

PARTIAL TEST REPORT

No.: 17-1-0231001T14a-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

for
IPETRONIK GmbH & Co KG

μCROS SL
Data Logger

FCC ID: 2ARF8UCROS-SL

Laboratory Accreditation and Listings



accredited according to DIN EN ISO/IEC 17025:2018

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The listed attachments are an integral part of this report.

1. Summary of test results

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

The Equipment Under Test (in this report, hereinafter referred as EUT) supports radiofrequency technologies. Delta tests apply to check for conformance against valid standards due already approved cellular wireless module **LISA-U200** from **ublox** with **FCC-ID: XPYLISAU200** and **ISED: 8595A-LISAU200**. Due no modifications on the WCDMA Part of the module only radiated tests have been performed. In addition power verification tests have been performed too. This test report shows results for W-CDMA 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 and Part 24, Subpart E (Broadband PCS) of the FCC CFR Title 47 Rules, Edition 2018 standards and Canada RSS-132 Issue 3, RSS-139, Issue 3, Issue RSS-133 Issue 6, and RSS-Gen Issue 5 standards.

1.1. TX mode, Test overview of FCC 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 4	--	--	NA
2	General field strength emissions (9 kHz - 30 MHz)	Enclosure + Inter-connecting cables (radiated)	§ 15.209(a)	RSS-Gen, Issue 5: Chapter 8.9, Table 6	2400/F(kHz) µV/m 24000/F(kHz) µV/m 30 µV/m	1	1,2,3	Passed
7	RF-Power (ERP/EIRP)		§2.1046	RSS-132, Issue 3: Chapter 5.4 SRSP-503: 5.1.3	< 7 Watt (ERP)	1	1,2,3	Calculated Passed
			§22.913(a)(2) §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)			
8	Spurious emissions		§2.1053(a) §2.1057	RSS-132: Chapter 5.5(i)(ii) RSS-133: Chapter 6.5.1(i)(ii)	Required attenuation below P(dBW): 43+10log(P) dBc	1	1,2,3	Passed
9	Band-Edge compliance	§22.917(a)(b) §24.238(a)(b) §27.53(h)	RSS-139: Issue 3 Chapter 6.6 (i) (ii)	1		1,2,3	Passed	

No. of Diagram group	Test case	Port	References & Limits			EUT set-up	EUT op-mode	Result
			FCC Standard	RSS Section	Test limit			
30	RF Power conducted	Antenna Terminal	§2.1046 §22.913(a)(5) §24.232(c) §27.50(d)(4)	RSS-132: 5.4 SRSP-503: 5.1.3 RSS-133: 4.1/6.4 SRSP-510: 5.1.2	< 7 Watt (ERP) < 2 Watt (EIRP) < 1 Watt (EIRP)	2	1+2+3	Passed
30	RF Power	Antenna terminal (conducted)	§2.1046 §22.913(a)(5) §24.232(c) §27.50(d)(4)	RSS-132: Chapter 5.4 SRSP-503: 5.1.3 RSS-133: Chapter 4.1/6.4 SRSP-510: 5.1.2 RSS-139, Issue 3: Chapter 6.5	< 7 Watt (ERP) < 2 Watt (EIRP) < 1 Watt (EIRP)	--	--	Remark *1)
34	26dB Emission bandwidth		§2.202 §2.1049(h) §22.917(a) §24.238(a) §27.53(h)	RSS-Gen., Issue 5: Chapter 6.7	99% Power	--	--	
35	99% Occupied bandwidth					--	--	
36	Spurious emissions		§2.1051 §2.1057	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)	Required attenuation below P(dBW): 43+10log(P) dBc	--	--	
37	Band-Edge compliance		§22.917(a)(b) §24.238(a)(b) §27.53(h)			--	--	
38	Frequency stability		§2.1055(a)(2) §22.355	RSS-132, Issue 3: Chapter 5.3	FCC/ISED: < ±2.5ppm	--	--	
		table C-1 §24.235	RSS-133, Issue 6: Chapter 6.3	FCC/ISED: fundamental emissions stay within the authorized bands ISED: < ±2.5ppm				
		§27.54	RSS-139, Issue 3: Chapter 6.4	FCC/ISED: fundamental emissions stay within the authorized bands				

Remark: 1.) Please refer to modular FCC test reports of FCC ID: XPYLISAU200

https://apps.fcc.gov/oetcf/tcb/reports/Tcb731GrantForm.cfm?mode=COPY&RequestTimeout=500&tcb_code=&application_id=mka%2FQOeS4d7b4gwntenUHQ%3D%3D&fcc_id=XPYLISAU200

The test report CETECOM_TR17-1-0231001T14a-C1 dated 2020-04-28 substitutes the test report CETECOM_TR17-1-0231001T14a, dated 2019-07-15. The substituted test report gets invalid herewith.

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 (ISED) standards. All requirements as shown in above table are met in accordance with enumerated standards.

.....
Dipl.-Ing. Niels Jeß
Responsible for test section

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

2. Administrative Data

2.1. Identification of the testing laboratory

Company name:	CETECOM GmbH
Address:	Im Teelbruch 116 45219 Essen - Kettwig Germany
Responsible for testing laboratory:	Mr. Volker Wittmann
Deputy of testing laboratory:	Dipl.-Ing. Ninovic Perez

2.2. Test location

2.2.1. Test laboratory "CTC"

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

Responsible for test report:	Dipl.-Ing. C. Lorenz
Project leader:	Dipl.-Ing. N. Perez
Receipt of EUT:	2018-04-09
Date(s) of test:	2018-04-22 to 2018-07-16
Date of report:	2020-04-28

Version of template:	13.02

2.4. Applicant's details

Applicant's name:	IPETRONIK GmbH & Co KG
Address:	Im Rollfeld 28 76532 Baden-Baden Germany
Contact person:	Mr. Peter Hütt

2.5. Manufacturer's details

Manufacturer's name:	see applicant's detail
Address:	see applicant's detail

3. Equipment under test (EUT)

3.1. TECHNICAL WCDMA DATA OF MAIN EUT DECLARED BY APPLICANT

Main function	Datalogger		
Type	μCROS SL		
Module	LISA-U200 from ublox		
Module FCC ID	FCC-ID: XPYLISAU200		
Module IC	ISED: 8595A-LISAU200		
TX-frequency range	☒ FDD Band 2: 1852.4–1907.6 MHz (Uplink), 1930-1990 MHz (Downlink) ☒ FDD Band 4: 1712.4–1752.6 MHz (Uplink), 2110-2155 MHz (Downlink) ☒ FDD Band 5: 826.4-846.6 MHz (Uplink), 869-894 MHz (Downlink)		
Type of modulation	☒ FDD-Mode Release99: QPSK ☒ FDD Mode Release 5+6: 16QAM additional		
Number of channels	☒ FDD Band 2: UARFCN range 9262 – 9400 – 9538 ☒ FDD Band 4: UARFCN range 1312 – 1450 – 1513 ☒ FDD Band 5: UARFCN range 4132 – 4185 – 4233		
UMTS-HSPA connectivity	☒ Uplink speed: 5.76 Mb/s (category 6) ☐ Uplink speed:		
Emission designator(s)	See original module's grant: https://apps.fcc.gov/oetcf/tcb/reports/Tcb731GrantForm.cfm?mode=COPY&RequestTimeout=500&tcb_code=&application_id=mka%2FQOeS4d7b4gwntenUHQ%3D%3D&fcc_id=XPYLISAU200		
Antenna Type	☐ Integrated (enclosure) ☐ External - dedicated, no RF- connector ☒ External, separate RF-connector		
Antenna Model	4G/3G/2G Antenna Taoglass Part Nr.: MA962.A.LBCG.003.ka Datasheet: SPE-18-8-070-B/SC		
Antenna Gain Tx ^{*1)}	FDD Band 2: 2.98 dBi ^{1.)} FDD Band 4: 3.18 dBi ^{1.)} FDD Band 5: 2.90 dBi ^{1.)}		
Max. Output Power:			
Conducted FDD-Mode 2	23.66 dBm (RMS)		
Conducted FDD-Mode 4	22.66 dBm (RMS)		
Conducted FDD-Mode 5	22.71 dBm (RMS)		
Peak EIRP:	= Max Output Power + Antenna Gain (including cable loss)		
Conducted FDD-Mode 2	23.66 dBm + 2.98 dBi = 26.64 dBm EIRP		
Conducted FDD-Mode 4	22.66 dBm + 3.18 dBi = 25.84 dBm EIRP		
Conducted FDD-Mode 5	22.71 dBm + 2.90 dBi = 25.61 dBm EIRP		
Peak ERP:	= EIRP – 2.15dBi		
Conducted FDD-Mode 2	26.64 dBm – 2.15dBi = 24.49 dBm ERP		
Conducted FDD-Mode 2	25.84 dBm – 2.15dBi = 23.69 dBm ERP		
Conducted FDD-Mode 5	25.61 dBm – 2.15dBi = 23.46 dBm ERP		
Installed option	☒ 802.11 a/n/ac (not tested within this report) ☒ 802.11 b/g/n (not tested within this report) ☒ GSM 850/1900 (not tested within this report) ☒ GNSS (not tested within this report)		
Power supply	☒ DC power only: 24 V DC ☐ Li-ion Battery: 3,7V DC		
Does EUT contain devices susceptible to magnetic fields, e.g. Hall elements, electrodynamics microphones, etc.?	☐ yes ☒ no		
EUT sample type	☐ Production	☒ Pre-Production	☐ Engineering
FCC label attached	☐ yes	☒ no	

Remark: ^{*1)} please refer to “Antenna Measurement Report of Taoglass Part Nr.: MA962.A.LBCG.003.ka

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 S03	μCROS SL	Data Logger	00061	HW1.03	SW1.30

*) 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	Power supply cable	100/50 PE	--	--	--
AE 2	MA962 Guardian 4 in 1 Adhesive Mount Antenna LTE + Wi-Fi*2 + GNSS (including 3m RG174 cables)	Part Nr.: MA962.A.LBCG.003. ka	--	--	--

*) 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 1 + AE 2	Used for radiated measurements.
set. 2	EUT A + AE 1	Used for conducted 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. *1)	Description of operating modes	Additional information
op. 1	FDD-Band II 12.2 kbps RMC	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: 21 dBm or 24dBm nominal. The input signal to the receiver is modulated with normal test 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 according Table E5.1/Table E5.1A as described in 3GPP TS34.121, Annex E.
op. 2	FDD-Band IV 12.2 kbps RMC	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: 21 dBm or 24dBm nominal. The input signal to the receiver is modulated with normal test 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 according Table E5.1/Table E5.1A as described in 3GPP TS34.121, Annex E.
op. 3	FDD-Band V 12.2 kbps RMC	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: 21 dBm or 24dBm nominal. The input signal to the receiver is modulated with normal test 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 according Table E5.1/Table E5.1A as described in 3GPP TS34.121, Annex E.

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

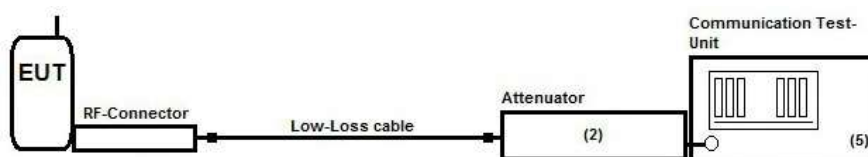
4. Description of test system set-up's

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 v03

Used Equipment	Passive Elements	Test Equipment	Remark:
	☒ 10 dB Attenuator (#603)	☒ CMU200 Communication Test-Unit for GSM/W-CDMA	See List of equipment under each test case and chapter 5.2 for calibration info
	☒ Low loss RF-cables	☒ DC-Power Supply	

Measurement uncertainty See chapter Measurement Uncertainties (Cel-2)

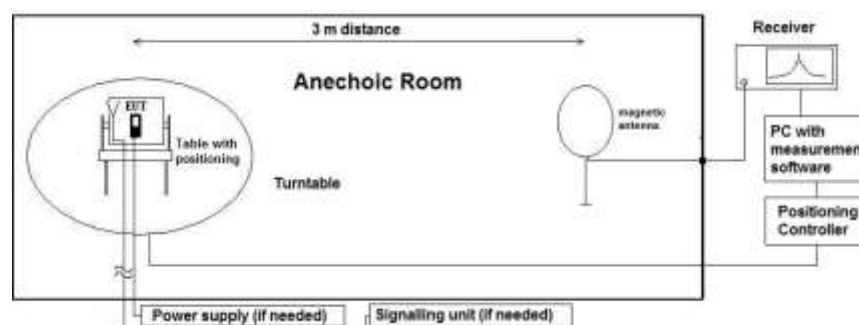
4.2. Test system set-up for radiated magnetic field measurements below 30 MHz

Specification: ANSI C63.10-2013 chapter 6.4 (§6.4.4.2)

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

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

Schematic:



Testing method:

Exploratory, preliminary measurement

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

Final measurement on critical frequencies

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

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

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

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

Formula:

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

$$M = L_T - E_C$$

AF = Antenna factor

C_L = Cable loss

D_F = Distance correction factor

E_C = Electrical field – corrected value

E_R = Receiver reading

G_A = Gain of pre-amplifier (if used)

L_T = Limit

M = Margin

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

Distance correction:

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

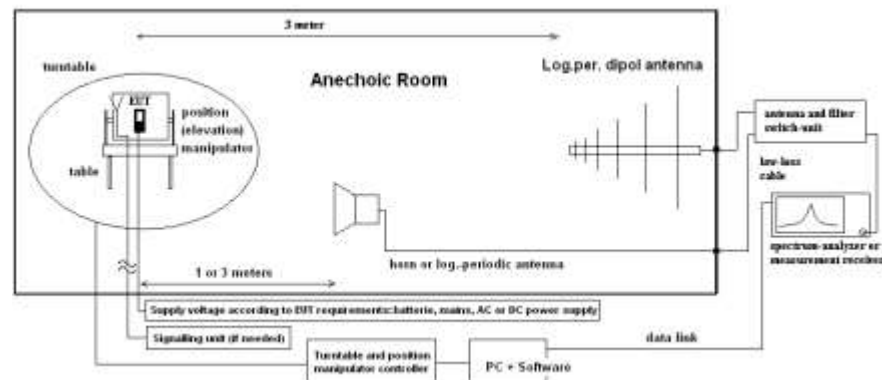
ANSI C63.10: 2013, §6.4.4.2 - Equations (2) + (3) + (4)

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

Specification: ANSI C63.26: 2015

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

Schematic:



Testing method:

Exploratory, preliminary measurements

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

Final measurement on critical frequencies

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

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

On the determined worst-case position, a final measurement with necessary bandwidth and detector according standard has been carried out. The readings on the spectrum analyzer are corrected with conversion value between field strength and E(I)RP, so the readings shown are equivalent to ERP/EIRP values. Critical measurements near the limit are re-measured with a substitution method accord. ANSI/TIA/EIA 603 C/D

Formula:

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

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

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

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)

$E_{C(I)RP}$ = 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-Value

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	☒ 670 CMU	
otherwise	☐ 400 FTC40x15E	☐ 401 FTC40x15E	☐ 110 USB LWL	☐ 482 Filter Matrix	☐ 378 RadiSense
DC power	☐ 611 E3636A	☒ 463 HP3245A	☐ 459 EA 2032-50	☐ 268 EA- 3050	☐ 494 AG6632A
otherwise	☐ 331 HC 4055	☐ 248 6 dB Att.	☐ 529 Power div.	☐ - cable OTA20	☐ 498 NGPE 40
Supply voltage	☐ 230 V 50 Hz via public mains		☒ 24 V DC		

5.1.2. Requirements and limits

FCC	☒ §2.1046 ☒ §22.913(a)(5) ☒ § 24.232(c) ☒ § 27.50(d)(4)
ISED	☒ RSS-132, Issue 3: 5.4 + SRSP 503:5.1.3 for FDD 5 ☒ RSS-133, Issue 6: 4.1/6.4 + SRSP-510:5.1.2 for FDD 2 ☒ RSS-139, Issue 3: 6.5 for FDD 4
ANSI	C63.26-2015
KDB	971168 D01 v03
Limits	Maximum Power Output of the wireless device should be determined while measured radiated E(I)RP
	☒ Limit FDD Band 5: 7 Watt ERP (38.4 dBm)
	☒ Limit FDD Band 2: 2 Watt EIRP (33.0 dBm)
	☒ Limit FDD Band 4: 1 Watt EIRP (30.0 dBm)
	PAPR ≤ 13dB

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" ANRITSU	
Measurement method	The measurements were performed with the integrated power measurement function of the „radio communication tester CMU200 from Rohde&Schwarz company. In this way spectrum-analyzers instrument limitations can be avoided or minimized. Instead, CMU manufacturers declared measurement error can be considered for this measurement. The attenuation (insertion loss) at the RF Inputs/Outputs of CMU were set according the path loss of the test set-up, determined in a step before starting the measurements. A suitable artificial antenna or RF-connector is provided by the applicant in order to perform the conducted measurements. Any data provided with the artificial antenna or connector, have been taken in account in order to correct the measurement data. (typical 0.3dB for attenuation of antenna connector) Peak and Average Values have been recorded for each channel on test set-up Cel-1. The Peak-to - Average-Power Ratio is determined by devices integrated CCDF capability with corresponding settings. (see annex 1 plots)	
EUT settings	A call was established on highest power transmit conditions in GMSK and RMC99 mode. UE is set TX mode, highest transmit power conditions, DTX, MPR or other power saving techniques have been disabled 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 wireless device, should be sufficient to demonstrate compliance.	

5.1.4. Measurement Results

Maximum values reported at this chapter, for other channels pls. check annex 1.

UMTS Band II

UMTS Band II	Set-up No	Op mode	Peak Power (dBm)	RMS Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	ERP (dBm)	Limit EIRP (dBm)	Margin (dB)	Result
Power (dBm)	2	1	26.73	23.66	2.98	26.64	24.49	33	6.36	passed
PAPR (dB)	2	1	3.07					13	9.93	passed

Remark: PAPR calculated as difference Peak to RMS (for measurements see original module's report)

UMTS Band IV

UMTS Band II	Set-up No	Op mode	Peak Power (dBm)	RMS Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	ERP (dBm)	Limit EIRP (dBm)	Margin (dB)	Result
Power (dBm)	2	2	25.65	22.66	3.18	25.84	23.69	30	4.16	passed
PAPR (dB)	2	2	3.09					13	9.91	passed

Remark: PAPR calculated as difference Peak to RMS (for measurements see original module's report)

UMTS Band V

UMTS Band V	Set-up No	Op mode	Peak Power (dBm)	RMS Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	ERP (dBm)	Limit ERP (dBm)	Margin (dB)	Result
Power (dBm)	2	3	25.64	22.71	2.90	25.61	23.46	38.4	12.79	passed
PAPR (dB)	2	3	2.93					13	10.07	passed

Remark: PAPR calculated as difference Peak to RMS (for measurements see original module's report)

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	☐ 377 ESCS30	☒ 001 ESS	☐
spectr. analys.	☐ 584 FSU	☐ 120 FSEM	☐ 264 FSEK
antenna	☐ 574 BTA-L	☐ 133 EMCO3115	☐ 302 BBHA9170
signaling	☐ 392 MT8820A	☐ 371 CBT32	☒ 436 CMU
otherwise	☐ 400 FTC40x15E	☐ 401 FTC40x15E	☐ 110 USB LWL
DC power	☐ 456 EA 3013A	☒ 457 EA 3013A	☐ 459 EA 2032-50
line voltage	☐ 230 V 50 Hz via public mains	☒ 24 V DC	

5.2.2. Requirements

FCC	Part 15, Subpart C, §15.205 & §15.209			
ISED	RSS-Gen: Issue 5: §8.9 Table 6			
ANSI	C63.10-2013			
Frequency [MHz]	Field strength limit		Distance [m]	Remarks
	[µV/m]	[dBµV/m]		
0.009 – 0.490	2400/f (kHz)	67.6 – 20Log(f) (kHz)	300	Correction factor used due to measurement distance of 3 m
0.490 – 1.705	24000/f (kHz)	87.6 – 20Log(f) (kHz)	30	Correction factor used due to measurement distance of 3 m
1.705 – 30	30	29.5	30	Correction factor used due to measurement distance of 3 m

5.2.3. 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	☒ 6 dB EMI-Receiver Mode ☐ 3dB Spectrum analyser Mode	
	Detector	Peak (pre-measurement) and Quasi-PK/Average (final if applicable)	
	Mode:	Repetitive-Scan, max-hold	
Sweep-Time		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 consult the diagrams included in annex 1. A representative choice of operating modes shows compliance.

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	
2.20a	II	9262	9 kHz-30 MHz	1	1	EUT Standing position	☒	☐	☐	passed
2.20b	II	9262	9 kHz-30 MHz	1	1	EUT Laying position	☒	☐	☐	passed
2.31a	IV	1312	9 kHz-30 MHz	1	1	EUT Standing position	☒	☐	☐	passed
2.31b	IV	1312	9 kHz-30 MHz	1	1	EUT Laying position	☒	☐	☐	passed
2.50a	V	4132	9 kHz-30 MHz	1	3	EUT Laying position	☒	☐	☐	passed
2.50b	V	4132	9 kHz-30 MHz	1	3	EUT Standing position	☒	☐	☐	passed

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

Frequency -Range	f [kHz/MHz]	Lambda [m]	Far-Field Point [m]	Distance Limit accord. 15.209 [m]	1st Condition ($d_{\text{meas}} \leq D_{\text{far-field}}$)	2te Condition (Limit distance bigger $d_{\text{near-field}}$)	Distance Correction accord. Formula
kHz	0.001 - 0.1	300000.00	1800.00	3000	fulfilled	not fulfilled	00.00
	1.001 - 0.4	75000.00	450.00		fulfilled	not fulfilled	00.00
	2.001 - 0.4	37500.00	225.00		fulfilled	not fulfilled	00.00
	3.001 - 0.4	25000.00	150.00		fulfilled	not fulfilled	00.00
	4.001 - 0.4	18750.00	112.50		fulfilled	not fulfilled	00.00
	5.001 - 0.4	15000.00	90.00		fulfilled	not fulfilled	00.00
	6.001 - 0.4	12500.00	75.00		fulfilled	not fulfilled	00.00
	7.001 - 0.4	10714.29	65.10		fulfilled	not fulfilled	00.00
	8.001 - 0.4	9375.00	56.25		fulfilled	not fulfilled	00.00
	9.001 - 0.4	8333.33	50.00		fulfilled	not fulfilled	00.00
	1.001 - 0.7	3000.00	90.00		fulfilled	not fulfilled	00.00
	1.501 - 0.7	2000.00	60.00		fulfilled	not fulfilled	00.00
	2.001 - 0.7	1500.00	45.00		fulfilled	fulfilled	00.00
	3.001 - 0.7	1000.00	30.00		fulfilled	fulfilled	00.00
	4.001 - 0.7	750.00	22.50		fulfilled	fulfilled	00.00
	5.001 - 0.7	600.00	18.00		fulfilled	fulfilled	00.00
	6.001 - 0.7	500.00	15.00		fulfilled	not fulfilled	00.00
	7.001 - 0.7	428.57	12.86		fulfilled	not fulfilled	00.00
	8.001 - 0.7	375.00	11.25		fulfilled	not fulfilled	00.00
	9.001 - 0.7	333.33	10.00		fulfilled	not fulfilled	00.00
	1.001 - 1.0	300.00	9.00		fulfilled	not fulfilled	00.00
	1.501 - 1.0	200.00	6.00		fulfilled	not fulfilled	00.00
	2.001 - 1.0	150.00	4.50		fulfilled	fulfilled	00.00
	3.001 - 1.0	100.00	3.00		fulfilled	fulfilled	00.00
	4.001 - 1.0	75.00	2.25		fulfilled	fulfilled	00.00
	5.001 - 1.0	60.00	1.80		fulfilled	fulfilled	00.00
	6.001 - 1.0	50.00	1.50		fulfilled	fulfilled	00.00
	7.001 - 1.0	42.86	1.29		fulfilled	fulfilled	00.00
	8.001 - 1.0	37.50	1.13		fulfilled	fulfilled	00.00
	9.001 - 1.0	33.33	1.00		fulfilled	fulfilled	00.00
	10.001 - 1.0	30.00	0.90		fulfilled	fulfilled	00.00
MHz	10.001 - 1.0	30.00	0.90	300	fulfilled	fulfilled	00.00
	15.001 - 1.0	20.00	0.60		fulfilled	fulfilled	00.00
	20.001 - 1.0	15.00	0.45		fulfilled	fulfilled	00.00
	25.001 - 1.0	12.00	0.36		fulfilled	fulfilled	00.00
	30.001 - 1.0	10.00	0.30		fulfilled	fulfilled	00.00
	35.001 - 1.0	8.57	0.26		fulfilled	fulfilled	00.00
	40.001 - 1.0	7.50	0.23		fulfilled	fulfilled	00.00
	45.001 - 1.0	6.67	0.20		fulfilled	fulfilled	00.00
	50.001 - 1.0	6.00	0.18		fulfilled	fulfilled	00.00
	55.001 - 1.0	5.45	0.16		fulfilled	fulfilled	00.00
	60.001 - 1.0	5.00	0.15		fulfilled	fulfilled	00.00
	65.001 - 1.0	4.62	0.14		fulfilled	fulfilled	00.00
	70.001 - 1.0	4.29	0.13		fulfilled	fulfilled	00.00
	75.001 - 1.0	4.00	0.12		fulfilled	fulfilled	00.00
	80.001 - 1.0	3.75	0.11		fulfilled	fulfilled	00.00
	85.001 - 1.0	3.53	0.10		fulfilled	fulfilled	00.00
	90.001 - 1.0	3.33	0.10		fulfilled	fulfilled	00.00
	95.001 - 1.0	3.16	0.09		fulfilled	fulfilled	00.00
	100.001 - 1.0	3.00	0.09		fulfilled	fulfilled	00.00
	100.001 - 1.0	3.00	0.09		fulfilled	fulfilled	00.00

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	☒ 439 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		
power supply	☒ 611 E3636A ☐ 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		
Supply voltage	☐ 230 V 50 Hz via public mains ☒ 24 V DC		

5.3.2. Requirements and limits

FCC	General: §2.1053(a) , §2.1057(a) ☒ FDD Band 5: Part 22: §22.917(a)(b) ☒ FDD Band 2: Part 24: §24.238(a)(b) ☒ FDD Band 4: Part 27: §27.53(h)
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)
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”
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 for critical measurements. According chapter 4.2
EUT settings	A call was established on highest power transmit conditions in RMC99 mode. 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 wireless device, should be sufficient to demonstrate compliance.

Spectrum-Analyzer settings for FDD band 2

	Start freq. MHz	Stop freq. MHz	R-BW MHz	V-BW MHz	Sweep time sec.	Att. [dB]	Detector
Sweep 1 (subrange 1)	30	1000	1	1	10	10	MaxH-PK
Sweep 1 (subrange 2)	1000	2800	1	1	15	0	MaxH-PK
Sweep 1 (subrange 3)	2800	19500	1	1	60	10	MaxH-PK
Sweep 2 (Band-Edge)	1849	1850	0.05	0.5	30	35	MaxH-PK
Sweep 3 (Band-Edge)	1910	1911	0.05	0.5	30	35	MaxH-PK

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 2 (Band-Edge)	1709	1710	0.05	0.5	30	35	MaxH-PK
Sweep 3 (Band-Edge)	1755	1756	0.05	0.5	30	35	MaxH-PK

Spectrum-analyzer settings for FDD 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	0.1	1	10	10	MaxH-PK
Sweep 1 (subrange 2)	1000	2800	0.1	1	15	0	MaxH-PK
Sweep 1 (subrange 3)	2800	9000	0.1	1	160	10	MaxH-PK
Sweep 2 (Band-Edge)	823	824	0.05	0.5	30	35	MaxH-PK
Sweep 3 (Band-Edge)	849	850	0.05	0.5	30	35	MaxH-PK

5.3.4. Results for Spurious Emissions

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

Diagram no.	Carrier Channel		Frequency range	Set – up no.	OP-mode no.	Remark	Used detector			Result
	Band	No.					PK	AV	QP	
8.20	II	9262	30 MHz to 19.5GHz	1	1	Carrier visible on diagram. Not relevant for results	☒	☐	☐	passed
8.30	IV	1312	30 MHz to 18GHz	1	2	Carrier visible on diagram. Not relevant for results	☒	☐	☐	passed
8.50	V	4132	30 MHz to 9GHz	1	3	Carrier visible on diagram. Not relevant for results	☒	☐	☐	passed

5.3.5. Results Band - Edge

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

Diagr No.	UMTS Band	CH	Set-up No	OP-mode No	Power RMS (dBm)	Limit (dBm)	Margin (dB)	Result
9.20	II	9262	1	1	-25.43	-13	12.43	passed
9.21	II	9538	1	1	-25.95	-13	12.95	passed
9.30	IV	1312	1	2	-26.29	-13	13.29	passed
9.31	IV	1513	1	2	-23.69	-13	10.69	passed
9.50	V	4132	1	3	-41.34	-13	28.34	passed
9.51	V	4233	1	3	-40.28	-13	27.28	passed

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 to its statistical distribution calculated.

Following table shows expectable uncertainties for each measurement type performed.

RF-Measurement	Reference	Frequency range	Calculated uncertainty based on a confidence level of 95%							Remarks
Conducted emissions (U _{CISPR})	CISPR 16-2-1	9 kHz - 150 kHz 150 kHz - 30 MHz	4.0 dB 3.6 dB							-
Radiated emissions Enclosure	CISPR 16-2-3	30 MHz - 1 GHz 1 GHz - 18 GHz	4.2 dB 5.1 dB							E-Field
Disturbance power	CISPR 16-2-2	30 MHz - 300 MHz	-							-
Power Output radiated	-	30 MHz - 4 GHz	3.17 dB							Substitution method
Power Output conducted	-	Set-up No.	Cel-C1	Cel-C2	BT1	W1	W2	--		
		9 kHz - 12.75 GHz	N/A	0.60	0.7	0.25	N/A	--		
		12.75 - 26.5GHz	N/A	0.82	--	N/A	N/A	--		
Conducted emissions on RF-port	-	9 kHz - 2.8 GHz	0.70	N/A	0.70	N/A	0.69	--		
		2.8 GHz - 12.75GHz	1.48	N/A	1.51	N/A	1.43	--		
		12.75 GHz - 18GHz	1.81	N/A	1.83	N/A	1.77	--		
		18 GHz - 26.5GHz	1.83	N/A	1.85	N/A	1.79	--		
Occupied bandwidth	-	9 kHz - 4 GHz	0.1272 ppm (Delta Marker)						Frequency error	
			1.0 dB						Power	
Emission bandwidth	-	9 kHz - 4 GHz	0.1272 ppm (Delta Marker)						Frequency error	
			See above: 0.70 dB						Power	
Frequency stability	-	9 kHz - 20 GHz	0.0636 ppm							
Radiated emissions Enclosure	-	150 kHz - 30 MHz	5.0 dB							
		30 MHz - 1 GHz	4.2 dB							
		1 GHz - 20 GHz	3.17 dB							

Table: measurement uncertainties, valid for conducted/radiated measurements

6. Abbreviations used in this report

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

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

Ref.-No.	Accreditation Certificate	Valid for laboratory area or test site	Accreditation Body
-	D-PL-12047-01-01 D-PL-12047-01-03 D-PL-12047-01-04	All laboratories and test sites of CETECOM GmbH, Essen	DAkkS, Deutsche Akkreditierungsstelle GmbH
337 487 558 348 348	736496	Radiated Measurements 30 MHz to 1 GHz, 3 m / 10 m (OATS) Radiated Measurements 30 MHz to 1 GHz, 3 m (SAR) Radiated Measurements above 1 GHz, 3 m (FAR) Mains Ports Conducted Interference Measurements Telecommunication Ports Conducted Interference Measurem.	FCC, Federal Communications Commission Laboratory Division, USA (MRA US-EU 0003)
337 487 550 558	3462D-1 3462D-2 3462D-2 3462D-3	Radiated Measurements 30 MHz to 1 GHz, 3 m / 10 m (OATS) Radiated Measurements 30 MHz to 1 GHz, 3 m (SAR) Radiated Measurements 1 GHz to 6 GHz, 3 m (SAR) Radiated Measurements above 1 GHz, 3 m (FAR)	IC, Industry Canada Certification and Engineering Bureau
487 550 348 348	R-2666 G-301 C-2914 T-1967	Radiated Measurements 30 MHz to 1 GHz, 3 m (SAR) Radiated Measurements 1 GHz to 6 GHz, 3 m (SAR) Mains Ports Conducted Interference Measurements Telecommunication Ports Conducted Interference Measurem.	VCCI, Voluntary Control Council for Interference by Information Technology Equipment, Japan
OATS = Open Area Test Site, SAR = Semi Anechoic Room, FAR = Fully Anechoic Room			

8. Instruments and Ancillary

8.1. Used equipment "CTC"

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

8.1.1. Test software and firmware of equipment

Ref.-No.	Equipment	Type	Serial-No.	Version of Firmware or Software during the test
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
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=
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)
699	Audio Analyzer	UPL16	833494/005	3.06

8.1.2. Single instruments and test systems

Ref.-No.	Equipment	Type	Serial-No.	Manufacturer	Interval of calibration	Remark	Cal due
005	AC - LISN (50 Ohm/50µH, test site 1)	ESH2-Z5	861741/005	Rohde & Schwarz	12 M	-	23.05.2020
007	Single-Line V-Network (50 Ohm/5µH)	ESH3-Z6	892563/002	Rohde & Schwarz	12 M	-	23.05.2020
009	Power Meter (EMS-radiated)	NRV	863056/017	Rohde & Schwarz	24 M	-	23.05.2021
016	Line Impedance Simulating Network	Op. 24-D	B6366	Spitzenberger+Spies	36 M	-	22.05.2022
020	Horn Antenna 18 GHz (Subst 1)	3115	9107-3699	EMCO	36/12 M	-	31.07.2021
021	Loop Antenna (H-Field)	6502	9206-2770	EMCO	36 M	-	30.05.2021
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	-	23.05.2021
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	16.11.2019
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	-	22.05.2022
133	horn antenna 18 GHz (Meas 1)	3115	9012-3629	EMCO	36 M	1c	10.03.2020
134	horn antenna 18 GHz (Subst 2)	3115	9005-3414	EMCO	36 M	-	10.03.2020
136	adjustable dipole antenna (Dipole 1)	3121C-DB4	9105-0697	EMCO	36 M	-	30.04.2018
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	-	30.05.2020
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	
287	pre-amplifier 25MHz - 4GHz	AMF-2D-100M4G-35-10P	379418	Miteq	12 M	1c	16.11.2019
291	high pass filter GSM 850/900	WHJ 2200-4EE	14	Wainwright GmbH	12 M	1c	16.11.2019
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	-	22.05.2020
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	-	10.01.2021
341	Digital Multimeter	Fluke 112	81650455	Fluke	24 M	-	30.05.2020
342	Digital Multimeter	Voltcraft M-4660A	IB 255466	Voltcraft	24 M	-	23.05.2021
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	-	21.05.2021
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	-	22.05.2020
377	EMI Test Receiver	ESCS 30	100160	Rohde & Schwarz	12 M	-	22.05.2020
389	Digital Multimeter	Keithley 2000	0583926	Keithley	pre-m	-	
392	Radio Communication Tester	MT8820A	6K00000788	Anritsu	12 M	-	01.07.2020
396	Thermo/Hygrometer	Thermo/Hygrometer	-	Conrad	24 M	-	09.01.2021
405	Thermo-/Hygrometer	OPUS 10 THI	126.0604.0003.3.3.3.22	LUFFT Mess u. Regeltechnik GmbH	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	-	25.05.2020
439	UltraLog-Antenna	HL 562	100248	Rohde & Schwarz	36 M	-	10.03.2020
441	CTC-SAR-EMI Cable Loss	System EMI field (SAR) Cable	-	CETECOM	12 M	5	05.06.2017

Ref.-No.	Equipment	Type	Serial-No.	Manufacturer	Interval of calibration	Remark	Cal due
443	CTC-FAR-EMI-RSE	System CTC-FAR-EMI-RSE	-	ETS-Lindgren / CETECOM	12 M	5	16.11.2019
448	notch filter WCDMA_FDD II	WRCT 1850.0/2170.0-5/40-10SSK	5	Wainwright Instruments GmbH	12 M	1c	16.11.2019
449	notch filter WCDMA FDD V	WRCT 824.0/894.0-5/40-8SSK	1	Wainwright	12 M	1c	16.11.2019
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	-	30.05.2020
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	-	30.05.2021
468	Digital Multimeter	Fluke 112	90090455	Fluke USA	36 M	-	30.04.2021
477	ReRadiating GPS-System	AS-47	-	Automotive Cons. Fink	-	3	
480	power meter (Fula)	NRVS	838392/031	Rohde & Schwarz	24 M	-	30.05.2021
482	filter matrix	Filter matrix SAR 1	-	CETECOM (Br)	-	1d	
484	pre-amplifier 2,5 - 18 GHz	AMF-5D-02501800-25-10P	1244554	Miteq	12 M	-	16.11.2019
487	System CTC NSA-Verification SAR-EMI	System EMI field (SAR) NSA	-	ETS Lindgren / CETECOM	24 M	-	16.04.2021
489	EMI Test Receiver	ESU40	1000-30	Rohde & Schwarz	12 M	-	30.06.2020
502	band reject filter	WRCG 1709/1786-1699/1796-	SN 9	Wainwright	pre-m	2	
503	band reject filter	WRCG 824/849-814/859-60/10SS	SN 5	Wainwright	pre-m	2	
512	notch filter GSM 850	WRCA 800/960-02/40-6EEK	SN 24	Wainwright	12 M	1c	16.11.2019
517	relais switch matrix	HF Relais Box Keithley System	SE 04	Keithley	pre-m	2	
523	Digital Multimeter	L4411A	MY46000154	Agilent	24 M	-	23.05.2021
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	-	30.07.2019
547	Univ. Radio Communication Tester	CMU 200	835390/014	Rohde & Schwarz	12 M	-	30.07.2019
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	-	30.08.2019
552	high pass filter 2,8-18GHz	WHKX 2.8/18G-10SS	4	Wainwright	12 M	1c	16.11.2019
557	System CTC-OTA-2	R&S TS8991	-	Rohde & Schwarz	12 M	5	24.01.2020
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	-	03.05.2022
584	Spectrum Analyzer	FSU 8	100248	Rohde & Schwarz	pre-m	-	
594	Wideband Radio Communication Tester	CMW 500	101757	Rohde & Schwarz	12 M	-	26.06.2020
597	Univ. Radio Communication Tester	CMU 200	100347	Rohde & Schwarz	pre-m	-	
600	power meter	NRVD (Reserve)	834501/018	Rohde & Schwarz	24 M	-	30.05.2021
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	-	30.05.2020
621	Step Attenuator 0-139 dB	RSP	100017	Rohde & Schwarz	pre-m	2	
625	Generic Test Load USB	Generic Test Load USB	-	CETECOM	-	2	
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 1,5m	-	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	-	30.05.2020
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	-	30.05.2020

Ref.-No.	Equipment	Type	Serial-No.	Manufacturer	Interval of calibration	Remark	Cal due
686	Field Analyzer	EHP-200A	160WX30702	Narda Safety Test Solutions	24 M	-	29.09.2019
687	Signal Generator	SMF 100A	102073	Rohde&Schwarz	12 M	-	30.05.2020
688	Pre Amp	JS-18004000-40-8P	1750117	Miteq	pre-m	-	
690	Spectrum Analyzer	FSU	100302/026	Rohde&Schwarz	24 M	-	30.05.2021
691	OSP120 Base Unit	OSP120	106833	Rohde & Schwarz	12 M	-	30.05.2020
692	Bluetooth Tester	CBT 32	100236	Rohde & Schwarz	36 M	-	29.05.2020
693	TS8997	CTC-Radio Lab 1 TS8997	-	Rohde&Schwarz	12 M	5	07.01.2020
697	Power Splitter	ZN4PD-642W-S+	165001445	Mini-Circuits	-	2	
701	CMW500 wide. Radio Comm.	CMW500	158150	Rohde & Schwarz	24 M	-	30.07.2020
703	INNCO Antennen Mast	MA 4010-KT080-XPET-ZSS3	MA4170-KT100-XPET-ZSS3	INNCO	pre-m	-	
704	INNCON Controller	CO 3000-4port	CO3000/933/384105 16/L	INNCO Systems GmbH	pre-m	-	
711	Harmonic Mixer 90 GHz - 140GHz	RPG FS-Z140	101004	RPG	36 M	-	22.02.2020
712	Harmonic Mixer 75 GHz - 110GHz	FS-Z110	101468	Rohde & Schwarz	36 M	-	22.02.2020
713	Harmonic Mixer, 50 GHz - 75GHz	FS-Z75	101022	Rohde & Schwarz	24 M	-	05.07.2021
714	Signal Analyzer 67GHz	FSW67	104023	Rohde & Schwarz	24 M	-	04.07.2021
715	Harmonic Mixer, 140 GHz - 220GHz	FS-Z220	101009	RPG Radiometer Physics	36 M	-	03.08.2020
716	Harmonic Mixer 220 GHz to 325 GHz	FS-Z325	101005	RPG Radiometer Physics	36 M	-	13.02.2020
747	Spectrum Analyzer	FSU 26	200152	Rohde & Schwarz	12 M	-	30.05.2019
748	Pickett-Potter Horn Antenna	FH-PP 4060	010001	Radiometer Physics	36 M	-	
750	Pickett-Potter Horn Antenna	FH-PP 220	010011	Radiometer Physics	36 M	-	
751	Digital Optical System	optoCAN-FD Transceiver	17-010416	mk-messtechnik GmbH	-	-	
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 Transceiver	17-010795	mk-messtechnik GmbH	-	-	
757	WIDEBAND RADIO COMMUNICATION	CMW500	163673	Rohde&Schwarz	12 M	-	30.05.2020
758	Signal Generator	SMU 200A	100754	Rohde & Schwarz	24 M	-	11.10.2019
781	Power Supply	PS 2042-10 B	2815450369	Elektro-Automatik GmbH & Co.KG	-	-	
782	Power Supply	PS 2042-10 B	2815450348	Elektro-Automatik GmbH & Co.KG	-	-	
783	Spectrum Analyzer	FSU 26	100414	Rohde & Schwarz	12 M	-	30.05.2020
784	Power Supply	NGSM 32/10	00196	Rohde & Schwarz	12 M	-	
785	RSP	RF Step Attenuator 0...139.9dB	860712/012	Rohde & Schwarz	12 M	-	
786	SAR Probe	ES3DV3	3340	Speag	36 M	-	14.02.2021
787	OSP	OSP B157WX	101264	Rohde & Schwarz	24 M	-	30.05.2020
788	Precision Omnidirectional Dipole	POD 618	6182558/Q	Seibersdorf Laboratories	36 M	-	30.06.2021
789	Precision Omnidirectional Dipole	POD 16	162496/Q	Seibersdorf Laboratories	36 M	-	30.06.2021
790	Horn Antenna	ASY-SGH-124-SMA	29F14182337	Antenna System Solutions	36 M	-	08.10.2021
791	Pickett-Potter Horn Antenna	FH-PP-325	10024	Radiometer Physics	36 M	-	
792	Pickett-Potter Horn Antenna	FH-PP 075	10006	Radiometer Physics	36 M	-	
793	Pickett-Potter Horn Antenna	FH-PP 140	10008	Radiometer Physics	36 M	-	
794	Pickett-Potter Horn Antenna	FH-PP 110	10014	Radiometer Physics	36 M	-	
795	SGH Antenna	SGH-26-WR10	1144	Antenal S.L.	36 M	-	
798	WR-22 Rectangular Gain Horn	SAR-2309-22-S2	13254-01	SAGE Millimeter, Inc.	36 M	-	
799	Transceiver	optoLAN-Gb	18-014746	mk messtechnik	pre-m	-	
801	Spectrum Analyzer	FSP 13	100960	Rohde & Schwarz	24 M	-	14.01.2021
802	Exposure Level Tester	ELT-400	O-0026	NARDA Safety Solutions	24 M	-	30.01.2021
803	Probe	ELT probe 3cm²	O-0026	Narda Safety Test Solution	24 M	-	30.01.2021
805	Thermo-Hygrometer	Web-Thermo-Hygrometer	02749814	W&T	24 M	-	
806	AC2600 Smart Wifi Router	Netgear Nighthawk x4S	5K5188590067B	Netgear	-	-	
807	Direct Coupler	Direct Coupler C-05020-10	511	ET Industries	-	-	
808	Diode Power Sensor	NRV-Z1	829894/001	Rohde & Schwarz	24 M	-	24.05.2021
809	Standard gain Horn Antenna	WR-159 Horn Antenna	-	Pasternack Enterprises Inc.	-	-	

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)
	1f	System CTC-CTIA-OTA (Ref.-No . 420)
	1g	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	2019-07-15
C1	Correction of the ERP and EIRP calculation in section 5.1.4	2020-04-28

END OF TEST REPORT