PARTIAL T E S T R E P O R T
No.: 17-1-0221001T20a-C1

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

ISED-Regulations
RSS-132 Issue 3, RSS-133 Issue 6,
RSS-139 Issue 3, RSS-Gen Issue 5
RSS-130 Issue 1

for

Actia Nordic AB

Telematic Device
ACUII-06

FCC ID: 2AGKKACUII-06H2
ISED: 20839-ACUII06H2

Laboratory Accreditation and Listings		
ilac-MRA DAkkS Deutsche Akkreditierungsstelle D-PL-12047-01-01 Accredited EMC-Test Laboratory	Industry Canada Reg. No.: 3462D-1 Reg. No.: 3462D-2 Reg. No.: 3462D-3	VCCI Voluntary Controls for Electromagnetic Emissions Reg. No.: R-4452, C-20009, T-20006, G-20013
Wi Fi ALLIANCE AUTHORIZED RF LABORATORY	ctia Authorized™ Test Lab Lab Code: 20011130-00	FEDERAL COMMUNICATIONS COMMISSION FC USA MRA US-EU 0003
accredited according to DIN EN ISO/IEC 17025		

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Laboratory Accreditation and Listings

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Total pages

The listed attachments are an integral part of this report.

1. Summary of test results

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

The Equipment Under Test (in this report, hereinafter referred as EUT) supports radiofrequency technologies and use an already approved cellular module with **ALS3-USR3** with **FCC-ID: QIPALS3-USR3** and **ISED: 7830A-ALS3USR3**.This test report shows results for LTE technology 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 FCC Part 27, Subpart C, of the FCC CFR Title 47 Rules, Edition 2017 and Canada RSS-132 Issue 3, RSS-133 Issue 6 and RSS-Gen Issue 5 standards.

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

No. of Diagram group	Test case	Port	References & Limits			EUT set-up	EUT op-mode	Result
			FCC Standard	RSS Section	Test limit			
1	AC-Power Lines Emissions Conducted (0,15 - 30 MHz)	AC-Power lines (conducted)	§15.207	RSS-Gen, Issue 5: Chapter 8.8	§15.207 limits ISED: Table 3, Chapter 8.8	--	--	Not applicable (DC-powered)
2	General field strength emissions (9 kHz - 30 MHz)	Cabinet + inter-connecting cables (radiated)	§15.209(a)	RSS-Gen, Issue 5: Chapter 8.9, Table 5+6	2400/F(kHz) µV/m 24000/F(kHz) µV/m 30 µV/m	1	1+2+3 +4	Pass
7	RF-Power (ERP/EIRP)		§2.1046 §22.913(a)(2)	RSS-132, Issue 3: Chapter 5.4 SRSP-503: 5.1.3	< 7 Watt (ERP)	1	1+2+3 +4	Pass (calculated from conducted result and antenna gain)
			§24.232(c)	RSS-133, Issue 6 Chapter 4.1/6.4 SRSP-510: 5.1.2	< 2 Watt (EIRP)			
			§27.50 (d)(4)	RSS-139: Issue 3 Chapter 6.5 SRSP-513: 5.1.2	< 1 Watt (EIRP)			
			§27.50(c)(10)	RSS-130, Issue 1, Chapter 4.4	< 3 Watt (ERP)			
8	Spurious emissions		§2.1053(a) §2.1057	RSS-Gen., Issue 5	43+10log(P) dBc	1+2	1+2+3 +4	Pass
			§22.917(a)(b)	RSS-132: Chapter 5.5(i)(ii)				
9	Band-Edge compliance		§24.238(a)(b)	RSS-133: Chapter 6.5.1(i)(ii)		3	1+2+3 +4	Pass (calculated from conducted result and antenna gain)
			§27.53(h)(1)(3) (i)(ii)(iii)	RSS-139: Issue 3 Chapter 6.6 (i) (ii)				
			§27.53(g)	RSS-130: Issue 1 Chapter 4.6.1				

30	RF Power	Antenna terminal (conducted)	§2.1046	--	N/A	1	1+2+3 +4	Pass
34	26dB Emission bandwidth		§2.1049(h)	RSS-Gen, Issue 5, Chapter 6.6	26dBc Emissions BW 99% Power	--	--	Not performed see initial modules's certification
35	99% Occupied bandwidth							
36	Spurious emissions	Antenna terminal (conducted)	§2.1051 §2.1057 §22.917(a)(b) §24.238(a)(b) §27.53	RSS-132, Issue 3: 5.5(i)(ii) 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	--	--	Not performed see initial modules's certification
37	Band-Edge compliance	Antenna terminal (conducted)			43+10log(P) dBc	3	1+2+3 +4	Pass
38	Frequency stability	Antenna terminal (conducted)	§22.355, table C-1 §24.235 §2.1055(a)(2) §27.54	RSS-132, Issue 3: Chapter 5.3 RSS-133, Issue 6: Chapter 6.3 RSS-130, Issue 1: Chapter 4.3 RSS-139, Issue 3, Chapter 6.4	< ±2.5ppm or ±0.1ppm	--	--	Not performed see initial modules's certification

Remark:

1.) for conducted tests see original grant under: https://apps.fcc.gov/oetcf/tcb/reports/Tcb731GrantForm.cfm?mode=COPY&RequestTimeout=500&tcb_code=&application_id=N1R4OGyLaKCotehafTuv1g%3D%3D&fcc_id=QIPALS3-USR3

1.2. 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.

The current version of the Test Report CETECOM_TR17-1-0221001T20a-C1 replaces the test report CETECOM_TR17-1-0221001T20a dated 2018-09-28. The replaced test report is herewith invalid.

Digital unterschrieben von B.Sc. Mohamed Ahmed
DN: cn=B.Sc. Mohamed Ahmed, o=Cetecom GmbH, ou=RC/EMC, email=mohamed.ahmed@cetecom.com, c=DE
Datum: 2019.01.02 14:23:42 +01'00'

.....	.....
Dipl.-Ing. Niels Jeß	B.Sc. Mohamed Ahmed
Responsible for test section	Responsible for test report

2. Administrative Data

2.1. Identification of the testing laboratory

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

2.2. Test location

2.2.1. Test laboratory "CTC"

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

2.3. Organizational items

Responsible for test report:	B.Sc. Mohamed Ahmed
Prjoject Leader:	B.Sc. Al-Amin Hossain
Receipt of EUT:	2018-05-18
Date(s) of test:	2018-05-30 to 2018-06-15
Date of report:	2019-01-02
---	---
Version of template:	13.02

2.4. Applicant's details

Applicant's name:	Actia Nordic AB
Address:	Hammarbacken 4A, 3tr SE-19149, Sollentuna, Sweden
Contact person:	Mr. Nicklas Andersson

2.5. Manufacturer's details

Manufacturer's name:	see applicant
Address:	see applicant

3. Equipment under test (EUT)

3.1. SUMMARY OF RESULTS AND TECHNICAL DATA OF MAIN EUT DECLARED BY APPLICANT

<table>
<tr><td>TX-frequency range
(E-UTRA operating bands)</td><td colspan="3">☒ LTE Band 2: 1850 - 1910 MHz (Uplink), 1930-1990 MHz (Downlink)
☒ LTE Band 4: 1710 - 1755 MHz (Uplink), 2110 - 2155 MHz (Downlink)
☒ LTE Band 5: 824 - 849 MHz (Uplink), 869-894 MHz (Downlink)
☒ LTE Band 17: 704 - 716 MHz (Uplink), 734 - 746 MHz (Downlink)</td></tr>
<tr><td>Type of modulation</td><td colspan="3">QPSK, 16-QAM</td></tr>
<tr><td>Data rates</td><td colspan="3">Cat3, Downlink: max. 100Mbps, Uplink: max. 50Mbps</td></tr>
<tr><td>Number of channels
– Table 5.4.4-1 accord. 3GPP TS36.521-1

(See Note in 3GPP-Standard about channels not to be used depending on channel bandwidths)</td><td colspan="3">☒ LTE Band 2: UARFCN range 18600 - 19199
☒ LTE Band 4: UARFCN range 19950 - 20399
☒ LTE Band 5: UARFCN range 20400 - 20649
☒ LTE Band 17: UARFCN range 23730 - 23849</td></tr>
<tr><td rowspan="2">Emission designator(s)</td><td>Channel bandwidth</td><td>QPSK Modulation:</td><td>16-QAM Modulation</td></tr>
<tr><td>1.4MHz
3 MHz
5MHz
10MHz
15MHz
20MHz</td><td>See initial certification of the module:
https://apps.fcc.gov/oetcf/tcb/reports/Tcb731GrantForm.cfm?mode=COPY&RequestTimeout=500&tcb_code=&application_id=N1R4OGyLaKCotehafTuv1g%3D%3D&fcc_id=QIPALS3-USR3</td><td>See initial certification of the module:
https://apps.fcc.gov/oetcf/tcb/reports/Tcb731GrantForm.cfm?mode=COPY&RequestTimeout=500&tcb_code=&application_id=N1R4OGyLaKCotehafTuv1g%3D%3D&fcc_id=QIPALS3-USR3</td></tr>
<tr><td>Antenna Type</td><td colspan="3">☒ Integrated
☐ External, no RF- connector
☒ External, separate RF-connector</td></tr>
<tr><td>Antenna Gain Tx *1)</td><td colspan="3">Internal/Backup Antenna
Band-2# 1850-1909MHz Band = 2.5 dBi
Band-4# 1710-1755MHz Band = 2.5 dBi
Band-5# 824-849MHz Band = (-2.9) dBi
Band-17# 704-716MHz Band = (-2.9) dBi

External Antenna
Band-2# 1850-1909MHz Band = 5.5 dBi
Band-4# 1710-1755MHz Band = 5 dBi
Band-5# 824-849MHz Band = 4 dBi
Band-17# 704-716MHz Band = 4 dBi</td></tr>
<tr><td>Internal Loss to Cellular Module to Antenna Feed Point</td><td colspan="3">Lower Band(f<1GHz): 0.8 dB
Higher Band(f>1GHz):
>LTE_Band_2 = 1.2 dB
>LTE_Band_4 = 1.2 dB</td></tr>
<tr><td>Cable Loss between Wireless Module and Antenna(Length_2.5meter)</td><td colspan="3">Lower Band(f<1GHz): 1.8 dB
Higher Band(f>1GHz):
>LTE_Band_2 = 3.0 dB
>LTE_Band_4 = 3.0 dB</td></tr>
<tr><td></td><td colspan="3"></td></tr>
<tr><td></td><td colspan="3"></td></tr>
</table>

MAX Average Output Power:			
Conducted	LTE-Mode 2	22.52 dBm (AV)	
	LTE-Mode 4	23.16 dBm (AV)	
	LTE-Mode 5	23.02 dBm (AV)	
	LTE-Mode 17	22.49 dBm (AV)	
EIRP_External Antenna		conducted output power + antenna gain - pathloss	
	LTE-Mode 2	22.52 dBm + 5.5 dBi – 2,6dB = 25.42 dBm	
	LTE-Mode 4	23.16 dBm + 5 dBi – 2,6dB = 25.56 dBm	
	LTE-Mode 5	23.02 dBm + 4 dBi – 4,2dB = 22.82 dBm	
	LTE-Mode 17	22.49 dBm + 4 dBi – 4,2dB = 22.29 dBm	
EIRP_Internal Antenna		conducted output power + antenna gain - pathloss	
	LTE-Mode 2	22.52 dBm + 2.5 dBi – 1,2dB = 23.82 dBm	
	LTE-Mode 4	23.16 dBm + 2,5 dBi – 1,2dB = 24.46 dBm	
	LTE-Mode 5	23.02 dBm + (-2,9) dBi – 0,8dB = 19.32 dBm	
	LTE-Mode 17	22.49 dBm + (-2,9) dBi – 0,8dB = 18.79 dBm	
ERP_External Antenna		EIRP – 2.15dBi	
	LTE-Mode 2	25.42 dBm – 2.15 dB = 23.27 dBm	
	LTE-Mode 4	25.56 dBm – 2.15 dB = 23.41 dBm	
	LTE-Mode 5	22.82 dBm – 2.15 dB = 20.67 dBm	
	LTE-Mode 12	22.29 dBm – 2.15 dB = 20.14 dBm	
ERP_Internal Antenna		EIRP – 2.15dBi	
	LTE-Mode 2	23.82 dBm – 2.15 dB = 21.67 dBm	
	LTE-Mode 4	24.46 dBm – 2.15 dB = 22.31 dBm	
	LTE-Mode 5	19.32 dBm – 2.15 dB = 17.17 dBm	
	LTE-Mode 12	18.79 dBm – 2.15 dB = 16.64 dBm	
Installed option		☒ GSM 850 and GSM 1900 Bands (Please see in another Report) ☒ GSM 900 and GSM 1800 Bands (not usable in USA/Canada) ☒ W-CDMA Band II, IV and Band V (Please see in another Report) ☒ W-CDMA Band I, III and Band VIII (not usable in USA/Canada) ☒ LTE Band I, III, VII, VIII and Band XX (not usable in USA/Canada) ☒ BT, WLAN_2G4_5G (Please see in another Report) ☒ GNSS (Please see in another Report)	
Power supply		☒ 13,8V DC	
Special EMI components		--	
EUT sample type		☐ Production	☒ Pre-Production	☐ Engineering
FCC/ISED label attached		☐ yes	☒ no	

Remark: *1)For antenna Data please see: Ort: \\cetecom.de\essen\LUISA\6_Projekte\15\0668_3

3.2. EUT: Type, S/N etc. and short descriptions used in this test report

Short description*)	EUT	Type	S/N serial number	HW hardware status	SW software status
EUT A	Telematic Device	ACUII-06	30207090	H2	14
EUT B	VOLVO	Antenna + Supply Cable	434-WLAN-GNSS-SDARSLTE 50751424	NAS version	--
EUT C	Telematic Device	ACUII-06	30207085	H2	14

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

3.3. Auxiliary Equipment (AE): Type, S/N etc. and short descriptions

AE short description *)	Auxiliary Equipment	Type	S/N serial number	HW hardware status	SW software status
AE 1	Main Harness External with SIM card Holder attached	--	0034	--	--
AE 2	DLC Ethernet cable	--	--	--	--
AE 3	ThinkPad USB 3.0 Ethernet Adapter	LENOVO	DL602XPL	--	--
AE 4	WLAN antenna cable	Fakra	--	--	--
AE 5	GNSS antenna cable	Fakra	--	--	--
AE 6	2G/3G/4G antenna cable	Fakra	--	--	--
AE 7	Termination for IHU Ethernet connector	--	--	--	--

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

3.4. EUT set-ups

EUT set-up no.*)	Combination of EUT and AE	Remarks
set. 1	EUT A + EUT B + AE 1 + AE 2 + AE 3 + AE 4 + AE 5 + AE 6 + AE 7	Used for radiated measurements of the External Antenna
set. 2	EUT A + EUT B + AE 1 + AE 2 + AE 3 + AE 4 + AE 5 + AE 6 + AE 7	Used for radiated measurements of the Internal Antenna(Internal Antenna activated from ACUII Certification Test Software)
set. 3	EUT C + AE 1 + AE 6	Used for conducted RF-measurements

*) 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
op. 1	LTE-Band 2 Channel_18900_Bandwidth_5MHz_1RB_Low_modulation_QPSK	A communication link is established between the mobile station (UE) and the test simulator. The transmitter is operated on its maximum rated output power class: 23dBm nominal. The input signal to the receiver is modulated with normal test modulation: QPSK or 16-QAM Modulation. The wanted RF input signal level to the receiver of the mobile station is set to a level to provide a stable communication link. NS_01 Network signaling value was used, no A-MPR was used therefore for this band.
op. 2	LTE-Band 4_ Channel_20175_Bandwidth_10MHz_1RB_High_modulation_QPSK	A communication link is established between the mobile station (UE) and the test simulator. The transmitter is operated on its maximum rated output power class: 23dBm nominal. The input signal to the receiver is modulated with normal test modulation: QPSK or 16-QAM Modulation. The wanted RF input signal level to the receiver of the mobile station is set to a level to provide a stable communication link. NS_01 Network signaling value was used, no A-MPR was used therefore for this band.
op. 3	LTE-Band 5_ Channel_20415_Bandwidth_3MHz_1RB_Low_modulation_QPSK	A communication link is established between the mobile station (UE) and the test simulator. The transmitter is operated on its maximum rated output power class: 23dBm nominal. The input signal to the receiver is modulated with normal test modulation: QPSK or 16-QAM Modulation. The wanted RF input signal level to the receiver of the mobile station is set to a level to provide a stable communication link. NS_01 Network signaling value was used, no A-MPR was used therefore for this band.
op. 4	LTE-Band 17_ Channel_23790_Bandwidth_5MHz_1RB_Low_modulation_QPSK	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 and/or 16-QAM Modulation. The wanted RF input signal level to the receiver of the mobile station is set to a level to provide a stable communication link. NS_01 Network signaling value was used, no A-MPR was used therefore for this band.

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

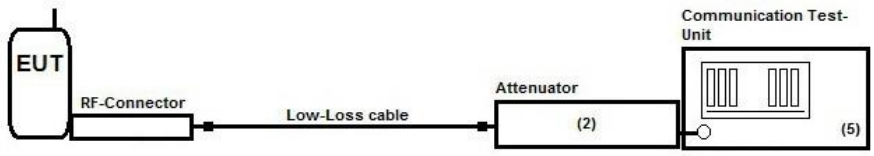
4. Description of test system set-up's

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

Cellular Conducted RF-Setup 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:
	☒ 10 dB Attenuator (#613)	☒ CMW500	See List of equipment under each test case and chapter 8. for calibration info
	☒ Low loss RF-cables	☒ DC-Power Supply	

Measurement uncertainty See chapter Measurement Uncertainties (Cel-2)

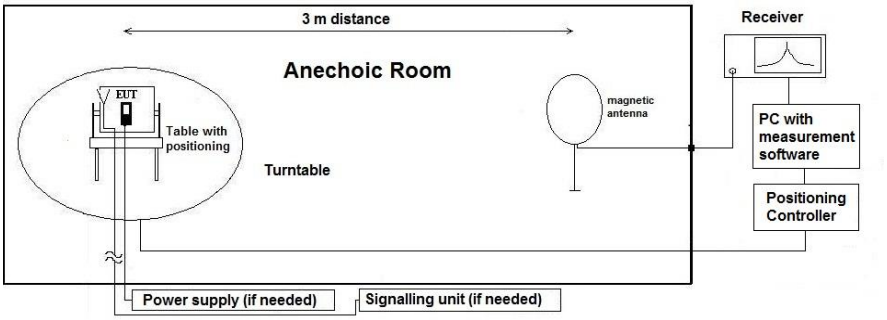
4.2. Test system set-up for radiated magnetic field measurements below 30 MHz

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

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

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

Schematic:



Testing method:

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

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

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

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

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

Formula:

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

$M = L_T - E_C$

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

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

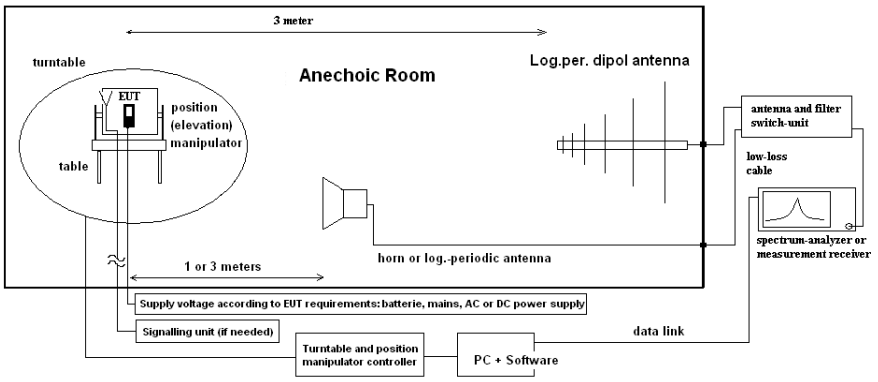
Distance correction: Reference for applied correction (extrapolating) factors due to reduced measurement distance:
ANSI C63.10:2013, §6.4.4.2 - Equations (2) + (3) + (4)

4.3. Test system set-up for radiated 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	☒ 757 CMW		
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, §27.50
ISED	RSS-132: 5.4 + SRSP 503:5.1.3 for FDD Band 5 RSS-133: 4.1/6.4 + SRSP-510:5.1.2 for FDD Band 2 RSS-139, Issue 3: 6.5 RSS-130, Issue 1 + SRSP-518
Limit	Maximum Power Output of the mobile phone should be determined while measured conducted.
	Limit LTE Band 5: 7 Watt ERP (38.4 dBm)
	Limit LTE Band 2: 2 Watt EIRP (33.0 dBm)
	Limit LTE Band 4: 1 Watt EIRP (30.0 dBm)
	Limit LTE Band 7: 2 Watt EIRP (33.0 dBm)
	FCC: Limit LTE Band 12/13/17: 3 Watt ERP (34.7dBm)
FCC Limit	FCC: Limit LTE Band 12/13/17: 3 Watt ERP (34.7dBm)
ISED Limit	ISED Limit LTE Band 12: 5 Watt EIRP (37dBm)
	ISED Limit LTE Band 13: 5 Watt EIRP (37dBm)
	ISED-Limit LTE Band 17: 5 Watt EIRP (37dBm)

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

LTE Band 2				
Signal-BW	QPSK		16-QAM	
	Peak	RMS	Peak	RMS
1.4	26,59	21,43	25,53	21,91
3	26,97	22,24	26,44	21,41
5	27,27	22,52	27,25	21,29
10	27,05	22,31	0,00	21,30
15	27,05	22,46	26,88	21,67
20	27,54	22,02	27,49	21,77

5.1.4.2. LTE Band 4

LTE Band 4				
Signal-BW	QPSK		16-QAM	
	Peak	RMS	Peak	RMS
1.4	27,32	22,53	26,73	21,60
3	27,02	22,59	26,51	21,62
5	27,17	22,55	26,60	21,47
10	27,16	23,16	26,67	22,72
15	27,62	22,91	26,89	22,05
20	27,49	22,76	26,91	21,45

5.1.4.3. LTE Band 5

LTE Band 5				
Signal-BW	QPSK		16-QAM	
	Peak	RMS	Peak	RMS
1.4	27,44	22,79	26,86	21,85
3	27,41	23,02	26,79	21,72
5	27,93	22,91	27,86	21,75
10	27,97	22,70	27,34	21,79

5.1.4.4. LTE Band 17

LTE Band 17				
Signal-BW	QPSK		16-QAM	
	Peak	RMS	Peak	RMS
5	27,90	22,49	27,01	21,46
10	27,71	22,28	26,88	21,19

Remark: pls. see annex 1 for full power results of LTE bands -2, 4, 5, 17

5.1.5. PAPR results

5.1.5.1. Test condition and test set-up

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

5.1.5.2. PAPR-results

According KDB 971168D01 v03r01 two method are allowed.

☐ Chapter 5.7.2 Subclause 5.2.3.4 of ANSI C63.26-2015 CCDF-Method (0.1% probability)
☒ Chapter 5.7.3: Subclause 5.6.2 of ANSI C63.26-2015 ($PAPR_{dB}=P_{PK\ |\ dBm\ or\ dBW}-P_{AVG\ |\ dBm\ or\ dBW}$)

LTE Band 2_Operating Mode 1		
	Max. PAPR Max. PAPR level with 0.1% probability / [dB]	
Signal-Bandwidth / [MHz]	QPSK Modulation	16-QAM Modulation
5	5.02	5.58

Remark: no Diagram in annex 1

LTE Band 4_Operating Mode 2		
	Max. PAPR level with 0.1% probability / [dB]	
Signal-Bandwidth / [MHz]	QPSK Modulation	16-QAM Modulation
10	4.46	4.19

Remark: no Diagram in annex 1

LTE Band 5_Operating Mode 3		
	Max. PAPR level with 0.1% probability / [dB]	
Signal-Bandwidth / [MHz]	QPSK Modulation	16-QAM Modulation
3	4.95	6.01

Remark: no Diagram in annex 1

LTE Band 12_Operating Mode 4		
	Max. PAPR level with 0.1% probability / [dB]	
Signal-Bandwidth / [MHz]	QPSK Modulation	16-QAM Modulation
5	5.41	5.55

Remark: no Diagram in annex 1

5.1.5.3. Conclusion

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

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

5.2.1. 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	☐	☒ 620 ESU 26	☐	☐	☐	☐
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	☒ 757 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		☒13,8V DC			

5.2.2. Requirements

FCC	Part 15, Subpart C, §15.205 & §15.209			
ISED	RSS-Gen: Issue 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

5.2.3. 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"		

5.2.4. Measurement Results

The results are presented below in summary form only. for more information please see the diagrams included in annex 1. (17-1-0221001T20a-C1-A1)

5.2.4.1. External Antenna Set-up

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	
2.01a	Mid	18900	9 kHz-30 MHz	1	1	EUT Standing	☒	☐	☐	passed
2.01b	Mid	18900	9 kHz-30 MHz	1	1	EUT Laying	☒	☐	☐	passed
2.02a	Mid	20175	9 kHz-30 MHz	1	2	EUT Standing	☒	☐	☐	passed
2.02b	Mid	20175	9 kHz-30 MHz	1	2	EUT Laying	☒	☐	☐	passed
2.03a	Mid	20415	9 kHz-30 MHz	1	3	EUT Standing	☒	☐	☐	passed
2.03b	Mid	20415	9 kHz-30 MHz	1	3	EUT Laying	☒	☐	☐	passed
2.04a	Mid	23790	9 kHz-30 MHz	1	4	EUT Standing	☒	☐	☐	passed
2.04b	Mid	23790	9 kHz-30 MHz	1	4	EUT Laying	☒	☐	☐	passed

Remark 1: For further information see Annex A1

5.2.4.2. Internal Antenna Set-up

Diagram No.	Carrier Channel		Frequency range	Set-up no.	OP-mode no.	Remark	Used detector			Result
	Range	No.					PK	AV	QP	
2.05a	Mid	18900	9 kHz-30 MHz	2	1	EUT Standing	☒	☐	☐	passed
2.05b	Mid	18900	9 kHz-30 MHz	2	1	EUT Laying	☒	☐	☐	passed
2.06a	Mid	20175	9 kHz-30 MHz	2	2	EUT Standing	☒	☐	☐	passed
2.06b	Mid	20175	9 kHz-30 MHz	2	2	EUT Laying	☒	☐	☐	passed
2.07a	Mid	20415	9 kHz-30 MHz	2	3	EUT Standing	☒	☐	☐	passed
2.07b	Mid	20415	9 kHz-30 MHz	2	3	EUT Laying	☒	☐	☐	passed
2.08a	Mid	23790	9 kHz-30 MHz	2	4	EUT Standing	☒	☐	☐	passed
2.08b	Mid	23790	9 kHz-30 MHz	2	4	EUT Laying	☒	☐	☐	passed

Remark 1: For further information see Annex A1

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

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

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

5.3. RF-Parameter - Radiated 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	☐ 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	☒ 757 CMW		
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		☐ 060 120 V/ 60 Hz via PAS 5000			

5.3.2. 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)
ISED	☒ 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

5.3.3. 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 resource blocks and channels in order to find worst-case configuration. Due to very big amount of possible combinations only certain combinations have been tested.		
Mobile phone settings		A call was established on highest power transmit conditions in RMC mode. MPR was deactivated. The measurements were made at the low, middle and high carrier frequencies of each of the supported operating band within the designated range within the allowed channel bandwidths. Choosing three TX-carrier frequencies of the mobile phone, should be sufficient to demonstrate compliance.		

Spectrum-Analyser 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-analyser 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-analyser settings for LTE Band 5

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

Spectrum-analyser settings for LTE Band 17

	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

5.3.4. Results

The results are presented below in summary form only. For more information please see the diagrams enclosed in annex 1. (17-1-0221001T20a-C1-A1)

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

Diagram no.	Carrier Channel		Frequency range	OP-mode no.	Remark	Used detector			Result
	Range	No.				PK	AV	QP	
8.01a	1RB low	18900	30 MHz to 18 GHz	1	External_Antenna_EUT Standing Carrier visible on diagram. Not relevant for results	☒	☐	☐	passed
8.01b					External_Antenna_EUT Laying Carrier visible on diagram. Not relevant for results	☒	☐	☐	passed
8.05a					Internal_Antenna_EUT Standing Carrier visible on diagram. Not relevant for results	☒	☐	☐	passed
8.05b					Internal_Antenna_EUT Laying Carrier visible on diagram. Not relevant for results	☒	☐	☐	passed

Remark: Used channel bandwidth of 5,0MHz mid channel_18900 was chosen as worst-case as determined within power measurements

5.3.4.1.1. Conducted Band-Edge Low: 1849-1850 MHz, 3MHz Signal BW

Diagram No.	Channel no.	Op. Mode	Number of RBs	Modulation scheme	Detector		Conducted value	Internal Loss	External cable loss	External Antenna Gain	Final value	Verdict
					PK	RMS	[dBm]	[dB]	[dB]	[dBi]	[dBm]	
37.203a	18615	1	☒ 1RB low	☒ QPSK modulation	☐	☒	-18.0	1.2	3.0	5.5	-16.7	Pass
37.203b	18615	1	☒ 1RB low	☒ 16-QAM modulation	☐	☒	-19.55	1.2	3.0	5.5	-20.85	Pass
37.204a	18615	1	☒ 15 RBs	☒ QPSK modulation	☐	☒	-25.03	1.2	3.0	5.5	-26.33	Pass
37.204b	18615	1	☒ 15 RBs	☒ QAM modulation	☐	☒	-26.21	1.2	3.0	5.5	-24.91	Pass

Remark: conducted value have been corrected by internal PCB path loss + cable path loss and added antenna gain for external antenna as declared by the applicant

5.3.4.1.2. Band-Edge High: 1910-1911MHz, 3MHz Signal BW

Diagram No.	Channel no.	Op. Mode	Number of RBs	Modulation scheme	Detector		Conducted value	Internal Loss	External cable loss	External Antenna Gain	Final value	Verdict
					PK	RMS	[dBm]	[dB]	[dB]	[dBi]	[dBm]	
37.215a	19185	1	☒ 1RB low	☒ QPSK modulation	☐	☒	-14.79	1.2	3.0	5.5	-13.49	Pass
37.215b	19185	1	☒ 1RB low	☒ 16-QAM modulation	☐	☒	-16.21	1.2	3.0	5.5	-14.91	Pass
37.216a	19185	1	☒ 15 RBs	☒ QPSK modulation	☐	☒	-25.69	1.2	3.0	5.5	-24.39	Pass
37.216b	19185	1	☒ 15 RBs	☒ QAM modulation	☐	☒	-26.88	1.2	3.0	5.5	-25.58	Pass

Remark: conducted value have been corrected by internal PCB path loss + cable path loss and added antenna gain for external antenna as declared by the applicant

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

Diagram no.	Carrier Channel		Frequency range	OP-mode no.	Remark	Used detector			Result
	Range	No.				PK	AV	QP	
8.02a	1RB high	20175	30 MHz to 18 GHz	2	External_Antenna_EUT Standing Carrier visible on diagram. Not relevant for results	☒	☐	☐	passed
8.02b					External_Antenna_EUT Laying Carrier visible on diagram. Not relevant for results	☒	☐	☐	passed
8.06a					Internal_Antenna_EUT Standing Carrier visible on diagram. Not relevant for results	☒	☐	☐	passed
8.06b					Internal_Antenna_EUT Laying Carrier visible on diagram. Not relevant for results	☒	☐	☐	passed

Remark: Used channel bandwidth of 10MHz channel_20175 found as worst-case as determined within power measurements

5.3.4.2.1. Band-Edge Low: 1709-1710 MHz

Diagram No.	Channel no.	Op. Mode	Number of RBs	Modulation scheme	Detector		Conducted value	Internal Loss	External cable loss	External Antenna Gain	Final value	Verdict
					PK	RMS	[dBm]	[dB]	[dB]	[dBi]	[dBm]	
37.409a	20025	2	☒ 1RB low	☒ QPSK modulation	☐	☒	-20.50	1.2	3.0	5.0	-19.70	Pass
37.409b	20025	2	☒ 1RB low	☒ 16-QAM modulation	☐	☒	-21.04	1.2	3.0	5.0	-20.24	Pass
37.410a	20025	2	☒ 75 RBs	☒ QPSK modulation	☐	☒	-28.85	1.2	3.0	5.0	-28.05	Pass
37.410b	20025	2	☒ 75 RBs	☒ QAM modulation	☐	☒	-29.66	1.2	3.0	5.0	-28.86	Pass

Remark: conducted value have been corrected by internal PCB path loss + cable path loss and added antenna gain for external antenna as declared by the applicant

5.3.4.2.2. Band-Edge High: 1755-1756MHz

Diagram No.	Channel no.	Op. Mode	Number of RBs	Modulation scheme	Detector		Conducted value	Internal Loss	External cable loss	External Antenna Gain	Final value	Verdict
					PK	RMS	[dBm]	[dB]	[dB]	[dBi]	[dBm]	
37.215a	20325	2	☒ 1RB low	☒ QPSK modulation	☐	☒	-21.53	1.2	3.0	5.0	-20.73	Pass
37.215b	20325	2	☒ 1RB low	☒ 16-QAM modulation	☐	☒	-22.34	1.2	3.0	5.0	-21.54	Pass
37.216a	20325	2	☒ 75 RBs	☒ QPSK modulation	☐	☒	-29.33	1.2	3.0	5.0	-28.53	Pass
37.216b	20325	2	☒ 55 RBs	☒ QAM modulation	☐	☒	-29.80	1.2	3.0	5.0	-29.0	Pass

Remark: conducted value have been corrected by internal PCB path loss + cable path loss and added antenna gain for external antenna as declared by the applicant

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

Diagram no.	Carrier Channel		Frequency range	OP-mode no.	Remark	Used detector			Result
	Range	No.				PK	AV	QP	
8.03a	1RB low	20415	30 MHz to 9 GHz	3	External_Antenna_EUT Standing Carrier visible on diagram. Not relevant for results	☒	☐	☐	passed
8.03b					External_Antenna_EUT Laying Carrier visible on diagram. Not relevant for results	☒	☐	☐	passed
8.07a					Internal_Antenna_EUT Standing Carrier visible on diagram. Not relevant for results	☒	☐	☐	passed
8.07b					Internal_Antenna_EUT Laying Carrier visible on diagram. Not relevant for results	☒	☐	☐	passed

Remark: Used channel bandwidth of 3MHz (channel_20415) found as worst-case as determined within power measurements

5.3.4.3.1. Band-Edge Low: 823-824MHz

Diagram No.	Channel no.	Op. Mode	Number of RBs	Modulation scheme	Detector		Conducted value	Internal Loss	External cable loss	External Antenna Gain	Final value	Verdict
					PK	RMS	[dBm]	[dB]	[dB]	[dBi]	[dBm]	
37.503a	20415	3	☒ 1RB low	☒ QPSK modulation	☐	☒	-19.68	0.8	1.8	4.0	-18.28	Pass
37.503b	20415	3	☒ 1RB low	☒ 16-QAM modulation	☐	☒	-20.42	0.8	1.8	4.0	-19.02	Pass
37.504a	20415	3	☒ 15 RBs	☒ QPSK modulation	☐	☒	-25.58	0.8	1.8	4.0	-24.18	Pass
37.504b	20415	3	☒ 15 RBs	☒ QAM modulation	☐	☒	-27.35	0.8	1.8	4.0	-25.95	Pass

Remark: conducted value have been corrected by internal PCB path loss + cable path loss and added antenna gain for external antenna as declared by the applicant

5.3.4.3.2. Band-Edge High: 849-850MHz

Diagram No.	Channel no.	Op. Mode	Number of RBs	Modulation scheme	Detector		Conducted value	Internal Loss	External cable loss	External Antenna Gain	Final value	Verdict
					PK	RMS	[dBm]	[dB]	[dB]	[dBi]	[dBm]	
37.512a	20635	3	☒ 1RB low	☒ QPSK modulation	☐	☒	-19.28	0.8	1.8	4.0	-17.88	Pass
37.512b	20635	3	☒ 1RB low	☒ 16-QAM modulation	☐	☒	-20.46	0.8	1.8	4.0	-19.06	Pass
37.513a	20635	3	☒ 15 RBs	☒ QPSK modulation	☐	☒	-26.87	0.8	1.8	4.0	-25.47	Pass
37.513b	20635	3	☒ 15 RBs	☒ QAM modulation	☐	☒	-27.78	0.8	1.8	4.0	-26.38	Pass

Remark: conducted value have been corrected by internal PCB path loss + cable path loss and added antenna gain for external antenna as declared by the applicant

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

Radiated spurious emission measurements:

Diagram no.	Carrier Channel		Frequency range	OP-mode no.	Remark	Used detector			Result
	Range	No.				PK	AV	QP	
8.04a	1RB low	23790	30 MHz to 9 GHz	4	External_Antenna_EUT Standing Carrier visible on diagram. Not relevant for results	☒	☐	☐	passed
8.04b					External_Antenna_EUT Laying Carrier visible on diagram. Not relevant for results	☒	☐	☐	passed
8.08a					Internal_Antenna_EUT Standing Carrier visible on diagram. Not relevant for results	☒	☐	☐	passed
8.08b					Internal_Antenna_EUT Laying Carrier visible on diagram. Not relevant for results	☒	☐	☐	passed

Remark: Used channel bandwidth of 5MHz channel_23790 was chosen as worst-case as determined within power measurements

Band-Edge Low: 703-704 MHz

Diagram No.	Channel no.	Op. Mode	Number of RBs	Modulation scheme	Detector		Conducted value	Internal Loss	External cable loss	External Antenna Gain	Final value	Verdict
					PK	RMS	[dBm]	[dB]	[dB]	[dBi]	[dBm]	
37.171a	23755	4	☒ 1RB low	☒ QPSK modulation	☐	☒	-20.84	0.8	1.8	4.0	-19.44	Pass
37.171b	23755	4	☒ 1RB low	☒ 16-QAM modulation	☐	☒	-21.98	0.8	1.8	4.0	-20.58	Pass
37.172a	23755	4	☒ 25 RBs	☒ QPSK modulation	☐	☒	-29.03	0.8	1.8	4.0	-27.63	Pass
37.172b	23755	4	☒ 25 RBs	☒ QAM modulation	☐	☒	-29.16	0.8	1.8	4.0	-27.76	Pass

Remark: conducted value have been corrected by internal PCB path loss + cable path loss and added antenna gain for external antenna as declared by the applicant

Band-Edge High: 716-717MHz

Diagram No.	Channel no.	Op. Mode	Number of RBs	Modulation scheme	Detector		Conducted value	Internal Loss	External cable loss	External Antenna Gain	Final value	Verdict
					PK	RMS	[dBm]	[dB]	[dB]	[dBi]	[dBm]	
37.175a	23825	4	☒ 1RB low	☒ QPSK modulation	☐	☒	-21.26	0.8	1.8	4.0	-19.86	Pass
37.175b	23825	4	☒ 1RB low	☒ 16-QAM modulation	☐	☒	-22.56	0.8	1.8	4.0	-21.16	Pass
37.176a	23825	4	☒ 25 RBs	☒ QPSK modulation	☐	☒	-27.50	0.8	1.8	4.0	-26.1	Pass
37.176b	23825	4	☒ 25 RBs	☒ QAM modulation	☐	☒	-27.33	0.8	1.8	4.0	-25.93	Pass

Remark: conducted value have been corrected by internal PCB path loss + cable path loss and added antenna gain for external antenna as declared by the applicant

5.4. Measurement uncertainties

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

Following table shows expectable uncertainties for each measurement type performed.

RF-Measurement	Reference	Frequency range	Calculated uncertainty based on a confidence level of 95%						Remarks
Conducted emissions (U_{CISPR})	CISPR 16-2-1	9 kHz - 150 kHz 150 kHz - 30 MHz	4.0 dB 3.6 dB						-
Radiated emissions Enclosure	CISPR 16-2-3	30 MHz - 1 GHz 1 GHz - 18 GHz	4.2 dB 5.1 dB						E-Field
Disturbance power	CISPR 16-2-2	30 MHz - 300 MHz	-						-
Power Output radiated	-	30 MHz - 4 GHz	3.17 dB						Substitution method
Power Output conducted	-	Set-up No.	Cel-C1	Cel-C2	BT1	W1	W2	--	
		9 kHz - 12.75 GHz	N/A	0.60	0.7	0.25	N/A	--	-
		12.75 - 26.5GHz	N/A	0.82	--	N/A	N/A	--	
Conducted emissions on RF-port	-	9 kHz - 2.8 GHz	0.70	N/A	0.70	N/A	0.69	--	N/A - not applicable
		2.8 GHz - 12.75GHz	1.48	N/A	1.51	N/A	1.43	--	
		12.75 GHz - 18GHz	1.81	N/A	1.83	N/A	1.77	--	
		18 GHz - 26.5GHz	1.83	N/A	1.85	N/A	1.79	--	
Power density	-	1 – 2.8GHz	1.40 dB						--
Occupied bandwidth	-	9 kHz - 4 GHz	0.1272 ppm (Delta Marker)						Frequency error
			1.0 dB						Power
Emission bandwidth	- -	9 kHz - 4 GHz	0.1272 ppm (Delta Marker)						Frequency error
			See above: 0.70 dB						Power
Frequency stability	-	9 kHz - 20 GHz	0.0636 ppm						-
Radiated emissions Enclosure	-	150 kHz - 30 MHz 30 MHz - 1 GHz 1 GHz - 20 GHz	5.0 dB 4.2 dB 3.17 dB						Magnetic field E-field Substitution

Table: measurement uncertainties, valid for conducted/radiated measurements

6. Abbreviations used in this report

The abbreviations	
ANSI	American National Standards Institute
AV , AVG, CAV	Average detector
EIRP	Equivalent isotropically radiated power, determined within a separate measurement
EGPRS	Enhanced General Packet Radio Service
EUT	Equipment Under Test
FCC	Federal Communications Commission, USA
IC	Industry Canada
n.a.	not applicable
Op-Mode	Operating mode of the equipment
PK	Peak
RBW	resolution bandwidth
RF	Radio frequency
RSS	Radio Standards Specification, Documents 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-1 3462D-2 3462D-2 3462D-3	Radiated Measurements 30 MHz to 1 GHz, 3 m / 10 m (OATS) Radiated Measurements 30 MHz to 1 GHz, 3 m (SAR) Radiated Measurements 1 GHz to 6 GHz, 3 m (SAR) Radiated Measurements above 1 GHz, 3 m (FAR)	ISED, Industry Canada Certification and Engineering Bureau
487 550 348 348	R- 4452 G- 20013 C- 20009 T- 20006	Radiated Measurements 30 MHz to 1 GHz, 3 m (SAR) Radiated Measurements 1 GHz to 6 GHz, 3 m (SAR) Mains Ports Conducted Interference Measurements Telecommunication Ports Conducted Interference Measurem.	VCCI, Voluntary Control Council for Interference by Information Technology Equipment, Japan
OATS = Open Area Test Site, SAR = Semi Anechoic Room, FAR = Fully Anechoic Room			

8. Instruments and Ancillary

8.1. Used equiment "CTC"

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

8.1.1. Test software and firmware of equipment

Ref.-No.	Equipment	Type	Serial-No.	Version of Firmware or Software during the test
001	EMI Test Receiver	ESS	825132/017	Firm.= 1.21 , OTP=2.0, GRA=2.0
012	Signal Generator (EMS-cond.)	SMY 01	839069/027	Firm.= V 2.02
013	Power Meter (EMS cond.)	NRVD	839111/003	Firm.= V 1.51
017	Digital Radiocommunication Tester	CMD 60 M	844365/014	Firmware = V 3.52 .22.01.99, DECT = D2.87 13.01.99
119	RT Harmonics Analyzer dig. Flickermeter	B10	G60547	Firm.= V 3.1DHG
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
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
607	Signal Generator	SMR 20	832033/011	V1.25
620	EMI Test Receiver	ESU 26	100362	4.43_SP3
642	Wideband Radio Communication Tester	CMW 500	126089	Setup V03.26, Test programm component V03.02.20
670	Univ. Radio Communication Tester	CMU 200	106833	µP1 =V8.50, Firmware = V.20
689	Vector Signal Generator	SMU200	100970	02.20.360.142
692	Bluetooth Tester	CBT 32	100236	CBT V 5.40, FW: V.2.41 (FPGA Digital, V. 3.09 FPGA RF)

8.1.2. Single instruments and test systems

Ref.-No.	Equipment	Type	Serial-No.	Manufacturer	Interval of calibration	Remark	Cal due
001	EMI Test Receiver	ESS	825132/017	Rohde & Schwarz	12 M	-	16.05.2019
005	AC - LISN (50 Ohm/50µH, test site 1)	ESH2-Z5	861741/005	Rohde & Schwarz	12 M	-	16.05.2019
007	Single-Line V-Network (50 Ohm/5µH)	ESH3-Z6	892563/002	Rohde & Schwarz	12 M	-	16.05.2019
009	Power Meter (EMS-radiated)	NRV	863056/017	Rohde & Schwarz	24 M	-	15.05.2019
016	Line Impedance Simulating Network	Op. 24-D	B6366	Spitzenberger+Spies	36 M	-	30.05.2019
021	Loop Antenna (H-Field)	6502	9206-2770	EMCO	36 M	-	30.06.2021
033	RF-current probe (100kHz-30MHz)	ESH2-Z1	879581/18	Rohde & Schwarz	24 M	-	15.05.2019
057	relay-switch-unit (EMS system)	RSU	494440/002	Rohde & Schwarz	pre-m	1a	
060	power amplifier (DC-2kHz)	PAS 5000	B6363	Spitzenberger+Spies	-	3	
086	DC - power supply, 0 -10 A	LNG 50-10	-	Heinzinger Electronic	pre-m	2	
087	DC - power supply, 0 -5 A	EA-3013 S	-	Elektro Automatik	pre-m	2	
091	USB-LWL-Converter	OLS-1	007/2006	Ing. Büro Scheiba	-	4	
099	passive voltage probe	ESH2-Z3	299.7810.52	Rohde & Schwarz	36 M	-	30.05.2021
100	passive voltage probe	Probe TK 9416	without	Schwarzbeck	36 M	-	30.05.2021
110	USB-LWL-Converter	OLS-1	-	Ing. Büro Scheiba	-	4	
119	RT Harmonics Analyzer dig. Flickermeter	B10	G60547	BOCONSULT	36 M	-	30.05.2019
133	horn antenna 18 GHz (Meas 1)	3115	9012-3629	EMCO	36 M	1c	10.03.2020
134	horn antenna 18 GHz (Subst 2)	3115	9005-3414	EMCO	36 M	-	10.03.2020
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	-	30.05.2020
262	Power Meter	NRV-S	825770/0010	Rohde & Schwarz	24 M	-	30.05.2019
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	-	30.05.2020
266	Peak Power Sensor	NRV-Z31, Model 04	843383/016	Rohde & Schwarz	24 M	-	30.05.2020
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	
298	Univ. Radio Communication Tester	CMU 200	832221/091	Rohde & Schwarz	pre-m	3	
300	AC LISN (50 Ohm/50µH, 1-phase)	ESH3-Z5	892 239/020	Rohde & Schwarz	12 M	-	17.05.2019
301	attenuator (20 dB) 50W, 18GHz	47-20-33	AW0272	Lucas Weinschel	pre-m	2	
302	horn antenna 40 GHz (Meas 1)	BBHA9170	155	Schwarzbeck	36 M	-	14.03.2020
303	horn antenna 40 GHz (Subst 1)	BBHA9170	156	Schwarzbeck	36 M	-	20.03.2020
331	Climatic Test Chamber -40/+180 Grad	HC 4055	43146	Heraeus Vötsch	24 M	-	30.10.2020
341	Digital Multimeter	Fluke 112	81650455	Fluke	24 M	-	30.05.2020
342	Digital Multimeter	Voltcraft M-4660A	IB 255466	Voltcraft	24 M	-	17.05.2019
347	laboratory site	radio lab.	-	-	-	5	
348	laboratory site	EMI conducted	-	-	-	5	
354	DC - Power Supply 40A	NGPE 40/40	448	Rohde & Schwarz	pre-m	2	
357	power sensor	NRV-Z1	861761/002	Rohde & Schwarz	24 M	-	24.05.2019
371	Bluetooth Tester	CBT32	100153	R&S	36 M	-	30.05.2019
373	Single-Line V-Network (50 Ohm/5µH)	ESH3-Z6	100535	Rohde & Schwarz	12 M	-	17.05.2019
377	EMI Test Receiver	ESCS 30	100160	Rohde & Schwarz	12 M	-	30.05.2019
389	Digital Multimeter	Keithley 2000	0583926	Keithley	pre-m	-	
405	Thermo-/Hygrometer	OPUS 10 THI	126.0604.0003.3.3.3.22	LUFFT Mess u. Regeltechnik	24 M	-	30.03.2019
431	Model 7405	Near-Field Probe Set	9305-2457	EMCO	-	4	
436	Univ. Radio Communication Tester	CMU 200	103083	Rohde & Schwarz	12 M	-	06.03.2019
439	UltraLog-Antenna	HL 562	100248	Rohde & Schwarz	36 M	-	10.03.2020
454	Oscilloscope	HM 205-3	9210 P 29661	Hameg	-	4	
456	DC-Power supply 0-5 A	EA 3013 S	207810	Elektro Automatik	pre-m	2	
459	DC -Power supply 0-5 A , 0-32 V	EA-PS 2032-50	910722	Elektro Automatik	pre-m	2	
460	Univ. Radio Communication Tester	CMU 200	108901	Rohde & Schwarz	12 M	-	30.05.2019
463	Universal source	HP3245A	2831A03472	Agilent	-	4	
466	Digital Multimeter	Fluke 112	89210157	Fluke USA	24 M	-	30.05.2020
467	Digital Multimeter	Fluke 112	89680306	Fluke USA	36 M	-	30.05.2019
468	Digital Multimeter	Fluke 112	90090455	Fluke USA	36 M	-	30.04.2021

Ref.-No.	Equipment	Type	Serial-No.	Manufacturer	Interval of calibration	Remark	Cal due
477	ReRadiating GPS-System	AS-47	-	Automotive Cons. Fink	-	3	
480	power meter (Fula)	NRVS	838392/031	Rohde & Schwarz	24 M	-	16.05.2019
482	filter matrix	Filter matrix SAR 1	-	CETECOM (Brl)	-	1d	
487	System CTC NSA-Verification SAR-EMI	System EMI field (SAR) NSA	-	ETS Lindgren / CETECOM	24 M	-	31.03.2019
502	band reject filter	WRCG 1709/1786-1699/1796-	SN 9	Wainwright	pre-m	2	
503	band reject filter	WRCG 824/849-814/859-	SN 5	Wainwright	pre-m	2	
517	relais switch matrix	HF Relais Box Keithley	SE 04	Keithley	pre-m	2	
523	Digital Multimeter	L4411A	MY46000154	Agilent	24 M	-	18.05.2019
529	6 dB Broadband resistive power divider	Model 1515	LH 855	Weinschel	pre-m	2	
530	10 dB Broadband resistive power divider	R 416110000	LOT 9828	-	pre-m	2	
436	Univ. Radio Communication Tester	CMU 200	103083	R&S	12 M	-	30.03.2019
549	Log.Per-Antenna	HL025	1000060	Rohde & Schwarz	36/12 M	-	31.07.2021
550	System CTC S-VSWR Verification SAR-EMI	System EMI Field SAR S-VSWR	-	ETS Lindgren/CETECOM	24 M	-	30.03.2019
558	System CTC FAR S-VSWR	System CTC FAR S-VSWR	-	CTC	24 M	-	08.08.2019
574	Biconilog Hybrid Antenna	BTA-L	980026L	Frankonia	36/12 M	-	31.03.2019
584	Spectrum Analyzer	FSU 8	100248	Rohde & Schwarz	pre-m	-	
594	Wideband Radio Communication Tester	CMW 500	101757	Rohde & Schwarz	12 M	-	30.05.2019
597	Univ. Radio Communication Tester	CMU 200	100347	Rohde & Schwarz	pre-m	-	
600	power meter	NRVD (Reserve)	834501/018	Rohde & Schwarz	24 M	-	17.05.2019
601	medium-sensitivity diode sensor	NRV-Z5 (Reserve)	8435323/003	Rohde & Schwarz	24 M	-	15.05.2019
602	peak power sensor	NRV-Z32 (Reserve)	835080	Rohde & Schwarz	24 M	-	
611	DC power supply	E3632A	KR 75305854	Agilent	pre-m	2	
612	DC power supply	E3632A	MY 40001321	Agilent	pre-m	2	
613	Attenuator	R416120000 20dB 10W	Lot. 9828	Radiall	pre-m	2	
616	Digitalmultimeter	Fluke 177	88900339	Fluke	24 M	-	30.05.2020
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	-	30.05.2019
621	Step Attenuator 0-139 dB	RSP	100017	Rohde & Schwarz	pre-m	2	
625	Generic Test Load USB	Generic Test Load USB	-	CETECOM	-	2	
627	data logger	OPUS 1	201.0999.9302.6.4.1.43	G. Lufft GmbH	24 M	-	30.03.2019
634	Spectrum Analyzer	FSM (HF-Unit)	826188/010	Rohde & Schwarz	pre-m	2	
637	High Speed HDMI with Ethernet 1m	HDMI cable with Ethernet 1m	-	KogiLink	-	2	
638	HDMI Kabel with Ethernet 1,5 m flach	HDMI cable with Ethernet	-	Reichelt	-	2	
640	HDMI cable 2m rund	HDMI cable 2m rund	-	Reichelt	-	2	
641	HDMI cable with Ethernet	Certified HDMI cable with	-	PureLink	-	2	
642	Wideband Radio Communication Tester	CMW 500	126089	Rohde&Schwarz	24 M	-	24.05.2019
644	Amplifierer	ZX60-2534M+	SN865701299	Mini-Circuits	-	-	
670	Univ. Radio Communication Tester	CMU 200	106833	Rohde & Schwarz	24 M	-	30.05.2020
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	-	30.05.2019
686	Field Analyzer	EHP-200A	160WX30702	Narda Safety Test Solutions	24 M	-	29.03.2019
687	Signal Generator	SMF 100A	102073	Rohde&Schwarz	12 M	-	30.05.2019
688	Pre Amp	JS-18004000-40-8P	1750117	Miteq	pre-m	-	
690	Spectrum Analyzer	FSU	100302/026	Rohde&Schwarz	24 M	-	16.05.2019
691	OSP120 Base Unit	OSP120	106833	Rohde & Schwarz	12 M	-	30.05.2019
692	Bluetooth Tester	CBT 32	100236	Rohde & Schwarz	36 M	-	29.05.2020
697	Power Splitter	ZN4PD-642W-S+	165001445	Mini-Circuits	-	2	
703	INNCO Antennen Mast	MA 4010-KT080-XPET-ZSS3	MA4170-KT100-XPET-	INNCO	pre-m	-	
704	INNCON Controller	CO 3000-4port	CO3000/933/38410516/L	INNCO Systems GmBh	pre-m	-	
711	Harmonic Mixer 90 GHz - 140GHz	RPG FS-Z140	101004	RPG	24 M	-	22.02.2019
712	Harmonic Mixer 75 GHz - 110GHz	FS-Z110	101468	Rohde & Schwarz	24 M	-	22.02.2019
713	Harmonic Mixer, 50 GHz - 75GHz	FS-Z75	101022	Rohde & Schwarz	24 M	-	22.05.2019
714	Signal Analyzer 67GHz	FSW67	104023	Rohde & Schwarz	24 M	-	28.02.2020
715	Harmonic Mixer, 140 GHz - 220GHz	FS-Z220	101009	RPG Radiometer Physics	24 M	-	03.08.2019
716	Harmonic Mixer 220 GHz to 325 GHZ	FS-Z325	101005	RPG Radiometer Physics	24 M	-	13.02.2019
747	Spectrum Analyzer	FSU 26	200152	Rohde & Schwarz	12 M	-	30.05.2019
748	Pickett-Potter Horn Antenna	FH-PP 4060	010001	Radiometer Physiscs	-	-	
749	Pickett-potter Horn Antenna	FH-PP 60-90	010003	Radiometer Physics	-	-	
750	Pickett-Potter Horn Antenna	FH-PP 140-220	010011	Radiometer Physics	-	-	
751	Digital Optical System	optoCAN-FD Transceiver	17-010416	mk-messtechnik GmbH	-	-	

Ref.-No.	Equipment	Type	Serial-No.	Manufacturer	Interval of calibration	Remark	Cal due
752	Digital Optical System	optoCAN-FD Transceiver	17-010083	mk-messtechnik GmbH	-	-	
753	Digital Optical System	optoCAN-FD Transceiver	17-010084	mk-messtechnik GmbH	-	-	
754	Digital Optical System	optoCAN-FD Transceiver	17-010415	mk-messtechnik GmbH	-	-	
755	Digital Optical System	optoLAN-100-MAX	17-010795	mk-messtechnik GmbH	-	-	
701	WIDEBAND RADIO COMMUNICATION	CMW500	158150	Rohde&Schwarz	12 M	-	20.07.2019
758	Signal Generator	SMU 200A	100754	Rohde & Schwarz	24 M	-	11.10.2019
781	Power Supply	PS 2042-10 B	2815450369	Elektro-Automatik GmbH	-	-	
782	Power Supply	PS 2042-10 B	2815450348	lektro-Automatik GmbH &Co.KG	-	-	
783	Spectrum Analyzer	FSU 26	100414	Rohde & Schwarz	12 M	-	30.05.2019
784	Power Supply	NGSM 32/10	00196	Rohde & Schwarz	12 M	-	
785	RSP	RF Step Attenuator	860712/012	Rohde & Schwarz	12 M	-	
786	SAR Probe	ES3DV3	3340	Speag	36 M	-	14.02.2021
787	OSP	OSP B157WX	101264	Rohde & Schwarz	12 M	-	30.05.2019

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

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

9. Versions of test reports (change history)

Version	Applied changes	Date of release
--	Initial release	2018-09-28
C1	Costumer Name updated and ‘End of Report’ added	2019-01-02

End of Report