InterLab

# EMC Measurement/Technical Report on

# Bluetooth Module
# WML-C30

**Report Reference:** 4_MITSU_0104_BTT_FCCd

**Test Laboratory (Headquarter):**

7 Layers AG
Borsigstr. 11
40880 Ratingen
Germany

TTI-P-G 178/99

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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# 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 0 to 19 (10-1-98 Edition). The following subparts are applicable to the results in this test report.

Part 2, Subpart J - Equipment Authorization Procedures, Certification Sections

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

**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 § 15.247 (a) (1) (ii)**

Occupied Bandwidth

The measurement was performed according to ANSI C63.4 1992

| OP-Mode | Setup | Port | Final Result |
|---|---|---|---|
| op-mode 1 | setup 1 | temporary antenna connector | passed |
| op-mode 2 | setup 1 | temporary antenna connector | passed |
| op-mode 3 | setup 1 | temporary antenna connector | passed |
| op-mode 4 | setup 1 | temporary antenna connector | passed |
| op-mode 5 | setup 1 | temporary antenna connector | passed |

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

Peak Power Output

The measurement was performed according to FCC §15.31 10-1-1998

| OP-Mode | Setup | Port | Final Result |
|---|---|---|---|
| op-mode 1 | setup 1 | temporary antenna connector | passed |
| op-mode 2 | setup 1 | temporary antenna connector | passed |
| op-mode 3 | setup 1 | temporary antenna connector | passed |
| op-mode 4 | setup 1 | temporary antenna connector | passed |
| op-mode 5 | setup 1 | temporary antenna connector | passed |

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

Spurious RF Conducted Emissions

The measurement was performed according to FCC §15.31 10-1-1998

| OP-Mode | Setup | Port | Final Result |
|---|---|---|---|
| op-mode 1 | setup 1 | temporary antenna connector | passed |
| op-mode 2 | setup 1 | temporary antenna connector | passed |
| op-mode 3 | setup 1 | temporary antenna connector | passed |

**FCC Part 15, Subpart C § 15.247 (c), §15.35 (b), § 15.209**

Spurious Radiated Emissions

The measurement was performed according to ANSI C63.4 1992

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

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

Dwell Time

The measurement was performed according to FCC §15.31 10-1-1998

| OP-Mode | Setup | Port | Final Result |
|---|---|---|---|
| op-mode 4 | setup 1 | temporary antenna connector | passed |
| op-mode 5 | setup 1 | temporary antenna connector | passed |

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

Power Density

The measurement was performed according to FCC §15.31 10-1-1998

| OP-Mode | Setup | Port | Final Result |
|---|---|---|---|
| op-mode 4 | setup 1 | temporary antenna connector | passed |
| op-mode 5 | setup 1 | temporary antenna connector | passed |

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

Channel Separation

The measurement was performed according to FCC §15.31 10-1-1998

| OP-Mode | Setup | Port | Final Result |
|---|---|---|---|
| op-mode 6 | setup 1 | temporary antenna connector | passed |

**The tests were chosen on customer's demand.**

Responsible for Accreditation Scope: _____

Responsible for Test Report: _____

# 1. Administrative Data

## 1.1 Testing Laboratory

| | |
|---|---|
| Company Name: | 7 Layers 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:

- 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

## 1.2 Project Data

| | |
|---|---|
| Responsible for testing and report: | Dipl.-Ing. Robert Machulec |
| Receipt of EUT: | 2004-08-10 |
| Date of Test(s): | 2004-08-11 |
| Date of Report: | 2004-11-04 |

## 1.3 Applicant Data

| | |
|---|---|
| Company Name: | Mitsumi Electric Co., Ltd. |
| Address: | 2-11-2, Tsurumaki, Tama-Shi<br>206-8567 Tokyo<br>Japan |
| Contact Person: | Mr. Ryoji Waki |

## 1.4 Manufacturer Data

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

# 2.0 Product Labeling

## 2.1 FCC ID Label:

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

## 2.2 Location of Label on the EUT:

see above

# 3. Testobject Data

## 3.1 General EUT Description

| | |
|---|---|
| **Equipment under Test:** | Bluetooth Module |
| **Type Designation:** | WML-C30 |
| **Kind of Device: (optional)** | Bluetooth transceiver module |
| **Voltage Type:** | DC |
| **Voltage level:** | 3.3 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, 79 RF channels spaced 1MHz apart are defined. The channel is represented by a pseudo-random hopping sequence through the 79 channels. The channel is devided into time slots, with a nominal slot length of 625µs, where each slot corresponds to different RF hop frequencies. The nominal hop rate is 1600 hops/s. All frequencies are equally used. The average time of occupancy is 0.3797 s within a 30 second period.
The symbol rate on the channel is 1 Ms/s.

**The EUT provides the following ports:**

**Ports**
enclosure
temporary antenna connector

**The main components of 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 (19023c00) | Bluetooth Module | WML-C30 | Testsample 1 | 18.1 | 1 | 2004-08-10 |
| EUT A is equipped with a temporary antenna connector. | | | | | | |
| EUT B (19023c01) | Bluetooth Module | WML-C30 | Testsample 2 | 18.1 | 1 | 2004-08-10 |
| EUT B is equipped with internal antenna | | | | | | |

**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 2 | Casira box | - | - | - | - | - |
| AE 1 | Mitsumi HCI Control board | BTDB02 (TZ16.0347) | - | - | AF49T | - |

## 3.4 EUT Setups

This chapter describes the combination of EUT's and ancillary equipment used for testing.

| Setup No. | Combination of EUTs | Description |
|---|---|---|
| setup 1 | EUT A + AE 1 | For conducted measurements |
| setup 2 | EUT B + AE 2 | For radiated 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 | Loopback mode on 2402 MHz | The test system TS8960 was used as master and the EUT was configured as slave. Data (DH 1 packet, PRBS 9) was sent from the master to the slave and returned back by the slave. |
| op-mode 2 | Loopback mode on 2441 MHz | The test system TS8960 was used as master and the EUT was configured as slave. Data (DH 1 packet, PRBS 9) was sent from the master to the slave and returned back by the slave. |
| op-mode 3 | Loopback mode on 2480 MHz | The test system TS8960 was used as master and the EUT was configured as slave. Data (DH 1 packet, PRBS 9) was sent from the master to the slave and returned back by the slave. |
| op-mode 4 | inquiry | The EUT transmits in Bluetooth inquiry mode |
| op-mode 5 | paging | The EUT transmits in Bluetooth page mode |
| op-mode 6 | 10 neighbouring channels | The EUT is set to transmit on ten neighbouring channels one after the other to see the channel separation. |

# 4. Test Results

## 4.1 Occupied Bandwidth

**Standard** FCC Part 15, Subpart C 10-1-98

**The test was performed according to:** ANSI C63.4 1992

### 4.1.1 Test Description

The test set-up was made in accordance to the general provisions of ANSI C63.4-1992.

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 produce the worst-case (widest) occupied bandwidth.

The resolution bandwidth for measuring the reference level and the occupied bandwidth was 10 kHz.

The reference level of the spectrum analyser was set equal to the reference level of the EUT.

### 4.1.2 Test Limits

FCC Part 15, Subpart C, §15.247 (a) (1) (ii)
(1) Frequency hopping systems operating in the 2400 - 2483.5 MHz band should use at least 75 hopping frequencies.
(2) The average time of occupancy on any frequency should not be greater than 0.4 seconds within a 30 second period.
(3) The maximum 20 dB bandwidth of the hopping channel is 1MHz.

### 4.1.3 Test Protocol

Temperature: 27 °C
Air Pressure: 1011 hPa
Humidity: 45 %

| Op. Mode | Setup | Port | Test Parameter |
|---|---|---|---|
| op-mode 1 | setup 1 | temporary antenna connector | |

| 20 dB Bandwidth MHz | Remarks |
|---|---|
| 0,806 | none |

Remark: Please see annex for the measurement plot.

Temperature: 27 °C
Air Pressure: 1011 hPa
Humidity: 45 %

| Op. Mode | Setup | Port | Test Parameter |
|---|---|---|---|
| op-mode 2 | setup 1 | temporary antenna connector | |

| 20 dB Bandwidth MHz | Remarks |
|---|---|
| 0,834 | none |

Remark: Please see annex for the measurement plot.

Temperature: 27 °C
Air Pressure: 1011 hPa
Humidity: 45 %

| Op. Mode | Setup | Port | Test Parameter |
|---|---|---|---|
| op-mode 3 | setup 1 | temporary antenna connector | |

| 20 dB Bandwidth MHz | Remarks |
|---|---|
| 0,826 | none |

Remark: Please see annex for the measurement plot.

Temperature: 23 °C
Air Pressure: 1017 hPa
Humidity: 38 %

| Op. Mode | Setup | Port | Test Parameter |
|---|---|---|---|
| op-mode 4 | setup 1 | temporary antenna connector | |

| 20 dB Bandwidth MHz | Remarks |
|---|---|
| 0,524 | none |

Remark: Please see annex for the measurement plot.

Temperature: 23 °C
Air Pressure: 1017 hPa
Humidity: 38 %

| Op. Mode | Setup | Port | Test Parameter |
|---|---|---|---|
| op-mode 5 | setup 1 | temporary antenna connector | |

| 20 dB Bandwidth MHz | Remarks |
|---|---|
| 0,416 | none |

Remark: Please see annex for the measurement plot.

### 4.1.3 Test result: Occupied Bandwidth

| FCC Part 15, Subpart C | Op. Mode | Setup | Port | Result |
|---|---|---|---|---|
| | op-mode 1 | setup 1 | temporary antenna connector | **passed** |
| | op-mode 2 | setup 1 | temporary antenna connector | **passed** |
| | op-mode 3 | setup 1 | temporary antenna connector | **passed** |
| | op-mode 4 | setup 1 | temporary antenna connector | **passed** |
| | op-mode 5 | setup 1 | temporary antenna connector | **passed** |

## 4.2 Peak Power Output

**Standard** FCC Part 15, Subpart C 10-1-98

**The test was performed according to:** FCC §15.31 10-1-1998

### 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 analyser was set equal to the output power of the EUT.

The EUT was connected to the spectrum analyzer via a short coax cable (Type: Rosenberger RTK 161, 1m, SMA connectors), with a known loss.

### 4.2.2 Test Limits

FCC Part 15, Subpart C, §15.247 (b) (1)
(1) For frequency hopping systems operating in the band 2400 - 2483,5 MHz or 5725 - 5850 MHz and for all direct sequence systems: 1 Watt

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

==> Maximum Output Power: 30 dBm

### 4.2.3 Test Protocol

Temperature: 27 °C
Air Pressure: 1011 hPa
Humidity: 45 %

| Op. Mode | Setup | Port | Test Parameter |
|---|---|---|---|
| op-mode 1 | setup 1 | temporary antenna connector | |

| Output Power dBm | Remarks |
|---|---|
| 14,27 | The EIRP including antenna gain (2,14 dBi) is 16,41 dBm |

Remark: Please see annex for the measurement plot.

Temperature: 27 °C
Air Pressure: 1011 hPa
Humidity: 45 %

| Op. Mode | Setup | Port | Test Parameter |
|---|---|---|---|
| op-mode 2 | setup 1 | temporary antenna connector | |

| Output Power dBm | Remarks |
|---|---|
| 14,19 | The EIRP including antenna gain (2,14 dBi) is 16,33 dBm |

Remark: Please see annex for the measurement plot.

Temperature: 27 °C
Air Pressure: 1011 hPa
Humidity: 45 %

| Op. Mode | Setup | Port | Test Parameter |
|---|---|---|---|
| op-mode 3 | setup 1 | temporary antenna connector | |

| Output Power dBm | Remarks |
|---|---|
| 13,87 | The EIRP including antenna gain (2,14 dBi) is 16,01 dBm |

Remark: Please see annex for the measurement plot.

Temperature: 23 °C
Air Pressure: 1017 hPa
Humidity: 38 %

| Op. Mode | Setup | Port | Test Parameter |
|---|---|---|---|
| op-mode 4 | setup 1 | temporary antenna connector | |

| Output Power dBm | Remarks |
|---|---|
| 13,8 | The EIRP including antenna gain (2,14 dBi) is 15,94 dBm |

Remark: Please see annex for the measurement plot.

Temperature: 23 °C
Air Pressure: 1017 hPa
Humidity: 38 %

| Op. Mode | Setup | Port | Test Parameter |
|---|---|---|---|
| op-mode 5 | setup 1 | temporary antenna connector | |

| Output Power dBm | Remarks |
|---|---|
| 13,75 | The EIRP including antenna gain (2,14 dBi) is 15,89 dBm |

Remark: Please see annex for the measurement plot.

### 4.2.3 Test result: Peak Power Output

| FCC Part 15, Subpart C | Op. Mode | Setup | Port | Result |
|---|---|---|---|---|
| | op-mode 1 | setup 1 | temporary antenna connector | **passed** |
| | op-mode 2 | setup 1 | temporary antenna connector | **passed** |
| | op-mode 3 | setup 1 | temporary antenna connector | **passed** |
| | op-mode 4 | setup 1 | temporary antenna connector | **passed** |
| | op-mode 5 | setup 1 | temporary antenna connector | **passed** |

## 4.3 Spurious RF Conducted Emissions

**Standard** FCC Part 15, Subpart C 10-1-98

**The test was performed according to:** FCC §15.31 10-1-1998

### 4.3.1 Test Description

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

The EUT was connected to spectrum analyzer via a short coax cable (Type: Rosenberger RTK 161, 1m, SMA connectors), with a known loss.

Analyser settings:
- Detector: Peak-Maxhold
- Frequency range: 30 – 25000 MHz
- Resolution Bandwidth (RBW): 100 kHz
- Video Bandwidth (VBW): 100 kHz
- Sweep Time: Coupled

The reference level of the spectrum analyser was set equal to the reference level of the EUT.

### 4.3.2 Test 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 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power.

### 4.3.3 Test Protocol

Temperature: 27 °C
Air Pressure: 1011 hPa
Humidity: 45 %

| Op. Mode | Setup | Port | Test Parameter |
|---|---|---|---|
| op-mode 1 | setup 1 | temporary antenna connector | |

| Frequency MHz | Measured Value dBm | Correction Factor dB | Corrected Value | Reference Value dBm | Limit dBm | Delta to Limit dB |
|---|---|---|---|---|---|---|
| 6935,00 | | | -36,53 | 14,01 | -5,99 | 30,54 |

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

Temperature: 27 °C
Air Pressure: 1011 hPa
Humidity: 45%

| Op. Mode | Setup | Port | Test Parameter |
|---|---|---|---|
| op-mode 2 | setup 1 | temporary antenna connector | |

| Frequency MHz | Measured Value dBm | Correction Factor dB | Corrected Value | Reference Value dBm | Limit dBm | Delta to Limit dB |
|---|---|---|---|---|---|---|
| 6885,00 | | | -36,31 | 14,23 | -5,77 | 30,54 |
| 18795,00 | | | -37,71 | 14,23 | -5,77 | 31,94 |

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

Temperature: 27 °C
Air Pressure: 1011 hPa
Humidity: 45 %

| Op. Mode | Setup | Port | Test Parameter |
|---|---|---|---|
| op-mode 3 | setup 1 | temporary antenna connector | |

| Frequency MHz | Measured Value dBm | Correction Factor dB | Corrected Value | Reference Value dBm | Limit dBm | Delta to Limit dB |
|---|---|---|---|---|---|---|
| 980,00 | | | -21,63 | 13,65 | -6,35 | 15,28 |

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

### 4.3.3 Test result: Spurious RF Conducted Emissions

| FCC Part 15, Subpart C | Op. Mode | Setup | Port | Result |
|---|---|---|---|---|
| | op-mode 1 | setup 1 | temporary antenna connector | **passed** |
| | op-mode 2 | setup 1 | temporary antenna connector | **passed** |
| | op-mode 3 | setup 1 | temporary antenna connector | **passed** |

## 4.4 Spurious Radiated Emissions

**Standard** FCC Part 15, Subpart C 10-1-98

**The test was performed according to:** ANSI C63.4 1992

### 4.4.1 Test Description

The test set-up was made in accordance to the general provisions of ANSI C63.4-1992.

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 an EUT to receiving antenna distance of 3m.
The radiated emissions measurements were made in a typical installation configuration.

The measurement procedure consists of four steps. It is implemented into EMI test software ES-K1 from R&S.

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 µs
- Turntable angle range: –180 to 180 °
- Turntable stepsize: 90°
- Height variation range: 1 – 3m
- Height variation stepsize: 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 stepsize: 45°
- Height variation range: 1 – 4m
- Height variation stepsize: 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

The following modfications 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 (invers linear-distance for field strength measurements, invers 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.
Detector: Peak, Average
RBW = VBW = 1 MHz, above 7 GHz 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 Limits

FCC Part 15, Subpart C, §15.247 (c)
(2) A radiated emission test applies to harmonic/spurs that fall in the restricted bands as listed in § 15.205(a). The maximum permitted QP (< 1GHz) and average (> 1GHz) field strength is listed in § 15.209(a).
(3)
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: Limit (dBµV/m) = 20 log (Limit (µV/m)/1µV/m)

### 4.4.3 Test Protocol

Temperature: 23 °C
Air Pressure: 1007 hPa
Humidity: 33 %

| Op. Mode | Setup | Port | Test Parameter |
|---|---|---|---|
| op-mode 1 | setup 2 | 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 | | | | |
| Vertical | 2386,00 | | 54,89 | 40,49 | 54,00 | 74,00 | 13,51 | 19,11 |
| Vertical | 4804,00 | | 53,69 | 42,30 | 54,00 | 74,00 | 11,70 | 20,31 |

Remark: No further spurious emission in the range 20 dB below the limit found.

Temperature: 23 °C
Air Pressure: 1007 hPa
Humidity: 33 %

| Op. Mode | Setup | Port | Test Parameter |
|---|---|---|---|
| op-mode 2 | setup 2 | 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 | | | | |
| Vertical | 4882,00 | | 57,05 | 45,85 | 54,00 | 74,00 | 8,15 | 16,95 |
| Vertical | 7322,00 | | 52,64 | 40,19 | 54,00 | 74,00 | 13,81 | 21,36 |

Remark: No further spurious emission in the range 20 dB below the limit found.

Temperature: 23 °C
Air Pressure: 1007 hPa
Humidity: 33 %

| Op. Mode | Setup | Port | Test Parameter |
|---|---|---|---|
| op-mode 3 | setup 2 | 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 | | | | |
| Vertical | 2483,00 | | 60,22 | 41,41 | 54,00 | 74,00 | 12,59 | 13,78 |
| Vertical | 4960,00 | | 61,32 | 50,05 | 54,00 | 74,00 | 3,95 | 12,68 |
| Vertical | 7440,00 | | 59,42 | 46,75 | 54,00 | 74,00 | 7,25 | 14,58 |

Remark: No further spurious emission in the range 20 dB below the limit found.

### 4.4.3 Test result: Spurious Radiated Emissions

| FCC Part 15, Subpart C | Op. Mode | Setup | Port | Result |
|---|---|---|---|---|
| | op-mode 1 | setup 2 | enclosure | **passed** |
| | op-mode 2 | setup 2 | enclosure | **passed** |
| | op-mode 3 | setup 2 | enclosure | **passed** |

## 4.5 Dwell Time

**Standard** FCC Part 15, Subpart C 10-1-98

**The test was performed according to:** FCC §15.31 10-1-1998

### 4.5.1 Test Description

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

The reference level of the spectrum analyser was set equal to the output power of the EUT.

The EUT was connected to the spectrum analyzer via a short coax cable (Type: Rosenberger RTK 161, 1m, SMA connectors), with a known loss.

To determine the dwell time, 3 single measurments are necessary.
The first plot shows the activity for an complete inquiry/paging on one channel.
The second plot shows the repetition rate on one channel, and the third plot shows the duration of the burst used in inquiry/paging.

With this 3 single values the dwell time of the channel can be calculated.

### 4.5.2 Test Limits

FCC Part 15, Subpart C, §15.247 (g)

The dwell time of the channel shall be less than 400 ms in a 30 s period

### 4.5.3 Test Protocol

Temperature: 23 °C
Air Pressure: 1017 hPa
Humidity: 38 %

| Op. Mode | Setup | Port | Test Parameter |
|---|---|---|---|
| op-mode 4 | setup 1 | temporary antenna connector | |

| Dwell time ms | Remarks |
|---|---|
| 95,472 | ( 3 * 2,55 s / 10 ms ) * 124,8 µs=95,472 ms |

Remark: Please see annex for the measurement plot.

Temperature: 23 °C
Air Pressure: 1017 hPa
Humidity: 38 %

| Op. Mode | Setup | Port | Test Parameter |
|---|---|---|---|
| op-mode 5 | setup 1 | temporary antenna connector | |

| Dwell time ms | Remarks |
|---|---|
| 31,722 | ( 5,1 s/ 20 ms ) * 124,4 µs = 31,722 ms |

Remark: Please see annex for the measurement plot.

### 4.5.3 Test result: Dwell Time

| FCC Part 15, Subpart C | Op. Mode | Setup | Port | Result |
|---|---|---|---|---|
| | op-mode 4 | setup 1 | temporary antenna connector | **passed** |
| | op-mode 5 | setup 1 | temporary antenna connector | **passed** |

## 4.6 Power Density

**Standard** FCC Part 15, Subpart C 10-1-98

**The test was performed according to:** FCC §15.31 10-1-1998

### 4.6.1 Test Description

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

The EUT was connected to spectrum analyzer via a short coax cable (Type: Rosenberger RTK 161, 1m, SMA connectors), with a known loss.

The Analyser settings are according 15.247 (d):
- Detector: Peak-Maxhold
- Span: 2 MHz
- Resolution Bandwidth (RBW): 3 kHz
- Video Bandwidth (VBW): 3 kHz
- Sweep Time: Coupled

The reference level of the spectrum analyser was set equal to the reference level of the EUT.

### 4.6.2 Test Limits

FCC Part 15, Subpart C, §15.247 (g)

The power density shall be below 8 dBm measured with a resolution bandwidth of 3 kHz.

### 4.6.3 Test Protocol

Temperature: 23 °C
Air Pressure: 1017 hPa
Humidity: 38 %

| Op. Mode | Setup | Port | Test Parameter |
|---|---|---|---|
| op-mode 4 | setup 1 | temporary antenna connector | |

| Power Density dBm/3 kHz | Remarks |
|---|---|
| 2,48 | Please see annex for the measurement plot. |

Remark: none

Temperature: 23 °C
Air Pressure: 1017 hPa
Humidity: 38 %

| Op. Mode | Setup | Port | Test Parameter |
|---|---|---|---|
| op-mode 5 | setup 1 | temporary antenna connector | |

| Power Density dBm/3 kHz | Remarks |
|---|---|
| 1,38 | Please see annex for the measurement plot. |

Remark: none

### 4.6.3 Test result: Power Density

| FCC Part 15, Subpart C | Op. Mode | Setup | Port | Result |
|---|---|---|---|---|
| | op-mode 4 | setup 1 | temporary antenna connector | **passed** |
| | op-mode 5 | setup 1 | temporary antenna connector | **passed** |

## 4.7 Channel Separation

**Standard** FCC Part 15, Subpart C 10-1-98

**The test was performed according to:** FCC §15.31 10-1-1998

### 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 (Type: Rosenberger RTK 161, 1m, SMA connectors), with a known loss.

Analyser settings:
- Detector: Peak-Maxhold
- Span: 10 MHz
- Resolution Bandwidth (RBW): 300 kHz
- Video Bandwidth (VBW): 300 kHz
- Sweep Time: Coupled

The reference level of the spectrum analyser was set equal to the reference level of the EUT.

### 4.7.2 Test 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: 28 ° C
Air Pressure: 1017 hPa
Humidity: 38 %

| Op. Mode | Setup | Port | Test Parameter |
|---|---|---|---|
| op-mode 6 | setup 1 | temporary antenna connector | |

| Channel Separation MHz | Remarks |
|---|---|
| 1 | Please see annex for the measurement plot. |

Remark: none

### 4.7.3 Test result: Channel Separation

| FCC Part 15, Subpart C | Op. Mode | Setup | Port | Result |
|---|---|---|---|---|
| | op-mode 6 | setup 1 | temporary antenna connector | **passed** |

# 5. Testequipment

## *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 | JS4-18002600-32-5P | 849785 | Miteq |
| Broadband Amplifier 30MHz-18GHz | JS4-00101800-35-5P | 896037 | Miteq |
| Broadband Amplifier 45MHz-27GHz | JS4-00102600-42-5A | 619368 | Miteq |
| Cable "ESI to EMI Antenna" | RTK081+Aircell7 | W18.01+W38.01a | Huber+Suhner |
| Cable "ESI to Horn Antenna" | RTK 081 | W18.04+3599/001 | Rosenberger |
| 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 | WRCA800/960-6EEK | 24 | Wainwright |
| Spectrum Analyzer 9KHz To 3GHz | FSP3 | 838164/004 | Rohde & Schwarz |
| Temperature Chamber | VT 4002 | 58566002150010 | Vötsch |
| Temperature Chamber | KWP 120/70 | 59226012190010 | Weiss |
| ThermoHygro_01 | 430202 | | Fischer |

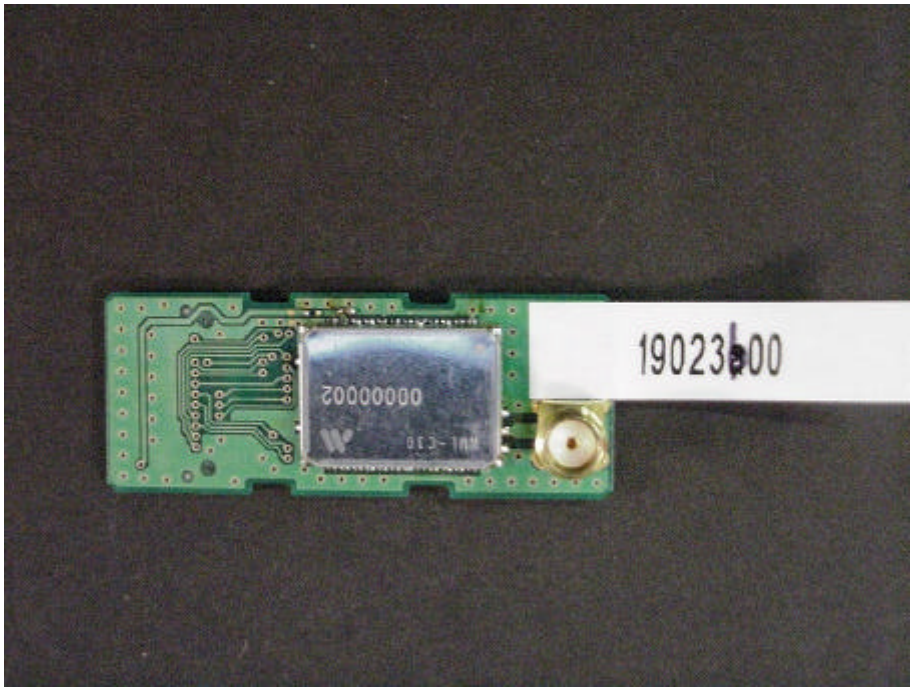
## *Anechoic Chamber*

| 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 |

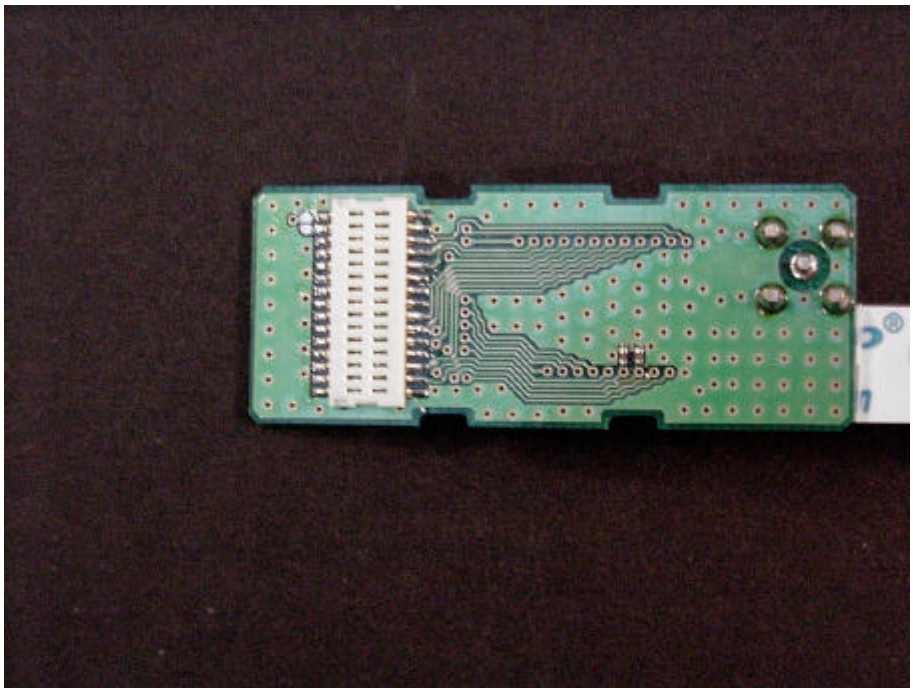
*7 layers Bluetooth™ Full RF Test Solution* *Bluetooth RF Conformance Test System TS8960*

| Equipment | Type | Serial No. | Manufacturer |
|---|---|---|---|
| 10MHz Reference | MFS | 5489/001 | Efratom |
| Power Meter 832025/059 | NRVD | 832025/059 | Rohde & Schwarz |
| Power Sensor A 832279/013 | NRV-Z1 | 832279/013 | Rohde & Schwarz |
| Power Sensor B 832279/015 | NRV-Z1 | 832279/015 | Rohde & Schwarz |
| Power Supply | E3632A | MY40003776 | Agilent |
| Power Supply | PS-2403D | - | Conrad |
| RF Step Attenuator 833695/001 | RSP | 833695/001 | Rohde & Schwarz |
| Rubidium Frequency Normal | MFS | 002 | Efratom |
| Signal Analyser FSIQ26 832695/007 | FSIQ26 | 832695/007 | Rohde & Schwarz |
| Signal Analyser FSP30 100051 | FSP30 | 100051 | Rohde & Schwarz |
| Signal Generator 101175 | SMIQ03B | 101175 | Rohde & Schwarz |
| Signal Generator 833680/003 | SMP 03 | 833680/003 | Rohde & Schwarz |
| Signal Generator A 834344/002 | SMIQ03B | 834344/002 | Rohde & Schwarz |
| Signal Generator B 832870/017 | SMIQ03B | 832870/017 | Rohde & Schwarz |
| Signal Switching and Conditioning Unit | SSCU | 338826/005 | Rohde & Schwarz |
| Signalling Unit PTW60 838312/014 | PTW60 for TS8960 | 838312/014 | Rohde & Schwarz |
| System Controller 829323/008 | PSM12 | 829323/008 | Rohde & Schwarz |

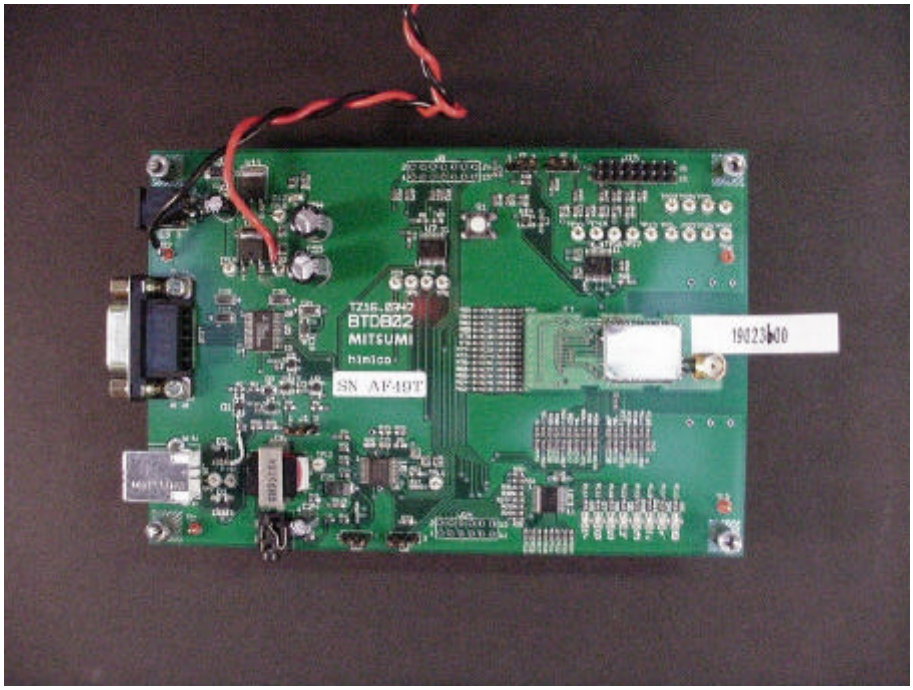
# 6. Foto Report



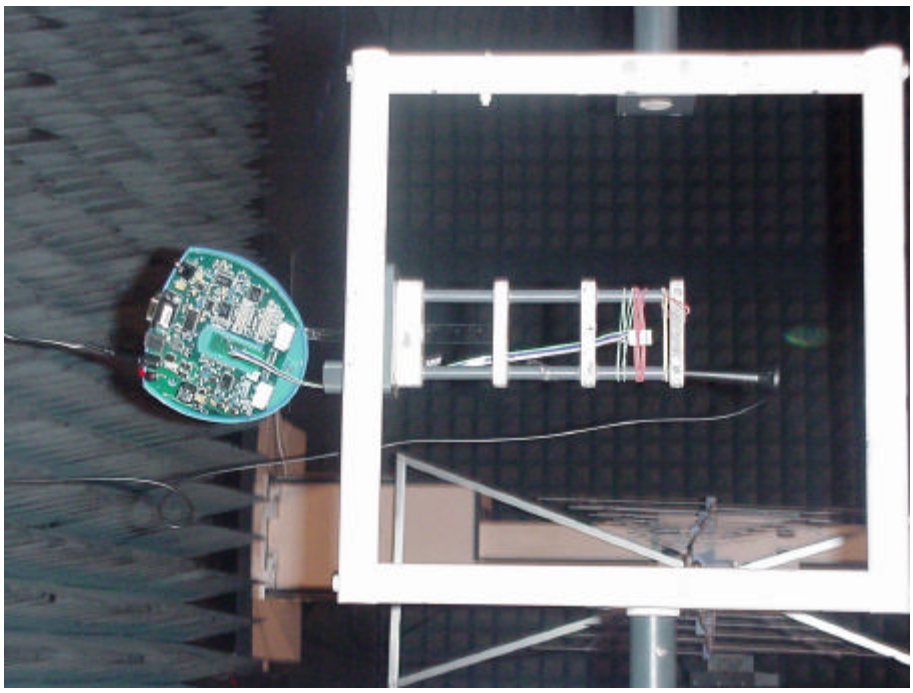

**Picture 1 : EUT for conducted tests (front view)**



**Picture 2 : EUT for conducted tests (rear view)**

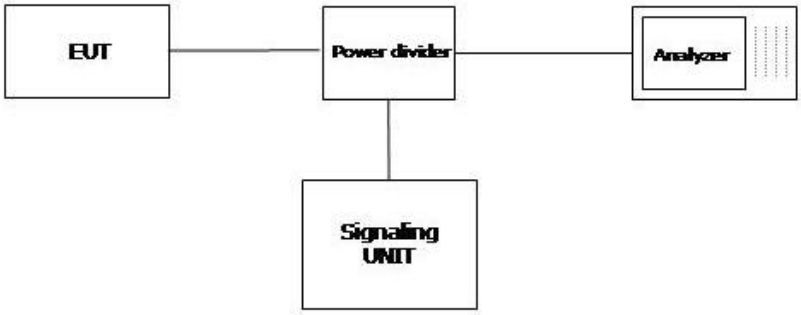



**Picture 3 : EUT for conducted tests in the Mitsumi HCI control board**

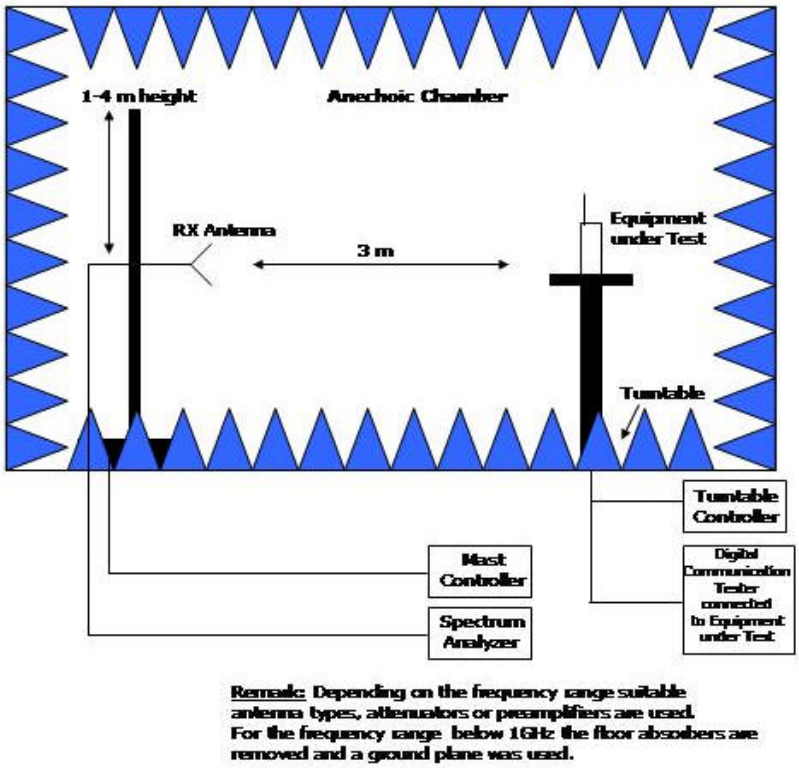


**Picture 4 : EUT for radiated tests in the Casira box**

# 7. Setup Drawings




**Drawing 1 : setup for conducted tests (in principle)**



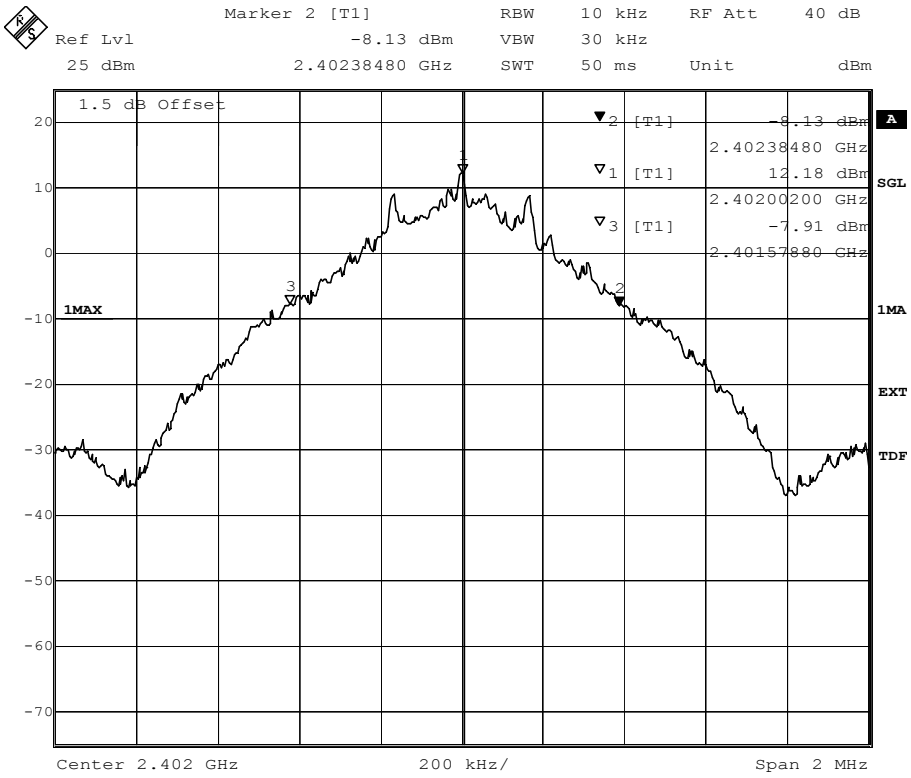

**Drawing 2 : setup for radiated tests (in principle)**

# 8. Annex

## Measurement plots

## Occupied Bandwidth

| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 1 Loopback mode on 2402 MHz | setup 1 | temporary antenna connector |

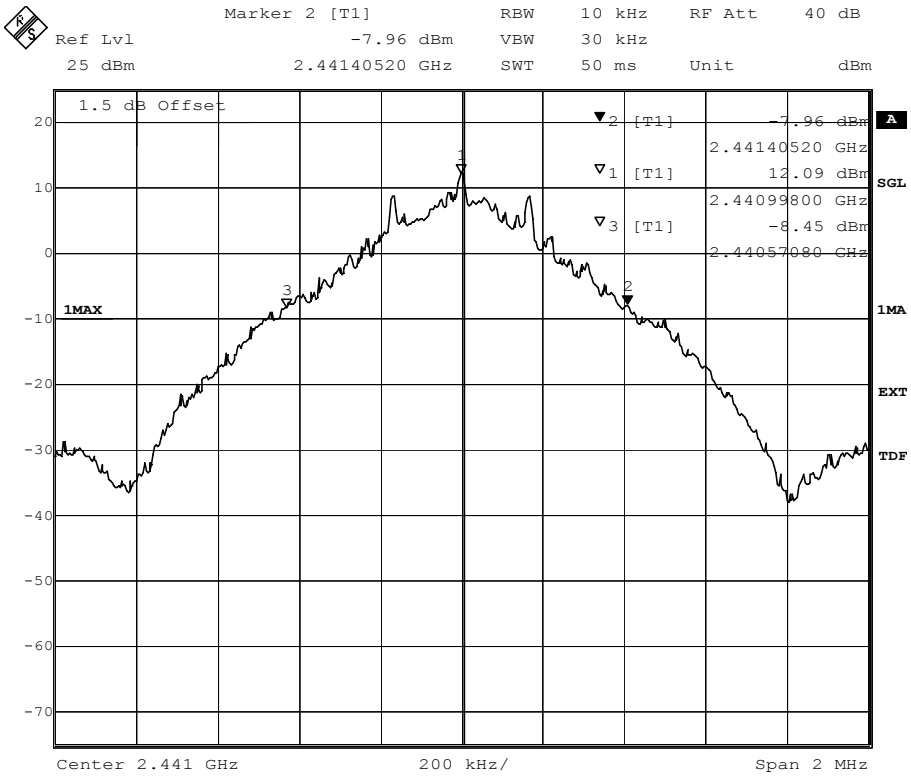



Title: 20dB Bandwidth
Comment A: CH B: 2402 MHz; 20dB bandwidth (kHz):806
Date: 11.AUG.2004 09:47:23

**20 dB bandwidth**

## Occupied Bandwidth

| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 2 Loopback mode on 2441 MHz | setup 1 | temporary antenna connector |

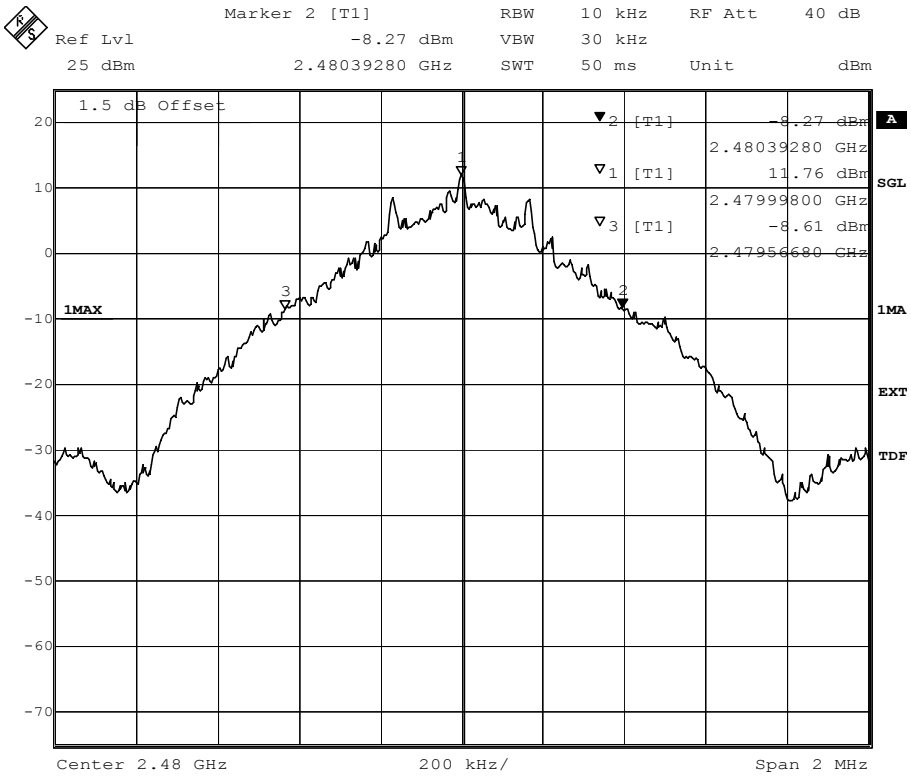



Title: 20dB Bandwidth
Comment A: CH M: 2441 MHz; 20dB bandwidth (kHz):834.4
Date: 11.AUG.2004 10:06:39

**20 dB bandwidth**

## Occupied Bandwidth

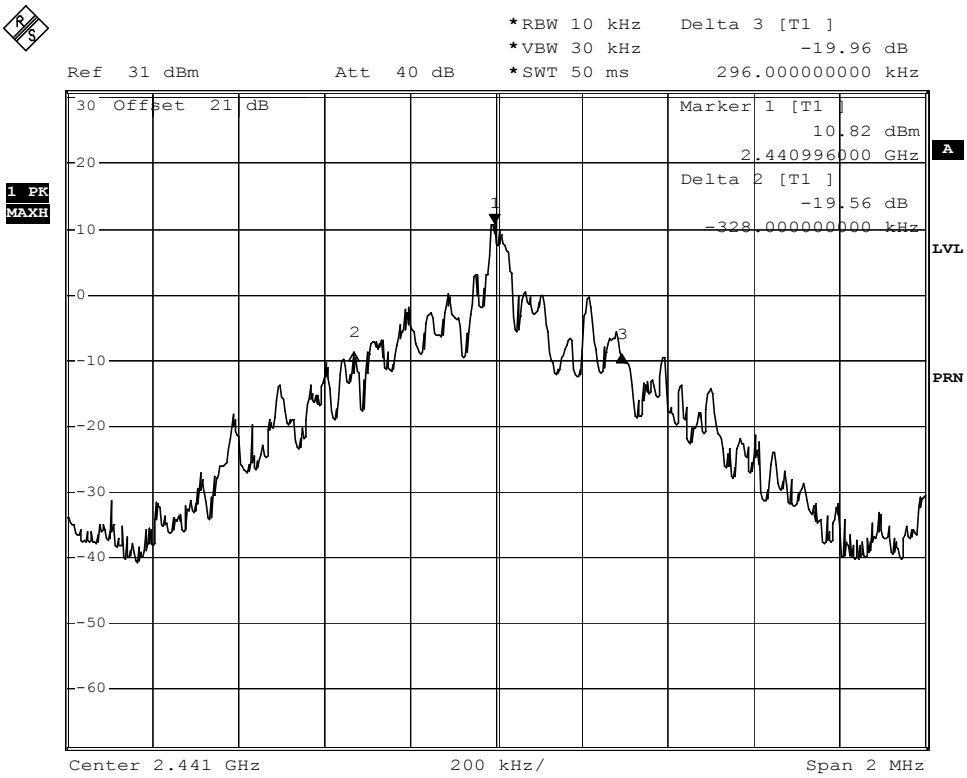
| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 3 Loopback mode on 2480 MHz | setup 1 | temporary antenna connector |




**20 dB bandwidth**

## Occupied Bandwidth

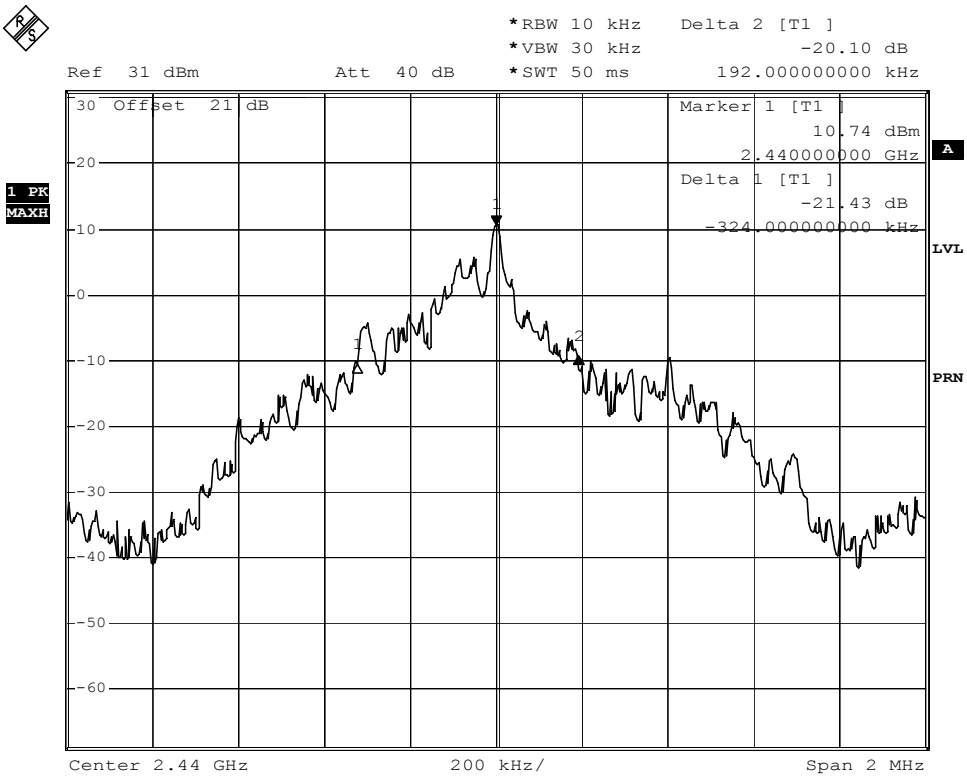
| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 4 inquiry | setup 1 | temporary antenna connector |




**20 dB bandwidth**

## Occupied Bandwidth

| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 5 paging | setup 1 | temporary antenna connector |

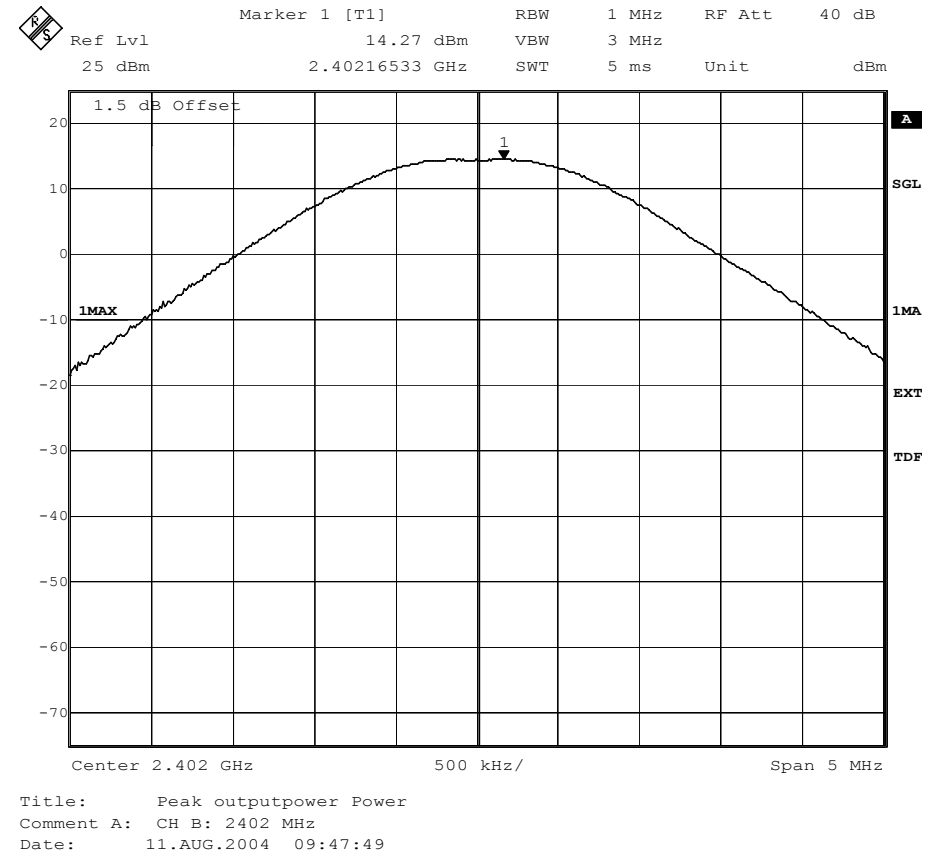



Date: 3.NOV.2004 15:42:13

**20 dB bandwidth**

## Peak Power Output

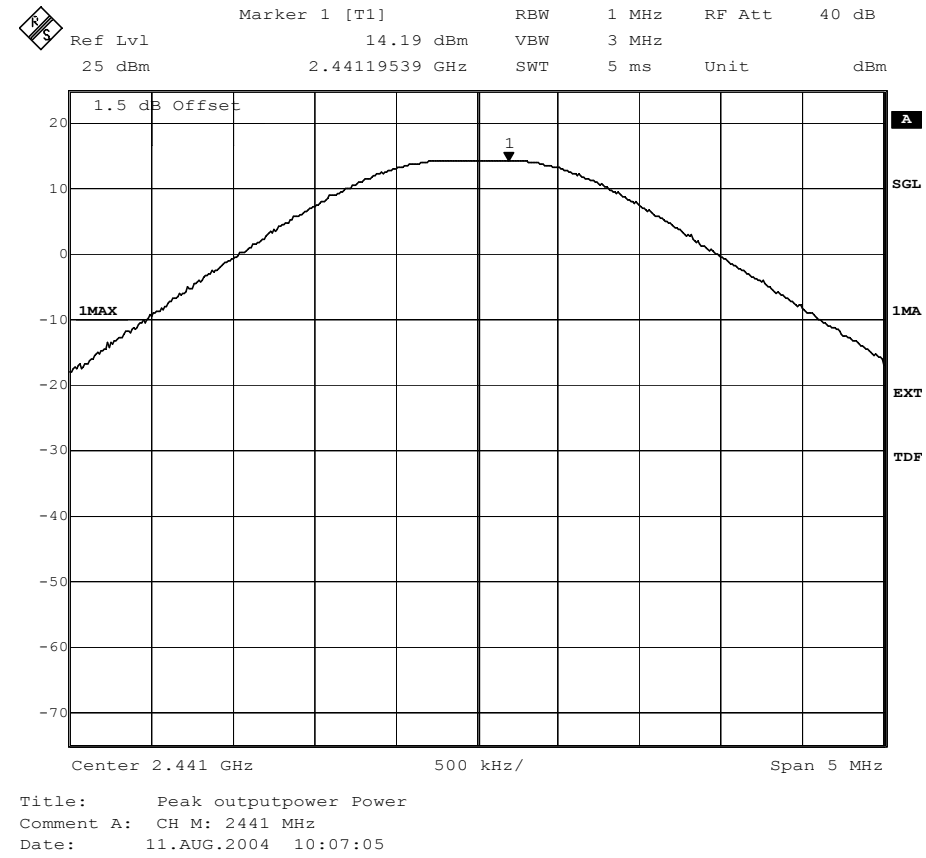
| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 1 Loopback mode on 2402 MHz | setup 1 | temporary antenna connector |




**peak output power**

## Peak Power Output

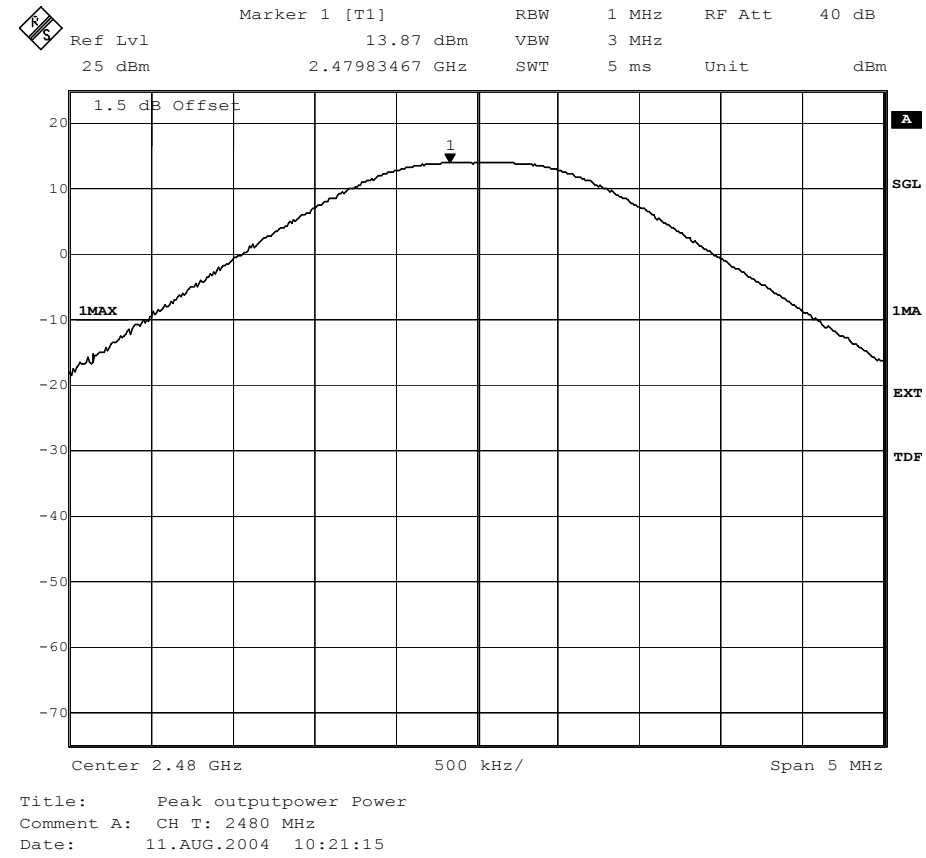
| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 2 Loopback mode on 2441 MHz | setup 1 | temporary antenna connector |




**peak output power**

## Peak Power Output

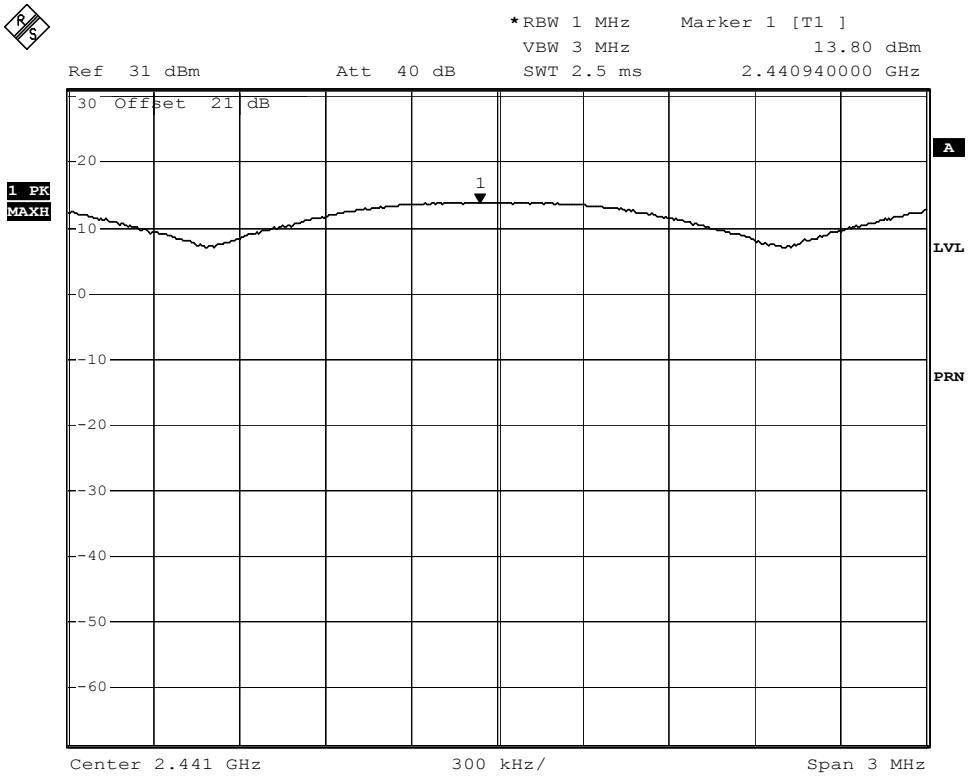
| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 3 Loopback mode on 2480 MHz | setup 1 | temporary antenna connector |




**peak output power**

## Peak Power Output

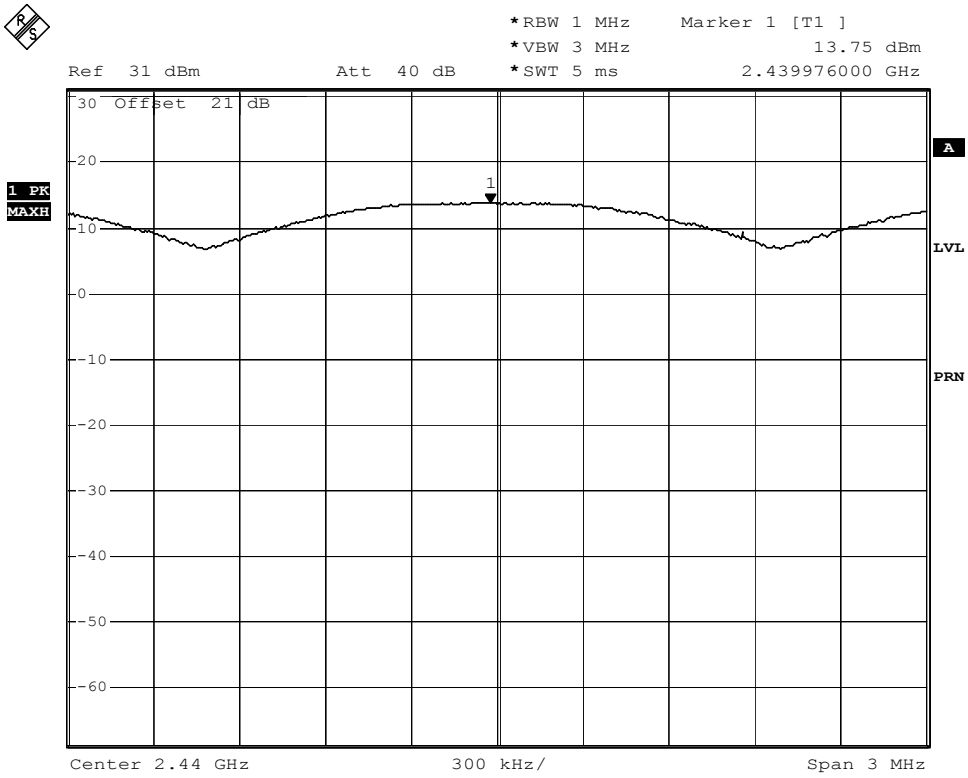
| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 4 inquiry | setup 1 | temporary antenna connector |




**peak output power**

## Peak Power Output

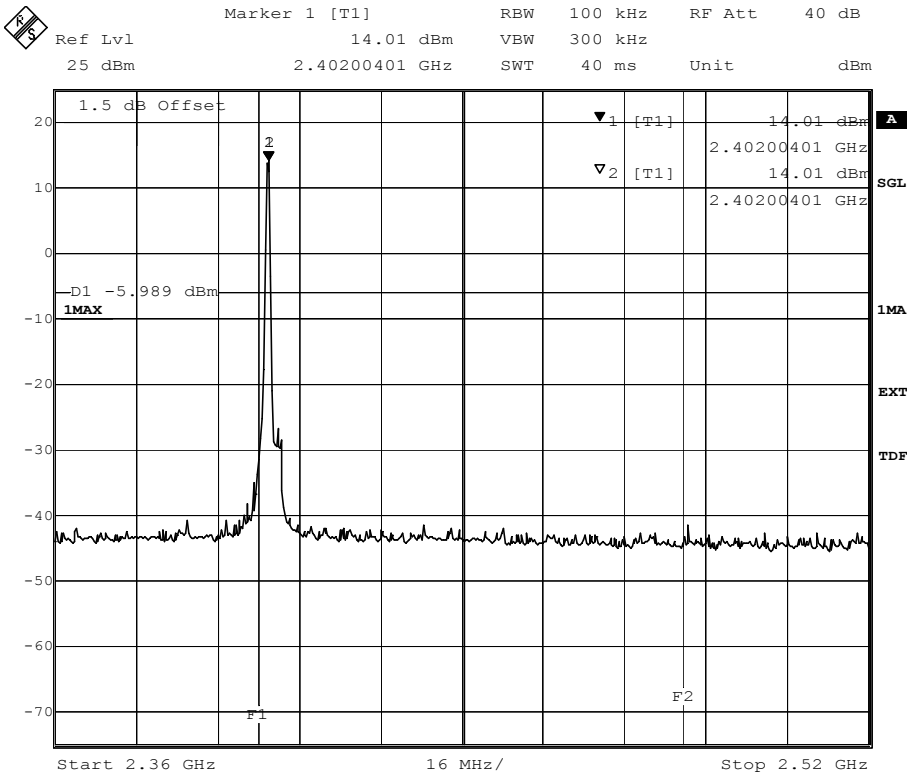
| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 5 paging | setup 1 | temporary antenna connector |




**peak output power**

## Spurious RF Conducted Emissions

| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 1 Loopback mode on 2402 MHz | setup 1 | temporary antenna connector |

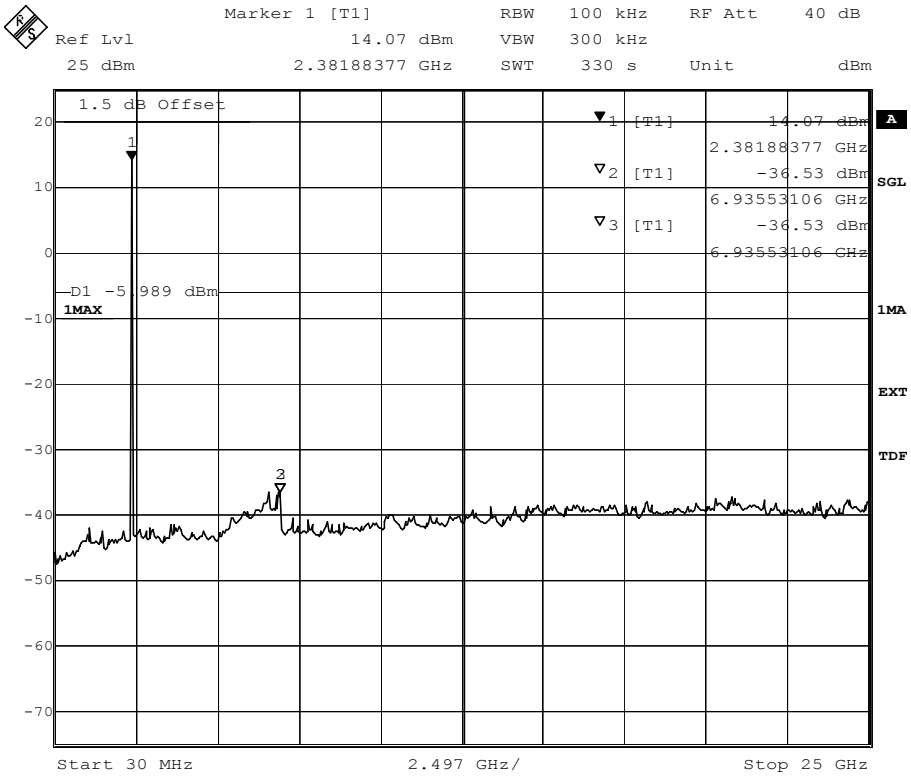



Title: Band Edge Compliance
Comment A: CH B: 2402 MHz
Date: 11.AUG.2004 09:37:30

**band edge compliance**

## Spurious RF Conducted Emissions

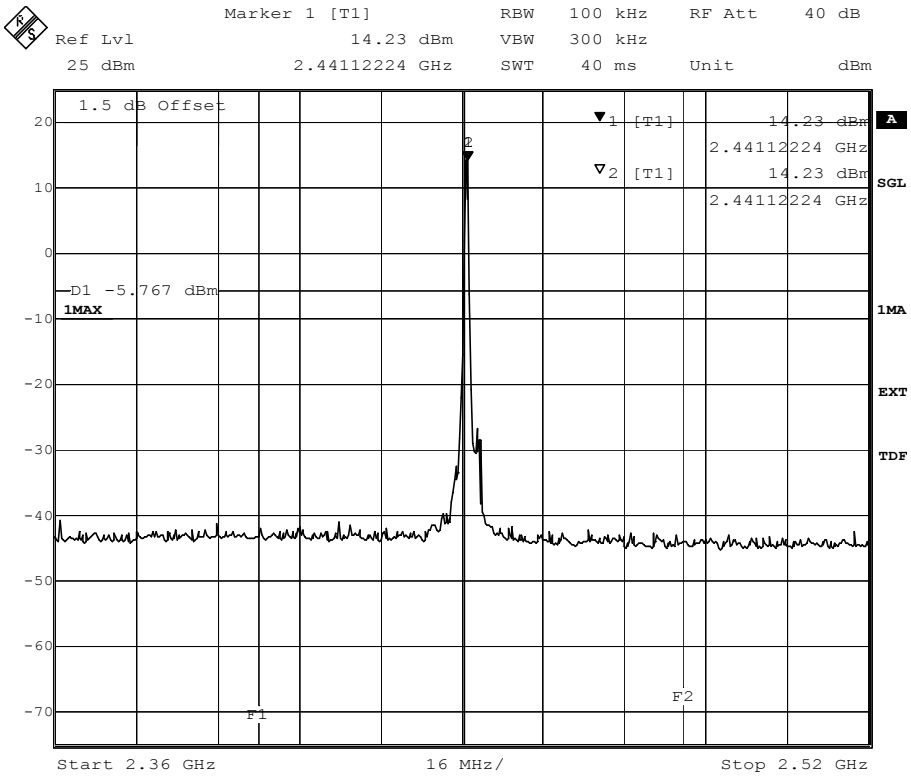
| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 1 Loopback mode on 2402 MHz | setup 1 | temporary antenna connector |




**spurious emissions conducted**

## Spurious RF Conducted Emissions

| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 2 Loopback mode on 2441 MHz | setup 1 | temporary antenna connector |

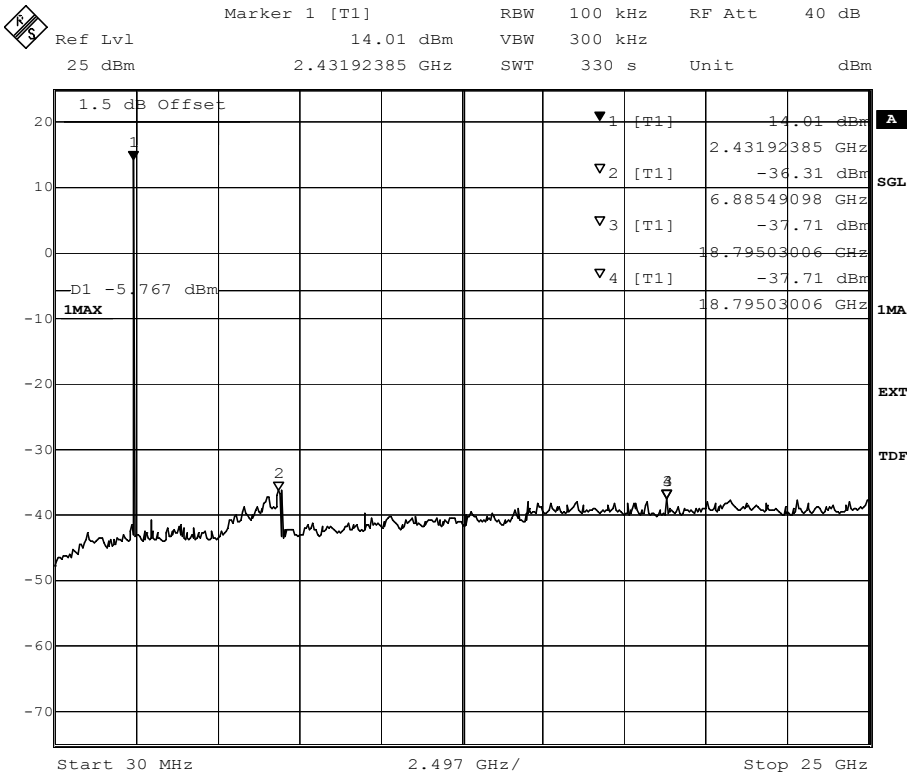



Title: Band Edge Compliance
Comment A: CH M: 2441 MHz
Date: 11.AUG.2004 09:56:56

**band edge compliance**

## Spurious RF Conducted Emissions

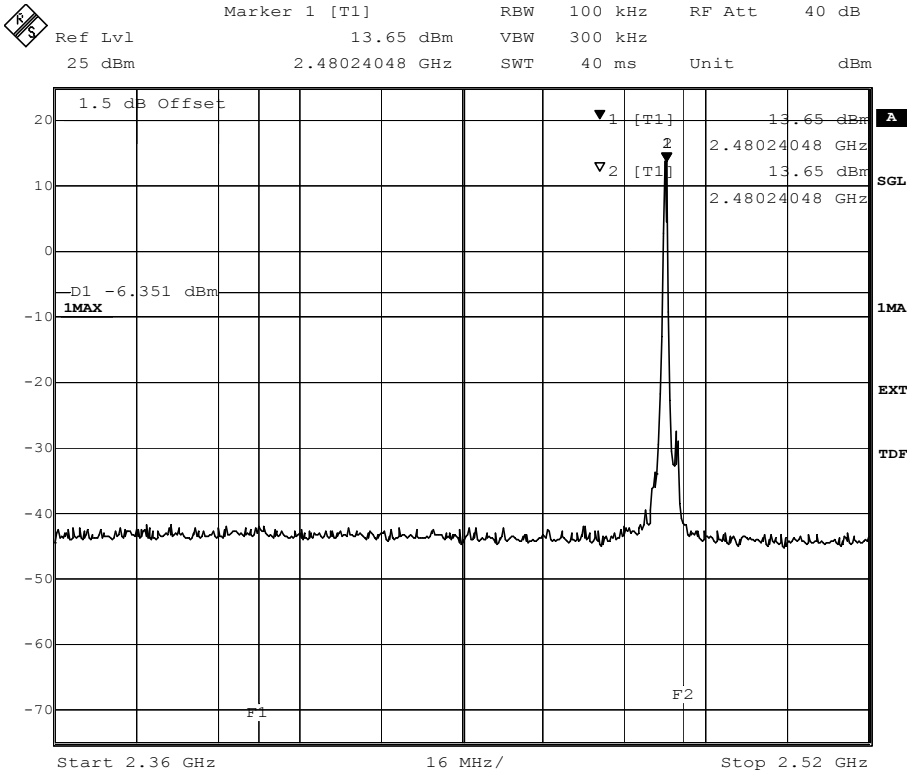
| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 2 Loopback mode on 2441 MHz | setup 1 | temporary antenna connector |




**spurious emissions conducted**

## Spurious RF Conducted Emissions

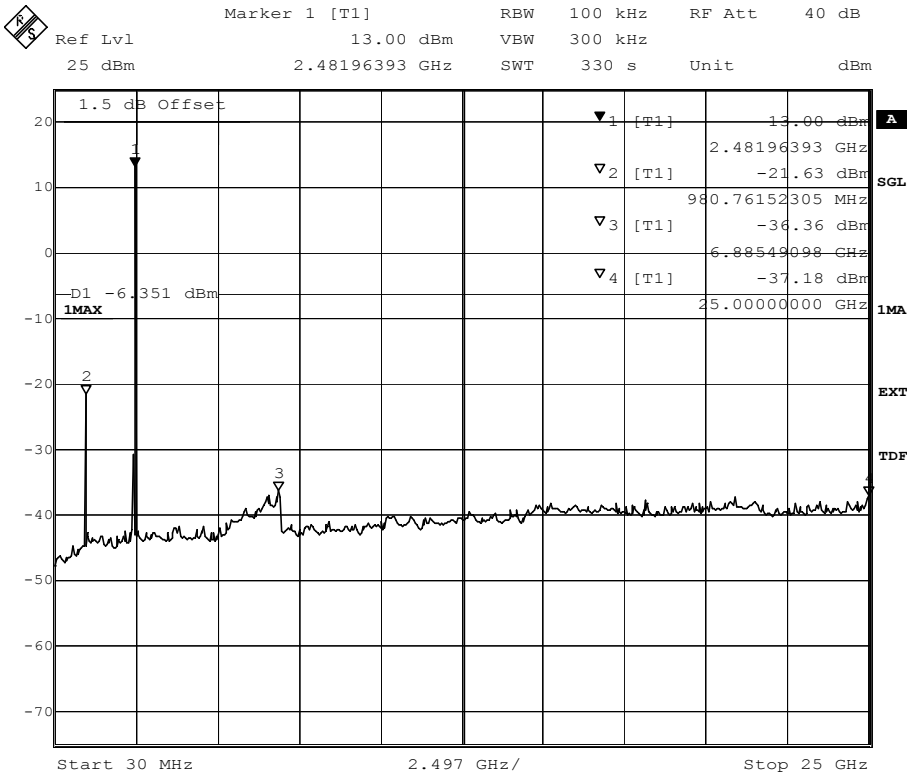
| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 3 Loopback mode on 2480 MHz | setup 1 | temporary antenna connector |




**band edge compliance**

## Spurious RF Conducted Emissions

| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 3 Loopback mode on 2480 MHz | setup 1 | temporary antenna connector |

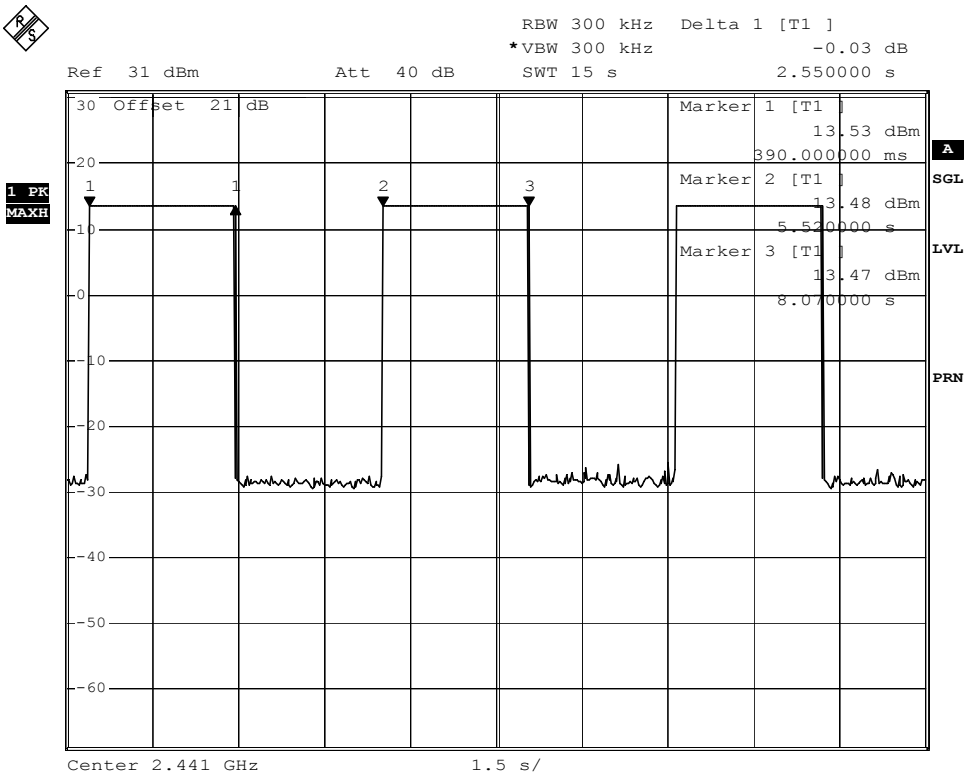



Title: spurious emissions
Comment A: CH T: 2480 MHz
Date: 11.AUG.2004 10:17:04

**spurious emissions conducted**

## Dwell Time

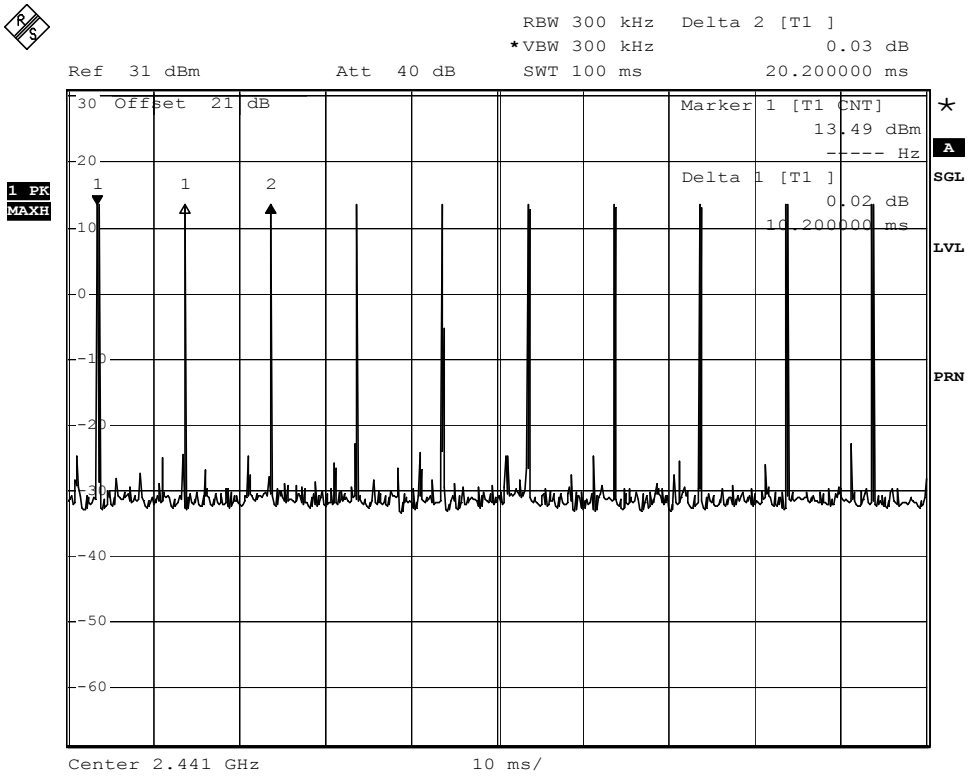
| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 4 inquiry | setup 1 | temporary antenna connector |




**15 seconds sweep for a complete inquiry**

## Dwell Time

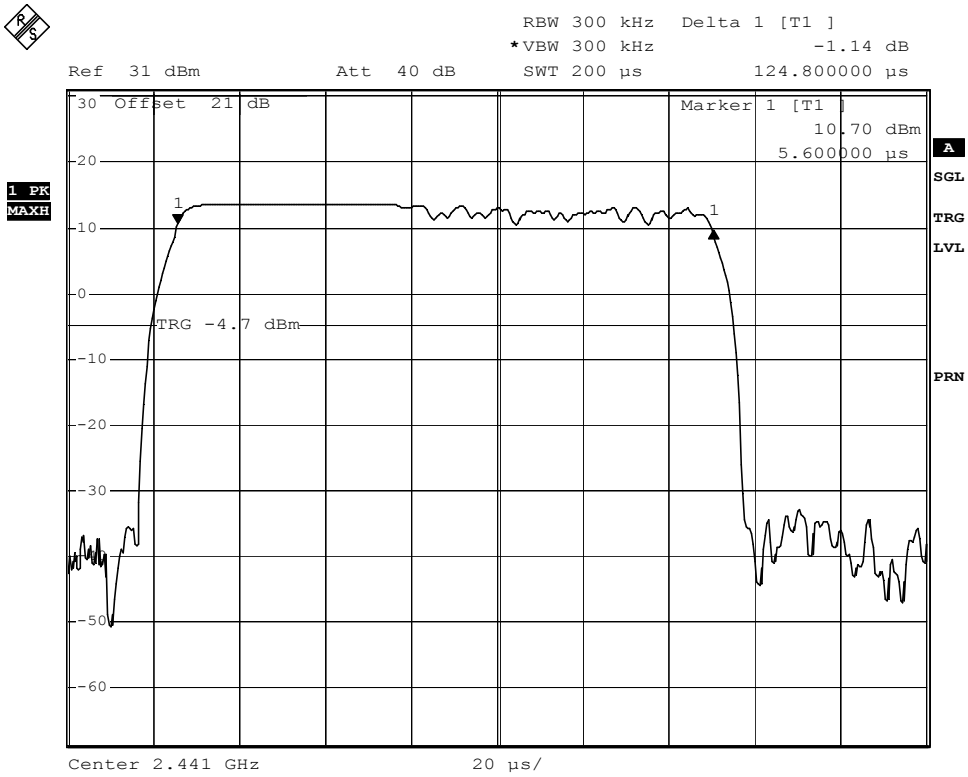
| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 4 inquiry | setup 1 | temporary antenna connector |




**100 ms sweep of a channel to determine the repetition frequency**

## Dwell Time

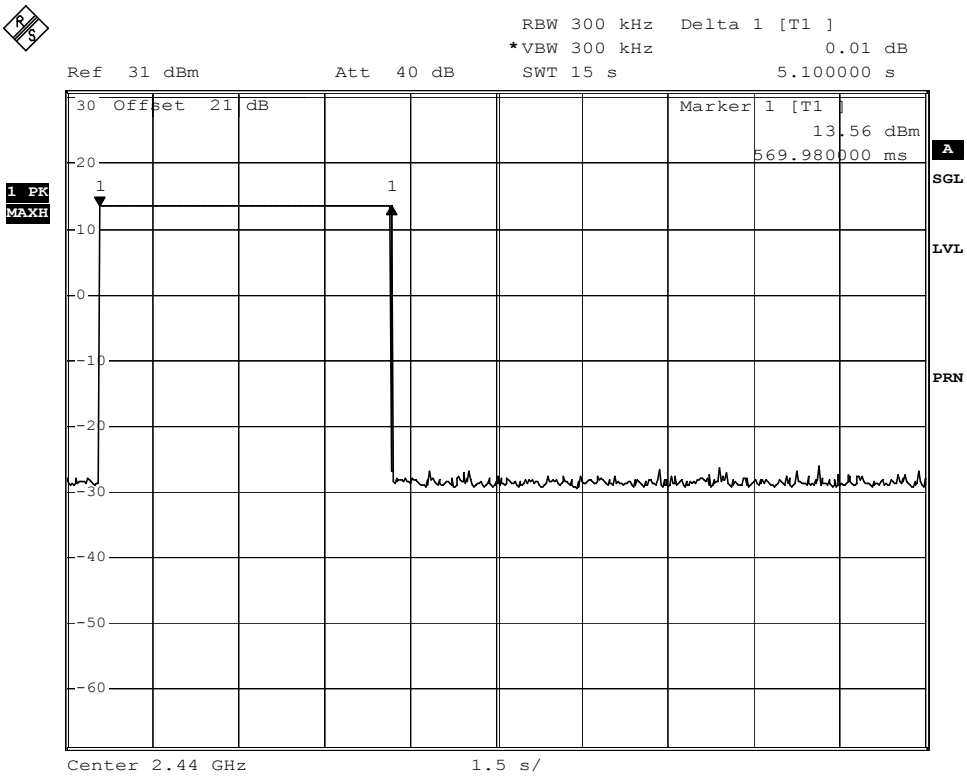
| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 4 inquiry | setup 1 | temporary antenna connector |




**200 µs sweep for a complete burst**

## Dwell Time

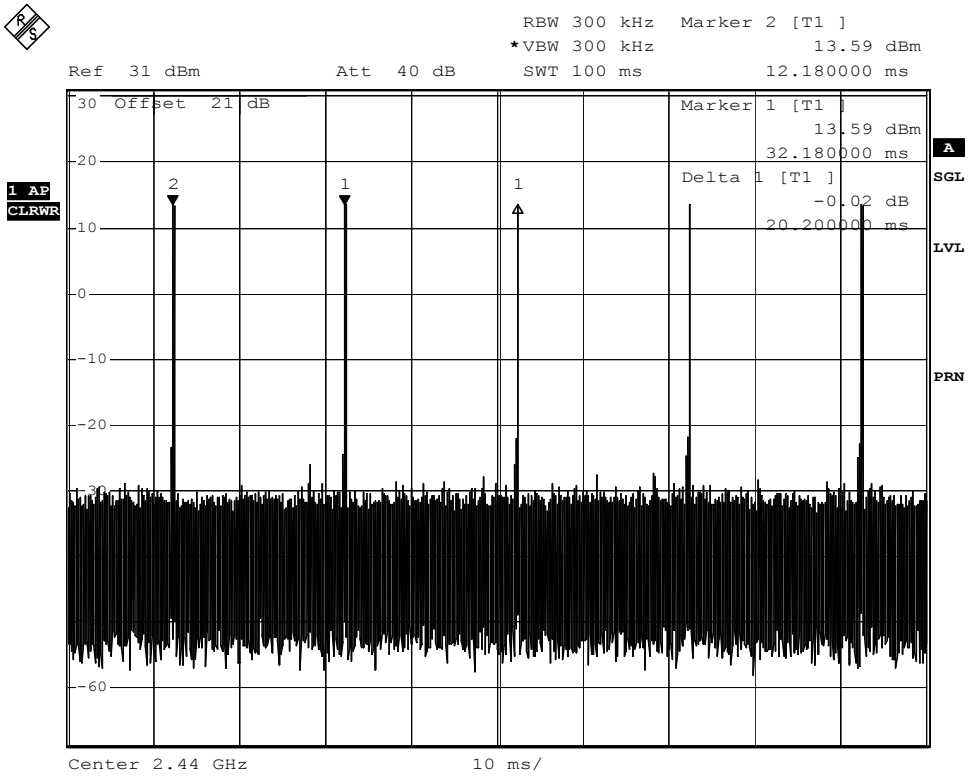
| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 5 paging | setup 1 | temporary antenna connector |




**15 seconds sweep for a complete paging**

## Dwell Time

| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 5 paging | setup 1 | temporary antenna connector |

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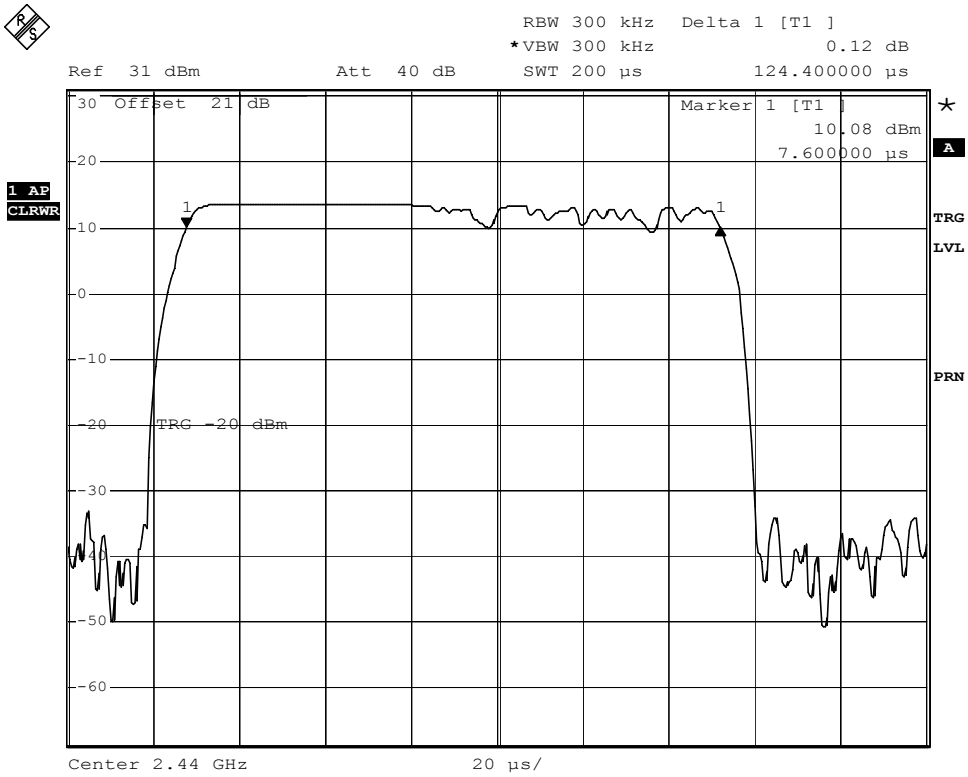
**100 ms sweep of a channel to determine the repetition frequency**

## Dwell Time

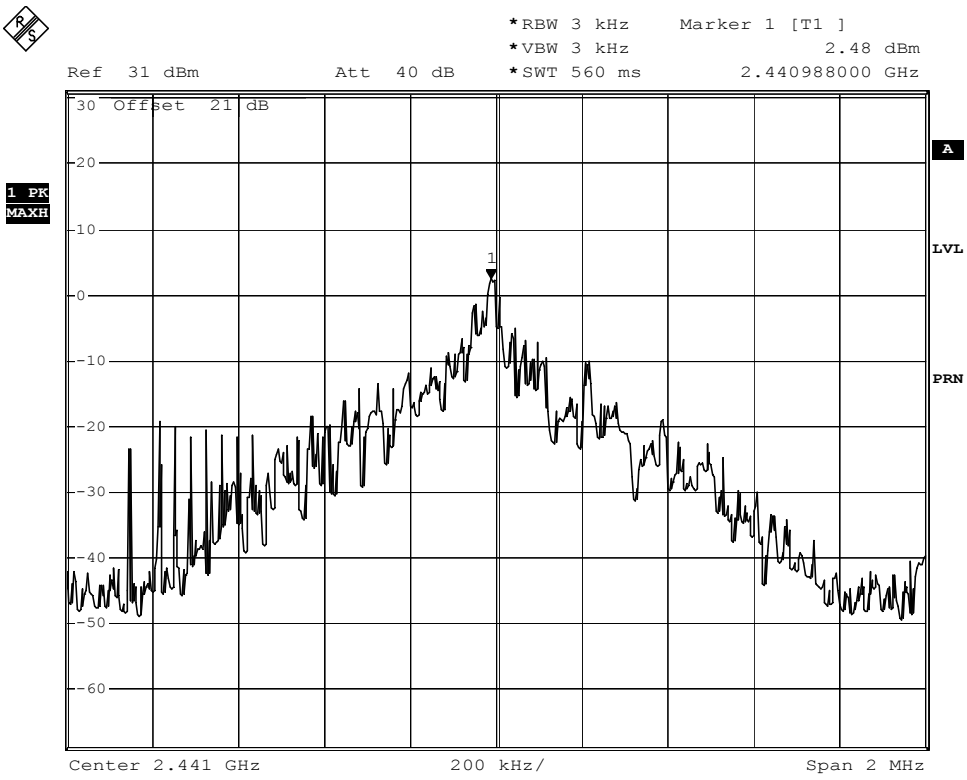
| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 5 paging | setup 1 | temporary antenna connector |




**200 µs sweep for a complete burst**

## Power Density

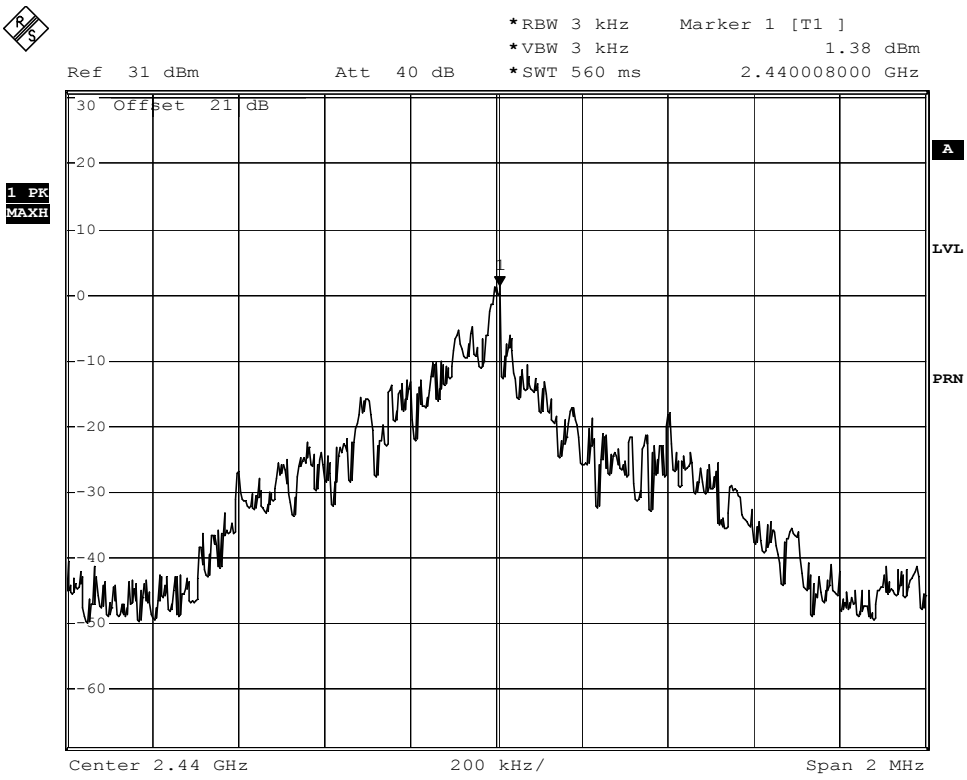
| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 4 inquiry | setup 1 | temporary antenna connector |




**power density**

## Power Density

| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 5 paging | setup 1 | temporary antenna connector |

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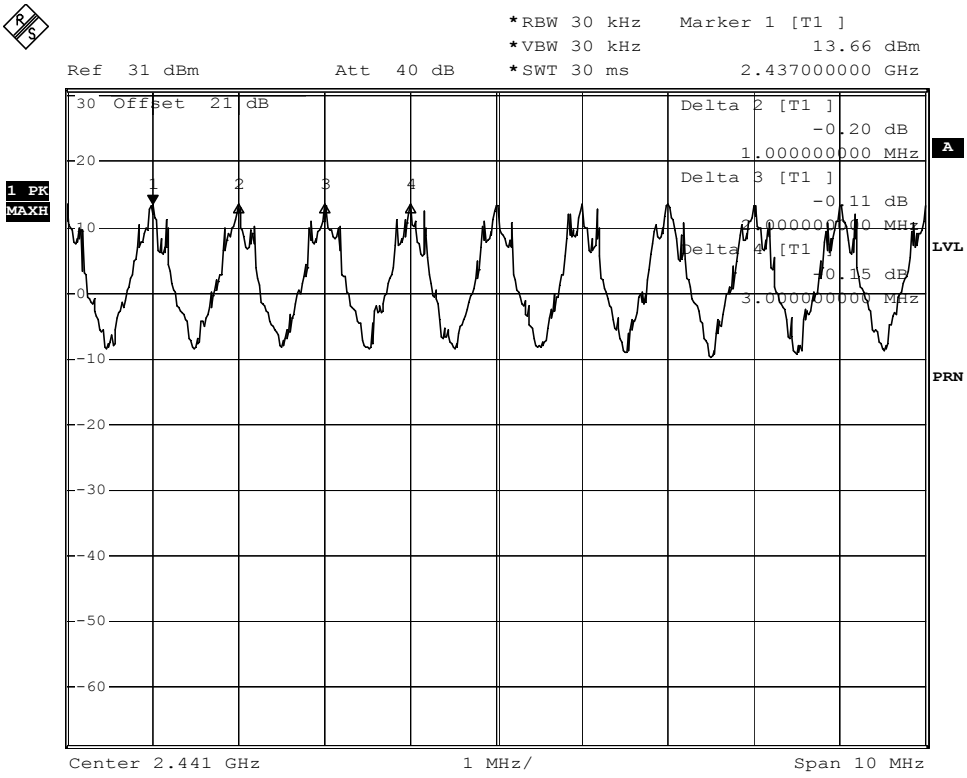
**power density**

## Channel Separation

| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 6 10 neighbouring channels | setup 1 | temporary antenna connector |

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**channel separation**