**FCC ID: VNP-ME1300** **IC: 11986A-ME1300**

# EMI – TEST REPORT

**- FCC Part 15.249, RSS210 -**

| **Test Report No. :** **T38450-00-00KJ** | 31. July 2014<br>Date of issue |
|---|---|

**Type / Model Name** : SONNET (market name) / OPUS 3 (internal development name)
Me1310 / Me1320 (product code)

**Product Description** : Audio processor for cochlear implant including an inductive remote control receiver and a 2.4 GHz transceiver with integral antenna

**Applicant** : MED-EL Elektromedizinische Geraete GmbH
Address : Fuerstenweg 77a
6020 INNSBRUCK, AUSTRIA

**Manufacturer** : MED-EL Elektromedizinische Geraete GmbH
Address : Fuerstenweg 77a
6020 INNSBRUCK, AUSTRIA

**Licence holder** : MED-EL Elektromedizinische Geraete GmbH
Address : Fuerstenweg 77a
6020 INNSBRUCK, AUSTRIA

| **Test Result** according to the standards listed in clause 1 test standards: | **POSITIVE** |
|---|---|

DAkkS Deutsche Akkreditierungsstelle D-PL-12030-01-00

# Contents

# 1 TEST STANDARDS

The tests were performed according to following standards:

**FCC Rules and Regulations Part 15, Subpart A - General (September, 2013)**

| | |
|---|---|
| Part 15, Subpart A, Section 15.31 | Measurement standards |
| Part 15, Subpart A, Section 15.33 | Frequency range of radiated measurements |
| Part 15, Subpart A, Section 15.35 | Measurement detector functions and bandwidths |

**FCC Rules and Regulations Part 15, Subpart B - Unintentional Radiators (September, 2013)**

| | |
|---|---|
| Part 15, Subpart B, Section 15.109 | Radiated emission limits |

**FCC Rules and Regulations Part 15, Subpart C – Intentional Radiators (September, 2013)**

| | |
|---|---|
| Part 15, Subpart C, Section 15.203 | Antenna requirement |
| Part 15, Subpart C, Section 15.204 | External radio frequency power amplifiers and antenna modifications |
| Part 15, Subpart C, Section 15.205 | Restricted bands of operation |
| Part 15, Subpart C, Section 15.207 | Conducted limits |
| Part 15, Subpart C, Section 15.209 | Radiated emission limits, general requirements |
| Part 15, Subpart C, Section 15.249 | Operation within the bands 902 – 928 MHz, 2400 – 2483.5 MHz, 5725 – 5875 MHz, and 24.0 – 24.25 GHz |
| ANSI C63.4: 2009 | Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz. |
| ANSI C95.1:2005 | IEEE Standard for Safety Levels with respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz |
| CISPR 16-4-2: 2003 | Uncertainty in EMC measurement |
| CISPR 22: 2005<br>EN 55022: 2006 | Information technology equipment |

# 2 SUMMARY

## 2.1 GENERAL REMARKS:

The EUT contains a 2.4 GHz transceiver with integral antenna. The radio frequency of the 2.4 GHz transceiver operates in the frequency band 2.400 MHz – 2.4835 MHz.

### 2.1.1 Antennas

The following antenna is used with the EUT:

| Number | Type | Certification name | Plug | *f*-range | Gain (dBi) |
|---|---|---|---|---|---|
| 1 | Chip antenna | Fractus FR05-S1-N-0-110 | none | 2.4 – 2.5 GHz | 0.2 |

### 2.1.2 Transmit operating modes

The EUT use GFSK and provide following data rate:

2 Mbps (Mbps = *Megabits per second)*

The test software for the EUT provides the special test mode TX continuous mode, modulated and the channel setting. The EUT is set with test modulation to transmit data during the tests with a max duty cycle (x) of assumed x = 13.6 % (-17.4 dB).

**As worst case the following channels and test modes are selected for the final test:**

| Standard | Available channel | Tested channels | Power setting | Modulation | Modulation type | Data rate |
|---|---|---|---|---|---|---|
| Proprietary | 1 to 39 | 1, 19, 39 | max | GFSK | digital | 2 Mbps |

### 2.1.3 Operation frequency and channel plan

The operating frequency is 2400 MHz to 2483.5 MHz.

| Channel No | $f_{[MHz]}$ | Channel No | $f_{[MHz]}$ | Channel No | $f_{[MHz]}$ |
|---|---|---|---|---|---|
| **1** | **2404** | 14 | 2430 | 27 | 2456 |
| 2 | 2406 | 15 | 2432 | 28 | 2458 |
| 3 | 2408 | 16 | 2434 | 29 | 2460 |
| 4 | 2410 | 17 | 2436 | 30 | 2462 |
| 5 | 2412 | 18 | 2438 | 31 | 2464 |
| 6 | 2414 | **19** | **2440** | 32 | 2466 |
| 7 | 2416 | 20 | 2442 | 33 | 2468 |
| 8 | 2418 | 21 | 2444 | 34 | 2470 |
| 9 | 2420 | 22 | 2446 | 35 | 2472 |
| 10 | 2422 | 23 | 2448 | 36 | 2474 |
| 11 | 2424 | 24 | 2450 | 37 | 2476 |
| 12 | 2426 | 25 | 2452 | 38 | 2478 |
| 13 | 2428 | 26 | 2454 | **39** | **2480** |

## 2.2 Test result summery

Operating in the 2400 MHz – 2483.5 MHz band:

| FCC Rule Part | RSS Rule Part | Description | Result |
|---|---|---|---|
| 15.35(c) | RSS-Gen, 4.5 | Pulsed operation | passed |
| 15.203 | RSS Gen, 7.1.2 | Antenna requirement | passed |
| 15.204 | RSS Gen, 7.1.1 | External radio frequency power amplifiers | passed |
| 15.205(a) | RSS-Gen, 7.2.2 | Emissions in restricted bands | passed |
| 15.207(a) | RSS Gen, 7.2.4 | AC power line conducted emissions | not applicable |
| 15.215(c) | | EBW | passed |
| | RSS-Gen, 4.6.1 | OBW | passed |
| 15.249(a) | RSS-210, A2.9(a) | Field strength of fundamental | passed |
| 15.249(d) | RSS Gen, 7.2.5<br>RSS-210, A2.9(b) | Out-of-band emission, radiated | passed |
| | RSS-Gen, 7.2.6 | Transmitter frequency stability | not applicable |
| 15.109(a) | RSS-Gen, 6.1 | Receiver, radiated emission | passed |

The mentioned RSS Rule Parts in the above table are related to:
RSS Gen, Issue 3, December 2010
RSS 210, Issue 8, December 2010
RSS 102, Issue 4, March 2010

## 2.3 FINAL ASSESSMENT:

The equipment under test **fulfills** the EMI requirements cited in clause 1 test standards.

Date of receipt of test sample : acc. to storage records

Testing commenced on : 01 July 2014

Testing concluded on : 02 July 2014

Checked by:

Klaus Gegenfurtner
I confirm the correctness and Integrity of this documents
2014.07.31 09:36:03 +02'00'

Klaus Gegenfurtner
Teamleader Radio

Tested by:

Josef Knab
I'm the autor of this document
2014.07.31 09:33:43 +02'00'

Josef Knab

# 3 EQUIPMENT UNDER TEST

## 3.1 Photo documentation of the EUT – Please see attachment A

## 3.2 Power supply system utilised

Power supply voltage : 2.3 V DC (Battery powered)

## 3.3 Short description of the equipment under test (EUT)

The OPUS 3 (product code: Me1310 / Me1320[1]) is a medical device similar to a hearing aid. It is worn behind the ear, converts acoustic signals and drives an implanted MED-EL cochlear implant which – based on the information from the audio processor - directly stimulates the acoustic nerve in the inner ear to evoke auditory sensations.
The inductive remote control receiver picks up commands from an external remote control (FineTuner, not part of this investigation) which is an accessory to the OPUS 3 that allows the user to modify various parameters as e.g. volume or microphone sensitivity of the OPUS 3.
Similar to the inductive remote control receiver the 2.4 GHz transceiver can receive commands from an external device (e.g. remote control, remote programmer etc.). Additionally it can transmit acknowledge messages to this external device (the external device is currently under development and not part of this investigation).

[1] The only difference between the device with the product code Me1320 and the device with the product code Me1310 is that the device with the product code Me1310 does not contain acoustic hearing aid functionality, i.e. does not contain an acoustic only output ("loudspeaker"). Separate testing of Me1310 devices is therefore not required.

Number of tested samples: OPUS 3 CPU EAS (Me1320), ser. no. 000033

**The following peripheral devices were used during the measurements:**

| | |
|---|---|
| Battery pack | Model: OPUS 3 BP (Ma060106), ser. no. 000033 |
| Coil | Model: DCoil (PM2288), ser. no. 0000415 |

## EUT operation mode:

The equipment under test was operated during the measurement under the following conditions:

- Cont. TX CW at CH1, CH19 and CH39

- Cont. TX modulated (bursts) at CH1, CH19 and CH39

- Cont. RX at CH1, CH19 and CH39

# 4 TEST ENVIRONMENT

## 4.1 Address of the test laboratory

**CSA Group Bayern GmbH**
**Ohmstrasse 1-4**
**94342 STRASSKIRCHEN**
**GERMANY**

## 4.2 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

| | |
|---|---|
| Temperature: | 15-35 ° C |
| Humidity: | 30-60 % |
| Atmospheric pressure: | 86-106 kPa |

## 4.3 Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. It is noted that the expanded measurement uncertainty corresponds to the measurement results from the standard measurement uncertainty multiplied by the coverage factor k = 2. The true value is located in the corresponding interval with a probability of 95 % The measurement uncertainty was calculated for all measurements listed in this test report acc. to CISPR 16-4-2 / 11.2003 „Uncertainties, statistics and limit modelling – Uncertainty in EMC measurements“ and is documented in the quality system acc. to DIN EN ISO/IEC 17025. For all measurements shown in this report, the measurement uncertainty of the test laboratory, CSA Group Bayern GmbH, is below the measurement uncertainty as defined by CISPR. Therefore, no special measures must be taken into consideration with regard to the limits according to CISPR. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

## 4.4 Measurement protocol for FCC and IC

### 4.4.1 General information

4.4.1.1 Test methodology

Conducted and radiated disturbance testing is performed according to the procedures set out by the International Special Committee on Radio Interference (CISPR) Publication 22, European Standard EN 55022 as shown under section 1 of this report.

The Open Area test site is a listed Open Site under the Canadian Test-Sites File-No:

**IC 3009A-1**

In compliance with RSS 210 testing for RSS compliance may be achieved by following the procedures set out in ANSI C63.4 and applying the CISPR 22 limits.

4.4.1.2 Justification

The equipment under test (EUT) is configured in a typical user arrangement in accordance with the manufacturer's instructions. A cable is connected to each available port and either terminated with a peripheral using the appropriate impedance characteristic or left unterminated. Where appropriate, cables are manually manipulated with respect to each other thus obtaining maximum disturbances from the unit.

4.4.1.3 Details of test procedures

The test methods used comply with CISPR Publication 22, EN 55022 - " Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement" and with ANSI C63.4 - "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz". In compliance with 47 CFR Part 15 Subpart A, Section 15.38 testing for FCC compliance may be achieved by following the procedures set out in ANSI C63.4 and applying the CISPR 22 limits.

# 5 TEST CONDITIONS AND RESULTS

## 5.1 AC power line conducted emissions

For test instruments and accessories used see section 6 Part **A 4**.

### 5.1.1 Description of the test location

Test location: NONE

**Remarks:** The measurement is not applicable, because the EuT is battery powered and has no AC mains connections.

## 5.2 Field strength of fundamental

For test instruments and accessories used see section 6 Part **CPR 3**.

### 5.2.1 Description of the test location

Test location: Anechoic chamber 2
Test distance: 3 m

### 5.2.2 Photo documentation of the test set-up

**See Attachment "Test setup photos"**

### 5.2.3 Applicable standard

According to FCC Part 15C, Section 15.249(a):
The field strength of emissions from intentional radiators operated within these frequency bands shall comply with the effective limits.

### 5.2.4 Description of Measurement

The radiated emission of the fundamental wave from the EUT is measured using a spectrum analyser and appropriate linear polarized antennas. The set up of the EUT and the measurement procedure is in accordance to ANSI C63.4, Item 8.3. The EUT is measured in TX continuous mode unmodulated under normal conditions.

Analyser settings:

| | | | | | | |
|---|---|---|---|---|---|---|
| Peak measurement: | RBW: | 1 MHz | VBW: | 1 MHz | Detector: | Max peak |
| AV measurement: | RBW: | 1 MHz | VBW: | 10 Hz | Detector: | Max peak |

### 5.2.5 Test result

| Frequency (MHz) | Reading level PK (dBµV) | Reading level AV (dBµV) | Bandwidth (kHz) | Correction factor (dB) | Corrected level PK dB(µV/m) | Corrected level AV dB(µV/m) | Limit AV dB(µV/m) | Delta (dB) |
|---|---|---|---|---|---|---|---|---|
| 2404 | 101.5 | - | 1000 | -13.8 | 87.7 | - | 94.0 | -6.3 |
| 2440 | 100.1 | - | 1000 | -13.7 | 86.4 | - | 94.0 | -7.6 |
| 2480 | 97.3 | - | 1000 | -13.5 | 83.9 | - | 94.0 | -10.1 |

Note: The correction factor includes cable loss and antenna factor.

Average-Limit according to FCC Part 15C, Section 15.249(a):

| Frequency | Field strength of fundamental | |
|---|---|---|
| (MHz) | (mV/m) | dB(µV/m) |
| 902 - 928 | 50 | 94 |
| **2400 - 2483.5** | **50** | **94** |
| 5725-5875 | 50 | 94 |
| 24000 - 24250 | 250 | 108 |

Peak-Limit according to FCC Part 15C, Section 15.249(e):
However the peak fieldstrength shall not exceed the maximum permitted average limit by more than 20 dB.

The requirements are **FULFILLED.**

**Remarks:** _____

_____

## 5.3 Out-of-band emission, radiated

For test instruments and accessories used see section 6 Part **SER1, SER 2, SER 3**.

### 5.3.1 Description of the test location

Test location: OATS 1
Test location: Anechoic chamber 2

Test distance: 3 m (< 18 GHz) / 1m (> 18 GHz)

### 5.3.2 Photo documentation of the test set-up

Test setup 9 kHz – 30 MHz:

**See Attachment "Test setup photos"**

Test setup 30 MHz – 1000 MHz:

**See Attachment "Test setup photos"**

Test setup 1 GHz – 18 GHz:

**See Attachment "Test setup photos"**

Test setup 18 GHz – 25 GHz:

**See Attachment "Test setup photos"**

### 5.3.3 Applicable standard

According to FCC Part 15C, Section 15.249 (d):
Emission radiated outside of the specified frequency bands, except harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated limit in FCC Part 15C, Section 15.209, whichever is the lesser attenuation.

### 5.3.4 Description of Measurement

The radiated emissions from the EUT are measured in the frequency range of 9 kHz to 1000 MHz using a tuned receiver and appropriate broadband linearly polarized antennas. The setup of the EUT and the measurement procedure is in accordance to ANSI C63.4, Item 8.3. In the frequency range above 1 GHz a spectrum analyser is used with appropriate linear polarized antennas. If the emission level in peak mode complies with the average limit testing is stopped and peak values will be reported, otherwise, the emission is measured in average mode again and reported. The EUT is measured in TX continuous mode unmodulated under normal conditions.

Instrument settings:

| | | |
|---|---|---|
| 9 kHz – 150 kHz | RBW: | 200 Hz |
| 150 kHz - 30 MHz | RBW: | 9 kHz |
| 30 MHz – 1000 MHz: | RBW: | 120 kHz |
| 1000 MHz – 25 GHz | RBW: | 1 MHz |

### 5.3.5 Test result f < 30 MHz

Note: The limits are extrapolated (D factor) to the measurement distance of 3 m.

Channel 19

| Frequency (MHz) | Reading level QP (dBµV) | Reading level AV (dBµV) | Bandwidth (kHz) | Correction factor (dB/m) | Corrected level QP dB(µV/m) | Corrected level AV dB(µV/m) | Limit @ 3m dB(µV/m) | Delta (dB) |
|---|---|---|---|---|---|---|---|---|
| 10.244 | 9.3 | - | 9 | 20 | 29.3 | - | 69.5 | -40.2 |
| 10.848 | 10.2 | - | 9 | 20 | 30.2 | - | 69.5 | -39.3 |
| 11.448 | 14.1 | - | 9 | 20 | 34.1 | - | 69.5 | -35.4 |
| 12.056 | 12.1 | - | 9 | 20 | 32.1 | - | 69.5 | -37.4 |

### 5.3.6 Test result f < 1 GHz

Channel 19

| Frequency (MHz) | Reading level QP (dBµV) | Reading level AV (dBµV) | Bandwidth (kHz) | Correction factor (dB/m) | Corrected level QP dB(µV/m) | Corrected level AV dB(µV/m) | Limit dB(µV/m) | Delta (dB) |
|---|---|---|---|---|---|---|---|---|
| 142.73 | 9.7 | - | 120 | 13.0 | 22.7 | - | 43.5 | -20.8 |
| 143.48 | 9.0 | - | 120 | 13.1 | 22.1 | - | 43.5 | -21.4 |
| 159.75 | 4.6 | - | 120 | 13.8 | 18.4 | - | 43.5 | -25.1 |
| 416.10 | 3.0 | - | 120 | 19.4 | 22.4 | - | 46.0 | -23.6 |

### 5.3.7 Test result f > 1 GHz

Channel 1

| Frequency (MHz) | Reading level PK (dBµV) | Duty Cycle Correction (dB) | Reading level AV (dBµV)*) | Correction factor (dB/m) | Corrected level PK dB(µV/m) | Corrected level AV dB(µV/m) | Limit PK dB(µV/m) | Limit AV dB(µV/m) | Delta (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 1042.4 | 60.2 | - | - | -20.6 | 39.6 | - | 74 | 54 | -14.4 |
| 1066.0 | 59.0 | - | - | -20.7 | 38.3 | - | 74 | 54 | -15.7 |
| 1174.8 | 61.1 | - | - | -19.3 | 41.8 | - | 74 | 54 | -12.2 |
| 1197.6 | 61.8 | - | - | -18.9 | 42.9 | - | 74 | 54 | -11.1 |
| 1221.3 | 62.4 | - | - | -18.6 | 43.8 | - | 74 | 54 | -10.2 |
| 3606.3 | 56.4 | - | - | -11.8 | 44.5 | - | 74 | 54 | -9.5 |
| 4808.0 | 54.1 | -17.4 | 36.7 | 2.3 | 56.4 | 39.0 | 74 | 54 | -15.0 |
| 7212.0 | 44.8 | -17.4 | 27.4 | 6.9 | 51.7 | 34.3 | 74 | 54 | -19.7 |

Channel 19

| Frequency (MHz) | Reading level PK (dBµV) | Duty Cycle Correction (dB) | Reading level AV (dBµV)*) | Correction factor (dB/m) | Corrected level PK dB(µV/m) | Corrected level AV dB(µV/m) | Limit PK dB(µV/m) | Limit AV dB(µV/m) | Delta (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 1039.8 | 60.7 | - | - | -20.5 | 40.2 | - | 74 | 54 | -13.8 |
| 1172.9 | 61.9 | - | - | -19.3 | 42.6 | - | 74 | 54 | -11.4 |
| 1196.9 | 61.6 | - | - | -18.9 | 42.7 | - | 74 | 54 | -11.3 |
| 1219.0 | 63.2 | - | - | -18.6 | 44.6 | - | 74 | 54 | -9.4 |
| 1577.9 | 61.0 | - | - | -20.7 | 40.3 | - | 74 | 54 | -13.7 |
| 1663.4 | 58.9 | - | - | -19.8 | 39.1 | - | 74 | 54 | -14.9 |
| 4880.0 | 56.5 | -17.4 | 39.1 | 2.4 | 58.9 | 41.5 | 74 | 54 | -12.5 |
| 7320.0 | 44.0 | -17.4 | 26.6 | 6.9 | 50.8 | 33.5 | 74 | 54 | -20.5 |

Channel 39

| Frequency (MHz) | Reading level PK (dBµV) | Duty Cycle Correction (dB) | Reading level AV (dBµV)*) | Correction factor (dB/m) | Corrected level PK dB(µV/m) | Corrected level AV dB(µV/m) | Limit PK dB(µV/m) | Limit AV dB(µV/m) | Delta (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 1008.6 | 57.3 | - | - | -20.0 | 37.3 | - | 74 | 54 | -16.7 |
| 1064.9 | 59.4 | - | - | -20.7 | 38.7 | - | 74 | 54 | -15.3 |
| 1174.4 | 60.9 | - | - | -19.3 | 41.6 | - | 74 | 54 | -12.4 |
| 1197.3 | 60.4 | - | - | -18.9 | 41.4 | - | 74 | 54 | -12.6 |
| 1220.5 | 61.7 | - | - | -18.6 | 43.1 | - | 74 | 54 | -10.9 |
| 1352.9 | 57.9 | - | - | -19.3 | 38.6 | - | 74 | 54 | -15.4 |
| 4960.0 | 57.4 | -17.4 | 40.0 | 2.7 | 60.1 | 42.7 | 74 | 54 | -11.3 |
| 7440.0 | 43.3 | -17.4 | 25.9 | 6.9 | 50.3 | 32.8 | 74 | 54 | -21.2 |

*) Average values were calculated from the peak values by application of the duty cycle correction factor.

Limit according to FCC Part 15C, Section 15.209:

| Frequency (MHz) | 15.209 Limits (µV/m) | Measurement distance (m) |
|---|---|---|
| 0.009 - -0.49 | 2400/f(kHz) | 300 |
| 0.49 – 1.705 | 24000/f(kHz) | 30 |
| 1.705 – 30.0 | 30 | 30 |
| 30 - 88 | 100 | 3 |
| 88 - 216 | 150 | 3 |
| 216 - 960 | 200 | 3 |
| Above 960 | 500 | 3 |

Average limit according to FCC Part 15C, Section 15.249(a):

| Fundamental frequency | Field strength of harmonics | |
|---|---|---|
| (MHz) | (µV/m) | dB(µV/m) |
| 902 - 928 | 500 | 54 |
| **2400 - 2483.5** | 500 | 54 |
| 5725 - 5875 | 500 | 54 |
| 24000 - 24250 | 2500 | 68 |

The requirements are **FULFILLED.**

**Remarks:** The measurement was performed up to the 10th harmonic.

Measurements below 1 GHz where only performed with CH19, because a different channel selection has no influence on the measured frequencies and levels.

## 5.4 EBW and OBW

For test instruments and accessories used see section 6 Part **MB**.

### 5.4.1 Description of the test location

Test location: Shielded Room S5

### 5.4.2 Photo documentation of the test set-up

**See Attachment "Test setup photos"**

### 5.4.3 Applicable standard

According to FCC Part 15, Section 15.215(c):
Intentional radiators operating under the alternative provisions to the general emission limits, as contained in Section 15.217 through Section 15.257, must be designed to ensure that the 20 dB bandwidth of the emission is contained within the frequency band designated in the rule section under which the equipment is operated.

### 5.4.4 Description of Measurement

The bandwidth is measured at an amplitude level reduced from the reference level by a specified ratio of -20 dB (99%). The x-dB-down (OBW) function of the analyser is used. The measurement is performed with normal modulation in TX continuous mode.

Spectrum analyser settings:
RBW: 100 kHz, VBW: 300 kHz, Span: 10 MHz, Trace mode: max. hold, Detector: max. peak;

### 5.4.5 Test result

| Operating frequency band (MHz) | 20 dB Bandwidth CH1 - 2404 MHz (MHz) | 20 dB Bandwidth CH19 - 2440 MHz (MHz) | 20 dB Bandwidth CH39 - 2480 MHz (MHz) |
|---|---|---|---|
| $f_{low}$ > 2400 | $f_{low}$ = 2403.02 | $f_{low}$ = 2439.00 | $f_{low}$ = 2479.01 |
| $f_{high}$< 2483.5 | $f_{high}$ = 2404.99 | $f_{high}$ = 2441.00 | $f_{high}$ = 2481.00 |
| Measured BW (MHz) | 1.97 | 2.00 | 1.99 |

| Operating frequency band (MHz) | 99% Bandwidth CH1 - 2404 MHz (MHz) | 99% Bandwidth CH19 - 2440 MHz (MHz) | 99% Bandwidth CH39 - 2480 MHz (MHz) |
|---|---|---|---|
| $f_{low}$ > 2400 | $f_{low}$ = 2403.11 | $f_{low}$ = 2439.11 | $f_{low}$ = 2479.10 |
| $f_{high}$< 2483.5 | $f_{high}$ = 2404.93 | $f_{high}$ = 2440.93 | $f_{high}$ = 2480.93 |
| Measured BW (MHz) | 1.82 | 1.82 | 1.83 |

Limit according to FCC Part 15C, Section 15.215(c):
If frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.Due to the channelising of the operating band into 39 channels with channel bandwidth of 2 MHz the limit central 80% of the permitted band can not be applied. Therefore the stability of the EUT will be shown staying within the operating frequency band with $f_{low}$ 2403.02 MHz and $f_{high}$ 2481.00 MHz.

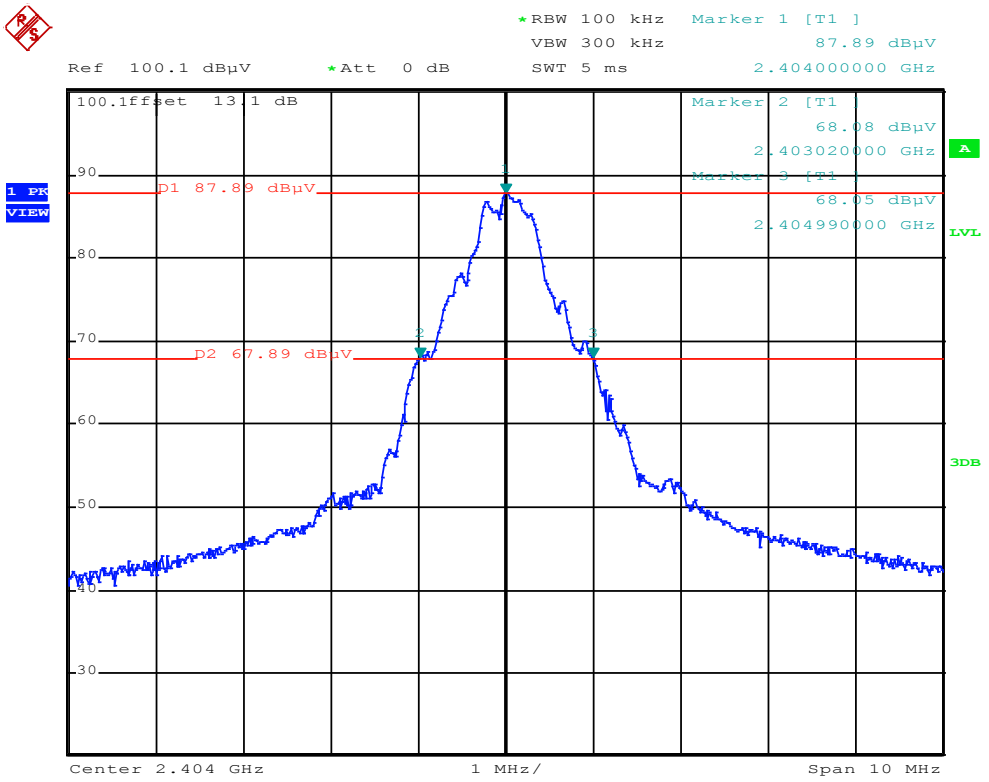
The requirements are **FULFILLED.**

**Remarks:** For detailed test results please refer to following test protocols.

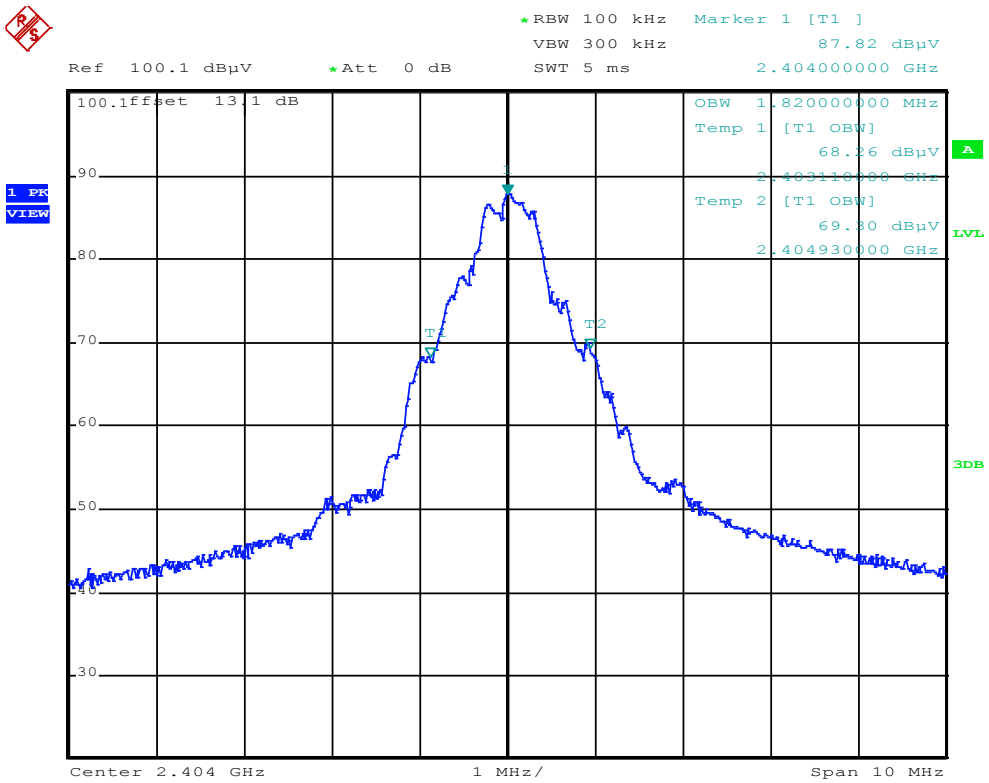
The OBW99 is measured for RSS only.

### 5.4.6 Test protocols

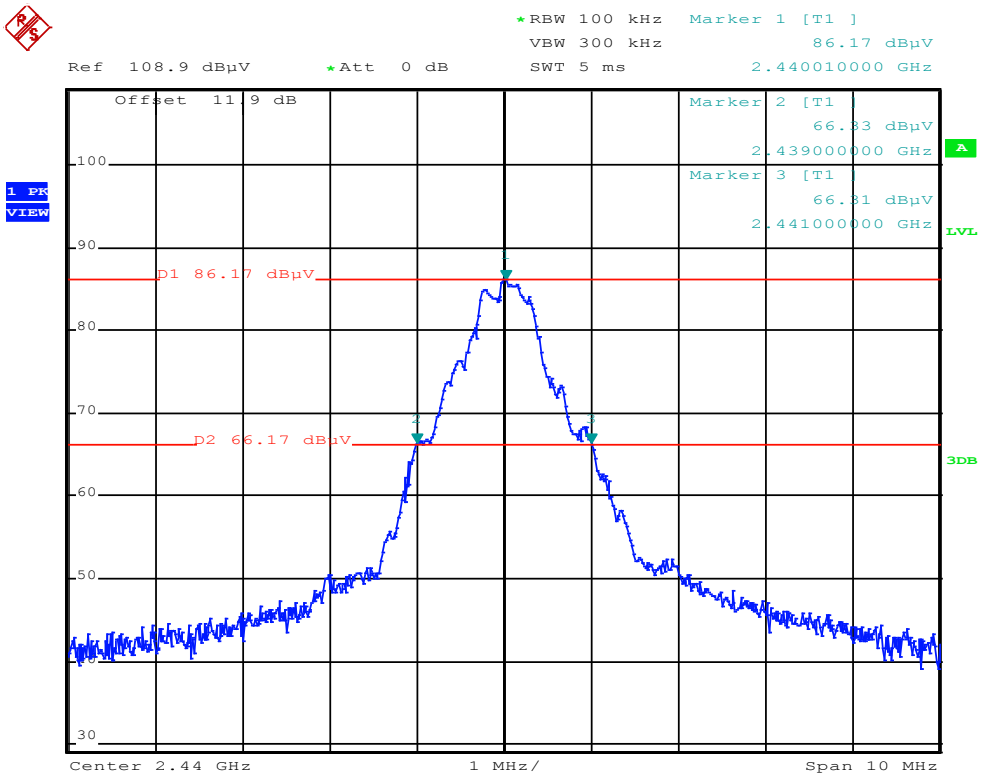
**20 dB bandwidth - CH1 - 2404 MHz**



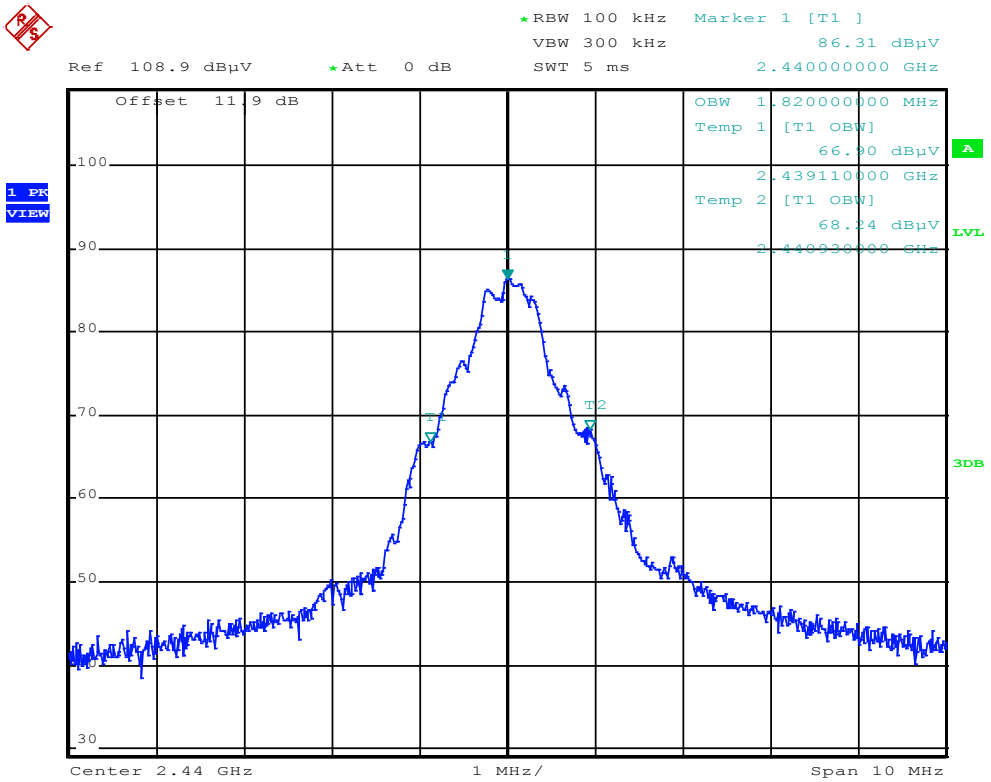

**OBW 99% - CH1 - 2404 MHz**



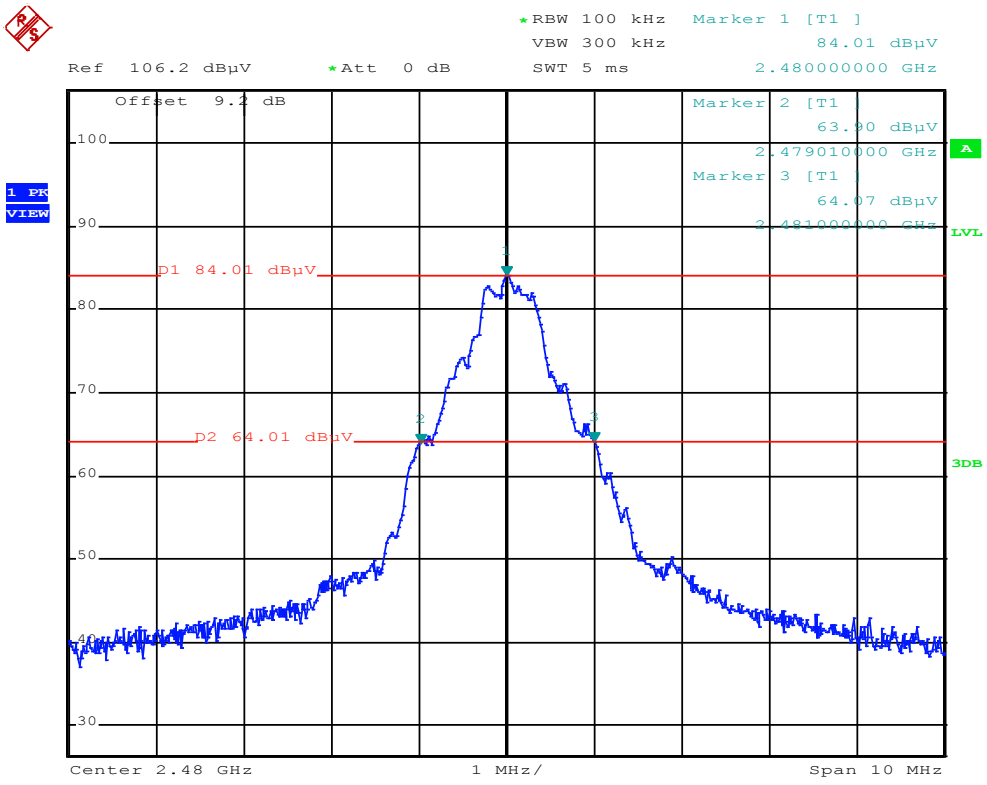
## 20 dB bandwidth - CH19 - 2440 MHz



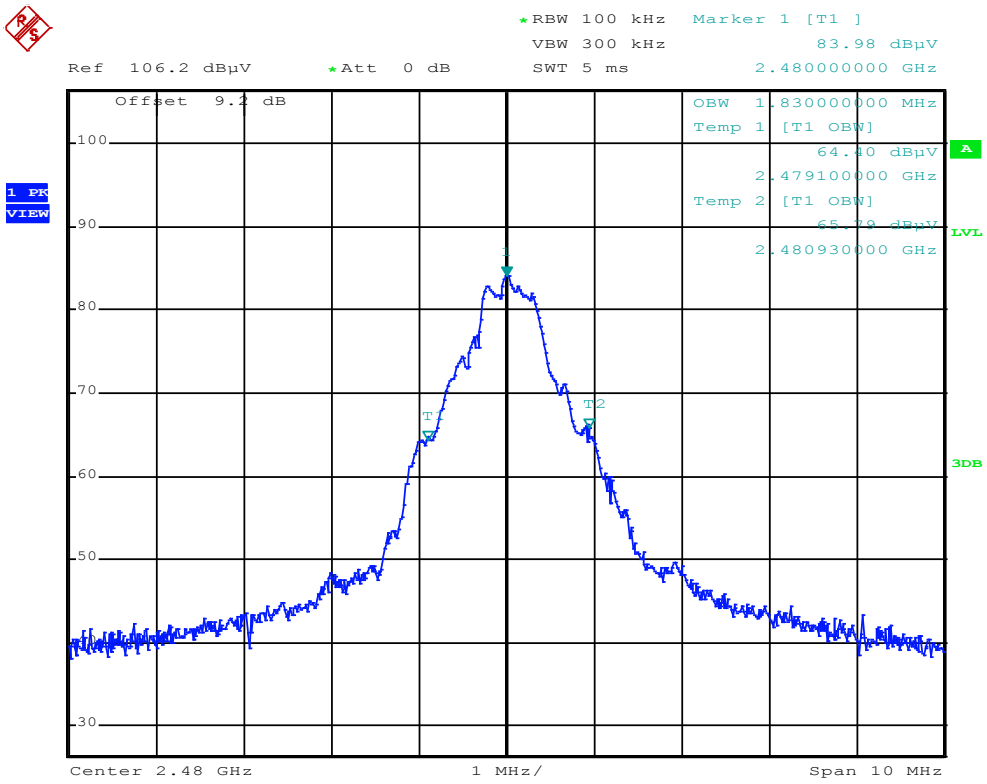

## OBW 99% - CH19 - 2440 MHz



## 20 dB bandwidth - CH39 - 2480 MHz




## OBW 99% - CH39 - 2480 MHz



## 5.5 Correction for pulse operation (duty cycle)

For test instruments and accessories used see section 6 Part **DC**.

### 5.5.1 Description of the test location

Test location: Shielded Room S5

### 5.5.2 Photo documentation of the test set-up

**See Attachment "Test setup photos"**

### 5.5.3 Applicable standard

According to FCC Part 15A, Section 15.35(c):
When the radiated emission limits are expressed in terms of average value and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete puls train, including blanking intervals, as long as the pulse train does not exceed 0.1s. In cases where the puls train exceeds 0.1s, the measured field strength shall be determined from the average absolute voltage during a 0.1s interval during which the field strength is at its maximum. The exact method of calculating the average field strength shall be submitted.

### 5.5.4 Description of Measurement

The duty cycle factor (dB) is calculated applying the following formula:

$$K_E = 20\ log \frac{(t_{iW}/T_B) * t_{iB}}{T_W}$$

$K_E$: pulse operation correction factor
$t_{iw}$ pulse duration for one complete pulse track
$t_{iB}$ pulse duration for one pulse
$T_w$ a period of the pulse track
$T_B$ a period of one pulse

### 5.5.5 Test result

| *CH* | $t_{iw}$ (ms) | $T_w$ (ms) | $t_{iB}$ (µs) | $T_B$ (ms) | $K_E$ (dB) |
|---|---|---|---|---|---|
| 1 | 100 | 100 | 170 | 1.253 | -17.4 |
| 19 | 100 | 100 | 170 | 1.253 | -17.4 |
| 39 | 100 | 100 | 170 | 1.253 | -17.4 |

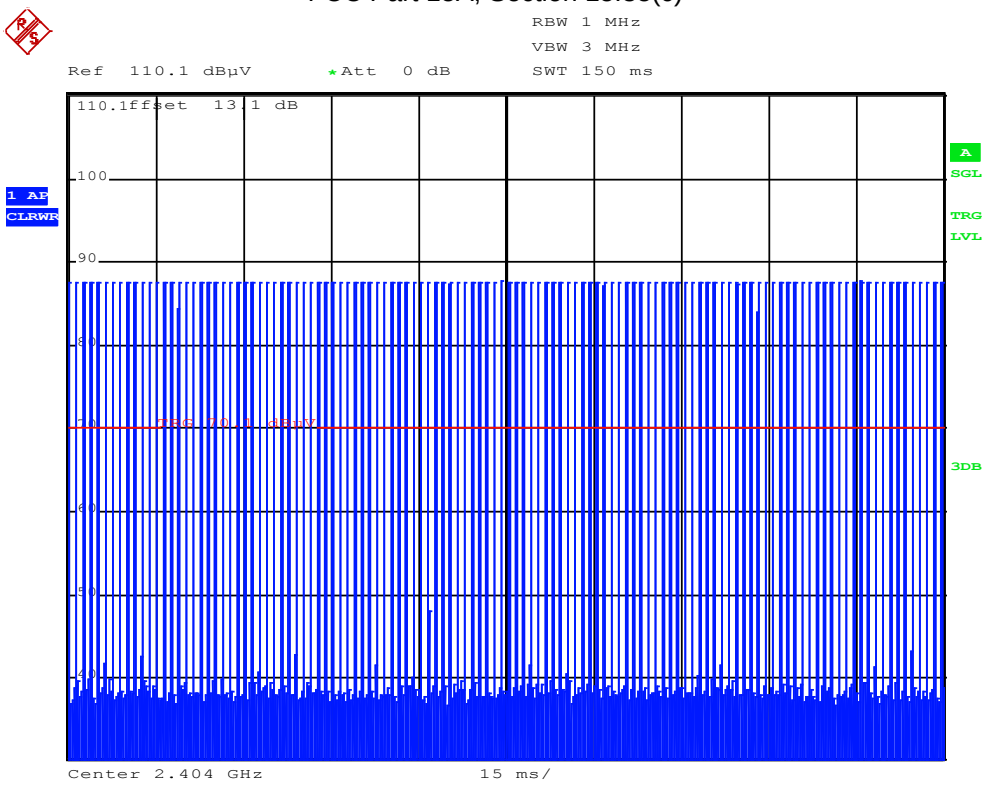
**Remarks:** The pulse train (*Tw*) exceeds 100 ms, therefore the duty cycle has been calculated by averaging the sum of the pulse widths over the 100 ms width with the highest average value.

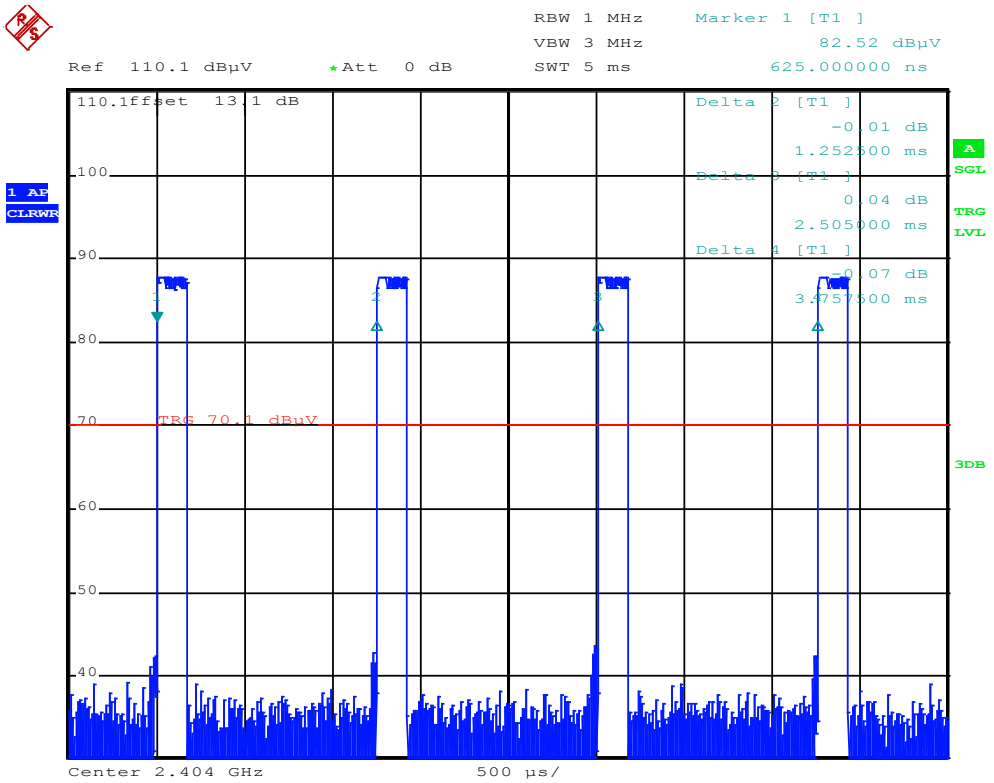
For detailed test results please refer to following test protocols.

### 5.5.6 Test protocol

**Correction for Pulse Operation (Duty Cycle) - CH1 - 2404 MHz**

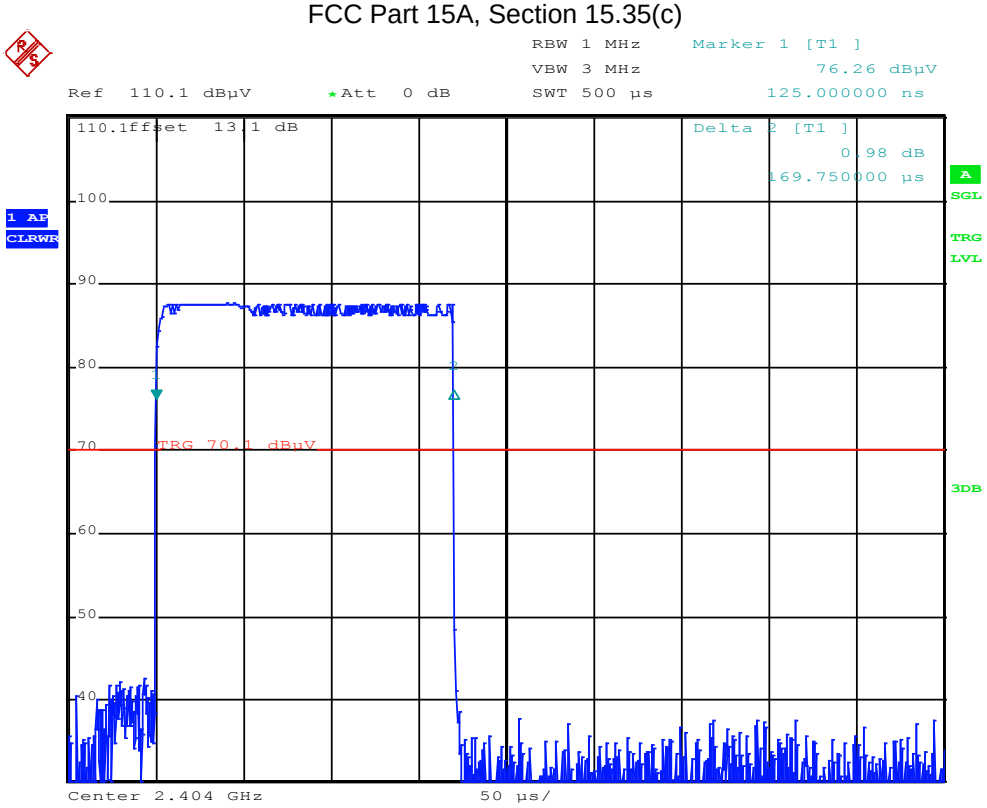
FCC Part 15A, Section 15.35(c)



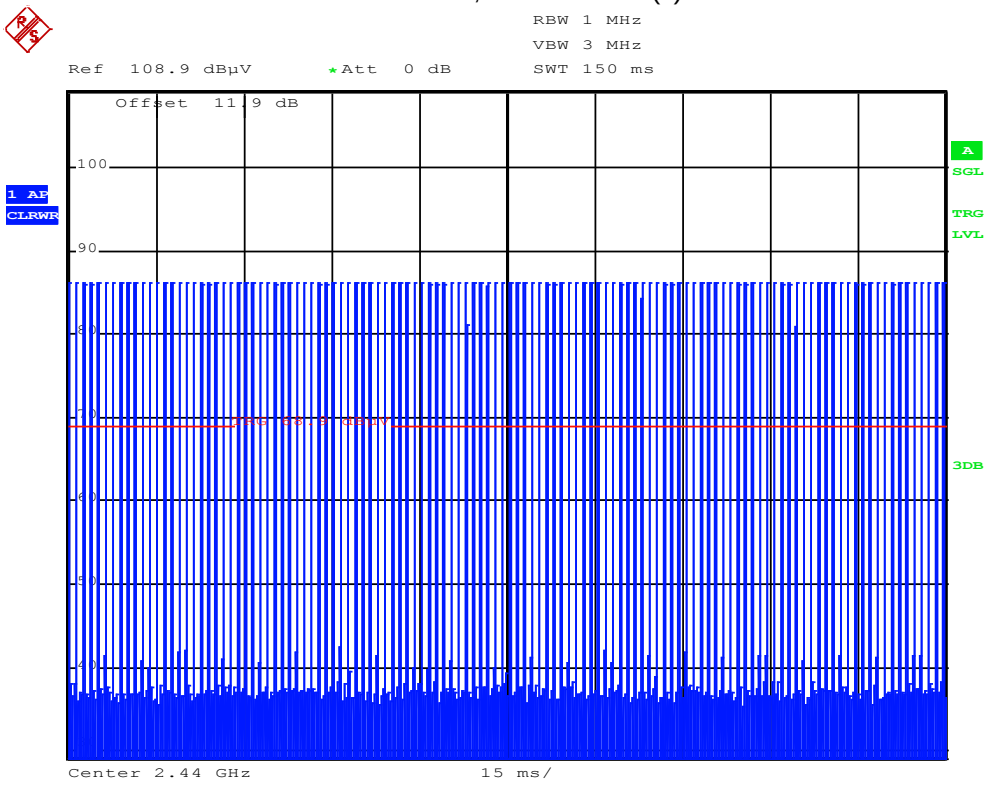
## Correction for Pulse Operation (Duty Cycle) - CH1 - 2404 MHz

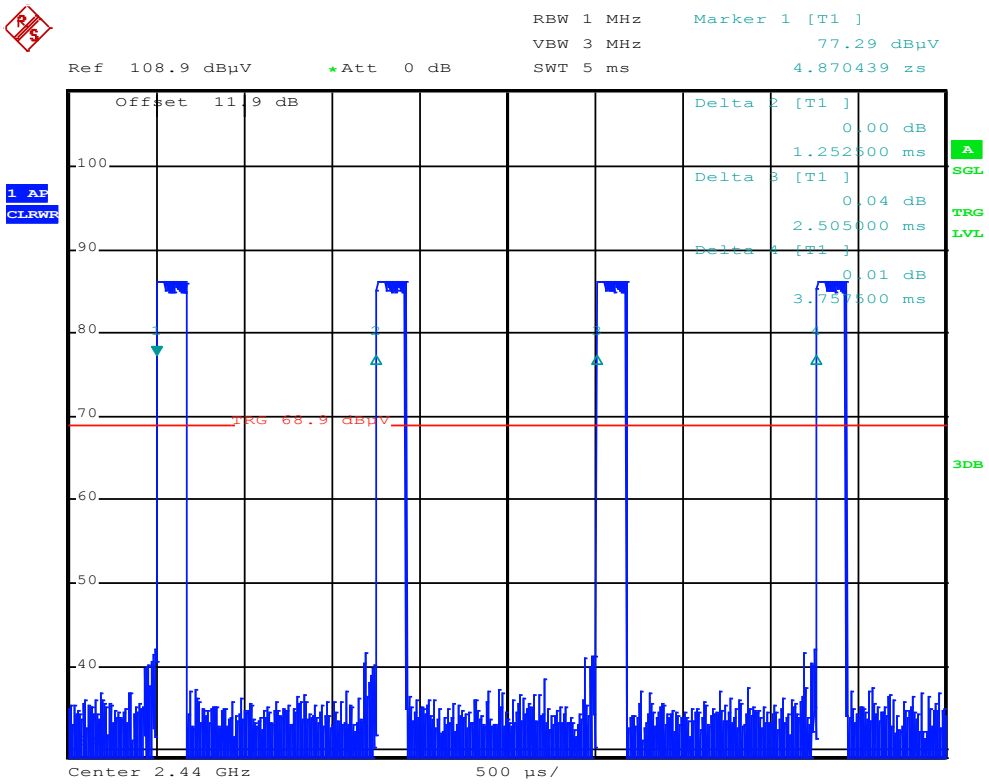
FCC Part 15A, Section 15.35(c)



## Correction for Pulse Operation (Duty Cycle) - CH19 - 2440 MHz

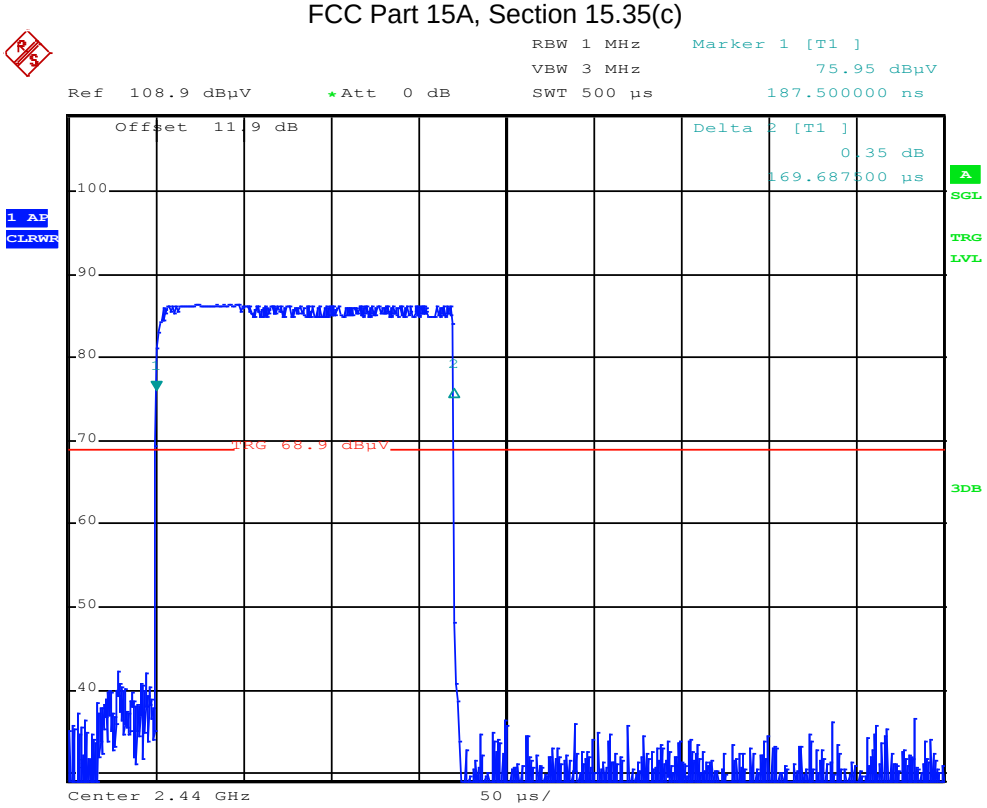
FCC Part 15A, Section 15.35(c)



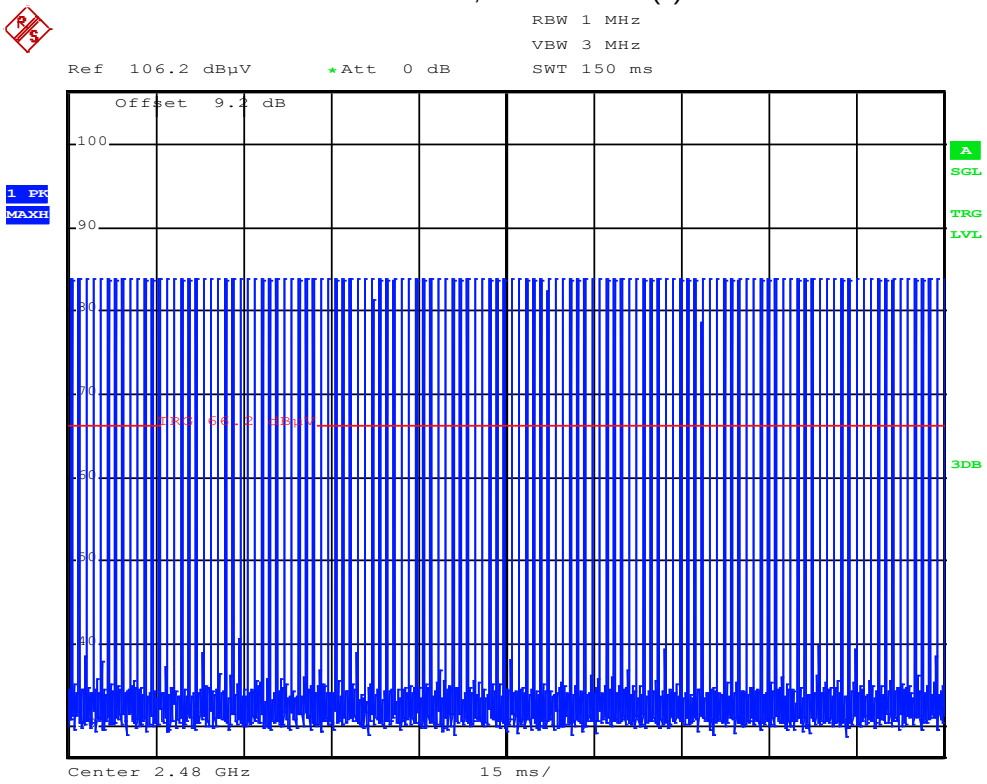
## Correction for Pulse Operation (Duty Cycle) - CH19 - 2440 MHz

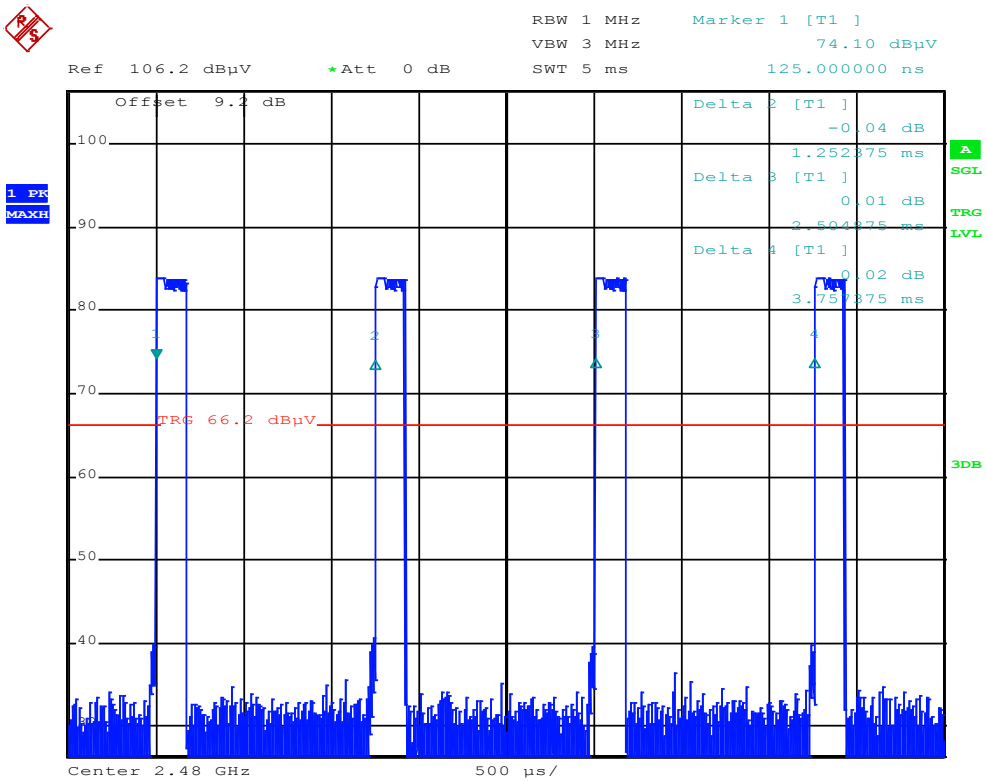
FCC Part 15A, Section 15.35(c)



## Correction for Pulse Operation (Duty Cycle) - CH39 - 2480 MHz

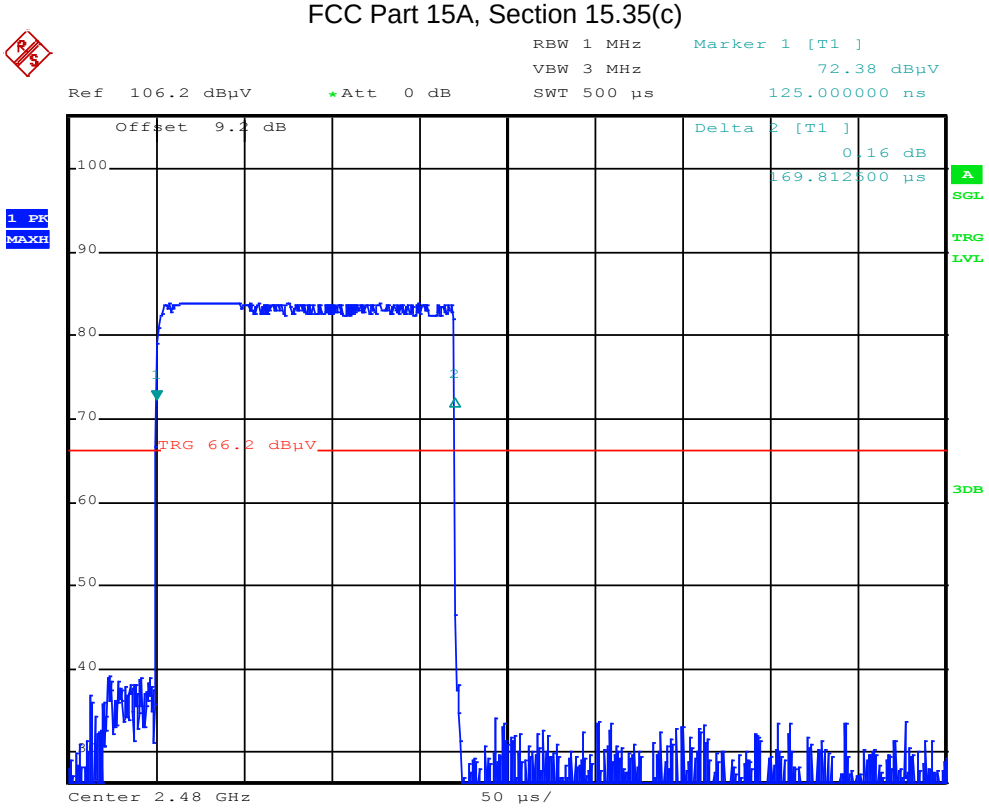
FCC Part 15A, Section 15.35(c)



## Correction for Pulse Operation (Duty Cycle) - CH39 - 2480 MHz

FCC Part 15A, Section 15.35(c)



## 5.6 Antenna application

### 5.6.1 Applicable standard

According to FCC Part 15C, Section 15.203:
An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section.

### 5.6.2 Result

**Remarks:** The EUT uses an integrated chip antenna. No other antenna than that furnished by the responsible party or external power amplifier can be applied by a customer.

The antenna of the EUT meets the requirement of FCC Part 15C, Section 15.203 and 15.204.

## 5.7 Receiver radiated emissions

For test instruments and accessories used see section 6 Part **SER1, SER 2, SER 3**.

### 5.7.1 Description of the test location

Test location: OATS 1
Test location: Anechoic chamber 2

Test distance: 3 m (< 18 GHz) / 1m (> 18 GHz)

### 5.7.2 Photo documentation of the test set-up

Test setup 9 kHz – 30 MHz:

**See Attachment "Test setup photos"**

Test setup 30 MHz – 1000 MHz:

**See Attachment "Test setup photos"**

Test setup 1 GHz – 18 GHz:

**See Attachment "Test setup photos"**

Test setup 18 GHz – 25 GHz:

**See Attachment "Test setup photos"**

### 5.7.3 Applicable standard

According to FCC Part 15C, Section 15.109(a):
Except for Class A digital devices, the field strength of radiated emissions from unintentional radiators at a distance of 3 m shall not exceed the given limit.

### 5.7.4 Description of Measurement

The radiated emissions from the EUT are measured in the frequency range of 9 kHz to 1000 MHz using a tuned receiver and appropriate broadband linearly polarized antennas. The setup of the EUT and the measurement procedure is in accordance to ANSI C63.4, Item 8.3. In the frequency range above 1 GHz a spectrum analyser is used with appropriate linear polarized antennas. If the emission level in peak mode complies with the average limit testing is stopped and peak values will be reported, otherwise, the emission is measured in average mode again and reported. The EUT is measured in RX continuous mode under normal conditions.

Instrument settings:

| | | |
|---|---|---|
| 9 kHz – 150 kHz | RBW: | 200 Hz |
| 150 kHz - 30 MHz | RBW: | 9 kHz |
| 30 MHz – 1000 MHz: | RBW: | 120 kHz |
| 1000 MHz – 25 GHz | RBW: | 1 MHz |

### 5.7.5 Test result f < 30 MHz

Note: The limts are extrapolated (D factor) to the measurement distance of 3 m.

Channel 19

| Frequency (MHz) | Reading level QP (dBµV) | Reading level AV (dBµV) | Bandwidth (kHz) | Correction factor (dB/m) | Corrected level QP dB(µV/m) | Corrected level AV dB(µV/m) | Limit @ 3m dB(µV/m) | Delta (dB) |
|---|---|---|---|---|---|---|---|---|
| 10.244 | 9.3 | - | 9 | 20 | 29.3 | - | 69.5 | -40.2 |
| 10.848 | 10.2 | - | 9 | 20 | 30.2 | - | 69.5 | -39.3 |
| 11.448 | 14.1 | - | 9 | 20 | 34.1 | - | 69.5 | -35.4 |
| 12.056 | 12.1 | - | 9 | 20 | 32.1 | - | 69.5 | -37.4 |

### 5.7.6 Test result f < 1 GHz

Channel 19

| Frequency (MHz) | Reading level QP (dBµV) | Reading level AV (dBµV) | Bandwidth (kHz) | Correction factor (dB/m) | Corrected level QP dB(µV/m) | Corrected level AV dB(µV/m) | Limit dB(µV/m) | Delta (dB) |
|---|---|---|---|---|---|---|---|---|
| 142.73 | 9.7 | - | 120 | 13.0 | 22.7 | - | 43.5 | -20.8 |
| 143.48 | 9.0 | - | 120 | 13.1 | 22.1 | - | 43.5 | -21.4 |
| 159.75 | 4.6 | - | 120 | 13.8 | 18.4 | - | 43.5 | -25.1 |
| 416.10 | 3.0 | - | 120 | 19.4 | 22.4 | - | 46.0 | -23.6 |

### 5.7.7 Test result f > 1 GHz

Channel 1

| Frequency (MHz) | Reading level PK (dBµV) | Duty Cycle Correction (dB) | Reading level AV (dBµV) | Correction factor (dB/m) | Corrected level PK dB(µV/m) | Corrected level AV dB(µV/m) | Limit PK dB(µV/m) | Limit AV dB(µV/m) | Delta (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 1041.3 | 60.4 | - | - | -20.6 | 39.8 | - | 74 | 54 | -14.2 |
| 1173.6 | 60.4 | - | - | -19.3 | 41.1 | - | 74 | 54 | -12.9 |
| 1196.5 | 60.7 | - | - | -18.9 | 41.8 | - | 74 | 54 | -12.2 |
| 1220.1 | 61.7 | - | - | -18.6 | 43.1 | - | 74 | 54 | -10.9 |
| 2580.1 | 57.7 | - | - | -12.9 | 44.8 | - | 74 | 54 | -9.2 |
| 3247.8 | 54.4 | - | - | -12.2 | 42.2 | - | 74 | 54 | -11.8 |

Channel 19

| Frequency (MHz) | Reading level PK (dBµV) | Duty Cycle Correction (dB) | Reading level AV (dBµV) | Correction factor (dB/m) | Corrected level PK dB(µV/m) | Corrected level AV dB(µV/m) | Limit PK dB(µV/m) | Limit AV dB(µV/m) | Delta (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 1041.3 | 60.2 | - | - | -20.6 | 39.6 | - | 74 | 54 | -14.4 |
| 1174.4 | 60.6 | - | - | -19.3 | 41.3 | - | 74 | 54 | -12.7 |
| 1197.6 | 60.5 | - | - | -18.9 | 41.5 | - | 74 | 54 | -12.5 |
| 1220.1 | 61.5 | - | - | -18.6 | 42.9 | - | 74 | 54 | -11.1 |
| 2791.0 | 54.3 | - | - | -12.6 | 41.8 | - | 74 | 54 | -12.2 |
| 3569.1 | 53.7 | - | - | -12.0 | 41.7 | - | 74 | 54 | -12.3 |

Channel 39

| Frequency (MHz) | Reading level PK (dBµV) | Duty Cycle Correction (dB) | Reading level AV (dBµV) | Correction factor (dB/m) | Corrected level PK dB(µV/m) | Corrected level AV dB(µV/m) | Limit PK dB(µV/m) | Limit AV dB(µV/m) | Delta (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 1041.6 | 60.5 | - | - | -20.6 | 39.9 | - | 74 | 54 | -14.1 |
| 1173.6 | 61.9 | - | - | -19.3 | 42.6 | - | 74 | 54 | -11.4 |
| 1196.5 | 60.2 | - | - | -18.9 | 41.3 | - | 74 | 54 | -12.7 |
| 1220.5 | 61.4 | - | - | -18.6 | 42.8 | - | 74 | 54 | -11.2 |
| 1599.3 | 59.2 | - | - | -20.7 | 38.4 | - | 74 | 54 | -15.6 |
| 2836.4 | 54.1 | - | - | -12.7 | 41.5 | - | 74 | 54 | -12.5 |
| 3511.4 | 54.0 | - | - | -12.0 | 42.0 | | 74 | 54 | -12.0 |

Limit according to FCC Part 15B, Section 15.109(a):

| Frequency (MHz) | 15.209 Limits (µV/m) | Measurement distance (m) |
|---|---|---|
| 30 - 88 | 100 | 3 |
| 88 - 216 | 150 | 3 |
| 216 - 960 | 200 | 3 |
| Above 960 | 500 | 3 |

The requirements are **FULFILLED.**

**Remarks:** The measurement was performed up to the 5th harmonic.

Measurements below 1 GHz where only performed with CH19, because a different channel selection has no influence on the measured frequencies and levels.

# 6 USED TEST EQUIPMENT AND ACCESSORIES

All test instruments used are calibrated and verified regularly. The calibration history is available on request.

| Test ID | Model Type | Equipment No. | Next Calib. | Last Calib. | Next Verif. | Last Verif. |
|---|---|---|---|---|---|---|
| CPR 3 | FSP 30 | 02-02/11-05-001 | 24/10/2014 | 24/10/2013 | | |
| | AFS5-12001800-18-10P-6 | 02-02/17-06-002 | | | | |
| | AFS4-01000400-10-10P-4 | 02-02/17-13-002 | | | | |
| | AMF-4F-04001200-15-10P | 02-02/17-13-003 | | | | |
| | 3117 | 02-02/24-05-009 | 07/05/2015 | 07/05/2014 | | |
| | Sucoflex N-1600-SMA | 02-02/50-05-073 | | | | |
| | Sucoflex N-2000-SMA | 02-02/50-05-075 | | | | |
| | SF104/11N/11N/1500MM | 02-02/50-13-015 | | | | |
| DC | FSP 30 | 02-02/11-05-001 | 24/10/2014 | 24/10/2013 | | |
| | LOBB 18 | 02-02/24-05-026 | | | 21/01/2015 | 21/01/2014 |
| MB | FSP 30 | 02-02/11-05-001 | 24/10/2014 | 24/10/2013 | | |
| | LOBB 18 | 02-02/24-05-026 | | | 21/01/2015 | 21/01/2014 |
| SER 1 | FMZB 1516 | 01-02/24-01-018 | | | 13/02/2015 | 13/02/2014 |
| | ESCI | 02-02/03-05-005 | 12/12/2014 | 12/12/2013 | | |
| | S10162-B | 02-02/50-05-031 | | | | |
| | KK-EF393-21N-16 | 02-02/50-05-033 | | | | |
| | NW-2000-NB | 02-02/50-05-113 | | | | |
| SER 2 | ESVS 30 | 02-02/03-05-006 | 28/06/2014 | 28/06/2013 | | |
| | VULB 9168 | 02-02/24-05-005 | 08/04/2015 | 08/04/2014 | 08/10/2014 | 08/04/2014 |
| | S10162-B | 02-02/50-05-031 | | | | |
| | NW-2000-NB | 02-02/50-05-113 | | | | |
| | KK-EF393/U-16N-21N20 m | 02-02/50-12-018 | | | | |
| SER 3 | FSP 30 | 02-02/11-05-001 | 24/10/2014 | 24/10/2013 | | |
| | FSP 40 | 02-02/11-11-001 | 30/09/2014 | 30/09/2013 | | |
| | JS4-18004000-30-5A | 02-02/17-05-017 | | | | |
| | AFS5-12001800-18-10P-6 | 02-02/17-06-002 | | | | |
| | AFS4-01000400-10-10P-4 | 02-02/17-13-002 | | | | |
| | AMF-4F-04001200-15-10P | 02-02/17-13-003 | | | | |
| | 3117 | 02-02/24-05-009 | 07/05/2015 | 07/05/2014 | | |
| | BBHA 9170 | 02-02/24-05-014 | | | | |
| | Sucoflex N-1600-SMA | 02-02/50-05-073 | | | | |
| | Sucoflex N-2000-SMA | 02-02/50-05-075 | | | | |
| | KMS102-0.2 m | 02-02/50-11-020 | | | | |
| | SF104/11N/11N/1500MM | 02-02/50-13-015 | | | | |