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# Test report

## 259622-1TRFWL

Date of issue: April 16, 2015

Applicant:

Sonatest AP Inc.

Product:

64 Elements – 5MHz

Model:

WP2

FCC ID:

2ACH4SONWP2

IC Registration number:

12048A-SONWP2

Specification:

- FCC 47 CFR Part 15, Subpart C, Chapter 15.231
  Periodic operation in the band 40.66–40.70 MHz and above 70 MHz
- RSS-210, Issue 8 Annex 1.1
  Momentarily operated devices

Test location

| | |
|---|---|
| Company name: | Nemko Canada Inc. |
| Address: | 303 River Road |
| City: | Ottawa |
| Province: | Ontario |
| Postal code: | K1V 1H2 |
| Country: | Canada |
| Telephone: | +1 613 737 9680 |
| Facsimile: | +1 613 737 9691 |
| Toll free: | +1 800 563 6336 |
| FCC site ID: | 176392 |
| IC site ID: | 2040A |
| Website: | www.nemko.com |

| | |
|---|---|
| Tested by: | Kevin Rose, Wireless/EMC Specialist |
| Reviewed by: | Andrey Adelberg, Senior Wireless/EMC Specialist |
| Date: | April 16, 2015 |
| Signature: |  |

Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contain in this report are within Nemko Canada's ISO/IEC 17025 accreditation.

Copyright notification

# Table of Contents

# Section 1 Report summary

## 1.1 Applicant

| | |
|---|---|
| Company name: | Sonatest AP Inc. |
| Address: | 2900 Chemin des Quatre-Bourgeois, Suite 305 |
| City: | Quebec City |
| Province/State: | Quebec |
| Postal/Zip code: | G1V 1Y4 |
| Country: | Canada |

## 1.2 Manufacturer

| | |
|---|---|
| Company name | Sonatest ltd |
| Address | Dickens Road, Old Wolverton |
| City | Milton Keynes |
| Postal/Zip code | MK12 5QQ |
| Country | United Kingdom |

## 1.3 Test specifications

| | |
|---|---|
| FCC 47 CFR Part 15, Subpart C, Chapter 15.231 | Periodic operation in the band 40.66–40.70 MHz and above 70 MHz |
| RSS-210, Issue 8 Annex 1.1 | Momentarily Operated Devices |

## 1.4 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was completed against all relevant requirements of the test standard. Results obtained indicate that the product under test complies in full with the requirements tested. The test results relate only to the items tested.

*See "Summary of test results" for full details.*

## 1.5 Test report revision history

**Table 1.5-1: Test report revision history**

| Revision # | Details of changes made to test report |
|---|---|
| TRF | Original report issued |

# Section 2 Summary of test results

## 2.1 FCC Part 15 Subpart C – Intentional Radiators, test results

| Part | Test description | Verdict |
|---|---|---|
| §15.207(a) | Conducted limits | Not applicable |
| §15.231(a) | Conditions for intentional radiators to comply with periodic operation | Pass |
| §15.231(b) | Field strength of emissions | Pass |
| §15.231(c) | Emission bandwidth | Pass |
| §15.231(d) | Requirements for devices operating within 40.66–40.70 MHz band | Not applicable |
| §15.231(e) | Conditions for intentional radiators to comply with periodic operation | Pass |

Notes: Battery operated device

## 2.2 RSS-210, Issue 8 Annex 1.1, test results

| Part | Test description | Verdict |
|---|---|---|
| RSS-Gen 4.6.1 | Occupied BW | Pass |
| RSS-Gen 6.1 | Receiver spurious emissions limits (radiated) | Not applicable |
| RSS-Gen 6.2 | Receiver spurious emissions limits (antenna conducted) | Not applicable |
| RSS-Gen 7.2.4 | AC power lines conducted emission limits | Not applicable |
| RSS-210 A1.1.1 | Types of momentary signals | Pass |
| RSS-210 A1.1.2 | Field strength and frequency bands | Pass |
| RSS-210 A1.1.3 | Bandwidth for momentary signals | Pass |
| RSS-210 A1.1.4 | Frequency stability within 40.66–40.70 MHz band | Not applicable |

Notes: 1 According to Notice 2012-DRS0126 (from January 2012) section 2.2 of RSS-Gen, Issue 3 has been revised. The EUT does not have a stand-alone receiver neither scanner receiver, therefore exempt from receiver requirements.

# Section 3 Equipment under test (EUT) details

## 3.1 Sample information

| | |
|---|---|
| Receipt date | May 28, 2014 |
| Nemko sample ID number | 1, 2 |

## 3.2 EUT information

| | |
|---|---|
| Product name | 64 Elements-5MHz |
| Model | WP2 |
| Serial number | Prototype 1 |
| Software version | Veo 16:64 |
| 99% Bandwidth | 59.45 kHz |
| Modulation | OOK |
| Power requirements | 3 $V_{DC}$ (Button Battery) |
| Product description and theory of operation | The EUT (WP or WheelProbe 2) was connected to a Jig providing the required power (5 $V_{DC}$) to the WheelProbe 2 and allowing verifying the functionality of the Wireless Remote.<br>This Jig has a button allowing synchronizing the Jig to the Wireless Remote to be tested. It provides as well one LED for this sync button and three different LEDs that are linked to the pressing of the three Wireless Remote push-buttons. It also has a Lemo connector that allows connecting the JIG to a WheelProbe 2. In this configuration, the Jig provides power to the WheelProbe 2. Its sync button also allows syncing the WheelProbe 2 to any Wireless Remote. The WheelProbe 2 LEDs will then individually be controlled by the Wireless Remote. |

## 3.3 EUT technical specifications

| | |
|---|---|
| Operating frequency range | 433.92 MHz |
| Number of channels | Not applicable |
| Channel spacing | Not applicable |
| Antenna data | Integral |

## 3.4 Operation of the EUT during testing

The EUT (WheelProbe) was connected to a Veo 16:64 with two different cables. The Encoder-GPIO cable provided power (5 $V_{DC}$) to the WheelProbe as well as several digital signals for the Position Encoder, push-buttons input (coming from Wireless Remote) and LED outputs. The I-PEX cable was used to pulse up to 64 ultrasound phased-array elements at 5 MHz.

A Veo 16.64 was used as support equipment for monitoring and controlling the WheelProbe. Here are the details:
- Powers the WheelProbe;
- Pulses and listens the 64 WheelProbe phased-array ultrasound elements;
- Reads the WheelProbe Position Encoder;
- Reads the WheelProbe buttons' status (coming from the Wireless Remote);
- Controls the WheelProbe status LEDs.

Apart from the Encoder-GPIO cable and I-PEX cable going from the Veo to the EUT, three Veo USB ports are used to connect a USB memory key containing the software application and configuration file, a keyboard and a mouse.

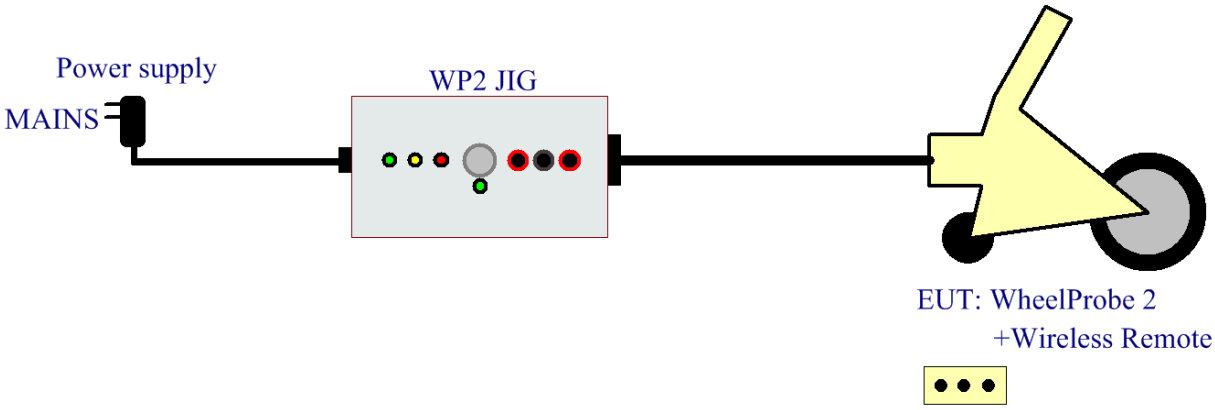
The Veo can either be powered by its external 15 V power supply connected to the MAINS or by its own internal batteries.

The Veo main application (Embedded G3) was used in play mode and monitored to see if the various tests have any impact on performance of the product. A configuration file for the 5MHz WheelProbe is available to configure easily and rapidly the Veo for WheelProbe application.

A JIG was also provided. Here are its features and how to operate it. The Jig has a button allowing synchronizing the Jig to the Wireless Remote to be tested. It provides as well one LED for this sync button and three LEDs that are linked to the pressing of the three Wireless Remote push-buttons. It also has a Lemo connector that allows connecting the JIG to a WheelProbe. In this configuration, the Jig sync button allows syncing the WheelProbe to a Wireless Remote. The WheelProbe LEDs will then individually be controlled by the Wireless Remote.

Two different Wireless Remotes were available. A normal Wireless Remote providing the usual features and a modified Wireless Remote which had one of its push-button shorted to simulate the continuous pressing of one of its push-buttons.

## 3.5 EUT setup details




Block Diagram (RF)

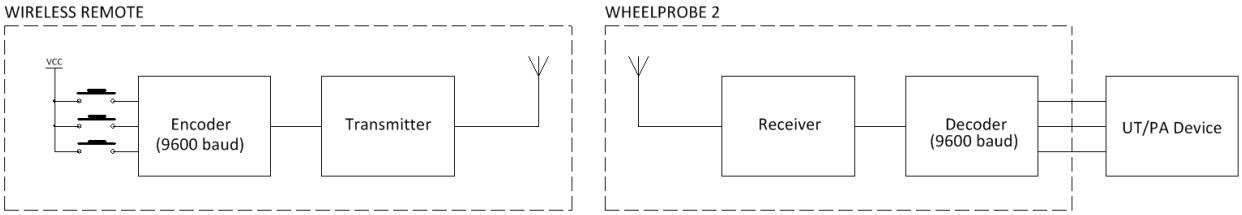



**Figure 3.5-1: Setup diagram**

# Section 4 Engineering considerations

## 4.1 Modifications incorporated in the EUT

There were no modifications performed to the EUT during this assessment.

## 4.2 Technical judgment

None

## 4.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

# Section 5 Test conditions

## 5.1 Atmospheric conditions

Temperature: 15–30 °C
Relative humidity: 20–75 %
Air pressure: 86–106 kPa

When it is impracticable to carry out tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests shall be recorded and stated.

## 5.2 Power supply range

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage, or any of the declared voltages ±5 %, for which the equipment was designed.

# Section 6 Measurement uncertainty

## 6.1 Uncertainty of measurement

Measurement uncertainty budgets for the tests are detailed below. Measurement uncertainty calculations assume a coverage factor of K = 2 with 95% certainty.

| Test name | Measurement uncertainty, dB |
|---|---|
| All antenna port measurements | 0.55 |
| Conducted spurious emissions | 1.13 |
| Radiated spurious emissions | 3.78 |
| AC power line conducted emissions | 3.55 |

# Section 7 Test equipment

## 7.1 Test equipment list

**Table 7.1-1: Equipment list**

| Equipment | Manufacturer | Model no. | Asset no. | Cal cycle | Next cal. |
|---|---|---|---|---|---|
| 3 m EMI test chamber | TDK | SAC-3 | FA002047 | 1 year | Mar. 18/15 |
| Flush mount turntable | Sunol | FM2022 | FA002082 | — | NCR |
| Controller | Sunol | SC104V | FA002060 | — | NCR |
| Antenna mast | Sunol | TLT2 | FA002061 | — | NCR |
| Receiver/spectrum analyzer | Rohde & Schwarz | ESU 26 | FA002043 | 1 year | Oct. 24/14 |
| Spectrum analyzer | Rohde & Schwarz | FSU | FA001877 | 1 year | Jan. 27/15 |
| Bilog antenna (20–3000 MHz) | Sunol | JB3 | FA002108 | 1 year | Mar. 12/15 |
| Horn antenna (1–18 GHz) | EMCO | 3115 | FA000825 | 1 year | Mar. 10/15 |
| Pre-amplifier (1–18 GHz) | JCA | JCA118-503 | FA002091 | 1 year | June 21/14 |
| 50 Ω coax cable | Huber + Suhner | NONE | FA002392 | 1 year | July. 17/14 |
| 50 Ω coax cable | C.C.A. | None | FA002555 | 1 year | Oct. 07/14 |

Notes: NCR - no calibration required

**Table 7.1-2: Test software details**

| Test description | Manufacturer of Software | Details |
|---|---|---|
| Radiated emissions | Rhode & Schwarz | EMC32, Software for EMC Measurements, Version 8.53.0 |

# Section 8 Testing data

## 8.1 Clause 15.231(e) RSS-210 A1.1 Conditions for intentional radiators to comply with periodic operation

### 8.1.1 Definitions and limits

**Clause 15.231(e)**
In addition, devices operated under the provisions of this paragraph shall be provided with a means for automatically limiting operation so that the duration of each transmission shall not be greater than one second and the silent period between transmissions shall be at least 30 times the duration of the transmission but in no case less than 10 seconds.

**RSS-210: A1.1.5 Reduced Field Strengths**
The following conditions shall be met to comply with the provisions for momentary operation:

1 Devices may be employed for any type of operation, including operation prohibited in Section A1.1.1, provided that the device complies with the requirements of sections A1.1.2 through A1.1.4 and that the field strength meets the limits in Table B of this annex.

2. In addition, devices operated under the provisions of this section (A1.1.5) shall be capable of automatically limiting their operation so that the duration of each transmission shall not be greater than 1 second and the silent period between transmissions shall be at least 30 times the duration of the transmission, but in no case less than 10 seconds. However, devices that are designed for limited use for the purpose of initial programming, reprogramming or installation, and not for regular operations, may operate up to 5 seconds provided that such devices are used only occasionally in connection with each unit being programmed or installed.

### 8.1.2 Test summary

| | | | |
|---|---|---|---|
| Test date: | June 2, 2014 | Temperature: | 23 °C |
| Test engineer: | Kevin Rose | Air pressure: | 1001 mbar |
| Verdict: | Pass | Relative humidity: | 37 % |

### 8.1.3 Observations/special notes

None

### 8.1.4 Test data

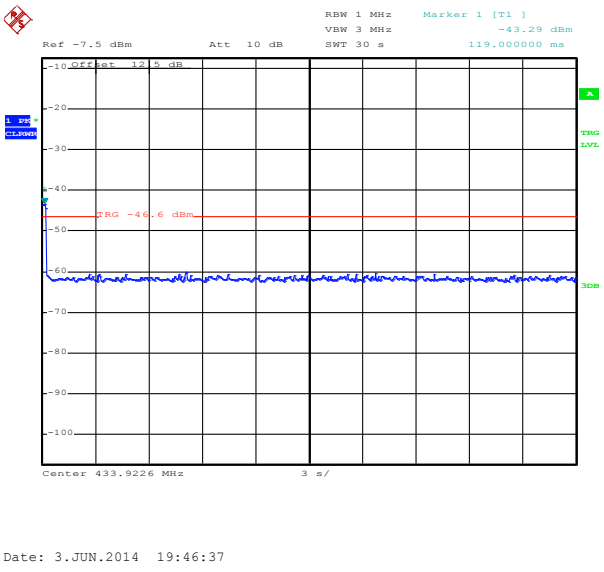



**Figure 8.1-1: 30 second off time**

**Table 8.1-1: Test summary 15.231(e)**

| FCC / IC | 1 / a |
|---|---|
| FCC | Comply Figure 8.1-2 |
| IC | Comply Figure 8.1-2 |

## 8.2 Clause 15.231(e) RSS-210 A1.1.2 Field strength of emissions

### 8.2.1 Definitions and limits

In addition to the provisions of §15.205 the field strength of emissions from intentional radiators operated under this section shall not exceed the following:

**Table 8.2-1: Field strength limits**

| Fundamental Frequency (MHz), excluding restricted band frequencies of RSS-Gen | Field Strength of the Fundamental (microvolts/m at 3 m) (Note 1) | Field Strength of Unwanted Emissions (microvolts/m at 3 m) |
|---|---|---|
| 260–470 | 1,500 to 5,000 | 150 to 500 |

Note 1: Limits on the field strength of emissions, as shown in this table, are based on the average value of the measured emissions. As an alternative, compliance with the limits in this table may bebased on the use of measurement instrumentation with a CISPR quasi-peak detector.* Linear interpolation with frequency
260–470 MHz: FS (microvolts/m) = (16.67 × F) − 2833.33

1) The above field strength limits are specified at a distance of 3 meters. The tighter limits apply at the band edges.
2) Intentional radiators operating under the provisions of this section shall demonstrate compliance with the limits on the field strength of emissions, as shown in the above table, based on the average value of the measured emissions. As an alternative, compliance with the limits in the above table may be based on the use of measurement instrumentation with a CISPR quasi-peak detector. The specific method of measurement employed shall be specified in the application for equipment authorization. If average emission measurements are employed, the provisions in §15.35 for averaging pulsed emissions and for limiting peak emissions apply. Further, compliance with the provisions of §15.205 shall be demonstrated using the measurement instrumentation specified in that section.
3) The limits on the field strength of the spurious emissions in the above table are based on the fundamental frequency of the intentional radiator. Spurious emissions shall be attenuated to the average (or, alternatively, CISPR quasi-peak) limits shown in this table or to the general limits shown in §15.209, whichever limit permits a higher field strength.

### 8.2.2 Test summary

| | | | |
|---|---|---|---|
| Test date: | June 2, 2014 | Temperature: | 23 °C |
| Test engineer: | Kevin Rose | Air pressure: | 1001 mbar |
| Verdict: | Pass | Relative humidity: | 37 % |

### 8.2.3 Observations/special notes

**Table 8.2-2: §15.209 and RSS 210 A1.1 – Radiated emission limits**

| Frequency (MHz) | Field strength (µV/m) | Measurement distance (dBµV/m) | (m) |
|---|---|---|---|
| 0.009–0.490 | 2400/F | 67.6−20log(F) | 300 |
| 0.490–1.705 | 24000/F | 87.6−20log(F) | 30 |
| 1.705–30.0 | 30 | 29.5 | 30 |
| 30–88 | 100 | 40.0 | 3 |
| 88–216 | 150 | 43.5 | 3 |
| 216–960 | 200 | 46.0 | 3 |
| above 960 | 500 | 54.0 | 3 |

– F = fundamental frequency in kHz
– In the emission table above, the tighter limit applies at the band edges.
– For frequencies above 1 GHz the limit on peak RF emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test.

8.2.3 Observations/special notes, continued

**Table 8.2-3: §15.205 – Restricted bands of operation**

| MHz | MHz | MHz | GHz |
|---|---|---|---|
| 0.090–0.110 | 16.42–16.423 | 399.9–410 | 4.5–5.15 |
| 0.495–0.505 | 16.69475–16.69525 | 608–614 | 5.35–5.46 |
| 2.1735–2.1905 | 16.80425–16.80475 | 960–1240 | 7.25–7.75 |
| 4.125–4.128 | 25.5–25.67 | 1300–1427 | 8.025–8.5 |
| 4.17725–4.17775 | 37.5–38.25 | 1435–1626.5 | 9.0–9.2 |
| 4.20725–4.20775 | 73–74.6 | 1645.5–1646.5 | 9.3–9.5 |
| 6.215–6.218 | 74.8–75.2 | 1660–1710 | 10.6–12.7 |
| 6.26775–6.26825 | 108–121.94 | 1718.8–1722.2 | 13.25–13.4 |
| 6.31175–6.31225 | 123–138 | 2200–2300 | 14.47–14.5 |
| 8.291–8.294 | 149.9–150.05 | 2310–2390 | 15.35–16.2 |
| 8.362–8.366 | 156.52475–156.52525 | 2483.5–2500 | 17.7–21.4 |
| 8.37625–8.38675 | 156.7–156.9 | 2690–2900 | 22.01–23.12 |
| 8.41425–8.41475 | 162.0125–167.17 | 3260–3267 | 23.6–24.0 |
| 12.29–12.293 | 167.72–173.2 | 3332–3339 | 31.2–31.8 |
| 12.51975–12.52025 | 240–285 | 3345.8–3358 | 36.43–36.5 |
| 12.57675–12.57725 | 322–335.4 | 3600–4400 | Above 38.6 |
| 13.36–13.41 | | | |

**Table 8.2-4: RSS-Gen– Restricted bands of operation**

| MHz | MHz | MHz | GHz |
|---|---|---|---|
| 0.090–0.110 | 12.51975–12.52025 | 399.9–410 | 5.35–5.46 |
| 2.1735–2.1905 | 12.57675–12.57725 | 608–614 | 7.25–7.75 |
| 3.020–3.026 | 13.36–13.41 | 960–1427 | 8.025–8.5 |
| 4.125–4.128 | 16.42–16.423 | 1435–1626.5 | 9.0–9.2 |
| 4.17725–4.17775 | 16.69475–16.69525 | 1645.5–1646.5 | 9.3–9.5 |
| 4.20725–4.20775 | 16.80425–16.80475 | 1660–1710 | 10.6–12.7 |
| 5.677-5.683 | 25.5–25.67 | 1718.8–1722.2 | 13.25–13.4 |
| 6.215–6.218 | 37.5–38.25 | 2200–2300 | 14.47–14.5 |
| 6.26775–6.26825 | 73–74.6 | 2310–2390 | 15.35–16.2 |
| 6.31175–6.31225 | 74.8–75.2 | 2655–2900 | 17.7–21.4 |
| 8.291–8.294 | 108–138 | 3260–3267 | 22.01–23.12 |
| 8.362–8.366 | 156.52475–156.52525 | 3332–3339 | 23.6–24.0 |
| 8.37625–8.38675 | 156.7–156.9 | 3345.8–3358 | 31.2–31.8 |
| 8.41425–8.41475 | 240–285 | 3500–4400 | 36.43–36.5 |
| 12.29–12.293 | 322–335.4 | 4500–5150 | Above 38.6 |

- The spectrum was searched from 30 MHz to the 10$^{th}$ harmonic at a distance of 3 m.
- The EUT was measured on three orthogonal axis.
- All measurements within 30–1000 MHz range: using a peak detector with 100 kHz/300 kHz RBW/VBW,
- above 1 GHz: using peak detector with 1 MHz/3 MHz RBW/VBW for peak results
- and using a duty cycle/average factor for average results calculations.
- Transmit output power was measured while supply voltage was varied from 2.5 VDC to 3 VDC. No change in transmit output power was observed.

8.2.4 Test data

**Table 8.2-5: Field strength measurement results**

| Frequency (MHz) | Polarization V/H | Peak Field strength (dBµV/m) | Limit (dBµV/m) | Margin (dB) |
|---|---|---|---|---|
| 433.92 | H | 61.3 | 72.8 | 11.5 |
| 2169.57 | H | 46.4 | 52.8 | 6.4 |
| 2590.30 | V | 31 | 52.8 | 21.8 |

Note: Field strength includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.

## 8.3 Clause 15.231(c) RSS-Gen 4.6.1 Emission bandwidth

### 8.3.1 Definitions and limits

FCC:
The bandwidth of the emission shall be no wider than 0.25 % of the center frequency for devices operating above 70 MHz and below 900 MHz. For devices operating above 900 MHz, the emission shall be no wider than 0.5 % of the center frequency. Bandwidth is determined at the points 20 dB down from the modulated carrier.

IC:
For the purpose of Section A1.1, the 99 % bandwidth shall be no wider than 0.25 % of the centre frequency for devices operating between 70 MHz and 900 MHz. For devices operating above 900 MHz, the emission shall be no wider than 0.5 % of the centre frequency.

### 8.3.2 Test summary

| | | | |
|---|---|---|---|
| Test date: | June 2, 2014 | Temperature: | 23 °C |
| Test engineer: | Kevin Rose | Air pressure: | 1001 mbar |
| Verdict: | Pass | Relative humidity: | 37 % |

### 8.3.3 Observations/special notes

The test was performed using peak detector of the spectrum analyzer with RBW no narrower than 1 % of the emission bandwidth.

### 8.3.4 Test data

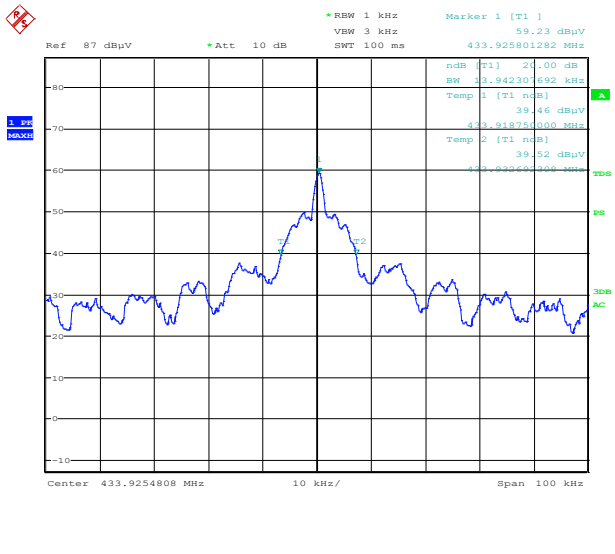



**Figure 8.3-1:** 20 dB bandwidth

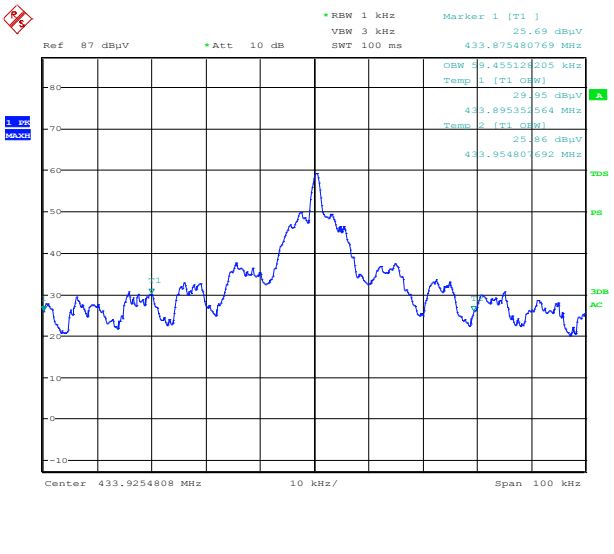


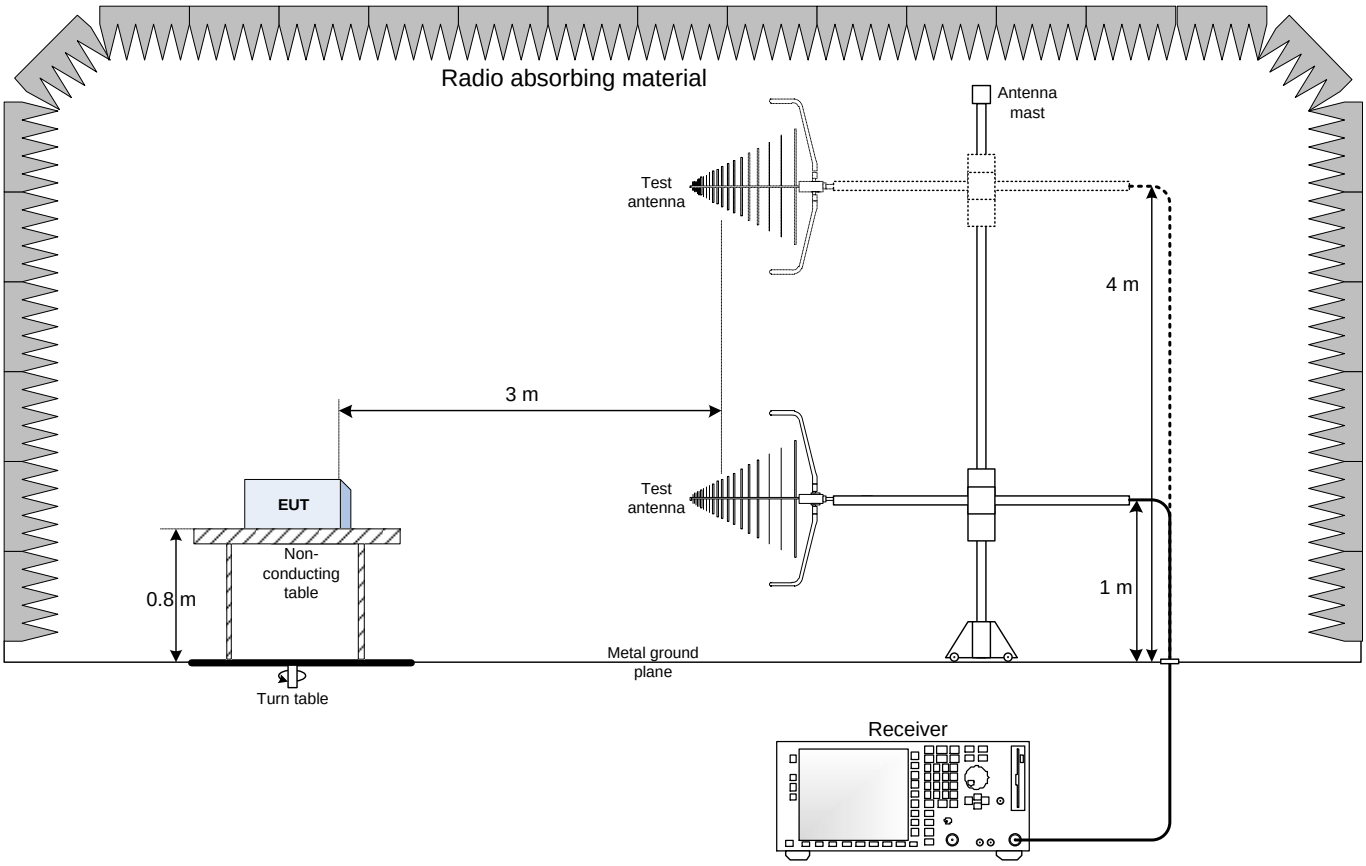

**Figure 8.3-2:** 99% bandwidth (59.45 kHz)

**Table 8.3-1: 20 dB bandwidth**

| 20 dB bandwidth (kHz) | Limit (MHz) | Margin (kHz) |
|---|---|---|
| 13.94 | 1.0848 | 1070.86 |

# Section 9 Block diagrams of test set-ups

## 9.1 Radiated emissions set-up



# Section 10 EUT photos

## 10.1 External photos

### 10.1.1 EUT front view

**Figure 10.1-1:** Top view

**Figure 10.1-2:** Bottom view