

TEST REPORT

No.: 16-1-0050601T35a

According to:
FCC Regulations
 Part 22, Part 27

for

peiker acoustic GmbH & Co. KG

GSM/ WCDMA/ LTE Telematics ROW Module
 V1233-0

FCC-ID: QWY-V1233-0

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

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The listed attachments are an integral part of this report.

1. Summary of test results

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

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

The 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 (0,15 - 30 MHz)	AC-Power lines (conducted)	Part 15, Subpart C §15.207	§15.207 limits IC: Table 3, Chapter 8.8	--	--	Remark 1.)
2	General field strength emissions (9 kHz - 30 MHz)	Cabinet + inter-connecting cables (radiated)	§15.209(a)	2400/F(kHz) μV/m 24000/F(kHz) μV/m 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 99% Power	1		For information only
35	99% Occupied bandwidth						
36	Spurious emissions		§2.1051 §2.1057 §27.53	43+10log(P) dBc		1+2	passed
37	Band-Edge compliance						Passed
38	Frequency stability		§2.1055(a)(2) §27.54	< ±2.5ppm	3	1+2	Passed 2.)

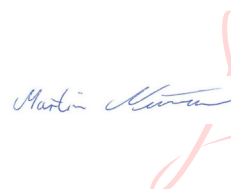
1.) EUT intended for car environment only

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
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Dipl.-Ing. Rachid Acharkaoui
Responsible for test section



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Date: 2017.09.20 12:53:08 +02'00'

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 45219 Essen - Kettwig Germany
Responsible for testing laboratory:	Dipl.-Ing. Rachid Acharkaoui
Deputy:	Dipl.-Ing. Niels Jeß

2.2. Test location

2.2.1. Test laboratory "CTC"

Company name:	see chapter 2.1. Identification of the testing laboratory
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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 acoustic GmbH & Co. KG
Address:	Max-Planck-Straße 28-32 61381 Friedrichsdorf/Ts. 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 (E-UTRA operating bands)	LTE Band 5: 824 - 849 MHz (Uplink), 869-894 MHz (Downlink) 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 – Table 5.4.4-1 accord. 3GPP TS36.521-1	LTE Band 5: UARFCN range 20400 - 20649 LTE Band 7: UARFCN range 20750 - 21449 (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 ☐ External, no RF- connector ☒ External, separate RF-connector: main TX + secondary RX connector		
Antenna Gain Tx (main)	☐ Not applicable ☒ from data sheet “BMW_Multibandantenna_Max Gain Tel GNSS_en” 699MHz – 716MHz: 8.3dBi 824MHz – 849MHz: 7.8dBi 1710MHz – 1755MHz: 7.3dBi 1850MHz – 1910MHz: 8.9dBi 2500MHz – 2570MHz: 6.8dBi ☐ No information from customer		
Path Losses	☒ from data sheet “TEL1_NAD_to_TEL1_TRUNK_table” LTE B2: 5.55dB LTE B4: 5.10dB LTE B5: 2.96dB LTE B7: 6.61dB LTE B12: 2.57dB		

MAX AV Output Power: Conducted	LTE-Mode 5 LTE-Mode 7	QPSK/dBm 23.10 22.57
EIRP: Radiated	LTE-Mode 5 LTE-Mode 7	(Output Power + Antenna gain – Path losses) QPSK/dBm 23.10dBm + 7.8dBi – 2.96dB= 27.94dBm 22.57dBm + 6.8dBi – 6.61dB= 22.76dBm
ERP: Radiated	LTE-Mode 5 LTE-Mode 7	(EIRP – 2.15) QPSK/dBm 27.94dBm – 2.15 = 25.79dBm 22.76dBm – 2.15 = 20.61dBm
Installed option		☐ GSM 900 and GSM 1800 Bands (not usable in USA/Canada) ☐ W-CDMA Band I and Band VIII (not usable in USA/Canada) ☒ 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 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. The input signal to the receiver is modulated with normal test modulation: QPSK or 16-QAM Modulation. The wanted RF input signal level to the receiver of the mobile station is set to a level to provide a stable communication link. NS_01 Network signalling value was used, no A-MPR was used therefore for this band.
2	LTE-Band 7 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. The input signal to the receiver is modulated with normal test modulation: QPSK or 16-QAM Modulation. The wanted RF input signal level to the receiver of the mobile station is set to a level to provide a stable communication link. 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

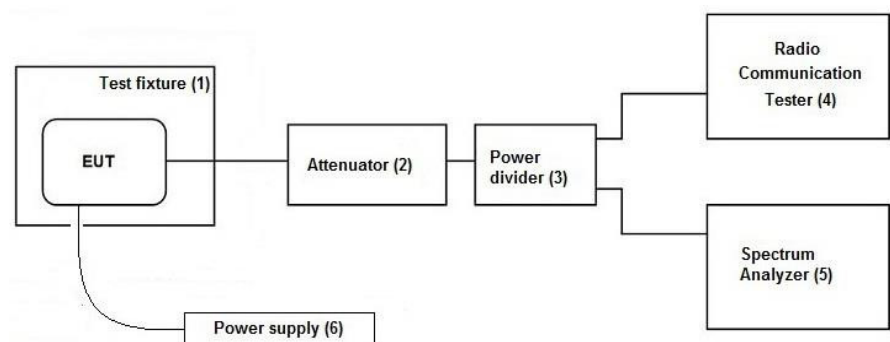
4.1. Test system set-up for conducted measurements on antenna port

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:

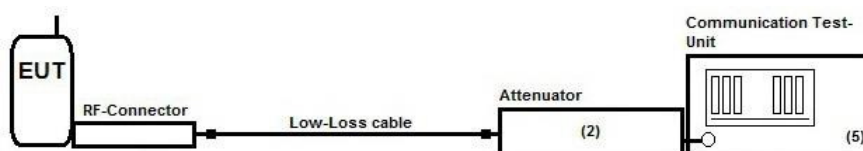


Used Equipment:	Passive Elements	Test Equipment	Remark:
	☒ 10 dB Attenuator (#530)	☒ CMW500 Communication Test-Unit for LTE	See List of equipment under each test case and chapter 8 for calibration info
	☒ Low loss RF-cables	☒ DC-Power Supply	
	☒ 6 dB resistive power divider/coupler (#529)	☒ Spectrum-Analyser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

Measurement uncertainty See chapter Measurement Uncertainties (Cel-2)

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

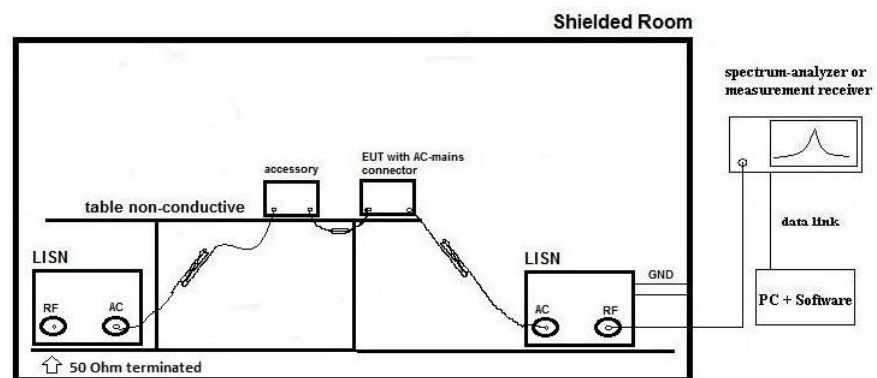
Specification: ANSI C63.4-2014 chapter 7, ANSI C63.10-2013chapter 6.2

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:

$$V_C = V_R + C_L \quad (1)$$

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

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.

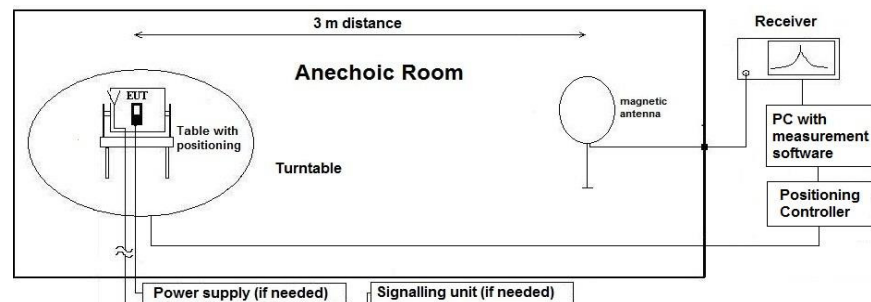
4.3. Test system set-up for radiated magnetic field measurements below 30 MHz

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

Final measurement on critical frequencies

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

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

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

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

Formula:

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

$$M = L_T - E_C$$

AF = Antenna factor

C_L = Cable loss

D_F = Distance correction factor

E_C = Electrical field – corrected value

E_R = Receiver reading

G_A = Gain of pre-amplifier (if used)

L_T = Limit

M = Margin

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

Distance correction:

Reference for applied correction (extrapolating) factors due to reduced measurement distance:

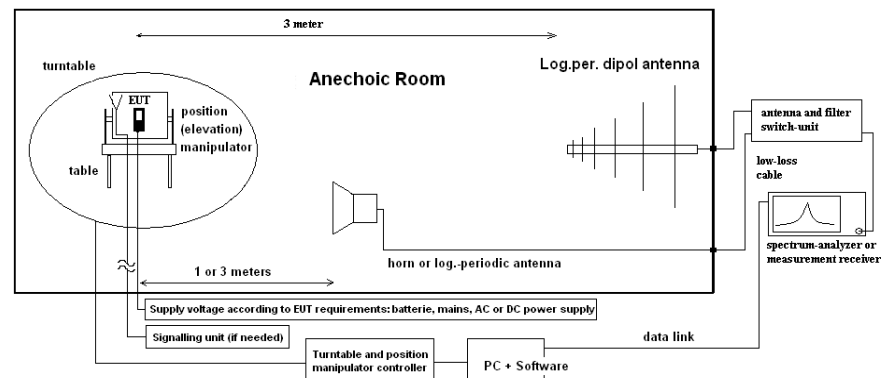
ANSI C63.10:2013, §6.4.4.2 - Equations (2) + (3) + (4)

4.4. 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:

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

$$E_{C(E)RP} = E_C - 95.2 \text{ dB}$$

$$M = L_T - E_{C(E)RP}$$

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)

$E_{C(E)RP}$ = 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
otherwise	☐ 331 HC 4055	☐ 248 6 dB Att.	☐ 529 Power div.	☐ - cable OTA20	☒ 611 E3632A
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. 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) 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). UE is set TX mode, highest transmit power conditions (RMC-mode), power saving techniques have been disabled (MPR-techniques) Tests have been performed in different EUT bandwidth settings and various settings for allocated RBs. 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		
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]				
14 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	
			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	5,949	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. modulation	max. modulation	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	27,18
			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			
			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			
			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			
			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. 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) The CCDF function of the measurement equipment as described in the operating manual was used (default settings). Further 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). UE is set TX mode, highest transmit power conditions (RMC-mode), power saving techniques have been disabled (MPR-techniques) 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)		
Signal-Bandwidth / [MHz]	Max. PAPR level with 0.1% probability / [dB]	
	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)		
Signal-Bandwidth / [MHz]	Max. PAPR level with 0.1% probability / [dB]	
	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). 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. 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
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
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) ☒ LTE Band 5: Part 22: §22.917(a)(b) ☐ LTE Band 2: Part 24: §24.238(a)(b) ☐ LTE Band 4: Part 27: §27.53(h) ☒ LTE Band 7: Part 27: §27.5(i)(2) ☐ LTE Band 13: Part 27: §27.53(c) , §27.53(f) ☐ 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. 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). UE is set TX mode, highest transmit power conditions (RMC-mode), power saving techniques have been disabled 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. 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:

Diagram no.	Carrier Channel		Measured frequency range	OP-mode no. *1.)	Remark	Used detector			Result
	Range	No.				PK	AV	QP	
37.501a 37.502a 37.503a 37.504a 37.505a 37.507a 37.508a 37.509a	Low	20407 (824.7MHz) 20415 (825.5MHz)	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 above 1MHz from channel-edge.	☐	☒	☐	passed
37.501b 37.502b 37.503b 37.504b 37.505b 37.507b 37.508b 37.509b	Low	20425 (826.5MHz) 20450 (829.0MHz)	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 above 1MHz from channel-edge.	☐	☒	☐	passed

Diagram no.	Carrier Channel		Measured frequency range	OP-mode no. *1.)	Remark	Used detector			Result
	Range	No.				PK	AV	QP	
37.510a 37.511a 37.512a 37.513a 37.514a 37.515a 37.516a 37.517a	High	20643 (848.3MHz) 20635 (847.5MHz)	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 above 1MHz from channel-edge.	☐	☒	☐	passed
37.510b 37.511b 37.512b 37.513b 37.514b 37.515b 37.516b 37.517b	High	20625 (846.5MHz) 20600 (844.0MHz)	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 above 1MHz 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:

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

Remark: Please see test measurement diagrams in annex 1

Diagram no.	Carrier Channel		Measured frequency range	OP-mode no. *1.)	Remark	Used detector			Result
	Range	No.				PK	AV	QP	
37.717 37.718 37.721 37.722 37.725 37.726 37.729 37.730	High QPSK	21425 (2567.5MHz)	2570 -2576 MHz	2	Band-Edge compliance Method: 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 37.720 37.723 37.724 37.727 37.728 37.731 37.732		21375 (2562.5MHz) 21350 (2560.0MHz)	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
receiver	☐ 377 ESCS30	☐ 001 ESS	☐ 489 ESU 40
spectr. analys.	☐ 584 FSU	☐ 120 FSEM	☒ 264 FSEK
antenna	☒ 608 HL 562	☒ 549 HL 025	☐ 302 BBHA9170
signaling	☐ 017 CMD 65	☐ 323 CMD 55	☐ 340 CMD 55
signaling	☐ 392 MT8820A	☐ 546 CMU	☐ 547 CMU
power supply	☒ 611 E3632A	☐ 457 EA 3013A	☐ 459 EA 2032-50
otherwise	☐ 529 6dB divider	☐ 530 6dB Att.	☐ 110 USB LWL
line voltage	☐ 230 V 50 Hz via public mains	☐ 060 110 V/60 Hz via PAS 5000	☐ 268 EA- 3050

5.3.6. Requirements and limits

FCC	General: §2.1053(a) , §2.1057(a) ☒ LTE Band 5: Part 22: §22.917(a)(b) ☐ LTE Band 2: Part 24: §24.238(a)(b) ☐ LTE Band 4: Part 27: §27.53(h) ☒ LTE Band 7: Part 27: §27.5(i)(2) ☐ LTE Band 13: Part 27: §27.53(c) , §27.53(f) ☐ 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“ -> 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: Scan Mode RBW VBW Sweep time Sweep mode Detector	Spectrum analyser mode 1 MHz 10 MHz Coupled (Auto) repetitive 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. 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

Diagram 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

Diagram no.	Carrier Channel		Frequency range	OP-mode no.	Remark	Used detector			Result
	Range	No.				PK	AV	QP	
8.53	Low	20850	30MHz – 2.8GHz 2.8GHz to 18 GHz	2	Carrier visible on diagram. Not relevant for results QPSK modulation	☒	☐	☐	passed
8.54	Middle	21100	30MHz – 2.8GHz 2.8GHz to 18 GHz	2	Carrier visible on diagram. Not relevant for results QPSK modulation	☒	☐	☐	passed
8.55	High	21400	30MHz – 2.8GHz 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
signaling	☐ 392 MT8820A	☐ 436 CMU	☒ 594 CMW500
DC power	☐ 611 E3632A	☐ 457 EA 3013A	☐ 268 EA- 3050
otherwise	☒ 529 6dB divider	☒ 530 10dB Att.	☐ 494 AG6632A
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	<i>"The frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block"</i>

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"
Measurement method	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. 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 As the standard requires that the fundamental emissions stays within the authorized band, a limit of $\pm 0.1 \text{ ppm}$ is considered low enough to ensure this. However the standard required a more relaxed limit of $\pm 2.5 \text{ ppm}$
Mobile phone settings	UE is set TX mode, highest transmit power conditions (RMC-mode), power saving techniques have been disabled 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				Verdict Limit=±0.1ppm
	Channel 20425/ BW= 5MHz				
	QPSK Modulation [Hz]	16-QAM Modulation [Hz]	QPSK Modulation [ppm]	16-QAM Modulation [ppm]	

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				Verdict Limit=±0.1ppm
	Channel 20525/ BW= 5MHz				
	QPSK Modulation [Hz]	16-QAM Modulation [Hz]	QPSK Modulation [ppm]	16-QAM Modulation [ppm]	

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				Verdict Limit=±0.1ppm
	Channel 20625/ BW= 5MHz				
	QPSK Modulation [Hz]	16-QAM Modulation [Hz]	QPSK Modulation [ppm]	16-QAM Modulation [ppm]	

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 Limit=±0.1ppm
	Channel 20775/ BW= 5MHz				
	QPSK Modulation [Hz]	16-QAM Modulation [Hz]	QPSK Modulation [ppm]	16-QAM Modulation [ppm]	
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 Limit=±0.1ppm
	Channel 21100/ BW= 5MHz				
	QPSK Modulation [Hz]	16-QAM Modulation [Hz]	QPSK Modulation [ppm]	16-QAM Modulation [ppm]	
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	

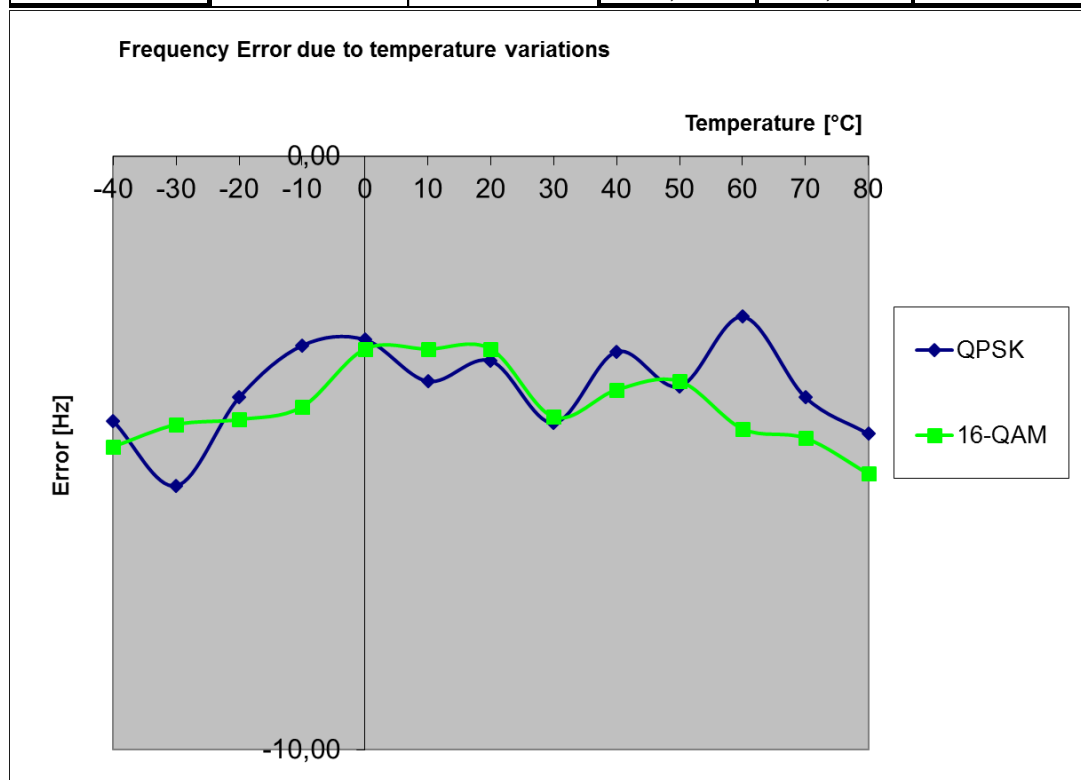
Voltage(V)	Maximum frequency error				Verdict
	Channel 21425/ BW= 5MHz				
	QPSK Modulation [Hz]	16-QAM Modulation [Hz]	QPSK Modulation [ppm]	16-QAM Modulation [ppm]	
					Limit=±0.1ppm
3,91	5,25	16,0789	0,002	0,006	Pass
4,0	15,5783	15,1348	0,006	0,006	
4.1	14,534	19,2404	0,006	0,007	

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.

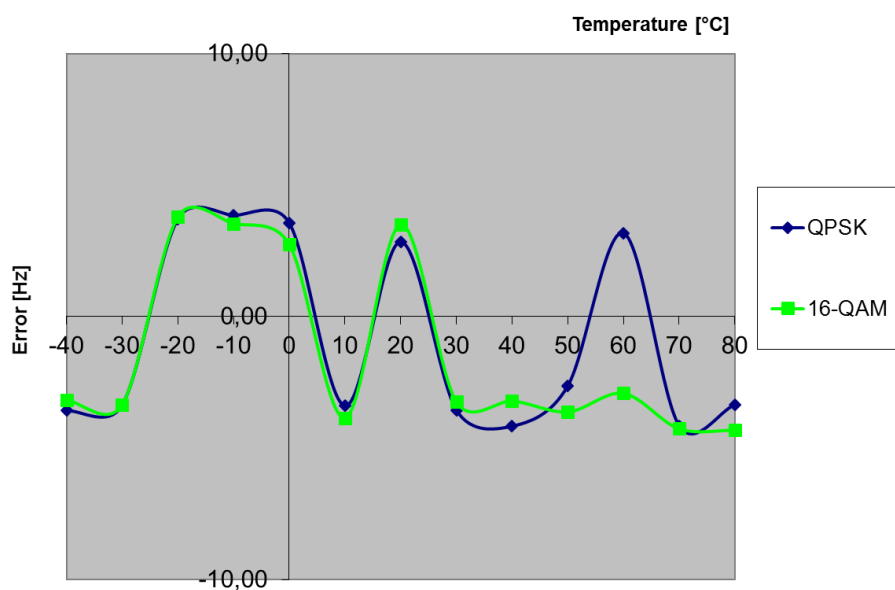
5.4.4.4. LTE Band 5

Temperature	Maximum frequency error				Verdict Limit=±0.1ppm
	Channel 20425/ BW= 5MHz				
	QPSK Modulation [Hz]	16-QAM Modulation [Hz]	QPSK Modulation [ppm]	16-QAM Modulation [ppm]	
-40	-4,4632	-4,8923	-0,005	-0,006	Pass
-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	
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	



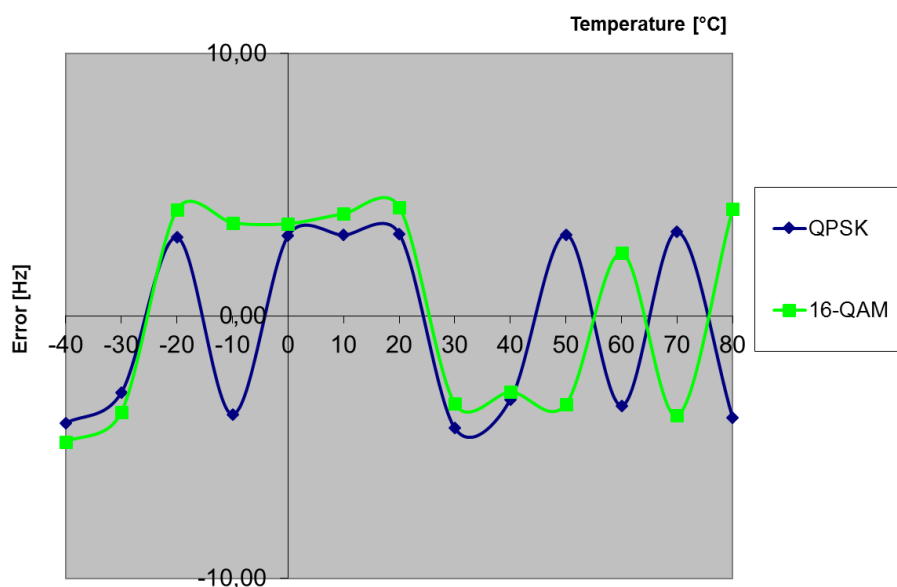
Temperature	Maximum frequency error				Verdict Limit=±0.1ppm
	Channel 20525/ BW= 5MHz				
	QPSK Modulation [Hz]	16-QAM Modulation [Hz]	QPSK Modulation [ppm]	16-QAM Modulation [ppm]	
-40	-3,5763	-3,1757	-0,004	-0,004	Pass
-30	-3,3617	-3,3474	-0,004	-0,004	
-20	3,7193	3,7909	0,004	0,005	
-10	3,8481	3,5334	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	

Frequency Error due to temperature variations



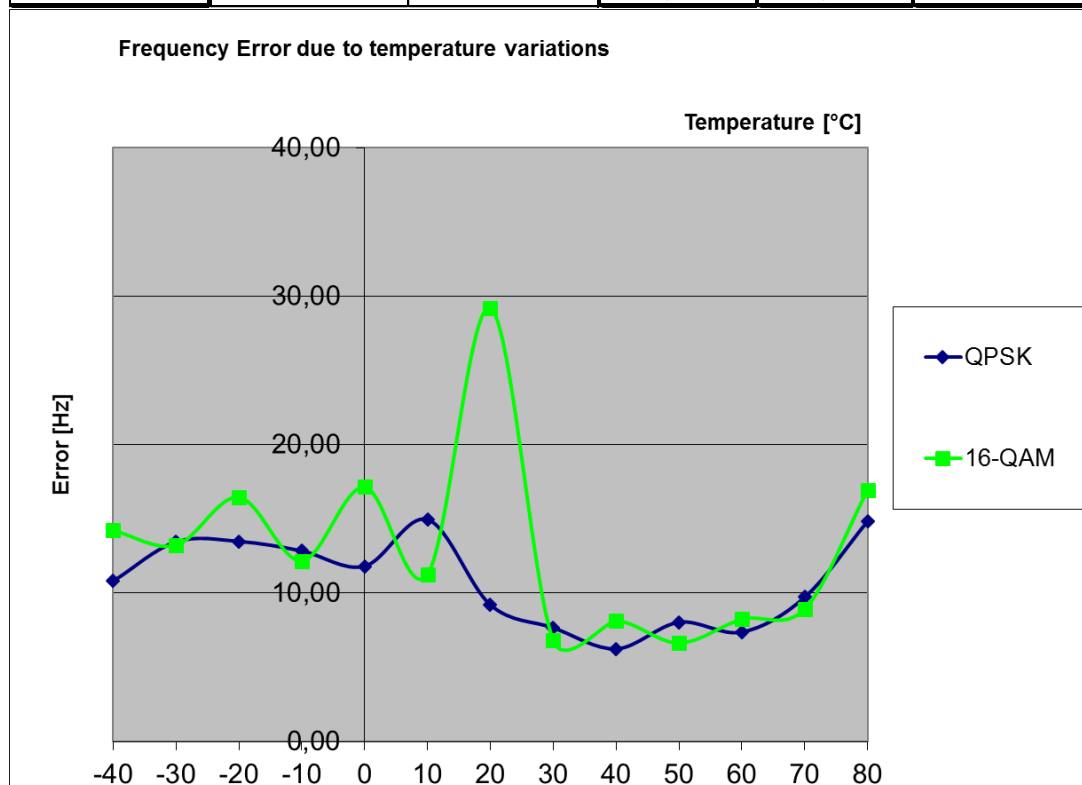
Temperature	Maximum frequency error				Verdict Limit=±0.1ppm
	Channel 20625/ BW= 5MHz				
	QPSK Modulation [Hz]	16-QAM Modulation [Hz]	QPSK Modulation [ppm]	16-QAM Modulation [ppm]	
-40	-4,077	-4,7922	-0,005	-0,006	Pass
-30	-2,9182	-3,6621	-0,003	-0,004	
-20	2,9898	4,0483	0,004	0,005	
-10	-3,7479	3,5477	-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	

Frequency Error due to temperature variations



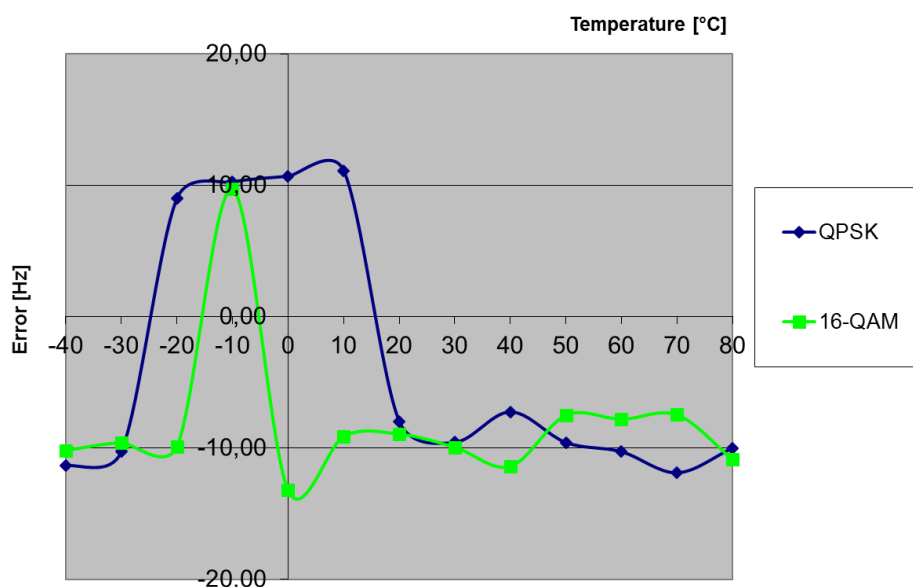
5.4.4.5. LTE Band 7

Temperature	Maximum frequency error				Verdict Limit=±0.1ppm
	Channel 20775/ BW= 5MHz				
	QPSK Modulation [Hz]	16-QAM Modulation [Hz]	QPSK Modulation [ppm]	16-QAM Modulation [ppm]	
-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	



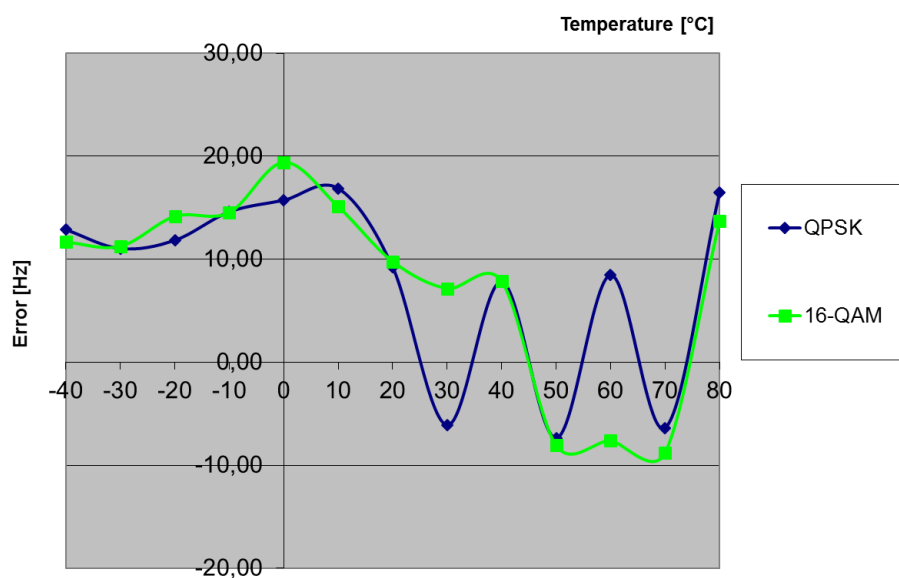
Temperature	Maximum frequency error				Verdict Limit=±0.1ppm
	Channel 21100/ BW= 5MHz				
	QPSK Modulation [Hz]	16-QAM Modulation [Hz]	QPSK Modulation [ppm]	16-QAM Modulation [ppm]	
-40	-11,3583	-10,1852	-0,004	-0,004	Pass
-30	-10,2711	-9,5987	-0,004	-0,004	
-20	8,9979	-9,8848	0,004	-0,004	
-10	10,2425	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	

Frequency Error due to temperature variations



Temperature	Maximum frequency error				Verdict Limit=±0.1ppm
	Channel 21425/ BW= 5MHz				
	QPSK Modulation [Hz]	16-QAM Modulation [Hz]	QPSK Modulation [ppm]	16-QAM Modulation [ppm]	
-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	

Frequency Error due to temperature variations



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
signaling	☐ 392 MT8820A	☐ 371 CBT32	☐ 547 CMU
otherwise	☐ 400 FTC40x15E	☐ 401 FTC40x15E	☐ 110 USB LWL
DC power	☐ 456 EA 3013A	☐ 457 EA 3013A	☐ 459 EA 2032-50
line voltage	☐ 230 V 50 Hz via public mains	☐ 060 120 V 60 Hz via PAS 5000	☐ 289 CBL 6141
			☒ 030 HFH-Z2
			☐ 477 GPS
			☐ 378 RadiSense
			☐ 494 AG6632A
			☐ 498 NGPE 40

5.5.2. Requirements

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

5.5.3. 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		
		☒ 150 kHz – 30 MHz RBW/VBW = 9 kHz Scan step = 4 kHz		
	Scan-Mode Detector Mode: Sweep-Time	☐ other:		
		☒ 6 dB EMI-Receiver Mode ☐ 3dB Spectrum analyser Mode		
Peak (pre-measurement) and Quasi-PK/Average (final if applicable)				
		Repetitive-Scan, max-hold		
		Coupled – calibrated display if continuous signal otherwise adapted to EUT’s individual transmission duty-cycle		
General measurement procedures		Please see chapter “Test system set-up radiated magnetic field measurements below 30 MHz”		

5.5.4. 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 $0.625 \times \text{Lambda}$. Formula 2+3+4 as presented in ANSI C63.10, Chapter 6.4.4 are used for the calculations of proper extrapolation factors.

Frequency -Range	f [kHz/MHz]	Lambda [m]	Far-Field Point [m]	Distance Limit accord. 15.209 [m]	1st Condition (d _{meas} < D _{near-field})	2 nd Condition (Limit distance bigger d _{near-field})	Distance Correction accord. Formula
kHz	9,00E+03	33333,33	5305,17	300	fulfilled	not fulfilled	-80,00
	1,00E+04	30000,00	4774,65		fulfilled	not fulfilled	-80,00
	2,00E+04	15000,00	2387,33		fulfilled	not fulfilled	-80,00
	3,00E+04	10000,00	1591,55		fulfilled	not fulfilled	-80,00
	4,00E+04	7500,00	1193,66		fulfilled	not fulfilled	-80,00
	5,00E+04	6000,00	954,93		fulfilled	not fulfilled	-80,00
	6,00E+04	5000,00	795,78		fulfilled	not fulfilled	-80,00
	7,00E+04	4285,71	682,09		fulfilled	not fulfilled	-80,00
	8,00E+04	3750,00	596,83		fulfilled	not fulfilled	-80,00
	9,00E+04	3333,33	530,52		fulfilled	not fulfilled	-80,00
	1,00E+05	3000,00	477,47		fulfilled	not fulfilled	-80,00
	1,25E+05	2400,00	381,97		fulfilled	not fulfilled	-80,00
	2,00E+05	1500,00	238,73		fulfilled	fulfilled	-78,02
	3,00E+05	1000,00	159,16		fulfilled	fulfilled	-74,49
	4,00E+05	750,00	119,37		fulfilled	fulfilled	-72,00
	4,90E+05	612,24	97,44		fulfilled	fulfilled	-70,23
	5,00E+05	600,00	95,49	30	fulfilled	not fulfilled	-40,00
	6,00E+05	500,00	79,58		fulfilled	not fulfilled	-40,00
	7,00E+05	428,57	68,21		fulfilled	not fulfilled	-40,00
	8,00E+05	375,00	59,68		fulfilled	not fulfilled	-40,00
	9,00E+05	333,33	53,05		fulfilled	not fulfilled	-40,00
MHz	1,00	300,00	47,75	30	fulfilled	not fulfilled	-40,00
	1,59	188,50	30,00		fulfilled	not fulfilled	-40,00
	2,00	150,00	23,87		fulfilled	fulfilled	-38,02
	3,00	100,00	15,92		fulfilled	fulfilled	-34,49
	4,00	75,00	11,94		fulfilled	fulfilled	-32,00
	5,00	60,00	9,55		fulfilled	fulfilled	-30,06
	6,00	50,00	7,96		fulfilled	fulfilled	-28,47
	7,00	42,86	6,82		fulfilled	fulfilled	-27,13
	8,00	37,50	5,97		fulfilled	fulfilled	-25,97
	9,00	33,33	5,31		fulfilled	fulfilled	-24,95
	10,00	30,00	4,77		fulfilled	fulfilled	-24,04
	10,60	28,30	4,50		fulfilled	fulfilled	-23,53
	11,00	27,27	4,34		fulfilled	fulfilled	-23,21
	12,00	25,00	3,98		fulfilled	fulfilled	-22,45
	13,56	22,12	3,52		fulfilled	fulfilled	-21,39
	15,00	20,00	3,18		fulfilled	fulfilled	-20,51
	15,92	18,85	3,00		fulfilled	fulfilled	-20,00
	17,00	17,65	2,81		not fulfilled	fulfilled	-20,00
	18,00	16,67	2,65		not fulfilled	fulfilled	-20,00
	20,00	15,00	2,39		not fulfilled	fulfilled	-20,00
	21,00	14,29	2,27		not fulfilled	fulfilled	-20,00
	23,00	13,04	2,08		not fulfilled	fulfilled	-20,00
	25,00	12,00	1,91		not fulfilled	fulfilled	-20,00
	27,00	11,11	1,77		not fulfilled	fulfilled	-20,00
	29,00	10,34	1,65		not fulfilled	fulfilled	-20,00
	30,00	10,00	1,59		not fulfilled	fulfilled	-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 150 kHz - 30 MHz	4.0 dB 3.6 dB							-
Radiated emissions Enclosure	CISPR 16-2-3	30 MHz - 1 GHz 1 GHz - 18 GHz	4.2 dB 5.1 dB							E-Field
Disturbance power	CISPR 16-2-2	30 MHz - 300 MHz	-							-
Power Output radiated	-	30 MHz - 4 GHz	3.17 dB							Substitution method
Power Output conducted	-	Set-up No.	Cel-C1	Cel-C2	BT1	W1	W2	--		
		9 kHz - 12.75 GHz	N/A	0.60	0.7	0.25	N/A	--		
		12.75 - 26.5GHz	N/A	0.82	--	N/A	N/A	--		
Conducted emissions on RF-port	-	9 kHz - 2.8 GHz	0.70	N/A	0.70	N/A	0.69	--		
		2.8 GHz - 12.75GHz	1.48	N/A	1.51	N/A	1.43	--		
		12.75 GHz - 18GHz	1.81	N/A	1.83	N/A	1.77	--		
		18 GHz - 26.5GHz	1.83	N/A	1.85	N/A	1.79	--		
Occupied bandwidth	-	9 kHz - 4 GHz	0.1272 ppm (Delta Marker)						Frequency error	
			1.0 dB						Power	
Emission bandwidth	-	9 kHz - 4 GHz	0.1272 ppm (Delta Marker)						Frequency error	
			See above: 0.70 dB						Power	
Frequency stability	-	9 kHz - 20 GHz	0.0636 ppm							-
Radiated emissions Enclosure	-	150 kHz - 30 MHz	5.0 dB							Magnetic field
		30 MHz - 1 GHz	4.2 dB							E-field
		1 GHz - 20 GHz	3.17 dB							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
337 487 558 348 348	(MRA US-EU 0003)	Radiated Measurements 30 MHz to 1 GHz, 3 m / 10 m (OATS) Radiated Measurements 30 MHz to 1 GHz, 3 m (SAR) Radiated Measurements above 1 GHz, 3 m (FAR) Mains Ports Conducted Interference Measurements Telecommunication Ports Conducted Interference Measur.	FCC, Federal Communications Commission Laboratory Division, USA
337 487 550 558	-- 3462D-2 3462D-2 3462D-3	Radiated Measurements 30 MHz to 1 GHz, 3 m / 10 m (OATS) Radiated Measurements 30 MHz to 1 GHz, 3 m (SAR) Radiated Measurements 1 GHz to 6 GHz, 3 m (SAR) Radiated Measurements above 1 GHz, 3 m (FAR)	IC, Industry Canada Certification and Engineering Bureau
487 550 348 348	R-2666 G-301 C-2914 T-1967	Radiated Measurements 30 MHz to 1 GHz, 3 m (SAR) Radiated Measurements 1 GHz to 6 GHz, 3 m (SAR) Mains Ports Conducted Interference Measurements Telecommunication Ports Conducted Interference Measur.	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 equipment “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	6K0000788	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	Wainwright	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	201.0999.9302.6.4.1.4 3	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
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