Test report no. : 205480-2

Item tested : CC2545EM

Type of equipment : 2.4GHz Transceiver

FCC ID : ZAT2545EM

Client : Texas Instruments Norway AS

FCC Part 15.247
Digital Transmission System

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

16 April 2012

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

www.nemko.com

Nemko AS, Gaustadalléen 30, P.O.Box 73 Blindern, NO-0314 Oslo Norway **T** +47 22 96 03 30 **F** +47 22 96 05 50 Enterprise number NO974404532
Visiting address: Nemko Kjeller, Instituttveien 6, P.O.Box 96, NO-2027 Kjeller Norway **T** +47 64 84 57 00 **F** +47 64 84 57 05

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:	39

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)

Name :	/
Address :	/

2 Test Information

2.1 Test Item

Name :	Texas Instruments
FCC ID :	ZAT2545EM
IC :	451H-2545EM
Model/version :	CC2545EM
Serial number :	/
Hardware identity and/or version:	/
Software identity and/or version :	/
Frequency Range :	2402 – 2480 MHz
Number of Channels :	/
Type of Modulation :	Digital (GFSK)
Rated output power:	/
Data rate:	2Mbps
User Frequency Adjustment :	None
Type of Power Supply :	Primary Batteries (2xAA batteries)
Antenna Connector :	PCB antenna
Antenna Diversity Supported :	No
Desktop Charger :	None

Description of Test Item

The tested EUT is a 2.4GHz transceiver with PCB antenna.

Exposure Evaluation

The EUT is exempted from RF Exposure Evaluation.

2.2 Test Environment

2.2.1 Normal test condition

Temperature:	20 – 23 °C
Relative humidity:	33 – 45 %
Normal test voltage:	3.0 V DC

The radiated emissions tests were performed with the EUT powered from a test-jig with 2xAA primary batteries. New batteries were used for all tests.

The values are the limit registered during the test period.

2.3 Test Period

Item received date:	2012-03-21
Test period :	from 2012-03-22 to 2012-03-26

3 TEST REPORT SUMMARY

3.1 General

Manufacturer: Texas Instruments

Model No.: CC2545EM

Serial No.: /

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 #: 205480-2

TESTED BY: _____ DATE: 2012-04-16

G.Suhanthakumar, Test engineer

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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	Pass

*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 Minimum 6 dB Bandwidth

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

Test Performed By: G.Suhanthakumar	**Date of Test: 24 Mar 2012**

Test Results: Complies

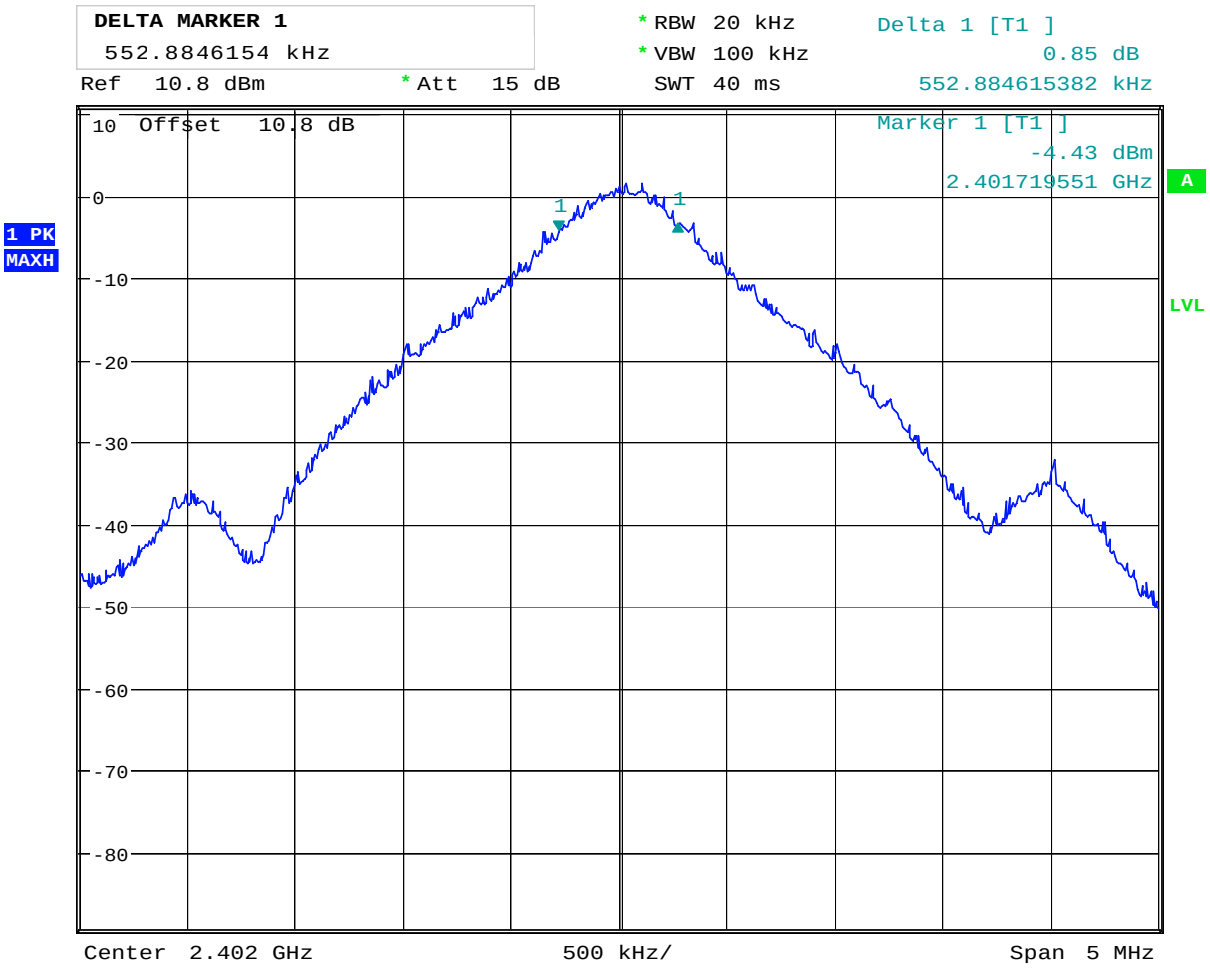
Measurement Data:

Measured 6 dB Bandwidth (MHz)		
2402MHz	**2440 MHz**	**2480MHz**
0.552	0.673	0.608

Conducted measurements

Requirements:

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



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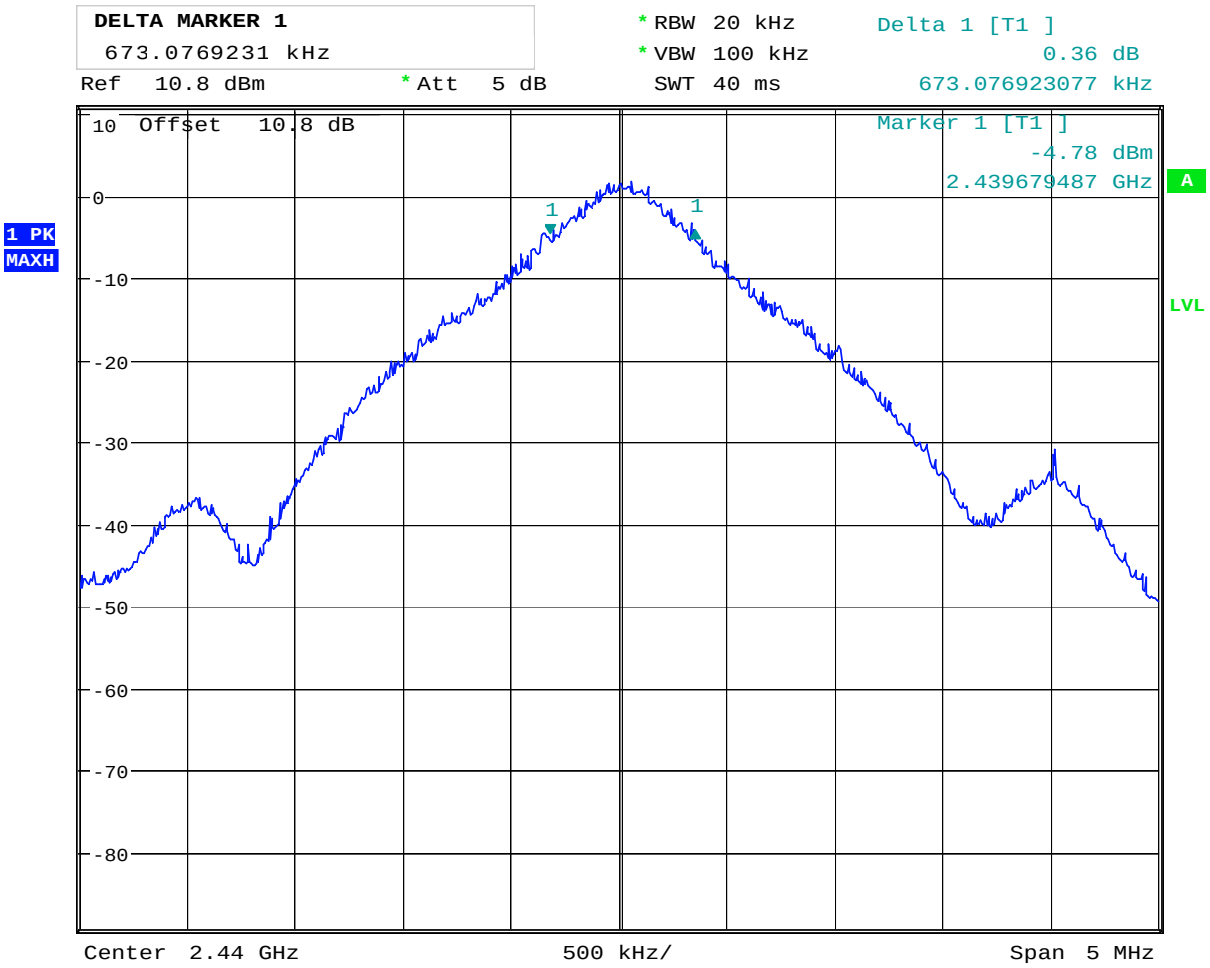
6 dB Bandwidth at 2402 MHz



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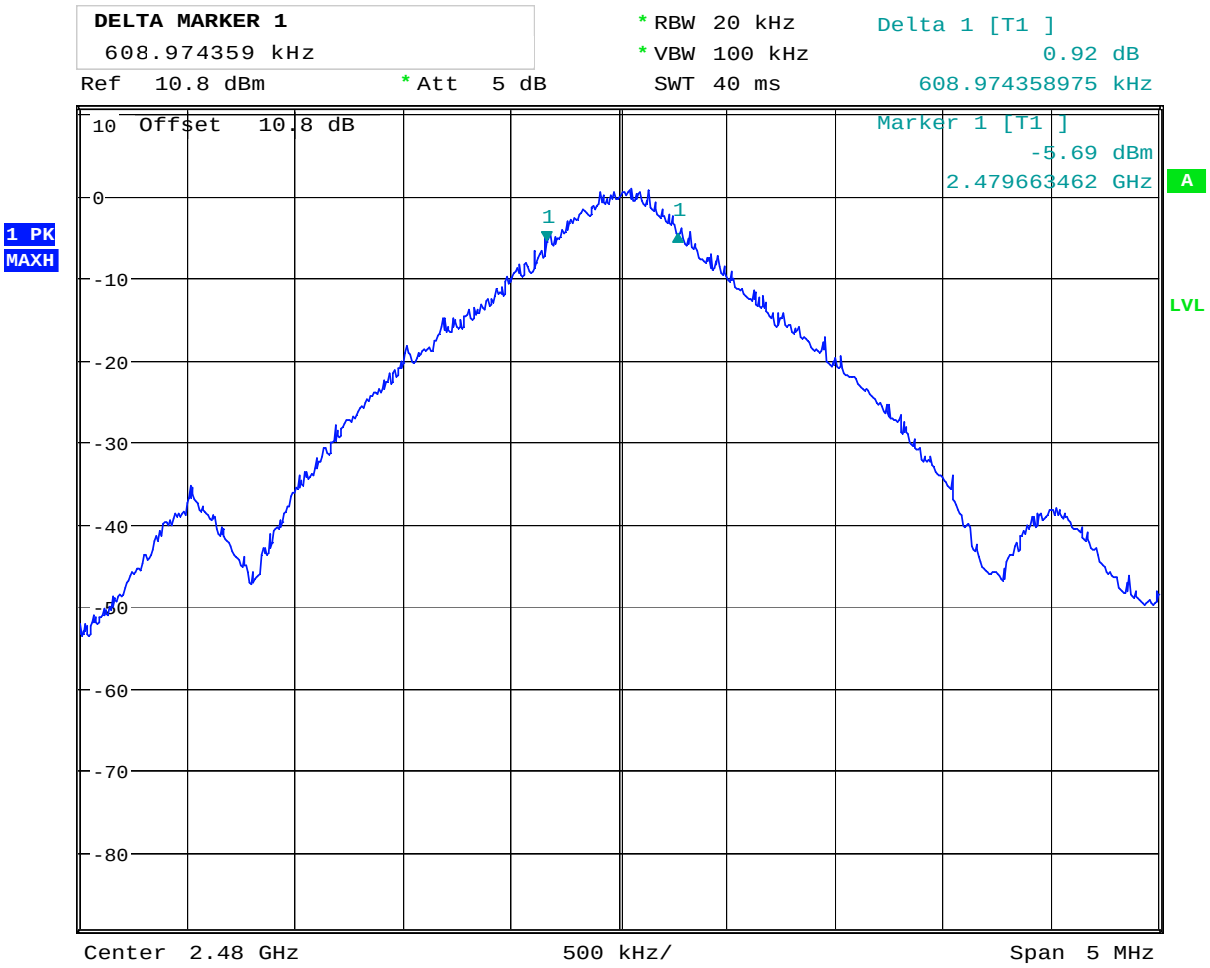
6 dB Bandwidth at 2440 MHz



Date: 24.MAR.2012 08:22:50

6 dB Bandwidth at 2480 MHz

4.2 20 dB Bandwidth

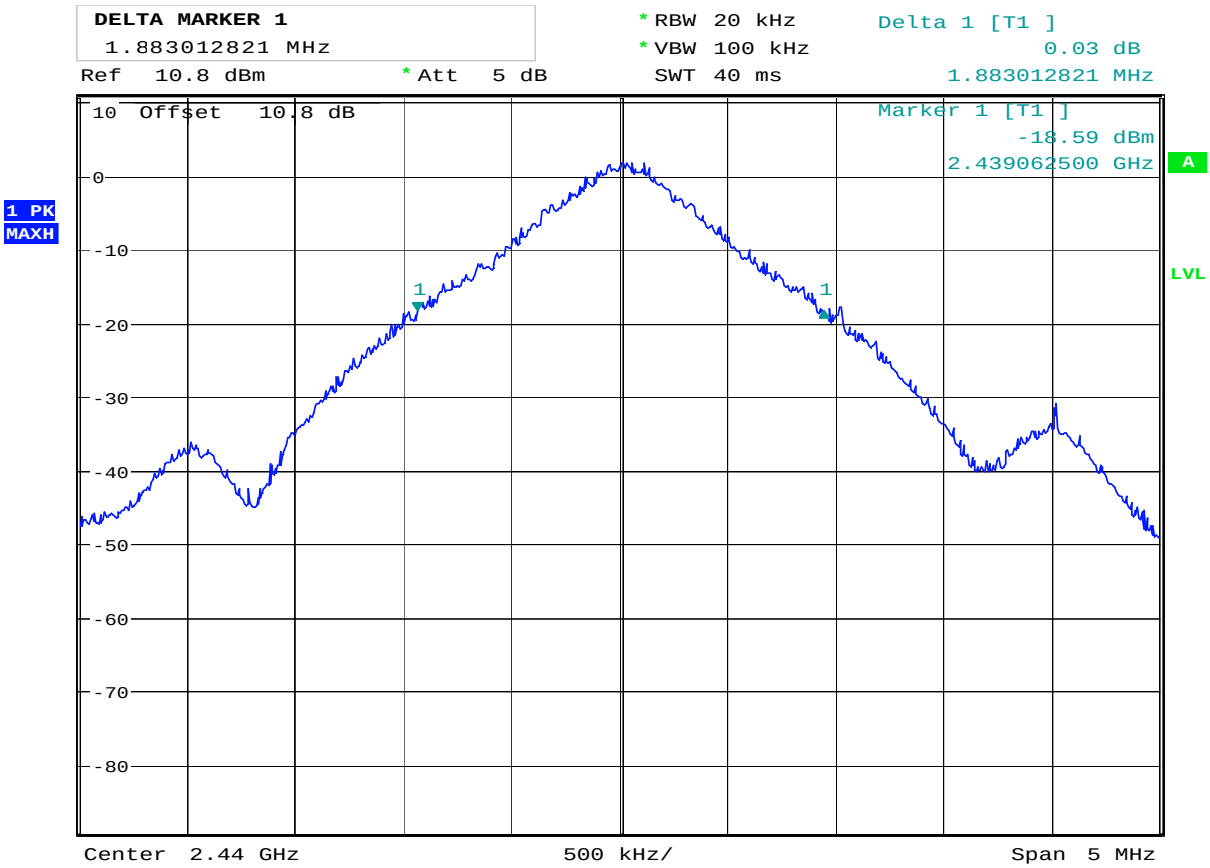
Test Performed By: G.Suhanthakumar	Date of Test: 24 Mar 2012

Measurement Data:

Measured 20 dB Bandwidth (MHz)
2440 MHz
1.88

Requirements:

No requirements. Reported for information only.



Date: 24.MAR.2012 08:20:14

20 dB Bandwidth at 2440 MHz

4.3 Peak Power Output

Para. No.: 15.247 (b)

Test Performed By: G.Suhanthakumar	**Date of Test: 22 -24 Mar 2012**

Test Results: Complies

Measurement Data:

RF channel	**2402 MHz**	**2440 MHz**	**2480 MHz**
Conducted Power (dBm)	5.49	5.37	4.96
Conducted Power (mW)	3.54	3.44	3.13
Measured Maxium Field strength (dBµV/m) –VP	102.16	101.21	100.99
Radiated Power (dBm)	6.93	5.98	5.76
Antenna Gain (dB)	1.44	0.61	0.80

Radiated Power is calculated from measured field strength by the formula in DA00-705.

See attached graph.

Detachable antenna? ☐ Yes ☒ No

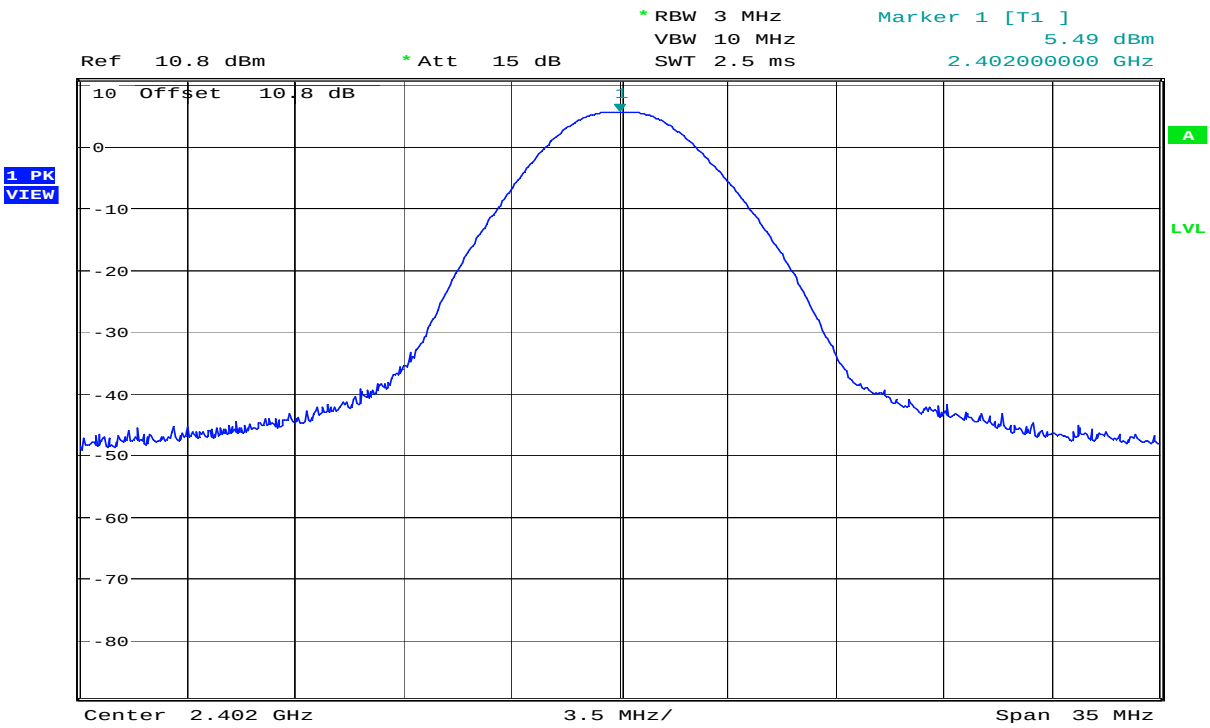
If detachable, is the antenna connector non-standard? ☐ Yes ☐ No

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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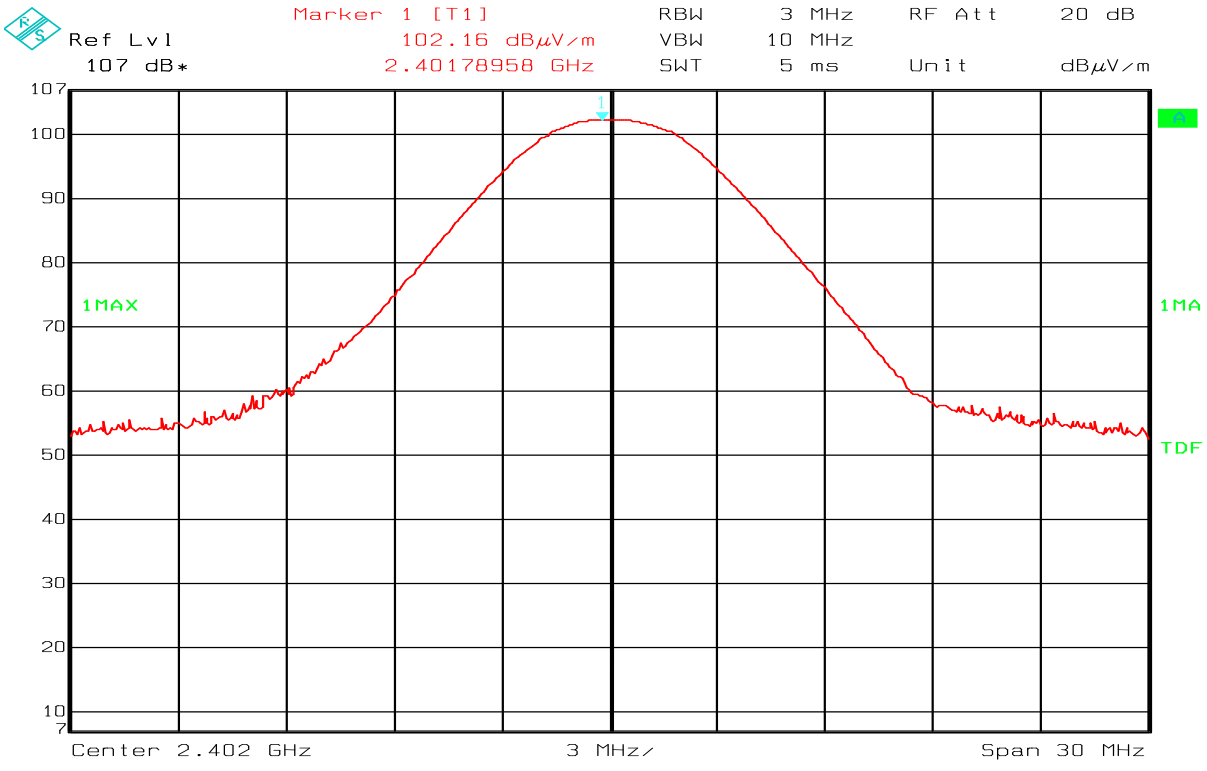
Conducted Power, 2402 MHz



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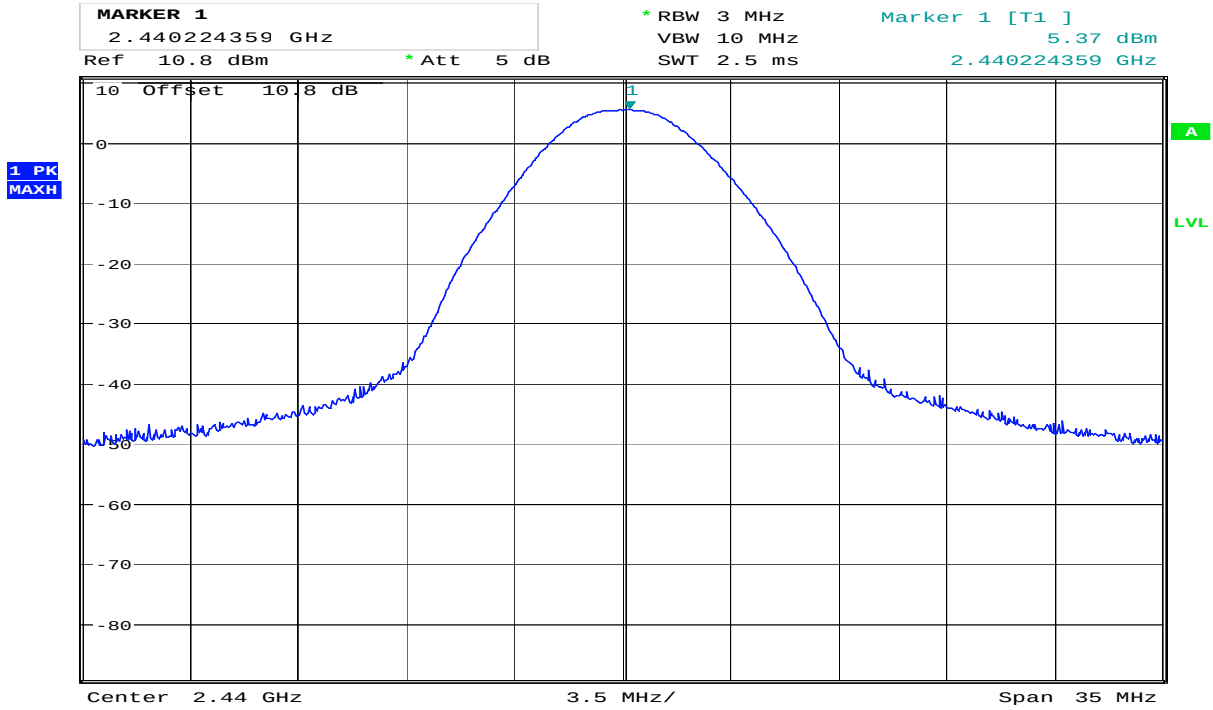
Radiated Field strength,VP , 2402 MHz



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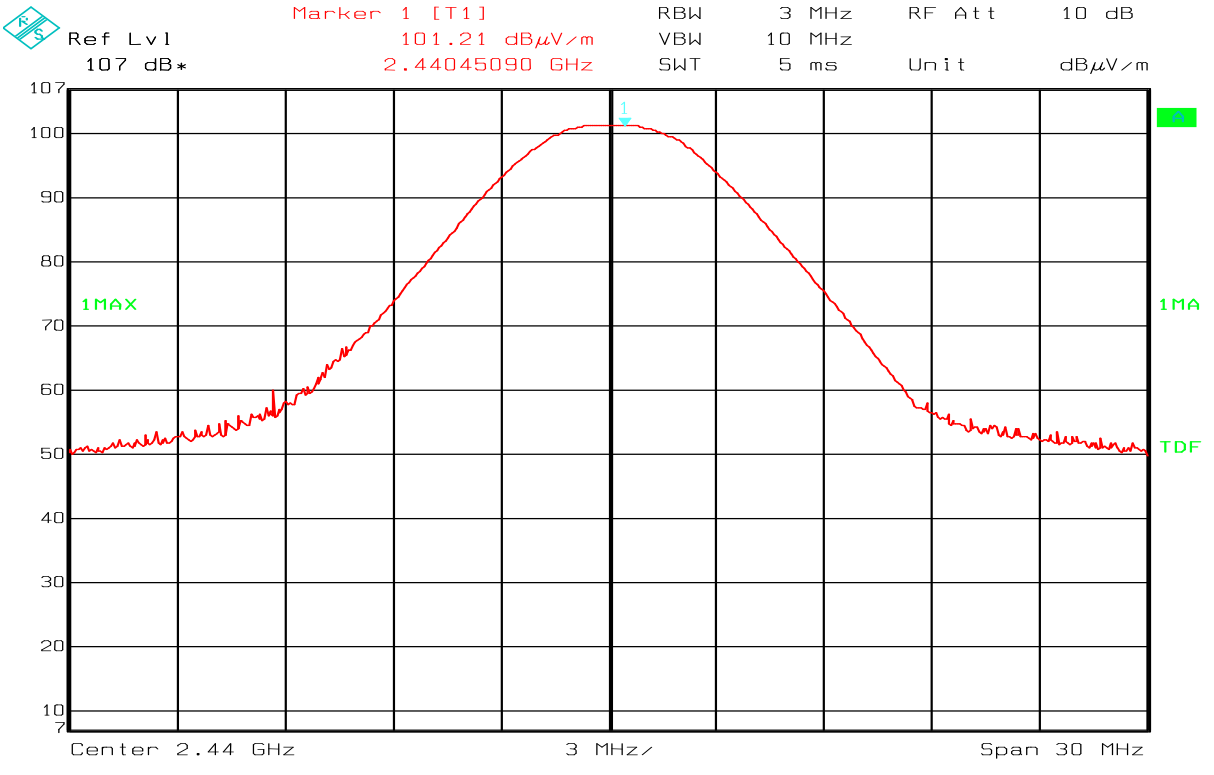
Conducted Power, 2440 MHz



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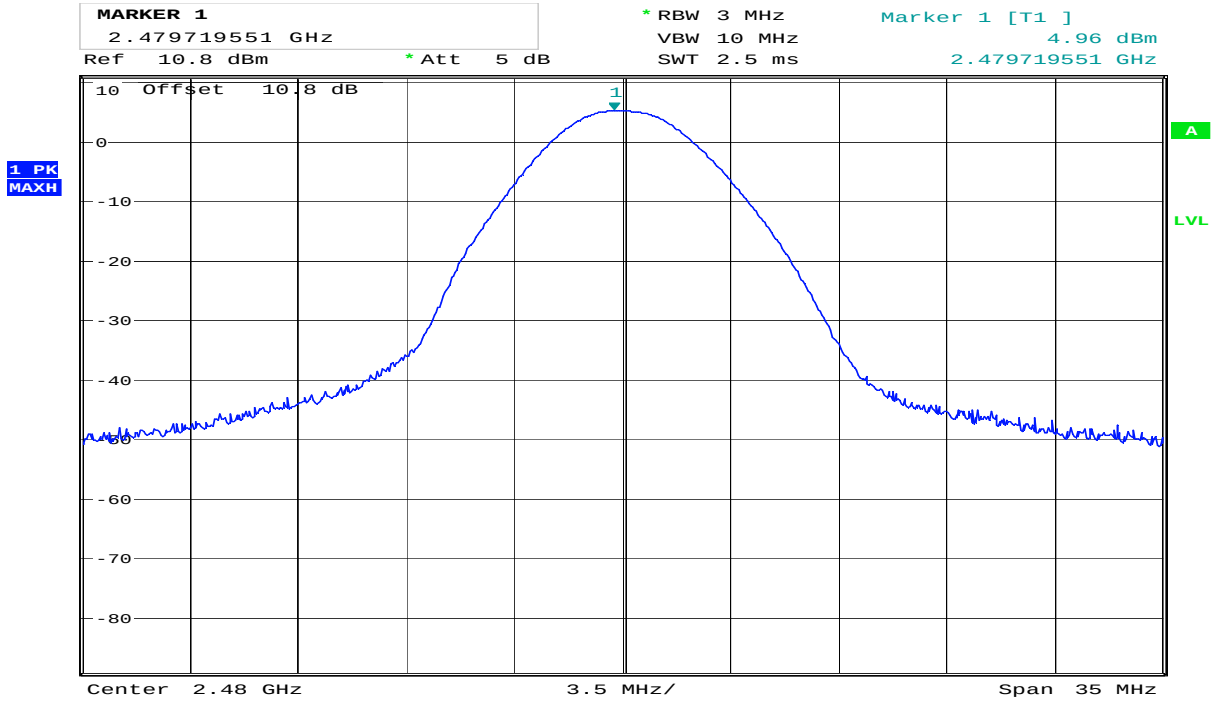
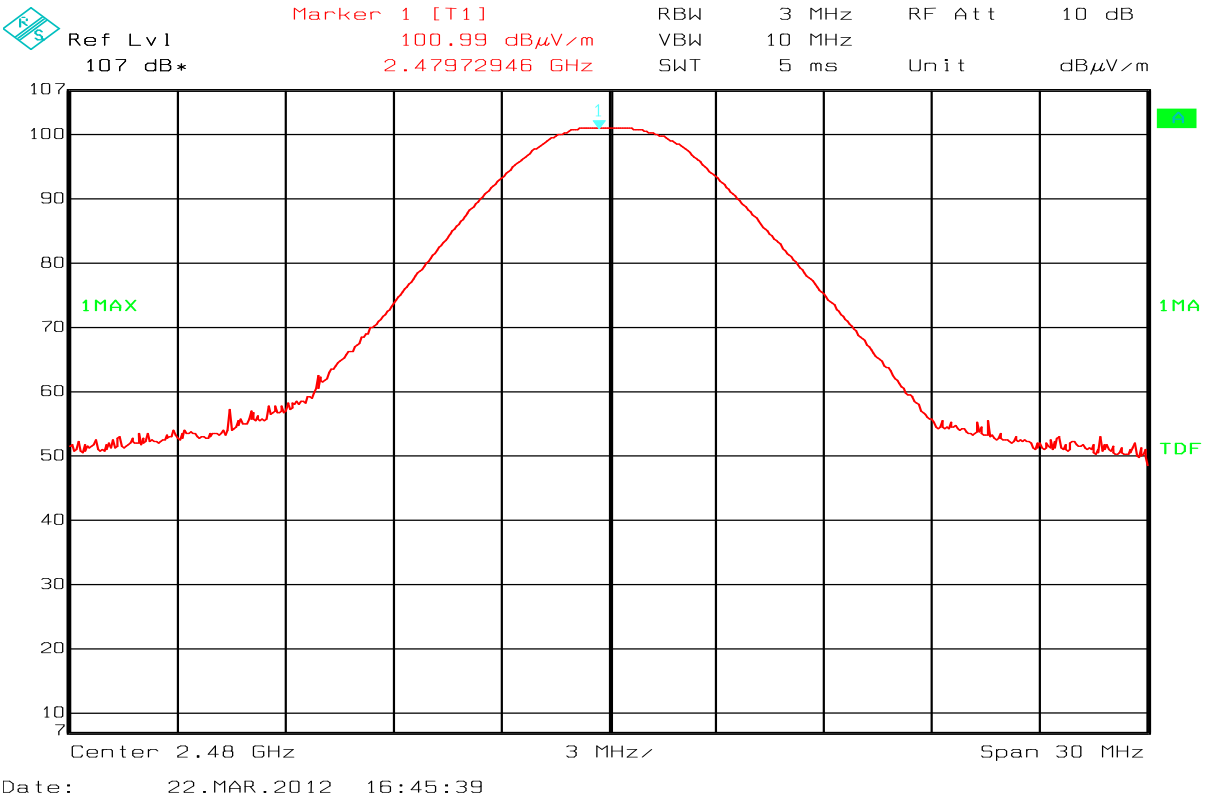
Radiated field strength,VP, 2440 MHz



Conducted Power, 2480 MHz



Radiated field strength, 2480 MHz

4.4 Spurious Emissions (Radiated)

Para. No.: 15.247 (c)

Test Performed By: G.Suhanthakumar	**Date of Test: 22 Mar 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	-	AV	54	-
	47.67	PK	74	26.33
2.4835 GHz	-	AV	54	-
	48.46	PK	74	25.54

See attached plots.

Marker Delta Calculation:

Lower Band:

Max: 102.16 dBµV/m

Delta : 54.49 dB

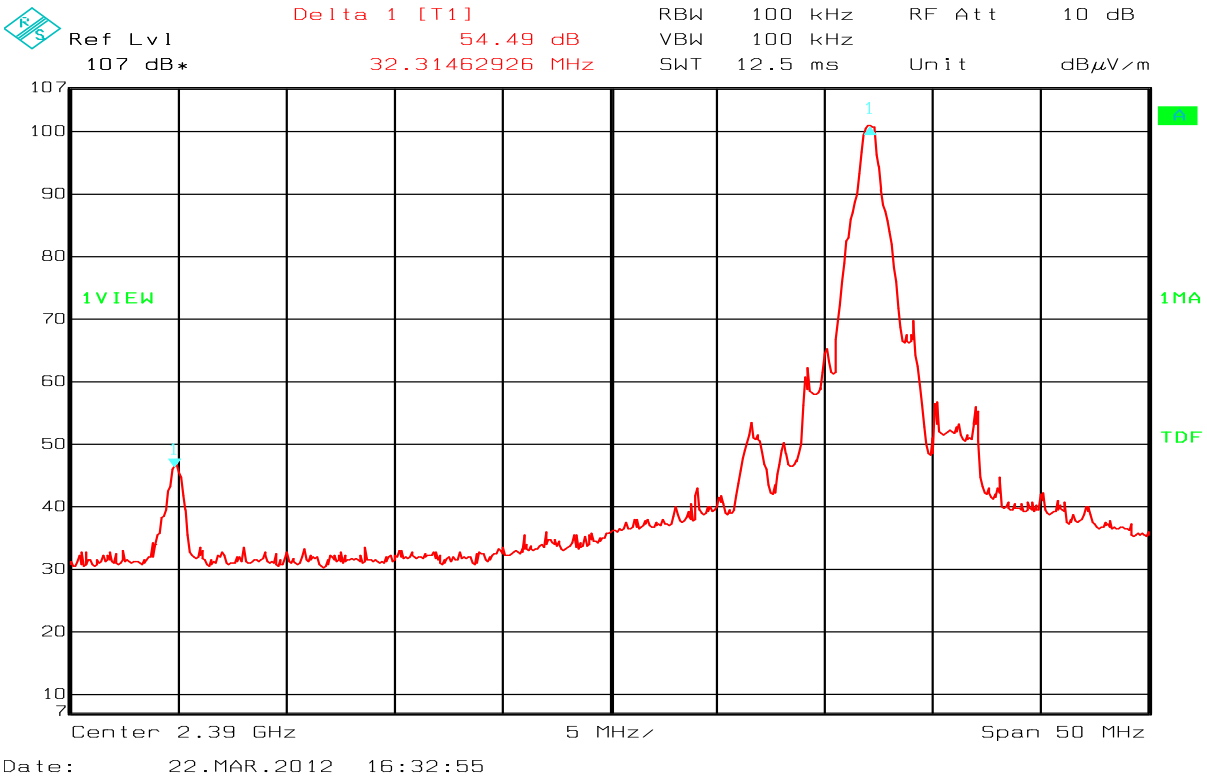
Band Edge Field Strength, Peak: 101.85 – 54.49 dBµV/m = 47.67 dBµV/m

RF conducted power

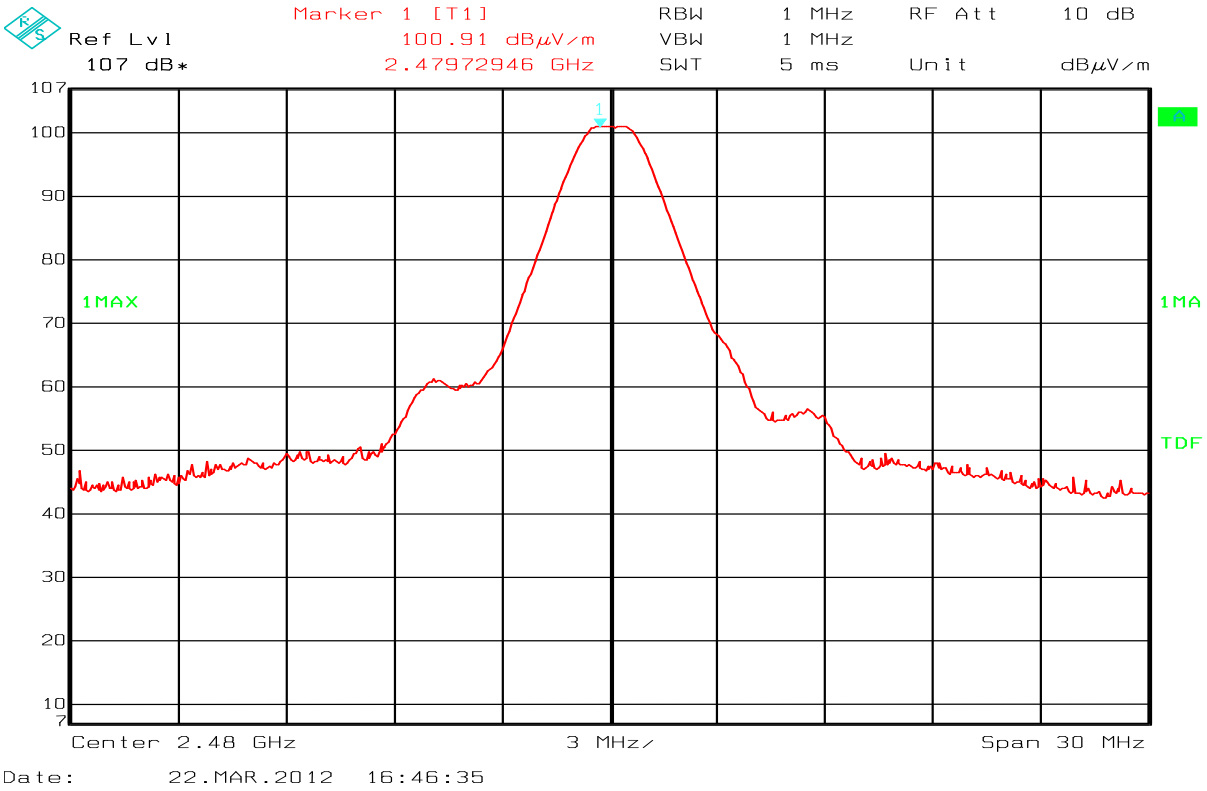
Scan performed radiated with 100 kHz Bandwidth from 0.001 to 25 GHz.

All emissions are more than 20dB below carrier.

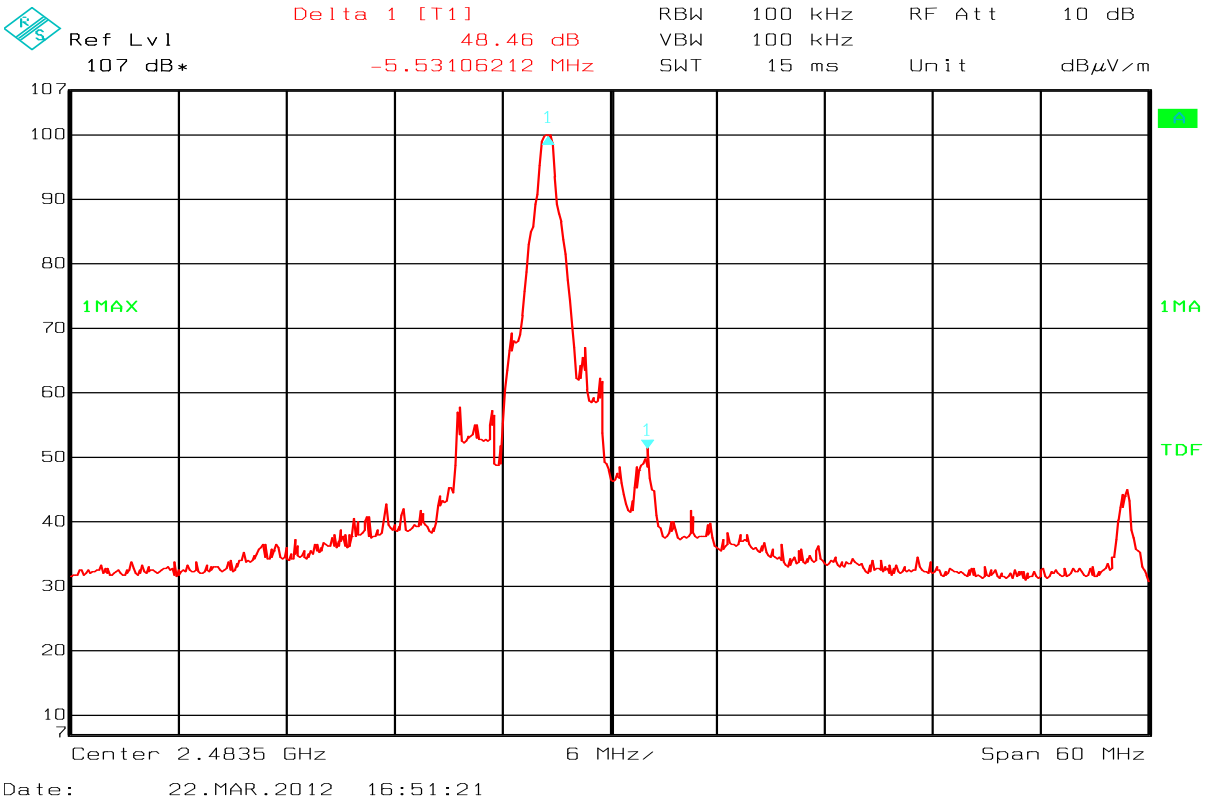
See plots.



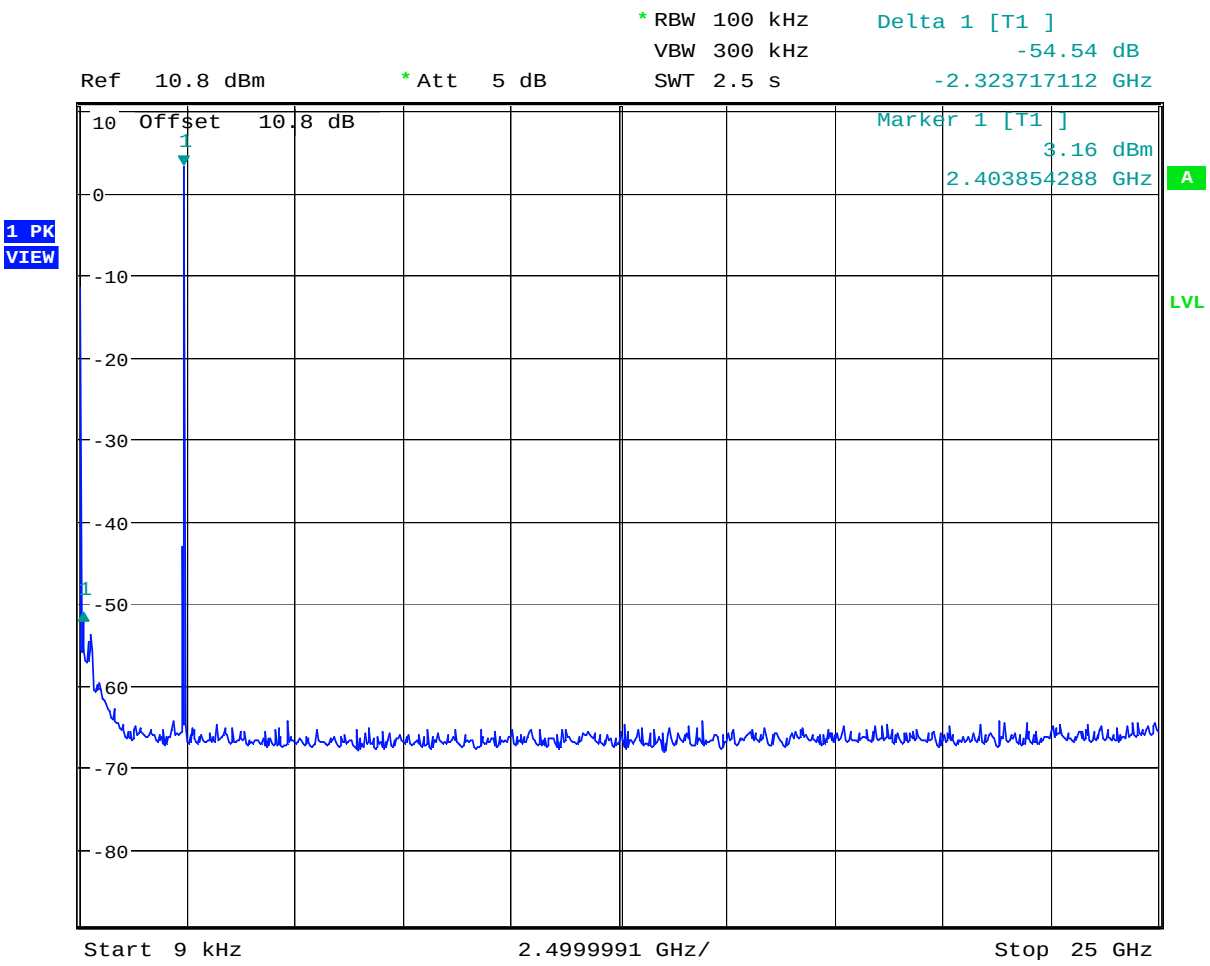
Band Edge, 2390 MHz, Peak Detector



Band Edge, 2483.5 MHz, Marker Delta, Max



Band Edge, 2483.5 MHz, Marker Delta, PK detector



Date: 24.MAR.2012 08:25:19

Conducted Emissions, 9kHz – 25GHz

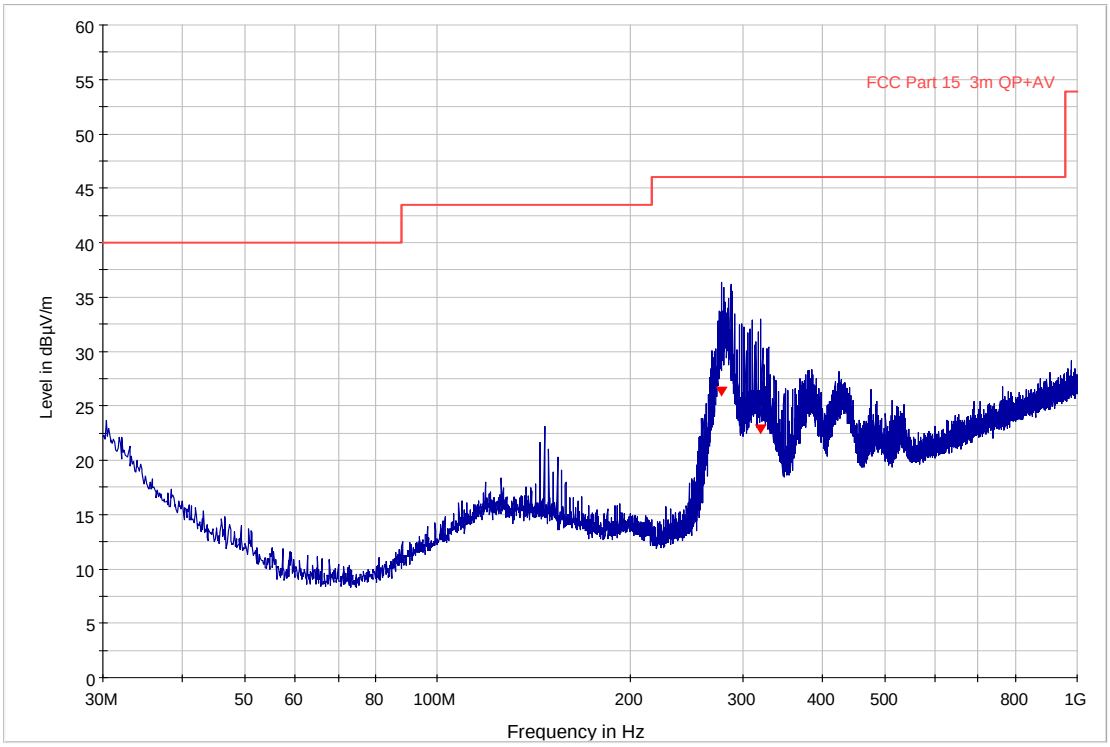
Radiated emission 30 – 1000 MHz.

Detector: Peak

Measuring distance 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

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
277.812984	26.3	1000.0	120.000	100.0	H	111.0	-9.1	19.7	46.0	
319.941499	22.8	1000.0	120.000	100.0	H	106.0	-8.4	23.2	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.

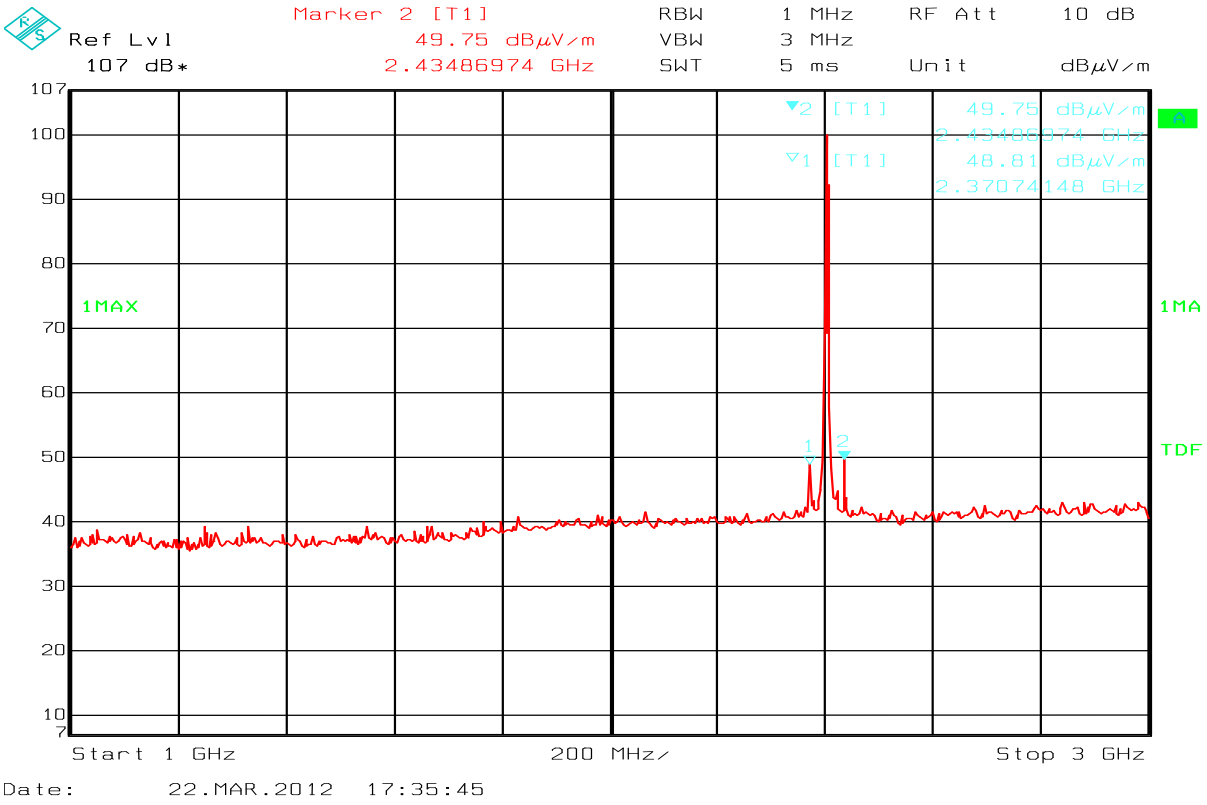
Frequency MHz	Field strength @1 & 3m dBµV/m	Detector	Limit dBµV/m	Margin dB
Ch 2402	None detected	Pk	-	-
Ch 2440	None detected	Pk	-	-
Ch 2480	None detected	Pk	-	-

The detected spurious emission is receiver LO leakage frequency .Please see cl.4.5 of this test report for receiver spurious emission.

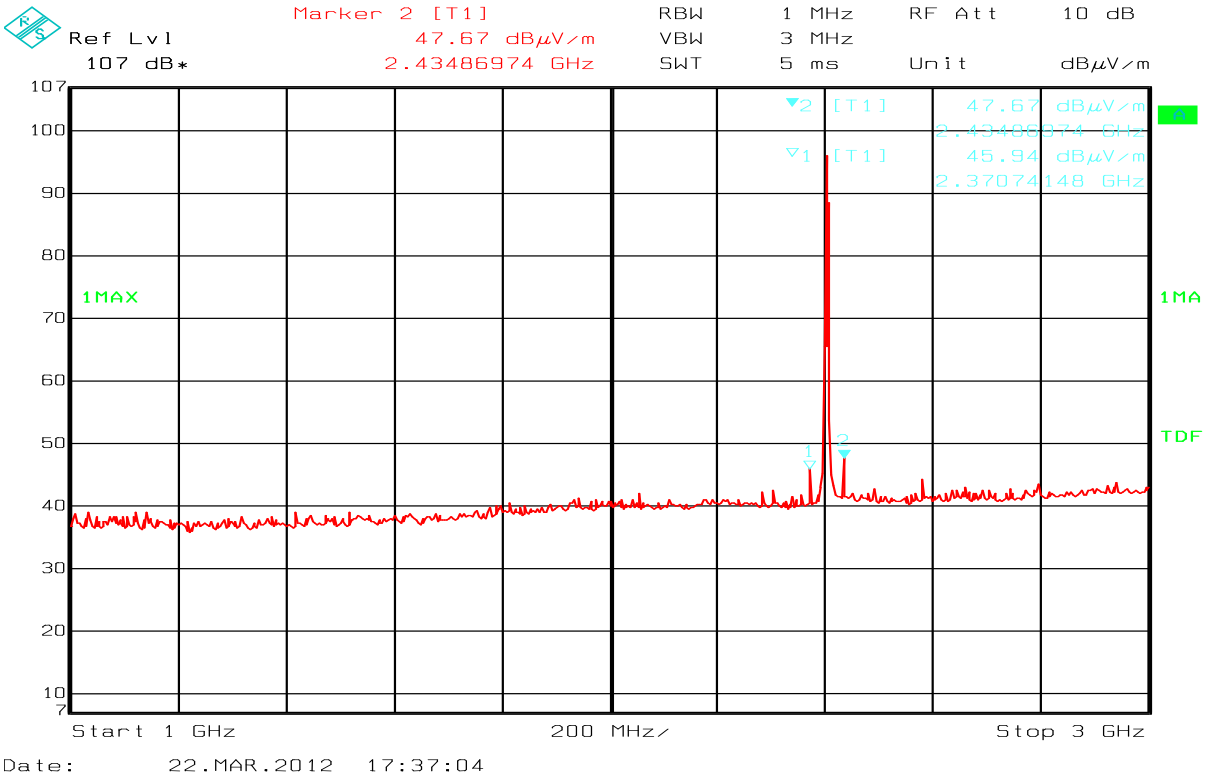
All emissions are below the Average Limit, even when measured with Peak Detector.

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

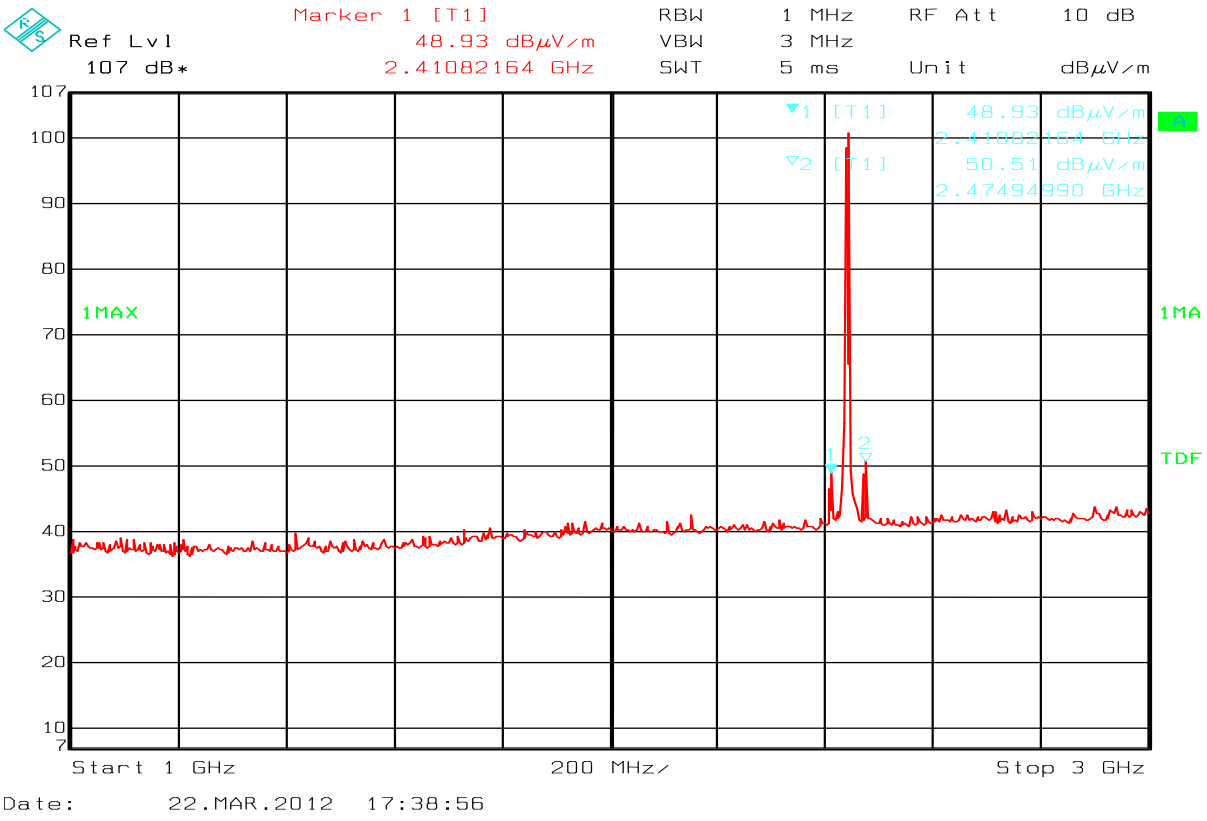
See attached graphs.



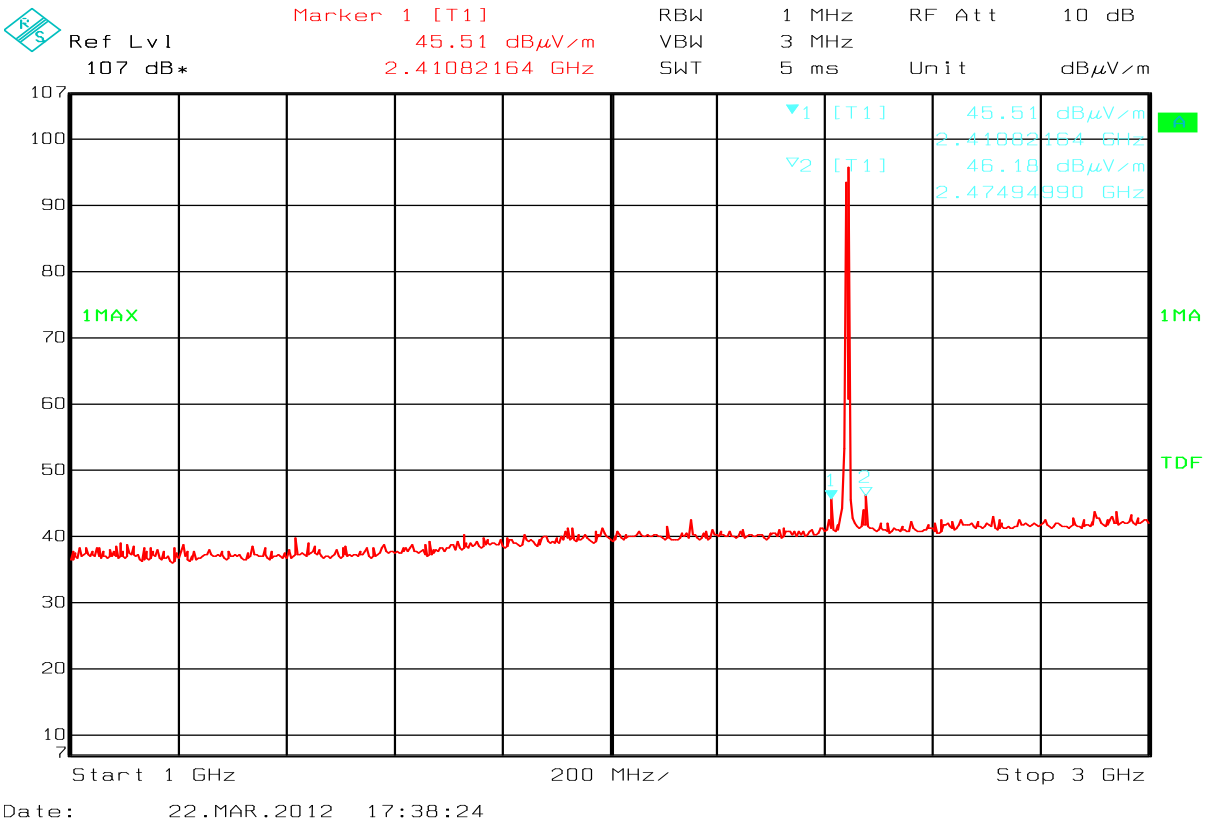
Radiated Emissions, 1 – 3 GHz, VP, @3m, ch 2402MHz



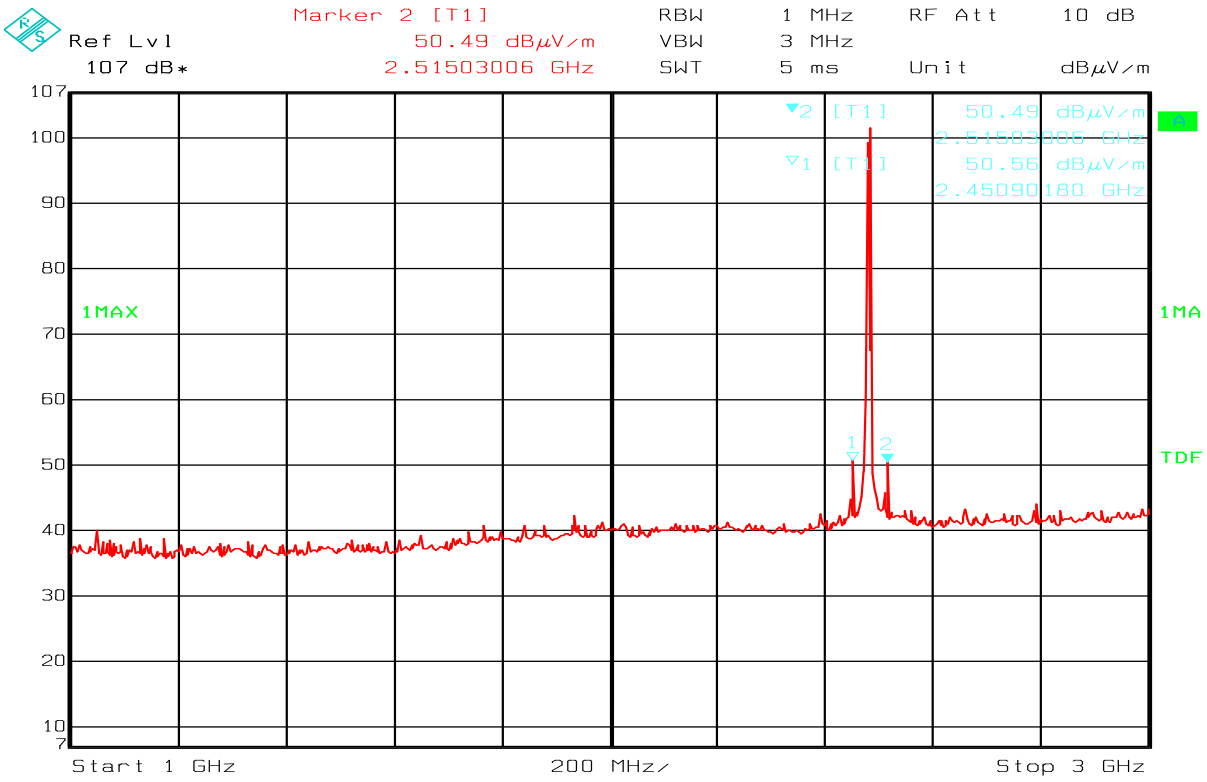
Radiated Emissions, 1 – 3 GHz, HP, @3m, Ch 2402MHz



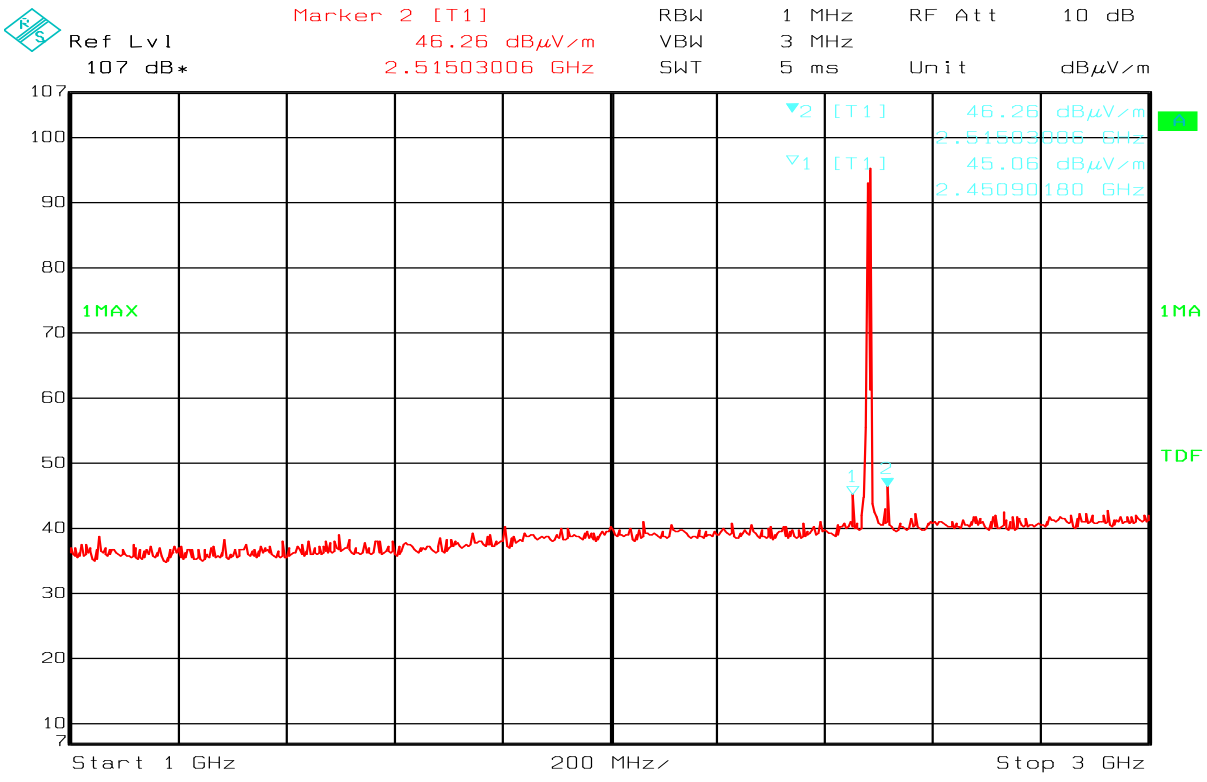
Radiated Emissions, 1 – 3 GHz, VP, @3m, Ch 2440MHz



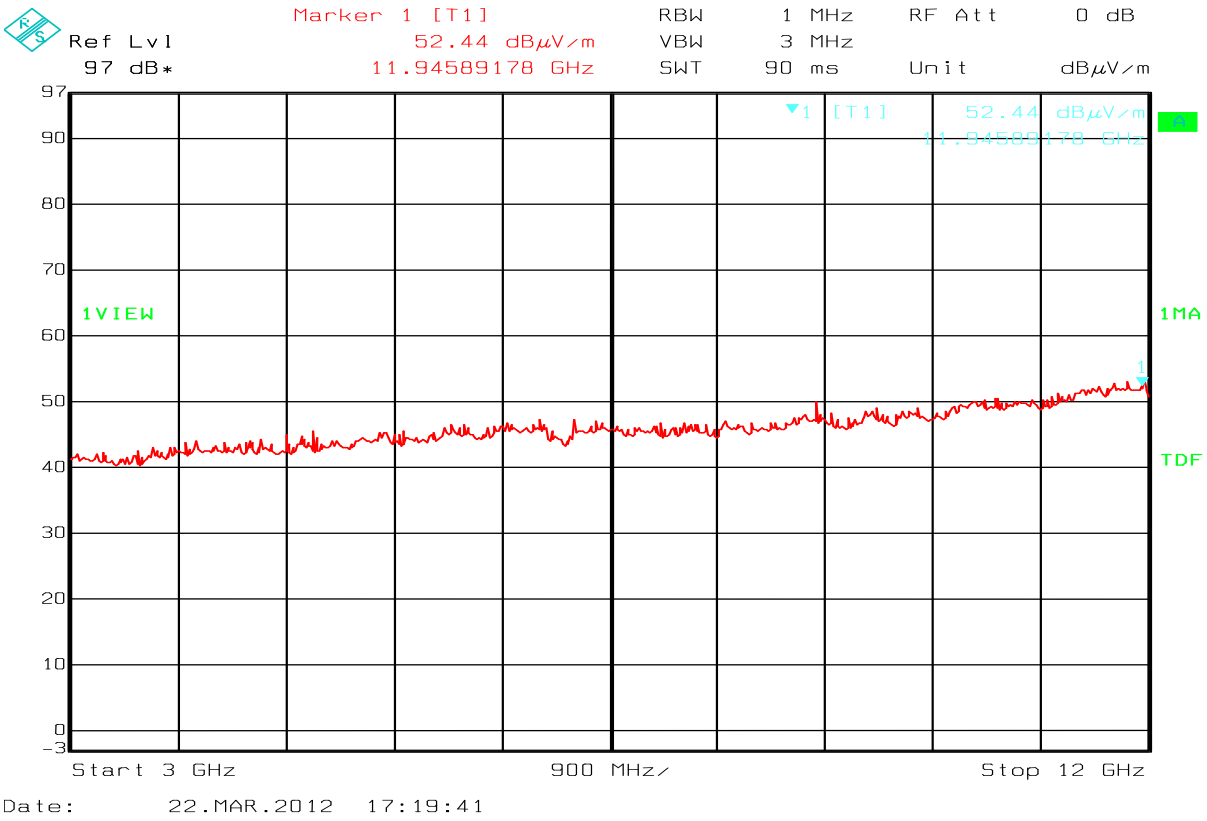
Radiated Emissions, 1 – 3 GHz, HP, @3m, Ch 2440MHz



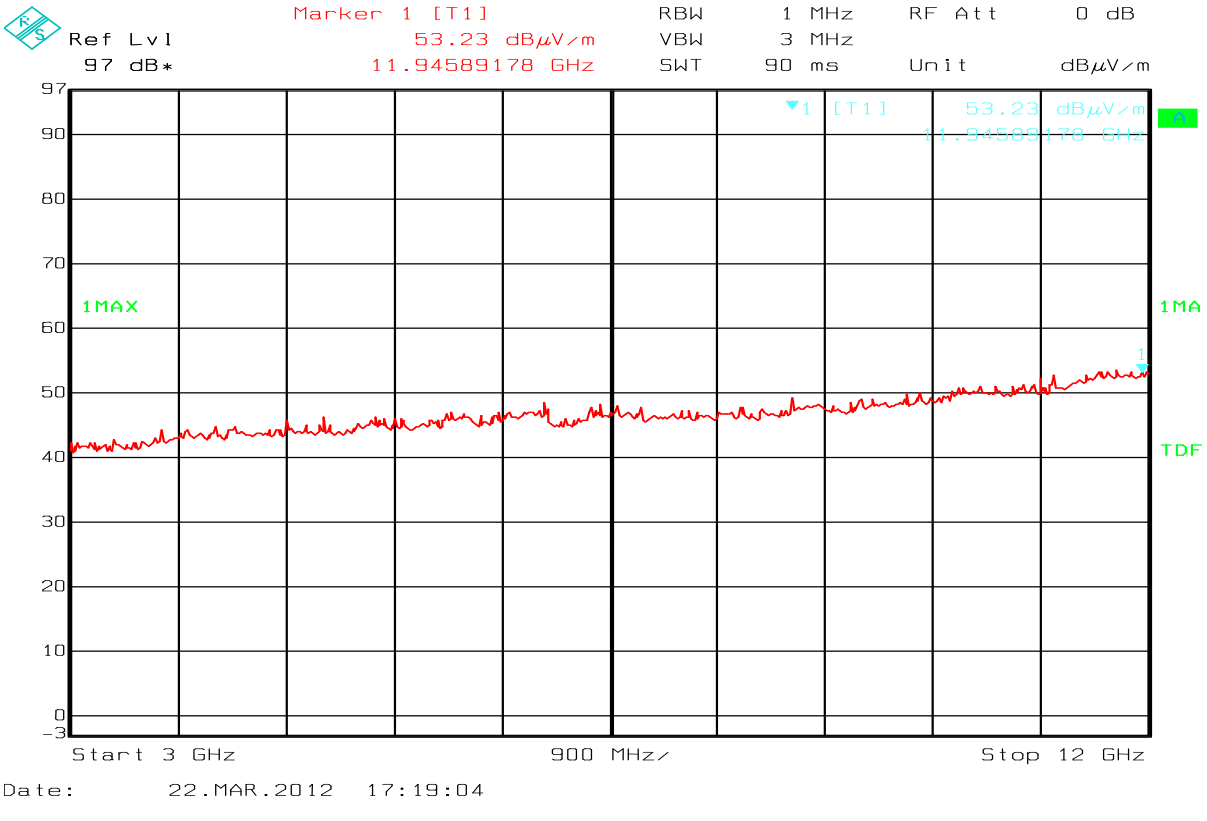
Radiated Emissions, 1 – 3 GHz, VP, @3m, Ch 2480MHz



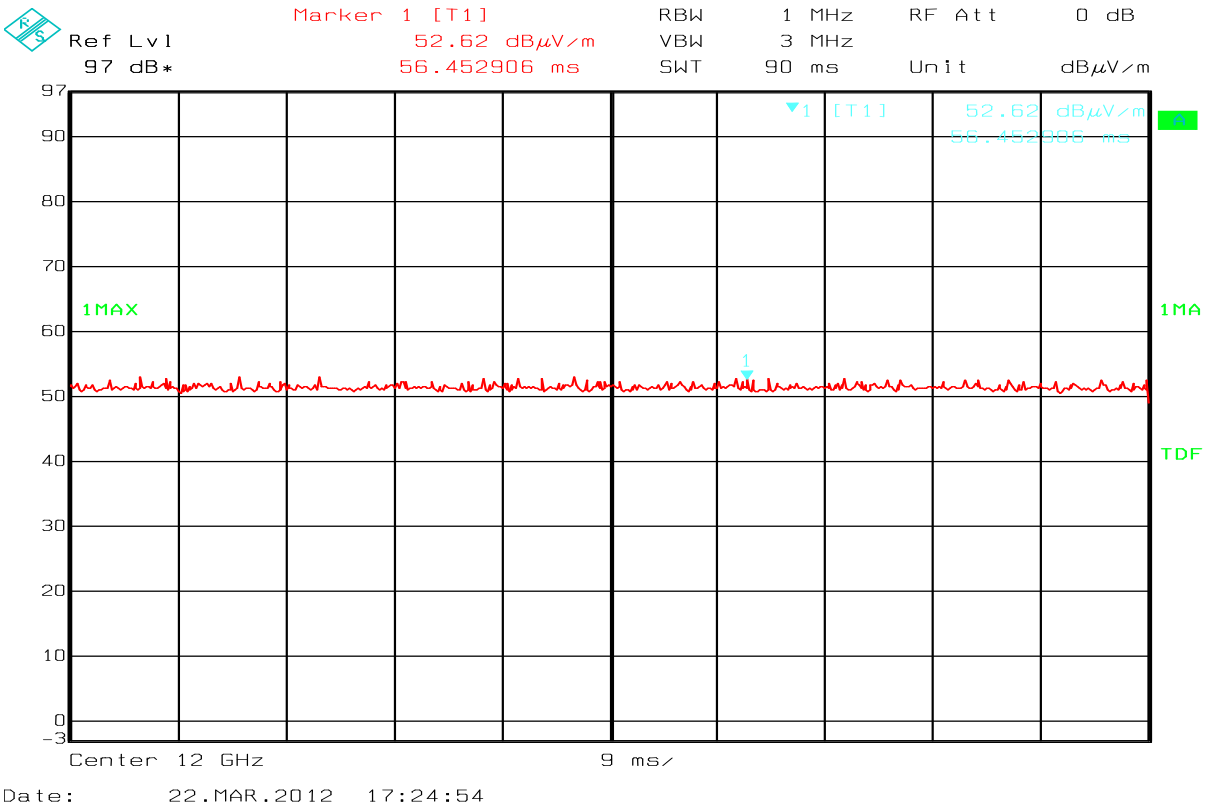
Radiated Emissions, 1 – 3 GHz, HP, @3m, Ch 2480MHz



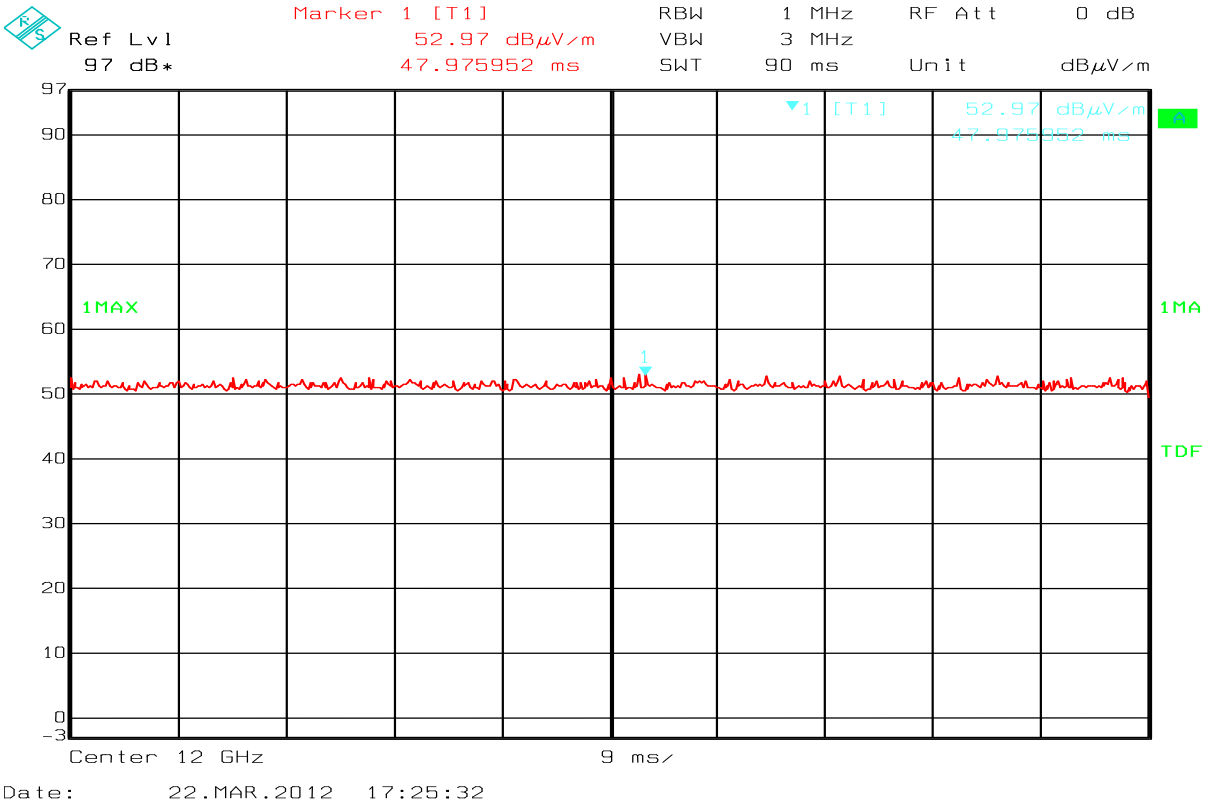
Radiated Emissions, 3 – 12 GHz, VP, @1m, with HP filter



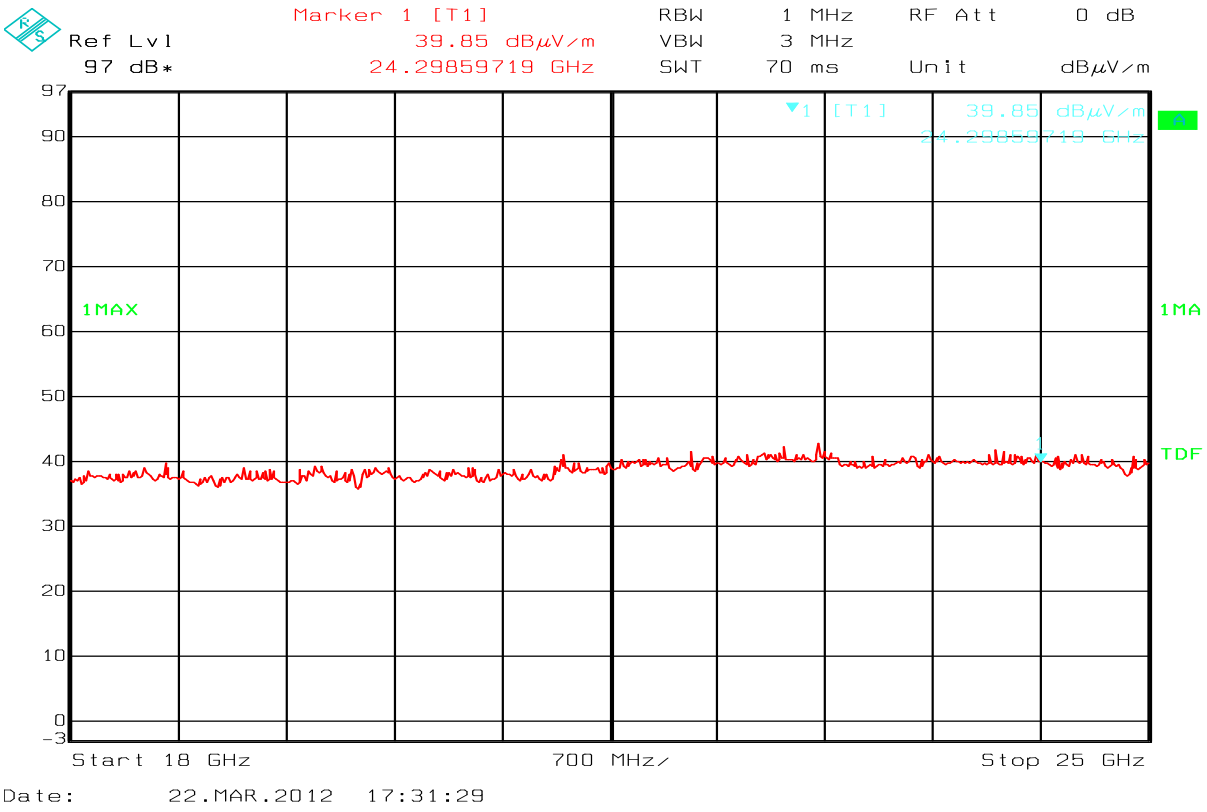
Radiated Emissions, 3 - 12GHz, HP, @1m,– with HP filter



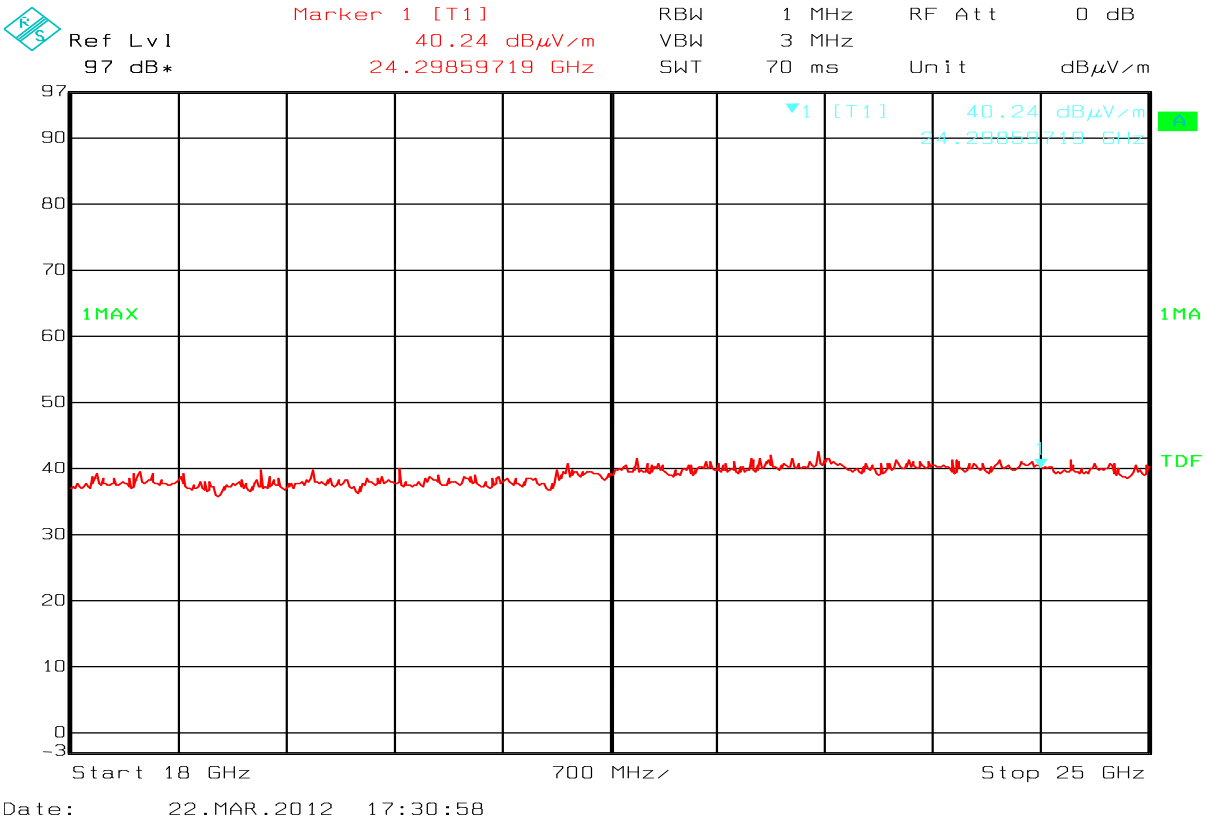
Radiated Emissions, 12 – 18 GHz, VP, @1m – pre-view scan



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



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



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

4.5 Receiver Spurious Emissions

Para. No.: 15.109 (a)

Test Performed By: G.Suhanthakumar	**Date of Test: 22 Mar 2012**

Measurement Procedure:

Industry Canada RSS-210 paragraph 2.3 and RSS-GEN paragraphs 4.10 and 6.

Test results:

RX LO leakage detected in the restricted band.

Channel MHz	Frequency MHz	Field strength @3m dBµV/m	Detector	Limit dBµV/m	Margin dB
Ch 2402	4804	46.18	Pk	54	7.82
Ch 2440	4880	47.85	Pk	54	6.15
Ch 2480	4960	49.66	Pk	54	4.34

The maximum detected at VP.

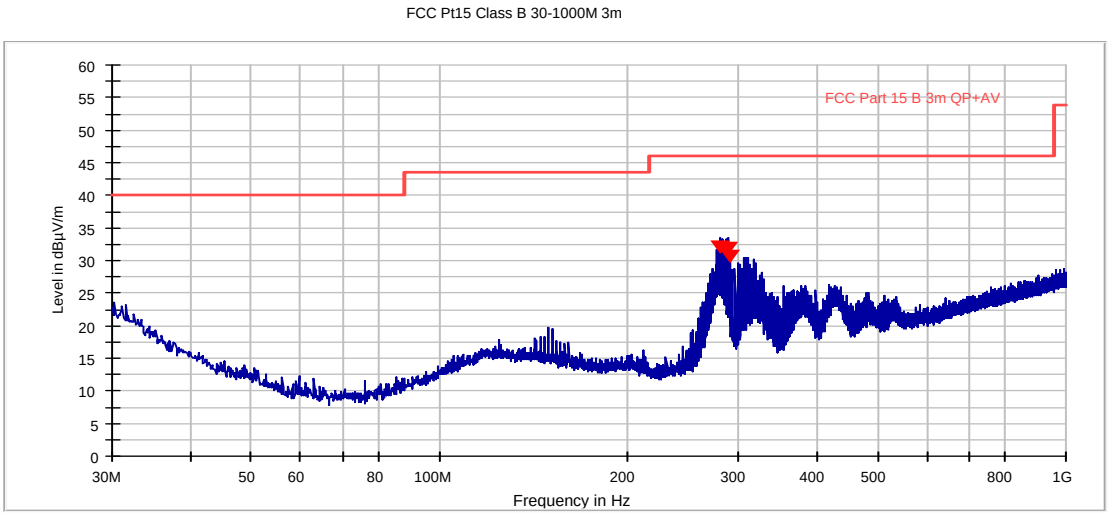
The measurement was performed radiated with the EUT in receive-only mode.

Requirements, RSS-GEN Issue 3, clause 6

The measurement can be performed either radiated or conducted.

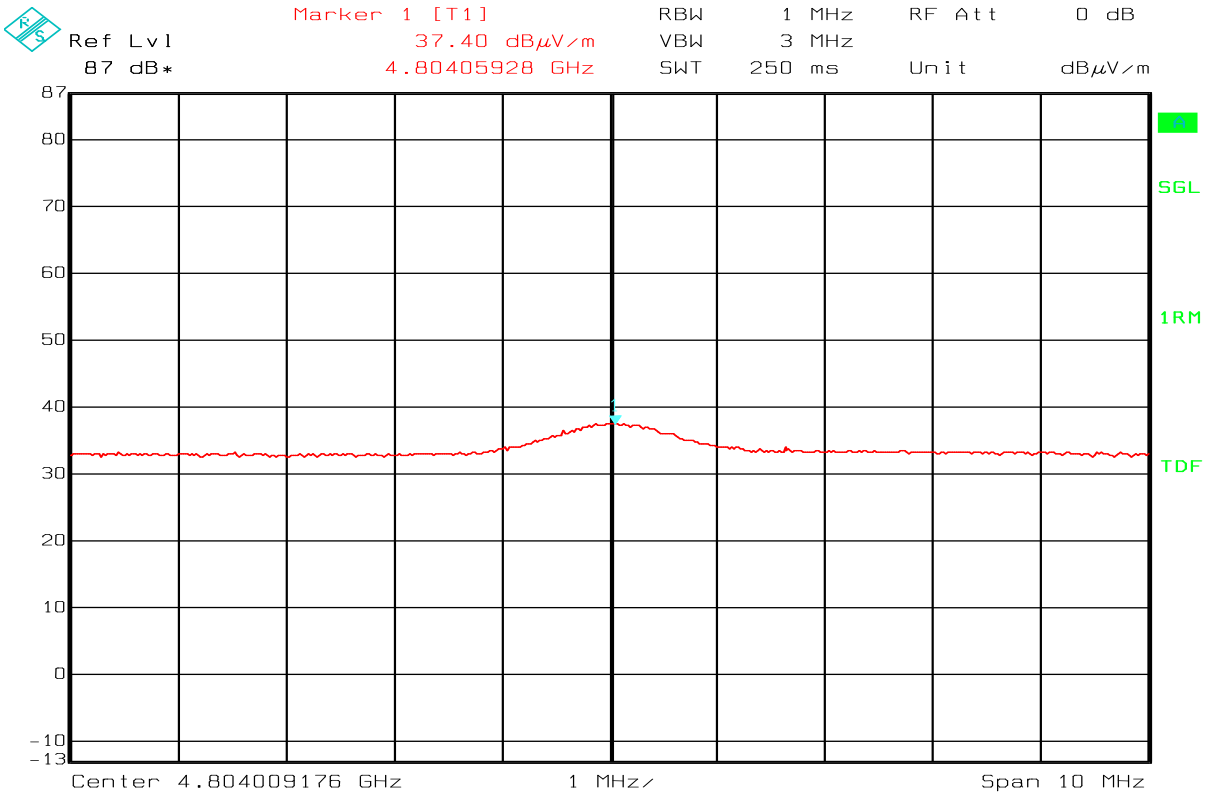
When measured Conducted*:* no spurious signals appearing at the antenna terminals shall exceed 2 nW per any 4 kHz spurious frequency in the band 30-1000 MHz, or 5 nW above 1 GHz.

When measured Radiated: See Table 2 in RSS-GEN Issue 3, clause 6.

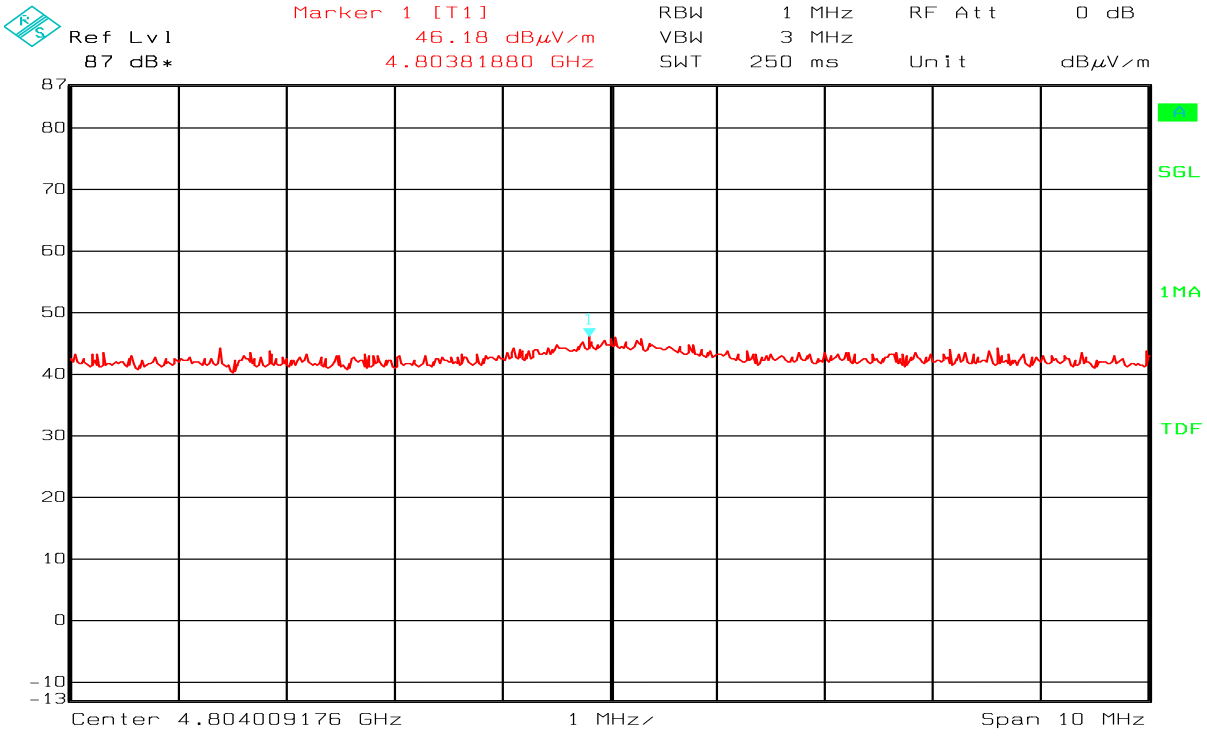


Radiated : RX - 30 1000MHz @ 3m

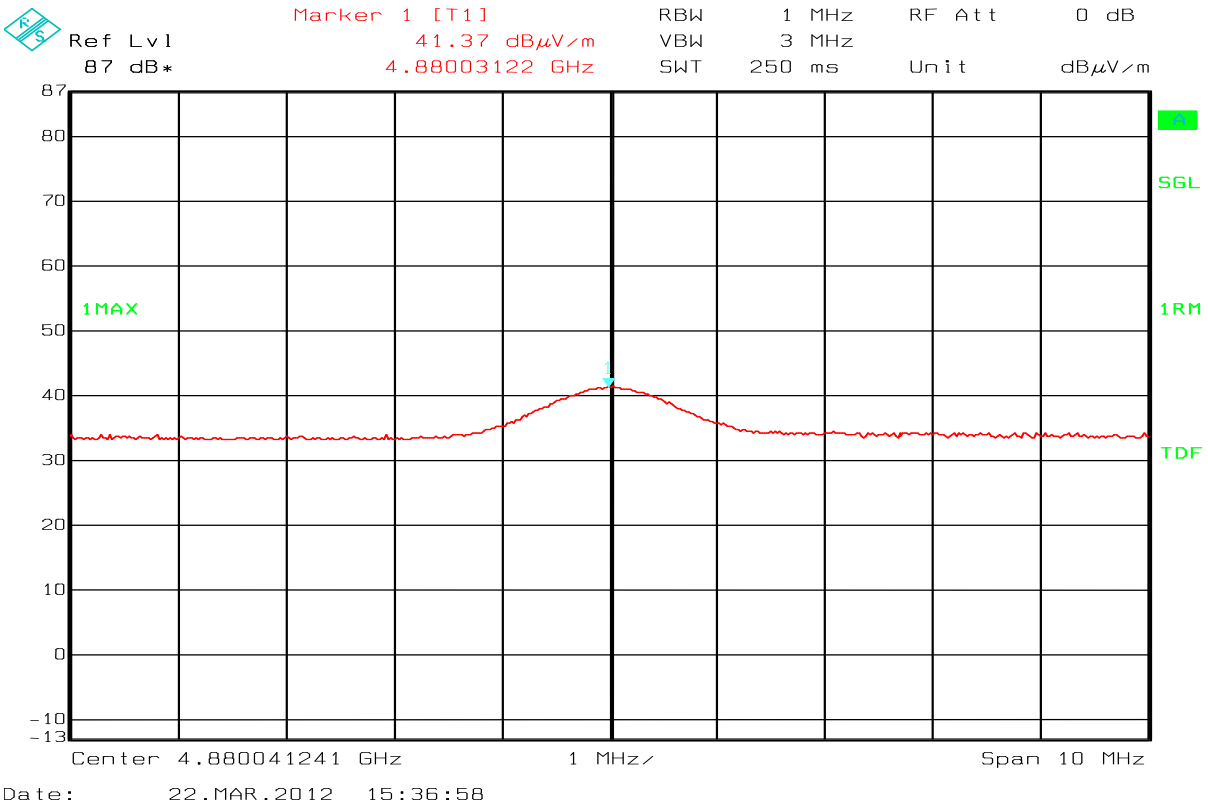
Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
279.977484	32.0	1000.0	120.000	100.0	H	293.0	-9.0	14.0	46.0	
289.315162	31.9	1000.0	120.000	100.0	H	98.0	-8.9	14.1	46.0	
291.652696	30.6	1000.0	120.000	100.0	H	99.0	-8.9	15.4	46.0	



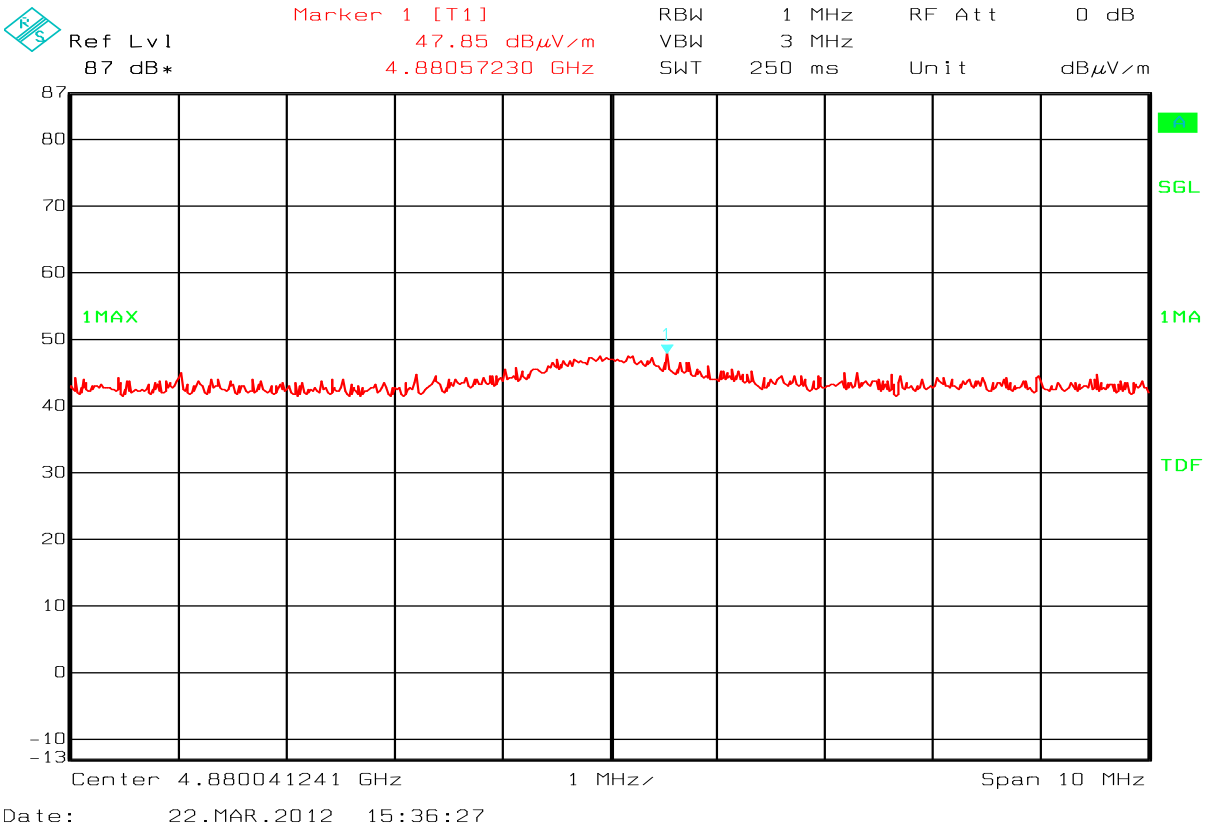
Receiver Radiated Emissions LO leakage, @ 2402MHz , VP - AV



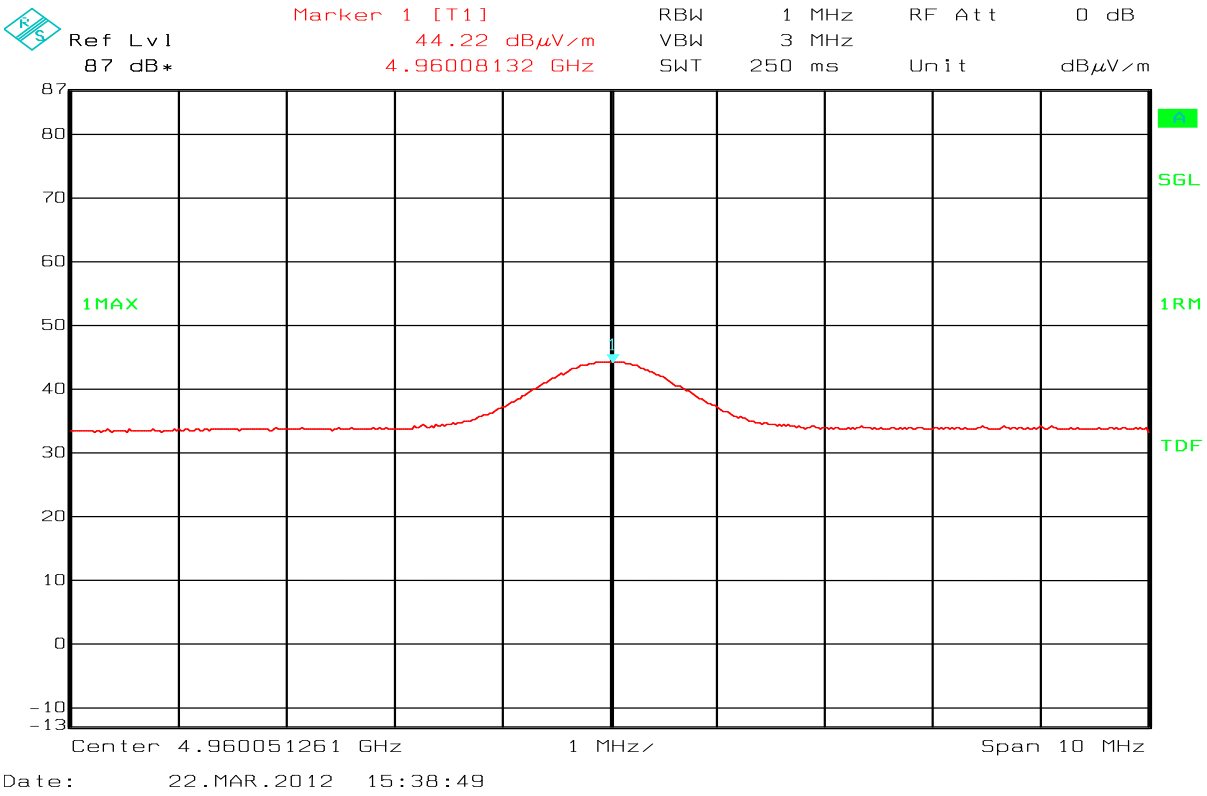
Receiver Radiated Emissions LO leakage, @ 2402MHz , VP - PK



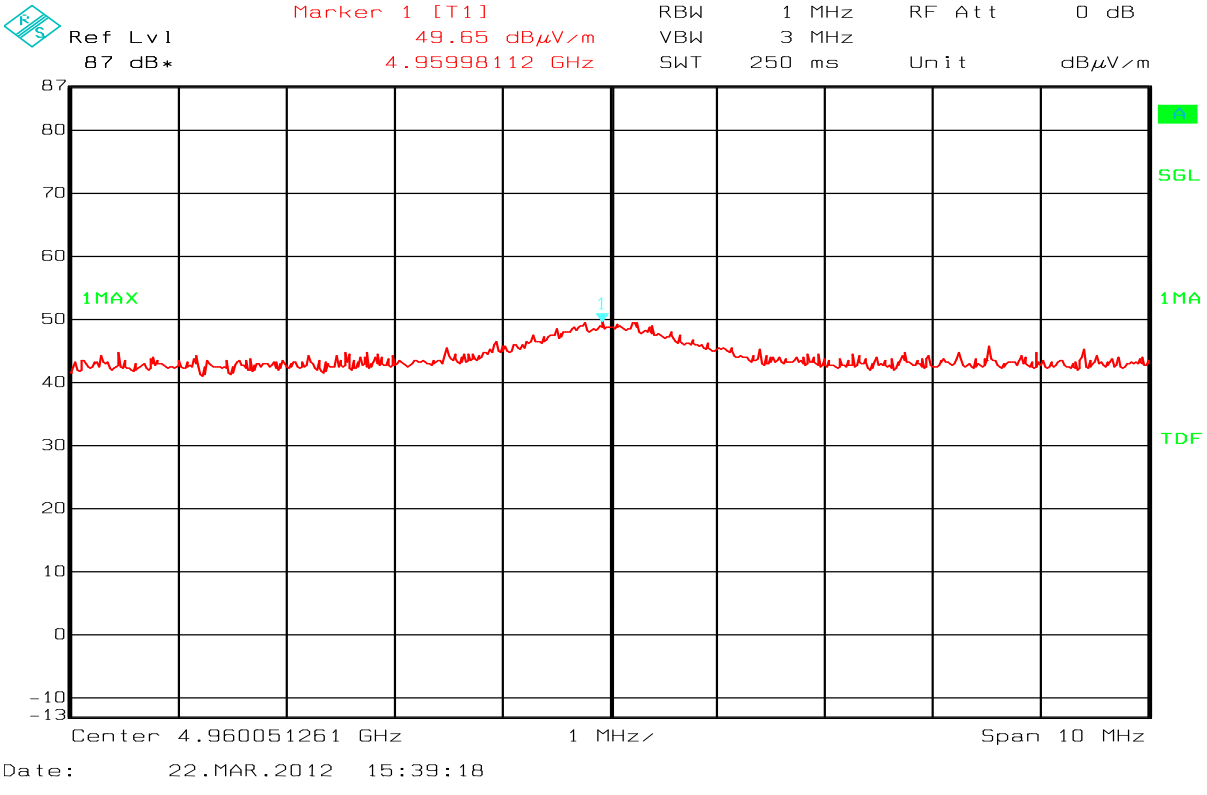
Receiver Radiated Emissions LO leakage, @ 2440MHz , VP - AV



Receiver Radiated Emissions LO leakage, @ 2440MHz , VP - PK



Receiver Radiated Emissions LO leakage, @ 2480MHz , VP - AV



Receiver Radiated Emissions LO leakage, @ 2480MHz , VP - PK

4.6 Power Spectral Density (PSD)

Para. No.: 15.247 (d)

Test Performed By: G.Suhanthakumar	**Date of Test: 23 Mar 2012**

Test Results: Passed

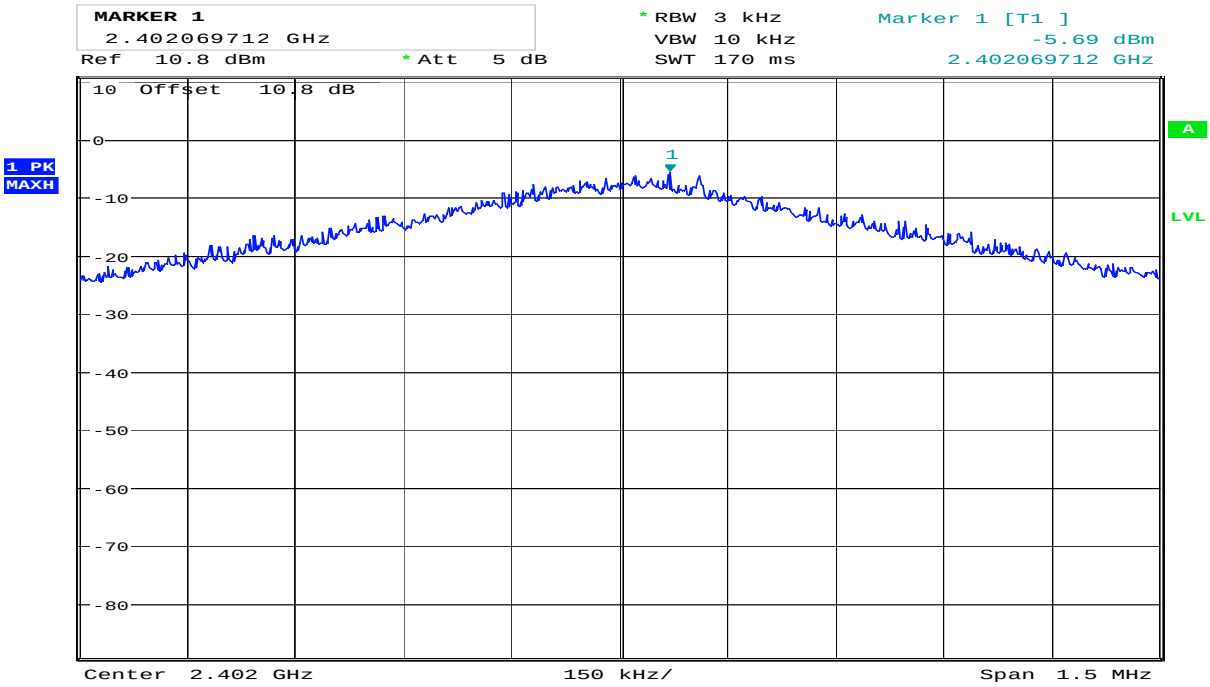
Measured and Calculated Data:

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 @2402 MHz	-3.95
Power Spectral Density @2440 MHz	-4.06
Power Spectral Density @2480 MHz	-4.59

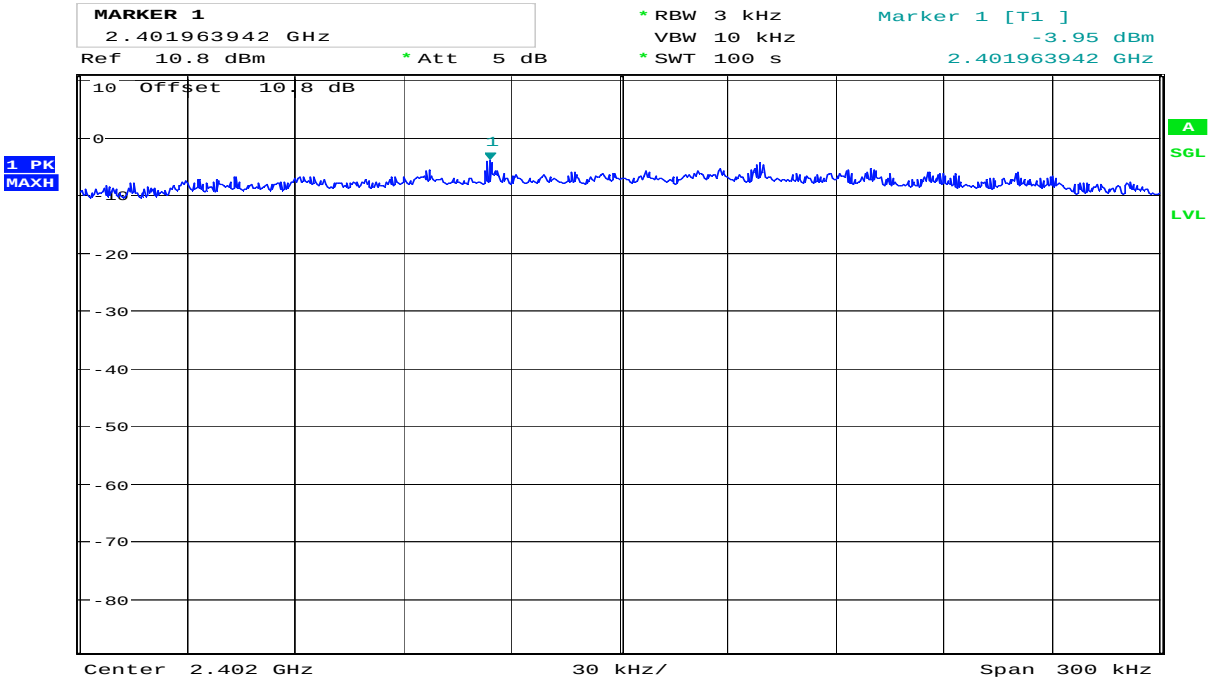
Requirements:

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



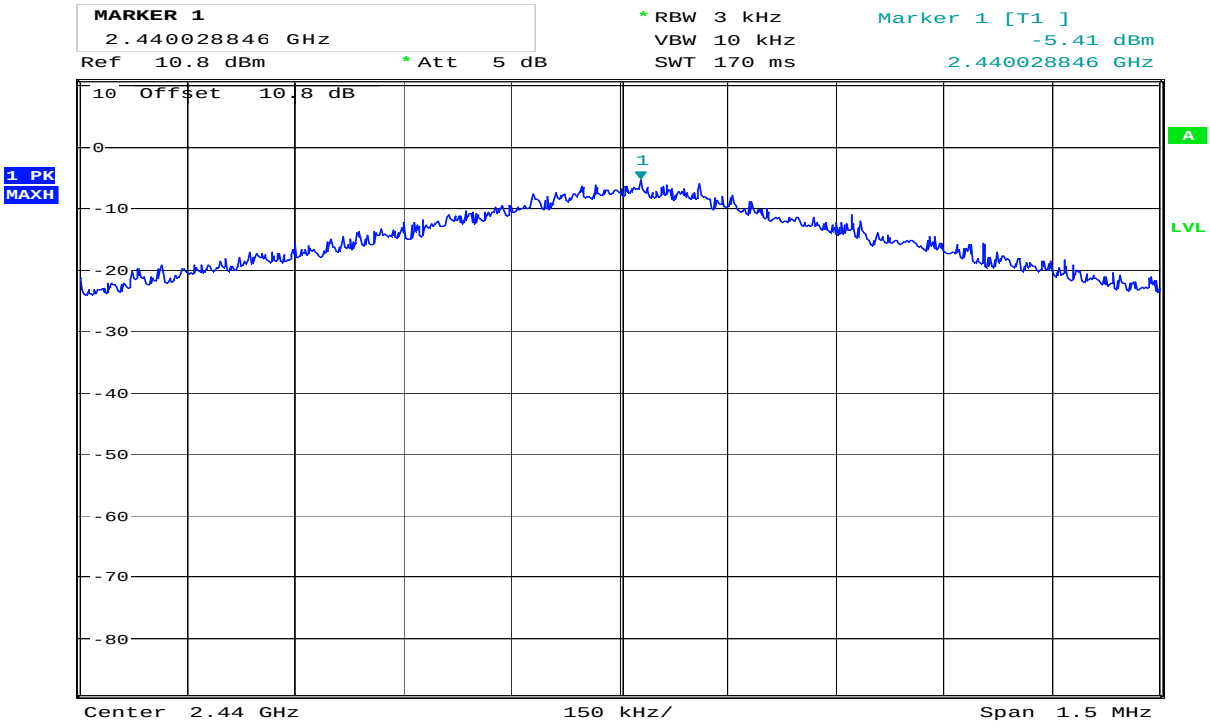
Date: 24.MAR.2012 08:29:38

PSD Overview - 2402MHz



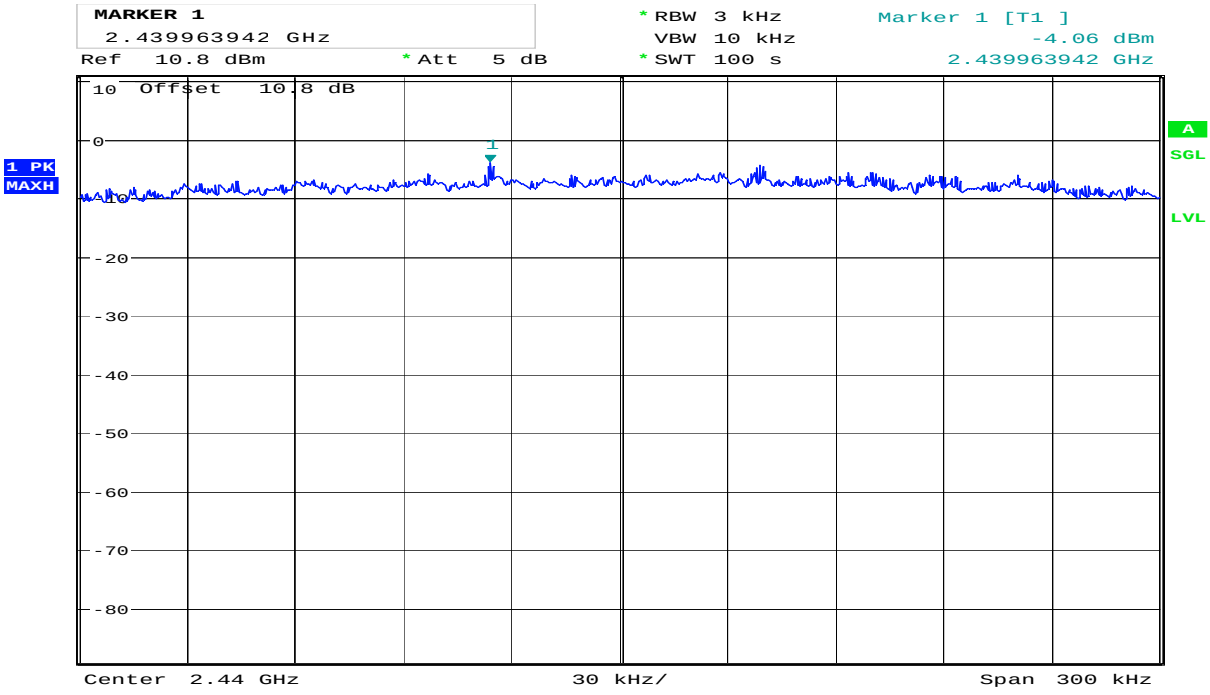
Date: 24.MAR.2012 08:32:24

PSD Measurement - 2402MHz



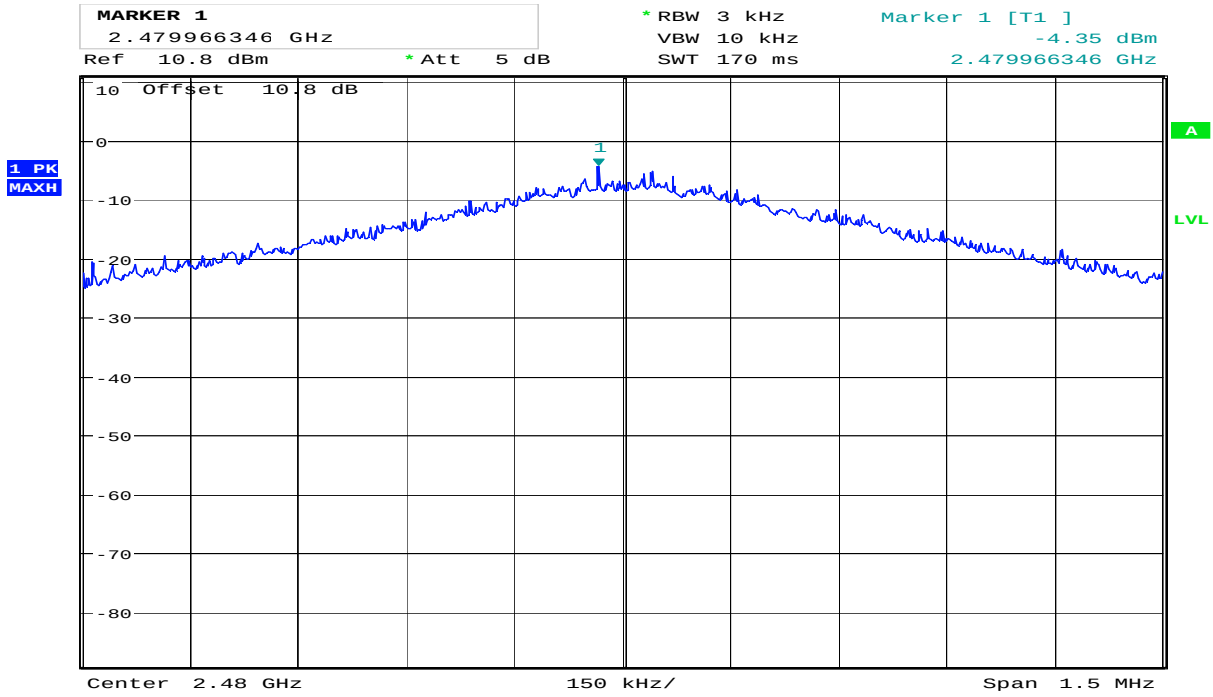
Date: 24.MAR.2012 08:34:05

PSD Overview- 2440MHz



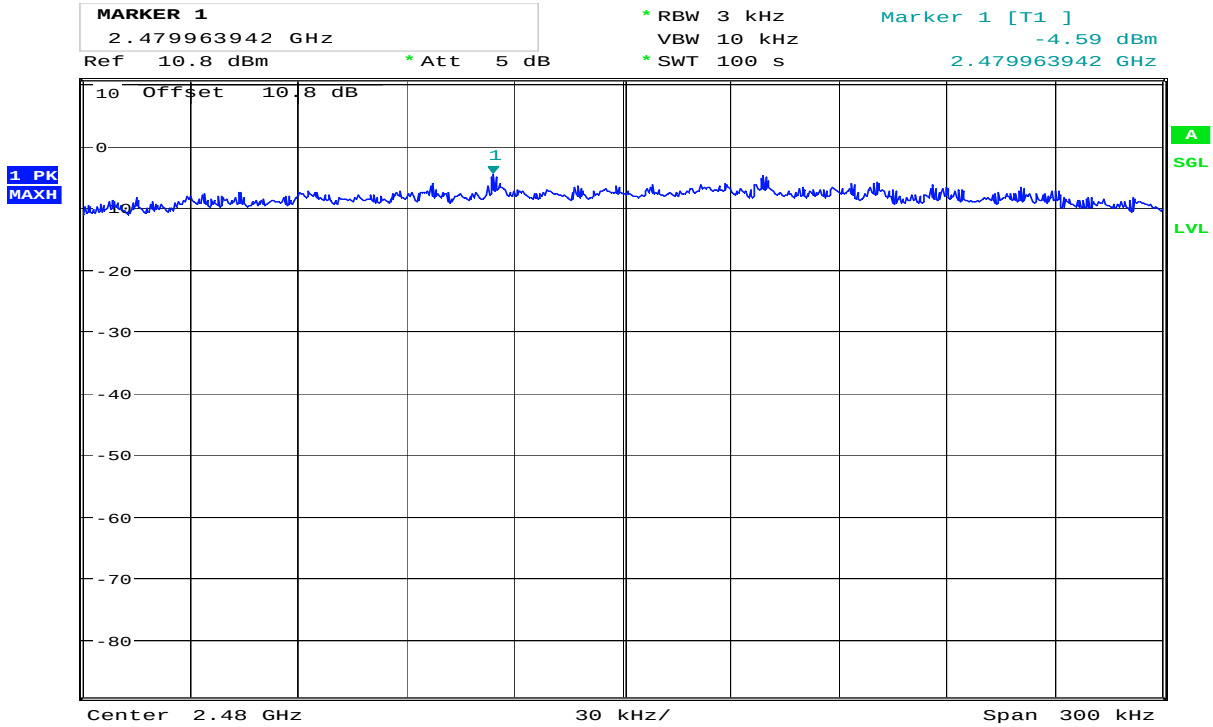
Date: 24.MAR.2012 08:36:24

PSD Measurement – 2440MHz



Date: 24.MAR.2012 08:38:25

PSD Overview – 2480MHz



Date: 24.MAR.2012 08:41:18

PSD Measurement - 2480MHz

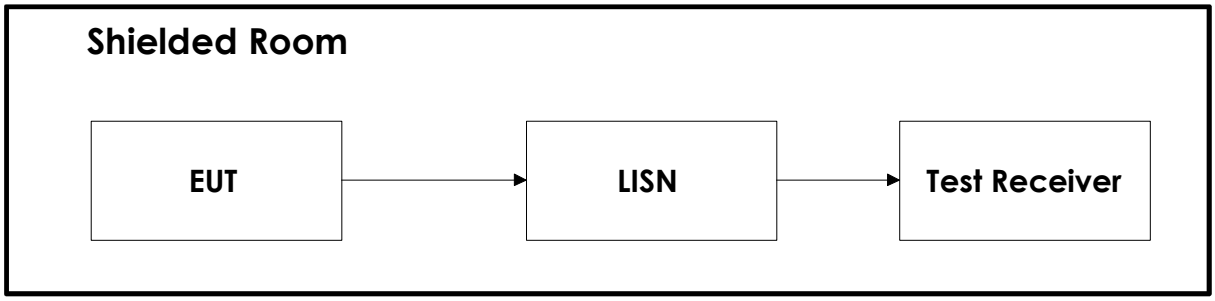
5 LIST OF TEST EQUIPMENT

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	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	

6 BLOCK DIAGRAM

6.1 Power Line Conducted Emission



6.2 Test Site Radiated Emission