Test of RADWIN 2000 2.5 GHz BAND

To: FCC 47 CFR Part 27, Subpart M

Test Report Serial No.: RDWN04-U1 Rev A

# TEST REPORT

From

**Test of:** Radwin 2000 2.5 GHz BAND

**To:** FCC 47 CFR Part 27 Subpart M

**Test Report Serial No.:** RDWN04-U1 Rev A

This report supersedes: None

| | |
|---|---|
| **Applicant:** | Radwin Ltd<br>27 Habarzel Street<br>Tel Aviv 69710<br>Israel |
| **Product Function:** | Dual Antenna Port 2.5 GHz BAND<br>PtP Wireless Communication |

**Copy No:** pdf **Issue Date:** 28th February 2011

**This Test Report is Issued Under the Authority of;**

**MiCOM Labs, Inc.**
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Phone: +1 (925) 462-0304
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ACCREDITED
TESTING CERTIFICATE #2381.01

**MiCOM Labs is an ISO 17025 Accredited Testing Laboratory**

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# 1 ACCREDITATION, LISTINGS & RECOGNITION

## 1.1 TESTING ACCREDITATION

MiCOM Labs, Inc. is an accredited Electrical testing laboratory per the international standard EN ISO/IEC 17025. The company is accredited by the American Association for Laboratory Accreditation (A2LA) www.a2la.org test laboratory number 2381.01. MiCOM Labs test schedule is available at the following URL; http://www.a2la.org/scopepdf/2381-01.pdf

## 1.2 RECOGNITION

MiCOM Labs, Inc has widely recognized Electrical testing capabilities. Our international recognition includes Conformity Assessment Body designation by APEC MRA** countries. Our test reports are widely accepted for global type approvals.

| Country | Recognition Body | Status | Phase | Identification No. |
|---|---|---|---|---|
| USA | Federal Communications Commission (FCC) | TCB | - | Listing #: 102167 |
| Canada | Industry Canada (IC) | FCB | APEC MRA 2 | Listing #: 4143A |
| Japan | VCCI | - | - | No. 2959 |
| Europe | European Commission | NB | EU MRA | NB 2280 |
| Australia | Australian Communications and Media Authority (ACMA) | CAB | APEC MRA 1 | US0159 |
| Hong Kong | Office of the Telecommunication Authority (OFTA) | CAB | APEC MRA 1 | |
| Korea | Ministry of Information and Communication Radio Research Laboratory (RRL) | CAB | APEC MRA 1 | |
| Singapore | Infocomm Development Authority (IDA) | CAB | APEC MRA 1 | |
| Taiwan | National Communications Commission (NCC) Bureau of Standards, Metrology and Inspection (BSMI) | CAB | APEC MRA 1 | |
| Vietnam | Ministry of Communication (MIC) | CAB | APEC MRA 1 | |

**APEC MRA – Asia Pacific Economic Community Mutual Recognition Agreement.
Is a recognition agreement under which test lab is accredited to regulatory standards of the APEC member countries.
Phase I - recognition for product testing
Phase II – recognition for both product testing and certification
N/A – Not Applicable

**EU MRA – European Union Mutual Recognition Agreement.
Is a recognition agreement under which test lab is accredited to regulatory standards of the EU member countries.

**NB – Notified Body

## 1.3 PRODUCT CERTIFICATION

MiCOM Labs, Inc. is an accredited Product Certification Body per the international standard EN ISO/IEC Guide 65. The company is accredited by the American Association for Laboratory Accreditation (A2LA) www.a2la.org test laboratory number 2381.02. MiCOM Labs test schedule is available at the following URL; http://www.a2la.org/scopepdf/2381-02.pdf


**United States of America – Telecommunication Certification Body (TCB)**

TCB Identifier – US0159

**Industry Canada – Certification Body**

CAB Identifier – US0159

**Europe – Notified Body**

Notified Body Identifier - 2280

# 2 DOCUMENT HISTORY

| Document History | | |
|---|---|---|
| **Revision** | **Date** | **Comments** |
| Draft | | |
| Rev A | 28th February 2011 | Initial Release |
| | | |
| | | |

# 3 TEST RESULT CERTIFICATE

| | | | |
|---|---|---|---|
| Applicant: | Radwin Ltd<br>27 Habarzel Street<br>Tel Aviv 69710<br>Israel | Tested By: | MiCOM Labs, Inc.<br>440 Boulder Court<br>Suite 200<br>Pleasanton<br>California, 94566, USA |
| Product: | Outdoor radio unit operating in the 2.5 GHz band. | Telephone: | +1 925 462 0304 |
| Model No.: | RADWIN 2000 2.5 GHz BAND | Fax: | +1 925 462 0306 |
| S/No's: | PBR250E000Z99999 | | |
| Date(s) Tested: | 8th – 11th February 2011 | Website: | www.micomlabs.com |

| STANDARD(S) | TEST RESULTS |
|---|---|
| FCC 47 CFR Part 27, Subpart M | EQUIPMENT COMPLIES |

MiCOM Labs, Inc. tested the equipment mentioned in accordance with the requirements set forth in the above standards. Test results indicate that the equipment tested complies with the requirements as documented in this report.

**Notes:**

1. This document reports conditions under which testing was conducted and the results of testing performed.
2. Details of test methods used have been recorded and kept on file by the laboratory.
3. Test results apply only to the item(s) tested.

**Approved & Released for MiCOM Labs, Inc. by:**

ACCREDITED
TESTING CERTIFICATE #2381.01

Graeme Grieve
Quality Manager MiCOM Labs, Inc.

Gordon Hurst
President & CEO MiCOM Labs, Inc.

# 4 REFERENCES AND MEASUREMENT UNCERTAINTY

## 4.1 Normative References

| Ref. | Publication | Year | Title |
|---|---|---|---|
| **i.** | FCC 47 CFR Part 27, Subpart M | 2009 | Title 47: Part 27, Subpart M Miscellaneous Wireless Communication Services |
| **ii.** | 47 CFR Part 15, Subpart B | 2010 | 47 CFR Part 15, Subpart B; Unintentional Radiators |
| **iii.** | ANSI C63.4 | 2009 | American National Standards for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz |
| **iv.** | CISPR 22/ EN 55022 | 2008 2006+A1:2007 | Limits and Methods of Measurements of Radio Disturbance Characteristics of Information Technology Equipment |
| **v.** | M 3003 | Edition 1 Dec. 1997 | Expression of Uncertainty and Confidence in Measurements |
| **vi.** | LAB34 | Edition 1 Aug 2002 | The expression of uncertainty in EMC Testing |
| **vii.** | ETSI TR 100 028 | 2001 | Parts 1 and 2 Electromagnetic compatibility and Radio Spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics |
| **viii.** | A2LA | 9th June 2010 | Reference to A2LA Accreditation Status – A2LA Advertising Policy |

## 4.2 Test and Uncertainty Procedures

Conducted and radiated emission measurements were conducted in accordance with American National Standards Institute ANSI C63.4, listed in the Normative References section of this report.

Measurement uncertainty figures are calculated in accordance with ETSI TR 100 028 Parts 1 and 2.

Measurement uncertainties stated are based on a standard uncertainty multiplied by a coverage factor k = 2, providing a level of confidence of approximately 95 % in accordance with UKAS document M 3003 listed in the Normative References section of this report.

# 5 TEST SUMMARY

**List of Measurements:** The following table represents the list of measurements required under FCC 47 CFR Part 27, Subpart M.

| Standard Section(s) | Test Description | Measurement Condition | Result | Notes | Test Report Section |
|---|---|---|---|---|---|
| §2.1049<br>§27.53 | Occupied Bandwidth (99% & 26 dB) | Conducted | PASS | Note 1,2,3 | 7.1 |
| §2.1033 (C)(4)<br>§2.1033 (C)(6)<br>§2.1033 (C)(7)<br>§2.1046<br>§2.1047<br>§27.50 (h)(1)<br>§27.53 (m)(6) | RF Output Power, Emission Mask, EIRP at the Antenna Terminals | Conducted | PASS | Note 1,2,3 | 7.2 |
| §27.50 (h)(4) | Power Spectral Density | Conducted | PASS | Note 1,2,3 | 7.3 |
| §2.1055<br>§27.54 | Frequency Stability | Conducted | PASS | Note 1,2,3 | 7.4 |
| §2.1093 | Maximum Permissible Exposure | Calculation | PASS | Note 1,2,3 | 7.5 |
| §2.1051<br>§2.1053<br>§2.1057<br>§27.53 (m)(2) | Conducted Spurious Emissions | Conducted | PASS | Note 1,2,3 | 7.6 |
| §2.1051<br>§2.1053<br>§2.1057<br>§27.53 (m)(2)<br>15.109 | Radiated Spurious Emissions | | | | 7.7 |
| | - Transmitter >1GHz | Radiated | PASS | Note 1,2,3 | 7.7.1 |
| | - Radiated (Digital) Emissions <1GHz | Radiated | PASS | Note 1,2,3 | 7.7.2 |
| 15.107 | AC Wireline Emissions 0.15 – 30 MHz | Conducted | PASS | Note 1,2,3 | 7.8 |

Note 1: Test results reported in this document relate only to the items tested

Note 2: The required tests demonstrated compliance as per client declaration of test configuration, monitoring methodology and associated pass/fail criteria

Note 3: Section 6.10 Equipment Modifications highlights the equipment modifications that were required to bring the product into compliance with the above test matrix

# 6 PRODUCT DETAILS AND TEST CONFIGURATIONS

## 6.1 Test Program Scope

The scope of the test program was to test the RADWIN 2000 2.5 GHz BAND transmitter for compliance against FCC 47 CFR Part 27, SubPart M.

Note: The RADWIN 2000 2.5 GHz BAND can further be configured as the RADWIN 1000 2.5 GHz BAND and RADWIN 5000 2.5 GHz BAND. These two configurations were not tested by MiCOM Labs.

**APPLICANT:** Radwin Ltd **PRODUCT:** RADWIN 2000 2.5 GHz BAND

**APPLICANT:** Radwin Ltd **PRODUCT:** RADWIN 2000 2.5 GHz BAND Label

## 6.2 EUT Details

| Detail | Description |
|---|---|
| Purpose: | Test of the RADWIN 2000 2.5 GHz BAND for compliance against FCC 47 CFR Part 27, Subpart M |
| Applicant: | Radwin Ltd<br>27 Habarzel Street<br>Tel Aviv 69710<br>Israel |
| Manufacturer: | Same as Applicant |
| Test Laboratory: | MiCOM Labs, Inc.<br>440 Boulder Court, Suite 200<br>Pleasanton, California 94566 USA |
| Test report reference number: | RDWN04-U1 |
| Date EUT received: | 8th February 2011 |
| Dates of test (from - to): | 8th – 11th February 2011 |
| Unit Tested: | PBR250E000Z99999 |
| Product Name: | Outdoor unit operating in the 2.5 GHz band. |
| Manufacturers Trade Name: | Radwin Ltd. |
| Model No.: | RADWIN 2000 2.5 GHz BAND |
| Equipment Primary Function: | 2.5 GHz BAND Outdoor Radio Unit for transmitting and receiving data. |
| Equipment Secondary Function(s): | N/A |
| Installation type: | Fixed Station |
| Construction/Location for Use: | Outdoor |
| Hardware Version: | Prototype |
| Software/Firmware Release: | Not Applicable |
| Test Software Release: | ART Ver. 0.9 |
| Rated Input Voltage and Current DC: | Nominal: 55Vdc, current: 1A |
| Operating Temperature Range ºC: | Min: -35 °C Max: 60 °C |
| Equipment Dimensions: | 7.1" x 2.2" x 10.6" |
| Weight: | 3 lbs |
| Long Term Frequency Stability: | 1.7 p.p.m. |
| Transmit/Receive Operation: | Full Duplex |
| Output Power Type | Variable 1 dB steps |

## 6.3 External A.C. / D.C. Power Adaptor

| Model | Description |
|---|---|
| ET0061040 | AC power adaptor:<br>Input: 100 - 240V AC; 50-60 Hz; 1.5 Amp<br>Output: 55V DC; 1 Amp |

## 6.4 Types of Modulation Supported

| Modulation / Mode | Bandwidth (MHz) |
|---|---|
| BPSK, QPSK, 16 QAM, 64 QAM | 5 |
| BPSK, QPSK, 16 QAM, 64 QAM | 10 |
| BPSK, QPSK, 16 QAM, 64 QAM | 20 |

## 6.5 Antenna Details

The following is a description of the EUT antennas, no antennas were used for test purposes.

| Antenna Type | Manufacturer | Model | Beamwidth | Gain (dBi) | Frequency Range (MHz) |
|---|---|---|---|---|---|
| Integrated Flat Panel | Radwin Ltd | RW-9612-2327INT | 16° | 17.5 | 2300-2700 |
| External Flat Panel | Radwin Ltd | RW-9612-2427 | 16° | 20 | 2400-2700 |
| Grid | Radwin Ltd | RW-9820-2001 | 8° | 24 | 2300-2900 |

## 6.6 Cabling and I/O Ports

The following is a description of the cable and input, output ports available on the EUT.

| Type of I/O Ports | Description | Screened (Y/N) | Length | Qty | Tested (Y/N) |
|---|---|---|---|---|---|
| Ethernet/POE | Ethernet cable to provide communication and power | Y | >3 meters | 1 | Y |
| Antenna | Connection to external antennas | Y | < 3 meters | 2 | Y |

## 6.7 EUT Configurations

### Channel plan and spacing

| Band (GHz) | Mode | Freq Band (MHz) | Freq Range (MHz) | Low Ch | Mid Ch | High Ch | Chan Spacing (MHz) |
|---|---|---|---|---|---|---|---|
| 2.5 | 64QAM | 2496 - 2690 | 2504.75 – 2687.25 | 2504.75 | -- | 2687.25 | 5.5 |
| | | | 2499 - 2593 | 2499 | 2593 | -- | 6.0 |
| | | | 2507.5 – 2684.5 | 2507.5 | 2590 | 2684.5 | 11/12 |
| | | | 2513 - 2679 | 2513 | 2590 | 2679 | 22/24 |

## 6.8 Support Equipment Details

The following is a description of supporting equipment used during the test program.

| Equipment | Equipment Description | Manufacturer | Model No. | Serial No (s). | Tested |
|---|---|---|---|---|---|
| POE Injector | PoE device with AC power feeding | LI SHIN | ET0061040 | L21032009463 | Y |

## 6.9 Test Configurations

| Operational Mode(s) | Mode/Data Rate Tested | Duty Cycle |
|---|---|---|
| 5.0 | 64QAM/32.5 Mbps | 100 % |
| 10.0 | 64QAM/65 Mbps | 100 % |
| 20.0 | 64QAM/130 Mbps | 100 % |

## 6.10 Equipment Modifications

The following modifications were required to bring the equipment into compliance:

1. NONE

## 6.11 Deviations from the Test Standard

The following deviations from the test standard were required in order to complete the test program:

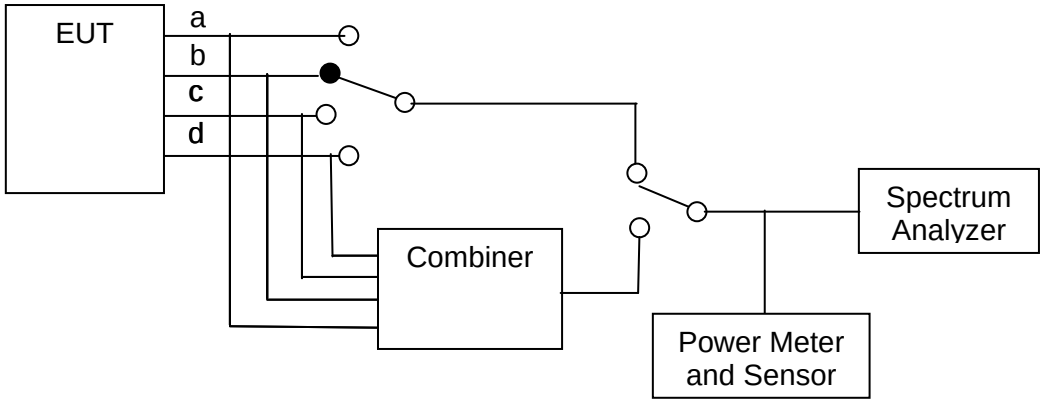
1. NONE

# 7 TEST RESULTS

## 7.1 26 dB and 99 % Occupied Bandwidth

**Test Procedure**
The bandwidth at 26 dB and 99 % is measured with a spectrum analyzer connected to the antenna terminal, while EUT is operating in transmission mode at the appropriate center frequency.

**Test Measurement Set up**




Measurement set up for 26 dB and 99 % bandwidth test

**Measurement Results for 26 dB & 99% Occupied Bandwidth**
Ambient conditions.
Temperature: 20.5 °C Relative humidity: 39 % Pressure: 1005 mbar

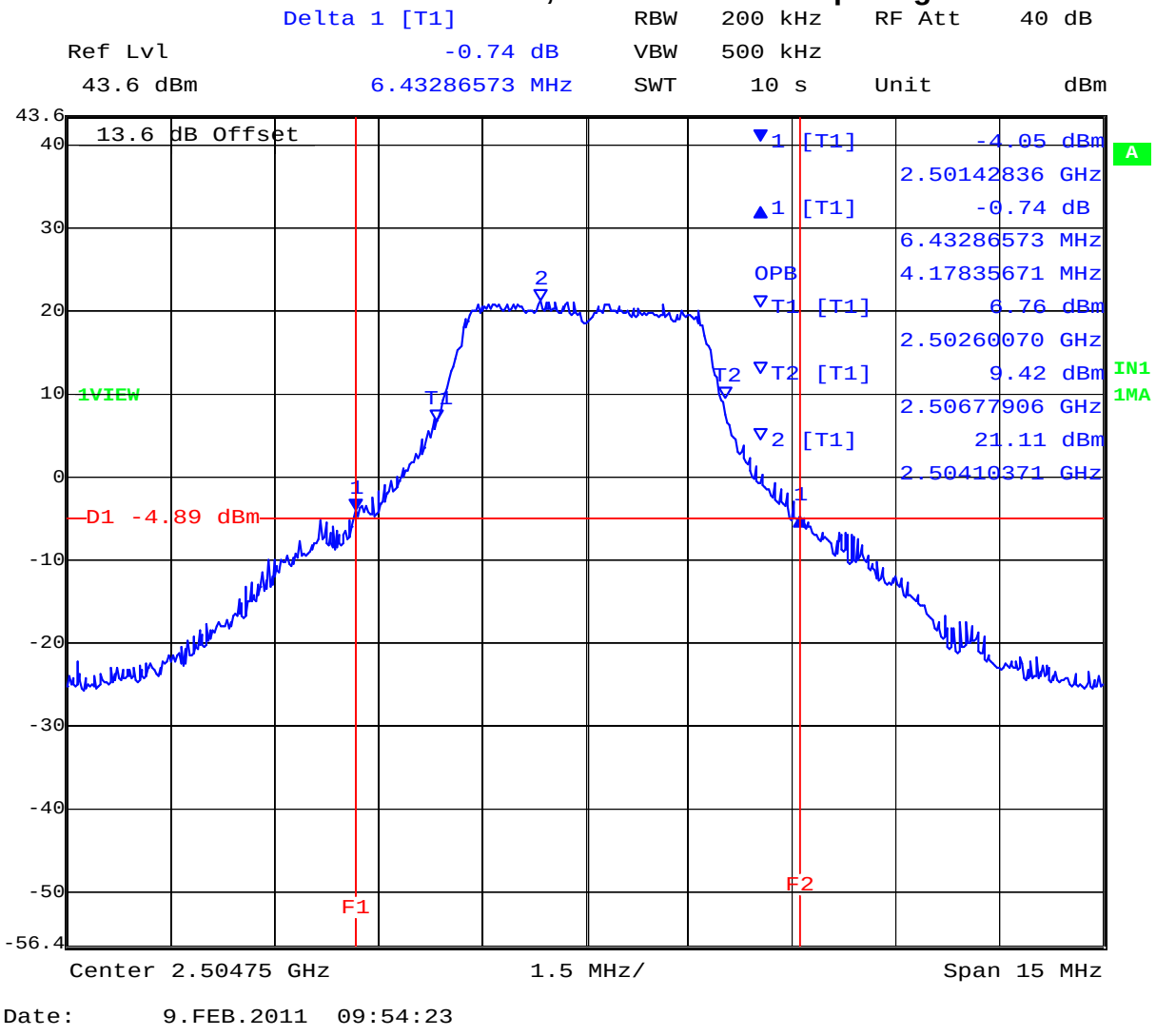
EUT parameters
Power Level: Maximum
Duty Cycle: 100%
Temperature: Ambient

### 7.1.1 Measurement results for 5.5 MHz

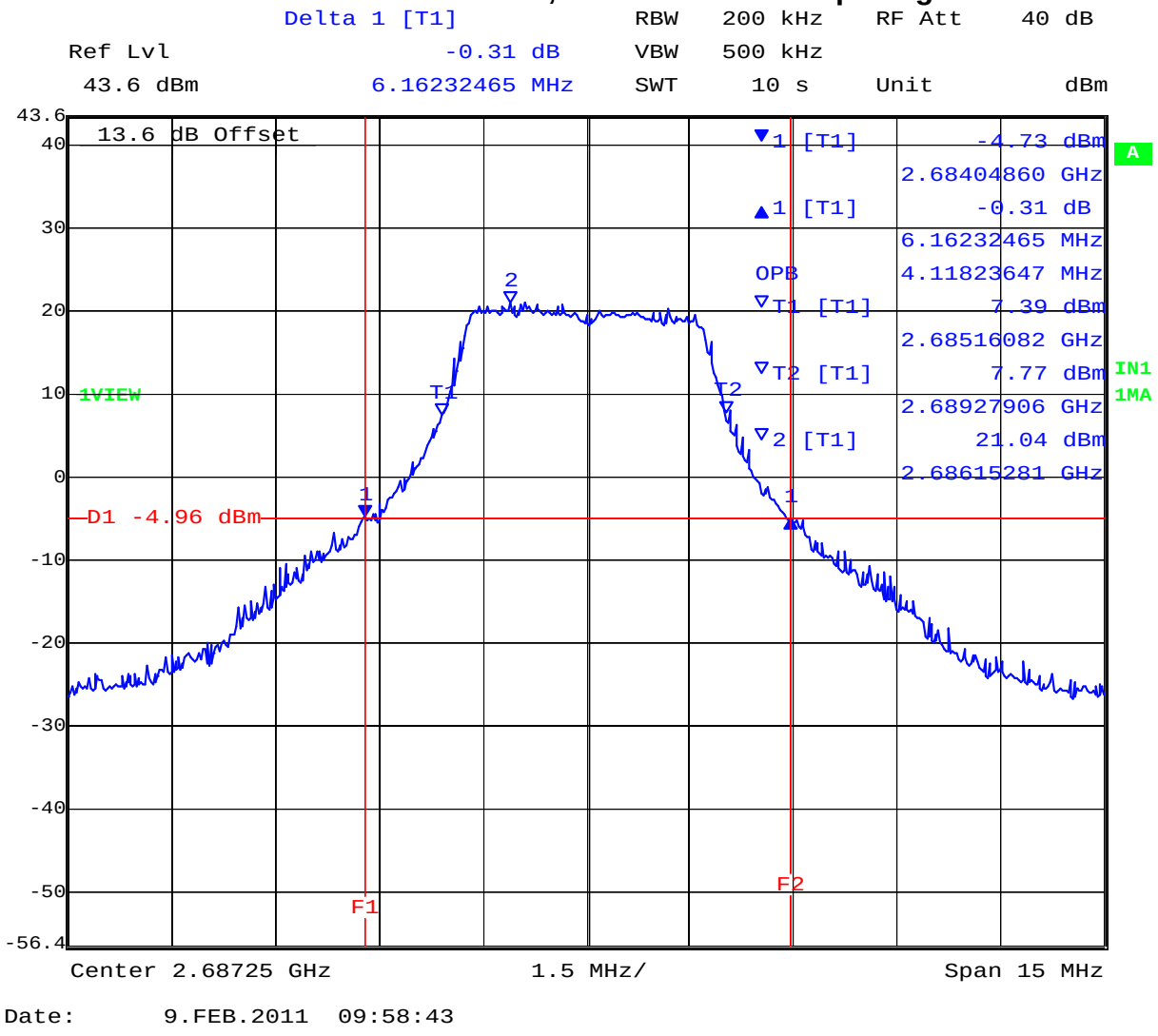
TABLE OF RESULTS – **5.5 MHz Channel Spacing**

| Center Frequency (MHz) | 26 dB Bandwidth (MHz) | 99 % BW (MHz) |
|---|---|---|
| 2504.75 | 6.433 | 4.178 |
| 2687.25 | 6.162 | 4.118 |

## 26 dB & 99% Occupied Bandwidth, Channel 2504.75 MHz, 5.5 MHz Channel Spacing



## 26 dB & 99% Occupied Bandwidth, Channel 2687.25 MHz, 5.5 MHz Channel Spacing

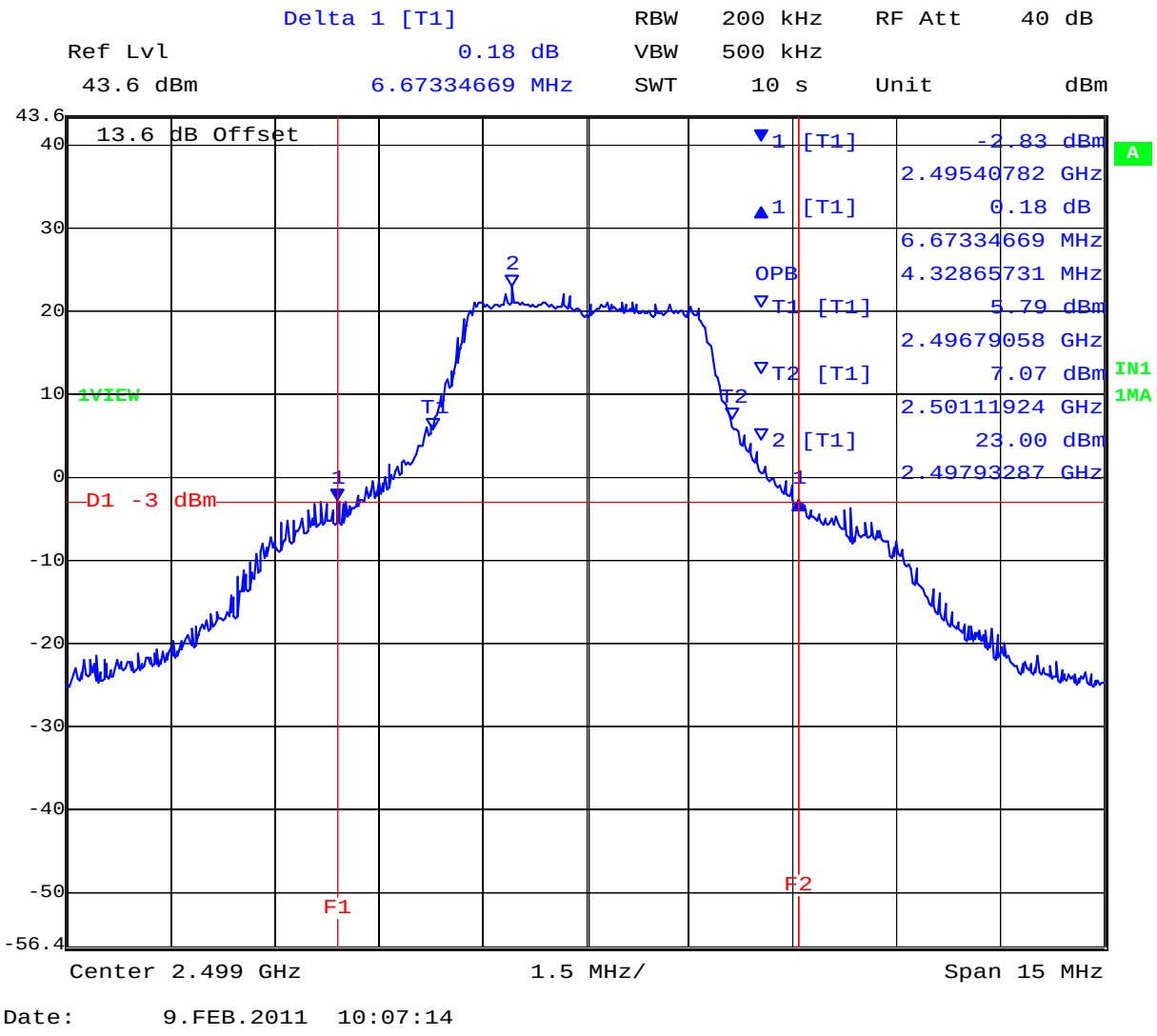


### 7.1.2 Measurement results for 6.0 MHz

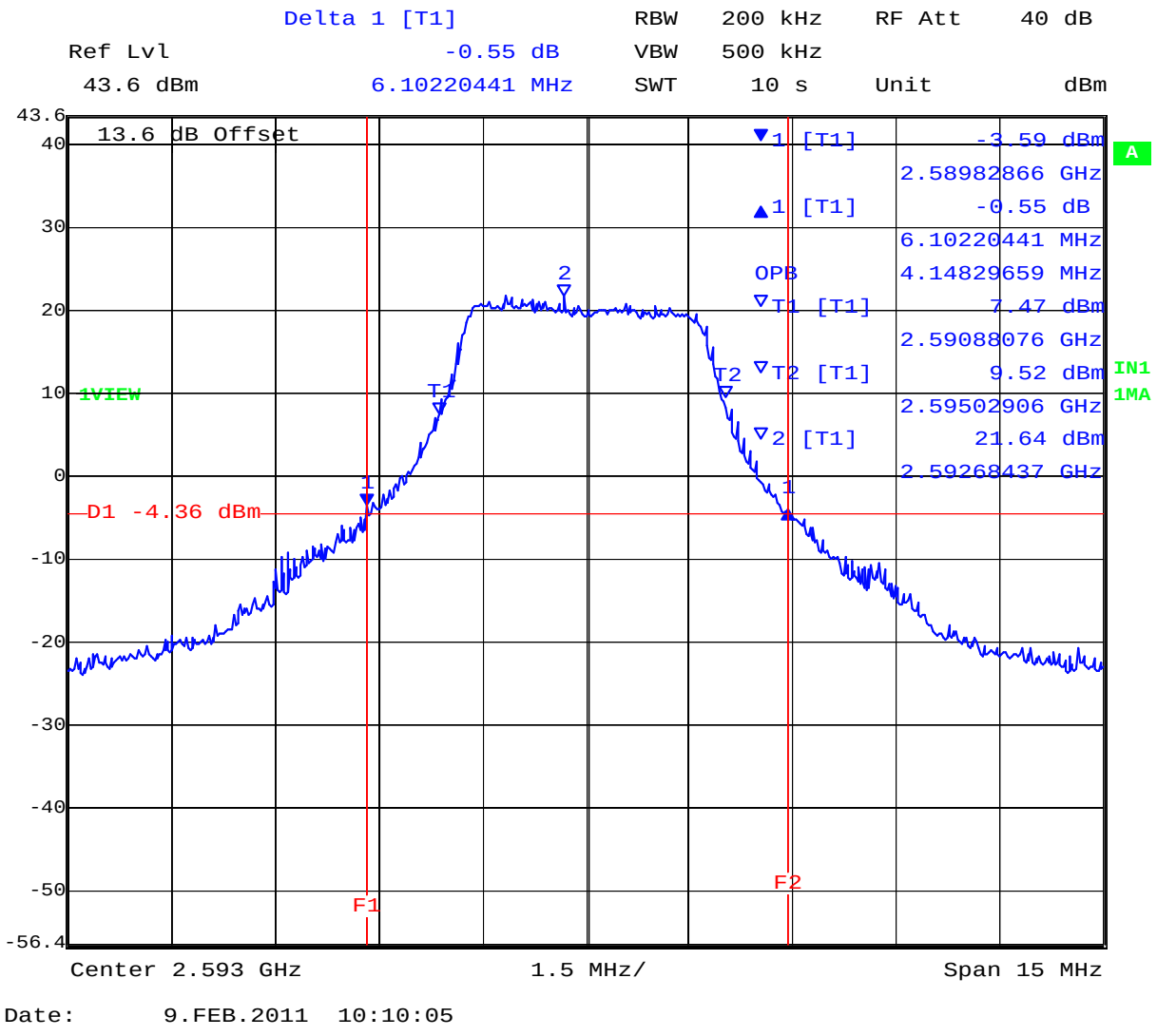
TABLE OF RESULTS – **6 MHz Channel Spacing**

| Center Frequency (MHz) | 26 dB Bandwidth (MHz) | 99 % BW (MHz) |
|---|---|---|
| 2499.00 | 6.673 | 4.329 |
| 2593.00 | 6.102 | 4.148 |

## 26 dB & 99% Occupied Bandwidth, Channel 2499.00 MHz, 6.0 MHz Channel Spacing



## 26 dB & 99% Occupied Bandwidth,
## Channel 2593.00 MHz, 6.0 MHz Channel Spacing

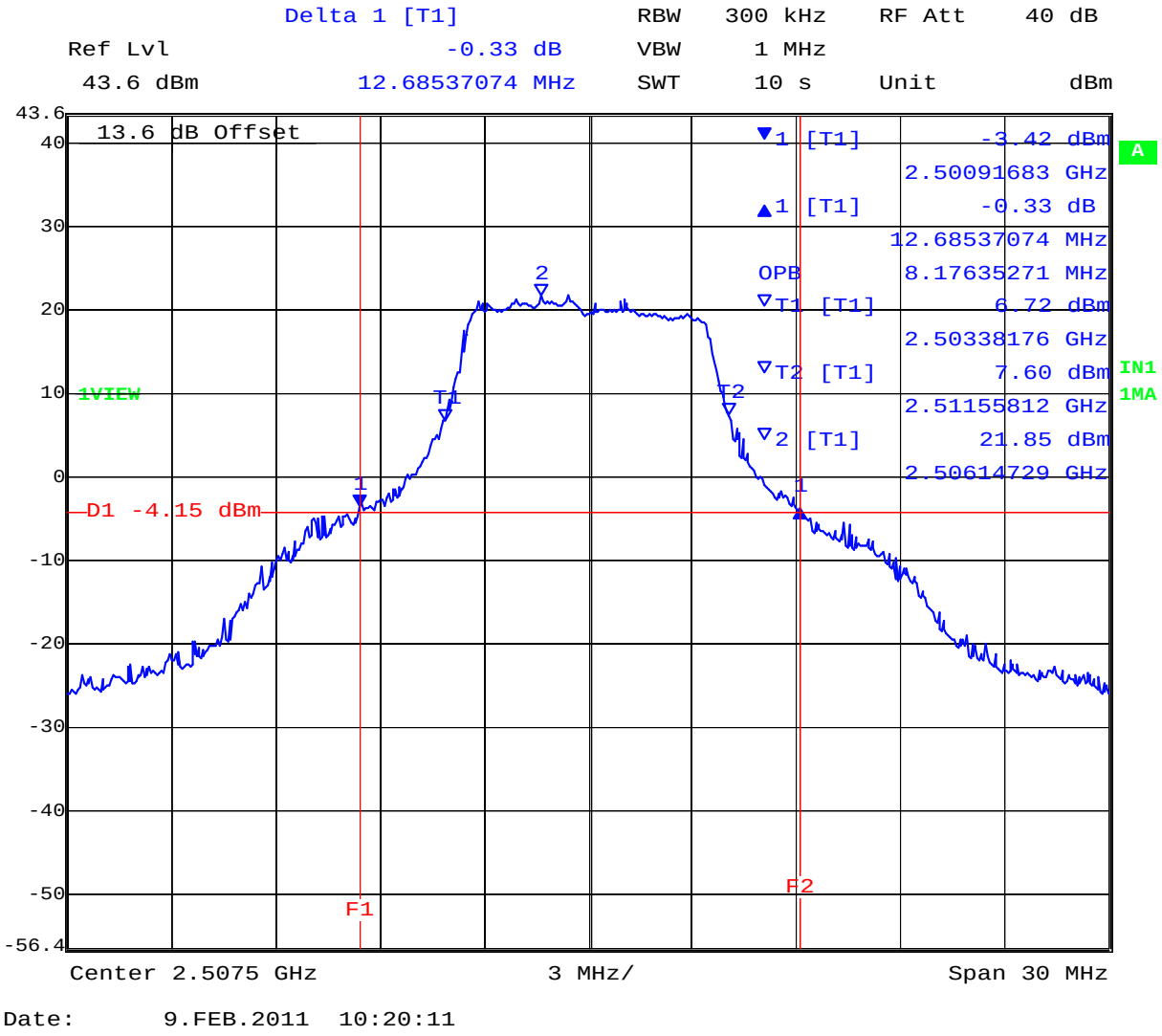


### 7.1.3 Measurement results for 11 and 12.0 MHz

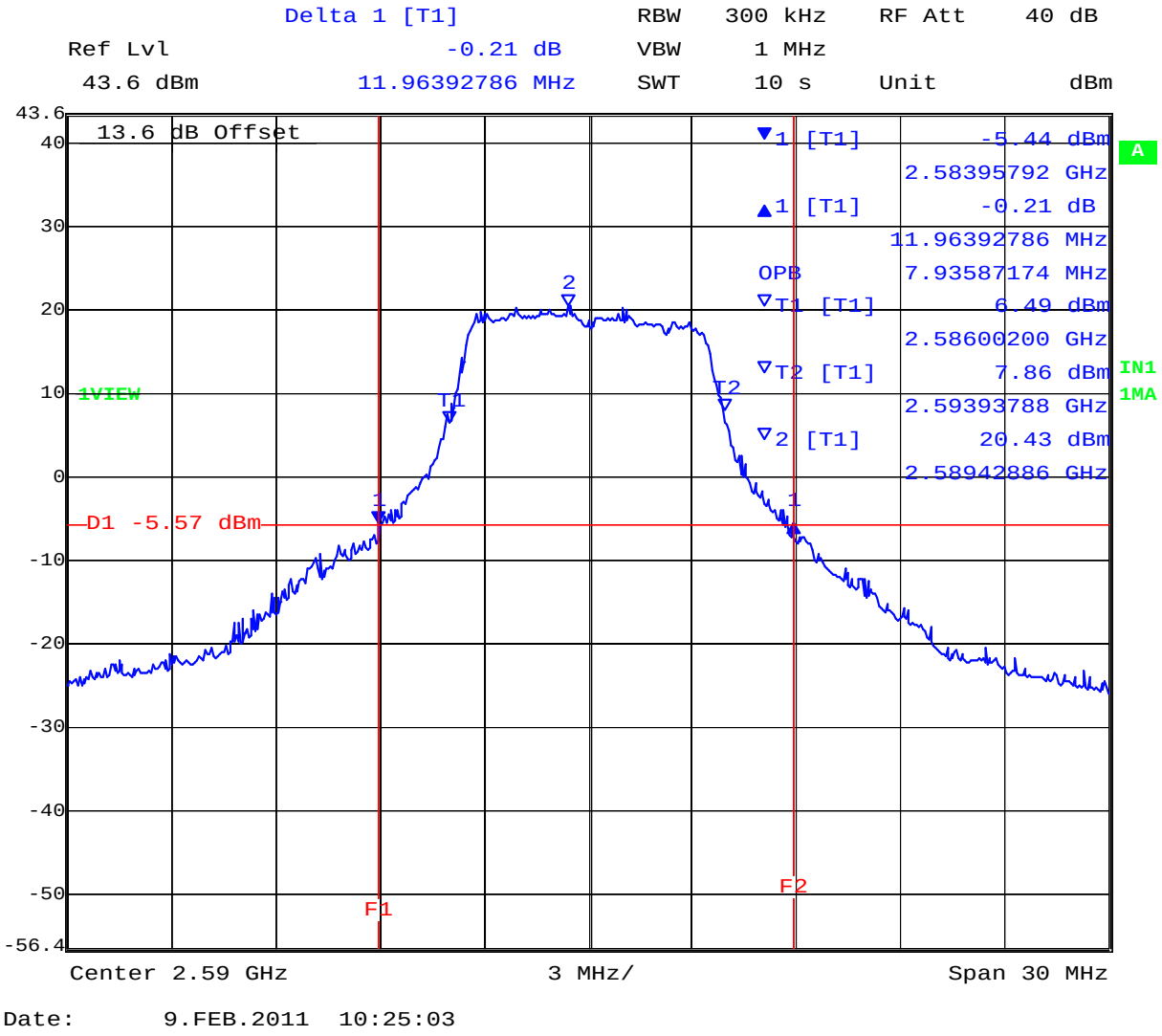
TABLE OF RESULTS – **11 MHz and 12 MHz Dual Channel Spacing**

| Center Frequency (MHz) | 26 dB Bandwidth (MHz) | 99 % BW (MHz) |
|---|---|---|
| 2507.50 | 12.685 | 8.176 |
| 2590.00 | 11.964 | 7.936 |
| 2684.50 | 12.745 | 8.116 |

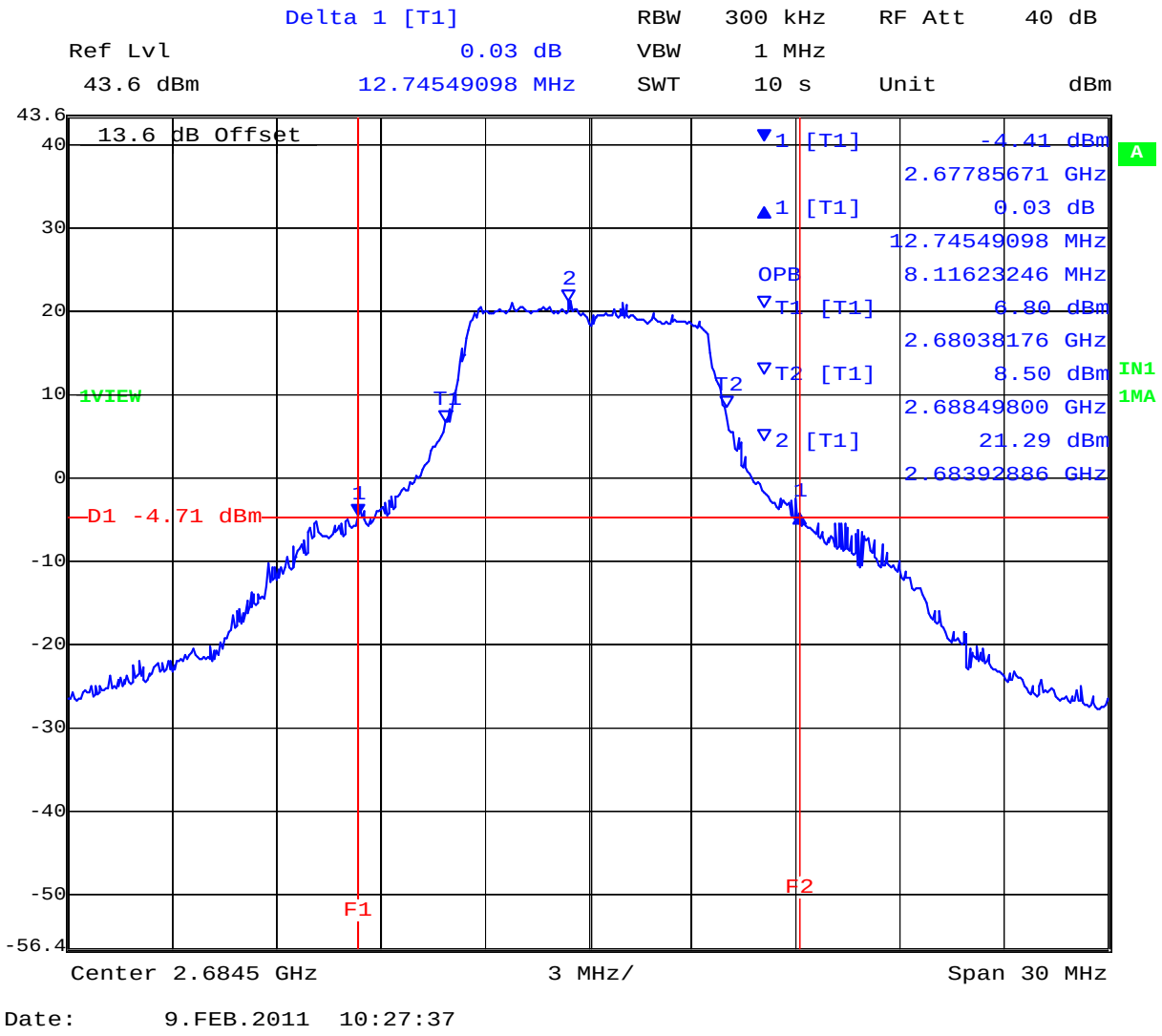
## 26 dB & 99% Occupied Bandwidth,
## Channel 2507.50 MHz, 11 MHz Dual Channel Spacing



## 26 dB & 99% Occupied Bandwidth,
## Channel 2590.00 MHz, 12 MHz Dual Channel Spacing



## 26 dB & 99% Occupied Bandwidth,
## Channel 2684.50 MHz, 11 MHz Dual Channel Spacing

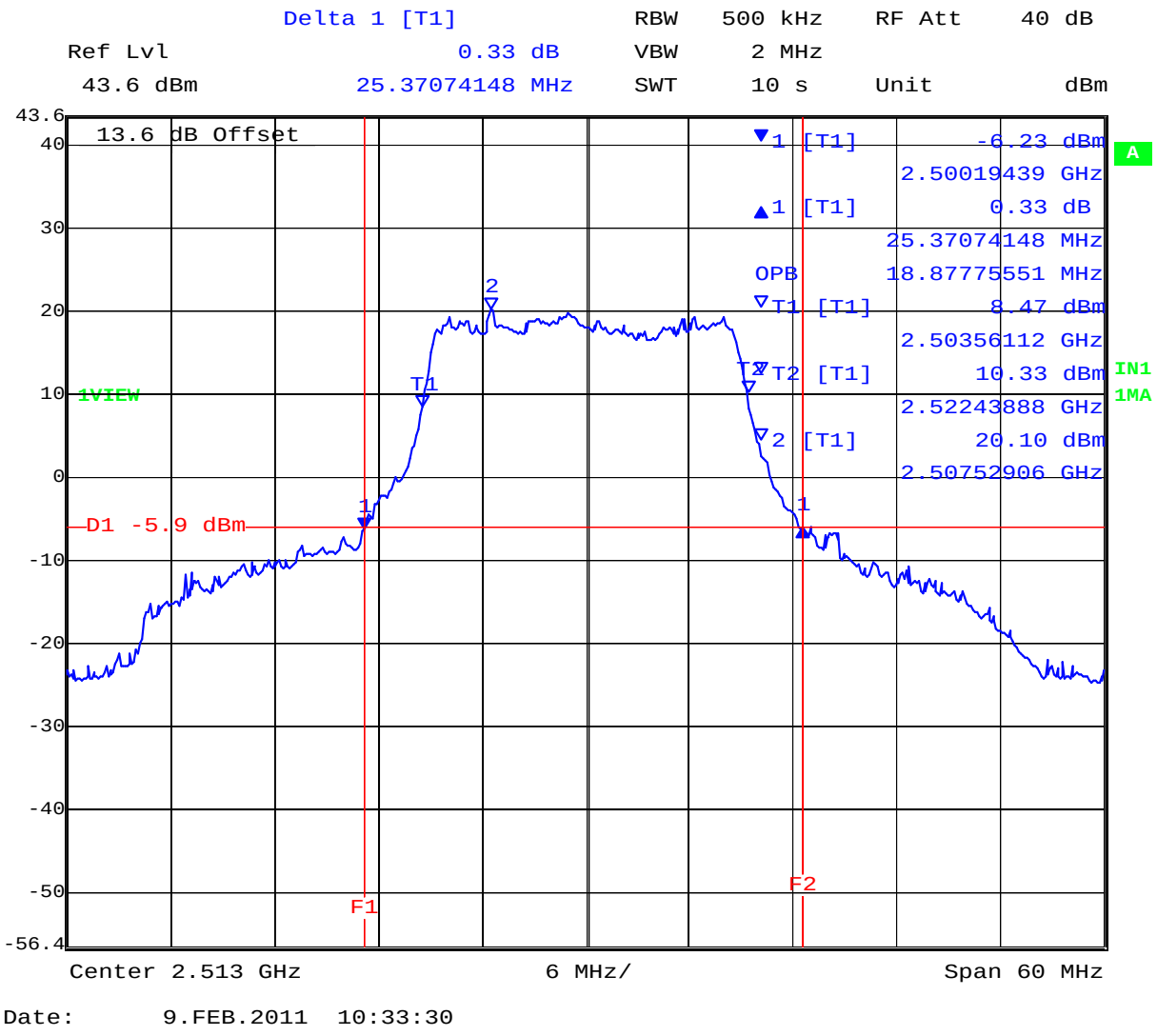


### 7.1.4 Measurement results for 22 and 24 MHz

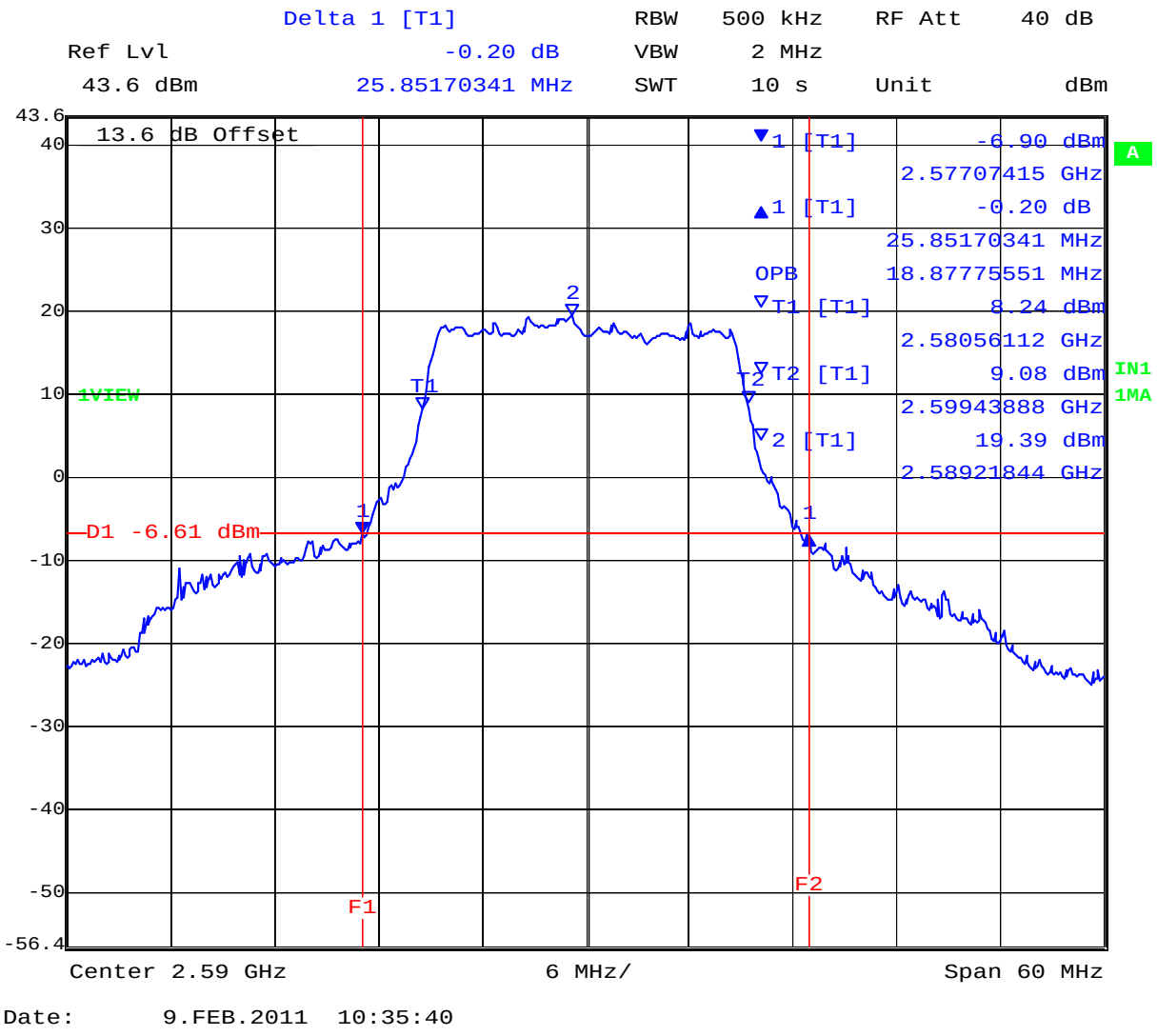
TABLE OF RESULTS – **22 MHz and 24 MHz Quad Channel Spacing**

| Center Frequency (MHz) | 26 dB Bandwidth (MHz) | 99 % BW (MHz) |
|---|---|---|
| 2513.00 | 25.371 | 18.878 |
| 2590.00 | 25.851 | 18.878 |
| 2679.00 | 25.010 | 18.878 |

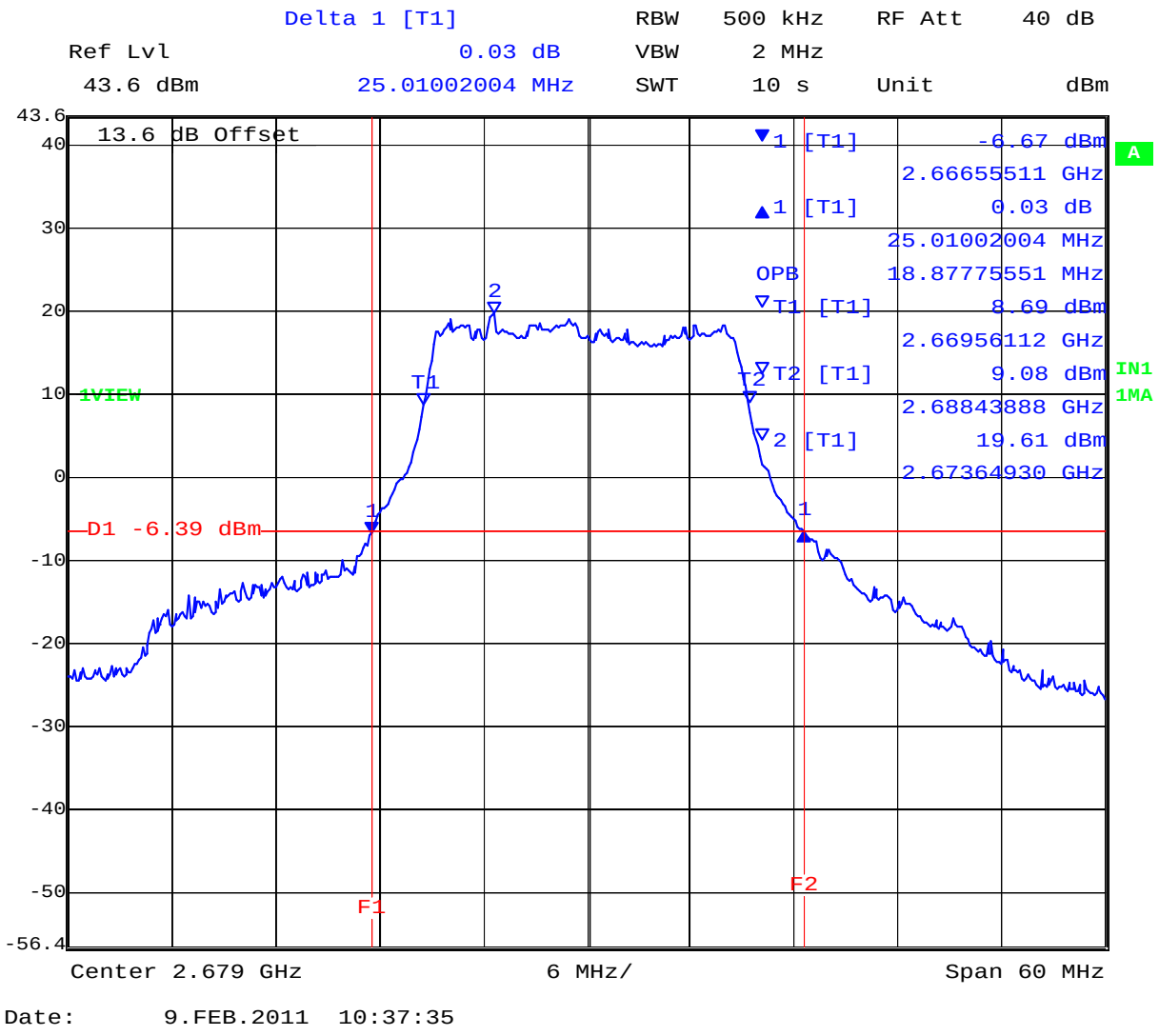
## 26 dB & 99% Occupied Bandwidth, Channel 2513.00 MHz, 22 MHz Quad Channel Spacing



## 26 dB & 99% Occupied Bandwidth, Channel 2590.00 MHz, 24 MHz Quad Channel Spacing



## 26 dB & 99% Occupied Bandwidth, Channel 2679.00 MHz, 22 MHz Quad Channel Spacing

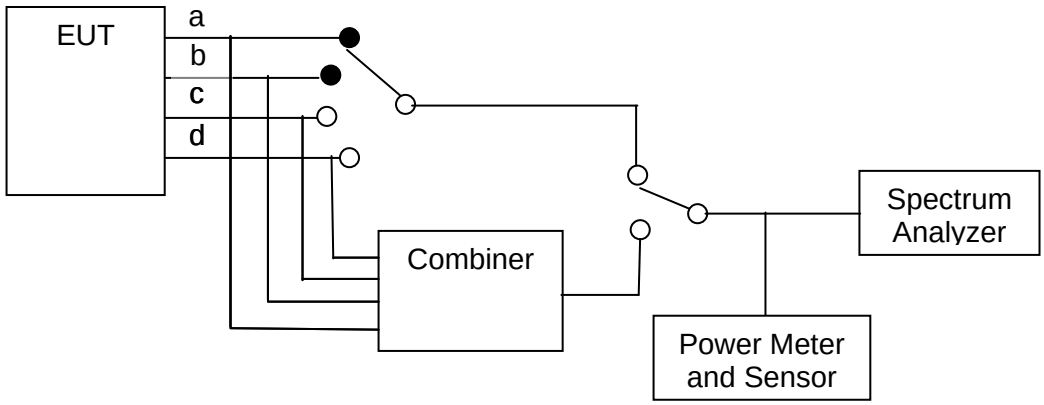


## 7.2 RF Output Power, Emission Mask, EIRP at the Antenna Terminals

### Test Procedure

The test methodology and conditions utilized for each measurement is referenced in the test results matrix. The output power was measured by the spectrum analyzer per the test configuration below. Per the standard measurements were taken at ambient conditions, nominal voltage.

### Test Configuration




Measurement setup for RF Output Power

**Specification**
**Power and antenna height limits.**

§ 27.50 (h) The following power limits shall apply in the BRS and EBS:

(1) Main, booster and base stations.

(i) The maximum EIRP of a main, booster or base station shall not exceed 33 dBW + 10log(X/Y) dBW, where X is the actual channel width in MHz and Y is either 6 MHz if prior to transition or the station is in the MBS following transition or 5.5 MHz if the station is in the LBS and UBS following transition, except as provided in paragraph (h)(1)(ii) of this section.

(ii) If a main or booster station sectorizes or otherwise uses one or more transmitting antennas with a non-omni-directional horizontal plane
radiation pattern, the maximum EIRP in dBW in a given direction shall be determined by the following formula: EIRP = 33 dBW + 10 log(X/Y) dBW + 10 log(360/beam width) dBW, where X is the actual channel width in MHz, Y is either (i) 6 MHz if prior to transition or
the station is in the MBS following transition or (ii) 5.5 MHz if the station is in the LBS and UBS following transition, and beam width is the total horizontal plane beam width of the individual transmitting antenna for the station or any sector measured at the half-power points.

**EIRP Calculation –**

| Channel Spacing (MHz) | Antenna Beam width | EIRP Limit (dBm) | Measured BW (MHz) |
|---|---|---|---|
| 5.5 | 16° | 77.20 | 6.433 |
| 6 | 16° | 76.98 | 6.673 |
| 11 | 16° | 77.16 | 12.745 |
| 12 | 16° | 76.51 | 11.964 |
| 22 | 16° | 77.14 | 25.371 |
| 24 | 16° | 76.84 | 25.851 |
| 5.5 | 8° | 80.21 | 6.433 |
| 6 | 8° | 79.99 | 6.673 |
| 11 | 8° | 80.17 | 12.745 |
| 12 | 8° | 79.52 | 11.964 |
| 22 | 8° | 80.15 | 25.371 |
| 24 | 8° | 79.85 | 25.851 |

**Traceability**

| Method | Test Equipment Used |
|---|---|
| Measurements were made per work instruction WI-01 'Measuring RF Output Power' | 0158, 0252, 0313, 0314, 0223, 0116, 0117, 0287, 0363 |

**Measurement Results for Transmit Output Power**
Ambient conditions.
Temperature: 20.5 °C Relative humidity: 39 % Pressure: 1005 mbar

EUT parameters.
Power Level: Maximum
Duty Cycle: 100%
Temperature: Ambient

### 7.2.1 Measurement results for 5.5 MHz

TABLE OF RESULTS – **5.5 MHz Channel Spacing**

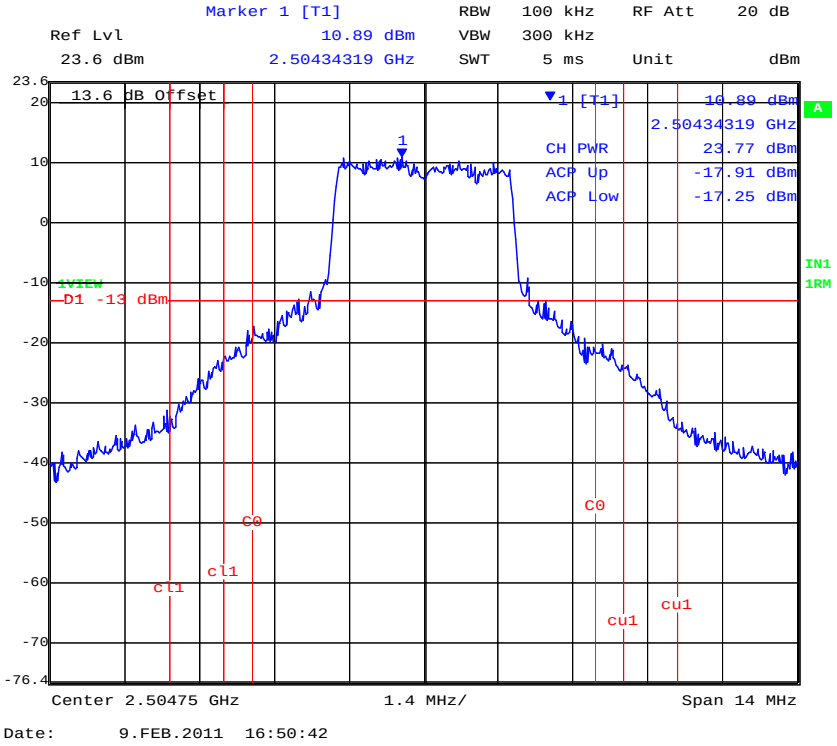
| Center Frequency (MHz) | Maximum Conducted Power (dBm) | |
|---|---|---|
| | Port A | Port B |
| 2504.75 | +23.77 | +22.72 |
| 2687.25 | +21.96 | +22.43 |

**Band-Edge Power (Power Integrated over 1 MHz @ 100 kHz Bandwidth)**

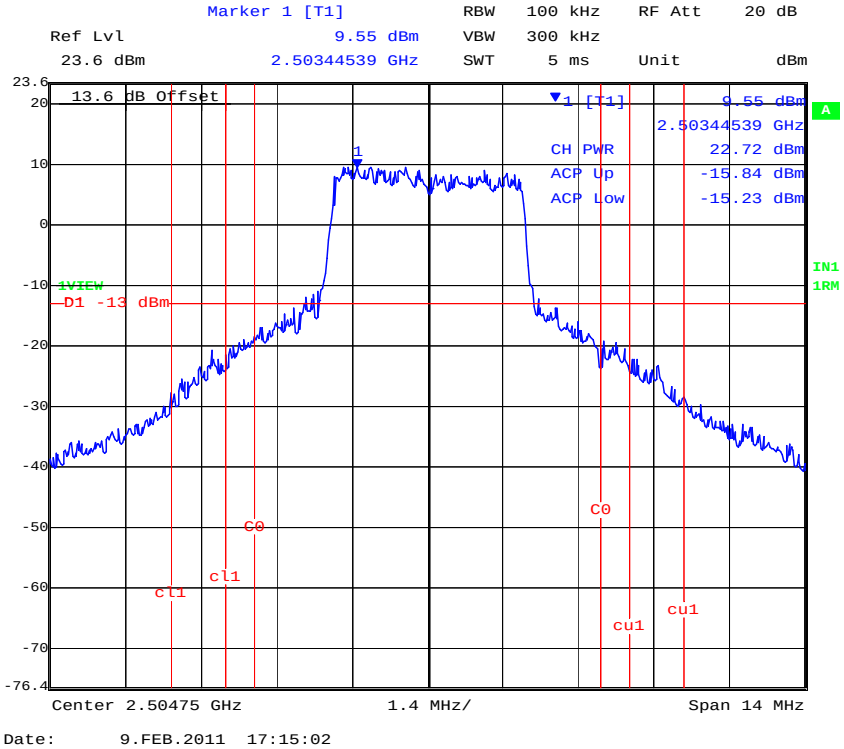
| Center Frequency (MHz) | Plot Reference | Band-Edge Power (dBm) | | Limit (dBm) |
|---|---|---|---|---|
| | | Port A | Port B | |
| 2504.75 | ACP Low (cl1-cl1) | -17.25 | -15.23 | -13.00 |
| 2687.25 | ACP Up (cu1-cu1) | -14.97 | -14.19 | |

## Output Power, Channel 2504.75 MHz, 5.5 MHz Channel Spacing

### Port A

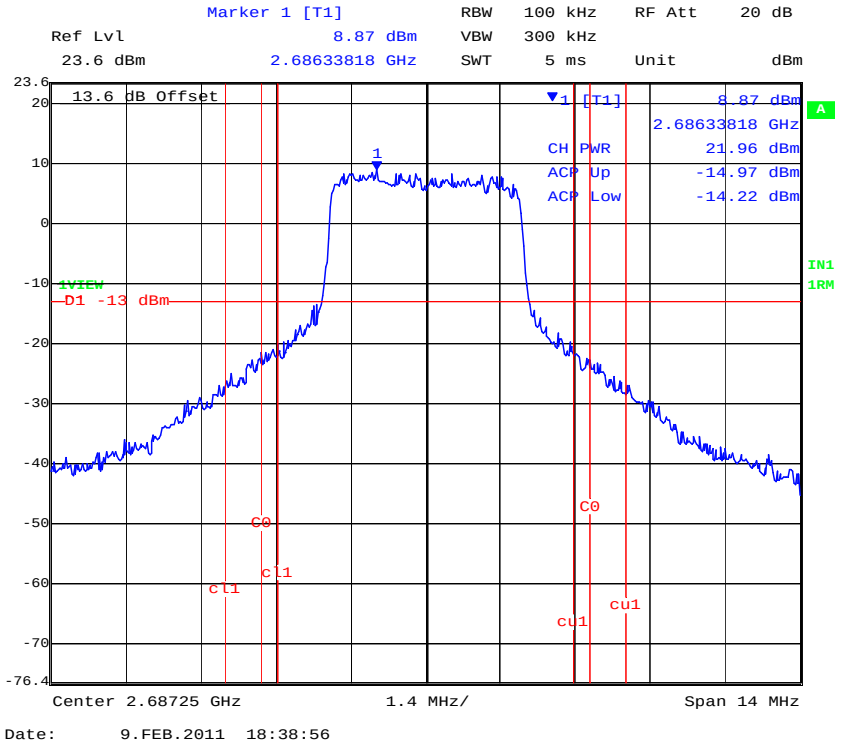



### Port B

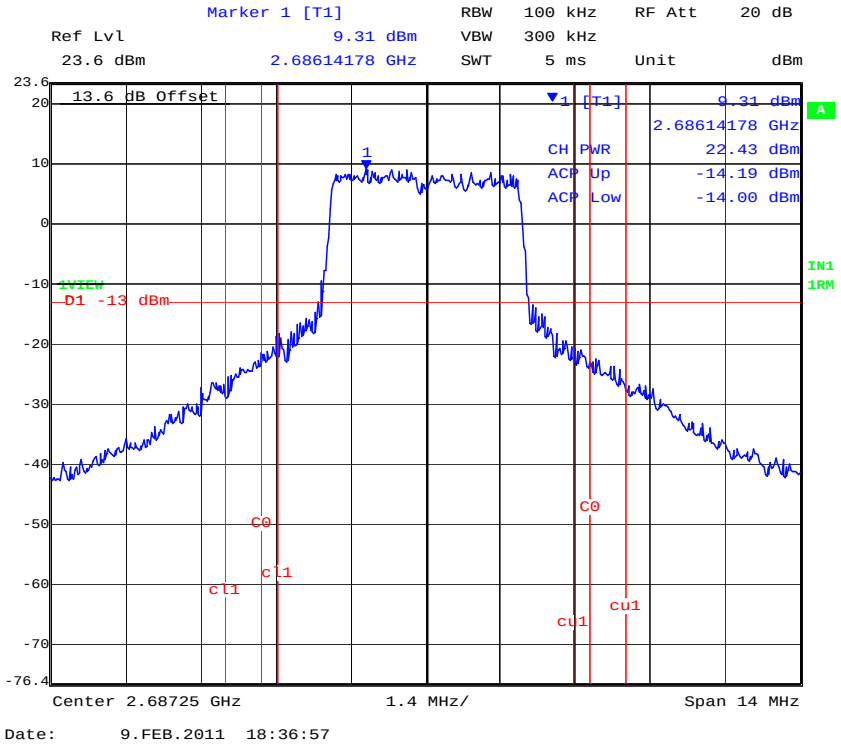


## Output Power, Channel 2687.25 MHz, 5.5 MHz Channel Spacing

### Port A




### Port B



### 7.2.2 Measurement results for 6.0 MHz

TABLE OF RESULTS – **6 MHz Channel Spacing**

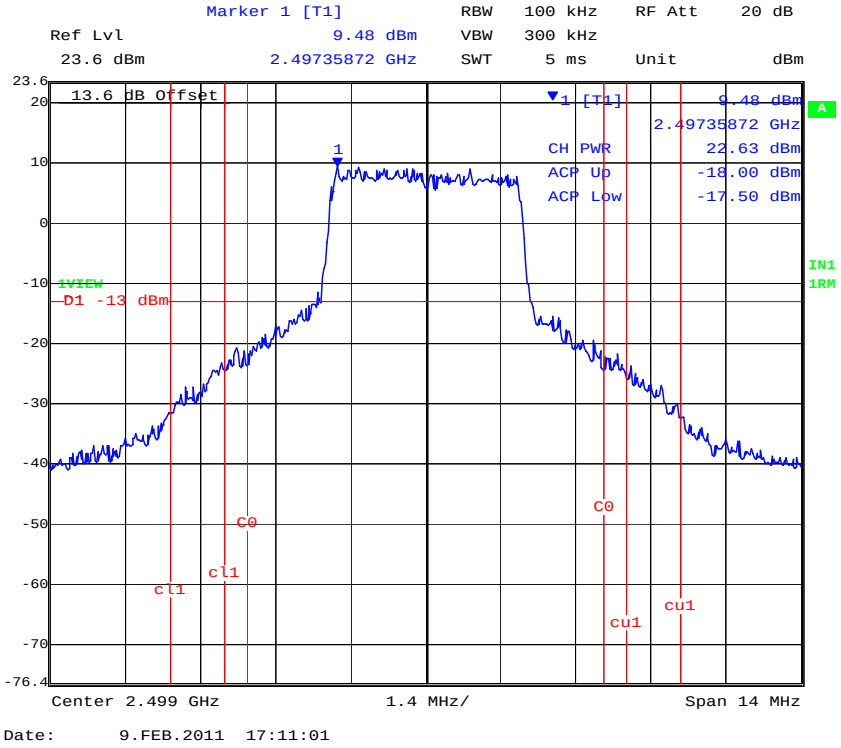
| Center Frequency (MHz) | Maximum Conducted Power (dBm) | |
|---|---|---|
| | Port A | Port B |
| 2499.00 | +22.63 | +22.19 |
| 2593.00 | +22.85 | +22.84 |

**Band-Edge Power (Power Integrated over 1 MHz @ 100 kHz Bandwidth)**

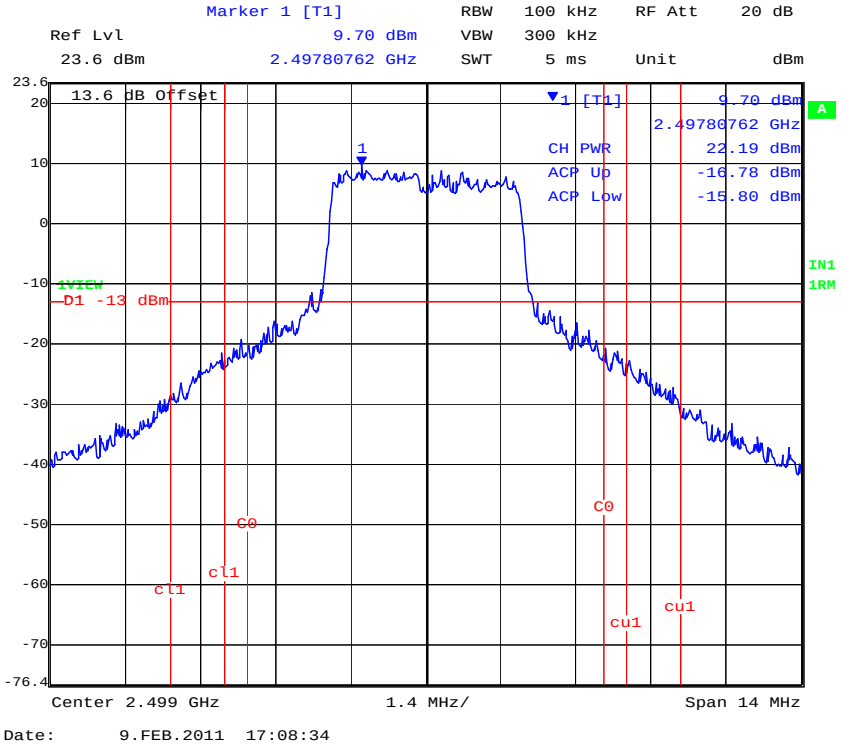
| Center Frequency (MHz) | Plot Reference | Band-Edge Power (dBm) | | Limit (dBm) |
|---|---|---|---|---|
| | | Port A | Port B | |
| 2499.00 | ACP Low (cl1-cl1) | -17. 50 | -15.80 | -13.00 |

## Output Power, Channel 2499.00 MHz, 6.0 MHz Channel Spacing

### Port A

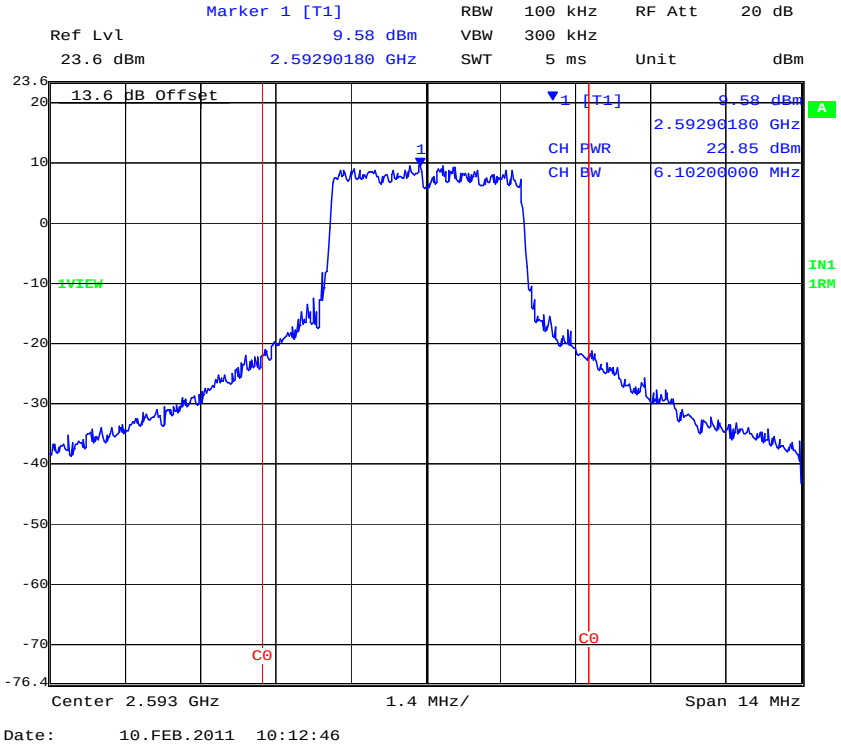



### Port B

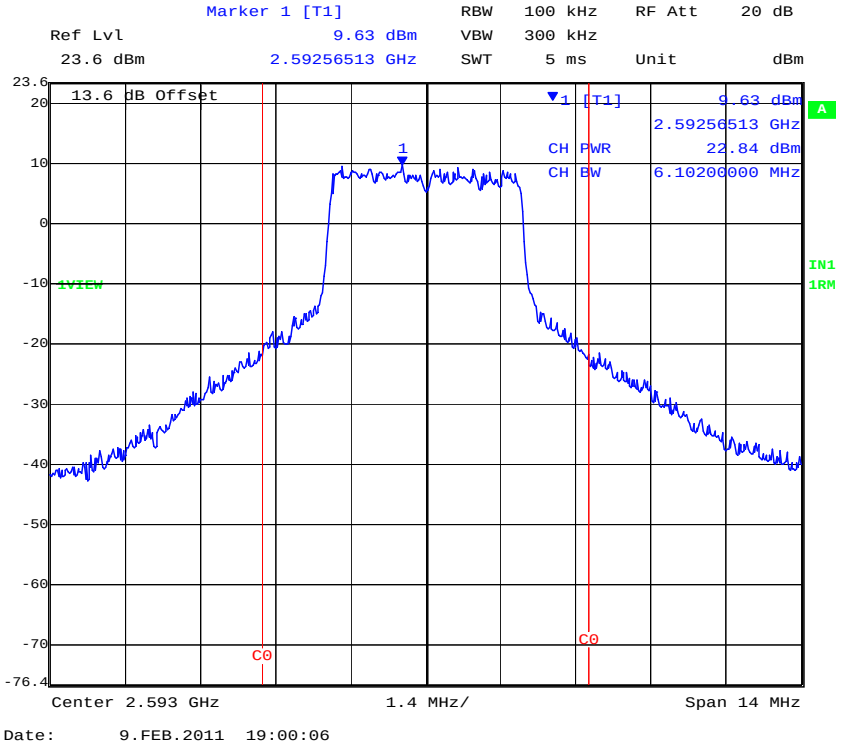


## Output Power, Channel 2593.00 MHz, 6.0 MHz Channel Spacing

### Port A




### Port B



### 7.2.3 Measurement results for 11 and 12 MHz

TABLE OF RESULTS – **11 and 12 MHz Dual Channel Spacing**

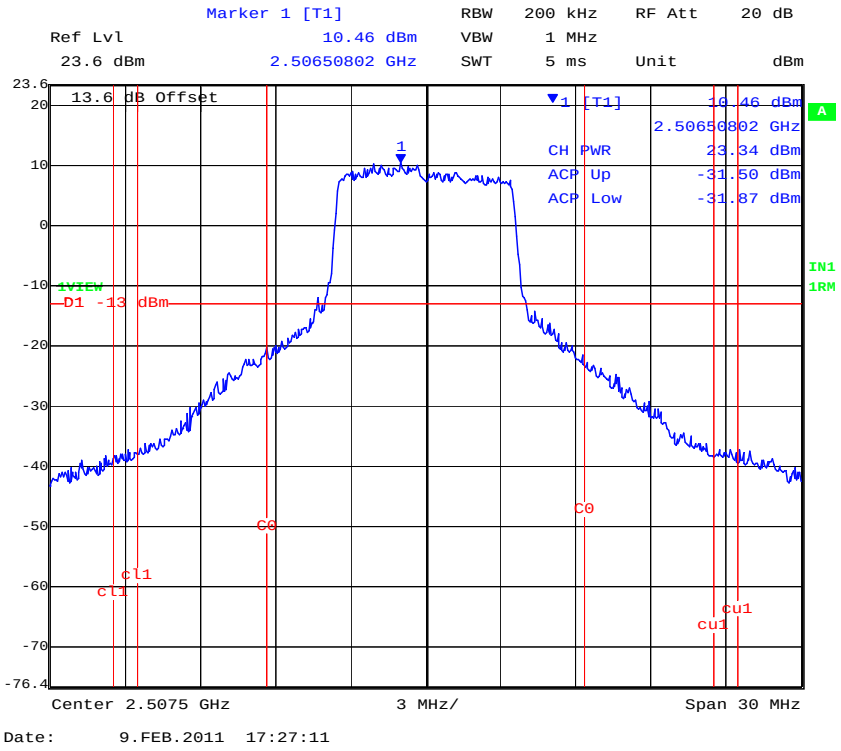
| Center Frequency (MHz) | Maximum Conducted Power (dBm) | |
|---|---|---|
| | Port A | Port B |
| 2507.50 | +23.34 | +23.55 |
| 2590.00 | +22.97 | +23.36 |
| 2684.50 | +22.26 | +23.32 |

**Band-Edge Power (Power Integrated over 1 MHz @ 100 kHz Bandwidth)**

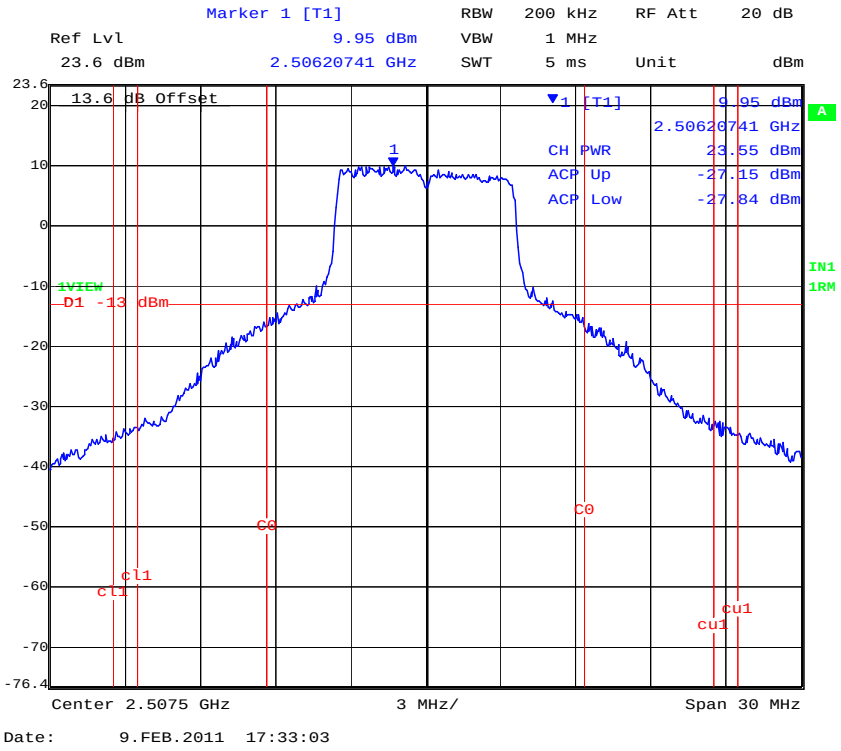
| Center Frequency (MHz) | Plot Reference | Band-Edge Power (dBm) | | Limit (dBm) |
|---|---|---|---|---|
| | | Port A | Port B | |
| 2507.50 | ACP Low (cl1-cl1) | -31.87 | -27.84 | -13.00 |
| 2684.50 | ACP Up (cu1-cu1) | -16.97 | -13.94 | |

## Output Power, Channel 2507.50 MHz, 11 MHz Dual Channel Spacing

### Port A

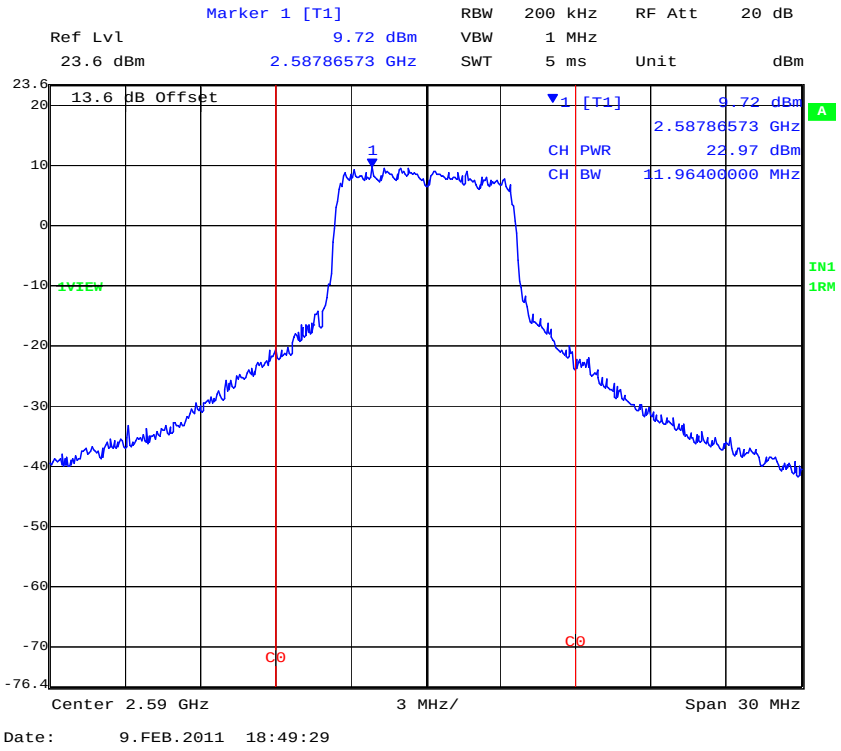



### Port B

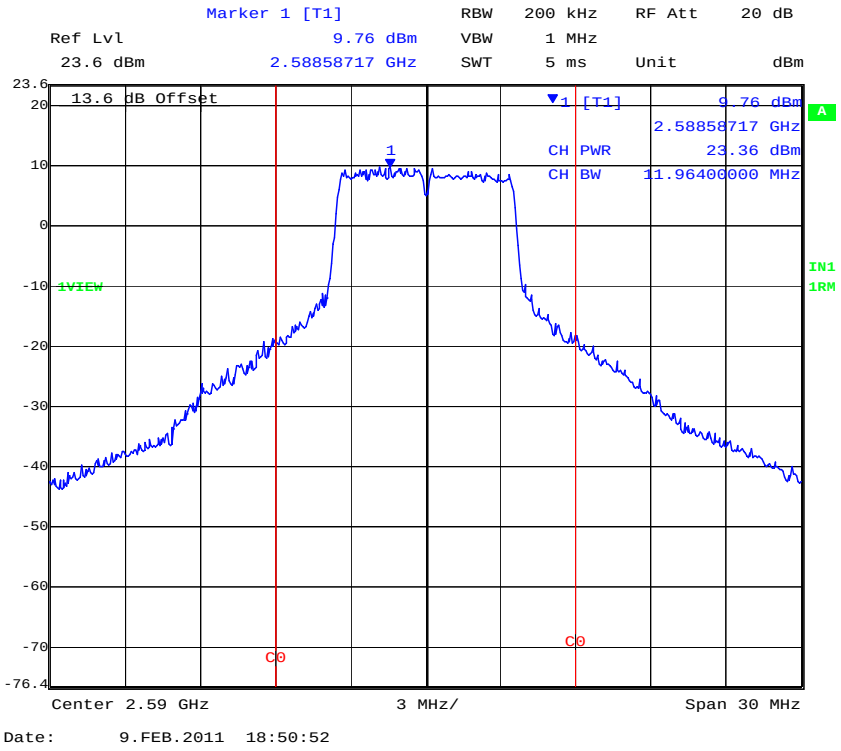


## Output Power, Channel 2590.00 MHz, 12 MHz Dual Channel Spacing

### Port A

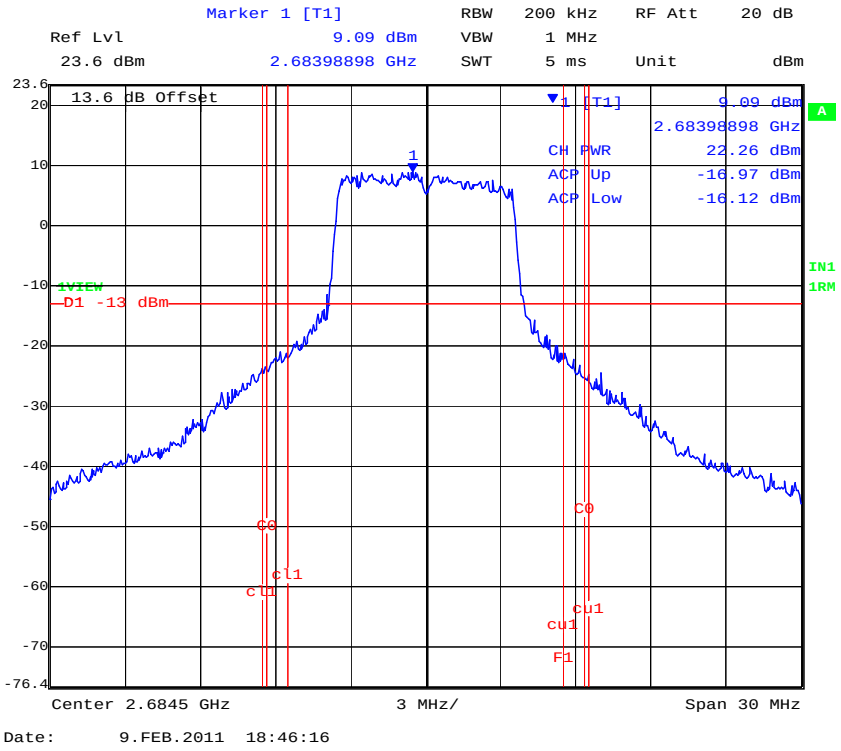



### Port B

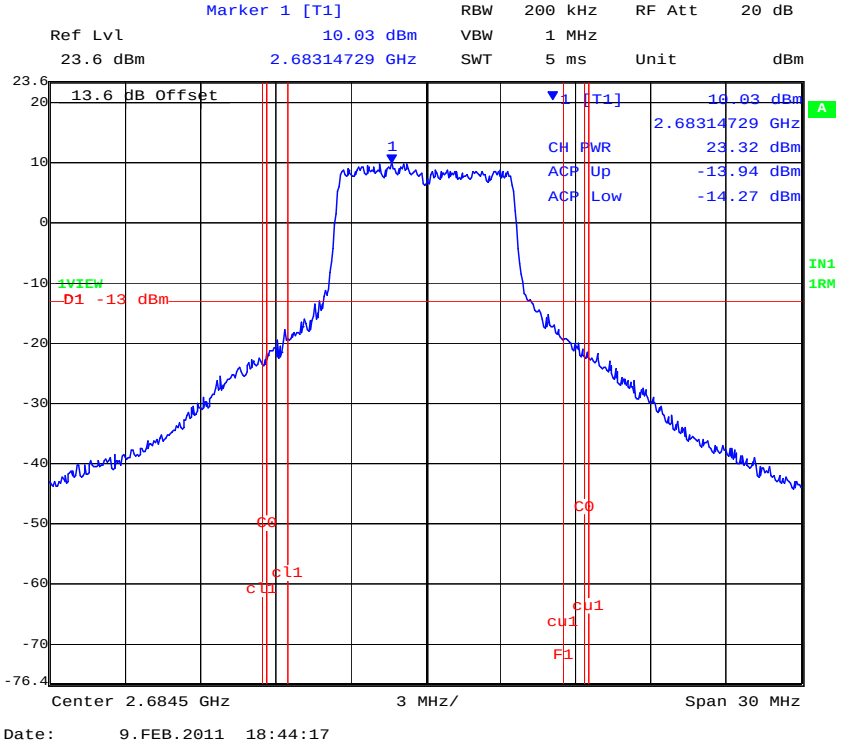


## Output Power, Channel 2684.50 MHz, 11 MHz Dual Channel Spacing

### Port A




### Port B



### 7.2.4 Measurement results for 22 and 24 MHz

TABLE OF RESULTS – **22 and 24 MHz Quad Channel Spacing**

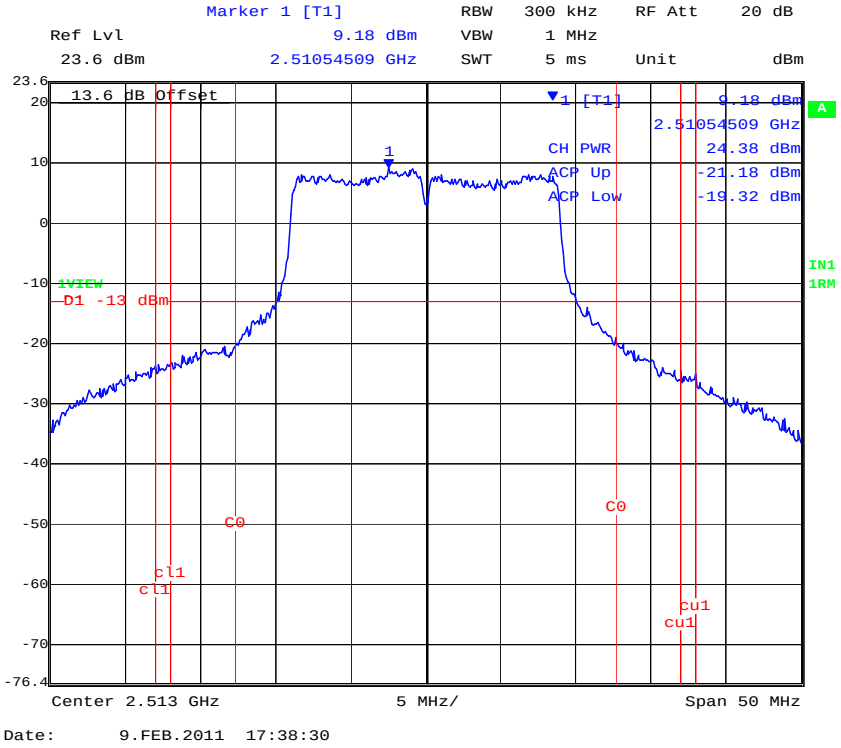
| Center Frequency (MHz) | Maximum Conducted Power (dBm) | |
|---|---|---|
| | Port A | Port B |
| 2513.00 | +24.38 | +24.36 |
| 2590.00 | +23.41 | +24.08 |
| 2679.00 | +22.17 | +23.15 |

**Band-Edge Power (Power Integrated over 1 MHz @ 100 kHz Bandwidth)**

| Center Frequency (MHz) | Plot Reference | Band-Edge Power (dBm) | | Limit (dBm) |
|---|---|---|---|---|
| | | Port A | Port B | |
| 2513.00 | ACP Low (cl1-cl1) | -19.32 | -14.90 | -13.00 |
| 2697.00 | ACP Up (cu1-cu1) | -15.77 | -13.59 | |

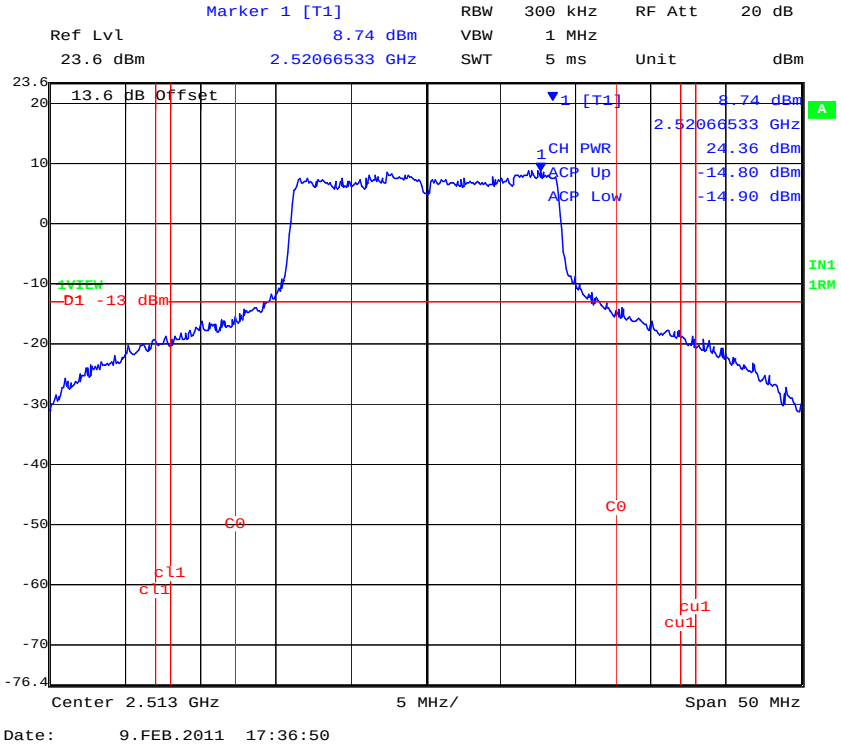
## Output Power, Channel 2513.00 MHz, 22 MHz Quad Channel Spacing

### Port A




Date: 9.FEB.2011 17:38:30

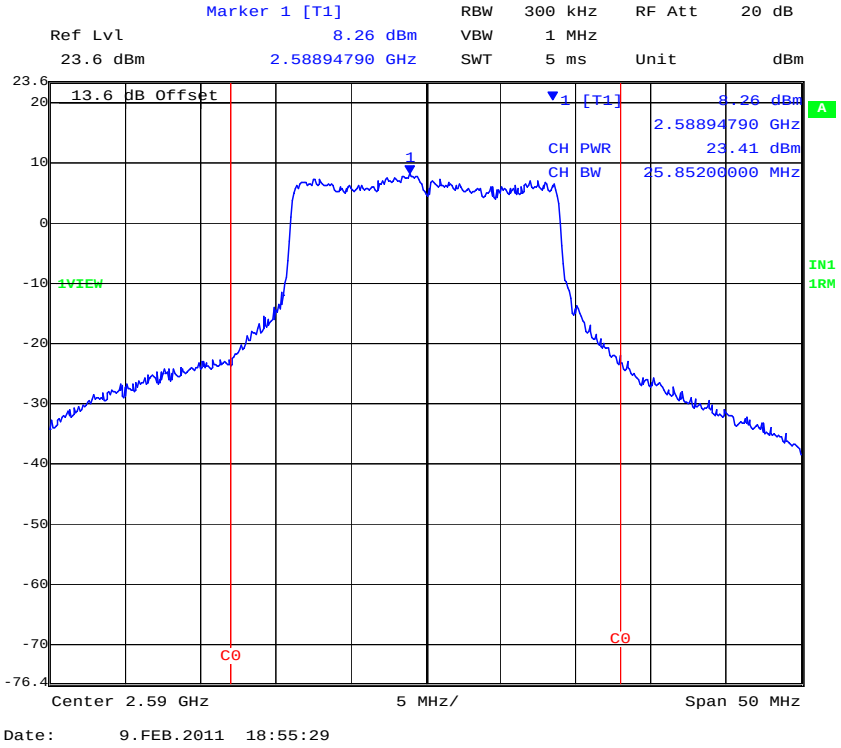
### Port B



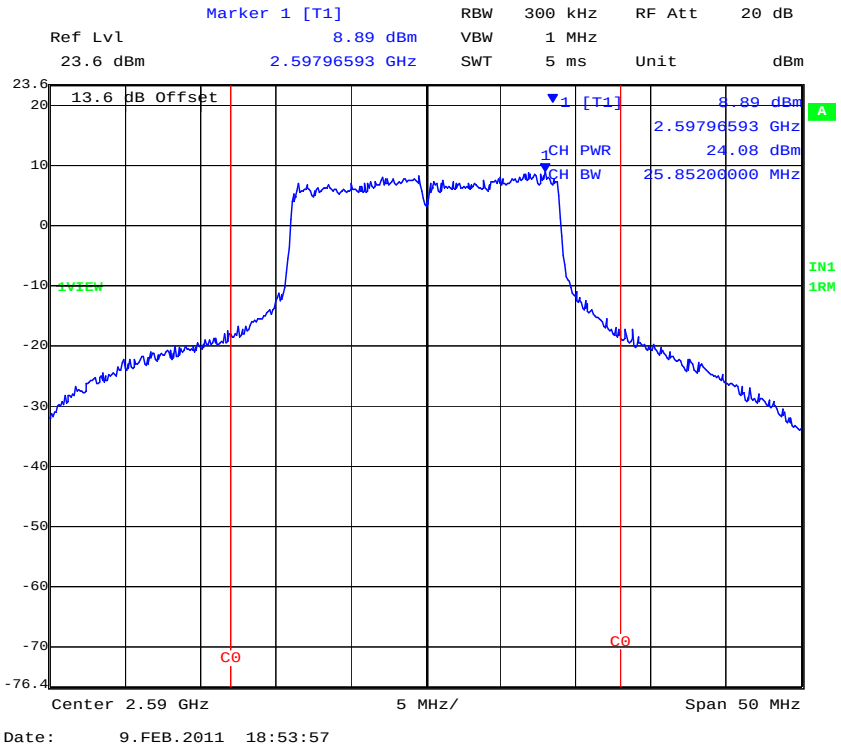

Date: 9.FEB.2011 17:36:50

## Output Power, Channel 2590.00 MHz, 24 MHz Quad Channel Spacing

### Port A

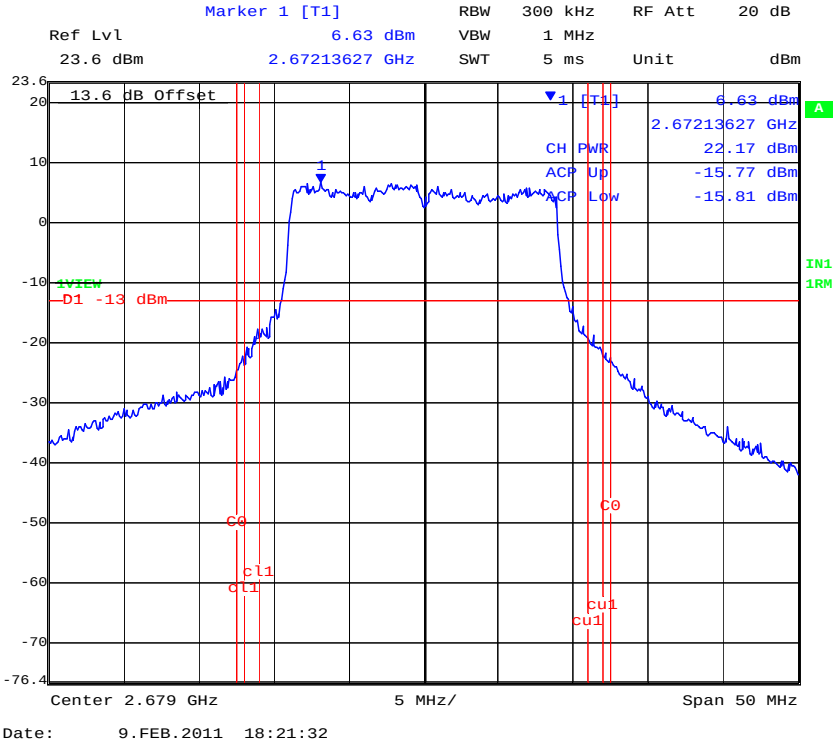



### Port B

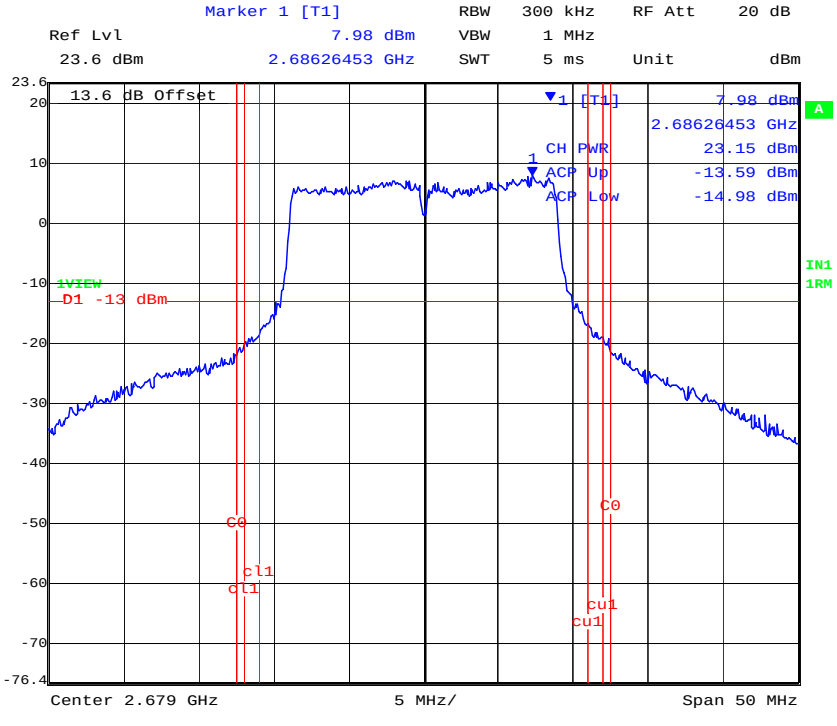


## Output Power, Channel 2679.00 MHz, 22 MHz Quad Channel Spacing

### Port A




### Port B



### 7.2.5 Output Power V's Antenna Gain (EIRP)

| Channel Spacing (MHz) | Antenna | Antenna Gain (dBi) | Maximum Measured Conducted Power (dBm) | EIRP (dBm) |
|---|---|---|---|---|
| 5.5 | Integrated Flat Panel | 17.5 | +23.77 | +41.27 |
| | External Flat Panel | 20 | | +43.77 |
| | Grid | 24 | | +47.77 |
| 6.0 | Integrated Flat Panel | 17.5 | +22.85 | +40.35 |
| | External Flat Panel | 20 | | +42.85 |
| | Grid | 24 | | +46.85 |
| 11.0/12.0 | Integrated Flat Panel | 17.5 | +23.55 | +41.05 |
| | External Flat Panel | 20 | | +43.55 |
| | Grid | 24 | | +47.55 |
| 22.0/24.0 | Integrated Flat Panel | 17.5 | +24.38 | +41.88 |
| | External Flat Panel | 20 | | +44.38 |
| | Grid | 24 | | +48.38 |

## 7.3 Power Spectral Density

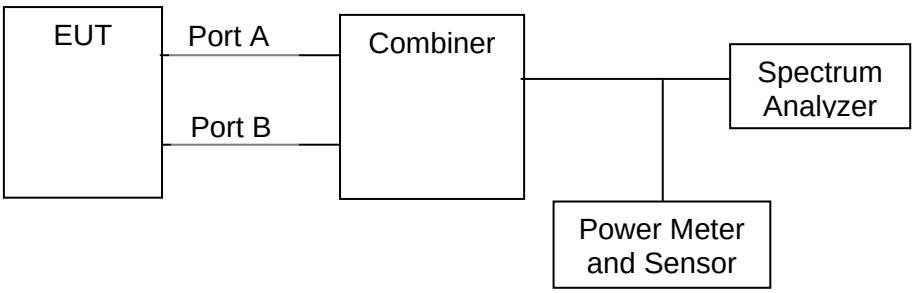
### Test Procedure

The test methodology and conditions utilized for each measurement is referenced in the following test results matrix. RF output power, transmit power control and power density were measured per the Test Configuration identified below.

Testing was performed on the highest and lowest power settings of the equipment.

Per the standard measurements were taken at ambient and nominal and voltage.

### Test Configuration




Measurement setup for Power Spectral Density

**Specification**
**Power and antenna height limits.**

§ 27.50 (h) The following power limits shall apply in the BRS and EBS:

(4) For main, booster and response stations utilizing digital emissions with non-uniform power spectral density (e.g. unfiltered QPSK), the power measured within any 100 kHz resolution bandwidth within the 6 MHz channel occupied by the non-uniform emission cannot exceed the power permitted within any 100 kHz resolution bandwidth within the 6 MHz channel if it were occupied by an emission with uniform power spectral density, i.e., if the maximum permissible power of a station utilizing a perfectly uniform power spectral density across a 6 MHz channel were 2000 watts EIRP, this would result in a maximum permissible power flux density for the station of 2000/60 = 33.3 watts EIRP per 100 kHz bandwidth. If a non-uniform emission were substituted at the station, station power would still be limited to a maximum of 33.3 watts EIRP within any 100 kHz segment of the 6 MHz channel, irrespective of the fact that this would result in a total 6 MHz channel power of less than 2000 watts EIRP.

**Power Density Calculation –**

| Channel Spacing (MHz) | Antenna Beam width | EIRP Limit (dBm) | Power Density Limit (dBm/100KHz) |
|---|---|---|---|
| 5.5 | 16° | 77.20 | 59.80 |
| 6 | 16° | 76.98 | 59.20 |
| 11 | 16° | 77.16 | 56.75 |
| 12 | 16° | 76.51 | 55.72 |
| 22 | 16° | 77.14 | 53.72 |
| 24 | 16° | 76.84 | 53.04 |
| 5.5 | 8° | 80.21 | 62.81 |
| 6 | 8° | 79.99 | 62.21 |
| 11 | 8° | 80.17 | 59.76 |
| 12 | 8° | 79.52 | 58.73 |
| 22 | 8° | 80.15 | 56.73 |
| 24 | 8° | 79.85 | 56.05 |

**Traceability**

| Method | Test Equipment Used |
|---|---|
| Measurements were made per work instruction WI-01 'Measuring RF Output Power' | 0158, 0252, 0313, 0314, 0223, 0116, 0117, 0287, 0363 |

**Measurement Results for Power Spectral Density**
Ambient conditions.
Temperature: 20.5 °C Relative humidity: 39 % Pressure: 1005 mbar

EUT parameters
Power Level: Maximum
Duty Cycle: 100%
Temperature: Ambient

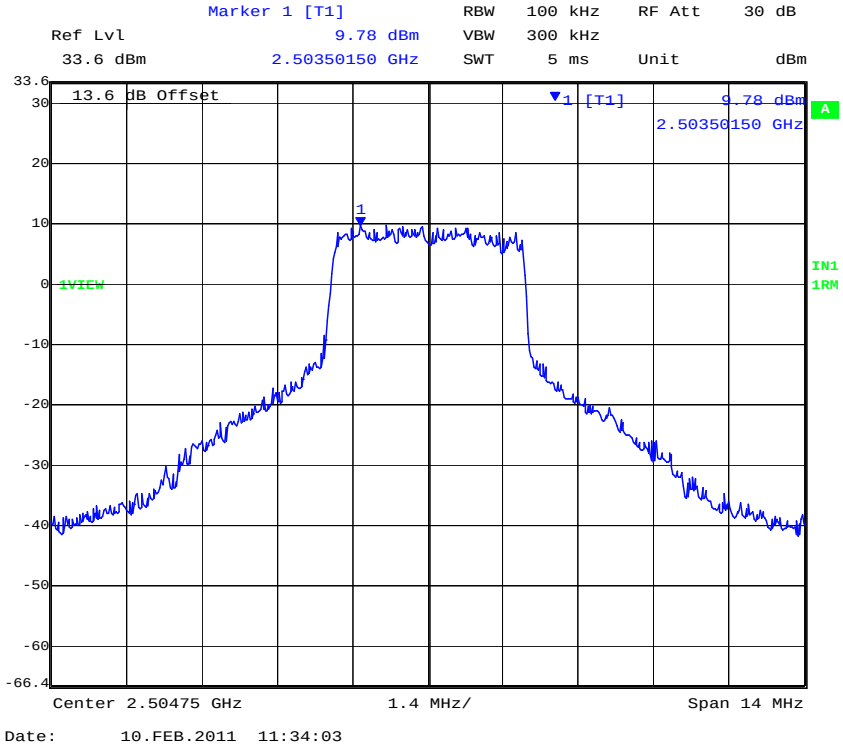
### 7.3.1 Measurement results for 5.5 MHz

TABLE OF RESULTS – **5.5 MHz Channel Spacing**

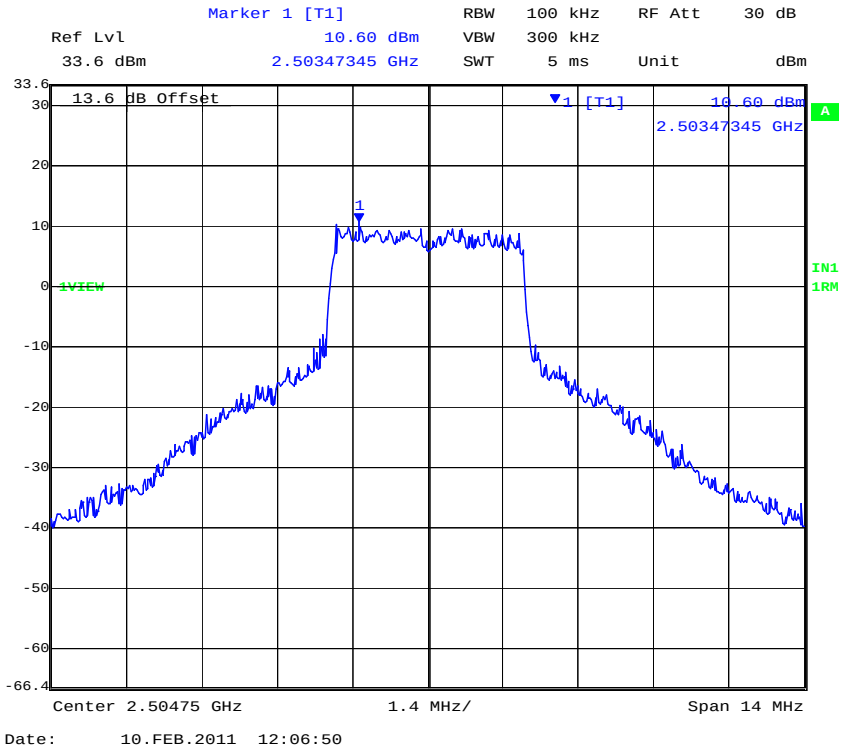
| Center Frequency (MHz) | Measured Power Spectral Density (dBm/100 kHz) | |
|---|---|---|
| | Port A | Port B |
| 2504.75 | +9.78 | +10.60 |
| 2687.25 | +9.91 | +9.49 |

## Power Spectral Density, Channel 2504.75 MHz, 5.5 MHz Channel Spacing

### Port A

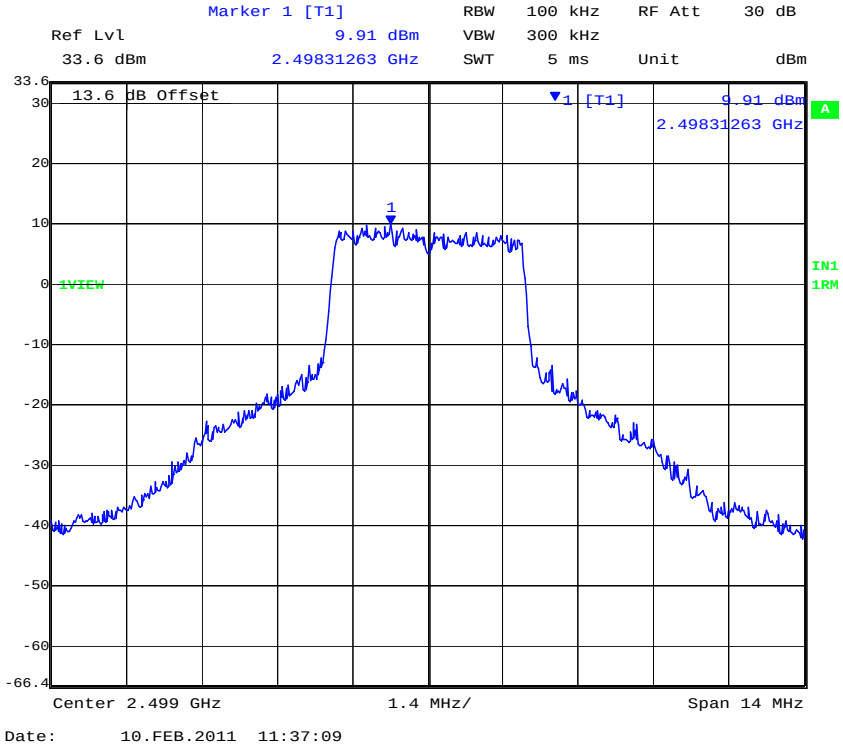



### Port B

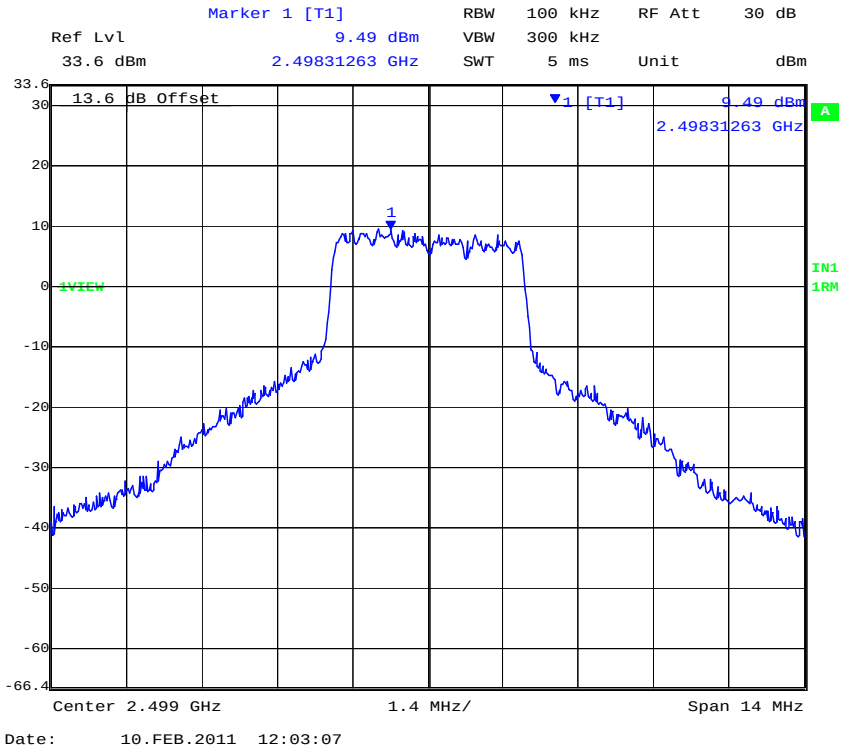


## Power Spectral Density, Channel 2687.25 MHz, 5.5 MHz Channel Spacing

### Port A




### Port B



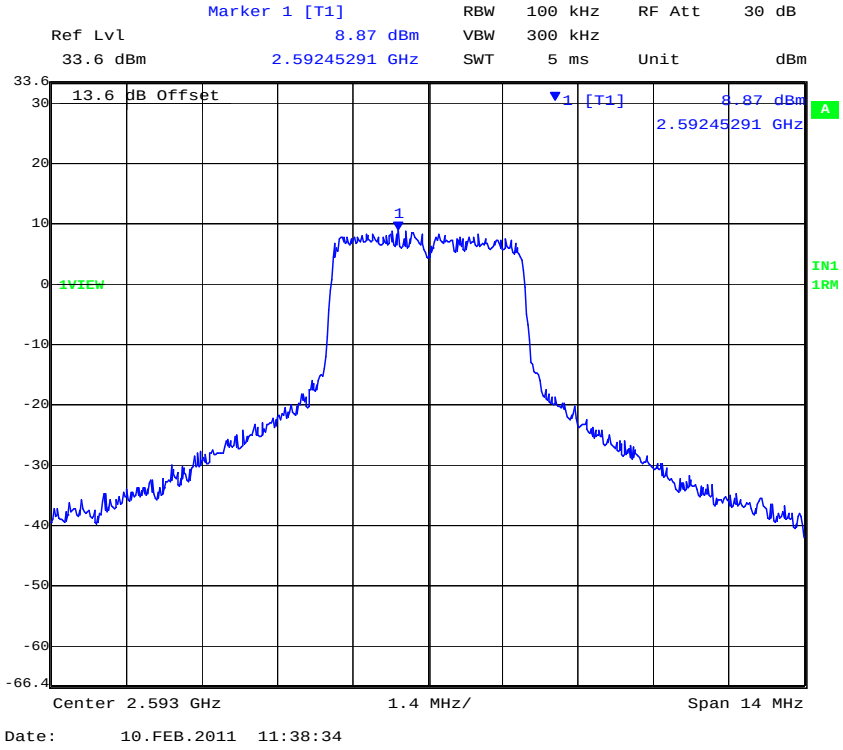
### 7.3.2 Measurement results for 6.0 MHz

TABLE OF RESULTS – **6 MHz Channel Spacing**

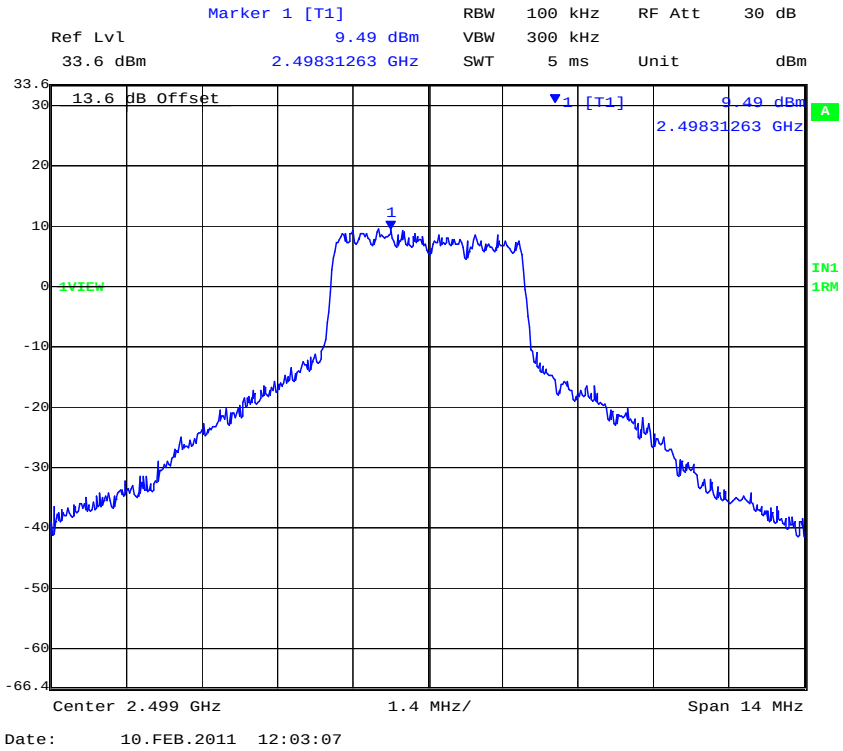
| Center Frequency (MHz) | Measured Power Spectral Density (dBm/100kHz) | |
|---|---|---|
| | Port A | Port B |
| 2499.00 | +8.87 | +9.49 |
| 2593.00 | +8.87 | +9.25 |

## Power Spectral Density, Channel 2499.00 MHz, 6.0 MHz Channel Spacing

### Port A

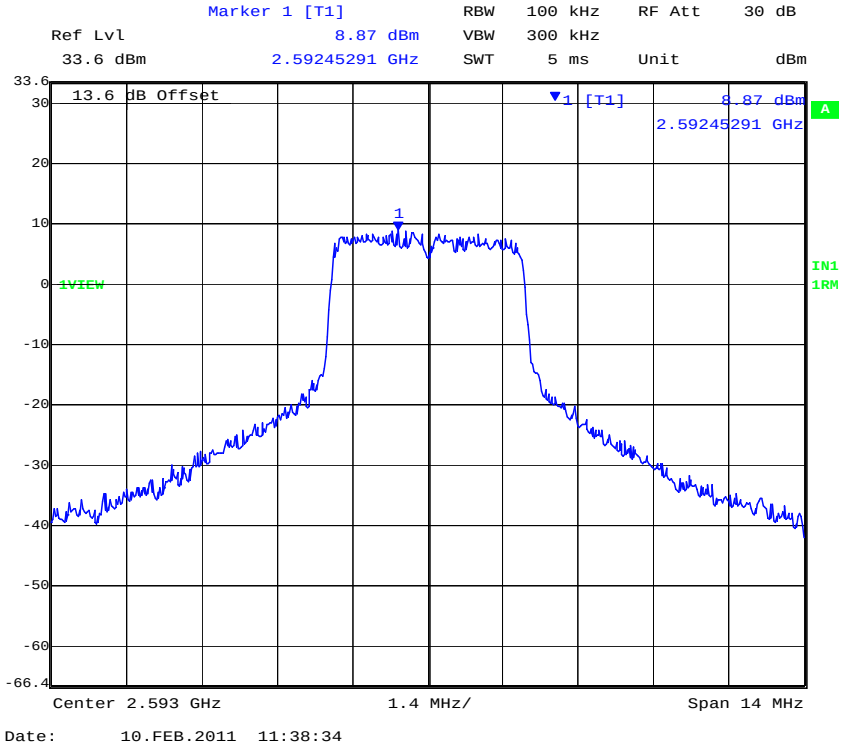



### Port B

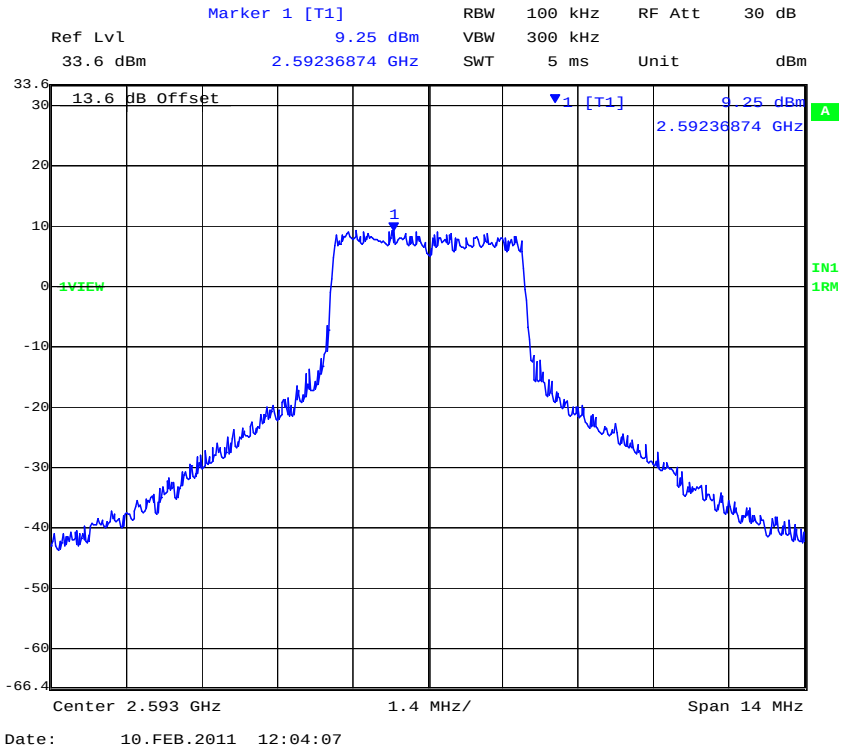


## Power Spectral Density, Channel 2593.00 MHz, 6.0 MHz Channel Spacing

### Port A




### Port B



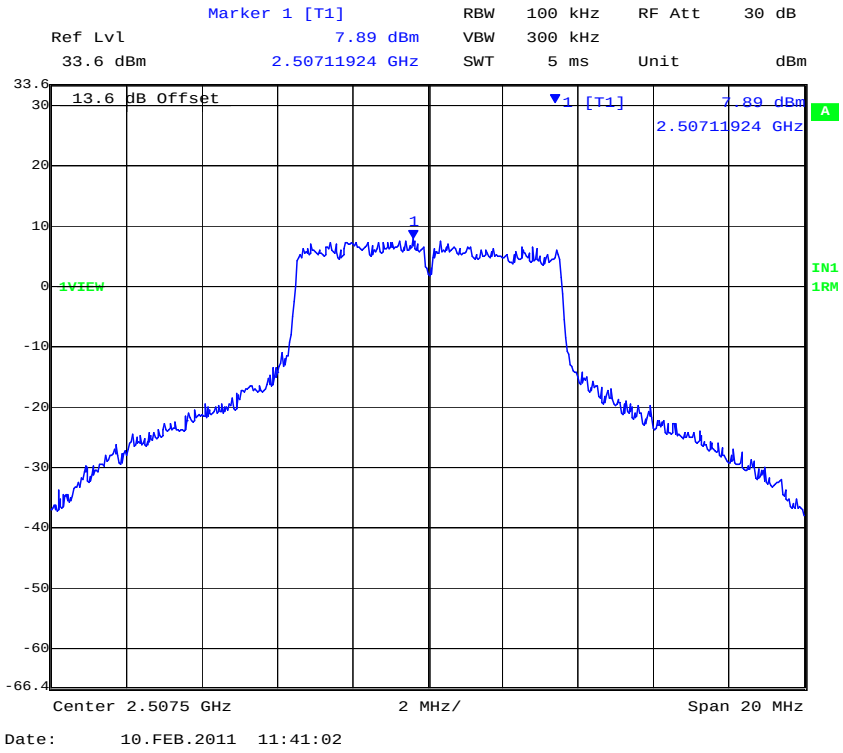
### 7.3.3 Measurement results for 11 and 12 MHz

TABLE OF RESULTS – **11 and 12 MHz Dual Channel Spacing**

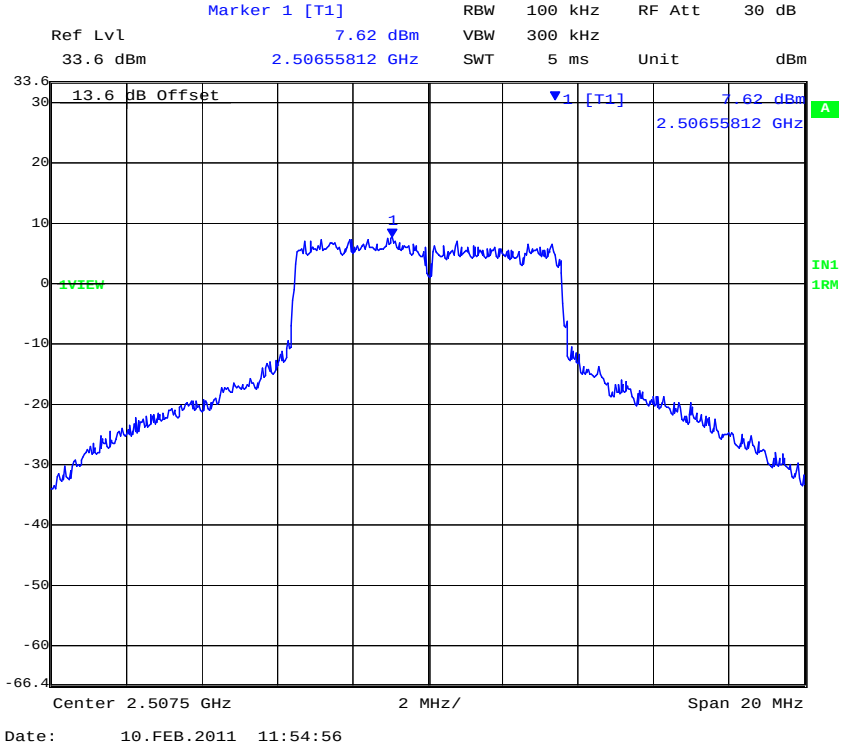
| Center Frequency (MHz) | Measured Power Spectral Density (dBm/100 kHz) | |
|---|---|---|
| | Port A | Port B |
| 2507.50 | +7.89 | +7.62 |
| 2590.00 | +7.59 | +6.97 |
| 2684.50 | +6.09 | +7.79 |

## Power Spectral Density, Channel 2507.50 MHz, 11 MHz Dual Channel Spacing

### Port A

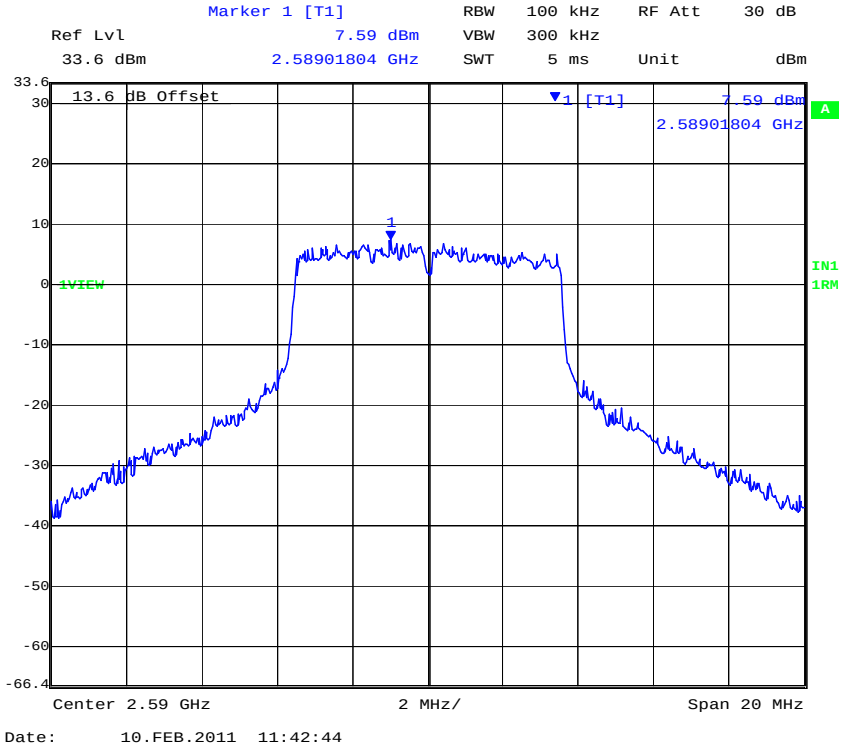



### Port B

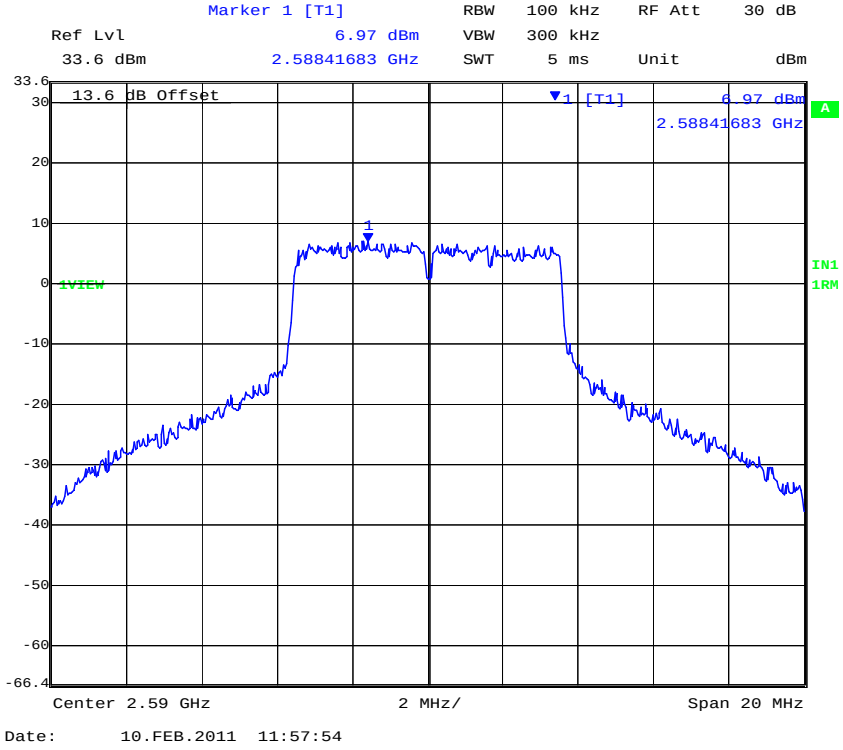


## Power Spectral Density, Channel 2590.00 MHz, 12 MHz Dual Channel Spacing

### Port A

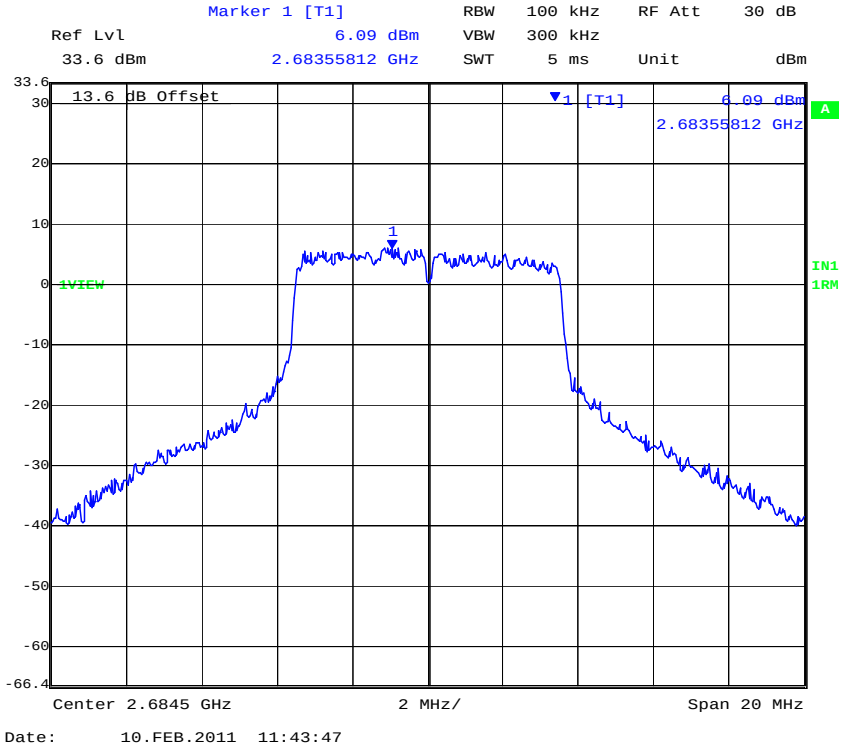



### Port B

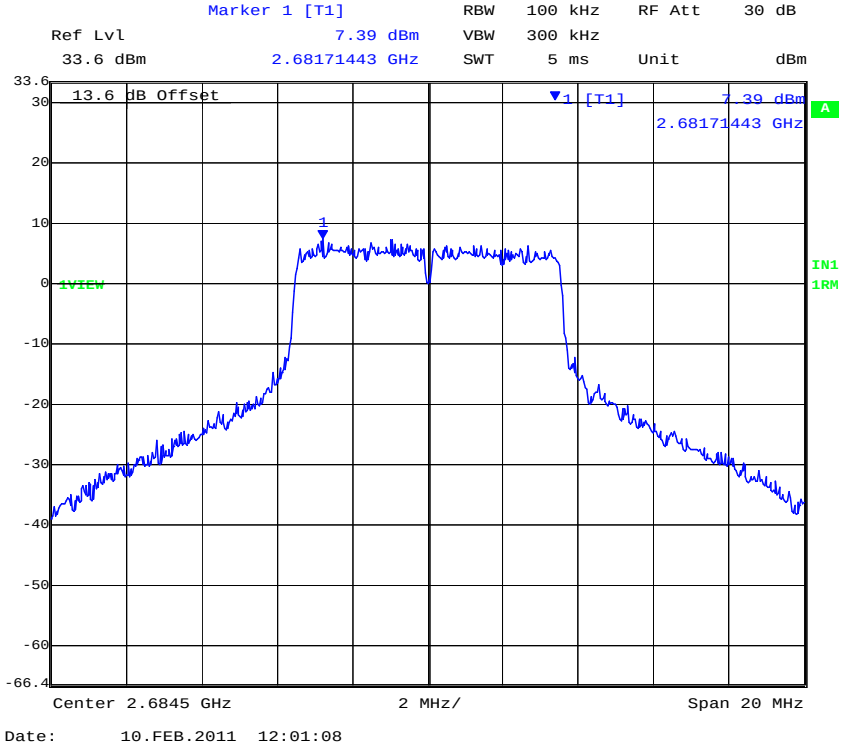


## Power Spectral Density, Channel 2684.50 MHz, 11 MHz Dual Channel Spacing

### Port A




### Port B



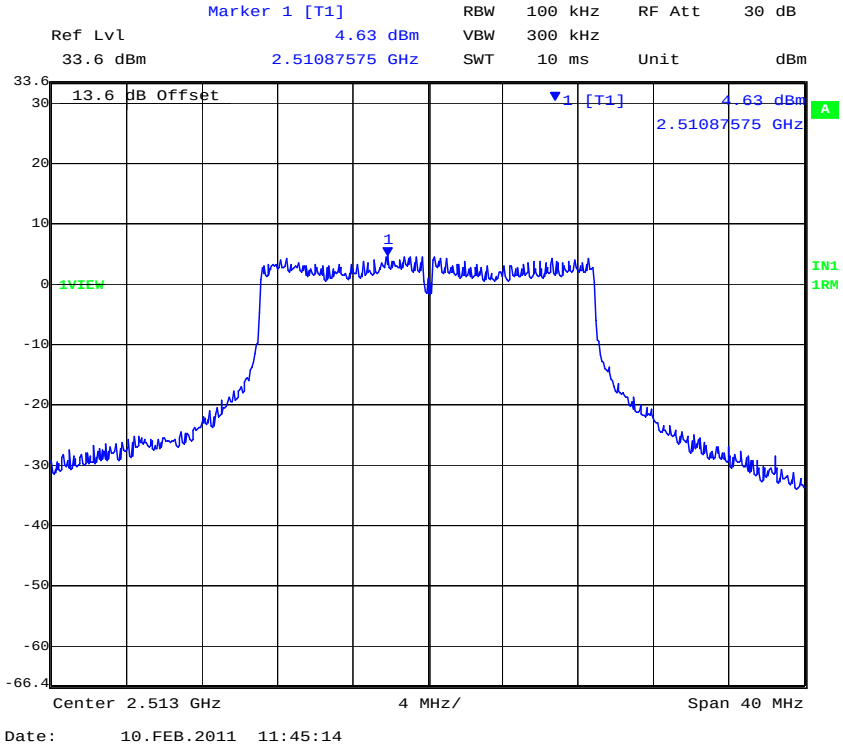
### 7.3.4 Measurement results for 22 and 24 MHz

TABLE OF RESULTS – **22 and 24 MHz Quad Channel Spacing**

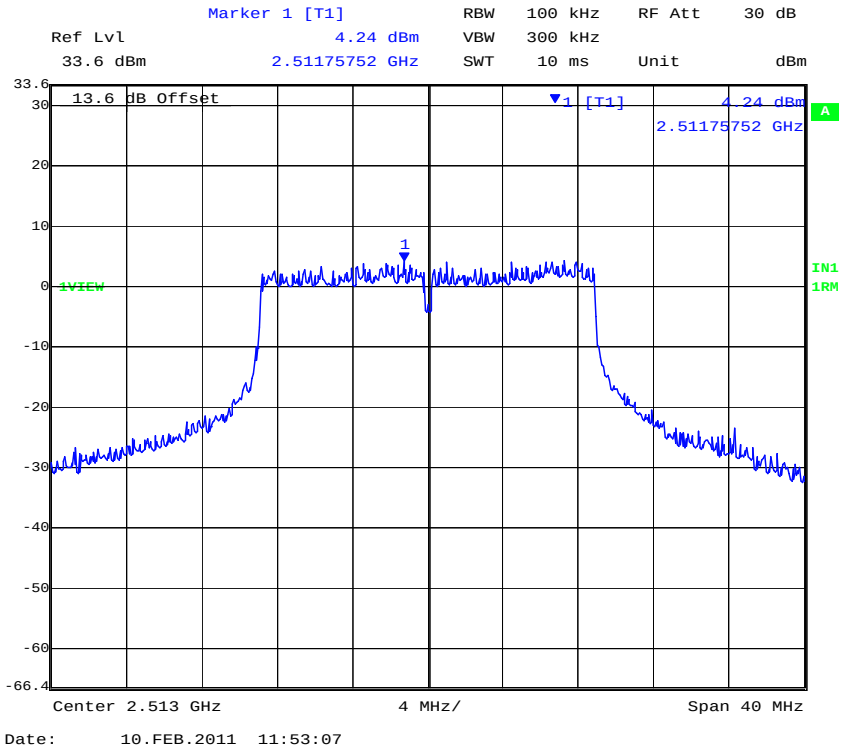
| Center Frequency (MHz) | Measured Power Spectral Density/100 kHz (dBm) | |
|---|---|---|
| | Port A | Port B |
| 2513.00 | +4.63 | +4.24 |
| 2590.00 | +4.41 | +4.19 |
| 2679.00 | +3.60 | +4.67 |

## Power Spectral Density, Channel 2513.00 MHz, 22 MHz Quad Channel Spacing

### Port A

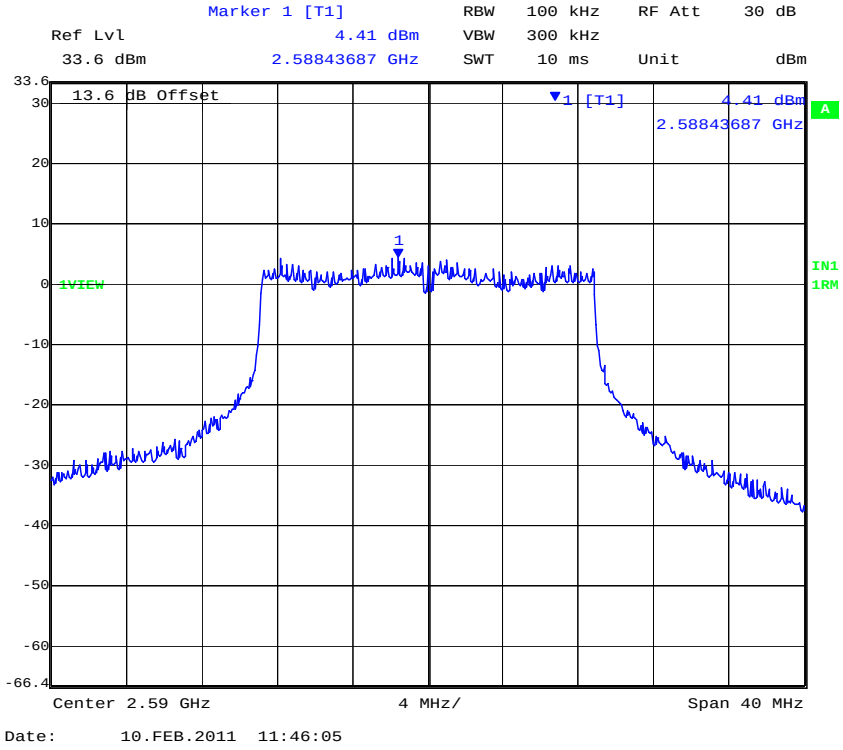



### Port B

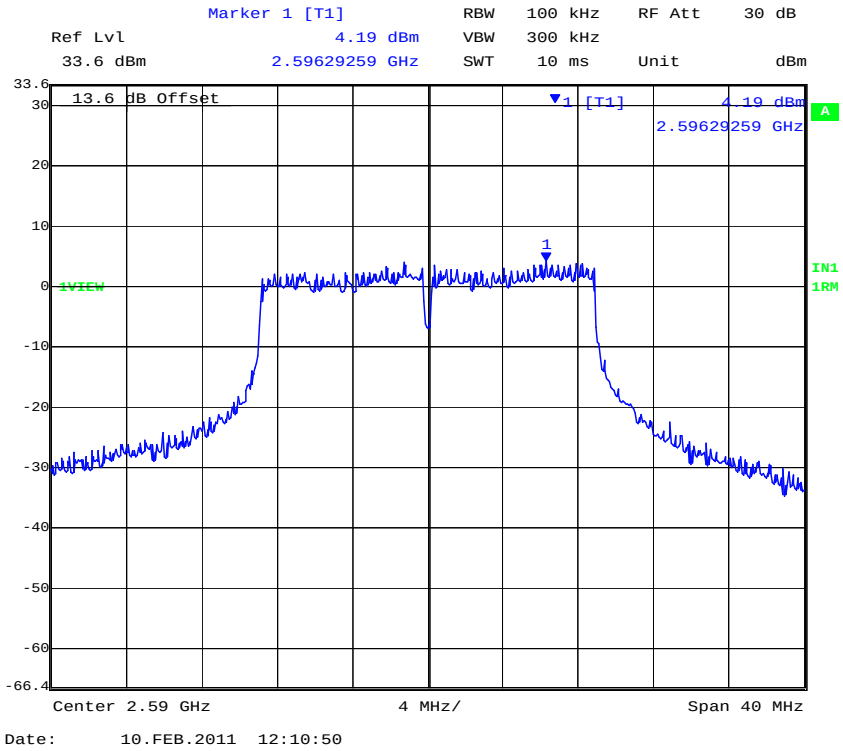


## Power Spectral Density, Channel 2590.00 MHz, 24 MHz Quad Channel Spacing

### Port A

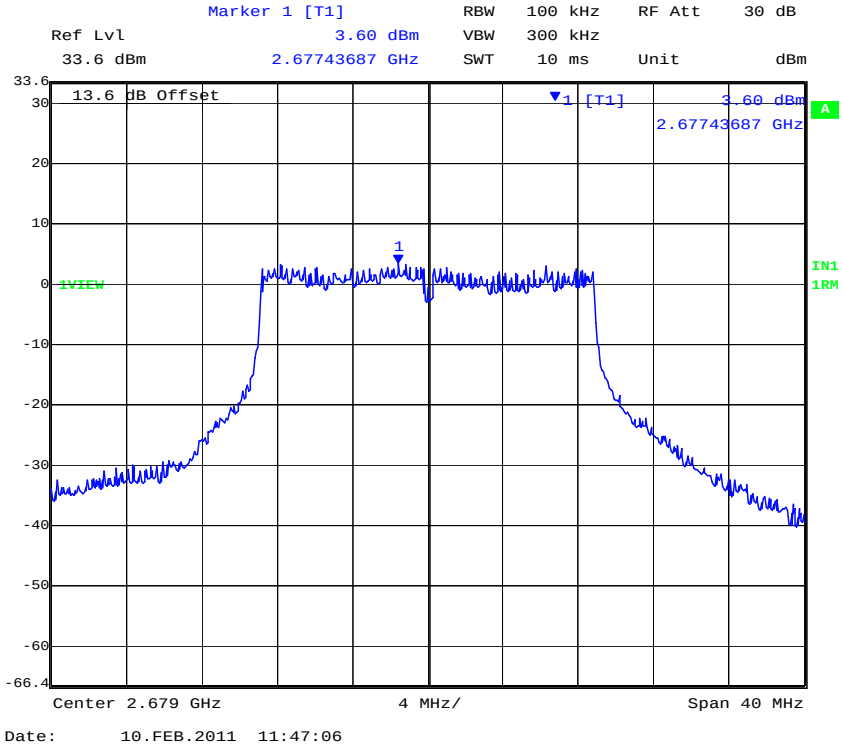



### Port B

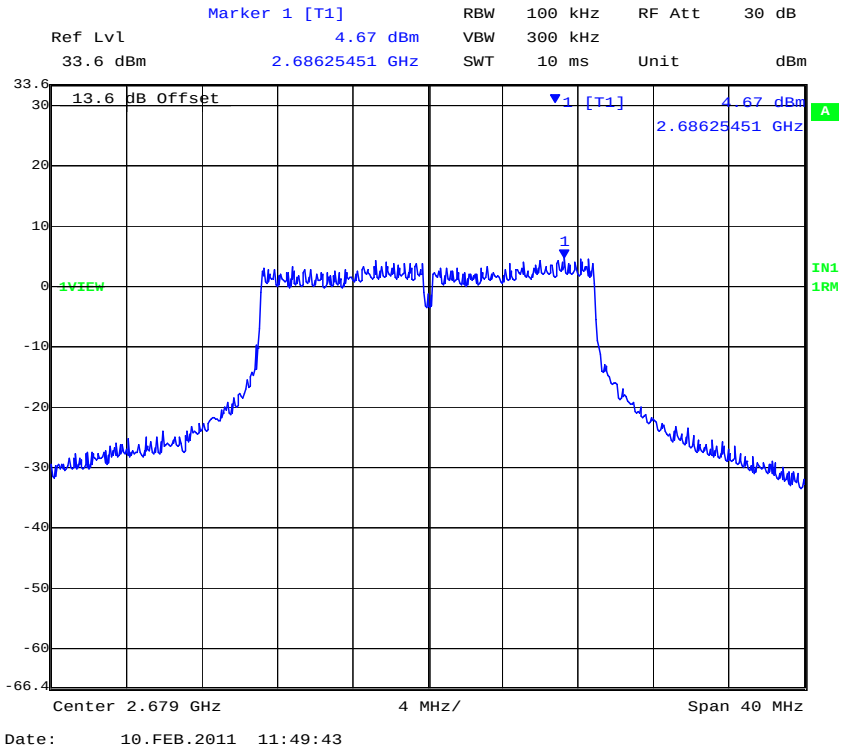


## Power Spectral Density, Channel 2679.00 MHz, 22 MHz Quad Channel Spacing

### Port A




### Port B



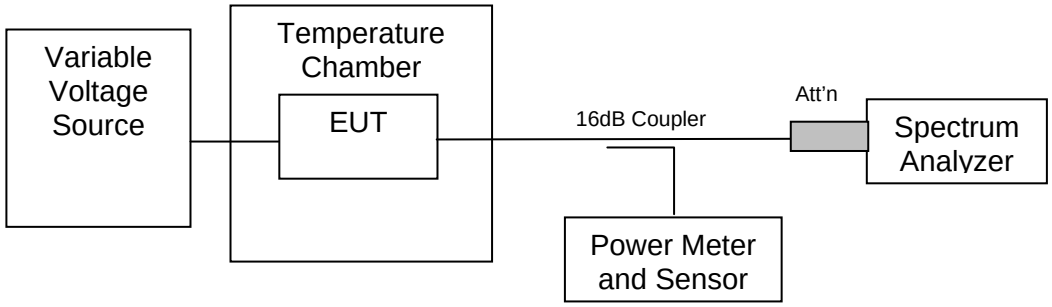
## 7.4 Frequency Stability

**Test Procedure**
The Frequency Stability of the device was measured with a spectrum analyzer connected to the antenna terminal, while EUT was operating in transmission mode at the appropriate center frequency.

The low, mid and high channels were measured over extremes of temperature. Frequency stability was further monitored at ambient conditions with a variation of input voltage.

The EUT transmitter output was connected to a spectrum analyzer and frequency monitored over temperature and voltage variations. The EUT was set in an operational mode in which allowed carrier breakthrough to be used to monitor stability.

**Test Measurement Set up**




Measurement set up for Frequency Stability

**Specification Limits**
§ 27.54 Frequency Stability.
The frequency stability shall be sufficient to ensure that the fundamental emissions stay within the authorized bands of operation.

**Measurement Results for Frequency Stability**

Ambient conditions.
Temperature: 20.5 °C Relative humidity: 39 % Pressure: 1005 mbar

Radio Parameters
Duty Cycle: 100%
Output: Modulated (Carrier Breakthrough)

### 7.4.1 Measurement results for Extremes of Temperature

| | Channels | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Temperature | Low Channel 2499 MHz | | | Mid Channel 2593 MHz | | | High Channel 2687.25 MHz | | |
| °C | Frequency | kHz | ppm | Frequency | kHz | ppm | Frequency | kHz | ppm |
| -35 | 2499.00131 | 1.31 | 0.524 | 2593.00160 | 1.6 | 0.617 | 2687.25152 | 1.52 | 0.566 |
| -25 | 2499.00167 | 1.67 | 0.668 | 2593.00178 | 1.78 | 0.686 | 2687.25187 | 1.87 | 0.696 |
| -15 | 2499.00351 | 3.51 | 1.405 | 2593.00264 | 2.64 | 1.018 | 2687.25266 | 2.66 | 0.990 |
| -5 | 2499.00368 | 3.68 | 1.473 | 2593.00384 | 3.84 | 1.481 | 2687.25399 | 3.99 | 1.485 |
| 5 | 2499.00427 | 4.27 | 1.709 | 2593.00441 | 4.41 | 1.701 | 2687.25456 | 4.56 | 1.697 |
| 15 | 2499.00385 | 3.85 | 1.541 | 2593.00401 | 4.01 | 1.546 | 2687.25416 | 4.16 | 1.548 |
| 25 | 2499.00258 | 2.58 | 1.032 | 2593.00265 | 2.65 | 1.022 | 2687.25273 | 2.73 | 1.016 |
| 35 | 2499.00215 | 2.15 | 0.860 | 2593.00222 | 2.22 | 0.856 | 2687.25231 | 2.31 | 0.860 |
| 45 | 2499.00189 | 1.89 | 0.756 | 2593.00195 | 1.95 | 0.752 | 2687.25206 | 2.06 | 0.767 |
| 55 | 2499.00252 | 2.52 | 1.008 | 2593.00263 | 2.63 | 1.014 | 2687.25277 | 2.77 | 1.031 |
| 60 | 2499.00345 | 3.45 | 1.381 | 2593.00358 | 3.58 | 1.381 | 2687.25372 | 3.72 | 1.384 |

Maximum Drift from nominal frequency: 1.709 ppm

### 7.4.2 Measurement results for Ambient Temperature V's Voltage Variation

| | | Channels | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Temp | Voltage | Low Channel 2499 MHz | | | Mid Channel 2593 MHz | | | High Channel 2687.25MHz | | |
| °C | Vdc | Frequency | kHz | ppm | Frequency | kHz | ppm | Frequency | kHz | ppm |
| 18 | 48.0 | 2499.00334 | 3.34 | 1.337 | 2593.00331 | 3.31 | 1.277 | 2687.25318 | 3.18 | 1.183 |
| 18 | 43.2 | 2499.00325 | 3.25 | 1.301 | 2593.00321 | 3.21 | 1.238 | 2687.25321 | 3.21 | 1.195 |
| 18 | 53.8 | 2499.00319 | 3.19 | 1.277 | 2593.00318 | 3.18 | 1.226 | 2687.25326 | 3.26 | 1.213 |

Maximum Drift from nominal frequency: 1.337 ppm

## 7.5 Maximum Permissible Exposure

### Calculations for Maximum Permissible Exposure Levels

Power Density = Pd ($mW/cm^2$) = $EIRP/(4\pi d^2)$

EIRP = P * G * 2

P = Peak output power (mW)

G = Antenna numeric gain (numeric)

d = Separation distance (cm)

Numeric Gain = 10 ^ (G (dBi)/10)

The RADWIN 2000 2.5 GHz BAND has two transmitters. The peak power in the table below is calculated by assuming a worst case scenario where the two transmitters are operating simultaneously in the same band. The Peak Power in mW is calculated by taking the maximum conducted power measured in each band and multiplying by 2.

Because the EUT belongs to the General Population/Uncontrolled Exposure the limit of power density is 1.0 $mW/cm^2$

| Freq. Band (MHz) | Antenna Gain (dBi) | Numeric Gain (numeric) | Peak Output Power (dBm) | Peak Output Power x 2 (mW) | Calculated Safe Distance @ 1mW/$cm^2$ Limit(cm) | Minimum Separation Distance (cm) |
|---|---|---|---|---|---|---|
| 2500 | 24.0 | 251.2 | +24.38 | 548.3 | 104.6 | 20.00 |

**Note:** for mobile or fixed location transmitters the minimum separation distance is 20cm, even if calculations indicate the MPE distance to be less.

### Specification
### Maximum Permissible Exposure Limits

| |
|---|
| **FCC §1.1310** Limit = 1mW / $cm^2$ from 1.310 Table 1 |

### Laboratory Measurement Uncertainty for Power Measurements

| | |
|---|---|
| Measurement uncertainty | ±1.33 dB |

## 7.6 Conducted Spurious Emissions

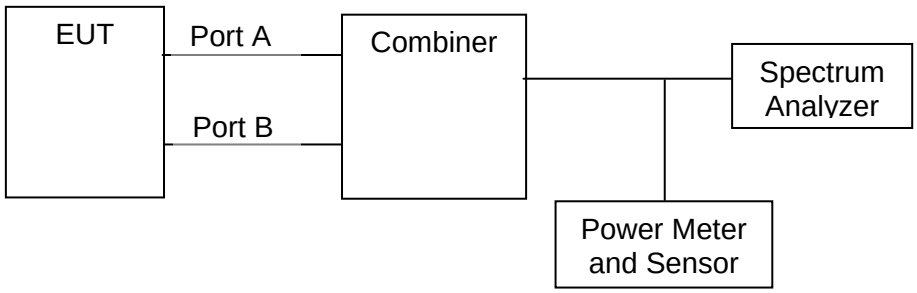
### Test Procedure

As detailed in ANSI TIA-603-C 2004 Section 2.2.12 referencing FCC Part 2.1053

Conducted emissions were measured at a limit of -13 dBm from 30 MHz to the 10$^{th}$ harmonic of the carrier frequency. Both antenna ports were combined and emissions were measured via the spectrum analyzer. Emissions at the band edge were measured and recorded in Section 7.1 RF Output Power, Emission Mask, EIRP at the Antenna Terminal.

Measurements were made while EUT was operating in the modulated mode at the appropriate center frequency.

### Test Configuration




Measurement setup for Conducted Spurious Emission

Specification Limits
§ 27.53 (m) For BRS and EBS stations, the power of any emissions outside the licensee's frequency bands of operation shall be attenuated below the transmitter power (P) measured in watts in accordance with the standards below. If a licensee has multiple contiguous channels, out-of-band emissions shall be measured from the upper and lower edges of the contiguous channels.

(2) For digital base stations, the attenuation shall be not less than 43+10 log (P) dB = -13 dBm

### Traceability

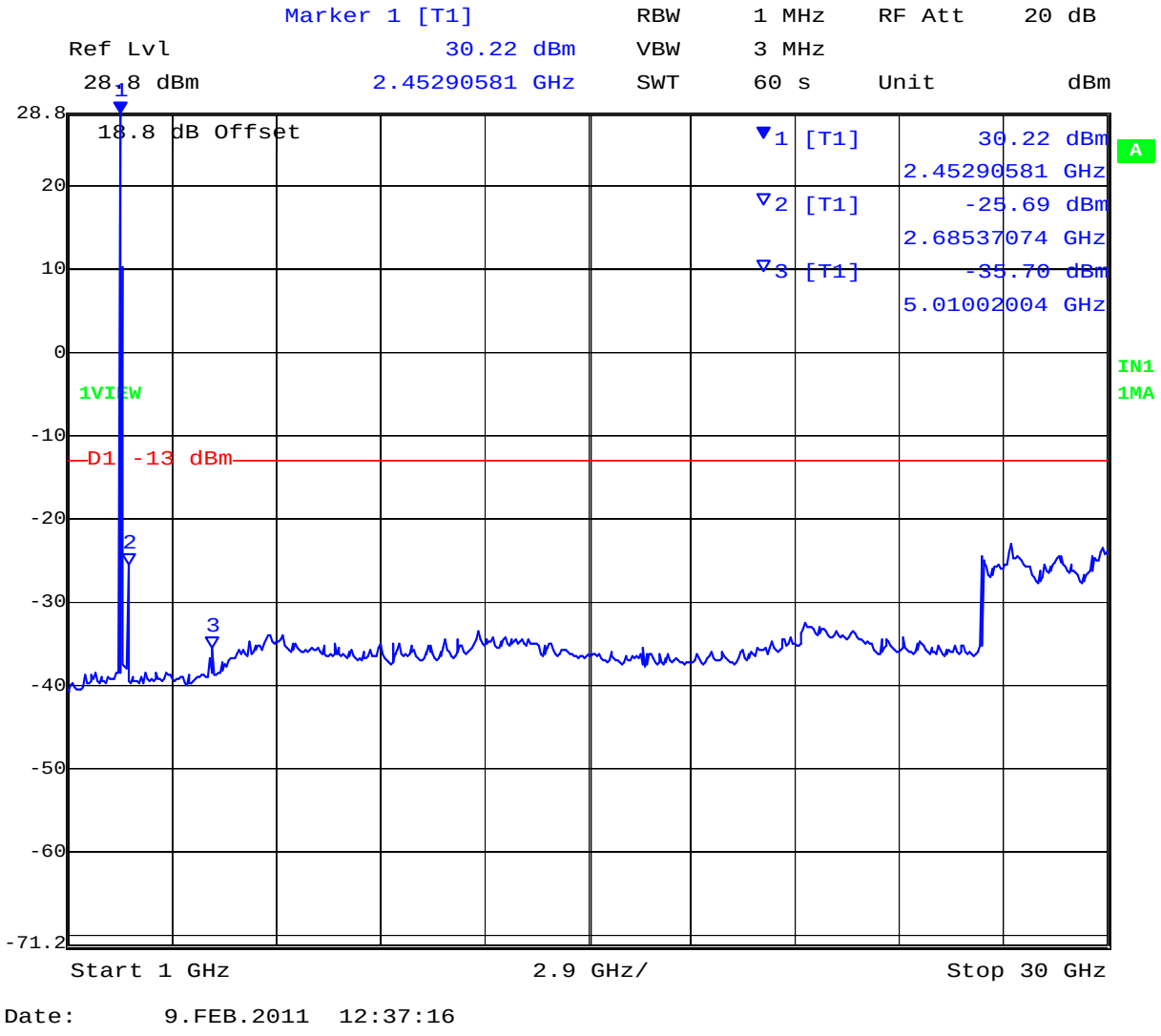
| Method | Test Equipment Used |
|---|---|
| WI-05 | 0158, 0252, 0313, 0314, 0223, 0116, 0117, 0287, 0363. |

### 7.6.1 Measurement results for 5.5 MHz

TABLE OF RESULTS – **5.5 MHz Channel Spacing**

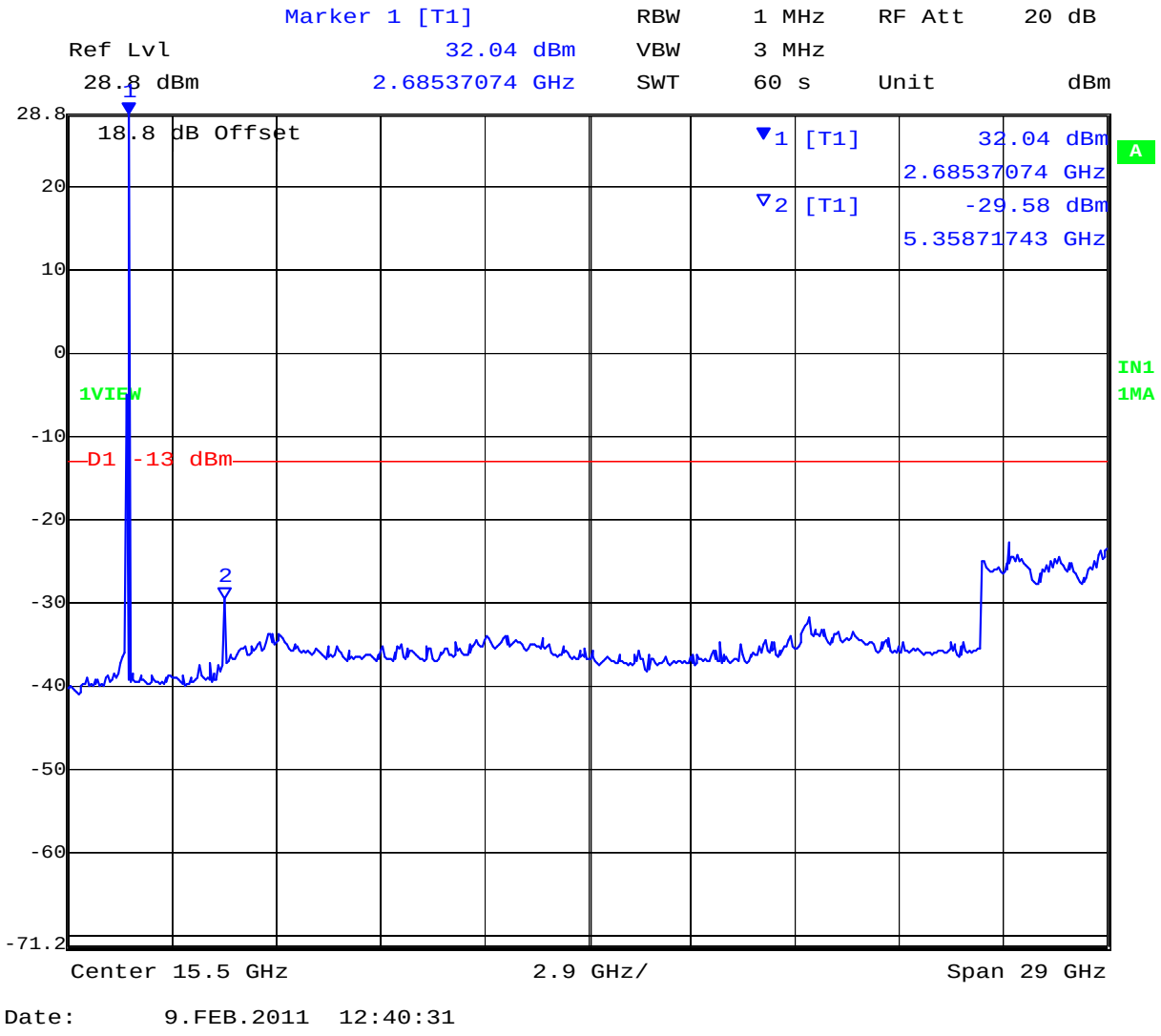
| Channel Centre Frequency (GHz) | Start Frequency (GHz) | Stop Frequency (GHz) | Maximum Emission Observed (dBm) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|---|
| 2504.75 | 1 | 30 | -25.69 | -13.00 | -12.69 |
| 2687.25 | | | -29.58 | | -16.58 |

## Conducted Spurious Emissions,
## Channel 2504.75 MHz, 5.5 MHz Channel Spacing




The emission breaking the limit line is the fundamental emission

## Conducted Spurious Emissions, Channel 2687.25 MHz, 5.5 MHz Channel Spacing



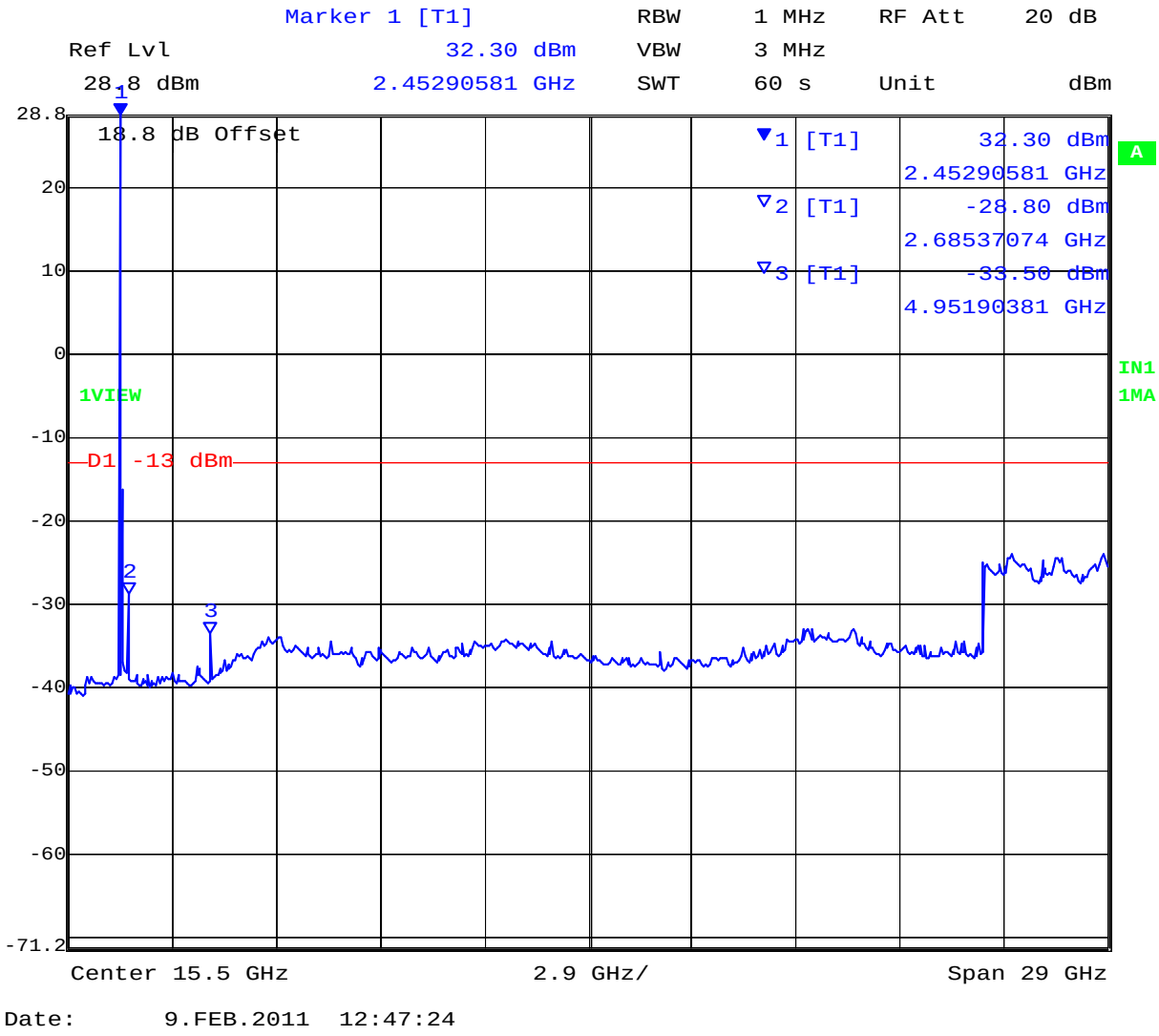

The emission breaking the limit line is the fundamental emission

### 7.6.2 Measurement results for 6.0 MHz

TABLE OF RESULTS – **6.0 MHz Channel Spacing**

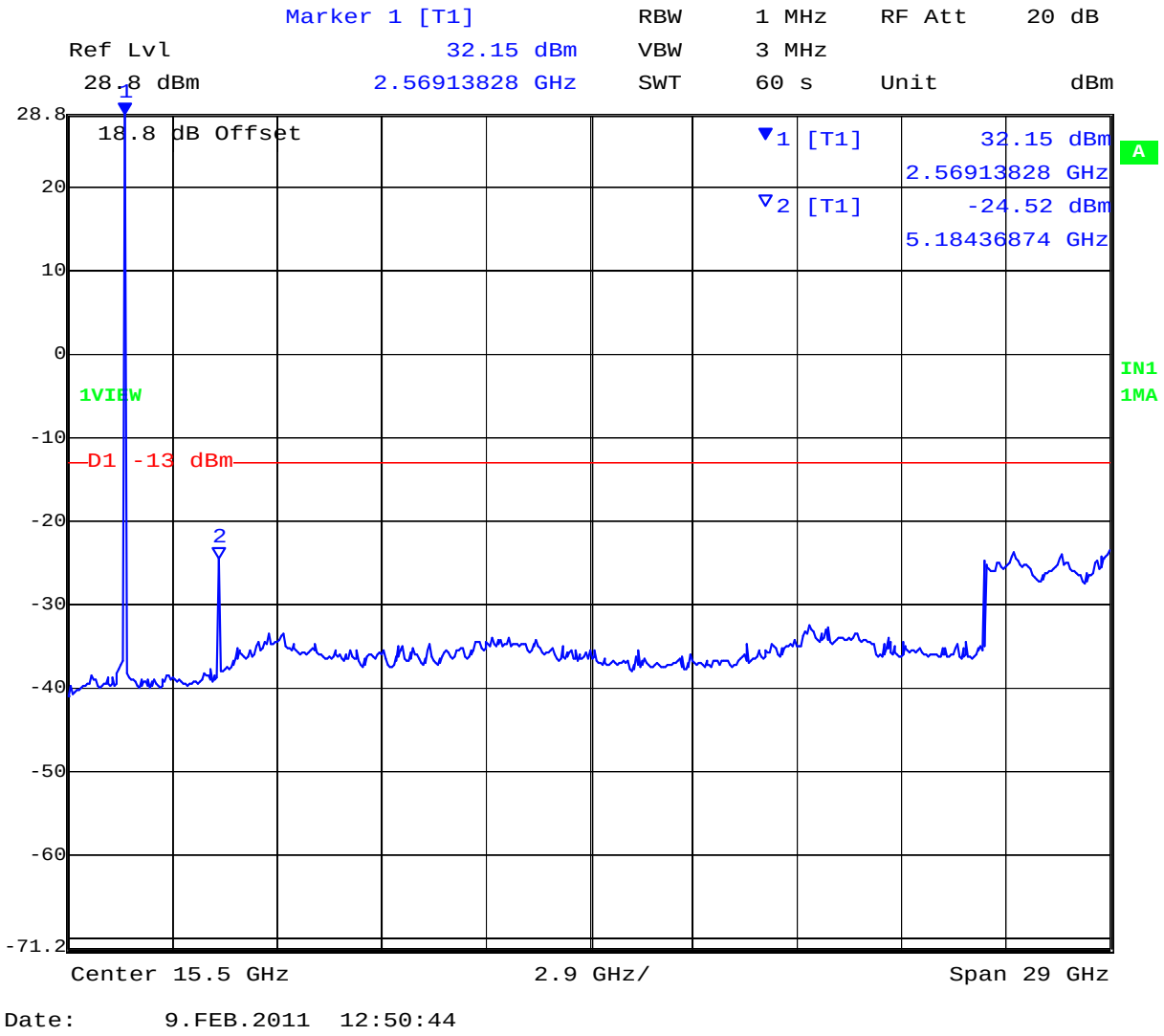
| Channel Centre Frequency (GHz) | Start Frequency (GHz) | Stop Frequency (GHz) | Maximum Emission Observed (dBm/MHz) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|---|
| 2499.00 | 1 | 30 | -28.80 | -13.00 | -15.80 |
| 2593.00 | | | -24.52 | | -11.52 |

## Conducted Spurious Emissions,
## Channel 2499.00 MHz, 6.0 MHz Channel Spacing




The emission breaking the limit line is the fundamental emission

## Conducted Spurious Emissions,
## Channel 2593.00 MHz, 6.0 MHz Channel Spacing



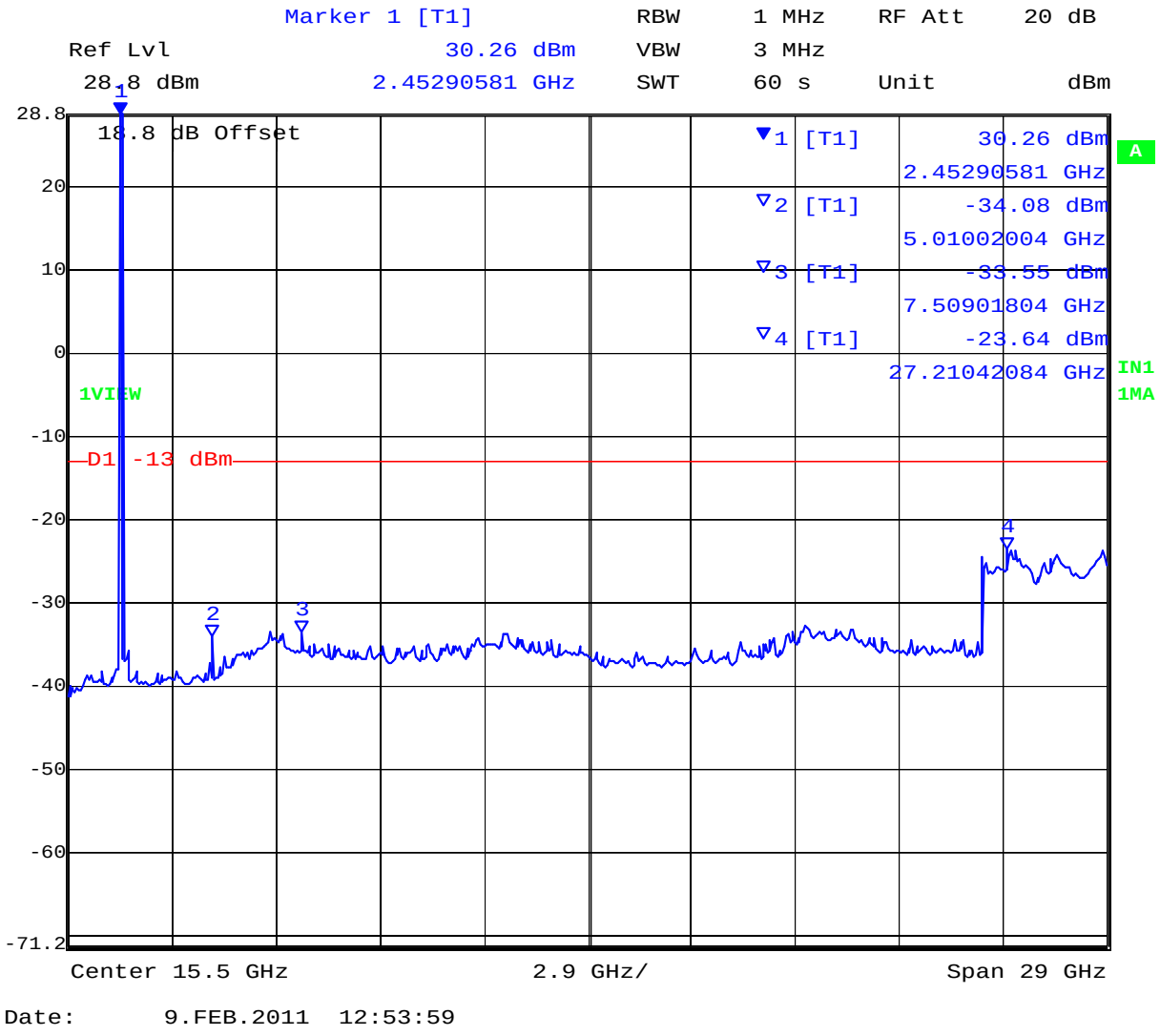

The emission breaking the limit line is the fundamental emission

### 7.6.3 Measurement results for 11 and 12 MHz

TABLE OF RESULTS – **11 and 12 MHz Dual Channel Spacing**

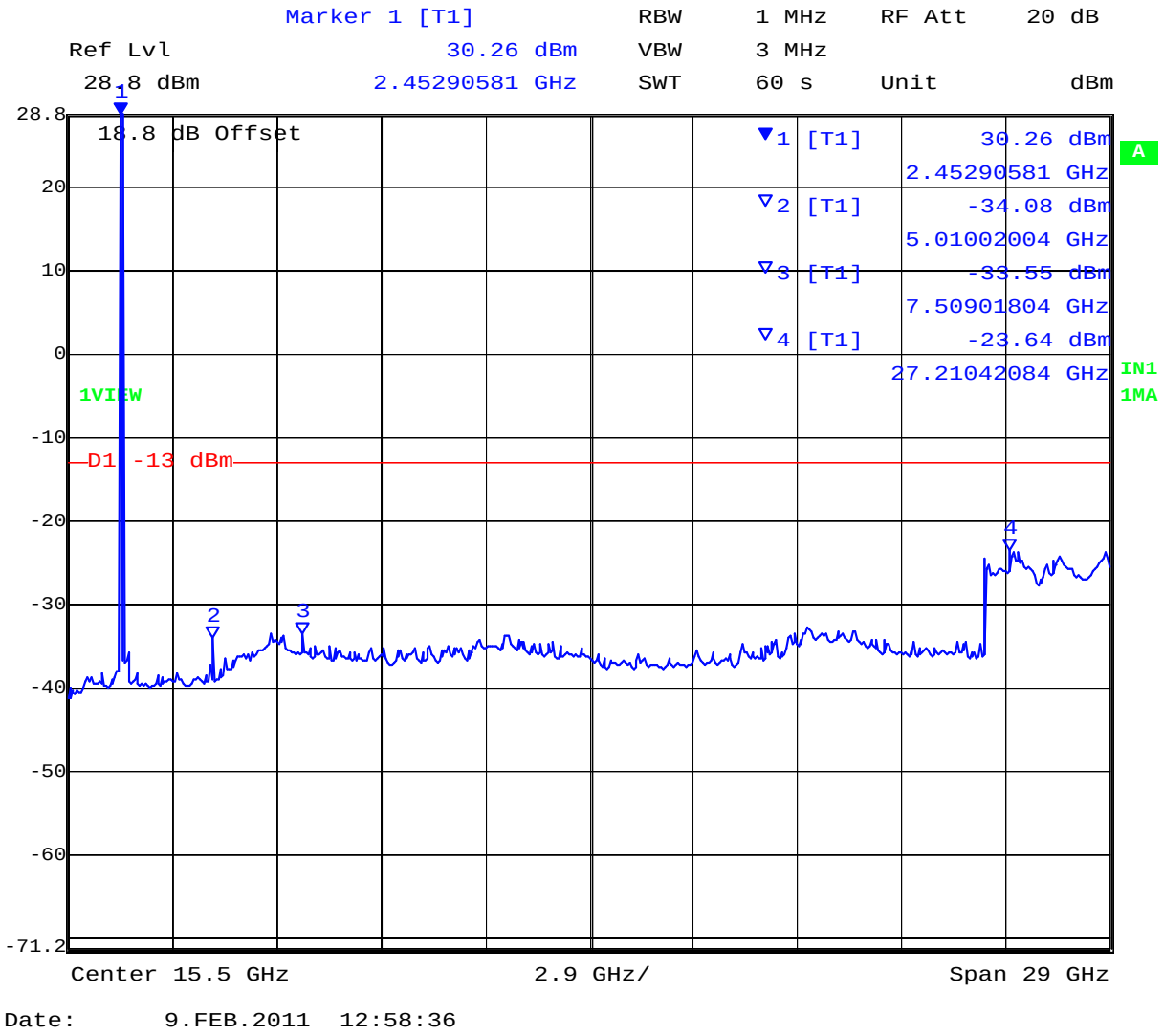
| Channel Centre Frequency (GHz) | Start Frequency (GHz) | Stop Frequency (GHz) | Maximum Emission Observed (dBm/MHz) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|---|
| 2507.50 | 1 | 30 | -23.64 | -13.00 | -10.64 |
| 2590.00 | | | -23.64 | | -10.64 |
| 2684.50 | | | -23.22 | | -10.22 |

## Conducted Spurious Emissions, Channel 2507.50 MHz, 11 MHz Dual Channel Spacing



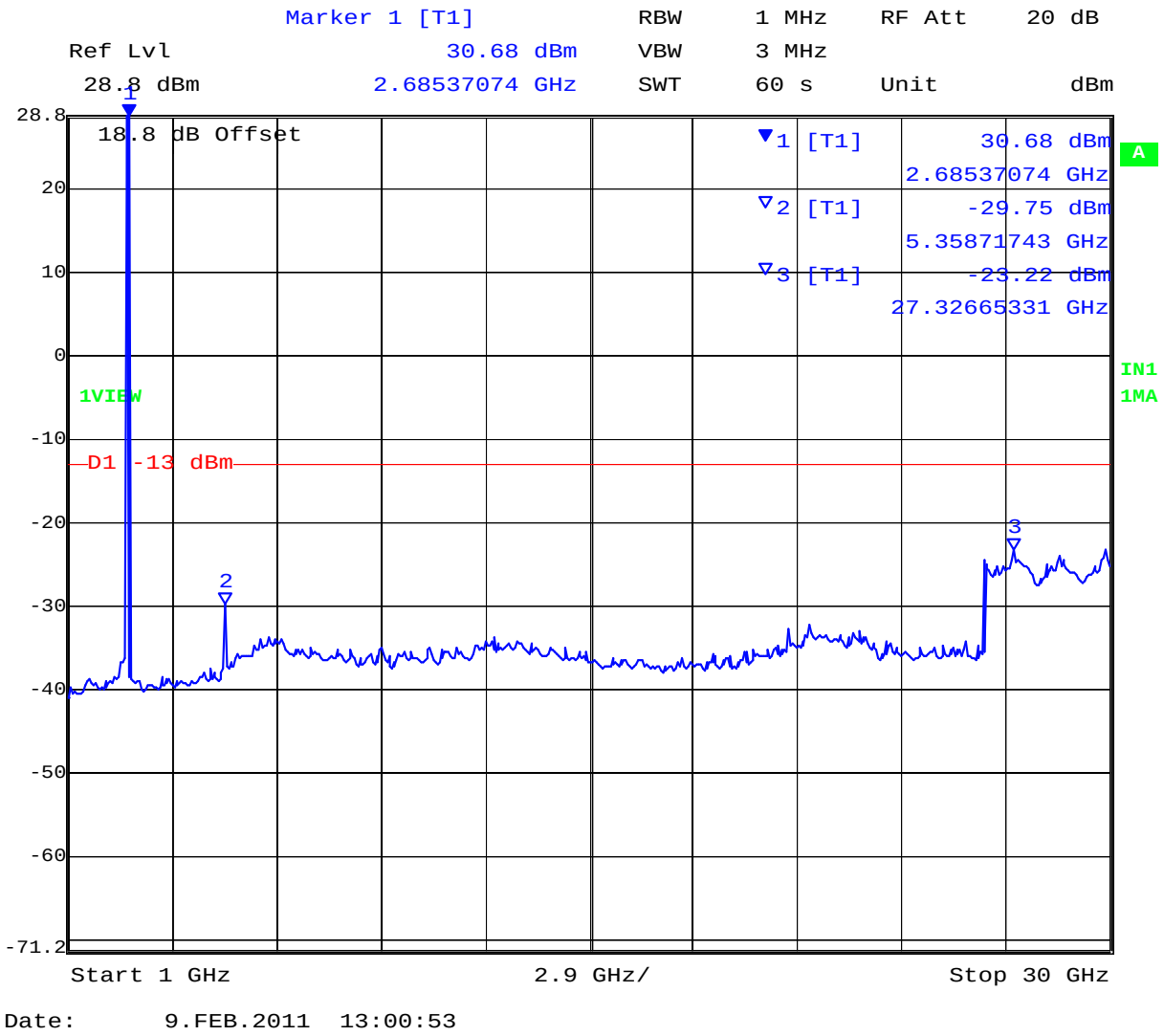

The emission breaking the limit line is the fundamental emission

## Conducted Spurious Emissions, Channel 2590.00 MHz, 12 MHz Dual Channel Spacing




The emission breaking the limit line is the fundamental emission

## Conducted Spurious Emissions,
## Channel 2684.50 MHz, 11 MHz Dual Channel Spacing



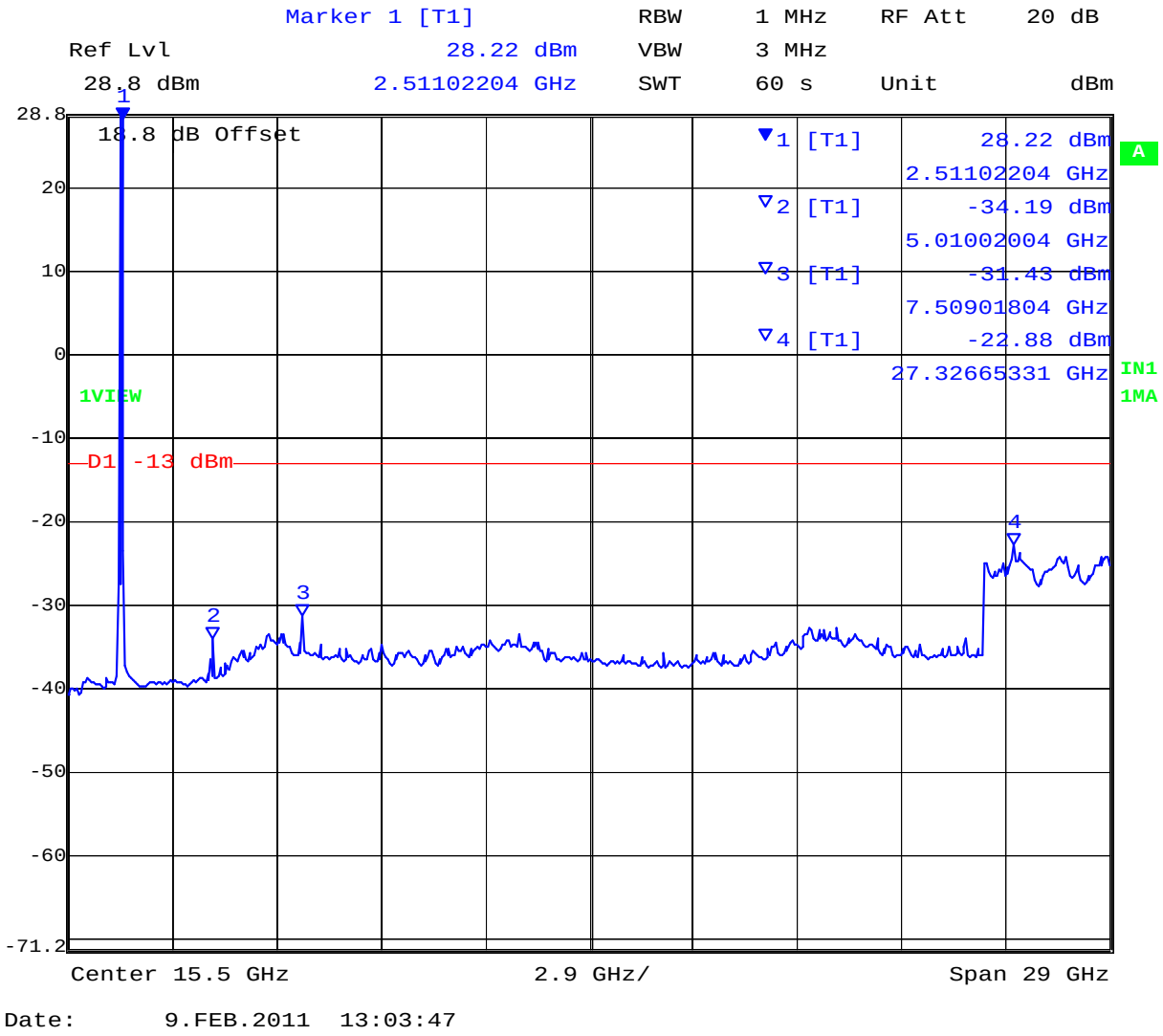

The emission breaking the limit line is the fundamental emission

### 7.6.4 Measurement results for 22 and 24 MHz

TABLE OF RESULTS – **22 and 24 MHz Quad Channel Spacing**

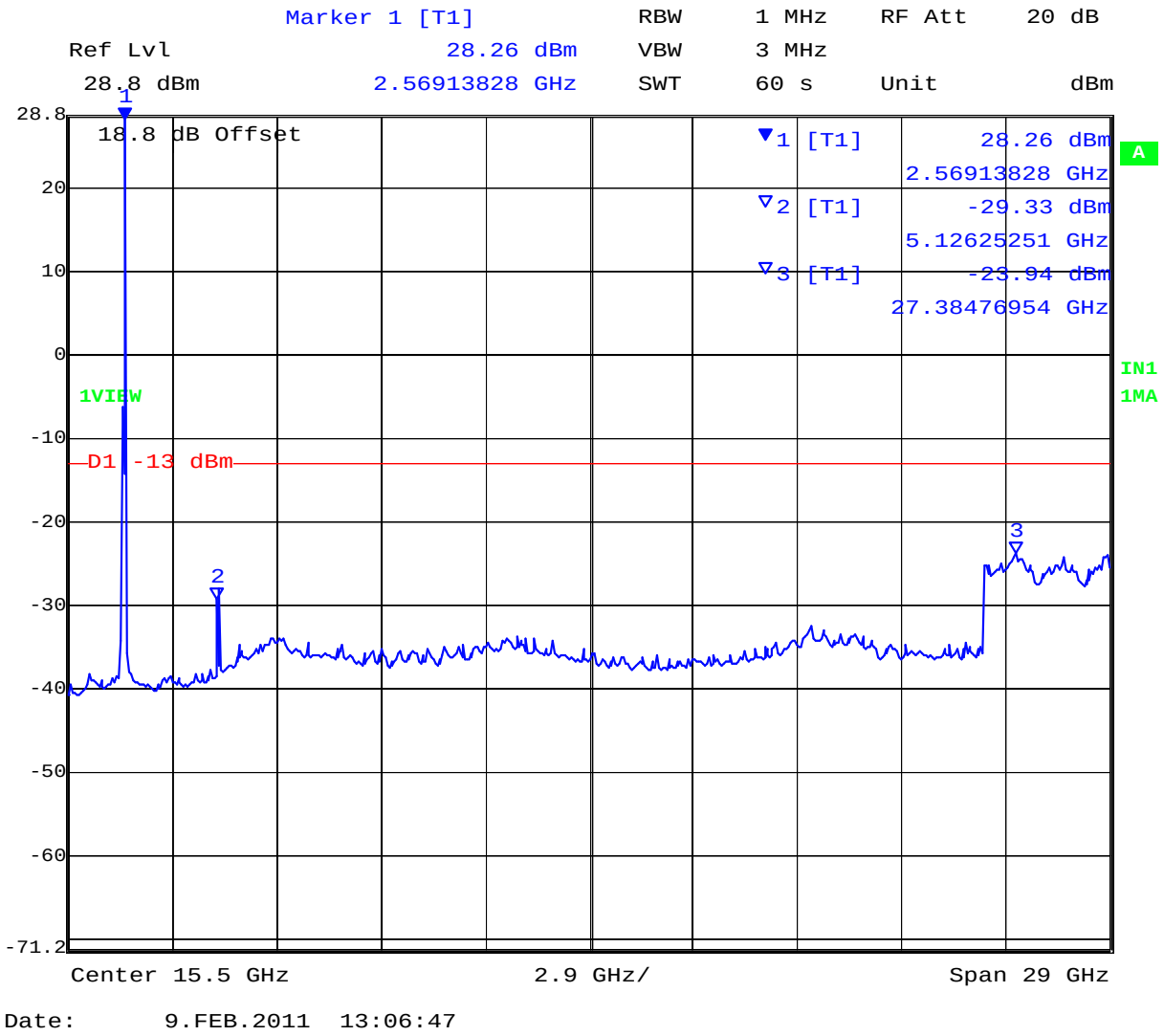
| Channel Centre Frequency (GHz) | Start Frequency (GHz) | Stop Frequency (GHz) | Maximum Emission Observed (dBm/MHz) | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|---|
| 2513.00 | 1 | 30 | -22.88 | -13.00 | -9.88 |
| 2590.00 | | | -23.94 | | -10.94 |
| 2679.00 | | | -23.04 | | -10.04 |

## Conducted Spurious Emissions,
## Channel 2513.00 MHz, 22 MHz Quad Channel Spacing



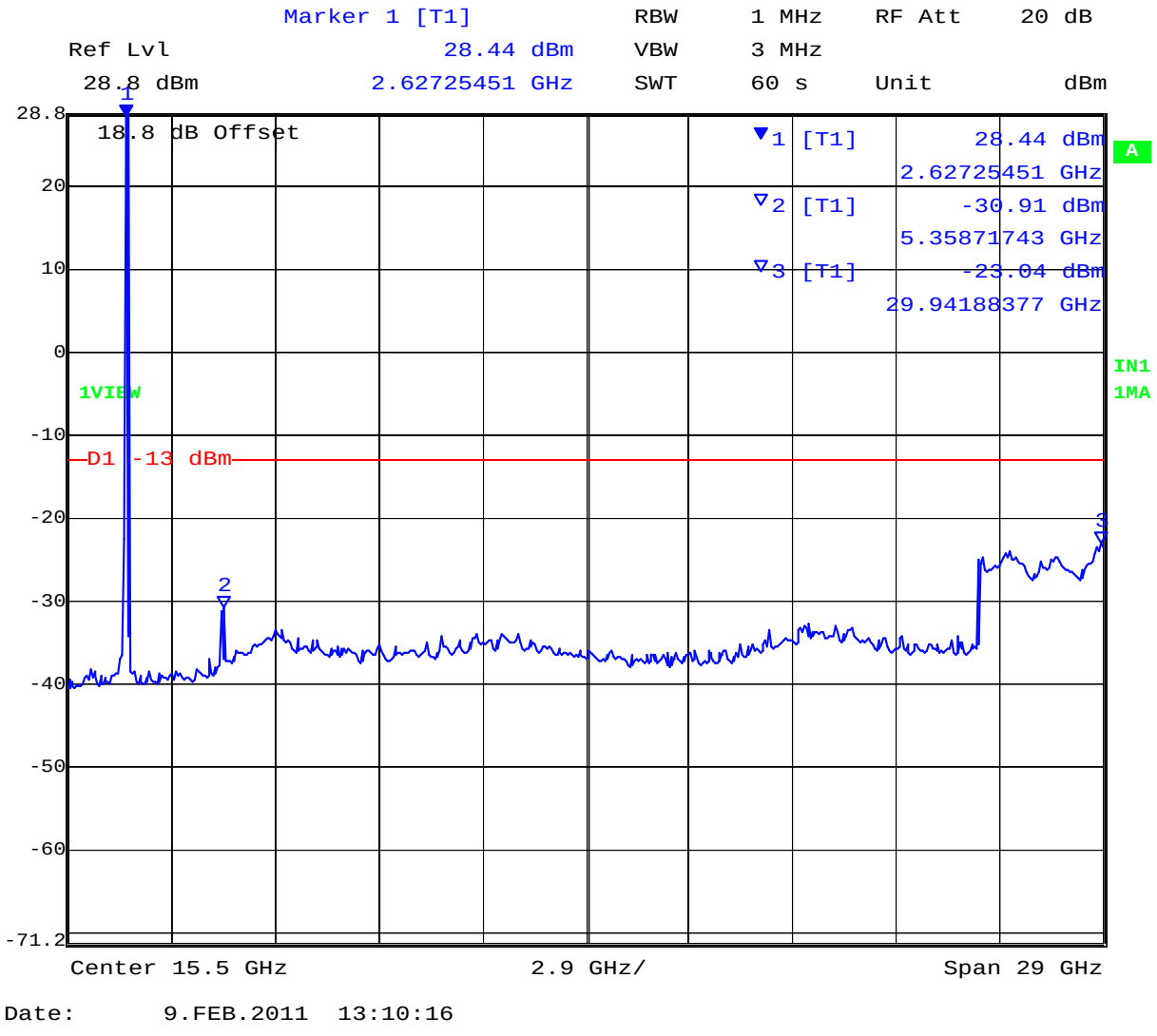

The emission breaking the limit line is the fundamental emission

## Conducted Spurious Emissions,
## Channel 2590.00 MHz, 24 MHz Quad Channel Spacing




The emission breaking the limit line is the fundamental emission

## Conducted Spurious Emissions,
## Channel 2670.00 MHz, 22 MHz Quad Channel Spacing




The emission breaking the limit line is the fundamental emission

## 7.7 Radiated Spurious Emissions

### Test Procedure

Testing was performed in a 3-meter anechoic chamber. Preliminary radiated emissions were measured on every azimuth and with the receiving antenna in both horizontal and vertical polarizations. Preliminary emissions were recorded with in Spectrum Analyzer mode, using a maximum peak detector while in peak hold mode.

Emissions nearest the limits were chosen for maximization and formal measurement using a CISPR Compliant receiver. Emissions above 1000 MHz are measured utilizing a CISPR compliant average detector with a tuned receiver, using a bandwidth of 1 MHz. Emissions from 30 MHz – 1000 MHz are measured utilizing a CISPR compliant quasi-peak detector with a tuned receiver, using a bandwidth of 120 kHz. Only the highest emissions relative to the limit are listed.

**Field Strength Calculation**

The field strength is calculated by adding the Antenna Factor and Cable Loss, and subtracting Amplifier Gain from the measured reading. All factors are included in the reported data.

**FS = R + AF + CORR – FO**

FS = Field Strength
R = Measured Spectrum analyzer Input Amplitude
AF = Antenna Factor

**CORR = Correction Factor = CL – AG + NFL**

CL = Cable Loss
AG = Amplifier Gain
FO = Distance Falloff Factor
NFL = Notch Filter Loss or Waveguide Loss

Field Strength Calculation Example:

Given receiver input reading of 51.5 dBμV; Antenna Factor of 8.5 dB; Cable Loss of 1.3 dB; Falloff Factor of 0 dB, an Amplifier Gain of 26 dB and Notch Filter Loss of 1 dB. The Field Strength of the measured emission is:

FS = 51.5 + 8.5 + 1.3 - 26.0 +1 = 36.3 dBμV/m

Conversion between dBμV/m (or dBμV) and μV/m (or μV) are done as:

Level (dBμV/m) = 20 * Log (level (μV/m))

40 dBμV/m = 100 μV/m
48 dBμV/m = 250 μV/m

**Laboratory Measurement Uncertainty for Spectrum Measurement**

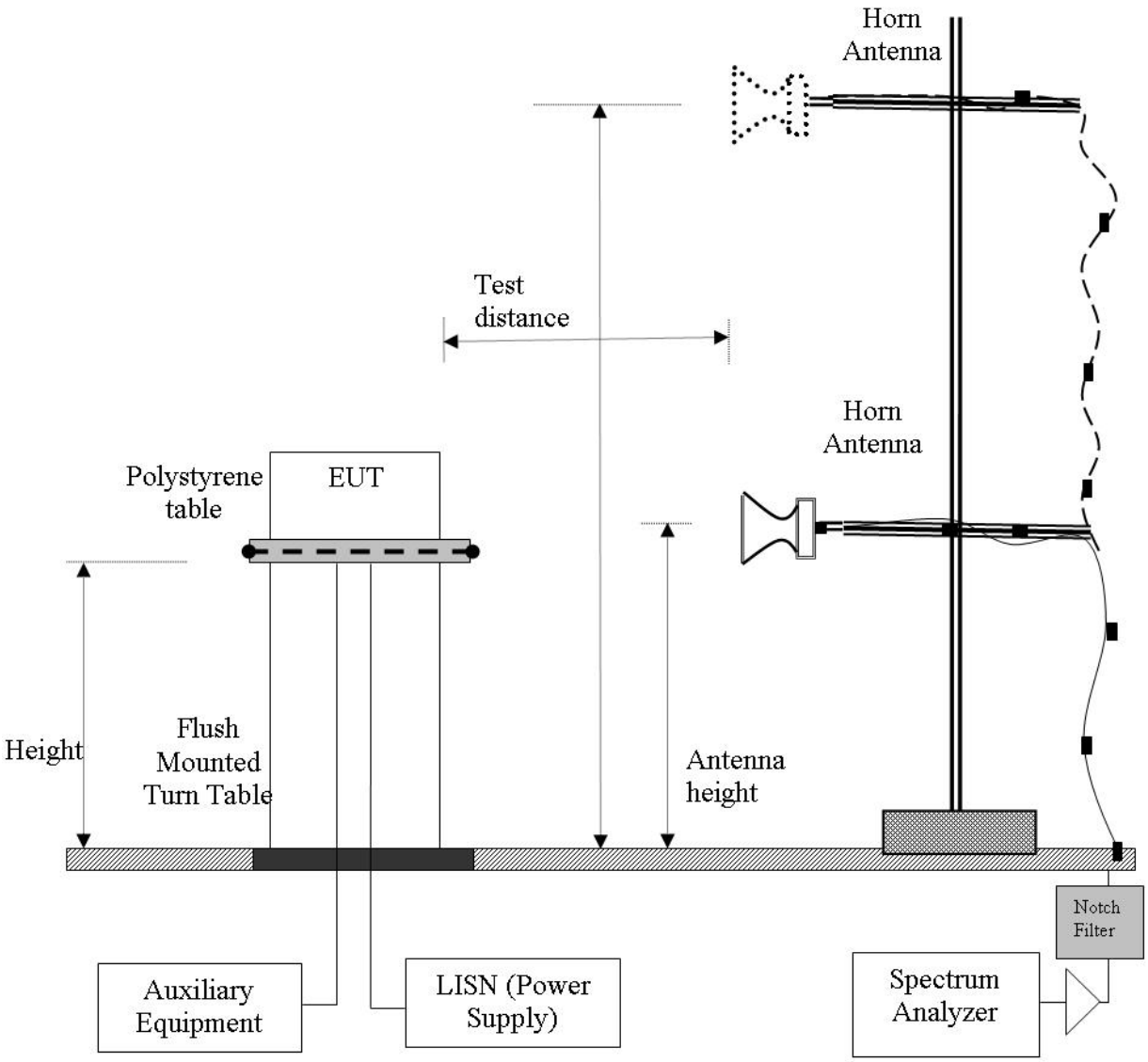
| | |
|---|---|
| **Measurement Uncertainty** | +5.6/ -4.5 dB |

**Traceability:**

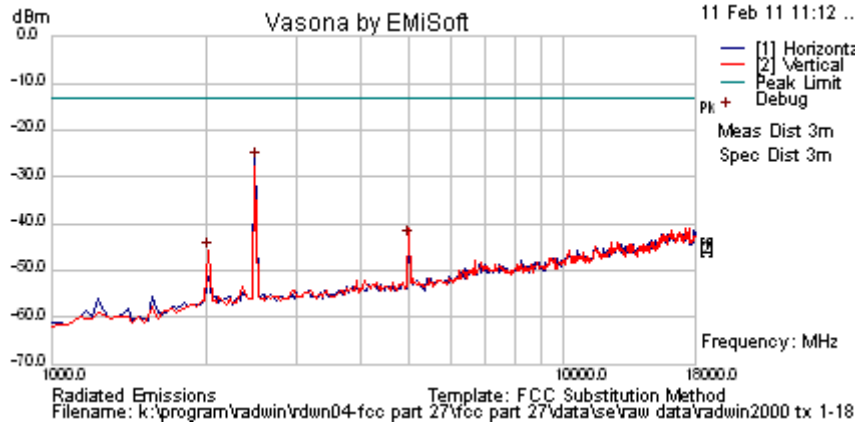
| Method | Test Equipment Used |
|---|---|
| Work instruction WI-03 | 0287, 0193, 0342, 0158, 0303, 0304, 0134, 0310, 0312 |

### 7.7.1 Transmitter Radiated Spurious Emission above 1 GHz

**Radiated Emission Measurement Setup – Above 1 GHz**



| | | | |
|---|---|---|---|
| **Test Freq.** | 2504.75 MHz | **Engineer** | EVF |
| **Variant** | 5.5 MHz Channel Spacing, Modulation 64 QAM | **Temp (°C)** | 19 |
| **Freq. Range** | 1000 MHz - 18000 MHz | **Rel. Hum.(%)** | 30 |
| **Power Setting** | max | **Press. (mBars)** | 1011 |
| **Antenna** | 3 feet long N-type cable with 50Ohm termination x2 | **Duty Cycle (%)** | 100 |
| **Test Notes 1** | Model: RADWIN2000 2.5GHz BAND; transmitting at 2504.75MHz (Channel Spacing 5.5MHz) | | |
| **Test Notes 2** | POE power supply (model: ET0061040) was placed on the table and connected to UUT through shielded ethernet cable; second ethernet cable was connected to PC in order to make the unit operational; UUT was placed 1.5 m above the ground reference plane. | | |



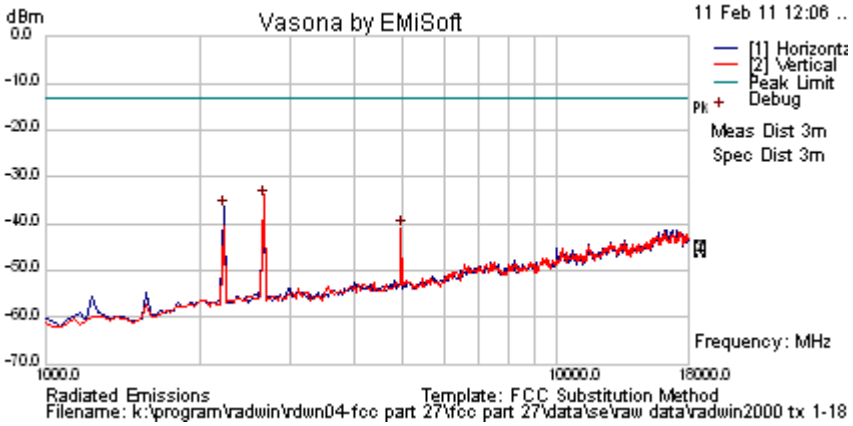

## Formally measured emission peaks

| Frequency MHz | Raw dBm | Cable Loss | AF dB | Level dBm | Measurement Type | Pol | Hgt cm | Azt Deg | Limit dBm | Margin dB | Pass /Fail | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2023.388 | -50.9 | 2.8 | 2.0 | -46.1 | Peak [Scan] | V | 152 | 360 | -13 | -33.1 | Pass | |
| 4979.965 | -51.9 | 4.6 | 3.8 | -43.5 | Peak [Scan] | V | 152 | 360 | -13 | -30.5 | Pass | HAR |
| 2496.102 | -31.3 | 3.0 | 1.9 | -26.5 | Peak [Scan] | H | | | | | | FUND |

| | |
|---|---|
| Legend: | TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; HAR = Harmonics |
| | RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak |

The emission closest to the limit is the fundamental

| | | | |
|---|---|---|---|
| **Test Freq.** | 2687.25 MHz | **Engineer** | EVF |
| **Variant** | 5.5 MHz Channel Spacing, Modulation 64 QAM | **Temp (ºC)** | 19 |
| **Freq. Range** | 1000 MHz - 18000 MHz | **Rel. Hum.(%)** | 30 |
| **Power Setting** | max | **Press. (mBars)** | 1011 |
| **Antenna** | 3' long N-type cable with 50Ohm termination x2 | **Duty Cycle (%)** | 100 |
| **Test Notes 1** | Model: RADWIN2000 2.5GHz BAND; transmitting at 2687.25MHz (Channel Spacing 5.5MHz) | | |
| **Test Notes 2** | POE power supply (model: ET0061040) was placed on the table and connected to UUT through shielded ethernet cable; second ethernet cable was connected to PC in order to make the unit operational; UUT was placed 1.5 m above the ground reference plane. | | |

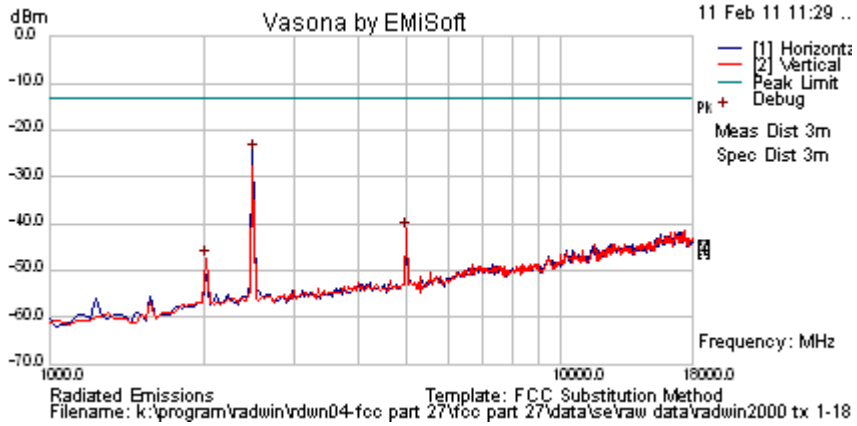



## Formally measured emission peaks

| Frequency MHz | Raw dBm | Cable Loss | AF dB | Level dBm | Measurement Type | Pol | Hgt cm | Azt Deg | Limit dBm | Margin dB | Pass /Fail | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2225.386 | -41.4 | 2.9 | 1.6 | -36.9 | Peak [Scan] | H | 152 | 360 | -13 | -23.9 | Pass | |
| 4950.389 | -50.0 | 4.6 | 3.8 | -41.6 | Peak [Scan] | V | 152 | 360 | -13 | -28.6 | Pass | HAR |
| 2671.514 | -40.4 | 3.1 | 1.9 | -35.4 | Peak [Scan] | V | | | | | | FUND |

| | |
|---|---|
| Legend: | TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; HAR = Harmonics |
| | RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak |

| | | | |
|---|---|---|---|
| **Test Freq.** | 2499 MHz | **Engineer** | EVF |
| **Variant** | 6 MHz Channel Spacing; Modulation 64 QAM | **Temp (ºC)** | 18.5 |
| **Freq. Range** | 1000 MHz - 18000 MHz | **Rel. Hum. (%)** | 31 |
| **Power Setting** | max | **Press. (mBars)** | 1011 |
| **Antenna** | 3 feet long N-type cable with 50Ohm termination x2 | **Duty Cycle (%)** | 100 |
| **Test Notes 1** | Model: RADWIN2000 2.5GHz BAND; transmitting at 2499 MHz (Channel Spacing 6MHz) | | |
| **Test Notes 2** | POE power supply (model: ET0061040) was placed on the table and connected to UUT through shielded ethernet cable; second ethernet cable was connected to PC in order to make the unit operational; UUT was placed 1.5 m above the ground reference plane. | | |



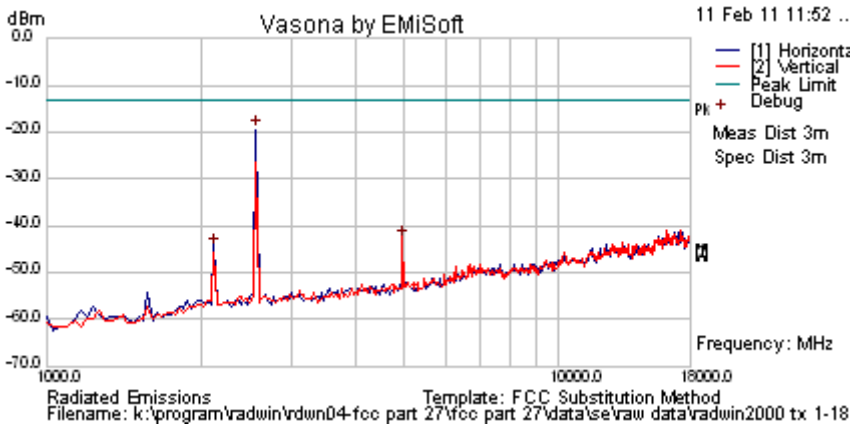

## Formally measured emission peaks

| Frequency MHz | Raw dBm | Cable Loss | AF dB | Level dBm | Measurement Type | Pol | Hgt cm | Azt Deg | Limit dBm | Margin dB | Pass /Fail | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2022.623 | -52.6 | 2.8 | 2.0 | -47.8 | Peak [Scan] | V | 152 | 360 | -13 | -34.8 | Pass | |
| 4980.065 | -49.9 | 4.6 | 3.8 | -41.5 | Peak [Scan] | V | 152 | 360 | -13 | -28.5 | Pass | HAR |
| 2496.866 | -29.8 | 3.0 | 1.9 | -24.9 | Peak [Scan] | H | | | | | | FUND |

| | |
|---|---|
| Legend: | TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; HAR = Harmonics |
| | RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak |

The emission closest to the limit is the fundamental

| | | | |
|---|---|---|---|
| **Test Freq.** | 2593 MHz | **Engineer** | EVF |
| **Variant** | 6 MHz Channel Spacing; Modulation 64 QAM | **Temp (ºC)** | 18.5 |
| **Freq. Range** | 1000 MHz - 18000 MHz | **Rel. Hum. (%)** | 31 |
| **Power Setting** | max | **Press. (mBars)** | 1011 |
| **Antenna** | 3 feet long N-type cable with 50Ohm termination x2 | **Duty Cycle (%)** | 100 |
| **Test Notes 1** | Model: RADWIN2000 2.5GHz BAND; transmitting at 2593 MHz (Channel Spacing 6MHz) | | |
| **Test Notes 2** | POE power supply (model: ET0061040) was placed on the table and connected to UUT through shielded ethernet cable; second ethernet cable was connected to PC in order to make the unit operational; UUT was placed 1.5 m above the ground reference plane. | | |




**Formally measured emission peaks**

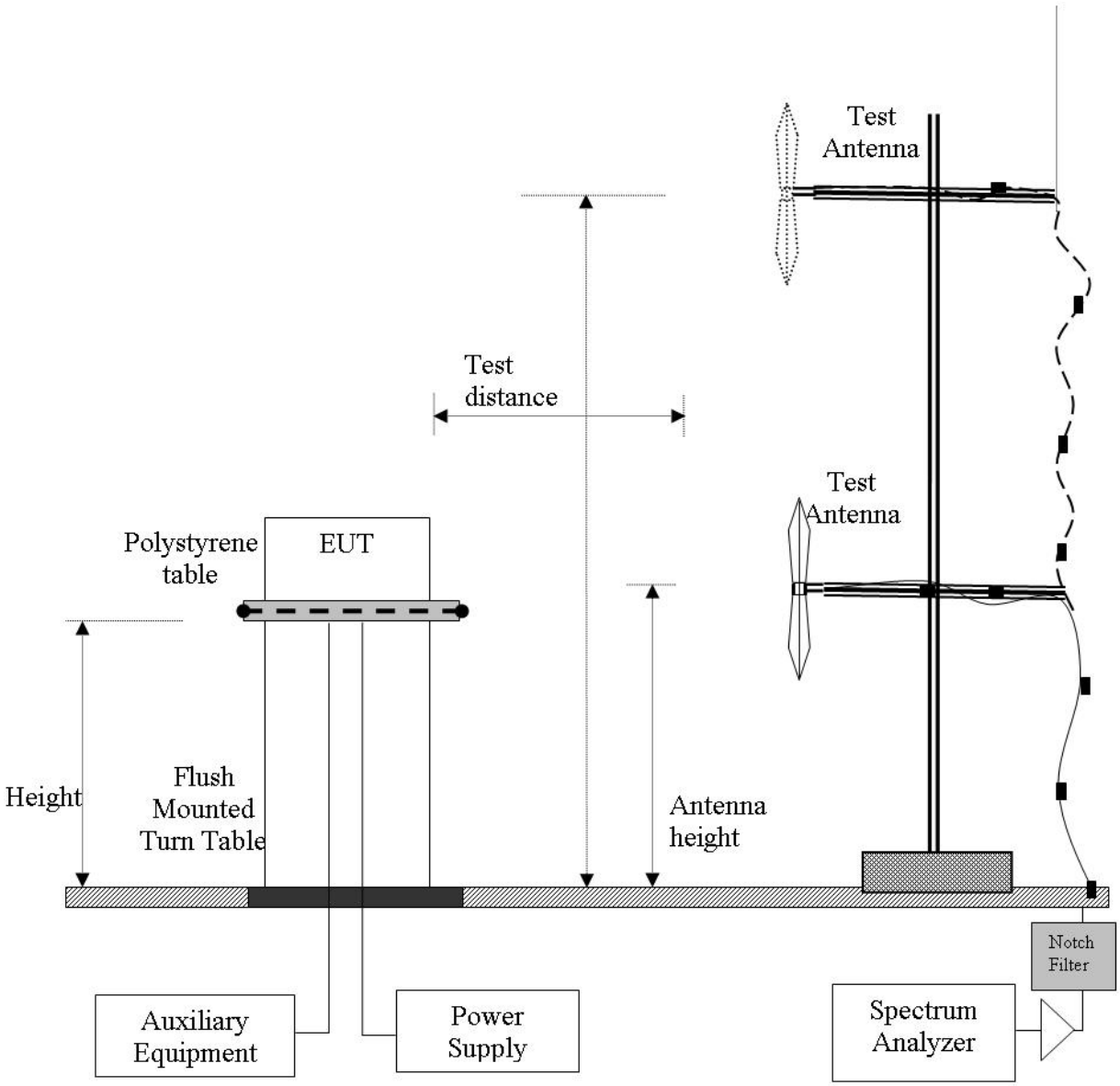
| Frequency MHz | Raw dBm | Cable Loss | AF dB | Level dBm | Measurement Type | Pol | Hgt cm | Azt Deg | Limit dBm | Margin dB | Pass /Fail | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2567.13427 | -24.4 | 3.1 | 1.9 | -19.5 | Peak [Scan] | H | | | | | | FUND |
| 2125.235 | -49.0 | 2.8 | 1.7 | -44.5 | Peak [Scan] | H | 152 | 360 | -13 | -31.5 | Pass | |
| 4960.152 | -51.2 | 4.6 | 3.9 | -42.7 | Peak [Scan] | V | 152 | 360 | -13 | -29.7 | Pass | HAR |

| | |
|---|---|
| Legend: | TX = Transmitter Emissions; DIG = Digital Emissions; FUND = Fundamental; HAR = Harmonics |
| | RB = Restricted Band (15.209 Limits); NRB = Non Restricted Band, Limit is 20dB below fundamental peak |

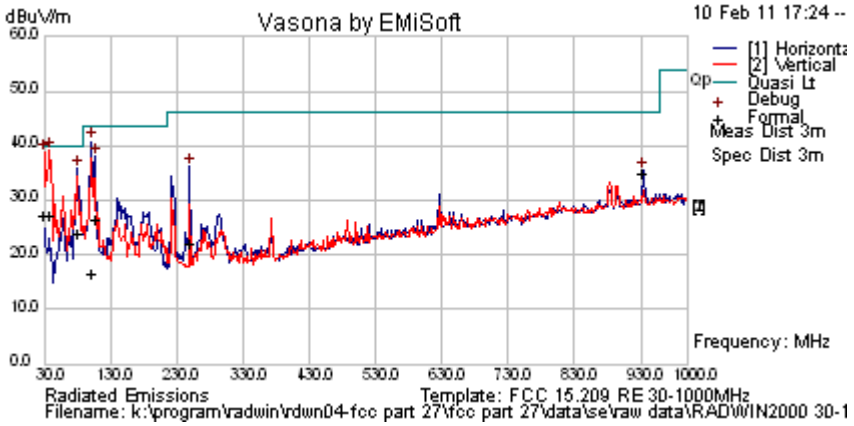
The emission closest to the limit is the fundamental

### 7.7.2 Radiated Spurious Emission Results below 1 GHz

**Radiated Emission Measurement Setup – Below 1 GHz**



| | | | |
|---|---|---|---|
| **Test Freq.** | Tx 2.499GHz | **Engineer** | EVF |
| **Variant** | Digital Emissions | **Temp (ºC)** | 18.5 |
| **Freq. Range** | 30 MHz - 1000 MHz | **Rel. Hum.(%)** | 33 |
| **Power Setting** | maximum (ART power setting 22.5) | **Press. (mBars)** | 1008 |
| **Antenna** | 3 feet long N-type cable with 50Ohm termination x2 | | |
| **Test Notes 1** | Model: RADWIN2000 2.5GHz BAND transmitting at 2.499GHz (Channel Spacing 6MHz) | | |
| **Test Notes 2** | POE power supply (model: ET0061040) was placed on the table and connected to UUT through shielded ethernet cable; second ethernet cable was connected to PC in order to make the unit operational; PC was placed underneath ground ref. plane in the chamber. | | |

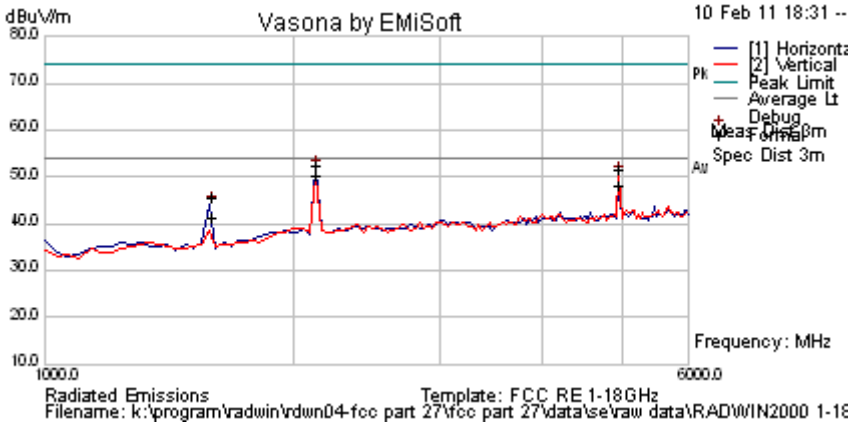



## Formally measured emission peaks

| Frequency MHz | Raw dBuV | Cable Loss | AF dB | Level dBuV/m | Measurement Type | Pol | Hgt cm | Azt Deg | Limit dBuV/m | Margin dB | Pass /Fail | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 38.180 | 39.3 | 3.5 | -15.6 | 27.2 | Quasi Max | V | 98 | 157 | 40 | -12.8 | Pass | |
| 30.321 | 33.2 | 3.4 | -9.5 | 27.1 | Quasi Max | V | 191 | 255 | 40 | -12.9 | Pass | |
| 101.896 | 32.7 | 4.2 | -20.5 | 16.4 | Quasi Max | H | 319 | 334 | 43.5 | -27.1 | Pass | |
| 81.213 | 43.4 | 4.0 | -23.5 | 23.8 | Quasi Max | H | 325 | 335 | 40 | -16.2 | Pass | |
| 107.311 | 41.2 | 4.2 | -18.9 | 26.5 | Quasi Max | H | 165 | 102 | 43.5 | -17.0 | Pass | |
| 249.996 | 36.0 | 5.0 | -18.8 | 22.2 | Quasi Max | H | 110 | 39 | 46 | -23.8 | Pass | |
| 933.312 | 34.3 | 7.5 | -7.0 | 34.8 | Quasi Max | H | 151 | 212 | 46 | -11.2 | Pass | |

| | |
|---|---|
| Legend: | DIG = Digital Device Emission; TX = Transmitter Emission; FUND = Fundamental Frequency |
| | NRB = Non-Restricted Band, Limit is 20 dB below Fundamental; RB = Restricted Band |

| | | | |
|---|---|---|---|
| **Test Freq.** | Rx 2593 MHz | **Engineer** | EVF |
| **Variant** | Digital Emissions | **Temp (ºC)** | 18.5 |
| **Freq. Range** | 1000 MHz - 6000 MHz | **Rel. Hum.(%)** | 33 |
| **Power Setting** | N/A | **Press. (mBars)** | 1000 |
| **Antenna** | 3 feet long N-type cable with 50Ohm termination x2 | | |
| **Test Notes 1** | Model: RADWIN2000 2.5GHz BAND | | |
| **Test Notes 2** | POE power supply (model: ET0061040) was placed on the table and connected to UUT through shielded ethernet cable; second ethernet cable was connected to PC in order to make the unit operational; PC was placed underneath ground ref. plane in the chamber. | | |




## Formally measured emission peaks

| Frequency MHz | Raw dBuV | Cable Loss | AF dB | Level dBuV/m | Measurement Type | Pol | Hgt cm | Azt Deg | Limit dBuV/m | Margin dB | Pass /Fail | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2133.046 | 61.2 | 2.8 | -11.5 | 52.6 | Peak Max | H | 100 | 284 | 74.0 | -21.4 | Pass | |
| 4960.060 | 56.2 | 4.6 | -9.1 | 51.8 | Peak Max | V | 100 | 115 | 74.0 | -22.2 | Pass | |
| 1600.080 | 57.4 | 2.5 | -14.3 | 45.6 | Peak Max | H | 193 | 267 | 74.0 | -28.4 | Pass | |
| 2133.046 | 59.2 | 2.8 | -11.5 | 50.5 | Average Max | H | 100 | 284 | 54.0 | -3.5 | Pass | |
| 4960.060 | 52.8 | 4.6 | -9.1 | 48.4 | Average Max | V | 100 | 115 | 54.0 | -5.6 | Pass | |
| 1600.080 | 53.0 | 2.5 | -14.3 | 41.2 | Average Max | H | 193 | 267 | 54.0 | -12.8 | Pass | |

| | |
|---|---|
| Legend: | DIG = Digital Device Emission; TX = Transmitter Emission; FUND = Fundamental Frequency |
| | NRB = Non-Restricted Band, Limit is 20 dB below Fundamental; RB = Restricted Band |

**Specification for FCC Part 15 Radiated Spurious Emissions**

**FCC §15.209 (a)** Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table.

**Table 1: FCC 15.209 Spurious Emissions Limits**

| Frequency (MHz) | Field Strength (µV/m) | Field Strength (dBµV/m) | Measurement Distance (meters) |
|---|---|---|---|
| 30-88 | 100 | 40.0 | 3 |
| 88-216 | 150 | 43.5 | 3 |
| 216-960 | 200 | 46.0 | 3 |
| Above 960 | 500 | 54.0 | 3 |

## 7.8 Conducted Disturbance at Mains Terminal (150 kHz – 30 MHz)

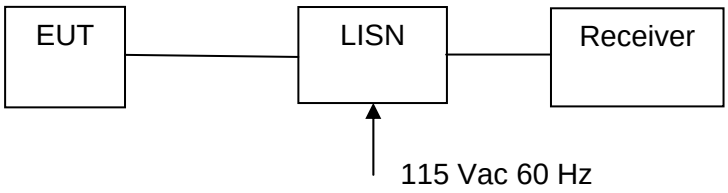
### Test Procedure

The EUT is configured in accordance with ANSI C63.4. The conducted emissions are measured in a shielded room with a spectrum analyzer in peak hold in the first instance. Emissions closest to the limit are measured in the quasi-peak mode (QP) with the tuned receiver using a bandwidth of 9 kHz. The emissions are maximized further by cable manipulation. The highest emissions relative to the limit are listed.

If the average limit is met when using a quasi-peak detector receiver, the EUT shall be deemed to meet both limits and measurement with the average detector receiver is unnecessary.

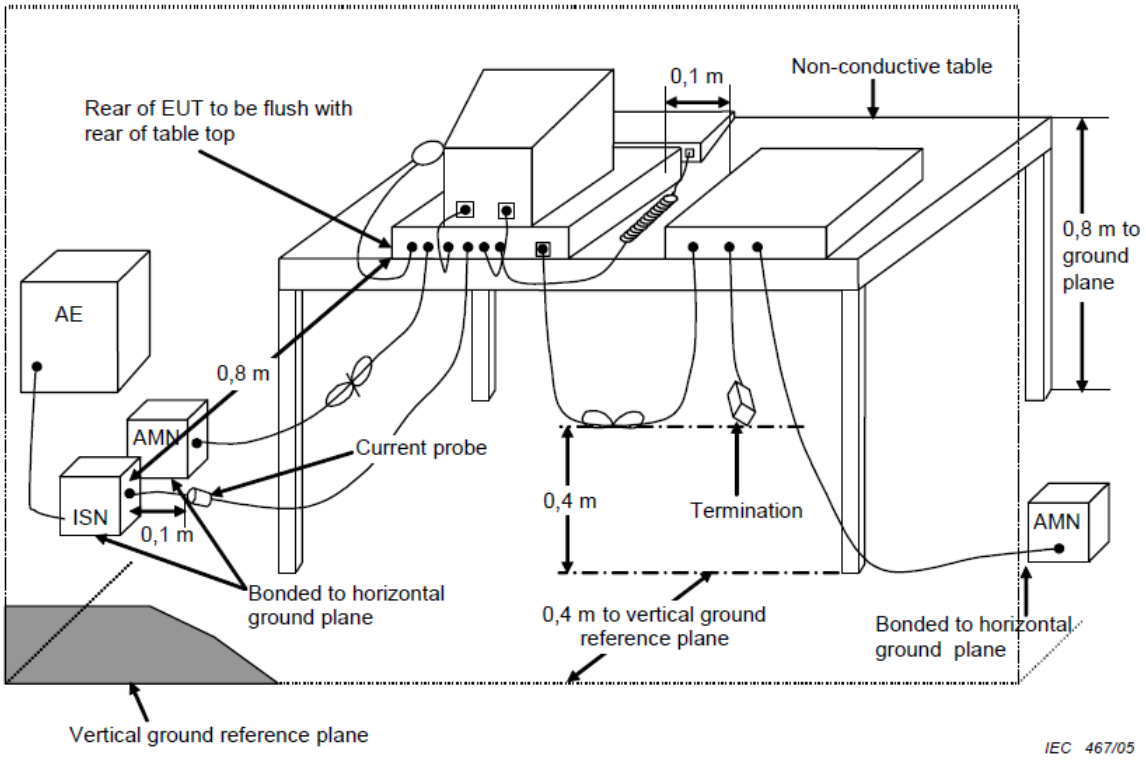
If the reading of the measuring receiver shows fluctuations close to the limit, the reading shall be observed for at least 15 s at each measurement frequency; the higher reading shall be recorded with the exception of any brief isolated high reading which shall be ignored.

### Test Measurement Set up




Measurement set up for AC Wireline Conducted Emissions Test

## Test Measurement Setup




Measurement setup for Conducted Disturbance at Mains Terminals

## Specification for Conducted Disturbance at Mains Terminal – Digital Apparatus

**FCC §15.207 (a)**

Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 μΩ line impedance stabilization network (LISN), see §15.207 (a) matrix below. Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal.

### Limits

| Frequency of Emission (MHz) | Conducted Limit (dBμV) | |
|---|---|---|
| | Quasi-peak | Average |
| 0.15-0.5 | 66 to 56* | 56 to 46* |
| 0.5-5 | 56 | 46 |
| 5-30 | 60 | 50 |

* Decreases with the logarithm of the frequency

### Traceability

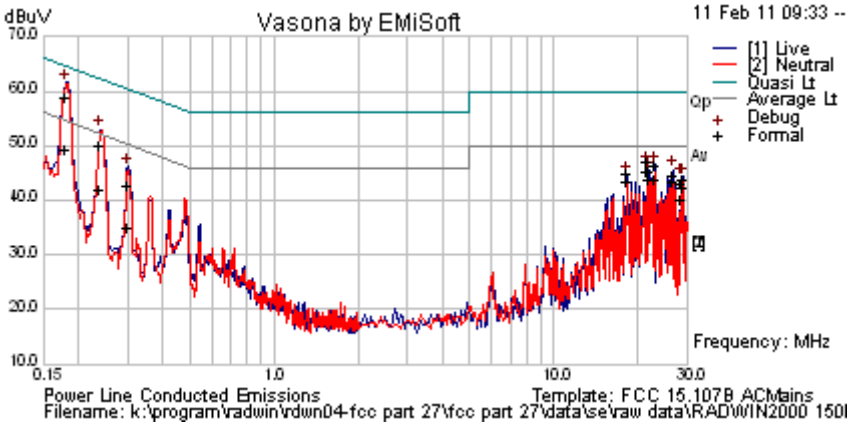
### Laboratory Measurement Uncertainty for Conducted Emissions

| | |
|---|---|
| **Measurement uncertainty** | ±2.64 dB |

### Traceability

| Method | Test Equipment Used |
|---|---|
| Work instruction WI-EMC-01 | 0158, 0184, 0193, 0190, 0293, 0307 |

| | | | |
|---|---|---|---|
| **Test Freq.** | N/A | **Engineer** | EVF |
| **Variant** | AC Line Emissions | **Temp (ºC)** | 18 |
| **Freq. Range** | 0.150 MHz - 30 MHz | **Rel. Hum.(%)** | 31 |
| **Power Setting** | 120VAC/ 60Hz | **Press. (mBars)** | 1010 |
| **Antenna** | 3 feet long N-type cable with 50Ohm termination x2 | | |
| **Test Notes 1** | Model: RADWIN2000 2.5GHz BAND transmitting at 2.499GHz (Channel Spacing 6MHz) | | |
| **Test Notes 2** | POE power supply (model: ET0061040) was placed on the table and connected to UUT through shielded ethernet cable; second ethernet cable was connected to PC in order to make the unit operational; PC was placed underneath ground ref. plane in the chamber. | | |




## Formally measured emission peaks

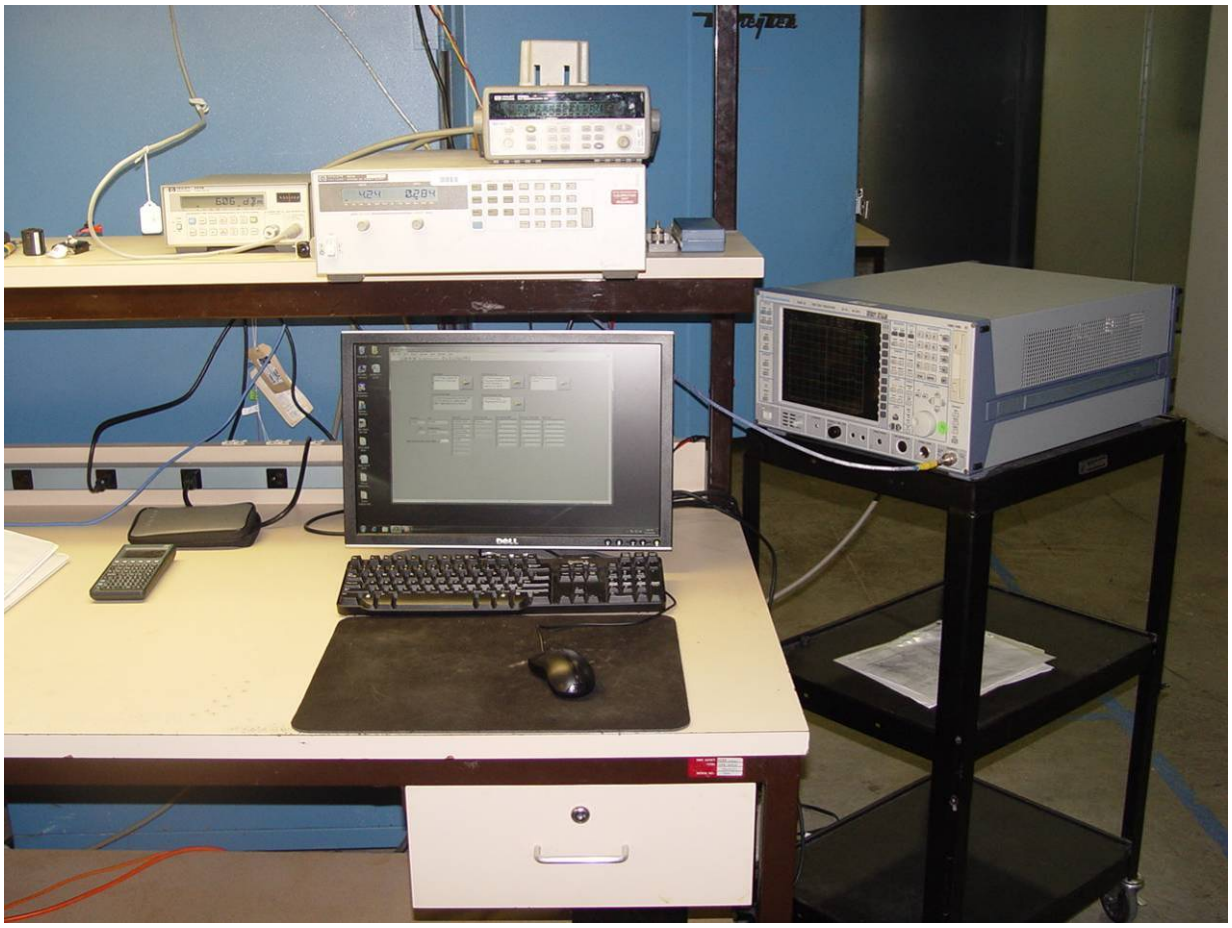
| Frequency MHz | Raw dBuV | Cable Loss | Factors dB | Level dBuV | Measurement Type | Line | Limit dBuV | Margin dB | Pass /Fail | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.179 | 49.0 | 9.9 | 0.1 | 59.0 | Quasi Peak | Live | 64.53 | -5.6 | Pass | |
| 0.239 | 40.1 | 9.9 | 0.1 | 50.1 | Quasi Peak | Live | 62.13 | -12.0 | Pass | |
| 23.129 | 35.0 | 10.6 | 0.9 | 46.5 | Quasi Peak | Live | 60 | -13.5 | Pass | |
| 21.663 | 35.7 | 10.6 | 0.8 | 47.0 | Quasi Peak | Live | 60 | -13.0 | Pass | |
| 0.299 | 32.9 | 9.9 | 0.1 | 42.9 | Quasi Peak | Live | 60.27 | -17.4 | Pass | |
| 26.609 | 32.8 | 10.7 | 0.9 | 44.4 | Quasi Peak | Live | 60 | -15.6 | Pass | |
| 0.179 | 39.3 | 9.9 | 0.1 | 49.3 | Average | Live | 54.53 | -5.2 | Pass | |
| 0.239 | 31.9 | 9.9 | 0.1 | 41.8 | Average | Live | 52.13 | -10.3 | Pass | |
| 23.129 | 32.3 | 10.6 | 0.9 | 43.8 | Average | Live | 50 | -6.2 | Pass | |
| 21.663 | 34.1 | 10.6 | 0.8 | 45.4 | Average | Live | 50 | -4.6 | Pass | |
| 0.299 | 24.9 | 9.9 | 0.1 | 34.9 | Average | Live | 50.27 | -15.4 | Pass | |
| 26.609 | 31.9 | 10.7 | 0.9 | 43.5 | Average | Live | 50 | -6.5 | Pass | |

| | |
|---|---|
| Legend: | DIG = Digital Device Emission; TX = Transmitter Emission; FUND = Fundamental Frequency |
| | NRB = Non-Restricted Band, Limit is 20 dB below Fundamental; RB = Restricted Band |

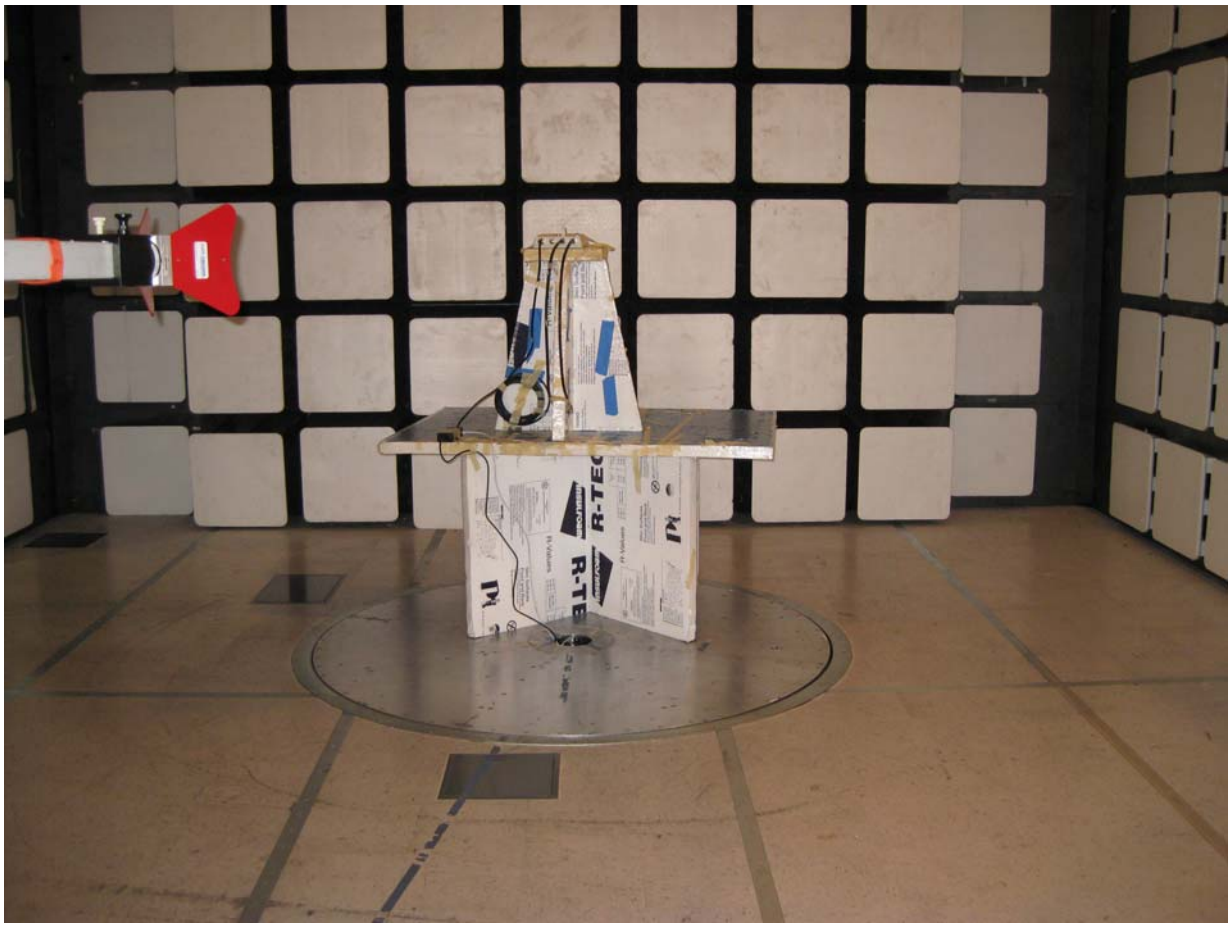
# 8 Photographs

## 8.1 Conducted RF Emissions - EUT

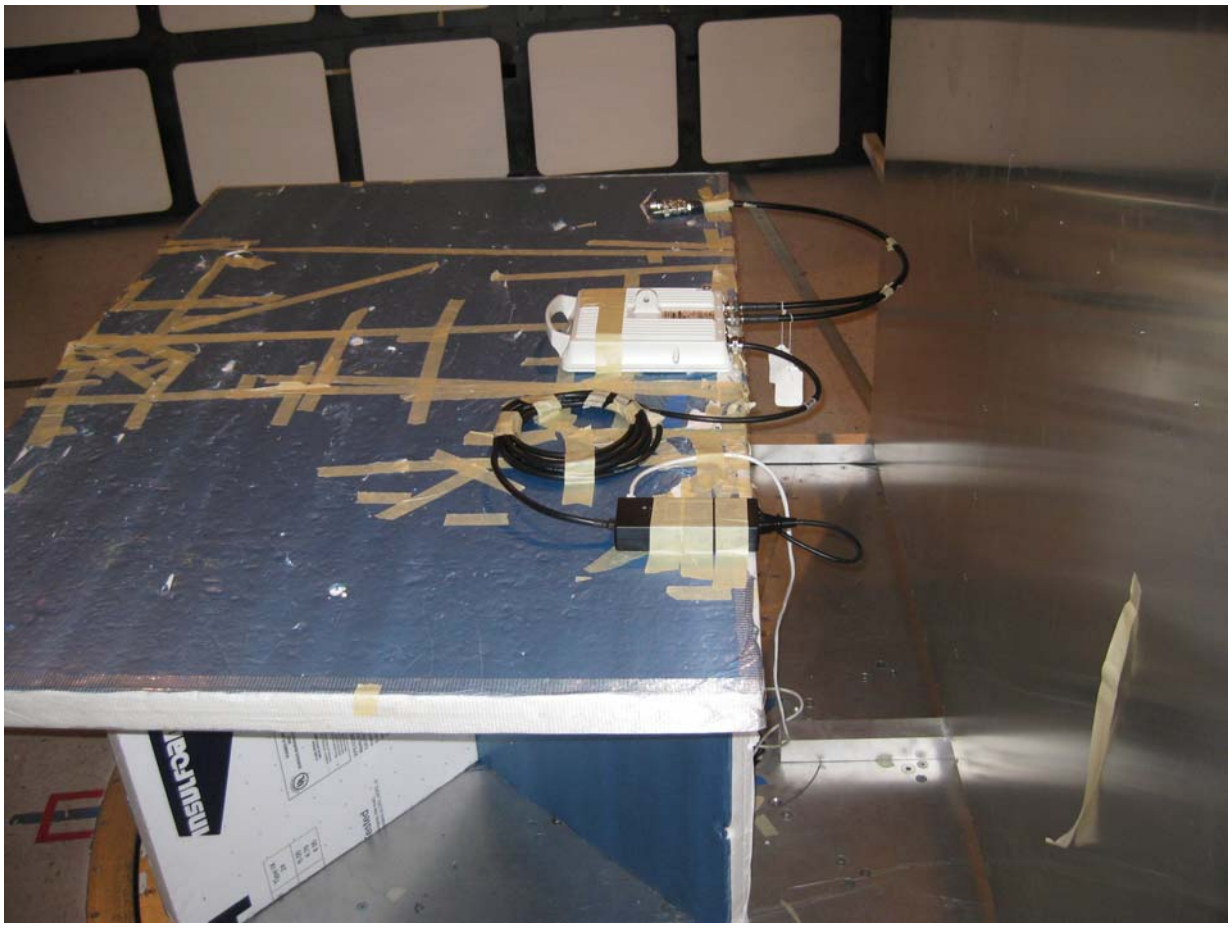
## 8.2 Conducted RF Emissions - Test Equipment



## 8.3 Transmitter Radiated Spurious Emission above 1 GHz



## 8.4 AC Mains Conducted Emissions



# 9 TEST EQUIPMENT DETAILS

| Asset # | Instrument | Manufacturer | Part # | Serial # |
|---|---|---|---|---|
| 0134 | Amplifier | Com Power | PA 122 | 181910 |
| 0158 | Barometer /Thermometer | Control Co. | 4196 | E2846 |
| 0287 | EMI Receiver | Rhode & Schwartz | ESIB 40 | 100201 |
| 0193 | EMI Receiver | Rhode & Schwartz | ESIB 7 | 838496/007 |
| 0252 | SMA Cable | Megaphase | Sucoflex 104 | None |
| 0310 | 2m SMA Cable | Micro-Coax | UFA210A-0-0787-3G03G0 | 209089-001 |
| 0312 | 3m SMA Cable | Micro-Coax | UFA210A-1-1181-3G0300 | 209092-001 |
| 0313 | Coupler | Hewlett Packard | 86205A | 3140A01285 |
| 0314 | 30dB N-Type Attenuator | ARRA | N9444-30 | 1623 |
| 0070 | Power Meter | Hewlett Packard | 437B | 3125U11552 |
| 0116 | Power Sensor | Hewlett Packard | 8485A | 3318A19694 |
| 0117 | Power Sensor | Hewlett Packard | 8487D | 3318A00371 |
| 0184 | Pulse Limiter | Rhode & Schwartz | ESH3Z2 | 357.8810.52 |
| 0190 | LISN | Rhode & Schwartz | ESH3Z5 | 836679/006 |
| 0293 | BNC Cable | Megaphase | 1689 1GVT4 | 15F50B001 |
| 0301 | 5.6 GHz Notch Filter | Micro-Tronics | RBC50704 | 001 |
| 0302 | 5.25 GHz Notch Filter | Micro-Tronics | BRC50703 | 002 |
| 0303 | 5.8 GHz Notch Filter | Micro-Tronics | BRC50705 | 003 |
| 0304 | 2.4GHzHz Notch Filter | Micro-Tronics | -- | 001 |
| 0307 | BNC Cable | Megaphase | 1689 1GVT4 | 15F50B002 |
| 0335 | 1-18GHz Horn Antenna | ETS- Lindgren | 3117 | 00066580 |
| 0337 | Amplifier | MiCOM Labs | -- | -- |
| 0338 | Antenna | Sunol Sciences | JB-3 | A052907 |
| 0342 | 2.4 GHz Notch Filter | EWT | EWT-14-0203 | H1 |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