



**Test report no. : 162018-6**

**Item tested : RC2400HP Hi gain antenna**

**Type of equipment : IEEE 802.15.4,  
2.4 GHz Evaluation Module**

**FCC ID : Y2NRC24XXHP**

**Client : Radiocrafts AS**

Limited Test report

**FCC Part 15.247**

Digital Transmission System

**RSS-210 Issue 8 & RSS Gen Issue 3**

Low Power Licence-Exempt  
Radio communication Devices

**6 April 2011**

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

A handwritten signature in blue ink, reading 'Frode Sveinsen'.

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  
Email: [comlab@nemko.no](mailto:comlab@nemko.no)  
FCC test firm : 994405  
IC OATS : 2040D-1  
Total Number of Pages: 27

### 1.2 Client Information

Name : Radiocrafts AS  
Address : Sandakerveien 64,  
0484 Oslo, Norway  
Telephone : +47 40 00 51 95  
Fax : --

**Contact:**

Name : Ørjan Nottveit  
Telephone : +47 40 00 51 95  
E-mail : [radiocrafts@radiocrafts.com](mailto:radiocrafts@radiocrafts.com)

### 1.3 Manufacturer

Same as client

## 2 Test Information

### 2.1 Test Item

Name :	Radiocrafts
Model/version :	RC2400HP Hi gain antenna
Serial number :	-
Hardware identity and/or version:	-
Software identity and/or version :	-
Frequency Range :	2405 – 2480 MHz
Number of Channels :	16
Operating Modes :	TX & RX
Type of Modulation :	DSSS/O-QPSK
Emissions Designator :	G1D
User Frequency Adjustment :	None, Software controlled
Rated Output Power :	100mW
Type of Power Supply :	3.6Vdc
Antenna Connector :	Reversed SMA
Antenna type:	Hi gain antenna
Antenna Diversity Supported :	None

#### Theory of Operation

The RC24xx RF-transceiver module for the 2.4 GHz ISM band. It is based on a system on- chip device. The physical layer of the radio is according to IEEE 802.15.4 with Direct Sequence Spread Spectrum(DSSS) and offset-QPSK modulation. The program is stored in flash and the temporary variables in the SW is stored in RAM.

## **2.2 Test Environment**

### **2.2.1 Normal test condition**

Temperature: 20 - 22 °C

Relative humidity: 20 - 40 %

Normal test voltage: 3.6Vdc

The values are the limit registered during the test period.

## **2.3 Test Period**

Item received date: 2010-12-09

Test period : from 2010-12-09 to 2011-01-10

### 3 TEST REPORT SUMMARY

#### 3.1 General

Manufacturer: Radiocrafts AS  
Model No.: RC2400HP Hi gain antenna  
Serial No.: /

All measurements are traceable to national standards.

The tests were conducted for the purpose of demonstrating compliance with FCC CFR 47 Part 15.247.

Radiated tests were conducted in accordance with ANSI C63.4-2009 and ANSI C63.10-2009. The radiated tests were made in a semi-anechoic chamber at measuring distances of 3 and 10 meters.

☒ New Submission

☒ Production Unit

☐ Class II Permissive Change

☐ Pre-production Unit

**DTS** Equipment Code

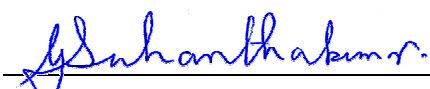
☐ Family Listing

**THIS TEST REPORT RELATES ONLY TO THE ITEM (S) TESTED.**

Deviations from, additions to, or exclusions from the test specifications are described in "Summary of Test Data".



**TEST REPORT #: 162018-6**

TESTED BY:   
G.Suwanthakumar, Test engineer

DATE: 2011-04-01

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This test report applies only to the items and configurations tested.

### 3.2 Test Summary

Name of test	FCC Part 15 reference	RSS210 Issue 8 & RSS Gen Issue 3	Result
Supply voltage variations	15.31 (e)	8 (RSS-GEN)	Complies <sup>2</sup>
Antenna requirement	15.203	7.1.4 (RSS-GEN)	Complies <sup>1</sup>
Radiated emissions limits for restricted bands	15.205(a)		Complies
Radiated emission limits	15.209(a)	A8.5	Complies
Peak Power Output	15.247(b)(3)	A8.4	Complies
Out-of-band emissions (Radiated)	15.247(c)	A8.5	Complies
Lower band edge radiated emission	15.247(c)	A8.5	Complies

<sup>1</sup> non- standard SMA connector (for laboratory use).

<sup>2</sup> The power is taken from extern power supply.

### 3.3 Description of modification for Modification Filing

Not applicable.

### 3.4 Comments

The channels are selected with a computer connected to the EUT. The computer is only used for selection of channels. The measurements are performed only at channels near bottom Ch 11. And the output level is set to maximum in the software. The EUT complies at this channel.

During radiated tests the selection of channels are done by manufacturer outside the test chamber..

The radiated measurements are tested on three axis.

An antenna connector is used only for making conducted RF measurements for evaluation purposes.

Power supply variation within manufacturer specified range 2.7 – 3.6V DC has no influence on measured values in this test report.

All radiated measurements are done with antenna type “Antenova Titanis”. This is the high gain antenna.

### 3.5 Family List Rationale

Not Applicable.

## 4 TEST RESULTS

### 4.1 Peak Power Output

Para. No.: 15.247 (b)

Test Performed By: G.Suhandhakumar

Date of Test: 10-Dec-2010

Test Results: Complies

#### Measurement Data:

##### Maximum Field strength

RF channel	Ch 11	Ch 18	Ch 26
VP: Measured value (dBμV/m)	119.94	116.25	-
HP: Measured value (dBμV/m)	-	-	-
VP: Calculated power (mW)	295.59	126.51	-

Free filed formula is used to calculate the out-put power.

Power supply variation within manufacturer specified range 2.7 – 3.6V DC has no influence on measured values in this test report.

Detachable antenna?

☒ Yes ☐ No

If detachable, is the antenna connector non-standard?

☒ Yes ☐ No

Reversed SMA connector

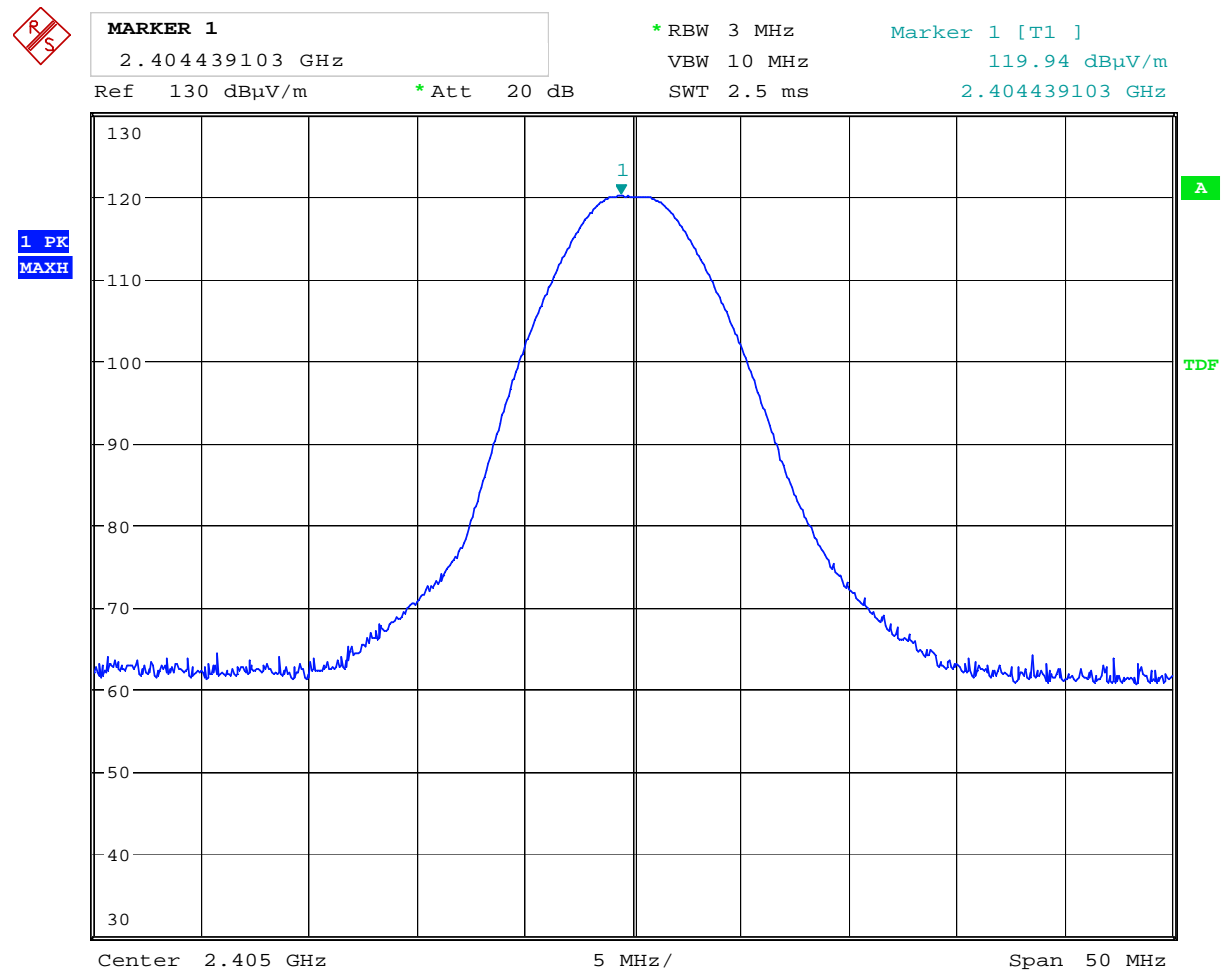
#### Requirements:

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

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

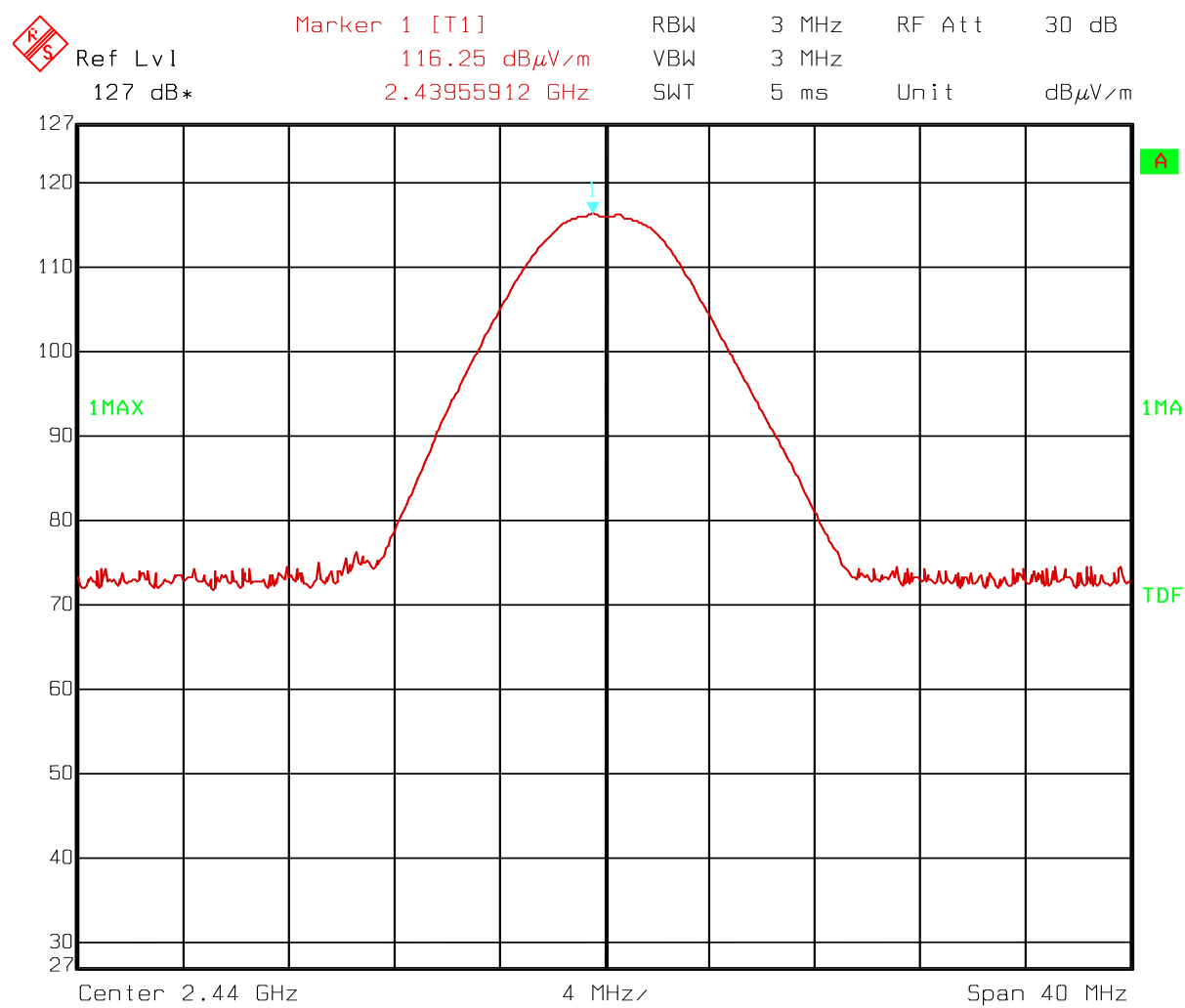
If transmitting antennas of directional gain greater than 6 dBi are used, the peak output power from the intentional radiator shall be reduced below the stated value above by the amount in dB that the directional gain of the antenna exceeds 6 dBi.





Date: 9.DEC.2010 12:03:26

**VP: Ch11 – Field strength**



Date: 10.JAN.2011 09:11:27

VP: Ch18 – Field strength

## 4.2 Spurious Emissions (Radiated)

Para. No.: 15.247 (c)

Test Performed By: G.Suwanthakumar

Date of Test: 10.12.2010

Test Results: Complies

Measurement Data:

Lower Band-edge radiated measurements

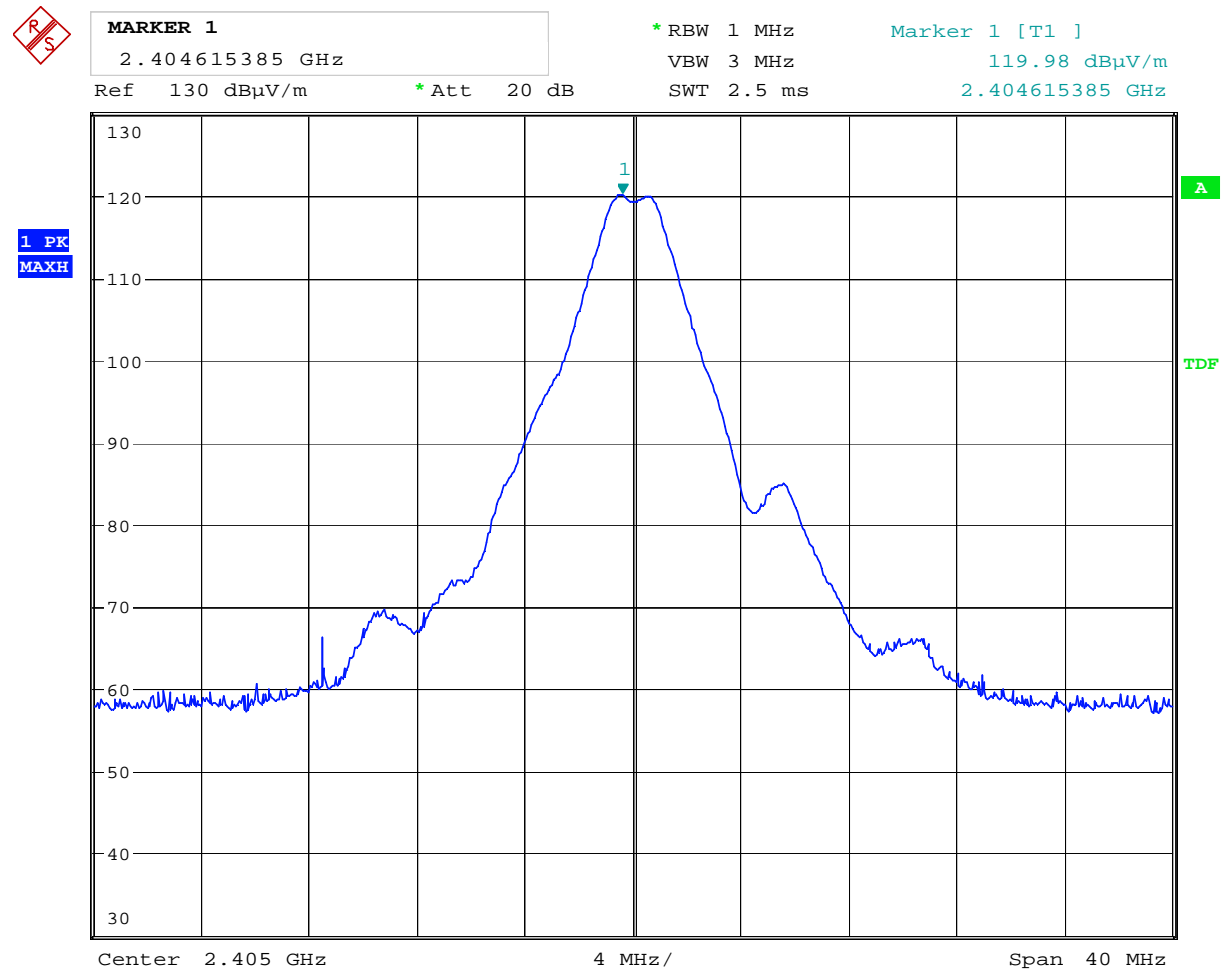
Frequency	Power below nearest channel, dB	Limit	Margin
GHz	RF ch 11 DSS	dB	dB
2.39	64.58	-20	44.58

Band-edge field strength 2.4 GHz:

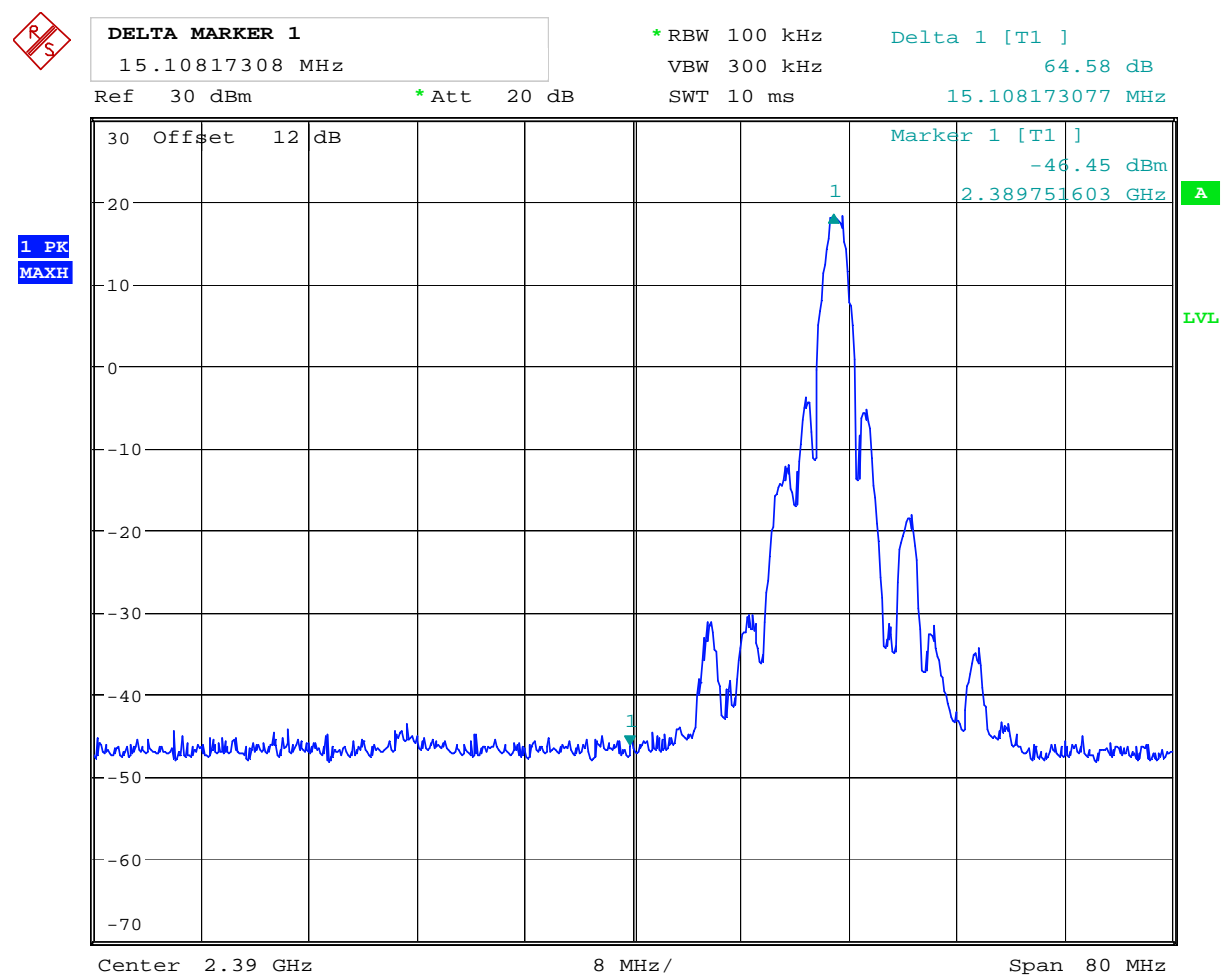
Marker Delta 100kHz RBW: 64.58dB

Peak Field Strength  $119.98 - 64.58 = 55.4$  dB $\mu$ V/m

100% duty cycle



Date:      9.DEC.2010    12:02:52



Date: 10.DEC.2010 14:13:44

**Ch11 – Lower-band-edge – Delta-marker**

**Duty Cycle Calculation:**

**Manufacturer statement:**

IEEE 802.15.4-2003 are used for application with low power consumption and in normal operation mode the TX duty cycle is much less than 1 %.

However, calculation have been made to show the maximum theoretical TX on time is 27%. This is based on max length packet of 127 bytes + preamble/sync. (4,256 ms per packet).

With up to 6,3 packets per 100ms this render max duty cycle of 27%.

Hence this approval is based on ZigBee or any other protocols ensuring max TX duty cycle of 27%

$$\text{Duty Cycle Correction Factor} = 20 \log (27/100) = 11 \text{ dB}$$

**Radiated Emissions with antenna, 1-25 GHz, peak**

1-18 GHz measured at a distance of 3m, 18-25 GHz measured at 1m.

**Measured with Peak Detector**

Frequency	RF channel	Dist. corr. factor	Field strength, Peak	Duty cycle corr. factor	Limit	Margin
GHz	11-26	dB	dB $\mu$ V/m	dB	dB $\mu$ V/m	dB
4.811	11	0	-	-	74	-
4.881	18	0	47.55	-	74	26.45
4.960	26	0	-	-	74	-
7,215	11	0	-	-	74	-
7,32	18	0	63.87	-	74	10.13
7,44	26	0	-	-	74	-
12,025	11	*	-	-	74	-
12,2	18	*	48.3	-	74	25.7
12,4	26	*	-	-	74	-
14,43	11	*	-	-	74	-
14,64	18	*	43.53	-	74	30.47
14,88	26	*	-	-	74	-
18 - 25	11,18,26	0	None detected	-	-	-

\* corrected on the plot , -9.5dB

**Non-restricted band spurious emission , Radiated – Peak detector**

Frequency	RF channel	Dist. corr. factor	Field strength, Peak	Field strength of desired frequency	Limit	Margin
GHz	11-26	dB	dB $\mu$ V/m	dB $\mu$ V/m	dB	dB
9.62	11	*	-	-	> 20	-
9.76	18	*	74.19	116.25	> 20	42.06
9.92	26	*	-	-	> 20	-
16.835	11	*	-	-	> 20	-
17.08	18	*	53.41	116.25	> 20	62.84
17.36	26	*	-	-	> 20	-

**Radiated emissions with antenna, 1- 25 GHz, Average**

Frequency	RF channel	Dist. corr. factor	Duty cycle corr. factor	Field strength, Peak	Limit	Margin
GHz	11-26	dB	dB	dB $\mu$ V/m	dB $\mu$ V/m	dB
4.811	11	0	11	-	54	-
4.881	18	0	11	36.55	54	17.45
4.960	26	0	11	-	54	-
7,215	11	0	11	-	54	-
7,32	18	0	11	52.87	54	1.13
7,44	26	0	11	-	54	-
12,025	11	*	11	-	54	-
12,2	18	*	11	37.3	54	16.7
12,4	26	*	11	-	54	-
14,43	11	*	11	-	54	-
14,64	18	*	11	32.53	54	21.47
14,88	26	*	11	-	54	-
18 - 25	11,18,26	0	11	None detected	-	-

\* corrected on the plot , -9.5dB The maximum is observed in vertical polarization

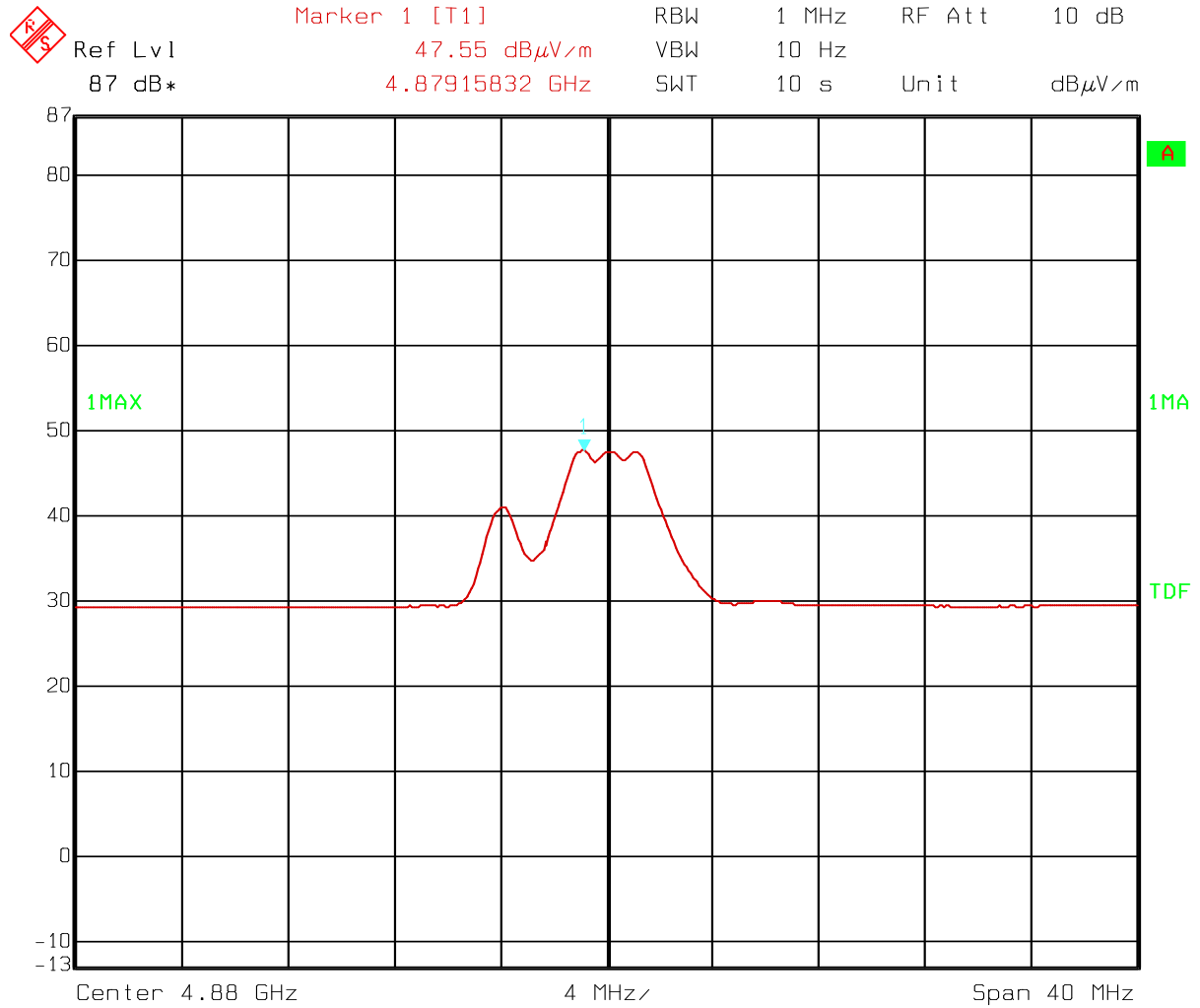
Antenna factor, amplifier gain and cable loss are included in spectrum analyzer "Transducer factor".

Restricted bands according to part 15.205 : 2310 – 2390 MHz , 483.5 – 2500 MHz, 7.250 – 7.750 GHz , 10.6 - 12.7 GHz , 14.47 - 14.5GHz and 15.35 - 16.2 GHz

**Requirement:**

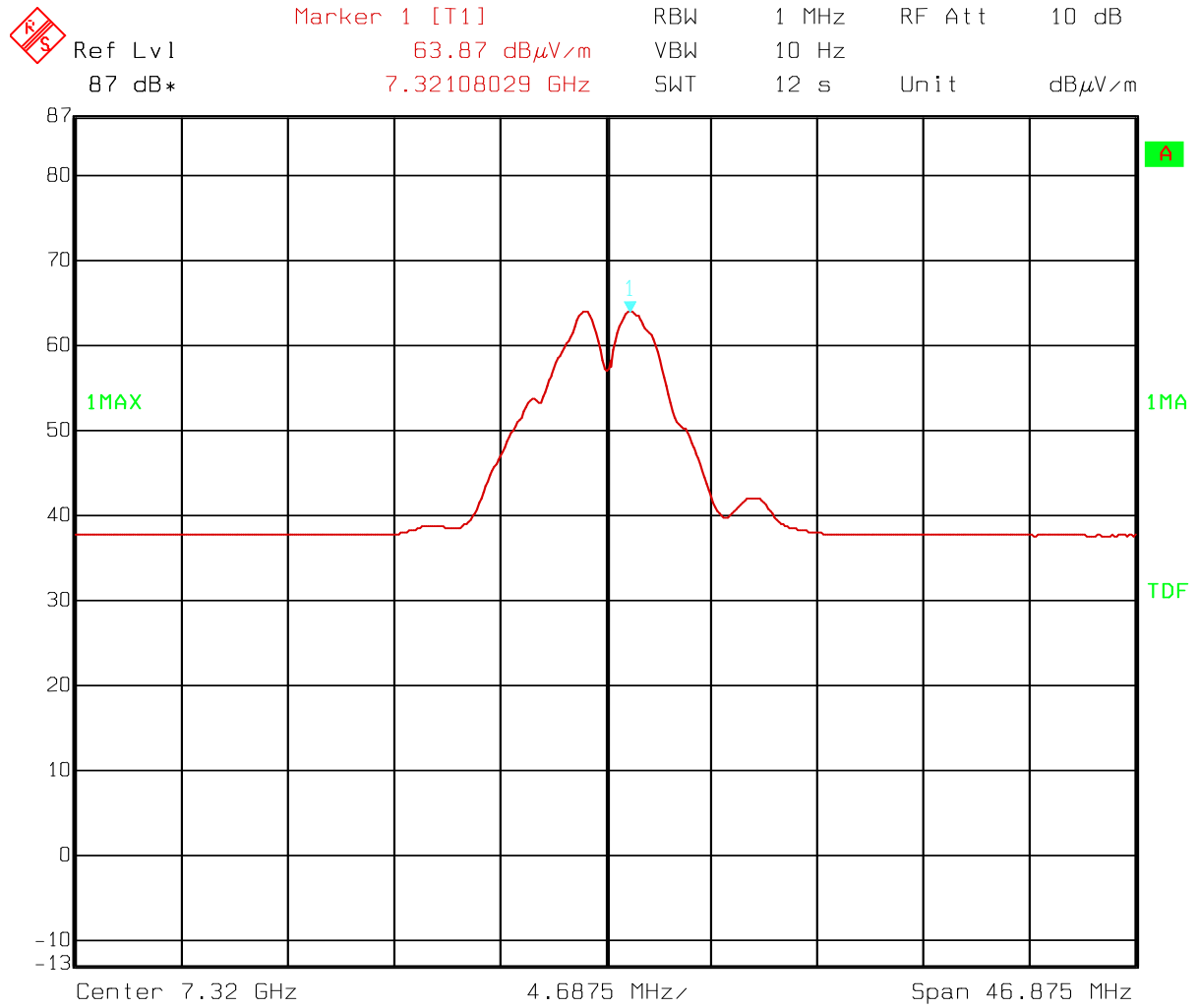
(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).





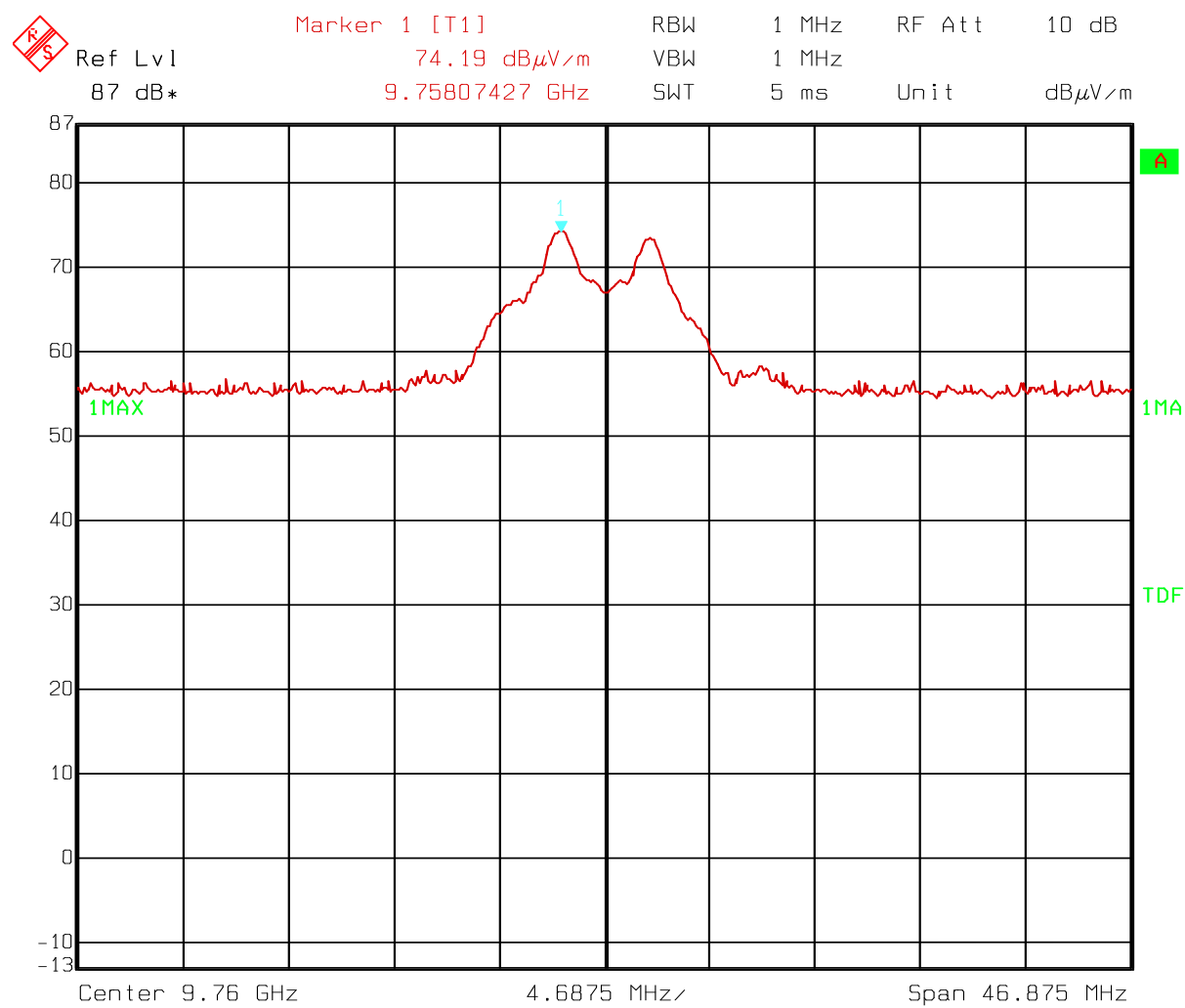
Date: 10.JAN.2011 09:05:49

**Ch18 – 2<sup>nd</sup> Harmonic**



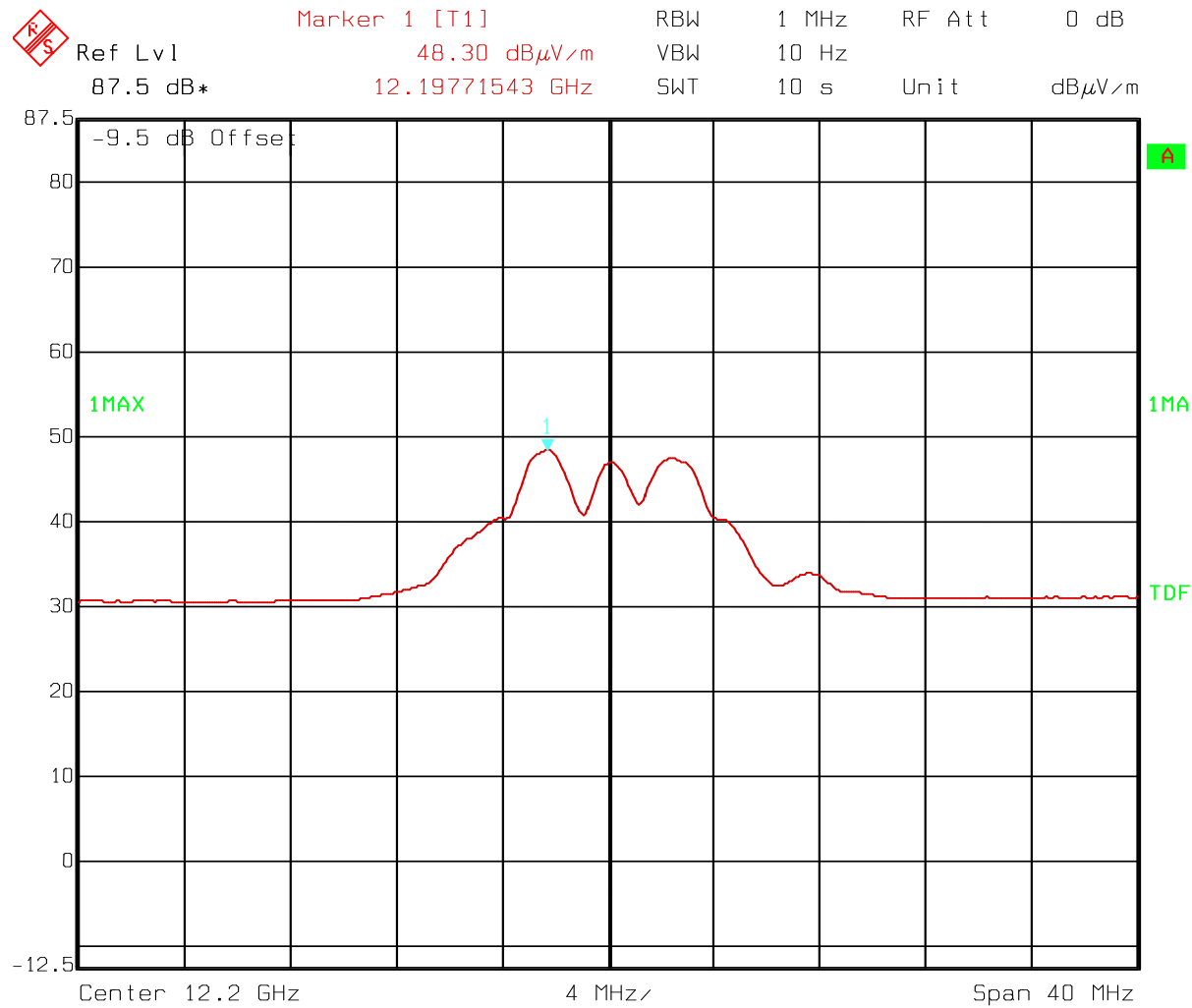
Date: 10.JAN.2011 08:52:29

**Ch18 – 3<sup>rd</sup> Harmonic**



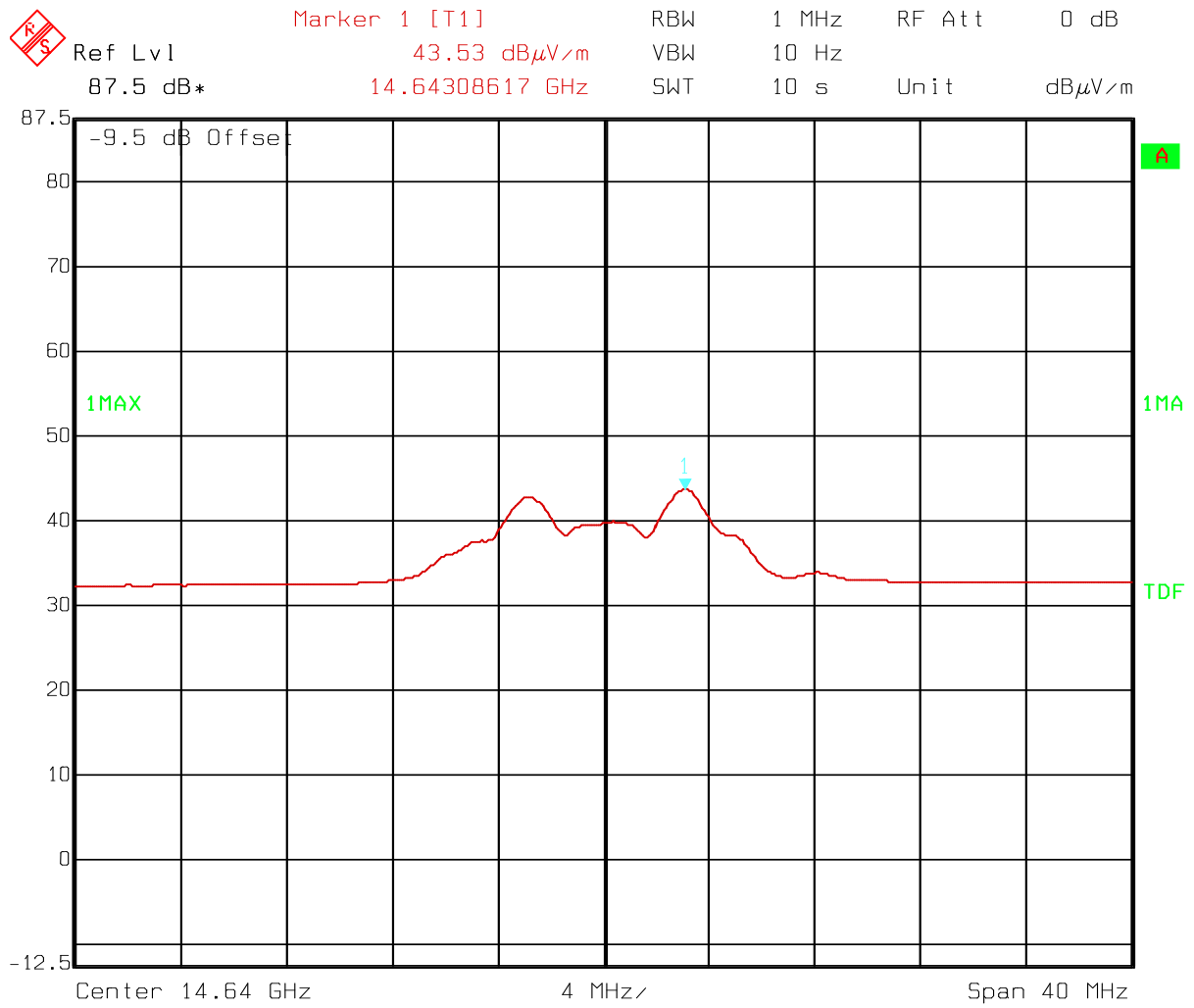
Date: 10.JAN.2011 08:41:04

Ch18 – 4<sup>th</sup> Harmonic



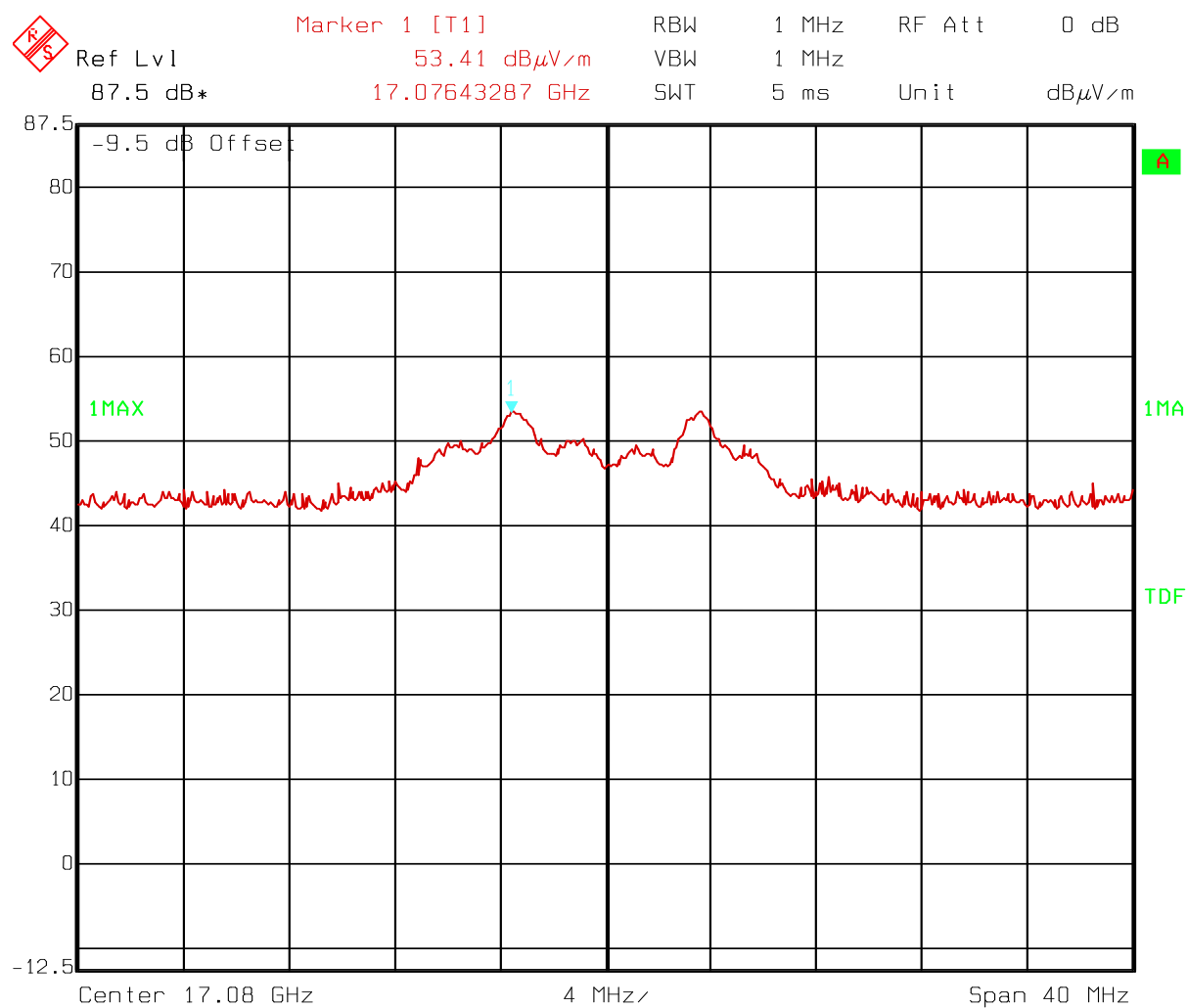
Date: 10.JAN.2011 09:18:07

**Ch18 – 5<sup>th</sup> Harmonic**



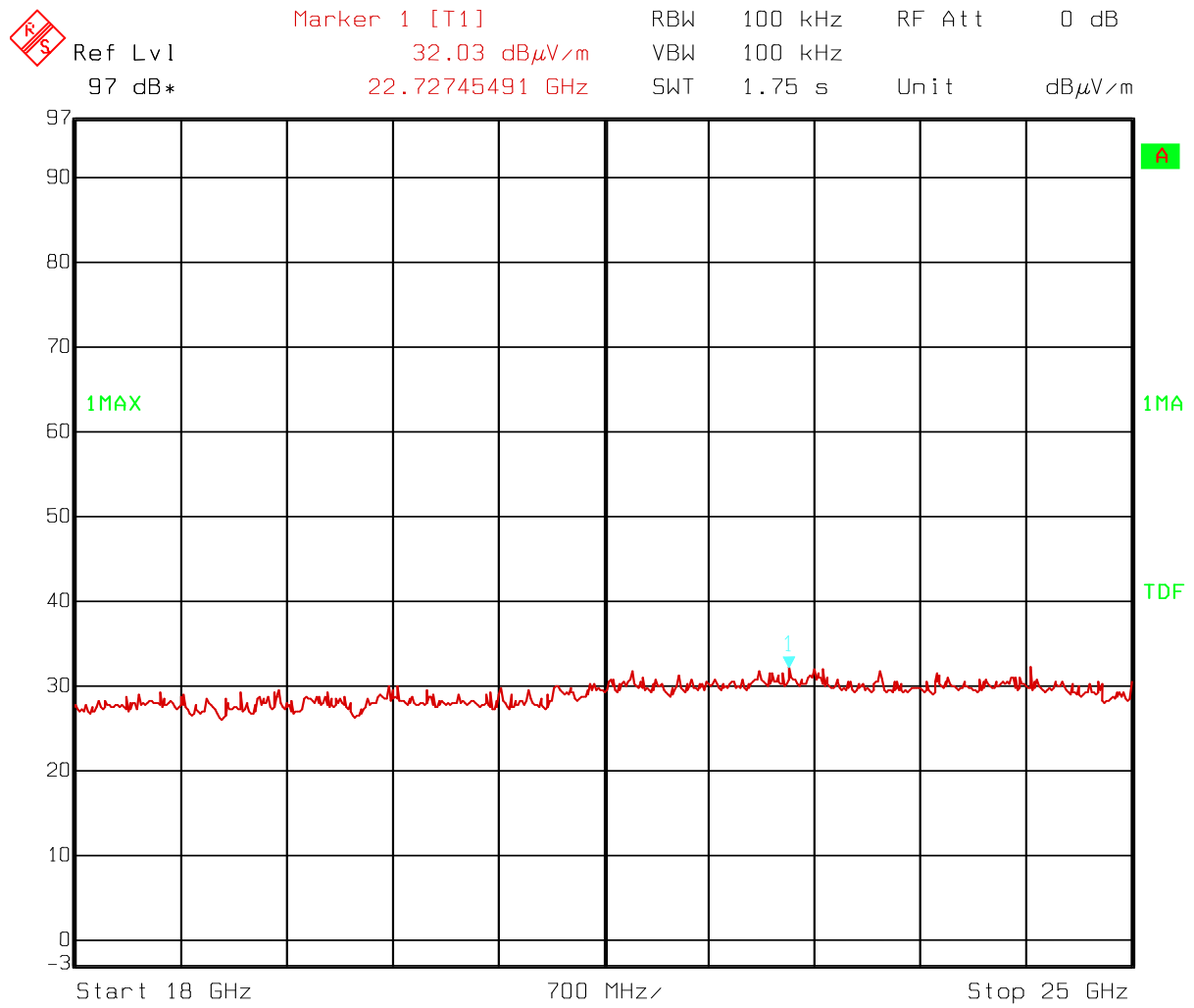
Date: 10.JAN.2011 09:21:28

**Ch18 – 6<sup>th</sup> Harmonic**



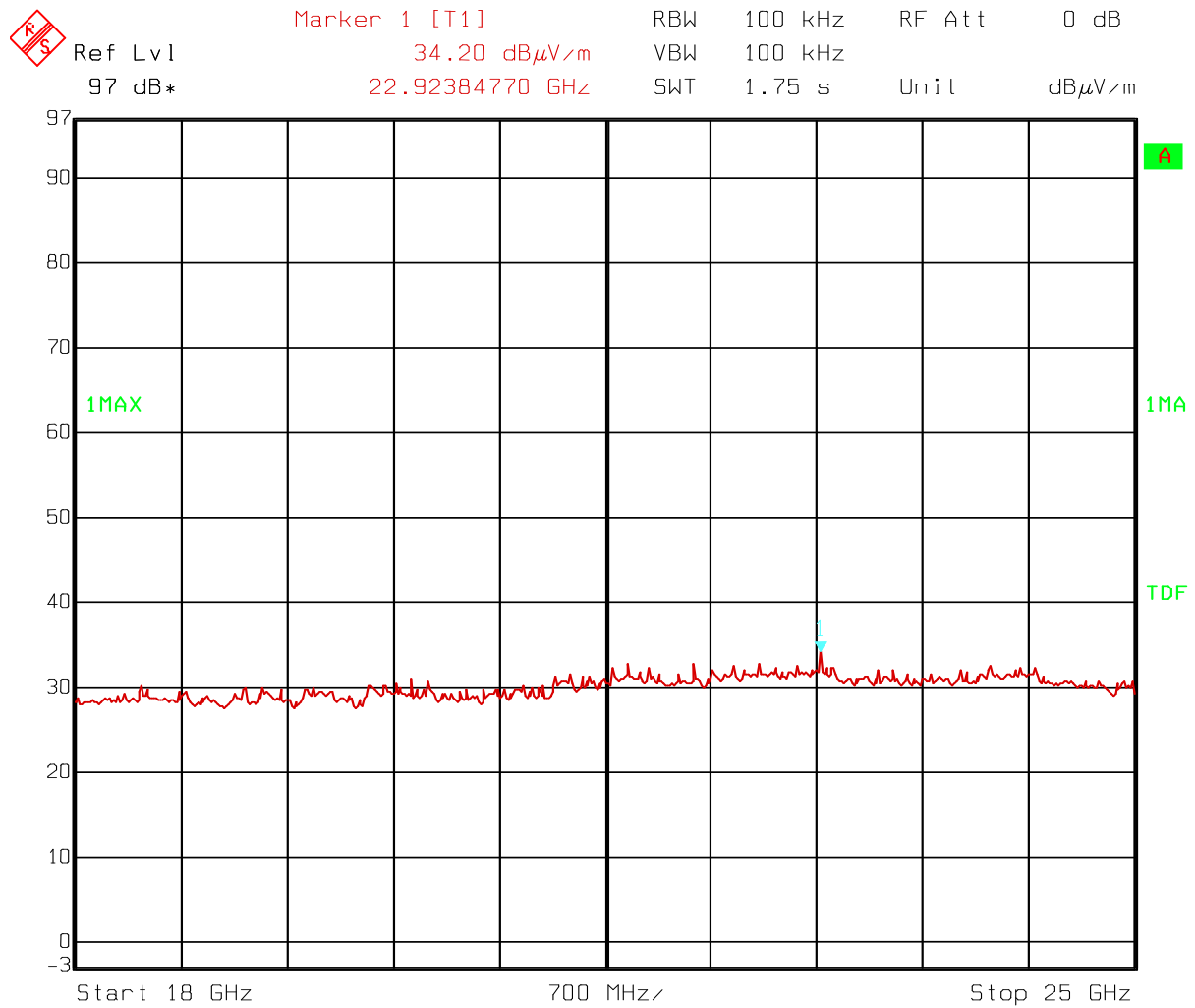
Date: 10.JAN.2011 09:23:48

### Ch18 – 7<sup>th</sup> Harmonic



Date: 10.JAN.2011 09:41:12

**CH 18-VP, pre-view scan 18 - 25GHz**



Date: 10.JAN.2011 09:43:41

**Ch18 – HP, pre-view scan 18 - 25GHz**



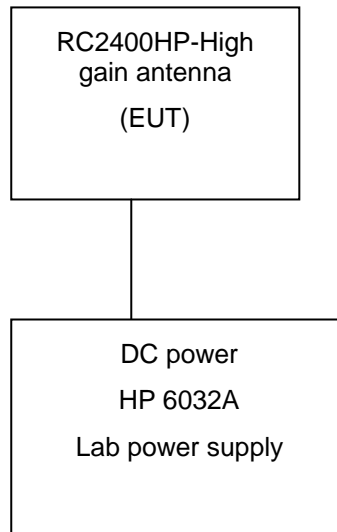
## 5 LIST OF TEST EQUIPMENT

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	28.09.2010	28.09.2011
2.	ESCI	EMI Receiver	Rohde & Schwarz	N 4259	09.09.2010	09.09.2011
3.	FSEK 1088,3494,30	Spectrum Analyzer	R&S	1337	15.12.2010	15.12.2011
4.	U2000A	USB power meter	Agilent Technology	LR 1523	15.01.2010	15.01.2011
5.	3115	Antenna horn	EMCO	LR 1330	05.08.2010	05.08.2013
6.	643	Antenna horn	Narda	LR 093	26.01.2009	26.01.2012
7.	642	Antenna horn	Narda	LR 220	26.01.2009	26.01.2012
8.	PM7320X	Antenna horn	Sivers lab	LR 103	26.01.2009	26.01.2012
9.	DBF-520-20	Antenna horn	Systron Donner	LR 101	26.01.2009	26.01.2012
10.	638	Antenna horn	Narda	LR 098	26.01.2009	26.01.2012
11.	Sucoflex 102E	Cable microwave	Suhner	LR 1370	-	-
12.	6032A	Power supply	HP	LR 1062	-	-
13.	77	Multimeter, Digital	Fluke	LR155	03.11.2010	03.11.2011
14.	8449B	Amplifier	Hewlett Packard	LR 1322	04.08.2009	04.08.2011
15.	HFH2-Z2	Antenna loop	Rohde and Schwarz	LR 285	08.10.2010	08.10.2013
16.	10855A	Amplifier	Hewlett Packard	LR 1445	04.08.2010	04.08.2011
17.	HL223	Antenna log.per	Rohde & Schwarz	LR 1261	19.05.2010	09.05.2013
18.	HK116	Antenna biconic	Rohde & Schwarz	LR 1260	19.05.2010	09.05.2013
19.	ESN	Test Receiver	Rohde & Schwarz	LR 1237	16.09.2010	06.09.2011
20.	ESH3-Z3	LISN	Rohde & Schwarz	LR 1076	22.10.2009	22.10.2011
21.	B32-10R	Power supply	Oltronix	LR 126	-	-
22.	ESAI	EMI Receiver	Rohde & Schwarz	LR 1090/1089	04.03.2010	04.03.2011
23.	ESH3-Z2	Pulse Limiter	Rohde & Schwarz	LR 1074	03.03.2010	03.03.2012

## 6 BLOCK DIAGRAM

### 6.1 System set up for radiated measurements



Test equipment: 1, 2, 3, 4, 6, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18

## 6.2 Test Site Radiated Emission

