



Test report no. : 182221-3

Item tested : CC2541EM

**Type of equipment : 2.4GHz Bluetooth Low Energy
Transceiver Evaluation Module**

FCC ID : ZAT2541EM

Client : Texas Instruments Norway AS

FCC Part 15.247

Digital Transmission System

RSS-210, Issue 8

Low Power Licence-Exempt
Radiocommunication Devices

2012-01-12

Authorized by :

Geir Antonsen
Geir Antonsen
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: 33

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 : Fredrik Kervel
Telephone : +47 22 95 83 62
E-mail : f.kervel@ti.com

1.3 Responsible Manufacturer (If other than client)

Name : /
Address : /

2 Test Information

2.1 Test Item

Name :	Texas Instruments
FCC ID :	ZAT2541EM
IC ID :	451H-2541EM
Model/version :	CC2541EM
Serial number :	/
Hardware identity and/or version:	/
Software identity and/or version :	/
Frequency Range :	2402 – 2480 MHz
Number of Channels :	/
Type of Modulation :	Digital
User Frequency Adjustment :	None
Type of Power Supply :	Primary Batteries (2xAA batteries)
Antenna Connector :	SMA
Antenna Diversity Supported :	No
Desktop Charger :	None

Description of Test Item

The tested EUT is a 2.4GHz transceiver SMA connector.

Exposure Evaluation

The EUT is exempted from RF Exposure Evaluation.

2.2 Test Environment

2.2.1 Normal test condition

Temperature:	19.8 – 21.6 °C
Relative humidity:	34.7 – 42.9 %
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.

The values are the limit registered during the test period.

2.3 Test Period

Item received date:	2011-10-04
Test period :	from 2011-10-10 to 2011-10-26

3 TEST REPORT SUMMARY

3.1 General

Manufacturer: Texas Instruments
Model No.: CC2541EM with SmartRF05EB
Serial No.: /

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 #: 182221-3

TESTED BY: Frode Sveinsen
Frode Sveinsen, Test engineer

DATE: 2011-10-26

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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: Frode Sveinsen	Date of Test: 11 Oct 2011
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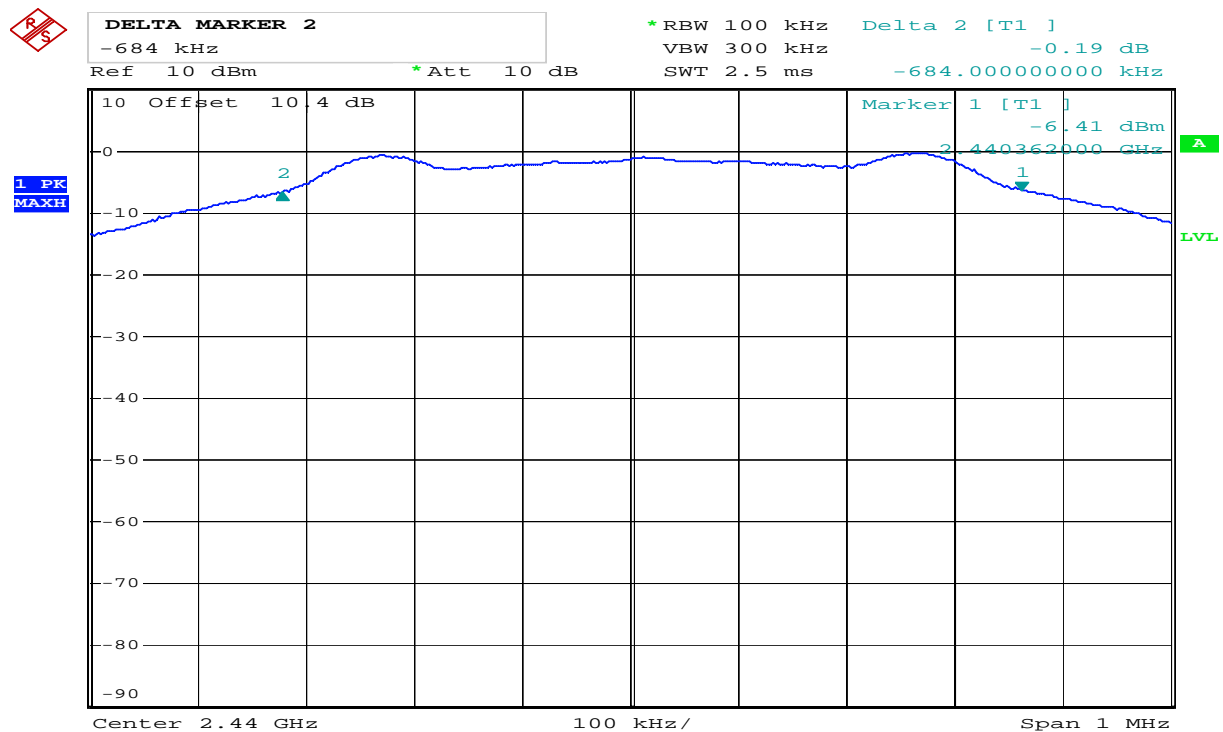
Test Results: Complies

Measurement Data:

Measured 6 dB Bandwidth (MHz)		
/	2440 MHz	/
/	0.684	/

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.2011 14:50:28

6 dB Bandwidth at 2440 MHz

4.2 20 dB Bandwidth

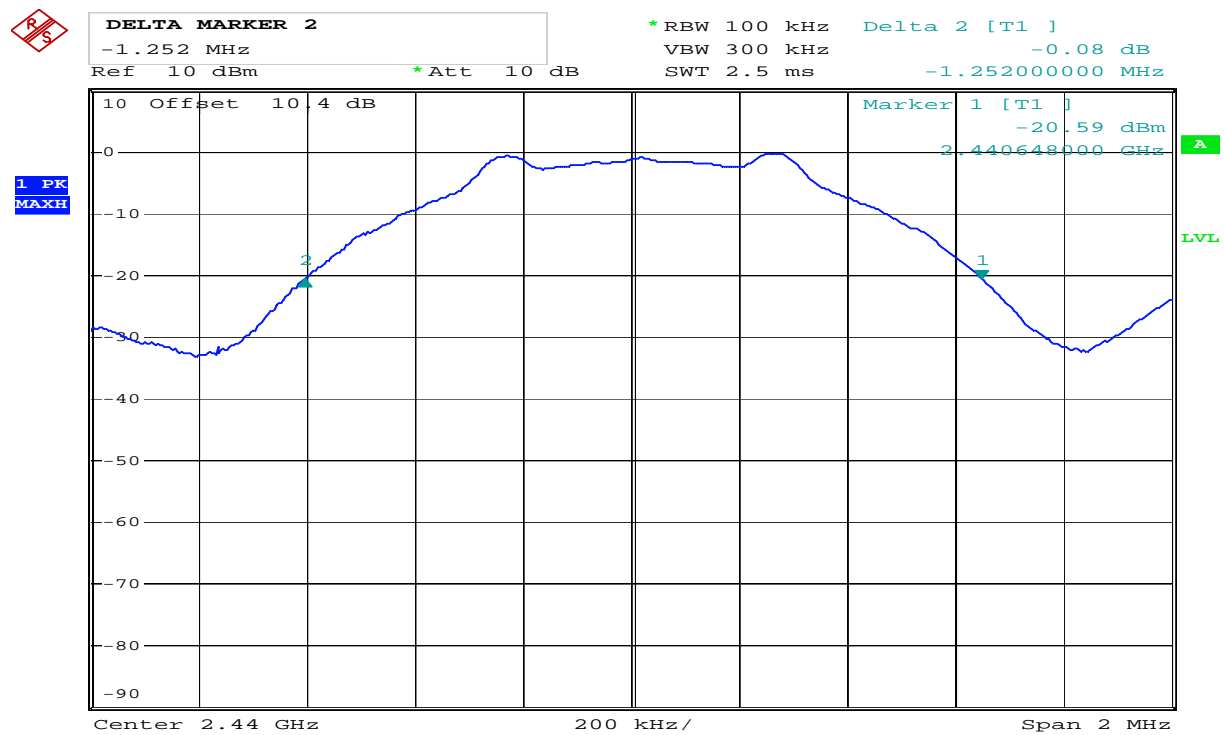
Test Performed By: Frode Sveinsen	Date of Test: 11 Oct 2011
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Measurement Data:

Measured 20 dB Bandwidth (MHz)
2440 MHz
1.25

Requirements:

No requirements. Reported for information only.



Date: 11.OCT.2011 14:57:58

20 dB Bandwidth at 2450 MHz

4.3 Peak Power Output

Para. No.: 15.247 (b)

Test Performed By: Frode Sveinsen	Date of Test: 10-11 Oct 2011
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Test Results: Complies

Measurement Data:

RF channel	2402 MHz	2440 MHz	2480 MHz
Conducted Power (dBm)	0.97	0.26	-0.25
Conducted Power (Watt)	0.0013	0.0011	0.0009
Measured EIRP (dBμV/m)	99.01	98.70	98.53
Radiated Power (dBm)	3.8	3.5	3.3
Antenna Gain (dB)	2.8	3.2	3.6

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

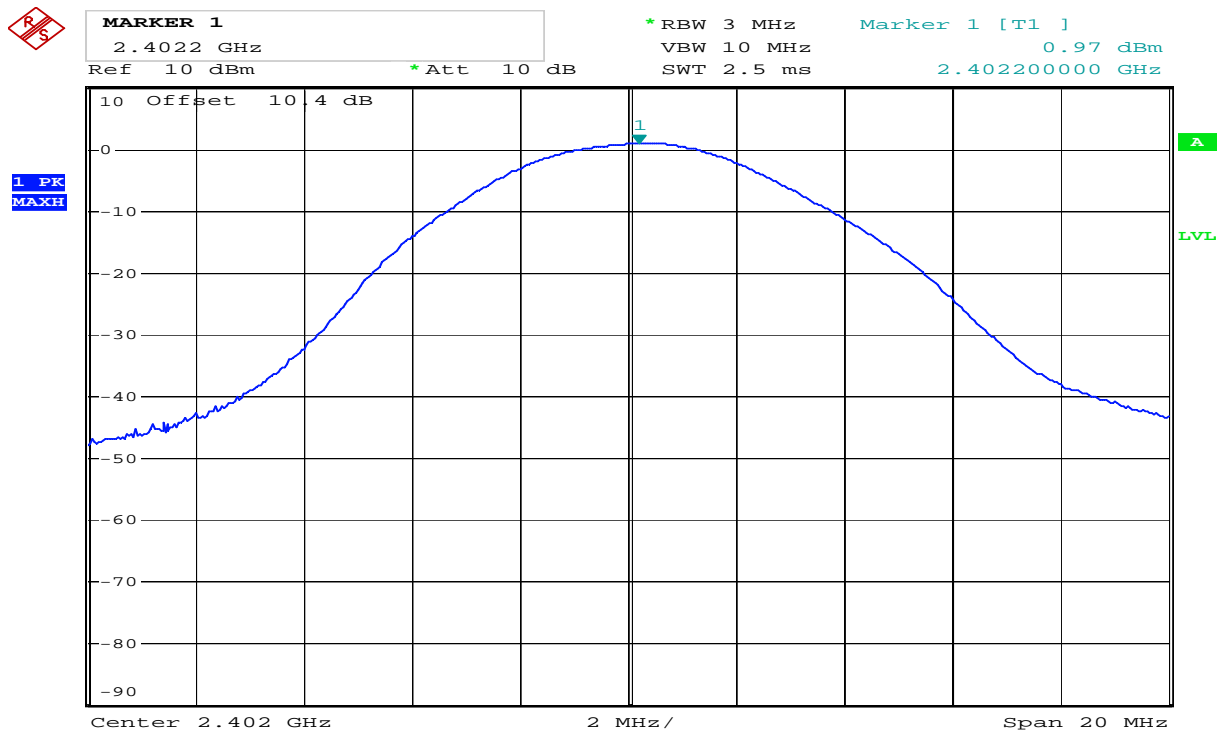
Type of antenna connector: SMA.

Requirements:

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

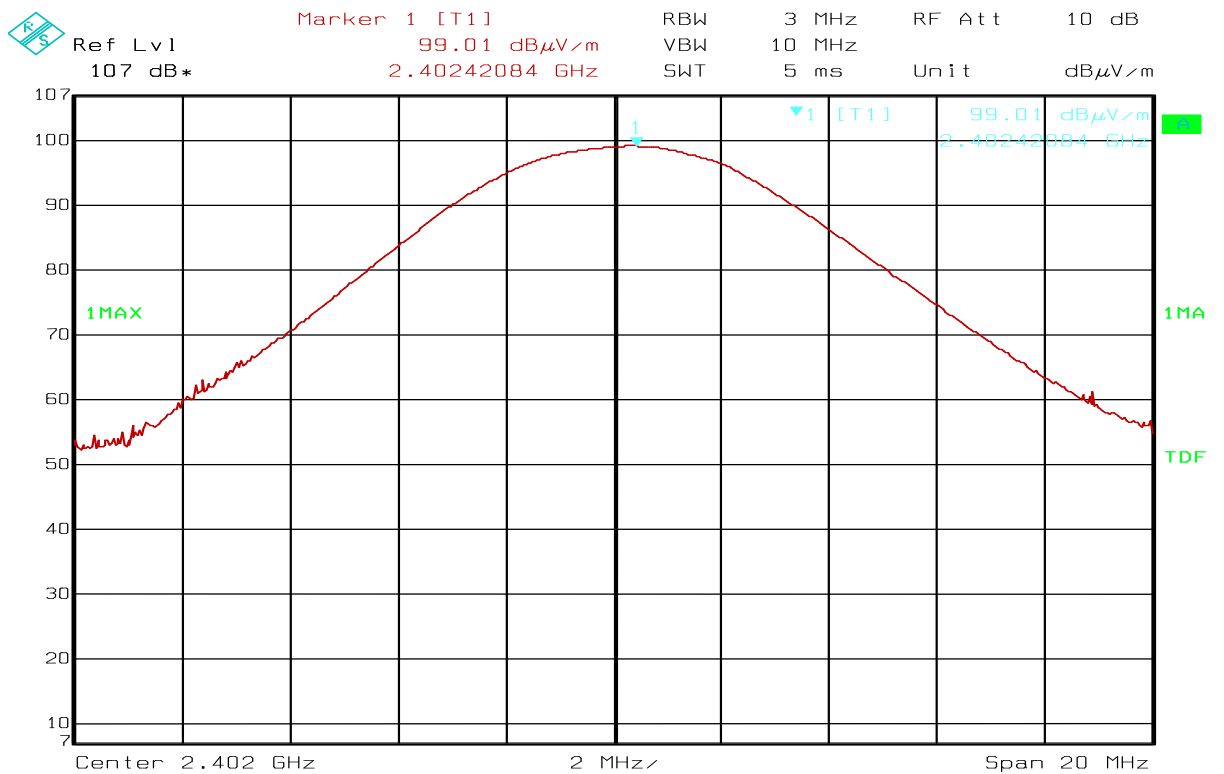
For Digital Transmission Systems in the 2400 - 2483.5 MHz band: 1 Watt

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.



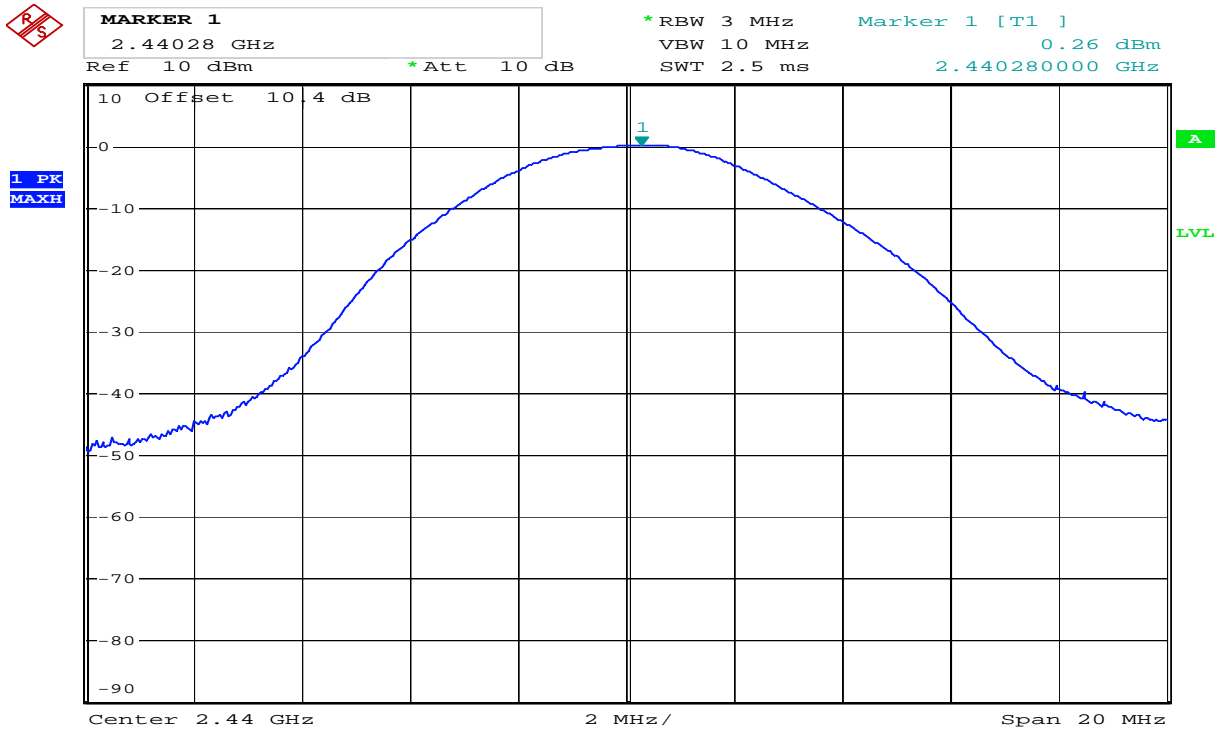
Date: 11.OCT.2011 14:39:42

Conducted Power, 2402 MHz



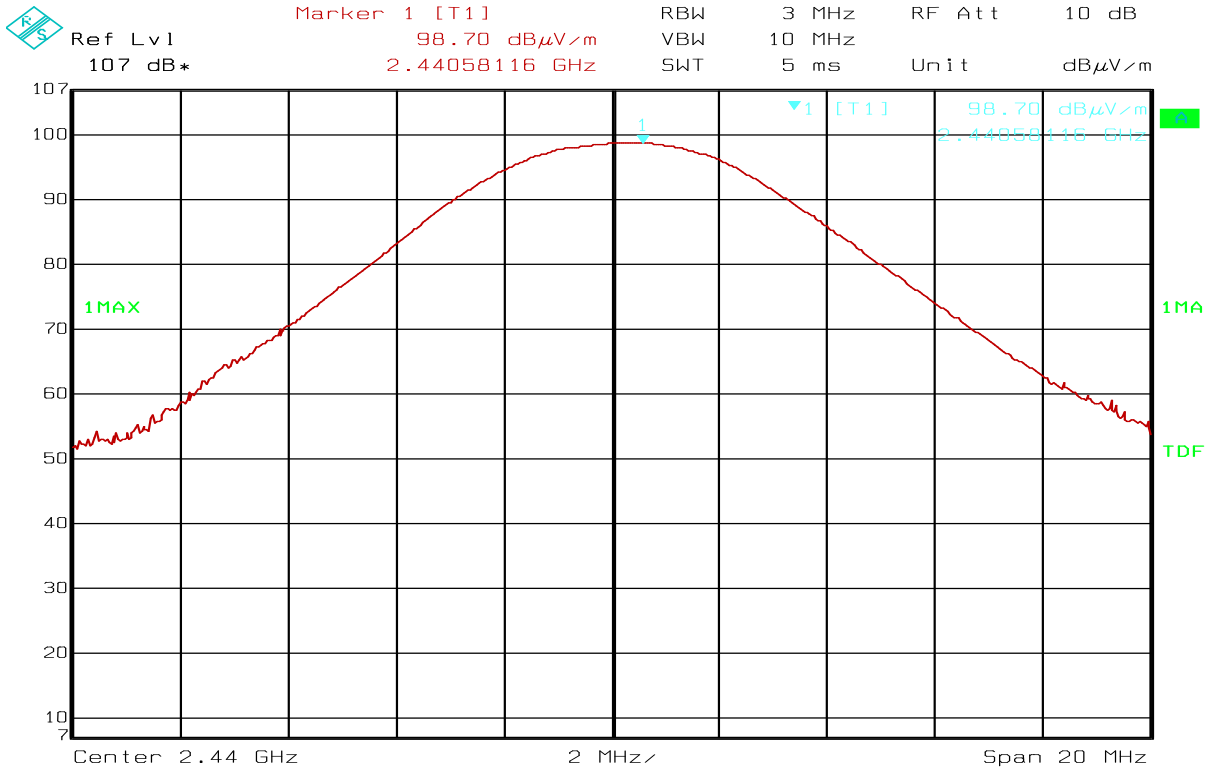
Date: 10.OCT.2011 16:49:20

Radiated Power, 2402 MHz



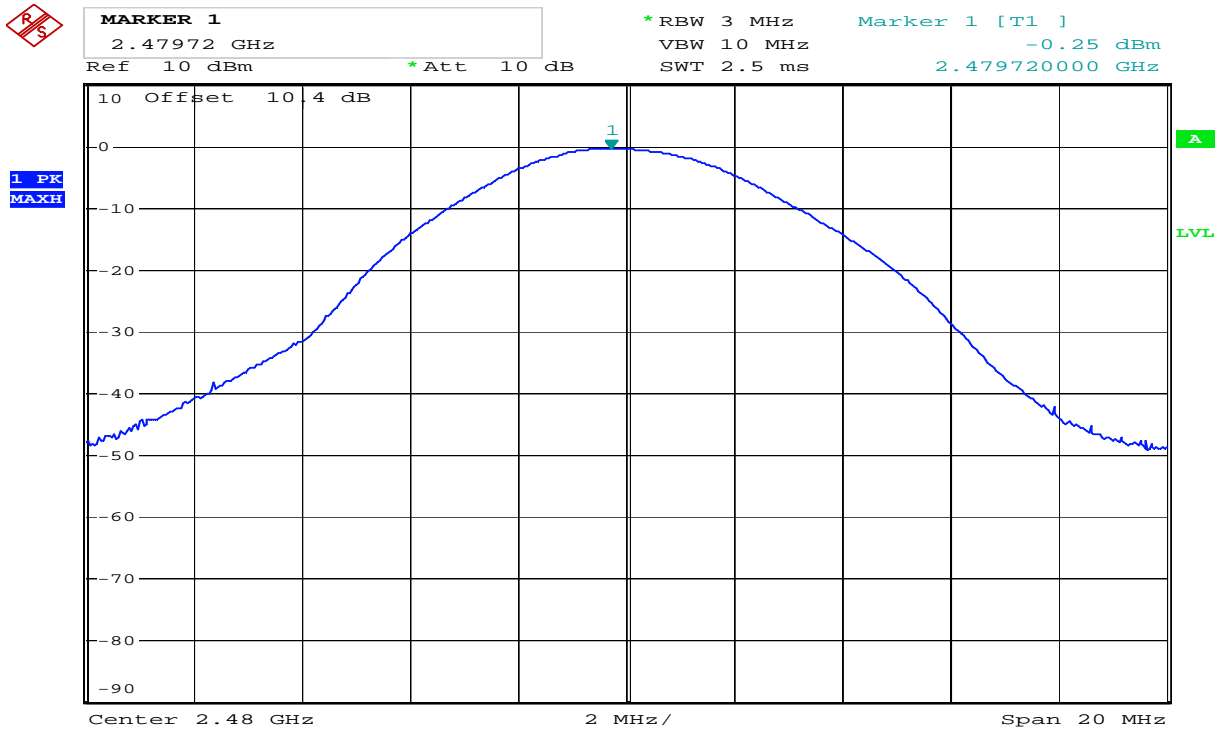
Date: 11.OCT.2011 14:40:08

Conducted Power, 2440 MHz



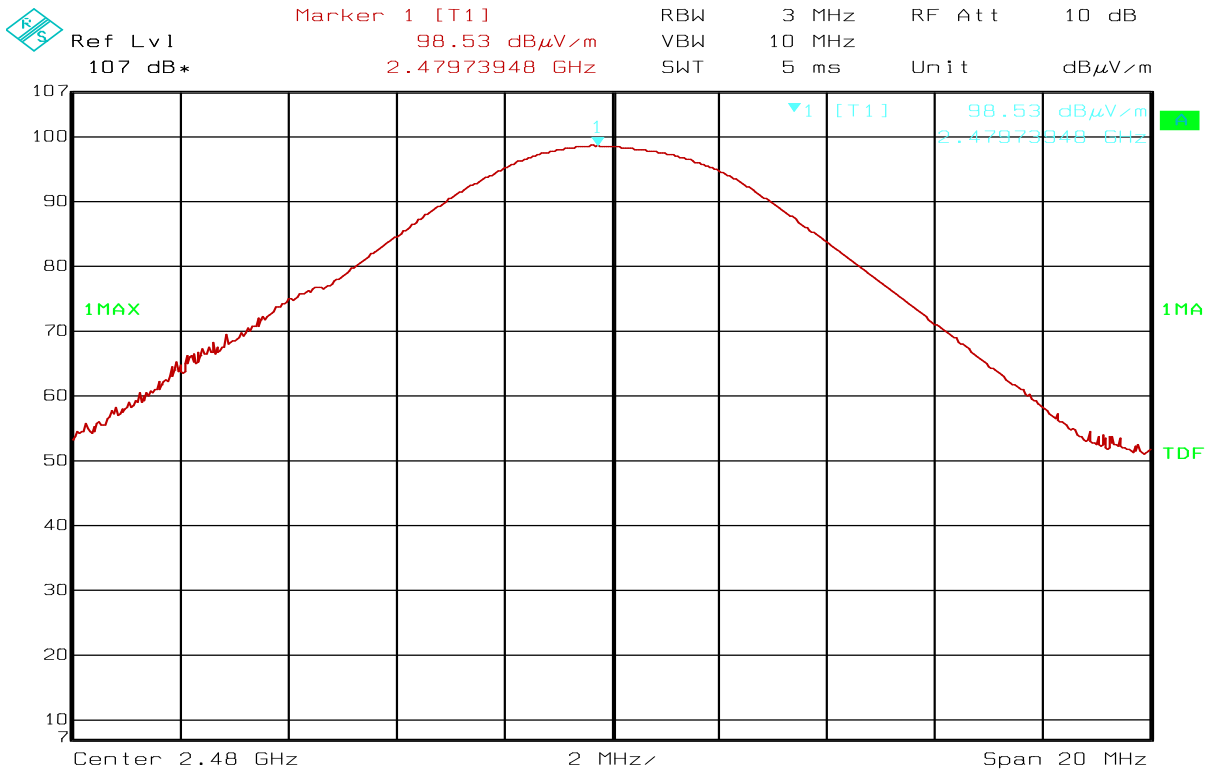
Date: 10.OCT.2011 16:24:45

Radiated Power, 2440 MHz



Date: 11.OCT.2011 14:40:47

Conducted Power, 2480 MHz



Date: 10.OCT.2011 16:38:45

Radiated Power, 2480 MHz

4.4 Spurious Emissions (Radiated)

Para. No.: 15.247 (c)

Test Performed By: Frode Sveinsen	Date of Test: 10 and 26 Oct 2011
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Test Results: Complies

Measurement Data:

Band-edge, @3m

Frequency	Measured Field Strength @3m, dBµV/m	Detector	Limit dBµV/m	Margin dB
2.39 GHz	45.2	AV	54	8.8
	45.2	PK	74	28.8
2.4835 GHz	50.6*	AV	54	3.4
	50.6*	PK	74	23.4

*Calculated with Marker-Delta method.

See attached plots.

Marker Delta Calculation:

Max: 98.39 dBµV/m

Delta: 47.75 dB

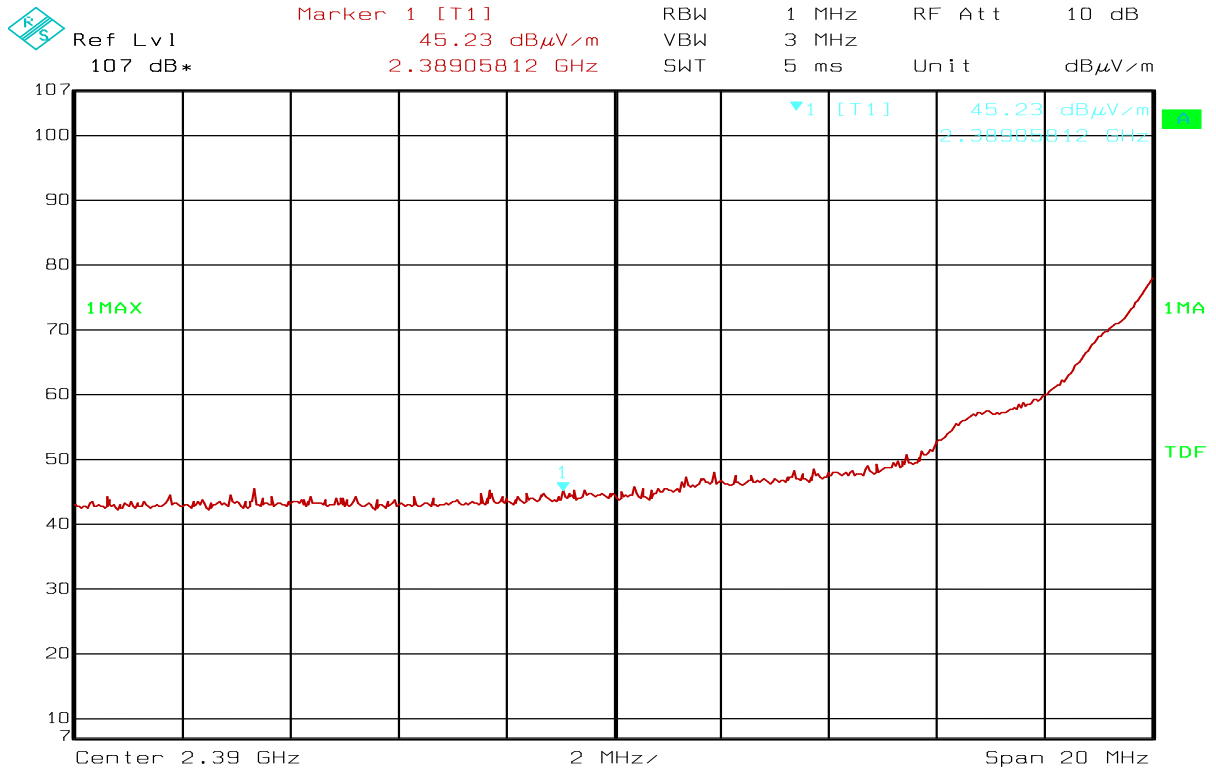
Band Edge Field Strength, Peak: 98.39 – 47.75 dBµV/m = 50.6 dBµV/m

RF conducted power

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

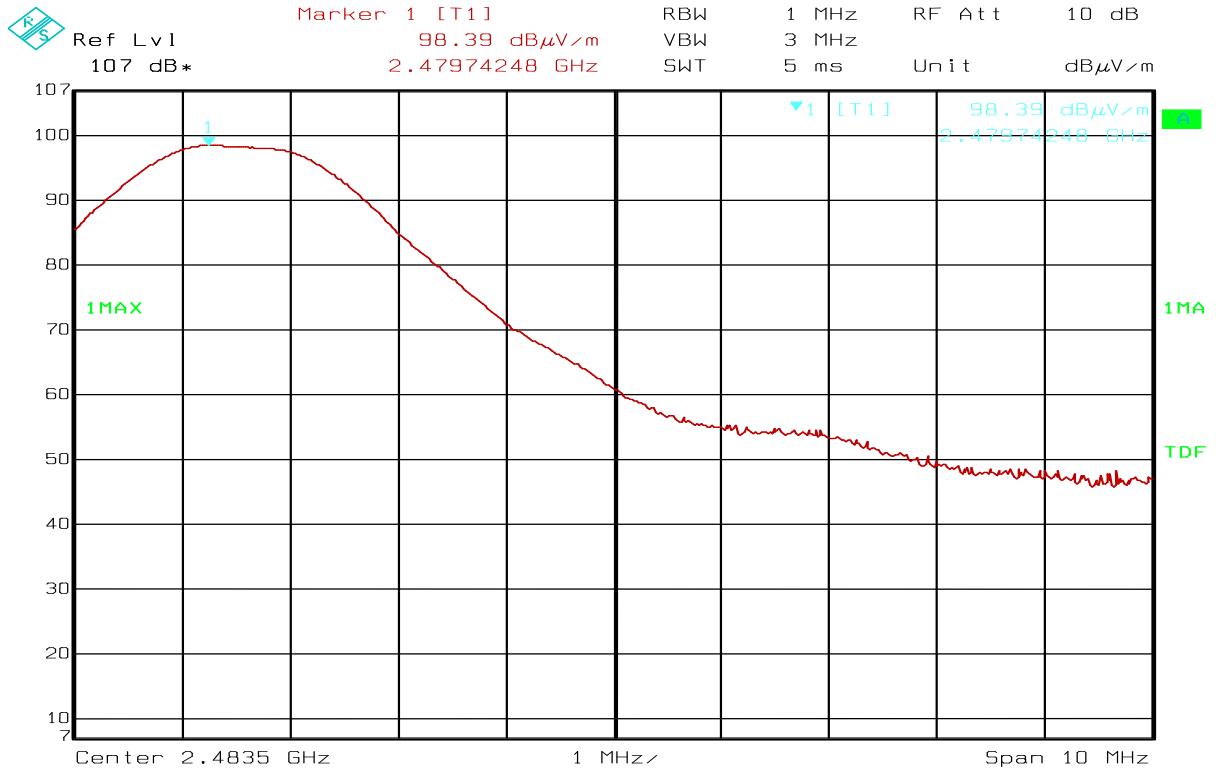
All emissions are more than 20dB below carrier.

See plots.



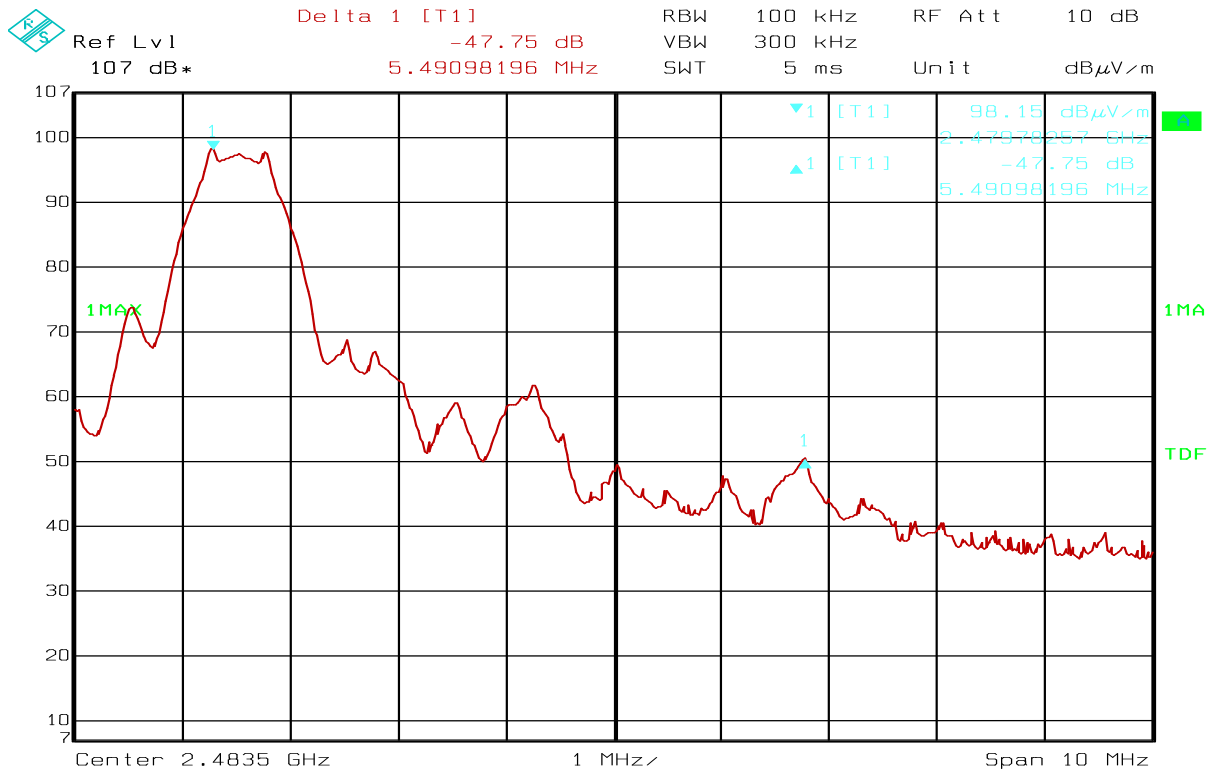
Date: 10.OCT.2011 16:47:04

Band Edge, 2390 MHz, Peak Detector



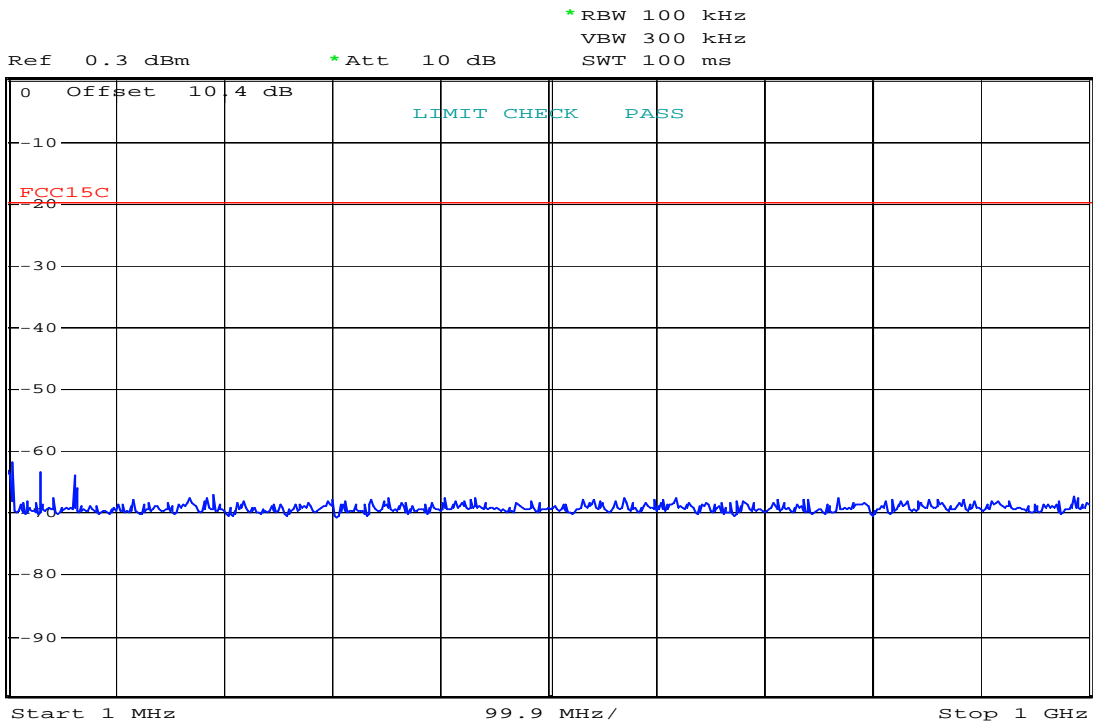
Date: 10.OCT.2011 16:40:59

Band Edge, 2483.5 MHz, Marker Delta, Max



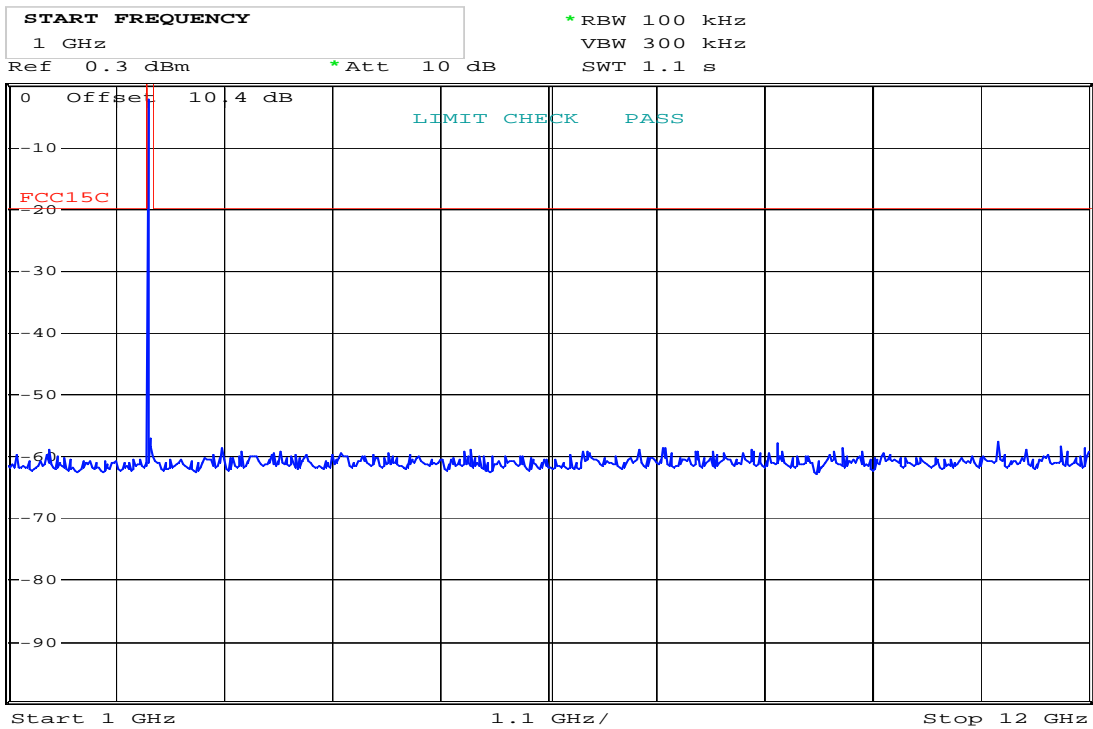
Date: 10.OCT.2011 16:42:26

Band Edge, 2483.5 MHz, Marker Delta, Delta



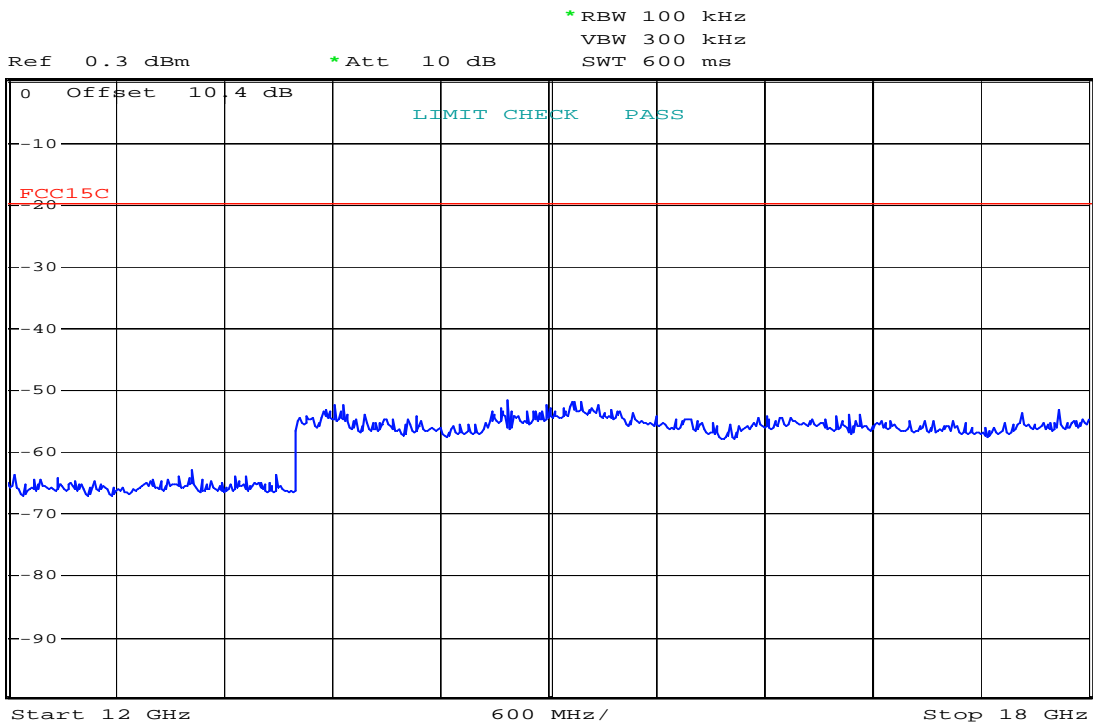
Date: 11.OCT.2011 15:07:09

Conducted Emissions, 1 – 1000 MHz



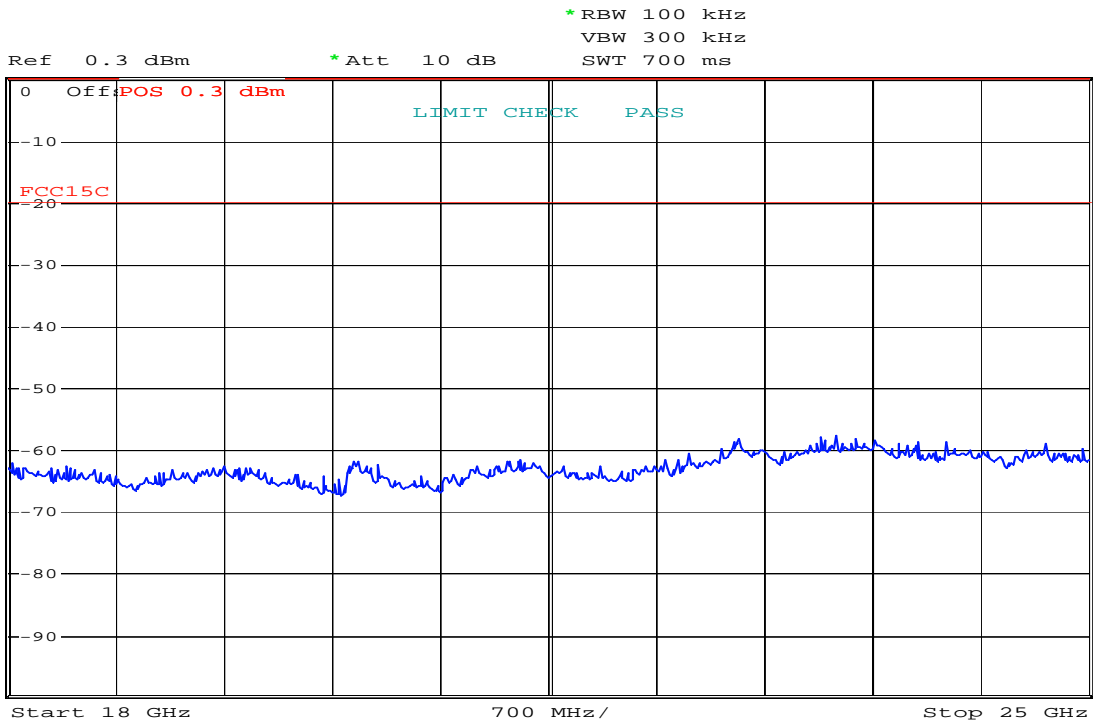
Date: 11.OCT.2011 15:05:42

Conducted Emissions, 1 – 12 GHz



Date: 11.OCT.2011 15:08:55

Conducted Emissions, 12 – 18 GHz



Date: 11.OCT.2011 15:11:21

Conducted Emissions, 18 – 25 GHz

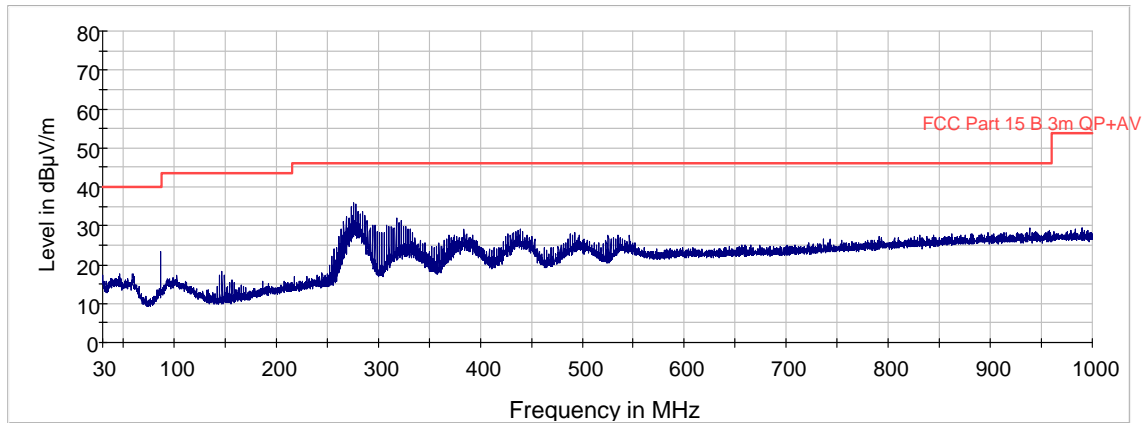
Radiated emission 30 – 1000 MHz.

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

Radiated Emissions, 1-25 GHz

1-12 GHz measured at a distance of 1 or 3m

12 - 18 GHz measured at 1m

Prescan performed from 18 to 25 GHz.

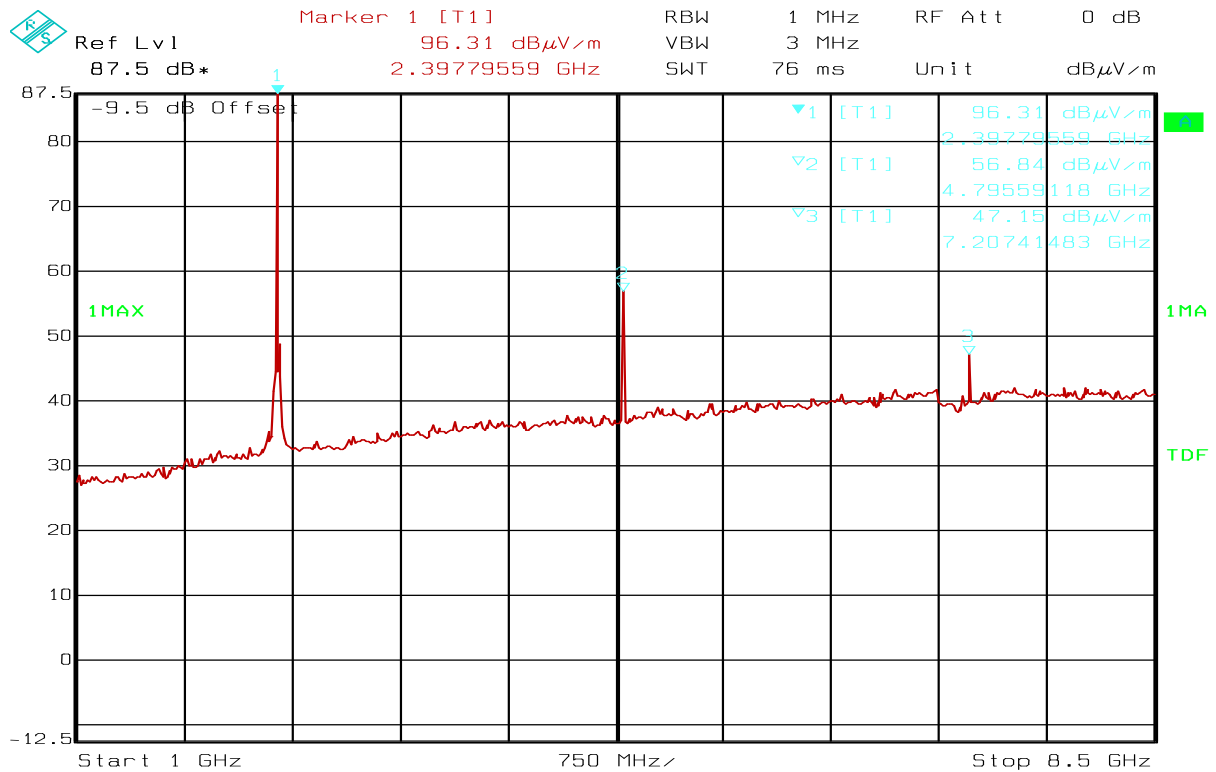
Frequency MHz	Field strength @3m dB μ V/m	Detector	Limit dB μ V/m	Margin dB
4810	52.9	Pk	74	21.1
4880	48.7	Pk	74	25.3
4960	46.5	Pk	74	27.5

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".

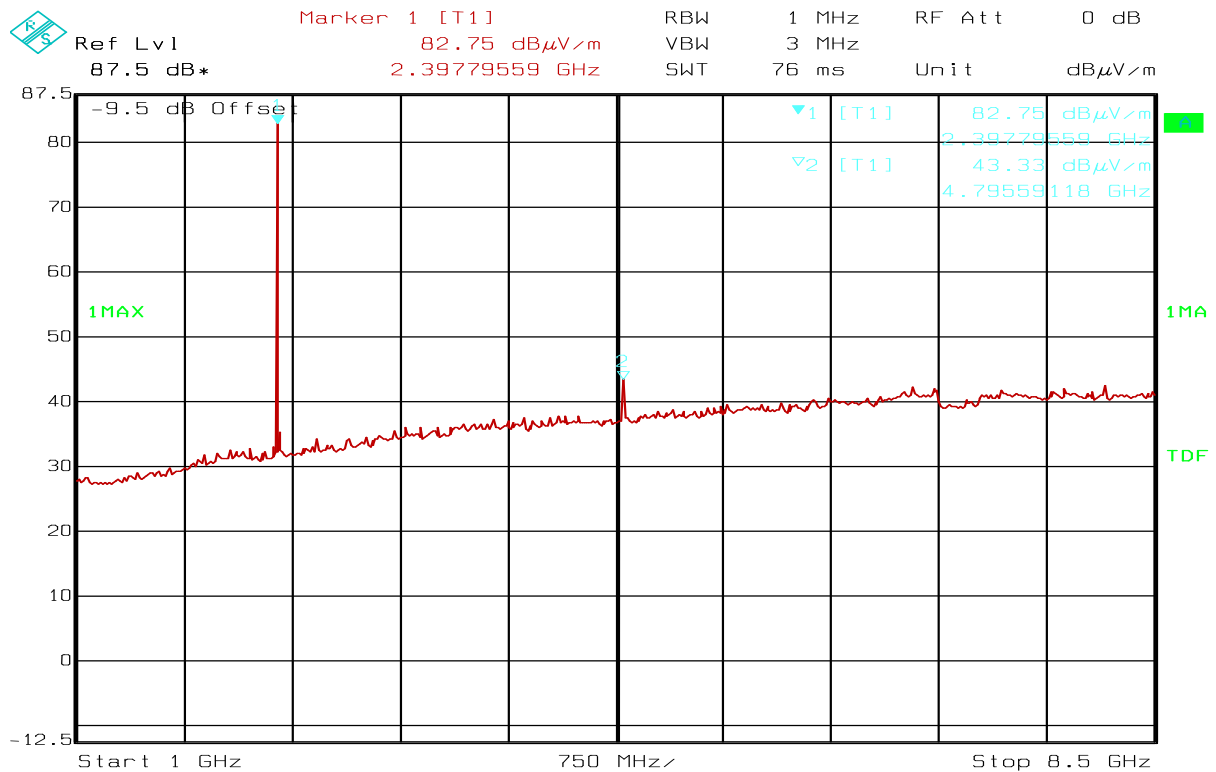
Distance Correction factor of 9.5 dB for measurements at 1m is included in above values

See attached graphs.



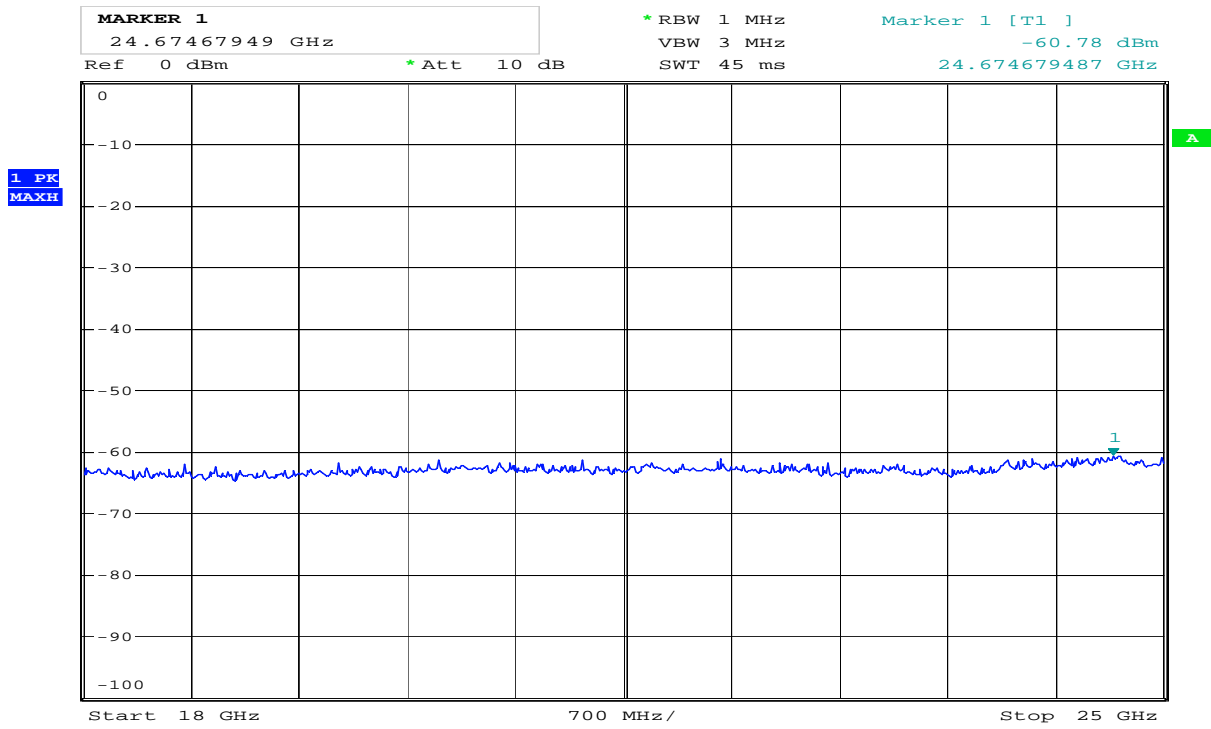
Date: 10.OCT.2011 17:07:15

Radiated Emissions, 1 – 8.5 GHz, VP, @1m



Date: 10.OCT.2011 17:05:13

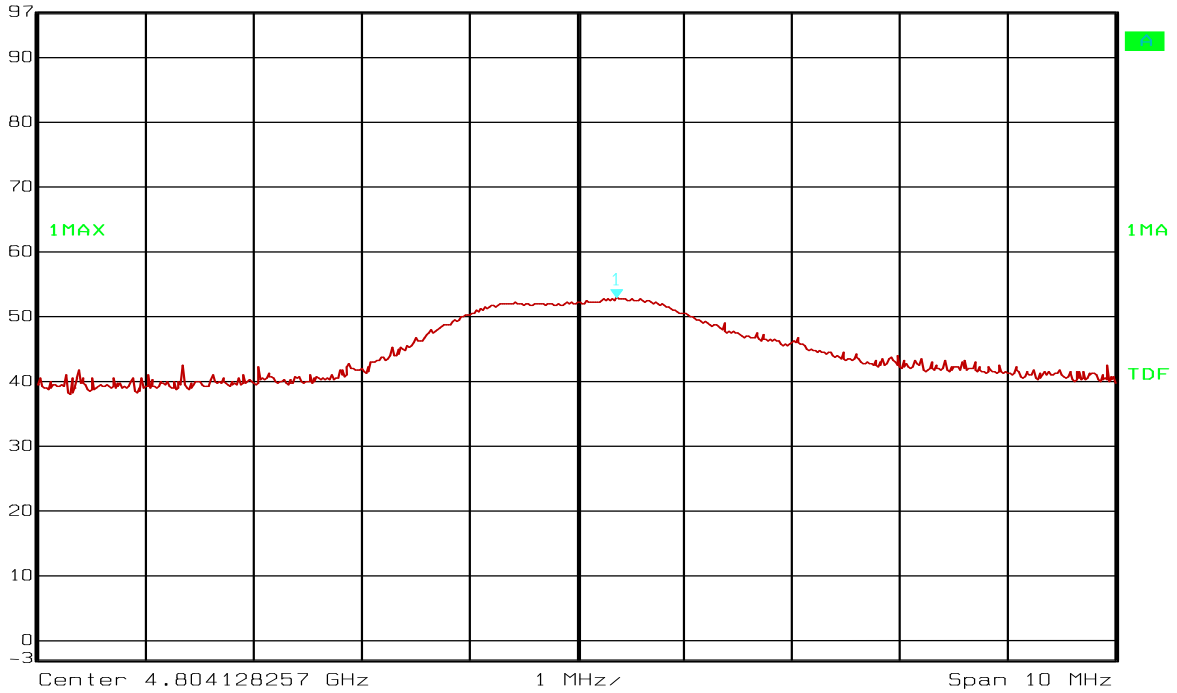
Radiated Emissions, 1 – 8.5 GHz, HP, @1m



Date: 26.OCT.2011 14:50:01

Pre-scan, 18 – 25 GHz

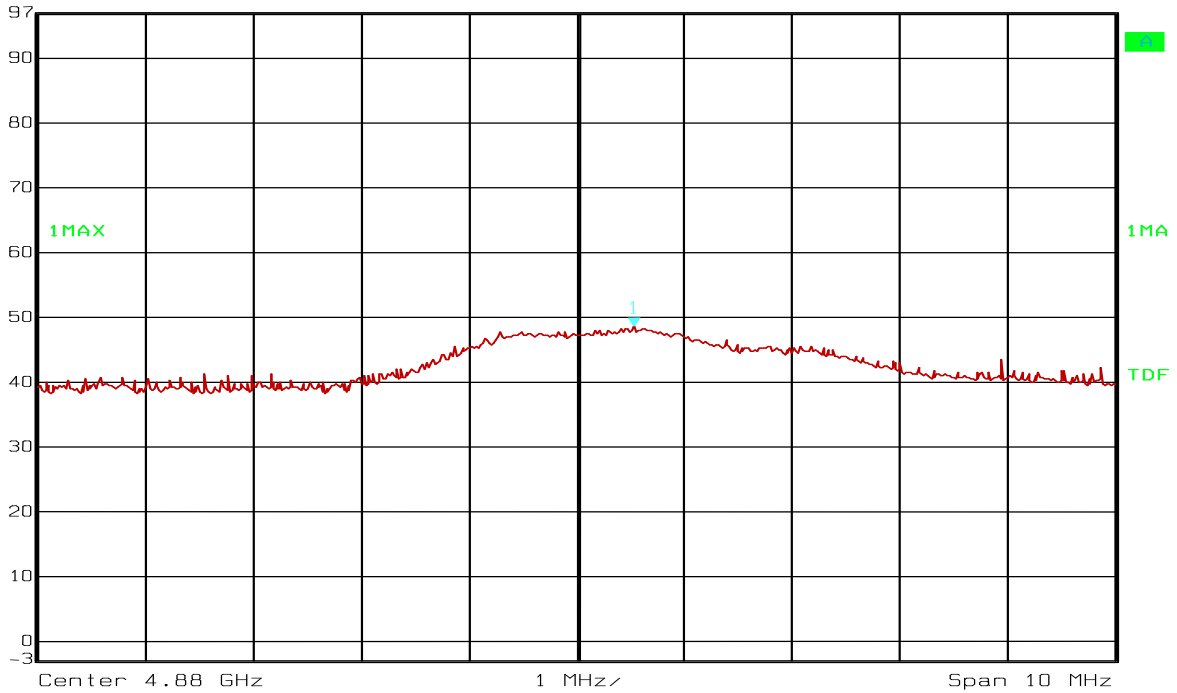
Marker 1 [T1]
 Ref Lvl 97 dB* 52.86 dB μ V/m RBW 1 MHz RF Att 0 dB
 4.80449900 GHz VBW 3 MHz Unit dB μ V/m
 SWT 5 ms



Date: 10.OCT.2011 15:56:55

Radiated Emissions, 4804 MHz, Max, Pk Det.

Marker 1 [T1]
 Ref Lvl 97 dB* 48.66 dB μ V/m RBW 1 MHz RF Att 0 dB
 4.88053106 GHz VBW 3 MHz Unit dB μ V/m
 SWT 5 ms

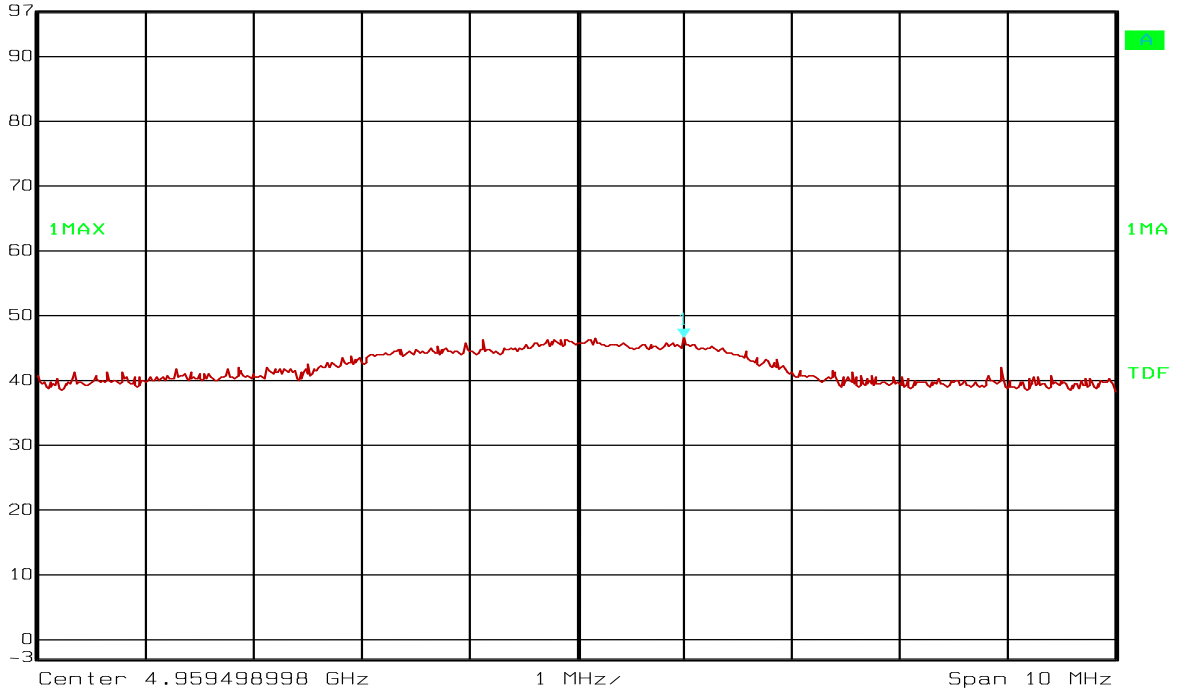


Date: 10.OCT.2011 15:50:46

Radiated Emissions, 4880 MHz, Max, Pk Det.



Ref Lvl 97 dB* Marker 1 [T1] RBW 1 MHz RF Att 0 dB
 46.51 dB μ V/m VBW 3 MHz
 4.96049098 GHz SWT 5 ms Unit dB μ V/m



Date: 10.OCT.2011 15:52:51

Radiated Emissions, 4960 MHz, Max, Pk Det.

4.5 Receiver Spurious Emissions

Measurement Procedure:

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

Test results:

Frequency MHz	Carrier Freq. MHz	Measured Value Radiated dBuV/m @3m	Limit dBuV/m @3m	Margin dB
30 – 1000	all	None found	/	/
2402	4806	43.7	54	10.3
2440	4882	44.6	54	9.4
2480	4958	45.2	54	8.8
> 1000 (all others)	all	None found	54	/

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

Requirements, RSS-GEN Issue 3, clause 6

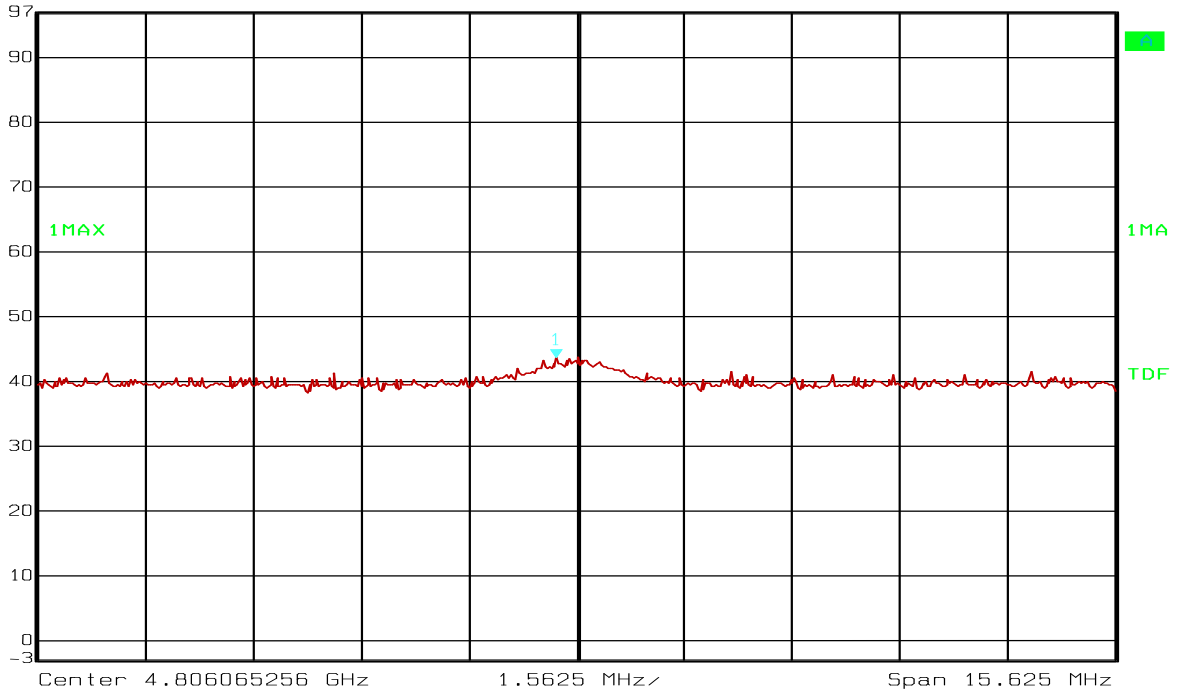
The measurement can be performed either radiated or conducted.

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.

Marker 1 [T1]
43.72 dB μ V/m
4.80576779 GHz

Ref Lvl 97 dB*
 RBW 1 MHz RF Att 0 dB
 VBW 3 MHz
 SWT 5 ms Unit dB μ V/m

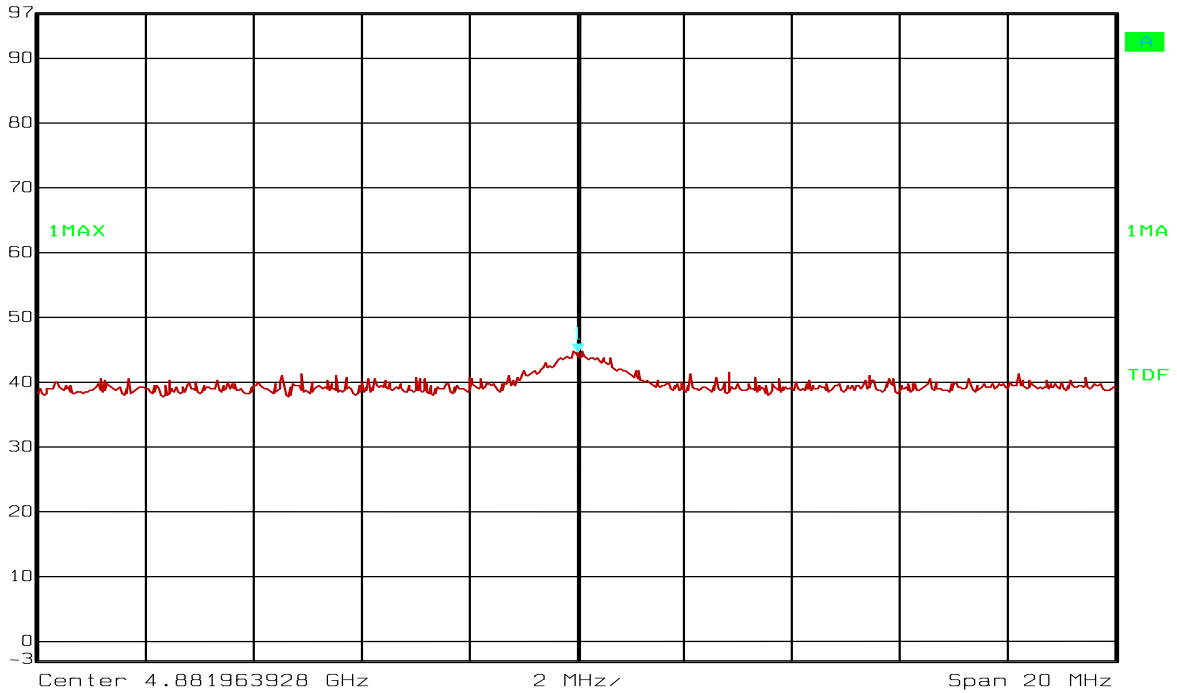


Date: 10.OCT.2011 16:00:08

Receiver Radiated Emissions, 4806 MHz

Marker 1 [T1]
44.60 dB μ V/m
4.88198397 GHz

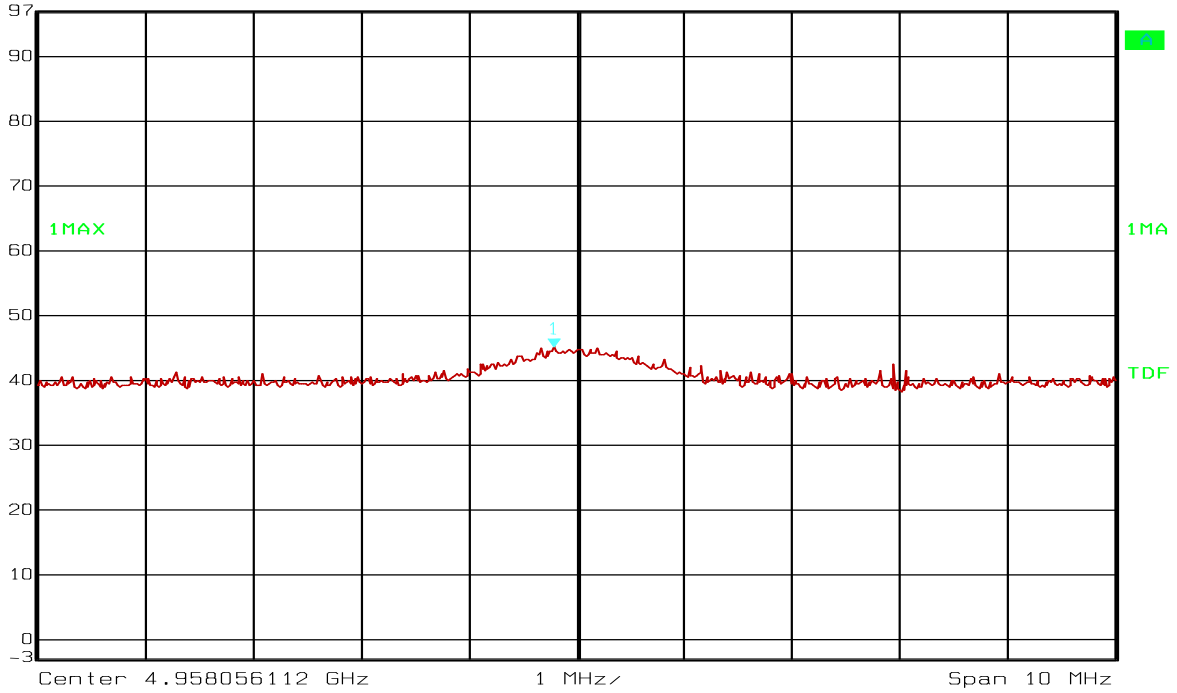
Ref Lvl 97 dB*
 RBW 1 MHz RF Att 0 dB
 VBW 3 MHz
 SWT 5 ms Unit dB μ V/m



Date: 10.OCT.2011 16:01:49

Receiver Radiated Emissions, 4882 MHz

FS	Ref Lvl	Marker 1 [T1]	RBW	1 MHz	RF Att	0 dB
	97 dB*	45.17 dB μ V/m	VBW	3 MHz		
		4.95784569 GHz	SWT	5 ms	Unit	dB μ V/m



Date: 10.OCT.2011 16:04:12

Receiver Radiated Emissions, 4958 MHz

4.6 Power Spectral Density (PSD)

Para. No.: 15.247 (d)

Test Performed By: Frode Sveinsen	Date of Test: 11 Oct 2011
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Test Results: Passed

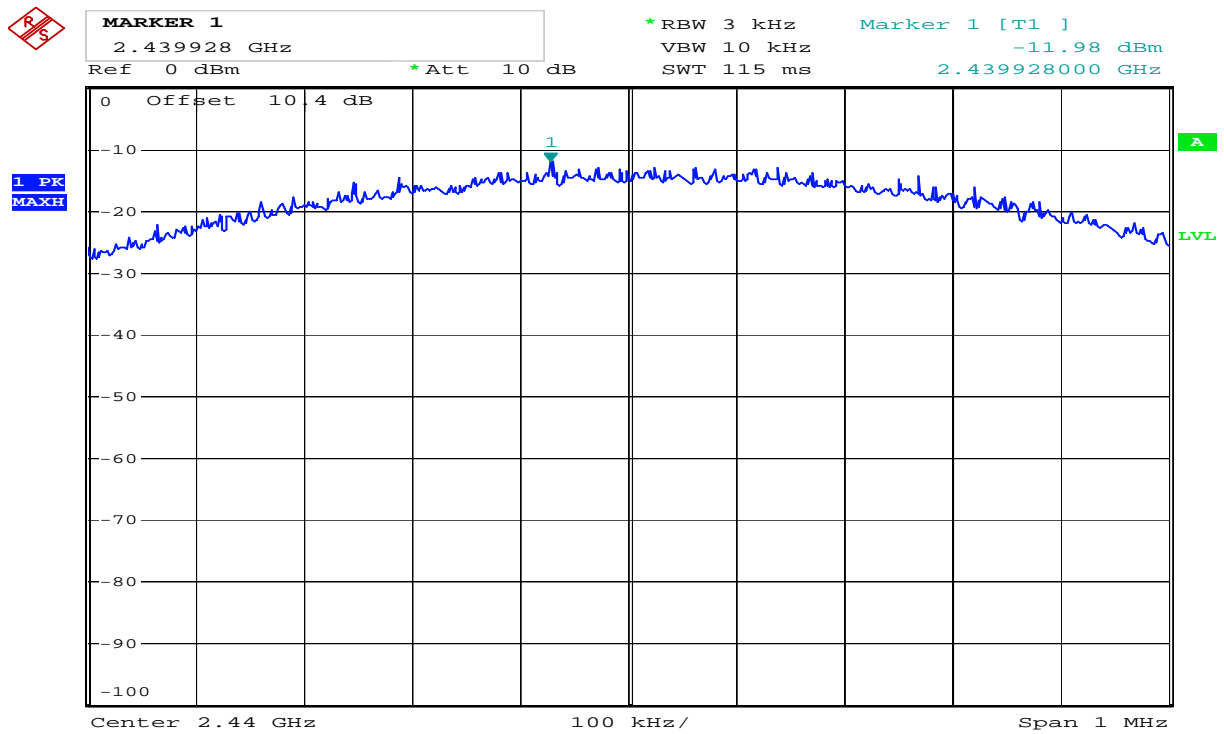
Measured and Calculated Data:

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 @2440 MHz	-11.9 dBm

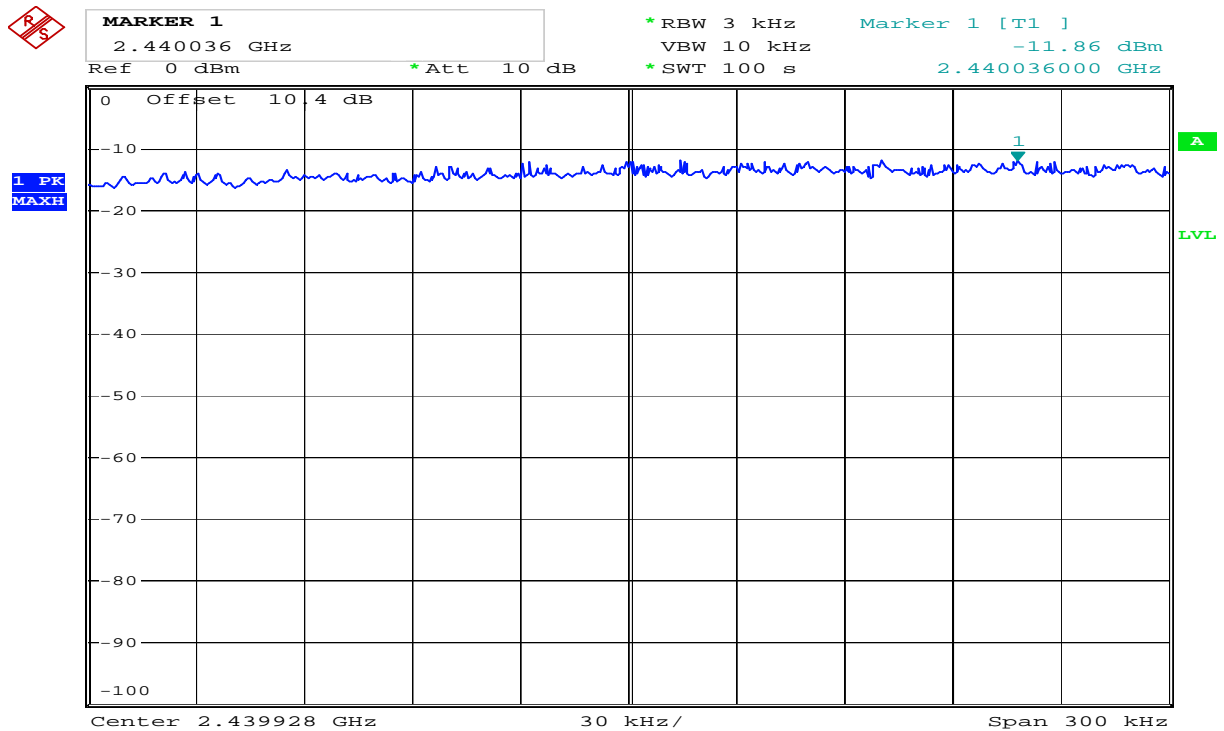
Requirements:

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



Date: 11.OCT.2011 14:42:50

PSD Overview



Date: 11.OCT.2011 14:47:22

PSD Measurement

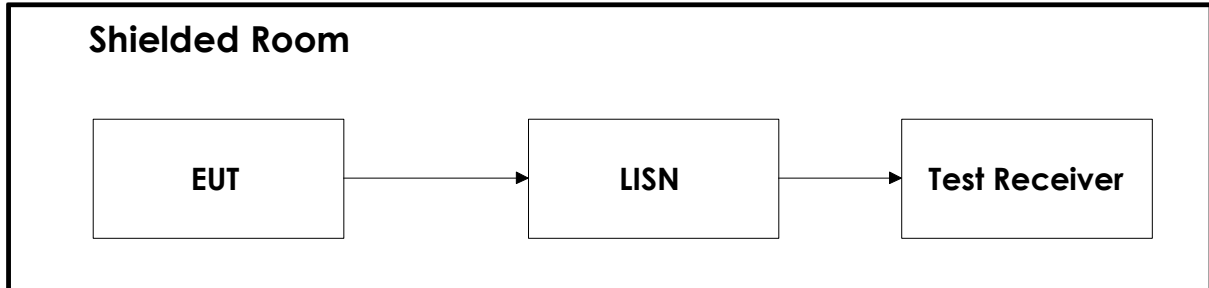
5 LIST OF TEST EQUIPMENT

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	LR 1090	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	2012.01.26
5	642	Antenna horn	Narda	LR 220	2009.01.26	2012.01.26
6	PM7320X	Antenna horn	Siverts lab	LR 103	2009.01.26	2012.01.26
7	DBF-520-20	Antenna horn	Systron Donner	LR 101	2009.01.26	2012.01.26
8	638	Antenna horn	Narda	LR 098	2010.06.17	2015.06.17
9	JB3	Antenna BiLog	Sunol Sciences	N-4525	2010-09	2011-09
10	8449B	Pre-amplifier	Hewlett Packard	LR 1322	2011-09-27	2012-09-27
11	LNA6900	Pre-amplifier	Teseq	LR 1593	2010-11	2011-11
12	ESCI	Test Receiver	Rohde & Schwarz	N-4529	2010.11.08	2011.11.02
13	ESH3-Z3	LISN	Rohde & Schwarz	LR 1076	2009-10-22	2011-10-22
14	80S	Signal Generator	Powertron	LT 502	Cal b4 use	
15	Model 87 V	Multimeter	Fluke	LR 1598	2010-12-14	2011-12-14
16	FSP30	Spectrum Analyzer	Rohde & Schwarz	LR 1551	2011-03	2012-02
17	FSU26	Spectrum Analyzer	Rohde & Schwarz	LR 1504	2010.09.28	2012.09.28

6 BLOCK DIAGRAM

6.1 Power Line Conducted Emission



6.2 Test Site Radiated Emission

