

PARTIAL Test Report 21-1-0165301T06a_C1



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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

Product: RKE module HAF FCC

Model: RKE223E1

FCC ID: 2ACC7RKE223E1 IC: 11980A-RKE223E1

Testing has been carried out in accordance with:

FCC Regulations: Title 47 CFR, Chapter I, Subchapter A, Subpart C: §15.231

ISED Regulations: RSS-210, Issue 10, Annex A

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:
☐ The EUT complies with the requirements in respect of selected parameters subject to

the test.

The test results relate only to devices specified in this document

This test report CETECOM_TR21-1-0165301T06a_C1 dated on 2022-Apr-12 substitutes the CETECOM_TR21-1-0165301T06a dated on 2022-Mar-01, which herewith gets invalid.

Signatures:

Dipl.-Ing. Christian Lorenz Senior Test Manager Authorization of test report Guangcheng Huang Test manager Responsible of test report

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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

Test case	Reference in FCC <mark>⊠</mark>	Reference in ISED ⊠	Page	Remark	Result
Radiated field strength emissions below 30	§15.205(a)	RSS-Gen: Issue 5			NT
MHz Radiated field strength emissions 30 MHz – 1 GHz (inclusive fundamental field strength)	§15.209(a) §15.231(b) §15.33 §15.35	§8.9 Table 6 RSS-210, Issue 10, §A.1, Table A.1	9	From 2 nd harmonic	Passed
Radiated field strength emissions above 1 GHz	§15.231(b)§ 15.33 §15.35	RSS-210, Issue 10, §A.1, Table A.1	12	Till 6 th harmonic	Passed
Transmitter timing: 1. Deactivation of transmissions 2. Periodic transmissions	§15.231 (a)(1)(2)(3)	RSS-210, Issue 10, §A1.1(a)(b)(c)		Not tested See initial modules report 1)	NT
20dBc bandwidth	§15.231(c)	RSS-210, Issue 10, §A1.3 RSS-Gen, Issue 5, Chapter 6.7		Not tested See initial modules report ¹⁾	NT
99% bandwidth	§2.1049	RSS-Gen, Issue 5, Chapter 6.7		Not tested See initial modules report 1)	NT

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.

Remark1: Details can be found in initial test report for the module: CETECOM_TR18_1_0257101T93a_C2.

1.2. Summary of Test Methods

Test case	Test method
Radiated field strength emissions below 30 MHz	ANSI C63.10-2013 §6.3, §6.4
Radiated field strength emissions 30 MHz – 1 GHz	ANSI C63.10-2013 chapter 6.5
Radiated field strength emissions above 1 GHz	ANSI C63.10-2013 chapter 6.6
20dBc bandwidth, 99% bandwidth	ANSI C63.10-2013, chapter 6.9

^{*}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.



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: Volker Briddigkeit

Accreditation scope: DAkkS Webpage

Test location: CETECOM GmbH; Mündelheimer Weg 35; 40472 Düsseldorf

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.: 21-1-01653OR01

Responsible test manager: Guangcheng Huang

Receipt of EUT: 2021-Feb-22

Date(s) of test: 2021-Feb-22 – 2021-Feb-23

Version of template: 14.5

2.5 Applicant's details

Applicant's name: Continental Advanced Antenna GmbH

Address: Römerring 1 31137 Hildesheim

Germany

Contact Person: Mr. Thomas Schuhbeck

Contact Person's Email: Thomas.schuhbeck@continental.com

2.6 Manufacturer's details

Manufacturer's name:	Continental Advanced Antenna, Sociedade Unipessoal Lda
Address:	Rua Professor Anton Kathrein
	5000-082 Vila Real
	Portugal



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

Short descrip tion*)	PMT Sample No.	Product	Model	Туре	S/N	HW status	SW status
EUT 01	S10	RKE Module HAF FCC	RKE223E1	Application sample (50020030)	000170	13612160B08 V00	11.31
EUT 02	S07	RKE Module BASE FCC	RKE223E1	Application sample (50020025)	000131	13612160B08 V00	11.31

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

Remark: EUT02 not tested regarding spurious emission, EUT01 determined as worst-case configuration regarding value of field strength during pre-tests session. Details can be found in test report for pre-tests CETECOM TR21-1-0165301T02a

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

Short descrip tion*)	PMT Sample No.	Auxiliary Equipment	Туре	S/N	HW status	SW status
AE 01	S24	Testbox FCC (Hex 0x2B)	Testbox	180401B35		RKE223_V7. 0
AE 02	S21	Mercedes-Benz EQS sedan (V297)	Car			

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

2.9 Connected cables

Short descrip tion*)	PMT Sample No.	Cable type	Connectors	Length
CAB 01	\$26	Cable harness Testbox to	Specific connector	1.5m
CABUI	320	Application sample	specific conflector	1.5111

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

2.10 Software

Short descrip tion*)	PMT Sample No.	Software	Туре	S/N	HW status	SW status

^{*)} SW short description is used to simplify the identification of the used software in this test report.

2.11 EUT set-ups

	set-up no.*)	Combination of EUT and AE	Description
I	Set. 1	EUT 01 + AE 01 + AE 02 + CAB 01	Used for Radiated measurements. EUT application mode

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

2.12 EUT operation modes

EUT operating mode no.*)	Operating modes	Additional information
Op. 1	TX application	Continuous modulated carrier with help of AE1.

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



3 Equipment under test (EUT)

3.1 General Data of Main EUT as Declared by Applicant

Product name	RKE223E1	RKE223E1			
Kind of product	RKE Module HAF	RKE Module HAF FCC			
Firmware	☐ for normal use	☐ for normal use ☐ Special version for test execution			
Power supply	☐ AC Mains	-	•		
	☑ DC Mains 12 V DC				
	☐ Battery	☐ Battery Wählen Sie ein Element aus.		nent aus.	
Operational conditions	T _{nom} =21 °C	T _{nom} =21 °C		T _{max} = °C	
EUT sample type	Pre-Production	Pre-Production Pre-Production			
Weight					
Size [LxWxH]					
Interfaces/Ports	See applicant's do	See applicant's documents			
For further details refer Applicants Dec	laration & following	technic	al documents	s:	

3.2 Modifications on Test sample





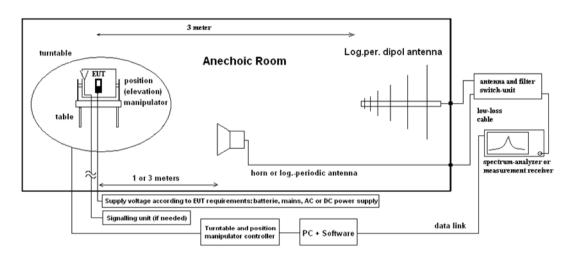
4 Measurements

4.1 Radiated field strength emissions <1 GHz

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

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:

The measurement is made according to relevant reference clauses: (See Tables Summary of Test Results and Summary of Test Methods on page 5)

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 main-taining 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:

 $E_C = E_R + AF + C_L + D_F - G_A \quad \mbox{(1)} \label{eq:eccentric}$ $AF = \mbox{Antenna factor}$ $C_L = \mbox{Cable loss}$

 $M = L_T - E_C$ (2) $D_F = Distance correction factor (if used)$

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 225911 - SAC5 - Radiated Emission <1GHz

4.1.3 Fundamental limits: FCC §15.231(b), RSS-210, Issue 10, Chapter A1.2

Frequency Range [MHz]	3 meters reference measurement		Spurious	settings
	Limit [μV/m]	Limit	Detector	RBW / VBW
		[dBµV/m]		[kHz]
40.66-40.70	2250	67.04		/
(Only USA)				
70-130	1250	61.93		/
130-174	1250 to 3750	61.93 to 71.48	QP-Peak or AV	/
174-260	3750	71.48	QP-Peak Of AV	/
260-470	3750 to 12500	71.48 to 81.93		1000 / 3000
Above 470	12500	81.93		/
Above 1000	12500	81.93		/

4.1.4 Spurious emission limits: FCC §15.231(b), RSS-210, Issue 10, Chapter A1.2

Frequency Range [MHz]	3 meters reference measurement		Spurious	settings
	Limit [μV/m]	Limit	Detector	RBW / VBW
		[dBµV/m]		[kHz]
40.66-40.70	225	47.04		100 / 300
(only USA)				
70-130	125	41.93		100 / 300
130-174	125 to 375	41.93 to 51.48	QP-Peak or AV	100 / 300
174-260	375	51.48	QP-Peak Of AV	100 / 300
260-470	375 to 1250	51.48 to 61.93		100 / 300
Above 470	1250	61.93		100 / 300
Above 1000	1250	61.93		1000/3000



4.1.5 Results for field strength of carrier

Diagram	Channel	Channel frequency	Op. Mode / Set-up no.	Maximum Level [dBμV/m]@3m	Limit: [dBµV/m]@3m	Result
	1 - low	433.47 MHz	1/1	78.41 AV	80.81 AV	Passed
	3 - middle	433.92 MHz	1/1	78.44 AV	80.82 AV	Passed
	2 - high	434.37 MHz	1/1	78.49 AV	80.84 AV	Passed

Remarks:

- 1.) For more information and graphical plot refer to Evaluation Report CETECOM_TR21-1-0163501T02a.
- 2.) power level setting: 0x2B, set on AE1
- 3.) RF-Path 2 used due higher power levels then RF Path 1 (pre-tested)
- 4.) Average value includes duty-cycle correction factor of -17.35 dB due timing of transmitter (modules certification)

4.1.6 Results for spurious emissions

Diagram	Channel	Mode/Set-up	Frequency Range 600 – 1000 MHz [dBµV/m]	Result
2.05	2	1/1	38.086	Passed

Remark 1: for more information and graphical plot see annex A1 CETECOM_TR21-1-0165301T06a_A1

Remark 2: Based on the basic homologation covered by the test report CETECOM_TR18_1_0257110T01b_C1, the tested frequency range of the spurious emissions is reduced. Thus the tested frequency range starts at 600 MHz.

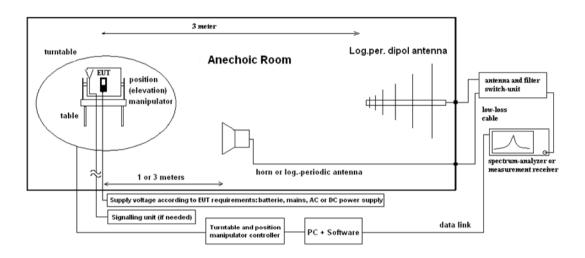


4.2 Radiated field strength emissions >1 GHz

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 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 5)

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 main-taining 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 and the height for EUT with large dimensions 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:

 $E_C = E_R + A_F + C_L + D_F - G_A \quad \text{(1)} \\ E_C = \text{Electrical field} - \text{corrected value} \\ E_R = \text{Receiver reading} \\ M = L_T - E_C \quad \text{(2)} \\ M = \text{Margin} \\ L_T = \text{Limit} \\ A_F = \text{Antenna factor} \\ C_L = \text{Cable loss} \\ D_F = \text{Distance correction factor (if used)}$

 G_A = Gain of pre-amplifier (if used)

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

4.2.2 Measurement Location

Test site 225912 - SAC5 - Radiated Emission >1GHz

4.2.3 Spurious emission limits: FCC §15.231(b), RSS-210, Issue 10, Chapter A1.2

Frequency Range [MHz]	3 meters reference	measurement	Spurious settings	
	Limit [μV/m]	Limit	Detector	RBW / VBW
		[dBµV/m]		[kHz]
Above 1000	1250	61.93	PK / AV	1000/3000

4.2.4 Result

Diagram	Channel	Mode/Set-up	Maximum Level [dBμV/m] Frequency Range 1 – 2.7 GHz	Result
2.06	2	TX / Ant 2 mod.	51.655 * (PK) / 41.977 (AV)	Passed

Remark: for more information and graphical plot see annex A1 CETECOM_TR21-1-0165301T06a_A1 Remark *: Noise level.



4.3 Results from external laboratory

None	-

4.4 Opinions and interpretations

None	-

4.5 List of abbreviations

None	-

5 Equipment lists

ID	Description	Manufacturer	SerNo	Cal due date
	225911 - SAC5 - Radiated Emission <1GHz			2026-Apr-05
25360	Antennenmast BAM 4.5-P	maturo GmbH	BAM 4.5- P/091/17791115	
25361	Controller NCD	maturo GmbH	NCD/202/17791115	
25348	EMI Test Receiver ESR7	Rohde & Schwarz Messgerätebau GmbH	101600	2023-Aug-09
25352	Open Switch and control Platform OSP120	Rohde & Schwarz Messgerätebau GmbH	101542-rV	
25358	Semi Anechoic Chamber SAC5	Albatross Projects GmbH	P27281-016	2026-Jun-30
25357	Ultrabroadband Antenna HL562E	Rohde & Schwarz Messgerätebau GmbH	100824	2023-Oct-09
25038	Loop Antenna HFH2-Z2	Rohde & Schwarz Messgerätebau GmbH	879824/13	2022-April- 01
	225912 - SAC5 - Radiated Emission >1GHz			2026-May-04
25360	Antennenmast BAM 4.5-P	maturo GmbH	BAM 4.5- P/091/17791115	
25361	Controller NCD	maturo GmbH	NCD/202/17791115	
25348	EMI Test Receiver ESR7	Rohde & Schwarz Messgerätebau GmbH	101600	2023-Aug-09
25352	Open Switch and control Platform OSP120	Rohde & Schwarz Messgerätebau GmbH	101542-rV	
25358	Semi Anechoic Chamber SAC5	Albatross Projects GmbH	P27281-016	30.06.2026



	225914 - SAC5 - Radiated Spurious Emission			2026-May-04
25374	Antennenmast CAM 4.0-P	maturo GmbH	CAM 4.0- P/239/2149.01	
25310	Double-Ridged Horn Antenna HF 907	Rohde & Schwarz Messgerätebau GmbH	100334	2024-Oct-03
25377	Low Noise Amplifier 10MHz - 12Ghz	B&Z Technologies	16095	
25378	Low Noise Amplifier 1Ghz - 18GHz	B&Z Technologies	16695-16511	
25372	Open Switch and control Platform OSP120	Rohde & Schwarz Messgerätebau GmbH	101833	
25348	EMI Test Receiver ESR7	Rohde & Schwarz Messgerätebau GmbH	101600	2023-Aug-09



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 it 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		9 kHz - 150 kHz	4.0 dB						
(U _{CISPR})	-	150 kHz - 30 MHz	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 GHz - 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		
			0.127	2 ppm (I	Delta M	/larker)			Frequency
Occupied bandwidth	-	9 kHz - 4 GHz							error
			1.0 dE	3				Power	
	-		0.127	2 ppm (Delta Marker)					Frequency
Emission bandwidth		9 kHz - 4 GHz							error
	-		See above: 0.70 dB						Power
Frequency stability	-	9 kHz - 20 GHz	0.0636 ppm					-	
	-	150 kHz - 30 MHz	5.01dB						Magnetic
Radiated emissions Enclosure								field strength	
		30 MHz - 1 GHz	5.83 c	5.83 dB					
		1 GHz - 18 GHz	4.91 dB						Field
		18-26.5 GHz	5.06 c	IB					strength



7 Versions of test reports (change history)

Version	Applied changes	Date of release
	Initial release	2022-Mar-01
C1	Update on the cover page: the formality of the FCC ID and IC ID. Update in section 4.1.6: Remark on reducing frequency range of the tested spurious emissions.	2022-Apr-12

End of Test Report