

TEST REPORT

No.: 16-1-0219301T14a

According to:
FCC Regulations
 Part 1.1310 , Part 2.1091

ISED-Regulations
 RSS-102, Issue 5

for

ACTIA Nordic

TEM4G Telematics Module
 + Antenna 31409875

FCC-ID: 2AGKKTEM4G
 ISED: 20839-TEM4G
 PMN: TEM4G
 HVIN: TEM4G
 FVIN: 13

Laboratory Accreditation and Listings		
 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
 	 Lab Code: 20011130-00	 MRA US-EU 0003
accredited according to DIN EN ISO/IEC 17025		
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Laboratory Accreditation and Listings		

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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.

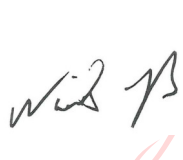
Following tests have been performed to show compliance with applicable FCC Part 2.1091 and FCC Part 1.1310 of the FCC CFR 47 Rules.

1.1 Summary of tests results

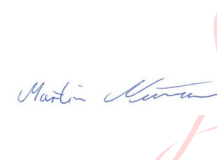
RF-Exposure Evaluation (separation distance user to RF-radiating element greater 20cm)								
Test cases	Port	References & Limits				EUT set-up	EUT op. mode	Result
		FCC Standard	Test Limit	RSS Standard	Test Limit			
Radio frequency radiation exposure Requirements	Cabinet + Inter-Connecting Cables (conducted)	§2.1091 §2.1093	RF-Field Strength Limits: FCC: "general population/uncontrolled" environment	RSS-102, Issue 5	Chapter 4 Table4	1 to 3	1 to 12	Pass

1.2 Attestation:

I declare that all measurements were performed by me or under my supervision and that all measurements have been performed and are correct to my best knowledge and belief to Industry Canada standards. All requirements as shown in above table are met in accordance with enumerated standards.

 Digital
unterschrieben von
Niels Jeß
Datum: 2017.08.03
18:09:28 +02'00'

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

 Digitally signed
by Martin Nunier
Date: 2017.08.03
14:31:18 +02'00'

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

2. Administrative Data

2.1. Identification of the testing laboratory

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

2.2. Test location

2.2.1. Test laboratory “CTC”

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

Responsible for project leader:	Dipl.-Ing. C. Lorenz
Responsible for test report:	B.Eng. Martin Nunier
Receipt of EUT:	2017-03-20
Date(s) of test:	2017-03-20 to 2017-06-29
Date of report:	2017-08-03

Version of template:	13.02

2.4. Applicant's details

Applicant's name:	Actia Nordic
Address:	Hammarbacken 4A 19149 Sollentuna Sweden
Contact person: 	Mr. Salah Alazawi

2.5. Manufacturer's details

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

3. Equipment under test (EUT)

3.1. TECHNICAL DATA OF MAIN EUT DECLARED BY APPLICANT

TX-frequency range	☒ GSM 850 ☒ GSM 900 ☒ GSM 1800 ☒ GSM 1900 ☒ WCDMA/HSPA 800 ☒ WCDMA/HSPA 850 ☒ WCDMA/HSPA 900 ☒ WCDMA/HSPA 2100 ☒ LTE 700 ☒ LTE 850 ☒ LTE 2100 ☒ WLAN 2.4GHz		
Antenna Type	☒ Integrated (enclosure) – Internal antenna for emergency SOS voice/messages ☐ External - dedicated, no RF- connector ☒ External, separate RF-connector: normal usage		
Antenna Gain TX (main external)	☒ Values: 850MHz Band: 0.4 dBd (2.55dBi) 1700MHz band: 4.62 dBi 1900MHz Band: 4.89 dBi		
Antenna Gain TX (secondary-backup antenna)	Accord. Document: <i>ACUII-05 / ACUII-06 Backup Antenna Specification Rev.1.0</i> 850MHz Band: -5.05 dBd (-2.9dBi) 1700MHz band: 2.5 dBi 1900MHz Band: 2.5 dBi		
Antenna Gain TX (WLAN internal)	2400-2484MHz: 3.27 dBi		
Antenna Gain Dx (diversity)	☐ Not applicable ☐ Value: xyz (Data sheet xyz) ☒ No information from customer		
Power supply	☒ DC power only: 12 Volt V _{NOM} (car environment)		
EUT sample type	☐ Production	☒ Pre-Production	☐ Engineering
FCC label attached	☐ yes	☒ no	

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

Short description*)	EUT	Type	S/N serial number	HW hardware status	SW software status
EUT A	TEM4G	Telematics Module	20071090027 (CONDUCTED)	H1	13
EUT B	TEM4G	Telematics Module	20071090026 (RADIATED)	H1	13
EUT C	External Antenna	31409875	#1	--	--

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

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

AE short description *)	Auxiliary Equipment	Type	S/N serial number	HW hardware status	SW software status
AE 1	Main harness with power supply cables	For TEM4G	1007-141-06	Rev A1.1	--
AE 2	External SIM card holder	For TEM4G	--	--	--
AE 3	Button Unit/Microphone	30710477	--	--	--
AE 4	USB Termination	--	--	--	--

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

3.4. EUT set-ups

EUT set-up no. *)	Combination of EUT and AE	Remarks
set. 1	EUT A + AE 1+ AE 2 + AE 2 + AE 4	Conducted measurement set-up
set. 2	EUT B + EUT C + AE 1+ AE 2 + AE 2 + AE 4	Radiated Set-up (main TX external-antenna activated)
set. 3	EUT B + EUT C + AE 1+ AE 2 + AE 2 + AE 4	Radiated Set-up (Backup antenna activated)

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

3.5. Configuration of cables used for testing

3.6. 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	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. 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: 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. 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: 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. 12	WLAN 2.4GHz	WLAN 2.4 GHz 802.11b/g/n

*) 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	<i>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.</i>
FCC § 2.1091	<i>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.</i>

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: $f/1500 \text{ mW/cm}^2$ 1500–100,000 MHz: 1.0 mW/cm^2
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

4.2. Radio Frequency Exposure Evaluation RSS-102, Issue 5

4.2.1. 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.		

4.3. Requirements and limits:

RSS-102, Issue 5	2.5 Exemption Limits for Routine Evaluation All transmitters are exempt from routine SAR and RF exposure evaluations provided that they comply with the requirements of <u>sections 2.5.1 or 2.5.2</u> . If the equipment under test (EUT) meets the requirements of sections 2.5.1 or 2.5.2, applicants are only required to submit a properly signed declaration of compliance (see Annex C). The information contained in the RF exposure technical brief may be limited to the value(s) of the maximum output power, the information that demonstrates how the maximum output power of the transmitter was derived and the rationale for the separation distances applied (see Table 1), which must be based on the most conservative exposure condition for the applicable module or host platform test procedure requirements.
	2.5.2 Exemption Limits for Routine Evaluation — RF Exposure Evaluation RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates as follows: - below 20 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1 W (adjusted for tune-up tolerance); - at or above 20 MHz and below 48 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $4.49/f^{0.5}$ W (adjusted for tune-up tolerance), where f is in MHz; - at or above 48 MHz and below 300 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 0.6 W (adjusted for tune-up tolerance); at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $1.31 \times 10^{-2} f^{0.6834}$ W (adjusted for tune-up tolerance), where f is in MHz; - at or above 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 5 W (adjusted for tune-up tolerance). In these cases, the information contained in the RF exposure technical brief may be limited to information that demonstrates how the e.i.r.p. was derived.
	2.6 User Manual Requirements The applicant is responsible for providing proper instructions to the user of the radio device, and any usage restrictions, including limits of exposure durations. The user manual shall provide installation and operation instructions, as well as any special usage conditions (e.g. proper accessory required, including the proper orientation of the device in the accessory, maximum antenna gain in the case of detachable antenna), in order to ensure compliance with SAR and/or RF field strength limits. For instance, compliance distance shall be clearly stated in the user manual. The user manual of devices intended for controlled use shall also include information relating to the operating characteristics of the device; the operating instructions to ensure compliance with SAR and/or RF field strength limits; information on the installation and operation of accessories to ensure compliance with SAR and/or RF field strength limits; and contact information where the user can obtain Canadian information on RF exposure and compliance. Other related information may also be included.

For given Power density limit at a single frequency (accord. Table 4 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:

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

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

4.4. 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 $10 \cdot \log_{10}(\text{max. number of possible active slots} / 8 \text{ slots})$ were applied

Please find in the following tables the calculations based on applicants information for the power values.

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 information for the power values.

Valid for WLAN Mode:

- The power was checked (see separate report for WLAN technology) and the results compared to applicant's declared power values (tune-up info).

Please find in the following tables the calculations based on applicants information for the power values.

4.5. Results for fixed and mobile operations using external antenna

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

4.5.1.1. MPE results FCC-Regulations

Operating Mode	Frequency on channel (MHz)	Declared maximum conducted output power (dBm)	Antenna Gain (dBi)	Ext. Path Loss to antenna (external cables) (dB)	Calculated maximum ERP (declared+ Tune-up+ antenna Gain) (dBm)	Duty cycle (%)	Declared Maximum ERP (W)	Equivalent ERP (maximum ERP 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 (PK)	824.2	33	2.55	2.9	32.65	50%	1.841	920	0.5495	0.1831	0.3664	0.3332	0.3332
	837	33	2.55	2.9	32.65		1.841	920	0.5580	0.1831	0.3749	0.3281	
	848.8	33	2.55	2.9	32.65		1.841	920	0.5659	0.1831	0.3828	0.3236	
GSM/GPRS (Avg. Burst Power)	824.2	33	2.55	2.9	32.65	50%	1.841	920	0.5495	0.1831	0.3664	0.3332	0.3332
	837	33	2.55	2.9	32.65		1.841	920	0.5580	0.1831	0.3749	0.3281	
	848.8	33	2.55	2.9	32.65		1.841	920	0.5659	0.1831	0.3828	0.3236	
EDGE (PK)	824.2	33	2.55	2.9	32.65	50%	1.841	920	0.5495	0.1831	0.3664	0.3332	0.3332
	837	33	2.55	2.9	32.65		1.841	920	0.5580	0.1831	0.3749	0.3281	
	848.8	33	2.55	2.9	32.65		1.841	920	0.5659	0.1831	0.3828	0.3236	
EDGE (Avg. Burst Power)	824.2	33	2.55	2.9	32.65	50%	1.841	920	0.5495	0.1831	0.3664	0.3332	0.3332
	837	33	2.55	2.9	32.65		1.841	920	0.5580	0.1831	0.3749	0.3281	
	848.8	33	2.55	2.9	32.65		1.841	920	0.5659	0.1831	0.3828	0.3236	
WCDMA FDD Band 5 (RMS-Value)	826.4	23	2.55	2.9	22.65	100%	0.184	184	0.5509	0.0366	0.5143	0.0665	0.0665
	836.4	23	2.55	2.9	22.65		0.184	184	0.5576	0.0366	0.5210	0.0657	
	846.6	23	2.55	2.9	22.65		0.184	184	0.5644	0.0366	0.5278	0.0649	
LTE Band 17 (QPSK, #RB=1, RMS-Value)	706.5	23	2.55	2.9	22.65	100%	0.184	184	0.4710	0.0366	0.4344	0.0778	0.0778
	710	23	2.55	2.9	22.65		0.184	184	0.4733	0.0366	0.4367	0.0774	
	713.5	23	2.55	2.9	22.65		0.184	184	0.4757	0.0366	0.4390	0.0770	
LTE Band 17 (16QAM, #RB=1, RMS-Value)	706.5	23	2.55	2.9	22.65	100%	0.184	184	0.4710	0.0366	0.4344	0.0778	0.0778
	710	23	2.55	2.9	22.65		0.184	184	0.4733	0.0366	0.4367	0.0774	
	713.5	23	2.55	2.9	22.65		0.184	184	0.4757	0.0366	0.4390	0.0770	
LTE Band 5 (QPSK, #RB=1, RMS-Value)	824.7	23	2.55	2.9	22.65	100%	0.184	184	0.5498	0.0366	0.5132	0.0666	0.0666
	836.5	23	2.55	2.9	22.65		0.184	184	0.5577	0.0366	0.5210	0.0657	
	848.3	23	2.55	2.9	22.65		0.184	184	0.5655	0.0366	0.5289	0.0648	
LTE Band 5 (16QAM, #RB=1, RMS-Value)	824.7	23	2.55	2.9	22.65	100%	0.184	184	0.5498	0.0366	0.5132	0.0666	0.0666
	836.5	23	2.55	2.9	22.65		0.184	184	0.5577	0.0366	0.5210	0.0657	
	848.3	23	2.55	2.9	22.65		0.184	184	0.5655	0.0366	0.5289	0.0648	

Maximum calculated MPE value:		
Lowest MPE-Limit in Frequency-Band:	0.4710	[mW/cm ²]
Highest MPE value in frequency-band:	0.1831	[mW/cm ²]
Lowest margin to limit in frequency band:	0.3664	[mW/cm ²]

4.5.1.2. MPE results ISED-Regulations

Operating Mode	Channel frequency (MHz)	Declared maximum conducted output power (dBm)	Antenna Gain (dBi)	Ext. Path Loss to antenna (external cables) (dB)	Power: (ERP) (dBm)	Duty-Cycle (%)	Maximum delivered power: (ERP) (W)	Power incl. Duty-Cycle: (ERP) (W)	MPE Limit accord. Table 4 (ERP-Limit) (W/m ²)	MPE-Value (ERP referred) (W/m ²)	Margin (W/m ²)	Fraction for Co-location calculations	Maximum Fraction Value within Frequency band
GSM/GPRS (PK)	824.2	33.0	2.55	2.9	32.65	50%	1.8408	0.9204	2.5760	1.8310	0.7450	0.7108	0.710801
	837.0	33.0	2.55	2.9	32.65	50%	1.8408	0.9204	2.6033	1.8310	0.7723	0.7034	
	848.8	33.0	2.55	2.9	32.65	50%	1.8408	0.9204	2.6283	1.8310	0.7973	0.6967	
EDGE (PK)	824.2	33.0	2.55	2.9	32.65	50%	1.8408	0.9204	2.5760	1.8310	0.7450	0.7108	
	837.0	33.0	2.55	2.9	32.65	50%	1.8408	0.9204	2.6033	1.8310	0.7723	0.7034	
	848.8	33.0	2.55	2.9	32.65	50%	1.8408	0.9204	2.6283	1.8310	0.7973	0.6967	
WCDMA FDD Band 5 (RMS-Value)	826.4	23.0	2.55	2.9	22.65	100%	0.1841	0.1841	2.5807	0.3662	2.2145	0.141901	0.141901
	837.0	23.0	2.55	2.9	22.65	100%	0.1841	0.1841	2.6033	0.3662	2.2371	0.140671	
	846.6	23.0	2.55	2.9	22.65	100%	0.1841	0.1841	2.6237	0.3662	2.2575	0.139579	
LTE Band 5 (QPSK, #RB=1, RMS-Value)	824.7	23.0	2.55	2.9	22.65	100%	0.1841	0.1841	2.5771	0.3662	2.2109	0.142101	0.142101
	836.5	23.0	2.55	2.9	22.65	100%	0.1841	0.1841	2.6022	0.3662	2.2360	0.140728	
	848.3	23.0	2.55	2.9	22.65	100%	0.1841	0.1841	2.6273	0.3662	2.2611	0.139388	
LTE Band 5 (16QAM, #RB=1, RMS-Value)	824.7	23.0	2.55	2.9	22.65	100%	0.1841	0.1841	2.5771	0.3662	2.2109	0.142101	
	836.5	23.0	2.55	2.9	22.65	100%	0.1841	0.1841	2.6022	0.3662	2.2360	0.140728	
	848.3	23.0	2.55	2.9	22.65	100%	0.1841	0.1841	2.6273	0.3662	2.2611	0.139388	
LTE Band 17 (QPSK, #RB=1, RMS-Value)	706.5	23.0	2.55	2.9	22.65	100%	0.1841	0.1841	2.3186	0.3662	1.9524	0.157947	0.157947
	710.0	23.0	2.55	2.9	22.65	100%	0.1841	0.1841	2.3264	0.3662	1.9602	0.157414	
	713.5	23.0	2.55	2.9	22.65	100%	0.1841	0.1841	2.3342	0.3662	1.9680	0.156886	
LTE Band 17 (16QAM, #RB=1, RMS-Value)	706.5	23.0	2.55	2.9	22.65	100%	0.1841	0.1841	2.3186	0.3662	1.9524	0.157947	
	710.0	23.0	2.55	2.9	22.65	100%	0.1841	0.1841	2.3264	0.3662	1.9602	0.157414	
	713.5	23.0	2.55	2.9	22.65	100%	0.1841	0.1841	2.3342	0.3662	1.9680	0.156886	

Maximum calculated MPE value:		
Lowest MPE-Limit within frequency-band:	2.3186	[W/m ²]
Highest MPE value within frequency-band:	1.8310	[W/m ²]
Lowest margin to limit within frequency-band:	0.7450	[W/m ²]

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

4.5.2.1. MPE results FCC-Regulations

Operating Mode	Frequency on channel (MHz)	Declared maximum conducted output power (dBm)	Antenna Gain (dBi)	Ext. Path Loss to antenna (external cables) (dB)	Calculated maximum ERP (declared+ Tune-up+ antenna Gain) (dBm)	Duty cycle (%)	Declared Maximum ERP (W)	Equivalent ERP (maximum ERP 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	4.6	3.8	23.82	100%	0.2410	241.0	1.0000	0.0479	0.9521	0.047944	0.0479435
	1740.0	23.0	4.6	3.8	23.82		0.2410	241.0	1.0000	0.0479	0.9521	0.047944	
	1752.6	23.0	4.6	3.8	23.82		0.2410	241.0	1.0000	0.0479	0.9521	0.047944	
LTE Band 4 (QPSK, #1RB, RMS-Value)	1710.7	23.0	4.6	3.8	23.82	100%	0.2410	241.0	1.0000	0.0479	0.9521	0.047944	0.0479435
	1732.5	23.0	4.6	3.8	23.82		0.2410	241.0	1.0000	0.0479	0.9521	0.047944	
	1754.3	23.0	4.6	3.8	23.82		0.2410	241.0	1.0000	0.0479	0.9521	0.047944	
LTE Band 4 (16QAM, #1RB, RMS-Value)	1710.7	23.0	4.6	3.8	23.82	100%	0.2410	241.0	1.0000	0.0479	0.9521	0.047944	0.0479435
	1732.5	23.0	4.6	3.8	23.82		0.2410	241.0	1.0000	0.0479	0.9521	0.047944	
	1754.3	23.0	4.6	3.8	23.82		0.2410	241.0	1.0000	0.0479	0.9521	0.047944	

Maximum calculated MPE value:		
Lowest MPE-Limit in frequency-band:	1.0000	[mW/cm ²]
Highest MPE value in frequency-band:	0.0479	[mW/cm ²]
Lowest margin to limit in frequency-band:	0.95	[mW/cm ²]

4.5.2.2. MPE results ISSED-Regulations

Operating Mode	Channel frequency (MHz)	Declared maximum conducted output power (dBm)	Antenna Gain (dBi)	Path Loss module to ext. antenna connector according manufacturer (dB)	Maximum delivered ERP power: (dBm)	Maximum delivered ERP-power: (W)	Duty-Cycle (%)	Maximum delivered ERP-power incl. Duty-Cycle: (W)	MPE Limit accord. Table 4 (W/m ²)	MPE-Value (W/m ²)	Margin (W/m ²)	Fraction for Co-location calculations	Maximum Fraction Value within Frequency band
FDD Band 4 (RMC 99)	1712.4	23.0	4.6	3.8	23.82	0.24099	100%	0.2409905	4.2460	0.4794	3.7666	0.112914272	0.112914272
	1732.5	23.0	4.6	3.8	23.82	0.24099		0.2409905	4.2800	0.4794	3.8006	0.112017365	
	1752.6	23.0	4.6	3.8	23.82	0.24099		0.2409905	4.3139	0.4794	3.8344	0.111137805	
LTE Band 4 (QPSK, #1RB RMS-Value)	1710.7	23.0	4.6	3.8	23.82	0.24099	100%	0.2409905	4.2431	0.4794	3.7637	0.112990943	0.112990943
	1732.5	23.0	4.6	3.8	23.82	0.24099		0.2409905	4.2800	0.4794	3.8006	0.112017365	
	1754.3	23.0	4.6	3.8	23.82	0.24099		0.2409905	4.3167	0.4794	3.8373	0.111064193	
LTE Band 4 (16QAM, #1RB RMS-Value)	1710.7	23.0	4.6	3.8	23.82	0.24099	100%	0.2409905	4.2431	0.4794	3.7637	0.112990943	0.112990943
	1732.5	23.0	4.6	3.8	23.82	0.24099		0.2409905	4.2800	0.4794	3.8006	0.112017365	
	1754.3	23.0	4.6	3.8	23.82	0.24099		0.2409905	4.3167	0.4794	3.8373	0.111064193	

Maximum calculated MPE value:		
Lowest MPE-Limit within frequency-band:	4.2431	[W/m ²]
Highest MPE value within frequency-band:	0.4794	[W/m ²]
Lowest margin to limit within frequency-band:	3.7637	[W/m ²]

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

4.5.3.1. MPE results FCC-Regulations

Operation Mode	Frequency on channel	Declared maximum conducted output power	Antenna Gain	Ext. Path Loss to antenna (external cables)	Declared maximum ERP (Measured+ Tune-up+ Antenna Gain)	Duty cycle	Declared Maximum ERP	Equivalent ERP (maximum ERP x duty cycle)	MPE Limit accord. Table 1	MPE-Value	Margin to limit:	Fraction for Co-Location calculations	Max. Fraction-Value within Frequency-Band
	(MHz)	(dBm)	(dBi)	(dB)	(dBm)	%	(W)	(mW)	(mW/cm ²)	(mW/cm ²)	(W/m ²)		
GSM GPRS (PK-Burst value)	1850.2	30.0	4.9	3.1	31.79	50%	1.510	755	1.0000	0.1502	0.8498	0.150210	0.1502105
	1880.0	30.0	4.9	3.1	31.79		1.510	755	1.0000	0.1502	0.8498	0.150210	
	1909.8	30.0	4.9	3.1	31.79		1.510	755	1.0000	0.1502	0.8498	0.150210	
GSM GPRS (AV Burst Power)	1850.2	30.0	4.9	3.1	31.79	50%	1.510	755	1.0000	0.1502	0.8498	0.150210	0.1502105
	1880.0	30.0	4.9	3.1	31.79		1.510	755	1.0000	0.1502	0.8498	0.150210	
	1909.8	30.0	4.9	3.1	31.79		1.510	755	1.0000	0.1502	0.8498	0.150210	
EDGE (PK-Burst value)	1850.2	30.0	4.9	3.1	31.79	50%	1.510	755	1.0000	0.1502	0.8498	0.150210	0.1502105
	1880.0	30.0	4.9	3.1	31.79		1.510	755	1.0000	0.1502	0.8498	0.150210	
	1909.8	30.0	4.9	3.1	31.79		1.510	755	1.0000	0.1502	0.8498	0.150210	
EDGE (AV Burst Power)	1850.2	30.0	4.9	3.1	31.79	50%	1.510	755	1.0000	0.1502	0.8498	0.150210	0.1502105
	1880.0	30.0	4.9	3.1	31.79		1.510	755	1.0000	0.1502	0.8498	0.150210	
	1909.8	30.0	4.9	3.1	31.79		1.510	755	1.0000	0.1502	0.8498	0.150210	
W-CDMA FDD Band 2 (RMS-Value)	1852.4	23.0	4.9	3.1	24.79	100%	0.301	301	1.0000	0.0599	0.9401	0.059942	0.0599419
	1880.0	23.0	4.9	3.1	24.79		0.301	301	1.0000	0.0599	0.9401	0.059942	
	1907.6	23.0	4.9	3.1	24.79		0.301	301	1.0000	0.0599	0.9401	0.059942	
LTE Band 2 (QPSK, #1RB, RMS-Value)	1850.7	23.0	4.9	3.1	24.79	100%	0.301	301	1.0000	0.0599	0.9401	0.059942	0.0599419
	1880.0	23.0	4.9	3.1	24.79		0.301	301	1.0000	0.0599	0.9401	0.059942	
	1909.3	23.0	4.9	3.1	24.79		0.301	301	1.0000	0.0599	0.9401	0.059942	
LTE Band 2 (16QAM, #1RB, RMS-Value)	1850.7	23.0	4.9	3.1	24.79	100%	0.301	301	1.0000	0.0599	0.9401	0.059942	0.0599419
	1880.0	23.0	4.9	3.1	24.79		0.301	301	1.0000	0.0599	0.9401	0.059942	
	1909.3	23.0	4.9	3.1	24.79		0.301	301	1.0000	0.0599	0.9401	0.059942	

Maximum calculated MPE value:		
Lowest MPE-Limit in frequency-band:	1.0000	[mW/cm ²]
Highest MPE value in frequency-band:	0.1502	[mW/cm ²]
Margin to limit in frequency-band:	0.8498	[mW/cm ²]

4.5.3.2. MPE results ISED-Regulations

Operating Mode	Frequency on channel (MHz)	Declared maximum conducted output power (dBm)	Antenna Gain (dBi)	Path Loss module to ext. antenna connector according manufacturer (dB)	Maximum delivered antenna power: (dBm)	Duty-Cycle	Maximum delivered power to Antenna: (W)	Maximum delivered power to Antenna incl. Duty-Cycle: (W)	MPE Limit accord. Table 4 (W/m ^2)	MPE-Value (W/m ^2)	Margin (W/m ^2)	Fraction for Co-location calculations	Maximum Fraction Value within Frequency band
GSM/GPRS (PK-Burst value)	1850.2	30.0	4.90	3.10	31.80	50%	1.5136	0.7568	4.4766	1.5056	2.9711	0.33631591	0.3363159
	1880.0	30.0	4.90	3.10	31.80		1.5136	0.7568	4.5258	1.5056	3.0202	0.33266352	
	1909.8	30.0	4.90	3.10	31.80		1.5136	0.7568	4.5747	1.5056	3.0691	0.32910731	
EDGE (PK-Burst value)	1850.2	30.0	4.90	3.10	31.80	50%	1.5136	0.7568	4.4766	1.5056	2.9711	0.33631591	
	1880.0	30.0	4.90	3.10	31.80		1.5136	0.7568	4.5258	1.5056	3.0202	0.33266352	
	1909.8	30.0	4.90	3.10	31.80		1.5136	0.7568	4.5747	1.5056	3.0691	0.32910731	
W-CDMA FDD Band 2 (RMS-Value)	1852.4	30.0	4.90	3.10	31.80	100%	1.5136	1.5136	4.4803	3.0111	1.4691	0.67208577	0.6720858
	1880.0	30.0	4.90	3.10	31.80		1.5136	1.5136	4.5258	3.0111	1.5147	0.66532704	
	1907.6	30.0	4.90	3.10	31.80		1.5136	1.5136	4.5711	3.0111	1.5600	0.65873330	
LTE Band 2 (QPSK, #1RB, RMS-Value)	1850.7	30.0	4.90	3.10	31.80	100%	1.5136	1.5136	4.4775	3.0111	1.4663	0.67250762	0.6725076
	1880.0	30.0	4.90	3.10	31.80		1.5136	1.5136	4.5258	3.0111	1.5147	0.66532704	
	1909.3	30.0	4.90	3.10	31.80		1.5136	1.5136	4.5739	3.0111	1.5627	0.65833241	
LTE Band 2 (16QAM, #1RB, RMS-Value)	1850.7	30.0	4.90	3.10	31.80	100%	1.5136	1.5136	4.4775	3.0111	1.4663	0.67250762	
	1880.0	30.0	4.90	3.10	31.80		1.5136	1.5136	4.5258	3.0111	1.5147	0.66532704	
	1909.3	30.0	4.90	3.10	31.80		1.5136	1.5136	4.5739	3.0111	1.5627	0.65833241	

Maximum calculated MPE value:		
Lowest MPE-Limit within frequency-band:	4.4766	[W/m ^2]
Highest MPE value within frequency-band:	3.0111	[W/m ^2]
Lowest margin to limit within frequency-band:	1.4663	[W/m ^2]

4.5.4. Results for operational band: WLAN 2.4GHz

4.5.4.1. MPE results FCC-Regulations

Operation Mode	Frequency on channel (MHz)	Declared maximum conducted output power (dBm)	Antenna Gain (dBi)	Declared maximum ERP (Measured+ Tune-up) (dBm)	Duty cycle (%)	Declared Maximum conducted output power (W)	Equivalent conducted output power (output power x duty cycle) (mW)	MPE Limit accord. Table 1 (mW/cm ²)	MPE-Value (mW/cm ²)	Margin to Limit:	Fraction for Co-Location calculations	Max. Fraction-Value within Frequency-Band
W-LAN 2.4GHz	2412.0	18.0	3.3	21.3	100%	0.1340	134.0	1.0000	0.0267	0.9733	0.026652	0.0266520
	2437.0	18.0	3.3	21.3		0.1340	134.0	1.0000	0.0267	0.9733	0.026652	
	2462.0	18.0	3.3	21.3		0.1340	134.0	1.0000	0.0267	0.9733	0.026652	

Maximum calculated MPE value:		
Lowest MPE-Limit:	1.0000	[mW/cm ²]
Highest MPE value:	0.0267	[mW/cm ²]
Lowest Margin to limit:	0.9733	[mW/cm ²]

4.5.4.2. MPE results ISSED-Regulations

Operation Mode	Frequency on channel (MHz)	Declared measured conducted output power (dBm)	Antenna Gain (dBi)	Calculated maximum ERP (declared+ Tune-up+ antenna Gain+ path loss) (dBm)	Duty-Cycle	Maximum ERP (W)	Equivalent ERP (ERP x duty cycle) (W)	MPE Limit accord. Table 4 (W/m ²)	MPE-Value (W/m ²)	Margin (W/m ²)	Fraction for Co-location calculations	Maximum Fraction-Value within Frequency band
W-LAN 2.4GHz	2412.0	18.00	3.27	21.27	100%	0.1340	0.134	5.3660	0.2665	5.0995	0.04967	0.04967
	2437.0	18.00	3.27	21.27	100%	0.1340	0.134	5.4040	0.2665	5.1374	0.04932	
	2462.0	18.00	3.27	21.27	100%	0.1340	0.134	5.4418	0.2665	5.1753	0.04898	

Maximum calculated MPE value:		
	2.4GHz Band	
Lowest MPE-Limit:	5.3660	[W/m ²]
Highest MPE value:	0.2665	[W/m ²]
Lowest margin to limit	5.0995	[W/m ²]

4.5.5. Co-location assessment (scenario)

Following table shows calculations with Wireless LAN technology active in the device.

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 interactions between the transmitting RF-antennas due small physical distance between 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.

4.5.5.1. MPE results FCC-Regulations

		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
	Ratio of MPE- Value/Limit	0.333241283	0.066470829	0.066607849	0.077751583	0.047943545	0.047943545	0.150210451	0.05994185	0.05994185
W-LAN or Bluetooth or Zigbee 2.4GHz	0.026652021	0.359893304	0.09312285	0.09325987	0.104403603	0.07459557	0.074595566	0.176862471	0.086593871	0.086593871
Maximum-Value		0.359893304								

4.5.5.2. MPE results ISSED-Regulations

		GSM/ G-PRS/ E-GPRS Band-850	W-CDMA Band 5	LTE- Band 5	LTE Band 17	FDD Band 4	LTE Band 4	GSM/GPRS/ E-GPRS Band 1900	W-CDMA Band 2	LTE Band 2
	Ratio of MPE- Value/Limit	0.710800893	0.141901436	0.142101271	0.157947004	0.112914272	0.112990943	0.336315905	0.672085774	0.672507616
W-LAN 2.4GHz	0.049668151	0.76046904	0.19156959	0.191769423	0.207615155	0.162582424	0.162659095	0.38598406	0.72175393	0.72217577
Maximum- Value		0.760469								

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).

4.6. Results for fixed and mobile operations using internal antenna

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

4.6.1.1. MPE results FCC-Regulations

Operating Mode	Frequency on channel (MHz)	Declared maximum conducted output power (dBm)	Antenna Gain (dBi)	Ext. Path Loss to antenna (external cables) (dB)	Calculated maximum ERP (declared+ Tune-up+ antenna Gain) (dBm)	Duty cycle %	Declared Maximum ERP (W)	Equivalent ERP (maximum ERP 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 (PK)	824.2	33	-2.9	0	30.1	50%	1.023	512	0.5495	0.1018	0.4477	0.1853	0.1853
	837	33	-2.9	0	30.1		1.023	512	0.5580	0.1018	0.4562	0.1824	
	848.8	33	-2.9	0	30.1		1.023	512	0.5659	0.1018	0.4641	0.1799	
GSM/GPRS (Avg. Burst Power)	824.2	33	-2.9	0	30.1	50%	1.023	512	0.5495	0.1018	0.4477	0.1853	0.1853
	837	33	-2.9	0	30.1		1.023	512	0.5580	0.1018	0.4562	0.1824	
	848.8	33	-2.9	0	30.1		1.023	512	0.5659	0.1018	0.4641	0.1799	
EDGE (PK)	824.2	33	-2.9	0	30.1	50%	1.023	512	0.5495	0.1018	0.4477	0.1853	0.1853
	837	33	-2.9	0	30.1		1.023	512	0.5580	0.1018	0.4562	0.1824	
	848.8	33	-2.9	0	30.1		1.023	512	0.5659	0.1018	0.4641	0.1799	
EDGE (Avg. Burst Power)	824.2	33	-2.9	0	30.1	50%	1.023	512	0.5495	0.1018	0.4477	0.1853	0.1853
	837	33	-2.9	0	30.1		1.023	512	0.5580	0.1018	0.4562	0.1824	
	848.8	33	-2.9	0	30.1		1.023	512	0.5659	0.1018	0.4641	0.1799	
WCDMA FDD Band 5 (RMS-Value)	826.4	23	-2.9	0	20.1	100%	0.102	102	0.5509	0.0204	0.5306	0.0370	0.0370
	836.4	23	-2.9	0	20.1		0.102	102	0.5576	0.0204	0.5372	0.0365	
	846.6	23	-2.9	0	20.1		0.102	102	0.5644	0.0204	0.5440	0.0361	
LTE Band 17 (QPSK, #RB=1, RMS-Value)	706.5	23	-2.9	0	20.1	100%	0.102	102	0.4710	0.0204	0.4506	0.0432	0.0432
	710	23	-2.9	0	20.1		0.102	102	0.4733	0.0204	0.4530	0.0430	
	713.5	23	-2.9	0	20.1		0.102	102	0.4757	0.0204	0.4553	0.0428	
LTE Band 17 (16QAM, #RB=1, RMS-Value)	706.5	23	-2.9	0	20.1	100%	0.102	102	0.4710	0.0204	0.4506	0.0432	0.0432
	710	23	-2.9	0	20.1		0.102	102	0.4733	0.0204	0.4530	0.0430	
	713.5	23	-2.9	0	20.1		0.102	102	0.4757	0.0204	0.4553	0.0428	
LTE Band 5 (QPSK, #RB=1, RMS-Value)	824.7	23	-2.9	0	20.1	100%	0.102	102	0.5498	0.0204	0.5294	0.0370	0.0370
	836.5	23	-2.9	0	20.1		0.102	102	0.5577	0.0204	0.5373	0.0365	
	848.3	23	-2.9	0	20.1		0.102	102	0.5655	0.0204	0.5452	0.0360	
LTE Band 5 (16QAM, #RB=1, RMS-Value)	824.7	23	-2.9	0	20.1	100%	0.102	102	0.5498	0.0204	0.5294	0.0370	0.0370
	836.5	23	-2.9	0	20.1		0.102	102	0.5577	0.0204	0.5373	0.0365	
	848.3	23	-2.9	0	20.1		0.102	102	0.5655	0.0204	0.5452	0.0360	

Maximum calculated MPE value:		
Lowest MPE-Limit in Frequency-Band:	0.4710	[mW/cm ²]
Highest MPE value in frequency-band:	0.1018	[mW/cm ²]
Lowest margin to limit in frequency band:	0.4477	[mW/cm ²]

4.6.1.2. MPE results ISED-Regulations

Operating Mode	Channel frequency (MHz)	Declared maximum conducted output power (dBm)	Antenna Gain (dBi)	Ext. Path Loss to antenna (external cables) (dB)	Power: (ERP) (dBm)	Duty-Cycle (%)	Maximum delivered power: (ERP) (W)	Power incl. Duty-Cycle: (ERP) (W)	MPE Limit accord. Table 4 (ERP-Limit) (W/m ²)	MPE-Value (ERP referred) (W/m ²)	Margin (W/m ²)	Fraction for Co-location calculations	Maximum Fraction Value within Frequency band
GSM/GPRS (PK)	824.2	33.0	-2.90	0	30.10	50%	1.0233	0.5116	2.5760	1.0179	1.5581	0.3951	0.395137
	837.0	33.0	-2.90	0	30.10	50%	1.0233	0.5116	2.6033	1.0179	1.5854	0.3910	
	848.8	33.0	-2.90	0	30.10	50%	1.0233	0.5116	2.6283	1.0179	1.6104	0.3873	
EDGE (PK)	824.2	33.0	-2.90	0	30.10	50%	1.0233	0.5116	2.5760	1.0179	1.5581	0.3951	
	837.0	33.0	-2.90	0	30.10	50%	1.0233	0.5116	2.6033	1.0179	1.5854	0.3910	
	848.8	33.0	-2.90	0	30.10	50%	1.0233	0.5116	2.6283	1.0179	1.6104	0.3873	
WCDMA FDD Band 5 (RMS-Value)	826.4	23.0	-2.90	0	20.10	100%	0.1023	0.1023	2.5807	0.2036	2.3772	0.078884	0.078884
	837.0	23.0	-2.90	0	20.10	100%	0.1023	0.1023	2.6033	0.2036	2.3997	0.078200	
	846.6	23.0	-2.90	0	20.10	100%	0.1023	0.1023	2.6237	0.2036	2.4201	0.077592	
LTE Band 5 (QPSK, #RB=1, RMS-Value)	824.7	23.0	-2.90	0	20.10	100%	0.1023	0.1023	2.5771	0.2036	2.3735	0.078995	0.078995
	836.5	23.0	-2.90	0	20.10	100%	0.1023	0.1023	2.6022	0.2036	2.3987	0.078231	
	848.3	23.0	-2.90	0	20.10	100%	0.1023	0.1023	2.6273	0.2036	2.4237	0.077486	
LTE Band 5 (16QAM, #RB=1, RMS-Value)	824.7	23.0	-2.90	0	20.10	100%	0.1023	0.1023	2.5771	0.2036	2.3735	0.078995	
	836.5	23.0	-2.90	0	20.10	100%	0.1023	0.1023	2.6022	0.2036	2.3987	0.078231	
	848.3	23.0	-2.90	0	20.10	100%	0.1023	0.1023	2.6273	0.2036	2.4237	0.077486	
LTE Band 17 (QPSK, #RB=1, RMS-Value)	706.5	23.0	-2.90	0	20.10	100%	0.1023	0.1023	2.3186	0.2036	2.1150	0.087803	0.087803
	710.0	23.0	-2.90	0	20.10	100%	0.1023	0.1023	2.3264	0.2036	2.1228	0.087507	
	713.5	23.0	-2.90	0	20.10	100%	0.1023	0.1023	2.3342	0.2036	2.1307	0.087214	
LTE Band 17 (16QAM, #RB=1, RMS-Value)	706.5	23.0	-2.90	0	20.10	100%	0.1023	0.1023	2.3186	0.2036	2.1150	0.087803	
	710.0	23.0	-2.90	0	20.10	100%	0.1023	0.1023	2.3264	0.2036	2.1228	0.087507	
	713.5	23.0	-2.90	0	20.10	100%	0.1023	0.1023	2.3342	0.2036	2.1307	0.087214	

Maximum calculated MPE value:		
Lowest MPE-Limit within frequency-band:	2.3186	[W/m ²]
Highest MPE value within frequency-band:	1.0179	[W/m ²]
Lowest margin to limit within frequency-band:	1.5581	[W/m ²]

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

4.6.2.1. MPE results FCC-Regulations

Operating Mode	Frequency on channel (MHz)	Declared maximum conducted output power (dBm)	Antenna Gain (dBi)	Ext. Path Loss to antenna (external cables) (dB)	Calculated maximum ERP (declared+ Tune-up+ antenna Gain) (dBm)	Duty cycle %	Declared Maximum ERP (W)	Equivalent ERP (maximum ERP 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	2.5	0.0	25.5	100%	0.3548	354.8	1.0000	0.0706	0.9294	0.070588	0.0705879
	1740.0	23.0	2.5	0.0	25.5		0.3548	354.8	1.0000	0.0706	0.9294	0.070588	
	1752.6	23.0	2.5	0.0	25.5		0.3548	354.8	1.0000	0.0706	0.9294	0.070588	
LTE Band 4 (QPSK, #1RB, RMS-Value)	1710.7	23.0	2.5	0.0	25.5	100%	0.3548	354.8	1.0000	0.0706	0.9294	0.070588	0.0705879
	1732.5	23.0	2.5	0.0	25.5		0.3548	354.8	1.0000	0.0706	0.9294	0.070588	
	1754.3	23.0	2.5	0.0	25.5		0.3548	354.8	1.0000	0.0706	0.9294	0.070588	
LTE Band 4 (16QAM, #1RB, RMS-Value)	1710.7	23.0	2.5	0.0	25.5	100%	0.3548	354.8	1.0000	0.0706	0.9294	0.070588	0.0705879
	1732.5	23.0	2.5	0.0	25.5		0.3548	354.8	1.0000	0.0706	0.9294	0.070588	
	1754.3	23.0	2.5	0.0	25.5		0.3548	354.8	1.0000	0.0706	0.9294	0.070588	

Maximum calculated MPE value:		
Lowest MPE-Limit in frequency-band:	1.0000	[mW/cm ²]
Highest MPE value in frequency-band:	0.0706	[mW/cm ²]
Lowest margin to limit in frequency-band:	0.93	[mW/cm ²]

4.6.2.2. MPE results ISSED-Regulations

Operating Mode	Channel frequency (MHz)	Declared maximum conducted output power (dBm)	Antenna Gain (dBi)	Path Loss module to ext. antenna connector according manufacturer (dB)	Maximum delivered ERP power: (dBm)	Maximum delivered ERP-power: (W)	Duty-Cycle (%)	Maximum delivered ERP-power incl. Duty-Cycle: (W)	MPE Limit accord. Table 4 (W/m ²)	MPE-Value (W/m ²)	Margin (W/m ²)	Fraction for Co-location calculations	Maximum Fraction Value within Frequency band
FDD Band 4 (RMC 99)	1712.4	23.0	2.5	0.0	25.50	0.35481	100%	0.3548134	4.2460	0.7059	3.5401	0.166245095	0.166245095
	1732.5	23.0	2.5	0.0	25.50	0.35481		0.3548134	4.2800	0.7059	3.5741	0.164924567	
	1752.6	23.0	2.5	0.0	25.50	0.35481		0.3548134	4.3139	0.7059	3.6080	0.163629580	
LTE Band 4 (QPSK, #1RB RMS-Value)	1710.7	23.0	2.5	0.0	25.50	0.35481	100%	0.3548134	4.2431	0.7059	3.5373	0.166357978	0.166357978
	1732.5	23.0	2.5	0.0	25.50	0.35481		0.3548134	4.2800	0.7059	3.5741	0.164924567	
	1754.3	23.0	2.5	0.0	25.50	0.35481		0.3548134	4.3167	0.7059	3.6109	0.163521200	
LTE Band 4 (16QAM, #1RB RMS-Value)	1710.7	23.0	2.5	0.0	25.50	0.35481	100%	0.3548134	4.2431	0.7059	3.5373	0.166357978	
	1732.5	23.0	2.5	0.0	25.50	0.35481		0.3548134	4.2800	0.7059	3.5741	0.164924567	
	1754.3	23.0	2.5	0.0	25.50	0.35481		0.3548134	4.3167	0.7059	3.6109	0.163521200	

Maximum calculated MPE value:		
Lowest MPE-Limit within frequency-band:	4.2431	[W/m ²]
Highest MPE value within frequency-band:	0.7059	[W/m ²]
Lowest margin to limit within frequency-band:	3.5373	[W/m ²]

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

4.6.3.1. MPE results FCC-Regulations

Operation Mode	Frequency on channel	Declared maximum conducted output power	Antenna Gain	Ext. Path Loss to antenna (external cables)	Declared maximum ERP (Measured+ Tune-up+ Antenna Gain)	Duty cycle	Declared Maximum ERP	Equivalent ERP (maximum ERP x duty cycle)	MPE Limit accord. Table 1	MPE-Value	Margin to limit:	Fraction for Co-Location calculations	Max. Fraction-Value within Frequency-Band
	(MHz)	(dBm)	(dBi)	(dB)	(dBm)	%	(W)	(mW)	(mW/cm ²)	(mW/cm ²)	(W/m ²)		
GSM GPRS (PK-Burst value)	1850.2	30.0	2.5	0.0	32.5	50%	1.778	889	1.0000	0.1769	0.8231	0.176889	0.1768887
	1880.0	30.0	2.5	0.0	32.5		1.778	889	1.0000	0.1769	0.8231	0.176889	
	1909.8	30.0	2.5	0.0	32.5		1.778	889	1.0000	0.1769	0.8231	0.176889	
GSM GPRS (AV Burst Power)	1850.2	30.0	2.5	0.0	32.5	50%	1.778	889	1.0000	0.1769	0.8231	0.176889	0.1768887
	1880.0	30.0	2.5	0.0	32.5		1.778	889	1.0000	0.1769	0.8231	0.176889	
	1909.8	30.0	2.5	0.0	32.5		1.778	889	1.0000	0.1769	0.8231	0.176889	
EDGE (PK-Burst value)	1850.2	30.0	2.5	0.0	32.5	50%	1.778	889	1.0000	0.1769	0.8231	0.176889	0.1768887
	1880.0	30.0	2.5	0.0	32.5		1.778	889	1.0000	0.1769	0.8231	0.176889	
	1909.8	30.0	2.5	0.0	32.5		1.778	889	1.0000	0.1769	0.8231	0.176889	
EDGE (AV Burst Power)	1850.2	30.0	2.5	0.0	32.5	50%	1.778	889	1.0000	0.1769	0.8231	0.176889	0.1768887
	1880.0	30.0	2.5	0.0	32.5		1.778	889	1.0000	0.1769	0.8231	0.176889	
	1909.8	30.0	2.5	0.0	32.5		1.778	889	1.0000	0.1769	0.8231	0.176889	
W-CDMA FDD Band 2 (RMS-Value)	1852.4	23.0	2.5	0.0	25.5	100%	0.355	355	1.0000	0.0706	0.9294	0.070588	0.0705879
	1880.0	23.0	2.5	0.0	25.5		0.355	355	1.0000	0.0706	0.9294	0.070588	
	1907.6	23.0	2.5	0.0	25.5		0.355	355	1.0000	0.0706	0.9294	0.070588	
LTE Band 2 (QPSK, #1RB, RMS-Value)	1850.7	23.0	2.5	0.0	25.5	100%	0.355	355	1.0000	0.0706	0.9294	0.070588	0.0705879
	1880.0	23.0	2.5	0.0	25.5		0.355	355	1.0000	0.0706	0.9294	0.070588	
	1909.3	23.0	2.5	0.0	25.5		0.355	355	1.0000	0.0706	0.9294	0.070588	
LTE Band 2 (16QAM, #1RB, RMS-Value)	1850.7	23.0	2.5	0.0	25.5	100%	0.355	355	1.0000	0.0706	0.9294	0.070588	0.0705879
	1880.0	23.0	2.5	0.0	25.5		0.355	355	1.0000	0.0706	0.9294	0.070588	
	1909.3	23.0	2.5	0.0	25.5		0.355	355	1.0000	0.0706	0.9294	0.070588	

Maximum calculated MPE value:		
Lowest MPE-Limit in frequency-band:	1.0000	[mW/cm ²]
Highest MPE value in frequency-band:	0.1769	[mW/cm ²]
Margin to limit in frequency-band:	0.8231	[mW/cm ²]

4.6.3.2. MPE results ISED-Regulations

Operating Mode	Frequency on channel (MHz)	Declared maximum conducted output power (dBm)	Antenna Gain (dBi)	Path Loss module to ext. antenna connector according manufacturer (dB)	Maximum delivered antenna power: (dBm)	Duty-Cycle	Maximum delivered power to Antenna: (W)	Maximum delivered power to Antenna incl. Duty-Cycle: (W)	MPE Limit accord. Table 4 (W/m ^2)	MPE-Value (W/m ^2)	Margin (W/m ^2)	Fraction for Co-location calculations	Maximum Fraction Value within Frequency band
GSM/GPRS (PK-Burst value)	1850.2	30.0	2.50	0.00	32.50	50%	1.7783	0.8891	4.4766	1.7689	2.7078	0.39513673	0.3951367
	1880.0	30.0	2.50	0.00	32.50		1.7783	0.8891	4.5258	1.7689	2.7569	0.39084555	
	1909.8	30.0	2.50	0.00	32.50		1.7783	0.8891	4.5747	1.7689	2.8058	0.38666737	
EDGE (PK-Burst value)	1850.2	30.0	2.50	0.00	32.50	50%	1.7783	0.8891	4.4766	1.7689	2.7078	0.39513673	
	1880.0	30.0	2.50	0.00	32.50		1.7783	0.8891	4.5258	1.7689	2.7569	0.39084555	
	1909.8	30.0	2.50	0.00	32.50		1.7783	0.8891	4.5747	1.7689	2.8058	0.38666737	
W-CDMA FDD Band 2 (RMS-Value)	1852.4	30.0	2.50	0.00	32.50	100%	1.7783	1.7783	4.4803	3.5378	0.9425	0.78963193	0.7896319
	1880.0	30.0	2.50	0.00	32.50		1.7783	1.7783	4.5258	3.5378	0.9880	0.78169111	
	1907.6	30.0	2.50	0.00	32.50		1.7783	1.7783	4.5711	3.5378	1.0333	0.77394414	
LTE Band 2 (QPSK, #1RB, RMS-Value)	1850.7	30.0	2.50	0.00	32.50	100%	1.7783	1.7783	4.4775	3.5378	0.9397	0.79012755	0.7901276
	1880.0	30.0	2.50	0.00	32.50		1.7783	1.7783	4.5258	3.5378	0.9880	0.78169111	
	1909.3	30.0	2.50	0.00	32.50		1.7783	1.7783	4.5739	3.5378	1.0361	0.77347314	
LTE Band 2 (16QAM, #1RB, RMS-Value)	1850.7	30.0	2.50	0.00	32.50	100%	1.7783	1.7783	4.4775	3.5378	0.9397	0.79012755	
	1880.0	30.0	2.50	0.00	32.50		1.7783	1.7783	4.5258	3.5378	0.9880	0.78169111	
	1909.3	30.0	2.50	0.00	32.50		1.7783	1.7783	4.5739	3.5378	1.0361	0.77347314	

Maximum calculated MPE value:		
Lowest MPE-Limit within frequency-band:	4.4766	[W/m ^2]
Highest MPE value within frequency-band:	3.5378	[W/m ^2]
Lowest margin to limit within frequency-band:	0.9397	[W/m ^2]

4.6.4. Results for operational band: WLAN 2.4GHz

4.6.4.1. MPE results FCC-Regulations

Operation Mode	Frequency on channel (MHz)	Declared maximum conducted output power (dBm)	Antenna Gain (dBi)	Declared maximum ERP (Measured+ Tune-up) (dBm)	Duty cycle (%)	Declared Maximum conducted output power (W)	Equivalent conducted output power (output power x duty cycle) (mW)	MPE Limit accord. Table 1 (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	18.0	3.3	21.3	100%	0.1340	134.0	1.0000	0.0267	0.9733	0.026652	0.0266520
	2437.0	18.0	3.3	21.3		0.1340	134.0	1.0000	0.0267	0.9733	0.026652	
	2462.0	18.0	3.3	21.3		0.1340	134.0	1.0000	0.0267	0.9733	0.026652	

Maximum calculated MPE value:		
Lowest MPE-Limit:	1.0000	[mW/cm ²]
Highest MPE value:	0.0267	[mW/cm ²]
Lowest Margin to limit:	0.9733	[mW/cm ²]

4.6.4.2. MPE results ISSED-Regulations

Operation Mode	Frequency on channel (MHz)	Declared measured conducted output power (dBm)	Antenna Gain (dBi)	Calculated maximum ERP (declared+ Tune-up+ antenna Gain+ path loss) (dBm)	Duty-Cycle	Maximum ERP (W)	Equivalent ERP (ERP x duty cycle) (W)	MPE Limit accord. Table 4 (W/m ²)	MPE-Value (W/m ²)	Margin (W/m ²)	Fraction for Co-location calculations	Maximum Fraction-Value within Frequency band
W-LAN 2.4GHz (20MHz BW)	2412.0	18.00	3.27	21.27	100%	0.1340	0.134	5.3660	0.2665	5.0995	0.04967	0.04967
	2437.0	18.00	3.27	21.27	100%	0.1340	0.134	5.4040	0.2665	5.1374	0.04932	
	2462.0	18.00	3.27	21.27	100%	0.1340	0.134	5.4418	0.2665	5.1753	0.04898	

Maximum calculated MPE value:		
2.4GHz Band		
Lowest MPE-Limit:	5.3660	[W/m ²]
Highest MPE value:	0.2665	[W/m ²]
Lowest margin to limit	5.0995	[W/m ²]

4.6.5. Co-location assessment (scenario)

Following table shows calculations with Wireless LAN technology active in the device.

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 interactions between the transmitting RF-antennas due small physical distance between 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.

4.6.5.1. MPE results FCC-Regulations

		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
Ratio of MPE-Value/Limit		0.185250248	0.036951417	0.037027587	0.043222436	0.070587881	0.070587881	0.176888724	0.070587881	0.070587881
W-LAN 2.4GHz	0.026652021	0.211902269	0.063603438	0.063679608	0.069874457	0.0972399	0.097239902	0.203540745	0.097239902	0.097239902
Maximum-Value		0.211902269								

4.6.5.2. MPE results ISCED-Regulations

		GSM/ G-PRS/ E-GPRS Band-850	W-CDMA Band 5	LTE- Band 5	LTE Band 17	FDD Band 4	LTE Band 4	GSM/GPRS/ E-GPRS Band 1900	W-CDMA Band 2	LTE Band 2
Ratio of MPE- Value/Limit		0.395137242	0.078883612	0.078994702	0.087803412	0.166245095	0.166357978	0.395136735	0.789631933	0.790127553
W-LAN 2.4GHz	0.049668151	0.44480539	0.12855176	0.128662853	0.137471563	0.215913246	0.21602613	0.44480489	0.83930008	0.8397957
Maximum- Value		0.8397957								

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

4.7. 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	5.0 dB							Magnetic field E-field Substitution
		30 MHz - 1 GHz	4.2 dB							
		1 GHz - 20 GHz	3.17 dB							

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 Measur.	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 Measur.	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

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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
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)

7.0.2. 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	-	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	-	30.04.2017
392	Radio Communication Tester	MT8820A	6K00000788	Anritsu	12 M	-	18.05.2018
405	Thermo-/Hygrometer	OPUS 10 THI	126.0604.0003.3.3.3.2	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
443	CTC-FAR-EMI-RSE	System CTC-FAR-EMI-RSE	-	ETS-Lindgren / CETECOM	12 M	5	30.09.2017
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	
487	System CTC NSA-Verification SAR-EMI	System EMI field (SAR) NSA	-	ETS Lindgren / CETECOM	24 M	-	30.09.2017
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	
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
549	Log.Per-Antenna	HL025	1000060	Rohde & Schwarz	36/12 M	-	31.07.2018
558	System CTC FAR S-VSWR	System CTC FAR S-VSWR	-	CTC	24 M	-	30.09.2017
574	Biconilog Hybrid Antenna	BTA-L	980026L	Frankonia	36/12 M	-	31.03.2019
584	Spectrum Analyzer	FSU 8	100248	Rohde & Schwarz	pre-m	-	
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	201.0999.9302.6.4.1.4 3	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
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
697	Power Splitter	ZN4PD-642W-S+	165001445	Mini-Circuits	-	2	
701	CMW500 wide. Radio Comm.	CMW500	158150	Rohde & Schwarz	12 M	-	01.05.2017
703	INNCO Antennen Mast	MA 4010-KT080-XPET-ZSS3	MA4170-KT100-XPET-	INNCO	pre-m	-	
704	INNCON Controller	CO 3000-4port	CO3000/933/3841051 6/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

Ref.-No.	Equipment	Type	Serial-No.	Manufacturer	Interval of calibration	Remark	Cal due
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 Physics	-	-	
749	Pickett-potter Horn Antenna	FH-PP 60-90	010003	Radiometer Physics	-	-	
750	Pickett-Potter Horn Antenna	FH-PP 140-220	010011	Radiometer Physics	-	-	

7.0.3. 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

8. Test report version

Version	Applied changes	Date of release
--	Initial release	2017-08-03
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