

Test Report

19-1-0173601T06a-C1



Deutsche
Akkreditierungsstelle
D-PL-12047-01-01
D-PL-12047-01-03
D-PL-12047-01-04

Number of pages:	26	Date of Report:	2021-Jan-20
Testing company:	CETECOM GmbH Im Teelbruch 116 45219 Essen Germany Tel. + 49 (0) 20 54 / 95 19-0 Fax: + 49 (0) 20 54 / 95 19-150	Applicant:	Continental Advanced Antenna GmbH
Test Object / Tested Device(s):	RKE-Transceiver , RKE232E1		
FCC ID:	2ACC7RKE232E1	IC:	11980A-RKE232E1
Testing has been carried out in accordance with:	FCC Regulations: Title 47, Subpart 15.231 ISED Regulations: RSS-Gen, Issue 5; RSS-210, Issue 10 Deviations, modifications or clarifications (if any) to above mentioned documents are written in each section under "Test method and limit".		
Tested Technology:	SRD		
Test Results:	<input checked="" type="checkbox"/> The EUT complies with the requirements in respect of all parameters subject to the test. The test results relate only to devices specified in this document The test report 19-1-0173601T06a_C1 on 2021-Jan-20 substitutes the test report 19-1-0173601T06a on 2020-Dec-16, which herewith gets invalid.		
Signatures:	<div></div> <div>Dipl.-Ing. Ninovic Perez Test Lab Manager Authorization of test report</div> <div>Guangcheng Huang Test manager Responsible of test report</div>		

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The listed attachments are separate documents.			

1 General information

1.1 Disclaimer and Notes

The test results of this test report relate exclusively to the test item specified in this test report as specified in chapter 2.7. CETECOM does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item.

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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.

1.1. Summary of Test Results

The EUT integrates a Bluetooth transmitter. Other implemented wireless technologies were not considered within this test report.

Test case	Reference Clause FCC ☒	Reference Clause ISSED ☒	Page	Remark	Result
Radiated field strength fundamental at 3 m	§2.1046 §15.205 §15.231(b)(1)(2)	RSS-210, Issue 9, Chapter A1.2	15	-	PASSED
20 dBc bandwidth	§2.202(a) §2.1049	RSS Gen, Issue 5, Chapter 6.7	20	-	PASSED
99% bandwidth	§2.202(a) §2.1049	RSS Gen, Issue 5, Chapter 6.7	21	-	PASSED
General field strength emissions (radiated 9 kHz to 30 MHz)	§15.209(a)	RSS-Gen, Issue 5 Chapter 8.9, Table 6	11	-	PASSED
Radiated field strength spurious emissions	§2.1046 §15.205 §15.231(b)(1)(2)	RSS-210, Issue 9, Chapter A1.2	15	-	PASSED
Transmitter timing: 1. Deactivation of transmissions 2. Periodic transmissions	§15.231 (a)(1)(2)(3)	RSS-210, Issue 9, Chapter A1.1	22	-	PASSED
Conducted emissions	§15.207	RSS-Gen, Issue 5: Chapter 8.8, Table 4	-	-	N/A

PASSED

The EUT complies with the essential requirements in the standard.

FAILED

The EUT does not comply with the essential requirements in the standard.

NP

The test was not performed by the CETECOM Laboratory.

NT

Not tested

N/A

Not applicable

*The calculation of the measurement uncertainty shows compliance with the "maximum measurement uncertainties" of the tested standard and therefore for result evaluation the stated uncertainties will not be additionally added to the measured results.

1.2. Summary of Test Methods

Test case	Test method
Duty-Cycle	ANSI 63.10:2013, §11.6(b)
Emission Bandwidth 20 dB	ANSI C63.10:2013
Occupied Channel Bandwidth 99%	ANSI C63.10:2013, §6.9.3
Emissions in non-restricted frequency bands	ANSI C63.10:2013, §11.11, §6.10.5
Transmitter Peak output power radiated	Result calculated with measured conducted RF-power value and stated/measured antenna gain for band of interest
Radiated field strength emissions below 30 MHz	ANSI C63.10-2013 §6.3, §6.4
Radiated field strength emissions 30 MHz- 1 GHz	ANSI C63.4-2014 §8.2.3, ANSI C63.10-2013 §6.3, § 6.5
Radiated field strength emissions above 1 GHz	ANSI C63.4-2014 §8.3, ANSI C63.10-2013 §6.3, § 6.6
AC-Power Lines Conducted Emissions	ANSI C63.4-2014 §7, ANSI C63.10-2013 § 6.2

And reference also to Test methods in KDB558074

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:	Niels Jeß
Accreditation scope:	DAkkS Webpage
Test location:	CETECOM GmbH; Im Teelbruch 116; 45219 Essen - Kettwig

2.2 General limits for environmental conditions

Temperature:	22±2 °C
Relative. humidity:	45±15% rH

2.3 Test Laboratories sub-contracted

Company name:

2.4 Organizational Items

Order No.:	1
Responsible test manager:	Guangcheng Huang
Receipt of EUT:	2020-Aug-06
Date(s) of test:	2020-Aug-10 – 2021-Jan-18
Version of template:	14.3

2.5 Applicant's details

Applicant's name:	Continental Advanced Antenna GmbH
Address:	Römerring 1 31137 Hildesheim Niedersachsen Deutschland
Contact Person:	Thomas Schuhbeck
Contact Person's Email:	thomas.schuhbeck@continental.com

2.6 Manufacturer's details

Manufacturer's name:	Same as the applicant
Address:	Same as the applicant

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

Short description*)	PMT Sample No.	EUT	Type	S/N	HW status	SW status
EUT A	19-1-01736S42_C01	Reference antenna FCC	Dipole with reflector	-	-	-
EUT B	19-1-01736S15_C01	RKE-Transceiver module	RKE232E1	-	13620027B02 V02	V11.31 FCC-CW (0x2E) ANT1/CH1
EUT C	19-1-01736S13_C01	RKE-Transceiver module	RKE232E1	-	13620027B02 V02	V11.31 FCC-CW (0x2E) ANT1/CH2
EUT D	19-1-01736S16_C01	RKE-Transceiver module	RKE232E1	-	13620027B02 V02	V11.31 FCC-CW (0x2E) ANT1/CH3
EUT E	19-1-01736S17_C01	RKE-Transceiver module	RKE232E1	-	13620027B02 V02	V11.31 FCC-CW (0x2E) ANT2/CH3
EUT F	19-1-01736S18_C01	RKE-Transceiver module	RKE232E1	-	13620027B02 V02	V11.31 FCC APPLICANT ION SAMPLE

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

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

Short description*)	PMT Sample No.	Auxiliary Equipment	Type	S/N	HW status	SW status
AE 1	19-1-01736S38_C01	Adapter-plate	For mounting module to reference antenna	-	-	-
AE 2	19-1-01736S22_C01	Testbox	RKE232 FCC flashed to 0x2E	180401C06	-	RKE223_V7.0
AE 3	19-1-01736S37_C01	Testkey	434 MHz	-	-	-
AE 4	19-1-01736S47_C01	Testkey	434 MHz	-	20/20/00	20/27/80
AE 5	19-1-01736S49_C01	Simulation testbench	-	-	-	-

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

2.9 Connected cables

Short description*)	PMT Sample No.	Cable type	Connectors	Lenght
CAB 1	19-1-01736S26_C01	DC supply to RKE-module	Banana	1.5 m
CAB 2	19-1-01736S25_C01	Testbox to RKE-module	RS232 serial	1.5 m

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

2.10 Softwares

Short description*)	PMT Sample No.	Software	Type	S/N	HW status	SW status
	-	-	-	-	-	-

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

2.11 EUT set-ups

set-up no. *)	Combination of EUT and AE	Description
Set. 1	EUT A + EUT B + AE 1 + CAB 1	Used for Radiated measurements (CW mode, ANT1/CH1)
Set. 2	EUT A + EUT E + AE 1 + CAB 1	Used for Radiated measurements (CW mode, ANT2/CH3)
Set. 3	EUT A + EUT F + AE 1 + AE 2 + CAB 2 (+AE 3)**	Used for Radiated measurements (RX mode)
Set. 4	EUT F + AE 1 + AE 2 + CAB 2	Used for Conducted measurements (modulated mode)
Set. 5	EUT F + AE 1 + AE 2 + AE 3 + CAB 2	Used for Conducted measurements (RX mode)
Set. 6	EUT F + AE 4 + AE 5	Used for measuring transmission timing

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

**) Device in the parentheses is only used before and after the test to verify that the EUT is under RX mode.

2.12 EUT operation modes

EUT operating mode no. *1)	Operating modes	Additional information
Op. 1	TX CW	Continuous wave
Op. 2	TX modulated	Continuously transmitting modulated signal
Op. 3	RX	Continuously receiving signal
Op. 4	Engine start 1	Communication when pressing the button "engine start" and the key fob is in the vehicle
Op. 5	Engine start 2	Communication when pressing the button "engine start" and the key fob is not in the vehicle
Op. 6	Unlock door 1	Communication before unlock the door and the key fob is near to the vehicle
Op. 7	Unlock door 2	Communication before unlock the door and the key fob is away from the vehicle

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

*2) Please refer to document TEST_SETUP_DESCRIPTION_RKE232E1_RKE232J1_2020-07-31.pdf

3 Equipment under test (EUT)

3.1 General Data of Main EUT as Declared by Applicant

Product name	RKE232E1		
Kind of product	RKE-Transceiver		
Firmware	<input type="checkbox"/> for normal use	<input checked="" type="checkbox"/> Special version for test execution	
Power supply	<input type="checkbox"/> AC Mains	-	
	<input checked="" type="checkbox"/> DC Mains	12 V DC via banana Connector	
	<input type="checkbox"/> Battery	-	
Operational conditions	T _{nom} =21 °C	T _{min} =-40 °C	T _{max} =+105 °C
EUT sample type	Pre-Production		
Weight	-		
Size	-		
Interfaces/Ports	-		
For further details refer Applicants Declaration & following technical documents			
EN_Angaben_RKE232E1_ANNEX D_2021-01-20.pdf (2021-01-20)			
TEST_SETUP_DESCRIPTION_RKE232E1_RKE232J1_2020-07-31.pdf (2020-07-31)			
Questionnaire V512_Reporte_RKE232E1_RKE232J1_V2.xlsx (2020-08-13)			

3.2 Detailed Technical data of Main EUT as Declared by Applicant

Frequency Band	433.47 MHz – 434.37 MHz	
Number of Channels (USA/Canada -bands)	3 (Ch1: 433.47 MHz / Ch2: 434.37 MHz / Ch3: 433.92 MHz) Range of operation < 1 MHz	
Number of antenna ports	2	
Nominal Channel Bandwidth	165 kHz	
Max. 20dB bandwidth (measured)	69.87 kHz	
Max. 99% bandwidth (measured)	62.82 kHz	
Type of Modulation Data Rate	<input checked="" type="checkbox"/> 2-FSK (Frequency shift keying) <input type="checkbox"/> $\pi/4$ DQPSK 2 Mbit / s <input type="checkbox"/> 8DPSK 3 Mbit / s	
Max. field strength (measured)	80.62 dB μ V/m AV@3m distance (Calculated from Peak value with Duty-Cycle Correction)	
Max. ERP Power (Calculated EIRP)	-14.58 dBm (0.035 mW)	
Installed options (Not tested within this report)	<input checked="" type="checkbox"/> None (No other wireless functionality)	
Antenna Type(s)	External, separate RF-connector	
Antenna Gain(s)	+2 dBi	
FCC label attached	No	
Test firmware / software and storage location	V11.31, CETECOM EMC storage room	
For further details refer Applicants Declaration & following technical documents		
Description of Reference Document (supplied by applicant)	Version	Total Pages
EN_Angaben_RKE232E1_ANNEX D_2021-01-20.pdf (2021-01-20)	-	2
Questionnaire V512_Reporte_RKE232E1_RKE232J1_V2.xlsx (2020-08-13)	V2	1

3.3 Modifications on Test sample

Additions/deviations or exclusions	
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4 Measurements

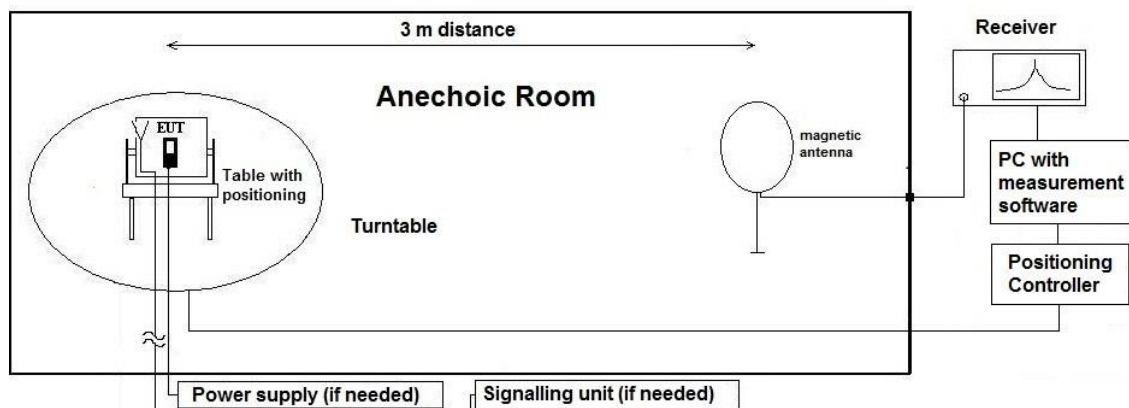
4.1 Radiated field strength emissions below 30 MHz

4.1.1 Description of the general test setup and methodology, see below example:

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:

The measurement is made according to relevant reference clauses:
(See Tables *Summary of Test Results* and *Summary of Test Methods* on page 6)

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 (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 (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.

4.1.2 Measurement Location

Test site	120901 - SAC - Radiated Emission <1GHz
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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 $0.625 \times \text{Lambda}$.
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 < Dnear-field)	2'te Condition (Limit distance bigger dnear-field)	Distance Correction accord. Formula
kHz	9.00E+03	33333.33	5305.17	300		fullfilled	not fullfilled	-80.00
	1.00E+04	30000.00	4774.65			fullfilled	not fullfilled	-80.00
	2.00E+04	15000.00	2387.33			fullfilled	not fullfilled	-80.00
	3.00E+04	10000.00	1591.55			fullfilled	not fullfilled	-80.00
	4.00E+04	7500.00	1193.66			fullfilled	not fullfilled	-80.00
	5.00E+04	6000.00	954.93			fullfilled	not fullfilled	-80.00
	6.00E+04	5000.00	795.78			fullfilled	not fullfilled	-80.00
	7.00E+04	4285.71	682.09			fullfilled	not fullfilled	-80.00
	8.00E+04	3750.00	596.83			fullfilled	not fullfilled	-80.00
	9.00E+04	3333.33	530.52			fullfilled	not fullfilled	-80.00
	1.00E+05	3000.00	477.47			fullfilled	not fullfilled	-80.00
	1.25E+05	2400.00	381.97			fullfilled	not fullfilled	-80.00
	2.00E+05	1500.00	238.73			fullfilled	fullfilled	-78.02
	3.00E+05	1000.00	159.16			fullfilled	fullfilled	-74.49
	4.00E+05	750.00	119.37			fullfilled	fullfilled	-72.00
	4.90E+05	612.24	97.44			fullfilled	fullfilled	-70.23
	5.00E+05	600.00	95.49			fullfilled	not fullfilled	-40.00
	6.00E+05	500.00	79.58			fullfilled	not fullfilled	-40.00
	7.00E+05	428.57	68.21			fullfilled	not fullfilled	-40.00
	8.00E+05	375.00	59.68			fullfilled	not fullfilled	-40.00
	9.00E+05	333.33	53.05			fullfilled	not fullfilled	-40.00
MHz	1.00	300.00	47.75	30		fullfilled	not fullfilled	-40.00
	1.59	188.50	30.00			fullfilled	not fullfilled	-40.00
	2.00	150.00	23.87			fullfilled	fullfilled	-38.02
	3.00	100.00	15.92			fullfilled	fullfilled	-34.49
	4.00	75.00	11.94			fullfilled	fullfilled	-32.00
	5.00	60.00	9.55			fullfilled	fullfilled	-30.06
	6.00	50.00	7.96			fullfilled	fullfilled	-28.47
	7.00	42.86	6.82			fullfilled	fullfilled	-27.13
	8.00	37.50	5.97			fullfilled	fullfilled	-25.97
	9.00	33.33	5.31			fullfilled	fullfilled	-24.95
	10.00	30.00	4.77			fullfilled	fullfilled	-24.04
	10.60	28.30	4.50			fullfilled	fullfilled	-23.53
	11.00	27.27	4.34			fullfilled	fullfilled	-23.21
	12.00	25.00	3.98			fullfilled	fullfilled	-22.45
	13.56	22.12	3.52			fullfilled	fullfilled	-21.39
	15.00	20.00	3.18			fullfilled	fullfilled	-20.51
	15.92	18.85	3.00			fullfilled	fullfilled	-20.00
	17.00	17.65	2.81			not fullfilled	fullfilled	-20.00
	18.00	16.67	2.65			not fullfilled	fullfilled	-20.00
	20.00	15.00	2.39			not fullfilled	fullfilled	-20.00
	21.00	14.29	2.27			not fullfilled	fullfilled	-20.00
	23.00	13.04	2.08			not fullfilled	fullfilled	-20.00
	25.00	12.00	1.91			not fullfilled	fullfilled	-20.00
	27.00	11.11	1.77			not fullfilled	fullfilled	-20.00
	29.00	10.34	1.65			not fullfilled	fullfilled	-20.00
	30.00	10.00	1.59			not fullfilled	fullfilled	-20.00

4.1.3 Limit

Radiated emissions limits, (3 meters)					
Frequency Range [MHz]	Limit [$\mu\text{V}/\text{m}$]	Limit [$\text{dB}\mu\text{V}/\text{m}$]	Distance [m]	Detector	RBW [kHz]
0.009 – 0.09	2400 / f [kHz]	67.6 – 20Log(f) (kHz)	300	Pk & Avg	0.2
0.09 – 0.11	2400 / f [kHz]	67.6 – 20Log(f) (kHz)	300	Quasi peak	0.2
0.11 – 0.15	2400 / f [kHz]	67.6 – 20Log(f) (kHz)	300	Pk & Avg	0.2
0.15 – 0.49	2400 / f [kHz]	67.6 – 20Log(f) (kHz)	300	Pk & Avg	9
0.49 – 1.705	24000 / f [kHz]	87.6 – 20Log(f) (kHz)	30	Quasi peak	9
1.705 - 30	30	29.5	30	Quasi peak	9

*Remark: In Canada same limits apply, just unit reference is different

4.1.4 Result

Diagram	Antenna port / Channel	Mode	Setup	Maximum Level [$\text{dB}\mu\text{V}/\text{m}$] Frequency Range 0.009 – 30 MHz	Result
2.01	Ant1 Ch1	TX CW	Standing position	19.71 (Noise floor)	PASSED
2.02	Ant1 Ch1	TX CW	Lying position	19.71 (Noise floor)	PASSED
2.03	Ant2 Ch2	TX CW	Lying position	19.50 (Noise floor)	PASSED

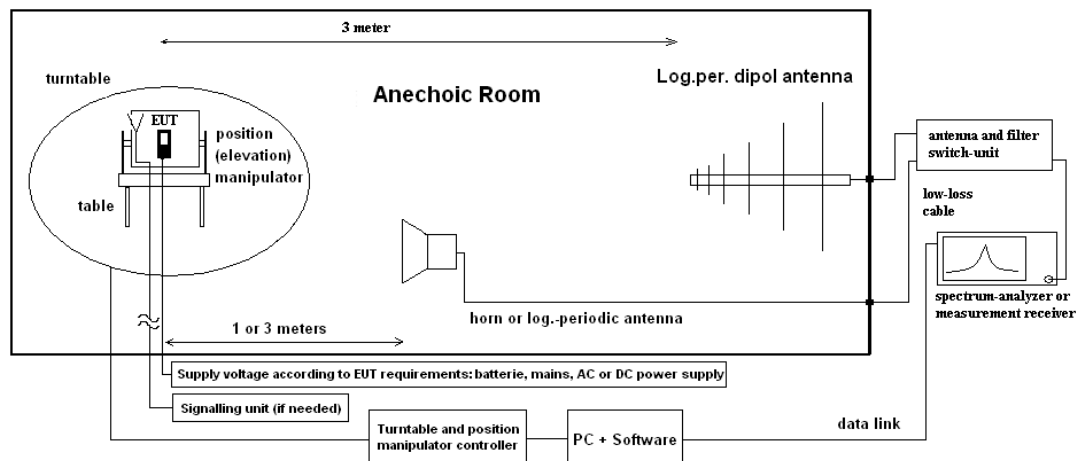
Remark: for more informations and graphical plot see annex A1CETECOM_TR19-1-0173601T06a_A1_C1

4.2 Radiated field strength emissions 30 MHz – 1 GHz

4.2.1 Description of the general test setup and methodology, see below example:

Evaluating the 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 16-1-4:2010 compliant semi anechoic room (SAR) and fully anechoic room (FAR) recognized by the regulatory commission. The measurement distance was set to 3 meter for frequencies up to 18 GHz and 2 meter above 18 GHz. 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:

The measurement is made according to relevant reference clauses:

(See Tables *Summary of Test Results* and *Summary of Test Methods* on page 6)

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.

4.2.2 Measurement Location

Test site	120901 - SAC - Radiated Emission <1GHz
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4.2.3 Limit

Fundamental: Radiated emissions limits, (3 meters)				
Frequency Range [MHz]	Limit [μV/m]	Limit [dBμV/m]	Detector	RBW / VBW [kHz]
40.66-40.70 (Only USA)	2250	67.04	Quasi peak	100 / 300
70-130	1250	61.93	Quasi peak	100 / 300
130-174	1250 to 3750	61.93 to 71.48	Quasi peak	100 / 300
174-260	3750	71.48	Quasi peak	100 / 300
260-470	3750 to 12500	71.48 to 81.93	Quasi peak	100 / 300
Above 470	12500	81.93	Quasi peak	100 / 300

Spurious: Radiated emissions limits, (3 meters)				
Frequency Range [MHz]	Limit [μV/m]	Limit [dBμV/m]	Detector	RBW / VBW [kHz]
40.66-40.70 (Only USA)	225	47.04	Quasi peak	100 / 300
70-130	125	41.93	Quasi peak	100 / 300
130-174	125 to 375	41.93 to 51.48	Quasi peak	100 / 300
174-260	375	51.48	Quasi peak	100 / 300
260-470	375 to 1250	51.48 to 61.93	Quasi peak	100 / 300
Above 470	1250	61.93	Quasi peak	100 / 300

4.2.4 Result

Fundamental emissions

Diagram	Channel / Antenna port	Mode	Setup	Max. PK Level [dBμV/m]	Max. AV Level [dBμV/m]	Limit AV level [dBμV/m]	Result
3.01b	Ch1 / Ant1	TX	Standing position	97.53	80.20	80.81	PASSED
3.03b	Ch1 / Ant1	TX	Lying position	92.27	74.94	80.81	PASSED
3.04b	Ch3 / Ant2	TX	Standing position	97.95	80.62	80.83	PASSED

Remark 1: for more informations and graphical plot see annex A1 **CETECOM_TR19-1-0173601T06a_A1_C1**

Remark 2: Duty cycle correction factor is -17.33 dB.

Spurious emissions

Diagram	Channel / Antenna port	Mode	Setup	Maximum Level [dBμV/m] Frequency Range 30 – 1000 MHz	Result
3.01a	Ch1 / Ant1	TX	Standing position	23 (Noise floor)	PASSED
3.01c	Ch1 / Ant1	TX	Standing position	33 (Noise floor)	PASSED
3.03a	Ch1 / Ant1	TX	Lying position	25 (Noise floor)	PASSED
3.03c	Ch1 / Ant1	TX	Lying position	33 (Noise floor)	PASSED
3.02a	Ch3 / Ant2	TX	Standing position	24 (Noise floor)	PASSED
3.02c	Ch3 / Ant2	TX	Standing position	34 (Noise floor)	PASSED
3.04	Ch2 / Ant2	RX	Standing position	33 (Noise floor)	PASSED

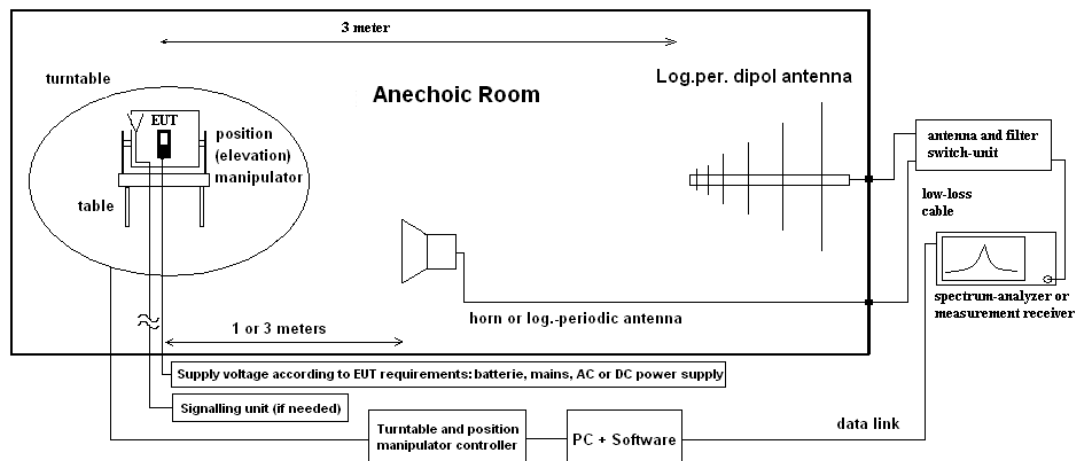
Remark: for more informations and graphical plot see annex A1 **CETECOM_TR19-1-0173601T06a_A1_C1**

4.3 Radiated field strength emissions above 1 GHz

4.3.1 Description of the general test setup and methodology, see below example:

Evaluating the 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 18-1-4:2010 compliant fully anechoic room (FAR) recognized by the regulatory commission. The measurement distance was set to 3 meter for frequencies up to 18 GHz and 2 meter above 18 GHz. 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:

The measurement is made according to relevant reference clauses:

(See Tables *Summary of Test Results* and *Summary of Test Methods* on page 6)

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.

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 over 3-orthogonal axis, the antenna height and tilting or three axis scan for portable/small equipment.

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

Formula:

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

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

E_C = Electrical field – corrected value

E_R = Receiver reading

M = Margin

L_T = Limit

A_F = 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.

4.3.2 Measurement Location

Test site 1 – 18 GHz	120904 - FAC1 - Radiated Emissions
Test site 18 – 26.5 GHz	120904 - FAC1 - Radiated Emissions

4.3.3 Limit

Radiated emissions limits, (3 meters)				
Frequency Range [MHz]	Limit [$\mu\text{V}/\text{m}$]	Limit [$\text{dB}\mu\text{V}/\text{m}$]	Detector	RBW / VBW [kHz]
Above 1000	500	54	Average	1000 / 3000
Above 1000	5000	74	Peak	1000 / 3000

4.3.4 Result

Diagram	Channel / Antenna port	Mode	Setup	Maximum Level [$\text{dB}\mu\text{V}/\text{m}$] Frequency Range 1 – 5 GHz	Result
4.02	Ch1 / Ant1	TX	EUT standing	60 (Noise floor)	PASSED
4.03	Ch1 / Ant1	TX	EUT lyng	60 (Noise floor)	PASSED
4.01	Ch3 / Ant1	RX	EUT standing	60 (Noise floor)	PASSED

Remark: for more informations and graphical plot see annex A1CETECOM_TR19-1-0173601T06a_A1_C1

4.4 Emission Bandwidth 20 dB

4.4.1 Description of the general test setup and methodology, see below example:

The EUT's RF-signal is coupled out by a suitable antenna coupling connector. The signal is first attenuated then connected to the spectrum – analyzer for specific RF-measurements. The specific attenuation losses for both signal paths/branches are determined prior to the measurement within a set-up calibration. These are then taken into account by correcting the measurement readings on the spectrum-analyzer.

Testing method:

The measurement is made according to relevant reference clauses:
(See Tables *Summary of Test Results* and *Summary of Test Methods* on page 6)

EUT settings

The continuous transmission is set in each channel and measured individually.
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.

4.4.2 Measurement Location

Test site	120910 - Radio Laboratory 1 (TS 8997)
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4.4.3 Limit

Limit [kHz]	Detector [MaxHold]	RBW / VBW [kHz]
--	MaxPeak	10 / 30
0.25% of fc	MaxPeak	1 / 3

Remark: fc is the center frequency. RBW is between 1% and 5% of the bandwidth.

4.4.4 Result

Mode	Channel / Antenna port	Frequency [MHz]	20 dB bandwidth [kHz]	Result
TX	Ch1 / Ant1	433.47	63.46	PASSED
TX	Ch2 / Ant1	434.37	63.14	PASSED
TX	Ch3 / Ant1	433.92	69.87	PASSED

Remark: for more informations and graphical plot see annex A1 **CETECOM_TR19-1-0173601T06a_A1_C1**

4.5 Occupied Channel Bandwidth 99%

4.5.1 Description of the general test setup and methodology, see below example:

The EUT's RF-signal is coupled out by a suitable antenna coupling connector. The signal is first attenuated then on the direct RF-path is connected to the spectrum – analyzer for specific RF-measurements. The specific attenuation losses for both signal paths/branches are determined prior to the measurement within a set-up calibration. These are then taken into account by correcting the measurement readings on the spectrum-analyzer.

Testing method:

The measurement is made according to relevant reference clauses:
(See Tables *Summary of Test Results* and *Summary of Test Methods* on page 6)

EUT settings

For FHSS-systems hopping mode was switched-off so fixed 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.

4.5.2 Measurement Location

Test site	120910 - Radio Laboratory 1 (TS 8997)
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4.5.3 Limit

When the occupied bandwidth limit is not stated in the applicable reference measurement method, the transmitted signal bandwidth shall be reported as the 99% emission bandwidth, as calculated or measured.

4.5.4 Result

Mode	Channel / Antenna port	Frequency [MHz]	99% Occupied bandwidth [kHz]
TX	Ch1 / Ant1	433.47	63.46
TX	Ch2 / Ant1	434.37	69.87
TX	Ch3 / Ant1	433.92	69.87

Remark: for more informations and graphical plot see annex A1 **CETECOM_TR19-1-0173601T06a_A1_C1**

4.6 Timing requirements

4.6.1 Description of the general test setup and methodology, see below example:

The EUT's RF-signal is coupled out by a suitable antenna coupling connector. The signal is first attenuated then on the direct RF-path is connected to the spectrum – analyzer for specific RF-measurements. The specific attenuation losses for both signal paths/branches are determined prior to the measurement within a set-up calibration. These are then taken into account by correcting the measurement readings on the spectrum-analyzer.

Testing method:

The measurement is made according to relevant reference clauses:
(See Tables *Summary of Test Results* and *Summary of Test Methods* on page 6)

EUT settings

The EUT is set to normal operating mode.

4.6.2 Measurement Location

Test site	120910 - Radio Laboratory 1 (TS 8997)
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4.6.3 Limit

- (1) TX shall switch off automatically within 5 s after being released/activated
- (2) Periodic transmission only permitted for polling or supervision transmissions. Total duration < 2 s/hour
- (3) transmission of set-up information for security systems < 10 s
- (4) Duration of each transmission < 1 s
- (5) Silent period between transmissions > 30 times the duration of the transmission
- (6) Silent period between transmissions > 10 s

4.6.4 Result

Activation of transmitter	De-activation of transmitter
<input checked="" type="checkbox"/> manual activation of transmitter	<input checked="" type="checkbox"/> automatical de-activation of transmitter
<input type="checkbox"/> automatical activation of transmitter	
Verdict	
Operating mode 4: PASSED Operating mode 5: PASSED Operating mode 6: PASSED Operating mode 7: PASSED	

Remark: for more informations and graphical plot see annex A1CETECOM_TR19-1-0173601T06a_A1_C1

4.7 Results from external laboratory

None

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4.8 Opinions and interpretations

None

-

4.9 List of abbreviations

None

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5 Equipment lists

ID	Description	Manufacturer	SerNo	Cal due date
	120901 - SAC - Radiated Emission <1GHz			21.07.2025
20574	Biconilog Hybrid Antenna BTA-L	Frankonia GmbH	980026L	03.05.2022
20487	CETECOM Semi Anechoic Chamber < 1GHz	ETS-Lindgren GmbH	-	15.07.2025
20620	EMI Test Receiver ESU26	Rohde & Schwarz Messgerätebau GmbH	100362	13.05.2021
20482	filter matrix Filter matrix SAR 1	CETECOM GmbH	-	
20885	Power Supply EA3632A	Agilent Technologies Deutschland GmbH	75305850	
	120904 - FAC1 - Radiated Emissions			
20341	Digital Multimeter Fluke 112	Fluke Deutschland GmbH	81650455	25.05.2022
20720	EMC32 [FAC]	Rohde & Schwarz Messgerätebau GmbH	V10.xx	
20489	EMI Test Receiver ESU40	Rohde & Schwarz Messgerätebau GmbH	1000-30	13.05.2021
20254	High Pass Filter SHC 2600/12750-1.5KK (GSM1800/1900/DECT)	Trilithic	23042	
20868	High Pass Filter AFH-07000	AtlanTecRF	16071300004	
20291	High Pass Filter WHJ 2200-4EE (GSM 850/900)	Wainwright Instruments GmbH	14	
20020	Horn Antenna 3115 (Subst 1)	EMCO Elektronik GmbH	9107-3699	19.07.2021
20302	Horn Antenna BBHA9170 (Meas 1)	Schwarzbeck Mess-Elektronik OHG	155	15.04.2023
20549	Log.Per-Antenna HL025	Rohde & Schwarz Messgerätebau GmbH	1000060	31.07.2021
20611	Power Supply E3632A	Agilent Technologies Deutschland GmbH	KR 75305854	
20338	Pre-Amplifier 100MHz - 26GHz JS4-00102600-38-5P	Miteq Inc.	838697	
20484	Pre-Amplifier 2,5GHz - 18GHz AMF-5D-02501800-25-10P	Miteq Inc.	1244554	
20287	Pre-Amplifier 25MHz - 4GHz AMF-2D-100M4G-35-10P	Miteq Inc.	379418	
20690	Spectrum Analyzer FSU	Rohde & Schwarz Messgerätebau GmbH	100302/026	23.05.2021

ID	Description	Manufacturer	SerNo	Cal due date
20439	UltraLog-Antenna HL 562	Rohde & Schwarz Messgerätebau GmbH	100248	10.03.2023
	120911 - Radio Laboratory 2			
20869	VT4002 Klimaschrank	Vötsch Industrietechnik GmbH	521/79152	11.10.2021
20431	Model 7405 Near-Field Probe Set	EMCO Elektronik GmbH	9305-2457	-

Tools used in 'P1M1'

6 Measurement Uncertainty valid for conducted/radiated measurements

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 its contribution to the overall uncertainty according its statistical distribution calculated.

RF-Measurement	Reference	Frequency range	Calculated uncertainty based on a confidence level of 95%						Remarks
Conducted emissions (U _{CISPR})	-	9 kHz - 150 kHz 150 kHz - 30 MHz	4.0 dB 3.6 dB						-
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 - 26.5 GHz	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 - 12.75 GHz	1.48	N/A	1.51	N/A	1.43	--	
		12.75 GHz – 18 GHz	1.81	N/A	1.83	N/A	1.77	--	
		18 GHz - 26.5 GHz	1.83	N/A	1.85	N/A	1.79	--	
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	5.01dB						Magnetic field strength
		30 MHz - 1 GHz	5.83 dB						Electrical
		1 GHz - 18 GHz	4.91 dB						Field
		18-26.5 GHz	5.06 dB						strength

7 Versions of test reports (change history)

Version	Applied changes	Date of release
--	Initial release	2020-Dec-16
C1	Update measuring results of bandwidth and radiated carrier power	2021-Jan-20
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End of Test Report