

TEST REPORT
No.: 6-0668-15-3-13c

According to:
FCC Regulations
Part 15.209
Part 15.247

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

for

ACTIA Nordic AB

Telematic unit for automotive use:
ACUII-06

FCC-ID: 2AGKKACUII-06
IC: 20839-ACUII06
PMN: ACUII-06
HVIN: ACUII-06







| Laboratory Accreditation and Listings | | | |
|--|---|--|--|
|  DAkKS Deutsche Akkreditierungsstelle D-PL-12047-01-01 |  FEDERAL COMMUNICATIONS COMMISSION USA • NOISES MRA US-EU 0003 |  Industry Canada Reg. No.: 3462D-1 Reg. No.: 3462D-2 Reg. No.: 3462D-3 |  Voluntary Controls for Electromagnetic Emissions Reg. No.: R-2666 C-2914, T-1967, G-301 |
|  WiFi ALLIANCE AUTHORIZED RF LABORATORY |  ctia Authorized TM Test Lab Lab Code: 20011130-00 | | |
| accredited according to DIN EN ISO/IEC 17025 | | | |
| <p align="center"> 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 </p> | | | |

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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 IEEE 802.11 b/g/n. Other implemented wireless technologies were not considered within this test report.

The build-in W-LAN module is already approved with FCC-ID VPYLB1ES and IC 772C-LB1ES.

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 4th 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 | 1 | For information only |
| 6 dB bandwidth | Antenna terminal (conducted) | §15.247(a)(2) | RSS-247, Chapter 5.2(1) RSS-Gen Issue 4: Chapter 4.6.2 | ≥ 500 kHz for DTS systems | -- | -- | See modules test report remark 1 |
| 99% occupied bandwidth | Antenna terminal (conducted) | 2.1049(h) | RSS-Gen Issue 4: Chapter 6.6 | 99% Power bandwidth | -- | -- | See modules test report remark 1 |
| Transmitter Peak output power | Antenna terminal (conducted) | §15.247(b)(3) | RSS-247, Chapter 5.4(4) | 1 Watt Peak | | | passed |
| 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 | 3 | 1+2+3 | Only calculation |
| Out-Of-Band RF- emissions Band-Edge emissions | Antenna terminal (conducted) | §15.247 (d) | RSS-247, Chapter 5.5 | 20 dBc | -- | -- | See modules test report remark 1 |
| Power spectral density | Antenna terminal (conducted) | §15.247(e) | RSS-247, Chapter 5.2(2) | 8dBm in any 3 kHz band | -- | -- | See modules test report, remark 1 |

| | | | | | | | |
|---|--|--------------------------------------|---|--|-----|-------|---|
| 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 RSS-Gen: Issue 4: § 8.9 Table 4+5+6 | Emissions in restricted bands must meet the general field-strength radiated limits | 1+2 | 1+2+3 | passed |
| AC-Power Lines 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 IC: Table 3, Chapter 8.8 | -- | -- | Not applicable, DC powered equipment |

Remarks:


1. See test reports RF150713C14 and IC150713C14

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

Remark:

1.2. 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.



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 45219 Essen - Kettwig 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: | 2015-10-13 |
| Date(s) of test: | 2015-12-28, 2016-02-26 |
| Date of report: | 2016-04-20 |
| ----- | |
| Version of template: | 13.02 |

2.4. Applicant's details

| | |
|-------------------|--|
| Applicant's name: | ACTIA Nordic AB |
| Address: | Hammarbacken 4a 19149 Linköping Sweden |
| Contact person: | Mr. Nicklas Andersson |

2.5. Manufacturer's details

| | |
|----------------------|---|
| Manufacturer's name: | ACTIA Automotive |
| Address: | 10 Avenue Edouard Serres Parc Aéronautique BP 60112 31772 Colomiers France |

3. Equipment under test (EUT)

3.1. TECHNICAL DATA OF MAIN EUT DECLARED BY APPLICANT

| | | | |
|--|---|--|--------------------------------------|
| Frequency range (US/Canada -bands) | 2412 MHz (Channel 1) to 2462 MHz (Channel 11) | | |
| Type of modulation | See chapter 3.2 | | |
| Number of channels (USA/Canada -bands) | 1 to 11 | | |
| Antenna Type | <input checked="" type="checkbox"/> Integrated <input type="checkbox"/> External, no RF- connector <input checked="" type="checkbox"/> External, separate RF-connector | | |
| Antenna Gain and Path Loss | Wifi-External (upward) | Max. 3.9 dBi gain according applicants information in 2.4 GHz band Path-Loss of External cables to antenna: 3.6dB Internal Loss: 2.0dB | |
| | Wifi-Internal (downward) | Max. 7.4 dBi gain according applicants information in 2.4 GHz band Path-Loss of External cables to antenna: 3.6dB Internal Loss: 2.0dB | |
| Installed options | <input checked="" type="checkbox"/> GSM 900 and GSM 1800 Bands (not usable in USA/Canada) <input checked="" type="checkbox"/> W-CDMA Band I and Band VIII (not usable in USA/Canada) <input checked="" type="checkbox"/> GPS (not tested within this test report) | | |
| Power supply | <input checked="" type="checkbox"/> DC power only: 13.8 V DC | | |
| Special EMI components | -- | | |
| EUT sample type | <input type="checkbox"/> Production | <input checked="" type="checkbox"/> Pre-Production | <input type="checkbox"/> Engineering |
| FCC label attached | <input type="checkbox"/> yes | <input checked="" type="checkbox"/> no | |

Pls. see applicants document ACUII-06 Technical description, Rev. 1.2, dated 2015-12-22 for further details

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.

| 802.11b-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 |

| 802.11g-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.

| 802.11n-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 Mbps | HT40 (MCS8..MCS9) | Yes |
| 90/120/180/240/270/300 Mbps | HT40 (MCS10..MCS15) | No |

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

| Short description*) | EUT | Type | S/N serial number | HW hardware status | SW software status |
|---------------------|--|-------------------------|----------------------|-------------------------------|--------------------|
| EUT A | Telematic unit for automotive use VCM High LTE US | ACUII-06 | 21790250902642 | C | 13 |
| EUT B | Telematic unit for automotive use VCM High LTE US | ACUII-06 | 21790250902643 | C | 13 |
| EUT C | Multiband Antenna 434-WLAN-GNSS- SDARS-LTE | VCC-Number: 31438105 | SDARS Modified #1 | 15W421 (Portugal AD801) | -- |

*) 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 description *) | Auxiliary Equipment | Type | S/N serial number | HW hardware status | SW software status |
|-------------------------|---|---|-------------------|---|--------------------|
| AE 1 | Main harness | 1007-141-06 | -- | Rev A1.1 1535 Long branch : 2.03 m length Short branch: 0.68m length | -- |
| AE 2 | external SIM card holder | 31324668 | 435614470037 | 826 14W47 1535 | -- |
| AE 3 | Alps SOS/ 2 button device | Type: 19206 30710477 | 06W35T | One button <i>SOS</i> One button <i>ON CALL</i> | -- |
| AE 4 | DLC Ethernet cable + Power Supply White Wire | Maxxtro Patch cable FTP CAT. 5E 26AWG Huber + Suhner Radox 125 | 1007-142-01 | Rev.B1.0 (Length:1.97 m) 0.34 MM2 (Length: 1.85 m) | -- |
| AE 5 | Mikrophone /Louspeaker unit | Integrated in Volvo C99ZA | 39841393AA | -- | -- |
| AE 6 | Antenna power supply cable (Twisted red cable 3-pin MQS) | Huber + Suhner Radox 125 | -- | 0.50 MM2 (Length:2.1 m) | -- |

| | | | | | |
|-------|--|----------------------------------|-----------|---------------------------------------|---|
| AE 7 | WLAN antenna cable (Orange Fakra connectors) | Huber + Suhner Enviroflex 400 | -- | E111025 AWM 522787 (Length: 2m) | -- |
| AE 8 | GNSS antenna cable (Blue Fakra connectors) | Huber + Suhner Enviroflex 400 | -- | E111025 AWM 522787 (Length: 2m) | -- |
| AE 9 | 2G/3G/4G antenna cable (Violet/Bordeaux Fakra connectors) | Huber + Suhner Enviroflex 400 | -- | E111025 AWM 522787 (Length: 2m) | -- |
| AE 10 | 3G/4G Diversity antenna cable (Pink Fakra connectors) | Huber + Suhner Enviroflex 400 | -- | E111025 AWM 522787 (Length: 2m) | -- |
| AE 11 | IHU Ethernet Termination (Navy Blue Fakra connectors) | -- | -- | (Length :0.096 m) | -- |
| AE 12 | Notebook | Dell Latitude E5440 | CTC432012 | -- | Windows 7 + ACTIA PC_Application -V1.1.0.17 |
| AE 13 | Flexray/CAN terminations | 3 pieces | -- | -- | -- |
| AE 14 | Speaker Termination | 1 piece | -- | -- | -- |
| AE 15 | USB cable Termination | resistive | -- | -- | -- |
| AE 16 | UART cable Termination | 3 Wired resistive | -- | -- | -- |
| AE 17 | Apple USB-Ethernet adapter | A1277 | -- | (Length:0.20 m) | -- |

*) AE short description is used to simplify the identification of the auxiliary equipment in this test report.
AE 5/AE17 not used for tests

3.5. EUT set-ups

| EUT set-up no. *) | Combination of EUT and AE | Remarks |
|-------------------|---|--|
| set. 1 | EUT A + EUT C + AE 1 + AE 2 + AE 3 + AE 4 + AE6 + AE 7 + AE 8 + AE 9 + AE10 + AE11+ AE12 + AE 13 + AE14 + AE 15 + AE 16 | Radiated measurements, Downward antenna (internal antenna). Pls. see applicants document <i>ACUII Test Setup for certification Testing, Rev.1.2</i> , dated 2015-12-22. Software 1.1.0.13 used |
| set. 2 | EUT A + EUT C + AE 1 + AE 2 + AE 3 + AE 4 + AE6 + AE 7 + AE 8 + AE 9 + AE10 + AE11+ AE12 + AE 13 + AE14 + AE 15 + AE 16 | Radiated measurements, Upward antenna (external antenna). Pls. see applicants document <i>ACUII Test Setup for certification Testing, Rev.1.2</i> , dated 2015-12-22. Software 1.1.0.13 used |
| set. 3 | EUT A + AE 1 + AE 2 + AE 3 + AE 4 + AE11 + AE12 + AE 13 + AE14 + AE 15 + AE 16 | Conducted RF measurements. Software 1.1.0.13 used |

*) 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 with help of a special firmware software. b-Mode Modulation scheme. For spurious emission tests 1MBit as worst-case from modules test report chosen. Power verification was performed on all modulations data rates. Nominal power value 17dBm. |
| op. 2 | WLAN Continuous TX-Mode (g-Mode) | The EUT was put to continuous transmissions mode with help of a special firmware software. g-Mode Modulation scheme. For spurious emission tests 6MBit as worst-case from modules test report chosen. Power verification was performed on all modulations data rates. Nominal power value 13dBm. |
| op. 3 | WLAN Continuous TX-Mode (n-Mode) | The EUT was put to continuous transmissions mode with help of a special firmware software. n-Mode Modulation scheme. For spurious emission tests MCS0 as worst-case from modules test report chosen. Power verification was performed on all modulations data rates. Nominal power value 13dBm. |

*) 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 | Main harness (AE1) | -- | 1007-141-06 | Rev A1.1 (Length : 2.03 m) | -- |
| Cable 2 | DLC ethernet cable (AE4) | Maxxtro Patch cable FTP CAT. 5E 26AWG | 1007-142-01 | Rev.B1.0 (Length:1.97 m) | |
| Cable 3 | Antenna power supply cable (Twisted red cable 3-pin MQS) | Huber + Suhner Radox 125 | -- | 0.50 MM2 (Length:2.1 m) | |
| Cable 4 | WLAN antenna cable (Orange Fakra connectors) | Huber + Suhner Enviroflex 400 | -- | E111025 AWM 522787 (Length: 2m) | |
| Cable 5 | GNSS antenna cable (Blue Fakra connectors) | Huber + Suhner Enviroflex 400 | -- | E111025 AWM 522787 (Length: 2m) | |
| Cable 6 | 2G/3G/4G antenna cable (Violet/Bordeaux Fakra connectors) | Huber + Suhner Enviroflex 400 | -- | E111025 AWM 522787 (Length: 2m) | -- |
| Cable 7 | 3G/4G Diversity antenna cable (Pink Fakra connectors) | Huber + Suhner Enviroflex 400 | -- | E111025 AWM 522787 (Length: 2m) | -- |

4. Description of test system set-up's

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

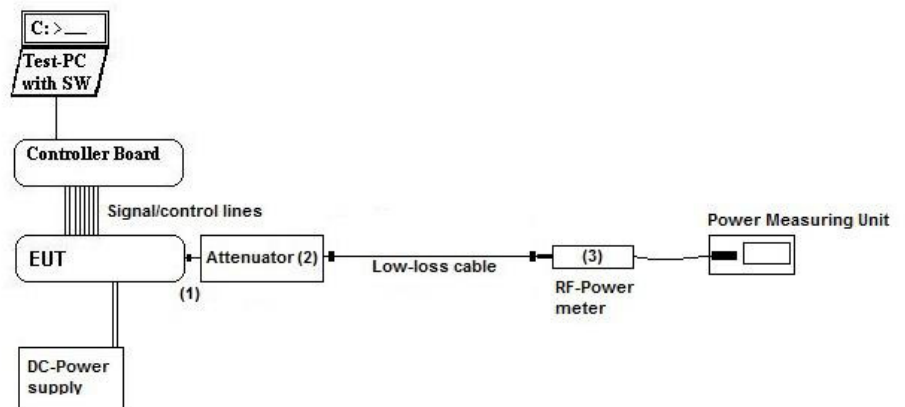
Conducted Set-up W1

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

- 20 dB Attenuator
- Low loss RF-cables

Test Equipment

- Power Meter
- DC-Power Supply
- Spectrum-Analyser

Remark:

See List of equipment under each test case and chapter 8 for calibration info

Measurement uncertainty

See chapter 5.6

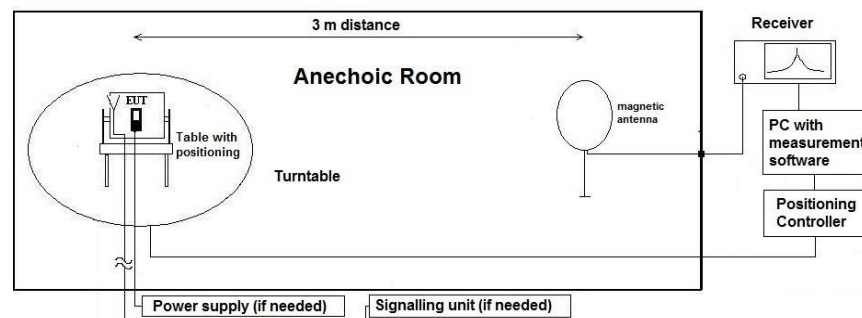
4.2. Test system set-up for radiated magnetic field measurements below 30 MHz

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 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 (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:

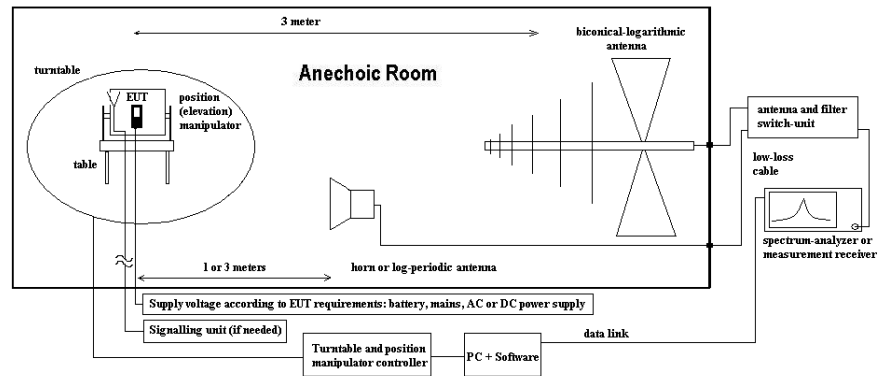
ANSI C63.10:2013, §6.4.4.2 - Equations (2) + (3) + (4)

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 its 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:

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

$$M = L_T - E_C \quad (2)$$

- 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

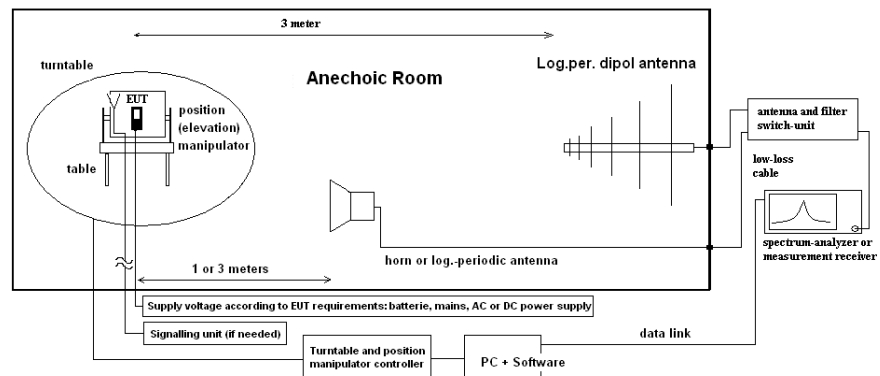
All units are dB-units, positive margin means value is below limit.

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 its 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:

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

$$M = L_T - E_C \quad (2)$$

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 | <input checked="" type="checkbox"/> CETECOM Essen (Chapter. 2.2.1) | <input type="checkbox"/> 443 System CTC-FAR-EMI- | <input type="checkbox"/> Please see Chapter. 2.2.3 |
| test site | <input type="checkbox"/> 441 EMI SAR | <input type="checkbox"/> 487 SAR NSA | <input checked="" type="checkbox"/> 347 Radio.lab. |
| receiver | <input type="checkbox"/> 377 ESCS30 | <input type="checkbox"/> 001 ESS | <input type="checkbox"/> 489 ESU 40 |
| spectr. analys. | <input type="checkbox"/> 584 FSU | <input type="checkbox"/> 120 FSEM | <input type="checkbox"/> 264 FSEK |
| antenna | <input type="checkbox"/> 574 BTA-L | <input type="checkbox"/> 133 EMCO3115 | <input type="checkbox"/> 302 BBHA9170 |
| signaling | <input type="checkbox"/> 392 MT8820A | <input type="checkbox"/> 436 CMU | <input type="checkbox"/> 547 CMU |
| otherwise | <input checked="" type="checkbox"/> 266 NRV-Z31 | <input checked="" type="checkbox"/> 600 NRVD | <input type="checkbox"/> 110 USB LWL |
| DC power | <input type="checkbox"/> 456 EA 3013A | <input checked="" type="checkbox"/> 463 HP3245A | <input type="checkbox"/> 459 EA 2032-50 |
| otherwise | <input type="checkbox"/> 331 HC 4055 | <input type="checkbox"/> 248 6 dB Attenuator | <input type="checkbox"/> 529 Power divider |
| line voltage | <input checked="" type="checkbox"/> 13.8V DC | <input type="checkbox"/> 060 110 V 60 Hz via PAS 5000 | <input checked="" type="checkbox"/> - cable OTA20 |

5.1.2. Reference

| | |
|---------------|--|
| FCC | <input checked="" type="checkbox"/> §15.247(b) (3) + KDB 558074 D01 DTS Meas Guidance v03r04 |
| IC | <input checked="" type="checkbox"/> RSS-247, Chapter 5.4(4) |
| ANSI | <input checked="" type="checkbox"/> ANSI 63.10:2013 |
| Specification | <i>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.</i> |

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): | <input type="checkbox"/> air link | <input type="checkbox"/> cable connection | <input checked="" type="checkbox"/> none |
| EUT-grounding | <input checked="" type="checkbox"/> none | <input type="checkbox"/> with power supply | <input type="checkbox"/> additional connection |
| Equipment set up | <input checked="" type="checkbox"/> table top 1.5m height | <input type="checkbox"/> 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.) <input type="checkbox"/> PK1-Method (§5.2.1.1): RBW > 6dB-bandwidth of the signal, ANSI 63.10: 2009, chapter 6.10.2.1a |
| | §15.247(b) (3) Maximum Average | 2.) <input type="checkbox"/> PK2-Method (§5.2.1.2): Channel integration method (ANSI 63.10:2009) 3.) <input checked="" type="checkbox"/> PK1-Method (§9.1.2 KDB): Peak Power Meter Method 4.) <input type="checkbox"/> AVG1 - power averaging over EBW + integrated band power measurement 5.) <input type="checkbox"/> AVG2 - trace averaging over EBW + integrated band power measurement 6.) <input type="checkbox"/> RMS power meter method |
| | MIMO | 7.) <input type="checkbox"/> 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 than 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 | | <input type="checkbox"/> normal <input type="checkbox"/> 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

APPLICANT'S DECLARED ANTENNA CHARACTERISTICS:

- Directional Gain < 6 dBi (taking cable loss into account)
- Directional Gain > 6 dBi (measured / applicant's declaration) -> conducted power reduction necessary
- Maximum declared antenna gain [isotropic]: 7.4dBi
- Due long cables to antenna a total path loss of 5.6 dB is considered too

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: Op-Mode: | 3 1+2+3 | Low channel = 1 (2412 MHz) | Middle channel = 6 (2437 MHz) | High channel = 11 (2462 MHz) |
| Measured Level b-Mode @1Mbps | | 20.20 | 20.89 | 19.36 |
| Measured Level g-Mode @9Mbps | | 16.85 | 17.41 | 15.46 |
| Measured Level n-Mode @MCS0 | | 17.55 | 17.65 | 17.7 |
| Max. Measured Level | | 20.20 | 20.89 | 19.36 |
| Limit | | 1 Watt (30dBm) Peak | | |

Remark:

- 1.) External Path Loss of measurement set-up-> 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

5.1.6.1. VERDICT: Maximum value of 20.89 dBm Peak conducted (122.74 mW) -> passed

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

5.2.1. Test location and equipment

| | | | |
|-----------------|--|---|--|
| test location | <input checked="" type="checkbox"/> CETECOM Essen (Chapter. 2.2.1) | <input type="checkbox"/> Please see Chapter. 2.2.2 | <input type="checkbox"/> Please see Chapter. 2.2.3 |
| test site | <input checked="" type="checkbox"/> 441 EMI SAR | <input type="checkbox"/> 487 SAR NSA | <input type="checkbox"/> 347 Radio.lab. |
| receiver | <input type="checkbox"/> 377 ESCS30 | <input checked="" type="checkbox"/> 001 ESS | <input type="checkbox"/> |
| spectr. analys. | <input type="checkbox"/> 584 FSU | <input type="checkbox"/> 120 FSEM | <input type="checkbox"/> 264 FSEK |
| antenna | <input type="checkbox"/> 574 BTA-L | <input type="checkbox"/> 133 EMCO3115 | <input type="checkbox"/> 302 BBHA9170 |
| signaling | <input type="checkbox"/> 392 MT8820A | <input type="checkbox"/> 371 CBT32 | <input type="checkbox"/> 547 CMU |
| otherwise | <input type="checkbox"/> 400 FTC40x15E | <input type="checkbox"/> 401 FTC40x15E | <input type="checkbox"/> 110 USB LWL |
| DC power | <input type="checkbox"/> 456 EA 3013A | <input type="checkbox"/> 457 EA 3013A | <input type="checkbox"/> 459 EA 2032-50 |
| line voltage | <input checked="" type="checkbox"/> 12V DC | <input type="checkbox"/> 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 | | Distance [m] | Remarks |
| | [μ V/m] | [dB μ V/m] | | |
| 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): | <input type="checkbox"/> air link | <input type="checkbox"/> cable connection | <input checked="" type="checkbox"/> none |
| EUT-grounding | <input checked="" type="checkbox"/> none | <input type="checkbox"/> with power supply | <input type="checkbox"/> additional connection |
| Equipment set up | <input checked="" type="checkbox"/> table top | | <input type="checkbox"/> floor standing |
| Climatic conditions | Temperature: (22 \pm 3°C) | | Rel. humidity: (40 \pm 20)% |
| EMI-Receiver or Analyzer Settings | Scan data | <input checked="" type="checkbox"/> 9 – 150 kHz RBW/VBW = 200 Hz Scan step = 80 Hz <input checked="" type="checkbox"/> 150 kHz – 30 MHz RBW/VBW = 9 kHz Scan step = 4 kHz <input type="checkbox"/> other: | |
| | Scan-Mode Detector Mode: Sweep-Time | <input checked="" type="checkbox"/> 6 dB EMI-Receiver Mode <input type="checkbox"/> 3dB Spectrum analyser Mode Peak (pre-measurement) and Quasi-PK/Average (final if applicable) Repetitive-Scan, max-hold 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.

The EUT is put on operation on middle channel only. If critical peaks are found (Margin <10 dB) the lowest and highest channels will be performed too. For more information please see the diagrams in annex 1. B-Mode with a data rate of 1Mbit was chosen as worst-case setting (regarding power mode)

Table of measurement results:

| Diagram No. | Carrier Channel | | Frequency range | Set-up no. | OP-mode no. | Remark | Used detector | | | Result |
|-------------|-----------------|-----|-----------------|------------|-------------|--|-------------------------------------|--------------------------|--------------------------|--------|
| | Range | No. | | | | | PK | AV | QP | |
| 2.01 Down | Middle | 6 | 9 kHz-30 MHz | 1 | 1 | b-Mode, 17dBm power setting, Downward WLAN Antenna | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | passed |
| 2.01Up | Middle | 6 | 9 kHz-30 MHz | 2 | 1 | b-Mode, 17dBm power setting, Upward WLAN Antenna | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | passed |

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

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

5.3.1. Test location and equipment

| | | | |
|-----------------|--|---|--|
| test location | <input checked="" type="checkbox"/> CETECOM Essen (Chapter. 2.2.1) | <input type="checkbox"/> Please see Chapter. 2.2.2 | <input type="checkbox"/> Please see Chapter. 2.2.3 |
| test site | <input checked="" type="checkbox"/> 441 EMI SAR | <input checked="" type="checkbox"/> 487 SAR NSA | |
| receiver | <input type="checkbox"/> 377 ESCS30 | <input checked="" type="checkbox"/> 001 ESS | <input type="checkbox"/> 489 ESU 40 <input type="checkbox"/> 620 ESU 26 |
| spectr. analys. | <input type="checkbox"/> 584 FSU | <input type="checkbox"/> 120 FSEM | <input type="checkbox"/> 264 FSEK |
| antenna | <input checked="" type="checkbox"/> 574 BTA-L | <input type="checkbox"/> 133 EMCO3115 | <input type="checkbox"/> 302 BBHA9170 <input type="checkbox"/> 289 CBL 6141 <input type="checkbox"/> 030 HFH-Z2 <input type="checkbox"/> 477 GPS |
| signaling | <input type="checkbox"/> 392 MT8820A | <input type="checkbox"/> 371 CBT32 | <input type="checkbox"/> 547 CMU <input type="checkbox"/> 594 CMW |
| otherwise | <input type="checkbox"/> 400 FTC40x15E | <input type="checkbox"/> 401 FTC40x15E | <input type="checkbox"/> 110 USB LWL <input checked="" type="checkbox"/> 482 Filter Matrix |
| DC power | <input type="checkbox"/> 456 EA 3013A | <input type="checkbox"/> 457 EA 3013A | <input type="checkbox"/> 459 EA 2032-50 <input type="checkbox"/> 268 EA- 3050 <input type="checkbox"/> 494 AG6632A <input type="checkbox"/> 498 NGPE |
| line voltage | <input checked="" type="checkbox"/> 12V DC | <input type="checkbox"/> 060 120 V 60 Hz via PAS 5000 | |

5.3.2. Requirements/Limits

| | | | |
|--------------|-----------------|--|---------------------------|
| FCC | | <input type="checkbox"/> Part 15 Subpart B, §15.109, class B <input checked="" type="checkbox"/> Part 15 Subpart C, §15.209 @ frequencies defined in §15.205 | |
| IC | | <input type="checkbox"/> RSS-Gen., Issue 4, Chapter 8.9, Table 4+6 (licence-exempt radio apparatus) <input type="checkbox"/> RSS-Gen., Issue 4, Chapter 7.1.2, Table 2 (receiver) <input type="checkbox"/> ICES-003, Issue 6, Table 5 (Class B) <input checked="" type="checkbox"/> RSS-247, Issue 1, Chapter 5 | |
| ANSI | | <input checked="" type="checkbox"/> C63.4-2014 <input type="checkbox"/> C63.10-2013 | |
| Limit | Frequency [MHz] | Radiated emissions limits, 3 meters | |
| | | QUASI Peak [μ V/m] | QUASI-Peak [dB μ V/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): | | <input type="checkbox"/> air link | <input type="checkbox"/> cable connection | <input checked="" type="checkbox"/> none |
| EUT-grounding | | <input checked="" type="checkbox"/> none | <input type="checkbox"/> with power supply | <input type="checkbox"/> additional connection |
| Equipment set up | | <input checked="" type="checkbox"/> table top 0.8m height | | <input type="checkbox"/> floor standing |
| Climatic conditions | | Temperature: (22±3°C) | | Rel. humidity: (40±20)% |
| EMI-Receiver (Analyzer) Settings | Scan frequency range: | <input checked="" type="checkbox"/> 30 – 1000 MHz <input type="checkbox"/> other: | | |
| | Scan-Mode | <input checked="" type="checkbox"/> 6 dB EMI-Receiver Mode <input type="checkbox"/> 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.

B-Mode with a data rate of 1Mbit was chosen as worst-case setting (regarding power mode)

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 Dwn | Middle | 6 | 30 MHz – 1 GHz | 1 | 1 | b-Mode, 17dBm power setting, Downward WLAN Antenna | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | passed |
| 3.01 Up | Low | 6 | 30 MHz – 1 GHz | 2 | 1 | b-Mode, 17dBm power setting, Upward WLAN Antenna | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input checked="" type="checkbox"/> | passed |

Remark:

5.4. General Limit - Radiated emissions, above 1 GHz

5.4.1. Test location and equipment FAR

| | | | | | | |
|-----------------|--|--|---|---|--|----------------------------------|
| test site | <input type="checkbox"/> 441 EMI SAR | <input type="checkbox"/> 348 EMI cond. | <input checked="" type="checkbox"/> 443 EMI FAR | <input type="checkbox"/> 347 Radio.lab. | <input type="checkbox"/> 337 OATS | <input type="checkbox"/> |
| spectr. analys. | <input type="checkbox"/> 584 FSU | <input type="checkbox"/> 120 FSEM | <input type="checkbox"/> 264 FSEK | <input checked="" type="checkbox"/> 489 ESU 40 | <input type="checkbox"/> | <input type="checkbox"/> |
| antenna meas | <input type="checkbox"/> 574 BTA-L | <input type="checkbox"/> 289 CBL 6141 | <input type="checkbox"/> 608 HL 562 | <input checked="" type="checkbox"/> 549 HL025 | <input checked="" type="checkbox"/> 302 BBHA9170 | <input type="checkbox"/> 477 GPS |
| antenna meas | <input type="checkbox"/> 123 HUF-Z2 | <input type="checkbox"/> 132 HUF-Z3 | <input type="checkbox"/> 030 HFH-Z2 | <input checked="" type="checkbox"/> 376 BBHA9120E | <input type="checkbox"/> | <input type="checkbox"/> |
| antenna subst | <input type="checkbox"/> 071 HUF-Z2 | <input type="checkbox"/> 020 EMCO3115 | <input type="checkbox"/> 063 LP 3146 | <input type="checkbox"/> 303 BBHA9170 | <input type="checkbox"/> | <input type="checkbox"/> |
| multimeter | <input type="checkbox"/> 341 Fluke 112 | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| signaling | <input type="checkbox"/> 392 MT8820A | <input type="checkbox"/> 371 CBT32 | <input type="checkbox"/> 547 CMU | <input type="checkbox"/> 594 CMW | <input type="checkbox"/> | <input type="checkbox"/> |
| DCpower | <input type="checkbox"/> 086 LNG50-10 | <input type="checkbox"/> 087 EA3013 | <input type="checkbox"/> 354 NGPE 40 | <input type="checkbox"/> 349 car battery | <input type="checkbox"/> 350 Car battery | <input type="checkbox"/> |
| line voltage | <input checked="" type="checkbox"/> 12V DC | | <input type="checkbox"/> 060 120 V 60 Hz via PAS 5000 | | | |

5.4.2. Requirements/Limits (CLASS B equipment)

| | | | | |
|---|--|----------------|----------------|----------------------------------|
| FCC | <input type="checkbox"/> Part 15 Subpart B, §15.109 class B <input checked="" type="checkbox"/> Part 15 Subpart C, §15.209 for frequencies defined in §15.205 <input type="checkbox"/> Part 15 Subpart C, §15.407(b)(1)(2)(3) 9 | | | |
| IC | <input checked="" type="checkbox"/> RSS-Gen., Issue 4, Chapter 8.9, Table 4+6 (transmitter licence exempt) <input type="checkbox"/> RSS-Gen., Issue 4, Chapter 8.9, Table 2 (receiver) <input type="checkbox"/> ICES-003, Issue 6, Chapter 6.2.2, Table 7 (class B) <input checked="" type="checkbox"/> RSS-247, Issue 1, Chapter 6 | | | |
| ANSI | <input type="checkbox"/> C63.4-2014 <input checked="" type="checkbox"/> 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 link to test system (if used): | <input type="checkbox"/> air link | <input type="checkbox"/> cable connection | <input checked="" type="checkbox"/> none |
| EUT-grounding | <input checked="" type="checkbox"/> none | <input type="checkbox"/> with power supply | <input type="checkbox"/> additional connection |
| Equipment set up | <input checked="" type="checkbox"/> table top 1.5m height | | <input type="checkbox"/> floor standing |
| Climatic conditions | Temperature: (22±3°C) | | Rel. humidity: (40±20)% |
| Spectrum-Analyzer settings | Scan frequency range: <input checked="" type="checkbox"/> 1 – 18 GHz <input type="checkbox"/> 18 – 25 GHz <input type="checkbox"/> 18 – 40 GHz <input type="checkbox"/> other: <input checked="" type="checkbox"/> 6 dB EMI-Receiver Mode <input type="checkbox"/> 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.

| Diagram no. | Carrier Channel | | Frequency range | Set-up no. | OP-mode no. | Remark | Used detector | | | Result |
|--------------|-----------------|-----|-----------------|------------|-------------|---|-------------------------------------|-------------------------------------|--------------------------|--------|
| | Range | No. | | | | | PK | AV | QP | |
| 4.01 Down | Low | 1 | 1-18GHz | 1 | 2 | g-Mode, 13dBm power setting, Downward WLAN Antenna | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> | passed |
| 4.06 Down | | | 18-25GHz | | | | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> | passed |
| 4.01 Up | Low | 1 | 1-18GHz | 2 | 2 | g-Mode, 13dBm power setting, Upward WLAN Antenna | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> | passed |
| 4.06 Up | | | 18-25GHz | | | | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> | passed |
| 4.03 Dwn | Middle | 6 | 1-18GHz | 1 | 1 | b-Mode, 17dBm power setting, Downward WLAN Antenna | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> | passed |
| 4.07 Down | | | 18-25GHz | | | | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> | passed |
| 4.03 Up | Middle | 6 | 1-18GHz | 2 | 1 | b-Mode, 17dBm power setting, Upward WLAN Antenna | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> | passed |
| 4.07 Up | | | 18-25GHz | | | | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> | passed |
| 4.05 Down | High | 11 | 1-18GHz | 1 | 1 | b-Mode, 17dBm power setting, Downward WLAN Antenna | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> | passed |
| 4.08 Down | | | 18-25GHz | | | | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> | passed |
| 4.05 Up | High | 11 | 1-18GHz | 2 | 1 | b-Mode, 17dBm power setting, Upward WLAN Antenna | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> | passed |
| 4.08 Up | | | 18-25GHz | | | | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> | passed |

Remark: see diagrams in annex 1 for more details

5.5. RF-Parameter - Radiated Band Edge compliance measurements

5.5.1. Test location and equipment FAR

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

5.5.2. Requirements/Limits

| | |
|-------------|--|
| FCC | <input type="checkbox"/> Part 15 Subpart B, §15.109 class B <input checked="" type="checkbox"/> Part 15 Subpart C, §15.209 @ frequencies defined in §15.205 |
| IC | <input type="checkbox"/> RSS-210, Issue 8, Annex 8 <input checked="" type="checkbox"/> RSS-247, Issue 1, Chapter 5.5; RSS-Gen: Issue 4: §8.9 Table 4+5+6 <input checked="" type="checkbox"/> RSS-Gen: Issue 4: §8.9, Table 4+6 |
| ANSI | <input type="checkbox"/> C63.4-2014 <input checked="" type="checkbox"/> C63.10-2013, Chapter 6.10.6 |

5.5.3. Test condition and measurement test set-up

| | | | |
|---------------------------------------|---|---|--|
| Signal link to test system (if used): | <input type="checkbox"/> air link | <input type="checkbox"/> cable connection | <input checked="" type="checkbox"/> none |
| EUT-grounding | <input checked="" type="checkbox"/> none | <input type="checkbox"/> with power supply | <input type="checkbox"/> additional connection |
| Equipment set up | <input checked="" type="checkbox"/> table top 1.5m height | | <input type="checkbox"/> floor standing |
| Climatic conditions | Temperature: (22±3°C) | | Rel. humidity: (40±20)% |
| Spectrum-Analyzer settings | Scan frequency range: | <input type="checkbox"/> 1 – 18 GHz <input type="checkbox"/> 18 – 25 GHz <input type="checkbox"/> 18 – 40 GHz <input checked="" type="checkbox"/> other: see diagrams | |
| | Scan-Mode | <input type="checkbox"/> 6 dB EMI-Receiver Mode <input checked="" type="checkbox"/> 3 dB Spectrum analyser Mode | |
| | Detector | Peak and Average | |
| | RBW/VBW | Left band-edge: 100kHz/300kHz | |
| | Mode: | Right band-edge: 1 MHz / 3 MHz (Step2: Marker Delta Method: RBW=30kHz) | |
| | Scan step | Repetitive-Scan, max-hold | |
| | Sweep-Time | 40kHz or 400 kHz | |
| General measurement procedures | Coupled – calibrated display if CW signal otherwise adapted to EUT’s individual duty-cycle | | |
| | 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 maximum intended power 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 FCC §15.247 and RSS-247, Issue 1, Chapter 5.5

| Diagram No. | 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 | | | | | | |
| 9.01_Dwn | 1 | no | 99,83 | 92,01 | 61,94 | 37,89 | 20 | 17,89 | PASS | b-Mode, PWR-VALUE=17 dBm used Dow nw ard antenna |
| 9.01_Up | 1 | no | 97,04 | 89,3 | 62,11 | 34,93 | 20 | 14,93 | PASS | b-Mode, PWR-VALUE=17 dBm used Upw ard antenna |
| 9.02_Dwn | 1 | no | 90,23 | 83,88 | 56,56 | 46,48 | 20 | 26,48 | PASS | g-Mode, PWR-Value=13dBm used dow nw ard antenna, 6Mbit |
| 9.02_Up | 1 | no | 88,39 | 81,7 | 56,14 | 32,25 | 20 | 12,25 | PASS | g-Mode, PWR-Value=13dBm used upw ard antenna, 6Mbit |
| 9.03_Dwn | 1 | no | 90,61 | 81,22 | 57,00 | 46,48 | 20 | 26,48 | PASS | g-Mode, PWR-Value=13dBm used dow nw ard antenna, MCS0 |
| 9.03_Up | 1 | no | 88,42 | 79,83 | 58,00 | 46,48 | 20 | 26,48 | PASS | g-Mode, PWR-Value=13dBm used upw ard antenna, MCS0 |
| 9.13_Dwn | 1 | no | 90,19 | 83,58 | 56,57 | 33,62 | 20 | 13,62 | PASS | g-Mode, PWR-Value=13dBm used, dow nw ard antenna, 9Mbit |
| 9.13_Up | 1 | no | 89,68 | 82,94 | 56,82 | 32,86 | 20 | 12,86 | PASS | g-Mode, PWR-Value=13dBm used, upw ard antenna, 9Mbit |

Remark:

pls. see annex 1 for results

Duty-Cycle correction factor > 98% -> no average correction factor necessary

5.5.6.2. Restricted bands near-by (§15.205 with limits accord. FCC §15.209) and (RSS-Gen, Issue 4, Chapter 8.10)

| Diagram No. | 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 | | |
| 9.04Down | 11 | yes | 103,36 | 100,93 | 64,19 | 46,16 | 74 | 54 | 9,81 | 7,84 | PASS | b-Mode, PWR-VALUE=17 dBm used Dow nw ard antenna |
| 9.04Up | 11 | yes | 100,31 | 97,35 | 57,36 | 46,25 | 74 | 54 | 16,64 | 7,75 | PASS | b-Mode, PWR-VALUE=17 dBm used Upw ard antenna |
| 9.07_Down | 11 | yes | 104,37 | 95,77 | 61,28 | 52,45 | 74 | 54 | 12,72 | 1,55 | PASS | g-Mode, PWR-VALUE=13 dBm used Dow nw ard antenna, DELTA Marker = 43.09dB |
| 9.11_Up | 11 | yes | 102,21 | 93,66 | 60,33 | 51,79 | 74 | 54 | 13,67 | 2,21 | PASS | g-Mode, PWR-VALUE=13 dBm used Upw ard antenna, Delta Marker = 41.87dB |
| 9.09_Up | 11 | yes | 100,89 | 92,55 | 59,1 | 50,76 | 74 | 54 | 14,9 | 3,24 | PASS | n-Mode, PWR-VALUE=13 dBm used Upw ard antenna, Delta Marker = 41.87dB |
| 9.10_Down | 11 | yes | 104,29 | 95,8 | 59,46 | 50,97 | 74 | 54 | 14,54 | 3,03 | PASS | n-Mode, PWR-VALUE=13 dBm used Dow nw ard antenna, Delta Marker = 44.83dB |

Remark:

pls. see annex 1 for results

Duty-Cycle correction factor > 98% -> no average correction factor necessary

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 150 kHz - 30 MHz | 4.0 dB 3.6 dB | | | | | | - |
| Radiated emissions Enclosure | CISPR 16-2-3 | 30 MHz - 1 GHz 1 GHz - 18 GHz | 4.2 dB 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 | 5.0 dB | | | | | | Magnetic field E-field Substitution |
| | | 30 MHz - 1 GHz | 4.2 dB | | | | | | |
| | | 1 GHz - 20 GHz | 3.17 dB | | | | | | |

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 |
| 337 487 558 348 348 | MRA US-EU 0003 | Radiated Measurements 30 MHz to 1 GHz, 3 m / 10 m (OATS) Radiated Measurements 30 MHz to 1 GHz, 3 m (SAR) Radiated Measurements above 1 GHz, 3 m (FAR) Mains Ports Conducted Interference Measurements Telecommunication Ports Conducted Interference Measurment. | FCC, Federal Communications Commission Laboratory Division, USA |
| 337 487 550 558 | 3462D-1 3462D-2 3462D-2 3462D-3 | Radiated Measurements 30 MHz to 1 GHz, 3 m / 10 m (OATS) Radiated Measurements 30 MHz to 1 GHz, 3 m (SAR) Radiated Measurements 1 GHz to 6 GHz, 3 m (SAR) Radiated Measurements above 1 GHz, 3 m (FAR) | IC, Industry Canada Certification and Engineering Bureau |
| 487 550 348 348 | R-2666 G-301 C-2914 T-1967 | Radiated Measurements 30 MHz to 1 GHz, 3 m (SAR) Radiated Measurements 1 GHz to 6 GHz, 3 m (SAR) Mains Ports Conducted Interference Measurements Telecommunication Ports Conducted Interference Measurment. | 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

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

8.0.1. 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 |
| 264 | Spectrum Analyzer | FSEK 30 | 826939/005 | Bios=2.1, Analyzer= 3.20 |
| 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 |
| 331 | Climatic Test Chamber -40/+80 Grad | HC 4055 | 43146 | TSI 1.53 |
| 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 | - | 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 |
| 692 | Bluetooth Tester | CBT 32 | 100236 | CBT V 5.40, FW: V.2.41 (FPGA Digital, V. 3.09 FPGA RF) |

8.0.2. 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 | - | 30.04.2016 |
| 005 | AC - LISN (50 Ohm/50µH, test site 1) | ESH2-Z5 | 861741/005 | Rohde & Schwarz | 12 M | - | 30.04.2016 |
| 007 | Single-Line V-Network (50 Ohm/5µH) | ESH3-Z6 | 892563/002 | Rohde & Schwarz | 12 M | - | 30.04.2016 |
| 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 | - | 31.03.2016 |
| 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 | |
| 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 | |
| 090 | Helmholtz coil: 2x10 coils in series | Helmholtz coil: 2x10 coils in | - | RWTÜV | 24 M | 4 | 31.03.2016 |
| 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 | - | 31.03.2016 |
| 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 | - | 31.03.2016 |
| 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 | - | 31.03.2016 |
| 262 | Power Meter | NRV-S | 825770/0010 | Rohde & Schwarz | 24 M | - | 31.03.2016 |
| 263 | Signal Generator | SMP 04 | 826190/0007 | Rohde & Schwarz | 36 M | - | 31.03.2016 |
| 264 | Spectrum Analyzer | FSEK 30 | 826939/005 | Rohde & Schwarz | 12 M | - | 30.04.2016 |
| 265 | peak power sensor | NRV-Z33, Model 04 | 840414/009 | Rohde & Schwarz | 24 M | - | 31.03.2016 |
| 266 | Peak Power Sensor | NRV-Z31, Model 04 | 843383/016 | Rohde & Schwarz | 24 M | - | 31.03.2016 |
| 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 | 30.09.2016 |
| 291 | high pass filter GSM 850/900 | WHJ 2200-4EE | 14 | Wainwright GmbH | 12 M | 1c | 30.09.2016 |
| 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 | - | 30.04.2016 |
| 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 | 24 M | - | 30.12.2016 |
| 341 | Digital Multimeter | Fluke 112 | 81650455 | Fluke | 24 M | - | 31.03.2016 |
| 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 | - | 31.03.2016 |
| 356 | power sensor | NRV-Z1 | 882322/014 | Rohde & Schwarz | 24 M | - | 31.03.2016 |
| 357 | power sensor | NRV-Z1 | 861761/002 | Rohde & Schwarz | 24 M | - | 30.04.2017 |
| 371 | Bluetooth Tester | CBT32 | 100153 | R&S | 24 M | - | 31.03.2016 |
| 373 | Single-Line V-Network (50 Ohm/5µH) | ESH3-Z6 | 100535 | Rohde & Schwarz | 24 M | - | 30.04.2017 |
| 377 | EMI Test Receiver | ESCS 30 | 100160 | Rohde & Schwarz | 12 M | - | 30.04.2016 |
| 389 | Digital Multimeter | Keithley 2000 | 0583926 | Keithley | 24 M | - | 30.04.2017 |
| 392 | Radio Communication Tester | MT8820A | 6K00000788 | Anritsu | 12 M | - | 30.04.2016 |
| 431 | Model 7405 | Near-Field Probe Set | 9305-2457 | EMCO | - | 4 | |
| 436 | Univ. Radio Communication Tester | CMU 200 | 103083 | Rohde & Schwarz | 12 M | - | 30.04.2016 |
| 439 | UltraLog-Antenna | HL 562 | 100248 | Rohde & Schwarz | 36 M | - | 31.03.2017 |
| 441 | CTC-SAR-EMI Cable Loss | System EMI field (SAR) Cable | - | CETECOM | 12 M | 5 | 30.01.2016 |

| Ref.-No. | Equipment | Type | Serial-No. | Manufacturer | Interval of calibration | Remark | Cal due |
|----------|---|-----------------------------|-------------------------|-----------------------------|-------------------------|--------|------------|
| 443 | CTC-FAR-EMI-RSE | System CTC-FAR-EMI-RSE | - | ETS-Lindgren / CETECOM | 12 M | 5 | 30.09.2016 |
| 448 | notch filter WCDMA_FDD II | WRCT 1850.0/2170.0-5/40- | 5 | Wainwright Instruments GmbH | 12 M | 1c | 30.09.2016 |
| 449 | notch filter WCDMA FDD V | WRCT 824.0/894.0-5/40-8SSK | 1 | Wainwright | 12 M | 1c | 30.09.2016 |
| 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 | |
| 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 | - | 30.04.2016 |
| 463 | Universal source | HP3245A | 2831A03472 | Agilent | - | 4 | |
| 466 | Digital Multimeter | Fluke 112 | 89210157 | Fluke USA | 24 M | - | 31.03.2016 |
| 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 | - | 30.09.2016 |
| 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 | - | 30.04.2016 |
| 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 | Wainwright | 12 M | 1c | 30.09.2016 |
| 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 | - | 30.04.2016 |
| 547 | Univ. Radio Communication Tester | CMU 200 | 835390/014 | Rohde & Schwarz | 12 M | - | 30.04.2016 |
| 548 | Digital-Barometer | GBP 2300 | without | Greisinger GmbH | - | - | |
| 549 | Log.Per-Antenna | HL025 | 1000060 | Rohde & Schwarz | 36 M | - | 31.07.2018 |
| 552 | high pass filter 2,8-18GHz | WHKX 2.8/18G-10SS | 4 | Wainwright | 12 M | 1c | 30.09.2016 |
| 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 | - | 30.09.2016 |
| 574 | Biconilog Hybrid Antenna | BTA-L | 980026L | Frankonia | 36/12 M | - | 31.03.2016 |
| 584 | Spectrum Analyzer | FSU 8 | 100248 | Rohde & Schwarz | pre-m | - | |
| 594 | Wideband Radio Communication Tester | CMW 500 | 101757 | Rohde & Schwarz | 12 M | - | 30.04.2016 |
| 597 | Univ. Radio Communication Tester | CMU 200 | 100347 | Rohde & Schwarz | 36 M | - | 31.03.2016 |
| 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 | - | 31.03.2016 |
| 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 | |
| 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 | 201.0999.9302.6.4.1.4 3 | G. Luft 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 | |
| 642 | Wideband Radio Communication Tester | CMW 500 | 126089 | Rohde&Schwarz | 12 M | - | 30.04.2016 |
| 644 | Amplifierer | ZX60-2534M+ | SN865701299 | Mini-Circuits | - | - | |
| 670 | Univ. Radio Communication Tester | CMU 200 | 106833 | Rohde & Schwarz | 24 M | - | 31.03.2016 |
| 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 | - | 30.04.2016 |
| 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 | - | 30.04.2016 |

| Ref.-No. | Equipment | Type | Serial-No. | Manufacturer | Interval of calibration | Remark | Cal due |
|----------|------------------|-------------------|------------|-----------------|-------------------------|--------|------------|
| 688 | Pre Amp | JS-18004000-40-8P | 1750117 | Miteq | pre-m | - | |
| 692 | Bluetooth Tester | CBT 32 | 100236 | Rohde & Schwarz | 24 M | - | 31.03.2016 |
| 697 | Power Splitter | ZN4PD-642W-S+ | 165001445 | Mini-Circuits | - | 2 | |

8.0.3. 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 |

9. Versions of test reports (change history)

| Version | Applied changes | Date of release |
|---------|-----------------|-----------------|
| -- | Initial release | 2016-04-20 |
| -- | -- | -- |