# TEST REPORT

| | | | |
|---|---|---|---|
| Date: | **ESPOO 28.11.2013** | Page: | **1 (18)** |
| | | Appendices | – |

Number: No. 1 / 1

**239892AI**

Date of handing in: 02.07.2013

Tested by:

Pekka Kälviäinen, Test Engineer

Reviewed by:

Timo Leismala, Test Manager

| | |
|---|---|
| SORT OF EQUIPMENT: | **2.4 GHz Transceiver** |
| TRADE MARK: | |
| TYPE: | ***instadose-2*** |
| MANUFACTURER: | ***Mirion Technologies (RADOS) Oy*** |
| CLIENT: | **Mirion Technologies (RADOS) Oy** |
| ADDRESS: | **P.O. Box 506 (Mustionkatu 2), FI – 20101 Turku, Finland** |
| TEST LABORATORY: | **Nemko Oy** |
| FCC REG. NO. | **359859 October 20, 2011** |
| IC FILE NO. | **2040F-1 November 22, 2012** |

SUMMARY:

In regard to the performed tests the equipment under test fulfils the requirements defined in the test specifications, see page 2 for details





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## Summary of performed tests and test results

| *Section in CFR 47* | *Section in RSS-GEN or RSS-210, Issue 8* | | *Result* |
|---|---|---|---|
| 15.249 (a) | A2.9 | Field strength of fundamental | PASS |
| 15.249 (d)(e), 15.209 | A2.9 | Band-edge compliance of RF emissions | PASS |
| 15.249 (d)(e), 15.209 | A2.9 | Spurious radiated emissions | PASS |
| 15.215 | | 20 dB bandwidth | - |
| 15.207 | 7.2.2 | AC power line conducted emissions | N.A. |

Explanations:

PASS The EUT passed that particular test.
FAIL The EUT failed that particular test.
N.A. The test not applicable, battery operated equipment
X The measurement was done, but there is no applicable performance criteria.

# Contents

# 1. EUT and Accessory Information

## 1.1 EUT description

2.4 GHz transceiver, Digital modulated, 16 channels

## 1.2 EUT and accessories

| | *unit* | *type* | *s/n* |
|---|---|---|---|
| *EUT1, 2402MHz* | **Transceiver** | **instadose-2** | **12000404** |
| *EUT2, 2440MHz* | **Transceiver** | **instadose-2** | **12000465** |
| *EUT3, 2480MHz* | **Transceiver** | **instadose-2** | **12000469** |

Operating voltages

**3.0 VDC 2 * AA Battery,** new batteries were used

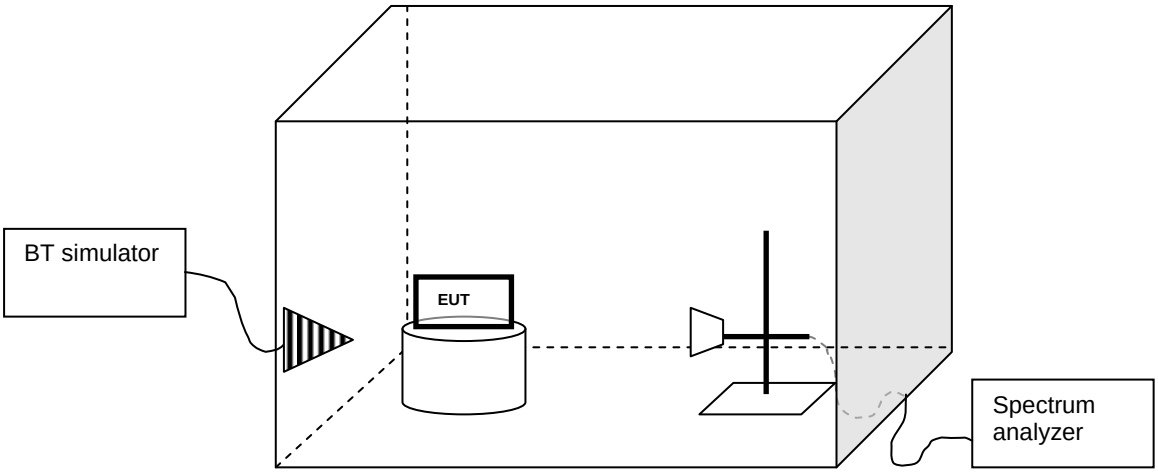
## 1.3 Additional information related to testing

| | | |
|---|---|---|
| Tested Technology: | **Digital modulated, 80 channels** | |
| Antenna: | **Integral** | |
| Type of Unit | **Transmitter** | |
| Modulation: | **BT** | |
| Power Supply Requirement: | **Nominal** | **3.0V** |
| Transmit Frequency Range | **2400 MHz to 2483.5 MHz** | |
| Transmit Channels Tested: | **Channel Frequency (MHz)** | |
| | **2402** | |
| | **2440** | |
| | **2480** | |

## 2. Test setups

**Setup (Radiated measurements)**

The test was performed inside a semi anechoic shielded room. For the duration of the test the EUT was placed on a non-conductive support 0.8 m high standing on the turntable. The tower and turn table were remotely controlled to turn the EUT and change the antenna polarization. The measured signal was routed from the measuring antenna to the spectrum analyzer. A BT simulator was not used.



# 3. Standards and measurement methods

The test were performed in guidance of the CFR 47, FCC Rules Part 15 Subpart C, ANSI C63.4 (2003), CISPR 22 Ed. 6.0, Public notice DA 00-705, ANSI C63.10 (2009), IC standards RSS-GEN (Issue 3, December 2010) and RSS-210 (Issue 8, December 2010).

# 4. Test results

## 4.1 Field strength of fundamental

The test was performed as a compliance test. The test parameters concerned were as follows:

| | |
|---|---|
| *EUT* | **EUT1, EUT2, EUT3** |
| *Site name* | **Nemko Oy / Perkkaa** |
| *FCC rule part* | **§ 15.249 (a)** |
| *Section in RSS-210* | **A2.9** |
| *Date of testing* | **02.07. and 12.11.2013** |
| *Test equipment* | **566, 525, 350** |
| *Test conditions* | **22 - 24 °C, 30 - 51 % RH** |

### 4.1.1 EUT operation mode

| | |
|---|---|
| *EUT frequency (MHz)* | **2402MHz, 2440MHz and 2480MHz** |

### 4.1.2 Test method and limit

| *Frequency range (MHz)* | Limit Average (dBµV/m) | Limit Peak (dBµV/m) |
|---|---|---|
| **2400 – 2483.5** | **≤ 94** | **≤ 114** |

The measurement results were obtained as described below.

$$E\ [\mathrm{dB}(\mu V/m)] = U_{RX} + A_{CABLE} + AF$$

Where

$U_{RX}$ receiver reading

$A_{CABLE}$ attenuation of the cable

$AF$ antenna factor

Duty Cycle correction factor(dB) -50.34 dB was used. (RFon 0.304ms/100ms)

### 4.1.3 Test results

| *frequency (MHz)* | *E Average (dBµV/m)* | *E Peak (dBµV/m)* | *Result* |
|---|---|---|---|
| **2402** | **36.90** | **87.24** | **PASS** |
| **2440** | **38.04** | **88.38** | **PASS** |
| **2480** | **36.81** | **87.15** | **PASS** |

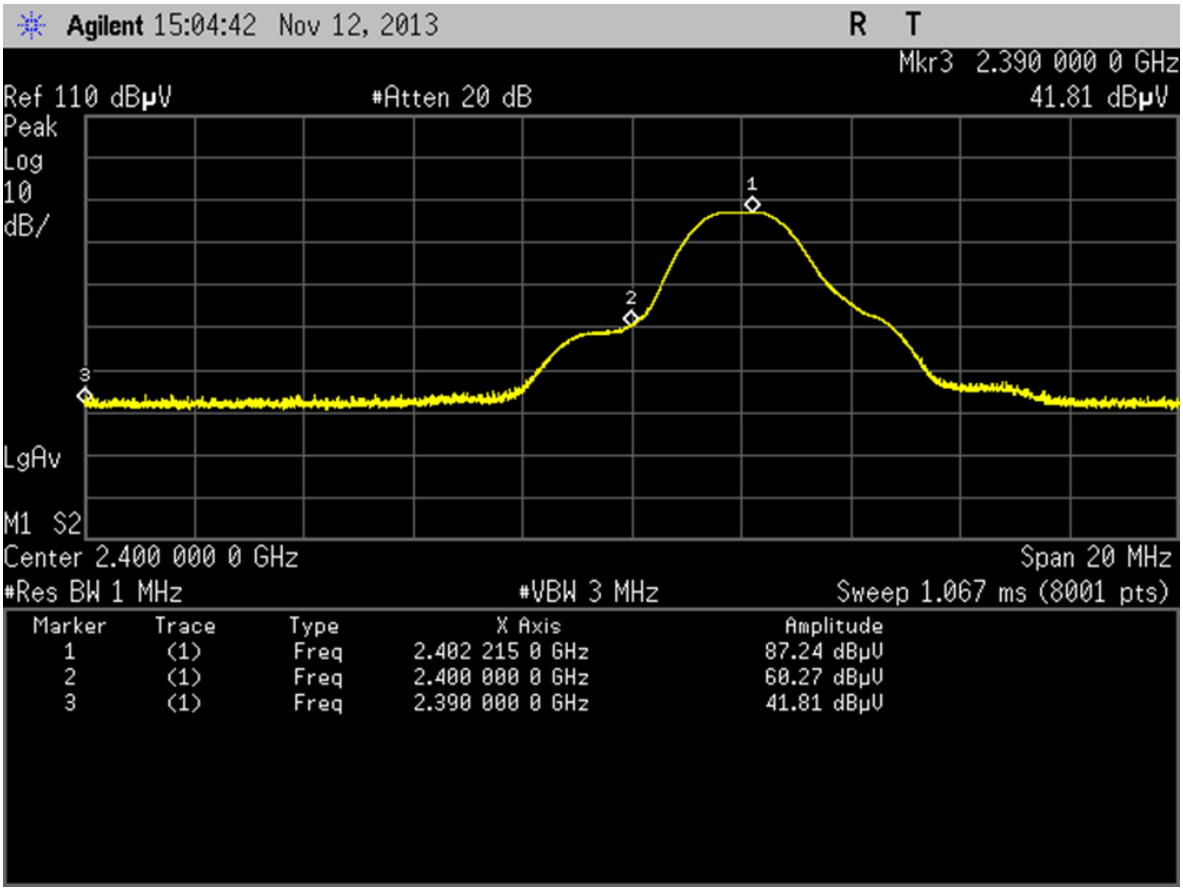


Figure 1. 2402MHz, Field strength of fundamental, peak and Band-edge compliance, low end, peak

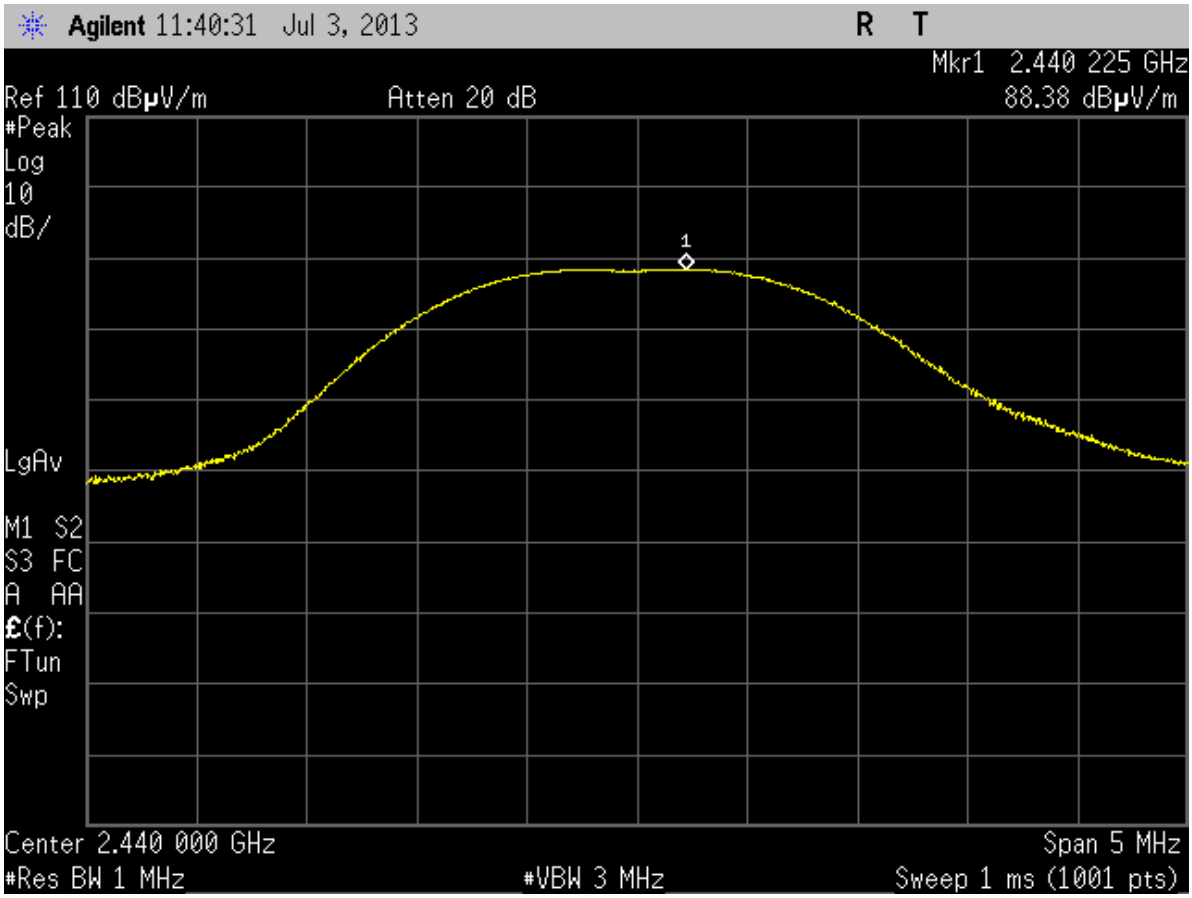



Figure 2. 2440MHz, Field strength of fundamental

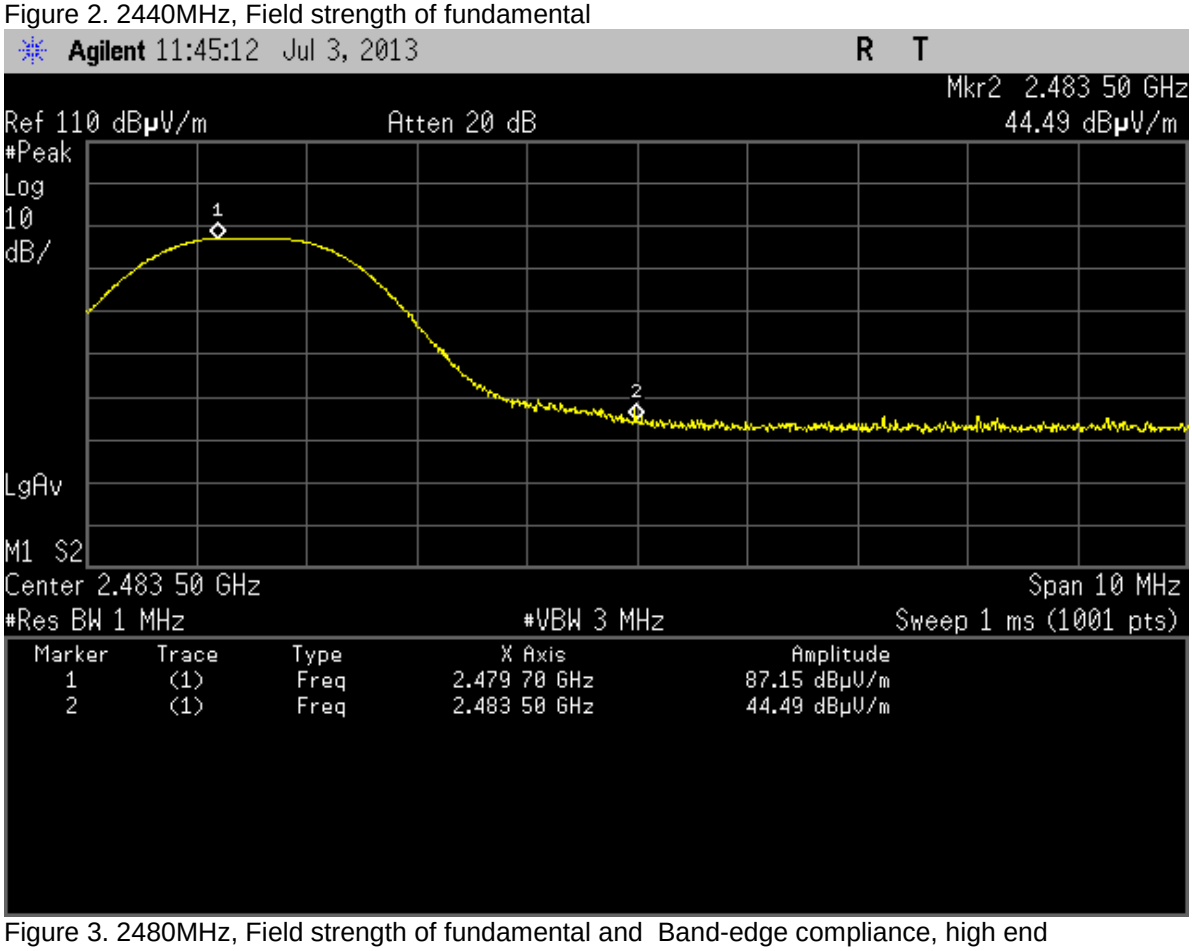



Figure 3. 2480MHz, Field strength of fundamental and Band-edge compliance, high end

## 4.2 Band-edge compliance of RF emissions

The test was performed as a compliance test. The test parameters concerned were as follows:

| | |
|---|---|
| *EUT* | **EUT1, EUT3** |
| *Site name* | **Nemko Oy / Perkkaa** |
| *FCC rule part* | **§ 15.249 (d)(e), § 15.209** |
| *Section in RSS-210* | **A2.9** |
| *Date of testing* | **02.07.2013** |
| *Test equipment* | **566, 525, 350** |
| *Test conditions* | **24 °C, 51 % RH** |
| *Test result* | **PASS** |

### 4.2.1 EUT operation mode

| | |
|---|---|
| *EUT frequency (MHz)* | **2402 and 2480** |

### 4.2.2 Test method and limit

The measurement is made according to Public notice DA 00-705 and IC standard RSS-210.

3m measurement distance

| *Frequency range (MHz)* | *Limit Average (dBµV/m)* | *Limit Peak (dBµV/m)* |
|---|---|---|
| **Below 2390 and above 2483.5** | **≤ 54** | **≤ 74** |

The measurement results were obtained as described below.

$$E\ [\mathrm{dB}(\mu V/m)] = U_{RX} + A_{CABLE} + AF$$

Where

$U_{RX}$ receiver reading

$A_{CABLE}$ attenuation of the cable

$AF$ antenna factor

Duty Cycle correction factor(dB) -50.34 dB was used. (RFon 0.304ms/100ms)

### 4.2.3 Test results

2402 MHz:

Below 2400 MHz:

| *Detector (RBW: 1MHz)* | *E (dBµV/m)* | *Result* |
|---|---|---|
| **Peak** | **60.27** | **PASS** |
| **Average** | **9.93** | **PASS** |

2480 MHz:

Above 2483.5 MHz:

| *Detector (RBW: 1MHz)* | *E (dBµV/m)* | *Result* |
|---|---|---|
| **Peak** | **44.49** | **PASS** |
| **Average** | **-6.05** | **PASS** |

## 4.3 Spurious radiated emission

The test was performed as a compliance test. The test parameters concerned were as follows:

| | |
|---|---|
| *EUT* | **EUT1, EUT2, EUT3** |
| *Site name* | **Nemko Oy / Perkkaa** |
| *FCC rule part* | **§ 15.249 (d)(e), § 15.209** |
| *Section in RSS-210* | **A2.9** |
| *Date of testing* | **03.07.2013** |
| *Test equipment* | **566, 709, 564, 559, 525, 319, 544, 350, 88, 710** |
| *Test conditions* | **24 °C, 52 % RH** |

### 4.3.1 EUT operation mode

| | |
|---|---|
| *EUT frequency (MHz)* | **2402, 2440 and 2480** |

### 4.3.2 Test method and limit

The test was performed in a semi-anechoic shielded room. The EUT was placed on a non-conductive 0.8 m high table standing on the turntable. During the test the distance from the EUT to the measuring antenna was 3 m. The excess length of the cables of the EUT was made into bundles 30-40 cm in length (see photograph 1). In order to find the maximum levels of the disturbance radiation the angle of the turntable, the height of the measuring antenna and the lay-out of the EUT cables were varied during the tests. The test was performed with the measuring antenna being both in horizontal and vertical polarizations.

Vertical and horizontal polarizations in the frequency range 30 – 1000 MHz was measured by using the peak detector. During the peak detector scan, the turntable was rotated from 0° to 360° with 30° step with the antenna heights 1.0 m and 3.0 m. The highest levels of the radiated interference field strength measured by using the quasi-peak detector were recorded.

Vertical and horizontal polarizations in the frequency range 1000 – 25000 MHz was measured by using the peak detector. During the peak detector scan, the turntable was rotated from 0° to 360° with 15° step with the antenna heights 1.0 m, 1,5m, 2.0m, 2,5m and 3.0 m. The highest levels of the radiated interference field strength measured by using the average and peak detectors were recorded.

**Minimum Standard**: Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in § 15.209, whichever is the lesser attenuation.

Emissions falling in the restricted bands of 15.205 shall not exceed the limits shown in §15.209.
At frequencies equal to or less than 1000 MHz, compliance with the limits in §15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in §15.209 shall be demonstrated based on the average value of the measured emissions.

3m measuring distance, FCC Part 15.209

| *Frequency band MHz* | *limit, Quasi peak detector dB(µV/m)* |
|---|---|
| **30 - 88** | **40** |
| **88 - 216** | **43.5** |
| **216 - 960** | **46** |
| **960 - 1000** | **54** |

| *Frequency band MHz* | *limit, average detector dB(µV/m)* | *limit, peak detector dB(µV/m)* |
|---|---|---|
| **1000 - 25000** | **54** | **74** |

The EUT was tested on three orthogonal axes.
The device was tested from 30 MHz to the tenth harmonic of the highest fundamental frequency per 15.33.
The device was tested on three channels per 15.31(l).

The CFR 47 Part 15. Subpart B. Class B limit of 500 µV/m has been calculated to correspond 54 dB(µV/m) as follows: [dB(µV/m)]=20log[µV/m].

The measurement results were obtained as described below.

$$E\ [\mathrm{dB}(\mu V/m)] = U_{RX} + A_{CABLE} + AF - G_{PREAMP}$$

Where

| | |
|---|---|
| $U_{RX}$ | receiver reading |
| $A_{CABLE}$ | attenuation of the cable |
| $AF$ | antenna factor |
| $G_{PREAMP}$ | gain of the preamplifier |

Duty Cycle correction factor(dB) -50.34 dB was used. (RFon 0.304ms/100ms)

### 4.3.3 Test results

below 1GHz: RBW 120kHz
above 1GHz: peak, RBW 1MHz, VBW 3MHz

2402MHz

| *Frequency MHz* | *Peak dB(µV/m)* | *Limit dB(µV/m)* | *Margin dB* | *Result* |
|---|---|---|---|---|
| **7206** | **60.8** | **74** | **13.2** | **PASS** |

| *Frequency MHz* | *Average dB(µV/m)* | *Limit dB(µV/m)* | *Margin dB* | *Result* |
|---|---|---|---|---|
| **7206** | **10.5** | **54** | **43.5** | **PASS** |

2440MHz

| *Frequency MHz* | *Peak dB(µV/m)* | *Limit dB(µV/m)* | *Margin dB* | *Result* |
|---|---|---|---|---|
| **7320** | **64.9** | **74** | **9.1** | **PASS** |

| *Frequency MHz* | *Average dB(µV/m)* | *Limit dB(µV/m)* | *Margin dB* | *Result* |
|---|---|---|---|---|
| **7320** | **14.6** | **54** | **39.4** | **PASS** |

2480MHz

| *Frequency MHz* | *Peak dB(µV/m)* | *Limit dB(µV/m)* | *Margin dB* | *Result* |
|---|---|---|---|---|
| **7440** | **61.4** | **74** | **12.6** | **PASS** |

| *Frequency MHz* | *Average dB(µV/m)* | *Limit dB(µV/m)* | *Margin dB* | *Result* |
|---|---|---|---|---|
| **7440** | **11.1** | **54** | **42.9** | **PASS** |

## 4.4 20 dB bandwidth

The test was performed as a compliance test. The test parameters concerned were as follows:

| | |
|---|---|
| *EUT* | **EUT1, EUT2, EUT3** |
| *Site name* | **Nemko Oy / Perkkaa** |
| *FCC rule part* | **§ 15.215** |
| *Date of testing* | **30.10. and 12.11.2013** |
| *Test equipment* | **566, 525, 350** |
| *Test conditions* | **22 °C, 30-31 % RH** |

### 4.4.1 EUT operation mode

| | |
|---|---|
| *EUT frequency (MHz)* | **2402, 2440 and 2480** |

### 4.4.2 Test method and limit

The measurement is made according to Public notice DA 00-705 and IC standard RSS-210.

| *Limit (MHz)* |
|---|
| **N/A** |

### 4.4.3 Test results

| *EUT frequency (MHz)* | *20 dB bandwidth (MHz)* |
|---|---|
| **02402** | **1.219** |
| **2440** | **1.180** |
| **2480** | **1.205** |

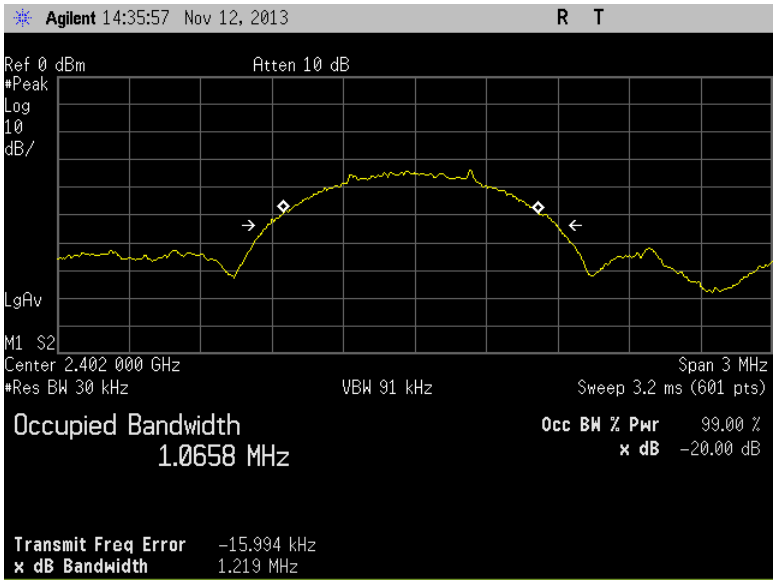



Figure 4. 2402MHz 0, 20 dB bandwidth

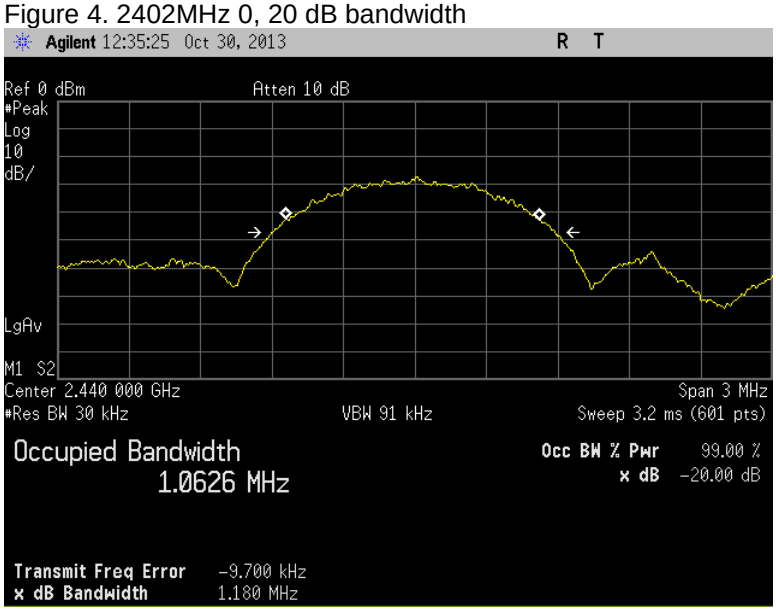



Figure 5.2440MHz, 20 dB bandwidth

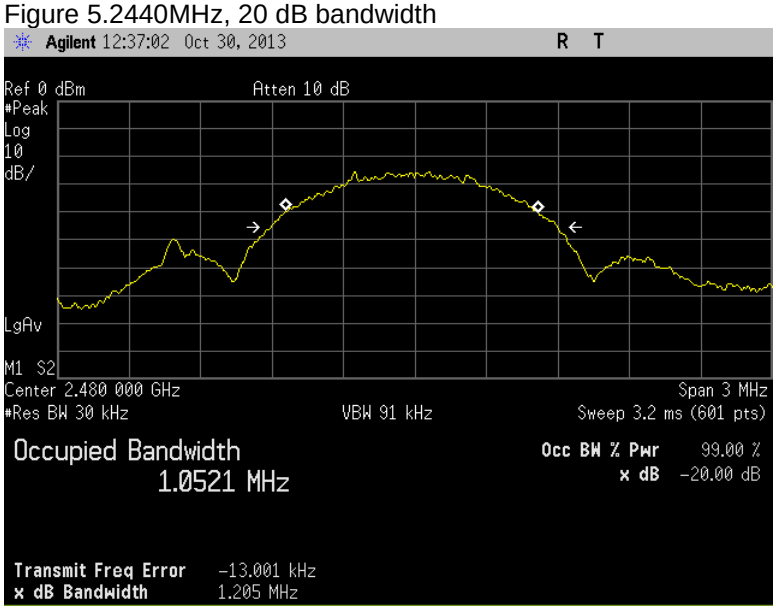



Figure 6. 2480MHz, 20 dB bandwidth

## 4.5 Duty cycle correction factor, Transmit time in 100 ms

Spectrum analyzer with zero span was used to investigate spectrum.

15.35(c) Unless otherwise specified, e.g.§ 15.255(b), when the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum value. The exact method of calculating the average field strength shall be submitted with any application for certification or shall be retained in the measurement data file for equipment subject to notification or verification.

### 4.5.1 Test data

*Pulses/100ms=1*
*Length of one pulse = 0.304ms*

*DutyCycleCorrectionFactor=20*log(Tocc/100)=20*log(1*0.304/100)=-50.34dB*

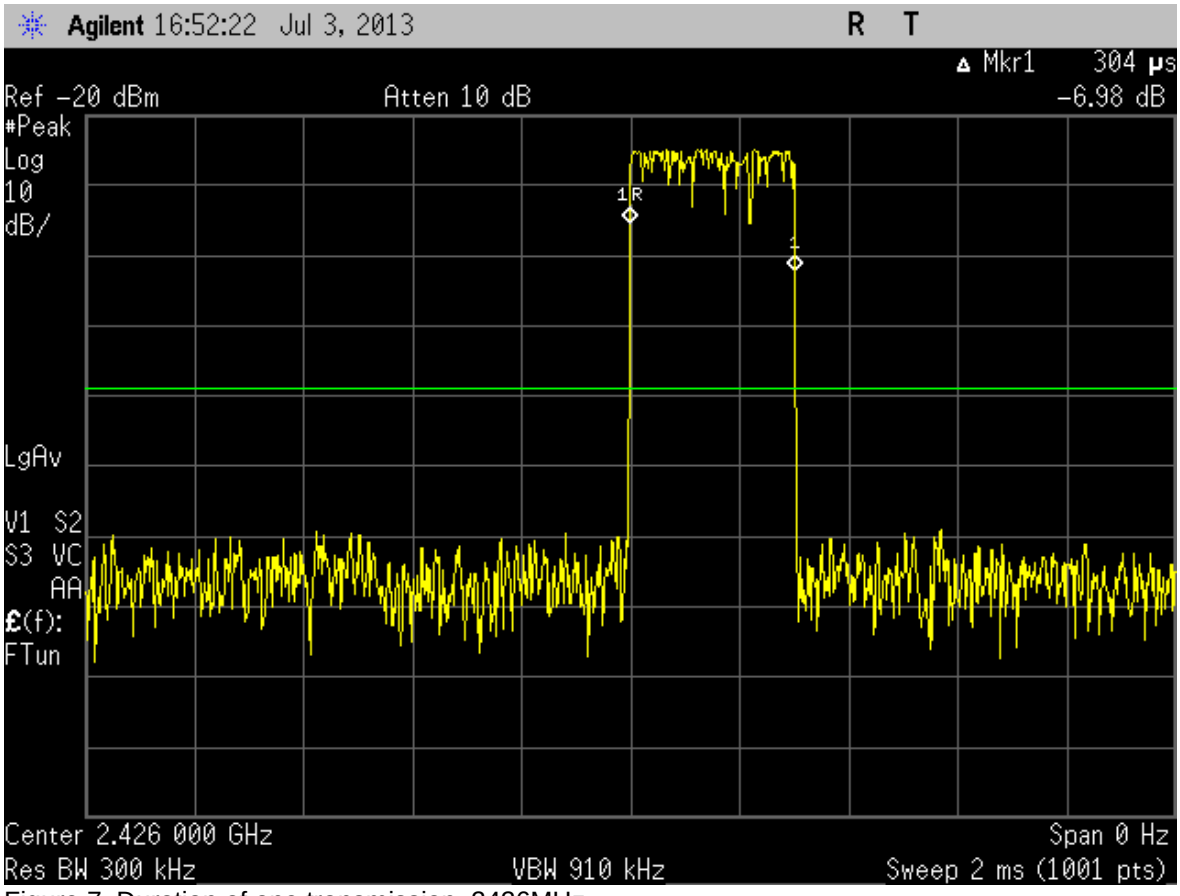


Figure 7. Duration of one transmission, 2426MHz

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## 5. List of test equipment

| Nr. | Equipment | Type | Manufacturer | Serial number | Cal date | Cal due |
|---|---|---|---|---|---|---|
| 375 | RF attenuator PAD | 757 C - 20 dB | Narda | - | 10.12.2011 | 12.2013 |
| 383 | Hybrid | 3033B | Narda | 01727 | | |
| 390 | RF attenuator PAD | WA2-10 | Weinschel | 3784 | 10.12.2011 | 12.2013 |
| 694 | EMI Test Receiver | ESPC | Rohde & Schwarz | 842888/023 | 11.12.2012 | 12.2013 |
| 566 | Spectrum analyzer | E4448A | Agilent | US42510236 | 17.4.2013 | 4.2014 |
| 709 | EMI test receiver | ESU8 | Rohde & Schwarz | 100297 | 24.07.2013 | 7.2014 |
| 567 | RF generator | E8257C | Agilent | MY43320736 | 25.2.2013 | 2.2014 |
| 544 | RF-amplifier | ZFL-2000VH2 | Mini-Circuits | QA0749010 | 9.1.2013 | 1.2014 |
| 564 | RF amplifier | CA018-4010 | CIAO Wireless | 132 | 9.1.2013 | 1.2014 |
| 710 | RF-amplifier | ALS 1826-41-12 | ALC Microwave Inc. | 0011 | 28.10.2011 | 10.2013 |
| 745 | 2-Line V-Network | ENV216 | Rohde & Schwarz | 101466 | 11.6.2013 | 06.2014 |
| 319 | Antenna | CBL6112 | Chase | 2018 | 12.7.2012 | 1.2014 |
| 525 | Double-Ridged Horn | 3115 | Emco | 6691 | 10.10.2012 | 4.2014 |
| 542 | Double-Ridged Horn | 3115 | Emco | 00023905 | 10.10.2012 | 4.2014 |
| 546 | Bluetooth Test Set | MT8850A | Anritsu | 6K00000092 | - | - |
| 559 | Highpass Filter | WHKX3.0/18G-10SS | Wainwright Instruments | 1 | 7.12.2011 | 12.2013 |
| 88 | Waveguide horn | 638 | Narda | 8003 | - | - |
| 371 | AC Power source | 500i-400 | California Instr. | HK 52064 | 23.5.2012 | 5.2013 |
| 350 | Semianechoic shielded room | RFD-F-100 | Euroshield Oy | 1327 | 26.10.2012 | 10.2014 |
| 348 | Shielded room | RFSD-100 | Euroshield Oy | 1320 | - | - |
| | | | | | | |

## 6. Photographs


Photograph 1: Test setup1.