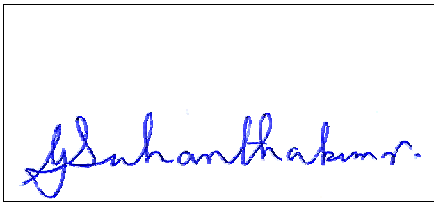
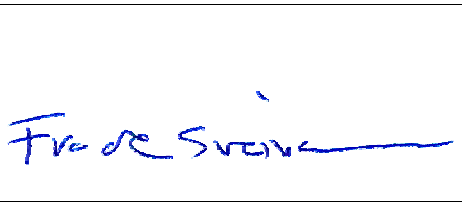
Report No. 215175-1

Test Report

Product	CC2540EM
Name and address of the applicant	Texas Instruments Norway AS Gaustadalléen 21, NO-0349 Oslo, Norway
Name and address of the manufacturer	Texas Instruments Norway AS Gaustadalléen 21, NO-0349 Oslo, Norway
Model	CC2540EM
Rating	3.0Vdc
Trademark	Texas Instruments
Serial number	/
Additional information	/
Tested according to	**FCC Part 15.247** Digital Transmission Systems **Industry Canada RSS-210, Issue 8** Low Power Licence-Exempt Radiocommunications Devices
Order number	215175
Tested in period	2013.11.15 to 2013.11.18
Issue date	2013.12.10
Name and address of the testing laboratory	Nemko Instituttveien 6 Kjeller, Norway FCC No: 994405 IC OATS: 2040D-1 TEL: (+47) 22 96 03 30 FAX: (+47) 22 96 05 50





Prepared by [G.Suhanthakumar] Approved by [Frode Sveinsen]

Template version: B

CONTENTS

1 INFORMATION

1.1 Test Item

Name :	Texas Instruments
FCC ID :	ZAT2540EM
IC :	451H-2540EM
Model/version :	CC2540EM
Serial number :	-
Hardware identity and/or version:	Rev.:1.5.1.1
Software identity and/or version :	-
Frequency Range :	2402 – 2480 MHz
Number of Channels :	16
Type of Modulation :	250 kHz, GFSK (Digital)
Conducted Output Power:	2.85 mW (Peak)
User Frequency Adjustment :	None
Type of Power Supply :	3.0V_{DC} (2xAA Battery)
Antenna Connector :	SMA
Antenna type:	Pulse W1010, ¼-wave dipole
Antenna Diversity Supported :	No
Desktop Charger :	None

Description of Test Item

The CC2540EM RF-transceiver module is an evaluation board for the CC2540 System-on-Chip designed to operate in the 2.4 GHz ISM band. The CC2540 radio complies with the BLE PHY requirements.

Exposure Evaluation

The EUT is exempted from RF Exposure Evaluation.

1.2 Test Environment

1.2.1 Normal test condition

Temperature:	21 - 22 °C
Relative humidity:	42 - 48 %
Normal test voltage:	3.0 V DC

The values are the limit registered during the test period.

1.3 Test Engineer(s)

G.Suhanthakumar

1.4 Test Equipment

See list of test equipment in clause 4.

2 TEST REPORT SUMMARY

2.1 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 and KDB 558074 D01 DTS Measurement Guidance v03r01. The radiated tests were made in a semi-anechoic chamber at measuring distances of 3m and 10m.

A description of the test facility is on file with the FCC and Industry Canada.

☒ New Submission	☐ Production Unit
☐ Class II Permissive Change	☒ Pre-production Unit
DTS Equipment Code	☐ Family Listing

2.2 Test Summary

Name of test	FCC Part 15 reference	RSS-210 Issue 8 & RSS-GEN Issue 3	Result
Supply Voltage Variations	15.31(e)	N/A	Complies [1]
Antenna Requirement	15.203	7.1.4 (RSS-GEN)	Complies[2]
Power Line Conducted Emission	15.107(a) 15.207(a)	7.2.2 (RSS-GEN)	N/A[1]
Minimum 6 dB Bandwidth	15.247(a)(2)	A8.2	Complies
Peak Power Output	15.247(b)	A8.4	Complies
Power Spectral Density	15.247(d)	A8.2	Complies
Spurious Emissions (Antenna Conducted)	15.247(c)	A8.5	Complies
Spurious Emissions (Radiated)	15.247(c) 15.109(a) 15.209(a)	A8.5	Complies
Receiver Emissions (Radiated)	N/A	2.3	N/A

[1] EUT is battery operated only.

[2] SMA connector "Professional Use Only"

RSS Gen issue 3 covers section 7 & 6

RSS 210 issue 8 covers section A2.9

2.3 Description of modification for Modification Filing

Not applicable.

2.4 Comments

All ports were populated during spurious emission measurements.

2.5 Family List Rational

Not Applicable.

3 TEST RESULTS

3.1 Power Line Conducted Emissions

Para. No.: 15.207 (a)

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

Test Performed By: -	**Date of Test: -**

Measurement procedure: **ANSI C63.4-2003 using 50 μH/50 ohms LISN.**
Test Results: **-**
Measurement Data: **-**

3.2 Minimum 6 dB Bandwidth

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

Test Performed By: G.Suhanthakumar	**Date of Test: 18 Nov 2013**

Test Results: Complies

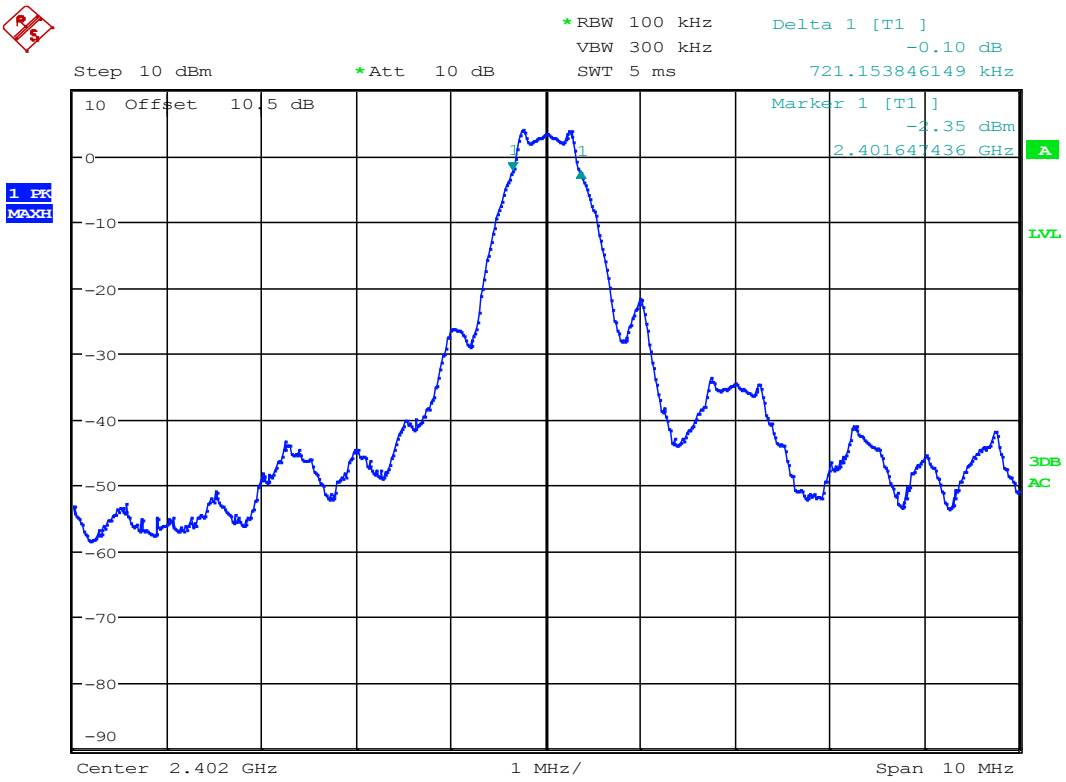
Measurement Data:

Measured 6 dB Bandwidth (kHz)		
2402MHz	**2440 MHz**	**2480MHz**
721.15	721.15	721.15

Tested according to KDB 558074 D01 DTS Meas Guidance v03r01, Section 8.1.

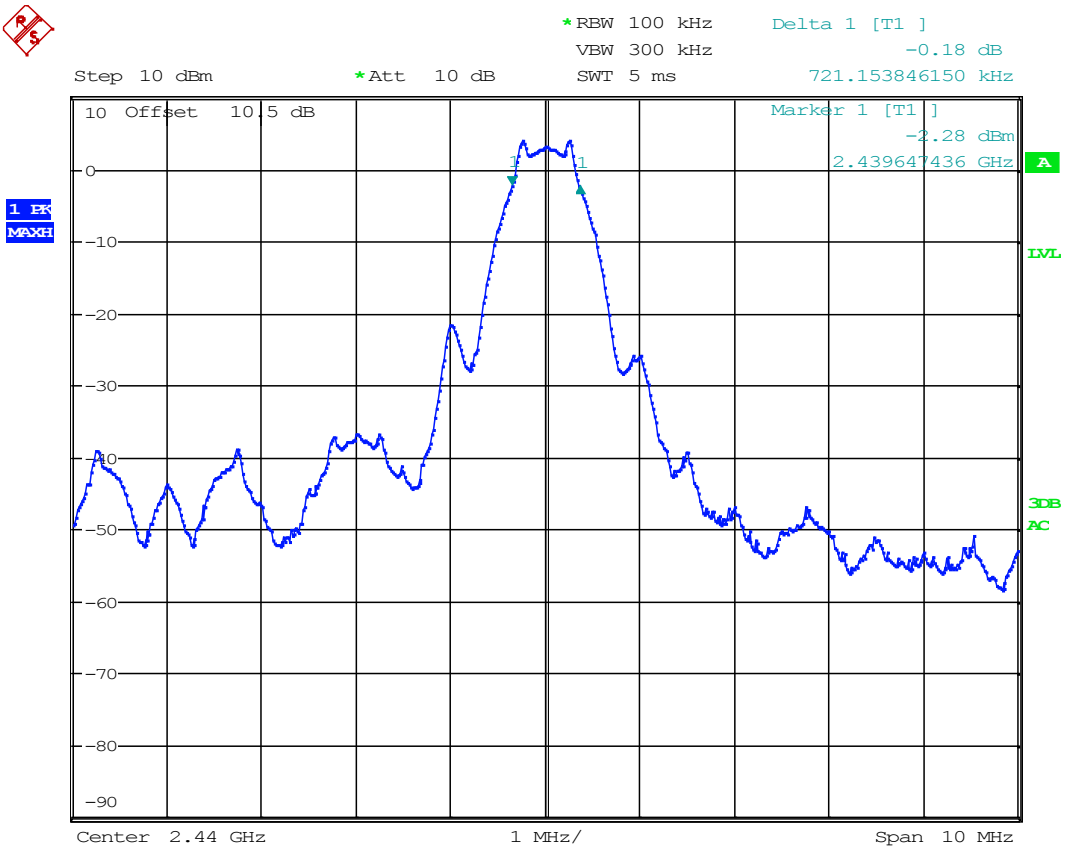
Requirements:

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



Date: 18.NOV.2013 18:33:54

6 dB Bandwidth at 2402 MHz



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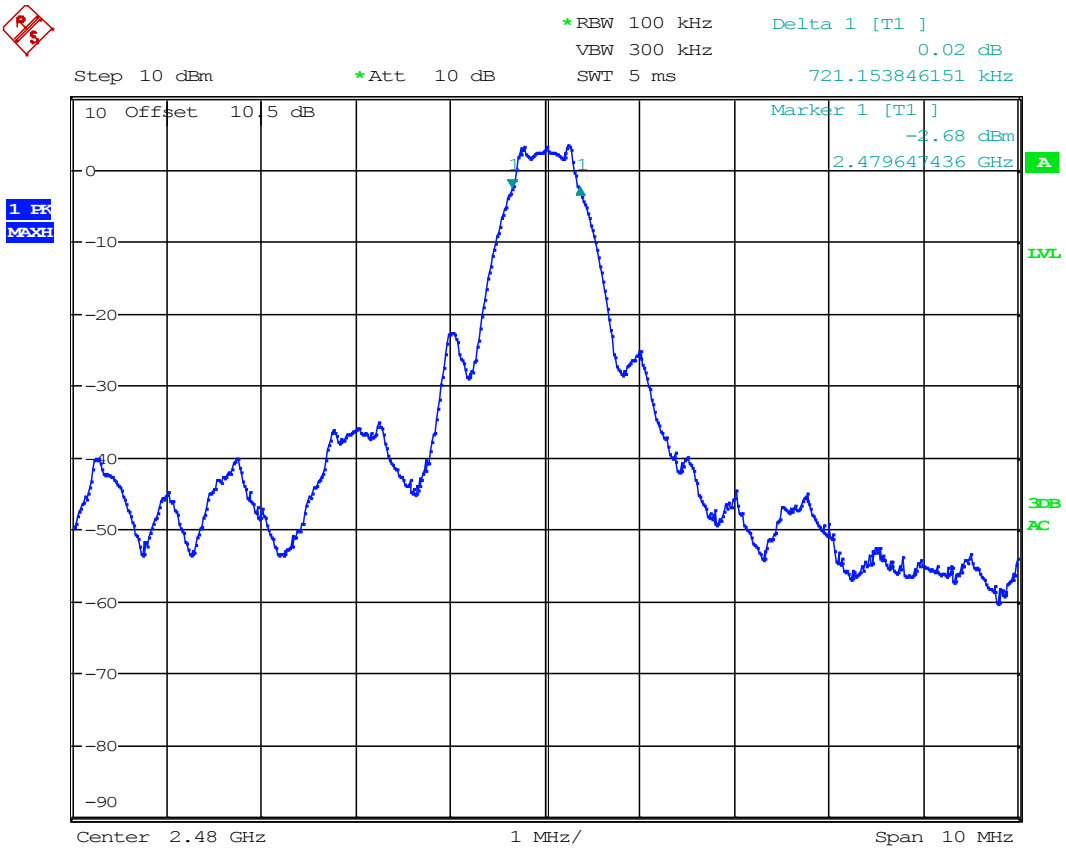
6 dB Bandwidth at 2440 MHz



Date: 18.NOV.2013 18:32:56

6 dB Bandwidth at 2480 MHz

3.3 20 dB Bandwidth

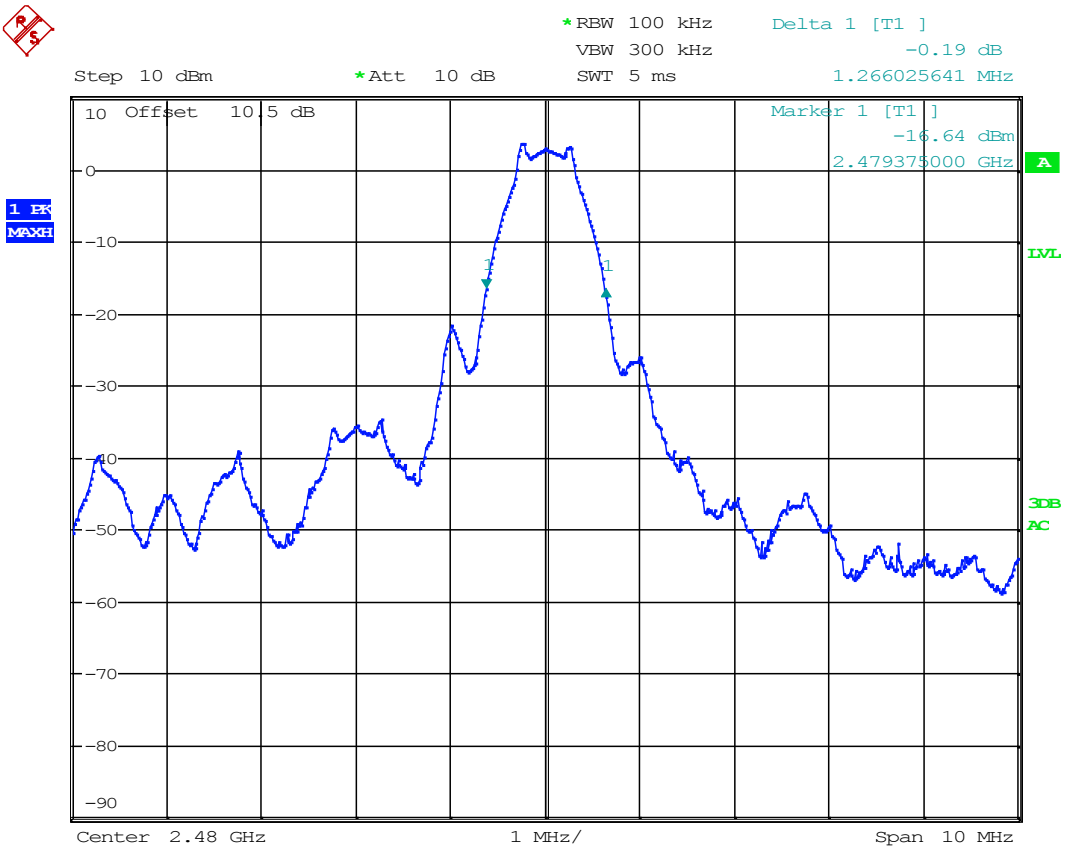
Test Performed By: G.Suhanthakumar	Date of Test: 18 Nov 2013

Measurement Data:

Measured 20 dB Bandwidth (MHz)
2440 MHz
1.27

Requirements:

No requirements. Reported for information only.



Date: 18.NOV.2013 18:36:54

20 dB Bandwidth at 2480 MHz

3.4 Peak Power Output

Para. No.: 15.247 (b)

Test Performed By: G.Suhanthakumar	**Date of Test: 18 Nov 2013**

Test Results: Complies

Measurement Data:

RF channel	**2402 MHz**	**2440 MHz**	**2480 MHz**
Measured Maxium Field strength (dBµV/m) –VP	101.92	102.22	102.70
Calc. Radiated Power (dBm)	6.66	6.96	7.44
Calc. Radiated Power (mW)	4.63	4.96	5.55
Measured Conducted Power (dBm)	4.55	4.40	4.19
Measured Conducted Power (mW)	2.85	2.75	2.62
Calculated Antenna Gain (dBi)	2.11	2.56	3.25

Tested according to KDB 558074 D01 DTS Meas Guidance v03r01, Section 9.1.1.
EIRP is calculated according to KDB 558074 D01 DTS Meas Guidance v03r01, Section 12.2.2. (e)
The maximum field strength is obtained in XZ plane and Vertical polarization.

See attached graph.

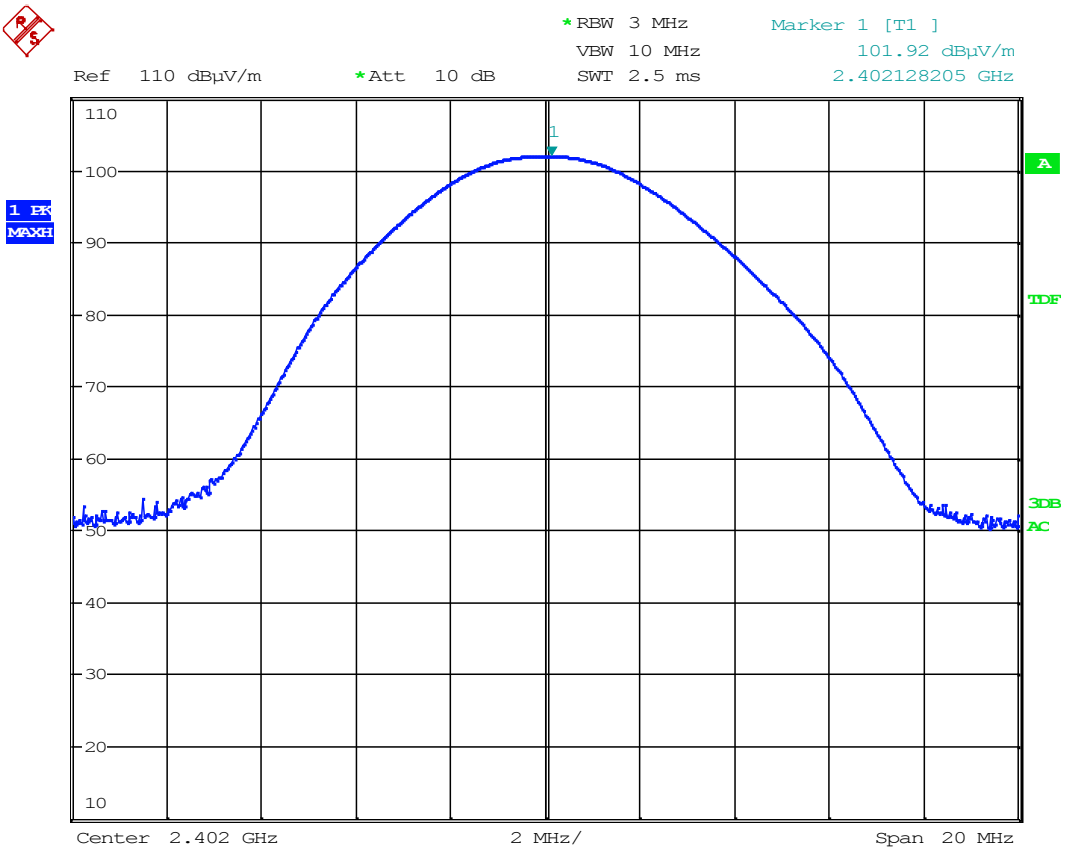
Detachable antenna? ☒ Yes ☐ No

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

SMA connector "Professional Use Only"

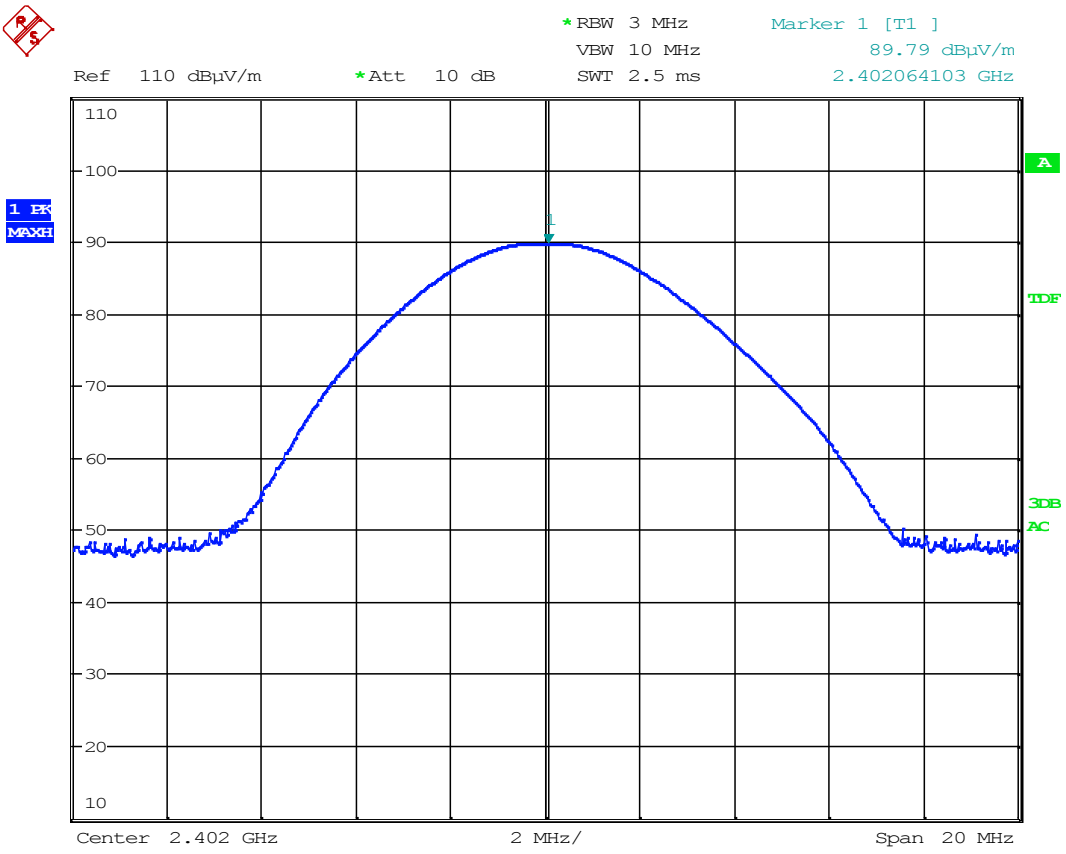
Requirements:

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.



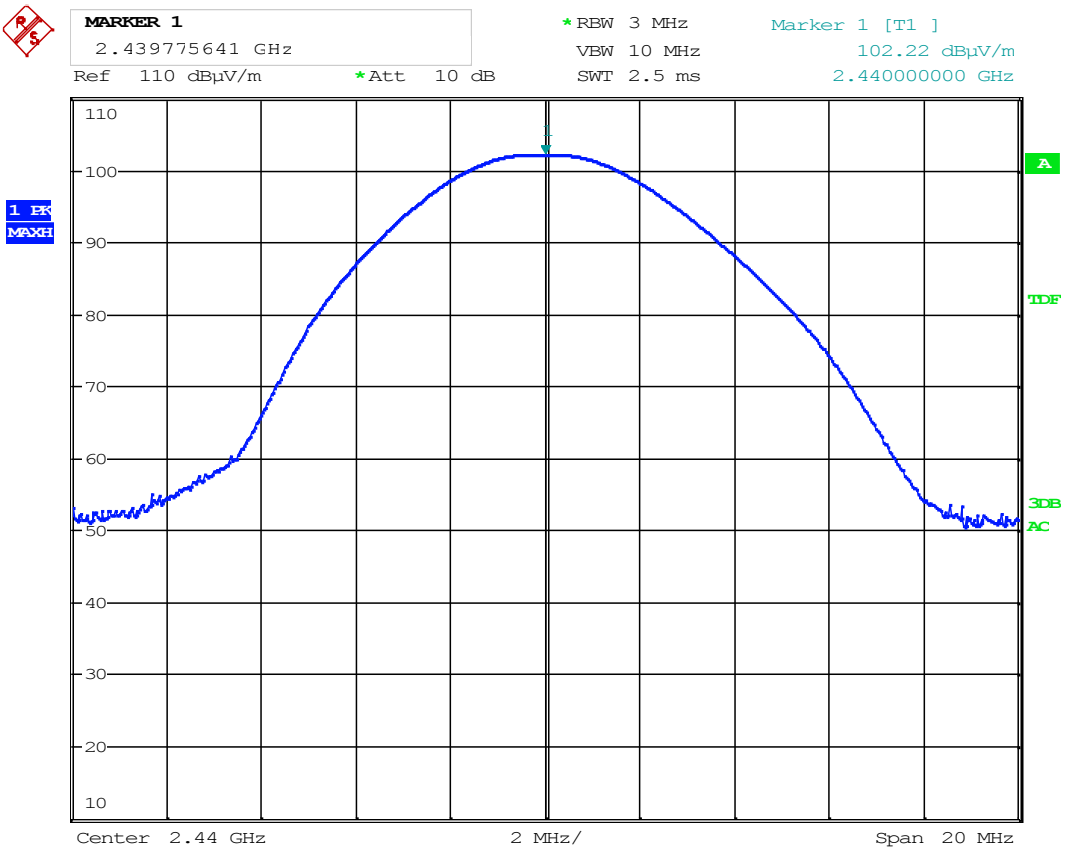
Date: 18.NOV.2013 16:35:09

Radiated Field strength, VP , 2402 MHz,PK



Date: 18.NOV.2013 16:35:56

Radiated field strength, HP, 2402 MHz,PK



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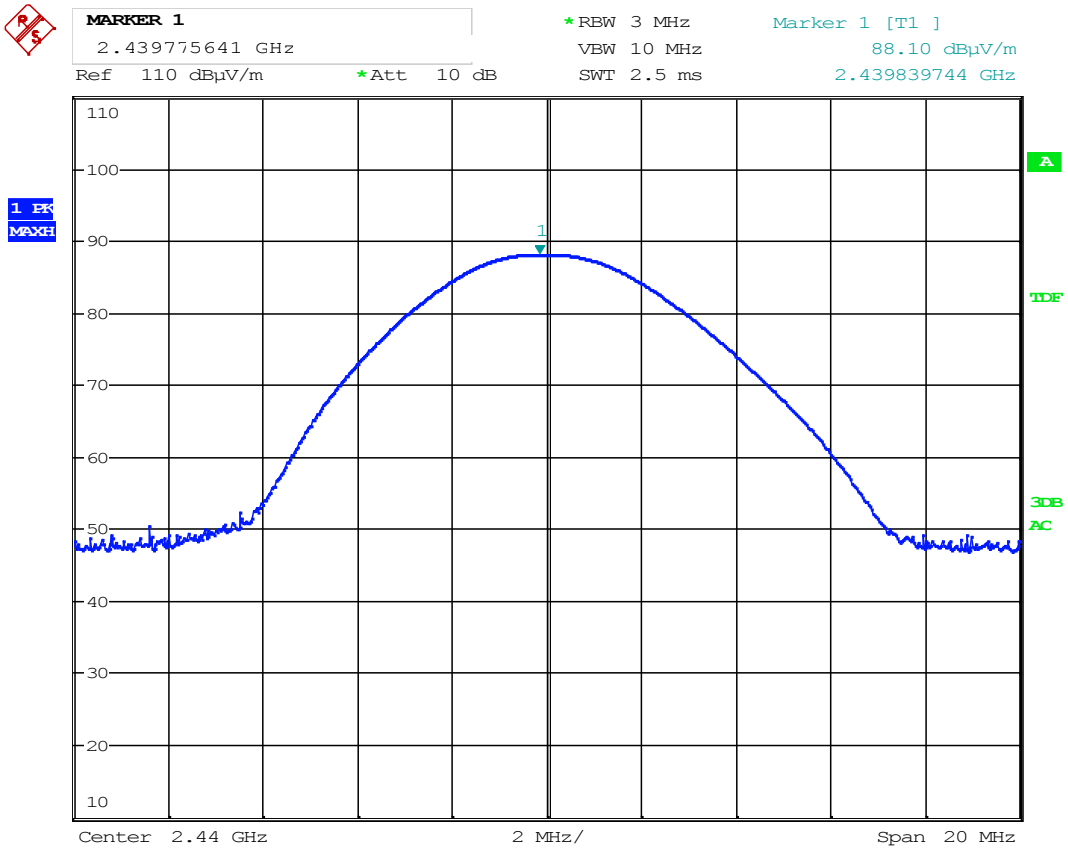
Radiated field strength, VP, 2440 MHz,PK



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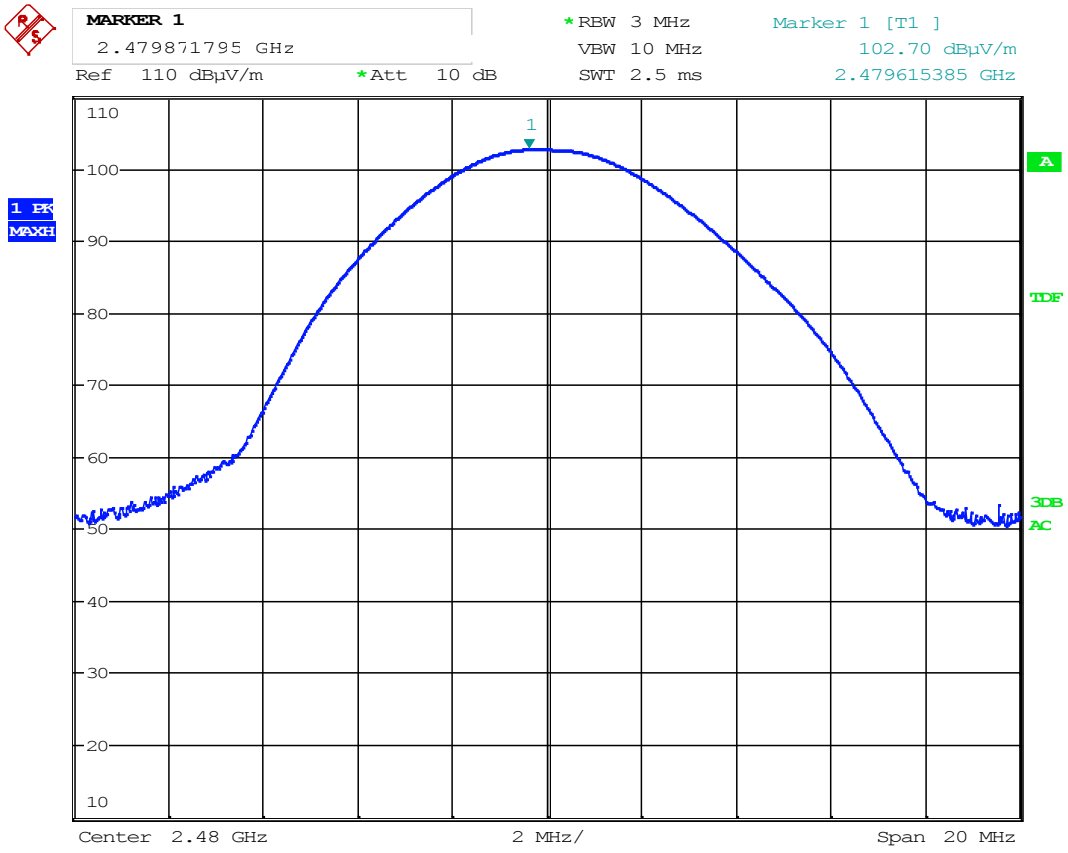
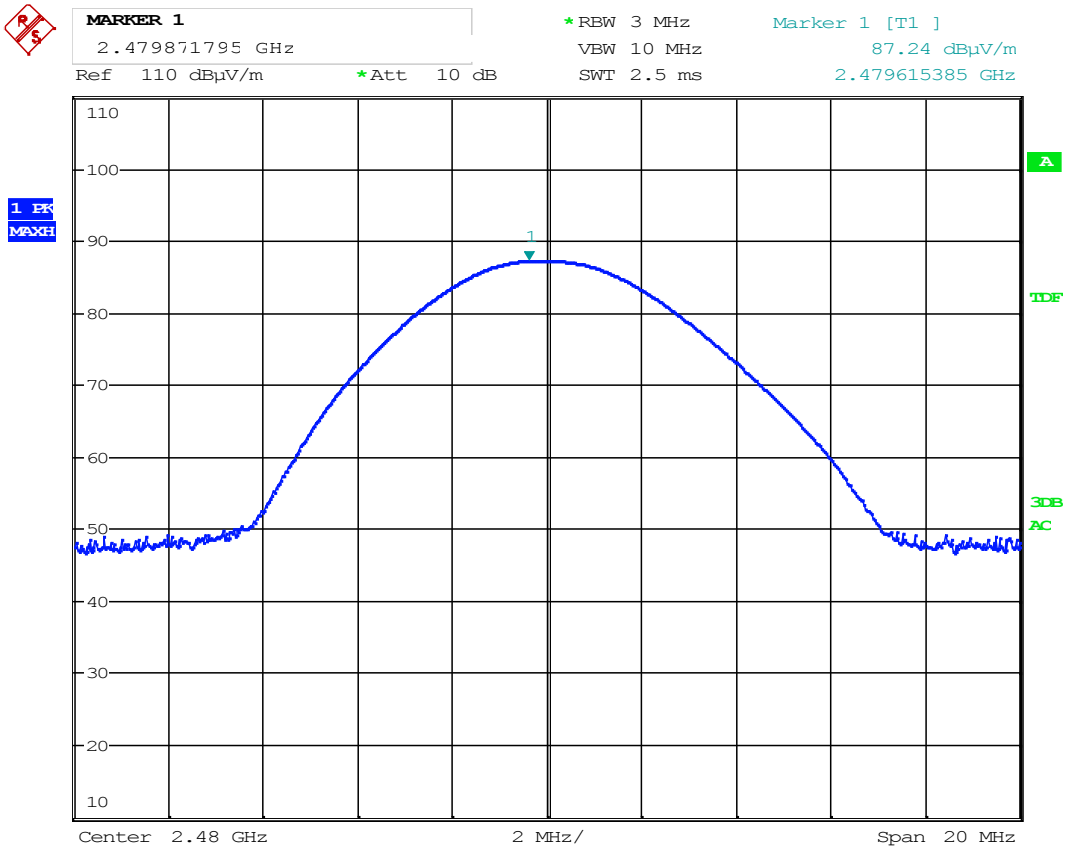
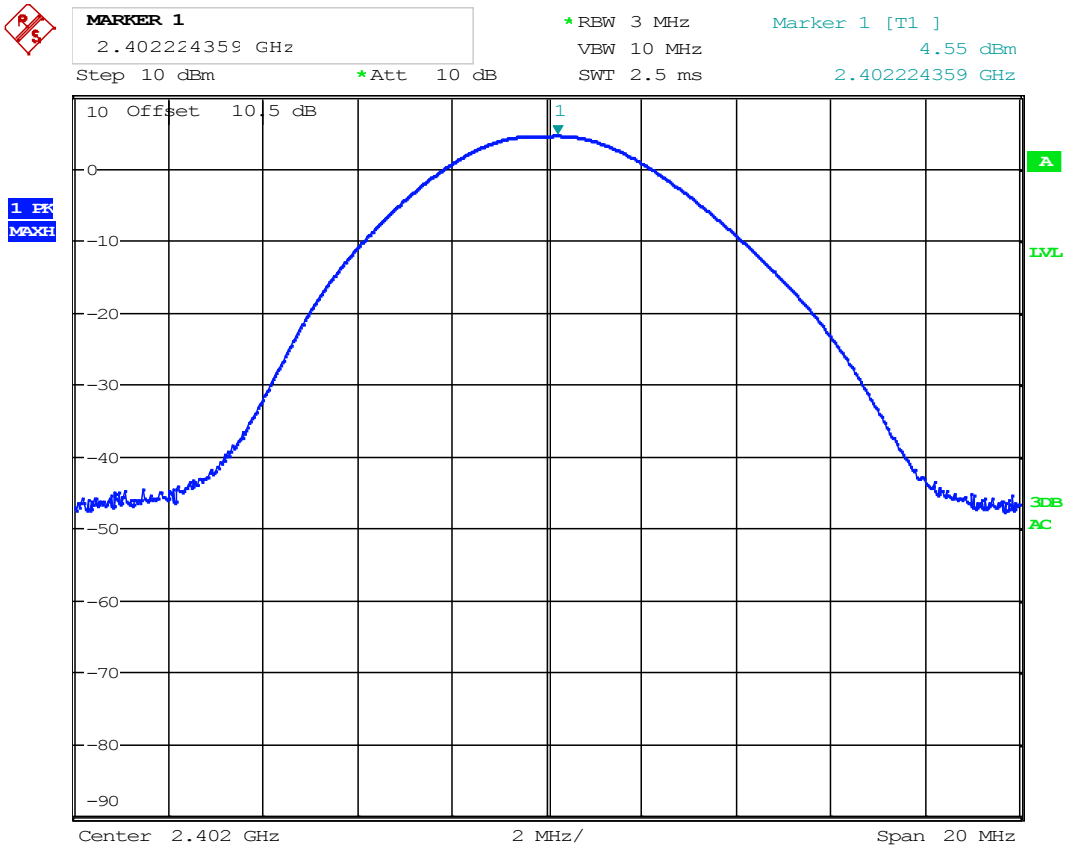
Radiated field strength, HP, 2440 MHz,PK



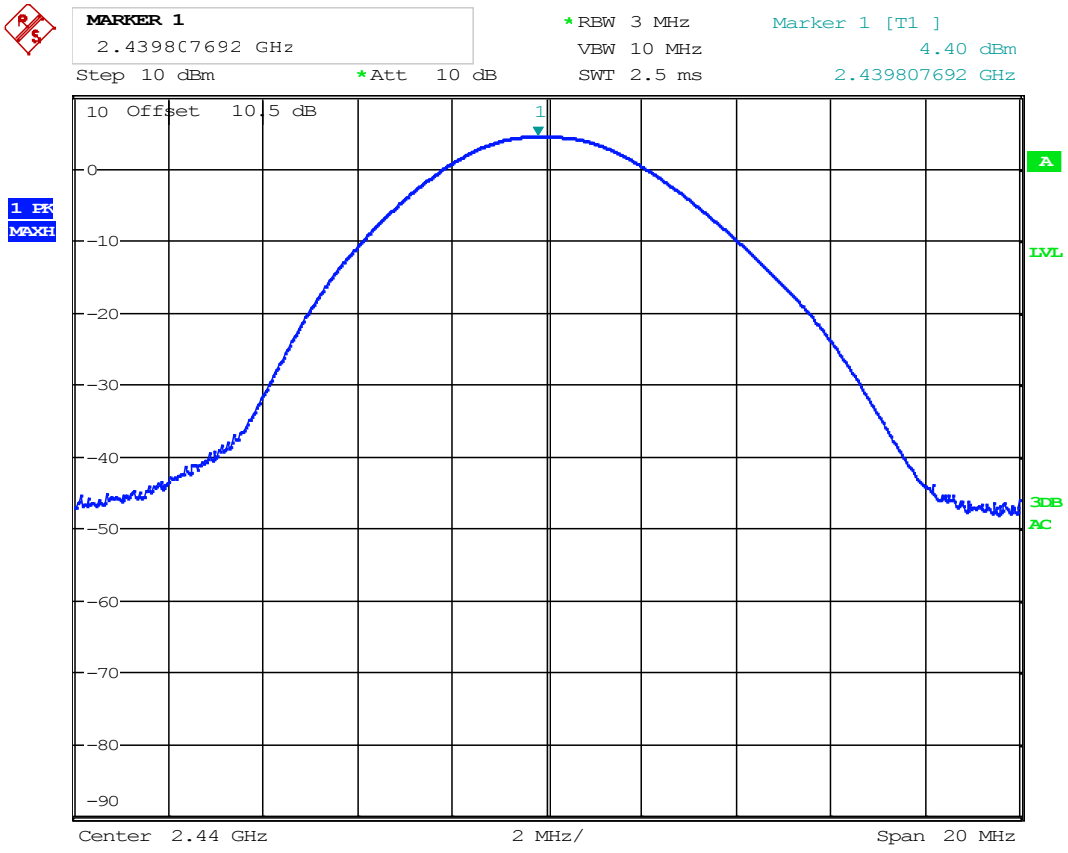
Radiated field strength, VP, 2480 MHz,PK



Radiated field strength, HP, 2480 MHz,PK



Conducted power – 2402MHz,PK



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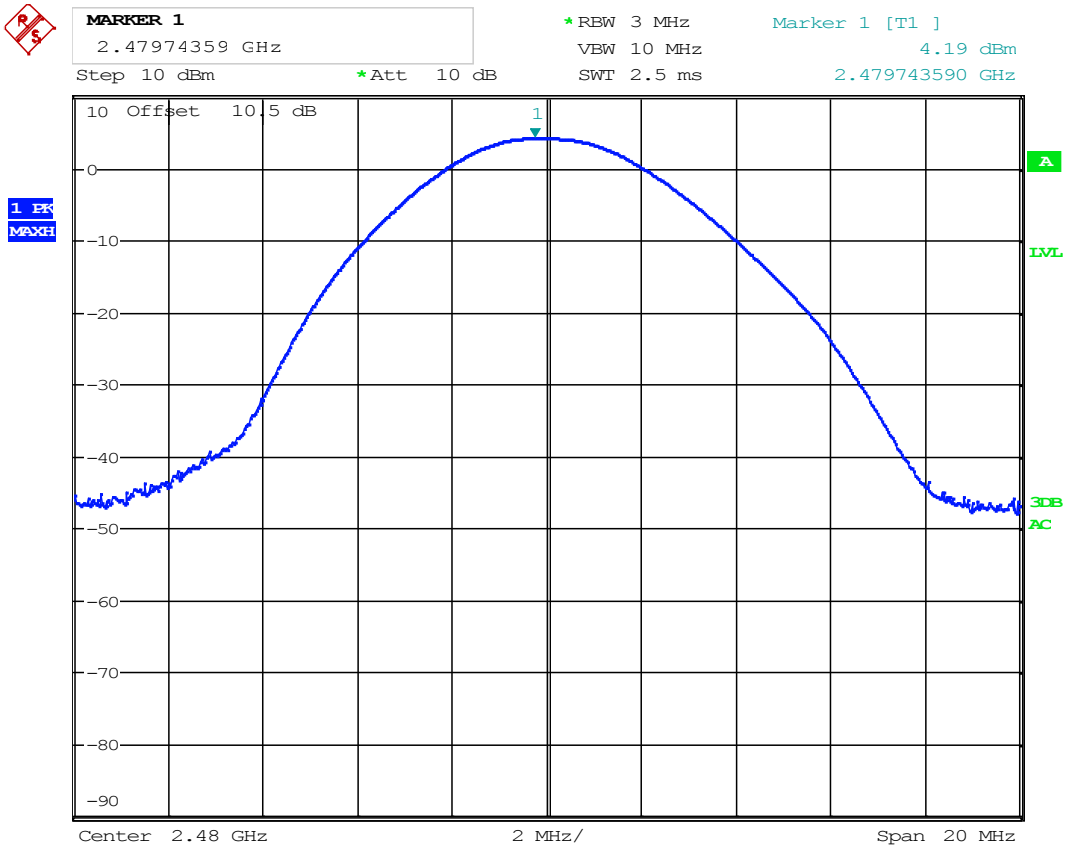
Conducted power – 2440MHz,PK



Date: 18.NOV.2013 18:29:34

Conducted power – 2480MHz, PK

3.5 Spurious Emissions (Radiated)

Para. No.: 15.247 (c)

Test Performed By: G.Suhanthakumar	Date of Test: 18 Nov 2013

Test Results: Complies

Measurement Data:
Band-edge, @3m

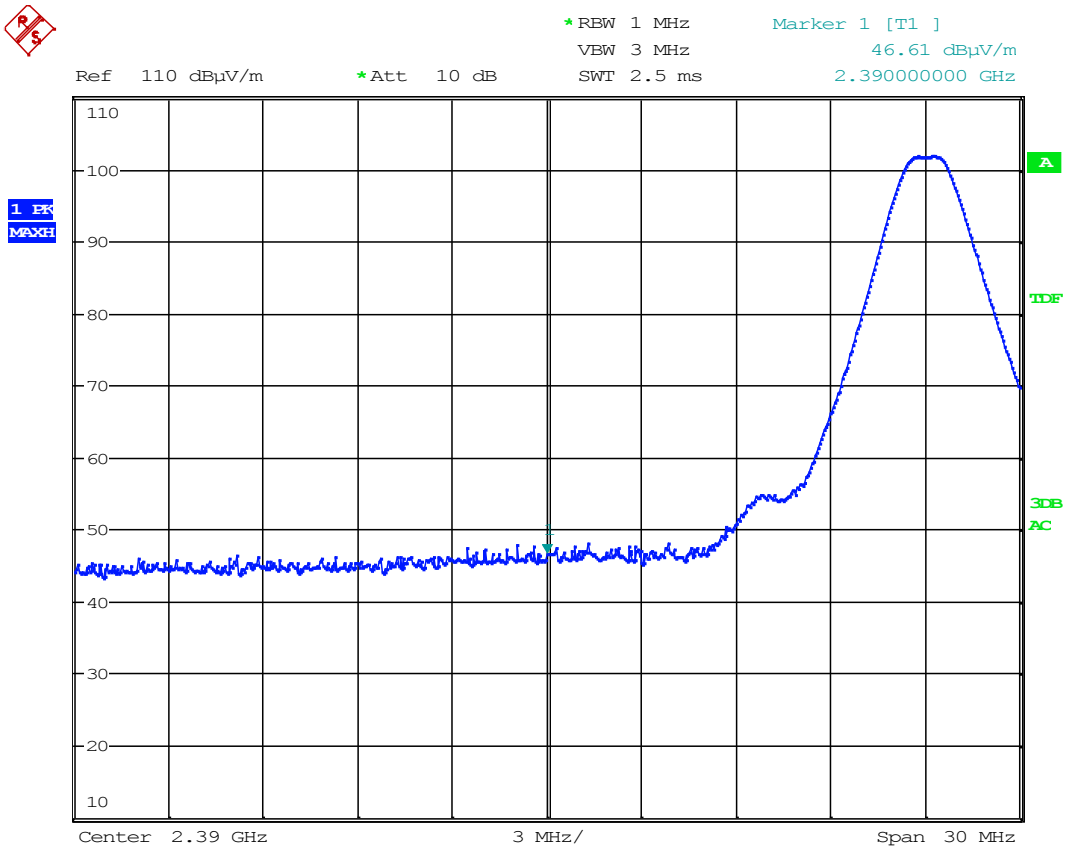
Frequency	Measured Field Strength @3m, dBµV/m	Detector	Limit dBµV/m	Margin dB
2.39 GHz	46.61	PK	74	27.39
	40.66	AV	54	13.34
2.4835 GHz	63.31	PK	74	10.69
	51.54	AV	54	2.46

Tested according to KDB 558074 D01 DTS Measurement Guidance v03r01, Section 13.1 & 13.3.2.

100% duty cycle

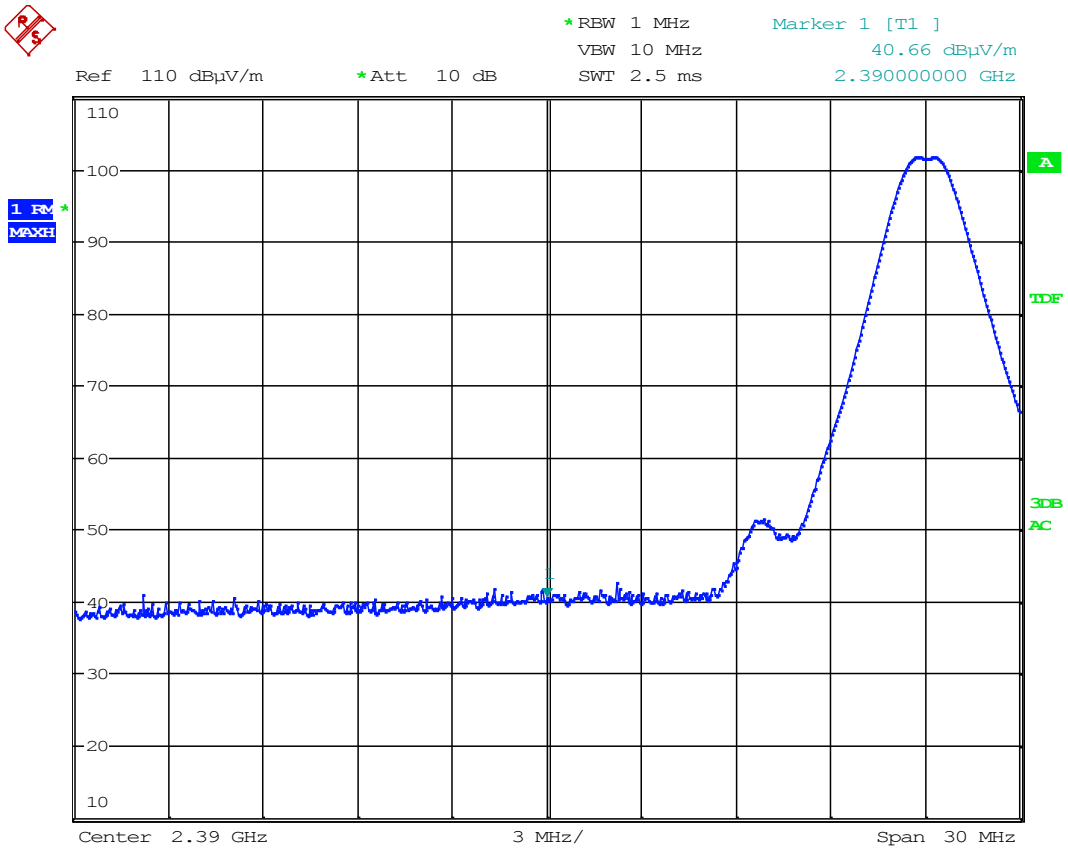
See attached plots.

RF conducted spurious emission
Scan performed with 100 kHz Bandwidth from 0.01 to 25 GHz.
All emissions are more than 20dB below carrier.
See plots.



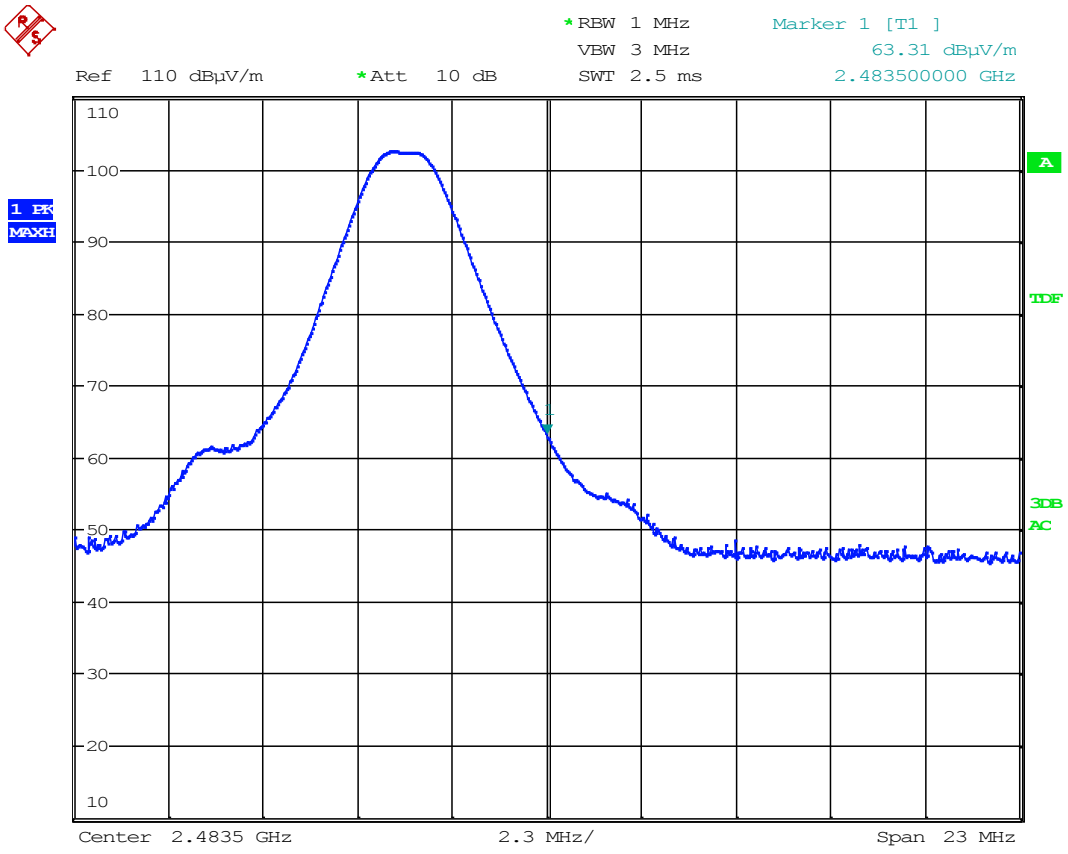
Date: 18.NOV.2013 16:39:34

Band Edge, 2390 MHz, Peak Detector



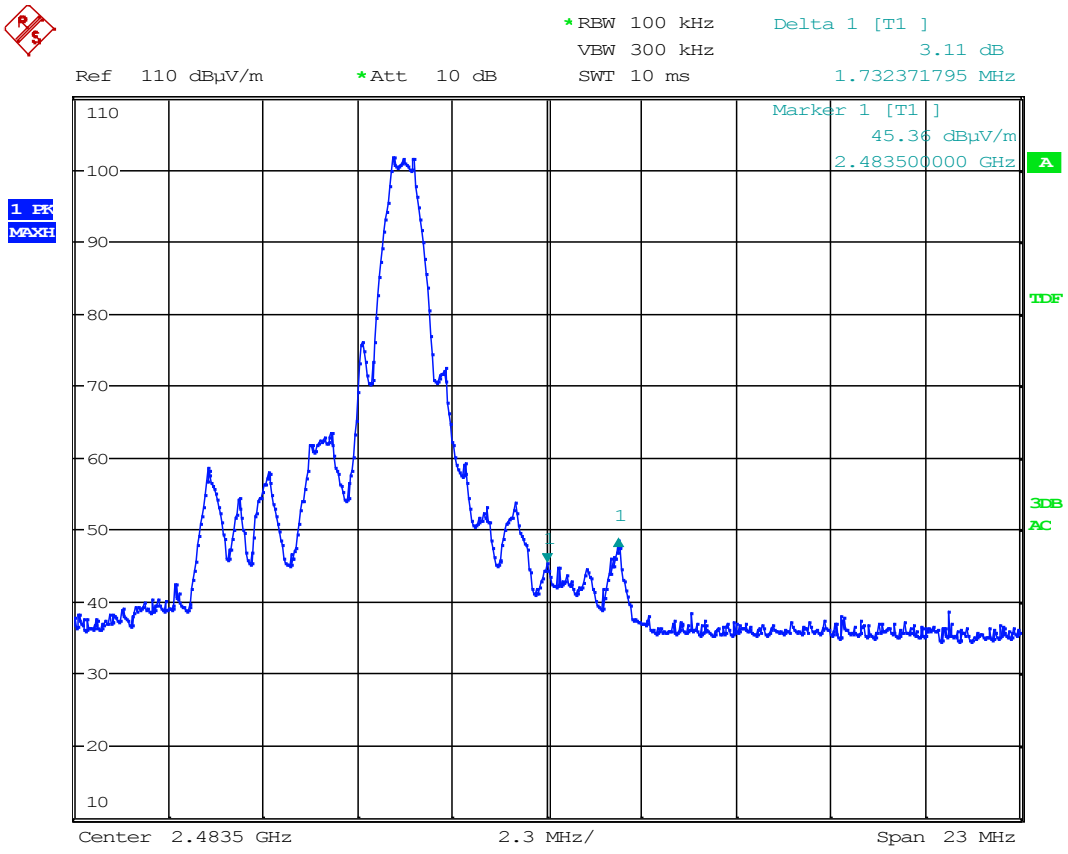
Date: 18.NOV.2013 16:40:49

Band Edge, 2390 MHz, Average Detector



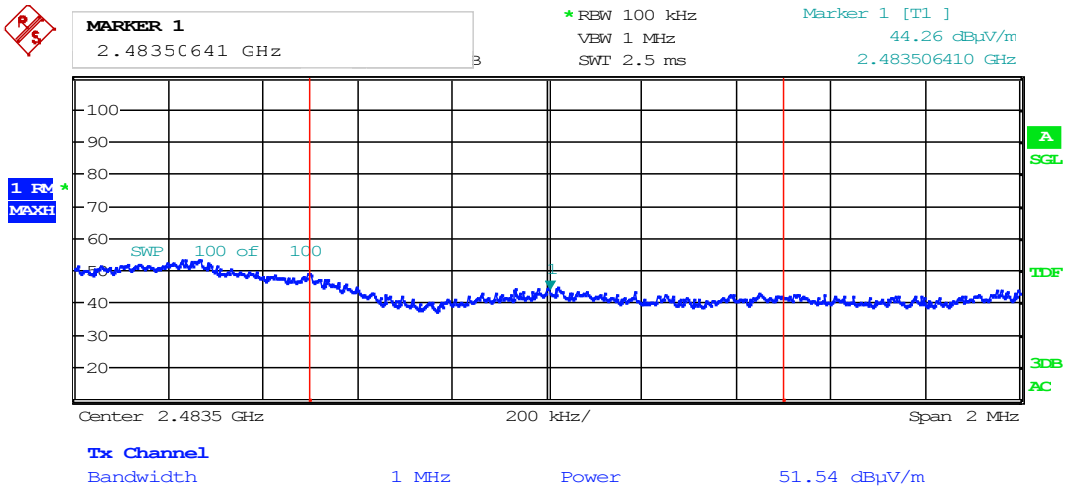
Date: 18.NOV.2013 17:07:22

Band Edge, 2483.5 MHz, Peak Detector



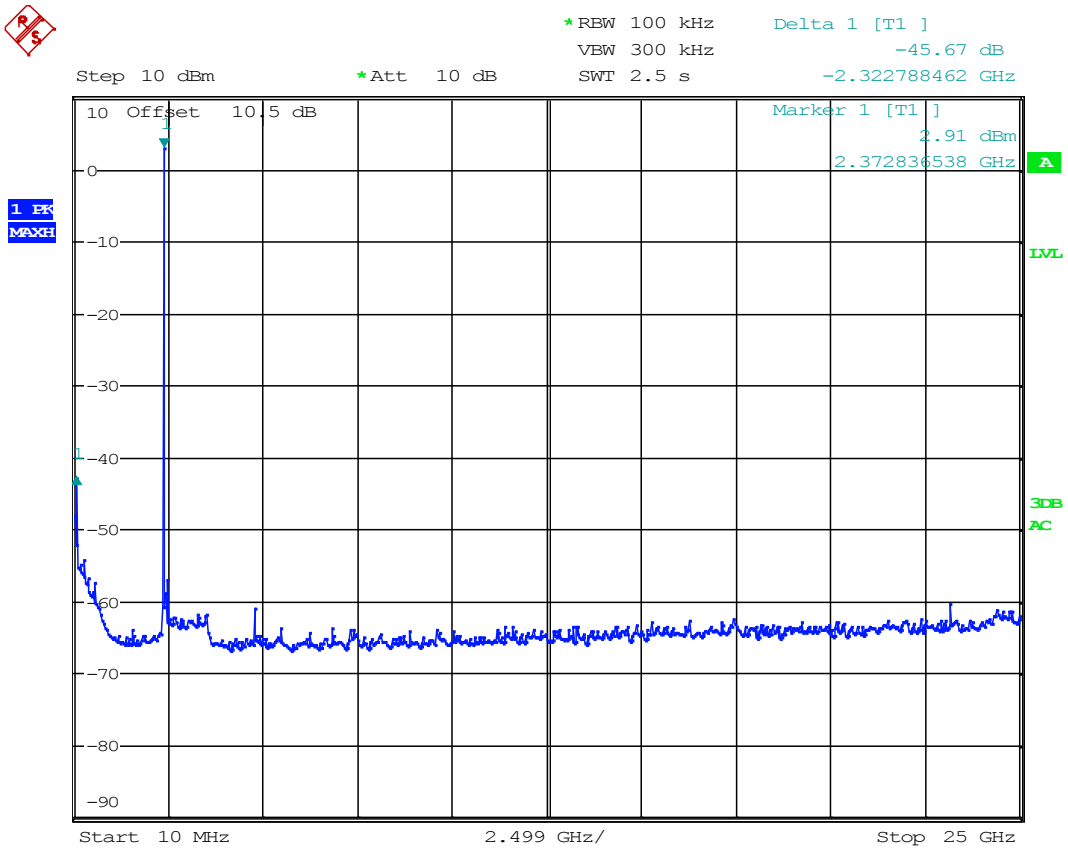
Date: 18.NOV.2013 17:09:24

Prescan at 2.4835GHz



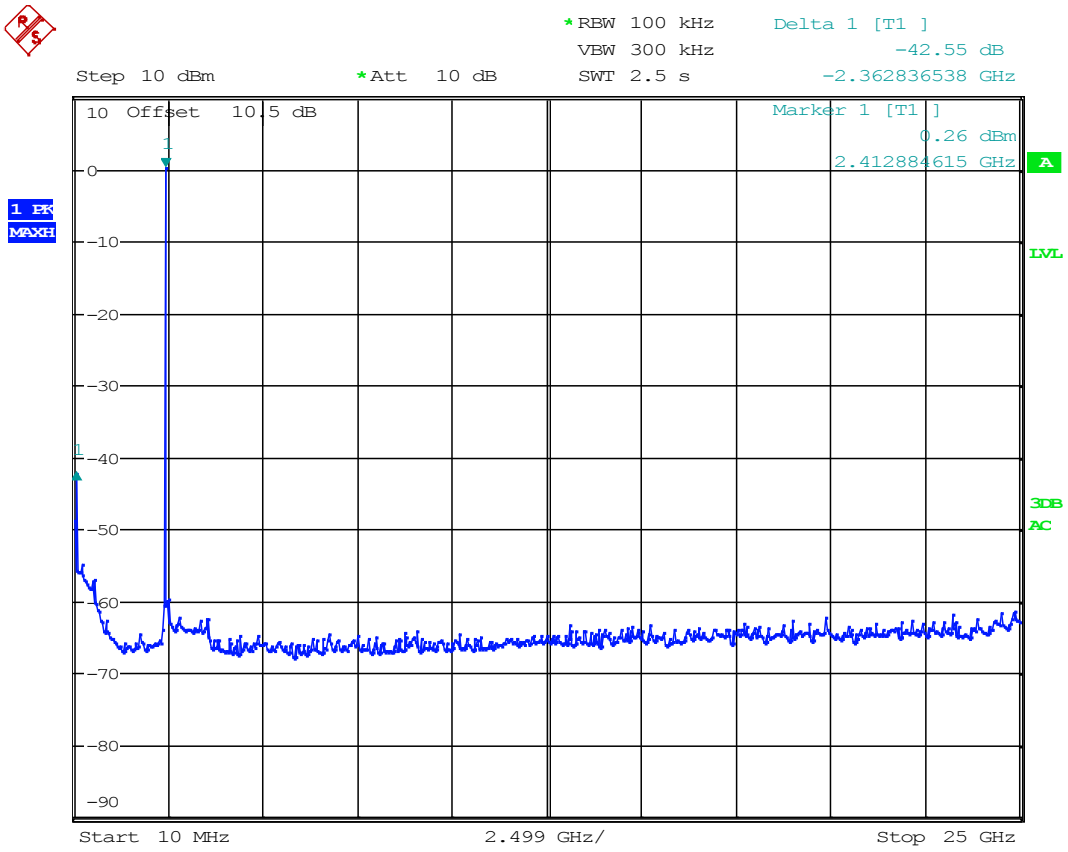
Date: 18.NOV.2013 17:21:14

Band edge power, 2483.5MHz, AV detector



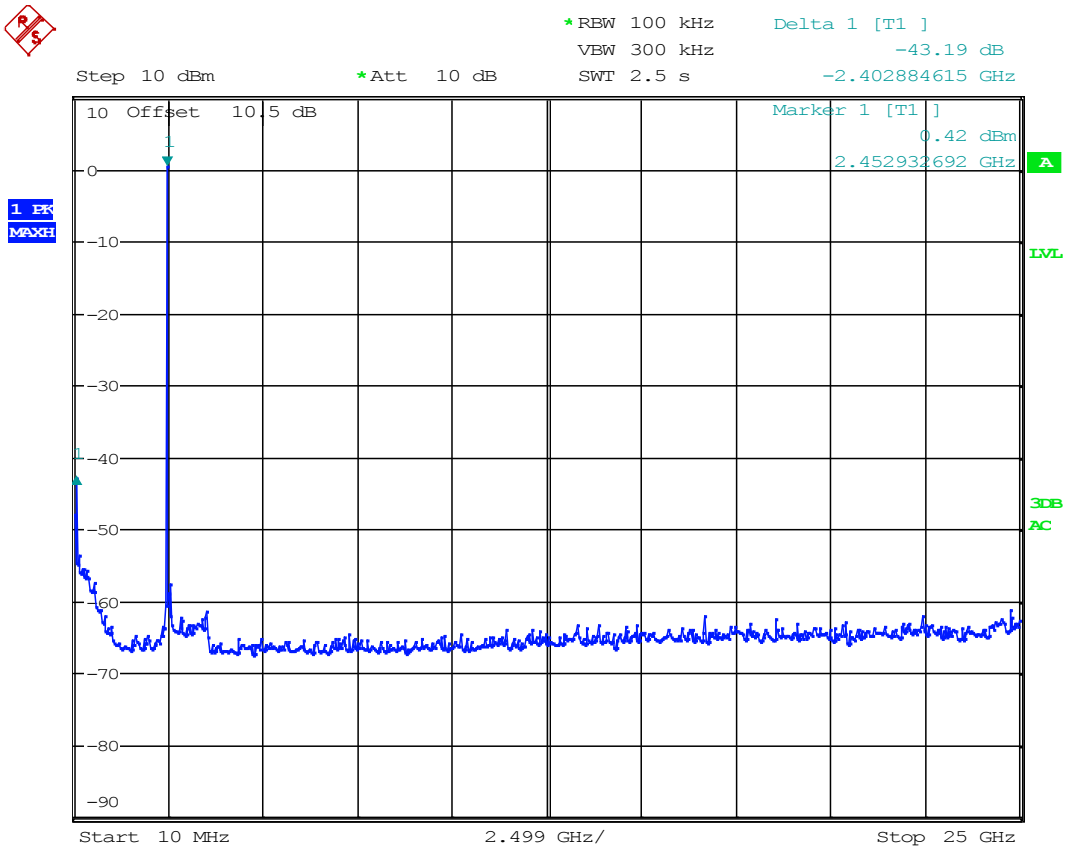
Date: 18.NOV.2013 18:27:34

Conducted spurious emission 10MHz – 25GHz - ch2402MHz



Date: 18.NOV.2013 18:28:31

Conducted spurious emission 10MHz – 25GHz - ch2440MHz



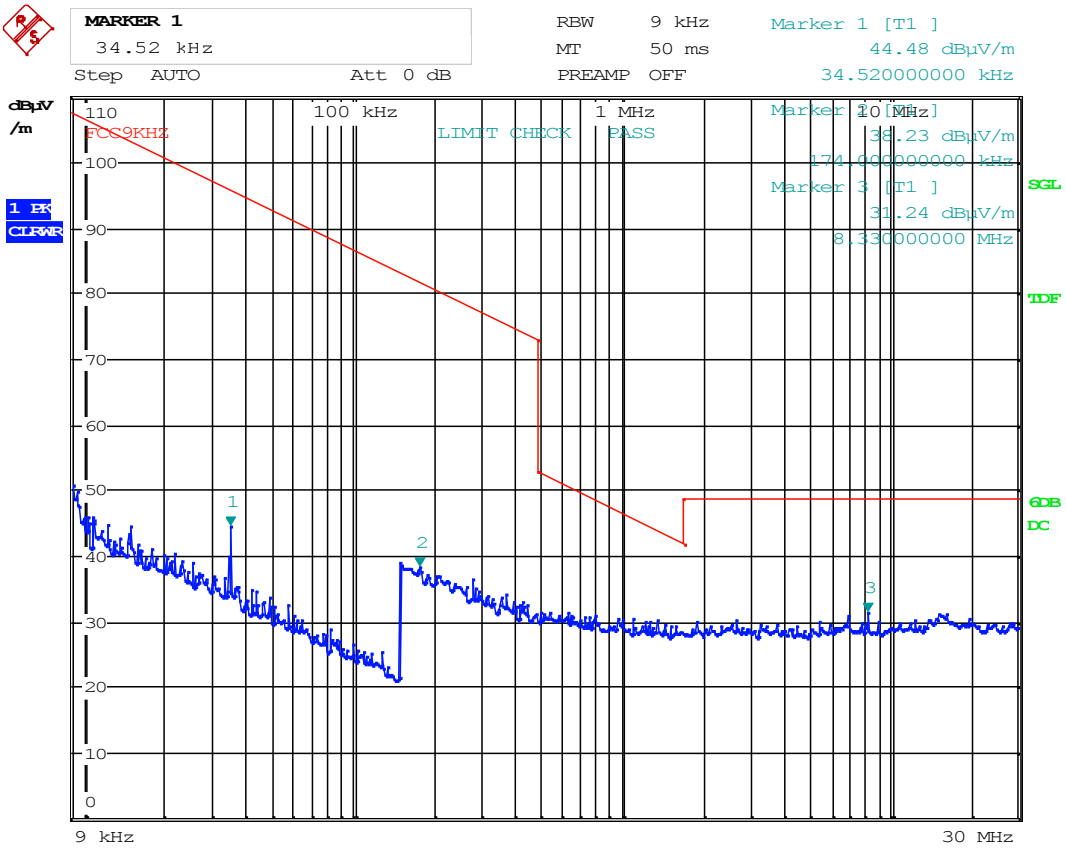
Date: 18.NOV.2013 18:28:55

Conducted spurious emission 10mHz – 25GHz - ch2480MHz

Radiated emissions 9kHz - 30 MHz.

Detector: Quasi-Peak

Measuring distance 10 m.



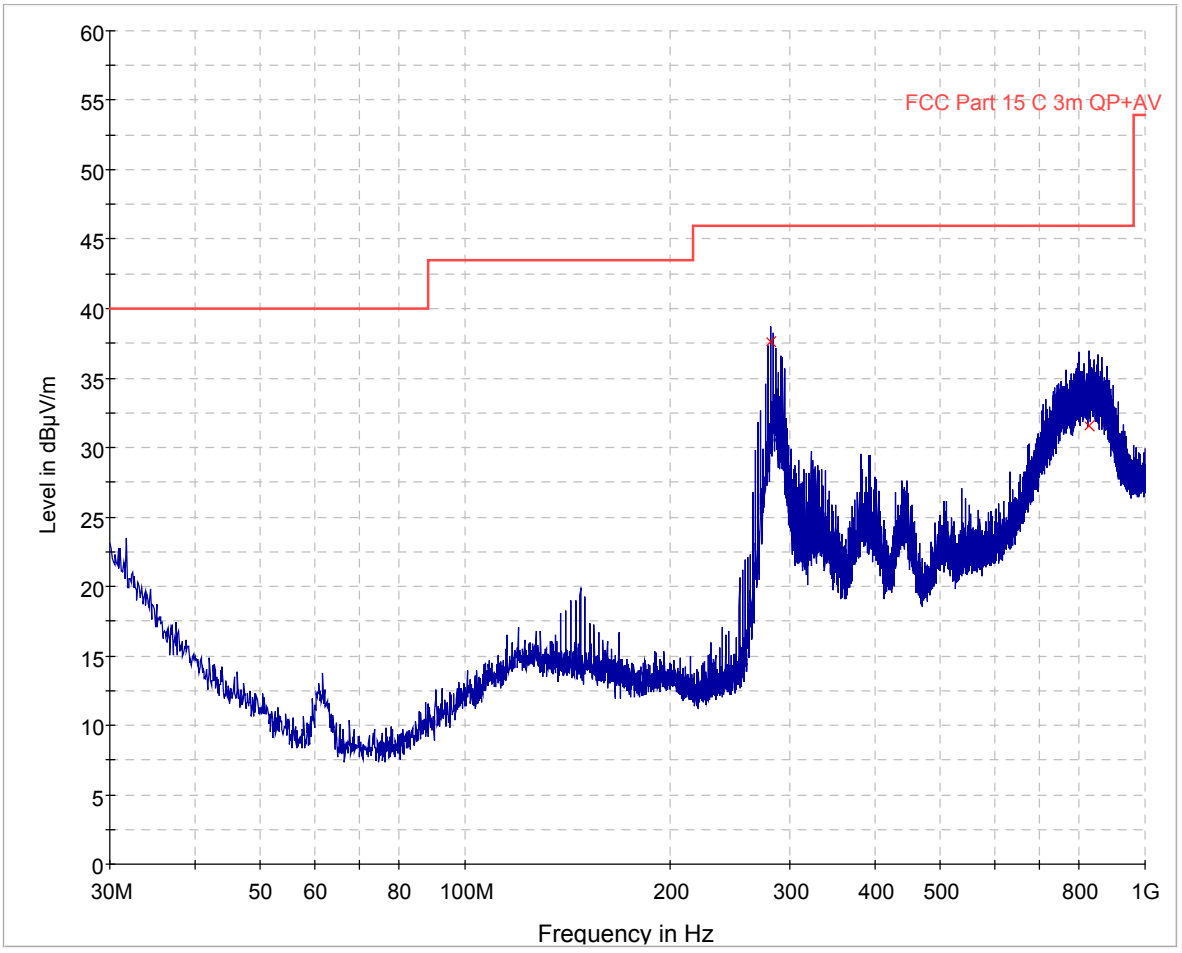
Date: 18.NOV.2013 18:22:40

Radiated Emissions, 9 kHz – 30 MHz @10m

Radiated emission 30 – 1000 MHz.
Detector: Peak
Measuring distance at 3m.
All values are below the limit even when measured with Peak Detector, RBW=100kHz, VBW=300kHz.

See attached plot.

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
281.282468	37.6	1000.0	120.000	100.0	H	112.0	-9.1	8.4	46.0	
828.380306	31.6	1000.0	120.000	100.0	H	120.0	0.7	14.4	46.0	



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

Radiated Emissions, 1-25 GHz

1-8 GHz measured at a distance of 3 m

8 - 25 GHz measured at 1m

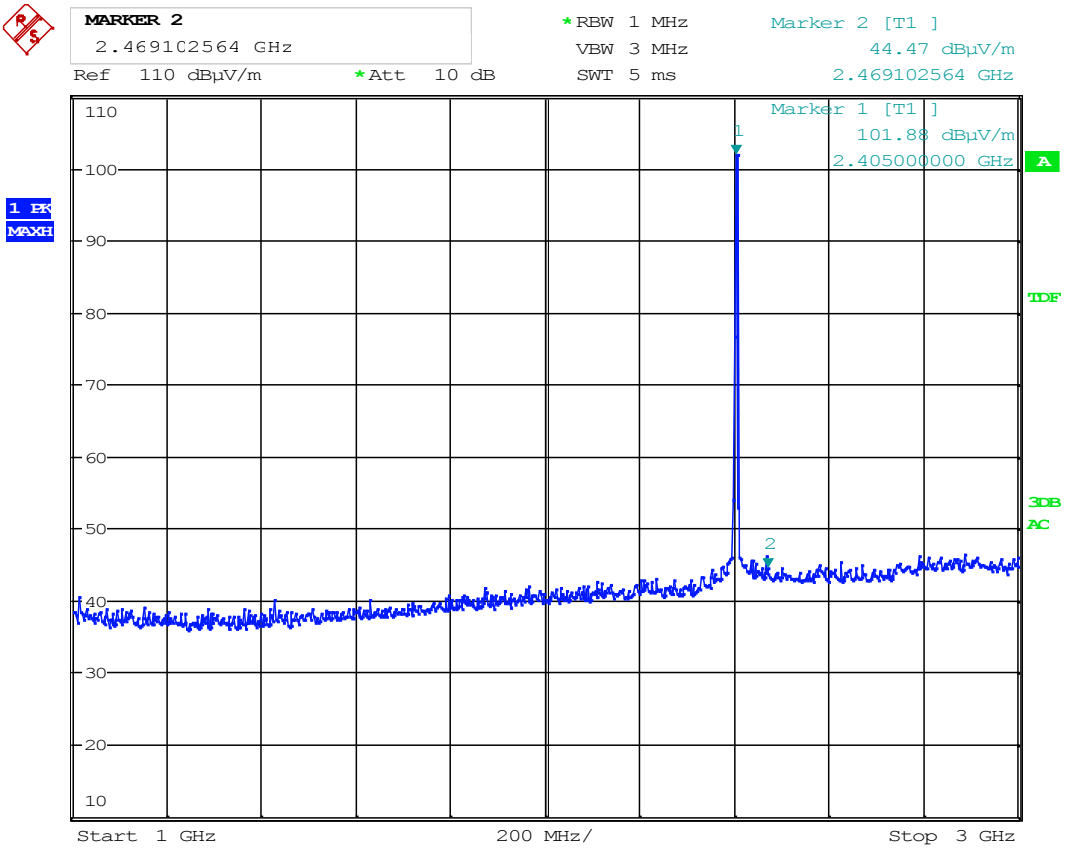
Peak detector

Frequency MHz	Field Strength @3m dBµV/m	Detector	Limit dBµV/m	Margin dB
4804	52.11	Pk	74	21.89
4880	49.94	Pk	74	24.06
4960	48.16	Pk	74	25.84

Average detector

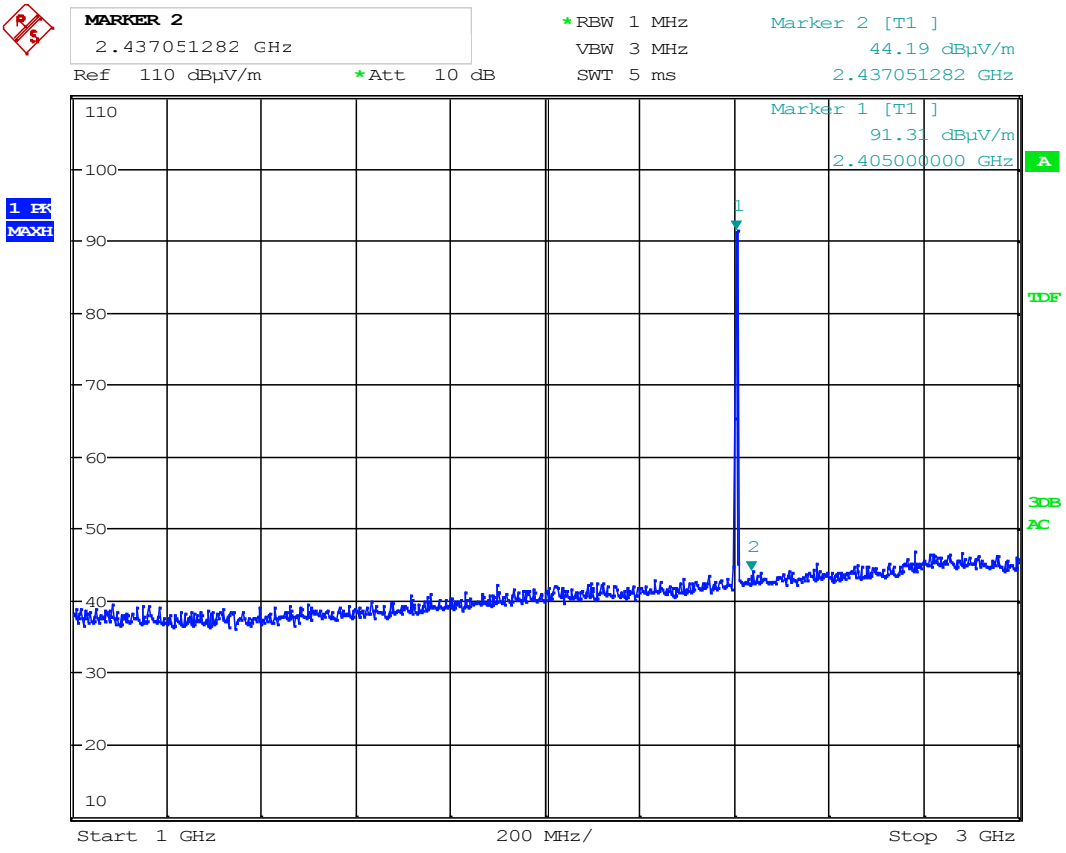
Frequency MHz	Field Strength @3m dBµV/m	Detector	Limit dBµV/m	Margin dB
4804	46.99	AV	54	1.89
4880	43.23	AV	54	4.06
4960	42.20	AV	54	5.84

Antenna factor, amplifier gain and cable loss are included in Spectrum Analyzer “Transducer factor”.
See attached graphs.



Date: 18.NOV.2013 17:24:04

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



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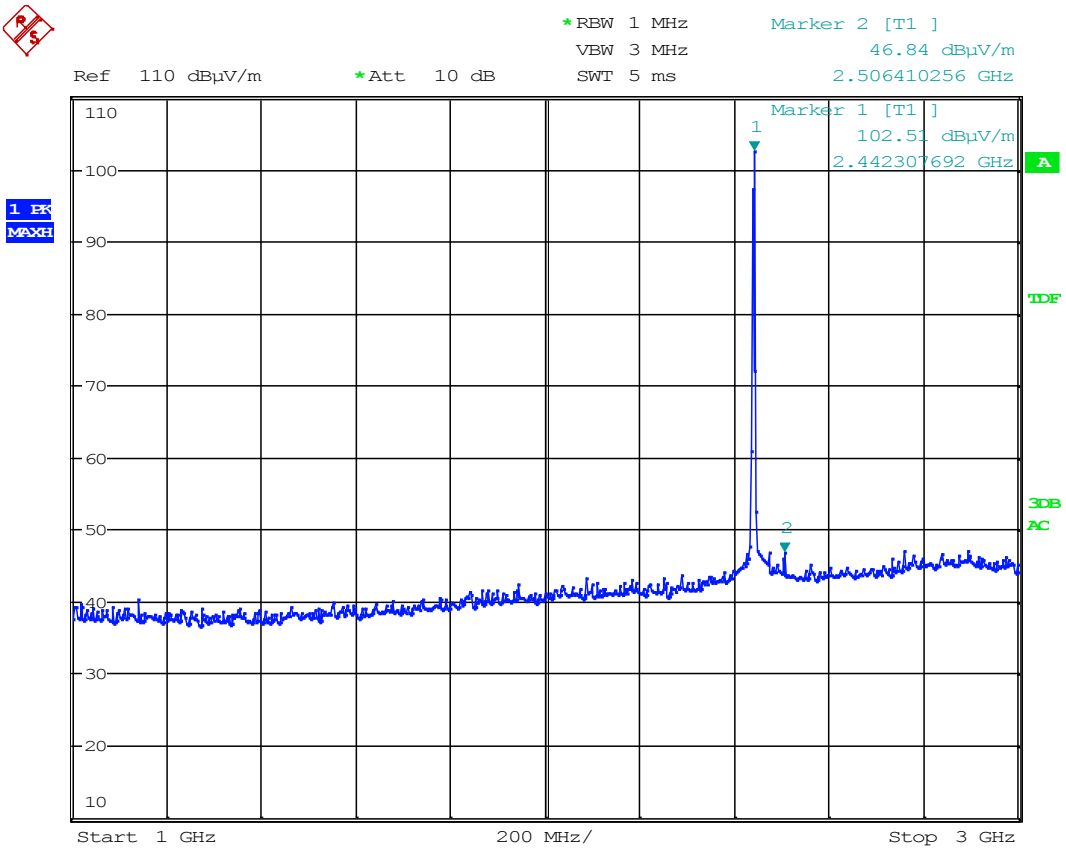
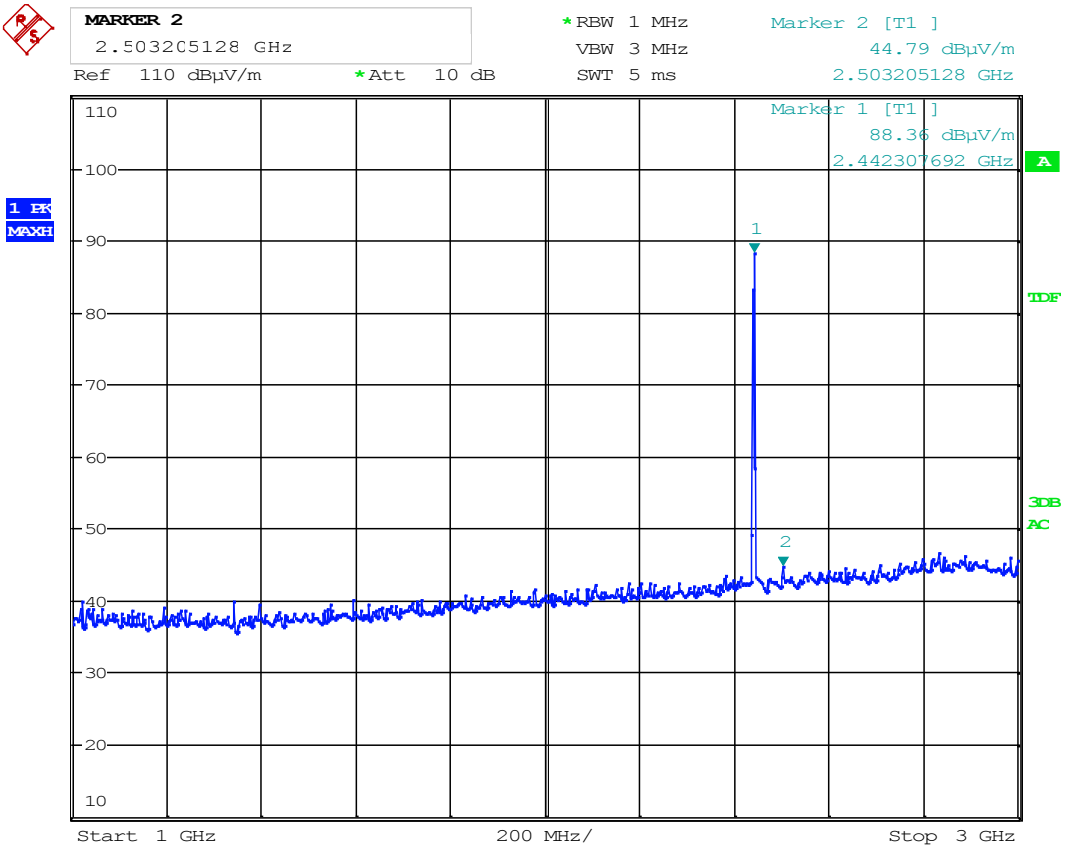
Radiated Emissions ch. 2402 MHz, 1 – 3 GHz, HP, @3m – Pre-scan with Peak detector



Date: 18.NOV.2013 16:56:48

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



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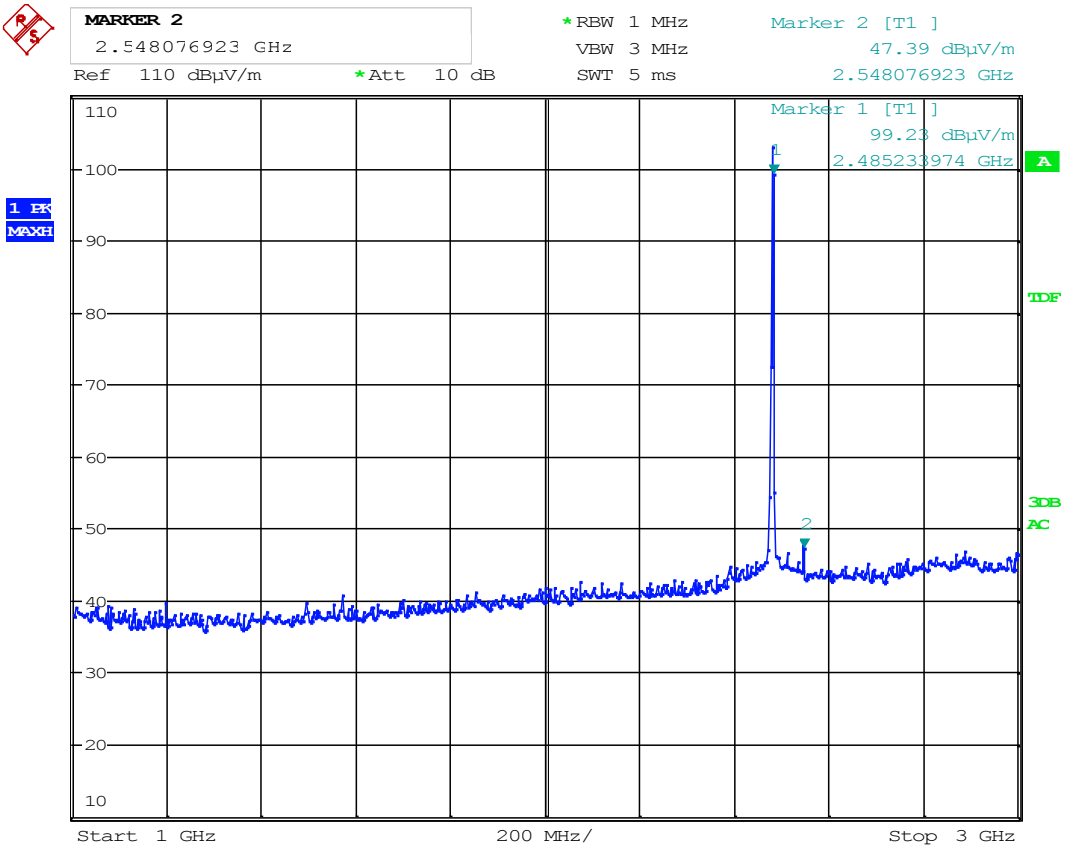
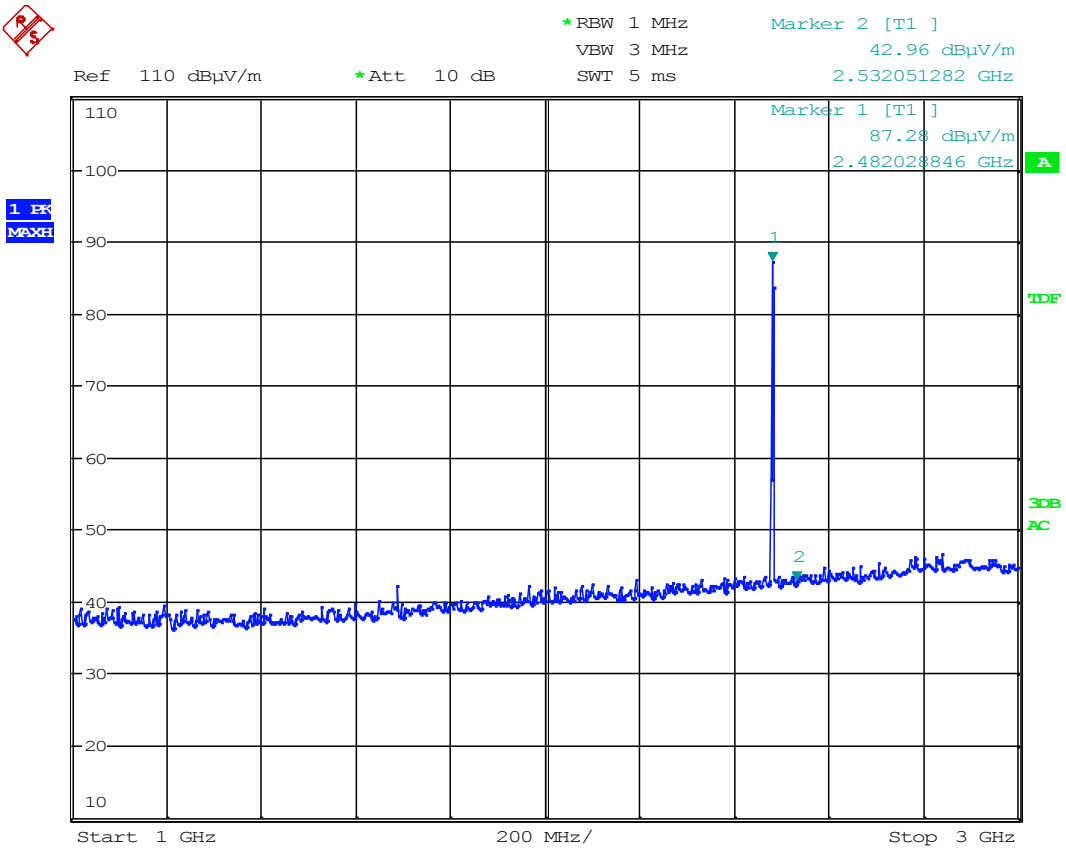
Radiated Emissions ch. 2440 MHz, 1 – 3 GHz, HP, @3m – Pre-scan with Peak detector



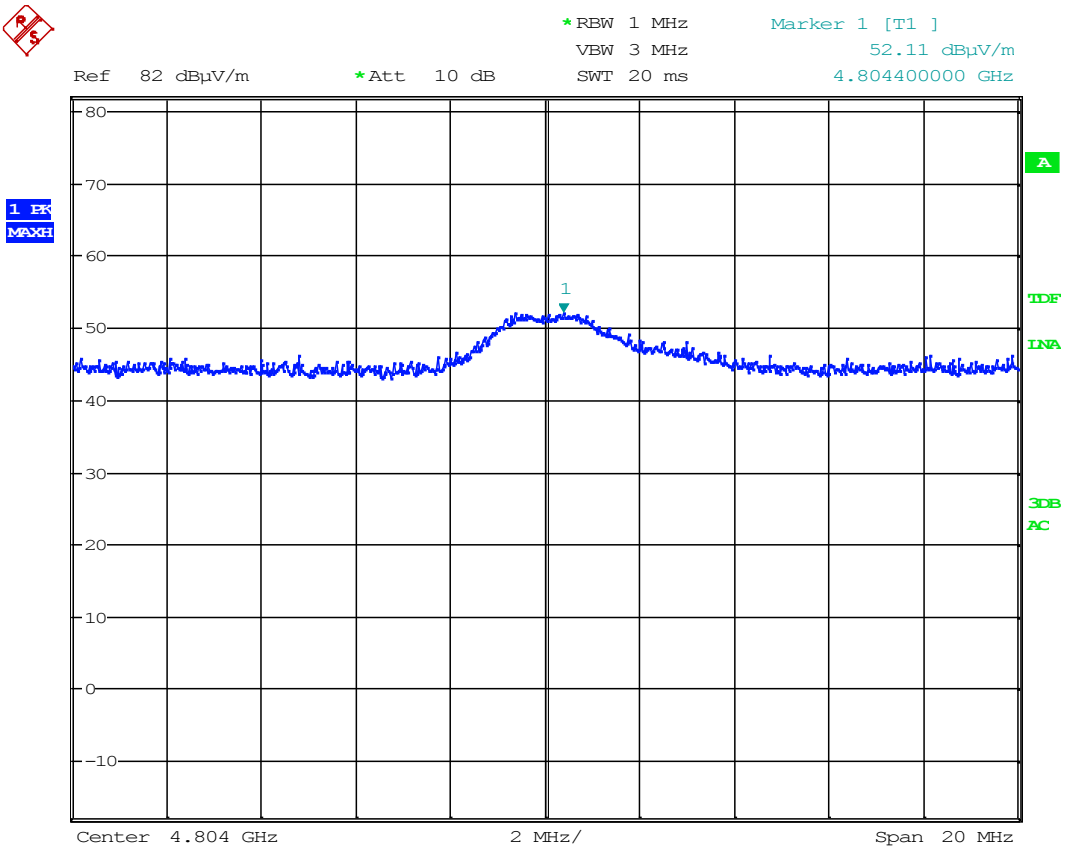
Date: 18.NOV.2013 17:15:48

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



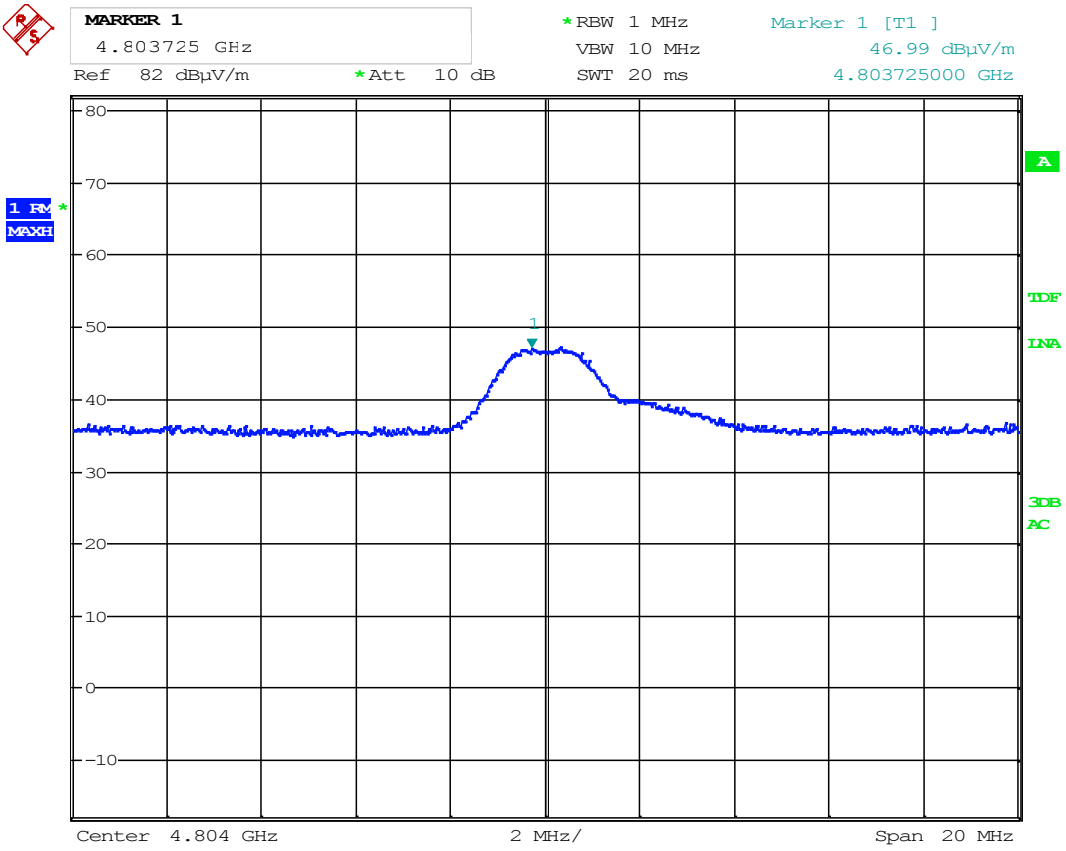
Date: 18.NOV.2013 17:17:22

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



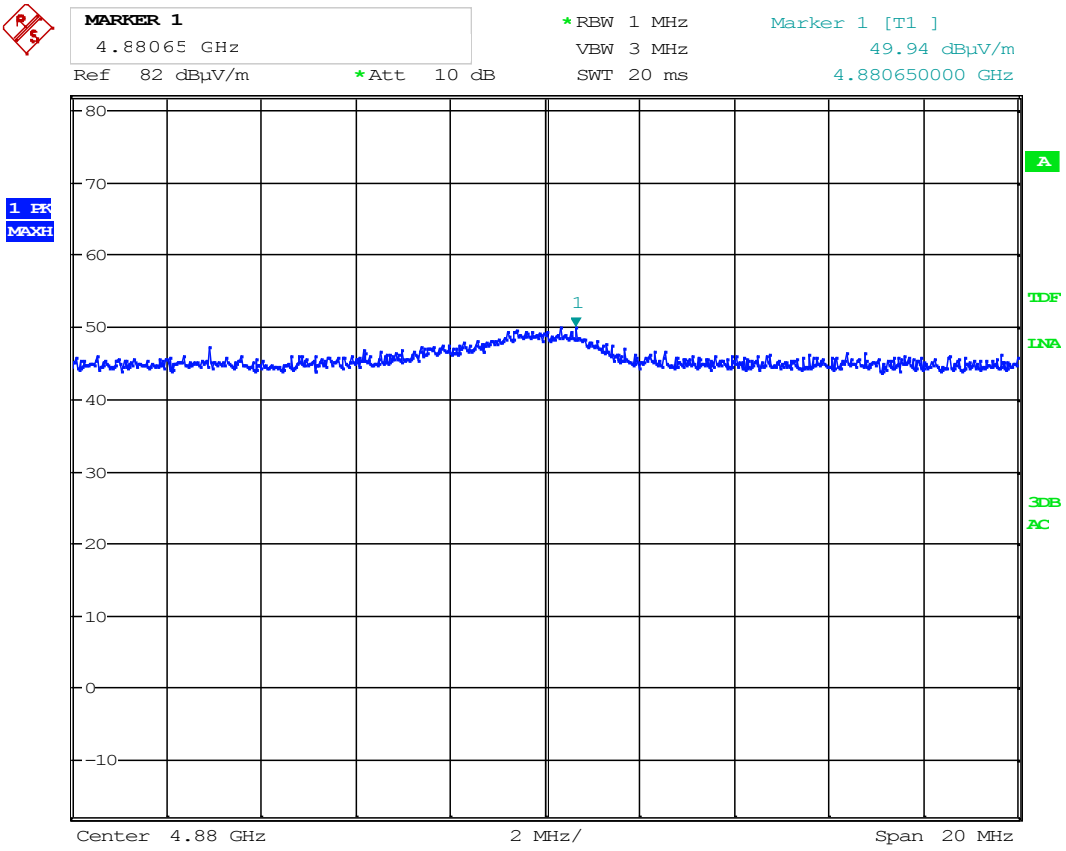
Date: 18.NOV.2013 17:39:27

2nd harmonic , ch2402MHz – VP, PK detector



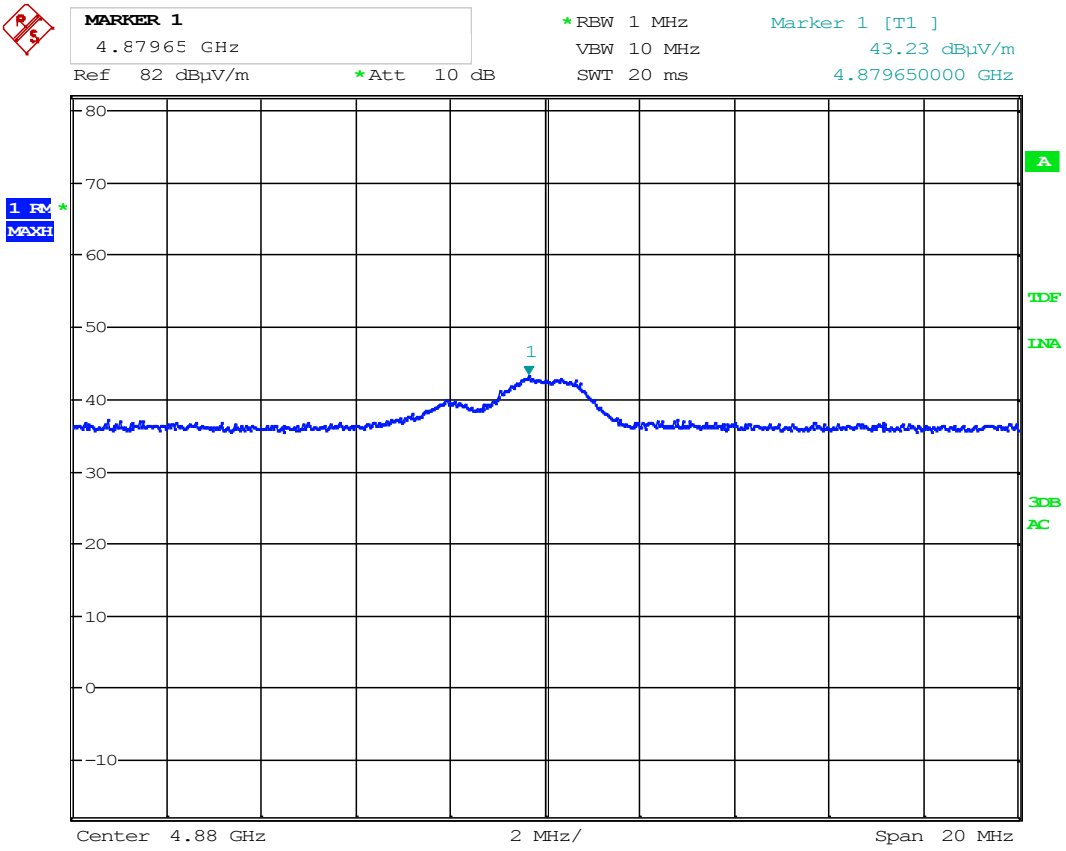
Date: 18.NOV.2013 17:39:55

2nd harmonic , ch2402MHz – VP, AV detector



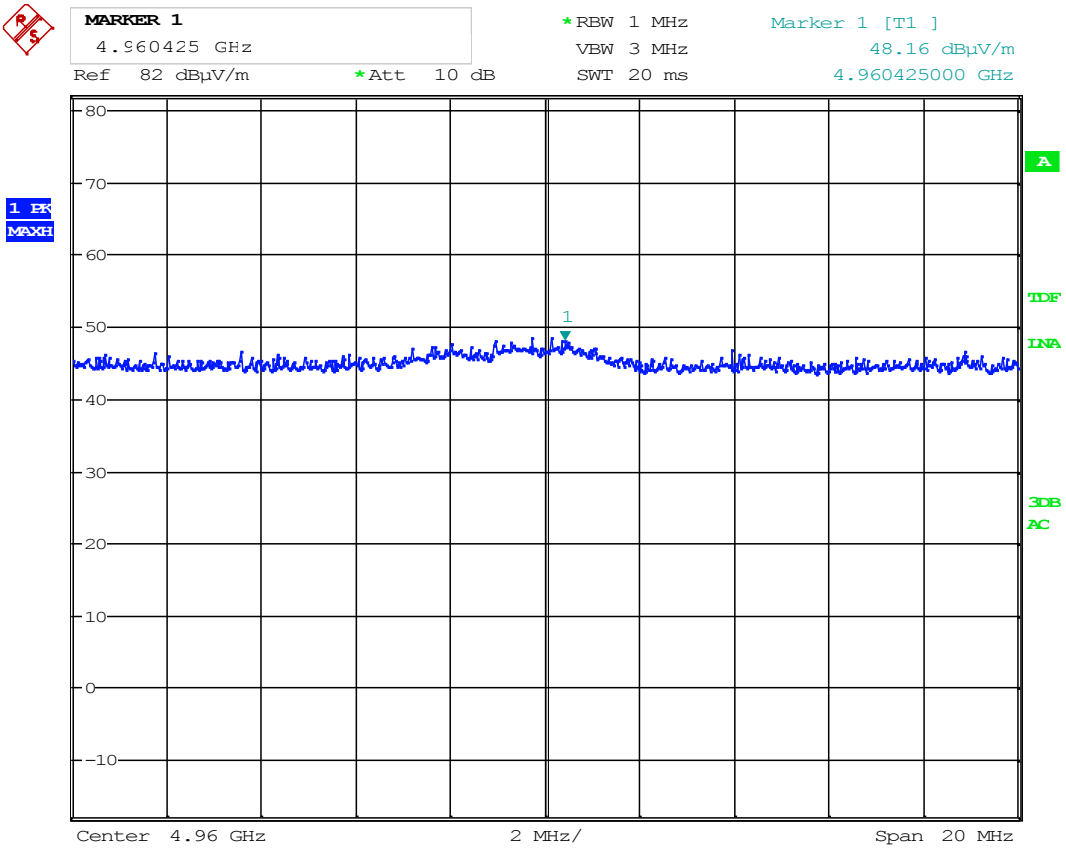
Date: 18.NOV.2013 17:43:51

2nd harmonic , ch2440MHz – VP, PK detector



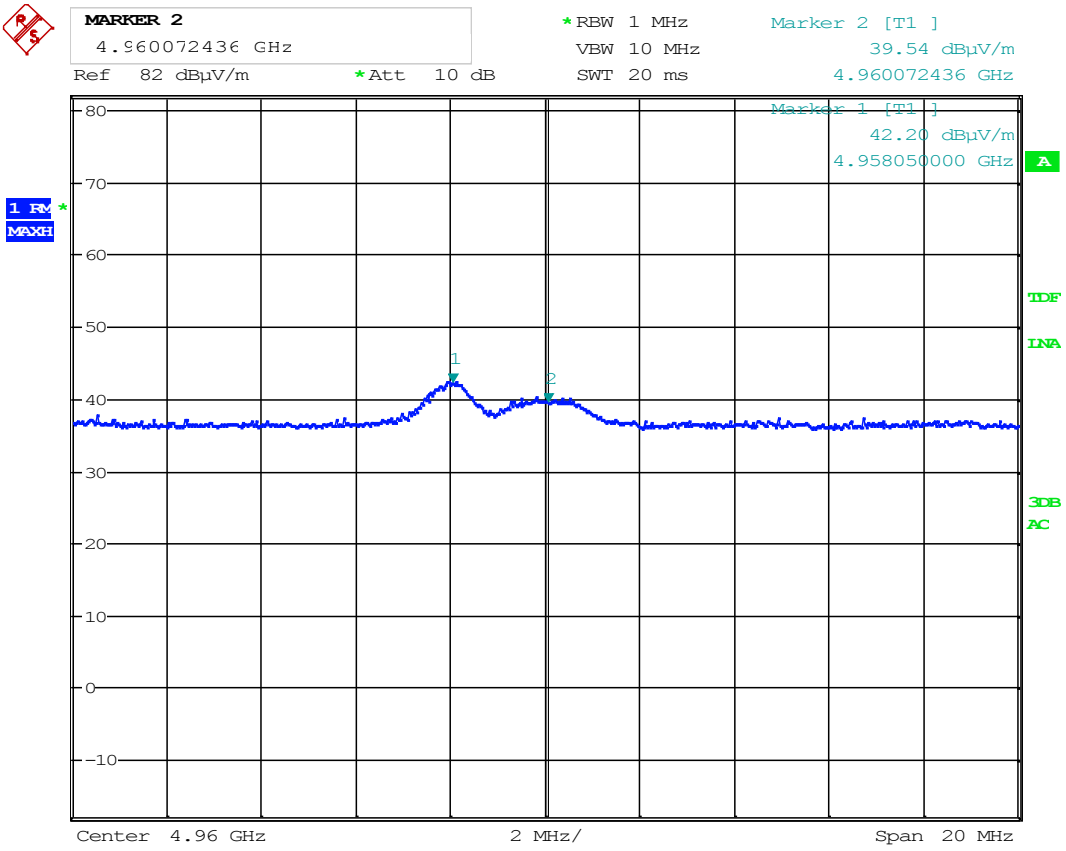
Date: 18.NOV.2013 17:44:24

2nd harmonic , ch2440MHz – VP, AV detector



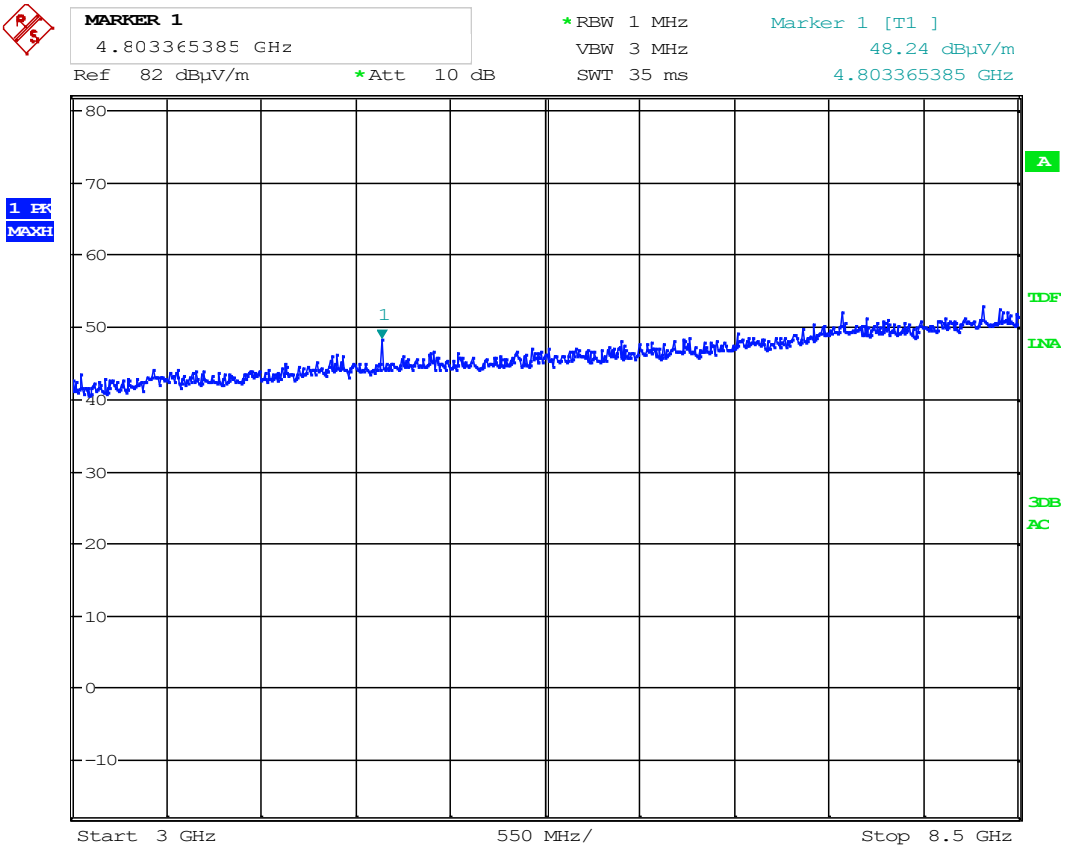
Date: 18.NOV.2013 17:47:32

2nd harmonic , ch2480MHz – VP, PK detector



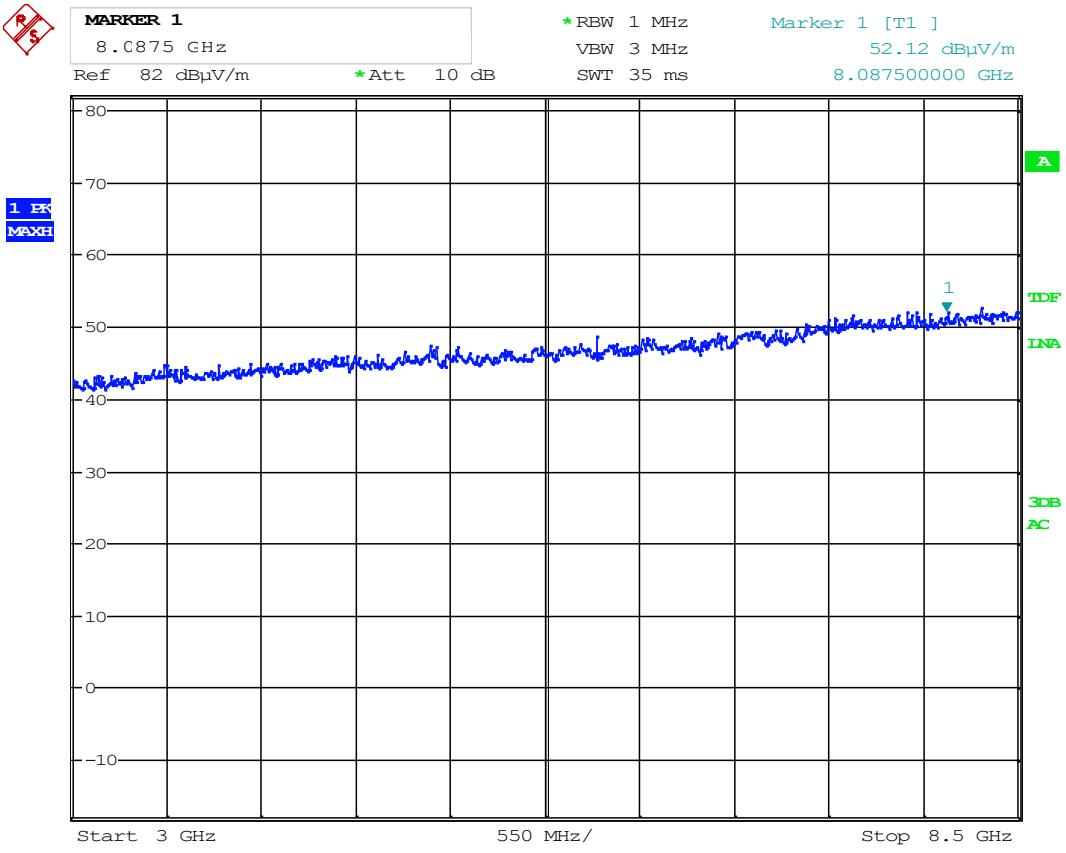
Date: 18.NOV.2013 17:49:06

2nd harmonic , ch2480MHz – VP, AV detector



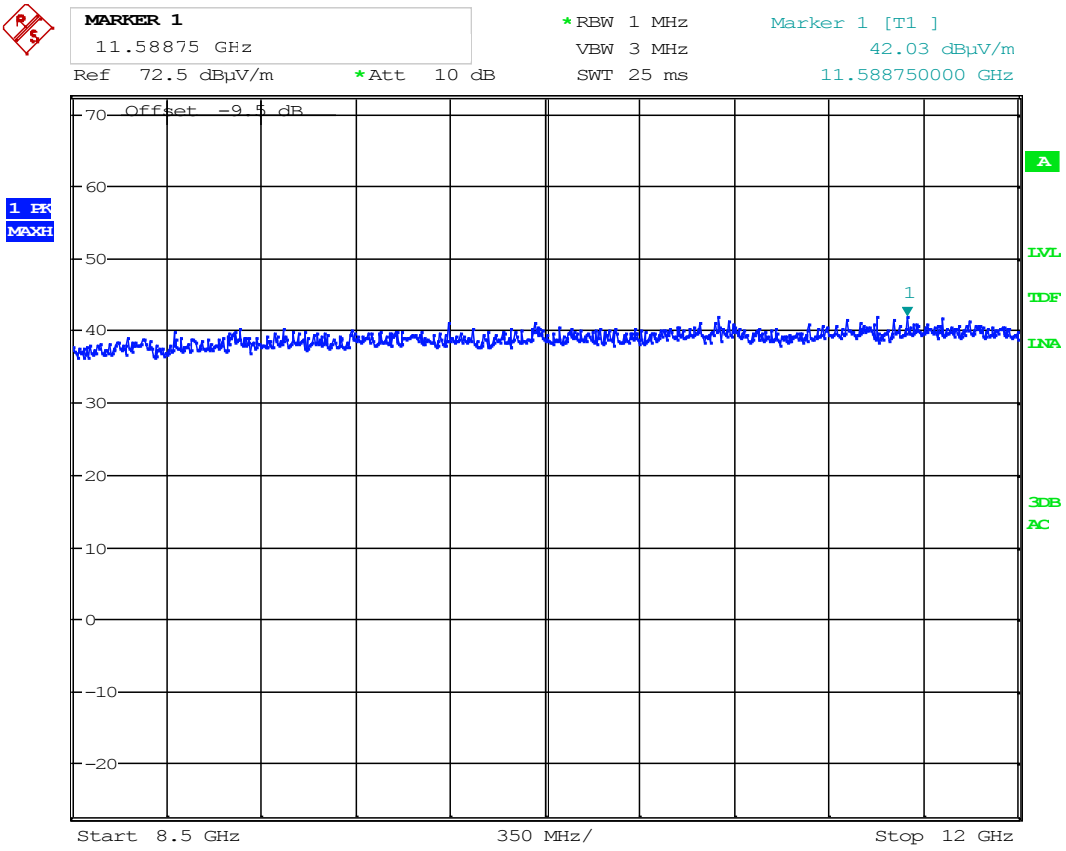
Date: 18.NOV.2013 17:33:03

Radiated Emissions ch. 2402 MHz, 3 – 8.5 GHz, VP, @3m – Pre-scan with Peak detector



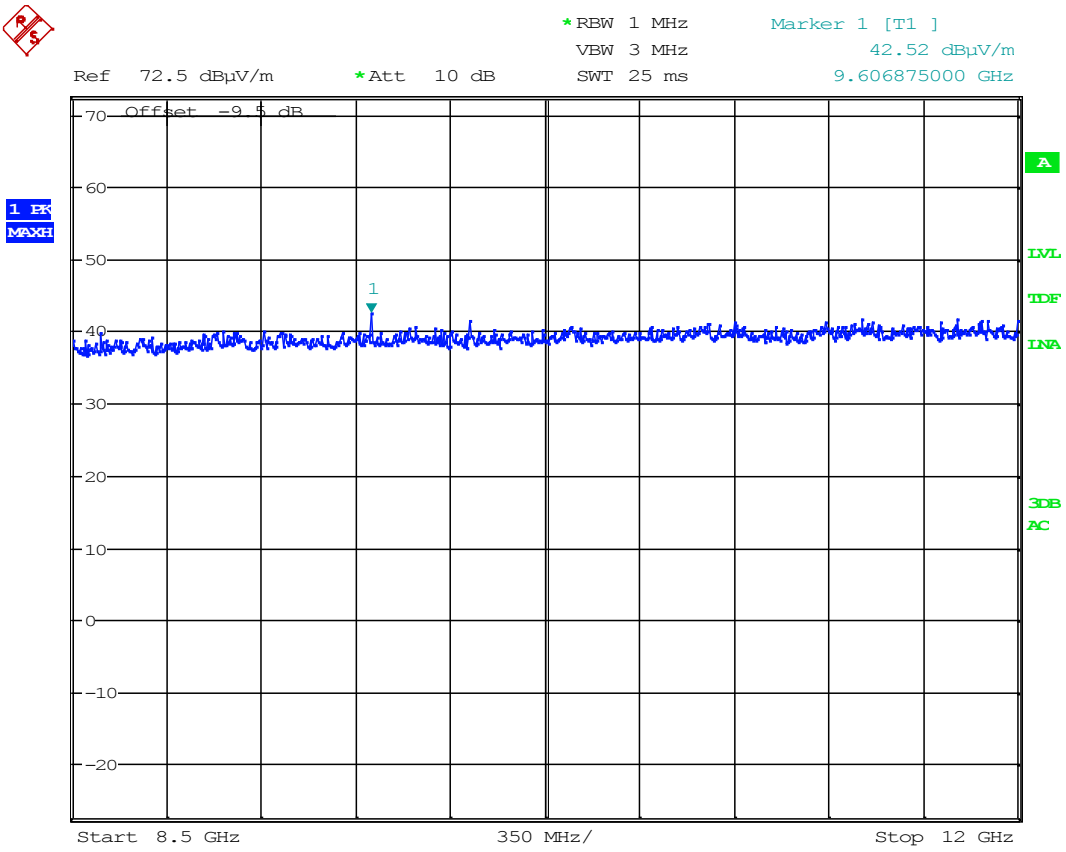
Date: 18.NOV.2013 17:31:11

Radiated Emissions ch. 2402 MHz, 3 – 8.5 GHz, HP, @3m – Pre-scan with Peak detector



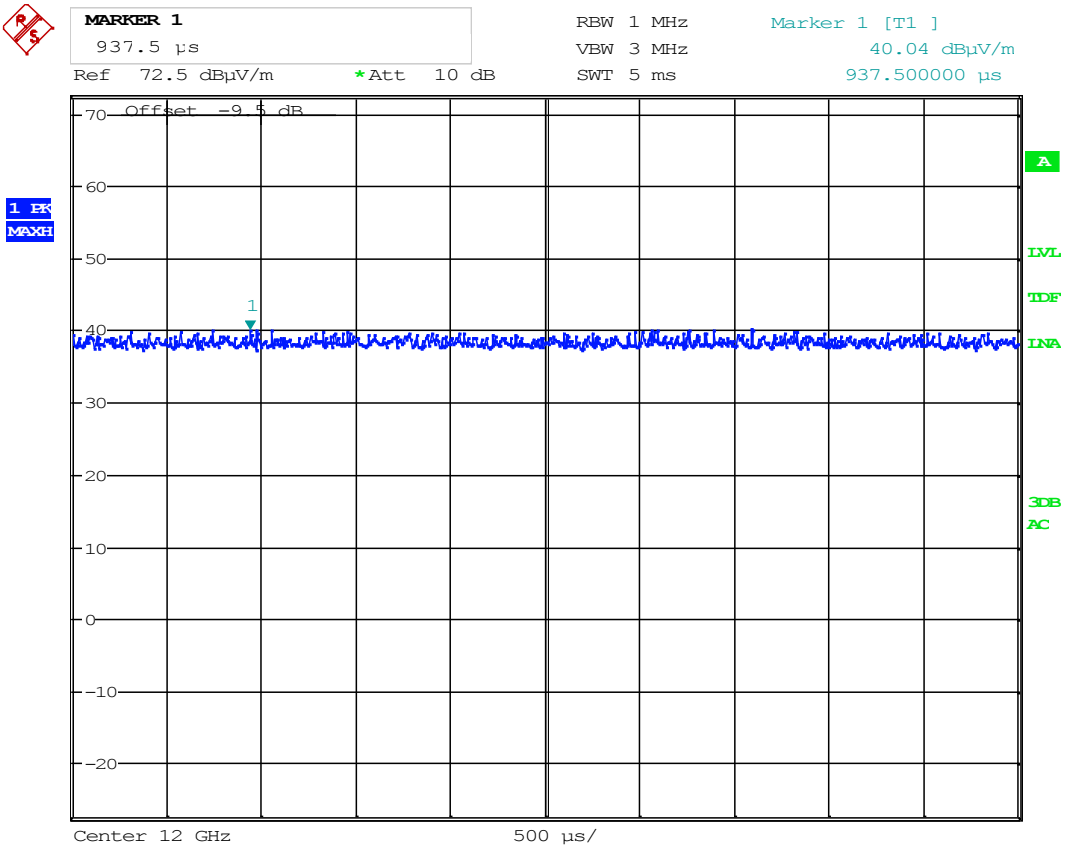
Date: 18.NOV.2013 17:57:44

Radiated Emissions ch. 2402 MHz, 8.5 – 12 GHz, VP, @1m – Pre-scan with Peak detector , Distance Correction factor of -9.5 dB is included in the graph



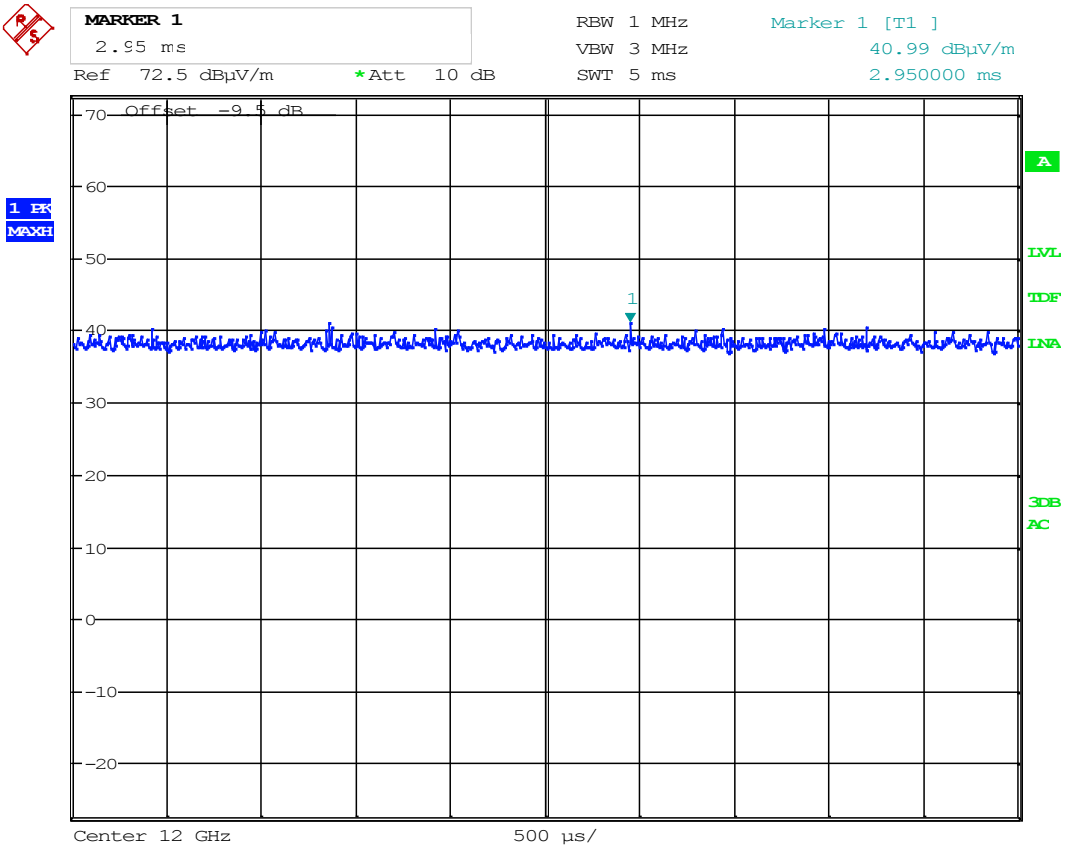
Date: 18.NOV.2013 17:57:19

Radiated Emissions ch. 2402 MHz, 8.5 – 12 GHz, HP, @1m – Pre-scan with Peak detector , Distance Correction factor of -9.5 dB is included in the graph.



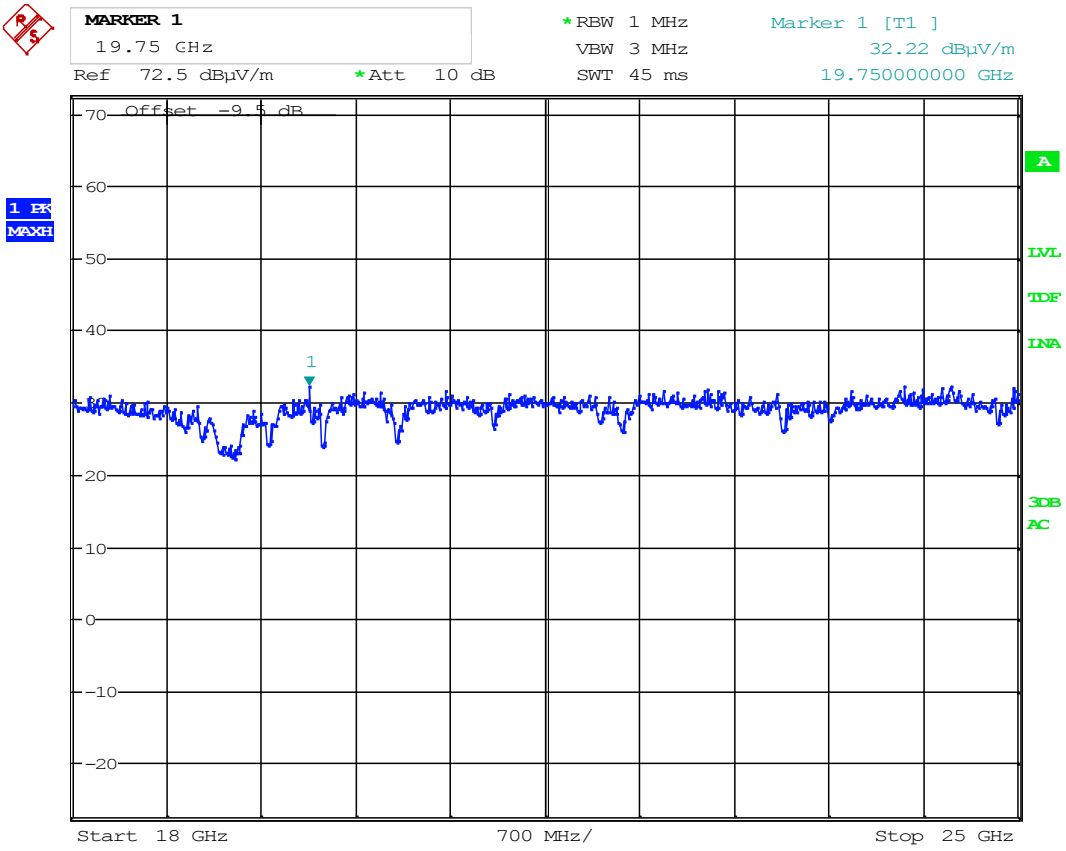
Date: 18.NOV.2013 18:03:52

Radiated Emissions ch. 2402 MHz, 12 – 18 GHz, VP, @1m – Pre-scan with Peak detector, Distance Correction factor of -9.5 dB is included in the graph.



Date: 18.NOV.2013 18:04:18

Radiated Emissions ch. 2402 MHz, 12 – 18 GHz, HP, @1m – Pre-scan with Peak detector, Distance Correction factor of -9.5dB is included in the graph.



Date: 18.NOV.2013 18:05:31

Radiated Emissions ch. 2402 MHz, 18 – 25 GHz, VP/HP, Pre-scan with Peak detector, Distance Correction factor -9.5dB is not included in the graph.

3.6 Power Spectral Density (PSD)

Para. No.: 15.247 (e)

Test Performed By: G.Suhanthakumar	**Date of Test: 18 Nov 2013**

Test Results: Complies

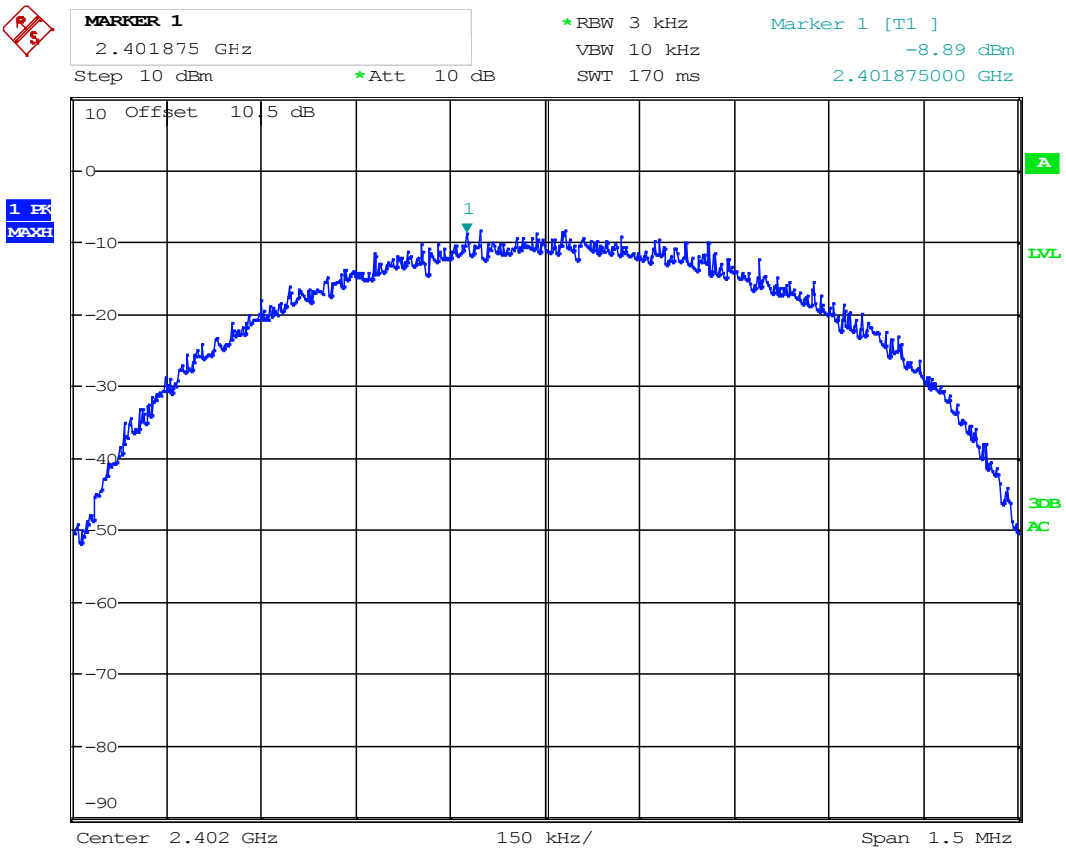
Measured and Calculated Data:

	calculated peak PSD dBm
Power Spectral Density @2405 MHz	-8.89
Power Spectral Density @2440 MHz	-9.15
Power Spectral Density @2480 MHz	-9.16

Tested according to KDB 558074 D01 DTS Meas Guidance v03r01, Section 10.2.

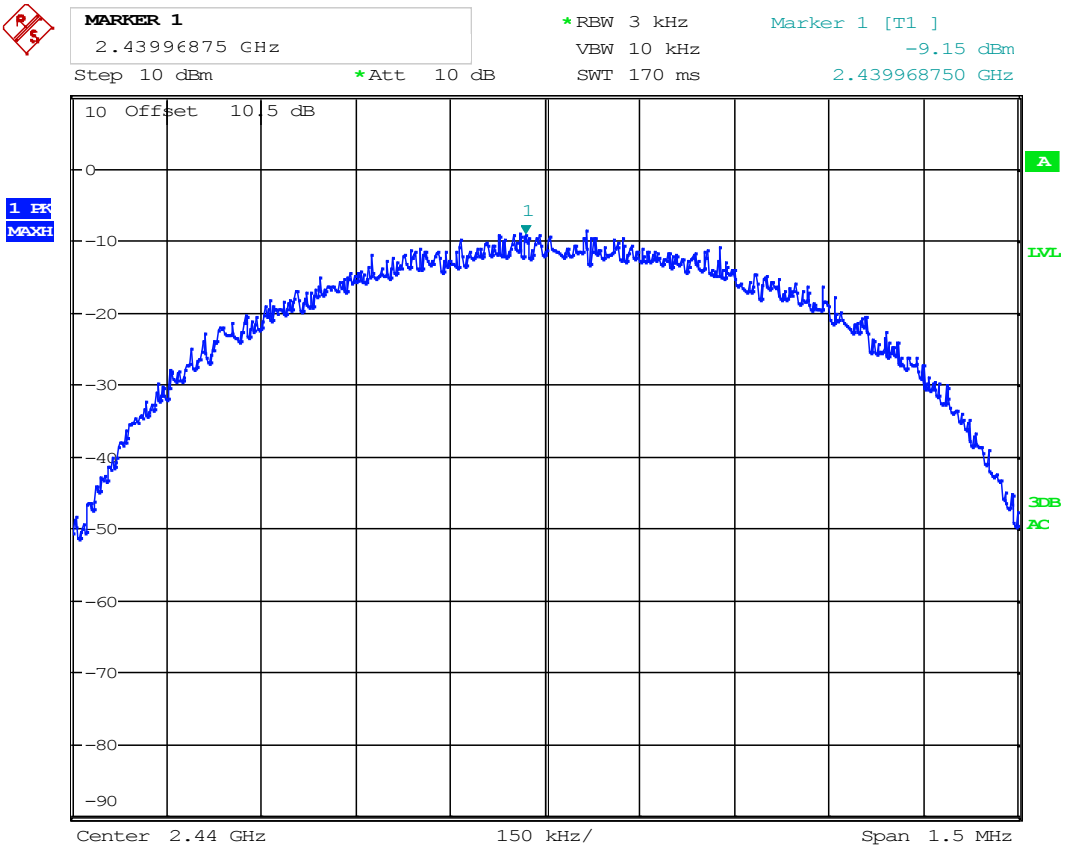
Requirements:

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



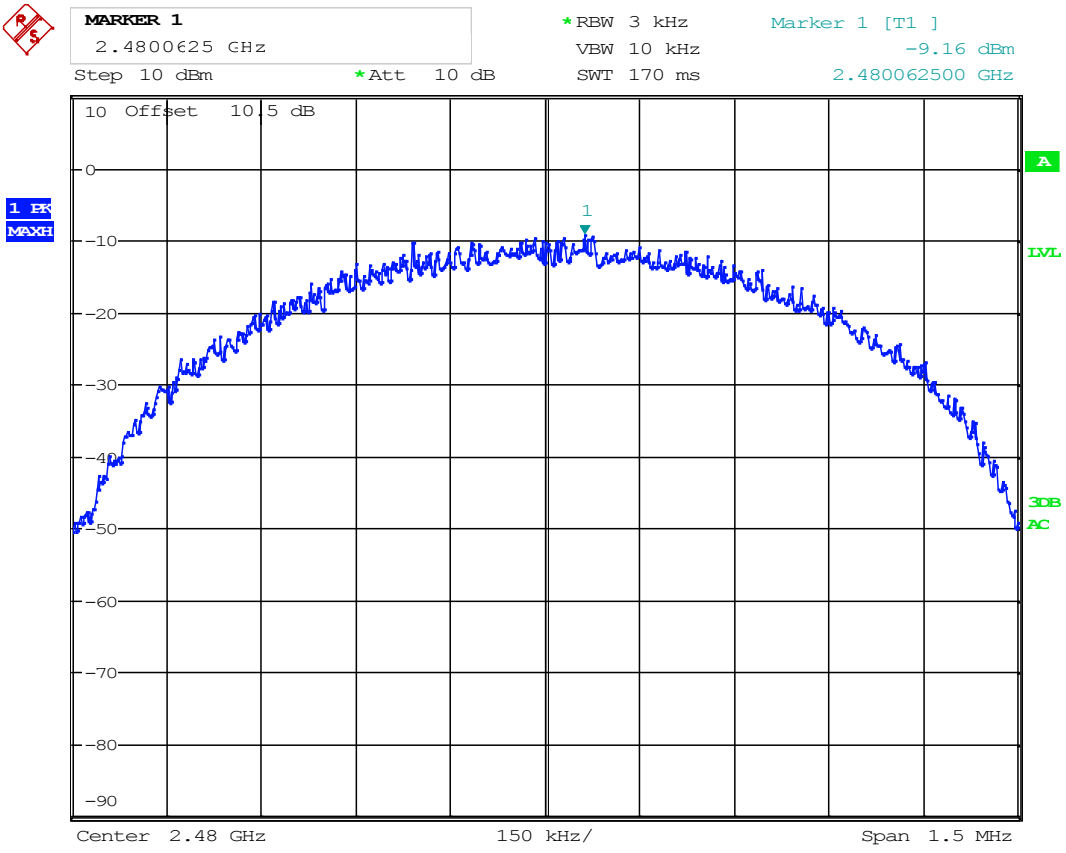
Date: 18.NOV.2013 18:46:01

PSD Measurement - 2402MHz



Date: 18.NOV.2013 18:46:27

PSD Measurement – 2440MHz



Date: 18.NOV.2013 18:46:47

PSD Measurement - 2480MHz

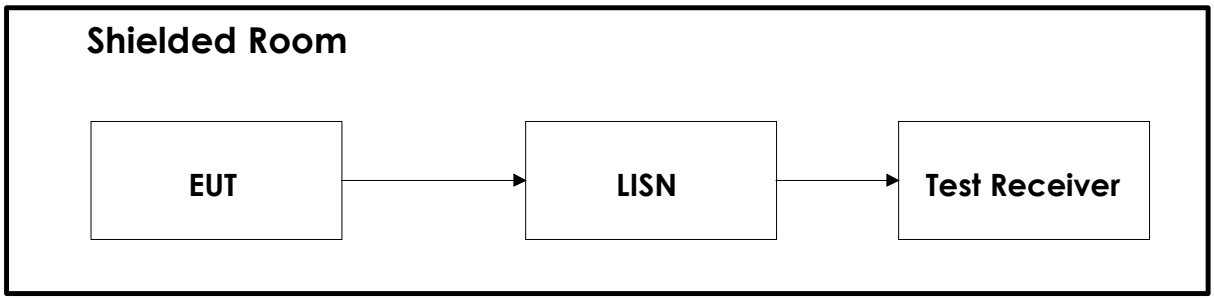
4 LIST OF TEST EQUIPMENT

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	FSU26	Spectrum Analyzer	Rohde & Schwarz	LR 1504	2011.11	2013.11
2	ESU40	EMI Receiver	Rohde & Schwarz	LR1639	2013.09.24	2014.09.24
3	3115	Antenna horn	EMCO	LR 1330	2010.08.05	2015.08.05
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	JB3	BiLog Antenna	Sunol Sciences	N-4525	2011.09.07	2014.09.07
10	8449B	Pre-amplifier	Hewlett Packard	LR 1322	2013.09.27	2014.09.27
11	LNA6900	Pre-amplifier	Teseq	LR 1593	2013.11	2014.11
14	80S	Signal Generator	Powertron	LT 502	Cal b4 use	
15	Model 87 V	Multimeter	Fluke	LR 1598	2012-12-14	2014-12-14
17	6810.17A	10 attenuator	Suhner	LR 1143	2012.09.15	2014.09.15
18	FA210A1010003030	Microwave cable	Rosenberger	LR1566	Cal b4 use	
19	6HC 3000-18000	HP Filter	Trithlic	LR1614	Cal b4 use	
20	6HC 2500-18000	HP Filter	Trithlic	LR1615	Cal b4 use	
21	FSW	Spectrum Analyzer	Rohde & Schwarz	LR1640	2012.06	2014.06

5 BLOCK DIAGRAM

5.1 Power Line Conducted Emission



5.2 Test Site Radiated Emission