InterLab®

# FCC Measurement/Technical Report on

# Kleer transceivers of NBT RSE

**Report Reference:** MDE_HARMAN_1013_FCCd

**Test Laboratory:**
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DAkkS
Deutsche
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# Table of Contents

# 0 Summary

## 0.1 Technical Report Summary

**Type of Authorization**
Certification for an Intentional Radiator (Digital Device / Spread Spectrum).

**Applicable FCC Rules**

Prepared in accordance with the requirements of FCC Rules and Regulations as listed in 47 CFR Ch.1 Parts 2 (10-1-11 Edition) and 15 (10-1-11 Edition). The following subparts are applicable to the results in this test report.

Part 2, Subpart J - Equipment Authorization Procedures, Certification

Part 15, Subpart C – Intentional Radiators

§ 15.201 Equipment authorization requirement

§ 15.207 Conducted limits

§ 15.209 Radiated emission limits; general requirements

§ 15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz

Note:
The tests were selected and performed with reference to the FCC measurement guide line “Measurement of Digital Transmission Systems Operating under Section 15.247 March 23, 2005”
Instead of applying ANSI C63.4–1992 which is referenced in the FCC Public Note, the newer ANSI C63.4–2009 is applied.

**Summary Test Results:**

**The EUT complied with all performed tests as listed in chapter 0.2 Measurement Summary.**

## 0.2 Measurement Summary

| **FCC Part 15, Subpart C** | **§ 15.207** | | |
|---|---|---|---|
| Conducted emissions (AC power line) | | | |
| The measurement was performed according to ANSI C63.4 | | | 2009 |
| **OP-Mode** | **Setup** | **Port** | **Final Result** |
| – | – | – | N/A |

| **FCC Part 15, Subpart C** | **§ 15.247 (a) (1)** | | |
|---|---|---|---|
| Occupied bandwidth | | | |
| The measurement was performed according to FCC § 15.31 | | | 10-1-11 Edition |
| **OP-Mode** | **Setup** | **Port** | **Final Result** |
| op-mode 1 | Setup_02 | Temp.ant.connector | passed |
| op-mode 2 | Setup_02 | Temp.ant.connector | passed |
| op-mode 3 | Setup_02 | Temp.ant.connector | passed |

| **FCC Part 15, Subpart C** | **§ 15.247 (b) (1)** | | |
|---|---|---|---|
| Peak power output | | | |
| The measurement was performed according to FCC § 15.31 | | | 10-1-11 Edition |
| **OP-Mode** | **Setup** | **Port** | **Final Result** |
| op-mode 1 | Setup_03 | Temp.ant.connector | passed |
| op-mode 2 | Setup_03 | Temp.ant.connector | passed |
| op-mode 3 | Setup_03 | Temp.ant.connector | passed |

| **FCC Part 15, Subpart C** | **§ 15.247 (d)** | | |
|---|---|---|---|
| Spurious RF conducted emissions | | | |
| The measurement was performed according to FCC § 15.31 | | | 10-1-11 Edition |
| **OP-Mode** | **Setup** | **Port** | **Final Result** |
| op-mode 1 | Setup_02 | Temp.ant.connector | passed |
| op-mode 2 | Setup_02 | Temp.ant.connector | passed |
| op-mode 3 | Setup_02 | Temp.ant.connector | passed |

| **FCC Part 15, Subpart C** | **§ 15.247 (d), § 15.35 (b), § 15.209** | | |
|---|---|---|---|
| Spurious radiated emissions | | | |
| The measurement was performed according to ANSI C63.4 | | | 2009 |
| **OP-Mode** | **Setup** | **Port** | **Final Result** |
| op-mode 1 | Setup_01 | Enclosure | passed |
| op-mode 2 | Setup_01 | Enclosure | passed |
| op-mode 3 | Setup_01 | Enclosure | passed |

| FCC Part 15, Subpart C | | § 15.247 (d) | |
|---|---|---|---|
| Band edge compliance | | | |
| The measurement was performed according to FCC § 15.31 / ANSI C63.4 | | | 10-1-11 Edition / 2009 |
| **OP-Mode** | **Setup** | **Port** | **Final Result** |
| op-mode 1 | Setup_02 | Temp.ant.connector | passed |
| op-mode 3 | Setup_02 | Temp.ant.connector | passed |
| op-mode 3 | Setup_01 | Enclosure | passed |

| FCC Part 15, Subpart C | | § 15.247 (e) | |
|---|---|---|---|
| Power density | | | |
| The measurement was performed according to FCC § 15.31 | | | 10-1-11 |
| **OP-Mode** | **Setup** | **Port** | **Final Result** |
| op-mode 1 | Setup_02 | Temp.ant.connector | passed |
| op-mode 2 | Setup_02 | Temp.ant.connector | passed |
| op-mode 3 | Setup_02 | Temp.ant.connector | passed |

N/A not applicable (the EUT is powered by DC)

Responsible for Accreditation Scope: _____ Responsible for Test Report: _____

7 layers AG, Borsigstr. 11
40880 Ratingen, Germany
Phone +49 (0)2102 749 0

# 1 Administrative Data

## 1.1 Testing Laboratory

| | |
|---|---|
| Company Name: | 7Layers AG |
| Address | Borsigstr. 11<br>40880 Ratingen<br>Germany |

This facility has been fully described in a report submitted to the FCC and accepted under the registration number 96716 .

The test facility is also accredited by the following accreditation organisation:

| | |
|---|---|
| Laboratory accreditation no.: | DAkkS D-PL-12140-01-01 |
| Responsible for Accreditation Scope: | Dipl.-Ing. Bernhard Retka<br>Dipl.-Ing. Robert Machulec<br>Dipl.-Ing. Thomas Hoell<br>Dipl.-Ing. Andreas Petz |
| Report Template Version: | 2012-03-14 |

## 1.2 Project Data

| | |
|---|---|
| Responsible for testing and report: | Dipl.-Ing. Marco Kullik |
| Date of Test(s): | 2012-03-08 to 2012-04-20 |
| Date of Report: | 2012-05-24 |

## 1.3 Applicant Data

| | |
|---|---|
| Company Name: | Harman Becker Automotive Systems GmbH |
| Address: | Becker-Göring-Straße 16<br>76307 Karlsbad<br>Germany |
| Contact Person: | Mr. Stefan Blaschek |

## 1.4 Manufacturer Data

| | |
|---|---|
| Company Name: | please see applicant data |
| Address: | |
| Contact Person: | |

# 2 Test object Data

## 2.1 General EUT Description

| | |
|---|---|
| **Equipment under Test:** | 2 Kleer transceivers |
| **Type Designation:** | NBT RSE |
| **Kind of Device:** | Part of Car Audio System |
| **(optional)** | |
| **Voltage Type:** | DC (vehicular) |
| **Voltage Level:** | 12.0 V |
| **Tested Modulation Type:** | FSK (MSK) |

**General product description:**

The Kleer Transceiver is operating in the 2.4 GHz ISM band in the range 2403.0 – 2478.0 MHz and uses the Direct Sequence Spread Spectrum (DSSS) Modulation.
The Kleer technology supports 16 channels in the 2.4 GHz ISM band, each spaced by 5 MHz whilst the nominal bandwidth is designed as 3 MHz.
The Kleer technology provides Dynamic Frequency Selection.

**Specific product description for the EUT:**

The EUT is a part of a car audio system for vehicular use containing two Kleer transceivers (indicated by “L” and “R”) which can operate simultaneously and independently from each other.

**The EUT provides the following ports:**

**Ports**
Temporary antenna connectors (connector L and R)
Enclosure
Main Port (incl. DC power)
CID left
CID right
Ethernet
Earphone Jack left
Earphone Jack left
3 Cinch Video connectors
USB connector

**The main components of the EUT are listed and described in Chapter 2.2**

## 2.2 EUT Main components

### Type, S/N, Short Descriptions etc. used in this Test Report

| Short Description | Equipment under Test | Type Designation | Serial No. | HW Status | SW Status | Date of Receipt |
|---|---|---|---|---|---|---|
| EUT A (Code: 43090a01) | Kleer transceivers | NBT RSE | 2361884 | D3 Muster | BIOS control | – |
| Remark: EUT A is equipped with integral antennas (gain = 4.1 dBi). | | | | | | |
| EUT A (Code: 43090b01) | Kleer transceivers | NBT RSE | – | D3 Muster | BIOS control | – |
| Remark: EUT B is equipped with temporary antenna connectors. | | | | | | |
| EUT C (Code: 43090o01) | Kleer transceivers | NBT RSE | – | D3 Muster | BIOS control | – |
| Remark: EUT C is equipped with temporary antenna connectors. | | | | | | |

NOTE: The short description is used to simplify the identification of the EUT in this test report.

## 2.3 Ancillary Equipment

For the purposes of this test report, ancillary equipment is defined as equipment which is used in conjunction with the EUT to provide operational and control features to the EUT. It is necessary to configure the system in a typical fashion, as a customer would normally use it. But nevertheless Ancillary Equipment can influence the test results.

| Short Description | Equipment under Test | Type Designation | HW Status | SW Status | Serial no. | FCC ID |
|---|---|---|---|---|---|---|
| – | – | – | – | – | – | – |

## 2.4 Auxiliary Equipment

For the purposes of this test report, auxiliary equipment is defined as equipment which is used temporarily to enable operational and control features especially used for the tests of the EUT which is not used during normal operation or equipment that is used during the tests in combination with the EUT but is not subject of this test report. It is necessary to configure the system in a typical fashion, as a customer would normally use it. But nevertheless Auxiliary Equipment can influence the test results.

| Short Description | Equipment under Test | Type Designation | Serial no. | HW Status | SW Status | FCC ID |
|---|---|---|---|---|---|---|
| AUX1 | uMost-Board | – (device used for BUS simulation) | – | UMOST II–30GW 2014.785-273 MOST | – | – |

NOTE: AUX1 is connected to the EUT via a fibre-optics link (no galvanic connection).

## 2.5 EUT Setups

This chapter describes the combination of EUTs and equipment used for testing. The rationale for selecting the EUTs, ancillary and auxiliary equipment and interconnecting cables, is to test a representative configuration meeting the requirements of the referenced standards.

| Setup No. | Combination of EUTs | Description and Rationale |
|---|---|---|
| Setup_01 | EUT A + AUX1 | setup for radiated measurements (AUX1 is used to enable the Kleer test mode), both transceivers are operated simultaneously at the same op-mode (see below) |
| Setup_02 | EUT C + AUX1 | setup for conducted measurements (AUX1 is used to enable the Kleer test mode), the measurements are performed for each transceiver separately |
| Setup_03 | EUT B + AUX1 | setup for conducted measurements (AUX1 is used to enable the Kleer test mode), the measurements are performed for each transceiver separately |

## 2.6 Operating Modes

This chapter describes the operating modes of the EUTs used for testing.

| Op. Mode | Description of Operating Modes | Remarks |
|---|---|---|
| op-mode 1 | TX-mode, the EUT transmits on the lowest channel (2403 MHz) | Operation on lowest frequency (channel 0) |
| op-mode 2 | TX-mode, the EUT transmits on the mid channel (2438 MHz) | Operation on mid frequency (channel 7) |
| op-mode 3 | TX-mode, the EUT transmits on the highest channel (2478 MHz) | Operation on highest frequency (channel 15) |

## 2.7 Special software used for testing

The EUT is running in a Kleer test mode set by a special software provided by the applicant. A batch-file "B075 BMW NBT RSE" is used to control the EUT.

## 2.8 Product labelling

### 2.8.1 FCC ID label

Please refer to the documentation of the applicant.

### 2.8.2 Location of the label on the EUT

Please refer to the documentation of the applicant.

# 3 Test Results

## 3.1 Occupied bandwidth

**Standard** FCC Part 15, 10-1-11 Subpart C

**The test was performed according to:** FCC §15.31

### 3.1.1 Test Description

The Equipment Under Test (EUT) was setup to perform the occupied bandwidth measurements.
The reference level is the level of the highest amplitude signal observed from the transmitter at either the fundamental frequency or first-order modulation products in all typical modes of operation, including the unmodulated carrier, even if atypical.
The results recorded were measured with the modulation which produce the worst-case (widest) occupied bandwidth.
The EUT was connected to spectrum analyzer via a short coax cable with a known loss.
Analyzer settings:
- Resolution Bandwidth (RBW): 100 kHz
- Video Bandwidth (VBW): 300 kHz
- Span: 30 MHz

### 3.1.2 Test Requirements / Limits

FCC Part 15, Subpart C, §15.247 (a) (2)
Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

Used conversion factor: Output power (dBm) = 10 log (Output power (W) / 1mW)

### 3.1.3 Test Protocol

Temperature: 22 °C
Air Pressure: 997 hPa
Humidity: 38 %

| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 1 | Setup_02 | Temp.ant.connector |

| 6 dB bandwidth MHz | Remarks |
|---|---|
| 1.75 | Connector L |
| 1.93 | Connector R |

Remark: Please see annex for the measurement plot.

| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 2 | Setup_02 | Temp.ant.connector |

| 6 dB bandwidth MHz | Remarks |
|---|---|
| 1.75 | Connector L |
| 1.87 | Connector R |

Remark: Please see annex for the measurement plot.

| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 3 | Setup_02 | Temp.ant.connector |

| 6 dB bandwidth MHz | Remarks |
|---|---|
| 1.75 | Connector L |
| 1.93 | Connector R |

Remark: Please see annex for the measurement plot.

### 3.1.4 Test result: Occupied bandwidth

| FCC Part 15, Subpart C | Op. Mode | Result |
|---|---|---|
| | op-mode 1 | passed |
| | op-mode 2 | passed |
| | op-mode 3 | passed |

## 3.2 Peak power output

**Standard** FCC Part 15, 10-1-11 Subpart C

**The test was performed according to:** FCC §15.31

### 3.2.1 Test Description

The Equipment Under Test (EUT) was set up to perform the output power measurements. The results recorded were measured with the modulation which produces the worst-case (highest) output power. The reference level of the spectrum analyzer was set higher than the output power of the EUT. The EUT was connected to the spectrum analyzer via a short coax cable with a known loss.

### 3.2.2 Test Requirements / Limits

FCC Part 15, Subpart C, §15.247 (b) (3)
For systems using digital modulation techniques in the 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz bands: 1 watt.

Used conversion factor: Limit (dBm) = 10 log (Limit (W)/1mW)
==> Maximum Output Power: 30 dBm

### 3.2.3 Test Protocol

Temperature: 23 °C
Air Pressure: 1003 hPa
Humidity: 35 %

| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 1 | Setup_03 | Temp.ant.connector |

| Output power dBm | Remarks |
|---|---|
| 1.4 | Connector L: The EIRP including antenna gain (4.1 dBi) is 5.5 dBm RMS |
| –0.1 | Connector R: The EIRP including antenna gain (4.1 dBi) is 4.0 dBm RMS |

Remark: Please see annex for the measurement plot.

| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 2 | Setup_03 | Temp.ant.connector |

| Output power dBm | Remarks |
|---|---|
| 1.0 | Connector L: The EIRP including antenna gain (4.1 dBi) is 5.1 dBm RMS |
| –0.1 | Connector R: The EIRP including antenna gain (4.1 dBi) is 4.0 dBm RMS |

Remark: Please see annex for the measurement plot.

| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 3 | Setup_03 | Temp.ant.connector |

| Output power dBm | Remarks |
|---|---|
| 0.5 | Connector L: The EIRP including antenna gain (4.1 dBi) is 4.6 dBm RMS |
| 0.1 | Connector R: The EIRP including antenna gain (4.1 dBi) is 4.2 dBm RMS |

Remark: Please see annex for the measurement plot.

### 3.2.4 Test result: Peak power output

| FCC Part 15, Subpart C | Op. Mode | Result |
|---|---|---|
| | op-mode 1 | passed |
| | op-mode 2 | passed |
| | op-mode 3 | passed |

## 3.3 Spurious RF conducted emissions

**Standard** FCC Part 15, 10-1-11 Subpart C

**The test was performed according to:** FCC §15.31

### 3.3.1 Test Description

The Equipment Under Test (EUT) was set up to perform the spurious emissions measurements.
The EUT was connected to spectrum analyzer via a short coax cable with a known loss.
Analyzer settings:
- Detector: Peak-Maxhold
- Frequency range: 30 – 25000 MHz
- Resolution Bandwidth (RBW): 100 kHz
- Video Bandwidth (VBW): 300 kHz
- Sweep Time: 330 s

The reference value for the measurement of the spurious RF conducted emissions is determined during the test “band edge compliance” (cf. chapter 3.5). This value is used to calculate the 20 dBc limit.

### 3.3.2 Test Requirements / Limits

FCC Part 15, Subpart C, §15.247 (c)
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

### 3.3.3 Test Protocol

Temperature: 22 °C
Air Pressure: 997 hPa
Humidity: 38 %

| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 1 | Setup_02 | Temp.ant.connector, Connector L |

| Frequency MHz | Measurement value dBm | Reference value dBm | Limit dBm | Margin to limit dB |
|---|---|---|---|---|
| 6886 | –35.0 | –3.1 | –23.1 | 11.9 |
| | | | | |

Remark: No (further) spurious emissions in the range 20 dB below the limit found.
Please see annex for the measurement plot.

| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 1 | Setup_02 | Temp.ant.connector, Connector R |

| Frequency MHz | Measurement value dBm | Reference value dBm | Limit dBm | Margin to limit dB |
|---|---|---|---|---|
| 6936 | –35.4 | –1.4 | –21.4 | 14.0 |
| 20647 | –37.0 | –1.4 | –21.4 | 15.6 |

Remark: No (further) spurious emissions in the range 20 dB below the limit found.
Please see annex for the measurement plot.

| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 2 | Setup_02 | Temp.ant.connector, Connector L |

| Frequency MHz | Measurement value dBm | Reference value dBm | Limit dBm | Margin to limit dB |
|---|---|---|---|---|
| 6886 | –34.4 | –2.0 | –22.0 | 12.4 |
| | | | | |

Remark: No (further) spurious emissions in the range 20 dB below the limit found.
Please see annex for the measurement plot.

| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 2 | Setup_02 | Temp.ant.connector, Connector R |

| Frequency MHz | Measurement value dBm | Reference value dBm | Limit dBm | Margin to limit dB |
|---|---|---|---|---|
| 6886 | –35.2 | –0.8 | –20.8 | 14.4 |
| | | | | |

Remark: No (further) spurious emissions in the range 20 dB below the limit found.
Please see annex for the measurement plot.

| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 3 | Setup_02 | Temp.ant.connector, Connector L |

| Frequency MHz | Measurement value dBm | Reference value dBm | Limit dBm | Margin to limit dB |
|---|---|---|---|---|
| 6886 | –35.7 | –1.9 | –21.9 | 13.8 |
| | | | | |

Remark: No (further) spurious emissions in the range 20 dB below the limit found.
Please see annex for the measurement plot.

| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 3 | Setup_02 | Temp.ant.connector, Connector R |

| Frequency MHz | Measurement value dBm | Reference value dBm | Limit dBm | Margin to limit dB |
|---|---|---|---|---|
| 6886 | –34.8 | –1.2 | –21.2 | 13.6 |
| | | | | |

Remark: No (further) spurious emissions in the range 20 dB below the limit found.
Please see annex for the measurement plot.

### 3.3.4 Test result: Spurious RF conducted emissions

| FCC Part 15, Subpart C | Op. Mode | Result |
|---|---|---|
| | op-mode 1 | passed |
| | op-mode 2 | passed |
| | op-mode 3 | passed |

## 3.4 Spurious radiated emissions

**Standard** FCC Part 15, 10-1-11 Subpart C

**The test was performed according to:** ANSI C63.4–2009

### 3.4.1 Test Description

The test set-up was made in accordance to the general provisions of ANSI C63.4–2009 in a typical installation configuration. The Equipment Under Test (EUT) was set up on a non-conductive table 1.0 x 2.0 m² in the semi-anechoic chamber. The influence of the EUT support table that is used between 30–1000 MHz was evaluated.
The test was performed at the distance of 3 m between the EUT and the receiving antenna. The measurement procedure is implemented into the EMI test software ES-K1 from R&S. The radiated emissions measurements were made in a typical installation configuration. Exploratory tests are performed at 3 orthogonal axes to determine the worst-case orientation of a body-worn or handheld EUT. The final test on all kind of EUTs is performed at 2 axes. A pre-check is also performed while the EUT is powered from both AC and DC (battery) power in order to find the worst-case operating condition.

**1. Measurement up to 30 MHz**
The test set-up was made in accordance to the general provisions of ANSI C 63.4-2009. The Equipment Under Test (EUT) was set up on a non-conductive table in the anechoic chamber.
The radiated emissions measurements were made in a typical installation configuration. The measurement procedure is implemented into the EMI test software ES-K1 from R&S. The Loop antenna HFH2-Z2 is used.
**Step 1:** pre measurement
- Anechoic chamber
- Antenna distance: 10 m
- Detector: Peak-Maxhold
- Frequency range: 0.009 - 0.15 and 0.15 – 30 MHz
- Frequency steps: 0.1 kHz and 5 kHz
- IF–Bandwidth: 0.2 kHz and 10 kHz
- Measuring time / Frequency step: 100 ms

Intention of this step is, to determine the radiated EMI-profile of the EUT. Afterwards the relevant emissions for the final measurement are identified.
**Step 2:** final measurement
For the relevant emissions determined in step 1, an additional measurement with the following settings will be performed. Intention of this step is to find the maximum emission level.
- Open area test side
- Antenna distance: according to the Standard
- Detector: Quasi-Peak
- Frequency range: 0.009 – 30 MHz
- Frequency steps: measurement at frequencies detected in step 1
- IF–Bandwidth: 200 Hz - 10 kHz
- Measuring time / Frequency step: 100 ms

**2. Measurement above 30 MHz and up to 1 GHz**

**Step 1:** Preliminary scan

Preliminary test to identify the highest amplitudes relative to the limit.

Settings for step 1:

- Antenna distance: 3 m
- Detector: Peak-Maxhold
- Frequency range: 30 – 1000 MHz
- Frequency steps: 60 kHz
- IF–Bandwidth: 120 kHz
- Measuring time / Frequency step: 100 µs
- Turntable angle range: –180° to 180°
- Turntable step size: 90°
- Height variation range: 1 – 3 m
- Height variation step size: 2 m
- Polarisation: Horizontal + Vertical

Intention of this step is, to determine the radiated EMI-profile of the EUT. Afterwards the relevant emissions for the final measurement are identified.

**Step 2:** second measurement

For the relevant emissions determined in step 1, an additional measurement with the following settings will be performed. Intention of this step is, to find out the approximate turntable angle and antenna height for each frequency.

- Detector: Peak – Maxhold
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 100 ms
- Turntable angle range: –180° to 180°
- Turntable step size: 45°
- Height variation range: 1 – 4 m
- Height variation step size: 0.5 m
- Polarisation: horizontal + vertical

After this step the EMI test system has determined the following values for each frequency (of step 1):

- Frequency
- Azimuth value (of turntable)
- Antenna height

The last two values have now the following accuracy:

- Azimuth value (of turntable): 45°
- Antenna height: 0.5 m

**Step 3:** final measurement

In this step the accuracy of the turntable azimuth and antenna height will be improved. This is necessary to find out the maximum value of every frequency.

For each frequency, which was determined the turntable azimuth and antenna height will be adjusted. The turntable azimuth will be slowly varied by +/- 22.5° around this value. During this action the value of emission is continuously measured. The turntable azimuth at the highest emission will be recorded and adjusted. In this position the antenna height is also slowly varied by +/- 25 cm around the antenna height determined. During this action the value of emission is also continuously measured. The antenna height of the highest emission will also be recorded and adjusted.

- Detector: Peak – Maxhold
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 100 ms
- Turntable angle range: –22.5° to + 22.5° around the determined value
- Height variation range: -0.25m to + 0.25m around the determined value

**Step 4:** final measurement with QP detector

With the settings determined in step 3, the final measurement will be performed:

EMI receiver settings for step 4:
- Detector: Quasi-Peak(< 1 GHz)
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 1 s

**3. Measurement above 1 GHz**
The following modifications apply to the measurement procedure for the frequency range above 1 GHz:
The Equipment Under Test (EUT) was set up on a non-conductive support at 1.4 m height in the fully-anechoic chamber. The measurement distance was reduced to 1 m. The results were extrapolated by the extrapolation factor of 20 dB/decade (inverse linear-distance for field strength measurements, inverse linear-distance squared for the power reference level measurements). Due to the fact that in this frequency range a double ridged wave guided horn antenna (up to 18 GHz) and a horn antenna (18–25 GHz) are used, the steps 2-4 are omitted. Step 1 was performed with one height of the receiving antenna only.
EMI receiver settings:
- Detector: Peak, Average
- IF Bandwidth = 1 MHz

After the measurement a plot will be generated which contains a diagram with the results of the preliminary scan and a chart with the frequencies and values of the results of the final measurement.
For the data rate in mode n the test is performed as worst-case-check in order to verify that emissions have a comparable level as found at modes b and g. Typically, the measurement is performed in the frequency range 1 to 8 GHz but it depends on the emissions found during the test for the modes b and g. Please refer to the results for the used frequency range.

### 3.4.2 Test Requirements / Limits

FCC Part 15, Subpart C, §15.247 (d)
... In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

FCC Part 15, Subpart C, §15.209, Radiated Emission Limits

| Frequency in MHz | Limit (µV/m) | Measurement distance (m) | Limit(dBµV/m @10m) |
|---|---|---|---|
| 0.009 – 0.49 | 2400/F(kHz) | 300 | Limit (dBµV/m) + 30 dB |
| 0.49 – 1.705 | 24000/F(kHz) | 30 | Limit (dBµV/m) + 10 dB |
| 1.705 – 30 | 30 | 30 | Limit (dBµV/m) + 10 dB |

| Frequency in MHz | Limit (µV/m) | Measurement distance (m) | Limit (dBµV/m) |
|---|---|---|---|
| 30 – 88 | 100 | 3 | 40.0 |
| 88 – 216 | 150 | 3 | 43.5 |
| 216 – 960 | 200 | 3 | 46.0 |
| above 960 | 500 | 3 | 54.0 |

§15.35(b)
..., there is also a limit on the radio frequency emissions, as measured using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit....

Used conversion factor: Limit (dBµV/m) = 20 log (Limit (µV/m)/1µV/m)

### 3.4.3 Test Protocol

Temperature: 22–24 °C
Air Pressure: 998–1029 hPa
Humidity: 32–36 %

#### *3.4.3.1 Measurement up to 30 MHz*

| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 2 | Setup_01 | Enclosure, L+R transmitting simultaneously |

| Antenna Position | Frequency MHz | Corrected value dBµV/m | | Limit dBµV/m | Limit dBµV/m | Margin to limit dB | Margin to limit dB |
|---|---|---|---|---|---|---|---|
| | | PK | AV | PK | AV | PK | AV |
| 0° | – | – | – | – | – | – | – |
| 90° | – | – | – | – | – | – | – |

Remark: No (further) spurious emissions in the range 20 dB below the limit found therefore step 2 was not performed. A peak at 99.2 kHz is an emission from the loop antenna's power supply.

#### *3.4.3.2 Measurement above 30 MHz*

| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 1 | Setup_01 | Enclosure, L+R transmitting simultaneously |

| Polarisation | Frequency MHz | Corrected value dBµV/m | | | Limit dBµV/m | Limit dBµV/m | Limit dBµV/m | Margin to limit dB | Margin to limit dB |
|---|---|---|---|---|---|---|---|---|---|
| | | QP | PK | AV | QP | PK | AV | QP/PK | AV |
| Hor. + Vert. | 1056 | – | 44.7 | 35.1 | – | 74.0 | 54.0 | 29.3 | 18.9 |
| | 1188 | – | 44.6 | 34.8 | – | 74.0 | 54.0 | 29.4 | 19.2 |
| | 4806 | – | 52.9 | 50.8 | – | 74.0 | 54.0 | 21.1 | 3.2 |
| | 12015 | – | 45.4 | 36.7 | – | 74.0 | 54.0 | 28.6 | 17.3 |

Remark: No (further) spurious emissions in the range 20 dB below the limit found.

| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 2 | Setup_01 | Enclosure, L+R transmitting simultaneously |

| Polarisation | Frequency MHz | Corrected value dBµV/m | | | Limit dBµV/m | Limit dBµV/m | Limit dBµV/m | Margin to limit dB | Margin to limit dB |
|---|---|---|---|---|---|---|---|---|---|
| | | QP | PK | AV | QP | PK | AV | QP/PK | AV |
| Hor. + Vert. | 1056 | – | 45.8 | 37.3 | – | 74.0 | 54.0 | 28.2 | 16.7 |
| | 1188 | – | 44.2 | 34.5 | – | 74.0 | 54.0 | 29.9 | 19.5 |
| | 2217 | – | 57.9 | 51.8 | – | 74.0 | 54.0 | 16.1 | 2.2 |
| | 2660 | – | 54.3 | 47.9 | – | 74.0 | 54.0 | 19.7 | 6.1 |
| | 4876 | – | 55.8 | 53.9 | – | 74.0 | 54.0 | 18.2 | 0.1 |
| | 7314 | – | 52.7 | 49.7 | – | 74.0 | 54.0 | 21.3 | 4.4 |
| | 12190 | – | 45.3 | 36.3 | – | 74.0 | 54.0 | 28.7 | 17.7 |
| | 19505 | – | 49.9 | 41.5 | – | 74.0 | 54.0 | 24.1 | 12.5 |

Remark: No (further) spurious emissions in the range 20 dB below the limit found.

| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 3 | Setup_01 | Enclosure, L+R transmitting simultaneously |

| Polari-sation | Frequency MHz | Corrected value dBµV/m | | | Limit dBµV/m | Limit dBµV/m | Limit dBµV/m | Margin to limit dB | Margin to limit dB |
|---|---|---|---|---|---|---|---|---|---|
| | | QP | PK | AV | QP | PK | AV | QP/PK | AV |
| Hor. + Vert. | 1056 | – | 45.2 | 37.4 | – | 74.0 | 54.0 | 28.8 | 16.6 |
| | 1188 | – | 44.6 | 34.6 | – | 74.0 | 54.0 | 29.4 | 19.4 |
| | 2253 | – | 59.3 | 53.9 | – | 74.0 | 54.0 | 14.7 | 0.1 |
| | 2484 | – | 52.1 | 41.7 | – | 74.0 | 54.0 | 21.9 | 12.3 |
| | 2704 | – | 56.0 | 50.5 | – | 74.0 | 54.0 | 18.0 | 3.6 |
| | 4956 | – | 56.6 | 53.9 | – | 74.0 | 54.0 | 17.5 | 0.1 |
| | 7434 | – | 53.2 | 49.5 | – | 74.0 | 54.0 | 20.8 | 4.5 |
| | 12390 | – | 44.8 | 34.8 | – | 74.0 | 54.0 | 29.2 | 19.2 |

Remark: No (further) spurious emissions in the range 20 dB below the limit found.

### 3.4.4 Test result: Spurious radiated emissions

| FCC Part 15, Subpart C | Op. Mode | Result |
|---|---|---|
| | op-mode 1 | passed |
| | op-mode 2 | passed |
| | op-mode 3 | passed |

## 3.5 Band edge compliance

**Standard** FCC Part 15, 10-1-11 Subpart C

**The test was performed according to:** ANSI C63.4–2009, FCC §15.31

### 3.5.1 Test Description

The procedure to show compliance with the band edge requirement is divided into two measurements:
1. Show compliance of the lower and higher band edge by a conducted measurement

For the conducted measurement, the Equipment Under Test (EUT) is placed in a shielded room. The EUT is set to transmit on the lowest channel. The lower band edge is 2400 MHz and the EUT is set to transmit on the highest channel. The higher band edge is 2483.5 MHz.
Analyzer settings for conducted measurement:
- Detector: Peak
- RBW / VBW = 100 / 300 kHz

2. Show compliance of the higher band edge falls in to restricted bands by a radiated measurement.
The radiated emissions measurements are performed in a typical installation configuration inside the fully anechoic chamber using a horn antenna at 1 m distance.
EMI receiver settings for radiated measurement:
- Detector: Peak, Average
- IF Bandwidth = 1 MHz

### 3.5.2 Test Requirements / Limits

FCC Part 15.247 (d)
“In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. ...
If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).”

For the conducted measurement the RF power at the band edge shall be “at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power...”

For the radiated measurement of the higher band edge connected to a restricted band the limit is “specified in Section 15.209(a)”.

### 3.5.3 Test Protocol

#### *3.5.3.1 Lower band edge*

Conducted measurement

Temperature: 22 °C
Air Pressure: 997 hPa
Humidity: 38 %

| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 1 | Setup_02 | Temp.ant.connector, Connector L |

| Frequency MHz | Measured value dBm | Reference value dBm | Limit dBm | Margin to limit dB |
|---|---|---|---|---|
| 2400.00 | –36.4 | –3.1 | –23.1 | 13.3 |

Remark: Please see annex for the measurement plot.

| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 1 | Setup_02 | Temp.ant.connector, Connector R |

| Frequency MHz | Measured value dBm | Reference value dBm | Limit dBm | Margin to limit dB |
|---|---|---|---|---|
| 2400.00 | –34.5 | –1.4 | –21.4 | 13.1 |

Remark: Please see annex for the measurement plot.

#### *3.5.3.2 Higher band edge*

Conducted measurement

Temperature: 22 °C
Air Pressure: 997 hPa
Humidity: 38 %

| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 3 | Setup_02 | Temp.ant.connector, Connector L |

| Frequency MHz | Measured value dBm | Reference value dBm | Limit dBm | Margin to limit dB |
|---|---|---|---|---|
| 2483.50 | –42.8 | –1.9 | –21.9 | 20.9 |

Remark: Please see annex for the measurement plot.

| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 3 | Setup_02 | Temp.ant.connector, Connector R |

| Frequency MHz | Measured value dBm | Reference value dBm | Limit dBm | Margin to limit dB |
|---|---|---|---|---|
| 2483.50 | –41.8 | –1.2 | –21.2 | 20.6 |

Remark: Please see annex for the measurement plot.

Radiated measurement

Temperature: 24 °C
Air Pressure: 1029 hPa
Humidity: 32 %

| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 3 | Setup_01 | Enclosure, L+R transmitting simultaneously |

| Frequency MHz | Polari-sation | Corrected value dBµV/m | | Limit dBµV/m | Limit dBµV/m | Margin to limit dB | Margin to limit dB |
|---|---|---|---|---|---|---|---|
| | | PK | AV | PK | AV | PK | AV |
| 2483.50 | Hor. + Vert. | 52.1 | 41.7 | 74.0 | 54.0 | 21.9 | 12.3 |

Remark: Please see annex for the measurement plot.

### 3.5.4 Test result: Band edge compliance

| FCC Part 15, Subpart C | Op. Mode | Result |
|---|---|---|
| | op-mode 1 | passed |
| | op-mode 3 | passed |

## 3.6 Power density

**Standard** FCC Part 15, 10-1-11 Subpart C

**The test was performed according to:** FCC §15.31

### 3.6.1 Test Description

The EUT was connected to spectrum analyzer via a short coax cable with a known loss.
Analyzer settings:
- Detector: Peak-Maxhold
- Resolution Bandwidth (RBW): 3 kHz
- Video Bandwidth (VBW): 30 kHz
- Sweep Time: Coupled

### 3.6.2 Test Requirements / Limits

FCC Part 15, Subpart C, §15.247 (e)

For digitally modulated systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.
...
The same method of determining the conducted output power shall be used to determine the power spectral density.

### 3.6.3 Test Protocol

Temperature: 22 °C
Air Pressure: 997 hPa
Humidity: 38 %

| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 1 | Setup_02 | Temp.ant.connector |

| Power density dBm / 3 kHz | Remarks |
|---|---|
| –16.2 | Connector L |
| –14.5 | Connector R |

Remark: Please see annex for the measurement plot.

| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 2 | Setup_02 | Temp.ant.connector |

| Power density dBm / 3 kHz | Remarks |
|---|---|
| –15.7 | Connector L |
| –14.3 | Connector R |

Remark: Please see annex for the measurement plot.

| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 3 | Setup_02 | Temp.ant.connector |

| Power density dBm / 3 kHz | Remarks |
|---|---|
| –14.3 | Connector L |
| –14.6 | Connector R |

Remark: Please see annex for the measurement plot.

### 3.6.4 Test result: Power density

| FCC Part 15, Subpart C | Op. Mode | Result |
|---|---|---|
| | op-mode 1 | passed |
| | op-mode 2 | passed |
| | op-mode 3 | passed |

# 4 Test Equipment

The calibration, hardware and software states are shown for the testing period.

### Test Equipment Anechoic Chamber

| | |
|---|---|
| ***Lab ID:*** | **Lab 1** |
| *Manufacturer:* | Frankonia |
| *Description:* | Anechoic Chamber for radiated testing |
| *Type:* | 10.58x6.38x6.00 m³ |

### Single Devices for Anechoic Chamber

| *Single Device Name* | *Type* | *Serial Number* | *Manufacturer* | |
|---|---|---|---|---|
| Air compressor | none | - | Atlas Copco | |
| Anechoic Chamber | 10.58 x 6.38 x 6.00 m³ | none | Frankonia | |
| | *Calibration Details* | | *Last Execution* | *Next Exec.* |
| | FCC listing 96716 3m Part15/18 | | 2011/01/11 | 2014/01/10 |
| | IC listing 3699A-1 3m | | 2011/02/07 | 2014/02/06 |
| Controller Maturo | MCU | 961208 | Maturo GmbH | |
| EMC camera | CE-CAM/1 | - | CE-SYS | |
| EMC camera Nr.2 | CCD-400E | 0005033 | Mitsubishi | |
| Filter ISDN | B84312-C110-E1 | | Siemens&Matsushita | |
| Filter Universal 1A | BB4312-C30-H3 | - | Siemens&Matsushita | |

### Test Equipment Auxiliary Equipment for Radiated emissions

| | |
|---|---|
| ***Lab ID:*** | **Lab 1** |
| *Description:* | Equipment for emission measurements |
| *Serial Number:* | see single devices |

### Single Devices for Auxiliary Equipment for Radiated emissions

| *Single Device Name* | *Type* | *Serial Number* | *Manufacturer* | |
|---|---|---|---|---|
| Antenna mast | AS 620 P | 620/37 | HD GmbH | |
| Biconical dipole | VUBA 9117 | 9117-108 | Schwarzbeck | |
| | *Calibration Details* | | *Last Execution* | *Next Exec.* |
| | Standard Calibration | | 2008/10/27 | 2013/10/26 |
| | Standard Calibration | | 2012/01/18 | 2015/01/17 |
| Broadband Amplifier 18MHz-26GHz | JS4-18002600-32-5P | 849785 | Miteq | |
| | *Calibration Details* | | *Last Execution* | *Next Exec.* |
| | Path Calibration | | 2011/11/15 | 2012/05/14 |
| Broadband Amplifier 1GHz-4GHz | AFS4-01000400-1Q-10P-4 | - | Miteq | |
| | *Calibration Details* | | *Last Execution* | *Next Exec.* |
| | Path Calibration | | 2011/11/15 | 2012/05/14 |
| Broadband Amplifier 30MHz-18GHz | JS4-00101800-35-5P | 896037 | Miteq | |
| | *Calibration Details* | | *Last Execution* | *Next Exec.* |
| | Path Calibration | | 2011/11/15 | 2012/05/14 |
| Cable "ESI to EMI Antenna" | EcoFlex10 | W18.01-2+W38.01-2 | Kabel Kusch | |
| | *Calibration Details* | | *Last Execution* | *Next Exec.* |

**Single Devices for Auxiliary Equipment for Radiated emissions (continued)**

| *Single Device Name* | *Type* | *Serial Number* | *Manufacturer* | |
|---|---|---|---|---|
| | Path Calibration | | 2011/11/15 | 2012/05/14 |
| Cable "ESI to Horn Antenna" | UFB311A+UFB293C | W18.02-2+W38.02-2 | Rosenberger Micro-Coax | |
| | *Calibration Details* | | *Last Execution* | *Next Exec.* |
| | Path Calibration | | 2011/11/15 | 2012/05/14 |
| Double-ridged horn | HF 906 | 357357/001 | Rohde & Schwarz GmbH & Co. KG | |
| | *Calibration Details* | | *Last Execution* | *Next Exec.* |
| | Standard Calibration | | 2009/04/16 | 2012/04/15 |
| Double-ridged horn | HF 906 | 357357/002 | Rohde & Schwarz GmbH & Co. KG | |
| | *Calibration Details* | | *Last Execution* | *Next Exec.* |
| | Standard Calibration | | 2009/04/28 | 2012/04/27 |
| High Pass Filter | 4HC1600/12750-1.5-KK | 9942011 | Trilithic | |
| | *Calibration Details* | | *Last Execution* | *Next Exec.* |
| | Path Calibration | | 2011/11/15 | 2012/05/14 |
| High Pass Filter | 5HC2700/12750-1.5-KK | 9942012 | Trilithic | |
| | *Calibration Details* | | *Last Execution* | *Next Exec.* |
| | Path Calibration | | 2011/11/15 | 2012/05/14 |
| High Pass Filter | 5HC3500/12750-1.2-KK | 200035008 | Trilithic | |
| | *Calibration Details* | | *Last Execution* | *Next Exec.* |
| | Path Calibration | | 2011/11/15 | 2012/05/14 |
| High Pass Filter | WHKX 7.0/18G-8SS | 09 | Wainwright | |
| | *Calibration Details* | | *Last Execution* | *Next Exec.* |
| | Path Calibration | | 2011/11/15 | 2012/05/14 |
| Log.-per. Antenna | HL 562 Ultralog | 830547/003 | Rohde & Schwarz GmbH & Co. KG | |
| | *Calibration Details* | | *Last Execution* | *Next Exec.* |
| | Standard Calibration | | 2009/05/27 | 2012/05/26 |
| Loop Antenna | HFH2-Z2 | 829324/006 | Rohde & Schwarz GmbH & Co. KG | |
| | *Calibration Details* | | *Last Execution* | *Next Exec.* |
| | Standard calibration | | 2011/10/27 | 2014/10/26 |
| Pyramidal Horn Antenna 26,5 GHz | 3160-09 | 00083069 | EMCO Elektronik GmbH | |
| Pyramidal Horn Antenna 40 GHz | 3160-10 | 00086675 | EMCO Elektronik GmbH | |
| Tilt device Maturo (Rohacell) | Antrieb TD1.5-10kg | TD1.5-10kg/024/3790709 | Maturo GmbH | |

## Test Equipment Auxiliary Test Equipment

| | |
|---|---|
| ***Lab ID:*** | **Lab 1** |
| *Manufacturer:* | see single devices |
| *Description:* | Single Devices for various Test Equipment |
| *Type:* | various |
| *Serial Number:* | none |

### Single Devices for Auxiliary Test Equipment

| *Single Device Name* | *Type* | *Serial Number* | *Manufacturer* |
|---|---|---|---|
| Broadband Power Divider N (Aux) | 1506A / 93459 | LM390 | Weinschel Associates |
| Broadband Power Divider SMA | WA1515 | A855 | Weinschel Associates |
| Digital Multimeter 03 (Multimeter) | Fluke 177 | 86670383 | Fluke Europe B.V. |
| | *Calibration Details* | | *Last Execution* *Next Exec.* |
| | Customized calibration | | 2011/10/19 2013/10/18 |
| Fibre optic link Satellite (Aux) | FO RS232 Link | 181-018 | Pontis |
| Fibre optic link Transceiver (Aux) | FO RS232 Link | 182-018 | Pontis |
| Isolating Transformer | LTS 604 | 1888 | Thalheimer Transformatorenwerke GmbH |
| Notch Filter Ultra Stable (Aux) | WRCA800/960-6EEK | 24 | Wainwright |
| Vector Signal Generator | SMIQ 03B | 832492/061 | Rohde & Schwarz GmbH & Co.KG |

## Test Equipment Digital Signalling Devices

| | |
|---|---|
| ***Lab ID:*** | **Lab 1** |
| *Description:* | Signalling equipment for various wireless technologies. |

### Single Devices for Digital Signalling Devices

| *Single Device Name* | *Type* | *Serial Number* | *Manufacturer* | |
|---|---|---|---|---|
| Bluetooth Signalling Unit CBT | CBT | 100589 | Rohde & Schwarz GmbH & Co. KG | |
| | *Calibration Details* | | *Last Execution* | *Next Exec.* |
| | Standard calibration | | 2011/11/24 | 2014/11/23 |
| Universal Radio Communication Tester | CMU 200 | 102366 | Rohde & Schwarz GmbH & Co. KG | |
| | *Calibration Details* | | *Last Execution* | *Next Exec.* |
| | Standard calibration | | 2011/05/26 | 2013/05/25 |
| | *HW/SW Status* | | *Date of Start* | *Date of End* |
| | Hardware:<br>B11, B21V14, B21-2, B41, B52V14, B52-2,<br>B53-2, B56V14, B68 3v04, PCMCIA, U65V04<br>Software:<br>K21 4v21, K22 4v21, K23 4v21, K24 4v21, K42 4v21,<br>K43 4v21, K53 4v21, K56 4v22, K57 4v22, K58 4v22,<br>K59 4v22, K61 4v22, K62 4v22, K63 4v22, K64 4v22,<br>K65 4v22, K66 4v22, K67 4v22, K68 4v22, K69 4v22<br>Firmware:<br>µP1 8v50 02.05.06<br>--- | | 2007/07/16 | |
| Universal Radio Communication Tester | CMU 200 | 837983/052 | Rohde & Schwarz GmbH & Co. KG | |
| | *Calibration Details* | | *Last Execution* | *Next Exec.* |
| | Standard calibration | | 2011/12/07 | 2014/12/06 |
| | *HW/SW Status* | | *Date of Start* | *Date of End* |
| | HW options:<br>B11, B21V14, B21-2, B41, B52V14, B52-2, B53-2,<br>B54V14, B56V14, B68 3v04, B95, PCMCIA, U65V02<br>SW options:<br>K21 4v11, K22 4v11, K23 4v11, K24 4v11, K27 4v10,<br>K28 4v10, K42 4v11, K43 4v11, K53 4v10, K65 4v10,<br>K66 4v10, K68 4v10,<br>Firmware:<br>µP1 8v40 01.12.05<br>--- | | 2007/01/02 | |
| | SW:<br>K62, K69 | | 2008/11/03 | |

### Test Equipment Emission measurement devices

| | |
|---|---|
| ***Lab ID:*** | **Lab 1** |
| *Description:* | Equipment for emission measurements |
| *Serial Number:* | see single devices |

### Single Devices for Emission measurement devices

| *Single Device Name* | *Type* | *Serial Number* | *Manufacturer* | |
|---|---|---|---|---|
| Personal Computer | Dell | 30304832059 | Dell | |
| Power Meter | NRVD | 828110/016 | Rohde & Schwarz GmbH & Co.KG | |
| | *Calibration Details* | | *Last Execution* | *Next Exec.* |
| | Standard calibration | | 2011/05/03 | 2012/05/02 |
| Sensor Head A | NRV-Z1 | 827753/005 | Rohde & Schwarz GmbH & Co.KG | |
| | *Calibration Details* | | *Last Execution* | *Next Exec.* |
| | Standard calibration | | 2011/05/02 | 2012/05/01 |
| Signal Generator | SMR 20 | 846834/008 | Rohde & Schwarz GmbH & Co. KG | |
| | *Calibration Details* | | *Last Execution* | *Next Exec.* |
| | standard calibration | | 2011/05/12 | 2014/05/11 |
| Spectrum Analyzer | ESIB 26 | 830482/004 | Rohde & Schwarz GmbH & Co. KG | |
| | *Calibration Details* | | *Last Execution* | *Next Exec.* |
| | Standard Calibration | | 2011/12/05 | 2013/12/04 |
| | *HW/SW Status* | | *Date of Start* | *Date of End* |
| | Firmware-Update 4.34.4 from 3.45 during calibration | | 2009/12/03 | |

### Test Equipment Multimeter 12

| | |
|---|---|
| ***Lab ID:*** | **Lab 2** |
| *Description:* | Ex-Tech 520 |
| *Serial Number:* | 05157876 |

### Single Devices for Multimeter 12

| *Single Device Name* | *Type* | *Serial Number* | *Manufacturer* | |
|---|---|---|---|---|
| Digital Multimeter 12 (Multimeter) | EX520 | 05157876 | Extech Instruments Corp. | |
| | *Calibration Details* | | *Last Execution* | *Next Exec.* |
| | Customized calibration | | 2011/10/18 | 2013/10/17 |

### Test Equipment Shielded Room 07

| | |
|---|---|
| ***Lab ID:*** | **Lab 2** |
| *Description:* | Shielded Room 4m x 6m |

### Test Equipment T/H Logger 04

| | |
|---|---|
| ***Lab ID:*** | **Lab 2** |
| *Description:* | Lufft Opus10 |
| *Serial Number:* | 7481 |

### Single Devices for T/H Logger 04

| *Single Device Name* | *Type* | *Serial Number* | *Manufacturer* |
|---|---|---|---|
| ThermoHygro Datalogger 04 (Environ) | Opus10 THI (8152.00) | 7481 | Lufft Mess- und Regeltechnik GmbH |

### Test Equipment Temperature Chamber 01

| | |
|---|---|
| ***Lab ID:*** | **Lab 2** |
| *Manufacturer:* | see single devices |
| *Description:* | Temperature Chamber KWP 120/70 |
| *Type:* | Weiss |
| *Serial Number:* | see single devices |

### Single Devices for Temperature Chamber 01

| *Single Device Name* | *Type* | *Serial Number* | *Manufacturer* | |
|---|---|---|---|---|
| Temperature Chamber Weiss 01 | KWP 120/70 | 59226012190010 | Weiss Umwelttechnik GmbH | |
| | *Calibration Details* | | *Last Execution* | *Next Exec.* |
| | Customized calibration | | 2012/03/12 | 2014/03/11 |

## Test Equipment WLAN RF Test Solution

| | |
|---|---|
| ***Lab ID:*** | **Lab 2** |
| *Manufacturer:* | 7 layers AG |
| *Description:* | Regulatory WLAN RF Tests |
| *Type:* | WLAN RF |
| *Serial Number:* | 001 |

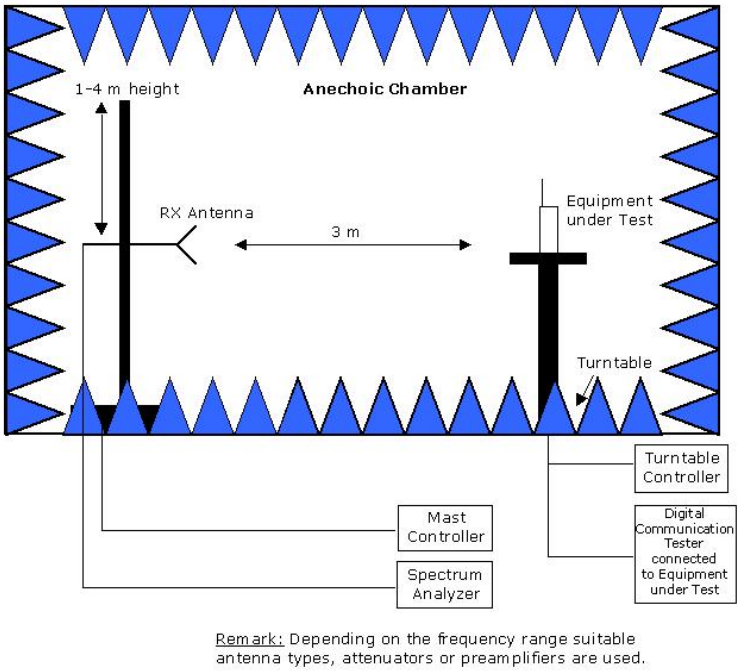
### Single Devices for WLAN RF Test Solution

| *Single Device Name* | *Type* | *Serial Number* | *Manufacturer* | |
|---|---|---|---|---|
| Arbitrary Waveform Generator | TGA12101 | 284482 | | |
| Power Meter NRVD | NRVD | 832025/059 | | |
| | *Calibration Details* | | *Last Execution* | *Next Exec.* |
| | Standard Calibration | | 2011/06/14 | 2012/06/13 |
| Power Sensor NRV Z1 A | PROBE | 832279/013 | | |
| | *Calibration Details* | | *Last Execution* | *Next Exec.* |
| | Standard Calibration | | 2011/06/14 | 2012/06/13 |
| Power Supply | NGSM 32/10 | 2725 | | |
| | *Calibration Details* | | *Last Execution* | *Next Exec.* |
| | Standard Calibration | | 2011/06/15 | 2013/06/14 |
| Rubidium Frequency Normal MFS | Datum MFS | 002 | Datum GmbH | |
| | *Calibration Details* | | *Last Execution* | *Next Exec.* |
| | Standard Calibration | | 2011/08/17 | 2012/08/16 |
| Signal Analyser FSIQ26 | 1119.6001.26 | 832695/007 | Rohde & Schwarz GmbH & Co.KG | |
| Spectrum Analyser | FSU26 | 100136 | Rohde & Schwarz GmbH & Co.KG | |
| | *Calibration Details* | | *Last Execution* | *Next Exec.* |
| | Standard calibration | | 2011/05/11 | 2012/05/10 |
| | *HW/SW Status* | | *Date of Start* | *Date of End* |
| | FSU FW Update to v4.61 SP3, K5 v4.60 and K73 v4.61 | | 2011/12/05 | |
| Spectrum Analyser | FSU3 | 200046 | Rohde & Schwarz GmbH & Co.KG | |
| | *Calibration Details* | | *Last Execution* | *Next Exec.* |
| | Standard calibration | | 2011/02/10 | 2013/02/09 |
| | *HW/SW Status* | | *Date of Start* | *Date of End* |
| | Firmware Version 4.51 SP1<br>Option FS-K72 4.50 SP1<br>Option FS-K73 4.50 SP1 | | 2011/12/07 | |
| TOCT Switching Unit | Switching Unit | 030106 | 7 layers, Inc. | |
| Vector Signal Generator SMIQ03B | SMIQ03B | 832870/017 | | |
| | *Calibration Details* | | *Last Execution* | *Next Exec.* |
| | Standard Calibration | | 2010/06/23 | 2013/06/20 |

# 5 Photo Report

Photos are included in an external report.

# 6 Setup Drawings




Remark: Depending on the frequency range suitable antenna types, attenuators or preamplifiers are used.

**Drawing 1:** Setup in the Anechoic chamber:
Measurements below 1 GHz: Semi-anechoic, conducting ground plane.
Measurements above 1 GHz: Fully-anechoic, absorbers on all surfaces.

# 7 FCC and IC Correlation of measurement requirements

The following tables show the correlation of measurement requirements for WLAN equipment and Digital Apparatus from FCC and IC standards.

**WLAN equipment**

| Measurement | FCC reference | IC reference |
|---|---|---|
| Conducted emissions on AC mains | § 15.207 | RSS-Gen: 7.2.4 |
| Occupied bandwidth | § 15.247 (a) (1) | RSS-210: A8.1 |
| Peak power output | § 15.247 (b) (1) | RSS-210: A8.4 |
| Spurious RF conducted emissions | § 15.247 (d) | RSS-Gen: 6;<br>RSS-210: A8.5 |
| Spurious radiated emissions | § 15.247 (d) | RSS-Gen: 6;<br>RSS-210: A8.5 |
| Band edge compliance | § 15.247 (d) | RSS-210: A8.5 |
| Power density | § 15.247 (e) | RSS-210: A8.2 (b) |
| Antenna requirement | § 15.203 / 15.204 | RSS-Gen: 7.1.2 |

**Digital Apparatus**

| Measurement | FCC reference | IC reference |
|---|---|---|
| Conducted Emissions (AC Power Line) | § 15.107 | ICES-003 |
| Spurious Radiated Emissions | § 15.109 | ICES-003 |

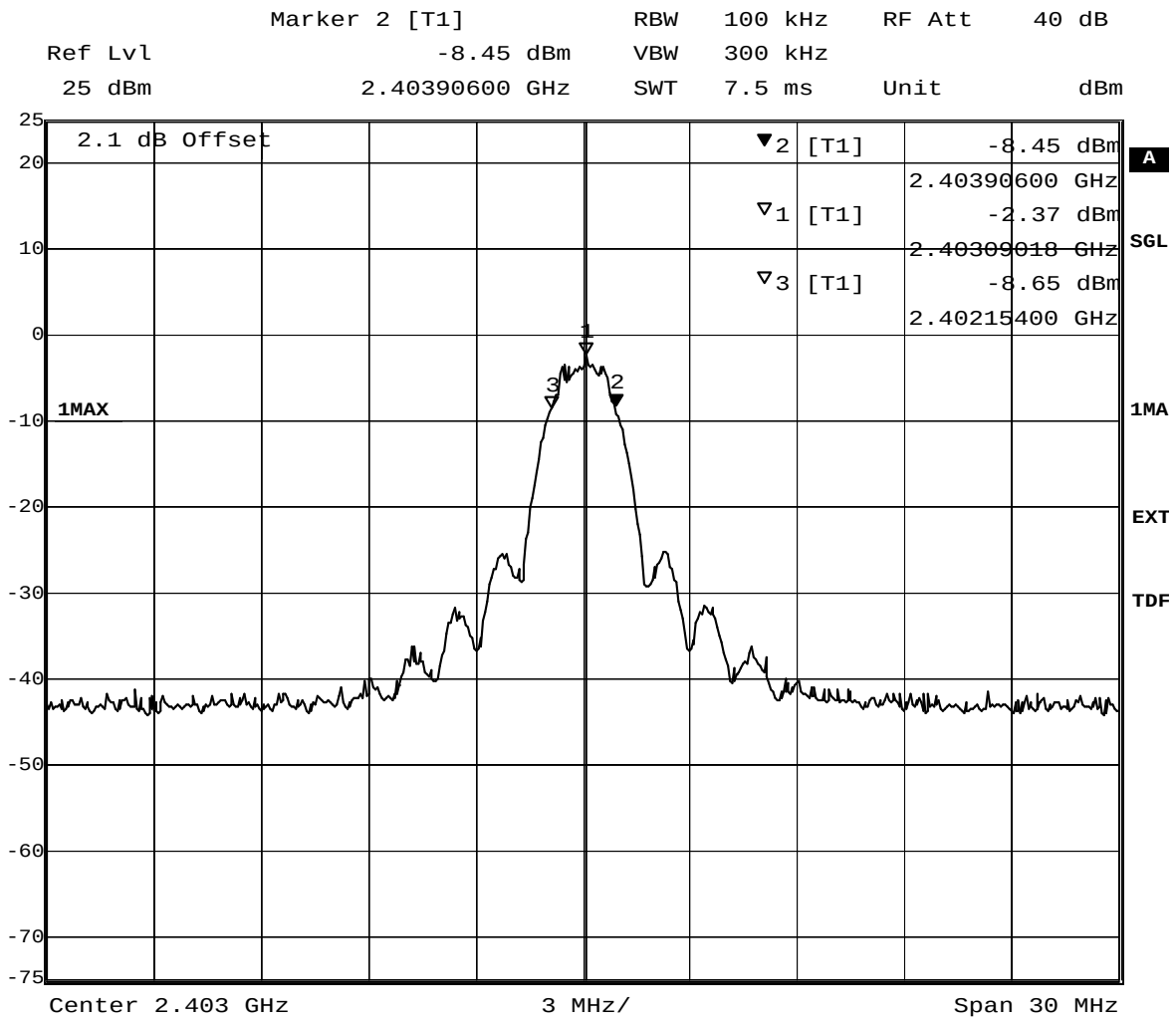
# 8 Annex measurement plots

## 8.1 Occupied bandwidth

### 8.1.1 Occupied bandwidth operating mode 1

**Op. Mode**

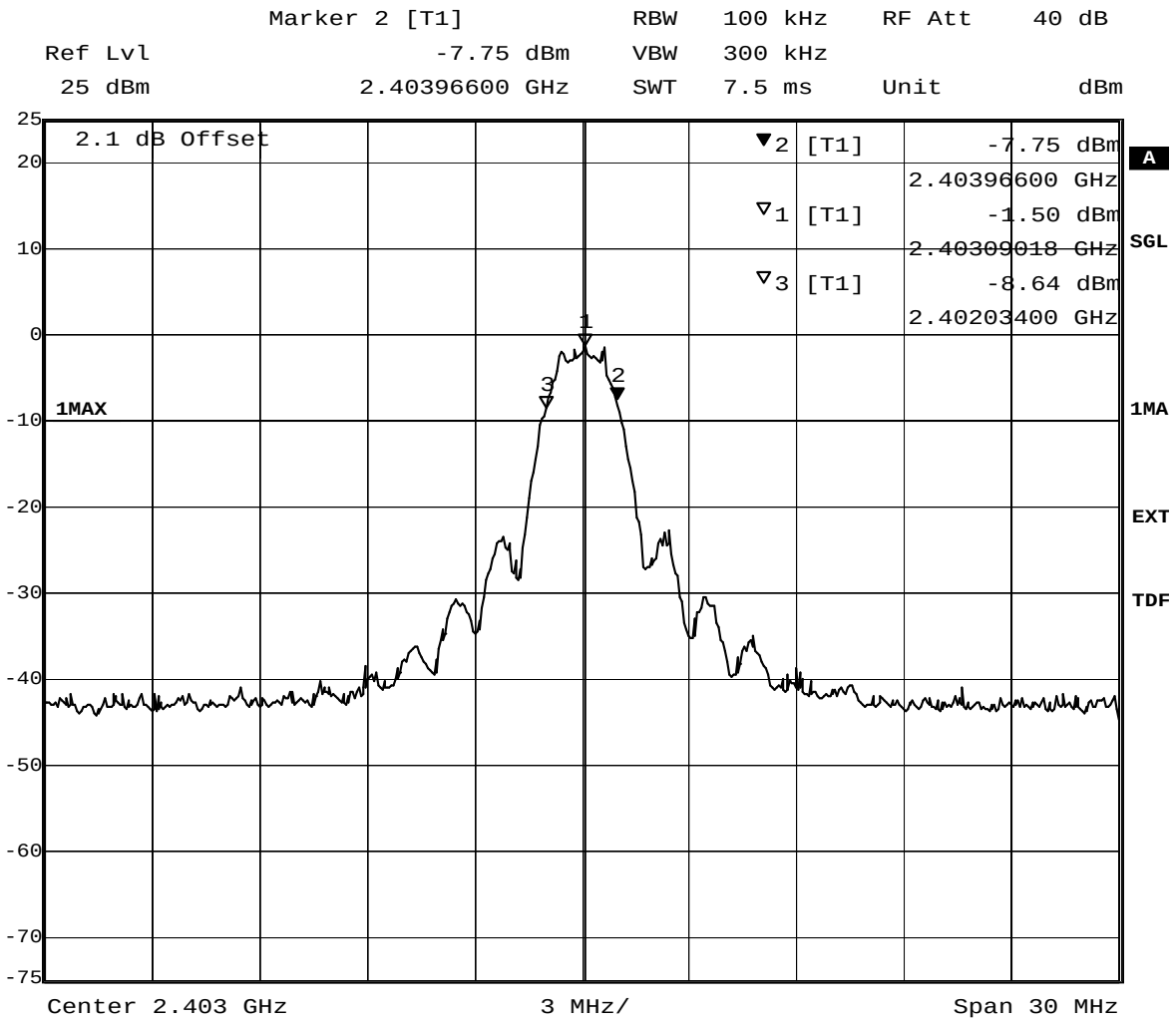
op-mode 1 Connector L




Title: 6dB Bandwidth
Comment A: CH B: 2403 MHz; 6dB bandwidth (kHz):1752
Date: 20.APR.2012 19:19:48

## Op. Mode

op-mode 1 Connector R

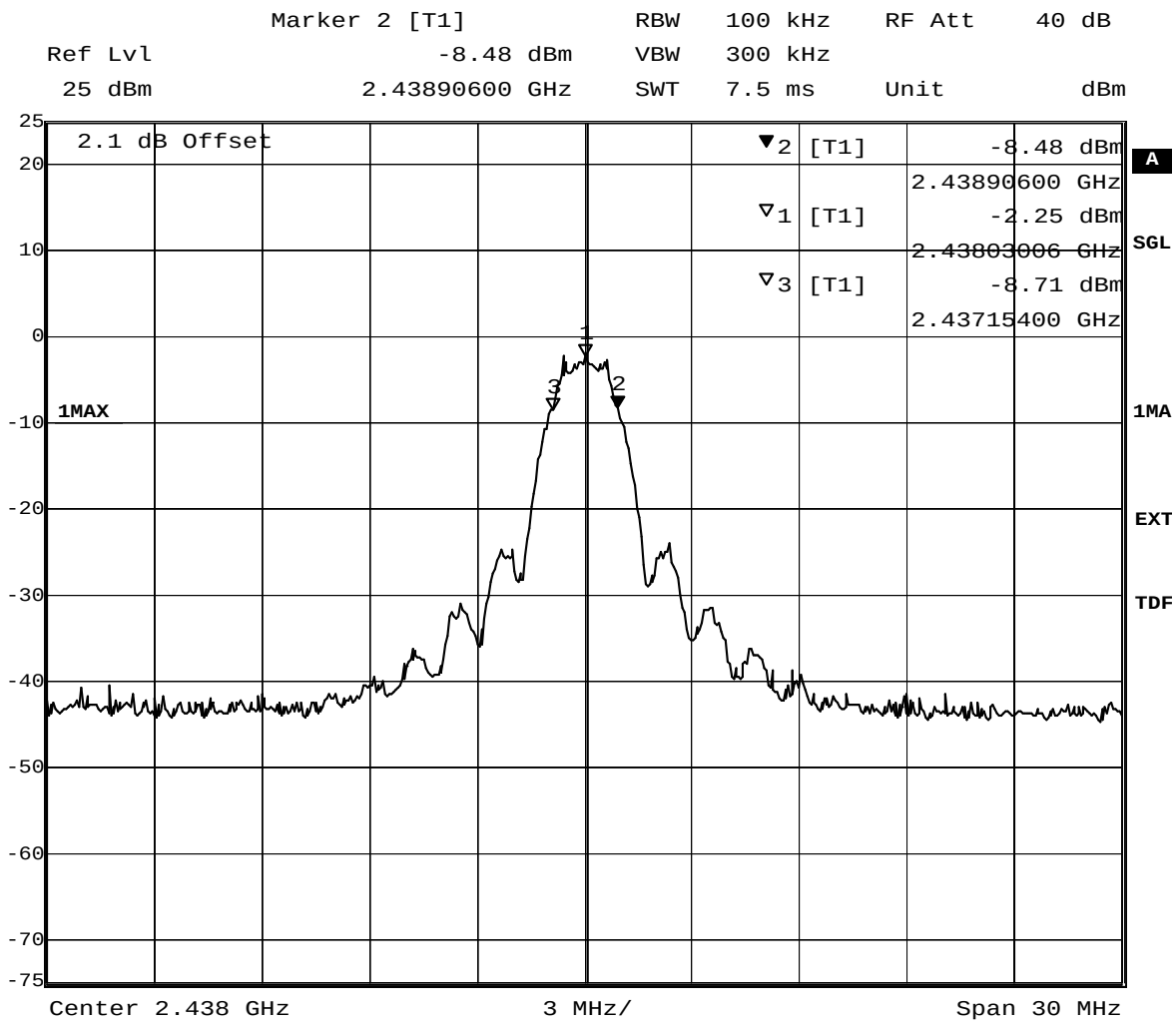



Title: 6dB Bandwidth
Comment A: CH B: 2403 MHz; 6dB bandwidth (kHz):1932
Date: 20.APR.2012 16:19:44

### 8.1.2 Occupied bandwidth operating mode 2

**Op. Mode**

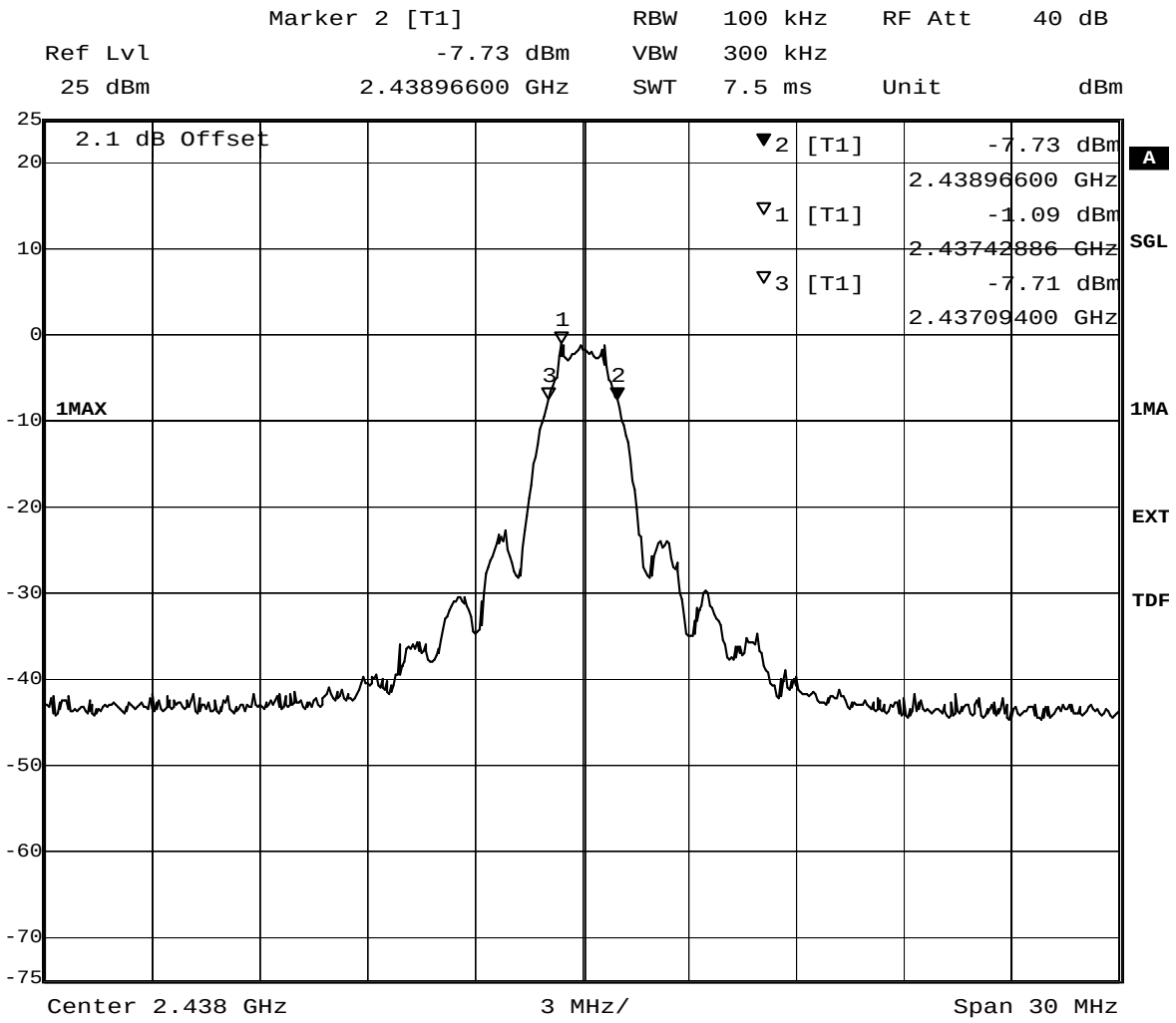
op-mode 2 Connector L




Title: 6dB Bandwidth
Comment A: CH M: 2438 MHz; 6dB bandwidth (kHz):1752
Date: 20.APR.2012 19:52:23

## Op. Mode

op-mode 2 Connector R

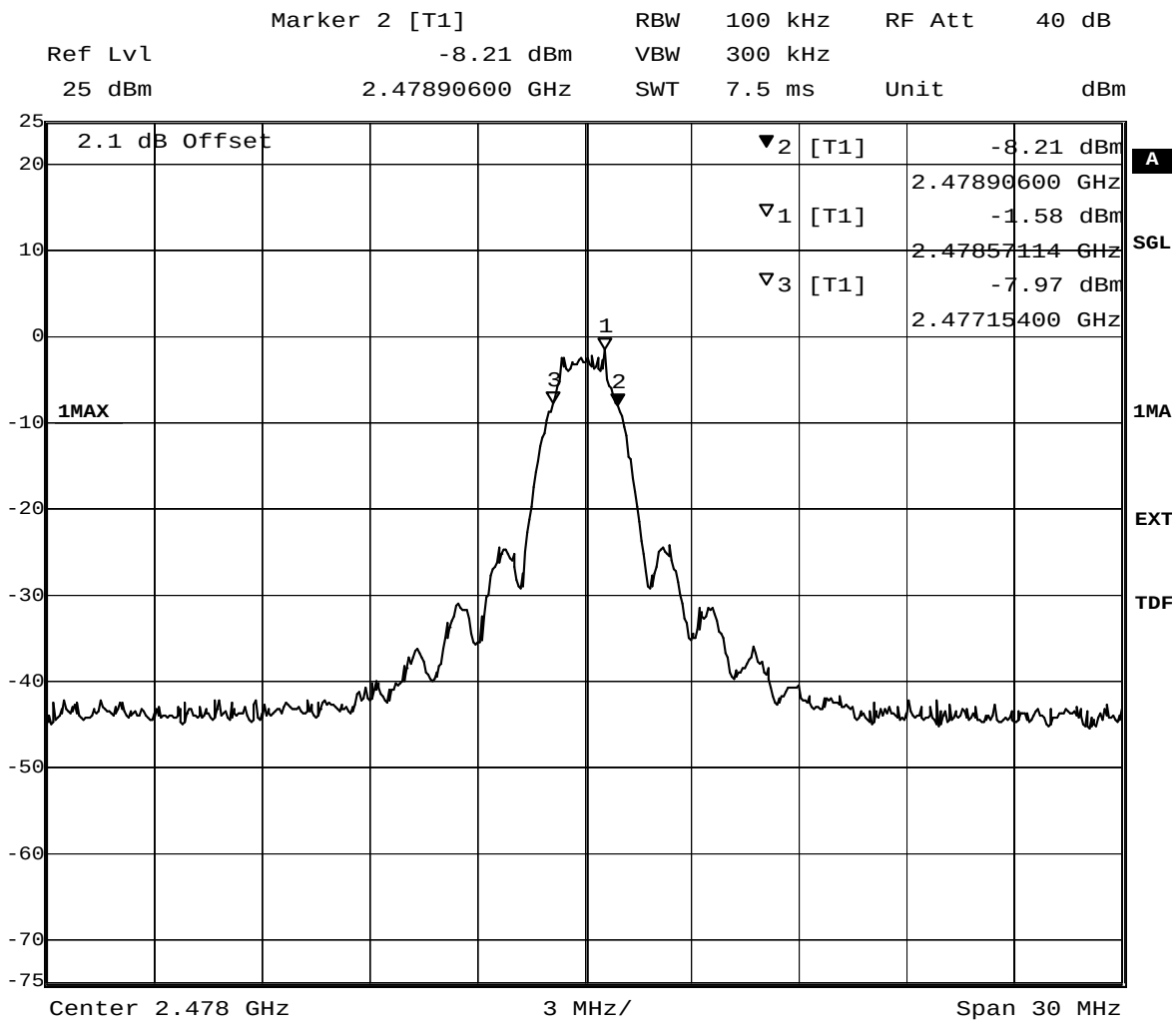



Title: 6dB Bandwidth
Comment A: CH M: 2438 MHz; 6dB bandwidth (kHz):1872
Date: 20.APR.2012 17:03:56

### 8.1.3 Occupied bandwidth operating mode 3

**Op. Mode**

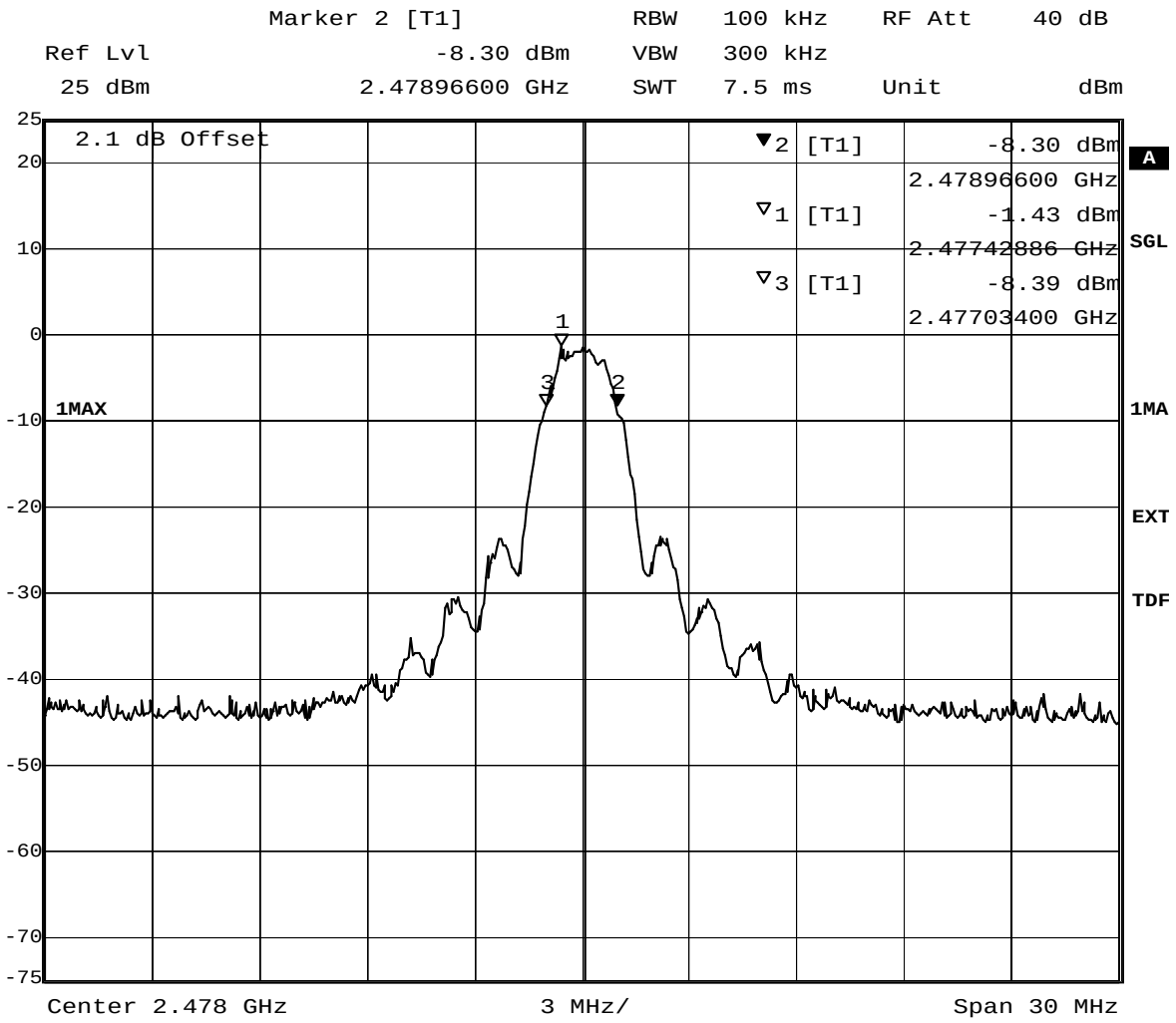
op-mode 3 Connector L




Title: 6dB Bandwidth
Comment A: CH T: 2478 MHz; 6dB bandwidth (kHz):1752
Date: 20.APR.2012 20:27:01

## Op. Mode

op-mode 3 Connector R



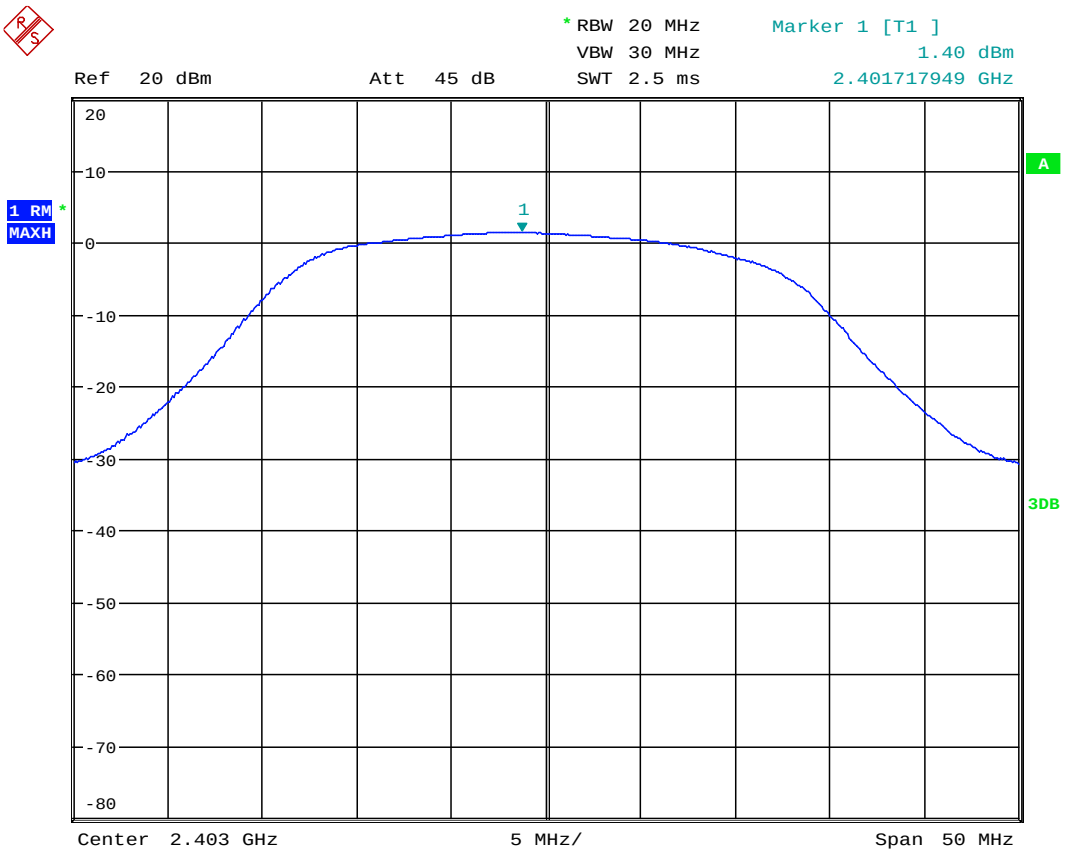

Title: 6dB Bandwidth
Comment A: CH T: 2478 MHz; 6dB bandwidth (kHz):1932
Date: 20.APR.2012 21:07:59

## 8.2 Peak power output

### 8.2.1 Peak power output operating mode 1

**Op. Mode**

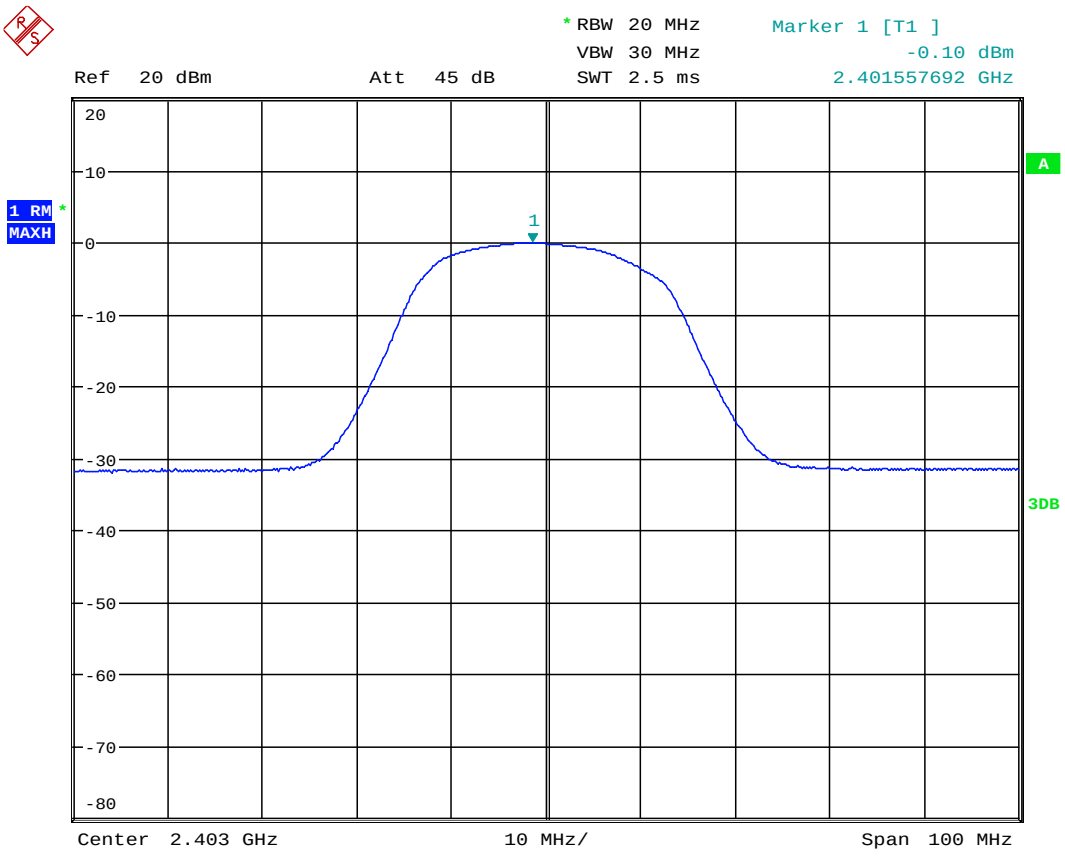
op-mode 1 Connector L




Date: 3.APR.2012 15:29:30

## Op. Mode

op-mode 1 Connector R

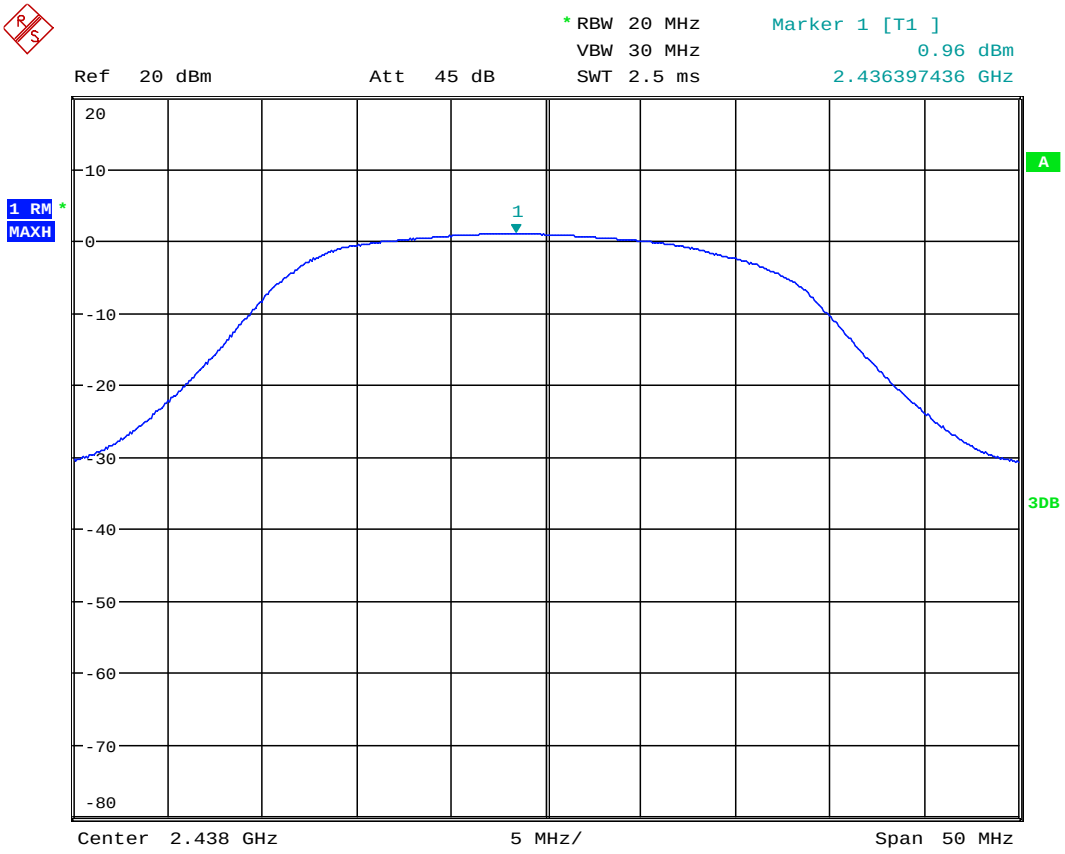



Date: 4.APR.2012 11:35:13

### 8.2.2 Peak power output operating mode 2

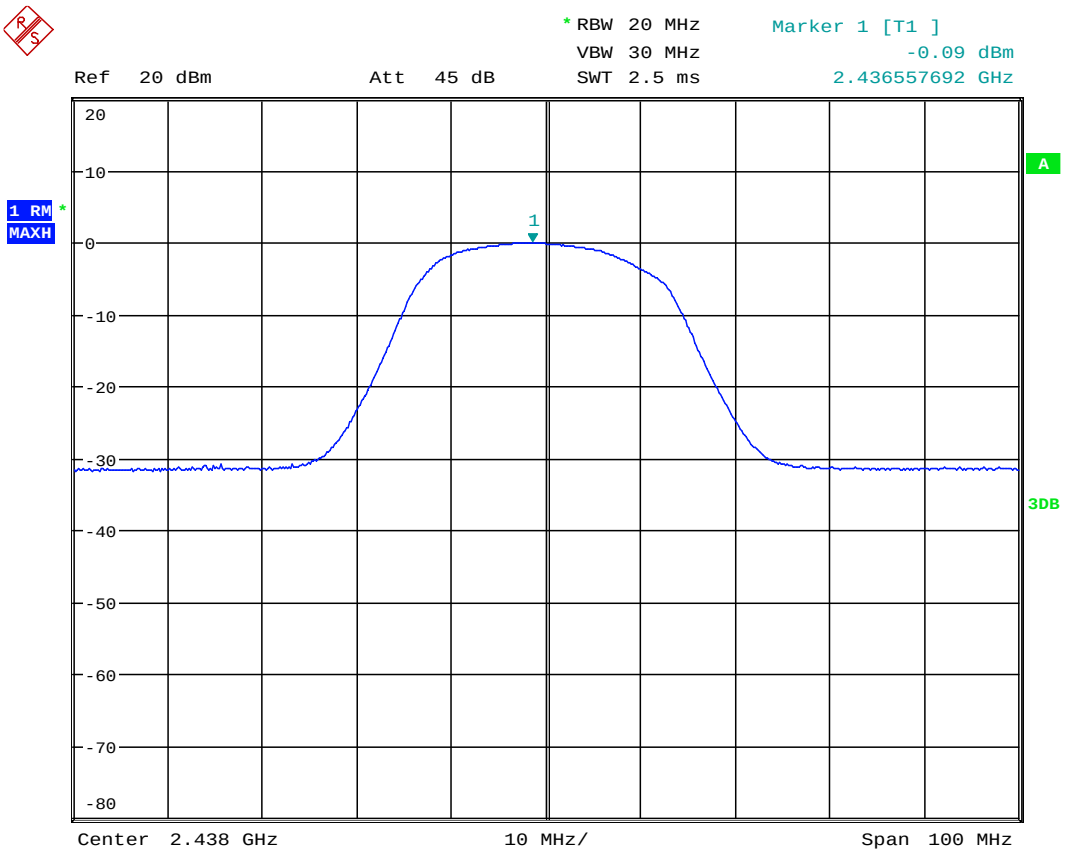
**Op. Mode**

op-mode 2 Connector L



## Op. Mode

op-mode 2 Connector R

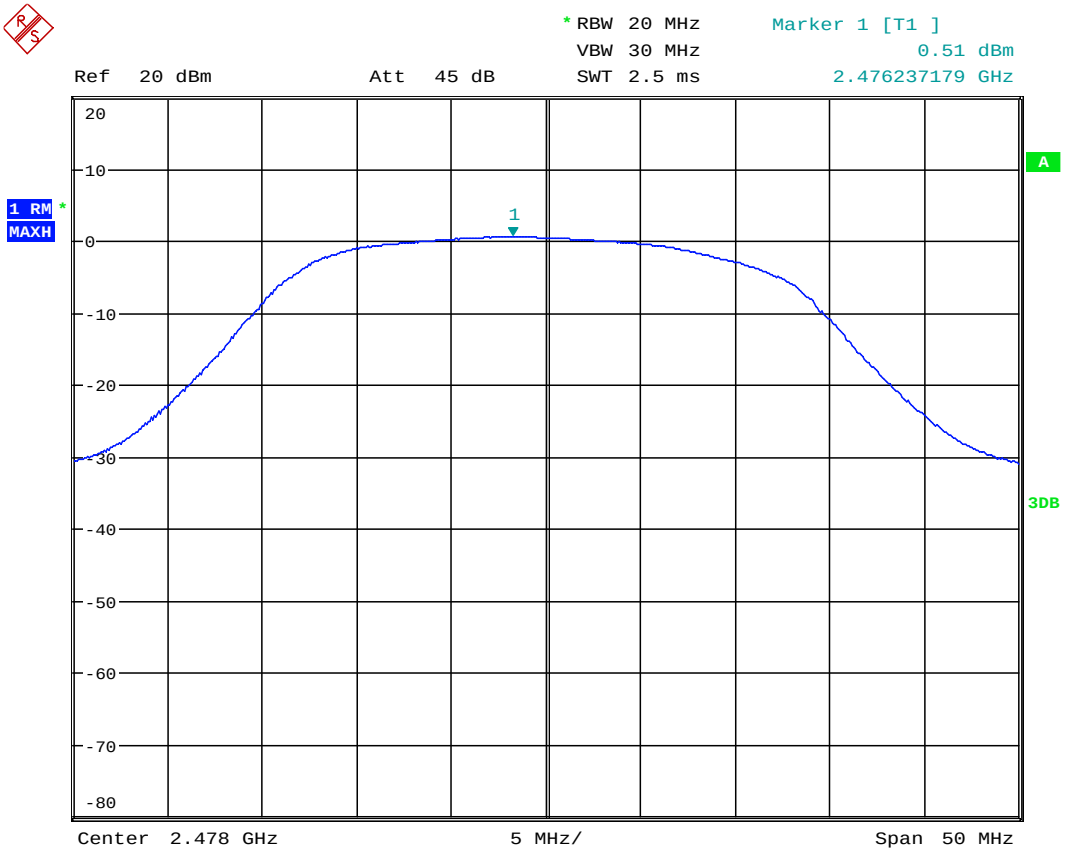



Date: 4.APR.2012 11:37:19

### 8.2.3 Peak power output operating mode 3

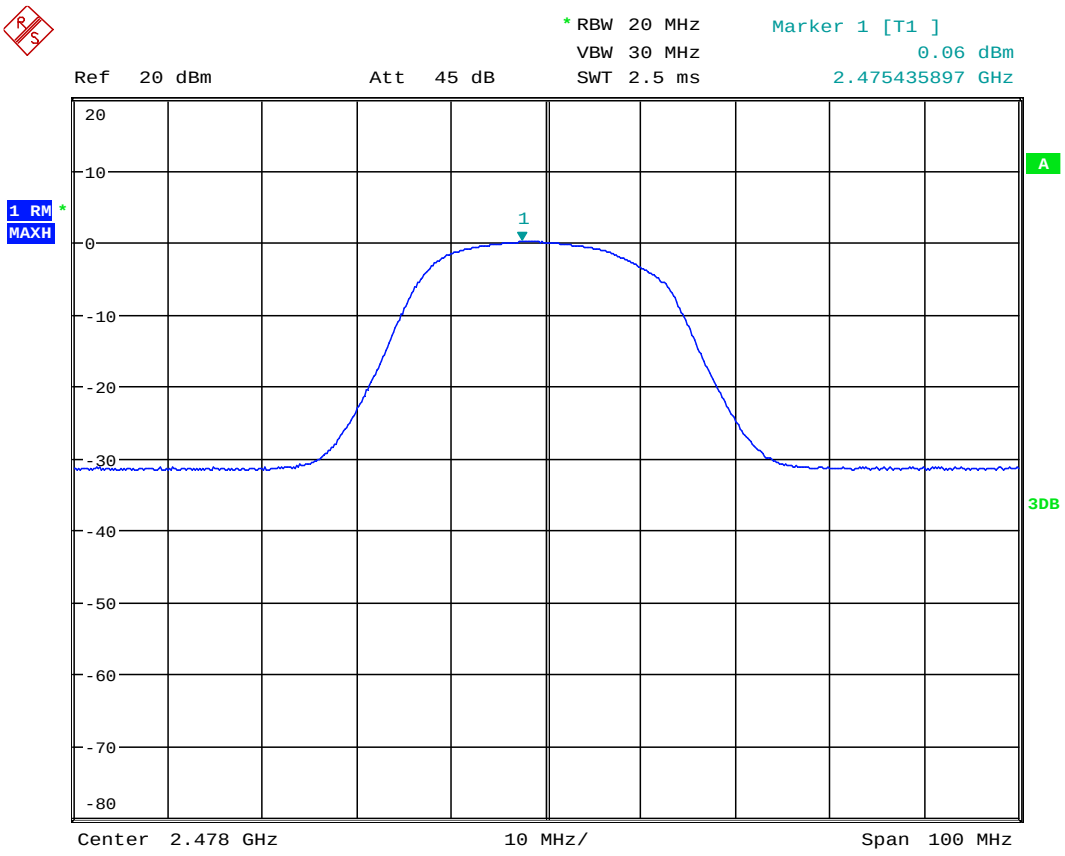
**Op. Mode**

op-mode 3 Connector L



## Op. Mode

op-mode 3 Connector R



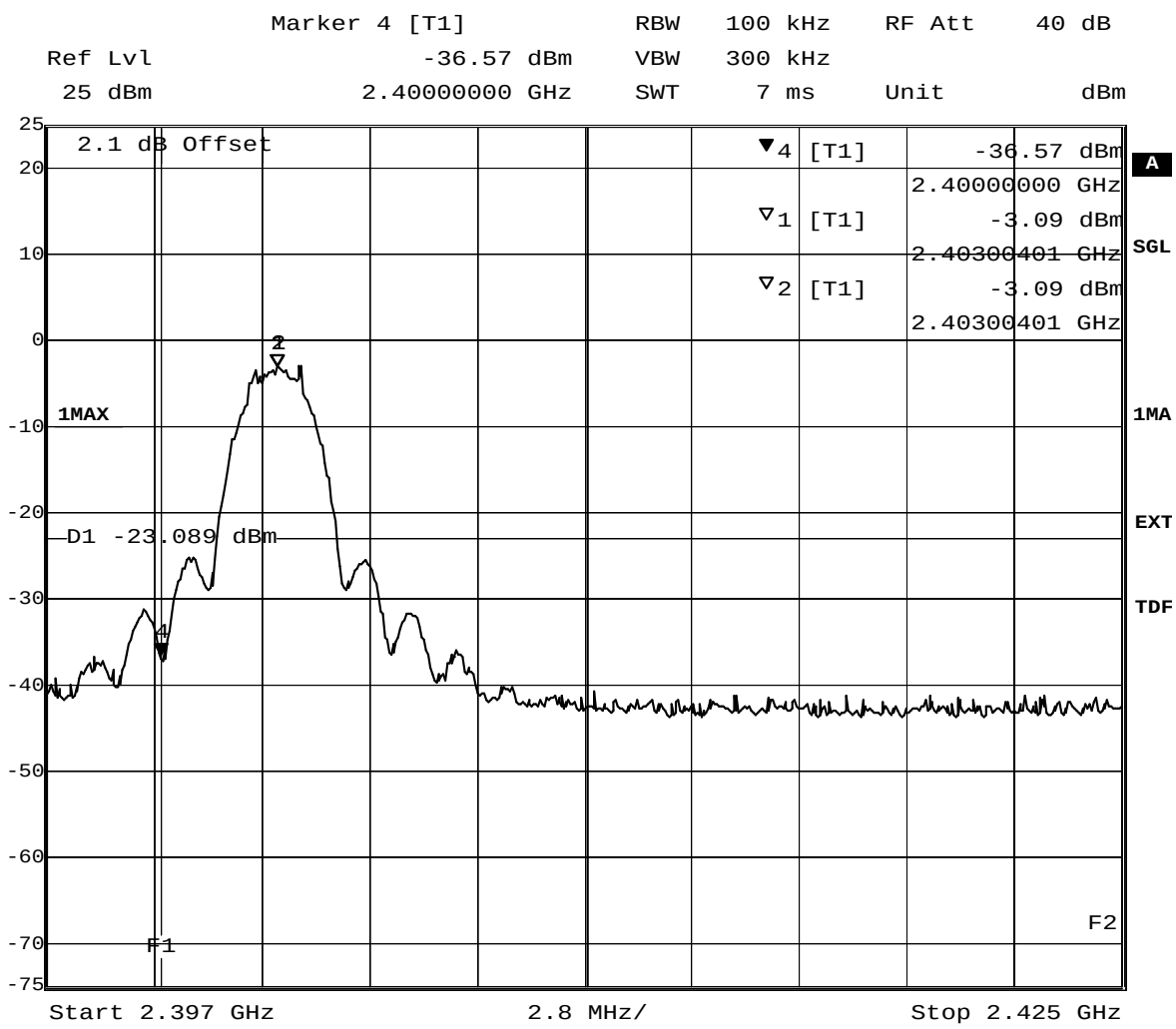

Date: 4.APR.2012 11:38:49

## 8.3 Band edge compliance conducted and Spurious RF conducted emissions

### 8.3.1 Band edge compliance and spurious RF conducted emissions operating mode 1

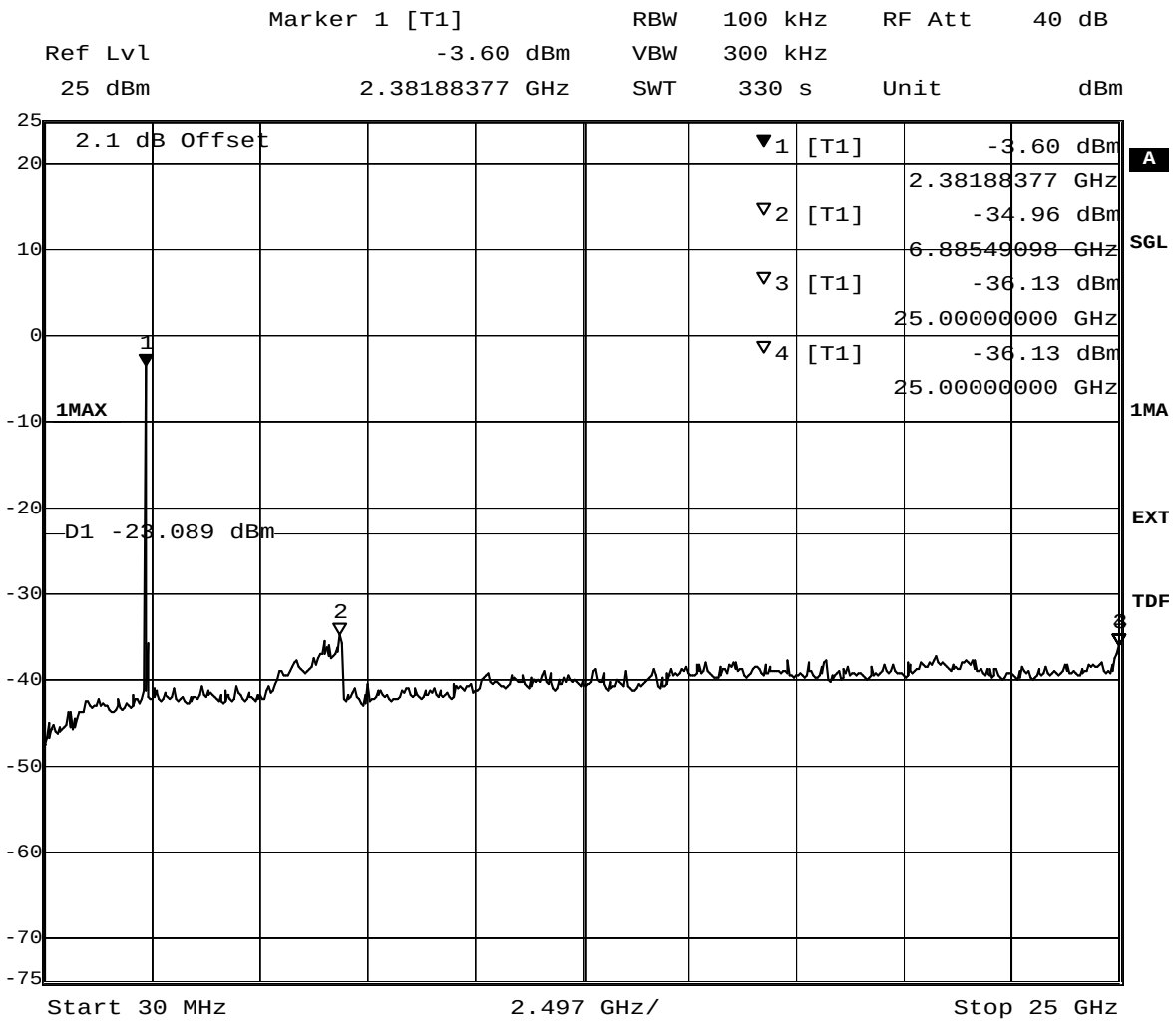
**Op. Mode**

op-mode 1 Connector L




Title: Band Edge Compliance
Comment A: CH B: 2403 MHz
Date: 20.APR.2012 19:04:54

(band edge compliance, conducted measurement, lower band edge)

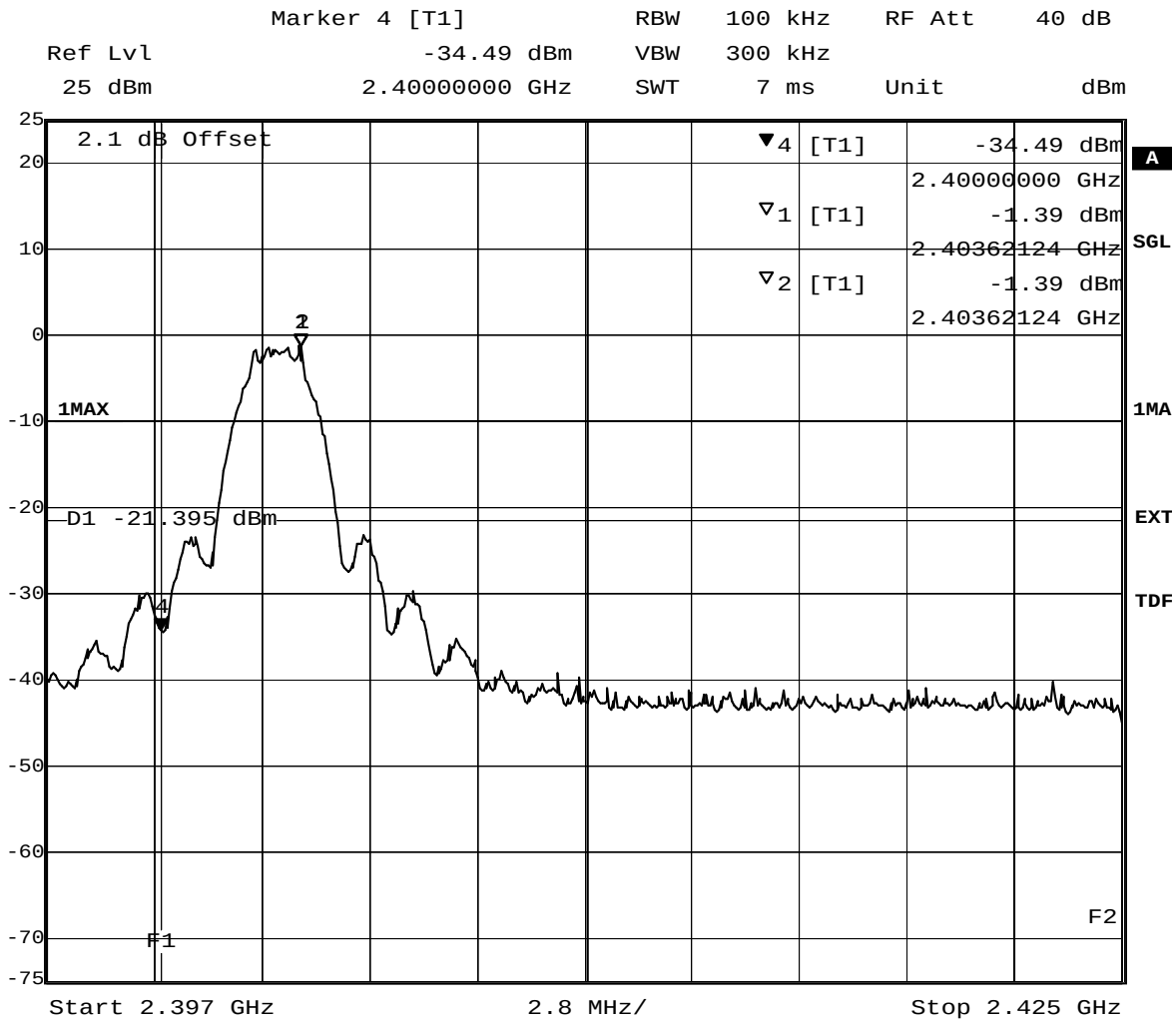



Title: spurious emissions
Comment A: CH B: 2403 MHz
Date: 20.APR.2012 19:16:33

(conducted spurious emissions)

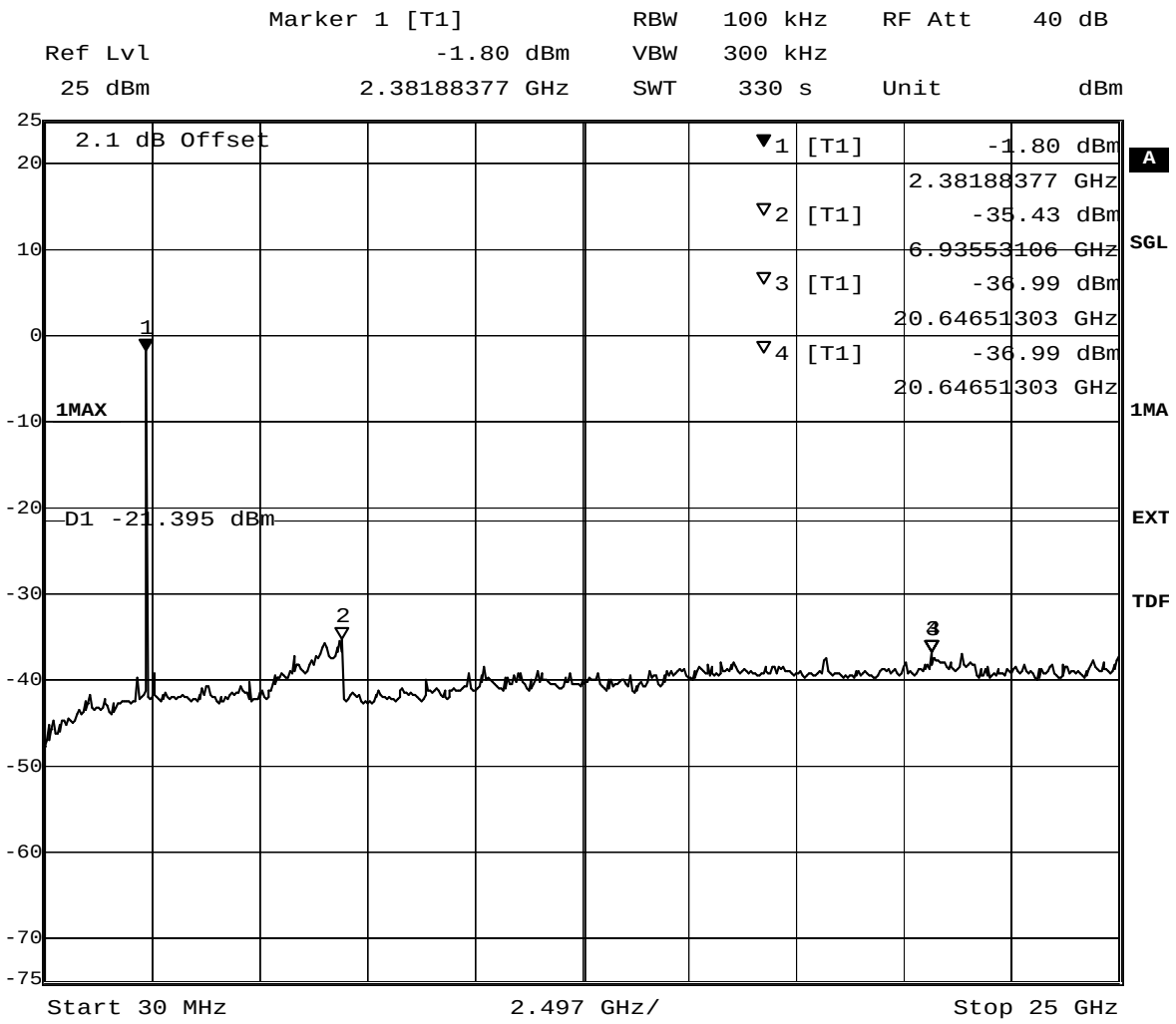
## Op. Mode

op-mode 1 Connector R




Title: Band Edge Compliance
Comment A: CH B: 2403 MHz
Date: 20.APR.2012 16:04:50

(band edge compliance, conducted measurement, lower band edge)



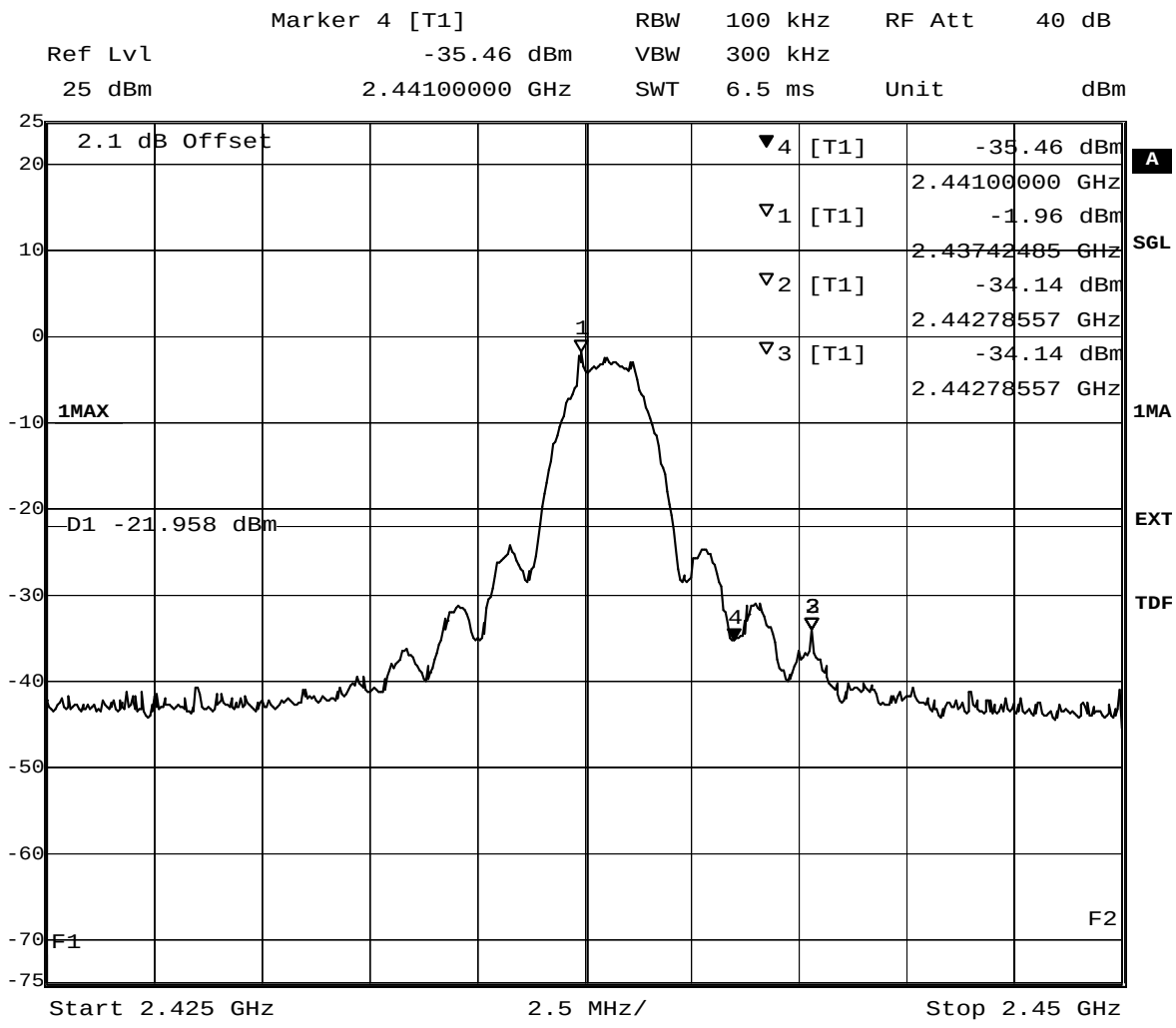

Title: spurious emissions
Comment A: CH B: 2403 MHz
Date: 20.APR.2012 16:16:29

(conducted spurious emissions)

### 8.3.2 Spurious RF conducted emissions operating mode 2

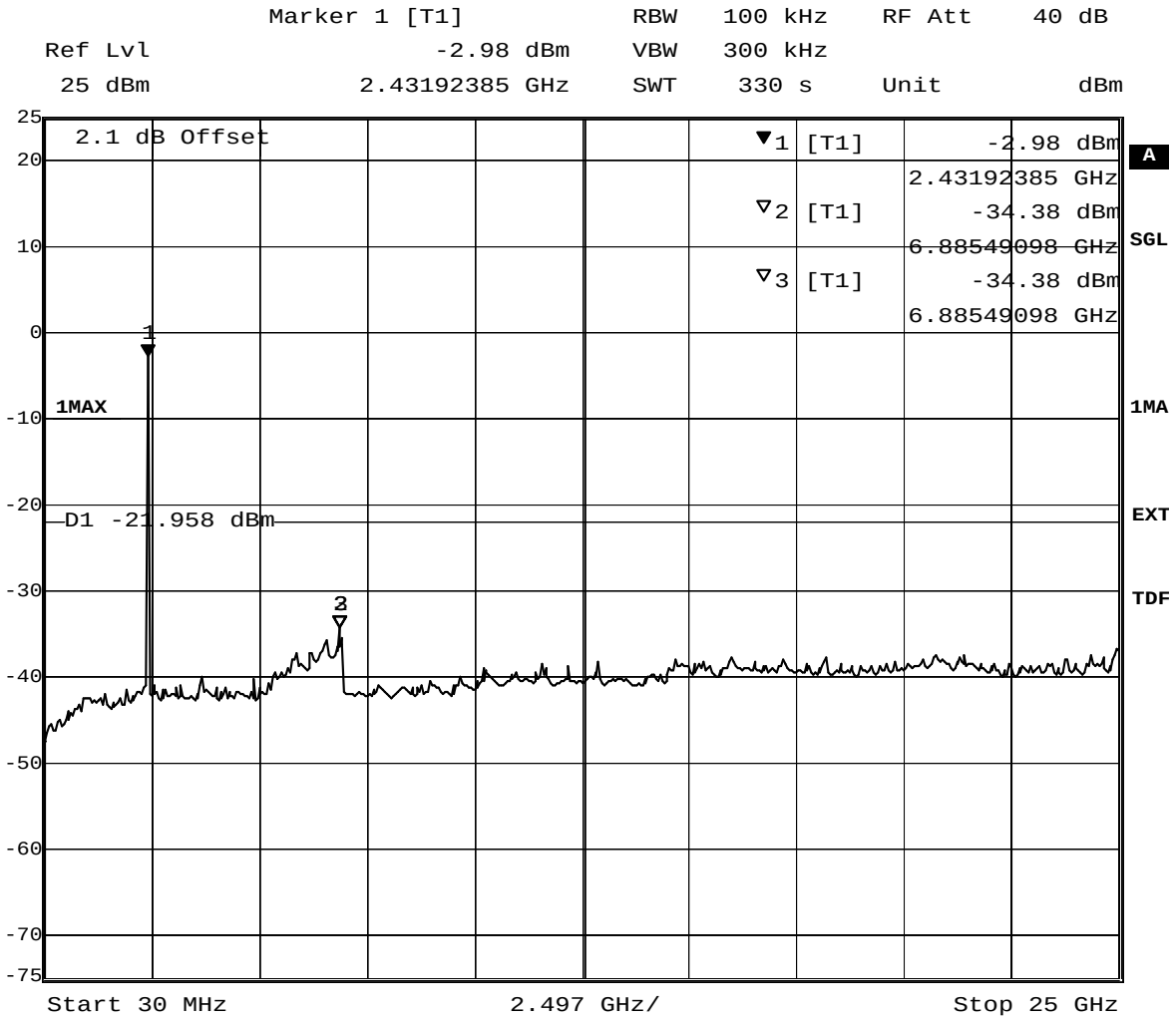
**Op. Mode**

op-mode 2 Connector L




Title: Band Edge Compliance
Comment A: CH M: 2438 MHz
Date: 20.APR.2012 19:37:30

(determination of reference value for spurious emissions measurement)

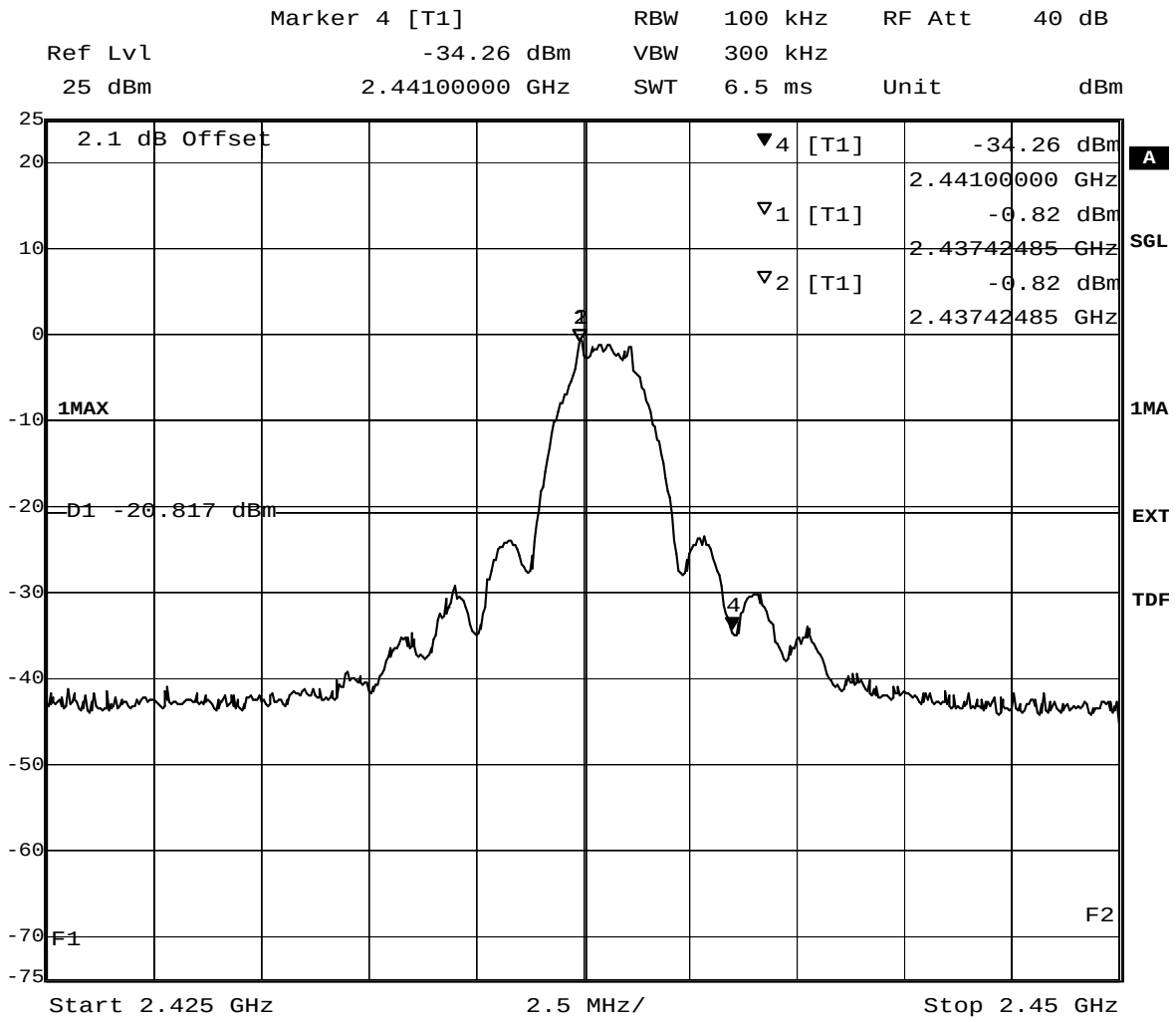



Title: spurious emissions
Comment A: CH M: 2438 MHz
Date: 20.APR.2012 19:49:08

(conducted spurious emissions)

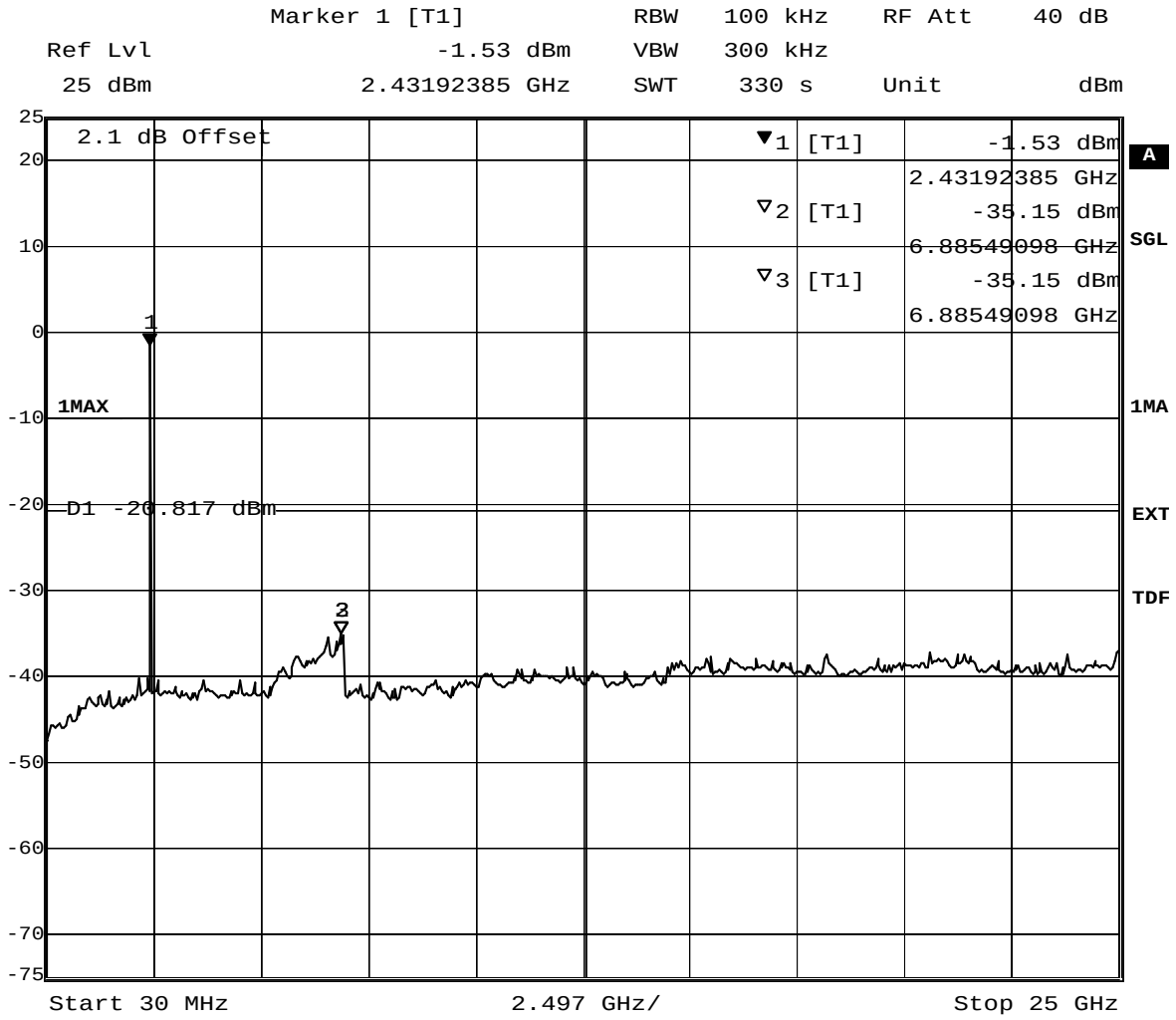
## Op. Mode

op-mode 2 Connector R




Title: Band Edge Compliance
Comment A: CH M: 2438 MHz
Date: 20.APR.2012 16:49:03

(determination of reference value for spurious emissions measurement)



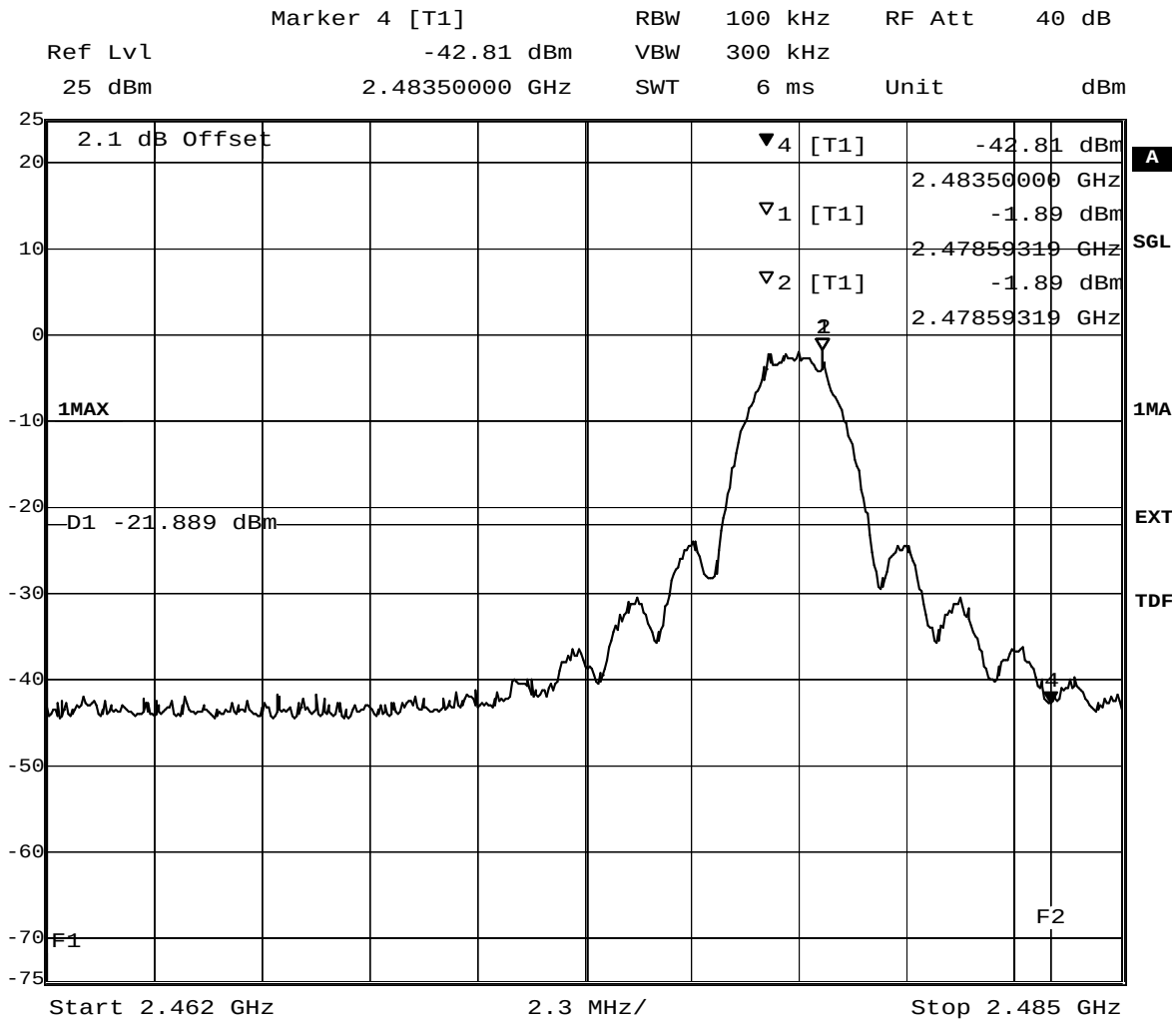

Title: spurious emissions
Comment A: CH M: 2438 MHz
Date: 20.APR.2012 17:00:41

(conducted spurious emissions)

### 8.3.3 Band edge compliance and spurious RF conducted emissions operating mode 3

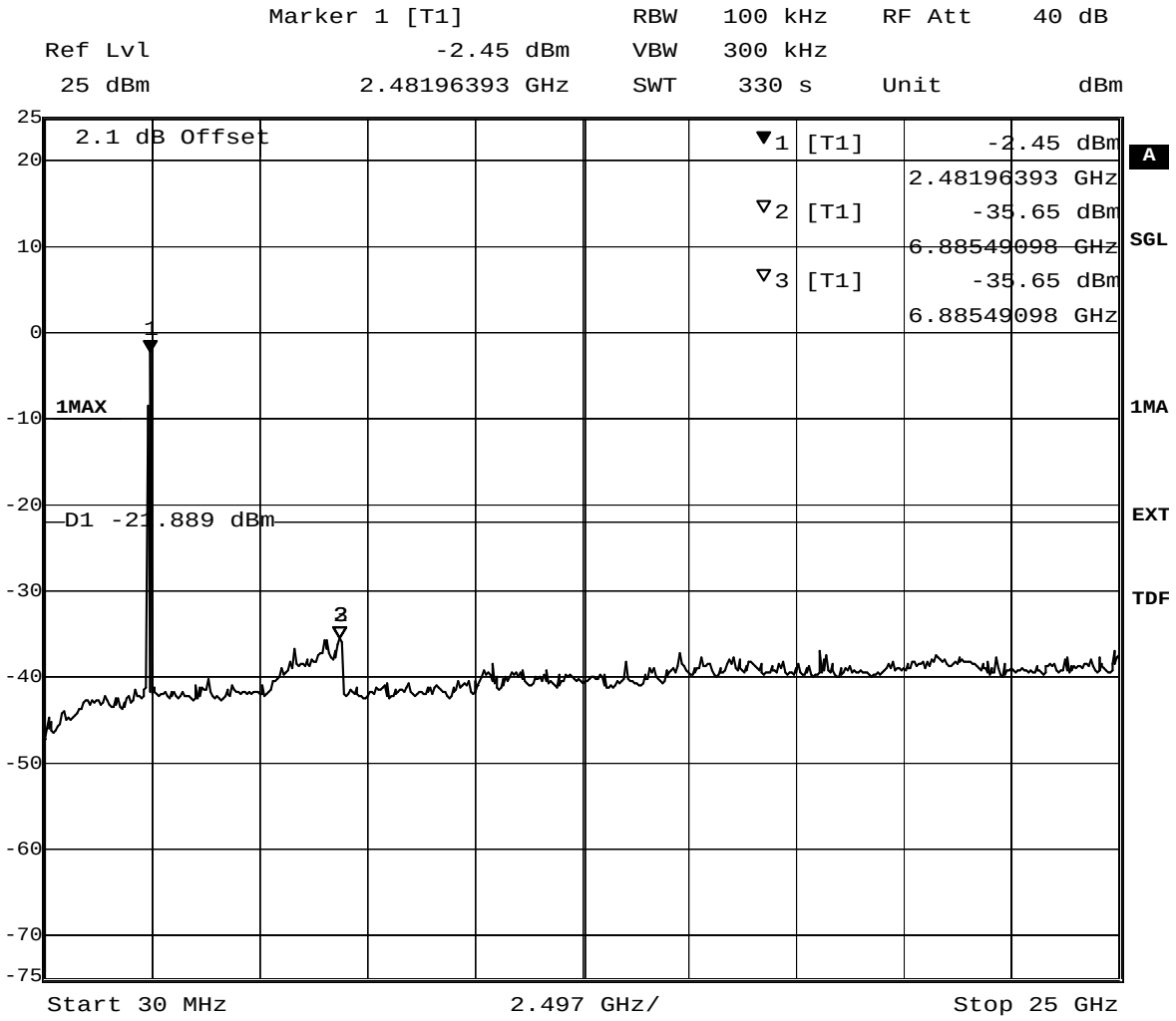
**Op. Mode**

op-mode 3 Connector L




Title: Band Edge Compliance
Comment A: CH T: 2478 MHz
Date: 20.APR.2012 20:12:08

(band edge compliance, conducted measurement, higher band edge)

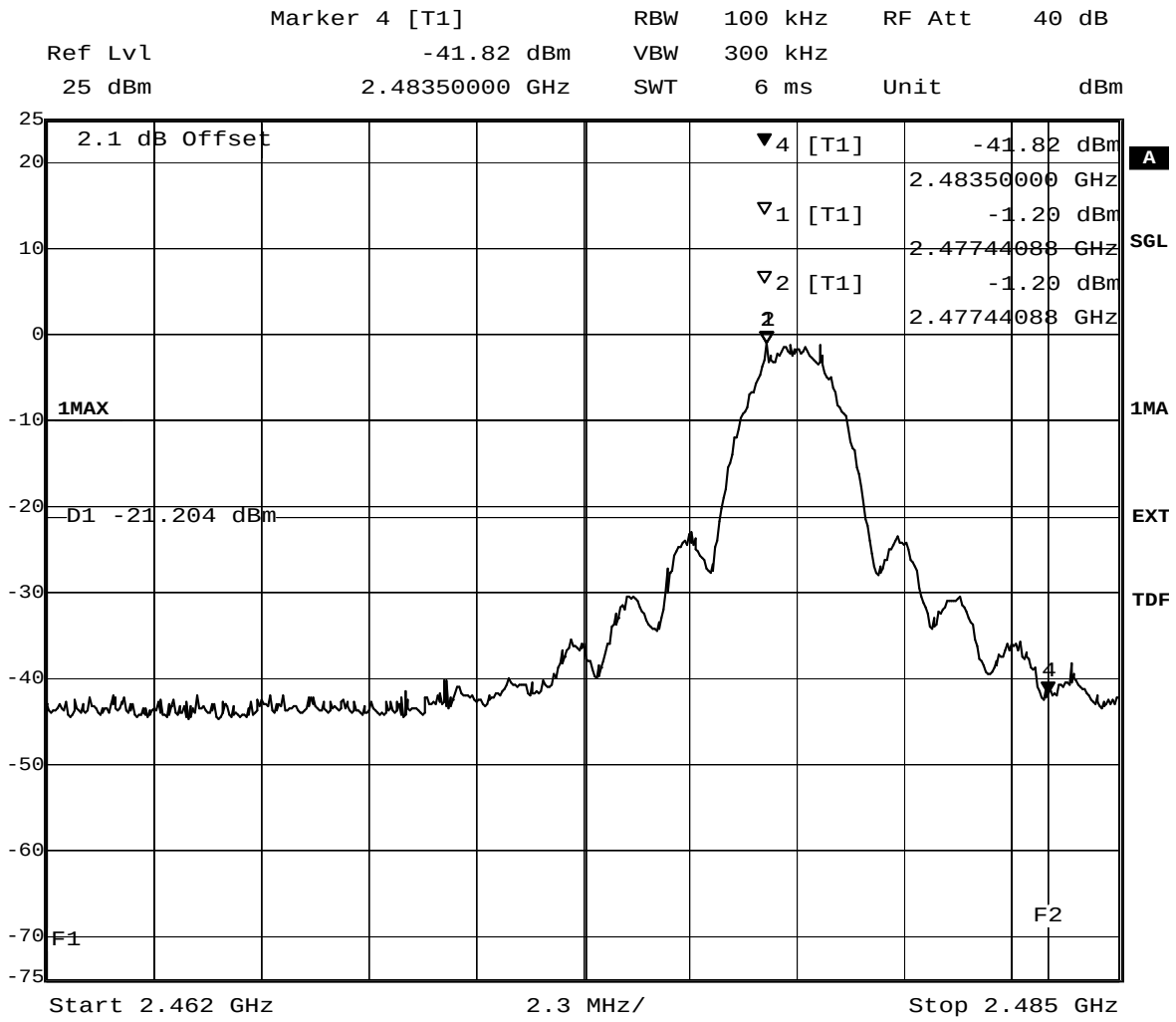



Title: spurious emissions
Comment A: CH T: 2478 MHz
Date: 20.APR.2012 20:23:46

(conducted spurious emissions)

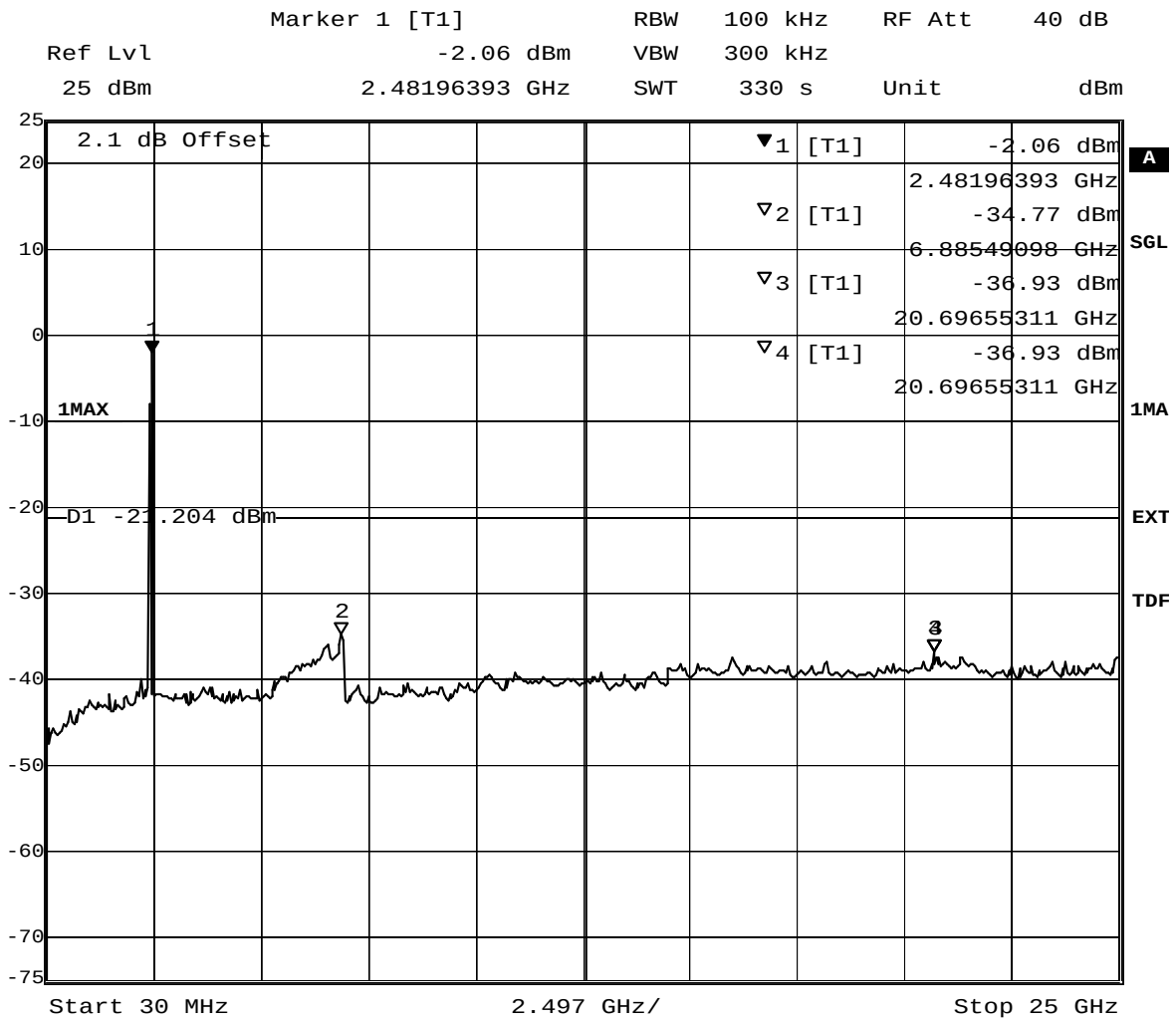
## Op. Mode

op-mode 3 Connector R




Title: Band Edge Compliance
Comment A: CH T: 2478 MHz
Date: 20.APR.2012 20:53:05

(band edge compliance, conducted measurement, higher band edge)




Title: spurious emissions
Comment A: CH T: 2478 MHz
Date: 20.APR.2012 21:04:44

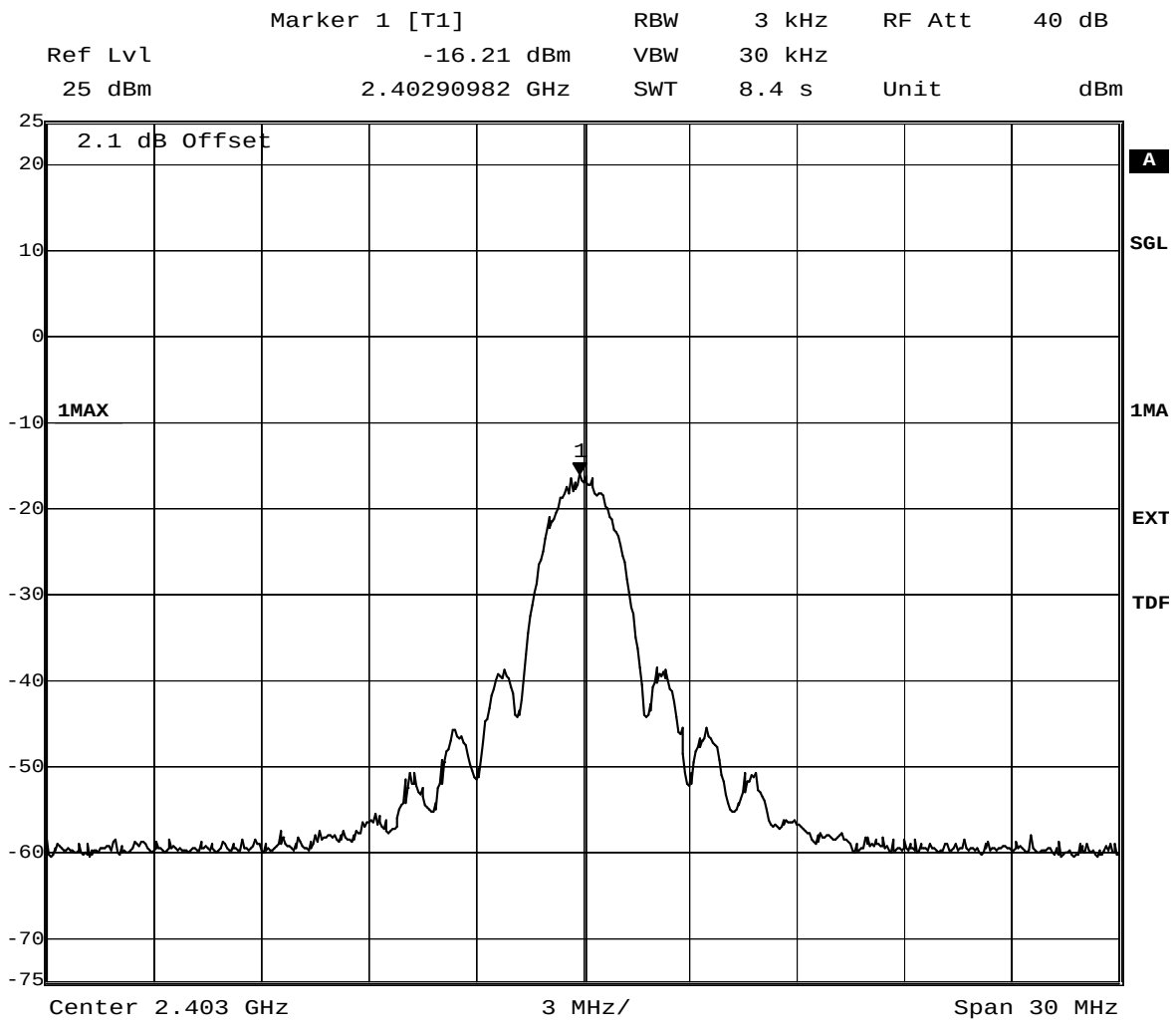
(conducted spurious emissions)

## 8.4 Power density

### 8.4.1 Power density operating mode 1

**Op. Mode**

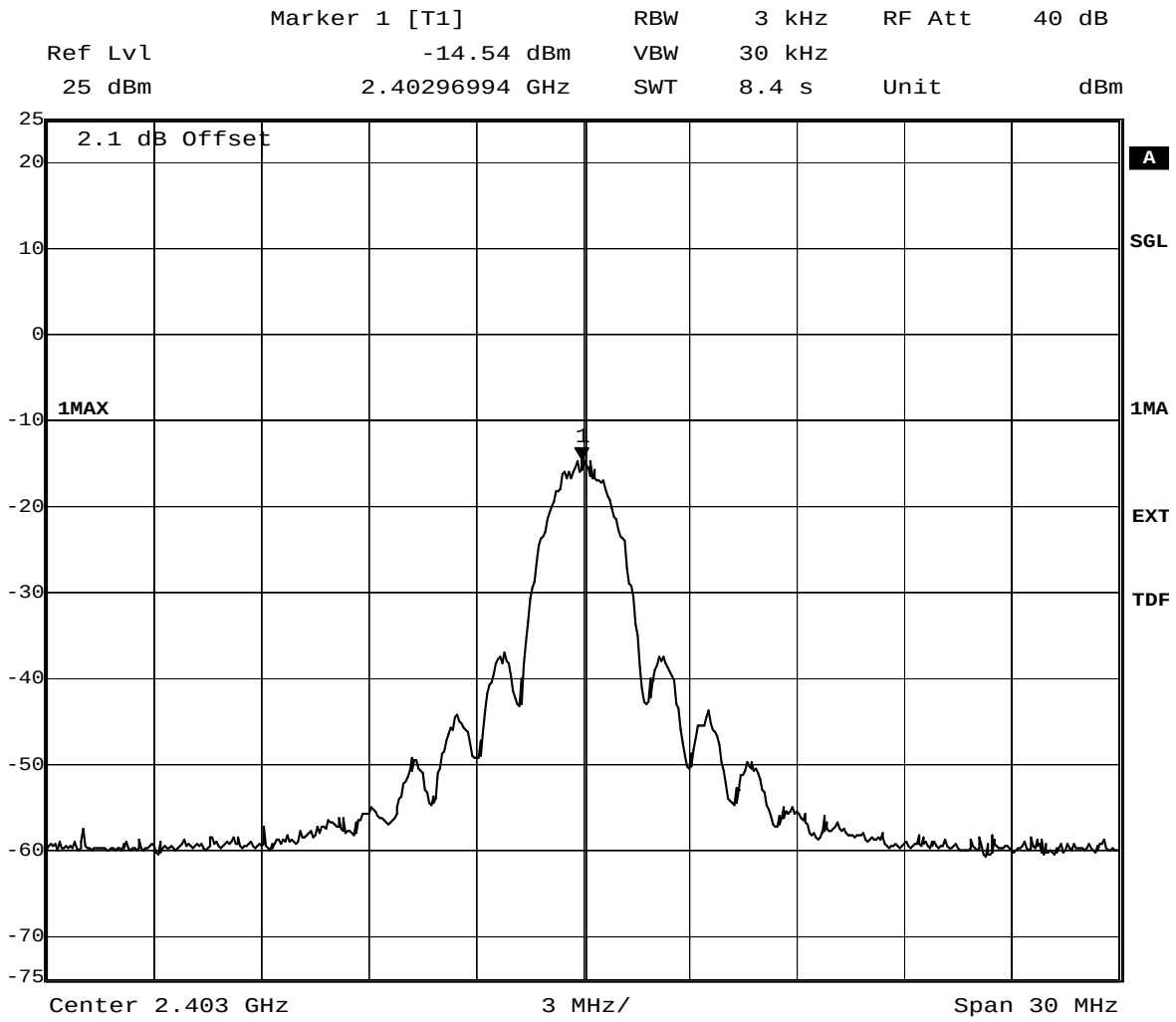
op-mode 1 Connector L




Title: Power Density
Comment A: CH B: 2403 MHz;
Date: 20.APR.2012 19:34:30

## Op. Mode

op-mode 1 Connector R

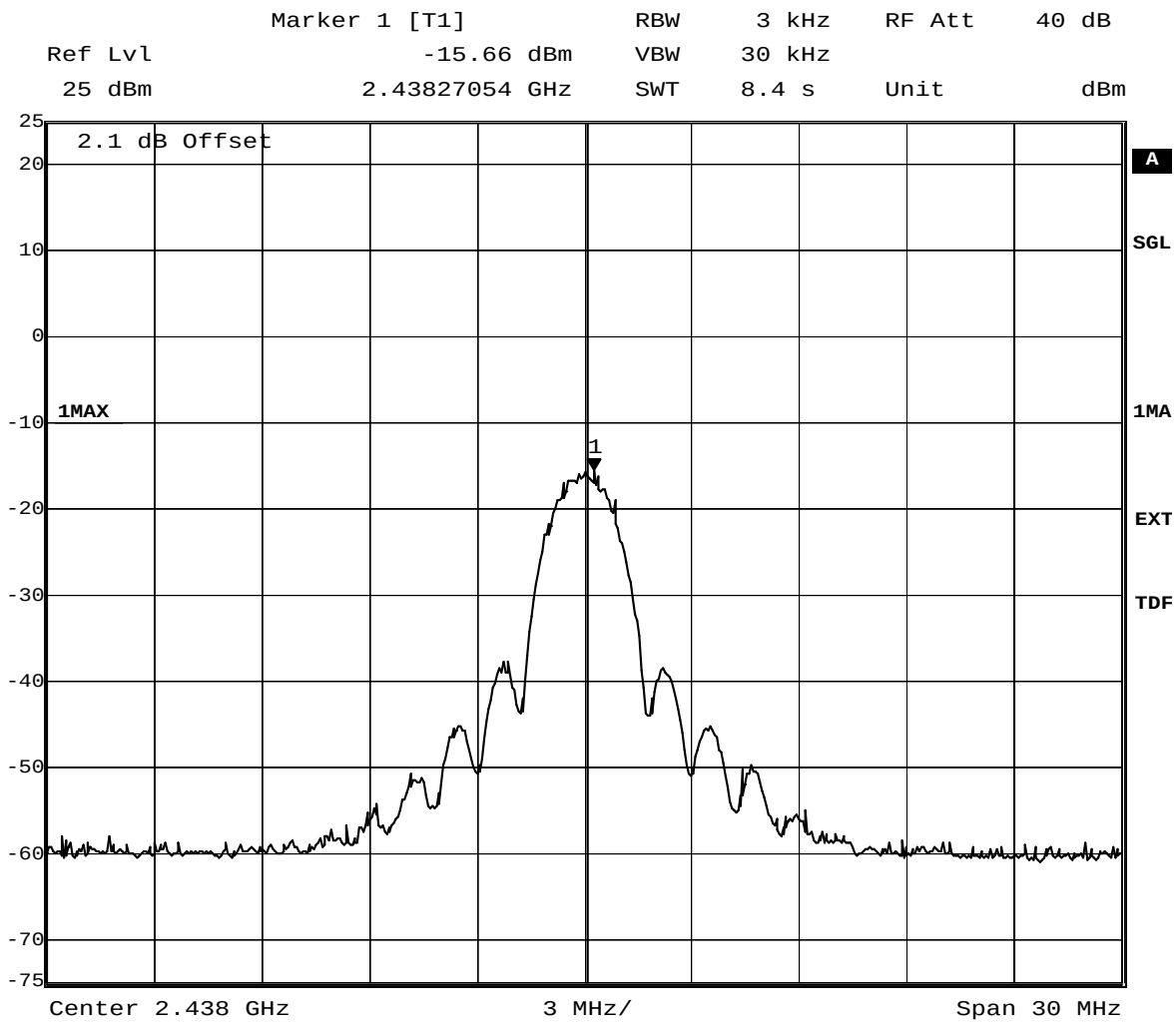



Title: Power Density
Comment A: CH B: 2403 MHz;
Date: 20.APR.2012 16:34:26

### 8.4.2 Power density operating mode 2

**Op. Mode**

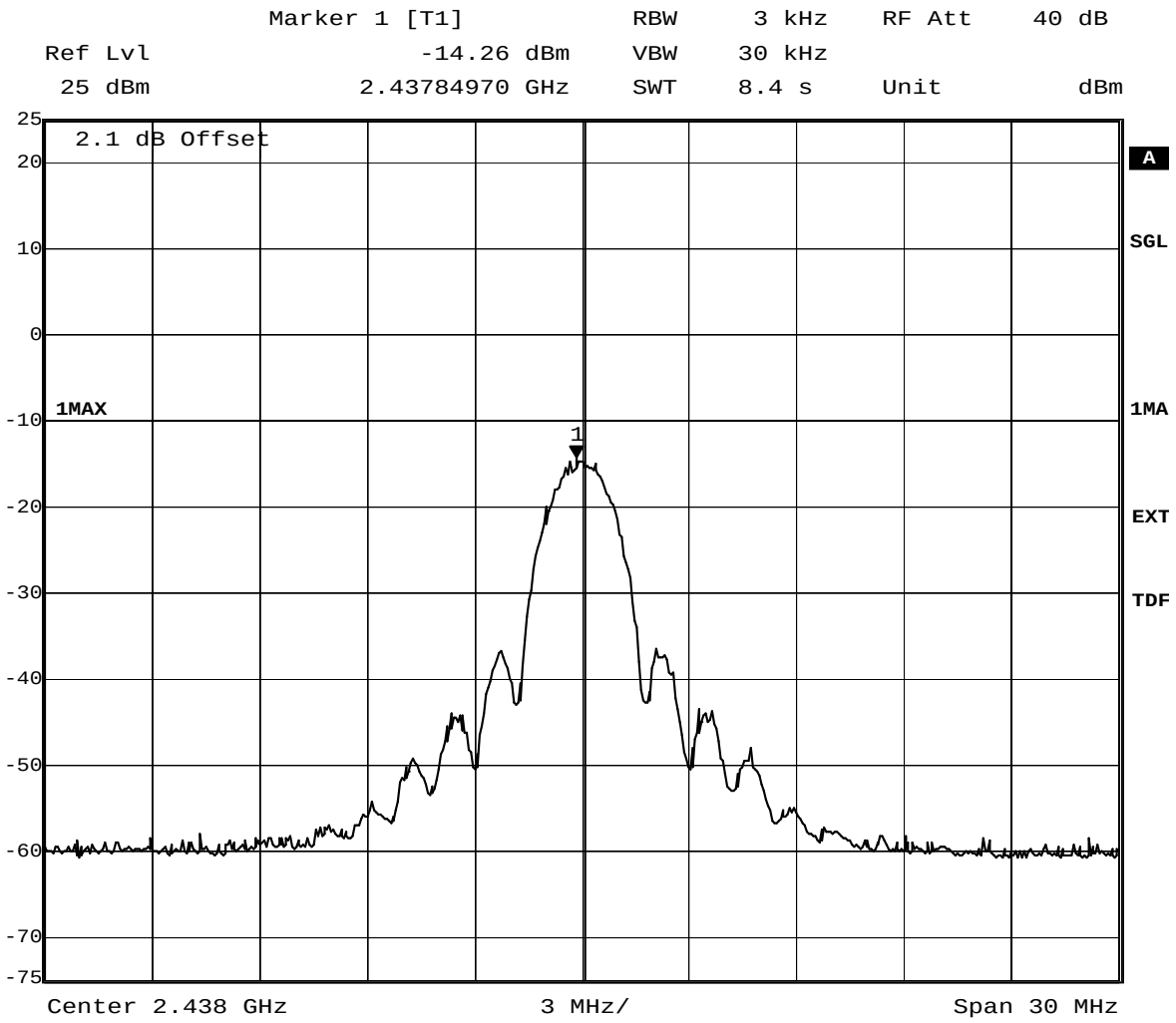
op-mode 2 Connector L




Title: Power Density
Comment A: CH M: 2438 MHz;
Date: 20.APR.2012 20:07:05

## Op. Mode

op-mode 2 Connector R

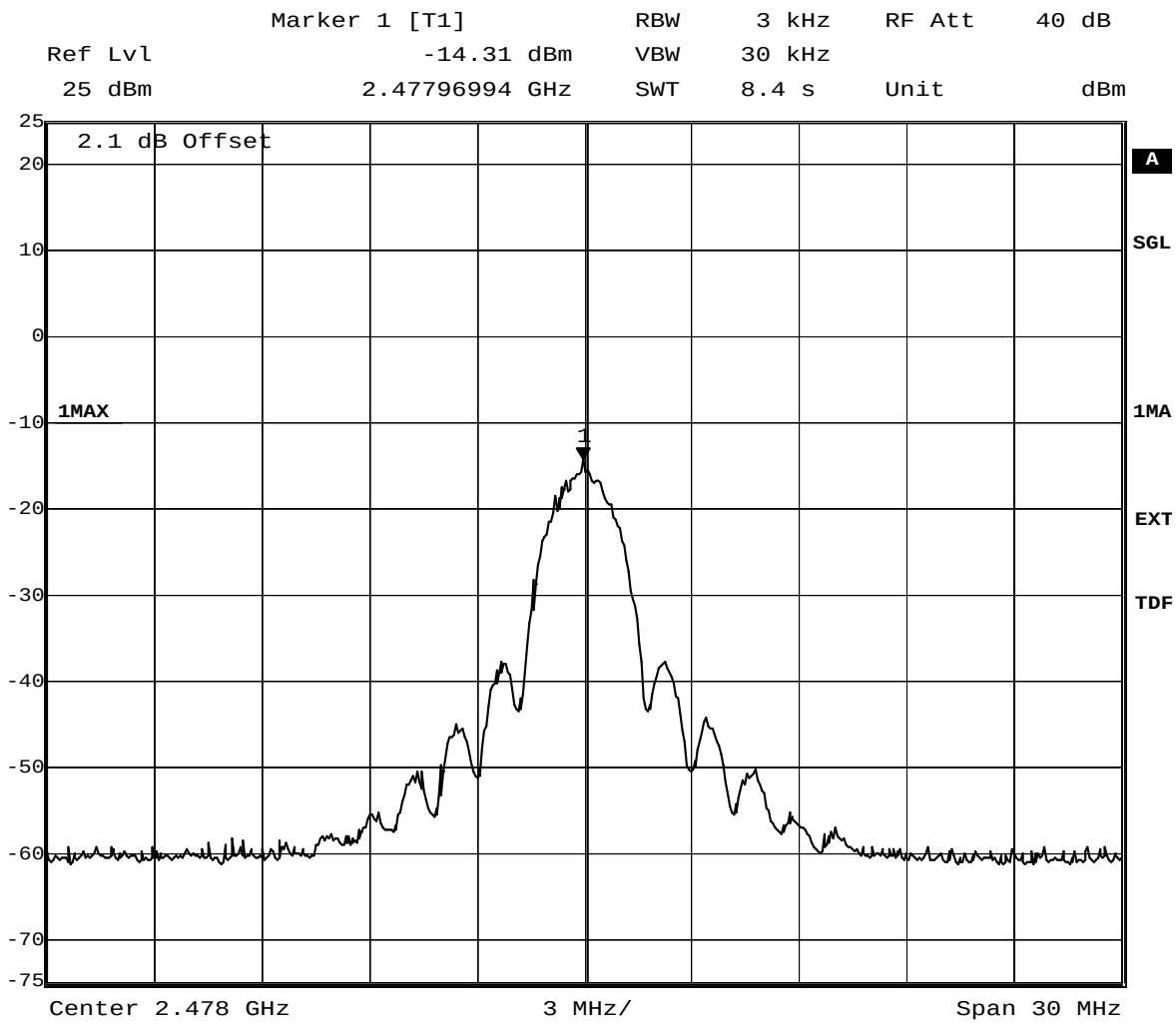



Title: Power Density
Comment A: CH M: 2438 MHz;
Date: 20.APR.2012 17:18:38

### 8.4.3 Power density operating mode 3

**Op. Mode**

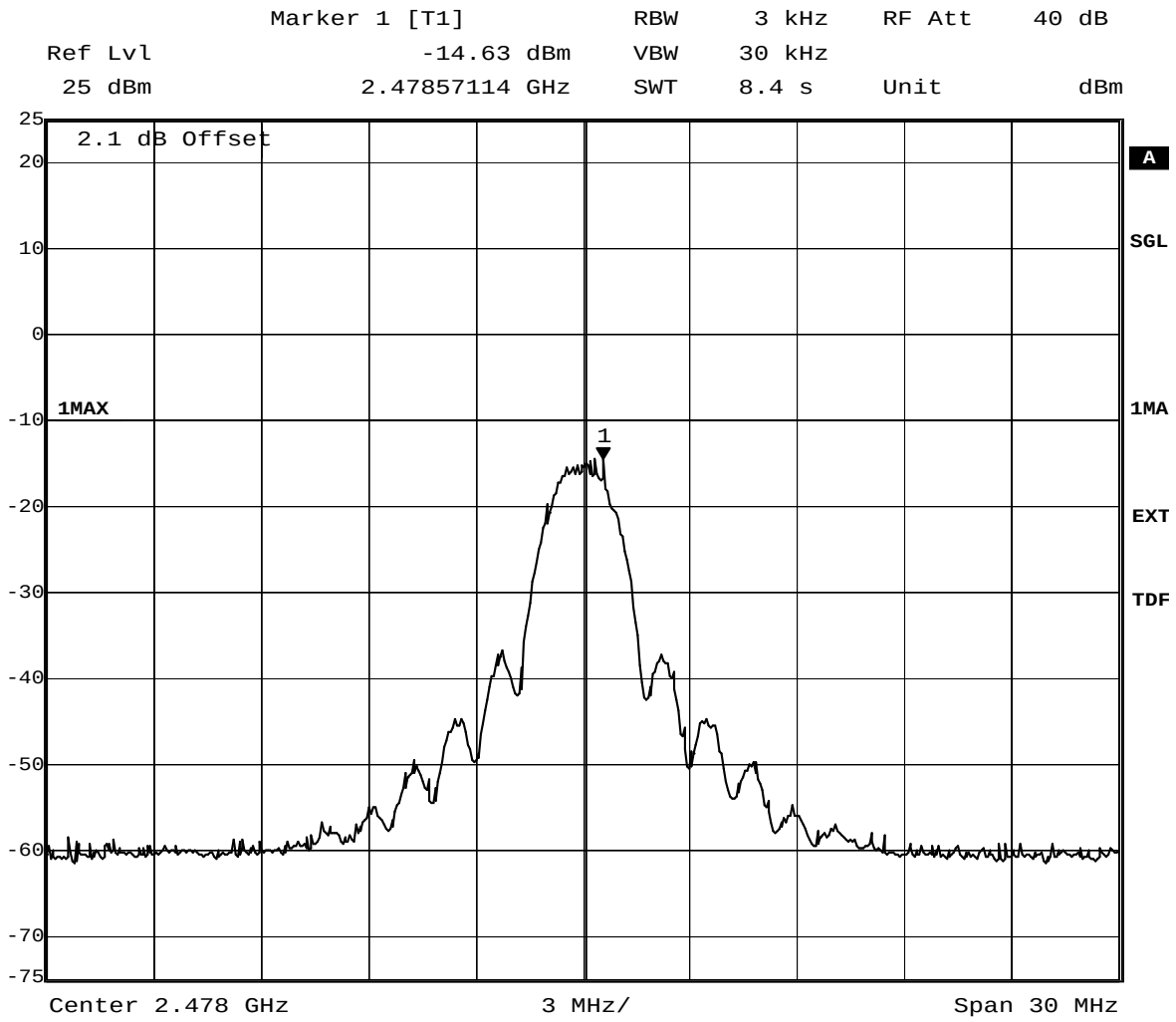
op-mode 3 Connector L




Title: Power Density
Comment A: CH T: 2478 MHz;
Date: 20.APR.2012 20:41:43

## Op. Mode

op-mode 3 Connector R




Title: Power Density
Comment A: CH T: 2478 MHz;
Date: 20.APR.2012 21:22:41