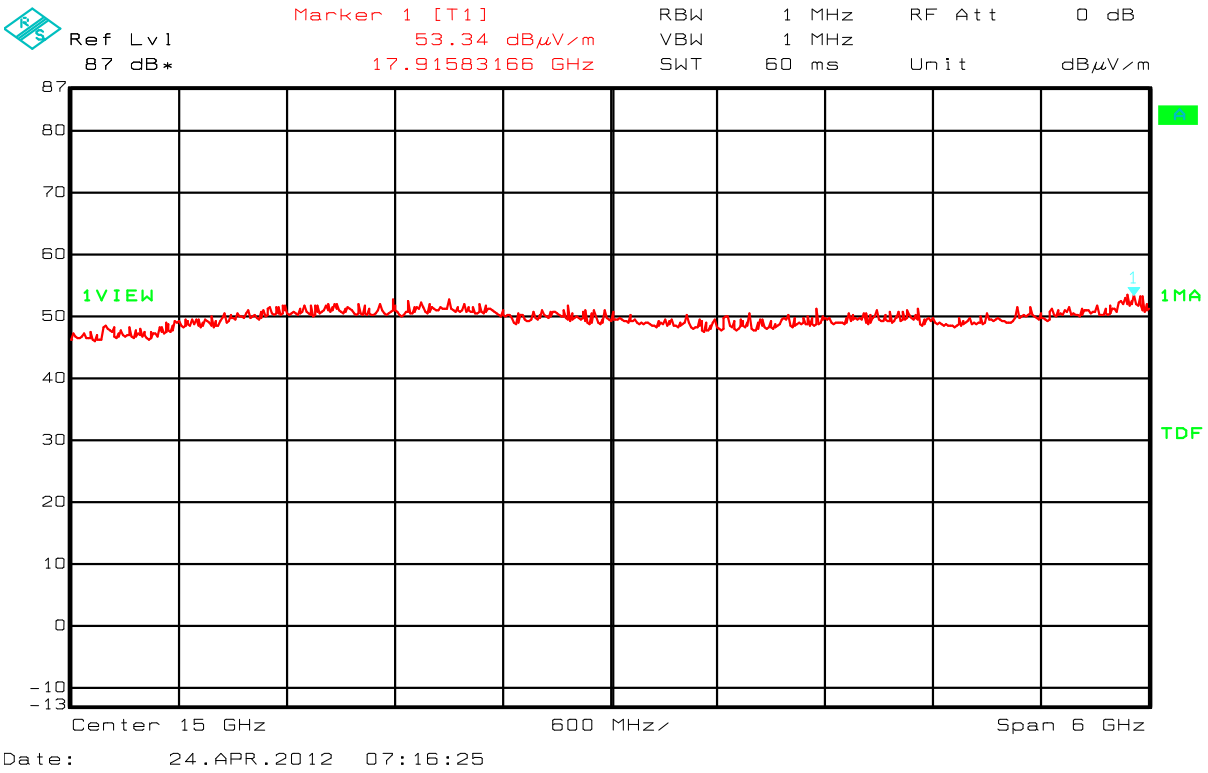
Radiated Emissions, HP, @3m, Ch 2480MHz – 2nd harmonic - AV



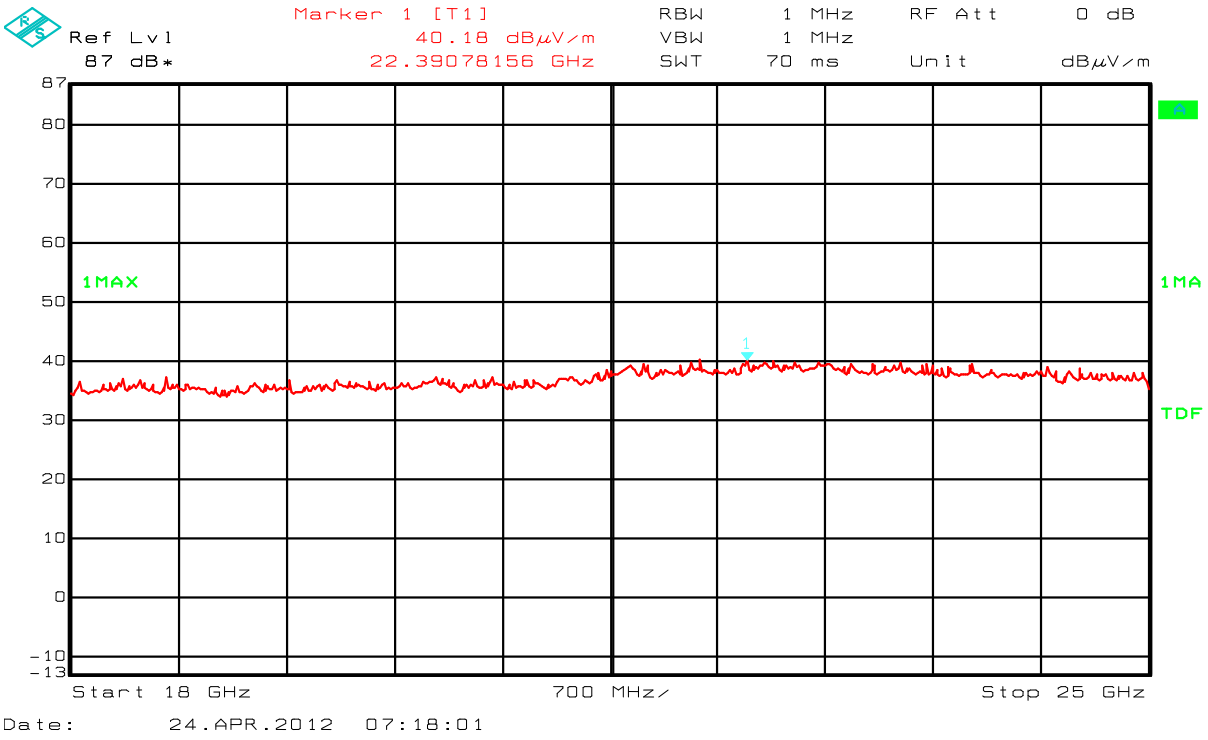
Radiated Emissions, 1 – 12 GHz, VP, @3m, VP



Radiated Emissions, 1 - 12GHz, HP, @3m,– HP



Radiated Emissions, 12 – 18 GHz, VP/HP, @1m – pre-view scan



Radiated Emissions, 18 – 25 GHz, VP/HP, @1m, Pre-view scan

4.6 Power Spectral Density (PSD)

Para. No.: 15.247 (d)

Test Performed By: G.Suhanthakumar	Date of Test: 11 June 2013

Test Results: Passed

Measured Data:

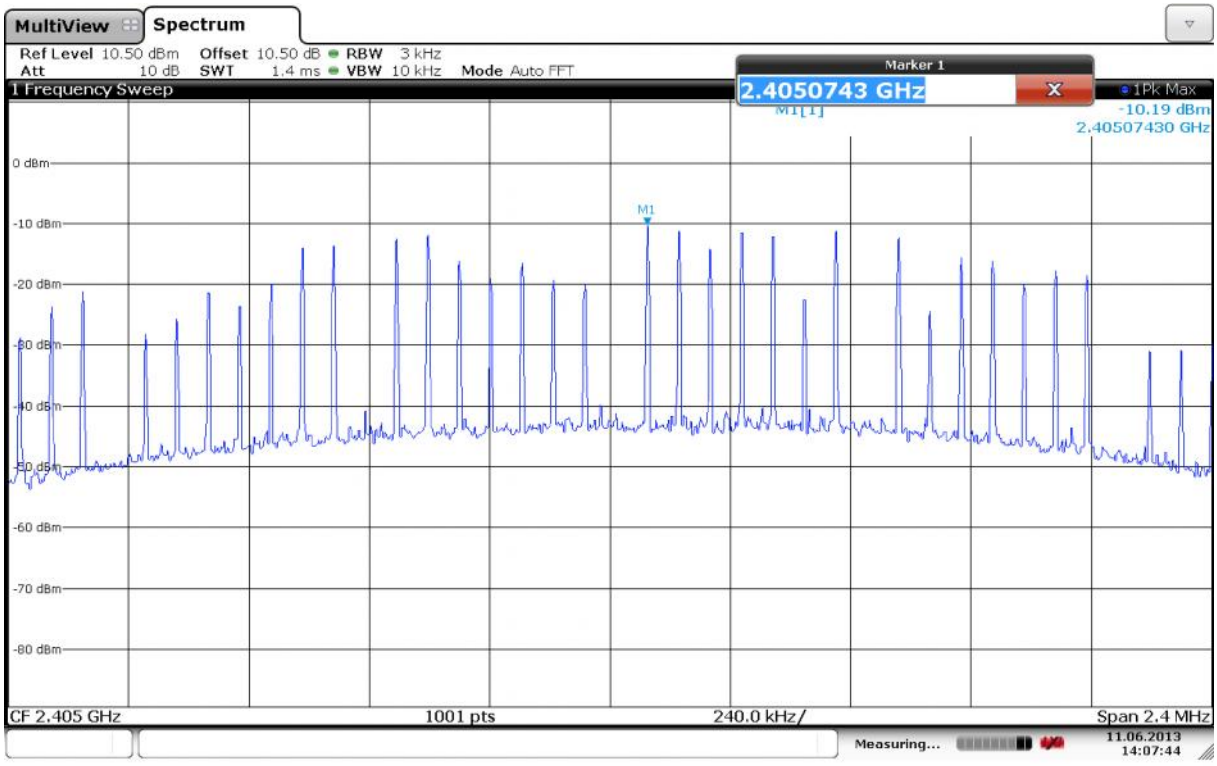
The alternative test procedures in point 2) A , B and formula 1 described in guidance on measurements for Digital Transmission Systems is used.

	Measured PSD
Power Spectral Density @2405 MHz	-10.19
Power Spectral Density @2440 MHz	-11.46
Power Spectral Density @2480 MHz	-12.81

Tested according to KDB 558074 D01 DTS Meas Guidance v02, Section 9.1.

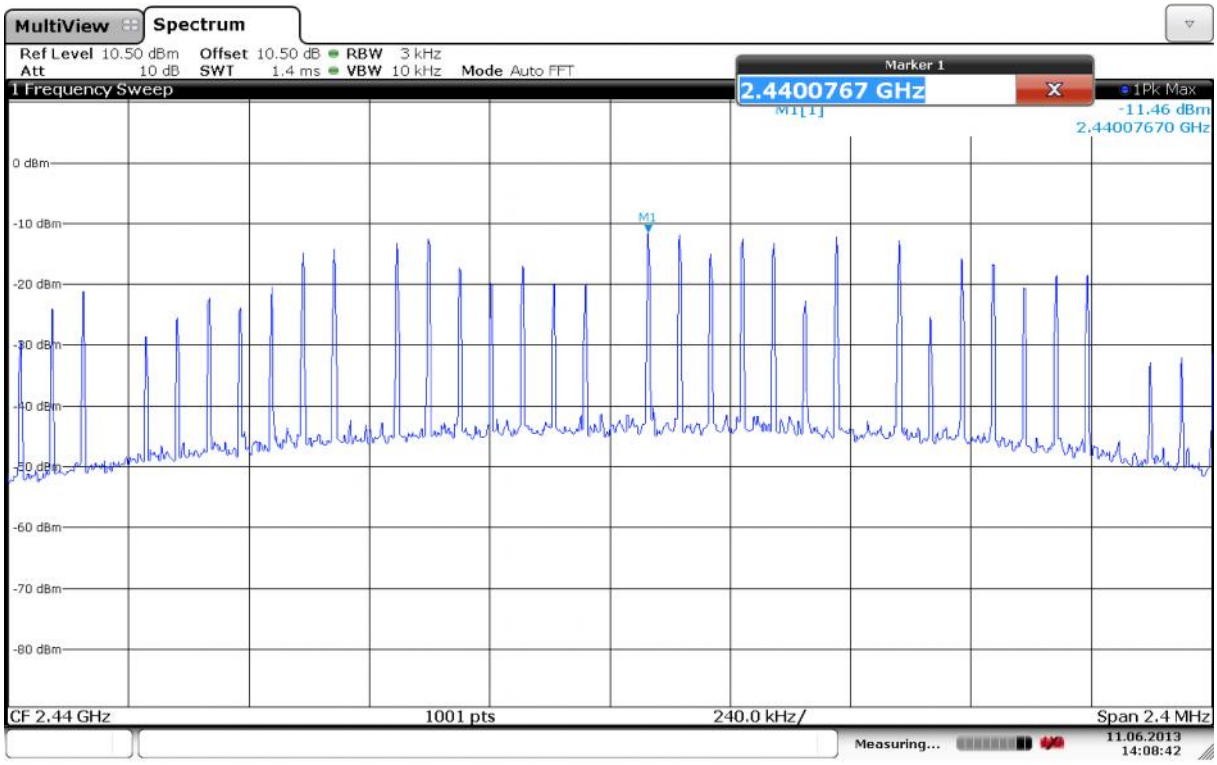
Requirements:

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



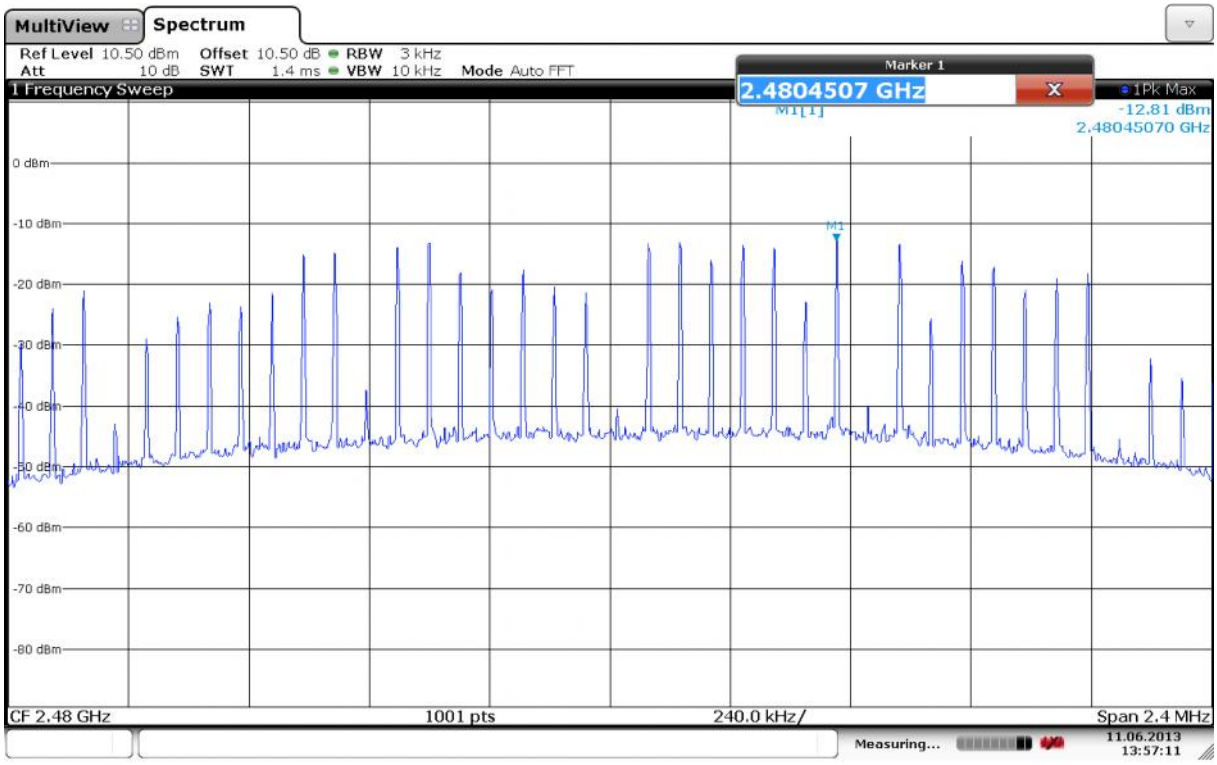
2397.500MHZ
Date: 11.JUN.2013 14:07:43

PSD Measurement - 2405MHz



2397.500MHZ
Date: 11.JUN.2013 14:08:42

PSD Measurement- 2440MHz



2397.500MHZ
Date: 11.JUN.2013 13:57:10

PSD Measurement - 2480MHz

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.

Date: 2012-04-18 to 2012-04-25

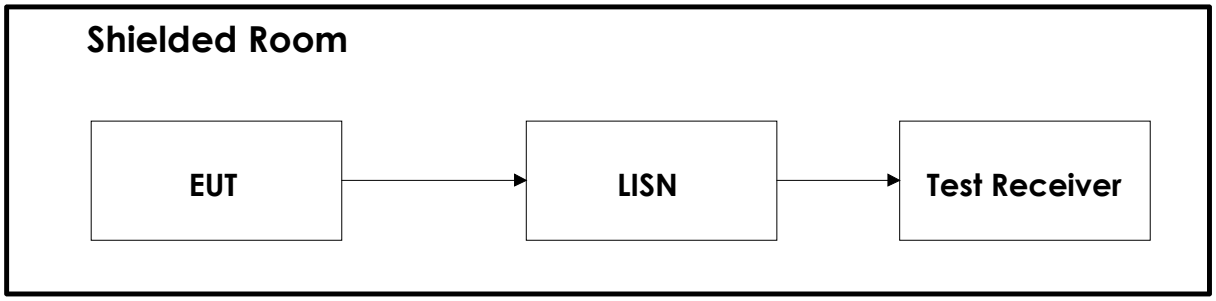
No.	Instrument/ ancillary	Type of instrument/ ancillary	Manufacturer	Ref. no.	Cal. Date	Cal. Due
1	FSEK	Spectrum Analyzer	Rohde & Schwarz	LR 1337	2010.12.15	2012.12.15
2	ESHS10	Spectrum Analyzer	Rohde & Schwarz	N-3528	2011.06.21	2012.06.21
3	3115	Antenna horn	EMCO	LR 1330	2010.08.05	2013.08.05
4	643	Antenna horn	Narda	LR 093	2009.01.26	2014.01.26
5	642	Antenna horn	Narda	LR 220	2009.01.26	2014.01.26
6	PM7320X	Antenna horn	Siverts lab	LR 103	2009.01.26	2014.01.26
7	DBF-520-20	Antenna horn	Systron Donner	LR 101	2009.01.26	2014.01.26
8	638	Antenna horn	Narda	LR 098	2010.06.17	2015.06.17
9	VULB 9163	Antenna TriLog	Schwarzbeck	LR1616	2010-08	2012-08
10	8449B	Pre-amplifier	Hewlett Packard	LR 1322	2011-09-27	2012-09-27
11	LNA6900	Pre-amplifier	Teseq	LR 1593	2011-11	2012-11
12	ESCI	Test Receiver	Rohde & Schwarz	N-4529	2010.11.08	2012.11.08
13	ESH3-Z3	LISN	Rohde & Schwarz	LR 1076	2011-11-03	2013-11-03
14	80S	Signal Generator	Powertron	LT 502	Cal b4 use	
15	Model 87 V	Multimeter	Fluke	LR 1598	2011-12-14	2012-12-14
17	FSU26	Spectrum Analyzer	Rohde & Schwarz	LR 1504	2010.09.28	2012.09.28
18	ESH3-Z2	Puls Limiter	Rohde & Schwarz	N-3932	2010.11.04	2012.11.04
19	6810.17A	10 attenuator	Suhner	LR 1143	2010.09.15	2012.09.15
20	FA210A1010003030	Microwave cable	Rosenberger	LR1566	Cal b4 use	

Date:11 - 13 June 2013

No.	Instrument/ ancillary	Type of instrument/ ancillary	Manufacturer	Ref. no.	Cal. Date	Cal. Due
1	FSW	Spectrum Analyzer	Rohde & Schwarz	LR1640	2012-06	2014-06

6 BLOCK DIAGRAM

6.1 Power Line Conducted Emission



6.2 Test Site Radiated Emission