



**Test report no. : 176935-4**

**Item tested : DoseAware Base station**

**Type of equipment : Low power Transceiver  
903 - 927MHz Electronic X-ray  
dose monitoring system**

**FCC ID : XWK8603022**

**Client : Unfors Instruments AB**

**FCC Part 15.249**

Low Power Transceiver  
902-928 MHz Band

**RSS-210, Issue 8 and RSS-GEN, Issue 3**

Low-Power Licence-exempt Radiocommunications devices  
902 – 928 MHz Band

**21 September 2011**

**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  
Email: [comlab@nemko.no](mailto:comlab@nemko.no)  
FCC test firm : 994405  
IC OATS : 2040D-1  
Total Number of Pages: 57

### 1.2 Client Information

Name : Unfors Instruments AB  
Address : Uggledalsvagen 29,  
SE-427 40 Billdal  
Telephone : +46 31 719 97 00  
Fax : +46 31 910 950

**Contact:**

Name : Mats Quick  
Telephone : +46 31 719 97 00  
E-mail : [info@unfors.se](mailto:info@unfors.se)

### 1.3 Manufacturer

Same as client

## 2 Test Information

### 2.1 Test Item

Name :	DoseAware Base station
Model/version :	4598 000 14852
Serial number :	/
Hardware identity and/or version:	/
Software identity and/or version :	/
Frequency Range :	903.0 - 927.0 MHz
Number of Channels :	1
Operating Modes :	TX & RX
Type of Modulation :	GFSK
Data rate:	125kbit/s
Emissions Designator :	/
User Frequency Adjustment :	None, Software controlled
Rated Output Power :	N/A
Type of Power Supply :	AC/DC adapter 100 - 250Vac, 50Hz/60Hz
Antenna Connector :	None (Integral antenna)
Antenna type:	/
Antenna Diversity Supported :	None

- 1) Only one channel in use at a time.
- 2) The power is supplied by 120V AC mains via AC/DC adapter. Since the EUT has low drop out (LDO) regulator the voltage variation of 85% and 115% does not affect the output power or frequency tolerance.

### Theory of Operation

The base station uses radio transceiver CC1100E from Texas instruments, which operates in the frequency band 902 – 928MHz. The base station is a part of a system called DoseAware. The base station displays the received radiation exposure in real time from the PDM(Personal dosimeter).The PDM is a portable radiation exposure measuring device worn by people who are working within the X-ray environment.

## **2.2 Test Environment**

### **2.2.1 Normal test condition**

Temperature: 23.3 – 24.1 °C  
Relative humidity: 41.1 – 42.4 %  
Normal test voltage: 120 V AC (Mains)

The values are the limit registered during the test period.

## **2.3 Test Period**

Item received date: 2011-06-16  
Test period : from 2011-06-16 to 2011-06-17

### 3 TEST REPORT SUMMARY

#### 3.1 General

Manufacturer: Unfors Instruments AB

Model No.: 4598 000 14852

Serial No.: -

All measurements are traceable to national standards.

The tests were conducted for the purpose of demonstrating compliance with FCC CFR 47 Part 15.249.

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

**DXT** Equipment Code

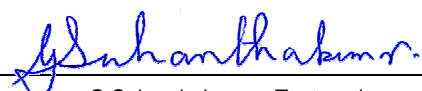
☐ Family Listing

**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 #: 176935-4**

TESTED BY:   
G.Suhanthakumar, Test engineer

DATE: 2011-09-15

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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)	4.5	Complies <sup>1</sup>
Transmitter frequency stability	15.31(m)	7.2.4	Complies
Antenna Requirement	15.203	7.1.4	NA <sup>2</sup>
Power-line Conducted Emission	15.207(c)	7.2.2	Complies
20 dB bandwidth	15.215(c)	-	Complies
Peak Power Output	15.249(a)(c)	A2.9	Complies
Band edge Emissions	15.249(d)	A.2.9	Complies
Spurious Emissions (Radiated)	15.249 (e)	A2.9 & 4.3	Complies
Spurious Emissions (Antenna Conducted)	15.249	7.2.3.1	Complies
Receiver Spurious Emissions (Radiated)	N/A	6 (RSS-GEN)	Complies
Receiver Spurious Emissions (Conducted)	N/A	6 (RSS-GEN)	Complies

<sup>1</sup> The power is taken from AC mains.

<sup>2</sup> integral antenna

RSS Gen issue 3 covers section 7 & 6

RSS 210 issue 8 covers section A2.9

### 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 at channels near top Ch >, near middle Ch > and near bottom Ch >. And the output level is set to maximum in the software. The EUT complies at these channels.

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

The radiated measurements are tested on three axis.

Power supply variation within between 85% and 115% has no influence on measured value.

### 3.5 Family List Rationale

Not Applicable.

## 4 TEST RESULTS

### 4.1 Power-line Conducted Emissions

Para. No.: 15.207 (a)

Test Performed By: G.Suwanthakumar	Date of Test: 17.06.2011
------------------------------------	--------------------------

Measurement procedure: ANSI C63.4-2009 using 50  $\mu$ H/50 ohms LISN.

Test Results: Complies.

Measurement Data: Peak detector was used.

The measured peak values are below the Quasi-Peak and Average limit

Measured at AC mains 120Vac/60Hz.

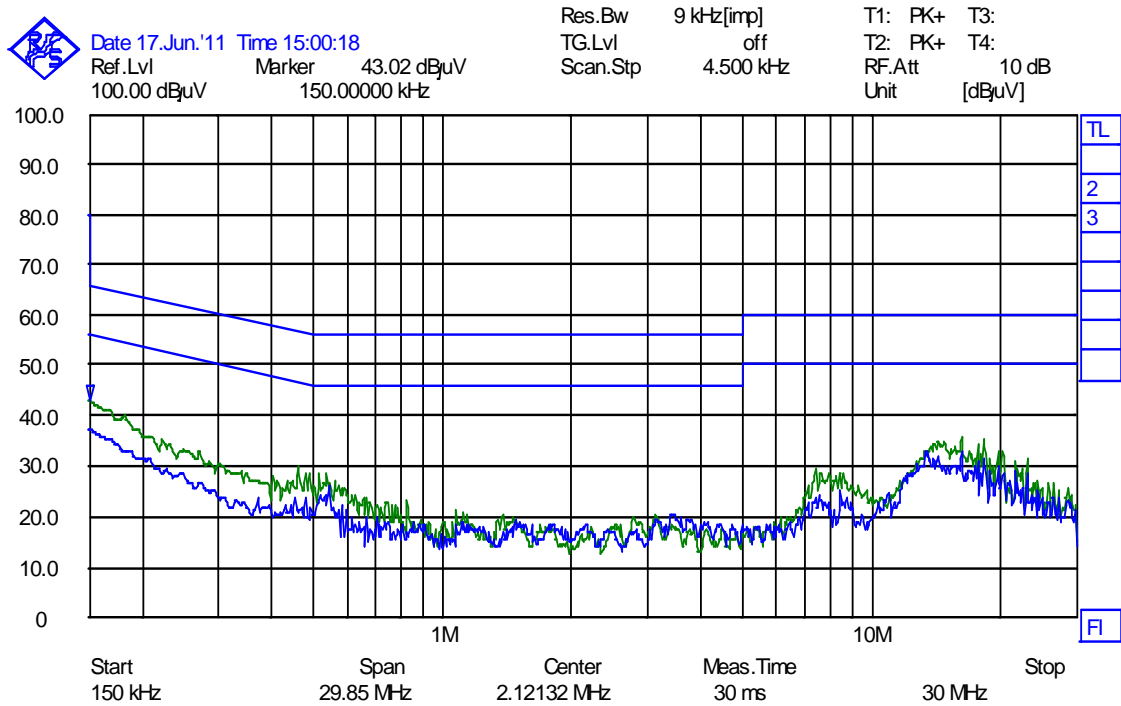
Model:DPS53-M

**Highest measured value (L and N):**

The measured peak values are below the Quasi-Peak and Average limit

See the attached plot for peak scans.





L1 & N polarity - power line conducted emission

## 4.2 Transmitter Frequency Stability

Para. No.: 15.31(m)/7.2.4

Test Performed By: G.Suwanthakumar

Date of Test: 16.06.2011

### Measurement Data:

Temperature	Channel nr.	Given Frequency (MHz)	Measured value (MHz)	Deviation (Hz)
20 ° C	Ch51	903.000	902.994840	-5160
	Ch52	915.000	914.994840	-5160
	Ch53	927.000	926.994840	-5160

Comment: Reported for information only. There are no requirements to frequency tolerance for low power devices in the 902-928 MHz band certified to 15.249 or RSS 210

### 4.3 20 dB Bandwidth

Para. No.: RSS-Gen

Test Performed By: G.Suwanthakumar

Date of Test: 16.06.2011

Test Results: Complies

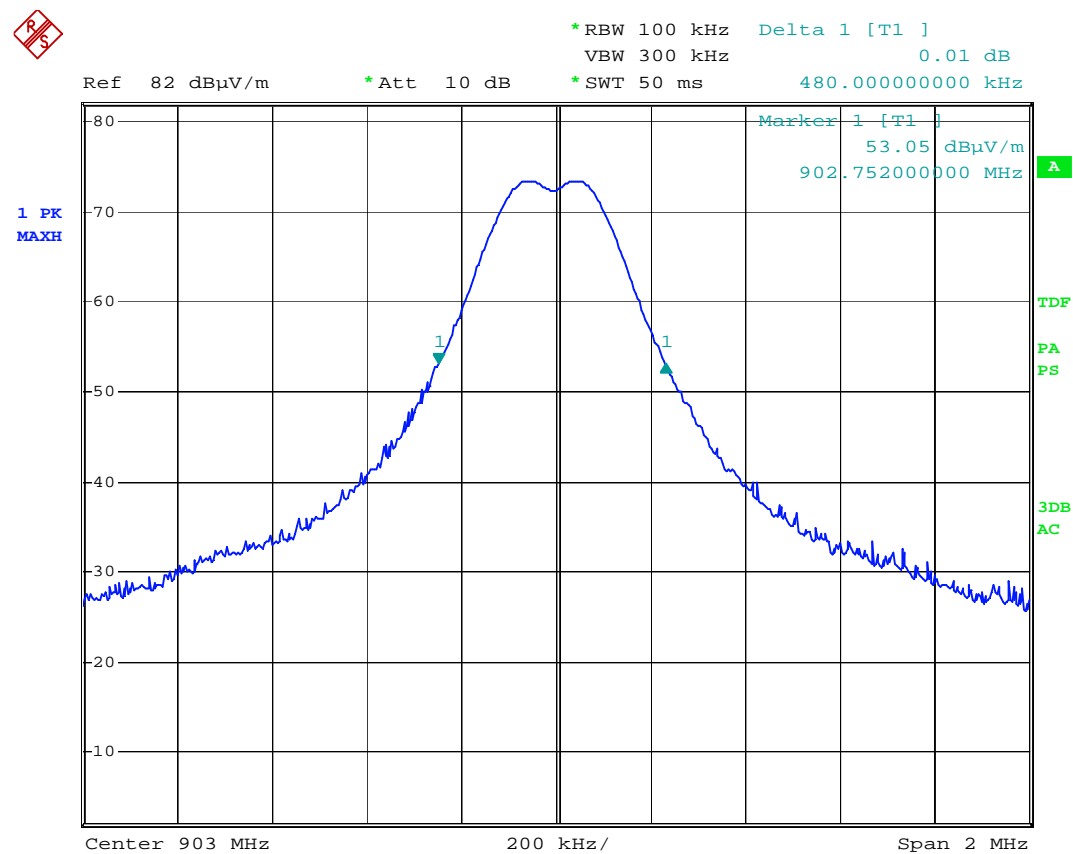
Measurement Data:

Data Rate	20 dB Bandwidth (kHz)		
	Ch 51 903.000MHz	Ch 52 915.000MHz	Ch 53 927.000MHz
120kbps	480	468	476

Power supply variation within between 85% and 115% has no influence on measured value.

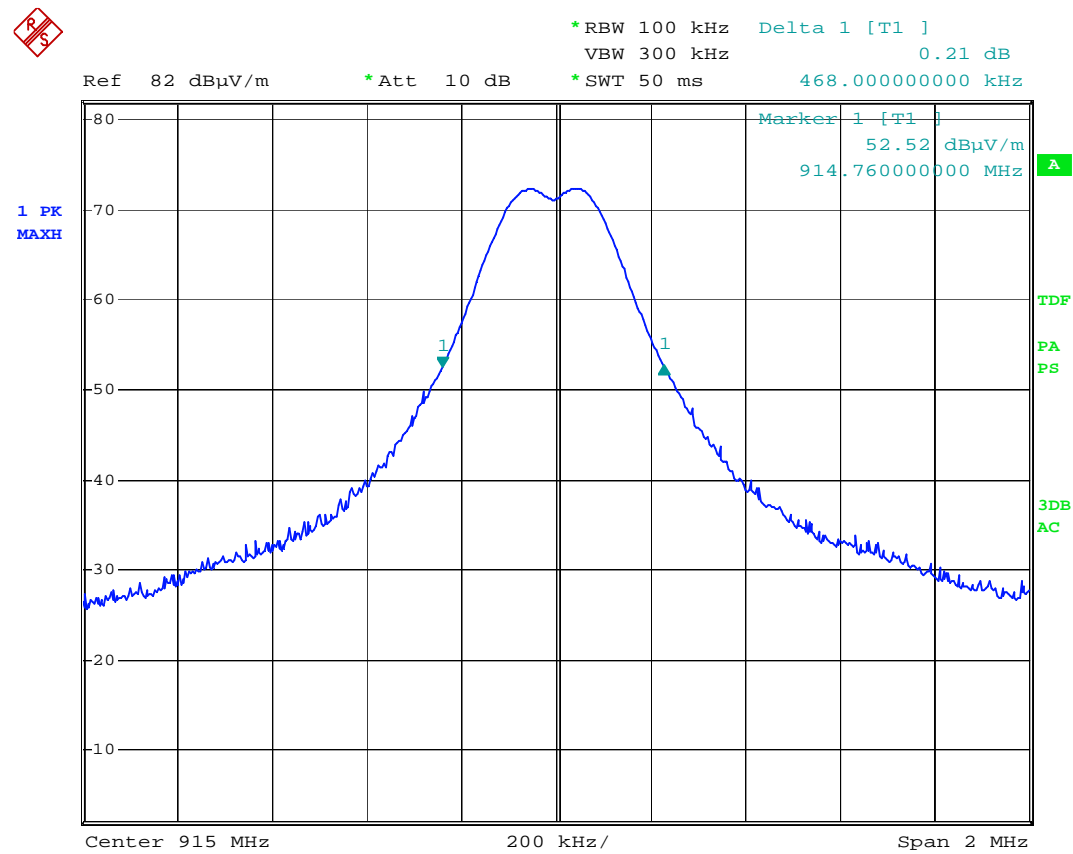
**Requirements:**

For information only



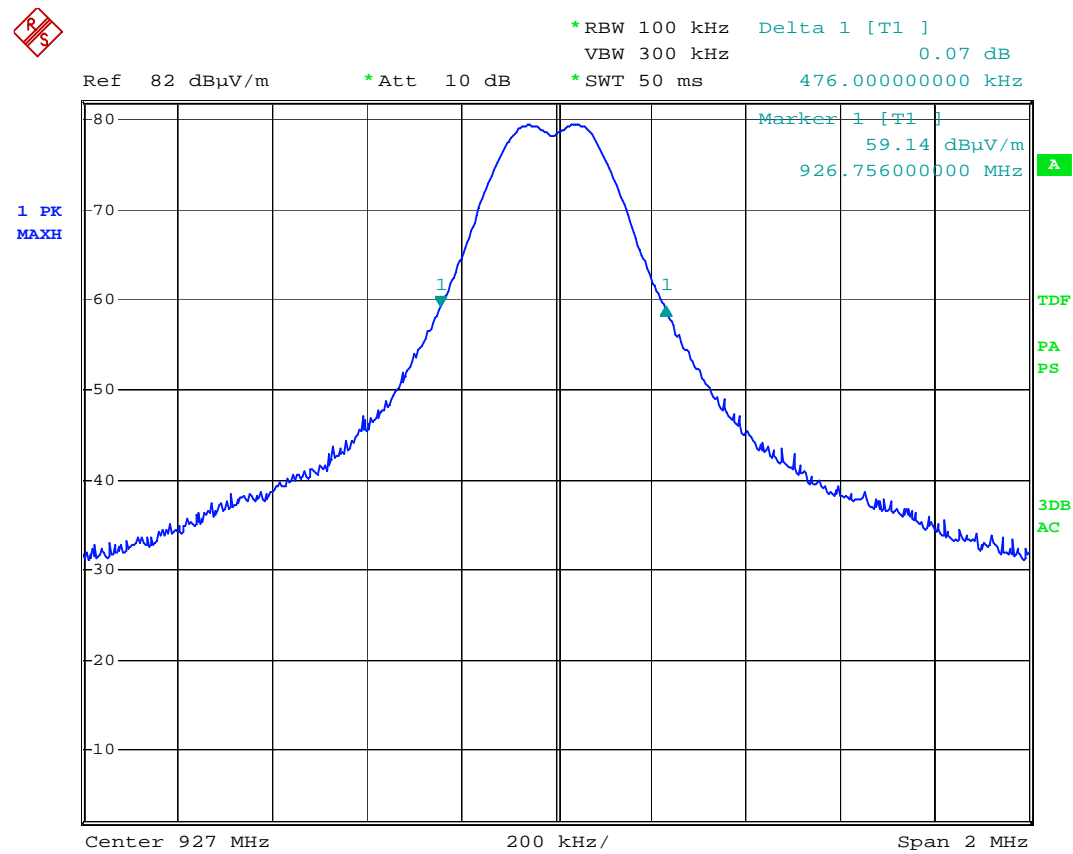
Date: 16.JUN.2011 10:50:16

**903MHz – 20 dB bandwidth – 480kHz**



Date: 16.JUN.2011 10:45:32

**915MHz – 20 dB bandwidth – 468kHz**



Date: 16.JUN.2011    10:59:33

**927MHz – 20 dB bandwidth – 476kHz**

## 4.4 Peak Power Output

Para. No.: 15.249 (a)/A.2,9

Test Performed By: G.Suhanthakumar

Date of Test: 16-June-2011

Test Results: Complies

Measurement Data:

Maximum Conducted Peak Output Power

RF channel	903MHz	915MHz	927MHz
@ >kbps, Measured value (dBm)	-20.49	-20.57	-20.74

Maximum Field strength

RF channel	903MHz	915MHz	927MHz
VP: Measured value (dB $\mu$ V/m)	73.46	73.99	79.41
HP: Measured value (dB $\mu$ V/m)	72.45	71.75	75.75

Radiated measurements are done at 3 m distance. Please see page 66 for test-setup

Detachable antenna?

☐ Yes ☒ No

If detachable, is the antenna connector non-standard?

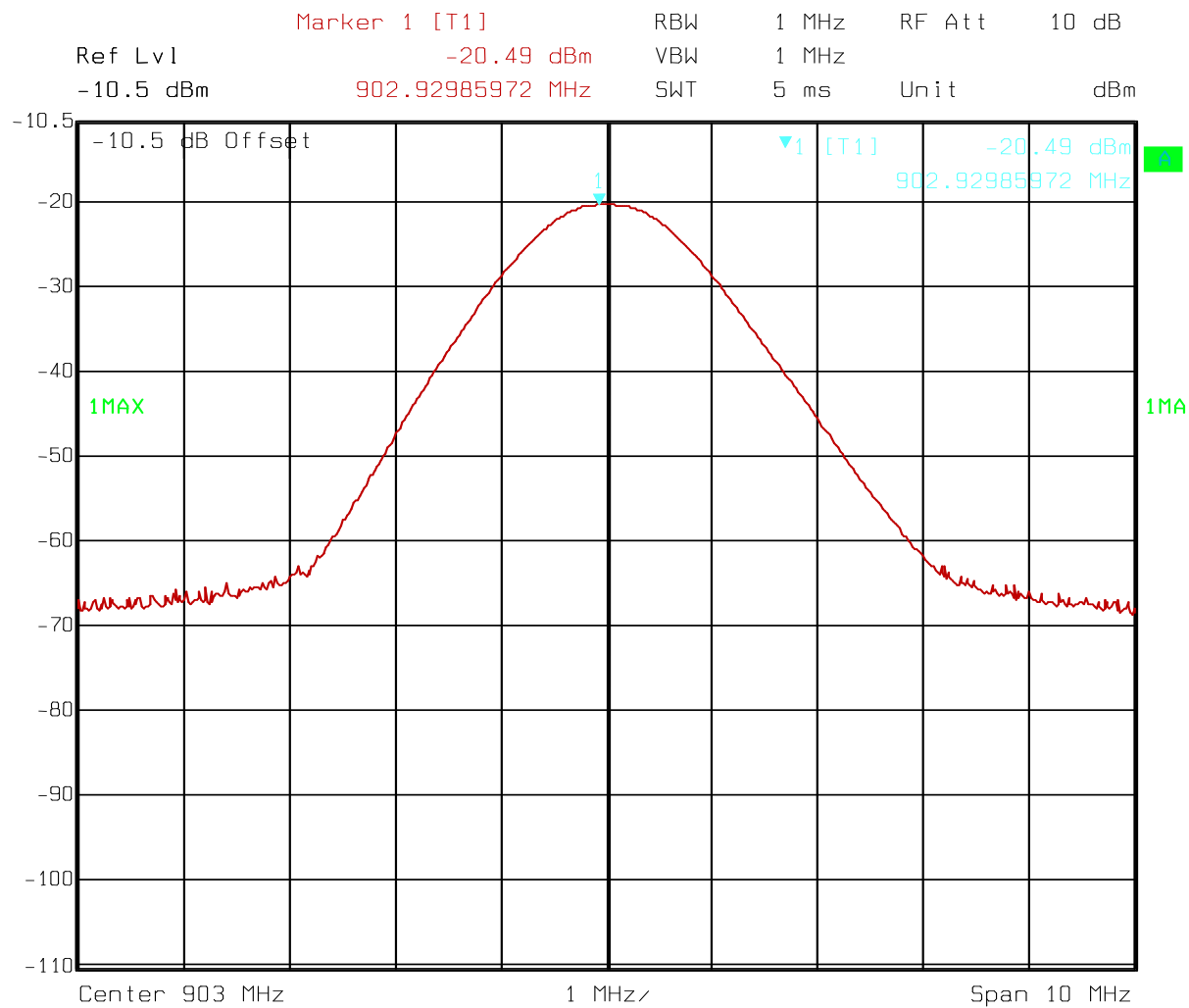
☐ Yes ☐ No

Reversed SMA connector

Power supply variation within between 85% and 115% has no influence on measured value.

Requirements:

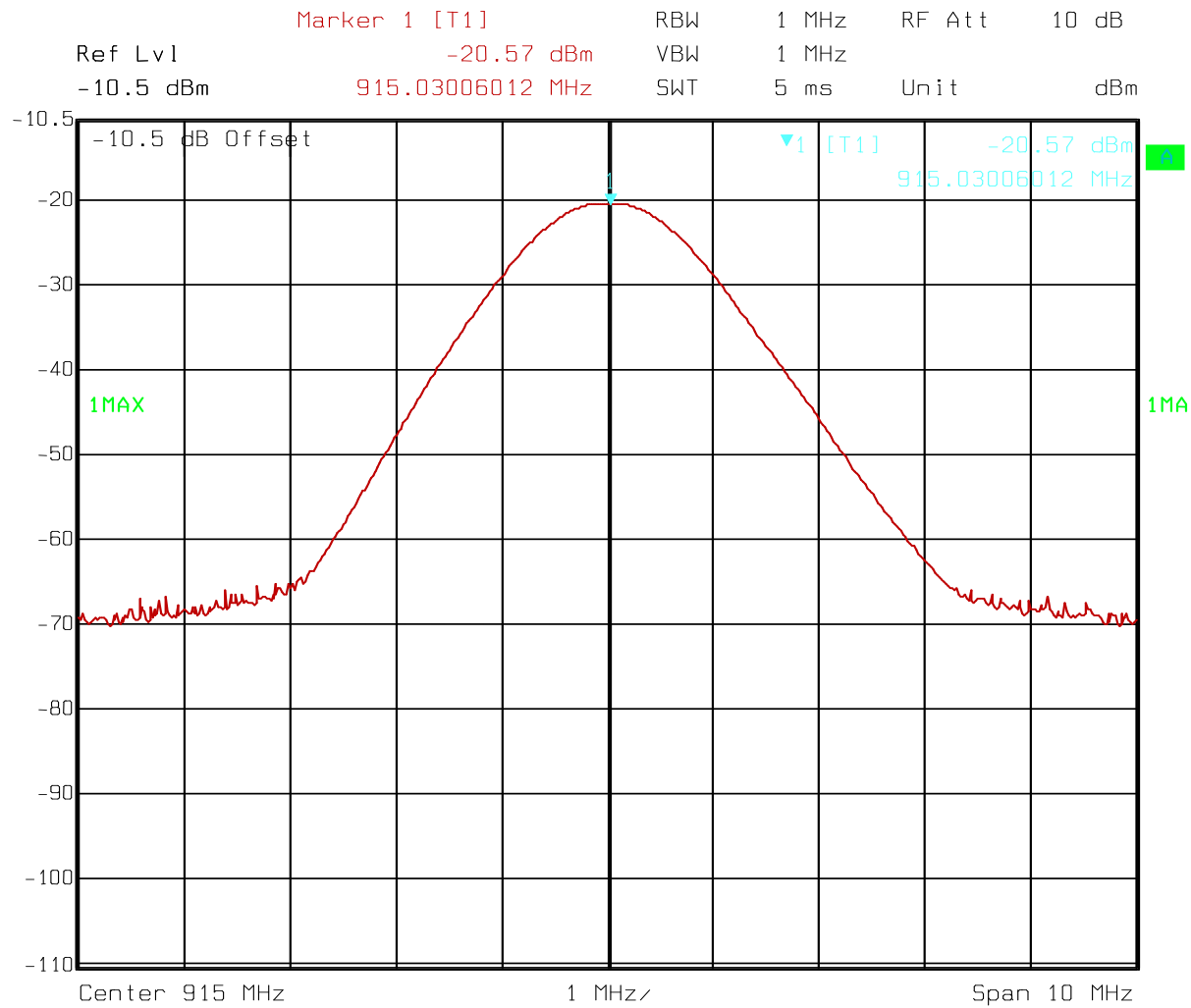
The maximum peak output power shall be  $\leq 94$ dB $\mu$ V/m



Date: 16.JUN.2011 13:02:01

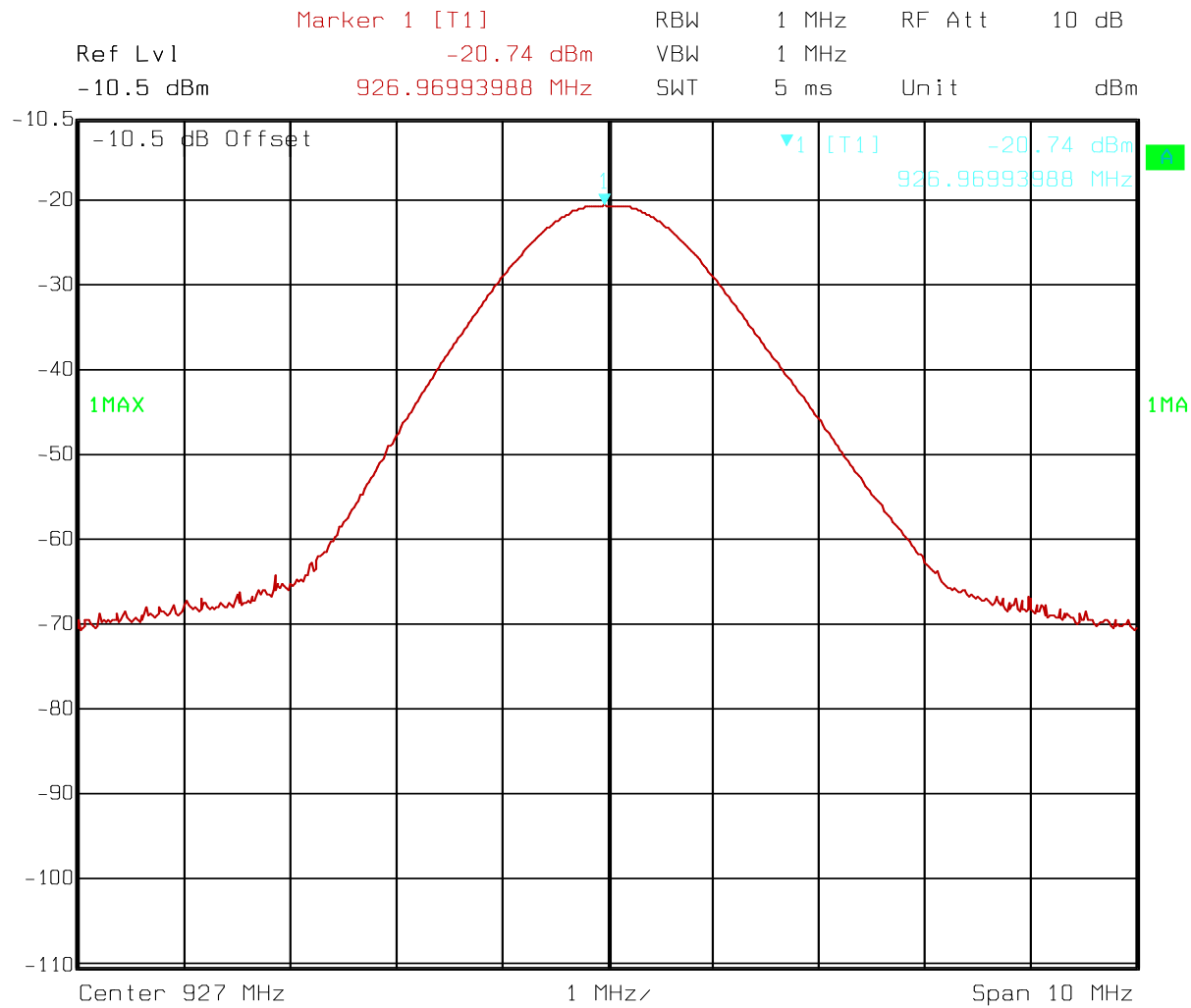
Conducted power – 903MHz





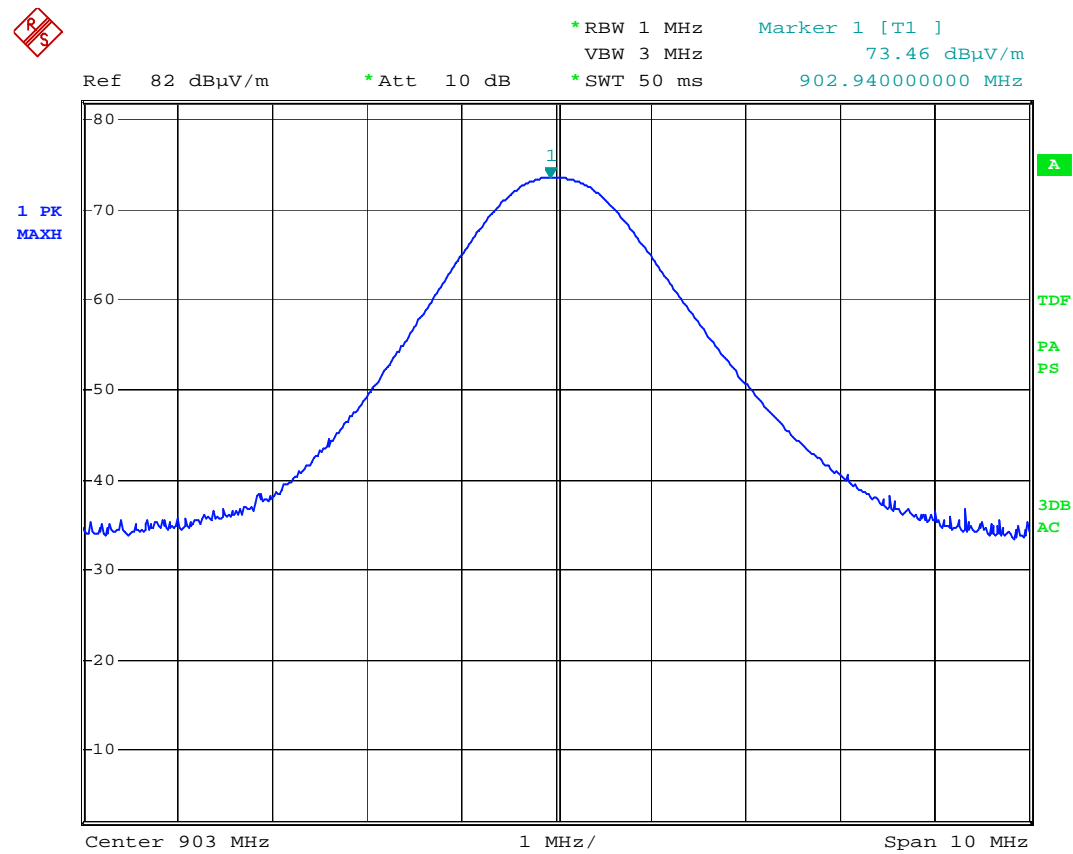
Date: 16.JUN.2011 13:05:33

Conducted power – 915MHz



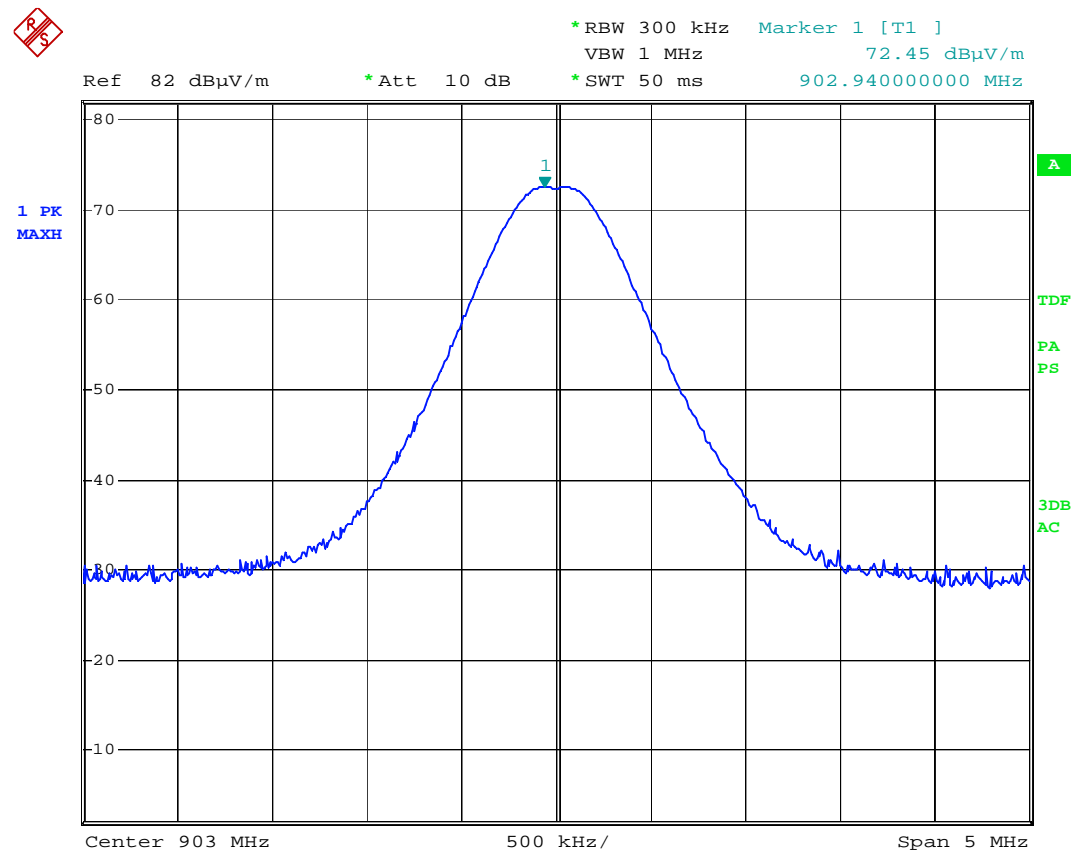
Date: 16.JUN.2011 13:08:55

Conducted power - 927MHz



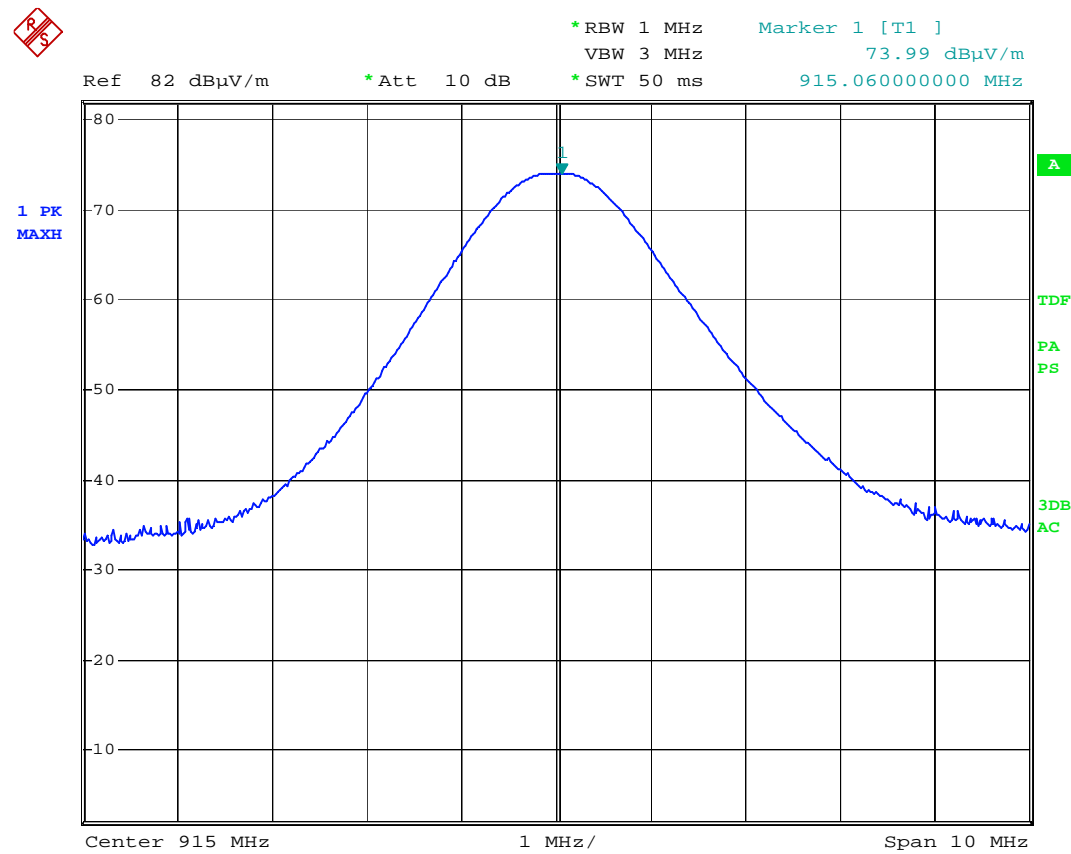
Date: 16.JUN.2011    11:09:39

**VP: 903MHz – Field strength**



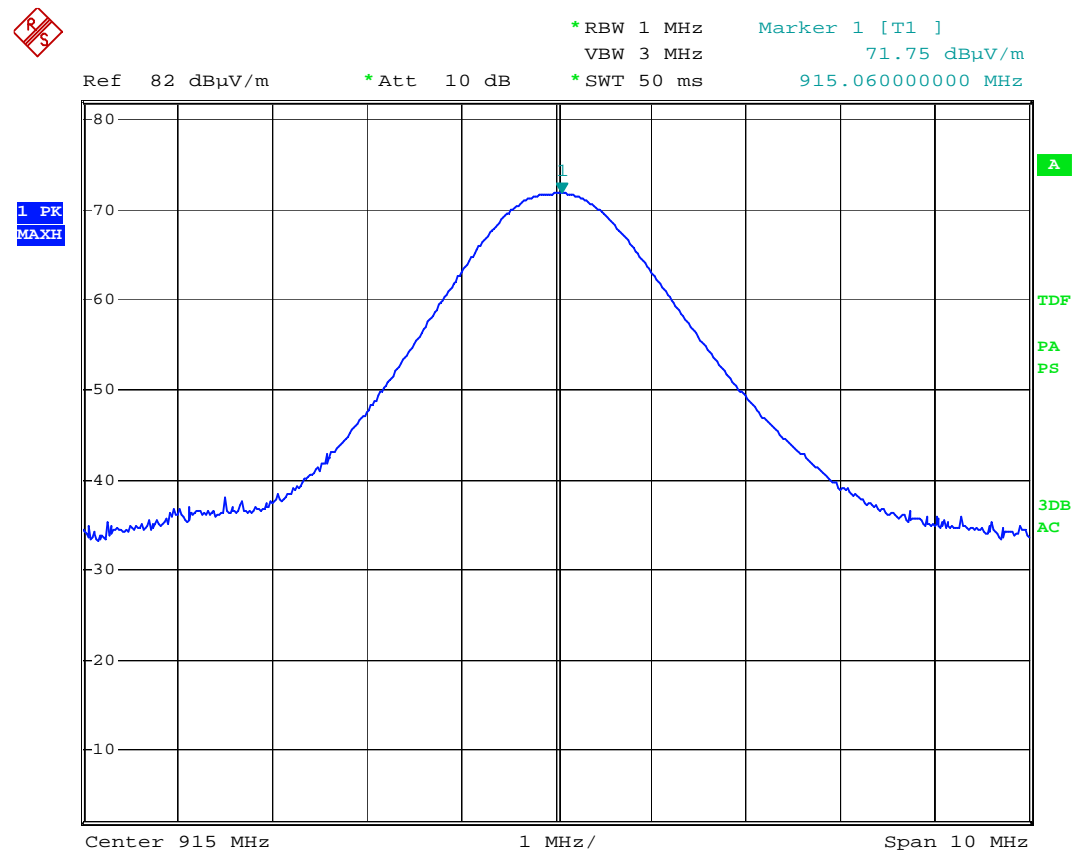
Date: 16.JUN.2011    10:53:34

**HP: 903MHz – Field strength**



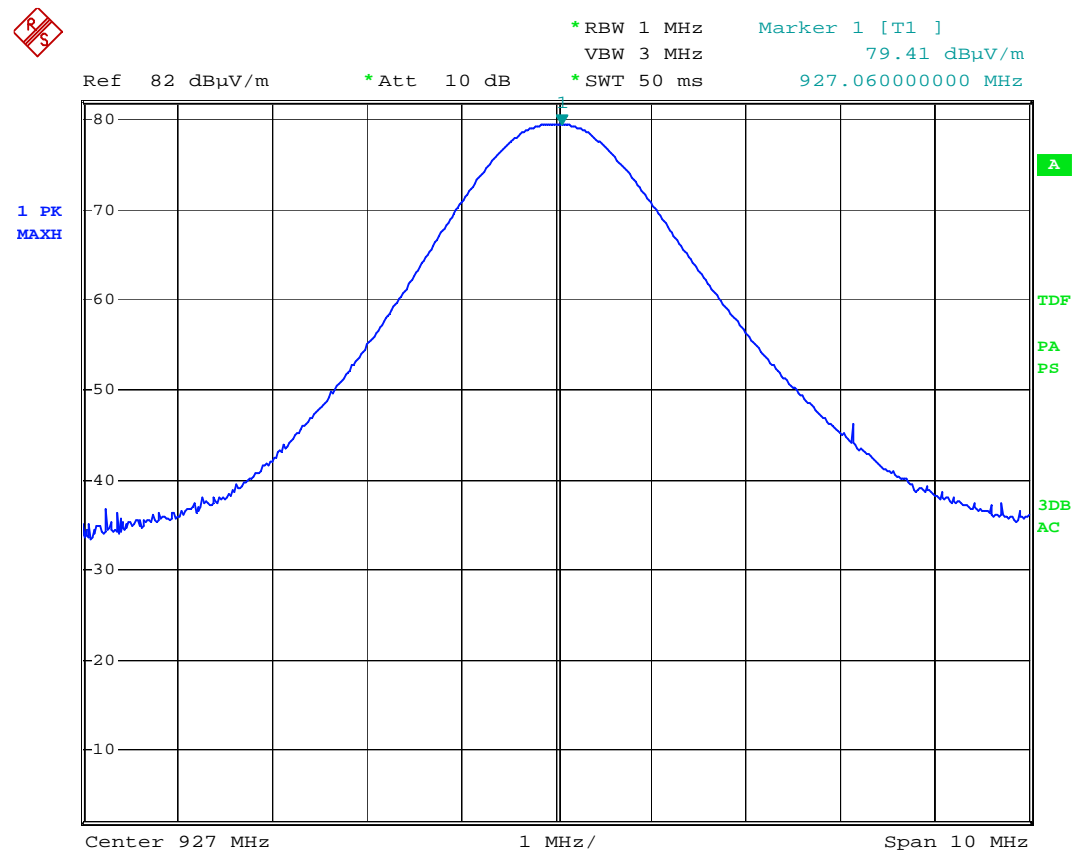
Date: 16.JUN.2011    11:04:16

**VP: 915MHz – Field strength**



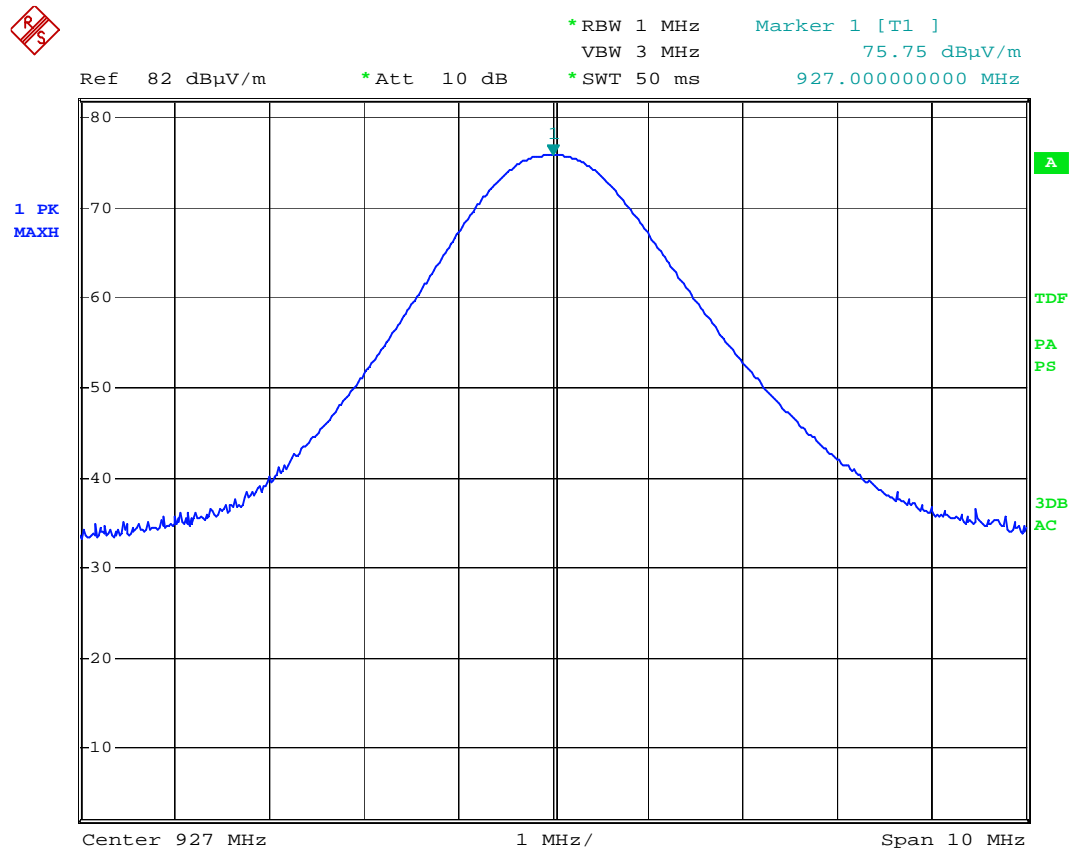
Date: 16.JUN.2011    11:06:18

**HP: 915MHz – Field strength**



Date: 16.JUN.2011 10:58:44

**VP: 927MHz – Field strength**



Date: 16.JUN.2011 10:56:58

**HP: 927MHz – Field strength**



## 4.5 Band Edge Emissions

Para. No.: 15.249 (d)

Test Performed By: G.Suwanthakumar

Date of Test: 15.09.2011

Test Results: Complies

### Measurement Data:

Lower Band edge :

RF channel	903.000MHz
Measured maximum dBc	51.23

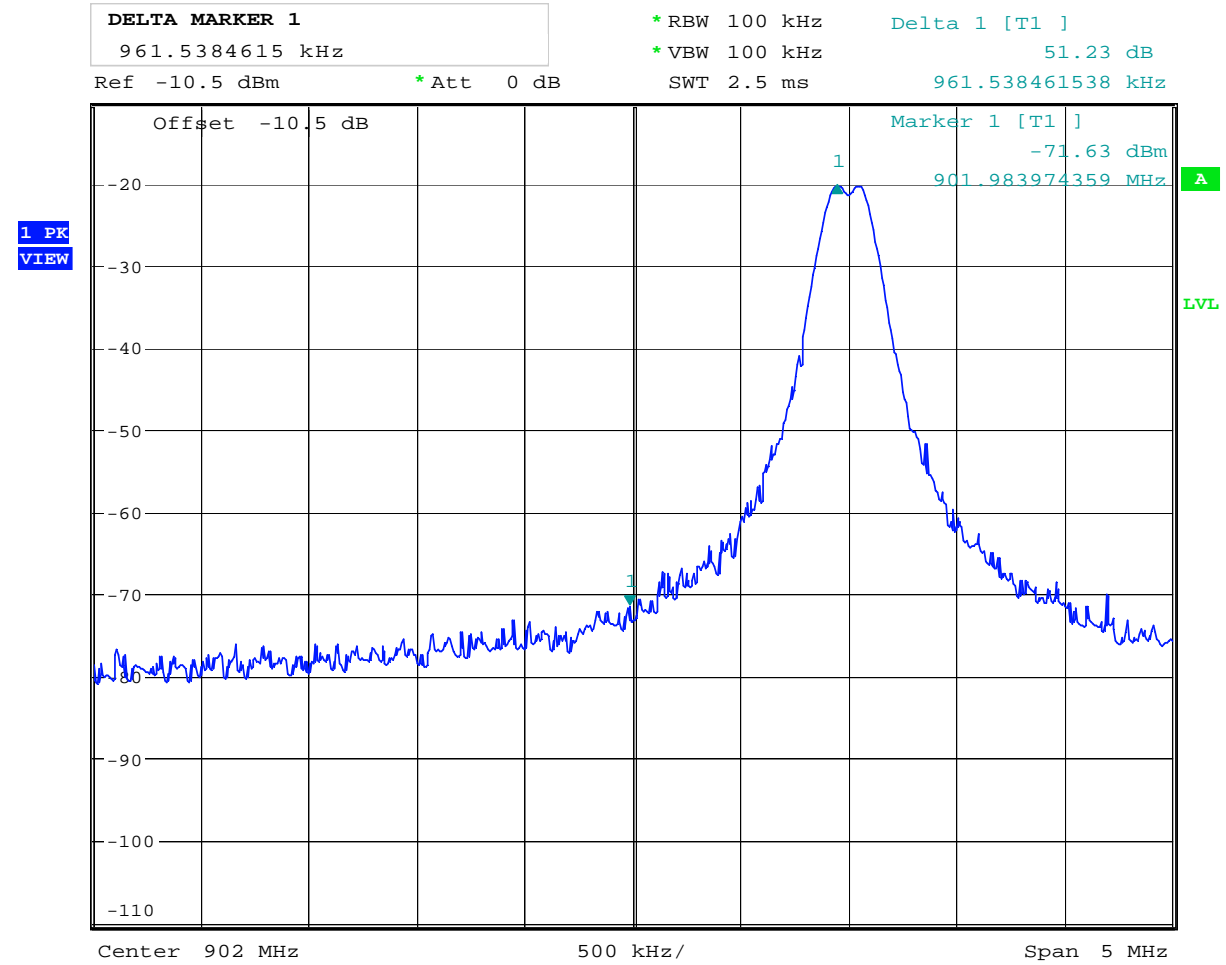
Upper Band edge :

RF channel	927.000MHz
Measured maximum dBc	51.00

See the attached graphs

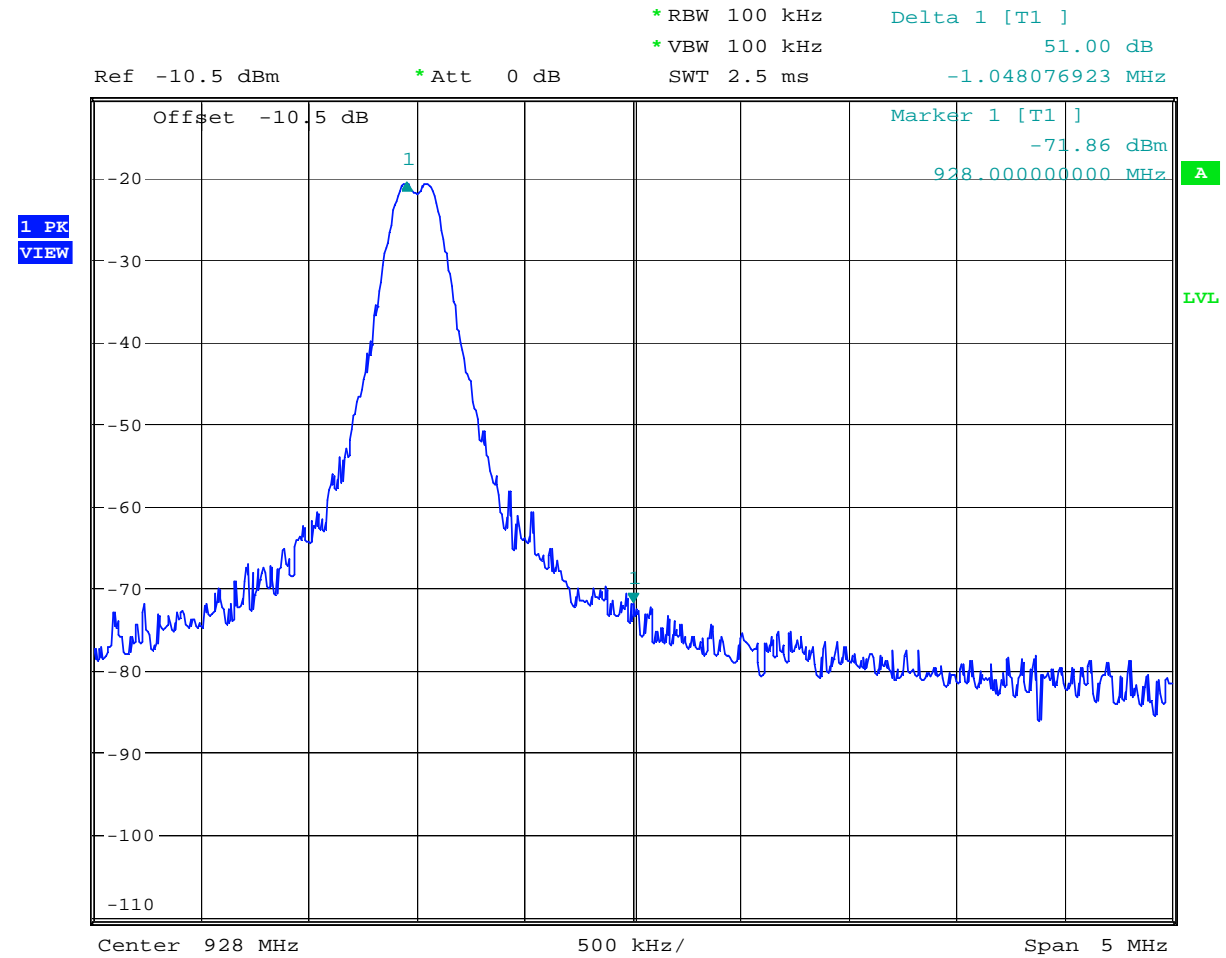
### Requirements:

Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental.



Date: 15.SEP.2011 11:32:47

903MHz- Lower band edge



Date: 15.SEP.2011 11:30:57

927MHz- upper band edge

## 4.6 Spurious Emissions (Radiated)

Para. No.: 15.249 (e)

<b>Test Performed By: G.Suwanthakumar</b>	<b>Date of Test: 16.06.2011</b>
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**Test Results: Complies**

**Measurement Data:**

**According to manufacturer there is no duty cycle correction (worst case RF packets are less than 5ms).**

**Tested item's transmission is with 100% duty cycle**

**RF conducted emissions 9kHz to 10 GHz**

Maximum RF level outside operating band:

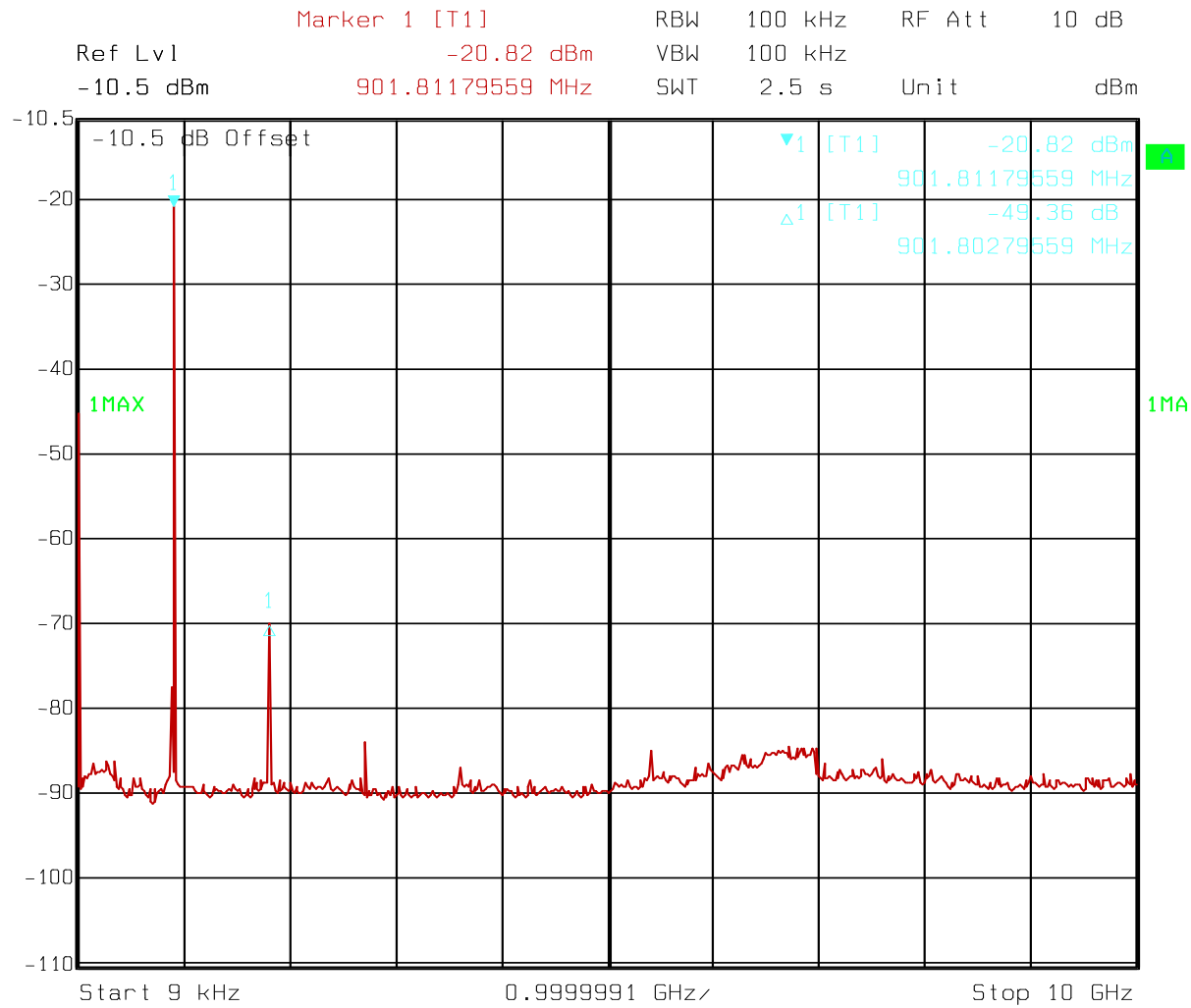
RF 903MHz: 49.36 dBC, margin > 20 dB

RF 915MHz: 50.64 dBC, margin > 20 dB

RF 927MHz: 51.12 dBC, margin > 20 dB

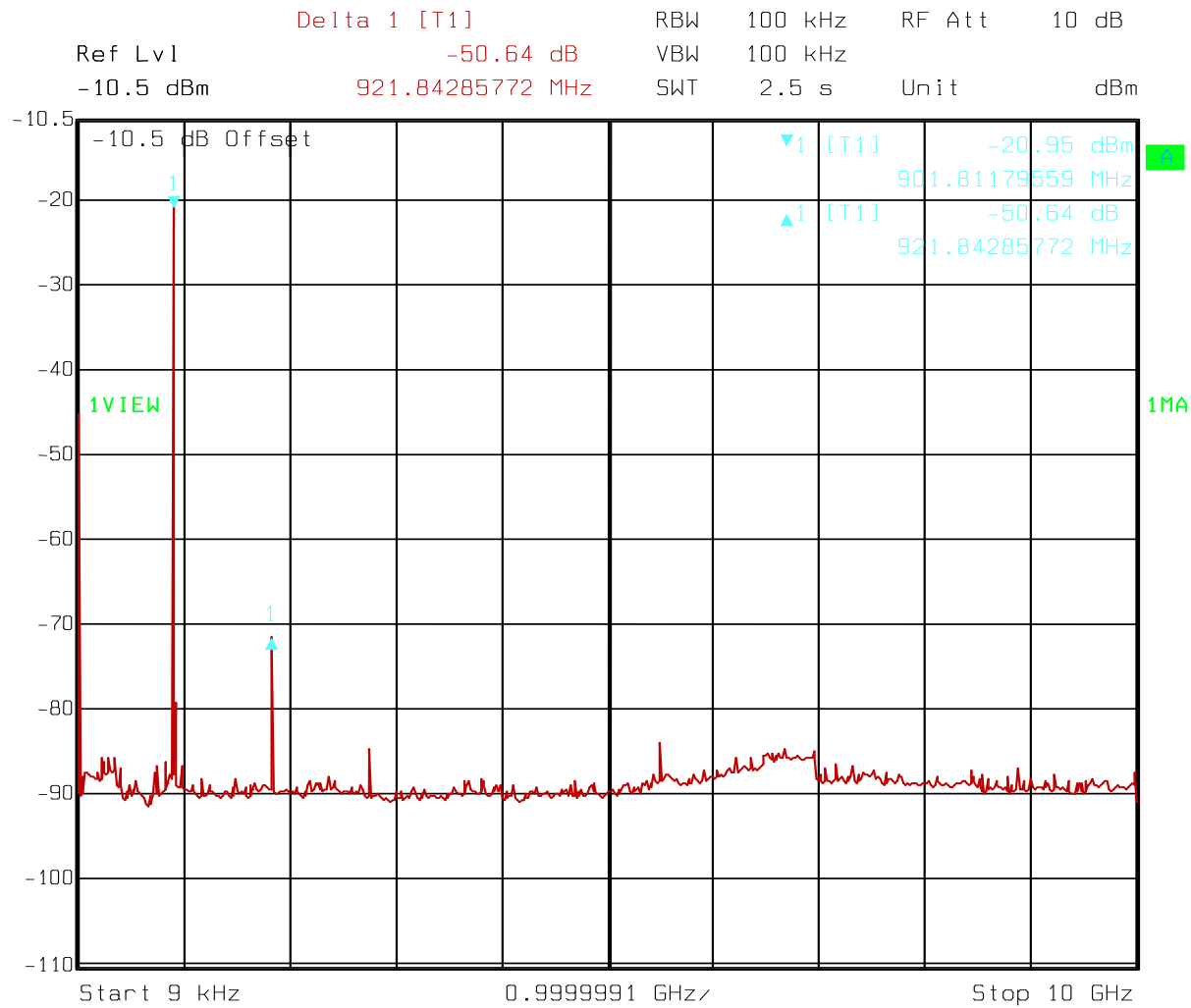
### **Requirements:**

As shown in §15.35(b), for frequencies above 1000 MHz, the field strength limits in paragraphs (a) of this section are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. the peak field strength shall not exceed 2500 millivolts/meter at 3 meters along the antenna azimuth.



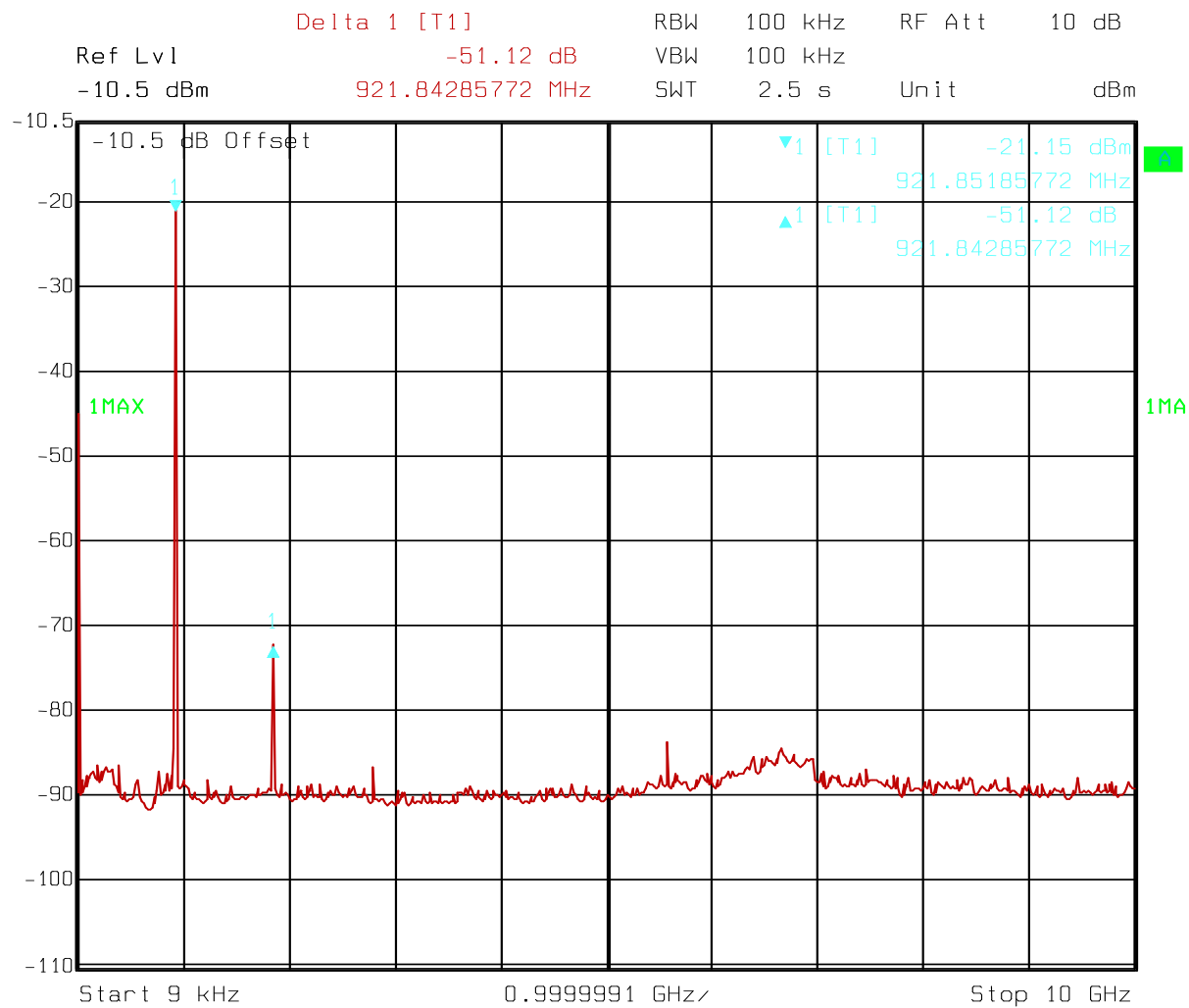
Date: 16.JUN.2011 13:01:02

903MHz – Conducted Spurious – 9kHz – 10GHz



Date: 16.JUN.2011 13:07:07

915MHz – Conducted Spurious – 9kHz – 10GHz



Date: 16.JUN.2011 13:08:19

927MHz – Conducted Spurious – 9kHz – 10GHz

**Duty Cycle Calculation:****Manufacturer statement:**

All radio communications are initiated by a PDM; therefore the default mode for the base station is receiving mode. When the PDM has sent a message, it immediately switches to receiving mode and waits for a few ms for a reply. If no reply is received, the radio in the PDM is shut off until next time its time to send a message.

If an answer is received two different things can happen:

1. If the base station has no data for the PDM it only acknowledges the message.
2. If there is data for the PDM it will be sent to the PDM. In this case the PDM acknowledges the message. If the message includes a question, a data reply will be sent ~100ms afterwards that is acknowledged by the base station.

Alternative 2 above is rare, and only happens when the PDM just have logged on to the base station, or a user is trying to retrieve data via the base station interface.

The shortest possible message takes approximately 1ms to send including pre-amble etc.

The longest possible message takes ~5ms.

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This means duty cycle correction will be 20 dB.



## Radiated Emissions with antenna, 1-10 GHz, peak

1-10 GHz measured at a distance of 3m..

### Measured with Peak Detector

Frequency	RF channel	Dist. corr. factor	Field strength, Peak	Duty cycle corr. factor	Limit	Margin
GHz	51,52,53	dB	dB $\mu$ V/m	dB	dB $\mu$ V/m	dB
1.806	51	0	42.30	-	74	31.70
1.830	52	0	41.10	-	74	32.90
1.854	53	0	41.20	-	74	32.80
>1.8 - 10	51,52,53	0	None detected	-	74	-

## Radiated emissions with antenna,1- 10 GHz, Average Detector

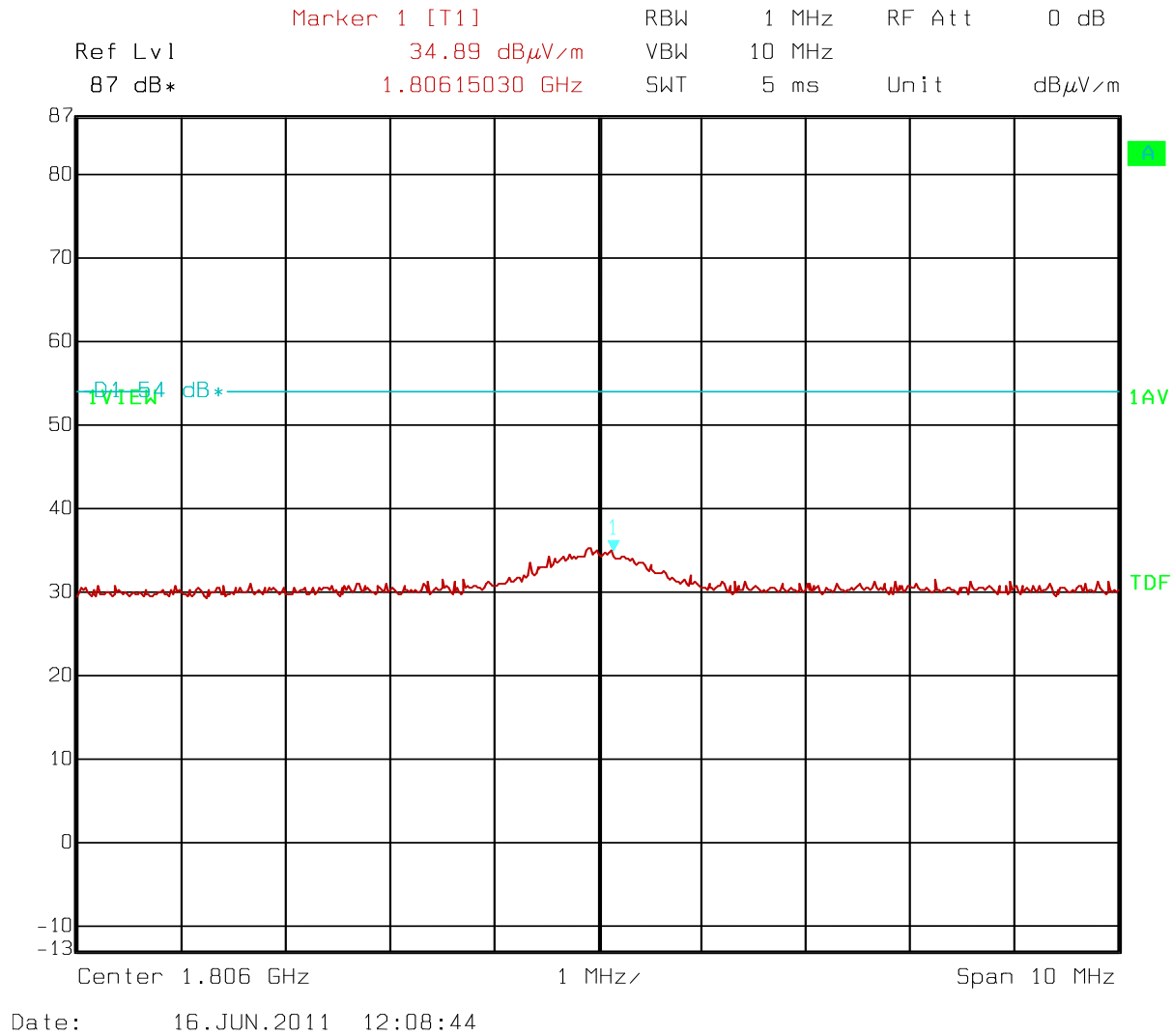
Frequency	RF channel	Dist. corr. factor	Duty cycle corr. factor	Field strength, AV	Limit	Margin
GHz	51,52,53	dB	dB	dB $\mu$ V/m	dB $\mu$ V/m	dB
1.806	51	0	0	34.69	54	19.31
1.830	52	0	0	32.70	54	21.30
1.854	53	0	0	31.24	54	22.76
>1.8 - 10	51,52,53	0	0	None detected	54	-

The maximum is observed in vertical polarization

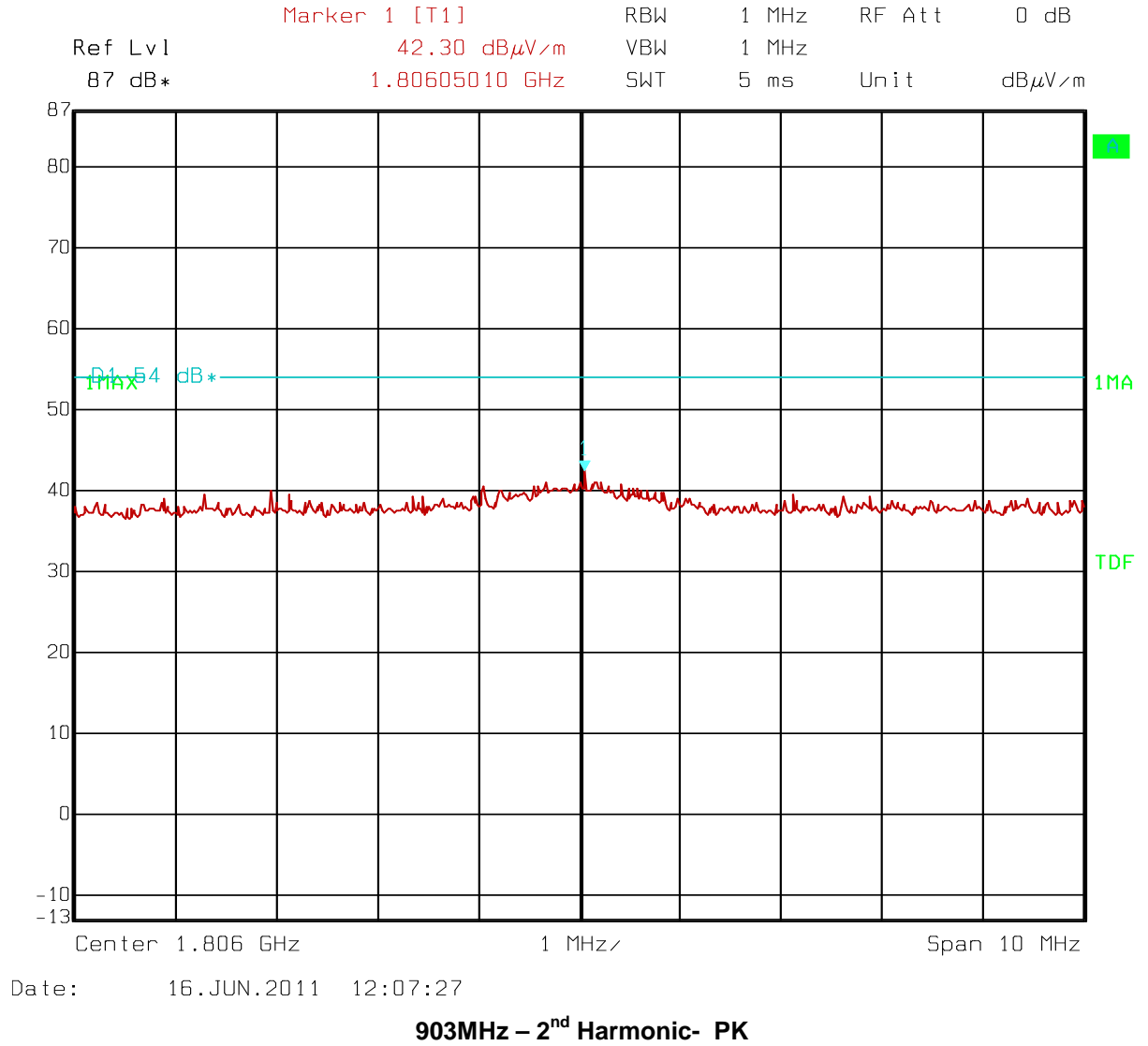
Antenna factor, amplifier gain and cable loss are included in spectrum analyzer "Transducer factor".

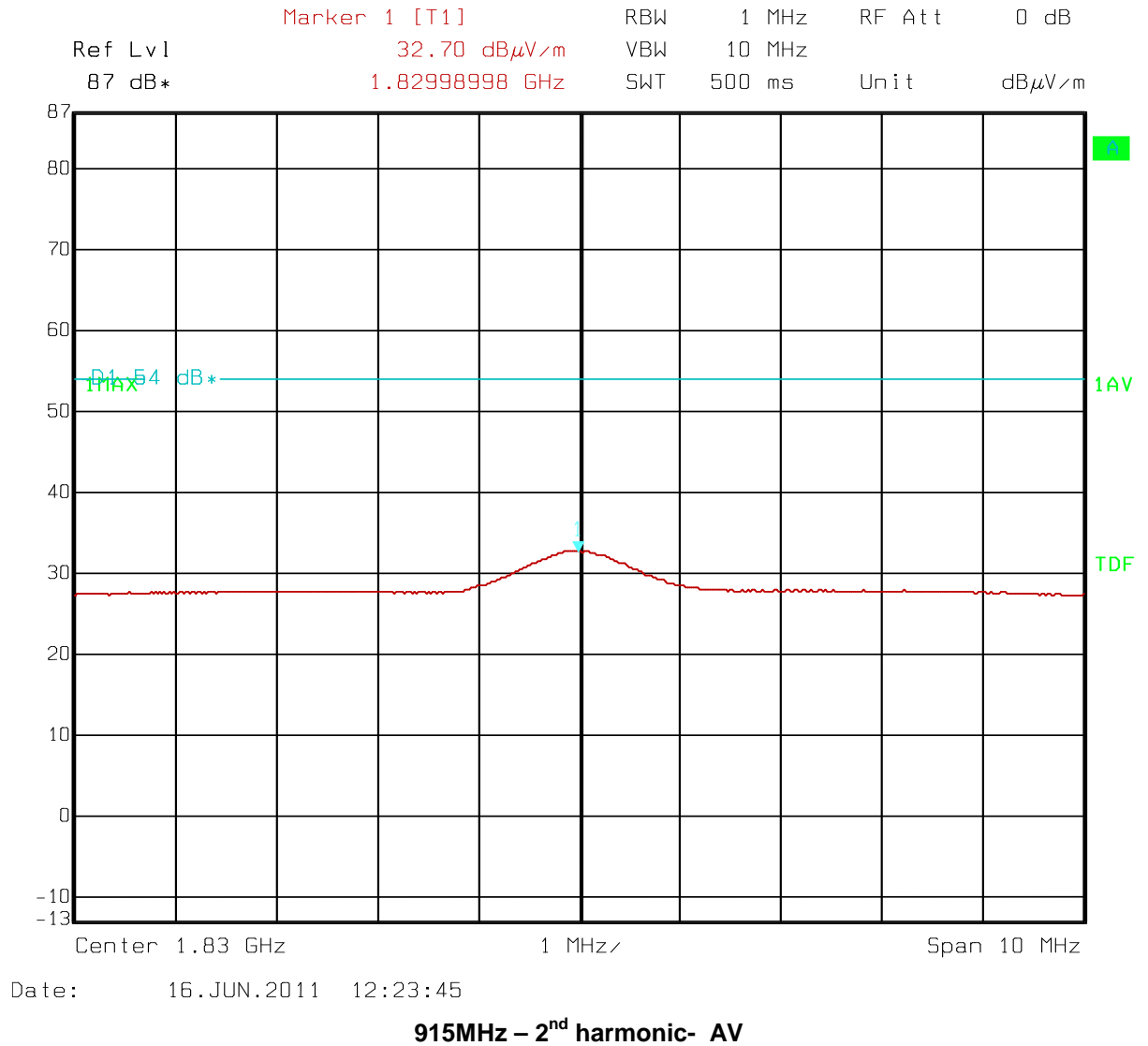
### Requirement:

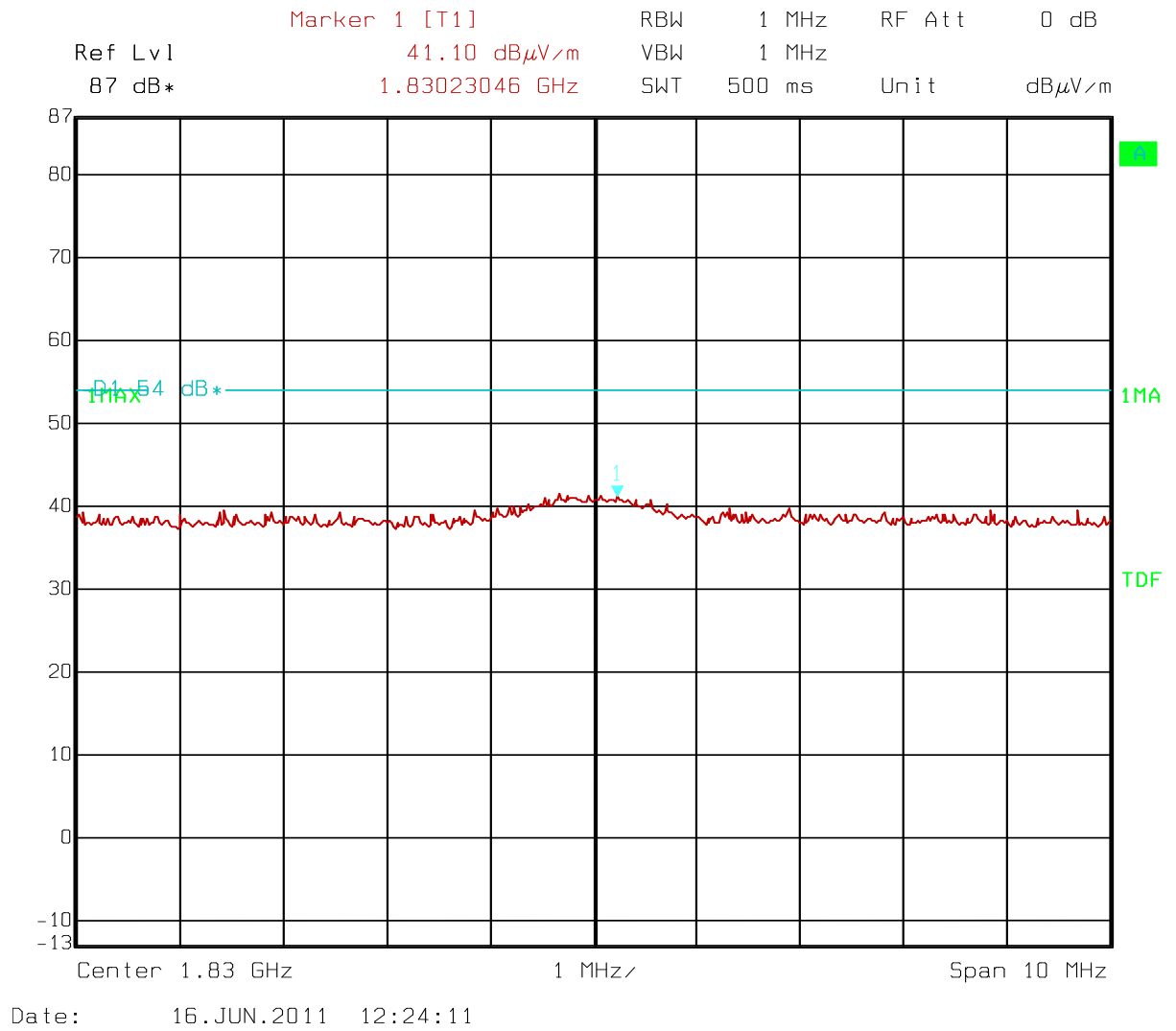
(d) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.



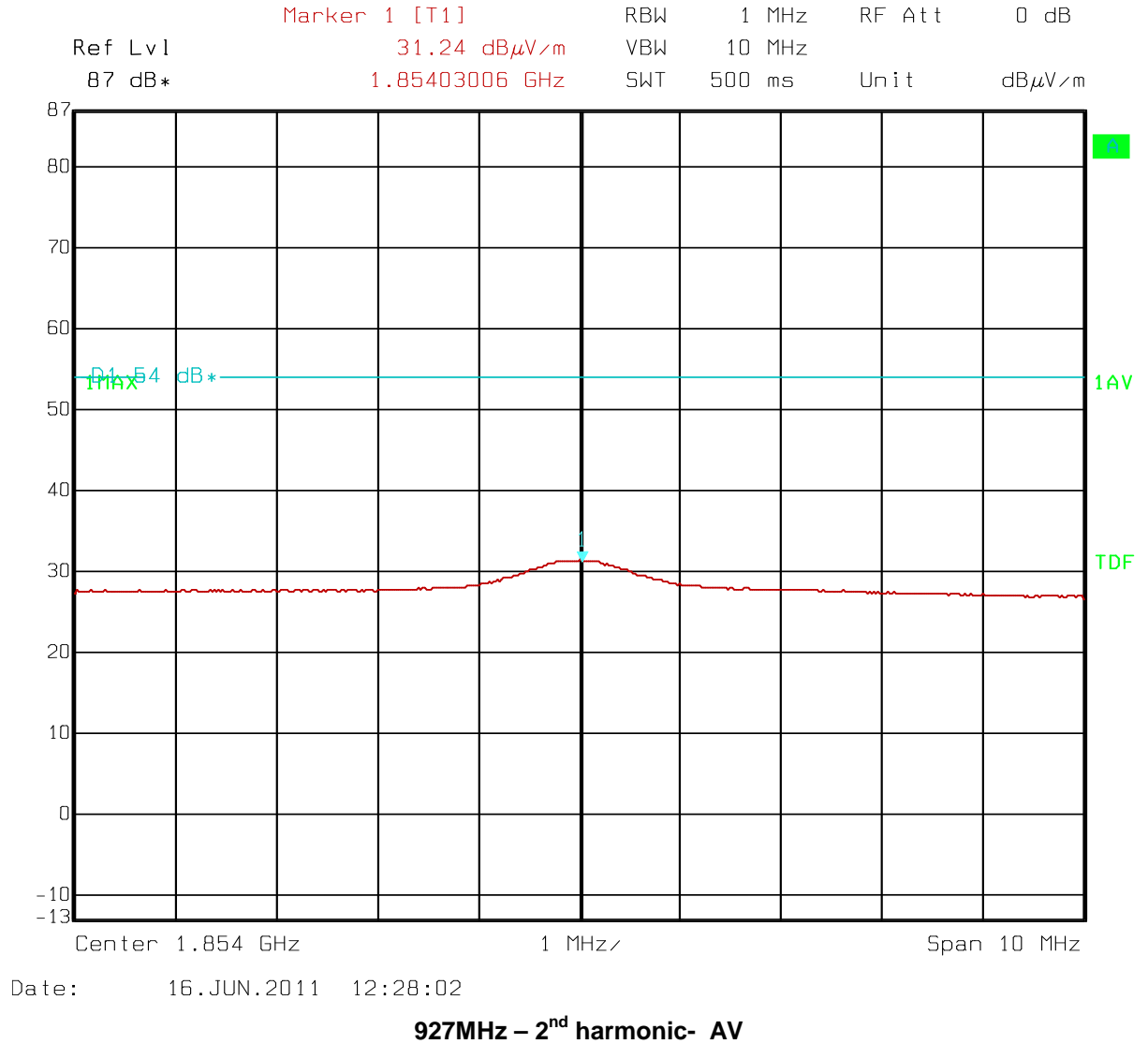
**903MHz – 2<sup>nd</sup> Harmonic- AV**

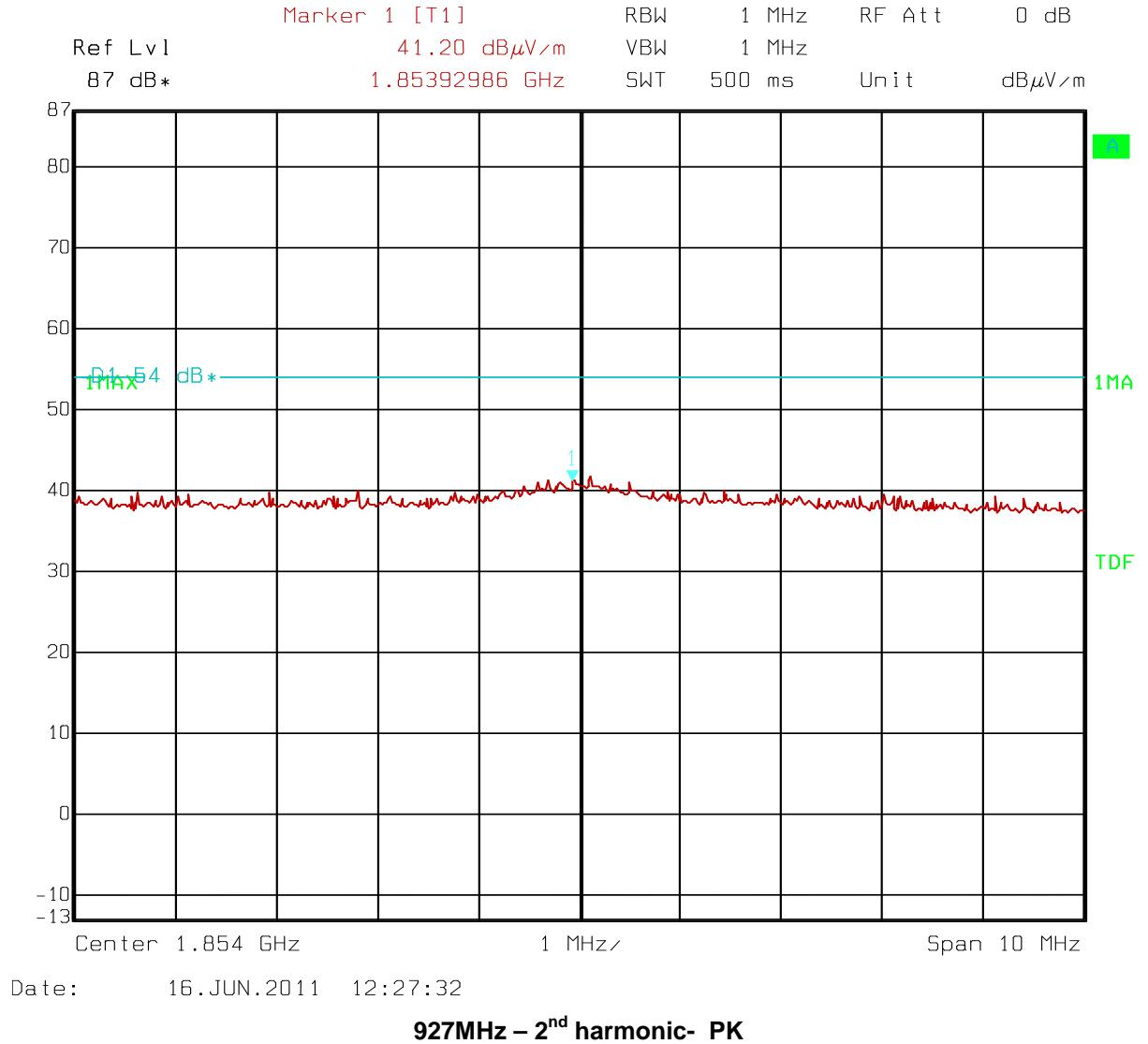


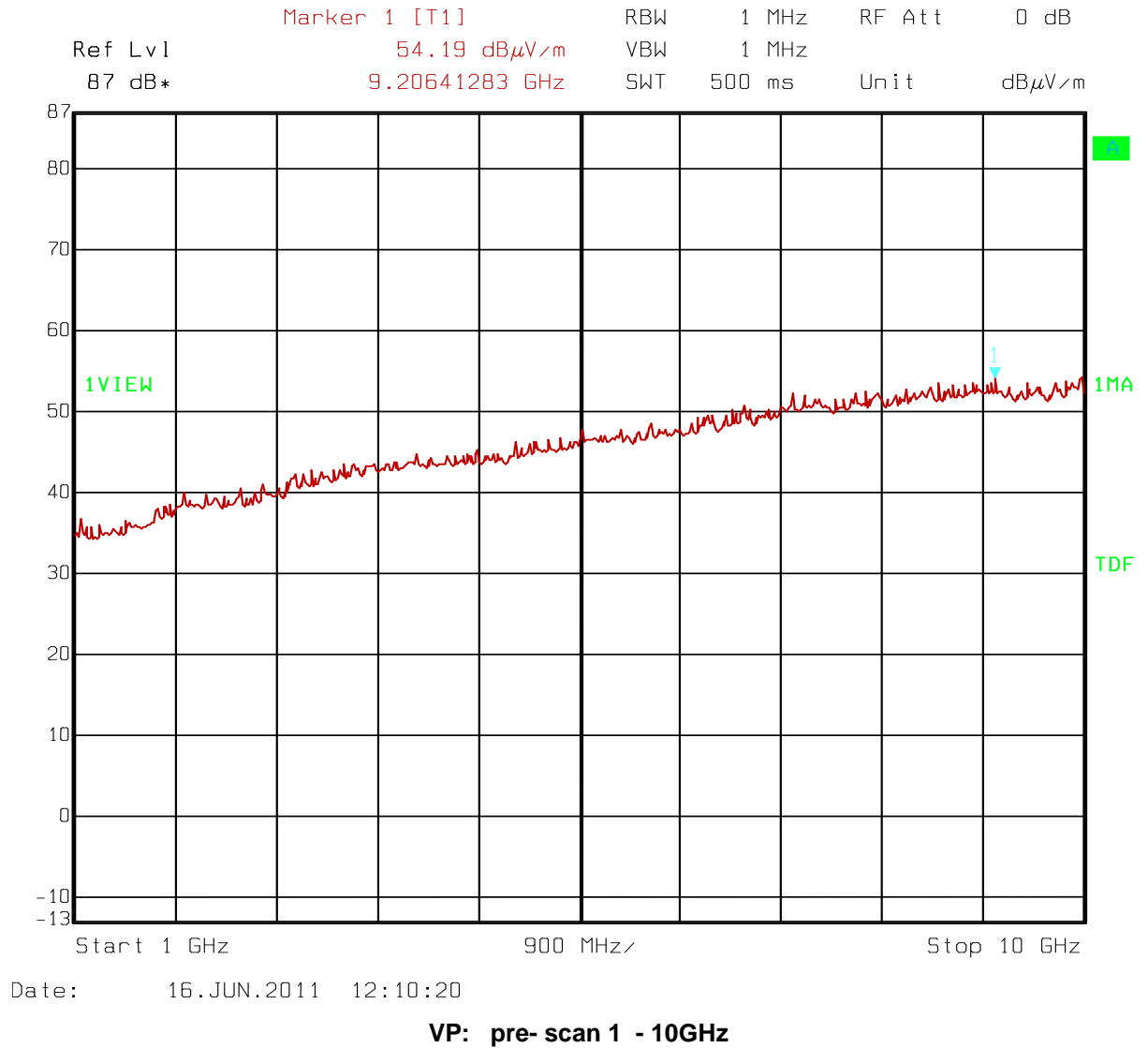




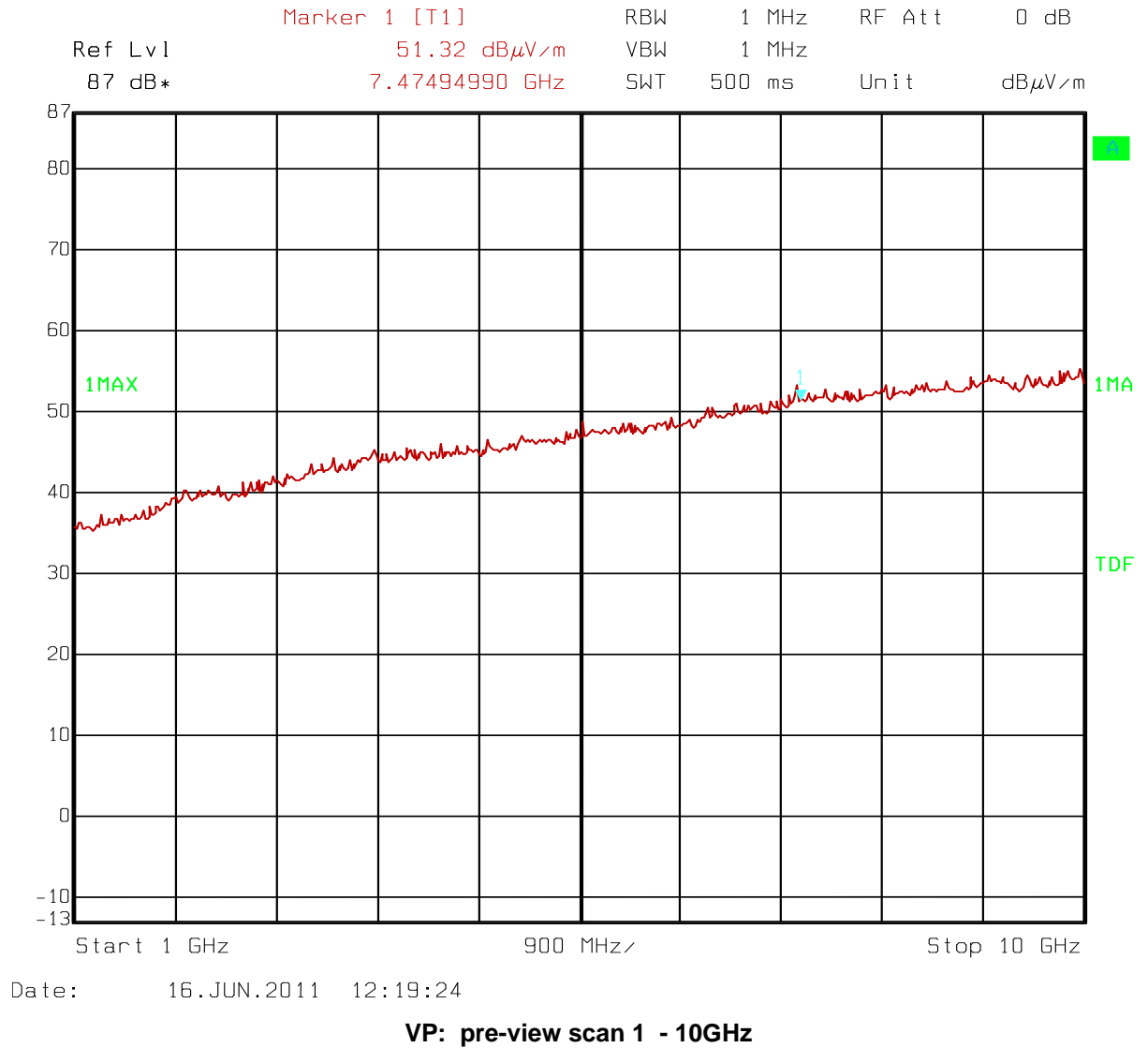
**915Mhz – 2<sup>nd</sup> Harmonic – PK**









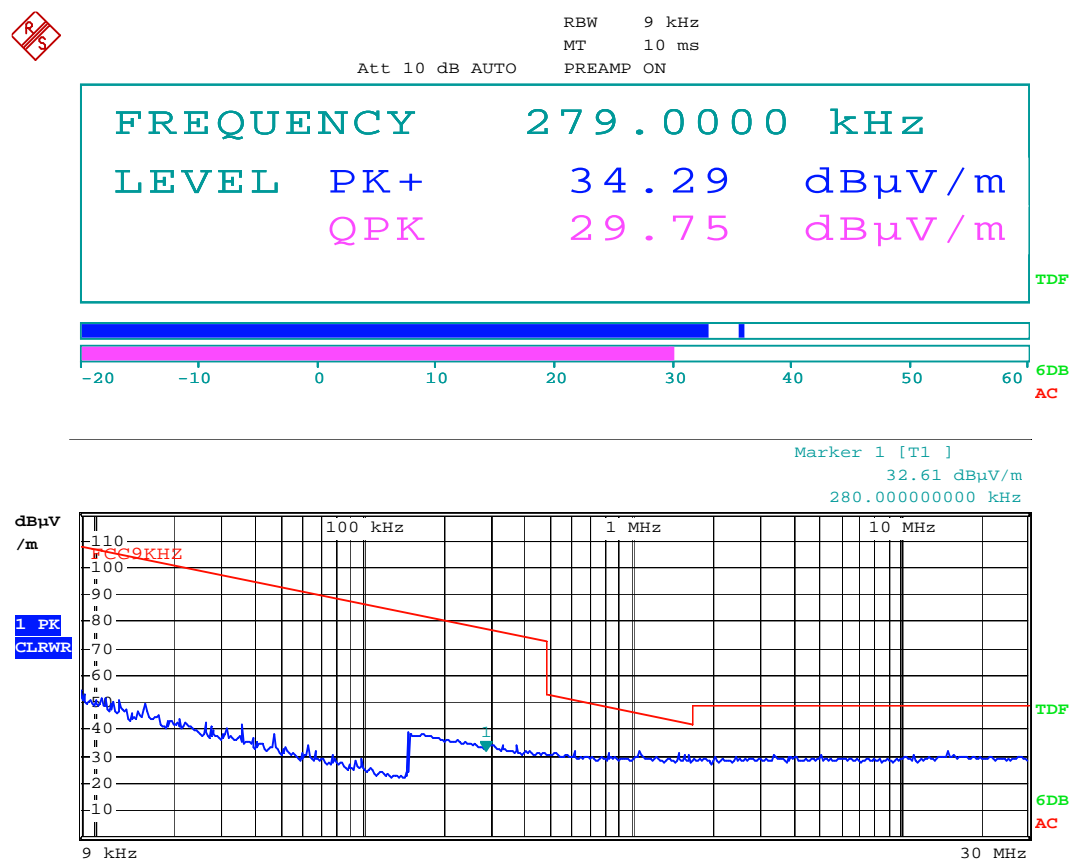


**Radiated emissions 9kHz - 30 MHz.**

Detector: Quasi-Peak

Measuring distance 10 m.

Frequency	Operational condition	Field strength	Measuring distance	Limit FCC15.209	Margin
MHz		dBµV/m	m	dBµV/m	dB
0.279	TX on	29.75	10	71.2	52.32



Date: 16.JUN.2011 12:29:04

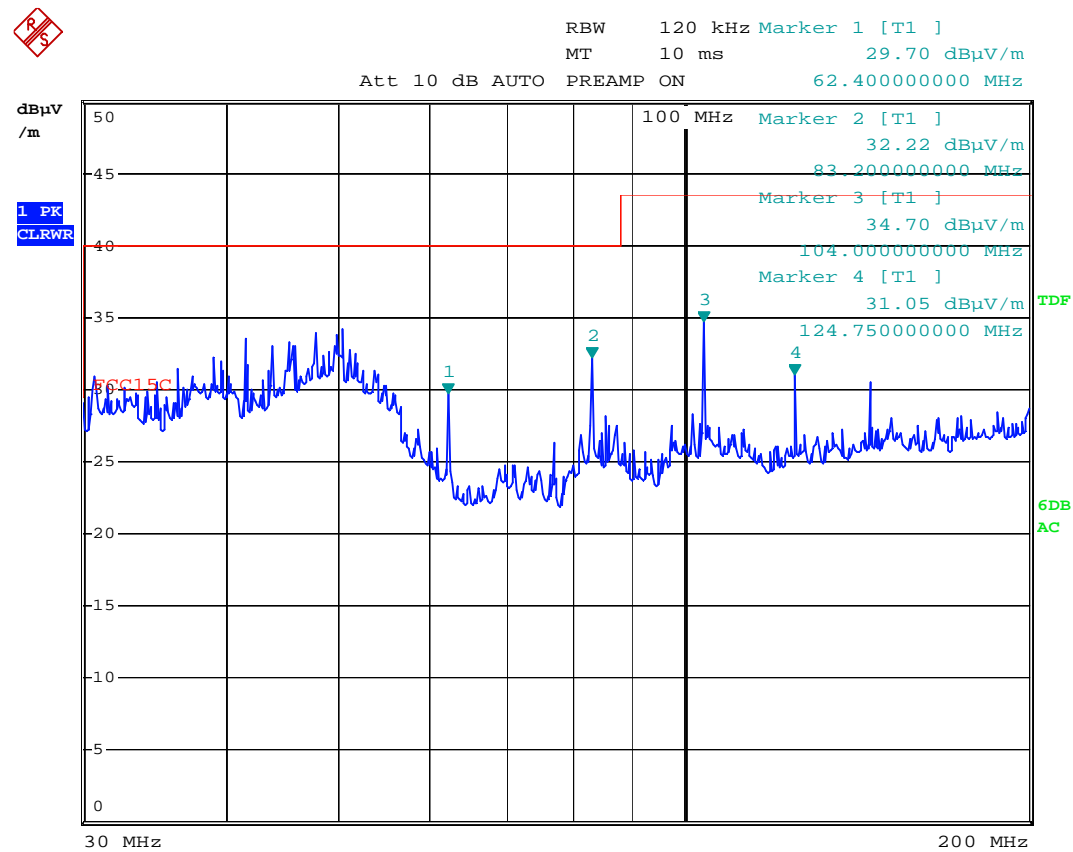
**9kHz - 30MHz**

**Radiated emissions 30 – 1000 MHz.**

Detector: Peak

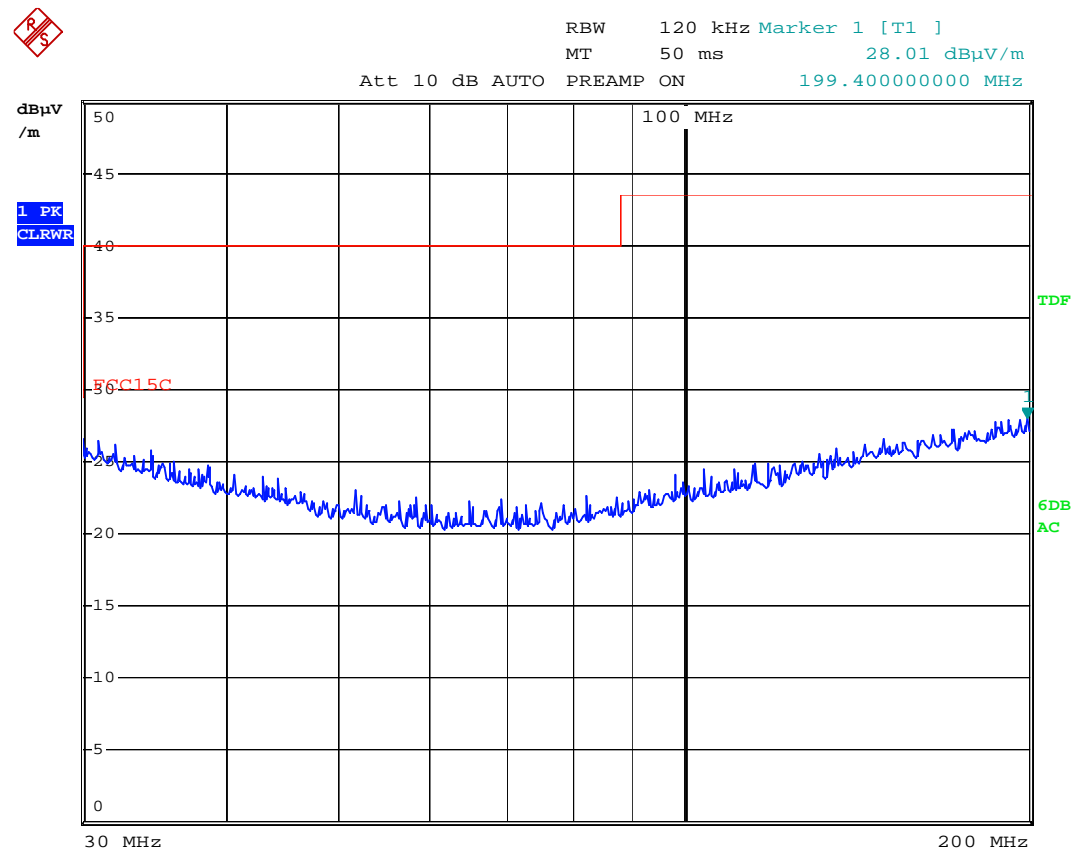
Measuring distance 3 m.

Frequency	Operational condition	Field strength	Measuring distance	Polarization	Limit FCC15.209	Margin
MHz		dB $\mu$ V/m	m	-	dB $\mu$ V/m	dB
62.4	TX ON	29.70	3	VP	40	10.3
83.2	TX ON	32.22	3	VP	40	7.78
104	TX ON	34.70	3	VP	43.5	8.80
124.75	TX ON	31.05	3	VP	43.5	12.45
250	TX ON	31.19	3	VP	46	14.81
311.9	TX on	32.11	3	HP	46	13.89



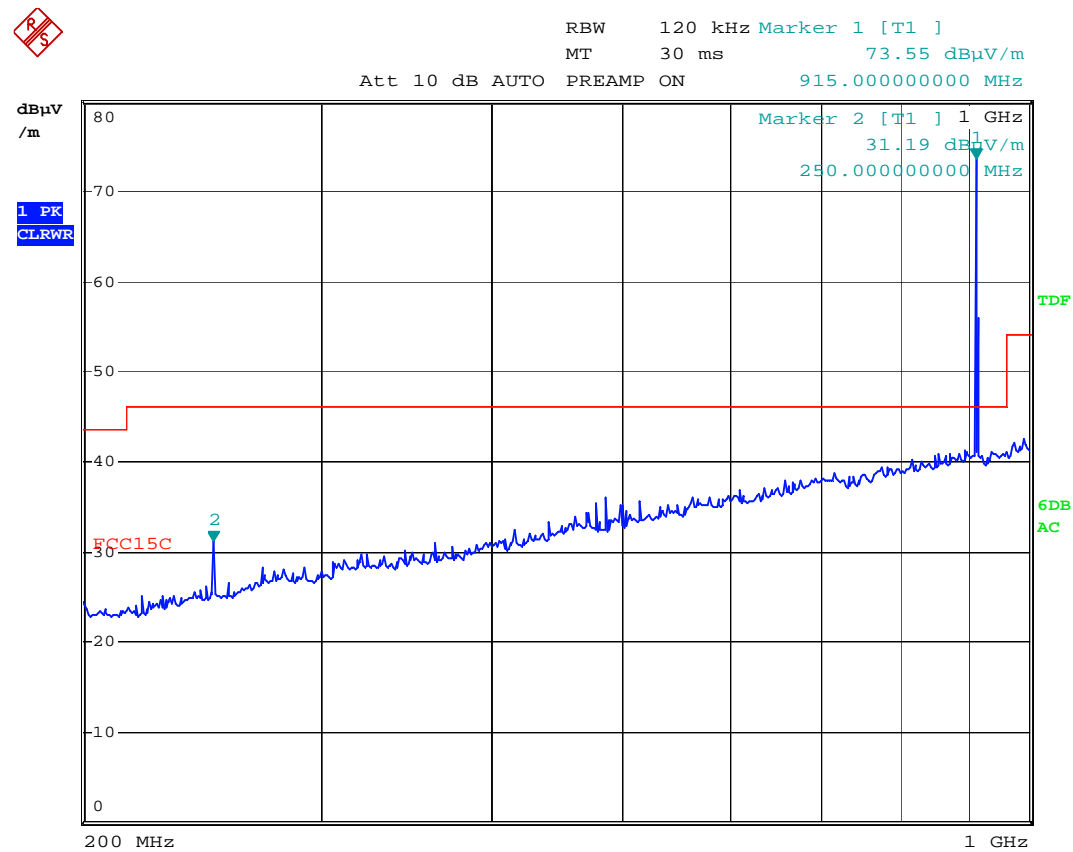
Date: 16.JUN.2011 09:39:04

VP – 30 – 200 MHz



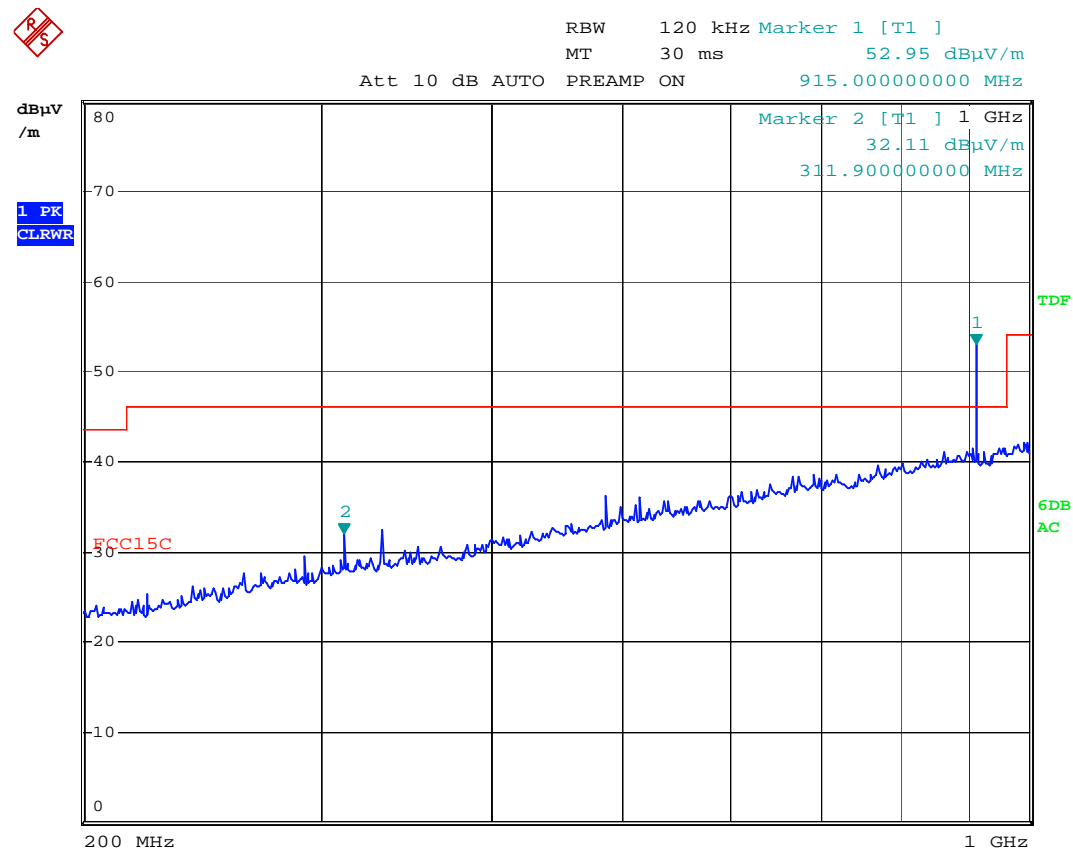
Date: 16.JUN.2011 09:43:39

HP - 30 - 200MHz



Date: 16.JUN.2011 10:22:32

**VP – 200 – 1000GHz**



Date: 16.JUN.2011 10:29:57

HP 200 – 1000MHz

## 4.7 Receiver Spurious Emissions (Conducted)

Para. No.: RSS-Gen (6)

Test Performed By: G.Suhandhakumar

Date of Test: 23.05.2011

Test Results: Complies

Measurement Data:

Conducted Emissions , 9kHz - 10 GHz, peak

Measured with Peak Detector

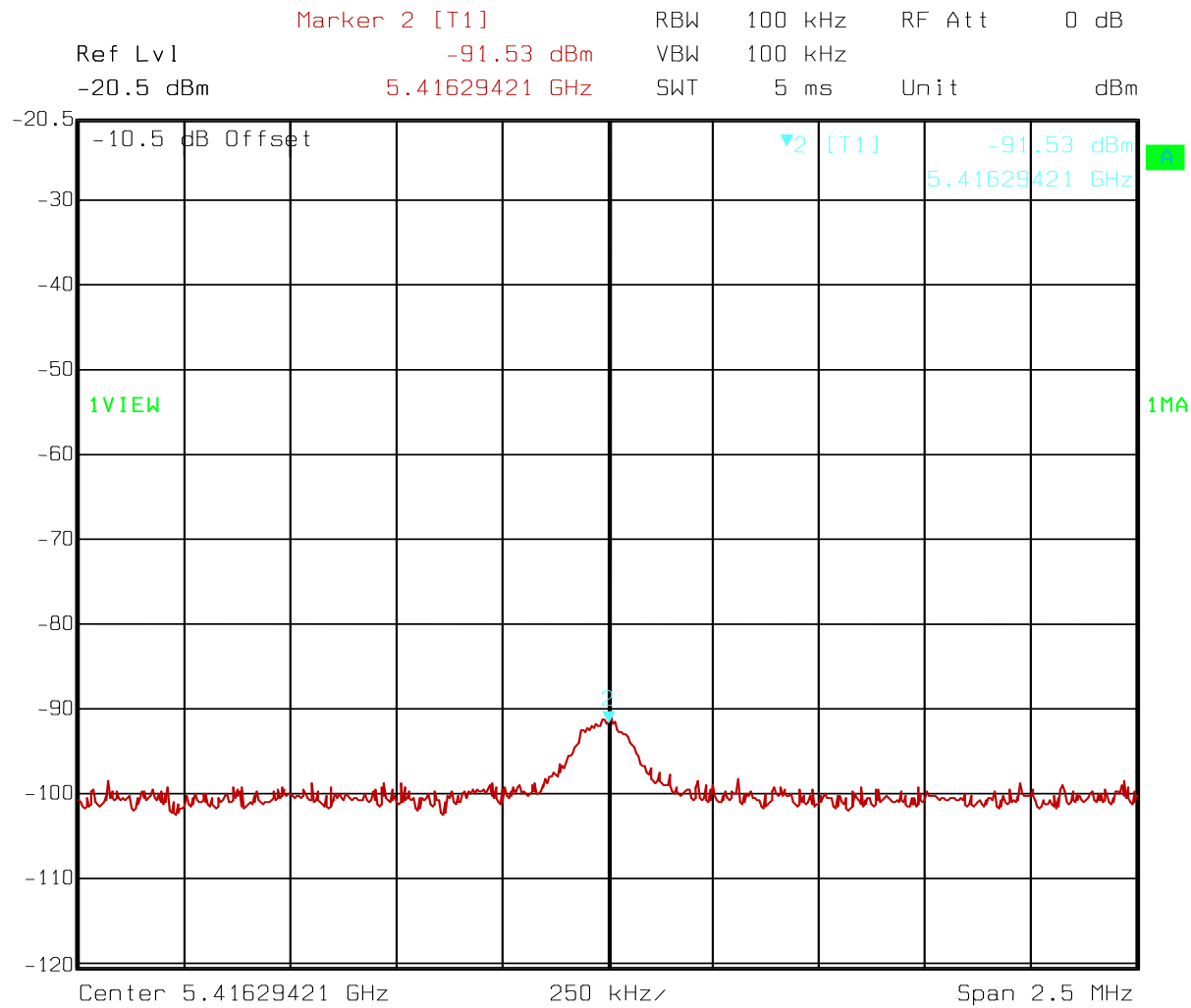
Frequency	RF channel	Measured value	Limit	Margin
GHz	51,52,53	dBm	dBm	dB
5.416	51	-91.53	-53	38.53
5.488	52	-91.87	-53	38.87
5.560	53	-91.31	-53	38.31
>6 - 10	51,52,53	None detected	-57	-

VCO leakage detected from the receiver.

**Requirement(conducted):**

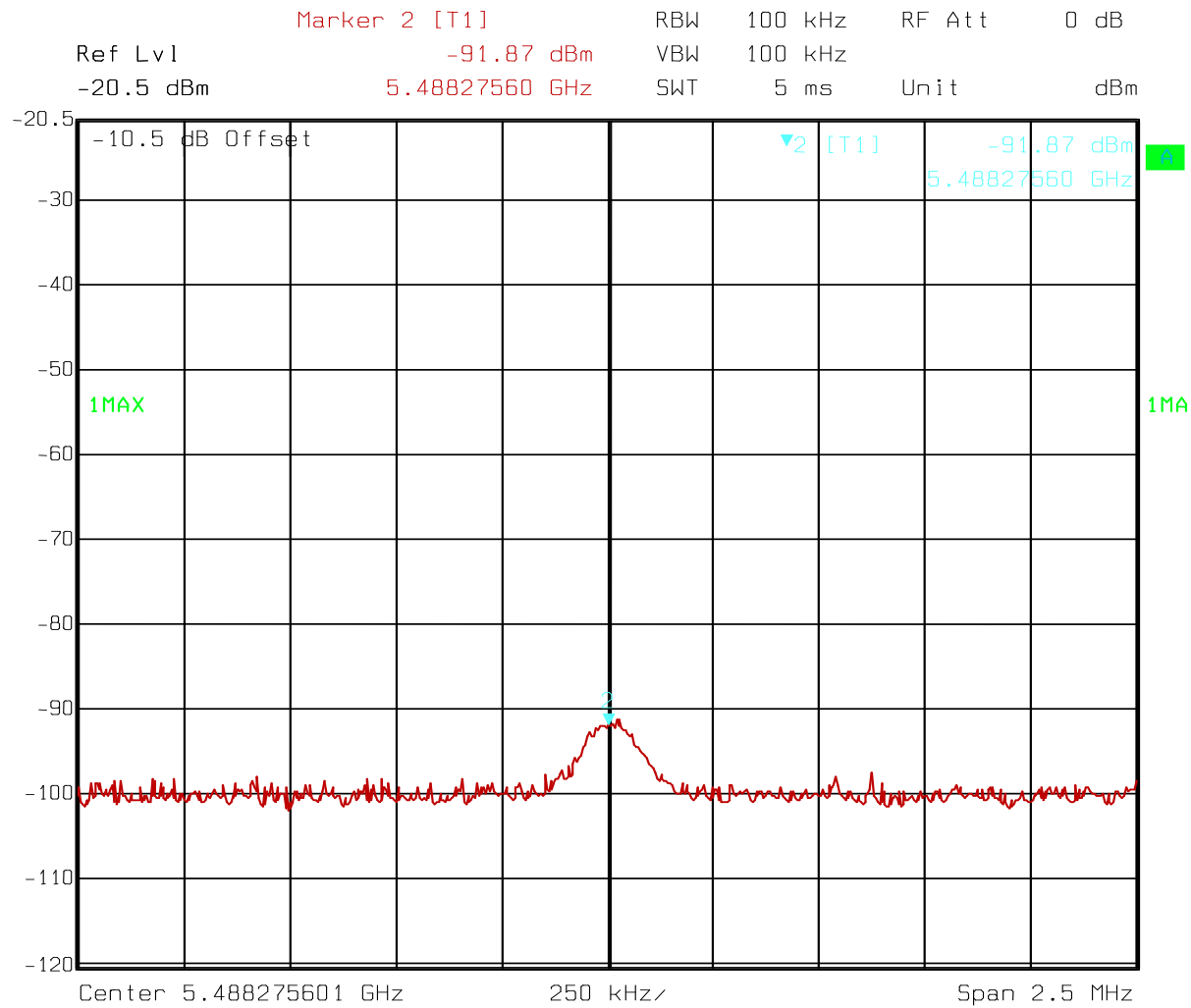
Receiver spurious emissions at any discrete frequency shall not exceed 2 nano watts in the band 30-1000 MHz, and 5 nano watts above 1000 MHz





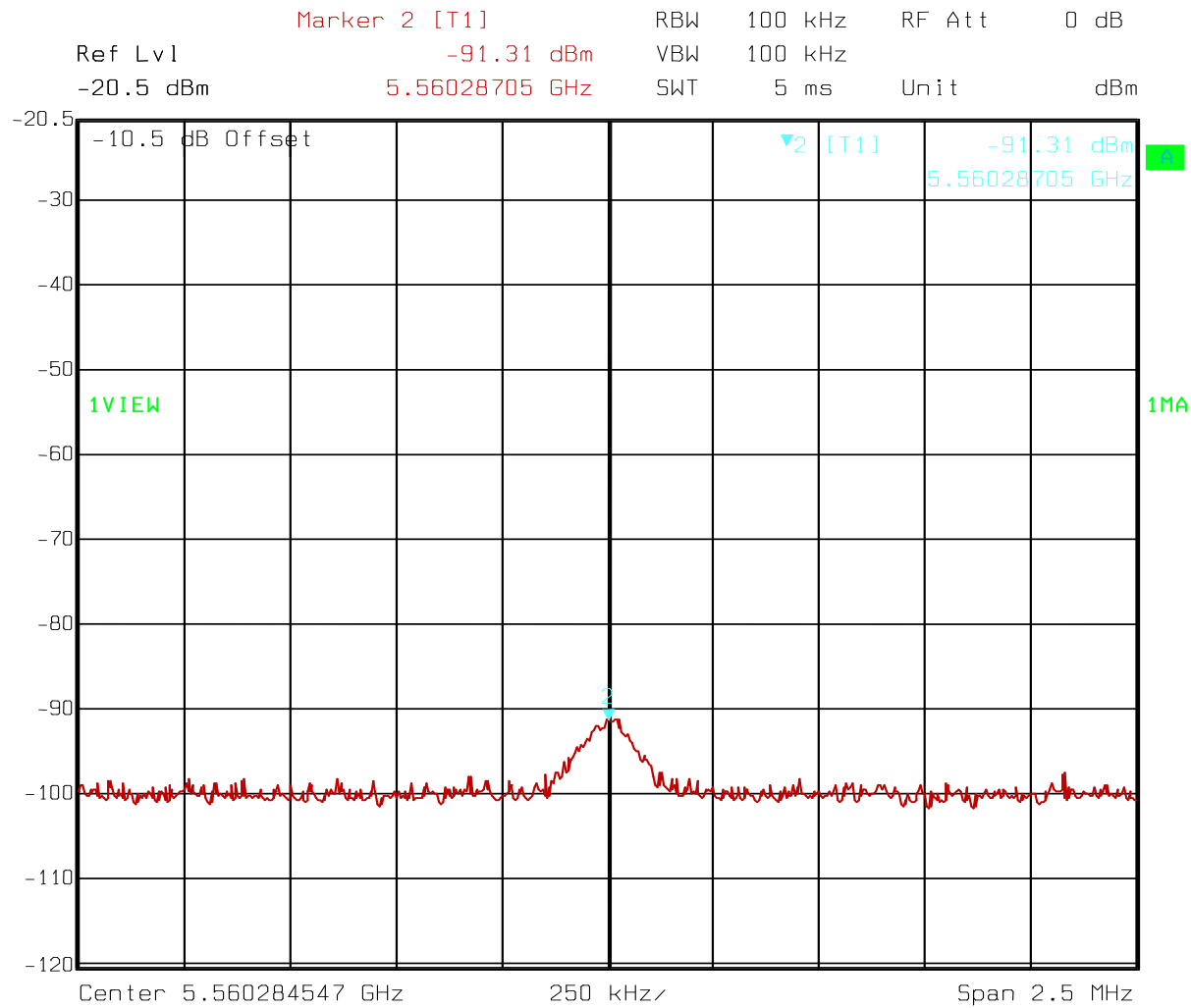
Date: 16.JUN.2011 13:16:14

903MHz: RX VCO leak



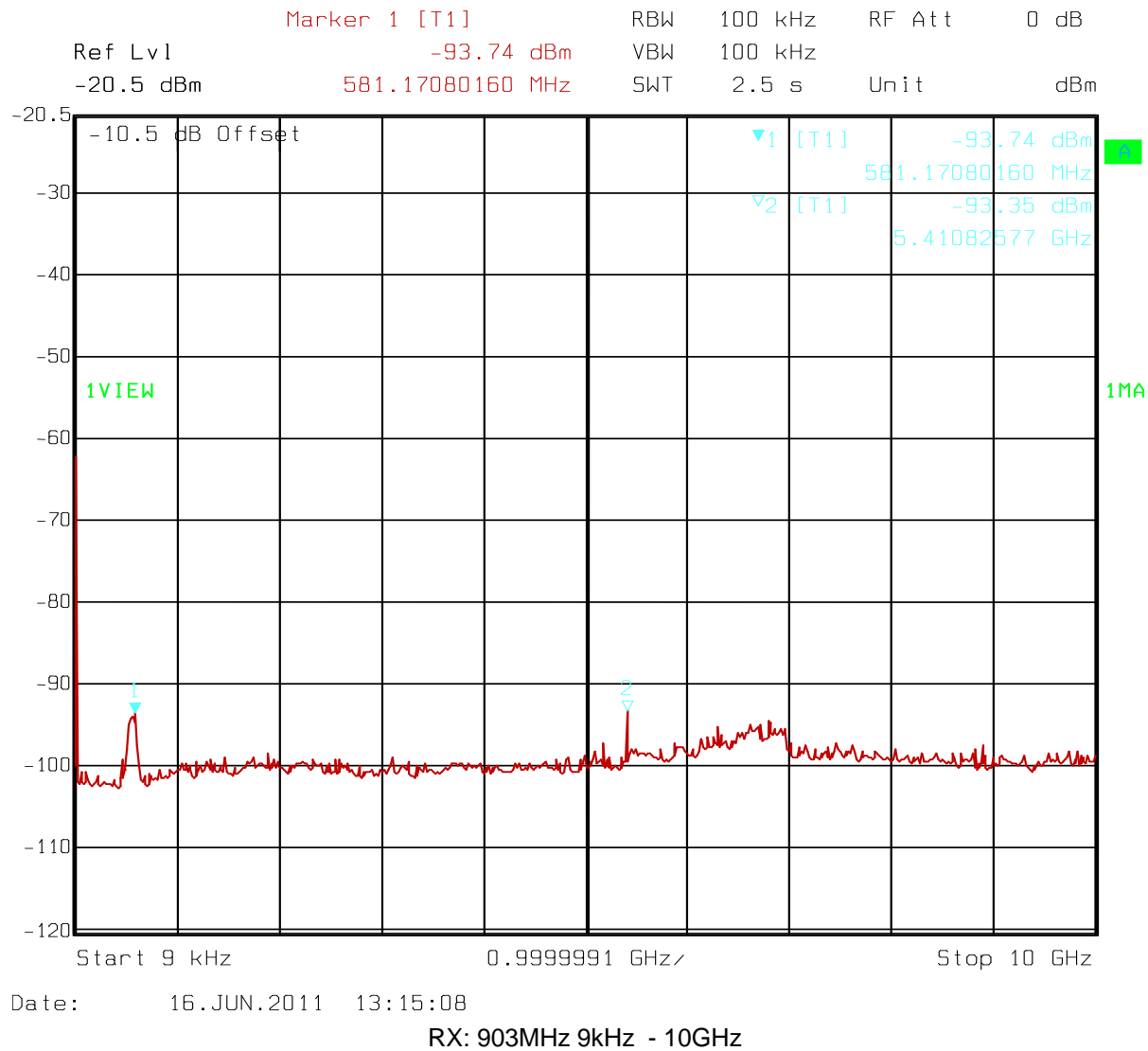
Date: 16.JUN.2011 13:13:03

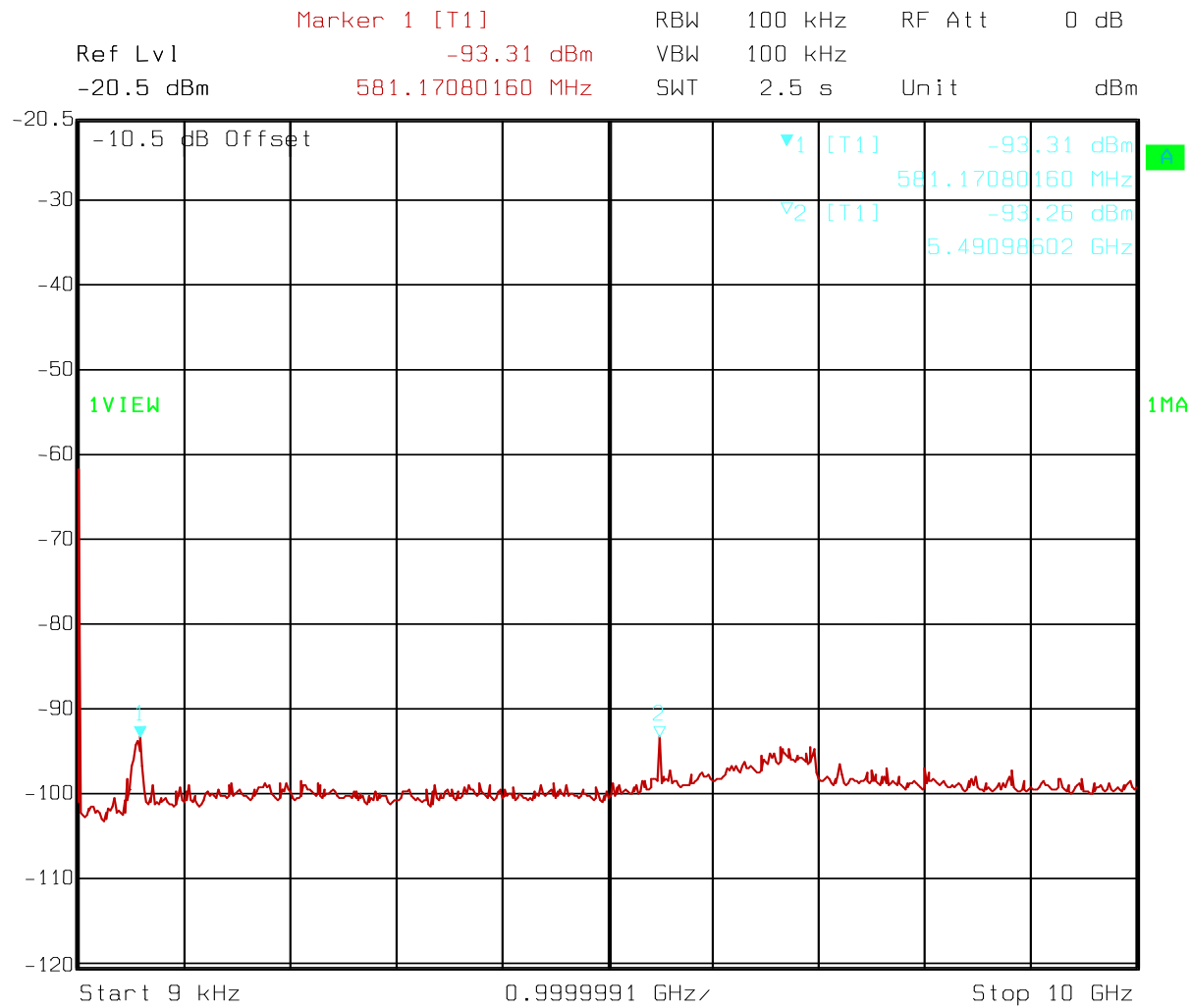
915MHz: RX VCO leak



Date: 16.JUN.2011 13:19:02

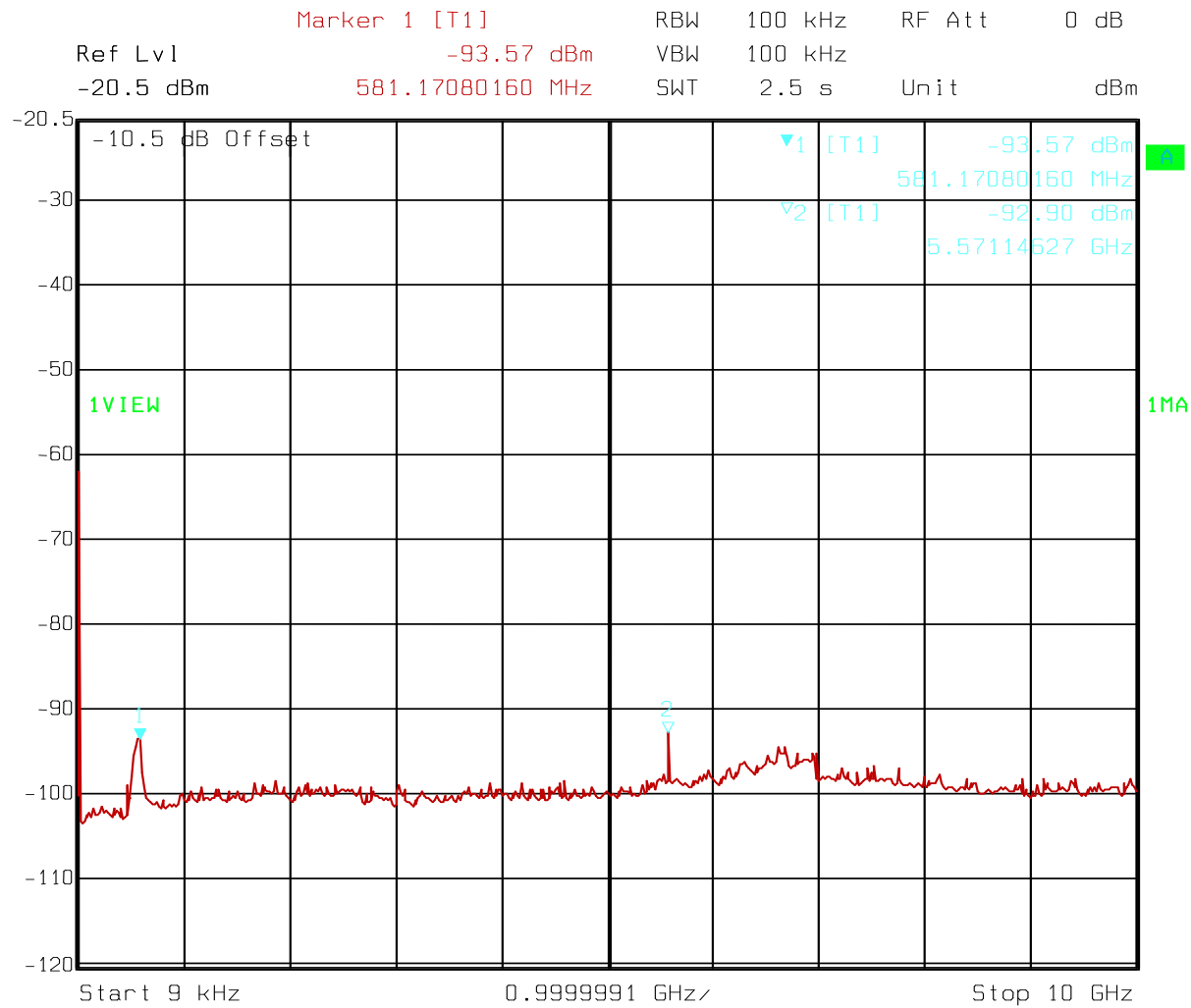
927MHz: RX VCO leak





Date: 16.JUN.2011 13:11:44

RX: 915MHz 9kHz - 10GHz



Date: 16.JUN.2011 13:17:48

RX: 927MHz 9kHz - 10GHz

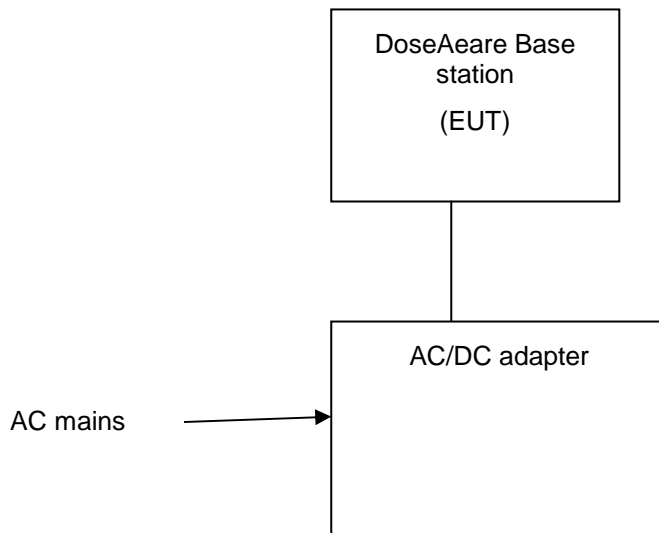
## 5 LIST OF TEST EQUIPMENT

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.	ESCI	EMI Receiver	Rohde & Schwarz	N 4259	09.09.2010	09.09.2011
2.	FSEK 1088,3494,30	Spectrum Analyzer	R&S	1337	15.12.2010	15.12.2011
3.	3115	Antenna horn	EMCO	LR 1330	05.08.2010	05.08.2013
4.	643	Antenna horn	Narda	LR 093	26.01.2009	26.01.2012
5.	642	Antenna horn	Narda	LR 220	26.01.2009	26.01.2012
6.	PM7320X	Antenna horn	Sivers lab	LR 103	26.01.2009	26.01.2012
7.	DBF-520-20	Antenna horn	Systron Donner	LR 101	26.01.2009	26.01.2012
8.	638	Antenna horn	Narda	LR 098	26.01.2009	26.01.2012
9.	Sucoflex 102E	Cable microwave	Suhner	LR 1370	-	-
10.	6032A	Power supply	HP	LR 1062	-	-
11.	77	Multimeter, Digital	Fluke	LR155	03.11.2010	03.11.2011
12.	8449B	Amplifier	Hewlett Packard	LR 1322	04.08.2009	04.08.2011
13.	HFH2-Z2	Antenna loop	Rohde and Schwarz	LR 285	08.10.2010	08.10.2013
14.	10855A	Amplifier	Hewlett Packard	LR 1445	04.08.2010	04.08.2011
15.	HL223	Antenna log.per	Rohde & Schwarz	LR 1261	19.05.2010	09.05.2013
16.	HK116	Antenna biconic	Rohde & Schwarz	LR 1260	19.05.2010	09.05.2013
17.	ESN	Test Receiver	Rohde & Schwarz	LR 1237	16.09.2010	06.09.2011
18.	ESH3-Z3	LISN	Rohde & Schwarz	LR 1076	22.10.2009	22.10.2011
19.	B504D	Power supply	Oltronix	LR 534	-	-
20.	ESAI	EMI Receiver	Rohde & Schwarz	LR 1090/1089	14.04.2011	14.04.2012
21.	ESH3-Z2	Pulse Limiter	Rohde & Schwarz	LR 1074	03.03.2010	03.03.2012

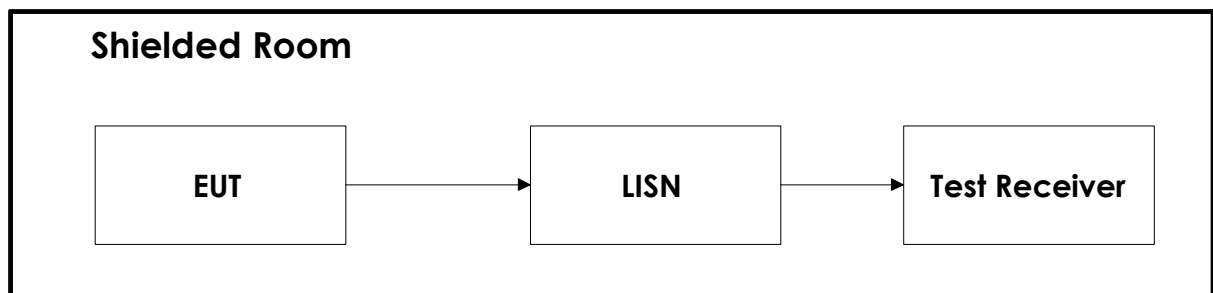
## 6 BLOCK DIAGRAM

### 6.1 System set up for radiated measurements



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

### 6.2 Power line Conducted Emission



Test equipment: 17,18,19,20,21



**6.3 Test Site Radiated Emission**

