

TEST REPORT

No.: 17-1-0264601T05

According to:
FCC Regulations
Part 15.517

for

Agilion GmbH

WIRELESS MESH GATEWAY PULSE | PHASE
Communication and Real time Location System

FCC ID: SCF6032502

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

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Separate document annex 1: Measurement diagrams

Separate document annex 2: External photographs of EUT

Separate document annex 3: Test set-up photographs

Separate document annex 4: Internal photographs of EUT

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. Also we refer on special conditions which the applicant should fulfill according §2.927 to §2.948, special focus regarding modification of the equipment and availability of sample equipment for market surveillance tests.

The presented Equipment Under Test (in this report, hereinafter referred as EUT) supports radiofrequency technologies with similar UWB technology and operating frequency range at 3.1 to 4.8 GHz. Other implemented wireless technologies were not considered within this test report.

Following test cases have been performed to show compliance with valid Part 15.207/15.209/15.517 of the FCC CFR Title 47 Rules, Edition 2017.

1.1. Tests measurement overview according of US CFR Title 47, Subpart 15C:

Test cases	Port	References & Limits		EUT set-up	EUT operating mode	Result
		FCC Standard	Test Limit			
TX-Mode						
Transmission time	Antenna terminal (conducted)	§15.517(a)(5)	-	3*	-	passed
10 dB bandwidth	Antenna terminal (conducted)	§15.517(b)	3.1 GHz – 10.6 GHz	4*	1, 2, 3, 4*	passed
Radiated emissions	Enclosure + Inter-connecting cables (radiated)	§15.209	Emissions in restricted bands must meet the general field-strength radiated limits	1*	1*	passed
		§15.517(c)		1*	1*	passed
Radiated emissions in the GPS bands	Enclosure + Inter-connecting cables (radiated)	§15.517(d)	-85.3 dBm	1*	1*	passed
Fundamental emission peak power	Enclosure + Inter-connecting cables (radiated)	§15.517(e)	0 dBm for RBW=50 MHz	1*	1*	passed
AC-Power Lines Conducted Emissions	AC-Power lines	§15.207	FCC §15.107 class B limits §15.207 limits	2*	1*	passed
Antenna requirement	-	§15.203	-	-	-	passed

* See chapter 3.4

1.2. Attestation:

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

.....
Dipl.-Ing. Christian Lorenz
Responsible for test section

.....
B.Sc. Piotr Sardyko
Responsible for test report

2. Administrative Data

2.1. Identification of the testing laboratory

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

2.2. Test location

2.2.1. Test laboratory "CTC"

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

Responsible for test report and project leader:	B.Sc. Piotr Sardyko
Receipt of EUT:	2018 - January
Date(s) of test:	2018 January/February
Date of report:	2018-03-22

Version of template:	13.02

2.4. Applicant's details

Applicant's name:	Agilion GmbH
Address:	Blankenauer Str. 74 09113 Chemnitz Germany
Contact person:	Sven Sieber

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 and Real Time Location System		
Device type	Fixed Device		
Frequency range	3100 MHz - 4800 MHz (not tested) 6000 MHz - 7000 MHz		
Type of modulation	BPSK with BPM		
Number of channels	2 UWB channels		
EMISSION DESIGNATOR(S)	IEEE 802.15.4-2011 UWB		
Antenna Type	☒ Integrated ☐ External, no RF- connector ☐ External, separate RF-connector		
MAX Field strength (radiated):	54 dB μ V/m@3m distance and 1 MHz RBW		
Installed options	IEEE 802.15.4 in 2,40 - 2,48 GHz ISM-Band		
Power supply	☒ over PoE adapter: 120V/60 Hz ☒ DC power only: 24Volt		
EUT sample type	☒ Production	☐ Pre-Production	☐ Engineering
FCC label attached	☐ yes	☒ no	

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

Short description*)	EUT	Type	S/N serial number	HW hardware status	SW software status
EUT A	WIRELESS MESH GATEWAY PULSE PHASE (Radiated Test Sample)	6032502	A33787	0583	2.0.8
EUT B	WIRELESS MESH GATEWAY PULSE PHASE (Conducted Test Sample)	6032502	A43476	0583	2.0.8

*) 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	Notebook	HP Probook 6560b	-	-	Windows 7 + TestModes MESH PPP SW V1.0.0
AE 2	PoE Injector	TL-POE150S	214348000006	-	-
AE 3	AC/DC adapter for AE2	-	-	-	-
AE 4	LAN cable for AC/DC adapter for AE2	0.3 m	-	-	-
AE 5	LAN cable for AC/DC adapter for AE2	1 m	-	-	-
AE 6	DC Power cable	-	-	-	-
AE 7	Wireless Tag Asset	-	-	-	-
AE 8	Ext. battery for AE 7	-	-	-	-
AE 9	Cable with debug interface	1.5 m	-	-	-

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

3.4. EUT set-ups

EUT set-up no. *)	Combination of EUT and AE	Remarks
set. 1	EUT A + AE 1 + AE 6 +AE 9	Radiated RF-setup, AE9 is used temporary for RF-connection set-up
set. 2	EUT A + AE 1 + AE 2 + AE 3 + AE 4 + AE 5 + AE 9	AE9 used temporary for RF-connection
set. 3	EUT B + AE 1 + AE 2 + AE 3 + AE 4 + AE 5 + AE 7 + AE 8	Conducted RF-setup
set. 4	EUT B + AE 1 + AE 6 +AE 9	Conducted RF-setup, AE9 is used temporary for RF-connection set-up
set. 5	EUT A + AE 1 + AE 2 + AE 3 + AE 4 + AE 5 + AE 9	Radiated RF-setup, AE9 is used temporary for RF-connection set-up

*) 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	TX, channel 5, PRF 16 MHz, datarate 110k, PreambleCode default auf channel 2, PreambleCode 36	Channel 5- 6489.6 MHz. Continuous TX-Mode, set-up by special software and with help of PC.
op. 2	TX, channel 5, PRF 64 MHz, datarate 110k, PreambleCode default auf channel 2, PreambleCode 36	Channel 5- 6489.6 MHz. Continuous TX-Mode, set-up by special software and with help of PC.
op. 3	TX, channel 5, PRF 16 MHz, datarate 6800k, PreambleCode default auf channel 2, PreambleCode 36	Channel 5- 6489.6 MHz. Continuous TX-Mode, set-up by special software and with help of PC.
op. 4	TX, channel 5, PRF 64 MHz, datarate 6800k, PreambleCode default auf channel 2, PreambleCode 36	Channel 5- 6489.6 MHz. Continuous TX-Mode, set-up by special software and with help of PC.

*) 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

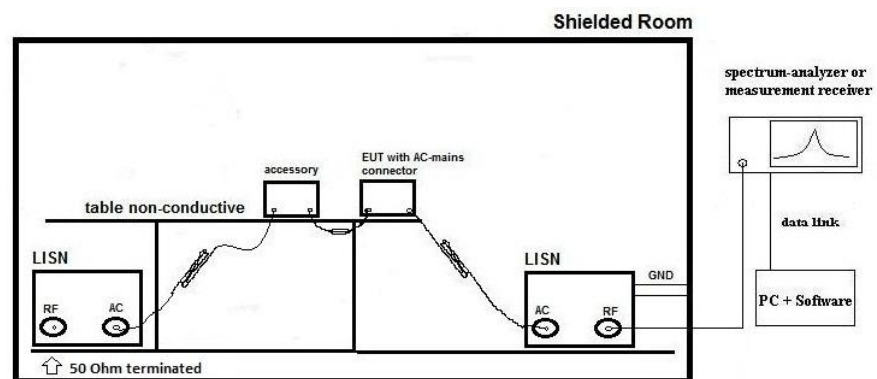
Specification: ANSI C63.4-2014 chapter 7, ANSI C63.10-2013, chapter 6.2

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 120 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:

$$V_C = V_R + C_L \quad (1)$$

$$M = L_T - V_C \quad (2)$$

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.

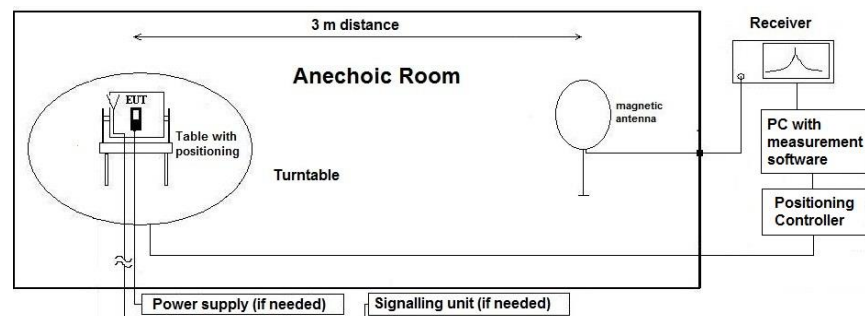
4.2. Test system set-up for radiated magnetic field measurements below 30 MHz

Specification: ANSI C63.4-2014 §5.3, §8.2.1, §8.3.1.1+§8.3.2.1 , ANSI C63.10-2013 chapter 6.4 (§6.4.4.2)

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

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 commission.

Schematic:



Testing method:

Exploratory, preliminary measurement

The EUT and its 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 was recorded. 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. 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 due to reduced measurement distance:

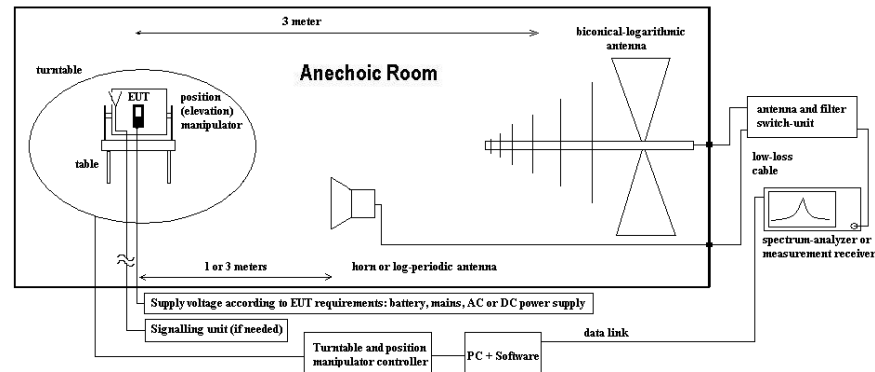
ANSI C63.10:2013, §6.4.4.2 - Equations (2) + (3) + (4)

4.3. Test system set-up for radiated electric field measurement 30 MHz to 960MHz

Specification: ANSI C63.4-2014 chapter 8.2.3, ANSI C63.10-2013 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 its 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 its characteristics was recorded with an EMI-receiver, broadband antenna and software.

Measurement antenna: horizontal and vertical, heights: 1,0 m and 1,82 m as worst-case determined by an exploratory emission measurements. 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. either on 10m OATS or 3m semi-anechoic room.

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:

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

$$M = L_T - E_C \quad (2)$$

AF = Antenna factor

C_L = Cable loss

D_F = Distance correction factor (if used)

E_C = Electrical field – corrected value

E_R = Receiver reading

G_A = Gain of pre-amplifier (if used)

L_T = Limit

M = Margin

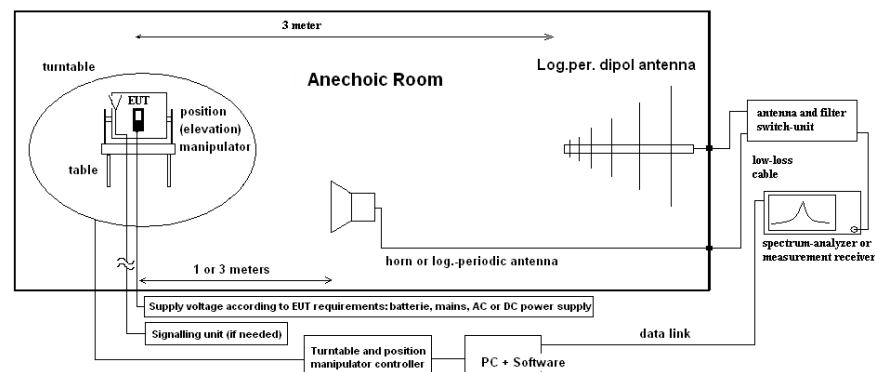
All units are dB-units, positive margin means value is below limit.

4.4. Test system set-up for radiated electric field measurement above 960MHz

Specification: ANSI C63.10-2013, chapter 10.3

General Description: The tests are performed in a CISPR 16-1-4:2010 compliant fully anechoic room (FAR) recognized by the regulatory commission. The measurement distance was set to 1 m or 3 m. A logarithmic periodic antenna is used for the frequency range 30 MHz to 1 GHz. Horn antennas are used for frequency range 1 GHz to 40 GHz. The EUT is aligned within 3 dB beam width of the measurement antenna with three orthogonal axis measurements on the EUT.

Schematic:



Testing method:

Exploratory, preliminary measurements

The EUT and its 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 15°) and the EUT itself either on 3-orthogonal axis (portable equipment) or 2-orthogonal axis (defined operational position of EUT) the emission spectrum and its 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.

Formula:

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

$$M = L_T - E_C \quad (2)$$

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 (if used)

G_A = Gain of pre-amplifier (if used)

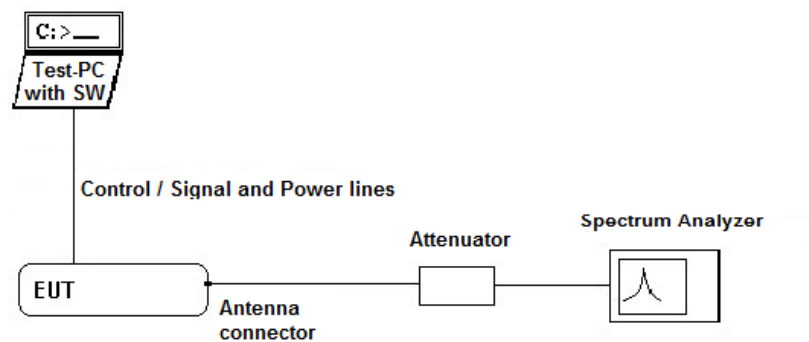
All units are dB-units, positive margin means value is below limit.

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

Specification: ANSI C63.13-2013

General Description: In order to avoid overload, the EUT's RF-signal is first attenuated before it is connected to the spectrum – analyzer/ power meter. The specific attenuation is determined prior to the measurement within a set-up calibration. The power measurement is done either with a suitable power meter or a spectrum analyzer. 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:



5. Measurements

5.1. Transmission time measurement

5.1.1. Test location and equipment

Ref.-No.	Equipment	Type	Serial-No.
714	Spectrum Analyzer	R&S FSU67	104023
087	Power supply	EA 3013 S	-
-	RF cable	Rosenberger	X105

5.1.2. Reference

FCC	☒ §15.517 (a)(5)
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5.1.3. EUT settings:

The EUT is switched on.

5.1.4. Test condition and measurement test set-up

EUT-grounding	☒ none	☐ with power supply	☐ additional connection
Equipment set up	☒ table top 1.0 m height	☐ floor standing	
Climatic conditions	Temperature: (22±3°C)	Rel. humidity: (40±20)%	
General measurement procedures	Please see chapter "Test system set-up for conducted RF-measurement at antenna Port"		

5.1.5. Measurement method and analyzer settings:

For test purpose the UWB port of the EUT is connected with the spectrum analyzer through a RF cable. The intentional radiator is located close by EUT. In this measurement intentional radiator is AE 7 (see chapter 3). The measurement is made in time domain by the central frequency of the channel. Measurement duration 30 s. RBW = 50 MHz.

The first measurement is made without turning on intentional radiator. It will be checked, that the EUT doesn't transmit.

Shortly before the second measurement an intentional radiator is switched on. Then the measurement is started by the spectrum analyzer. It is checked, whether the EUT transmits, when the intentional radiator is switched on. After 15 s the intentional radiator is switched off. And it will be checked, whether the EUT continues to transmit and if so then how long.

5.1.6. RESULTS

The EUT stops to transmit immediately after the intentional radiator is switched off.

5.1.6.1. VERDICT: PASS. For graphical results pls. see annex 1 to this test report.

5.2. 10 dB bandwidth measurement

5.2.1. Test location and equipment

Ref.-No.	Equipment	Type	Serial-No.
714	Spectrum Analyzer	R&S FSU67	104023
087	Power supply	EA 3013 S	-
-	RF cable	Rosenberger	X105

5.2.2. Reference

FCC	☒ §15.517 (b)
-----	---

5.2.3. Test condition and measurement test set-up

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)%
General measurement procedures	Please see chapter "Test system set-up for conducted RF-measurement at antenna Port" (W2 Set-up)

5.2.4. EUT Settings:

The EUT was instructed to transmit continuously with maximum power (if adjustable) according applicants declared and applicable settings.

Different characteristics have been checked, e.g. data rates which EUT can operate if applicable.

5.2.5. Measurement method:

The frequency at which the maximum power level is measured with the peak detector is designated f_M (RBW=1 MHz, VBW= 3 MHz, peak detection, maxhold). The outermost 1 MHz segments above and below f_M , where the peak power falls by 10 dB relative to the level at f_M , are designated as f_H and f_L . The UWB transmission, and the -10 dB bandwidth (B - 10), is defined as ($f_H - f_L$). -10 dB bandwidth should be ≥ 500 MHz and must be contained between 3100 MHz and 10.600 MHz.

5.2.6. Spectrum-Analyzer settings:

Span	1.5 GHz
Scale display	approximate 30dB below the maximum PEAK level
Resolution Bandwidth (RBW)	ANSI 63.10-2013, chapter 10.1
Video Bandwidth (VBW)	Minimum 3 times the resolution bandwidth
Sweep time	Auto-coupled
Detector	Peak detector
Sweep mode	Repetitive Mode, MAX-HOLD, trace stabilization

5.2.7. Results:

Op. Mode:	The frequency at which the maximum power f_M , [MHz]	Power of the frequency f_M , [dBm]	Lowest frequency bound f_L , [MHz]	Highest frequency bound f_H , [MHz]	-10 dB bandwidth, [MHz]
1	6489,75	-19,86	6178,57	6800,32	621,75
2	6489,45	-33,39	6173,17	6815,02	641,85
3	6489,15	-21,04	6117,86	6878,85	760,99
4	6490,35	-26,70	6109,46	6869,75	760,29

Remark: For graphical results pls. see annex 1 to this test report.

The operation mode No 1 shows the highest power value. This mode will be used furthermore for other measurements.

VERDICT: PASS

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

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	☐ 347 Radio.lab.
receiver	☐ 377 ESCS30	☒ 001 ESS	☐
spectr. analys.	☐ 584 FSU	☐ 120 FSEM	☐ 264 FSEK
antenna	☐ 574 BTA-L	☐ 133 EMCO3115	☐ 302 BBHA9170
signalling	☐ 757 CMW500	☐ 371 CBT32	☐ 547 CMU
otherwise	☐ 400 FTC40x15E	☐ 401 FTC40x15E	☐ 110 USB LWL
DC power	☐ 456 EA 3013A	☐ 457 EA 3013A	☐ 459 EA 2032-50
line voltage	☐ 230 V 50 Hz via public mains	☐ 060 120 V 60 Hz via PAS 5000	☐ 289 CBL 6141
			☐ 030 HFH-Z2
			☒ 021 EMCO6502
			☐ 594 CMW500
			☐ 482 Filter Matrix
			☐ 378 RadiSense
			☐ 494 AG6632A
			☐ 498 NGPE 40

5.3.2. Requirements

FCC	Part 15, Subpart C, §15.205 & §15.209			
ANSI	C63.10-2013			
Frequency [MHz]	Field strength limit		Distance [m]	Remarks
	[µV/m]	[dBµV/m]		
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

5.3.3. Test condition and test set-up

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 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	☒ 6 dB EMI-Receiver Mode	
	Detector	☐ 3dB Spectrum analyser Mode	
	Mode: Sweep-Time	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"	

5.3.4. Measurement Results

The results are presented below in summary form only. For more information please consult the diagrams included in annex 1.

Measurement No	Frequency range	Ch. No	OP-mode no.	Remark	Detector	Result
1	9 kHz-30 MHz	2	1	Op. mode- worst case. Laying position, 24V DC power supply	Peak	passed
2	9 kHz-30 MHz	2	1	Op. mode- worst case. Standing position, 24V DC power supply	Peak	passed

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

The used correction factors when the measurement distance is reduced compared to regulatory measurement distance, are calculated according Extrapolation formulas valid for EUT's with maximum dimension of 0.625xLambda. Formula 2+3+4 as presented in ANSI C63.10, Chapter 6.4.4 are used for the calculations of proper extrapolation factors.

Frequency -Range	f [kHz/MHz]	Lambda [m]	Far-Field Point [m]	Distance Limit accord. 15.209 [m]	1st Condition (dmeas < D _{near-field})	2 ^{te} Condition (Limit distance bigger d _{near-field})	Distance Correction accord. Formula
kHz	9,00E+03	33333,33	5305,17	300	fulfilled	not fulfilled	-80,00
	1,00E+04	30000,00	4774,65		fulfilled	not fulfilled	-80,00
	2,00E+04	15000,00	2387,33		fulfilled	not fulfilled	-80,00
	3,00E+04	10000,00	1591,55		fulfilled	not fulfilled	-80,00
	4,00E+04	7500,00	1193,66		fulfilled	not fulfilled	-80,00
	5,00E+04	6000,00	954,93		fulfilled	not fulfilled	-80,00
	6,00E+04	5000,00	795,78		fulfilled	not fulfilled	-80,00
	7,00E+04	4285,71	682,09		fulfilled	not fulfilled	-80,00
	8,00E+04	3750,00	596,83		fulfilled	not fulfilled	-80,00
	9,00E+04	3333,33	530,52		fulfilled	not fulfilled	-80,00
	1,00E+05	3000,00	477,47		fulfilled	not fulfilled	-80,00
	1,25E+05	2400,00	381,97		fulfilled	not fulfilled	-80,00
	2,00E+05	1500,00	238,73		fulfilled	fulfilled	-78,02
	3,00E+05	1000,00	159,16		fulfilled	fulfilled	-74,49
	4,00E+05	750,00	119,37		fulfilled	fulfilled	-72,00
	4,90E+05	612,24	97,44		fulfilled	fulfilled	-70,23
	5,00E+05	600,00	95,49		fulfilled	not fulfilled	-40,00
	6,00E+05	500,00	79,58		fulfilled	not fulfilled	-40,00
MHz	7,00E+05	428,57	68,21	30	fulfilled	not fulfilled	-40,00
	8,00E+05	375,00	59,68		fulfilled	not fulfilled	-40,00
	9,00E+05	333,33	53,05		fulfilled	not fulfilled	-40,00
	1,00	300,00	47,75		fulfilled	not fulfilled	-40,00
	1,59	188,50	30,00		fulfilled	not fulfilled	-40,00
	2,00	150,00	23,87		fulfilled	fulfilled	-38,02
	3,00	100,00	15,92		fulfilled	fulfilled	-34,49
	4,00	75,00	11,94		fulfilled	fulfilled	-32,00
	5,00	60,00	9,55		fulfilled	fulfilled	-30,06
	6,00	50,00	7,96		fulfilled	fulfilled	-28,47
	7,00	42,86	6,82		fulfilled	fulfilled	-27,13
	8,00	37,50	5,97		fulfilled	fulfilled	-25,97
	9,00	33,33	5,31		fulfilled	fulfilled	-24,95
	10,00	30,00	4,77		fulfilled	fulfilled	-24,04
	10,60	28,30	4,50		fulfilled	fulfilled	-23,53
	11,00	27,27	4,34		fulfilled	fulfilled	-23,21
	12,00	25,00	3,98		fulfilled	fulfilled	-22,45
	13,56	22,12	3,52		fulfilled	fulfilled	-21,39
	15,00	20,00	3,18		fulfilled	fulfilled	-20,51
	15,92	18,85	3,00		fulfilled	fulfilled	-20,00
	17,00	17,65	2,81		not fulfilled	fulfilled	-20,00
	18,00	16,67	2,65		not fulfilled	fulfilled	-20,00
	20,00	15,00	2,39		not fulfilled	fulfilled	-20,00
	21,00	14,29	2,27		not fulfilled	fulfilled	-20,00
	23,00	13,04	2,08		not fulfilled	fulfilled	-20,00
	25,00	12,00	1,91		not fulfilled	fulfilled	-20,00
	27,00	11,11	1,77		not fulfilled	fulfilled	-20,00
	29,00	10,34	1,65		not fulfilled	fulfilled	-20,00
	30,00	10,00	1,59		not fulfilled	fulfilled	-20,00

5.4. General Limit - Radiated field strength emissions, 30 MHz – 960 MHz

5.4.1. 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
signalling	☐ 392 MT8820A ☐ 371 CBT32	☐ 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	☒ 060 120 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	
ANSI		☐ C63.4-2014 ☒ C63.10-2013	
Limit	Frequency [MHz]	Radiated emissions limits, 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

5.4.3. Restricted bands of operation (FCC §15.205/ RSS-Gen, Issue 4 Chapter 8.9, Table 4)

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			

5.4.4. Test condition and measurement test set-up

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: ☒ 6 dB EMI-Receiver Mode ☐ 3 dB 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 electric field measurement in the range 30 MHz to 1 GHz"		

5.4.5. MEASUREMENT RESULTS

The results are presented below in summary form only. For more information please consult the diagrams included in annex 1.

Measurement No	Frequency range	Ch. No	OP-mode no.	Remark	Detector	Result
1	30 MHz - 960 MHz	2	1	Op. mode- worst case. Laying position, 24V DC power supply	Peak	passed
2	30 MHz - 960 MHz	2	1	Op. mode- worst case. Standing position, 24V DC power supply	Peak	passed

5.5. General Limit – Radiated field strength emissions, above 960 MHz

5.5.1. Test location and equipment

Ref.-No.	Equipment	Type	Serial-No.
Frequency range 960 MHz – 18000 MHz			
Measurement in FAR 1 with the distance between the EUT and the antenna 1 m			
714	Spectrum Analyzer	R&S FSU67	104023
087	Power supply	EA 3013 S	-
549	Antenna	HL025	1000060
338	RF Amplifier	Miteq JS4-00102600-38-5P	838697
Measurement in FAR 2 with the distance between the EUT and the antenna 3 m			
714	Spectrum Analyzer	R&S FSU67	104023
087	Power supply	EA 3013 S	-
134	Antenna	EMCO 3115	9005-3414
-	RF Amplifier	Wright Technologies ASG18B-4010	-
Frequency range 18000 MHz – 40000 MHz			
Measurement in FAR 2 with the distance between the EUT and the antenna 1 m			
714	Spectrum Analyzer	R&S FSU67	104023
087	Power supply	EA 3013 S	-
302	Antenna	BBHA9170	155
688	RF Amplifier	Miteq JS-18004000-40-8P	1750117

5.5.2. Requirements/Limits

FCC	☒ Part 15.517 (c) ☒ Part 15.521 (h)
ANSI	☐ C63.4-2014 ☒ C63.10-2013
Frequency [MHz]	Limits, EIRP in dBm
960-1610	-75.3
1610-1990	-53.3
1990-3100	-51.3
3100-10600	-41.3
10600- 40000	-51.3

5.5.3. Measurement method:

Measurement method is described in general in chapter 4.4.

Due to the fact that limits in frequency range 960 MHz – 3100 MHz and 10600 MHz – 40 GHz are very low, the measurement distance for these frequency ranges is reduced to 1m. The spectrum analyzer is placed immediately after the receiving antenna. Preferably short RF cable is used for the connection of the antenna and the spectrum analyzer.

In frequency range 3100 MHz – 10600 MHz the limit isn't so low as in other frequency ranges. Therefore the distance 3 m is used. It is also possible to place the spectrum analyzer outside the FAR.

5.5.4. Test condition and measurement test set-up

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: RMS RBW/VBW: 1 MHz / 3 MHz Mode: Repetitive-Scan, max-hold Sweep-Time: ≤ 1 ms over each measurement bin
General measurement procedures	Please see chapter "Test system set-up for radiated electric field measurements above 1 GHz"

5.5.5. Measurement Results

The results are presented below in summary form only. For more information please consult the diagrams included in annex 1.

Measurement No	Frequency range	Ch. No	OP-mode no.	Remark	Detector	Result
1	960 MHz – 1610 MHz	2	1	Op. mode- worst case. 24V DC power supply	RMS	passed
2	1610 MHz – 3100 MHz	2	1	Op. mode- worst case. 24V DC power supply	RMS	passed
3	3100 MHz – 10600 MHz	2	1	Op. mode- worst case. 24V DC power supply	RMS	passed
4	10600 MHz – 15000 MHz	2	1	Op. mode- worst case. 24V DC power supply	RMS	passed
5	15000 MHz – 18000 MHz	2	1	Op. mode- worst case. 24V DC power supply	RMS	passed
5	18000 MHz – 40000 MHz	2	1	Op. mode- worst case. 24V DC power supply	RMS	passed

Remark : see diagrams in annex 1 for more details.

From 47 CFR Section 15.517 (c): Emissions from digital circuitry used to enable the operation of the UWB transmitter shall comply with the limits in Section 15.209 of this chapter, rather than the limits specified in this subpart, provided it can be clearly demonstrated that those emissions from the UWB device are due solely to emissions from digital circuitry contained within the transmitter and that the emissions are not intended to be radiated from the transmitter's antenna. Emissions from associated digital devices, as defined in Section 15.3(k) of this chapter, e.g., emissions from digital circuitry used to control additional functions or capabilities other than the UWB transmission, are subject to the limits contained in Subpart B of Part 15 of this chapter.

Therefore the measurement is made twice in some frequency ranges. Once with UWB signal turned on and once with UWB signal turned off.

5.6. Radiated emissions in the GPS bands

5.6.1. Test location and equipment

Ref.-No.	Equipment	Type	Serial-No.
Measurement in FAR 2 with the distance between the EUT and the antenna 3 m			
714	Spectrum Analyzer	R&S FSU67	104023
087	Power supply	EA 3013 S	-
134	Antenna	EMCO 3115	9005-3414
-	RF Amplifier	Wright Technologies ASG18B-4010	-

5.6.2. Requirements/Limits

FCC	☒ Part 15.517 (d)
ANSI	☐ C63.4-2014 ☒ C63.10-2013
Frequency [MHz]	Limits, EIRP in dBm
1164-1240	-85.3
1559-1610	-85.3

5.6.3. Test condition and measurement test set-up

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	☐ 6 dB EMI-Receiver Mode ☒ 3 dB Spectrum analyser Mode RMS 1 kHz / 3 kHz Repetitive-Scan, max-hold ≤ 1 ms over each measurement bin
General measurement procedures	Please see chapter "Test system set-up for radiated electric field measurements above 1 GHz"

5.6.4. Measurement Results

The results are presented below in summary form only. For more information please consult the diagrams included in annex 1.

Measurement No	Frequency range	Ch. No	OP-mode no.	Remark	Detector	Result
1	1164-1240	2	1	Op. mode- worst case. 24V DC power supply	RMS	passed
2	1559-1610	2	1	Op. mode- worst case. 24V DC power supply	RMS	passed

Remark : see diagrams in annex 1 for more details.

5.7. Fundamental emission peak power

5.7.1. Test location and equipment FAR

Ref.-No.	Equipment	Type	Serial-No.
Measurement in FAR 2 with the distance between the EUT and the antenna 3 m			
714	Spectrum Analyzer	R&S FSU67	104023
087	Power supply	EA 3013 S	-
134	Antenna	EMCO 3115	9005-3414
-	RF Amplifier	Wright Technologies ASG18B-4010	-

5.7.2. Requirements/Limits

FCC	☒ Part 15.517 (e)
ANSI	☐ C63.4-2014 ☒ C63.10-2013
Frequency [MHz]	Limits, EIRP in dBm
Frequency with the highest radiated emission contained within a 50 MHz bandwidth from the measurement according to FCC 15.517 5(c)	0

5.7.3. Test condition and measurement test set-up

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-Mode Detector RBW/VBW Mode: Sweep-Time ☐ 6 dB EMI-Receiver Mode ☒ 3 dB Spectrum analyser Mode MaxPeak 50 MHz / 80 MHz Repetitive-Scan, max-hold ≤ 1 ms over each measurement bin
General measurement procedures	Please see chapter "Test system set-up for radiated electric field measurements above 1 GHz"

5.7.4. Measurement Results

The results are presented below in summary form only. For more information please consult the diagrams included in annex 1.

Measurement No	Frequency [MHz]	Ch. No	OP-mode no.	Remark	Detector	Result
1	6477.5	2	1	24V DC power supply	RMS	passed

Remark: frequency with the highest radiated emission contained within a 50 MHz bandwidth from the measurement according to FCC 15.517 5(c) is the frequency inside of the fundamental emission.

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

5.8.1. 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
LISN	☒ 005 ESH2-Z5	☐ 007 ESH3-Z6	☐ 300 ESH3-Z5 & 50Ω used for AE
signalling	☐ 392 MT8820A	☐ 436 CMU	☐ 547 CMU
line voltage	☐ 230 V 50 Hz via public mains	☒ 060 120 V 60 Hz via PAS 5000 and AE1	☐ 594 CMW

5.8.2. Requirements

FCC		Part 15, Subpart B, §15.207	
ANSI		C63.10-2013	
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			

5.8.3. Test condition and test set-up

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	6 dB EMI-Receiver Mode	
	Pre-measurement	Peak detector, Repetitive-Scan, max-hold, sweep-time 50 μs per frequency point	
General measurement procedures		Average & Quasi-peak detector at critical frequencies	
		Please see chapter “Test system set-up for AC power line conducted emissions measurements”	

5.8.4. Measurement results

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

Diagram No.	EUT operating mode no. or comment	Used Detector	Power line	Additional (scan-) information or remarks	Result
1	EUT operating mode 1	☒ Peak (pre-scan) ☒ AV (final) ☐ QP (final)	L1/ N	Op. mode- worst case. Standing position, 24V DC power supply	passed

5.9. Antenna requirement according to FCC 15.203

The antenna is permanently affixed to the module.

5.10. Measurement uncertainties

The reported uncertainties are calculated based on the standard uncertainty multiplied with the appropriate coverage factor **k**, such that a confidence level of approximately 95% is achieved.

For uncertainty determination, each component used in the concrete measurement set-up was taken in account and it's contribution to the overall uncertainty according it's statistical distribution calculated.

Following table shows expectable uncertainties for each measurement type performed.

RF-Measurement	Reference	Frequency range	Calculated uncertainty based on a confidence level of 95%							Remarks
Conducted emissions (U _{CISPR})	CISPR 16-2-1	9 kHz - 150 kHz 150 kHz - 30 MHz	4.0 dB 3.6 dB							-
Radiated emissions Enclosure	CISPR 16-2-3	30 MHz - 1 GHz 1 GHz - 18 GHz	4.2 dB 5.1 dB							E-Field
Disturbance power	CISPR 16-2-2	30 MHz - 300 MHz	-							-
Power Output radiated	-	30 MHz - 4 GHz	3.17 dB							Substitution method
Power Output conducted	-	Set-up No.	Cel-C1	Cel-C2	BT1	W1	W2	--	-	
		9 kHz - 12.75 GHz	N/A	0.60	0.7	0.25	N/A	--		
		12.75 - 26.5GHz	N/A	0.82	--	N/A	N/A	--		
Conducted emissions on RF-port	-	9 kHz - 2.8 GHz	0.70	N/A	0.70	N/A	0.69	--	N/A - not applicable	
		2.8 GHz - 12.75GHz	1.48	N/A	1.51	N/A	1.43	--		
		12.75 GHz - 18GHz	1.81	N/A	1.83	N/A	1.77	--		
		18 GHz - 26.5GHz	1.83	N/A	1.85	N/A	1.79	--		
Power density	-	1 – 2.8GHz	1.40 dB							--
Occupied bandwidth	-	9 kHz - 4 GHz	0.1272 ppm (Delta Marker)							Frequency error
			1.0 dB							Power
Emission bandwidth	-	9 kHz - 4 GHz	0.1272 ppm (Delta Marker)							Frequency error
	-		See above: 0.70 dB							Power
Frequency stability	-	9 kHz - 20 GHz	0.0636 ppm							-
Radiated emissions Enclosure	-	150 kHz - 30 MHz	5.0 dB							Magnetic field E-field Substitution
		30 MHz - 1 GHz	4.2 dB							
		1 GHz - 20 GHz	3.17 dB							

Table: measurement uncertainties, valid for conducted/radiated measurements

6. Abbreviations used in this report

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

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	(MRA US-EU 0003)	Radiated Measurements 30 MHz to 1 GHz, 3 m / 10 m (OATS) Radiated Measurements 30 MHz to 1 GHz, 3 m (SAR) Radiated Measurements above 1 GHz, 3 m (FAR) Mains Ports Conducted Interference Measurements Telecommunication Ports Conducted Interference Measurem.	FCC, Federal Communications Commission Laboratory Division, USA
337 487 550 558	-- 3462D-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)	ISED, Industry Canada Certification and Engineering Bureau
487 550 348 348	R- 4452 G- 20013 C- 20009 T- 20006	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
295	Racal Digital Radio Test Set	6103	1572	UNIT Firmware= 4.04, SW-Main=4.04, SW-BBP=1.04, SW-DSP=1.02, Hardboot=1.02, Softboot=2.02
298	Univ. Radio Communication Tester	CMU 200	832221/091	R&S Test Firmware =3.53 /3.54 (current Testsoftw. f. all band used
323	Digital Radiocommunication Tester	CMD 55	825878/0034	Firm.= 3.52 .22.01.99
335	CTC-EMS-Conducted	System EMS Conducted	-	EMC 32 V 8.52
340	Digital Radiocommunication Tester	CMD 55	849709/037	Firm.= 3.52 .22.01.99
355	Power Meter	URV 5	891310/027	Firm.= 1.31
365	10V Insertion Unit 50 Ohm	URV5-Z2	100880	Eprom Data = 31.03.08
366	Ultra Compact Simulator	UCS 500 M4	V0531100594	Firm. UCS 500=001925/3.06a02, rc=ISMIEC 4.10
371	Bluetooth Tester	CBT32	100153	CBT V5.30+ SW-Option K55, K57
377	EMI Test Receiver	ESCS 30	100160	Firm.= 2.30, OTP= 02.01, GRA= 02.36
378	Broadband RF Field Monitor	RadiSense III	03D00013SNO-08	Firm.= V.03D13
389	Digital Multimeter	Keithley 2000	0583926	Firm. = A13 (Mainboard) A02 (Display)
392	Radio Communication Tester	MT8820A	6K00000788	Firm.= 4.50 #005, IPL=4.01#001, OS=4.02#001, GSM=4.41#013, W-CDMA= 4.54#004, scenario= 4.52#002
436	Univ. Radio Communication Tester	CMU 200	103083	R&S Test Firmware Base=5.14, Mess-Software= GSM:5.14 WCDMA:5.14 (current Testsoftw. F. all band
441	CTC-SAR-EMI Cable Loss	System EMI field (SAR)	-	EMC 32 Version 8.52
442	CTC-SAR-EMS	System EMS field (SAR)	-	EMC 32 Version 8.40
443	CTC-FAR-EMI-RSE	System CTC-FAR-EMI-RSE	-	Spuri 7.2.5 or EMC 32 Ver. 9.15.00
444	CTC-FAR-EMS field	System-EMS-Field (FAR)	-	EMC 32 Version 9.15.00
460	Univ. Radio Communication Tester	CMU 200	108901	R&S Test Firmware Base=5.14, GSM=5.14 WCDMA=5.14 (current Testsoftw.,f. all band to be used,
489	EMI Test Receiver	ESU40	1000-30	Firmware=4.43 SP3, Bios=V5.1-16-3, Spec. =01.00
491	ESD Simulator dito	ESD dito	dito307022	V 2.30
524	Voltage Drop Simulator	VDS 200	0196-16	Software Nr. 000037 Version V4.20a01
526	Burst Generator	EFT 200 A	0496-06	Software Nr. 000034 Version V2.32
527	Micro Pulse Generator	MPG 200 B	0496-05	Software-Nr. 000030 Version V2.43
528	Load Dump Simulator	LD 200B	0496-06	Software-Nr. 000031 Version V2.35a01
546	Univ. Radio Communication Tester	CMU 200	106436	R&S Test Firmware Base=5.14, GSM=5.14 WCDMA=5.14 (current Testsoftw.,f. all band to be used
547	Univ. Radio Communication Tester	CMU 200	835390/014	R&S Test Firmware Base=V5.1403 (current Testsoftw., f. all band used, GSM = 5.14 WCDMA: = 5.14
584	Spectrum Analyzer	FSU 8	100248	2.82_SP3
597	Univ. Radio Communication Tester	CMU 200	100347	R&S Test Firmware Base=5.01, GSM=5.02 WCDMA= not installed, Mainboard= µP1=V.850
598	Spectrum Analyzer	FSEM 30	831259/013	Firmware Bios 3.40 , Analyzer 3.40 Sp 2
607	Signal Generator	SMR 20	832033/011	V1.25
620	EMI Test Receiver	ESU 26	100362	4.43_SP3
642	Wideband Radio Communication Tester	CMW 500	126089	Setup V03.26, Test programm component V03.02.20
670	Univ. Radio Communication Tester	CMU 200	106833	µP1 =V8.50, Firmware = V.20
689	Vector Signal Generator	SMU200	100970	02.20.360.142
692	Bluetooth Tester	CBT 32	100236	CBT V 5.40, FW: V.2.41 (FPGA Digital, V. 3.09 FPGA RF)

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	-	16.05.2018
005	AC - LISN (50 Ohm/50µH, test site 1)	ESH2-Z5	861741/005	Rohde & Schwarz	12 M	-	15.05.2018
007	Single-Line V-Network (50 Ohm/5µH)	ESH3-Z6	892563/002	Rohde & Schwarz	12 M	-	17.05.2018
009	Power Meter (EMS-radiated)	NRV	863056/017	Rohde & Schwarz	24 M	-	15.05.2019
016	Line Impedance Simulating Network	Op. 24-D	B6366	Spitzenberger+Spies	36 M	-	30.05.2019
021	Loop Antenna (H-Field)	6502	9206-2770	EMCO	36 M	-	30.04.2018
030	Loop Antenna (H-field)	HFH-Z2	879604/026	Rohde & Schwarz	36 M	-	30.04.2018
033	RF-current probe (100kHz-30MHz)	ESH2-Z1	879581/18	Rohde & Schwarz	24 M	-	15.05.2019
057	relay-switch-unit (EMS system)	RSU	494440/002	Rohde & Schwarz	pre-m	1a	
060	power amplifier (DC-2kHz)	PAS 5000	B6363	Spitzenberger+Spies	-	3	
086	DC - power supply, 0 -10 A	LNG 50-10	-	Heinzinger Electronic	pre-m	2	
087	DC - power supply, 0 -5 A	EA-3013 S	-	Elektro Automatik	pre-m	2	
091	USB-LWL-Converter	OLS-1	007/2006	Ing. Büro Scheiba	-	4	
099	passive voltage probe	ESH2-Z3	299.7810.52	Rohde & Schwarz	36 M	-	30.04.2018
100	passive voltage probe	Probe TK 9416	without	Schwarzbeck	36 M	-	30.04.2018
110	USB-LWL-Converter	OLS-1	-	Ing. Büro Scheiba	-	4	
119	RT Harmonics Analyzer dig. Flickermeter	B10	G60547	BOCONSULT	36 M	-	30.05.2019
133	horn antenna 18 GHz (Meas 1)	3115	9012-3629	EMCO	36 M	1c	10.03.2020
134	horn antenna 18 GHz (Subst 2)	3115	9005-3414	EMCO	36 M	-	10.03.2020
136	adjustable dipole antenna (Dipole 1)	3121C-DB4	9105-0697	EMCO	36 M	-	30.04.2018
140	Signal Generator	SMHU	831314/006	Rohde & Schwarz	24 M	-	30.05.2018
248	attenuator	SMA 6dB 2W	-	Radiall	pre-m	2	
249	attenuator	SMA 10dB 10W	-	Radiall	pre-m	2	
252	attenuator	N 6dB 12W	-	Radiall	pre-m	2	
256	attenuator	SMA 3dB 2W	-	Radiall	pre-m	2	
257	hybrid	4031C	04491	Narda	pre-m	2	
260	hybrid coupler	4032C	11342	Narda	pre-m	2	
261	Thermal Power Sensor	NRV-Z55	825083/0008	Rohde & Schwarz	24 M	-	30.05.2018
262	Power Meter	NRV-S	825770/0010	Rohde & Schwarz	24 M	-	30.05.2018
263	Signal Generator	SMP 04	826190/0007	Rohde & Schwarz	36 M	-	30.05.2019
265	peak power sensor	NRV-Z33, Model 04	840414/009	Rohde & Schwarz	24 M	-	30.05.2018
266	Peak Power Sensor	NRV-Z31, Model 04	843383/016	Rohde & Schwarz	24 M	-	30.05.2018
267	notch filter GSM 850	WRCA 800/960-6EEK	9	Wainwright GmbH	pre-m	2	
270	termination	1418 N	BB6935	Weinschel	pre-m	2	
271	termination	1418 N	BE6384	Weinschel	pre-m	2	
272	attenuator (20 dB) 50 W	Model 47	BF6239	Weinschel	pre-m	2	
273	attenuator (10 dB) 100 W	Model 48	BF9229	Weinschel	pre-m	2	
274	attenuator (10 dB) 50 W	Model 47 (10 dB) 50 W	BG0321	Weinschel	pre-m	2	
275	DC-Band	Model 7003 (N)	C5129	Weinschel	pre-m	2	
276	DC-Band	Model 7006 (SMA)	C7061	Weinschel	pre-m	2	
279	power divider	1515 (SMA)	LH855	Weinschel	pre-m	2	
298	Univ. Radio Communication Tester	CMU 200	832221/091	Rohde & Schwarz	pre-m	3	
300	AC LISN (50 Ohm/50µH, 1-phase)	ESH3-Z5	892 239/020	Rohde & Schwarz	12 M	-	17.05.2018
301	attenuator (20 dB) 50W, 18GHz	47-20-33	AW0272	Lucas Weinschel	pre-m	2	
302	horn antenna 40 GHz (Meas 1)	BBHA9170	155	Schwarzbeck	36 M	-	14.03.2020
303	horn antenna 40 GHz (Subst 1)	BBHA9170	156	Schwarzbeck	36 M	-	20.03.2020
331	Climatic Test Chamber -40/+180 Grad	HC 4055	43146	Heraeus Vötsch	24 M	-	30.10.2018
341	Digital Multimeter	Fluke 112	81650455	Fluke	24 M	-	30.05.2018
342	Digital Multimeter	Voltcraft M-4660A	IB 255466	Voltcraft	24 M	-	17.05.2019
347	laboratory site	radio lab.	-	-	-	5	
348	laboratory site	EMI conducted	-	-	-	5	
354	DC - Power Supply 40A	NGPE 40/40	448	Rohde & Schwarz	pre-m	2	
355	Power Meter	URV 5	891310/027	Rohde & Schwarz	24 M	-	30.05.2018
357	power sensor	NRV-Z1	861761/002	Rohde & Schwarz	24 M	-	24.05.2019
371	Bluetooth Tester	CBT32	100153	R&S	36 M	-	30.05.2019
373	Single-Line V-Network (50 Ohm/5µH)	ESH3-Z6	100535	Rohde & Schwarz	12 M	-	17.05.2018
377	EMI Test Receiver	ESCS 30	100160	Rohde & Schwarz	12 M	-	15.05.2018
392	Radio Communication Tester	MT8820A	6K00000788	Anritsu	12 M	-	18.05.2018
405	Thermo-Hygrometer	OPUS 10 THI	126.0604.0003.3.3.3.2	LUFFT Mess u. Regeltechnik	24 M	-	30.03.2019
431	Model 7405	Near-Field Probe Set	9305-2457	EMCO	-	4	
436	Univ. Radio Communication Tester	CMU 200	103083	Rohde & Schwarz	12 M	-	24.05.2018
439	UltraLog-Antenna	HL 562	100248	Rohde & Schwarz	36 M	-	10.03.2020
454	Oscilloscope	HM 205-3	9210 P 29661	Hameg	-	4	
456	DC-Power supply 0-5 A	EA 3013 S	207810	Elektro Automatik	pre-m	2	
459	DC -Power supply 0-5 A , 0-32 V	EA-PS 2032-50	910722	Elektro Automatik	pre-m	2	
460	Univ. Radio Communication Tester	CMU 200	108901	Rohde & Schwarz	12 M	-	16.06.2018
463	Universal source	HP3245A	2831A03472	Agilent	-	4	
466	Digital Multimeter	Fluke 112	89210157	Fluke USA	24 M	-	30.05.2018

Ref.-No.	Equipment	Type	Serial-No.	Manufacturer	Interval of calibration	Remark	Cal due
467	Digital Multimeter	Fluke 112	89680306	Fluke USA	36 M	-	30.04.2018
468	Digital Multimeter	Fluke 112	90090455	Fluke USA	36 M	-	30.04.2018
477	ReRadiating GPS-System	AS-47	-	Automotive Cons. Fink	-	3	
480	power meter (Fula)	NRVS	838392/031	Rohde & Schwarz	24 M	-	16.05.2019
482	filter matrix	Filter matrix SAR 1	-	CETECOM (Brl)	-	1d	
487	System CTC NSA-Verification SAR-EMI	System EMI field (SAR) NSA	-	ETS Lindgren / CETECOM	24 M	-	31.03.2019
489	EMI Test Receiver	ESU40	1000-30	Rohde & Schwarz	12 M	-	18.05.2019
502	band reject filter	WRCG 1709/1786-1699/1796-	SN 9	Wainwright	pre-m	2	
503	band reject filter	WRCG 824/849-814/859-	SN 5	Wainwright	pre-m	2	
517	relais switch matrix	HF Relais Box Keithley	SE 04	Keithley	pre-m	2	
523	Digital Multimeter	L4411A	MY46000154	Agilent	24 M	-	18.05.2019
529	6 dB Broadband resistive power divider	Model 1515	LH 855	Weinschel	pre-m	2	
530	10 dB Broadband resistive power divider	R 416110000	LOT 9828	-	pre-m	2	
546	Univ. Radio Communication Tester	CMU 200	106436	R&S	12 M	-	30.03.2018
547	Univ. Radio Communication Tester	CMU 200	835390/014	Rohde & Schwarz	12 M	-	05.07.2018
549	Log.Per-Antenna	HL025	1000060	Rohde & Schwarz	36/12 M	-	31.07.2018
550	System CTC S-VSWR Verification SAR-EMI	System EMI Field SAR S-VSWR	-	ETS Lindgren/CETECOM	24 M	-	30.03.2019
557	System CTC-OTA-2	R&S TS8991	-	Rohde & Schwarz	12 M	5	30.09.2016
558	System CTC FAR S-VSWR	System CTC FAR S-VSWR	-	CTC	24 M	-	08.08.2019
574	Biconilog Hybrid Antenna	BTA-L	980026L	Frankonia	36/12 M	-	31.03.2019
584	Spectrum Analyzer	FSU 8	100248	Rohde & Schwarz	pre-m	-	
597	Univ. Radio Communication Tester	CMU 200	100347	Rohde & Schwarz	pre-m	-	
600	power meter	NRVD (Reserve)	834501/018	Rohde & Schwarz	24 M	-	17.05.2019
601	medium-sensitivity diode sensor	NRV-Z5 (Reserve)	8435323/003	Rohde & Schwarz	24 M	-	15.05.2019
602	peak power sensor	NRV-Z32 (Reserve)	835080	Rohde & Schwarz	24 M	-	
611	DC power supply	E3632A	KR 75305854	Agilent	pre-m	2	
612	DC power supply	E3632A	MY 40001321	Agilent	pre-m	2	
613	Attenuator	R416120000 20dB 10W	Lot. 9828	Radiall	pre-m	2	
616	Digitalmultimeter	Fluke 177	88900339	Fluke	24 M	-	30.05.2018
617	Power Splitter/Combiner	ZFSC-2-2-S+	S F987001108	Mini Circuits	-	2	
618	Power Splitter/Combiner	50PD-634	600994	JFW Industries USA	-	2	
619	Power Splitter/Combiner	50PD-634	600995	JFW Industries, USA	-	3	
620	EMI Test Receiver	ESU 26	100362	Rohde-Schwarz	12 M	-	16.05.2018
621	Step Attenuator 0-139 dB	RSP	100017	Rohde & Schwarz	pre-m	2	
625	Generic Test Load USB	Generic Test Load USB	-	CETECOM	-	2	
627	data logger	OPUS 1	201.0999.9302.6.4.1.4 3	G. Lufft GmbH	24 M	-	30.03.2019
634	Spectrum Analyzer	FSM (HF-Unit)	826188/010	Rohde & Schwarz	pre-m	2	
637	High Speed HDMI with Ethernet 1m	HDMI cable with Ethernet 1m	-	KogiLink	-	2	
638	HDMI Kabel with Ethernet 1,5 m flach	HDMI cable with Ethernet	-	Reichelt	-	2	
640	HDMI cable 2m rund	HDMI cable 2m rund	-	Reichelt	-	2	
641	HDMI cable with Ethernet	Certified HDMI cable with	-	PureLink	-	2	
642	Wideband Radio Communication Tester	CMW 500	126089	Rohde&Schwarz	12 M	-	24.05.2018
644	Amplifierer	ZX60-2534M+	SN865701299	Mini-Circuits	-	-	
670	Univ. Radio Communication Tester	CMU 200	106833	Rohde & Schwarz	24 M	-	30.05.2018
671	DC-power supply 0-5 A	EA-3013S	-	Elektro Automatik	pre-m	2	
678	Power Meter	NRP	101638	Rohde&Schwarz	pre-m	-	
683	Spectrum Analyzer	FSU 26	200571	Rohde & Schwarz	12 M	-	17.05.2018
686	Field Analyzer	EHP-200A	160WX30702	Narda Safety Test Solutions	24 M	-	29.03.2019
687	Signal Generator	SMF 100A	102073	Rohde&Schwarz	12 M	-	17.05.2018
688	Pre Amp	JS-18004000-40-8P	1750117	Miteq	pre-m	-	
690	Spectrum Analyzer	FSU	100302/026	Rohde&Schwarz	12 M	-	16.05.2018
691	OSP120 Base Unit	OSP120	101183	Rohde & Schwarz	12 M	-	22.05.2018
692	Bluetooth Tester	CBT 32	100236	Rohde & Schwarz	36 M	-	29.05.2020
697	Power Splitter	ZN4PD-642W-S+	165001445	Mini-Circuits	-	2	
703	INNCO Antennen Mast	MA 4010-KT080-XPET-ZSS3	MA4170-KT100-XPET-	INNCO	pre-m	-	
704	INNCON Controller	CO 3000-4port	CO3000/933/3841051 6/L	INNCO Systems GmBh	pre-m	-	
711	Harmonic Mixer 90 GHz - 140GHz	RPG FS-Z140	101004	RPG	12 M	-	22.02.2018
712	Harmonic Mixer 75 GHz - 110GHz	FS-Z110	101468	Rohde & Schwarz	12 M	-	22.02.2018
713	Harmonic Mixer, 50 GHz - 75GHz	FS-Z75	101022	Rohde & Schwarz	12 M	-	22.05.2018
714	Signal Analyzer 67GHz	FSW67	104023	Rohde & Schwarz	24 M	-	03.03.2019
715	Harmonic Mixer, 140 GHz - 220GHz	FS-Z220	101009	RPG Radiometer Physics	12 M	-	03.08.2018
716	Harmonic Mixer 220 GHz to 325 GHZ	FS-Z325	101005	RPG Radiometer Physics	12 M	-	13.02.2018
747	Spectrum Analyzer	FSU 26	200152	Rohde & Schwarz	12 M	-	18.05.2018

Ref.-No.	Equipment	Type	Serial-No.	Manufacturer	Interval of calibration	Remark	Cal due
748	Pickett-Potter Horn Antenna	FH-PP 4060	010001	Radiometer Physiscs	-	-	
749	Pickett-potter Horn Antenna	FH-PP 60-90	010003	Radiometer Physics	-	-	
750	Pickett-Potter Horn Antenna	FH-PP 140-220	010011	Radiometer Physics	-	-	
757	CMW500 wide, Radio Comm.	CMW500	158150	Rohde & Schwarz	12 M	-	01.05.2017

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	2018-03-22
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