

Test Report

Product	Zigbee Light Link Remote Control
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	ZLLRC
Rating	3.0Vdc
Trademark	Texas Instruments
Serial number	/
Additional information	/
Tested according to	FCC Part 15.247 Digital Transmission Systems Industry Canada RSS-210, Issue 8 Low Power Licence-Exempt Radiocommunications Devices
Order number	239391
Tested in period	05.07.2013 – 11.07.2013
Issue date	02.09.2013
Name and address of the testing laboratory	 <div style="display: flex; justify-content: space-between; margin-top: 10px;"> <div> FCC No: 994405 IC OATS: 2040D-1 TEL: (+47) 22 96 03 30 FAX: (+47) 22 96 05 50 </div> <div> Instituttveien 6 Kjeller, Norway </div> </div>
<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  Prepared by [G.Suhanthakumar] </div> <div style="text-align: center;">  Approved by [Frode Sveinsen] </div> </div>	
This report shall not be reproduced except in full without the written approval of Nemko. Opinions and interpretations expressed within this report are not part of the current accreditation. This report was originally distributed electronically with digital signatures. For more information contact Nemko.	

CONTENTS

1	INFORMATION	3
1.1	Test Item.....	3
1.2	Test Environment.....	4
1.2.1	Normal test condition	4
1.3	Test Engineer(s)	4
1.4	Test Equipment.....	4
2	TEST REPORT SUMMARY	5
2.1	General.....	5
2.2	Test Summary	6
2.3	Description of modification for Modification Filing.....	6
2.4	Comments	6
2.5	Family List Rational	6
3	TEST RESULTS.....	7
3.1	Power Line Conducted Emissions	7
3.2	Minimum 6 dB Bandwidth	8
3.3	20 dB Bandwidth.....	12
3.4	Peak Power Output.....	13
3.5	Spurious Emissions (Radiated).....	23
3.6	Power Spectral Density (PSD).....	52
4	LIST OF TEST EQUIPMENT.....	56
5	BLOCK DIAGRAM	57
5.1	Power Line Conducted Emission	57
5.2	Test Site Radiated Emission.....	57

1 INFORMATION

1.1 Test Item

Name :	Texas Instruments
FCC ID :	ZATZLLRC
IC :	451H-ZLLRC
Model/version :	ZLLRC
Serial number :	-
Hardware identity and/or version:	Rev.1.1
Software identity and/or version :	-
Frequency Range :	2405 – 2480 MHz
Number of Channels :	16
Type of Modulation :	250 kbps, OQPSK (Digital)
Conducted Output Power:	2.1 mW (Peak)
User Frequency Adjustment :	None
Type of Power Supply :	3.0V _{DC} (Lithium Battery)
Antenna Connector :	No, PCB antenna
Antenna Diversity Supported :	No
Desktop Charger :	None

Description of Test Item

The ZigBee Light Link Remote Control (ZLLRC) is based on the CC2530 System-on-Chip device operating in the 2.4 GHz ISM band. The CC2530 physical layer complies with the IEEE 802.15.4 standard.

Exposure Evaluation

The EUT is exempted from RF Exposure Evaluation.

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.Suwanthakumar

1.4 Test Equipment

See list of test equipment in clause 5.

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".

Nemko Group authorizes the above named company to reproduce this report provided it is reproduced in its entirety and for use by the company's employees only. Any reproduction of parts of this report requires approval in writing from Nemko Group.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. Nemko Group accepts no responsibility for damages suffered by any third party as a result of decisions made or actions based on this report.

2.2 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.

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: 05 July 2013

Test Results: Complies

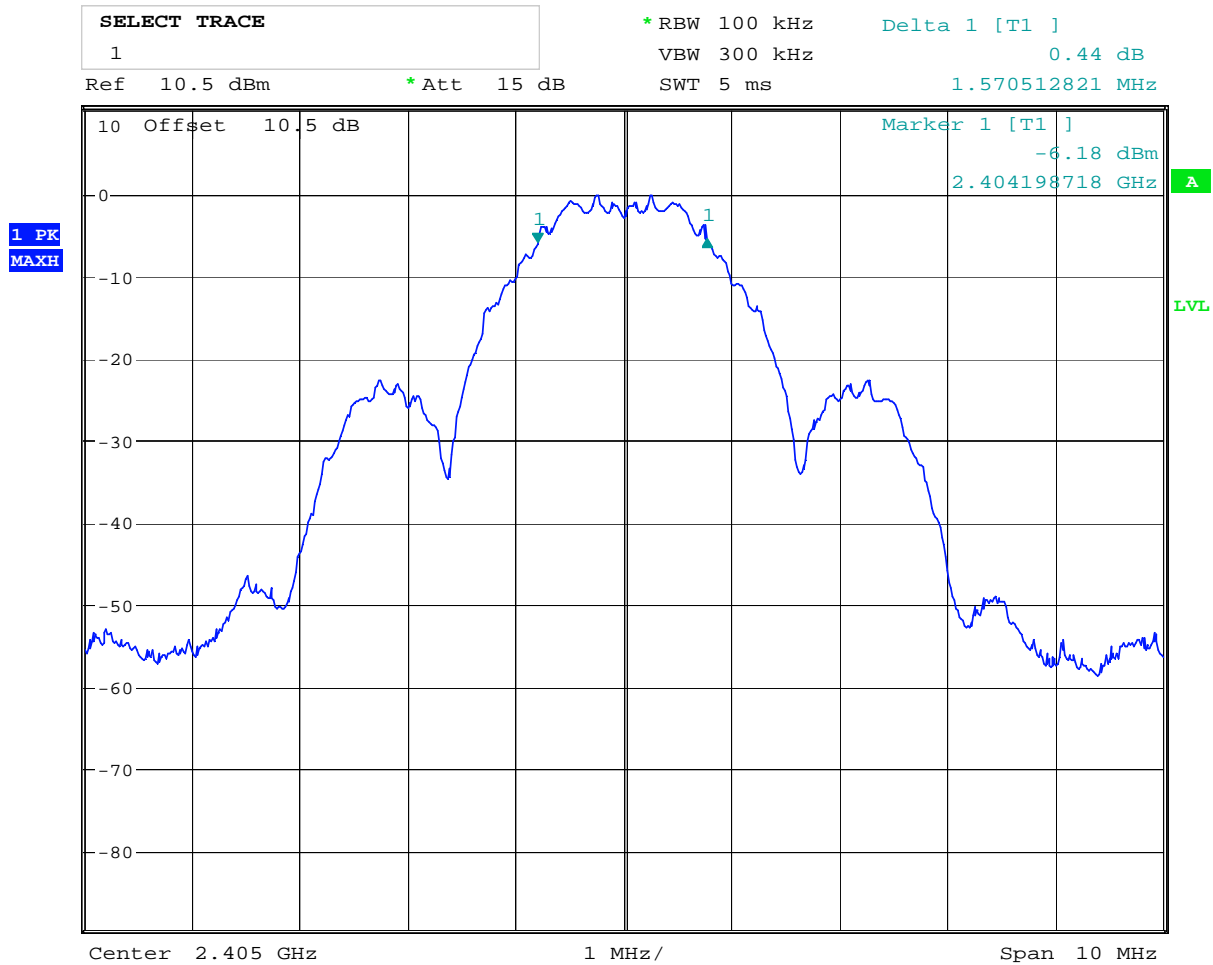
Measurement Data:

Measured 6 dB Bandwidth (MHz)		
2405MHz	2440 MHz	2480MHz
1.57	1.63	1.60

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

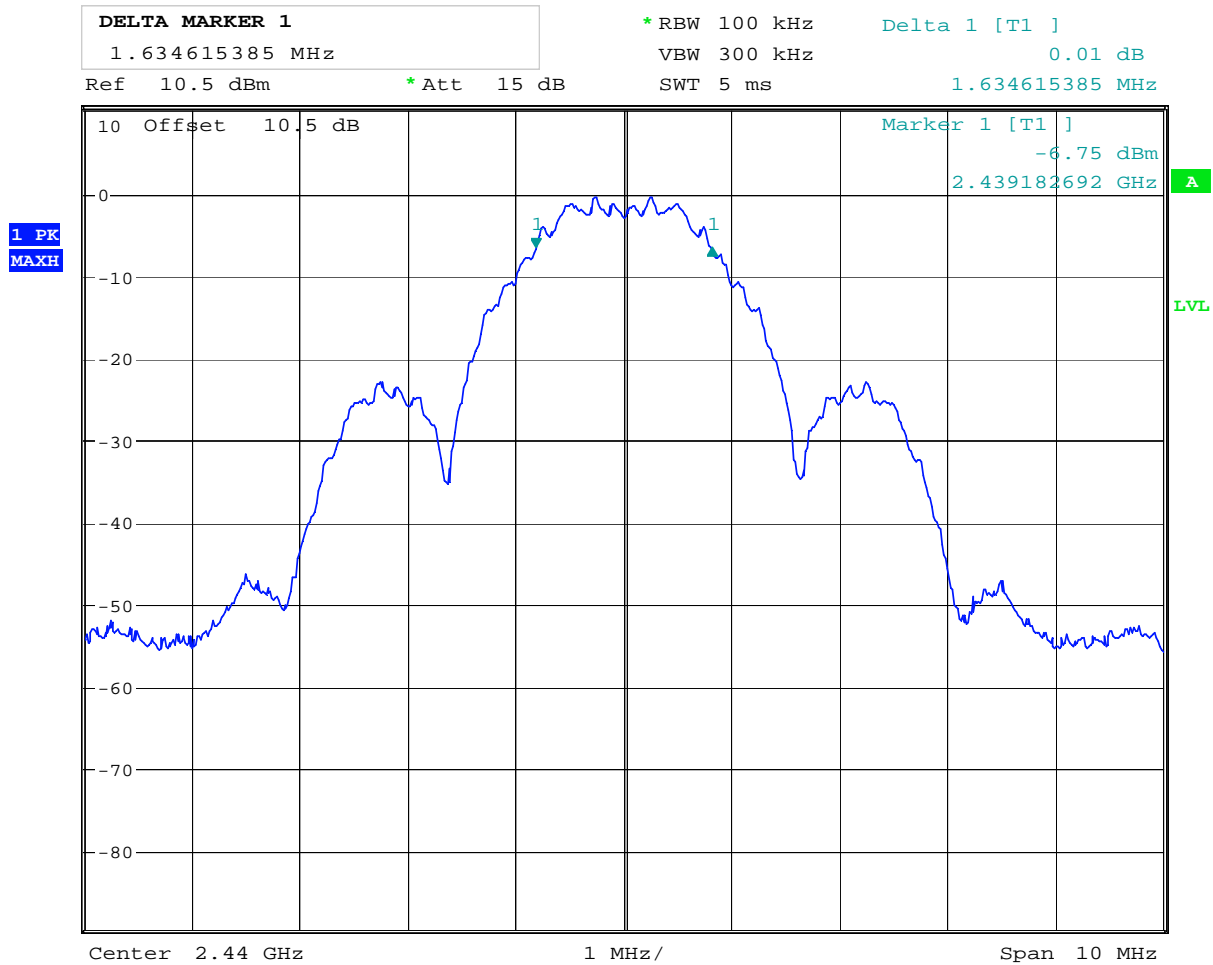
Requirements:

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



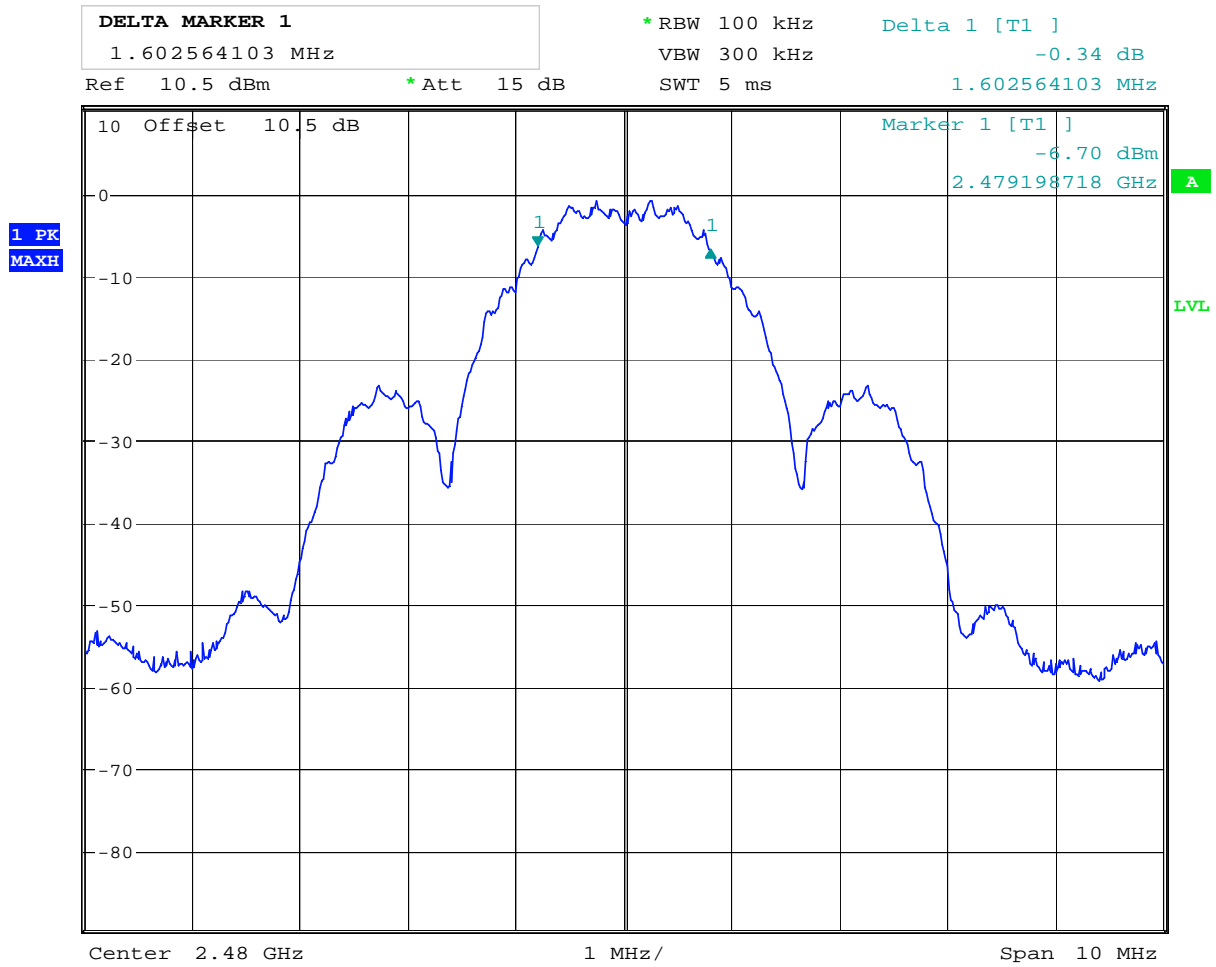
Date: 5.JUL.2013 14:07:31

6 dB Bandwidth at 2405 MHz



Date: 5.JUL.2013 14:14:59

6 dB Bandwidth at 2440 MHz



Date: 5.JUL.2013 14:19:48

6 dB Bandwidth at 2480 MHz

3.3 20 dB Bandwidth

Test Performed By: G.Suwanthakumar

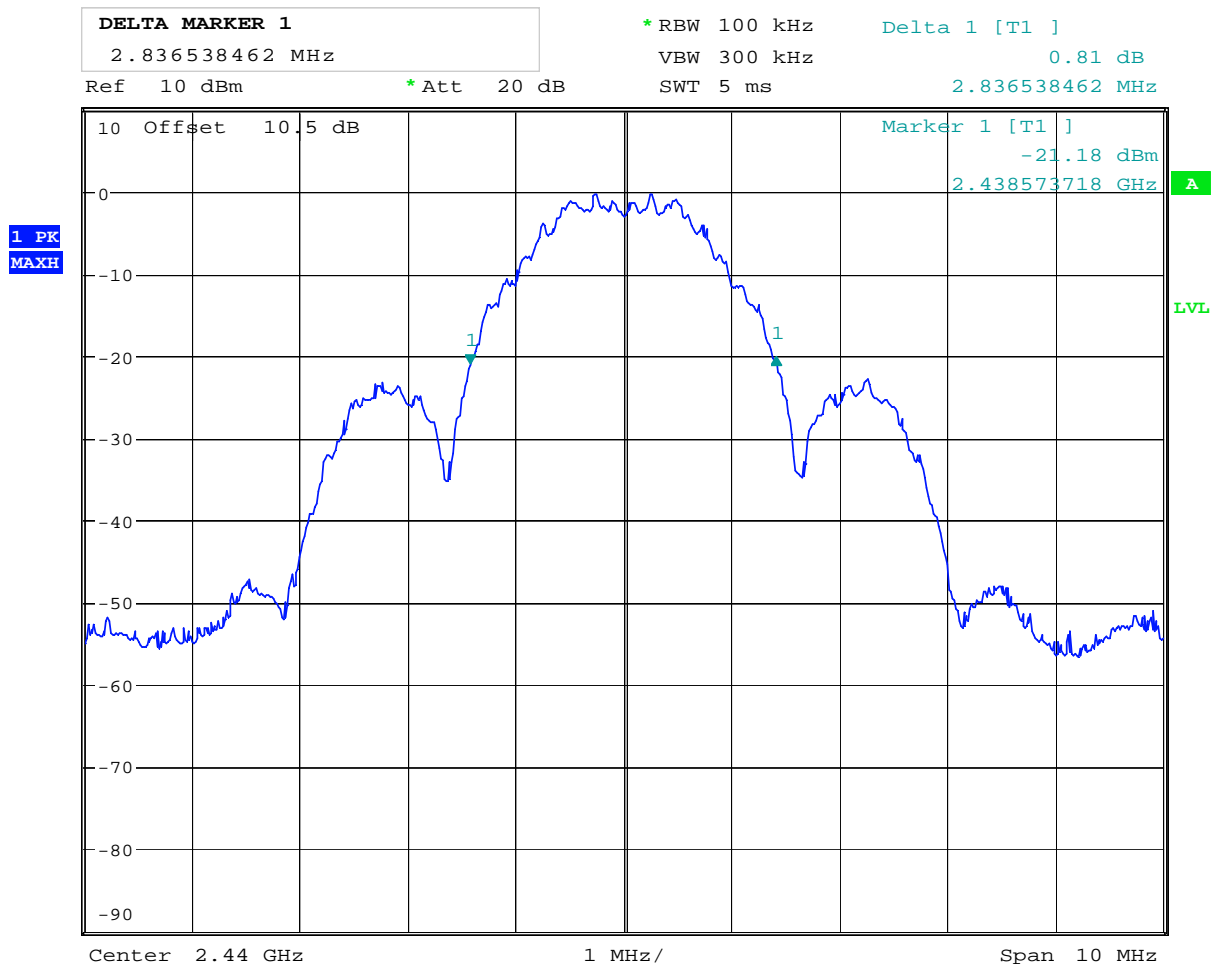
Date of Test: 09 July 2013

Measurement Data:

Measured 20 dB Bandwidth (MHz)
2440 MHz
2.84

Requirements:

No requirements. Reported for information only.



Date: 9.JUL.2013 15:45:20

20 dB Bandwidth at 2440 MHz

3.4 Peak Power Output

Para. No.: 15.247 (b)

Test Performed By: G.Suwanthakumar	Date of Test: 05 & 09 July 2013
------------------------------------	---------------------------------

Test Results: Complies

Measurement Data:

RF channel	2405 MHz	2440 MHz	2480 MHz
Measured Maximum Field strength (dB μ V/m) –HP	101.2	100.4	98.9
Calc. Radiated Power (dBm)	6.3	5.1	3.6
Calc. Radiated Power (mW)	4.3	3.2	2.3
Measured Conducted Power (dBm)	3.2	2.9	2.6
Measured Conducted Power (mW)	2.1	1.9	1.8
Calculated Antenna Gain (dBi)	3.1	2.2	1.1

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 XZ plane and Horizontal 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.



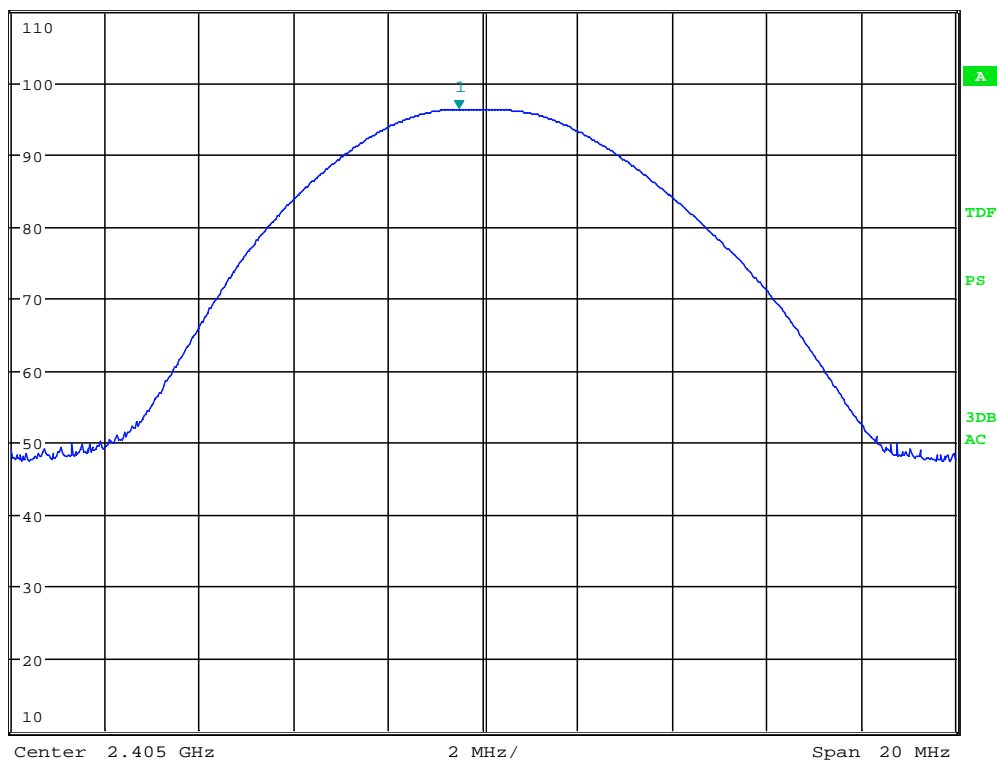
*RBW 3 MHz
VBW 10 MHz
SWT 2.5 ms

Marker 1 [T1]
96.34 dBμV/m
2.404487179 GHz

Ref 110 dBμV/m

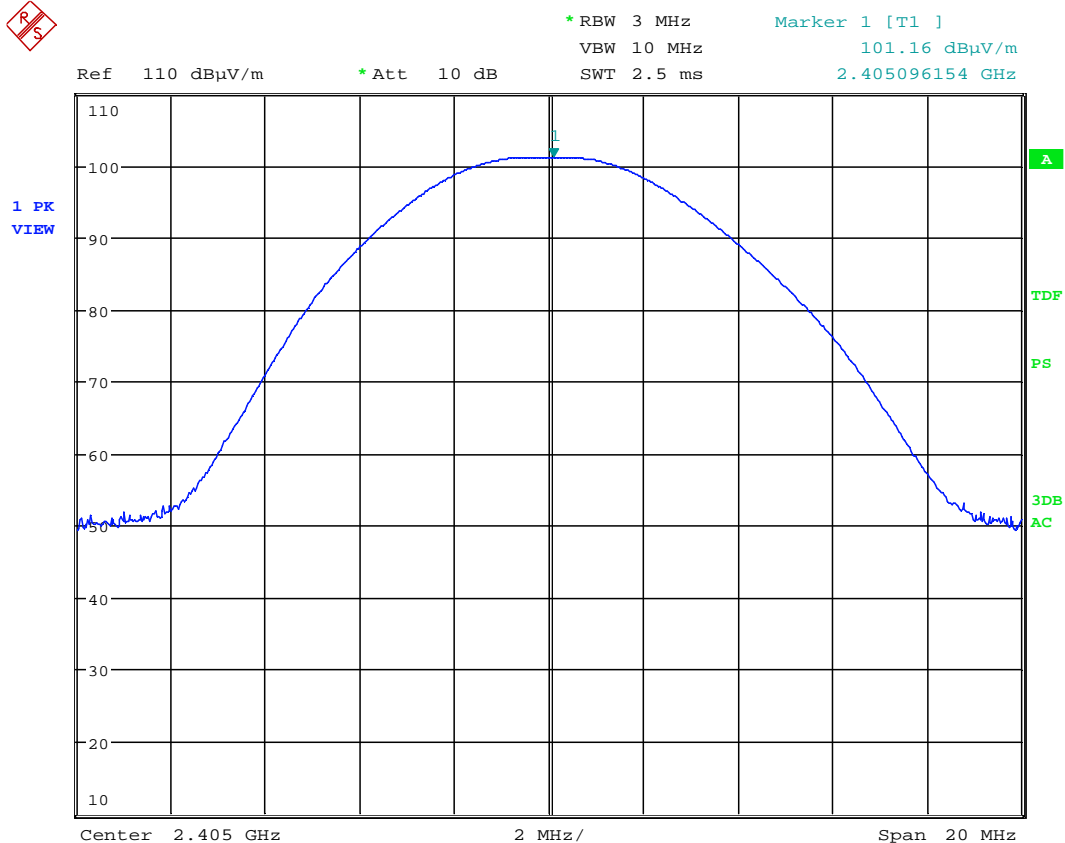
*Att 10 dB

1 PK
MAXH



Date: 9.JUL.2013 09:25:08

Radiated Field strength, VP , 2405 MHz,PK



Date: 9.JUL.2013 09:30:21

Radiated field strength, HP, 2405 MHz,PK

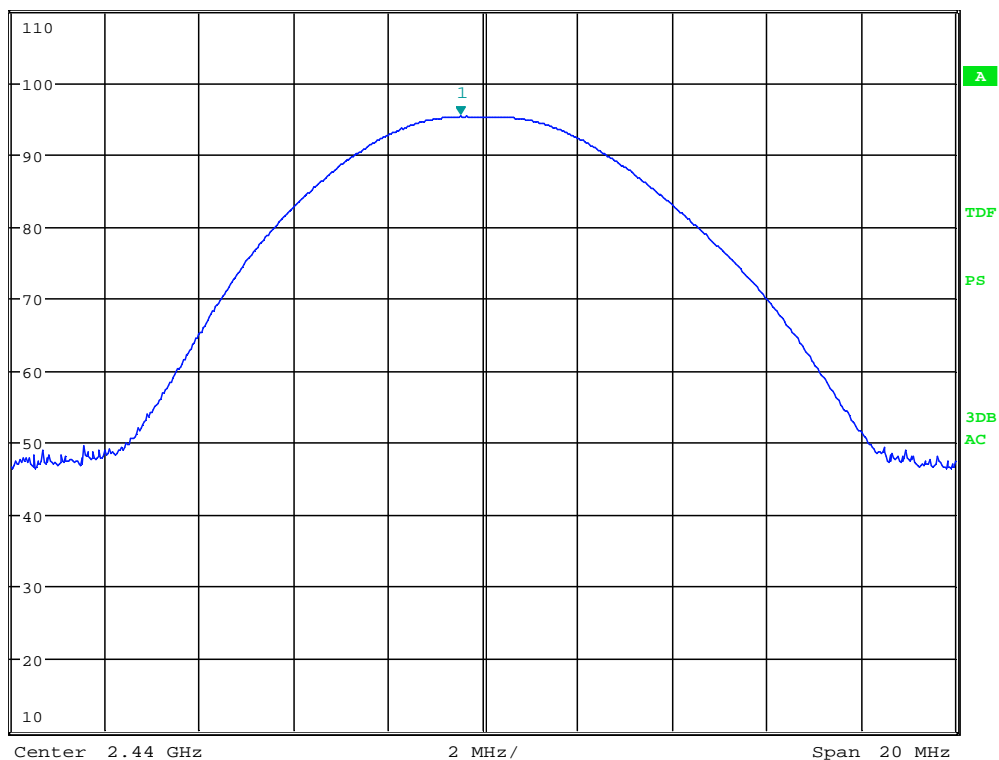


*RBW 3 MHz
VBW 10 MHz
SWT 2.5 ms
Marker 1 [T1]
95.31 dBμV/m
2.439519231 GHz

Ref 110 dBμV/m

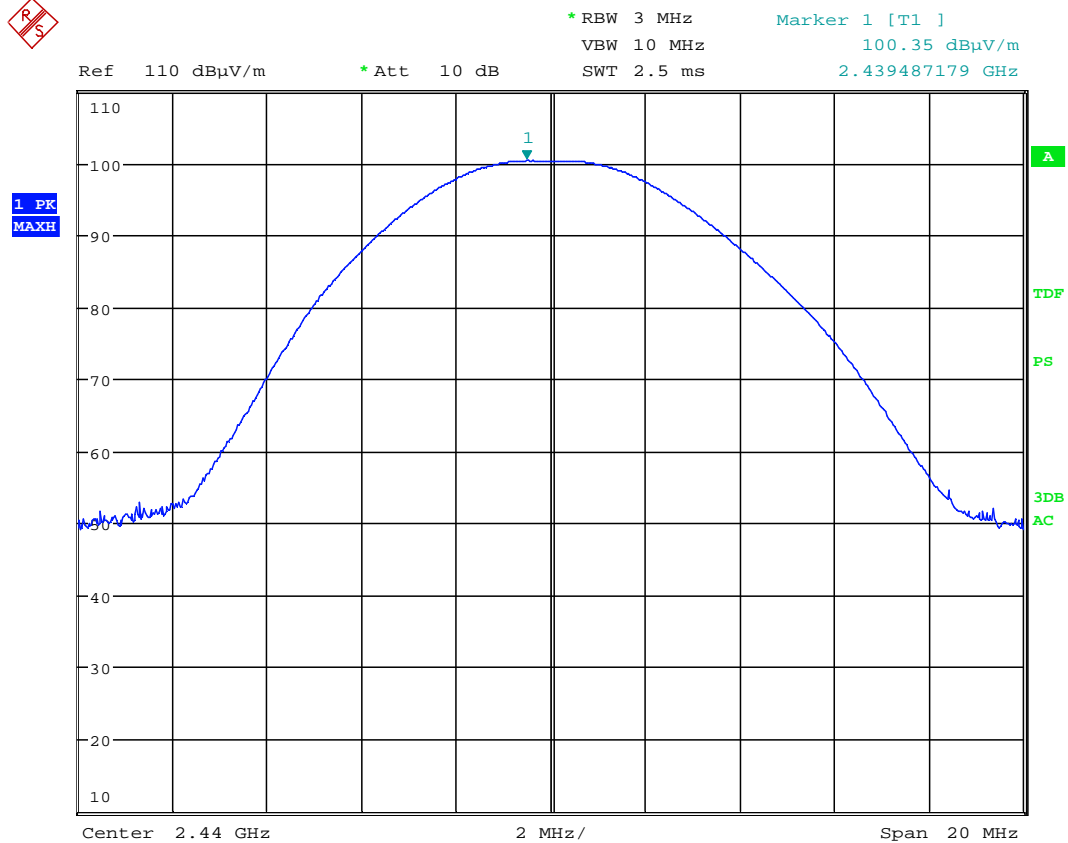
*Att 10 dB

1 PK
MAXH



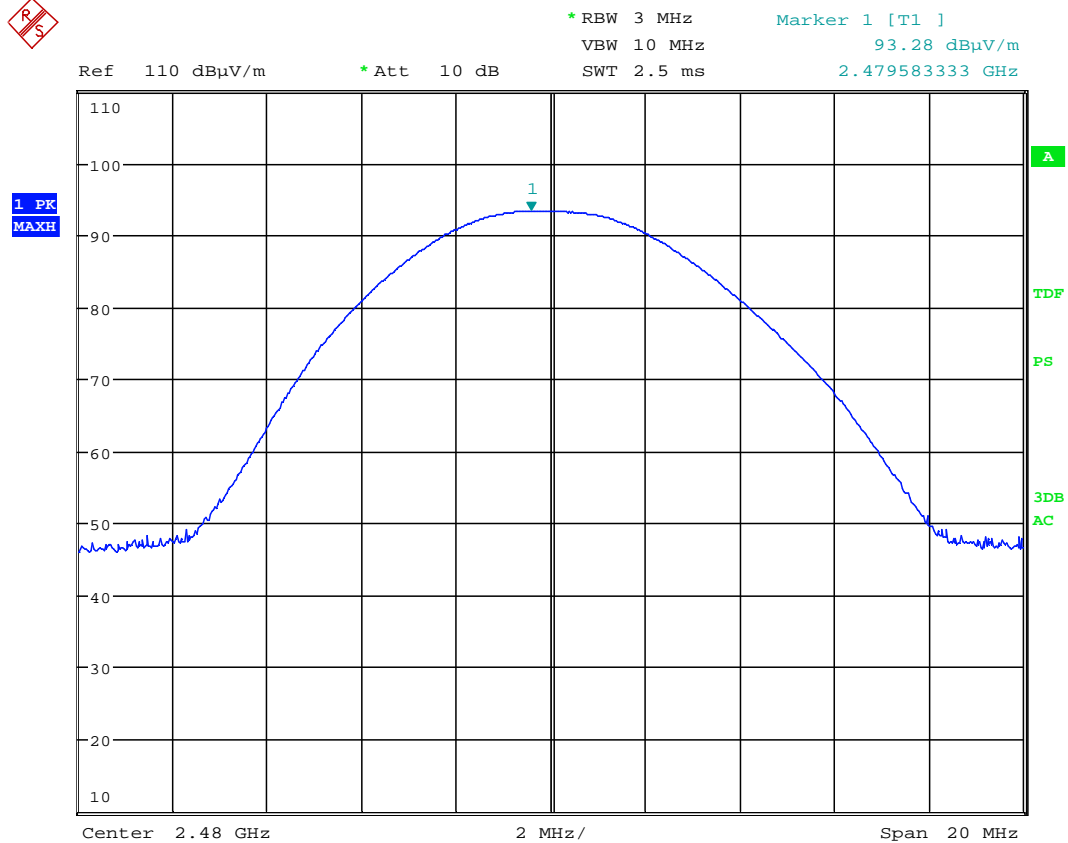
Date: 9.JUL.2013 09:33:58

Radiated field strength, VP, 2440 MHz,PK



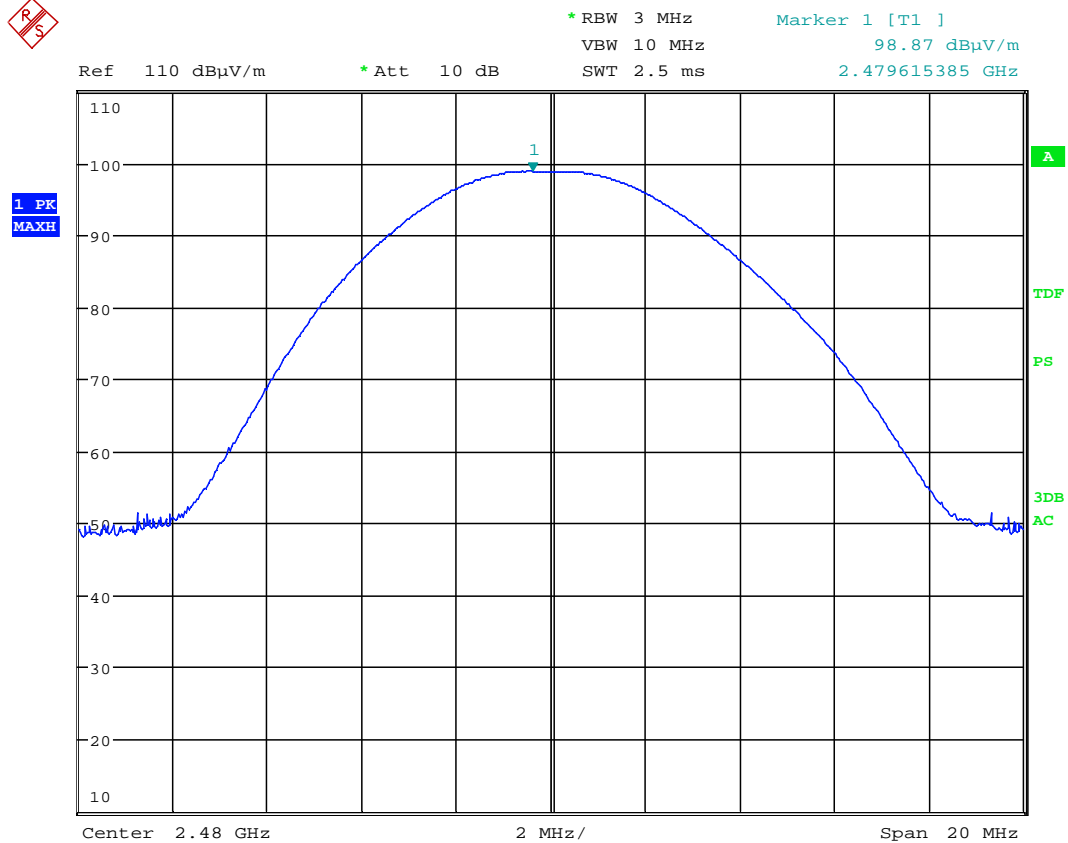
Date: 9.JUL.2013 09:33:02

Radiated field strength, HP, 2440 MHz,PK



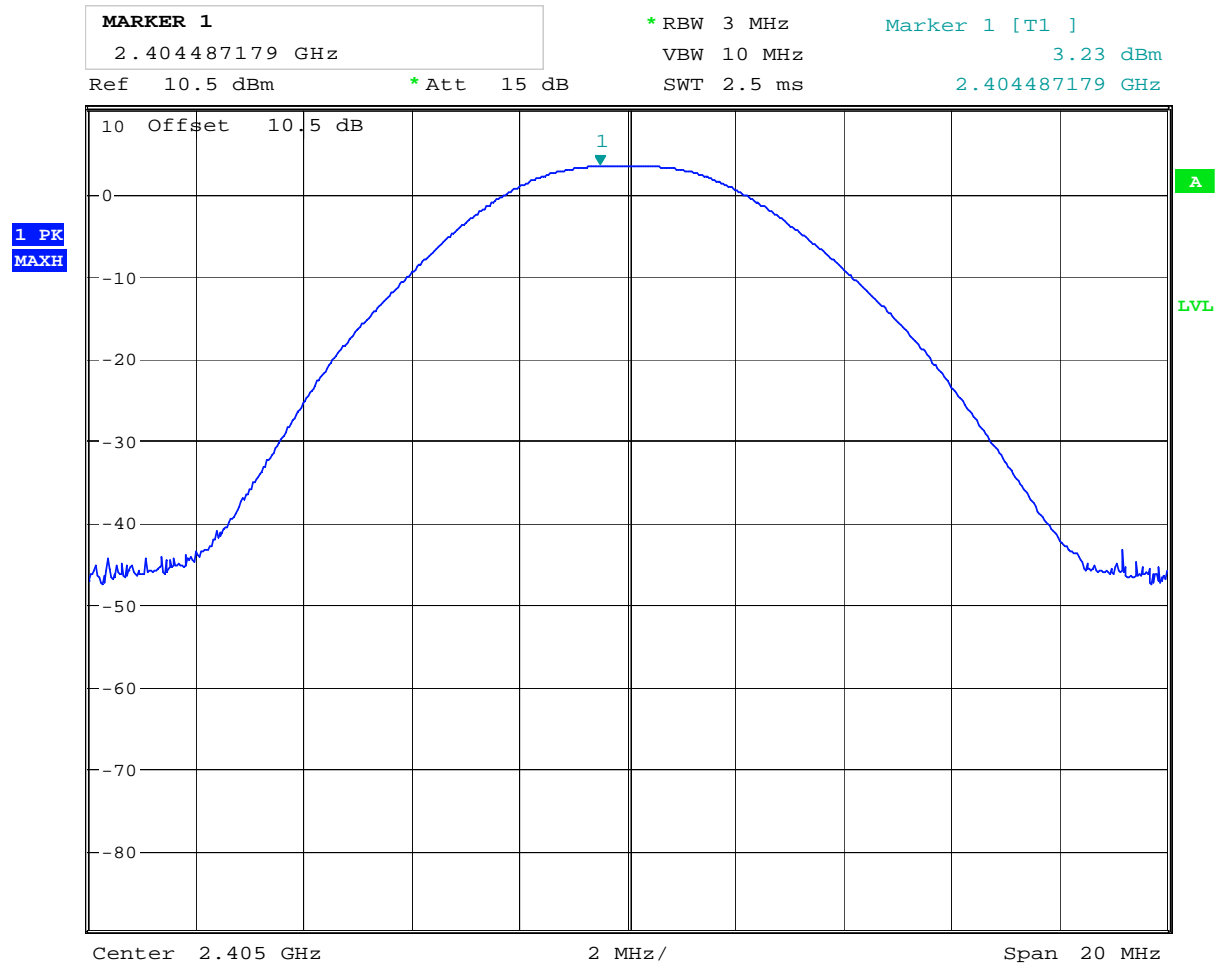
Date: 9.JUL.2013 09:36:28

Radiated field strength, VP, 2480 MHz,PK



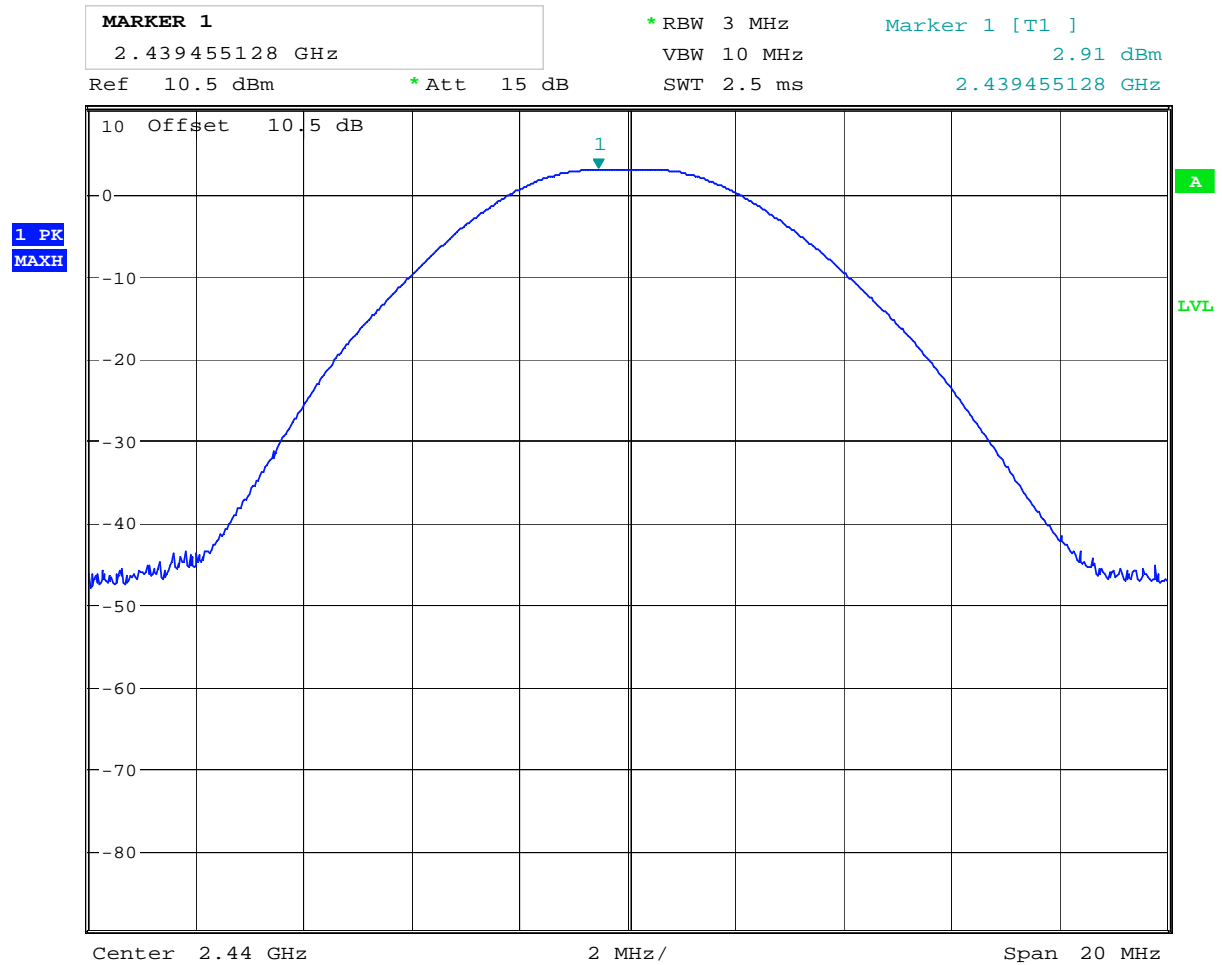
Date: 9.JUL.2013 09:37:56

Radiated field strength, HP, 2480 MHz,PK



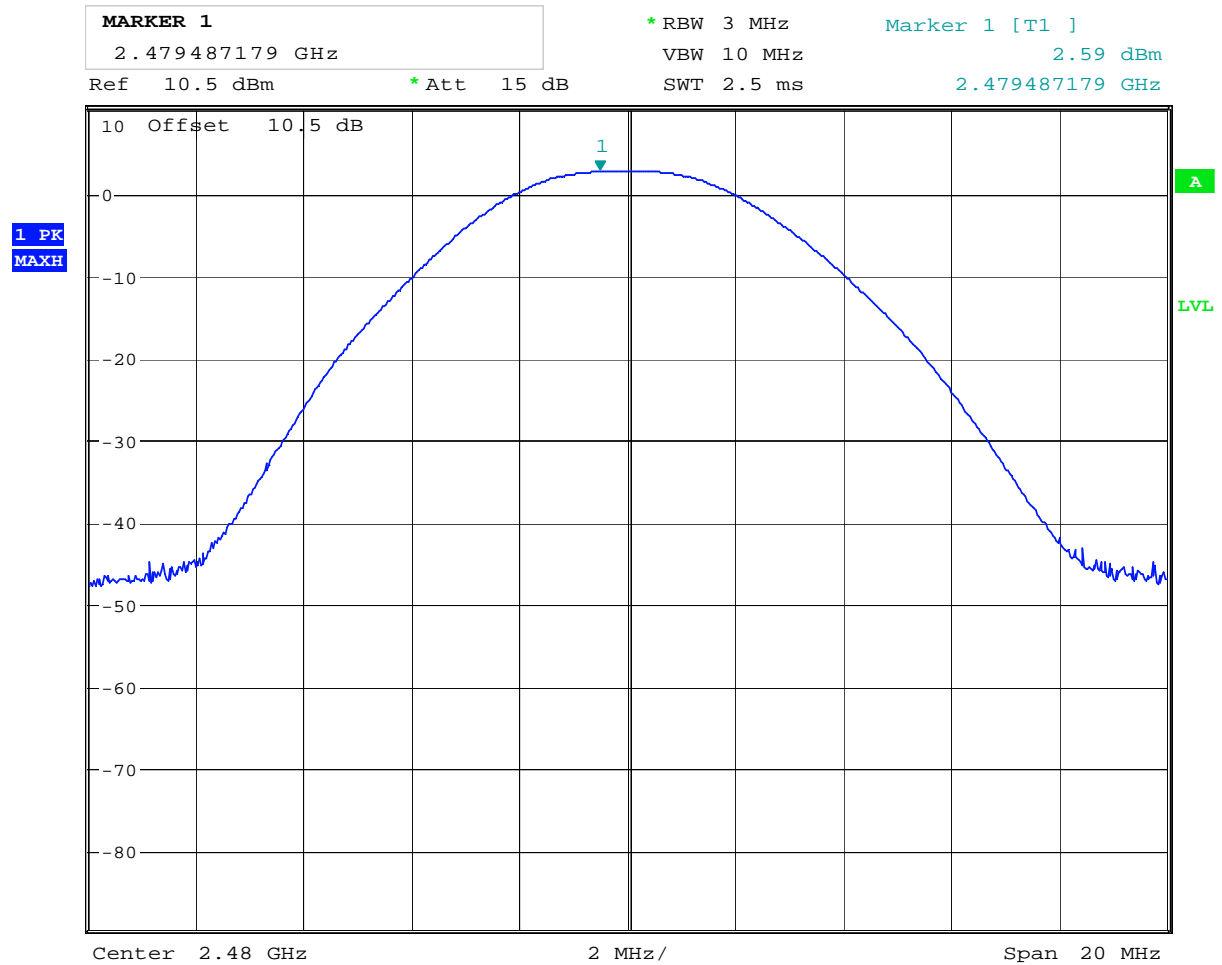
Date: 5.JUL.2013 14:09:00

Conducted power – 2405MHz,PK



Date: 5.JUL.2013 14:23:51

Conducted power – 2440MHz,PK



Date: 5.JUL.2013 14:21:30

Conducted power – 2480MHz, PK

3.5 Spurious Emissions (Radiated)

Para. No.: 15.247 (c)

Test Performed By: G.Suwanthakumar	Date of Test: 09 - 11 July 2013
------------------------------------	---------------------------------

Test Results: Complies

Measurement Data:

Band-edge, @3m

Frequency	Measured Field Strength @3m, dBμV/m	Detector	Limit dBμV/m	Margin dB
2.39 GHz	42.4	PK	74	31.6
	36.7	AV	54	17.3
2.4835 GHz	67.3	PK	74	6.7
	44.6	AV	54	9.4

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

100% duty cycle

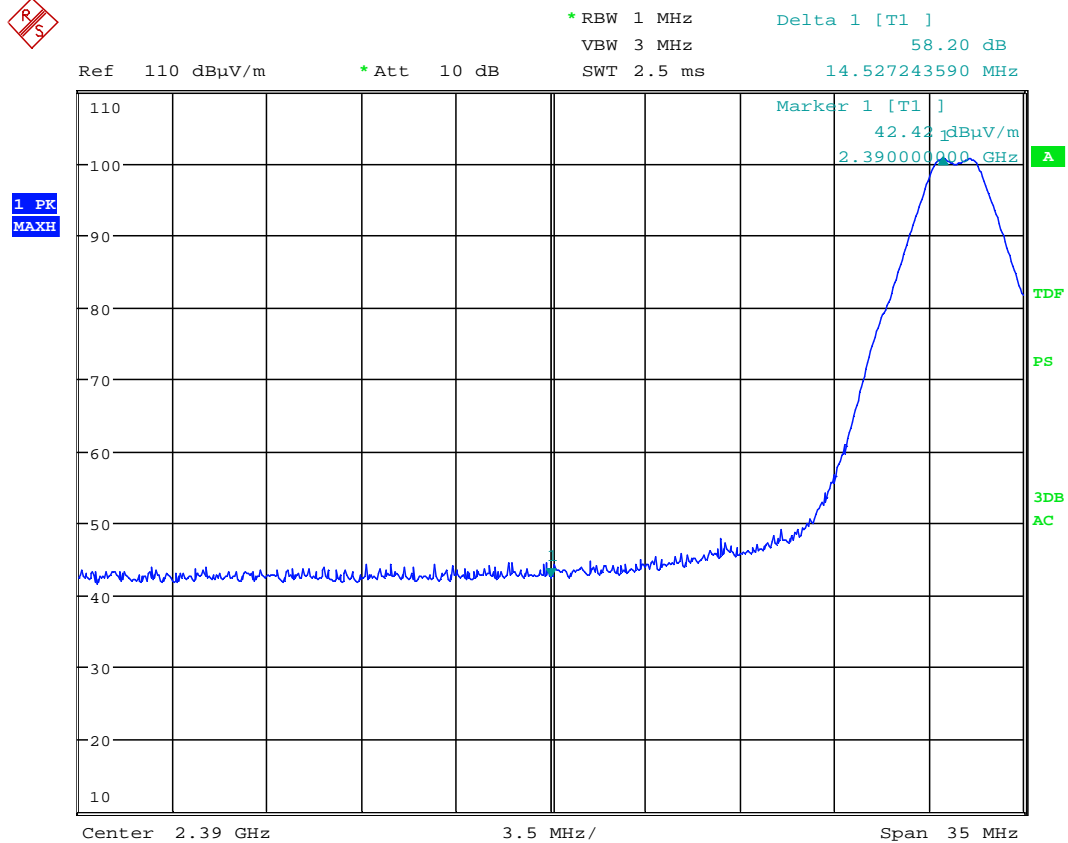
See attached plots.

RF conducted power

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

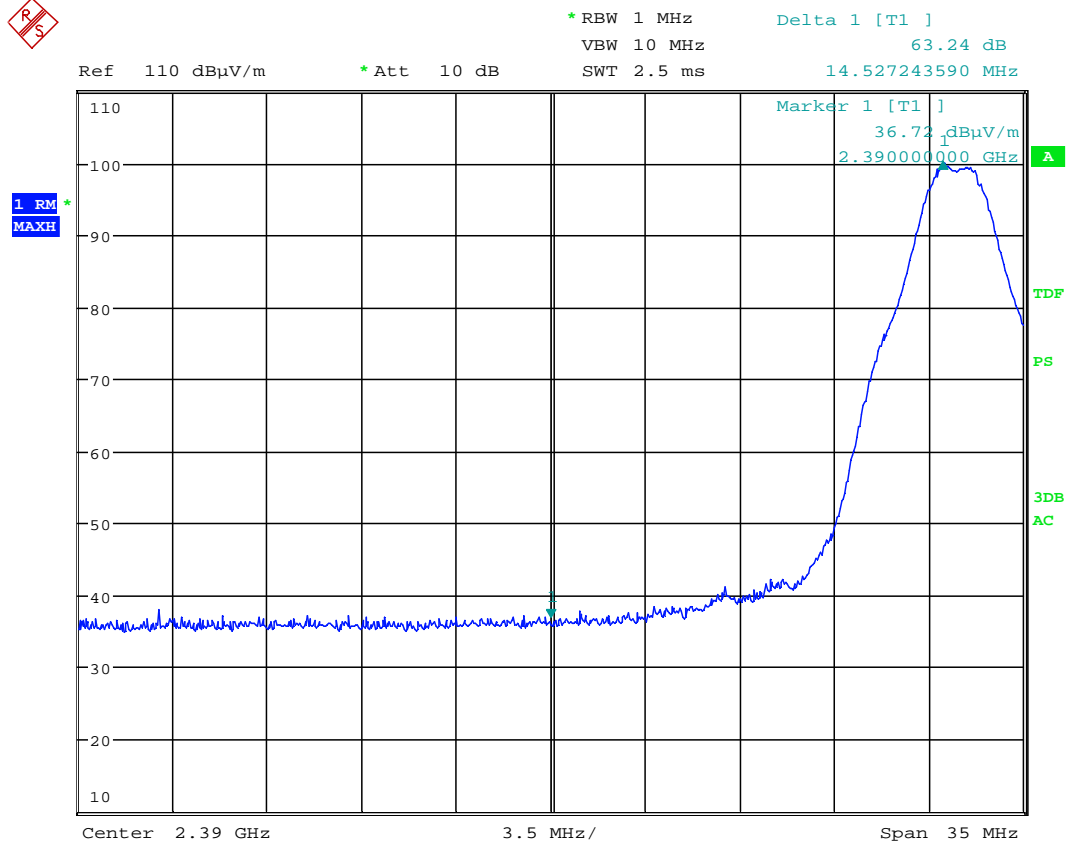
All emissions are more than 20dB below carrier.

See plots.



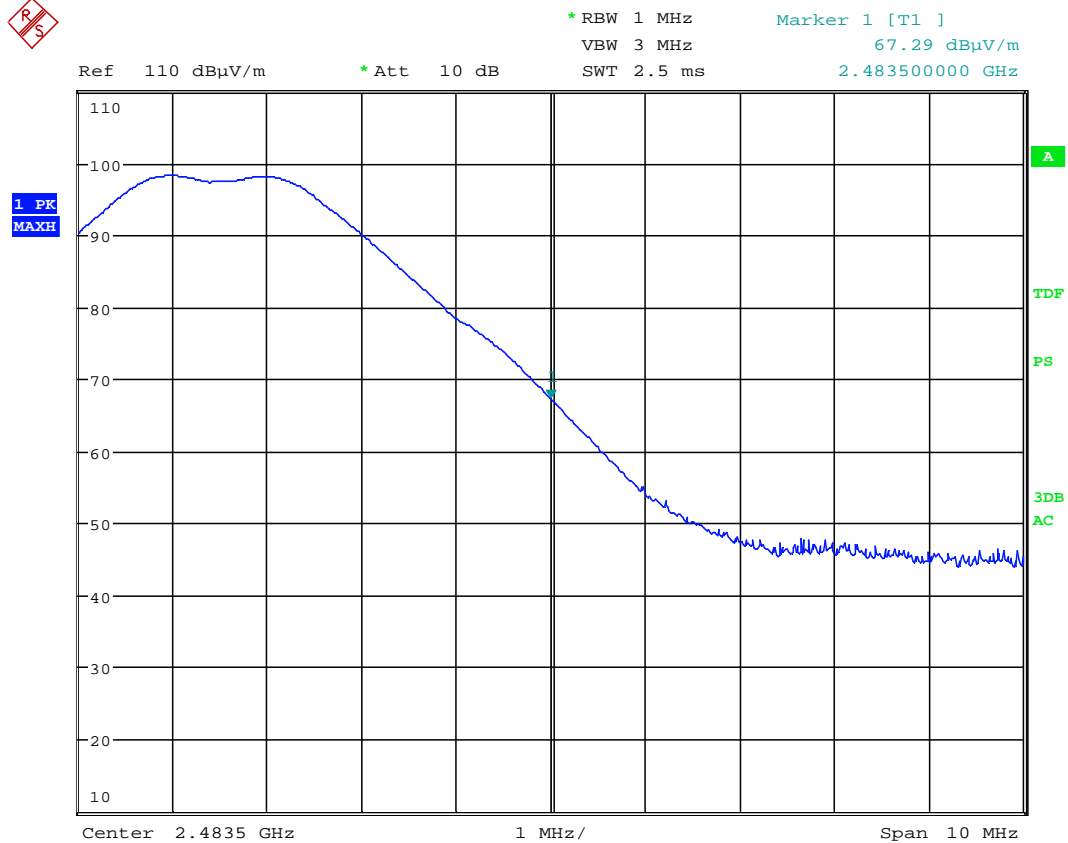
Date: 9.JUL.2013 13:11:04

Band Edge, 2390 MHz, Peak Detector



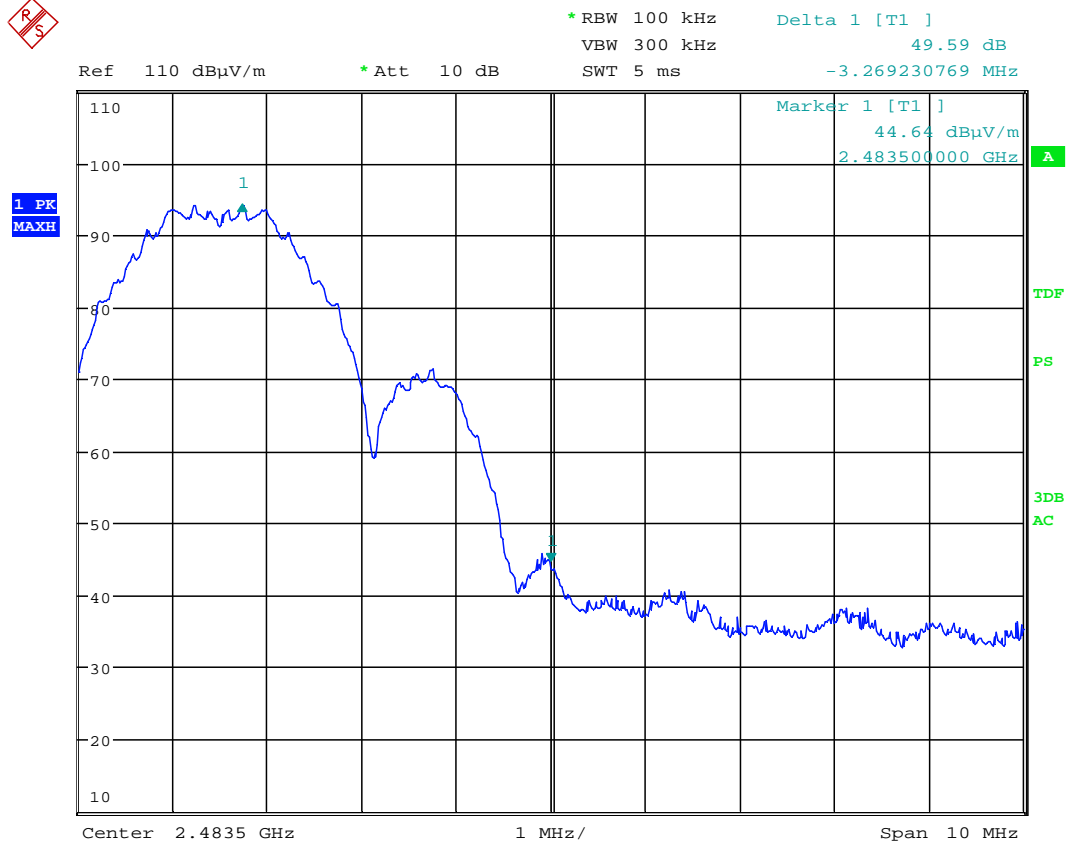
Date: 9.JUL.2013 13:10:42

Band Edge, 2390 MHz, Average Detector



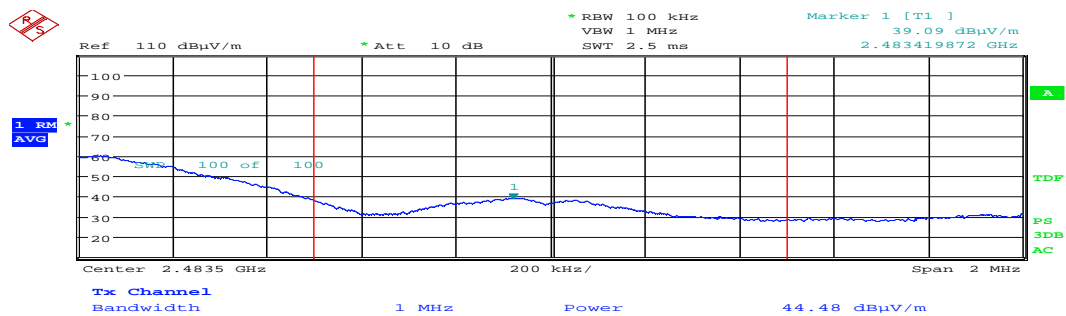
Date: 9.JUL.2013 13:12:48

Band Edge, 2483.5 MHz, Peak Detector



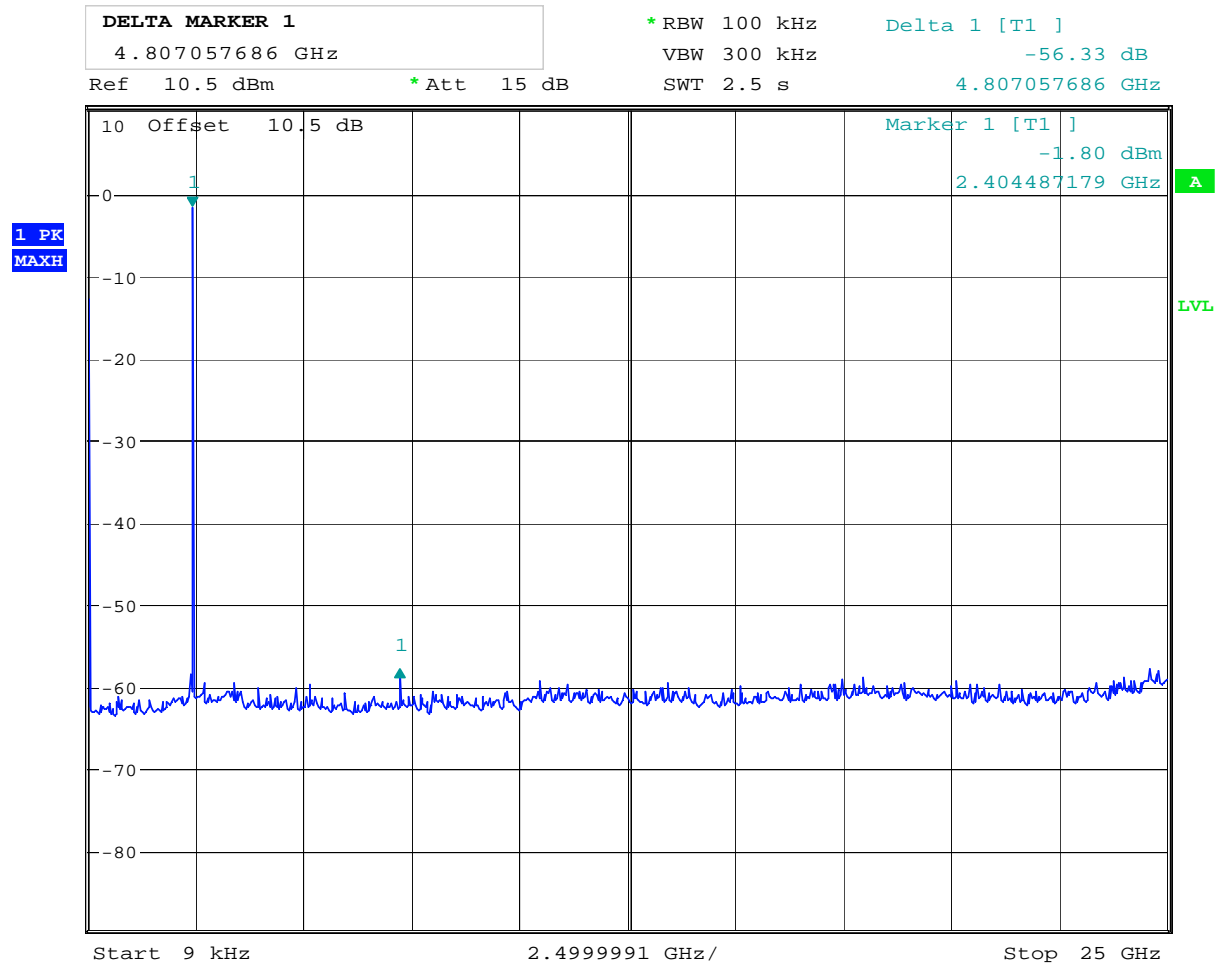
Date: 9.JUL.2013 13:14:11

Prescan at 2.4835GHz



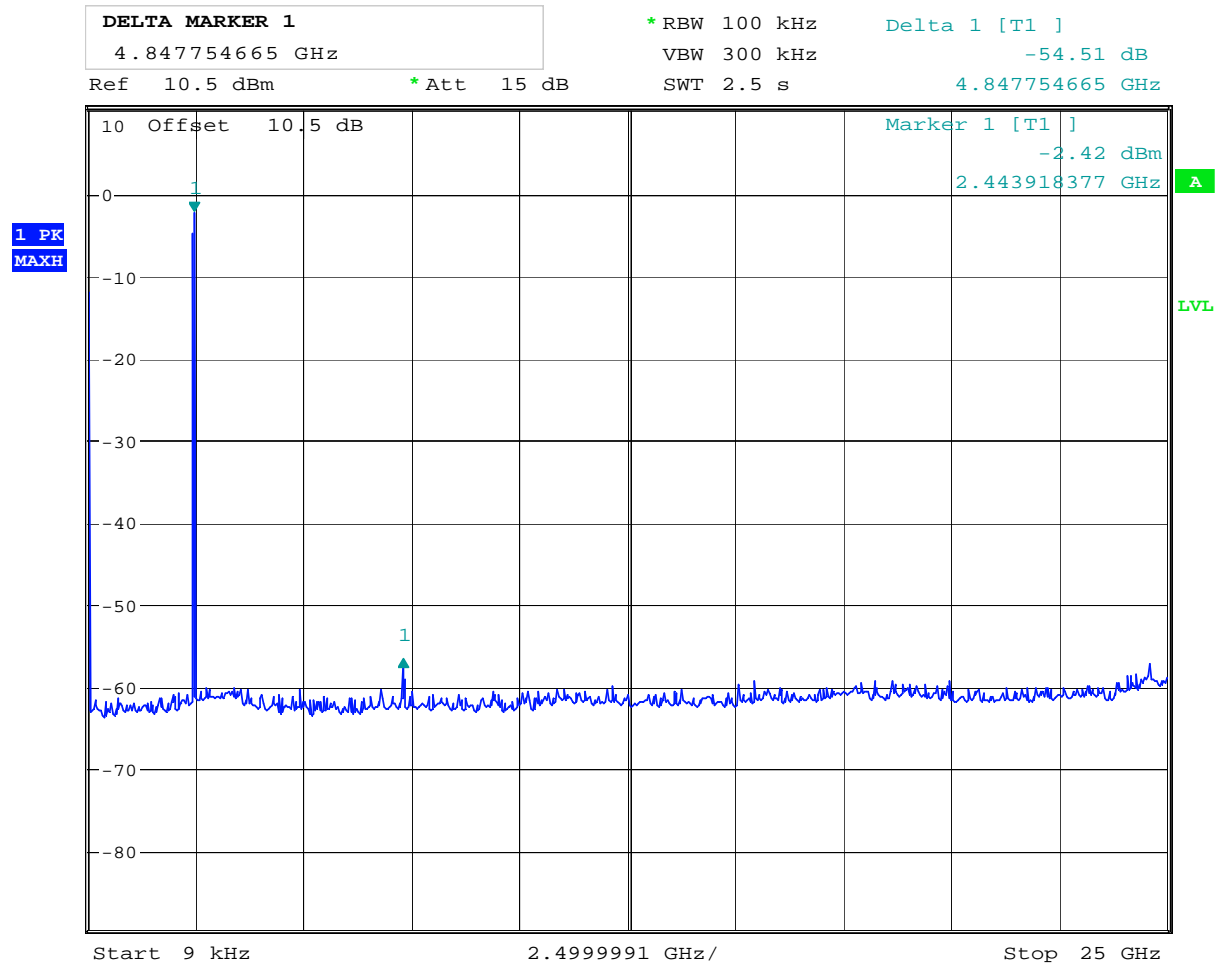
Date: 9.JUL.2013 13:56:49

Band edge power, 2483.5MHz, AV detector



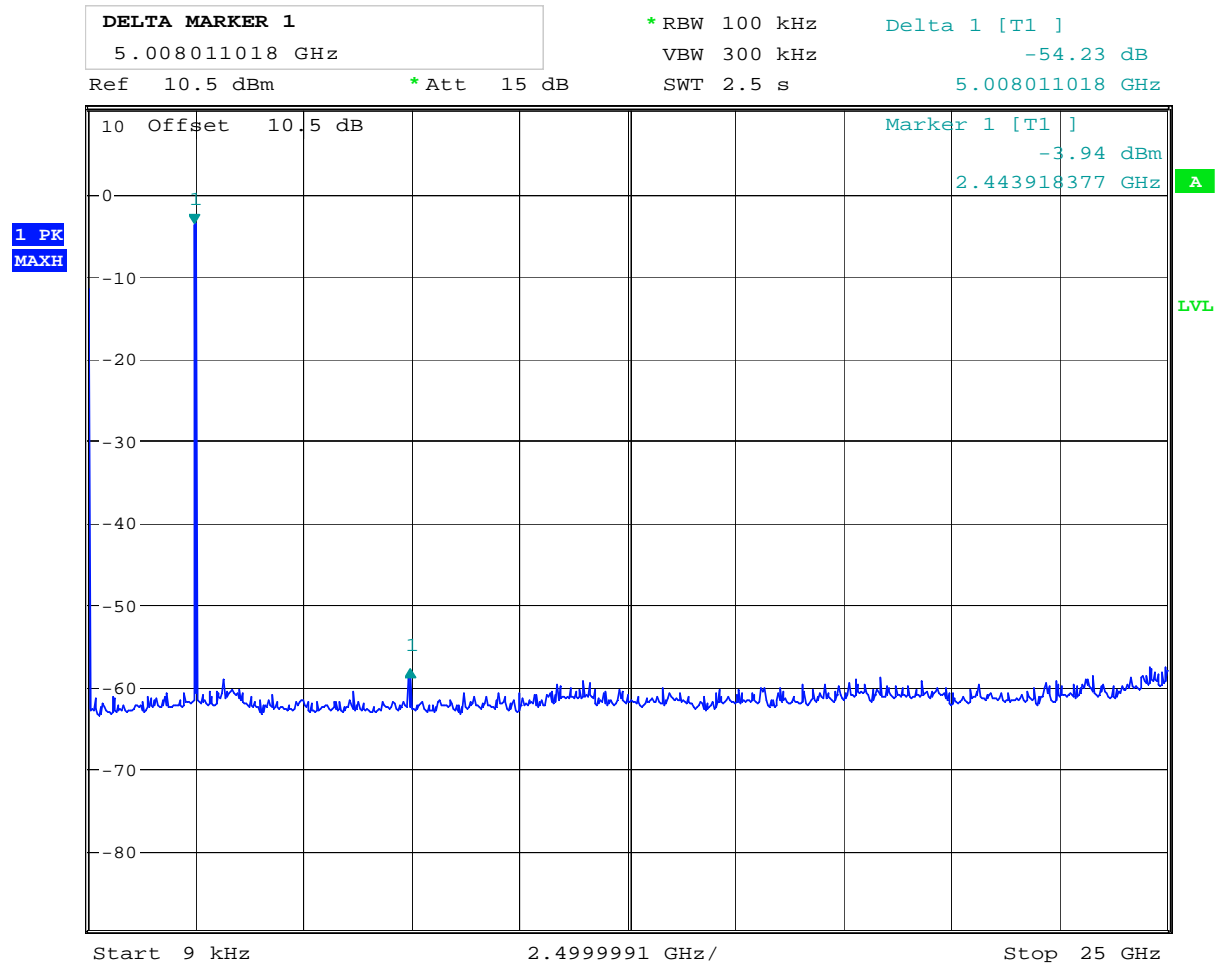
Date: 5.JUL.2013 14:09:57

Conducted spurious emission 9kHz – 25GHz - ch2405MHz



Date: 5.JUL.2013 14:16:51

Conducted spurious emission 9kHz – 25GHz - ch2440MHz



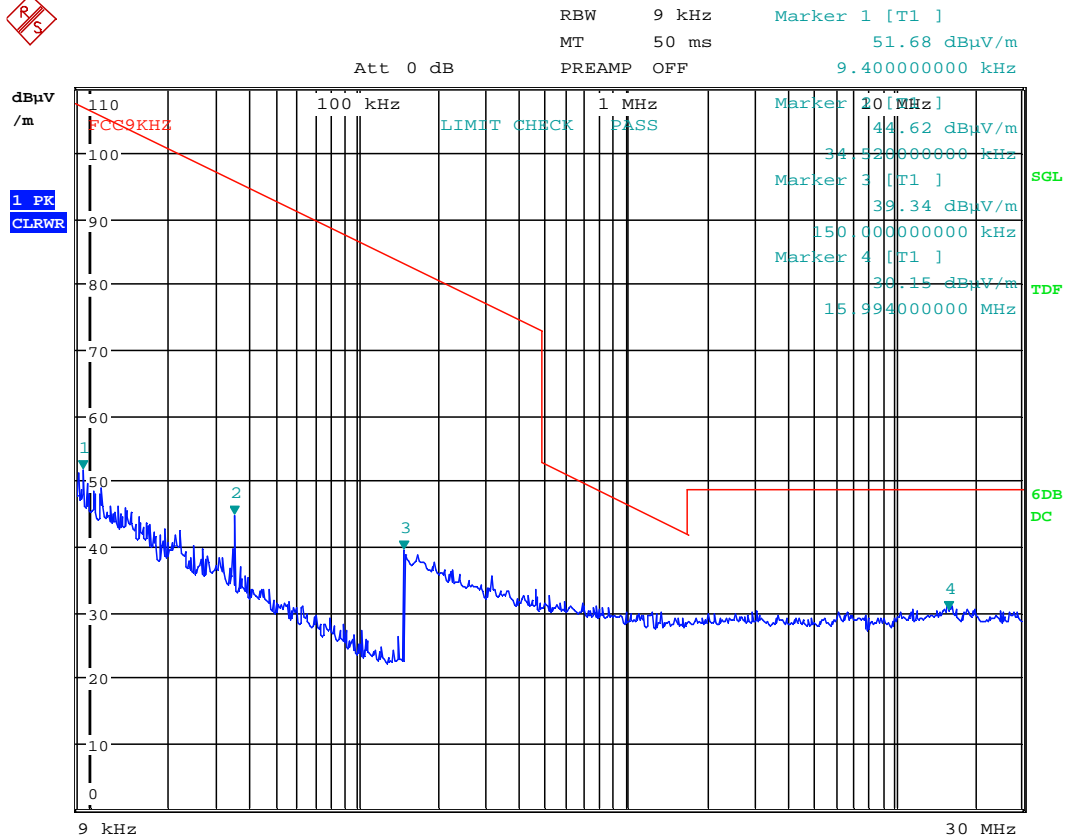
Date: 5.JUL.2013 14:20:37

Conducted spurious emission 9kHz – 25GHz - ch2480MHz

Radiated emissions 9kHz - 30 MHz.

Detector: Quasi-Peak

Measuring distance 10 m.



Date: 9.JUL.2013 15:07:17

Radiated Emissions, 9 kHz – 30 MHz @10m

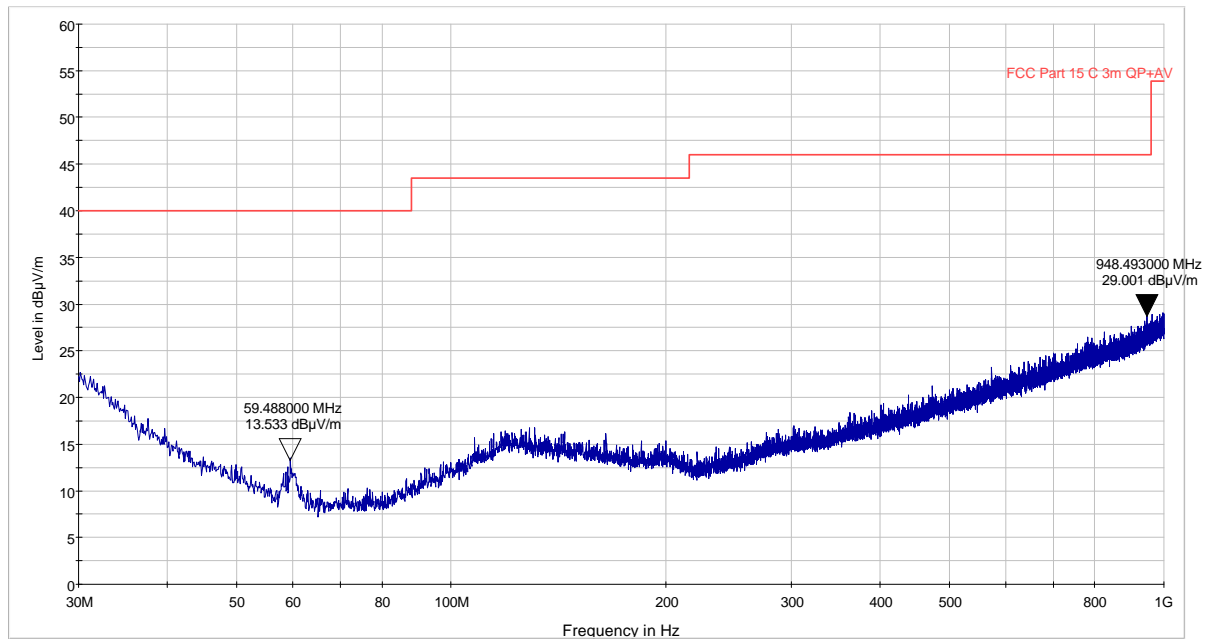
Radiated emission 30 – 1000 MHz.

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.



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

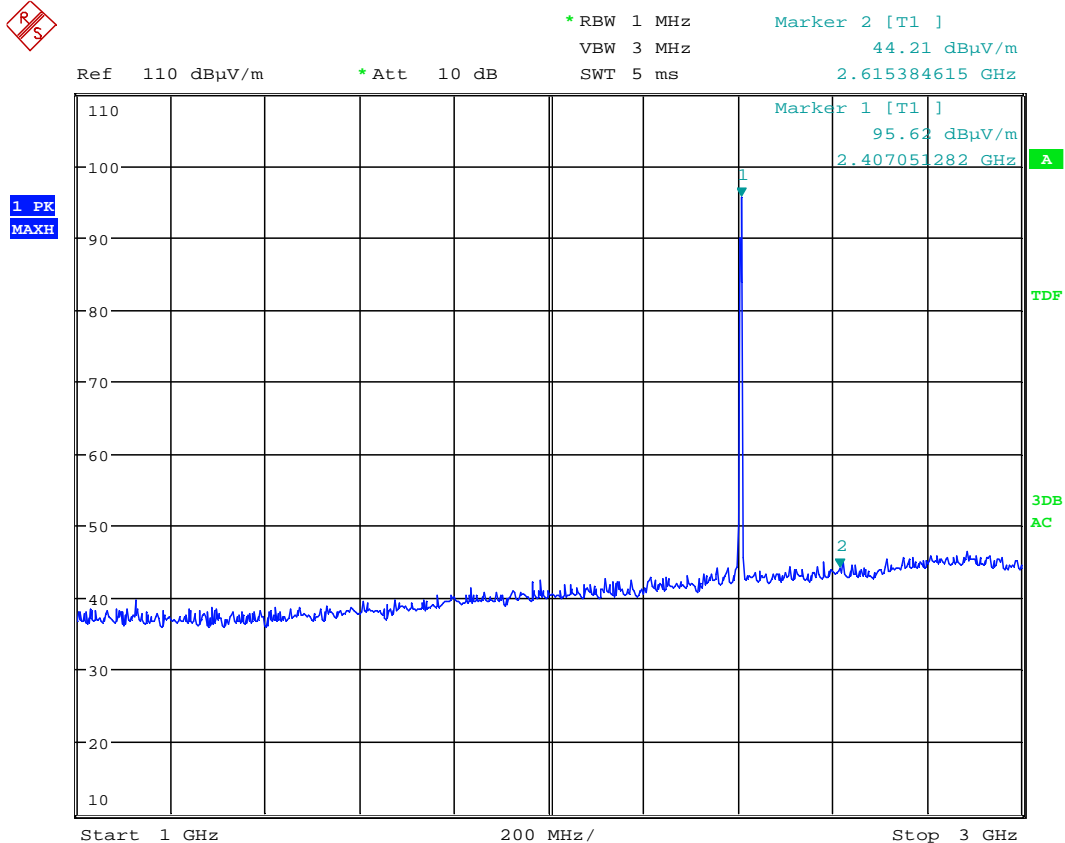
Frequency MHz	Field Strength @3m dB μ V/m	Detector	Limit dB μ V/m	Margin dB
All freqs	None detected	Pk	74	-

Average detector

Frequency MHz	Field Strength @3m dB μ V/m	Detector	Limit dB μ V/m	Margin dB
All freqs	None detected	Av	54	-

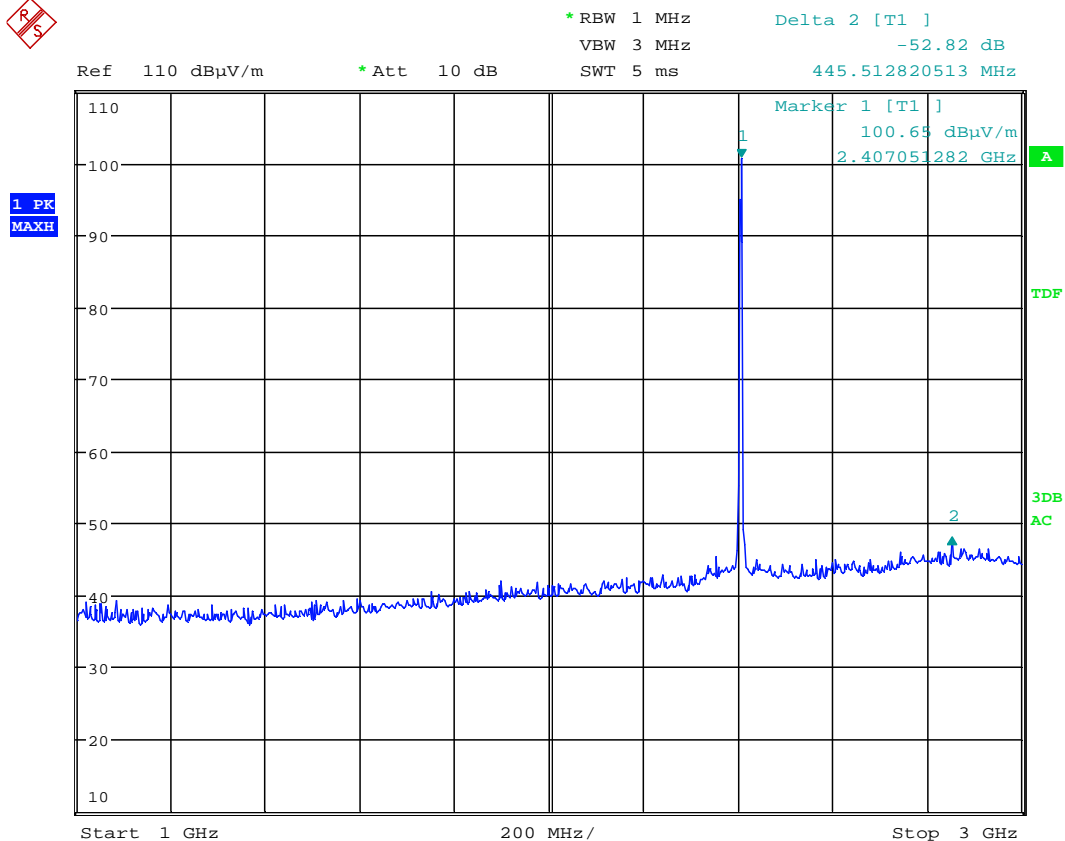
Antenna factor, amplifier gain and cable loss are included in Spectrum Analyzer "Transducer factor".

See attached graphs.



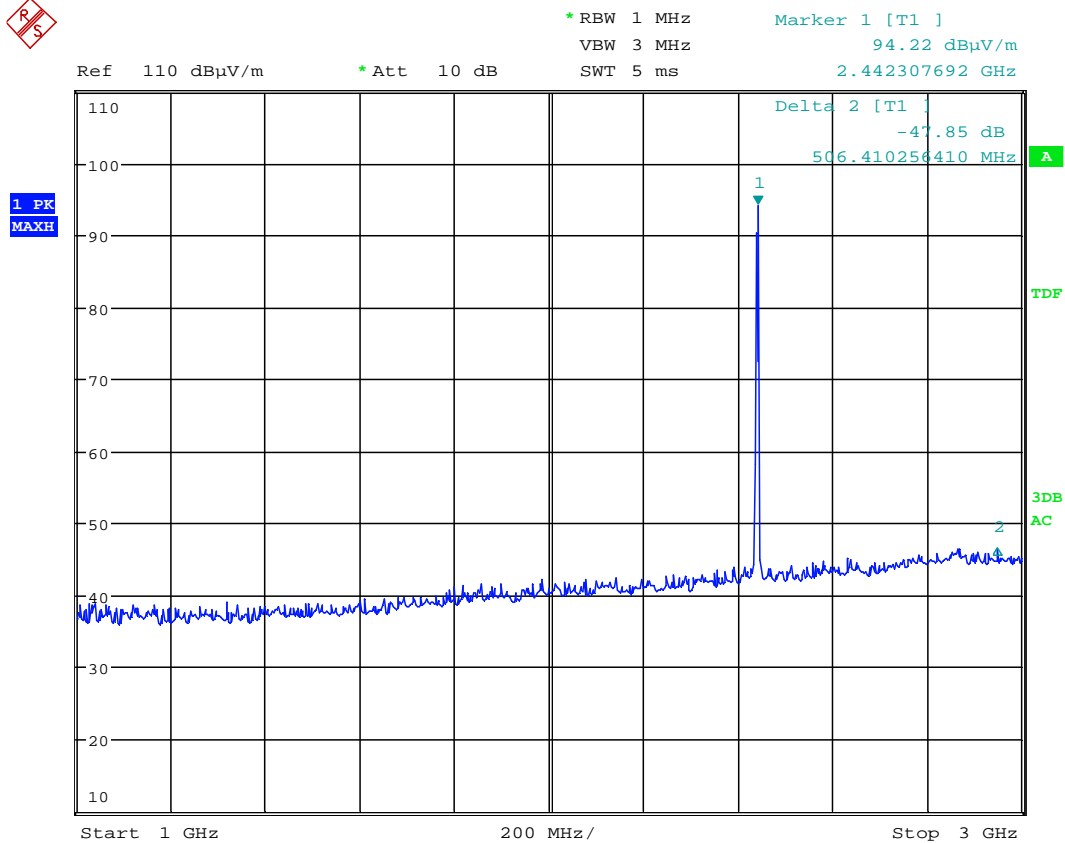
Date: 9.JUL.2013 12:41:41

Radiated Emissions ch. 2405 MHz, 1 – 3 GHz, VP, @3m – Pre-scan with Peak detector



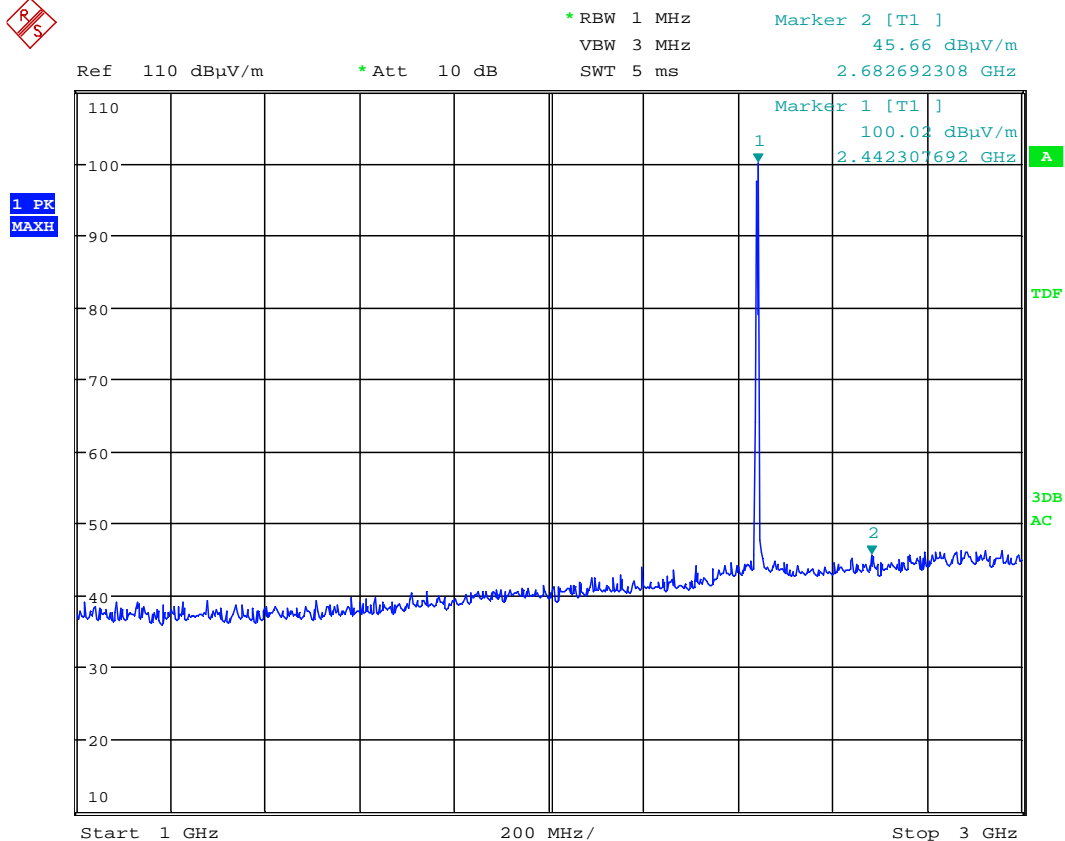
Date: 9.JUL.2013 12:42:54

Radiated Emissions ch. 2405 MHz, 1 – 3 GHz, HP, @3m – Pre-scan with Peak detector



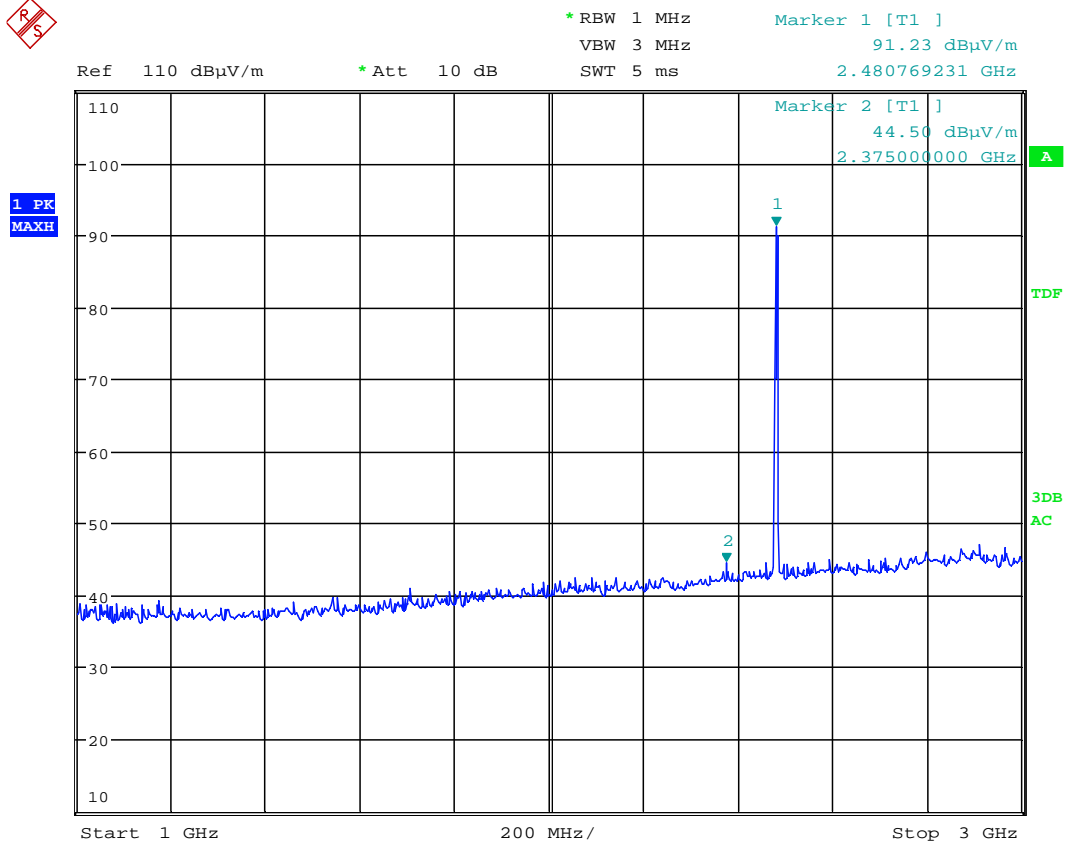
Date: 9.JUL.2013 12:44:14

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



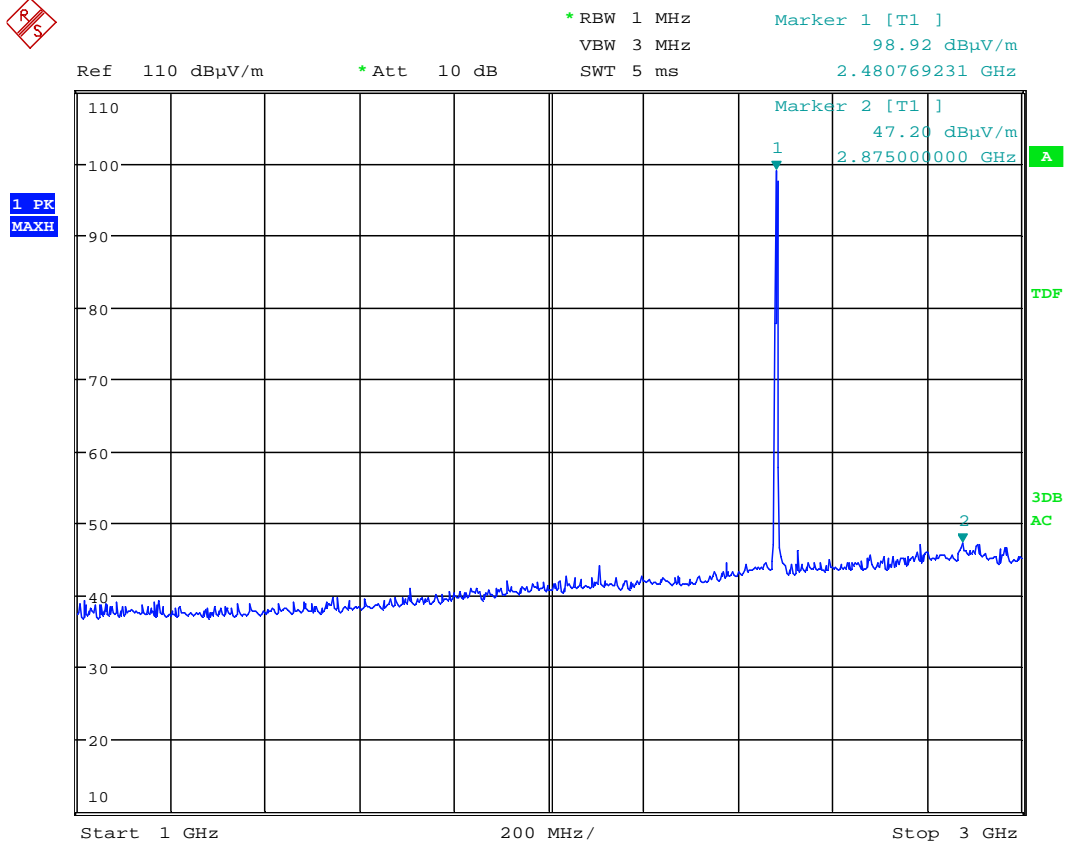
Date: 9.JUL.2013 12:43:47

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



Date: 9.JUL.2013 12:45:12

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



Date: 9.JUL.2013 12:45:35

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

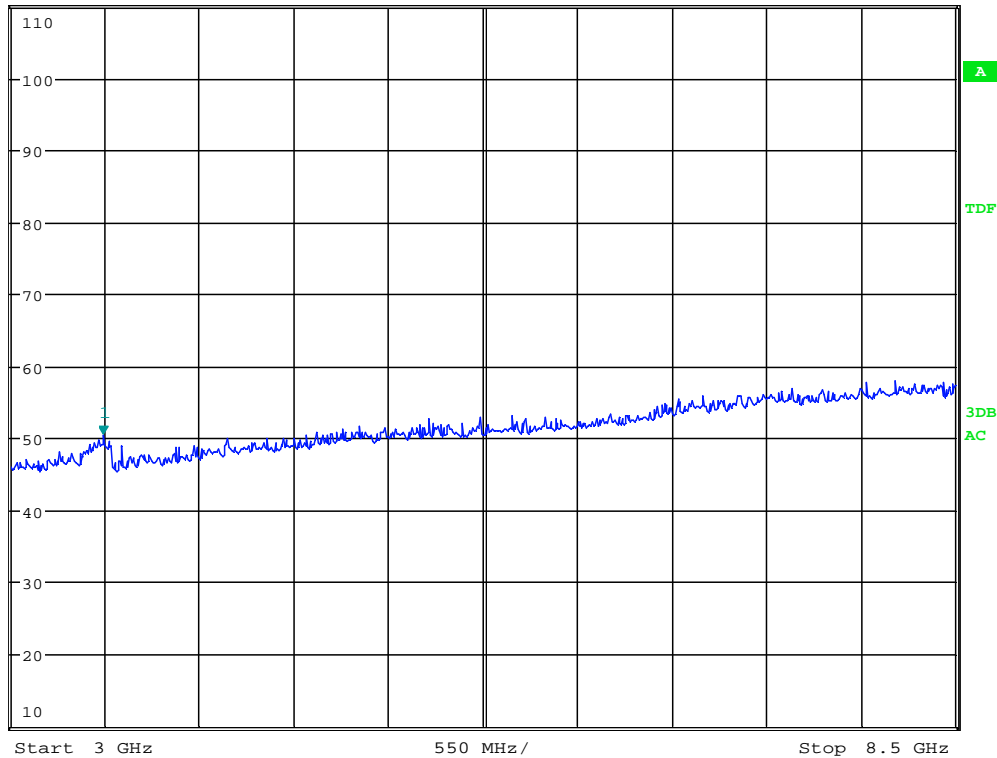


* RBW 1 MHz Marker 1 [T1]
VBW 3 MHz 50.38 dBμV/m
SWT 35 ms 3.537660256 GHz

Ref 110 dBμV/m

* Att 10 dB

1 PK
MAXH



Date: 9.JUL.2013 12:56:22

Radiated Emissions ch. 2405 MHz, 3 – 8.5 GHz, VP, @3m – Pre-scan with Peak detector



* RBW 1 MHz Marker 1 [T1]
VBW 3 MHz 57.80 dBμV/m
SWT 35 ms 8.156250000 GHz

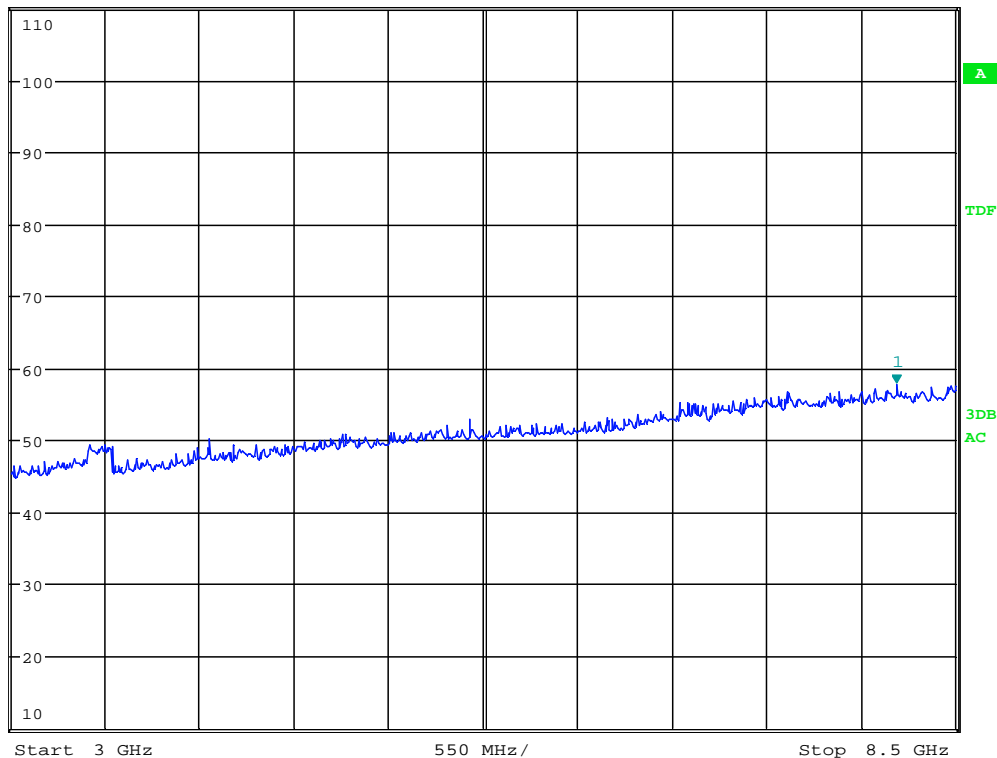
Ref 110 dBμV/m

* Att 10 dB

SWT 35 ms

8.156250000 GHz

1 PK
MAXH



Date: 9.JUL.2013 12:55:12

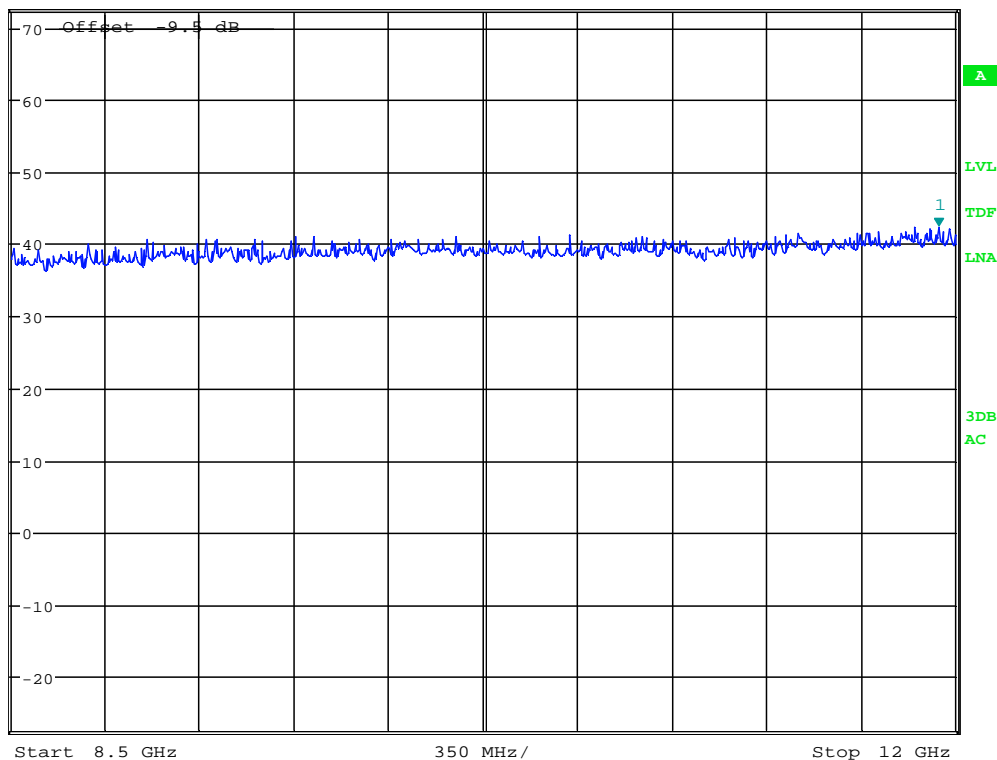
Radiated Emissions ch. 2405 MHz, 3 – 8.5 GHz, HP, @3m – Pre-scan with Peak detector



* RBW 1 MHz Marker 1 [T1]
VBW 3 MHz 42.26 dBµV
SWT 25 ms 11.938301282 GHz

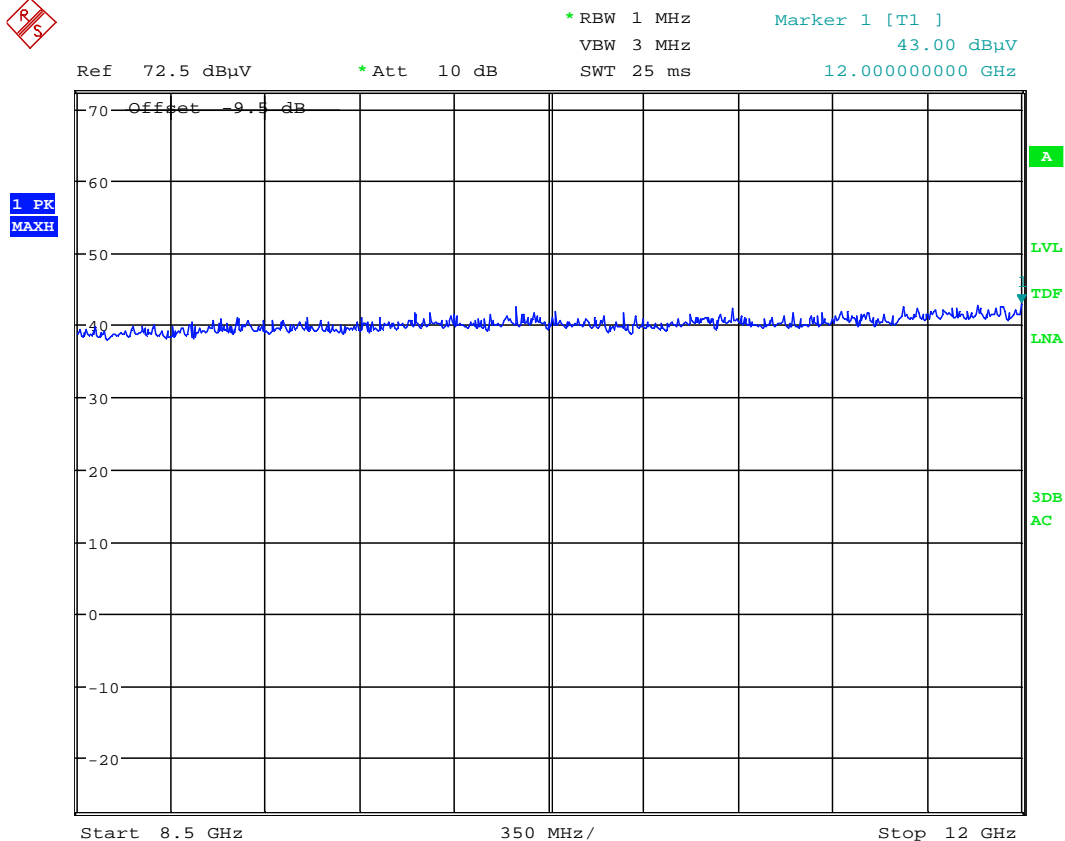
Ref 72.5 dBµV * Att 10 dB

1 PK
MAXH



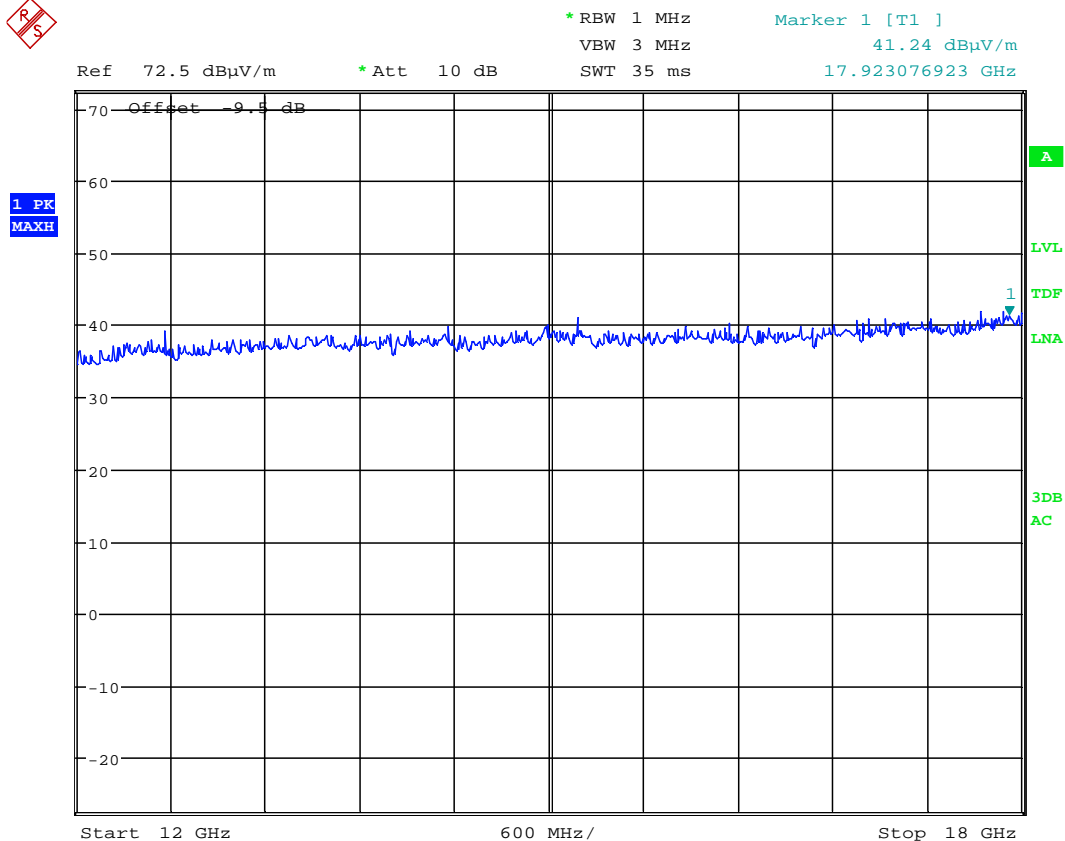
Date: 9.JUL.2013 14:10:06

Radiated Emissions ch. 2405 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: 9.JUL.2013 14:10:45

Radiated Emissions ch. 2405 MHz, 8.5 – 12 GHz, HP, @1m – Pre-scan with Peak detector , Distance Correction factor of -9.5 dB is included in the graph.



Date: 9.JUL.2013 14:42:42

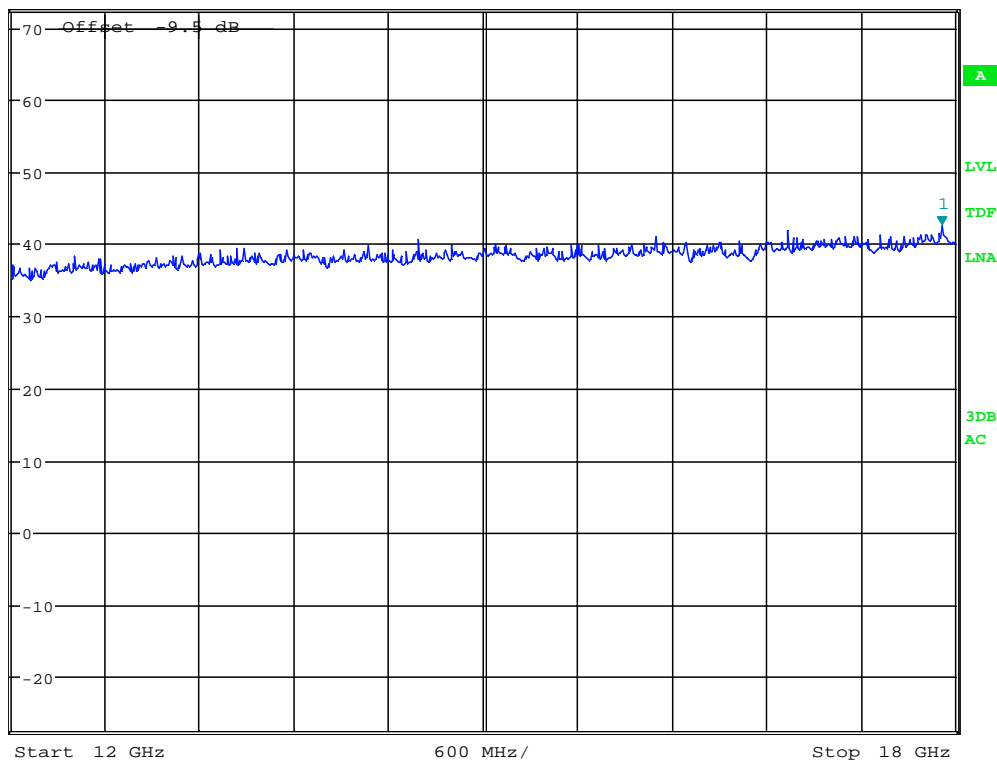
Radiated Emissions ch. 2405 MHz, 12 – 18 GHz, VP, @1m – Pre-scan with Peak detector, Distance Correction factor of -9.5 dB is included in the graph.



* RBW 1 MHz Marker 1 [T1]
VBW 3 MHz 42.60 dBμV/m
SWT 35 ms 17.913461538 GHz

Ref 72.5 dBμV/m * Att 10 dB

1 PK
MAXH



Date: 9.JUL.2013 14:43:18

Radiated Emissions ch. 2405 MHz, 12 – 18 GHz, HP, @1m – Pre-scan with Peak detector, Distance Correction factor of -9.5dB is included in the graph.

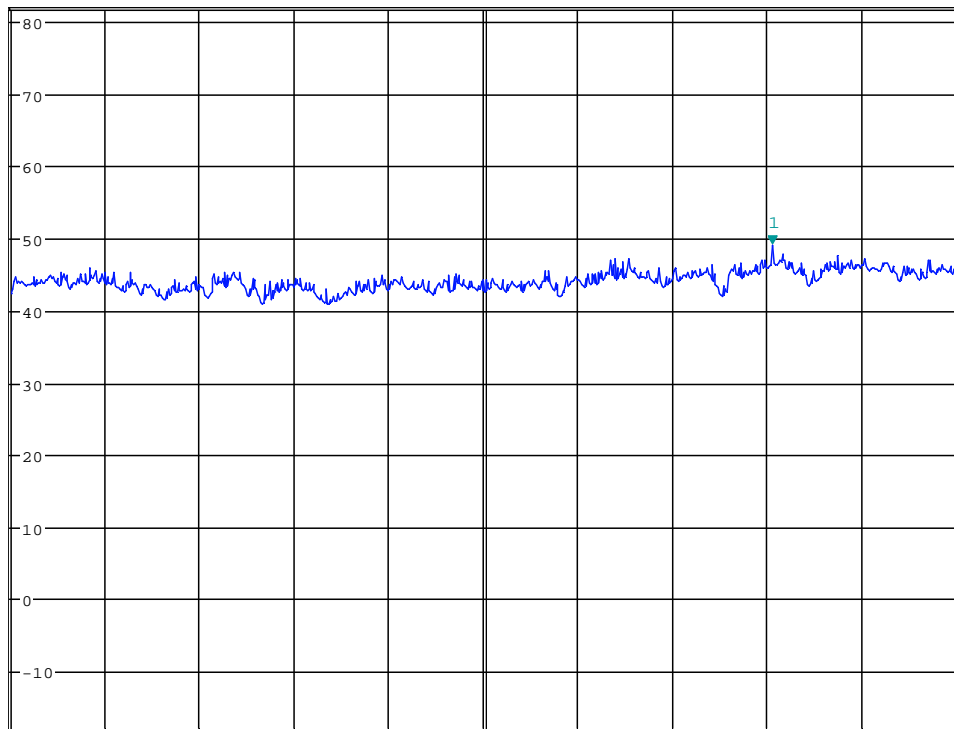


* RBW 1 MHz Marker 1 [T1]
VBW 3 MHz 49.09 dBμV/m
SWT 45 ms 23.642628205 GHz

Ref 82 dBμV/m

* Att 10 dB

1 PK
MAXH



Start 18 GHz

700 MHz/

Stop 25 GHz

Date: 9.JUL.2013 14:45:26

**Radiated Emissions ch. 2405 MHz, 18 – 25 GHz, VP/HP, Pre-scan with Peak detector,
Distance Correction factor -9.5dB is not included in the graph.**

LO leakage emissions detected in receive mode:

Peak detector

Frequency MHz	Channel MHz	Field Strength @3m dB μ V/m	Detector	Limit dB μ V/m	Margin dB
4809	2405	50.31	Pk	74	23.69
4879	2440	50.26	Pk	74	23.74
4900	2480	50.44	Pk	74	23.56

Average detector

Frequency MHz	Channel MHz	Field Strength @3m dB μ V/m	Detector	Limit dB μ V/m	Margin dB
4809	2405	45.24	Av	54	8.76
4879	2440	43.90	Av	54	10.1
4900	2480	43.58	Av	54	10.42

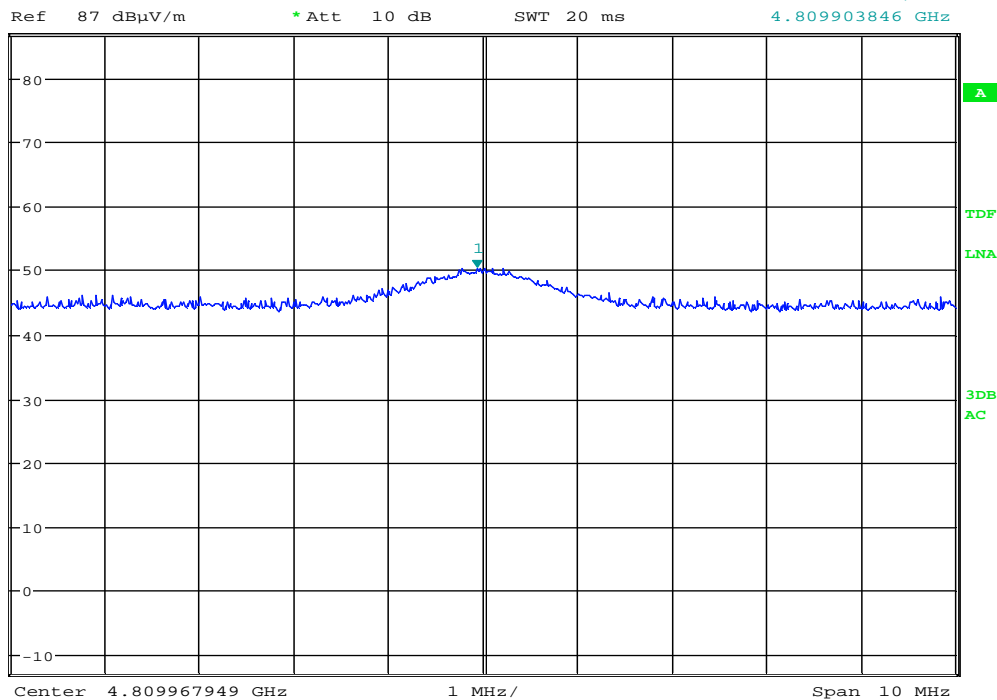
The detected spurious emissions are within the restricted band (4.5 - 5.15 GHz).

The maximum is detected in Horizontal polarization.

See attached graphs.



* RBW 1 MHz
VBW 3 MHz
SWT 20 ms
Marker 1 [T1]
50.31 dBμV/m
4.809903846 GHz

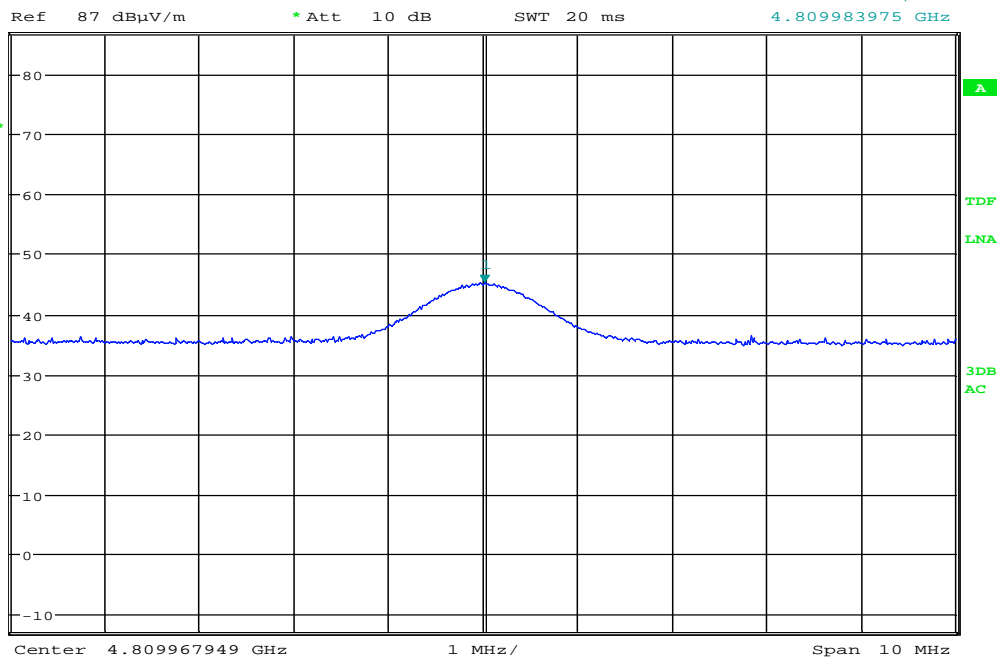


Date: 11.JUL.2013 14:04:43

LO leakage at ch 2405MHz – VP : PK detector

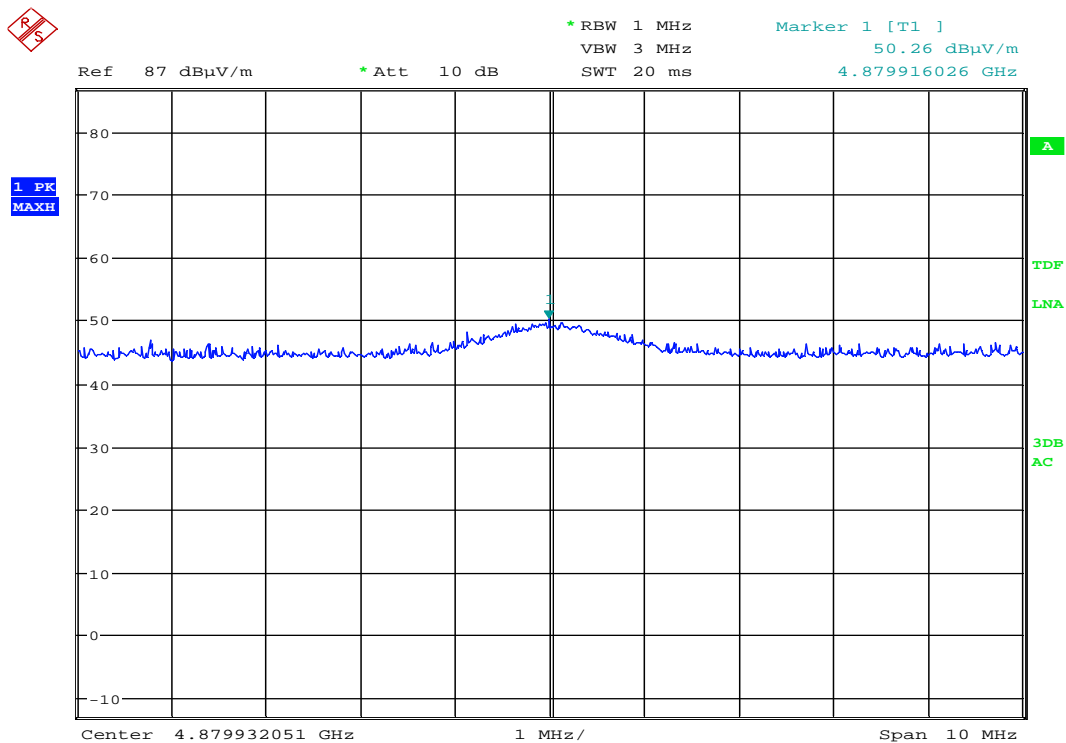


* RBW 1 MHz
VBW 10 MHz
SWT 20 ms
Marker 1 [T1]
45.24 dBμV/m
4.809983975 GHz



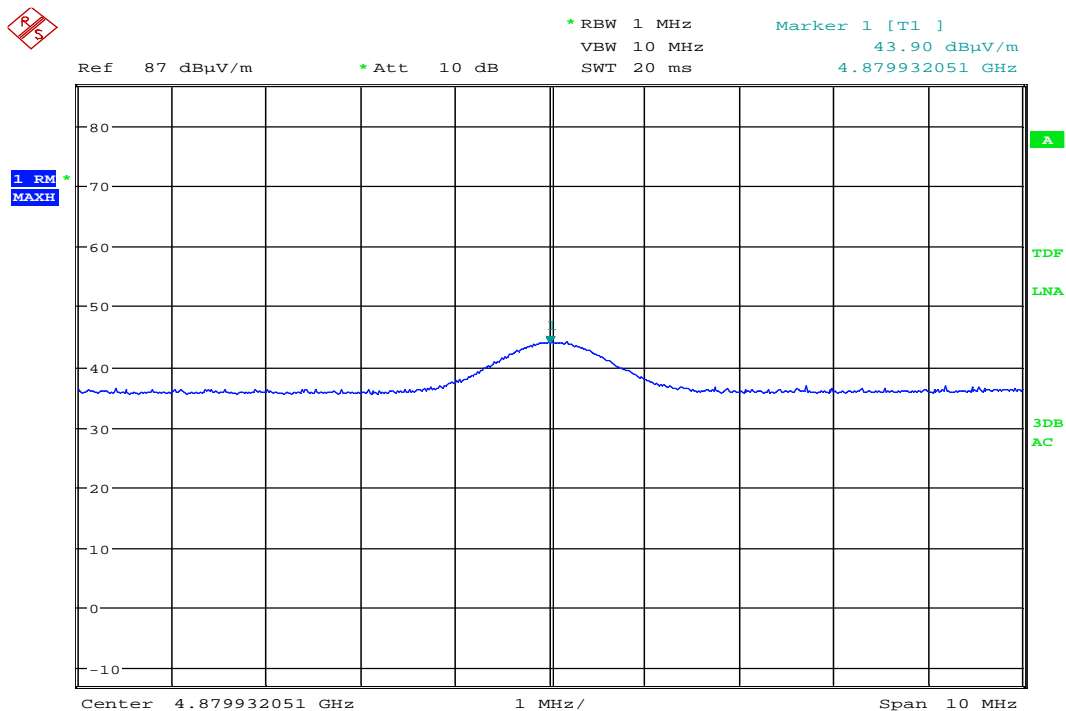
Date: 11.JUL.2013 14:05:02

LO leakage at ch 2405MHz – VP : AV detector



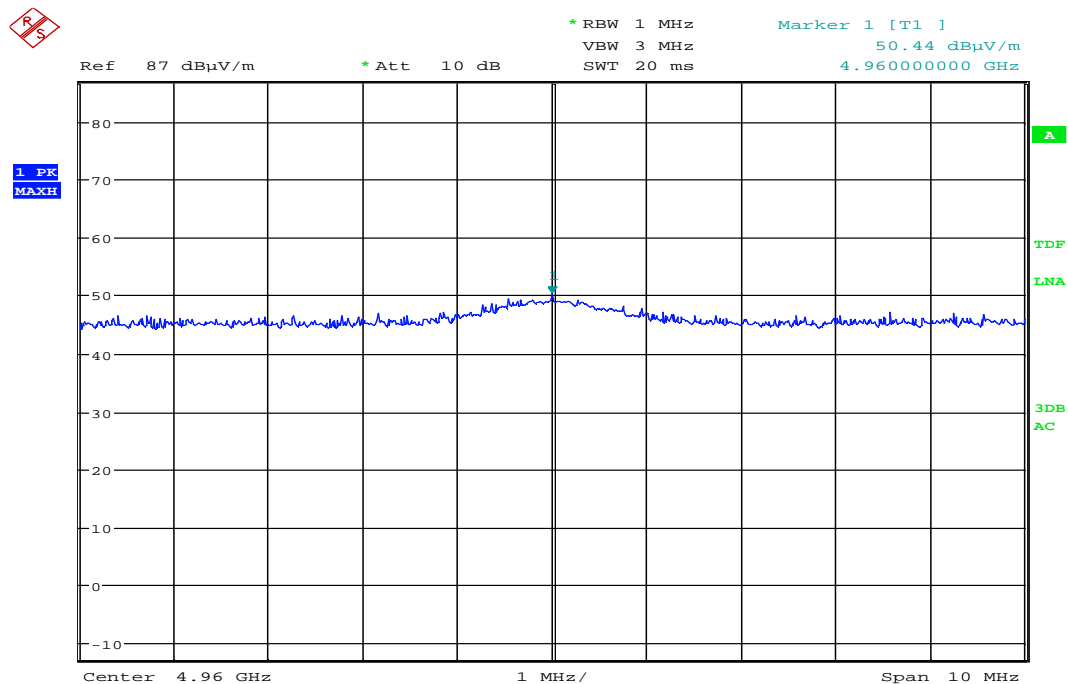
Date: 11.JUL.2013 14:06:48

LO leakage at ch 2440MHz – VP : PK detector



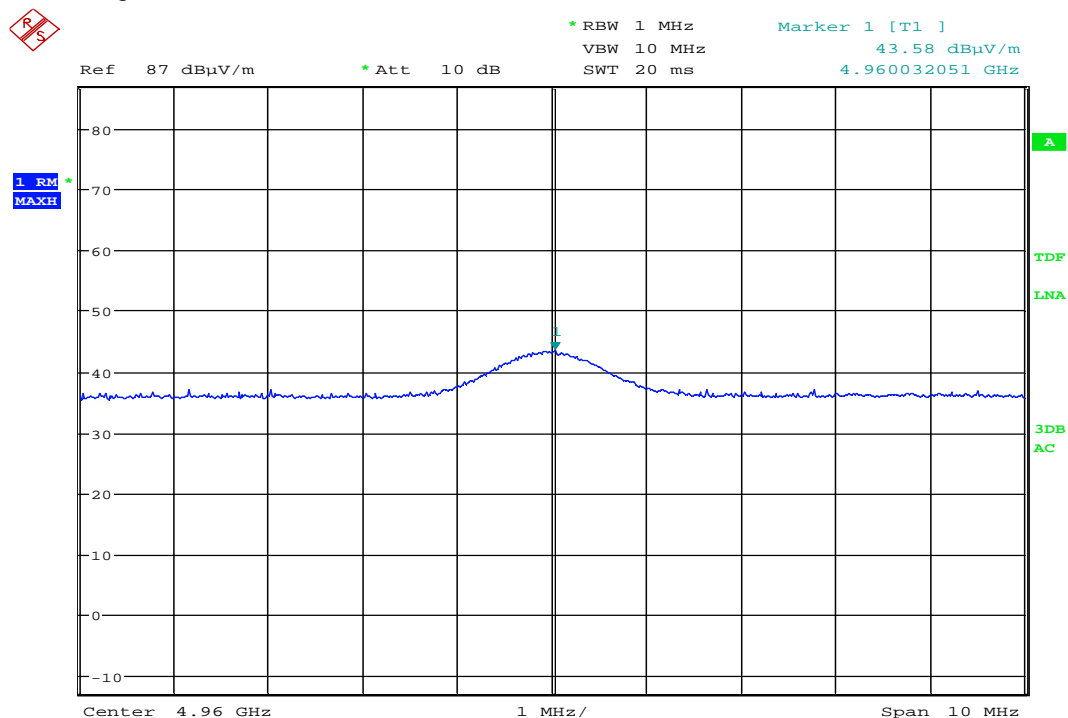
Date: 11.JUL.2013 14:06:24

LO leakage at ch 2440MHz – VP : AV detector



Date: 11.JUL.2013 14:07:51

LO leakage at ch 2480MHz – VP : PK detector



Date: 11.JUL.2013 14:08:07

LO leakage at ch 2480MHz – VP : AV detector

3.6 Power Spectral Density (PSD)

Para. No.: 15.247 (e)

Test Performed By: G.Suwanthakumar

Date of Test: 05 July 2013

Test Results: Complies

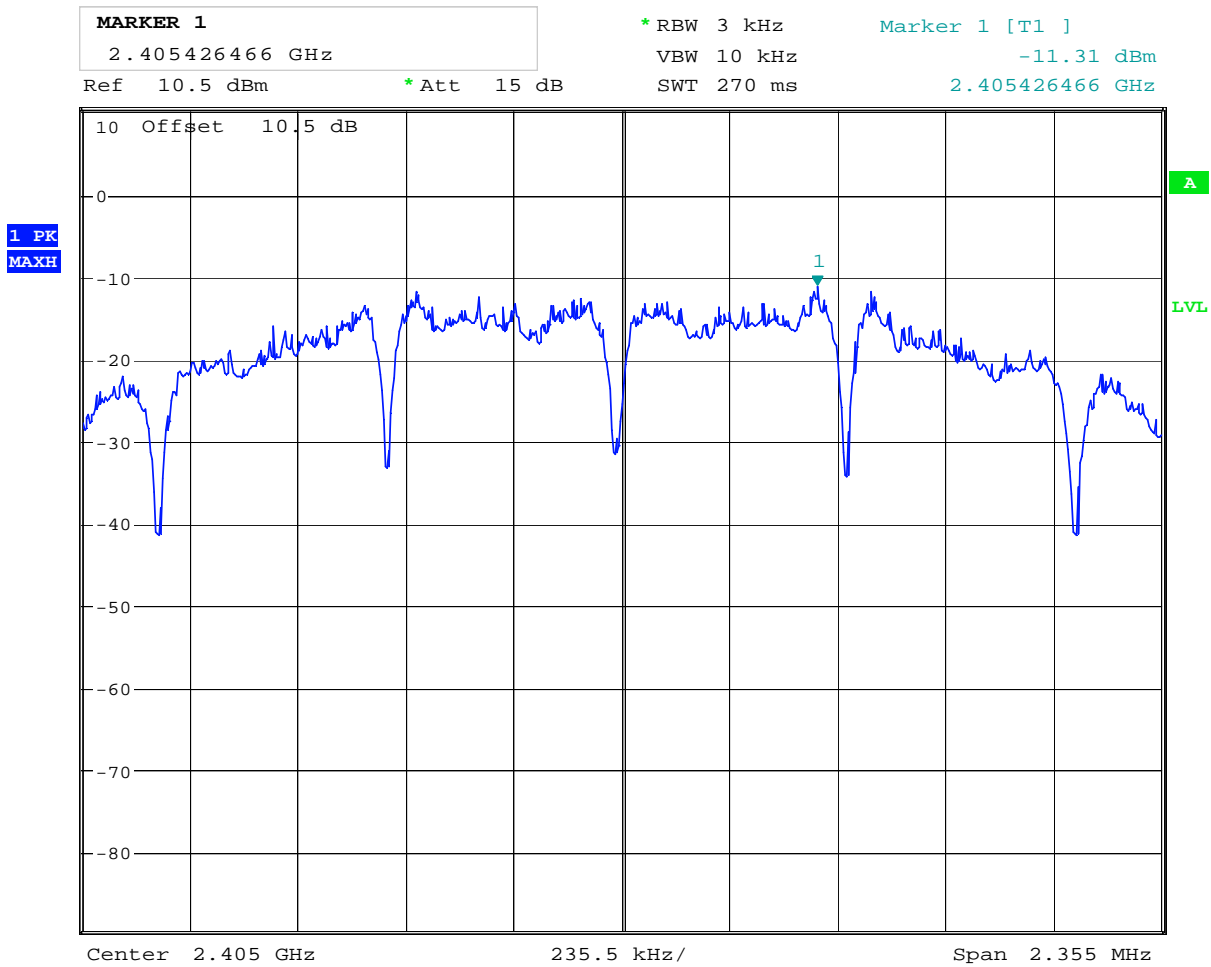
Measured and Calculated Data:

	calculated peak PSD dBm
Power Spectral Density @2405 MHz	-11.31
Power Spectral Density @2440 MHz	-11.73
Power Spectral Density @2480 MHz	-12.75

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

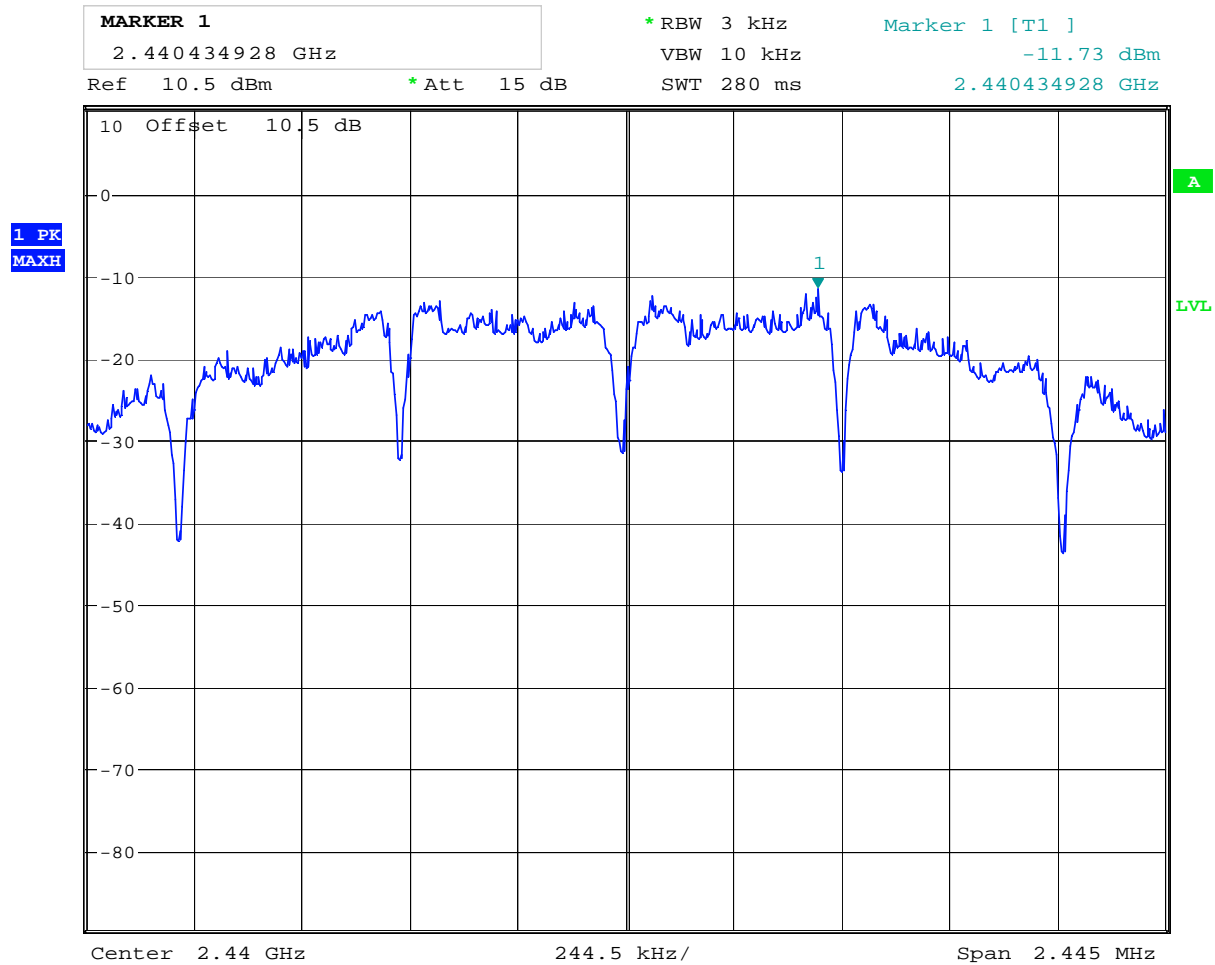
Requirements:

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



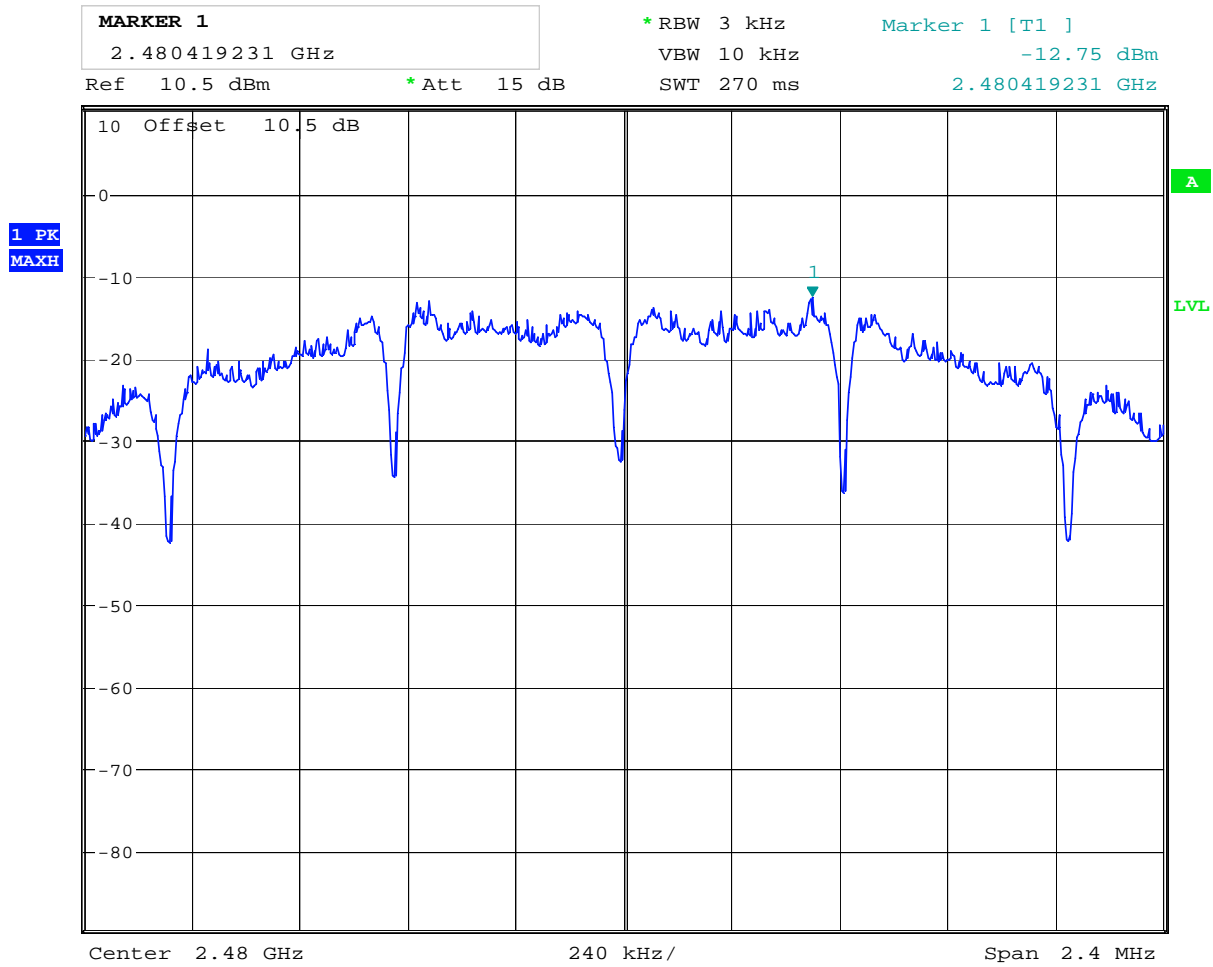
Date: 5.JUL.2013 14:12:17

PSD Measurement - 2405MHz



Date: 5.JUL.2013 14:16:12

PSD Measurement – 2440MHz



Date: 5.JUL.2013 14:22:56

PSD Measurement - 2480MHz

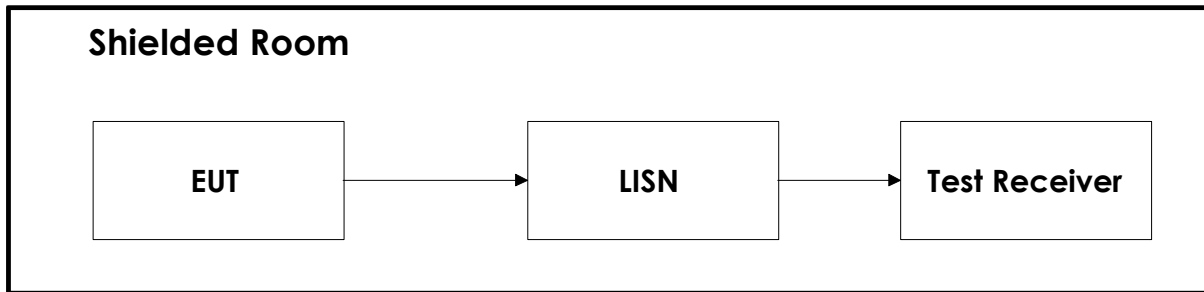
4 LIST OF TEST EQUIPMENT

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	2011.11.03	2013.11.03
2	ESU40	EMI Receiver	Rohde & Schwarz	LR1639	2013.06	2014.06
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

5 BLOCK DIAGRAM

5.1 Power Line Conducted Emission



5.2 Test Site Radiated Emission

