# T E S T  R E P O R T
# No.: 16-1-0050601T35a

According to:
**FCC Regulations**
Part 22, Part 27

for

peiker acustic GmbH & Co. KG

GSM/ WCDMA/ LTE Telematics ROW Module
V1233-0

FCC-ID: QWY-V1233-0

| Laboratory Accreditation and Listings | | |
|---|---|---|
| DAkkS Deutsche Akkreditierungsstelle D-PL-12047-01-01<br>Accredited EMC-Test Laboratory | Industry Canada<br>Reg. No.: 3462D-1<br>Reg. No.: 3462D-2<br>Reg. No.: 3462D-3 | Voluntary Controls for Electromagnetic Emissions<br>Reg. No.:<br>R-20013, C-20009,<br>T-20006, G-20013 |
| Wi Fi ALLIANCE AUTHORIZED RF LABORATORY | ctia Authorized™ Test Lab<br>Lab Code: 20011130-00 | FCC<br>MRA US-EU 0003 |
| accredited according to DIN EN ISO/IEC 17025 | | |


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Laboratory Accreditation and Listings

# Table of contents

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

1.1. TX mode, Test overview of FCC and Canada IC (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. EUT: Type, S/N etc. and short descriptions used in this test report 7
3.3. Auxiliary Equipment (AE): Type, S/N etc. and short descriptions 8
3.4. EUT set-ups 8
3.5. Configuration of cables used for testing 8
3.6. EUT operating modes 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 AC power-line conducted emission measurements 12
4.3. Test system set-up for radiated magnetic field measurements below 30 MHz 13
4.4. Test system set-up for radiated spurious emission measurements 14

**5. MEASUREMENTS** **15**

5.1. **RF-Parameter - RF Peak power output conducted and PAPR** 15
5.2. **RF-Parameter - Occupied bandwidth and emission bandwidth** 22
5.3. **RF-Parameter - Conducted out of Band RF emissions and Band Edge** 26
5.4. **RF-Parameter - Frequency stability on temperature and voltage variations** 37
5.5. General Limit - Radiated field strength emissions below 30 MHz 46
5.6. Measurement uncertainties 48

**6. ABBREVIATIONS USED IN THIS REPORT** **49**

**7. ACCREDITATION DETAILS OF CETECOM'S LABORATORIES AND TEST SITES** **49**

**8. INSTRUMENTS AND ANCILLARY** **50**

8.1. Used equiment "CTC" 50

**9. VERSIONS OF TEST REPORTS (CHANGE HISTORY)** **53**

# Table of annex

**Total pages**

**Annex 1: Test result diagrams** (separate document) CETECOM_TR16-1-0050601T35a-A1 218

**Annex 2: External photographs of EUT** (separate document) CETECOM_TR16_1_0050601T38a-A2 6

**Annex 3: Internal photographs of EUT** (separate document) --

**Annex 4: Test set-up photographs** (separate document) CETECOM_TR16_1_0050601T38a-A4 5

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 surveilance tests.**

The Equipment Under Test (in this report, hereinafter referred as EUT) supports radiofrequency technologies. This test report shows results for LTE technologies only. Other implemented wireless technologies were not considered within this test report.

Following tests have been performed to show compliance with applicable FCC Part 2, Part 22, Subpart Hand Part 27, Subpart C of the FCC CFR Title 47 Rules, Edition 4th November 2014.

## 1.1. TX mode, Test overview of FCC and Canada IC (RSS) Standards

| No. of Diagram group | Test case | Port | References & Limits | | EUT set-up | EUT op-mode | Result |
|---|---|---|---|---|---|---|---|
| | | | FCC Standard | Test limit | | | |
| 1 | AC-Power Lines Emissions Conducted<br>(0,15 - 30 MHz) | AC-Power lines<br>(conducted) | Part 15, Subpart C §15.207 | §15.207 limits<br>IC: Table 3, Chapter 8.8 | -- | -- | Remark 1.) |
| 2 | General field strength emissions (9 kHz - 30 MHz) | Cabinet + inter-connecting cables<br>(radiated) | §15.209(a) | 2400/F(kHz) µV/m<br>24000/F(kHz) µV/m<br>30 µV/m | 2 | 1+2 | Not performed |
| 7 | E(I)RP Power | | §2.1046 §22.913(a)(2) | < 7 Watt (ERP) | 2 | 1+2 | Pass (calculated with conducted vlaues and delivered antenna gain) |
| | | | §27.50 (d)(4) | < 1 Watt (EIRP) | | | |
| 8 | Spurious emissions | | §2.1053(a) §2.1057 | 43+10log(P) dBc | 2 | 1+2 | passed |
| | | | §22.917(a)(b) | | | | |
| 9 | Band-Edge compliance | | §27.53(h)(1)(3) (i)(ii)(iii) | | 2 | 1+2 | passed |
| | | | §27.53(g) | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 30 | RF Power | Antenna terminal (conducted) | §2.1046 | N/A | 1 | 1+2 | passed |
| 34 | 26dB Emission bandwidth | | §2.1049(h) | 26dBc Emissions BW<br>99% Power | 1 | 1+2 | For information only |
| 35 | 99% Occupied bandwidth | | | | | | |
| 36 | Spurious emissions | | §2.1051<br>§2.1057<br><br>§27.53 | 43+10log(P) dBc | | | passed |
| 37 | Band-Edge compliance | | | | | | Passed |
| 38 | Frequency stability | | §2.1055(a)(2)<br><br>§27.54 | < ±2.5ppm | 3 | 1+2 | Passed 2.) |

1.) EUT intended for car environment only
2.) Tests only performed across extreme voltage rang for information: limited approval
OEM integrators should consult grant and applicants recommendations on power supply design rules.

Digital unterschrieben von Rachid Acharkaoui
DN: cn=Rachid Acharkaoui, o=CETECOM GmbH, ou=RC&EMC, email=rachid.acharkaoui@cetecom.com, c=DE
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Date: 2017.09.20 12:53:08 +02'00'

Dipl.-Ing. Rachid Acharkaoui
Responsible for test section

B.Eng. Martin Nunier
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

| | |
|---|---|
| Project leader: | Dipl.-Ing. Mario Schmidt-Mecklenbrauck |
| Responsible for test report: | M. Nunier |
| Receipt of EUT: | 2017-01-18 |
| Date(s) of test: | 2017-01-20 to 2017-07-14 |
| Date of report: | 2017-08-30 |
| --- | |
| Version of template: 13.02 | |

## 2.4. Applicant’s details

| | |
|---|---|
| Applicant’s name: | peiker acustic GmbH & Co. KG |
| Address: | Max-Planck-Straße 28-32<br>61381 Friedrichsdorf/Ts.<br><br>Germany |
| Contact person: | Philippe Seguret |

## 2.5. Manufacturer’s details

| | |
|---|---|
| Manufacturer’s name: | please see Applicant's details |
| Address: | please see Applicant's details |

# 3. Equipment under test (EUT)

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

| | | | |
|---|---|---|---|
| Main function | GSM/ WCDMA/ LTE Telematics US Module | | |
| Type | V1233-0 | | |
| TX-frequency range<br>(E-UTRA operating bands) | LTE Band 5: 824 - 849 MHz (Uplink), 869-894 MHz (Downlink)<br>LTE Band 7: 2500-2570 MHz (Uplink), 2620-2690 MHz (Downlink) | | |
| Type of modulation | QPSK, 16-QAM | | |
| Data rates | Cat3, Downlink: max. 100Mbps, Uplink: max. 50Mbps | | |
| Number of channels<br><br>– Table 5.4.4-1 accord. 3GPP TS36.521-1 | LTE Band 5: UARFCN range 20400 - 20649<br>LTE Band 7: UARFCN range 20750 - 21449<br>(only for use in USA) | | See Note about channels not to be used depending on channel bandwidths |
| Emission designator(s) | Channel bandwidth | QPSK Modulation: | 16-QAM Modulation: |
| | 1.4 MHz | 1M09G7D | 1M09W7D |
| | 3 MHz | 2M71G7D | 2M71W7D |
| | 5 MHz | 4M48G7D | 4M84W7D |
| | 10 MHz | 8M95G7D | 8M95W7D |
| | 15 MHz | 13M4G7D | 13M4W7D |
| | 20 MHz | 17M7G7D | 17M9W7D |
| Antenna Type | ☐ Integrated<br>☐ External, no RF- connector<br>☒ External, separate RF-connector: main TX + secondary RX connector | | |
| Antenna Gain Tx (main) | ☐ Not applicable<br>☒ from data sheet “BMW_Multibandantenna_Max Gain Tel GNSS_en”<br>699MHz – 716MHz: 8.3dBi<br>824MHz – 849MHz: 7.8dBi<br>1710MHz – 1755MHz: 7.3dBi<br>1850MHz – 1910MHz: 8.9dBi<br>2500MHz – 2570MHz: 6.8dBi<br>☐ No information from customer | | |
| Path Losses | ☒ from data sheet “TEL1_NAD_to_TEL1_TRUNK_table”<br>LTE B2: 5.55dB<br>LTE B4: 5.10dB<br>LTE B5: 2.96dB<br>LTE B7: 6.61dB<br>LTE B12: 2.57dB | | |

| | | | |
|---|---|---|---|
| MAX AV Output Power:<br>Conducted LTE-Mode 5<br>LTE-Mode 7 | QPSK/dBm<br>23.10<br>22.57 | | |
| EIRP:<br><br>Radiated LTE-Mode 5<br>LTE-Mode 7 | (Output Power + Antenna gain – Path losses)<br>QPSK/dBm<br>23.10dBm + 7.8dBi – 2.96dB= 27.94dBm<br>22.57dBm + 6.8dBi – 6.61dB= 22.76dBm | | |
| ERP:<br><br>Radiated LTE-Mode 5<br>LTE-Mode 7 | (EIRP – 2.15)<br>QPSK/dBm<br>27.94dBm – 2.15 = 25.79dBm<br>22.76dBm – 2.15 = 20.61dBm | | |
| Installed option | ☐ GSM 900 and GSM 1800 Bands (not usable in USA/Canada)<br>☐ W-CDMA Band I and Band VIII (not usable in USA/Canada)<br>☒ GPS (not tested within this test report) | | |
| Power supply | ☒ 12VDC | | |
| Special EMI components | -- | | |
| EUT sample type | ☐ Production | ☒ Pre-Production | ☐ Engineering |
| FCC label attached | ☐ yes | ☒ no | |

## 3.2. 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 | GSM/ WCDMA/ LTE Telematics ROW Module | V1233-0 | 004402580050122 | V1233-0_Ver.1 | MPSS.TH.2.0.2-00220 |
| EUT B | Kathrein Cellular/GNSS antenna | Model No: 9396828-02 | 50110256 | -- | -- |
| EUT C | Kathrein Cellular antenna” | Model No: 9396827-02 | 50110255 | -- | -- |
| EUT D | GSM/ WCDMA/ LTE Telematics ROW Module | V1233-0 | 004402580050197 | V1233-0_Ver.1 | MPSS.TH.2.0.2.c4-00018 |

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

## 3.3. 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 | Loudspeaker | KL3 / 4-Ohm | - | - | - |
| AE 2 | Microphone | ME 39 | - | - | - |
| AE 3 | DC cable | -- | -- | -- | -- |
| AE 4 | Dell Laptop Computer | DELL Latitude D610 | EMC#3 | Pentium IV Centrino | Windows XP Professional |

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

## 3.4. EUT set-ups

| EUT set-up no.*) | Combination of EUT and AE | Remarks |
|---|---|---|
| set. 1 | EUT A + AE 3 | RF-Conducted Measurement set-up |
| set. 2 | EUT A + EUT 2 + EUT 3+ AE 1 + AE 2 + AE 3 | RF-radiated measurement set-up |
| set. 3 | EUT D + AE3 | Frequency stability measurement set-up |

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

## 3.5. Configuration of cables used for testing

| Cable number | Item | Type | S/N serial number | HW hardware status | Cable length |
|---|---|---|---|---|---|
| Cable 1 | Microphone line | -- | -- | -- | <3m |
| Cable 2 | Speaker line | -- | -- | -- | <3m |
| Cable 3 | DC cable | -- | -- | -- | <3m |
| Cable 4 | GPS antenna cable | -- | -- | -- | <3m |
| Cable 5 | Antenna cable TRX | -- | -- | -- | <3m |
| Cable 6 | Antenna cable DRX | -- | -- | -- | <3m |

## 3.6. EUT operating modes

| EUT operating mode no.*) | Description of operating modes | Additional information |
|---|---|---|
| 1 | LTE-Band 5<br><br>RMC Mode | A communication link is established between the mobile station (UE) and the test simulator. The transmitter is operated on its maximum rated output power class: 23dBm nominal.<br>The input signal to the receiver is modulated with normal test modulation: QPSK or 16-QAM Modulation.<br>The wanted RF input signal level to the receiver of the mobile station is set to a level to provide a stable communication link.<br>NS_01 Network signalling value was used, no A-MPR was used therefore for this band. |
| 2 | LTE-Band 7<br><br>RMC Mode | A communication link is established between the mobile station (UE) and the test simulator. The transmitter is operated on its maximum rated output power class: 23dBm nominal.<br>The input signal to the receiver is modulated with normal test modulation: QPSK or 16-QAM Modulation.<br>The wanted RF input signal level to the receiver of the mobile station is set to a level to provide a stable communication link.<br>NS_01 Network signalling value was used, no A-MPR was used therefore for this band. |

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

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

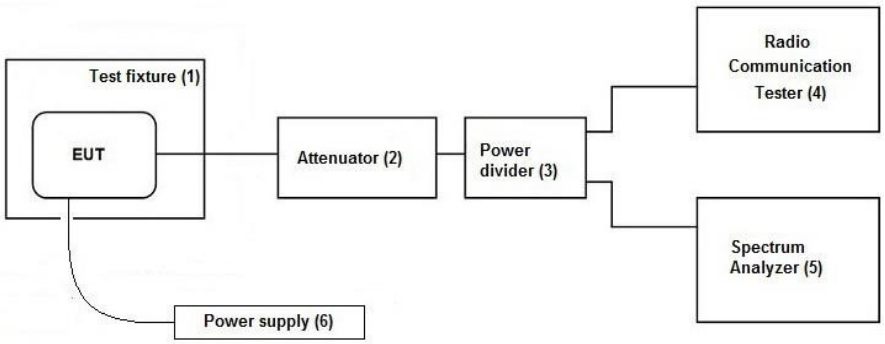
## 4.1. Test system set-up for conducted measurements on antenna port

**Cellular Conducted RF-Setup 1 (Cel-1 Set-up)**

**Tests Specification:** Conducted spurious emissions, Emission Bandwidth

**General Description:** The EUT's RF-signal is coupled out by a suitable antenna coupling connector (1). The signal is first attenuated (2) before it is 0° divided by a power divider (3). One of the RF-signal path is connected to the test unit communication tester (4), other RF-path is connected to the spectrum – analyzer (5) for specific RF-measurements. The specific attenuation losses for both signal paths/branches are determined prior to the measurement within a set-up calibration. These are then taken into account by correcting the measurement readings on the spectrum-analyzer.

**Schematic:**




**Used Equipment:**

| Passive Elements | Test Equipment | Remark: |
|---|---|---|
| ☒ 10 dB Attenuator (#530) | ☒ CMW500 Communication Test-Unit for LTE | See List of equipment under each test case and chapter 8 for calibration info |
| ☒ Low loss RF-cables | ☒ DC-Power Supply | |
| ☒ 6 dB resistive power divider/coupler (#529) | ☒ Spectrum-Analyser | |

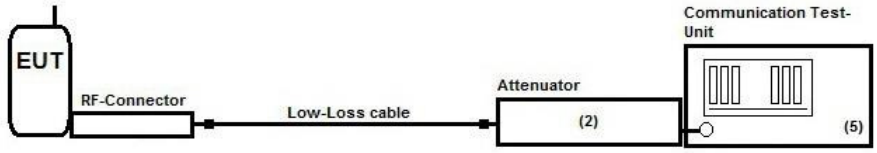
**Testing method:** ANSI C63.26:2015, KDB 971168 D01 v02r02

**Measurement uncertainty:** See chapter Measurement Uncertainties (Cel-1)

**Cellular Conducted RF-Setup 2 (Cel-2 Set-up)**

**Tests Specification:** Conducted Carrier power, Frequency Error

**Schematic:** Following modified test set-up apply for tests performed inside the climatic chamber (frequency stability) or conducted RF-carrier power-measurement. The EUT RF-Signal is directly connected over suitable RF-connector over low-loss cable and an attenuator (2) to the cellular radio communication test-unit. (5)




**Testing method:** ANSI C63.10:2013, KDB 971168 D01 v02r02

| **Used Equipment** | Passive Elements | Test Equipment | Remark: |
|---|---|---|---|
| | ☒ 20 dB Attenuator (#613)<br>☒ Low loss RF-cables | ☒ CMW500 Communication Test-Unit for LTE<br>☒ DC-Power Supply | See List of equipment under each test case and chapter 8 for calibration info |

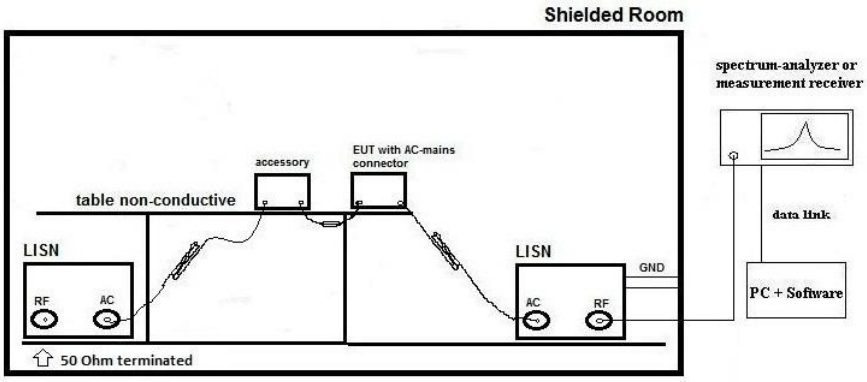
**Measurement uncertainty** See chapter Measurement Uncertainties (Cel-2)

## 4.2. Test system set-up for AC power-line conducted emission measurements

**Specification:** ANSI C63.4-2014 chapter 7, ANSI C63.10-2013chapter 6.2

**General Description:** The radio frequency voltage conducted back into the AC power line in the frequency range 150 kHz to 30 MHz has to be investigated. Compliance should be tested by measuring the radio frequency voltage between each power line and ground at the power terminals in the stated frequency range.
A 50 Ohm / 50 µH line impedance stabilization network (LISN) is used coupling the interface to the measurement equipment. The EUT power input leads are connected through the LISN to the AC-power source. The LISN enclosure is electrically connected to the ground plane. The measuring instrument is connected to the coaxial output of the LISN.
Tabletop devices were set-up on a 80 cm height above reference ground plane, floor standing equipment 10 cm raised above ground plane. Measurements have been performed on each phase line and neutral line of the devices AC-power lines. The EUT was power supplied with 110 V/60 Hz. The EUT was tested in the defined operating mode and installed (connected) to accessory equipment according the general description of use given by the applicant.

**Schematic:**




Only schematic view, we refer to figure 6, 7 and 8 of ANSI C63.4-2009 for more details.

**Testing method:** **Exploratory, preliminary measurements** as a first step, determines the worst-case phase line (neutral or phase) as well as the most critical operating mode of the equipment. A complete frequency-sweep with PK-Detector is performed on each current-carrying conductor.

**Final testing** for power phases and critical frequencies (Margin to AV- or QP limit lower than 3 dB) as a second step includes measurements with receivers detector set to Quasi-Peak and Average.

**Formula:**

$V_C = V_R + C_L$ (1)
$M = L_T - V_C$ (2)

$V_C$ = measured Voltage –corrected value
$V_R$ = Receiver reading
$C_L$ = Cable loss
M = Margin
$L_T$ = Limit

Values are in dB, positive margin means value is below limit.

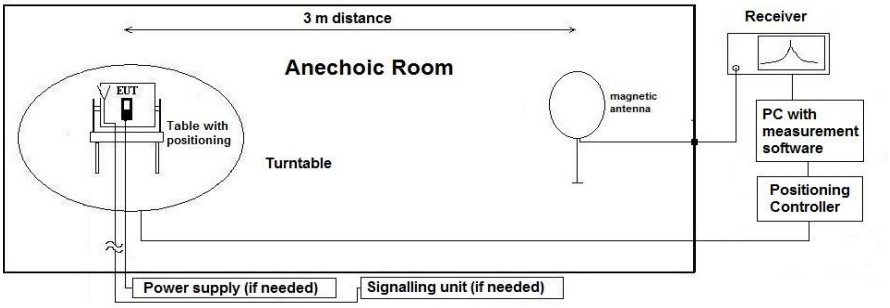
## 4.3. Test system set-up for radiated magnetic field measurements below 30 MHz

**Specification:** ANSI C63.4-2014 §5.3, §8.2.1, §8.3.1.1+§8.3.2.1 , 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.

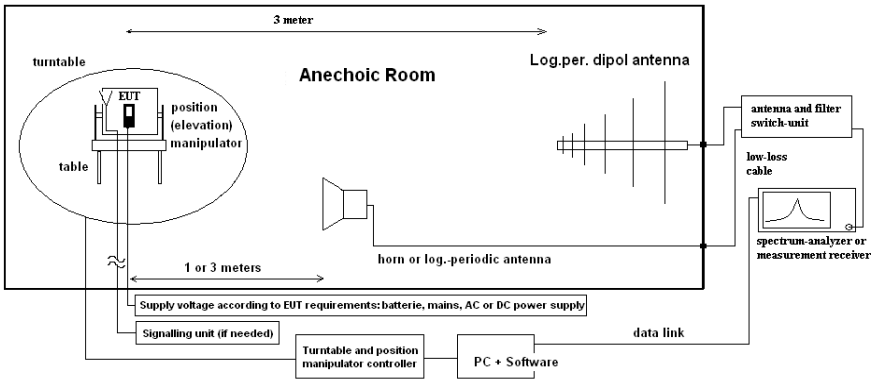
**Distance correction:** Reference for applied correction (extrapolating) factors due to reduced measurement distance:
**ANSI C63.10:2013, §6.4.4.2 - Equations (2) + (3) + (4)**

## 4.4. Test system set-up for radiated spurious emission measurements

**Specification:** ANSI C63.4-2014 chapter 8.3, ANSI C63.10-2013 chapter 6.6.3.3 & 6.6.4, ANSI C63.26-2015, Chapter 4.6.3.3

**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 1.50 m height which is placed on the turntable. By rotating the turntable (range 0° to 360°, step 45°) and the EUT itself on 3-orthogonal axis (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.
The readings on the spectrum analyzer are corrected with conversion value between field strength and E(I)RP, so the readings shown are equivalent to ERP/EIRP values. Critical measurements near the limit are re-measured with a substitution method accord. ANSI/TIA/EIA 603 C/D

**Formula:**

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

$Ec_{E(I)RP} = Ec - 95.2\ dB$

$M = L_T - Ec_{E(I)RP}$

$E_C$ = 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)
$Ec_{E(I)RP}$ = Electrical field corrected for E(I)RP

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

# 5. Measurements

## 5.1. RF-Parameter - RF Peak power output conducted and PAPR

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

| | | | | | | |
|---|---|---|---|---|---|---|
| test location | ☒ CETECOM Essen (Chapter. 2.2.1) | | ☐ Please see Chapter. 2.2.2 | | | |
| test site | ☐ 347 Radio.lab. 1 | ☒ Radio.lab. 2 | | | | |
| spectr. analys. | ☐ 584 FSU | ☐ 489 ESU 40 | ☐ 264 FSEK | ☐ 620 ESU 26 | | |
| signaling | ☐ 392 MT8820A | ☐ 436 CMU | ☐ 547 CMU | ☒ 594 CMW500 | | |
| otherwise | ☐ 400 FTC40x15E | ☐ 401 FTC40x15E | ☐ 110 USB LWL | ☐ 482 Filter Matrix | ☐ 378 RadiSense | |
| DC power | ☐ 456 EA 3013A | ☐ 463 HP3245A | ☐ 459 EA 2032-50 | ☐ 268 EA- 3050 | ☐ 494 AG6632A | ☒ 611 E3632A |
| otherwise | ☐ 331 HC 4055 | ☐ 248 6 dB Att. | ☐ 529 Power div. | ☐ - cable OTA20 | | ☒ 530 10 dB Att. |
| line voltage | ☐ 230 V 50 Hz via public mains | | ☐ 060 110 V/ 60 Hz via PAS 5000 | | | |

### 5.1.2. Requirements and limits

| | |
|---|---|
| **FCC** | §2.1046 |
| **Limit** | Maximum Power Output of the mobile phone should be determined while measured conducted. |
| | Limit LTE Band 5: 7 Watt EIRP (38.4 dBm) |
| | Limit LTE Band 2: 2 Watt EIRP (33.0 dBm) |
| | Limit LTE Band 4: 1 Watt EIRP (30.0 dBm) |
| | Limit LTE Band 7: 2 Watt EIRP (33.0 dBm) |
| | |

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

| | | |
|---|---|---|
| Climatic conditions | Temperature: (22±3°C) | Rel. humidity: (40±20)% |
| Test system set-up | Please see chapter "Test system set-up for conducted measurements on antenna port" | |
| Measurement method | The measurements were performed with the integrated power measurement function of the „radio communication tester CMW500 from Rohde&Schwarz company. In this way spectrum-analyzers instrument limitations can be avoided or minimized. Instead, CMW manufacturers declared measurement error can be considered for this measurement.<br><br>The attenuation (insertion loss) at the RF Inputs/Outputs of CMW were set according the path loss of the test set-up, determined in a step before starting the measurements. A suitable artificial antenna or RF-connector is provided by the applicant in order to perform the conducted measurements. Any data provided with the artificial antenna or connector, have been taken in account in order to correct the measurement data. (typical 0.3dB for attenuation of antenna connector)<br><br>Peak and Average Values have been recorded for each channel and band. The Peak-to -Average-Ratio is determined by comparing the total peak power to total average power for each measurement. | |
| Mobile phone settings | A call was established with a suitable communication test unit (CMW500).<br>UE is set TX mode, highest transmit power conditions (RMC-mode), power saving techniques have been disabled (MPR-techniques)<br><br>Tests have been performed in different EUT bandwidth settings and various settings for allocated RBs.<br><br>The measurements were made at the low, middle and high carrier frequencies of each of the supported operating band within the designated range within the allowed channel bandwidths. Choosing three TX-carrier frequencies of the mobile phone, should be sufficient to demonstrate compliance. | |

### 5.1.4. Power results

#### 5.1.4.1. LTE Band 5 Results

| LTE-Band 5 | | | | QPSK-Modulation | | | 16-QAM-Modulation | | | max. modulation QPSK | max. modulation 16-QAM | max. channel | absolute max. value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| channel bandwidth | ARFCN ch. no. | ARFCN-Frequency [MHz] | Resource block allocation | Peak detektor [dBm] | RMS detektor [dBm] | PAR Faktor [dB] | Peak detektor [dBm] | RMS detektor [dBm] | PAR Faktor [dB] | | | | |
| 1.4 MHz | 20407 | 824.7 | 1 RB low | 27,131 | 22,71 | 4,4206 | 27,2411 | 22,2698 | 4,9713 | 22,74 | 22,36 | 22,74 | 23,10 |
| | | | 1 RB high | 27,133 | 22,739 | 4,3938 | 27,082 | 22,363 | 4,719 | | | | |
| | | | 50%RB mid | 27,317 | 22,688 | 4,6291 | 27,2111 | 21,824 | 5,3871 | | | | |
| | | | 100%RB | 27,735 | 21,82 | 5,9149 | 27,7361 | 20,8906 | 6,8455 | | | | |
| | 20525 | 836.5 | 1 RB low | 27,4 | 22,551 | 4,8496 | 27,6918 | 22,2594 | 5,4324 | 22,61 | 22,47 | | |
| | | | 1 RB high | 27,487 | 22,605 | 4,8818 | 27,7685 | 22,465 | 5,3035 | | | | |
| | | | 50%RB mid | 27,76 | 22,546 | 5,2156 | 27,9043 | 22,0492 | 5,8551 | | | | |
| | | | 100%RB | 28,149 | 21,892 | 6,2566 | 28,0201 | 20,846 | 7,1741 | | | | |
| | 20643 | 848.3 | 1 RB low | 27,247 | 22,398 | 4,8498 | 27,286 | 22,1387 | 5,1473 | 22,40 | 22,14 | | |
| | | | 1 RB high | 27,258 | 22,309 | 4,9485 | 27,2909 | 22,0137 | 5,2772 | | | | |
| | | | 50%RB mid | 27,567 | 22,345 | 5,2224 | 27,5369 | 21,6204 | 5,9165 | | | | |
| | | | 100%RB | 27,692 | 21,23 | 6,4622 | 27,798 | 20,7886 | 7,0094 | | | | |
| 3 MHz | 20415 | 825.5 | 1 RB low | 27,228 | 22,945 | 4,2825 | 27,1829 | 22,4797 | 4,7032 | 22,95 | 22,48 | 22,95 | |
| | | | 1 RB high | 27,032 | 22,945 | 4,0874 | 26,972 | 22,4015 | 4,5705 | | | | |
| | | | 50%RB mid | 26,513 | 21,973 | 4,5395 | 27,0381 | 22,0729 | 4,9652 | | | | |
| | | | 100%RB | 27,735 | 21,779 | 5,9567 | 27,4043 | 20,824 | 6,5803 | | | | |
| | 20525 | 836.5 | 1 RB low | 27,162 | 22,426 | 4,7359 | 27,4924 | 22,3912 | 5,1012 | 22,45 | 22,48 | | |
| | | | 1 RB high | 27,28 | 22,449 | 4,8317 | 27,7121 | 22,4842 | 5,2279 | | | | |
| | | | 50%RB mid | 26,858 | 21,891 | 4,9671 | 27,5204 | 22,0551 | 5,4653 | | | | |
| | | | 100%RB | 28,117 | 21,889 | 6,2281 | 27,7574 | 20,9913 | 6,7661 | | | | |
| | 20635 | 847.5 | 1 RB low | 26,754 | 22,392 | 4,3615 | 26,7864 | 21,9056 | 4,8808 | 22,43 | 21,99 | | |
| | | | 1 RB high | 26,92 | 22,43 | 4,4902 | 27,2055 | 21,9932 | 5,2123 | | | | |
| | | | 50%RB mid | 26,467 | 21,339 | 5,1282 | 27,0284 | 21,714 | 5,3144 | | | | |
| | | | 100%RB | 27,296 | 21,349 | 5,9468 | 27,6589 | 20,8804 | 6,7785 | | | | |
| 5 MHz | 20425 | 826.5 | 1 RB low | 27,41 | 23,102 | 4,3076 | 27,3646 | 22,461 | 4,9036 | 23,10 | 22,46 | 23,10 | |
| | | | 1 RB high | 27,212 | 23,102 | 4,1098 | 27,241 | 22,443 | 4,798 | | | | |
| | | | 50%RB mid | 26,909 | 21,928 | 4,9808 | 27,1887 | 22,1068 | 5,0819 | | | | |
| | | | 100%RB | 27,381 | 21,929 | 5,4526 | 27,5214 | 20,9893 | 6,5321 | | | | |
| | 20525 | 836.5 | 1 RB low | 27,158 | 22,562 | 4,5964 | 27,608 | 22,4258 | 5,1822 | 22,63 | 22,65 | | |
| | | | 1 RB high | 27,31 | 22,63 | 4,6761 | 27,8346 | 22,6492 | 5,1854 | | | | |
| | | | 50%RB mid | 27,4 | 22,001 | 5,3992 | 27,6249 | 22,0476 | 5,5773 | | | | |
| | | | 100%RB | 28,851 | 22,027 | 6,8236 | 28,0775 | 21,1014 | 6,9761 | | | | |
| | 20625 | 846.5 | 1 RB low | 26,588 | 22,464 | 4,1243 | 27,0655 | 22,5588 | 4,5067 | 22,46 | 22,56 | | |
| | | | 1 RB high | 27,176 | 22,465 | 4,711 | 27,4225 | 22,0681 | 5,3544 | | | | |
| | | | 50%RB mid | 26,744 | 21,271 | 5,473 | 27,1031 | 21,5794 | 5,5237 | | | | |
| | | | 100%RB | 27,803 | 21,313 | 6,4898 | 27,6616 | 20,955 | 6,7066 | | | | |
| 10 MHz | 20450 | 829 | 1 RB low | 27,237 | 22,754 | 4,4824 | 27,2234 | 22,0425 | 5,1809 | 22,75 | 22,21 | 22,75 | |
| | | | 1 RB high | 27,208 | 22,512 | 4,6962 | 27,3592 | 22,2093 | 5,1499 | | | | |
| | | | 50%RB mid | 26,881 | 21,795 | 5,0854 | 26,4396 | 20,8568 | 5,5828 | | | | |
| | | | 100%RB | 27,987 | 21,804 | 6,183 | 28,2901 | 20,8244 | 7,4657 | | | | |
| | 20525 | 836.5 | 1 RB low | 26,89 | 22,55 | 4,34 | 27,0844 | 22,3037 | 4,7807 | 22,55 | 22,30 | | |
| | | | 1 RB high | 27,004 | 22,474 | 4,53 | 27,2019 | 22,1205 | 5,0814 | | | | |
| | | | 50%RB mid | 27,253 | 21,863 | 5,3894 | 26,8713 | 20,967 | 5,9043 | | | | |
| | | | 100%RB | 28,245 | 21,725 | 6,5194 | 27,8642 | 20,7411 | 7,1231 | | | | |
| | 20600 | 844 | 1 RB low | 27,294 | 22,736 | 4,558 | 27,2373 | 22,2783 | 4,959 | 22,74 | 22,28 | | |
| | | | 1 RB high | 27,103 | 22,478 | 4,6252 | 27,2178 | 21,968 | 5,2498 | | | | |
| | | | 50%RB mid | 26,832 | 21,666 | 5,1663 | 26,251 | 20,7641 | 5,4869 | | | | |
| | | | 100%RB | 28,113 | 21,565 | 6,5471 | 28,0607 | 20,7055 | 7,3552 | | | | |

Remark: Marked cells shows maximum values for 1RB and 100% RBs and on which PAPR measurements have been performed

**Max-Values for different signal bandwidths:**

| LTE Band 5 | | | | | |
|---|---|---|---|---|---|
| Signal-BW | | QPSK | | 16-QAM | |
| | | Peak | RMS | Peak | RMS |
| 1.4 | | 28,15 | 22,74 | 28,02 | 22,47 |
| 3 | | 28,12 | 22,95 | 27,76 | 22,48 |
| 5 | | 28,85 | 23,10 | 28,08 | 22,65 |
| 10 | | 28,24 | 22,75 | 28,29 | 22,30 |

**Max-Values for Modulation:**

| LTE Band 5 | | | |
|---|---|---|---|
| QPSK | | 16-QAM | |
| Peak | RMS | Peak | RMS |
| 28,85 | 23,10 | 28,29 | 22,65 |

### 5.1.4.2. LTE Band 7 Results

| LTE-Band 7 | | | | QPSK-Modulation | | | 16-QAM-Modulation | | | max.- modulatio | max. modulatio | max. channel | absolute max. value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| channel bandwidth | ARFCN ch. no. | ARFCN-Frequency [MHz] | Resource block allocation | Peak detektor [dBm] | RMS detektor [dBm] | PAR Faktor [dB] | Peak detektor [dBm] | RMS detektor [dBm] | PAR Faktor [dB] | | | | |
| 5 MHz | 20775 | | 1 RB low | 26,024 | 22,006 | 4,018 | 26,0437 | 21,42 | 4,6237 | 26,921 | 27,18 | 27,18 | 27,69 |
| | | | 1 RB high | 26,297 | 22 | 4,2969 | 26,3313 | 21,4561 | 4,8752 | | | | |
| | | | 50%RB mid | 26,097 | 20,846 | 5,2511 | 26,2503 | 21,0711 | 5,1792 | | | | |
| | | | 100%RB | 26,864 | 20,949 | 5,9155 | 26,9212 | 19,9986 | 6,9226 | | | | |
| | 21100 | | 1 RB low | 26,527 | 22,092 | 4,4358 | 26,5778 | 21,8167 | 4,7611 | 27,18 | | | |
| | | | 1 RB high | 26,356 | 21,87 | 4,4861 | 26,488 | 21,6056 | 4,8824 | | | | |
| | | | 50%RB mid | 26,129 | 20,897 | 5,232 | 26,5441 | 21,1516 | 5,3925 | | | | |
| | | | 100%RB | 27,18 | 20,866 | 6,3148 | 27,0173 | 19,9804 | 7,0369 | | | | |
| | 21425 | | 1 RB low | 26,551 | 22,255 | 4,2957 | 26,6347 | 21,5242 | 5,1105 | 26,988 | | | |
| | | | 1 RB high | 26,882 | 22,112 | 4,77 | 26,4488 | 21,5806 | 4,8682 | | | | |
| | | | 50%RB mid | 26,292 | 21,047 | 5,2454 | 26,5356 | 21,337 | 5,1986 | | | | |
| | | | 100%RB | 26,988 | 21,012 | 5,9756 | 26,8883 | 20,1029 | 6,7854 | | | | |
| 10 MHz | 20800 | | 1 RB low | 26,553 | 22,298 | 4,255 | 26,5471 | 22,0342 | 4,5129 | 27,21 | 27,336 | 27,34 | |
| | | | 1 RB high | 26,899 | 22,567 | 4,332 | 26,9796 | 22,0227 | 4,9569 | | | | |
| | | | 50%RB mid | 26,31 | 20,994 | 5,316 | 25,9412 | 20,0754 | 5,8658 | | | | |
| | | | 100%RB | 27,21 | 21,081 | 6,1288 | 27,201 | 20,0779 | 7,1231 | | | | |
| | 21000 | | 1 RB low | 26,626 | 22,364 | 4,2627 | 26,6858 | 21,9204 | 4,7654 | 27,189 | | | |
| | | | 1 RB high | 26,583 | 22,242 | 4,3412 | 26,5845 | 21,7299 | 4,8546 | | | | |
| | | | 50%RB mid | 26,182 | 20,914 | 5,2679 | 25,7827 | 20,0507 | 5,732 | | | | |
| | | | 100%RB | 27,121 | 21,004 | 6,1171 | 27,1892 | 19,9556 | 7,2336 | | | | |
| | 21400 | | 1 RB low | 26,578 | 22,39 | 4,1877 | 26,9322 | 22,0069 | 4,9253 | 27,336 | | | |
| | | | 1 RB high | 26,418 | 22,447 | 3,9709 | 26,8016 | 22,0247 | 4,7769 | | | | |
| | | | 50%RB mid | 26,43 | 22,1 | 4,328 | 26,1331 | 20,3596 | 5,7735 | | | | |
| | | | 100%RB | 26,886 | 21,158 | 5,728 | 27,3363 | 20,2847 | 7,0516 | | | | |
| 15 MHz | 2825 | | 1 RB low | 26,587 | 22,045 | 4,5419 | 26,524 | 21,6186 | 4,9054 | 27,58 | 27,58 | 27,58 | |
| | | | 1 RB high | 26,841 | 22,194 | 4,6469 | 26,9557 | 21,875 | 5,0807 | | | | |
| | | | 50%RB mid | 26,482 | 21,011 | 5,471 | 26,9098 | 21,2054 | 5,7044 | | | | |
| | | | 100%RB | 27,58 | 21,1 | 6,48 | 27,3635 | 20,1063 | 7,2572 | | | | |
| | 21100 | | 1 RB low | 26,364 | 21,968 | 4,3963 | 26,44 | 21,6549 | 4,7851 | 27,27 | | | |
| | | | 1 RB high | 26,407 | 22,059 | 4,3476 | 26,441 | 21,5799 | 4,8611 | | | | |
| | | | 50%RB mid | 26,212 | 21,084 | 5,1277 | 26,5418 | 21,2047 | 5,3371 | | | | |
| | | | 100%RB | 27,27 | 20,967 | 6,3027 | 27,1199 | 19,9958 | 7,1241 | | | | |
| | 21375 | | 1 RB low | 26,88 | 22,06 | 4,8187 | 26,4318 | 21,7887 | 4,6431 | 27,238 | | | |
| | | | 1 RB high | 26,189 | 22,04 | 4,1489 | 26,343 | 21,5555 | 4,7875 | | | | |
| | | | 50%RB mid | 26,145 | 20,987 | 5,1581 | 26,5042 | 21,2149 | 5,2893 | | | | |
| | | | 100%RB | 27,238 | 20,956 | 6,2817 | 27,1858 | 20,0377 | 7,1481 | | | | |
| 20 MHz | 20850 | | 1 RB low | 26,862 | 22,094 | 4,7681 | 26,6886 | 21,6584 | 5,0302 | 27,693 | 27,693 | 27,69 | |
| | | | 1 RB high | 27,188 | 22,393 | 4,7948 | 27,1543 | 21,7483 | 5,406 | | | | |
| | | | 50%RB mid | 26,624 | 21,089 | 5,5344 | 27,0833 | 21,1274 | 5,9559 | | | | |
| | | | 100%RB | 27,693 | 21,117 | 6,5765 | 27,152 | 20,0205 | 7,1315 | | | | |
| | 21100 | | 1 RB low | 26,537 | 22,288 | 4,249 | 26,5241 | 21,6663 | 4,8578 | 27,364 | | | |
| | | | 1 RB high | 26,426 | 22,117 | 4,3085 | 26,4656 | 21,7133 | 4,7523 | | | | |
| | | | 50%RB mid | 26,135 | 21,008 | 5,1276 | 26,5463 | 21,1325 | 5,4138 | | | | |
| | | | 100%RB | 27,364 | 20,944 | 6,4196 | 27,3274 | 19,9397 | 7,3877 | | | | |
| | 21300 | | 1 RB low | 26,512 | 22,268 | 4,2439 | 26,5142 | 21,6211 | 4,8931 | 27,388 | | | |
| | | | 1 RB high | 26,239 | 22,065 | 4,1743 | 26,3798 | 21,5757 | 4,8041 | | | | |
| | | | 50%RB mid | 26,088 | 20,936 | 5,1526 | 26,4429 | 21,0483 | 5,3946 | | | | |
| | | | 100%RB | 27,388 | 20,945 | 6,4428 | 27,3193 | 19,9573 | 7,362 | | | | |

Remark: Marked cells shows maximum values for 1RB and 100% RBs and on which PAPR measurements have been performed

**Max-Values for different signal bandwidths:**

| LTE Band 7 / [mW] | | | | |
|---|---|---|---|---|
| Signal-BW | QPSK | | 16-QAM | |
| | Peak | RMS | Peak | RMS |
| 1.4 | 27,18 | 22,26 | 27,02 | 21,82 |
| 3 | 27,21 | 22,57 | 27,34 | 22,03 |
| 5 | 27,58 | 22,19 | 27,36 | 21,88 |
| 10 | 27,69 | 22,39 | 27,33 | 21,75 |

**Max-Values for Modulation:**

| LTE Band 7 / [mW] | | | |
|---|---|---|---|
| QPSK | | 16-QAM | |
| Peak | RMS | Peak | RMS |
| 27,69 | 22,57 | 27,36 | 22,03 |

### 5.1.5. PAPR results

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

| | | |
|---|---|---|
| Climatic conditions | Temperature: (22±3°C) | Rel. humidity: (40±20)% |
| Test system set-up | Please see chapter "Test system set-up for conducted measurements on antenna port" | |
| Measurement method | The measurements were performed with the integrated power measurement function of the „radio communication tester CMW500 from Rohde&Schwarz company.<br><br>The attenuation (insertion loss) at the RF Inputs/Outputs of CMW were set according the path loss of the test set-up, determined in a step before starting the measurements. A suitable artificial antenna or RF-connector is provided by the applicant in order to perform the conducted measurements. Any data provided with the artificial antenna or connector, have been taken in account in order to correct the measurement data. (typical 0.3dB for attenuation of antenna connector)<br><br>The CCDF function of the measurement equipment as described in the operating manual was used (default settings). Futher details can be found in KDB 971168 D01 v02r02 chapter 5.7.1. | |
| Mobile phone settings | A call was established with a suitable communication test unit (CMW500).<br>UE is set TX mode, highest transmit power conditions (RMC-mode), power saving techniques have been disabled (MPR-techniques)<br><br>Tests have been performed in different EUT bandwidth settings and various settings for allocated RBs. | |

#### 5.1.5.2. PAPR-results

According KDB 5.7.1 two method are allowed.

☒ Chapter 5.7.2 for determining worst-case configuration (Signal bandwidth, modulation, RB allocation)
☒ Chapter 5.7.1 CCDF-Method (0.1% probability)

| **LTE Band 5 (max RMS)** | | |
|---|---|---|
| | Max. PAPR level with 0.1% probability / [dB] | |
| Signal-Bandwidth / [MHz] | QPSK Modulation | 16-QAM Modulation |
| 1.4 | 22.74 | 22.47 |
| 3.0 | 22.95 | 22.48 |
| 5.0 | 23.10 | 22.56 |
| 10 | 22.75 | 22.30 |

| **LTE Band 5 (max PAR Factor)** | | |
|---|---|---|
| | Max. PAPR level with 0.1% probability / [dB] | |
| Signal-Bandwidth / [MHz] | QPSK Modulation | 16-QAM Modulation |
| 1.4 | 4.39 | 5.30 |
| 3.0 | 4.28 | 5.22 |
| 5.0 | 4.31 | 4.51 |
| 10 | 4.48 | 4.78 |

Remark: pls. see annex 1 for graphical plots

| LTE Band 7 (max RMS) | | |
|---|---|---|
| Signal-Bandwidth / [MHz] | Max. PAPR level with 0.1% probability / [dB] | |
| | QPSK Modulation | 16-QAM Modulation |
| 5 | 22.11 | 21.61 |
| 10 | 22.57 | 22.03 |
| 15 | 22.19 | 21.79 |
| 20 | 22.39 | 21.75 |

| LTE Band 7 (max PAR Factor) | | |
|---|---|---|
| Signal-Bandwidth / [MHz] | Max. PAPR level with 0.1% probability / [dB] | |
| | QPSK Modulation | 16-QAM Modulation |
| 5 | 4.77 | 4.88 |
| 10 | 4.33 | 4.51 |
| 15 | 4.65 | 4.64 |
| 20 | 4.79 | 5.41 |

Remark: pls. see annex 1 for graphical plots

For each possible LTE signal-bandwidth on each maximum rms-value a value was recorded
two modulation schemes have been investigated: QPSK and 16-QAM
Values have been recorded for 1RB and a maximized RB value (50% or 100%)

### 5.1.5.3. Conclusion

☒ Peak conducted output power - pass
☒ PAPR <13dB - pass

## 5.2. RF-Parameter - Occupied bandwidth and emission bandwidth

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

| | | | | | | |
|---|---|---|---|---|---|---|
| test site | ☐ 347 Radio.lab. 1 | ☒ Radio.lab. 2 | | | | |
| spectr. analys. | ☐ 584 FSU8 | ☐ 489 ESU | ☒ 620 ESU26 | ☐ 264 FSEK | | |
| attenuator | ☒ 530 10 dB | ☐ | ☐ | | | |
| signaling | ☐ 392 MT8820A | ☐ 436 CMU | ☐ 547 CMU | ☒ 594 CMW500 | | |
| DC Power | ☒ 611 E3632A | ☐ 087 EA3013 | ☐ 354 NGPE 40 | ☐ 086 LNG50-10 | ☒ 611 E3632A | |
| otherwise | ☒ 529 6dB divider | | | | | |
| line voltage | ☐ 230 V 50 Hz via public mains | | ☐ 060 110 V/ 60 Hz via PAS 5000 | | | |

### 5.2.2. Requirements and Limits

| | | |
|---|---|---|
| FCC | CFR47, §2.202(a), §2.1049, §24.238(b), 27.53(h)(3), §27.53(m)(6) | „the **occupied bandwidth** is the frequency bandwidth, such that, below it lower and above it upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated" |
| ANSI | C63.26-2015 | |

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

| | | | |
|---|---|---|---|
| Climatic conditions | | Temperature: (22±3°C) | Rel. humidity: (40±20)% |
| Test system set-up | | Please see chapter "Test system set-up for conducted measurements at antenna port" | |
| Spectrum Analyzer Settings | Parameter | Occupied bandwidth: | Emission bandwidth |
| | Scan Mode | Spectrum analyser mode | Spectrum analyser mode |
| | Span | 1.8MHz/4MHz/6MHz /12MHz/17MHz/22MHz | 2MHz/4MHz/7MHz /12MHz/17MHz/22MHz |
| | RBW | 30kHz/50kHz/100kHz/ | 30kHz/50kHz/100kHz/ |
| | VBW | 500kHz/1MHz/ | 300 kHz/500kHz/1MHz/ |
| | Sweep time | Coupled (Auto) | Coupled (Auto) |
| | Sweep mode | Repetitive, max-hold | Repetitive, max-hold |
| | Detector | Peak | Peak |
| Measurement method | | The used spectrum analyzer FSE or ESU from Rohde & Schwarz contains an integrated function to calculate the occupied bandwidth automatically. From left and right display margin, the upper and lower frequency points where the accumulated power becomes 0.5% of the total power, are calculated. Subtracting the previous determined two frequency points, yields the occupied bandwidth. | Bandwidth defined between 2 markers with are 26dBc compared to highest In-Band Peak Emission. |
| Mobile phone settings | | A call was established with a suitable communication test unit (CMW500).<br>UE is set TX mode, highest transmit power conditions (RMC-mode), power saving techniques have been disabled. All RBs as possible per EUT signal bandwidth have been allocated.<br><br>The measurements were made at the low, middle and high carrier frequencies of each of the supported operating band. Choosing three TX-carrier frequencies of the mobile phone, should be sufficient to demonstrate compliance. | |

### 5.2.4. Results

#### 5.2.4.1. LTE Band 5: Op. Mode 1, Set-up 1

Test are performed at 100% resource blocks allocation as per bandwidth

| Operational Band | Modulation | Signal bandwidth [MHz] | Channel no. | | 99%-Occupied bandwidth | | 26 dB Emission Bandwidth | |
|---|---|---|---|---|---|---|---|---|
| | | | Range | Channel no. | Diagram no. | Value [MHz] | Diagram no. | Value [MHz] |
| Band 5 | QPSK | 1.4 | Low | 20407 | 35.501 | 1.083 | 34.501 | 1.2204 |
| | | | Mid | 20525 | 35.502 | 1.085 | 34.502 | 1.2186 |
| | | | High | 20643 | 35.503 | 1.083 | 34.503 | 1.2114 |
| | | 3 | Low | 20415 | 35.504 | 2.7 | 34.504 | 2.9960 |
| | | | Mid | 20525 | 35.505 | 2.7 | 34.505 | 2.98 |
| | | | High | 20635 | 35.506 | 2.704 | 34.506 | 3 |
| | | 5 | Low | 20425 | 35.507 | 4.476 | 34.507 | 4.892 |
| | | | Mid | 20525 | 35.508 | 4.476 | 34.508 | 4.884 |
| | | | High | 20625 | 35.509 | 4.482 | 34.509 | 4.902 |
| | | 10 | low | 20450 | 35.510 | 8.940 | 34.510 | 9.648 |
| | | | Mid | 20525 | 35.511 | 8.940 | 34.511 | 9.66 |
| | | | High | 20600 | 35.512 | 8.928 | 34.512 | 9.588 |

| Operational Band | Modulation | Signal bandwidth [MHz] | Channel no. | | 99%-Occupied bandwidth | | 26 dB Emission Bandwidth | |
|---|---|---|---|---|---|---|---|---|
| | | | Range | Channel no. | Diagram no. | Value [MHz] | Diagram no. | Value [MHz] |
| Band 5 | 16-QAM | 1.4 | Low | 20407 | 35.513 | 1.085 | 34.513 | 1.218 |
| | | | Mid | 20525 | 35.514 | 1.083 | 34.514 | 1.22 |
| | | | High | 20643 | 35.515 | 1.089 | 34.515 | 1.218 |
| | | 3 | Low | 20415 | 35.516 | 2.708 | 34.516 | 2.984 |
| | | | Mid | 20525 | 35.517 | 2.704 | 34.517 | 2.956 |
| | | | High | 20635 | 35.518 | 2.704 | 34.518 | 2.988 |
| | | 5 | Low | 20425 | 35.519 | 4.842 | 34.519 | 4.872 |
| | | | Mid | 20525 | 35.520 | 4.482 | 34.520 | 4.866 |
| | | | High | 20625 | 35.521 | 4.476 | 34.521 | 4.884 |
| | | 10 | low | 20450 | 35.522 | 8.952 | 34.522 | 9.66 |
| | | | Mid | 20525 | 35.523 | 8.940 | 34.523 | 9.696 |
| | | | High | 20600 | 35.524 | 8.928 | 34.524 | 9.648 |

Remarks:

1.) see diagrams in annex 1, only maximum of 26dBc EBW was tested

### 5.2.4.2. LTE Band 7: Op. Mode 2, Set-up 1

Test are performed at 100% resource blocks allocation as per bandwidth

| Operational Band | Modulation | Signal bandwidth [MHz] | Channel no. | | 99%-Occupied bandwidth | | 26 dB Emission Bandwidth | |
|---|---|---|---|---|---|---|---|---|
| | | | Range | Channel no. (Frequenz [MHz]) | Diagram no. | Value [MHz] | Diagram no. | Value [MHz] |
| Band 7 | QPSK | 5 | Low | Ch20775 (2502.5) | 35.701 | 4.482 | 34.701 | 4.878 |
| | | | Mid | Ch21100 (2535) | 35.702 | 4.482 | 34.702 | 4.884 |
| | | | High | Ch21425 (2567.5) | 35.703 | 4.482 | 34.703 | 4.890 |
| | | 10 | Low | Ch20800 (2505) | 35.704 | 8.952 | 34.704 | 9.66 |
| | | | Mid | Ch21100 (2535) | 35.705 | 8.940 | 34.705 | 9.684 |
| | | | High | Ch21400 (2565) | 35.706 | 8.940 | 34.706 | 9.624 |
| | | 15 | Low | Ch20825 2507.5 | 35.707 | 13.396 | 34.707 | 14.331 |
| | | | Mid | Ch21100 (2535) | 35.708 | 13.396 | 34.708 | 14.314 |
| | | | High | Ch21375 2562.5 | 35.709 | 13.396 | 34.709 | 14.331 |
| | | 20 | low | Ch20850 2510 | 35.710 | 17.864 | 34.710 | 18.964 |
| | | | Mid | Ch21100 (2535) | 35.711 | 17.842 | 34.711 | 18.942 |
| | | | High | Ch21350 2560 | 35.712 | 17.864 | 34.712 | 19.008 |

| Operational Band | Modulation | Signal bandwidth [MHz] | Channel no. | | 99%-Occupied bandwidth | | 26 dB Emission Bandwidth | |
|---|---|---|---|---|---|---|---|---|
| | | | Range | Channel no. (Frequenz [MHz]) | Diagram no. | Value [MHz] | Diagram no. | Value [MHz] |
| Band 7 | 16-QAM | 5 | Low | Ch20775 (2502.5) | 35.713 | 4.482 | 34.713 | 4.894 |
| | | | Mid | Ch21100 (2535) | 35.714 | 4.482 | 34.714 | 4.866 |
| | | | High | Ch21425 (2567.5) | 35.715 | 4.482 | 34.715 | 4.890 |
| | | 10 | Low | Ch20800 (2505) | 35.716 | 8.940 | 34.716 | 9.648 |
| | | | Mid | Ch21100 (2535) | 35.717 | 8.940 | 34.717 | 9.672 |
| | | | High | Ch21400 (2565) | 35.718 | 8.952 | 34.718 | 9.648 |
| | | 15 | Low | Ch20825 2507.5 | 35.719 | 13.413 | 34.719 | 14.416 |
| | | | Mid | Ch21100 (2535) | 35.720 | 13.396 | 34.720 | 14.297 |
| | | | High | Ch21375 2562.5 | 35.721 | 13.396 | 34.721 | 14.314 |
| | | 20 | low | Ch20850 2510 | 35.722 | 17.864 | 34.722 | 18.964 |
| | | | Mid | Ch21100 (2535) | 35.523 | 17.842 | 34.723 | 18.81 |
| | | | High | Ch21350 2560 | 35.524 | 17.886 | 34.724 | 19.008 |

Remark:

1.) see diagrams in annex 1

## 5.3. RF-Parameter - Conducted out of Band RF emissions and Band Edge

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

| | | | | | | |
|---|---|---|---|---|---|---|
| test location | ☒ CETECOM Essen (Chapter. 2.2.1) | | ☐ Please see Chapter. 2.2.2 | | ☐ Please see Chapter. 2.2.3 | |
| test site | ☐ 347 Radio.lab. 1 | ☒ Radio.lab. 2 | | | | |
| spectr. analys. | ☐ 584 FSU | ☐ 120 FSEM | ☐ 264 FSEK | ☒ 620 ESU26 | | |
| signaling | ☐ 017 CMD 65 | ☐ 323 CMD 55 | ☐ 340 CMD 55 | | | |
| signaling | ☐ 392 MT8820A | ☐ 436 CMU | ☒ 594 CMW500 | | | |
| power supply | ☒ 611 E3632A | ☐ 457 EA 3013A | ☐ 459 EA 2032-50 | ☐ 268 EA- 3050 | ☐ 494 AG6632A | ☐ 498 NGPE 40 |
| otherwise | ☒ 529 6dB divider | ☒ 530 10dB Att. | ☐ 431 Near field | | | |
| line voltage | ☐ 230 V 50 Hz via public mains | | ☐ 060 110 V/ 60 Hz via PAS 5000 | | | |

### 5.3.2. Requirements and limits

| | |
|---|---|
| **FCC** | General: §2.1051, §2.1057(2)<br>☒ LTE Band 5: Part 22: §22.917(a)(b)<br>☐ LTE Band 2: Part 24: §24.238(a)(b)<br>☐ LTE Band 4: Part 27: §27.53(h)<br>☒ LTE Band 7: Part 27: §27.5(i)(2)<br>☐ LTE Band 13: Part 27: §27.53(c) , §27.53(f)<br>☐ LTE Band 17: Part 27: §27.53(g) |
| **Limit** | „the power of emissions shall be attenuated below the transmitter output power (p) by at least 43+10Log(P) dB“ |

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

| | | |
|---|---|---|
| Climatic conditions | Temperature: (22±3°C) | Rel. humidity: (40±20)% |
| Test system set-up | Please see chapter “Test system set-up for conducted measurements on antenna port” | |
| Measurement method | The spectrum was scanned from 9 kHz to the 10th harmonic of the highest frequency generated within the equipment. A PEAK detector was used except measurements near the block-edge where a AVERAGE detector applied.<br><br>A suitable artificial antenna or RF-connector is provided by the applicant in order to perform the conducted measurements. Any data provided with the artificial antenna or connector, have been taken in account in order to correct the measurement data. (typical 0.3dB for attenuation of antenna connector) | |
| Spectrum-Analyzer settings | See below tables | |
| Mobile phone settings | A call was established with a suitable communication test unit (CMW500).<br>UE is set TX mode, highest transmit power conditions (RMC-mode), power saving techniques have been disabled<br><br>Tests have been performed in various settings for the device regarding allocated ressource blocks and channels in order to find worst-case configuration. Due to very big amount of possible combinations only certain combinations have been tested.<br><br>The measurements were made at the low, middle and high carrier frequencies of each of the supported operating band. Choosing three TX-carrier frequencies of the mobile phone, should be sufficient to demonstrate compliance. | |

## Spectrum-Analyzer Settings LTE Band 5

| | Start freq. MHz | Stop freq. MHz | R-BW kHz | V-BW MHz | Sweep time sec. | Att. | Detector |
|---|---|---|---|---|---|---|---|
| Sweep 1 (subrange 1) | 0.009 | 0.150 | 0.0001 | --[1.)] | 10 | 25 | MaxH-PK |
| Sweep 1 (subrange 2) | 0.150 | 1 | 0.009 | --[1.)] | 10 | 25 | MaxH-PK |
| Sweep 1 (subrange 3) | 1 | 30 | 0.1 | --[1.)] | 5 | 25 | MaxH-PK |
| Sweep 2 (subrange 1) | 30 | 9000 | 1 | --[1.)] | >60 | 35 | MaxH-PK |
| Sweep 3a (Block-Edge) | 823 | 824 | 20[2.)] to 100 | --[1.)] | 30 | 35 | MaxH-PK |
| Sweep 3b (Block-Edge) | 823 | 824 | | --[1.)] | 30 | 35 | MaxH-AV |
| Sweep 4a (Block-Edge) | 850 | 851 | | --[1.)] | 30 | 35 | MaxH-PK |
| Sweep 4b (Block-Edge) | 850 | 851 | | --[1.)] | 30 | 35 | MaxH-AV |

Remark: 1.) EMI 6dB receiver mode used
2.) according rules approx. 1% of emission bandwidth depending of chosen signal bandwidth

## Spectrum-Analyzer Settings LTE Band 7

| | Start freq. MHz | Stop freq. MHz | R-BW kHz | V-BW MHz | Sweep time sec. | Att. [dB] | Detector |
|---|---|---|---|---|---|---|---|
| Sweep 1 | 0.009 | 0.150 | 0.0001 | --[1.)] | 10 | 25 | MaxH-PK |
| Sweep 1 | 0.150 | 1 | 0.009 | --[1.)] | 10 | 25 | MaxH-PK |
| Sweep 1 | 1 | 30 | 0.1 | --[1.)] | 5 | 25 | MaxH-PK |
| Sweep 2 | 30 | 19500 | 1 | --[1.)] | >60 | 35 | MaxH-PK |
| Sweep 3a (Band-Edge) | 2477.905 | 2501.095 | 50kHz[1.)] | 500kHz | 30 | 35 | MaxH-AV |
| Sweep 3b (Band-Edge) | 2568.5 | 2592.5 | 50MHz[1.)] | 500kHz | 30 | 35 | MaxH-AV |

Remark:
1.) EMI 6dB receiver mode used
2.) Integrated BW Method used, results integrated to 1MHz reference bandwidth

### 5.3.4. Results

#### 5.3.4.1. LTE Band 5: Op. Mode 1, Set-up 1

| Dia-gram no. | Carrier Channel | | Frequency range | OP-mode no. | Remark | Used detector | | | Result |
|---|---|---|---|---|---|---|---|---|---|
| | Range | No. | | | | PK | AV | QP | |
| 36.50a | Low | 20425 | 9kHz to 30MHz | 1 | QPSK modulation | ☒ | ☐ | ☐ | passed |
| 36.50b | Low | 20425 | 9kHz to 30MHz | | 16QAM-Modulation | ☒ | ☐ | ☐ | passed |
| 36.51a | Low | 20425 | 30 MHz to 19.5GHz | | Carrier visible on diagram, not relevant for results QPSK modulation | ☒ | ☐ | ☐ | passed |
| 36.51b | Low | 20425 | 30 MHz to 19.5GHz | | Carrier visible on diagram, not relevant for results 16QAM-Modulation | ☒ | ☐ | ☐ | passed |
| 36.52a | Middle | 20525 | 9kHz to 30MHz | | QPSK modulation | ☒ | ☐ | ☐ | passed |
| 36.52b | Middle | 20525 | 9kHz to 30MHz | | 16QAM modulation | ☒ | ☐ | ☐ | passed |
| 36.53a | Middle | 20525 | 30 MHz to 19.5GHz | | Carrier visible on diagram, not relevant for results QPSK modulation | ☒ | ☐ | ☐ | passed |
| 36.53b | Middle | 20525 | 30 MHz to 19.5GHz | | Carrier visible on diagram, not relevant for results QAM modulation | ☒ | ☐ | ☐ | passed |
| 36.54a | High | 20643 | 9kHz to 30MHz | | QPSK modulation | ☒ | ☐ | ☐ | passed |
| 36.54b | High | 20643 | 30 MHz to 19.5GHz | | Carrier visible on diagram, not relevant for results 16QAM modulation | ☒ | ☐ | ☐ | passed |
| 36.55a | High | 20643 | 9kHz to 30MHz | | QPSK modulation | ☒ | ☐ | ☐ | passed |
| 36.55b | High | 20643 | 30 MHz to 19.5GHz | | Carrier visible on diagram, not relevant for results QAM modulation | ☒ | ☐ | ☐ | passed |

Remark:

| Dia-gram no. | Carrier Channel | | Measured frequency range | OP-mode no.*1.) | Remark | Used detector | | | Result |
|---|---|---|---|---|---|---|---|---|---|
| | Rang | No. | | | | PK | AV | QP | |
| 37.501a<br>37.502a<br>37.503a<br>37.504a<br>37.505a<br>37.507a<br>37.508a<br>37.509a | Low | 20407 (824.7MHz)<br>20415 (825.5MHz)<br>20425 (826.5MHz)<br>20450 (829.0MHz) | 823 – 824 MHz | 1 | Band-Edge compliance QPSK modulation, an integrated bandwidth method was used for measurement. Consult TX-channel value for first 1MHz near band-edge as well as Adjacent/alternate channels On LOWER-column for the results for frequency above1MHz from channel-edge. | ☐ | ☒ | ☐ | passed |
| 37.501b<br>37.502b<br>37.503b<br>37.504b<br>37.505b<br>37.507b<br>37.508b<br>37.509b | Low | | 823 – 824 MHz | | Band-Edge compliance QAM modulation, an integrated bandwidth method was used for measurement. Consult TX-channel value for first 1MHz near band-edge as well as Adjacent/alternate channels On LOWER-column for the results for frequency above1MHz from channel-edge. | ☐ | ☒ | ☐ | passed |

| Dia-gram no. | Carrier Channel | | Measured frequency range | OP-mode no.*1.) | Remark | Used detector | | | Result |
|---|---|---|---|---|---|---|---|---|---|
| | Range | No. | | | | PK | AV | QP | |
| 37.510a<br>37.511a<br>37.512a<br>37.513a<br>37.514a<br>37.515a<br>37.516a<br>37.517a | High | 20643 (848.3MHz)<br>20635 (847.5MHz)<br>20625 (846.5MHz)<br>20600 (844.0MHz) | 849 – 850 MHz | 1 | Band-Edge compliance QPSK modulation, an integrated bandwidth method was used for measurement. Consult TX-channel value for first 1MHz near band-edge as well as Adjacent/alternate channels On UPPER-column for the results for frequency above1MHz from channel-edge. | ☐ | ☒ | ☐ | passed |
| 37.510b<br>37.511b<br>37.512b<br>37.513b<br>37.514b<br>37.515b<br>37.516b<br>37.517b | High | | 849 – 850 MHz | | Band-Edge compliance QAM modulation, an integrated bandwidth method was used for measurement. Consult TX-channel value for first 1MHz near band-edge as well as Adjacent/alternate channels On UPPER-column for the results for frequency above1MHz from channel-edge. | ☐ | ☒ | ☐ | passed |

Remark: *1.) Please see test measurement in annex 4 - diagrams and values for detailed overview of the tested operating mode.

### 5.3.4.2. LTE Band 7: Op. Mode 2, Set-up 1

| Dia-gram no. | Carrier Channel | | Frequency range | OP-mode no. | Remark | Used detector | | | Result |
|---|---|---|---|---|---|---|---|---|---|
| | Range | No. | | | | PK | AV | QP | |
| 36.720a | Low | 20850 | 9kHz to 30MHz | 2 | QPSK modulation | ☒ | ☐ | ☐ | passed |
| 36.726b | Low | 20850 | 9kHz to 30MHz | | 16QAM-Modulation | ☒ | ☐ | ☐ | passed |
| 36.721a | Low | 20850 | 30 MHz to 19.5GHz | | Carrier visible on diagram, not relevant for results QPSK modulation | ☒ | ☐ | ☐ | passed |
| 36.727b | Low | 20850 | 30 MHz to 19.5GHz | | Carrier visible on diagram, not relevant for results 16QAM-Modulation | ☒ | ☐ | ☐ | passed |
| 36.722a | Middle | 21100 | 9kHz to 30MHz | | QPSK modulation | ☒ | ☐ | ☐ | passed |
| 36.728b | Middle | 21100 | 9kHz to 30MHz | | 16QAM-Modulation | ☒ | ☐ | ☐ | passed |
| 36.723a | Middle | 21100 | 30 MHz to 19.5GHz | | Carrier visible on diagram, not relevant for results QPSK modulation | ☒ | ☐ | ☐ | passed |
| 36.729b | Middle | 21100 | 30 MHz to 19.5GHz | | Carrier visible on diagram, not relevant for results QAM modulation | ☒ | ☐ | ☐ | passed |
| 36.724a | High | 21400 | 9kHz to 30MHz | | QPSK modulation | ☒ | ☐ | ☐ | passed |
| 36.720b | High | 21400 | 30 MHz to 19.5GHz | | Carrier visible on diagram, not relevant for results QPSK modulation | ☒ | ☐ | ☐ | passed |
| 36.725a | High | 21400 | 9kHz to 30MHz | | QAM modulation | ☒ | ☐ | ☐ | passed |
| 36.721b | High | 21400 | 30 MHz to 19.5GHz | | Carrier visible on diagram, not relevant for results QAM modulation | ☒ | ☐ | ☐ | passed |

Remark:

| Dia-gram no. | Carrier Channel | | Measured frequency range | OP-mode no.*1.) | Remark | Used detector | | | Result |
|---|---|---|---|---|---|---|---|---|---|
| | Rang | No. | | | | PK | AV | QP | |
| 37.701<br>37.702<br>37.705<br>37.706<br>37.709<br>37.710<br>37.713<br>37.714 | Low | 20775 (2502.5MHz)<br>20800 (2505.0MHz)<br>20825 (2507.5MHz)<br>20850 (2510.0MHz) | 2486 - 2500 MHz | 2 | Band-Edge compliance QPSK modulation type | ☐ | ☒ | ☐ | passed |
| 37.703<br>37.704<br>37.707<br>37.708<br>37.711<br>37.712<br>37.715<br>37.716 | Low | | 2486 - 2500 MHz | | Band-Edge compliance, 16-QAM modulation type | ☐ | ☒ | ☐ | passed |

Remark: Please see test measurement diagrams in annex 1

| Dia-gram no. | Carrier Channel | | Measured frequency range | OP-mode no.*1.) | Remark | Used detector | | | Result |
|---|---|---|---|---|---|---|---|---|---|
| | Range | No. | | | | PK | AV | QP | |
| 37.717<br>37.718<br>37.721<br>37.722<br>37.725<br>37.726<br>37.729<br>37.730 | High<br>QPSK | 21425 (2567.5MHz)<br>21400 (2565.0MHz)<br>21375 (2562.5MHz)<br>21350 (2560.0MHz) | 2570 -2576 MHz | 2 | Band-Edge compliance<br>Method:<br>An integrated bandwidth method combined with classical sweep method was used for the measurements. Pls. consult TX-channel value for first 1MHz near band-edge as well as Adjacent/alternate channels on the UPPER-column for the results for frequencies far from high band-edge. | ☐ | ☒ | ☐ | passed |
| 37.719<br>37.720<br>37.723<br>37.724<br>37.727<br>37.728<br>37.731<br>37.732 | High<br>16-QAM | | 2570 -2576 MHz | | | ☐ | ☒ | ☐ | passed |

Remark:
1. Please see test measurement diagrams in annex 1
2. High Band-Edge defined as the frequency area directly above LTE-Band 7 range (2570MHz) F2 line in diagram.

## 5.3.4.3. RF-Parameter - Radiated out of Band RF emissions and Band Edge

**5.3.5. Test location and equipments** (for reference numbers please see chapter 'List of test 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 | ☒ 443 FAR | ☐ 347 Radio.lab.1 | ☐ 347 Radio.lab.2 | |
| receiver | ☐ 377 ESCS30 | ☐ 001 ESS | ☐ 489 ESU 40 | ☐ ESU 26 | | |
| spectr. analys. | ☐ 584 FSU | ☐ 120 FSEM | ☒ 264 FSEK | | | |
| antenna | ☒ 608 HL 562 | ☒ 549 HL 025 | ☐ 302 BBHA9170 | ☐ 289 CBL 6141 | ☐ 030 HFH-Z2 | ☐ 477 GPS |
| signaling | ☐ 017 CMD 65 | ☐ 323 CMD 55 | ☐ 340 CMD 55 | | | |
| signaling | ☐ 392 MT8820A | ☐ 546 CMU | ☐ 547 CMU | ☒ 642 CMW500 | | |
| power supply | ☒ 611 E3632A | ☐ 457 EA 3013A | ☐ 459 EA 2032-50 | ☐ 268 EA- 3050 | ☐ 494 AG6632A | ☐ 498 NGPE 40 |
| otherwise | ☐ 529 6dB divider | ☐ 530 6dB Att. | ☐ 110 USB LWL | ☐ 482 Filter Matrix | ☐ 431 Near field | |
| line voltage | ☐ 230 V 50 Hz via public mains | | ☐ 060 110 V/ 60 Hz via PAS 5000 | | | |

**5.3.6. Requirements and limits**

| | |
|---|---|
| **FCC** | General: §2.1053(a) , §2.1057(a)<br>☒ LTE Band 5: Part 22: §22.917(a)(b)<br>☐ LTE Band 2: Part 24: §24.238(a)(b)<br>☐ LTE Band 4: Part 27: §27.53(h)<br>☒ LTE Band 7: Part 27: §27.5(i)(2)<br>☐ LTE Band 13: Part 27: §27.53(c) , §27.53(f)<br>☐ LTE Band 17: Part 27: §27.53(g) |
| **Limit** | „the power of emissions shall be attenuated below the transmitter output power (p) by at least 43+10Log(P) dB“<br>-> Resulting limits for all power levels of the Mobile Phone: -13dBm |

**5.3.7. Test condition and test set-up**

| | | | | |
|---|---|---|---|---|
| link to test system (if used): | | ☒ air link | ☐ cable connection | ☐ |
| 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)% |
| Test system set-up | | Please see chapter “Test system set-up for radiated spurious emission measurements up to 20 GHz” | | |
| Spectrum Analyzer Settings | **Parameter:**<br>Scan Mode<br>RBW<br>VBW<br>Sweep time<br>Sweep mode<br>Detector | Spectrum analyser mode<br>1 MHz<br>10 MHz<br>Coupled (Auto)<br>repetitive<br>Peak | | |
| Measurement method | | The spectrum was scanned from 9 kHz to the 10th harmonic of the highest frequency generated within the equipment. A PEAK detector was used except measurements near the Band-Edge where a AVERAGE detector applied when results are critical (low margin or limit exceed). Tests have been performed in various settings for the device regarding allocated ressource blocks and channels in order to find worst-case configuration. Due to very big amount of possible combinations only certain combinations have been tested. | | |
| Mobile phone settings | | A call was established on highest power transmit conditions in RMC mode. MPR was deactivated.<br><br>The measurements were made at the low, middle and high carrier frequencies of each of the supported operating band within the designated range within the allowed channel bandwidths. Choosing three TX-carrier frequencies of the mobile phone, should be sufficient to demonstrate compliance. | | |

## Spectrum-analyzer settings for LTE Band 5

| | Start freq. MHz | Stop freq. MHz | R-BW MHz | V-BW MHz | Sweep time sec. | Att. | Detector |
|---|---|---|---|---|---|---|---|
| Sweep 1 (subrange 1) | 30 | 1000 | 1 | 10 | 10 | 10 | MaxH-PK |
| Sweep 1 (subrange 2) | 1000 | 2800 | 1 | 10 | 15 | 0 | MaxH-PK |
| Sweep 1 (subrange 3) | 2800 | 9000 | 1 | 10 | 160 | 10 | MaxH-PK |
| Sweep 2a (Band-Edge) | 823 | 824 | 0.02 | 0.2 | 30 | 35 | MaxH-PK |
| Sweep 2b (Band-Edge) | 823 | 824 | 0.02 | 0.2 | 30 | 35 | MaxH-AV |
| Sweep 3a (Band-Edge) | 850 | 851 | 0.02 | 0.2 | 30 | 35 | MaxH-PK |
| Sweep 3b (Band-Edge) | 850 | 851 | 0.02 | 0.2 | 30 | 35 | MaxH-AV |

## Spectrum-analyzer settings for LTE Band 7

| | Start freq. MHz | Stop freq. MHz | R-BW MHz | V-BW MHz | Sweep time sec. | Att. | Detector |
|---|---|---|---|---|---|---|---|
| Sweep 1 (subrange 1) | 30 | 1000 | 1 | 10 | 10 | 10 | MaxH-PK |
| Sweep 1 (subrange 2) | 1000 | 2800 | 1 | 10 | 15 | 0 | MaxH-PK |
| Sweep 1 (subrange 3) | 2800 | 18000 | 1 | 10 | 160 | 10 | MaxH-PK |
| Sweep 2a (Band-Edge) | | | 0.05 | 0.5 | 30 | 35 | MaxH-PK |
| Sweep 2b (Band-Edge) | | | 0.05 | 0.5 | 30 | 35 | MaxH-AV |
| Sweep 3a (Band-Edge) | | | 0.05 | 0.5 | 30 | 35 | MaxH-PK |
| Sweep 3b (Band-Edge) | | | 0.05 | 0.5 | 30 | 35 | MaxH-AV |

### 5.3.8. Results

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

#### 5.3.8.1. LTE Band 5: Op. Mode 1, Set-up 2

| Dia-gram no. | Carrier Channel | | Frequency range | OP-mode no. | Remark | Used detector | | | Result |
|---|---|---|---|---|---|---|---|---|---|
| | Range | No. | | | | PK | AV | QP | |
| 8.50 | Low | 20425 | 30 MHz to 9 GHz | 1 | Carrier visible on diagram. Not relevant for results QPSK modulation | ☒ | ☐ | ☐ | passed |
| 8.51 | Middle | 20525 | 30 MHz to 9 GHz | 1 | Carrier visible on diagram. Not relevant for results QPSK modulation | ☒ | ☐ | ☐ | passed |
| 8.52 | High | 20643 | 30 MHz to 9 GHz | 1 | Carrier visible on diagram. Not relevant for results 16-QAM modulation | ☒ | ☐ | ☐ | passed |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 9.508b | Band-edge low | 20425 | 823 – 824 MHz | 1 | Band-Edge compliance 16-QAM modulation | ☐ | ☒ | ☐ | Passed |
| 9.508a | | 20425 | 823 – 824 MHz | 1 | Band-Edge compliance QPSK modulation | ☐ | ☒ | ☐ | passed |
| 9.510a | | 20425 | 823 – 824 MHz | 1 | Band-Edge compliance QPSK modulation | ☐ | ☒ | ☐ | passed |
| 9.510b | | 20425 | 823 – 824 MHz | 1 | Band-Edge compliance 16-QAM modulation | ☐ | ☒ | ☐ | passed |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 9.502a | Band-edge high | 20643 | 849 – 850 MHz | 1 | Band-Edge compliance QPSK modulation | ☐ | ☒ | ☐ | Passed |
| 9.502b | | 20643 | 849 – 850 MHz | 1 | Band-Edge compliance 16-QAM modulation | ☐ | ☒ | ☐ | passed |
| 9.503a | | 20643 | 849 – 850 MHz | 1 | Band-Edge compliance QPSK modulation | ☐ | ☒ | ☐ | passed |
| 9.503b | | 20643 | 849 – 850 MHz | 1 | Band-Edge compliance 16-QAM modulation | ☐ | ☒ | ☐ | passed |

Remark1:

### 5.3.8.2. LTE Band 7: Op. Mode 2, Set-up 2

| Dia-gram no. | Carrier Channel | | Frequency range | OP-mode no. | Remark | Used detector | | | Result |
|---|---|---|---|---|---|---|---|---|---|
| | Range | No. | | | | PK | AV | QP | |
| 8.53 | Low | 20850 | 30MHz – 2.8GHz<br>2.8GHz to 18 GHz | 2 | Carrier visible on diagram. Not relevant for results QPSK modulation | ☒ | ☐ | ☐ | passed |
| 8.54 | Middle | 21100 | 30MHz – 2.8GHz<br>2.8GHz to 18 GHz | 2 | Carrier visible on diagram. Not relevant for results QPSK modulation | ☒ | ☐ | ☐ | passed |
| 8.55 | High | 21400 | 30MHz – 2.8GHz<br>2.8GHz to 18 GHz | 2 | Carrier visible on diagram. Not relevant for results 16-QAM modulation | ☒ | ☐ | ☐ | passed |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 9.701 | Band-edge low 5 MHz | 20775 | 2486 – 2500 MHz | 2 | Band-Edge compliance QPSK modulation | ☐ | ☒ | ☐ | Passed |
| 9.702 | | 20775 | 2486 – 2500 MHz | 2 | Band-Edge compliance QPSK modulation | ☐ | ☒ | ☐ | passed |
| 9.703 | | 20775 | 2486 – 2500 MHz | 2 | Band-Edge compliance 16-QAM modulation | ☐ | ☒ | ☐ | passed |
| 9.704 | | 20775 | 2486 – 2500 MHz | 2 | Band-Edge compliance 16-QAM modulation | ☐ | ☒ | ☐ | passed |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 9.705 | Band-edge low 10 MHz | 20800 | 2486 – 2500 MHz | 2 | Band-Edge compliance QPSK modulation | ☐ | ☒ | ☐ | Passed |
| 9.706 | | 20800 | 2486 – 2500 MHz | 2 | Band-Edge compliance QPSK modulation | ☐ | ☒ | ☐ | passed |
| 9.707 | | 20800 | 2486 – 2500 MHz | 2 | Band-Edge compliance 16-QAM modulation | ☐ | ☒ | ☐ | passed |
| 9.708 | | 20800 | 2486 – 2500 MHz | 2 | Band-Edge compliance 16-QAM modulation | ☐ | ☒ | ☐ | passed |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 9.709 | Band-edge low 15MHz | 20825 | 2486 – 2500 MHz | 2 | Band-Edge compliance QPSK modulation | ☐ | ☒ | ☐ | Passed |
| 9.710 | | 20825 | 2486 – 2500 MHz | 2 | Band-Edge compliance QPSK modulation | ☐ | ☒ | ☐ | passed |
| 9.711 | | 20825 | 2486 – 2500 MHz | 2 | Band-Edge compliance 16-QAM modulation | ☐ | ☒ | ☐ | passed |
| 9.712 | | 20825 | 2486 – 2500 MHz | 2 | Band-Edge compliance 16-QAM modulation | ☐ | ☒ | ☐ | passed |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 9.713 | Band-edge low 20MHz | 20850 | 2486 – 2500 MHz | 2 | Band-Edge compliance QPSK modulation | ☐ | ☒ | ☐ | Passed |
| 9.714 | | 20850 | 2486 – 2500 MHz | 2 | Band-Edge compliance QPSK modulation | ☐ | ☒ | ☐ | passed |
| 9.715 | | 20850 | 2486 – 2500 MHz | 2 | Band-Edge compliance 16-QAM modulation | ☐ | ☒ | ☐ | passed |
| 9.716 | | 20850 | 2486 – 2500 MHz | 2 | Band-Edge compliance 16-QAM modulation | ☐ | ☒ | ☐ | passed |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 9.717 | Band-edge high 5MHz | 21425 | 2572-2592 MHz | 2 | Band-Edge compliance QPSK modulation | ☐ | ☒ | ☐ | Passed |
| 9.718 | | 21425 | 2572-2592 MHz | 2 | Band-Edge compliance QPSK modulation | ☐ | ☒ | ☐ | passed |
| 9.719 | | 21425 | 2572-2592 MHz | 2 | Band-Edge compliance 16-QAM modulation | ☐ | ☒ | ☐ | passed |
| 9.720 | | 21425 | 2572-2592 MHz | 2 | Band-Edge compliance 16-QAM modulation | ☐ | ☒ | ☐ | passed |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 9.721 | Band-edge high 10MHz | 21400 | 2570-2590 MHz | 2 | Band-Edge compliance QPSK modulation | ☐ | ☒ | ☐ | Passed |
| 9.722 | | 21400 | 2570-2590 MHz | 2 | Band-Edge compliance QPSK modulation | ☐ | ☒ | ☐ | passed |
| 9.723 | | 21400 | 2570-2590 MHz | 2 | Band-Edge compliance 16-QAM modulation | ☐ | ☒ | ☐ | passed |
| 9.724 | | 21400 | 2570-2590 MHz | 2 | Band-Edge compliance 16-QAM modulation | ☐ | ☒ | ☐ | passed |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 9.725 | Band-edge high 15MHz | 21375 | 2570-2590 MHz | 2 | Band-Edge compliance QPSK modulation | ☐ | ☒ | ☐ | Passed |
| 9.726 | | 21375 | 2570-2590 MHz | 2 | Band-Edge compliance QPSK modulation | ☐ | ☒ | ☐ | passed |
| 9.727 | | 21375 | 2570-2590 MHz | 2 | Band-Edge compliance 16-QAM modulation | ☐ | ☒ | ☐ | passed |
| 9.728 | | 21375 | 2570-2590 MHz | 2 | Band-Edge compliance 16-QAM modulation | ☐ | ☒ | ☐ | passed |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 9.729 | Band-edge high 20MHz | 21350 | 2570-2590 MHz | 2 | Band-Edge compliance QPSK modulation | ☐ | ☒ | ☐ | Passed |
| 9.730 | | 21350 | 2570-2590 MHz | 2 | Band-Edge compliance QPSK modulation | ☐ | ☒ | ☐ | passed |
| 9.731 | | 21350 | 2570-2590 MHz | 2 | Band-Edge compliance 16-QAM modulation | ☐ | ☒ | ☐ | passed |
| 9.732 | | 21350 | 2570-2590 MHz | 2 | Band-Edge compliance 16-QAM modulation | ☐ | ☒ | ☐ | passed |

Remark1:

## 5.4. RF-Parameter - Frequency stability on temperature and voltage variations

**5.4.1. Test location and equipments** (for reference numbers please see chapter 'List of test equipment')

| | | | | | | |
|---|---|---|---|---|---|---|
| test location | ☒ CETECOM Essen (Chapter. 2.2.1) | | ☐ Please see Chapter. 2.2.2 | | ☐ Please see Chapter. 2.2.3 | |
| test site | ☐ 347 Radio.lab.1 | ☒ Radio.lab.2 | | | ☐ | ☐ |
| spectr. analys. | ☐ 584 FSU | ☐ 489 ESU 40 | ☐ 264 FSEK | ☐ 620 ESU 26 | ☐ | ☐ |
| signaling | ☐ 392 MT8820A | ☐ 436 CMU | ☐ 547 CMU | ☒ 594 CMW500 | ☐ 594 CMW500 | |
| DC power | ☐ 611 E3632A | ☐ 457 EA 3013A | ☐ 459 EA 2032-50 | ☐ 268 EA- 3050 | ☐ 494 AG6632A | ☐ 498 NGPE 40 |
| otherwise | ☒ 529 6dB divider | ☒ 530 10dB Att. | ☐ 431 Near field | | | |
| Climatic test chamber | ☒ 331 HC 4055 | ☒ VT 4002 | ☒ 627 OPUS 1 | | | |
| line voltage | ☐ 230 V 50 Hz via public mains | | ☐ 060 110 V/ 60 Hz via PAS 5000 | | | |

**5.4.2. Requirements and limits**

| | |
|---|---|
| **FCC** | §2.1055(a)(1) , §24.235, §27.54 |
| **Limit** | *"The frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block"* |

**5.4.3. Test condition and test set-up**

| | |
|---|---|
| Test system set-up | Please see chapter "Test system set-up for conducted measurements on antenna port"<br><br>In order to maintain the voltage constant over the time period of the tests, a dummy battery was connected to a laboratory power supply. The power supply voltage was controlled on the input of the power supply terminals of the EUT. |
| Measurement method | The RF Channel spacing is 100 kHz according LTE-Spec, with a guard band depending of the TX signal bandwidth. Details can be found in standard 3GPP36.521. The aim of the EUT is to function under all extreme conditions within authorized sub-bands in regard to temperature and voltage variations. The frequency deviation was recorded with base station's build in capability. (CMW500) for both modulations possible: QPSK and 16-QAM<br><br>As the standard requires that the fundamental emissions stays within the authorized band, a limit of ±0.1ppm is considered low enough to ensure this. However the standard required a more relaxed limit of ±2.5ppm |
| Mobile phone settings | UE is set TX mode, highest transmit power conditions (RMC-mode), power saving techniques have been disabled<br><br>Tests have been done in RMC operating mode ,maximum power at lowest per bandwidth allowed TX signal bandwidth: 1.4MHz or 5MHz. Both modulations have been tested: QPSK and 16-QAM. |

**5.4.3.1. Frequency shift of carrier against a voltage range at constant nominal temperature of 20° Celsius**

Tests only performed across extreme voltage range for information: limited approval
OEM integrators should consult grant and applicants recommendations on power supply design rules.

1.) determine the carrier frequency for the lowest and highest channel at room temperature and nominal voltage [20°C]
2.) The voltage was reduced in 0.1 Volt steps to the lower end point, where the mobile phone stops working. (this shall be specified by the manufacturer) Record the carrier frequency shift within 2 minutes after powering on the mobile phone, to prevent for self heating effects.
3.) The voltage was increased in 0.1 Volt steps to the upper declared voltage of the battery. Record the carrier frequency shift within 2 minutes after powering on the mobile phone, to prevent for self heating effects.

### 5.4.4. Measurement Results:

#### 5.4.4.1. LTE Band 5

| Voltage(V) | Maximum frequency error Channel 20425/ BW= 5MHz QPSK Modulation [Hz] | 16-QAM Modulation [Hz] | QPSK Modulation [ppm] | 16-QAM Modulation [ppm] | Verdict Limit=±0.1ppm |
|---|---|---|---|---|---|
| 3,91 | -3,0327 | -4,3201 | -0,004 | -0,005 | Pass |
| 4,0 | -4,0483 | -3,1185 | -0,005 | -0,004 | |
| 4,1 | -2,861 | -3,2187 | -0,003 | -0,004 | |

| Voltage(V) | Maximum frequency error Channel 20525/ BW= 5MHz QPSK Modulation [Hz] | 16-QAM Modulation [Hz] | QPSK Modulation [ppm] | 16-QAM Modulation [ppm] | Verdict Limit=±0.1ppm |
|---|---|---|---|---|---|
| 3,91 | -3,562 | -2,7323 | -0,004 | -0,003 | Pass |
| 4,0 | -3,376 | -2,2316 | -0,004 | -0,003 | |
| 4,1 | -3,0184 | 1,8024 | -0,004 | 0,002 | |

| Voltage(V) | Maximum frequency error Channel 20625/ BW= 5MHz QPSK Modulation [Hz] | 16-QAM Modulation [Hz] | QPSK Modulation [ppm] | 16-QAM Modulation [ppm] | Verdict Limit=±0.1ppm |
|---|---|---|---|---|---|
| 3,91 | -2,6751 | -3,4189 | -0,003 | -0,004 | Pass |
| 4,0 | -2,8896 | 2,8324 | -0,003 | 0,003 | |
| 4,1 | -2,9469 | -2,532 | -0,003 | -0,003 | |

### 5.4.4.2. LTE Band 7

| Voltage(V) | Maximum frequency error | | | | Verdict |
|---|---|---|---|---|---|
| | Channel 20775/ BW= 5MHz | | | | |
| | QPSK Modulation [Hz] | 16-QAM Modulation [Hz] | QPSK Modulation [ppm] | 16-QAM Modulation [ppm] | Limit=±0.1ppm |
| 3,91 | 11,0149 | 12,9461 | 0,004 | 0,005 | Pass |
| 4,0 | 20,0129 | 11,5442 | 0,008 | 0,005 | |
| 4,1 | 20,4134 | 19,8984 | 0,008 | 0,008 | |

| Voltage(V) | Maximum frequency error | | | | Verdict |
|---|---|---|---|---|---|
| | Channel 21100/ BW= 5MHz | | | | |
| | QPSK Modulation [Hz] | 16-QAM Modulation [Hz] | QPSK Modulation [ppm] | 16-QAM Modulation [ppm] | Limit=±0.1ppm |
| 3,91 | 15,6784 | 10,5715 | 0,006 | 0,004 | Pass |
| 4,0 | 8,6546 | -9,0981 | 0,003 | -0,004 | |
| 4,1 | 16,1362 | 14,1191 | 0,006 | 0,006 | |

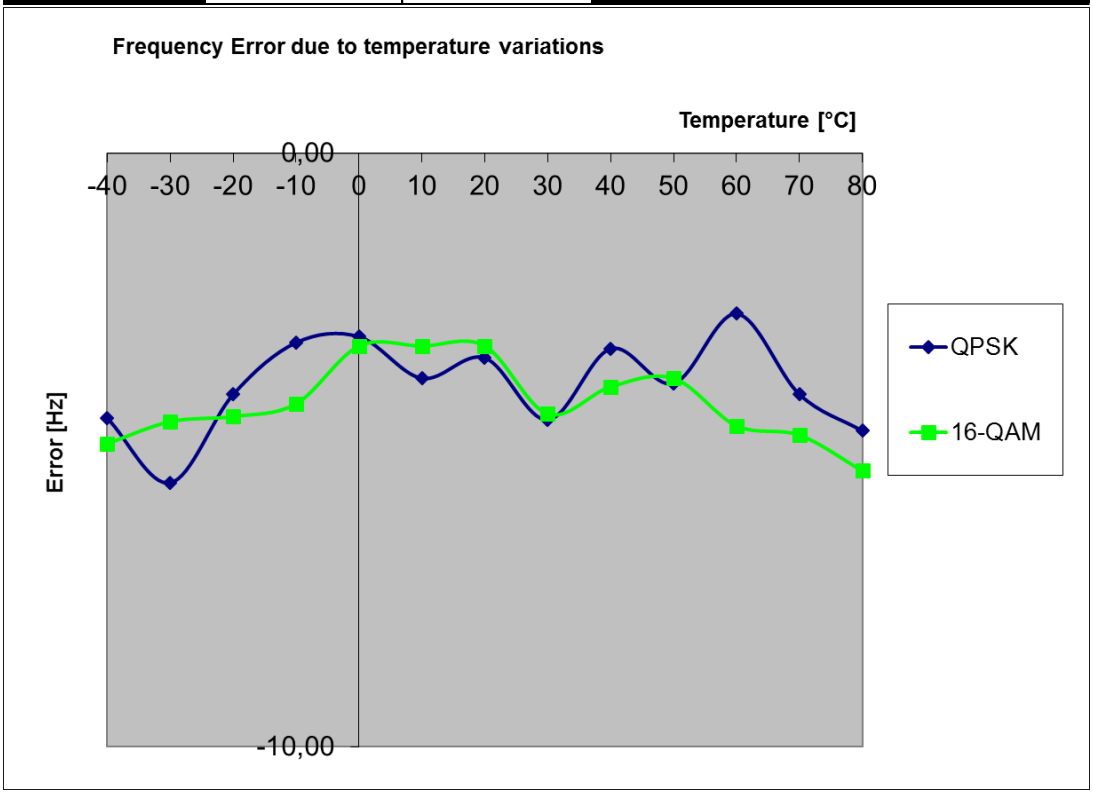
| Voltage(V) | Maximum frequency error | | | | Verdict |
|---|---|---|---|---|---|
| | Channel 21425/ BW= 5MHz | | | | |
| | QPSK Modulation [Hz] | 16-QAM Modulation [Hz] | QPSK Modulation [ppm] | 16-QAM Modulation [ppm] | Limit=±0.1ppm |
| 3,91 | 5,25 | 16,0789 | 0,002 | 0,006 | Pass |
| 4,0 | 15,5783 | 15,1348 | 0,006 | 0,006 | |
| 4,1 | 14,534 | 19,2404 | 0,006 | 0,007 | |

### 5.4.4.3. Frequency shift of carrier against temperature at constant power supply voltage

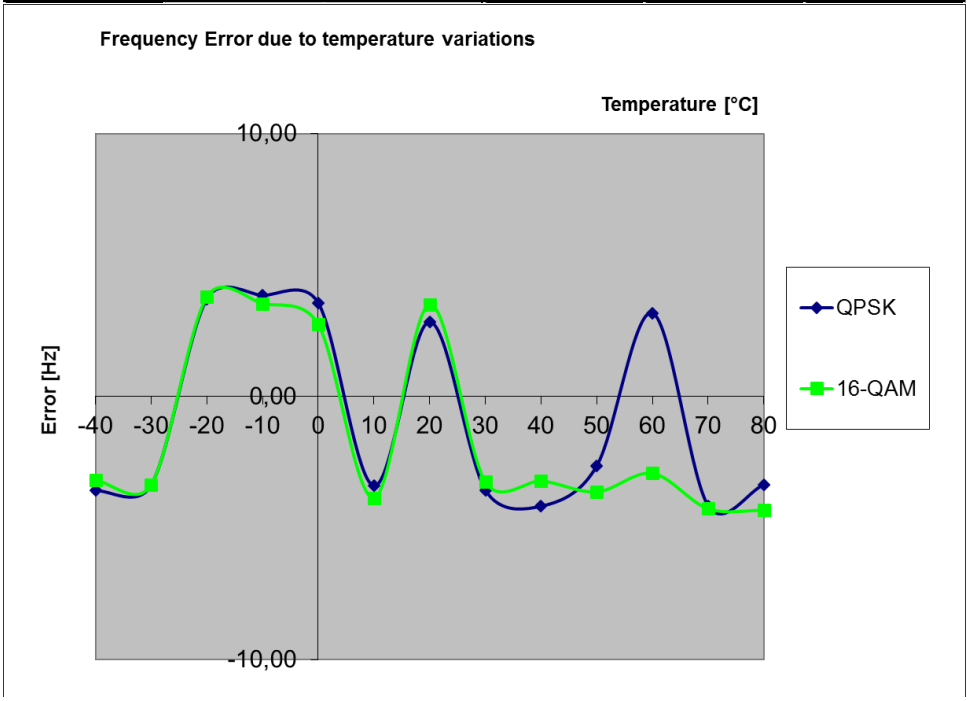
1.) determine the carrier frequency for the lowest, middle and highest channel at room temperature and nominal voltage [20°C]
2.) expose the mobile station to –30°C, wait sufficient time to have constant temperature.
3.) Perform the carrier frequencies measurements in 10°C increments from –40°C to +80°C. For about half hour at the specified temperature the mobile was powered-off. After powering-on, the measurements were made within 2 minute for the channel lower channel, in order to prevent self-warming of the mobile.

### 5.4.4.4. LTE Band 5

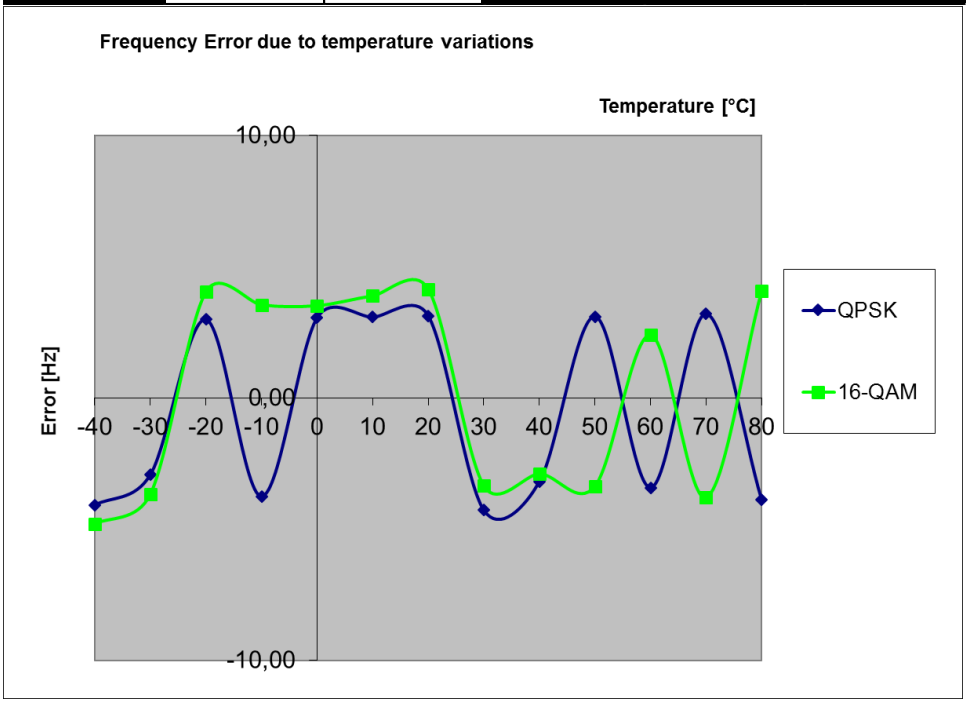
| Temperature | Maximum frequency error Channel 20425/ BW= 5MHz QPSK Modulation [Hz] | 16-QAM Modulation [Hz] | QPSK Modulation [ppm] | 16-QAM Modulation [ppm] | Verdict Limit=±0.1ppm |
|---|---|---|---|---|---|
| -40 | -4,4632 | -4,8923 | -0,005 | -0,006 | |
| -30 | -5,5504 | -4,5204 | -0,007 | -0,005 | |
| -20 | -4,0627 | -4,4346 | -0,005 | -0,005 | |
| -10 | -3,19 | -4,22 | -0,004 | -0,005 | |
| 0 | -3,0899 | -3,2473 | -0,004 | -0,004 | |
| 10 | -3,7909 | -3,2473 | -0,005 | -0,004 | |
| 20 | -3,4475 | -3,2473 | -0,004 | -0,004 | Pass |
| 30 | -4,4918 | -4,3917 | -0,005 | -0,005 | |
| 40 | -3,2902 | -3,9339 | -0,004 | -0,005 | |
| 50 | -3,8767 | -3,7909 | -0,005 | -0,005 | |
| 60 | -2,7037 | -4,5919 | -0,003 | -0,006 | |
| 70 | -4,0627 | -4,7493 | -0,005 | -0,006 | |
| 80 | -4,6778 | -5,3501 | -0,006 | -0,006 | |



| Temperature | Maximum frequency error | | | | Verdict |
|---|---|---|---|---|---|
| | Channel 20525/ BW= 5MHz | | | | |
| | QPSK Modulation [Hz] | 16-QAM Modulation [Hz] | QPSK Modulation [ppm] | 16-QAM Modulation [ppm] | Limit=±0.1ppm |
| -40 | -3,5763 | -3,1757 | -0,004 | -0,004 | Pass |
| -30 | -3,3617 | -3,3474 | -0,004 | -0,004 | |
| -20 | 3,7193 | 3,7909 | 0,004 | 0,005 | |
| -10 | 3,8481 | 3,5334 | 0,005 | 0,004 | |
| 0 | 3,562 | 2,7466 | 0,004 | 0,003 | |
| 10 | -3,3903 | -3,8481 | -0,004 | -0,005 | |
| 20 | 2,8467 | 3,5048 | 0,003 | 0,004 | |
| 30 | -3,5477 | -3,2473 | -0,004 | -0,004 | |
| 40 | -4,1628 | -3,2043 | -0,005 | -0,004 | |
| 50 | -2,6321 | -3,6192 | -0,003 | -0,004 | |
| 60 | 3,1757 | -2,9182 | 0,004 | -0,003 | |
| 70 | -4,1485 | -4,2629 | -0,005 | -0,005 | |
| 80 | -3,3474 | -4,3201 | -0,004 | -0,005 | |

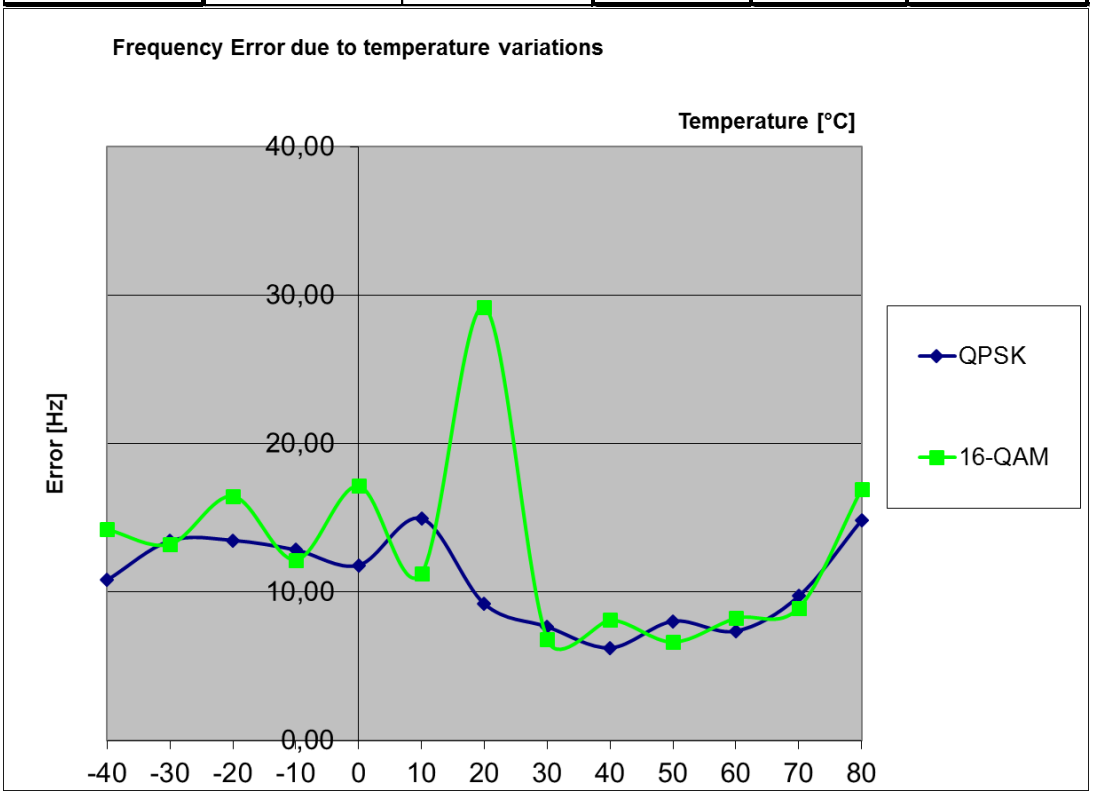


| Temperature | Maximum frequency error | | | | Verdict |
|---|---|---|---|---|---|
| | Channel 20625/ BW= 5MHz | | | | |
| | QPSK Modulation [Hz] | 16-QAM Modulation [Hz] | QPSK Modulation [ppm] | 16-QAM Modulation [ppm] | Limit=±0.1ppm |
| -40 | -4,077 | -4,7922 | -0,005 | -0,006 | Pass |
| -30 | -2,9182 | -3,6621 | -0,003 | -0,004 | |
| -20 | 2,9898 | 4,0483 | 0,004 | 0,005 | |
| -10 | -3,7479 | 3,5477 | -0,004 | 0,004 | |
| 0 | 3,0613 | 3,5191 | 0,004 | 0,004 | |
| 10 | 3,0756 | 3,891 | 0,004 | 0,005 | |
| 20 | 3,1328 | 4,1485 | 0,004 | 0,005 | |
| 30 | -4,2772 | -3,3474 | -0,005 | -0,004 | |
| 40 | -3,19 | -2,8896 | -0,004 | -0,003 | |
| 50 | 3,1042 | -3,3617 | 0,004 | -0,004 | |
| 60 | -3,4189 | 2,4033 | -0,004 | 0,003 | |
| 70 | 3,2043 | -3,7909 | 0,004 | -0,004 | |
| 80 | -3,891 | 4,0913 | -0,005 | 0,005 | |

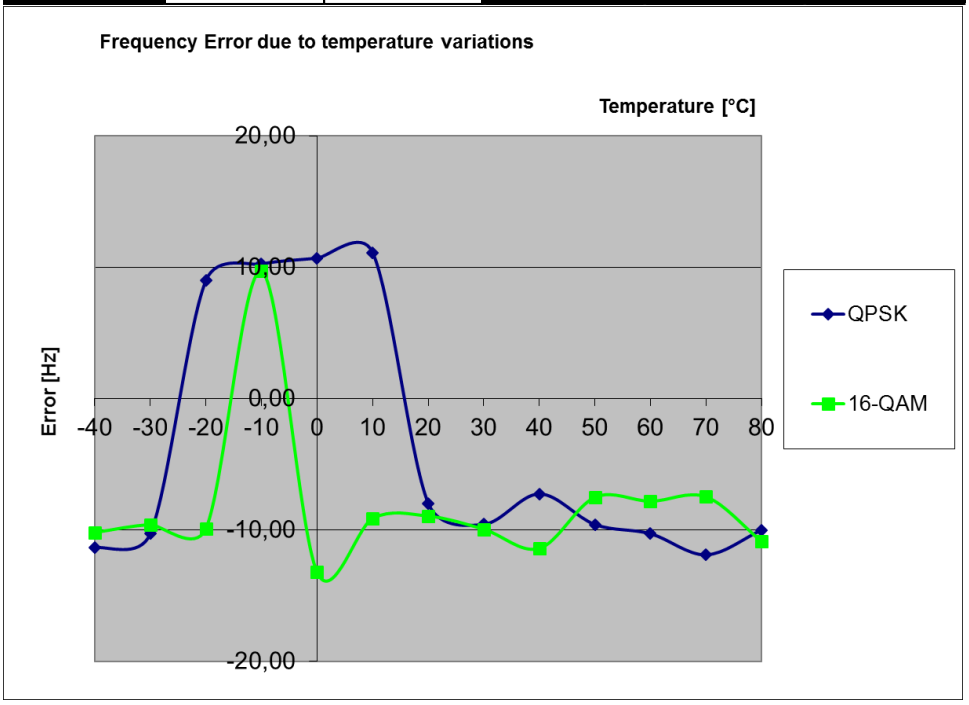


### 5.4.4.5. LTE Band 7

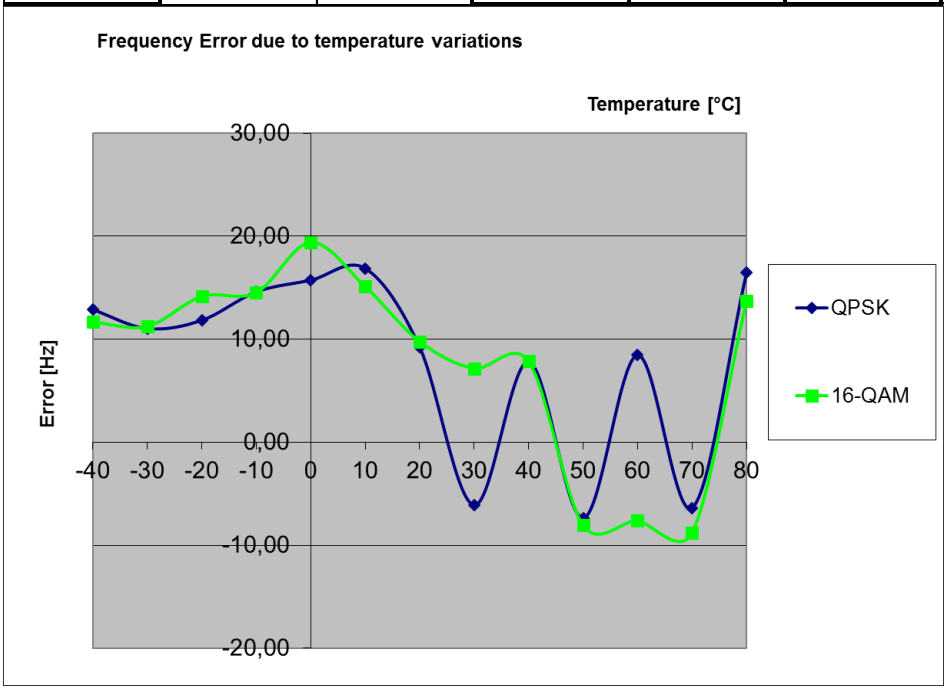
| Temperature | Maximum frequency error<br>Channel 20775/ BW= 5MHz<br>QPSK Modulation [Hz] | 16-QAM Modulation [Hz] | QPSK Modulation [ppm] | 16-QAM Modulation [ppm] | Verdict<br>Limit=±0.1ppm |
|---|---|---|---|---|---|
| -40 | 10,8147 | 14,2193 | 0,004 | 0,006 | Pass |
| -30 | 13,4611 | 13,2322 | 0,005 | 0,005 | |
| -20 | 13,4897 | 16,4652 | 0,005 | 0,007 | |
| -10 | 12,846 | 12,1737 | 0,005 | 0,005 | |
| 0 | 11,816 | 17,1518 | 0,005 | 0,007 | |
| 10 | 14,9632 | 11,2724 | 0,006 | 0,005 | |
| 20 | 9,2125 | 29,211 | 0,004 | 0,012 | |
| 30 | 7,6675 | 6,8092 | 0,003 | 0,003 | |
| 40 | 6,2513 | 8,1253 | 0,002 | 0,003 | |
| 50 | 8,0395 | 6,6376 | 0,003 | 0,003 | |
| 60 | 7,3814 | 8,2397 | 0,003 | 0,003 | |
| 70 | 9,7275 | 8,9407 | 0,004 | 0,004 | |
| 80 | 14,8487 | 16,9373 | 0,006 | 0,007 | |



| Temperature | Maximum frequency error | | | | Verdict |
|---|---|---|---|---|---|
| | Channel 21100/ BW= 5MHz | | | | |
| | QPSK Modulation [Hz] | 16-QAM Modulation [Hz] | QPSK Modulation [ppm] | 16-QAM Modulation [ppm] | Limit=±0.1ppm |
| -40 | -11,3583 | -10,1852 | -0,004 | -0,004 | Pass |
| -30 | -10,2711 | -9,5987 | -0,004 | -0,004 | |
| -20 | 8,9979 | -9,8848 | 0,004 | -0,004 | |
| -10 | 10,2425 | 9,6846 | 0,004 | 0,004 | |
| 0 | 10,6859 | -13,2179 | 0,004 | -0,005 | |
| 10 | 11,1151 | -9,1124 | 0,004 | -0,004 | |
| 20 | -7,9679 | -8,9407 | -0,003 | -0,004 | |
| 30 | -9,5701 | -9,9421 | -0,004 | -0,004 | |
| 40 | -7,2527 | -11,4012 | -0,003 | -0,004 | |
| 50 | -9,5844 | -7,5102 | -0,004 | -0,003 | |
| 60 | -10,2854 | -7,8106 | -0,004 | -0,003 | |
| 70 | -11,8875 | -7,4816 | -0,005 | -0,003 | |
| 80 | -9,9993 | -10,8719 | -0,004 | -0,004 | |



| Temperature | Maximum frequency error | | | | Verdict |
|---|---|---|---|---|---|
| | Channel 21425/ BW= 5MHz | | | | |
| | QPSK Modulation [Hz] | 16-QAM Modulation [Hz] | QPSK Modulation [ppm] | 16-QAM Modulation [ppm] | Limit=±0.1ppm |
| -40 | 12,8603 | 11,6587 | 0,005 | 0,005 | Pass |
| -30 | 11,0292 | 11,2438 | 0,004 | 0,004 | |
| -20 | 11,8303 | 14,1621 | 0,005 | 0,006 | |
| -10 | 14,5912 | 14,5197 | 0,006 | 0,006 | |
| 0 | 15,7213 | 19,3977 | 0,006 | 0,008 | |
| 10 | 16,8657 | 15,1062 | 0,007 | 0,006 | |
| 20 | 9,2268 | 9,7704 | 0,004 | 0,004 | |
| 30 | -6,1083 | 7,1526 | -0,002 | 0,003 | |
| 40 | 7,8106 | 7,8535 | 0,003 | 0,003 | |
| 50 | -7,3814 | -8,0824 | -0,003 | -0,003 | |
| 60 | 8,4543 | -7,6246 | 0,003 | -0,003 | |
| 70 | -6,3801 | -8,7976 | -0,002 | -0,003 | |
| 80 | 16,4366 | 13,69 | 0,006 | 0,005 | |



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

### 5.5.1. 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 | | | |

### 5.5.2. Requirements

| **FCC** | Part 15, Subpart C, §15.205 & §15.209 | | | |
|---|---|---|---|---|
| **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 |

### 5.5.3. 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" | | |

### 5.5.4. Measurement Results LTE FDD Band 5:

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 | |
| 2.50 | Low | 20425 | 9 kHz-30 MHz | 2 | 2 | LTE Band 5 QPSK modulation | ☒ | ☐ | ☐ | passed |
| 2.51 | Middle | 20525 | 9 kHz-30 MHz | 2 | 2 | LTE Band 5 QPSK modulation | ☒ | ☐ | ☐ | passed |
| 2.52 | High | 20643 | 9 kHz-30 MHz | 2 | 2 | LTE Band 5 QPSK modulation | ☒ | ☐ | ☐ | passed |

### 5.5.5. Measurement Results LTE FDD Band 7:

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 | |
| 2.56 | Low | 20850 | 9 kHz-30 MHz | 2 | 2 | LTE Band 7 QPSK modulation | ☒ | ☐ | ☐ | passed |
| 2.57 | Middle | 21100 | 9 kHz-30 MHz | 2 | 2 | LTE Band 7 QPSK modulation | ☒ | ☐ | ☐ | passed |
| 2.58 | High | 21300 | 9 kHz-30 MHz | 2 | 2 | LTE Band 7 QPSK modulation | ☒ | ☐ | ☐ | passed |

### 5.5.6. 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 |

## 5.6. 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 |

# 9. Versions of test reports (change history)

| Version | Applied changes | Date of release |
|---|---|---|
| -- | Initial release | 2017-08-30 |
| -- | -- | -- |
| -- | -- | -- |