TEST REPORT
No.: 6-0010-11-1-2b-C1

According to:
FCC Regulations
Part 15C, §15.231(e), §15.207
Part15B, §15.107 class B, §15.109 class B

IC-Regulations
RSS-Gen, Issue 3
RSS-210, Issue 8

I+ME ACTIA GmbH

Integrated Radio Access Module (IRAM) IME 4203401

Laboratory Accreditation and Listings			
DAkkS Deutsche Akkreditierungsstelle D-PL-12047-01-01	Reg. No.: 736496 MRA US-EU 0003	Industry Canada Reg. No.: 3462D-1 Reg. No.: 3462D-2 Reg. No.: 3462D-3	Voluntary Controls for Electromagnetic Emissions Reg. No.: R-2665, R-2666 C-2914, T-1967, G-301
Wi Fi ALLIANCE AUTHORIZED RF LABORATORY	CTIA Authorized Test Lab LAB CODE 20011130-00		
accredited according to DIN EN ISO/IEC 17025			

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Table of contents

Table of annex

	Total pages
Annex 1: Measurement diagrams	32
Annex 2: External EUT photographs	4
Annex 3: Set-up photographs	7
Annex 4: Internal EUT photographs	5
Annex 5: Timing diagrams	to be supplied by applicant

The listed attachments are an integral part of this report.

1. Summary of test results

The presented device integrates a multiband transmitter on 315/434MHz band for low-range data communication. We refer to applicants technical documentation for further information about the involved technology.

Following test cases have been performed to show compliance with Part 15.231 of the FCC CFR 47 Rules, Edition 1st October 2011 and IC RSS-210 Issue 8/RSS-Gen Issue 3 standards.

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.

1.1. Tests overview FCC and Canada IC Standards (RSS)

TEST CASES	PORT	REFERENCES & LIMITS			EUT set-up	EUT operating mode	Result
		FCC Standard	RSS Section	TEST LIMIT			
TX-Mode							
Field strength of fundamental	Cabinet + Inter-connecting cables (radiated)	§15.231(e) §15.35	RSS-210, Issue8: A1.1	FCC: §15.231(e) IC: Table B	1	1+2	Passed
20dB bandwidth	Antenna terminal (conducted)	§15.231(c)	RSS-210 Issue 8: A1.1.3 (a) RSS-Gen Issue 3: Chapter 4.6.3	0.25% of the centre frequency	4	1+2	Passed
99% occupied bandwidth	Antenna terminal (conducted)	--	RSS-210, Issue 8: A1.1.3	No wider than 0.25% of the centre frequency	4	1+2	Passed
Transmitter frequency stability	Antenna terminal (conducted)	--	RSS-Gen, Issue 3, Chapter 4.7	Operation within designated operational band	4	1+2	Passed
Limiting of operation	Antenna terminal	§15.231(e)	RSS-210, Issue 8: A1.1.5 (2)	Duration of transmission max 1sec silent period 30times the transmission time but not less than 10seconds	--	--	Not performed by test lab -> applicant will provide diagrams
General field strength emissions + restricted bands	Cabinet + Inter-connecting cables (radiated)	§15.231(e) §15.33 §15.35	RSS-210, Issue8: A1.1	FCC: §15.231(e) IC: Table B	1+3	1+2	Passed
AC-Power Lines Conducted Emissions	AC-Power lines	§15.207	RSS-Gen, Issue 3: Chapter 7.2.4, Table 4	FCC: §15.207 IC: Table 4, Chapter 7.2.4	4	1+2	Passed

RX Mode							
AC-Power Lines Conducted Emissions	AC-Power lines	§15.107	RSS-Gen, Issue 3: Chapter 7.2.4, Table 4	§15.107 class B limits IC: Table 4, Chapter 7.2.4	4	3+4	Passed
RECEIVER Radiated emissions	Cabinet + Inter-connecting cables (radiated)	§15.109 §15.33 §15.35	RSS-Gen, Issue 3: Chapter 6.1	FCC 15.109 class B limits IC-limits: Table 1, Chapter 6	1+2	3+4	Passed

Remark: due to customer request no EUT photographs should be inside of this test report.

The current version of the test report TR6-0010-11-1-2b-C1 dated 2012-07-05, replaces test report TR6-0010-11-1-2b dated 2012-04-26. The replaced test report is herewith invalid.

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.

W. Richter

Dipl.-Ing. W. Richter
Responsible for test section

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

2. Administrative Data

2.1. Identification of the testing laboratory

Company name:	CETECOM GmbH
Address:	Im Teelbruch 116 45219 Essen - Kettwig Germany
Responsible for testing laboratory:	Dipl.-Ing. W. Richter
Deputy:	Dipl.-Ing. J. Schmitt

2.2. Test location

2.2.1. Test laboratory "CTC"

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

2.3. Organizational items

Responsible for test report and project leader:	Dipl.-Ing. C. Lorenz
Receipt of EUT:	2011-12-01
Date(s) of test:	2012-01-03 to 2012-06-27
Date of report:	2012-07-05

Version of template: 12.04	

2.4. Applicant's details

Applicant's name:	I+ME ACTIA GmbH
Address:	Dresdenstrasse 17/18 38124 Braunschweig Germany
Contact person:	Mr. Kai Dorau/Mr. Jürgen Thiele

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 description of main EUT

Main function		Integrated Radio Access Module (IRAM)		
Type		IME 4203401 (weather covered version)		
Frequency range (US/Canada -bands)		315.0 MHz 434.64 MHz		
Type of modulation		FSK		
Number of channels (USA/Canada -bands)		1		
Antenna Type		☐ Integrated ☐ External, no RF- connector ☒ External, separate RF-connector		
Antenna Gain		Not available		
MAX Field strength (radiated):	315.0 MHz	PK: 80.71 dBµV/m@3m distance AV: 65.79 (value calculated over duty-cycle correction factor)		
	434.64 MHz	PK: 90.4 dBµV/m@3m distance AV: 71.4 (value calculated over duty-cycle correction factor)		
FCC-ID		XB7IRAM		
IC		7474A-IRAM		
Installed options		☒ 868.6MHz transmitter (not usable in USA/Canada)		
Power supply		☒ 48 V DC nominal voltage (over PoE adapter as accessory)		
Special EMI components		--		
EUT sample type		☐ Production	☒ Pre-Production	☐ Engineering

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

Short descrip-tion*)	EUT	Type	S/N serial number	HW hardware status	SW software status
EUT A	Integrated Radio Access Module (IRAM)	IME 4203401	192.168.1.45	IR12403	*hdlctestV1.0* *certtest V1.0* *modulated_cw V1.1* (Remark1)
EUT B	Weather cover protection	for IRAM	--	--	--

*) EUT short description is used to simplify the identification of the EUT in this test report.
Remark 1.) a special firmware version and test program script was used for establishing a RF-connection

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

AE short descrip-tion *)	Auxiliary Equipment	Type	S/N serial number	HW hardware status	SW software status
AE 1	PoE -Adapter	PHIHONG PSA16U-480	#1	Input: 100-240 AC Output: 48V DC	--
AE 2	PoE Adapter	DIGITUS PSE151	#1	Input: 100-240V AC Output: 48V (16W)	--
AE 3	Notebook	Dell D610	CTC PC#3	--	Windows XP
AE 4	AC/DC Adapter for AE 3	PA12 Family	--	--	--
AE 5	Ethernet RJ45 cable	CAT5e	shielded	3m long	--
AE 6	Ethernet RJ45 cable	CAT5e	shielded	10m long	--

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

3.4. EUT set-ups

EUT set-up no.*)	Combination of EUT and AE	Remarks
Set. 1	EUT A + EUT B +AE 1 + AE 3 + AE 4 + AE 5	PoE-Adapter type 1 used. PoE-Adapter and Notebook placed inside the anechoic chamber
Set. 2	EUT A + EUT B + AE 2 + AE 3 + AE4 + AE 5	PoE-Adapter Type 2 used. PoE-Adapter and Notebook placed inside the anechoic chamber
Set. 3	EUT A + EUT B + AE 1 + (AE3 + AE4 + AE6)	PoE and notebook placed outside the anechoic chamber
Set. 4	EUT A + EUT B + AE 2 + AE 3 + AE4 + AE 6	PoE-Adapter Type 2 used.

*) 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

Cable number	Item	Type	S/N serial number	HW hardware status	Cable length
Cable 1	Ethernet cable	CAT5e	-	-	10m

3.6. EUT operating modes

EUT operating mode no.*)	Description of operating modes	Additional information
op. 1	TX 315MHz	A TX (traffic) connection was established. Port 1 and/or 2 chosen for transmitting with help of special program HDLCTEST.SH or MODULATED_CW.SH. continuous mode activated. Transmit power software setting: -18
op. 2	TX 434.64MHz	A TX (traffic) connection was established. Port 3 and/or 4 chosen for transmitting with help of special program HDLCTEST.SH or MODULATED_CW.SH. continuous mode activated. Transmit power software setting: -9
op. 3	RX mode 315MHz	Receive mode established with help of special program HDLCTEST.SH
op. 4	RX mode 434.64MHz	Receive mode established with help of special program HDLCTEST.SH

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

3.7. Parameter settings on EUT

For testing purposes a special software is running on the device for establishing the required operating mode.

Due to many configurable parameters compliance and all test results as presented within this test report are guaranteed for following parameters only.

The applicant was informed about the need to implement these settings on the final software version.

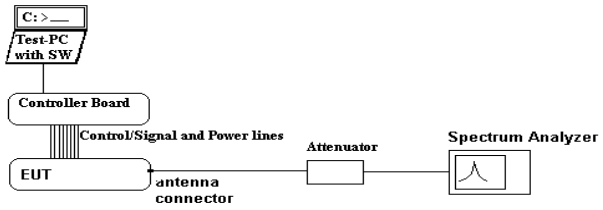
Following settings apply during the measurements:

Software Parameter	Setting chosen	Remarks
Power Setting 315 MHz Band	-18	Software setting
Power Setting 434 MHz Band	-9	Software setting
Data rate 315MHz band	5000kBits/s, 19200kBit/s	Software setting
Data rate 434MHz band	8000kBits/s, 19200kBit/s	Software setting
Length of data transmission during one burst (Duty-Cycle)	Not exceeding a total transmission time of 17.94ms for 315MHz band and 11.21ms for 434MHz band	Within 100ms transmission time, a duty-cycle is applying. Therefore also provisions as stated in §15.35(c) apply. Therefore a correction factor is used for correcting the Peak field strength value to required AVERAGE value.
Antenna Port 315MHz Mode	Port 1 & 2	For radiated spurious emission tests, worst-case port (maximum power) was used.
Antenna Port 434MHz Mode	Port 3 & 4	For radiated spurious emission tests, worst-case port (maximum power) was used.

4. DESCRIPTION OF TEST SET-UP's

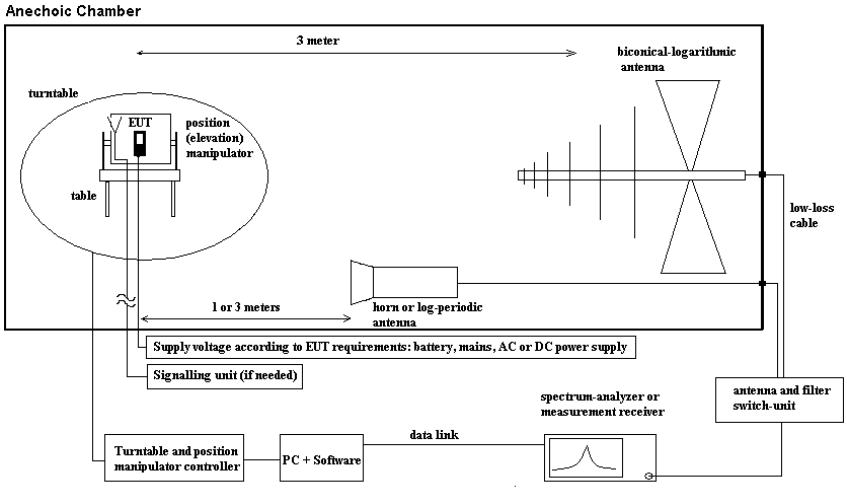
4.1. Test Set-up for conducted measurements

EUT's RF-signal is first attenuated before it is feed to the spectrum analyzer. Customers RF-adapters are used in case of no suitable RF-Adapters are mounted on the EUT. The specific attenuation losses for the RF-signal path is determined within a path-loss calibration and the measurement readings corrected therefore.



Schematic: Test set-up for conducted for RF-tests

4.2. Test set-up for radiated measurements



Schematic: radiated measurements test set-up

MEASUREMENT METHOD in the range 30 MHz to 1 GHz
An EMI receiver together with a broadband antenna was used in order to identify the emissions from the EUT by positioning the antenna close to the EUT surfaces. The interconnecting cables and equipment position were varied in order to maximize the emissions. Then most critical frequencies are recorded for further investigations. Based on the exploratory measurements, the most critical frequencies are re-measured by maintaining the EUT's operating mode, cable position, etc. The EUT was placed on a non-conductive support of 0.8m height. By rotating the turntable angle in the range 0 to 360 degree, the EUT itself either over 3-orthogonal axis (not defined usage position) or 2-orthogonal axis (defined usage position) and the measurement antenna height from 1 meter to 4 meters, the maximized emissions are recorded. The measurements are performed for both polarizations of the measuring antenna: horizontal and vertical.

MEASUREMENT METHOD in the range 1 GHz to 26.5 GHz or 40 GHz):
The EUT and accessories are placed on a non-conducting tipping table of 0.8m height (semi-anechoic chamber) or 1.55m height (fully-anechoic chamber) which is situated in the middle of the turntable. The turntable can rotate the device under test 360 degree, the tipping table can rotate the device from laid to standing position. This way the device under test can be rotated in all three orthogonal planes in order to maximize the detected emissions. The turn- and tipping table are controlled by a controller unit. All positions manipulations are software controlled from a operator PC.
The measurements are performed for both receiving antenna polarisations: vertical and horizontal.

Up to 18 GHz a measurement distance of 3 meters is used, above 18 GHz the distance is 1 meter. A logarithmic-periodic antenna for frequencies above 1 GHz up to 26.5 GHz is used. For frequencies above 26.5 GHz a horn antenna is used, pls. compare the equipment list for more details.

The EUT is powered by an PoE adapter driven with nominal voltage of 110V/60Hz.

5. Measurements

5.1. General Limit - Conducted emissions on AC-Power lines

5.1.1. 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	
test site	☐ 333 EMI field	☒ 348 EMI cond.				
receiver	☐ 001 ESS	☒ 377 ESCS 30	☒ 489 ESU 40	☐ 620 ESU 26		
LISN	☒ 005 ESH2-Z5	☐ 007 ESH3-Z6	☒ 300 ESH3-Z5 & 50Ω used for AE		☐ no LISN for AE	
signaling	☐ 392 MT8820A	☐ 436 CMU	☐ 547 CMU			
line voltage	☐ 230 V 50 Hz via public mains		☒060 110 V 60 Hz via PAS 5000			

5.1.2. Standards and Limits:

Part15B: §15.107 Class B & Part15C: §15.207, RSS-Gen, ANSI C63.4:2009 for RX-Mode, ANSI C63.10: 2009 for TX

Frequency [MHz]	☒ Conducted limit Class B accord. §15.107 ☒ Conducted limit accord. §15.207		☐ Conducted limit Class A	
	QUASI-Peak [dBµV]	AVERAGE [dBµV]	QUASI-Peak [dBµV]	AVERAGE [dBµV]
0.15 – 0.5	66 to 56*	56 to 46*	79	66
0.5 – 5	56	46	73	60
5 – 30	60	50	73	60
Remark: * decreases with the logarithm of the frequency				

5.1.3.Test condition and measurement procedures test set-up

link to test system (if used):	☐ air link	☐ cable connection	☐
EUT-grounding	☒ none	☐ with power supply	☐ additional connection
Equipment set up	☒ table top (40 cm distance to reference ground plane (wall)		☐ floor standing EUT stands isolated on reference ground plane (floor)
Climatic conditions	Temperature: (22±3°C)		Rel. humidity: (40±20)%
EMI-Receiver (Analyzer) Settings	Please see diagram		

Devices which can be connected to the public AC-power network, should be tested against the radio frequency voltage conducted back into the AC-power line in the frequency range 150kHz to 30 MHz. Compliance should be tested by measuring the radio frequency voltage between each power line and ground at the power terminals in the stated frequency range.
A 50Ohm/50µH line impedance stabilization network (LISN) is used therefore. The EUT power input leads are connected through the LISN to the AC-power source. The LISN enclosure is electrically connected to the GND-plane. The measuring instrument is connected to the coaxial output of the LISN.
Tabletop devices were set-up on a 80 cm height over reference ground plane, floor standing equipment 10 cm raised above ground plane.
Measurements have been performed on each phase line and neutral line of the devices AC-power lines. The EUT was power supplied with 110 V/60Hz.
The EUT was tested in the defined operating mode and installed (connected) to accessory equipment according the general description of use given by the applicant.
Preliminary testing as a first step, determines the worst-case phase line (neutral or phase) as well as the most critical amplitude by changing the operating mode. A complete frequency-sweep is performed with PK-Detector.

Final testing for power phases and critical frequencies (Margin to AV- or QP limit lower than 3dB) as a second step includes measurements either on discrete frequency components with receivers detector set to Quasi-Peak and Average per frequency component or a complete frequency sweep with corresponding detector.

5.1.4. MEASUREMENT RESULTS

EUT Type and S/N or EUT set-up no.		EUT set-up 4				
Diagram No.	EUT operating mode no. or commend	Used Detector	Power line	Limit Class	Additional (scan-) information	Result
1.02	EUT operating mode 2	☒ Peak ☒ AV ☒ QP	L1/ N	☐ A ☒ B	Pre-measurement on L1 and N with Peak-Detector in maxhold mode. (please see diagram) The final measurement was carried out with QP and CAV Detector.	passed
1.03	EUT operating mode 1	☒ Peak ☒ AV ☒ QP	L1/ N	☐ A ☒ B	Pre-measurement on L1 and N with Peak-Detector in maxhold mode. (please see diagram) The final measurement was carried out with QP and CAV Detector.	passed
1.04	EUT operating mode 3/4	☒ Peak ☒ AV ☒ QP	L1/ N	☐ A ☒ B	Pre-measurement on L1 and N with Peak-Detector in maxhold mode. (please see diagram) The final measurement was carried out with QP and CAV Detector.	passed

Remarks:
For more information please see diagrams enclosed in the annex to this Report.
Positive margin means passed result.

Margin to Limit for verdict: $M = L_T - R_R + C_{Loss}$

Abbreviations used:
- R_R : Receiver readings in dBµV
- C_{Loss}: cable loss
- L_T : Limit in dBµV

VERDICT

Summary of measurement results for conducted emissions on AC-Power lines: Passed

5.2. Field strength of fundamental accord. §15.231(e)

5.2.1. 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	
test site	☒ 441 EMI SAR	☐ 487 SAR NSA				
receiver	☒ 377 ESCS30	☒ 001 ESS	☒ 489 ESU 40	☒ 620 ESU 26		
spectr. analys.	☐ 584 FSU	☐ 120 FSEM	☐ 264 FSEK			
antenna	☐ 574 BTA-L	☐ 133 EMCO3115	☐ 302 BBHA9170	☐ 289 CBL 6141	☐ 030 HFH-Z2	☐ 477 GPS
signaling	☐ 392 MT8820A	☐ 436 CMU	☐ 547 CMU			
otherwise	☐ 400 FTC40x15E	☐ 401 FTC40x15E	☐ 110 USB LWL	☒ 482 Filter Matrix		
DC power	☐ 456 EA 3013A	☐ 457 EA 3013A	☐ 459 EA 2032-50	☐ 268 EA- 3050	☐ 494 AG6632A	☐ 498 NGPE
line voltage	☐ 230 V 50 Hz via public mains		☒ 060 110 V 60 Hz via PAS 5000			

5.2.2. STANDARDS AND LIMITS: FCC §15.231(e), RSS-210, ISSUE 8, ANSI C63.10:2009

Fundamental frequency (MHz)	Field strength of fundamental (microvolts/meter)
40.66–40.70	1,000
70–130	500
130–174	500 to 1,500[1]
174–260	1,500
260–470	1,500 to 5,000[1]
Above 470	5,000

[1]Linear interpolations.

5.2.3. TEST CONDITION AND MEASUREMENT TEST SET-UP

link to test system (if used):	☐ air link	☐ cable connection	☐
EUT-grounding	☒ none	☐ with power supply	☐ additional connection
Equipment set up	☒ table top 0.8m height		☐ floor standing
Climatic conditions	Temperature: (22±3°C)		Rel. humidity: (40±20)%
EMI-Receiver (Analyzer) Settings	Span/Range: 30 MHz to 1 GHz RBW/VBW: 120 kHz / (auto)		

5.2.4. GENERAL MEASUREMENT PROCEDURES:

The measurement test set-up and test procedure are in accordance with the provisions described in ANSI63.10:2009

The ***Equipment under Test*** (EUT) set-up to defined operating mode and installed (connected) to accessory equipment according the general description of use given by the applicant.

The EUT was put to continuous transmit mode, un-modulated carrier.

The determined software power level for maximum TX-Power level should not be exceeded in the applications in order to be compliant with the limits as stated in the regulations.

5.2.5. RESULTS FOR 315MHz MODE

Set-up No.	1
Operating Mode	1
TX-Port activated	1 and 2
SW TX Power Level	-18

Diagram no.	**Port activated**	Frequency (MHz)	Max level PK (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Antenna height (cm)	Polarity	Turntable position (deg)	Elevation	Corr.(dB) (C_F)	Margin (dB) (M)	Limit (dBµV/m) (L_T)
2.29	1	314.96	77.45[1.)]	10	120	1..4m	V/H	0..360°	0°	--	--	87.66 PK
2.27	2	314.96	80.71[1.)]						0°	--	-	67.66 AV

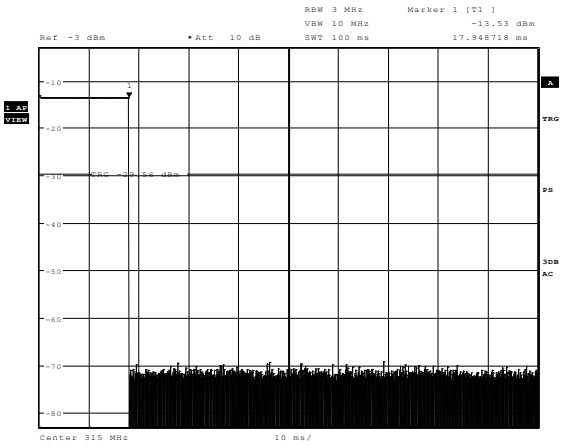
Remark:
1.) as an average limit is specified, a duty-cycle correction factor as shown below will apply for determining the field strength average value

5.2.6. DUTY-CYCLE CORRECTION FACTORS

Due to burst sending and average limit, provisions of §15.35(c) apply.

As the burst-transmitting time depends from the data rate/ data length transmitted the maximum data length allowed for minimum necessary PK-AV correction is determined and calculated. The applicant was informed not to exceed this maximum transmitting time in later software application.

5.2.6.0.1. Duty-Cycle correction factor for Data rate 5000kBit/s

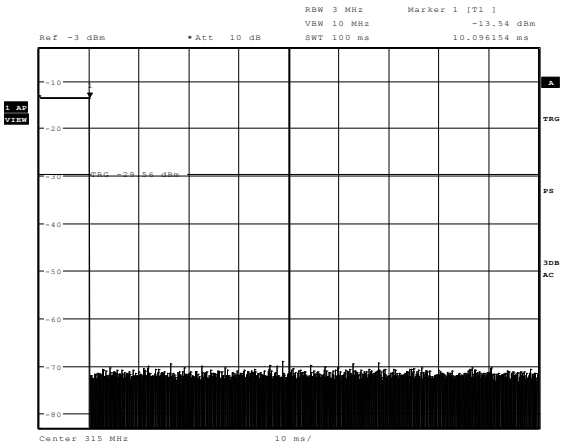


Date: 25.APR.2012 10:47:09

With Data-Length = 4 following burst time could be measured.
TX,on-time=17.94ms within 100ms period -> one burst only

Duty-Cycle correction factor=20*log(17.94ms/100ms) = -14.92 dB

5.2.6.0.2. Duty-Cycle correction factor for Data rate 19200kBit/s



Date: 25.APR.2012 10:42:15

With Data-Length = 17 following burst time could be measured.
TX,on-time=10.09ms within 100ms period -> one burst only

Duty-Cycle correction factor=20*log(10.09ms/100ms) = -19.92dB

RESULTING AVERAGE VALUE: 80.71 dBuV-14.92dB (minimum correction factor) = 65.79 dBuV/m@3m with maximum data length parameter=4 for a data rate of 5000 kbit/s

Limit at 315MHz: 67.66 dBuV/m (AVERAGE VALUE)

5.2.7. RESULTS FOR 434MHz MODE

Set-up No.	1
Operating Mode	2
TX-Port activated	3 and 4
SW TX Power Level	-9

Diagram no.	**Port activated**	Frequency (MHz)	Max level PK (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Antenna height (cm)	Polarity	Turntable position (deg)	Elevation	Corr.(dB) (C_F)	Margin (dB) (M)	Limit (dBµV/m) (L_T)
2.10	3	434.63	90.40[1.)]	10	120	1..4m	V/H	0..360°	90°	--	--	92.89 PK
2.12	4	434.62	90.22[1.)]						90°	--	--	72.89 AV

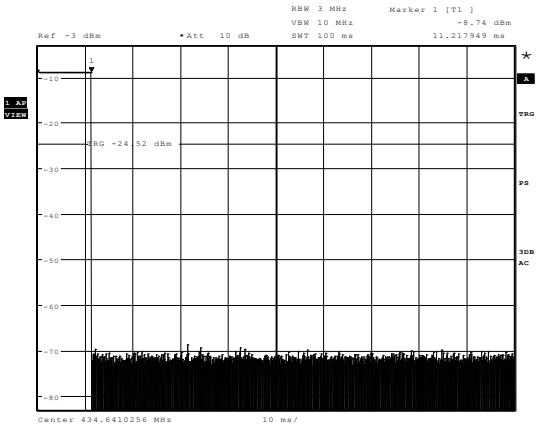
Remark:
1.) as an average limit is specified, a duty-cycle correction factor as shown below will apply for determining the field strength average value

5.2.8. DUTY-CYCLE CORRECTION FACTORS

Due to burst sending and average limit, provisions of §15.35(c) apply.

As the burst-transmitting time depends from the data rate/ data length transmitted the maximum data length allowed for minimum necessary PK-AV correction is determined and calculated. The applicant was informed not to exceed this maximum transmitting time in later software application.

5.2.8.0.1. Duty-Cycle correction factor for Data rate 8000kBit/s

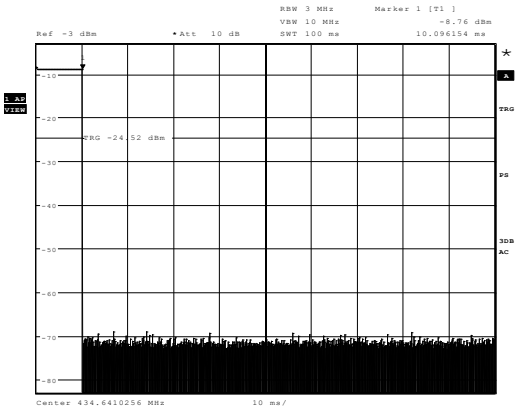


Date: 25.APR.2012 10:23:45

With Data-Length = 4 following burst time could be measured.
TX,on-time=11.21ms within 100ms period -> one burst only

Duty-Cycle correction
factor=20*log(11.21ms/100ms) = -19.0 dB

5.2.8.0.2. Duty-Cycle correction factor for Data rate 19200kBit/s



Date: 25.APR.2012 10:26:34

With Data-Length = 17 following burst time could be measured.
TX,on-time=10.09ms within 100ms period -> one burst only

Duty-Cycle correction
factor=20*log(10.09ms/100ms)= -19.92 dB

RESULTING AVERAGE VALUE: 90.40 dBuV-19.0dB (minimum correction factor) = 71.4 dBuV/m@3m with maximum data length parameter=4 for a data rate of 8000kbit/s

Limit at 434.64MHz: 72.89 dBuV/m (AVERAGE VALUE)

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

5.3.1. 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	
test site	☒ 441 EMI SAR	☐ 487 SAR NSA	☐ 347 Radio.lab.		☐	☐
receiver	☐ 377 ESCS30	☒ 001 ESS	☐	☐	☐	☐
spectr. analys.	☐ 584 FSU	☐ 120 FSEM	☐ 264 FSEK	☐	☐	☐
antenna	☐ 574 BTA-L	☐ 133 EMCO3115	☐ 302 BBHA9170	☐ 289 CBL 6141	☒ 030 HFH-Z2	☐ 477 GPS
signaling	☐ 392 MT8820A	☐ 436 CMU	☐ 547 CMU			
otherwise	☐ 400 FTC40x15E	☐ 401 FTC40x15E	☐ 110 USB LWL	☐ 482 Filter Matrix	☐ 378 RadiSense	
DC power	☐ 456 EA 3013A	☐ 457 EA 3013A	☐ 459 EA 2032-50	☐ 268 EA- 3050	☐ 494 AG6632A	☐ 498 NGPE 40
line voltage	☐ 230 V 50 Hz via public mains		☒060 110 V 60 Hz via PAS 5000			

5.3.2. STANDARDS AND LIMITS: CFR 47, §15.205, §15.209, RSS-Gen, ANSI C63.10:2009

Frequency [MHz]	Field strength [µV/m]	Field strength [dBuV/m]	Measurement distance [meters]	Remarks
0.009 – 0.490	2400/f (kHz)	67.6 – 20Log(f) (kHz)	300	Correction factor used due to measurement distance of 3m
0.490 – 1.705	24000/f (kHz)	87.6 – 20 Log(f) (kHz)	30	Correction factor used due to measurement distance of 3m
1.705 – 30	30	29.54	30	Correction factor used due to measurement distance of 3m
Remark: * decreases with the logarithm of the frequency				

5.3.3. TEST CONDITION AND MEASUREMENT TEST SET-UP

link to test system (if used):	☐ air link	☐ cable connection	☐
EUT-grounding	☒ none	☐ with power supply	☐ additional connection
Equipment set up	☒ table top		☐ floor standing
Climatic conditions	Temperature: (22±3°C)		Rel. humidity: (40±20)%
EMI-Receiver (Analyzer) Settings	Span/Range: 9kHz to 150kHz; 150 kHz to 30 MHz RBW/VBW: 200Hz/auto; 10 kHz/ auto (ANSI63.10/CISPR#16) Detector/ Mode: PEAK, TRACE max-hold mode, repetitive scan for exploratory measurements Quasi-Peak, for final measurement on critical frequencies (f<1GHz)		

5.3.4. GENERAL MEASUREMENT PROCEDURES:

The measurement test set-up and test procedure are in accordance with the provisions described in ANSI 63.10: 2009

The **Equipment under Test** (EUT) was set-up to defined operating mode and installed (connected) to accessory equipment according the general description of use given by the applicant.

The measurement loop antenna was situated in 3m distance to the EUT. Between EUT and measurement antenna absorbers are covering the GND-Plane. With these absorbers the chamber fulfills CIPR16-1-4 site VSWR-criteria. Radiated magnetic emission measurements were made with the antenna situated in 1 meter height. The loop antenna was moved at least to 2-perpendicular axes (antenna vector in direction of EUT and parallel to EUT) in order to maximize the emissions, the EUT itself either over 3-orthogonal axes (no defined usage position) or 2-orthogonal axis (defined usage position) by the position manipulator.

According the standard the compliance should be checked in 30m and 300m measurement distance. Therefore a additional extrapolation factor was used in order to normalize the measurement data. The frequency dependent extrapolation factor used for this reduced measurement distance, can be found on the end of this chapter.

5.3.5. MEASUREMENT RESULTS

Set-up No.		1								
Operating Mode		2								
Diagram no.	Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Antenna height (cm)	Polarity	Turntable position (deg)	Corr. (dB) (C_F)	Margin (dB) (M)	Limit (dBµV/m) (L_T)
3.01	0.009 to 0.150	<-57.0	10.0	0.2	100	--	0..360°	300 to 3m	>20	See diagram
	0.150 to 0.5	<-55.0		10				300 to 3m	>20	
	17.57 18.94 23.43	21.39 26.61 20.95		10				300 to 3m 30 to 3m	8.1 2.9 8.6	

Remark: EUT vertical

Set-up No.		1								
Operating Mode		2								
Diagram no.	Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Antenna height (cm)	Polarity	Turntable position (deg)	Corr. (dB) (C_F)	Margin (dB) (M)	Limit (dBµV/m) (L_T)
3.02	0.009 to 0.150	<-57.0	10.0	0.2	100	--	0..360°	300 to 3m	>20	See diagram
	0.150 to 0.5	<-60.0		10				300 to 3m	>20	
	8.99 17.40 18.96 22.87	17.91 20.49 22.29 15.15		10				300 to 3m 30 to 3m	11.6 9.0 7.2 14.4	

Remark: EUT horizontal

Set-up No.		1								
Operating Mode		1								
Diagram no.	Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Antenna height (cm)	Polarity	Turntable position (deg)	Corr. (dB) (C_F)	Margin (dB) (M)	Limit (dBµV/m) (L_T)
3.03	0.009 to 0.150	<-57.0	10.0	0.2	100	--	0..360°	300 to 3m	>20	See diagram
	0.150 to 0.5	<-60.0		10				300 to 3m	>20	
	17.59 18.96 22.88	18.77 22.53 21.21		10				300 to 3m 30 to 3m	10.80 7.0 8.3	

Remark: EUT vertical

Margin to Limit:

$$M = L_T - R_R + C_F + D_F$$
$$= L_T - R_R + \left(AF_{ANTENNA} + Cable_{LOSS}\right) + D_F$$

Remark: positive margin means passed result

Abbreviations used:

- R_R : Receiver readings in dBµV/m
- C_F: Transducer in dB = AF (antenna factor) + CL (cable loss)
- D_F : distance correction factor (if different measurement distance used than specified in the standard
- L_T : Limit in dBµV/m

VERDICT: Summary of measurement results for radiated frequencies below 30 MHz - Passed

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

The used correction factors when the measurement distance is reduced, are taken from IEEC Transaction EMC, Vol 47, No.3, Aug. 2005, Journal Paper *"EXTRAPOLATING NEAR-FIELD EMISSIONS OF LOW-FREQUENCY LOOP TRANSMITTERS"*.

Used Transducer factors (f < 30 MHz)					
1	2	3	4	5	6
					=2+3+4+5
Frequency	Antenna factor	Corection factor		Cable loss	Transducer factor
		300m to 3m	30m to 3m		
kHz	dB µV/m	dB	dB	dB	dB µV/m
9,0	20,0	-116,7		0,0	-96,7
10,6	20,0	-116,7		0,0	-96,7
12,6	20,0	-116,7		0,0	-96,7
14,8	20,0	-116,7		0,0	-96,7
17,5	20,0	-116,6		0,0	-96,6
20,7	20,0	-116,6		0,0	-96,6
24,4	20,0	-116,6		0,0	-96,6
28,9	20,0	-116,6		0,0	-96,6
34,1	20,0	-116,5		0,0	-96,5
40,3	20,0	-116,4		0,0	-96,4
47,6	20,0	-116,3		0,0	-96,3
56,2	20,0	-116,2		0,0	-96,2
66,4	20,0	-116,0		0,0	-96,0
78,4	20,0	-115,8		0,0	-95,8
92,7	20,0	-115,4		0,0	-95,4
109,4	20,0	-115,0		0,0	-95,0
129,3	20,0	-114,5		0,0	-94,5
152,7	20,0	-113,9		0,0	-93,9
180,4	20,0	-113,1		0,0	-93,1
213,1	20,0	-112,2		0,0	-92,2
251,7	20,0	-111,3		0,0	-91,3
297,3	20,0	-108,3		0,0	-88,3
351,2	20,0	-105,2		0,0	-85,2
414,8	20,0	-102,1		0,0	-82,1
490,0	20,0	-99,1		0,0	-79,1
490,0	20,0		-56,4	0,1	-36,3
582,0	20,0		-56,2	0,1	-36,1
690,0	20,0		-56,0	0,2	-35,8
820,0	20,0		-55,7	0,2	-35,5
973,0	20,0		-55,4	0,2	-35,2
1.155,0	20,0		-54,9	0,3	-34,6
1.371,0	20,0		-54,4	0,3	-34,1
1.627,0	20,0		-53,7	0,3	-33,4
1.931,0	20,0		-52,9	0,4	-32,5
2.292,0	20,0		-52,0	0,4	-31,6
2.721,0	20,0		-49,8	0,5	-29,3
3.230,0	20,0		-46,6	0,5	-26,1
3.834,0	20,0		-43,3	0,6	-22,7
4.551,0	20,0		-40,1	0,6	-19,5
5.402,0	20,0		-36,8	0,7	-16,1
6.412,0	20,0		-33,5	0,7	-12,8
7.612,0	20,0		-30,3	0,8	-9,5
9.035,0	20,0		-27,0	0,8	-6,2
10.725,0	20,0		-23,9	0,9	-3,0
12.730,0	20,0		-21,2	0,9	-0,3
15.111,0	20,0		-19,3	1,0	1,7
17.937,0	20,0		-18,4	1,0	2,6
21.292,0	20,0		-18,2	1,1	2,9
25.274,0	20,0		-18,3	1,1	2,8
30.000,0	20,0		-18,4	1,2	2,8

5.4. General Limit - Radiated field strength emissions, 30 MHz - 1 GHz

5.4.1. 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	
test site	☒ 441 EMI SAR	☐ 487 SAR NSA				
receiver	☒ 377 ESCS30	☒ 001 ESS	☒ 489 ESU 40	☒ 620 ESU 26		
spectr. analys.	☐ 584 FSU	☐ 120 FSEM	☐ 264 FSEK			
antenna	☐ 574 BTA-L	☐ 133 EMCO3115	☐ 302 BBHA9170	☐ 289 CBL 6141	☐ 030 HFH-Z2	☐ 477 GPS
signaling	☐ 392 MT8820A	☐ 436 CMU	☐ 547 CMU			
otherwise	☐ 400 FTC40x15E	☐ 401 FTC40x15E	☐ 110 USB LWL	☒ 482 Filter Matrix		
DC power	☐ 456 EA 3013A	☐ 457 EA 3013A	☐ 459 EA 2032-50	☐ 268 EA- 3050	☐ 494 AG6632A	☐ 498 NGPE
line voltage	☐ 230 V 50 Hz via public mains		☒ 060 110 V 60 Hz via PAS 5000			

5.4.2. STANDARDS AND LIMITS: CFR 47, §15.231(e), §15.109, RSS-GEN, ISSUE 3 RSS-210, ISSUE 8, ANSI C63.10:2009, ANSI 63.4:2009

For TX-Mode:

Fundamental frequency (MHz)	Field strength of spurious emission (microvolts/meter)	
	[microvolts/meter]	[dBµV/m]
40.66–40.70	100	40.0
70–130	50	34.0
130–174	50 to 150[1]	34.0 to 43.52
174–260	150	43.52
260–470	150 to 500[1]	43.52 to 54.0
Above 470	500	54.0

[1]Linear interpolations.

For RX-Mode

Frequency [MHz]	☒ Radiated emission limits, Class B, 3 meters		☐ Radiated emission limits, Class A, 10 meters	
	QUASI-Peak [microvolts/meter]	QUASI-Peak [dBµV/m]	QUASI-Peak [microvolts/meter]	QUASI-Peak [dBµV/m]
30-88	100	40.0	90	39.0
88-216	150	43.5	150	43.5
216-960	200	46.0	210	46.4
above 960	500	54.0	300	59.5

5.4.3. TEST CONDITION AND MEASUREMENT TEST SET-UP

link to test system (if used):	☐ air link	☐ cable connection	☐
EUT-grounding	☒ none	☐ with power supply	☐ additional connection
Equipment set up	☒ table top 0.8m height		☐ floor standing
Climatic conditions	Temperature: (22±3°C)		Rel. humidity: (40±20)%
EMI-Receiver (Analyzer) Settings	Span/Range: 30 MHz to 1 GHz RBW/VBW: 120 kHz / (auto)		

5.4.4. RESTRICTED BANDS OF OPERATION, §15.205

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.20725-4.20775	37.5-38.25	1645.5-1646.5	9.3-9.5
6.215-6.218	73-74.6	1660-1710	10.6-12.7
6.26775-6.26825	74.8-75.2	1718.8-1722.2	13.25-13.4
6.31175-6.31225	108-121.94	2200-2300	14.47-14.5
8.291-8.294	123-138	2310-2390	15.35-16.2
8.362-8.366	149.9-150.05	2483.5-2500	17.7-21.4
8.37625-8.38675	156.52475-156.52525	2690-2900	22.01-23.12
8.41425-8.41475	156.7-156.9	3260-3267	23.6-24.0
12.29-12.293	162.0125-167.17	3332-3339	31.2-31.8
12.51975-12.52025	167.72-173.2	3345.8-3358	36.43-36.5
12.57675-12.57725	240-285	3600-4400	--
13.36-13.41	322-335.4	--	--

Remark: only spurious emissions are allowed within these frequency bands not exceeding the limits per §15.209

5.4.5. GENERAL MEASUREMENT PROCEDURES:

The measurement test set-up and test procedure are in accordance with the provisions described in ANSI 63.4: 2009 for RX-Mode of the device or ANSI63.10:2009 for TX-mode of the device.

The ***Equipment under Test*** (EUT) set-up to defined operating mode and installed (connected) to accessory equipment according the general description of use given by the applicant.

5.4.6. MEASUREMENT RESULTS RADIATED EMISSIONS FOR TX-MODE 315 MHz

All necessary accessories like AE2 and AE3 were placed **outside** the anechoic-chamber. Emission limits according Part 15.231(e) are more critical compared to FCC Part 15.109, class B emission limits. Pre-Tests have shown broadband emissions from PoE and notebook exceeding the lower §15.231(e) limits. However they comply with Part15.109, class B limits.

Set-up No.		3									
Operating Mode		1									
TX-Port activated		2									
SW TX Power Level		-15									
Diagram no.	Frequency (MHz)	Max level AV (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Antenna height (cm)	Polarity	Turntable position (deg)	Elevation	Corr.(dB) (C_F)	Margin (dB) (M)	Limit (dBµV/m) (L_T)
2.17	314.97[1.)]	--	--	--	--	--	--	--	--	--	--[1.)]
	365.51[2.)]	39.5	100.0	120.0	100.0	H	98.0	90.0	16.4	9.30	48.80

Remark: 1.) TX-carrier on diagram, not relevant for results
2.) Notebook PC-Bus clock frequency

Set-up No.		1									
Operating Mode		1									
TX-Port activated		2									
SW TX Power Level		-15									
Diagram no.	Frequency (MHz)	Max level AV (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Antenna height (cm)	Polarity	Turntable position (deg)	Elevation	Corr.(dB) (C_F)	Margin (dB) (M)	Limit (dBµV/m) (L_T)
2.17b	32.41	25.3	100.0	120.0	161.0	H	149.0	90.0	20.7	14.70	40.00
	96.22	12.2	100.0	120.0	138.0	V	246.0	0.0	8.2	21.80	34.00
	106.64	18.9	100.0	120.0	100.0	V	208.0	90.0	8.3	15.10	34.00
	115.64	17.7	100.0	120.0	100.0	V	216.0	90.0	8.2	16.30	34.00

Remark: --

5.4.7. MEASUREMENT RESULTS RADIATED EMISSIONS TX-MODE 434.64 MHz

All necessary accessories like AE2 and AE3 were placed **outside** the anechoic-chamber. Emission limits according Part 15.231(e) are more critical compared to FCC Part 15.109, class B emission limits. Pre-Tests have shown broadband emissions from PoE and notebook exceeding the lower §15.231(e) limits. However they comply with Part15.109, class B limits.

Set-up No.	3
Operating Mode	2
TX-Port activated	3
SW TX Power Level	-9

Diagram no.	Frequency (MHz)	Max level AV (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Antenna height (cm)	Polarity	Turntable position (deg)	Elevation	Corr.(dB) (C_F)	Margin (dB) (M)	Limit (dBµV/m) (L_T)
8.214 b	30.690	26.6	100.0	120.0	144.0	H	2.0	0.0	21.5	13.40	40.00
	107.450	18.9	100.0	120.0	100.0	V	225.0	90.0	8.4	15.10	34.00
	115.880	21.4	100.0	120.0	100.0	V	222.0	90.0	8.2	12.60	34.00
	230.720	24.3	100.0	120.0	111.0	H	227.0	90.0	12.7	19.20	43.50

Remark: 1.) TX-carrier on diagram, not relevant for results

5.4.8. MEASUREMENT RESULTS RX-MODE 434.64MHz

All necessary accessories like AE1/2 and AE3/4 were placed inside the anechoic-chamber due to defined compliance with radiated measurements according FCC Part 15.109, Class B.

Set-up No.	1
Operating Mode	4

Diagram no.	Frequency (MHz)	Max level QP or PK (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Antenna height (cm)	Polarity	Turntable position (deg)	Elevation	Corr.(dB) (C_F)	Margin (dB) (M)	Limit (dBµV/m) (L_T)
2.215	48.47	31.7	1000.0	120.0	144.0	V	156.0	0.0	13.7	8.3	40.0
	66.85	30.3	1000.0	120.0	100.0	V	152.0	90.0	7.0	9.7	40.0
	94.40	28.7	1000.0	120.0	100.0	V	284.0	0.0	8.3	14.8	43.5
	104.77	30.8	1000.0	120.0	119.0	V	264.0	90.0	8.3	12.7	43.5
	205.94	16.6	1000.0	120.0	100.0	V	176.0	90.0	11.7	26.9	43.5
	567.16	23.9	1000.0	120.0	120.0	V	172.0	90.0	21.6	22.1	46.0
	898.060	31.3	1000.0	120.0	100.0	V	32.0	0.0	26.4	14.7	46.0

Remark: Port 3 (default)

Set-up No.	2										
Operating Mode	4										
Diagram no.	Frequency (MHz)	Max level QP or PK (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Antenna height (cm)	Polarity	Turntable position (deg)	Elevation	Corr.(dB) (C_F)	Margin (dB) (M)	Limit (dBµV/m) (L_T)
2.04	30.22	31.2	1000.0	120.00	182.0	H	156.0	90°	21.7	8.8	40.0
	69.78	27.6	1000.0	120.00	178.0	V	244.0		6.8	12.4	40.0
	93.56	32.6	1000.0	120.00	100.0	V	229.0		8.2	10.9	43.5
	98.45	36.4	1000.0	120.00	100.0	V	130.0		8.2	7.1	43.5
	228.01	41.1	1000.0	120.00	100.0	H	36.0		12.6	4.9	46.0
	366.33	42.4	1000.0	120.00	100.0	H	321.0		16.4	3.6	46.0
	929.43	29.8	1000.0	120.00	224.0	H	208.0		26.5	16.2	46.0

Remark: Port 3 (default), EUT standing
Accessories placed inside anechoic chamber

Set-up No.	2										
Operating Mode	4										
Diagram no.	Frequency (MHz)	Max level QP or PK (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Antenna height (cm)	Polarity	Turntable position (deg)	Elevation	Corr.(dB) (C_F)	Margin (dB) (M)	Limit (dBµV/m) (L_T)
2.05	35.10	29.9	1000.0	120.0	182.0	H	150.0	0°	19.4	10.1	40.0
	52.52	29.1	1000.0	120.0	100.0	V	94.0		12.1	10.9	40.0
	98.43	38.0	1000.0	120.0	100.0	V	104.0		8.2	5.5	43.5
	109.36	29.7	1000.0	120.0	100.0	V	168.0		8.4	13.8	43.5
	123.10	24.7	1000.0	120.0	214.0	V	351.0		8.2	18.8	43.5
	132.79	30.0	1000.0	120.0	100.0	V	243.0		9.6	13.5	43.5
	137.88	29.1	1000.0	120.0	120.0	V	0.0		9.3	14.4	43.5

Remark: Port 3 (default), EUT laying
Accessories placed inside anechoic chamber

5.4.9. MEASUREMENT RESULTS RX-MODE 315 MHz

All necessary accessories like AE1/2 and AE3/4 were placed inside the anechoic-chamber due to defined compliance with radiated measurements according FCC Part 15.109, Class B.

Set-up No.		1									
Operating Mode		3									
Diagram no.	Frequency (MHz)	Max level QP or PK (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Antenna height (cm)	Polarity	Turntable position (deg)	Elevation	Corr.(dB) (C_F)	Margin (dB) (M)	Limit (dBµV/m) (L_T)
2.19	60.22	32.3	1000.0	120.00	186.0	V	8.0	0.0	8.8	7.7	40.0
	104.73	37.1	1000.0	120.00	129.0	V	279.0	0.0	8.3	6.4	43.5
	185.17	24.7	1000.0	120.00	100.0	H	120.0	90.0	11.3	18.8	43.5
	250.01	39.0	1000.0	120.00	100.0	H	99.0	0.0	13.3	7.0	46.0

Remark: Port 2 activated
Accessories placed inside anechoic chamber

Margin to Limit:

$$M = L_T - R_R + C_F + D_F$$
$$= L_T - R_R + \left(AF_{ANTENNA} + Cable_{LOSS}\right) + D_F$$

Remark: positive margin means passed result

Abbreviations used:

- R_R : Receiver readings in dBµV/m
- CF: Transducer in dB = AF (antenna factor) + CL (cable loss)
- D_F : distance correction factor (if different measurement distance used than specified in the standard
- L_T : Limit in dBµV/m

5.4.10. VERDICT

Summary of measurement results for radiated emissions above 30 MHz and below 1 GHz : Passed

5.5. General Limit - Radiated emissions, above 1GHz

5.5.1. TEST LOCATION AND EQUIPMENT (for reference numbers please see chapter 'List of test equipment')

test site	☐ 441 EMI SAR	☐ 348 EMI cond.	☒ 443 EMI FAR	☐ 347 Radio.lab.	☐ 337 OATS	☐
equipment	☐ 331 HC 4055	☐	☐	☐	☐	☐
spectr. analys.	☐ 584 FSU	☐ 120 FSEM	☐ 264 FSEK	☒ 489 ESU	☐ 620 ESU 26	☐
antenna meas	☐ 574 BTA-L	☐ 289 CBL 6141	☒ 608 HL 562	☒ 549 HL025	☐ 302 BBHA9170	☐ 477 GPS
antenna meas	☐ 123 HUF-Z2	☐ 132 HUF-Z3	☐ 030 HFH-Z2	☐	☐	☐
antenna subst	☐ 071 HUF-Z2	☐ 020 EMCO3115	☐ 063 LP 3146	☐ 303 BBHA9170	☐	☐
power meter	☐ 009 NRV	☐ 010 URV5-Z2	☐ 011 URV5-Z2	☐	☐	☐
signalgener.	☐ 008 SMG	☐ 140 SMHU	☐ 263 SMP04	☐	☐	☐
power meter	☐ 262 NRV-S	☐ 266 NRV-Z31	☐ 265 NRV-Z33	☐ 261 NRV-Z55	☐ 356 NRV-Z1	☐
multimeter	☐ 341 Fluke 112	☐	☐	☐	☐	☐
signaling	☐ 392 MT8820A	☐ 436 CMU	☐ 547 CMU			
DCpower	☐ 086 LNG50-10	☐ 087 EA3013	☐ 354 NGPE 40	☐ 349 car battery	☐ 350 Car battery	☒ 611 E3632A
line voltage	☐ 230 V 50 Hz via public mains		☒060 110 V 60 Hz via PAS 5000			

5.5.2. STANDARDS AND LIMITS (CLASS B): CFR 47, §15.109, §15.209, RSS-Gen, Issue 3, RSS-210, ISSUE 8, ANSI C63.4:2009, ANSI C63.10:2009

Frequency [MHz]	Radiated emission limits Class B, 3 meters measurement distance			
	☒ 3 meters measurement distance			
	AV [microvolts/meter]	AV [dBµV/m]	Peak [microvolts/meter]	Peak [dBµV/m]
above 1GHz	500	54.0	5000	74.0

5.5.3. TEST CONDITION AND MEASUREMENT TEST SET-UP

link to test system (if used):	☐ air link	☐ cable connection	☐
EUT-grounding	☒ none	☐ with power supply	☐ additional connection
Equipment set up	☒ table top 1.5m height		☐ floor standing
Climatic conditions	Temperature: (22±3°C)		Rel. humidity: (40±20)%
Spectrum-Analyzer settings	Span/Frequency range :	TX 315 MHz Mode: 1..3.2 GHz TX 434MHz Mode: 1..4.4 GHz RX 315/434MHz Mode: 1..2.8 GHz	
	RBW/VBW:	1 MHz / 3 MHz	
	Detector/ Mode:	Peak, MAX-hold, repetitive scan for exploratory measurement PEAK/ AVERAGE, for final measurement for critical frequencies	
	Antenna Polarisation	Horizontal / Vertical	

5.5.4. GENERAL MEASUREMENT PROCEDURES:

The measurement test set-up and test procedure are in accordance with the provisions described in ANSI C63.4: 2009 (RX) oder ANSI C63.10:2009 (TX)

The ***Equipment under Test*** (EUT) was placed on a non-conductive positioning table of 0.8 or 1.5 meter height depending from the frequency range. The measuring distance was set to 3 meter for frequencies up to 18GHz and 1 meter above 18GHz.
The EUT was set-up to defined operating mode and installed (connected) to accessory equipment according the general description of use given by the applicant.

For the upper frequency measurement range, it was assumed that the highest frequency generated in the device is same as the highest operable TX-frequency in each operating mode.

Also for the RX mode the operating frequency was considered being the highest generated frequency within the device.

1. **Step exploratory measurement**: see above description as in the frequency range lower 1GHz.
2. **Step Final Measurement(1 GHz<f <18 GHz)**: On the Worst-Case EUT configuration, frequency components with a margin lower than 6 dB to the limits, will be re-measured by maintaining the EUT's operating mode, cable position, etc.. For find the worst-case emission, the turntable was changed in the range 0 to 360 degree and the EUT itself either over 3-orthogonal axis (not defined usage position) or 2-orthogonal axis (defined usage position). The measurements are performed for both polarizations of the measuring antenna: horizontal and vertical.

5.5.5. MEASUREMENT RESULTS TX-MODE 315 MHz

Set-up No.:		1								
Operating Mode:		1								
TX-Port activated		2								
SW TX Power Level		-15								
Diagram no.	Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Antenna height (cm)	Polarity	Turntable position (deg)	Corr. (dB) (C_F)	Margin (dB) (M)	Limit (dBµV/m) (L_T)
2.21	PK-detector									
	1000-2800	<60.0	10	1000	155	H/V	0..360°	--	>14.0	74.0
	AV-detector									
	1000..2800	<46	10	1000	155	H/V	0..360°	--	>9	54.0
	1.039	39.04	100	1000	155	H	188°	--	15.0	
	1.087	39.49	100	1000	155	V	51°	--	14.5	
	1.319	42.68	100	1000	155	H	84°	--	11.30	
2.22	PK-detector									
	2800.. 18000	<44.43	10	1000	155	H/V	0..360°	--	>29.6	74.0
	AV-detector									
	2800.. 18000	<27.5	10	1000	155	H/V	0..360°	--	>26.5	54.0
	2835	37.79	100	1000	155	H	268°	-1.86	16.2	
	3150	36.71	100	1000	155	V	84°	-1.51	17.29	

Remark:

5.5.6. Measurement Results TX-Mode 434 MHz

Set-up No.:		1								
Operating Mode:		2								
TX-Port activated		3								
SW TX Power Level		-9								
Diagram no.	Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Antenna height (cm)	Polarity	Turntable position (deg)	Corr. (dB) (C_F)	Margin (dB) (M)	Limit (dBµV/m) (L_T)
2.217	PK-detector									
	1000-2800	<60.0	10	1000	155	H/V	0..360°	--	>14.0	74.0
	AV-detector									
	1000..2800	<46	10	1000	155	H/V	0..360°	--	>9	54.0
	1320.1	43.29	100	1000	155	V	26°	--	10.7	
2.218	PK-detector									
	2800..18000	<43.24	10	1000	155	H/V	0..360°	--	>20	74.0
	AV-detector									
	2800..18000	<30	10	1000	155	H/V	0..360°	--	>14.0	54.0
	3477.0	28.14	100	1000	155	V	158°	--	25.86	

Remark:

5.5.7. MEASUREMENT RESULTS RX-MODE 315 MHz

Set-up No.:		1								
Operating Mode:		3								
Diagram no.	Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Antenna height (cm)	Polarity	Turntable position (deg)	Corr. (dB) (C_F)	Margin (dB) (M)	Limit (dBµV/m) (L_T)
2.20	PK-detector									
	1000-2800	<49.77	10	1000	155	H/V	0..360°	--	>20	74.0
	AV-detector									
	1000..2800	<34.0	10	1000	155	H/V	0..360°	--	>20	54.0
	1320.2	35.87	100	1000	155	V	117°	--	18.13	

Remark:

5.5.8. MEASUREMENT RESULTS RX-MODE 434 MHz

Set-up No.:		1								
Operating Mode:		4								
Diagram no.	Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Antenna height (cm)	Polarity	Turntable position (deg)	Corr. (dB) (C_F)	Margin (dB) (M)	Limit (dBµV/m) (L_T)
8.216	PK-detector									
	1000-2800	<50.02	10	1000	155	H/V	0..360°	--	>20	74.0
	AV-detector									
	1000..2800	<32.45	10	1000	155	H/V	0..360°	--	>20	54.0
	1320.2	36.97	100	1000	155	V	0°	--	17.03	

Remark:

Margin to Limit:

$$M = L_T - R_R + C_F + D_F$$
$$= L_T - R_R + \left(AF_{ANTENNA} + Cable_{LOSS}\right) + D_F$$

Remark: positive margin means passed result

Abbreviations used:

- R_R : Receiver readings in dBµV/m
- CF: Transducer in dB = AF (antenna factor) + CL (cable loss)
- D_F : distance correction factor (if different measurement distance used than specified in the standard
- L_T : Limit in dBµV/m

Verdict

Summary of measurement results for radiated emissions above 1 GHz : Passed

5.6. RF-Parameter - 20 dB Bandwidth and 99% occupied bandwidth

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

test site	☐ 441 EMI SAR	☐ 348 EMI cond.	☐ 443 EMI FAR	☒ 347 Radio.lab.	☐ 337 OATS	☐
spectr. analys.	☐ 584 FSU	☐ 120 FSEM	☐ 264 FSEK	☒ 489 ESU	☐	☐
attenuator	☐ 530 10 dB	☐	☐	☐	☐	☐
signaling	☐ 392 MT8820A	☐ 436 CMU	☐ 547 CMU			
DCpower	☐ 463 Power source	☐ 087 EA3013	☐ 354 NGPE 40	☐ 086 LNG50-10	☐	☐
line voltage	☐ 230 V 50 Hz via public mains		☒060 110 V 60 Hz via PAS 5000			

5.6.2.Test condition and measurement test set-up

link to test system (if used):	☐ air link	☒ cable connection	☐
Climatic conditions	Temperature: (22±3°C)		Rel. humidity: (40±20)%

5.6.3. References of occupied and 20dB emission bandwidth

§15.231(C): *the bandwidth of the emissions should be not wider than 0.25% for the centre frequency for device operating above 70MHz and below 900MHz.*

5.6.4. EUT Settings:

The EUT was instructed to send with maximum power (if adjustable) according applicants instructions. Different modulation characteristics have been checked, e.g. data rates which EUT can operate.

5.6.5. Measurement method:

The measurement was performed with the RBW set to 1kHz. The span was set to cover the complete carrier. A DELTA Marker method was set to measure the bandwidth compared to the highest In-Band power. The operating modes have been varied (e.g. data rate, modulation scheme, etc.). If applicable the hopping-mode is switched off.

Also the **99% emission bandwidth** was measured. Two markers are placed on frequency points such that left to lower f-marker and right to higher f-marker only 1% of the TX-power is contained. Between the markers, 99% of the power is laying. The RBW value is readjusted and the measurement repeated until the RBW/EBW ratio is around 1%.

5.6.6. Spectrum-Analyzer SeTTINGS:

Span	Set as to fully display the emissions and at least 20dB below the PEAK level
Resolution Bandwidth (RBW)	Set to approx 1% of the emission width
Video Bandwidth (VBW)	3 times the resolution bandwidth
Sweep time	Coupled and low enough to have no gaps within power envelope
Detector	Sample (if bin width: Span/no. of frequency points SA < 0.5*RBW SA otherwise Peak detector)
Sweep mode	Repetitive Mode, MAX-HOLD

5.6.7. Results:

20dB BANDWIDTH:

Set-up no.: 4	**20dB BANDWIDTH [kHz]**			
T_{NOM} =21°C V_{NOM} = 48V	**Port 1**	**Port 2**	**Port 3**	**Port 4**
Carrier at 315.0 MHz Data rate 5000kBit/s	73.07	73.07	--	--
Carrier at 315.0 MHz Data rate 19200kBit/s	**116.44**	116.34	--	--
Carrier at 434.64 MHz Data rate 8000kBit/s	--	--	64.90	64.42
Carrier at 434.64 MHz Data rate 19200kBit/s	--	--	116.34	**116.82**

Remark: 1.) see diagrams and results for different modulation types(Data rates) in separate document A1
2.) high lined - maximum 20dB bandwidth value

99% OCCUPIED BANDWIDTH:

Set-up no.: 4	**OCCUPIED BANDWIDTH [kHz]**			
T_{NOM} =21°C V_{NOM} = 48V	**Port 1**	**Port 2**	**Port 3**	**Port 4**
Carrier at 315.0 MHz Data rate 5000kBit/s	89.42	88.46	--	--
Carrier at 315.0 MHz Data rate 19200kBit/s	114.42	114.42	--	--
Carrier at 434.64 MHz Data rate 8000kBit/s	--	--	38.46	39.42
Carrier at 434.64 MHz Data rate 19200kBit/s	--	--	114.42	114.42

Remark: 1.) see diagrams and results for different modulation types(Data rates) in separate document A1
2.) maximum occupied bandwidth value

LIMITS FOR 20dB EMISSION BANDWIDTH:

315.0 MHz Operating mode: 787.5 kHz
434.64 MHz Operating Mode: 1086.6 kHz

VERDICT: pass

5.7. RF-Parameter - Frequency stability on temperature and voltage variations

5.7.1. 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	
test site	☐ 441 EMI SAR	☐ 487 SAR NSA	☒ 347 Radio.lab.		☐	☐
receiver	☐ 377 ESCS30	☐ 001 ESS	☒ 489 ESU 40	☐ 620 ESU 26	☐	☐
spectr. analys.	☐ 584 FSU	☐ 120 FSEM	☐ 264 FSEK	☐	☐	☐
antenna	☐ 574 BTA-L	☐ 133 EMCO3115	☐ 302 BBHA9170	☐ 289 CBL 6141	☐ 030 HFH-Z2	☐ 477 GPS
signaling	☐ 392 MT8820A	☐ 436 CMU	☐ 547 CMU			
otherwise	☐ 400 FTC40x15E	☐ 401 FTC40x15E	☐ 110 USB LWL	☐ 482 Filter Matrix	☐ 378 RadiSense	
DC power	☐ 456 EA 3013A	☐ 457 EA 3013A	☐ 459 EA 2032-50	☐ 268 EA- 3050	☐ 494 AG6632A	☐ 498 NGPE 40
Climatic test chamber	☒ 331 HC 4055					
line voltage	☐ 230 V 50 Hz via public mains		☒ 060 110 V 60 Hz via PAS 5000			

5.7.2. STANDARDS AND REFERENCES:

IC: RSS-Gen., Issue 3

5.7.3. TEST CONDITION AND MEASUREMENT TEST SET-UP

link to test system (if used):	☐ air link	☒ cable connection	☐
Climatic conditions	Temperature: (22±3°C)		Rel. humidity: (40±20)%

5.7.4. TEST SET-UP

A conducted measurement test set-up like described in chapter 4.1 was used.

5.7.5. EUT SETTINGS

The EUT was instructed to transmit with maximum allowed power level
An un-modulated carrier was set-up for testing.

5.7.6. TEST METHOD

In accordance with RSS-Gen. Issue 3, §4.7 the frequency stability was measured on temperature and voltage variations.

5.7.7. Frequency shift of carrier against a voltage range at constant nominal temperature of 20° Celsius

1.) determine the carrier frequency room temperature[20°C] and nominal voltage [110V/AC to 48V/DC over PoE converter]. This frequency is set as reference.
2.) The voltage was reduced from nominal voltage by -15%: PoE low voltage range =100V and the frequency shift measured
3.) The voltage was raised from nominal voltage to nominal voltage + 15% and the frequency shift measured

5.7.7.1. MEASUREMENT RESULTS

Set-up 4

Nominal frequency	Port	Measured frequency [MHz]			Frequency drift relative to reference [Hz/ppm]	
		V_{NOM} 110V	V_{MIN} 100V	V_{MAX} 126,5V	V_{MIN} 100V	V_{MAX} 126,5V
315.0 MHz	1	**314.9984901**	314.9984880	314.9985026	-2.1 Hz	12.5 Hz
	2	**314.9964874**	314.9964623	314.9964924	-25.1 Hz	5 Hz
434.64 MHz	3	**434.6358487**	434.6343301	434.6343134	-1518.6Hz / -3.49ppm	-1535.3 Hz/ -3.53ppm
	4	**434.6345556**	434.6346082	434.6345612	52.6Hz	5.6 Hz

Remark: only max. deviation is calculated in ppm unit

5.7.8. Frequency shift of carrier against temperature at constant power supply voltage

1.) determine the carrier frequency f at room temperature[20°C] and nominal voltage [110V/AC to 48V/DC over PoE converter]. This frequency is set as reference.
2.) expose the mobile station to –30°C, wait sufficient time to have constant temperature.
3.) Perform the carrier frequencies measurements for –30°C and +50°C. During the heating time, the device was powered-off. A sufficient time was given between the temperatures.
4.) After powering-on, the measurements were made within 1 minute in order to prevent self-warming of the mobile.

5.7.8.1. Measurement results

Set-up 4

Nominal frequency	Port	Measured frequency [MHz]			Frequency drift relative to reference [Hz/ppm]	
		T_{NOM} 20°C	T_{MIN} -30°C	T_{MAX} 50°C	T_{MIN} -30°C	T_{MAX} 50°C
315.0 MHz	1	**314.9984901**	314.9966000	315.0015306	-1890.1	3040.5 Hz 9.65 ppm
	2	**314.9964874**	314.9960873	314.9990549	-400.1	2567.5 Hz 8.15 ppm
434.64 MHz	3	**434.6358487**	434.6343270	434.6383004	-1521.7	2451.7 Hz 5.64 ppm
	4	**434.6345556**	434.6332585	434.6382119	-1297.1	3656.3 Hz 8.41 ppm

Remark: only max. deviation is calculated in ppm unit

5.8. RF-Parameter – Limiting operation

5.8.1. STANDARDS AND REFERENCES:

FCC: §15.231(e)
IC: RSS-210, Issue 8, A1.1.5

5.8.2. VERDICT

Not measured or judged by CETECOM laboratory

Additional Information: The applicant will supply diagrams showing the operation of maximum 1 second and the silence period of at least 10seconds between the transmissions. This silent period will be programmed in the final application and cannot be measured at moment with the special firmware for continuous transmissions. The final software is not available of the time of writing the test report.

5.9. 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	Frequency range	Calculated uncertainty based on a confidence level of 95%	Remarks:
Power Output conducted	9 kHz .. 20 GHz	1.0 dB	--
Power Output radiated	30 MHz .. 4 GHz	3.17 dB	Substitution method
Conducted emissions on antenna ports	9 kHz .. 20 GHz	1.0 dB	--
Radiated emissions enclosure	150 kHz .. 30 MHz	5.0 dB	Magnetic field
	30 MHz .. 1 GHz	4.2 dB	E-Field
	1 GHz .. 20 GHz	3.17 dB	Substitution method
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
		1.0 dB	Power
Frequency stability	9 kHz .. 20 GHz	0.0636 ppm	--
Conducted emissions on AC-mains port (U_{CISPR})	9 kHz .. 150 kHz	4.0 dB	--
	150 kHz .. 30 MHz	3.6 dB	

Table: measurement uncertainties, valid for conducted/radiated measurements

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	736496	Radiated Measurements 30 MHz to 1 GHz, 3 m / 10 m (OATS)	FCC, Federal Communications Commission Laboratory Division, USA (MRA US-EU 0003)
487		Radiated Measurements 30 MHz to 1 GHz, 3 m (SAR)	
558		Radiated Measurements above 1 GHz, 3 m (FAR)	
348		Mains Ports Conducted Interference Measurements	
348		Telecommunication Ports Conducted Interference Measurem.	
337	3462D-1	Radiated Measurements 30 MHz to 1 GHz, 3 m / 10 m (OATS)	IC, Industry Canada Certification and Engineering Bureau
487	3462D-2	Radiated Measurements 30 MHz to 1 GHz, 3 m (SAR)	
550	3462D-2	Radiated Measurements 1 GHz to 6 GHz, 3 m (SAR)	
558	3462D-3	Radiated Measurements above 1 GHz, 3 m (FAR)	
337	R-2665	Radiated Measurements 30 MHz to 1 GHz, 3 m / 10 m (OATS)	VCCI, Voluntary Control Council for Interference by Information Technology Equipment, Japan
487	R-2666	Radiated Measurements 30 MHz to 1 GHz, 3 m (SAR)	
550	G-301	Radiated Measurements 1 GHz to 6 GHz, 3 m (SAR)	
348	C-2914	Mains Ports Conducted Interference Measurements	
348	T-1967	Telecommunication Ports Conducted Interference Measurem.	
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
264	Spectrum Analyzer	FSEK 30	826939/005	Bios=2.1, Analyzer= 3.20
295	Racal Digital Radio Test Set	6103	1572	UNIT Firmware= 4.04, SW-Main=4.04, SW-BBP=1.04, SW-DSP=1.02, Hardboot=1.02, Softboot=2.02
298	Univ. Radio Communication Tester	CMU 200	832221/091	R&S Test Firmware =3.53 /3.54 (current Testsoftw. f. all band used
323	Digital Radiocommunication Tester	CMD 55	825878/0034	Firm.= 3.52 .22.01.99
331	Climatic Test Chamber -40/+80 Grad	HC 4055	43146	TSI 1.53
335	System-CTC-EMS-Conducted	System EMS Conducted	-	EMC 32 V 8.40
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
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
383	Signal Generator	SME 03	842 828 /034	Firm.= 4.61
389	Digital Multimeter	Keithley 2000	0583926	Firm. = A13 (Mainboard) A02 (Display)
392	Radio Communication Tester	MT8820A	6K00000788	Firm.= 4.50 #005, IPL=4.01#001,OS=4.02#001, GSM=4.41#013, W-CDMA= 4.54#004, scenario=
436	Univ. Radio Communication Tester	CMU 200	103083	R&S Test Firmware Base=5.14, Mess-Software= GSM:5.14 WCDMA:5.14 (current Testsoftw. F. all
441	CTC-SAR-EMI Cable Loss	System EMI field (SAR)	-	EMC 32 Version 8.40
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. 8.40
444	CTC-FAR-EMS field	System-EMS-Field (FAR)	-	EMC 32 Version 8.40
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
594	Univ. Radio Communication Tester	CMW500	101757	Firmware Base=2.0.20.9, LTE=2.0.20.8. CDMA= 2.0.10
597	Univ. Radio Communication Tester	CMU 200	100347	R&S Test Firmware Base=5.01, GSM=5.02 WCDMA= not installed, Mainboard= µP1=V.850
598	Spectrum Analyzer	FSEM 30 (Reserve)	831259/013	Firmware Bios 3.40 , Analyzer 3.40 Sp 2
620	EMI Test Receiver	ESU 26	100362	4.43_SP3

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	-	31.03.2013
005	AC - LISN (50 Ohm/50µH, test site 1)	ESH2-Z5	861741/005	Rohde & Schwarz	24/12 M	-	31.03.2014
007	DC - LISN (50 Ohm/5µH)	ESH3-Z6	892563/002	Rohde & Schwarz	24/12 M	-	31.03.2014
009	Power Meter (EMS-radiated)	NRV	863056/017	Rohde & Schwarz	24 M	-	31.03.2013
016	Line Impedance Simulating Network	Op. 24-D	B6366	Spitzenberger+Spies	36 M	-	31.03.2013
020	Horn Antenna 18 GHz (Subst 1)	3115	9107-3699	EMCO	36/12 M	-	31.03.2013
021	Loop Antenna (H-Field)	6502	9206-2770	EMCO	36 M	-	31.03.2015
030	Loop Antenna (H-field)	HFH-Z2	879604/026	Rohde & Schwarz	36 M	-	31.03.2015
033	RF-current probe (100kHz-30MHz)	ESH2-Z1	879581/18	Rohde & Schwarz	24 M	-	31.03.2013
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	1c	30.06.2012
086	DC - power supply, 0 -10 A	LNG 50-10	-	Heinzinger Electronic	pre-m	2	
087	DC - power supply, 0 -5 A	EA-3013 S	-	Elektro Automatik	pre-m	2	
090	Helmholtz coil: 2x10 coils in series	-	-	RWTÜV	-	4	
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	-	31.03.2015
100	passive voltage probe	Probe TK 9416	without	Schwarzbeck	36 M	-	31.03.2015
110	USB-LWL-Converter	OLS-1	-	Ing. Büro Scheiba	-	4	
119	RT Harmonics Analyzer dig. Flickermeter	B10	G60547	BOCONSULT	36 M	-	31.03.2013
134	horn antenna 18 GHz (Subst 2)	3115	9005-3414	EMCO	12 M	-	31.03.2014
136	adjustable dipole antenna (Dipole 1)	3121C-DB4	9105-0697	EMCO	36 M	-	31.03.2015
140	Signal Generator	SMHU	831314/006	Rohde & Schwarz	24 M	-	31.03.2014
248	attenuator	SMA 6dB 2W	-	Radiall	pre-m	2	
249	attenuator	SMA 10dB 10W	-	Radiall	pre-m	2	
252	attenuator	N 6dB 12W	-	Radiall	pre-m	2	
256	attenuator	SMA 3dB 2W	-	Radiall	pre-m	2	
257	hybrid	4031C	04491	Narda	pre-m	2	
260	hybrid coupler	4032C	11342	Narda	pre-m	2	
261	Thermal Power Sensor	NRV-Z55	825083/0008	Rohde & Schwarz	24 M	-	31.03.2014
262	Power Meter	NRV-S	825770/0010	Rohde & Schwarz	24 M	-	31.03.2014
263	Signal Generator	SMP 04	826190/0007	Rohde & Schwarz	36 M	-	31.03.2013
264	Spectrum Analyzer	FSEK 30	826939/005	Rohde & Schwarz	12 M	-	31.03.2013
265	peak power sensor	NRV-Z33, Model 04	840414/009	Rohde & Schwarz	24 M	-	31.03.2014
266	peak power sensor	NRV-Z31, Model 04	843383/016	Rohde & Schwarz	24 M	-	31.03.2014
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	30.06.2012
291	high pass filter GSM 850/900	WHJ 2200-4EE	14	Wainwright GmbH	12 M	1c	30.06.2012
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	24/12 M	-	31.03.2014
301	attenuator (20 dB) 50W, 18GHz	47-20-33	AW0272	Lucas Weinschel	pre-m	2	
302	horn antenna 40 GHz (Meas 1)	BBHA9170	155	Schwarzbeck	36 M	-	31.03.2014
303	horn antenna 40 GHz (Subst 1)	BBHA9170	156	Schwarzbeck	36 M	-	31.03.2014
331	Climatic Test Chamber -40/+80 Grad	HC 4055	43146	Heraeus Vötsch	24 M	-	30.11.2012
341	Digital Multimeter	Fluke 112	81650455	Fluke	24 M	-	31.03.2014
342	Digital Multimeter	Voltcraft M-4660A	IB 255466	Voltcraft	24 M	-	31.03.2013
347	laboratory site	radio lab.	-	-	-	5	
348	laboratory site	EMI conducted	-	-	-	5	
354	DC - Power Supply 40A	NGPE 40/40	448	Rohde & Schwarz	pre-m	2	
355	Power Meter	URV 5	891310/027	Rohde & Schwarz	24 M	-	31.03.2014
356	power sensor	NRV-Z1	882322/014	Rohde & Schwarz	24 M	-	31.03.2013
357	power sensor	NRV-Z1	861761/002	Rohde & Schwarz	24 M	-	31.03.2013
373	V-Network 5µH/50 Ohm	ESH3-Z6	100535	Rohde & Schwarz	24/12 M	-	31.03.2014
376	Horn Antenna 6 GHz	BBHA9120 E	BBHA 9120 E 179	Schwarzbeck	12 M	-	31.03.2013
377	Emi Test Receiver	ESCS 30	100160	Rohde & Schwarz	12 M	-	31.03.2013
389	Digital Multimeter	Keithley 2000	0583926	Keithley	24 M	-	31.03.2013
392	Radio Communication Tester	MT8820A	6K00000788	Anritsu	12 M	-	31.03.2013
431	Model 7405	Near-Field Probe Set	9305-2457	EMCO	-	4	
436	Univ. Radio Communication Tester	CMU 200	103083	Rohde & Schwarz	12 M	-	31.03.2013
441	CTC-SAR-EMI Cable Loss	System EMI field (SAR) Cable	-	CETECOM	12 M	5	31.10.2012

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	30.06.2012
448	notch filter WCDMA_FDD II	WRCT 1850.0/2170.0-5/40-	5	Wainwright Instruments GmbH	12 M	1c	30.06.2012
449	notch filter WCDMA FDD V	WRCT 824.0/894.0-5/40-8SSK	1	Wainwright	12 M	1c	30.06.2012
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	-	31.03.2013
463	Universal source	HP3245A	2831A03472	Agilent	-	4	
466	Digital Multimeter	Fluke 112	89210157	Fluke USA	24 M	-	31.03.2014
467	Digital Multimeter	Fluke 112	89680306	Fluke USA	24 M	-	31.03.2014
468	Digital Multimeter	Fluke 112	90090455	Fluke USA	24 M	-	31.03.2014
477	ReRadiating GPS-System	AS-47	-	Automotive Cons. Fink	-	3	
480	power meter (Fula)	NRVS	838392/031	Rohde & Schwarz	24 M	-	31.03.2013
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	-	30.07.2012
487	System CTC NSA-Verification SAR-EMI	System EMI field (SAR) NSA	-	ETS Lindgren/CETECOM	24 M	-	30.09.2013
489	Emi Test Receiver	ESU40	1000-30	Rohde & Schwarz	12 M	-	31.03.2013
502	band reject filter	WRCG 1709/1786-1699/1796-	SN 9	Wainwright	pre-m	2	
503	band reject filter	WRCG 824/849-814/859-60/10SS	SN 5	Wainwright	pre-m	2	
512	notch filter GSM 850	WRCA 800/960-02/40-6EEK	SN 24	Wainwrght	12 M	1c	30.06.2012
517	relais switch matrix	HF Relais Box Keithley System	SE 04	Keithley	pre-m	2	
523	Digital Multimeter	L4411A	MY46000154	Agilent	24 M	-	31.03.2013
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	-	31.03.2013
547	Univ. Radio Communication Tester	CMU 200	835390/014	Rohde & Schwarz	12 M	-	31.03.2013
548	Digital-Barometer	GBP 2300	without	Greisinger GmbH	36/12 M	-	31.03.2012
549	Log.Per-Antenna	HL025	1000060	Rohde & Schwarz	36/12 M	-	31.03.2015
552	high pass filter 2,8-18GHz	WHKX 2.8/18G-10SS	4	Wainwright	12 M	1c	30.07.2012
558	System CTC FAR S-VSWR	System CTC FAR S-VSWR	-	CTC	24 M	-	31.07.2013
574	Biconilog Hybrid Antenna	BTA-L	980026L	Frankonia	36/12 M	-	30.03.2013
584	Spectrum Analyzer	FSU 8	100248	Rohde & Schwarz	12 M	-	31.03.2013
594	Univ. Radio Communication Tester	CMW500	101757	Rohde & Schwarz	24 M	-	31.03.2014
597	Univ. Radio Communication Tester	CMU 200	100347	Rohde & Schwarz	12 M	-	31.03.2012
598	Spectrum Analyzer	FSEM 30 (Reserve)	831259/013	Rohde & Schwarz	24 M	-	13.01.2013
600	power meter	NRVD (Reserve)	834501/018	Rohde & Schwarz	24 M	-	31.03.2013
601	medium-sensitivity diode sensor	NRV-Z5 (Reserve)	8435323/003	Rohde & Schwarz	24 M	-	12.01.2013
602	peak power sensor	NRV-Z32 (Reserve)	835080	Rohde & Schwarz	24 M	-	12.01.2013
608	UltraLog-Antenna	HL 562	830547/009	Rohde & Schwarz	36/12 M	-	31.03.2014
611	DC power supply	E3632A	KR 75305854	Agilent	pre-m	2	
612	DC power supply	E3632A	MY 40001321	Agilent	pre-m	2	
613	Attenuator	R416120000 20dB 10W	Lot. 9828	Radiall	pre-m	2	
616	Digitalmultimeter	Fluke 177	88900339	Fluke	24 M	-	31.03.2014
617	Power Splitter/Combiner	ZFSC-2-2-S+	S F987001108	Mini Circuits	-	2	
618	Power Splitter/Combiner	50PD-634	600994	JFW Industries USA	-	2	
619	Power Splitter/Combiner	50PD-634	600995	JFW Industries, USA	-	3	
620	EMI Test Receiver	ESU 26	100362	Rohde-Schwarz	12 M	-	01.01.2013
621	Step Attenuator 0-139 dB	RSP	100017	Rohde & Schwarz	pre-m	2	

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