

**Test report no. : 215170- 3**

**Item tested : CC2540KEYFOB**

**Type of equipment : 2.4 GHz Transceiver**

**FCC ID : ZAT2540KEYFOB**

**Client : Texas Instruments Norway AS**

www.nemko.com

**FCC Part 15.247**

Digital Transmission System

**RSS-210, Issue 8**

Low Power Licence-Exempt  
Radiocommunication Devices

**19 October 2012**

**Authorized by :**  .....

Frode Sveinsen  
Technical Verificator

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## 1 GENERAL INFORMATION

### 1.1 Testhouse Info

Name : Nemko AS  
Address : Nemko Kjeller  
Instituttveien 6, Box 96  
NO-2027 Kjeller, NORWAY  
Telephone : +47 64 84 57 00  
Fax : +47 64 84 57 05  
E-mail: [comlab@nemko.com](mailto:comlab@nemko.com)  
FCC test firm : 994405  
IC OATS : 2040D-1  
Total Number of Pages: 44

### 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](mailto: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 :	ZAT2540KEYFOB
IC :	451H-2540KEYFOB
Model/version :	CC2540KEYFOB
Serial number :	0000 1243 (with PCB antenna) 0000 1293 (with SMA connector)
Hardware identity and/or version:	/
Software identity and/or version :	/
Frequency Range :	2402 – 2480 MHz
Number of Channels :	40
Type of Modulation :	GFSK
Output power:	1.5 mW (Conducted)
Data rate:	1000kbps
User Frequency Adjustment :	None
Type of Power Supply :	3.0 V DC (one CR2032 cell battery)
Antenna Connector :	PCB antenna
Antenna Diversity Supported :	No
Desktop Charger :	None

#### Description of Test Item

The CC2540KEYFOB supports the Bluetooth Low Energy (BLE) standard, which is considered Digital Modulation per FCC part 15.247a.

#### Exposure Evaluation

The EUT is exempted from RF Exposure Evaluation.

## 2.2 Test Environment

### 2.2.1 Normal test condition

Temperature:	21.4 – 23.4 °C
Relative humidity:	31.8 – 44.6 %
Normal test voltage:	Nominal 3 VDC (2 x AAA battery type/ LR03)

New batteries were used for all tests.

The values are the limit registered during the test period.

## 2.3 Test Period

Item received date:	2012-05-11
Test period :	from 2012-05-30 to 2012-06-26

### 3 TEST REPORT SUMMARY

#### 3.1 General

Manufacturer: Texas Instruments

Model No.: CC2540KEYFOB

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.

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 #: 215170-3**

TESTED BY: Thomas Dangle  
Thomas Dangle, Test engineer

DATE: 2012-07-30

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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	NT**

\*EUT is battery operated only.

\*\* Not tested.

### 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 a cell coin battery.

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

Test Results: -

Measurement Data: -



## 4.2 Minimum 6 dB Bandwidth

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

Test Performed By: Thomas Dangle	Date of Test: 26 June 2012
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Test Results: Complies

Measurement Data:

Measured 6 dB Bandwidth (kHz)		
2402MHz	2440 MHz	2480MHz
780	780	800

### Requirements:

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



**DELTA MARKER 2**  
 780 kHz  
 Ref 6.7 dBm \* Att 10 dB

\*RBW 30 kHz Delta 2 [T1 ]  
 VBW 100 kHz -1.06 dB  
 SWT 15 ms 780.000000000 kHz

1 PK  
 MAXH



Center 2.402 GHz 1 MHz/ Span 10 MHz

Date: 26.JUN.2012 13:13:14

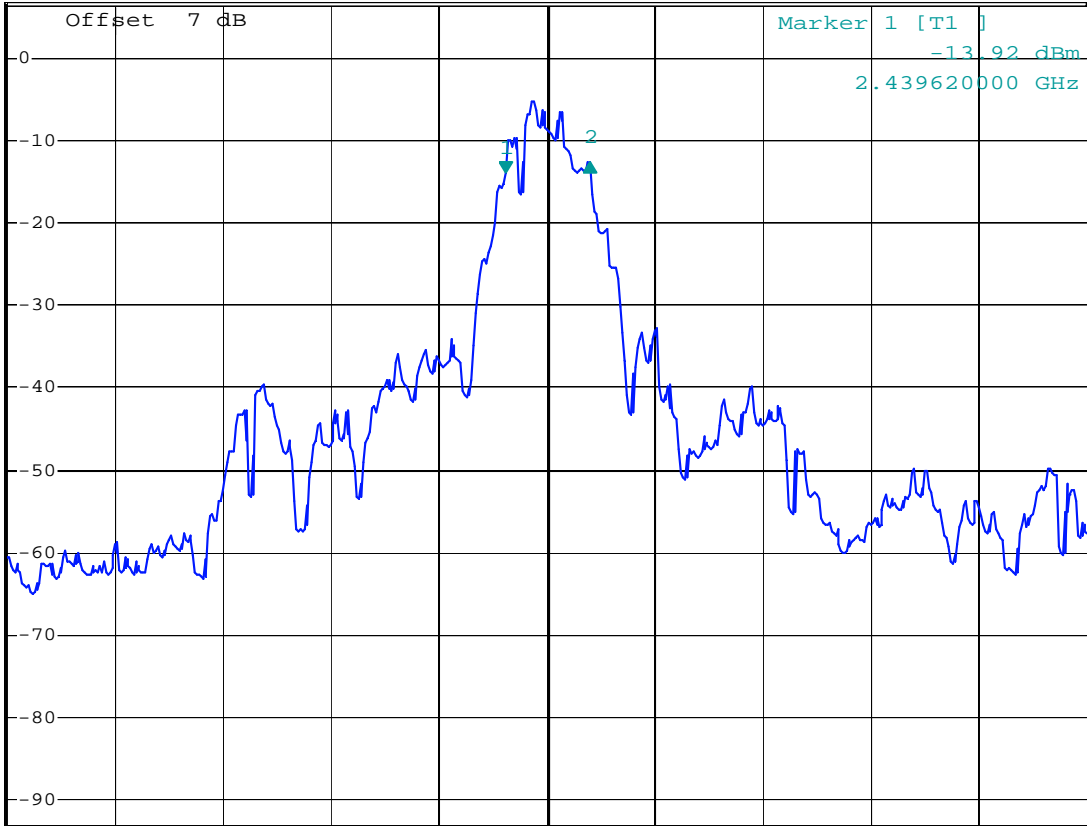
**6 dB Bandwidth at 2402 MHz**



**DELTA MARKER 2**  
 780 kHz  
 Ref 6.7 dBm \* Att 10 dB

\*RBW 30 kHz Delta 2 [T1 ]  
 VBW 100 kHz 1.40 dB  
 SWT 15 ms 780.000000000 kHz

1 PK  
 MAXH



Offset 7 dB Marker 1 [T1 ]  
 -13.92 dBm  
 2.439620000 GHz  
 LVL  
 Center 2.44 GHz 1 MHz/ Span 10 MHz

Date: 26.JUN.2012 13:15:11

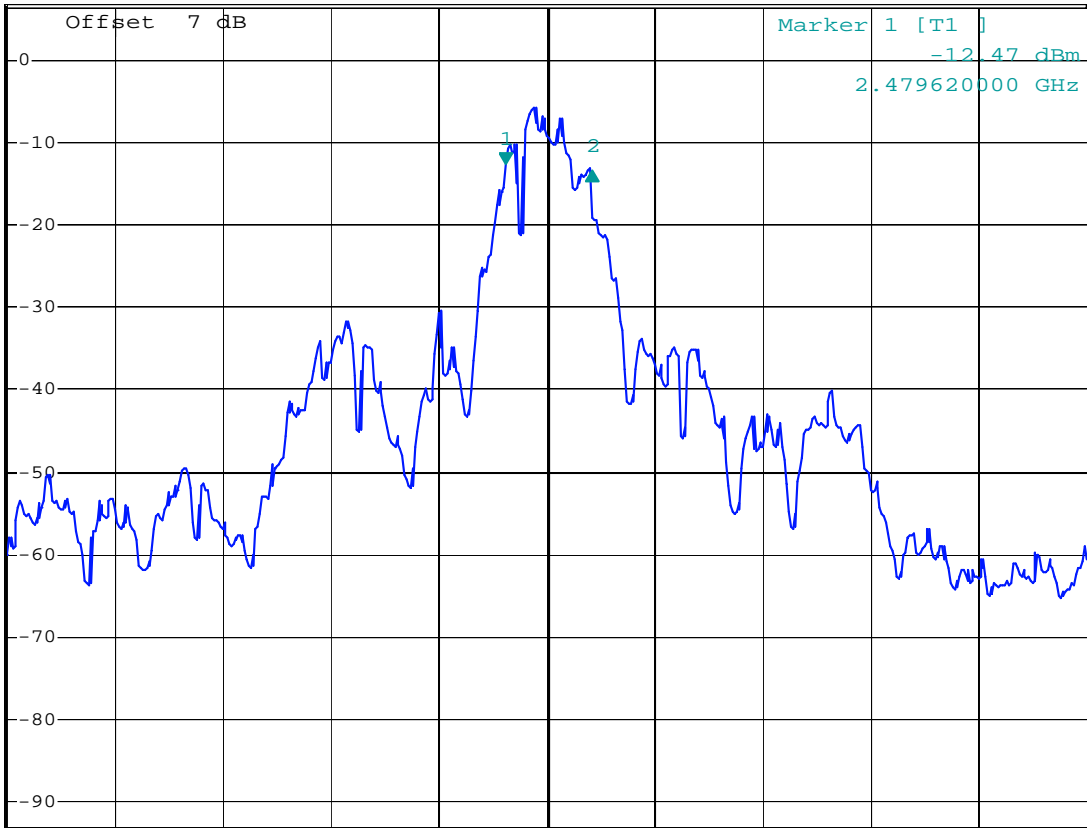
**6 dB Bandwidth at 2440 MHz**



**DELTA MARKER 2**  
 800 kHz  
 Ref 6.7 dBm \* Att 10 dB

\*RBW 30 kHz Delta 2 [T1 ]  
 VBW 100 kHz -0.97 dB  
 SWT 15 ms 800.000000000 kHz

1 PK  
 MAXH



Offset 7 dB Marker 1 [T1 ]  
 -12.47 dBm  
 2.479620000 GHz  
 Center 2.48 GHz 1 MHz/ Span 10 MHz

Date: 26.JUN.2012 13:18:11

**6 dB Bandwidth at 2480 MHz**

### 4.3 20 dB Bandwidth

Test Performed By: Thomas Dangle	Date of Test: 26 June 2012
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**Measurement Data:**

Measured 20 dB Bandwidth (MHz)
2440 MHz
1.28

**Requirements:**

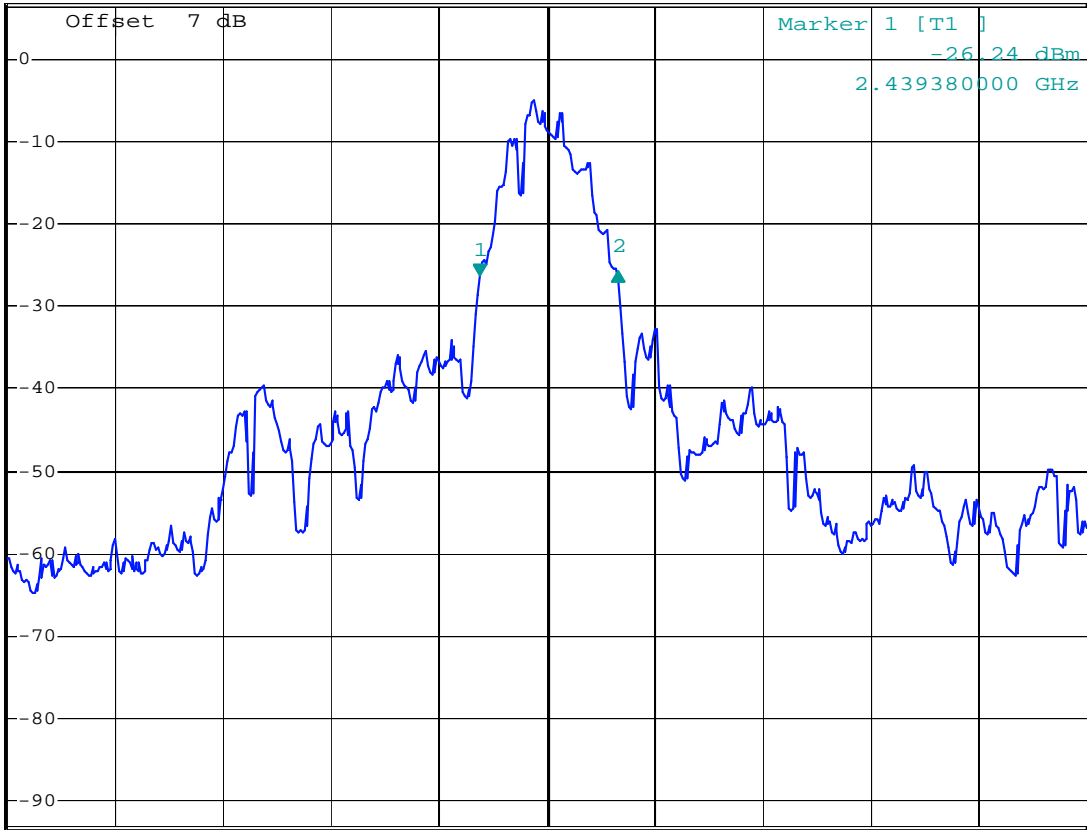
No requirements. Reported for information only.



**DELTA MARKER 2**  
 1.28 MHz  
 Ref 6.7 dBm \*Att 10 dB

\*RBW 30 kHz Delta 2 [T1 ]  
 VBW 100 kHz 0.51 dB  
 SWT 15 ms 1.28000000 MHz

1 PK  
 MAXH



Date: 26.JUN.2012 13:16:43

**20 dB Bandwidth at 2440 MHz**

#### 4.4 Peak Power Output

Para. No.: 15.247 (b)

Test Performed By: Thomas Dangle	Date of Test: 14 & 27 June 2012
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Test Results: Complies

##### Measurement Data:

RF channel	2402 MHz	2440 MHz	2480 MHz
Measured Conducted Power (dBm)	1.8	1.5	1.1
Measured Maxium Field strength (dB $\mu$ V/m) –VP	95.2	95.2	94.8
Calc. Radiated Power (dBm)	0.0	-0.1	-0.5
Calc. Antenna Gain (dB)	-1.8	-1.5	-1.6

The maximum field strength is obtained in YZ plane and vertical 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

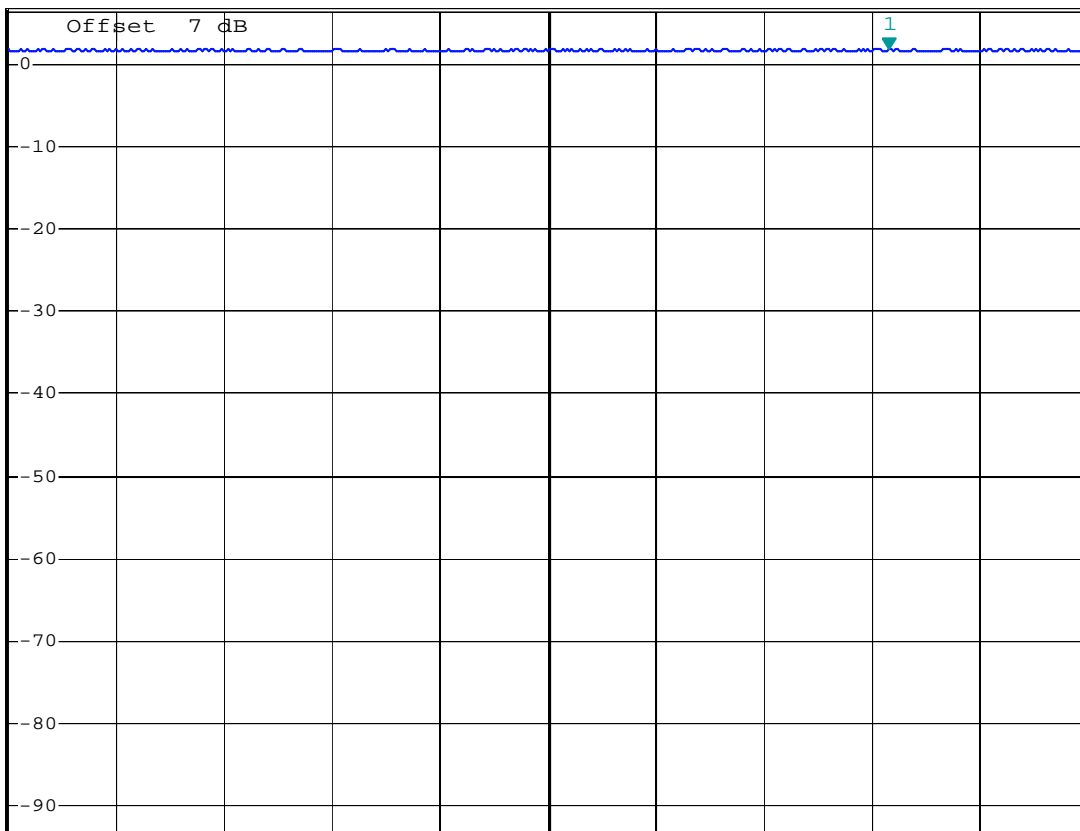
If transmitting antennas of directional gain greater than 6 dBi are used, the peak output power from the intentional radiator shall be reduced below the stated value above by the amount in dB that the directional gain of the antenna exceeds 6 dBi.



**MARKER 1**  
 2.04 ms  
 Ref 6.7 dBm \*Att 10 dB

RBW 3 MHz Marker 1 [T1 ]  
 VBW 10 MHz 1.79 dBm  
 SWT 2.5 ms 2.040000 ms

1 PK  
 MAXH



Center 2.40192 GHz 250 μs/

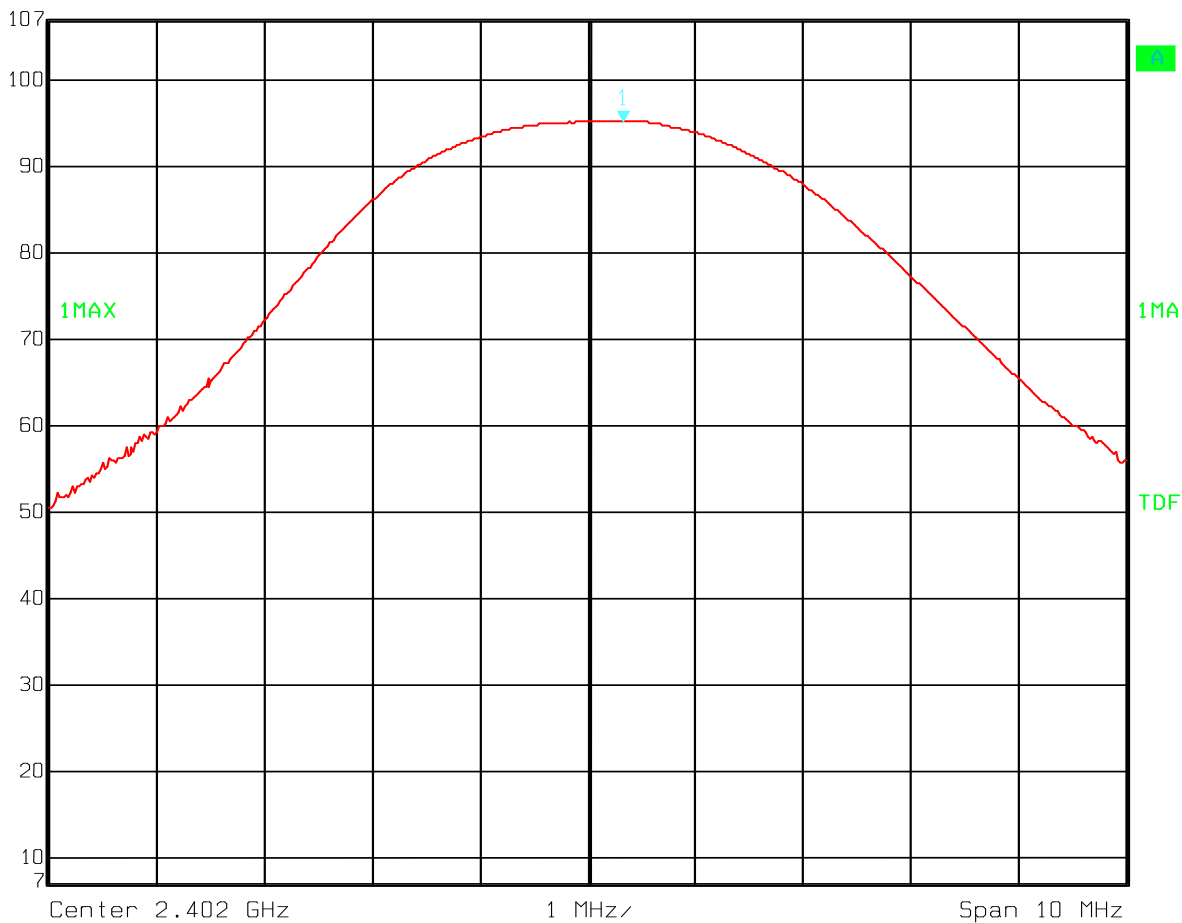
Date: 27.JUN.2012 11:20:05

**Conducted Power, 2402 MHz**





Ref Lvl	Marker 1 [T1]	RBW	2 MHz	RF Att	10 dB
107 dB*	95.23 dB $\mu$ V/m	VBW	5 MHz		
	2.40233066 GHz	SWT	5 ms	Unit	dB $\mu$ V/m



Date: 14.JUN.2012 10:56:55

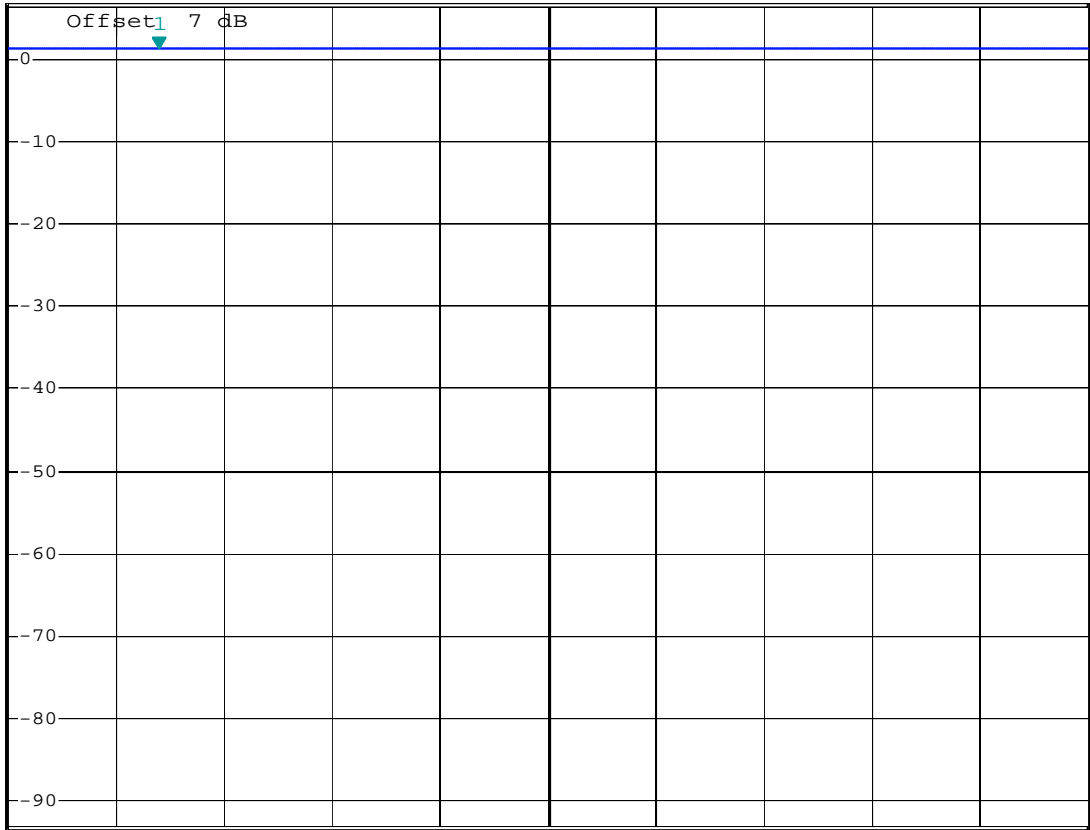
**Radiated Field strength,VP , 2402 MHz**



**MARKER 1**  
 350  $\mu$ s  
 Ref 6.7 dBm \*Att 10 dB

RBW 3 MHz Marker 1 [T1 ]  
 VBW 10 MHz 1.45 dBm  
 SWT 2.5 ms 350.000000  $\mu$ s

1 PK  
 MAXH

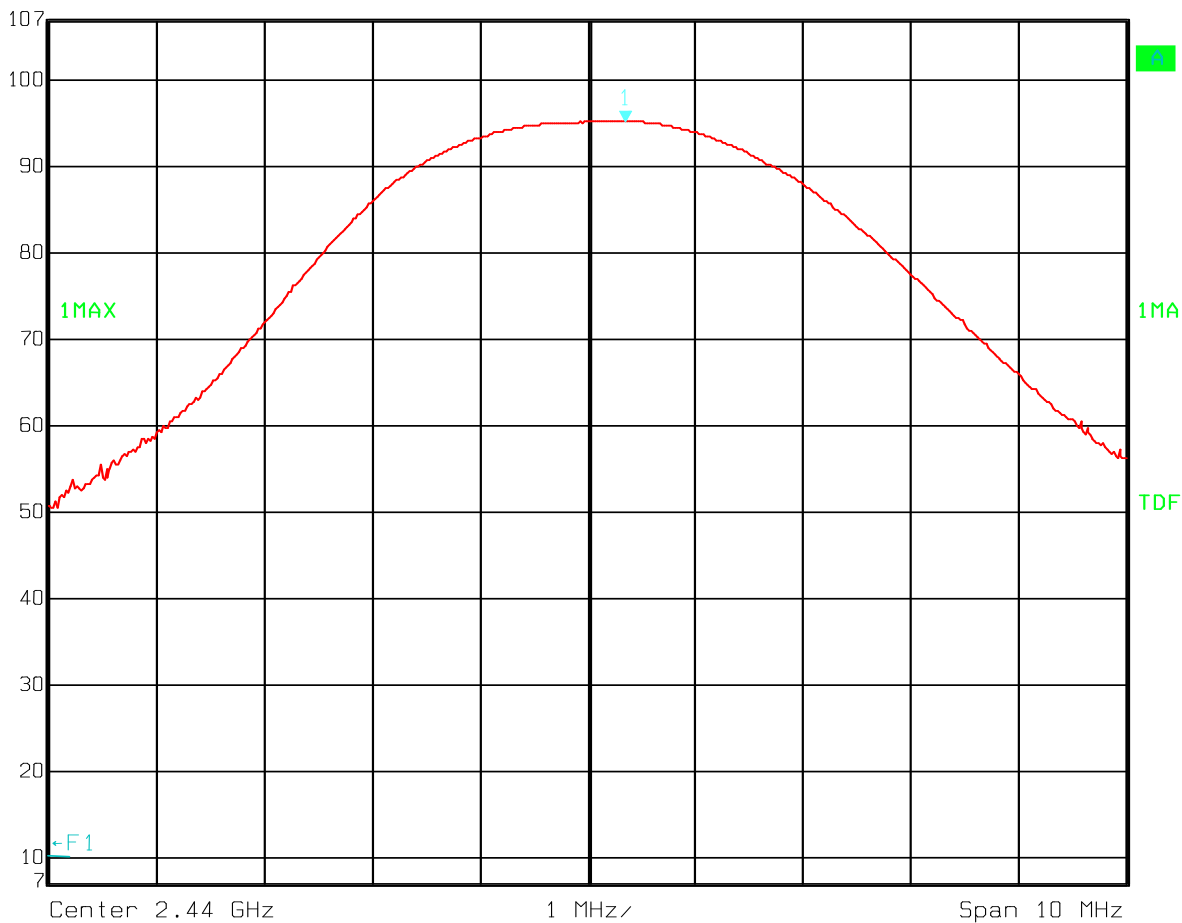


Date: 27.JUN.2012 11:22:20

**Conducted Power, 2440 MHz**



Ref Lvl	Marker 1 [T1]	RBW	2 MHz	RF Att	10 dB
107 dB*	95.17 dB $\mu$ V/m	VBW	5 MHz		
	2.44035070 GHz	SWT	5 ms	Unit	dB $\mu$ V/m



Date: 14.JUN.2012 11:03:54

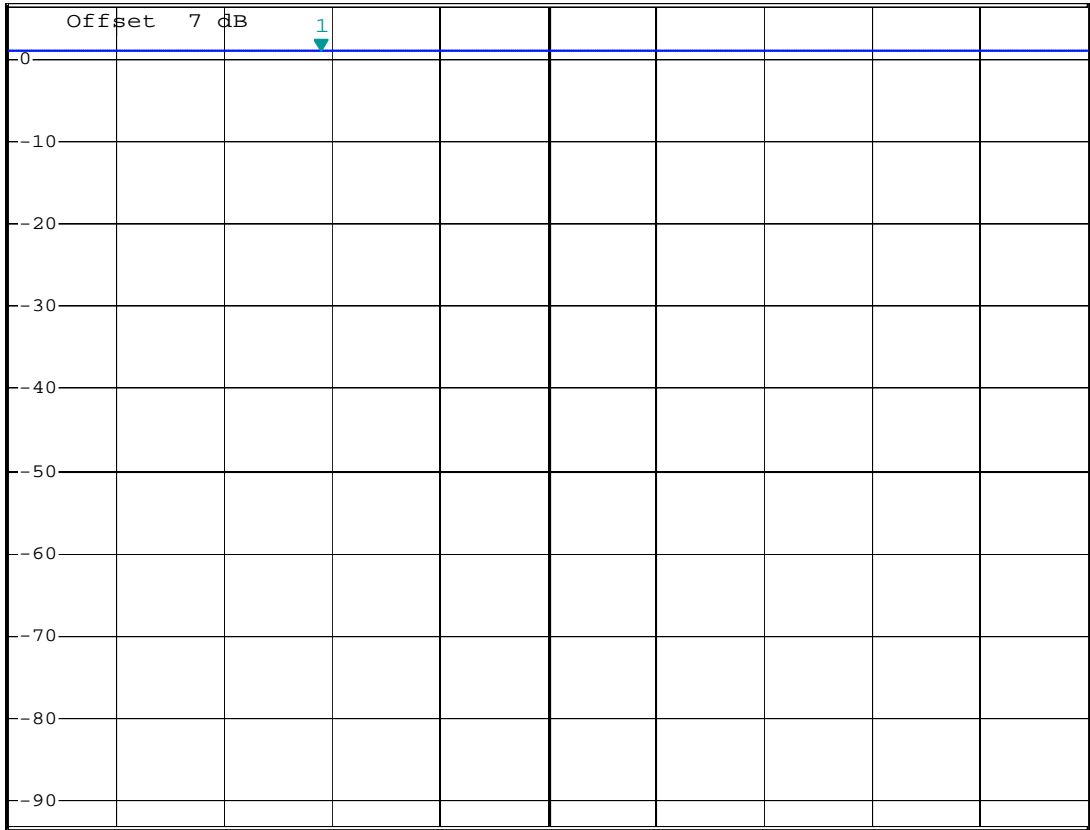
**Radiated field strength,VP, 2440 MHz**



**MARKER 1**  
 725  $\mu$ s  
 Ref 6.7 dBm \*Att 10 dB

RBW 3 MHz Marker 1 [T1 ]  
 VBW 10 MHz 1.11 dBm  
 SWT 2.5 ms 725.000000  $\mu$ s

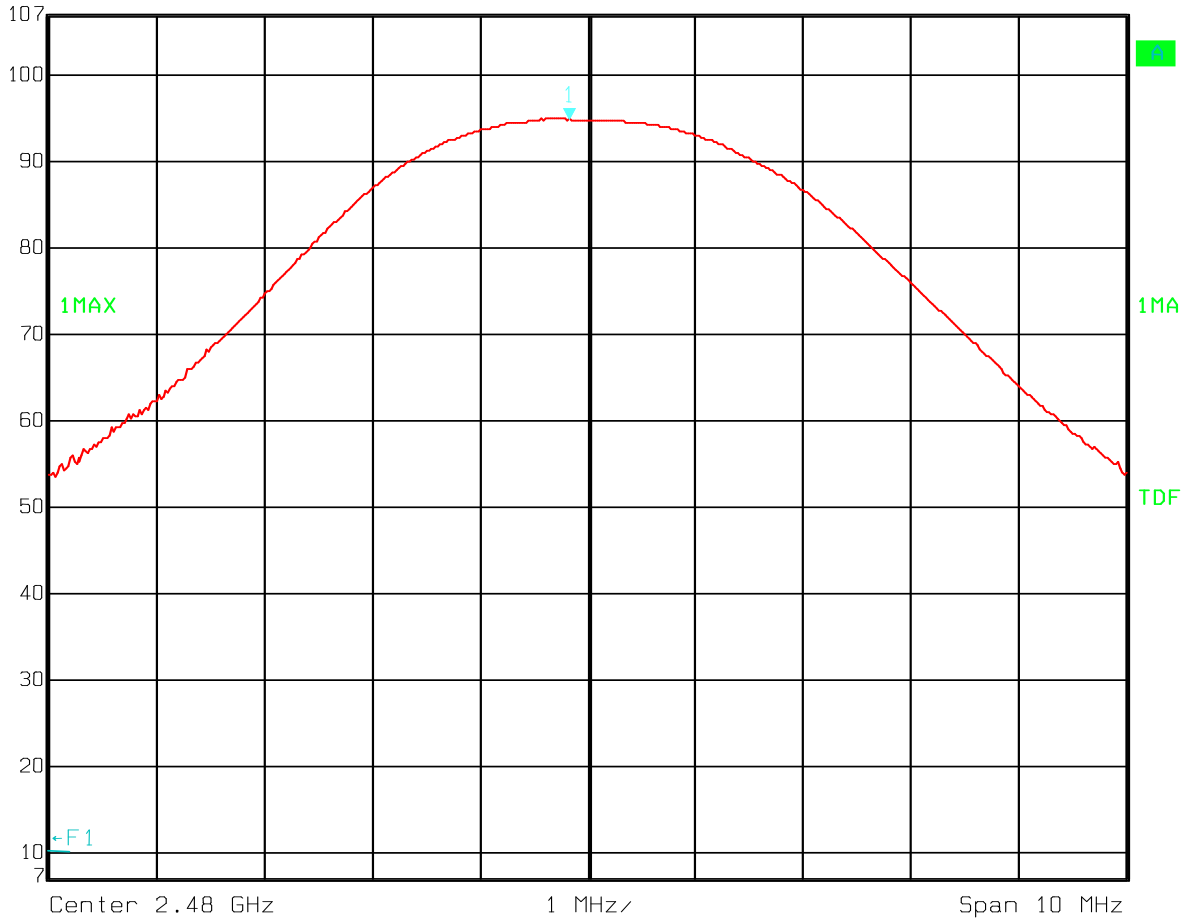
1 PK  
 MAXH



Date: 27.JUN.2012 11:23:34

**Conducted Power, 2480 MHz**

	Ref Lvl	Marker 1 [T1]	RBW	2 MHz	RF Att	10 dB
	107 dB*	94.76 dB $\mu$ V/m	VBW	5 MHz		
		2.47982966 GHz	SWT	5 ms	Unit	dB $\mu$ V/m



Date: 14.JUN.2012 11:05:04

**Radiated field strength, 2480 MHz**

#### 4.5 Spurious Emissions (Radiated)

Para. No.: 15.247 (c)

Test Performed By: Thomas Dangle	Date of Test: 14 & 27 June 2012
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Test Results: Complies

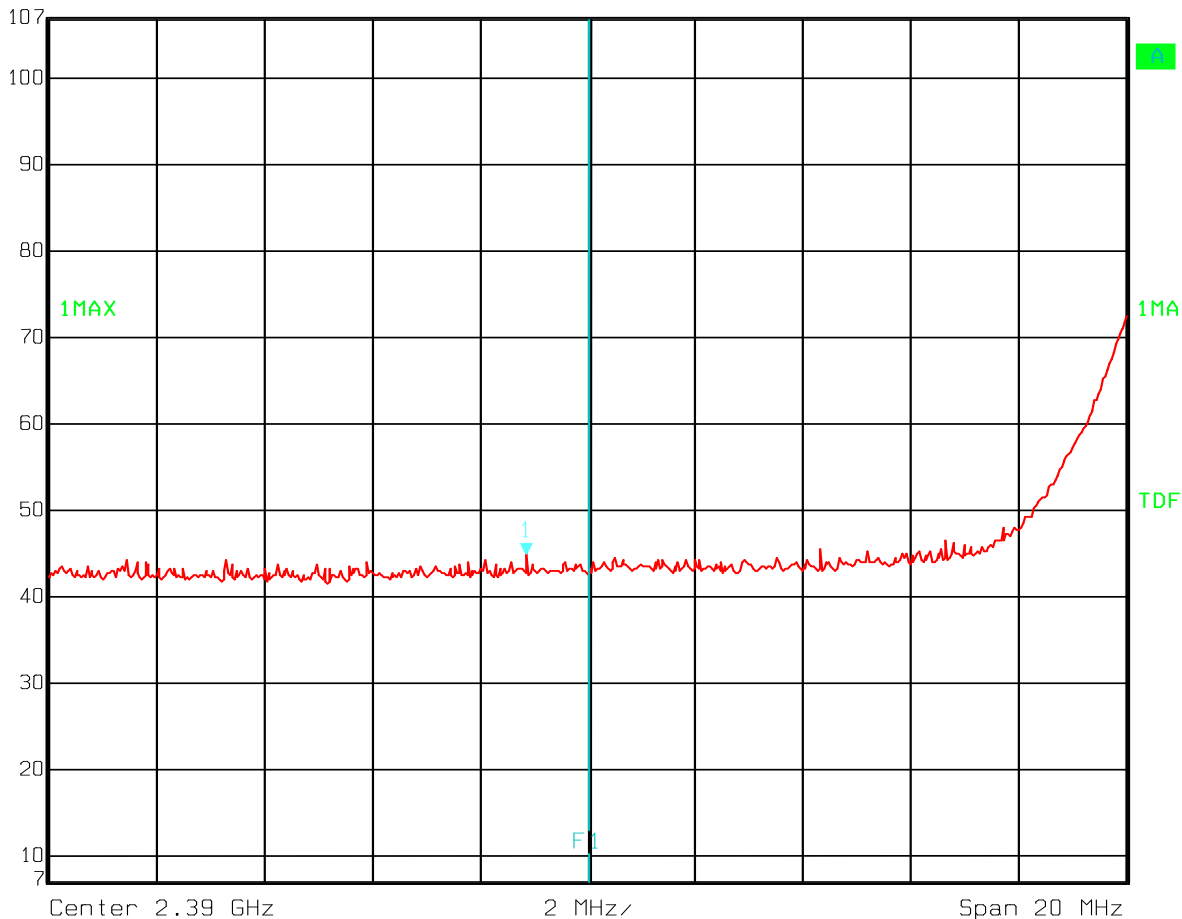
##### Measurement Data:

Band-edge, @3m

Frequency	Measured Field Strength @3m, dB $\mu$ V/m	Detector	Limit dB $\mu$ V/m	Margin dB
2.39 GHz	44.9	AV	54	29.1
	44.9	PK	74	29.1
2.4835 GHz	45.1	AV	54	8.9
	53.6	PK	74	20.4

See attached plots.

	Marker 1 [T1]	RBW	1 MHz	RF Att	10 dB
	Ref Lvl	44.86 dB $\mu$ V/m	VBW	3 MHz	
	107 dB*	2.38885812 GHz	SWT	5 ms	Unit

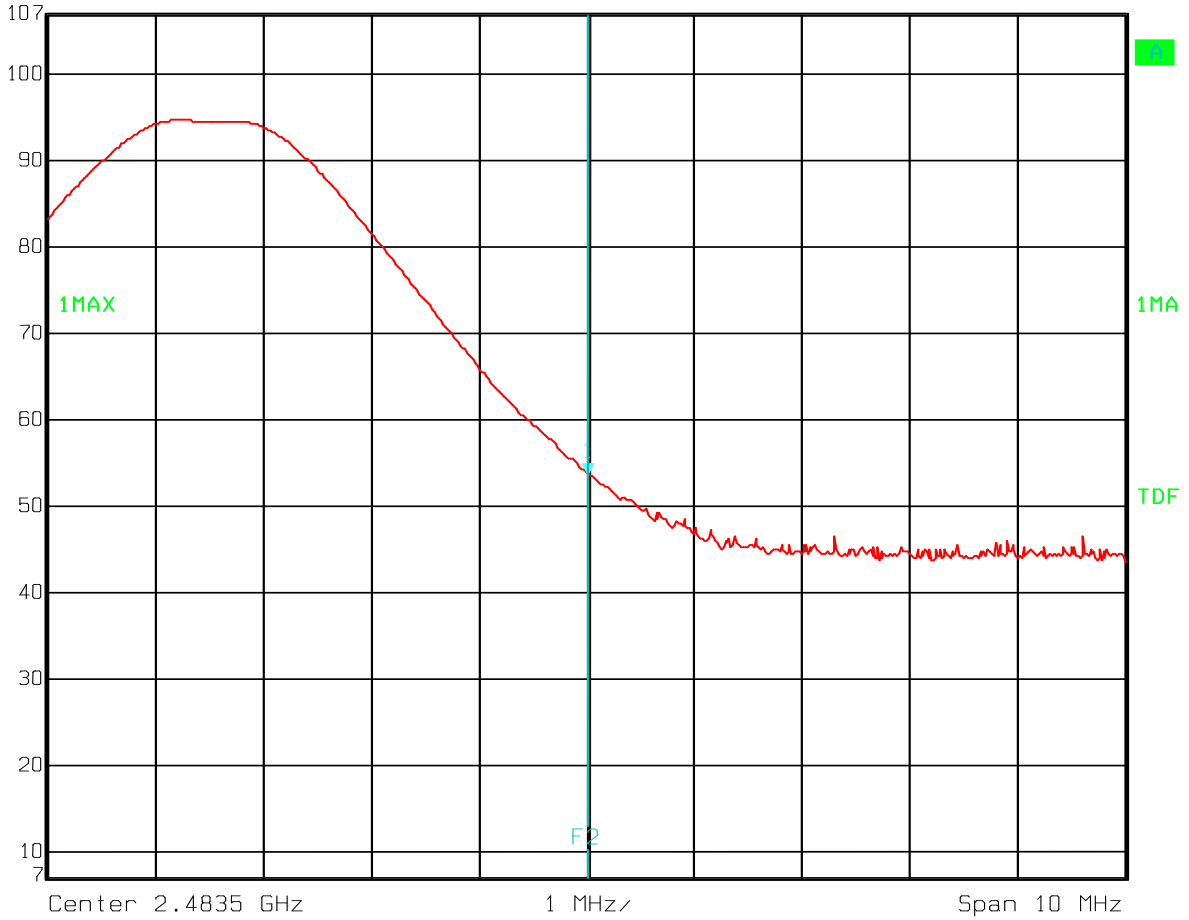


Date: 14.JUN.2012 11:01:21

**Band Edge, 2390 MHz, Peak Detector**



Ref Lvl	Marker 1 [T1]	RBW	1 MHz	RF Att	10 dB
107 dB*	53.56 dB $\mu$ V/m	VBW	3 MHz		
	2.48351703 GHz	SWT	5 ms	Unit	dB $\mu$ V/m

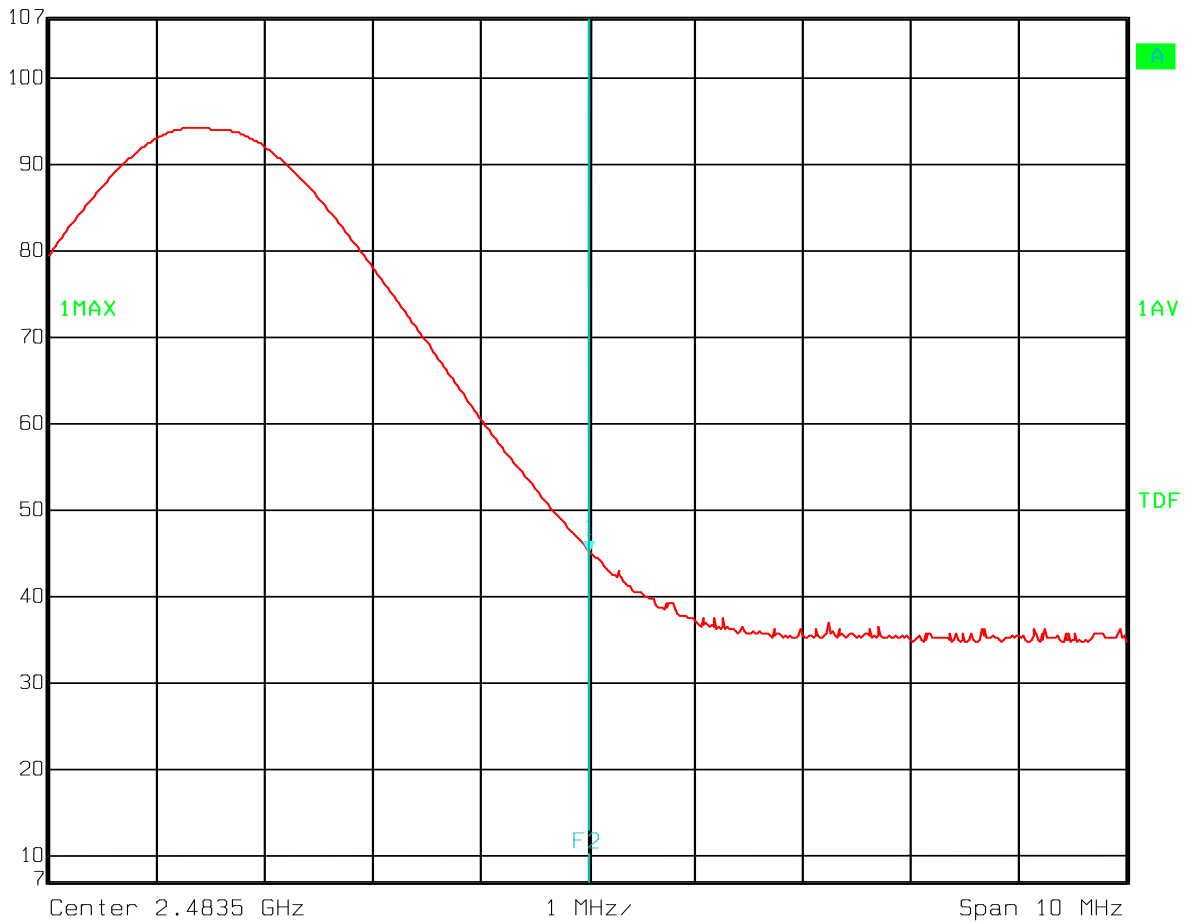


Date: 14.JUN.2012 11:07:01

**Band Edge, 2483.5 MHz, Peak detector**



KS	Ref Lvl	Marker 1 [T1]	RBW	1 MHz	RF Att	10 dB
	107 dB*	45.08 dB $\mu$ V/m	VBW	3 MHz		
		2.48351002 GHz	SWT	5 ms	Unit	dB $\mu$ V/m



Date: 14.JUN.2012 11:08:20

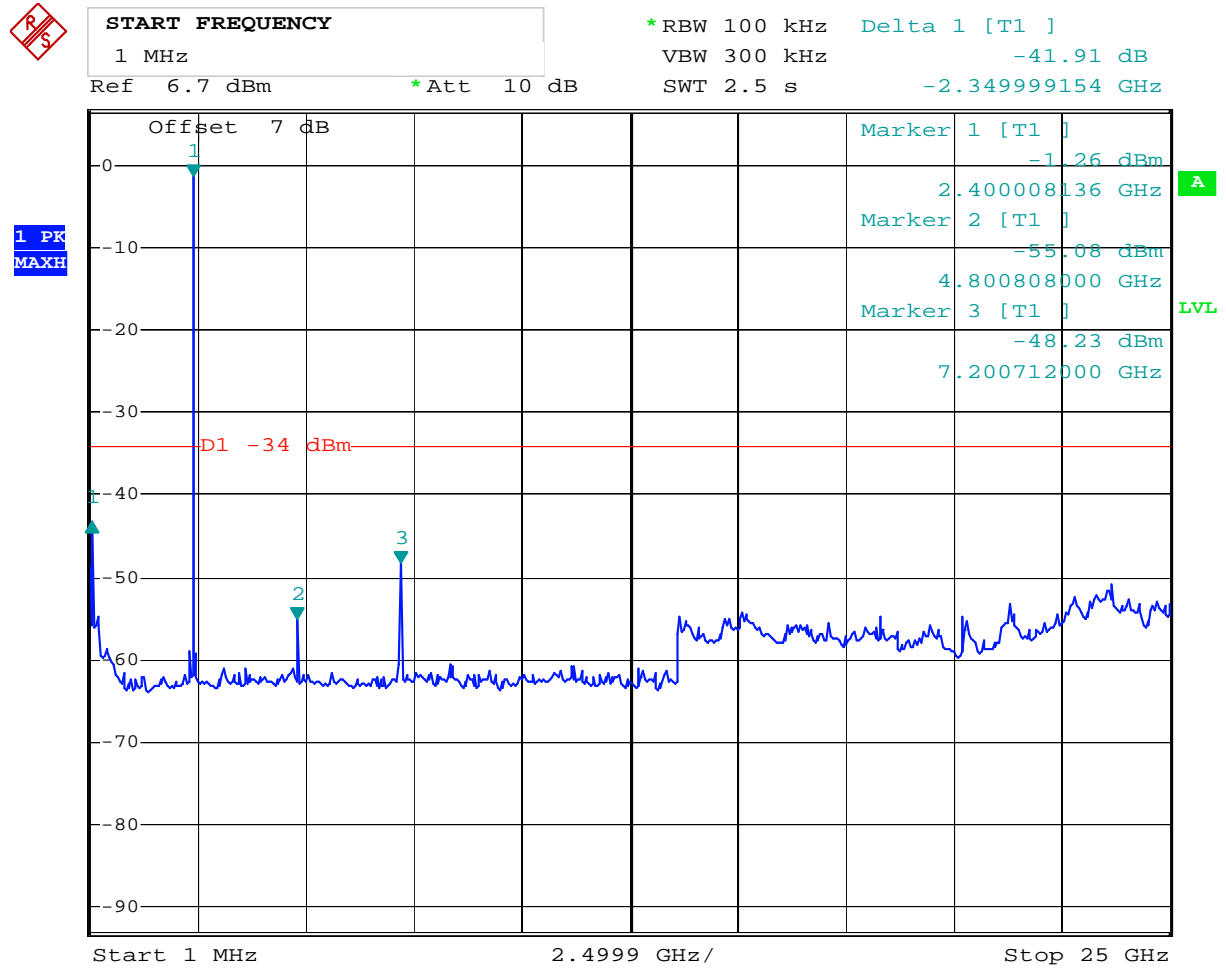
**Band Edge, 2483.5 MHz, AV detector**

**RF conducted power**

Scan performed radiated with 100 kHz Bandwidth from 1 MHz to 25 GHz.

All emissions are more than 20dB below carrier.

See attached plots.



Date: 27.JUN.2012 08:10:20

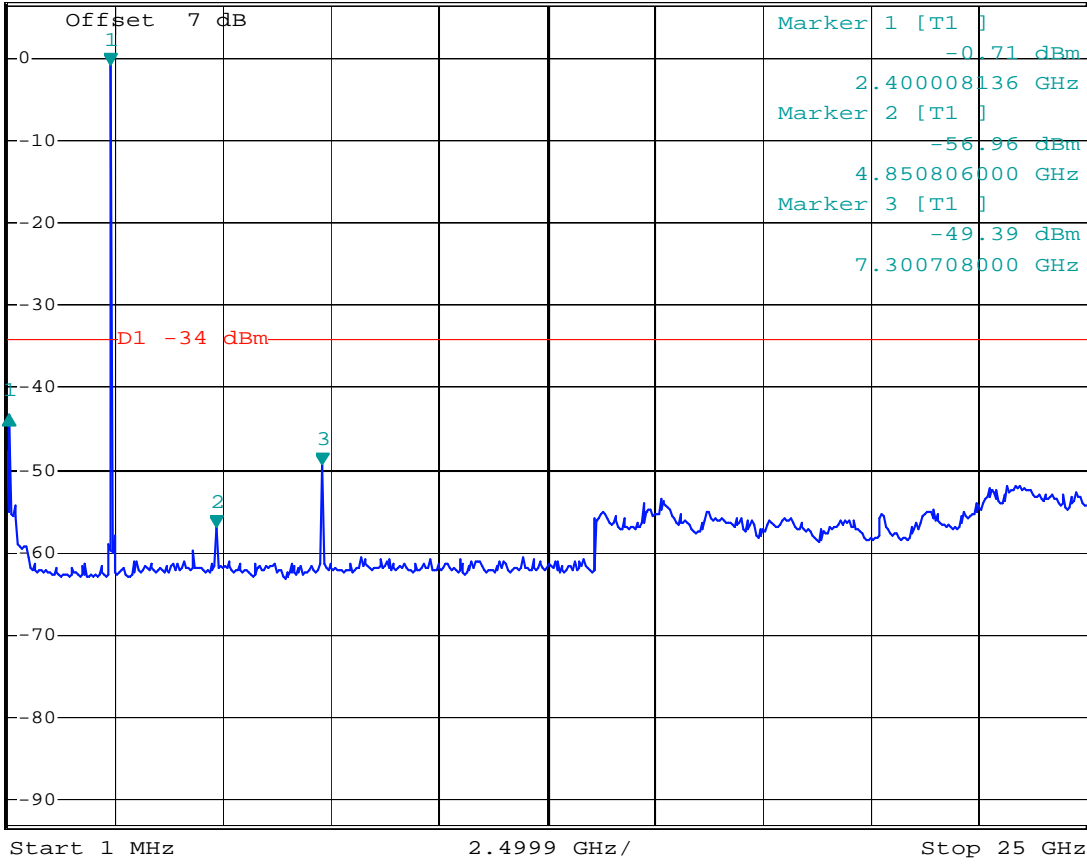
**Ch 2402 MHz, Conducted Emissions, 1 MHz – 25 GHz**



**DELTA MARKER 1**  
 -2.349999154 GHz  
 Ref 6.7 dBm \*Att 10 dB

\*RBW 100 kHz Delta 1 [T1 ]  
 VBW 300 kHz -42.55 dB  
 SWT 2.5 s -2.349999154 GHz

1 PK  
 MAXH



Date: 27.JUN.2012 08:15:33

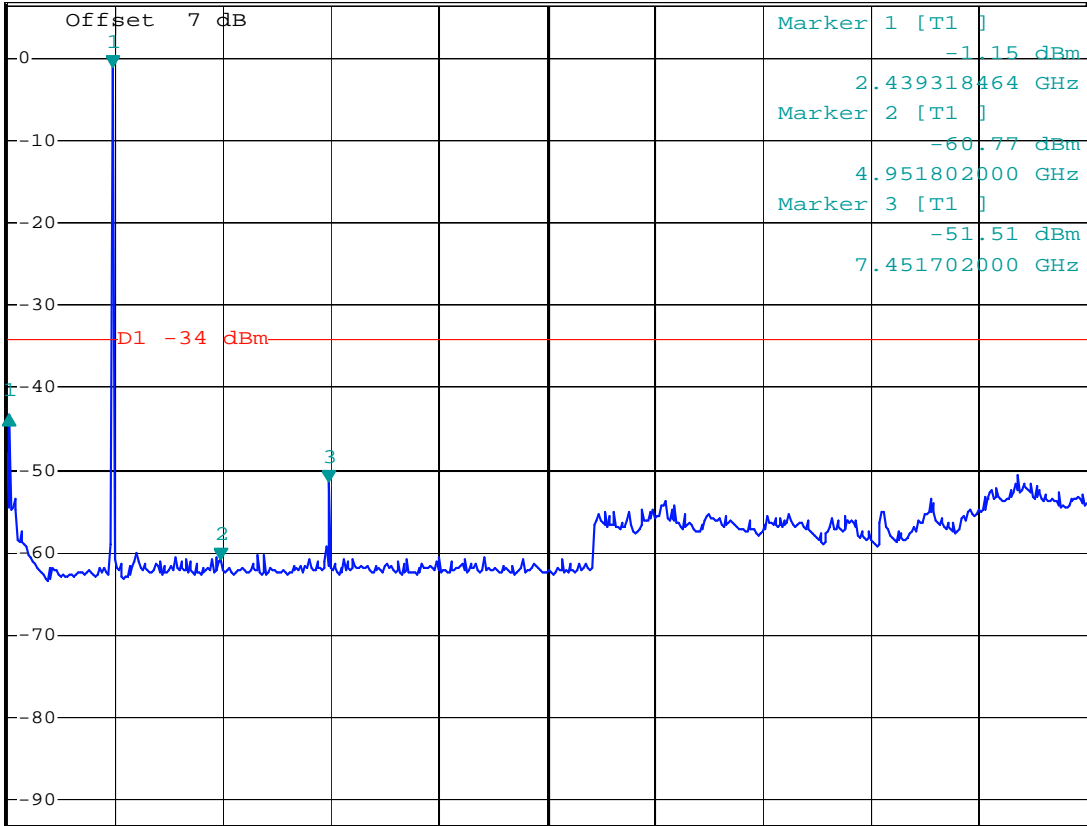
**Ch 2440 MHz, Conducted Emissions, 1 MHz – 25 GHz**



**DELTA MARKER 1**  
 -2.388320464 GHz  
 Ref 6.7 dBm \*Att 10 dB

\*RBW 100 kHz Delta 1 [T1 ]  
 VBW 300 kHz -42.10 dB  
 SWT 2.5 s -2.388320464 GHz

1 PK  
 MAXH



Start 1 MHz 2.4999 GHz/ Stop 25 GHz

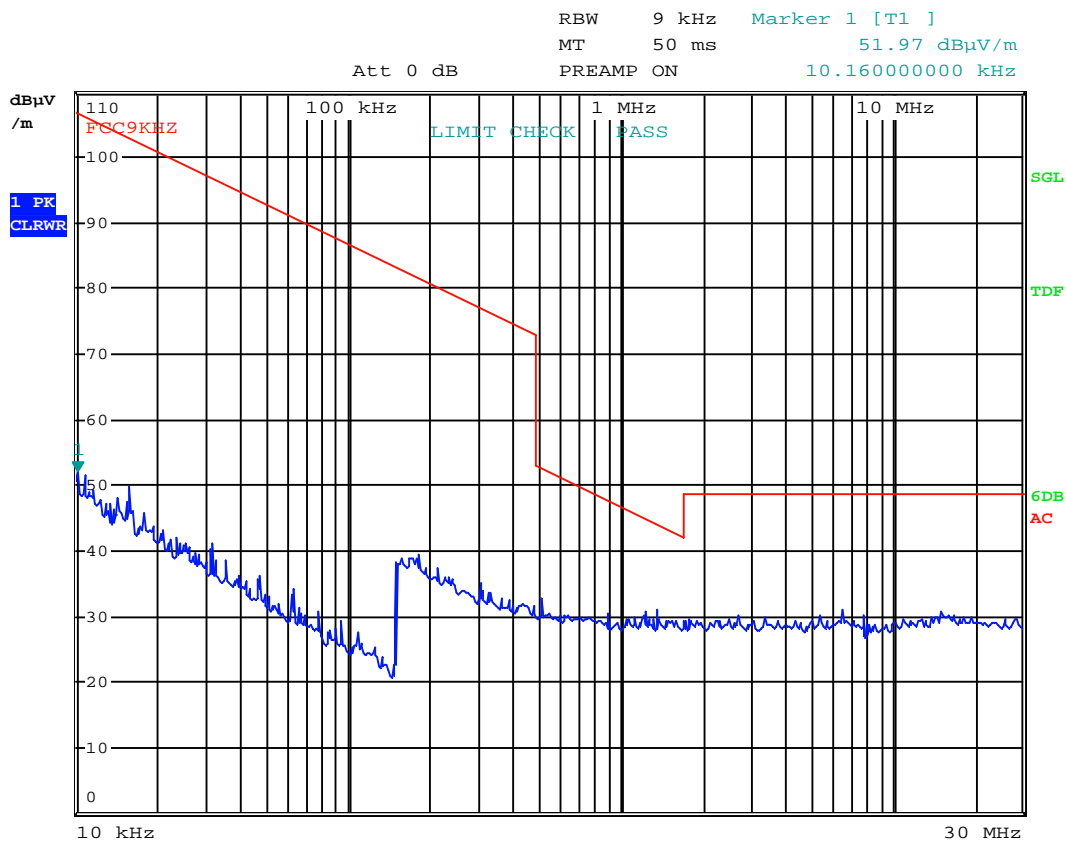
Date: 27.JUN.2012 08:18:34

**Ch 2480 MHz, Conducted Emissions, 1 MHz – 25 GHz**

**Radiated emissions 9kHz - 30 MHz.**

Detector: Quasi-Peak

Measuring distance 10 m.



Date: 14.JUN.2012 12:55:57

**Radiated Emissions, 9 kHz – 30 MHz @10m – TX on at ch. 2440 MHz**

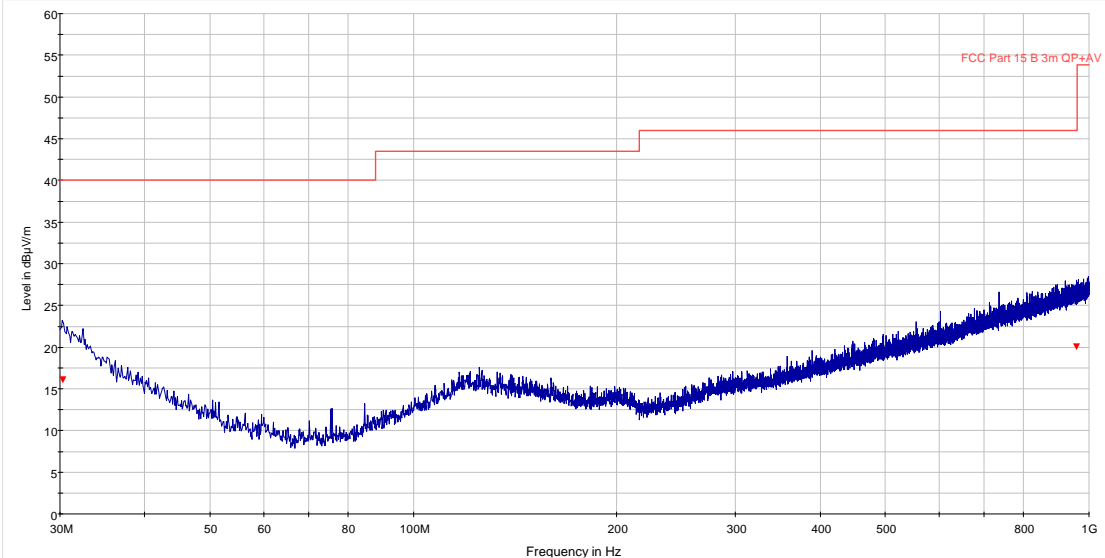
**Radiated emission 30 – 1000 MHz.**

Detector: Peak

Measuring distance at 3m.

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

See attached plot.



**Radiated Emissions, 30 – 1000 MHz, VP and HP, @3m –TX on at ch. 2440 MHz**

**Radiated Emissions, 1-25 GHz**

1-3 GHz measured at a distance of 3 m

3 - 18 GHz measured at 1m

Prescan performed from 18 to 25 GHz.

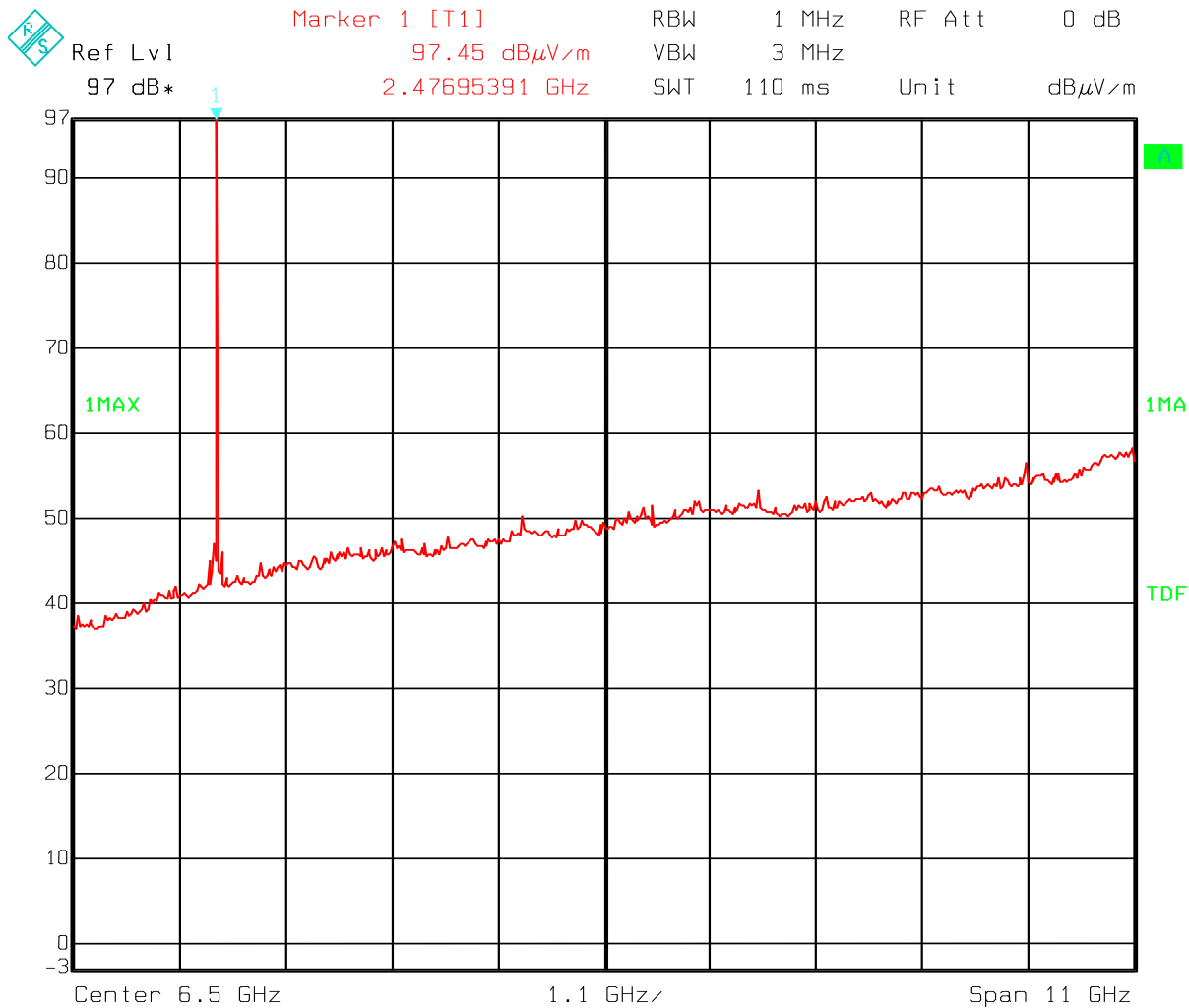
Frequency MHz	Field strength @1 & 3m dB $\mu$ V/m	Detector	Limit dB $\mu$ V/m	Margin dB
Ch 2402	-	Pk	74	-
Ch 2440	-	Pk	74	-
Ch 2480	-	Pk	74	-

Frequency MHz	Field strength @1 & 3m dB $\mu$ V/m	Detector	Limit dB $\mu$ V/m	Margin dB
Ch 2402	-	AV	54	-
Ch 2440	-	AV	54	-
Ch 2480	-	AV	54	-

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.

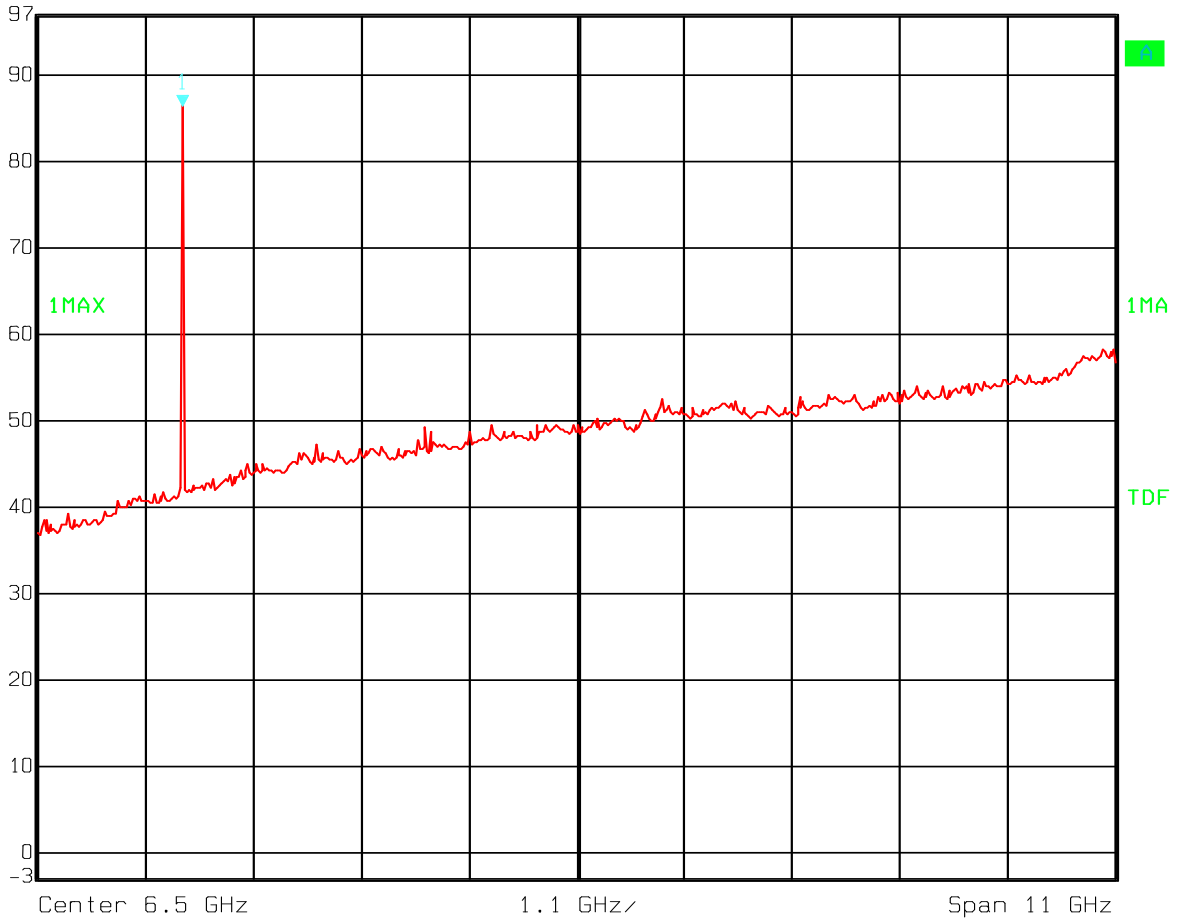


Date: 14.JUN.2012 11:19:10

**Radiated Emissions ch. 2480 MHz, 1 – 12 GHz, VP, @3m – Pre-scan with Peak detector**



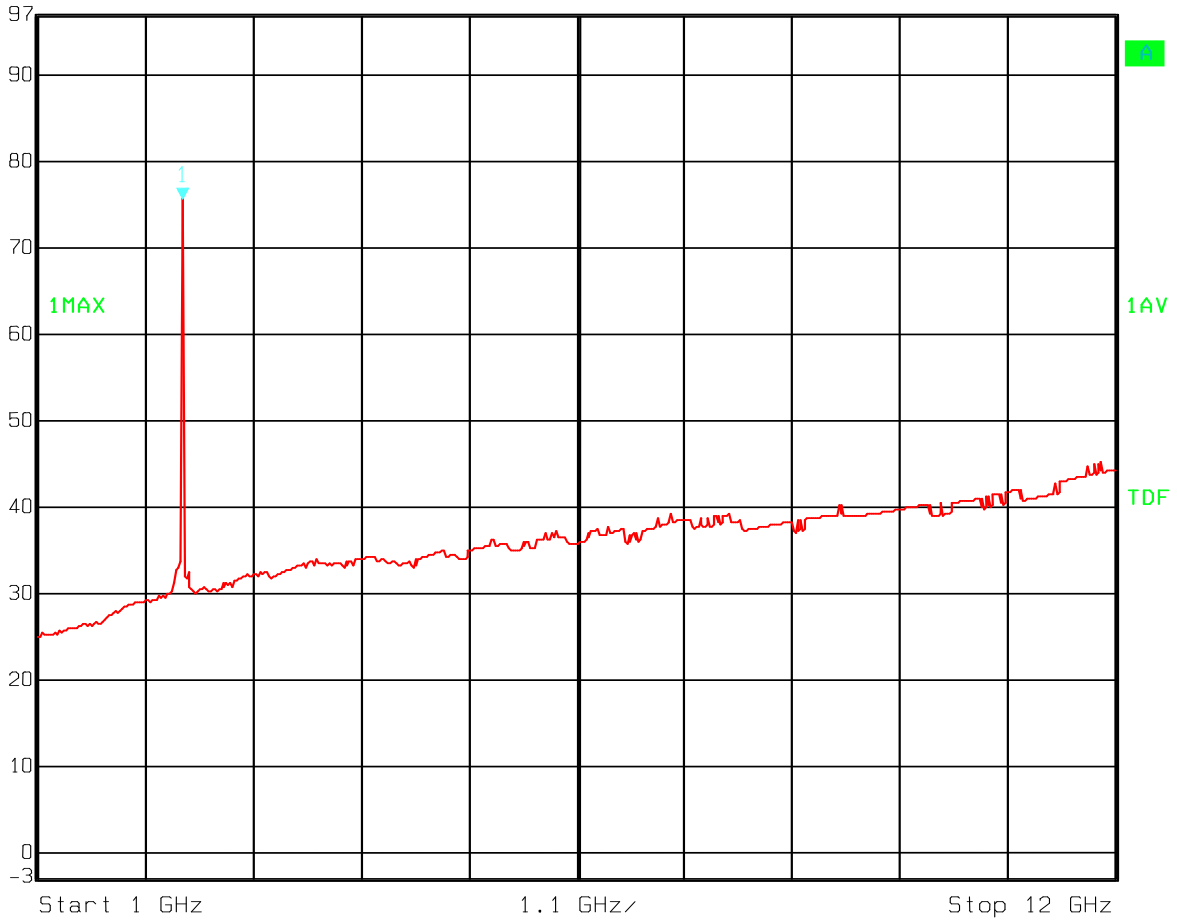
RS	Ref Lvl	Marker 1 [T1]	RBW	1 MHz	RF Att	0 dB
	97 dB*	86.29 dB $\mu$ V/m	VBW	3 MHz		
		2.47695391 GHz	SWT	110 ms	Unit	dB $\mu$ V/m



Date: 14.JUN.2012 11:21:44

**Radiated Emissions ch. 2480 MHz, 1 – 12 GHz, HP, @3m – Pre-scan with Peak detector**

RS	Marker 1 [T1]	RBW	1 MHz	RF Att	0 dB
	Ref Lvl	75.63 dB $\mu$ V/m	VBW	3 MHz	
	97 dB*	2.47695391 GHz	SWT	110 ms	Unit dB $\mu$ V/m



Date: 14.JUN.2012 11:25:11

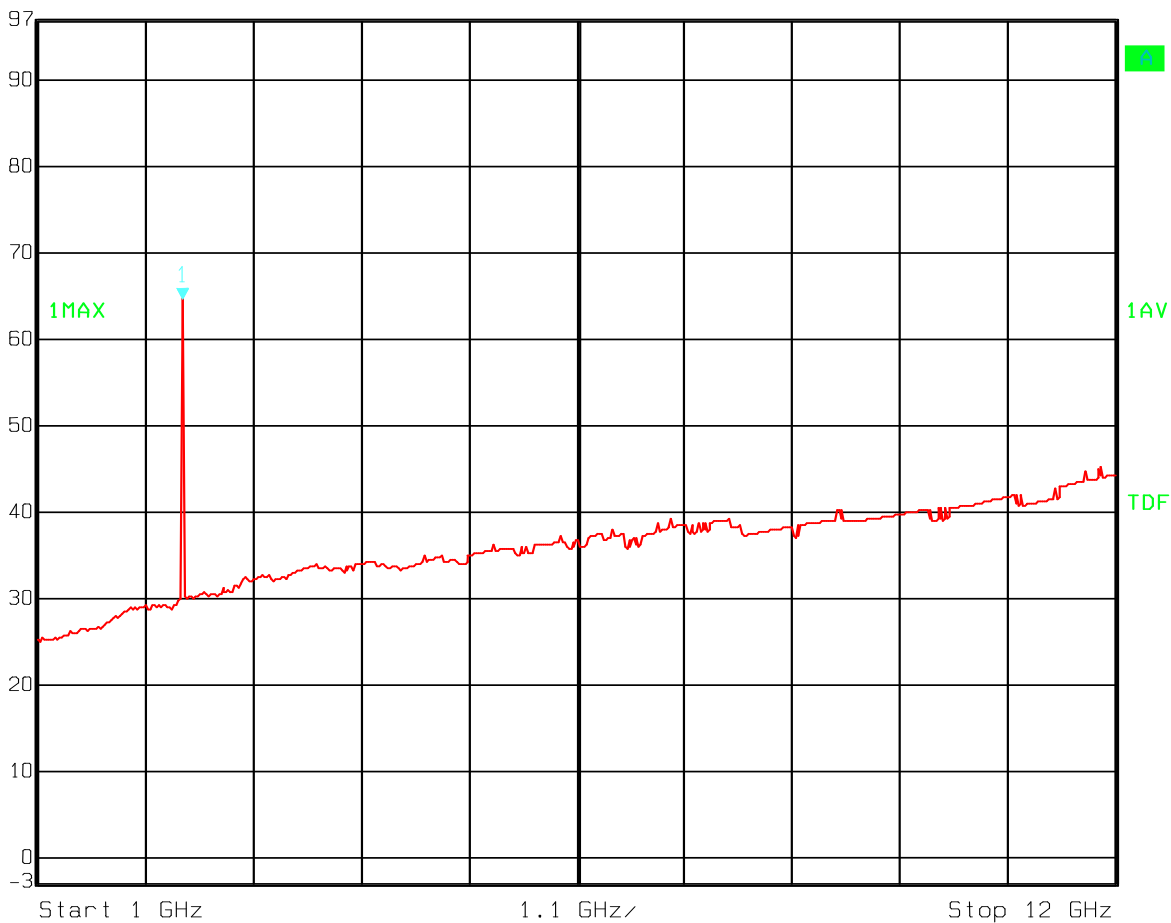
**Radiated Emissions ch. 2480 MHz, 1 – 12 GHz, VP, @3m – Pre-scan with AV detector**



Ref Lvl  
97 dB\*

Marker 1 [T1]  
64.53 dB $\mu$ V/m  
2.47695391 GHz

RBW 1 MHz  
RF Att 0 dB  
VBW 3 MHz  
SWT 110 ms  
Unit dB $\mu$ V/m

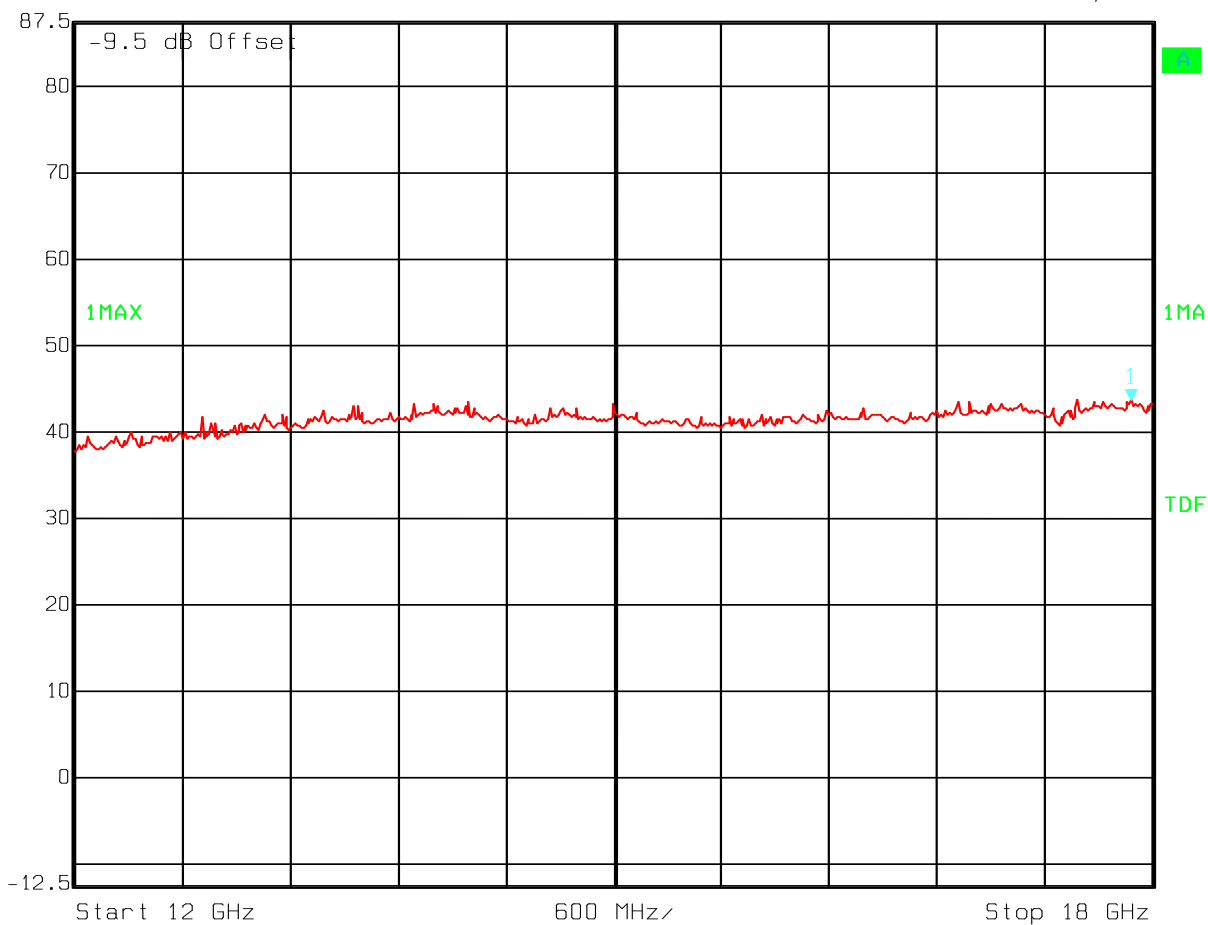


Date: 14.JUN.2012 11:27:39

Radiated Emissions ch. 2480 MHz, 1 – 12 GHz, HP, @3m – Pre-scan with AV detector



Ref Lvl 87.5 dB\*      Marker 1 [T1]      RBW 1 MHz      RF Att 0 dB  
 43.62 dB $\mu$ V/m      VBW 3 MHz  
 17.87975952 GHz      SWT 60 ms      Unit dB $\mu$ V/m

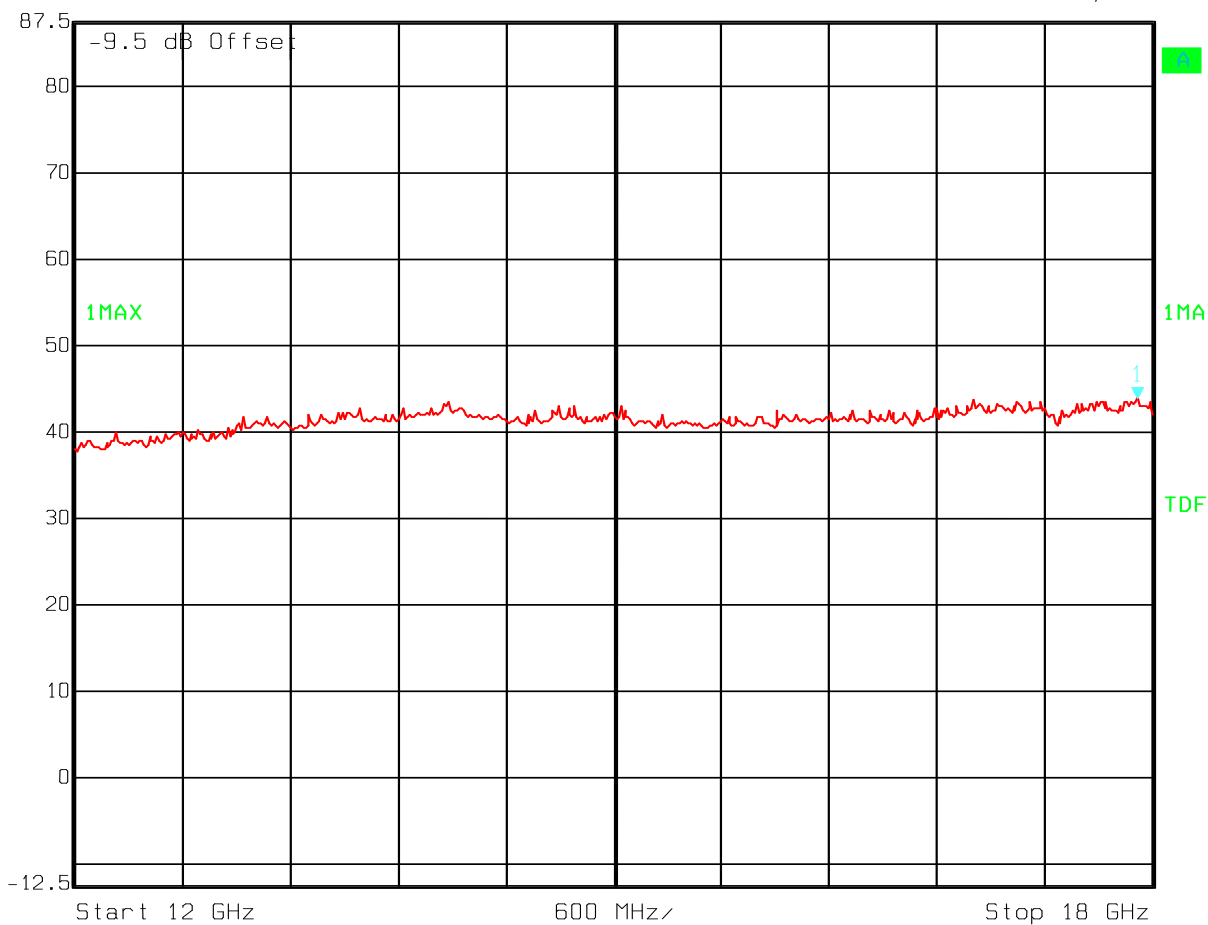


Date: 14.JUN.2012 12:14:35

**Radiated Emissions ch. 2440 MHz, 12 – 18 GHz, VP, @1m – Pre-scan with Peak detector**



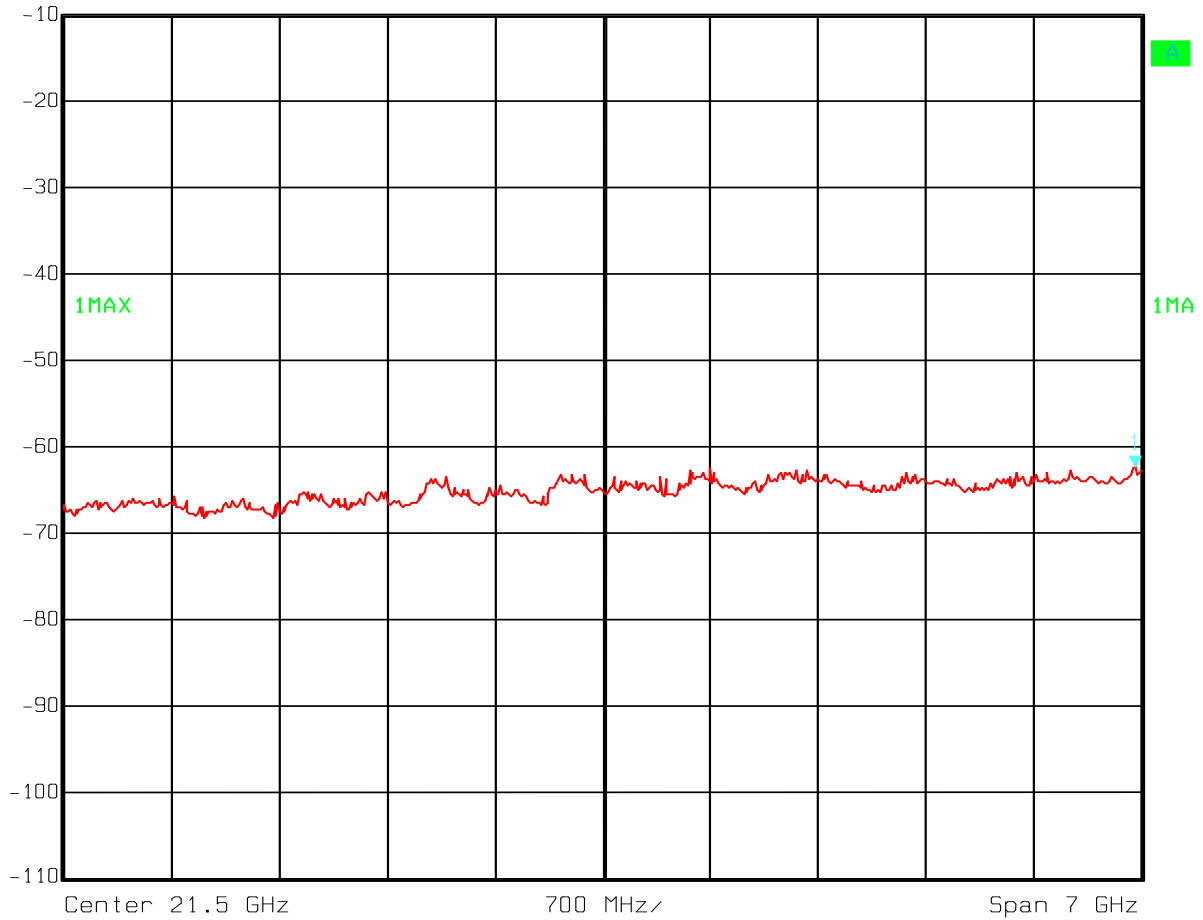
Ref Lvl 87.5 dB\*      Marker 1 [T1]      RBW 1 MHz      RF Att 0 dB  
 43.98 dB $\mu$ V/m      VBW 3 MHz  
 17.91583166 GHz      SWT 60 ms      Unit dB $\mu$ V/m



Date: 14.JUN.2012 12:17:23

**Radiated Emissions ch. 2440 MHz, 12 – 18 GHz, HP, @1m – Pre-scan with Peak detector**

	Marker 1 [T1]	RBW	1 MHz	RF Att	10 dB
	Ref Lvl	-62.34 dBm	VBW	3 MHz	
	-10 dBm	24.95791583 GHz	SWT	70 ms	Unit dBm



Date: 14.JUN.2012 13:23:07

**Radiated Emissions ch. 2440 MHz, 18 – 25 GHz, VP/HP, @1m, Pre-scan with Peak detector**

#### 4.6 Power Spectral Density (PSD)

Para. No.: 15.247 (d)

Test Performed By: Thomas Dangle	Date of Test: 26 June 2012
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Test Results: Complies

##### 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 dBm
Power Spectral Density @2402 MHz	-15.4
Power Spectral Density @2440 MHz	-15.7
Power Spectral Density @2480 MHz	-16.2

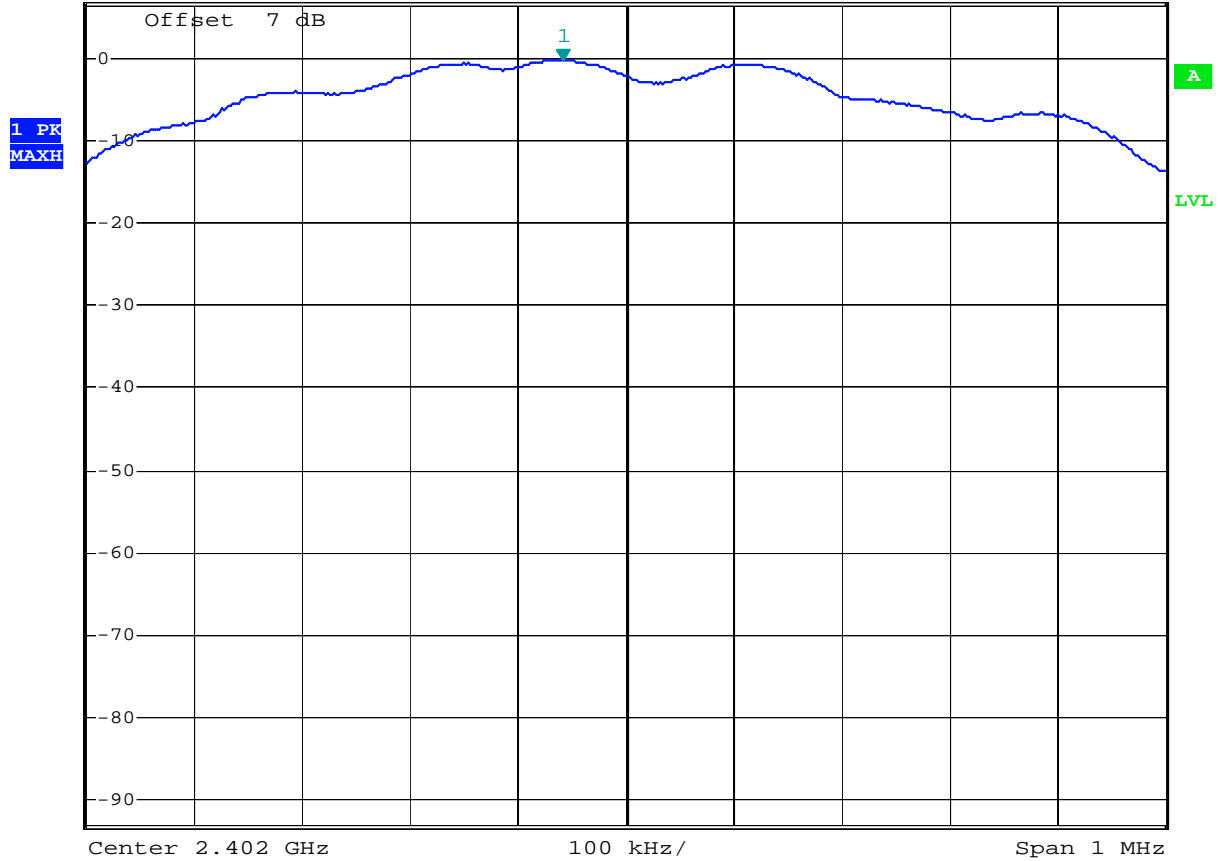
##### Requirements:

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



**MARKER 1**  
 2.401942 GHz  
 Ref 6.7 dBm \*Att 10 dB

\*RBW 100 kHz Marker 1 [T1 ]  
 VBW 300 kHz -0.20 dBm  
 SWT 2.5 ms 2.401942000 GHz



Date: 26.JUN.2012 13:41:29

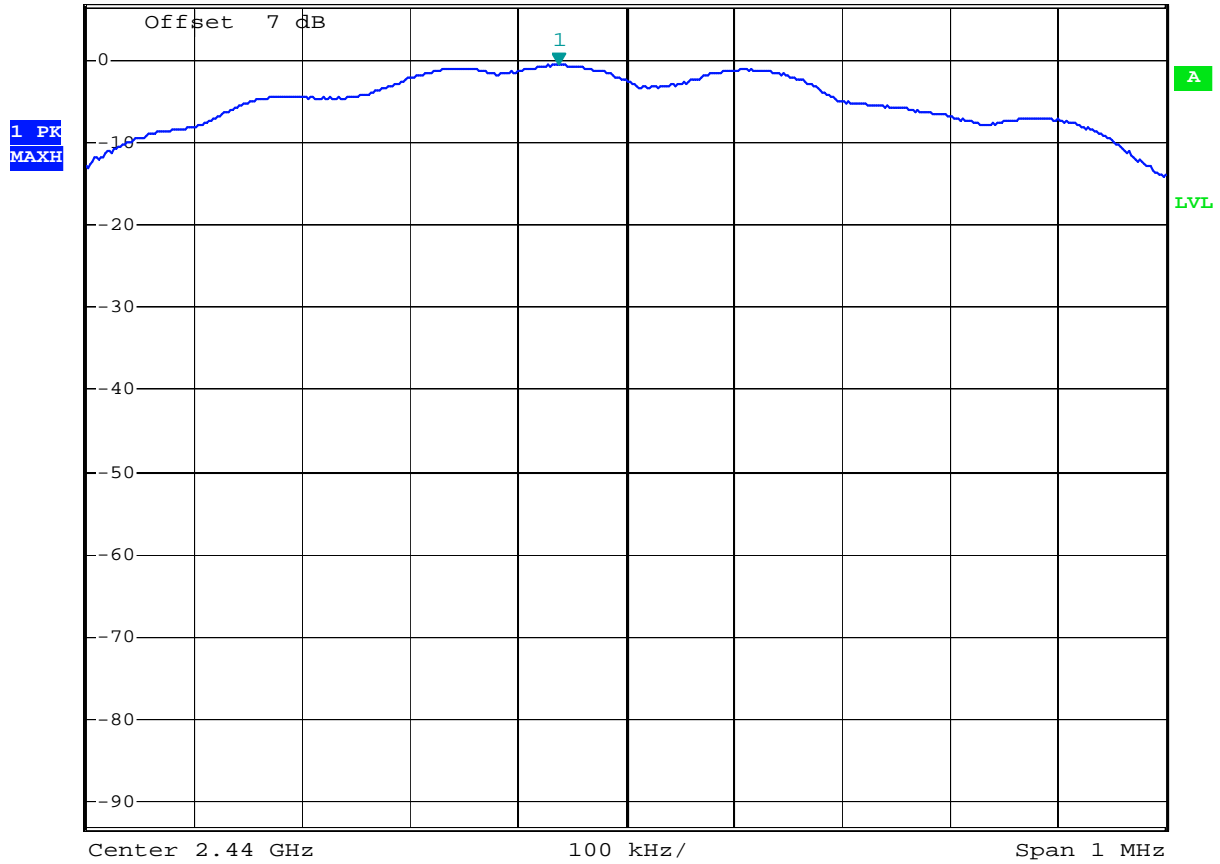
**PSD Measurement - 2402MHz**





**MARKER 1**  
 2.439938 GHz  
 Ref 6.7 dBm \* Att 10 dB

\*RBW 100 kHz Marker 1 [T1 ]  
 VBW 300 kHz -0.54 dBm  
 SWT 2.5 ms 2.439938000 GHz



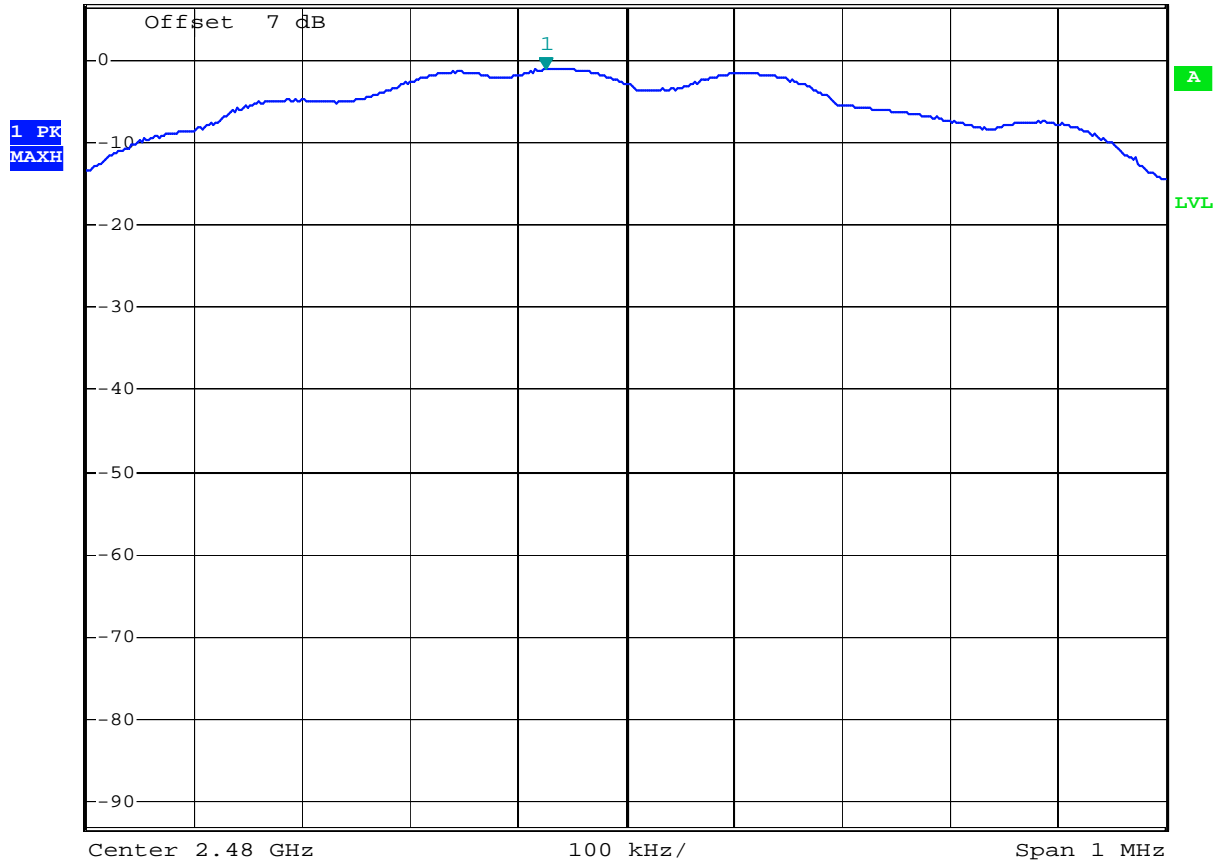
Date: 26.JUN.2012 13:37:27

**PSD Measurement – 2440MHz**



**MARKER 1**  
 2.479926 GHz  
 Ref 6.7 dBm \* Att 10 dB

\*RBW 100 kHz Marker 1 [T1 ]  
 VBW 300 kHz -1.02 dBm  
 SWT 2.5 ms 2.479926000 GHz



Date: 26.JUN.2012 13:38:23

**PSD Measurement - 2480MHz**

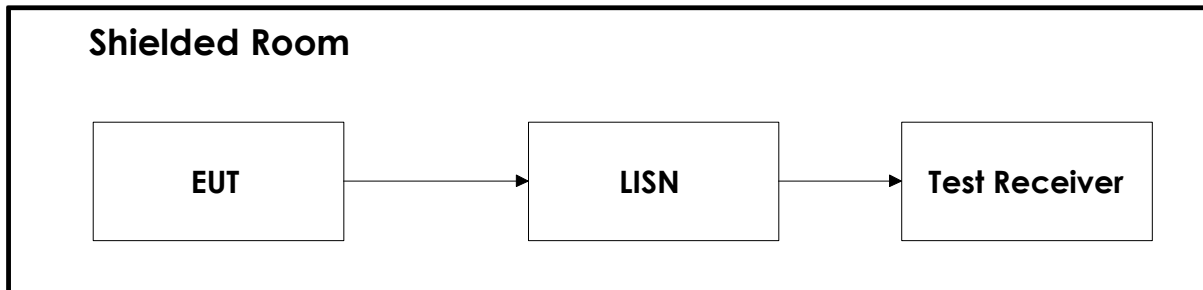
## 5 LIST OF TEST EQUIPMENT

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	ESCS30	Spectrum Analyzer	Rohde & Schwarz	N-3924	2011.12.15	2012.12.15
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

