TEST REPORT
No.: 6-0196-12-1-2a-C1

According to:

FCC Regulations

Part 15.107, Part 15.207,
Part 15.209 & Part15.247

IC-Regulations

RSS-Gen Issue 3
RSS-210 Issue 8

for

Miele & Cie. KG

Communication unit for household appliances EI 8800 /-A
(ZigBee™)

FCC-ID: 2ACUWEI8800
IC: 5669C-EI8800

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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The listed attachments are an integral part of this report.

1. Summary of test results

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

The Equipment Under Test (in this report, hereinafter referred as EUT) supports radiofrequency technology. The presented device integrates a ZigBee wireless transmitter (IEEE802.15.4) at 2.405 to 2.480 GHz frequency operating range.

This test report have been corrected to include certification IDs, especially chapter 8 reflects the situation of the calibrated equipment on the date of the tests.

Following test cases have been performed to show compliance with valid Part 15.207/15.209/15.247 of the FCC CFR 47 Rules, Edition 1st October 2013 and IC RSS-210 Issue 8/ RSS-Gen Issue 3 standards.

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

TEST CASES	PORT	REFERENCES & LIMITS			EUT set-up	EUT operating mode	Result
		FCC Standard	RSS Section	TEST LIMIT			
TX-Mode							
6 dB bandwidth	Antenna terminal (conducted)	§15.247(a)(2)	RSS-210 Issue 8: A8.2 (a) RSS-Gen Issue 3: Chapter 4.6.2	≥ 500 kHz for DTS systems	1	1	passed
99% occupied bandwidth	Antenna terminal (conducted)	--	RSS-Gen Issue 3: Chapter 4.6.1	--	1	1	for information only
Transmitter Peak output power	Antenna terminal (conducted)	§15.247(b)(1)	RSS-210 Issue 8: A8.4 (4)	1 Watt Peak	2	1	passed
Transmitter Peak output power radiated	Cabinet (radiated)	§15.247(b)(4)	RSS-210 Issue 8:A8.4 (4)	< 4 Watt (EIRP) for antenna with directional gain less 6dBi	2	1	passed
Out-Of-Band RF- emissions Band-Edge emissions	Antenna terminal (conducted)	§15.247 (d)	RSS-210 Issue 8: A8.5	20 dBc	2	1	passed
Power spectral density	Antenna terminal (conducted)	§15.247(e)	RSS-210 Issue 8: A8.2 (b)	8dBm in any 3 kHz band	1	1	passed
Transmitter frequency stability	Antenna terminal (conducted)	--	RSS-Gen, Issue 3, Chapter 4.7 and Chapter 7.2.6	Operation within designated operational band	2	2	passed
General field strength emissions + restricted bands	Cabinet + Inter-connecting cables (radiated)	§15.247 (d) §15.205 §15.209	RSS-210 Issue 8, Chapter 2.5 RSS-Gen: Issue 3: §7.2.5 Table 3+5+6	Emissions in restricted bands must meet the general field-strength radiated limits	4	1	passed

AC-Power Lines Conducted Emissions	AC-Power lines	§15.207	RSS-Gen, Issue 3: Chapter 7.2.4, Table 4	FCC §15.107 class B limits §15.207 limits IC: Table 4, Chapter 7.2.4	3	1	passed
RX Mode							
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 2	5	3	passed
AC-Power Lines Conducted Emissions	AC-Power lines	§15.107	RSS-Gen, Issue 3: Chapter 7.2.4, Table 4	FCC §15.107 class B limits §15.207 limits IC: Table 4, Chapter 7.2.4	5	3	passed

Remark: --

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.

The current version of the test report 6-0196-12-1-2a-C1, dated 2014-09-24 replaces the test report 6-0196-12-1-2a, dated 2012-09-29. The replaced test report is declared invalid herewith.

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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. Niels Jeß
Deputy:	Dipl.-Ing. Rachid Acharkaoui

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	Dipl.-Ing. C. Lorenz
Project leader:	Dipl.-Ing. B. Taslica
Receipt of EUT:	April 2012
Date(s) of test:	April 2012 – August 2012 (see diagrams)
Date of report:	2014-09-24
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Version of template: 12.08	

2.4. Applicant's details

Applicant's name:	Miele & Cie. KG
Address:	Carl-Miele-Straße 33332 Gütersloh Germany
Contact person:	Mr. Gunnar Borgelt

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

Main function	Communication unit for household appliances with integrated IEEE 802.15.4 ZigBee technology		
Type	EI 8800 /-A		
Frequency range and channels (US/Canada -bands)	2405 MHz (Channel 11) to 2480 MHz (Channel 26)		
Type of modulation (packet types)	QPSK		
Number of channels (USA/Canada -bands)	1 to 16		
EMISSION DESIGNATOR(S)	2M62G1D		
Antenna Type	☒ Integrated ☐ External, no RF- connector ☐ External, separate RF-connector		
Antenna Gain	2 dBi average according applicants information in 2.4GHz band		
MAX Field strength (radiated):	101.7 dBµV/m@3m distance on nominal 2.440 GHz (PK) 98.1 dBµV/m@3m distance on nominal 2.440 GHz (AV) (measured as electrical field strength with RBW=1MHz)		
MAX PEAK Output Power: (conducted)	2.32 mW on nominal 2440 MHz		
FCC-ID	2ACUWEI8800		
IC	5669C-EI8800		
Installed options (not tested within this test report)	☒ no other technology installed		
Power supply	☒ Range 3.23 V to 3.37 V, nominal U_{art} = 3.3 V DC ☒ over DC		
Special EMI components	--		
EUT sample type	☐ Production	☒ Pre-Production	☐ Engineering
Firmware	☐ for normal use		☒ Special version for test execution
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	Communication unit for household appliances	EI 8800 (unshielded)	# 10/18/23 (Low/Middle/ High channels)	05032012 (TX unit, conducted)	1.0
EUT B	Communication unit for household appliances	EI 8800 (unshielded)	# 18/20/22 (Low/Middle/ High channels)	07052012 (TX unit, conducted)	1.0
EUT C	Communication unit for household appliances	EI 8800-A (shielded)	# 20 (Middle channel)	07052012 (TX unit, radiated)	1.0
EUT D	Communication unit for household appliances	EI 8800-A (shielded)	# 15/8/9 (Low/Middle/ High channels)	07052012 (TX unit, radiated)	1.0
EUT E	Communication unit for household appliances	EI 8800-A (shielded)	# 12 (Middle channel)	07052012 (RX unit)	1.0

*) 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	PCB	8800 DA EPL	--	09052012	--
AE 2	USB to U_{art} dongle	B75937	--	CP2101	--
AE 3	Notebook Dell	Latitude 2120	CTC062011	--	Windows 7

*) 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	Set-up for conducted TX EMI measurements
Set. 2	EUT B	Set-up for conducted TX EMI measurements
Set. 3	EUT C + AE 1	Set-up for radiated TX EMI measurements
Set. 4	EUT D + AE 1	Set-up for radiated TX EMI measurements
Set. 5	EUT E + AE 2+ AE 3	Set-up for conducted RX EMI measurements

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

3.5. EUT operating modes

EUT operating mode no.*)	Description of operating modes	Additional information
op. 1	ZigBee Continuous TX-Mode (modulated)	Preprogrammed Module The transmitter (modulated) is set to certain transmission frequency within the operational range and send a modulated carrier (100% duty cycle factor). The EUT could be set to lowest (2405 MHz), middle (2440 MHz) and highest (2480 MHz) possible working frequencies within the assigned operational band.
op. 2	ZigBee Continuous TX-Mode (unmod.)	Preprogrammed Module The transmitter (unmodulated) is set to certain transmission frequency within the operational range and send a unmodulated carrier (100% duty cycle factor). The EUT could be set to lowest (2405 MHz), middle (2440 MHz) and highest (2480 MHz) possible working frequencies within the assigned operational band.
op. 3	ZigBee RX mode	Preprogrammed Module The EUT E/F is programmed by applicant as receiver mode. The test sample is showing the received packets with a corresponding installed software. Ch 15 Middle (2425 MHz) Outputs Statistics via UART. RX only if PER_TX absent (=Idle)

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

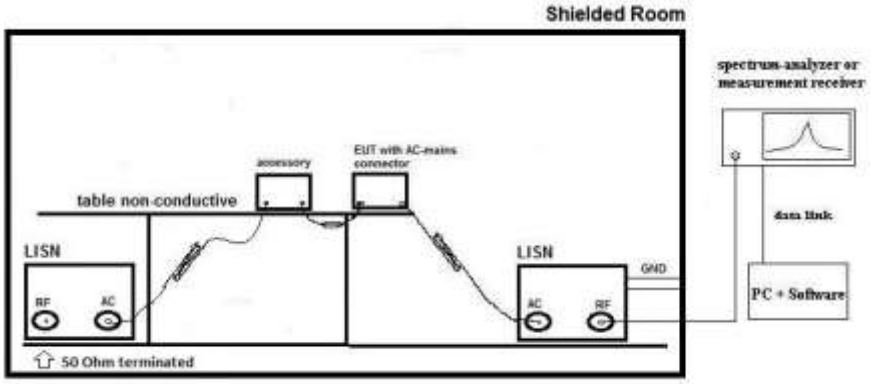
4. Description of test system set-up's

4.1. Test system set-up for AC power-line conducted emission measurements

Specification: ANSI C63.4-2009 chapter 7, ANSI C63.10-2009 chapter 6.2

General Description: The radio frequency voltage conducted back into the AC power line in the frequency range 150 kHz to 30 MHz has to be investigated. 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 50 Ohm / 50 µH line impedance stabilization network (LISN) is used coupling the interface to the measurement equipment. The EUT power input leads are connected through the LISN to the AC-power source. The LISN enclosure is electrically connected to the ground plane. The measuring instrument is connected to the coaxial output of the LISN.
Tabletop devices were set-up on a 80 cm height above 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/60 Hz. 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.

Schematic:



Only schematic view, we refer to figure 6, 7 and 8 of ANSI C63.4-2009 for more details.

Testing method:

Exploratory, preliminary measurements as a first step, determines the worst-case phase line (neutral or phase) as well as the most critical operating mode of the equipment. A complete frequency-sweep with PK-Detector is performed on each current-carrying conductor.

Final testing for power phases and critical frequencies (Margin to AV- or QP limit lower than 3 dB) as a second step includes measurements with receivers detector set to Quasi-Peak and Average.

Formula:

$V_C = V_R + C_1$ (1)
$M = L_T - V_C$ (2)

V_C = measured Voltage –corrected value
V_R = Receiver reading
C_L = Cable loss
M = Margin
L_T = Limit

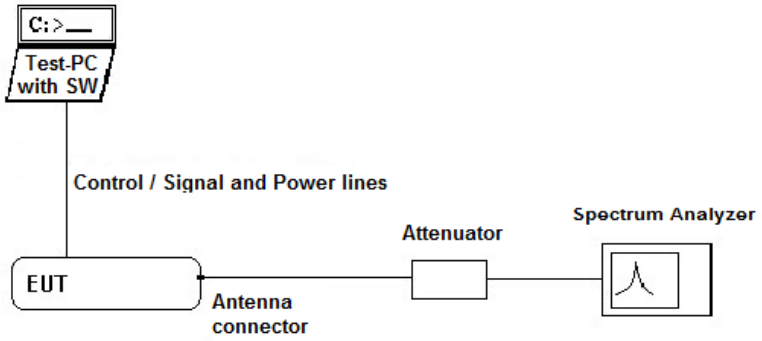
Values are in dB, positive margin means value is below limit.

4.2. Test system set-up for conducted RF-measurement at antenna port

Specification: ANSI C63.10-2009

General Description: The EUT's RF-signal is first attenuated before it is connected to the spectrum – analyzer to avoid overload. The specific attenuation is determined prior to the measurement within a set-up calibration. The value is taken into account by correcting the measurement readings on the spectrum-analyzer either by a transducer factor (TDF) or an relative offset to reference level.

Schematic:



Testing method: According to ANSI C63.10-2009 for each individual test, see details in each chapter.

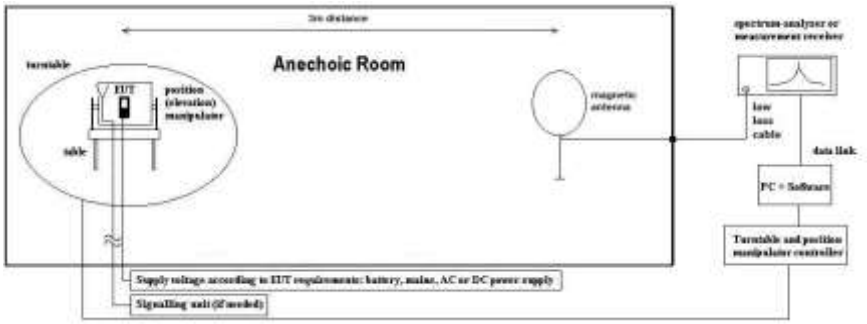
4.3. Test system set-up for radiated magnetic field measurements below 30 MHz

Specification: ANSI C63.4-2009 chapter 8.2.1, ANSI C63.10-2009 chapter 6.4

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

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

Schematic:



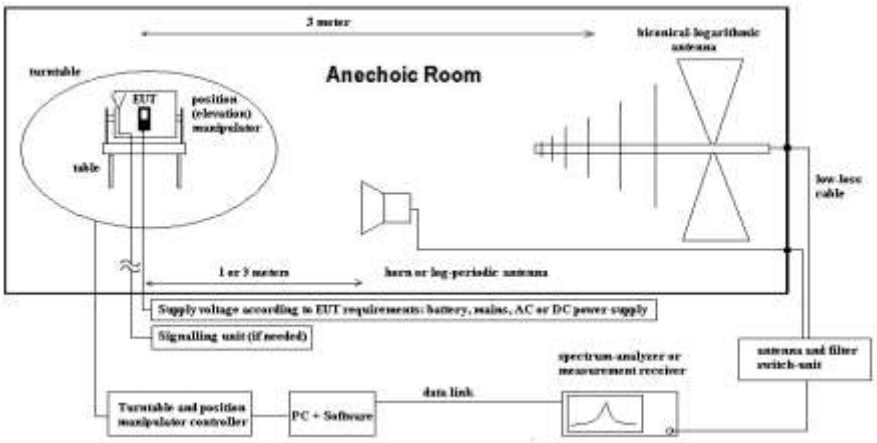
Testing method:	**Exploratory, preliminary measurement** The EUT and it's associated accessories are placed on a non-conductive position manipulator (tipping device) of 0.8 m height which is placed on the turntable. By rotating the turntable (step 90°, range 0°to 360°) and the EUT itself either on 3-orthogonal axis (portable equipment) or 2-orthogonal axis (defined operational position of EUT), the emission spectrum and it's characteristics was recorded with an EMI-receiver, broadband loop antenna and software. The loop antenna was moved at least to 2-perpendicular axes (antenna vector in direction of EUT and parallel to EUT) in order to maximize the emissions. The results are documented in a diagram. Critical frequencies (low margin to limit) are saved within a data reduction table for further investigations. If various operating modes are supported, further investigations are made to find the worst-case of them. Also the interconnection cables and equipment position were varied in order to maximize the emissions.	**Final measurement on critical frequencies** Based on the exploratory measurements, the most critical frequencies are re-measured by maintaining the EUT's worst-case operation mode, cable position, etc. First a frequency zoom around the critical frequency is done to locate the frequency more precisely. After this step, for all identified critical frequencies, the maximum peak was determined. Following parameters were varied: the turntable angle continuously in the range 0 to 360 degree, the EUT itself either over 3-orthogonal axis (not defined usage position) or 2-orthogonal axis (defined usage position). On the determined worst-case position, a final measurement with necessary bandwidth and detector according standard has been carried out.
Formula:	$E_C = E_R + AF + C_L + D_F - G_A$ $M = L_T - E_C$	AF =Antenna factor C_L = Cable loss D_F= Distance correction factor E_C = Electrical field – corrected value E_R = Receiver reading G_A= Gain of pre-amplifier (if used) L_T = Limit M = Margin
	All units are dB-units, positive margin means value is below limit.	
Distance correction:	Reference for applied correction (extrapolating) factors: IEEC Transaction EMC, Vol. 47, No. 3 , Aug. 2005, Journal Paper "*Extrapolating Near-field emissions of low frequency loop transmitters".*	

4.4. Test system set-up for electric field measurement in the range 30 MHz to 1 GHz

Specification: ANSI C63.4-2009 chapter 8, ANSI C63.10-2009 chapter 6.5

General Description: Evaluating the field emissions have to be done first by an exploratory emissions measurement and a final measurement for most critical frequencies. The tests are performed in a NSA-compliant semi anechoic room (SAR) recognized by the regulatory commissions.

Schematic:



Testing method:

Exploratory, preliminary measurements
The EUT and it's associated accessories are placed on a non-conductive position manipulator (tipping device) of 0.8 m height which is placed on the turntable. By rotating the turntable (range 0° to 360°, step 90°) and the EUT itself either on 3-orthogonal axis (portable equipment) or 2-orthogonal axis (defined operational position of EUT) the emission spectrum and it's characteristics was recorded with an EMI-receiver, broadband antenna and software.

Measurement antenna: horizontal and vertical, heights: 1,0 m and 1,82 m. The results are documented in a diagram. Critical frequencies (low margin to limit) are saved within a table for further investigations. If various operating modes are supported, further investigations are made to find the worst-case of them. Also the interconnection cables and equipment position were varied in order to maximize the emissions.

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

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

Following parameters were varied: the turntable angle continuously in the range 0 to 360 degree, the EUT itself either over 3-orthogonal axis (not defined usage position) or 2-orthogonal axis (defined usage position). The measurement antenna height between 1 m and 4 m.

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

Formula:

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

$M = L_T - E_C$ (2)

AF = Antenna factor
C_L = Cable loss
D_F = Distance correction factor
E_C = Electrical field – corrected value
E_R = Receiver reading
G_A = Gain of pre-amplifier (if used)
L_T = Limit
M = Margin

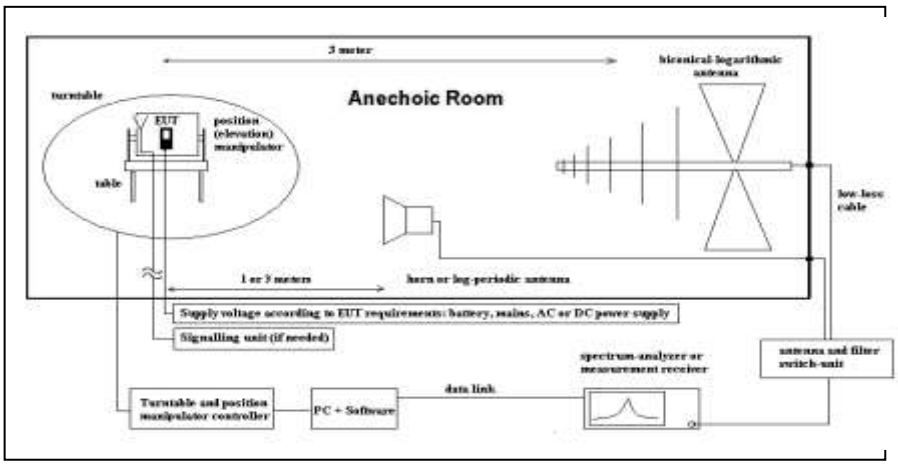
All units are dB-units, positive margin means value is below limit.

4.5. Test system set-up for electric field measurement above 1 GHz

Specification: ANSI C63.4-2009 chapter 8, ANSI C63.10-2009 chapter 6.6

General Description: Evaluating the field emissions have to be done first by an exploratory emissions measurement and a final measurement for most critical frequencies. The tests are performed in a CISPR 16-4 compliant fully anechoic room (FAR) recognized by the regulatory commissions. The measurement distance was set to 3 meter for frequencies up to 18 GHz and 1 meter above 18 GHz. Logarithmic periodic antenna is used for frequency range 1 GHz to 18 GHz, above 18 GHz a horn antenna is used. The antennas are set to fixed antenna height of 1.55 m and the EUT aligned within 3 dB cone of radiation pattern.

Schematic:



Testing method:

Exploratory, preliminary measurements
The EUT and it's associated accessories are placed on a non-conductive position manipulator (tipping device) of 1.55 m height which is placed on the turntable. By rotating the turntable (range 0° to 360°, step 45°) and the EUT itself either on 3-orthogonal axis (portable equipment) or 2-orthogonal axis (defined operational position of EUT) the emission spectrum and it's characteristics was recorded with an EMI-receiver, broadband antenna and software.
The measurements are performed in horizontal and vertical polarization of the measurement antennas. The results are documented in a diagram. Critical frequencies (low margin to limit) are saved within a table for further investigations. If various operating modes are supported, further investigations are made to find the worst-case of them. Also the interconnection cables and equipment position were varied in order to maximize the emissions.

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

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

Following parameters were varied: the turntable angle continuously in the range 0 to 360 degree, the EUT itself either over 3-orthogonal axis (not defined usage position) or 2-orthogonal axis (defined usage position). The measurement antenna height is fixed to 1.55 m.

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

Formula:

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

$M = L_T - E_C$ (2)

E_C = Electrical field – corrected value
E_R = Receiver reading
M = Margin
L_T = Limit
AF = Antenna factor
C_L = Cable loss
D_F = Distance correction factor
G_A = Gain of pre-amplifier (if used)

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

5. Measurements

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

5.1.1. Test location and equipment

test location	☒ CETECOM Essen (Chapter 2.2.1)		☐ Please see Chapter 2.2.2		☐ Please see Chapter 2.2.3	
test site	☐ 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	☐ 594 CMW		
line voltage	☐ 230 V 50 Hz via public mains		☒060 110 V 60 Hz via PAS 5000			

5.1.2. Requirements (RX mode)

FCC		Part 15, Subpart B, §15.107			
IC		RSS-Gen., § 7.2.4			
ANSI		C63.4-2009, § 5.2, 6, 7			
Limit	Frequency [MHz]	☒ Conducted limit Class B		☐ 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. Requirements (TX mode)

FCC		Part 15, Subpart C, §15.207	
IC		RSS-Gen., § 7.2.4	
ANSI		C63.10-2009	
Limit	Frequency [MHz]	QUASI-Peak [dBµV]	AVERAGE [dBµV]
	0.15 – 0.5	66 to 56*	56 to 46*
	0.5 – 5	56	46
	5 – 30	60	50
Remark: * decreases with the logarithm of the frequency			

5.1.4. Test condition and test set-up

link to test system (if used):		☒ air link	☐ cable connection	☐
EUT-grounding		☐ none	☒ with power supply	☐ additional connection
Equipment set up		☒ table top (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 or Analyzer settings	Scan data	☐ 9 – 150 kHz, RBW = 200 Hz, Step = 61 Hz ☒ 150 kHz – 30 MHz RBW = 9 kHz, Step = 4 kHz ☐ other:		
	Scan-Mode Pre-measurement Final measurement	6 dB EMI-Receiver Mode Peak detector, Repetitive-Scan, max-hold, sweep-time 50 µs per frequency point Average & Quasi-peak detector at critical frequencies		
General measurement procedures		Please see chapter "Test system set-up for AC power line conducted emissions measurements"		

5.1.5. Measurement results

The results are presented below in summary form only. For more information please see the diagrams.

TX-Mode

EUT Type and S/N or set-up no.			set-up 3		
Diagram No.	EUT operating mode no. or commend	Used Detector	Power line	Additional (scan-) information or remarks	Result
1.01	1	☒ Peak (pre-scan) ☒ CAV (final) ☒ QP (final)	L1/ N	-	passed

RX-Mode

EUT Type and S/N or set-up no.			set-up 5		
Diagram No.	EUT operating mode no. or commend	Used Detector	Power line	Additional (scan-) information or remarks	Result
1.02	2	☒ Peak (pre-scan) ☐ CAV (final) ☐ QP (final)	L1/ N	-	passed

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

5.2.1. Test location and equipment

test location	☒ CETECOM Essen (Chapter. 2.2.1)		☐ Please see Chapter. 2.2.2		☐ Please see Chapter. 2.2.3	
test site	☒ 441 EMI SAR	☐ 487 SAR NSA	☐ 347 Radio.lab.		☐	☐
receiver	☐ 377 ESCS30	☒ 001 ESS	☐	☐	☐	☐
spectr. analys.	☐ 584 FSU	☐ 120 FSEM	☐ 264 FSEK	☐	☐	☐
antenna	☐ 574 BTA-L	☐ 133 EMCO3115	☐ 302 BBHA9170	☐ 289 CBL 6141	☒ 030 HFH-Z2	☐ 477 GPS
signaling	☐ 392 MT8820A	☐ 436 CMU	☐ 547 CMU	☐ 594 CMW		
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 bei Bedarf andere Werte einsetzen			

5.2.2. Requirements

FCC	Part 15, Subpart C, §15.205 & §15.209			
IC	RSS-Gen., Issue 3			
ANSI	C63.10-2009			
Frequency [MHz]	Field strength limit [µV/m]	[dBµV/m]	Distance [m]	Remarks
0.009 – 0.490	2400/f (kHz)	67.6 – 20Log(f) (kHz)	300	Correction factor used due to measurement distance of 3 m
0.490 – 1.705	24000/f (kHz)	87.6 – 20Log(f) (kHz)	30	Correction factor used due to measurement distance of 3 m
1.705 – 30	30	29.5	30	Correction factor used due to measurement distance of 3 m

5.2.3. Test condition and test set-up

link to test system (if used):		☒ air link	☐ cable connection	☐
EUT-grounding		☐ none	☒ with power supply	☐ additional connection: between potential equalisation connector (EUT) and GND with a lab wire 1,2 m
Equipment set up		☒ table top		☐ floor standing
Climatic conditions		Temperature: (22±3°C)		Rel. humidity: (40±20)%
EMI-Receiver or Analyzer Settings	Scan data	☒ 9 – 150 kHz RBW/VBW = 200 Hz Scan step = 80 Hz ☒ 150 kHz – 30 MHz RBW/VBW = 9 kHz Scan step = 4 kHz ☐ other:		
	Scan-Mode Detector Mode: Sweep-Time	☒ 6 dB EMI-Receiver Mode ☐ 3dB Spectrum analyser Mode Peak (pre-measurement) and Quasi-PK/Average (final if applicable) Repetitive-Scan, max-hold Coupled – calibrated display if continuous signal otherwise adapted to EUT's individual transmission duty-cycle		
General measurement procedures		Please see chapter "Test system set-up radiated magnetic field measurements below 30 MHz"		

5.2.4. Measurement Results

The results are presented below in summary form only. For more information please see the diagrams.
Table of measurement results:

Diagram No.	Carrier Channel		Frequency range	Set-up no.	OP-mode no.	Remark	Used detector			Result
	Range	No.					PK	AV	QP	
2.01	Low	11	9 kHz-30 MHz	4	1	--	☒	☒	☒	passed
2.02	Middle	18	9 kHz-30 MHz			--	☒	☐	☐	passed
2.03	High	26	9 kHz-30 MHz			--	☒	☐	☐	passed

5.2.5. 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

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

5.3.1. TEST LOCATION AND EQUIPMENT

test location	☒ CETECOM Essen (Chapter. 2.2.1)		☐ Please see Chapter. 2.2.2		☐ Please see Chapter. 2.2.3	
test site	☒ 441 EMI SAR	☒ 487 SAR NSA				
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	☐ 594 CMW		
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			

5.3.2. Requirements/Limits

FCC		☒ Part 15 Subpart B, §15.109, class B in RX-Mode ☒ Part 15 Subpart C, §15.209 @ frequencies defined in §15.205 in TX-Mode	
IC		RSS-Gen., Issue 3	
ANSI		☒ C63.4-2009 for RX-Mode ☒ C63.10-2009 for TX-Mode	
Limit	Frequency [MHz]	Radiated emissions limits, Class B, 3 meters	
		QUASI Peak [µV/m]	QUASI-Peak [dBµV/m]
	30 - 88	100	40.0
	88 - 216	150	43.5
	216 - 960	200	46.0
	above 960	500	54.0

5.3.3. 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			

5.3.4. 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	Scan frequency range:	☒ 30 – 1000 MHz ☐ other:		
	Scan-Mode	☒ 6dB EMI-Receiver Mode ☐ 3dB spectrum analyser mode		
	Detector	Peak / Quasi-peak		
	RBW/VBW	100 kHz/300 kHz		
	Mode:	Repetitive-Scan, max-hold		
	Scan step	80 kHz		
	Sweep-Time	Coupled – calibrated display if continuous tx-signal otherwise adapted to EUT's individual duty-cycle		
General measurement procedures		Please see chapter "Test system set-up for radiated measurements"		

5.3.5. MEASUREMENT RESULTS: TX-MODE

The results are presented below in summary form only. For more information please see diagrams.

Table of measurement results:

Diagram no.	Carrier Channel		Frequency range	Set-up no.	OP-mode no.	Remark	Used detector			Result
	Range	No.					PK	AV	QP	
3.01	Low	11	30 MHz..1 GHz	4	1	--	☒	☐	☒	passed
3.02	Mid.	18					☒	☐	☒	passed
3.03	High	26					☒	☐	☒	passed

Remark: --

5.3.6. MEASUREMENT RESULTS RX-MODE

The results are presented below in summary form only. For more information please see diagrams.

Diagram no.	Frequency range	Set-up no.	OP-mode no.	Remark	Used detector			Result
					PK	AV	QP	
3.04	30 MHz .. 1 GHz	5	3	--	☒	☐	☒	passed

5.4. General Limit - Radiated emissions, above 1 GHz

5.4.1. Test location and 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 40	☐	☐
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	☐594 CMW		
DCpower	☐086 LNG50-10	☐087 EA3013	☐354 NGPE 40	☐349 car battery	☐350 Car battery	☐
line voltage	☐ 230 V 50 Hz via public mains		☒060 110 V 60 Hz via PAS 5000			

5.4.2. Requirements/Limits

FCC	☒ Part 15 Subpart B, §15.109 class B ☒ Part 15 subpart C, §15.209 @ frequencies defined in §15.205			
IC	RSS-Gen., Issue 3			
ANSI	☒ C63.4-2009 for RX-Mode ☒ C63.10-2009 for TX-mode			
Frequency [MHz]	Limits			
	AV [µV/m]	AV [dBµV/m]	Peak [µV/m]	Peak [dBµV/m]
above 1 GHz	500	54.0	5000	74.0

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 1.5m height		☐ floor standing
Climatic conditions		Temperature: (22±3°C)		Rel. humidity: (40±20)%
Spectrum-Analyzer settings	Scan frequency range:	☒ 1 – 18 GHz ☒ 18 – 25 GHz ☐ 18 – 40 GHz ☐ other:		
	Scan-Mode	☒ 6 dB EMI-Receiver Mode ☐ 3 dB Spectrum analyser Mode		
	Detector	Peak and Average		
	RBW/VBW	1 MHz / 3 MHz		
	Mode:	Repetitive-Scan, max-hold		
	Scan step	400 kHz		
	Sweep-Time	Coupled – calibrated display if CW signal otherwise adapted to EUT's individual duty-cycle		
General measurement procedures		Please see chapter "Test system set-up for radiated measurements"		

5.4.4. Measurement Results TX-Mode:

The results are presented below in summary form only. For more information please see diagrams.

Table of measurement results:

Diagram no.	Carrier Channel		Frequency range	Set-up no.	OP-mode no.	Remark	Used detector			Result
	Range	No.					PK	AV	QP	
4.01	Low	11	1 .. 18 GHz	4	1	--	☒	☒	☐	passed
4.02	Mid.	18					☒	☒	☐	passed
4.03	High	26					☒	☒	☐	passed
4.04	Low	11	18 .. 25 GHz	4	1	Only noise-floor	☒	☒	☐	passed
4.05	Mid.	18					☒	☒	☐	passed
4.06	High	26					☒	☒	☐	passed

Remark: --

5.4.5. Measurement Results RX-Mode:

The results are presented below in summary form only. For more information please see diagrams.

Diagram no.	Frequency range	Set-up no.	OP-mode no.	Remark	Used detector			Result
					PK	AV	QP	
4.07	1 .. 10 GHz	5	3	--	☒	☒	☐	passed

Remark: --

5.5. RF Parameter - Band-Edge compliance measurements

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

test location	☒ CETECOM Essen (Chapter. 2.2.1)		☒ 443 System CTC-FAR-EMI-		☐ Please see Chapter. 2.2.3	
test site	☐ 441 EMI SAR	☐ 487 SAR NSA	☐ 337 OATS	☐ 347 Radio.lab.	☐	☐
receiver	☐ 377 ESCS30	☐ 001 ESS	☒ 489 ESU 40	☐ 620 ESU 26	☐	☐
spectr. analys.	☐ 264 FSEK	☐ 120 FSEM	☐	☐	☐	☐
antenna meas	☐ 574 BTA-L	☐ 289 CBL 6141	☒ 608 HL 562	☒ 549 HL025	☐ 302 BBHA917	☐ 477 GPS
line voltage	☐ 230 V 50 Hz via public mains			☒060 110 V 60 Hz via PAS		

5.5.2. Reference

FCC	☒ §15.247(d) , §15.209(a) @ frequencies defined in §15.205(a)
IC	☒ RSS-Gen, Issue 3(7.2.2.)
ANSI	☒ C63.10-2009(6.9)

5.5.3. Measurement method

A Delta marker method was used for showing compliance to restricted bands according §15.205. The method is according Public Notice “Marker-Delta method”, Extract from ANSI-C63.10:2009. The method consists of three independent steps:

1. Step: Prior to the measurement the fundamental radiated In-Band field strength was performed. The determined value is used as reference value.
2. Step: Second step consist of finding the relative attenuation between the fundamental emission and the maximum local out-of-band emission (within 2 MHz range around the band edge either on the band-edge directly or some modulation product if the level is greater than that on the band-edge) when measured with lower resolution bandwidth.
3. Step: The delta value recorded in step 2 will be subtracted from value recorded in step 1, thus giving the required field strength at the band-edge. This value must fulfil the requirements for radiated spurious emissions in restricted bands in §15.205 with the general limits of §15.209.

5.5.4. EUT settings:

The EUT was instructed to send with maximum power (if adjustable) according to applicants instructions.

5.5.5. RESULTS

Set-up: 4 Op. Mode. 1							
Tnom= 21°C Vnom= 110V AC		Delta marker value of Band-edge	Fundamental field strength-radiated	Subtraction: Fund. field strength – Delta value	Value at Band-Edge	Limit	Verdict
Diagram No.	Channel No.	[dB]	[dBµV/m]	[dBc]	[dBµV/m]		
4.01_BE / 4.01_EIRP	Channel Low= 11	97.9 (PK_h) – 47.7 (PK_l)= 50.2	101.2 (PK) 50.2 (AV)	101.2-50.2 = 51.0	N/A	>20dBc	Passed
4.03_BE / 4.03_EIRP	Channel High= 26	93.5 (PK_h) – 46.6 (PK_l)= 46.9	100.1 (PK) - 46.9 = 53.2	N/A	53.2 (PK)	74 dBµV/m	Passed
			96.5 (AV) - 46.9 = 49.6	N/A	49.6 (AV)	54 dBµV/m	Passed

5.5.6. Final test results: Passed

5.6. RF Parameter – RF Power (EIRP)

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. anal.	☐ 620 ESU 26	☐ 120 FSEM	☐ 264 FSEK	☒ 489 ESU 40	☐	☐
antenna meas	☒ 549 HL025	☐ 289 CBL 6141	☐ 439 HL 562	☐ 133 EMCO3115	☐ 302 BBHA9170	☐ 477 GPS
line voltage	☐ 230 V 50 Hz via public mains			☒ 060 110 V 60 Hz via PAS		

5.6.2. EUT Settings:
For DSSS-systems were three different channels could be measured.
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.

5.6.3. Requirements/Limits

FCC	☒ §15.247(b)(4)
IC	☒ RSS-210, Issue 8
ANSI	☒ C63.10-2009(6.3.1)
Limit	4 Watt (36.02 dBm) Peak - EIRP

5.6.4. Measurement method: The method is according ANSI/TIA/EIA-603-C-2004 and consist of two steps.
First step: The maximum power was recorded by turning the EUT continuously 360 degree steps, the EUT in horizontal (laying) and vertical (standing) position. Measurements have been performed with the measurement antenna set to horizontal and vertical polarisation. The spectrum analyzer was set to MAX-PEAK Detector, MAX-Hold Mode. The RBW used was bigger than the 6-dB bandwidth of the EUT and set to 3 MHz. VBW set to 10 MHz with coupled sweep time. The maximum trace peak value was recorded.

Second step: a horn antenna was set instead of the EUT and connected to the signal generator. The level was adjusted such as the same level as in step 1 could be reached. The conducted power delivered to the antenna was measured and the value corrected with the known antenna eirp gain.

Alternative measurement method: a field strength measurement was performed in 3m distance to the EUT. General measurement procedures as shown in chapter ‚Test system set-up for electric field measurement above 1 GHz' applies therefore. Using transformation formula between field strength and e.i.r.p. power as shown in ANSI63.10: 2009, chapter 7.8.2 is used for conversion. In addition a bandwidth correction factor applied: 10*log(6 dB BW/RBW=1MHz)

5.6.5. Results: Max. Field Strength measured in 3m distance

Diagram no.	4.01	4.02	4.03
Set-up no.: 4 Op. Mode: 1	Low channel = 11 (2405 MHz)	Middle channel = 18 (2440 MHz)	High channel = 26 (2480 MHz)
Determined field strength [dBµV/m] in 3 m distance with RBW=1 MHz	101.2 (PK) 97.6 (AV)	101.7 (PK) 98.1 (AV)	100.1 (PK) 96.5 (AV)
Value in dBm using conversion formula and assumed numeric Gain=1: $E=\sqrt{\left(\frac{30*P*G}{d^2}\right)}$ [dBm]	3.5 (PK)	3.7 (PK)	3.1 (PK)
Bandwidth correction factor[1.)] [dB]	2.28	2.23	1.82
e.i.r.p. power [dBm] assumed 0dBi gain	5.70	6.20	4.60
Actual declared gain of antenna by applicant [dBi]	2		
Calculated Power (e.i.r.p.) in [dBm]:	7.80	**7.95**	6.92

Remark: 1.) Please see 6 dB BW results at chapter ‚RF Parameter - 6 dB and 99% occupied bandwidth'

Verdict: Passed, Maximum value: 7.95 dBm (antenna gain < 6 dBi compare to RF power conducted result)

5.7. RF Parameter - RF Power Conducted

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

test location	☒ CETECOM Essen (Chapter. 2.2.1)		☒ 443 System CTC-FAR-EMI-		☐ Please see Chapter. 2.2.3	
test site	☐ 441 EMI SAR	☐ 487 SAR NSA	☐ 337 OATS	☒ 347 Radio.lab.	☐	☐
receiver	☐ 377 ESCS30	☐ 001 ESS	☒ 489 ESU	☐	☐	☐
spectr. analys.	☐ 489 ESU	☐ 120 FSEM	☐ 264 FSEK	☐	☐	☐
power supply	☐ 456 EA 3013A	☐ 457 EA 3013A	☐ 459 EA 2032-50	☐ 268 EA- 3050	☐ 494 AG6632A	☒ 498 NGPE 40
otherwise	☒530 10dB Attenuator			☒ cable K5		

Reference:

FCC	☒ §15.247(b)(3)
IC	☒ RSS-210, Issue 8
ANSI	☒ C63.10-2009(6.10.2)
Limit	1 Watt (30 dBm) Peak

Antenna characteristics:

According §15.247(b)(4):
☒ directional gain < 6 dBi (measured: difference between measured conducted and eirp radiated power)
☐ directional gain > 6 dBi (measured / applicant's declaration) -> conducted power reduction necessary

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.

Measurement method:

The measurement was performed in modulated transmission mode with the carrier set to lowest/middle and highest channel.
The power was also checked for different data rates, modulation scheme or packet types if applicable.

Settings on Spectrum-Analyzer:

Center Frequency	Nominal channel frequency
Span	150 MHz
Resolution Bandwidth (RBW)	10 MHz > 6 dB-Bandwidth of the signal
Video Bandwidth (VBW)	10 MHz
Sweep time	coupled
Detector	Peak, Max hold mode
Sweep Mode	Repetitive mode

5.7.1. Conducted measurement: Max. Peak Power

- Maximum declared antenna gain [isotropical]: 2.0 dBi

Results

Set-up no.: 2 & Op-Mode: 1	MAX PEAK POWER (conducted)			
	Diagram no.	10.01	10.02	10.03
	Channel	Low channel = 11 (2405 MHz)	Middle channel = 18 (2440 MHz)	High channel = 26 (2480 MHz)
	Ext. Path loss [dB] (10 dB Attenuator + Cable attenuation)	10.80	10.80	10.80
	Resulting Peak Power	**3.66 dBm 2.32 mW**	3.40 dBm 2.19 mW	2.71 dBm 1.87 mW
Limit		1 Watt (30dBm) Peak		

Remark: The results were taken directly from the spectrum analyzer display, the path loss and attenuators were included as reference level offset in the spectrum analyzer. Please refer the diagrams at annex 4.

5.7.2. Final verdict: Passed

5.8. RF Parameter - Power Spectral Density

5.8.1. 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	☐ 337 OATS	☒ 347 Radio.lab.	☐	☐
receiver	☐ 377 ESCS30	☐ 001 ESS	☒ 489 ESU	☐	☐	☐
spectr. analys.	☐ 215 FSU	☐ 120 FSEM	☐ 264 FSEK	☐	☐	☐
power supply	☐ 456 EA 3013A	☐ 457 EA 3013A	☐ 459 EA 2032-50	☐ 268 EA- 3050	☐ 494 AG6632A	☒ 498 NGPE 40
otherwise	☒530 10dB Attenuator	☒1506A 6 dB Power divider	☒ cable K5			

5.8.2. ReferenceS: §15.247(e), RSS-210:A8.3

(e) *For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.*

5.8.3. EUT settings:

For DSSS-systems were three different channels measured.
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.

5.8.4. Measurement Method:

A frequency sweep around nominal carrier frequency is performed over the complete power envelope of the signal with PEAK detector, MAX hold mode. The maximum peak is located and the frequency recorded. With the nominal frequency set to the determined frequency in the step before, a new frequency sweep is performed with a reduced resolution bandwidth of 3 kHz. The measured value is corrected due to external measuring set-up and the resulting value is compared with the standard requirement.

5.8.5. Results

	Power spectral density			
Set-up no.: 1 & Op. Mode: 1	Diagram no.	11.01	11.02	11.03
	Channel	Low channel =11 (2405 MHz)	Middle channel = 18 (2440 MHz)	High channel = 26 (2480 MHz)
	Measured Level [dBm/3 kHz]	-25.52	-25.92	-27.23
	Ext. Path loss [dB] (10 dB Attenuator+ 6 dB Power divider+ Cable loss)	17.0	17.0	17.0
	Calculated Power spectral density [dBm/ 3 kHz]	**-8.52**	-8.92	-10.23
Limit		< 8 dBm/ 3 kHz		

Remark: The results were taken directly from the spectrum analyzer display, the path loss and attenuators were included as transducer factor in the spectrum analyzer. Please refer the diagrams at annex 4.

5.8.6. Final verdict: Passed

5.9. RF Parameter – 20 dBc Emission specification

5.9.1. 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	☐ 337 OATS	☒ 347 Radio.lab.	☐	☐
receiver	☐ 377 ESCS30	☐ 001 ESS	☒ 489 ESU	☐	☐	☐
spectr. analys.	☐ 215 FSU	☐ 120 FSEM	☐ 264 FSEK	☐	☐	☐
power supply	☐ 456 EA 3013A	☐ 457 EA 3013A	☐ 459 EA 2032-50	☐ 268 EA- 3050	☐ 494 AG6632A	☒ 498 NGPE 40
otherwise	☒530 10dB Attenuator			☒ cable K15		

5.9.2. References: §15.247, §15.205, RSS-210: A8.5

(d) *In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits.*

5.9.3. EUT settings:

The EUT was instructed to send with maximum power (if adjustable) according applicants instructions.

5.9.4. Measurement method:

The frequency spectrum was investigated for **conducted/radiated** spurious emissions values lower than 20dB related to the RF-carrier power value. Three carrier frequencies (low/middle/high channel) were used for showing the compliance with this requirement. The detector were chosen according §15.209(d). The video bandwidth (VBW) was chosen 10 times the resolution bandwidth (RBW). The frequency scan was up to 10 times the highest channel frequency within the operational mode. The spectrum-analyzer was set to MAX-PEAK Detector, MAX-Hold Mode.

F or DSSS-systems were three different channels measured.
The EUT was instructed to send with maximum power (if adjustable) according applicants instructions.

5.9.5. Results

Set-up no.: 2 Op. Mode: 1	**RF-Conducted test: 20 dBc spurious emissions**					
Diagram no.	12.01		12.02		12.03	
Frequency Range	Low channel =11 (2405 MHz) Level Reference (In-Band) = 109.49 dBµV		Middle channel = 18 (2440 MHz) Level Reference (In-Band) = 109.16 dBµV		High channel = 26 (2480 MHz) Level Reference (In-Band) = 107.80 dBµV	
	Frequency [MHz]	Worst-case Value [dBc]	Frequency [MHz]	Worst-case Value [dBc]	Frequency [MHz]	Worst-case Value [dBc]
0.03 .. 1 GHz	254.91	62.50 dBµV Margin>26 dB to limit 89.49 dBµV	254.91	59.36 dBµV Margin>29dB to limit 89.16 dBµV	62.64	62.01 dBµV Margin>25dB to limit 87.80 dBµV
1 GHz .. 18 GHz	7216	72.04 dBµV Margin +17dB	7325	72.31 dBµV Margin +16dB	7441	68.93 dBµV Margin +18dB
18..25GHz	No remarkable peaks found					

Remark: The limit on the diagrams is 20 dB under the reference level measured In-Band for each channel.

5.9.6. Final verdict: Passed

5.10. RF Parameter - 6 dB Bandwidth and 99% occupied Bandwidth

5.10.1. 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			

5.10.2.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)%

5.10.3. References of occupied and emission bandwidth

§15.247(a)(1), RSS-210: A8.1(b)

(1) *Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.*

(2) *DSSS Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.*

5.10.4. 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.

5.10.5. Measurement method:

The measurement was performed with the RBW set to 100 kHz. The span was set to cover the complete carrier. Three carrier frequencies (low/middle/high) were used for showing the compliance with this requirement. 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% occupied 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%.

5.10.6. 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% to 5% 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

5.10.7. Results:

Set-up no.:			1
Op. Mode:			1
T_{NOM} = 21.4°C V_{NOM} = 5.0V			**6 dB Bandwidth [MHz]**
Diagram no.	13.01	Low channel = 11 (2405 MHz)	1.69
	13.02	Middle channel = 18 (2440 MHz)	1.66
	13.03	High channel = 26 (2480 MHz)	1.52

Remark: See extract of diagrams and results for different modulation types(Data rates) in separate document A4

Conclusion: 6 dB bandwidth is bigger than 500 kHz so tests according Part 15.247 should apply for this wireless technology.

5.10.8. Verdict: Passed

Set-up no.:			1
Op. Mode:			1
T_{NOM} = 21.7°C V_{NOM} = 5.0V			**99% Occupied Bandwidth [MHz]**
Diagram no.	14.01	Low channel = 11 (2405 MHz)	2.61
	14.02	Middle channel = 18 (2440 MHz)	2.62
	14.03	High channel = 26 (2480 MHz)	2.61

Remark: See extract of diagrams and results for different modulation types(Data rates) in separate document A4

5.11. RF Parameter - Frequency stability

5.11.1. 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	☒ 489 ESU 40	☐	☐
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 cham.	☒ 331 HC 4055					
attenuator	☒ 530 10 dB Att.	☐	☐	☐	☐	☐
\ line voltage	☐ 230 V 50 Hz via public mains		☐ 060 110 V 60 Hz via PAS 5000			

5.11.2. Requirements

FCC	--
IC	RSS-Gen Issue 3,Chapter 4.7 and Chapter 7.2.6
Limits criteria	*"...measurement of the frequency stability is not required provided that the occupied bandwidth of the licence-exempt radio apparatus lies entirely outside the restricted bands and the prohibited TV bands of 54-72 MHz, 76-88 MHz, 174-216 MHz, 470-608 MHz and 614-806 MHz."*
According to our expert's opinion	The 99% occupied bandwidth (OBW) shall lie under all conditions within the assigned frequency band.

5.11.3. 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)%

5.11.4. EUT settings

The measurements were made at the upper and lower carrier frequencies of the operating band. Choosing two representative TX-carrier frequencies of the EUT within each operable licence-exempt radio apparatus band, should be sufficient to demonstrate compliance.

5.11.5. Test method

The aim of the EUT is to function at the center frequency under all normal and extreme conditions within authorized band in regard to temperature and voltage variations. The center frequency deviation was recorded with the spectrum analyzer.
The lowest and highest measured center frequency result will be selected to subtract and add up with the half of 99% occuppied bandwidth.
Please refer also chapter 'RF Parameter – 6 dB Bandwidth and 99% occupied bandwidth'.

5.11.6. Test procedure

1.) Determine the carrier frequency for the lowest and highest channels at room temperature [+20°C] at nominal high and low voltages.

2.) Expose the EUT to +50°C, wait sufficient time to have constant temperature.

3.) Perform the carrier frequencies measurements at low and high channels in low and high voltages.

4.) Switch-off the EUT, decrease temperature to -20°C, wait sufficient time to have constant temperature.

5.) Powering on EUT, repeat the measurements within 2 minutes for the lowest and highest channel at low and high voltages in order to prevent self-warming of the EUT

5.11.7. Measurement Results

LOW CHANNEL 11=2405 MHz			
Op. mode 2, Set-up no. 2 Diagram no.	Input Voltage [V]	Temperature [°Celsius]	Measured Center Frequency [GHz]
15.01	V_{min}= 3.23	-20	2.404998
15.02		+20	2.404997
15.03		+50	**2.404986**
15.04	V_{nom}= 3.30	+20	2.404996
15.05	V_{max}= 3.37	-20	2.405001
15.06		+20	2.404996
15.07		+50	**2.404986**
Lowest measured frequency			**2.404986**

Calculated frequency

Lowest center frequency -1/2 (99% OBW) [GHz]	f_L [GHz]	Verdict
2.404986 – 0.001305	2.403681	Passed

HIGH CHANNEL 26=2480 MHz			
Op. mode 2, Set-up no. 2 Diagram no.	Input Voltage [V]	Temperature [°Celsius]	Measured Center Frequency [GHz]
15.08	V_{min}= 3.23	-20	2.480000
15.09		+20	2.479999
15.10		+50	2.479989
15.11	V_{nom}= 3.30	+20	2.479999
15.12	V_{max}= 3.37	-20	**2.480002**
15.13		+20	2.479999
15.14		+50	2.479988
Highest measured frequency			**2.480002**

Calculated frequency

Highest center frequency + 1/2 (99% OBW) [GHz]	f_H [GHz]	Verdict
2.480002 + 0.001305	2.481307	Passed

5.11.8. LIMITS (assigned frequency band)

Under all test conditions	$f_L \geq 2.400$ GHz	$f_H \leq 2.4835$ GHz

5.12. 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. Abbreviations used in this report

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

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

Ref.-No.	Accreditation Certificate	Valid for laboratory area or test site	Accreditation Body
-	D-PL-12047-01-01	All laboratories and test sites of CETECOM GmbH, Essen	DAkkS, Deutsche Akkreditierungsstelle GmbH
337 487 558 348 348	736496	Radiated Measurements 30 MHz to 1 GHz, 3 m / 10 m (OATS) Radiated Measurements 30 MHz to 1 GHz, 3 m (SAR) Radiated Measurements above 1 GHz, 3 m (FAR) Mains Ports Conducted Interference Measurements Telecommunication Ports Conducted Interference Measurem.	FCC, Federal Communications Commission Laboratory Division, USA (MRA US-EU 0003)
337 487 550 558	3462D-1 3462D-2 3462D-2 3462D-3	Radiated Measurements 30 MHz to 1 GHz, 3 m / 10 m (OATS) Radiated Measurements 30 MHz to 1 GHz, 3 m (SAR) Radiated Measurements 1 GHz to 6 GHz, 3 m (SAR) Radiated Measurements above 1 GHz, 3 m (FAR)	IC, Industry Canada Certification and Engineering Bureau
337 487 550 348 348	R-2665 R-2666 G-301 C-2914 T-1967	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) Mains Ports Conducted Interference Measurements Telecommunication Ports Conducted Interference Measurem.	VCCI, Voluntary Control Council for Interference by Information Technology Equipment, Japan
OATS = Open Area Test Site, SAR = Semi Anechoic Room, FAR = Fully Anechoic Room			

8. Instruments and Ancillary

8.1. Used equipment "CTC"

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

8.1.1. Test software and firmware of equipment

Ref.-No.	Equipment	Type	Serial-No.	Version of Firmware or Software during the test
001	EMI Test Receiver	ESS	825132/017	Firm.= 1.21 , OTP=2.0, GRA=2.0
012	Signal Generator (EMS-cond.)	SMY 01	839069/027	Firm.= V 2.02
013	Power Meter (EMS cond.)	NRVD	839111/003	Firm.= V 1.51
017	Digital Radiocommunication Tester	CMD 60 M	844365/014	Firmware = V 3.52 .22.01.99, DECT = D2.87 13.01.99
053	Audio Analyzer	UPA3	860612/022	Firm. V 4.3
119	RT Harmonics Analyzer dig. Flickermeter	B10	G60547	Firm.= V 3.1DHG
140	Signal Generator	SMHU	831314/006	Firm.= 3.21
261	Thermal Power Sensor	NRV-Z55	825083/0008	EPROM-Datum 02.12.04, SE EE 1 B
262	Power Meter	NRV-S	825770/0010	Firm.= 2.6
263	Signal Generator	SMP 04	826190/0007	Firm.=3.21
264	Spectrum Analyzer	FSEK 30	826939/005	Bios=2.1, Analyzer= 3.20
295	Racal Digital Radio Test Set	6103	1572	UNIT Firmware= 4.04, SW-Main=4.04, SW-BBP=1.04, SW-DSP=1.02, Hardboot=1.02, Softboot=2.02
298	Univ. Radio Communication Tester	CMU 200	832221/091	R&S Test Firmware =3.53 /3.54 (current Testsoftw. f. all band used
323	Digital Radiocommunication Tester	CMD 55	825878/0034	Firm.= 3.52 .22.01.99
331	Climatic Test Chamber -40/+80 Grad	HC 4055	43146	TSI 1.53
335	CTC-EMS-Conducted	System EMS Conducted	-	EMC 32 V 8.52
340	Digital Radiocommunication Tester	CMD 55	849709/037	Firm.= 3.52 .22.01.99
355	Power Meter	URV 5	891310/027	Firm.= 1.31
365	10V Insertion Unit 50 Ohm	URV5-Z2	100880	Eprom Data = 31.03.08
366	Ultra Compact Simulator	UCS 500 M4	V0531100594	Firm. UCS 500=001925/3.06a02, rc=ISMIEC 4.10
371	Bluetooth Tester	CBT32	100153	CBT V5,30+ SW-Option K55, K57
377	EMI Test Receiver	ESCS 30	100160	Firm.= 2.30, OTP= 02.01, GRA= 02.36
378	Broadband RF Field Monitor	RadiSense III	03D00013SNO-08	Firm.= V.03D13
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= 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. 8.53
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	Wideband 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
642	Wideband Radio Communication Tester	CMW 500	126089	

8.1.2. 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	Single-Line V-Network (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	1g	30.06.2013
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	30.06.2013
291	high pass filter GSM 850/900	WHJ 2200-4EE	14	Wainwright GmbH	12 M	1c	30.06.2013
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
371	Bluetooth Tester	CBT32	100153	R&S	12 M	-	31.03.2013
373	Single-Line V-Network (50 Ohm/5µH)	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)	-	CETECOM	12 M	5	31.10.2012

Ref.-No.	Equipment	Type	Serial-No.	Manufacturer	Interval of calibration	Remark	Cal due
		Cable					
443	CTC-FAR-EMI-RSE	System CTC-FAR-EMI-RSE	-	ETS-Lindgren / CETECOM	12 M	5	30.06.2013
448	notch filter WCDMA_FDD II	WRCT 1850.0/2170.0-5/40-	5	Wainwright Instruments GmbH	12 M	1c	30.06.2013
449	notch filter WCDMA FDD V	WRCT 824.0/894.0-5/40-8SSK	1	Wainwright	12 M	1c	30.06.2013
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	-	30.06.2013
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-	SN 5	Wainwright	pre-m	2	
512	notch filter GSM 850	WRCA 800/960-02/40-6EEK	SN 24	Wainwrght	12 M	1c	30.06.2013
517	relais switch matrix	HF Relais Box Keithley	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 M	-	30.06.2015
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	30.06.2013
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	Wideband Radio Communication Tester	CMW500	101757	Rohde & Schwarz	24 M	-	31.03.2014
597	Univ. Radio Communication Tester	CMU 200	100347	Rohde & Schwarz	12 M	-	31.03.2013
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	
625	Generic Test Load USB	Generic Test Load USB	-	CETECOM	-	2	
627	data logger	OPUS 1	201.0999.9302.6.4.1.43	G. Lufft GmbH	24 M	-	30.05.2014
634	Spectrum Analyzer	FSM (HF-Unit)	826188/010	Rohde & Schwarz	pre-m	2	
635	DFS Testbox	DFS Testbox	2012 V01	CETECOM SHA	-	-	
636	Wärmebildkamera	Ti32	Ti32-12060213, Tele	Fluke Corporation	24 M	-	31.07.2014
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	24 M	-	31.03.2014

8.1.3. Legend

Note / remarks		Calibrated during system calibration:
	1a	System CTC-SAR-EMS (Ref.-No. 442)
	1b	System-CTC-EMS-Conducted (Ref.-No. 335)
	1c	System CTC-FAR-EMI-RSE (Ref.-No . 443)
	1d	System CTC-SAR-EMI (Ref.-No . 441)
	1e	System CTC-OATS (EMI radiated) (Ref.-No. 337)
	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

9. Versions of test reports (change history)

Version	Applied changes	Date of release
--	Initial release	2012-09-29
C1	FCC-ID and IC Number included	2014-09-24