



Test report no. : 215166- 3

Item tested : CC2541S Boosterpack

Type of equipment : 2.4 GHz Transceiver

FCC ID : ZAT2541SBOOST

Client : Texas Instruments Norway AS

www.nemko.com

FCC Part 15.247

Digital Transmission System

RSS-210, Issue 8

Low Power Licence-Exempt
Radiocommunication Devices

13 December 2012

Authorized by : 

Frode Sveinsen
Technical Verificator

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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: 52

1.2 Client Information

Name : Texas Instruments Norway AS
Address : Gaustadalléen 21,
NO-0349 Oslo, Norway
Telephone : +47 22 95 85 44
Fax : +47 22 95 85 46

Contact:

Name : Dag Grini
Telephone : +47 22 95 83 01
E-mail : d.grini@ti.com

1.3 Responsible Manufacturer (If other than client)

Same as the client

2 TEST INFORMATION

2.1 Test Item

Name :	Texas Instruments
FCC ID :	ZAT2541KEYFOB
IC :	451H-2541KEYFOB
Model/version :	CC2541S Boosterpack
Serial number :	-
Hardware identity and/or version:	1.1.0
Software identity and/or version :	-
Frequency Range :	2402 – 2480 MHz
Number of Channels :	40
Type of Modulation :	GFSK
Conducted Output power:	1.3 mW (Peak)
User Frequency Adjustment :	None
Type of Power Supply :	3.0 V DC (2 x AAA battery type/ LR03)
Antenna Connector :	PCB antenna
Antenna Diversity Supported :	No
Desktop Charger :	None

Description of Test Item

The CC2541S Booster Pack supports the Bluetooth Low Energy (BLE) standard, which is considered Digital Modulation per FCC part 15.247.

Exposure Evaluation

The EUT is exempted from RF Exposure Evaluation.

2.2 Test Environment

2.2.1 Normal test condition

Temperature:	19.7 – 21.2 °C
Relative humidity:	38.5 – 42.7 %
Normal test voltage:	Nominal 3 V DC (2 x AAA battery type/ LR03)

New batteries were used for all tests.

The values are the limit registered during the test period.

2.3 Test Period

Item received date:	2012-10-05
Test period :	from 2012-10-11 to 2012-10-31

3 TEST REPORT SUMMARY

3.1 General

Manufacturer: Texas Instruments
Model No.: CC2541S Booster Pack

All measurements are traceable 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.

- | | |
|---|---|
| <input checked="" type="checkbox"/> New Submission | <input checked="" type="checkbox"/> Production Unit |
| <input type="checkbox"/> Class II Permissive Change | <input type="checkbox"/> Pre-production Unit |
| DTS Equipment Code | <input type="checkbox"/> 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 #: 222600-3

TESTED BY: Thomas Dangle
Thomas Dangle, Test engineer

DATE: 2012-10-31

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3.2 Test Summary

Name of test	FCC Part 15 reference	RSS-210 Issue 8 reference	Result
Antenna Requirement	15.203	7.1.4 (RSS-GEN)	Pass
Power Line Conducted Emission	15.107(a) 15.207(a)	7.2.2 (RSS-GEN)	N/A*
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(d)	A8.2	Pass
Spurious Emissions (Antenna Conducted)	15.247(c)	A8.5	Pass
Spurious Emissions (Radiated)	15.247(c) 15.109(a) 15.209(a)	A8.5	Pass
Receiver Emissions (Radiated)	N/A	2.3	N/A

*EUT is battery operated only.

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)

The test is not applicable since the device is powered by battery.

Test Performed By: -	Date of Test: -
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Measurement procedure: ANSI C63.4-2003 using 50 μ H/50 ohms LISN.

Test Results: -

Measurement Data: -

4.2 Minimum 6 dB Bandwidth

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

Test Performed By: Thomas Dangle	Date of Test: 11 Oct. 2012
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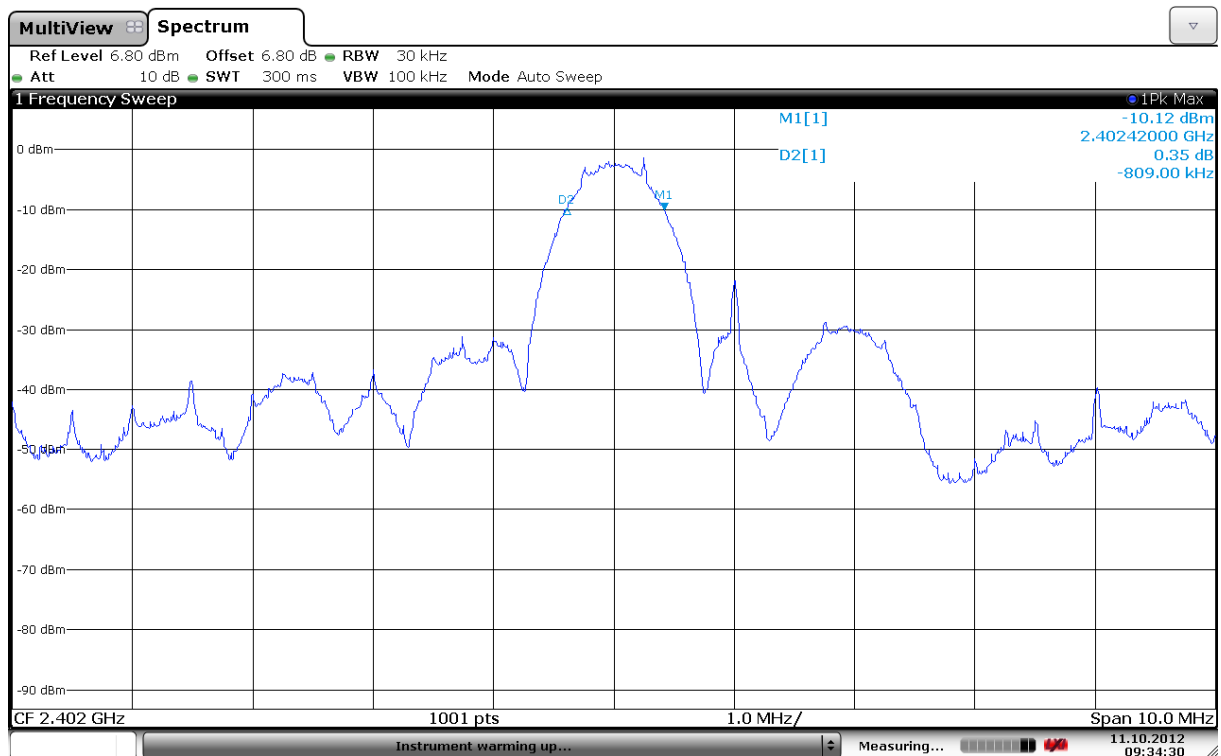
Test Results: Complies

Measurement Data:

Measured 6 dB Bandwidth (kHz)		
2402MHz	2440 MHz	2480MHz
809	869	889

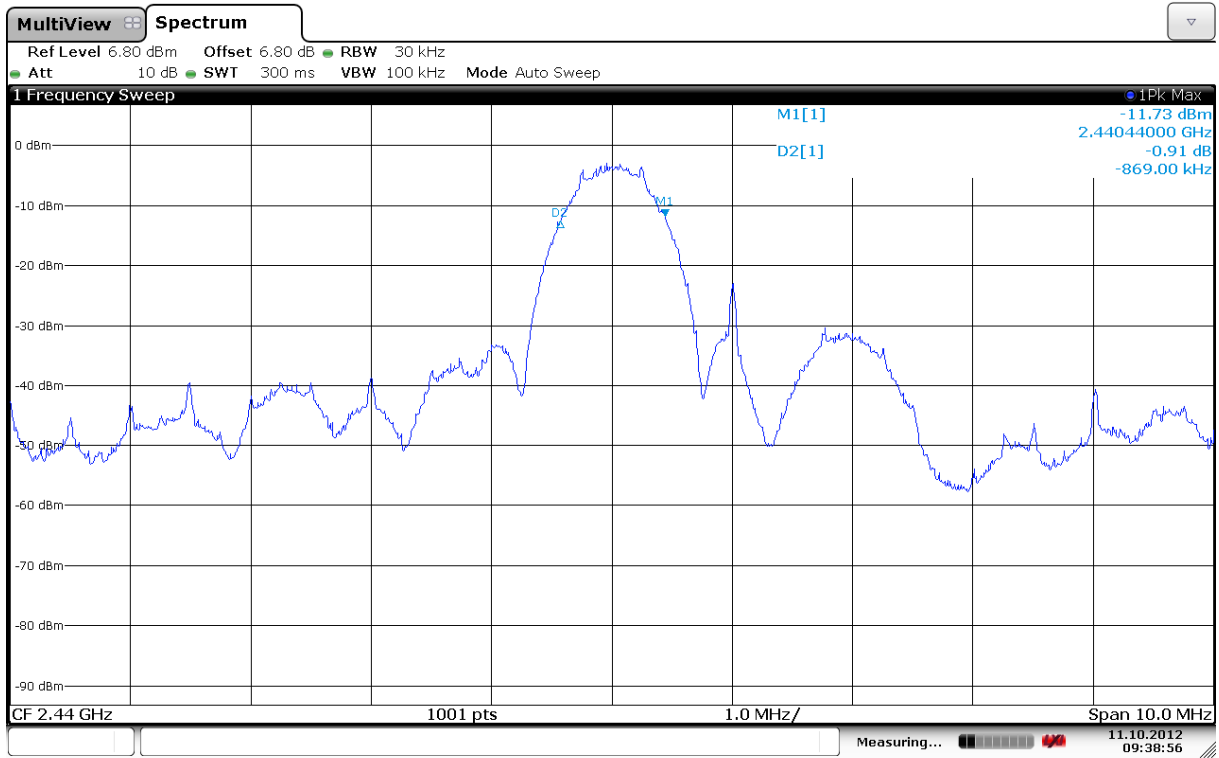
Requirements:

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



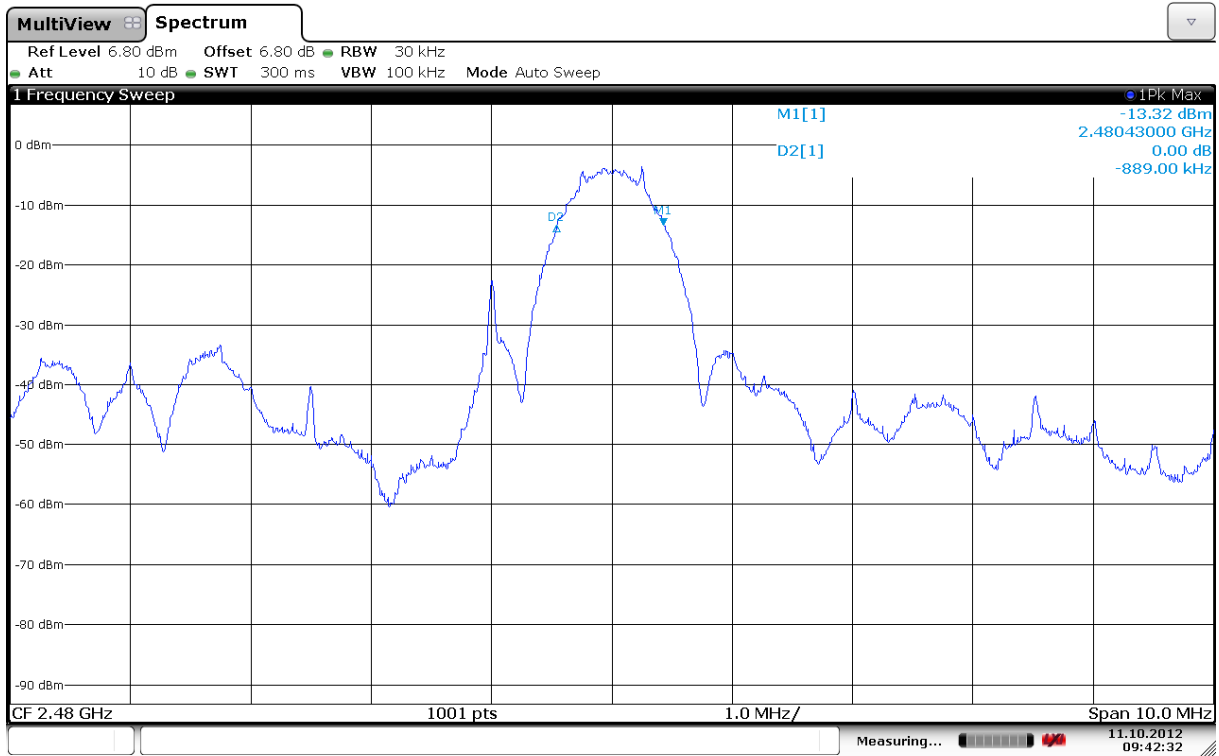
Date: 11.OCT.2012 09:34:31

6 dB Bandwidth at 2402 MHz



Date: 11.OCT.2012 09:38:56

6 dB Bandwidth at 2440 MHz



Date: 11.OCT.2012 09:42:32

6 dB Bandwidth at 2480 MHz

4.3 20 dB Bandwidth

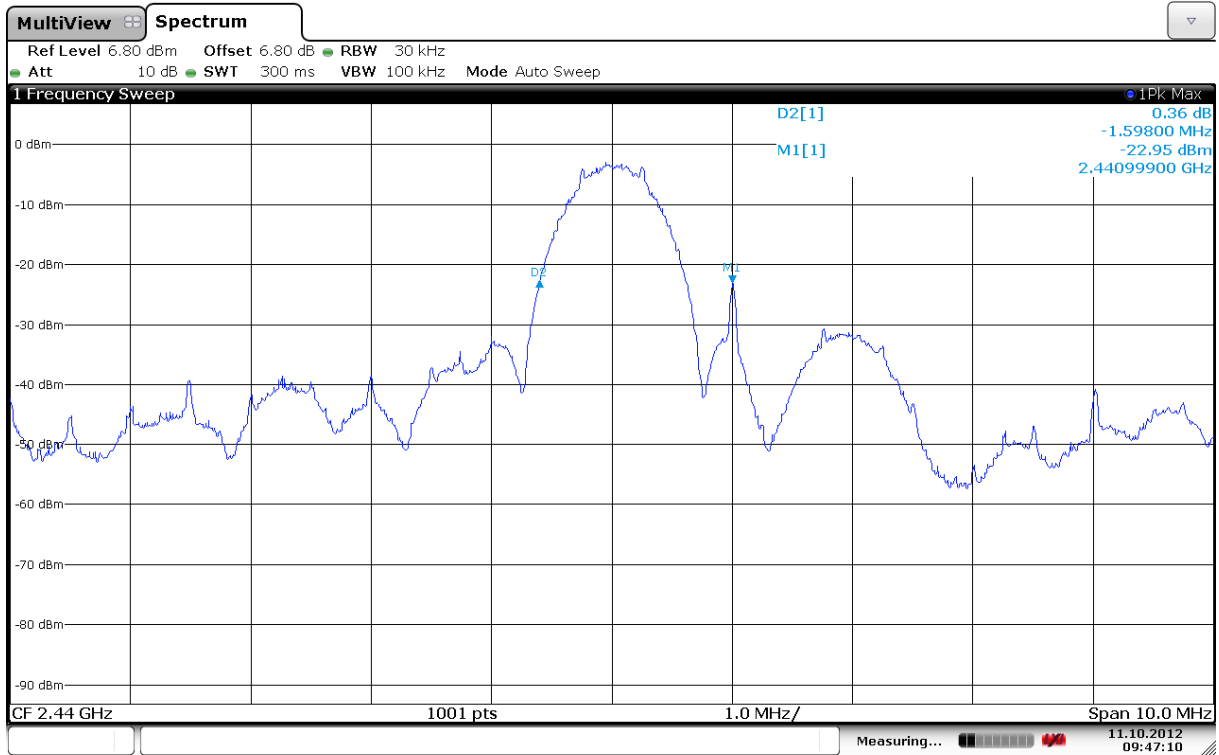
Test Performed By: Thomas Dangle	Date of Test: 11 Oct. 2012
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Measurement Data:

Measured 20 dB Bandwidth (MHz)
2440 MHz
1.60

Requirements:

No requirements. Reported for information only.



Date: 11.OCT.2012 09:47:10

20 dB Bandwidth at 2440 MHz

4.4 Peak Power Output

Para. No.: 15.247 (b)

Test Performed By: Thomas Dangle	Date of Test: 11 & 12 Oct 2012
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Test Results: Complies

Measurement Data:

RF channel	2402 MHz	2440 MHz	2480 MHz
Measured Conducted Power (dBm)	1.06	0.29	-0.42
Measured Maxium Field strength (dBµV/m) –HP	103.0	100.2	99.0
Calc. Radiated Power (dBm)	5.6	2.8	1.6
Calc. Antenna Gain (dB)	4.5	2.5	2.0

The maximum field strength is obtained in YZ plane and horizontal polarization.

Radiated Power is calculated from measured field strength using the methods in “KDB 412172 D01 Determining ERP and EIRP v01”.

See attached graph.

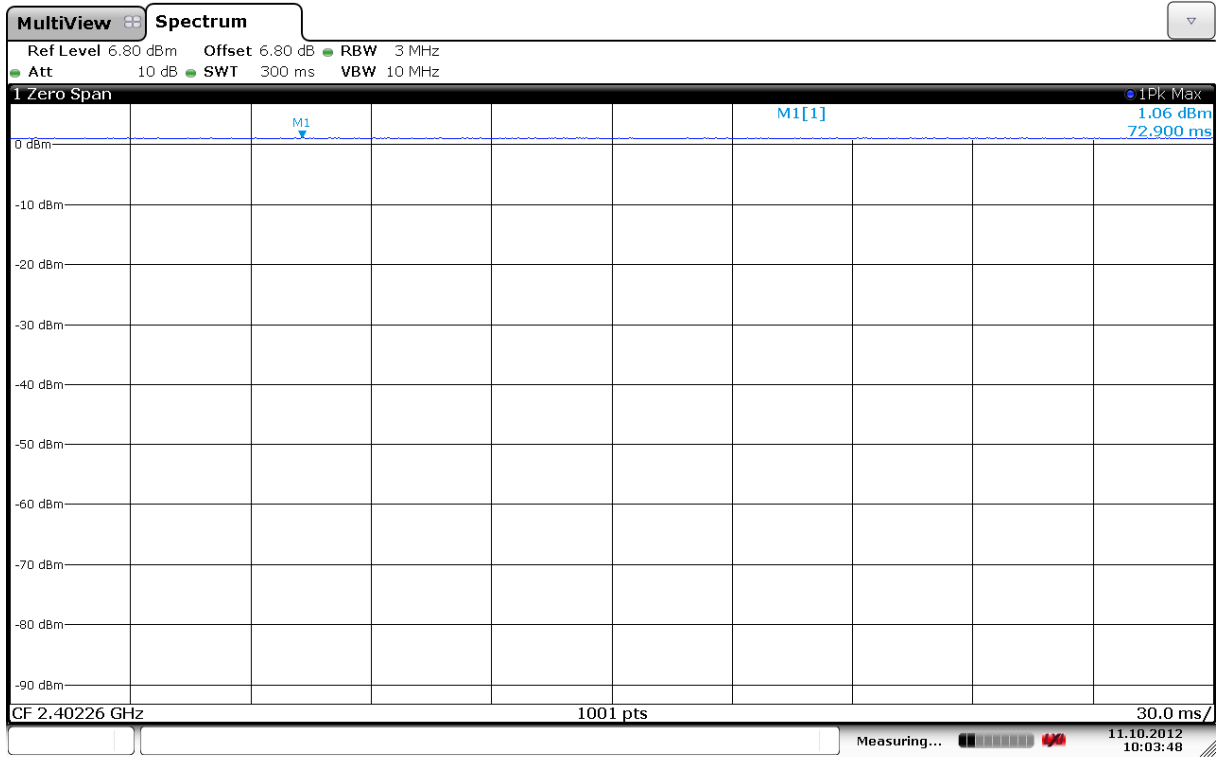
- Detachable antenna? Yes No
- If detachable, is the antenna connector non-standard? Yes No

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.

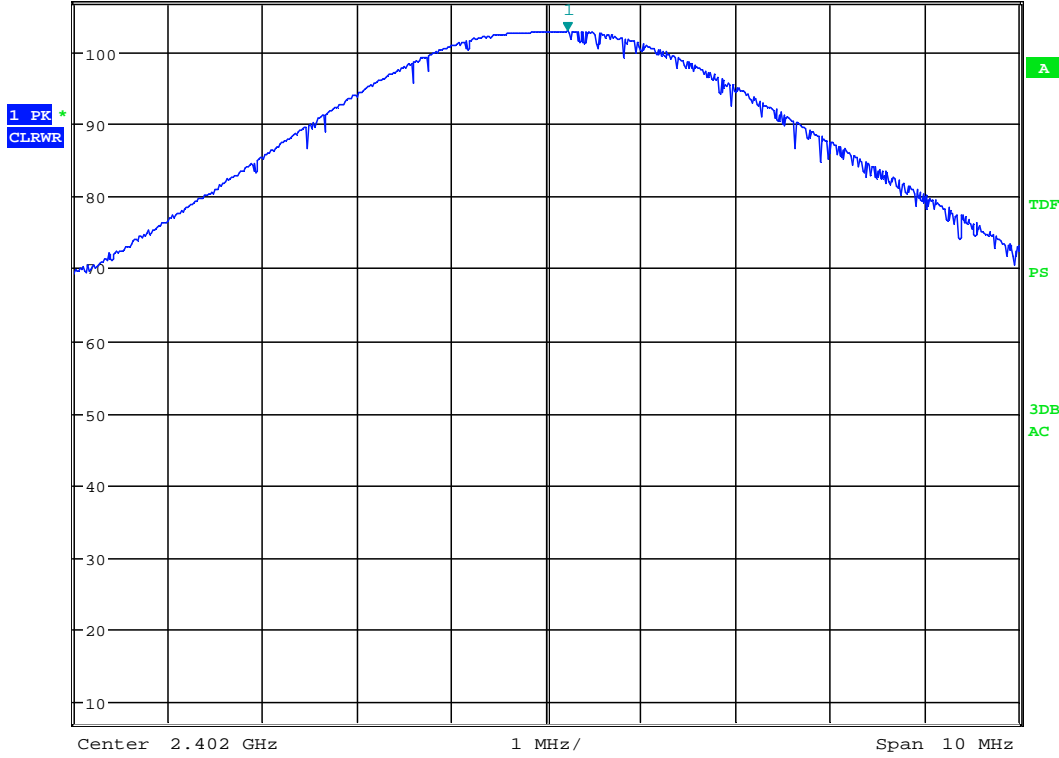


Date: 11.OCT.2012 10:03:47

Conducted Power, 2402 MHz

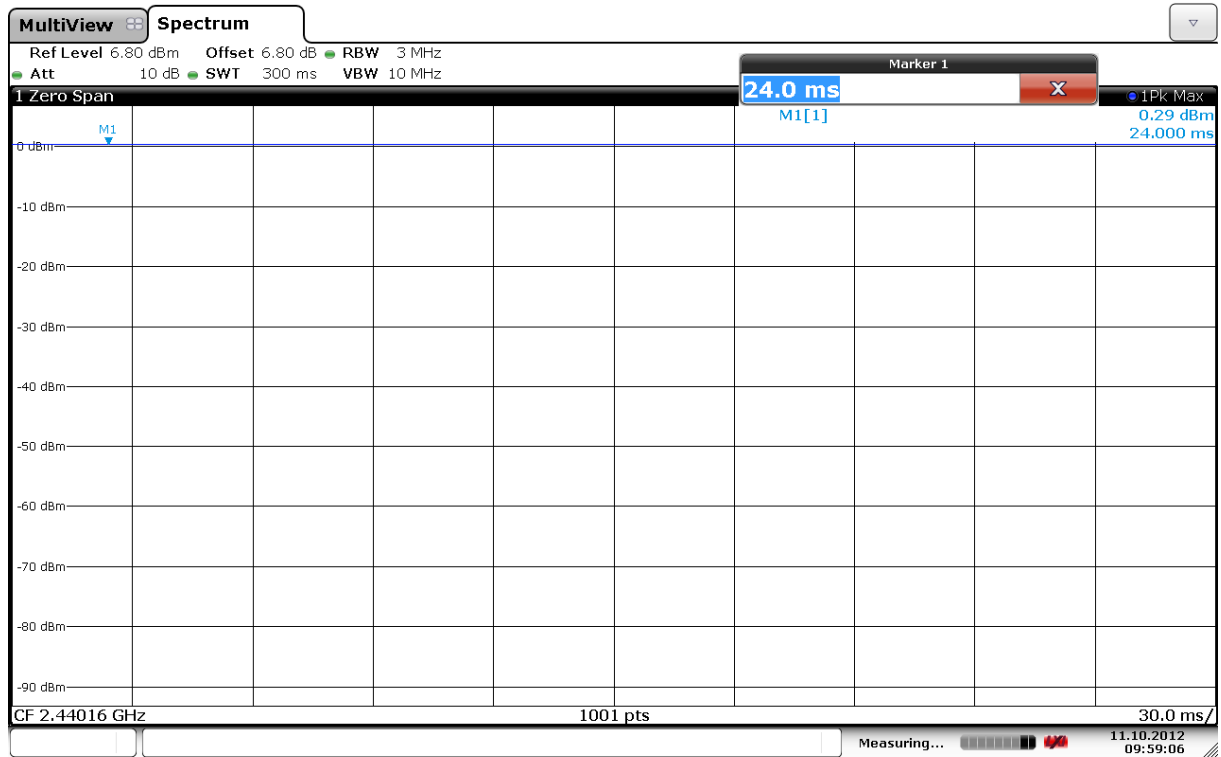


Ref 107 dB μ V/m *Att 10 dB *RBW 2 MHz Marker 1 [T1]
 VBW 5 MHz 102.94 dB μ V/m
 SWT 5 ms 2.402220000 GHz



Date: 12.OCT.2012 12:51:24

Radiated Field strength, HP , 2402 MHz

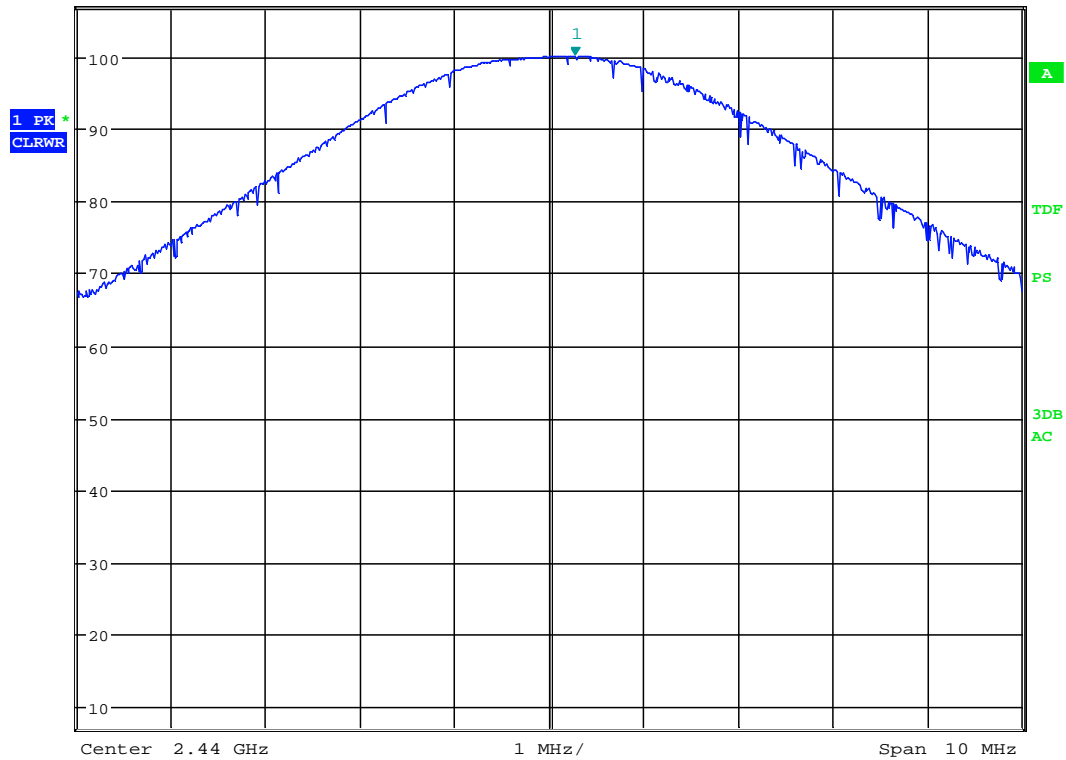


Date: 11.OCT.2012 09:59:06

Conducted Power, 2440 MHz

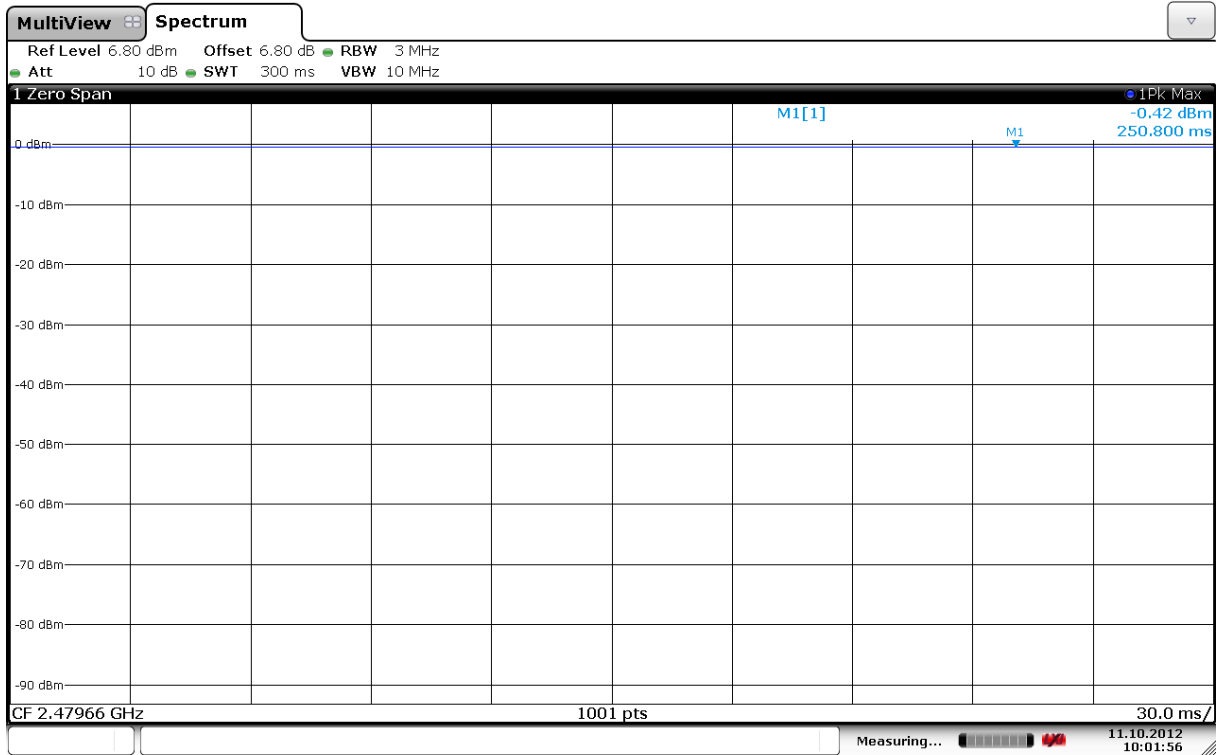


Ref 107 dB μ V/m *Att 10 dB *RBW 2 MHz Marker 1 [T1]
 VBW 5 MHz 100.15 dB μ V/m
 SWT 5 ms 2.440280000 GHz



Date: 12.OCT.2012 13:23:17

Radiated field strength, HP, 2440 MHz

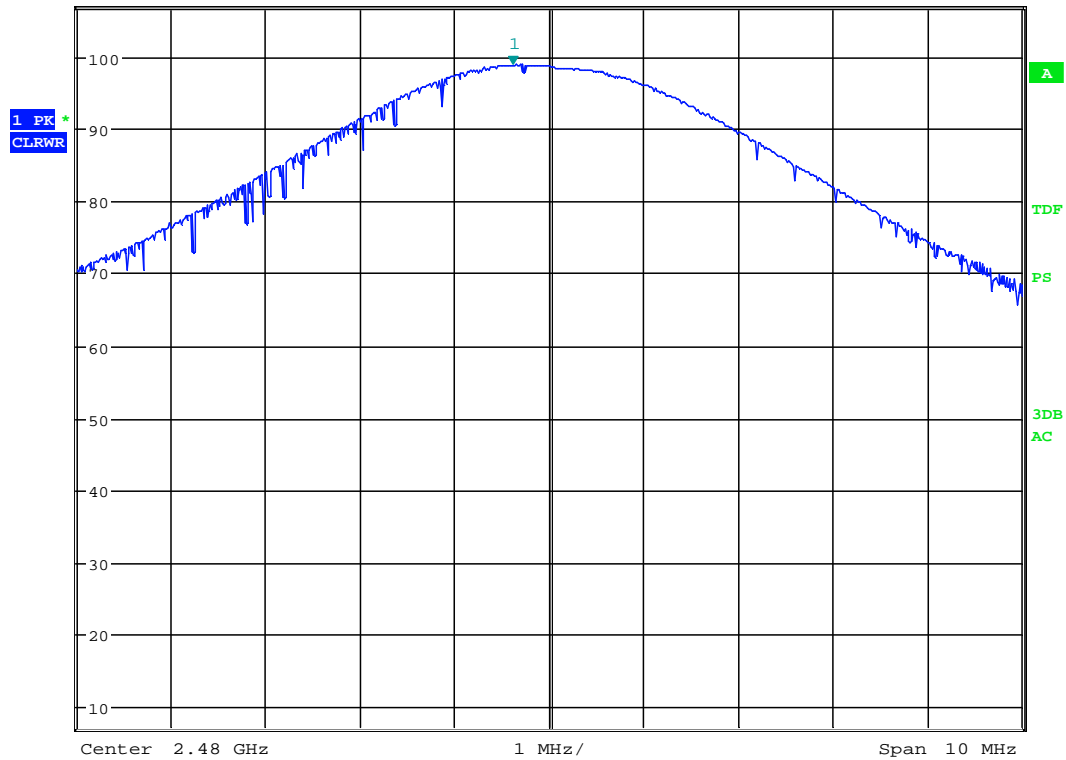


Date: 11.OCT.2012 10:01:56

Conducted Power, 2480 MHz



Ref 107 dBµV/m *Att 10 dB *RBW 2 MHz Marker 1 [T1]
 VBW 5 MHz 98.98 dBµV/m
 SWT 5 ms 2.479610000 GHz



Date: 12.OCT.2012 13:31:37

Radiated field strength, HP, 2480 MHz

4.5 Spurious Emissions (Radiated)

Para. No.: 15.247 (c)

Test Performed By: Thomas Dangle	Date of Test: 11,12, 23 & 31 Oct 2012
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Test Results: Complies

Measurement Data:

Band-edge, @3m

Frequency	Measured Field Strength @3m, dB μ V/m	Detector	Limit dB μ V/m	Margin dB
2.39 GHz	39.7	AV	54	14.3
	59.7	PK	74	14.3
2.4835 GHz	46.2	AV	54	7.8
	66.2	PK	74	7.8

Average Detector values include 20 dB Duty Cycle Correction Factor

See attached plots.

Maximum Duty Cycle is 1.8%. Duty Cycle Correction factor is 20 dB. See document from applicant with duty cycle calculation.

RF conducted power

Scan performed radiated with 100 kHz Bandwidth from 1 MHz to 26 GHz.

All emissions are more than 20dB below carrier.

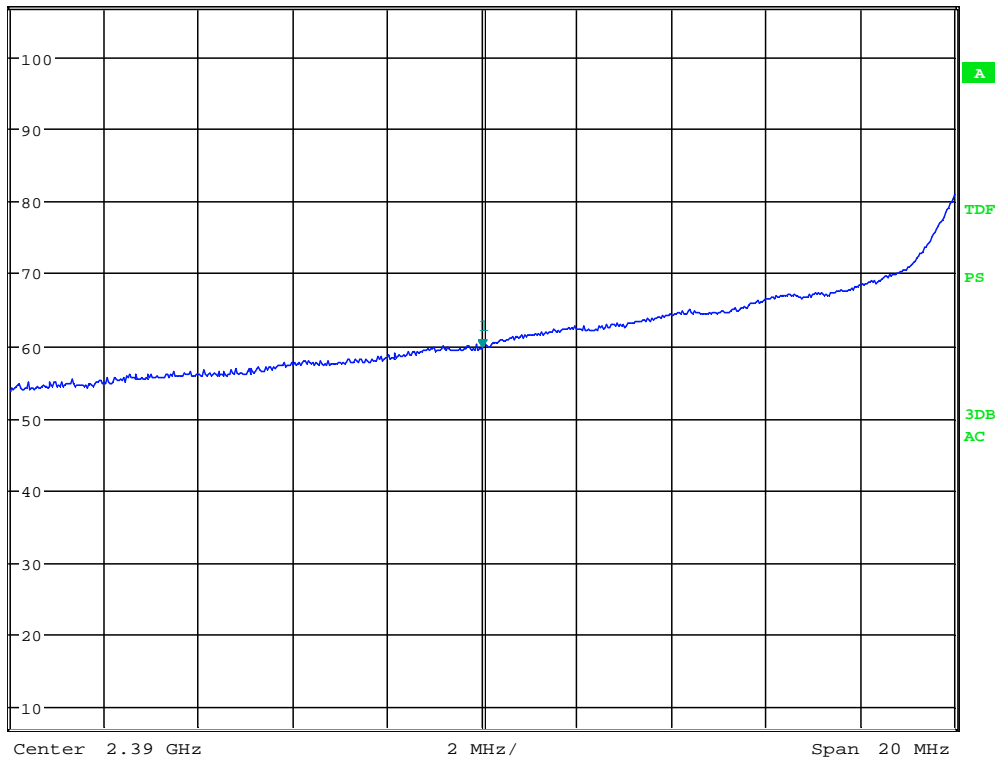
See attached plots.



* RBW 1 MHz Marker 1 [T1]
 VBW 3 MHz 59.65 dBμV/m
 SWT 5 ms 2.390000000 GHz

Ref 107 dBμV/m * Att 10 dB

1 PK
 MAXH



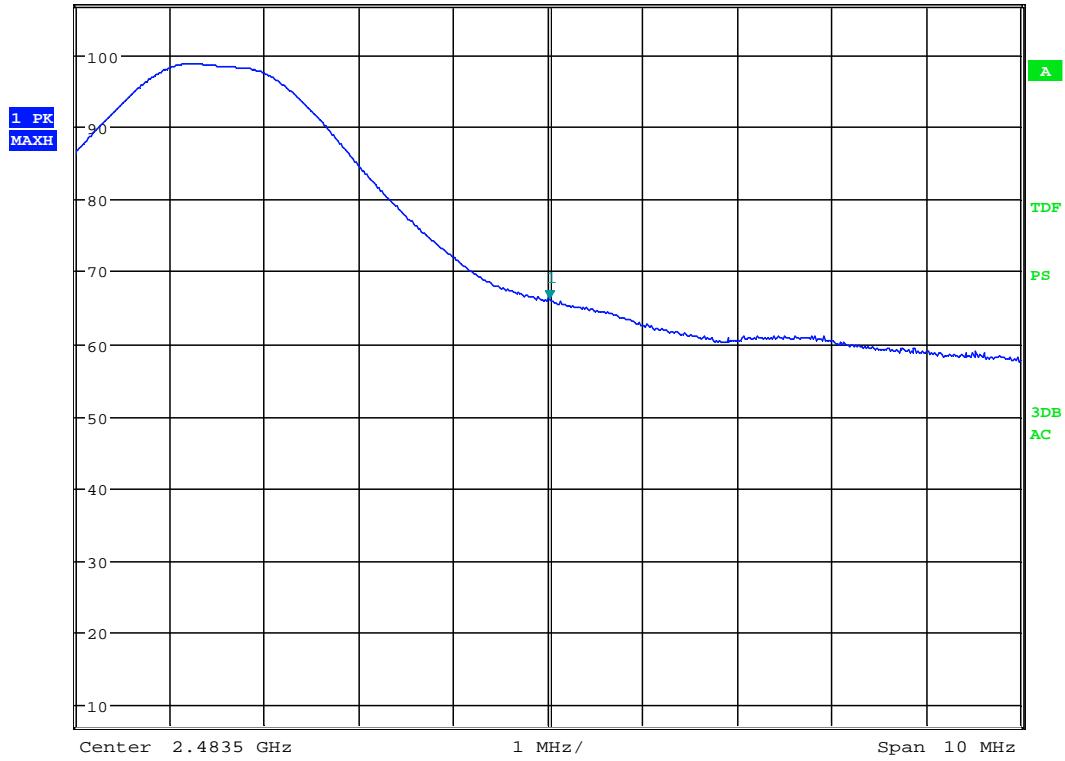
Date: 12.OCT.2012 14:34:43

Band Edge, 2390 MHz, Peak Detector



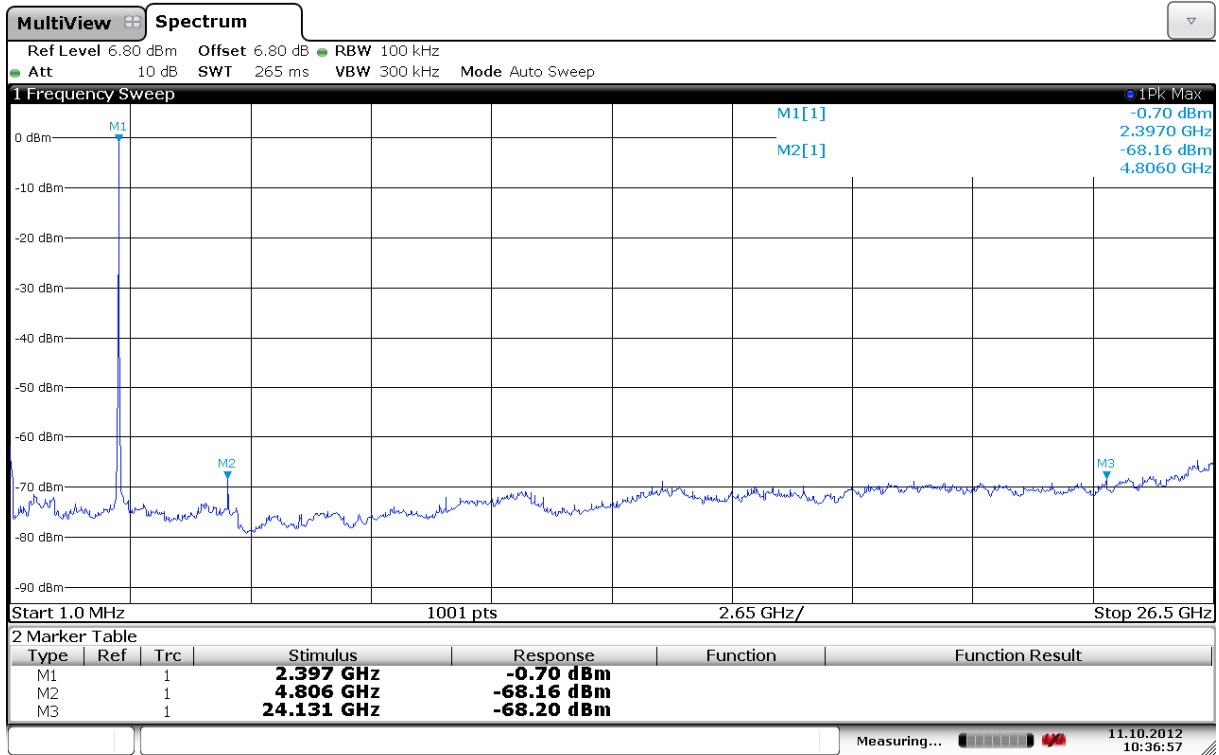
* RBW 1 MHz Marker 1 [T1]
 VBW 3 MHz 66.16 dBμV/m
 SWT 5 ms 2.483522051 GHz

Ref 107 dBμV/m * Att 10 dB



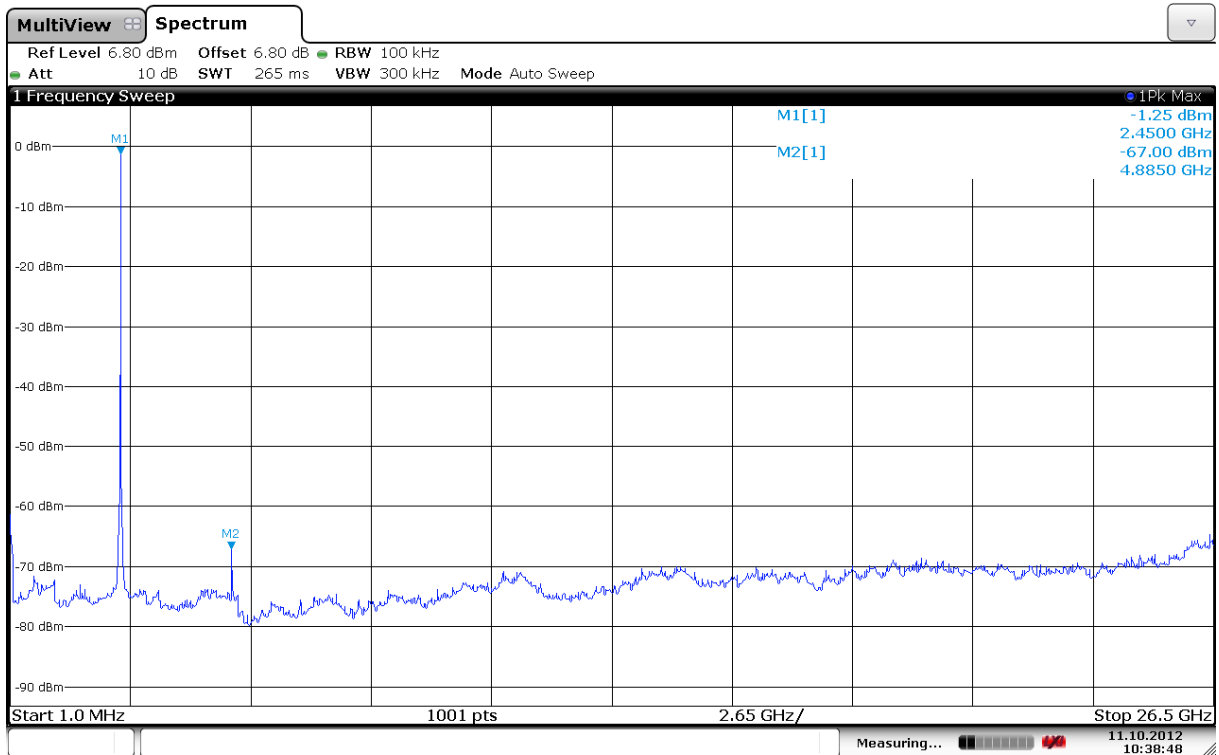
Date: 12.OCT.2012 13:52:26

Band Edge, 2483.5 MHz, Peak Detector



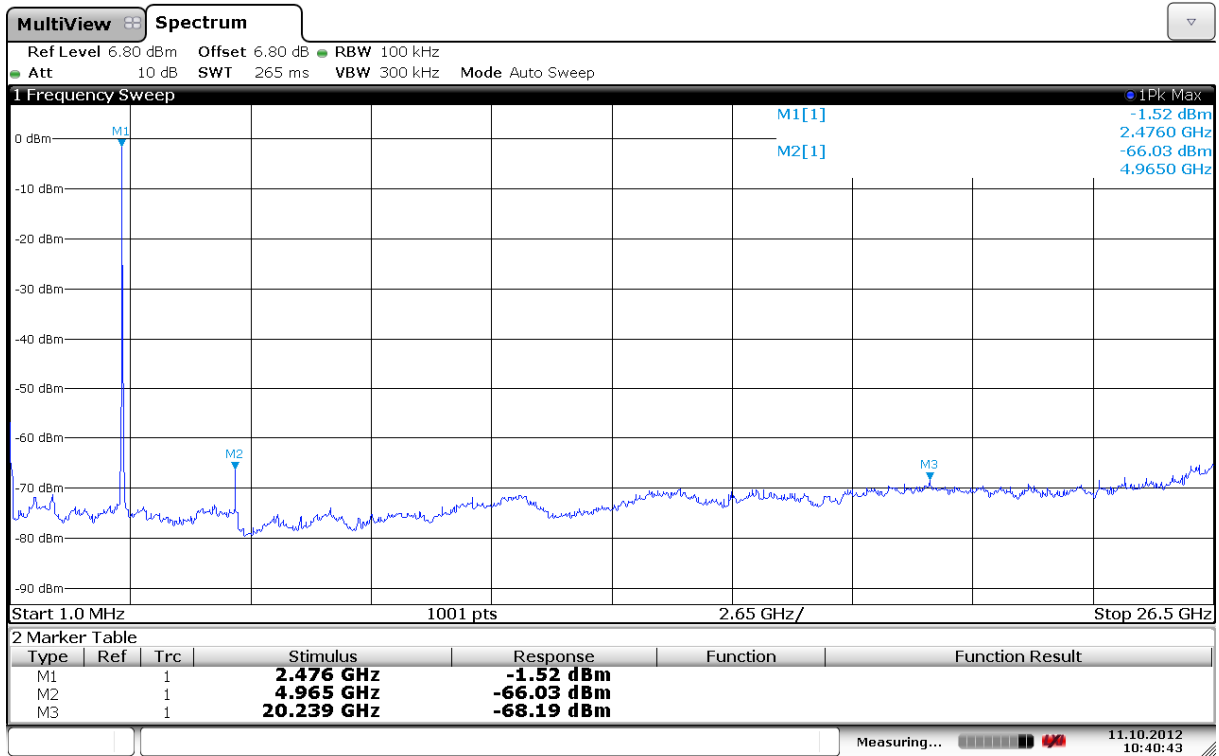
Date: 11.OCT.2012 10:36:57

Ch 2402 MHz, Conducted Emissions, 1 MHz – 26 GHz



Date: 11.OCT.2012 10:38:48

Ch 2440 MHz, Conducted Emissions, 1 MHz – 26 GHz



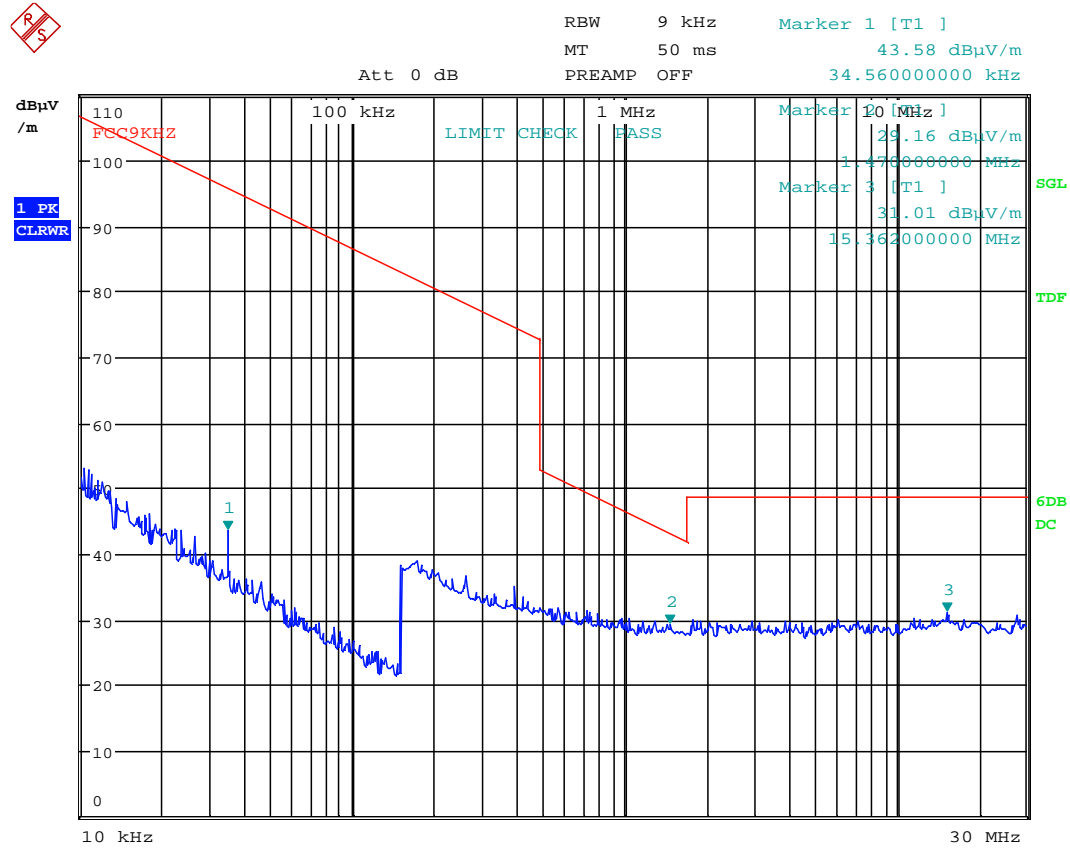
Date: 11.OCT.2012 10:40:43

Ch 2480 MHz, Conducted Emissions, 1 MHz – 26 GHz

Radiated emissions 9kHz - 30 MHz.

Detector: Quasi-Peak

Measuring distance 10 m.



Date: 23.OCT.2012 12:39:18

Radiated Emissions, 9 kHz – 30 MHz @10m – TX on at ch. 2402 MHz

Radiated emission 30 – 1000 MHz.

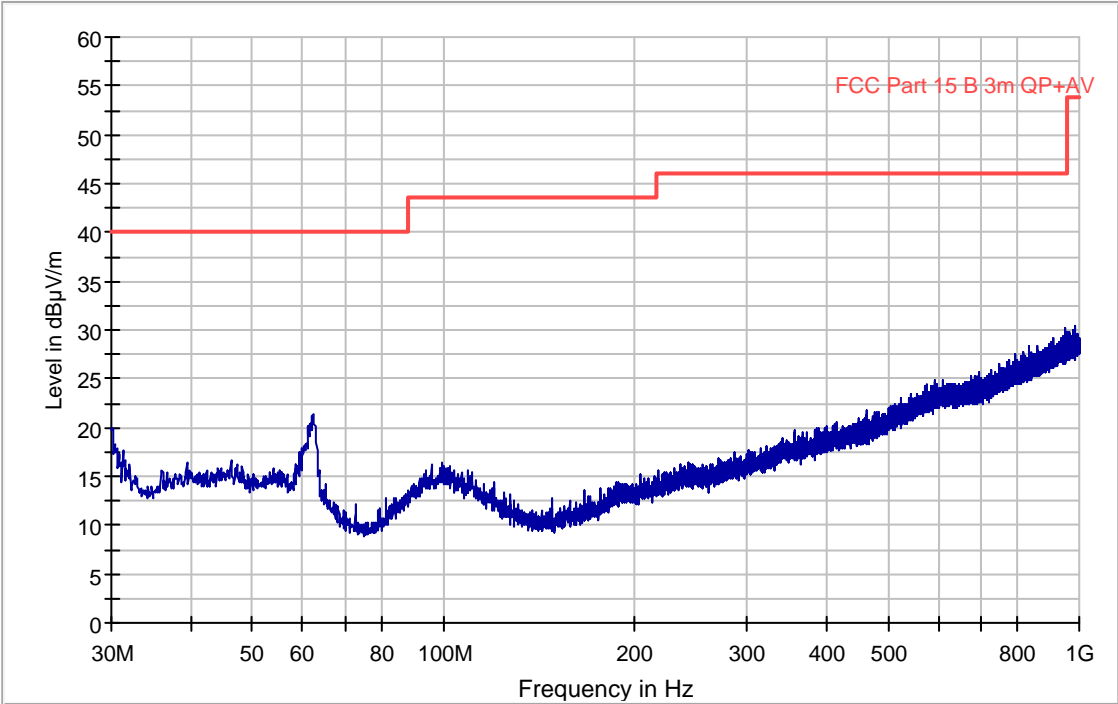
Detector: Peak

Measuring distance at 3m.

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

See attached plot.

FCC Pt15 Class B 30-1000M 3m



Radiated Emissions, 30 – 1000 MHz, VP and HP, @3m – TX on at ch. 2402 MHz

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.

Peak detector

Frequency MHz	Field Strength @3m dBµV/m	Detector	Limit dBµV/m	Margin dB
4804	57.5	Pk	74	16.5
4880	56.4	Pk	74	17.6
4960	52.7	Pk	74	21.3
7206	56.8	Pk	74	17.2
7320	54.6	Pk	74	19.4
7440	52.3	Pk	74	21.7

Average detector

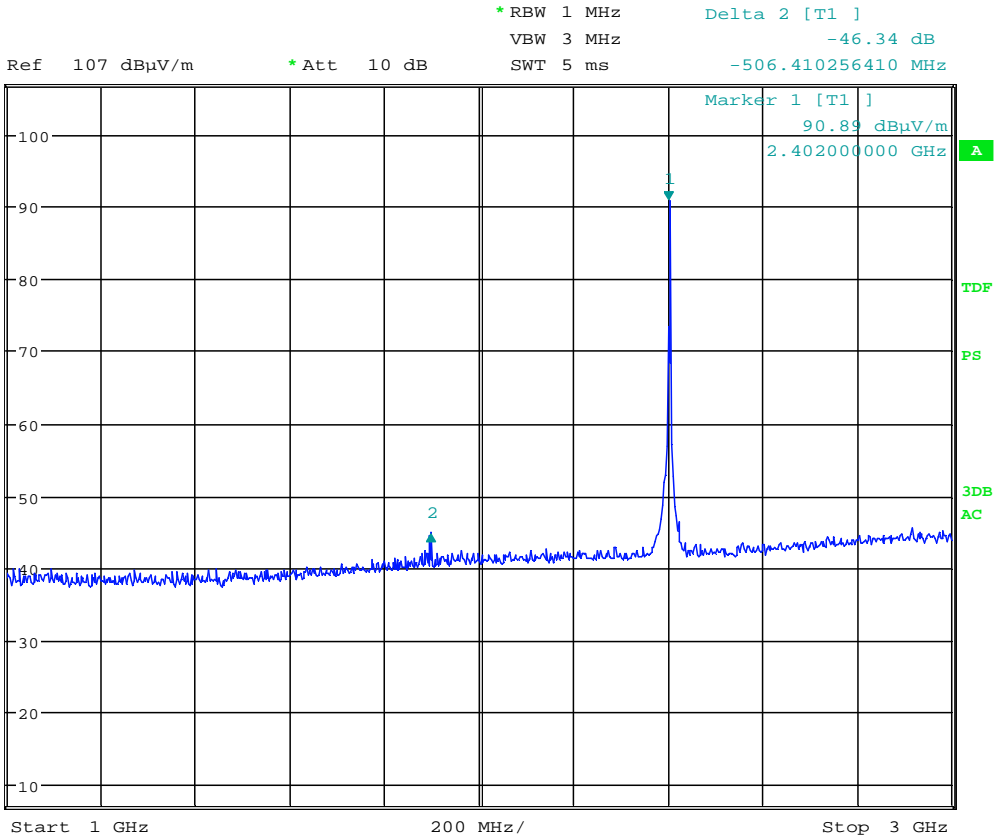
Frequency MHz	Field Strength @3m dBµV/m	Detector	Limit dBµV/m	Margin dB
4804	37.5	Av	54	16.5
4880	36.4	Av	54	17.6
4960	32.7	Av	54	21.3
7206	36.8	Av	54	17.2
7320	34.6	Av	54	19.4
7440	32.3	Av	54	21.7

All values above include distance correction factor.

Average Detector values includes 20 dB Duty Cycle Correction Factor.

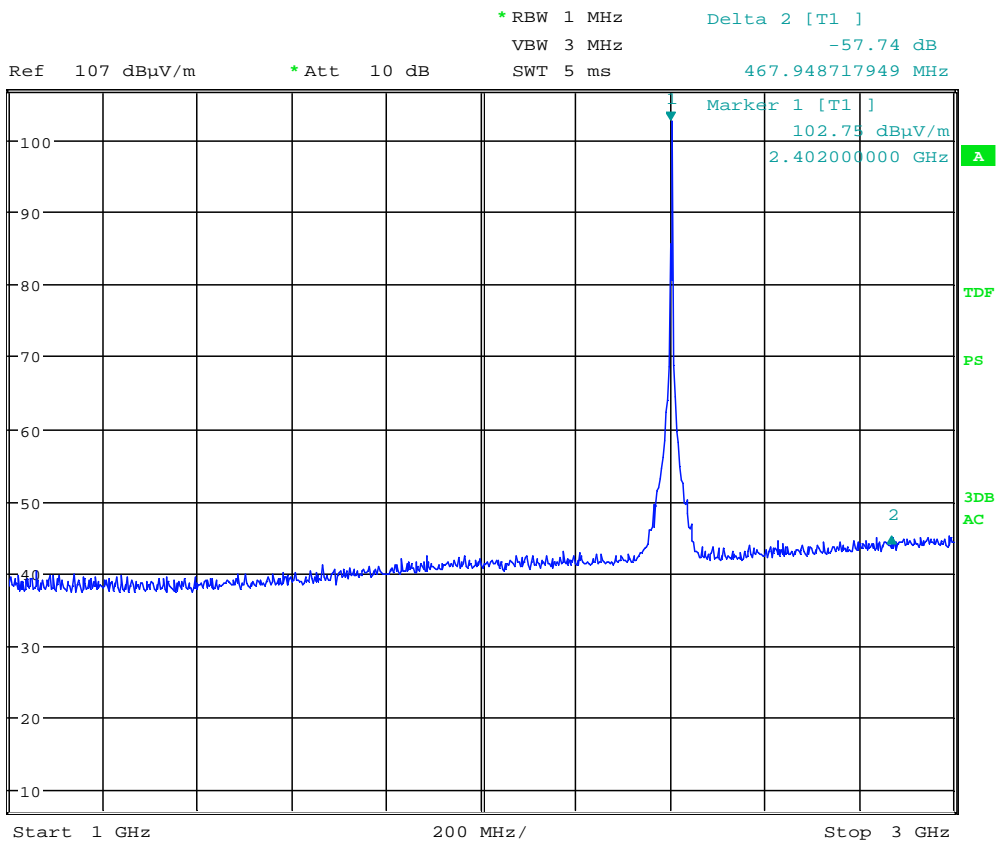
Antenna factor, amplifier gain and cable loss are included in Spectrum Analyzer "Transducer factor".

See attached graphs.



Date: 12.OCT.2012 15:06:28

Radiated Emissions ch. 2402 MHz, 1 – 3 GHz, VP, @3m – Pre-scan with Peak detector

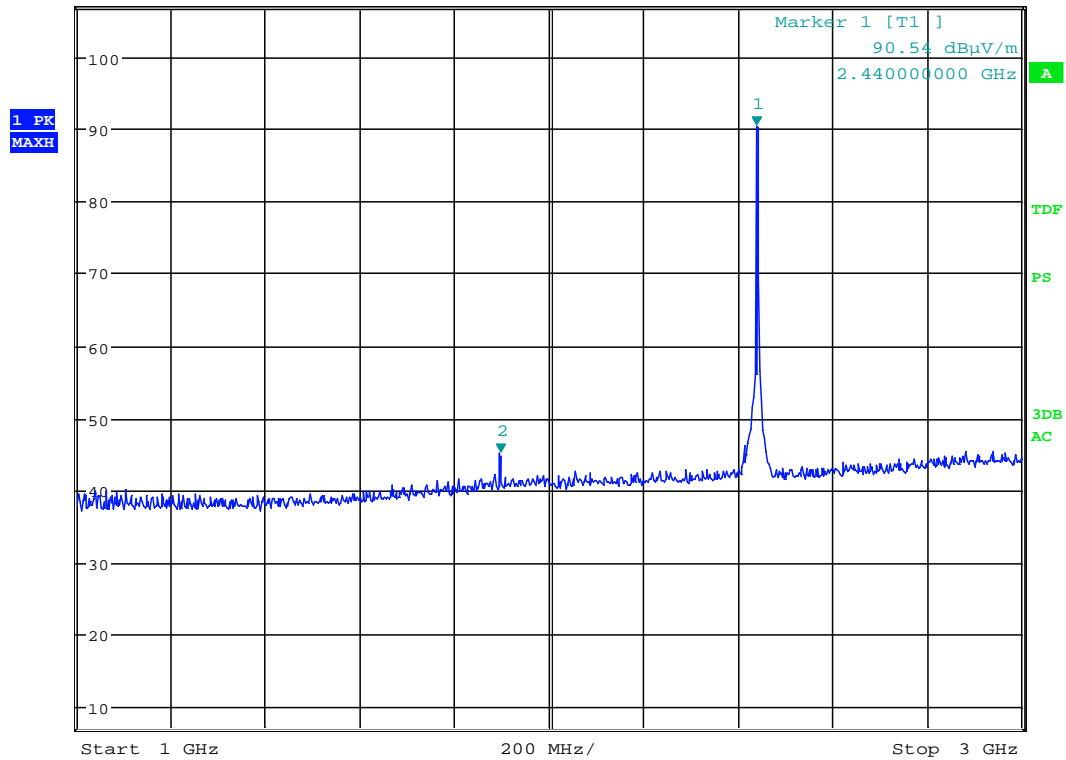


Date: 12.OCT.2012 15:03:16

Radiated Emissions ch. 2402 MHz, 1 – 3 GHz, HP, @3m – Pre-scan with Peak detector

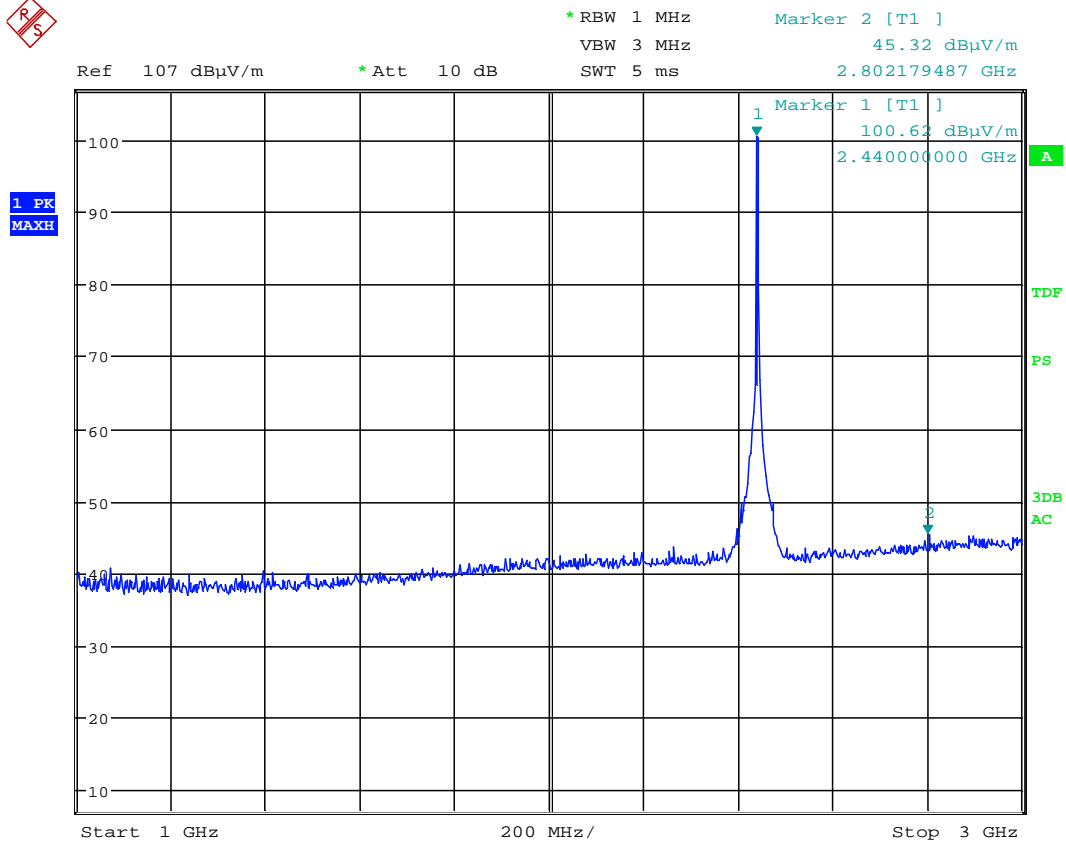


Ref 107 dB μ V/m *Att 10 dB *RBW 1 MHz Marker 2 [T1]
 VBW 3 MHz 45.13 dB μ V/m
 SWT 5 ms 1.895128205 GHz



Date: 12.OCT.2012 15:09:46

Radiated Emissions ch. 2440 MHz, 1 – 3 GHz, VP, @3m – Pre-scan with Peak detector

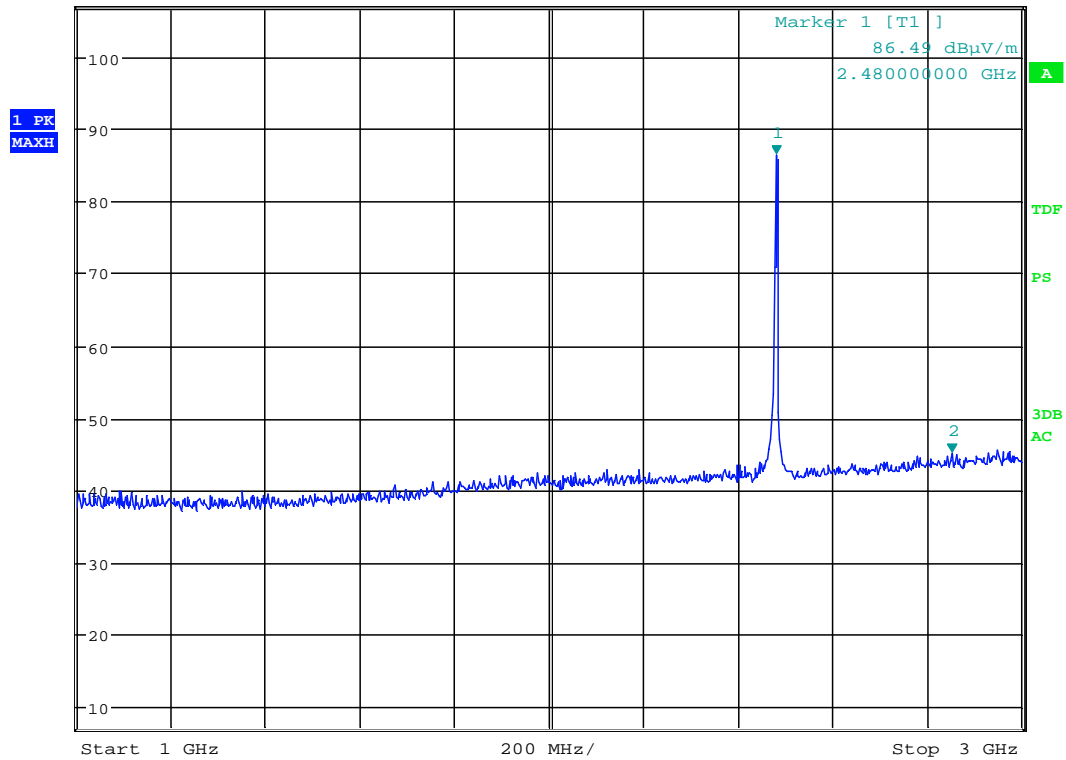


Date: 12.OCT.2012 15:12:12

Radiated Emissions ch. 2440 MHz, 1 – 3 GHz, HP, @3m – Pre-scan with Peak detector

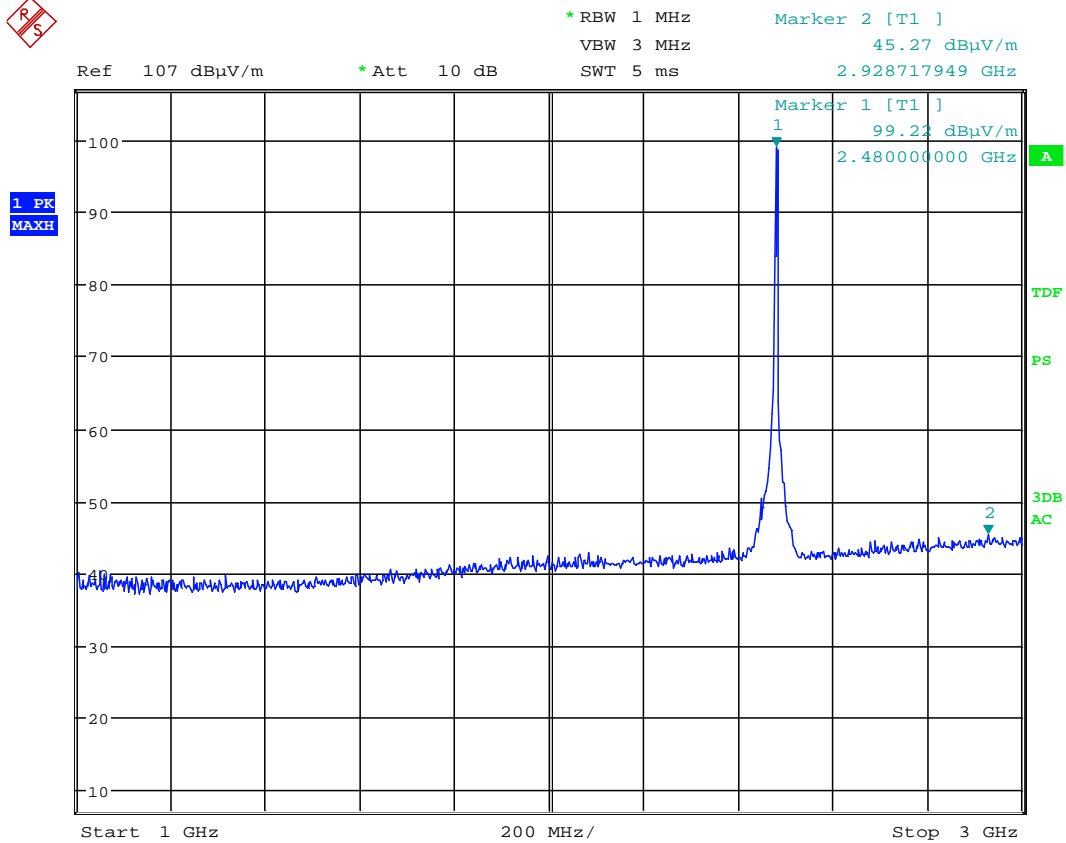


Ref 107 dB μ V/m * Att 10 dB * RBW 1 MHz Marker 2 [T1]
 VBW 3 MHz 45.07 dB μ V/m
 SWT 5 ms 2.851794872 GHz



Date: 12.OCT.2012 15:19:06

Radiated Emissions ch. 2480 MHz, 1 – 3 GHz, VP, @3m – Pre-scan with Peak detector

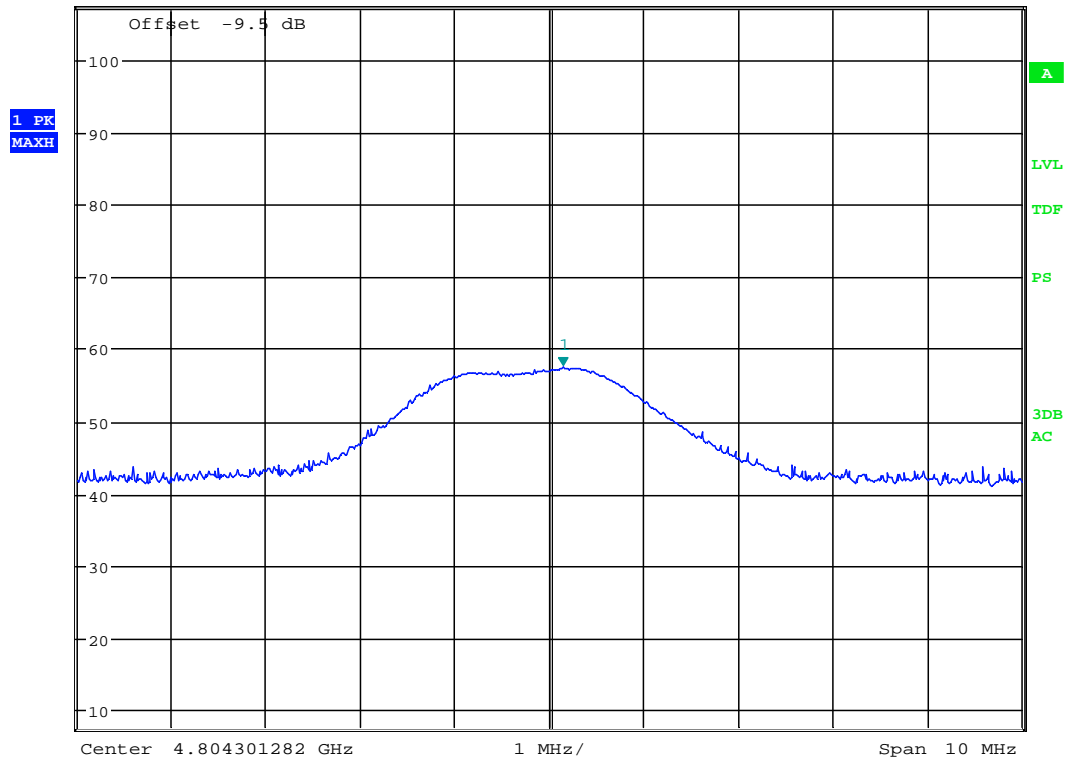


Date: 12.OCT.2012 15:15:26

Radiated Emissions ch. 2480 MHz, 1 – 3 GHz, HP, @3m – Pre-scan with Peak detector



Ref 107.5 dBµV/m *Att 10 dB *RBW 1 MHz Marker 1 [T1]
 VBW 3 MHz 57.52 dBµV/m
 SWT 20 ms 4.804445513 GHz

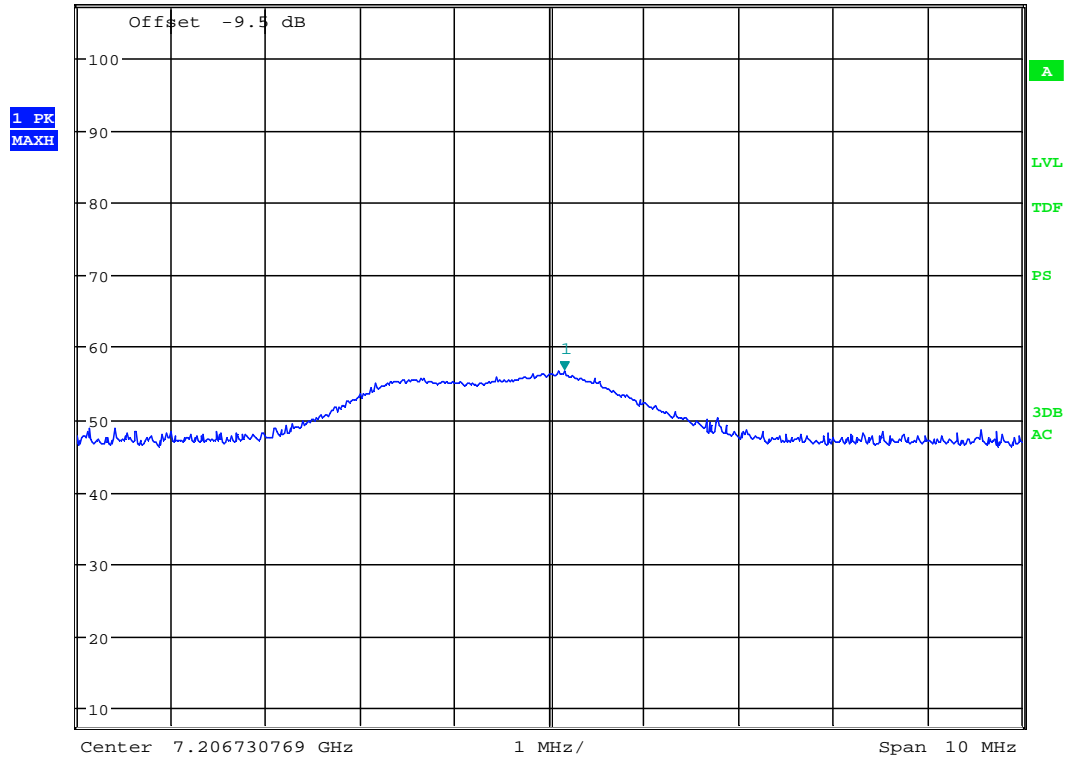


Date: 31.OCT.2012 11:51:26

**Radiated Emissions ch. 2402 MHz, second harmonic, HP/VP,
 @1m. Distance Correction factor included on plot**



Ref 107.5 dBµV/m *Att 10 dB *RBW 1 MHz Marker 1 [T1]
 VBW 3 MHz 56.78 dBµV/m
 SWT 20 ms 7.206891026 GHz

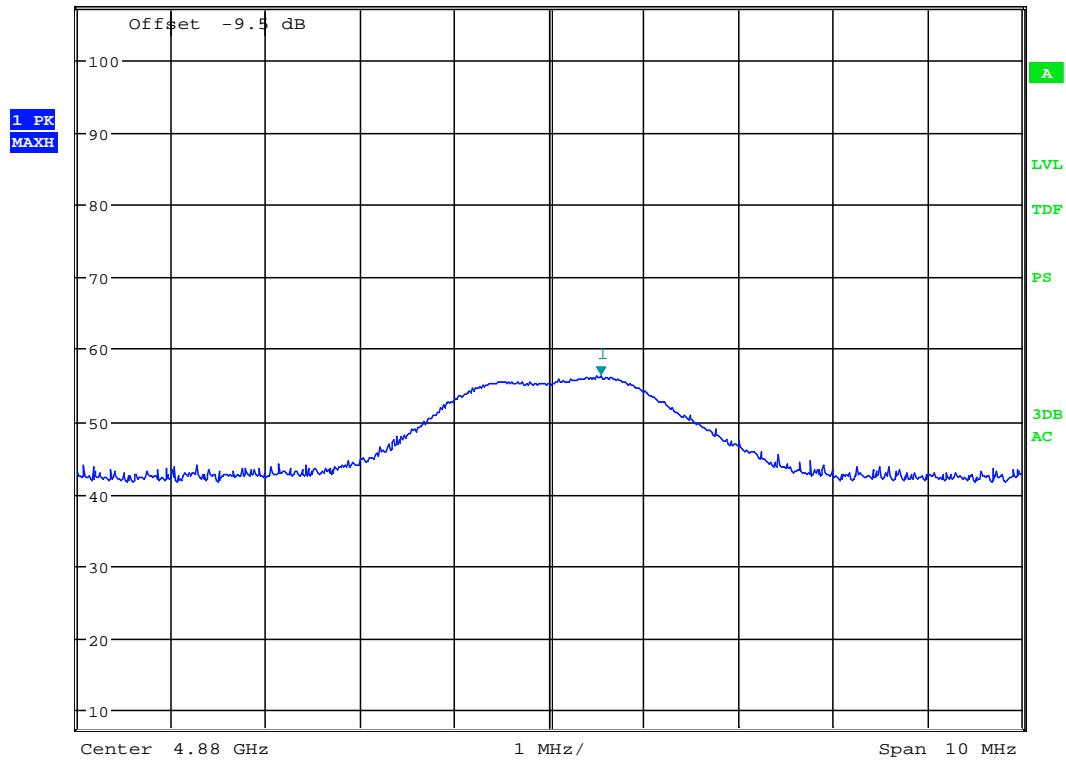


Date: 31.OCT.2012 11:56:54

**Radiated Emissions ch. 2402 MHz, third harmonic, HP/VP,
 @1m. Distance Correction factor included on plot**



Ref 107.5 dBµV/m *Att 10 dB *RBW 1 MHz Marker 1 [T1]
 VBW 3 MHz 56.36 dBµV/m
 SWT 20 ms 4.880544872 GHz

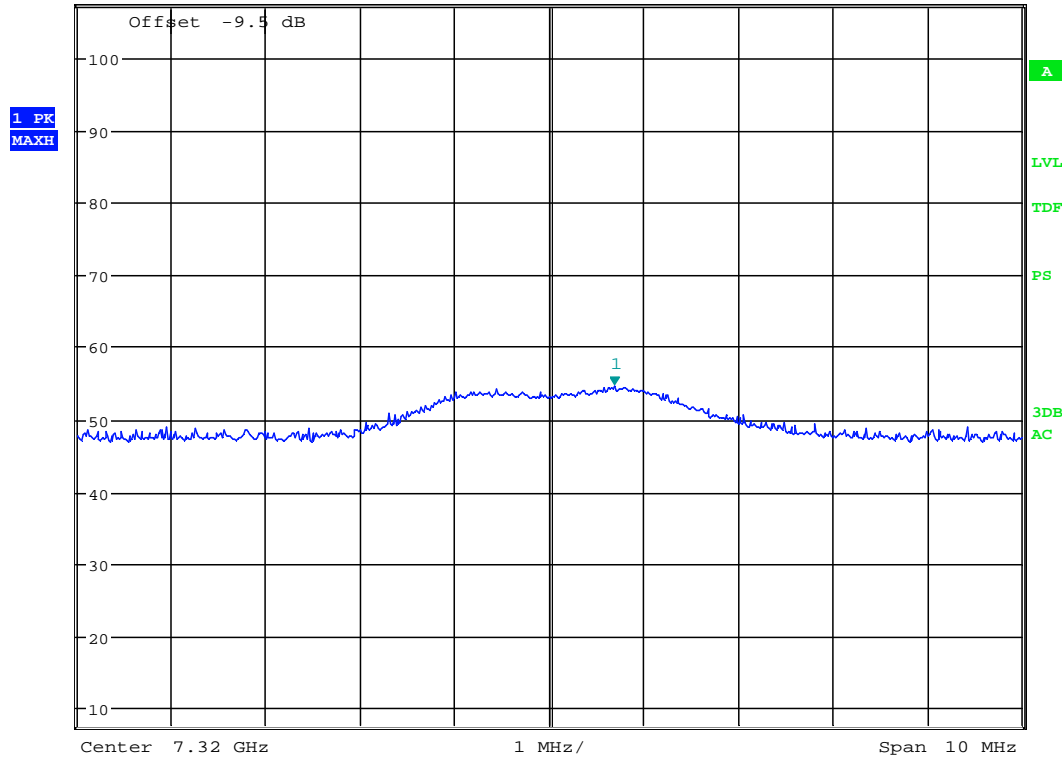


Date: 31.OCT.2012 12:09:35

**Radiated Emissions ch. 2440 MHz, second harmonic, HP/VP,
 @1m. Distance Correction factor included on plot**

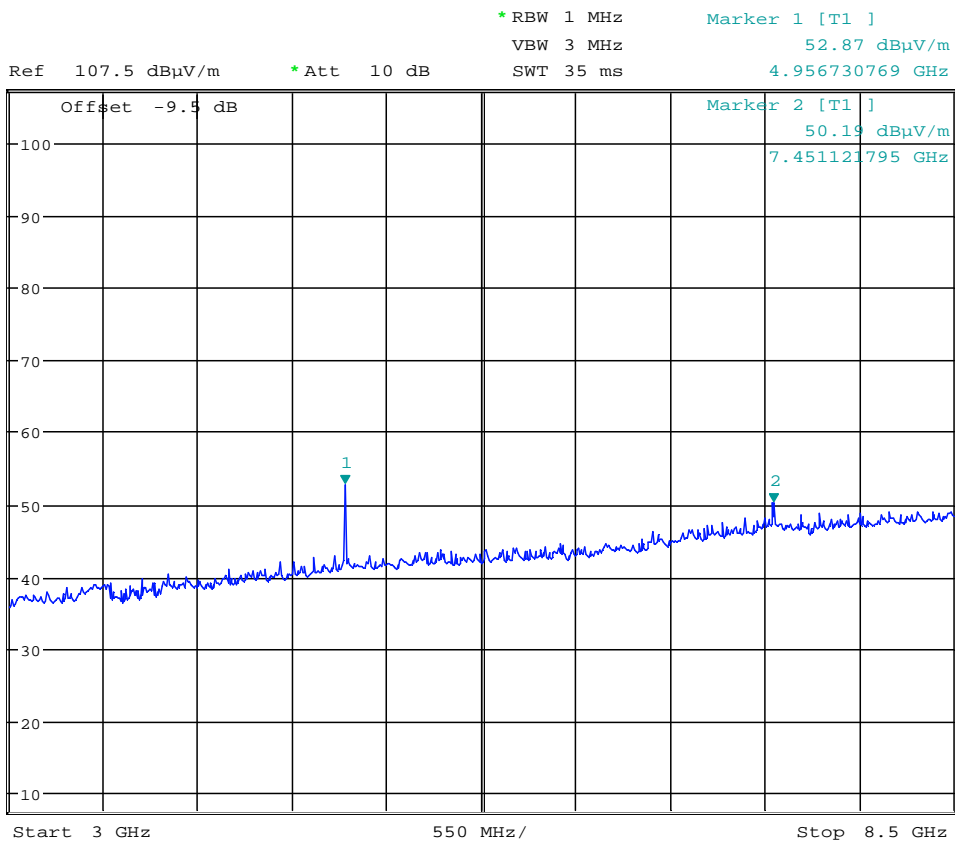


Ref 107.5 dBµV/m *Att 10 dB *RBW 1 MHz Marker 1 [T1]
 VBW 3 MHz 54.58 dBµV/m
 SWT 20 ms 7.320689103 GHz



Date: 31.OCT.2012 12:11:48

**Radiated Emissions ch. 2440 MHz, third harmonic, HP/VP,
 @1m. Distance Correction factor included on plot**

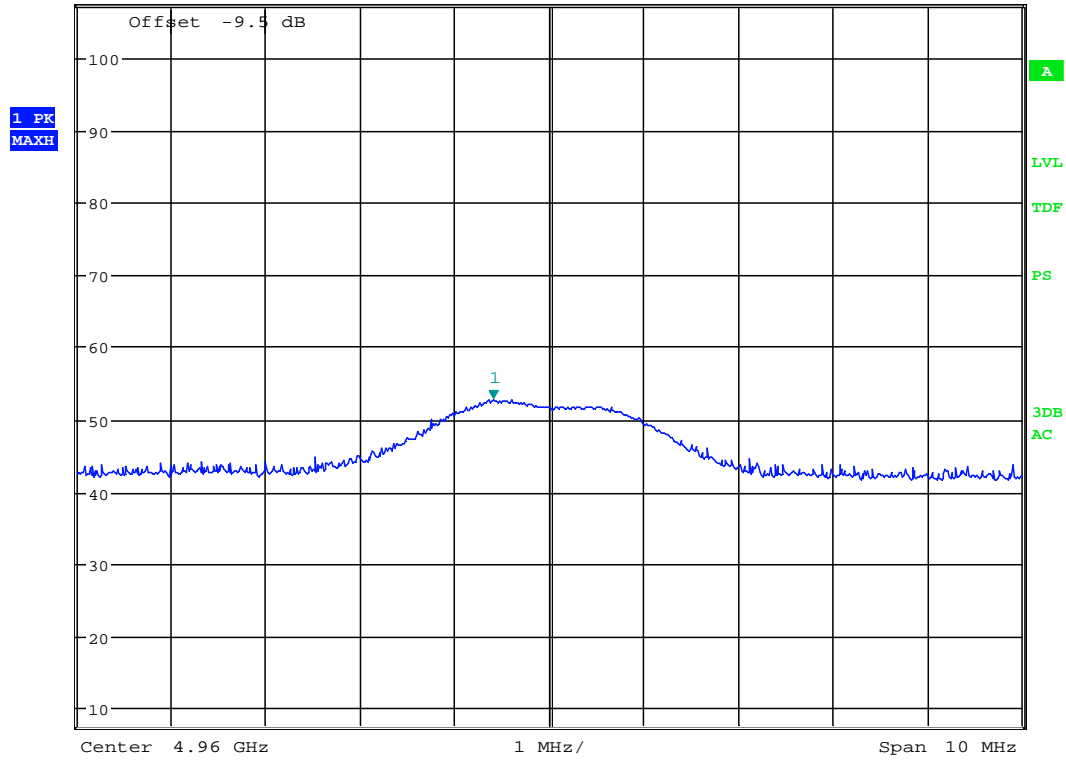


Date: 31.OCT.2012 12:15:09

Radiated Emissions ch. 2480 MHz, 3 – 8.5 GHz, HP, @1m – Pre-scan with Peak detector and High Pass filter, Distance Correction factor included on plot



Ref 107.5 dBµV/m *Att 10 dB *RBW 1 MHz Marker 1 [T1]
 VBW 3 MHz 52.71 dBµV/m
 SWT 20 ms 4.959407051 GHz

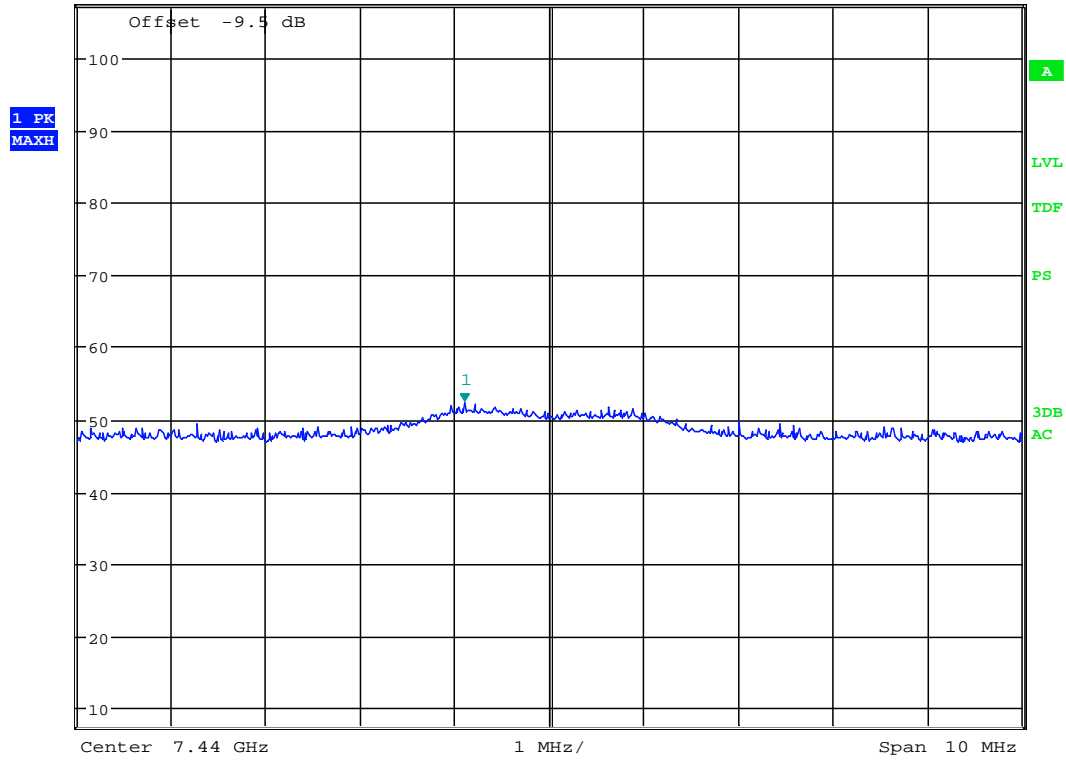


Date: 31.OCT.2012 12:16:21

**Radiated Emissions ch. 2480 MHz, second harmonic, HP/VP,
 @1m. Distance Correction factor included on plot**



Ref 107.5 dBµV/m *Att 10 dB *RBW 1 MHz Marker 1 [T1]
 VBW 3 MHz 52.29 dBµV/m
 SWT 20 ms 7.439102564 GHz

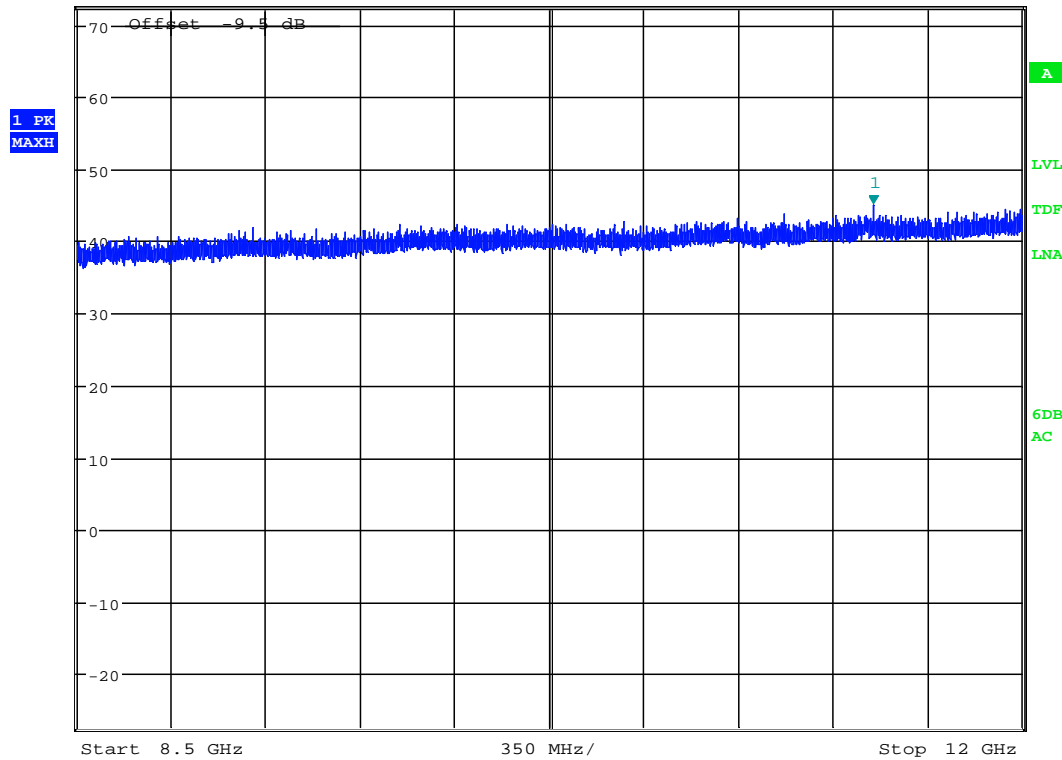


Date: 31.OCT.2012 12:18:29

**Radiated Emissions ch. 2480 MHz, third harmonic, HP/VP,
 @1m. Distance Correction factor included on plot**



Ref 87 dB μ V/m *Att 10 dB *RBW 1 MHz Marker 1 [T1]
 VBW 3 MHz 45.04 dB μ V/m
 SWT 45 ms 11.449800000 GHz

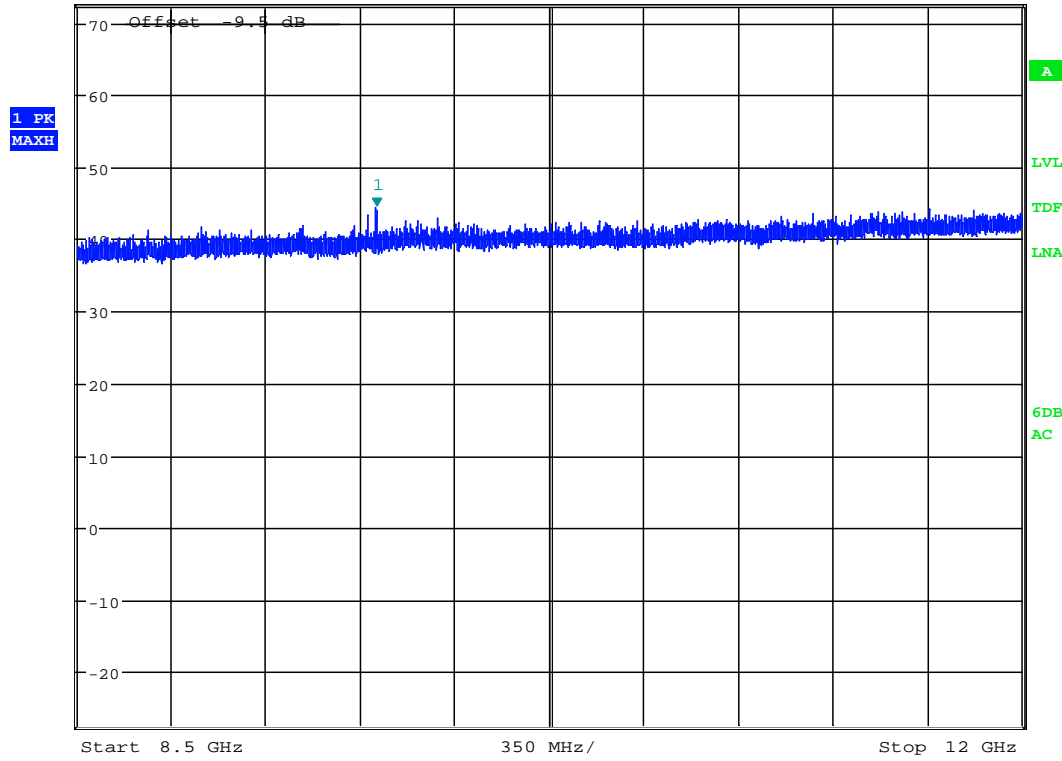


Date: 23.OCT.2012 10:54:26

Radiated Emissions ch. 2402 MHz, 8.5 – 12 GHz, HP, @1m – Pre-scan with Peak detector and High Pass filter, Distance Correction factor included on plot



Ref 87 dB μ V/m *Att 10 dB *RBW 1 MHz Marker 1 [T1]
 Offset -9.4 dB VBW 3 MHz 44.38 dB μ V/m
 SWT 45 ms 9.608800000 GHz

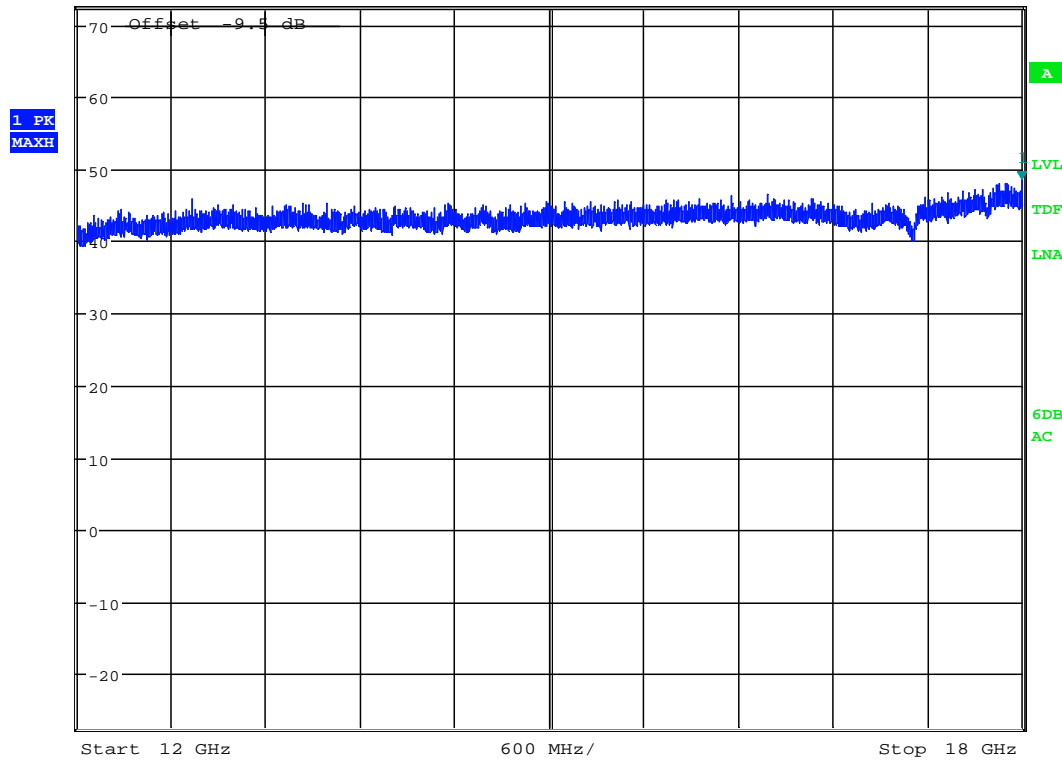


Date: 23.OCT.2012 10:51:42

Radiated Emissions ch. 2402 MHz, 8.5 – 12 GHz, VP, @1m – Pre-scan with Peak detector and High Pass filter, Distance Correction factor included on plot

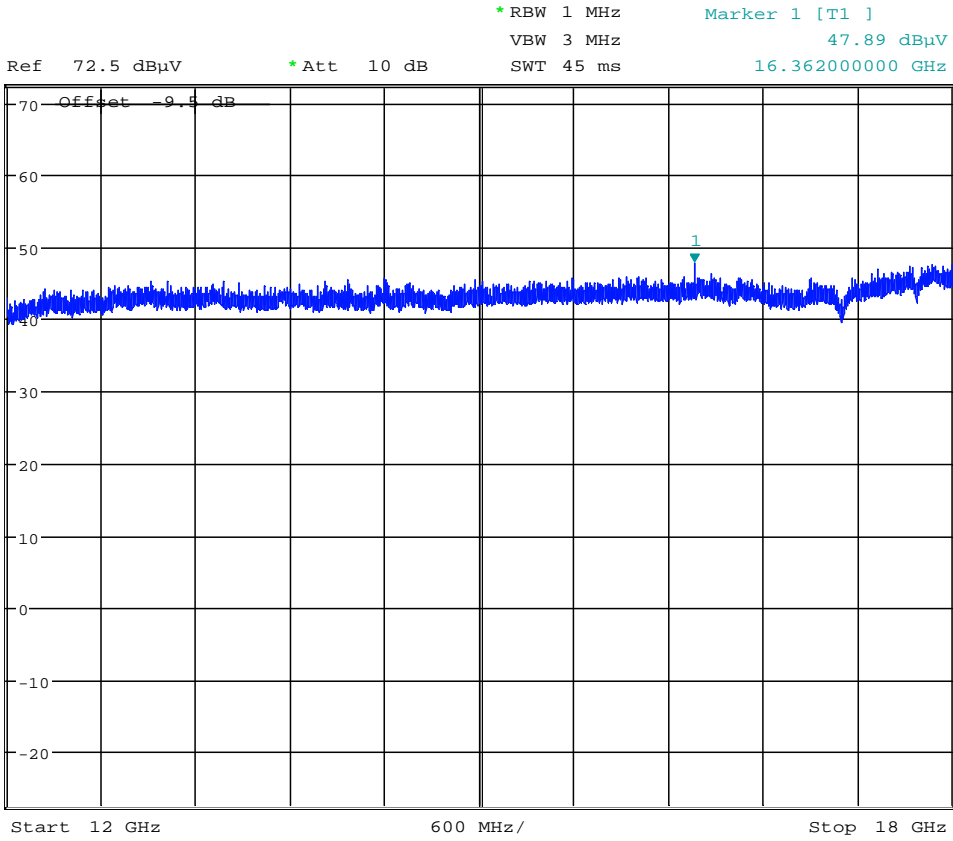


Ref 72.5 dBµV *Att 10 dB *RBW 1 MHz Marker 1 [T1]
 VBW 3 MHz 48.42 dBµV
 SWT 45 ms 17.998800000 GHz



Date: 23.OCT.2012 11:03:57

**Radiated Emissions ch. 2402 MHz, 12 – 18 GHz, VP, @1m – Pre-scan with Peak detector,
 Distance Correction factor included on plot**

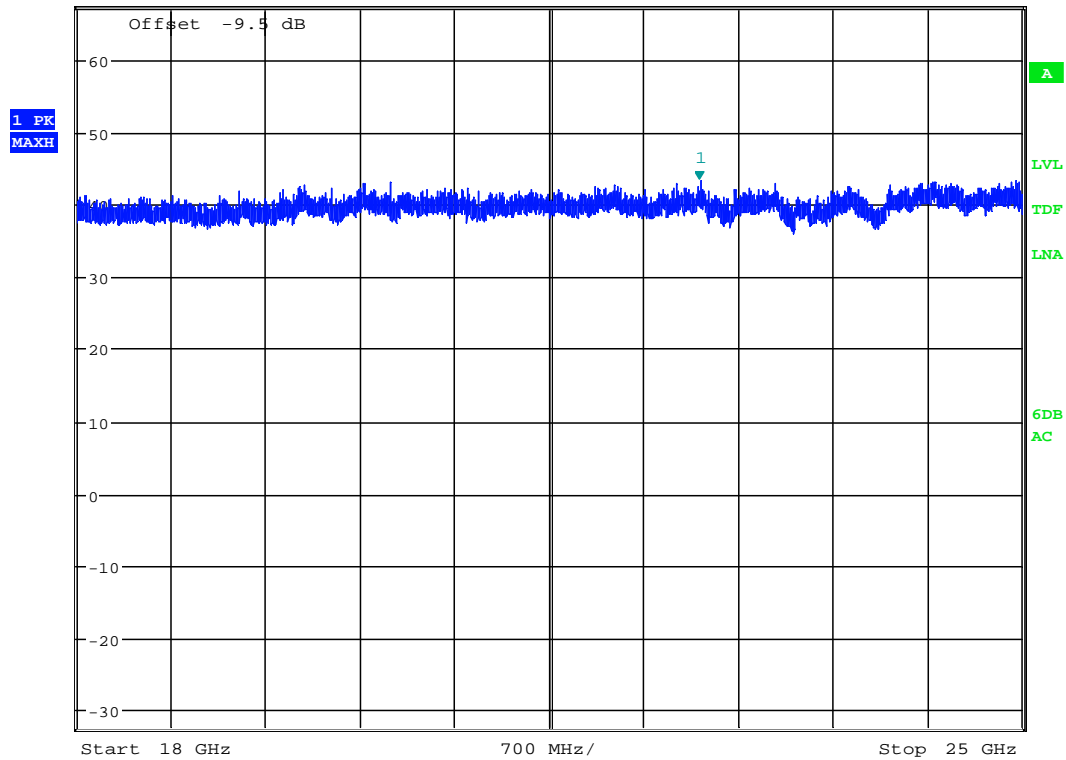


Date: 23.OCT.2012 11:06:44

Radiated Emissions ch. 2402 MHz, 12 – 18 GHz, HP, @1m – Pre-scan with Peak detector, Distance Correction factor included on plot



Ref 67.5 dBµV/m *Att 0 dB *RBW 1 MHz Marker 1 [T1]
 VBW 3 MHz 43.39 dBµV/m
 SWT 45 ms 22.615100000 GHz



Date: 23.OCT.2012 12:08:08

**Radiated Emissions ch. 2402 MHz, 18 – 25 GHz, VP/HP, Pre-scan with Peak detector,
 Distance Correction factor included on plot**

4.6 Power Spectral Density (PSD)

Para. No.: 15.247 (e)

Test Performed By: Thomas Dangle	Date of Test: 16 Oct. 2012
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Test Results: Complies

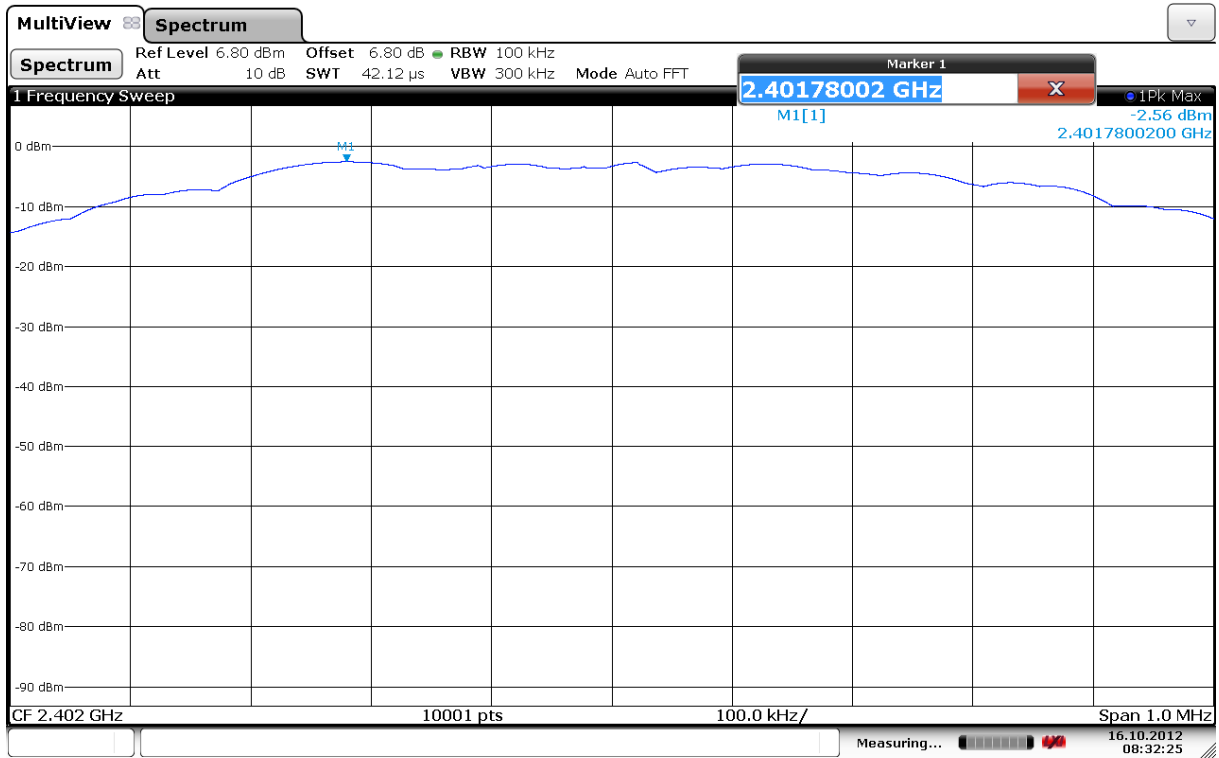
Measured and Calculated Data:

The test procedure in chapter 5.3.1 and the bandwidth correction factor BWCF = -15.2 dB described in guidance on measurements for Digital Transmission Systems is used.

	Measured and calculated peak PSD dBm
Power Spectral Density @2402 MHz	-17.7
Power Spectral Density @2440 MHz	-18.0
Power Spectral Density @2480 MHz	-18.8

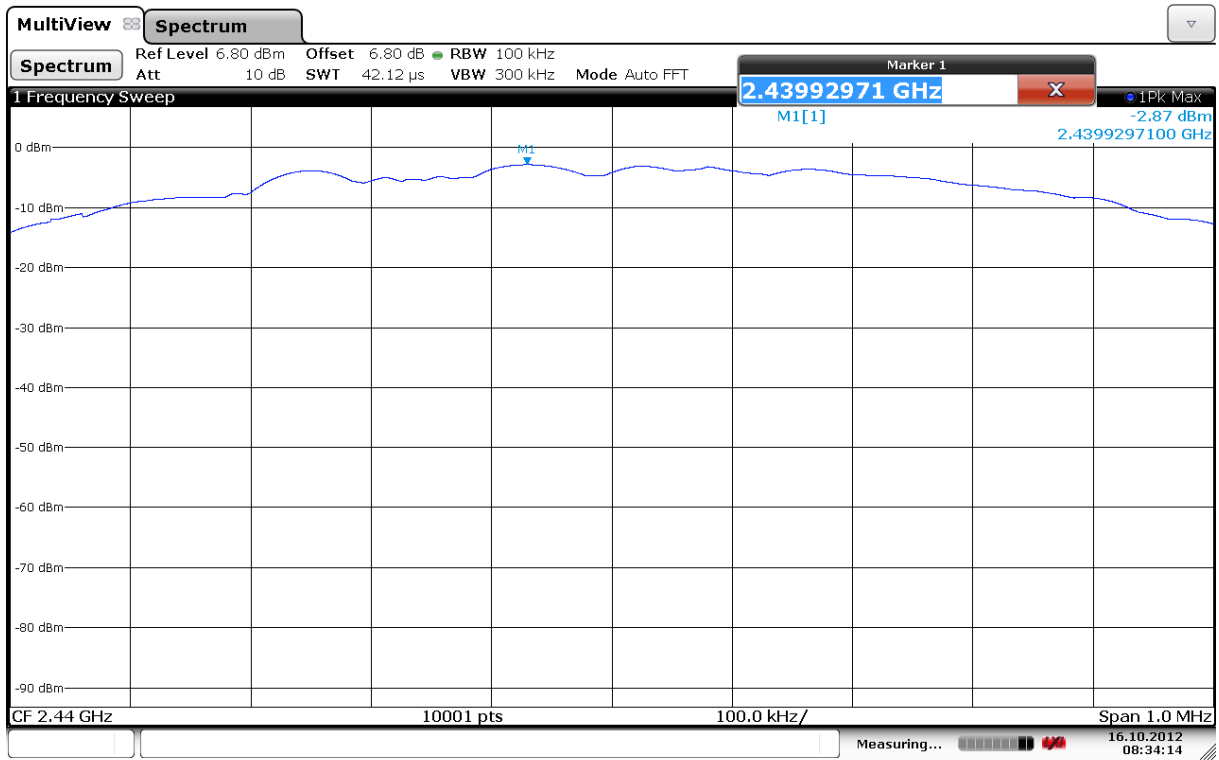
Requirements:

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



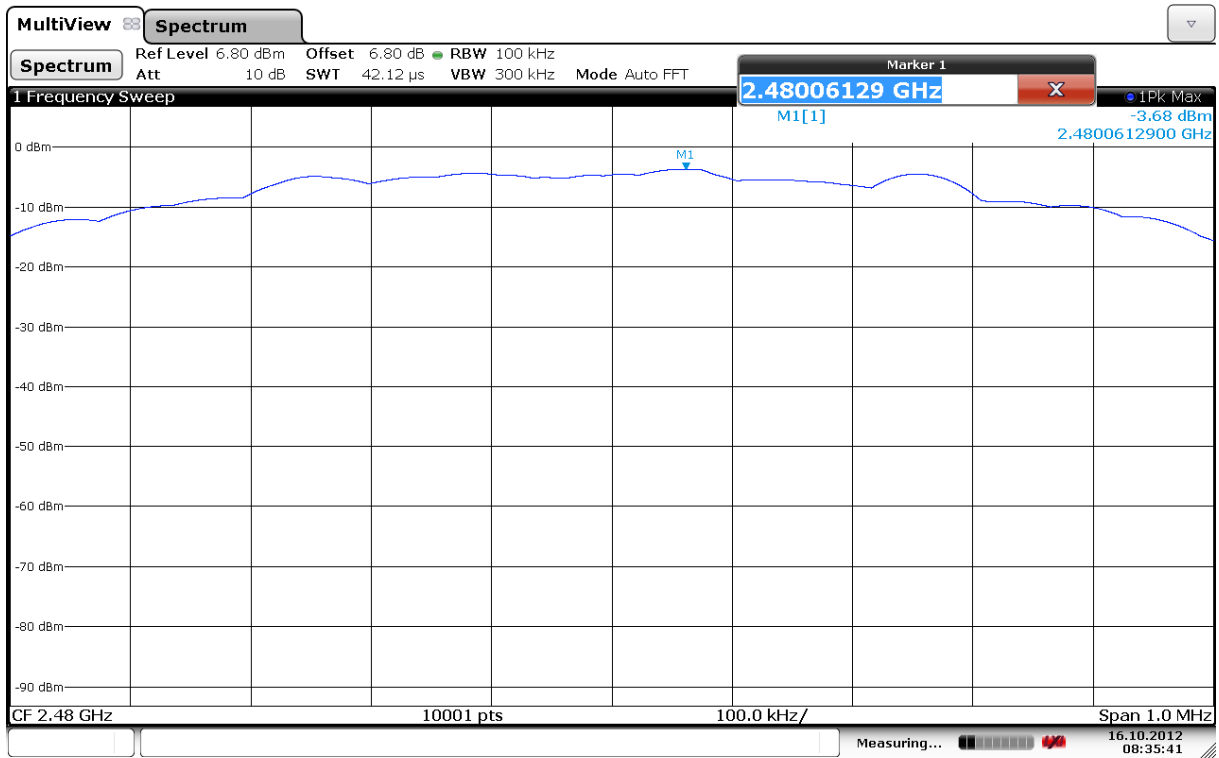
Date: 16.OCT.2012 08:32:25

PSD Measurement - 2402MHz



Date: 16.OCT.2012 08:34:14

PSD Measurement – 2440MHz



Date: 16.OCT.2012 08:35:41

PSD Measurement - 2480MHz

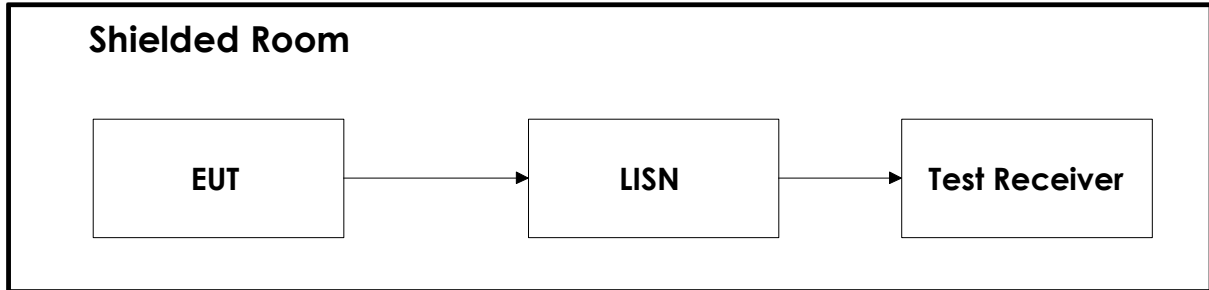
5 LIST OF TEST EQUIPMENT

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.

No.	Instrument/ ancillary	Type of instrument/ ancillary	Manufacturer	Ref. no.	Cal. Date	Cal. Due
1	FSP30	Spectrum Analyzer	Rohde & Schwarz	LR 1551	2012.04.05	2013.04.05
2	ESU40	EMI Receiver	Rohde & Schwarz	LR1639	2010.06	2013.06
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	
21	6HC 3000-18000	HP Filter	Trithlic	LR1614	Cal b4 use	
22	6HC 2500-18000	HP Filter	Trithlic	LR1615	Cal b4 use	
23	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

