



InterLab®

FCC Measurement/Technical Report on

Bluetooth® transceiver  
LMX9820A

**Report Reference:** 4\_Natasc\_IRV\_0104\_BTT\_FCCa

**Test Laboratory:**

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**Note:**

The following test results relate only to the devices specified in this document. This report shall not be reproduced in parts without the written approval of the testing laboratory.

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## Table of Contents

|     |                                        |    |
|-----|----------------------------------------|----|
| 0   | Summary .....                          | 3  |
| 0.1 | Technical Report Summary .....         | 3  |
| 0.2 | Measurement Summary .....              | 4  |
| 1   | Administrative Data.....               | 6  |
| 1.1 | Testing Laboratory .....               | 6  |
| 1.2 | Project Data .....                     | 6  |
| 1.3 | Applicant Data .....                   | 6  |
| 1.4 | Manufacturer Data.....                 | 6  |
| 2   | Product labeling .....                 | 7  |
| 2.1 | FCC ID label .....                     | 7  |
| 2.2 | Location of the label on the EUT ..... | 7  |
| 3   | Test object Data .....                 | 8  |
| 3.1 | General EUT Description .....          | 8  |
| 3.2 | EUT Main components .....              | 9  |
| 3.3 | Ancillary Equipment .....              | 9  |
| 3.4 | EUT Setups.....                        | 9  |
| 3.5 | Operating Modes .....                  | 9  |
| 4   | Test Results .....                     | 10 |
| 4.1 | Occupied bandwidth.....                | 10 |
| 4.2 | Peak power output .....                | 12 |
| 4.3 | Spurious RF conducted emissions .....  | 14 |
| 4.4 | Spurious radiated emissions .....      | 16 |
| 4.5 | Band edge compliance.....              | 20 |
| 4.6 | Dwell time .....                       | 22 |
| 4.7 | Channel separation .....               | 24 |
| 4.8 | Number of hopping frequencies.....     | 25 |
| 5   | Test Equipment .....                   | 26 |
| 6   | Photo Report .....                     | 29 |
| 7   | Setup Drawings .....                   | 33 |
| 8   | Annex.....                             | 34 |



## **0 Summary**

### **0.1 Technical Report Summary**

#### **Type of Authorization**

Certification for an Intentional Radiator (Frequency Hopping 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 (2001-10-01 Edition) and 15 (2004-07-12 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 Public Notice DA 00-705, released March 30, 2000

Instead of applying ANSI C63.4-1992 which is referenced in the FCC Public Note, the newer ANSI C63.4-2003 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)

Not applicable because the EUT is not powered by AC Mains.

### FCC Part 15, Subpart C § 15.247 (a) (1) (ii)

Occupied bandwidth

The measurement was performed according to FCC § 15.31

2004

| OP-Mode   | Setup    | Port             | Final Result |
|-----------|----------|------------------|--------------|
| op-mode 1 | 4E040b01 | temp. ant. conn. | passed       |
| op-mode 2 | 4E040b01 | temp. ant. conn. | passed       |
| op-mode 3 | 4E040b01 | temp. ant. conn. | passed       |

### FCC Part 15, Subpart C § 15.247 (b) (1)

Peak power output

The measurement was performed according to FCC § 15.31

2004

| OP-Mode   | Setup    | Port             | Final Result |
|-----------|----------|------------------|--------------|
| op-mode 1 | 4E040b01 | temp. ant. conn. | passed       |
| op-mode 2 | 4E040b01 | temp. ant. conn. | passed       |
| op-mode 3 | 4E040b01 | temp. ant. conn. | passed       |

### FCC Part 15, Subpart C § 15.247 (d)

Spurious RF conducted emissions

The measurement was performed according to FCC § 15.31

2004

| OP-Mode   | Setup    | Port             | Final Result |
|-----------|----------|------------------|--------------|
| op-mode 1 | 4E040b01 | temp. ant. conn. | passed       |
| op-mode 2 | 4E040b01 | temp. ant. conn. | passed       |
| op-mode 3 | 4E040b01 | temp. ant. conn. | 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

2003

| OP-Mode   | Setup    | Port      | Final Result |
|-----------|----------|-----------|--------------|
| op-mode 1 | 4E040a01 | enclosure | passed       |
| op-mode 2 | 4E040a01 | enclosure | passed       |
| op-mode 3 | 4E040a01 | enclosure | passed       |

### FCC Part 15, Subpart C § 15.247 (d)

Band edge compliance

The measurement was performed according to FCC § 15.31  
(2004) / ANSI C63.4 (2003)

2004 / 2003

| OP-Mode   | Setup    | Port             | Final Result |
|-----------|----------|------------------|--------------|
| op-mode 1 | 4E040b01 | temp. ant. conn. | passed       |
| op-mode 3 | 4E040a01 | enclosure        | passed       |

**FCC Part 15, Subpart C****§ 15.247 (a) (1) (iii)**

Dwell time

The measurement was performed according to FCC § 15.31

2004

**OP-Mode****Setup****Port****Final Result**

op-mode 2

4E040b01

temp. ant. conn.

passed

**FCC Part 15, Subpart C****§ 15.247 (a) (1)**

Channel separation

The measurement was performed according to FCC § 15.31

2004

**OP-Mode****Setup****Port****Final Result**

op-mode 4

4E040b01

temp. ant. conn.

passed

**FCC Part 15, Subpart C****§ 15.247 (a)**

Number of hopping frequencies

The measurement was performed according to FCC § 15.31

2004

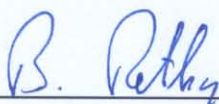
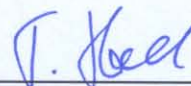
**OP-Mode****Setup****Port****Final Result**

op-mode 4

4E040b01

temp. ant. conn.

passed

Responsible for  
Accreditation Scope:Responsible  
for Test Report:



## **1 Administrative Data**

### **1.1 Testing Laboratory**

Company Name: 7 Layers AG

Address Borsigstr. 11  
40880 Ratingen  
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:  
- Deutscher Akkreditierungs Rat DAR- Registration no. TTI-P-G 178/99

Responsible for Accreditation Scope: Dipl.- Ing. Bernhard Retka  
Dipl.- Ing. Arndt Stöcker  
Dipl.- Ing. Thomas Hoell

Report Template Version: 2004-12-09

### **1.2 Project Data**

Responsible for testing and report: Dipl.- Ing. Thomas Hoell

Date of Test(s): 2004-09-16 to 2004-09-28  
Date of Report: 2004-12-15

### **1.3 Applicant Data**

Company Name: National Semiconductor

Address: 5825 Oberlin Drive. Suite 400  
San Diego  
USA

Contact Person: Mr. Peter Zhang

### **1.4 Manufacturer Data**

Company Name: please see applicant data

Address:

Contact Person:



## **2 Product labeling**

### **2.1 FCC ID label**

At the time of the report there was no FCC label available.

### **2.2 Location of the label on the EUT**

see above

### 3 Test object Data

#### 3.1 General EUT Description

|                             |                               |
|-----------------------------|-------------------------------|
| <b>Equipment under Test</b> | Bluetooth® transceiver module |
| <b>Type Designation:</b>    | LMX9820A                      |
| <b>Kind of Device:</b>      | Module                        |
| <b>(optional)</b>           | Bluetooth Serial Port Adapter |
| <b>Voltage Type:</b>        | DC                            |
| <b>Voltage level:</b>       | 5.0 V                         |

#### General product description:

Bluetooth is a short-range radio link intended to be a cable replacement between portable and/or fixed electronic devices.

Bluetooth operates in the unlicensed ISM Band at 2.4 GHz. In the US a band of 83.5 MHz width is available. In this band, the Bluetooth technology defines 79 RF channels spaced 1 MHz (2402 - 2480 MHz). The actual RF channel is chosen from a pseudo-random hopping sequence through the 79 channels. A channel is occupied for a defined amount of time slots, with a nominal slot length of 625 µs. The maximum dwell time on one channel is defined by the packet type and is 0.625 ms for DH1 packets, 1.875 ms for DH3 and 3.125 ms for DH5. The nominal hop rate is 1600 hops/s for DH1, 1600/3 for DH3 and 1600/5 for DH5. All frequencies are equally used. The maximum nominal average time of occupancy is 0.4 s within a period of 79\*0.4 seconds.

#### The EUT provides the following ports:

##### Ports

Temporary antenna connector  
Enclosure

**The main components of the EUT are listed and described in Chapter 3.2**

### 3.2 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<br>(Code: 4E040a01)                                         | Bluetooth <sup>®</sup> transceiver module | LMX 9820A        | none       | 3.1       | 6.13      | 2004-11-10      |
| Remark: EUT A is equipped with an integral antenna (gain= 0 dBi). |                                           |                  |            |           |           |                 |
| EUT B<br>(Code: 4E040a01)                                         | Bluetooth <sup>®</sup> transceiver module | LMX 9820A        | none       | 3.1       | 6.13      | 2004-11-10      |
| Remark: EUT B is equipped with a temporary antenna connector.     |                                           |                  |            |           |           |                 |

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

### 3.3 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 |
|-------------------|----------------------|------------------------|-------------------------|------------------------------|-------------------|--------|
| AE 1              | Laptop               | Toshiba S4090XCDT/ 4.3 | Model.-No. S409EYX-GR9X | Microsoft Windows 2000 Prof. | 10441164G PCN0357 | -      |

### 3.4 EUT Setups

This chapter describes the combination of EUTs and ancillary equipment used for testing.

| Setup No. | Combination of EUT's | Description                      |
|-----------|----------------------|----------------------------------|
| 4E040a01  | EUT A + AE 1         | setup for radiated measurements  |
| 4E040b01  | EUT B + AE 1         | setup for conducted measurements |

### 3.5 Operating Modes

This chapter describes the operating modes of the EUT's used for testing.

| Op. Mode  | Description of Operating Modes | Remarks                                 |
|-----------|--------------------------------|-----------------------------------------|
| op-mode 1 | The EUT transmits on 2402 MHz  | Loopback mode / TX-mode / local TX mode |
| op-mode 2 | The EUT transmits on 2441 MHz  | Loopback mode / TX-mode / local TX mode |
| op-mode 3 | The EUT transmits on 2480 MHz  | Loopback mode / TX-mode / local TX mode |
| op-mode 4 | The EUT is in Hopping mode     | The EUT is hopping on 79 channels       |

## 4 Test Results

### 4.1 Occupied bandwidth

**Standard** FCC Part 15, 2004-07-12  
Subpart C

**The test was performed according to:** FCC §15.31, 2004-07-12

#### 4.1.1 Test Description

The Equipment Under Test (EUT) was setup in a shielded room 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 produces the worst-case (widest) occupied bandwidth. The resolution bandwidth for measuring the reference level and the occupied bandwidth was 10 kHz.

The EUT was connected to the spectrum analyzer via a short coax cable.

#### 4.1.2 Test Requirements / Limits

FCC Part 15, Subpart C, §15.247 (a) (1)

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

#### 4.1.3 Test Protocol

Temperature: 23 °C  
Air Pressure: 1017 hPa  
Humidity: 33 %

| Op. Mode  | Setup    | Port             |
|-----------|----------|------------------|
| op-mode 1 | 4E040b01 | temp. ant. conn. |

| 20 dB bandwidth<br>MHz | Remarks |
|------------------------|---------|
| 0.986                  |         |

Remark: Please see annex for the measurement plot.

Temperature: 23 °C  
Air Pressure: 1017 hPa  
Humidity: 33 %

| Op. Mode  | Setup    | Port             |
|-----------|----------|------------------|
| op-mode 2 | 4E040b01 | temp. ant. conn. |

| 20 dB bandwidth<br>MHz | Remarks |
|------------------------|---------|
| 0,986                  |         |

Remark: Please see annex for the measurement plot.

Temperature: 23 °C  
Air Pressure: 1017 hPa  
Humidity: 33 %

| Op. Mode  | Setup    | Port             |
|-----------|----------|------------------|
| op-mode 3 | 4E040b01 | temp. ant. conn. |

| 20 dB bandwidth<br>MHz | Remarks |
|------------------------|---------|
| 0,962                  |         |

Remark: Please see annex for the measurement plot.

#### 4.1.4 Test result: Occupied bandwidth

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

## 4.2 Peak power output

**Standard** FCC Part 15, 2004-07-12  
Subpart C

**The test was performed according to:** FCC §15.31, 2004-07-12

### 4.2.1 Test Description

The Equipment Under Test (EUT) was set up in a shielded room to perform the output power measurements.

The results recorded were measured with the modulation which produces the worst-case (highest) output power.

The resolution bandwidth for measuring the output power was 1 MHz.

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.

### 4.2.2 Test Requirements / Limits

FCC Part 15, Subpart C, §15.247 (b) (1)

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt.

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

### 4.2.3 Test Protocol

Temperature: 23 °C  
Air Pressure: 1017 hPa  
Humidity: 33 %

| Op. Mode  | Setup    | Port           |
|-----------|----------|----------------|
| op-mode 1 | 4E040b01 | temp.ant.conn. |

| Output power<br>dBm | Remarks                                             |
|---------------------|-----------------------------------------------------|
| 2,04                | The EIRP including antenna gain (0 dBi) is 2,04 dBm |

Remark: Please see annex for the measurement plot.

Temperature: 23 °C  
Air Pressure: 1017 hPa  
Humidity: 33 %

| Op. Mode  | Setup    | Port           |
|-----------|----------|----------------|
| op-mode 2 | 4E040b01 | temp.ant.conn. |

| Output power<br>dBm | Remarks                                             |
|---------------------|-----------------------------------------------------|
| 2,12                | The EIRP including antenna gain (0 dBi) is 2,12 dBm |

Remark: Please see annex for the measurement plot.

Temperature: 23 °C  
Air Pressure: 1017 hPa  
Humidity: 33 %

| Op. Mode  | Setup    | Port           |
|-----------|----------|----------------|
| op-mode 3 | 4E040b01 | temp.ant.conn. |

| Output power<br>dBm | Remarks                                             |
|---------------------|-----------------------------------------------------|
| 1,99                | The EIRP including antenna gain (0 dBi) is 1,99 dBm |

Remark: Please see annex for the measurement plot.

#### 4.2.4 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 |

### 4.3 Spurious RF conducted emissions

**Standard** FCC Part 15, 2004-07-12  
Subpart C

**The test was performed according to:** FCC §15.31, 2004-07-12

#### 4.3.1 Test Description

The Equipment Under Test (EUT) was set up in a shielded room 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

#### 4.3.2 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.

#### 4.3.3 Test Protocol

Temperature: 23 °C  
Air Pressure: 1017 hPa  
Humidity: 33 %

| Op. Mode  | Setup    | Port           |
|-----------|----------|----------------|
| op-mode 1 | 4E040b01 | temp.ant.conn. |

| Frequency MHz | Corrected measurement value dBm | Reference value dBm | Limit dBm | Delta to limit dB |
|---------------|---------------------------------|---------------------|-----------|-------------------|
| 280,2         | -36,74                          | 1,066               | -18,93    | 17,81             |
| 580,44        | -40,16                          | 1,066               | -18,93    | 21,23             |
| 6935,53       | -36,77                          | 1,066               | -18,93    | 17,84             |
| 24950         | -36,60                          | 1,066               | -18,93    | 17,67             |

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

Temperature: 23 °C  
Air Pressure: 1017 hPa  
Humidity: 33 %

| Op. Mode  | Setup    | Port           |
|-----------|----------|----------------|
| op-mode 2 | 4E040b01 | temp.ant.conn. |

| Frequency MHz | Corrected measurement value dBm | Reference value dBm | Limit dBm | Delta to limit dB |
|---------------|---------------------------------|---------------------|-----------|-------------------|
| 280,2         | -38,66                          | 1,225               | -18,78    | 19,88             |
| 4883,89       | -36,62                          | 1,225               | -18,78    | 17,84             |
| 6935,53       | -35,98                          | 1,225               | -18,78    | 17,20             |
| 25000         | -37,69                          | 1,225               | -18,78    | 18,91             |

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

Temperature: 23 °C  
Air Pressure: 1017 hPa  
Humidity: 33 %

| Op. Mode  | Setup    | Port           |
|-----------|----------|----------------|
| op-mode 3 | 4E040b01 | temp.ant.conn. |

| Frequency MHz | Corrected measurement value dBm | Reference value dBm | Limit dBm | Delta to limit dB |
|---------------|---------------------------------|---------------------|-----------|-------------------|
| 280,2         | -38,38                          | 1,33                | -18,67    | 19,71             |
| 6885,49       | -36,02                          | 1,33                | -18,67    | 17,35             |
| 21046,80      | -37,84                          | 1,33                | -18,67    | 19,17             |

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

#### 4.3.4 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 |

## 4.4 Spurious radiated emissions

**Standard** FCC Part 15, 2004-07-12  
Subpart C

**The test was performed according to:** ANSI C 63.4, 2003

### 4.4.1 Test Description

The test set-up was made in accordance to the general provisions of ANSI C 63.4-2003. The Equipment Under Test (EUT) was set up on a non-conductive table 1.0 x 2.0 m in the semi-anechoic chamber. The test was performed at the distance of 3 m between the EUT and the receiving antenna. 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.

#### Measurement up to 1GHz

Step 1: Preliminary scan

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

Settings for step 1:

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

Intention of this step is, to determine the radiated EMI-profile of the EUT. With this data, the test system performs (to reduce the number of final measurements) a data reduction with the following parameters:

- Offset for acceptance analysis: Limit line – 10 dB
- Maximum number of final measurements: 12

Step 2:

With the frequencies 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.

Settings for step 2:

- Detector: Peak – Maxhold
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 100ms
- Turntable angle range: –180 to 180 °
- Turntable step size: 45°
- Height variation range: 1 – 4m
- Height variation step size: 0,5m
- 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: 0,5m

#### Step 3:

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 the turntable azimuth and antenna height, which was determined in step 3, 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 in step 3. During this action the value of emission is also continuously measured. The antenna height of the highest emission will also be recorded and adjusted.

Settings for step 3:

- Detector: Peak – Maxhold
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 100ms
- Turntable angle range: -22,5° to + 22,5 ° around the value determined in step 2
- Height variation range: -0,25m to + 0,25m around the value determined in step 2

#### Step 4:

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

EMI receiver settings for step 4:

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

### Measurement above 1GHz

The following modifications apply to the measurement procedure for the frequency range above 1 GHz:

The measurement distance was reduced to 1m. 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
- RBW = VBW = 100 kHz

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.

#### 4.4.2 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 Range (MHz) | Class B Limit (dBµV/m) |
|-----------------------|------------------------|
| 30 – 88               | 40,0                   |
| 88 – 216              | 43,5                   |
| 216 – 960             | 46,0                   |
| above 960             | 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:  $\text{Limit (dBµV/m)} = 20 \log (\text{Limit (µV/m)}/1\mu\text{V/m})$

#### 4.4.3 Test Protocol

Temperature: 22 °C  
Air Pressure: 1007 hPa  
Humidity: 33 %

| Op. Mode  | Setup    | Port      |
|-----------|----------|-----------|
| op-mode 1 | 4E040a01 | enclosure |

| Polarisation | Frequency MHz | Corrected value dBµV / m |       |       | Limit QP / AV dBµV / m | Limit Peak dBµV / m | Delta to AV / QP limit / dB | Delta to Peak limit dB |
|--------------|---------------|--------------------------|-------|-------|------------------------|---------------------|-----------------------------|------------------------|
|              |               | QP                       | Peak  | AV    |                        |                     |                             |                        |
| horizontal   | 4804          |                          | 63,57 | 48,15 | 54                     | 74                  | 5,85                        | 10,43                  |
| horizontal   | 4956          |                          | 55,99 | 47,48 | 54                     | 74                  | 6,52                        | 18,01                  |

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

Temperature: 22 °C  
Air Pressure: 1007 hPa  
Humidity: 33 %

| Op. Mode  | Setup    | Port      |
|-----------|----------|-----------|
| op-mode 2 | 4E040a01 | enclosure |

| Polarisation | Frequency MHz | Corrected value dBµV / m |       |       | Limit QP / AV dBµV / m | Limit Peak dBµV / m | Delta to AV / QP limit / dB | Delta to Peak limit dB |
|--------------|---------------|--------------------------|-------|-------|------------------------|---------------------|-----------------------------|------------------------|
|              |               | QP                       | Peak  | AV    |                        |                     |                             |                        |
| horizontal   | 4800          |                          | 56,95 | 48,60 | 54                     | 74                  | 5,40                        | 17,04                  |
| horizontal   | 4882          |                          | 62,25 | 47,71 | 54                     | 74                  | 6,29                        | 11,75                  |
| vertical     | 7323          |                          | 55,26 | 33,79 | 54                     | 74                  | 20,21                       | 18,74                  |

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

Temperature: 22 °C  
Air Pressure: 1007 hPa  
Humidity: 33 %

| Op. Mode  | Setup    | Port      |
|-----------|----------|-----------|
| op-mode 3 | 4E040a01 | enclosure |

| Polarisation | Frequency MHz | Corrected value dBµV / m |       |       | Limit QP / AV dBµV / m | Limit Peak dBµV / m | Delta to AV / QP limit / dB | Delta to Peak limit dB |
|--------------|---------------|--------------------------|-------|-------|------------------------|---------------------|-----------------------------|------------------------|
|              |               | QP                       | Peak  | AV    |                        |                     |                             |                        |
| horizontal   | 4800          |                          | 57,07 | 48,60 | 54                     | 74                  | 5,40                        | 16,93                  |
| horizontal   | 4960          |                          | 60,41 | 46,90 | 54                     | 74                  | 7,10                        | 13,59                  |

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

#### 4.4.4 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 |

## 4.5 Band edge compliance

**Standard** FCC Part 15, 2004-07-12  
Subpart C

**The test was performed according to:** ANSI C 63.4, 2003  
FCC §15.31, 2004-07-12

### 4.5.1 Test Description

The procedure to show compliance with the band edge requirement is divided into two measurements: 1. Show compliance of the lower band edge by a conducted measurement and 2. show compliance of the higher band edge by a radiated measurement.

For the first measurement the EUT is set to transmit on the lowest channel (2402 MHz). The lower band edge is 2400 MHz.

Analyzer settings:

- Detector: Peak
- RBW= 100 kHz
- VBW= 300 kHz

For the second measurement the EUT is set to transmit on the highest channel (2480 MHz). The higher band edge is 2483,5 MHz.

Analyzer settings:

- Detector: Peak, Average
- RBW = VBW = 100 kHz

### 4.5.2 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.

...

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 measurement of the **lower bandedge** the RF power at the bandedge 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 measurement of the **higher bandedge** the limit is “specified in Section 15.209(a)”.

### 4.5.3 Test Protocol

#### 4.5.3.1 Lower bandedge

Temperature: 21 °C  
Air Pressure: 1019 hPa  
Humidity: 37 %

| Op. Mode  | Setup    | Port           |
|-----------|----------|----------------|
| op-mode 1 | 4E040b01 | temp.ant.conn. |

| Frequency MHz | Corrected value dBm | Reference value dBm | Limit dBm | Delta to limit dB |
|---------------|---------------------|---------------------|-----------|-------------------|
| 2400,00       | -50,57              | -14,51              | -34,51    | -16,06            |

Remark: none

#### 4.5.3.2 Higher bandedge

Temperature: 22 °C  
Air Pressure: 1007 hPa  
Humidity: 33 %

| Op. Mode  | Setup    | Port      |
|-----------|----------|-----------|
| op-mode 3 | 4E040a01 | enclosure |

| Frequency MHz | Polarisation | Corrected value dBµV / m |    | Limit AV dBµV / m | Limit Peak dBµV / m | Delta to AV limit / dB | Delta to Peak limit dB |
|---------------|--------------|--------------------------|----|-------------------|---------------------|------------------------|------------------------|
|               |              | Peak                     | AV |                   |                     |                        |                        |
| 2483,50       |              | 47,17                    |    | 54,00             | 74,00               |                        | 6,83                   |

Remark: none

### 4.5.4 Test result: Band edge compliance

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



## 4.6 Dwell time

**Standard** FCC Part 15, 2004-07-12  
Subpart C

**The test was performed according to:** FCC §15.31, 2004-07-12

### 4.6.1 Test Description

The Equipment Under Test (EUT) was set up in a shielded room to perform the dwell time measurements.

The EUT was connected to the spectrum analyzer via a short coax cable with a known loss.

The time slot length is measured of three different packet types which are available in the Bluetooth technology. Those are DH1, DH3 and DH5 packets. The dwell time is calculated by:

$\text{Dwell time} = \text{time slot length} * \text{hop rate} / \text{number of hopping channels} * 31.6\text{s}$

with:

- hop rate =  $1600 * 1/\text{s}$  for DH1 packets = 1600
- hop rate =  $1600/3 * 1/\text{s}$  for DH3 packets = 533.33
- hop rate =  $1600/5 * 1/\text{s}$  for DH5 packets = 320
- number of hopping channels = 79
- $31.6\text{ s} = 0.4\text{ seconds multiplied by the number of hopping channels} = 0.4\text{s} * 79$

### 4.6.2 Test Requirements / Limits

FCC Part 15, Subpart C, §15.247 (a) (1) (iii)

Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

Since the Bluetooth technology uses 79 channels this period is calculated to be 31.6 seconds.

#### 4.6.3 Test Protocol

Temperature: 23 °C  
Air Pressure: 1017 hPa  
Humidity: 33 %

| Op. Mode  | Setup    | Port           |
|-----------|----------|----------------|
| op-mode 2 | 4E040b01 | temp.ant.conn. |

| Packet type | Time slot length<br>μs | Dwell time<br>ms | Remark |
|-------------|------------------------|------------------|--------|
| DH1         | 392,79                 | 0,251            |        |
| DH3         | 1655,33                | 0,353            |        |
| DH5         | 2903,80                | 0,372            |        |

Remark: Please see annex for the measurement plots.

#### 4.6.4 Test result: Dwell time

| FCC Part 15, Subpart C |           | Op. Mode | Result |
|------------------------|-----------|----------|--------|
|                        | op-mode 2 | DH1      | passed |
|                        | op-mode 2 | DH3      | passed |
|                        | op-mode 2 | DH5      | passed |

#### 4.7 Channel separation

**Standard** FCC Part 15, 2004-07-12  
Subpart C

**The test was performed according to:** FCC §15.31, 2004-07-12

##### 4.7.1 Test Description

The Equipment Under Test (EUT) was set up in a shielded room to perform the channel separation measurements.

The EUT was connected to spectrum analyzer via a short coax cable with a known loss.  
Analyzer settings:

- Detector: Peak-Maxhold
- Span: 10 MHz
- Centre Frequency: 2441 MHz
- Resolution Bandwidth (RBW): 30 kHz
- Video Bandwidth (VBW): 30 kHz
- Sweep Time: Coupled

##### 4.7.2 Test Requirements / Limits

FCC Part 15, Subpart C, §15.247 (a) (1)

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

##### 4.7.3 Test Protocol

Temperature: 21 °C  
Air Pressure: 1030 hPa  
Humidity: 33 %

| Op. Mode  | Setup    | Port           |
|-----------|----------|----------------|
| op-mode 4 | 4E040b01 | temp.ant.conn. |

| Channel separation<br>MHz | Remarks |
|---------------------------|---------|
| 1,02                      |         |

Remark: Please see annex for the measurement plot.

##### 4.7.4 Test result: Channel separation

| FCC Part 15, Subpart C | Op. Mode  | Result |
|------------------------|-----------|--------|
|                        | op-mode 4 | passed |

#### 4.8 Number of hopping frequencies

**Standard** FCC Part 15, 2004-07-12  
Subpart C

**The test was performed according to:** FCC §15.31, 2004-07-12

##### 4.8.1 Test Description

The Equipment Under Test (EUT) was set up in a shielded room to perform the channel separation measurements.

The EUT was connected to spectrum analyzer via a short coax cable with a known loss.  
Analyzer settings:

- Detector: Peak-Maxhold
- Span: 83,5 MHz
- Resolution Bandwidth (RBW): 100 kHz
- Video Bandwidth (VBW): 300 kHz
- Sweep Time: Coupled

##### 4.8.2 Test Requirements / Limits

FCC Part 15, Subpart C, §15.247 (a)

##### 4.8.3 Test Protocol

Temperature: 21 °C  
Air Pressure: 1030 hPa  
Humidity: 33 %

| Op. Mode  | Setup    | Port           |
|-----------|----------|----------------|
| op-mode 4 | 4E040b01 | temp.ant.conn. |

| Number of hopping channels | Remarks |
|----------------------------|---------|
| 79                         |         |

Remark: Please see annex for the measurement plot.

##### 4.8.4 Test result: Number of hopping frequencies

| FCC Part 15, Subpart C | Op. Mode  | Result |
|------------------------|-----------|--------|
|                        | op-mode 4 | passed |

## 5 Test Equipment

### *EUT Digital Signalling System*

| Equipment                                        | Type    | Serial No. | Manufacturer    |
|--------------------------------------------------|---------|------------|-----------------|
| Digital Radio Communication Tester               | CMD 55  | 831050/020 | Rohde & Schwarz |
| Signalling Unit for Bluetooth Spurious Emissions | PTW60   | 100004     | Rohde & Schwarz |
| Universal Radio Communication Tester             | CMU 200 | 102366     | Rohde & Schwarz |

### *EMI Test System*

| Equipment                | Type    | Serial No. | Manufacturer    |
|--------------------------|---------|------------|-----------------|
| Comparison Noise Emitter | CNE III | 99/016     | York            |
| EMI Analyzer             | ESI 26  | 830482/004 | Rohde & Schwarz |
| Signal Generator         | SMR 20  | 846834/008 | Rohde & Schwarz |

### *EMI Radiated Auxiliary Equipment*

| Equipment                       | Type                 | Serial No.          | Manufacturer          |
|---------------------------------|----------------------|---------------------|-----------------------|
| Antenna mast 4m                 | MA 240               | 240/492             | HD GmbH H. Deisel     |
| Biconical dipole                | VUBA 9117            | 9117108             | Schwarzbeck           |
| Broadband Amplifier 18MHz-26GHz | JS4-18002600-32      | 849785              | Miteq                 |
| Broadband Amplifier 30MHz-18GHz | JS4-00101800-35      | 896037              | Miteq                 |
| Broadband Amplifier 45MHz-27GHz | JS4-00102600-42      | 619368              | Miteq                 |
| Cable "ESI to EMI Antenna"      | EcoFlex10            | W18.01-2 + W38.01-2 | Kabel Kusch           |
| Cable "ESI to Horn Antenna"     | UFB311A + UFB293C    | W18.02-2 + W38.02-2 | Rosenberger-Microcoax |
| Double-ridged horn              | HF 906               | 357357/002          | Rohde & Schwarz       |
| Double-ridged horn              | HF 906               | 357357/001          | Rohde & Schwarz       |
| High Pass Filter                | 5HC3500/12750-1.2-KK | 200035008           | Trilithic             |
| High Pass Filter                | 5HC2700/12750-1.5-KK | 9942012             | Trilithic             |
| High Pass Filter                | 4HC1600/12750-1.5-KK | 9942011             | Trilithic             |
| KUEP pre amplifier              | Kuep 00304000        | 001                 | 7layers               |
| Log.-per. Antenna               | HL 562 Ultralog      | 830547/003          | Rohde & Schwarz       |
| Loop Antenna                    | HFH2-Z2              | 829324/006          | Rohde & Schwarz       |
| Pyramidal Horn Antenna 26,5 GHz | Model 3160-09        | 9910-1184           | EMCO                  |

### EMI Conducted Auxiliary Equipment

| Equipment           | Type     | Serial No.    | Manufacturer    |
|---------------------|----------|---------------|-----------------|
| Cable "LISN to ESI" | RG214    | W18.03+W48.03 | Huber+Suhner    |
| Two-Line V-Network  | ESH 3-Z5 | 828304/029    | Rohde & Schwarz |
| Two-Line V-Network  | ESH 3-Z5 | 829996/002    | Rohde & Schwarz |

### Auxiliary Test Equipment

| Equipment                           | Type                 | Serial No.     | Manufacturer                      |
|-------------------------------------|----------------------|----------------|-----------------------------------|
| Broadband Resist. Power Divider N   | 1506A / 93459        | LM390          | Weinschel                         |
| Broadband Resist. Power Divider SMA | 1515 / 93459         | LN673          | Weinschel                         |
| Digital Multimeter 01               | Voltcraft M-3860M    | IJ096055       | Conrad                            |
| Digital Multimeter 02               | Voltcraft M-3860M    | IJ095955       | Conrad                            |
| Digital Oscilloscope                | TDS 784C             | B021311        | Tektronix                         |
| Fibre optic link Satellite          | FO RS232 Link        | 181-018        | Pontis                            |
| Fibre optic link Transceiver        | FO RS232 Link        | 182-018        | Pontis                            |
| I/Q Modulation Generator            | AMIQ-B1              | 832085/018     | Rohde & Schwarz                   |
| Notch Filter ultra stable           | WRCA800/960-6E       | 24             | Wainwright                        |
| Spectrum Analyzer 9 kHz to 3 GHz    | FSP3                 | 838164/004     | Rohde & Schwarz                   |
| Temperature Chamber                 | VT 4002              | 58566002150010 | Vötsch                            |
| Temperature Chamber                 | KWP 120/70           | 59226012190010 | Weiss                             |
| ThermoHygro Datalogger 03           | Opus10 THI (8152.00) | 7482           | Lufft Mess- und Regeltechnik GmbH |

### Anechoic Chamber

| Equipment                         | Type           | Serial No. | Manufacturer       |
|-----------------------------------|----------------|------------|--------------------|
| Air Compressor (pneumatic)        |                |            | Atlas Copco        |
| Controller                        | HD 100         | 100/603    | HD GmbH H. Deisel  |
| EMC Camera                        | CE-CAM/1       |            | CE-SYS             |
| EMC Camera for observation of EUT | CCD-400E       | 0005033    | Mitsubishi         |
| Filter ISDN                       | B84312-C110-E1 |            | Siemens&Matsushita |
| Filter telephone systems / modem  | B84312-C40-B1  |            | Siemens&Matsushita |
| Filter Universal 1A               | B84312-C30-H3  |            | Siemens&Matsushita |
| Fully/Semi AE Chamber             | 10.58x6.38x6   |            | Frankonia          |
| Turntable                         | DS 420S        | 420/573/99 | HD GmbH, H. Deisel |
| Valve Control Unit (pneum.)       | VE 615P        | 615/348/99 | HD GmbH, H. Deisel |

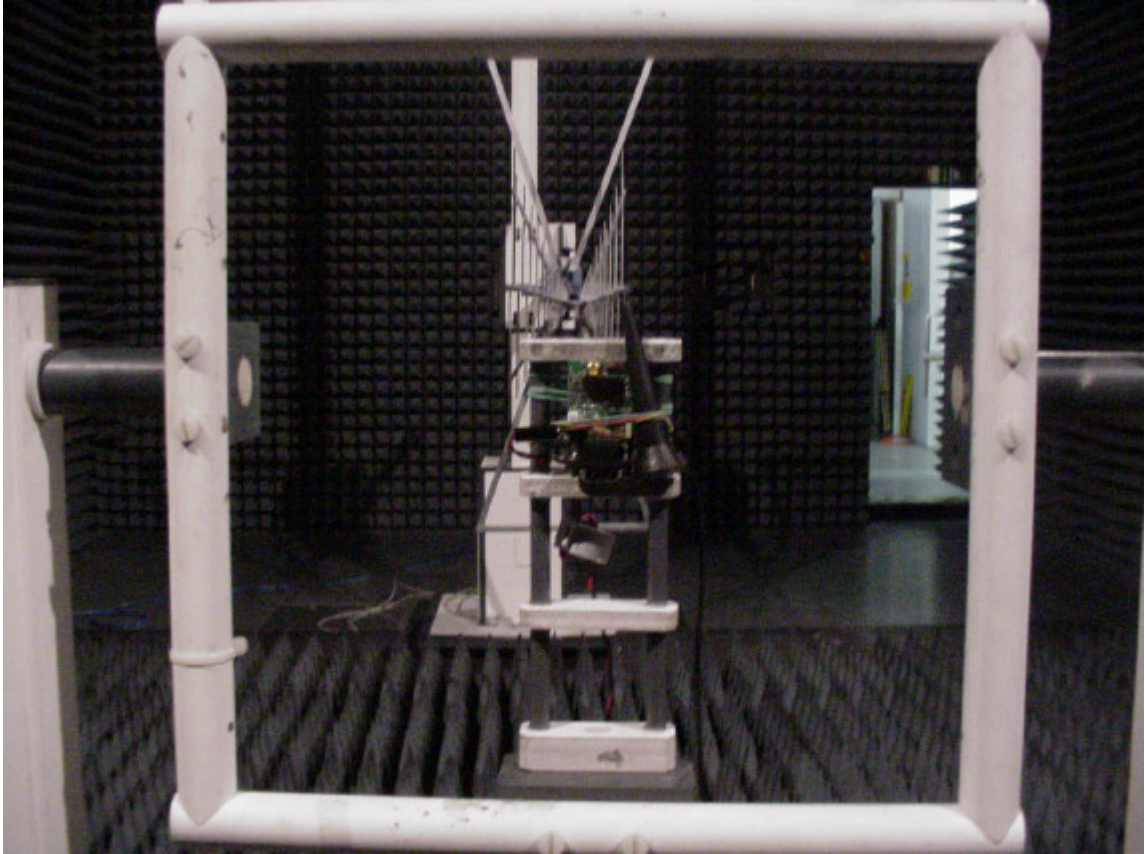


*7 layers Bluetooth Full RF Test  
Solution*

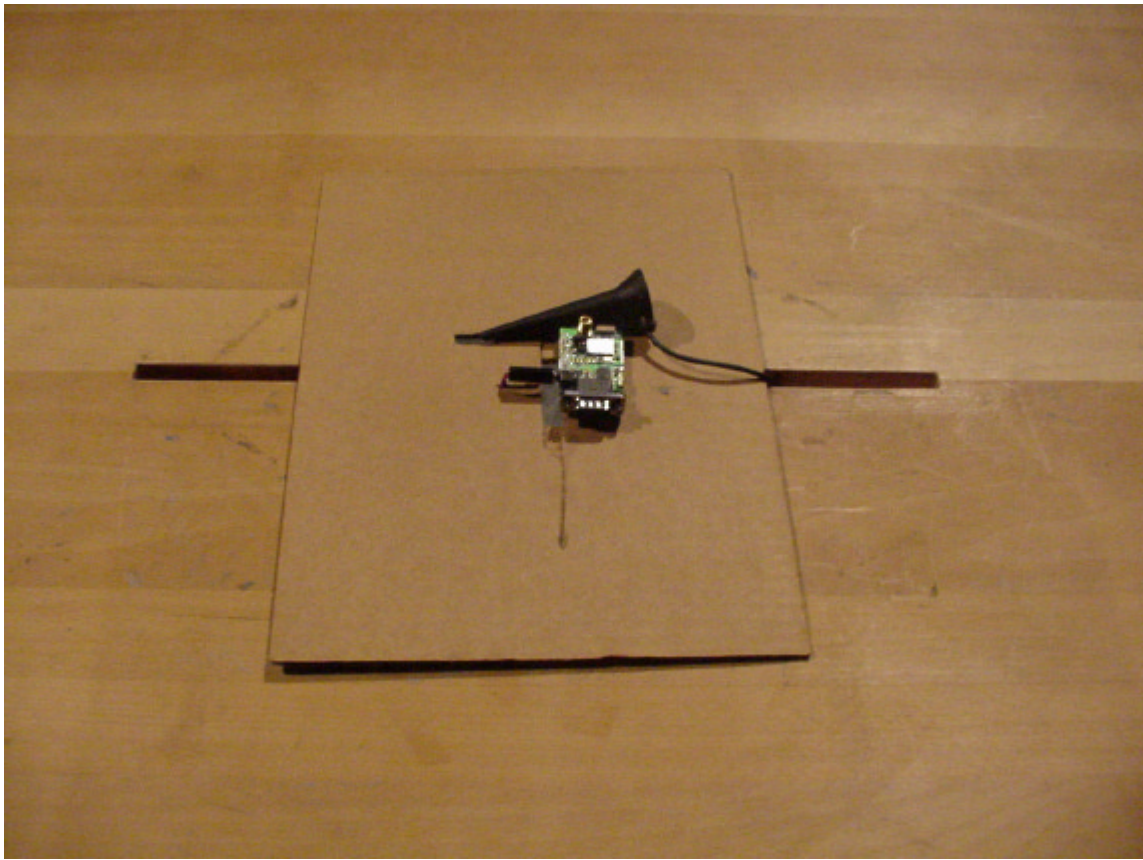
*Bluetooth RF Conformance  
Test System TS8960*

| <b>Equipment</b>                          | <b>Type</b>      | <b>Serial No.</b> | <b>Manufacturer</b> |
|-------------------------------------------|------------------|-------------------|---------------------|
| 10 MHz Reference                          | MFS              | 5489/001          | Efratom             |
| Power Meter<br>832025/059                 | NRVD             | 832025/059        | Rohde & Schwarz     |
| Power Sensor A<br>832279/013              | NRV-Z1           | 832279/013        | Rohde & Schwarz     |
| Power Sensor B<br>832279/015              | NRV-Z1           | 832279/015        | Rohde & Schwarz     |
| Power Supply                              | E3632A           | MY40003776        | Agilent             |
| Power Supply                              | PS-2403D         | -                 | Conrad              |
| RF Step Attenuator<br>833695/001          | RSP              | 833695/001        | Rohde & Schwarz     |
| Rubidium Frequency<br>Normal              | MFS              | 002               | Efratom             |
| Signal Analyzer FSIQ26<br>832695/007      | FSIQ26           | 832695/007        | Rohde & Schwarz     |
| Signal Generator<br>833680/003            | SMP 03           | 833680/003        | Rohde & Schwarz     |
| Signal Generator A<br>834344/002          | SMIQ03B          | 834344/002        | Rohde & Schwarz     |
| Signal Generator B<br>832870/017          | SMIQ03B          | 832870/017        | Rohde & Schwarz     |
| Signal Switching and<br>Conditioning Unit | SSCU             | 338826/005        | Rohde & Schwarz     |
| Signalling Unit PTW60<br>838312/014       | PTW60 for TS8960 | 838312/014        | Rohde & Schwarz     |
| System Controller<br>829323/008           | PSM12            | 829323/008        | Rohde & Schwarz     |

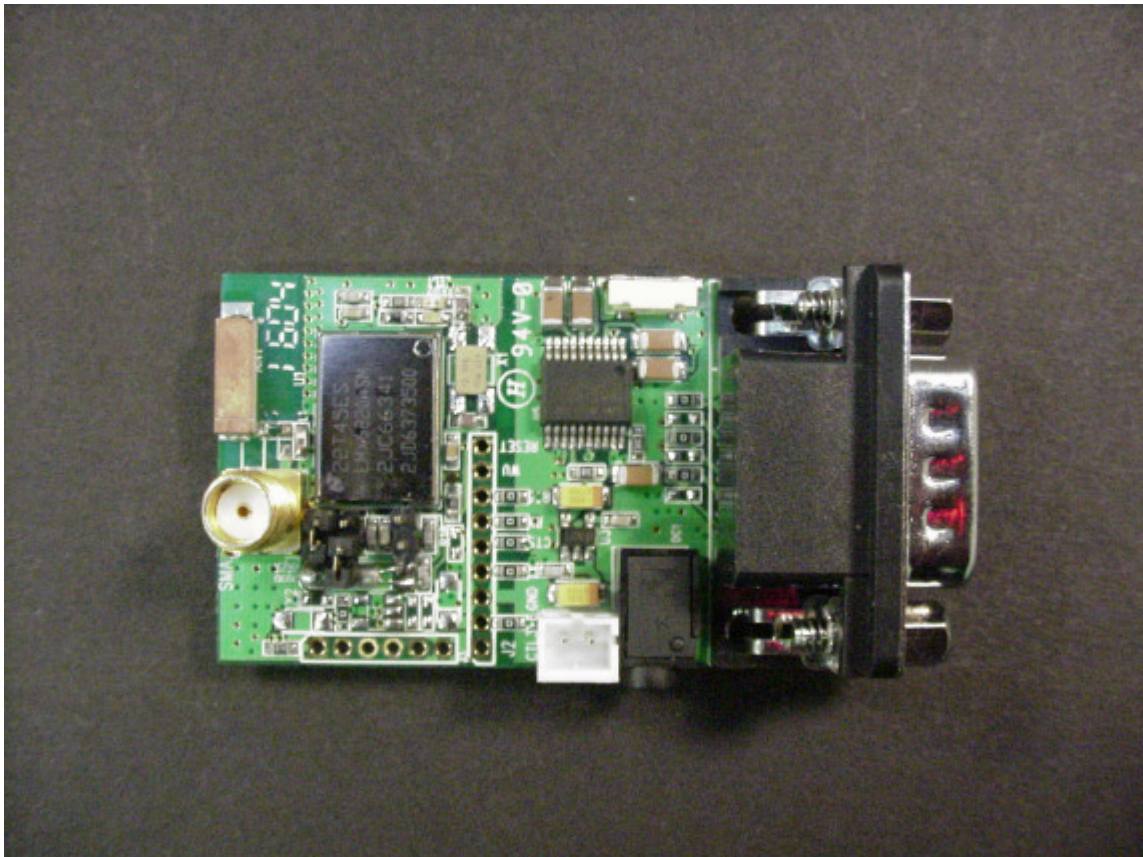
## 6 Photo Report



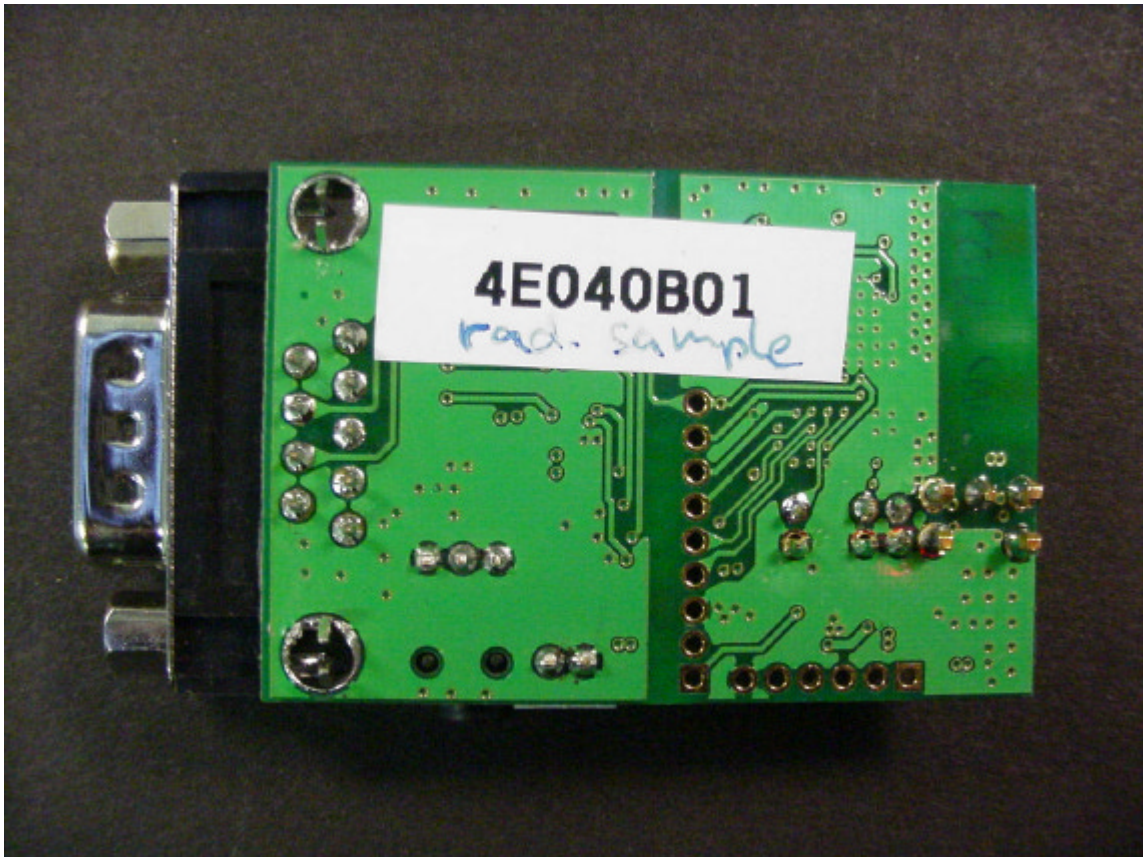
**Photo 1:** Test setup for radiated measurements ( $> 1$  GHz)



**Photo 2:** Detail of test setup for radiated measurements ( $< 1$  GHz)

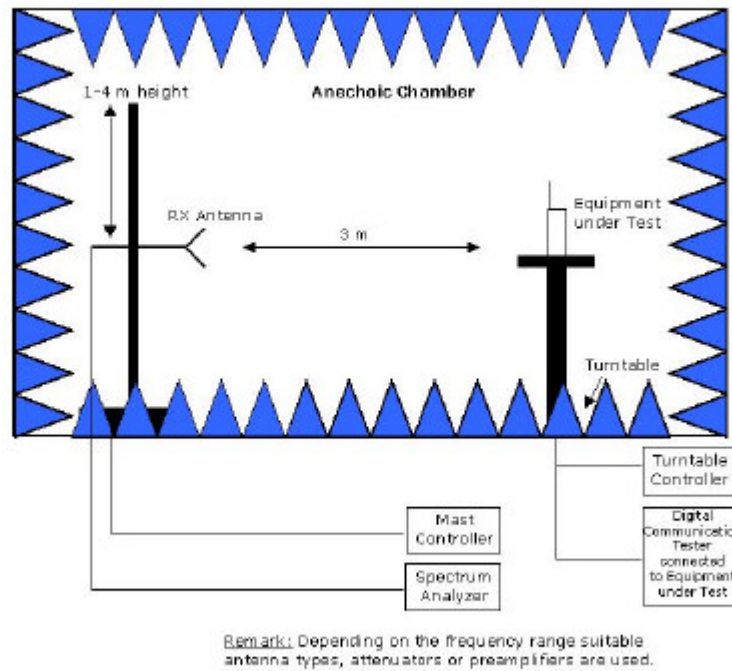


**Photo 3:** EUT (front side)



**Photo 4:** EUT (rear side)

## 7 Setup Drawings



**Drawing 1:** Setup in the Anechoic chamber. For measurements below 1 GHz the ground was replaced by a conducting ground plane.

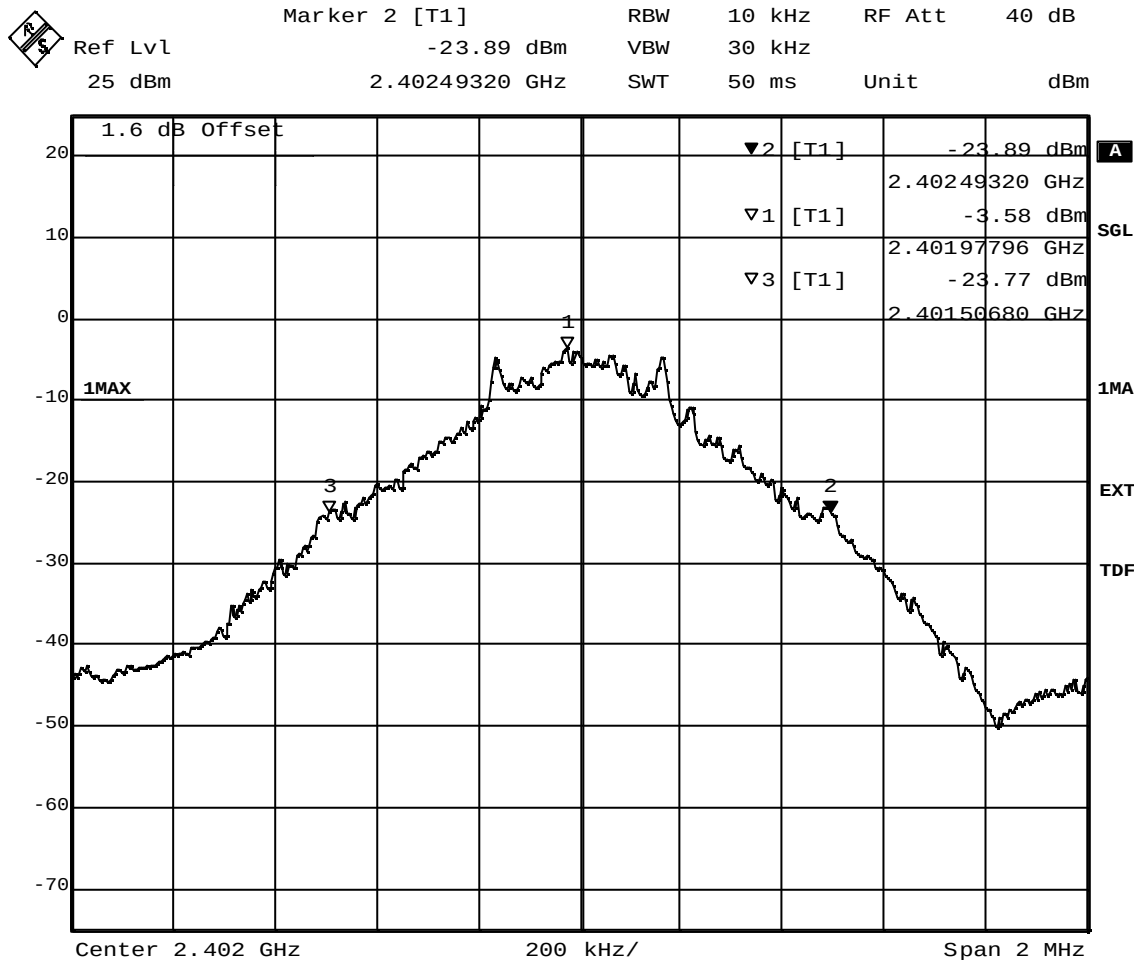
## 8 Annex

Measurement plots

### Occupied bandwidth

#### Op. Mode

op-mode 1



Title: 20dB Bandwidth

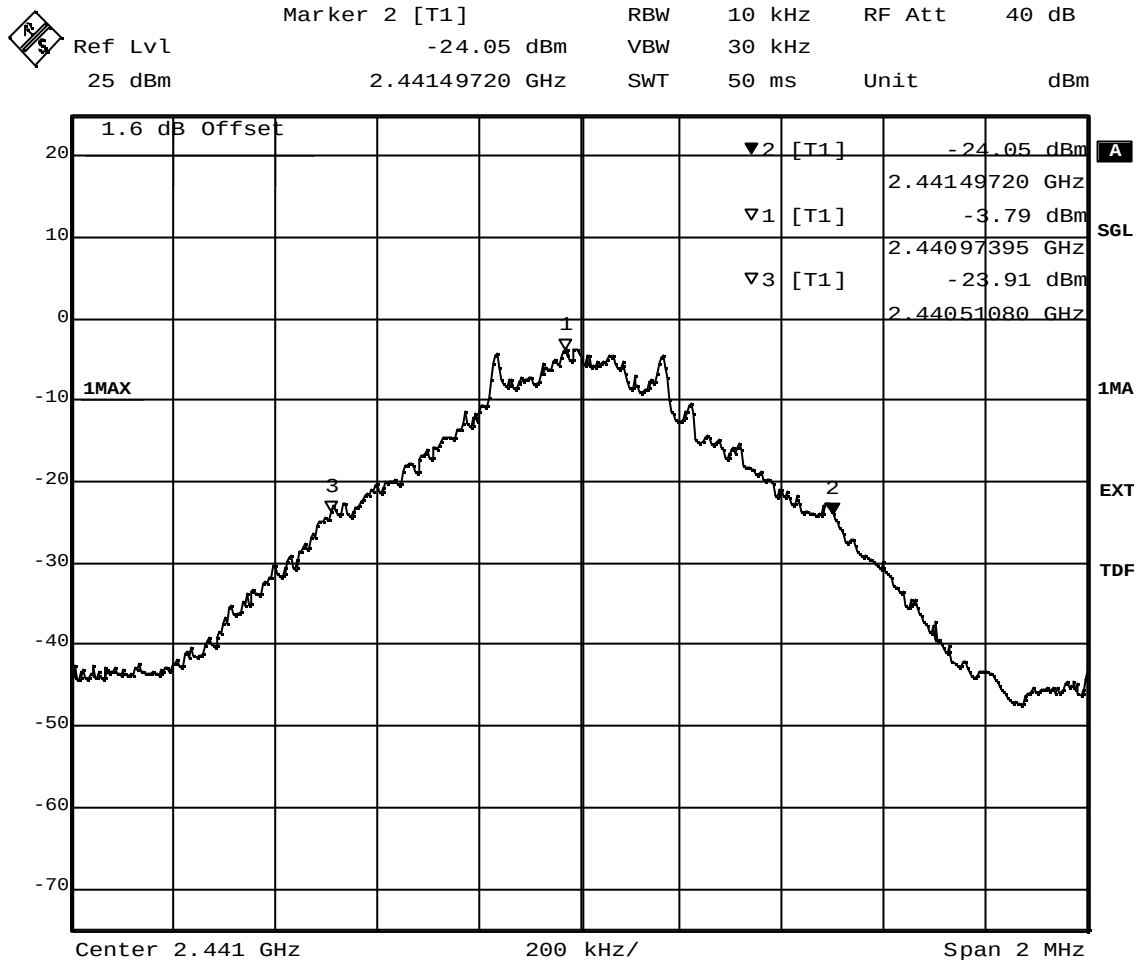
Comment A: CH B: 2402 MHz; 20dB bandwidth (kHz):986.4

Date: 16.NOV.2004 10:27:54

## Occupied bandwidth

### Op. Mode

op-mode 2



Title: 20dB Bandwidth

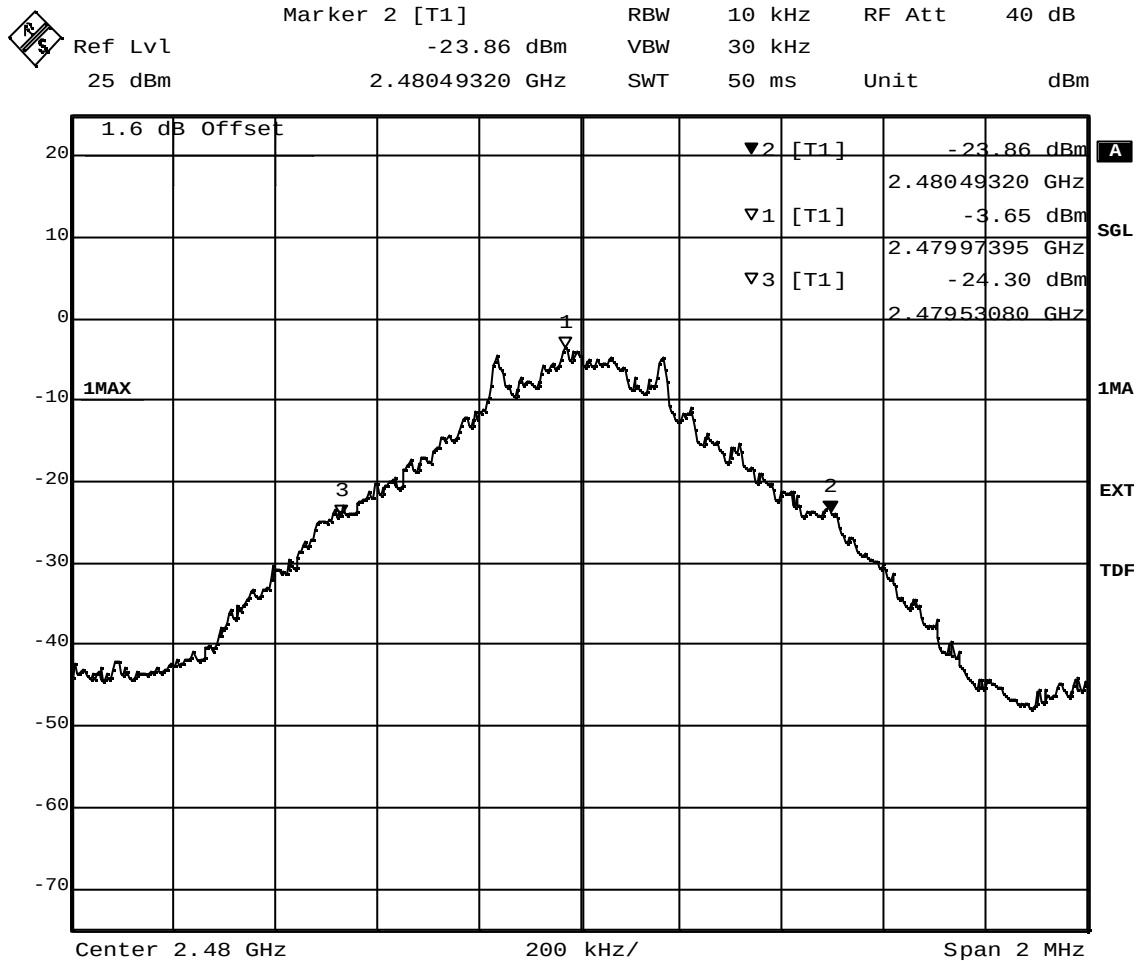
Comment A: CH M: 2441 MHz; 20dB bandwidth (kHz):986.4

Date: 16.NOV.2004 10:54:37

## Occupied bandwidth

### Op. Mode

op-mode 3



Title: 20dB Bandwidth

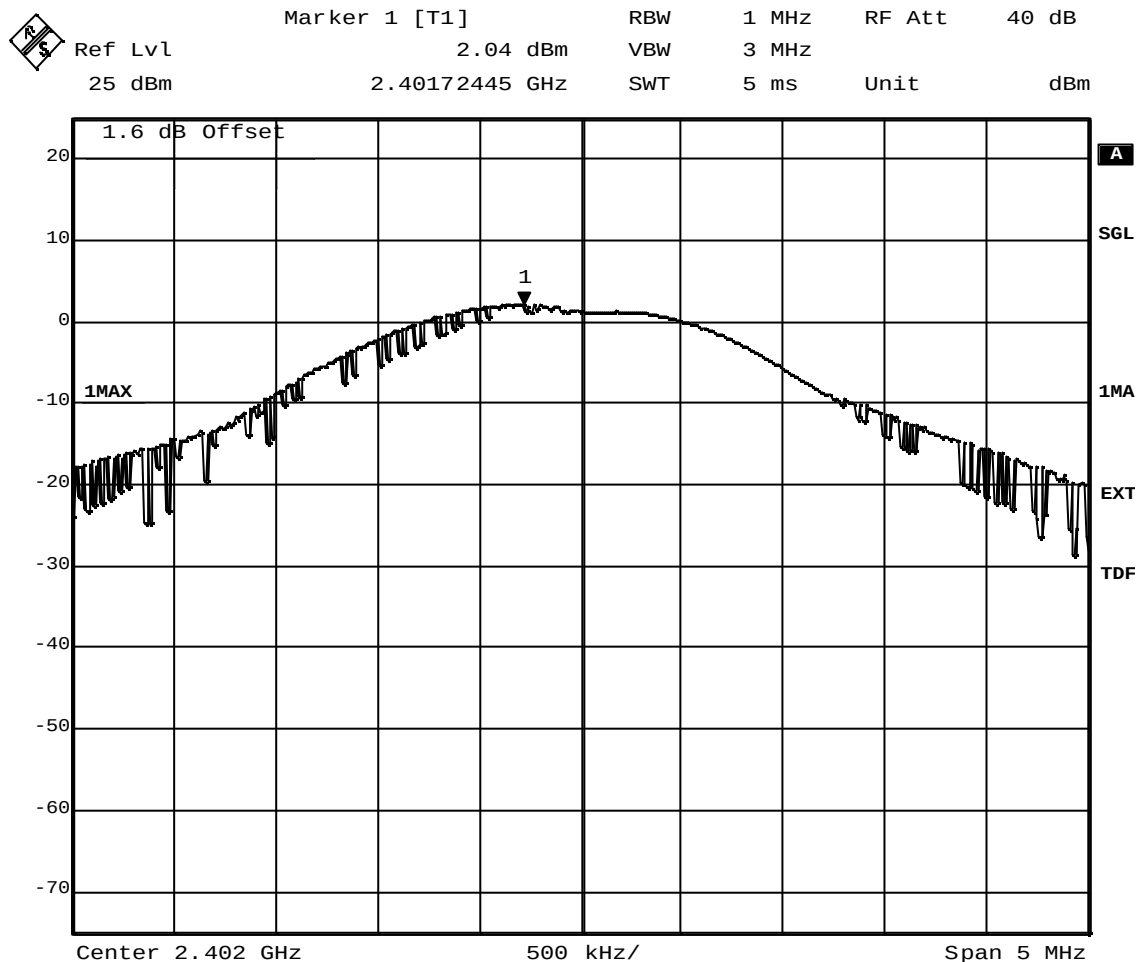
Comment A: CH T: 2480 MHz; 20dB bandwidth (kHz):962.4

Date: 16.NOV.2004 09:50:52

## Peak power output

### Op. Mode

op-mode 1



Title: Peak outputpower Power

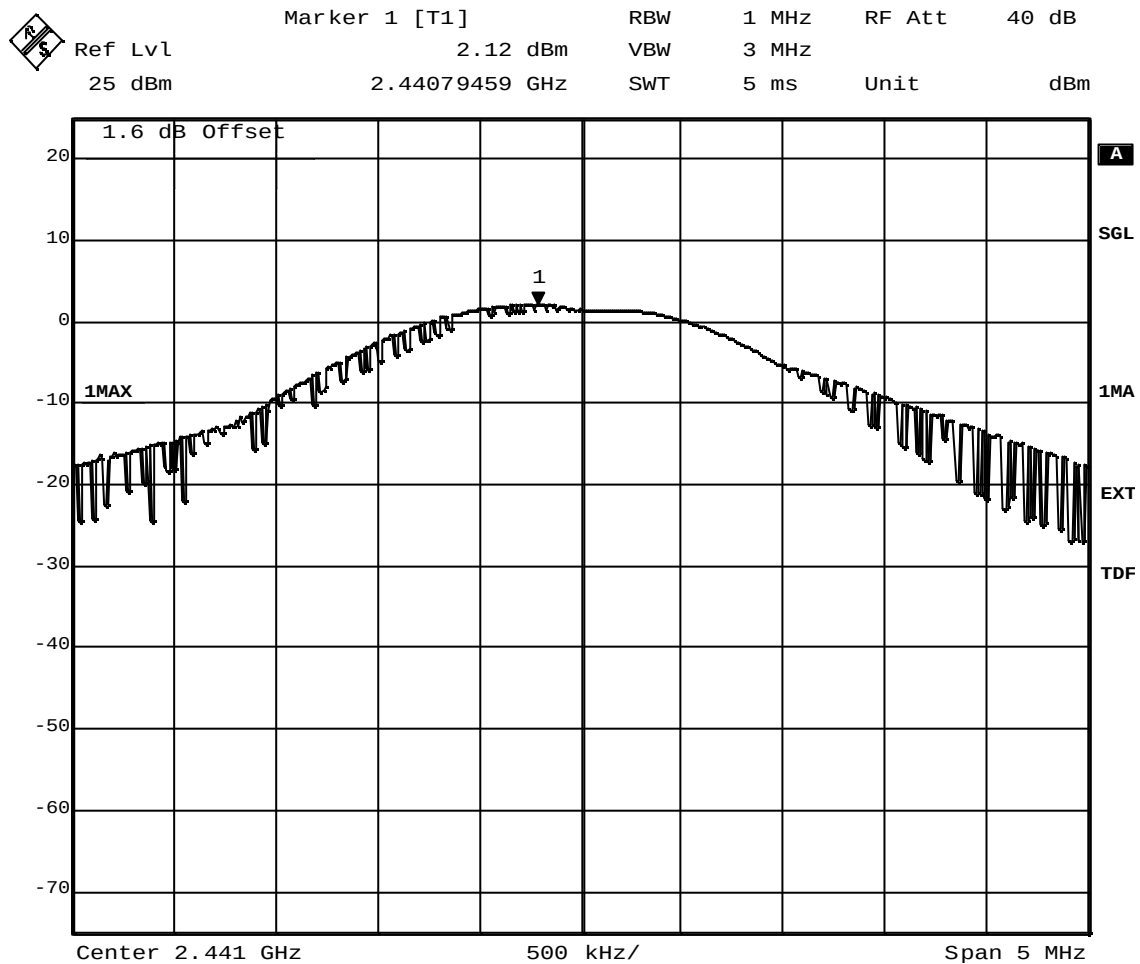
Comment A: CH B: 2402 MHz

Date: 16.NOV.2004 10:28:21

## Peak power output

### Op. Mode

op-mode 2



Title: Peak outputpower Power

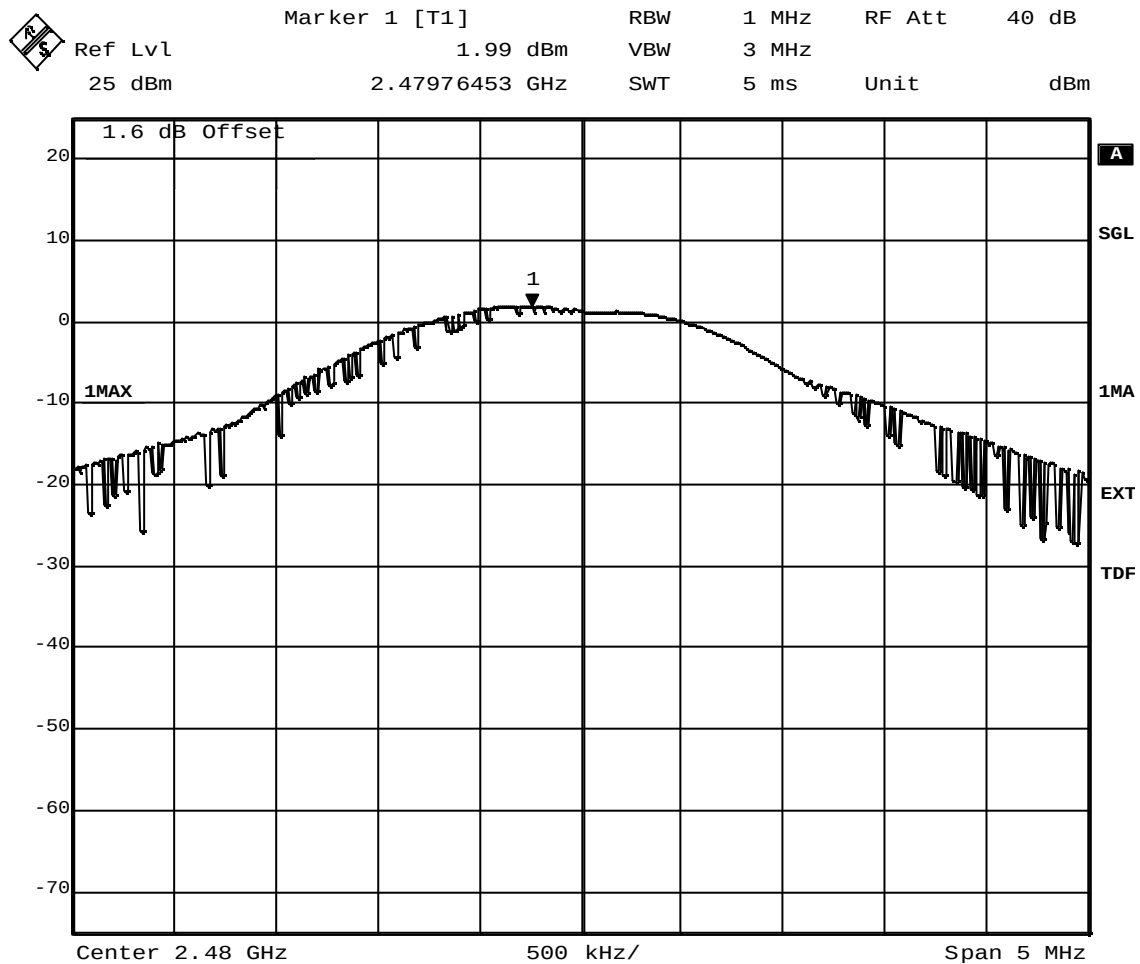
Comment A: CH M: 2441 MHz

Date: 16.NOV.2004 10:55:04

## Peak power output

### Op. Mode

op-mode 3



Title: Peak outputpower Power

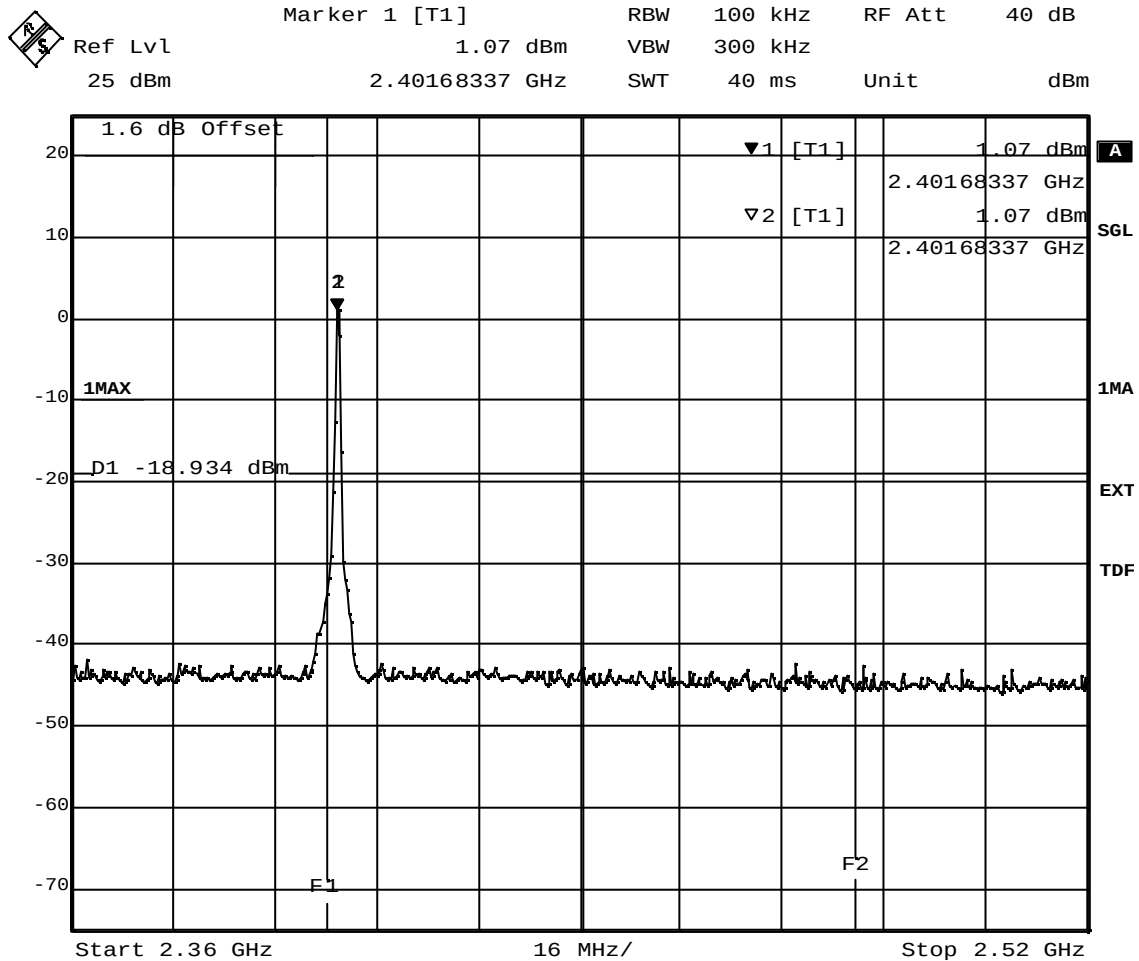
Comment A: CH T: 2480 MHz

Date: 16.NOV.2004 09:51:20

## Spurious RF conducted emission

### Op. Mode

op-mode 1

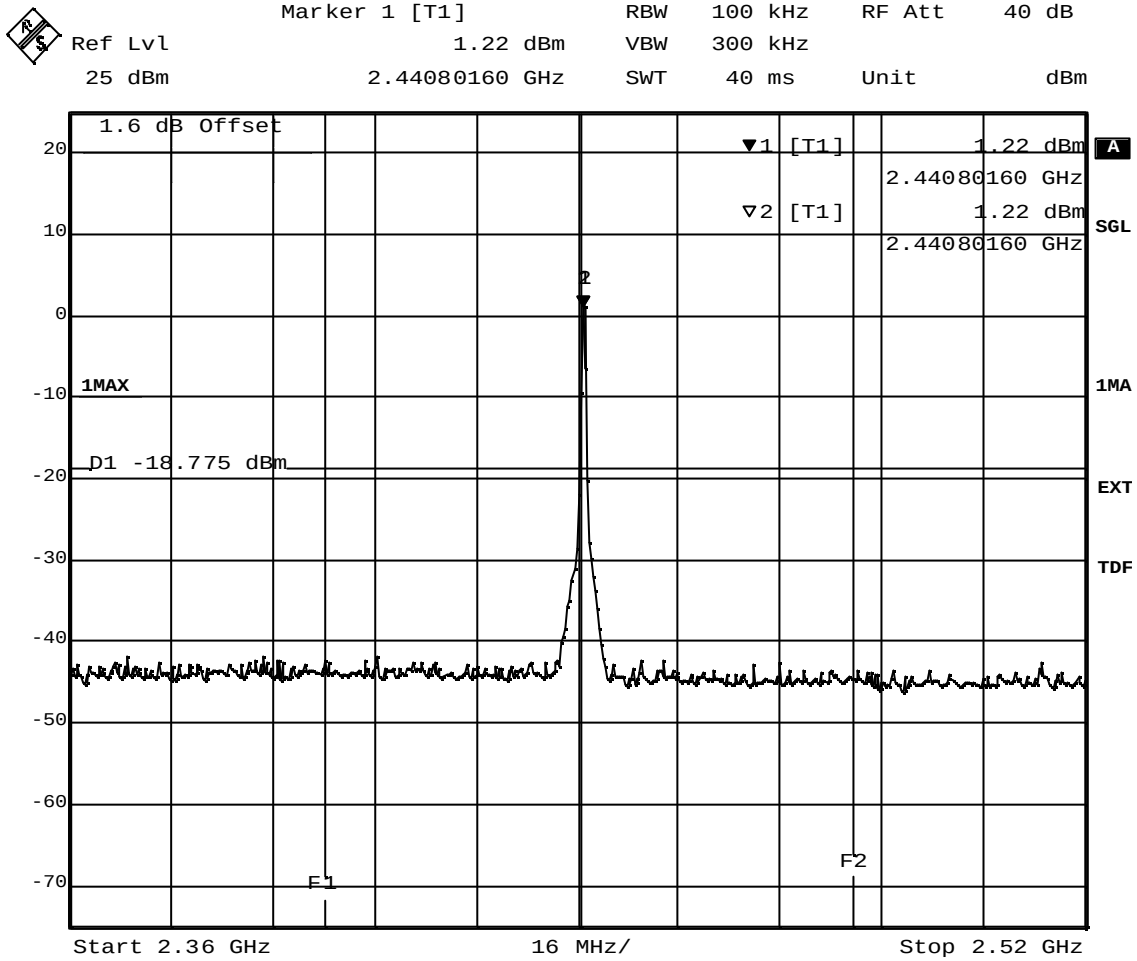


Title: Band Edge Compliance

Comment A: CH B: 2402 MHz

Date: 16.NOV.2004 10:18:16

(determination of reference value)



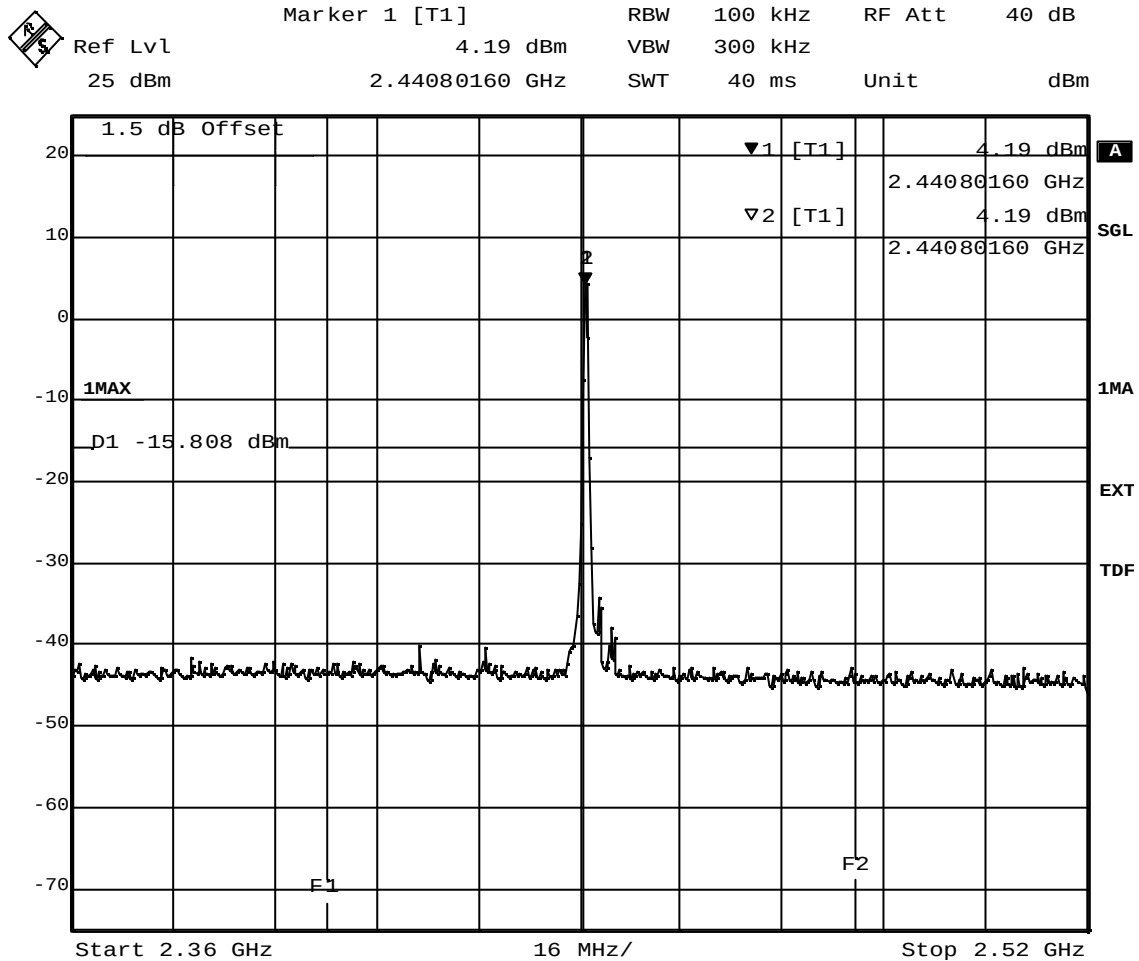
Title: Band Edge Compliance  
 Comment A: CH M: 2441 MHz  
 Date: 16.NOV.2004 10:45:08

(spurious emissions measurement)

## Spurious RF conducted emission

### Op. Mode

op-mode 2



Title: Band Edge Compliance

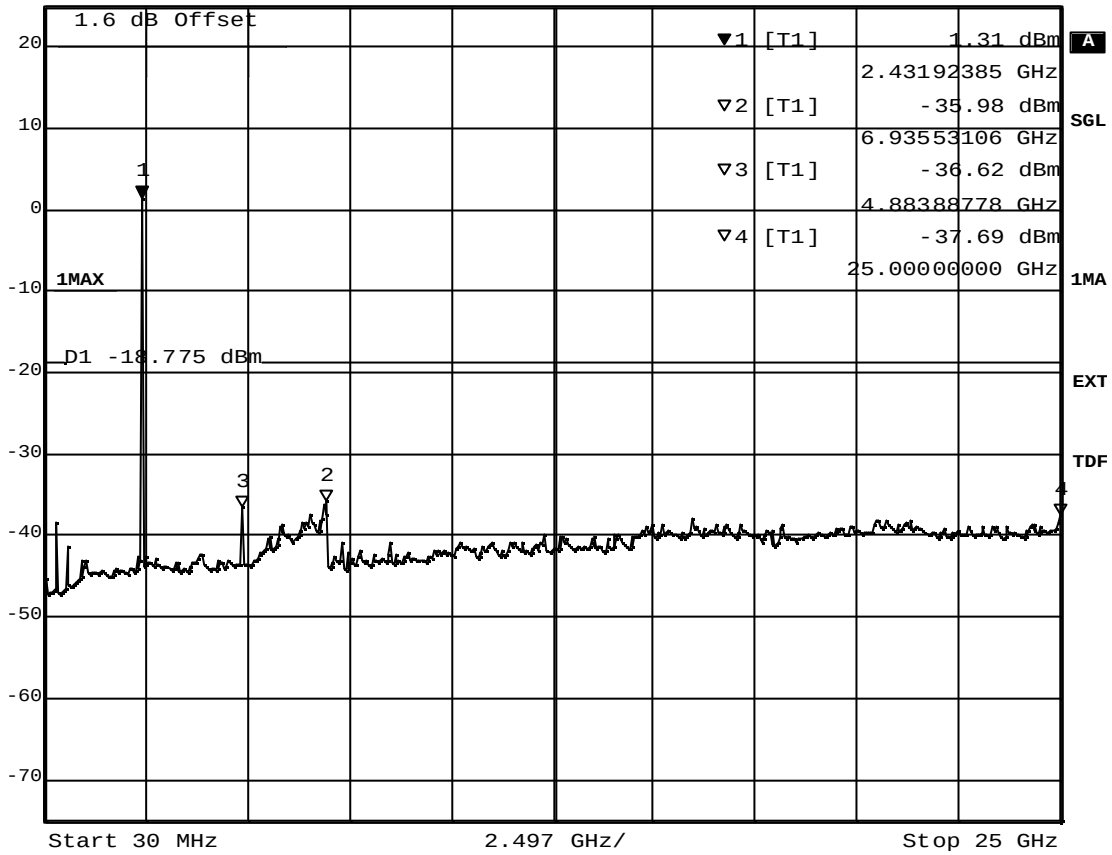
Comment A: CH M: 2441 MHz

Date: 22.OCT.2004 13:46:39

(determination of reference value)



Marker 1 [T1]      RBW    100 kHz    RF Att    40 dB  
 Ref Lvl                    1.31 dBm    VBW    300 kHz  
 25 dBm                    2.43192385 GHz    SWT    330 s    Unit            dBm



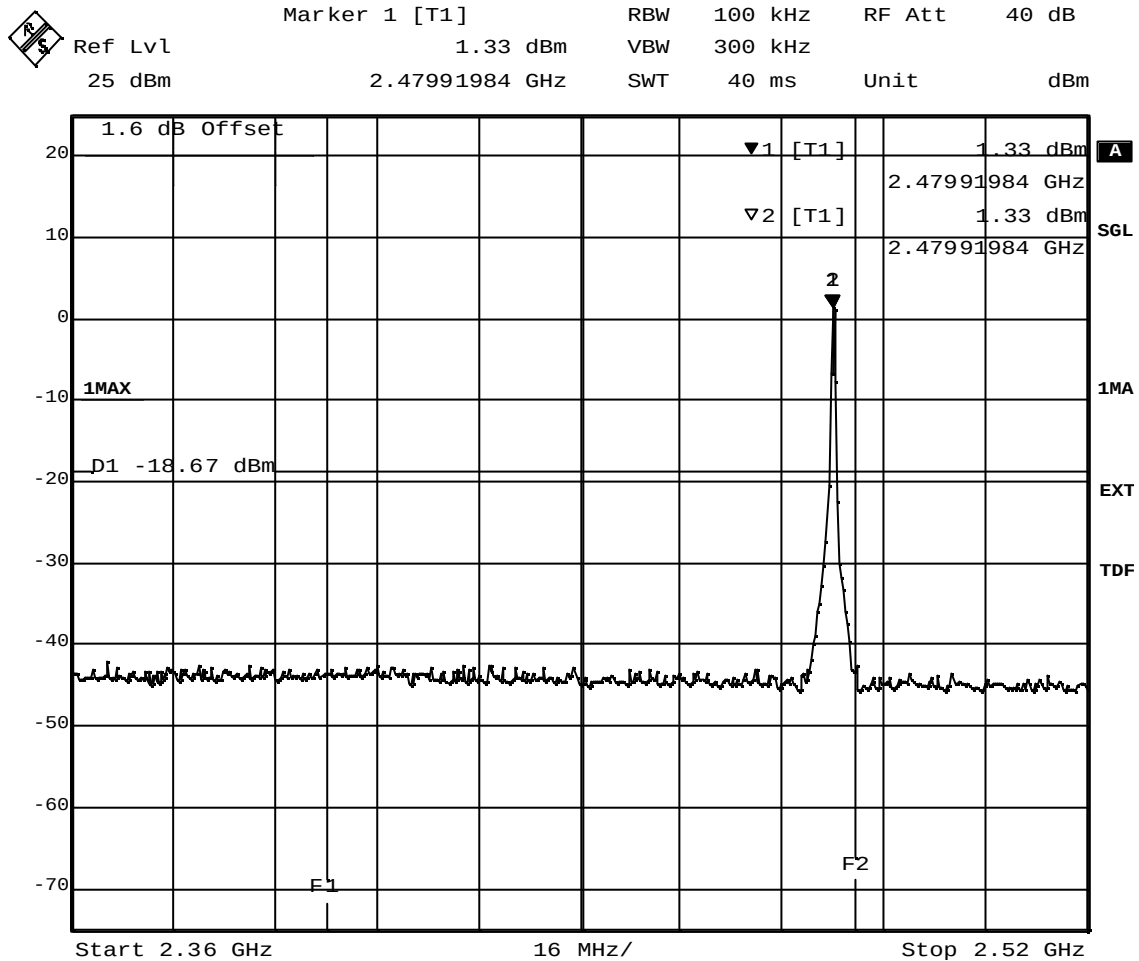
Title:            spurious emissions  
 Comment A:    CH M: 2441 MHz  
 Date:            16.NOV.2004 10:51:15

(spurious emissions measurement)

## Spurious RF conducted emission

### Op. Mode

op-mode 3



Title: Band Edge Compliance

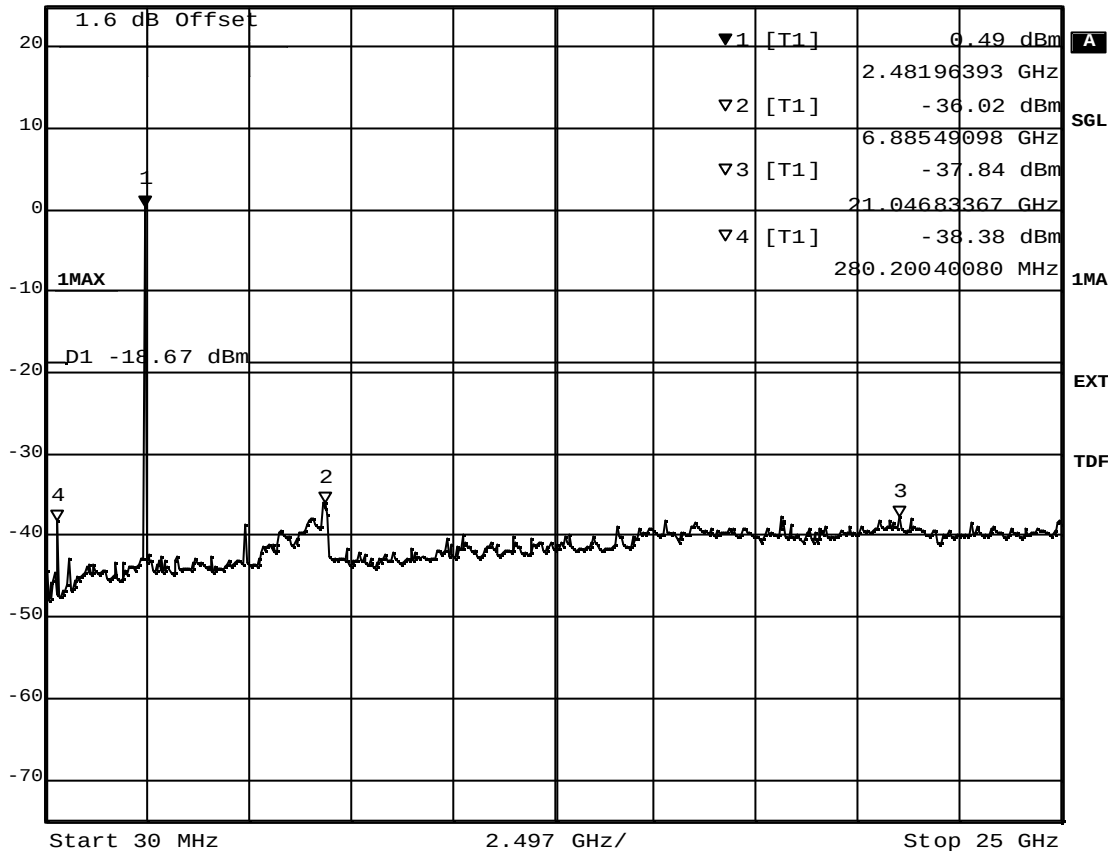
Comment A: CH T: 2480 MHz

Date: 16.NOV.2004 09:41:12

(determination of reference value)



Ref Lvl 25 dBm  
 Marker 1 [T1] 0.49 dBm  
 RBW 100 kHz  
 VBW 300 kHz  
 RF Att 40 dB  
 SWT 330 s  
 Unit dBm



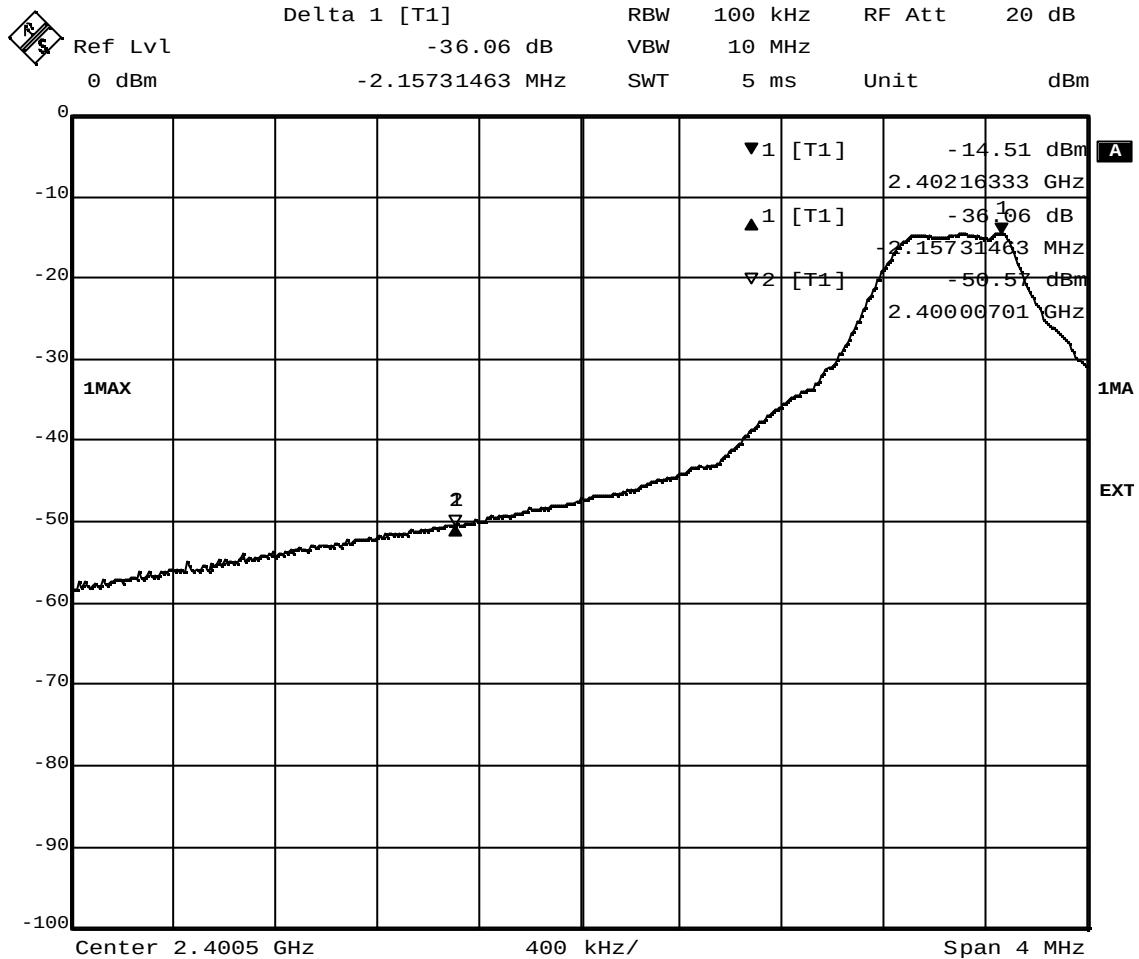
Title: spurious emissions  
 Comment A: CH T: 2480 MHz  
 Date: 16.NOV.2004 09:47:19

(spurious emissions measurement)

## Band Edge Compliance

### Op. Mode

op-mode 1

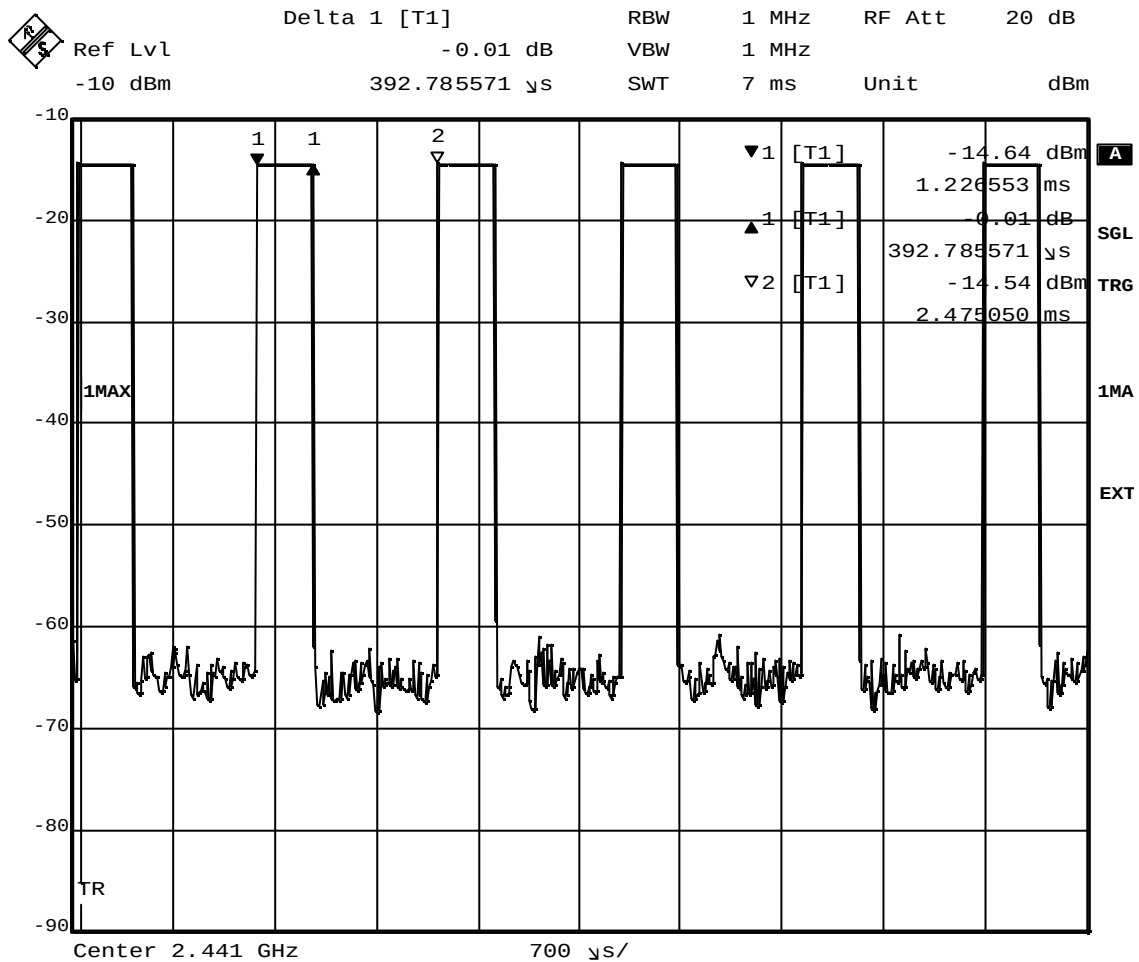


Date: 17.NOV.2004 14:52:23

## Dwell time

### Op. Mode

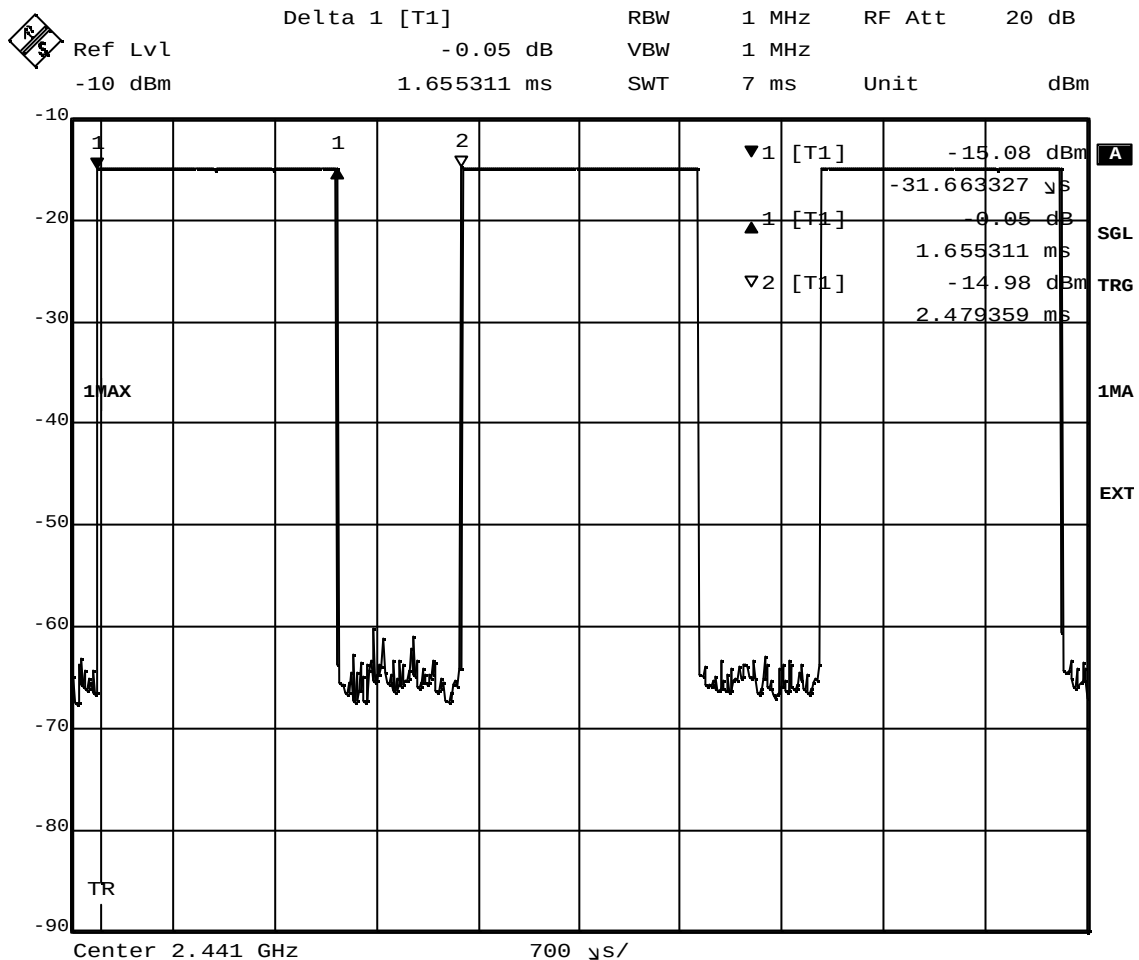
op-mode 2 Time slot measurement of a DH1 packet



## Dwell time

### Op. Mode

op-mode 2 Time slot measurement of a DH3 packet

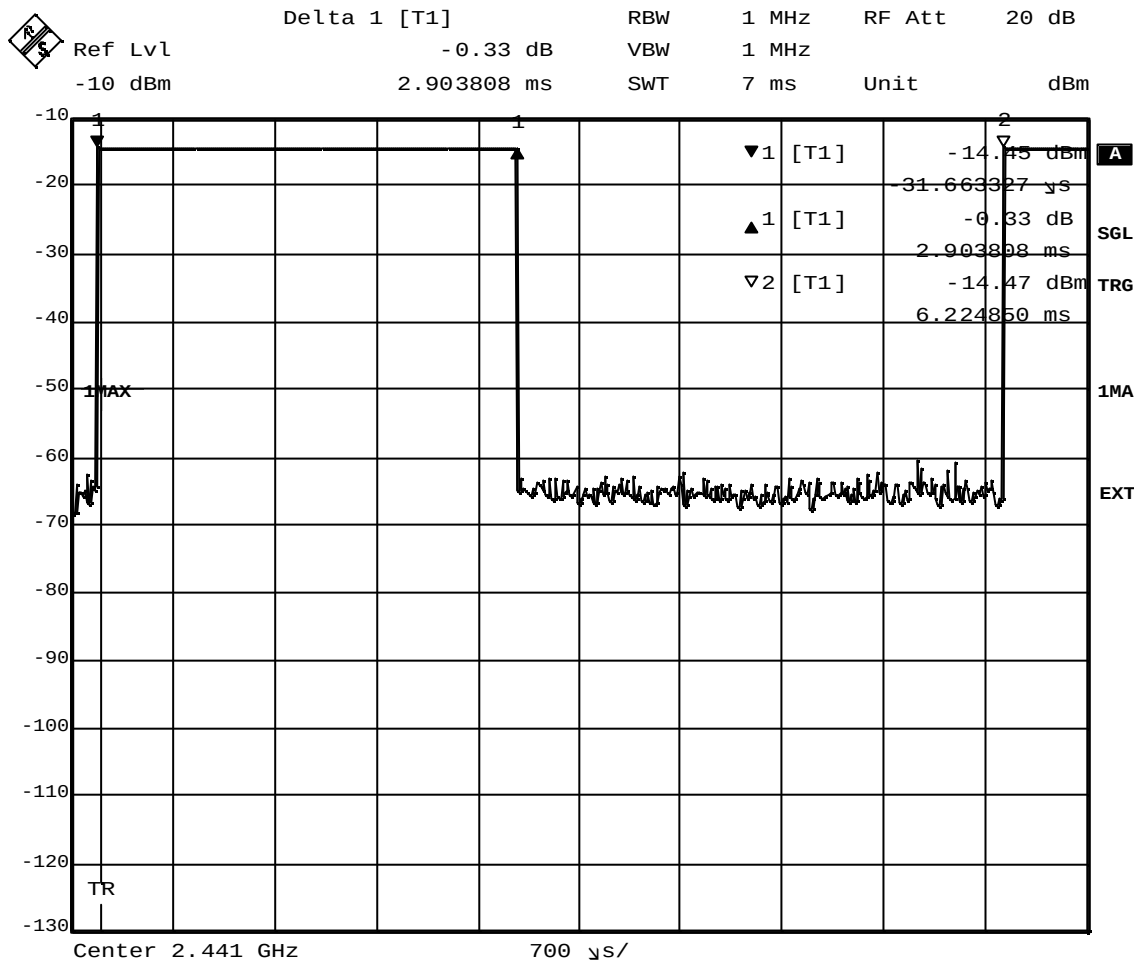


Date: 16.NOV.2004 15:37:27

## Dwell time

### Op. Mode

op-mode 2 Time slot measurement of a DH5 packet

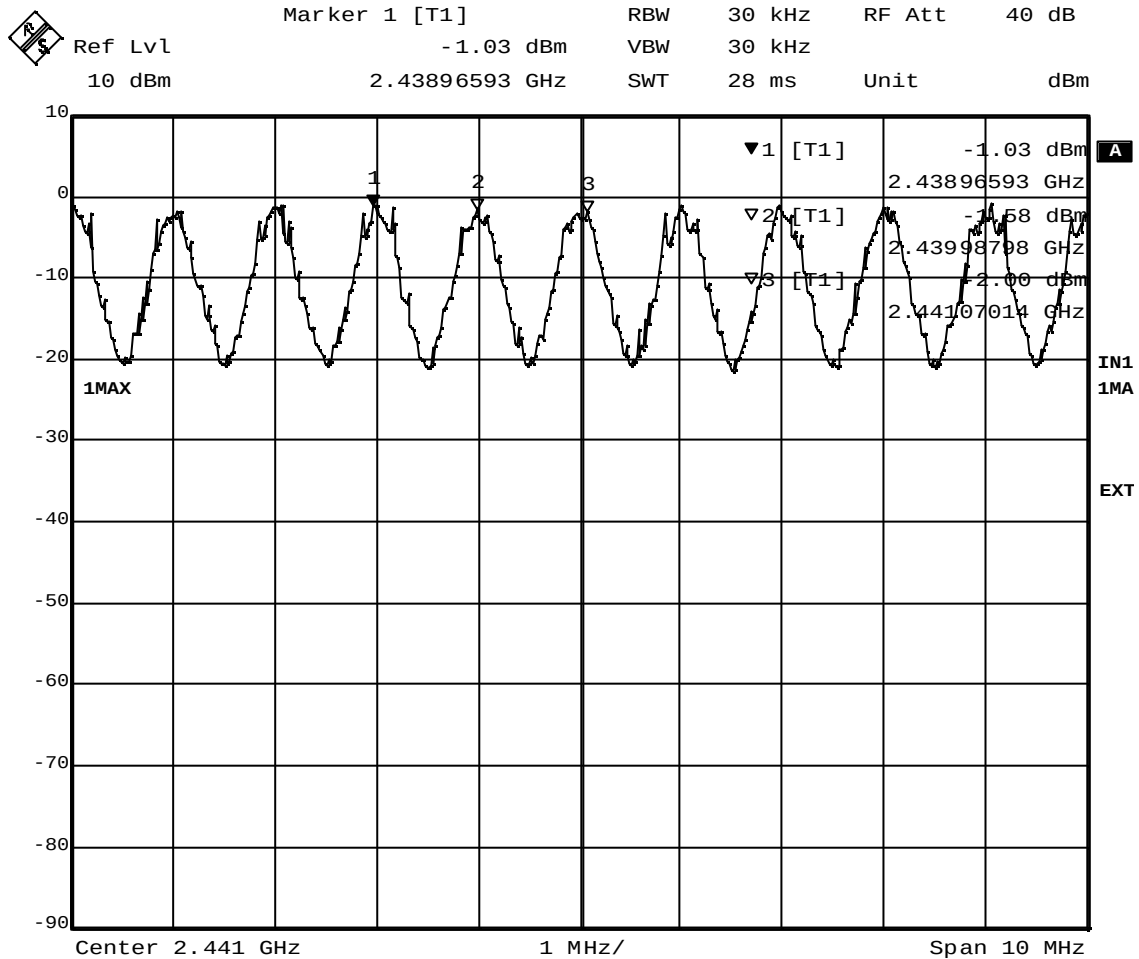


Date: 16.NOV.2004 15:04:10

## Channel separation

### Op. Mode

op-mode 4

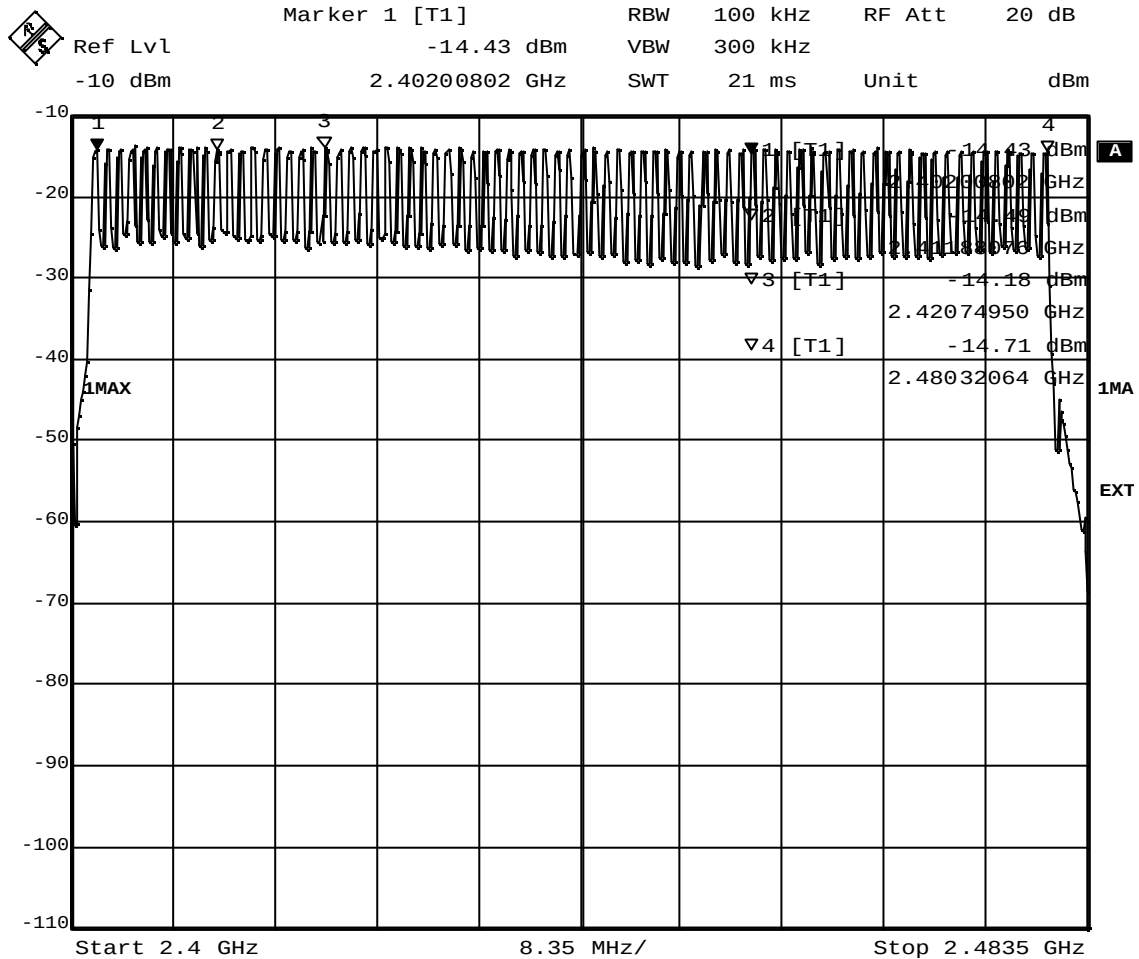


Date: 7.DEC.2004 09:06:28

## Number of hopping frequencies

### Op. Mode

op-mode 4



Date: 16.NOV.2004 13:26:08