T E S T R E P O R T
No.: 18-1-0039301T02a

According to:
FCC Regulations
Part 27

for

Gemalto M2M GmbH

LTE Module Rel.13 CAT-M1 EMS31-V

FCC-ID: QIPEMS31-VR1

Laboratory Accreditation and Listings		
DAkkS 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
Wi Fi ALLIANCE AUTHORIZED RF LABORATORY	ctia Authorized™ Test Lab Lab Code: 20011130-00	FCC FEDERAL COMMUNICATIONS COMMISSION USA 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. 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 (4G) 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 27 (Miscellaneous wireless communications services) of the CFR Title 47 Rules, Edition 4th November 2017.

1.1. TX mode, Test overview of FCC 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)	§15.207	§15.207 limits	--	--	Remark 1.)
2	General field strength emissions (9 kHz - 30 MHz)	Cabinet + inter-connecting cables	§15.209(a)	2400/F(kHz) µV/m 24000/F(kHz) µV/m 30 µV/m	2	1+2	Pass
7	RF-Power (ERP/EIRP)	Cabinet + inter-connecting cables (radiated)	§27.50(d)(4)	< 1 Watt (EIRP) LTE4	1	1+2	Only calculations with declared antenna gain
			§27.50(b)(10)	< 5 Watt (EIRP) LTE 13			
8	Spurious emissions	Cabinet + inter-connecting cables (radiated)	§2.1053(a) §2.1057	43+10log(P) dBc	2	1+2	Pass
9	Band-Edge compliance		§27.53(h)(1)(3)(i)(ii)(iii)		2	1+2	Pass
			§27.53(c)(1-4)(5)	43+10log(P) dBc + Spectrum Mask			
			§27.53(f)	(a) 763-775MHz & 793-806MHz (i): 76+10log10(P) dB (ii): 65+10log10(P) dB (b) 1559-1610MHz: -70dBW/MHz or -80dBW EIRP			
			§27.53(g)				

30	RF Power	Antenna terminal (conducted)	§2.1046	N/A	1	1+2	Pass
34	26dB Emission bandwidth		§2.1049(h)	26dBc Emissions BW 99% Power	1	1+2	For information only
35	99% Occupied bandwidth						
36	Spurious emissions		§2.1051 §2.1057 §27.53	43+10log(P) dBc + (a) 763-775MHz & 793-806MHz (i): 76+10log10(P) dB (ii): 65+10log10(P) dB + (b) 1559-1610MHz: -70dBW/MHz or -80dBW EIRP			Pass
37	Band-Edge compliance						Pass
38	Frequency stability		§2.1055(a)(2) §27.54	Frequency plan should be within authorized band			Pass

Remarks: 1.) no final implementation and usage of the module, only DC powered for initial approval

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

Christian Lorenz 2018.03.15 08:30:08 +01'00'
.....
Dipl.-Ing. C. Lorenz
Responsible for test report

2. Administrative Data

2.1. Identification of the testing laboratory

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

2.2. Test location

2.2.1. Test laboratory "CTC"

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

2.3. Organizational items

Responsible for test report and project leader:	Dipl.-Ing. C. Lorenz
Receipt of EUT:	2017 - Dezember
Date(s) of test:	2018 – January/February/March
Date of report:	2018-03-14
Version of template: 13.02	

2.4. Applicant's details

Applicant's name:	Gemalto M2M GmbH
Address:	Werinherstrasse 81 81541 Munich Germany
Contact person:	Mr. Axel Heike

2.5. Manufacturer's details

Manufacturer's name:	please see Applicant's details
Address:	please see Applicant's details

3. Equipment under test (EUT)

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 7: 824 - 849 MHz (Uplink), 869-894 MHz (Downlink) ☒ LTE Band 13: 777 - 787 MHz (Uplink), 746-756 MHz (Downlink) ☐ LTE Band 17: 704 - 716 MHz (Uplink), 734 - 746 MHz (Downlink)			
Type of modulation	QPSK, 16-QAM			
Data rates	Cat. M1, Downlink: max. 300kbps, Uplink: max. 375kbps			
Number of channels – Table 5.4.4-1 accord. 3GPP TS36.521-1 (See Note in 3GPP-Standard about channels not to be used depending on channel bandwidths)	☐ LTE Band 2: UARFCN range 18600 - 19199 ☒ LTE Band 4: UARFCN range 19950 - 20399 ☐ LTE Band 5: UARFCN range 20400 - 20649 ☐ LTE Band 7: UARFCN range 20750 - 21449 ☒ LTE Band 13: UARFCN range 23180 - 23279 ☐ LTE Band 17: UARFCN range 23730 - 23849			
Emission designator(s)		Channel bandwidth	QPSK Modulation:	16-QAM Modulation Remark 1:
	LTE Band 13	5MHz (remark2)	1M15G7D	1M00W7D
	LTE Band 4	5MHz (remark 1)	1M14G7D	1M00W7D
Antenna Type	☐ Integrated ☐ External, no RF- connector ☒ External, separate RF-connector			
Antenna Gain	698 – 960MHz: 1dBi 1710-2170MHz: 2.4 dBi			
MAX PEAK Output Power: Radiated LTE-Mode 4 LTE Band 13:	ERP: 25.38dBm +2.4 dBi = 27.78 dBm EIRP ERP: dBm +1dBi - 2.15 dB = 23.98dBm ERP			
MAX PEAK Output Power: Conducted LTE-Mode 4 LTE Mode 13	25.38 dBm (AV) 25.13 dBm (AV)			
Installed option	☐ W-LAN, Bluetooth©, ANT+ wireless technologies ☐ battery charging option ☐ GPS (not tested within this test report) ☐ FM-Radio (Receiver only)			
Power supply	☒ DC power only: 9-12 Volt on DSB75-Adapter with external AC/DC AC-power supply Converted to voltage range of 3.3 V to 4.41 V by DSB75-Adapter board or direct connection to DC			
Special EMI components	--			
EUT sample type	☒ Production	☐ Pre-Production	☐ Engineering	
FCC label attached	☐ yes	☒ no	☐ other:	

Remarks:

1.) For 16-QAM maximum 5RBs could be activated in regard to category M1 device (3GPP 36.101, Annex 2.1.3) therefore nominal signal-bandwidth of 3/5/10/15/20MHz not possible

2.) For 16-QAM maximum 5RBs could be activated in regard to category M1 device (3GPP 36.101, Annex 2.1.3) therefore nominal signal-bandwidth of 5/10MHz not possible

3.1. 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	LTE Module Rel.13 CAT-M1	EMS31-V	004401082207149	B2.1.1	5.0.0.0d
EUT B	LTE Module Rel.13 CAT-M1	EMS31-V	004401082208584	B2.1.1	5.0.0.0d

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

3.2. 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	Cellular LTE Magnetic mount antenna	2J300M	#1	698-960MHz: Peak Gain:1dBi Gain 1710-2170MHz: Peak Gain: 2.4dBi	--
AE 2	Development support board	DSB75	#1	Rev. B1, Version v12	--
AE 3	DSB75 Adaptor	AH6	#1	--	--
AE 4	RF-cable	--	#1	10cm long	--
AE 5	USB to RS232 Adapter	Moxa UPort 1110	#1	--	--
AE 6	Notebook	Dell E6430	CTC462012	--	Win7 + Terminal program

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

3.3. EUT set-ups

EUT set-up no.*)	Combination of EUT and AE	Remarks
set. 1	EUT A + AE 2 + AE 3 + (AE 5 + AE 6)	Conducted set-up: for conducted measurements on RF port. AE 5 and AE 6 temporary included in the set-up for connection establishment.
set. 2	EUT B + AE 1 + AE 2 + AE 3 + AE 4 +(AE 5 + AE 6)	Radiated set-up: for radiated measurements. AE 5 and AE 6 temporary included in the set-up for connection establishment.

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

3.4. EUT operating modes

EUT operating mode no.*)	Description of operating modes	Additional information
op. 1	LTE-Band 4 eMTC Mode Auto RMC99	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.
op. 2	LTE-Band 13 eMTC Mode Auto	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.

3.5. Configuration of cables used for testing

Cable number	Item	Type	S/N serial number	HW hardware status	Cable length
Cable 1	DC cable for AE 2	unshielded	--	--	2 m
Cable 2	Antenna port of AE1	shielded	--	--	2.5 m

4. Description of test system set-up's

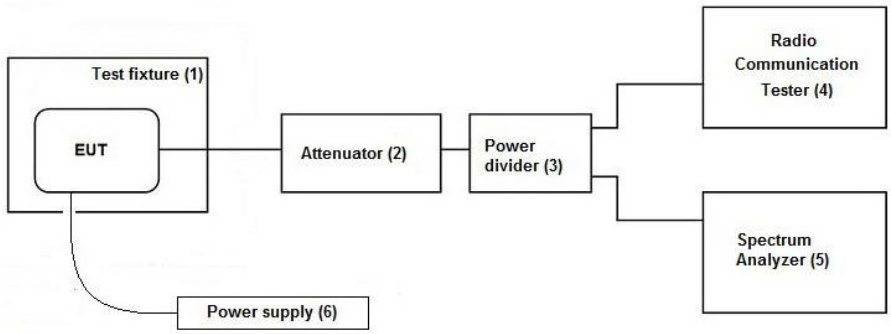
4.1. Test system set-up for conducted measurements on antenna port

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 eMTC Mode	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	

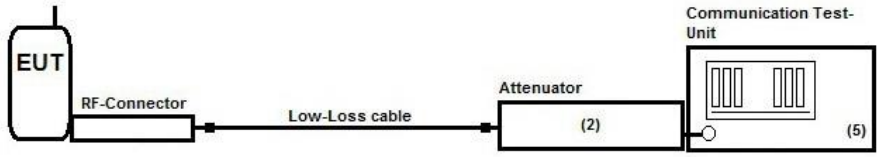
Testing method: ANSI C63.10:2013, KDB 971168 D01 v03
ANSI C63.26: 2015

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 v03
ANSI C63.26: 2015

Used Equipment

Passive Elements	Test Equipment	Remark:
☒ 10 dB Attenuator (#603)	☒ CMW500 Communication Test-Unit for LTE eMTC Mode (cat M1 devices)	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)

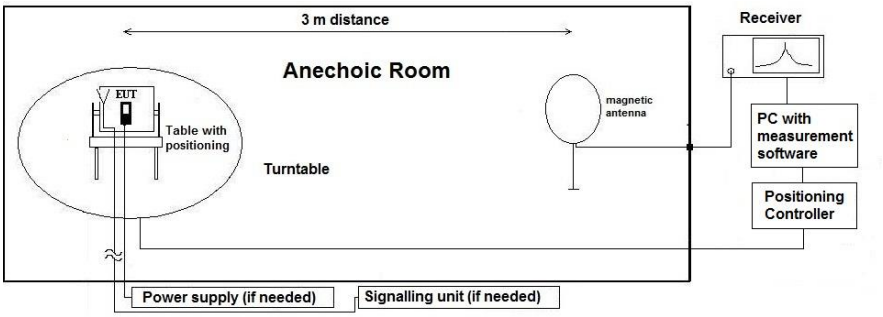
4.2. Test system set-up for radiated magnetic field measurements below 30 MHz

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), ANSI C63.26: 2015

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

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

Schematic:



Testing method:

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

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

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

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

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

Formula:

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

$M = L_T - E_C$

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

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

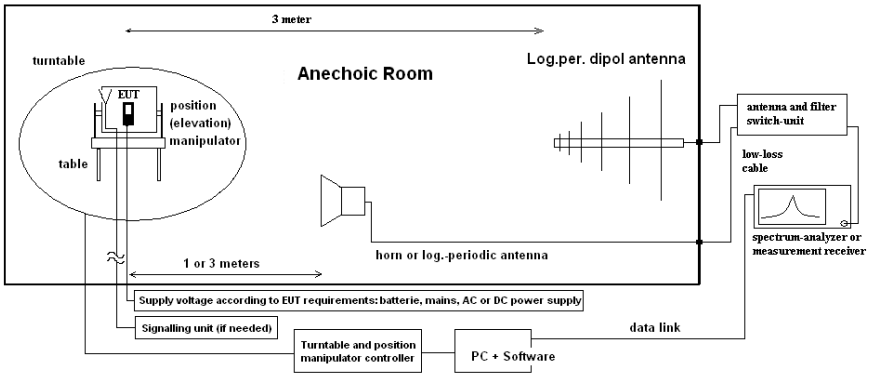
Distance correction: Reference for applied correction (extrapolating) factors due to reduced measurement distance:
ANSI C63.10:2013, §6.4.4.2 - Equations (2) + (3) + (4)

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

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

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

Schematic:



Testing method:

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

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

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

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

Formula:

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

$M = L_T - E_C$ (2)

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

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

5. Measurements

5.1. 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	☒ 757 CMW500		
otherwise	☐ 400 FTC40x15E	☐ 401 FTC40x15E	☐ 110 USB LWL	☐ 482 Filter Matrix	☐ 378 RadiSense	
DC power	☐ 456 EA 3013A	☐ 463 HP3245A	☐ 459 EA 2032-50	☐ 268 EA- 3050	☐ 494 AG6632A	☒ 611 E3632A
otherwise	☐ 331 HC 4055	☐ 248 6 dB Att.	☐ 529 Power div.	☐ - cable OTA20		☒ 530 10 dB Att.
line voltage	☐ 230 V 50 Hz via public mains		☐ 060 110 V/ 60 Hz via PAS 5000			

5.1.2. Requirements and limits (Variante RF-Parameter)

FCC	§2.1046, §27.50
Limits	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 7: 2 Watt EIRP (33.0 dBm)
	FCC: Limit LTE Band 12/13/17: 3 Watt ERP (34.7dBm)

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 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. 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
0.1. LTE Band 4 Results

LTE-Band 4				QPSK-Modulation			16-QAM-Modulation			max- modulation QPSK	max. modulation 16-QAM	max. channel	absolute max. value
channel bandwidth	ARFCN ch. no.	ARFCN-Frequency [MHz]	Resource block allocation	Peak detektor [dBm]	RMS detektor [dBm]	PAR Faktor [dB]	Peak detektor [dBm]	RMS detektor [dBm]	PAR Faktor [dB]				
5 MHz	19975	1712,5	1RB low(NB=1)	28,74	25,27	3,47	28,72	25,33	3,39	25,27	25,37	25,37	25,38
			1RB high(NB=4)	28,69	25,23	3,46	28,67	25,37	3,3				
			50%RB mid(NB=2)	28,36	25,18	3,18	28,5	25,17	3,33				
			100%RB(NB=2)	28,41	25,18	3,23	28,38	25,17	3,21				
	20175	1732,5	1RB low(NB=1)	28,4	24,87	3,53	28,53	25,0	3,53	24,87	25		
			1RB high(NB=4)	28,32	24,8	3,52	28,44	24,93	3,3				
			50%RB mid(NB=2)	28,11	24,81	3,3	28,47	24,8	3,67				
			100%RB(NB=2)	28,08	24,8	3,28	28,09	24,81	3,28				
	20375	1752,5	1RB low(NB=1)	27,97	24,42	3,55	28,26	24,61	3,65	24,42	24,61		
			1RB high(NB=4)	28,2	24,36	3,84	28,26	24,52	3,74				
			50%RB mid(NB=2)	27,83	24,35	3,48	27,97	24,37	3,6				
			100%RB(NB=2)	27,83	24,36	3,47	27,86	24,36	3,5				
10 MHz	20000	1715	1RB low(NB=1)	28,68	25,22	3,46	28,73	25,38	3,35	25,22	25,38	25,38	
			1RB high(NB=8)	28,6	25,15	3,45	28,64	25,27	3,37				
			50%RB mid(NB=4)	28,46	25,2	3,26	28,62	25,12	3,5				
			100%RB(NB=4)	28,32	25,13	3,19	28,52	25,13	3,39				
	20175	1732,5	1RB low(NB=1)	28,4	24,96	3,44	28,49	24,89	3,6	24,96	24,89		
			1RB high(NB=8)	28,34	24,83	3,51	28,45	24,77	3,68				
			50%RB mid(NB=4)	28,32	24,83	3,49	28,33	24,78	3,56				
			100%RB(NB=4)	28,09	24,76	3,33	28,36	24,8	3,56				
	20350	1750	1RB low(NB=1)	28,12	24,52	3,6	28,16	24,61	3,55	24,52	24,61		
			1RB high(NB=8)	28,06	24,36	3,7	28,11	24,44	3,67				
			50%RB mid(NB=4)	28,01	24,39	3,62	28,34	24,41	3,93				
			100%RB(NB=4)	27,83	24,39	3,44	28,12	24,37	3,75				
15 MHz	20025	1717,5	1RB low(NB=1)	28,43	25,19	3,24	28,77	25,29	3,48	25,19	25,29	25,29	
			1RB high(NB=12)	27,62	25,01	2,61	28,62	25,01	3,61				
			50%RB mid(NB=6)	28,46	25,11	3,35	28,6	25	3,6				
			100%RB(NB=6)	28,42	25,04	3,63	28,52	25,01	3,51				
	20175	1732,5	1RB low(NB=1)	28,16	24,96	3,2	28,34	24,84	3,5	24,96	24,84		
			1RB high(NB=12)	28,22	24,71	3,51	28,1	24,73	3,37				
			50%RB mid(NB=6)	28,28	24,85	3,43	28,32	24,73	3,59				
			100%RB(NB=6)	28,23	24,75	3,48	28,41	24,68	3,73				
	20325	1747,5	1RB low(NB=1)	27,84	24,62	3,22	28,28	24,6	3,68	24,62	24,8		
			1RB high(NB=12)	28,08	24,35	3,73	28,27	24,8	3,47				
			50%RB mid(NB=6)	28,07	24,47	3,6	28,18	24,42	3,76				
			100%RB(NB=6)	**28,07**	24,44	3,63	28,27	24,35	3,92				
20 MHz	20050	1720	1RB low(NB=1)	27,54	24,93	2,61	28,62	25,14	3,48	25,08	25,14	25,14	
			1RB high(NB=16)	27,56	24,98	2,58	27,54	24,93	2,61				
			50%RB mid(NB=8)	28,36	25,08	3,28	28,43	24,93	3,5				
			100%RB(NB=8)	28,54	24,98	3,56	28,59	24,99	3,6				
	20175	1732,5	1RB low(NB=1)	27,36	24,72	2,64	27,37	24,72	2,65	24,8	24,76		
			1RB high(NB=16)	28,05	24,68	3,37	28,36	24,76	3,6				
			50%RB mid(NB=8)	28,05	24,8	3,25	28,33	24,72	3,61				
			100%RB(NB=8)	28,11	24,7	3,41	28,27	24,76	3,51				
	20300	1745	1RB low(NB=1)	28,26	24,76	3,5	27,12	24,41	2,71	24,76	24,43		
			1RB high(NB=16)	28,09	24,39	3,7	27,1	24,41	2,69				
			50%RB mid(NB=8)	28,00	24,44	3,56	28,08	24,43	3,65				
			100%RB(NB=8)	27,13	24,44	2,69	28,3	24,42	3,88				

Remark:
1.) Marked cells shows maximum power conducted values on which also PAPR measurements have been performed
2.) 1.4/3 MHz nominal signal bandwidth not possible accord. Applicants declaration

0.1. LTE Band 13 Results

LTE-Band 13				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 QPSK	max. modulation 16QAM	max. channel	absolute max. value
5 MHz	23205	779,5	1RB low(NB=1)	28,53	24,84	3,61	28,53	24,96	3,47	24,85	24,96	25,13	25,13
			1RB high(NB=4)	28,32	24,83	3,58	28,52	24,96	3,46				
			50%RB mid(NB=2)	28,38	24,85	3,53	28,5	24,84	3,66				
			100%RB(NB=2)	28,27	24,84	3,43	28,32	24,86	3,46				
	23230	782	1RB low(NB=1)	28,44	24,83	3,61	28,53	25,06	3,47	24,84	25,09		
			1RB high(NB=4)	28,42	24,84	3,58	28,55	25,09	3,46				
			50%RB mid(NB=2)	28,32	24,84	3,48	28,46	24,83	3,63				
			100%RB(NB=2)	28,24	24,83	3,41	28,31	24,87	3,44				
	23255	784,5	1RB low(NB=1)	28,6	24,83	3,77	28,63	25,12	3,51	24,84	25,13		
			1RB high(NB=4)	28,59	24,83	3,76	28,62	25,13	3,49				
			50%RB mid(NB=2)	28,15	24,83	3,32	28,42	24,82	3,6				
			100%RB(NB=2)	28,17	24,84	3,33	28,13	24,86	3,27				
10 MHz	23180		1RB low(NB=1)			0			0	0	0	24,92	
			1RB high(NB=8)			0			0				
			50%RB mid(NB=4)			0			0				
			100%RB(NB=4)			0			0				
	23230		1RB low(NB=1)	28,34	24,89	3,45	28,57	24,92	3,65	24,89	24,92		
			1RB high(NB=8)	28,36	24,86	3,5	28,58	24,91	3,67				
			50%RB mid(NB=4)	28,42	24,84	3,58	28,59	24,83	3,76				
			100%RB(NB=4)	28,21	24,86	3,35	28,52	24,85	3,67				
	23279		1RB low(NB=1)			0			0	0	0		
			1RB high(NB=8)			0			0				
			50%RB mid(NB=4)			0			0				
			100%RB(NB=4)			0			0				

Remark: Marked cells shows maximum power conducted values on which also PAPR measurements have been performed

0.1. Conclusion

	Channel BW	LTE Band 4		LTE Band 13	
		QPSK	16-QAM	QPSK	16-QAM
RF-Power [dBm]	5	25,27	25,37	24,85	25,13
	10	25,22	25,38	24,89	24,92
	15	25,19	25,29	--	--
	20	25,08	25,14	--	--

	Channel BW	LTE Band 4		LTE Band 13	
		QPSK	16-QAM	QPSK	16-QAM
RF-Power [mW]	5	336,51	344,35	305,49	325,84
	10	332,66	345,14	308,32	310,46
	15	330,37	338,06	--	--
	20	322,11	326,59	--	--

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 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) 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 v03 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 4		
Signal-Bandwidth / [MHz]	Max. PAPR level with 0.1% probability / [dB]	
	QPSK Modulation	16-QAM Modulation
1.4	Remark 2.)	
3.0		
5.0	3.422	3.328
10	3.281	3.516
15	3.281	3.656
20	3.234	3.656

Remark:
1.) pls. see annex 1 for graphical plots
2.) power measurement, not required according 3GPP TS36.521

LTE Band 13		
Signal-Bandwidth / [MHz]	Max. PAPR level with 0.1% probability / [dB]	
	QPSK Modulation	16-QAM Modulation
5.0	3.938	3.797
10	3.281	3.656

Remark: pls. see annex 1 for graphical plots

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	☒ 757 CMW500		
DC Power	☒ 611 E3632A	☐ 087 EA3013	☐ 354 NGPE 40	☐ 086 LNG50-10	☒ 611 E3632A	
otherwise	☒ 529 6dB divider	☒ 530 10 dB Att.				
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, 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	C63.10-2013	

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 13: 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 13	QPSK	5	Low	23205	35.1301	1.1442	34.1301	1.4230
			Mid	23230	35.1302	1.1442	34.1302	1.5048
			High	23255	35.1303	1.1442	34.1303	1.4903
		10	low	23230	35.1304	**1.1490**	34.1304	1.4759
			Mid					
			High					
	QAM	5	Low	23205	35.1307	0.9855	34.1307	1.5000
			Mid	23230	35.1306	**1.0000**	34.1306	1.4519
			High	23255	35.1308	0.9839	34.1308	1.2115
		10	low	23230	35.1305	1.0000	34.1305	1.6298
			Mid					
			High					

Remark: --

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

Due marginal results as shown in band 13 only middle channel with signal BW of 5MHz tested.

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	5	Low	19975	35.407	--	34.407	--
			Mid	20175	35.408	1.1394	34.408	1.4855
			High	20375	35.409	--	34.409	--

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	5	Low	19975	35.425	--	34.425	--
			Mid	20175	35.426	1.0048	34.426	1.4567
			High	20375	35.427	--	34.427	--

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

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

test location	☒ CETECOM Essen (Chapter. 2.2.1)		☐ Please see Chapter. 2.2.2		☐ Please see Chapter. 2.2.3	
test site	☐ 347 Radio.lab. 1	☒ Radio.lab. 2				
spectr. analys.	☐ 584 FSU	☐ 120 FSEM	☐ 264 FSEK	☒ 620 ESU26		
signaling	☐ 017 CMD 65	☐ 323 CMD 55	☐ 340 CMD 55			
signaling	☐ 392 MT8820A	☐ 436 CMU	☒ 757 CMW500			
power supply	☒ 611 E3632A	☐ 457 EA 3013A	☐ 459 EA 2032-50	☐ 268 EA- 3050	☐ 494 AG6632A	☐ 498 NGPE 40
otherwise	☒ 529 6dB divider	☒ 530 10dB Att.	☐ 431 Near field			
line voltage	☐ 230 V 50 Hz via public mains		☐ 060 110 V/ 60 Hz via PAS 5000			

5.3.2. Requirements and limits

FCC	General: §2.1051 , §2.1057(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 12: Part 27: §27.53(g)☒ 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 Band-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 Bands 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 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	30	18000	1	--[1.)]	>60	35	MaxH-PK
Sweep 3b (Band-Edge low)	1709	1710	20[2.)] to 200	--[1.)]	30	35	MaxH-AV
Sweep 4b (Band-Edge low)	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 13

	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	30	9000	1	--[1.)]	>60	35	MaxH-PK
Sweep 3	1559	1610	1	10	10	0	MaxH, AV
Sweep 4a (Band-Edge low)	760	763	100	1	1	5	MaxH-AV
Sweep 4b (Band-Edge low)	763	775	10 [2.)]	0.1	2		
Sweep 4c (Band-Edge low)	775	776	100	1	1		
Sweep 5a (Band-Edge high)	788	793	100	1	1		
Sweep 5b (Band-Edge high)	793	805	10 [2.)]	0.1	2		
Sweep 5c (Band-Edge high)	805	810	100	1	1		

Remark:
1.) EMI 6dB receiver mode used
2.) RBW=10kHz used (nearest value higher then 6.25kHz)

5.3.4. Results

The results are presented below in summary form only. See also diagrams enclosed in annex 1 for more details.

5.3.4.1. LTE Band 4: 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	
36.40b	Low	20000	9kHz to 30MHz	1	16-QAM modulation	☒	☐	☐	passed
36.41b			30 MHz to 18GHz		Carrier visible on diagram, not relevant for results 16-QAM modulation	☒	☐	☐	passed
36.42b	Middle	20175	9kHz to 30MHz		16-QAM modulation	☒	☐	☐	passed
36.43b			30 MHz to 18GHz		Carrier visible on diagram, not relevant for results 16-QAM modulation	☒	☐	☐	passed
36.44a	High	20300	9kHz to 30MHz		QPSK modulation	☒	☐	☐	passed
36.45a			30 MHz to 18MHz		Carrier visible on diagram, not relevant for results QPSK modulation	☒	☐	☐	passed

Remark:

5.3.4.2. LTE Band 13: Op. Mode 2, Set-up 2

Low-Channel 23205

Diagram no.	Carrier Channel		Frequency range	OP-mode no.	Remark	Used detector			Result
	Range	No.				PK	AV	QP	
50.1301	Low	23205	9kHz to 30MHz	2	16-QAM modulation	☒	☐	☐	passed
50.1302			30 MHz to 9GHz		Carrier visible on diagram, not relevant for results 16-QAM modulation	☒	☐	☐	passed
50.1306			1559-1610MHz		GPS protection band 16-QAM modulation	☐	☒	☐	passed
50.1303		23205	9kHz to 30MHz		QPSK modulation	☒	☐	☐	passed
50.1304			30 MHz to 9GHz		Carrier visible on diagram, not relevant for results QPSK modulation	☒	☐	☐	passed
50.1305			1559-1610MHz		GPS protection band QPSK modulation	☐	☒	☐	passed

Remark:

Middle-Channel 23230

Diagram no.	Carrier Channel		Frequency range	OP-mode no.	Remark	Used detector			Result
	Range	No.				PK	AV	QP	
15.1310	Middle	23230	9kHz to 30MHz	2	16-QAM modulation	☒	☐	☐	passed
50.1311			30 MHz to 9GHz		Carrier visible on diagram, not relevant for results 16-QAM modulation	☒	☐	☐	passed
50.1315			1559-1610MHz		GPS protection band 16-QAM modulation	☐	☒	☐	passed
15.1312		23230	9kHz to 30MHz		QPSK modulation	☒	☐	☐	passed
50.1313			30 MHz to 9GHz		Carrier visible on diagram, not relevant for results 16-QPSK modulation	☒	☐	☐	passed
50.1314			1559-1610MHz		GPS protection band QPSK modulation	☐	☒	☐	passed

Remark:

High-Channel 23255

Diagram no.	Carrier Channel		Frequency range	OP-mode no.	Remark	Used detector			Result
	Range	No.				PK	AV	QP	
50.1320	High	23255	9kHz to 30MHz	2	16-QAM modulation	☒	☐	☐	passed
50.1321			30 MHz to 9GHz		Carrier visible on diagram, not relevant for results 16-QAM modulation	☒	☐	☐	passed
50.1325			1559-1610MHz		GPS protection band 16-QAM modulation	☐	☒	☐	passed
50.1320		23255	9kHz to 30MHz		QPSK modulation	☒	☐	☐	passed
50.1321			30 MHz to 9GHz		Carrier visible on diagram, not relevant for results QPSK modulation	☒	☐	☐	passed
50.1325			1559-1610MHz		GPS protection band QPSK modulation	☐	☒	☐	passed

Remark:

Band-Edge Low Channel (Bd. 4)

Test: Band-Edge Low						
Diagram No.	Channel no.	BW	RBs	Result [dBm]	Verdict	Remark
37.405a	19975	5	1	-28.96	Pass	QPSK
37.405b			1	-27.78	Pass	16-QAM
37.406a			6	-28.33	Pass	QPSK
37.406b			5	-28.46	Pass	16-QAM
37.407a	20000	10	1	-31.74	Pass	QPSK
37.407b			1	-32.00	Pass	16-QAM
37.408a			6	-28.25	Pass	QPSK
37.408b			5	-28.35	Pass	16-QAM
37.409a	20025	15	1	-31.63	Pass	QPSK
37.409b			1	-32.00	Pass	16-QAM
37.410a			6	-26.90	Pass	QPSK
37.410b			5	-29.03	Pass	16-QAM
37.411a	20050	20	1	-32.92	Pass	QPSK
37.411b			1	-33.14	Pass	16-QAM
37.412a			6	-31.67	Pass	QPSK
37.412b			5	-31.48	Pass	16-QAM

Band-Edge High Channel (Bd. 4)

Test: Band-Edge High						
Diagram No.	Channel no.	BW	RBs	Result [dBm]	Verdict	Remark
37.417a	20375	5	6	-26.00	Pass	QPSK
37.417b			5	-26.00	Pass	16-QAM
37.418a			1	-26.00	Pass	QPSK
37.418b			1	-26.00	Pass	16-QAM
37.419a	20350	10	1	-35.63	Pass	QPSK
37.419b			1	-35.84	Pass	16-QAM
37.420a			6	-30.64	Pass	QPSK
37.420b			5	-30.05	Pass	16-QAM
37.421a	20325	15	1	-30.67	Pass	QPSK
37.421b			1	-30.40	Pass	16-QAM
37.422a			6	-26.06	Pass	QPSK
37.422b			5	-27.78	Pass	16-QAM
37.423a	20300	20	6	-31.55	Pass	QPSK
37.423b			5	-31.07	Pass	16-QAM
37.424a			1	-32.77	Pass	QPSK
37.424b			1	-32.49	Pass	16-QAM

Band-Edge Low Channel (Bd. 13)

Test: Band-Edge Low						
Diagram No.	Channel no.	BW	RBs	Result [dBm]	Verdict	Remark
37.131a	23205	5	1	<-37.5	Pass	QPSK
37.131b			1	<-37.5	Pass	16-QAM
37.132a			6	<-35.0	Pass	QPSK
37.132b			5	<-37.5	Pass	16-QAM
37.133a	23230	10	1	<-40.0	Pass	QPSK
37.133b			1	<-40.58	Pass	16-QAM
37.134a			6	<-36.95	Pass	QPSK
37.134b			5	<-40.74	Pass	16-QAM

Band-Edge High Channel (Bd. 13)

Test: Band-Edge High						
Diagram No.	Channel no.	BW	RBs	Result [dBm]	Verdict	Remark
37.135a	23255	5	1	<-40.68	Pass	QPSK
37.135b			1	<-42.5	Pass	16-QAM
37.136a			25	<-34.89	Pass	QPSK
37.136b			25	<-42.5	Pass	16-QAM
37.137a	23230	10	1	<-41.44	Pass	QPSK
37.137b			1	<-41.66	Pass	16-QAM
37.138a			50	<-36.78	Pass	QPSK
37.138b			50	<-41.93	Pass	16-QAM

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

5.4.1. Test location and equipment

test location	☒ CETECOM Essen (Chapter. 2.2.1)		☐ Please see Chapter. 2.2.2		☐ Please see Chapter. 2.2.3	
test site	☒ 441 EMI SAR	☐ 487 SAR NSA	☐ 347 Radio.lab.		☐	☐
receiver	☐ 377 ESCS30	☒ 001 ESS	☐	☐	☐	☐
spectr. analys.	☐ 584 FSU	☐ 120 FSEM	☐ 264 FSEK	☐	☐	☐
antenna	☐ 574 BTA-L	☐ 133 EMCO3115	☐ 302 BBHA9170	☐ 289 CBL 6141	☒ 021 EMCO6502	
signaling	☐ 392 MT8820A	☐ 371 CBT32	☐ 547 CMU	☐ 594 CMW		
otherwise	☐ 400 FTC40x15E	☐ 401 FTC40x15E	☐ 110 USB LWL	☐ 482 Filter Matrix	☐ 378 RadiSense	
DC power	☒ 456 EA 3013A	☐ 457 EA 3013A	☐ 459 EA 2032-50	☐ 268 EA- 3050	☐ 494 AG6632A	☐ 498 NGPE 40
line voltage	☐ 230 V 50 Hz via public mains		☐ 060 120 V 60 Hz via PAS 5000			

5.4.2. Requirements

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

5.4.3. 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 ☐ other:		
	Scan-Mode Detector Mode: Sweep-Time	☒ 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"		

5.4.4. Measurement Results

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

Table of measurement results for LTE Band 4:

Diagram No.	Carrier Channel		Frequency range	Set-up no.	OP-mode no.	Remark	Used detector			Result
	Range	No.					PK	AV	QP	
2.02a/b	Low	20000	9 kHz-30 MHz	2	1	Laying/Standing position	☒	☐	☐	passed
2.03b	Middle	20175	9 kHz-30 MHz	2	1	Standing position (worst case)	☒	☐	☐	passed
2.04b	High	20300	9 kHz-30 MHz	2	1	Standing position (worst case)	☒	☐	☐	passed

Table of measurement results for LTE Band 13:

Diagram No.	Carrier Channel		Frequency range	Set-up no.	OP-mode no.	Remark	Used detector			Result
	Range	No.					PK	AV	QP	
2.01a/b	High	23255	9 kHz-30 MHz	2	2	Laying/Standing position	☒	☐	☐	passed
2.05a/b	Low	23205	9 kHz-30 MHz	2	2	Laying/Standing position	☒	☐	☐	passed
2.06a/b	Middle	23230	9 kHz-30 MHz	2	2	Laying/Standing position	☒	☐	☐	passed

Remark: tests on Worst-Case power value setting for LTE only

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

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

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

5.5. RF-Parameter - Radiated 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	☐ 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	
signaling	☐ 017 CMD 65	☐ 323 CMD 55	☐ 340 CMD 55			
signaling	☐ 392 MT8820A	☐ 546 CMU	☐ 547 CMU	☒ 757 CMW500		
power supply	☒ 611 E3632A	☐ 457 EA 3013A	☐ 459 EA 2032-50	☐ 268 EA- 3050	☐ 494 AG6632A	☐ 489 NGPE 408
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			

5.5.2. 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 12: Part 27: §27.53(g)☒ 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

5.5.3. 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 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 Bands 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 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 2b (Band-Edge)	1709	1710	0.03	0.3	30	35	MaxH-AV
Sweep 3b (Band-Edge)	1755	1756	0.03	0.3	30	35	MaxH-AV

Spectrum-Analyzer settings for LTE Band 13

	Start freq. MHz	Stop freq. MHz	R-BW kHz	V-BW MHz	Sweep time sec.	Att. [dB]	Detector
Sweep 1	30	9000	100	300	>60	35	MaxH-AV
Sweep2a	763	775	10	30	2	35	MaxH-AV
Sweep2b	775	777	100	300	2	35	MaxH-AV
Sweep3a	787	793	100	300	2	35	MaxH-AV
Sweep3b	793	806	10	30	2	35	MaxH-AV
Sweep4	1559	1600	1000	3000	5	0	MaxH-AV
Sweep 5b (Band-Edge)	776	777	30 or remark 2	--[1.)]	30	35	MaxH-AV
Sweep 6b (Band-Edge)	787	788		--[1.)]	30	35	MaxH-AV

Remark:
2.) according rules approx. 1% of emission bandwidth depending of chosen signal bandwidth; this was chosen according power max values as worst-case

5.5.4. Results

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

5.5.4.1. LTE 4: Radiated emissions (30-1800GHz)

Diagram No.	Channel no.	Op. Mode	Number of RBs	Modulation scheme	Detector		Verdict
					PK	RMS	
8.401	20000 (Low)	1	1RB low	☒ 16-QAM modulation	☒	☐	passed
8.402	20175 (middle)	1	1RB low	☒ 16-QAM modulation	☒	☐	passed
9.403	20300 (high)	1	full: 5	☒ 16-QAM modulation	☒	☐	passed

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

5.5.4.2. LTE 4: Band-Edge Low: 1709-1710 MHz

Diagram No.	Channel no.	Op. Mode	Number of RBs	Modulation scheme	Detector		Verdict
					PK	RMS	
9.405a	19975	1	1RB low	☒ 16-QAM modulation	☐	☒	passed
9.405b			1RB low	☒ 16-QAM modulation	☐	☒	passed
9.406a			full: 5	☒ 16-QAM modulation	☐	☒	passed
9.406b			full: 6	☒ QPSK modulation	☐	☒	passed

Remark:

2.) LTE EUT channel bandwidth of 5MHz used for measurements as worst-case as determined within power measurements

5.5.4.3. LTE4: Band-Edge High: 1755-1756MHz

Diagram No.	Channel no.	Op. Mode	Number of RBs	Modulation scheme	Detector		Verdict
					PK	RMS	
9.417a	20375	1	1RB high	☒ QPSK modulation	☐	☒	passed
9.417b			1RB high	☒ QPSK modulation	☐	☒	passed
9.418a			full: 6	☒ QPSK modulation	☐	☒	passed
9.418b			full: 5	☒ 16-QAM modulation	☐	☒	passed

Remark:

1.) LTE EUT channel bandwidth of 5MHz used for measurements as worst-case as determined within power measurements

5.5.4.4. LTE 13: Radiated emissions (30-9GHz)

Diagram No.	Channel no.	Op. Mode	Number of RBs	Modulation scheme	Detector		Verdict
					PK	RMS	
8.1301	23255 (high)	2	1RB high	☐ QPSK modulation ☒ 16-QAM modulation	☒	☐	passed
8.1303	23205 (low)	2	1RB low	☐ QPSK modulation ☒ 16-QAM modulation	☒	☐	passed
8.1305	23230 (middle)	2	1RB high	☐ QPSK modulation ☒ 16-QAM modulation	☒	☐	passed

Remark:

3.) LTE EUT channel bandwidth of 5MHz used for measurements as worst-case as determined within power measurements

5.5.4.5. LTE 13: §27.53(f), Chapter 4.6.2(b), Radiated emissions (1559-1610MHz)

Diagram No.	Channel no.	Op. Mode	Number of RBs	Modulation scheme	Detector		Verdict
					PK	RMS	
8.1302	23255 (high)	2	1RB high	☐ QPSK modulation ☒ 16-QAM modulation	☐	☒	passed
8.1304	23205 (low)	2	1RB low	☐ QPSK modulation ☒ 16-QAM modulation	☐	☒	passed
8.1306	23230 (middle)	2	1RB low	☐ QPSK modulation ☒ 16-QAM modulation	☐	☒	passed

Remark:

1.) LTE EUT channel bandwidth of 5MHz used for measurements as worst-case as determined within power measurements

5.5.4.6. LTE 13 - 5MHz Signal BW: §27.53(c)(1)-(4) Band-Edge Low: 776 - 777 MHz

Diagram No.	Channel no.	Op. Mode	Number of RBs	Modulation scheme	Detector		Verdict
					PK	RMS	
9.131a	23205	2	1RB low	☒ QPSK modulation	☐	☒	passed
9.131b	23205	2	1RB low	☒ 16-QAM modulation	☐	☒	passed
9.132a	23205	2	full: 6	☒ QPSK modulation	☐	☒	passed
9.132b	23205	2	full: 5	☒ 16-QAM modulation	☐	☒	passed

Remark:

5.5.4.7. LTE13 - 5MHz Signal BW: §27.53(c)(1)-(4) Band-Edge High: 787-788MHz

Diagram No.	Channel no.	Op. Mode	Number of RBs	Modulation scheme	Detector		Verdict
					PK	RMS	
9.135a	23255	2	1RB high	☒ QPSK modulation	☐	☒	passed
9.135b	23255	2	1RB high	☒ 16-QAM modulation	☐	☒	passed
9.136a	23255	2	full: 6	☒ QPSK modulation	☐	☒	passed
9.136b	23255	2	full: 5	☒ 16-QAM modulation	☐	☐	passed

Remark:

5.5.4.8. LTE13 - 10MHz Signal BW: §27.53(c)(1)-(4) Band-Edge Low/High

Diagram No.	Channel no.	Op. Mode	Number of RBs	Modulation scheme	Detector		Verdict
					PK	RMS	
9.133a	23230	2	1RB high	☒ QPSK modulation	☐	☒	passed
9.133b	23230	2	1RB high	☒ 16-QAM modulation	☐	☒	passed
9.134a	23230	2	full: 6	☒ QPSK modulation	☐	☒	passed
9.134b	23230	2	full: 5	☒ 16-QAM modulation	☐	☒	passed

Remark:
1.) only one channel with nominal 10MHz signal bandwidth possible

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	☒ 757 CMW500	☐ 594 CMW500	
DC power	☐ 611 E3632A	☐ 457 EA 3013A	☐ 459 EA 2032-50	☐ 268 EA- 3050	☐ 494 AG6632A	☐ 498 NGPE 40
otherwise	☐ 529 6dB divider	☒ 530 10dB Att.	☐ 431 Near field			
Climatic test chamber	☐ 331 HC 4055	☒ VT 4002	☒ 627 OPUS 1			
line voltage	☐ 230 V 50 Hz via public mains		☐ 060 110 V/ 60 Hz via PAS 5000			

5.6.2. Requirements and limits

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

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" In order to maintain the voltage constant over the time period of the tests, a dummy battery was connected to a laboratory power supply. The power supply voltage was controlled on the input of the power supply terminals of the EUT.
Measurement method	The RF Channel spacing is 100 kHz according LTE-Spec, with a guard band depending of the TX signal bandwidth. Details can be found in standard 3GPP36.521. The aim of the EUT is to function under all extreme conditions within authorized sub-bands in regard to temperature and voltage variations. The frequency deviation was recorded with base station's build in capability. (CMW500) for both modulations possible: QPSK and 16-QAM 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 according 3GPP standard. Because an absolute limit is not stated in the regulations of part 27, in case of 3GPP over limit condition, the definition of occupied bandwidth within authorized bandwidth for licensed equipment under all operating conditions, should be used. This means the point of 0.5% power should not be outside the authorized bandwidth, also when temperature conditions are included in this issue.
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 TX signal bandwidth of 5MHz. Both modulations have been tested: QPSK and 16-QAM.

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

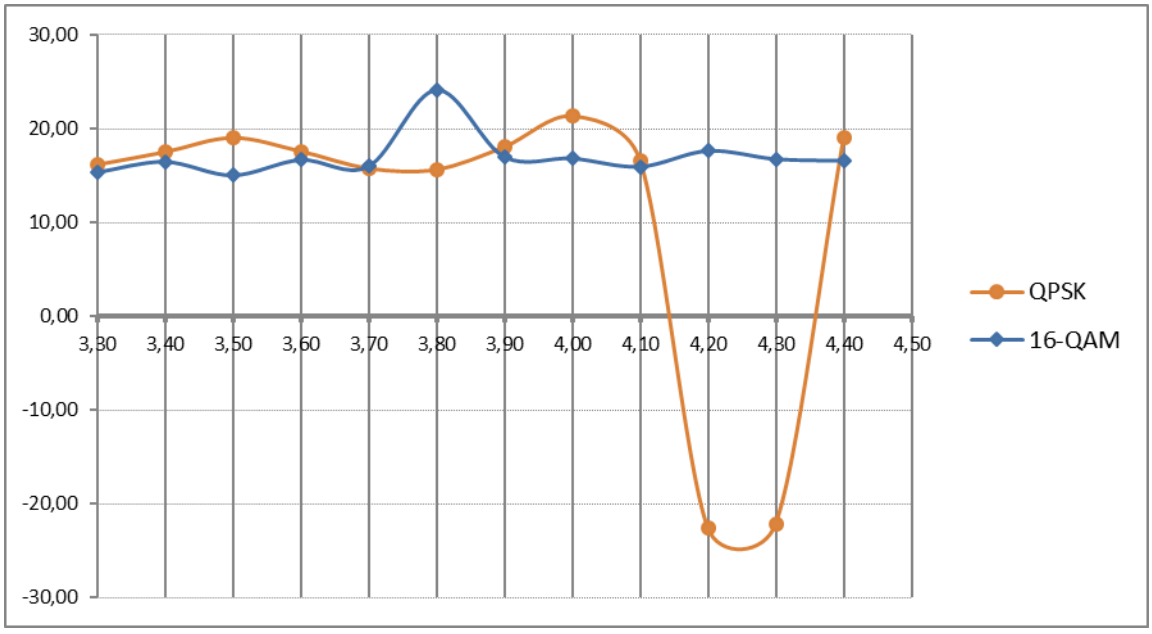
1.) determine the carrier frequency for the lowest and highest channel at room temperature and nominal voltage [20°C]
2.) The voltage was reduced in 0.1 Volt steps to the lower end point, where the EUT stops working. (this shall be specified by the manufacturer) Record the carrier frequency shift within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

5.6.3.1.1. LTE Band 4

Low- channel 19975:

LTE Band 4 / Channel 19975 BW=5 MHz/Full RBs						
Voltage	Nominal Frequency	**Maximum frequency error [Hz]**		**Maximum Frequency error**		Verdict
		QPSK	16-QAM	QPSK	16-QAM	
[V]	[MHz]	[Hz]	[Hz]	[ppm]	[ppm]	Limit=0.1ppm
3,30	1,7125E+09	16,14	15,36	0,0094	0,0090	passed
3,40		17,48	16,48	0,0102	0,0096	
3,50		19,00	15,05	0,0111	0,0088	
3,60		17,57	16,68	0,0103	0,0097	
3,70		15,75	15,99	0,0092	0,0093	
3,80		**15,62**	**24,09**	**0,0091**	**0,0141**	
3,90		18,04	17,01	0,0105	0,0099	
4,00		21,31	16,84	0,0124	0,0098	
4,10		16,62	15,96	0,0097	0,0093	
4,20		-22,59	17,64	-0,0132	0,0103	
4,30		-22,10	16,77	-0,0129	0,0098	
4,40		19,05	16,59	0,0111	0,0097	

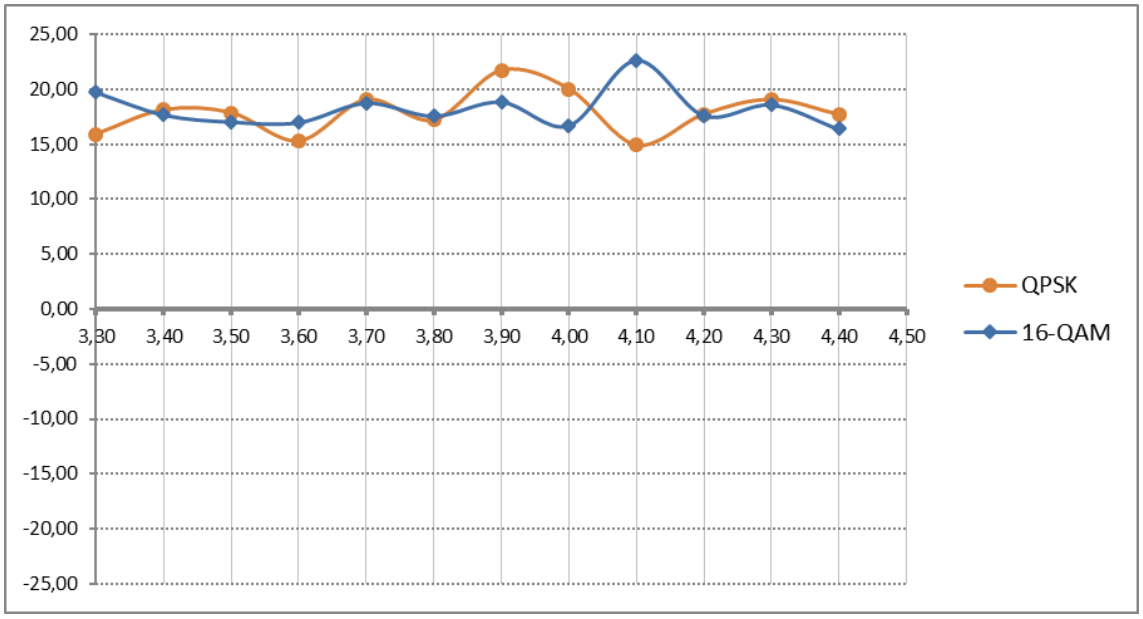
Remark: 4.5V could not be reached – maximum is 4.414 Volt



High channel 20375:

LTE Band 4 / Channel 20375/BW=5 MHz/Full RBs						
Voltage	Nominal Frequency	Maximum Frequency error [Hz]		Maximum Frequency error		Verdict
		QPSK	16-QAM	QPSK	16-QAM	
[V]	[MHz]	[Hz]	[Hz]	[ppm]	[ppm]	Limit=0.1ppm
3,30	1,7525E+09	15,92	19,7	0,0091	0,0112	passed
3,40		18,12	17,67	0,0103	0,0101	
3,50		17,85	17,04	0,0102	0,0097	
3,60		15,29	16,99	0,0087	0,0097	
3,70		19,04	18,74	0,0109	0,0107	
3,80		**17,19**	**17,57**	**0,0098**	**0,0100**	
3,90		21,69	18,84	0,0124	0,0108	
4,00		20,03	16,71	0,0114	0,0095	
4,10		14,92	22,59	0,0085	0,0129	
4,20		17,71	17,62	0,0101	0,0101	
4,30		19,05	18,58	0,0109	0,0106	
4,40		17,68	16,39	0,0101	0,0094	

Remark: 4.5V could not be reached – maximum is 4.414 Volt



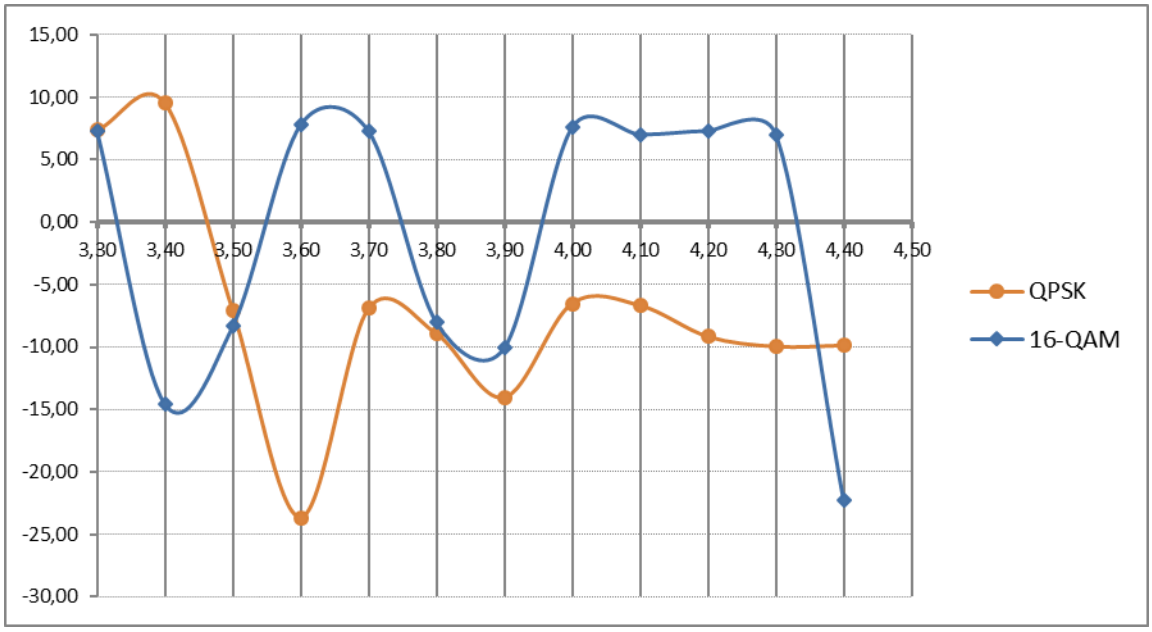
5.6.3.1.1.1. Verdict: Pass

5.6.3.1.2. LTE Band 13

Low- channel 23205:

LTE Band 13 / Channel 23205 BW=5 MHz/Full RBs						
Voltage	Nominal Frequency	Maximum frequency error [Hz]		Maximum Frequency error		Verdict
		QPSK	16-QAM	QPSK	16-QAM	
[V]	[MHz]	[Hz]	[Hz]	[ppm]	[ppm]	Limit=0.1ppm
3,30	7,7950E+08	7,38	7,30	0,0095	0,0094	passed
3,40		9,56	-14,55	0,0123	-0,0187	
3,50		-7,05	-8,35	-0,0090	-0,0107	
3,60		-23,67	7,78	-0,0304	0,0100	
3,70		-6,92	7,28	-0,0089	0,0093	
3,80		**-8,94**	**-8,01**	-0,0115	-0,0103	
3,90		-14,06	-10,07	-0,0180	-0,0129	
4,00		-6,51	7,57	-0,0084	0,0097	
4,10		-6,67	7,02	-0,0086	0,0090	
4,20		-9,17	7,30	-0,0118	0,0094	
4,30		-9,97	7,01	-0,0128	0,0090	
4,40		-9,88	-22,29	-0,0127	-0,0286	

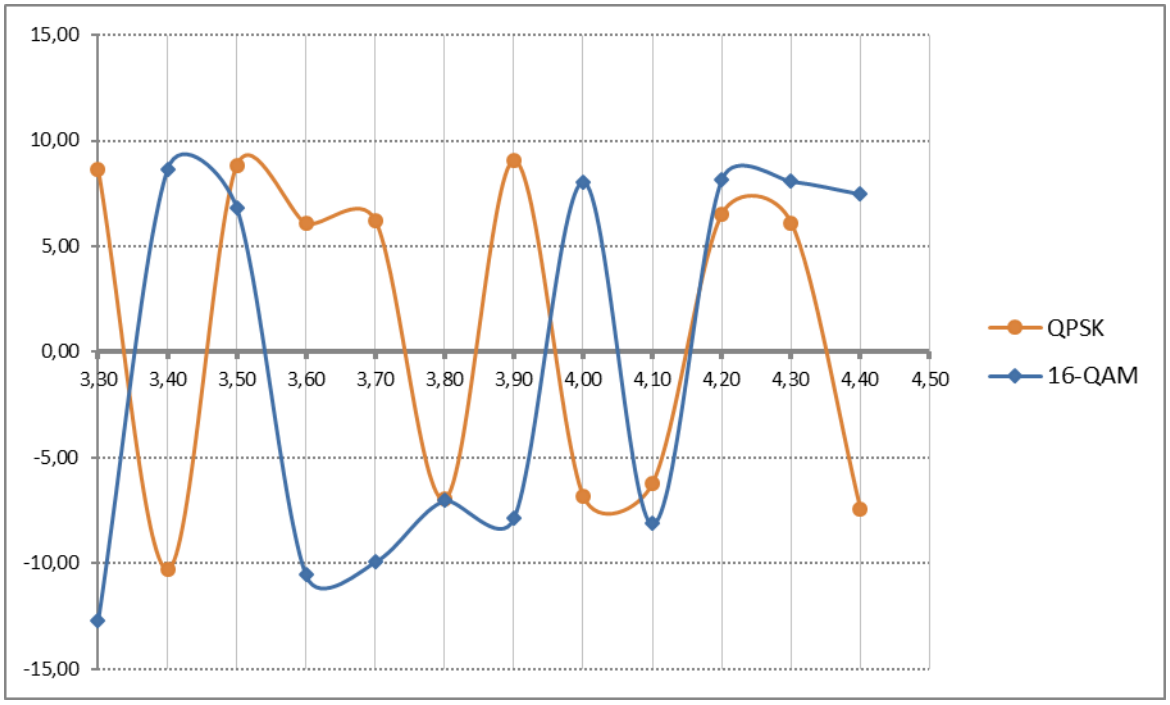
Remark: 4.5V could not be reached – maximum is 4.414 Volt



High channel 23255:

LTE Band 13 / Channel 23255/BW=5 MHz/Full RBs						
Voltage	Nominal Frequency	Maximum Frequency error [Hz]		Maximum Frequency error		Verdict
		QPSK	16-QAM	QPSK	16-QAM	
[V]	[MHz]	[Hz]	[Hz]	[ppm]	[ppm]	Limit=0.1ppm
3,30	7,8450E+08	8,64	-12,7	0,0110	-0,0162	passed
3,40		-10,27	8,65	-0,0131	0,0110	
3,50		8,81	6,82	0,0112	0,0087	
3,60		6,09	-10,54	0,0078	-0,0134	
3,70		6,22	-9,91	0,0079	-0,0126	
3,80		**-6,95**	**-7,01**	**-0,0089**	**-0,0089**	
3,90		9,06	-7,84	0,0115	-0,0100	
4,00		-6,81	8,05	-0,0087	0,0103	
4,10		-6,19	-8,11	-0,0079	-0,0103	
4,20		6,54	8,17	0,0083	0,0104	
4,30		6,12	8,07	0,0078	0,0103	
4,40		-7,41	7,47	-0,0094	0,0095	

Remark: 4.5V could not be reached – maximum is 4.414 Volt



5.6.3.1.2.1. Verdict: Pass

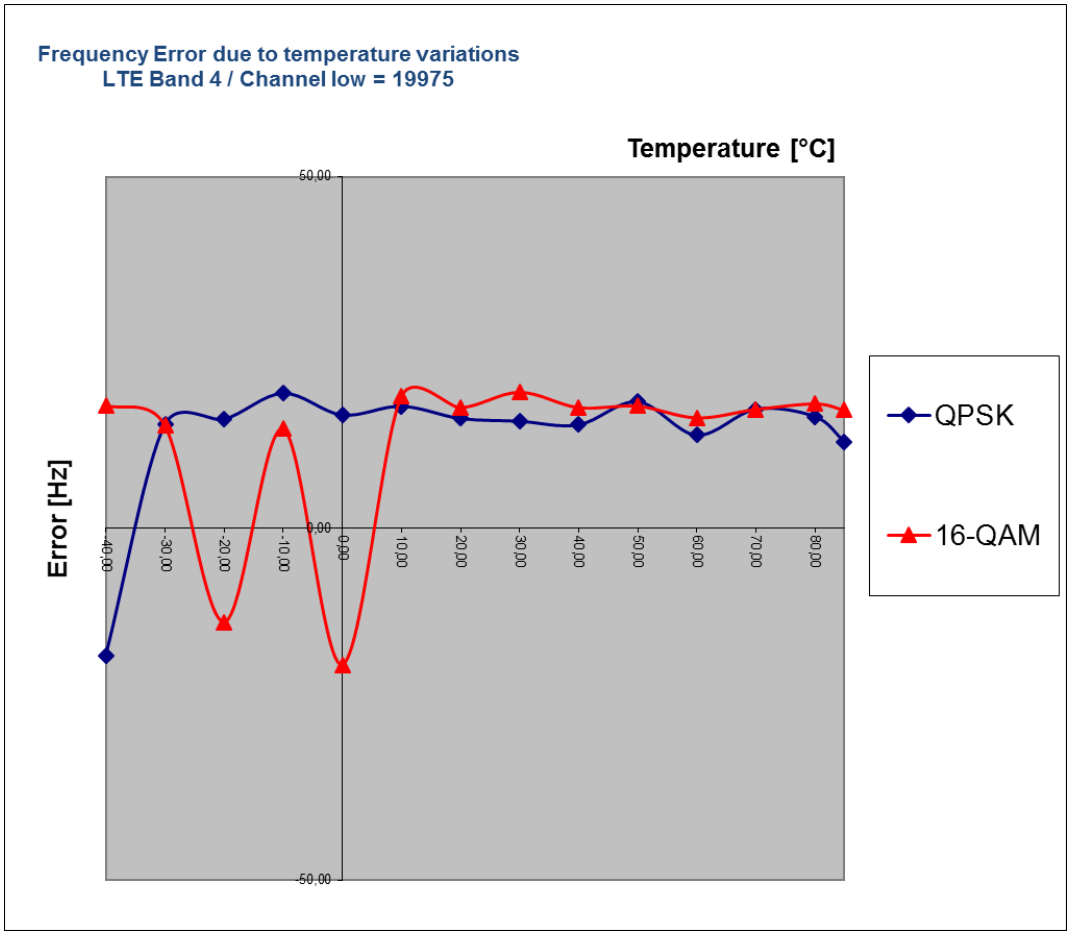
5.6.3.2. Frequency shift of carrier against temperature at constant power supply voltage

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 (or other stated minimum temperature), wait sufficient time to have constant temperature within climatic chamber.
3.) Perform the carrier frequencies measurements in 10°C increments from –30°C to +60°C (or other MAX. stated temperature). 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 channels, in order to prevent self-warming of the mobile.

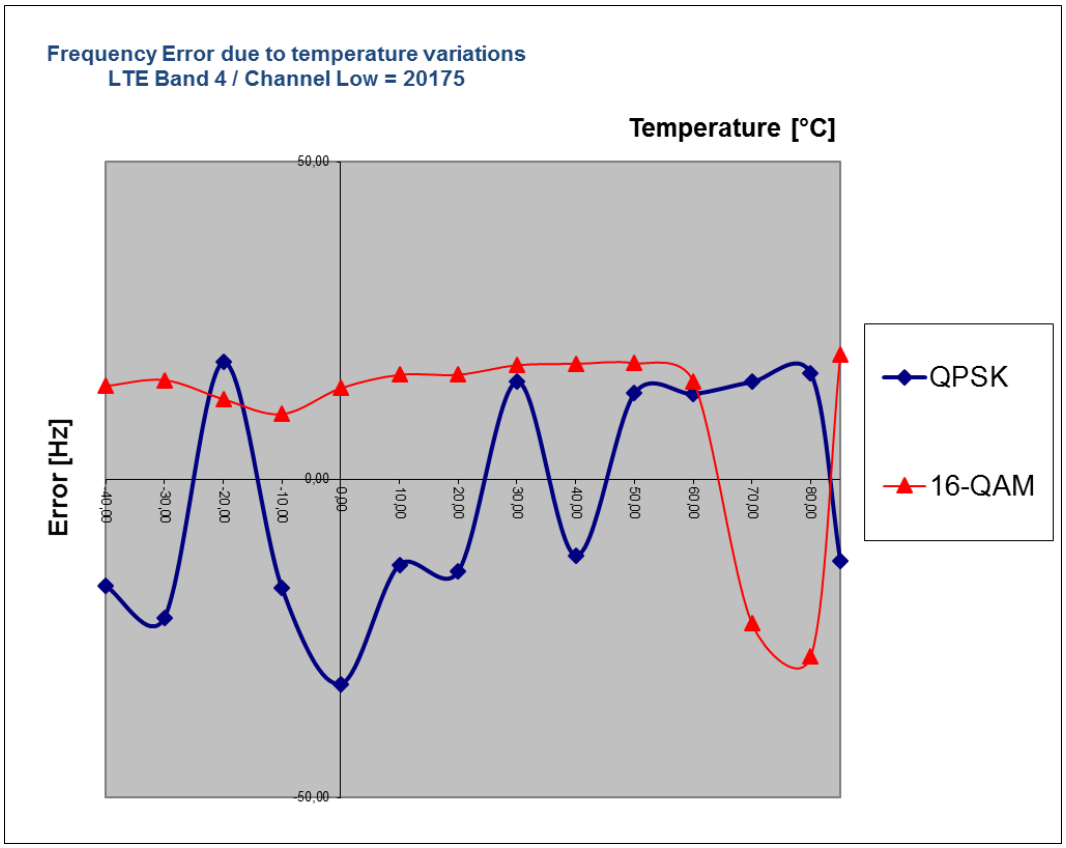
5.6.3.2.1. LTE Band 4

Due customer requests the temperature range is extended compared to the standard requirements: -40°C to + 85°C

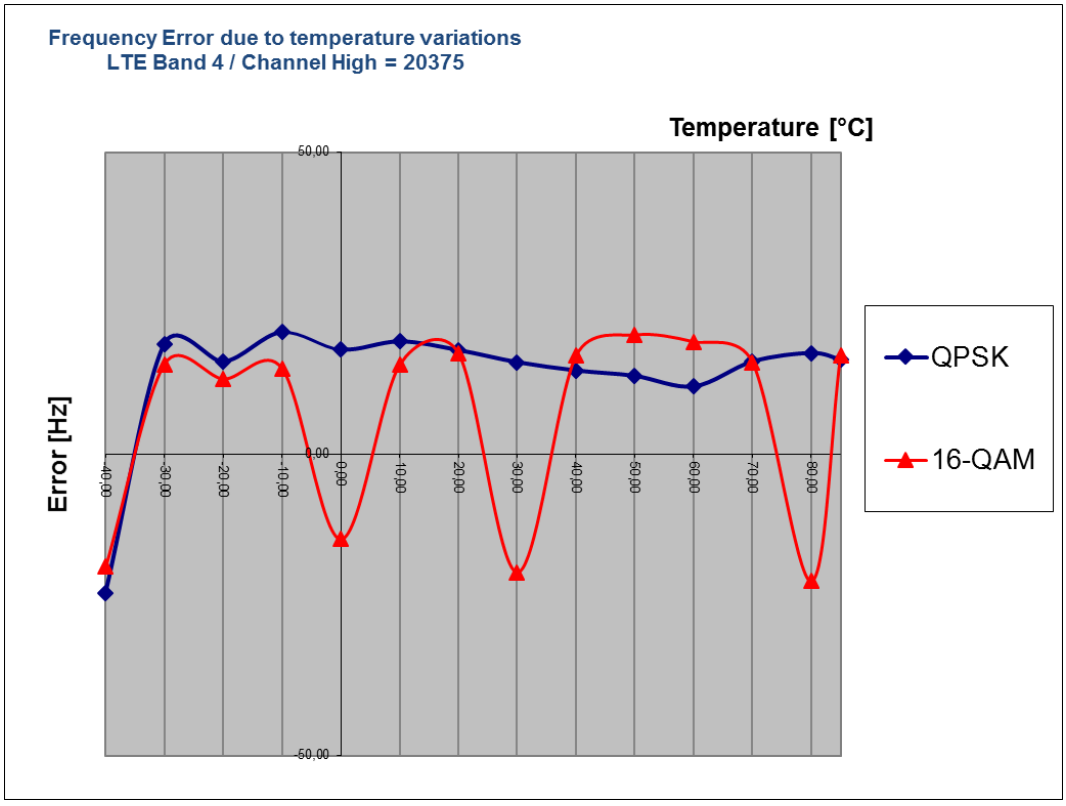
fc=	1712500000	Hz			
	Maximum frequency error				
	Channel 19975/ BW= 5MHz				
Temperature	QPSK Modulation [Hz]	16-QAM Modulation [Hz]	QPSK Modulation [ppm]	16-QAM Modulation [ppm]	Verdict Limit=±0.1ppm
-40	-18,04	17,51	-0,011	0,010	pass
-30	14,75	14,68	0,009	0,009	
-20	15,51	-13,33	0,009	-0,008	
-10	19,21	14,18	0,011	0,008	
0	16,12	-19,40	0,009	-0,011	
10	17,37	18,75	0,010	0,011	
20	15,62	17,21	0,009	0,010	
30	15,23	19,40	0,009	0,011	
40	14,73	17,21	0,009	0,010	
50	18,01	17,42	0,011	0,010	
60	13,26	15,75	0,008	0,009	
70	16,95	16,95	0,010	0,010	
80	15,89	17,74	0,009	0,010	
85	12,32	16,84	0,007	0,010	



fc=	1732500000	Hz			
	Maximum frequency error				
	Channel 20175 BW=5MHz				
Temperature	QPSK Modulation [Hz]	16-QAM Modulation [Hz]	QPSK Modulation [ppm]	16-QAM Modulation [ppm]	Verdict Limit=±0.1ppm
-40	-16,74	14,73	-0,010	0,009	pass
-30	-21,74	15,66	-0,013	0,009	
-20	18,48	12,67	0,011	0,007	
-10	-17,08	10,31	-0,010	0,006	
0	-32,16	14,38	-0,019	0,008	
10	-13,38	16,49	-0,008	0,010	
20	-14,46	16,51	-0,008	0,010	
30	15,42	18,01	0,009	0,010	
40	-11,94	18,22	-0,007	0,011	
50	13,62	18,31	0,008	0,011	
60	13,52	15,42	0,008	0,009	
70	15,41	-22,67	0,009	-0,013	
80	16,67	-27,74	0,010	-0,016	
85	-12,76	19,68	-0,007	0,011	



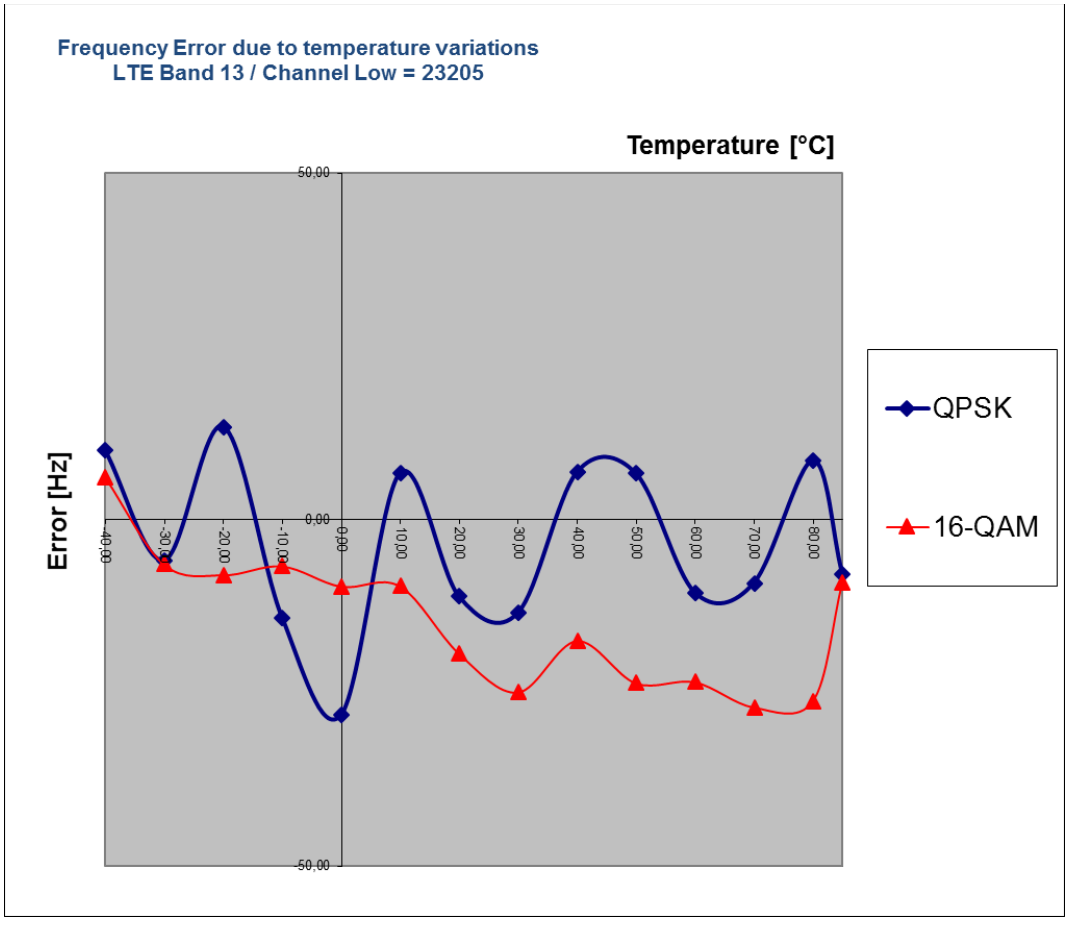
fc=	1752500000	Hz			
	Maximum frequency error				
	Channel 20375 BW=5MHz				
Temperature	QPSK Modulation [Hz]	16-QAM Modulation [Hz]	QPSK Modulation [ppm]	16-QAM Modulation [ppm]	Verdict Limit=±0.1ppm
-40	-22,99	-18,67	-0,013	-0,011	pass
-30	18,18	14,88	0,010	0,008	
-20	15,26	12,37	0,009	0,007	
-10	20,17	14,10	0,012	0,008	
0	17,27	-14,13	0,010	-0,008	
10	18,63	14,76	0,011	0,008	
20	17,19	16,62	0,010	0,009	
30	15,19	-19,60	0,009	-0,011	
40	13,82	16,25	0,008	0,009	
50	12,92	19,67	0,007	0,011	
60	11,19	18,55	0,006	0,011	
70	15,31	15,19	0,009	0,009	
80	16,71	-21,09	0,010	-0,012	
85	15,59	16,26	0,009	0,009	



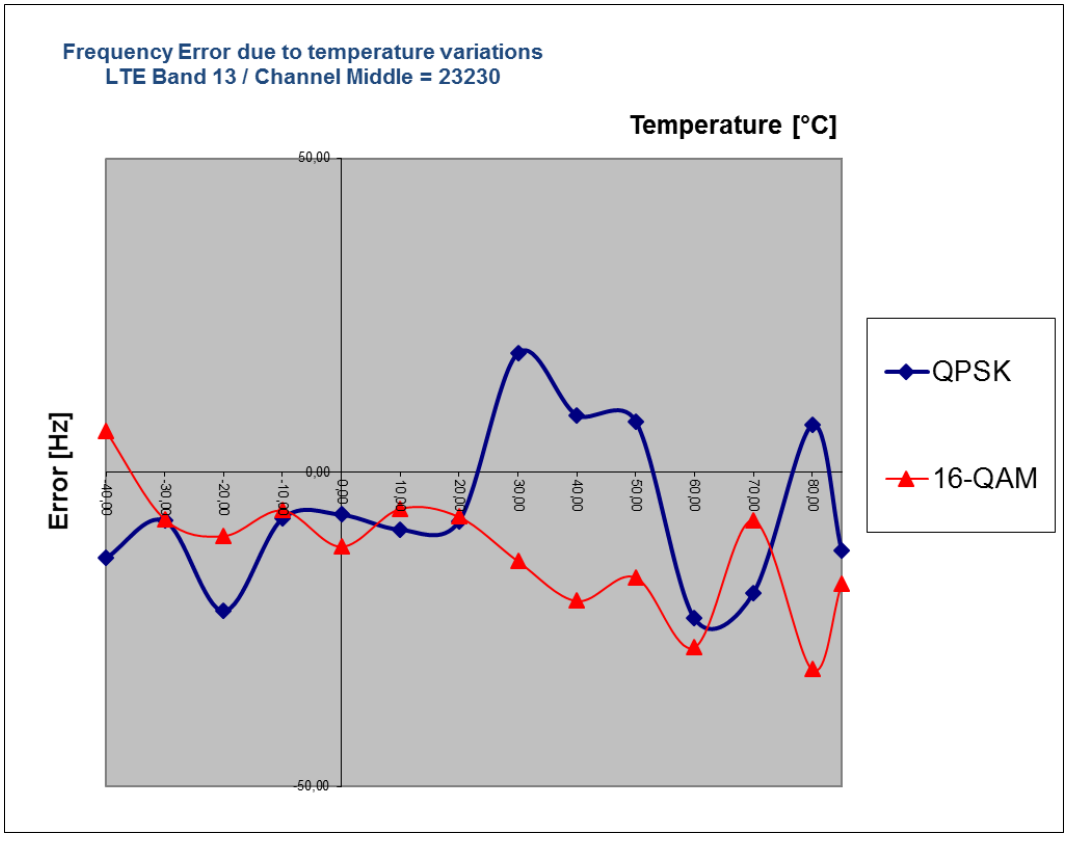
5.6.3.2.2. LTE Band 13

Due customer requests the temperature range is extended compared to the standard requirements: -40°C to + 85°C

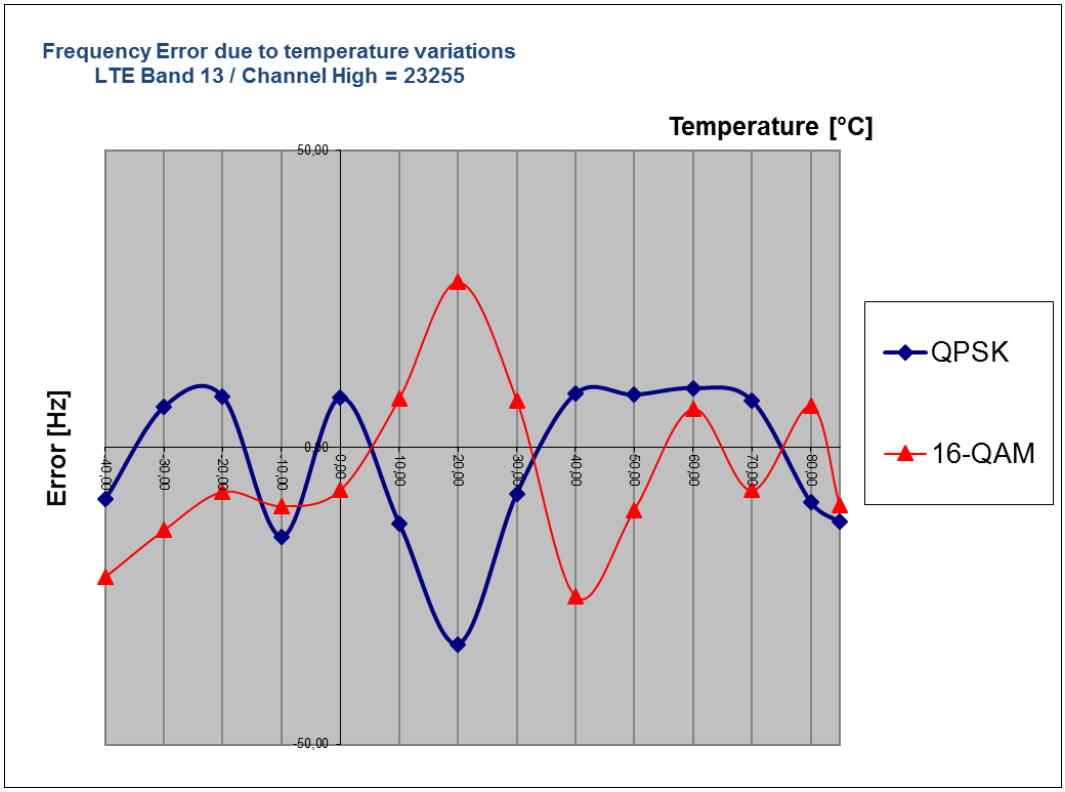
fc=	779500000	Hz			
	Maximum frequency error				
	Channel 23205/ BW= 5MHz				
Temperature	QPSK Modulation [Hz]	16-QAM Modulation [Hz]	QPSK Modulation [ppm]	16-QAM Modulation [ppm]	Verdict Limit=±0.1ppm
-40	10,0	6,21	0,013	0,008	pass
-30	-5,87	-6,41	-0,008	-0,008	
-20	13,43	-7,94	0,017	-0,010	
-10	-14,08	-6,65	-0,018	-0,009	
0	-28,14	-9,58	-0,036	-0,012	
10	6,72	-9,53	0,009	-0,012	
20	-11,07	-19,25	-0,014	-0,025	
30	-13,43	-24,85	-0,017	-0,032	
40	6,84	-17,42	0,009	-0,022	
50	6,67	-23,53	0,009	-0,030	
60	-10,5	-23,37	-0,013	-0,030	
70	-9,13	-27,01	-0,012	-0,035	
80	8,53	-26,12	0,011	-0,034	
85	-7,82	-9,00	-0,010	-0,012	



fc=	782000000	Hz			
	Maximum frequency error				
	Channel 23230 BW=5MHz				
Temperature	QPSK Modulation [Hz]	16-QAM Modulation [Hz]	QPSK Modulation [ppm]	16-QAM Modulation [ppm]	Verdict Limit=±0.1ppm
-40	-13,6	6,64	-0,017	0,008	pass
-30	-7,68	-7,41	-0,010	-0,009	
-20	-21,97	-10,07	-0,028	-0,013	
-10	-7,3	-5,99	-0,009	-0,008	
0	-6,71	-11,76	-0,009	-0,015	
10	-9,06	-5,74	-0,012	-0,007	
20	-7,72	-7,04	-0,010	-0,009	
30	18,95	-14,08	0,024	-0,018	
40	9,1	-20,41	0,012	-0,026	
50	8,14	-16,65	0,010	-0,021	
60	-23,19	-27,77	-0,030	-0,036	
70	-19,15	-7,55	-0,024	-0,010	
80	7,51	-31,33	0,010	-0,040	
85	-12,45	-17,65	-0,016	-0,023	



fc=	784500000	Hz			
	Maximum frequency error				
	Channel 23255 BW=5MHz				
Temperature	QPSK Modulation [Hz]	16-QAM Modulation [Hz]	QPSK Modulation [ppm]	16-QAM Modulation [ppm]	Verdict Limit=±0.1ppm
-40	-8,71	-21,69	-0,011	-0,028	pass
-30	6,87	-13,83	0,009	-0,018	
-20	8,53	-7,41	0,011	-0,009	
-10	-15,01	-9,83	-0,019	-0,013	
0	8,4	-7,08	0,011	-0,009	
10	-12,75	8,23	-0,016	0,010	
20	-33,09	27,84	-0,042	0,035	
30	-7,8	7,98	-0,010	0,010	
40	9,04	-24,99	0,012	-0,032	
50	8,88	-10,49	0,011	-0,013	
60	9,98	6,54	0,013	0,008	
70	7,93	-7,18	0,010	-0,009	
80	-9,16	7,01	-0,012	0,009	
85	-12,53	-9,73	-0,016	-0,012	



5.6.3.2.2.1. Verdict:

Pass

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	Reference	Frequency range	Calculated uncertainty based on a confidence level of 95%						Remarks
Conducted emissions (U_{CISPR})	CISPR 16-2-1	9 kHz - 150 kHz 150 kHz - 30 MHz	4.0 dB 3.6 dB						-
Radiated emissions Enclosure	CISPR 16-2-3	30 MHz - 1 GHz 1 GHz - 18 GHz	4.2 dB 5.1 dB						E-Field
Disturbance power	CISPR 16-2-2	30 MHz - 300 MHz	-						-
Power Output radiated	-	30 MHz - 4 GHz	3.17 dB						Substitution method
Power Output conducted	-	Set-up No.	Cel-C1	Cel-C2	BT1	W1	W2	--	
		9 kHz - 12.75 GHz	N/A	0.60	0.7	0.25	N/A	--	-
		12.75 - 26.5GHz	N/A	0.82	--	N/A	N/A	--	
Conducted emissions on RF-port	-	9 kHz - 2.8 GHz	0.70	N/A	0.70	N/A	0.69	--	N/A - not applicable
		2.8 GHz - 12.75GHz	1.48	N/A	1.51	N/A	1.43	--	
		12.75 GHz - 18GHz	1.81	N/A	1.83	N/A	1.77	--	
		18 GHz - 26.5GHz	1.83	N/A	1.85	N/A	1.79	--	
Power density	-	1 – 2.8GHz	1.40 dB						--
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 30 MHz - 1 GHz 1 GHz - 20 GHz	5.0 dB 4.2 dB 3.17 dB						Magnetic field E-field 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 Measurem.	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)	ISED, Industry Canada Certification and Engineering Bureau
487 550 348 348	R- 4452 G- 20013 C- 20009 T- 20006	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 equiment "CTC"

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

8.1.1. Test software and firmware of equipment

Ref.-No.	Equipment	Type	Serial-No.	Version of Firmware or Software during the test
001	EMI Test Receiver	ESS	825132/017	Firm.= 1.21 , OTP=2.0, GRA=2.0
012	Signal Generator (EMS-cond.)	SMY 01	839069/027	Firm.= V 2.02
013	Power Meter (EMS cond.)	NRVD	839111/003	Firm.= V 1.51
017	Digital Radiocommunication Tester	CMD 60 M	844365/014	Firmware = V 3.52 .22.01.99, DECT = D2.87 13.01.99
053	Audio Analyzer	UPA3	860612/022	Firm. V 4.3
119	RT Harmonics Analyzer dig. Flickermeter	B10	G60547	Firm.= V 3.1DHG
140	Signal Generator	SMHU	831314/006	Firm.= 3.21
261	Thermal Power Sensor	NRV-Z55	825083/0008	EPROM-Datum 02.12.04, SE EE 1 B
262	Power Meter	NRV-S	825770/0010	Firm.= 2.6
263	Signal Generator	SMP 04	826190/0007	Firm.=3.21
295	Racal Digital Radio Test Set	6103	1572	UNIT Firmware= 4.04, SW-Main=4.04, SW-BBP=1.04, SW-DSP=1.02, Hardboot=1.02, Softboot=2.02
298	Univ. Radio Communication Tester	CMU 200	832221/091	R&S Test Firmware =3.53 /3.54 (current Testsoftw. f. all band used
323	Digital Radiocommunication Tester	CMD 55	825878/0034	Firm.= 3.52 .22.01.99
335	CTC-EMS-Conducted	System EMS Conducted	-	EMC 32 V 8.52
340	Digital Radiocommunication Tester	CMD 55	849709/037	Firm.= 3.52 .22.01.99
355	Power Meter	URV 5	891310/027	Firm.= 1.31
365	10V Insertion Unit 50 Ohm	URV5-Z2	100880	Eprom Data = 31.03.08
366	Ultra Compact Simulator	UCS 500 M4	V0531100594	Firm. UCS 500=001925/3.06a02, rc=ISMIEC 4.10
371	Bluetooth Tester	CBT32	100153	CBT V5,30+ SW-Option K55, K57
377	EMI Test Receiver	ESCS 30	100160	Firm.= 2.30, OTP= 02.01, GRA= 02.36
378	Broadband RF Field Monitor	RadiSense III	03D00013SNO-08	Firm.= V.03D13
389	Digital Multimeter	Keithley 2000	0583926	Firm. = A13 (Mainboard) A02 (Display)
392	Radio Communication Tester	MT8820A	6K00000788	Firm.= 4.50 #005, IPL=4.01#001,OS=4.02#001, GSM=4.41#013, W-CDMA= 4.54#004, scenario= 4.52#002
436	Univ. Radio Communication Tester	CMU 200	103083	R&S Test Firmware Base=5.14, Mess-Software= GSM:5.14 WCDMA:5.14 (current Testsoftw. F. all band
441	CTC-SAR-EMI Cable Loss	System EMI field (SAR)	-	EMC 32 Version 8.52
442	CTC-SAR-EMS	System EMS field (SAR)	-	EMC 32 Version 8.40
443	CTC-FAR-EMI-RSE	System CTC-FAR-EMI-RSE	-	Spuri 7.2.5 or EMC 32 Ver. 9.15.00
444	CTC-FAR-EMS field	System-EMS-Field (FAR)	-	EMC 32 Version 9.15.00
460	Univ. Radio Communication Tester	CMU 200	108901	R&S Test Firmware Base=5.14, GSM=5.14 WCDMA=5.14 (current Testsoftw.,f. all band to be used,
489	EMI Test Receiver	ESU40	1000-30	Firmware=4.43 SP3, Bios=V5.1-16-3, Spec. =01.00
491	ESD Simulator dito	ESD dito	dito307022	V 2.30
524	Voltage Drop Simulator	VDS 200	0196-16	Software Nr: 000037 Version V4.20a01
526	Burst Generator	EFT 200 A	0496-06	Software Nr. 000034 Version V2.32
527	Micro Pulse Generator	MPG 200 B	0496-05	Software-Nr. 000030 Version V2.43
528	Load Dump Simulator	LD 200B	0496-06	Software-Nr. 000031 Version V2.35a01
546	Univ. Radio Communication Tester	CMU 200	106436	R&S Test Firmware Base=5.14, GSM=5.14 WCDMA=5.14 (current Testsoftw.,f. all band to be used
547	Univ. Radio Communication Tester	CMU 200	835390/014	R&S Test Firmware Base=V5.1403 (current Testsoftw., f. all band used, GSM = 5.14 WCDMA: = 5.14
584	Spectrum Analyzer	FSU 8	100248	2.82_SP3
597	Univ. Radio Communication Tester	CMU 200	100347	R&S Test Firmware Base=5.01, GSM=5.02 WCDMA= not installed, Mainboard= µP1=V.850
598	Spectrum Analyzer	FSEM 30	831259/013	Firmware Bios 3.40 , Analyzer 3.40 Sp 2
607	Signal Generator	SMR 20	832033/011	V1.25
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	-	16.05.2018
005	AC - LISN (50 Ohm/50µH, test site 1)	ESH2-Z5	861741/005	Rohde & Schwarz	12 M	-	15.05.2018
007	Single-Line V-Network (50 Ohm/5µH)	ESH3-Z6	892563/002	Rohde & Schwarz	12 M	-	17.05.2018
009	Power Meter (EMS-radiated)	NRV	863056/017	Rohde & Schwarz	24 M	-	15.05.2019
016	Line Impedance Simulating Network	Op. 24-D	B6366	Spitzenberger+Spies	36 M	-	30.05.2019
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	-	15.05.2019
057	relay-switch-unit (EMS system)	RSU	494440/002	Rohde & Schwarz	pre-m	1a	
060	power amplifier (DC-2kHz)	PAS 5000	B6363	Spitzenberger+Spies	-	3	
086	DC - power supply, 0 -10 A	LNG 50-10	-	Heinzinger Electronic	pre-m	2	
087	DC - power supply, 0 -5 A	EA-3013 S	-	Elektro Automatik	pre-m	2	
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
133	horn antenna 18 GHz (Meas 1)	3115	9012-3629	EMCO	36 M	1c	10.03.2020
134	horn antenna 18 GHz (Subst 2)	3115	9005-3414	EMCO	36 M	-	10.03.2020
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-Band	Model 7003 (N)	C5129	Weinschel	pre-m	2	
276	DC-Band	Model 7006 (SMA)	C7061	Weinschel	pre-m	2	
279	power divider	1515 (SMA)	LH855	Weinschel	pre-m	2	
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	-	17.05.2018
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	-	14.03.2020
303	horn antenna 40 GHz (Subst 1)	BBHA9170	156	Schwarzbeck	36 M	-	20.03.2020
331	Climatic Test Chamber -40/+180 Grad	HC 4055	43146	Heraeus Vötsch	24 M	-	30.10.2018
341	Digital Multimeter	Fluke 112	81650455	Fluke	24 M	-	30.05.2018
342	Digital Multimeter	Voltcraft M-4660A	IB 255466	Voltcraft	24 M	-	17.05.2019
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	-	24.05.2019
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	-	17.05.2018
377	EMI Test Receiver	ESCS 30	100160	Rohde & Schwarz	12 M	-	15.05.2018
392	Radio Communication Tester	MT8820A	6K00000788	Anritsu	12 M	-	18.05.2018
405	Thermo-/Hygrometer	OPUS 10 THI	126.0604.0003.3.3.3.2 2	LUFFT Mess u. Regeltechnik	24 M	-	30.03.2019
431	Model 7405	Near-Field Probe Set	9305-2457	EMCO	-	4	
436	Univ. Radio Communication Tester	CMU 200	103083	Rohde & Schwarz	12 M	-	24.05.2018
439	UltraLog-Antenna	HL 562	100248	Rohde & Schwarz	36 M	-	10.03.2020
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	-	16.06.2018
463	Universal source	HP3245A	2831A03472	Agilent	-	4	
466	Digital Multimeter	Fluke 112	89210157	Fluke USA	24 M	-	30.05.2018

Ref.-No.	Equipment	Type	Serial-No.	Manufacturer	Interval of calibration	Remark	Cal due
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	-	16.05.2019
482	filter matrix	Filter matrix SAR 1	-	CETECOM (Brl)	-	1d	
487	System CTC NSA-Verification SAR-EMI	System EMI field (SAR) NSA	-	ETS Lindgren / CETECOM	24 M	-	31.03.2019
489	EMI Test Receiver	ESU40	1000-30	Rohde & Schwarz	12 M	-	18.05.2019
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	
517	relais switch matrix	HF Relais Box Keithley	SE 04	Keithley	pre-m	2	
523	Digital Multimeter	L4411A	MY46000154	Agilent	24 M	-	18.05.2019
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	-	30.03.2018
547	Univ. Radio Communication Tester	CMU 200	835390/014	Rohde & Schwarz	12 M	-	05.07.2018
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	-	30.03.2019
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	-	08.08.2019
574	Biconilog Hybrid Antenna	BTA-L	980026L	Frankonia	36/12 M	-	31.03.2019
584	Spectrum Analyzer	FSU 8	100248	Rohde & Schwarz	pre-m	-	
597	Univ. Radio Communication Tester	CMU 200	100347	Rohde & Schwarz	pre-m	-	
600	power meter	NRVD (Reserve)	834501/018	Rohde & Schwarz	24 M	-	17.05.2019
601	medium-sensitivity diode sensor	NRV-Z5 (Reserve)	8435323/003	Rohde & Schwarz	24 M	-	15.05.2019
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	-	16.05.2018
621	Step Attenuator 0-139 dB	RSP	100017	Rohde & Schwarz	pre-m	2	
625	Generic Test Load USB	Generic Test Load USB	-	CETECOM	-	2	
627	data logger	OPUS 1	201.0999.9302.6.4.1.43	G. Lufft GmbH	24 M	-	30.03.2019
634	Spectrum Analyzer	FSM (HF-Unit)	826188/010	Rohde & Schwarz	pre-m	2	
637	High Speed HDMI with Ethernet 1m	HDMI cable with Ethernet 1m	-	KogiLink	-	2	
638	HDMI Kabel with Ethernet 1,5 m flach	HDMI cable with Ethernet	-	Reichelt	-	2	
640	HDMI cable 2m rund	HDMI cable 2m rund	-	Reichelt	-	2	
641	HDMI cable with Ethernet	Certified HDMI cable with	-	PureLink	-	2	
642	Wideband Radio Communication Tester	CMW 500	126089	Rohde&Schwarz	12 M	-	24.05.2018
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	-	17.05.2018
686	Field Analyzer	EHP-200A	160WX30702	Narda Safety Test Solutions	24 M	-	29.03.2019
687	Signal Generator	SMF 100A	102073	Rohde&Schwarz	12 M	-	17.05.2018
688	Pre Amp	JS-18004000-40-8P	1750117	Miteq	pre-m	-	
690	Spectrum Analyzer	FSU	100302/026	Rohde&Schwarz	12 M	-	16.05.2018
691	OSP120 Base Unit	OSP120	101183	Rohde & Schwarz	12 M	-	22.05.2018
692	Bluetooth Tester	CBT 32	100236	Rohde & Schwarz	36 M	-	29.05.2020
697	Power Splitter	ZN4PD-642W-S+	165001445	Mini-Circuits	-	2	
703	INNCO Antennen Mast	MA 4010-KT080-XPET-ZSS3	MA4170-KT100-XPET-	INNCO	pre-m	-	
704	INNCON Controller	CO 3000-4port	CO3000/933/38410516/L	INNCO Systems GmBh	pre-m	-	
711	Harmonic Mixer 90 GHz - 140GHz	RPG FS-Z140	101004	RPG	12 M	-	22.02.2018
712	Harmonic Mixer 75 GHz - 110GHz	FS-Z110	101468	Rohde & Schwarz	12 M	-	22.02.2018
713	Harmonic Mixer, 50 GHz - 75GHz	FS-Z75	101022	Rohde & Schwarz	12 M	-	22.05.2018
714	Signal Analyzer 67GHz	FSW67	104023	Rohde & Schwarz	24 M	-	03.03.2019
715	Harmonic Mixer, 140 GHz - 220GHz	FS-Z220	101009	RPG Radiometer Physics	12 M	-	03.08.2018
716	Harmonic Mixer 220 GHz to 325 GHZ	FS-Z325	101005	RPG Radiometer Physics	12 M	-	13.02.2018
747	Spectrum Analyzer	FSU 26	200152	Rohde & Schwarz	12 M	-	18.05.2018

Ref.-No.	Equipment	Type	Serial-No.	Manufacturer	Interval of calibration	Remark	Cal due
748	Pickett-Potter Horn Antenna	FH-PP 4060	010001	Radiometer Physiscs	-	-	
749	Pickett-potter Horn Antenna	FH-PP 60-90	010003	Radiometer Physics	-	-	
750	Pickett-Potter Horn Antenna	FH-PP 140-220	010011	Radiometer Physics	-	-	
757	CMW500 wide. Radio Comm.	CMW500	158150	Rohde & Schwarz	12 M	-	01.05.2017

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	2018-03-14
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