T E S T R E P O R T
No.: 16-1-0164301T02a

According to:
FCC Regulations
Part 24, Part 27, Part 15C - §15.207

IC-Regulations
RSS-133 Issue 6, RSS-139 Issue 2
RSS-130 Issue 1, RSS-Gen Issue 4

for

Telit Communications S.p.A

LTE module LE866A1-NA

FCC-ID:RI7XE866A1NA
IC: 5131A-XE866A1NA
PMN: LE866A1-NA
HVIN: LE866A1-NA

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

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Table of contents

1. SUMMARY OF TEST RESULTS ... 3

1.1. TX mode, Test overview of FCC and Canada IC (RSS) Standards ... 3
1.2. RX mode, tests overview according FCC Part 15B and Canadian RSS Standards ... 5
1.3. Attestation: ... 5

2. ADMINISTRATIVE DATA ... 6

2.1. Identification of the testing laboratory ... 6
2.2. Test location ... 6
2.3. Organizational items ... 6
2.4. Applicant's details ... 6
2.5. Manufacturer's details ... 6

3. EQUIPMENT UNDER TEST (EUT) ... 7

3.1. TECHNICAL DATA OF MAIN EUT DECLARED BY APPLICANT ... 7
3.2. EUT: Type, S/N etc. and short descriptions used in this test report ... 8
3.3. Auxiliary Equipment (AE): Type, S/N etc. and short descriptions ... 8
3.4. EUT set-ups ... 8
3.5. EUT operating modes ... 9
3.6. Configuration of cables used for testing ... 9

4. DESCRIPTION OF TEST SYSTEM SET-UP'S ... 10

4.1. Test system set-up for conducted measurements on antenna port ... 10
4.2. Test system set-up for AC power-line conducted emission measurements ... 12
4.3. Test system set-up for radiated magnetic field measurements below 30 MHz ... 13
4.4. Test system set-up for radiated spurious emission measurements ... 14

5. MEASUREMENTS ... 15

5.1. RF-Parameter - RF Peak power output conducted and PAPR ... 15
5.2. RF-Parameter - Occupied bandwidth and emission bandwidth ... 23
5.3. RF-Parameter - Conducted out of Band RF emissions and Band Edge ... 27
5.4. RF-Parameter - Radiated out of Band RF emissions and Band Edge ... 35
5.5. RF-Parameter - Frequency stability on temperature and voltage variations ... 40
5.6. General Limit - Conducted emissions on AC-Power lines ... 62
5.7. General Limit - Radiated field strength emissions below 30 MHz ... 63
5.8. Measurement uncertainties ... 66

6. ABBREVIATIONS USED IN THIS REPORT ... 67

7. ACCREDITATION DETAILS OF CETECOM'S LABORATORIES AND TEST SITES ... 67

8. INSTRUMENTS AND ANCILLARY ... 68

8.1. Used equiment "CTC" ... 68

9. VERSIONS OF TEST REPORTS (CHANGE HISTORY) ... 71

Table of annex

	Total pages
Annex 1: SEPARATE DOCUMENT Measurement diagrams: CETECOM-TR16-1-0164301T02a-A1	247
Annex 2: SEPARATE DOCUMENT External photographs of EUT: CETECOM-16-1-0164301T03a	7
Annex 3: SEPARATE DOCUMENT Test set-up photographs: CETECOM_TR16-1-0164301T03a-A3	7

The listed attachments are an integral part of this report.

1. Summary of test results

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

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

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

Following tests have been performed to show compliance with applicable FCC Part 2, Part 22, Subpart H, Part 24, Subpart E (Broadband PCS) and Part 27, Subpart C of the FCC CFR Title 47 Rules, Edition 4th November 2014 and Canada RSS-132 Issue 3, RSS-133 Issue 6 and RSS-Gen Issue 4 standards.

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

No. of Diagram group	Test case	Port	References & Limits			EUT set-up	EUT op-mode	Result
			FCC Standard	RSS Section	Test limit			
1	AC-Power Lines Emissions Conducted (0,15 - 30 MHz)	AC-Power lines (conducted)	Part 15, Subpart C §15.207	RSS-Gen, Issue 4: Chapter 8.8	§15.207 limits IC: Table 3, Chapter 8.8	2	1+2+3	Remark 1.)
2	General field strength emissions (9 kHz - 30 MHz)	Cabinet + inter-connecting cables (radiated)	§15.209(a)	RSS-Gen, Issue 4: Chapter 8.9, Table 5+6	2400/F(kHz) µV/m 24000/F(kHz) µV/m 30 µV/m	2	1+2+3	passed
7	E(I)RP Power		LTE 2: §24.232(c)	RSS-133, Issue 6 Chapter 4.1/6.4 SRSP-510: 5.1.2	< 2 Watt (EIRP)	2	1+2+3	Pass (calculated with conducted vlaues and delivered antenna gain)
			LTE 4: §27.50 (d)(4)	RSS-139: Issue 3 Chapter 6.5 SRSP-513: 5.1.2	< 1 Watt (EIRP)			
			LTE 12: §27.50(c)(10)	RSS-130, Issue 1, Chapter 4.4	Handheld: < 3 Watt (ERP)			
8	Spurious emissions		§2.1053(a) §2.1057	RSS-Gen., Issue 4	43+10log(P) dBc	2	1+2+3	passed
9	Band-Edge compliance		LTE 2: §24.238(a)(b)	RSS-133: Chapter 6.5.1(i)(ii)		2	1+2+3	passed
			LTE4: §27.53(h)(1)(3)(i)(ii)(iii)	RSS-139: Issue 3 Chapter 6.6 (i) (ii)				
			LTE 12:§27.53(g)	RSS-130: Issue 1 Chapter 4.6.1				

30	RF Power	Antenna terminal (conducted)	§2.1046	RSS-130, Issue 1 SRSP-518	Handheld: 3 Watt (ERP)	1	1+2+3	passed
34	26dB Emission bandwidth		§2.1049(h)	RSS-Gen, Issue 4, Chapter 6.6	26dBc Emissions BW 99% Power	1	1+2+3	passed
35	99% Occupied bandwidth							
36	Spurious emissions		§2.1051 §2.1057 §24.238(a)(b) §27.53	RSS-133, Issue 6: 6.5.1(i)(ii) RSS-139, Issue 3 Chapt. 6.6 (i) (ii) RSS-130, Issue 1 Chapt. 4.6.1 Chapt. 4.6.2	43+10log(P) dBc			passed
37	Band-Edge compliance							passed
38	Frequency stability		§24.235 §2.1055(a)(2) §27.54	RSS-133, Issue 6: Chapter 6.3 RSS-130, Issue 1: Chapter 4.3 RSS-139, Issue 3, Chapter 6.4	< ±2.5ppm	3	1+2+3	passed

Remarks: 1.)

1.2. RX mode, tests overview according FCC Part 15B 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 conducted Emissions	AC-Power lines	§15.107 §15.207	RSS-Gen, Issue 8: Chapter 8.8	FCC §15.107 class B limits §15.207 limits RSS-Gen: Table 3	--	--	Remark 1
3	Receiver radiated emissions	Cabinet + Interconnecting cables	§15.109 §15.33 §15.35	RSS-132, Issue 3: 6.6 RSS-Gen, Issue 4: 5.3 RSS 133, Issue 6: 6.6	FCC 15.109 class B limits RSS-Gen: Chapter 5.3+Chapter 7.1.2	--	--	Passed, Remark 2

Remark:

1.) Only DC powered, no AC power supply
2.) See separate test report CETECOM_TR16-1-0164301T03a for measurements according Part 15, Subpart B.

1.3. 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.

Digital unterschrieben von Rachid Acharkaoui
DN: cn=Rachid Acharkaoui, o=CETECOM GmbH, ou=RC&EMC, email=rachid.acharkaoui@cetecom.com, c=DE
Datum: 2017.09.05 15:39:43 +02'00'

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

Digitally signed by Martin Nunier
Date: 2017.09.05 13:41:07 +02'00'

.....
B.Eng. Martin Nunier
Responsible for test report

2. Administrative Data

2.1. Identification of the testing laboratory

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

2.2. Test location

2.2.1. Test laboratory “CTC”

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

2.3. Organizational items

Project leader:	Dipl.-Ing. N.Perez
Responsible for test report:	B.Eng. Martin Nunier
Receipt of EUT:	2017-01-15
Date(s) of test:	2017-01-21 to 2017-07-26
Date of report:	2017-09-01
Version of template: 13.02	

2.4. Applicant’s details

Applicant’s name:	Telit Communications S.p.A
Address:	Via Stazione di Prosecco 5/B 34010 Sgonico-Trieste Italy
Contact person:	Mr. Antonino Sgroi

2.5. Manufacturer’s details

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

3. Equipment under test (EUT)

3.1. TECHNICAL DATA OF MAIN EUT DECLARED BY APPLICANT

Main function	LTE communication		
Type	LTE module		
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 12: 698 - 716 MHz (Uplink), 728-746 MHz (Downlink)		
Type of modulation	QPSK, 16-QAM		
Data rates	Cat1, Downlink: max. 10Mbps, Uplink: max. 5Mbps		
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 12: UARFCN range 23010 - 23179 (only for use in USA)		See Note about channels not to be used depending on channel bandwidths
Emission designator(s)	Channel bandwidth	QPSK Modulation:	16-QAM Modulation Remark 1:
	1.4 MHz	Not supported	Not supported
	3 MHz	Not supported	Not supported
	5 MHz	4M50G7D	4M51W7D
	10 MHz	9M00G7D	5M08W7D, remark1
	15 MHz	13M4G7D	5M08W7D, remark 1
	20 MHz	17M9G7D	5M11W7D, remark 1
Antenna Type	☐ Integrated ☐ External, no RF- connector ☒ External, separate RF-connector: main TX + secondary RX connector		
Antenna Gain	f < 1GHz: -1.85dBd / 0.3dBi max. f > 1GHz: 2.1 dBi max.		
MAX PEAK Output Power: Radiated LTE-Mode 2 LTE-Mode 4 LTE-Mode 12	 23.86 dBm + 2.1dBi = 25.96 dBm EIRP 23.86 dBm + 2.1dBi = 25.96 dBm EIRP 23.44 dBm – 1.85dBd = 21.59 dBm ERP		
MAX PEAK Output Power: Conducted LTE-Mode 2 LTE-Mode 4 LTE-Mode 12	 23.86 dBm (AV) 23.86 dBm (AV) 23.44 dBm (AV)		
Installed option	☐ GSM 900 and GSM 1800 Bands (not usable in USA/Canada) ☐ W-CDMA Band I and Band VIII (not usable in USA/Canada)		
Power supply	☒ DC power only: 9-12 Volt on DSB75-Adapter with external AC/DC Adapter Converted to voltage range of 3.3 V to 4.2 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	

Remark 1: For 16-QAM maximum 27RBs could be activated in regard to category 1 device (3GPP 36.101, Annex 2.1.3). Therefore nominal signal-bandwidth only theoretical.

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	LE866A1-NA	LTE module	358832079990 549	0.00	M0A.30020-B102
EUT B	LE866A1-NA	LTE module	358832079990 572	0.00	M0A.30020-B116

*) 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 MAGNETIC ANTENNA	T-AT305			
AE 2	Interface Board	CS1634B	163490000022	--	--
AE 3	Development support board (Motherboard)	EVK2	113990006260	--	REV.2
AE 4	USB 2.0 cable	USB 2.0 Mini-B connector	--	--	--
AE 5	RS232 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 + AE 2+ AE 3 + AE 4 + AE 5	RF-Conducted Measurement set-up except frequency stability
set. 2	EUT A + AE 1 + AE 2+ AE 3 + AE 4 + AE 5	RF-radiated measurement set-up
set. 3	EUT B + AE 2+ AE 3 + AE 4 + AE 5	RF-conducted measurement for frequency-stability External power supply used

*) 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 12 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	AC/DC cable	From AE1	--	--	1.90m

4. Description of test system set-up's

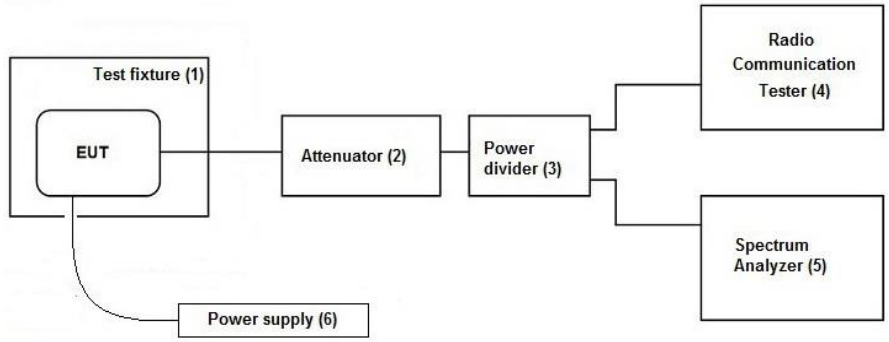
4.1. Test system set-up for conducted measurements on antenna port

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

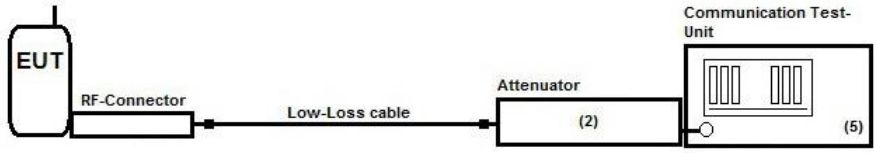
Testing method: ANSI C63.26:2015, KDB 971168 D01 v02r02

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

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

Tests Specification: Conducted Carrier power, Frequency Error

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



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

Used Equipment

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

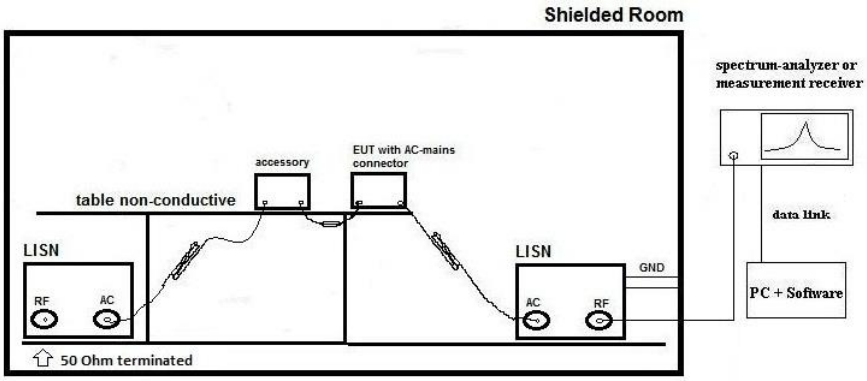
Measurement uncertainty See chapter Measurement Uncertainties (Cel-2)

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

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

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

Schematic:



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

Testing method:

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

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

Formula:

$V_C = V_R + C_L$ (1)

$M = L_T - V_C$ (2)

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

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

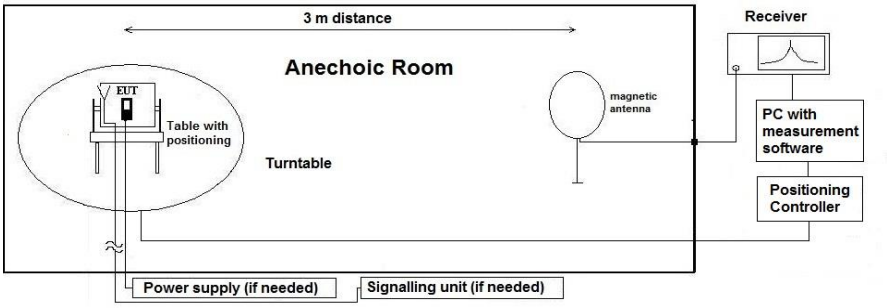
4.3. Test system set-up for radiated magnetic field measurements below 30 MHz

Specification: ANSI C63.4-2014 §5.3, §8.2.1, §8.3.1.1+§8.3.2.1 , ANSI C63.10-2013 chapter 6.4 (§6.4.4.2)

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

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

Schematic:



Testing method:

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

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

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

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

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

Formula:

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

$M = L_T - E_C$

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

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

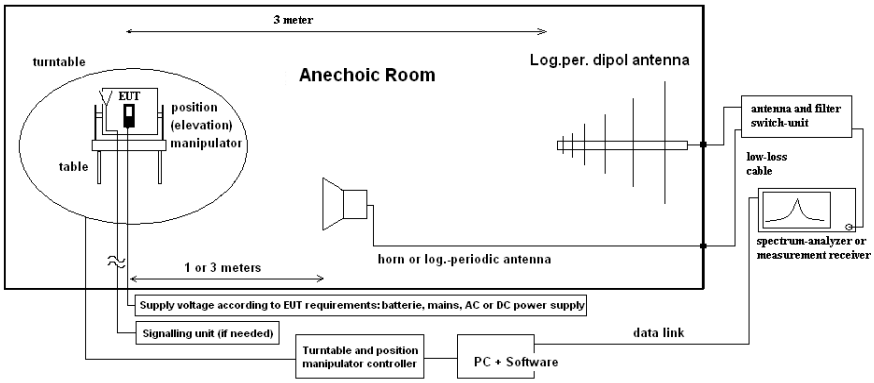
Distance correction: Reference for applied correction (extrapolating) factors due to reduced measurement distance:
ANSI C63.10:2013, §6.4.4.2 - Equations (2) + (3) + (4)

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

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

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

Schematic:



Testing method:

Exploratory, preliminary measurements
The EUT and its associated accessories are placed on a non-conductive position manipulator (tipping device) of 1.50 m height which is placed on the turntable. By rotating the turntable (range 0° to 360°, step 45°) and the EUT itself on 3-orthogonal axis (the emission spectrum and it's characteristics was recorded with an EMI-receiver, broadband antenna and software.
The measurements are performed in horizontal and vertical polarization of the measurement antennas. The results are documented in a diagram. Critical frequencies (low margin to limit) are saved within a table for further investigations. If various operating modes are supported, further investigations are made to find the worst-case of them. Also the interconnection cables and equipment position were varied in order to maximize the emissions.

Final measurement on critical frequencies
Based on the exploratory measurements, the most critical frequencies are re-measured by maintaining the EUT's worst-case operation mode, cable position, etc.
First a frequency zoom around the critical frequency is done to locate the frequency more precisely. After this step, for all identified critical frequencies, the maximum peak was determined.
Following parameters were varied: the turntable angle continuously in the range 0 to 360 degree, the EUT itself over 3-orthogonal axis and the height for EUT with large dimensions.
On the determined worst-case position, a final measurement with necessary bandwidth and detector according standard has been carried out.
The readings on the spectrum analyzer are corrected with conversion value between field strength and E(I)RP, so the readings shown are equivalent to ERP/EIRP values. Critical measurements near the limit are re-measured with a substitution method accord. ANSI/TIA/EIA 603 C/D

Formula:

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

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

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

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

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

5. Measurements

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

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

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

5.1.2. Requirements and limits

FCC	§2.1046
IC	RSS-133: Issue 6, 4.1/6.4 + SRSP-510:5.1.2 for LTE-FDD Band 2 RSS-139, Issue 3: 6.5 + SRSP-513, Chapter 5.1.2 RSS-130: Issue 1, §4.4 + PAR PK-AV ≤ 13 dB
Limit	Maximum Power Output of the mobile phone should be determined while measured conducted.
	Limit LTE Band 2: 2 Watt EIRP (33.0 dBm)
	Limit LTE Band 4: 1 Watt EIRP (30.0 dBm)
	Limit LTE Band 12: 3 Watt ERP/5W EIRP (34.77 dBm ERP/ 37dBm EIRP)

5.1.3. Test condition and test set-up

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

5.1.4. Power results

5.1.4.1. LTE Band 2 Results

LTE-Band 2				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. bandwidth	absolute max. value channels/bandwidths
5 MHz	18625	1852,5	1RB low	28,35	23,4	4,9561	28,252	22,305	5,9467	23,399	22,756	23,488	
			1RB high	28,43	23,37	5,0583	28,469	22,314	6,155				
			50%RB mid	28,38	22,31	6,0674	27,996	22,756	5,2393				
			100%RB	28,22	22,32	5,9012	28,69	21,658	7,0317				
	18900	1880	1RB low	30,44	23,49	6,9487	29,924	22,708	7,2157	23,488	22,885		
			1RB high	28,75	23,46	5,2975	28,566	22,885	5,6801				
			50%RB mid	29,33	22,2	7,1278	29,088	22,841	6,247				
			100%RB	29,13	22,24	6,8907	29,692	21,488	8,2038				
	19175	1907,5	1RB low	27,85	23,1	4,7547	27,94	22,801	5,1392	23,097	22,801		
			1RB high	27,23	22,89	4,332	27,506	22,566	4,9404				
			50%RB mid	27,16	21,93	5,2283	26,943	22,368	4,5753				
			100%RB	27,39	21,91	5,4776	27,668	21,262	6,4067				
10 MHz	18650	1855	1RB low	28,61	23,26	5,3469	28,144	23,308	4,8355	23,264	23,398	23,564	
			1RB high	28,67	23,24	5,433	29,141	23,398	5,7434				
			50%RB mid	28,2	22,37	5,8346	27,966	21,769	6,197				
			100%RB	28,3	22,26	6,047	28,759	21,533	7,2255				
	18900	1880	1RB low	29,93	23,56	6,3693	30,004	22,828	7,1759	23,564	22,828		
			1RB high	28,82	23,51	5,315	29,604	22,777	6,8275				
			50%RB mid	28,72	22,12	6,6016	29,024	21,452	7,572				
			100%RB	28,7	22,14	6,5632	28,743	21,4	7,3431				
	19150	1905	1RB low	29,31	**23,26**	6,0463	28,2	22,34	5,86	**23,26**	22,395		
			1RB high	27,74	22,92	4,8233	28,1	22,395	5,705				
			50%RB mid	27,87	22,09	5,7815	27,812	21,418	6,394				
			100%RB	27,67	22,11	5,56	28,463	21,406	7,0577				
15 MHz	18675	1857,5	1RB low	29,1	23,6	5,4988	28,975	23,47	5,5048	23,599	23,488	23,651	
			1RB high	28,83	23,53	5,2961	29,674	23,488	6,1857				
			50%RB mid	28,11	22,47	5,6394	29,119	22,706	6,4126				
			100%RB	29,21	22,6	6,6185	28,532	21,814	6,7186				
	18900	1880	1RB low	30,38	**23,65**	6,7309	30,484	22,902	7,5826	**23,65**	22,902		
			1RB high	29,13	23,48	5,6437	29,38	22,786	6,5938				
			50%RB mid	28,79	22,48	6,3087	29,748	22,534	7,2138				
			100%RB	29,7	22,59	7,104	29,396	21,875	7,5207				
	19125	1902,5	1RB low	28,65	23	5,6507	29,641	23,1	6,5408	22,999	23,1		
			1RB high	27,49	22,68	4,8084	27,913	22,575	5,3378				
			50%RB mid	28,15	22,09	6,0558	28,363	22,359	6,004				
			100%RB	28,55	22,33	6,2281	28,315	21,647	6,6686				
20 MHz	18700	1860	1RB low	29,6	23,59	6,0107	28,95	23,138	5,812	**23,68**	23,293	23,683	
			1RB high	29,22	**23,68**	5,5339	29,846	23,293	6,5528				
			50%RB mid	28,7	22,28	6,4196	28,578	22,589	5,9894				
			100%RB	29	22,29	6,7059	28,839	21,556	7,2827				
	18900	1880	1RB low	30,57	23,34	7,2339	29,676	23,249	6,4271	23,498	23,249		
			1RB high	29,7	23,5	6,2026	29,132	23,211	5,9215				
			50%RB mid	28,78	22,17	6,6113	29,325	22,486	6,8386				
			100%RB	29,16	22,26	6,9037	29,016	21,539	7,4766				
	19100	1900	1RB low	29,9	23,26	6,6476	29,814	23,164	6,6502	23,256	23,164		
			1RB high	28,63	22,92	5,7097	28,838	22,718	6,1199				
			50%RB mid	28,84	22,02	6,8212	29,241	22,416	6,8251				
			100%RB	28,87	22,03	6,8469	29,063	21,368	7,6946				

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

Max-Values for different signal bandwidths:

LTE Band 2				
Signal-BW	QPSK		16-QAM	
	Peak	RMS	Peak	RMS
5	30,44	23,49	29,92	22,89
10	29,93	23,56	30,00	23,40
15	30,38	23,65	30,48	23,49
20	30,57	23,68	29,85	23,29

Max-Values for Modulation:

LTE Band 2			
QPSK		16-QAM	
Peak	RMS	Peak	RMS
30,57	23,68	30,48	23,49

5.1.4.2. LTE Band 4 Results

LTE-Band 4				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 16-QAM	max. channel	absolute max. value
5 MHz	19975	1712,5	1RB low	28,51	23,3	5,2078	28,618	22,236	6,3825	23,301	22,469	23,443	
			1RB high	28,34	23,14	5,198	28,494	21,998	6,4962				
			50%RB mid	28,57	22,2	6,3638	28,339	22,469	5,8703				
			100%RB	28,31	22,18	6,1329	28,815	21,407	7,4083				
	20175	1732,5	1RB low	29,71	23,44	6,2664	29,313	22,553	6,7603	23,443	22,755		
			1RB high	28,65	23,41	5,2457	28,629	22,755	5,8739				
			50%RB mid	29,12	22,19	6,925	28,715	22,708	6,0071				
			100%RB	28,98	22,2	6,7808	29,522	21,348	8,1742				
	20375	1752,5	1RB low	28,31	23,26	5,047	28,386	22,201	6,1858	23,262	22,609		
			1RB high	28,41	23,15	5,26	28,44	22,134	6,3057				
			50%RB mid	28,4	22,2	6,1933	28,194	22,609	5,585				
			100%RB	28,2	22,14	6,0508	28,676	21,447	7,2283				
10 MHz	20000	1715	1RB low	28,6	23,13	5,4653	27,841	22,756	5,0846	**23,41**	22,756	23,502	
			1RB high	28,27	**23,41**	4,86	28,683	22,579	6,1039				
			50%RB mid	27,94	22,09	5,8434	27,702	21,413	6,2892				
			100%RB	27,92	21,95	5,9726	28,471	21,303	7,1687				
	20175	1732,5	1RB low	29,32	23,39	5,9238	29,36	22,739	6,6214	23,502	22,741		
			1RB high	28,83	23,5	5,3284	29,737	22,741	6,9957				
			50%RB mid	28,56	22,08	6,4789	28,839	21,449	7,3899				
			100%RB	28,62	22,12	6,5028	28,73	21,353	7,3769				
	20350	1750	1RB low	28,78	22,95	5,8348	29,247	23,193	6,0544	22,948	23,193		
			1RB high	27,98	22,94	5,0436	28,671	23,018	5,6534				
			50%RB mid	28,02	22,05	5,9669	27,998	21,403	6,5951				
			100%RB	28,37	22,18	6,19	28,771	21,341	7,4293				
15 MHz	20025	1717,5	1RB low	28,75	23,32	5,4304	28,935	23,257	5,6778	23,328	23,257	23,47	
			1RB high	28,62	23,33	5,2906	29,292	23,215	6,0769				
			50%RB mid	27,98	22,2	5,7817	28,307	22,376	5,9318				
			100%RB	28,65	22,27	6,3765	28,217	21,494	6,7227				
	20175	1732,5	1RB low	29,44	23,45	5,9942	29,54	22,688	6,852	23,47	22,83		
			1RB high	29,01	23,47	5,54	29,41	22,83	6,5802				
			50%RB mid	29,18	23,44	5,7414	29,04	22,482	6,5576				
			100%RB	28,53	22,31	6,2155	29,297	21,746	7,5515				
	20325	1747,5	1RB low	29,43	22,4	7,0352	30,315	23,238	7,0768	23,124	23,238		
			1RB high	29,5	23,12	6,3721	28,56	22,874	5,6861				
			50%RB mid	28,73	22,23	6,4986	28,873	22,441	6,432				
			100%RB	29,2	22,38	6,8214	28,697	21,655	7,0426				
20 MHz	20050	1720	1RB low	29,49	23,27	6,2275	29,268	23,438	5,8297	23,343	23,438	**23,78**	
			1RB high	29,53	23,34	6,1912	29,806	23,228	6,5784				
			50%RB mid	28,71	22,14	6,5699	28,55	22,502	6,0477				
			100%RB	29,01	22,22	6,7917	28,828	21,444	7,3847				
	20175	1732,5	1RB low	29,73	23,68	6,0431	28,649	22,924	5,7244	**23,78**	23,252		
			1RB high	29,98	**23,78**	6,1988	29,372	23,252	6,1193				
			50%RB mid	28,49	22	6,4971	28,908	22,42	6,488				
			100%RB	29,18	22,19	6,9904	28,765	22,43	6,335				
	20300	1745	1RB low	29,95	**23,47**	6,4862	30,649	23,284	7,3643	**23,47**	23,284		
			1RB high	28,25	23,35	4,8906	29,505	23,057	6,4482				
			50%RB mid	28,71	22,14	6,5671	29,713	22,564	7,1497				
			100%RB	28,6	22,19	6,4099	29,274	21,454	7,8206				

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

Max-Values for different signal bandwidths:

LTE Band 4				
Signal-BW	QPSK		16-QAM	
	Peak	RMS	Peak	RMS
5	29,71	23,44	29,52	22,75
10	29,32	23,50	29,74	23,19
15	29,50	23,47	30,31	23,26
20	29,98	23,78	30,65	23,44

Max-Values for Modulation:

LTE Band 4			
QPSK		16-QAM	
Peak	RMS	Peak	RMS
29,98	23,78	30,65	23,44

5.1.4.3. LTE Band 12 Results

LTE-Band 12				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 16-QAM	max. channel	absolute max. value
5 MHz	23035		1RB low	28,4	23,05	5,3436	28,429	22,127	6,3017	23,05	22,13	23,19	
			1RB high	28,15	23	5,1533	28,305	21,943	6,3613				
			50%RB mid	27,29	22,19	5,1001	27,246	21,42	5,8254				
			100%RB	28,05	22,12	5,9238	28,532	21,399	7,1332				
	23095		1RB low	29,1	23,08	6,0255	28,624	22,282	6,3416	23,19	22,66		
			1RB high	27,9	23,19	4,705	27,876	22,656	5,2202				
			50%RB mid	28,27	22	6,2738	27,271	21,467	5,8039				
			100%RB	28,21	21,98	6,229	28,924	21,312	7,6119				
	23155		1RB low	28,19	23,17	5,0235	28,069	22,805	5,2644	**23,17**	22,91		
			1RB high	28,2	**23,17**	5,0272	28,572	22,908	5,6639				
			50%RB mid	27,23	22,12	5,1079	26,856	21,275	5,5812				
			100%RB	27,71	22,08	5,6353	27,904	21,341	6,5625				
10 MHz	23060		1RB low	29,05	**23,13**	5,9261	28,43	23,066	5,3633	**23,13**	23,07	23,27	
			1RB high	28,21	23,06	5,157	29,115	22,996	6,1192				
			50%RB mid	28,09	22,17	5,9191	28,051	21,433	6,6187				
			100%RB	28,23	22,11	6,1164	28,758	21,488	7,2707				
	23095		1RB low	28,71	23,14	5,5737	28,084	23,036	5,0488	**23,27**	23,05		
			1RB high	27,61	**23,27**	4,346	29,131	23,046	6,0849				
			50%RB mid	27,7	22,08	5,6128	28,216	21,422	6,7941				
			100%RB	28,01	22,07	5,9364	28,791	21,505	7,286				
	23130		1RB low	28,28	22,93	5,3499	29,007	22,329	6,6776	22,96	22,36		
			1RB high	28,06	22,96	5,1022	28,915	22,363	6,5525				
			50%RB mid	27,51	22,05	5,4579	27,49	21,459	6,0309				
			100%RB	27,76	22,08	5,6754	27,667	21,392	6,275				

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

Max-Values for different signal bandwidths:

LTE Band 12				
Signal-BW	QPSK		16-QAM	
	Peak	RMS	Peak	RMS
5	29,10	23,19	28,92	22,91
10	29,05	20,00	29,13	20,00

Max-Values for Modulation:

LTE Band 12			
QPSK		16-QAM	
Peak	RMS	Peak	RMS
29,10	23,19	29,13	22,91

5.1.5. PAPR results

5.1.5.1. Test condition and test set-up

Climatic conditions	Temperature: (22±3°C)	Rel. humidity: (40±20)%
Test system set-up	Please see chapter "Test system set-up for conducted measurements on antenna port"	
Measurement method	The measurements were performed with the integrated power measurement function of the „radio communication tester CMW500 from Rohde&Schwarz company. The attenuation (insertion loss) at the RF Inputs/Outputs of CMW were set according the path loss of the test set-up, determined in a step before starting the measurements. A suitable artificial antenna or RF-connector is provided by the applicant in order to perform the conducted measurements. Any data provided with the artificial antenna or connector, have been taken in account in order to correct the measurement data. (typical 0.3dB for attenuation of antenna connector) The CCDF function of the measurement equipment as described in the operating manual was used (default settings). Futher details can be found in KDB 971168 D01 v02r02 chapter 5.7.1.	
Mobile phone settings	A call was established with a suitable communication test unit (CMW500). 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 2				
	Max. PAPR Max. PAPR level with 0.1% probability / [dB]			
	QPSK Modulation		16-QAM Modulation	
Signal-Bandwidth / [MHz]	1RB	50% or 100% RBs	1RB or 50% RB	100% RBs
1.4	N/A		N/A	
3.0	N/A		N/A	
5.0	4.95	6.44	5.29	7.42
10	5.65	6.97	5.98	7.78
15	4.93	6.95	5.07	5.06
20	4.72	4.85	7.42	5.70

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

LTE Band 4				
	Max. PAPR level with 0.1% probability / [dB]			
	QPSK Modulation		16-QAM Modulation	
Signal-Bandwidth / [MHz]	1RB	50% or 100% RBs	1RB if not other statement	50% or 100% RBs
1.4	N/A		N/A	
3.0	N/A		N/A	
5.0	5.28	6.24	5.52	7.00
10	5.25	6.91	6.27	7.39
15	4.41	5.36	5.12	6.70
20	5.18	5.75	5.40	7.04

Remark: pls. see annex 1 for graphical plots

LTE Band 12				
	Max. PAPR level with 0.1% probability / [dB]			
	QPSK Modulation		16-QAM Modulation	
Signal-Bandwidth / [MHz]	1RB	50% or 100% RBs	1RB if not other statement	50% or 100% RBs
1.4	N/A		N/A	
3.0	N/A		N/A	
5.0	5.02	6.19	5.34	6.75
10	5.53	6.19	6.53	7.18

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	☒ 594 CMW500		
DC Power	☒ 611 E3632A	☐ 087 EA3013	☐ 354 NGPE 40	☐ 086 LNG50-10	☒ 611 E3632A	
otherwise	☒ 529 6dB divider					
line voltage	☐ 230 V 50 Hz via public mains		☐ 060 110 V/ 60 Hz via PAS 5000			

5.2.2. Requirements and Limits

FCC	CFR47, §2.202(a), §2.1049, §24.238(b), 27.53(h)(3), §27.53(m)(6)	„the **occupied bandwidth** is the frequency bandwidth, such that, below it lower and above it upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated"
IC	RSS-Gen, Issue 4: §6.6	
ANSI	C63.26-2015	

5.2.3. Test condition and test set-up

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

5.2.4. Results

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

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	5	Low	18625	35.206	4.482	34.206	4.848
			Mid	18900	35.207	4.476	34.207	4.848
			High	19175	35.208	4.464	34.208	4.846
		10	low	18650	35.209	8.94	34.209	9.624
			Mid	18900	35.210	8.928	34.210	9.6
			High	19150	35.211	8.952	34.211	9.672
		15	Low	18675	35.212	13.413	34.212	14.38
			Mid	18900	35.213	13.43	34.213	14.31
			High	19125	35.214	13.464	34.214	14.45
		20	Low	18700	35.215	17.908	34.215	19.09
			Mid	18900	35.216	17.864	34.216	18.92
			High	19100	35.217	17.864	34.217	18.92

1.) see diagrams in annex 1

Band 2	16-QAM	5	low	18625	35.224	4.47	34.224	4.812
			mid	18900	35.225	4.476	34.225	4.884
			high	19175	35.226	4.482	34.226	4.848
		10 remark 2	low	18650	35.227	8.94	34.227	9.696
			mid	18900	35.228	8.952	34.228	9.744
			high	19150	35.229	8.928	34.229	9.648
		15 remark 2	low	18675	35.230	13.413	34.230	14.41
			Mid	18900	35.231	13.413	34.231	14.348
			High	19125	35.232	13.464	34.232	14.45
		20 remark 2	low	18700	35.233	17.886	34.233	18.96
			Mid	18900	35.234	17.864	34.234	18.92
			High	19100	35.235	17.886	34.235	19.09

Remark:

1.) see diagrams in annex 1

5.2.4.2. LTE Band 4: Op. Mode 2, Set-up 1

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	4.476	34.407	4.86
			Mid	20175	35.408	4.476	34.408	4.86
			High	20375	35.409	4.464	34.409	4.836
		10	low	20000	35.410	8.928	34.410	9.6
			Mid	20175	35.411	8.928	34.411	9.648
			High	20350	35.412	8.928	34.412	9.696
		15	Low	20025	35.413	13.413	34.413	14.246
			Mid	20175	35.414	13.464	34.414	14.416
			High	20325	35.415	13.396	34.415	14.28
		20	Low	20050	35.416	17.842	34.416	19.008
			Mid	20175	35.417	17.95	34.417	19.05
			High	20300	35.418	17.82	34.418	18.7

2.) see diagrams in annex 1

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	4.482	34.425	4.86
			Mid	20175	35.426	4.476	34.426	4.86
			High	20375	35.427	4.464	34.427	4.80
		10 remark 2	low	20000	35.428	8.952	34.428	9.672
			Mid	20175	35.429	8.94	34.429	9.672
			High	20350	35.430	8.928	34.430	9.6
		15 remark 2	Low	20025	35.431	13.396	34.431	14.41
			Mid	20175	35.432	13.46	34.432	14.41
			High	20325	35.433	13.379	34.433	14.28
		20 remark 2	Low	20050	35.434	17.864	34.434	18.788
			Mid	20175	35.435	17.908	34.435	19.09
			High	20300	35.436	17.842	34.436	18.83

Remark:

1.) see diagrams in annex 1

5.2.4.3. LTE Band 12: Op. Mode 3, Set-up 1

Operational Band	Modulation	Signal bandwidth [MHz]	Channel no.		99%-Occupied bandwidth		26 dB Emission Bandwidth	
			Range	Channel no.	Diagram no.	Value [MHz]	Diagram no.	Value [MHz]
Band 12	QPSK	5	Low	23035	35.133	4.476	34.133	4.824
			Mid	23095	35.134	4.476	34.134	4.848
			High	23155	35.135	4.476	34.135	4.484
		10	low	23060	35.136	8.916	34.136	9.6
			Mid	23095	35.137	8.976	34.137	9.696
			High	23130	35.138	8.904	34.138	9.672
	16-QAM	5	Low	23035	35.139	4.464	34.139	4.872
			Mid	23095	35.140	4.476	34.140	4.872
			High	23155	35.141	4.476	34.141	4.848
		10	low	23060	35.142	8.928	34.142	9.648
			Mid	23095	35.143	8.952	34.143	9.744
			High	23130	35.144	8.928	34.144	9.672

Remarks:

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

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

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

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

5.3.2. Requirements and limits

FCC	General: §2.1051, §2.1057(2) ☐ 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)
IC	☐ FDD Band 5: RSS-132, Issue 3: 5.5(i)(ii) ☒ FDD Band 2: RSS-133, Issue 6: 6.5.1(i)(ii) ☒ FDD Band 4: RSS-139, Issue 3: 6.6 (i)(ii) ☒ FDD Band 12: RSS-130, Issue 1: 4.6.1 ☐FDD Band 13: RSS-130, Issue 1: 4.6.2(a)(i)(ii) + 4.6.2(b)☐ FDD Band 17: RSS-130, Issue 1: 4.6.1
Limit	„the power of emissions shall be attenuated below the transmitter output power (p) by at least 43+10Log(P) dB“

5.3.3. Test condition and test set-up

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

Spectrum-Analyzer settings 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; this was choosen according power max values as worst-case

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, this was choosen according power max values as worst-case

Spectrum-Analyzer Settings LTE Band 12

	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)	697	698	50 2.) to 100	--1.)	30	35	MaxH-PK
Sweep 3b (Block-Edge)	697	698		--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, this was choosen according power max values as worst-case

5.3.4. Results

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

5.3.4.1. 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	[dBm]
36.21b	Low	18700	9kHz to 30MHz	1	16-QAM-Modulation	☒	☐	☐	passed
36.20a	Low	18700	9kHz to 30MHz		QPSK-Modulation	☒	☐	☐	passed
36.21b	Low	18700	30 MHz to 19.5GHz		Carrier visible on diagram, not relevant for results 16-QAM-modulation	☒	☐	☐	passed
36.20a	Low	18700	30 MHz to 19.GHz		Carrier visible on diagram, not relevant for results QPSK-modulation	☒	☐	☐	passed
37.205a	Band-Edge low	18625	1849 – 1850 MHz	1	Band Edge Compliance QPSK-modulation	☐	☒	☐	Passed
37.205b		18625	1849 – 1850 MHz		Band Edge Compliance 16-QAM-modulation	☐	☒	☐	Passed
37.206b		18625	1849 – 1850 MHz		Band Edge Compliance 16-QAM-modulation	☐	☒	☐	passed
37.206a		18625	1849 – 1850 MHz		Band Edge Compliance QPSK modulation	☐	☒	☐	passed
36.22b	Middle	18900	9kHz to 30MHz	1	16-QAM-modulation	☒	☐	☐	passed
36.22a	Middle	18900	9kHz to 30MHz		QPSK-Modulation	☒	☐	☐	Passed
36.23b	Middle	18900	30 MHz to 19.5MHz		Carrier visible on diagram, not relevant for results 16-QAM-modulation	☒	☐	☐	passed
36.23a	Middle	18900	30 MHz to 19.5MHz		Carrier visible on diagram, not relevant for results QPSK-modulation	☒	☐	☐	passed
36.24a	High	19150	9kHz to 30MHz	1	QPSK-modulation	☒	☐	☐	passed
36.24b		19150	9kHz to 30MHz		16-QAM-modulation	☒	☐	☐	passed
36.25a		19150	30 MHz to 19.5GHz		QPSK-modulation	☒	☐	☐	passed
36.25b		19150	30 MHz to 19.5GHz		16-QAM-modulation	☒	☐	☐	passed

37.217a	Band-Edge high	19175	1910 – 1911 MHz	1	Band-Edge compliance QPSK Modulation	☐	☒	☐	passed
37.217b		19175	1910 – 1911 MHz		Band-Edge compliance QAM Modulation	☐	☒	☐	passed
37.218b		19175	1910 – 1911 MHz		Band-Edge compliance QAM Modulation	☐	☒	☐	passed
37.218a		19175	1910 – 1911 MHz		Band-Edge compliance QPSK Modulation	☐	☒	☐	passed

Remark:

5.3.4.2. 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	
36.40a	Low	20000	9kHz to 30MHz	2	QPSK modulation	☒	☐	☐	passed
36.40b	Low	20000	9kHz to 30MHz		16-QAM modulation	☒	☐	☐	passed
36.41a	Low	20000	30 MHz to 18GHz		Carrier visible on diagram, not relevant for results QPSK modulation	☒	☐	☐	passed
36.41b	Low	20000	30 MHz to 18GHz		Carrier visible on diagram, not relevant for results 16-QAM modulation	☒	☐	☐	passed

37.405a	Band-Edge low	19975	1709 -1710 MHz	2	Band Edge Compliance QPSK modulation	☐	☒	☐	Passed
37.405b		19975	1709 -1710 MHz		Band Edge Compliance 16-QAM modulation	☐	☒	☐	passed
37.406a		19975	1709 -1710 MHz		Band Edge Compliance QPSK modulation	☐	☒	☐	passed
37.406b		19975	1709 -1710 MHz		Band Edge Compliance 16-QAM modulation	☐	☒	☐	passed

36.42a	Middle	20175	9kHz to 30MHz	2	QPSK modulation	☒	☐	☐	passed
36.42b	Middle	20175	9kHz to 30MHz		16-QAM modulation	☒	☐	☐	passed
36.43a	Middle	20175	30 MHz to 18GHz		Carrier visible on diagram, not relevant for results QPSK modulation	☒	☐	☐	passed
36.43b	Middle	20175	30 MHz to 18GHz		Carrier visible on diagram, not relevant for results 16-QAM modulation	☒	☐	☐	passed

36.44a	High	20300	9kHz to 30MHz	2	QPSK modulation	☒	☐	☐	passed
36.44b	High	20300	30 MHz to 18GHz		Carrier visible on diagram, not relevant for results QPSK modulation	☒	☐	☐	passed
36.45a	High	20230	9kHz to 30MHz		16-QAM modulation	☒	☐	☐	passed
36.45b	High	20230	30 MHz to 19.5MHz		Carrier visible on diagram, not relevant for results 16-QAM modulation	☒	☐	☐	passed

37.417a	Band-Edge high	20375	1755 - 1756 MHz	2	Band-Edge compliance QPSK modulation	☐	☒	☐	Passed
37.417b		20375	1755 - 1756 MHz		Band-Edge compliance 16-QAM modulation	☐	☒	☐	passed
37.418a		20375	1709 -1710 MHz		Band Edge Compliance QPSK modulation	☐	☒	☐	passed
37.418b		20375	1709 -1710 MHz		Band Edge Compliance 16-QAM modulation	☐	☒	☐	passed

Remark:

5.3.4.3. LTE Band 12: 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	[dBm]
36.1201 a	Low	23060	9kHz to 30MHz	3	QPSK modulation	☒	☐	☐	passed
36.1201 b	Low	23060	9kHz to 30MHz		16QAM modulation	☒	☐	☐	passed
36.1202 a	Low	23060	30 MHz to 9GHz		Carrier visible on diagram, not relevant for results QPSK modulation	☒	☐	☐	passed
36.1202 b	Low	23060	30 MHz to 9GHz		Carrier visible on diagram, not relevant for results QAM modulation	☒	☐	☐	passed
37.1205 b	Band-Edge Low	23025	697 - 698 MHz	3	Band Edge Compliance 16-QAM modulation	☐	☒	☐	Passed
37.1205 a		23025	697 - 698 MHz		Band Edge Compliance QPSK modulation	☐	☒	☐	Passed
37.1206 a		23025	697 - 698 MHz		Band Edge Compliance QPSK modulation	☐	☒	☐	passed
37.1206 b		23025	697 - 698 MHz		Band Edge Compliance QAM modulation	☐	☒	☐	Passed
36.1203 a	Middle	23095	9kHz to 30MHz	3	QPSK modulation	☒	☐	☐	Passed
36.1203 b	Middle	23095	9kHz to 30MHz		16QAM modulation	☒	☐	☐	passed
36.1204 a	Middle	23095	30 MHz to 9GHz		Carrier visible on diagram, not relevant for results QPSK modulation	☒	☐	☐	passed
36.1204 b	Middle	23095	30 MHz to 9GHz		Carrier visible on diagram, not relevant for results QAM modulation	☒	☐	☐	passed
36.1205 a	High	23155	9kHz to 30MHz	3	QPSK modulation	☒	☐	☐	passed
36.1205 b	High	23155	9kHz to 30MHz		QAM modulation	☒	☐	☐	passed
36.1206 a	High	23155	30 MHz to 9GHz		Carrier visible on diagram, not relevant for results QPSK modulation	☒	☐	☐	passed
36.1206 b	High	23155	30 MHz to 9GHz		Carrier visible on diagram, not relevant for results QAM modulation	☒	☐	☐	passed

37.1213 a	Band-Edge High	23155	716 - 717 MHz	3	Band-Edge compliance QPSK modulation	☐	☒	☐	Passed
37.1213 b		23155	716 - 717 MHz		Band-Edge compliance QAM modulation	☐	☒	☐	passed
37.1214 b		23155	716 - 717 MHz		Band-Edge compliance QAM modulation	☐	☒	☐	passed
37.1214 a		23155	716 - 717 MHz		Band-Edge compliance QPSK modulation	☐	☒	☐	passed

Remark:

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

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

test location	☒ CETECOM Essen (Chapter. 2.2.1)		☐ Please see Chapter. 2.2.2		☐ Please see Chapter. 2.2.3	
test site	☐ 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			

5.4.2. 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)
IC	☐ FDD Band 5: RSS-132, Issue 3: 5.5(i)(ii) ☒ FDD Band 2: RSS-133, Issue 6: 6.5.1(i)(ii) ☒ FDD Band 4: RSS-139, Issue 3: 6.6 (i)(ii) ☒ FDD Band 12: RSS-130, Issue 1: 4.6.1 ☐FDD Band 13: RSS-130, Issue 1: 4.6.2(a)(i)(ii) + 4.6.2(b)☐ FDD Band 17: RSS-130, Issue 1: 4.6.1
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

5.4.3. 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 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	10	10	10	MaxH-PK
Sweep 1 (subrange 2)	1000	2800	1	10	15	0	MaxH-PK
Sweep 1 (subrange 3)	2800	20000	1	10	60	10	MaxH-PK
Sweep 2a (Band-Edge)	1849	1850	0.03	0.3	30	35	MaxH-PK
Sweep 2b (Band-Edge)	1849	1850	0.03	0.3	30	35	MaxH-AV
Sweep 3a (Band-Edge)	1910	1911	0.03	0.3	30	35	MaxH-PK
Sweep 3b (Band-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 (Band-Edge)	1709	1710	0.03	0.3	30	35	MaxH-PK
Sweep 2b (Band-Edge)	1709	1710	0.03	0.3	30	35	MaxH-AV
Sweep 3a (Band-Edge)	1755	1756	0.03	0.3	30	35	MaxH-PK
Sweep 3b (Band-Edge)	1755	1756	0.03	0.3	30	35	MaxH-AV

Spectrum-analyzer settings for LTE Band 12

	Start freq. MHz	Stop freq. MHz	R-BW kHz	V-BW kHz	Sweep time sec.	Att.	Detector
Sweep 1 (subrange 1)	30	1000	100	300	10	10	MaxH-PK
Sweep 1 (subrange 2)	1000	2800	100	300	15	0	MaxH-PK
Sweep 1 (subrange 3)	2800	9000	100	300	160	10	MaxH-PK
Sweep 2a (Band-Edge)	697	698	50	300	30	35	MaxH-PK, Signal-BW=5MHz
Sweep 2b (Band-Edge)	697	698	100	300	30	35	MaxH-PK, Signal-BW=10MHz
Sweep 3a (Band-Edge)	716	717	500	300	30	35	MaxH-PK, Signal-BW=5MHz
Sweep 3b (Band-Edge)	716	717	100	300	30	35	MaxH-PK, Signal-BW=10MHz

5.4.4. Results

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

5.4.4.1. 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	
8.01	Low	18700	30 MHz to 19.5 GHz	1	Carrier visible on diagram. Not relevant for results QPSK modulation	☒	☐	☐	passed
8.02	Middle	18700	30 MHz to 19.5 GHz	1	Carrier visible on diagram. Not relevant for results 16-QAM modulation	☒	☐	☐	passed
8.03	High	19150	30 MHz to 19.5 GHz	1	Carrier visible on diagram. Not relevant for results 16-QAM modulation	☒	☐	☐	passed
9.209a	Band-Edge low	18675	1849 – 1850 MHz	1	Band-Edge compliance QPSK modulation	☒	☒	☐	passed
9.209b		18675	1849 – 1850 MHz	1	Band-Edge compliance 16-QAM modulation	☒	☒	☐	passed
9.210a		18675	1849 – 1850 MHz	1	Band-Edge compliance QPSK modulation	☒	☒	☐	passed
9.210b		18675	1849 – 1850 MHz	1	Band-Edge compliance 16-QAM modulation	☒	☒	☐	passed
9.221a	Band-Edge high	19175	1910 – 1911 MHz	1	Band-Edge compliance QPSK modulation	☐	☒	☐	Passed
9.221b		19175	1910 – 1911 MHz	1	Band-Edge compliance 16-QAM modulation	☐	☒	☐	passed
9.222a		19175	1910 – 1911 MHz	1	Band-Edge compliance QPSK modulation	☐	☒	☐	passed
9.222b		19175	1910 – 1911 MHz	1	Band-Edge compliance 16-QAM modulation	☐	☒	☐	passed

Remark1:

5.4.4.2. 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	
8.07	Low	20000	30 MHz to 18 GHz	2	Carrier visible on diagram. Not relevant for results QPSK modulation	☒	☐	☐	passed
8.08	Middle	20175	30MHz – 2.8GHz 2.8GHz to 18 GHz	2	Carrier visible on diagram. Not relevant for results QPSK modulation	☒	☐	☐	passed
8.09	High	20300	30 MHz to 18 GHz	2	Carrier visible on diagram. Not relevant for results 16-QAM modulation	☒	☐	☐	passed
9.409b	Band-edge low	20025	1709 – 1710 MHz	2	Band-Edge compliance 16-QAM modulation	☐	☒	☐	Passed
9.409a		20025	1709 – 1710 MHz	2	Band-Edge compliance QPSK modulation	☐	☒	☐	passed
9.410a		20025	1709 – 1710 MHz	2	Band-Edge compliance QPSK modulation	☐	☒	☐	passed
9.410b		20025	1709 – 1710 MHz	2	Band-Edge compliance 16-QAM modulation	☐	☒	☐	passed
9.421a	Band-edge high	20325	1755 – 1756 MHz	2	Band-Edge compliance QPSK modulation	☐	☒	☐	Passed
9.421b		20325	1755 – 1756 MHz	2	Band-Edge compliance 16-QAM modulation	☐	☒	☐	passed
9.422a		20325	1755 – 1756 MHz	2	Band-Edge compliance QPSK modulation	☐	☒	☐	passed
9.422b		20325	1755 – 1756 MHz	2	Band-Edge compliance 16-QAM modulation	☐	☒	☐	passed

Remark1:

5.4.4.3. LTE Band 12: 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	
8.06	Low	23060	30 MHz to 9 GHz	2	Carrier visible on diagram. Not relevant for results QPSK modulation	☒	☐	☐	passed
8.05	Middle	23095	30 MHz to 9 GHz	2	Carrier visible on diagram. Not relevant for results QPSK modulation	☒	☐	☐	passed
8.04	High	23155	30 MHz to 9 GHz	2	Carrier visible on diagram. Not relevant for results QPSK modulation	☒	☐	☐	passed

9.1207 a	Band-Edge low	23035	697 – 698 MHz	2	Band-Edge compliance QPSK modulation Remark 1	☒	☒	☐	Passed
9.1207 b		23035	697 – 698 MHz	2	Band-Edge compliance QAM modulation Remark 1	☒	☒	☐	passed
9.1208 a		23035	697 – 698 MHz	2	Band-Edge compliance QPSK modulation Remark 1	☒	☒	☐	passed
9.1208 b		23035	697 – 698 MHz	2	Band-Edge compliance QAM modulation Remark 1	☒	☒	☐	passed

9.1213 a	Band-Edge high	23155	716 – 717 MHz	2	Band-Edge compliance QPSK modulation Remark 1	☒	☒	☐	Passed
9.1213 b		23155	716 – 717 MHz	2	Band-Edge compliance QAM modulation Remark 1	☒	☒	☐	passed
9.1214 a		23155	716 – 717 MHz	2	Band-Edge compliance QPSK modulation Remark 1	☒	☒	☐	passed
9.1214 b		23155	716 – 717 MHz	2	Band-Edge compliance QAM modulation Remark 1	☒	☒	☐	passed

Remark1:

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

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	☐ 489 ESU 40	☐ 264 FSEK	☐ 620 ESU 26	☐	☐
signaling	☐ 392 MT8820A	☐ 436 CMU	☐ 547 CMU	☒ 594 CMW500	☐ 594 CMW500	
DC power	☐ 611 E3632A	☐ 457 EA 3013A	☐ 459 EA 2032-50	☐ 268 EA- 3050	☐ 494 AG6632A	☐ 498 NGPE 40
otherwise	☒ 529 6dB divider	☒ 530 10dB Att.	☐ 431 Near field			
Climatic test chamber	☒ 331 HC 4055	☒ VT 4002	☒ 627 OPUS 1			
line voltage	☐ 230 V 50 Hz via public mains		☐ 060 110 V/ 60 Hz via PAS 5000			

5.5.2. Requirements and limits

FCC	§2.1055(a)(1) , §24.235, §27.54
IC	RSS-133: 6.3 RSS-139, Issue 3: 6.4RSS-130, Issue 1: §4.3
Limit	*"The frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block"*

5.5.3. Test condition and test set-up

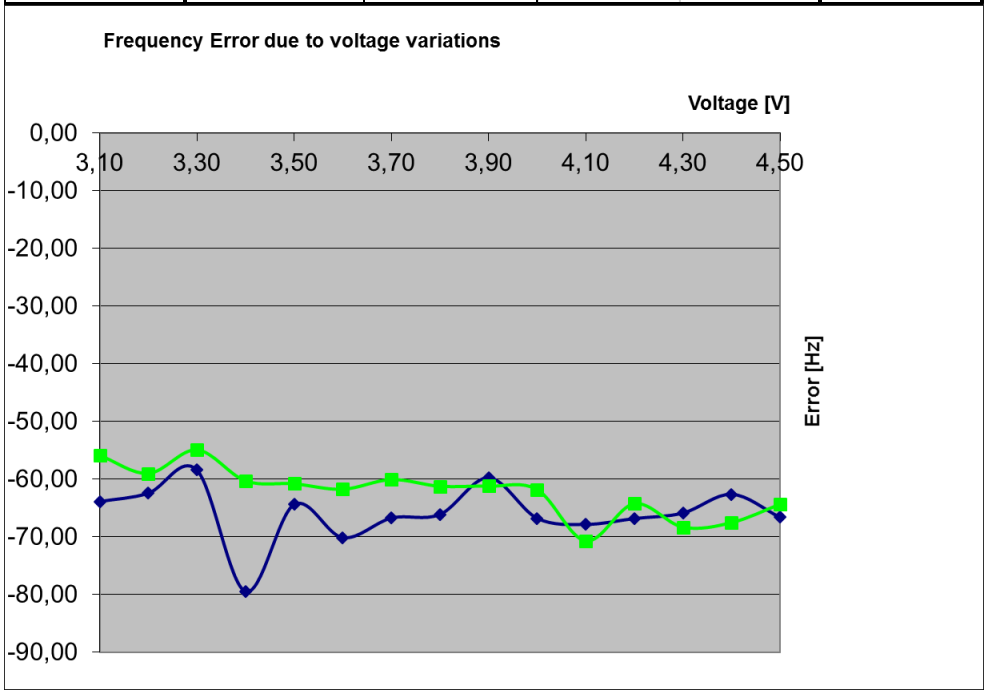
Test system set-up	Please see chapter "Test system set-up for conducted measurements on antenna port" In order to maintain the voltage constant over the time period of the tests, a dummy battery was connected to a laboratory power supply. The power supply voltage was controlled on the input of the power 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. 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.

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

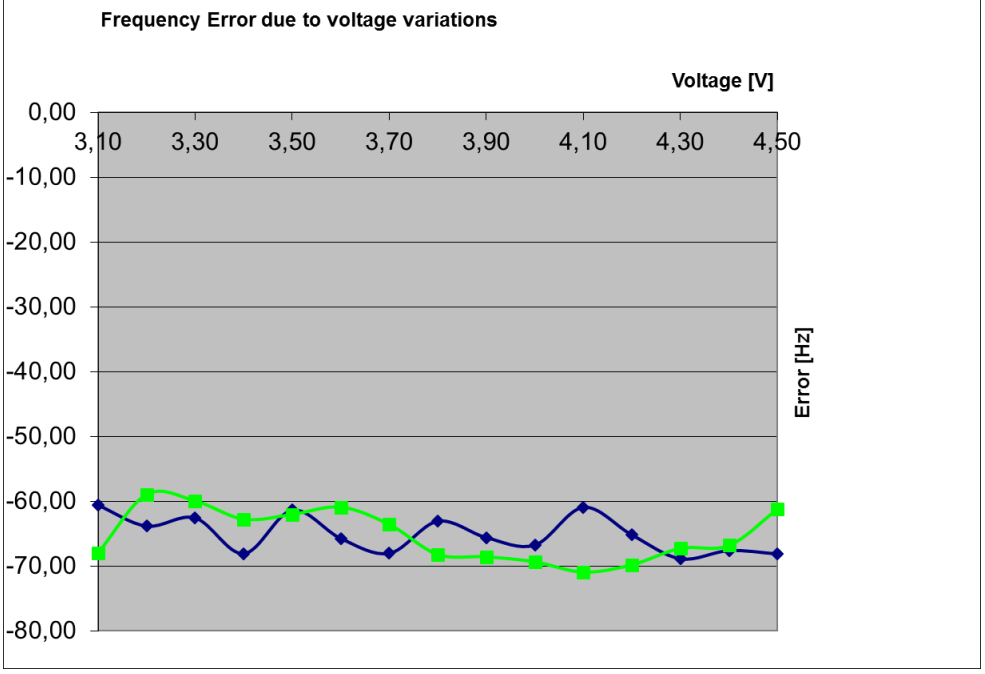
1.) determine the carrier frequency for the lowest and highest channel at room temperature and nominal voltage [20°C]
2.) The voltage was reduced in 0.1 Volt steps to the lower end point, where the mobile phone stops working. (this shall be specified by the manufacturer) Record the carrier frequency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

5.5.4. Measurement Results:
5.5.4.1. LTE Band 2: Maximum frequency Error during connection state

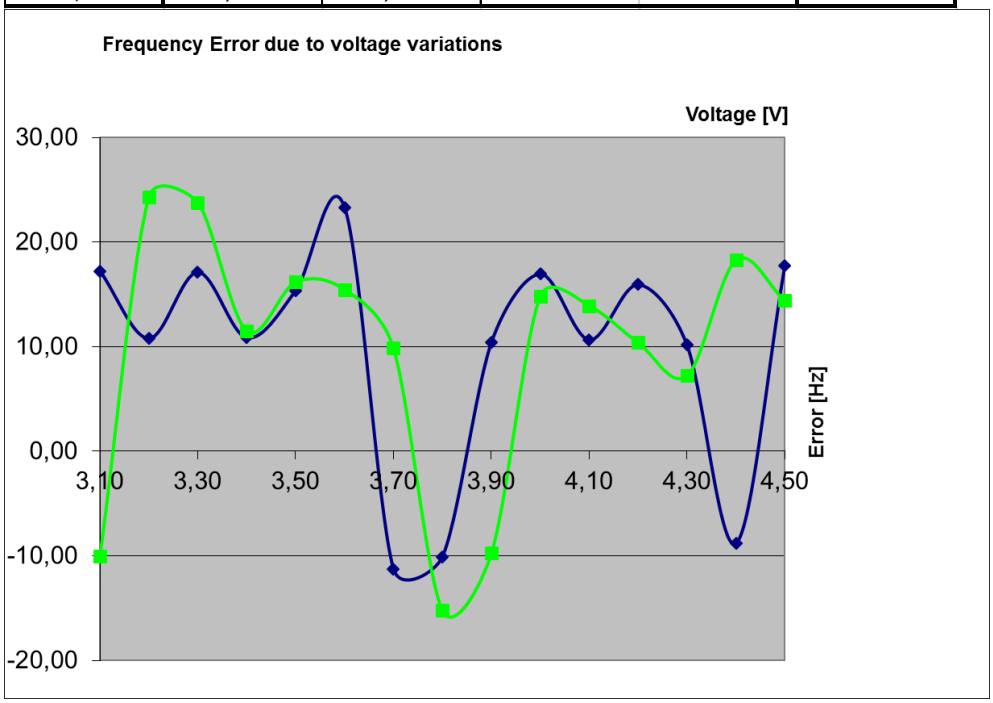
Voltage	Maximum frequency error				Verdict
	Channel 18625/ BW=5 MHz				
	QPSK Modulation [Hz]	16-QAM Modulation [Hz]	QPSK Modulation [ppm]	16-QAM Modulation [ppm]	Limit=±0.1ppm
3,10	-63,8437	-55,8472	-0,034	-0,030	Pass
3,20	-62,3989	-58,9657	-0,034	-0,032	
3,30	-58,3935	-54,8887	-0,032	-0,030	
3,40	-79,4506	-60,2674	-0,043	-0,033	
3,50	-64,3587	-60,7681	-0,035	-0,033	
3,60	-70,0951	-61,7123	-0,038	-0,033	
3,70	-66,7048	-60,0386	-0,036	-0,032	
3,80	-66,0753	-61,1973	-0,036	-0,033	
3,90	-59,7238	-61,183	-0,032	-0,033	
4,00	-66,7477	-61,7695	-0,036	-0,033	
4,10	-67,8062	-70,6816	-0,037	-0,038	
4,20	-66,7906	-64,2157	-0,036	-0,035	
4,30	-65,8321	-68,2926	-0,036	-0,037	
4,40	-62,5849	-67,4915	-0,034	-0,036	
4,50	-66,5903	-64,2872	-0,036	-0,035	



Voltage	Maximum frequency error Channel 18900/ BW=5 MHz				Verdict
	QPSK Modulation [Hz]	16-QAM Modulation [Hz]	QPSK Modulation [ppm]	16-QAM Modulation [ppm]	Limit=±0.1ppm
3,10	-60,6251	-67,9493	-0,032	-0,036	Pass
3,20	-63,8437	-58,9514	-0,034	-0,031	
3,30	-62,5849	-59,9527	-0,033	-0,032	
3,40	-68,0923	-62,7708	-0,036	-0,033	
3,50	-61,3832	-62,027	-0,033	-0,033	
3,60	-65,7606	-60,9112	-0,035	-0,032	
3,70	-68,0351	-63,5862	-0,036	-0,034	
3,80	-63,0856	-68,2211	-0,034	-0,036	
3,90	-65,6176	-68,5644	-0,035	-0,036	
4,00	-66,762	-69,3512	-0,036	-0,037	
4,10	-60,9398	-70,9391	-0,032	-0,038	
4,20	-65,217	-69,809	-0,035	-0,037	
4,30	-68,8791	-67,2626	-0,037	-0,036	
4,40	-67,6203	-66,8335	-0,036	-0,036	
4,50	-68,1353	-61,2116	-0,036	-0,033	

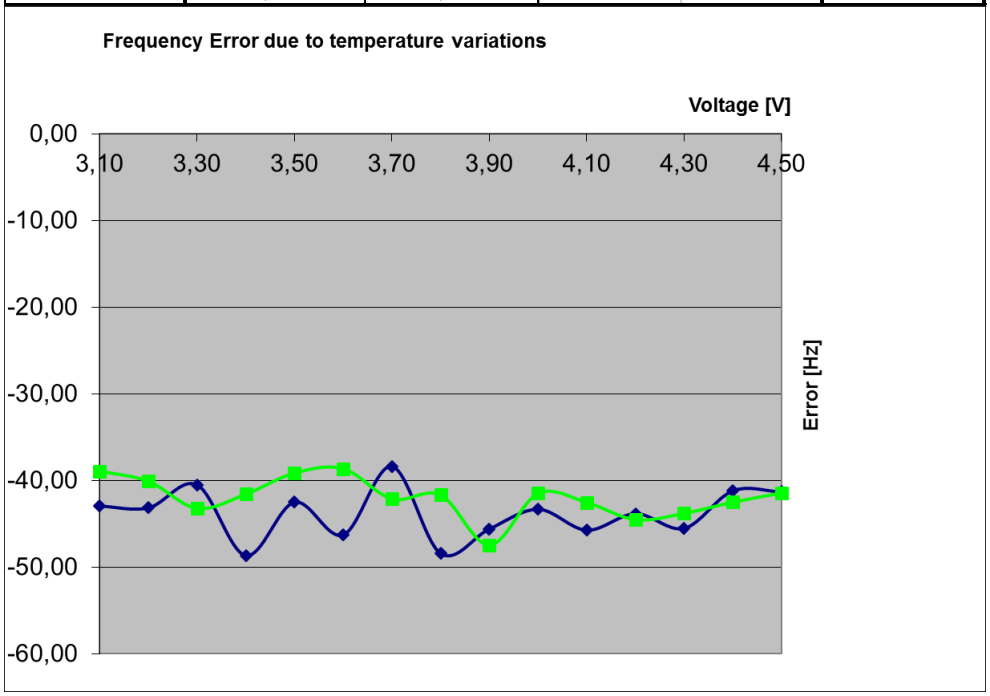


Voltage	Maximum frequency error Channel 19175/ BW=5 MHz QPSK Modulation [Hz]	16-QAM Modulation [Hz]	QPSK Modulation [ppm]	16-QAM Modulation [ppm]	Verdict Limit=±0.1ppm
3,10	17,2377	-9,9993	0,009	-0,005	Pass
3,20	10,7861	24,3044	0,006	0,013	
3,30	17,1232	23,7894	0,009	0,012	
3,40	10,8576	11,5156	0,006	0,006	
3,50	15,3637	16,1648	0,008	0,008	
3,60	23,3173	15,4638	0,012	0,008	
3,70	-11,2438	9,8562	-0,006	0,005	
3,80	-10,0851	-15,2349	-0,005	-0,008	
3,90	10,3855	-9,7561	0,005	-0,005	
4,00	16,9516	14,8344	0,009	0,008	
4,10	10,6573	13,9046	0,006	0,007	
4,20	15,9359	10,3855	0,008	0,005	
4,30	10,1423	7,2384	0,005	0,004	
4,40	-8,812	18,2676	-0,005	0,010	
4,50	17,7526	14,4053	0,009	0,008	

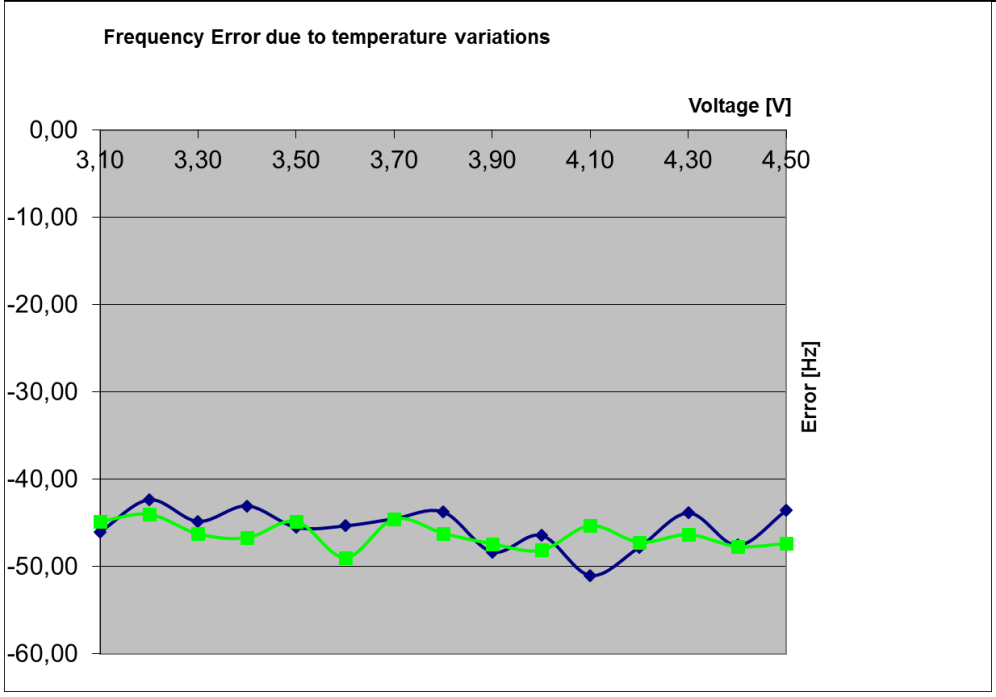


5.5.4.2. LTE Band 4

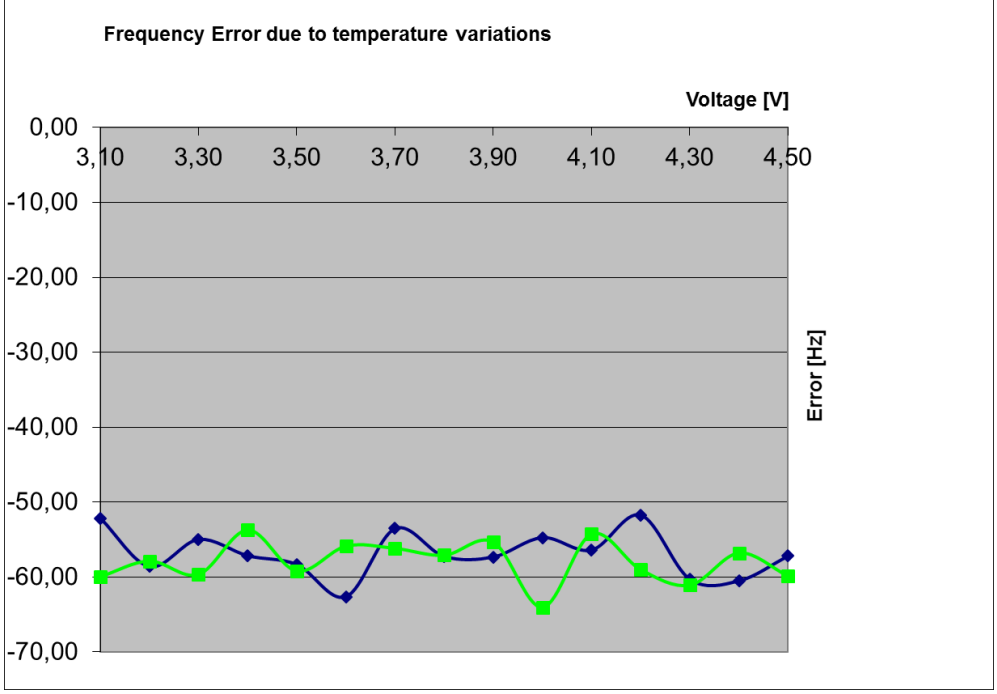
Voltage	Maximum frequency error				Verdict
	Channel 19975/ BW= 5MHz				
	QPSK Modulation [Hz]	16-QAM Modulation [Hz]	QPSK Modulation [ppm]	16-QAM Modulation [ppm]	Limit=±0.1ppm
3,10	-42,9297	-38,8956	-0,025	-0,023	Pass
3,20	-43,1442	-40,0829	-0,025	-0,023	
3,30	-40,4835	-43,2015	-0,024	-0,025	
3,40	-48,6517	-41,5564	-0,028	-0,024	
3,50	-42,4862	-39,1245	-0,025	-0,023	
3,60	-46,2627	-38,6238	-0,027	-0,023	
3,70	-38,3663	-42,1143	-0,022	-0,025	
3,80	-48,4085	-41,6565	-0,028	-0,024	
3,90	-45,5761	-47,4501	-0,027	-0,028	
4,00	-43,3016	-41,4705	-0,025	-0,024	
4,10	-45,7191	-42,5148	-0,027	-0,025	
4,20	-43,8023	-44,5032	-0,026	-0,026	
4,30	-45,5046	-43,7737	-0,027	-0,026	
4,40	-41,1701	-42,4862	-0,024	-0,025	
4,50	-41,2989	-41,4133	-0,024	-0,024	



Voltage	Maximum frequency error				Verdict
	Channel 20175/ BW= 5MHz				
	QPSK Modulation [Hz]	16-QAM Modulation [Hz]	QPSK Modulation [ppm]	16-QAM Modulation [ppm]	Limit=±0.1ppm
3,10	-46,0052	-44,8179	-0,027	-0,026	Pass
3,20	-42,3288	-43,9882	-0,024	-0,025	
3,30	-44,8036	-46,2341	-0,026	-0,027	
3,40	-43,0298	-46,6776	-0,025	-0,027	
3,50	-45,4903	-44,8036	-0,026	-0,026	
3,60	-45,3186	-48,9664	-0,026	-0,028	
3,70	-44,5032	-44,5175	-0,026	-0,026	
3,80	-43,7307	-46,1769	-0,025	-0,027	
3,90	-48,3084	-47,3785	-0,028	-0,027	
4,00	-46,4058	-48,1081	-0,027	-0,028	
4,10	-50,9977	-45,29	-0,029	-0,026	
4,20	-47,7505	-47,1926	-0,028	-0,027	
4,30	-43,8452	-46,32	-0,025	-0,027	
4,40	-47,5502	-47,679	-0,027	-0,028	
4,50	-43,5305	-47,3356	-0,025	-0,027	

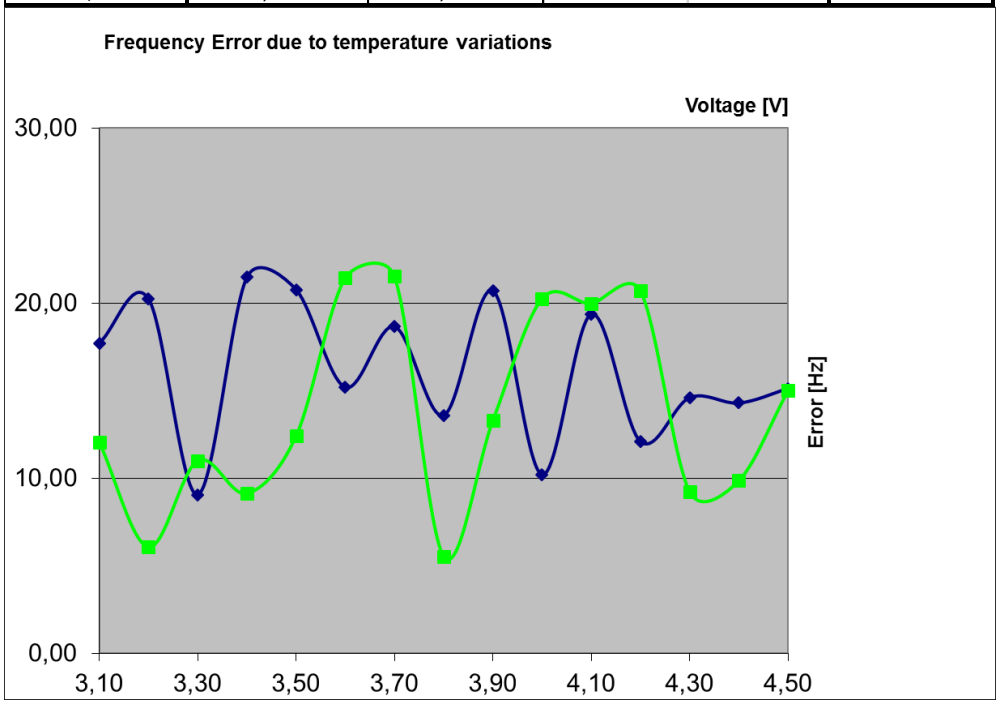


Voltage	Maximum frequency error				Verdict
	Channel 20375/ BW= 5MHz				
	QPSK Modulation [Hz]	16-QAM Modulation [Hz]	QPSK Modulation [ppm]	16-QAM Modulation [ppm]	Limit=±0.1ppm
3,10	-52,1421	-59,9527	-0,030	-0,034	Pass
3,20	-58,5937	-57,8642	-0,033	-0,033	
3,30	-54,9746	-59,6523	-0,031	-0,034	
3,40	-57,1489	-53,7157	-0,033	-0,031	
3,50	-58,3363	-59,2089	-0,033	-0,034	
3,60	-62,6278	-55,8758	-0,036	-0,032	
3,70	-53,5297	-56,1762	-0,031	-0,032	
3,80	-57,2491	-57,0917	-0,033	-0,033	
3,90	-57,3206	-55,3322	-0,033	-0,032	
4,00	-54,7314	-64,044	-0,031	-0,037	
4,10	-56,3908	-54,245	-0,032	-0,031	
4,20	-51,7273	-59,0086	-0,030	-0,034	
4,30	-60,2961	-61,0828	-0,034	-0,035	
4,40	-60,5106	-56,7913	-0,035	-0,032	
4,50	-57,2062	-59,8526	-0,033	-0,034	

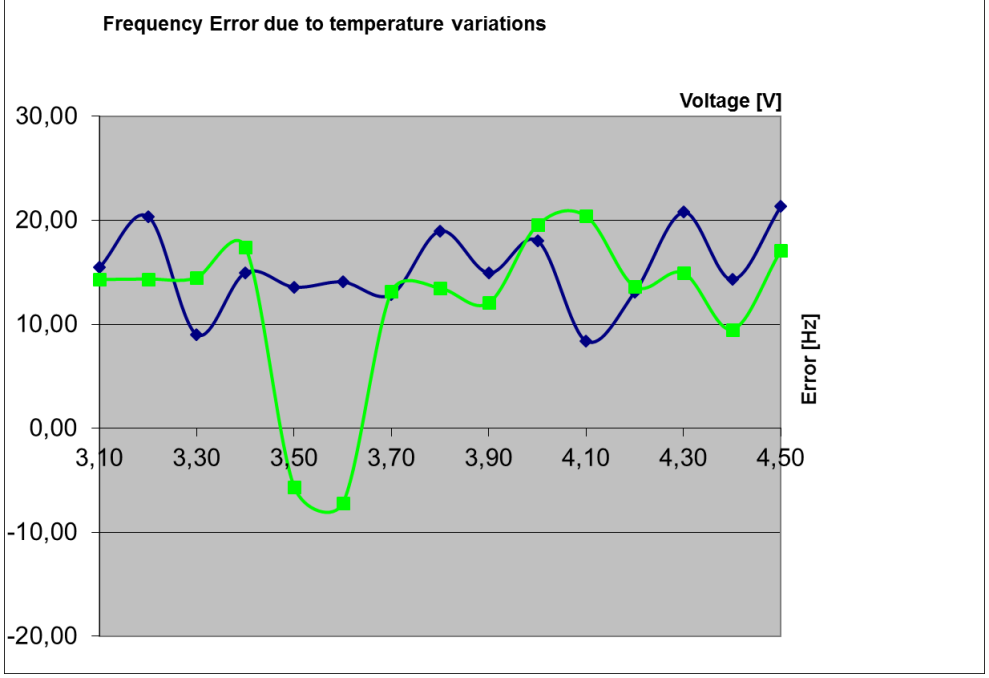


5.5.4.3. LTE Band 12

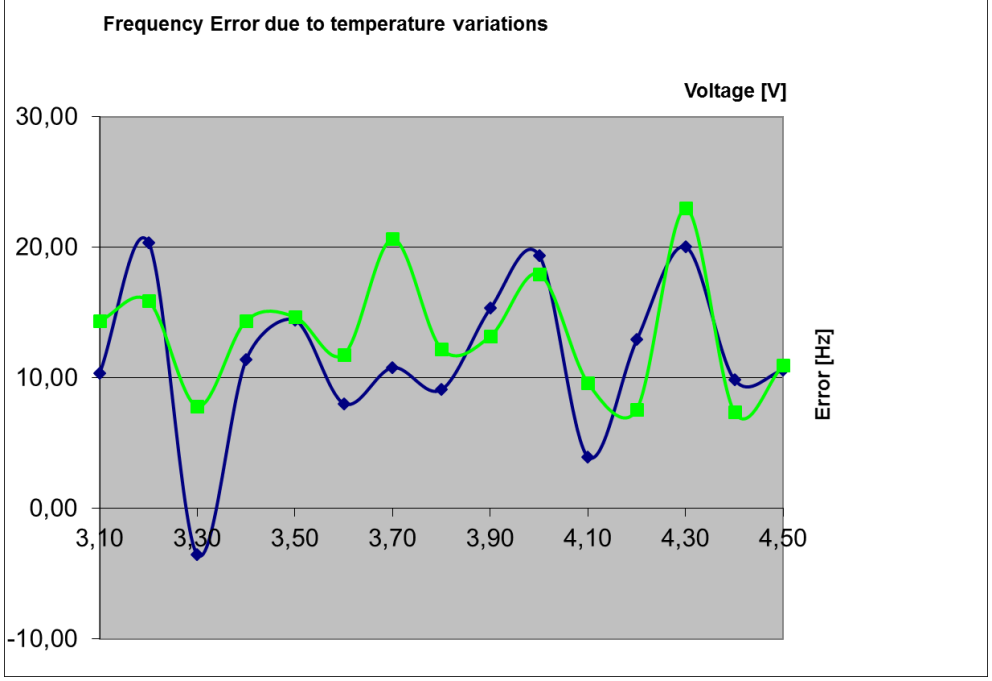
Voltage	Maximum frequency error				Verdict
	Channel 23035/ BW= 5MHz				
	QPSK Modulation [Hz]	16-QAM Modulation [Hz]	QPSK Modulation [ppm]	16-QAM Modulation [ppm]	Limit=±0.1ppm
3,10	17,724	12,0735	0,025	0,017	Pass
3,20	20,256	6,0797	0,029	0,009	
3,30	9,0694	11,0149	0,013	0,016	
3,40	21,4863	9,141	0,031	0,013	
3,50	20,7853	12,4168	0,030	0,018	
3,60	15,2063	21,4577	0,022	0,031	
3,70	18,6682	21,5292	0,027	0,031	
3,80	13,6042	5,5504	0,019	0,008	
3,90	20,7138	13,3038	0,030	0,019	
4,00	10,2139	20,2704	0,015	0,029	
4,10	19,3834	19,9842	0,028	0,028	
4,20	12,1021	20,6995	0,017	0,030	
4,30	14,6198	9,2268	0,021	0,013	
4,40	14,3051	9,8705	0,020	0,014	
4,50	15,1348	15,0204	0,022	0,021	



Voltage	Maximum frequency error				Verdict
	Channel23095/ BW= 5MHz				
	QPSK Modulation [Hz]	16-QAM Modulation [Hz]	QPSK Modulation [ppm]	16-QAM Modulation [ppm]	Limit=±0.1ppm
3,10	15,4638	14,3194	0,022	0,020	Pass
3,20	20,3705	14,3623	0,029	0,020	
3,30	9,0122	14,4768	0,013	0,020	
3,40	14,9775	17,3807	0,021	0,025	
3,50	13,5755	-5,6362	0,019	-0,008	
3,60	14,0762	-7,1812	0,020	-0,010	
3,70	12,8603	13,1464	0,018	0,019	
3,80	18,9829	13,4611	0,027	0,019	
3,90	14,9345	12,0592	0,021	0,017	
4,00	18,0388	19,5551	0,025	0,028	
4,10	8,3828	20,3991	0,012	0,029	
4,20	13,1178	13,6042	0,019	0,019	
4,30	20,771	14,9488	0,029	0,021	
4,40	14,2908	9,4986	0,020	0,013	
4,50	21,3289	17,0946	0,030	0,024	



Voltage	Maximum frequency error				Verdict
	Channel23155/ BW= 5MHz				
	QPSK Modulation [Hz]	16-QAM Modulation [Hz]	QPSK Modulation [ppm]	16-QAM Modulation [ppm]	Limit=±0.1ppm
3,10	10,3855	14,3766	0,015	0,020	Pass
3,20	20,3705	15,893	0,029	0,022	
3,30	-3,5334	7,8392	-0,005	0,011	
3,40	11,4155	14,391	0,016	0,020	
3,50	14,4339	14,677	0,020	0,021	
3,60	8,0395	11,8017	0,011	0,017	
3,70	10,8004	20,6423	0,015	0,029	
3,80	9,1124	12,2166	0,013	0,017	
3,90	15,3351	13,2036	0,021	0,019	
4,00	19,3834	17,9672	0,027	0,025	
4,10	3,9625	9,613	0,006	0,013	
4,20	12,9318	7,6103	0,018	0,011	
4,30	20,0415	22,9883	0,028	0,032	
4,40	9,8705	7,3814	0,014	0,010	
4,50	10,6001	10,9863	0,015	0,015	

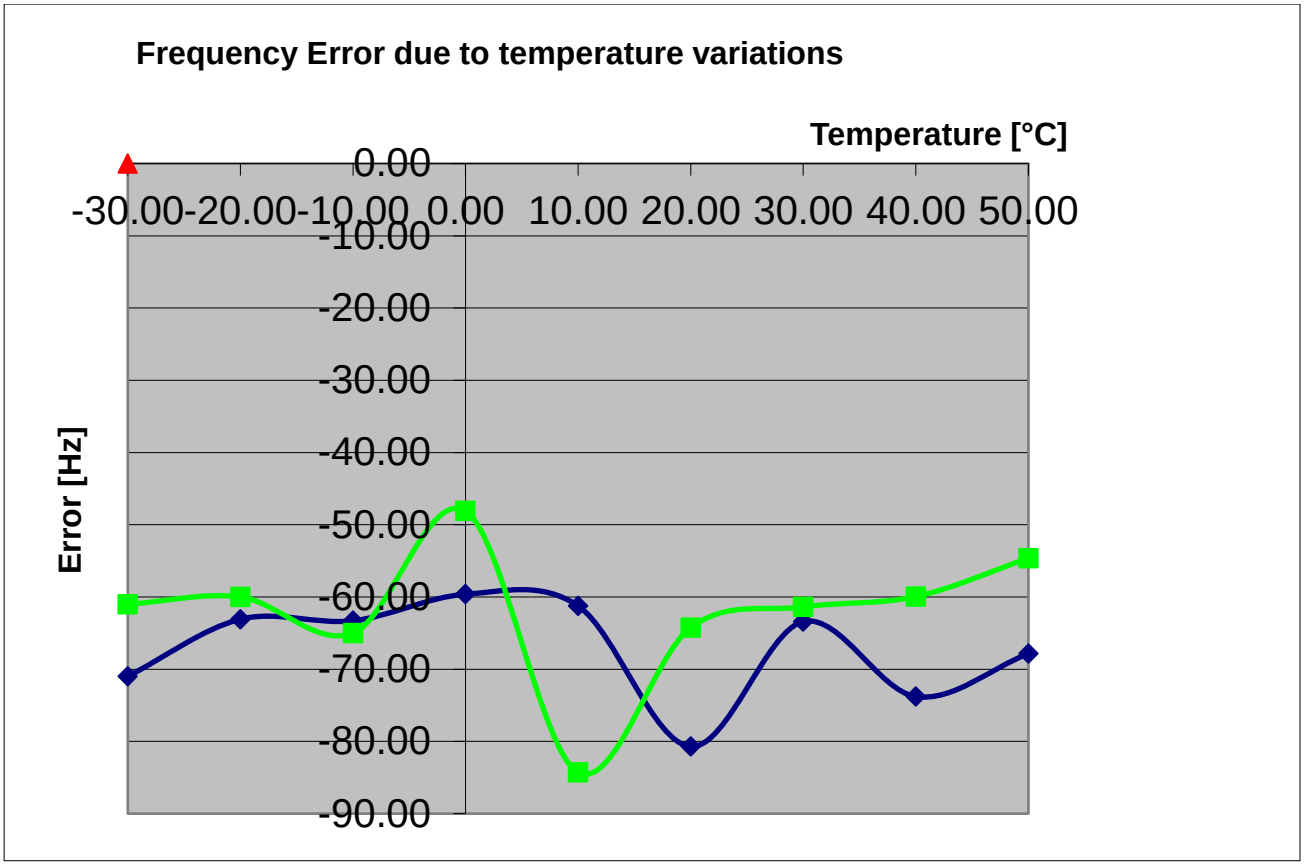


5.5.4.4. Frequency shift of carrier against temperature at constant power supply voltage

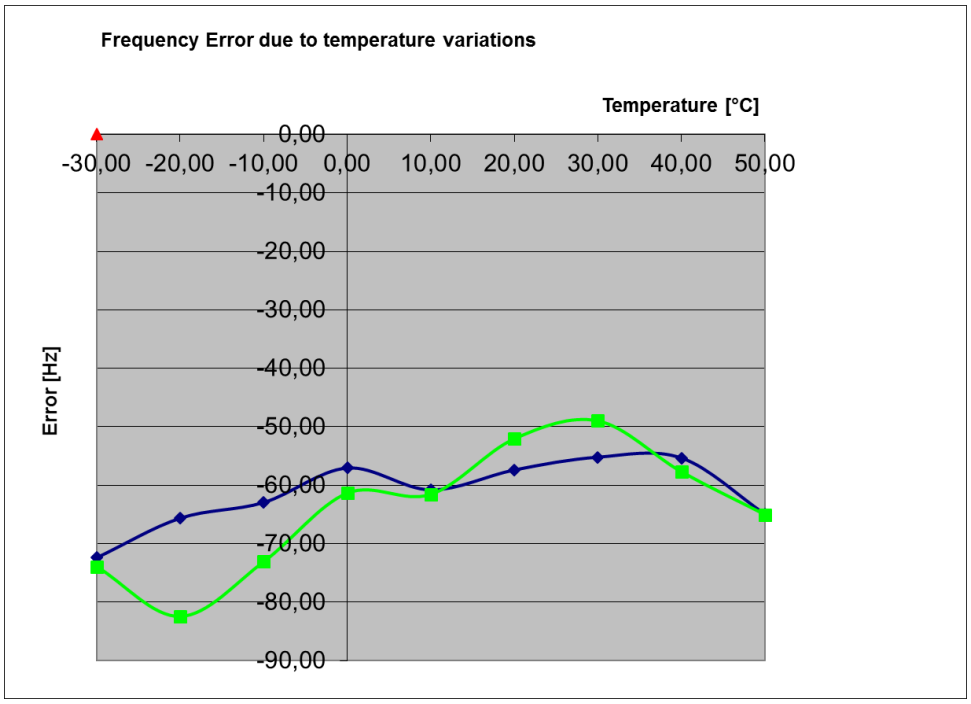
1.) determine the carrier frequency for the lowest, middle and highest channel at room temperature and nominal voltage [20°C]
2.) expose the mobile station to –30°C, wait sufficient time to have constant temperature.
3.) Perform the carrier frequencies measurements in 10°C increments from –30°C to +60°C. 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.

5.5.4.5. LTE Band 2: Maximum frequency Error during connection state

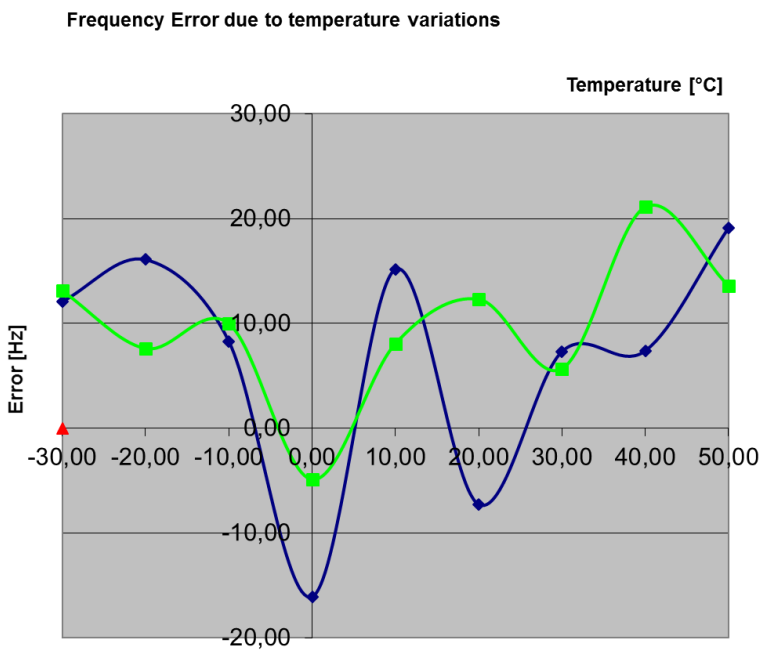
Temperature	Maximum frequency error				Verdict
	Channel 18625/ BW=5 MHz				
	QPSK Modulation [Hz]	16-QAM Modulation [Hz]	QPSK Modulation [ppm]	16-QAM Modulation [ppm]	Limit=±0.1ppm
-30	-70,982	-61,0256	-0,038	-0,033	Pass
-20	-63,0856	-59,9956	-0,034	-0,032	
-10	-63,3001	-65,0024	-0,034	-0,035	
0	-59,6237	-48,0938	-0,032	-0,026	
10	-61,2402	-84,2857	-0,033	-0,045	
20	-80,7095	-64,2443	-0,044	-0,035	
30	-63,4146	-61,3832	-0,034	-0,033	
40	-73,7858	-59,9527	-0,040	-0,032	
50	-67,8492	-54,6455	-0,037	-0,029	



Temperature	Maximum frequency error				Verdict
	Channel 18900/ BW=5 MHz				
	QPSK Modulation [Hz]	16-QAM Modulation [Hz]	QPSK Modulation [ppm]	16-QAM Modulation [ppm]	Limit=±0.1ppm
-30	-72,3982	-73,9002	-0,039	-0,039	Pass
-20	-65,6319	-82,4261	-0,035	-0,044	
-10	-62,9425	-73,0705	-0,033	-0,039	
0	-57,0488	-61,3403	-0,030	-0,033	
10	-60,7824	-61,5549	-0,032	-0,033	
20	-57,3778	-52,042	-0,031	-0,028	
30	-55,1891	-48,9807	-0,029	-0,026	
40	-55,3322	-57,6925	-0,029	-0,031	
50	-64,9309	-65,0168	-0,035	-0,035	



Temperature	Maximum frequency error				Verdict
	Channel 19175/ BW=5 MHz				
	QPSK Modulation [Hz]	16-QAM Modulation [Hz]	QPSK Modulation [ppm]	16-QAM Modulation [ppm]	Limit=±0.1ppm
-30	12,1021	13,1178	0,006	0,007	Pass
-20	16,0933	7,6103	0,008	0,004	
-10	8,297	9,985	0,004	0,005	
0	-16,0789	-4,8923	-0,008	-0,003	
10	15,1634	8,0824	0,008	0,004	
20	-7,2813	12,3167	-0,004	0,006	
30	7,3242	5,6791	0,004	0,003	
40	7,3957	21,1287	0,004	0,011	
50	19,1402	13,5899	0,010	0,007	



5.5.4.6. LTE Band 2: Canada requierement regarding emission/occupied bandwith

Measurement Method:
With results of chapter 5.5.4.5 (frequency error) and of chapter 5.2.4.1 (occupied bandwidth) a calculations should show that the emissions bandwidth remains within authorized bands. Negative frequency error shifts the carrier (T1 and T2 points) more closer to the left band-edge (1850MHz), positive frequency error shifts the carrier (T1 and T2 points) more closer to the right band-edge (1910MHz).
Following table shows the results calculated with above presumptions:

from occupied bandwidth diagramms point (T1)

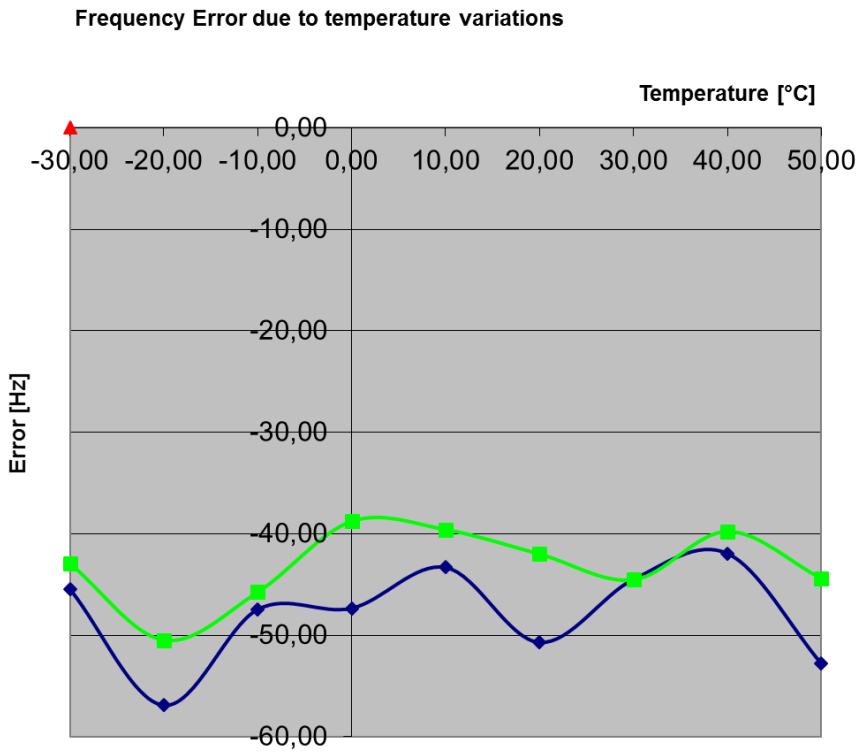
Modulation -Scheme	LTE Signal Bandwidth [MHz]	**FL [MHz]**	Low Band-Edge [MHz]	Margin to band-Edge except Frequency Error [MHz]	Frequency of Maximum Deviation during climatic tests [MHz]	**Margin to Low-Band-Edge including climatic conditions [MHz]**	Verdict
QPSK	5	1850,25	1850	0,25	-0,00001821	0,24998179	pass
	10	1850,519231		0,519231	-0,00001821	0,51921279	pass
	15	1850,802		0,802	-0,00001821	0,80198179	pass
	20	1851,044872		1,044872	-0,00001821	1,04485379	pass
16-QAM	5	1850,25	1850	0,25	0,00001146	0,25001146	pass
	10	1850,480769		0,480769	0,00001146	0,48078046	pass
	15	1850,716346		0,716346	0,00001146	0,71635746	pass
	20	1850,945513		0,945513	0,00001146	0,94552446	pass

from occupied bandwidth diagramms point (T2)

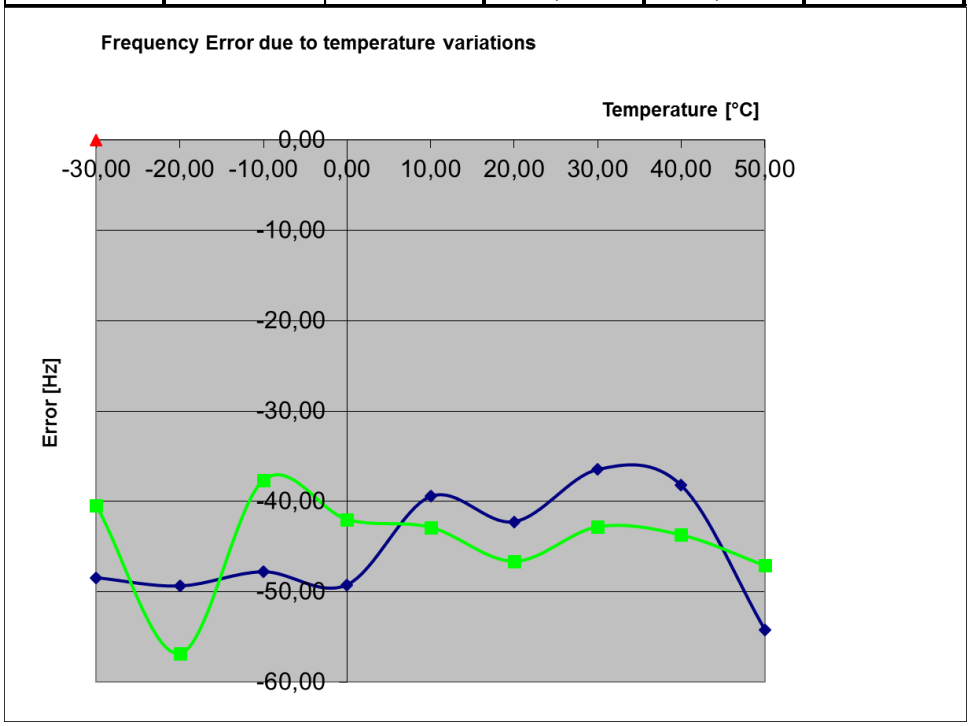
Modulation -Scheme	LTE Signal Bandwidth [MHz]	**FH [MHz]**	High Band-Edge [MHz]	Margin to band-Edge except Frequency Error [MHz]	Frequency of Maximum Deviation during climatic tests [MHz]	**Margin to Low-Band-Edge including climatic conditions**	Verdict
QPSK	5	1909,744	1910	0,256	0,00001963	0,25598037	pass
	10	1909,461538		0,538462	0,00001963	0,53844237	pass
	15	1909,147436		0,852564	0,00001963	0,85254437	pass
	20	1908,955128		1,044872	0,00001963	1,04485237	pass
16-QAM	5	1909,744	1910	0,256	0,00001648	0,25598352	pass
	10	1909,52724400		0,472756	0,00001648	0,47273952	pass
	15	1909,286859		0,713141	0,00001648	0,71312452	pass
	20	1909,046474		0,953526	0,00001648	0,95350952	pass

5.5.4.7. LTE Band 4

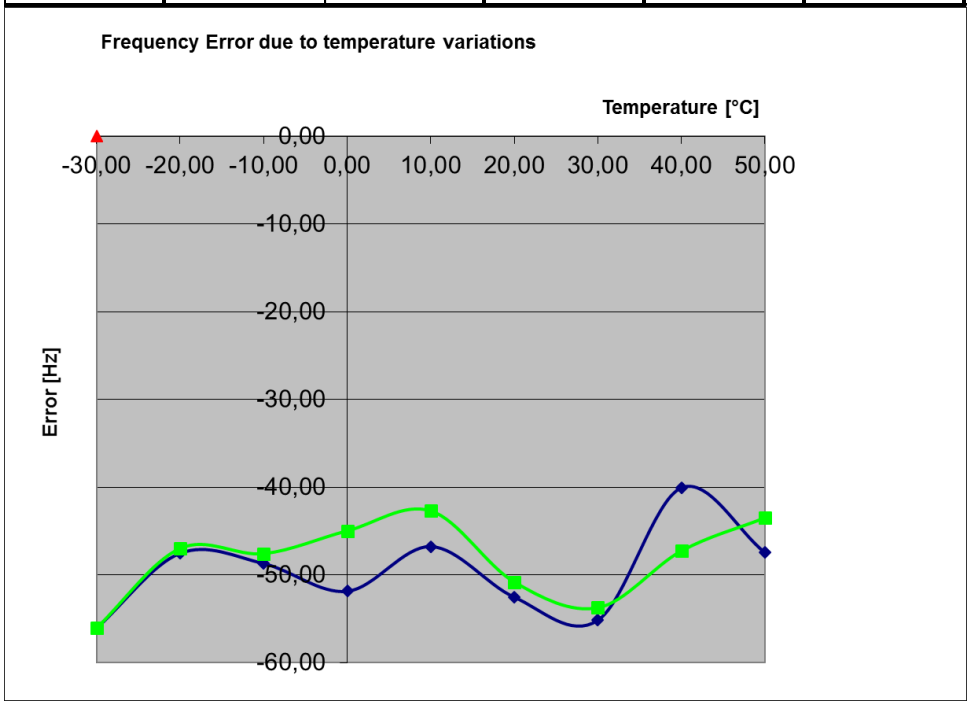
Temperature	Maximum frequency error				Verdict
	Channel 19975/ BW= 5MHz				
	QPSK Modulation [Hz]	16-QAM Modulation [Hz]	QPSK Modulation [ppm]	16-QAM Modulation [ppm]	Limit=±0.1ppm
-30	-45,4474	-42,9297	-0,027	-0,025	Pass
-20	-56,9057	-50,4828	-0,033	-0,029	
-10	-47,4501	-45,7478	-0,028	-0,027	
0	-47,3356	-38,7669	-0,028	-0,023	
10	-43,3159	-39,5823	-0,025	-0,023	
20	-50,7116	-41,9998	-0,030	-0,025	
30	-44,4889	-44,5318	-0,026	-0,026	
40	-41,9426	-39,7682	-0,024	-0,023	
50	-52,8002	-44,4031	-0,031	-0,026	



Temperature	Maximum frequency error				Verdict
	Channel 20175/ BW= 5MHz				
	QPSK Modulation [Hz]	16-QAM Modulation [Hz]	QPSK Modulation [ppm]	16-QAM Modulation [ppm]	Limit=±0.1ppm
-30	-40,4692	-48,4371	-0,023	-0,028	Pass
-20	-56,8199	-49,3526	-0,033	-0,028	
-10	-37,6368	-47,7791	-0,022	-0,028	
0	-41,9855	-49,2239	-0,024	-0,028	
10	-42,8581	-39,4392	-0,025	-0,023	
20	-46,6204	-42,243	-0,027	-0,024	
30	-42,8009	-36,4637	-0,025	-0,021	
40	-43,7021	-38,2233	-0,025	-0,022	
50	-47,0924	-54,1878	-0,027	-0,031	



Temperature	Maximum frequency error				Verdict
	Channel 20375/ BW= 5MHz				
	QPSK Modulation [Hz]	16-QAM Modulation [Hz]	QPSK Modulation [ppm]	16-QAM Modulation [ppm]	Limit=±0.1ppm
-30	-56,0474	-56,0761	-0,032	-0,032	Pass
-20	-46,978	-47,5359	-0,027	-0,027	
-10	-47,574	-48,7089	-0,027	-0,028	
0	-44,9753	-51,8704	-0,026	-0,030	
10	-42,7008	-46,7634	-0,024	-0,027	
20	-50,8118	-52,5427	-0,029	-0,030	
30	-53,7443	-55,1748	-0,031	-0,031	
40	-47,2641	-40,0686	-0,027	-0,023	
50	-43,4875	-47,4644	-0,025	-0,027	



5.5.4.8. LTE Band 4: Canada requierement regarding emission/occupied bandwith

Measurement Method:
With results of chapter 5.5.4.7 (frequency error) and of chapter 5.2.4.2 (occupied bandwidth) a calculations should show that the emissions bandwidth remains within authorized bands. Negative frequency error shifts the carrier (T1 and T2 points) more closer to the left band-edge (1710MHz), positive frequency error shifts the carrier (T1 and T2 points) more closer to the right band-edge (1755MHz).
Following table shows the results calculated with above presumptions:

from occupied bandwidth diagramms point

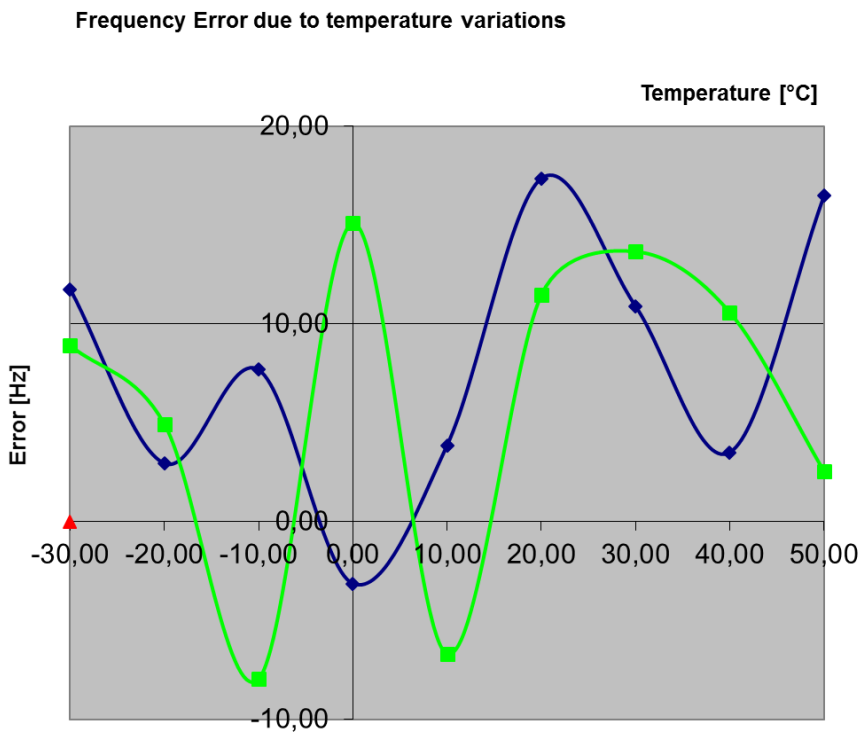
Modulation -Scheme	LTE Signal Bandwidth [MHz]	**FL [MHz]**	Low Band-Edge [MHz]	Margin to band-Edge except Frequency Error [MHz]	Frequency of Maximum Deviation during climatic tests [MHz]	**Margin to Low-Band-Edge including climatic conditions [MHz]**	Verdict
QPSK	5	1710,259615	1710	0,259615	-0,00001295	0,25960205	pass
	10	1710,5		0,5	-0,00001295	0,49998705	pass
	15	1710,802		0,802	-0,00001295	0,80198705	pass
	20	1711,024		1,024	-0,00001295	1,02398705	pass
16-QAM	5	1710,25	1710	0,25	-0,00001542	0,24998458	pass
	10	1710,461538		0,461538	-0,00001542	0,46152258	pass
	15	1710,689103		0,689103	-0,00001542	0,68908758	pass
	20	1710,939103		0,939103	-0,00001542	0,93908758	pass

from occupied bandwidth diagramms point

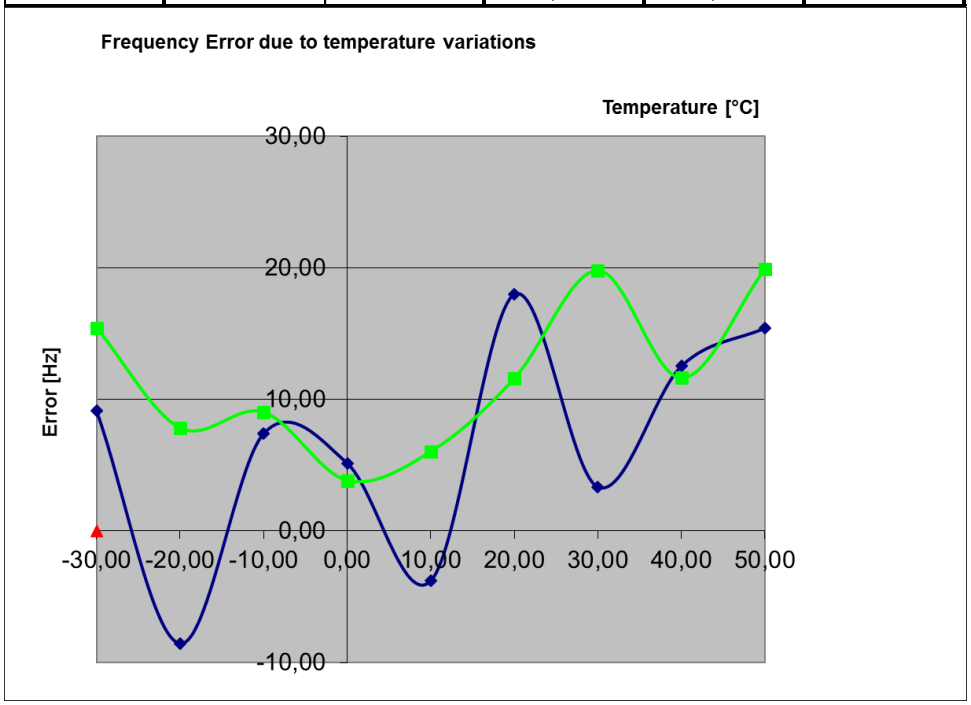
Modulation -Scheme	LTE Signal Bandwidth [MHz]	**FH [MHz]**	High Band-Edge [MHz]	Margin to band-Edge except Frequency Error [MHz]	Frequency of Maximum Deviation during climatic tests [MHz]	Margin to Low-Band-Edge including climatic conditions [MHz]	Verdict
QPSK	5	1754,744	1755	0,256	0,00001911	0,25598089	pass
	10	1754,488		0,512	0,00001911	0,51198089	pass
	15	1754,17		0,83	0,00001911	0,82998089	pass
	20	1753,955		1,045	0,00001911	1,04498089	pass
16-QAM	5	1754,756	1755	0,244	0,00001966	0,24398034	pass
	10	1754,527244		0,472756	0,00001966	0,47273634	pass
	15	1754,270833		0,729167	0,00001966	0,72914734	pass
	20	1754,080897		0,919103	0,00001966	0,91908334	pass

5.5.4.9. LTE Band 12

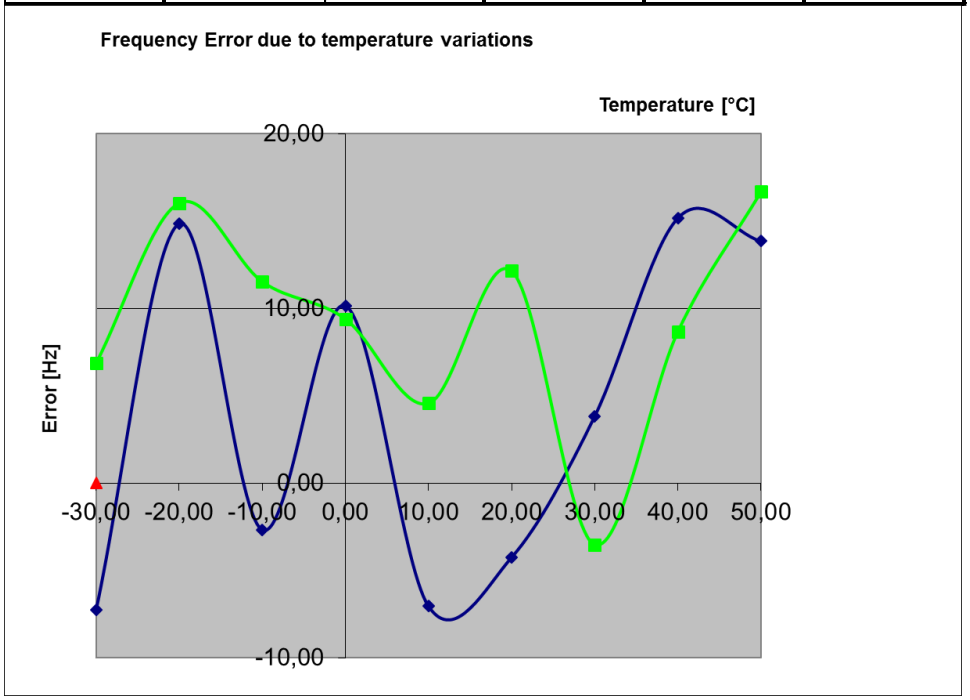
Temperature	Maximum frequency error				Verdict
	Channel 23035/ BW= 5MHz				
	QPSK Modulation [Hz]	16-QAM Modulation [Hz]	QPSK Modulation [ppm]	16-QAM Modulation [ppm]	Limit=±0.1ppm
-30	11,7588	8,9121	0,017	0,013	Pass
-20	2,9469	4,9353	0,004	0,007	
-10	7,6818	-7,9536	0,011	-0,011	
0	-3,1328	15,0919	-0,004	0,022	
10	3,8624	-6,6805	0,006	-0,010	
20	17,3664	11,4727	0,025	0,016	
30	10,9005	13,6614	0,016	0,019	
40	3,5048	10,5858	0,005	0,015	
50	16,4795	2,5463	0,023	0,004	



Temperature	Maximum frequency error				Verdict
	Channel23095/ BW= 5MHz				
	QPSK Modulation [Hz]	16-QAM Modulation [Hz]	QPSK Modulation [ppm]	16-QAM Modulation [ppm]	Limit=±0.1ppm
-30	15,4495	9,1267	0,022	0,013	Pass
-20	7,8392	-8,5545	0,011	-0,012	
-10	9,0408	7,41	0,013	0,010	
0	3,8481	5,1498	0,005	0,007	
10	6,0368	-3,7909	0,009	-0,005	
20	11,6014	17,9958	0,016	0,025	
30	19,8126	3,3474	0,028	0,005	
40	11,6301	12,5313	0,016	0,018	
50	19,9127	15,4352	0,028	0,022	



Temperature	Maximum frequency error				Verdict
	Channel23155/ BW= 5MHz				
	QPSK Modulation [Hz]	16-QAM Modulation [Hz]	QPSK Modulation [ppm]	16-QAM Modulation [ppm]	Limit=±0.1ppm
-30	6,8665	-7,267	0,010	-0,010	Pass
-20	16,036	14,8487	0,022	0,021	
-10	11,5299	-2,6751	0,016	-0,004	
0	9,3985	10,1423	0,013	0,014	
10	4,5633	-7,0524	0,006	-0,010	
20	12,145	-4,2486	0,017	-0,006	
30	-3,5191	3,8338	-0,005	0,005	
40	8,6832	15,1777	0,012	0,021	
50	16,6798	13,8474	0,023	0,019	



5.5.4.10. LTE Band 12: Canada requierement regarding emission/occupied bandwith

Measurement Method:
With results of chapter 5.5.4.9 (frequency error) and spectrum mask diagrams (see annex 1) a calculations should show that the points FH and FL remain within authorized band. Negative frequency error shifts the carrier (F_L point) more closer to the left band-edge (698MHz), positive frequency error shifts the carrier (F_H) more closer to the right band-edge (716MHz).

Following table shows the results calculated with above presumptions:

Modulation -Scheme	LTE Signal Bandwidth [MHz]	**from spectrum diagram F_L [MHz]**	Low Band-Edge [MHz]	Margin to band-Edge except Frequency Error [MHz]	Frequency of Maximum Deviation during climatic tests [MHz]	**Margin to Low-Band-Edge including climatic conditions [MHz]**	Verdict
QPSK	5	699,201923077	698	1,201923077	-0,00000738	1,20191570	pass
	10	699,384615385		1,384615385	-0,00000738	1,38460800	pass
16-QAM	5	699,192307692	698	1,192307692	-0,00000833	1,19229936	pass
	10	699,384615385		1,384615385	-0,00000833	1,38460705	pass

Modulation -Scheme	LTE Signal Bandwidth [MHz]	**from spectrum diagram F_H [MHz]**	High Band-Edge [MHz]	Margin to band-Edge except Frequency Error [MHz]	Frequency of Maximum Deviation during climatic tests [MHz]	Margin to Low-Band-Edge including climatic conditions [MHz]	Verdict
QPSK	5	715,807692308	716	0,192307692	0,00000710	0,19230059	pass
	10	715,615384615		0,384615385	0,00000710	0,38460828	pass
16-QAM	5	715,807692308	716	0,192307692	0,00001439	0,19229330	pass
	10	715,615384615		0,384615385	0,00001439	0,38460099	pass

5.6. General Limit - Conducted emissions on AC-Power lines

5.6.1. 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	☐ 333 EMI field	☒ 348 EMI cond.				
receiver	☐ 001 ESS	☒ 377 ESCS 30	☐ 489 ESU 40	☐ 620 ESU 26		
LISN	☒ 005 ESH2-Z5	☐ 007 ESH3-Z6	☐ 300 ESH3-Z5 & 50Ω used for AE		☐ no LISN for AE	
signaling	☐ 392 MT8820A	☐ 436 CMU	☐ 547 CMU	☐ 594 CMW		
line voltage	☐ 230 V 50 Hz via public mains		☒ 060 120 V 60 Hz via PAS 5000			

5.6.2. Requirements

FCC		Part 15, Subpart B, §15.207	
IC		RSS-Gen Issue 4, Chapter 8.8, Table 3	
ANSI		C63.10-2013	
Limit	Frequency [MHz]	QUASI-Peak [dBµV]	AVERAGE [dBµV]
	0.15 – 0.5	66 to 56*	56 to 46*
	0.5 – 5	56	46
	5 – 30	60	50
Remark: * decreases with the logarithm of the frequency			

5.6.3. 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 (40 cm distance to reference ground plane (wall)		☐ floor standing EUT stands isolated on reference ground plane (floor)
Climatic conditions		Temperature: (22±3°C)		Rel. humidity: (40±20)%
EMI-Receiver or Analyzer settings	Scan data	☐ 9 – 150 kHz, RBW = 200 Hz, Step = 61 Hz ☒ 150 kHz – 30 MHz RBW = 9 kHz, Step = 4 kHz ☐ other:		
	Scan-Mode Pre-measurement Final measurement	6 dB EMI-Receiver Mode Peak detector, Repetitive-Scan, max-hold, sweep-time 50 µs per frequency point Average & Quasi-peak detector at critical frequencies		
General measurement procedures		Please see chapter "Test system set-up for AC power line conducted emissions measurements"		

5.6.4. Measurement results

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

EUT set-up no.:			set-up 2		
Diagram No.	EUT operating mode no. or commend	Used Detector	Power line	Additional (scan-) information or remarks	Result
1.01	EUT operating mode 2	☒ Peak (pre-scan) ☒ AV (final) ☒ QP (final)	L1/ N	LTE Band 4: Tested on channel 20175, SignaBW:5MHz, 25RBs	passed
1.02	EUT operating mode 1	☒ Peak (pre-scan) ☒ AV (final) ☒ QP (final)	L1/ N	LTE Band 2: Tested on channel 18900, SignaBW:5MHz, 25RBs	passed
1.03	EUT operating mode 3	☒ Peak (pre-scan) ☒ AV (final) ☒ QP (final)	L1/ N	LTE Band 12: Tested on channel 23095, SignaBW:5MHz, 25RBs	passed

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

5.7.1. Test location and equipment

test location	☒ CETECOM Essen (Chapter. 2.2.1)		☐ Please see Chapter. 2.2.2		☐ Please see Chapter. 2.2.3	
test site	☒ 441 EMI SAR	☐ 487 SAR NSA	☐ 347 Radio.lab.		☐	☐
receiver	☐ 377 ESCS30	☒ 001 ESS	☐	☐	☐	☐
spectr. analys.	☐ 584 FSU	☐ 120 FSEM	☐ 264 FSEK	☐	☐	☐
antenna	☐ 574 BTA-L	☐ 133 EMCO3115	☐ 302 BBHA9170	☐ 289 CBL 6141	☒ 030 HFH-Z2	☐ 477 GPS
signaling	☐ 392 MT8820A	☐ 371 CBT32	☐ 547 CMU	☐ 594 CMW		
otherwise	☐ 400 FTC40x15E	☐ 401 FTC40x15E	☐ 110 USB LWL	☐ 482 Filter Matrix	☐ 378 RadiSense	
DC power	☐ 456 EA 3013A	☐ 457 EA 3013A	☐ 459 EA 2032-50	☐ 268 EA- 3050	☐ 494 AG6632A	☐ 498 NGPE 40
line voltage	☐ 230 V 50 Hz via public mains		☒ 060 120 V 60 Hz via PAS 5000			

5.7.2. Requirements

FCC	Part 15, Subpart C, §15.205 & §15.209			
IC	RSS-Gen: Issue 4: §8.9 Table 5			
ANSI	C63.10-2013			
Frequency [MHz]	Field strength limit [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

5.7.3. 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"		

5.7.4. Measurement Results LTE FDD Band 2:

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

Table of measurement results:

Diagram No.	Carrier Channel		Frequency range	Set-up no.	OP-mode no.	Remark	Used detector			Result
	Range	No.					PK	AV	QP	
2.01	High	19175	9 kHz-30 MHz		1	LTE Band 2 QPSK modulation	☒	☐	☐	passed
2.02	Middle	18900	9 kHz-30 MHz		1	LTE Band 2 16-QAM modulation	☒	☐	☐	passed
2.03	Low	18700	9 kHz-30 MHz		1	LTE Band 2 16-QAM modulation	☒	☐	☐	passed

5.7.5. Measurement Results LTE FDD Band 4:

Table of measurement results:

Diagram No.	Carrier Channel		Set-up no.	OP-mode no.	Remark	Remark	Used detector			Result
	Range	No.					PK	AV	QP	
2.01	High	19175	9 kHz-30 MHz		1	LTE Band 2 QPSK modulation	☒	☐	☐	passed
2.05	High	20300	9 kHz-30 MHz		2	LTE Band 4 QPSK modulation	☒	☐	☐	Passed
2.06	Middle	19975	9 kHz-30 MHz		2	LTE Band 4 QPSK modulation	☒	☐	☐	passed
2.07	Low	20175	9 kHz-30 MHz		2	LTE Band 4 16-QAM modulation	☒	☐	☐	passed

5.7.6. Measurement Results LTE FDD Band 12:

Table of measurement results:

Diagram No.	Carrier Channel		Frequency range	Set-up no.	OP-mode no.	Remark	Used detector			Result
	Range	No.					PK	AV	QP	
2.08	Low	23035	9 kHz-30 MHz		2	LTE Band 12 QPSK modulation	☒	☐	☐	Passed
2.09	Middle	23095	9 kHz-30 MHz		2	LTE Band 12 QPSK modulation	☒	☐	☐	passed
2.10	High	23155	9 kHz-30 MHz		2	LTE Band 12 QPSK modulation	☒	☐	☐	passed

5.7.7. 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

5.8. Measurement uncertainties

The reported uncertainties are calculated based on the standard uncertainty multiplied with the appropriate coverage factor **k**, such that a confidence level of approximately 95% is achieved.
For uncertainty determination, each component used in the concrete measurement set-up was taken in account and it's contribution to the overall uncertainty according it's statistical distribution calculated.

Following table shows expectable uncertainties for each measurement type performed.

RF-Measurement	Reference	Frequency range	Calculated uncertainty based on a confidence level of 95%						Remarks
Conducted emissions (U_{CISPR})	CISPR 16-2-1	9 kHz - 150 kHz 150 kHz - 30 MHz	4.0 dB 3.6 dB						-
Radiated emissions Enclosure	CISPR 16-2-3	30 MHz - 1 GHz 1 GHz - 18 GHz	4.2 dB 5.1 dB						E-Field
Disturbance power	CISPR 16-2-2	30 MHz - 300 MHz	-						-
Power Output radiated	-	30 MHz - 4 GHz	3.17 dB						Substitution method
Power Output conducted	-	Set-up No.	Cel-C1	Cel-C2	BT1	W1	W2	--	
		9 kHz - 12.75 GHz	N/A	0.60	0.7	0.25	N/A	--	-
		12.75 - 26.5GHz	N/A	0.82	--	N/A	N/A	--	
Conducted emissions on RF-port	-	9 kHz - 2.8 GHz	0.70	N/A	0.70	N/A	0.69	--	N/A - not applicable
		2.8 GHz - 12.75GHz	1.48	N/A	1.51	N/A	1.43	--	
		12.75 GHz - 18GHz	1.81	N/A	1.83	N/A	1.77	--	
		18 GHz - 26.5GHz	1.83	N/A	1.85	N/A	1.79	--	
Occupied bandwidth	-	9 kHz - 4 GHz	0.1272 ppm (Delta Marker)						Frequency error
			1.0 dB						Power
Emission bandwidth	-	9 kHz - 4 GHz	0.1272 ppm (Delta Marker)						Frequency error
	-		See above: 0.70 dB						Power
Frequency stability	-	9 kHz - 20 GHz	0.0636 ppm						-
Radiated emissions Enclosure	-	150 kHz - 30 MHz 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)	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 equiment "CTC"

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

8.1.1. Test software and firmware of equipment

Ref.-No.	Equipment	Type	Serial-No.	Version of Firmware or Software during the test
001	EMI Test Receiver	ESS	825132/017	Firm.= 1.21 , OTP=2.0, GRA=2.0
012	Signal Generator (EMS-cond.)	SMY 01	839069/027	Firm.= V 2.02
013	Power Meter (EMS cond.)	NRVD	839111/003	Firm.= V 1.51
017	Digital Radiocommunication Tester	CMD 60 M	844365/014	Firmware = V 3.52 .22.01.99, DECT = D2.87 13.01.99
053	Audio Analyzer	UPA3	860612/022	Firm. V 4.3
119	RT Harmonics Analyzer dig. Flickermeter	B10	G60547	Firm.= V 3.1DHG
140	Signal Generator	SMHU	831314/006	Firm.= 3.21
261	Thermal Power Sensor	NRV-Z55	825083/0008	EPROM-Datum 02.12.04, SE EE 1 B
262	Power Meter	NRV-S	825770/0010	Firm.= 2.6
263	Signal Generator	SMP 04	826190/0007	Firm.=3.21
295	Racal Digital Radio Test Set	6103	1572	UNIT Firmware= 4.04, SW-Main=4.04, SW-BBP=1.04, SW-DSP=1.02, Hardboot=1.02, Softboot=2.02
298	Univ. Radio Communication Tester	CMU 200	832221/091	R&S Test Firmware =3.53 /3.54 (current Testsoftw. f. all band used
323	Digital Radiocommunication Tester	CMD 55	825878/0034	Firm.= 3.52 .22.01.99
335	CTC-EMS-Conducted	System EMS Conducted	-	EMC 32 V 8.52
340	Digital Radiocommunication Tester	CMD 55	849709/037	Firm.= 3.52 .22.01.99
355	Power Meter	URV 5	891310/027	Firm.= 1.31
365	10V Insertion Unit 50 Ohm	URV5-Z2	100880	Eprom Data = 31.03.08
366	Ultra Compact Simulator	UCS 500 M4	V0531100594	Firm. UCS 500=001925/3.06a02, rc=ISMIEC 4.10
371	Bluetooth Tester	CBT32	100153	CBT V5,30+ SW-Option K55, K57
377	EMI Test Receiver	ESCS 30	100160	Firm.= 2.30, OTP= 02.01, GRA= 02.36
378	Broadband RF Field Monitor	RadiSense III	03D00013SNO-08	Firm.= V.03D13
389	Digital Multimeter	Keithley 2000	0583926	Firm. = A13 (Mainboard) A02 (Display)
392	Radio Communication Tester	MT8820A	6K00000788	Firm.= 4.50 #005, IPL=4.01#001,OS=4.02#001, GSM=4.41#013, W-CDMA= 4.54#004, scenario= 4.52#002
436	Univ. Radio Communication Tester	CMU 200	103083	R&S Test Firmware Base=5.14, Mess-Software= GSM:5.14 WCDMA:5.14 (current Testsoftw. F. all band
441	CTC-SAR-EMI Cable Loss	System EMI field (SAR)	-	EMC 32 Version 8.52
442	CTC-SAR-EMS	System EMS field (SAR)	-	EMC 32 Version 8.40
443	CTC-FAR-EMI-RSE	System CTC-FAR-EMI-RSE	-	Spuri 7.2.5 or EMC 32 Ver. 9.15.00
444	CTC-FAR-EMS field	System-EMS-Field (FAR)	-	EMC 32 Version 9.15.00
460	Univ. Radio Communication Tester	CMU 200	108901	R&S Test Firmware Base=5.14, GSM=5.14 WCDMA=5.14 (current Testsoftw.,f. all band to be used,
489	EMI Test Receiver	ESU40	1000-30	Firmware=4.43 SP3, Bios=V5.1-16-3, Spec. =01.00
491	ESD Simulator dito	ESD dito	dito307022	V 2.30
524	Voltage Drop Simulator	VDS 200	0196-16	Software Nr: 000037 Version V4.20a01
526	Burst Generator	EFT 200 A	0496-06	Software Nr. 000034 Version V2.32
527	Micro Pulse Generator	MPG 200 B	0496-05	Software-Nr. 000030 Version V2.43
528	Load Dump Simulator	LD 200B	0496-06	Software-Nr. 000031 Version V2.35a01
546	Univ. Radio Communication Tester	CMU 200	106436	R&S Test Firmware Base=5.14, GSM=5.14 WCDMA=5.14 (current Testsoftw.,f. all band to be used
547	Univ. Radio Communication Tester	CMU 200	835390/014	R&S Test Firmware Base=V5.1403 (current Testsoftw., f. all band used, GSM = 5.14 WCDMA: = 5.14
584	Spectrum Analyzer	FSU 8	100248	2.82_SP3
597	Univ. Radio Communication Tester	CMU 200	100347	R&S Test Firmware Base=5.01, GSM=5.02 WCDMA= not installed, Mainboard= µP1=V.850
598	Spectrum Analyzer	FSEM 30 (Reserve)	831259/013	Firmware Bios 3.40 , Analyzer 3.40 Sp 2
620	EMI Test Receiver	ESU 26	100362	4.43_SP3
642	Wideband Radio Communication Tester	CMW 500	126089	Setup V03.26, Test programm component V03.02.20
670	Univ. Radio Communication Tester	CMU 200	106833	µP1 =V8.50, Firmware = V.20
689	Vector Signal Generator	SMU200	100970	02.20.360.142
692	Bluetooth Tester	CBT 32	100236	CBT V 5.40, FW: V.2.41 (FPGA Digital, V. 3.09 FPGA RF)

8.1.2. Single instruments and test systems

Ref.-No.	Equipment	Type	Serial-No.	Manufacturer	Interval of calibration	Remark	Cal due
001	EMI Test Receiver	ESS	825132/017	Rohde & Schwarz	12 M	-	30.05.2017
005	AC - LISN (50 Ohm/50µH, test site 1)	ESH2-Z5	861741/005	Rohde & Schwarz	12 M	-	30.05.2017
007	Single-Line V-Network (50 Ohm/5µH)	ESH3-Z6	892563/002	Rohde & Schwarz	12 M	-	30.05.2017
009	Power Meter (EMS-radiated)	NRV	863056/017	Rohde & Schwarz	24 M	-	30.04.2017
016	Line Impedance Simulating Network	Op. 24-D	B6366	Spitzenberger+Spies	36 M	-	30.05.2019
020	Horn Antenna 18 GHz (Subst 1)	3115	9107-3699	EMCO	36/12 M	-	31.03.2017
021	Loop Antenna (H-Field)	6502	9206-2770	EMCO	36 M	-	30.04.2018
030	Loop Antenna (H-field)	HFH-Z2	879604/026	Rohde & Schwarz	36 M	-	30.04.2018
033	RF-current probe (100kHz-30MHz)	ESH2-Z1	879581/18	Rohde & Schwarz	24 M	-	30.04.2017
057	relay-switch-unit (EMS system)	RSU	494440/002	Rohde & Schwarz	pre-m	1a	
060	power amplifier (DC-2kHz)	PAS 5000	B6363	Spitzenberger+Spies	-	3	
066	notch filter (WCDMA; FDD1)	WRCT 1900/2200-5/40-10EEK	5	Wainwright GmbH	12 M	1g	30.06.2016
086	DC - power supply, 0 -10 A	LNG 50-10	-	Heinzinger Electronic	pre-m	2	
087	DC - power supply, 0 -5 A	EA-3013 S	-	Elektro Automatik	pre-m	2	
091	USB-LWL-Converter	OLS-1	007/2006	Ing. Büro Scheiba	-	4	
099	passive voltage probe	ESH2-Z3	299.7810.52	Rohde & Schwarz	36 M	-	30.04.2018
100	passive voltage probe	Probe TK 9416	without	Schwarzbeck	36 M	-	30.04.2018
110	USB-LWL-Converter	OLS-1	-	Ing. Büro Scheiba	-	4	
119	RT Harmonics Analyzer dig. Flickermeter	B10	G60547	BOCONSULT	36 M	-	30.05.2019
136	adjustable dipole antenna (Dipole 1)	3121C-DB4	9105-0697	EMCO	36 M	-	30.04.2018
140	Signal Generator	SMHU	831314/006	Rohde & Schwarz	24 M	-	30.05.2018
248	attenuator	SMA 6dB 2W	-	Radiall	pre-m	2	
249	attenuator	SMA 10dB 10W	-	Radiall	pre-m	2	
252	attenuator	N 6dB 12W	-	Radiall	pre-m	2	
256	attenuator	SMA 3dB 2W	-	Radiall	pre-m	2	
257	hybrid	4031C	04491	Narda	pre-m	2	
260	hybrid coupler	4032C	11342	Narda	pre-m	2	
261	Thermal Power Sensor	NRV-Z55	825083/0008	Rohde & Schwarz	24 M	-	30.05.2018
262	Power Meter	NRV-S	825770/0010	Rohde & Schwarz	24 M	-	30.05.2018
263	Signal Generator	SMP 04	826190/0007	Rohde & Schwarz	36 M	-	30.05.2019
265	peak power sensor	NRV-Z33, Model 04	840414/009	Rohde & Schwarz	24 M	-	30.05.2018
266	Peak Power Sensor	NRV-Z31, Model 04	843383/016	Rohde & Schwarz	24 M	-	30.05.2018
267	notch filter GSM 850	WRCA 800/960-6EEK	9	Wainwright GmbH	pre-m	2	
270	termination	1418 N	BB6935	Weinschel	pre-m	2	
271	termination	1418 N	BE6384	Weinschel	pre-m	2	
272	attenuator (20 dB) 50 W	Model 47	BF6239	Weinschel	pre-m	2	
273	attenuator (10 dB) 100 W	Model 48	BF9229	Weinschel	pre-m	2	
274	attenuator (10 dB) 50 W	Model 47 (10 dB) 50 W	BG0321	Weinschel	pre-m	2	
275	DC-Block	Model 7003 (N)	C5129	Weinschel	pre-m	2	
276	DC-Block	Model 7006 (SMA)	C7061	Weinschel	pre-m	2	
279	power divider	1515 (SMA)	LH855	Weinschel	pre-m	2	
287	pre-amplifier 25MHz - 4GHz	AMF-2D-100M4G-35-10P	379418	Miteq	12 M	1c	30.06.2017
291	high pass filter GSM 850/900	WHJ 2200-4EE	14	Wainwright GmbH	12 M	1c	30.06.2017
298	Univ. Radio Communication Tester	CMU 200	832221/091	Rohde & Schwarz	pre-m	3	
300	AC LISN (50 Ohm/50µH, 1-phase)	ESH3-Z5	892 239/020	Rohde & Schwarz	12 M	-	30.05.2017
301	attenuator (20 dB) 50W, 18GHz	47-20-33	AW0272	Lucas Weinschel	pre-m	2	
302	horn antenna 40 GHz (Meas 1)	BBHA9170	155	Schwarzbeck	36 M	-	31.03.2017
303	horn antenna 40 GHz (Subst 1)	BBHA9170	156	Schwarzbeck	36 M	-	31.03.2017
331	Climatic Test Chamber -40/+80 Grad	HC 4055	43146	Heraeus Vötsch	Pre-m	2	
341	Digital Multimeter	Fluke 112	81650455	Fluke	24 M	-	30.05.2018
342	Digital Multimeter	Voltcraft M-4660A	IB 255466	Voltcraft	24 M	-	30.04.2017
347	laboratory site	radio lab.	-	-	-	5	
348	laboratory site	EMI conducted	-	-	-	5	
354	DC - Power Supply 40A	NGPE 40/40	448	Rohde & Schwarz	pre-m	2	
355	Power Meter	URV 5	891310/027	Rohde & Schwarz	24 M	-	30.05.2018
357	power sensor	NRV-Z1	861761/002	Rohde & Schwarz	24 M	-	30.04.2017
371	Bluetooth Tester	CBT32	100153	R&S	36 M	-	30.05.2019
373	Single-Line V-Network (50 Ohm/5µH)	ESH3-Z6	100535	Rohde & Schwarz	12 M	-	30.05.2017
377	EMI Test Receiver	ESCS 30	100160	Rohde & Schwarz	12 M	-	30.05.2017
389	Digital Multimeter	Keithley 2000	0583926	Keithley	24 M	-	30.04.2017
392	Radio Communication Tester	MT8820A	6K00000788	Anritsu	12 M	-	30.05.2017
431	Model 7405	Near-Field Probe Set	9305-2457	EMCO	-	4	
436	Univ. Radio Communication Tester	CMU 200	103083	Rohde & Schwarz	12 M	-	30.04.2017
439	UltraLog-Antenna	HL 562	100248	Rohde & Schwarz	36 M	-	31.03.2017
443	CTC-FAR-EMI-RSE	System CTC-FAR-EMI-RSE	-	ETS-Lindgren / CETECOM	12 M	5	30.06.2017
448	notch filter WCDMA_FDD II	WRCT 1850.0/2170.0-5/40-	5	Wainwright Instruments GmbH	12 M	1c	30.06.2017
449	notch filter WCDMA FDD V	WRCT 824.0/894.0-5/40-8SSK	1	Wainwright	12 M	1c	30.06.2017
454	Oscilloscope	HM 205-3	9210 P 29661	Hameg	-	4	
456	DC-Power supply 0-5 A	EA 3013 S	207810	Elektro Automatik	pre-m	2	

Ref.-No.	Equipment	Type	Serial-No.	Manufacturer	Interval of calibration	Remark	Cal due
459	DC -Power supply 0-5 A , 0-32 V	EA-PS 2032-50	910722	Elektro Automatik	pre-m	2	
460	Univ. Radio Communication Tester	CMU 200	108901	Rohde & Schwarz	12 M	-	30.04.2017
463	Universal source	HP3245A	2831A03472	Agilent	-	4	
466	Digital Multimeter	Fluke 112	89210157	Fluke USA	24 M	-	30.05.2018
467	Digital Multimeter	Fluke 112	89680306	Fluke USA	36 M	-	30.04.2018
468	Digital Multimeter	Fluke 112	90090455	Fluke USA	36 M	-	30.04.2018
477	ReRadiating GPS-System	AS-47	-	Automotive Cons. Fink	-	3	
480	power meter (Fula)	NRVS	838392/031	Rohde & Schwarz	24 M	-	30.04.2017
482	filter matrix	Filter matrix SAR 1	-	CETECOM (Brl)	-	1d	
484	pre-amplifier 2,5 - 18 GHz	AMF-5D-02501800-25-10P	1244554	Miteq	12 M	-	30.06.2017
487	System CTC NSA-Verification SAR-EMI	System EMI field (SAR) NSA	-	ETS Lindgren / CETECOM	24 M	-	31.07.2017
489	EMI Test Receiver	ESU40	1000-30	Rohde & Schwarz	12 M	-	30.05.2017
502	band reject filter	WRCG 1709/1786-1699/1796-	SN 9	Wainwright	pre-m	2	
503	band reject filter	WRCG 824/849-814/859-	SN 5	Wainwright	pre-m	2	
512	notch filter GSM 850	WRCA 800/960-02/40-6EEK	SN 24	Wainwrght	12 M	1c	30.06.2017
517	relais switch matrix	HF Relais Box Keithley	SE 04	Keithley	pre-m	2	
523	Digital Multimeter	L4411A	MY46000154	Agilent	24 M	-	30.04.2017
529	6 dB Broadband resistive power divider	Model 1515	LH 855	Weinschel	pre-m	2	
530	10 dB Broadband resistive power divider	R 416110000	LOT 9828	-	pre-m	2	
546	Univ. Radio Communication Tester	CMU 200	106436	R&S	12 M	-	30.05.2017
547	Univ. Radio Communication Tester	CMU 200	835390/014	Rohde & Schwarz	12 M	-	30.04.2017
549	Log.Per-Antenna	HL025	1000060	Rohde & Schwarz	36/12 M	-	31.07.2018
550	System CTC S-VSWR Verification SAR-EMI	System EMI Field SAR S-VSWR	-	ETS Lindgren/CETECOM	24 M	-	31.07.2017
552	high pass filter 2,8-18GHz	WHKX 2.8/18G-10SS	4	Wainwright	12 M	1c	30.06.2017
557	System CTC-OTA-2	R&S TS8991	-	Rohde & Schwarz	12 M	5	30.09.2016
558	System CTC FAR S-VSWR	System CTC FAR S-VSWR	-	CTC	24 M	-	19.04.2017
574	Biconilog Hybrid Antenna	BTA-L	980026L	Frankonia	36/12 M	-	31.03.2019
584	Spectrum Analyzer	FSU 8	100248	Rohde & Schwarz	pre-m	-	
594	Wideband Radio Communication Tester	CMW 500	101757	Rohde & Schwarz	12 M	-	30.04.2017
597	Univ. Radio Communication Tester	CMU 200	100347	Rohde & Schwarz	pre-m	-	
598	Spectrum Analyzer	FSEM 30 (Reserve)	831259/013	Rohde & Schwarz	24 M	-	30.04.2017
600	power meter	NRVD (Reserve)	834501/018	Rohde & Schwarz	24 M	-	30.04.2017
601	medium-sensitivity diode sensor	NRV-Z5 (Reserve)	8435323/003	Rohde & Schwarz	24 M	-	30.04.2017
602	peak power sensor	NRV-Z32 (Reserve)	835080	Rohde & Schwarz	24 M	-	
611	DC power supply	E3632A	KR 75305854	Agilent	pre-m	2	
612	DC power supply	E3632A	MY 40001321	Agilent	pre-m	2	
613	Attenuator	R416120000 20dB 10W	Lot. 9828	Radiall	pre-m	2	
616	Digitalmultimeter	Fluke 177	88900339	Fluke	24 M	-	30.05.2018
617	Power Splitter/Combiner	ZFSC-2-2-S+	S F987001108	Mini Circuits	-	2	
618	Power Splitter/Combiner	50PD-634	600994	JFW Industries USA	-	2	
619	Power Splitter/Combiner	50PD-634	600995	JFW Industries, USA	-	3	
620	EMI Test Receiver	ESU 26	100362	Rohde-Schwarz	12 M	-	30.05.2017
621	Step Attenuator 0-139 dB	RSP	100017	Rohde & Schwarz	pre-m	2	
625	Generic Test Load USB	Generic Test Load USB	-	CETECOM	-	2	
627	data logger	OPUS 1	201.0999.9302.6.4.1.4 3	G. Lufft GmbH	24 M	-	30.04.2017
634	Spectrum Analyzer	FSM (HF-Unit)	826188/010	Rohde & Schwarz	pre-m	2	
637	High Speed HDMI with Ethernet 1m	HDMI cable with Ethernet 1m	-	KogiLink	-	2	
638	HDMI Kabel with Ethernet 1,5 m flach	HDMI cable with Ethernet	-	Reichelt	-	2	
640	HDMI cable 2m rund	HDMI cable 2m rund	-	Reichelt	-	2	
641	HDMI cable with Ethernet	Certified HDMI cable with	-	PureLink	-	2	
644	Amplifierer	ZX60-2534M+	SN865701299	Mini-Circuits	-	-	
670	Univ. Radio Communication Tester	CMU 200	106833	Rohde & Schwarz	24 M	-	30.05.2018
671	DC-power supply 0-5 A	EA-3013S	-	Elektro Automatik	pre-m	2	
678	Power Meter	NRP	101638	Rohde&Schwarz	pre-m	-	
683	Spectrum Analyzer	FSU 26	200571	Rohde & Schwarz	12 M	-	30.05.2017
686	Field Analyzer	EHP-200A	160WX30702	Narda Safety Test Solutions	24 M	-	30.04.2017
687	Signal Generator	SMF 100A	102073	Rohde&Schwarz	12 M	-	30.05.2017
688	Pre Amp	JS-18004000-40-8P	1750117	Miteq	pre-m	-	
690	Spectrum Analyzer	FSU	100302/026	Rohde&Schwarz	12 M	-	30.05.2017
692	Bluetooth Tester	CBT 32	100236	Rohde & Schwarz	36 M	-	31.03.2017
697	Power Splitter	ZN4PD-642W-S+	165001445	Mini-Circuits	-	2	

8.1.3. Legend

Note / remarks		Calibrated during system calibration:
	1a	System CTC-SAR-EMS (Ref.-No. 442)
	1b	System-CTC-EMS-Conducted (Ref.-No. 335)
	1c	System CTC-FAR-EMI-RSE (Ref.-No . 443)
	1d	System CTC-SAR-EMI (Ref.-No . 441)
	1e	System CTC-OATS (EMI radiated) (Ref.-No. 337)
	1 f	System CTC-CTIA-OTA (Ref.-No . 420)
	1 g	System CTC-FAR-EMS (Ref.-No . 444)
	2	Calibration or equipment check immediately before measurement
	3	Regulatory maintained equipment for functional check or support purpose
	4	Ancillary equipment without calibration e.g. mechanical equipment or monitoring equipment
	5	Test System

Interval of calibration	12 M	12 month
	24 M	24 month
	36 M	36 month
	24/12 M	Calibration every 24 months, between this every 12 months internal validation
	36/12 M	Calibration every 36 months, between this every 12 months internal validation
	Pre-m	Check before starting the measurement
	-	Without calibration

9. Versions of test reports (change history)

Version	Applied changes	Date of release
--	Initial release	2017-09-01
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