T E S T R E P O R T
No.: 6-0315-13-1-3c

According to:
FCC Regulations
Part 22, Part 24, Part 27

IC-Regulations
RSS-132 Issue 3, RSS-133 Issue 6
RSS-139 Issue 2, RSS-Gen Issue 3

for

Peiker Acustic GmbH & Co. KG

GSM/W-CDMA/LTE Module V1140-101
+ Antenna US34105
(LTE-Mode Band II/IV/V/XVII)

FCC-ID: QWY-V1140-101
IC: 6588A-V1140101

Laboratory Accreditation and Listings			
DAkkS Deutsche Akkreditierungsstelle D-PL-12047-01-01	Reg. No.: 736496 MRA US-EU 0003	Industry Canada Reg. No.: 3462D-1 Reg. No.: 3462D-2 Reg. No.: 3462D-3	Voluntary Controls for Electromagnetic Emissions Reg. No.: R-2666 C-2914, T-1967, G-301
WiFi ALLIANCE AUTHORIZED RF LABORATORY	CTIA Authorized Test Lab LAB CODE 20011130-00		
accredited according to DIN EN ISO/IEC 17025			

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The test results relate only to the individual items which have been tested. This report shall not be reproduced in parts without the written approval of the testing laboratory © Copyright: All rights reserved by CETECOM

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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 Equipment Under Test (in this report, hereinafter referred as EUT) supports radiofrequency technologies.
The presented wireless module includes GPRS/(E)GPRS, W-CDMA and LTE wireless technology. 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 H, Part 27, Subpart C and Part 24, Subpart E (Broadband PCS) of the FCC CFR 47 Rules, Edition 1st October 2012 and Canada RSS-132, RSS-133, RSS-139 and RSS-Gen standards.

1.1. TX mode, tests overview according FCC and Canadian RSS-Standards

No. of Diagram group	Test case	Port	References & Limits			EUT set-up	EUT op-mode	Result
			FCC Standard	RSS Section	Test limit			
1	AC-Power Lines Emissions Conducted (0,15 - 30 MHz)	AC-Power lines (conducted)	§15.207	RSS-Gen, Issue 3: Chapter 7.2.4	§15.207 limits IC: Table 4, Chapter 7.2.4	--	--	Remark 1.)
2	General field strength emissions (9 kHz - 30 MHz)	Cabinet + inter-connecting cables (radiated)	§15.209(a)	RSS-Gen, Issue 3: Chapter 4.11 Chapter 7.2.5, Table 5+6	2400/F(kHz) µV/m 24000/F(kHz) µV/m 30 µV/m	--	--	Remark 1.)
7	RF-Power (ERP/EIRP)		§2.1046 §22.913(a)(2)	RSS-132: 5.4 SRSP-503: 5.1.3	< 7 Watt (ERP)	2	3	passed 2.)
			§24.232(c)	RSS-133:4.1/6.4 SRSP-510: 5.1.2	< 2 Watt (EIRP)		1	
			§27.50 (d)(4)(5)(6)	RSS-139: 6.4	< 1 Watt (EIRP)		2	
			§27.50(c)(10)	RSS-130: 4.4	< 3 Watt (ERP) < 5 Watt (IC)		4	
8	Spurious emissions		§2.1053(a) §2.1057 §22.917(a)(b) §24.238(a)(b) §27.53(h)(3)(ii)(iii)	RSS-132: 4.5.1 & 4.5.2 RSS-133: 6.5.1(a)(b) RSS-139: Issue 2 Chapter 6.5 (i) (ii)	43+10log(P) dBc	1+2	1+2+3	Passed 2.)
9	Band-Edge compliance		§27.53(g)	RSS-130: Issue 1 Chapter 4.6.1/4.6.2(b)		1+2	4	Passed 2.)

30	RF Power	Antenna terminal (conducted)	§2.1046	RSS-130	< 5 Watt & PAPR < 13dB	3	1+2+3 +4	Passed
34	26dB Emission bandwidth		§2.202 §2.1049 §22.917(a) §24.238(a) §27.53(h)(3)	RSS-Gen:4.6.1	99% Power	1	1+2+3 +4	For information only
35	99% Occupied bandwidth							
36	Spurious emissions		§2.1051 §2.1057 §22.917(a)(b) §24.238(a)(b) §27.53(h)(3) (ii)(iii)	RSS-132: 5.5(i)(ii) RSS-133: 6.5.1(i)(ii) RSS-139: 6.5(i)(ii)	43+10log(P) dBc	1	1+2+3	Passed [2.)]
37	Band-Edge compliance							
			§27.53(g)	RSS-130: 4.6.1		1	4	Passed [2.)]
38	Frequency stability		§22.355, table C-1 §24.235 §2.1055(a)(2) §27.54	RSS-132: 5.3 -- RSS-133: 6.3 RSS-139: 6.3	< ±2.5ppm	3	1+2+3 +4	Passed [2.)]

Remarks: 1.) see separate test report TR6-0315-13-1-3d for tests according FCC Part15C
2.) for tests according RSS-130 (LTE Band XVII) pls. check also separate test report TR6-0315-13-1-9c for additional measurements

Attestation:

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

D. Franke
Responsible for test section

CETECOM GmbH Im Teelbruch 116 45219 Essen Tel.: +49 (0) 20 54 / 95 19 - 0 Fax: +49 (0) 20 54 / 95 19 - 997

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

2. Administrative Data

2.1. Identification of the testing laboratory

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

2.2. Test location

2.2.1. Test laboratory "CTC"

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

2.3. Organizational items

Responsible for test report and project leader:	Dipl.-Ing. C. Lorenz
Receipt of EUT:	2013-06-05
Date(s) of test:	2013-06-05 to 2013-07-17
Date of report:	2013-07-27
Lorenz	

2.4. Applicant's details

Applicant's name:	Peiker Acustic GmbH & Co. KG
Address:	Max-Planck-Straße 28-32 61381 Friedrichsdorf/Ts. Germany
Contact person:	Mr. 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. SUMMARY OF RESULTS AND TECHNICAL DATA OF MAIN EUT DECLARED BY APPLICANT-

Main function	GSM/W-CDMA/LTE Module		
Type	V1140-101		
TX-frequency range (E-UTRA operating bands)	LTE Band 2: 1850 - 1910 MHz (Uplink), 1930-1990 MHz (Downlink) LTE Band 4: 1710 - 1755 MHz (Uplink), 2110 - 2155 MHz (Downlink) LTE Band 5: 824 - 849 MHz (Uplink), 869-894 MHz (Downlink) LTE Band 17: 704 - 716 MHz (Uplink), 734 - 746 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 2: UARFCN range 18600 - 19199 LTE Band 4: UARFCN range 19950 - 20399 LTE Band 5: UARFCN range 20400 - 20649 LTE Band 17: UARFCN range 23730 - 23849		See Note about channels not to be used depending on channel bandwidths
Emission designator(s) (Max. Value across all operating bands)	Channel bandwidth	QPSK Modulation:	16-QAM Modulation
	1.4 MHz	1M08G7D	1M08W7D
	3 MHz	2M69G7D	2M69W7D
	5 MHz	4M47G7D	4M46W7D
	10 MHz	8M92G7D	8M92W7D
	15 MHz	13M4G7D	13M4W7D
	20 MHz	17M8G7D	17M8W7D
Antenna Type	☐ Integrated ☐ External, no RF- connector ☒ External, separate RF-connector: main TX + secondary RX connector		
Antenna Gain	No information from customer		
MAX PEAK Output Power: Radiated LTE-Mode 2 LTE-Mode 4 LTE-Mode 5 LTE-Mode 17	 32.3 dBm (PK) 29.2 dBm (PK) 28.8 dBm (PK) 28.5 dBm (PK)		
MAX PEAK Output Power: Conducted LTE-Mode 2 LTE-Mode 4 LTE-Mode 5 LTE-Mode 17	 23.67 dBm (AV) 24.03 dBm (AV) 23.35 dBm (AV) 23.17 dBm (AV)		
FCC-ID	QWY-V1140-101		
IC	6588A-V1140101		
Installed option	☒ GSM 900 and GSM 1800 Bands (not usable in USA/Canada) ☒ GPS (not tested within this test report)		
Power supply	☒ DC power only: 3.7V by external laboratory power supply		
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 descrip-tion*)	EUT	Type	S/N serial number	HW hardware status	SW software status
EUT A	GSM/W-CDMA/LTE Module	V1140-101	US#405V1140-101 HW1613	3.0	M9615A-CETWTAZM-5.0.17006
EUT B	Antenna	US34105	#34105 US	A02	--
EUT C	Antenna	US34105	#34105 US	A03	--
EUT D	GSM/W-CDMA/LTE Module	V1140-101	US#406V1140-101HW1613	3.0	M9615A-CETWTAZM-5.0.17006

*) 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 descrip-tion *)	Auxiliary Equipment	Type	S/N serial number	HW hardware status	SW software status
AE 1	LTE-NAD Evaluation Board	Test board	--	--	--
AE 2	KL1/B	Microphone	--	--	--
AE 3	Speaker	Loudspeaker	--	--	--
AE 4	USB cable	--	--	--	--

*) 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 + EUT B + AE 1 + AE 2 + AE 3 + AE 4	Radiated and conducted tests performed
set. 2	EUT A + EUT C + AE 1 + AE 2 + AE 3 + AE 4	Re-Tests performed: radiated tests
set. 3	EUT D + AE 1 + AE 2+ AE 3+ AE 4	Conducted tests performed: frequency error

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

3.5. EUT operating modes

EUT operating mode no.*)	Description of operating modes	Additional information
1	LTE-Band 2 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.
2	LTE-Band 4 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.
3	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.
4	LTE-Band 17 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.

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

3.6. Configuration of cables used for testing

Cable number	Item	Type	S/N serial number	HW hardware status	Cable length
Cable 1	Antenna lines	--	--	--	1.3 m
Cable 2	USB line	--	--	--	1.5 m
Cable 3	Audio line	--	--	--	1.5 m
Cable 4	Microphone line	--	--	--	0.1 m
Cable 5	Power line	DC power line	--	--	1.5m

Remarks:--

4. Description of test system set-up's

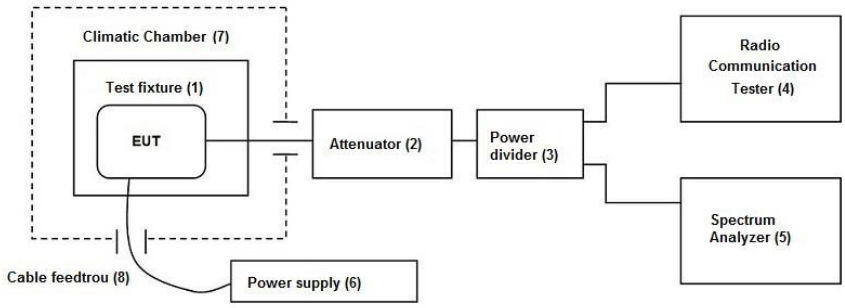
4.1. Test system set-up for conducted measurements on antenna port

Specification: ANSI C63.10:2009

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 signal path is connected to the radio communication tester (4), other branch is connected to the spectrum – analyzer (5). 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: Following modified test set-up schematic apply for tests performed inside the climatic chamber: (Frequency stability)

In case **an external connector is available (test fixture)**, following set-up is used for measurements.



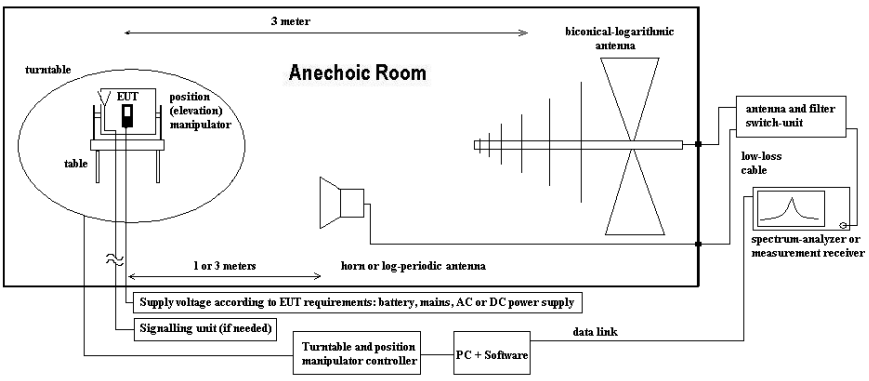
Testing method: Accord. Spec.

4.2. Test system set-up for radiated spurious emission measurements

Specification: ANSI C63.4-2009 chapter 8, ANSI C63.10-2009 chapter 6.5&6.6

General Description: Evaluating the field emissions have to be done first by an exploratory emissions measurement and a final measurement for most critical frequencies. The tests are performed in a CISPR 16-4 compliant fully anechoic room (FAR) recognized by the regulatory commission. The measurement distance was set to 3 meter for frequencies up to 20 GHz and 1 meter above 20 GHz. A logarithmic periodic antenna is used for the frequency range 30 MHz to 20 GHz. From 20 GHz to 40 GHz a horn antenna is used. The antennas are set to fixed antenna height of 1.55 m and the EUT aligned within 3 dB cone of radiation pattern.

Schematic:



Testing method:

Exploratory, preliminary measurements
The EUT and it's associated accessories are placed on a non-conductive position manipulator (tipping device) of 1.55 m height which is placed on the turntable. By rotating the turntable (range 0° to 360°, step 45°) and the EUT itself either on 3-orthogonal axis (portable equipment) or 2-orthogonal axis (defined operational position of EUT) the emission spectrum and it's characteristics was recorded with an EMI-receiver, broadband antenna and software.
The measurements are performed in horizontal and vertical polarization of the measurement antennas. The results are documented in a diagram. Critical frequencies (low margin to limit) are saved within a table for further investigations. If various operating modes are supported, further investigations are made to find the worst-case of them. Also the interconnection cables and equipment position were varied in order to maximize the emissions.

Final measurement on critical frequencies
Based on the exploratory measurements, the most critical frequencies are re-measured by maintaining the EUT's worst-case operation mode, cable position, etc.
First a frequency zoom around the critical frequency is done to locate the frequency more precisely. After this step, for all identified critical frequencies, the maximum peak was determined.
Following parameters were varied: the turntable angle continuously in the range 0 to 360 degree, the EUT itself either over 3-orthogonal axis (not defined usage position) or 2-orthogonal axis (defined usage position). The measurement antenna height is fixed to 1.55 m.
On the determined worst-case position, a final measurement with necessary bandwidth and detector according standard has been carried out.
The readings on the spectrum analyzer are corrected with conversion value between field strength and E(I)RP, so the readings shown are equivalent to ERP/EIRP values. Critical measurements near the limit are re-measured with a substitution method accord. ANSI/TIA/EIA 603 C/D

Formula:

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

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

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

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

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

5. Measurements

5.1. RF-Parameter - RF Peak power output radiated

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

test location	☒ CETECOM Essen (Chapter. 2.2.1)		☐ 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	☐ 620 ESU 26	☐	☐
spectr. analys.	☐ 584 FSU	☐ 120 FSEM	☒ 264 FSEK	☐	☐	☐
antenna	☐ 574 BTA-L	☐ 133 EMCO3115	☐ 302 BBHA9170	☒ 608 HL 562	☒ 549 HL025	
signalling	☐ 392 MT8820A	☐ 436 CMU	☒ 546 CMU			
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	☐ 498 NGPE 40
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(a), §22.913, § 24.232(c); §27.50(d)(4), §27.50(c)(10)
IC	RSS-132: 5.4 + SRSP 503:5.1.3 for FDD Band 5; RSS-133:4.1/6.4 + SRSP-510:5.1.2 for FDD Band 2 RSS-139, Issue 2: 6.4 + PAR PK-AV ≤ 13 dB
Limit	Maximum Power Output of the mobile phone should be determined while measured radiated E(I)RP.
	Limit LTE Band 5: 7 Watt ERP (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 17: FCC 3 Watt ERP (34.7 dBm)

5.1.3. 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 Span RBW VBW Sweep time Sweep mode Detector	Spectrum analyser mode 100 MHz 10 MHz 10 MHz Coupled repetitive Peak		
Measurement method		The measurements were performed by using the **substitution method** (ANSI/TIA/EIA 603C/D) with a spectrum-analyzer. This method can be described like follows: 1. choosing of suitable spectrum-analyzer settings for performing the measurements. This settings of the spectrum analyzer must be maintained for both stages of the measurements: EUT emission measurements and also for measurements of the substituted level. 2. The maximum level of the peak power was recorded, while the emissions were maximized by rotating the EUT in three orthogonal axes, which was situated on a non-conductive turntable of 1.55 m height ($P_{MEAS,1}$). This was performed for both measuring antenna polarisations (vertical/horizontal), the maximum of both values is used for further measurements and final substitution ($P_{MEAS,1,MAX}$). 3. As the maximum emission is recorded, the EUT is replaced by a frequency dependant suitable antenna, which is connected to a RF-signal generator, which is transmitting on the determined worst-case frequency as determined in step 2. 4. The RF-signal level of the signal generator is adjusted as long the same worst-case level determined first step is measured at the spectrum analyzer ($P_{SMHU}=P_{MEAS,1,MAX}$) 5. Than the RF-signal cable is disconnected from the antenna and connected to a power-level meter. The level is determined ($P_{MEAS,2}$). 6. The final result is calculated by adding the ERP/EIRP gain of the antenna which substitutes the EUT. $P_{EUT,SUBST} = P_{MEAS,2} + G_{ANTENNA}$		
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.		

5.1.4. Results

Worst-Case channel, Signal bandwidth and resource block configuration from conducted tests cases, re-tested in order to have ERP. and EIRP values.

EUT			Set-up 1, Op.Mode 1				
Operating Mode	Channel		Peak Output Power [dBm]			Antenna Polarisation for maximum Power	Result
	Range	No.	PK	AV			
LTE Band 2	Low	18700	30.0	1.)	EIRP-Value	V	pass
	Middle	18900	30.2				
	High	19100	**32.3**				

Remark: 1.) see conducted measurements for PAR factor

EUT			Set-up 1, Op.Mode 2				
Operating Mode	Channel		Peak Output Power [dBm]			Antenna Polarisation for maximum Power	Result
	Range	No.	PK	AV			
LTE Band 4	Low	19957	**29.2**	1.)	EIRP-Value	V	pass
	Middle	20175	28.9				
	High	20393	25.8				

Remark: 1.) see conducted measurements for PAR factor

EUT			Set-up 1, Op.Mode 3				
Operating Mode	Channel		Peak Output Power [dBm]			Antenna Polarisation for maximum Power	Result
	Range	No.	PK	AV			
LTE Band 5	Low	20415	**28.8**	1.)	ERP-Value	H	pass
	Middle	20525	27.5				
	High	20635	28.0				

Remark: 1.) see conducted measurements for PAR factor

EUT			Set-up 2, Op.Mode 4				
Operating Mode	Channel		Peak Output Power [dBm]			Antenna Polarisation for maximum Power	Result
	Range	No.	PK	AV			
LTE Band 17	Low	23755	27.8	1.)	ERP-Value	H	pass
	Middle	23790	27.9				
	High	23825	**28.5**				

Remark: 1.) see conducted measurements for PAR factor

5.2. RF-Parameter - Radiated out of Band RF emissions and Band-Edge

5.2.1. 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	☐ 441 EMI SAR	☐ 487 SAR NSA	☒ 443 FAR	☐ 347 Radio.lab.1	☐ 347 Radio.lab.2	
receiver	☐ 377 ESCS30	☐ 001 ESS	☐ 489 ESU 40	☐ ESU 26		
spectr. analys.	☐ 584 FSU	☐ 120 FSEM	☒ 264 FSEK			
antenna	☒ 608 HL 562	☒ 549 HL 025	☐ 302 BBHA9170	☐ 289 CBL 6141	☐ 030 HFH-Z2	☐477 GPS
signaling	☐ 017 CMD 65	☐ 323 CMD 55	☐ 340 CMD 55			
signaling	☐ 392 MT8820A	☐ 546 CMU	☐ 547 CMU	☒ 642 CMW500		
power supply	☒ 611 E3632A	☐ 457 EA 3013A	☐ 459 EA 2032-50	☐ 268 EA- 3050	☐ 494 AG6632A	☐498 NGPE 40
otherwise	☐ 529 6dB divider	☐ 530 6dB Att.	☐ 110 USB LWL	☐ 482 Filter Matrix	☐ 431 Near field	
line voltage	☐ 230 V 50 Hz via public mains		☒ 060 110 V/ 60 Hz via PAS 5000			

5.2.2. Requirements and limits

FCC	§2.1053(a)-radiated , §2.1057(a)(a) , §22.917(a)(b) ; §24.238(a)(b) ; §27.53(h)(1)(3)(i)(ii)(iii) §27.53(g)
IC	RSS-132, Issue 2: 4.5.1.2, RSS-133, Issue 4: 6.5.1(a)(i)&(b), RSS-139, Issue 2: 6.5 (i)(ii)
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

5.2.3. 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	**Parameters:** Scan Mode RBW VBW Sweep time Sweep mode Detector	Spectrum analyser mode 1 MHz 10 MHz Coupled 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 block-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 resource 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 2

	Start freq. MHz	Stop freq. MHz	R-BW MHz	V-BW MHz	Sweep time sec.	Att. [dB]	Detector
Sweep 1 (subrange 1)	30	1000	1	1	10	10	MaxH-PK
Sweep 1 (subrange 2)	1000	2800	1	1	15	0	MaxH-PK
Sweep 1 (subrange 3)	2800	20000	1	1	60	10	MaxH-PK
Sweep 2a (Block-Edge)	1849	1850	0.03	0.3	30	35	MaxH-PK
Sweep 2b (Block-Edge)	1849	1850	0.03	0.3	30	35	MaxH-AV
Sweep 3a (Block-Edge)	1910	1911	0.03	0.3	30	35	MaxH-PK
Sweep 3b (Block-Edge)	1910	1911	0.03	0.3	30	35	MaxH-AV

Spectrum-analyzer settings for FDD Band 4

	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 (Block-Edge)	1709	1710	0.03	0.3	30	35	MaxH-PK
Sweep 2b (Block-Edge)	1709	1710	0.03	0.3	30	35	MaxH-AV
Sweep 3a (Block-Edge)	1755	1756	0.03	0.3	30	35	MaxH-PK
Sweep 3b (Block-Edge)	1755	1756	0.03	0.3	30	35	MaxH-AV

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	1	10	10	MaxH-PK
Sweep 1 (subrange 2)	1000	2800	1	1	15	0	MaxH-PK
Sweep 1 (subrange 3)	2800	9000	1	1	160	10	MaxH-PK
Sweep 2a (Block-Edge)	823	824	0.02	0.2	30	35	MaxH-PK
Sweep 2b (Block-Edge)	823	824	0.02	0.2	30	35	MaxH-AV
Sweep 3a (Block-Edge)	850	851	0.02	0.2	30	35	MaxH-PK
Sweep 3b (Block-Edge)	850	851	0.02	0.2	30	35	MaxH-AV

Spectrum-analyzer settings for LTE Band 17

	Start freq. MHz	Stop freq. MHz	R-BW MHz	V-BW MHz	Sweep time sec.	Att.	Detector
Sweep 1 (subrange 1)	30	1000	1	1	10	10	MaxH-PK
Sweep 1 (subrange 2)	1000	2800	1	1	15	0	MaxH-PK
Sweep 1 (subrange 3)	2800	9000	1	1	160	10	MaxH-PK
Sweep 2a (Block-Edge)	703	704	0.05	0.5	30	35	MaxH-PK
Sweep 2b (Block-Edge)	703	704	0.05	0.5	30	35	MaxH-AV
Sweep 3a (Block-Edge)	716	717	0.05	0.5	30	35	MaxH-PK
Sweep 3b (Block-Edge)	716	717	0.05	0.5	30	35	MaxH-AV

5.2.4. Results

The results are presented below in summary form only. For more information please see the diagrams enclosed in annex 4.

5.2.4.1. LTE Band 2: 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	
8.20a	Low	18607	30 MHz to 20 GHz	1	Carrier visible on diagram. Not relevant for results QPSK modulation	☒	☐	☐	passed
8.20b	Low	18607	30 MHz to 20 GHz	1	Carrier visible on diagram. Not relevant for results 16-QAM modulation	☒	☐	☐	passed
9.203a	Low	18615	1849 – 1850 MHz	1	Band-Edge compliance QPSK modulation Remark 1	☒	☒	☐	passed
9.203b	Low	18615	1849 – 1850 MHz	1	Band-Edge compliance QAM modulation Remark 1	☒	☒	☐	passed
8.21a	Middle	18900	30 MHz to 20 GHz	1	Carrier visible on diagram. Not relevant for results	☒	☐	☐	passed
8.21b	Middle	18900	30 MHz to 20 GHz	1	Carrier visible on diagram. Not relevant for results	☒	☐	☐	passed
8.22	High	19100	30 MHz to 20 GHz	1	Carrier visible on diagram. Not relevant for results	☒	☐	☐	passed
9.215a	High	19185	1910 – 1911 MHz	1	Band-Edge compliance QPSK modulation Remark 1	☒	☒	☐	passed
9.215b	High	19185	1910 – 1911 MHz	1	Band-Edge compliance QAM modulation Remark 1	☒	☒	☐	passed

Remark1: LTE EUT channel bandwidth of 3MHz was chosen as worst-case as determined within the conducted band-edge measurements

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

Dia-gram no.	Carrier Channel		Frequency range	OP-mode no.	Remark	Used detector			Result
	Range	No.				PK	AV	QP	
8.23	Middle	18900	30 MHz to 20 GHz	1	Carrier visible on diagram. Not relevant for results	☒	☐	☐	passed

Remark: re-tests with EUT C

5.2.4.3. LTE Band 4: 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	
8.40	Low	19957	30 MHz to 20 GHz	2	Carrier visible on diagram. Not relevant for results	☒	☐	☐	passed
9.520a	Low	19965	1709 - 1710 MHz	2	Band Edge Compliance QPSK modulation, remark 1	☒	☒	☐	passed
9.520b	Low	19965	1709 - 1710 MHz	2	Band Edge Compliance 16-QAM modulation, remark1	☒	☒	☐	passed
8.41	Middle	20175	30 MHz to 20 GHz	2	Carrier visible on diagram. Not relevant for results	☒	☐	☐	passed
8.42	High	20300	30 MHz to 20 GHz	2	Carrier visible on diagram. Not relevant for results	☒	☐	☐	passed
9.532a	High	20385	1755 – 1756 MHz	2	Band Edge Compliance QPSK modulation, remark 1	☒	☒	☐	passed
9.532b	High	20385	1755 – 1756 MHz	2	Band Edge Compliance 16-QAM modulation remark 1	☒	☒	☐	passed

Remark1: LTE EUT channel bandwidth of 3MHz was chosen as worst-case as determined within the conducted band-edge measurements

5.2.4.4. LTE Band 4: Op. Mode 2, Set-up 2

Dia-gram no.	Carrier Channel		Frequency range	OP-mode no.	Remark	Used detector			Result
	Range	No.				PK	AV	QP	
8.43	Middle	20175	30 MHz to 12.75 GHz	2	Carrier visible on diagram. Not relevant for results	☒	☐	☐	passed

Remark1: re-tests with EUT C

5.2.4.5. LTE Band 5: Op. Mode 3, Set-up 1

Dia-gram no.	Carrier Channel		Frequency range	OP-mode no.	Remark	Used detector			Result
	Range	No.				PK	AV	QP	
8.50a	Low	20407	30 MHz to 9 GHz	3	Carrier visible on diagram. Not relevant for results	☒	☐	☐	passed
8.50b	Low	20407	30 MHz to 9 GHz	3	Carrier visible on diagram. Not relevant for results	☒	☐	☐	passed
9.506a	Low	20415	823 – 824 MHz	3	Band Edge Compliance QPSK modulation, remark 1	☒	☒	☐	passed
9.506b	Low	20415	823 – 824 MHz	3	Band Edge Compliance 16-QAM modulation remark 1	☒	☒	☐	passed
8.51a	Middle	20525	30 MHz to 9 GHz	3	Carrier visible on diagram. Not relevant for results	☒	☐	☐	passed
8.51b	Middle	20525	30 MHz to 9 GHz	3	Carrier visible on diagram. Not relevant for results	☒	☐	☐	passed
8.52	High	20600	30 MHz to 9 GHz	3	Carrier visible on diagram. Not relevant for results	☒	☐	☐	passed
9.512a	Low	20643	849 - 850 MHz	3	Band Edge Compliance QPSK modulation, remark 1	☒	☒	☐	passed
9.514b	Low	20643	849 - 850 MHz	3	Band Edge Compliance 16-QAM modulation remark 1	☒	☒	☐	passed

Remark: LTE EUT Signal bandwidth of 3 or 5 MHz was chosen as worst-case as determined within the conducted band-edge measurements

5.2.4.6. LTE Band 5: Op. Mode 3, Set-up 2

Dia-gram no.	Carrier Channel		Frequency range	OP-mode no.	Remark	Used detector			Result
	Range	No.				PK	AV	QP	
8.53	Middle	20525	30 MHz to 9 GHz	3	Carrier visible on diagram. Not relevant for results	☒	☐	☐	passed

Remark: re-tests with EUT C

5.2.4.7. LTE Band 17: Op. Mode 4 Set-up 1

Dia-gram no.	Carrier Channel		Frequency range	OP-mode no.	Remark	Used detector			Result
	Range	No.				PK	AV	QP	
8.171a	Low	23755	30 MHz to 1 GHz	4	Carrier visible on diagram. Not relevant for results	☒	☐	☐	passed
9.171a	Low	23755	703 - 704 MHz	4	Band Edge Compliance QPSK modulation Remark 1	☒	☒	☐	passed
9.171b	Low	23755	703 - 704 MHz	4	Band Edge Compliance 16-QAM modulation remark 1	☒	☐	☐	passed
8.172	Middle	23790	30 MHz to 9 GHz	4	Carrier visible on diagram. Not relevant for results	☒	☐	☐	passed
8.173	High	23800	30 MHz to 9 GHz	4	Carrier visible on diagram. Not relevant for results	☒	☐	☐	passed
9.175a	High	23825	716 – 717 MHz	4	Band Edge Compliance QPSK modulation Remark 1	☒	☒	☐	passed
9.175b	High	23825	716 – 717 MHz	4	Band Edge Compliance 16-QAM modulation remark 1	☒	☒	☐	passed

Remark: 1.) LTE EUT channel bandwidth of 5MHz used for measurements as worst-case as determined within the conducted band-edge measurements

5.2.4.8. LTE Band 17: Op. Mode 4 Set-up 2

Dia-gram no.	Carrier Channel		Frequency range	OP-mode no.	Remark	Used detector			Result
	Range	No.				PK	AV	QP	
8.174	Middle	23790	30 MHz to 9 GHz	4	Carrier visible on diagram. Not relevant for results	☒	☐	☐	passed

Remark: re-tests with EUT C

5.3. RF-Parameter - RF Peak power output conducted

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

5.3.2. Requirements and limits

FCC	§2.1046
IC	RSS-132:5.4 + SRSP 503:5.1.3 for FDD Band 5; RSS-133:4.1/6.4 + SRSP-510:5.1.2 for FDD Band 2 RSS-139, Issue 2: 6.4 + PAR PK-AV ≤ 13 dB
Limit	Maximum Power Output of the mobile phone should be determined while measured conducted.
	Limit LTE Band 5: 7 Watt ERP (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 17: 3 Watt ERP (34.7dBm)

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 measurements were performed with the integrated power measurement function of the „radio communication tester CMU200 from Rohde&Schwarz company. In this way spectrum-analyzers instrument limitations can be avoided or minimized. Instead, CMU manufacturers declared measurement error can be considered for this measurement. The attenuation (insertion loss) at the RF Inputs/Outputs of CMU 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.	
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.	

5.3.4. Measurement Results
5.3.4.1. LTE Band 2 Results

LTE-Band 2 (FCC Part 24)				QPSK-Modulation			16-QAM-Modulation					
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]	max- modulation	max. channel	absolute max. value
1.4 MHz	18607	1850,7	1 RB low	27,57	23,35	4,22	27,36	22,69	4,67	28,27	28,37	29,02
			1 RB high	27,6	23,24	4,36	27,33	22,59	4,74			
			50% RB mid	28,02	23,33	4,69	28,27	22,33	0			
			100% RB	27,97	22,31	5,66	28,09	21,42	6,67			
	18900	1880	1 RB low	28,07	23,39	4,68	27,16	22,14	5,02	28,37		
			1 RB high	28,06	23,35	4,71	27,05	22,1	4,95			
			50% RB mid	28,28	23,25	5,03	28,37	22,42	0			
			100% RB	27,93	22,26	5,67	28,08	21,15	6,93			
	19193	1909,3	1 RB low	26,78	22,95	3,83	26,28	21,97	4,31	27,49		
			1 RB high	26,69	22,89	3,8	26,19	21,77	4,42			
			50% RB mid	27,19	23,01	4,18	27,49	21,94	0			
			100% RB	27,24	21,98	5,26	27,3	21,11	6,19			
3 MHz	18615	1851,5	1 RB low	27,71	23,44	4,27	27,09	22,37	4,72	28,4	28,78	
			1 RB high	27,85	23,24	4,61	27,1	22,2	4,9			
			50% RB mid	27,57	22,28	5,29	27,96	22,52	5,44			
			100% RB	28,19	22,19	6	28,4	21,27	7,13			
	18900	1880	1 RB low	27,96	23,07	4,89	27,46	22,35	5,11	28,78		
			1 RB high	27,82	23,16	4,66	27,34	22,25	5,09			
			50% RB mid	27,93	22,23	5,7	28,4	22,41	5,99			
			100% RB	28,78	22,12	6,66	28,28	21,22	7,06			
	19185	1908,5	1 RB low	26,89	23,22	3,67	27,2	22,78	4,42	27,7		
			1 RB high	26,69	22,81	3,88	26,99	22,42	4,57			
			50% RB mid	26,8	22,23	4,57	27,19	22,55	4,64			
			100% RB	27,7	22	5,7	27,42	21,23	6,19			
5 MHz	18625	1852,5	1 RB low	27,54	23,5	4,04	27,74	22,73	5,01	28,43	28,73	
			1 RB high	27,87	23,45	4,42	28,2	22,87	5,33			
			50% RB mid	27,91	22,34	5,57	27,86	22,24	5,62			
			100% RB	28,32	22,14	6,18	28,43	21,13	7,3			
	18900	1880	1 RB low	28,35	23,14	5,21	28,39	22,46	5,93	28,73		
			1 RB high	28,07	23,18	4,89	28,08	22,41	5,67			
			50% RB mid	27,8	22,13	5,67	28,52	22,19	6,33			
			100% RB	28,73	22,04	6,69	28,69	21,05	7,64			
	19175	1907,5	1 RB low	27,12	23,19	3,93	26,63	22,12	4,51	27,96		
			1 RB high	26,72	22,8	3,92	26,25	21,74	4,51			
			50% RB mid	27,34	22,15	5,19	27,4	22,34	5,06			
			100% RB	27,96	22,06	5,9	27,7	21,16	6,54			

10 MHz	18650	1855	1 RB low	27,59	23,21	4,38	27,18	22,15	5,03	28,63	28,63	
			1 RB high	28,44	23,24	5,2	27,59	22,21	5,38			
			50% RB mid	28,12	22,19	5,93	27,9	21,35	6,55			
			100% RB	28,36	22,09	6,27	28,63	21,08	7,55			
	18900	1880	1 RB low	28,36	23,16	5,2	27,35	22,11	5,24	28,36		
			1 RB high	27,96	23,27	4,69	27,1	22,14	4,96			
			50% RB mid	28,18	22,09	6,09	27,98	21,17	6,81			
			100% RB	28,26	21,91	6,35	28,23	21,02	7,21			
	19150	1905	1 RB low	27,57	23,18	4,39	27,01	22,07	4,94	28,02		
			1 RB high	26,86	23,24	3,62	26,29	21,77	4,52			
			50% RB mid	27,76	22,14	5,62	27,71	21,27	6,44			
			100% RB	27,7	22,07	5,63	28,02	21,13	6,89			
15 MHz	18675	1857,5	1 RB low	27,52	23,18	4,34	27,34	22,71	4,63	28,73	28,73	
			1 RB high	28,33	23,25	5,08	27,93	22,75	5,18			
			50% RB mid	28,17	22,08	6,09	28,18	22,36	5,82			
			100% RB	28,73	21,96	6,77	28,46	20,98	7,48			
	18900	1880	1 RB low	28,53	23,31	5,22	27,39	22,18	5,21	28,69		
			1 RB high	27,88	23,31	4,57	27,02	22,13	4,89			
			50% RB mid	28,22	21,93	6,29	28,56	22,29	6,27			
			100% RB	28,69	21,99	6,7	28,31	20,9	7,41			
	19125	1902,5	1 RB low	27,67	23,3	4,37	27,37	22,76	4,61	28,28		
			1 RB high	26,79	23,23	3,56	26,47	22,3	4,17			
			50% RB mid	27,99	22,22	5,77	28,28	22,27	6,01			
			100% RB	28,2	22,11	6,09	28,02	21,22	6,8			
20 MHz	18700	1860	1 RB low	27,63	23,19	4,44	27,2	22,15	5,05	29,01	29,02	
			1 RB high	28,69	23,67	5,02	27,71	22,16	5,55			
			50% RB mid	28,13	22,03	6,1	28,11	22,28	5,83			
			100% RB	29,01	22,01	7	28,84	21,1	7,74			
	18900	1880	1 RB low	28,71	23,36	5,35	27,52	22,25	5,27	**29,02**		
			1 RB high	27,93	23,42	4,51	27,1	22,26	4,84			
			50% RB mid	28,31	22,08	6,23	**29,02**	22,18	6,84			
			100% RB	28,38	21,98	6,4	28,32	20,95	7,37			
	19100	1900	1 RB low	27,76	23,21	4,55	27,23	22,18	5,05	28,28		
			1 RB high	26,96	23,34	3,62	26,43	21,9	4,53			
			50% RB mid	27,87	22,06	5,81	28,15	22,31	5,84			
			100% RB	28,28	22,03	6,25	28,22	21,01	7,21			

Remark: Maximum determined Peak-Average Ration: 7.74 dB

5.3.4.2. LTE Band 4 Results

LTE-Band 4 (FCC Part 27)				QPSK-Modulation			16-QAM-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]			
1.4 MHz	19957	1710,7	1 RB low	28,64	24,01	4,63	27,82	22,55	5,27	29,11	29,98	29.98
			1 RB high	28,86	24,03	4,83	27,98	22,62	5,36			
			50% RB mid	29,11	23,96	5,15	N/A	N/A				
			100% RB	28,62	22,64	5,98	28,81	21,71	7,1			
	20175	1732,5	1 RB low	28,69	23,33	5,36	27,52	22,21	5,31	28,92		
			1 RB high	28,69	23,16	5,53	27,45	22,15	5,3			
			50% RB mid	28,92	23,31	5,61	N/A	N/A				
			100% RB	28,31	22,32	5,99	28,47	21,32	7,15			
	20393	1754,3	1 RB low	28,83	23,12	5,71	27,7	22,14	5,56	29,98		
			1 RB high	28,74	23,17	5,57	27,67	22,08	5,59			
			50% RB mid	29,39	23,18	6,21	N/A	N/A				
			100% RB	29,98	23,27	6,71	28,78	21,36	7,42			
3 MHz	19965	1711,5	1 RB low	28,7	23,99	4,71	27,93	22,62	5,31	29,43	29,73	
			1 RB high	28,74	23,39	5,35	27,86	22,42	5,44			
			50% RB mid	28,46	22,66	5,8	28,92	22,71	6,21			
			100% RB	29,43	22,61	6,82	29,23	21,71	7,52			
	20175	1732,5	1 RB low	28,71	23,28	5,43	27,41	22,16	5,25	28,93		
			1 RB high	28,75	23,4	5,35	27,54	22,17	5,37			
			50% RB mid	28,2	22,29	5,91	28,87	22,54	6,33			
			100% RB	28,69	22,32	6,37	28,93	21,23	7,7			
	20385	1753,5	1 RB low	28,74	23,1	5,64	27,74	22,12	5,62	29,73		
			1 RB high	28,79	23,12	5,67	27,75	22,11	5,64			
			50% RB mid	28,47	22,17	6,3	29,07	22,23	6,84			
			100% RB	29,73	22,19	7,54	29,02	21,32	7,7			
5 MHz	19975	1712,5	1 RB low	29,06	24,02	5,04	28,86	22,82	6,04	29,42	29,43	
			1 RB high	29,21	23,33	5,88	29,2	22,46	6,74			
			50% RB mid	28,42	22,74	5,68	29,11	22,58	6,53			
			100% RB	29,42	22,4	7,02	29,25	21,3	7,95			
	20175	1732,5	1 RB low	28,38	23,3	5,08	28,91	22,82	6,09	28,93		
			1 RB high	28,34	23,26	5,08	28,84	22,75	6,09			
			50% RB mid	28,93	22,27	6,66	28,86	22,21	6,65			
			100% RB	28,79	22,2	6,59	28,9	21,16	7,74			
	20375	1752,5	1 RB low	29,23	23,25	5,98	29,2	22,39	6,81	29,43		
			1 RB high	29,25	23,23	6,02	29,25	22,36	6,89			
			50% RB mid	28,25	22,18	6,07	29,43	22,19	7,24			
			100% RB	29,23	22	7,23	28,94	21,12	7,82			

10 MHz	20000	1715	1 RB low	28,64	23,65	4,99	27,89	22,52	5,37	29,17	29,17	
			1 RB high	28,84	23,19	5,65	27,79	22,16	5,63			
			50% RB mid	29,15	22,38	6,77	29,02	21,73	7,29			
			100% RB	28,83	22,24	6,59	29,17	21,27	7,9			
	20175	1732,5	1 RB low	28,9	23,27	5,63	27,52	22,1	5,42	28,9		
			1 RB high	28,74	23,3	5,44	27,53	22,19	5,34			
			50% RB mid	28,76	22,24	6,52	28,43	21,35	7,08			
			100% RB	28,8	22,15	6,65	28,7	21,12	7,58			
	20350	1750	1 RB low	28,76	23,19	5,57	27,8	22,16	5,64	29,16		
			1 RB high	28,81	23,14	5,67	27,81	22,14	5,67			
			50% RB mid	29,16	22,08	7,08	28,97	21,26	7,71			
			100% RB	28,63	22,05	6,58	29,1	21,08	8,02			
15 MHz	20025	1717,5	1 RB low	28,48	23,59	4,89	28,25	23,26	4,99	**29,4**	**29,4**	
			1 RB high	28,54	23,18	5,36	28,16	22,77	5,39			
			50% RB mid	28,95	22,24	6,71	29,37	22,47	6,9			
			100% RB	**29,18**	22,12	7,06	28,91	21,2	7,71			
	20175	1732,5	1 RB low	28,96	23,28	5,68	27,58	22,19	5,39	29,08		
			1 RB high	28,71	23,25	5,46	27,5	22,12	5,38			
			50% RB mid	28,78	22,13	6,65	29,04	22,34	6,7			
			100% RB	29,08	22,15	6,93	28,77	21,14	7,63			
	20325	1747,5	1 RB low	28,45	23,26	5,19	28	22,68	5,32	29,32		
			1 RB high	28,54	23,18	5,36	28	22,58	5,42			
			50% RB mid	28,7	22	6,7	29,32	22,28	7,04			
			100% RB	28,99	22,01	6,98	28,83	21,02	7,81			
20 MHz	20050	1720	1 RB low	28,74	23,74	5	28,21	22,9	5,31	29,22	29,6	
			1 RB high	28,68	23,19	5,49	27,79	22,16	5,63			
			50% RB mid	28,78	22,13	6,65	29,22	22,45	6,77			
			100% RB	29,22	22,07	7,15	29	21,15	7,85			
	20175	1732,5	1 RB low	29,08	23,36	5,72	27,6	22,22	5,38	29,6		
			1 RB high	28,77	23,19	5,58	27,47	22,07	5,4			
			50% RB mid	28,81	22,17	6,64	29,6	22,27	7,33			
			100% RB	28,92	22,11	6,81	28,84	21,11	7,73			
	20300	1745	1 RB low	28,45	23,19	5,26	27,69	22,17	5,52	29,1		
			1 RB high	28,82	23,13	5,69	27,82	22,13	5,69			
			50% RB mid	28,6	22,01	6,59	29,01	22,3	6,71			
			100% RB	29,1	22,03	7,07	29,06	21,07	7,99			

Remark: Maximum determined Peak-Average Ration: 8.02 dB

5.3.4.3. LTE Band 5 Results

LTE-Band 5 (Part 22)				QPSK-Modulation			16-QAM-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]			
1.4 MHz	20407	824.7	1 RB low	28,35	23,04	5,31	27,73	22,31	5,42	28,93	29,25	29,62
			1 RB high	28,38	23,01	5,37	27,63	22,19	5,44			
			50% RB mid	28,93	23,06	5,87	--	--	####			
			100% RB	28,47	22,27	6,2	28,6	21,32	7,28			
	20525	836.5	1 RB low	29,07	23,35	5,72	27,53	22,19	5,34	29,23		
			1 RB high	29,09	23,26	5,83	27,58	22,27	5,31			
			50% RB mid	29,23	23,22	6,01	--	--	####			
			100% RB	28,48	22,36	6,12	28,71	21,41	7,3			
	20643	848.3	1 RB low	28,6	23,06	5,54	27,57	22,03	5,54	29,25		
			1 RB high	28,47	22,93	5,54	27,44	21,92	5,52			
			50% RB mid	29,25	23,12	6,13	--	--	--			
			100% RB	28,24	22	6,24	28,69	21,28	7,41			
3 MHz	20415	825.5	1 RB low	28,38	23,03	5,35	27,51	22,17	5,34	29,48	29,62	
			1 RB high	28,35	22,99	5,36	27,53	22,07	5,46			
			50% RB mid	28,31	22,19	6,12	28,83	22,36	6,47			
			100% RB	29,48	22,24	7,24	28,64	21,36	7,28			
	20525	836.5	1 RB low	28,93	23,11	5,82	27,43	22,06	5,37	29,22		
			1 RB high	29,09	23,3	5,79	27,54	22,24	5,3			
			50% RB mid	28,33	22,22	6,11	29,18	22,49	6,69			
			100% RB	**28,89**	22,21	6,68	29,22	21,22	8			
	20635	847.5	1 RB low	28,7	23,09	5,61	27,71	22,12	5,59	29,62		
			1 RB high	28,45	22,92	5,53	27,51	21,92	5,59			
			50% RB mid	28,42	22,2	6,22	28,95	22,14	6,81			
			100% RB	29,62	22,12	7,5	29,15	21,35	7,8			

5 MHz	20425	826.5	1 RB low	28,13	23,14	4,99	28,65	22,62	6,03	28,86	29,47	29.62
			1 RB high	28,19	23,12	5,07	28,78	22,69	6,09			
			50% RB mid	28,86	22,12	6,74	28,76	22,17	6,59			
			100% RB	28,5	21,97	6,53	28,78	21,09	7,69			
	20525	836.5	1 RB low	28,28	23,03	5,25	29,13	22,64	6,49	29,29		
			1 RB high	28,51	23,26	5,25	29,28	22,85	6,43			
			50% RB mid	29,19	22,06	7,13	29,29	22,2	7,09			
			100% RB	28,86	22,05	6,81	29,01	21,1	7,91			
	20625	846.5	1 RB low	29,17	23,21	5,96	29,23	22,54	6,69	29,47		
			1 RB high	28,9	22,95	5,95	28,91	22,13	6,78			
			50% RB mid	28,65	22,08	6,57	29,47	22,17	7,3			
			100% RB	29,17	21,97	7,2	29,22	21,06	8,16			
10 MHz	20450	829	1 RB low	28,42	23,09	5,33	27,56	22,07	5,49	29,02	29,48	
			1 RB high	28,66	22,89	5,77	27,67	22,04	5,63			
			50% RB mid	28,67	22,1	6,57	28,75	21,33	7,42			
			100% RB	28,57	21,89	6,68	29,02	21,11	7,91			
	20525	836.5	1 RB low	28,43	22,92	5,51	29,29	22,89	6,4	29,48		
			1 RB high	28,75	23,18	5,57	29,48	23,02	6,46			
			50% RB mid	28,99	22,09	6,9	28,87	21,2	7,67			
			100% RB	28,79	22,02	6,77	29,41	21,11	8,3			
	20600	844	1 RB low	29,18	23,18	6	27,52	22,09	5,43	29,18		
			1 RB high	28,76	23,01	5,75	27,28	21,93	5,35			
			50% RB mid	28,94	22,13	6,81	28,63	21,35	7,28			
			100% RB	28,74	22,1	6,64	28,79	21,14	7,65			

Remark: Maximum determined Peak-Average Ration: 8.3 dB

5.3.4.4. LTE Band 17 Results

LTE-Band 17 (Part 27)				QPSK-Modulation			16-QAM-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	23755	706,5	1 RB low	28,45	23,1	5,35	29,24	22,68	6,56	29,43		
			1 RB high	28,35	23,17	5,18	29,09	22,67	6,42			
			50% RB mid	29,36	22,03	7,33	29,43	22,05	7,38			
			100% RB	28,75	22,00	6,75	28,89	**20,89**	8			
	23790	710	1 RB low	29,13	22,88	6,25	29,19	22,07	7,12	29,39	**29,4**	
			1 RB high	28,53	22,82	5,71	28,52	21,99	6,53			
			50% RB mid	28,34	21,84	6,5	29,39	21,94	7,45			
			100% RB	28,52	21,73	6,79	28,95	20,78	8,17			
	23825	713,5	1 RB low	28,13	22,82	5,31	27,19	21,81	5,38	**28,9**		
			1 RB high	27,95	22,32	5,63	27,05	21,4	5,65			
			50% RB mid	28,91	21,77	7,14	28,64	21,97	6,67			
			100% RB	28,88	21,57	7,31	28,43	20,72	7,71			
10 MHz	23780	709	1 RB low	28,73	22,84	5,89	27,76	21,93	5,83	29,31	29,31	**29,4**
			1 RB high	28,29	22,78	5,51	27,28	21,73	5,55			
			50% RB mid	29,31	21,85	7,46	29,14	21,01	8,13			
			100% RB	28,5	21,67	6,83	28,97	**20,65**	8,32			
	23790	710	1 RB low	29,11	22,95	6,16	27,54	21,89	5,65	29,11		
			1 RB high	28,51	22,8	5,71	27,12	21,68	5,44			
			50% RB mid	28,85	21,8	7,05	28,46	20,93	7,53			
			100% RB	28,69	21,62	7,07	28,58	20,67	7,91			
	23800	711	1 RB low	28,74	22,76	5,98	27,64	21,75	5,89	29,03		
			1 RB high	28,18	22,5	5,68	27,19	21,48	5,71			
			50% RB mid	29,03	21,82	7,21	29,03	21,11	7,92			
			100% RB	28,48	21,59	6,89	28,86	20,66	8,2			

Remark: Maximum determined Peak-Average Ration: 8.32 dB

5.4. RF-Parameter - Occupied bandwidth and emission bandwidth

5.4.1. 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	☒ 530 10dB attenuator		☒ 529 Power div.			
line voltage	☐ 230 V 50 Hz via public mains		☐ 060 110 V/ 60 Hz via PAS 5000			

5.4.2. Requirements and Limits

FCC	CFR47, §2.202(a), §2.1049, §22.917(b), §24.238(b), 27.53(h)(3)	„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"
IC	RSS-Gen, Issue 3: §4.6.1	
ANSI	C63.10-2009	

5.4.3. 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	60 Sec	Coupled
	Sweep mode	Single max-hold	Repetitive, max-hold
	Detector	RMS	PK
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.	

5.4.4. Results

5.4.4.1. LTE Band 2: Op. Mode 1, Set-up 2

Operational Band	Modulation	Signal bandwidth [MHz]	Channel no.		Occupied bandwidth		26 dB Bandwidth	
			Range	Channel no.	Diagram no.	Value [MHz]	Diagram no.	Value [MHz]
Band 2	QPSK	1.4	Low	18607	35.200	1.0817	34.200	**1.3153**
			Mid	18900	35.201	--	34.201	1.298
			High	19193	35.202	--	34.202	1.286
		3	Low	18615	35.203	2.6923	34.203	**3.0576**
			Mid	18900	35.204	--	34.204	3.0384
			High	19185	35.205	--	34.205	3.057
		5	Low	18625	35.206	--	34.206	4.990
			Mid	18900	35.207	4.461	34.207	**5.009**
			High	19175	35.208	--	34.208	4.942
		10	low	18650	35.209	8.923	34.209	**9.826**
			Mid	18900	35.210	--	34.210	9.750
			High	19150	35.211	--	34.211	9.769
		15	Low	18675	35.212	13.403	34.212	**14.657**
			Mid	18900	35.213	--	34.213	14.439
			High	19125	35.214	--	34.214	14.575
		20	Low	18700	35.215	--	34.215	19.073
			Mid	18900	35.216	--	34.216	18.967
			High	19100	35.217	17.839	34.217	**19.250**

Remark: see extract of diagrams with max. values in annex 4

Band 2	16-QAM	1.4	low	18607	35.218	1.0817	34.218	**1.3038**
			mid	18900	35.219	--	34.219	1.280
			high	19193	35.220	--	34.220	1.295
		3	low	18615	35.221	--	34.221	3.0641
			mid	18900	35.222	--	34.222	3.0512
			high	19185	35.223	2.6858	34.223	**3.064**
		5	low	18625	35.224	--	34.224	4.9807
			mid	18900	35.225	4.461	34.225	**5.028**
			high	19175	35.226	--	34.226	4.990
		10	low	18650	35.227	--	34.227	9.769
			mid	18900	35.228	8.923	34.228	**9.769**
			high	19150	35.229	--	34.229	9.730
		15	low	18675	35.230	--	34.230	14.439
			Mid	18900	35.231	--	34.231	14.439
			High	19125	35.232	13.376	34.232	**14.466**
		20	low	18700	35.233	--	34.233	19.073
			Mid	18900	35.234	--	34.234	19.144
			High	19100	35.235	17.839	34.235	**19.214**

5.4.4.2. LTE Band 4: Op. Mode 2, Set-up 2

Operational Band	Modulation	Signal bandwidth [MHz]	Channel no.		Occupied bandwidth		26 dB Bandwidth	
			Range	Channel no.	Diagram no.	Value [MHz]	Diagram no.	Value [MHz]
Band 4	QPSK	1.4	Low	19957	35.401	1.0817	34.401	**1.3125**
			Mid	20175	--	--	34.402	1.2836
			High	20393	--	--	34.403	1.2865
		3	Low	19965	35.404	2.692	34.404	**3.0576**
			Mid	20175	--	--	34.405	3.0512
			High	20385	--	--	34.406	3.0512
		5	Low	19975	--	--	34.407	4.9711
			Mid	20175	35.408	4.4711	34.408	5.0288
			High	20375	--	--	34.409	4.9615
		10	low	20000	35.410	8.9230	34.410	9.8076
			Mid	20175	--	--	34.411	9.750
			High	20350	--	--	34.412	9.7884
		15	Low	20025	35.413	13.376	34.413	14.602
			Mid	20175	--	--	34.414	14.493
			High	20325	--	--	34.415	14.575
		20	Low	20050	--	--	34.416	19.003
			Mid	20175	--	--	34.417	19.003
			High	20300	35.418	17.839	34.418	**19.038**

Remark: see extract of diagrams with max. values in annex 4

Operational Band	Modulation	Signal bandwidth [MHz]	Channel no.		Occupied bandwidth		26 dB Bandwidth	
			Range	Channel no.	Diagram no.	Value [MHz]	Diagram no.	Value [MHz]
Band 4	16-QAM	1.4	Low	19957	--	--	34.419	1.2807
			Mid	20175	--	--	34.420	1.2894
			High	20393	35.421	1.0788	34.421	1.3125
		3	Low	19965	--	--	34.422	3.0576
			Mid	20175	35.423	2.6923	34.423	3.0641
			High	20385	--	--	34.424	3.0576
		5	Low	19975	--	--	34.425	5.0192
			Mid	20175	35.426	4.4615	34.426	5.0834
			High	20375	--	--	34.427	4.9807
		10	low	20000	--	--	34.428	9.7692
			Mid	20175	--	--	34.429	9.750
			High	20350	35.430	8.9230	34.430	9.7692
		15	Low	20025	--	--	34.431	14.330
			Mid	20175	--	--	34.432	14.466
			High	20325	35.433	13.403	34.433	14.738
		20	Low	20050	--	--	34.434	19.073
			Mid	20175	--	--	34.435	18.897
			High	20300	35.436	17.839	34.436	19.214

Remark: see extract of diagrams with max. values in annex 4

5.4.4.3. LTE Band 5: Op. Mode 3, Set-up 2

Operational Band	Modulation	Signal bandwidth [MHz]	Channel no.		Occupied bandwidth		26 dB Bandwidth	
			Range	Channel no.	Diagram no.	Value [MHz]	Diagram no.	Value [MHz]
Band 5	QPSK	1.4	Low	20407	--	--	34.501	1.2750
			Mid	20525	--	--	34.502	1.2807
			High	20643	35.503	1.0817	34.503	1.3038
		3	Low	20415	35.504	2.6858	34.504	3.0448
			Mid	20525	--	--	34.505	3.0384
			High	20635	--	--	34.506	3.0384
		5	Low	20425	--	--	34.507	4.9487
			Mid	20525	--	--	34.508	4.9615
			High	20625	35.509	4.4743	34.509	5.0128
		10	low	20450	--	--	34.510	9.5769
			Mid	20525	--	--	34.511	9.5961
			High	20600	35.512	8.9230	34.512	9.5769

Remark: see extract of diagrams with max. values in annex 4

Operational Band	Modulation	Signal bandwidth [MHz]	Channel no.		Occupied bandwidth		26 dB Bandwidth	
			Range	Channel no.	Diagram no.	Value [MHz]	Diagram no.	Value [MHz]
Band 5	16-QAM	1.4	Low	20407	--	--	34.513	1.2951
			Mid	20525	35.514	1.0788	34.514	1.3153
			High	20643	--	--	34.515	1.2778
		3	Low	20415	--	--	34.516	3.0512
			Mid	20525	--	--	34.517	3.0512
			High	20635	35.518	2.6858	34.518	3.0576
		5	Low	20425	--	--	34.519	4.9487
			Mid	20525	35.520	4.4615	34.520	5.0128
			High	20625	--	--	34.521	4.9615
		10	low	20450	--	--	34.522	9.5576
			Mid	20525	--	--	34.523	9.5576
			High	20600	35.524	8.9230	34.524	9.5576

Remark: see extract of diagrams with max. values in annex 4

5.4.4.4. LTE Band 17: Op. Mode 4, Set-up 2

Operational Band	Modulation	Signal bandwidth [MHz]	Channel no.		Occupied bandwidth		26 dB Bandwidth	
			Range	Channel no.	Diagram no.	Value [MHz]	Diagram no.	Value [MHz]
Band 17	QPSK	5	Low	23755	35.171	4.4743	34.171	**5.0641**
			Mid	23790	--	--	34.172	4.9615
			High	23825	--	--	34.173	4.9871
		10	low	23780	--	--	34.174	9.6538
			Mid	23790	35.175	8.9230	34.175	**9.7115**
			High	23800	--	--	34.176	9.6923
	QAM	5	Low	23755	--	--	34.177	4.9743
			Mid	23790	35.178	4.4615	34.178	**5.0512**
			High	23825	--	--	34.179	4.9743
		10	low	23780	35.180	8.9230	34.180	**9.6923**
			Mid	23790	--	--	34.181	9.5961
			High	23800	--	--	34.182	9.6730

Remark: pls. see extract of diagrams with max. values in annex 4

5.5. RF-Parameter - Conducted out of Band RF emissions and Band Edge

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

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

5.5.2. Requirements and limits

FCC	§2.1051-conducted, §2.1057, §22.917(a)(b), §24.238(a)(b), §27.53(h)(3)(ii)(iii), §27.53(g)
IC	RSS-132, Issue 3: 6.5.1, RSS-133, Issue 4: 6.5.1(i)(ii), RSS-139, Issue 2: 6.5 (i)(ii)
Limit	„the power of emissions shall be attenuated below the transmitter output power (p) by at least 43+10Log(P) dB“

5.5.3. 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 for LTE Band 2

	Start freq. MHz	Stop freq. MHz	R-BW kHz	V-BW MHz	Sweep time sec.	Att. [dB]	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	19500	1	--[1.)]	>60	35	MaxH-PK
Sweep 3a (Block-Edge)	1849	1850	20[2.)] to 200	--[1.)]	30	35	MaxH-PK
Sweep 3b (Block-Edge)	1849	1850		--[1.)]	30	35	MaxH-AV
Sweep 4a (Block-Edge)	1910	1911		--[1.)]	30	35	MaxH-PK
Sweep 4b (Block-Edge)	1910	1911		--[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 4

	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	18000	1	--[1.)]	>60	35	MaxH-PK
Sweep 3a (Block-Edge)	1709	1710	20[2.)] to 200	--[1.)]	30	35	MaxH-PK
Sweep 3b (Block-Edge)	1709	1710		--[1.)]	30	35	MaxH-AV
Sweep 4a (Block-Edge)	1755	1756		--[1.)]	30	35	MaxH-PK
Sweep 4b (Block-Edge)	1755	1756		--[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 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 17

	Start freq. MHz	Stop freq. MHz	R-BW MHz	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)	703	704	50[2.)] to 100	--[1.)]	30	35	MaxH-PK
Sweep 3b (Block-Edge)	703	704		--[1.)]	30	35	MaxH-AV
Sweep 4a (Block-Edge)	716	717		--[1.)]	30	35	MaxH-PK
Sweep 4b (Block-Edge)	716	717		--[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

5.5.4. Results

The results are presented below in summary form only. For more information please see diagrams enclosed in annex 4.

5.5.4.1. LTE Band 2: Op. Mode 1, Set-up 2

Diagram no.	Carrier Channel		Frequency range	OP-mode no.	Remark	Used detector			Result
	Range	No.				PK	AV	QP	
36.20a	Low	18607	9kHz to 30MHz	1	QPSK modulation	☒	☐	☐	passed
36.20b			9kHz to 30MHz		16QAM-Modulation	☒	☐	☐	passed
36.21a			30 MHz to 19.5MHz		Carrier visible on diagram, not relevant for results QPSK modulation	☒	☐	☐	passed
36.21b			30 MHz to 19.5MHz		Carrier visible on diagram, not relevant for results QPSK modulation	☒	☐	☐	passed
37.203a		18615	1849 – 1850 MHz		Band Edge Compliance QPSK modulation	☐	☒	☐	passed
37.203b		18615	1849 – 1850 MHz		Band Edge Compliance QAM modulation	☐	☒	☐	passed
36.22a	Middle	18900	9kHz to 30MHz		QPSK modulation	☒	☐	☐	passed
36.22b			9kHz to 30MHz		16QAM-Modulation	☒	☐	☐	passed
36.23a			30 MHz to 19.5MHz		Carrier visible on diagram, not relevant for results QPSK modulation	☒	☐	☐	passed
36.23b			30 MHz to 19.5MHz		Carrier visible on diagram, not relevant for results QAM modulation	☒	☐	☐	passed
36.24a	High	19100	9kHz to 30MHz		QPSK modulation	☒	☐	☐	passed
36.25a			30 MHz to 19.5MHz		QPSK modulation	☒	☐	☐	passed
36.24b			9kHz to 30MHz		QAM modulation	☒	☐	☐	passed
36.25b			30 MHz to 19.5MHz		QAM modulation	☒	☐	☐	passed
37.215a		19185	1910 – 1911 MHz		Band-Edge compliance QPSK Modulation	☐	☒	☐	passed
37.215b		19185	1910 – 1911 MHz		Band-Edge compliance QAM Modulation	☐	☒	☐	passed

Remark:

5.5.4.2. LTE Band 4: Op. Mode 2, Set-up 2

Diagram no.	Carrier Channel		Frequency range	OP-mode no.	Remark	Used detector			Result
	Range	No.				PK	AV	QP	
36.40a	Low	19957	9kHz to 30MHz	2	QPSK modulation	☒	☐	☐	passed
36.40b					16-QAM modulation	☒	☐	☐	passed
36.43a			30 MHz to 18GHz		Carrier visible on diagram, not relevant for results QPSK modulation	☒	☐	☐	passed
36.43b			30 MHz to 18GHz		Carrier visible on diagram, not relevant for results 16-QAM modulation	☒	☐	☐	passed
37.520a	Low	19965	1709 -1710 MHz	2	Band Edge Compliance QPSK modulation	☐	☒	☐	passed
37.520b		19965	1709 -1710 MHz		Band Edge Compliance QAM modulation	☐	☒	☐	passed
36.41a	Middle	20175	9kHz to 30MHz	2	QPSK modulation	☒	☐	☐	passed
36.41b		20175			16-QAM modulation	☒	☐	☐	passed
36.44a		20175	30 MHz to 18GHz		Carrier visible on diagram, not relevant for results QPSK modulation	☒	☐	☐	passed
36.44b		20175	30 MHz to 18GHz		Carrier visible on diagram, not relevant for results QAM modulation	☒	☐	☐	passed
36.42a	High	20393	9kHz to 30MHz	2	QPSK modulation	☒	☐	☐	passed
36.42b					16-QAM modulation	☒	☐	☐	passed
36.45a			30 MHz to 19.5MHz		Carrier visible on diagram, not relevant for results QPSK modulation	☒	☐	☐	passed
36.45b			30 MHz to 19.5MHz		Carrier visible on diagram, not relevant for results QAM modulation	☒	☐	☐	passed
37.532a	High	20385	1755 - 1756 MHz	2	Band-Edge compliance QPSK modulation	☐	☒	☐	passed
37.532b		20385	1755 - 1756 MHz		Band-Edge compliance QAM modulation	☐	☒	☐	passed

Remark:

5.5.4.3. LTE Band 5: Op. Mode 3, Set-up 2

Diagram no.	Carrier Channel		Frequency range	OP-mode no.	Remark	Used detector			Result
	Range	No.				PK	AV	QP	
36.50a	Low	20407	9kHz to 30MHz	3	QPSK modulation	☒	☐	☐	passed
36.56b			9kHz to 30MHz		16-QAM Modulation	☒	☐	☐	passed
36.51a			30 MHz to 9GHz		Carrier visible on diagram, not relevant for results QPSK modulation	☒	☐	☐	passed
36.57b			30 MHz to 9GHz		Carrier visible on diagram, not relevant for results 16-QAM modulation	☒	☐	☐	passed
37.512a	Low	20415	823 – 824 MHz	3	Band Edge Compliance QPSK modulation	☐	☒	☐	passed
37.514b	Low		823 – 824 MHz		Band Edge Compliance QPSK modulation	☐	☒	☐	passed
36.52a	Middle	20525	9kHz to 30MHz	3	QPSK modulation	☒	☐	☐	passed
36.58b			9kHz to 30MHz	3	16-QAM modulation	☒	☐	☐	passed
36.53a			30 MHz to 9GHz		Carrier visible on diagram, not relevant for results QPSK modulation	☒	☐	☐	passed
36.59b			30 MHz to 9GHz		Carrier visible on diagram, not relevant for results 16-QAM modulation	☒	☐	☐	passed
36.54a	High	20600	9kHz to 30MHz	3	QPSK modulation	☒	☐	☐	passed
36.60b	High		9kHz to 30MHz		16-QAM modulation	☒	☐	☐	passed
36.55a	High		30 MHz to 9GHz		Carrier visible on diagram, not relevant for results	☒	☐	☐	passed
36.61b	High		30 MHz to 9GHz		Carrier visible on diagram, not relevant for results	☒	☐	☐	passed
37.506a	High	20625	849 – 850 MHz	3	Band Edge Compliance QPSK modulation	☐	☒	☐	passed
37.506b	High		849 – 850 MHz		Band Edge Compliance 16-QAM modulation	☐	☒	☐	passed

Remark:

5.5.4.4. LTE Band 17: Op. Mode 4, Set-up 2

Diagram no.	Carrier Channel		Frequency range	OP-mode no.	Remark	Used detector			Result
	Range	No.				PK	AV	QP	
36.170a	Low	23755	9kHz to 30MHz	4	QPSK modulation	☒	☐	☐	passed
36.170b			9kHz to 30MHz		16-QAM modulation	☒	☐	☐	passed
36.171a			30 MHz to 9GHz		Carrier visible on diagram, not relevant for results QPSK modulation	☒	☐	☐	passed
36.171b			30 MHz to 9GHz		Carrier visible on diagram, not relevant for results 16-QAM modulation	☒	☐	☐	passed
37.171a	Low	23755	703 – 704 MHz	4	Band-Edge compliance QPSK modulation	☒	☐	☐	passed
37.171b			703 – 704 MHz		Band-Edge compliance 16-QAM modulation	☒	☐	☐	passed
36.172a	Middle	23790	9kHz to 30MHz	4	QPSK modulation	☒	☐	☐	passed
36.172b			9kHz to 30MHz		16-QAM modulation	☒	☐	☐	passed
36.174a			30 MHz to 9GHz		Carrier visible on diagram, not relevant for results QPSK modulation	☒	☐	☐	passed
36.174b			30 MHz to 9GHz		Carrier visible on diagram, not relevant for results 16-QAM modulation	☒	☐	☐	passed
36.173a	High	23800	9kHz to 30MHz	4	QPSK Modulation	☒	☐	☐	passed
36.173b			9kHz to 30MHz		16-QAM modulation	☒	☐	☐	passed
36.175a			30 MHz to 9GHz		Carrier visible on diagram, not relevant for results QPSK modulation	☒	☐	☐	passed
36.175b			30 MHz to 9GHz		Carrier visible on diagram, not relevant for results 16-QAM modulation	☒	☐	☐	passed
37.175a	High	23825	716 -717 MHz	4	Band-Edge compliance QPSK modulation	☐	☒	☐	passed
37.175b			716 -717 MHz		Band-Edge compliance 16-QAM modulation	☐	☒	☐	passed

Remark:

5.6. RF-Parameter - Frequency stability on temperature and voltage variations

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

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

5.6.2. Requirements and limits

FCC	§2.1055(a)(1) , §22.355, §24.235, §27.54
IC	RSS-132: 5.3, RSS-133: 6.3; RSS-139, Issue 2: 6.3
Limit	*"The frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block"*

5.6.3. Test condition and test set-up

Test system set-up	Please see chapter "Test system set-up for conducted measurements on antenna port" The power supply voltage was controlled on the input of the power supply terminals of the EUT.
Measurement method	The RF Channel spacing is 100 kHz according LTE-Spec, with a guard band depending of the TX signal bandwidth. Details can be found in standard 3GPP36.521. The aim of the EUT is to function under all extreme conditions within authorized sub-bands in regard to temperature and voltage variations. The frequency deviation was recorded with base station's build in capability. (CMW500) for both modulations possible: QPSK and 16-QAM As the standard requires that the fundamental emissions stays within the authorized band, a limit of ±0.1ppm is considered low enough to ensure this. However the standard required a more relaxed limit of ±2.5ppm
Mobile phone settings	UE is set TX mode, highest transmit power conditions (RMC-mode), power saving techniques have been disabled 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. Full per signal bandwidth allowed resource-blocks allocation have been used: 6RB(BW=1.4MHz) or 25 RB (BW=5MHz)

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

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 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 self-heating effects.

5.6.4. Measurement Results:

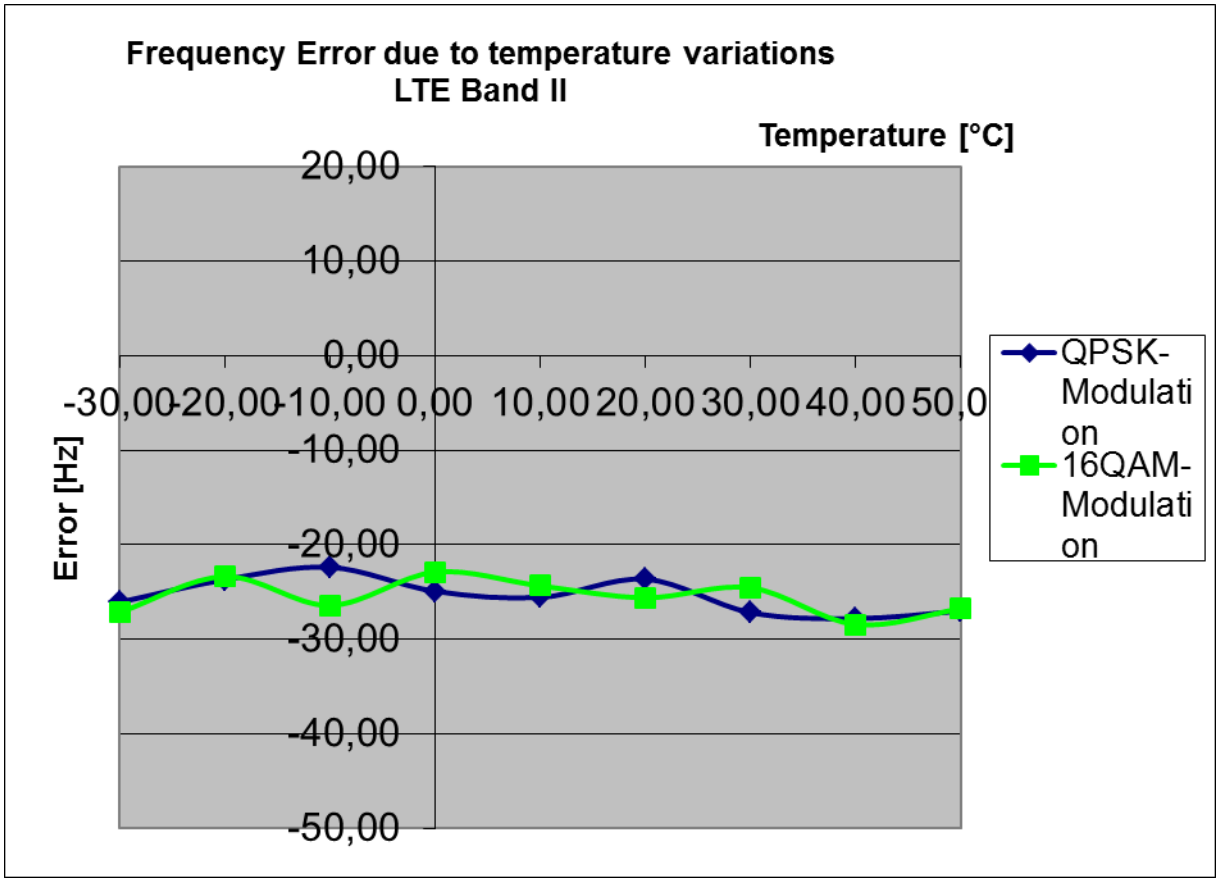
No tests performed across extreme voltage range: limited approval.
OEM integrators should consult grant and applicants recommendations on power supply design rules.

5.6.4.1. 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 –30°C to +60°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.

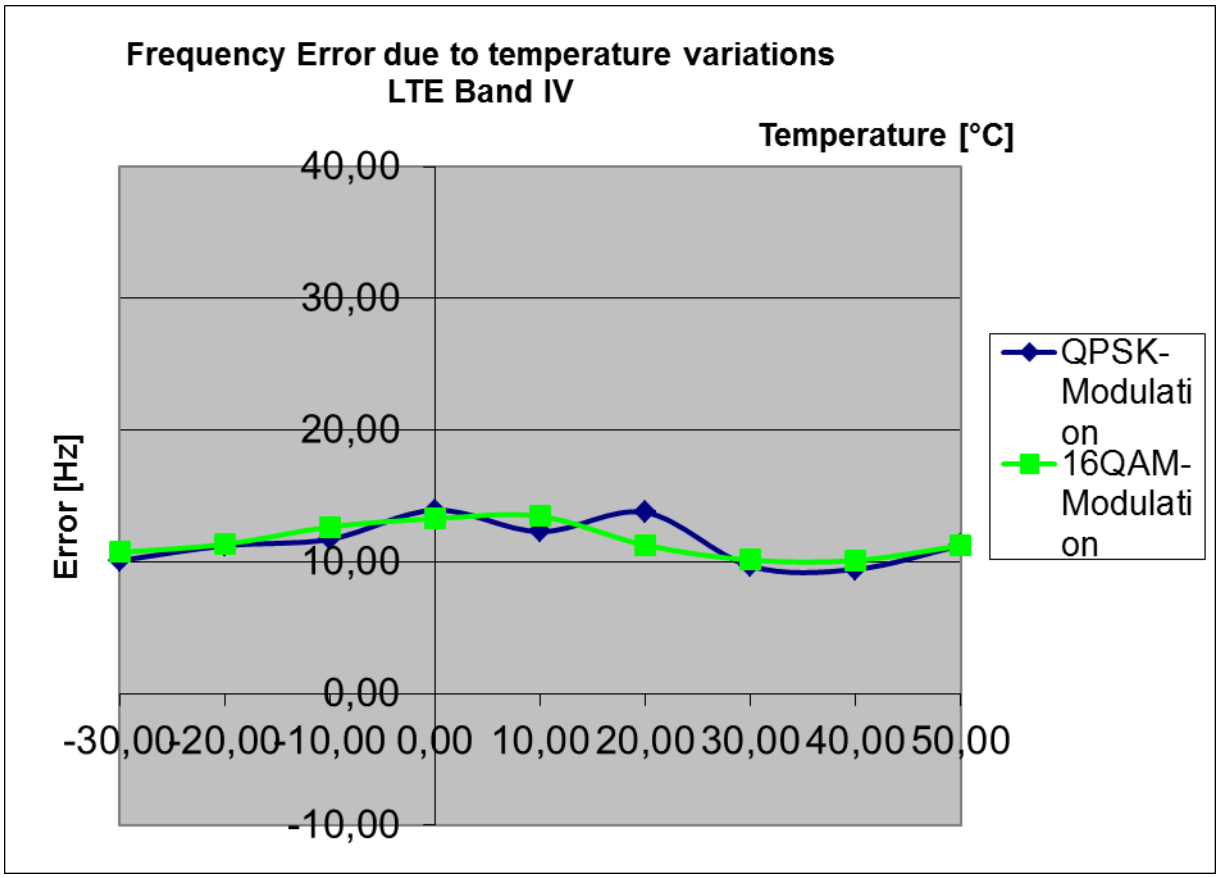
5.6.4.2. LTE Band 2

	Maximum frequency error				
	Channel 18900/ BW=1.4 MHz				
Temperature	QPSK Modulation [Hz]	16-QAM Modulation [Hz]	QPSK Modulation [ppm]	16-QAM Modulation [ppm]	Verdict Limit=±0.1ppm
-30	-26,08	-27,15	-0,014	-0,014	
-20	-23,70	-23,37	-0,013	-0,012	
-10	-22,39	-26,42	-0,012	-0,014	
0	-24,93	-22,90	-0,013	-0,012	
10	-25,58	-24,35	-0,014	-0,013	Passed
20	-23,65	-25,61	-0,013	-0,014	
30	-27,18	-24,56	-0,014	-0,013	
40	-27,82	-28,44	-0,015	-0,015	
50	-27,02	-26,78	-0,014	-0,014	



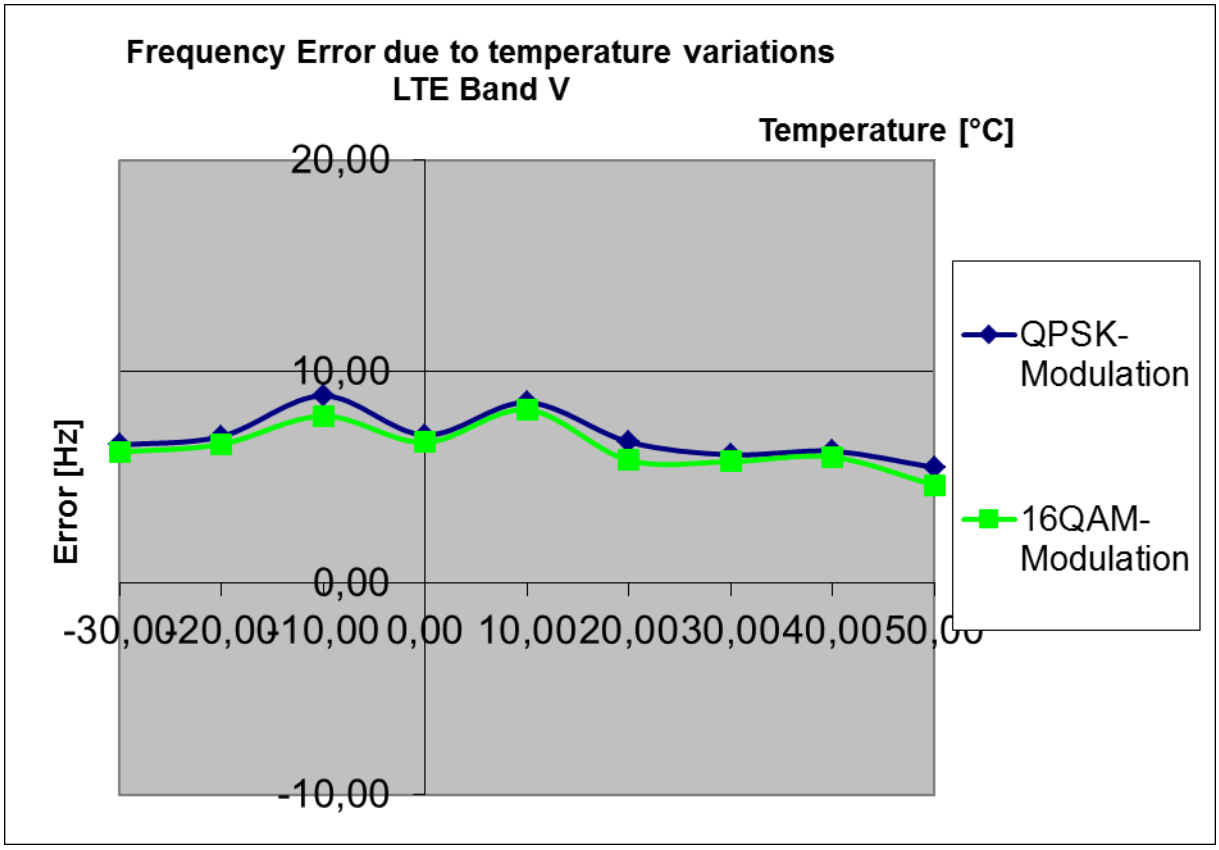
5.6.4.3. LTE Band 4

Temperature	Maximum frequency error Channel 20175/ BW= 1.4MHz QPSK Modulation [Hz]	16-QAM Modulation [Hz]	QPSK Modulation [ppm]	16-QAM Modulation [ppm]	Verdict Limit=±0.1ppm
-30	10,10	10,73	0,006	0,006	
-20	11,23	11,34	0,006	0,007	
-10	11,72	12,66	0,007	0,007	
0	13,93	13,29	0,008	0,008	
10	12,30	13,46	0,007	0,008	Passed
20	13,75	11,27	0,008	0,007	
30	9,67	10,14	0,006	0,006	
40	9,44	10,11	0,005	0,006	
50	11,26	11,24	0,006	0,006	



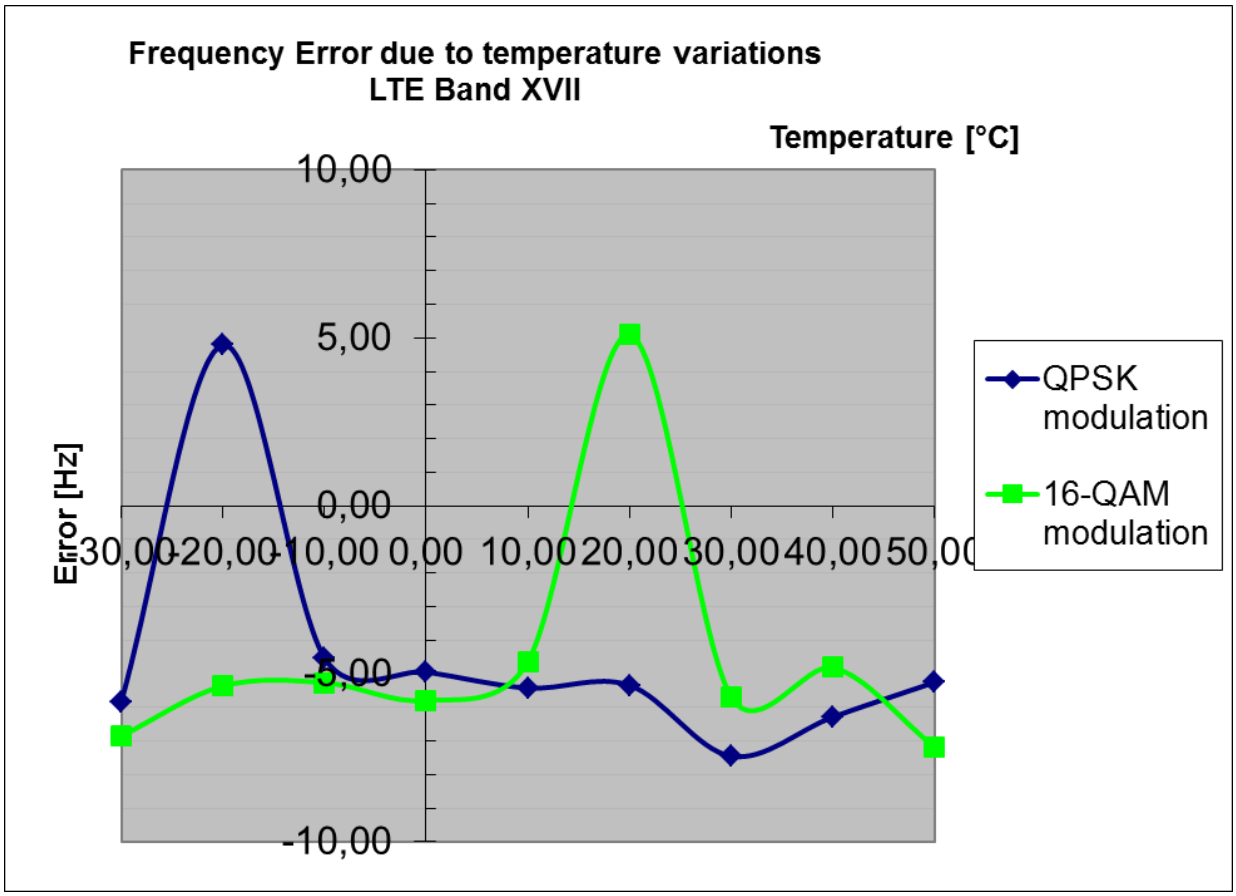
5.6.4.4. LTE Band 5

Temperature	Maximum frequency error Channel 20525/ BW= 1.4MHz QPSK Modulation [Hz]	16-QAM Modulation [Hz]	QPSK Modulation [ppm]	16-QAM Modulation [ppm]	Verdict Limit=±0.1ppm
-30	6,54	6,21	0,008	0,007	
-20	6,95	6,58	0,008	0,008	
-10	8,87	7,91	0,011	0,009	
0	7,02	6,67	0,008	0,008	
10	8,55	8,21	0,010	0,010	Passed
20	6,69	5,82	0,008	0,007	
30	6,08	5,76	0,007	0,007	
40	6,25	5,97	0,007	0,007	
50	5,48	4,65	0,007	0,006	



5.6.4.5. LTE Band 17

Maximum frequency error					
	Channel 23790/ BW=5MHz				
Temperature	QPSK Modulation [Hz]	16-QAM Modulation [Hz]	QPSK Modulation [ppm]	16-QAM Modulation [ppm]	Verdict Limit=±0.1ppm
-30	-5,82	-6,85	-0,008	-0,010	Passed
-20	4,79	-5,36	0,007	-0,008	
-10	-4,53	-5,26	-0,006	-0,007	
0	-4,94	-5,79	-0,007	-0,008	
10	-5,42	-4,63	-0,008	-0,007	
20	-5,34	5,09	-0,008	0,007	
30	-7,45	-5,69	-0,010	-0,008	
40	-6,28	-4,81	-0,009	-0,007	
50	-5,25	-7,18	-0,007	-0,010	



5.7. 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	Frequency range	Calculated uncertainty based on a confidence level of 95%	Remarks:
Power Output conducted	9 kHz .. 20 GHz	1.0 dB	--
Power Output radiated	30 MHz .. 4 GHz	3.17 dB	Substitution method
Conducted emissions on antenna ports	9 kHz .. 20 GHz	1.0 dB	--
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 method
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
		1.0 dB	Power
Frequency stability	9 kHz .. 20 GHz	0.0636 ppm	--
Conducted emissions on AC-mains port (U_{CISPR})	9 kHz .. 150 kHz	4.0 dB	--
	150 kHz .. 30 MHz	3.6 dB	

Table: measurement uncertainties, valid for conducted/radiated measurements

6. Abbreviations used in this report

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

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

Ref.-No.	Accreditation Certificate	Valid for laboratory area or test site	Accreditation Body
-	D-PL-12047-01-01	All laboratories and test sites of CETECOM GmbH, Essen	DAkkS, Deutsche Akkreditierungsstelle GmbH
337 487 558 348 348	736496	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 Measurem.	FCC, Federal Communications Commission Laboratory Division, USA (MRA US-EU 0003)
337 487 550 558	3462D-1 3462D-2 3462D-2 3462D-3	Radiated Measurements 30 MHz to 1 GHz, 3 m / 10 m (OATS) Radiated Measurements 30 MHz to 1 GHz, 3 m (SAR) Radiated Measurements 1 GHz to 6 GHz, 3 m (SAR) Radiated Measurements above 1 GHz, 3 m (FAR)	IC, Industry Canada Certification and Engineering Bureau
487 550 348 348	R-2666 G-301 C-2914 T-1967	Radiated Measurements 30 MHz to 1 GHz, 3 m (SAR) Radiated Measurements 1 GHz to 6 GHz, 3 m (SAR) Mains Ports Conducted Interference Measurements Telecommunication Ports Conducted Interference Measurem.	VCCI, Voluntary Control Council for Interference by Information Technology Equipment, Japan
OATS = Open Area Test Site, SAR = Semi Anechoic Room, FAR = Fully Anechoic Room			

8. Instruments and Ancillary

8.1. Used 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
264	Spectrum Analyzer	FSEK 30	826939/005	Bios=2.1, Analyzer= 3.20
295	Racal Digital Radio Test Set	6103	1572	UNIT Firmware= 4.04, SW-Main=4.04, SW-BBP=1.04, SW-DSP=1.02, Hardboot=1.02, Softboot=2.02
298	Univ. Radio Communication Tester	CMU 200	832221/091	R&S Test Firmware =3.53 /3.54 (current Testsoftw. f. all band used
323	Digital Radiocommunication Tester	CMD 55	825878/0034	Firm.= 3.52 .22.01.99
331	Climatic Test Chamber -40/+80 Grad	HC 4055	43146	TSI 1.53
335	CTC-EMS-Conducted	System EMS Conducted	-	EMC 32 V 8.52
340	Digital Radiocommunication Tester	CMD 55	849709/037	Firm.= 3.52 .22.01.99
355	Power Meter	URV 5	891310/027	Firm.= 1.31
365	10V Insertion Unit 50 Ohm	URV5-Z2	100880	Eprom Data = 31.03.08
366	Ultra Compact Simulator	UCS 500 M4	V0531100594	Firm. UCS 500=001925/3.06a02, rc=ISMIEC 4.10
371	Bluetooth Tester	CBT32	100153	CBT V5,30+ SW-Option K55, K57
377	EMI Test Receiver	ESCS 30	100160	Firm.= 2.30, OTP= 02.01, GRA= 02.36
378	Broadband RF Field Monitor	RadiSense III	03D00013SNO-08	Firm.= V.03D13
383	Signal Generator	SME 03	842 828 /034	Firm.= 4.61
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. 8.53
444	CTC-FAR-EMS field	System-EMS-Field (FAR)	-	EMC 32 Version 8.40
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
594	Wideband Radio Communication Tester	CMW 500	101757	Firmware Base=2.0.20.9, LTE=2.0.20.8. CDMA= 2.0.10
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 V02.12.01

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	-	31.03.2014
005	AC - LISN (50 Ohm/50µH, test site 1)	ESH2-Z5	861741/005	Rohde & Schwarz	24/12 M	-	31.03.2014
007	Single-Line V-Network (50 Ohm/5µH)	ESH3-Z6	892563/002	Rohde & Schwarz	24/12 M	-	31.03.2014
009	Power Meter (EMS-radiated)	NRV	863056/017	Rohde & Schwarz	24 M	-	31.03.2015
016	Line Impedance Simulating Network	Op. 24-D	B6366	Spitzenberger+Spies	36 M	-	31.03.2016
020	Horn Antenna 18 GHz (Subst 1)	3115	9107-3699	EMCO	36/12 M	-	31.03.2014
021	Loop Antenna (H-Field)	6502	9206-2770	EMCO	36 M	-	31.03.2015
030	Loop Antenna (H-field)	HFH-Z2	879604/026	Rohde & Schwarz	36 M	-	31.03.2015
033	RF-current probe (100kHz-30MHz)	ESH2-Z1	879581/18	Rohde & Schwarz	24 M	-	31.03.2015
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	30.06.2014
086	DC - power supply, 0 -10 A	LNG 50-10	-	Heinzinger Electronic	pre-m	2	
087	DC - power supply, 0 -5 A	EA-3013 S	-	Elektro Automatik	pre-m	2	
090	Helmholtz coil: 2x10 coils in series	-	-	RWTÜV	-	4	
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	-	31.03.2015
100	passive voltage probe	Probe TK 9416	without	Schwarzbeck	36 M	-	31.03.2015
110	USB-LWL-Converter	OLS-1	-	Ing. Büro Scheiba	-	4	
119	RT Harmonics Analyzer dig. Flickermeter	B10	G60547	BOCONSULT	36 M	-	31.03.2016
134	horn antenna 18 GHz (Subst 2)	3115	9005-3414	EMCO	pre-m	-	31.03.2014
136	adjustable dipole antenna (Dipole 1)	3121C-DB4	9105-0697	EMCO	36 M	-	31.03.2015
140	Signal Generator	SMHU	831314/006	Rohde & Schwarz	24 M	-	31.03.2014
248	attenuator	SMA 6dB 2W	-	Radiall	pre-m	2	
249	attenuator	SMA 10dB 10W	-	Radiall	pre-m	2	
252	attenuator	N 6dB 12W	-	Radiall	pre-m	2	
256	attenuator	SMA 3dB 2W	-	Radiall	pre-m	2	
257	hybrid	4031C	04491	Narda	pre-m	2	
260	hybrid coupler	4032C	11342	Narda	pre-m	2	
261	Thermal Power Sensor	NRV-Z55	825083/0008	Rohde & Schwarz	24 M	-	31.03.2014
262	Power Meter	NRV-S	825770/0010	Rohde & Schwarz	24 M	-	31.03.2014
263	Signal Generator	SMP 04	826190/0007	Rohde & Schwarz	36 M	-	31.03.2016
264	Spectrum Analyzer	FSEK 30	826939/005	Rohde & Schwarz	12 M	-	31.03.2014
265	peak power sensor	NRV-Z33, Model 04	840414/009	Rohde & Schwarz	24 M	-	31.03.2014
266	peak power sensor	NRV-Z31, Model 04	843383/016	Rohde & Schwarz	24 M	-	31.03.2014
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	30.06.2014
291	high pass filter GSM 850/900	WHJ 2200-4EE	14	Wainwright GmbH	12 M	1c	30.06.2014
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	24/12 M	-	31.03.2014
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	-	31.03.2014
303	horn antenna 40 GHz (Subst 1)	BBHA9170	156	Schwarzbeck	36 M	-	31.03.2014
331	Climatic Test Chamber -40/+80 Grad	HC 4055	43146	Heraeus Vötsch	24 M	-	30.11.2014
341	Digital Multimeter	Fluke 112	81650455	Fluke	24 M	-	31.03.2014
342	Digital Multimeter	Voltcraft M-4660A	IB 255466	Voltcraft	24 M	-	31.03.2015
347	laboratory site	radio lab.	-	-	-	5	
348	laboratory site	EMI conducted	-	-	-	5	
354	DC - Power Supply 40A	NGPE 40/40	448	Rohde & Schwarz	pre-m	2	
355	Power Meter	URV 5	891310/027	Rohde & Schwarz	24 M	-	31.03.2014
356	power sensor	NRV-Z1	882322/014	Rohde & Schwarz	24 M	-	31.03.2015
357	power sensor	NRV-Z1	861761/002	Rohde & Schwarz	24 M	-	31.03.2015
371	Bluetooth Tester	CBT32	100153	R&S	24 M	-	31.03.2014
373	Single-Line V-Network (50 Ohm/5µH)	ESH3-Z6	100535	Rohde & Schwarz	24/12 M	-	31.03.2014
376	Horn Antenna 6 GHz	BBHA9120 E	BBHA 9120 E 179	Schwarzbeck	12 M	-	31.03.2014
377	EMI Test Receiver	ESCS 30	100160	Rohde & Schwarz	12 M	-	31.03.2014
389	Digital Multimeter	Keithley 2000	0583926	Keithley	24 M	-	31.03.2015
392	Radio Communication Tester	MT8820A	6K00000788	Anritsu	12 M	-	31.03.2014
431	Model 7405	Near-Field Probe Set	9305-2457	EMCO	-	4	
436	Univ. Radio Communication Tester	CMU 200	103083	Rohde & Schwarz	12 M	-	31.03.2014
441	CTC-SAR-EMI Cable Loss	System EMI field (SAR)	-	CETECOM	12 M	5	31.10.2013

Ref.-No.	Equipment	Type	Serial-No.	Manufacturer	Interval of calibration	Remark	Cal due
		Cable					
443	CTC-FAR-EMI-RSE	System CTC-FAR-EMI-RSE	-	ETS-Lindgren / CETECOM	12 M	5	15.07.2014
448	notch filter WCDMA_FDD II	WRCT 1850.0/2170.0-5/40-	5	Wainwright Instruments GmbH	12 M	1c	30.06.2014
449	notch filter WCDMA FDD V	WRCT 824.0/894.0-5/40-8SSK	1	Wainwright	12 M	1c	30.06.2014
454	Oscilloscope	HM 205-3	9210 P 29661	Hameg	-	4	
456	DC-Power supply 0-5 A	EA 3013 S	207810	Elektro Automatik	pre-m	2	
459	DC -Power supply 0-5 A , 0-32 V	EA-PS 2032-50	910722	Elektro Automatik	pre-m	2	
460	Univ. Radio Communication Tester	CMU 200	108901	Rohde & Schwarz	12 M	-	31.03.2014
463	Universal source	HP3245A	2831A03472	Agilent	-	4	
466	Digital Multimeter	Fluke 112	89210157	Fluke USA	24 M	-	31.03.2014
467	Digital Multimeter	Fluke 112	89680306	Fluke USA	24 M	-	31.03.2014
468	Digital Multimeter	Fluke 112	90090455	Fluke USA	24 M	-	31.03.2014
477	ReRadiating GPS-System	AS-47	-	Automotive Cons. Fink	-	3	
480	power meter (Fula)	NRVS	838392/031	Rohde & Schwarz	24 M	-	31.03.2015
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	-	30.06.2014
487	System CTC NSA-Verification SAR-EMI	System EMI field (SAR) NSA	-	ETS Lindgren / CETECOM	24 M	-	30.06.2015
489	EMI Test Receiver	ESU40	1000-30	Rohde & Schwarz	12 M	-	31.03.2014
502	band reject filter	WRCG 1709/1786-1699/1796-	SN 9	Wainwright	pre-m	2	
503	band reject filter	WRCG 824/849-814/859-	SN 5	Wainwright	pre-m	2	
512	notch filter GSM 850	WRCA 800/960-02/40-6EEK	SN 24	Wainwrght	12 M	1c	30.06.2014
517	relais switch matrix	HF Relais Box Keithley	SE 04	Keithley	pre-m	2	
523	Digital Multimeter	L4411A	MY46000154	Agilent	24 M	-	31.03.2015
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	-	31.03.2014
547	Univ. Radio Communication Tester	CMU 200	835390/014	Rohde & Schwarz	12 M	-	31.03.2014
548	Digital-Barometer	GBP 2300	without	Greisinger GmbH	36 M	-	30.06.2015
549	Log.Per-Antenna	HL025	1000060	Rohde & Schwarz	36/12 M	-	31.03.2015
552	high pass filter 2,8-18GHz	WHKX 2.8/18G-10SS	4	Wainwright	12 M	1c	30.06.2014
558	System CTC FAR S-VSWR	System CTC FAR S-VSWR	-	CTC	24 M	-	31.07.2015
574	Biconilog Hybrid Antenna	BTA-L	980026L	Frankonia	36/12 M	-	31.03.2016
584	Spectrum Analyzer	FSU 8	100248	Rohde & Schwarz	24 M	-	31.03.2014
594	Wideband Radio Communication Tester	CMW 500	101757	Rohde & Schwarz	24 M	-	31.03.2014
597	Univ. Radio Communication Tester	CMU 200	100347	Rohde & Schwarz	12 M	-	31.03.2014
598	Spectrum Analyzer	FSEM 30 (Reserve)	831259/013	Rohde & Schwarz	24 M	-	13.01.2015
600	power meter	NRVD (Reserve)	834501/018	Rohde & Schwarz	24 M	-	31.03.2015
601	medium-sensitivity diode sensor	NRV-Z5 (Reserve)	8435323/003	Rohde & Schwarz	24 M	-	31.03.2015
602	peak power sensor	NRV-Z32 (Reserve)	835080	Rohde & Schwarz	24 M	-	31.03.2015
608	UltraLog-Antenna	HL 562	830547/009	Rohde & Schwarz	36/12 M	-	31.03.2014
611	DC power supply	E3632A	KR 75305854	Agilent	pre-m	2	
612	DC power supply	E3632A	MY 40001321	Agilent	pre-m	2	
613	Attenuator	R416120000 20dB 10W	Lot. 9828	Radiall	pre-m	2	
616	Digitalmultimeter	Fluke 177	88900339	Fluke	24 M	-	31.03.2014
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	-	01.03.2014
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	-	30.05.2014
634	Spectrum Analyzer	FSM (HF-Unit)	826188/010	Rohde & Schwarz	pre-m	2	
636	Thermal Imaging camera	Ti32	Ti32-12060213	Fluke Corporation	24 M	-	31.07.2014
637	High Speed HDMI with Ethernet 1m	HDMI cable with Ethernet 1m	-	KogiLink	-	2	
638	HDMI Kabel with Ethernet 1,5 m flach	HDMI cable with Ethernet	-	Reichelt	-	2	
640	HDMI cable 2m rund	HDMI cable 2m rund	-	Reichelt	-	2	
641	HDMI cable with Ethernet	Certified HDMI cable with	-	PureLink	-	2	
642	Wideband Radio Communication Tester	CMW 500	126089	Rohde&Schwarz	24 M	-	31.03.2014
644	Amplifierer	ZX60-2534M+	SN865701299	Mini-Circuits	-	-	
670	Univ. Radio Communication Tester	CMU 200	106833	Rohde & Schwarz	12 M	-	31.03.2014
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	200571	Rohde & Schwarz	pre-m	-	
686	Field Analyzer	EHP-200A	160WX30702	Narda Safety Test Solutions	24 M	-	18.07.2015

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