# T E S T  R E P O R T
# No.: 6-0698-15-2-3a-C2

According to:
**FCC Regulations**
Part 15.209
Part 15.247

**IC-Regulations**
RSS-Gen, Issue 4
RSS-247, Issue 1

for
Vorwerk Elektrowerke GmbH & Co. KG

WLAN-Interface for kitchen cooking Appliance CK-WLAN Cook-Key

FCC-ID: 2AGELCK1
IC: 20889-CK1

| Laboratory Accreditation and Listings | | | |
|---|---|---|---|
| DAkkS Deutsche Akkreditierungsstelle D-PL-12047-01-01 | MRA US-EU 0003 | Industry Canada<br>Reg. No.: 3462D-2<br>Reg. No.: 3462D-3 | Voluntary Controls for Electromagnetic Emissions<br>Reg. No.: R-2666 C-2914, T-1967, G-301 |
| Wi Fi ALLIANCE AUTHORIZED RF LABORATORY | ctia Authorized™ Test Lab Lab Code: 20011130-00 | | |
| accredited according to DIN EN ISO/IEC 17025 | | | |

**CETECOM GmbH**
Laboratory Radio Communications & Electromagnetic Compatibility
Im Teelbruch 116 • 45219 Essen • Germany
Registered in Essen, Germany, Reg. No.: HRB Essen 8984
Tel.: + 49 (0) 20 54 / 95 19-954 • Fax: + 49 (0) 20 54 / 95 19-964
E-mail: info@cetecom.com • Internet: www.cetecom.com

# Table of contents

**1. SUMMARY OF TEST RESULTS ..... 3**

1.1. Tests measurement overview according of US CFR Title 47, Subpart 15C and Canada RSS-Standards: ..... 3

**2. ADMINISTRATIVE DATA ..... 5**

2.1. Identification of the testing laboratory ..... 5
2.2. Test location ..... 5
2.3. Organizational items ..... 5
2.4. Applicant's details ..... 5
2.5. Manufacturer's details ..... 5

**3. EQUIPMENT UNDER TEST (EUT) ..... 6**

3.1. TECHNICAL DATA OF MAIN EUT DECLARED BY APPLICANT ..... 6
3.2. IEEE 802.11 OVERVIEW: MODULATION AND DATA RATES ..... 7
3.3. EUT: Type, S/N etc. and short descriptions used in this test report ..... 7
3.4. Auxiliary Equipment (AE): Type, S/N etc. and short descriptions ..... 8
3.5. EUT set-ups ..... 8
3.6. EUT operating modes ..... 9
3.7. Configuration of cables used for testing ..... 9

**4. DESCRIPTION OF TEST SYSTEM SET-UP'S ..... 10**

4.1. Test system set-up for conducted measurements on antenna port ..... 10
4.2. Test system set-up for radiated magnetic field measurements below 30 MHz ..... 11
4.3. Test system set-up for radiated electric field measurement 30 MHz to 1 GHz ..... 12
4.4. Test system set-up for radiated electric field measurement above 1 GHz ..... 13

**5. MEASUREMENTS ..... 14**

5.1. Maximum peak conducted output power ..... 14
5.2. General Limit - Radiated field strength emissions below 30 MHz ..... 17
5.3. General Limit - Radiated field strength emissions, 30 MHz - 1 GHz ..... 19
5.4. General Limit - Radiated emissions, above 1 GHz ..... 21
5.5. RF-Parameter - Radiated Band Edge compliance measurements ..... 23
5.6. Measurement uncertainties ..... 25

**6. ABBREVIATIONS USED IN THIS REPORT ..... 26**

**7. ACCREDITATION DETAILS OF CETECOM'S LABORATORIES AND TEST SITES ..... 26**

**8. INSTRUMENTS AND ANCILLARY ..... 27**

8.1. Used equiment "CTC" ..... 27

**9. VERSIONS OF TEST REPORT (CHANGE HISTORY) ..... 31**

# Table of annex

| | **Total pages** |
|---|---|
| Separate document Annex 1: Measurement diagrams | 36 |
| Separate document Annex 2: External photographs of EUT | 5 |
| Separate document Annex 3: Internal photographs of EUT | 4 |
| Separate document Annex 4: Test set-up photographs | 6 |

The listed attachments are an integral part of this report.

# 1. Summary of test results

The test results apply exclusively to the test samples as presented in this Report. The CETECOM GmbH does not assume responsibility for any conclusions and generalizations taken in conjunction with other specimens or samples of the type of the item presented to tests.

**The test results apply exclusively to the test samples as presented in this Report. The CETECOM GmbH does not assume responsibility for any conclusions and generalizations taken in conjunction with other specimens or samples of the type of the item presented to tests. Also we refer on special conditions which the applicant should fulfill according §2.927 to §2.948, special focus regarding modification of the equipment and availability of sample equipment for market surveillance tests.**

The presented Equipment Under Test (in this report, hereinafter referred as EUT) supports radiofrequency technologies with WLAN technology and operating frequency range at 2.412 to 2.462 GHz according to IEE 802.11 b/g/n. Other implemented wireless technologies were not considered within this test report.

Following test cases have been performed to show compliance with valid Part 15.207/15.209/15.247 of the FCC CFR Title 47 Rules, Edition November 2015 and IC RSS-247 Issue 1/RSS-Gen Issue 4 standards.

## 1.1. Tests measurement overview according of US CFR Title 47, Subpart 15C and Canada RSS-Standards:

| Test cases | Port | References & Limits | | | EUT set-up | EUT operating mode | Result |
|---|---|---|---|---|---|---|---|
| | | FCC Standard | RSS Section | Test Limit | | | |
| TX-Mode | | | | | | | |
| Timing of transmitter (pulsed operation) | Antenna Terminal or enclosure | §15.35 | RSS-Gen, Issue 4 | -- | 1+2 | 1+2+3+4 | 100% |
| 6 dB bandwidth | Antenna terminal (conducted) | §15.247(a)(2) | RSS-247, Chapter 5.2(1)<br>RSS-Gen Issue 4: Chapter 4.6.2 | ≥ 500 kHz for DTS systems | -- | -- | See separate test report<br>Remark 1 |
| 99% occupied bandwidth | Antenna terminal (conducted) | 2.1049(h) | RSS-Gen Issue 4: Chapter 6.6 | 99% Power bandwidth | -- | -- | |
| Transmitter Peak output power | Antenna terminal (conducted) | §15.247(b)(3) | RSS-247, Chapter 5.4(4) | 1 Watt Peak conducted (4 Watt EIRP) | 2 | 1+2+3+4 | Pass |
| Transmitter Peak output power radiated | Enclosure + Inter-connecting cables (radiated) | §15.247(b)(4) | RSS-247, Chapter 5.4(4) | < 4 Watt (EIRP) for antenna with directional gain less 6dBi | -- | -- | See separate test report<br>Remark 1 |
| Out-Of-Band RF- emissions<br>Band-Edge emissions | Antenna terminal (conducted) | §15.247 (d) | RSS-247, Chapter 5.5 | 20 dBc | -- | -- | |
| Power spectral density | Antenna terminal (conducted) | §15.247(e) | RSS-247, Chapter 5.2(2) | 8dBm in any 3 kHz band | -- | -- | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| General field strength emissions + restricted bands | Enclosure + Inter-connecting cables (radiated) | §15.247 (d) §15.205 §15.209 | RSS-247 Issue 1, Chapter 5.5<br><br>RSS-Gen: Issue 4: §8.9 Table 4+5+6 | Emissions in restricted bands must meet the general field-strength radiated limits | 1 | 1+2+3+4 | passed |
| AC-Power Lines<br><br>Conducted Emissions | AC-Power lines | §15.207 | RSS-Gen, Issue 4: Chapter 8.8, Table 3 | FCC §15.107 class B limits §15.207 limits<br><br>IC: Table 3, Chapter 8.8 | -- | -- | See separate test report<br><br>Remark 2.) |
| RX Mode | | | | | | | |
| RECEIVER<br><br>Radiated emissions | Enclosure + Inter-connecting cables (radiated) | §15.109 §15.33 §15.35 | RSS-Gen, Issue 4: Chapter 7.1.2 | FCC 15.109 class B limits<br><br>IC-limits: Table 2 | -- | -- | See separate test report<br><br>Remark 2.) |

| **RF-Exposure Evaluation (separation distance user to RF-radiating element greater 20cm)** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Test cases** | **Port** | **References & Limits** | | | **EUT set-up** | **EUT opera-ting mode** | **Result** |
| | | **FCC Standard** | **RSS Section** | **Test Limit** | | | |
| Radio frequency radiation exposure requirements | Cabinet + Inter-connecting cables (radiated) | §1.1310(d)(2) §2.1091 §2.1093 | RSS-102 Issue 5 | **SAR-Limits FCC:** 1.1310(b) "general population/ uncontrolled" environment Table 1 | 1+2 | 1+2+3+4 | Pass (Remark3) |
| | | | | **RF-Field Strength Limits: IC:** Table 4 | 1+2 | 1+2+3+4 | |

Remarks:
1.) see separate test report G0M-1411-4339-TFC247WF-V01
2.) see separate test reports G0M-1411-4339-EF0115B-V01 and TR6-0698-15-2-3b-C2 for Part15B G0M-1411-4339-TFC247WF-V01 and TR6-0698-15-2-3b-C2 for Part15C
3) for user to EUT separations more then 20cm, calculations with conducted power value and antenna gain

**Attestation:**

I declare that all measurements were performed by me or under my supervision and that all measurements have been performed and are correct to my best knowledge and belief to Industry Canada standards. All requirements as shown in above table are met in accordance with enumerated standards.

Report number 6-0698-15-2-3a-C2, dated 2017-01-18 substitutes report number 6-0698-15-2-3a-C1 dated 2016-10-28. The substituted test report gets invalid therefore.

Digitally signed by christian.lorenz@cetecom.com
DN: cn=christian.lorenz@cetecom.com
Date: 2017.01.18 15:06:36 +01'00'

.....
Dipl.-Ing. Rachid Acharkaoui
Responsible for test section

.....
Dipl.-Ing. C. Lorenz
Responsible for test report

# 2. Administrative Data

## 2.1. Identification of the testing laboratory

| | |
|---|---|
| Company name: | CETECOM GmbH |
| Address: | Im Teelbruch 116<br>45219 Essen - Kettwig<br>Germany |
| Responsible for testing laboratory: | Dipl.-Ing. Rachid Acharkaoui |
| Deputy: | Dipl.-Ing. Niels Jeß |

## 2.2. Test location

### 2.2.1. Test laboratory "CTC"

| | |
|---|---|
| Company name: | see chapter 2.1. Identification of the testing laboratory |

## 2.3. Organizational items

| | |
|---|---|
| Responsible for test report and project leader: | Dipl.-Ing. C. Lorenz |
| Receipt of EUT: | 2015-05-20 |
| Date(s) of test: | 2015-07-29, 2015-10-28 |
| Date of report: | 2016-12-01 |
| Version of template: 13.02 | |

## 2.4. Applicant's details

| | |
|---|---|
| Applicant's name: | Vorwerk Elektrowerke GmbH & Co. KG |
| Address: | Mühlenweg 17-37<br>42270 Wuppertal<br>Germany |
| Contact person: | Mr. Christian Lichau |

## 2.5. Manufacturer's details

| | |
|---|---|
| Manufacturer's name: | Rosenberger Magyarország Kft |
| Address: | 5123 Jászárokszállás<br>Rosenberger Katalin út 1<br>Hungary |

# 3. Equipment under test (EUT)

## 3.1. TECHNICAL DATA OF MAIN EUT DECLARED BY APPLICANT

| | | | |
|---|---|---|---|
| Main function | IEEE 802.11b/g/n WLAN-Interface for kitchen cooking Appliance | | |
| Type | Cook-Key | | |
| Frequency range<br>(US/Canada -bands) | 2412 MHz (Channel 1) to 2462 MHz (Channel 11)<br>2422 MHz (channel 15) to 2452 MHZ ( channel 711) | | |
| Type of modulation | See chapter 3.2 | | |
| Number of channels<br>(USA/Canada -bands) | 1 to 11 (20MHz Mode)<br>15 – low 2422MHz (40MHz Mode)<br>48 – middle 2437MHz (40MHz Mode)<br>711 – high 2452MHz (40MHz Mode) | | |
| Antenna Type | ☒ Integrated<br>☐ External, no RF- connector<br>☐ External, separate RF-connector | | |
| Antenna Gain | Max. 2.4 dBi gain according applicants information in 2.4 GHz band | | |
| EUT nominal Power levels | b-Mode: 18 dBm<br>g-Mode: 16 dBm<br>n-Mode: 15 dBm | | |
| MAX Field strength (radiated): | Peak Detector: 101.706 dBµV/m | Average Detector: 99.320 dBµV/m | |
| | @3m distance on nominal 2412 MHz | | |
| FCC-ID | 2AGELCK1 | | |
| IC | 20889-CK1 | | |
| Installed options | -- | | |
| Power supply | ☒ DC power only: 5V DC | | |
| Special EMI components | -- | | |
| EUT sample type | ☐ Production | ☒ Pre-Production | ☐ Engineering |
| FCC label attached | ☒ yes | ☐ no | |

## 3.2. IEEE 802.11 OVERVIEW: MODULATION AND DATA RATES

The modulations and data rates defined for 802.11 b/g/n transmitters are identified in the table below. Also it shows which operational mode is possible for the device under test (EUT) according applicant's information.

| 802.11**b**-Mode (DSSS System) | | |
|---|---|---|
| Data rate [MBps] | Modulation type | Supported by EUT |
| 1 | DBPSK (Differential binary phase shift keying) | YES |
| 2 | DQPSK (Differential quadrature phase shift keying) | YES |
| 5.5 / 11 | CCK/PBCC (8-chip complementary code keying) | YES |
| 22 | ERP-PBCC (Packet binary convolutional coding) | YES |

| 802.11**g**-Mode (OFDM system) | | |
|---|---|---|
| Brutto data rate [MBps] | Modulation type of subcarriers | Supported by EUT |
| 6 / 9 | BPSK | YES |
| 12 /18 | QPSK | YES |
| 24 / 36 | 16-QAM | YES |
| 48 / 54 | 64-QAM | YES |

Remark: 52 sub-carriers which can be modulated at different data-rates.

| 802.11**n**-Mode (OFDM) | | |
|---|---|---|
| Brutto data rate [MBps] | Modulation type | Supported by EUT |
| 7.2/14.4/21.7/28.9/43.3/57.8/65/72.2 Mbps | HT20 (MCS0..MCS7) | Yes |
| 14.444/28.889/43.333/57.778/86.667/ 115.556/130/144.444 Mbps | HT20 (MCS8..MCS15) | No |
| 15/30/45/60/90/120/135/150 Mbps | HT40 (MCS0..MCS7) | Yes |
| 30/60/90/120/180/240/270/300 Mbps | HT40 (MCS8..MCS15) | No |

## 3.3. EUT: Type, S/N etc. and short descriptions used in this test report

| Short descrip-tion*) | EUT | Type | S/N serial number | HW hardware status | SW software status |
|---|---|---|---|---|---|
| EUT A | Cook-Key | WLAN-Interface for kitchen cooking Appliance CK-WLAN | MAC: 00:13:43:0f:30: C3 | Rev. 800 | V0.992 |
| EUT B | Cook-Key | WLAN-Interface for kitchen cooking Appliance CK-WLAN | MAC: 00:13:43:0d:c0: e5 | Rev. 800 | V0.992 |

*) EUT short description is used to simplify the identification of the EUT in this test report.

## 3.4. Auxiliary Equipment (AE): Type, S/N etc. and short descriptions

| AE short descrip-tion *) | Auxiliary Equipment | Type | S/N serial number | HW hardware status | SW software status |
|---|---|---|---|---|---|
| AE 1 | USB cable (adapter) | - | -- | 1.2 m length | -- |
| AE 2 | Notebook | Dell Latitude E5440 | DJDNN32 | -- | Linux |
| AE 3 | Notebook | Dell | CTC RSE#1 | -- | Windows 7 + Putty program |
| AE 4 | Ethernet cable | CAT5e | -- | 1m length | -- |

*) AE short description is used to simplify the identification of the auxiliary equipment in this test report.

## 3.5. EUT set-ups

| EUT set-up no.*) | Combination of EUT and AE | Remarks |
|---|---|---|
| set. 1 | EUT A + AE 1 + AE 2 + (AE3 + AE 4) | AE3 + AE 4 used temporary for Transmission mode set-up. We refer to applicants documents for details. |
| set. 2 | EUT B + + AE 1 + AE 2 + AE3 + AE 4 | Conducted set-up for RF-power measurements |

*) EUT set-up no. is used to simplify the identification of the EUT set-up in this test report.

## 3.6. EUT operating modes

| EUT operating mode no.*) | Description of operating modes | Additional information |
|---|---|---|
| op. 1 | WLAN Continuous TX-Mode b-Mode | The EUT was put to continuous transmissions mode (near 100 duty-cycle) with help of a special firmware software. **Test settings radiated:** 17 0; 112 0; 12 1; 22 1 18 0; 17 1 1 |
| | | **Test Settings RF-conducted:** 17 0; 112 0; 12 1; 22 1 18 0; 17 1 1 (last number in range 1 to 4 in order to have desired data rates in b-Mode). Also mid/high channels used:1/6/11 |
| op. 2 | WLAN Continuous TX-Mode g-Mode | The EUT was put to continuous transmissions mode (near 100 duty-cycle) with help of a special firmware software. **Test settings radiated:** 17 0; 112 0; 12 6; 22 6 16 1; 17 1 6 |
| | | **Test Settings RF-conducted:** last number in range 6 to 13 in order to have desired data rates in g-Mode). Also low/high channels used: 1/6/11 |
| op. 3 | WLAN Continuous TX-Mode n-Mode, HT20-mode | The EUT was put to continuous transmissions mode (near 100 duty-cycle) with help of a special firmware software. **Test settings radiated:** 17 0; 112 0; 12 11; 22 11 15 1; 17 1 15 |
| | | **Test Settings RF-conducted:** last number in range 15 to 22 in order to have desired data rates in n-Mode). Also low/mid channels used: 1/6/11 |
| op. 4 | WLAN Continuous TX-Mode n-Mode, HT40-mode | The EUT was put to continuous transmissions mode (near 100 duty-cycle) with help of a special firmware software. **Test settings radiated:** 17 0; 112 1; 12 711; 22 711 13 1; 17 1 15 |
| | | **Test Settings RF-conducted:** last number in range 15 to 22 in order to have desired data rates in n-Mode). Also low/mid channels used. Also low/mid/high channels used: 15/48/711 (2422/2437/2452MHz) |

*) EUT operating mode no. is used to simplify the test report.

## 3.7. Configuration of cables used for testing

| Cable number | Item | Type | S/N serial number | HW hardware status | Cable length |
|---|---|---|---|---|---|
| Cable 1 | Ethernet | CAT5e | -- | -- | 1m |
| Cable 2 | USB Adapter | -- | #1 | -- | 1.2m |

# 4. Description of test system set-up's

## 4.1. Test system set-up for conducted measurements on antenna port

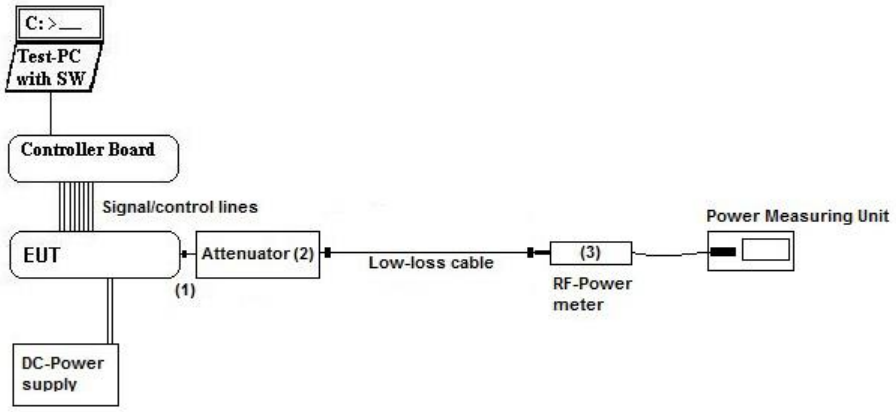
**Conducted Set-up W1**

**W-LAN/Zigbee conducted RF-Setup 1 (W1 Set-up)**

**General description:**

The EUT's RF-signal is coupled out by a suitable antenna coupling connector (1). The signal is first attenuated (2) then connected to the power meter (3) for conducted power measurements. The specific attenuation loss is determined prior to the measurement within a set-up attenuation measurement. These are then taken into account by correcting the measurement readings.

**Schematic:**




**Testing method:** ANSI C63.10:2013, KDB 558074 D01 DTS Meas.Guidance v03r05

**Used Equipment**

| Passive Elements | Test Equipment | Remark: |
|---|---|---|
| ☒ 20 dB Attenuator | ☒ Power Meter | See List of equipment under each test case and chapter 8 for calibration info |
| ☒ Low loss RF-cables | ☐ DC-Power Supply | |
| ☐ | ☐ Spectrum-Analyser | |

**Measurement uncertainty** See chapter 5.6

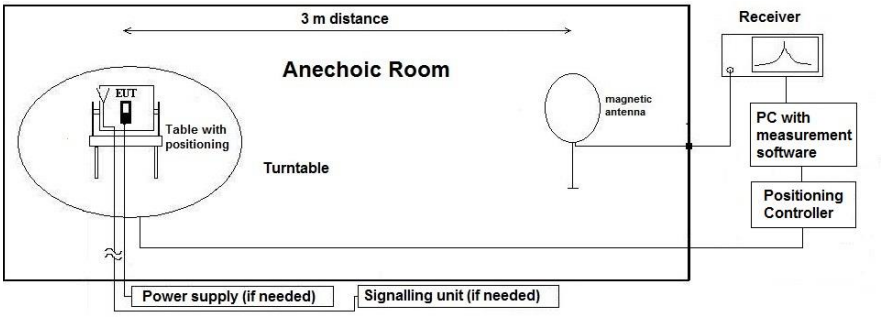
## 4.2. Test system set-up for radiated magnetic field measurements below 30 MHz

**Specification:** ANSI C63.10-2013 chapter 6.4 (§6.4.4.2)

**General Description:** Evaluating the radiated field emissions are done first by an exploratory emission measurement and a final measurement for most critical frequencies determined.

The loop antenna was placed at 1 m height above ground plane and 3 m measurement distance from set-up for investigations. Because of reduced measurement distance, correction data were applied, as stated in chapter "General Limit - Radiated field strength emissions below 30 MHz". The tests are performed in the semi anechoic room recognized by the regulatory commission.

**Schematic:**




**Testing method:**

**Exploratory, preliminary measurement**
The EUT and it's associated accessories are placed on a non-conductive position manipulator (tipping device) of 0.8 m height which is placed on the turntable. By rotating the turntable (step 90°, range 0°to 360°) and the EUT itself either on 3-orthogonal axis (portable equipment) or 2-orthogonal axis (defined operational position of EUT), the emission spectrum was recorded. The loop antenna was moved at least to 2-perpendicular axes (antenna vector in direction of EUT and parallel to EUT) in order to maximize the emissions. The results are documented in a diagram. Critical frequencies (low margin to limit) are saved within a data reduction table for further investigations. If various operating modes are supported, further investigations are made to find the worst-case. Also the interconnection cables and equipment position were varied in order to maximize the emissions.

**Final measurement on critical frequencies**
Based on the exploratory measurements, the most critical frequencies are re-measured by maintaining the EUT's worst-case operation mode, cable position, etc.

First a frequency zoom around the critical frequency is done to locate the frequency more precisely. After this step, for all identified critical frequencies, the maximum peak was determined.

Following parameters were varied: the turntable angle continuously in the range 0 to 360 degree, the EUT itself either over 3-orthogonal axis (not defined usage position) or 2-orthogonal axis (defined usage position).

On the determined worst-case position, a final measurement with necessary bandwidth and detector according standard has been carried out.

**Formula:**

$E_C = E_R + AF + C_L + D_F - G_A$

$M = L_T - E_C$

AF =Antenna factor
$C_L$ = Cable loss
$D_F$= Distance correction factor
$E_C$ = Electrical field – corrected value
$E_R$ = Receiver reading
$G_A$= Gain of pre-amplifier (if used)
$L_T$ = Limit
M = Margin

All units are dB-units, positive margin means value is below limit.

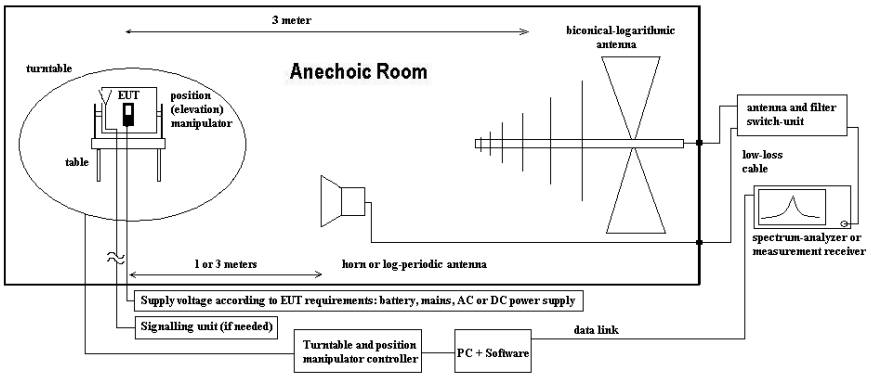
**Distance correction:** Reference for applied correction (extrapolating) factors due to reduced measurement distance: ANSI C63.10:2013, §6.4.4.2 - Equations (2) + (3) + (4)

## 4.3. Test system set-up for radiated electric field measurement 30 MHz to 1 GHz

**Specification:** ANSI C63.4-2014 chapter 8.2.3, ANSI C63.10-2013 chapter 6.5

**General Description:** Evaluating the field emissions have to be done first by an exploratory emissions measurement and a final measurement for most critical frequencies. The tests are performed in a NSA-compliant semi anechoic room (SAR) recognized by the regulatory commissions.

**Schematic:**




**Testing method:**

**Exploratory, preliminary measurements**
The EUT and its associated accessories are placed on a non-conductive position manipulator (tipping device) of 0.8 m height which is placed on the turntable. By rotating the turntable (range 0° to 360°, step 90°) and the EUT itself either on 3-orthogonal axis (portable equipment) or 2-orthogonal axis (defined operational position of EUT) the emission spectrum and it's characteristics was recorded with an EMI-receiver, broadband antenna and software.

Measurement antenna: horizontal and vertical, heights: 1,0 m and 1,82 m as worst-case determined by an exploratory emission measurements. The results are documented in a diagram. Critical frequencies (low margin to limit) are saved within a table for further investigations. If various operating modes are supported, further investigations are made to find the worst-case of them. Also the interconnection cables and equipment position were varied in order to maximize the emissions.

**Final measurement on critical frequencies**
Based on the exploratory measurements, the most critical frequencies are re-measured by maintaining the EUT's worst-case operation mode, cable position, etc. either on 10m OATS or 3m semi-anechoic room.

First a frequency zoom around the critical frequency is done to locate the frequency more precisely. After this step, for all identified critical frequencies, the maximum peak was determined.

Following parameters were varied: the turntable angle continuously in the range 0 to 360 degree, the EUT itself either over 3-orthogonal axis (not defined usage position) or 2-orthogonal axis (defined usage position). The measurement antenna height between 1 m and 4 m.

On the determined worst-case position, a final measurement with necessary bandwidth and detector according standard has been carried out.

**Formula:**

$E_C = E_R + AF + C_L + D_F - G_A$ (1)

$M = L_T - E_C$ (2)

AF = Antenna factor
$C_L$ = Cable loss
$D_F$ = Distance correction factor (if used)
$E_C$ = Electrical field – corrected value
$E_R$ = Receiver reading
$G_A$ = Gain of pre-amplifier (if used)
$L_T$ = Limit
M = Margin

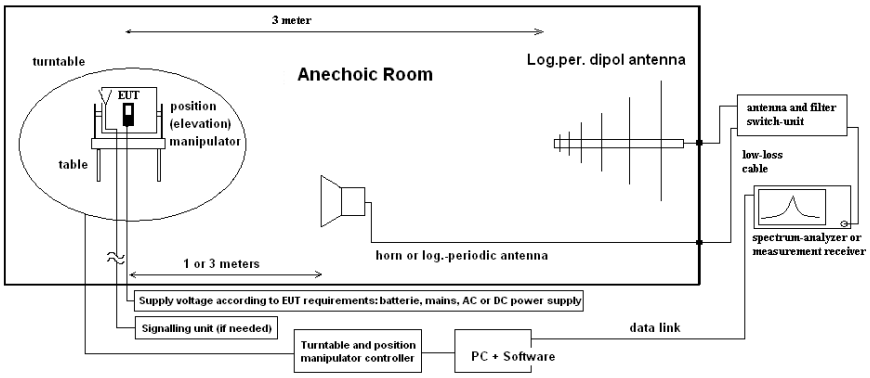
All units are dB-units, positive margin means value is below limit.

## 4.4. Test system set-up for radiated electric field measurement above 1 GHz

**Specification:** ANSI C63.4-2014 chapter 8.3, ANSI C63.10-2013 chapter 6.6.3.3 & 6.6.4

**General Description:** Evaluating the emissions have to be done first by an exploratory emissions measurement and a final measurement for most critical frequencies. The tests are performed in a CISPR 16-1-4:2010 compliant fully anechoic room (FAR) recognized by the regulatory commission. The measurement distance was set to 3 meter for frequencies up to 18 GHz and 2 meter above 18 GHz. A logarithmic periodic antenna is used for the frequency range 30 MHz to 1 GHz. Horn antennas are used for frequency range 1 GHz to 40 GHz. The EUT is aligned within 3 dB beam width of the measurement antenna with three orthogonal axis measurements on the EUT.

**Schematic:**




**Testing method:**

**Exploratory, preliminary measurements**
The EUT and its associated accessories are placed on a non-conductive position manipulator (tipping device) of 1.55 m height which is placed on the turntable. By rotating the turntable (range 0° to 360°, step 15°) and the EUT itself either on 3-orthogonal axis (portable equipment) or 2-orthogonal axis (defined operational position of EUT) the emission spectrum and it's characteristics was recorded with an EMI-receiver, broadband antenna and software.
The measurements are performed in horizontal and vertical polarization of the measurement antennas. The results are documented in a diagram. Critical frequencies (low margin to limit) are saved within a table for further investigations. If various operating modes are supported, further investigations are made to find the worst-case of them. Also the interconnection cables and equipment position were varied in order to maximize the emissions.

**Final measurement on critical frequencies**
Based on the exploratory measurements, the most critical frequencies are re-measured by maintaining the EUT's worst-case operation mode, cable position, etc.

First a frequency zoom around the critical frequency is done to locate the frequency more precisely. After this step, for all identified critical frequencies, the maximum peak was determined. Following parameters were varied: the turntable angle continuously in the range 0 to 360 degree, the EUT itself over 3-orthogonal axis and the height for EUT with large dimensions.

On the determined worst-case position, a final measurement with necessary bandwidth and detector according standard has been carried out. On the determined worst-case position, a final measurement with necessary bandwidth and detector according standard has been carried out.

**Formula:**

$E_C = E_R + AF + C_L + D_F - G_A$ (1)

$M = L_T - E_C$ (2)

$E_C$ = Electrical field – corrected value
$E_R$ = Receiver reading
M = Margin
$L_T$ = Limit
AF = Antenna factor
$C_L$ = Cable loss
$D_F$ = Distance correction factor (if used)
$G_A$ = Gain of pre-amplifier (if used)

All units are dB-units, positive margin means value is below limit.

# 5. Measurements

## 5.1. Maximum peak conducted output power

### 5.1.1. Test location and equipment (for reference numbers please see chapter 'List of test equipment')

| | | | | | | |
|---|---|---|---|---|---|---|
| test location | ☒ CETECOM Essen (Chapter. 2.2.1) | | ☐ 443 System CTC-FAR-EMI- | | ☐ Please see Chapter. 2.2.3 | |
| test site | ☐ 441 EMI SAR | ☐ 487 SAR NSA | ☒ 347 Radio.lab. | | ☐ | ☐ |
| receiver | ☐ 377 ESCS30 | ☐ 001 ESS | ☐ 489 ESU 40 | ☐ | ☐ | ☐ |
| spectr. analys. | ☐ 584 FSU | ☐ 120 FSEM | ☐ 264 FSEK | ☐ 489 ESU 40 | ☒ 683 FSU26 | ☐ |
| antenna | ☐ 574 BTA-L | ☐ 133 EMCO3115 | ☐ 302 BBHA9170 | ☐ 289 CBL 6141 | ☐ 030 HFH-Z2 | ☐ 477 GPS |
| signaling | ☐ 392 MT8820A | ☐ 436 CMU | ☐ 547 CMU | | | |
| otherwise | ☒ 266 NRV-Z31 | ☒ 600 NRVD | ☐ 110 USB LWL | ☐ 482 Filter Matrix | ☐ 378 RadiSense | ☐ 693 TS8997 |
| DC power | ☐ 456 EA 3013A | ☒ 463 HP3245A | ☐ 459 EA 2032-50 | ☐ 268 EA- 3050 | ☐ 494 AG6632A | ☐ 498 NGPE 40 |
| otherwise | ☐ 331 HC 4055 | ☐ 248 6 dB Attenuator | ☐ 529 Power divider | ☒ - cable OTA20 | | |
| | ☐ 513 20dB Attenuator | | ☐ K 4 Cable kit | | | |
| line voltage | ☐ 230 V 50 Hz via public mains | | ☐ 060 110 V 60 Hz via PAS 5000 | | | |

### 5.1.2. Reference

| | |
|---|---|
| FCC | ☒ §15.247(b) (3) + KDB 558074 D01 DTS Meas Guidance v03r05 |
| IC | ☒ RSS-247, Chapter 5.4(4) |
| ANSI | ☒ ANSI 63.10:2013 |
| Specification | *For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signalling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.* |

### 5.1.3. EUT settings:

The EUT was instructed to send with maximum power (if adjustable) according applicants instructions.
Different modulation characteristics have been checked, e.g. data rates which EUT can operate.

### 5.1.4. Test condition and measurement test set-up

| | | | |
|---|---|---|---|
| Signal link to test system (if used): | ☐ air link | ☐ cable connection | ☒ none |
| EUT-grounding | ☒ none | ☐ with power supply | ☐ additional connection |
| Equipment set up | ☒ table top 1.5m height | | ☐ floor standing |
| Climatic conditions | Temperature: (22±3°C) | | Rel. humidity: (40±20)% |
| General measurement procedures | Please see chapter “Test system set-up for conducted RF-measurement at antenna Port” (W1 Set-up) | | |

### 5.1.5. Measurement method and analyzer settings:

The measurement was performed in non-hopping transmission mode with the carrier set to lowest/middle and highest channel. The power was also checked for different data rates, modulation scheme or packet types if applicable.

**MEASUREMENT METHOD/ SPECTRUM-ANALYZER SETTINGS:**

| | | |
|---|---|---|
| Measurement Method [1.)] | §15.247(b) (3) Maximum Peak | 1.) ☐ PK1-Method (§5.2.1.1): RBW > 6dB-bandwidth of the signal, ANSI 63.10: 2009, chapter 6.10.2.1a<br>2.) ☐ PK2-Method (§5.2.1.2): Channel integration method (ANSI 63.10:2009)<br>3.) ☒ PK1-Method (§9.1.2 KDB): Peak Power Meter Method |
| | §15.247(b) (3) Maximum Average | 4.) ☐ AVG1 - power averaging over EBW + integrated band power measurement<br>5.) ☐ AVG2 - trace averaging over EBW + integrated band power measurement<br>6.) ☐ RMS power meter method |
| | MIMO | 7.) ☐ Method as described in Chapter 3.8 was used for measurements on two available RF-Antenna ports. |
| Center Frequency | | Nominal channel frequency |
| Span | | 30% higher then the EBW measured before |
| Resolution Bandwidth (RBW) | | 1MHz |
| Video Bandwidth (VBW) | | 3MHz |
| Sweep time | | coupled |
| Detector | | Peak, Max hold mode for method PK1/PK2 or RMS and trace average for method AVG1/AVG2 |
| Sweep Mode | | Repetitive mode, allow trace to stabilize |
| Analyzer-Mode | | ☐ normal<br>☐ activated channel integration method with limits set to the EBW of the signal |

Remark 1: guidance 558074 D01 measurement DTS guidance v03r05

### 5.1.6. RESULTS

**APLICANT'S DECLARED ANTENNA CHARACTERISTICS:**

☐ Directional Gain < 6 dBi (measured: difference between measured conducted and radiated eirp. power)
☒ Directional Gain > 6 dBi (measured / applicant's declaration) -> conducted power reduction necessary

- Maximum declared antenna gain [isotropic]: 2.4 dBi for 2.4GHz band

Different modulation types and data rates were tested in order to find the maximum peak conducted output power. **Enclosed are only the maximum values for each modulation format**, pls. compare separate document A1 for all results.

| Max. Peak power (conducted) [dBm] | | | |
|---|---|---|---|
| Set-up no: 2<br>Op-Mode: 1 to 4 | Low channel = 1<br>(2412 MHz) | Middle channel = 6<br>(2437 MHz) | High channel = 11<br>(2462 MHz) |
| Measured Level<br>b-Mode | **16.19**<br>(1Mbit) | 15.73<br>(2Mbit) | 16.03<br>(1Mbit) |
| Measured Level<br>g-Mode (24Mbit) | 15.85 | 16.28 | **16.61** |
| Measured Level<br>n-Mode | 14.48<br>(MCS3/MCS7) | **14.56**<br>(MCS5) | 14.34<br>(MCS7) |
| Limit | 1 Watt (30dBm) Peak | | |

Remark:

| Max. Peak power (conducted) [dBm] | | | |
|---|---|---|---|
| Set-up no: 2<br>Op-Mode: 1 to 4 | Low channel = 15<br>(2422 MHz) | Middle channel = 48<br>(2437 MHz) | High channel = 711<br>(2452 MHz) |
| Measured Level<br>n-Mode | 12.59<br>(MCS5) | **12.72**<br>(MCS5) | 12.31<br>(MCS6) |
| Limit | 1 Watt (30dBm) Peak | | |

Remark:

1.) External Path Loss -> set as either as correction factor in spectrum-analyzer or activated as transducer table
2.) at this place only each maximum power reported, pls. compare separate annex 1 for more details
3.) maximum value among all data rates and modulations, pls. compare separate annex 1 for more details

**5.1.6.1. VERDICT:** Maximum value of 16.61 dBm Peak (45.81 mW) -> passed

## 5.2. General Limit - Radiated field strength emissions below 30 MHz

### 5.2.1. Test location and equipment

| | | | | | | |
|---|---|---|---|---|---|---|
| test location | ☒ CETECOM Essen (Chapter. 2.2.1) | | ☐ Please see Chapter. 2.2.2 | | ☐ Please see Chapter. 2.2.3 | |
| test site | ☒ 441 EMI SAR | ☐ 487 SAR NSA | ☐ 347 Radio.lab. | | ☐ | ☐ |
| receiver | ☐ 377 ESCS30 | ☒ 001 ESS | ☐ | ☐ | ☐ | ☐ |
| spectr. analys. | ☐ 584 FSU | ☐ 120 FSEM | ☐ 264 FSEK | ☐ | ☐ | ☐ |
| antenna | ☐ 574 BTA-L | ☐ 133 EMCO3115 | ☐ 302 BBHA9170 | ☐ 289 CBL 6141 | ☒ 030 HFH-Z2 | ☐ 477 GPS |
| signaling | ☐ 392 MT8820A | ☐ 371 CBT32 | ☐ 547 CMU | ☐ 594 CMW | | |
| otherwise | ☐ 400 FTC40x15E | ☐ 401 FTC40x15E | ☐ 110 USB LWL | ☐ 482 Filter Matrix | ☐ 378 RadiSense | |
| DC power | ☐ 456 EA 3013A | ☐ 457 EA 3013A | ☐ 459 EA 2032-50 | ☐ 268 EA- 3050 | ☐ 494 AG6632A | ☐ 498 NGPE 40 |
| line voltage | ☐ 230 V 50 Hz via public mains | | ☐ 060 120 V 60 Hz via PAS 5000 | | | |

### 5.2.2. Requirements

| | | | | |
|---|---|---|---|---|
| **FCC** | Part 15, Subpart C, §15.205 & §15.209 | | | |
| **IC** | RSS-Gen: Issue 4: §8.9 Table 5 | | | |
| **ANSI** | C63.10-2013 | | | |
| Frequency [MHz] | Field strength limit [µV/m] | [dBµV/m] | Distance [m] | Remarks |
| 0.009 – 0.490 | 2400/f (kHz) | 67.6 – 20Log(f) (kHz) | 300 | Correction factor used due to measurement distance of 3 m |
| 0.490 – 1.705 | 24000/f (kHz) | 87.6 – 20Log(f) (kHz) | 30 | Correction factor used due to measurement distance of 3 m |
| 1.705 – 30 | 30 | 29.5 | 30 | Correction factor used due to measurement distance of 3 m |

### 5.2.3. Test condition and test set-up

| | | | | |
|---|---|---|---|---|
| Signal link to test system (if used): | | ☐ air link | ☐ cable connection | ☐ none |
| EUT-grounding | | ☒ none | ☐ with power supply | ☐ additional connection |
| Equipment set up | | ☒ table top | | ☐ floor standing |
| Climatic conditions | | Temperature: (22±3°C) | | Rel. humidity: (40±20)% |
| EMI-Receiver or Analyzer Settings | Scan data | ☒ 9 – 150 kHz RBW/VBW = 200 Hz Scan step = 80 Hz<br>☒ 150 kHz – 30 MHz RBW/VBW = 9 kHz Scan step = 4 kHz<br>☐ other: | | |
| | Scan-Mode<br>Detector<br>Mode:<br>Sweep-Time | ☒ 6 dB EMI-Receiver Mode ☐ 3dB Spectrum analyser Mode<br>Peak (pre-measurement) and Quasi-PK/Average (final if applicable)<br>Repetitive-Scan, max-hold<br>Coupled – calibrated display if continuous signal otherwise adapted to EUT's individual transmission duty-cycle | | |
| General measurement procedures | | Please see chapter "Test system set-up radiated magnetic field measurements below 30 MHz" | | |

### 5.2.4. Measurement Results

The results are presented below in summary form only. For more information please consult the diagrams included in annex 1.

Table of measurement results:

| Diagram No. | Carrier Channel Range | Carrier Channel No. | Frequency range | Set-up no. | OP-mode no. | Remark | Used detector PK | Used detector AV | Used detector QP | Result |
|---|---|---|---|---|---|---|---|---|---|---|
| 2.01 | Low | 1 | 9 kHz-30 MHz | 1 | 1 | b-Mode, 1MBps data rate, remark 2 | ☒ | ☐ | ☐ | passed |
| 2.02 | Middle | 6 | 9 kHz-30 MHz | 1 | 2 | g-Mode, 6MBps data rate remark 2 | ☒ | ☐ | ☐ | passed |
| 2.03 | High | 9 | 9 kHz-30 MHz | 1 | 4 | n-Mode, HT20, MCS0 data rate, remark 2 | ☒ | ☐ | ☐ | passed |

Remark:
1.) For further details please refer measurement diagrams in Annex 1
2.) Compliance can be shown with specific commands as stated in chapter 3.6

### 5.2.5. Correction factors due to reduced meas. distance (f< 30 MHz)

The used correction factors when the measurement distance is reduced compared to regulatory measurement distance, are calculated according Extrapolation formulas valid for EUT's with maximum dimension of 0.625xLambda. Formula 2+3+4 as presented in ANSI C63.10, Chapter 6.4.4 are used for the calculations of proper extrapolation factors.

| Frequency -Range | f [kHz/MHz] | Lambda [m] | Far-Field Point [m] | Distance Limit accord. 15.209 [m] | 1st Condition (dmeas< $D_{near-field}$) | 2'te Condition (Limit distance bigger $d_{near-field}$) | Distance Correction accord. Formula |
|---|---|---|---|---|---|---|---|
| kHz | 9,00E+03 | 33333,33 | 5305,17 | 300 | fullfilled | not fullfilled | -80,00 |
| | 1,00E+04 | 30000,00 | 4774,65 | | fullfilled | not fullfilled | -80,00 |
| | 2,00E+04 | 15000,00 | 2387,33 | | fullfilled | not fullfilled | -80,00 |
| | 3,00E+04 | 10000,00 | 1591,55 | | fullfilled | not fullfilled | -80,00 |
| | 4,00E+04 | 7500,00 | 1193,66 | | fullfilled | not fullfilled | -80,00 |
| | 5,00E+04 | 6000,00 | 954,93 | | fullfilled | not fullfilled | -80,00 |
| | 6,00E+04 | 5000,00 | 795,78 | | fullfilled | not fullfilled | -80,00 |
| | 7,00E+04 | 4285,71 | 682,09 | | fullfilled | not fullfilled | -80,00 |
| | 8,00E+04 | 3750,00 | 596,83 | | fullfilled | not fullfilled | -80,00 |
| | 9,00E+04 | 3333,33 | 530,52 | | fullfilled | not fullfilled | -80,00 |
| | 1,00E+05 | 3000,00 | 477,47 | | fullfilled | not fullfilled | -80,00 |
| | **1,25E+05** | 2400,00 | 381,97 | | fullfilled | not fullfilled | -80,00 |
| | 2,00E+05 | 1500,00 | 238,73 | | fullfilled | fullfilled | -78,02 |
| | 3,00E+05 | 1000,00 | 159,16 | | fullfilled | fullfilled | -74,49 |
| | 4,00E+05 | 750,00 | 119,37 | | fullfilled | fullfilled | -72,00 |
| | **4,90E+05** | 612,24 | 97,44 | | fullfilled | fullfilled | -70,23 |
| | 5,00E+05 | 600,00 | 95,49 | 30 | fullfilled | not fullfilled | -40,00 |
| | 6,00E+05 | 500,00 | 79,58 | | fullfilled | not fullfilled | -40,00 |
| | 7,00E+05 | 428,57 | 68,21 | | fullfilled | not fullfilled | -40,00 |
| | 8,00E+05 | 375,00 | 59,68 | | fullfilled | not fullfilled | -40,00 |
| | 9,00E+05 | 333,33 | 53,05 | | fullfilled | not fullfilled | -40,00 |
| MHz | 1,00 | 300,00 | 47,75 | | fullfilled | not fullfilled | -40,00 |
| | 1,59 | 188,50 | 30,00 | | fullfilled | not fullfilled | -40,00 |
| | 2,00 | 150,00 | 23,87 | | fullfilled | fullfilled | -38,02 |
| | 3,00 | 100,00 | 15,92 | | fullfilled | fullfilled | -34,49 |
| | 4,00 | 75,00 | 11,94 | | fullfilled | fullfilled | -32,00 |
| | 5,00 | 60,00 | 9,55 | | fullfilled | fullfilled | -30,06 |
| | 6,00 | 50,00 | 7,96 | | fullfilled | fullfilled | -28,47 |
| | 7,00 | 42,86 | 6,82 | | fullfilled | fullfilled | -27,13 |
| | 8,00 | 37,50 | 5,97 | | fullfilled | fullfilled | -25,97 |
| | 9,00 | 33,33 | 5,31 | | fullfilled | fullfilled | -24,95 |
| | 10,00 | 30,00 | 4,77 | | fullfilled | fullfilled | -24,04 |
| | 10,60 | 28,30 | 4,50 | | fullfilled | fullfilled | -23,53 |
| | 11,00 | 27,27 | 4,34 | | fullfilled | fullfilled | -23,21 |
| | 12,00 | 25,00 | 3,98 | | fullfilled | fullfilled | -22,45 |
| | **13,56** | 22,12 | 3,52 | | fullfilled | fullfilled | -21,39 |
| | 15,00 | 20,00 | 3,18 | | fullfilled | fullfilled | -20,51 |
| | 15,92 | 18,85 | 3,00 | | fullfilled | fullfilled | -20,00 |
| | 17,00 | 17,65 | 2,81 | | not fullfilled | fullfilled | -20,00 |
| | 18,00 | 16,67 | 2,65 | | not fullfilled | fullfilled | -20,00 |
| | 20,00 | 15,00 | 2,39 | | not fullfilled | fullfilled | -20,00 |
| | 21,00 | 14,29 | 2,27 | | not fullfilled | fullfilled | -20,00 |
| | 23,00 | 13,04 | 2,08 | | not fullfilled | fullfilled | -20,00 |
| | 25,00 | 12,00 | 1,91 | | not fullfilled | fullfilled | -20,00 |
| | 27,00 | 11,11 | 1,77 | | not fullfilled | fullfilled | -20,00 |
| | 29,00 | 10,34 | 1,65 | | not fullfilled | fullfilled | -20,00 |
| | 30,00 | 10,00 | 1,59 | | not fullfilled | fullfilled | -20,00 |

## 5.3. General Limit - Radiated field strength emissions, 30 MHz - 1 GHz

### 5.3.1. Test location and equipment

| | | | | | | |
|---|---|---|---|---|---|---|
| test location | ☒ CETECOM Essen (Chapter. 2.2.1) | | ☐ Please see Chapter. 2.2.2 | | ☐ Please see Chapter. 2.2.3 | |
| test site | ☒ 441 EMI SAR | ☒ 487 SAR NSA | | | | |
| receiver | ☐ 377 ESCS30 | ☒ 001 ESS | ☐ 489 ESU 40 | ☐ 620 ESU 26 | | |
| spectr. analys. | ☐ 584 FSU | ☐ 120 FSEM | ☐ 264 FSEK | | | |
| antenna | ☒ 574 BTA-L | ☐ 133 EMCO3115 | ☐ 302 BBHA9170 | ☐ 289 CBL 6141 | ☐ 030 HFH-Z2 | ☐ 477 GPS |
| signaling | ☐ 392 MT8820A | ☐ 371 CBT32 | ☐ 547 CMU | ☐ 594 CMW | | |
| otherwise | ☐ 400 FTC40x15E | ☐ 401 FTC40x15E | ☐ 110 USB LWL | ☒ 482 Filter Matrix | | |
| DC power | ☐ 456 EA 3013A | ☐ 457 EA 3013A | ☐ 459 EA 2032-50 | ☐ 268 EA- 3050 | ☐ 494 AG6632A | ☐ 498 NGPE |
| line voltage | ☐ 230 V 50 Hz via public mains | | ☒ 060 120 V 60 Hz via PAS 5000 | | | |

### 5.3.2. Requirements/Limits

| | | | |
|---|---|---|---|
| **FCC** | | ☐ Part 15 Subpart B, §15.109, class B<br>☒ Part 15 Subpart C, §15.209 @ frequencies defined in §15.205 | |
| **IC** | | ☒ RSS-Gen., Issue 4, Chapter 8.9, Table 4+6<br>☒ RSS-247, Issue 1, Chapter 5 | |
| **ANSI** | | ☒ C63.10-2013 | |
| **Limit** | Frequency [MHz] | Radiated emissions limits, 3 meters | |
| | | QUASI Peak [µV/m] | QUASI-Peak [dBµV/m] |
| | 30 - 88 | 100 | 40.0 |
| | 88 - 216 | 150 | 43.5 |
| | 216 - 960 | 200 | 46.0 |
| | above 960 | 500 | 54.0 |

### 5.3.3. Restricted bands of operation (FCC §15.205/ RSS-Gen, Issue 4 Chapter 8.9, Table 4)

| 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 |
| 4.20725-4.20775 | 37.5-38.25 | 1645.5-1646.5 | 9.3-9.5 |
| 6.215-6.218 | 73-74.6 | 1660-1710 | 10.6-12.7 |
| 6.26775-6.26825 | 74.8-75.2 | 1718.8-1722.2 | 13.25-13.4 |
| 6.31175-6.31225 | 108-121.94 | 2200-2300 | 14.47-14.5 |
| 8.291-8.294 | 123-138 | 2310-2390 | 15.35-16.2 |
| 8.362-8.366 | 149.9-150.05 | 2483.5-2500 | 17.7-21.4 |
| 8.37625-8.38675 | 156.52475-156.52525 | 2690-2900 | 22.01-23.12 |
| 8.41425-8.41475 | 156.7-156.9 | 3260-3267 | 23.6-24.0 |
| 12.29-12.293 | 162.0125-167.17 | 3332-3339 | 31.2-31.8 |
| 12.51975-12.52025 | 167.72-173.2 | 3345.8-3358 | 36.43-36.5 |
| 12.57675-12.57725 | 240-285 | 3600-4400 | -- |
| 13.36-13.41 | 322-335.4 | -- | -- |
| Remark: only spurious emissions are allowed within these frequency bands not exceeding the limits per §15.209 | | | |

### 5.3.4. Test condition and measurement test set-up

| | | | | |
|---|---|---|---|---|
| Signal link to test system (if used): | | ☐ air link | ☐ cable connection | ☐ none |
| EUT-grounding | | ☒ none | ☐ with power supply | ☐ additional connection |
| Equipment set up | | ☒ table top 0.8m height | | ☐ floor standing |
| Climatic conditions | | Temperature: (22±3°C) | | Rel. humidity: (40±20)% |
| EMI-Receiver (Analyzer) Settings | Scan frequency range: | ☒ 30 – 1000 MHz ☐ other: | | |
| | Scan-Mode | ☒ 6 dB EMI-Receiver Mode ☐ 3 dB spectrum analyser mode | | |
| | Detector | Peak / Quasi-peak | | |
| | RBW/VBW | 100 kHz/300 kHz | | |
| | Mode: | Repetitive-Scan, max-hold | | |
| | Scan step | 80 kHz | | |
| | Sweep-Time | Coupled – calibrated display if continuous tx-signal otherwise adapted to EUT's individual duty-cycle | | |
| General measurement procedures | | Please see chapter "Test system set-up for electric field measurement in the range 30 MHz to 1 GHz" | | |

### 5.3.5. MEASUREMENT RESULTS

The results are presented below in summary form only. For more information please consult the diagrams included in annex 1.

Table of measurement results:

| Dia-gram no. | Carrier Channel | | Frequency range | Set-up no. | OP-mode no. | Remark | Used detector | | | Result |
|---|---|---|---|---|---|---|---|---|---|---|
| | Range | No. | | | | | PK | AV | QP | |
| 3.01 | Low | 1 | 30 MHz – 1 GHz | 1 | 1 | b-Mode, 1MBps data rate, remark 2 | ☒ | ☐ | ☒ | passed |
| 3.02 | Middle | 6 | | 1 | 2 | g-Mode, 6MBps data rate, remark 2 | ☒ | ☐ | ☒ | passed |
| 3.03 | High | 11 | | 1 | 3 | n-Mode, HT20 mode, MCS0 data rate, remark 2 | ☒ | ☐ | ☒ | passed |
| 3.04 | High | 9 | | 1 | 4 | n-Mode, HT40 mode, MCS0 data rate, remark 2 | ☒ | ☐ | ☒ | passed |

Remark:
1.) For further details please refer measurement diagrams in Annex 1
2.) Compliance can be shown with specific commands as stated in chapter 3.6

## 5.4. General Limit - Radiated emissions, above 1 GHz

### 5.4.1. Test location and equipment

| | | | | | | |
|---|---|---|---|---|---|---|
| test site | ☐441 EMI SAR | ☐348 EMI cond. | ☒443 EMI FAR | ☒347 Radio.lab. | ☐337 OATS | ☐ |
| spectr. analys. | ☐584 FSU | ☐120 FSEM | ☐264 FSEK | ☒489 ESU 40 | ☐ | ☐ |
| antenna meas | ☐574 BTA-L | ☐289 CBL 6141 | ☐608 HL 562 | ☒549 HL025 | ☒302 BBHA9170 | ☐477 GPS |
| antenna meas | ☐123 HUF-Z2 | ☐132 HUF-Z3 | ☐030 HFH-Z2 | ☐376 BBHA9120E | | ☐ |
| antenna subst | ☐071 HUF-Z2 | ☐020 EMCO3115 | ☐063 LP 3146 | ☐303 BBHA9170 | ☐ | ☐ |
| multimeter | ☐341 Fluke 112 | ☐ | ☐ | ☐ | ☐ | ☐ |
| signaling | ☐392 MT8820A | ☐371 CBT32 | ☐547 CMU | ☐594 CMW | | |
| DCpower | ☐086 LNG50-10 | ☐087 EA3013 | ☐354 NGPE 40 | ☐349 car battery | ☐350 Car battery | ☐ |
| line voltage | ☐ 230 V 50 Hz via public mains | | ☒ 060 120 V 60 Hz via PAS 5000 | | | |

### 5.4.2. Requirements/Limits (CLASS B equipment)

| | | | | |
|---|---|---|---|---|
| **FCC** | ☐ Part 15 Subpart B, §15.109 class B<br>☒ Part 15 Subpart C, §15.209 for frequencies defined in §15.205<br>☐ Part 15 Subpart C, §15.407(b)(1)(2)(3) 9 | | | |
| **IC** | ☒ RSS-Gen., Issue 4, Chapter 8.9, Table 4+6<br>☒ RSS-247, Issue 1, Chapter 6 | | | |
| **ANSI** | ☒ C63.10-2013 | | | |
| Frequency [MHz] | Limits | | | |
| | AV [µV/m] | AV [dBµV/m] | Peak [µV/m] | Peak [dBµV/m] or [dBm/MHz] |
| above 1 GHz for frequencies as defined in §15.205 or RSS-Gen., Issue 4, §8.10 - Table 6 | 500 | 54.0 | 5000 | 74.0 dBµV/m |

### 5.4.3. Test condition and measurement test set-up

| | | | | |
|---|---|---|---|---|
| Signal ink to test system (if used): | | ☐ air link | ☐ cable connection | ☐ none |
| EUT-grounding | | ☒ none | ☐ with power supply | ☐ additional connection |
| Equipment set up | | ☒ table top 1.5m height | | ☐ floor standing |
| Climatic conditions | | Temperature: (22±3°C) | | Rel. humidity: (40±20)% |
| Spectrum-Analyzer settings | Scan frequency range: | ☒ 1 – 18 GHz ☒ 18 – 25 GHz ☐ 18 – 40 GHz ☐ other: | | |
| | Scan-Mode | ☒ 6 dB EMI-Receiver Mode ☐ 3 dB Spectrum analyser Mode | | |
| | Detector | Peak and Average | | |
| | RBW/VBW | 1 MHz / 3 MHz | | |
| | Mode: | Repetitive-Scan, max-hold | | |
| | Scan step | 400 kHz | | |
| | Sweep-Time | Coupled – calibrated display if CW signal otherwise adapted to EUT's individual duty-cycle | | |
| General measurement procedures | | Please see chapter "Test system set-up for radiated electric field measurements above 1 GHz" | | |

### 5.4.4. Measurement Results

The results are presented below in summary form only. For more information please consult the diagrams included in annex 1.

| Dia-gram no. | Carrier Channel | | Frequency range | Set-up no. | OP-mode no. | Remarks | Used detector | | | Result |
|---|---|---|---|---|---|---|---|---|---|---|
| | Range | No. | | | | | PK | AV | QP | |
| 4.10 | Low | 1 | 1-18GHz | 1 | 1 | b-Mode, 1MBps data rate | ☒ | ☒ | ☐ | passed |
| 4.11 | Middle | 6 | | 1 | 2 | g-Mode, 6MBps data rate | ☒ | ☒ | ☐ | passed |
| 4.12 | High | 11 | | 1 | 3 | n-Mode, HT20 mode, MCS0 | ☒ | ☒ | ☐ | passed |
| 4.13 | High | 9 | | 1 | 4 | n-Mode, HT40 mode, MCS0 | ☒ | ☒ | ☐ | passed |
| 4.14 | Low | 1 | 18-25 GHz | 1 | 1 | b-Mode, 1MBps data rate | ☒ | ☒ | ☐ | passed |
| 4.15 | Middle | 6 | | 1 | 2 | g-Mode, 6MBps data rate | ☒ | ☒ | ☐ | passed |
| 4.16 | High | 11 | | 1 | 3 | n-Mode, HT20 mode, MCS0 | ☒ | ☒ | ☐ | passed |
| 4.17 | High | 9 | | 1 | 4 | n-Mode, HT40 mode, MCS0 | ☒ | ☒ | ☐ | passed |

Remark:

1.) For further details please refer measurement diagrams in Annex 1
Compliance can be shown with specific commands as stated in chapter 3.6

## 5.5. RF-Parameter - Radiated Band Edge compliance measurements

### 5.5.1. Test location and equipment FAR

| | | | | | | |
|---|---|---|---|---|---|---|
| test site | ☐441 EMI SAR | ☐348 EMI cond. | ☒443 EMI FAR | ☐347 Radio.lab. | ☐337 OATS | ☐ |
| spectr. analys. | ☐584 FSU | ☐120 FSEM | ☐264 FSEK | ☒489 ESU 40 | ☐ | ☐ |
| antenna meas | ☐574 BTA-L | ☐289 CBL 6141 | ☐608 HL 562 | ☒549 HL025 | ☒302 BBHA9170 | ☐477 GPS |
| antenna meas | ☐123 HUF-Z2 | ☐132 HUF-Z3 | ☐030 HFH-Z2 | ☐ | ☐ | ☐ |
| antenna subst | ☐071 HUF-Z2 | ☐020 EMCO3115 | ☐063 LP 3146 | ☐303 BBHA9170 | ☐ | ☐ |
| multimeter | ☐341 Fluke 112 | ☐ | ☐ | ☐ | ☐ | ☐ |
| signaling | ☐392 MT8820A | ☐371 CBT32 | ☐547 CMU | ☐594 CMW | | |
| DC power | ☐086 LNG50-10 | ☐087 EA3013 | ☐354 NGPE 40 | ☐349 car battery | ☐350 Car battery | ☐ |
| line voltage | ☐ 230 V 50 Hz via public mains | | ☐ 060 120 V 60 Hz via PAS 5000 | | | |

### 5.5.2. Requirements/Limits

| | |
|---|---|
| **FCC** | ☐ Part 15 Subpart B, §15.109 class B<br>☒ Part 15 subpart C, §15.209 @ frequencies defined in §15.205 |
| **IC** | ☐ RSS-210, Issue 8, Annex 8<br>☒ RSS-247, Issue 1, Chapter 5.5; RSS-Gen: Issue 4: §8.9 Table 4+5+6<br>☒ RSS-Gen: Issue 4: §8.9, Table 4+6 |
| **ANSI** | ☐ C63.4-2014 ☒ C63.10-2013, Chapter 6.10.6 |

### 5.5.3. Test condition and measurement test set-up

| | | | | |
|---|---|---|---|---|
| Signal ink to test system (if used): | | ☐ air link | ☐ cable connection | ☒ none |
| EUT-grounding | | ☒ none | ☐ with power supply | ☐ additional connection |
| Equipment set up | | ☒ table top 1.5m height | | ☐ floor standing |
| Climatic conditions | | Temperature: (22±3°C) | | Rel. humidity: (40±20)% |
| Spectrum-Analyzer settings | Scan frequency range:<br>Scan-Mode<br>Detector<br>RBW/VBW<br><br>Mode:<br>Scan step<br>Sweep-Time | ☐ 1 – 18 GHz ☐ 18 – 25 GHz ☐ 18 – 40 GHz ☒ other: see diagrams<br>☐ 6 dB EMI-Receiver Mode ☒ 3 dB Spectrum analyser Mode<br>Peak and Average<br>Left band-edge: 100kHz/300kHz<br>Right band-edge: 1 MHz / 3 MHz<br>Repetitive-Scan, max-hold<br>40kHz or 400 kHz<br>Coupled – calibrated display if CW signal otherwise adapted to EUT's individual duty-cycle | | |
| General measurement procedures | | Please see chapter "Test system set-up for radiated electric field measurements above 1 GHz" for general measurements procedures in anechoic chamber. | | |

### 5.5.4. Measurement Method

For uncritical results where a measurement resolution bandwidth of 1MHz can clearly show the compliance without influencing the results, a field strength measurement was performed to show compliance.

For critical results a Marker-Delta marker method was used for showing compliance to restricted bands. The method is according ANSI C63.10:2013, Chapter 6.10.6 "Marker-Delta method",. The method consists of three independent steps:

**1. Step:** Prior to the measurement the fundamental radiated In-Band field strength was performed. The determined value is used as reference value.

**2. Step**: Second step consist of finding the relative attenuation between the fundamental emission and the maximum local out-of-band emission (within 2 MHz range around the band edge either on the band-edge directly or some modulation product if the level is greater than that on the band-edge) when measured with lower resolution bandwidth.

**3. Step:** The delta value recorded in step 2 will be subtracted from value recorded in step 1, thus giving the required field strength at the band-edge. This value must fulfil the requirements for radiated spurious emissions in restricted bands in FCC §15.205 or RSS-Gen, Issue 4, Chapter 8.10, Table 6 with the general limits of FCC §15.209 or RSS-Gen, Issue 4 Chapter 8.9, Table 4.

### 5.5.5. EUT settings

The EUT was instructed to send with power levels as described in chapter 3.1 (if adjustable) according to applicants instructions.

### 5.5.6. Results: for non-restricted bands near-by

### 5.5.6.1. Non-restricted bands near-by - limits according and RSS-247, Issue 1, Chapter 5.5

| Channel no. | Restricted band ? | Fundamental Value [dBuV/m] | | Peak-Value at Band-Edge [dBuV/m] | Difference [dB] | Limit [dBc] | Margin [dB] | Verdict | Remark: |
|---|---|---|---|---|---|---|---|---|---|
| | | Peak-Value | Average-Value | | | | | | |
| 1 | no | 96,86 | 90,17 | 55,82 | 41,04 | 20 | 21,04 | PASS | b-Mode, 1MBps |
| 1 | no | 90,65 | 84,09 | 58,22 | 32,43 | 20 | 12,43 | PASS | g-Mode, 6Mbps |
| 1 | no | 91,01 | 84,15 | 58,22 | 32,79 | 20 | 12,79 | PASS | n-Mode, HT20, MCS0 |
| 3 | no | 84,95 | 78,67 | 56,36 | 28,59 | 20 | 8,59 | PASS | n-Mode, HT40, MCS0 |

Remark:
1. 100% Duty-Cycle, no average value correction necessary
2. Compliance can be shown with specific commands as stated in chapter 3.6

### 5.5.6.2. Restricted bands near-by
### (§15.205 with limits accord. FCC §15.209) and (RSS-Gen, Issue4, Chapter 8.10)

| Channel no. | Restricted band ? | Fundamental Value [dBuV/m] | | Value at Band-Edge [dBuV/m] | | Limits [dBuV/m] | | Margin [dB] | | Verdict | Remark: |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Peak-Value | Average-Value | Peak -Value | Average -Value | Peak -Value | Average -Value | Peak | Average | | |
| 11 | yes | 101,4 | 93,94 | 67,23 | 51,9 | 74 | 54 | 6,77 | 2,1 | PASS | b-Mode, 1MBps |
| 11 | yes | 95,55 | 88,71 | 62,58 | 51,34 | 74 | 54 | 11,42 | 2,66 | PASS | g-Mode, 6MBps |
| 11 | yes | 102,27 | 95,24 | 65,23 | 51,49 | 74 | 54 | 8,77 | 2,51 | PASS | n-Mode, HT20, MCS0 |
| 9 | yes | 101,71 | 99,36 | 57,50 | 47,00 | 74 | 54 | 16,50 | 7 | PASS | n-Mode, HT40, MCS0 |

Remark:
1. 100% Duty-Cycle, no average value correction necessary
2. Compliance can be shown with specific commands as stated in chapter 3.6

**5.5.7. Verdict:** passed

## 5.6. Measurement uncertainties

The reported uncertainties are calculated based on the standard uncertainty multiplied with the appropriate coverage factor **k**, such that a confidence level of approximately 95% is achieved.
For uncertainty determination, each component used in the concrete measurement set-up was taken in account and it's contribution to the overall uncertainty according it's statistical distribution calculated.

Following table shows expectable uncertainties for each measurement type performed.

| RF-Measurement | Reference | Frequency range | Calculated uncertainty based on a confidence level of 95% | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| Conducted emissions ($U_{CISPR}$) | CISPR 16-2-1 | 9 kHz - 150 kHz<br>150 kHz - 30 MHz | 4.0 dB<br>3.6 dB | | | | | | - |
| Radiated emissions Enclosure | CISPR 16-2-3 | 30 MHz - 1 GHz<br>1 GHz - 18 GHz | 4.2 dB<br>5.1 dB | | | | | | E-Field |
| Disturbance power | CISPR 16-2-2 | 30 MHz - 300 MHz | - | | | | | | - |
| Power Output radiated | - | 30 MHz - 4 GHz | 3.17 dB | | | | | | Substitution method |
| Power Output conducted | - | Set-up No. | Cel-C1 | Cel-C2 | BT1 | W1 | W2 | -- | |
| | | 9 kHz - 12.75 GHz | N/A | 0.60 | 0.7 | 0.25 | N/A | -- | - |
| | | 12.75 - 26.5GHz | N/A | 0.82 | -- | N/A | N/A | -- | |
| Conducted emissions on RF-port | - | 9 kHz - 2.8 GHz | 0.70 | N/A | 0.70 | N/A | 0.69 | -- | N/A - not applicable |
| | | 2.8 GHz - 12.75GHz | 1.48 | N/A | 1.51 | N/A | 1.43 | -- | |
| | | 12.75 GHz - 18GHz | 1.81 | N/A | 1.83 | N/A | 1.77 | -- | |
| | | 18 GHz - 26.5GHz | 1.83 | N/A | 1.85 | N/A | 1.79 | -- | |
| Occupied bandwidth | - | 9 kHz - 4 GHz | 0.1272 ppm (Delta Marker) | | | | | | Frequency error |
| | | | 1.0 dB | | | | | | Power |
| Emission bandwidth | - | 9 kHz - 4 GHz | 0.1272 ppm (Delta Marker) | | | | | | Frequency error |
| | - | | See above: 0.70 dB | | | | | | Power |
| Frequency stability | - | 9 kHz - 20 GHz | 0.0636 ppm | | | | | | - |
| Radiated emissions Enclosure | - | 150 kHz - 30 MHz<br>30 MHz - 1 GHz<br>1 GHz - 20 GHz | 5.0 dB<br>4.2 dB<br>3.17 dB | | | | | | Magnetic field<br>E-field<br>Substitution |

**Table: measurement uncertainties, valid for conducted/radiated measurements**

# 6. Abbreviations used in this report

| The abbreviations | |
|---|---|
| ANSI | American National Standards Institute |
| AV , AVG, CAV | Average detector |
| EIRP | Equivalent isotropically radiated power, determined within a separate measurement |
| EGPRS | Enhanced General Packet Radio Service |
| EUT | Equipment Under Test |
| FCC | Federal Communications Commission, USA |
| IC | Industry Canada |
| n.a. | not applicable |
| Op-Mode | Operating mode of the equipment |
| PK | Peak |
| RBW | resolution bandwidth |
| RF | Radio frequency |
| RSS | Radio Standards Specification, Dokuments from Industry Canada |
| Rx | Receiver |
| TCH | Traffic channel |
| Tx | Transmitter |
| QP | Quasi peak detector |
| VBW | Video bandwidth |
| ERP | Effective radiated power |

# 7. Accreditation details of CETECOM's laboratories and test sites

| Ref.-No. | Accreditation Certificate | Valid for laboratory area or test site | Accreditation Body |
|---|---|---|---|
| - | D-PL-12047-01-01 | All laboratories and test sites of CETECOM GmbH, Essen | DAkkS, Deutsche Akkreditierungsstelle GmbH |
| 337<br>487<br>558<br>348<br>348 | MRA US-EU 0003 | Radiated Measurements 30 MHz to 1 GHz, 3 m / 10 m (OATS)<br>Radiated Measurements 30 MHz to 1 GHz, 3 m (SAR)<br>Radiated Measurements above 1 GHz, 3 m (FAR)<br>Mains Ports Conducted Interference Measurements<br>Telecommunication Ports Conducted Interference Measurem. | FCC, Federal Communications Commission<br>Laboratory Division, USA |
| 337<br>487<br>550<br>558 | --<br>3462D-2<br>3462D-2<br>3462D-3 | Radiated Measurements 30 MHz to 1 GHz, 3 m / 10 m (OATS)<br>Radiated Measurements 30 MHz to 1 GHz, 3 m (SAR)<br>Radiated Measurements 1 GHz to 6 GHz, 3 m (SAR)<br>Radiated Measurements above 1 GHz, 3 m (FAR) | IC, Industry Canada Certification and Engineering Bureau |
| 487<br>550<br>348<br>348 | R-2666<br>G-301<br>C-2914<br>T-1967 | Radiated Measurements 30 MHz to 1 GHz, 3 m (SAR)<br>Radiated Measurements 1 GHz to 6 GHz, 3 m (SAR)<br>Mains Ports Conducted Interference Measurements<br>Telecommunication Ports Conducted Interference Measurem. | VCCI, Voluntary Control Council for Interference by Information Technology Equipment, Japan |
| OATS = Open Area Test Site, SAR = Semi Anechoic Room, FAR = Fully Anechoic Room | | | |

# 8. Instruments and Ancillary

### 8.1. Used equiment "CTC"

The "Ref.-No" in the left column of the following tables allows the clear identification of the laboratory equipment.

#### 8.1.1. Test software and firmware of equipment

| Ref.-No. | Equipment | Type | Serial-No. | Version of Firmware or Software during the test |
|---|---|---|---|---|
| 001 | EMI Test Receiver | ESS | 825132/017 | Firm.= 1.21 , OTP=2.0, GRA=2.0 |
| 012 | Signal Generator (EMS-cond.) | SMY 01 | 839069/027 | Firm.= V 2.02 |
| 013 | Power Meter (EMS cond.) | NRVD | 839111/003 | Firm.= V 1.51 |
| 017 | Digital Radiocommunication Tester | CMD 60 M | 844365/014 | Firmware = V 3.52 .22.01.99, DECT = D2.87 13.01.99 |
| 053 | Audio Analyzer | UPA3 | 860612/022 | Firm. V 4.3 |
| 119 | RT Harmonics Analyzer dig. Flickermeter | B10 | G60547 | Firm.= V 3.1DHG |
| 140 | Signal Generator | SMHU | 831314/006 | Firm.= 3.21 |
| 261 | Thermal Power Sensor | NRV-Z55 | 825083/0008 | EPROM-Datum 02.12.04, SE EE 1 B |
| 262 | Power Meter | NRV-S | 825770/0010 | Firm.= 2.6 |
| 263 | Signal Generator | SMP 04 | 826190/0007 | Firm.=3.21 |
| 295 | Racal Digital Radio Test Set | 6103 | 1572 | UNIT Firmware= 4.04, SW-Main=4.04, SW-BBP=1.04, SW-DSP=1.02, Hardboot=1.02, Softboot=2.02 |
| 298 | Univ. Radio Communication Tester | CMU 200 | 832221/091 | R&S Test Firmware =3.53 /3.54 (current Testsoftw. f. all band used |
| 323 | Digital Radiocommunication Tester | CMD 55 | 825878/0034 | Firm.= 3.52 .22.01.99 |
| 335 | CTC-EMS-Conducted | System EMS Conducted | - | EMC 32 V 8.52 |
| 340 | Digital Radiocommunication Tester | CMD 55 | 849709/037 | Firm.= 3.52 .22.01.99 |
| 355 | Power Meter | URV 5 | 891310/027 | Firm.= 1.31 |
| 365 | 10V Insertion Unit 50 Ohm | URV5-Z2 | 100880 | Eprom Data = 31.03.08 |
| 366 | Ultra Compact Simulator | UCS 500 M4 | V0531100594 | Firm. UCS 500=001925/3.06a02, rc=ISMIEC 4.10 |
| 371 | Bluetooth Tester | CBT32 | 100153 | CBT V5,30+ SW-Option K55, K57 |
| 377 | EMI Test Receiver | ESCS 30 | 100160 | Firm.= 2.30, OTP= 02.01, GRA= 02.36 |
| 378 | Broadband RF Field Monitor | RadiSense III | 03D00013SNO-08 | Firm.= V.03D13 |
| 389 | Digital Multimeter | Keithley 2000 | 0583926 | Firm. = A13 (Mainboard) A02 (Display) |
| 392 | Radio Communication Tester | MT8820A | 6K00000788 | Firm.= 4.50 #005, IPL=4.01#001,OS=4.02#001, GSM=4.41#013, W-CDMA= 4.54#004, scenario= 4.52#002 |
| 436 | Univ. Radio Communication Tester | CMU 200 | 103083 | R&S Test Firmware Base=5.14, Mess-Software= GSM:5.14 WCDMA:5.14 (current Testsoftw. F. all band |
| 441 | CTC-SAR-EMI Cable Loss | System EMI field (SAR) | - | EMC 32 Version 8.52 |
| 442 | CTC-SAR-EMS | System EMS field (SAR) | - | EMC 32 Version 8.40 |
| 443 | CTC-FAR-EMI-RSE | System CTC-FAR-EMI-RSE | - | Spuri 7.2.5 or EMC 32 Ver. 9.15.00 |
| 444 | CTC-FAR-EMS field | System-EMS-Field (FAR) | - | EMC 32 Version 9.15.00 |
| 460 | Univ. Radio Communication Tester | CMU 200 | 108901 | R&S Test Firmware Base=5.14, GSM=5.14 WCDMA=5.14 (current Testsoftw.,f. all band to be used, |
| 489 | EMI Test Receiver | ESU40 | 1000-30 | Firmware=4.43 SP3, Bios=V5.1-16-3, Spec. =01.00 |
| 491 | ESD Simulator dito | ESD dito | dito307022 | V 2.30 |
| 524 | Voltage Drop Simulator | VDS 200 | 0196-16 | Software Nr: 000037 Version V4.20a01 |
| 526 | Burst Generator | EFT 200 A | 0496-06 | Software Nr. 000034 Version V2.32 |
| 527 | Micro Pulse Generator | MPG 200 B | 0496-05 | Software-Nr. 000030 Version V2.43 |
| 528 | Load Dump Simulator | LD 200B | 0496-06 | Software-Nr. 000031 Version V2.35a01 |
| 546 | Univ. Radio Communication Tester | CMU 200 | 106436 | R&S Test Firmware Base=5.14, GSM=5.14 WCDMA=5.14 (current Testsoftw.,f. all band to be used |
| 547 | Univ. Radio Communication Tester | CMU 200 | 835390/014 | R&S Test Firmware Base=V5.1403 (current Testsoftw., f. all band used, GSM = 5.14 WCDMA: = 5.14 |
| 584 | Spectrum Analyzer | FSU 8 | 100248 | 2.82_SP3 |
| 597 | Univ. Radio Communication Tester | CMU 200 | 100347 | R&S Test Firmware Base=5.01, GSM=5.02 WCDMA= not installed, Mainboard= µP1=V.850 |
| 598 | Spectrum Analyzer | FSEM 30 (Reserve) | 831259/013 | Firmware Bios 3.40 , Analyzer 3.40 Sp 2 |
| 620 | EMI Test Receiver | ESU 26 | 100362 | 4.43_SP3 |
| 642 | Wideband Radio Communication Tester | CMW 500 | 126089 | Setup V03.26, Test programm component V03.02.20 |
| 670 | Univ. Radio Communication Tester | CMU 200 | 106833 | µP1 =V8.50, Firmware = V.20 |
| 689 | Vector Signal Generator | SMU200 | 100970 | 02.20.360.142 |
| 692 | Bluetooth Tester | CBT 32 | 100236 | CBT V 5.40, FW: V.2.41 (FPGA Digital, V. 3.09 FPGA RF) |
| | | | | |

#### 8.1.2. Single instruments and test systems

| Ref.-No. | Equipment | Type | Serial-No. | Manufacturer | Interval of calibration | Remark | Cal due |
|---|---|---|---|---|---|---|---|
| 001 | EMI Test Receiver | ESS | 825132/017 | Rohde & Schwarz | 12 M | - | 30.05.2017 |
| 005 | AC - LISN (50 Ohm/50µH, test site 1) | ESH2-Z5 | 861741/005 | Rohde & Schwarz | 12 M | - | 30.05.2017 |
| 007 | Single-Line V-Network (50 Ohm/5µH) | ESH3-Z6 | 892563/002 | Rohde & Schwarz | 12 M | - | 30.05.2017 |
| 009 | Power Meter (EMS-radiated) | NRV | 863056/017 | Rohde & Schwarz | 24 M | - | 30.04.2017 |
| 016 | Line Impedance Simulating Network | Op. 24-D | B6366 | Spitzenberger+Spies | 36 M | - | 30.05.2019 |
| 020 | Horn Antenna 18 GHz (Subst 1) | 3115 | 9107-3699 | EMCO | 36/12 M | - | 31.03.2017 |
| 021 | Loop Antenna (H-Field) | 6502 | 9206-2770 | EMCO | 36 M | - | 30.04.2018 |
| 030 | Loop Antenna (H-field) | HFH-Z2 | 879604/026 | Rohde & Schwarz | 36 M | - | 30.04.2018 |
| 033 | RF-current probe (100kHz-30MHz) | ESH2-Z1 | 879581/18 | Rohde & Schwarz | 24 M | - | 30.04.2017 |
| 057 | relay-switch-unit (EMS system) | RSU | 494440/002 | Rohde & Schwarz | pre-m | 1a | |
| 060 | power amplifier (DC-2kHz) | PAS 5000 | B6363 | Spitzenberger+Spies | - | 3 | |
| 066 | notch filter (WCDMA; FDD1) | WRCT 1900/2200-5/40-10EEK | 5 | Wainwright GmbH | 12 M | 1g | 30.06.2016 |
| 086 | DC - power supply, 0 -10 A | LNG 50-10 | - | Heinzinger Electronic | pre-m | 2 | |
| 087 | DC - power supply, 0 -5 A | EA-3013 S | - | Elektro Automatik | pre-m | 2 | |
| 091 | USB-LWL-Converter | OLS-1 | 007/2006 | Ing. Büro Scheiba | - | 4 | |
| 099 | passive voltage probe | ESH2-Z3 | 299.7810.52 | Rohde & Schwarz | 36 M | - | 30.04.2018 |
| 100 | passive voltage probe | Probe TK 9416 | without | Schwarzbeck | 36 M | - | 30.04.2018 |
| 110 | USB-LWL-Converter | OLS-1 | - | Ing. Büro Scheiba | - | 4 | |
| 119 | RT Harmonics Analyzer dig. Flickermeter | B10 | G60547 | BOCONSULT | 36 M | - | 30.05.2019 |
| 136 | adjustable dipole antenna (Dipole 1) | 3121C-DB4 | 9105-0697 | EMCO | 36 M | - | 30.04.2018 |
| 140 | Signal Generator | SMHU | 831314/006 | Rohde & Schwarz | 24 M | - | 30.05.2018 |
| 248 | attenuator | SMA 6dB 2W | - | Radiall | pre-m | 2 | |
| 249 | attenuator | SMA 10dB 10W | - | Radiall | pre-m | 2 | |
| 252 | attenuator | N 6dB 12W | - | Radiall | pre-m | 2 | |
| 256 | attenuator | SMA 3dB 2W | - | Radiall | pre-m | 2 | |
| 257 | hybrid | 4031C | 04491 | Narda | pre-m | 2 | |
| 260 | hybrid coupler | 4032C | 11342 | Narda | pre-m | 2 | |
| 261 | Thermal Power Sensor | NRV-Z55 | 825083/0008 | Rohde & Schwarz | 24 M | - | 30.05.2018 |
| 262 | Power Meter | NRV-S | 825770/0010 | Rohde & Schwarz | 24 M | - | 30.05.2018 |
| 263 | Signal Generator | SMP 04 | 826190/0007 | Rohde & Schwarz | 36 M | - | 30.05.2019 |
| 265 | peak power sensor | NRV-Z33, Model 04 | 840414/009 | Rohde & Schwarz | 24 M | - | 30.05.2018 |
| 266 | Peak Power Sensor | NRV-Z31, Model 04 | 843383/016 | Rohde & Schwarz | 24 M | - | 30.05.2018 |
| 267 | notch filter GSM 850 | WRCA 800/960-6EEK | 9 | Wainwright GmbH | pre-m | 2 | |
| 270 | termination | 1418 N | BB6935 | Weinschel | pre-m | 2 | |
| 271 | termination | 1418 N | BE6384 | Weinschel | pre-m | 2 | |
| 272 | attenuator (20 dB) 50 W | Model 47 | BF6239 | Weinschel | pre-m | 2 | |
| 273 | attenuator (10 dB) 100 W | Model 48 | BF9229 | Weinschel | pre-m | 2 | |
| 274 | attenuator (10 dB) 50 W | Model 47 (10 dB) 50 W | BG0321 | Weinschel | pre-m | 2 | |
| 275 | DC-Block | Model 7003 (N) | C5129 | Weinschel | pre-m | 2 | |
| 276 | DC-Block | Model 7006 (SMA) | C7061 | Weinschel | pre-m | 2 | |
| 279 | power divider | 1515 (SMA) | LH855 | Weinschel | pre-m | 2 | |
| 287 | pre-amplifier 25MHz - 4GHz | AMF-2D-100M4G-35-10P | 379418 | Miteq | 12 M | 1c | 30.06.2017 |
| 291 | high pass filter GSM 850/900 | WHJ 2200-4EE | 14 | Wainwright GmbH | 12 M | 1c | 30.06.2017 |
| 298 | Univ. Radio Communication Tester | CMU 200 | 832221/091 | Rohde & Schwarz | pre-m | 3 | |
| 300 | AC LISN (50 Ohm/50µH, 1-phase) | ESH3-Z5 | 892 239/020 | Rohde & Schwarz | 12 M | - | 30.05.2017 |
| 301 | attenuator (20 dB) 50W, 18GHz | 47-20-33 | AW0272 | Lucas Weinschel | pre-m | 2 | |
| 302 | horn antenna 40 GHz (Meas 1) | BBHA9170 | 155 | Schwarzbeck | 36 M | - | 31.03.2017 |
| 303 | horn antenna 40 GHz (Subst 1) | BBHA9170 | 156 | Schwarzbeck | 36 M | - | 31.03.2017 |
| 331 | Climatic Test Chamber -40/+80 Grad | HC 4055 | 43146 | Heraeus Vötsch | Pre-m | 2 | |
| 341 | Digital Multimeter | Fluke 112 | 81650455 | Fluke | 24 M | - | 30.05.2018 |
| 342 | Digital Multimeter | Voltcraft M-4660A | IB 255466 | Voltcraft | 24 M | - | 30.04.2017 |
| 347 | laboratory site | radio lab. | - | - | - | 5 | |
| 348 | laboratory site | EMI conducted | - | - | - | 5 | |
| 354 | DC - Power Supply 40A | NGPE 40/40 | 448 | Rohde & Schwarz | pre-m | 2 | |
| 355 | Power Meter | URV 5 | 891310/027 | Rohde & Schwarz | 24 M | - | 30.05.2018 |
| 357 | power sensor | NRV-Z1 | 861761/002 | Rohde & Schwarz | 24 M | - | 30.04.2017 |
| 371 | Bluetooth Tester | CBT32 | 100153 | R&S | 36 M | - | 30.05.2019 |
| 373 | Single-Line V-Network (50 Ohm/5µH) | ESH3-Z6 | 100535 | Rohde & Schwarz | 12 M | - | 30.05.2017 |
| 377 | EMI Test Receiver | ESCS 30 | 100160 | Rohde & Schwarz | 12 M | - | 30.05.2017 |
| 389 | Digital Multimeter | Keithley 2000 | 0583926 | Keithley | 24 M | - | 30.04.2017 |
| 392 | Radio Communication Tester | MT8820A | 6K00000788 | Anritsu | 12 M | - | 30.05.2017 |
| 431 | Model 7405 | Near-Field Probe Set | 9305-2457 | EMCO | - | 4 | |
| 436 | Univ. Radio Communication Tester | CMU 200 | 103083 | Rohde & Schwarz | 12 M | - | 30.04.2017 |
| 439 | UltraLog-Antenna | HL 562 | 100248 | Rohde & Schwarz | 36 M | - | 31.03.2017 |
| 443 | CTC-FAR-EMI-RSE | System CTC-FAR-EMI-RSE | - | ETS-Lindgren / CETECOM | 12 M | 5 | 30.06.2017 |
| 448 | notch filter WCDMA_FDD II | WRCT 1850.0/2170.0-5/40- | 5 | Wainwright Instruments GmbH | 12 M | 1c | 30.06.2017 |
| 449 | notch filter WCDMA FDD V | WRCT 824.0/894.0-5/40-8SSK | 1 | Wainwright | 12 M | 1c | 30.06.2017 |
| 454 | Oscilloscope | HM 205-3 | 9210 P 29661 | Hameg | - | 4 | |
| 456 | DC-Power supply 0-5 A | EA 3013 S | 207810 | Elektro Automatik | pre-m | 2 | |

| Ref.-No. | Equipment | Type | Serial-No. | Manufacturer | Interval of calibration | Remark | Cal due |
|---|---|---|---|---|---|---|---|
| 459 | DC -Power supply 0-5 A , 0-32 V | EA-PS 2032-50 | 910722 | Elektro Automatik | pre-m | 2 | |
| 460 | Univ. Radio Communication Tester | CMU 200 | 108901 | Rohde & Schwarz | 12 M | - | 30.04.2017 |
| 463 | Universal source | HP3245A | 2831A03472 | Agilent | - | 4 | |
| 466 | Digital Multimeter | Fluke 112 | 89210157 | Fluke USA | 24 M | - | 30.05.2018 |
| 467 | Digital Multimeter | Fluke 112 | 89680306 | Fluke USA | 36 M | - | 30.04.2018 |
| 468 | Digital Multimeter | Fluke 112 | 90090455 | Fluke USA | 36 M | - | 30.04.2018 |
| 477 | ReRadiating GPS-System | AS-47 | - | Automotive Cons. Fink | - | 3 | |
| 480 | power meter (Fula) | NRVS | 838392/031 | Rohde & Schwarz | 24 M | - | 30.04.2017 |
| 482 | filter matrix | Filter matrix SAR 1 | - | CETECOM (Brl) | - | 1d | |
| 484 | pre-amplifier 2,5 - 18 GHz | AMF-5D-02501800-25-10P | 1244554 | Miteq | 12 M | - | 30.06.2017 |
| 487 | System CTC NSA-Verification SAR-EMI | System EMI field (SAR) NSA | - | ETS Lindgren / CETECOM | 24 M | - | 31.07.2017 |
| 489 | EMI Test Receiver | ESU40 | 1000-30 | Rohde & Schwarz | 12 M | - | 30.05.2017 |
| 502 | band reject filter | WRCG 1709/1786-1699/1796- | SN 9 | Wainwright | pre-m | 2 | |
| 503 | band reject filter | WRCG 824/849-814/859- | SN 5 | Wainwright | pre-m | 2 | |
| 512 | notch filter GSM 850 | WRCA 800/960-02/40-6EEK | SN 24 | Wainwrght | 12 M | 1c | 30.06.2017 |
| 517 | relais switch matrix | HF Relais Box Keithley | SE 04 | Keithley | pre-m | 2 | |
| 523 | Digital Multimeter | L4411A | MY46000154 | Agilent | 24 M | - | 30.04.2017 |
| 529 | 6 dB Broadband resistive power divider | Model 1515 | LH 855 | Weinschel | pre-m | 2 | |
| 530 | 10 dB Broadband resistive power divider | R 416110000 | LOT 9828 | - | pre-m | 2 | |
| 546 | Univ. Radio Communication Tester | CMU 200 | 106436 | R&S | 12 M | - | 30.05.2017 |
| 547 | Univ. Radio Communication Tester | CMU 200 | 835390/014 | Rohde & Schwarz | 12 M | - | 30.04.2017 |
| 549 | Log.Per-Antenna | HL025 | 1000060 | Rohde & Schwarz | 36/12 M | - | 31.07.2018 |
| 550 | System CTC S-VSWR Verification SAR-EMI | System EMI Field SAR S-VSWR | - | ETS Lindgren/CETECOM | 24 M | - | 31.07.2017 |
| 552 | high pass filter 2,8-18GHz | WHKX 2.8/18G-10SS | 4 | Wainwright | 12 M | 1c | 30.06.2017 |
| 557 | System CTC-OTA-2 | R&S TS8991 | - | Rohde & Schwarz | 12 M | 5 | 30.09.2016 |
| 558 | System CTC FAR S-VSWR | System CTC FAR S-VSWR | - | CTC | 24 M | - | 19.04.2017 |
| 574 | Biconilog Hybrid Antenna | BTA-L | 980026L | Frankonia | 36/12 M | - | 31.03.2019 |
| 584 | Spectrum Analyzer | FSU 8 | 100248 | Rohde & Schwarz | pre-m | - | |
| 594 | Wideband Radio Communication Tester | CMW 500 | 101757 | Rohde & Schwarz | 12 M | - | 30.04.2017 |
| 597 | Univ. Radio Communication Tester | CMU 200 | 100347 | Rohde & Schwarz | pre-m | - | |
| 598 | Spectrum Analyzer | FSEM 30 (Reserve) | 831259/013 | Rohde & Schwarz | 24 M | - | 30.04.2017 |
| 600 | power meter | NRVD (Reserve) | 834501/018 | Rohde & Schwarz | 24 M | - | 30.04.2017 |
| 601 | medium-sensitivity diode sensor | NRV-Z5 (Reserve) | 8435323/003 | Rohde & Schwarz | 24 M | - | 30.04.2017 |
| 602 | peak power sensor | NRV-Z32 (Reserve) | 835080 | Rohde & Schwarz | 24 M | - | |
| 611 | DC power supply | E3632A | KR 75305854 | Agilent | pre-m | 2 | |
| 612 | DC power supply | E3632A | MY 40001321 | Agilent | pre-m | 2 | |
| 613 | Attenuator | R416120000 20dB 10W | Lot. 9828 | Radiall | pre-m | 2 | |
| 616 | Digitalmultimeter | Fluke 177 | 88900339 | Fluke | 24 M | - | 30.05.2018 |
| 617 | Power Splitter/Combiner | ZFSC-2-2-S+ | S F987001108 | Mini Circuits | - | 2 | |
| 618 | Power Splitter/Combiner | 50PD-634 | 600994 | JFW Industries USA | - | 2 | |
| 619 | Power Splitter/Combiner | 50PD-634 | 600995 | JFW Industries, USA | - | 3 | |
| 620 | EMI Test Receiver | ESU 26 | 100362 | Rohde-Schwarz | 12 M | - | 30.05.2017 |
| 621 | Step Attenuator 0-139 dB | RSP | 100017 | Rohde & Schwarz | pre-m | 2 | |
| 625 | Generic Test Load USB | Generic Test Load USB | - | CETECOM | - | 2 | |
| 627 | data logger | OPUS 1 | 201.0999.9302.6.4.1.43 | G. Lufft GmbH | 24 M | - | 30.04.2017 |
| 634 | Spectrum Analyzer | FSM (HF-Unit) | 826188/010 | Rohde & Schwarz | pre-m | 2 | |
| 637 | High Speed HDMI with Ethernet 1m | HDMI cable with Ethernet 1m | - | KogiLink | - | 2 | |
| 638 | HDMI Kabel with Ethernet 1,5 m flach | HDMI cable with Ethernet | - | Reichelt | - | 2 | |
| 640 | HDMI cable 2m rund | HDMI cable 2m rund | - | Reichelt | - | 2 | |
| 641 | HDMI cable with Ethernet | Certified HDMI cable with | - | PureLink | - | 2 | |
| 644 | Amplifierer | ZX60-2534M+ | SN865701299 | Mini-Circuits | - | - | |
| 670 | Univ. Radio Communication Tester | CMU 200 | 106833 | Rohde & Schwarz | 24 M | - | 30.05.2018 |
| 671 | DC-power supply 0-5 A | EA-3013S | - | Elektro Automatik | pre-m | 2 | |
| 678 | Power Meter | NRP | 101638 | Rohde&Schwarz | pre-m | - | |
| 683 | Spectrum Analyzer | FSU 26 | 200571 | Rohde & Schwarz | 12 M | - | 30.05.2017 |
| 686 | Field Analyzer | EHP-200A | 160WX30702 | Narda Safety Test Solutions | 24 M | - | 30.04.2017 |
| 687 | Signal Generator | SMF 100A | 102073 | Rohde&Schwarz | 12 M | - | 30.05.2017 |
| 688 | Pre Amp | JS-18004000-40-8P | 1750117 | Miteq | pre-m | - | |
| 690 | Spectrum Analyzer | FSU | 100302/026 | Rohde&Schwarz | 12 M | - | 30.05.2017 |
| 692 | Bluetooth Tester | CBT 32 | 100236 | Rohde & Schwarz | 36 M | - | 31.03.2017 |
| 697 | Power Splitter | ZN4PD-642W-S+ | 165001445 | Mini-Circuits | - | 2 | |
| | | | | | | | |

### 8.1.3. Legend

| Note / remarks | | Calibrated during system calibration: |
|---|---|---|
| | 1a | System CTC-SAR-EMS (Ref.-No. 442) |
| | 1b | System-CTC-EMS-Conducted (Ref.-No. 335) |
| | 1c | System CTC-FAR-EMI-RSE (Ref.-No . 443) |
| | 1d | System CTC-SAR-EMI (Ref.-No . 441) |
| | 1e | System CTC-OATS (EMI radiated) (Ref.-No. 337) |
| | 1 f | System CTC-CTIA-OTA (Ref.-No . 420) |
| | 1 g | System CTC-FAR-EMS (Ref.-No . 444) |
| | 2 | Calibration or equipment check immediately before measurement |
| | 3 | Regulatory maintained equipment for functional check or support purpose |
| | 4 | Ancillary equipment without calibration e.g. mechanical equipment or monitoring equipment |
| | 5 | Test System |

| | | |
|---|---|---|
| Interval of calibration | 12 M | 12 month |
| | 24 M | 24 month |
| | 36 M | 36 month |
| | 24/12 M | Calibration every 24 months, between this every 12 months internal validation |
| | 36/12 M | Calibration every 36 months, between this every 12 months internal validation |
| | Pre-m | Check before starting the measurement |
| | - | Without calibration |

### 8.1.4. Legend

| Note / remarks | | Calibrated during system calibration: |
|---|---|---|
| | 1a | System CTC-SAR-EMS (Ref.-No. 442) |
| | 1b | System-CTC-EMS-Conducted (Ref.-No. 335) |
| | 1c | System CTC-FAR-EMI-RSE (Ref.-No . 443) |
| | 1d | System CTC-SAR-EMI (Ref.-No . 441) |
| | 1e | System CTC-OATS (EMI radiated) (Ref.-No. 337) |
| | 1 f | System CTC-CTIA-OTA (Ref.-No . 420) |
| | 1 g | System CTC-FAR-EMS (Ref.-No . 444) |
| | 2 | Calibration or equipment check immediately before measurement |
| | 3 | Regulatory maintained equipment for functional check or support purpose |
| | 4 | Ancillary equipment without calibration e.g. mechanical equipment or monitoring equipment |
| | 5 | Test System |

| | | |
|---|---|---|
| Interval of calibration | 12 M | 12 month |
| | 24 M | 24 month |
| | 36 M | 36 month |
| | 24/12 M | Calibration every 24 months, between this every 12 months internal validation |
| | 36/12 M | Calibration every 36 months, between this every 12 months internal validation |
| | Pre-m | Check before starting the measurement |
| | - | Without calibration |

# 9. Versions of test report (change history)

| Version | Applied changes | Date of release |
|---|---|---|
| -- | initial release | 2015-12-03 |
| C1 | new antenna gain information | 2016-10-28 |
| C2 | Inclusion of RF-Power conducted measurements and MPE values | 2017-01-18 |