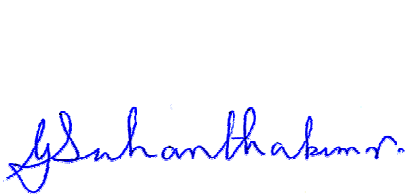
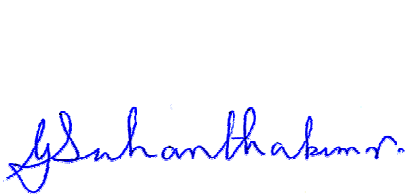
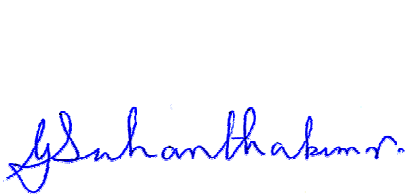


Test Report

Product	Evaluation Board for 2.4 GHz BT Low Energy System-on-Chip		
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	xTAG		
Rating	3.0Vdc		
Trademark	Texas Instruments		
Serial number	/		
Additional information	Bluetooth Low Energy (BLE) device		
Tested according to	FCC Part 15.247 Digital Transmission Systems Industry Canada RSS-210, Issue 8 Low Power Licence-Exempt Radiocommunications Devices		
Order number	250972		
Tested in period	2014.01.02 to 2014.01.06		
Issue date	2014.01.17		
Name and address of the testing laboratory	 FCC No: 994405 IC OATS: 2040D-1 Instituttveien 6 Kjeller, Norway TEL: (+47) 22 96 03 30 FAX: (+47) 22 96 05 50		
<table border="1" style="width: 100%;"> <tr> <td style="width: 50%; text-align: center;">  Prepared by [G.Suhanthakumar] </td> <td style="width: 50%; text-align: center;">  Approved by [Frode Sveinsen] </td> </tr> </table>		 Prepared by [G.Suhanthakumar]	 Approved by [Frode Sveinsen]
 Prepared by [G.Suhanthakumar]	 Approved by [Frode Sveinsen]		
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1 INFORMATION

1.1 Test Item

Name :	Texas Instruments
FCC ID :	ZATXTAG
IC :	451H-XTAG
Model/version :	xTAG
Serial number :	-
Hardware identity and/or version:	Rev.0.4
Software identity and/or version :	-
Frequency Range :	2402 – 2480 MHz
Number of Channels :	40
Type of Modulation :	GFSK, 250 kHz deviation (Digital)
Conducted Output Power:	3.07 mW (Peak)
User Frequency Adjustment :	None
Type of Power Supply :	3.0V _{DC} (1x CR2032 Lithium Battery)
Antenna Connector :	N/A
Antenna type:	PCB antenna
Antenna Diversity Supported :	No
Desktop Charger :	None

Description of Test Item

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

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 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 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



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".

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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)	N/A 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 PCB antenna

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 μ H/50 ohms LISN.

Test Results: -

Measurement Data: -

3.2 Minimum 6 dB Bandwidth

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

Test Performed By: G.Suwanthakumar	Date of Test: 06 Jan 2014
------------------------------------	---------------------------

Test Results: Complies

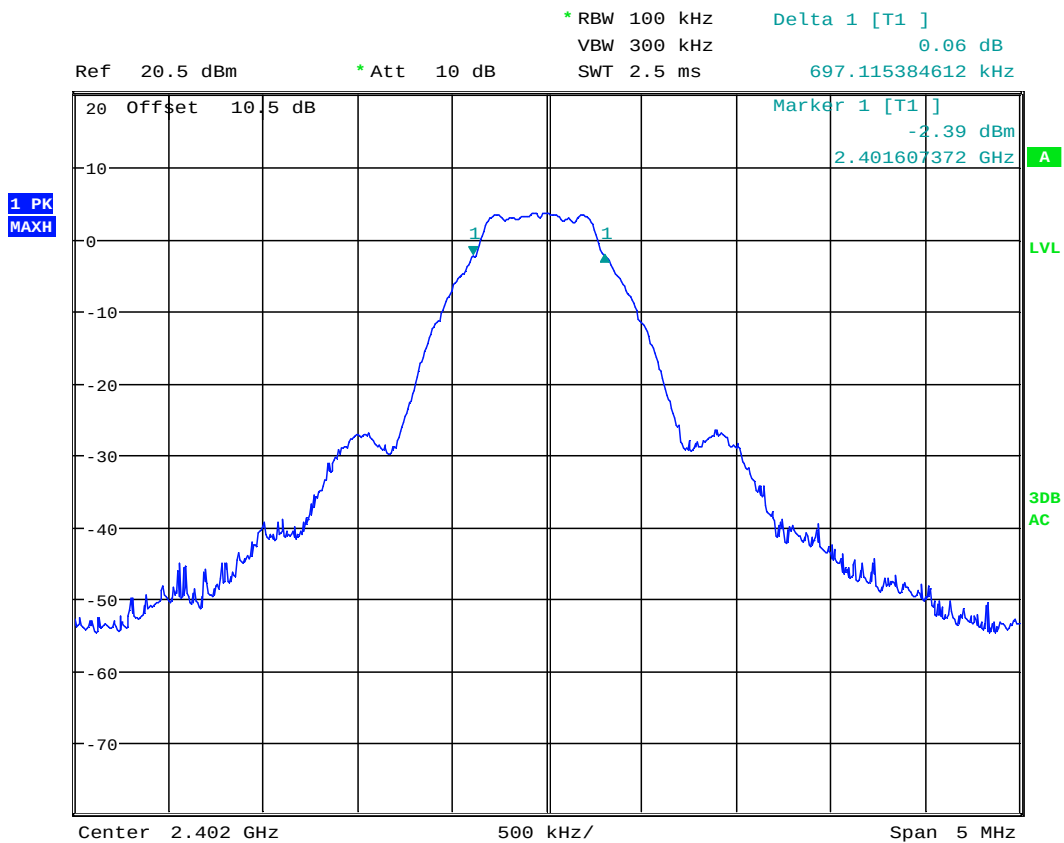
Measurement Data:

Measured 6 dB Bandwidth (kHz)		
2402MHz	2440 MHz	2480MHz
697.1	753.2	785.2

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

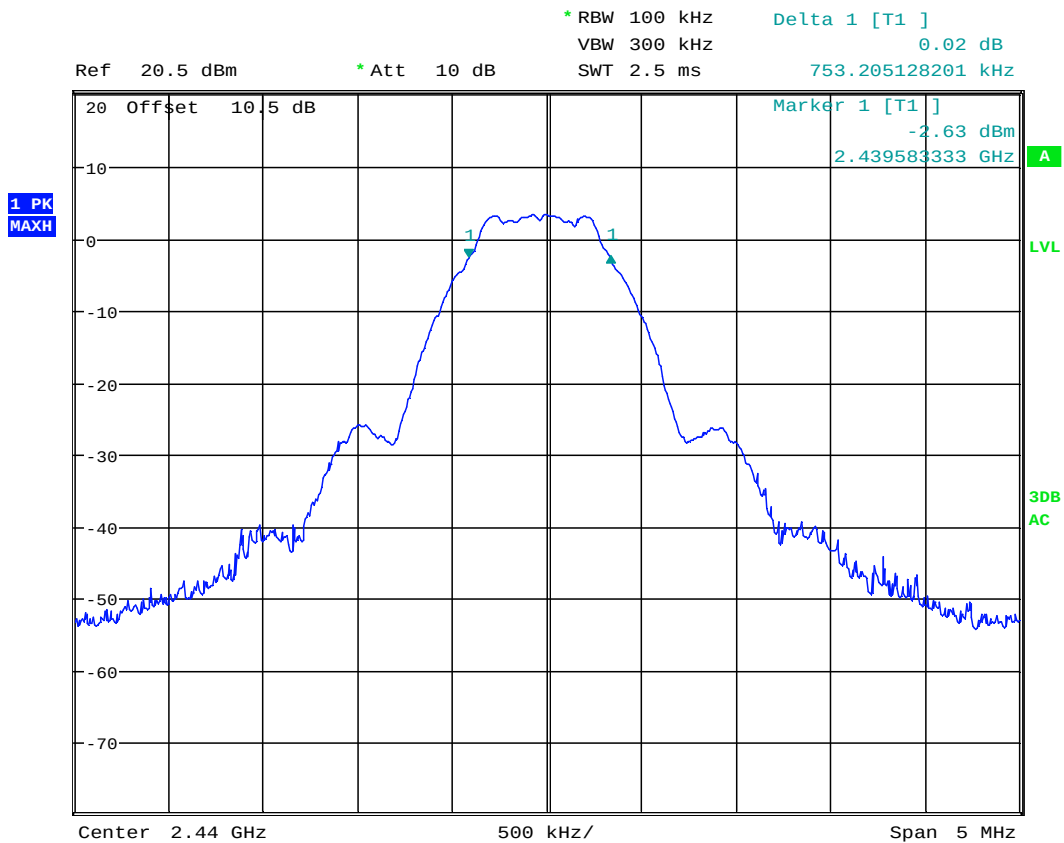
Requirements:

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



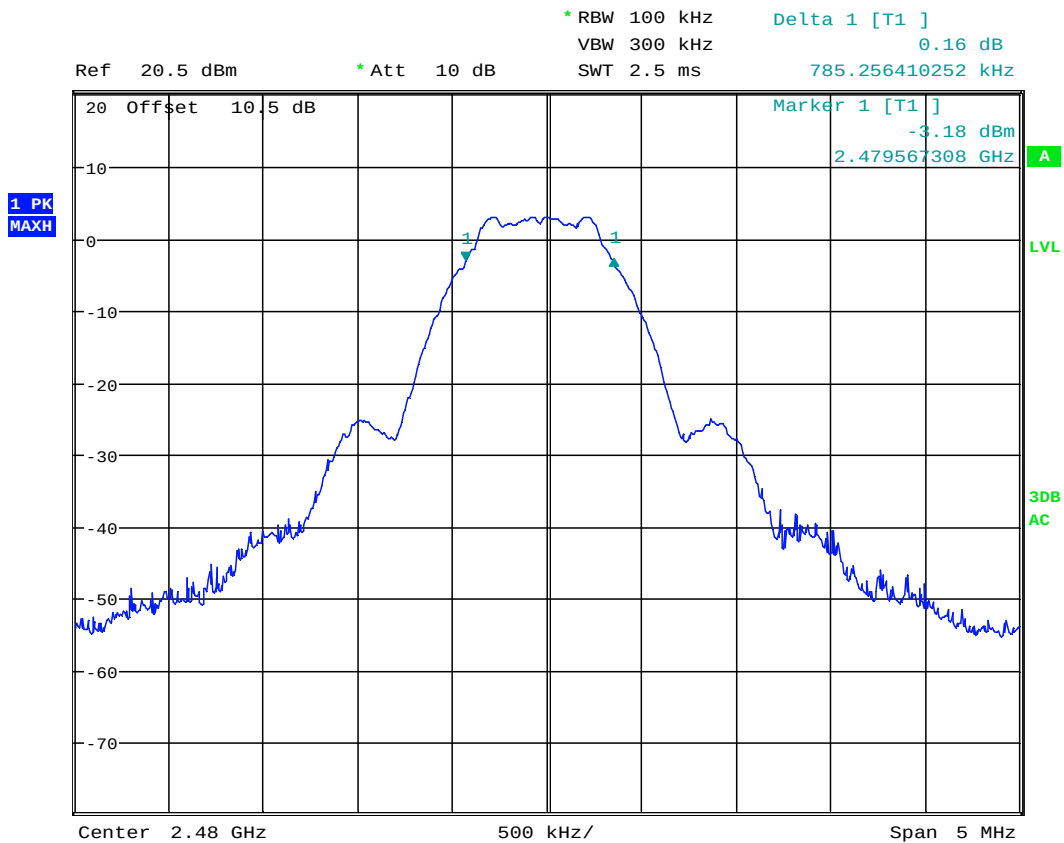
Date: 6.JAN.2014 16:36:59

6 dB Bandwidth at 2402 MHz



Date: 6.JAN.2014 16:48:56

6 dB Bandwidth at 2440 MHz



Date: 6.JAN.2014 16:42:47

6 dB Bandwidth at 2480 MHz

3.3 20 dB Bandwidth

Test Performed By: G.Suwanthakumar

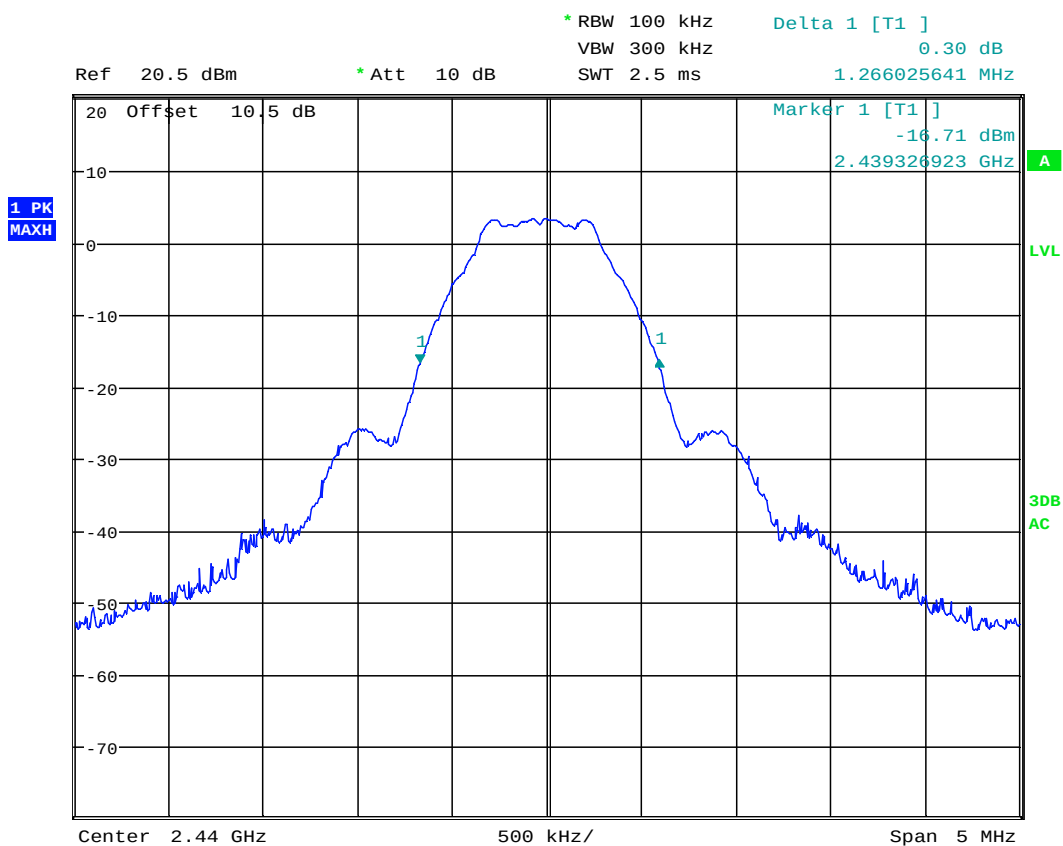
Date of Test: 06 Jan 2014

Measurement Data:

Measured 20 dB Bandwidth (MHz)
2440 MHz
1.27

Requirements:

No requirements. Reported for information only.



Date: 6. JAN. 2014 16:49:56

20 dB Bandwidth at 2440 MHz

3.4 Peak Power Output

Para. No.: 15.247 (b)

Test Performed By: G.Suwanthakumar	Date of Test: 02 Jan 2014
------------------------------------	---------------------------

Test Results: Complies

Measurement Data:

RF channel	2402 MHz	2440 MHz	2480 MHz
Measured Maxium Field strength (dBμV/m) –VP	100.61	96.85	98.01
Calc. Radiated Power (dBm)	5.35	1.59	2.75
Calc. Radiated Power (mW)	3.42	1.44	1.88
Measured Conducted Power (dBm)	4.87	4.73	4.58
Measured Conducted Power (mW)	3.07	2.97	2.87
Calculated Antenna Gain (dBi)	0.48	-3.13	-1.82

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 XY plane and Vertical polarization.

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.



* RBW 3 MHz
VBW 10 MHz
SWT 2.5 ms

Marker 1 [T1]
100.61 dBμV/m
2.401839744 GHz

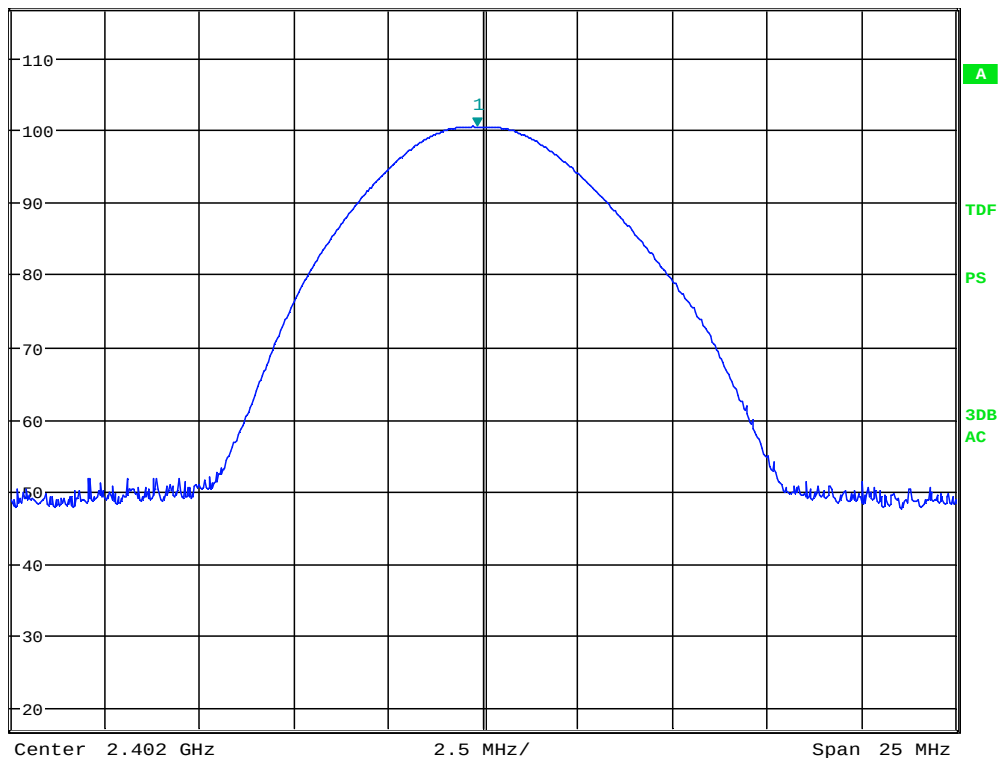
Ref 117 dBμV/m

* Att 10 dB

SWT 2.5 ms

2.401839744 GHz

1 PK
MAXH



Date: 2.JAN.2014 13:55:31

Radiated Field strength, VP , 2402 MHz,PK

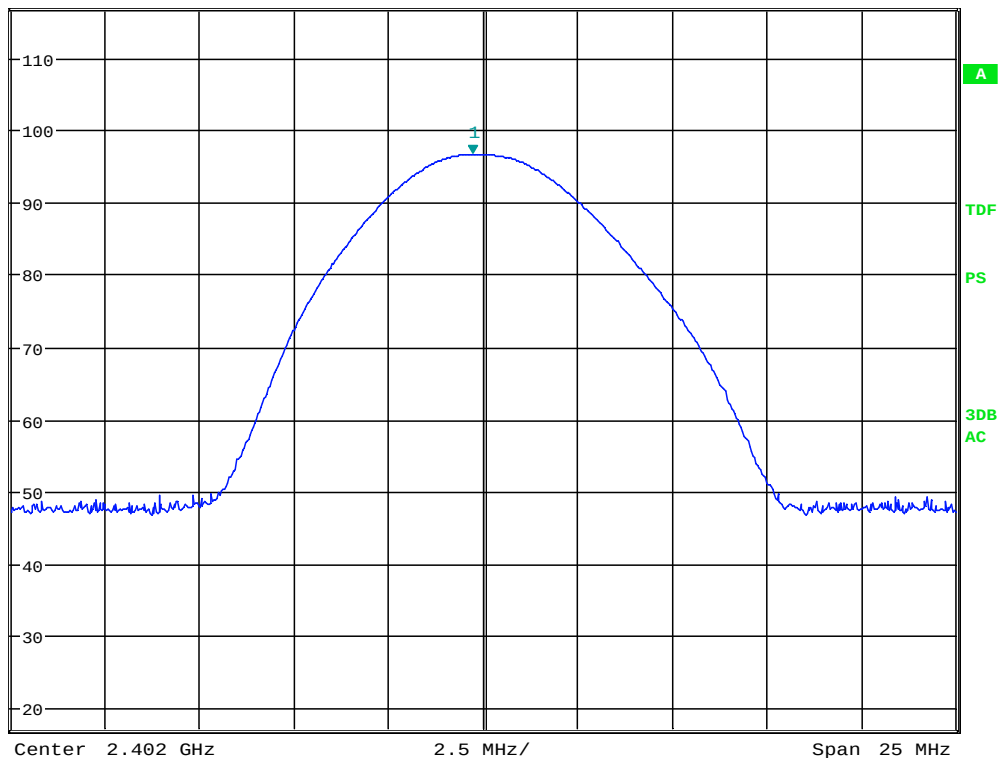


* RBW 3 MHz Marker 1 [T1]
VBW 10 MHz 96.73 dBμV/m
SWT 2.5 ms 2.401719551 GHz

Ref 117 dBμV/m

* Att 10 dB

1 PK
MAXH



Date: 2.JAN.2014 13:56:41

Radiated field strength, HP, 2402 MHz,PK

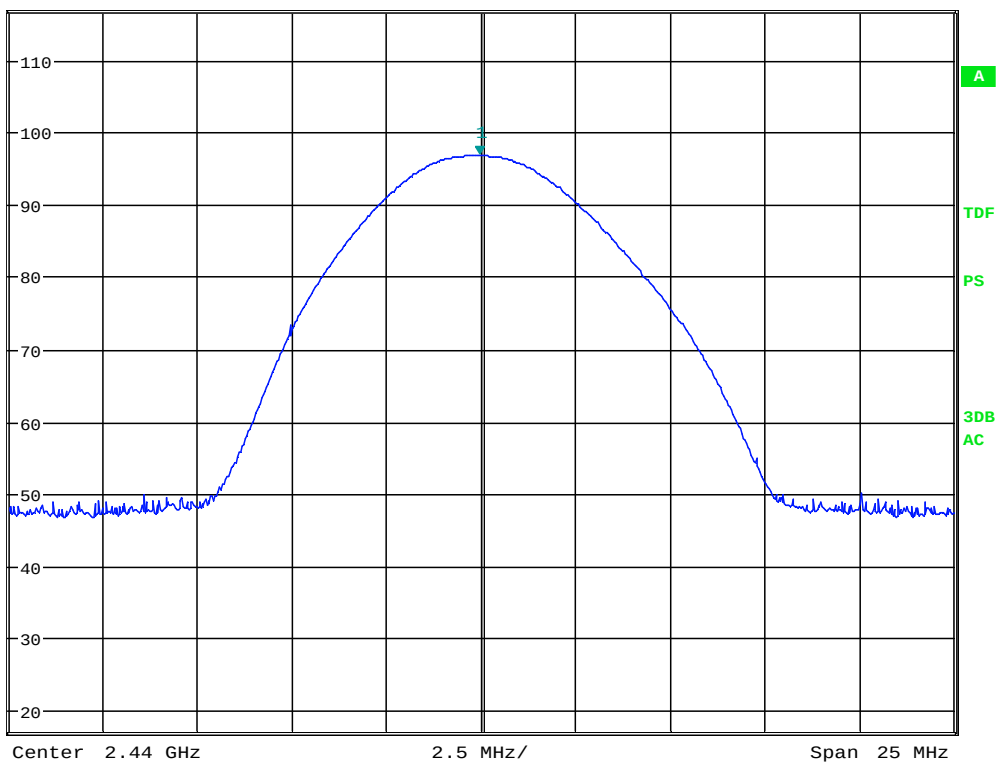


*RBW 3 MHz
VBW 10 MHz
SWT 2.5 ms
Marker 1 [T1]
96.85 dBμV/m
2.439959936 GHz

Ref 117 dBμV/m

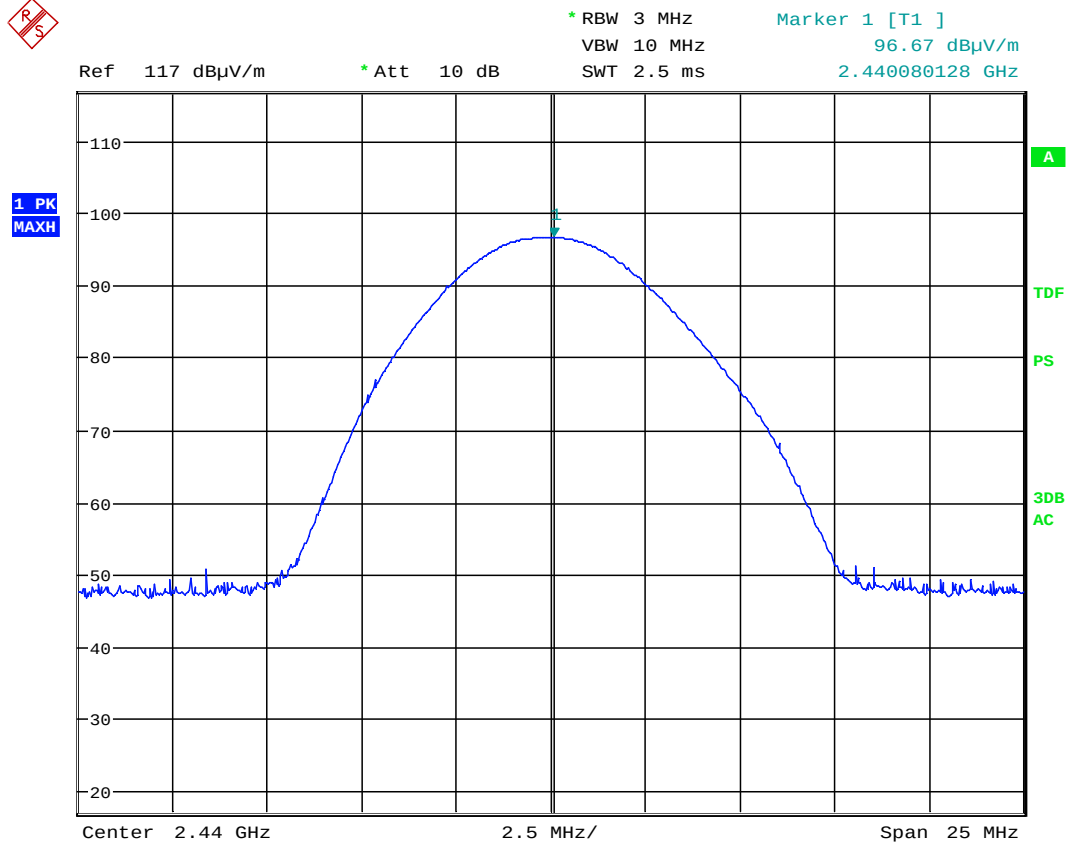
*Att 10 dB

1 PK
MAXH



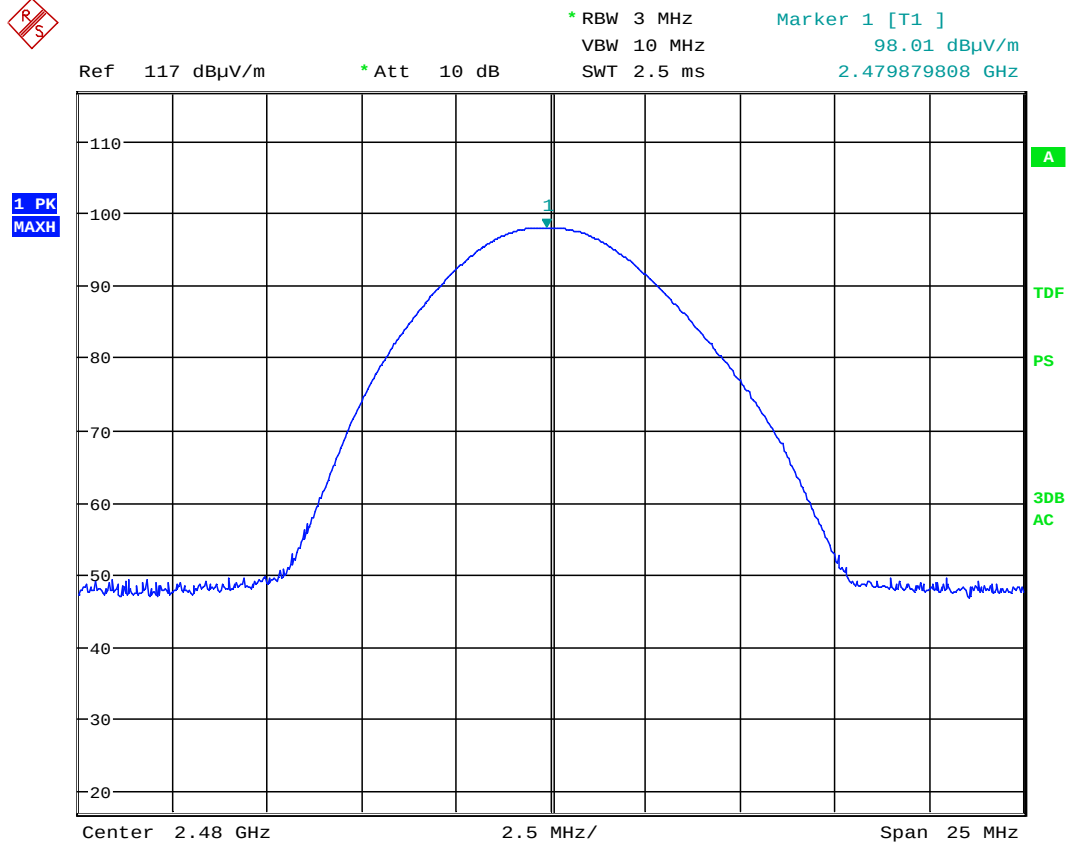
Date: 2.JAN.2014 14:04:41

Radiated field strength, VP, 2440 MHz,PK



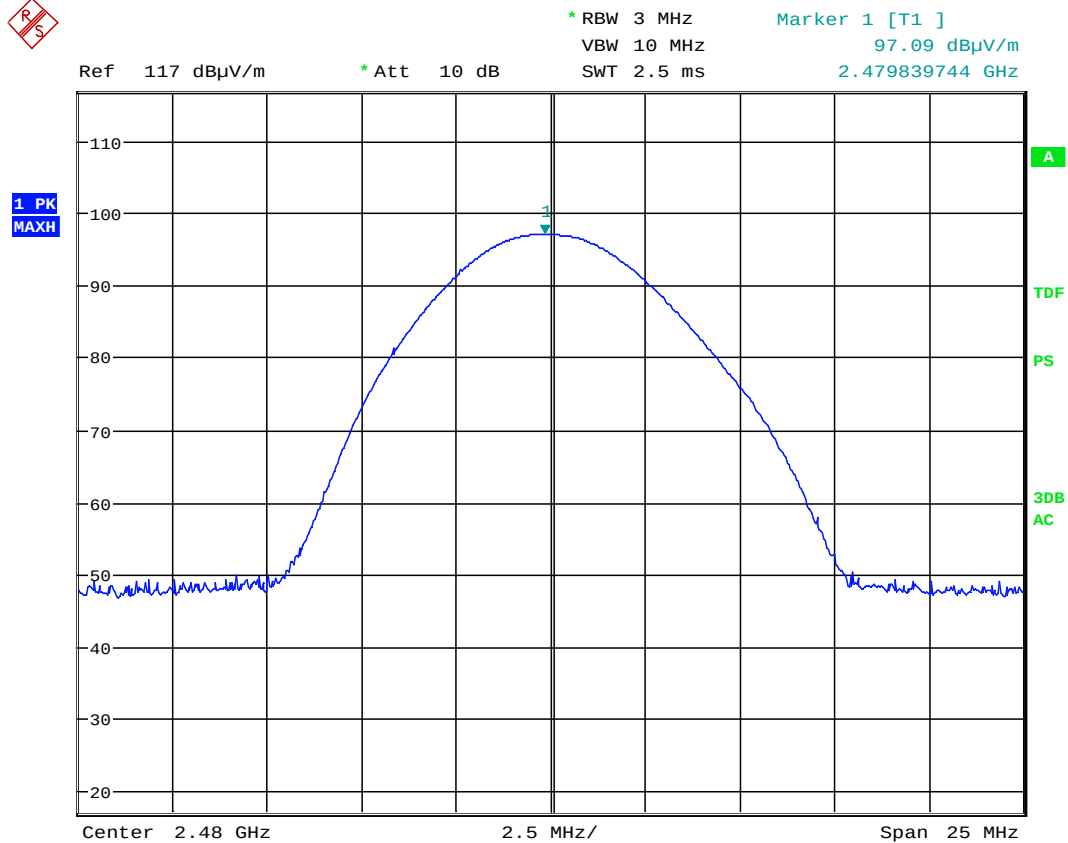
Date: 2.JAN.2014 14:04:01

Radiated field strength, HP, 2440 MHz,PK



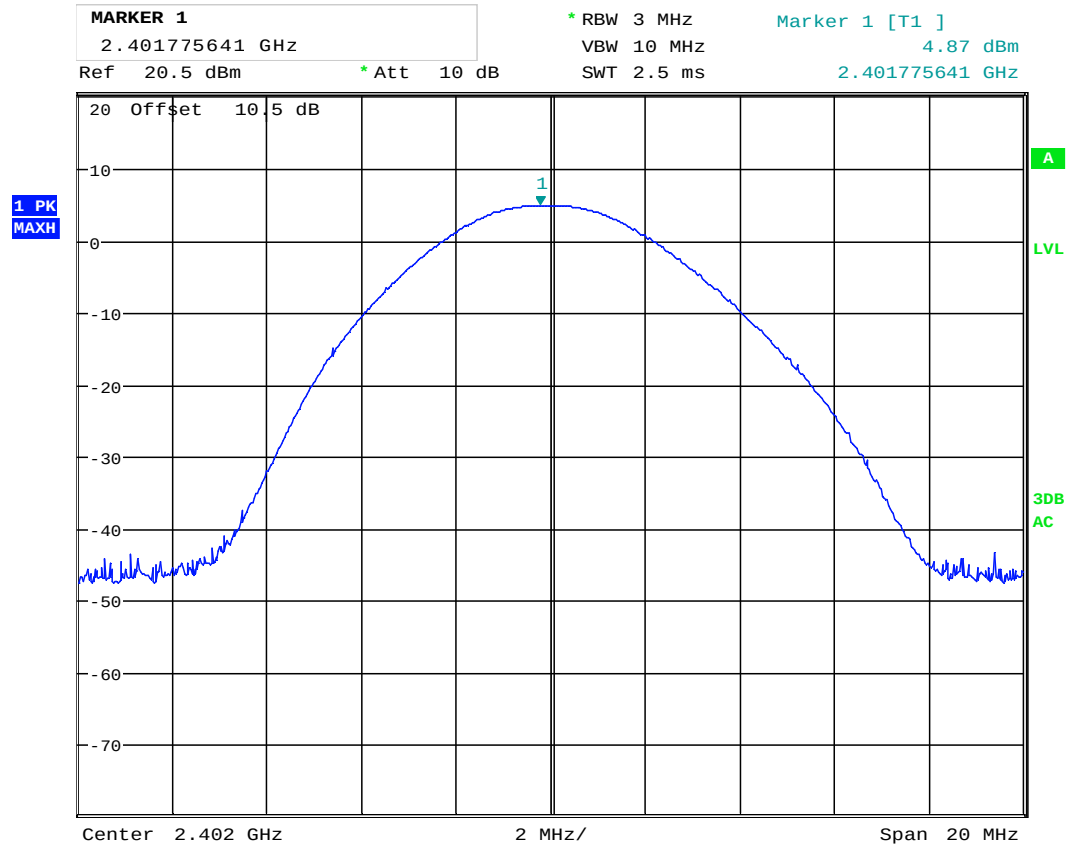
Date: 2.JAN.2014 14:13:34

Radiated field strength, VP, 2480 MHz,PK



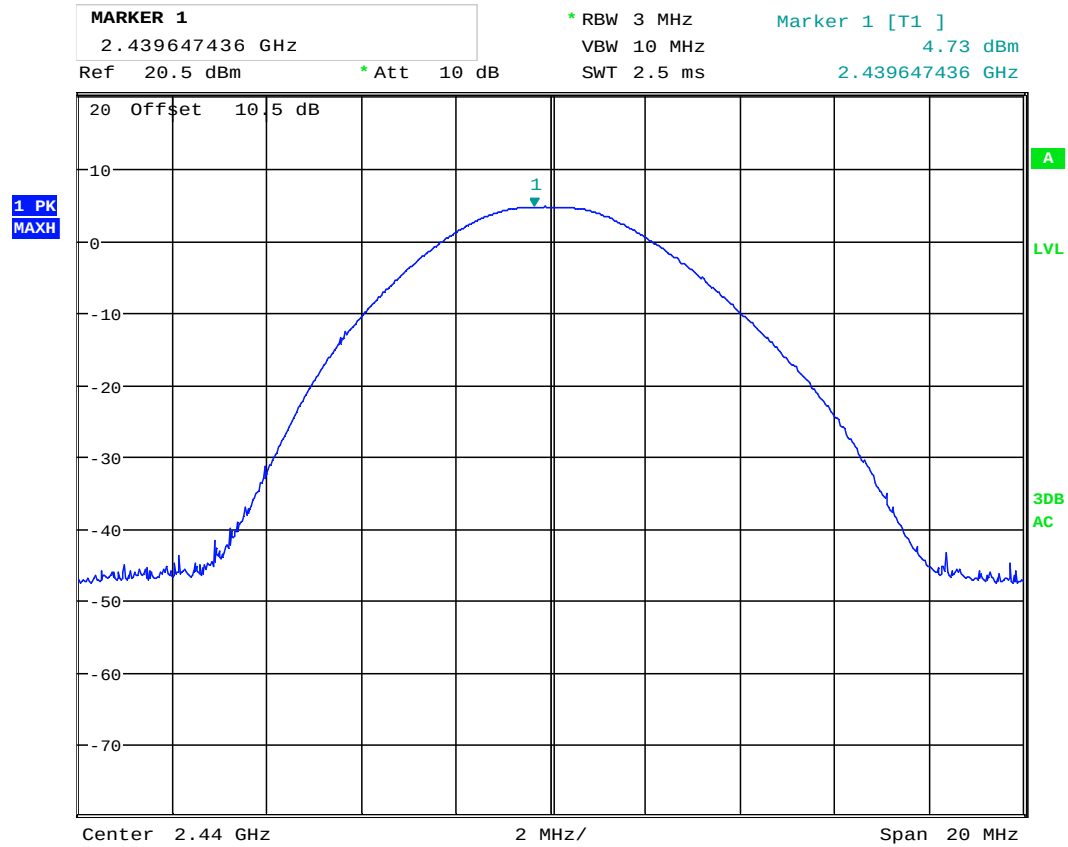
Date: 2.JAN.2014 14:12:55

Radiated field strength, HP, 2480 MHz,PK



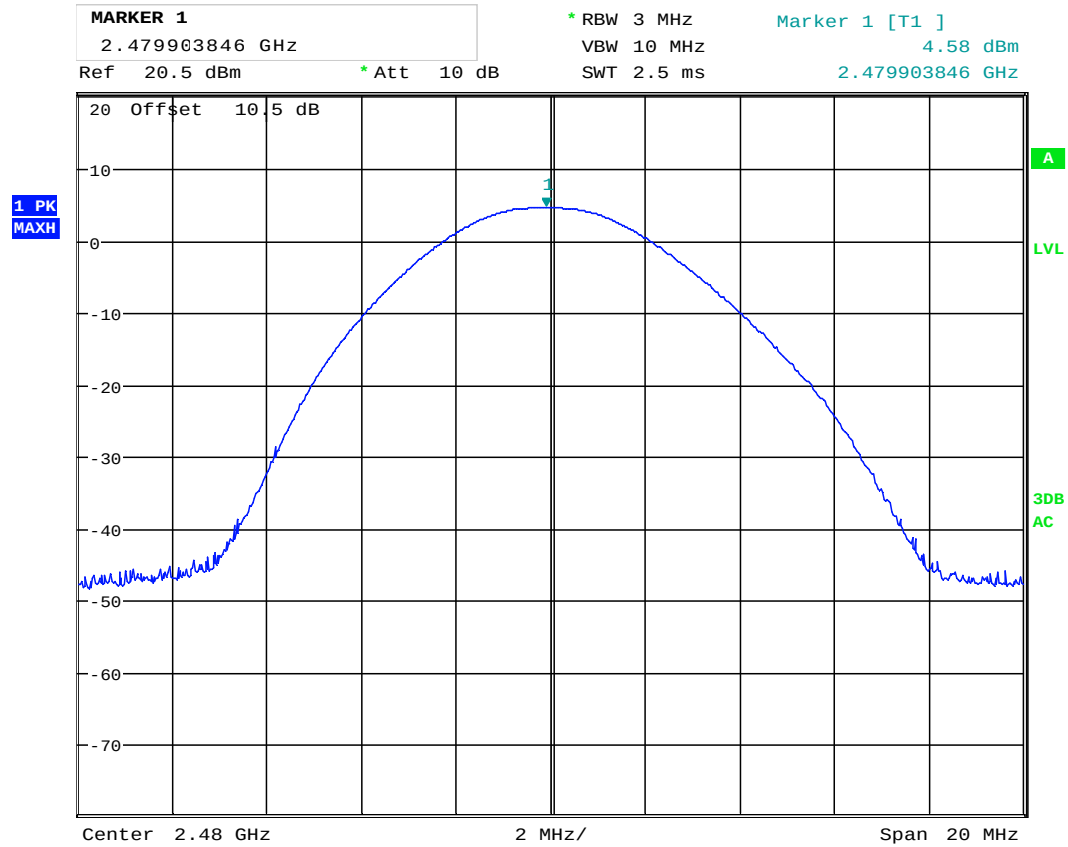
Date: 6.JAN.2014 16:38:13

Conducted power – 2402MHz,PK



Date: 6.JAN.2014 16:47:52

Conducted power – 2440MHz,PK



Date: 6.JAN.2014 16:41:48

Conducted power – 2480MHz, PK

3.5 Spurious Emissions (Radiated)

Para. No.: 15.247 (c)

Test Performed By: G.Suhanthakumar	Date of Test: 02 jan 2014
------------------------------------	---------------------------

Test Results: Complies

Measurement Data:

Band-edge, @3m

Frequency	Measured Field Strength @3m, dBµV/m	Detector	Limit dBµV/m	Margin dB
2.39 GHz	46.54	PK	74	27.46
	41.34	AV	54	12.66
2.4835 GHz	57.56	PK	74	16.44
	33.40	AV	54	20.6

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

100% duty cycle

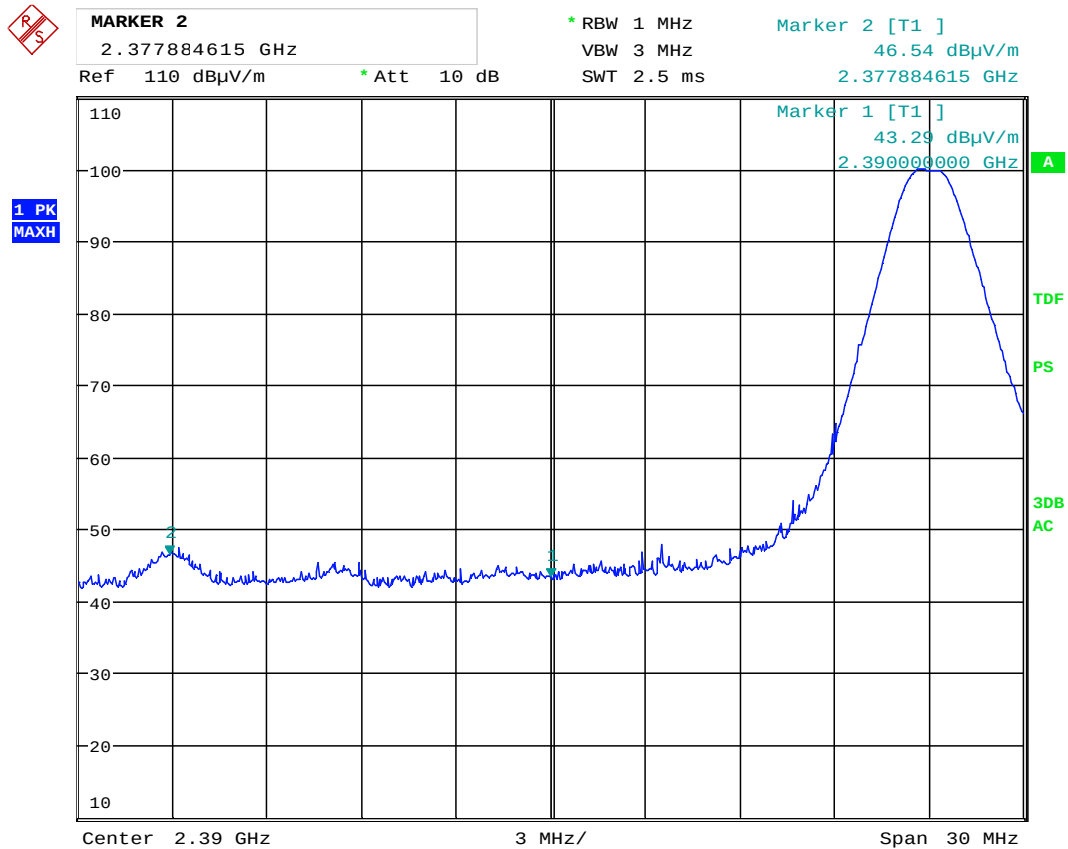
See attached plots.

RF conducted spurious emission

Scan performed with 100 kHz Bandwidth from 0.01 to 25 GHz.

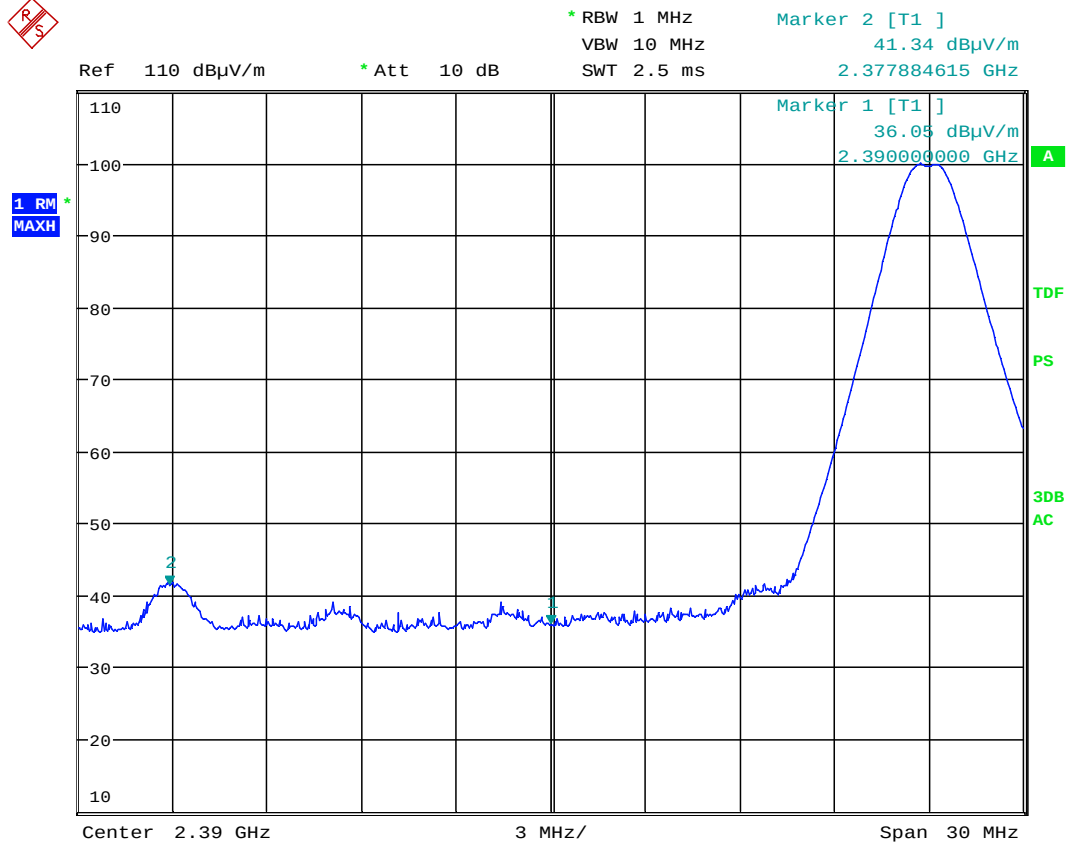
All emissions are more than 20dB below carrier.

See attached plots.



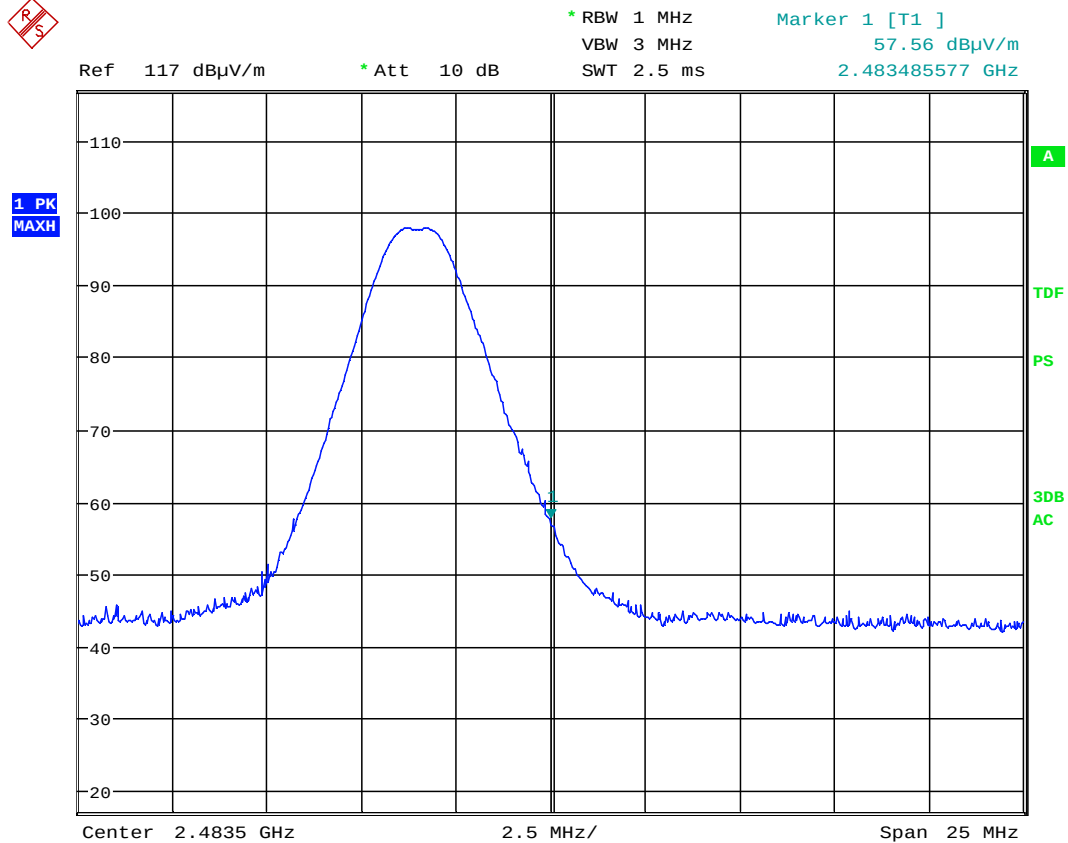
Date: 2.JAN.2014 14:53:38

Band Edge, 2390 MHz, Peak Detector



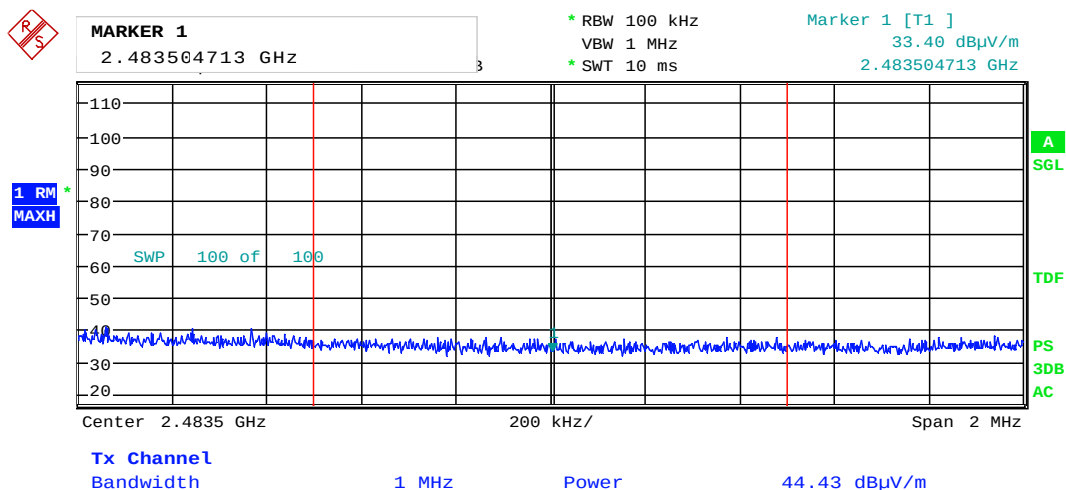
Date: 2.JAN.2014 14:54:06

Band Edge, 2390 MHz, Average Detector



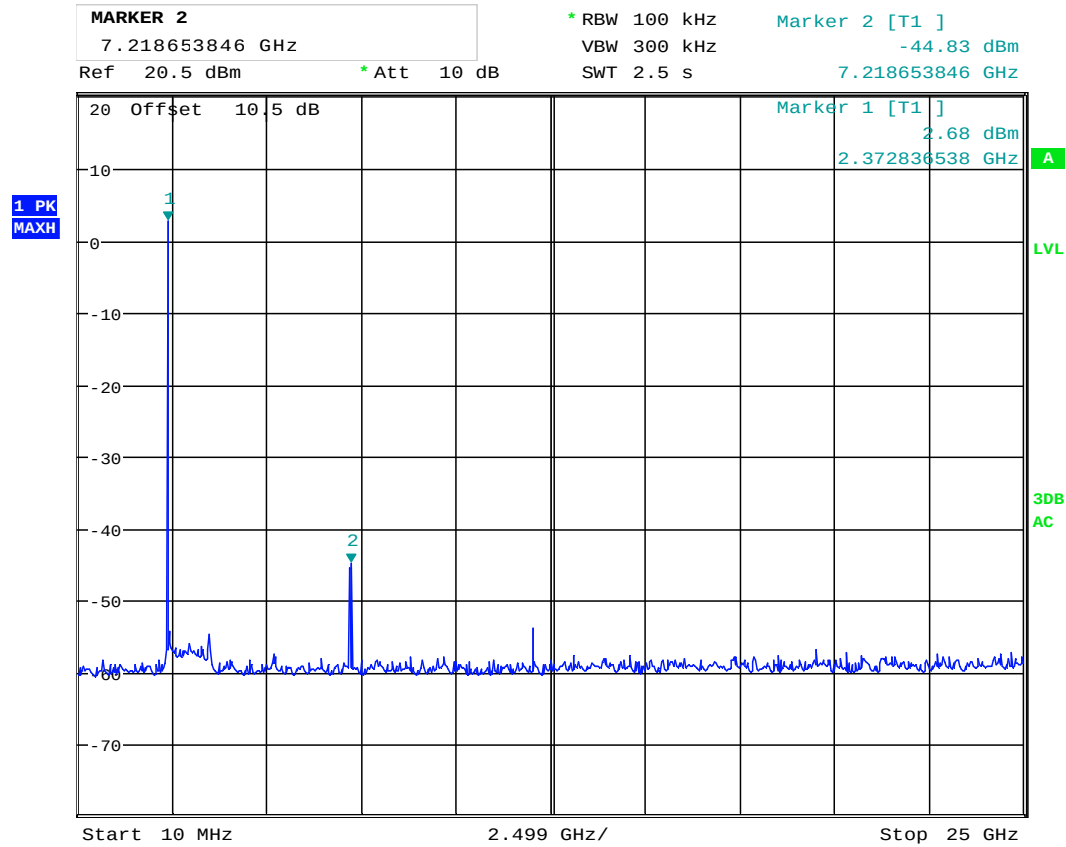
Date: 2.JAN.2014 14:33:11

Band Edge, 2483.5 MHz, Peak Detector



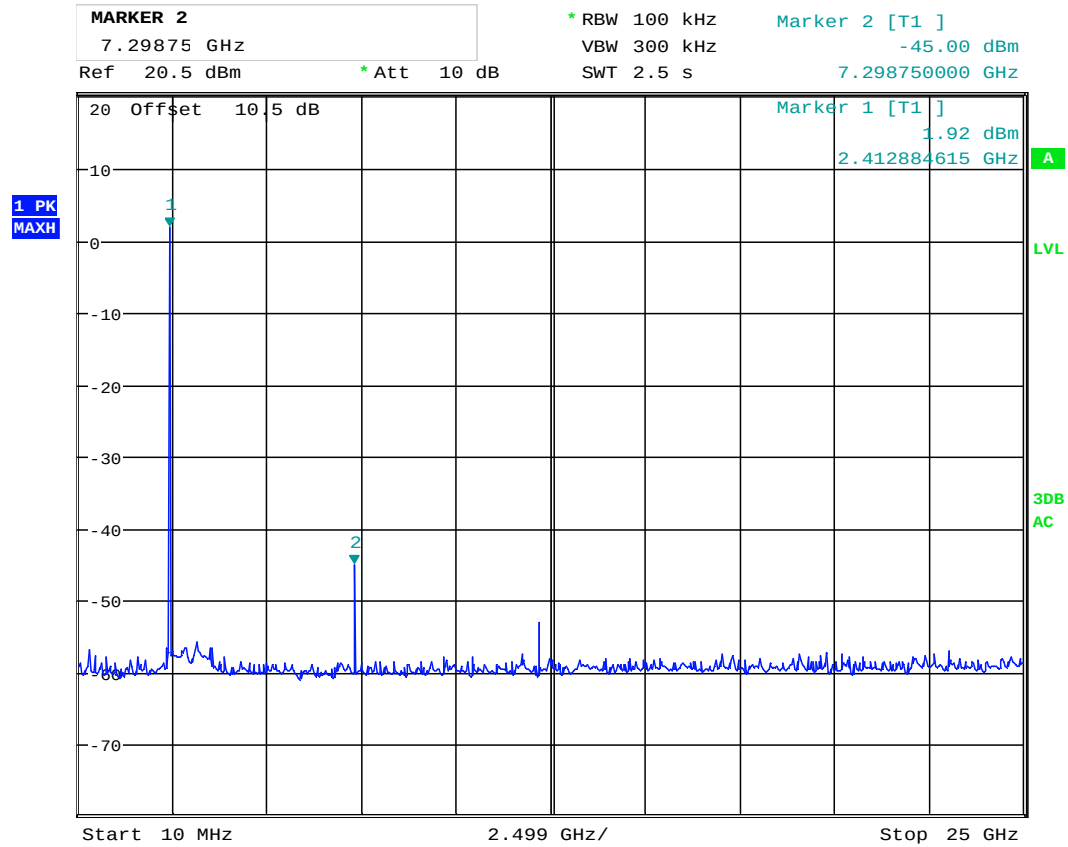
Date: 2.JAN.2014 14:36:44

Band edge power, 2483.5MHz, AV detector



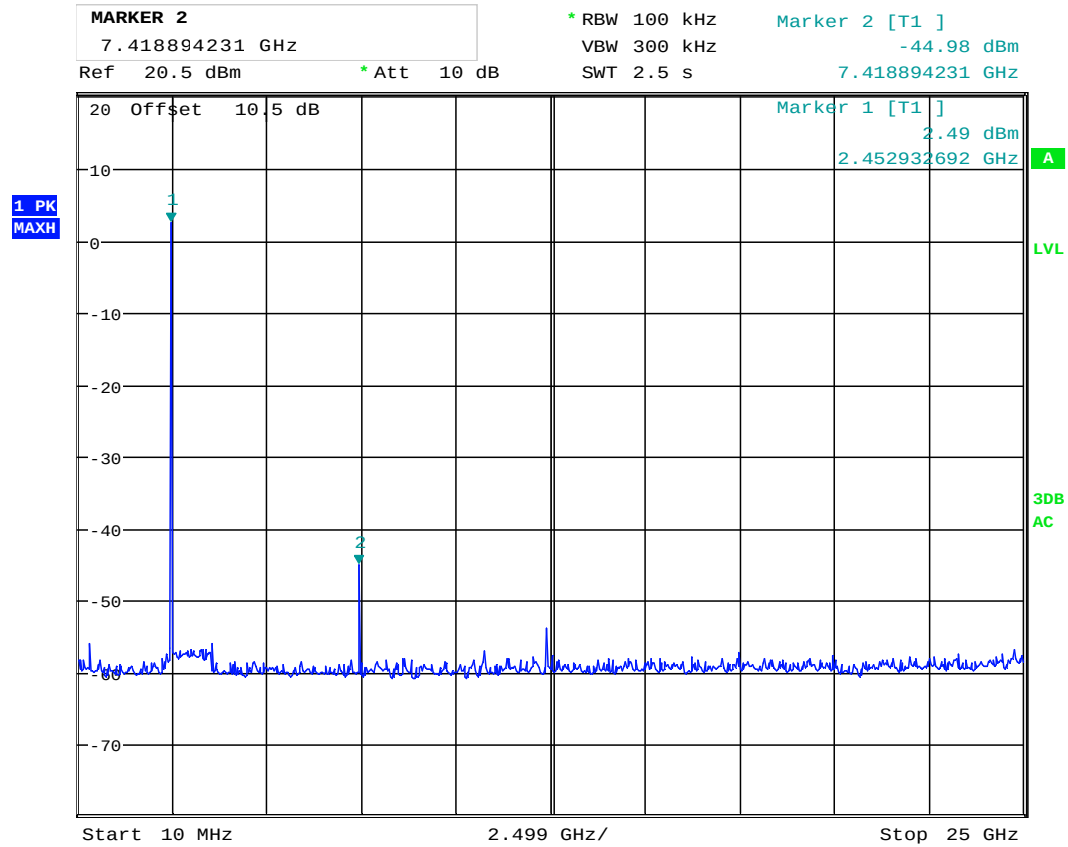
Date: 6.JAN.2014 16:39:26

Conducted spurious emission 10MHz – 25GHz - ch2402MHz



Date: 6.JAN.2014 16:50:29

Conducted spurious emission 10MHz – 25GHz - ch2440MHz



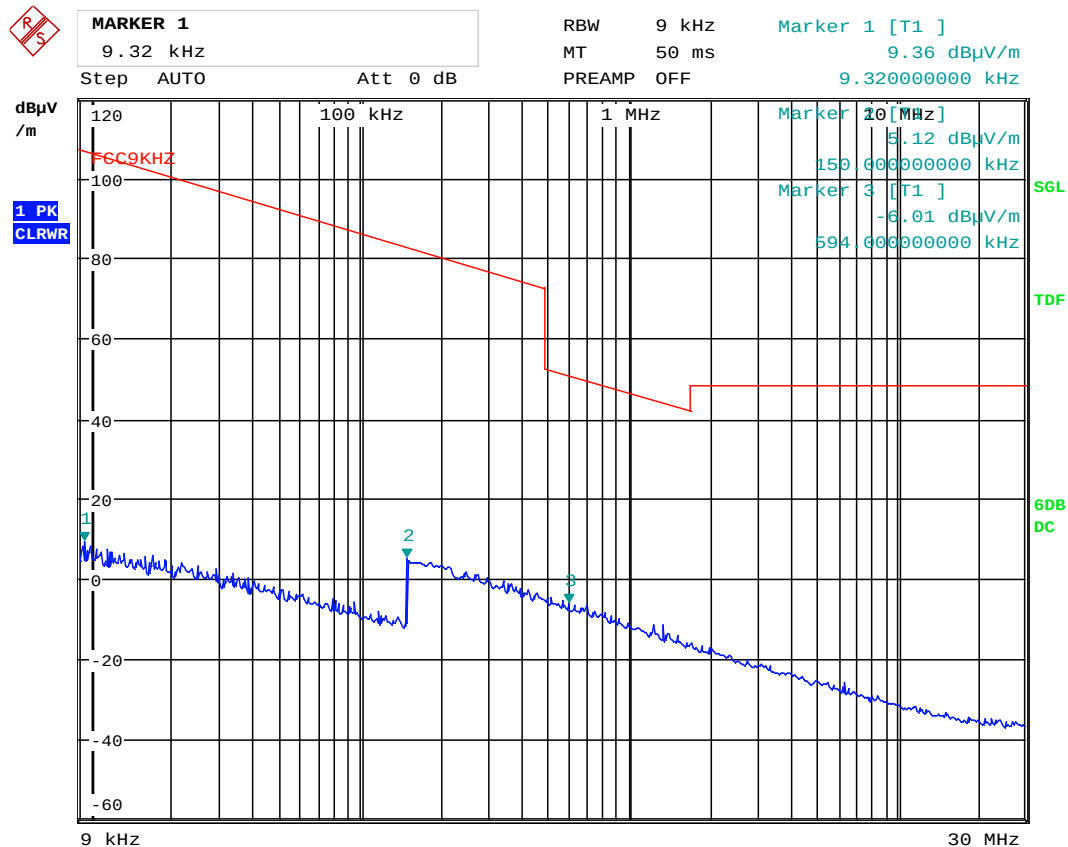
Date: 6.JAN.2014 16:41:14

Conducted spurious emission 10MHz – 25GHz - ch2480MHz

Radiated emissions 9kHz - 30 MHz.

Detector: Quasi-Peak

Measuring distance 10 m.



Date: 3.JAN.2014 12:24:52

Radiated Emissions, 9 kHz – 30 MHz @10m

Radiated emission 30 – 1000 MHz.

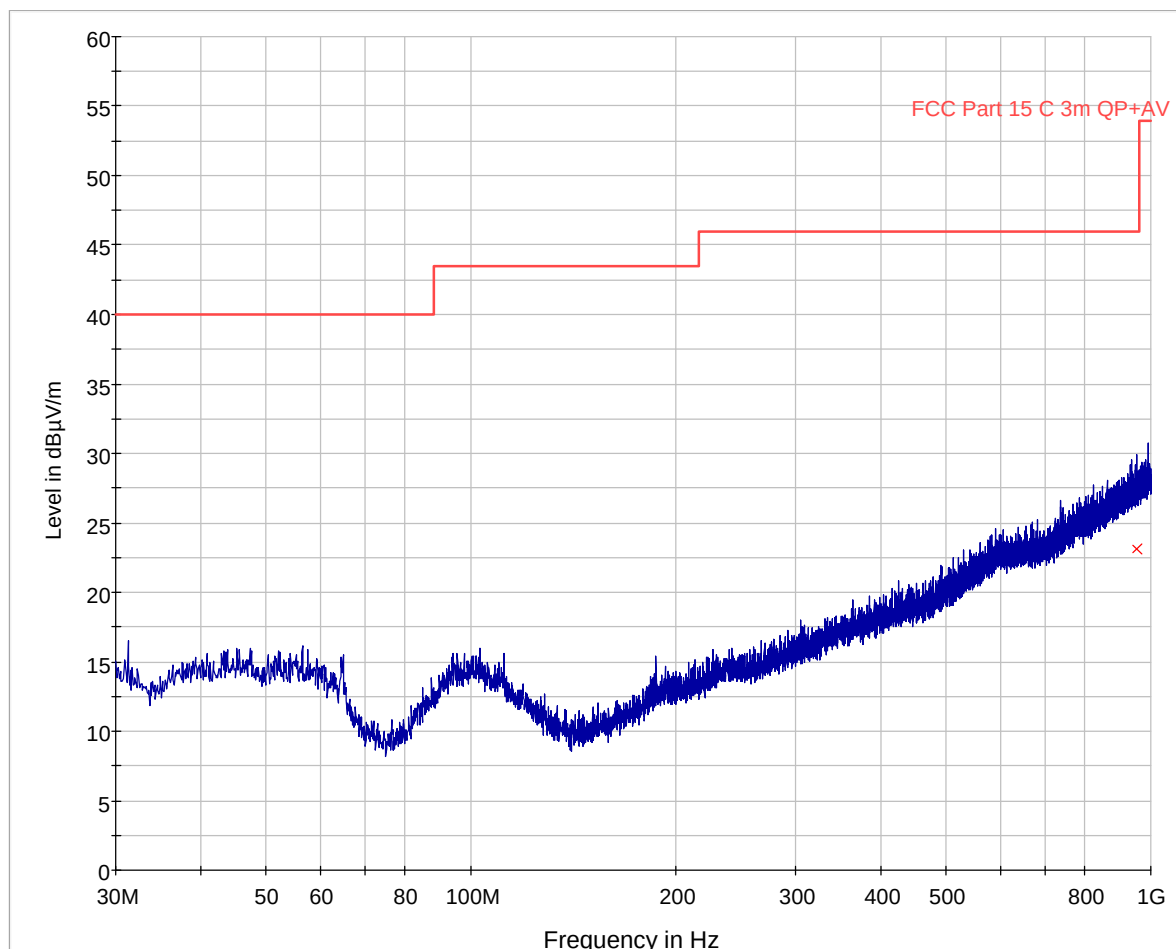
Detector: Peak

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
953.612769	23.2	1000.0	120.000	228.0	V	4.0	3.0	22.8	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

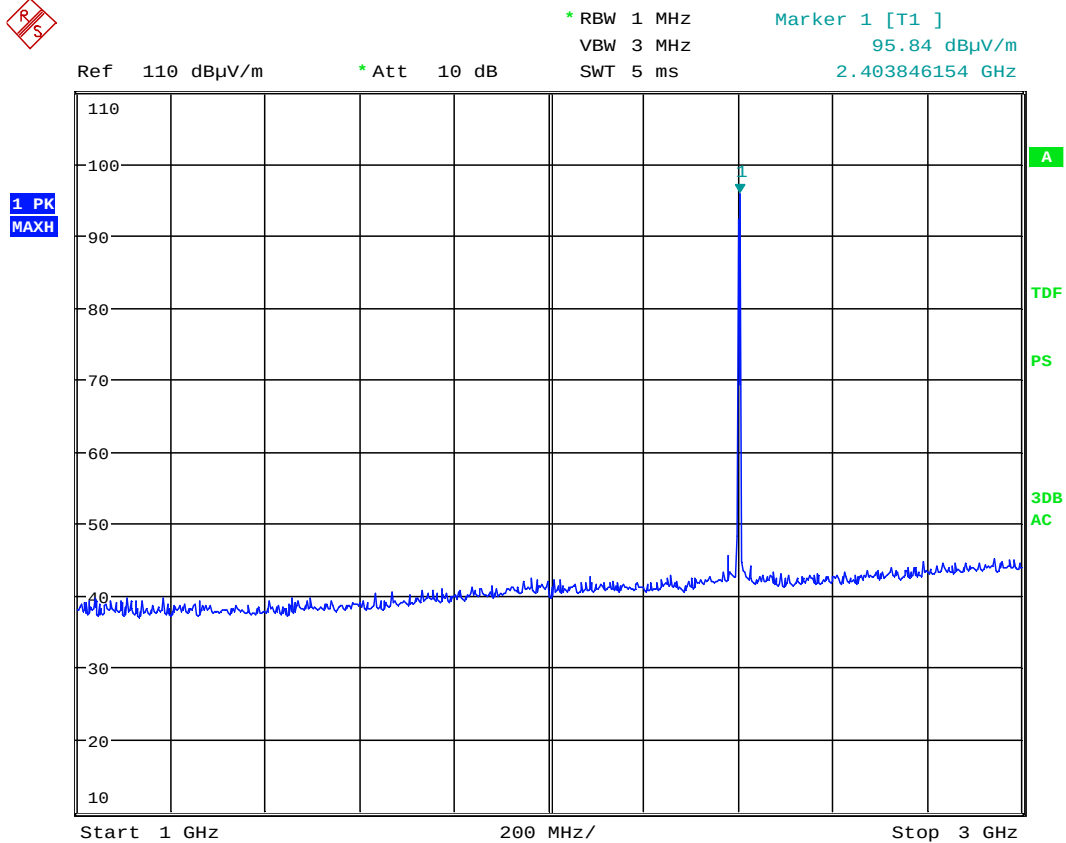
Frequency MHz	Field Strength @3m dB μ V/m	Detector	Limit dB μ V/m	Margin dB
4803	47.83	Pk	74	26.17
4880	46.79	Pk	74	27.21
4960	45.85	Pk	74	28.15

Average detector

Frequency MHz	Field Strength @3m dB μ V/m	Detector	Limit dB μ V/m	Margin dB
4804	39.11	AV	54	14.89
4880	38.52	AV	54	15.48
4960	38.13	AV	54	15.87

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

See attached graphs.



Date: 2.JAN.2014 14:56:23

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

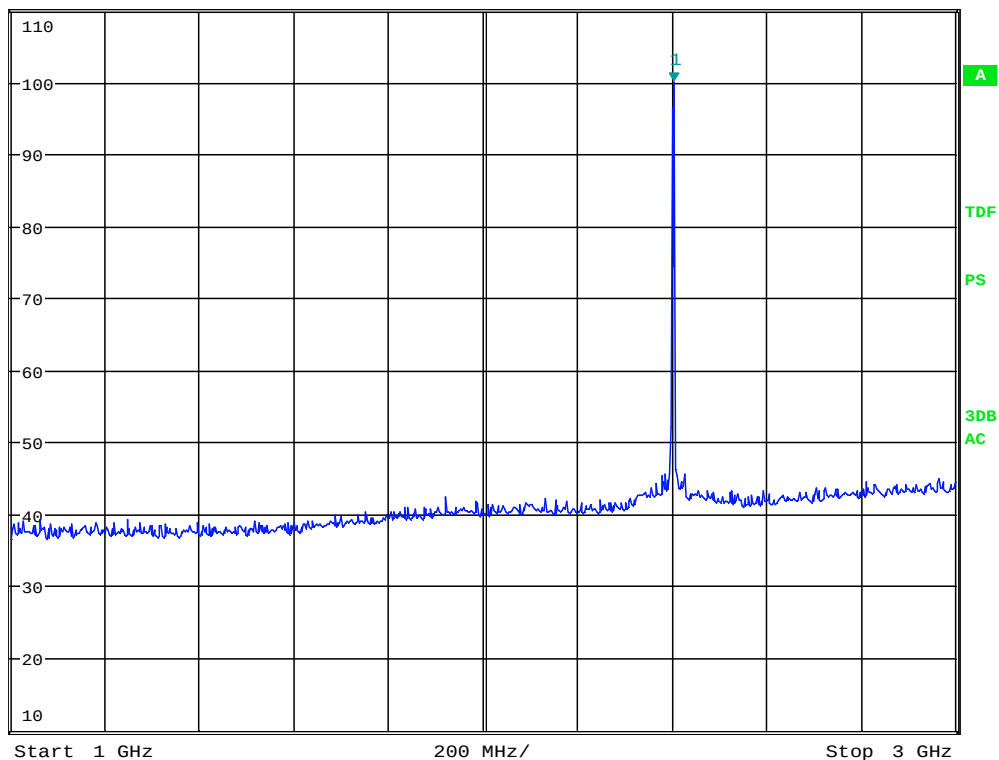


MARKER 1
2.403846154 GHz
Ref 110 dBμV/m * Att 10 dB

* RBW 1 MHz
VBW 3 MHz
SWT 5 ms

Marker 1 [T1]
100.09 dBμV/m
2.403846154 GHz

1 PK
MAXH



Date: 2.JAN.2014 14:54:45

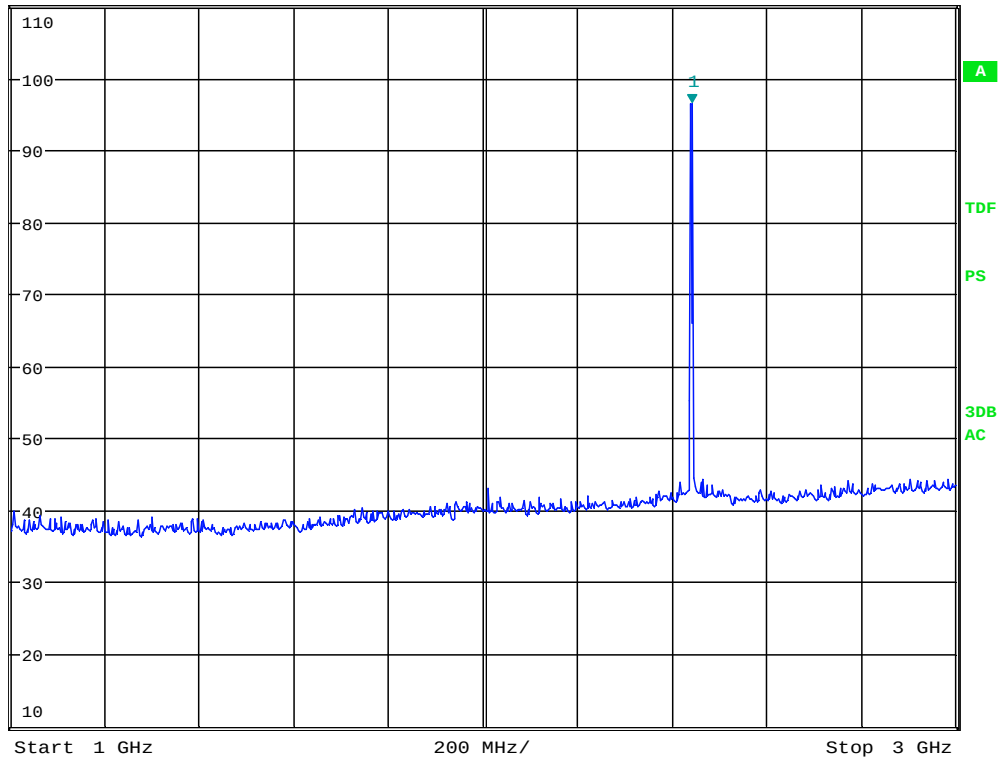
Radiated Emissions ch. 2402 MHz, 1 – 3 GHz, HP, @3m – Pre-scan with Peak detector



MARKER 1
2.442307692 GHz
Ref 110 dBμV/m * Att 10 dB

* RBW 1 MHz Marker 1 [T1]
VBW 3 MHz 96.51 dBμV/m
SWT 5 ms 2.442307692 GHz

1 PK
MAXH



Date: 2.JAN.2014 15:03:28

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



MARKER 2

2.298076923 GHz

Ref 110 dB μ V/m

* Att 10 dB

* RBW 1 MHz

VBW 3 MHz

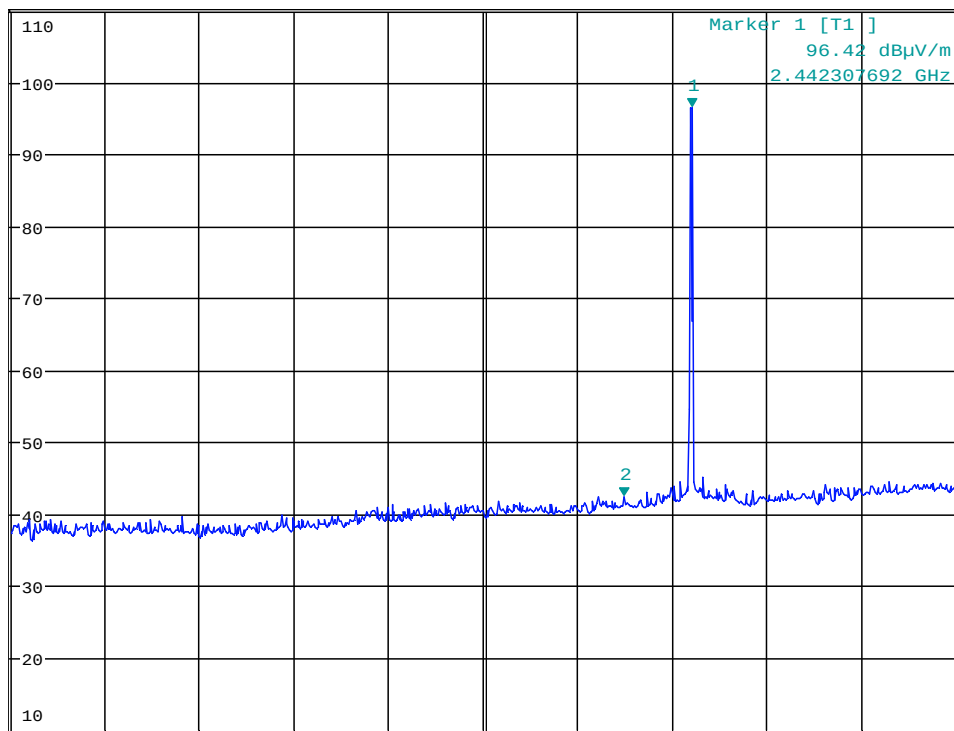
SWT 5 ms

Marker 2 [T1]

42.43 dB μ V/m

2.298076923 GHz

1 PK
MAXH



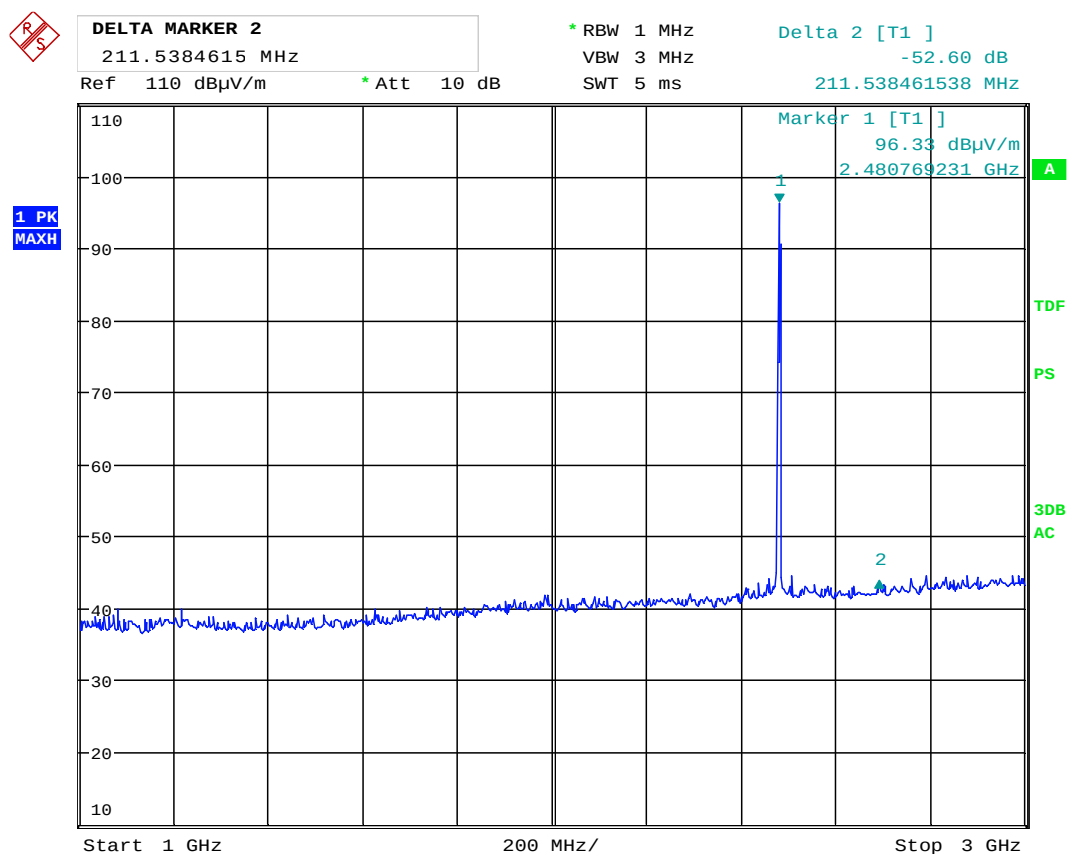
Start 1 GHz

200 MHz/

Stop 3 GHz

Date: 2.JAN.2014 15:04:20

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



Date: 2.JAN.2014 15:07:56

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

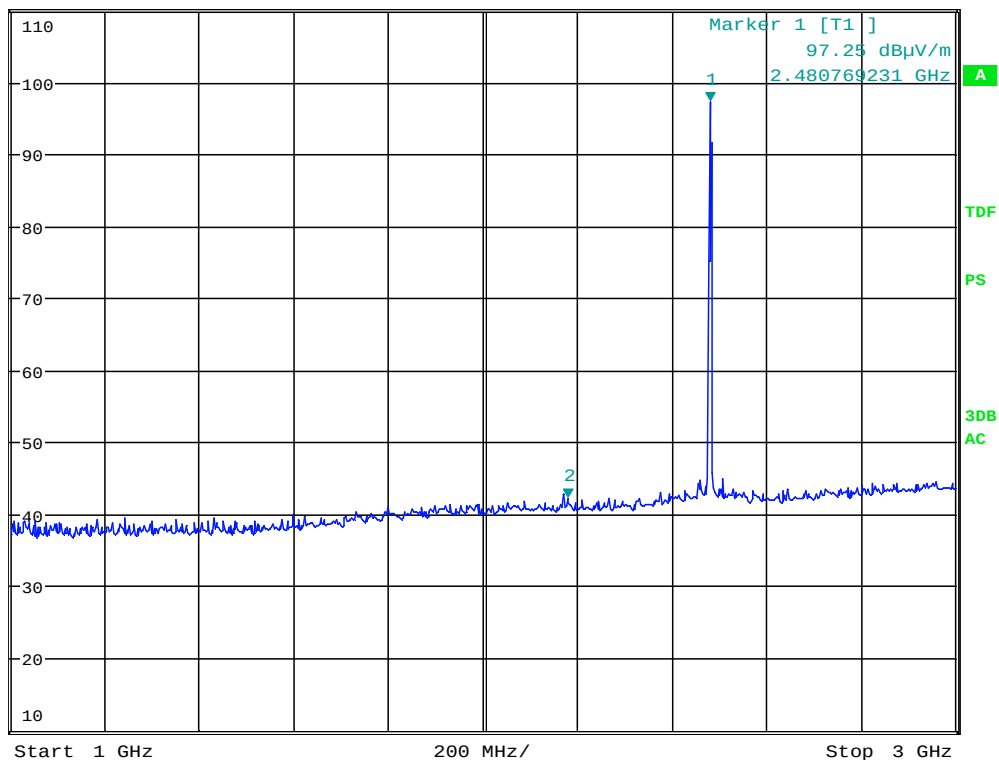


MARKER 2
2.179487179 GHz
Ref 110 dBμV/m * Att 10 dB

* RBW 1 MHz
VBW 3 MHz
SWT 5 ms

Marker 2 [T1]
42.31 dBμV/m
2.179487179 GHz

1 PK
MAXH



Date: 2.JAN.2014 15:07:26

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



* RBW 1 MHz
VBW 3 MHz
SWT 20 ms
Marker 1 [T1]
47.83 dBμV/m
4.803230769 GHz

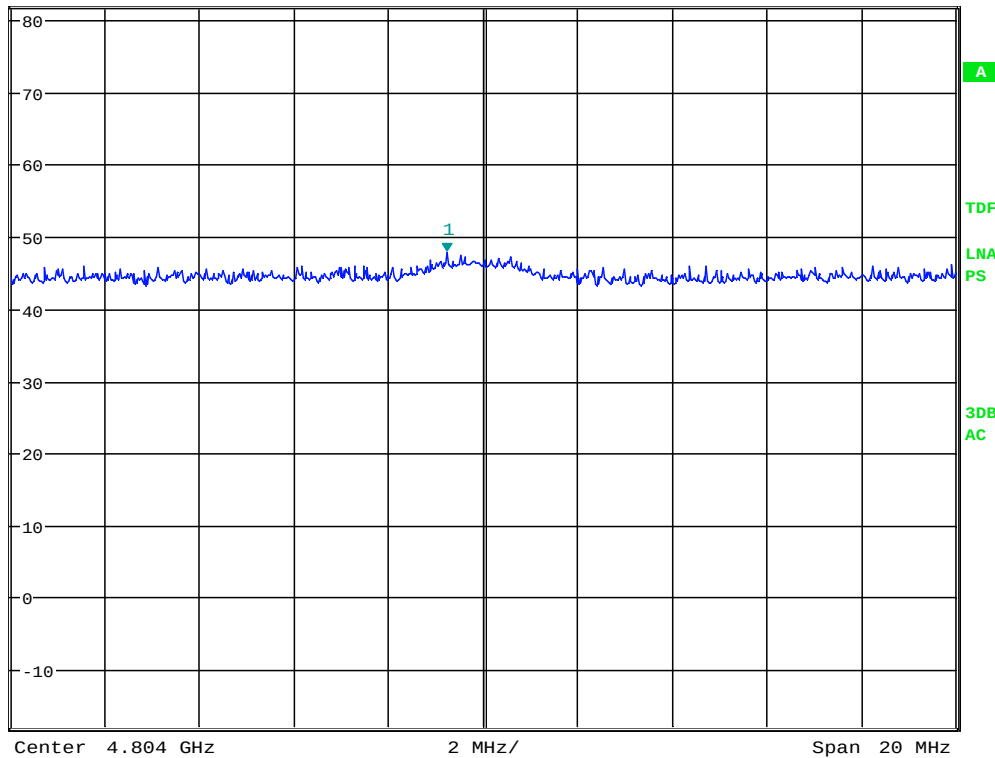
Ref 82 dBμV/m

* Att 10 dB

SWT 20 ms

4.803230769 GHz

1 PK
MAXH



Date: 2.JAN.2014 15:46:01

2nd harmonic , ch2402MHz – HP, PK detector

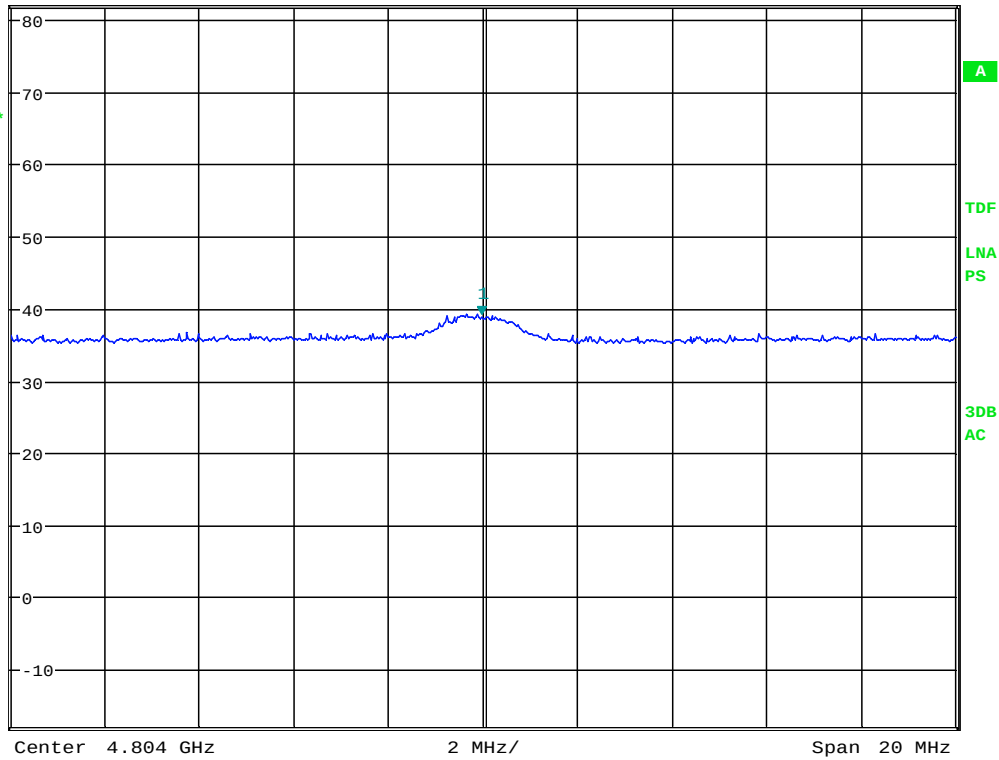


MARKER 1
4.803967949 GHz
Ref 82 dBμV/m * Att 10 dB

* RBW 1 MHz
VBW 10 MHz
SWT 20 ms

Marker 1 [T1]
39.11 dBμV/m
4.803967949 GHz

1 RM
MAXH



Date: 2.JAN.2014 15:47:18

2nd harmonic , ch2402MHz – HP, AV detector

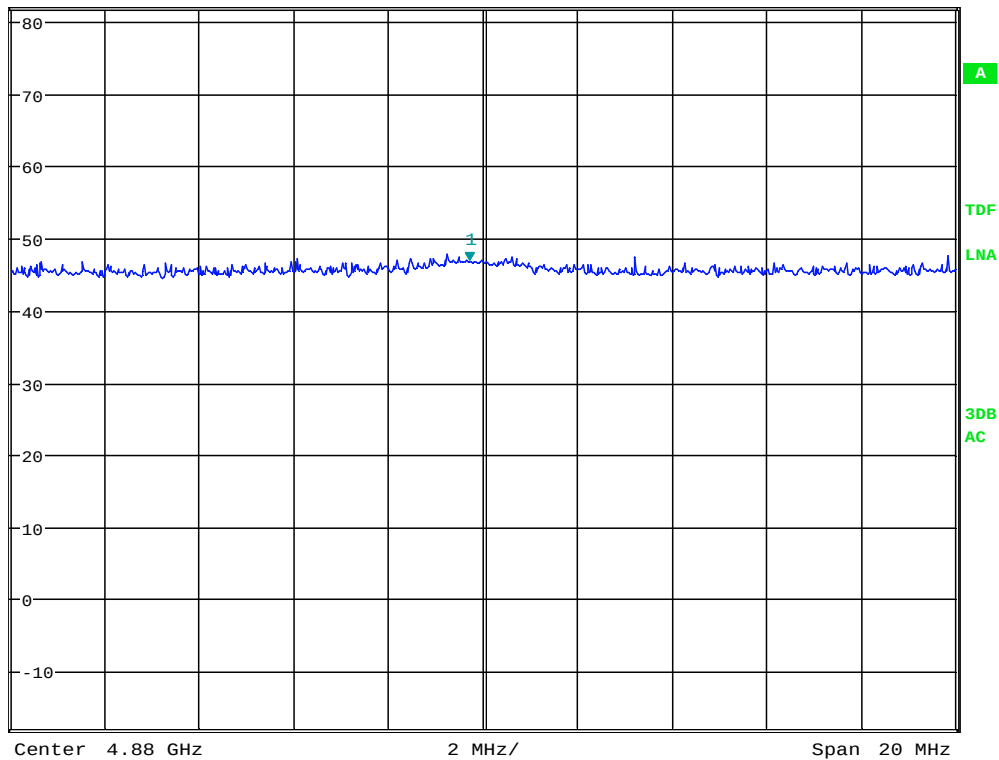


MARKER 1
4.879711538 GHz
Ref 82 dBμV/m * Att 10 dB

* RBW 1 MHz
VBW 3 MHz
SWT 20 ms

Marker 1 [T1]
46.79 dBμV/m
4.879711538 GHz

1 PK
MAXH



Date: 2.JAN.2014 15:54:47

2nd harmonic , ch2440MHz – HP, PK detector

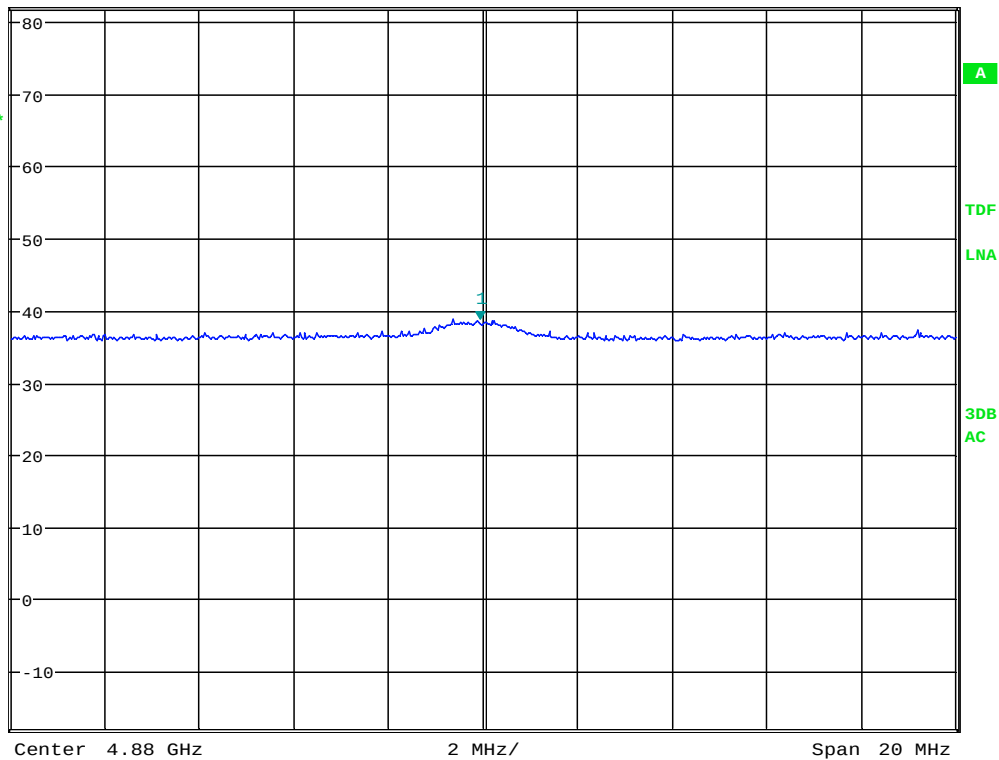


MARKER 1
4.879935897 GHz
Ref 82 dBμV/m * Att 10 dB

* RBW 1 MHz
VBW 10 MHz
SWT 20 ms

Marker 1 [T1]
38.52 dBμV/m
4.879935897 GHz

1 RM
MAXH



Date: 2.JAN.2014 15:55:30

2nd harmonic , ch2440MHz – HP, AV detector

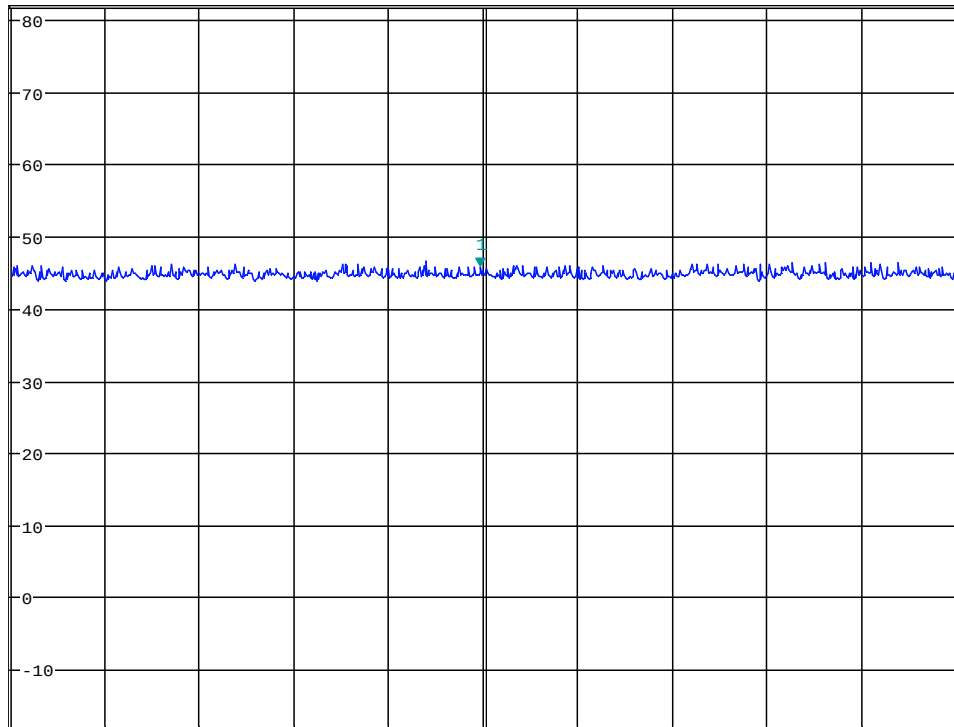


* RBW 1 MHz
VBW 3 MHz
SWT 20 ms
Marker 1 [T1]
45.85 dBμV/m
4.959935897 GHz

Ref 82 dBμV/m

* Att 10 dB

1 PK
MAXH



Center 4.96 GHz

2 MHz/

Span 20 MHz

Date: 2.JAN.2014 15:58:47

2nd harmonic , ch2480MHz – HP, PK detector

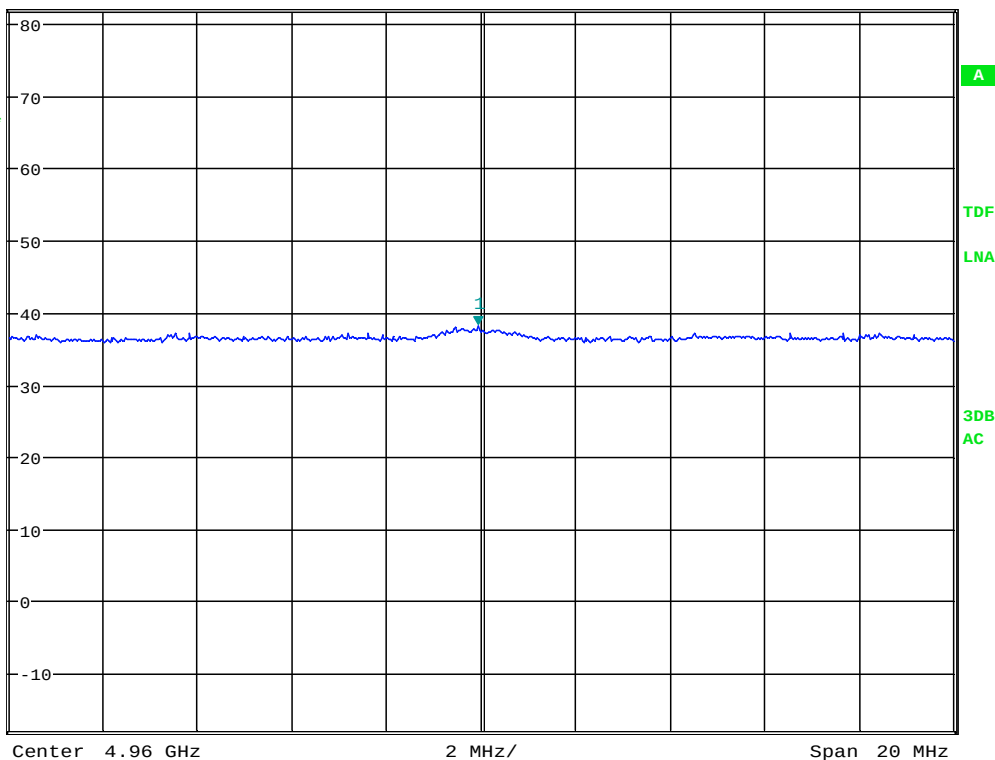


MARKER 1
4.959935897 GHz
Ref 82 dBμV/m * Att 10 dB

* RBW 1 MHz
VBW 10 MHz
SWT 20 ms

Marker 1 [T1]
38.13 dBμV/m
4.959935897 GHz

1 RM
MAXH



Date: 2.JAN.2014 15:58:27

2nd harmonic , ch2480MHz – HP, AV detector

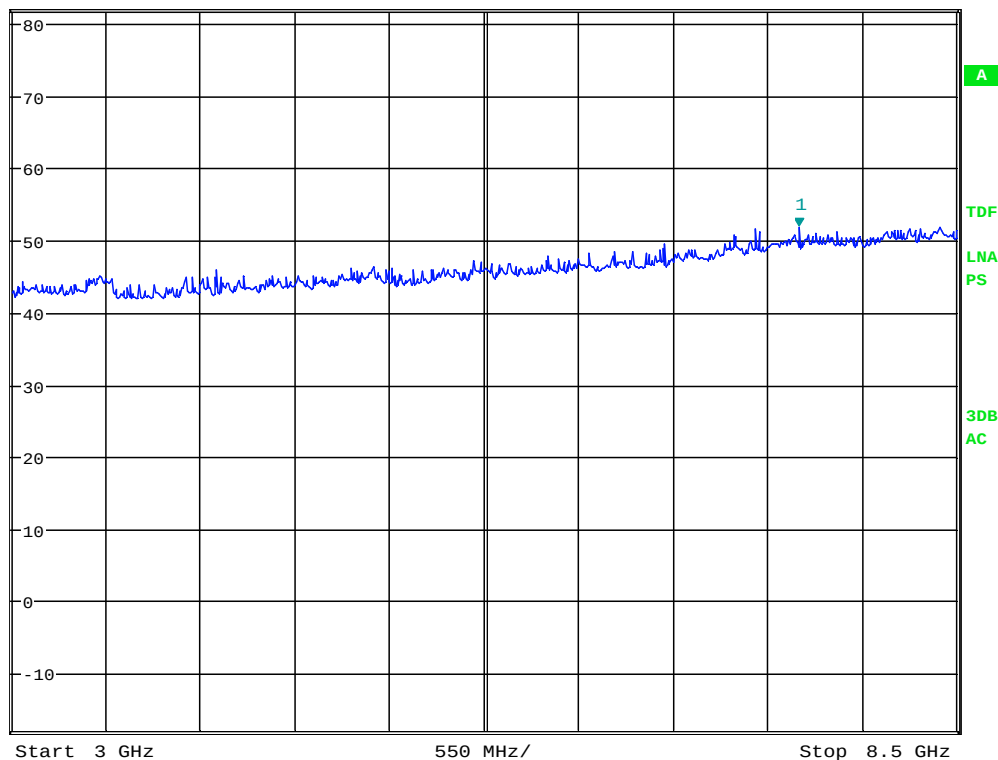


MARKER 1
7.583333333 GHz
Ref 82 dBμV/m * Att 10 dB

* RBW 1 MHz
VBW 3 MHz
SWT 35 ms

Marker 1 [T1]
51.90 dBμV/m
7.583333333 GHz

1 PK
MAXH



Date: 2.JAN.2014 15:49:27

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

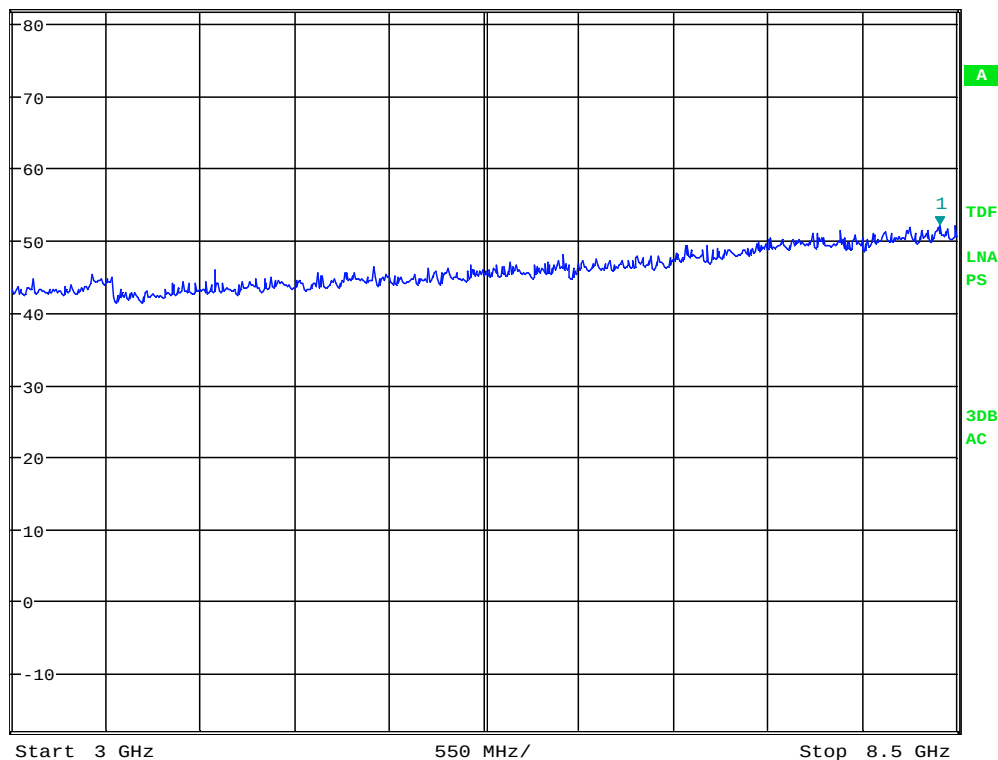


MARKER 1
8.403044872 GHz
Ref 82 dBμV/m * Att 10 dB

* RBW 1 MHz
VBW 3 MHz
SWT 35 ms

Marker 1 [T1]
52.02 dBμV/m
8.403044872 GHz

1 PK
MAXH



Date: 2.JAN.2014 15:48:26

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



MARKER 1

11.41666667 GHz

Ref 72.5 dBμV

* Att 10 dB

* RBW 1 MHz

VBW 3 MHz

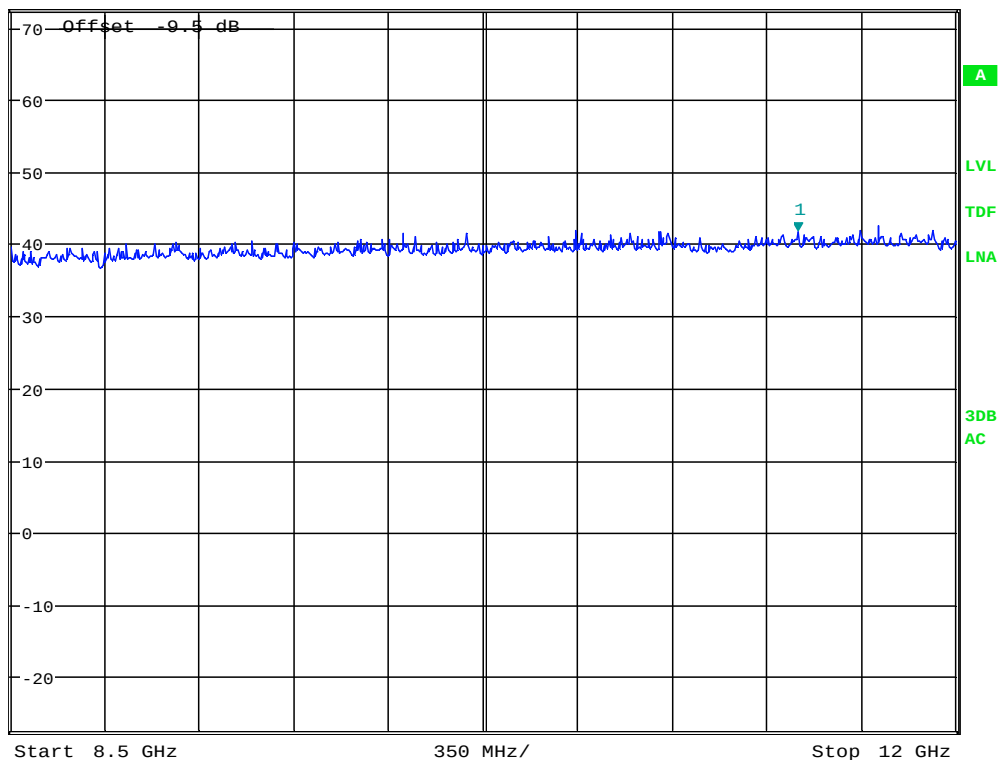
SWT 25 ms

Marker 1 [T1]

41.71 dBμV

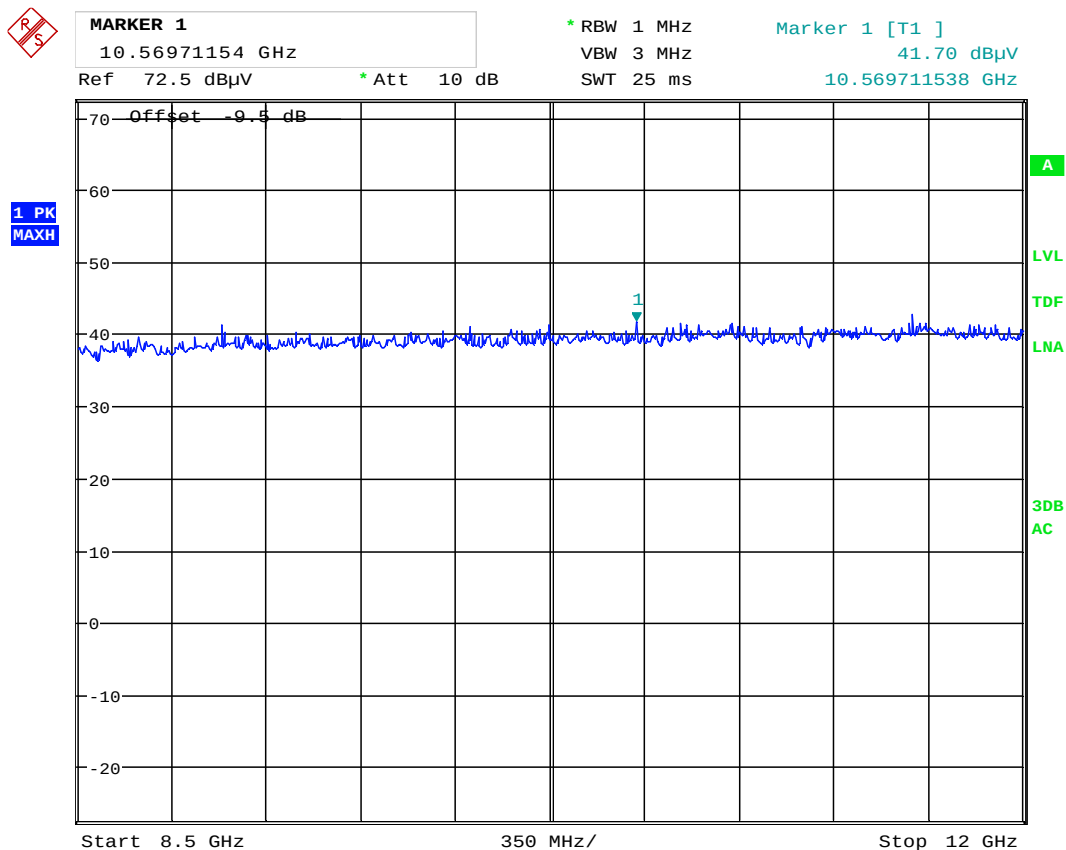
11.41666667 GHz

1 PK
MAXH



Date: 2.JAN.2014 16:07:27

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: 2.JAN.2014 16:08:03

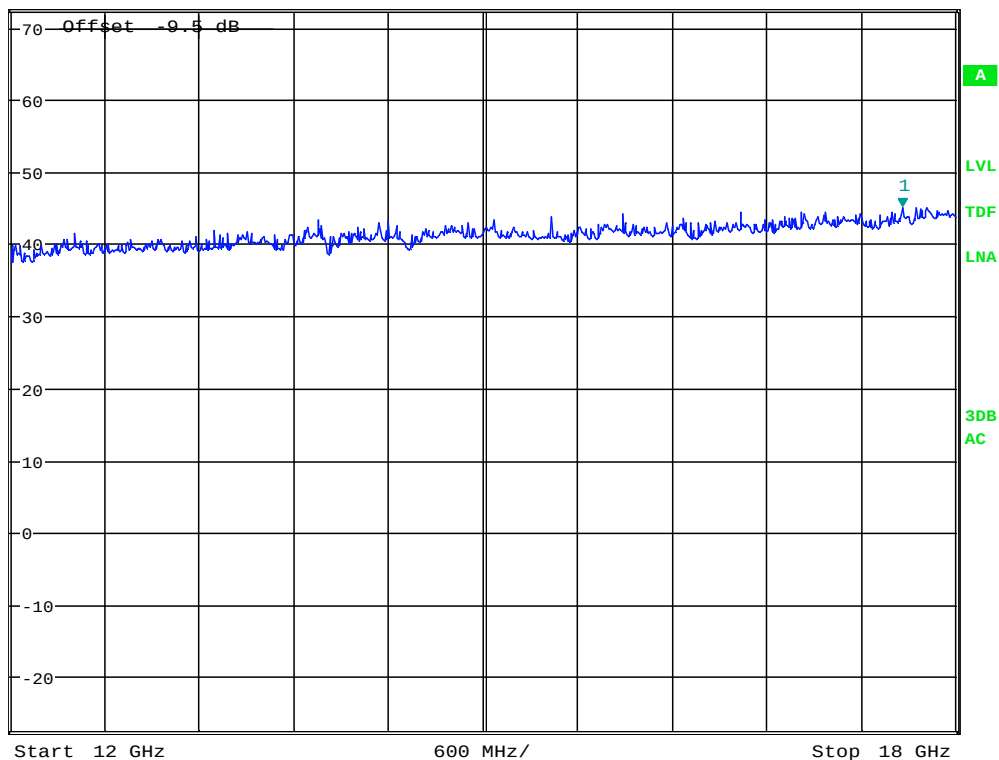
Radiated Emissions ch. 2402 MHz, 8.5 – 12 GHz, HP, @1m – Pre-scan with Peak detector , Distance Correction factor of -9.5 dB is included in the graph.



MARKER 1
17.66346154 GHz
Ref 72.5 dBμV/m * Att 10 dB

* RBW 1 MHz Marker 1 [T1]
VBW 3 MHz 45.14 dBμV/m
SWT 35 ms 17.663461538 GHz

1 PK
MAXH



Date: 2.JAN.2014 16:10:05

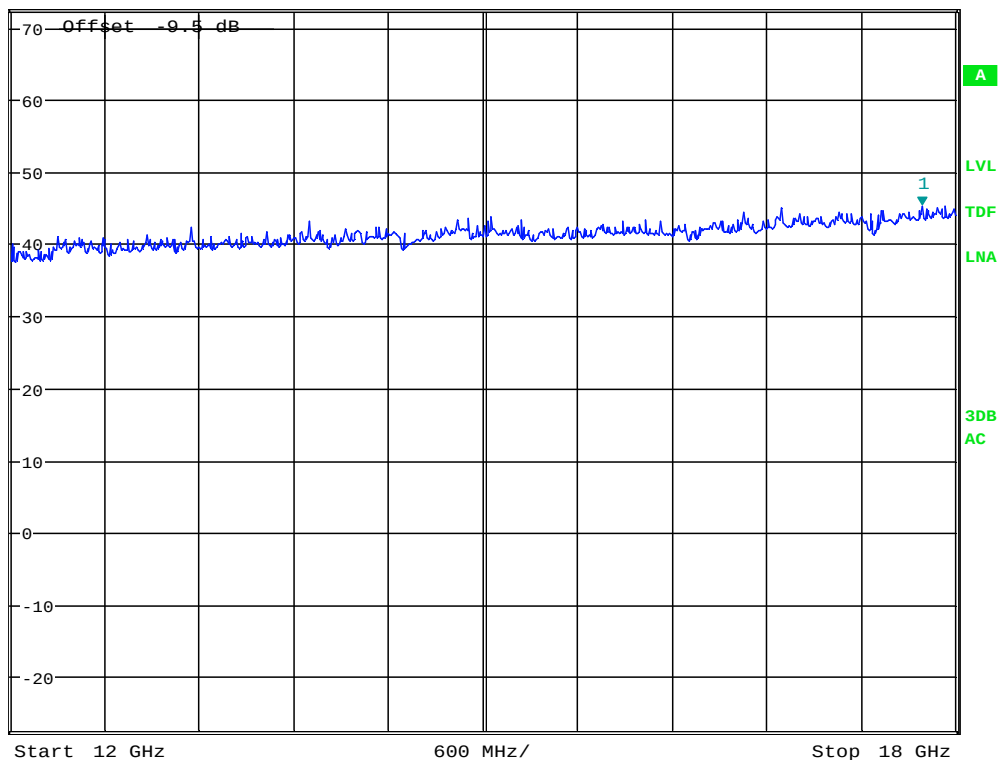
Radiated Emissions ch. 2402 MHz, 12 – 18 GHz, VP, @1m – Pre-scan with Peak detector, Distance Correction factor of -9.5 dB is included in the graph.



MARKER 1
17.78846154 GHz
Ref 72.5 dBμV/m * Att 10 dB

* RBW 1 MHz Marker 1 [T1]
VBW 3 MHz 45.29 dBμV/m
SWT 35 ms 17.788461538 GHz

1 PK
MAXH



Date: 2.JAN.2014 16:10:32

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.



MARKER 1

24.52884615 GHz

Ref 72.5 dBμV/m

* Att 10 dB

* RBW 1 MHz

VBW 3 MHz

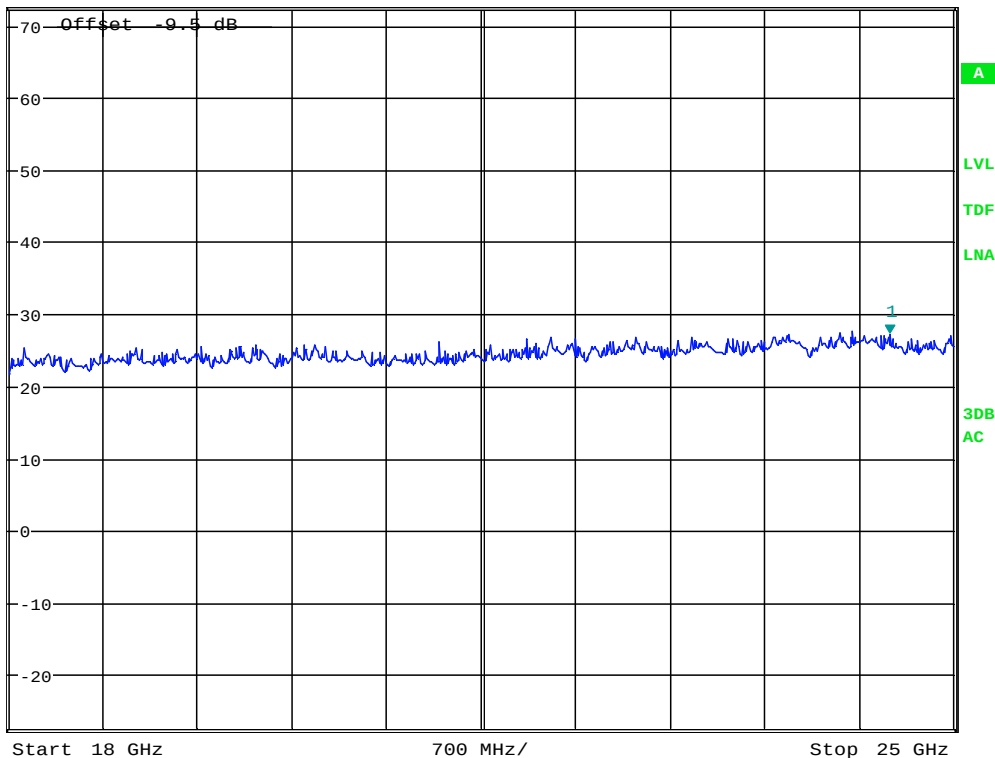
SWT 45 ms

Marker 1 [T1]

27.26 dBμV/m

24.528846154 GHz

1 PK
MAXH



Date: 2.JAN.2014 16:18:44

Radiated Emissions ch. 2402 MHz, 18 – 25 GHz, VP/HP, Pre-scan with Peak detector, Distance Correction factor -9.5dB is included in the graph.

3.6 Power Spectral Density (PSD)

Para. No.: 15.247 (e)

Test Performed By: G.Suhanthakumar

Date of Test: 06 Jan 2014

Test Results: Complies

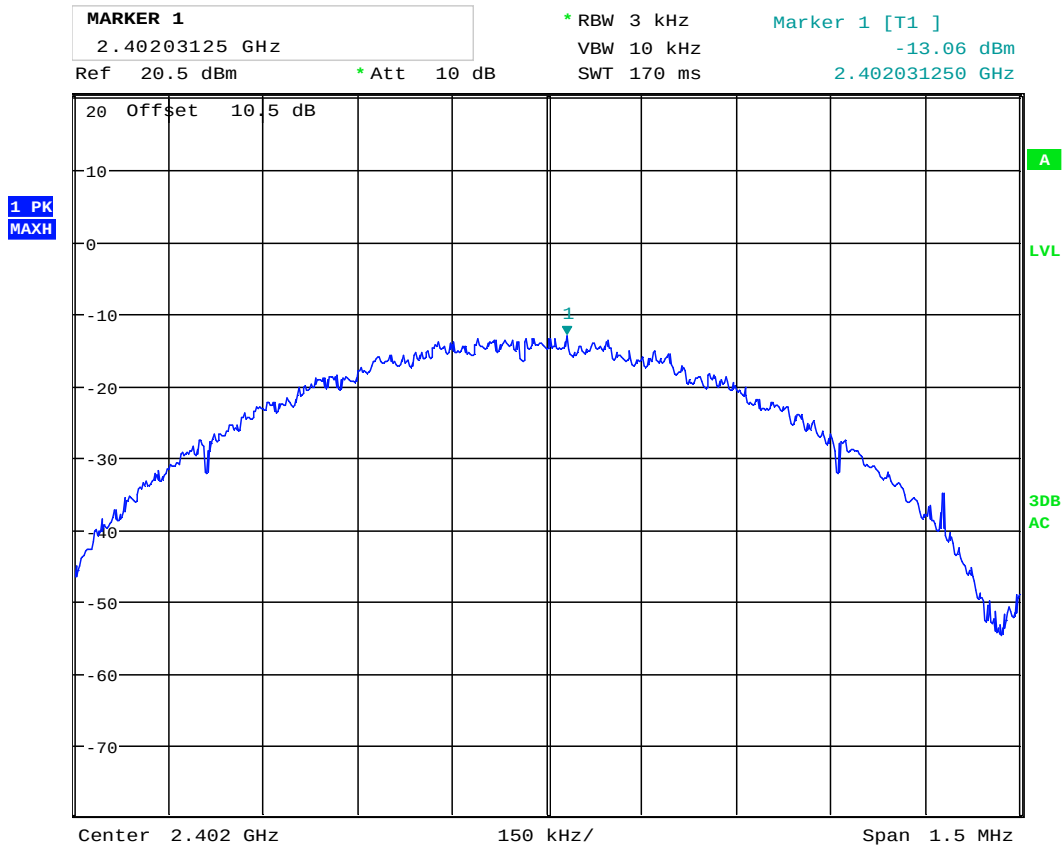
Measured and Calculated Data:

	calculated peak PSD dBm
Power Spectral Density @2402 MHz	-13.06
Power Spectral Density @2440 MHz	-13.91
Power Spectral Density @2480 MHz	-13.71

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

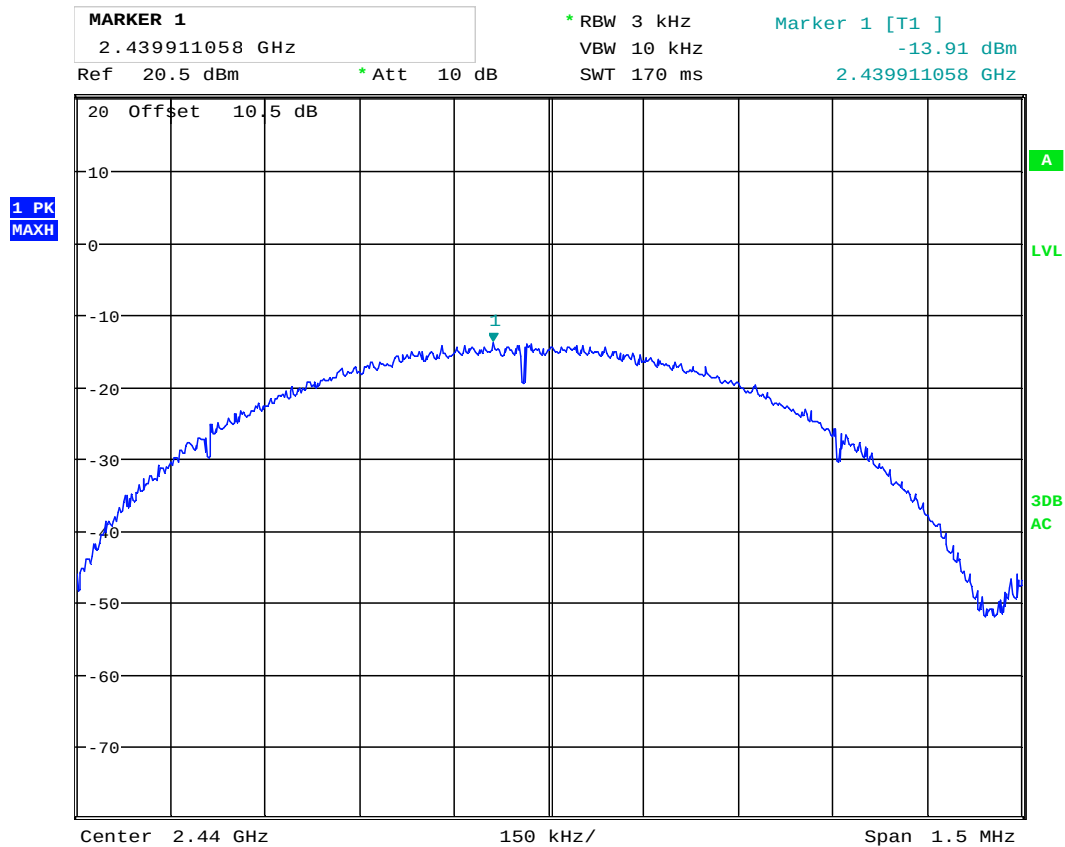
Requirements:

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



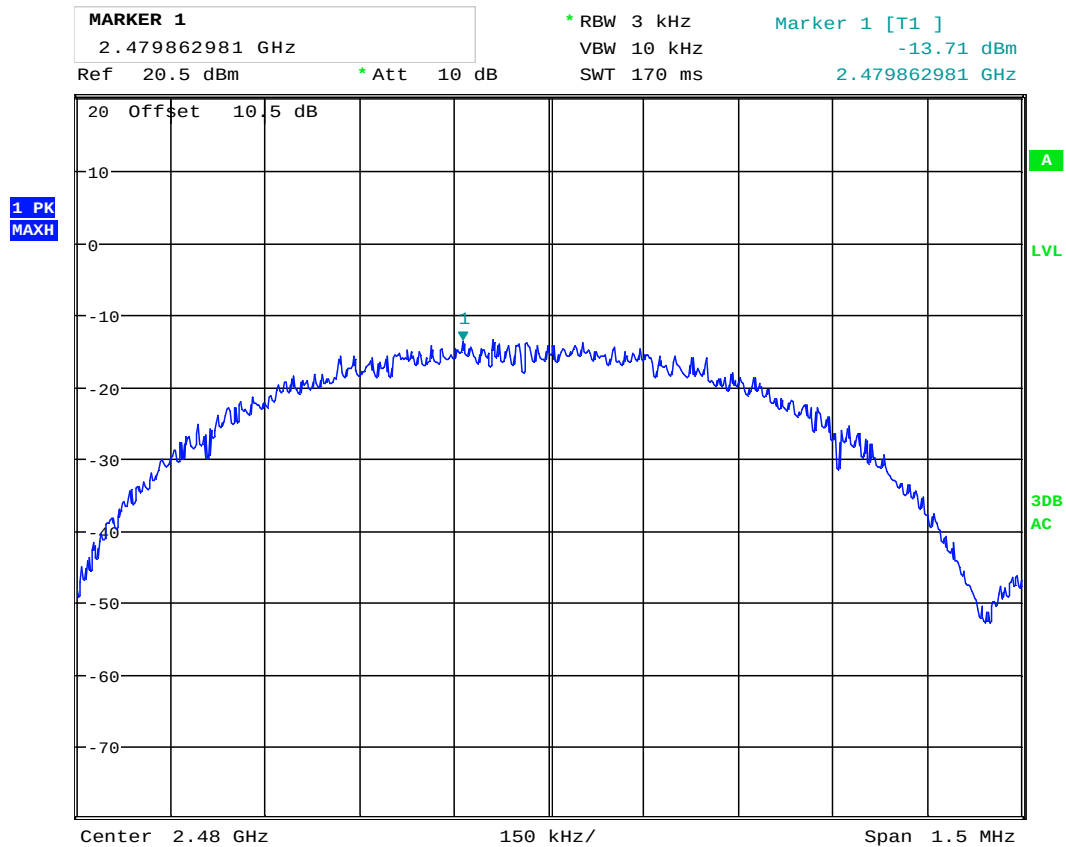
Date: 6.JAN.2014 16:38:49

PSD Measurement - 2402MHz



Date: 6.JAN.2014 16:47:16

PSD Measurement – 2440MHz



Date: 6.JAN.2014 16:43:27

PSD Measurement - 2480MHz

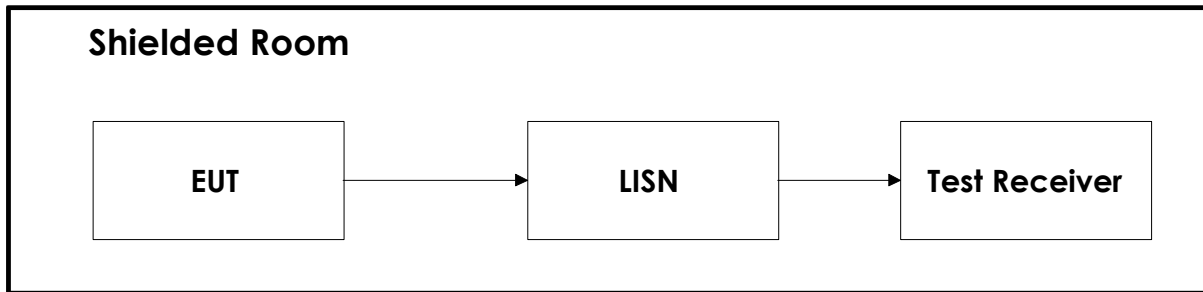
4 LIST OF TEST EQUIPMENT

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	2013.11	2015.11
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
22	6502	Antenna, Loop	EMCO	N3488	2010.10.08	2014.10.08

5 BLOCK DIAGRAM

5.1 Power Line Conducted Emission



5.2 Test Site Radiated Emission

