Test report no. : 227631- 3

Item tested : CC2541ARC

Type of equipment : 2.4 GHz Transceiver

FCC ID : ZAT2541ARC

Client : Texas Instruments Norway AS

FCC Part 15.247
Digital Transmission System

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

28 January 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:	60

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 :	ZAT2541ARC
IC :	451H-2541ARC
Model/version :	CC2541ARC
Serial number :	-
Hardware identity and/or version:	-
Software identity and/or version :	-
Frequency Range :	2402 – 2480 MHz
Number of Channels :	40
Type of Modulation :	GFSK
Conducted Output power:	1.15 mW (Peak)
User Frequency Adjustment :	None
Type of Power Supply :	4.5 V_{DC} (three AAA LR03 1.5 V_{DC} batteries)
Antenna Connector :	PCB antenna
Antenna Diversity Supported :	No
Desktop Charger :	None

Description of Test Item

The CC2541ARC 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 4.5 V DC (3 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:	2012-12-05
Test period :	from 2012-12-26 and 2013-01-28

3 TEST REPORT SUMMARY

3.1 General

Manufacturer: Texas Instruments

Model No.: CC2541ARC

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 #: 227631-3

TESTED BY: _____ DATE: 2013-01-28

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	7.1.4 (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: -**

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

Test Results: **-**

Measurement Data: **-**

4.2 Minimum 6 dB Bandwidth

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

Test Performed By: G.Suhanthakumar	Date of Test: 27 Dec 2012

Test Results: Complies

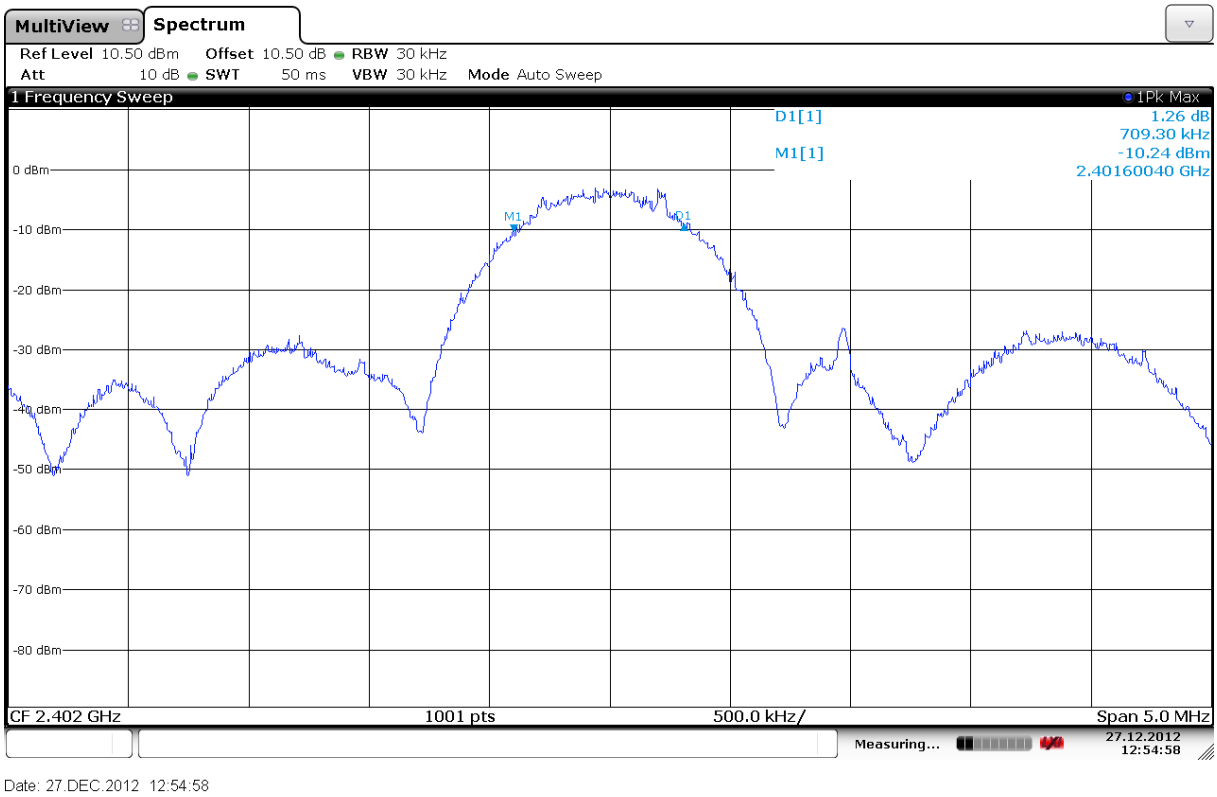
Measurement Data:

Measured 6 dB Bandwidth (kHz)		
2402MHz	**2440 MHz**	**2480MHz**
709.3	704.3	699.3

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

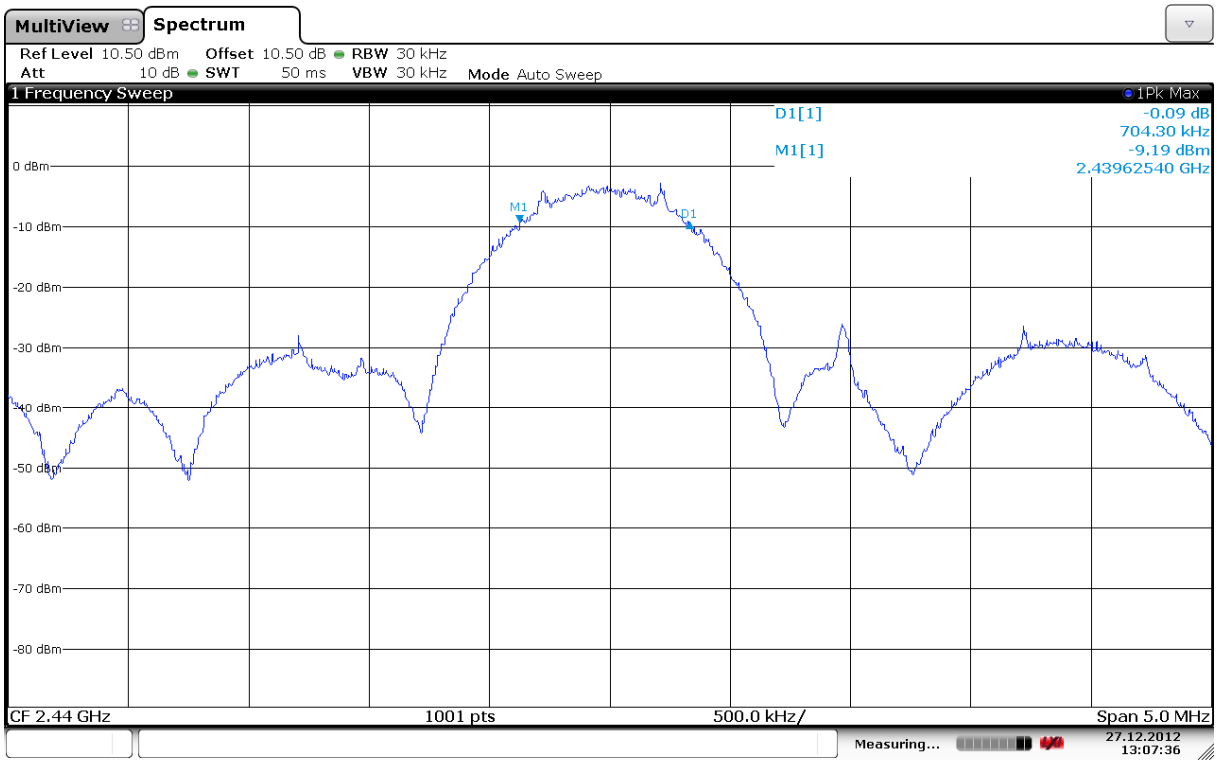
Requirements:

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



Date: 27.DEC.2012 12:54:58

6 dB Bandwidth at 2402 MHz



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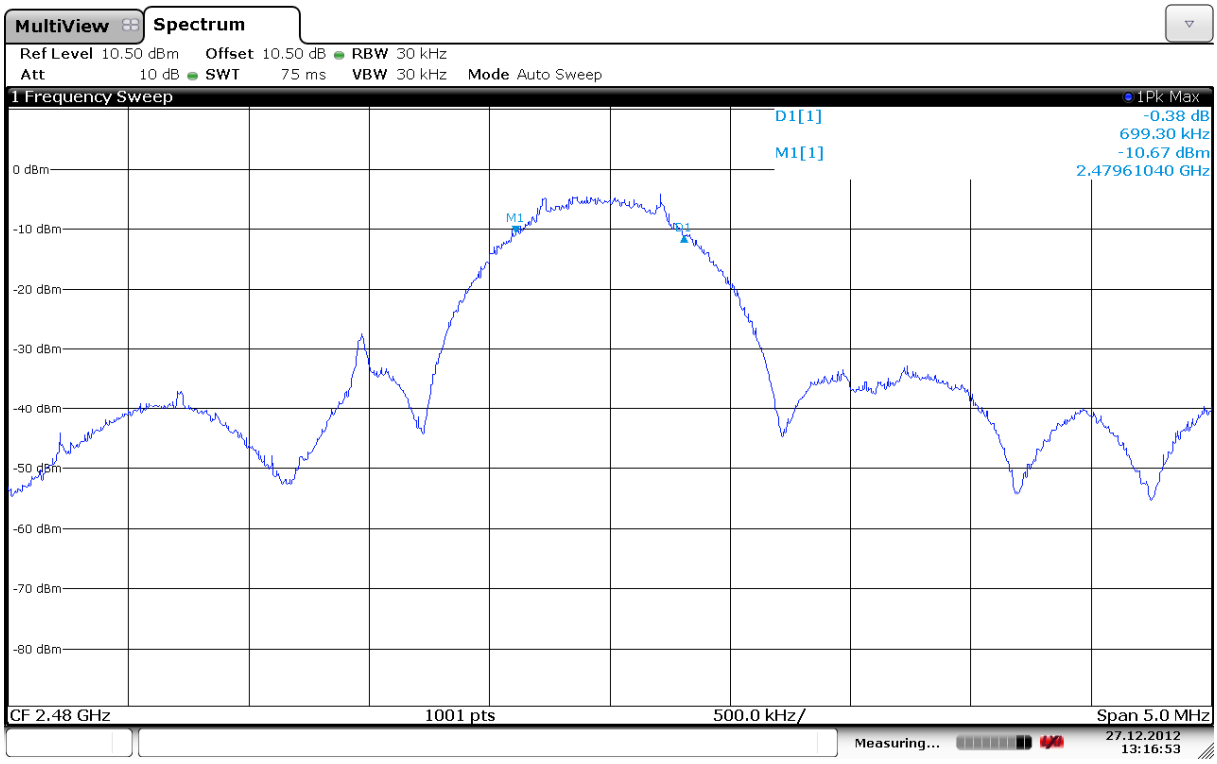
6 dB Bandwidth at 2440 MHz



Date: 27.DEC.2012 13:16:53

6 dB Bandwidth at 2480 MHz

4.3 20 dB Bandwidth

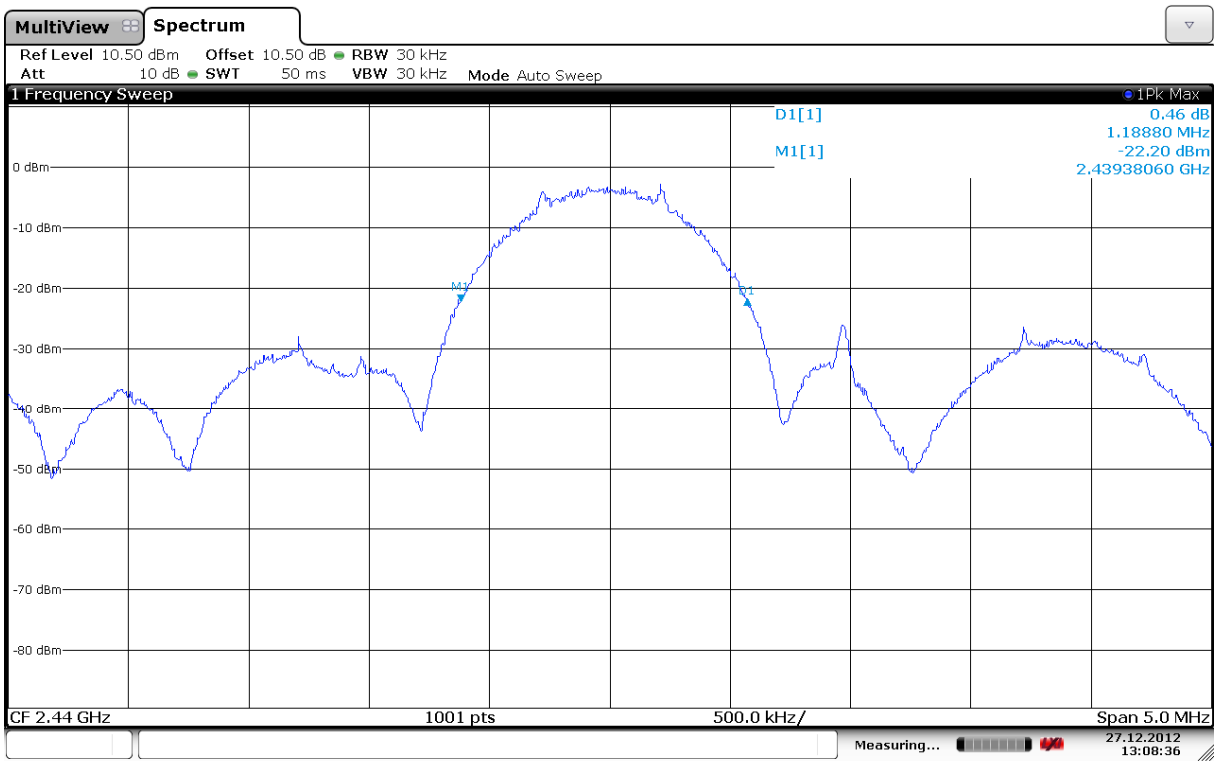
Test Performed By: G.Suhanthakumar	Date of Test: 27 Dec. 2012

Measurement Data:

Measured 20 dB Bandwidth (MHz)
2440 MHz
1.19

Requirements:

No requirements. Reported for information only.



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20 dB Bandwidth at 2440 MHz

4.4 Peak Power Output

Para. No.: 15.247 (b)

Test Performed By: G.Suhanthakumar	**Date of Test: 27 Dec 2012**

Test Results: Complies

Measurement Data:

RF channel	**2402 MHz**	**2440 MHz**	**2480 MHz**
Measured Conducted Power (dBm)	0.6	-0.5	0.0
Measured Maxium Field strength (dBµV/m) –HP	96.6	97.0	97.1
Calc. Radiated Power (dBm)	1.3	1.8	1.9
Calc. Antenna Gain (dBi)	0.7	2.3	1.9

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

The maximum field strength is obtained in XY 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

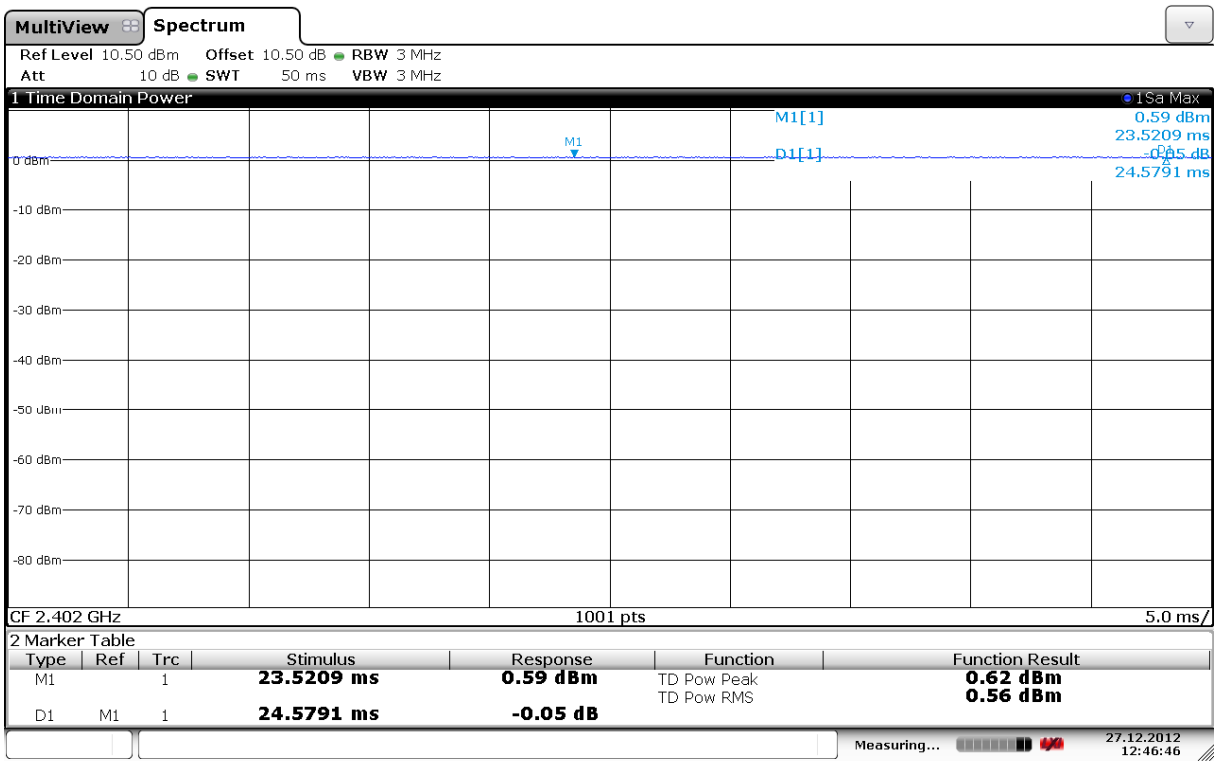
If detachable, is the antenna connector non-standard? ☐ Yes ☐ No

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.



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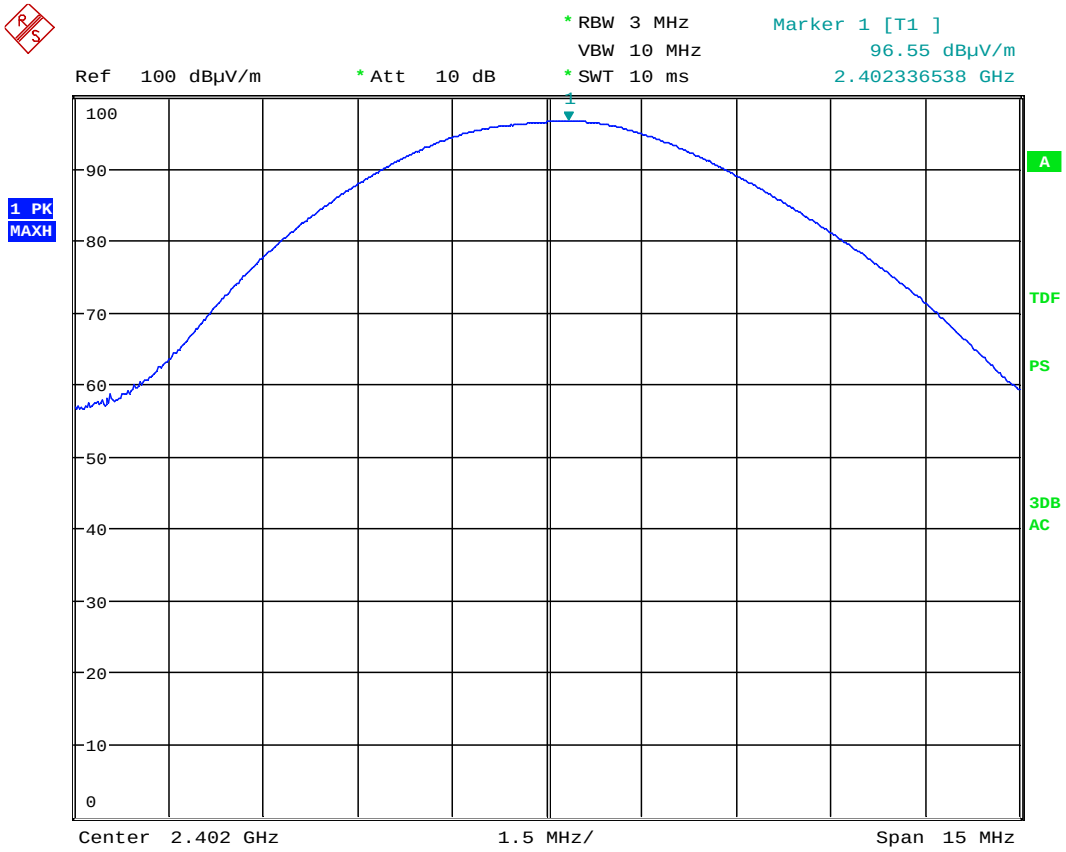
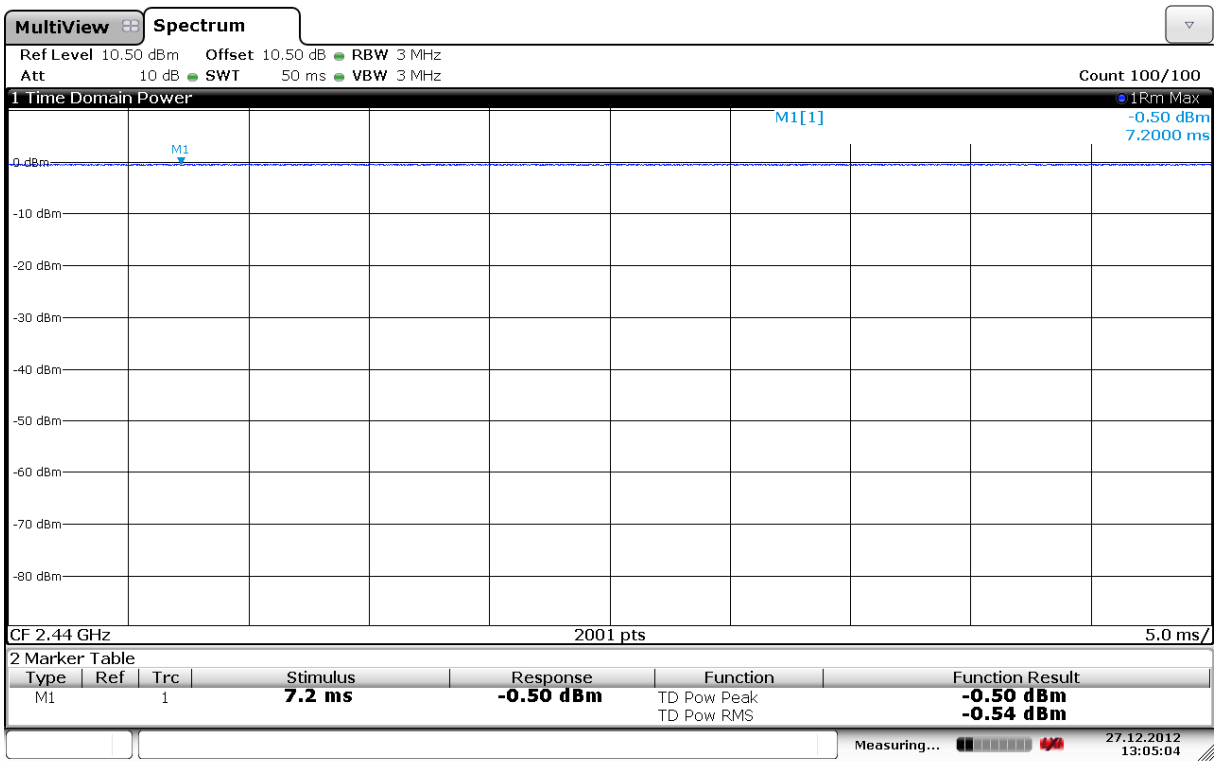
Conducted Power, 2402 MHz- Peak detector



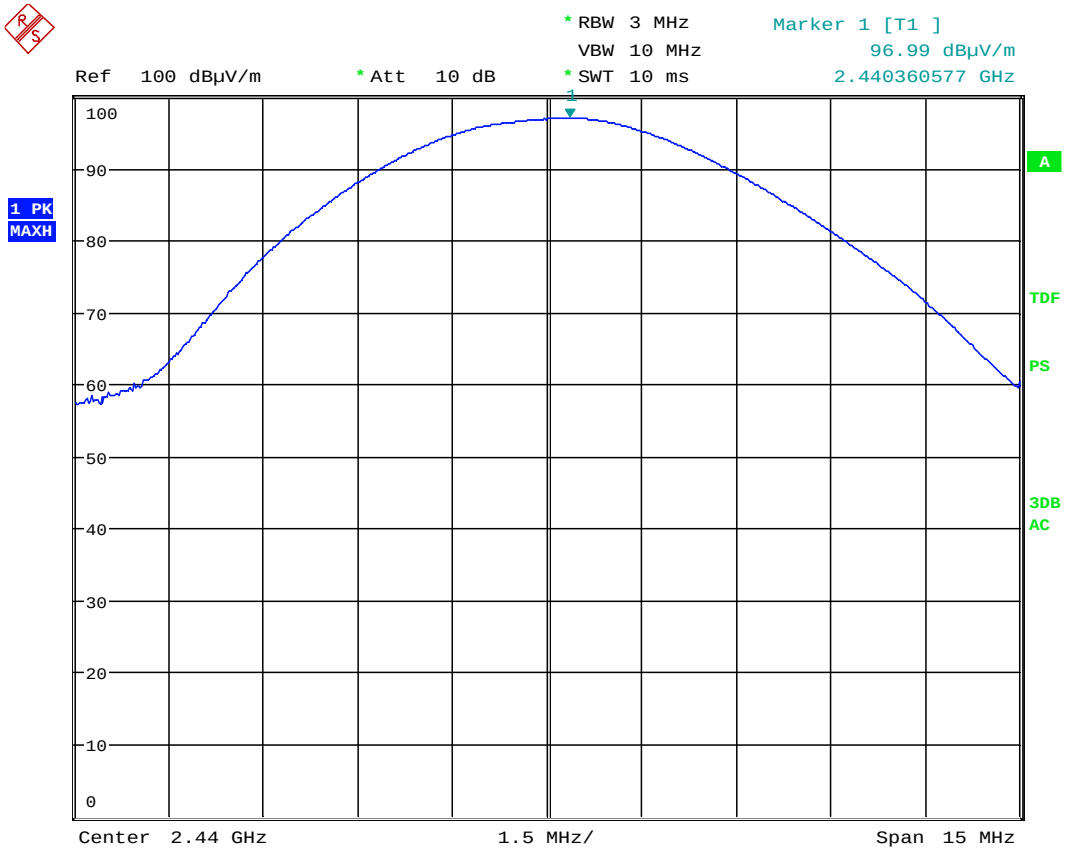
Date: 26.DEC.2012 09:56:53

Radiated Field strength, HP , 2402 MHz



Date: 27.DEC.2012 13:05:03

Conducted Power, 2440 MHz- Peak detector



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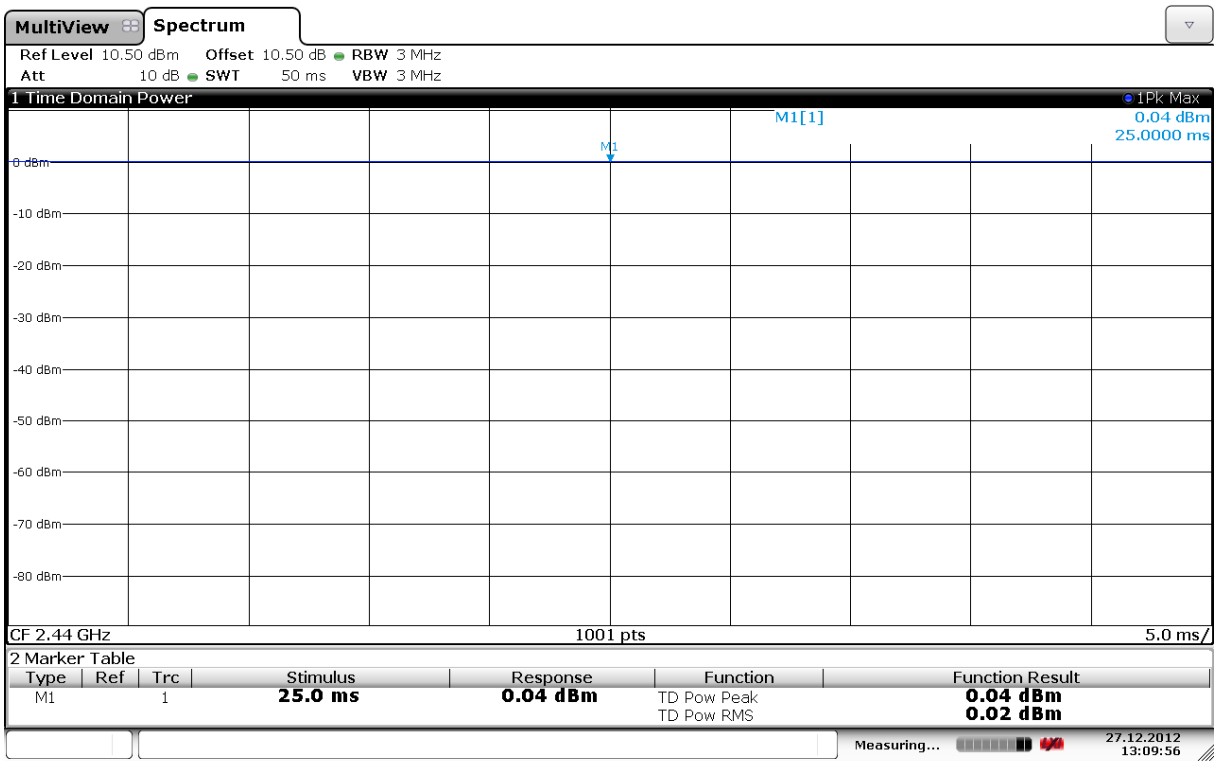
Radiated field strength, HP, 2440 MHz



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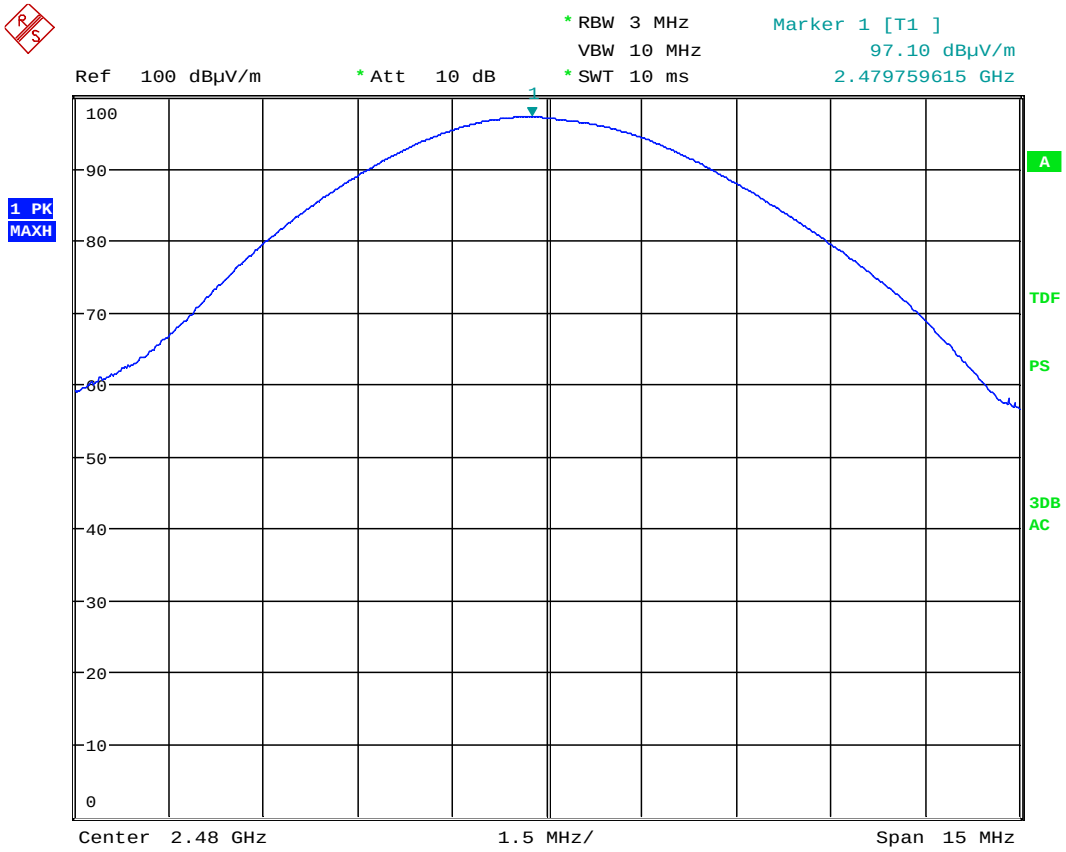
Conducted Power, 2480 MHz – Peak detector



Date: 26.DEC.2012 09:49:06

Radiated field strength, HP, 2480 MHz

4.5 Spurious Emissions (Radiated)

Para. No.: 15.247 (c)

Test Performed By: G.Suhanthakumar	**Date of Test: 27 Dec 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	38.3	PK	74	35.7
	33.2	AV	54	20.8
2.4835 GHz	61.3	PK	74	12.7
	53.1	AV	54	0.9

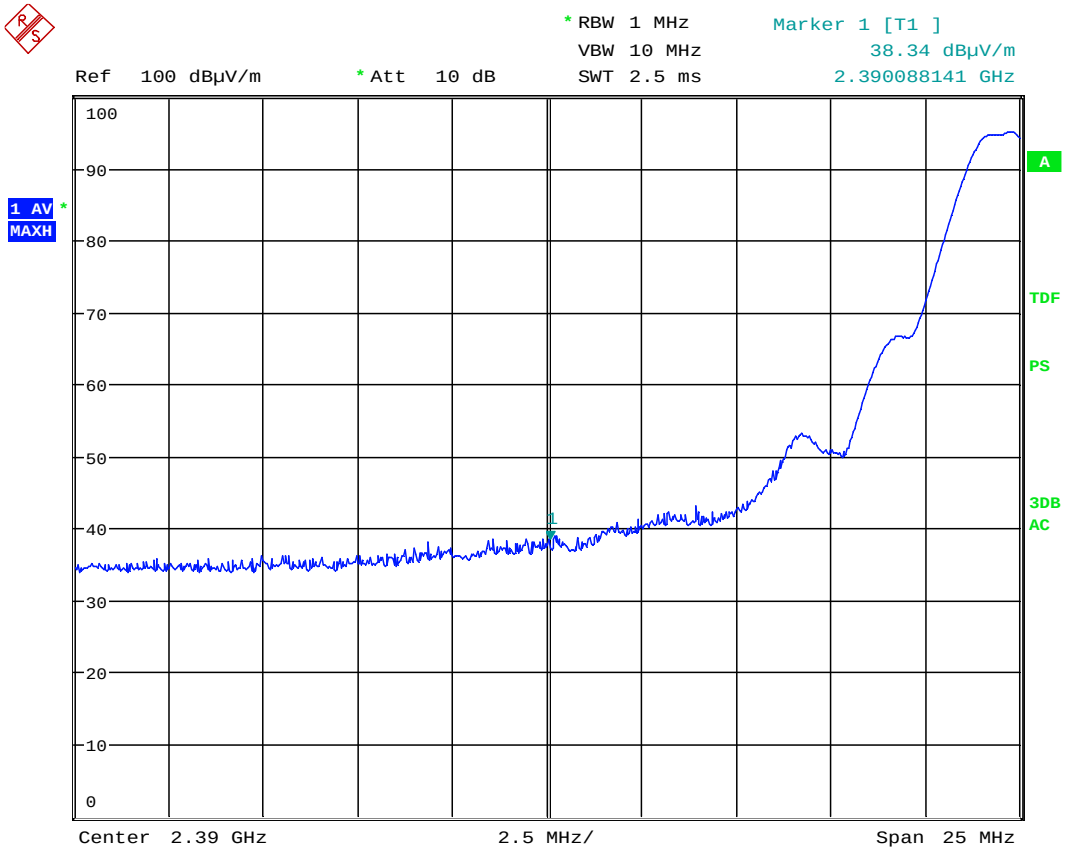
See attached plots.

RF conducted power

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

All emissions are more than 20dB below carrier.

See attached plots.



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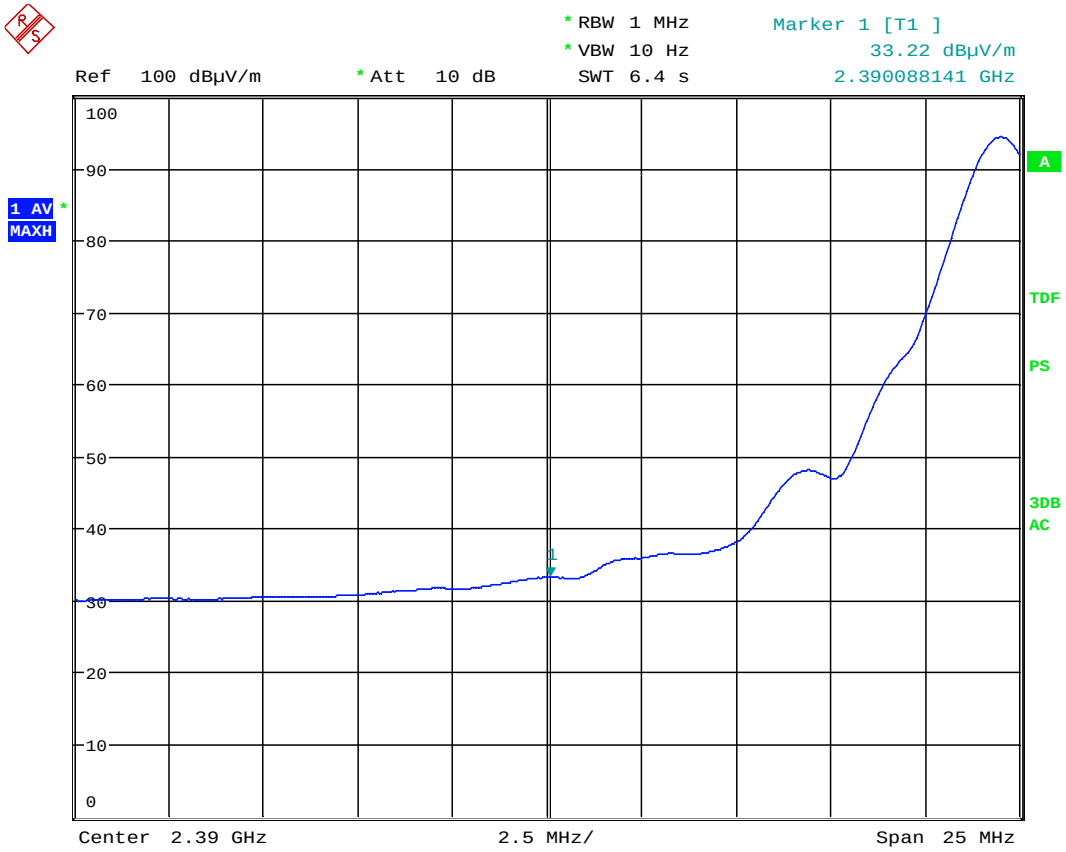
Band Edge, 2390 MHz, Peak Detector



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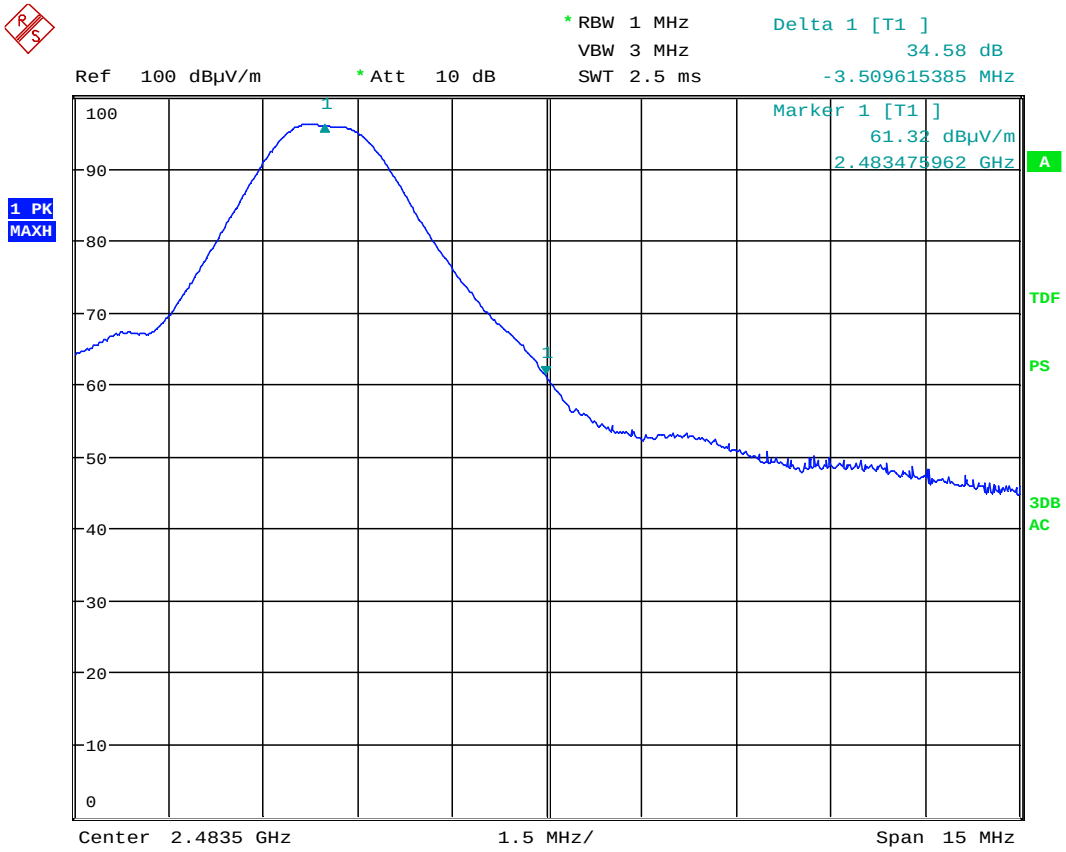
Band Edge, 2390 MHz, AV Detector



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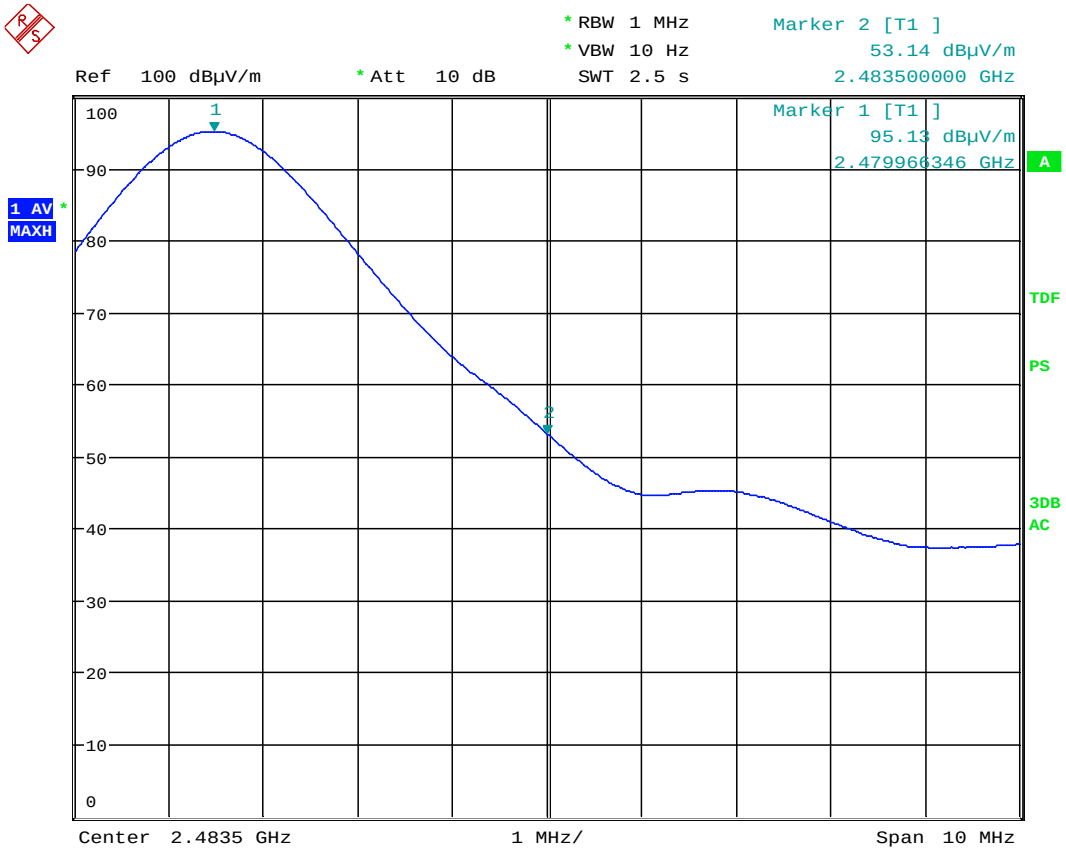
Band Edge, 2483.5 MHz, Peak Detector



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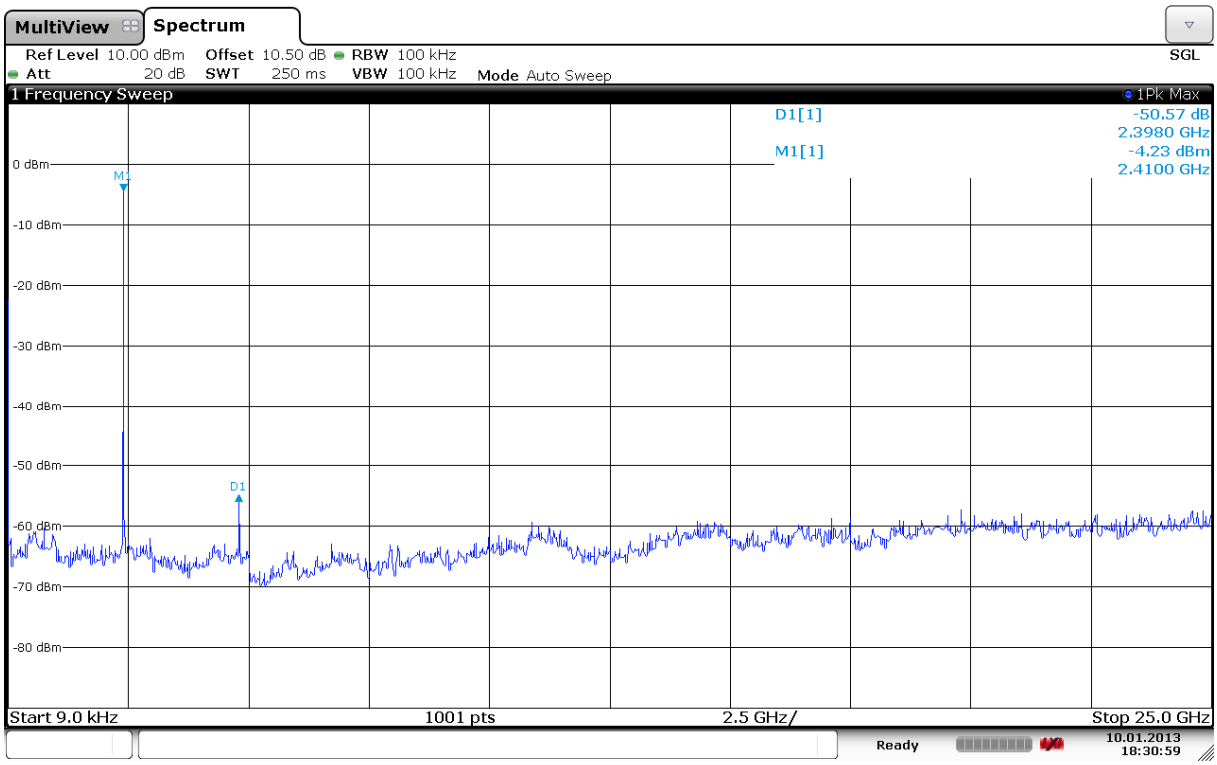
Band Edge, 2483.5 MHz, AV Detector



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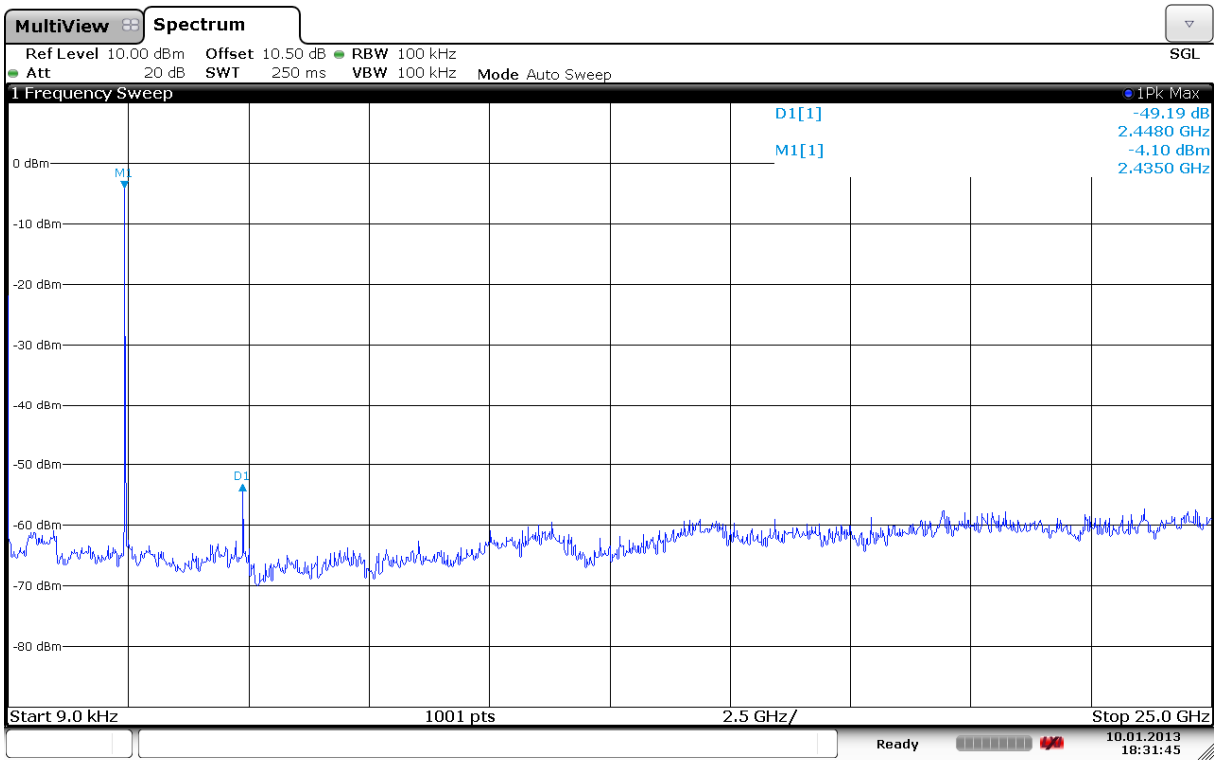
Ch 2402 MHz, Conducted Emissions, 9kHz – 25 GHz



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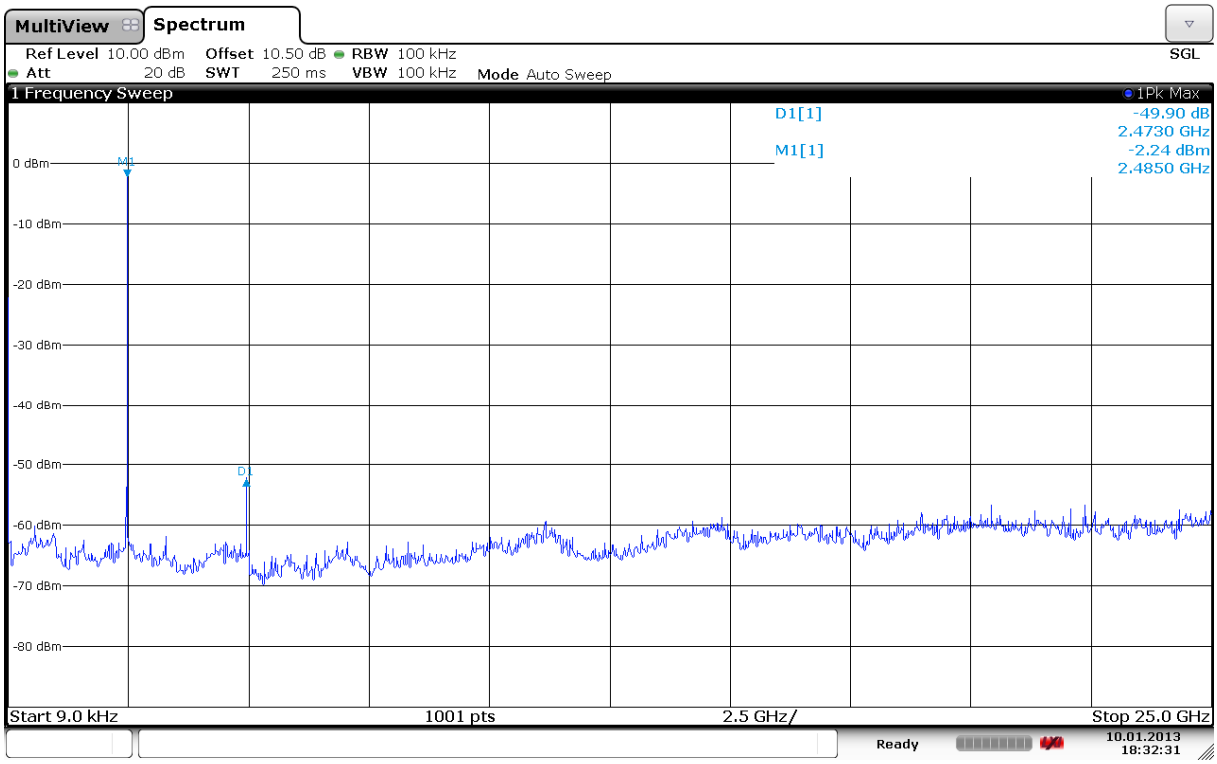
Ch 2440 MHz, Conducted Emissions, 9kHz – 25 GHz



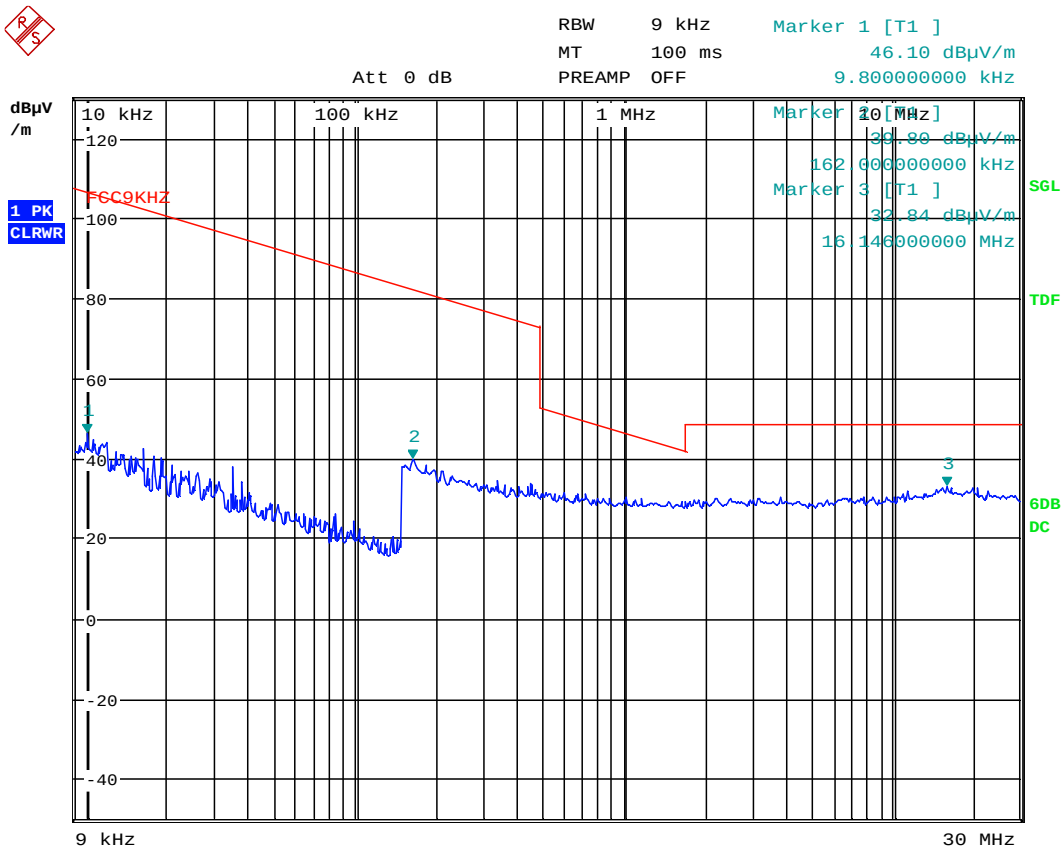
Date: 10.JAN.2013 18:32:32

Ch 2480 MHz, Conducted Emissions, 9 kHz – 25 GHz

Radiated emissions 9kHz - 30 MHz.

Detector: Quasi-Peak

Measuring distance 10 m.



Date: 27.DEC.2012 10:55:57

Radiated Emissions, 9 kHz – 30 MHz @10m

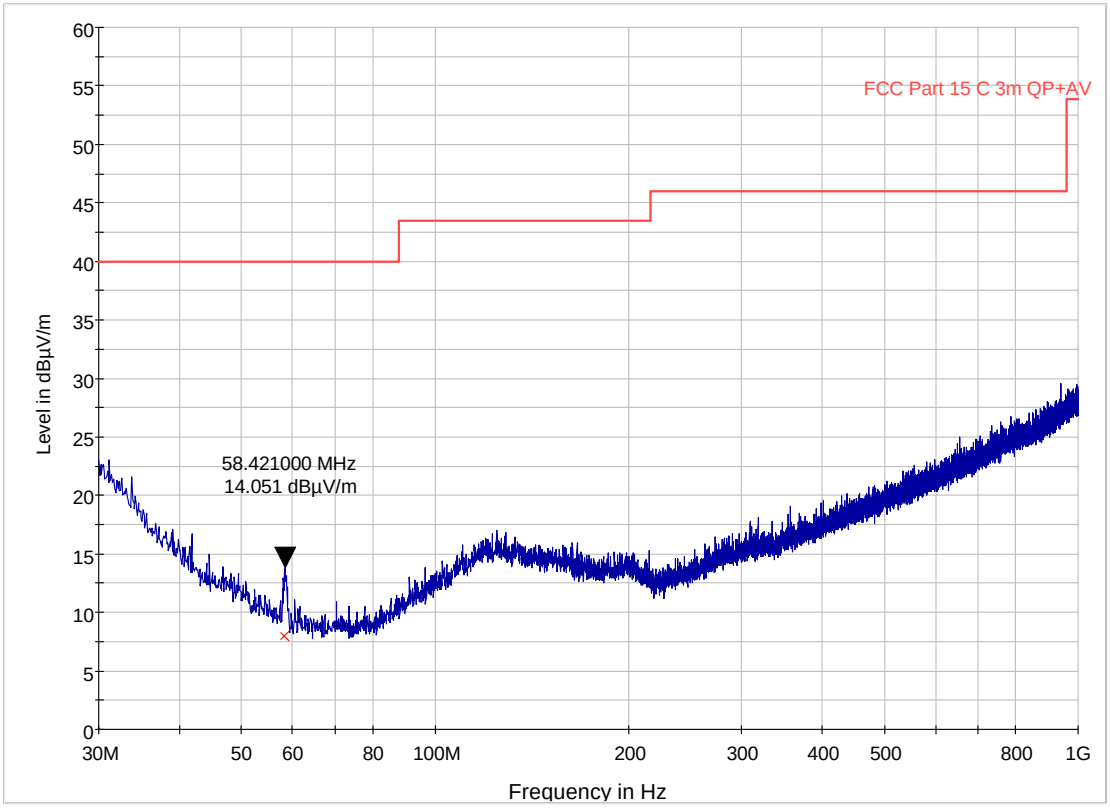
Radiated emission 30 – 1000 MHz.

Detector: Peak

Measuring distance at 3m.

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

See attached plot.



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	53.6	Pk	74	20.4
4880	52.0	Pk	74	22
4960	53.2	Pk	74	20.8
7206	55.5	Pk	74	18.5
7320	54.6	Pk	74	19.4
7440	55.7	Pk	74	18.3

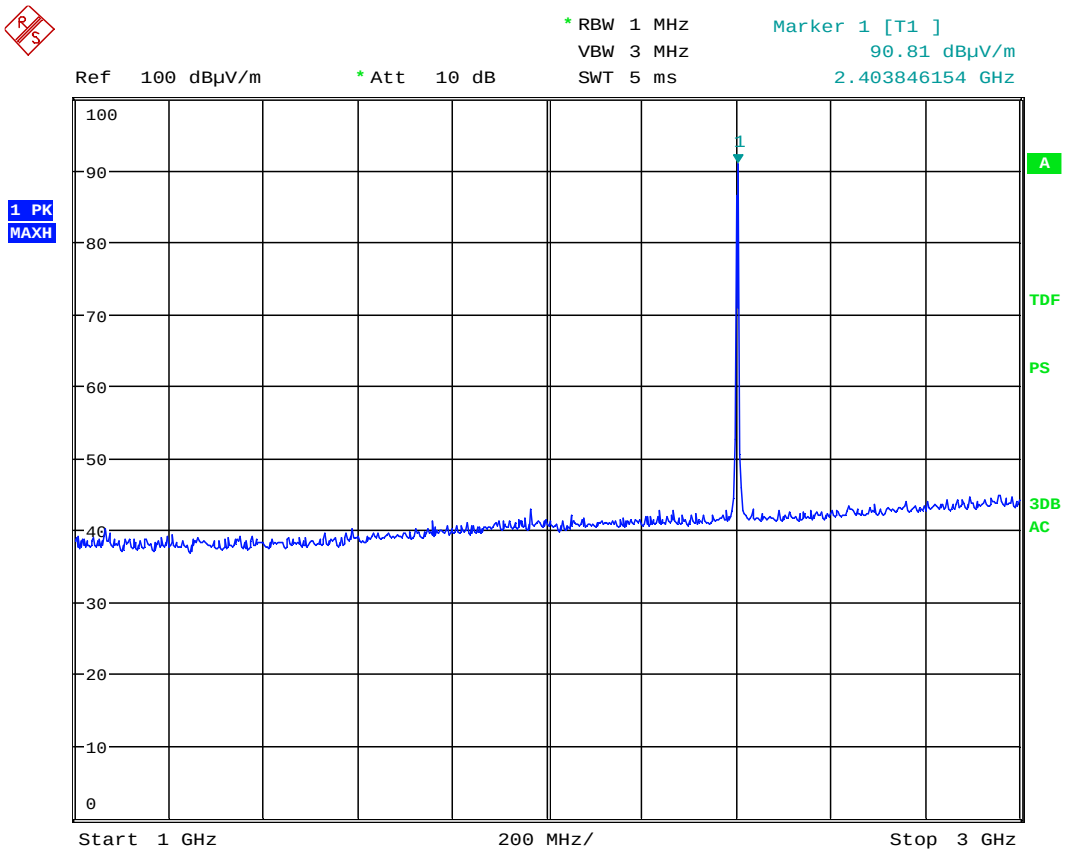
Average detector

Frequency MHz	Field Strength @3m dBµV/m	Detector	Limit dBµV/m	Margin dB
4804	47.8	Av	54	6.2
4880	46.5	Av	54	7.5
4960	47.4	Av	54	6.6
7206	48.2	Av	54	5.8
7320	46.4	Av	54	7.6
7440	48.3	Av	54	5.7

Maximum is obtained in vertical polarization.

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

See attached graphs.



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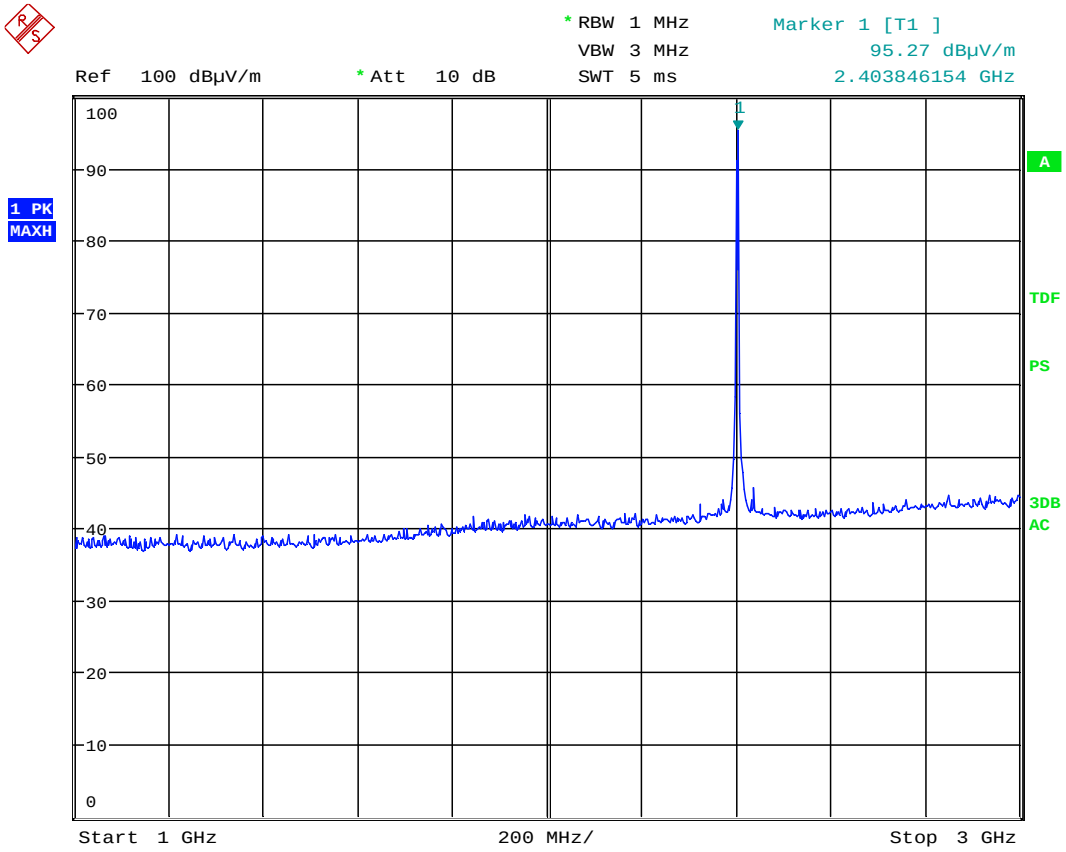
Radiated Emissions ch. 2402 MHz, 1 – 3 GHz, VP, @3m – Pre-scan with Peak detector



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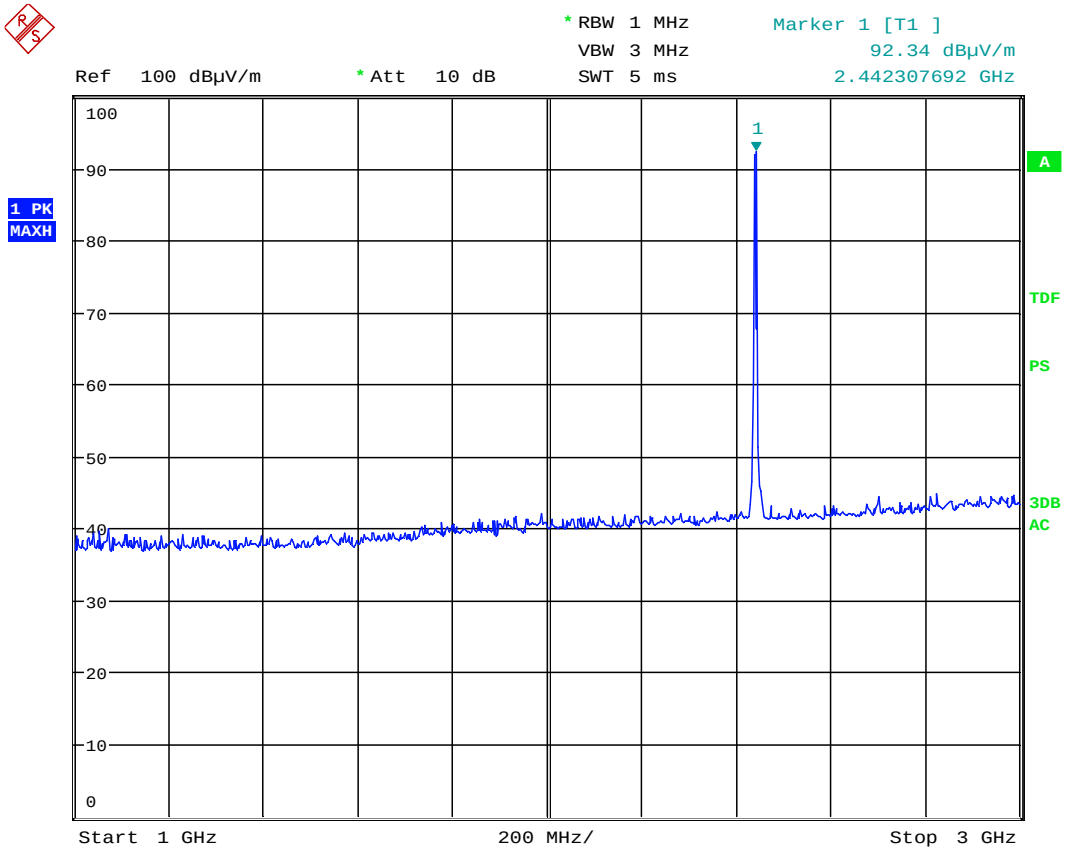
Radiated Emissions ch. 2402 MHz, 1 – 3 GHz, HP, @3m – Pre-scan with Peak detector



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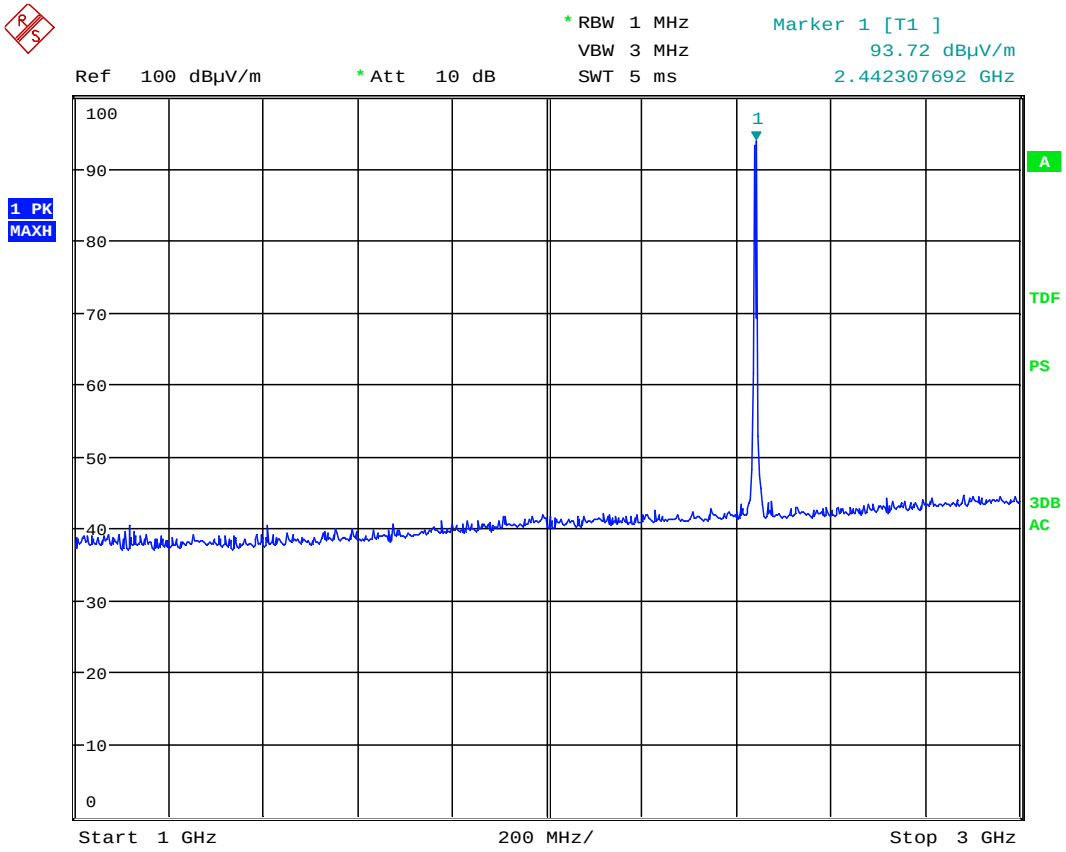
Radiated Emissions ch. 2440 MHz, 1 – 3 GHz, VP, @3m – Pre-scan with Peak detector



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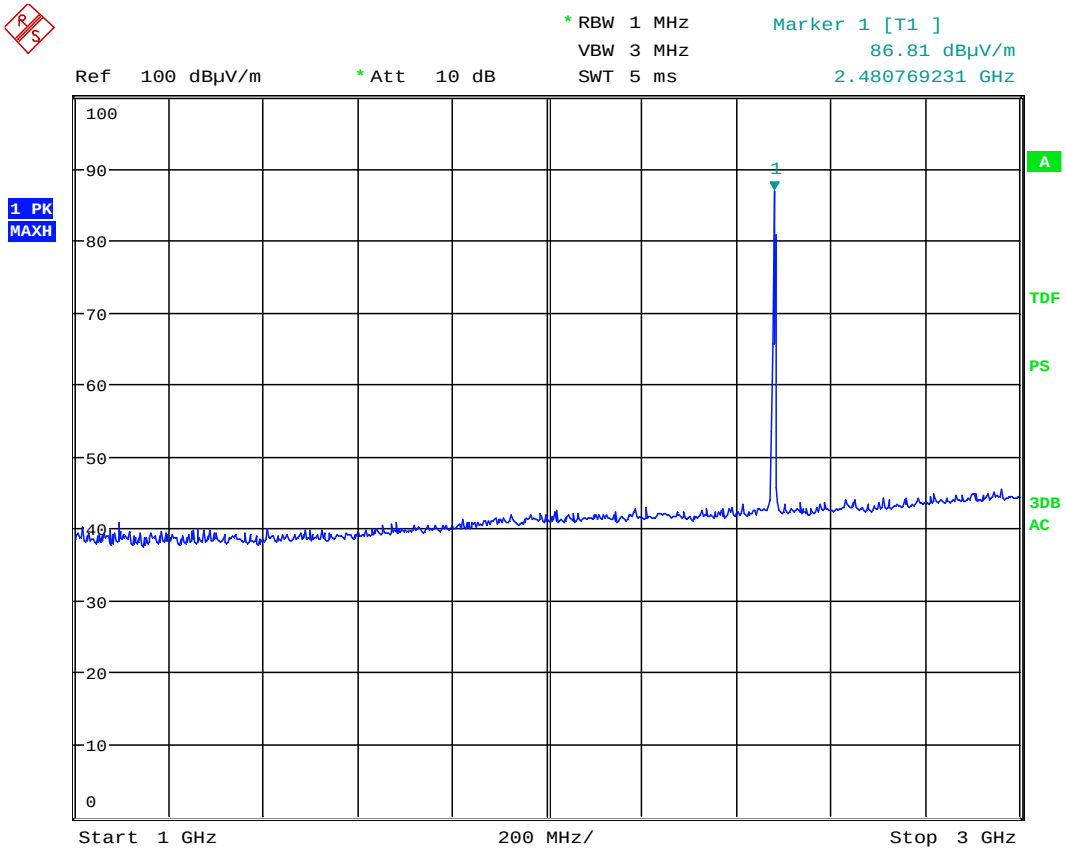
Radiated Emissions ch. 2440 MHz, 1 – 3 GHz, HP, @3m – Pre-scan with Peak detector



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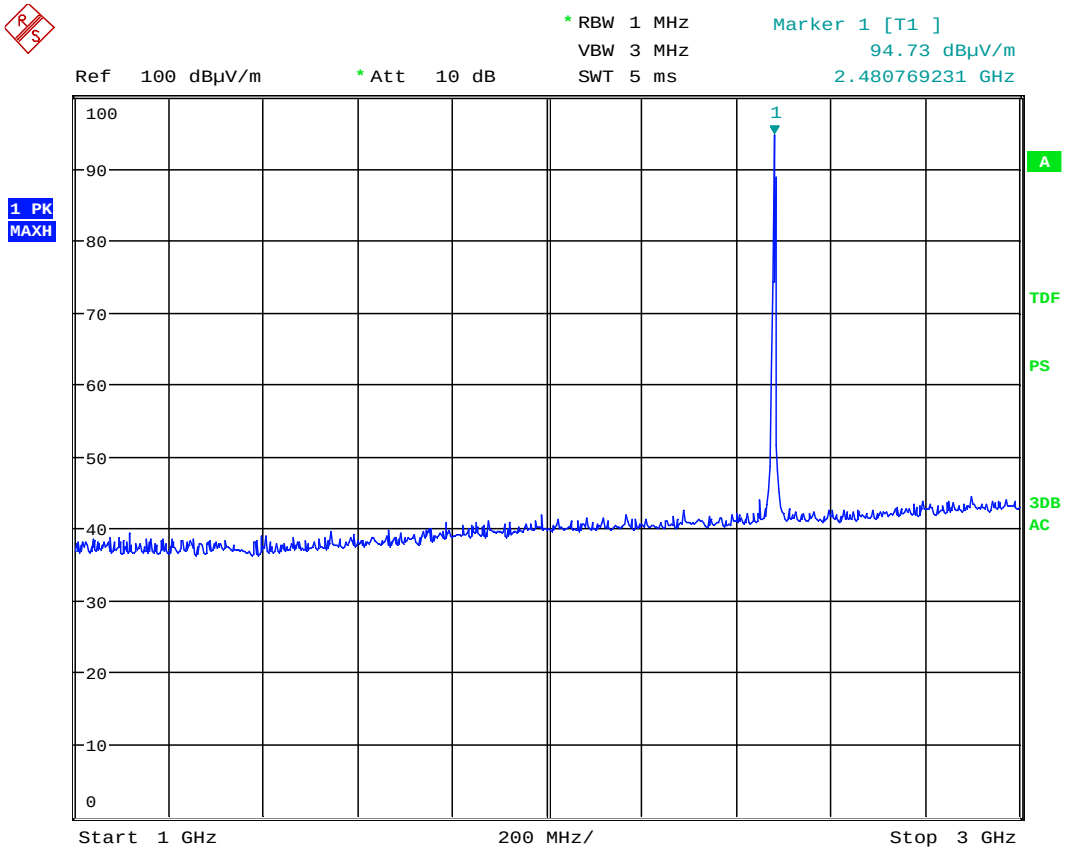
Radiated Emissions ch. 2480 MHz, 1 – 3 GHz, VP, @3m – Pre-scan with Peak detector



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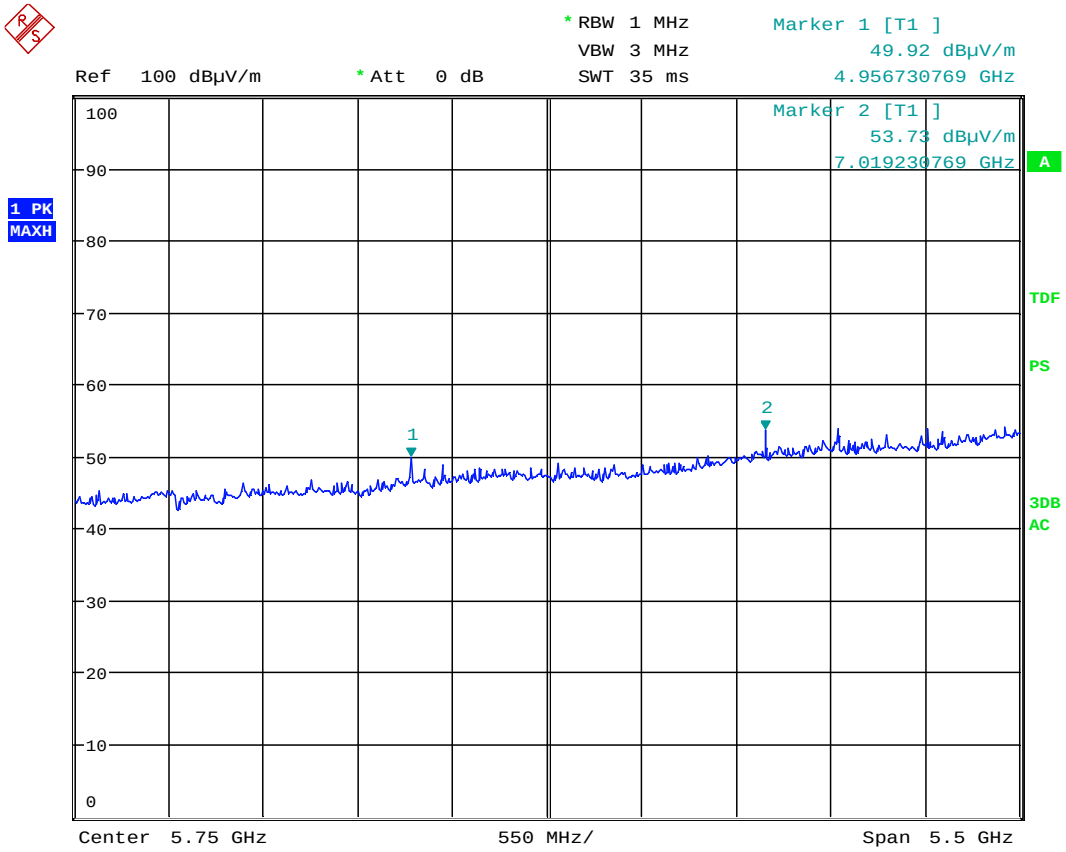
Radiated Emissions ch. 2480 MHz, 1 – 3 GHz, HP, @3m – Pre-scan with Peak detector



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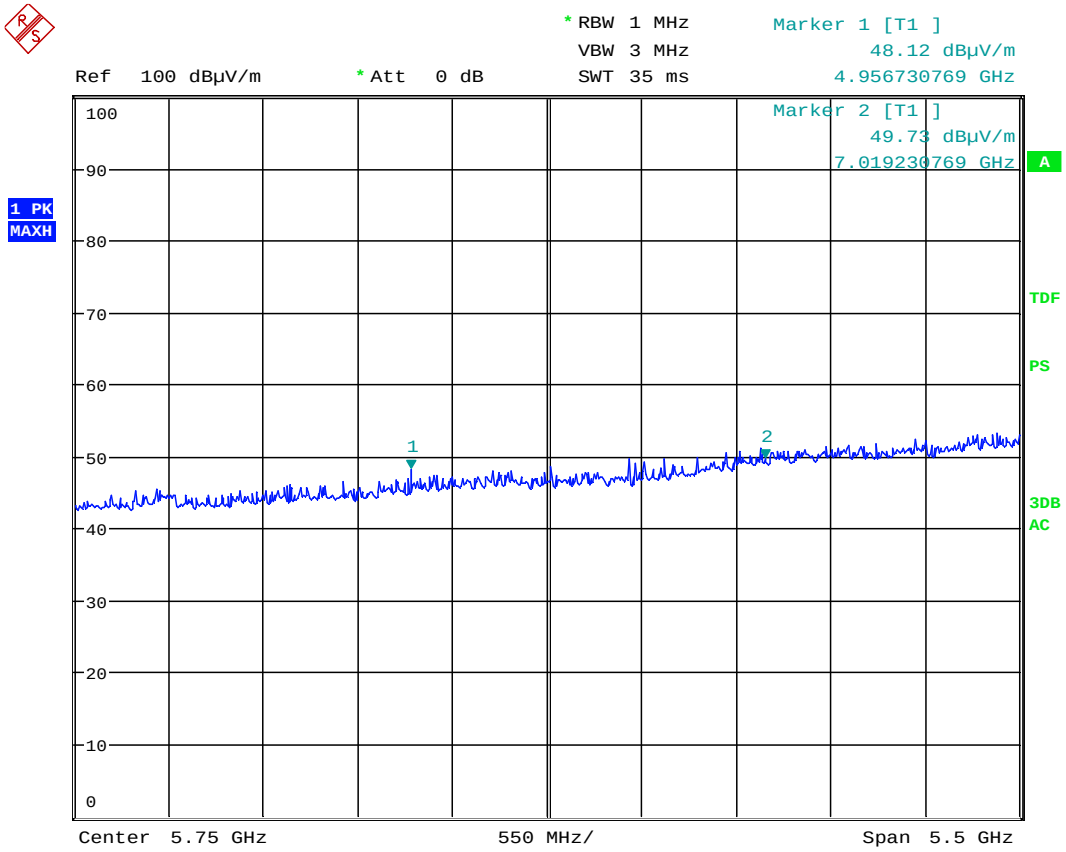
Radiated Emissions ch. 2480 MHz, 3 – 8.5 GHz, VP, @3m – Pre-scan with Peak detector



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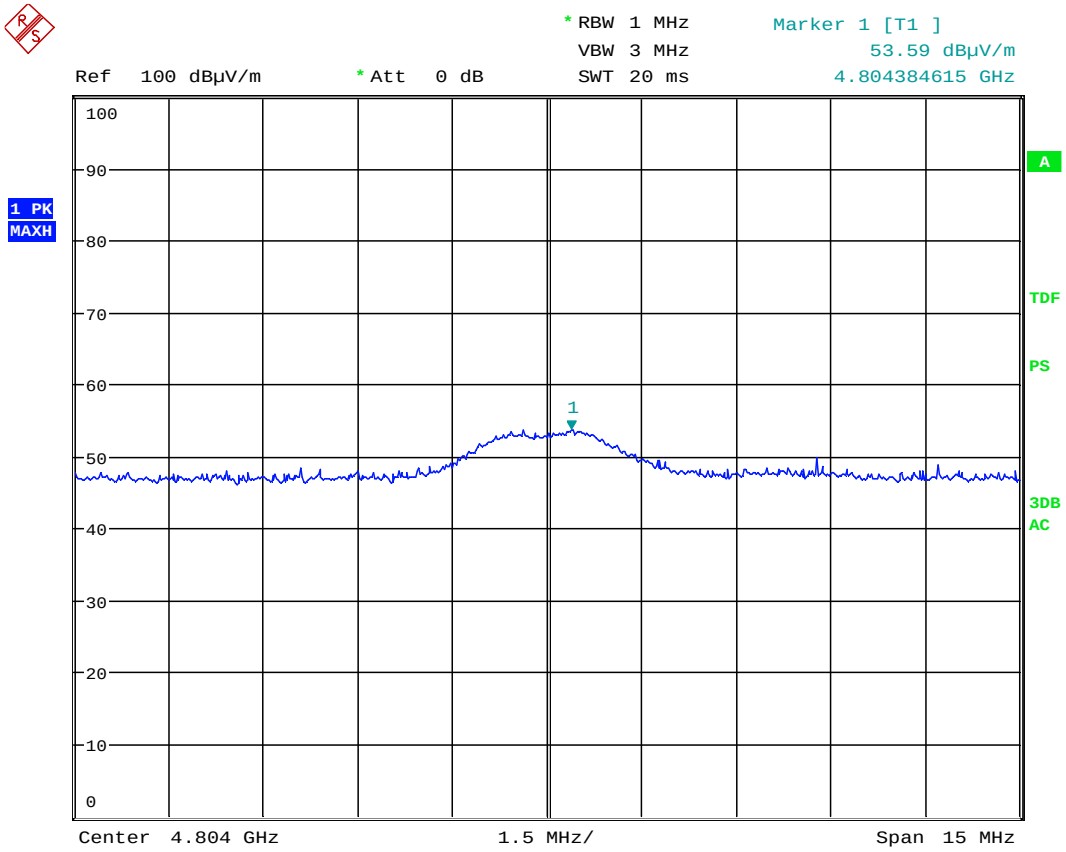
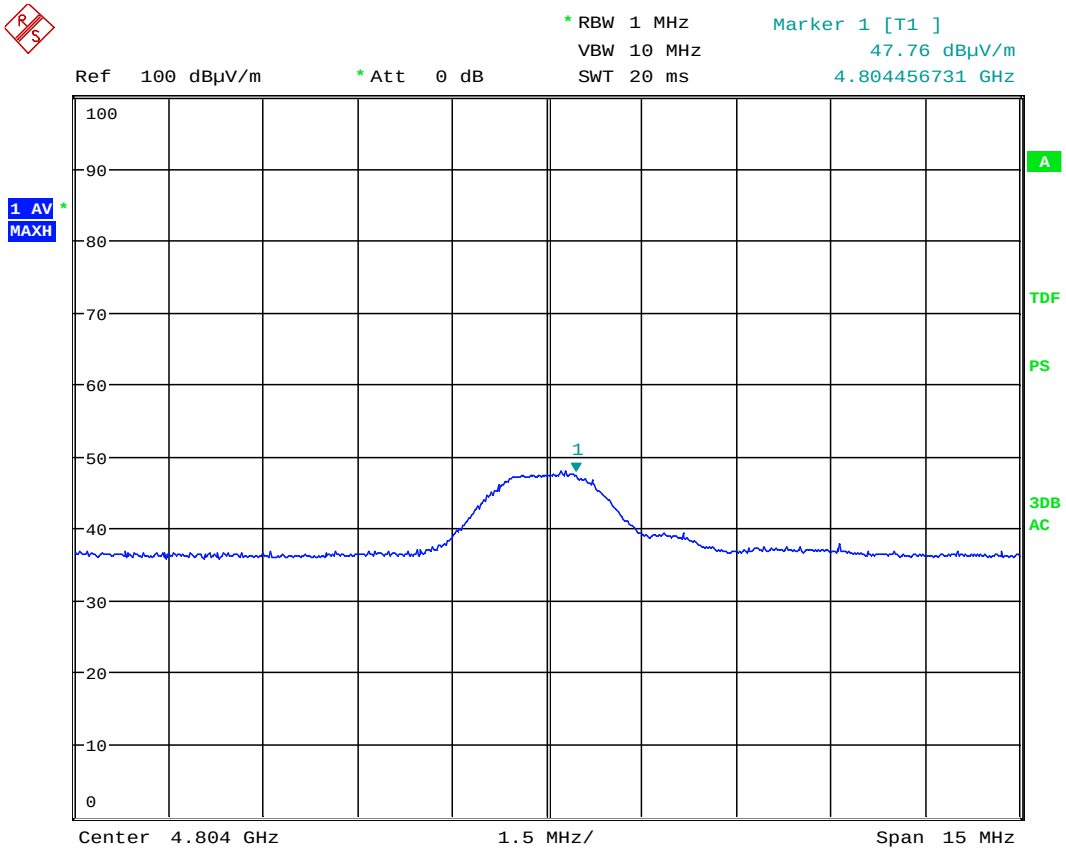
Radiated Emissions ch. 2480 MHz, 3 – 8.5 GHz, HP, @3m – Pre-scan with Peak detector



Date: 27.DEC.2012 09:59:41

2nd harmonic-ch2402MHz – VP @3m- peak detector



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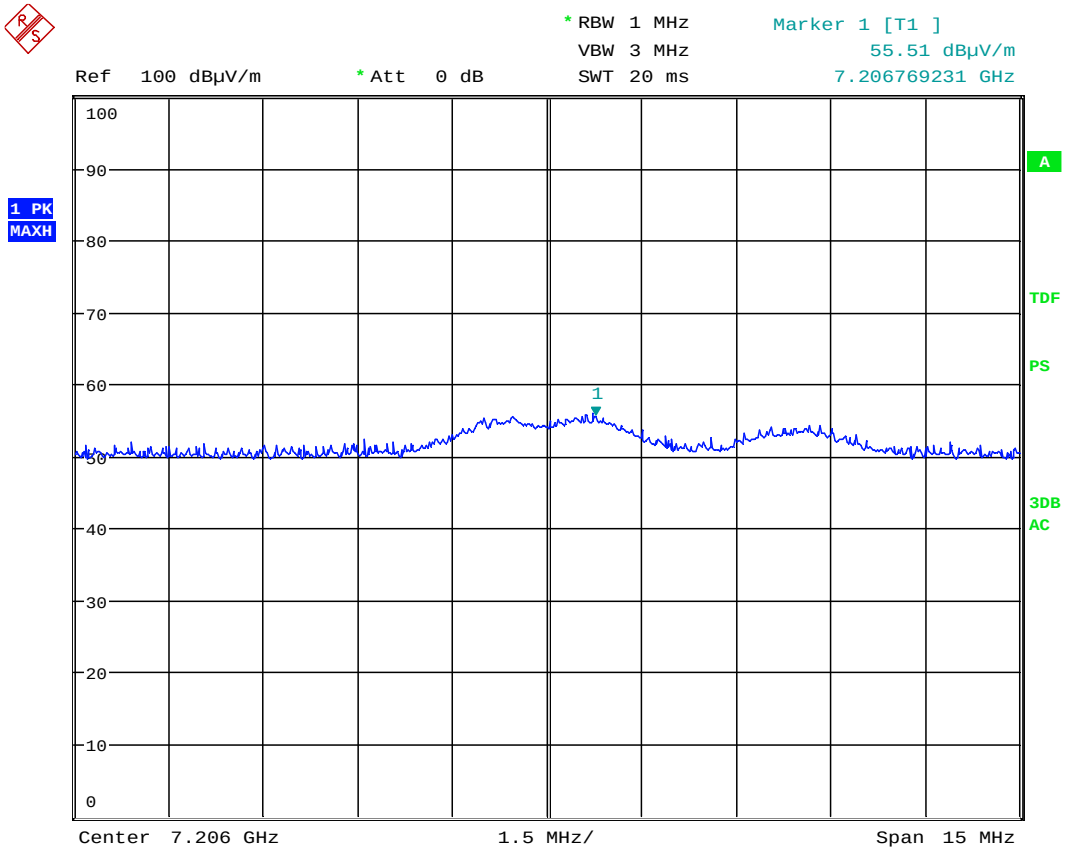
2nd harmonic-ch2402MHz – VP @3m- AV detector



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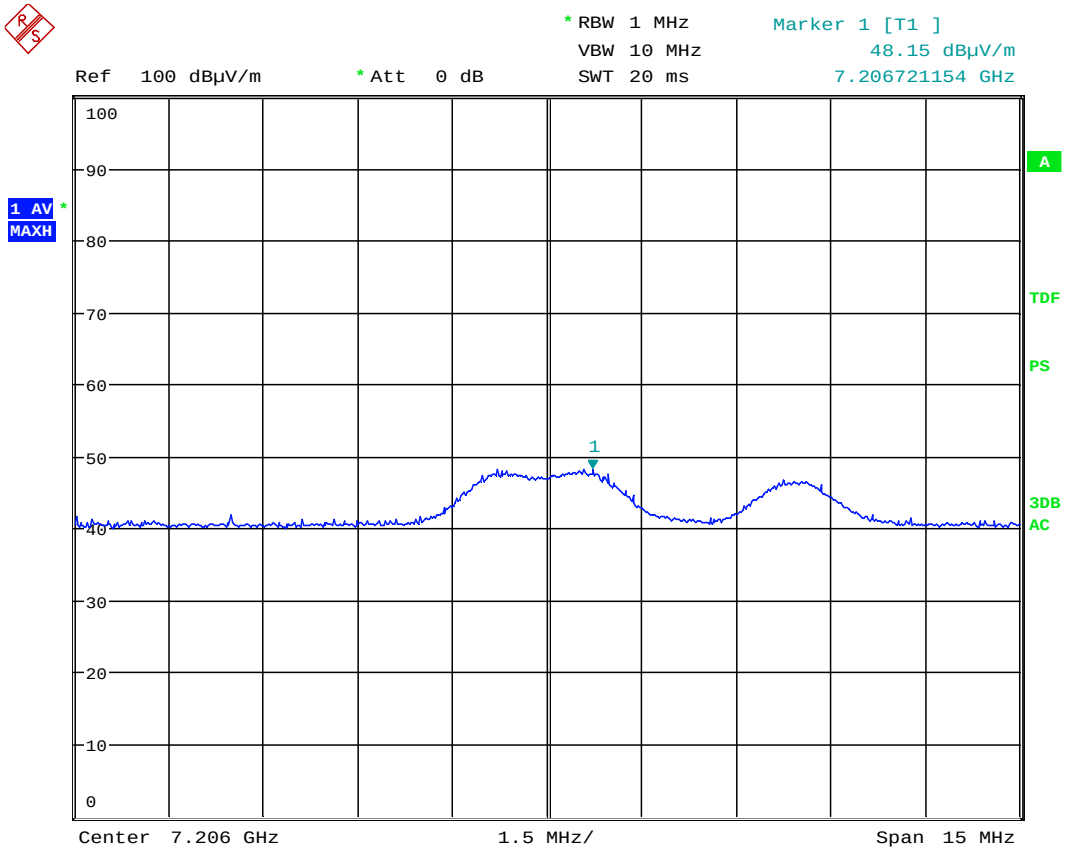
3rd harmonic-ch2402MHz – VP @3m- peak detector



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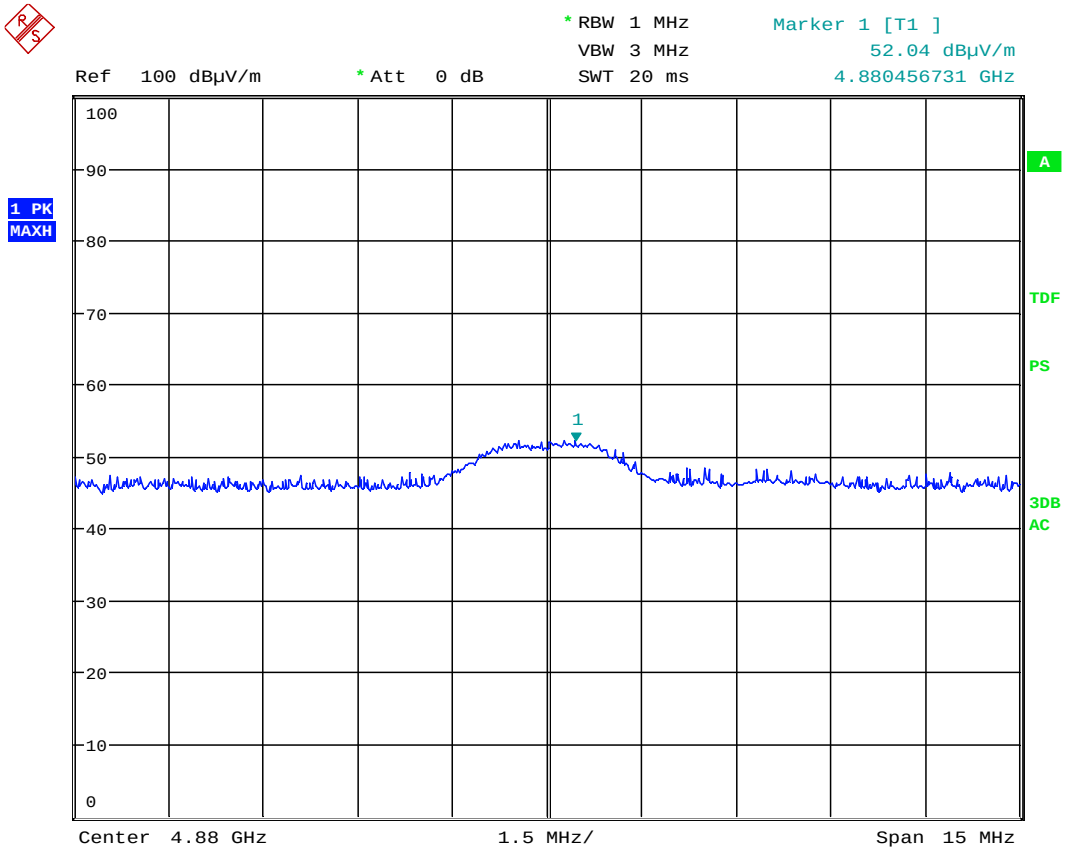
3rd harmonic-ch2402MHz – VP @3m- AV detector



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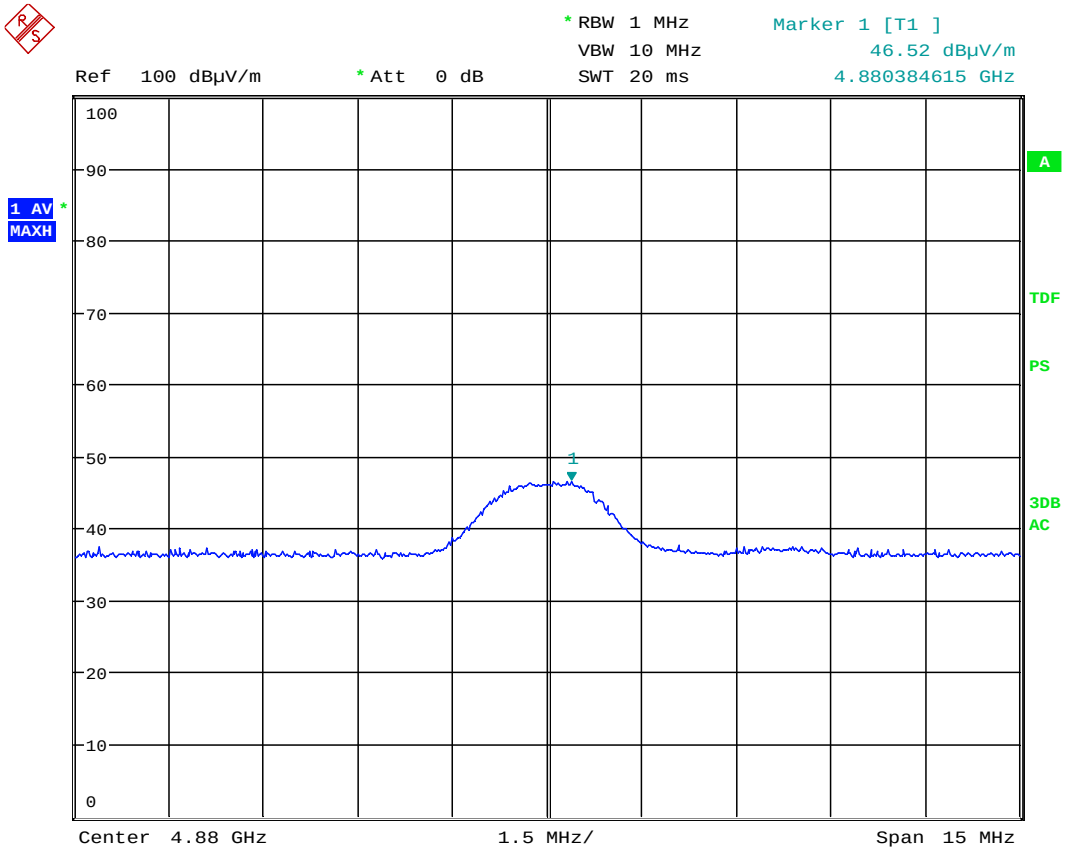
2nd harmonic-ch2440MHz – VP @3m- Peak detector



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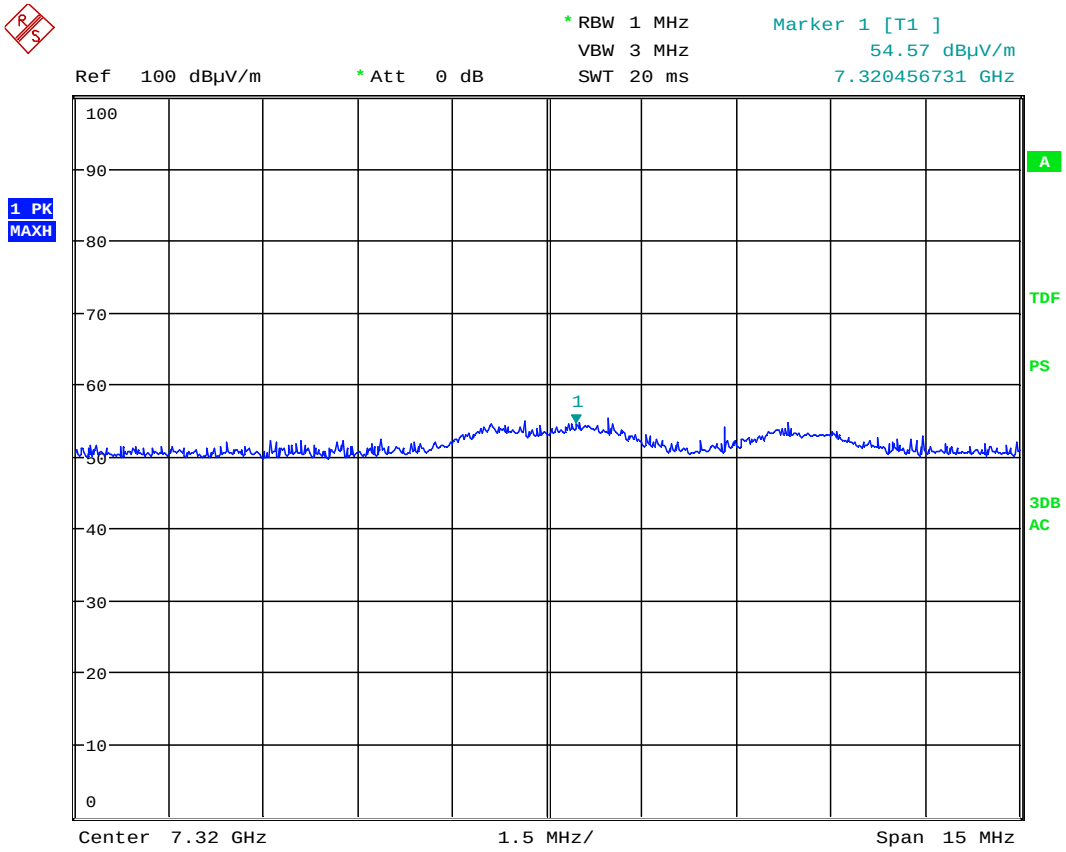
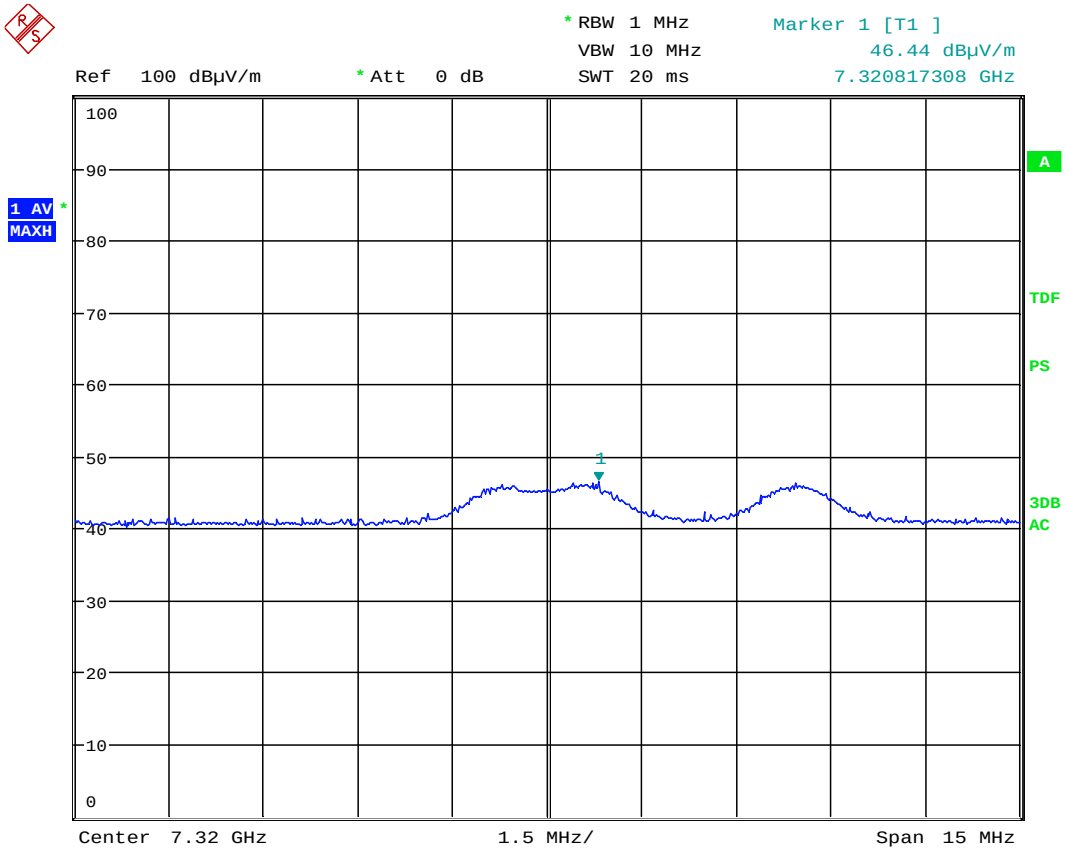
2nd harmonic-ch2440MHz – VP @3m- AV detector



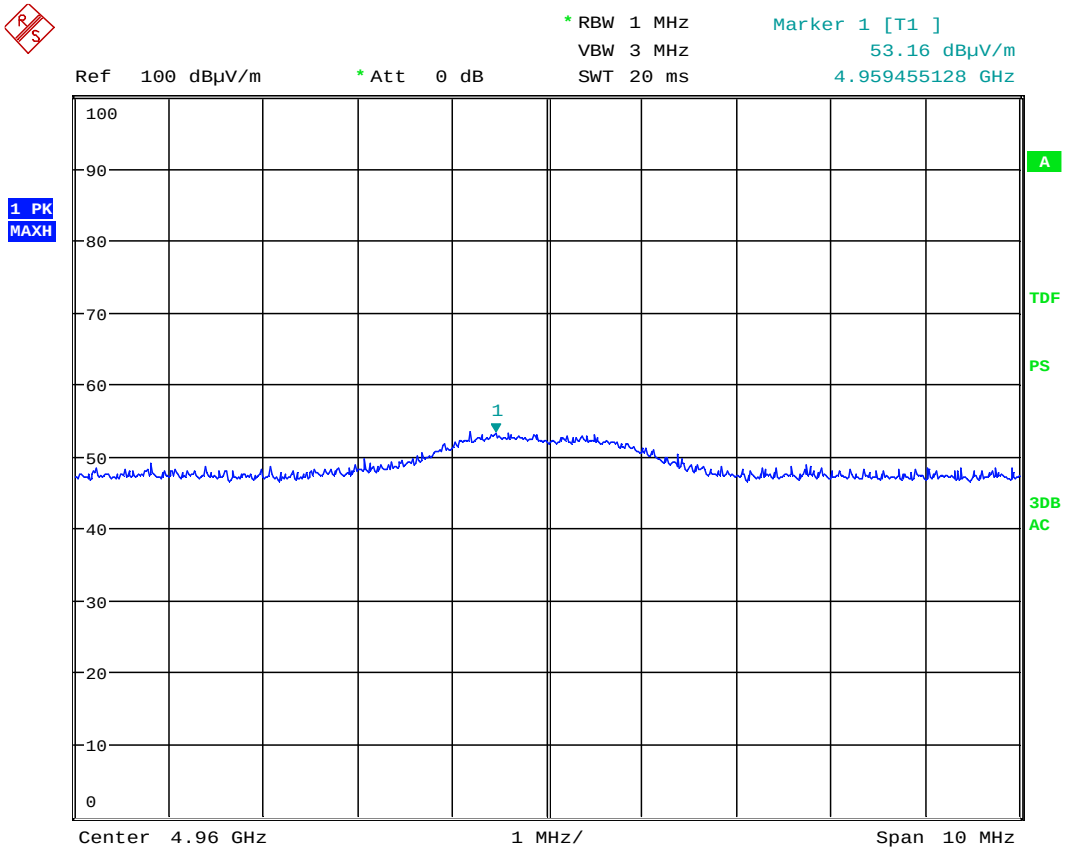
Date: 27.DEC.2012 10:03:52

3rd harmonic-ch2440MHz – VP @3m- peak detector



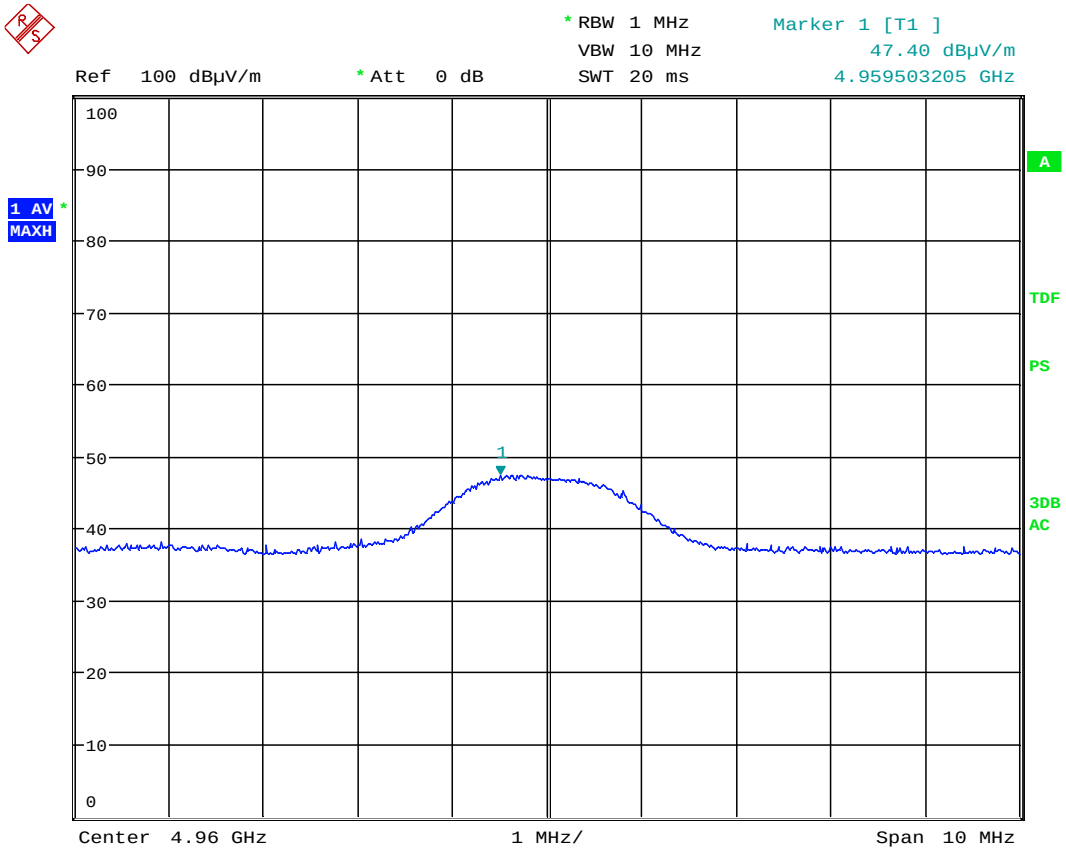
Date: 27.DEC.2012 10:03:33

3rd harmonic-ch2440MHz – VP @3m- AV detector



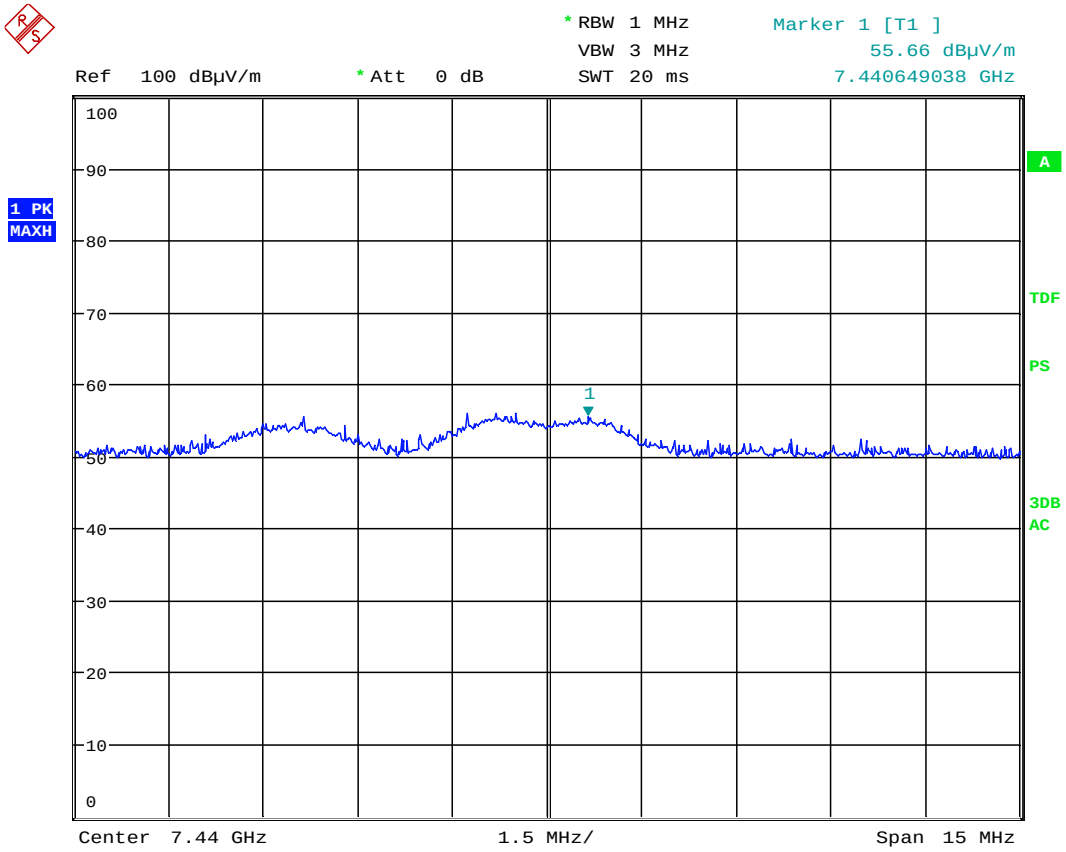
Date: 27.DEC.2012 09:41:32

2nd harmonic-ch2480MHz – VP @3m- Peak detector



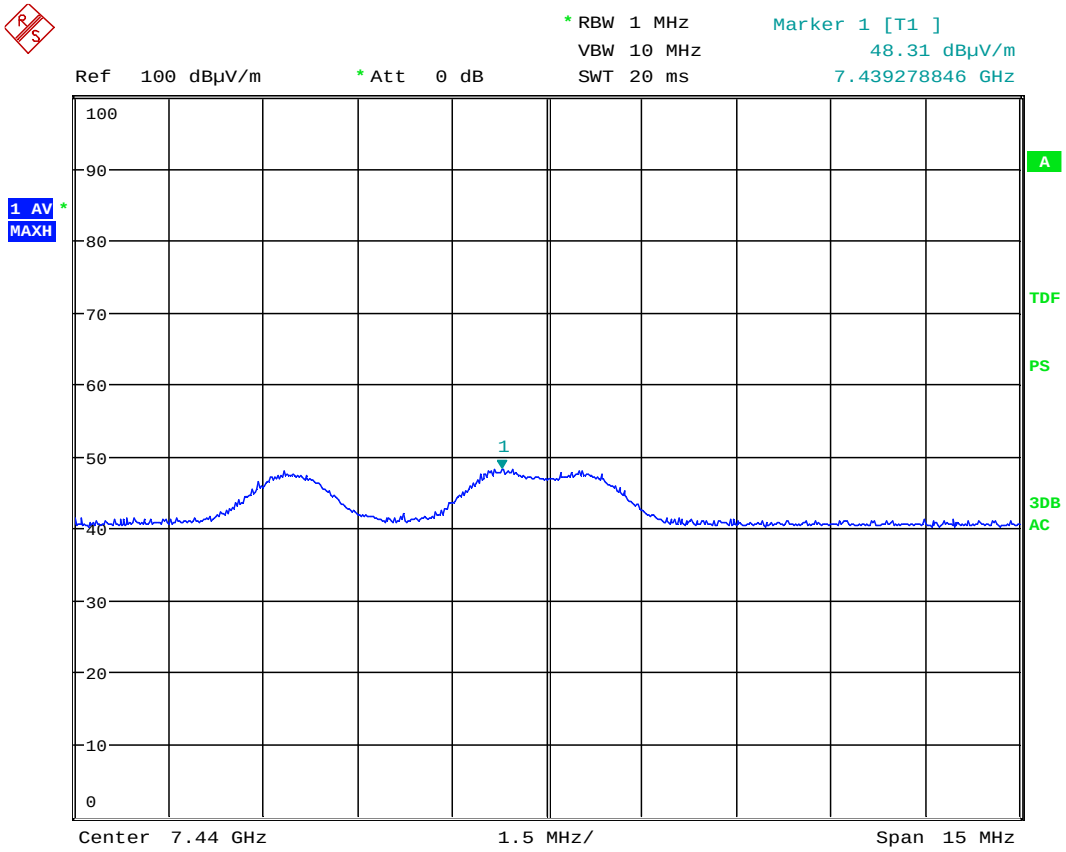
Date: 27.DEC.2012 09:42:09

2nd harmonic-ch2480MHz – VP @3m- AV detector



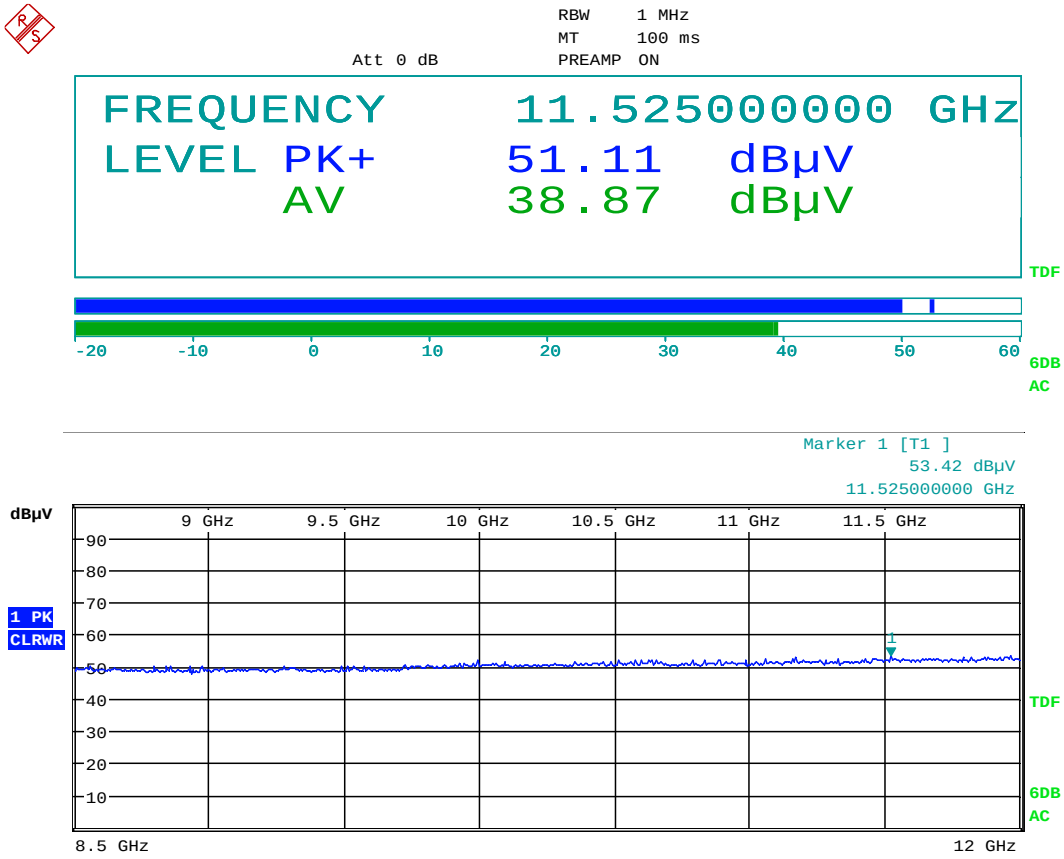
Date: 27.DEC.2012 09:50:07

3rd harmonic-ch2480MHz – VP @3m- Peak detector



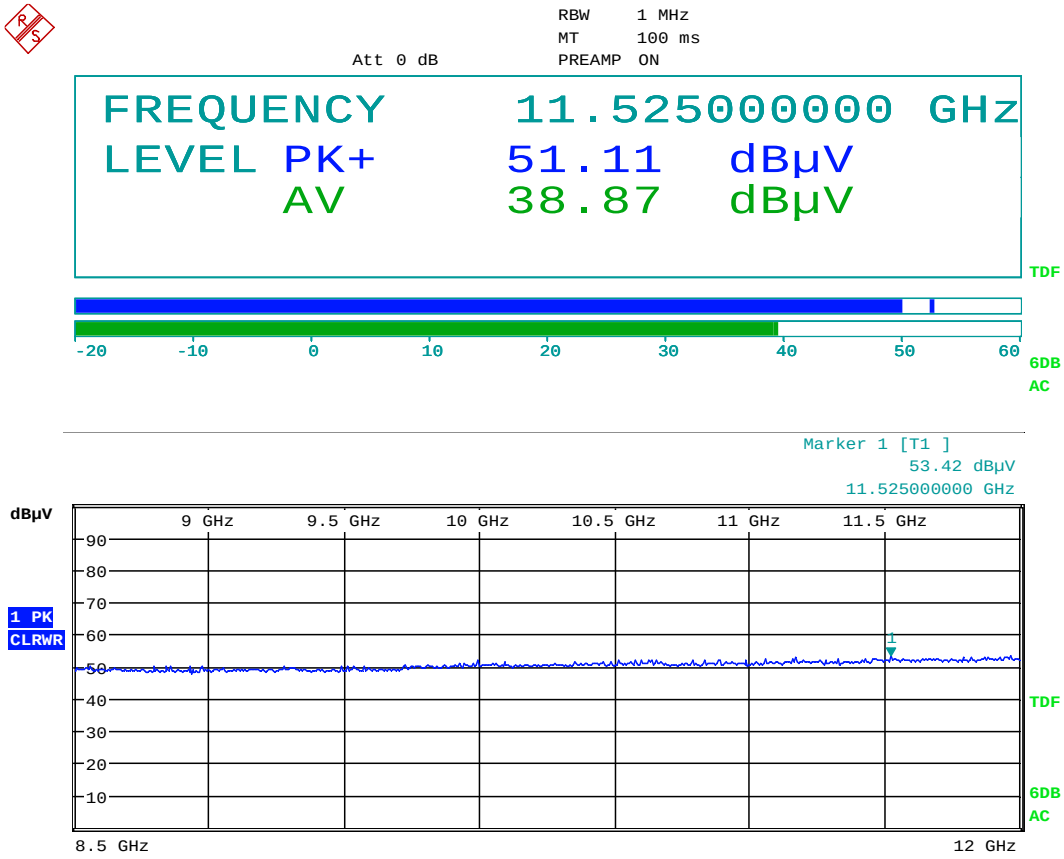
Date: 27.DEC.2012 09:50:35

3rd harmonic-ch2480MHz – VP @3m- AV detector



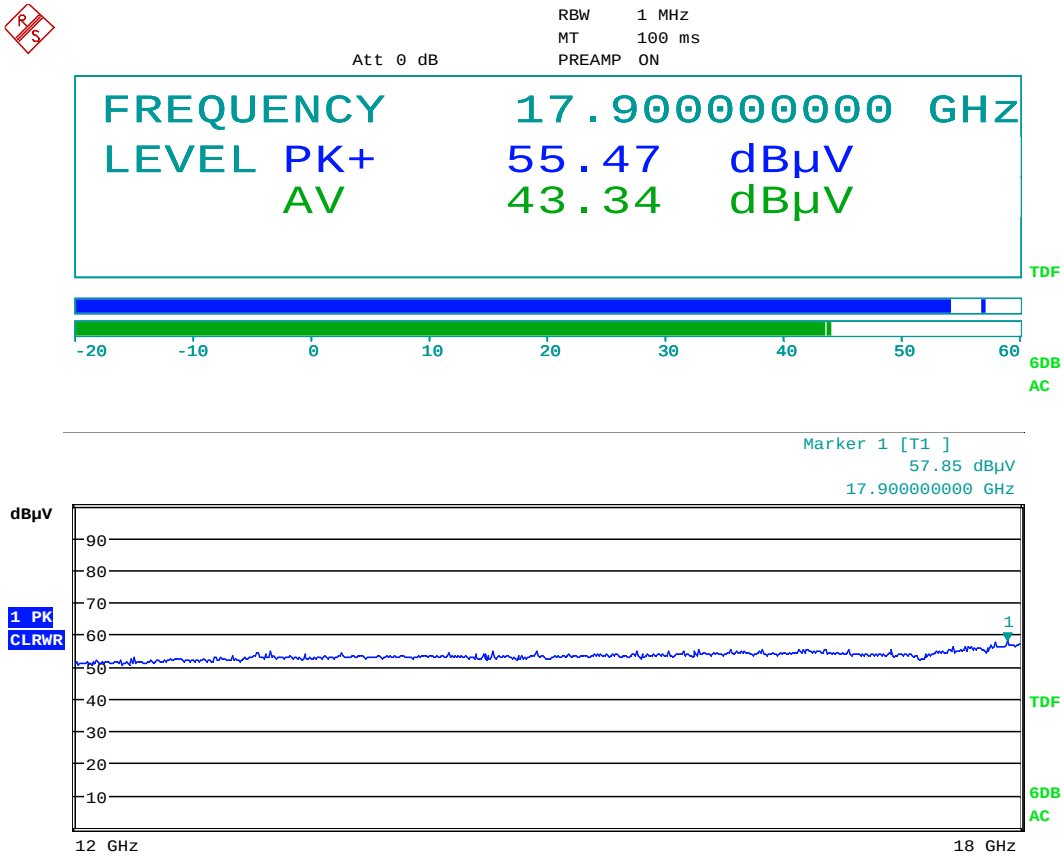
Date: 27.DEC.2012 10:15:36

Radiated Emissions, 8.5 – 12 GHz, HP, @1m – Pre-scan with Peak detector , Distance Correction factor of -9.5 dB shall be used.



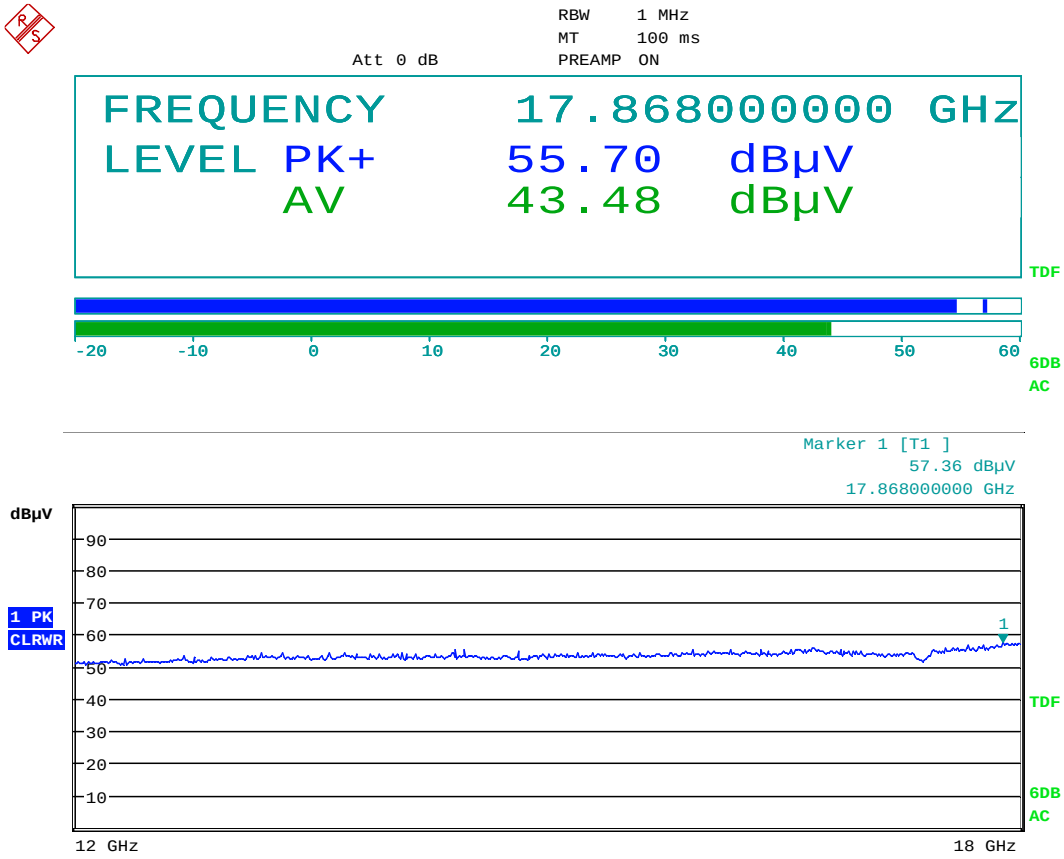
Date: 27.DEC.2012 10:15:36

Radiated Emissions , 8.5 – 12 GHz, VP, @1m – Pre-scan with Peak detector , Distance Correction factor of -9.5 dB shall be used.



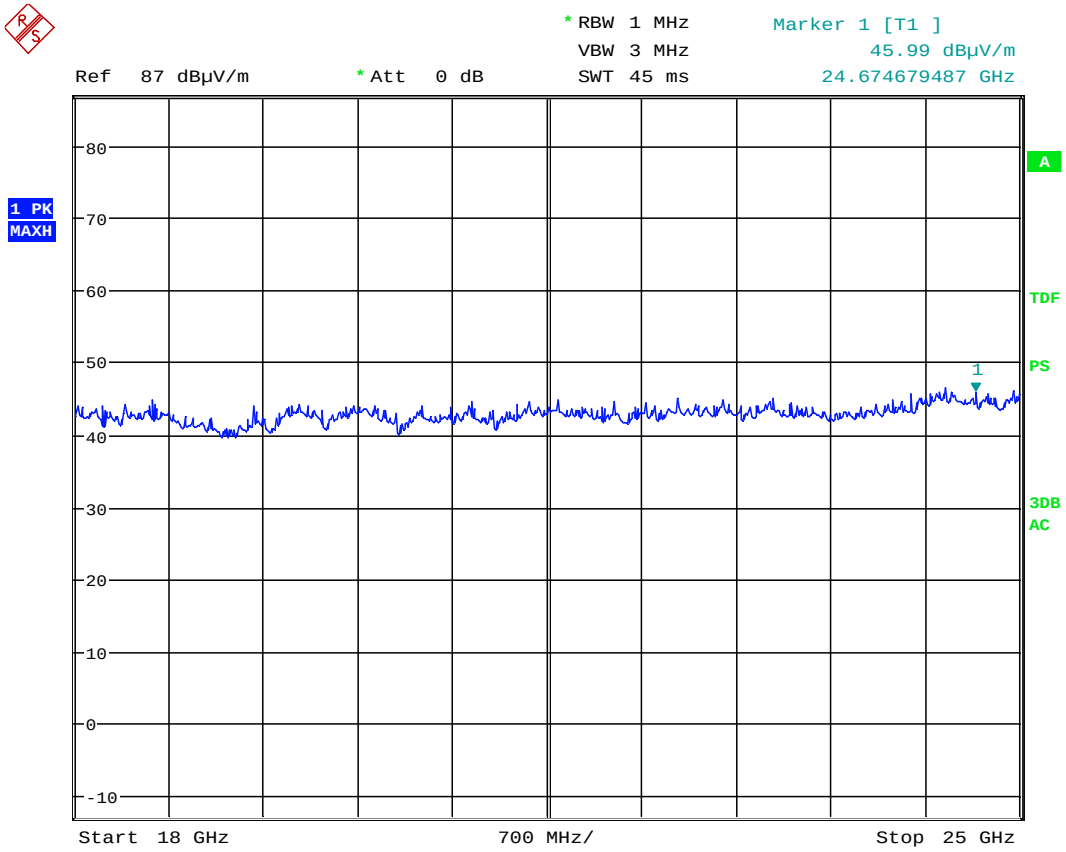
Date: 27.DEC.2012 10:22:33

Radiated Emissions, 12 – 18 GHz, VP, @1m – Pre-scan with Peak detector, Distance Correction factor of -9.5 dB shall be used.



Date: 27.DEC.2012 10:25:03

Radiated Emissions ch. 2402 MHz, 12 – 18 GHz, HP, @1m – Pre-scan with Peak detector, Distance Correction factor of -9.5dB shall be used.



Date: 27.DEC.2012 10:32:32

Radiated Emissions ch. 2402 MHz, 18 – 25 GHz, VP/HP, Pre-scan with Peak detector, Distance Correction factor -9.5dB shall be used.

4.6 Power Spectral Density (PSD)

Para. No.: 15.247 (e)

Test Performed By: G.Suhanthakumar	**Date of Test: 28 Jan. 2013**

Test Results: Complies

Measured and Calculated Data:

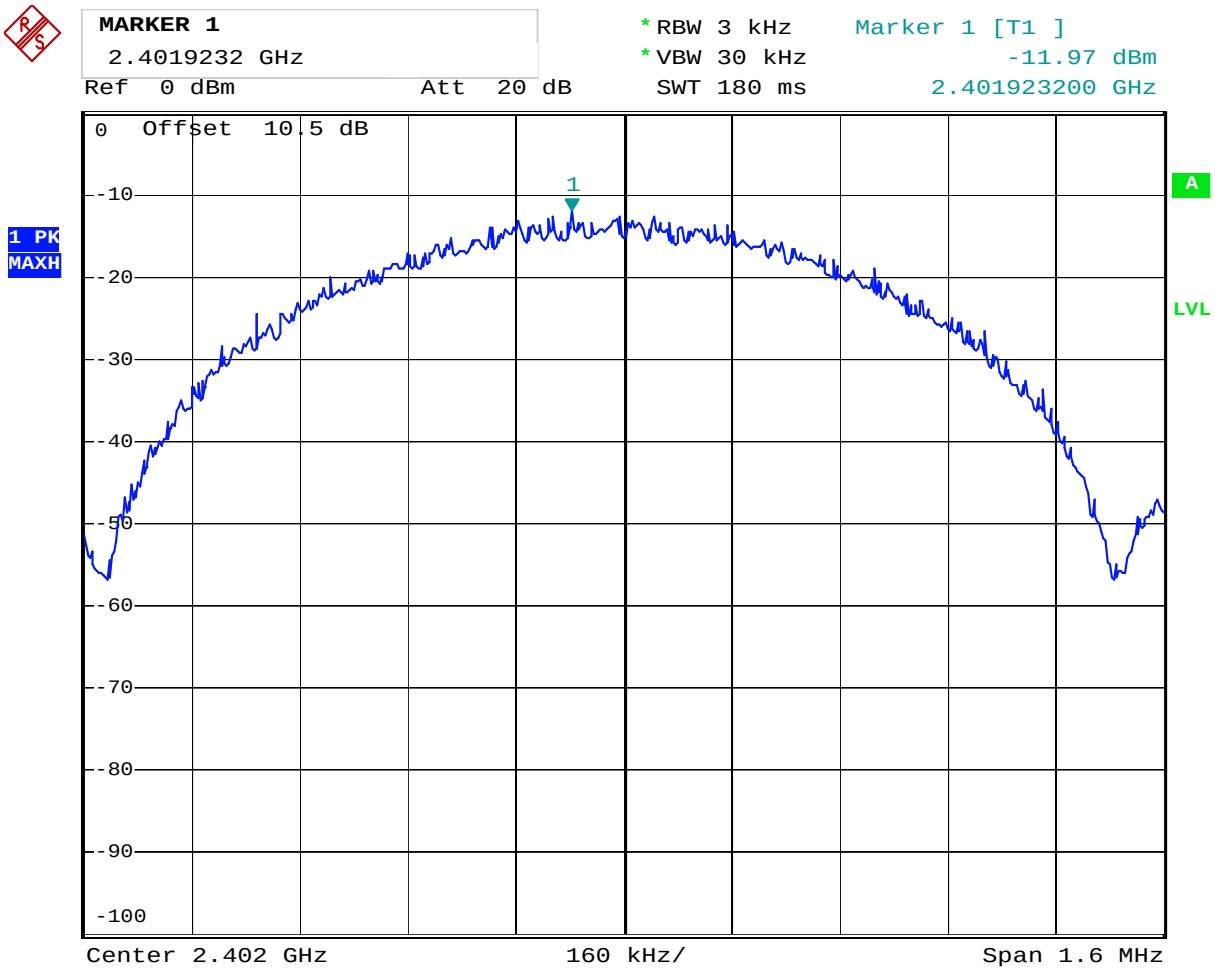
.

	Measured and calculated peak PSD dBm
Power Spectral Density @2402 MHz	-12.0
Power Spectral Density @2440 MHz	-13.2
Power Spectral Density @2480 MHz	-13.5

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

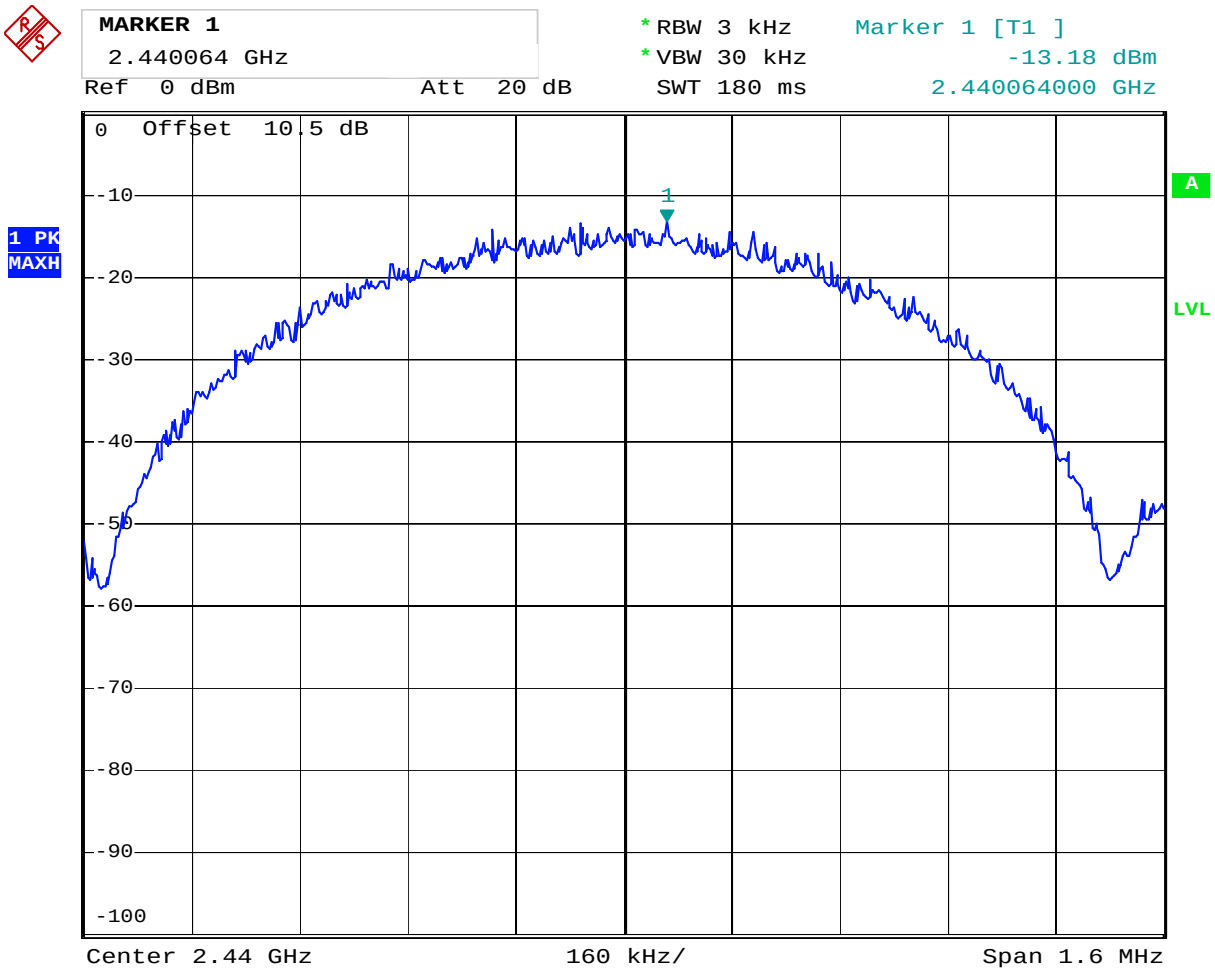
Requirements:

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



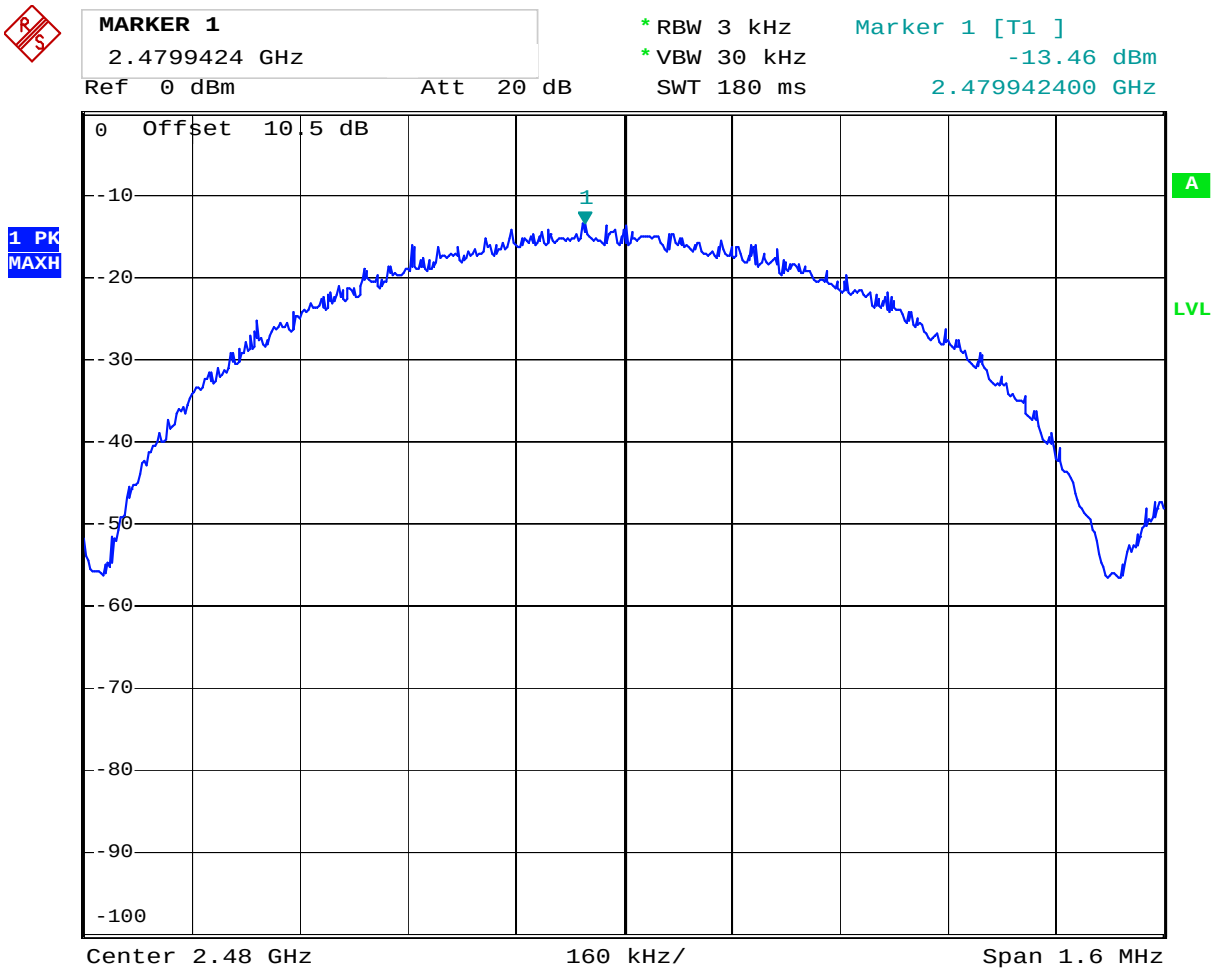
Date: 28.JAN.2013 16:32:44

PSD Measurement - 2402MHz



Date: 28.JAN.2013 16:45:49

PSD Measurement – 2440MHz



Date: 28.JAN.2013 16:35:39

PSD Measurement - 2480MHz

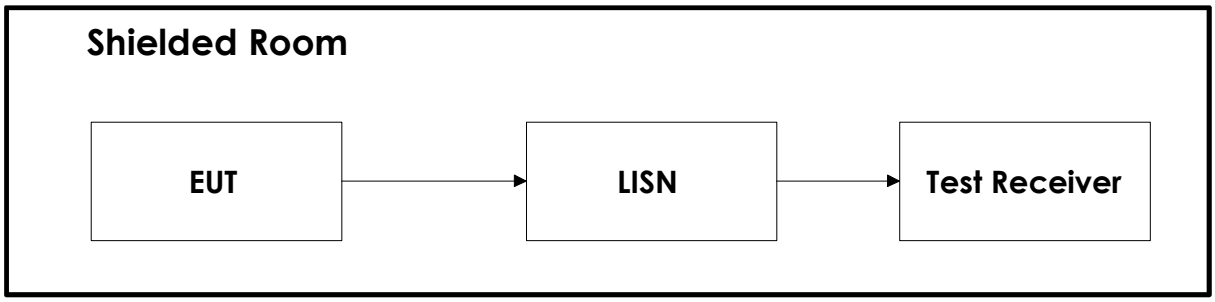
5 LIST OF TEST EQUIPMENT

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	2012-08	2013-08
10	8449B	Pre-amplifier	Hewlett Packard	LR 1322	2012-09-27	2013-09-27
11	LNA6900	Pre-amplifier	Teseq	LR 1593	2012-11	2013-11
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

6 BLOCK DIAGRAM

6.1 Power Line Conducted Emission



6.2 Test Site Radiated Emission