



InterLab®

FCC Measurement/Technical Report on Bluetooth® transceiver Carkit CAN FSE255X

Report Reference: 4_Temic_0501_TAS_FCCa

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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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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)

The measurement was performed according to ANSI C63.4

| OP-Mode | Setup | Port | Final Result |
|-----------|-----------|----------------------|------------------------|
| op-mode 2 | Setup_a01 | AC Port (power line) | 2003 not applicable |

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

Occupied bandwidth

The measurement was performed according to FCC § 15.31

| OP-Mode | Setup | Port | Final Result |
|-----------|-----------|-------------------|----------------|
| op-mode 1 | Setup_b01 | Antenna connector | 2004 passed |
| op-mode 2 | Setup_b01 | Antenna connector | passed |
| op-mode 3 | Setup_b01 | Antenna connector | passed |

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

Peak power output

The measurement was performed according to FCC § 15.31

| OP-Mode | Setup | Port | Final Result |
|-----------|-----------|-------------------|----------------|
| op-mode 1 | Setup_b01 | Antenna connector | 2004 passed |
| op-mode 2 | Setup_b01 | Antenna connector | passed |
| op-mode 3 | Setup_b01 | Antenna connector | passed |

FCC Part 15, Subpart C § 15.247 (d)

Spurious RF conducted emissions

The measurement was performed according to FCC § 15.31

| OP-Mode | Setup | Port | Final Result |
|-----------|-----------|-------------------|----------------|
| op-mode 1 | Setup_b01 | Antenna connector | 2004 passed |
| op-mode 2 | Setup_b01 | Antenna connector | passed |
| op-mode 3 | Setup_b01 | Antenna connector | passed |

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

Spurious radiated emissions

The measurement was performed according to ANSI C63.4

| OP-Mode | Setup | Port | Final Result |
|-----------|-----------|-------------------|----------------|
| op-mode 1 | Setup_a01 | Enclosure | 2003 passed |
| op-mode 2 | Setup_a01 | Enclosure | passed |
| op-mode 3 | Setup_a01 | Enclosure | passed |
| op-mode 1 | Setup_a02 | Enclosure + Cable | passed |
| op-mode 2 | Setup_a02 | Enclosure + Cable | passed |
| op-mode 3 | Setup_a02 | Enclosure + Cable | 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)

| OP-Mode | Setup | Port | Final Result |
|-----------|-----------|-------------------|-----------------------|
| op-mode 1 | Setup_b01 | Antenna connector | 2004 / 2003 passed |
| op-mode 3 | Setup_a01 | 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

Setup_b01

Antenna connector

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

Setup_b01

Antenna connector

passed

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

Number of hopping frequencies

The measurement was performed according to FCC § 15.31

2004

OP-Mode
Setup
Port
Final Result

op-mode 4

Setup_b01

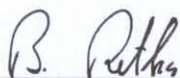
Antenna connector

passed



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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: 2005-02-01

1.2 Project Data

Responsible for testing and report: Dipl.-Ing. Andreas Petz
Date of Test(s): 2005-03-02 to 2005-03-03
Date of Report: 2005-03-15

1.3 Applicant Data

Company Name: Temic SDS GmbH
Address: Soeflinger Strasse 100
D-89077 Ulm
Germany
Contact Person: Mr. Joachim Schneider

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

| | |
|-----------------------------|-----------------------------------|
| Equipment under Test | Bluetooth® transceiver |
| Type Designation: | Carkit CAN FSE255X |
| Kind of Device: | Bluetooth handsfree carkit |
| (optional) | |
| Voltage Type: | DC |
| Voltage level: | 9.0 - 16.0 V (measured at 12.0 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

Antenna connector (Fakra connector)
Enclosure
Cable (Antenna cable type: RG58, length: 3.0 m)
DC Port

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 (Code: 1N021a01) | Bluetooth® transceiver | Carkit CAN FSE255X | 2U5X_H19_Lab_004 | 19 | 0050 | 2005-03-02 |
| Remark: EUT A is equipped with an permanent 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 | External Antenna | Radiall BT antenna 1202 | – (gain = 2.14 dBi) | – | – | – |
| AE 2 | Antenna cable | RG58 (3.0 m) / Fakra connector | – | – | – | – |

3.4 EUT Setups

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

| Setup No. | Combination of EUT's | Description |
|-----------|----------------------|---|
| Setup_a01 | EUT A + AE 1 | setup for radiated measurements (with ext. antenna) |
| Setup_a02 | EUT A + AE 1 + AE 2 | setup for radiated measurements (with ext. antenna + coaxial cable) |
| Setup_b01 | EUT A | setup for conducted measurements (stand alone) |

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 |
| op-mode 2 | The EUT transmits on 2441 MHz | Loopback mode |
| op-mode 3 | The EUT transmits on 2480 MHz | Loopback 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: 25 °C
Air Pressure: 1015 hPa
Humidity: 34 %

| Op. Mode | Setup | Port |
|-----------|-----------|-------------------|
| op-mode 1 | Setup_b01 | Antenna connector |

| 20 dB bandwidth kHz | Remarks |
|------------------------|---------|
| 938 | none |

Remark: Please see annex for the measurement plot.

| Op. Mode | Setup | Port |
|-----------|-----------|-------------------|
| op-mode 2 | Setup_b01 | Antenna connector |

| 20 dB bandwidth kHz | Remarks |
|------------------------|---------|
| 934 | none |

Remark: Please see annex for the measurement plot.

| Op. Mode | Setup | Port |
|-----------|-----------|-------------------|
| op-mode 3 | Setup_b01 | Antenna connector |

| 20 dB bandwidth kHz | Remarks |
|------------------------|---------|
| 938 | none |

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: 25 °C
Air Pressure: 1015 hPa
Humidity: 34 %

| Op. Mode | Setup | Port |
|-----------|-----------|-------------------|
| op-mode 1 | Setup_b01 | Antenna connector |

| Output power dBm | Remarks |
|---------------------|--|
| 0.98 | The EIRP including antenna gain (2.14 dBi) is 3.12 dBm |

Remark: Please see annex for the measurement plot.

| Op. Mode | Setup | Port |
|-----------|-----------|-------------------|
| op-mode 2 | Setup_b01 | Antenna connector |

| Output power dBm | Remarks |
|---------------------|--|
| 1.43 | The EIRP including antenna gain (2.14 dBi) is 3.57 dBm |

Remark: Please see annex for the measurement plot.

| Op. Mode | Setup | Port |
|-----------|-----------|-------------------|
| op-mode 3 | Setup_b01 | Antenna connector |

| Output power dBm | Remarks |
|---------------------|--|
| 1.47 | The EIRP including antenna gain (2.14 dBi) is 3.61 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: 25 °C
Air Pressure: 1015 hPa
Humidity: 34 %

| Op. Mode | Setup | Port |
|-----------|-----------|-------------------|
| op-mode 1 | Setup_b01 | Antenna connector |

| Frequency MHz | Corrected measurement value dBm | Reference value dBm | Limit dBm | Delta to limit dB |
|---------------|---------------------------------|---------------------|-----------|-------------------|
| 4784 | -55.65 | 0.89 | -19.11 | 36.54 |

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

| Op. Mode | Setup | Port | | |
|---------------|---------------------------------|---------------------|-----------|-------------------|
| op-mode 2 | Setup_b01 | Antenna connector | | |
| Frequency MHz | Corrected measurement value dBm | Reference value dBm | Limit dBm | Delta to limit dB |
| 4884 | -56.91 | 1.30 | -18.7 | 38.21 |
| 7336 | -59.42 | 1.30 | -18.7 | 40.72 |

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

| Op. Mode | Setup | Port | | |
|---------------|---------------------------------|---------------------|-----------|-------------------|
| op-mode 3 | Setup_b01 | Antenna connector | | |
| Frequency MHz | Corrected measurement value dBm | Reference value dBm | Limit dBm | Delta to limit dB |
| 4934 | -57.71 | 1.20 | -18.8 | 38.91 |
| 7436 | -56.51 | 1.20 | -18.8 | 37.71 |

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 1 GHz

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 μ 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: 25 °C
Air Pressure: 1015 hPa
Humidity: 36 %

| Op. Mode | Setup | Port |
|-----------|-----------|-----------|
| op-mode 1 | Setup_a01 | Enclosure |

| Polarisation | Frequency MHz | Corrected value dBµV/m | | | Limit dBµV/m | Limit dBµV/m | Limit dBµV/m | Delta to limit dB | Delta to limit dB |
|-----------------------|---------------|------------------------|-------|-------|--------------|--------------|--------------|-------------------|-------------------|
| | | QP | Peak | AV | QP | Peak | AV | QP/Peak | AV |
| Vertical + horizontal | 4804 | | 40.81 | 29.69 | | 74 | 54 | 33.19 | 24.31 |
| | | | | | | | | | |

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

| Op. Mode | Setup | Port |
|-----------|-----------|-------------------|
| op-mode 1 | Setup_a02 | Enclosure + cable |

| Polarisation | Frequency MHz | Corrected value dBµV/m | | | Limit dBµV/m | Limit dBµV/m | Limit dBµV/m | Delta to limit dB | Delta to limit dB |
|-----------------------|---------------|------------------------|------|-------|--------------|--------------|--------------|-------------------|-------------------|
| | | QP | Peak | AV | QP | Peak | AV | QP/Peak | AV |
| Vertical + horizontal | 4804 | | 36.3 | 24.19 | | 74 | 54 | 37.70 | 29.81 |
| | | | | | | | | | |

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

Op. Mode **Setup** **Port**
op-mode 2 Setup_a01 Enclosure

| Polarisation | Frequency MHz | Corrected value dBµV/m | | | Limit dBµV/m | Limit dBµV/m | Limit dBµV/m | Delta to limit dB | Delta to limit dB |
|-----------------------|---------------|------------------------|-------|-------|--------------|--------------|--------------|-------------------|-------------------|
| | | QP | Peak | AV | QP | Peak | AV | QP/Peak | AV |
| Vertical + horizontal | 4882 | | 40.12 | 28.74 | | 74 | 54 | 33.88 | 25.26 |
| | | | | | | | | | |

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

Op. Mode **Setup** **Port**
op-mode 2 Setup_a02 Enclosure + cable

| Polarisation | Frequency MHz | Corrected value dBµV/m | | | Limit dBµV/m | Limit dBµV/m | Limit dBµV/m | Delta to limit dB | Delta to limit dB |
|-----------------------|---------------|------------------------|-------|-------|--------------|--------------|--------------|-------------------|-------------------|
| | | QP | Peak | AV | QP | Peak | AV | QP/Peak | AV |
| Vertical + horizontal | 4882 | | 35.73 | 23.54 | | 74 | 54 | 38.27 | 30.46 |
| | | | | | | | | | |

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

Op. Mode **Setup** **Port**
op-mode 3 Setup_a01 Enclosure

| Polarisation | Frequency MHz | Corrected value dBµV/m | | | Limit dBµV/m | Limit dBµV/m | Limit dBµV/m | Delta to limit dB | Delta to limit dB |
|-----------------------|---------------|------------------------|-------|-------|--------------|--------------|--------------|-------------------|-------------------|
| | | QP | Peak | AV | QP | Peak | AV | QP/Peak | AV |
| Vertical + horizontal | 4960 | | 39.47 | 28.22 | | 74 | 54 | 34.53 | 25.78 |
| Vertical + horizontal | 7440 | | 41.38 | 29.05 | | 74 | 54 | 32.62 | 24.95 |

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

Op. Mode **Setup** **Port**
op-mode 3 Setup_a02 Enclosure + cable

| Polarisation | Frequency MHz | Corrected value dBµV/m | | | Limit dBµV/m | Limit dBµV/m | Limit dBµV/m | Delta to limit dB | Delta to limit dB |
|-----------------------|---------------|------------------------|-------|-------|--------------|--------------|--------------|-------------------|-------------------|
| | | QP | Peak | AV | QP | Peak | AV | QP/Peak | AV |
| Vertical + horizontal | 4960 | | 36.66 | 23.44 | | 74 | 54 | 23.44 | 37.34 |
| | | | | | | | | | |

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 |
|------------------------|--|-----------|--------|
| Setup_a01 | | op-mode 1 | passed |
| | | op-mode 2 | passed |
| | | op-mode 3 | passed |
| Setup_a02 | | 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 band edge** the RF power at the band edge shall be "at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power..."

For the measurement of the **higher band edge** the limit is "specified in Section 15.209(a)".

4.5.3 Test Protocol

4.5.3.1 Lower band edge

Temperature: 25 °C
Air Pressure: 1015 hPa
Humidity: 34 %

| Op. Mode | Setup | Port |
|-----------|-----------|-------------------|
| op-mode 1 | Setup_b01 | Antenna connector |

| Frequency MHz | Measured value dBm | Reference value dBm | Limit dBm | Delta to limit dB |
|---------------|--------------------|---------------------|-----------|-------------------|
| 2400,00 | -62.17 | -5.94 | -25.94 | 36.23 |

Remark: Please see annex for the measurement plot.

4.5.3.2 Higher band edge

Temperature: 25 °C
Air Pressure: 1015 hPa
Humidity: 36 %

| Op. Mode | Setup | Port |
|-----------|-----------|-----------|
| op-mode 3 | Setup_a01 | Enclosure |

| Frequency MHz | Polarisation | Corrected value dBµV/m | | Limit Peak dBµV/m | Limit AV dBµV/m | Delta to Peak limit/dB | Delta to AV limit dB |
|---------------|-----------------------|------------------------|-------|-------------------|-----------------|------------------------|----------------------|
| | | Peak | AV | | | | |
| 2483,50 | Vertical + horizontal | 47.69 | 35.46 | 74.00 | 54.00 | 26.31 | 18.54 |

Remark: Please see annex for the measurement plot.

| Op. Mode | Setup | Port |
|-----------|-----------|-------------------|
| op-mode 3 | Setup_a02 | Enclosure + cable |

| Frequency MHz | Polarisation | Corrected value dBµV/m | | Limit Peak dBµV/m | Limit AV dBµV/m | Delta to Peak limit/dB | Delta to AV limit dB |
|---------------|-----------------------|------------------------|-------|-------------------|-----------------|------------------------|----------------------|
| | | Peak | AV | | | | |
| 2483,50 | Vertical + horizontal | 47.54 | 35.02 | 74.00 | 54.00 | 26.46 | 18.98 |

Remark: Please see annex for the measurement plot.

4.5.4 Test result: Band edge compliance

| FCC Part 15, Subpart C | Op. Mode | Result |
|------------------------|-----------|--------|
| | op-mode 1 | passed |
| Setup_a01 | op-mode 3 | passed |
| Setup_a02 | 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:

Dwell time = time slot length * hop rate / number of hopping channels * 31.6

with:

- hop rate=1600 * 1/s for DH1 packets =1600
- hop rate=1600/3 * 1/s for DH3 packets =533.33
- hop rate=1600/5 * 1/s for DH5 packets =320
- number of hopping channels=79
- 31.6 s=0.4 seconds multiplied by the number of hopping channels=0.4s * 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: 25 °C
Air Pressure: 1015 hPa
Humidity: 34 %

| Op. Mode | Setup | Port |
|-----------|-----------|-------------------|
| op-mode 2 | Setup_b01 | Antenna connector |

| Packet type | Time slot length ms | Dwell time | Dwell time ms |
|-------------|------------------------|---|------------------|
| DH1 | 0.418 | time slot length * 1600 /79 * 31.6 | 267.52 |
| DH3 | 1.692 | time slot length * 1600/3 /79 * 31.6 | 360.96 |
| DH5 | 2.938 | time slot length * 1600/5 /79 * 31.6 | 376.06 |

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: 3 MHz
- Centre Frequency: 2441 MHz
- Resolution Bandwidth (RBW): 30 kHz
- Video Bandwidth (VBW): 100 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: 25 °C
Air Pressure: 1015 hPa
Humidity: 34 %

| Op. Mode | Setup | Port |
|-----------|-----------|-------------------|
| op-mode 4 | Setup_b01 | Antenna connector |

| Channel separation MHz | Remarks |
|---------------------------|---------|
| 1.002 | none |

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 number of hopping frequencies measurement.

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

Analyzer settings:

- Detector: Peak-Maxhold
- Start frequency: 2402 MHz
- Stop frequency: 2483.5 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) (iii)

Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels.

4.8.3 Test Protocol

Temperature: 25 °C
Air Pressure: 1015 hPa
Humidity: 34 %

| Op. Mode | Setup | Port |
|-----------|-----------|-------------------|
| op-mode 4 | Setup_b01 | Antenna connector |

| Number of hopping channels | Remarks |
|----------------------------|---------|
| 79 | none |

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

| Equipment | Type | Serial No. | Manufacturer |
|---|------------------|-------------------|---------------------|
| 10 MHz 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 Analyzer FSIQ26 832695/007 | FSIQ26 | 832695/007 | 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 Photo Report

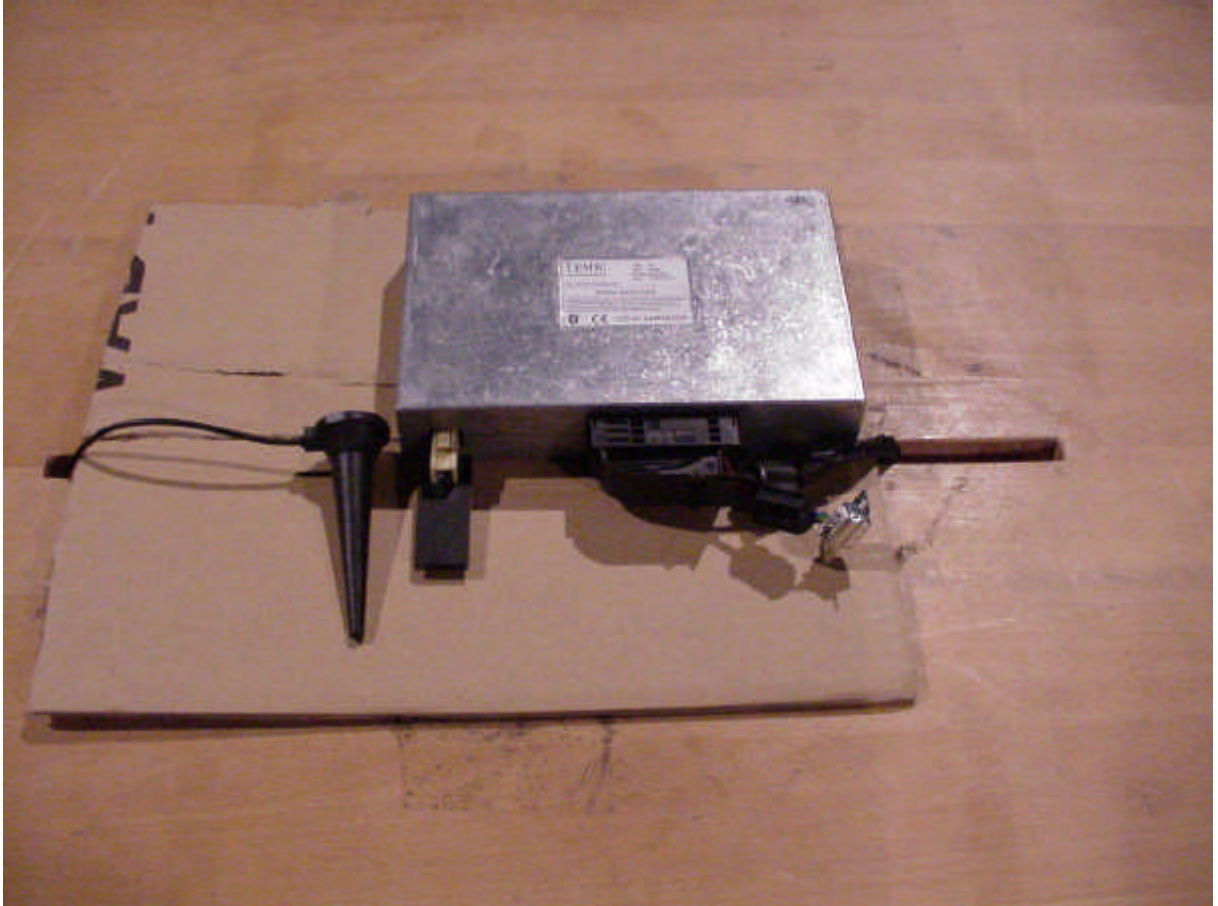


Photo 1: Test setup for radiated measurements (setup_a01)

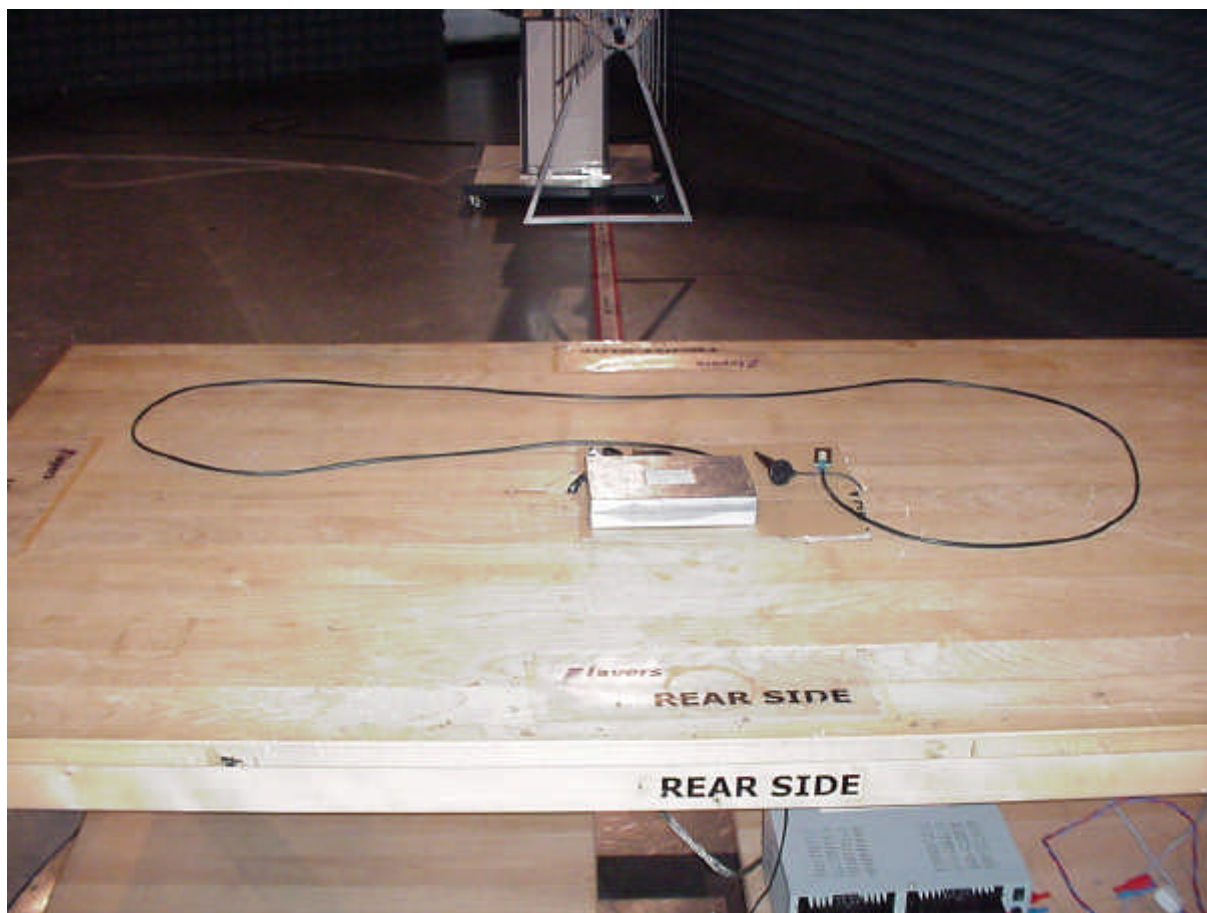


Photo 2: Test setup for radiated measurements (setup_a02)



Photo 3: EUT (view to the connectors, top side)

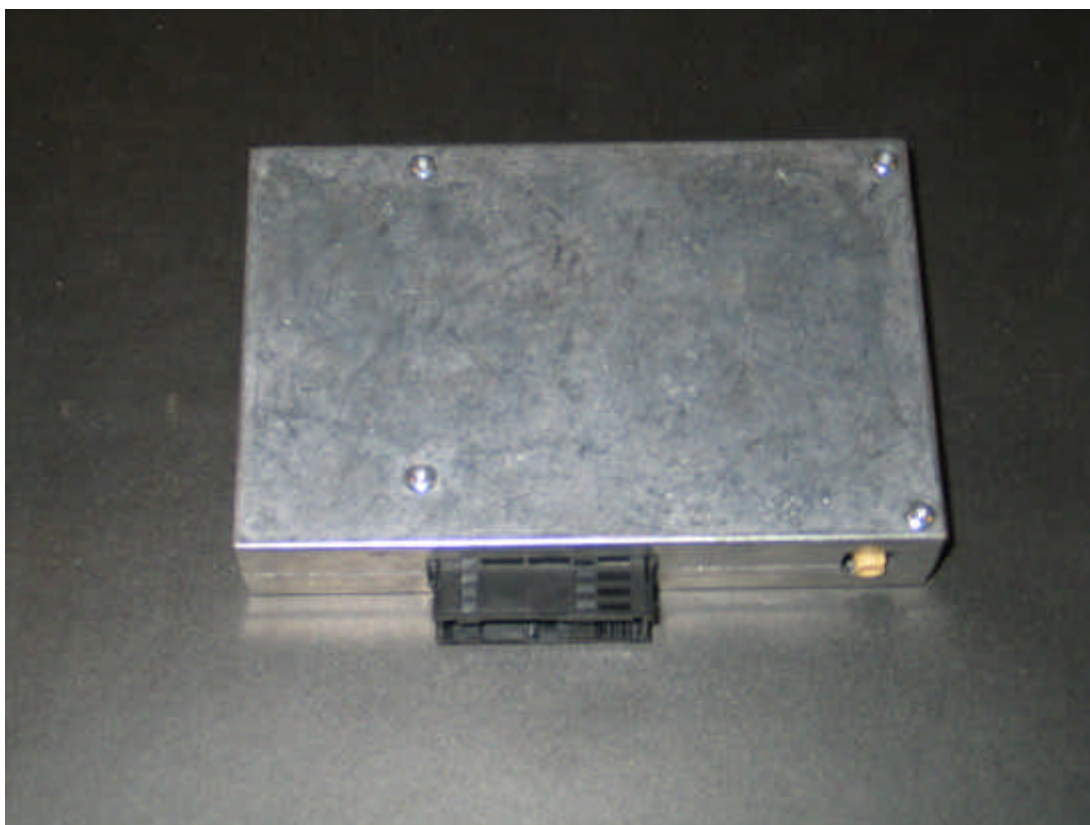
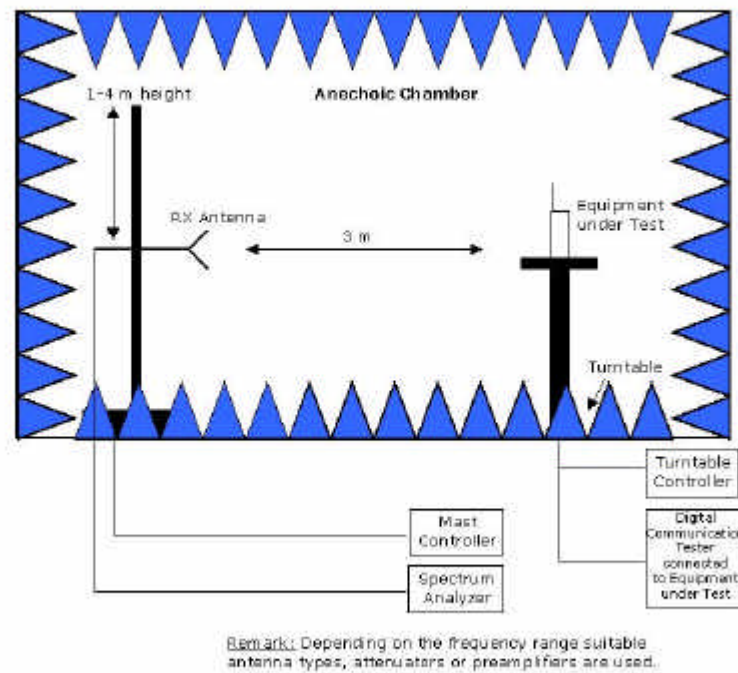


Photo 4: EUT (view to the enclosure, bottom side)

7 Setup Drawings



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

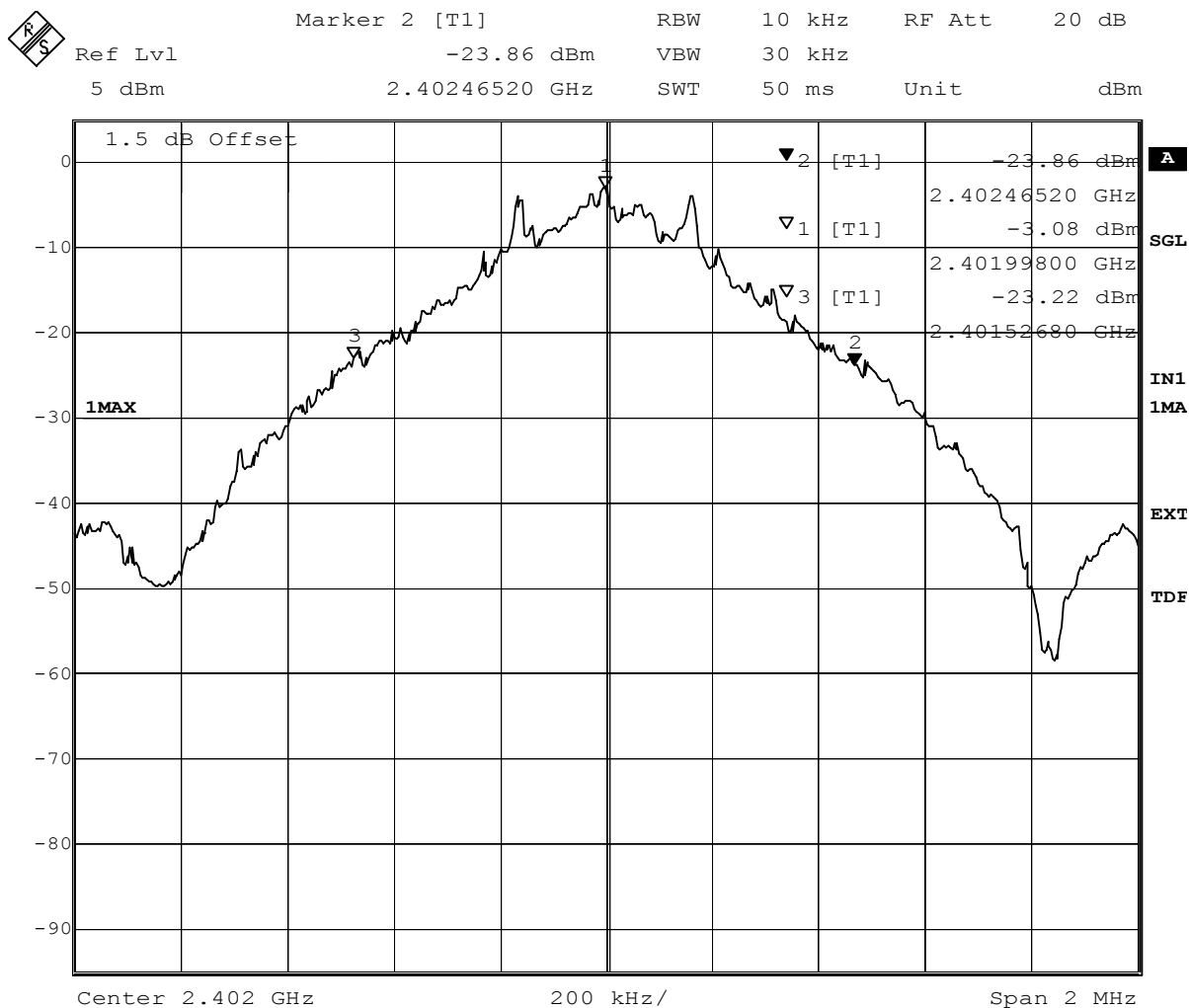
8 Annex

Measurement plots

Occupied bandwidth

Op. Mode

op-mode 1



Title: 20dB Bandwidth

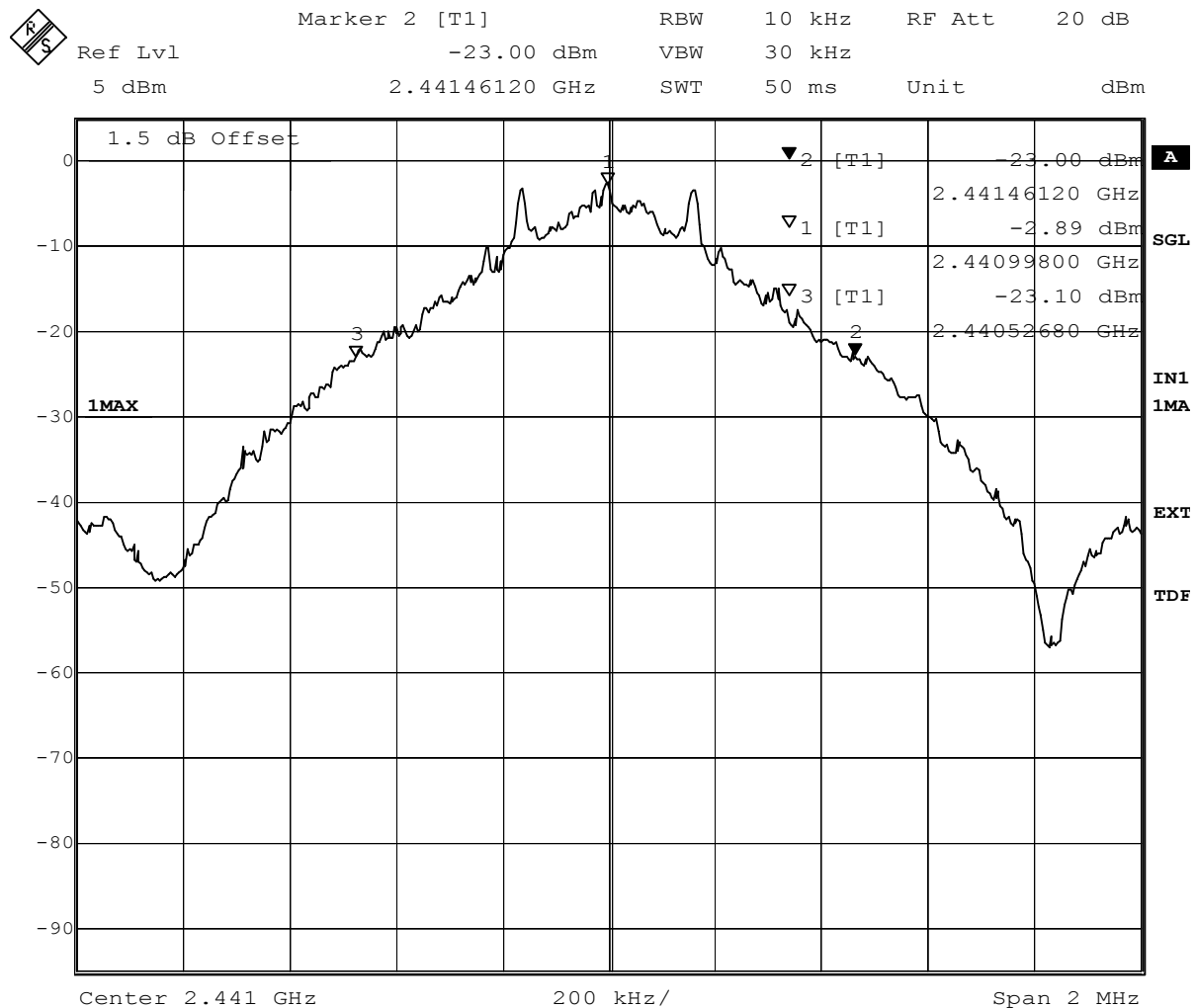
Comment A: CH B: 2402 MHz; 20dB bandwidth (kHz):938.4

Date: 2.MAR.2005 10:32:06

Occupied bandwidth

Op. Mode

op-mode 2

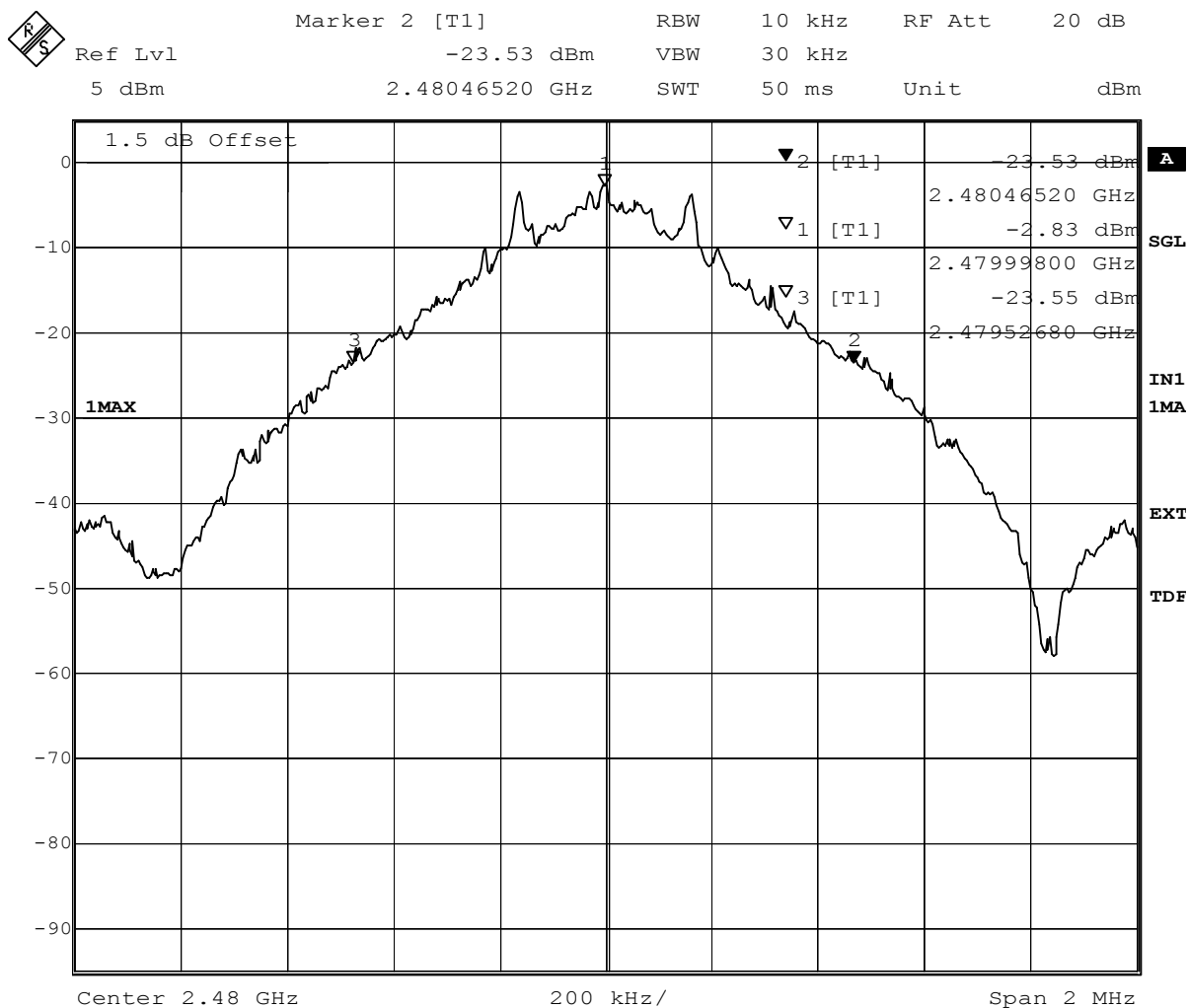


Title: 20dB Bandwidth
 Comment A: CH M: 2441 MHz; 20dB bandwidth (kHz):934.4
 Date: 2.MAR.2005 10:52:36

Occupied bandwidth

Op. Mode

op-mode 3



Title: 20dB Bandwidth


Comment A: CH T: 2480 MHz; 20dB bandwidth (kHz):938.4

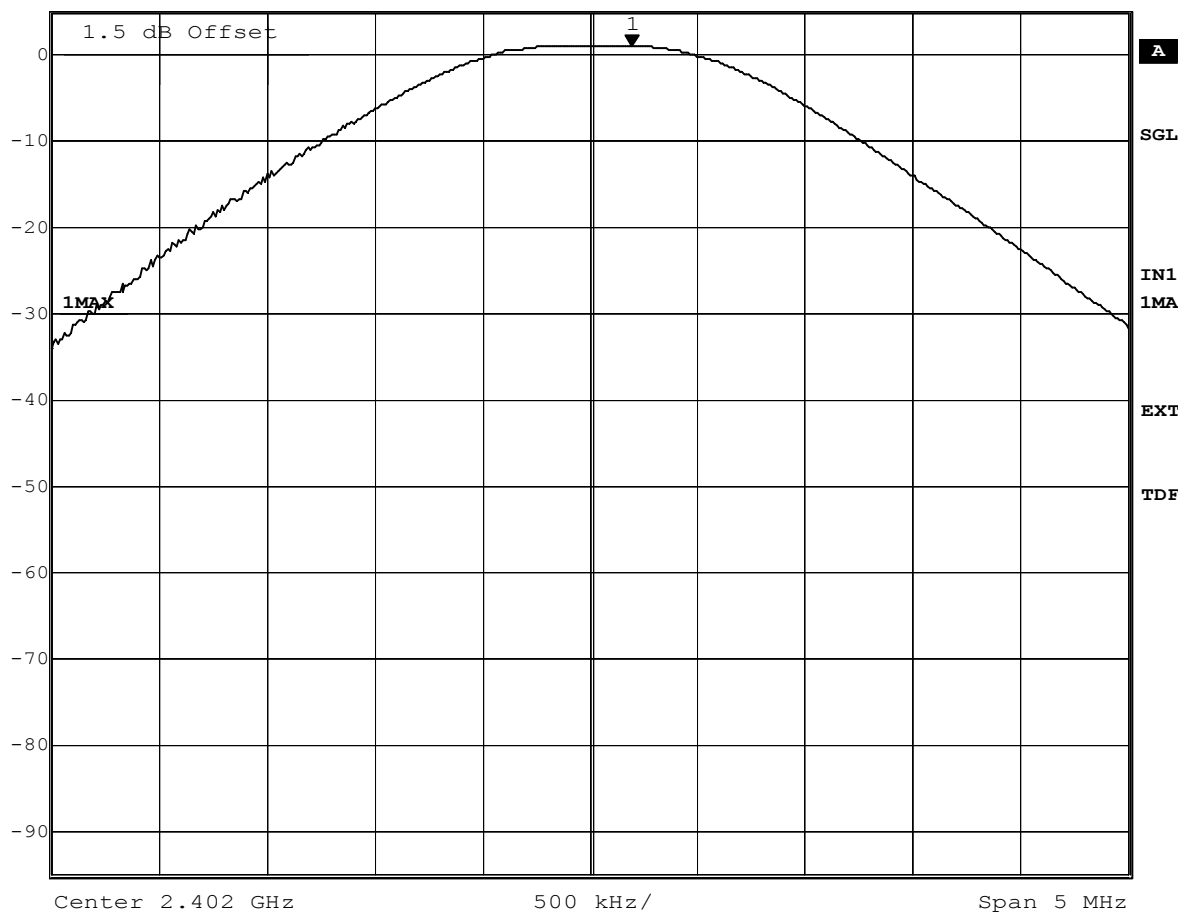
Date: 2.MAR.2005 11:12:12

Peak power output

Op. Mode

op-mode 1

| | | | | | |
|---|---------------|----------------|-------|--------|----------|
|  | Marker 1 [T1] | RBW | 1 MHz | RF Att | 20 dB |
| | Ref Lvl | 0.98 dBm | VBW | 3 MHz | |
| | 5 dBm | 2.40219539 GHz | SWT | 5 ms | Unit dBm |



Title: Peak outputpower Power

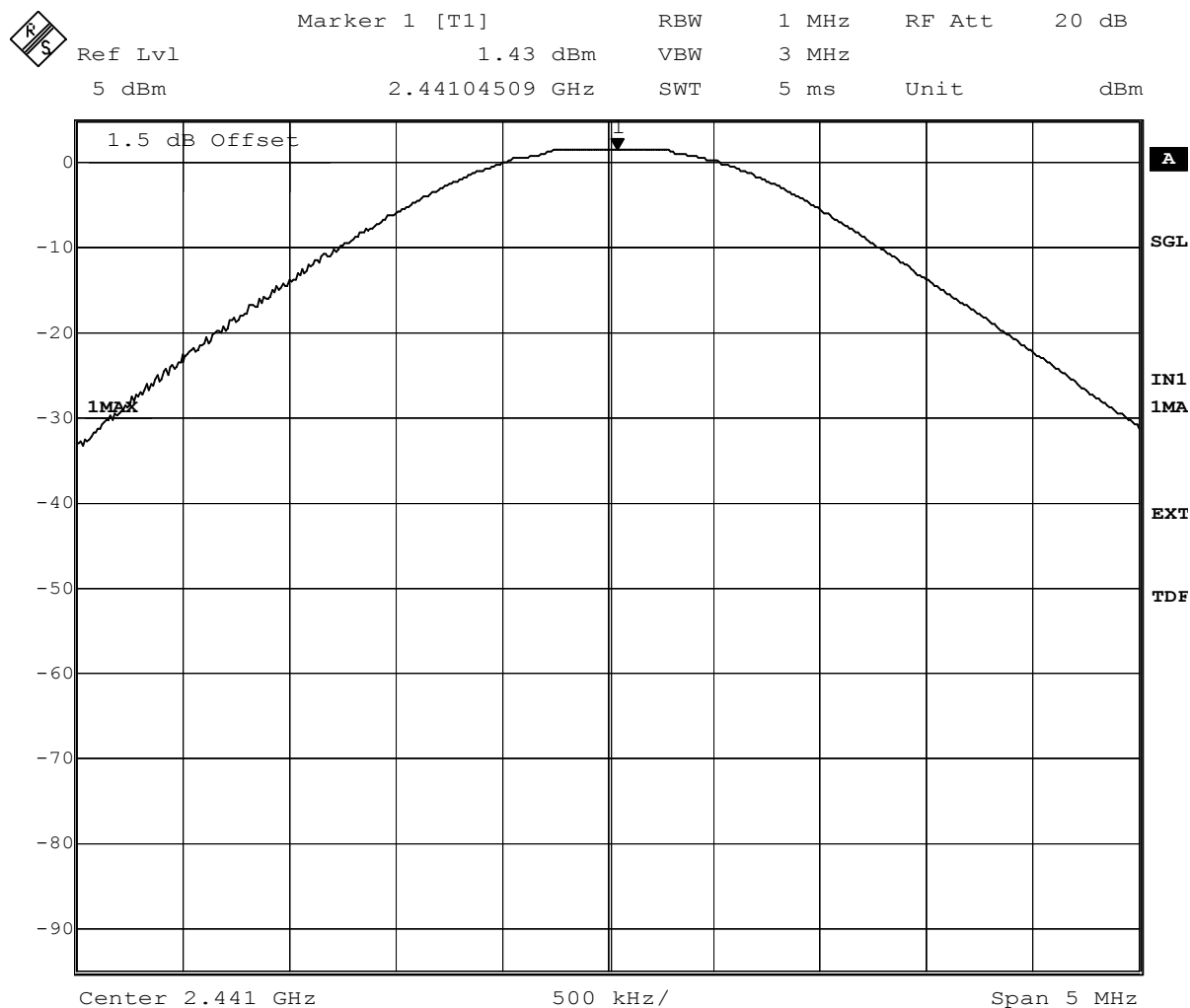
Comment A: CH B: 2402 MHz

Date: 2.MAR.2005 10:32:35

Peak power output

Op. Mode

op-mode 2



Title: Peak outputpower Power

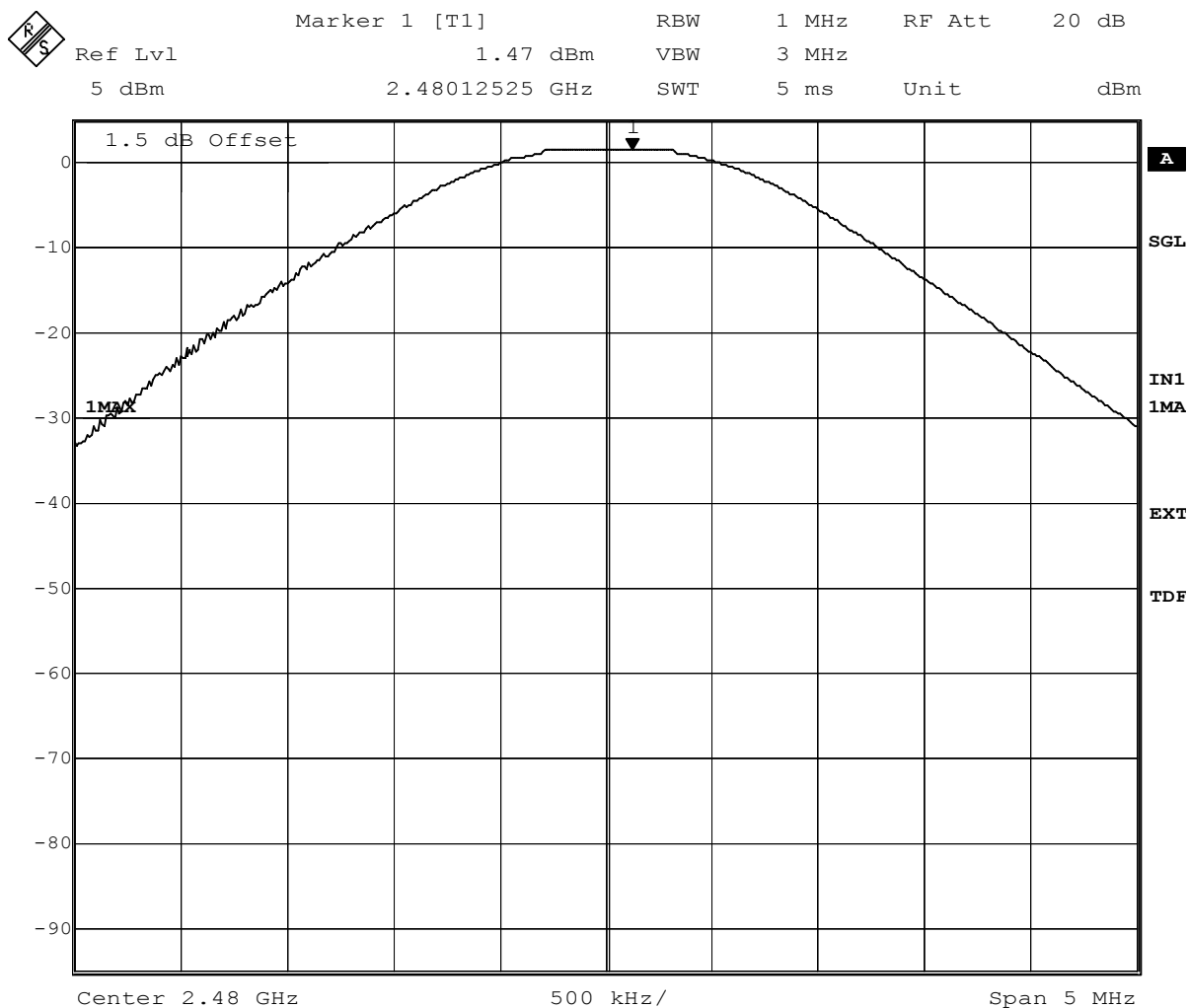
Comment A: CH M: 2441 MHz

Date: 2.MAR.2005 10:53:04

Peak power output

Op. Mode

op-mode 3



Title: Peak outputpower Power

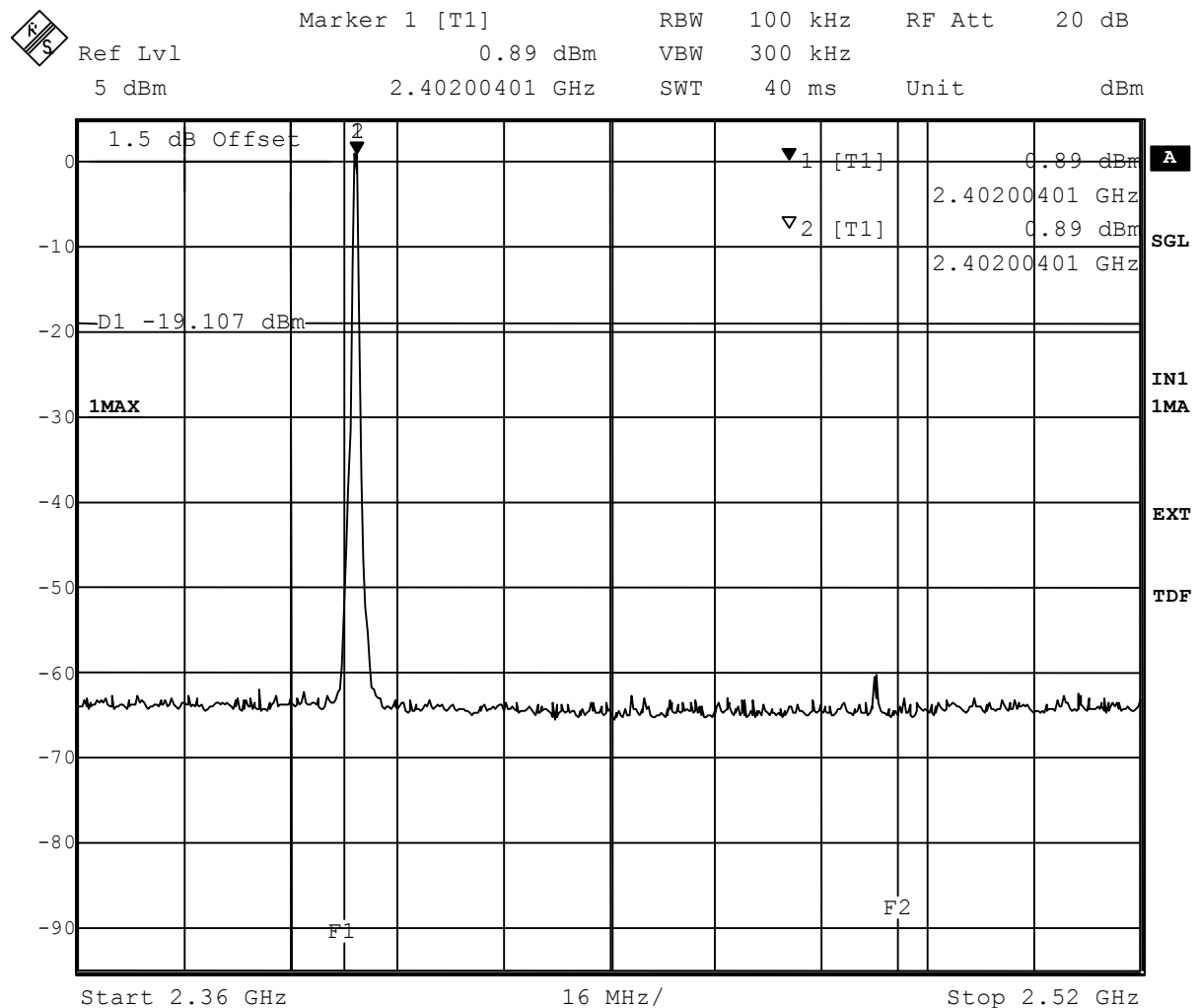
Comment A: CH T: 2480 MHz

Date: 2.MAR.2005 11:12:41

Spurious RF conducted emission

Op. Mode

op-mode 1



Title:

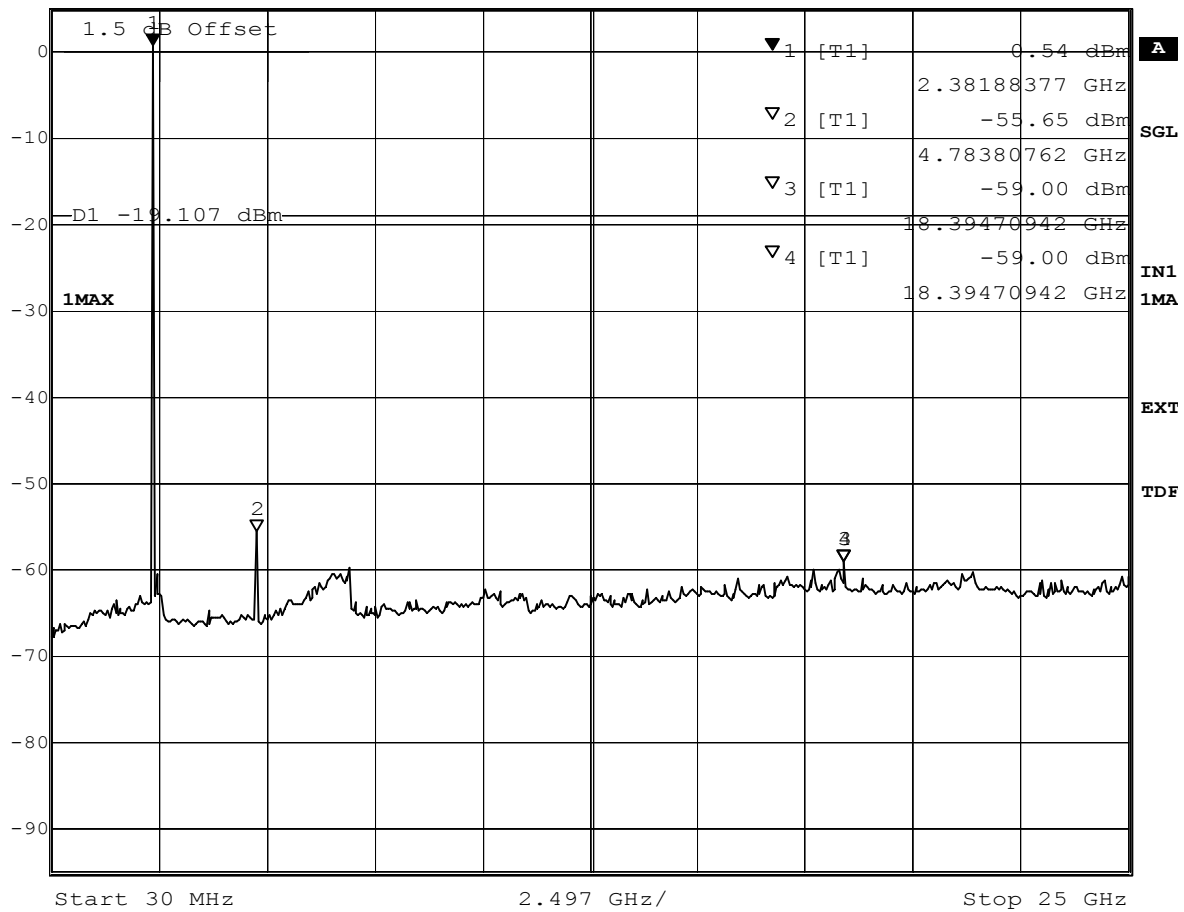
Comment A: CH B: 2402 MHz

Date: 2.MAR.2005 10:16:52

(determination of reference value)



Marker 1 [T1] RBW 100 kHz RF Att 20 dB
 Ref Lvl 0.54 dBm VBW 300 kHz
 5 dBm 2.38188377 GHz SWT 330 s Unit dBm



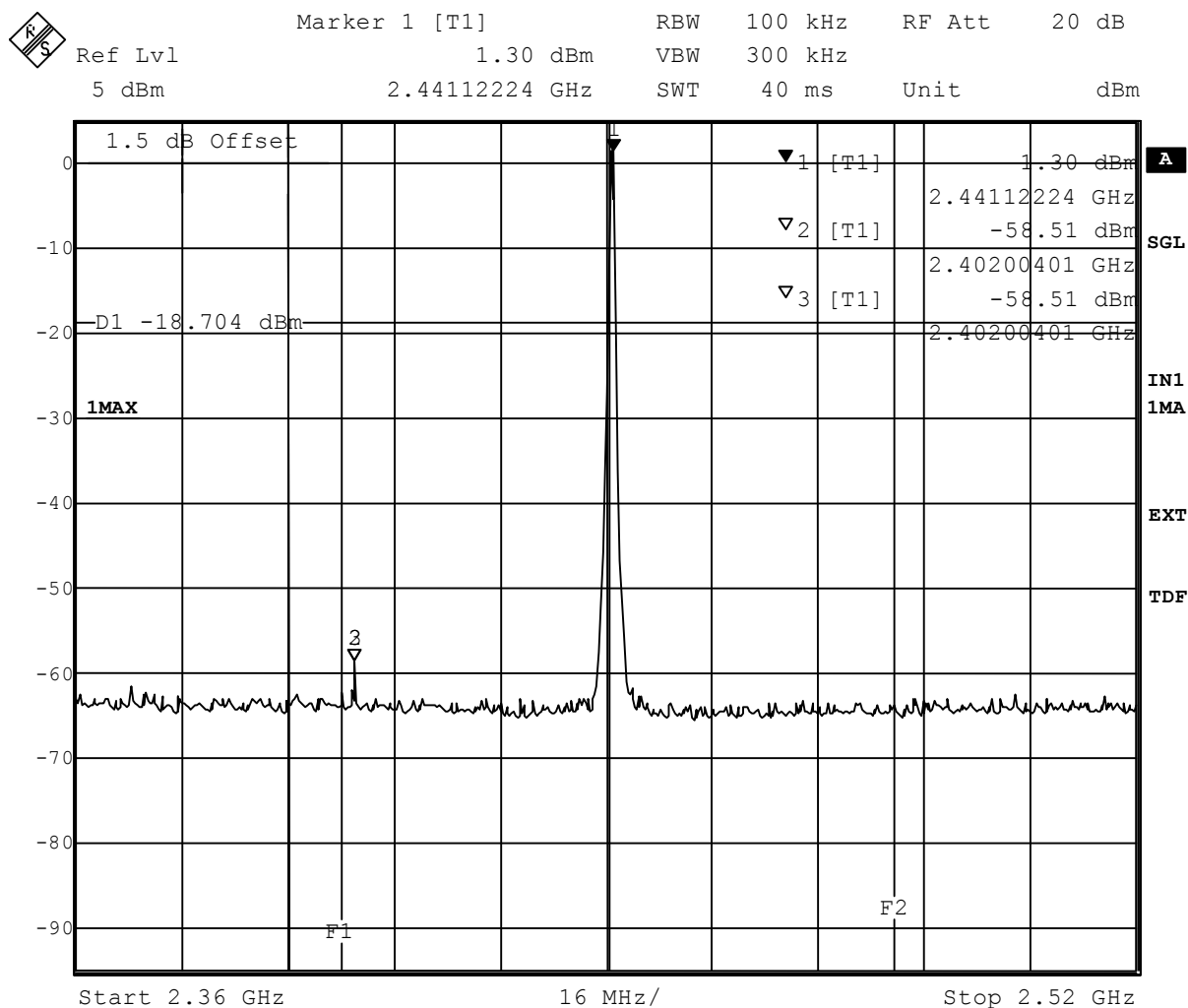
Title: spurious emissions
 Comment A: CH B: 2402 MHz
 Date: 2.MAR.2005 10:28:31

(spurious emissions measurement)

Spurious RF conducted emission

Op. Mode

op-mode 2



Title:

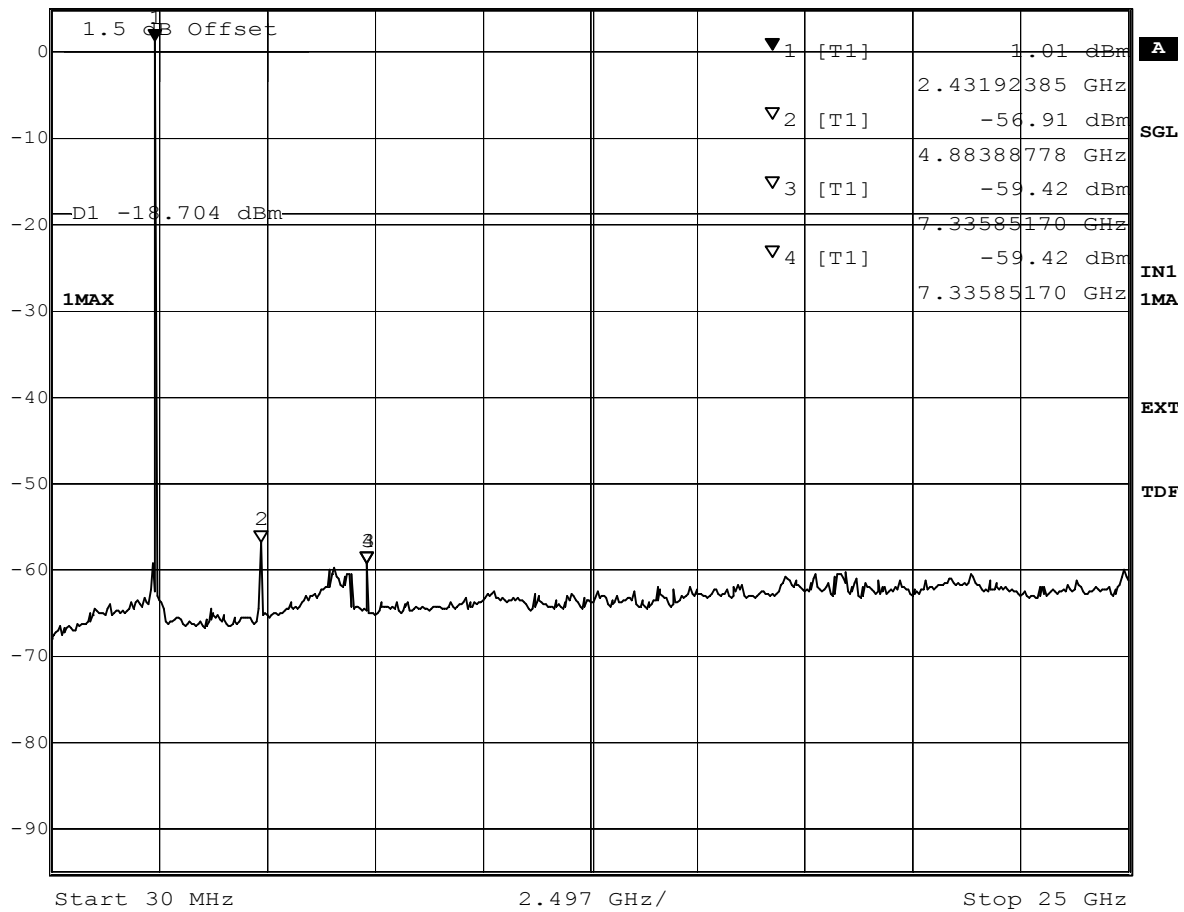
Comment A: CH M: 2441 MHz

Date: 2.MAR.2005 10:37:28

(determination of reference value)



Marker 1 [T1] RBW 100 kHz RF Att 20 dB
 Ref Lvl 1.01 dBm VBW 300 kHz
 5 dBm 2.43192385 GHz SWT 330 s Unit dBm



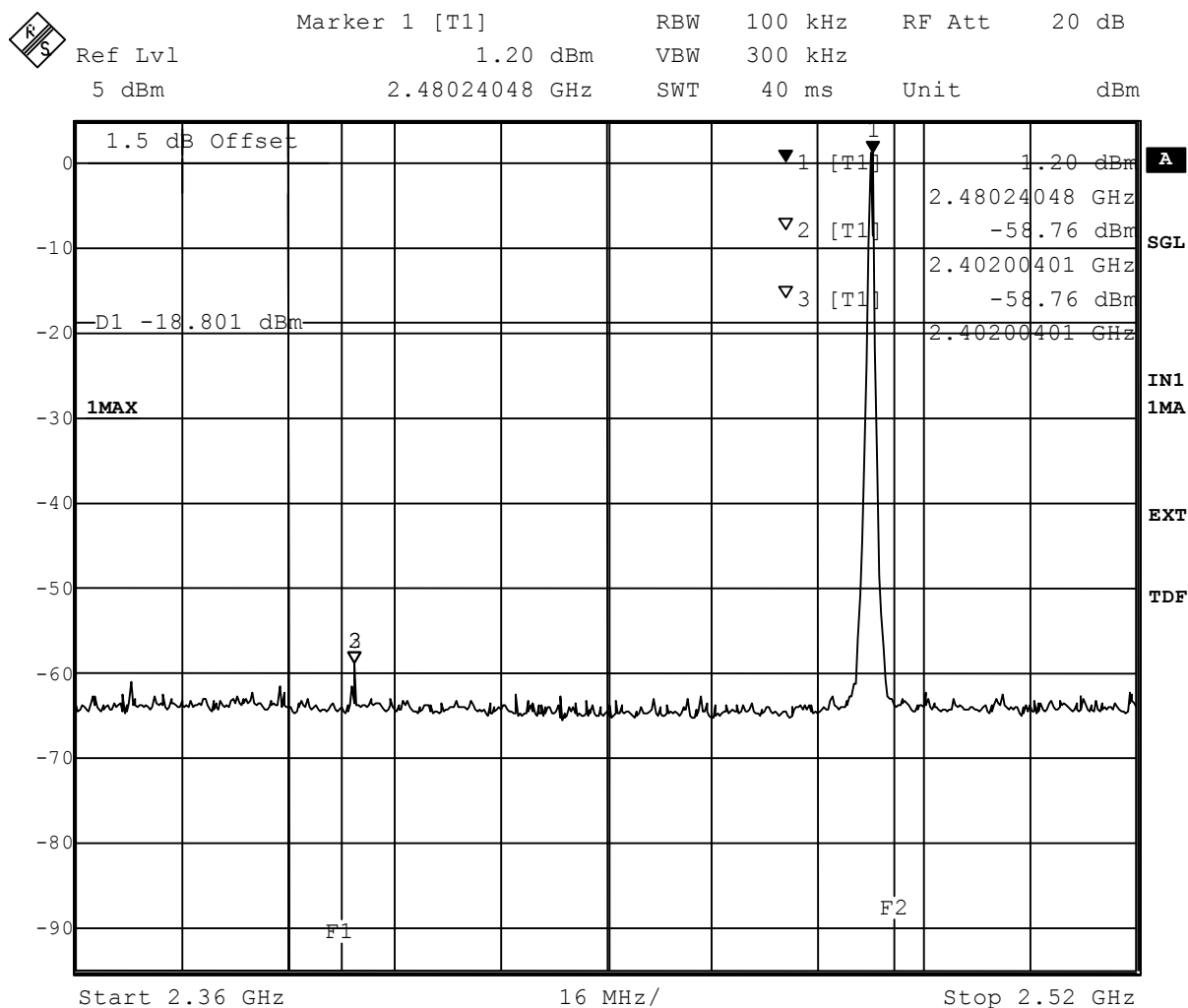
Title: spurious emissions
 Comment A: CH M: 2441 MHz
 Date: 2.MAR.2005 10:49:07

(spurious emissions measurement)

Spurious RF conducted emission

Op. Mode

op-mode 3



Title:

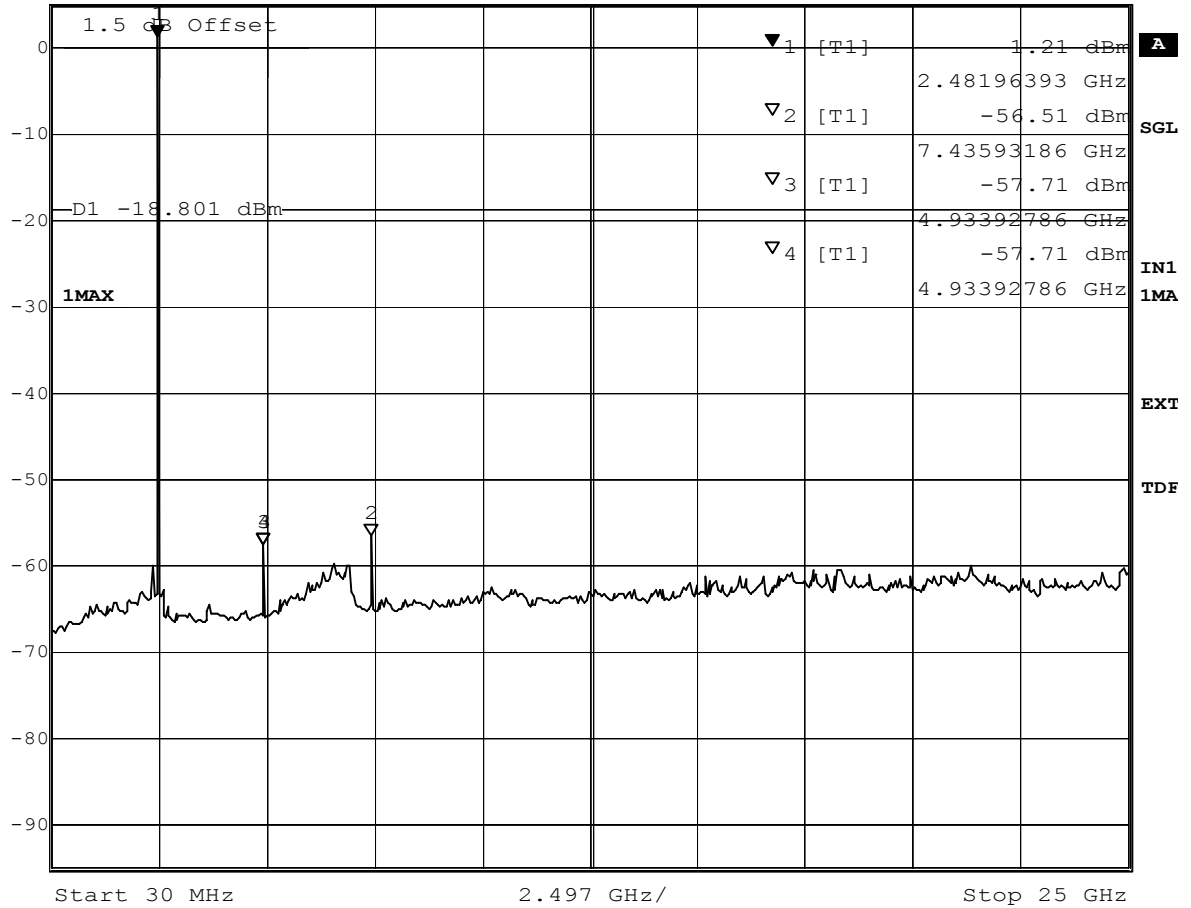
Comment A: CH T: 2480 MHz

Date: 2.MAR.2005 10:56:49

(determination of reference value)



Marker 1 [T1] RBW 100 kHz RF Att 20 dB
 Ref Lvl 1.21 dBm VBW 300 kHz
 5 dBm 2.48196393 GHz SWT 330 s Unit dBm



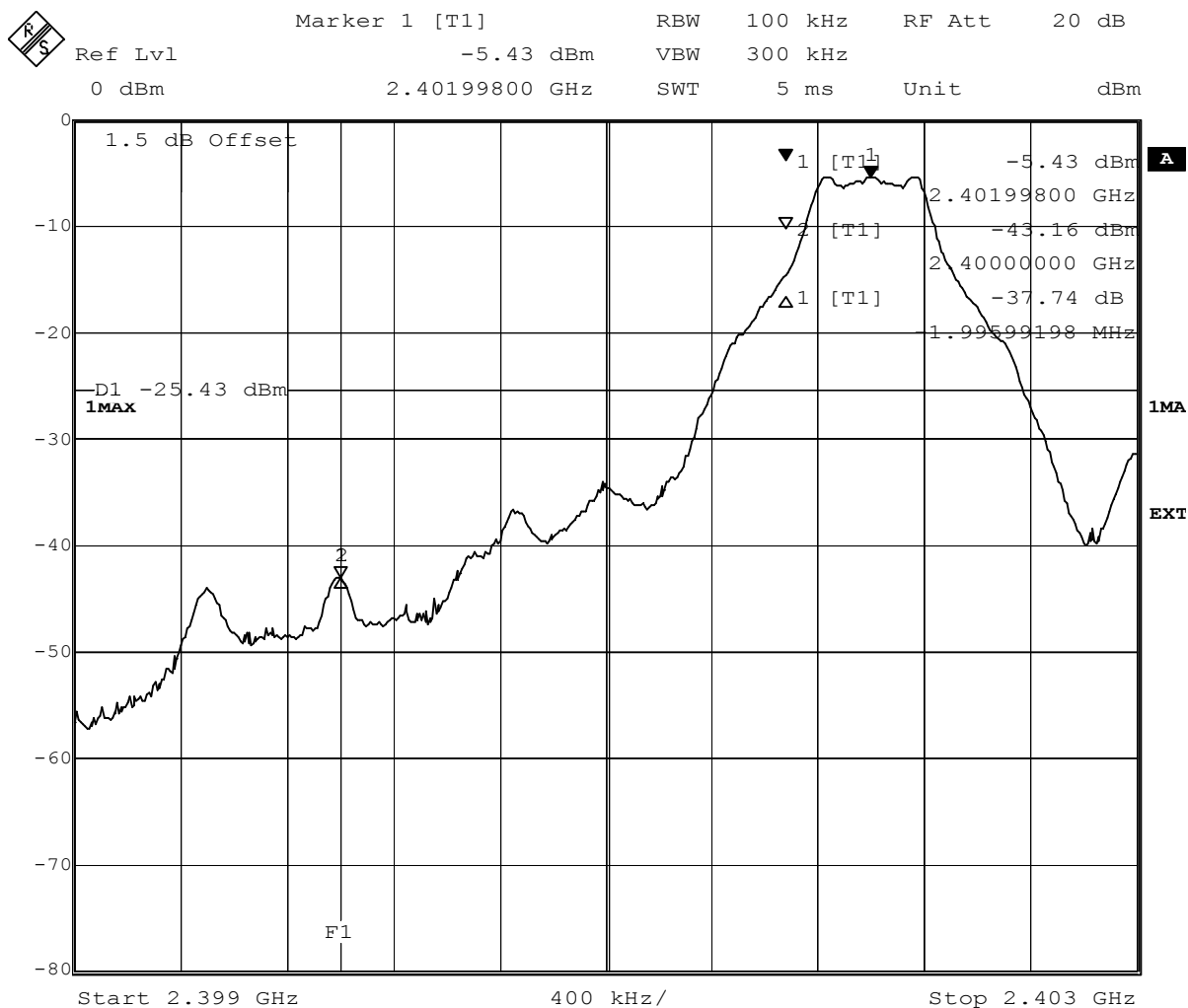
Title: spurious emissions
 Comment A: CH T: 2480 MHz
 Date: 2.MAR.2005 11:08:27

(spurious emissions measurement)

Band Edge Compliance

Op. Mode **lower band edge**

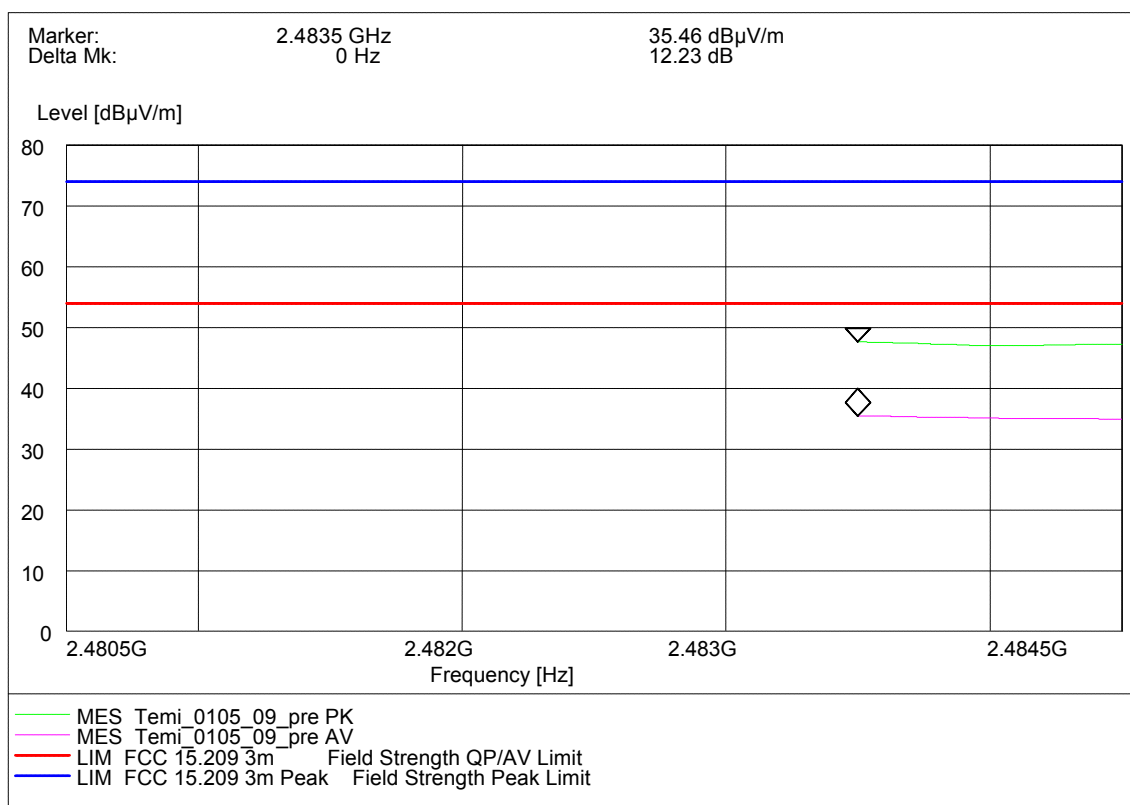
op-mode 1 **TX on 2402 MHz**



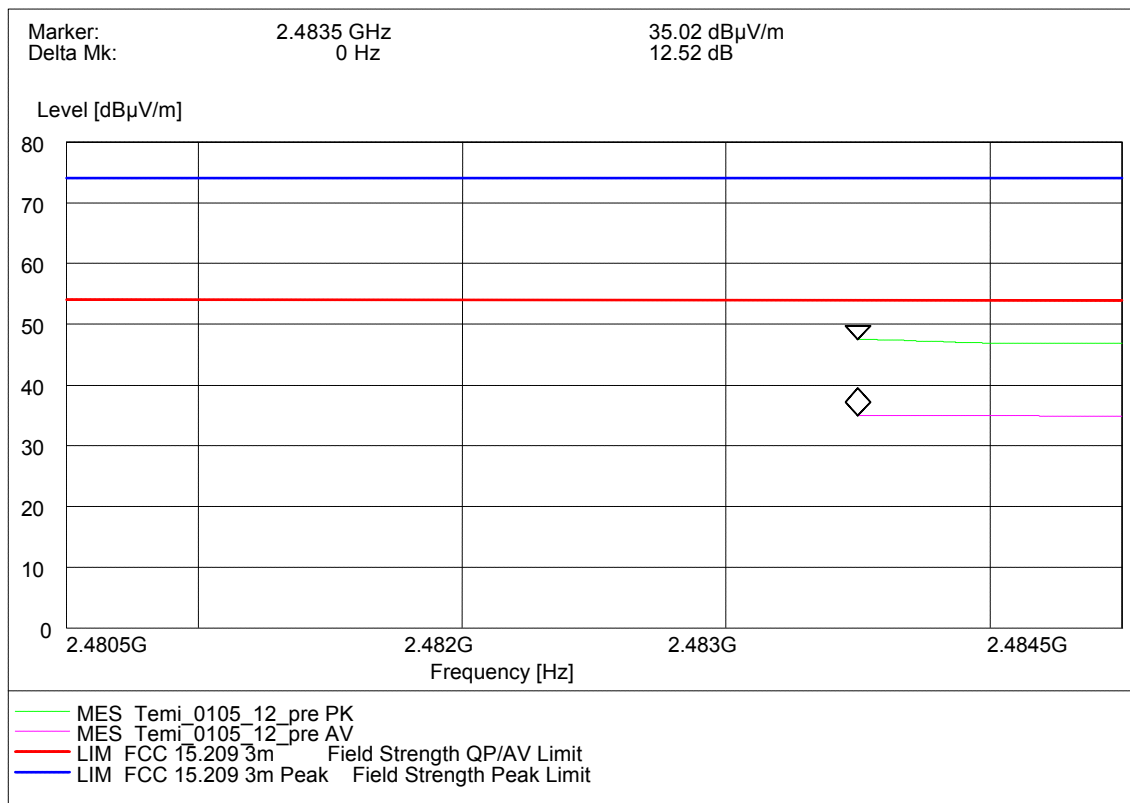
Date: 16.DEC.2004 19:13:49

Op. Mode higher band edge

op-mode 3 TX on 2480 MHz Setup_a01



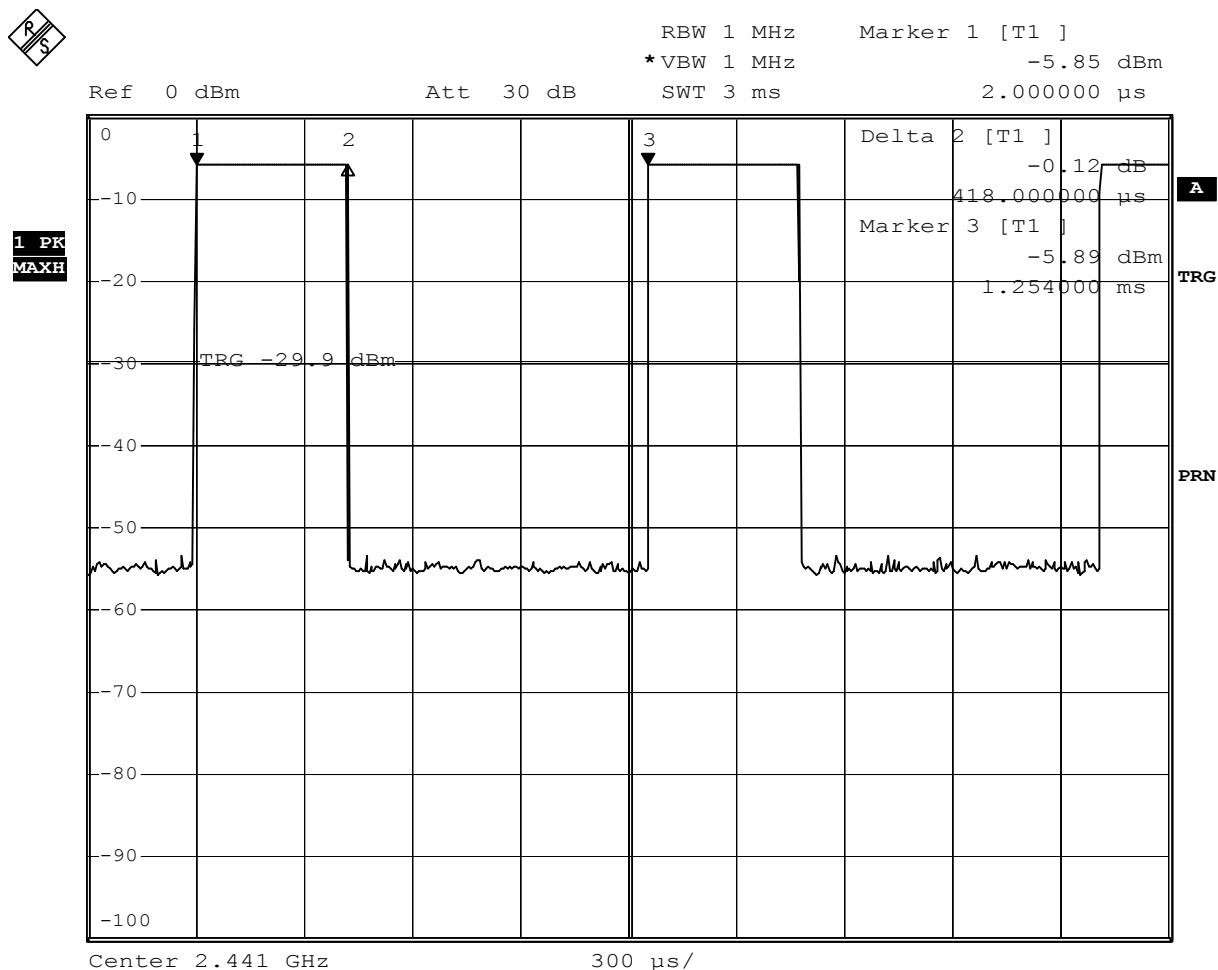
op-mode 3 **TX on 2480 MHz** Setup_a02



Dwell time

Op. Mode

op-mode 2 Time slot measurement of a DH1 packet

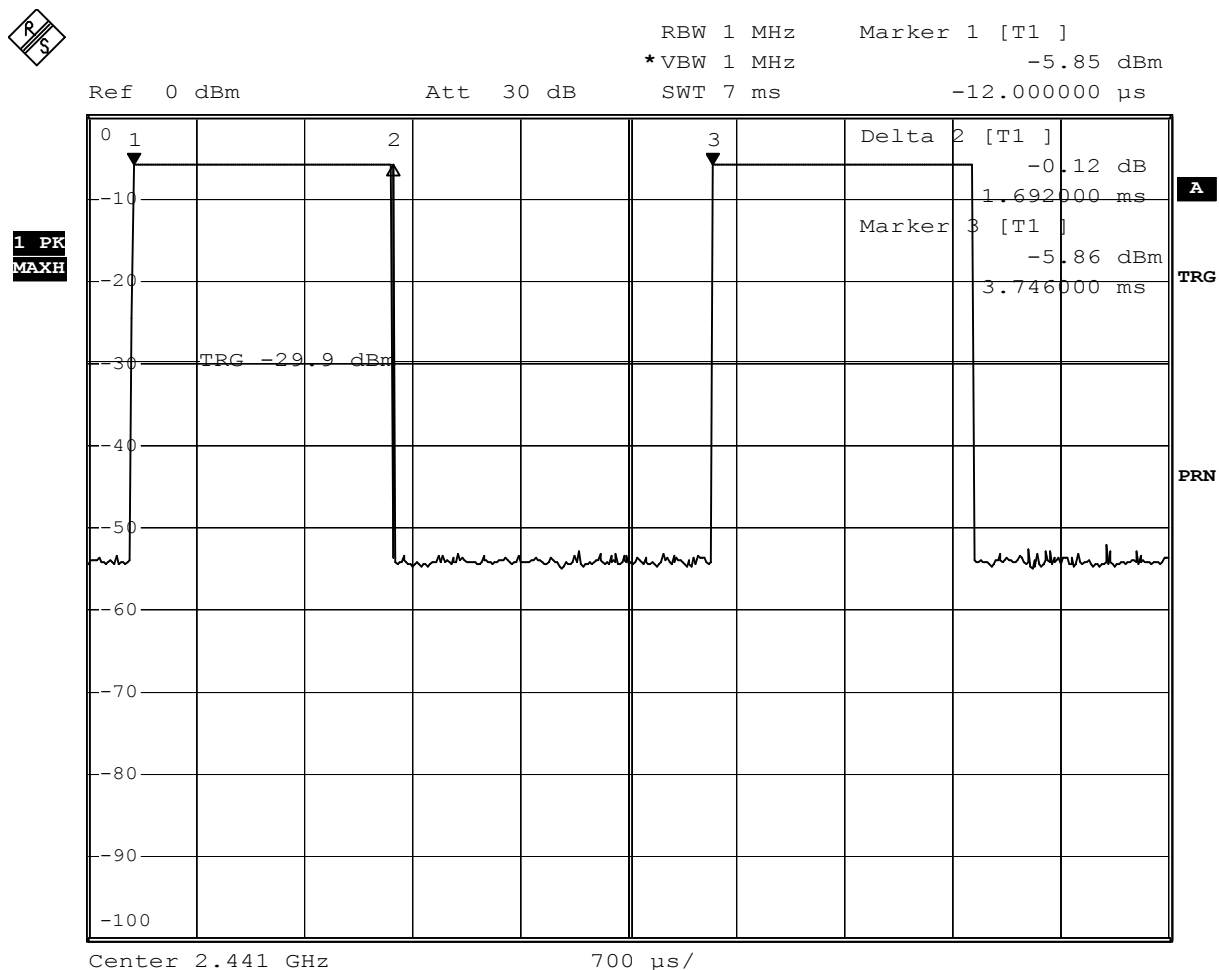


Date: 3.MAR.2005 10:03:54

Dwell time

Op. Mode

op-mode 2 Time slot measurement of a DH3 packet

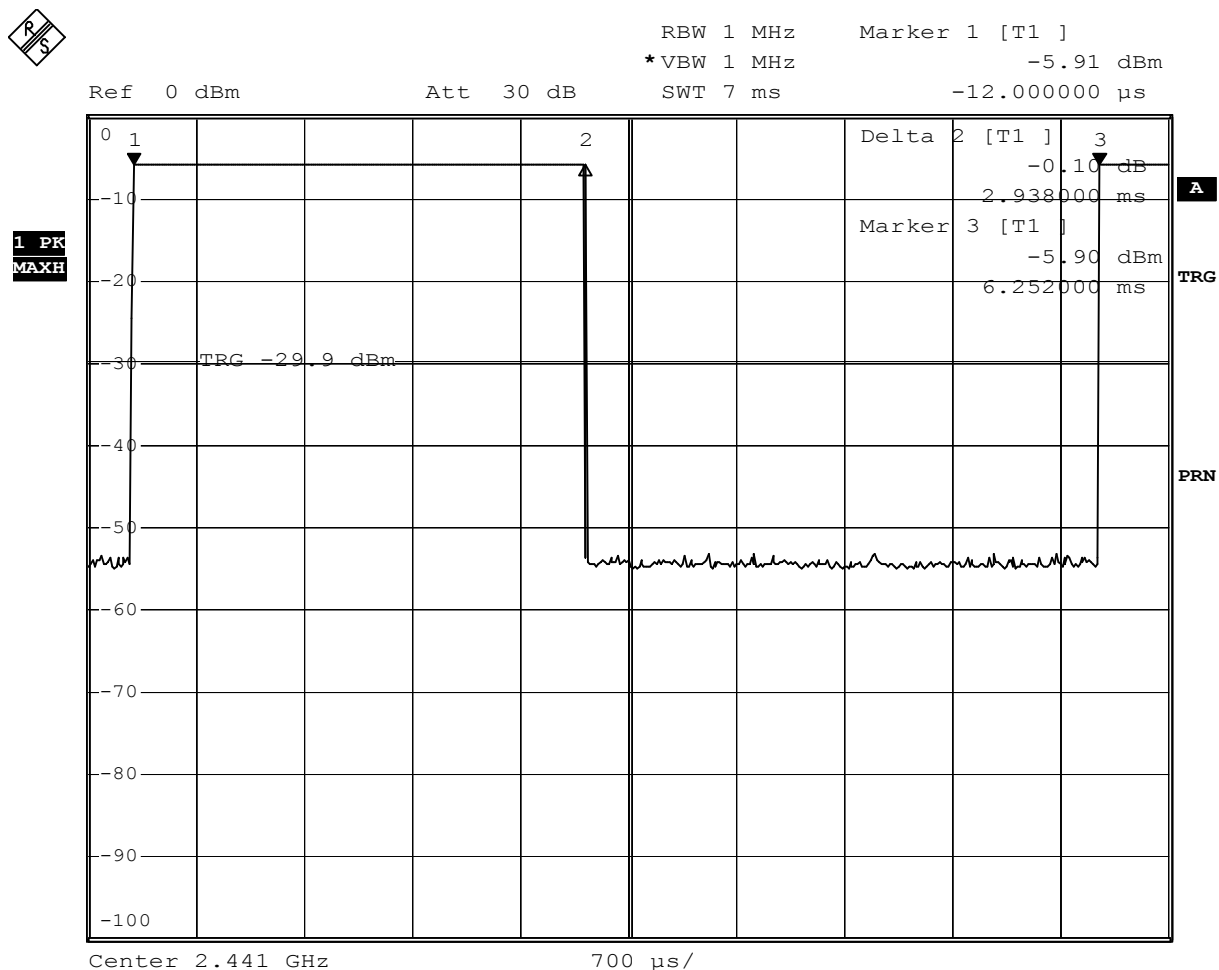


Date: 3.MAR.2005 10:07:44

Dwell time

Op. Mode

op-mode 2 Time slot measurement of a DH5 packet



Date: 3.MAR.2005 10:17:16

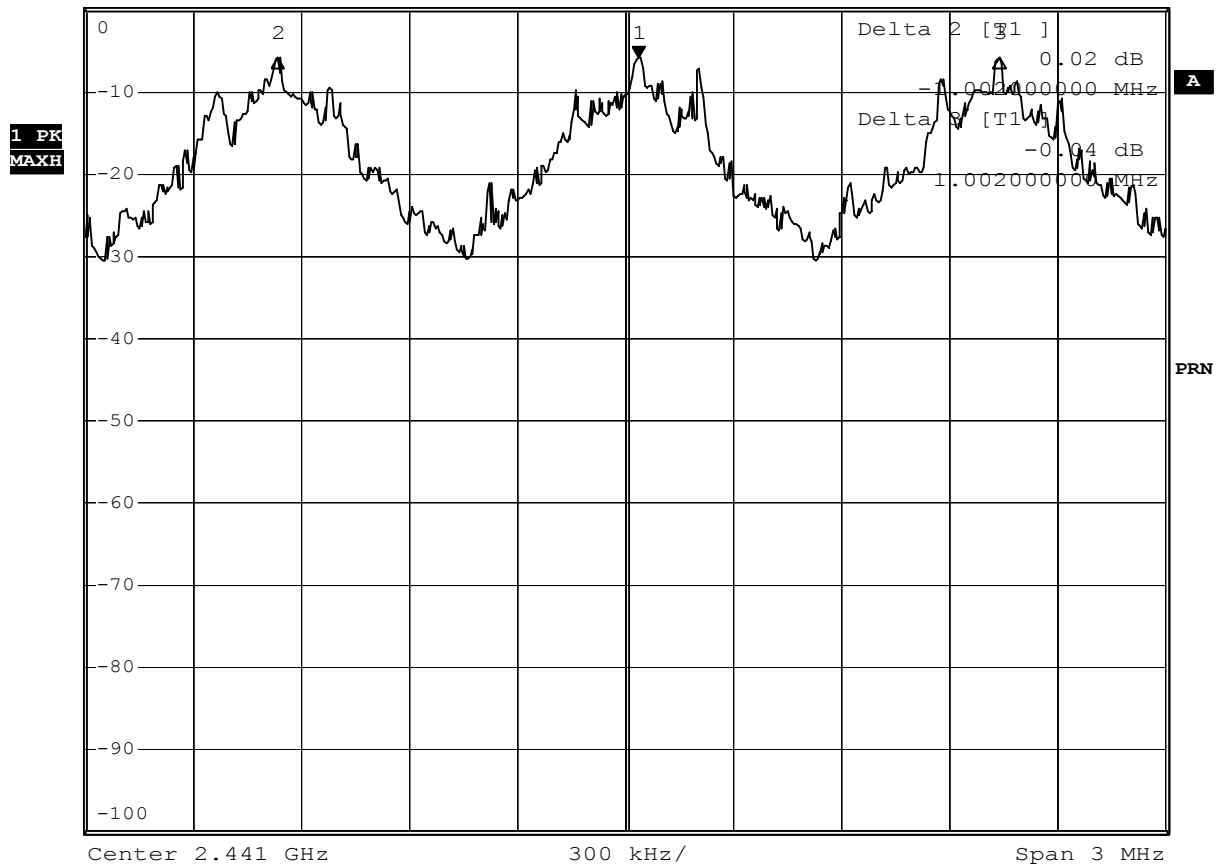
Channel separation

Op. Mode

op-mode 4



Ref 0 dBm Att 30 dB SWT 5 ms 2.441036000 GHz
 *RBW 30 kHz Marker 1 [T1]
 *VBW 100 kHz -5.87 dBm

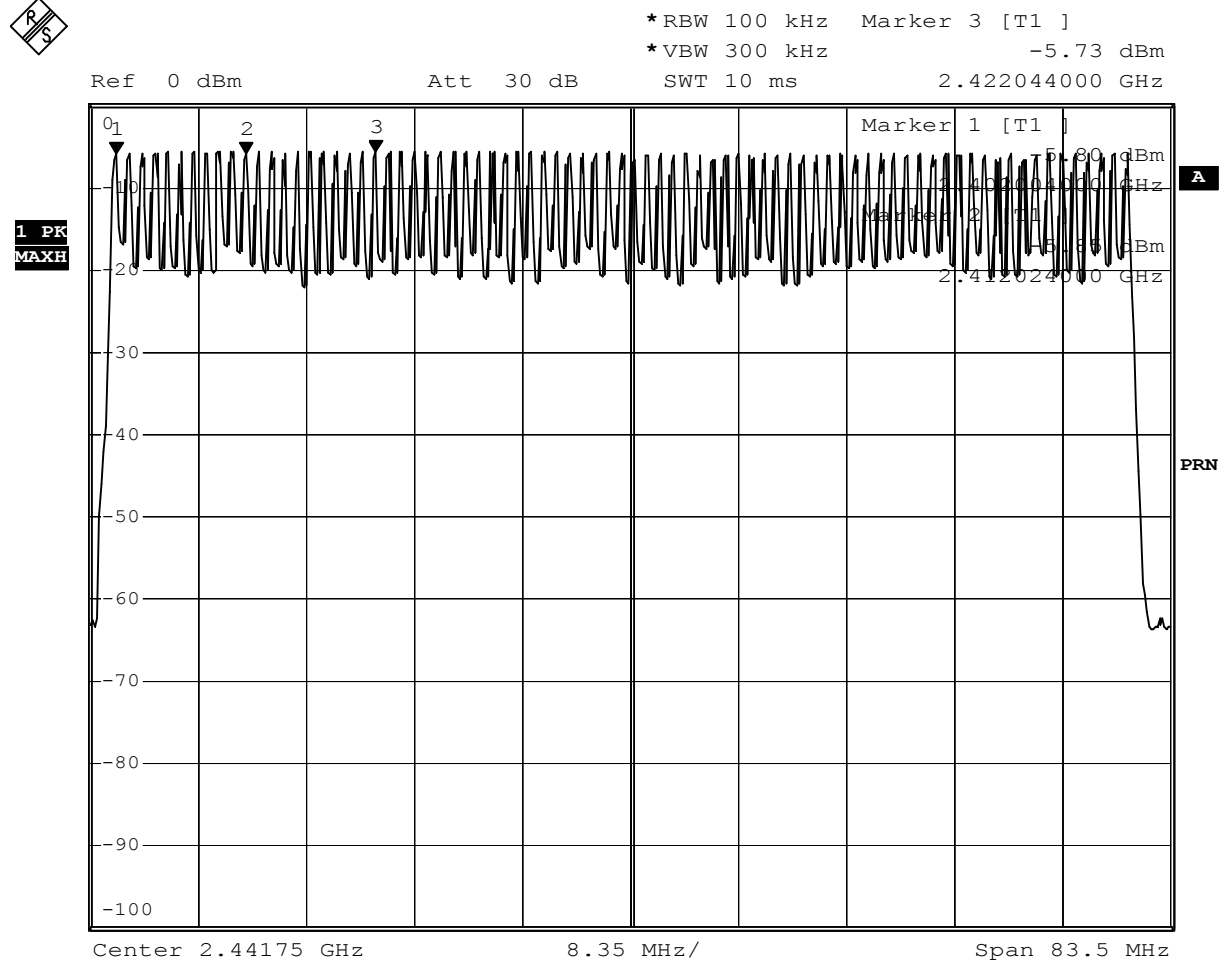


Date: 3.MAR.2005 09:42:12

Number of hopping frequencies

Op. Mode

op-mode 4



Date: 3.MAR.2005 09:47:27