T E S T R E P O R T
No.: 6-0744-15-3-1b

According to:
FCC Regulations
Part 1.1310 , Part 2.1091

for

Gemalto M2M GmbH

Wireless Module ALS3-US R3

FCC-ID: QIPALS3-USR3

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

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The listed attachments are an integral part of this report.

1. Summary of test results

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

The Equipment Under Test (in this report, hereinafter referred as EUT) supports radiofrequency technologies. The presented RF Data-Module can be build inside host applications and extends their capability by wireless GSM, W-CDMA and LTE technologies. Data transmissions application is possible field application. Other implemented wireless technologies were not considered within this test report.
Following tests have been performed to show compliance with applicable FCC Part 2.1091 and FCC Part 1.1310 of the FCC CFR 47 Rules..

1.1. TX mode, tests overview FCC Part 2.1091

No. of Diagram group	Test Cases	Port	References & Limits		EUT set-up	EUT op-mode	Result
			FCC Standard	Test limits			
--	RF Power (conducted)	Antenna terminal (conducted)	§2.1046	N/A	1	1 to 11	passed Remark 1+2
--	RF Power (radiated)	Cabinet	§2.1046 §22.913(a)(2)	< 7 Watt ERP	2	1 to 11	passed
			§24.232(c)	< 2Watt (EIRP)			Remark 1+2
			§27.50(c)(10)	< 3 Watt (ERP)			
			§27.50(d)	< 1 Watt (EIRP)			
--	Radio frequency Exposure Evaluation (MPE)	Cabinet	§1.1310 §2.1091	FCC: §1.1310 Table 1, Limits for General Population	2	1 to 11	Passed, Remark3

Remark:
1.) See separate test reports GSM TR-20835060e and W-CDMA TR-20835060b-C1, LTE TR6-0744-15-3-1a and corresponding annexes
2.) LTE Reports 1-9521/15-01-02-A, 1-9521/15-01-03-A and 1-9521/15-01-04-A
3.) Calculations based on Tune-Up Info delivered by applicant

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

2. Administrative Data

2.1. Identification of the testing laboratory

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

2.2. Test location

2.2.1. Test laboratory "CTC"

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

2.3. Organizational items

Responsible for test report and project leader:	Dipl.-Ing. C. Lorenz
Receipt of EUT:	2015-07-06
Date(s) of test:	2015-07-10 to 2015-07-13
Date of report:	2015-08-03
Version of template: 13.02	

2.4. Applicant's details

Applicant's name:	Gemalto M2M GmbH
Address:	Siemensdamm 50 13629 Berlin Germany
Contact person:	Mr. Thorsten Liebig

2.5. Manufacturer's details

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

3. Equipment under test (EUT)

3.1. TECHNICAL GSM/W-CDMA DATA OF MAIN EUT DECLARED BY APPLICANT

Pls. check test reports GSM TR-20835060e and W-CDMA TR-20835060b-C1.

3.2. TECHNICAL LTE DATA OF MAIN EUT DECLARED BY APPLICANT

Main function	Wireless Module		
Type	ALS3-US R3		
TX-frequency range (E-UTRA operating bands)	LTE Band 2: 1850 - 1910 MHz (Uplink), 1930-1990 MHz (Downlink) LTE Band 4: 1710 - 1755 MHz (Uplink), 2110 - 2155 MHz (Downlink) LTE Band 5: 824 - 849 MHz (Uplink), 869-894 MHz (Downlink) LTE Band 17: 704 - 716 MHz (Uplink), 734 - 746 MHz (Downlink)		
Type of modulation	QPSK, 16-QAM		
Data rates	Cat3, Downlink: max. 100Mbps, Uplink: max. 50Mbps		
Number of channels – Table 5.4.4-1 accord. 3GPP TS36.521-1	LTE Band 2: UARFCN range 18600 - 19199 LTE Band 4: UARFCN range 19950 - 20399 LTE Band 5: UARFCN range 20400 - 20649 LTE Band 17: UARFCN range 23730 - 23849		See Note about channels not to be used depending on channel bandwidths
FCC-ID	QIPALS3-USR3		
IC	7830A-ALS3USR3		
Installed option	☐ GPS (not tested within this test report)		
Power supply	☒ DC over AE1: range 3.5V to 4.2V over AE4		
Special EMI components	--		
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	

3.3. 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	Wireless Module	ALS3-US R3	IMEI: 004401081453 421	R3 (Rev. 2.3)	Rev. 03.004

*) EUT short description is used to simplify the identification of the EUT in this test report.
Remark: no tests, for evaluation applicants Tune-Up Info is used.

3.3.1. 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	SMARTEQ MiniMag. mount antenna 1	2.6m RG174, SMA-m 0dBd, 824-960 / 1710-2170MHz	59801B	1140.26 SMA	--
AE 2	SMARTEQ MiniMag. mount antenna 2	2.6m RG174, SMA-m 0dBd, 824-960 / 1710-2170MHz	59801B	1140.26 SMA	--
AE 3	SMARTEQ MiniMag. mount antenna 3	2.6m RG174, SMA-m 0dBd, 824-960 / 1710-2170MHz	59801B	1140.26 SMA	--
AE 4	DSB75-Adapter	DSB75	W30880-Q9812-X-2	AH6-DSB75-1	--
AE 5	Handset Votronic	Telephone receiver with RJ11 connector	4017953211 311	HH-SI-30.3/V3.0/0	--
AE 6	USB cable	1m	--	--	--
AE 7	CETECOM Notebook	Dell Latitude E6420	CTC01034	--	Windows 7 + Terminal Program + Driver USB

*) 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 4 + AE 5 + AE 6 (+ AE 7)	Set-up for conducted RF-tests. AE 7 used only temporary for setting up right AT-commands
set. 2	EUT A + AE 1 + AE 2 + AE 3 +AE 4 + AE 5 + AE 6 (+ AE 7)	Set-up for radiated RF-tests. AE 7 used only temporary for setting up right AT-commands

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

3.5. Additional declaration and description of EUT

(Applicant's declaration, ☐ = not selected, ☒ = selected)

EUT A	☐ table-top ☐ floor-standing ☐ wall-mounted ☒ not defined	typical use ☐ portable use ☐ fixed use ☐ vehicular use ☒ general	typical operating cycle of EUT. ☒ < 0,5 sec. ☐ :
Place of use	☐ Residential, commercial and light industry ☐ Industrial environment ☐ vehicular use ☒ general		
Highest frequency generated or used in the device or on which the device operates or tunes	☐ below 1.705 MHz -> up to 30 MHz ☐ 1.705 MHz – 108 MHz -> up to 1 GHz ☐ 108 MHz -500 MHz -> up to 2 GHz ☐ 500MHz 1000 MHz -> up to 5 GHz ☒ Above 1000 MHz -> 5th harmonic or 40 GHz		
Power line: ☐ AC ☐ L1, ☐ L2, ☐ L3, ☐ N ____Hz ☐ 12V, ☐ 24V, ☐ 230V, ☐ 400V ☒ DC ☒ Range 3.5 to 4.2 V over AE4 Tested at 4.2V DC Internally regulated	EUT-grounding: ☒ none ☐ with power supply ☐ additional: (in case of deviation during tests the single details are described on chapter 4)		

Other Ports (description of interconnecting cables)	Connector	possible total cable length	shielding	connected during test
1. Antenna Main	SMA	☒ < 3m ☐> 3m ☐ : other	☒ screened ☐ unscreened	☒ yes ☐ no
2. Antenna Second	SMA	☒ < 3m ☐> 3m ☐ : other	☒ screened ☐ unscreened	☒ yes ☐ no
3. GPS -line	SMA	☒ < 3m ☐> 3m ☐ : other	☒ screened ☐ unscreened	☒ yes ☐ no
4. USB-line	Mini-USB	☒ < 3m ☐> 3m ☐ : other	☐ screened ☐ unscreened	☒ yes ☐ no
5. RJ11 Handset Line		☒ < 3m ☐> 3m ☐ : other	☐ screened ☒ unscreened	☒ yes ☐ no
Does EUT contain devices susceptible to magnetic fields, e.g. Hall elements, electrodynamics microphones, etc.?				☐ yes ☒ no
Is mounting position / usual operating position defined?				☐ yes ☒ no

3.6. Configuration of cables used for testing

Cable number	Item	Type	S/N serial number	HW hardware status	Cable length
Cable 1	USB Port	--	--	--	1 m
Cable 2	RJ11 handset line	--	--	--	1.5 m
Cable 3	RF-antenna port 1 (main)	--	--	--	1.5 m
Cable 4	RF-antenna port 2 (secondary)	--	--	--	1.5 m
Cable 5	RF-antenna port 3 (GPS)	--	--	--	1.5 m

3.7. EUT operating modes

EUT operating mode no.*)	Description of operating modes	Additional information
op. 1	GPRS 850 Data Traffic channels = 128/192/251	A communication link is established between the mobile station and the test simulator. The transmitter is operated at its maximum rated output power: 33 dBm (power class 4; power control level 5). USF_Duty CYCLE set to 100%, coding scheme CS-1 for GMSK modulation, slot 3 active, uplink gamma: 3 (33 dBm). 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.
op. 2	E-GPRS 850 Data Traffic channels = 128/192/251	A communication link is established between the mobile station and the test simulator. The transmitter is operated at its maximum rated output power: 33 dBm (power class 4; power control level 5). USF_Duty CYCLE set to 100%, coding scheme MCS-5 for 8PSK modulation, slot 3 active, uplink gamma: 6 (27dBm). 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.
op. 3	GPRS 1900 Data Traffic channels = 512/661/810	A communication link is established between the mobile station and the test simulator. The transmitter is operated at its maximum rated output power: 30 dBm (power class 1; power control level 0). USF_Duty CYCLE set to 100%, coding scheme CS-1 for GMSK modulation, slot 3 active, uplink gamma: 3 (30 dBm). 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
op. 4	E-GPRS 1900 Data traffic channels = 512/661/810	A communication link is established between the mobile station and the test simulator. The transmitter is operated at its maximum rated output power: 30 dBm (power class 1; power control level 0). USF_Duty CYCLE set to 100%, coding scheme MCS-5 for 8-PSK modulation, slot 3 active, uplink gamma: 5 (26 dBm). 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.

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

EUT operating mode no.*)	Description of operating modes	Additional information
op. 5	FDD-Band 2 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. The description of the settings performed can be found in chapter 3.5
op. 6	FDD-Band 4 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. The description of the settings performed can be found in chapter 3.5
op. 7	FDD-Band 5 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. The description of the settings performed can be found in chapter 3.5

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

EUT operating mode no.*)	Description of operating modes	Additional information
op. 8	LTE-Band 2 RMC Mode	A communication link is established between the mobile station (UE) and the test simulator. The transmitter is operated on its maximum rated output power class: QPSK 23dBm nominal, 16-QAM 22dBm nominal The input signal to the receiver is modulated with normal test modulation: QPSK or 16-QAM Modulation. The wanted RF input signal level to the receiver of the mobile station is set to a level to provide a stable communication link.
op. 9	LTE-Band 4 RMC Mode	A communication link is established between the mobile station (UE) and the test simulator. The transmitter is operated on its maximum rated output power class: QPSK 23dBm nominal, 16-QAM 22dBm nominal The input signal to the receiver is modulated with normal test modulation: QPSK or 16-QAM Modulation. The wanted RF input signal level to the receiver of the mobile station is set to a level to provide a stable communication link.
op. 10	LTE-Band 5 RMC Mode	A communication link is established between the mobile station (UE) and the test simulator. The transmitter is operated on its maximum rated output power class: QPSK 23dBm nominal, 16-QAM 22dBm nominal The input signal to the receiver is modulated with normal test modulation: QPSK or 16-QAM Modulation. The wanted RF input signal level to the receiver of the mobile station is set to a level to provide a stable communication link.
op. 11	LTE-Band 17 RMC Mode	A communication link is established between the mobile station (UE) and the test simulator. The transmitter is operated on its maximum rated output power class: QPSK 23dBm nominal, 16-QAM 22dBm nominal The input signal to the receiver is modulated with normal test modulation: QPSK or 16-QAM Modulation. The wanted RF input signal level to the receiver of the mobile station is set to a level to provide a stable communication link.

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

4. Measurements

4.1. Radio Frequency Exposure Evaluation §2.1091

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

test location	☒ CETECOM Essen (Chapter. 2.2.1)	☐ Please see Chapter. 2.2.2	☐ Please see Chapter. 2.2.3
	For Evaluation instruments are not needed. Results are determined by calculation based on applicants delivered Tune-Up procedure.		

4.1.2. Requirements

FCC: §1.1310	*The criteria used for the evaluation of human exposure to radio frequency radiation is table 1 according FCC §1.1310 and table chapter 4.2 of RSS-102 standard and it is subject for evaluation of the RF exposure prior to equipment authorization.* *As the mobile equipment is authorized under Part 22 (Subpart H) and Part 24 of the FCC Rules, it is subject for evaluation of the RF exposure prior to equipment authorization.*
FCC § 2.1091	*Further information on evaluating compliance with these limits can be found in the FCC's OST/OET Bulletin Number 65, ''Evaluating Compliance with FCC-Specified Guidelines for Human Exposure to Radiofrequency Radiation.''* *For purposes of these requirements mobile devices are defined by the FCC as transmitters designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimeters is normally maintained between radiating structures and the body of the user or nearby persons. These devices are normally evaluated for exposure potential with relation to the MPE limits given in Table 1 of Appendix A.*

4.1.2.1. Valid for FCC

Table 1: LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)				
Frequency range [MHz]	Electric field strength [V/m]	Magnetic field strength [A/m]	Power density [mW/cm²]	Averaging time [minutes]
30 - 300	61.4	0.163	1.0	6
300 - 1500	-		f/300	6
1500 - 100,000	-		5	6
(B) Limits for General Population / Uncontrolled Exposure				
0.3 – 1.34	614	1.63	*(100)	30
1.34 – 30	824/f	2.19/f	*(180/f²)	30
30 - 300	27.5	0.073	0.2	30
300 - 1500	-	-	f/1500	30
1500 – 100,0	-	-	1.0	30

For given Power density limit at a single frequency (accord. Table 1 Limits) the maximum antenna gain can be calculated.

The used equation to predict the power density in the far-field of one single radiating antenna can be made by following equation:

$$S = \frac{EIRP}{4\pi R^2} = \frac{P * G}{4\pi R^2}$$

$$G_{NUMERIC} = \frac{S * 4\pi R^2}{P}$$

4.1.3. General Limits:

FCC: §1.1307	*Cellular Radiotelephone Service (subpart H of part 22)* *Non-building-mounted antennas: height above ground level to lowest point of antenna < 10 m and total power of all channels > 1000 W ERP (1640 W EIRP)*
FCC §1.1307	*Personal Communications Services (part 24)* *Broadband PCS (subpart E): non-building-mounted antennas: height above ground level to lowest point of antenna < 10 m and total power of all channels > 2000 W ERP (3280 W EIRP)*
FCC §1.1310	*LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)* *Table 1(B) Limits for General Population/Uncontrolled Exposure* *300–1500 MHz: f/1500 mW/cm²* *1500–100,000 MHz: 1.0 mW/cm²*
FCC §2.1091	*Subject to routine evaluation is required when the device operate at frequencies of 1.5 GHz or below and their effective radiated power (ERP) is 1.5 watts or more, or if they operate at frequencies above 1.5 GHz and their ERP is 3 watts or more.*
FCC §24.232	*(a) Base stations are limited to 1640 watts peak equivalent isotropically radiated power (e.i.r.p.) with an antenna height up to 300 meters HAAT.* *b) Mobile/portable stations are limited to 2 watts e.i.r.p. peak power, …*
FCC §22.913	*(a) Maximum ERP. The effective radiated power (ERP) of base transmitters and cellular repeaters must not exceed 500 Watts. The ERP of mobile transmitters and auxiliary test transmitters must not exceed 7 Watts.*
FCC §27.50 (C)(10)	*(10) Portable stations (hand-held devices) are limited to 3 watts ERP; and*
FCC §27.50(d)	*(4) Fixed, mobile, and portable (hand-held) stations operating in the 1710-1755 MHz band are limited to 1 watt EIRP.*
KDBs	*No. 447498 D01 v05r02*

4.1.4. Evaluation Method

Valid for GSM/GPRS/EDGE mode:

• The power was tested on 3 frequencies (lowest/middle/highest) within each operable bands and the results compared to applicant's declared power values (tune-up info).
• Average burst power (slot power) and peak were measured (see separate report for GSM/GPRS/E-GPRS technology)
• Only one uplink slot (1 TX) was measured. 4 TX slots are maximum possible for this device and calculated as worst-case
• A duty-cycle correction factor of 10*log10 (max. number of possible active slots / 8 slots) were applied

Please find in the following tables the calculations based on applicants tune-up information for the power values. Also the maximum admissible allowed antenna gain is calculated which is not exceeding the MPE limit for fixed and mobile operations.

Valid for W-CDMA/LTE Mode:

• The power was checked on 3 frequencies (lowest/middle/highest) within each operable FDD-band (see separate report for W-CDMA technology) and the results compared to applicant's declared power values (tune-up info). A RMS detector was used.
• No duty-cycle correction factor is applicable

Please find in the following tables the calculations based on applicants tune-up information, dated 2015-07-20

Also the maximum admissible allowed antenna gain for shown application is calculated not exceeding the MPE limit for fixed and mobile operations. This gain-value does not consider a second transmitter within the EUT unit. It will accordingly be lower value for such cases.

4.2. Results for fixed and mobile operations

4.2.1. Results for lower operational band: LTE Band 5 and LTE band 17, GSM850 and FDD Band 5

4.2.1.1. MPE results

Operating Mode	Frequency on channel (MHz)	Declared maximum conducted output power (dBm)	Max. positive tolerance according manufacturer (dB)	Antenna Gain (dBi)	Calculated maximum EIRP (declared+ Tune-up+ antenna Gain) (dBm)	Duty cycle %	Declared Maximum EIRP (W)	Equivalent EIRP (maximum EIRP x duty cycle) (mW)	MPE Limit accord. Table 4 (mW/cm^2)	MPE-Value (mW/cm^2)	Margin to limit: (mW/cm^2)	Fraction for Co-Location calculations	Max. Fraction-Value within Frequency-Band
GSM/GPRS (PK)	824,2	33	0,5	2,15	35,65	50%	3,673	1836	0,5495	0,3653	**0,1841**	0,6649	0,6649
	837	33	0,5	2,15	35,65		3,673	1836	0,5580	0,3653	**0,1927**	0,6547	
	848,8	33	0,5	2,15	35,65		3,673	1836	0,5659	0,3653	**0,2005**	0,6456	
GSM/GPRS (Avg. Burst Power)	824,2	33	0,5	2,15	35,65	50%	3,673	1836	0,5495	0,3653	**0,1841**	0,6649	0,6649
	837	33	0,5	2,15	35,65		3,673	1836	0,5580	0,3653	**0,1927**	0,6547	
	848,8	33	0,5	2,15	35,65		3,673	1836	0,5659	0,3653	**0,2005**	0,6456	
EDGE (PK)	824,2	27	0,5	2,15	29,65	50%	0,923	461	0,5495	0,0918	**0,4577**	0,1670	0,1670
	837	27	0,5	2,15	29,65		0,923	461	0,5580	0,0918	**0,4662**	0,1645	
	848,8	27	0,5	2,15	29,65		0,923	461	0,5659	0,0918	**0,4741**	0,1622	
EDGE (Avg. Burst Power)	824,2	27	0,5	2,15	29,65	50%	0,923	461	0,5495	0,0918	**0,4577**	0,1670	0,1670
	837	27	0,5	2,15	29,65		0,923	461	0,5580	0,0918	**0,4662**	0,1645	
	848,8	27	0,5	2,15	29,65		0,923	461	0,5659	0,0918	**0,4741**	0,1622	
WCDMA FDD Band 5 (RMS-Value)	826,4	24	0,5	2,15	26,65	100%	0,462	462	0,5509	0,0920	**0,4589**	0,1670	0,1670
	836,4	24	0,5	2,15	26,65		0,462	462	0,5576	0,0920	**0,4656**	0,1650	
	846,6	24	0,5	2,15	26,65		0,462	462	0,5644	0,0920	**0,4724**	0,1630	
LTE Band 17 (QPSK, #RB=1, RMS-Value)	706,5	23	0,5	2,15	25,65	100%	0,367	367	0,4710	0,0731	**0,3979**	0,1551	0,1551
	710	23	0,5	2,15	25,65		0,367	367	0,4733	0,0731	**0,4003**	0,1544	
	713,5	23	0,5	2,15	25,65		0,367	367	0,4757	0,0731	**0,4026**	0,1536	
LTE Band 17 (16QAM, #RB=1, RMS-Value)	706,5	22	0,5	2,15	24,65	100%	0,292	292	0,4710	0,0580	**0,4130**	0,1232	0,1232
	710	22	0,5	2,15	24,65		0,292	292	0,4733	0,0580	**0,4153**	0,1226	
	713,5	22	0,5	2,15	24,65		0,292	292	0,4757	0,0580	**0,4176**	0,1220	
LTE Band 5 (QPSK, #RB=1, RMS-Value)	824,7	23	0,5	2,15	25,65	100%	0,367	367	0,5498	0,0731	**0,4767**	0,1329	0,1329
	836,5	23	0,5	2,15	25,65		0,367	367	0,5577	0,0731	**0,4846**	0,1310	
	848,3	23	0,5	2,15	25,65		0,367	367	0,5655	0,0731	**0,4925**	0,1292	
LTE Band 5 (16QAM, #RB=1, RMS-Value)	824,7	22	0,5	2,15	24,65	100%	0,292	292	0,5498	0,0580	**0,4918**	0,1056	0,1056
	836,5	22	0,5	2,15	24,65		0,292	292	0,5577	0,0580	**0,4996**	0,1041	
	848,3	22	0,5	2,15	24,65		0,292	292	0,5655	0,0580	**0,5075**	0,1026	

Maximum calculated MPE value:		
Lowest MPE-Limit in Frequency-Band:	0,4710	[mW/cm^2]
Highest MPE value in frequency-band:	0,3653	[mW/cm^2]
Lowest margin to limit in frequency band:	**0,1841**	[mW/cm^2]

4.2.1.2. Max. antenna gain calculations

Maximum antenna gain considerations for fixed/mobile operations for complying with limits:		
P	Maximum power input to the antenna incl. Duty cycle [mW]: (Avg. Burst Power or RMS)	1836
R	Distance [cm]:	20
S	MPE limit acc. §1.1310 for uncontrolled exposure [mW/cm²]: (FCC use mW/cm²)	0,47
G_1	Maximum Antenna gain to comply with MPE limit [dBi]:	**1,10**

(For G1 the lowest measured channel to reach minimum ant. Gain selected)

	ERP power limit according to §2.1091 [W]: (Avg. Burst Power or RMS)	1,50
G_2	Max. Antenna gain to comply with limit incl. Duty cycle [dBi]:	**1,27**

(For G2 select the max. Avg. Burst Power or RMS value incl. Duty cycle)

	ERP power limit according to §22.913 [W ERP]:	7,00
G_3	Max. Antenna gain to comply with limit [dBi]:	**4,95**

(For G3 select the max. Average burst power value excluding Duty cycle)

$G_{850\ MHz\ band}$	**Min (G_1, G_2, G_3) [dBi]**	**1,10**

Summarized results:	The max. ant. gain for mobile operation at 700/850 MHz band to comply with MPE and EIRP limits incl. path loss shall not exceed **(dBi)**:	**1,10**

4.2.2. Results for upper operational band: FDD band 4 and LTE band 4

4.2.2.1. MPE results

Operating Mode	Frequency on channel (MHz)	Declared maximum conducted output power (dBm)	Max. positive tolerance according manufacturer (dB)	Antenna Gain (dBi)	Calculated maximum EIRP (declared+ Tune-up+ antenna Gain) (dBm)	Duty cycle %	Declared Maximum EIRP (W)	Equivalent EIRP (maximum EIRP x duty cycle) (mW)	MPE Limit accord. Table 4 (mW/cm^2	MPE-Value (mW/cm^2)	Margin to limit: (mW/cm^2)	Fraction for Co-Location calculations	Max. Fraction-Value within Frequency-Band
W-CDMA Band 4 (RMS-Value)	1712,4	24,0	0,5	2,15	26,65	100%	0,4624	462,4	1,0000	0,0920	**0,9080**	0,091988	0,0919878
	1740,0	24,0	0,5	2,15	26,65		0,4624	462,4	1,0000	0,0920	**0,9080**	0,091988	
	1752,6	24,0	0,5	2,15	26,65		0,4624	462,4	1,0000	0,0920	**0,9080**	0,091988	
LTE Band 4 (QPSK, #1RB, RMS-Value)	1710,7	23,0	0,5	2,15	25,65	100%	0,3673	367,3	1,0000	0,0731	**0,9269**	0,073068	0,0730685
	1732,5	23,0	0,5	2,15	25,65		0,3673	367,3	1,0000	0,0731	**0,9269**	0,073068	
	1754,3	23,0	0,5	2,15	25,65		0,3673	367,3	1,0000	0,0731	**0,9269**	0,073068	
LTE Band 4 (16QAM, #1RB, RMS-Value)	1710,7	22,0	0,5	2,15	24,65	100%	0,2917	291,7	1,0000	0,0580	**0,9420**	0,058040	0,0580404
	1732,5	22,0	0,5	2,15	24,65		0,2917	291,7	1,0000	0,0580	**0,9420**	0,058040	
	1754,3	22,0	0,5	2,15	24,65		0,2917	291,7	1,0000	0,0580	**0,9420**	0,058040	

Maximum calculated MPE value:		
Lowest MPE-Limit in frequency-band:	1,0000	[mW/cm^2]
Highest MPE value in frequency-band:	0,0920	[mW/cm^2]
Lowest margin to limit in frequency-band:	0,91	[mW/cm^2]

4.2.2.2. Max. antenna gain calculations

Maximum antenna gain considerations for fixed/mobile operations for complying with limits:			
P	Maximum power input to the antenna incl. Duty cycle (mW): (Avg. Burst Power or RMS)		462
R	Distance (cm):		20
S	MPE limit acc. §1.1310 for uncontrolled exposure (mW/cm²): (FCC use mW)		1,00
G_1	Maximum Antenna gain to comply with MPE limit (dBi):		**10,36**

(For G1 the lowest measured channel to reach minimum ant. Gain selected)

	ERP power limit according to §2.1091 [W]: (Avg. Burst Power or RMS)		3,00
G_2	Max. Antenna gain to comply with this limit incl. Duty cycle (dBi):		**10,27**

(For G2 select the max. Avg. Burst Power or RMS value incl. Duty cycle)

	EIRP power limit according to §27.50(d) [W]:		1,00
G_3	Max. Antenna gain to comply with this limit (dBi):		**3,35**

(For G3 select the max. Average burst power value excluding Duty cycle)

Min (G_1, G_2, G_3) (dBi)		**3,35**

Summarized results:	The max. ant. gain for mobile operation at 1700 MHz band to comply with MPE and EIRP limits incl. path loss shall not exceed **(dBi)**:		**3,35**

4.2.3. Results for upper operational band: FDD 2, LTE 2 and GSM1900

4.2.3.1. MPE results

Operation Mode	Frequency on channel (MHz)	Declared maximum conducted output power (dBm)	Max. positive tolerance according manfacturer (dB)	Antenna Gain (dBi)	Declared maximum EIRP (Measured+ Tune-up+ Antenna Gain) (dBm)	Duty cycle %	Declared Maximum EIRP (W)	Equivalent EIRP (maximum EIRP x duty cycle) (W) (mW)	MPE Limit accord. Table 4 (mW/cm^2)	MPE-Value (mW/cm^2)	Margin to limit: (W/m^2)	Fraction for Co-Location calculations	Max. Fraction-Value within Frequency-Band
GSM/GPRS (PK-Burst value)	1850,2	30,0	0,50	2,15	32,65	50%	1,841	920	1,0000	0,1831	**0,8169**	0,183105	0,1831050
	1880,0	30,0		2,15	32,15		1,641	820	1,0000	0,1632	**0,8368**	0,163192	
	1909,8	30,0		2,15	32,15		1,641	820	1,0000	0,1632	**0,8368**	0,163192	
GSM/GPRS (AV Burst Power)	1850,2	30,0	0,50	2,15	32,65	50%	1,841	920	1,0000	0,1831	**0,8169**	0,183105	0,1831050
	1880,0	30,0		2,15	32,15		1,641	820	1,0000	0,1632	**0,8368**	0,163192	
	1909,8	30,0		2,15	32,15		1,641	820	1,0000	0,1632	**0,8368**	0,163192	
EDGE (PK-Burst value)	1850,2	26,0	0,50	2,15	28,65	50%	0,733	366	1,0000	0,0729	**0,9271**	0,072895	0,0728954
	1880,0	26,0		2,15	28,15		0,653	327	1,0000	0,0650	**0,9350**	0,064968	
	1909,8	26,0		2,15	28,15		0,653	327	1,0000	0,0650	**0,9350**	0,064968	
EDGE (AV Burst Power)	1850,2	26,0	0,50	2,15	28,65	50%	0,733	366	1,0000	0,0729	**0,9271**	0,072895	0,0728954
	1880,0	26,0		2,15	28,15		0,653	327	1,0000	0,0650	**0,9350**	0,064968	
	1909,8	26,0		2,15	28,15		0,653	327	1,0000	0,0650	**0,9350**	0,064968	
W-CDMA FDD Band 2 (RMS-Value)	1852,4	24,0	0,50	2,15	26,65	100%	0,462	462	1,0000	0,0920	**0,9080**	0,091988	0,0919878
	1880,0	24,0		2,15	26,15		0,412	412	1,0000	0,0820	**0,9180**	0,081984	
	1907,6	24,0		2,15	26,15		0,412	412	1,0000	0,0820	**0,9180**	0,081984	
LTE Band 2 (QPSK, #1RB, RMS-Value)	1850,7	23,0	0,50	2,15	25,65	100%	0,367	367	1,0000	0,0731	**0,9269**	0,073068	0,0730685
	1880,0	23,0		2,15	25,15		0,327	327	1,0000	0,0651	**0,9349**	0,065122	
	1909,3	23,0		2,15	25,15		0,327	327	1,0000	0,0651	**0,9349**	0,065122	
LTE Band 2 (16QAM, #1RB, RMS-Value)	1850,7	22,0	0,50	2,15	24,65	100%	0,292	292	1,0000	0,0580	**0,9420**	0,058040	0,0580404
	1880,0	22,0		2,15	24,15		0,260	260	1,0000	0,0517	**0,9483**	0,051729	
	1909,3	22,0		2,15	24,15		0,260	260	1,0000	0,0517	**0,9483**	0,051729	

Maximum calculated MPE value:		
Lowest MPE-Limit in frequency-band:	**1,0000**	**[mW/cm^2]**
Highest MPE value in frequency-band:	**0,1831**	**[mW/cm^2]**
Margin to limit in frequency-band:	**0,8169**	**[mW/cm^2]**

4.2.3.2. Max. antenna gain calculations

Maximum antenna gain considerations for fixed/mobile operations for complying with limits:					
P	Maximum power input to the antenna incl. Duty cycle (mW): (Avg. Burst Power or RMS)				920
R	Distance (cm):				20
S	MPE limit acc. §1.1310 for uncontrolled exposure (mW/cm²): (FCC use mW/cm²)				1,00
G_1	Maximum Antenna gain to comply with MPE limit (dBi):				**7,37**

(For G1 the lowest measured channel to reach minimum ant. Gain selected)

	ERP power limit according to §2.1091 [W]: (Avg. Burst Power or RMS)				3,00
G_2	Max. Antenna gain to comply with this limit incl. Duty cycle (dBi):				**7,28**

(For G2 select the max. Avg. Burst Power or RMS value incl. Duty cycle)

	EIRP power limit according to §24.232 [W]:				2,00
G_3	Max. Antenna gain to comply with this limit (dBi):				**0,36**

(For G3 select the max. Average burst power value excluding Duty cycle)

Min (G_1, G_2, G_3) (dBi)				**0,36**

Summarized results:	The max. ant. gain for mobile operation at 1900 MHz band to comply with MPE and EIRP limits incl. path loss shall not exceed **(dBi):**				**0,36**

4.3. Conclusion for maximum admissible antenna gain (FCC)

Max. Gain in Lower operational band GSM850/W-CDMA V, LTE Band 5/17 **[dBi]**	1.1 dBi + 2.15 dBi = 3.25 dBi (1.1 dBd)
Max. Gain in Higher operational band W-CDMA Band IV, LTE Band 4 **[dBi]**	3.35 dBi + 2.15 dBi = 5.5 dBi
Max. Gain in Higher operational band GSM1900/W-CDMA II, LTE Band 2 **[dBi]**	0.36dBi + 2.15 dBi = 2.51 dBi

Remark: calculations does not include a second transmitters (Co-location condition)

4.3.1. Co-location assessment (scenario)

Following table shows calculations with DTM scenario when two cellular modular transmitters are active at same time. This can be valid for special DTM operations for Class A GSM/GPRS/E-GPRS devices.

Also it shows the MPE calculations on a scenario when additional to the cellular transmitter a non-licensed modular transmitter is active at same time. Special limitations such as interractions between the transmitting RF-antennas due small physical distance betweeen them, are not sufficient modeled by the far field formula for power density. For such cases a non-linear program electromagnetic software or MPE measurements should be performed.

Operation Mode	Frequency on channel (MHz)	Declared maximum conducted output power (dBm)	Max. positive tolerance according manfacturer (dB)	Declared maximum output power (Measured+ Tune-up) (dBm)	Duty cycle %	Declared Maximum conducted output power (W)	Equivalent conducted output power (maximum conducted output power x duty cycle) (mW)	MPE Limit accord. Table 4 (mW/cm^2)	MPE-Value (mW/cm^2)	Margin to Limit:	Fraction for Co-Location calculations	Max. Fraction-Value within Frequency-Band
W-LAN or Bluetooth or Zigbee 2.4GHz	2412,0	30,0	1,0	31,0	100%	1,2589	1258,9	1,0000	0,2505	0,7495	0,250455	0,2504553
	2437,0	30,0	1,0	31,0		1,2589	1258,9	1,0000	0,2505	0,7495	0,250455	
	2462,0	30,0	1,0	31,0		1,2589	1258,9	1,0000	0,2505	0,7495	0,250455	
W-LAN 5GHz	5180,0	30,0	1,0	31,0	100%	1,2589	1258,9	1,0000	0,2505	0,7495	0,250455	0,2504553
	5500,0	24,0	1,0	25,0		0,3162	316,2	1,0000	0,0629	0,9371	0,062912	
	5720,0	30,0	1,0	31,0		1,2589	1258,9	1,0000	0,2505	0,7495	0,250455	

Remark: 0dBi antenna gain assumed

According KDB447498 D01 v05r02 simultanuos transmission MPE test exclusion applies, when the sum of ratio MPE-Value/MPE-Limit for all active transmitters is equal/less 1. (<=1).

	Ratio of MPE-Value/Limit	GSM/G-PRS/ E-GPRS Band-850	W-CDMA Band 5	LTE- Band 5	LTE Band 17	W-CDMA Band 4	LTE Band 4	GSM/GPRS/ E-GPRS Band 1900	W-CDMA Band 2	LTE Band 2	W-LAN or Bluetooth or Zigbee 2.4GHz	W-LAN 5GHz
		0,664903774	0,166967173	0,132900131	0,155134803	0,091987781	0,073068492	0,183104977	0,091987781	0,073068492	0,250455253	0,250455253
GSM/G-PRS/ E-GPRS Band-850	0,664903774	--	0,831870947	0,797803905	0,820038576	0,75689156	0,737972266	0,848008751	0,756891555	0,737972266	0,915359027	0,915359027
W-CDMA Band 5	0,166967173	0,831870947	--	0,299867305	0,322101976	0,25895495	0,240035666	0,35007215	0,258954955	0,240035666	0,417422426	0,417422426
LTE- Band 5	0,132900131	0,797803905	0,299867305	--	0,288034934	0,22488791	0,205968623	0,316005108	0,224887912	0,205968623	0,383355384	0,383355384
LTE Band 17	0,155134803	0,820038576	0,322101976	0,288034934	--	0,24712258	0,228203295	0,33823978	0,247122584	0,228203295	0,405590055	0,405590055
W-CDMA Band 4	0,091987781	0,923858729	0,258954955	0,224887912	0,247122584	--	0,165056273	0,275092758	0,183975563	0,165056273	0,342443034	0,342443034
LTE Band 4	0,073068492	0,737972266	0,240035666	0,205968623	0,228203295	0,16505627	--	0,256173469	0,165056273	0,146136984	0,323523745	0,323523745
GSM/GPRS E-GPRS Band 1900	0,183104977	0,848008751	0,35007215	0,316005108	0,33823978	0,27509276	0,256173469	--	0,275092758	0,256173469	0,43356023	0,43356023
W-CDMA Band 2	0,091987781	0,756891555	0,258954955	0,224887912	0,247122584	0,18397556	0,165056273	0,275092758	--	0,165056273	0,342443034	0,342443034
LTE Band 2	0,073068492	0,737972266	0,240035666	0,205968623	0,228203295	0,16505627	0,146136984	0,256173469	0,165056273	--	0,323523745	0,323523745
W-LAN or Bluetooth or Zigbee 2.4GHz	0,250455253	0,915359027	0,417422426	0,383355384	0,405590055	0,34244303	0,323523745	0,43356023	0,342443034	0,323523745	--	0,500910506
W-LAN 5GHz	0,250455253	0,915359027	0,417422426	0,383355384	0,405590055	0,34244303	0,323523745	0,43356023	0,342443034	0,323523745	0,500910506	--
Maximum-Value		0,923858729										

Furthermore following is assumed: the compliance calculation is based on a cellular antenna gain of 0dBd/2.15dBi and W-LAN antenna of 0dBi. Maximum allowed conducted power values for W-LAN technology is assumed.

Therefore these results should be taken with caution and an additional analysis performed on the final product which integrates more than two modular transmitters should be performed as the final design.

Remark: just rough estimation, final calculation or measurements should be performed on final configuration with defined stated antenna gains from manufacturer and concrete physical constraints of EUT.

4.4. 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	--	--	--		-
		12.75 - 26.5GHz	N/A	0.82	--	--	--		
Conducted emissions on RF-port	-	9 kHz - 2.8 GHz	0.70	N/A	--	--	--		N/A - not applicable
		2.8 GHz - 12.75GHz	1.48	N/A	--	--	--		
		12.75 GHz - 18GHz	1.81	N/A	--	--	--		
		18 GHz - 26.5GHz	1.83	N/A	--	--	--		
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

5. 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

6. 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)	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			

7. Instruments and Ancillary

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

7.0.1. Test software and firmware of equipment

Ref.-No.	Equipment	Type	Serial-No.	Version of Firmware or Software during the test
001	EMI Test Receiver	ESS	825132/017	Firm.= 1.21 , OTP=2.0, GRA=2.0
012	Signal Generator (EMS-cond.)	SMY 01	839069/027	Firm.= V 2.02
013	Power Meter (EMS cond.)	NRVD	839111/003	Firm.= V 1.51
017	Digital Radiocommunication Tester	CMD 60 M	844365/014	Firmware = V 3.52 .22.01.99, DECT = D2.87 13.01.99
053	Audio Analyzer	UPA3	860612/022	Firm. V 4.3
119	RT Harmonics Analyzer dig. Flickermeter	B10	G60547	Firm.= V 3.1DHG
140	Signal Generator	SMHU	831314/006	Firm.= 3.21
261	Thermal Power Sensor	NRV-Z55	825083/0008	EPROM-Datum 02.12.04, SE EE 1 B
262	Power Meter	NRV-S	825770/0010	Firm.= 2.6
263	Signal Generator	SMP 04	826190/0007	Firm.=3.21
264	Spectrum Analyzer	FSEK 30	826939/005	Bios=2.1, Analyzer= 3.20
295	Racal Digital Radio Test Set	6103	1572	UNIT Firmware= 4.04, SW-Main=4.04, SW-BBP=1.04, SW-DSP=1.02, Hardboot=1.02, Softboot=2.02
298	Univ. Radio Communication Tester	CMU 200	832221/091	R&S Test Firmware =3.53 /3.54 (current Testsoftw. f. all band used
323	Digital Radiocommunication Tester	CMD 55	825878/0034	Firm.= 3.52 .22.01.99
331	Climatic Test Chamber -40/+80 Grad	HC 4055	43146	TSI 1.53
335	CTC-EMS-Conducted	System EMS Conducted	-	EMC 32 V 8.52
340	Digital Radiocommunication Tester	CMD 55	849709/037	Firm.= 3.52 .22.01.99
355	Power Meter	URV 5	891310/027	Firm.= 1.31
365	10V Insertion Unit 50 Ohm	URV5-Z2	100880	Eprom Data = 31.03.08
366	Ultra Compact Simulator	UCS 500 M4	V0531100594	Firm. UCS 500=001925/3.06a02, rc=ISMIEC 4.10
371	Bluetooth Tester	CBT32	100153	CBT V5,30+ SW-Option K55, K57
377	EMI Test Receiver	ESCS 30	100160	Firm.= 2.30, OTP= 02.01, GRA= 02.36
378	Broadband RF Field Monitor	RadiSense III	03D00013SNO-08	Firm.= V.03D13
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	-	EMC 32 Ver. 9.15.00
444	CTC-FAR-EMS field	System-EMS-Field (FAR)	-	EMC 32 Version 9.15.00
460	Univ. Radio Communication Tester	CMU 200	108901	R&S Test Firmware Base=5.14, GSM=5.14 WCDMA=5.14 (current Testsoftw.,f. all band to be used,
489	EMI Test Receiver	ESU40	1000-30	Firmware=4.43 SP3, Bios=V5.1-16-3, Spec. =01.00
491	ESD Simulator dito	ESD dito	dito307022	V 2.30
524	Voltage Drop Simulator	VDS 200	0196-16	Software Nr: 000037 Version V4.20a01
526	Burst Generator	EFT 200 A	0496-06	Software Nr. 000034 Version V2.32
527	Micro Pulse Generator	MPG 200 B	0496-05	Software-Nr. 000030 Version V2.43
528	Load Dump Simulator	LD 200B	0496-06	Software-Nr. 000031 Version V2.35a01
546	Univ. Radio Communication Tester	CMU 200	106436	R&S Test Firmware Base=5.14, GSM=5.14 WCDMA=5.14 (current Testsoftw.,f. all band to be used
547	Univ. Radio Communication Tester	CMU 200	835390/014	R&S Test Firmware Base=V5.1403 (current Testsoftw., f. all band used, GSM = 5.14 WCDMA: = 5.14
584	Spectrum Analyzer	FSU 8	100248	2.82_SP3
597	Univ. Radio Communication Tester	CMU 200	100347	R&S Test Firmware Base=5.01, GSM=5.02 WCDMA= not installed, Mainboard= µP1=V.850
598	Spectrum Analyzer	FSEM 30 (Reserve)	831259/013	Firmware Bios 3.40 , Analyzer 3.40 Sp 2
620	EMI Test Receiver	ESU 26	100362	4.43_SP3
642	Wideband Radio Communication Tester	CMW 500	126089	Setup V03.26, Test programm component V03.02.20
692	Bluetooth Tester	CBT 32	100236	CBT V 5.40, FW: V.2.41 (FPGA Digital, V. 3.09 FPGA RF)

7.0.2. Single instruments and test systems

Ref.-No.	Equipment	Type	Serial-No.	Manufacturer	Interval of calibration	Remark	Cal due
001	EMI Test Receiver	ESS	825132/017	Rohde & Schwarz	12 M	-	30.04.2016
005	AC - LISN (50 Ohm/50µH, test site 1)	ESH2-Z5	861741/005	Rohde & Schwarz	12 M	-	30.04.2016
007	Single-Line V-Network (50 Ohm/5µH)	ESH3-Z6	892563/002	Rohde & Schwarz	12 M	-	30.04.2016
009	Power Meter (EMS-radiated)	NRV	863056/017	Rohde & Schwarz	24 M	-	30.04.2017
016	Line Impedance Simulating Network	Op. 24-D	B6366	Spitzenberger+Spies	36 M	-	31.03.2016
020	Horn Antenna 18 GHz (Subst 1)	3115	9107-3699	EMCO	36/12 M	-	31.03.2017
021	Loop Antenna (H-Field)	6502	9206-2770	EMCO	36 M	-	30.04.2018
030	Loop Antenna (H-field)	HFH-Z2	879604/026	Rohde & Schwarz	36 M	-	30.04.2018
033	RF-current probe (100kHz-30MHz)	ESH2-Z1	879581/18	Rohde & Schwarz	24 M	-	30.04.2017
057	relay-switch-unit (EMS system)	RSU	494440/002	Rohde & Schwarz	pre-m	1a	
060	power amplifier (DC-2kHz)	PAS 5000	B6363	Spitzenberger+Spies	-	3	
066	notch filter (WCDMA; FDD1)	WRCT 1900/2200-5/40-10EEK	5	Wainwright GmbH	12 M	1g	30.09.2015
086	DC - power supply, 0 -10 A	LNG 50-10	-	Heinzinger Electronic	pre-m	2	
087	DC - power supply, 0 -5 A	EA-3013 S	-	Elektro Automatik	pre-m	2	
090	Helmholtz coil: 2x10 coils in series	Helmholtz coil: 2x10 coils in	-	RWTÜV	24 M	4	31.03.2016
091	USB-LWL-Converter	OLS-1	007/2006	Ing. Büro Scheiba	-	4	
099	passive voltage probe	ESH2-Z3	299.7810.52	Rohde & Schwarz	36 M	-	30.04.2018
100	passive voltage probe	Probe TK 9416	without	Schwarzbeck	36 M	-	30.04.2018
110	USB-LWL-Converter	OLS-1	-	Ing. Büro Scheiba	-	4	
119	RT Harmonics Analyzer dig. Flickermeter	B10	G60547	BOCONSULT	36 M	-	31.03.2016
136	adjustable dipole antenna (Dipole 1)	3121C-DB4	9105-0697	EMCO	36 M	-	30.04.2018
140	Signal Generator	SMHU	831314/006	Rohde & Schwarz	24 M	-	31.03.2016
248	attenuator	SMA 6dB 2W	-	Radiall	pre-m	2	
249	attenuator	SMA 10dB 10W	-	Radiall	pre-m	2	
252	attenuator	N 6dB 12W	-	Radiall	pre-m	2	
256	attenuator	SMA 3dB 2W	-	Radiall	pre-m	2	
257	hybrid	4031C	04491	Narda	pre-m	2	
260	hybrid coupler	4032C	11342	Narda	pre-m	2	
261	Thermal Power Sensor	NRV-Z55	825083/0008	Rohde & Schwarz	24 M	-	31.03.2016
262	Power Meter	NRV-S	825770/0010	Rohde & Schwarz	24 M	-	31.03.2016
263	Signal Generator	SMP 04	826190/0007	Rohde & Schwarz	36 M	-	31.03.2016
264	Spectrum Analyzer	FSEK 30	826939/005	Rohde & Schwarz	12 M	-	30.04.2016
265	peak power sensor	NRV-Z33, Model 04	840414/009	Rohde & Schwarz	24 M	-	31.03.2016
266	Peak Power Sensor	NRV-Z31, Model 04	843383/016	Rohde & Schwarz	24 M	-	31.03.2016
267	notch filter GSM 850	WRCA 800/960-6EEK	9	Wainwright GmbH	pre-m	2	
270	termination	1418 N	BB6935	Weinschel	pre-m	2	
271	termination	1418 N	BE6384	Weinschel	pre-m	2	
272	attenuator (20 dB) 50 W	Model 47	BF6239	Weinschel	pre-m	2	
273	attenuator (10 dB) 100 W	Model 48	BF9229	Weinschel	pre-m	2	
274	attenuator (10 dB) 50 W	Model 47 (10 dB) 50 W	BG0321	Weinschel	pre-m	2	
275	DC-Block	Model 7003 (N)	C5129	Weinschel	pre-m	2	
276	DC-Block	Model 7006 (SMA)	C7061	Weinschel	pre-m	2	
279	power divider	1515 (SMA)	LH855	Weinschel	pre-m	2	
287	pre-amplifier 25MHz - 4GHz	AMF-2D-100M4G-35-10P	379418	Miteq	12 M	1c	30.09.2015
291	high pass filter GSM 850/900	WHJ 2200-4EE	14	Wainwright GmbH	12 M	1c	30.09.2015
298	Univ. Radio Communication Tester	CMU 200	832221/091	Rohde & Schwarz	pre-m	3	
300	AC LISN (50 Ohm/50µH, 1-phase)	ESH3-Z5	892 239/020	Rohde & Schwarz	12 M	-	30.04.2016
301	attenuator (20 dB) 50W, 18GHz	47-20-33	AW0272	Lucas Weinschel	pre-m	2	
302	horn antenna 40 GHz (Meas 1)	BBHA9170	155	Schwarzbeck	36 M	-	31.03.2017
303	horn antenna 40 GHz (Subst 1)	BBHA9170	156	Schwarzbeck	36 M	-	31.03.2017
331	Climatic Test Chamber -40/+80 Grad	HC 4055	43146	Heraeus Vötsch	24 M	-	30.12.2016
341	Digital Multimeter	Fluke 112	81650455	Fluke	24 M	-	31.03.2016
342	Digital Multimeter	Voltcraft M-4660A	IB 255466	Voltcraft	24 M	-	30.04.2017
347	laboratory site	radio lab.	-	-	-	5	
348	laboratory site	EMI conducted	-	-	-	5	
354	DC - Power Supply 40A	NGPE 40/40	448	Rohde & Schwarz	pre-m	2	
355	Power Meter	URV 5	891310/027	Rohde & Schwarz	24 M	-	31.03.2016
356	power sensor	NRV-Z1	882322/014	Rohde & Schwarz	24 M	-	31.03.2015
357	power sensor	NRV-Z1	861761/002	Rohde & Schwarz	24 M	-	30.04.2017
371	Bluetooth Tester	CBT32	100153	R&S	24 M	-	31.03.2016
373	Single-Line V-Network (50 Ohm/5µH)	ESH3-Z6	100535	Rohde & Schwarz	24 M	-	30.04.2017
377	EMI Test Receiver	ESCS 30	100160	Rohde & Schwarz	12 M	-	30.04.2016
389	Digital Multimeter	Keithley 2000	0583926	Keithley	24 M	-	30.04.2017
392	Radio Communication Tester	MT8820A	6K00000788	Anritsu	12 M	-	30.04.2016
431	Model 7405	Near-Field Probe Set	9305-2457	EMCO	-	4	
436	Univ. Radio Communication Tester	CMU 200	103083	Rohde & Schwarz	12 M	-	30.04.2016
439	UltraLog-Antenna	HL 562	100248	Rohde & Schwarz	36 M	-	31.03.2017
441	CTC-SAR-EMI Cable Loss	System EMI field (SAR) Cable	-	CETECOM	12 M	5	30.01.2016
443	CTC-FAR-EMI-RSE	System CTC-FAR-EMI-	-	ETS-Lindgren /	12 M	5	30.09.2015

Ref.-No.	Equipment	Type	Serial-No.	Manufacturer	Interval of calibration	Remark	Cal due
		RSE		CETECOM			
448	notch filter WCDMA_FDD II	WRCT 1850.0/2170.0-5/40-	5	Wainwright Instruments GmbH	12 M	1c	30.09.2015
449	notch filter WCDMA FDD V	WRCT 824.0/894.0-5/40-8SSK	1	Wainwright	12 M	1c	30.09.2015
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	-	30.04.2016
463	Universal source	HP3245A	2831A03472	Agilent	-	4	
466	Digital Multimeter	Fluke 112	89210157	Fluke USA	24 M	-	31.03.2016
467	Digital Multimeter	Fluke 112	89680306	Fluke USA	36 M	-	30.04.2018
468	Digital Multimeter	Fluke 112	90090455	Fluke USA	36 M	-	30.04.2018
477	ReRadiating GPS-System	AS-47	-	Automotive Cons. Fink	-	3	
480	power meter (Fula)	NRVS	838392/031	Rohde & Schwarz	24 M	-	30.04.2017
482	filter matrix	Filter matrix SAR 1	-	CETECOM (Brl)	-	1d	
484	pre-amplifier 2,5 - 18 GHz	AMF-5D-02501800-25-10P	1244554	Miteq	12 M	-	30.09.2015
487	System CTC NSA-Verification SAR-EMI	System EMI field (SAR) NSA	-	ETS Lindgren / CETECOM	24 M	-	31.07.2017
489	EMI Test Receiver	ESU40	1000-30	Rohde & Schwarz	12 M	-	30.04.2016
502	band reject filter	WRCG 1709/1786-1699/1796-	SN 9	Wainwright	pre-m	2	
503	band reject filter	WRCG 824/849-814/859-	SN 5	Wainwright	pre-m	2	
512	notch filter GSM 850	WRCA 800/960-02/40-6EEK	SN 24	Wainwrght	12 M	1c	30.09.2015
517	relais switch matrix	HF Relais Box Keithley	SE 04	Keithley	pre-m	2	
523	Digital Multimeter	L4411A	MY46000154	Agilent	24 M	-	30.04.2017
529	6 dB Broadband resistive power divider	Model 1515	LH 855	Weinschel	pre-m	2	
530	10 dB Broadband resistive power divider	R 416110000	LOT 9828	-	pre-m	2	
546	Univ. Radio Communication Tester	CMU 200	106436	R&S	12 M	-	30.04.2016
547	Univ. Radio Communication Tester	CMU 200	835390/014	Rohde & Schwarz	12 M	-	30.04.2016
548	Digital-Barometer	GBP 2300	without	Greisinger GmbH	-	-	
549	Log.Per-Antenna	HL025	1000060	Rohde & Schwarz	36 M	-	31.07.2018
552	high pass filter 2,8-18GHz	WHKX 2.8/18G-10SS	4	Wainwright	12 M	1c	30.09.2015
557	System CTC-OTA-2	R&S TS8991	-	Rohde & Schwarz	12 M	5	30.09.2015
558	System CTC FAR S-VSWR	System CTC FAR S-VSWR	-	CTC	24 M	-	30.09.2015
574	Biconilog Hybrid Antenna	BTA-L	980026L	Frankonia	36/12 M	-	31.03.2016
584	Spectrum Analyzer	FSU 8	100248	Rohde & Schwarz	pre-m	-	
594	Wideband Radio Communication Tester	CMW 500	101757	Rohde & Schwarz	12 M	-	30.04.2016
597	Univ. Radio Communication Tester	CMU 200	100347	Rohde & Schwarz	36 M	-	31.03.2016
598	Spectrum Analyzer	FSEM 30 (Reserve)	831259/013	Rohde & Schwarz	24 M	-	30.04.2017
600	power meter	NRVD (Reserve)	834501/018	Rohde & Schwarz	24 M	-	30.04.2017
601	medium-sensitivity diode sensor	NRV-Z5 (Reserve)	8435323/003	Rohde & Schwarz	24 M	-	30.04.2017
602	peak power sensor	NRV-Z32 (Reserve)	835080	Rohde & Schwarz	24 M	-	
611	DC power supply	E3632A	KR 75305854	Agilent	pre-m	2	
612	DC power supply	E3632A	MY 40001321	Agilent	pre-m	2	
613	Attenuator	R416120000 20dB 10W	Lot. 9828	Radiall	pre-m	2	
616	Digitalmultimeter	Fluke 177	88900339	Fluke	24 M	-	31.03.2016
617	Power Splitter/Combiner	ZFSC-2-2-S+	S F987001108	Mini Circuits	-	2	
618	Power Splitter/Combiner	50PD-634	600994	JFW Industries USA	-	2	
619	Power Splitter/Combiner	50PD-634	600995	JFW Industries, USA	-	3	
620	EMI Test Receiver	ESU 26	100362	Rohde-Schwarz	12 M	-	01.12.2015
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	-	30.04.2017
634	Spectrum Analyzer	FSM (HF-Unit)	826188/010	Rohde & Schwarz	pre-m	2	
636	Thermal Imaging camera	Ti32	Ti32-12060213	Fluke Corporation	36 M	-	31.07.2015
637	High Speed HDMI with Ethernet 1m	HDMI cable with Ethernet 1m	-	KogiLink	-	2	
638	HDMI Kabel with Ethernet 1,5 m flach	HDMI cable with Ethernet	-	Reichelt	-	2	
640	HDMI cable 2m rund	HDMI cable 2m rund	-	Reichelt	-	2	
641	HDMI cable with Ethernet	Certified HDMI cable with	-	PureLink	-	2	
642	Wideband Radio Communication Tester	CMW 500	126089	Rohde&Schwarz	12 M	-	30.04.2016
644	Amplifierer	ZX60-2534M+	SN865701299	Mini-Circuits	-	-	
670	Univ. Radio Communication Tester	CMU 200	106833	Rohde & Schwarz	24 M	-	31.03.2016
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	-	30.04.2016
686	Field Analyzer	EHP-200A	160WX30702	Narda Safety Test Solutions	24 M	-	30.04.2017
687	Signal Generator	SMF 100A	102073	Rohde&Schwarz	12 M	-	30.04.2016
688	Pre Amp	JS-18004000-40-8P	1750117	Miteq	pre-m	-	

Ref.-No.	Equipment	Type	Serial-No.	Manufacturer	Interval of calibration	Remark	Cal due
692	Bluetooth Tester	CBT 32	100236	Rohde & Schwarz	24 M	-	31.03.2016
693	TS8997	CTC-Radio Lab 1_TS8997	-	Rohde&Schwarz	12 M	5	01.05.2015
697	Power Splitter	ZN4PD-642W-S+	165001445	Mini-Circuits	-	2	

7.0.3. Legend

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

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

Version	Applied changes	Date of release
--	Initial release	2015-08-03
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