T E S T R E P O R T
No.: 16-1-0050601T42a

According to:
FCC Regulations
Part 1.1310 , Part 2.1091

for

peiker acustic GmbH & Co. KG

GSM/ WCDMA/ LTE Telematics US Module
V1231-0

FCC-ID: QWY-V1231-0

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

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Laboratory Accreditation and Listings

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The listed attachments are an integral part of this report.

1. Summary of test results

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

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 12	passed Remark 1
--	RF Power (radiated)	Cabinet	§2.1046 §22.913(a)(2)	< 7 Watt ERP	2	1 to 12	passed Remark 1
			§24.232(c)	< 2Watt (EIRP)			
			§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 12	passed, Remark 2

Remark:
1.) See separate test reports GSM no. CETECOM_TR16-1-0050601T39a, W-CDMA no. CETECOM_TR16-1-0050601T41a and LTE no. CETECOM_TR16-1-0050601T40a and corresponding annexes
2.) Calculations based on Tune-Up Info delivered by applicant.

Digital unterschrieben von Rachid Acharkaoui
DN: cn=Rachid Acharkaoui, o=CETECOM GmbH, ou=RC&EMC, email=rachid.acharkaoui@cetecom.com, c=DE
Datum: 2017.09.15 11:36:05 +02'00'

Digitally signed by Martin Nunier
Date: 2017.09.15 11:29:32 +02'00'

Dipl.-Ing. Rachid Acharkaoui
Responsible for test section

B.Eng. Martin Nunier
Responsible for test report

2. Administrative Data

2.1. Identification of the testing laboratory

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

2.2. Test location

2.2.1. Test laboratory "CTC"

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

2.3. Organizational items

Responsible for test report and project leader:	B.Eng. Martin Nunier
Receipt of EUT:	2017-01-18
Date(s) of test:	2017-01-20 to 2017-07-14
Date of report:	2017-08-23
Version of template: 13.02	**Remark 1:** based on applicants tune-up info

2.4. Applicant's details

Applicant's name:	peiker acustic GmbH & Co. KG
Address:	Max-Planck-Straße 28-32 61381 Friedrichsdorf/Ts. Germany
Contact person:	Philippe Seguret

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 DATA OF MAIN EUT DECLARED BY APPLICANT

GSM Frequency range (US/Canada -bands)	☒ GSM 850: 824 – 849 MHz (Uplink), 869-894 MHz (Downlink) ☒ GSM1900: 1850-1910 MHz (Uplink), 1930-1990 MHz (Downlink)		
Type of modulation	☒ GSM,GPRS: GMSK ☒ EGPRS-Mode: 8-PSK		
Number of channels (USA/Canada -bands)	☒ GSM 850: 128 – 251, 125 channels ☐ GSM1900: 512 – 810, 300 channels		
Test Channel frequencies	☒ GSM/E-GPRS 850 MHz Band: Channel 128/192/251 ☒ GSM/E-GPRS 1900 MHz Band: Channel 512/661/810		
Emission designator(s)	245KGXW (GSM850) 247KGXW (EDGE850) 245KG7W (GSM1900) 245KG7W (EDGE 1900)		
Antenna Type	☐ Integrated (enclosure) ☐ External - dedicated, no RF- connector ☒ External, separate RF-connector		
Antenna Gain Tx (main)	☐ Not applicable ☒ from data sheet "BMW_Multibandantenna_Max Gain Tel GNSS_en" 699MHz – 716MHz: 8.3dBi 824MHz – 849MHz: 7.8dBi 1710MHz – 1755MHz: 7.3dBi 1850MHz – 1910MHz: 8.9dBi 2500MHz – 2570MHz: 6.8dBi ☐ No information from customer		
Path Losses	☒ from data sheet "TEL1_NAD_to_TEL1_TRUNK_table" GSM 850: 3.04dB GSM 1900: 5.74dB		
Measured Output Power [dBm]: Conducted GSM 850 Conducted EDGE850	 AV: 31.95/ PK: 32.57 AV: 26.44/ PK: 29.40		
Measured Output Power [dBm]: Conducted GSM 1900 Conducted EDGE 1900	 AV:29.24 / PK:29.75 AV:25.15 / PK:28.06		
Peak EIRP [dBm]: GSM 850 EDGE850	(Peak Output Power + Antenna Gain – Path losses) 31.95dBm + 7.8dBi-3.04dB= 36.71dBm 29.40dBm + 7.8dBi-3.04dB= 34.16dBm		
Peak ERP [dBm]: GSM 850 EDGE850	(Peak EIRP – 2.15 = ERP) 36.71dBm – 2.15 = 34.56dBm 34.16dBm – 2.15 = 32.01dBm		
Peak EIRP [dBm]: GSM 1900 EDGE 1900	(Peak Output Power + Antenna Gain – Path losses) 29.75dBm + 8.9dBi-5.74dB= 32.91dBm 28.06dBm + 8.9dBi-5.74dB= 31.22dBm		
Installed options	☒ GSM 900 and GSM 1800 Bands (not usable in USA/Canada) ☒ W-CDMA Band I and Band VIII (not usable in USA/Canada) ☒ GPS (not tested within this test report)		
Power supply	☒ DC power only: 12Volt		
Special EMI components	--		
Does EUT contain devices susceptible to magnetic fields, e.g. Hall elements, electrodynamics microphones, etc.?	☒ yes ☐ no		
Highest radio frequency signal	Assumed to be highest TX carrier frequency: 1908.8MHz (Ch810)		
EUT sample type	☐ Production	☒ Pre-Production	☐ Engineering
FCC label attached	☐ yes	☒ no	

3.2. TECHNICAL W-CDMA DATA OF MAIN EUT DECLARED BY APPLICANT

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 – 4183 – 4233		
UMTS-HSPA connectivity	☒ Uplink speed: 5.76 Mb/s (category 6) ☐ Uplink speed:		
Emission designator(s)	4M18F9W		
Antenna Type	☐ External - dedicated, no RF- connector ☒ External, separate RF-connector: normal usage		
Antenna Gain Tx (main)	☐ Not applicable ☒ from data sheet "BMW_Multibandantenna_Max Gain Tel GNSS_en" 699MHz – 716MHz: 8.3dBi 824MHz – 849MHz: 7.8dBi 1710MHz – 1755MHz: 7.3dBi 1850MHz – 1910MHz: 8.9dBi 2500MHz – 2570MHz: 6.8dBi ☐ No information from customer		
Path Losses	☒ from data sheet "TEL1_NAD_to_TEL1_TRUNK_table" W-CDMA FDDV: 2.96dB W-CDMA FDDII: 5.55dB W-CDMA FDDIV: 5.10dB		
MAX PEAK Output Power[dBm]: Conducted FDD-Mode 2 FDD-Mode 4 FDD-Mode 5	 26.0 (PK) / 22.6 (AV) 26.9 (PK) / 23.0 (AV) 27.4 (PK) / 23.4 (AV)		
PEAK EIRP [dBm]: Radiated FDD-Mode 2 FDD-Mode 4 FDD-Mode 5	(Peak Output Power + Antenna Gain – Path losses) 26.0dBm + 8.9dBi – 5.55dB = 29.35dBm 26.9dBm + 7.3dBi – 5.10dB = 29.10dBm 27.4dBm + 7.8dBi – 2.96dB = 32.24dBm		
PEAK ERP [dBm]: Radiated FDD-Mode 2 FDD-Mode 4 FDD-Mode 5	(PEAK EIRP – 2.15) 29.35dBm –2.15 = 27.20dBm 29.10dBm – 2.15= 26.95dBm 32.24dBm – 2.15= 30.09dBm		
Installed option	☒ GSM 900 and GSM 1800 Bands (not usable in USA/Canada) ☒ W-CDMA Band I and Band VIII (not usable in USA/Canada) ☒ W-LAN (not tested within this test report) ☒ GPS (not tested within this test report)		
Power supply	☒ DC power only: 12 Volt V_{NOM} (car environment)		
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. TECHNICAL DATA OF MAIN EUT (LTE-TECHNOLOGY) DECLARED BY APPLICANT

Main function	GSM/ WCDMA/ LTE Telematics US Module		
Type	V1231-0		
TX-frequency range (E-UTRA operating bands)	LTE Band 2: 1850 - 1910 MHz (Uplink), 1930-1990 MHz (Downlink) LTE Band 4: 1710 - 1755 MHz (Uplink), 2110 - 2155 MHz (Downlink) LTE Band 5: 824 - 849 MHz (Uplink), 869-894 MHz (Downlink) LTE Band 7: 2500-2570 MHz (Uplink), 2620-2690 MHz (Downlink) LTE Band 12: 698 - 716 MHz (Uplink), 728-746 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 7: UARFCN range 20750 - 21449 LTE Band 12: UARFCN range 23010 - 23179 (only for use in USA)		See Note about channels not to be used depending on channel bandwidths
Emission designator(s)	Channel bandwidth	QPSK Modulation:	16-QAM Modulation:
	1.4 MHz	1M09G7D	1M09W7D
	3 MHz	2M70G7D	2M70W7D
	5 MHz	4M50G7D	4M50W7D
	10 MHz	9M00G7D	9M00W7D
	15 MHz	13M5G7D	13M4W7D
	20 MHz	17M9G7D	17M9W7D
Antenna Type	☐ Integrated ☐ External, no RF- connector ☒ External, separate RF-connector: main TX + secondary RX connector		
Antenna Gain Tx (main)	☐ Not applicable ☒ from data sheet “BMW_Multibandantenna_Max Gain Tel GNSS_en” 699MHz – 716MHz: 8.3dBi 824MHz – 849MHz: 7.8dBi 1710MHz – 1755MHz: 7.3dBi 1850MHz – 1910MHz: 8.9dBi 2500MHz – 2570MHz: 6.8dBi ☐ No information from customer		
Path Losses	☒ from data sheet “TEL1_NAD_to_TEL1_TRUNK_table” LTE B2: 5.55dB LTE B4: 5.10dB LTE B5: 2.96dB LTE B7: 6.61dB LTE B12: 2.57dB		

MAX AV Output Power[dBm]:	QPSK		
Conducted LTE-Mode 2	23.91		
LTE-Mode 4	24.05		
LTE-Mode 5	23.73		
LTE-Mode 7	22.46		
LTE-Mode 12	22.97		
EIRP[dBm]:	(max peak output power + antenna gain – path losses)		
	QPSK		
LTE-Mode 2	23.91dBm + 8.9dBi – 5.55dB=27.26dBm		
LTE-Mode 4	24.05dBm + 7.3dBi – 5.10dB=26.25dBm		
LTE-Mode 5	23.73dBm + 7.8dBi – 2.96dB=28.57dBm		
LTE-Mode 7	22.46dBm + 6.8dBi – 5.10dB=24.16dBm		
LTE-Mode 12	22.97dBm + 8.3dBi – 2.57dB=28.70dBm		
ERP[dBm]:	(Peak EIRP – 2.15)		
LTE-Mode 2	27.26dBm – 2.15= 25.11dBm		
LTE-Mode 4	26.25dBm – 2.15= 24.09dBm		
LTE-Mode 5	28.57dBm – 2.15= 26.42dBm		
LTE-Mode 7	24.16dBm – 2.15= 22.01dBm		
LTE-Mode 12	28.70dBm – 2.15= 26.55dBm		
Installed option	☐ GSM 900 and GSM 1800 Bands (not usable in USA/Canada) ☐ W-CDMA Band I and Band VIII (not usable in USA/Canada) ☒ GPS (not tested within this test report)		
Power supply	☒ 12VDC		
Special EMI components	--		
EUT sample type	☐ Production	☒ Pre-Production	☐ Engineering
FCC label attached	☐ yes	☒ no	

3.4. 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	GSM/ WCDMA/ LTE Telematics US Module	V1231-0	004402580040446	V1231-0_Ver.1	MPSS.TH.2.0.2-00256
EUT B	Kathrein Cellular/GNSS antenna	Model No: 9396828-02	50110256	--	--
EUT C	Kathrein Cellular antenna	Model No: 9396827-02	50110255	--	--

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

3.5. 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	Loudspeaker	KL3 / 4-Ohm	-	-	-
AE 2	Microphone	ME 39	-	-	-
AE 3	Dell Laptop Computer	DELL Latitude D610	EMC#3	Pentium IV Centrino	Windows XP Professional

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

3.6. EUT set-ups

EUT set-up no.*)	Combination of EUT and AE	Remarks
set. 1	EUT A + AE 3	RF-Conducted Measurement set-up
set. 2	EUT A + EUT B + EUT C+ AE 1 + AE 2 + AE 3	RF-Radiated measurement set-up

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

3.7. Configuration of cables used for testing

Cable number	Item	Type	S/N serial number	HW hardware status	Cable length
Cable 1	Cable 2	Microphone line	--	--	--
Cable 3	Cable 4	Speaker line	--	--	--
Cable 5	Cable 6	GPS antenna cable	--	--	--
Cable 7	Cable 8	Antenna cable TRX	--	--	--
Cable 9	Cable 10	Antenna cable DRX	--	--	--

3.8. EUT operating modes

EUT operating mode no.*)	Description of operating modes	Additional information
op. 1	GPRS 850 TCH mode TCH=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 (33dBm). 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 TCH mode TCH=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 TCH mode TCH=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 (30dBm). 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 TCH mode PCL=0 (max. power) TCH=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: 26 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 (26dBm).** 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. 5	FDD Mode 2 RMC99-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: 24dBm.** 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. Chosen settings: 12.2kbps RMC + HSPA 34.108 This setting was chosen for all Release 6 mobile equipment.
op. 6	FDD Mode 4 RMC99-Mode	
op. 7	FDD Mode 5 RMC99-Mode	

*) 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: 23dBm nominal. The input signal to the receiver is modulated with normal test modulation: QPSK or 16-QAM Modulation. The wanted RF input signal level to the receiver of the mobile station is set to a level to provide a stable communication link.
op. 9	LTE-Band 4 RMC Mode	
op. 10	LTE-Band 5 RMC Mode	
op. 11	LTE-Band 7 RMC Mode	
op. 12	LTE-Band 12 RMC Mode	

*) 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 v06*

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 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.

4.2. Results for fixed and mobile operations

Following documents have been used:

- Tune-Up Information for LTE-NAD-A module type V1231-0
- BMW_Multibandantenna_Max Gain Tel GNSS_en
- TEL1_NAD_to_TEL1_TRUNK_table

4.2.1. Results for lower operational band: LTE Band 5 and LTE band 12, 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)	Ext. Path Loss to antenna (external cables) (dB)	Calculated maximum output power (dBm)	Duty cycle %	Declared Maximum EIRP (W)	Equivalent EIRP (maximum EIRP x duty cycle) (mW)	MPE Limit accord. Table 1 (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 (Avg. Burst Power)	824.2	27	2	0	2.96	26.04	50%	0.402	201	0.5495	0.0400	**0.5095**	0.0727	0.0727
	837.0	27	2	0	3.01	25.99		0.397	199	0.5580	0.0395	**0.5185**	0.0708	
	848.8	27	2	0	3.04	25.96		0.394	197	0.5659	0.0392	**0.5266**	0.0693	
EDGE (Avg. Burst Power)	824.2	21	2	0	2.96	20.04	50%	0.101	50	0.5495	0.0100	**0.5394**	0.0183	0.0183
	837.0	21	2	0	3.01	19.99		0.100	50	0.5580	0.0099	**0.5481**	0.0178	
	848.8	21	2	0	3.04	19.96		0.099	50	0.5659	0.0099	**0.5560**	0.0174	
WCDMA FDD Band 5 (RMS-Value)	826.4	23	2	0	2.96	22.04	100%	0.160	160	0.5509	0.0318	**0.5191**	0.0578	0.0578
	836.4	23	2	0	3.01	21.99		0.158	158	0.5576	0.0315	**0.5261**	0.0564	
	846.6	23	2	0	3.04	21.96		0.157	157	0.5644	0.0312	**0.5332**	0.0554	
LTE Band 5 (QPSK, #RB=1, RMS-Value)	824.7	23	2	0	2.96	22.04	100%	0.160	160	0.5498	0.0318	**0.5180**	0.0579	0.0579
	836.5	23	2	0	3.00	22		0.158	158	0.5577	0.0315	**0.5261**	0.0565	
	848.3	23	2	0	3.04	21.96		0.157	157	0.5655	0.0312	**0.5343**	0.0552	
LTE Band 5 (16QAM, #RB=1, RMS-Value)	824.7	23	2	0	2.96	22.04	100%	0.160	160	0.5498	0.0318	**0.5180**	0.0579	0.0579
	836.5	23	2	0	3.00	22		0.158	158	0.5577	0.0315	**0.5261**	0.0565	
	848.3	23	2	0	3.04	21.96		0.157	157	0.5655	0.0312	**0.5343**	0.0552	
LTE Band 12 (QPSK, #RB=1, RMS-Value)	699.7	23	2	0	2.53	22.47	100%	0.177	177	0.4665	0.0351	**0.4313**	0.0753	0.0753
	707.4	23	2	0	2.55	22.45		0.176	176	0.4716	0.0350	**0.4366**	0.0742	
	715.3	23	2	0	2.57	22.43		0.175	175	0.4769	0.0348	**0.4421**	0.0730	
LTE Band 12 (16QAM, #RB=1, RMS-Value)	699.7	23	2	0	2.53	22.47	100%	0.177	177	0.4665	0.0351	**0.4313**	0.0753	0.0753
	707.4	23	2	0	2.55	22.45		0.176	176	0.4716	0.0350	**0.4366**	0.0742	
	715.3	23	2	0	2.57	22.43		0.175	175	0.4769	0.0348	**0.4421**	0.0730	

Maximum calculated MPE value:		
Lowest MPE-Limit in Frequency-Band:	**0.4665**	**[mW/cm^2]**
Highest MPE value in frequency-band:	**0.0400**	**[mW/cm^2]**
Lowest margin to limit in frequency band:	**0.4313**	**[mW/cm^2]**

Remark: The used reported power for GSM/GPRS is the GPRS power, because of the 1 TS in GSM, the resulting average power is lower.

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)	201
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]:	**11.23**

(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]:	**10.88**

(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
$G_{3\ -(850MHZ)}$	Max. Antenna gain to comply with limit [dBi]:	**14.56**

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

	ERP power limit according to §27.50(c)(10) [W ERP]:	3.00
$G_{3\ -(698MHZ)}$	Max. Antenna gain to comply with limit [dBi]:	**10.88**

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

$G_{850\ MHz\ band}$	**Min (G_1, G_2, G_3) [dBi]**	**10.88**

Summarized results:	The max. ant. gain for mobile operation at 700/850MHz band to comply with MPE and EIRP limits incl. path loss shall not exceed **(dBi)**:	10.88	**dBi**
		8.73	**dBd**

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)	Ext. Path Loss to antenna (external cables) (dB)	Calculated maximum output power (dBm)	Duty cycle %	Declared Maximum EIRP (W)	Equivalent EIRP (maximum EIRP x duty cycle) (mW)	MPE Limit accord. Table 1 (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	23.0	2.0	0.0	5.10	19.9	100%	0.0977	97.7	1.0000	0.0194	0.9806	0.019442	0.0194415
	1740.0	23.0	2.0	0.0	5.14	19.86		0.0968	96.8	1.0000	0.0193	0.9807	0.019263	
	1752.6	23.0	2.0	0.0	5.21	19.79		0.0953	95.3	1.0000	0.0190	0.9810	0.018955	
LTE Band 4 (QPSK, #1RB, RMS-Value)	1710.7	23.0	2.0	0.0	5.10	19.9	100%	0.0977	97.7	1.0000	0.0194	0.9806	0.019442	0.0194415
	1732.5	23.0	2.0	0.0	5.14	19.86		0.0968	96.8	1.0000	0.0193	0.9807	0.019263	
	1754.3	23.0	2.0	0.0	5.21	19.79		0.0953	95.3	1.0000	0.0190	0.9810	0.018955	
LTE Band 4 (16QAM, #1RB, RMS-Value)	1710.7	23.0	2.0	0.0	5.10	19.9	100%	0.0977	97.7	1.0000	0.0194	0.9806	0.019442	0.0194415
	1732.5	23.0	2.0	0.0	5.14	19.86		0.0968	96.8	1.0000	0.0193	0.9807	0.019263	
	1754.3	23.0	2.0	0.0	5.21	19.79		0.0953	95.3	1.0000	0.0190	0.9810	0.018955	

Maximum calculated MPE value:		
Lowest MPE-Limit in frequency-band:	1.0000	[mW/cm^2]
Highest MPE value in frequency-band:	0.0194	[mW/cm^2]
Lowest margin to limit in frequency-band:	0.98	[mW/cm^2]

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)		98
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):		**17.11**

(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):		**17.02**

(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):		**10.10**

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

Min (G_1, G_2, G_3) (dBi)			**10.10**

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)**:		**10.10**

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)	Ext. Path Loss to antenna (external cables) (dB)	Calculated maximum output power (dBm)	Duty cycle %	Declared Maximum EIRP (W)	Equivalent EIRP (maximum EIRP x duty cycle) (mW)	MPE Limit accord. Table 1 (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 (AV Burst Power)	1850.2	24.00	2.00	0.0	5.55	20.45	50%	0.111	55	1.0000	0.0110	0.9890	0.011033	0.0110332
	1880.0	24.00	2.00	0.0	5.65	20.35		0.108	54	1.0000	0.0108	0.9892	0.010782	
	1909.8	24.00	2.00	0.0	5.74	20.26		0.106	53	1.0000	0.0106	0.9894	0.010561	
EDGE (AV Burst Power)	1850.2	20.00	2.00	0.0	5.55	16.45	50%	0.044	22	1.0000	0.0044	0.9956	0.004392	0.0043924
	1880.0	20.00	2.00	0.0	5.65	16.35		0.043	22	1.0000	0.0043	0.9957	0.004292	
	1909.8	20.00	2.00	0.0	5.74	16.26		0.042	21	1.0000	0.0042	0.9958	0.004204	
W-CDMA FDD Band 2 (RMS-Value)	1852.4	23.00	2.00	0.0	5.55	19.45	100%	0.088	88	1.0000	0.0175	0.9825	0.017528	0.0175279
	1880.0	23.00	2.00	0.0	5.65	19.35		0.086	86	1.0000	0.0171	0.9829	0.017129	
	1907.6	23.00	2.00	0.0	5.73	19.27		0.085	85	1.0000	0.0168	0.9832	0.016816	
LTE Band 2 (QPSK, #1RB, RMS-Value)	1860.0	23.00	2.00	0.0	5.55	19.45	100%	0.088	88	1.0000	0.0175	0.9825	0.017528	0.0175279
	1880.0	23.00	2.00	0.0	5.65	19.35		0.086	86	1.0000	0.0171	0.9829	0.017129	
	1909.3	23.00	2.00	0.0	5.74	19.26		0.084	84	1.0000	0.0168	0.9832	0.016778	
LTE Band 2 (16QAM, #1RB, RMS-Value)	1850.7	23.00	2.00	0.0	5.55	19.45	100%	0.088	88	1.0000	0.0175	0.9825	0.017528	0.0175279
	1880.0	23.00	2.00	0.0	5.65	19.35		0.086	86	1.0000	0.0171	0.9829	0.017129	
	1909.3	23.00	2.00	0.0	5.74	19.26		0.084	84	1.0000	0.0168	0.9832	0.016778	

Maximum calculated MPE value:		
Lowest MPE-Limit in frequency-band:	1.0000	[mW/cm^2]
Highest MPE value in frequency-band:	0.0175	[mW/cm^2]
Margin to limit in frequency-band:	0.9825	[mW/cm^2]

Remark: The used reported power for GSM/GPRS is the GPRS power, because of the 1 TS in GSM, the resulting average power is lower.

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)					88
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):					**17.56**

(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):				**17.47**

(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):				**12.56**

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

Min (G_1, G_2, G_3) (dBi)				**12.56**

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):**				**12.56**

4.2.4. Results for upper operational band: LTE 7

4.2.4.1. MPE results

Operation Mode	Frequency on channel (MHz)	Declared maximum conducted output power (dBm)	Max. positive tolerance according manfacturer (dB)	Antenna Gain (dBi)	Ext. Path Loss to antenna (external cables) (dB)	Calculated maximum output power (dBm)	Duty cycle %	Declared Maximum EIRP (W)	Equivalent EIRP (maximum EIRP x duty cycle) (mW)	MPE Limit accord. Table 1 (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
LTE Band 7 (QPSK, #1RB, RMS-Value)	2500.7	23.0	2.00	0.00	6.61	18.4	100%	0.069	69	1.0000	0.0137	0.9863	0.013732	0.0140517
	2535.0	23.0	2.00	0.00	6.59	18.4		0.069	69	1.0000	0.0138	0.9862	0.013795	
	2569.3	23.0	2.00	0.00	6.51	18.5		0.071	71	1.0000	0.0141	0.9859	0.014052	
LTE Band 7 (16QAM, #1RB, RMS-Value)	2500.7	23.0	2.00	0.00	6.61	18.4	100%	0.069	69	1.0000	0.0137	0.9863	0.013732	0.0140517
	2535.0	23.0	2.00	0.00	6.59	18.4		0.069	69	1.0000	0.0138	0.9862	0.013795	
	2569.3	23.0	2.00	0.00	6.51	18.5		0.071	71	1.0000	0.0141	0.9859	0.014052	

Maximum calculated MPE value:		
Lowest MPE-Limit in frequency-band:	1.0000	[mW/cm^2]
Highest MPE value in frequency-band:	0.0141	[mW/cm^2]
Margin to limit in frequency-band:	0.9859	[mW/cm^2]

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)				71
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):				**18.52**

(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):				**18.43**

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

	EIRP power limit according to §27.50(h)(2) [W]:				2.00
G_3	Max. Antenna gain to comply with this limit (dBi):				**14.52**

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

Min (G_1, G_2, G_3) (dBi)				**14.52**

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):**				**14.52**

4.3. Conclusion for maximum admissible antenna gain

Max. Gain in Lower operational band f < 1GHz **(GSM850, FDD/LTE Band 5, LTE Band 12)**	10.88 dBi
Max. Gain in Higher operational band (1700MHz) **(FDD/LTE Band 4)**	10.10 dBi
Max. Gain in Higher operational band (1900MHz) **(GSM1900, FDD/LTE Band 2)**	12.56 dBi
Max. Gain in Higher operational band (2500MHz) **(LTE Band 7)**	14.52 dBi

Remark: calculations does not include a second transmitters situated near-by (Co-location condition) which may reduce allowed antenna gain.

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, Documents 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

7.1. Used equipment "CTC"

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

7.1.1. Test software and firmware of equipment

Ref.-No.	Equipment	Type	Serial-No.	Version of Firmware or Software during the test
001	EMI Test Receiver	ESS	825132/017	Firm.= 1.21 , OTP=2.0, GRA=2.0
012	Signal Generator (EMS-cond.)	SMY 01	839069/027	Firm.= V 2.02
013	Power Meter (EMS cond.)	NRVD	839111/003	Firm.= V 1.51
017	Digital Radiocommunication Tester	CMD 60 M	844365/014	Firmware = V 3.52 .22.01.99, DECT = D2.87 13.01.99
053	Audio Analyzer	UPA3	860612/022	Firm. V 4.3
119	RT Harmonics Analyzer dig. Flickermeter	B10	G60547	Firm.= V 3.1DHG
140	Signal Generator	SMHU	831314/006	Firm.= 3.21
261	Thermal Power Sensor	NRV-Z55	825083/0008	EPROM-Datum 02.12.04, SE EE 1 B
262	Power Meter	NRV-S	825770/0010	Firm.= 2.6
263	Signal Generator	SMP 04	826190/0007	Firm.=3.21
295	Racal Digital Radio Test Set	6103	1572	UNIT Firmware= 4.04, SW-Main=4.04, SW-BBP=1.04, SW-DSP=1.02, Hardboot=1.02, Softboot=2.02
298	Univ. Radio Communication Tester	CMU 200	832221/091	R&S Test Firmware =3.53 /3.54 (current Testsoftw. f. all band used
323	Digital Radiocommunication Tester	CMD 55	825878/0034	Firm.= 3.52 .22.01.99
335	CTC-EMS-Conducted	System EMS Conducted	-	EMC 32 V 8.52
340	Digital Radiocommunication Tester	CMD 55	849709/037	Firm.= 3.52 .22.01.99
355	Power Meter	URV 5	891310/027	Firm.= 1.31
365	10V Insertion Unit 50 Ohm	URV5-Z2	100880	Eprom Data = 31.03.08
366	Ultra Compact Simulator	UCS 500 M4	V0531100594	Firm. UCS 500=001925/3.06a02, rc=ISMIEC 4.10
371	Bluetooth Tester	CBT32	100153	CBT V5,30+ SW-Option K55, K57
377	EMI Test Receiver	ESCS 30	100160	Firm.= 2.30, OTP= 02.01, GRA= 02.36
378	Broadband RF Field Monitor	RadiSense III	03D00013SNO-08	Firm.= V.03D13
389	Digital Multimeter	Keithley 2000	0583926	Firm. = A13 (Mainboard) A02 (Display)
392	Radio Communication Tester	MT8820A	6K00000788	Firm.= 4.50 #005, IPL=4.01#001,OS=4.02#001, GSM=4.41#013, W-CDMA= 4.54#004, scenario= 4.52#002
436	Univ. Radio Communication Tester	CMU 200	103083	R&S Test Firmware Base=5.14, Mess-Software= GSM:5.14 WCDMA:5.14 (current Testsoftw. F. all band
441	CTC-SAR-EMI Cable Loss	System EMI field (SAR)	-	EMC 32 Version 8.52
442	CTC-SAR-EMS	System EMS field (SAR)	-	EMC 32 Version 8.40
443	CTC-FAR-EMI-RSE	System CTC-FAR-EMI-RSE	-	Spuri 7.2.5 or EMC 32 Ver. 9.15.00
444	CTC-FAR-EMS field	System-EMS-Field (FAR)	-	EMC 32 Version 9.15.00
460	Univ. Radio Communication Tester	CMU 200	108901	R&S Test Firmware Base=5.14, GSM=5.14 WCDMA=5.14 (current Testsoftw.,f. all band to be used,
489	EMI Test Receiver	ESU40	1000-30	Firmware=4.43 SP3, Bios=V5.1-16-3, Spec. =01.00
491	ESD Simulator dito	ESD dito	dito307022	V 2.30
524	Voltage Drop Simulator	VDS 200	0196-16	Software Nr: 000037 Version V4.20a01
526	Burst Generator	EFT 200 A	0496-06	Software Nr. 000034 Version V2.32
527	Micro Pulse Generator	MPG 200 B	0496-05	Software-Nr. 000030 Version V2.43
528	Load Dump Simulator	LD 200B	0496-06	Software-Nr. 000031 Version V2.35a01
546	Univ. Radio Communication Tester	CMU 200	106436	R&S Test Firmware Base=5.14, GSM=5.14 WCDMA=5.14 (current Testsoftw.,f. all band to be used
547	Univ. Radio Communication Tester	CMU 200	835390/014	R&S Test Firmware Base=V5.1403 (current Testsoftw., f. all band used, GSM = 5.14 WCDMA: = 5.14
584	Spectrum Analyzer	FSU 8	100248	2.82_SP3
597	Univ. Radio Communication Tester	CMU 200	100347	R&S Test Firmware Base=5.01, GSM=5.02 WCDMA= not installed, Mainboard= µP1=V.850
598	Spectrum Analyzer	FSEM 30	831259/013	Firmware Bios 3.40 , Analyzer 3.40 Sp 2
607	Signal Generator	SMR 20	832033/011	V1.25
620	EMI Test Receiver	ESU 26	100362	4.43_SP3
642	Wideband Radio Communication Tester	CMW 500	126089	Setup V03.26, Test programm component V03.02.20
670	Univ. Radio Communication Tester	CMU 200	106833	µP1 =V8.50, Firmware = V.20
689	Vector Signal Generator	SMU200	100970	02.20.360.142
692	Bluetooth Tester	CBT 32	100236	CBT V 5.40, FW: V.2.41 (FPGA Digital, V. 3.09 FPGA RF)

7.1.2. Single instruments and test systems

Ref.-No.	Equipment	Type	Serial-No.	Manufacturer	Interval of calibration	Remark	Cal due
001	EMI Test Receiver	ESS	825132/017	Rohde & Schwarz	12 M	-	16.05.2018
005	AC - LISN (50 Ohm/50µH, test site 1)	ESH2-Z5	861741/005	Rohde & Schwarz	12 M	-	15.05.2018
007	Single-Line V-Network (50 Ohm/5µH)	ESH3-Z6	892563/002	Rohde & Schwarz	12 M	-	17.05.2018
009	Power Meter (EMS-radiated)	NRV	863056/017	Rohde & Schwarz	24 M	-	15.05.2019
016	Line Impedance Simulating Network	Op. 24-D	B6366	Spitzenberger+Spies	36 M	-	30.05.2019
020	Horn Antenna 18 GHz (Subst 1)	3115	9107-3699	EMCO	36/12 M	-	31.07.2017
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	-	15.05.2019
057	relay-switch-unit (EMS system)	RSU	494440/002	Rohde & Schwarz	pre-m	1a	
060	power amplifier (DC-2kHz)	PAS 5000	B6363	Spitzenberger+Spies	-	3	
066	notch filter (WCDMA; FDD1)	WRCT 1900/2200-5/40-10EEK	5	Wainwright GmbH	12 M	1g	30.06.2017
086	DC - power supply, 0 -10 A	LNG 50-10	-	Heinzinger Electronic	pre-m	2	
087	DC - power supply, 0 -5 A	EA-3013 S	-	Elektro Automatik	pre-m	2	
091	USB-LWL-Converter	OLS-1	007/2006	Ing. Büro Scheiba	-	4	
099	passive voltage probe	ESH2-Z3	299.7810.52	Rohde & Schwarz	36 M	-	30.04.2018
100	passive voltage probe	Probe TK 9416	without	Schwarzbeck	36 M	-	30.04.2018
110	USB-LWL-Converter	OLS-1	-	Ing. Büro Scheiba	-	4	
119	RT Harmonics Analyzer dig. Flickermeter	B10	G60547	BOCONSULT	36 M	-	30.05.2019
133	horn antenna 18 GHz (Meas 1)	3115	9012-3629	EMCO	36 M	1c	10.03.2020
134	horn antenna 18 GHz (Subst 2)	3115	9005-3414	EMCO	36 M	-	10.03.2020
136	adjustable dipole antenna (Dipole 1)	3121C-DB4	9105-0697	EMCO	36 M	-	30.04.2018
140	Signal Generator	SMHU	831314/006	Rohde & Schwarz	24 M	-	30.05.2018
248	attenuator	SMA 6dB 2W	-	Radiall	pre-m	2	
249	attenuator	SMA 10dB 10W	-	Radiall	pre-m	2	
252	attenuator	N 6dB 12W	-	Radiall	pre-m	2	
256	attenuator	SMA 3dB 2W	-	Radiall	pre-m	2	
257	hybrid	4031C	04491	Narda	pre-m	2	
260	hybrid coupler	4032C	11342	Narda	pre-m	2	
261	Thermal Power Sensor	NRV-Z55	825083/0008	Rohde & Schwarz	24 M	-	30.05.2018
262	Power Meter	NRV-S	825770/0010	Rohde & Schwarz	24 M	-	30.05.2018
263	Signal Generator	SMP 04	826190/0007	Rohde & Schwarz	36 M	-	30.05.2019
265	peak power sensor	NRV-Z33, Model 04	840414/009	Rohde & Schwarz	24 M	-	30.05.2018
266	Peak Power Sensor	NRV-Z31, Model 04	843383/016	Rohde & Schwarz	24 M	-	30.05.2018
267	notch filter GSM 850	WRCA 800/960-6EEK	9	Wainwright GmbH	pre-m	2	
270	termination	1418 N	BB6935	Weinschel	pre-m	2	
271	termination	1418 N	BE6384	Weinschel	pre-m	2	
272	attenuator (20 dB) 50 W	Model 47	BF6239	Weinschel	pre-m	2	
273	attenuator (10 dB) 100 W	Model 48	BF9229	Weinschel	pre-m	2	
274	attenuator (10 dB) 50 W	Model 47 (10 dB) 50 W	BG0321	Weinschel	pre-m	2	
275	DC-Block	Model 7003 (N)	C5129	Weinschel	pre-m	2	
276	DC-Block	Model 7006 (SMA)	C7061	Weinschel	pre-m	2	
279	power divider	1515 (SMA)	LH855	Weinschel	pre-m	2	
287	pre-amplifier 25MHz - 4GHz	AMF-2D-100M4G-35-10P	379418	Miteq	12 M	1c	30.06.2017
291	high pass filter GSM 850/900	WHJ 2200-4EE	14	Wainwright GmbH	12 M	1c	30.06.2017
298	Univ. Radio Communication Tester	CMU 200	832221/091	Rohde & Schwarz	pre-m	3	
300	AC LISN (50 Ohm/50µH, 1-phase)	ESH3-Z5	892 239/020	Rohde & Schwarz	12 M	-	17.05.2018
301	attenuator (20 dB) 50W, 18GHz	47-20-33	AW0272	Lucas Weinschel	pre-m	2	
302	horn antenna 40 GHz (Meas 1)	BBHA9170	155	Schwarzbeck	36 M	-	14.03.2020
303	horn antenna 40 GHz (Subst 1)	BBHA9170	156	Schwarzbeck	36 M	-	20.03.2020
331	Climatic Test Chamber -40/+180 Grad	HC 4055	43146	Heraeus Vötsch	24 M	-	30.10.2018
341	Digital Multimeter	Fluke 112	81650455	Fluke	24 M	-	30.05.2018
342	Digital Multimeter	Voltcraft M-4660A	IB 255466	Voltcraft	24 M	-	17.05.2019
347	laboratory site	radio lab.	-	-	-	5	
348	laboratory site	EMI conducted	-	-	-	5	
354	DC - Power Supply 40A	NGPE 40/40	448	Rohde & Schwarz	pre-m	2	
355	Power Meter	URV 5	891310/027	Rohde & Schwarz	24 M	-	30.05.2018
357	power sensor	NRV-Z1	861761/002	Rohde & Schwarz	24 M	-	24.05.2019
371	Bluetooth Tester	CBT32	100153	R&S	36 M	-	30.05.2019
373	Single-Line V-Network (50 Ohm/5µH)	ESH3-Z6	100535	Rohde & Schwarz	12 M	-	17.05.2018
377	EMI Test Receiver	ESCS 30	100160	Rohde & Schwarz	12 M	-	15.05.2018
389	Digital Multimeter	Keithley 2000	0583926	Keithley	24 M	-	31.12.2017
392	Radio Communication Tester	MT8820A	6K00000788	Anritsu	12 M	-	18.05.2018
405	Thermo-/Hygrometer	OPUS 10 THI	126.0604.0003.3.3.3.22	LUFFT Mess u. Regeltechnik	24 M	-	30.03.2019
431	Model 7405	Near-Field Probe Set	9305-2457	EMCO	-	4	
436	Univ. Radio Communication Tester	CMU 200	103083	Rohde & Schwarz	12 M	-	24.05.2018
439	UltraLog-Antenna	HL 562	100248	Rohde & Schwarz	36 M	-	10.03.2020

Ref.-No.	Equipment	Type	Serial-No.	Manufacturer	Interval of calibration	Remark	Cal due
441	CTC-SAR-EMI Cable Loss	System EMI field (SAR) Cable	-	CETECOM	12 M	5	31.12.2017
443	CTC-FAR-EMI-RSE	System CTC-FAR-EMI-RSE	-	ETS-Lindgren / CETECOM	12 M	5	31.12.2017
448	notch filter WCDMA_FDD II	WRCT 1850.0/2170.0-5/40-	5	Wainwright Instruments GmbH	12 M	1c	31.12.2017
449	notch filter WCDMA FDD V	WRCT 824.0/894.0-5/40-8SSK	1	Wainwright	12 M	1c	31.12.2017
454	Oscilloscope	HM 205-3	9210 P 29661	Hameg	-	4	
456	DC-Power supply 0-5 A	EA 3013 S	207810	Elektro Automatik	pre-m	2	
459	DC -Power supply 0-5 A , 0-32 V	EA-PS 2032-50	910722	Elektro Automatik	pre-m	2	
460	Univ. Radio Communication Tester	CMU 200	108901	Rohde & Schwarz	12 M	-	16.06.2018
463	Universal source	HP3245A	2831A03472	Agilent	-	4	
466	Digital Multimeter	Fluke 112	89210157	Fluke USA	24 M	-	30.05.2018
467	Digital Multimeter	Fluke 112	89680306	Fluke USA	36 M	-	30.04.2018
468	Digital Multimeter	Fluke 112	90090455	Fluke USA	36 M	-	30.04.2018
477	ReRadiating GPS-System	AS-47	-	Automotive Cons. Fink	-	3	
480	power meter (Fula)	NRVS	838392/031	Rohde & Schwarz	24 M	-	16.05.2019
482	filter matrix	Filter matrix SAR 1	-	CETECOM (Brl)	-	1d	
484	pre-amplifier 2,5 - 18 GHz	AMF-5D-02501800-25-10P	1244554	Miteq	12 M	-	30.07.2017
487	System CTC NSA-Verification SAR-EMI	System EMI field (SAR) NSA	-	ETS Lindgren / CETECOM	24 M	-	31.03.2019
489	EMI Test Receiver	ESU40	1000-30	Rohde & Schwarz	12 M	-	18.05.2019
502	band reject filter	WRCG 1709/1786-1699/1796-	SN 9	Wainwright	pre-m	2	
503	band reject filter	WRCG 824/849-814/859-	SN 5	Wainwright	pre-m	2	
512	notch filter GSM 850	WRCA 800/960-02/40-6EEK	SN 24	Wainwrght	12 M	1c	31.12.2017
517	relais switch matrix	HF Relais Box Keithley	SE 04	Keithley	pre-m	2	
523	Digital Multimeter	L4411A	MY46000154	Agilent	24 M	-	18.05.2019
529	6 dB Broadband resistive power divider	Model 1515	LH 855	Weinschel	pre-m	2	
530	10 dB Broadband resistive power divider	R 416110000	LOT 9828	-	pre-m	2	
546	Univ. Radio Communication Tester	CMU 200	106436	R&S	12 M	-	30.03.2018
547	Univ. Radio Communication Tester	CMU 200	835390/014	Rohde & Schwarz	12 M	-	05.07.2018
549	Log.Per-Antenna	HL025	1000060	Rohde & Schwarz	36/12 M	-	31.07.2018
550	System CTC S-VSWR Verification SAR-EMI	System EMI Field SAR S-VSWR	-	ETS Lindgren/CETECOM	24 M	-	30.03.2019
552	high pass filter 2,8-18GHz	WHKX 2.8/18G-10SS	4	Wainwright	12 M	1c	31.12.2017
557	System CTC-OTA-2	R&S TS8991	-	Rohde & Schwarz	12 M	5	31.12.2017
558	System CTC FAR S-VSWR	System CTC FAR S-VSWR	-	CTC	24 M	-	08.08.2019
574	Biconilog Hybrid Antenna	BTA-L	980026L	Frankonia	36/12 M	-	31.03.2019
584	Spectrum Analyzer	FSU 8	100248	Rohde & Schwarz	pre-m	-	
594	Wideband Radio Communication Tester	CMW 500	101757	Rohde & Schwarz	12 M	-	30.04.2017
597	Univ. Radio Communication Tester	CMU 200	100347	Rohde & Schwarz	pre-m	-	
600	power meter	NRVD (Reserve)	834501/018	Rohde & Schwarz	24 M	-	17.05.2019
601	medium-sensitivity diode sensor	NRV-Z5 (Reserve)	8435323/003	Rohde & Schwarz	24 M	-	15.05.2019
602	peak power sensor	NRV-Z32 (Reserve)	835080	Rohde & Schwarz	24 M	-	
611	DC power supply	E3632A	KR 75305854	Agilent	pre-m	2	
612	DC power supply	E3632A	MY 40001321	Agilent	pre-m	2	
613	Attenuator	R416120000 20dB 10W	Lot. 9828	Radiall	pre-m	2	
616	Digitalmultimeter	Fluke 177	88900339	Fluke	24 M	-	30.05.2018
617	Power Splitter/Combiner	ZFSC-2-2-S+	S F987001108	Mini Circuits	-	2	
618	Power Splitter/Combiner	50PD-634	600994	JFW Industries USA	-	2	
619	Power Splitter/Combiner	50PD-634	600995	JFW Industries, USA	-	3	
620	EMI Test Receiver	ESU 26	100362	Rohde-Schwarz	12 M	-	16.05.2018
621	Step Attenuator 0-139 dB	RSP	100017	Rohde & Schwarz	pre-m	2	
625	Generic Test Load USB	Generic Test Load USB	-	CETECOM	-	2	
627	data logger	OPUS 1	201.0999.9302.6.4.1.43	G. Lufft GmbH	24 M	-	30.03.2019
634	Spectrum Analyzer	FSM (HF-Unit)	826188/010	Rohde & Schwarz	pre-m	2	
637	High Speed HDMI with Ethernet 1m	HDMI cable with Ethernet 1m	-	KogiLink	-	2	
638	HDMI Kabel with Ethernet 1,5 m flach	HDMI cable with Ethernet	-	Reichelt	-	2	
640	HDMI cable 2m rund	HDMI cable 2m rund	-	Reichelt	-	2	
641	HDMI cable with Ethernet	Certified HDMI cable with	-	PureLink	-	2	
642	Wideband Radio Communication Tester	CMW 500	126089	Rohde&Schwarz	12 M	-	24.05.2018
644	Amplifierer	ZX60-2534M+	SN865701299	Mini-Circuits	-	-	
670	Univ. Radio Communication Tester	CMU 200	106833	Rohde & Schwarz	24 M	-	30.05.2018
671	DC-power supply 0-5 A	EA-3013S	-	Elektro Automatik	pre-m	2	
678	Power Meter	NRP	101638	Rohde&Schwarz	pre-m	-	
683	Spectrum Analyzer	FSU 26	200571	Rohde & Schwarz	12 M	-	17.05.2018

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	-	29.03.2019
687	Signal Generator	SMF 100A	102073	Rohde&Schwarz	12 M	-	17.05.2018
688	Pre Amp	JS-18004000-40-8P	1750117	Miteq	pre-m	-	
690	Spectrum Analyzer	FSU	100302/026	Rohde&Schwarz	12 M	-	16.05.2018
691	OSP120 Base Unit	OSP120	101183	Rohde & Schwarz	12 M	-	22.05.2018
692	Bluetooth Tester	CBT 32	100236	Rohde & Schwarz	36 M	-	29.05.2020
693	TS8997	CTC-Radio Lab 1_TS8997	-	Rohde&Schwarz	12 M	5	31.12.2017
697	Power Splitter	ZN4PD-642W-S+	165001445	Mini-Circuits	-	2	
701	CMW500 wide. Radio Comm.	CMW500	158150	Rohde & Schwarz	12 M	-	31.12.2017
703	INNCO Antennen Mast	MA 4010-KT080-XPET-ZSS3	MA4170-KT100-XPET-	INNCO	pre-m	-	
704	INNCON Controller	CO 3000-4port	CO3000/933/38410516/L	INNCO Systems GmBh	pre-m	-	
711	Harmonic Mixer 90 GHz - 140GHz	RPG FS-Z140	101004	RPG	12 M	-	22.02.2018
712	Harmonic Mixer 75 GHz - 110GHz	FS-Z110	101468	Rohde & Schwarz	12 M	-	22.02.2018
713	Harmonic Mixer, 50 GHz - 75GHz	FS-Z75	101022	Rohde & Schwarz	12 M	-	22.05.2018
714	Signal Analyzer 67GHz	FSW67	104023	Rohde & Schwarz	24 M	-	03.03.2019
715	Harmonic Mixer, 140 GHz - 220GHz	FS-Z220	101009	RPG Radiometer Physics	12 M	-	03.08.2018
716	Harmonic Mixer 220 GHz to 325 GHZ	FS-Z325	101005	RPG Radiometer Physics	12 M	-	13.02.2018
747	Spectrum Analyzer	FSU 26	200152	Rohde & Schwarz	12 M	-	18.05.2018
748	Pickett-Potter Horn Antenna	FH-PP 4060	010001	Radiometer Physiscs	-	-	
749	Pickett-potter Horn Antenna	FH-PP 60-90	010003	Radiometer Physics	-	-	
750	Pickett-Potter Horn Antenna	FH-PP 140-220	010011	Radiometer Physics	-	-	

7.1.3. Legend

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

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

8. Test report version

Version	Applied changes	Date of release
--	Initial release	2017-08-23
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