Test report no. : 215172-3

Item tested : CC2541SensorTag

Type of equipment : 2.4 GHz Transceiver

FCC ID : ZAT2541SENSOR

Industry Canada ID : 451H-2541SENSOR

Client : Texas Instruments Norway AS

FCC Part 15.247
Digital Transmission System

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

25 October 2012

Authorized by : .....
Jon Fredrik Mo
Technical Verificator

CONTENTS

1 GENERAL INFORMATION

1.1 Testhouse Info

Name :	Nemko AS
Address :	Nemko Kjeller Instituttveien 6, Box 96 NO-2027 Kjeller, NORWAY
Telephone :	+47 64 84 57 00
Fax :	+47 64 84 57 05
E-mail:	comlab@nemko.com
FCC test firm :	994405
IC OATS :	2040D-1
Total Number of Pages:	48

1.2 Client Information

Name :	Texas Instruments Norway AS
Address :	Gaustadalléen 21, NO-0349 Oslo, Norway
Telephone :	+47 22 95 85 44
Fax :	+47 22 95 85 46

Contact:

Name :	Dag Grini
Telephone :	+47 22 95 83 01
E-mail :	d.grini@ti.com

1.3 Manufacturer (if other than client)

Same as client.

2 Test Information

2.1 Test Item

Name :	Texas Instruments
FCC ID :	ZAT2541SENSOR
Industry Canada ID :	451H-2541SENSOR
Model/version :	CC2541SensorTag
Serial number :	-
Hardware identity and/or version:	1.1
Software identity and/or version :	SensorTag_RC1 (rev1.0)
Frequency Range :	2402 – 2480 MHz
Number of Channels :	40
Type of Modulation :	Digital (GFSK)
User Frequency Adjustment :	None
Conducted Output Power :	0.001 Watt
Type of Power Supply :	Primary Batteries (one CR2032 coin cell battery)*
Antenna Connector :	None – integral antenna
Number of Antennas :	1
Antenna Diversity Supported :	No
Desktop Charger :	N/A

*All tests were performed with two AAA LR03 Alkaline batteries

Theory of Operation

The EUT is a Bluetooth low energy (BLE) development board.

Exposure Evaluation

The EUT is a mobile device intended to be used more than 20cm from any persons.

Test Environment

2.1.1 Normal test condition

Temperature:	20 - 21 °C
Relative humidity:	24 - 42 %
Normal test voltage:	3.0 V DC (2xAAA Batteries)

All radiated tests were performed with fresh batteries.

The values are the limit registered during the test period.

2.2 Test Period

Item received date: 2012-08-28

Test period : from 2012-09-03 to 2012-10-25

2.3 Test Engineer(s)

Jan Gunnar Eriksen

2.4 Test Equipment

See list of test equipment in clause 6.

3 TEST REPORT SUMMARY

3.1 General

Manufacturer: Texas Instruments Norway AS

Model No.: CC2541SensorTag

All measurements are tracable to national standards.

The tests were conducted for the purpose of demonstrating compliance with FCC CFR 47 Part 15, paragraph 15.247 and Industry Canada RSS-210 Issue 8.

All tests were conducted in accordance with ANSI C63.4-2003 and KDB 558074 D01 DTS Measurement Guidance v01.

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".

TEST REPORT #: 215172-3

TESTED BY: _____ **DATE: 25 October 2012**

Jan Gunnar Eriksen, Test engineer

3.2 Test Summary

Name of test	FCC Part 15 reference	RSS-210 Issue 8 reference	Result
Supply Voltage Variations	15.31(e)	8 (RSS-GEN)	N/A[1]
Antenna Requirement	15.203	7.1.4 (RSS-GEN)	Complies
Power Line Conducted Emission	15.107(a) 15.207(a)	7.2.2 (RSS-GEN)	N/A[1]
Occupied Bandwidth	N/A	A8.1	No requirement
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

[1] The tested equipment is battery operated only.

3.3 Description of modification for Modification Filing

Not applicable.

3.4 Comments

The EUT was rotated in 3 planes for the radiated emissions and radiated outpurt power tests.

3.5 Family List Rational

Not Applicable.

4 TEST RESULTS

4.1 Occupied Bandwidth

Para. No.: 15.247 (a)(1)(iii)

Test Performed By: Jan G Eriksen	**Date of Test: 25 Oct 2012**

Test Results: Complies

Measurement Data: 40 RF channels in use

	Occupied Bandwidth (kHz)
2440 MHz	1093.75

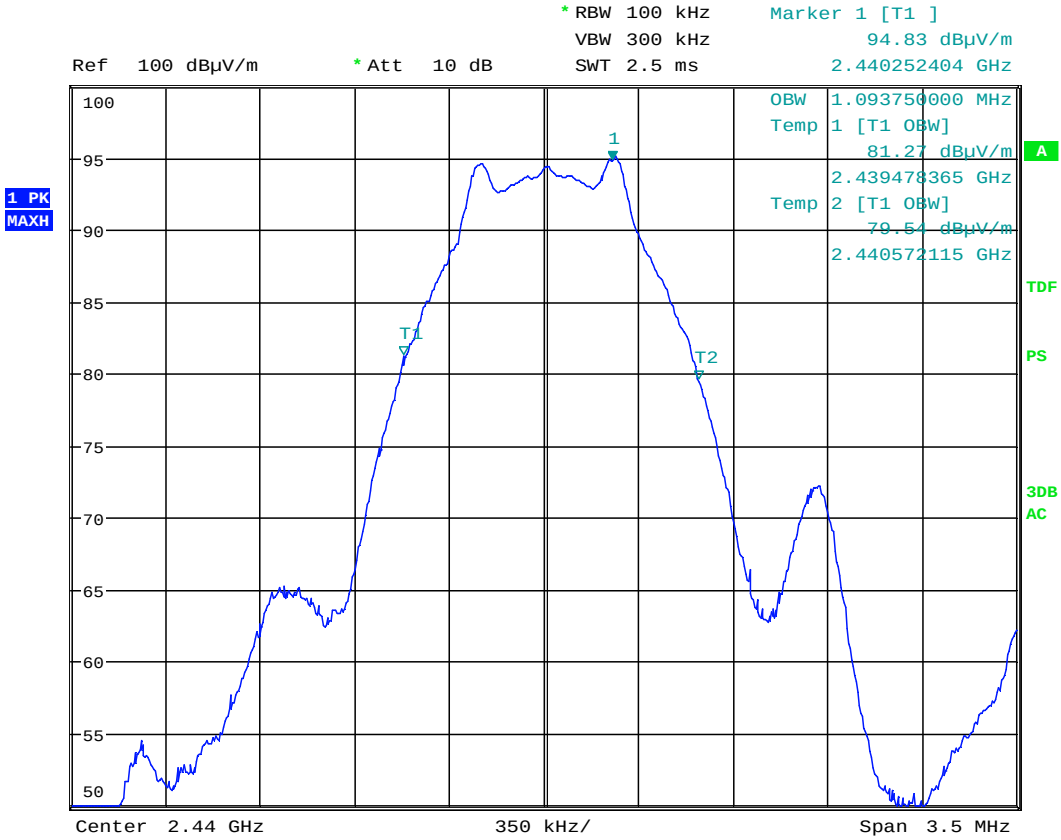
Occupied Bandwith is reported for information only.

See attached graph.

Requirements:

No requirements for Digital Transmission Systems.

Occupied Bandwidth, 2440 MHz



Date: 25.OCT.2012 07:44:18

4.2 Minimum 6 dB Bandwidth

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

Test Performed By: Jan G Eriksen	**Date of Test: 25 Oct 2012**

Test Results: Complies

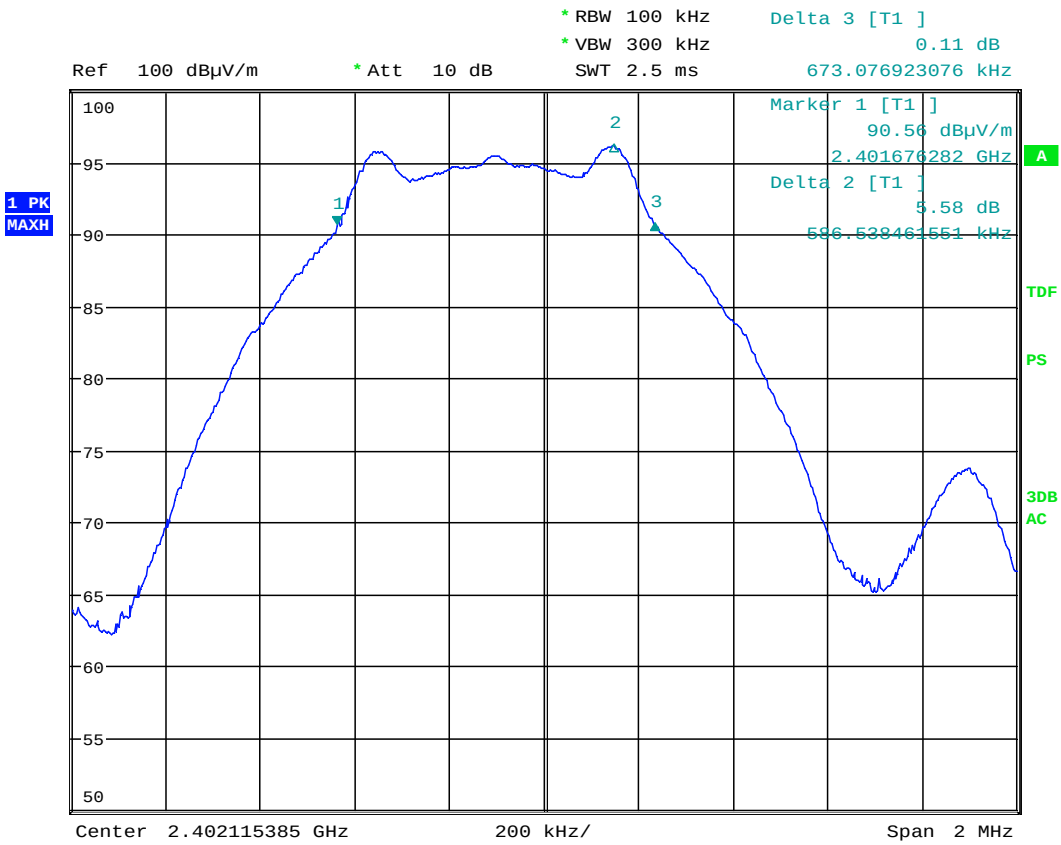
Measurement Data:

	Measured 6 dB Bandwidth (kHz)
Ch 01, 2402 MHz	673.1
Ch 19, 2440 MHz	679.5
Ch 40, 2480 MHz	666.7

Power supply variation within 85 % to 115% of nominal value has no influence on measured value.

Requirements:

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



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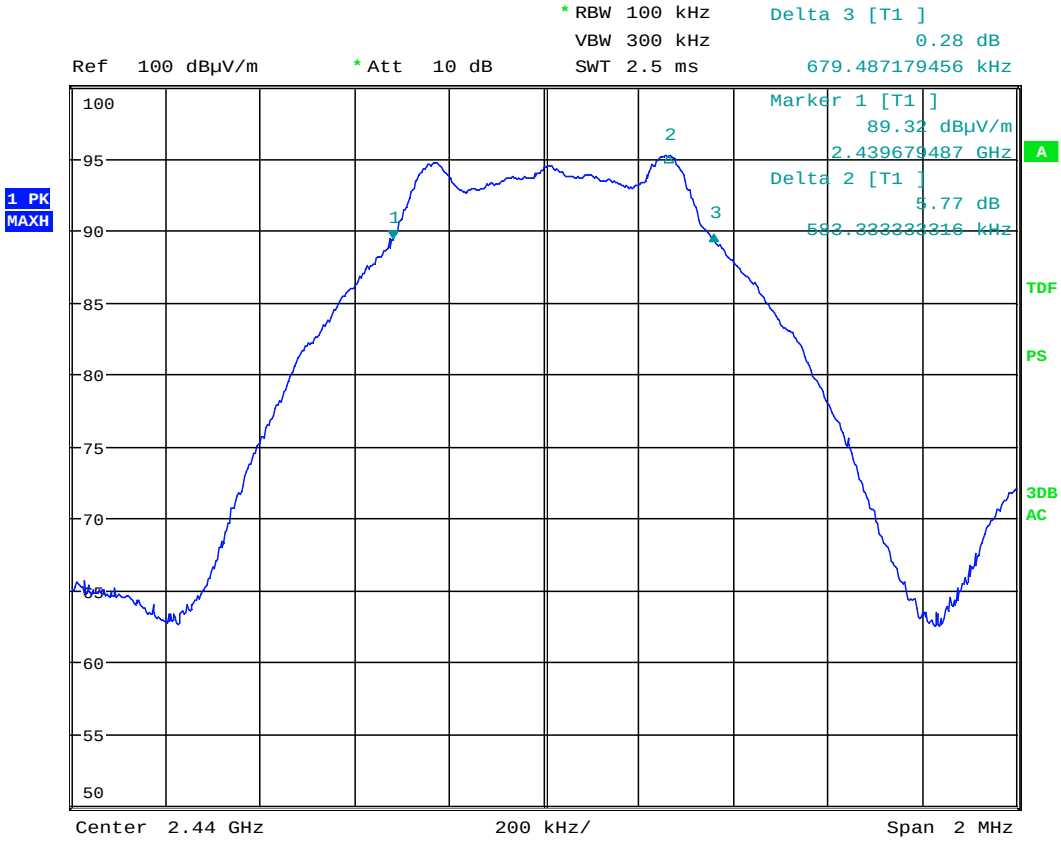
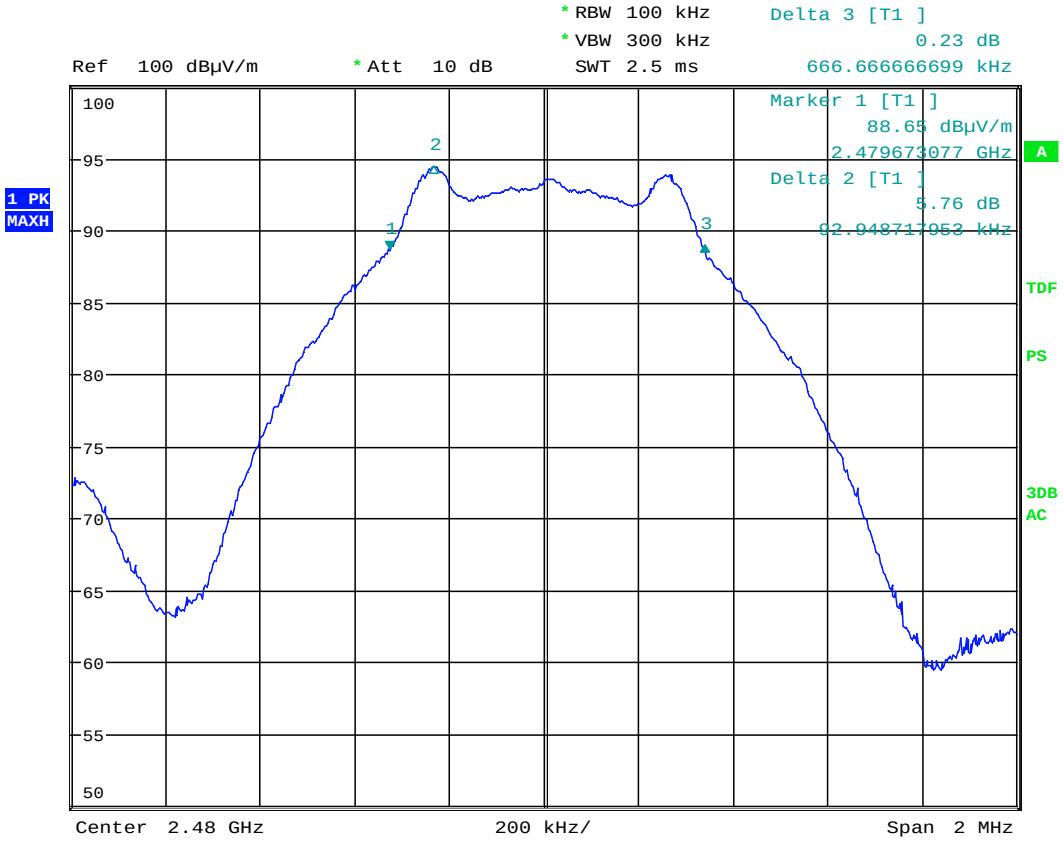
6 dB Bandwidth, 2402 MHz



Date: 25.OCT.2012 07:42:34

6 dB Bandwidth, 2440 MHz



Date: 25.OCT.2012 07:54:30

6 dB Bandwidth, 2480 MHz

4.3 Peak Power Output

Para. No.: 15.247 (b)

Test Performed By: Jan G Eriksen	**Date of Test: 1-31 Sept 2012**

Test Results: Complies

Measurement Data:

Carrier Frequency	Maximum Conducted Output Power, Watts	Maximum EIRP, Watts	Maximum Antenna Gain, dBi
2402 MHz	0.001	0.0013	1.1
2440 MHz	0.001	0.0010	0.0
2480 MHz	0.001	0.0007	-1.5

Antenna gain is declared by manufacturer. Conducted Power is calculated value.

EIRP is calculated from measured field strength by the formulas in KDB 412172 D01 Determining ERP and EIRP v01.

See attached plots.

Detachable antenna? ☐ Yes ☒ No

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

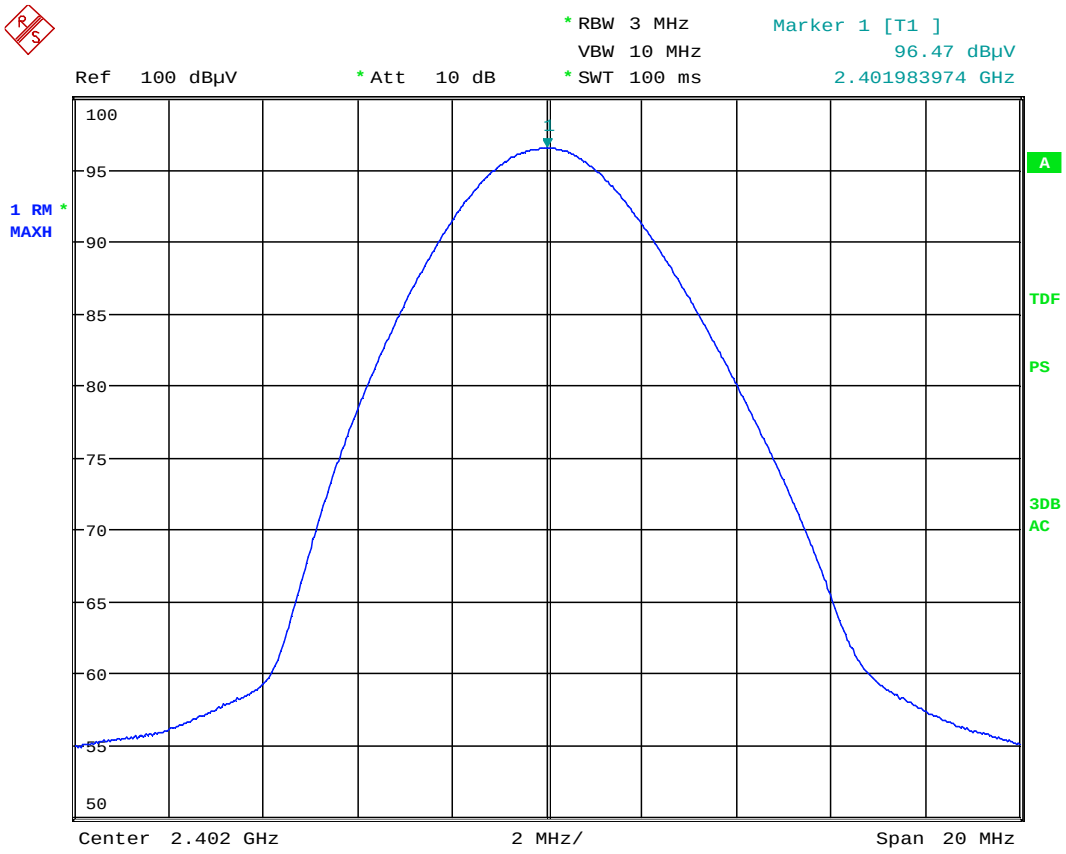
Type of antenna connector: N/A

Requirements:

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

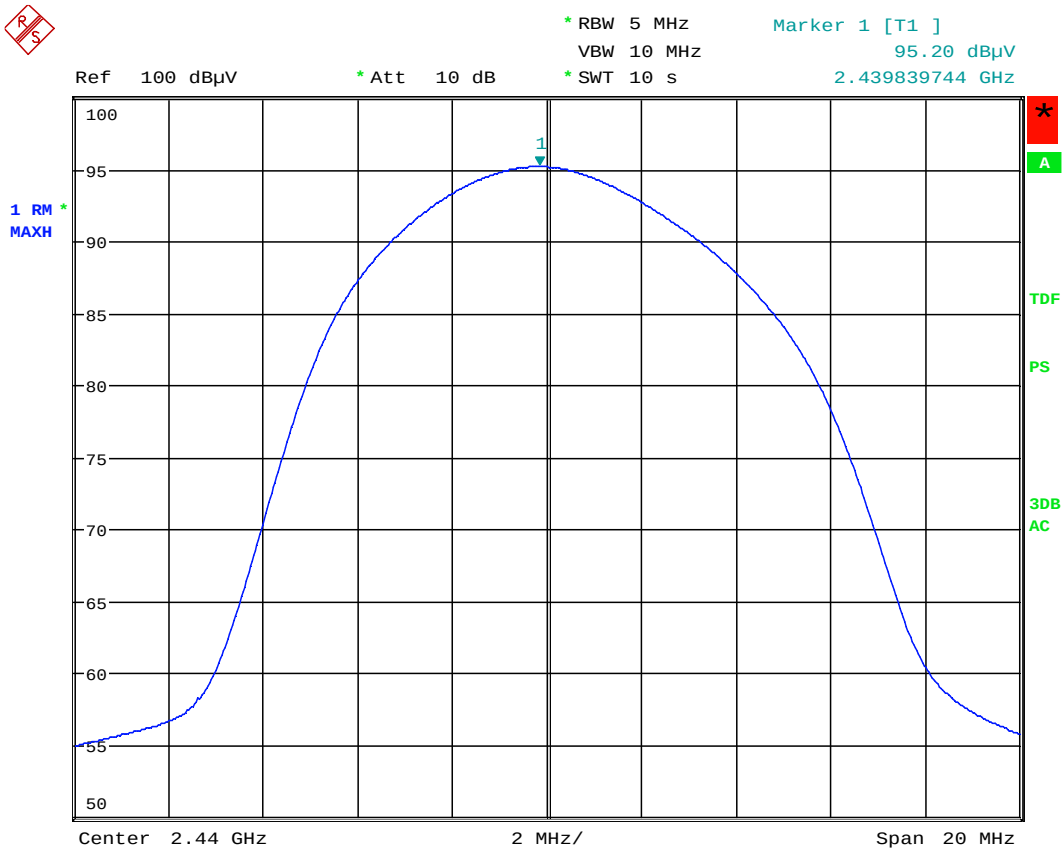
For Digital Transmission Systems in the 2400 - 2483.5 MHz band: 1 Watt

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.



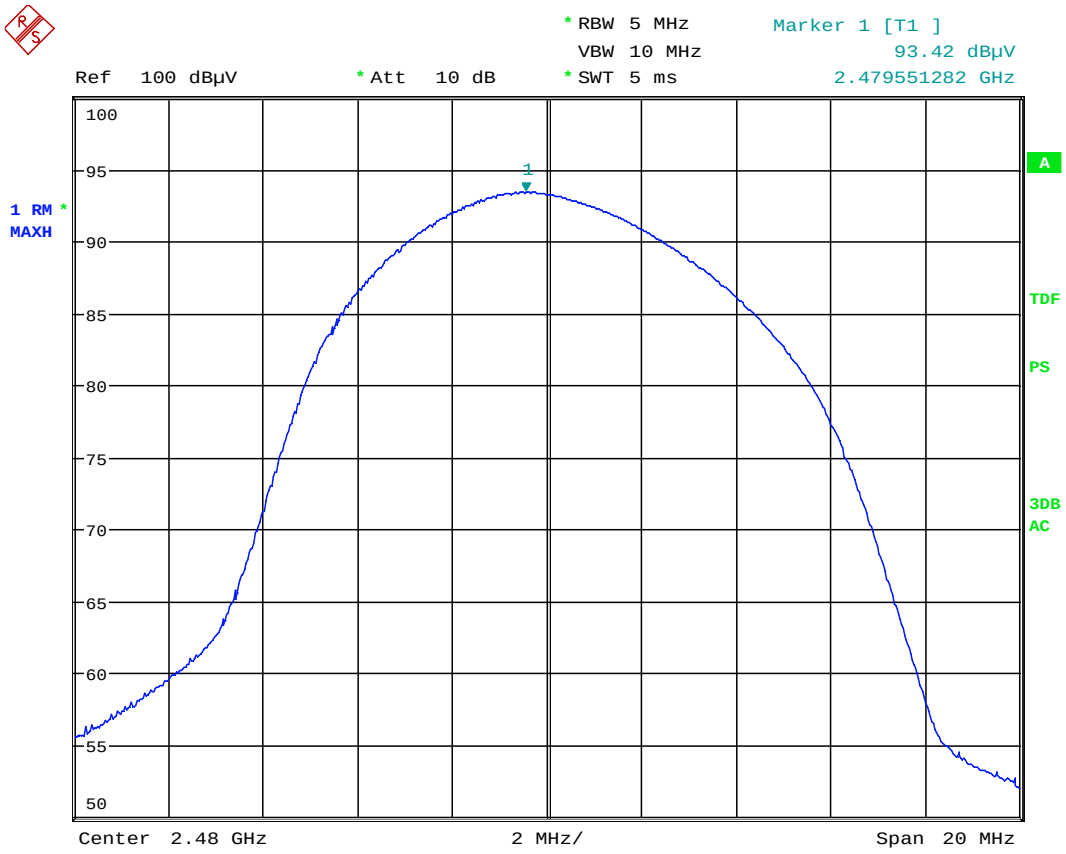
Date: 25.SEP.2012 10:59:44

Radiated Output Power, 2402 MHz (Max: VP)



Date: 25.SEP.2012 11:36:29

Radiated Output Power, 2440 MHz (Max: VP)



Date: 25.SEP.2012 11:42:44

Radiated Output Power, 2480 MHz (Max: VP)

4.4 Spurious Emissions (Radiated)

Para. No.: 15.247 (c)

Test Performed By: Jan G Eriksen	**Date of Test: 1-31 Sept 2012**

Test Results: Complies

Measurement Data:

	Measured field strength (dBµV/m)		**Limit**	**Margin**	
	2390 MHz	**2483.5 MHz**	**dB**	**dB**	
Peak Detector	56.4	61.4	74	17.6	12.6
Average Detector	48.3	53.6	54	5.7	0.4

Average values are measured with Peak Detector and corrected for Duty Cycle.

See attached plots.

Duty Cycle Correction Factor Calculation:

See also Para 4.4 Occupancy Time.

RF duty cycle: Calculation according to RF burst Para 15.35 (c)

Maximum Duty Cycle: 50%

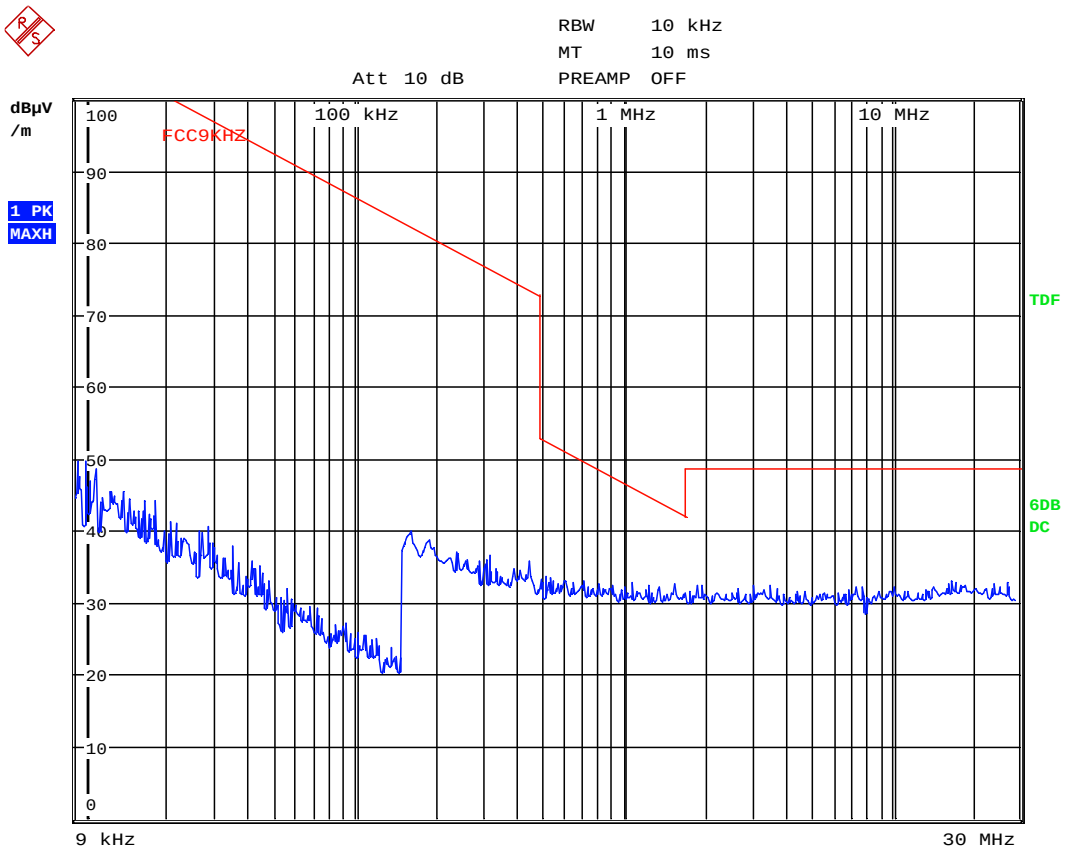
Duty Cycle Correction factor = -20 x log(0.50) = 6.0 dB

Radiated emissions 9 kHz-30 MHz.

Measuring distance 3 m, measured with Peak detector.

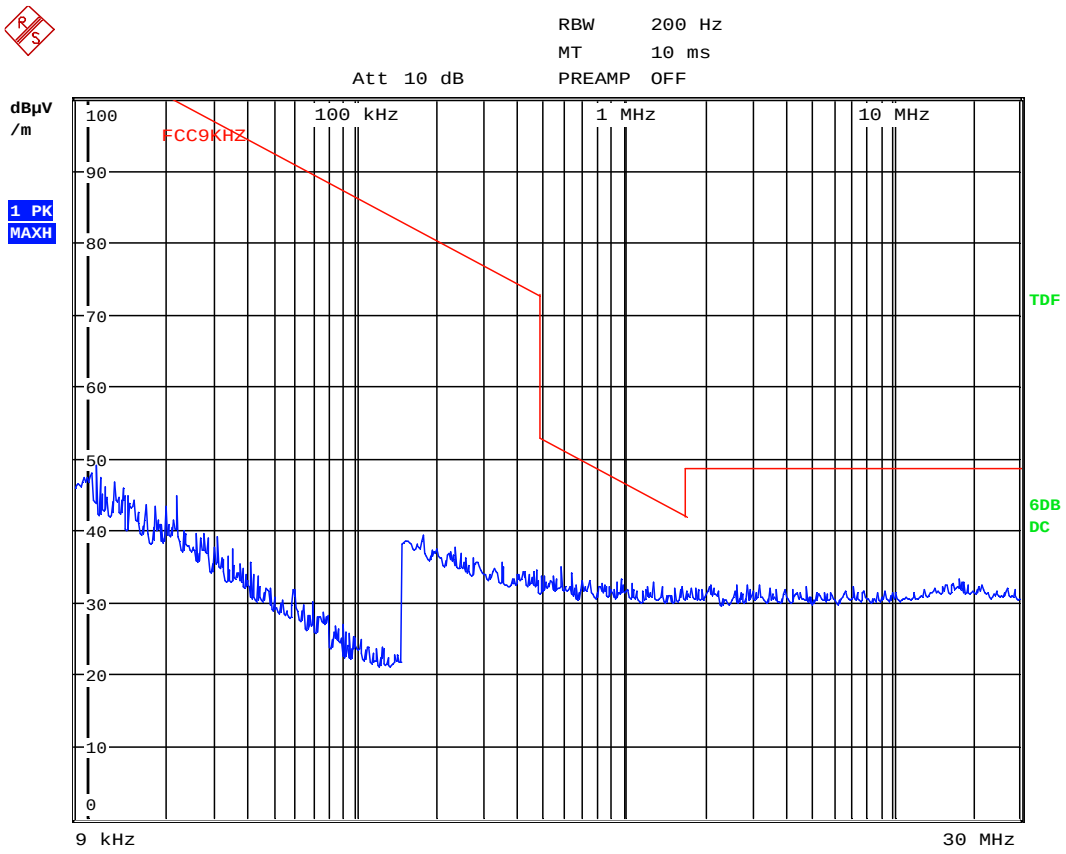
No component detected, see plot.

Limit is converted to 3 m using 40 dB/decade according to 15.31 (f) (2).



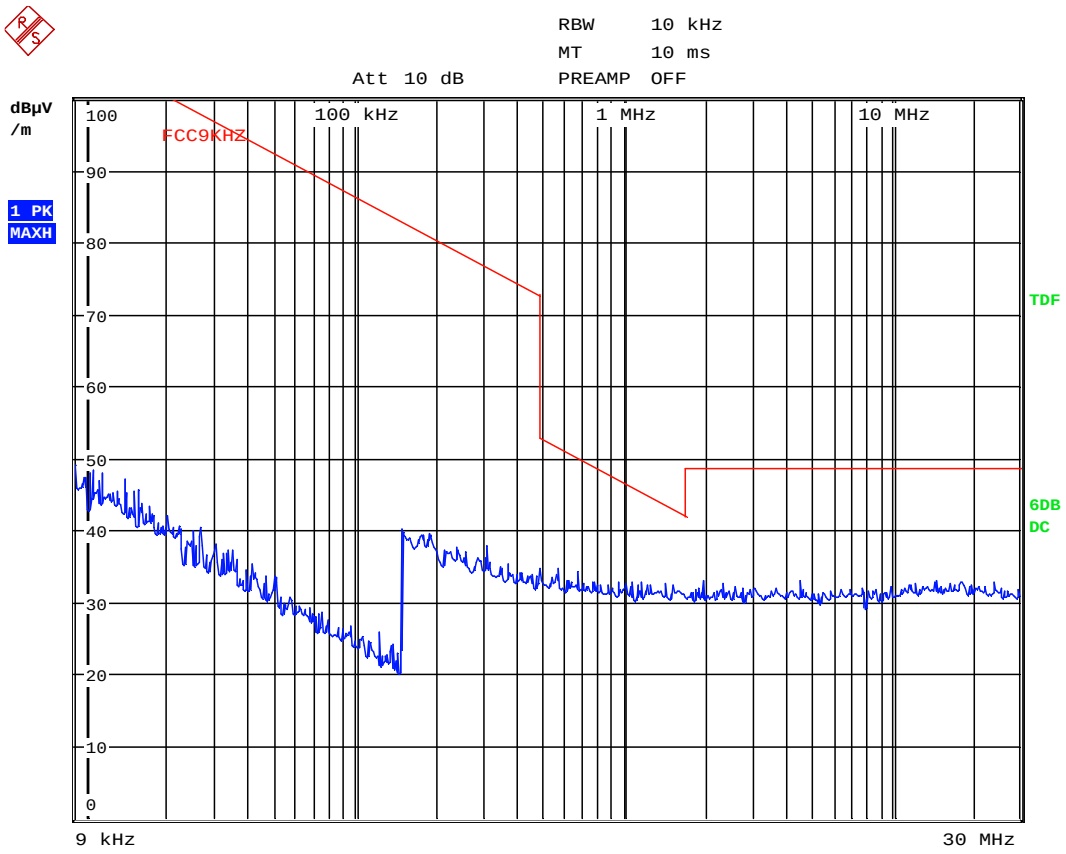
Date: 25.SEP.2012 15:11:51

Radiated Emissions, 0.150 - 30 MHz, 2402MHz, @3m, Loop Antenna



Date: 25.SEP.2012 15:15:33

Radiated Emissions, 0.150 - 30 MHz, 2440MHz, @ 3m, Loop Antenna



Date: 25.SEP.2012 15:19:39

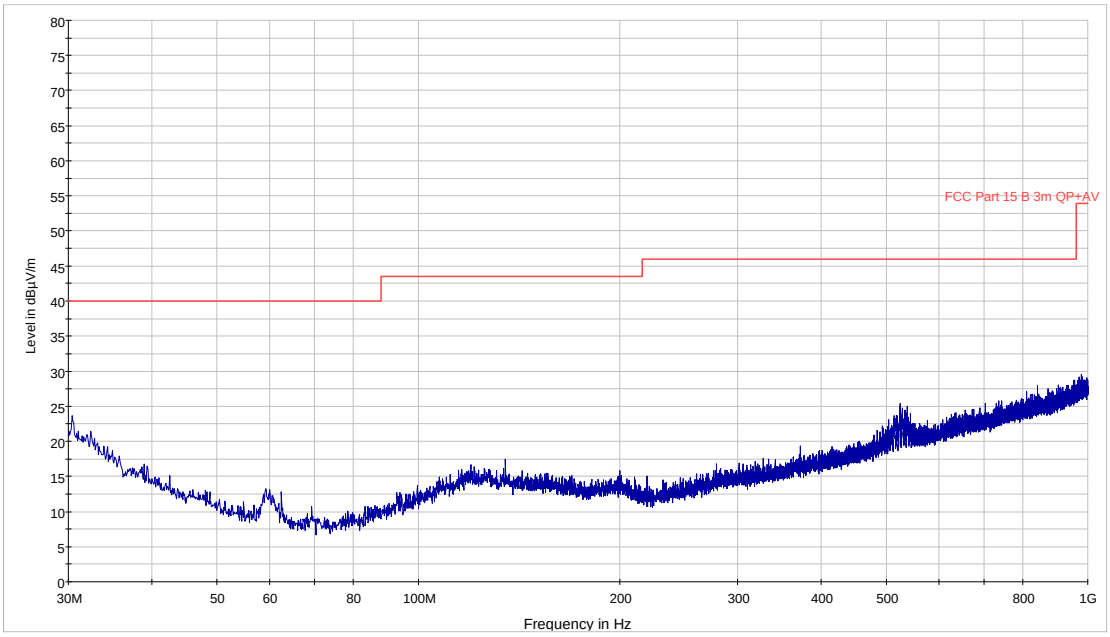
Radiated Emissions, 0.150 - 30 MHz, 2480MHz, @ 3m, Loop Antenna

Radiated emission 30 – 1000 MHz.

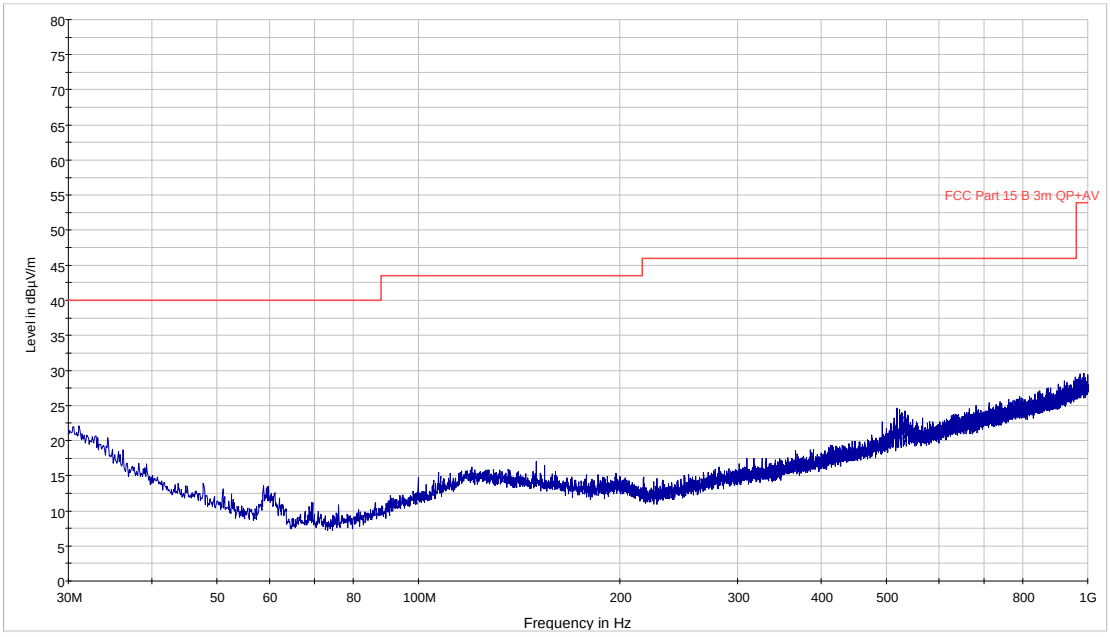
Detector: Quasi-Peak

Measuring distance 3m.

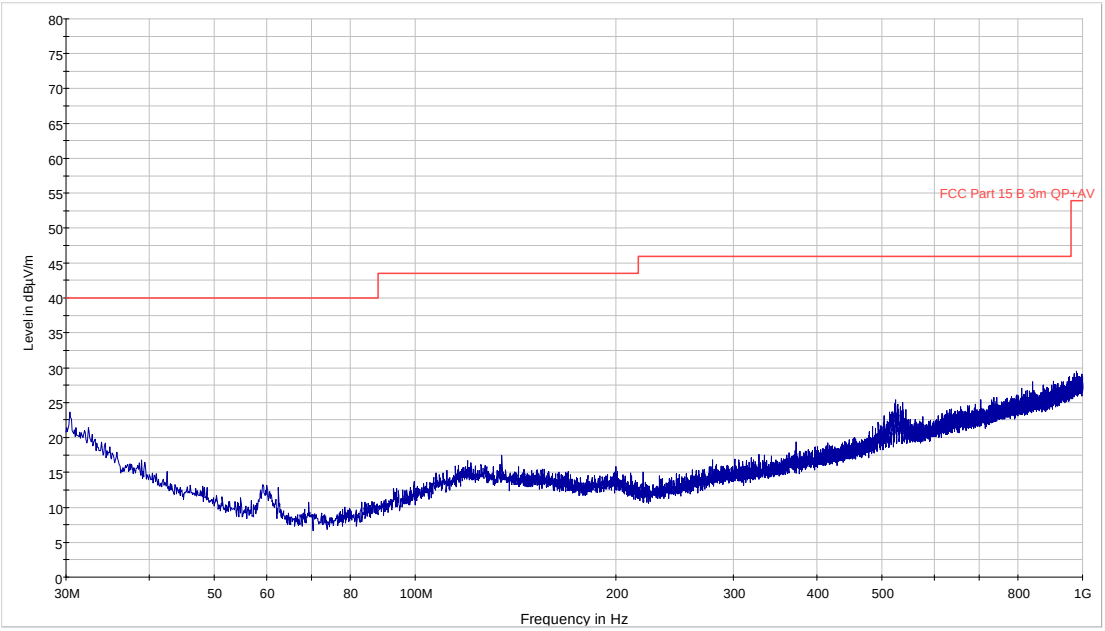
See plot.



Radiated Emissions, 30-1000 MHz, 2402MHz, @ 3m



Radiated Emissions, 30-1000 MHz, 2440MHz, @ 3m



Radiated Emissions, 30-1000 MHz, 2480MHz, @ 3m

Radiated Emissions, 1-25 GHz

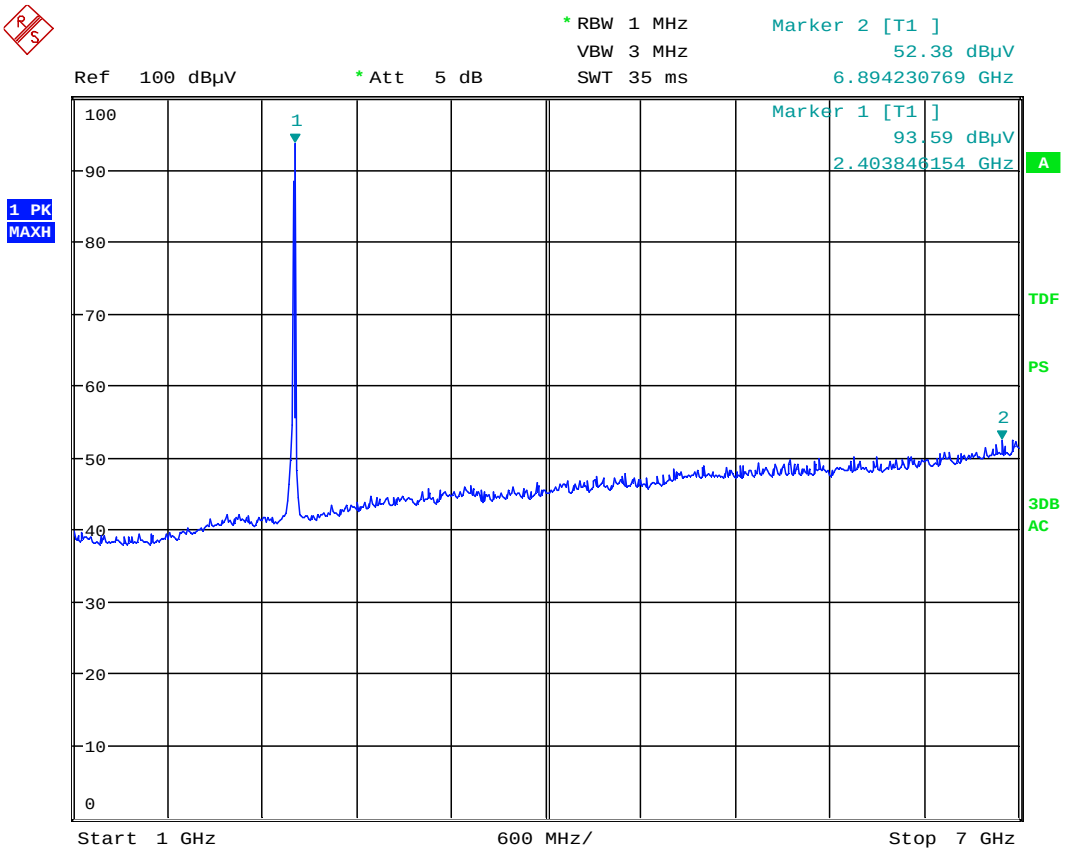
Measuring distance: 3m (1 – 8.5 GHz)
1m (8.5 – 18 GHz) (Plots show uncorrected values)

A pre-scan was performed above 18 GHz and no spurious emissions were detected.

No spurious emissions were found.

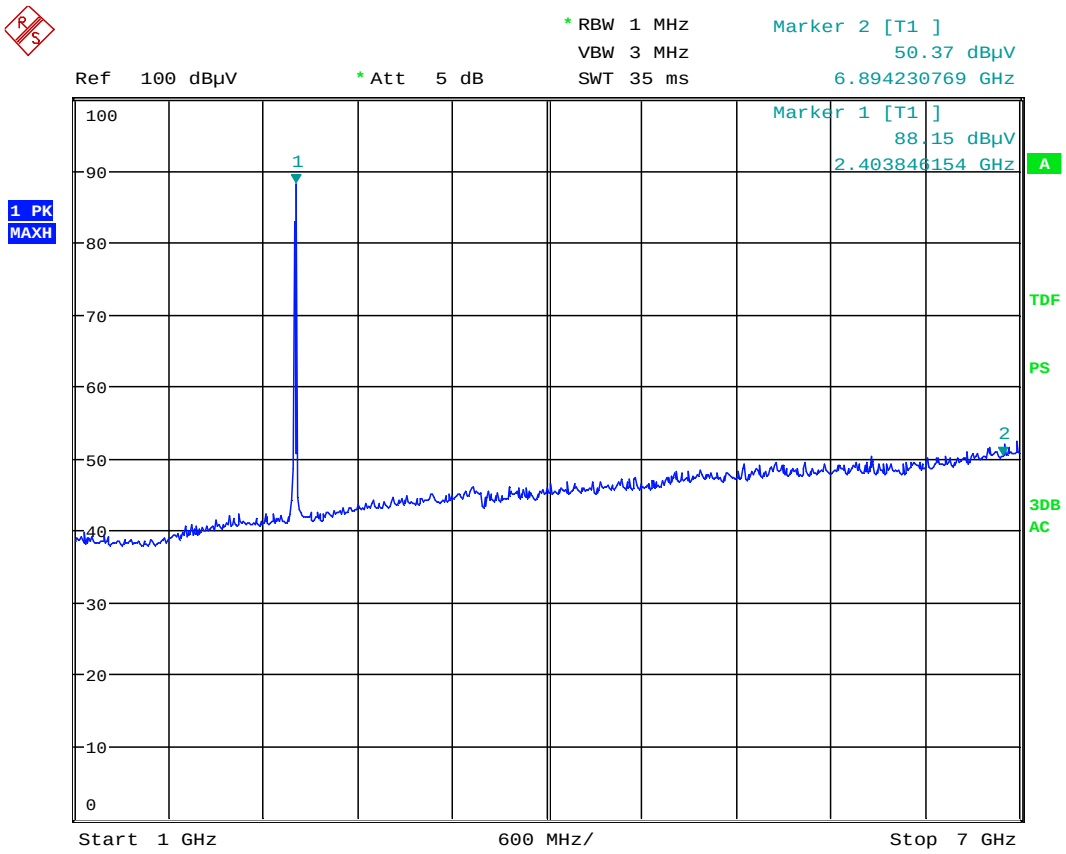
Antenna factor, amplifier gain and cable loss are included in spectrum analyzer “Transducer factor”.

See plots.



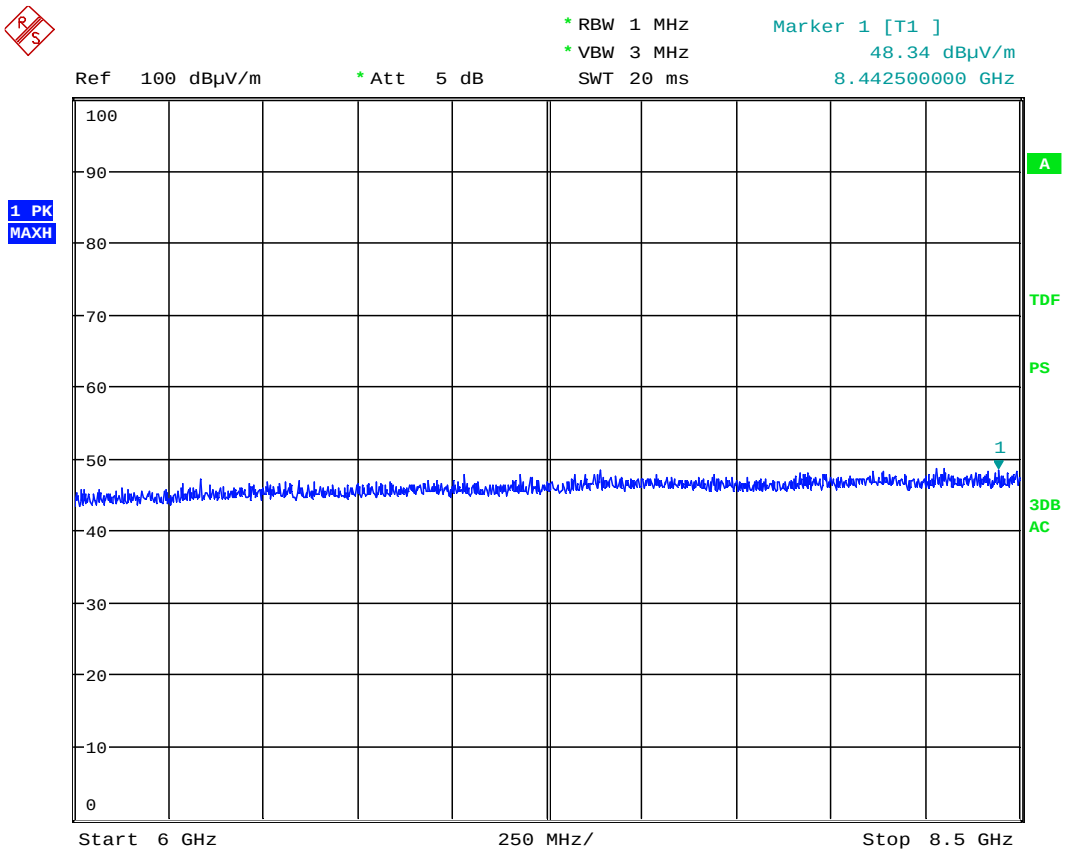
Date: 21.SEP.2012 14:44:55

Radiated Emissions, 1000 - 7000 MHz, 2402MHz, VP



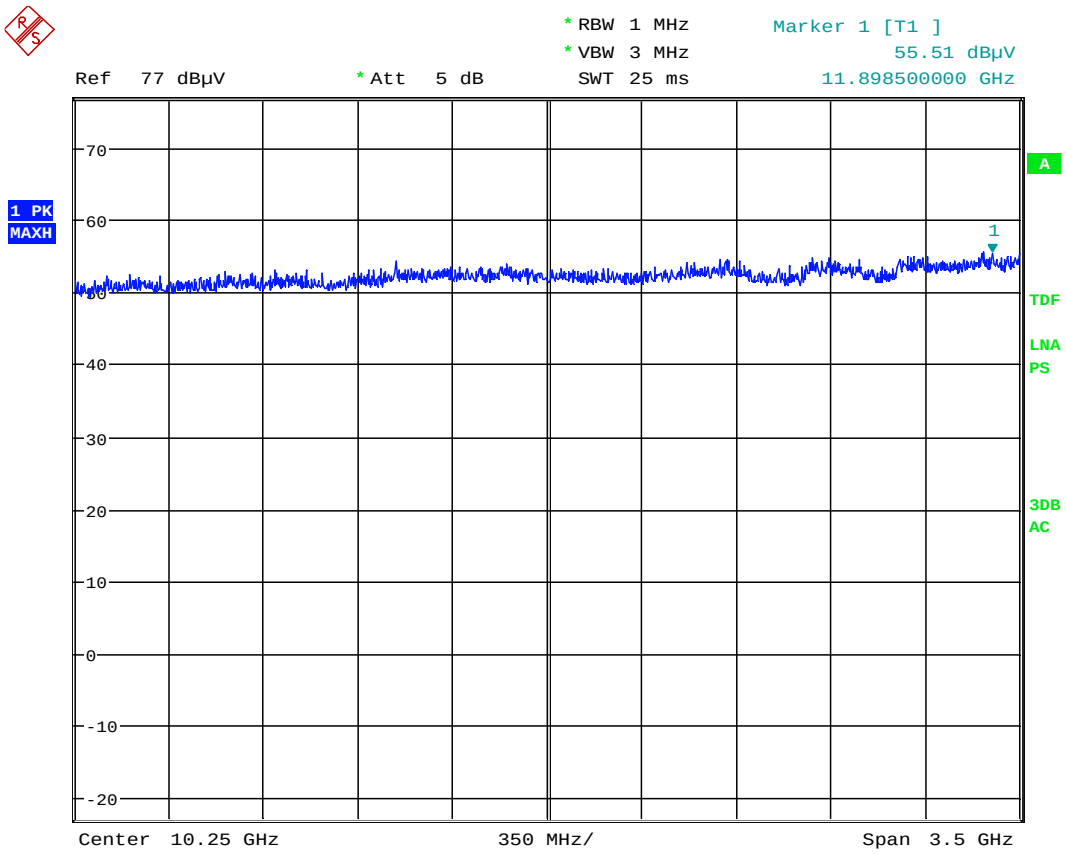
Date: 21.SEP.2012 14:47:03

Radiated Emissions, 1000 - 7000 MHz, 2402MHz, HP



Date: 25.SEP.2012 12:51:07

Radiated Emissions, 6000 - 8500 MHz, 2402MHz, VP/HP



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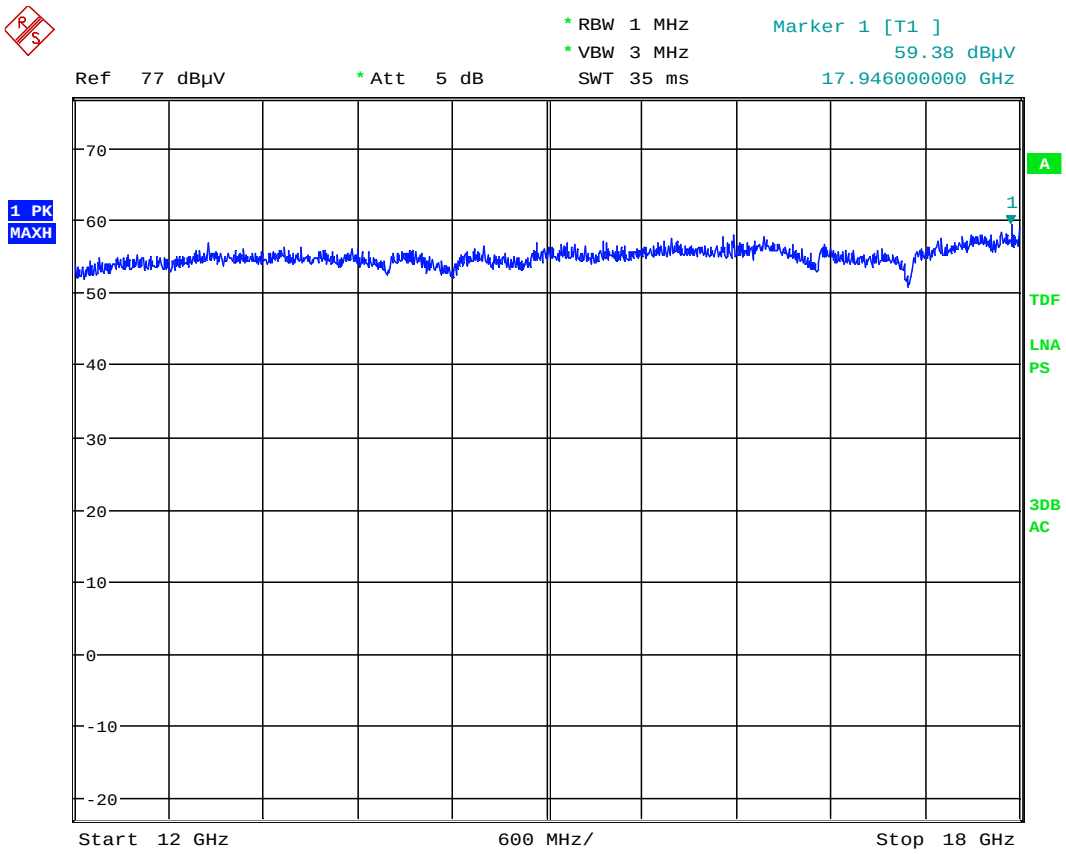
Radiated Emissions, 8.5 - 12 GHz, 2402MHz, VP/HP, @1m



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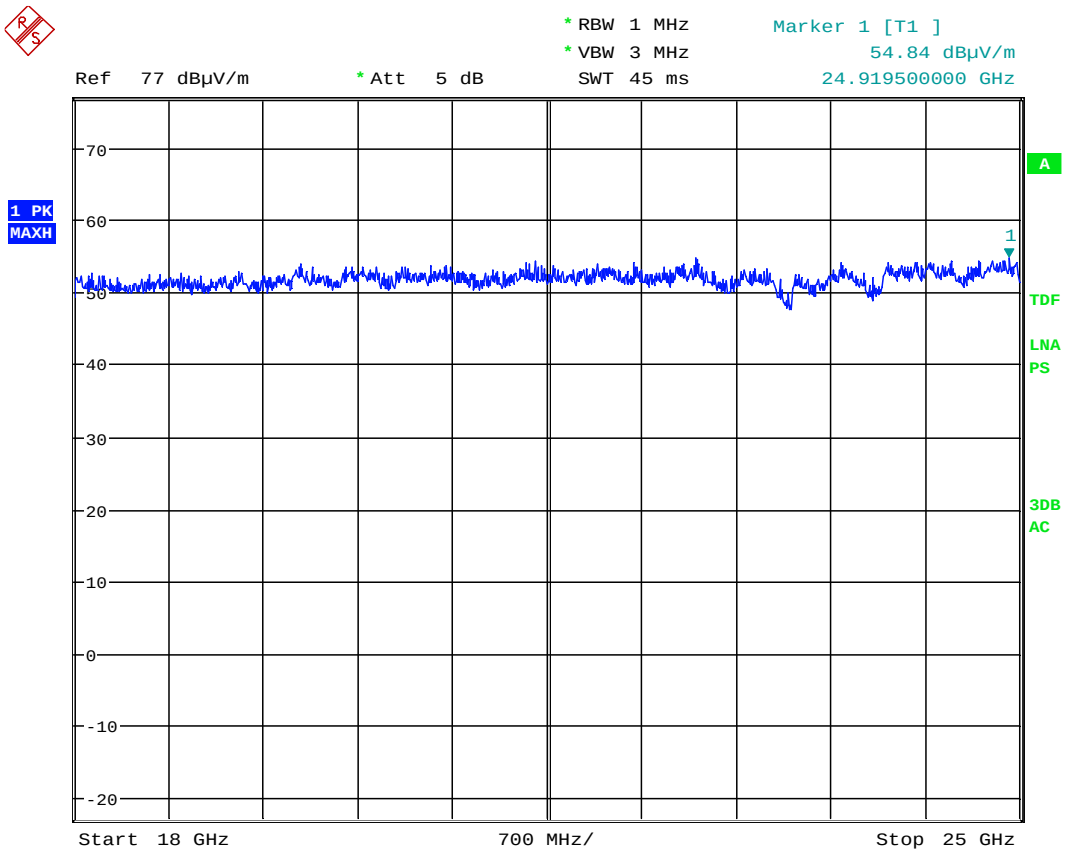
Radiated Emissions, 12 - 18 GHz, 2402MHz, VP/HP, @1m



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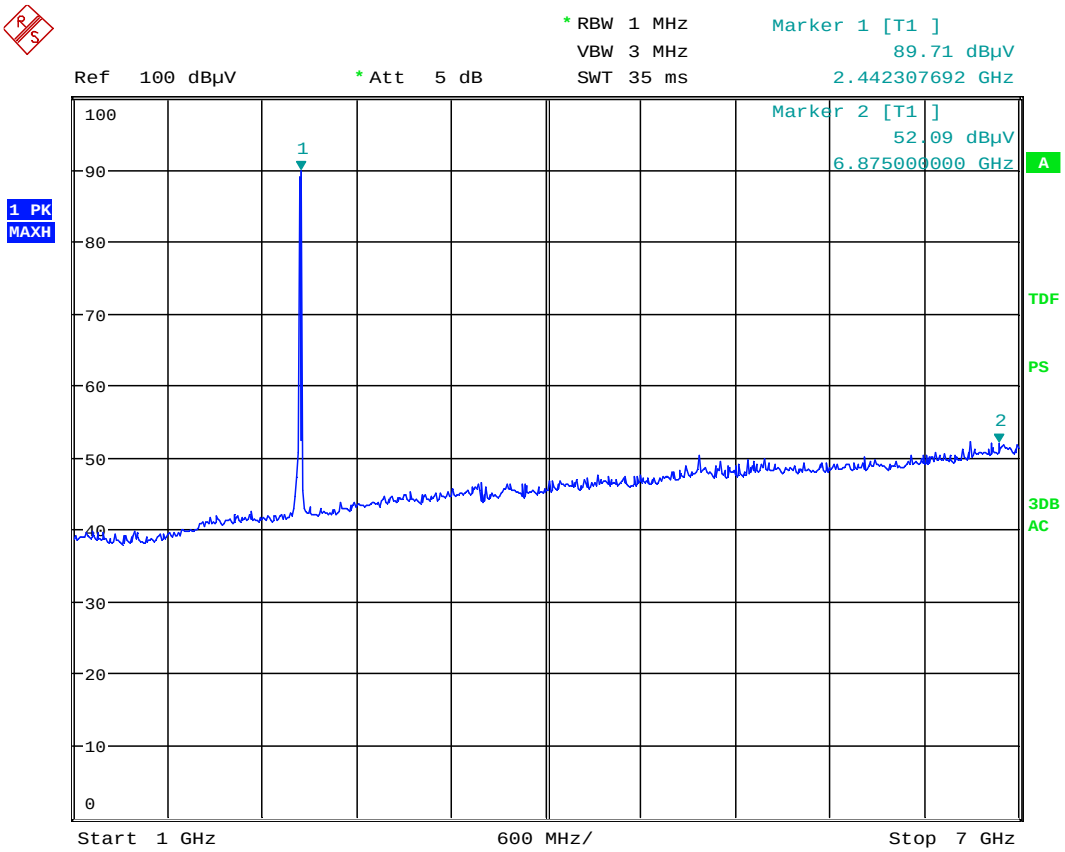
Radiated Emissions, 18 - 25 GHz, 2402MHz, VP/HP, @0.2m



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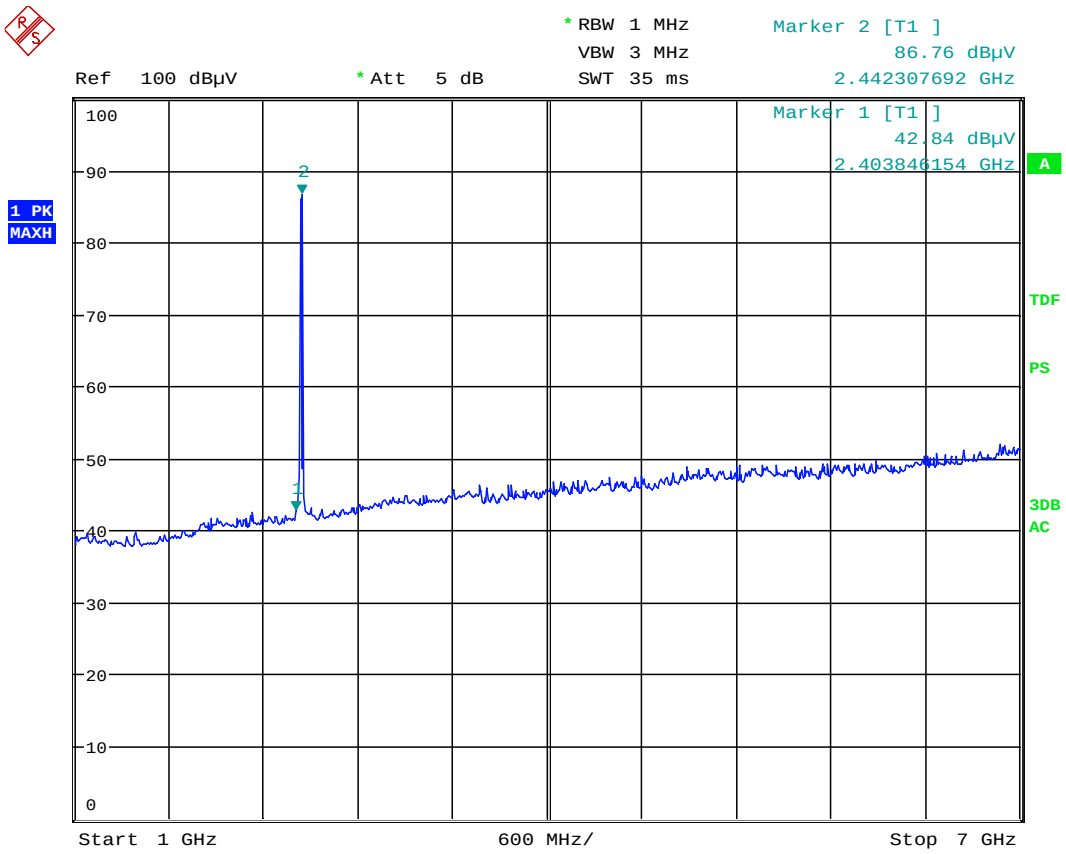
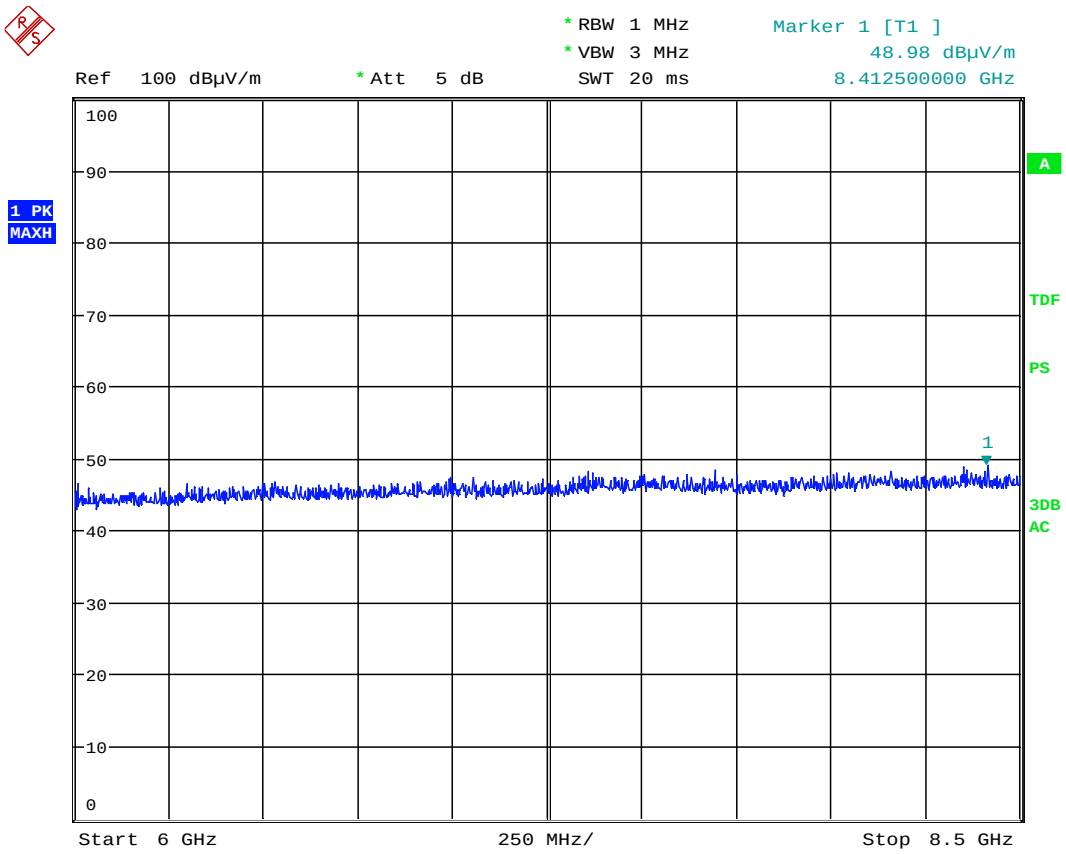
Radiated Emissions, 1000 - 7000 MHz, 2440MHz, VP



Date: 21.SEP.2012 14:49:29

Radiated Emissions, 1000 - 7000 MHz, 2440MHz, HP



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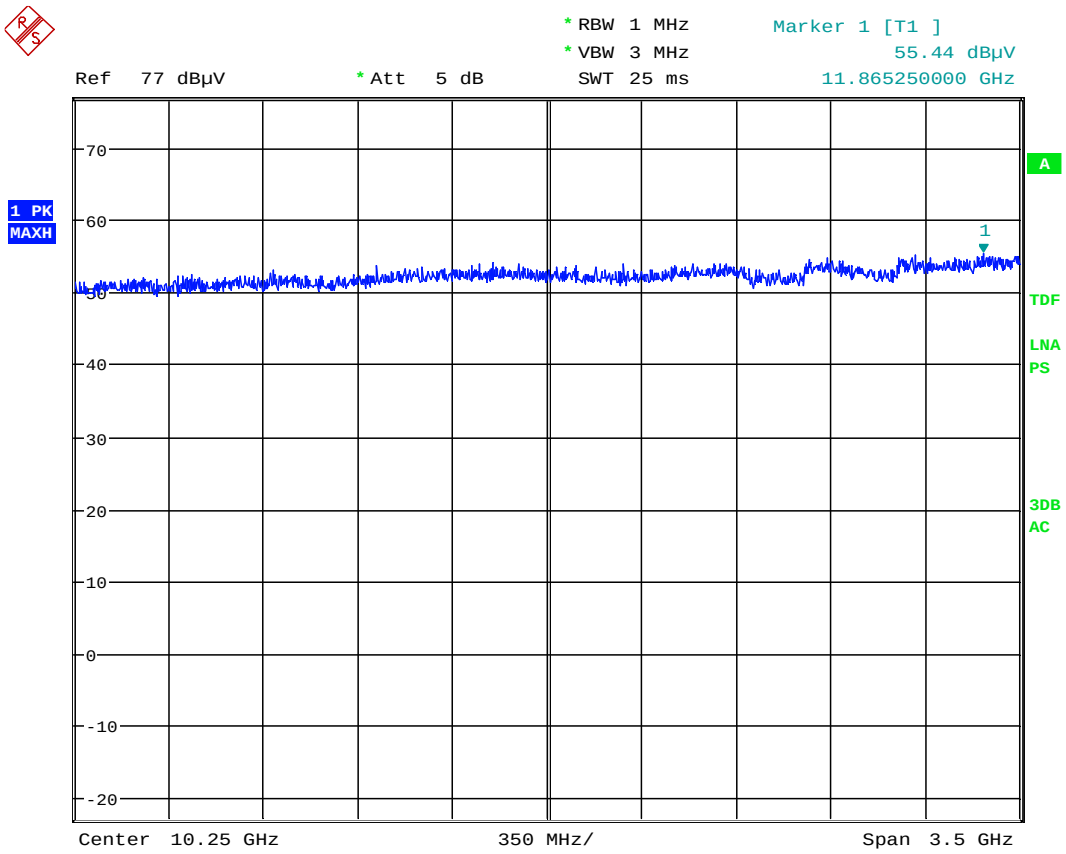
Radiated Emissions, 6000 - 8500 MHz, 2440MHz, VP/HP



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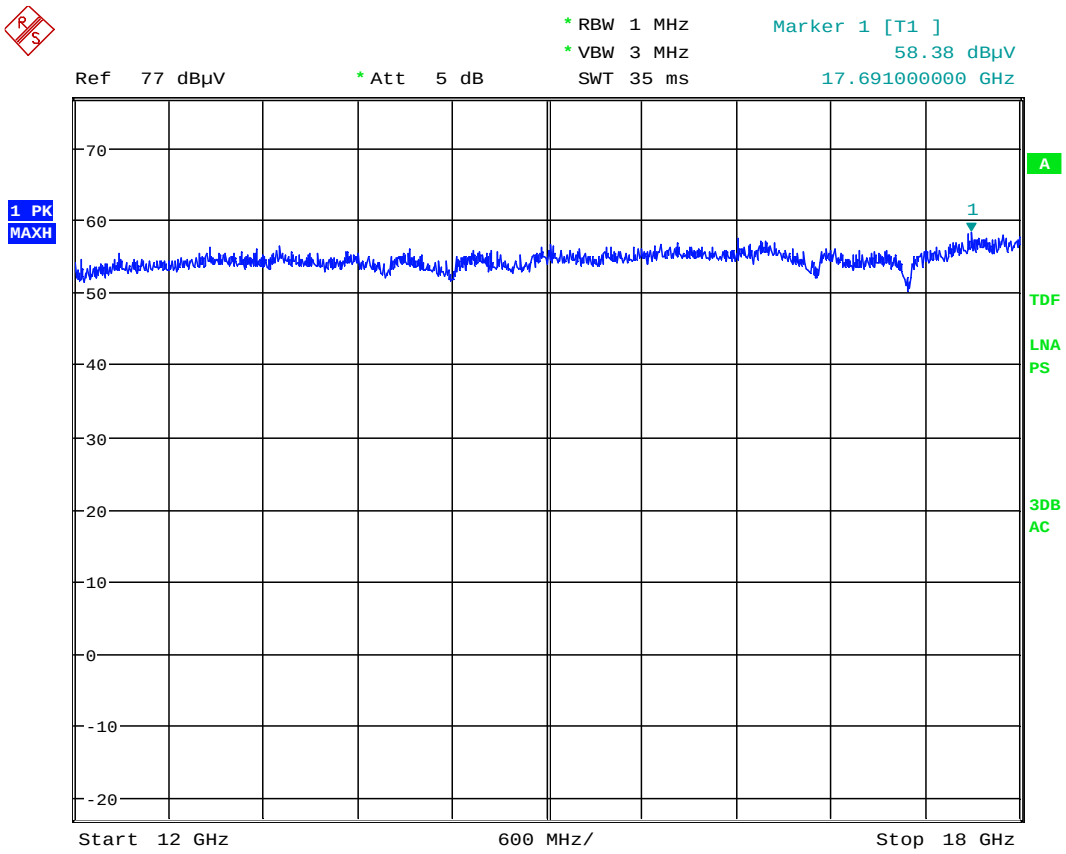
Radiated Emissions, 8.5 -12 GHz, 2440MHz, VP/HP, @1m



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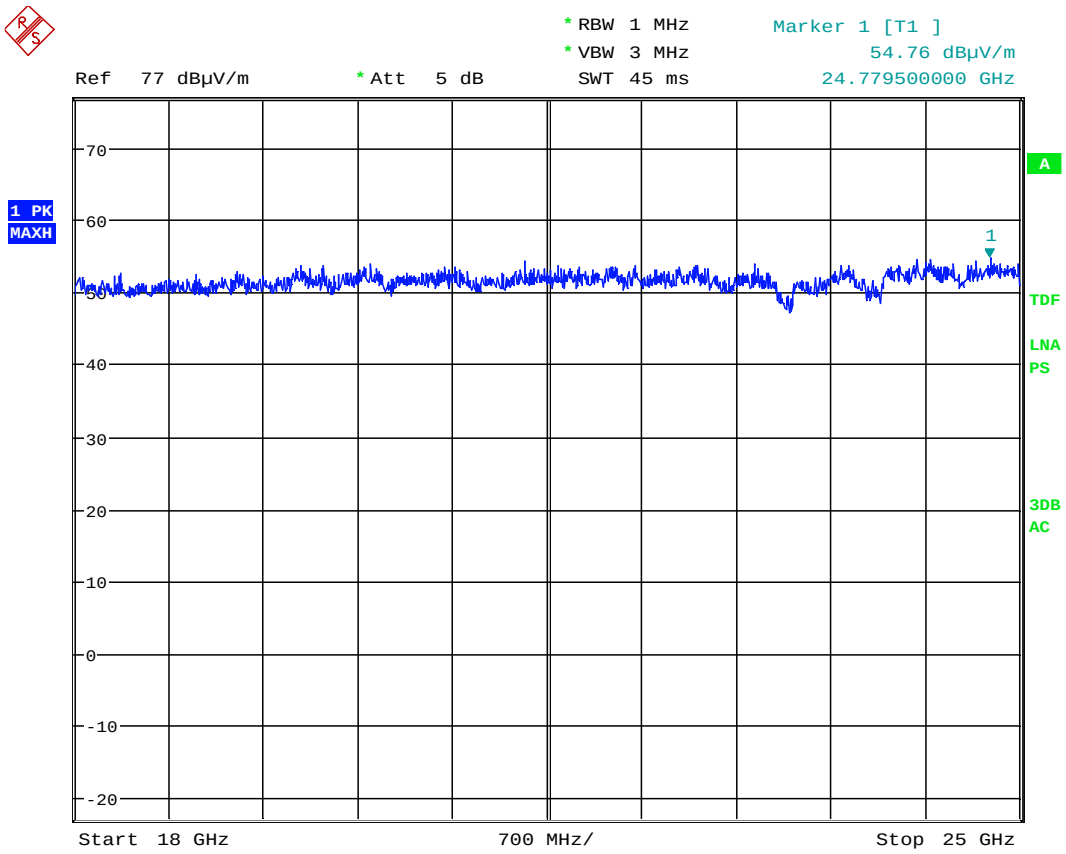
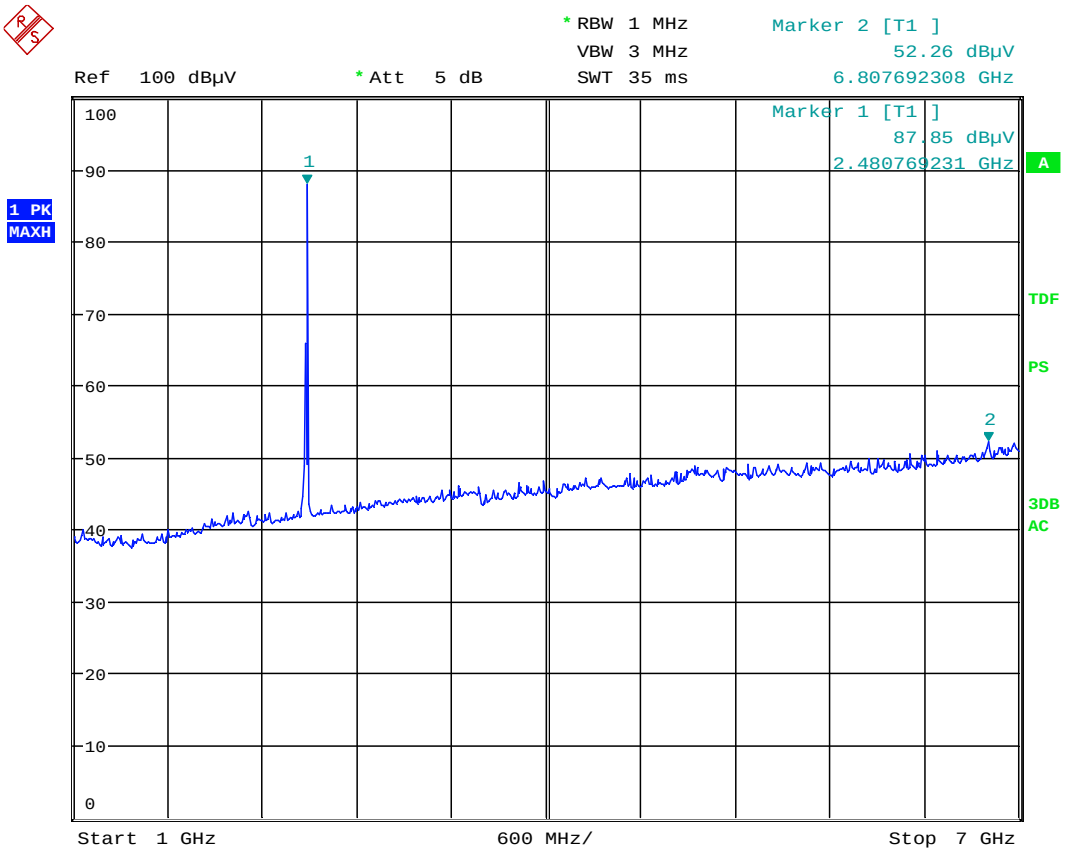
Radiated Emissions, 12 -18 GHz, 2440MHz, VP/HP, @1m



Radiated Emissions, 18 -25 GHz, 2440MHz, VP/HP, @0.2m



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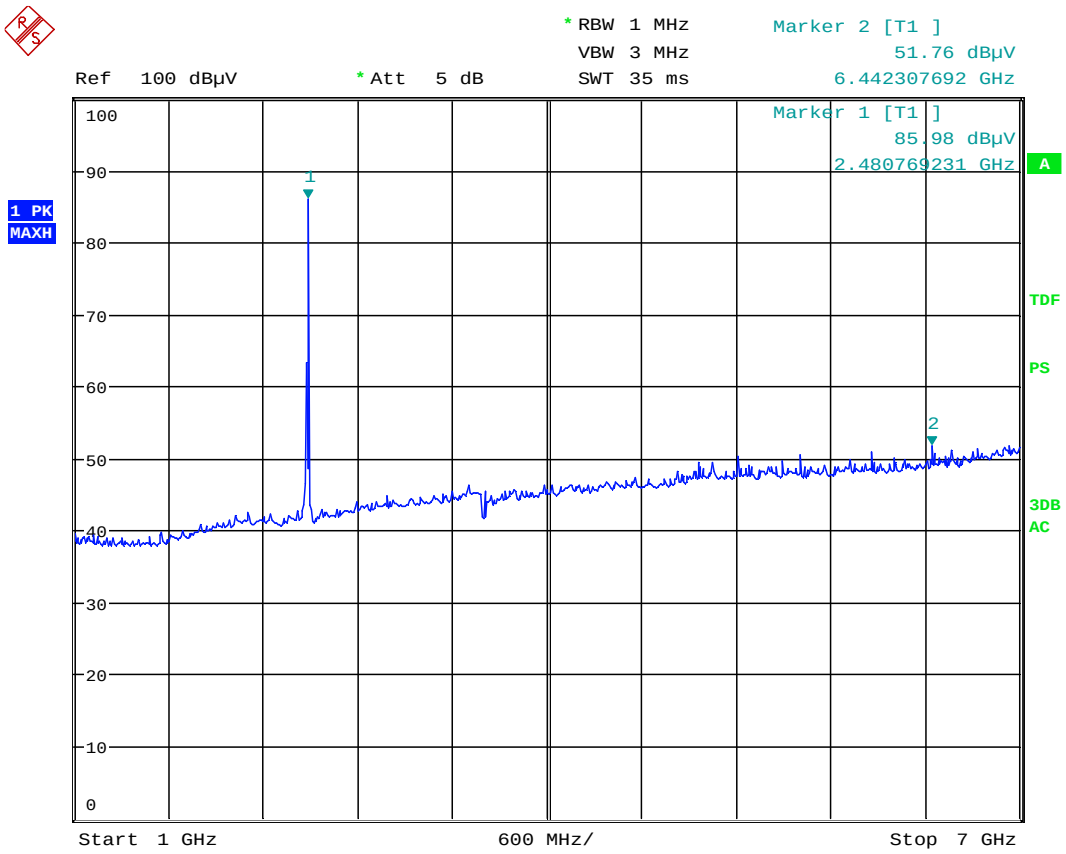
Radiated Emissions, 1000 -7000 MHz, 2480MHz, VP



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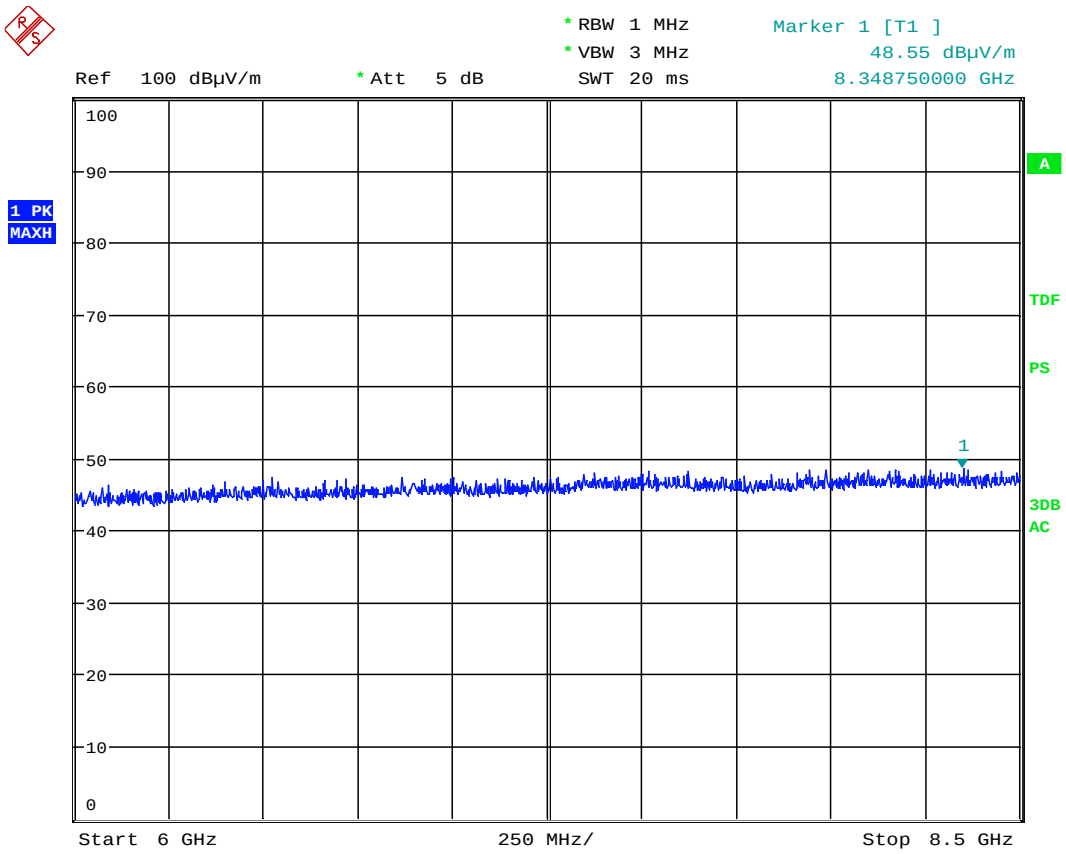
Radiated Emissions, 1000 - 7000 MHz, 2480MHz, HP



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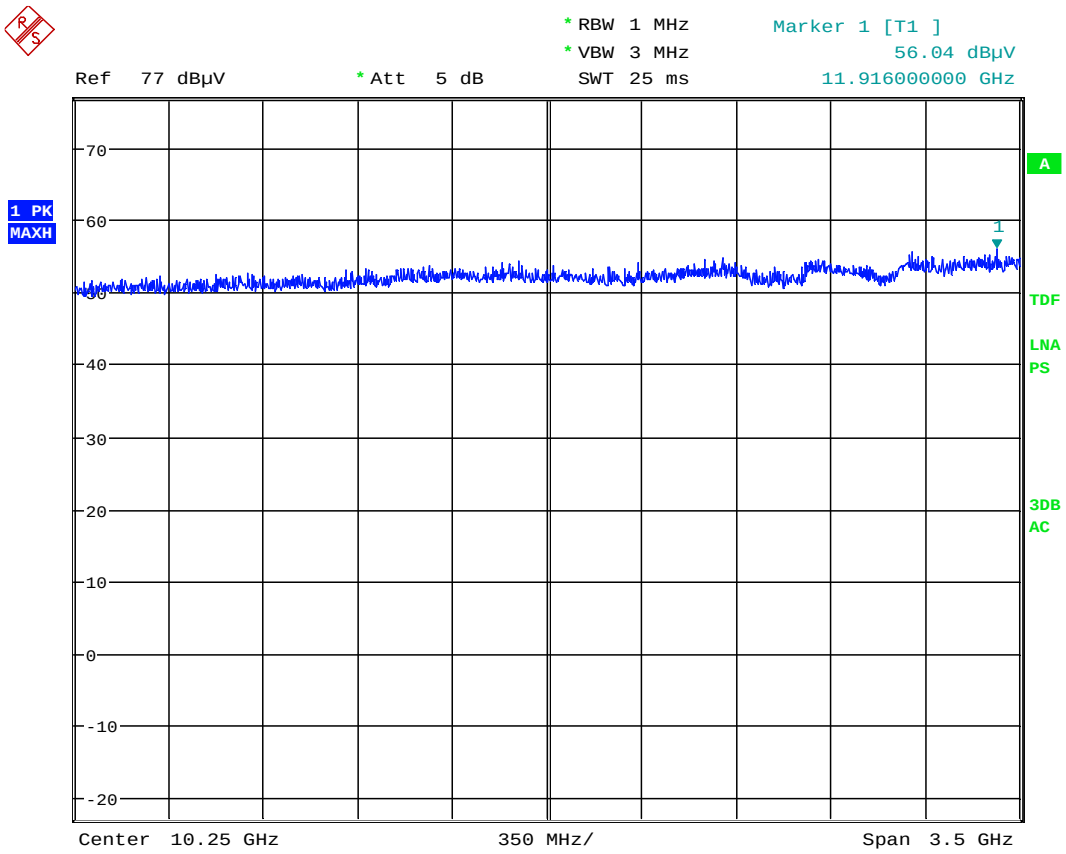
Radiated Emissions, 6000 - 8500 MHz, 2480MHz, VP/HP



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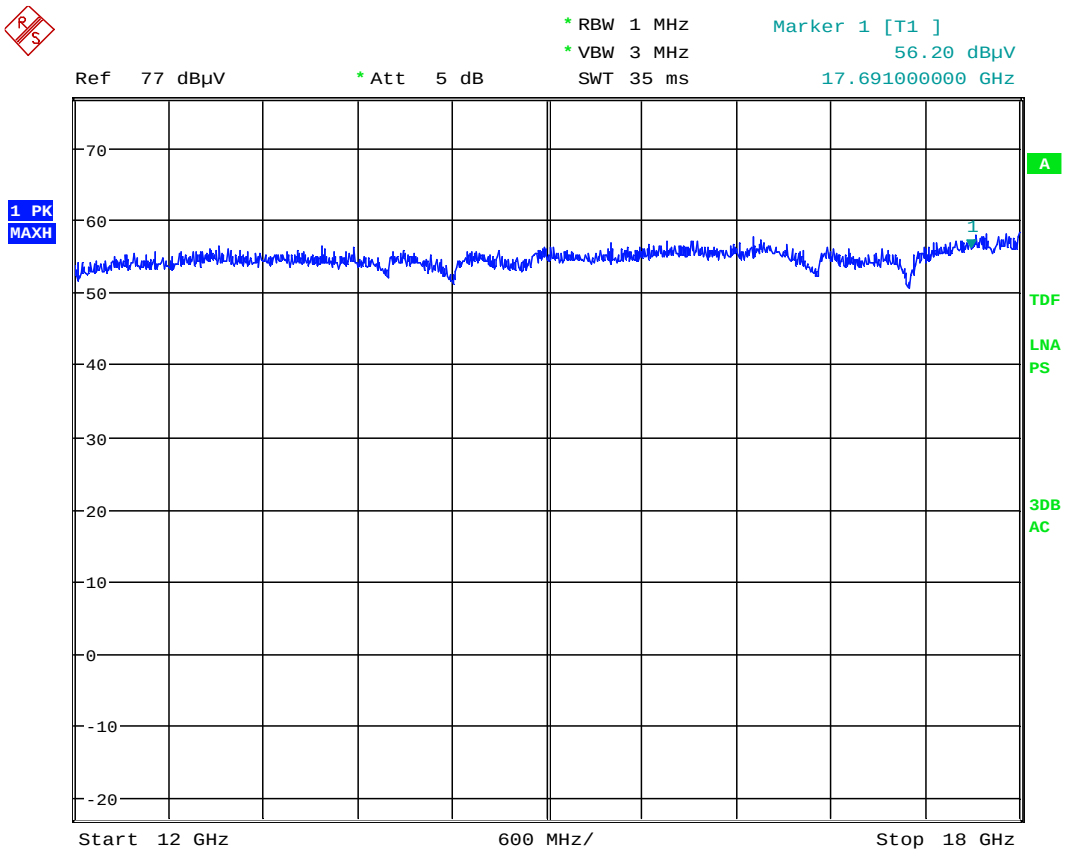
Radiated Emissions, 8.5 - 12 GHz, 2480MHz, VP/HP, @1m



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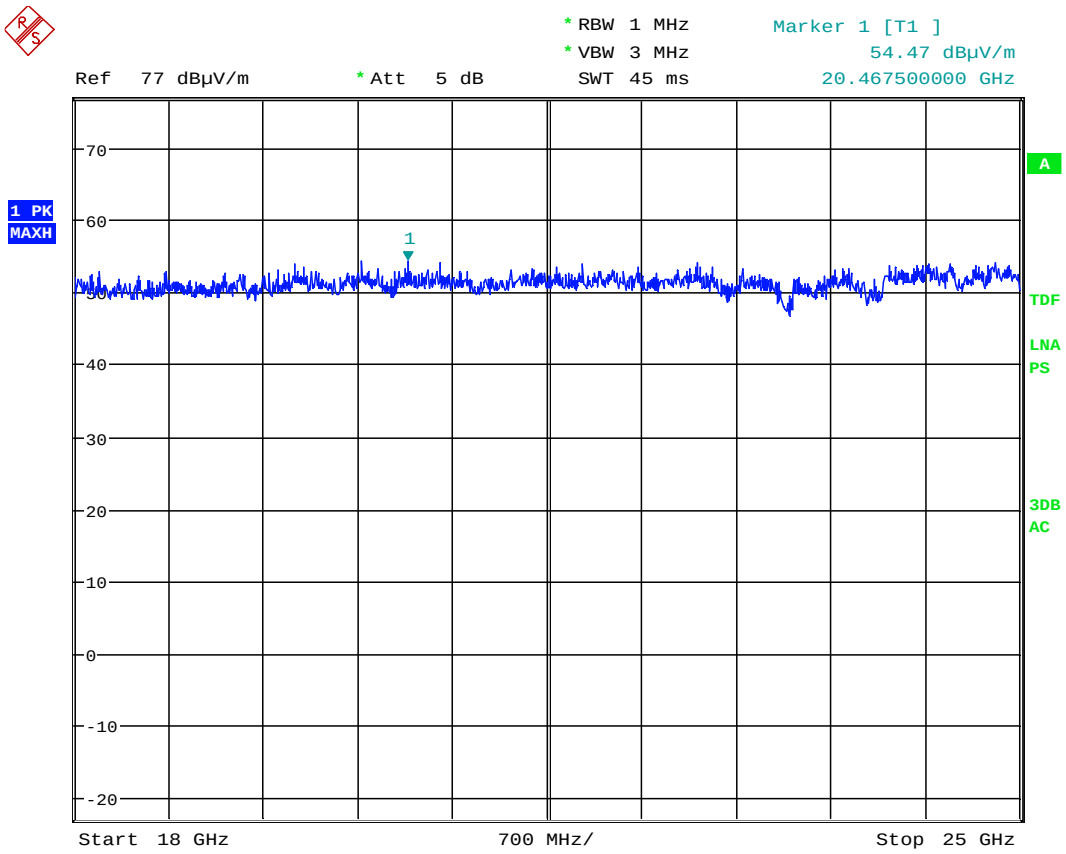
Radiated Emissions, 12 - 18 GHz, 2480MHz, VP/HP, @1m



Date: 25.SEP.2012 14:28:20

Radiated Emissions, 18 - 25 GHz, 2480MHz, VP/HP, @0.2m

4.5 Power Spectral Density (PSD)

Para. No.: 15.247 (d)

Test Performed By: Jan G Eriksen	**Date of Test: 25 Oct 2012**

Test Results: Passed

Measured and Calculated Data:

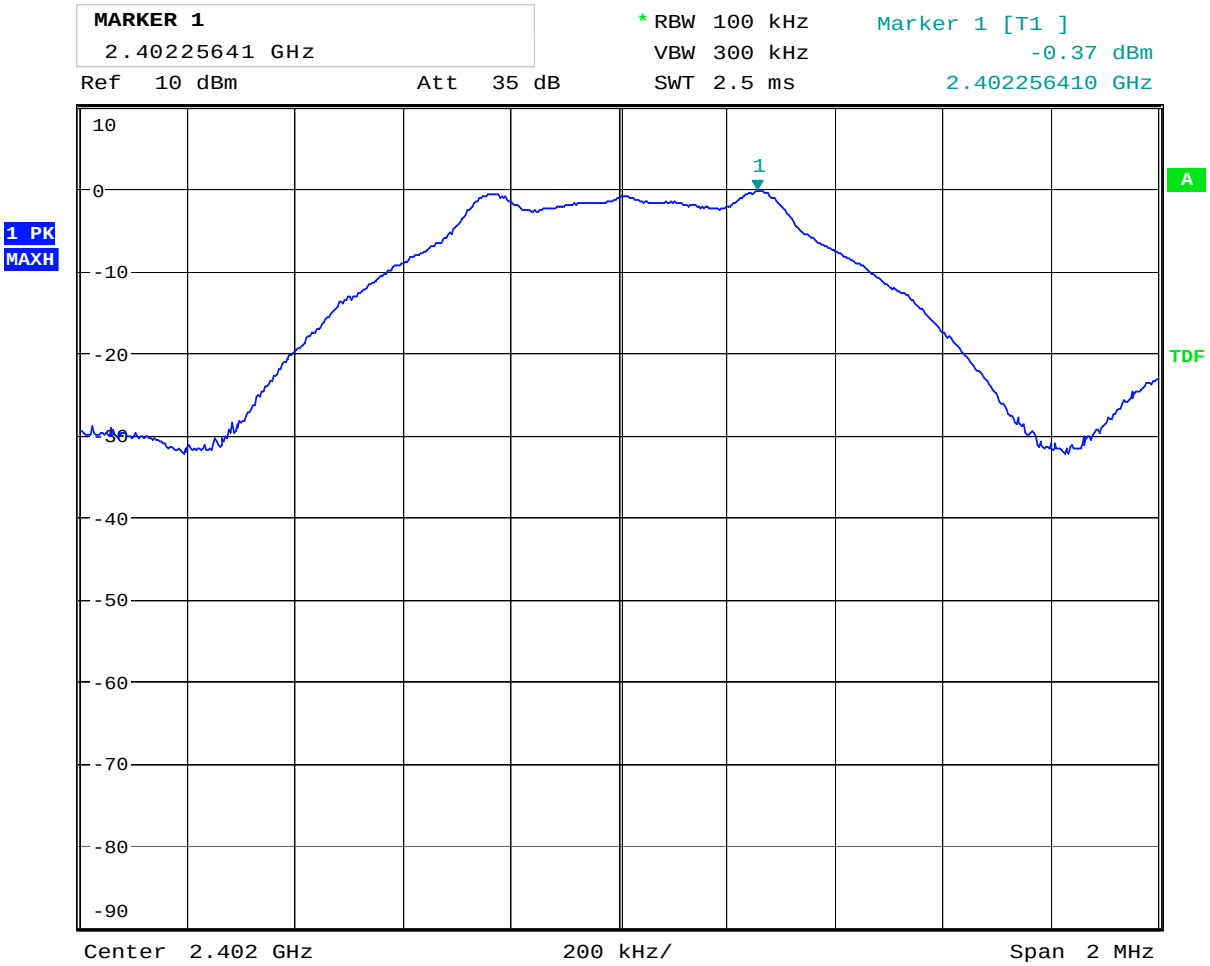
The measurement procedures PKPSD described in KDB 558074 D01 v01 was used.

Carrier Frequency (MHz)	**Power Spectral Density (dBm)**	
	Measured 100kHz	**Corrected Value**
2402	-0.4	-15.6
2440	-0,8	-16.0
2480	-0.4	-15.6

The measured values with 100kHz RBW are corrected by a Bandwidth Correction Factor of -15.2 dB.

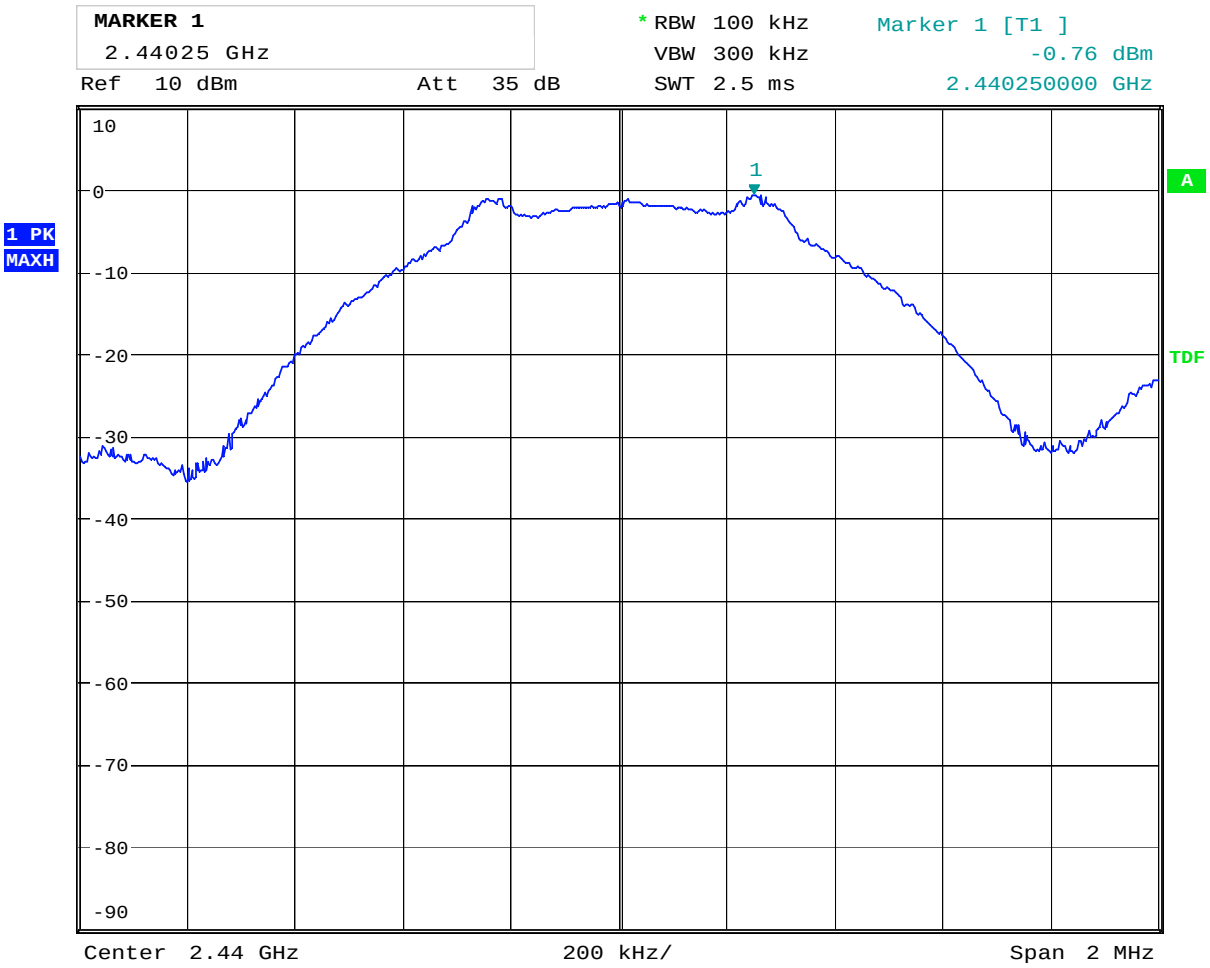
Requirements:

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



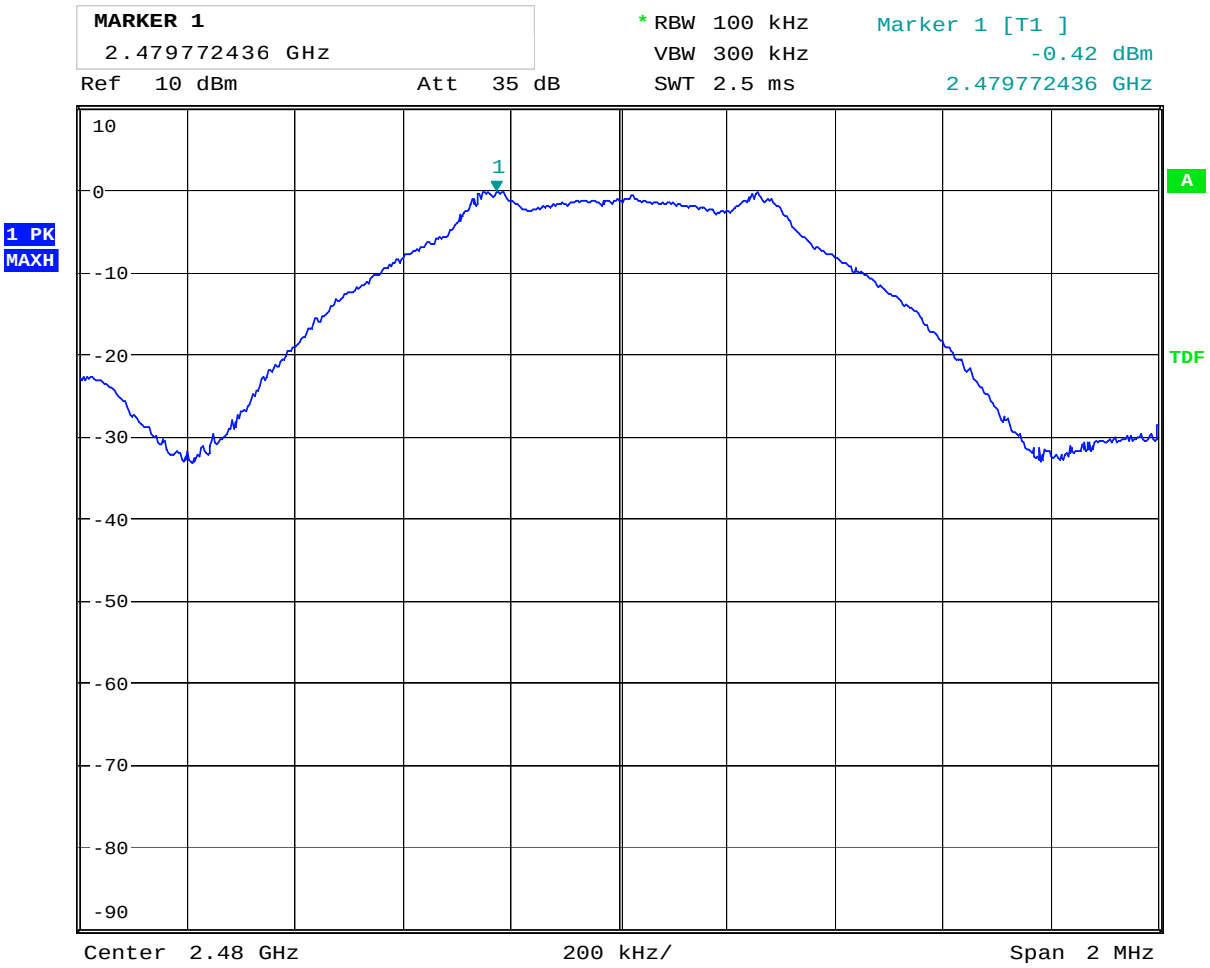
Date: 25.OCT.2012 10:57:48

PSD, 2402 MHz



Date: 25.OCT.2012 10:58:49

PSD, 2440 MHz



Date: 25.OCT.2012 10:59:34

PSD, 2480 MHz

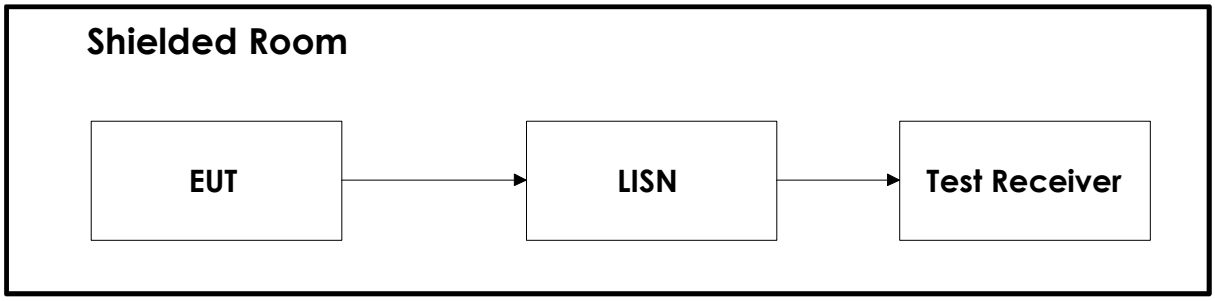
5 LIST OF TEST EQUIPMENT

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.

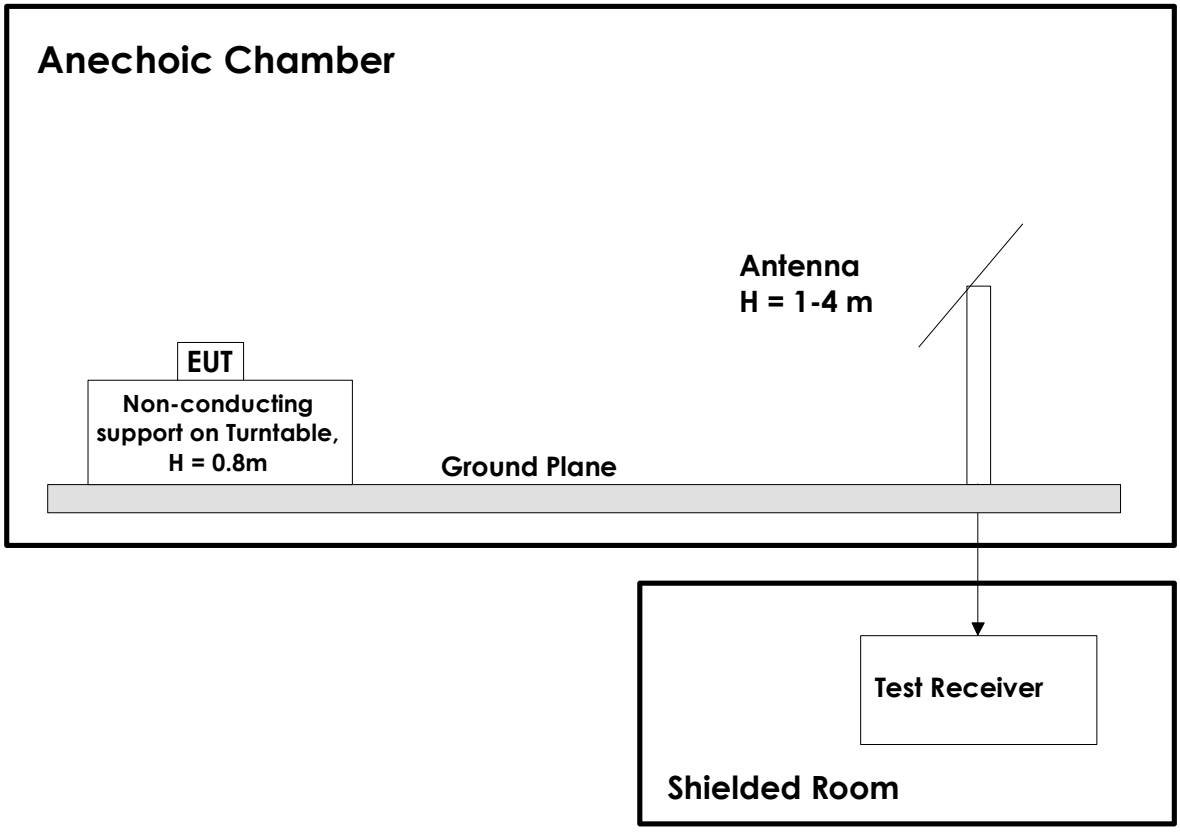
No.	Model number	Description	Manufacturer	Ref. no.	Cal. date	Cal. Due
1	FSU26	Spectrum Analyzer	Rohde & Schwarz	LR 1504	2011-11	2013-11
2	ESU40	Measuring Receiver	Rohde & Schwarz	LR 1639	2012-06	2013-06
3	4768-10	Attenuator	Narda	LR 1356	Cal b4 use	
4	6HC3000/18000	Highpass Filter	Trilithic	LR 1614	Cal b4 use	
5	JB3	BiLog Antenna	Sunol Sciences	N-4525	2011.09.07	2014.09.07
6	LNA6900	Preamplifier	Teseq	LR 1593	2010.11.16	2012.11.16
7	3115	Horn Antenna	EMCO	LR 1330	2010.08.05	2013.08.05
8	8449A	Pre-amplifier	Hewlett Packard	LR 1322	2011.09.27	2012.09.27
9	643	Antenna Horn	Narda	LR 093	2009.01.26	2014.01.26
10	PM7320X	Antenna Horn	Sivers Lab	LR 102	2009.01.26	2014.01.26
11	DBF-520-20	Antenna Horn	Systron Donner	LR 100	2009.01.26	2014.01.26
12	638	Antenna Horn	Narda	LR 1480	2010.06.17	2013.06.17
14	HFH2-Z2	Loop Antenna	Rohde & Schwarz	LR 285	2010.10.08	2013.10.08

6 BLOCK DIAGRAM

6.1 Power Line Conducted Emission



6.2 Test Site Radiated Emission



6.3 Conducted Tests