

PARTIAL Test Report

19-1-0202601T10a-C1



Number of pages: 28 **Date of Report:** 2021-Jan-27

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:** Eppendorf AG

Product: WiFi-extension for handheld electronic pipettes of Eppendorf Xplorer® family,
Model: Eppendorf Xplorer® connect

FCC ID: 2AXZD4861490500 **IC:** 26635-4861490500

Testing has been carried out in accordance with: **Title 47 CFR, Chapter I**
FCC Regulations, Subchapter A
§15.247 (DTS)

ISED-Regulations
RSS-Gen, Issue 5
RSS 247, Issue 2

Deviations, modifications or clarifications (if any) to above mentioned documents are written in each section under "Test method and limit".

Tested Technology: 2.4GHz W-LAN (IEEE 802.11)

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

Test report 19-1-0202601T10a-C1 is replacing original test report 19-1-0202601T10a, dated 2021-Jan-25. The replaced test report gets invalid herewith.

Signatures:

Dipl.-Ing. Ninovic Perez
Test Lab Manager
Authorization of test report

M. Sc. Patrick Marzotko
Test manager
Responsible of test report

Table of Contents

Table of Annex	3
1 General information	4
1.1 Disclaimer and Notes.....	4
1.1. Summary of Test Results	5
1.2. Summary of Test Methods	6
2 Administrative Data	7
2.1 Identification of the Testing Laboratory.....	7
2.2 General limits for environmental conditions.....	7
2.3 Test Laboratories sub-contracted.....	7
2.4 Organizational Items	7
2.5 Applicant's details	7
2.6 Manufacturer's details	7
2.7 EUT: Type, S/N etc. and short descriptions used in this test report	8
2.8 Auxiliary Equipment (AE): Type, S/N etc. and short descriptions.....	8
2.9 Connected cables	8
2.10 Software.....	8
2.11 EUT set-ups	8
2.12 EUT operation modes.....	9
2.13 Test mode setting.....	9
3 Equipment under test (EUT)	10
3.1 General Data of Main EUT as Declared by Applicant.....	10
3.2 Detailed Technical data of Main EUT as Declared by Applicant	11
3.3 Worst case identification.....	11
3.4 Modifications on Test sample	11
4 Measurements.....	12
4.1 Duty-Cycle	12
4.2 RF output power.....	13
4.3 Radiated field strength emissions below 30 MHz	15
4.4 Radiated field strength emissions 30 MHz – 1 GHz	19
4.5 Radiated field strength emissions above 1 GHz	21
4.6 Conducted Band-Edge emissions	23
4.7 Results from external laboratory.....	25
4.8 Opinions and interpretations	25
4.9 List of abbreviations	25
5 Equipment lists	25
6 Measurement Uncertainty valid for conducted/radiated measurements	27
7 Versions of test reports (change history)	28

Table of Annex

Annex No.	Contents	Reference Description	Total Pages
Annex 1	Test result diagrams	CETECOM_TR19_1_0202601T04a_C1_A1	71
Annex 2	Internal photographs of EUT	Please refer to applicant's documentation	--
Annex 3	External photographs of EUT	CETECOM_TR19_1_0202601T04a_C1_A3	5
Annex 4	Test set-up photographs	CETECOM_TR19_1_0202601T04a_C1_A4	4

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.

The test report may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of CETECOM.

The testing service provided by CETECOM has been rendered under the current "General Terms and Conditions for CETECOM". CETECOM will not be liable for any loss or damage resulting from false, inaccurate, inappropriate or incomplete product information provided by the customer.

Under no circumstances does the CETECOM test report include any endorsement or warranty regarding the functionality, quality or performance of any other product or service provided.

Under no circumstances does the CETECOM test report include or imply any product or service warranties from CETECOM, including, without limitation, any implied warranties of merchantability, fitness for purpose, or non-infringement, all of which are expressly disclaimed by CETECOM.

All rights and remedies regarding vendor's products and services for which CETECOM has prepared this test report shall be provided by the party offering such products or services and not by CETECOM.

In no case this test report can be considered as a Letter of Approval.

This test report is electronically signed and valid without handwritten signature. For verification of the electronic signatures, the public keys can be requested at the testing laboratory.

The test report must always be reproduced in full; reproduction of an excerpt only is subject to written approval of the testing laboratory. The documentation of the testing performed on the tested devices is archived for 10 years at CETECOM.

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 2.4 GHz W-LAN transmitter. Other implemented wireless technologies were not considered within this test report.

Test case	Reference Clause FCC 	Reference Clause ISED 	Page	Remark	Result
Duty-Cycle	§15.35(c)	RSS-Gen Issue 5, §8.2	12	--	NP
Minimum Emission Bandwidth 6 dB	§15.247 5.2(a)	RSS-247, § 5.2(a) RSS-Gen Issue 5,: § 6.7	--	1*)	NP
Occupied Channel Bandwidth 99%	2.1049(h)	RSS-Gen Issue 5, § 6.7		1*)	NP
RF output power	§15.247(b)(3)	RSS-247, § 5.4(d)	13		PASSED
Transmitter Peak output power radiated	§15.247(b)(4)(c) (i)	RSS-247, § 5.4(d)	--	--	NP
Emissions in non-restricted frequency bands	§15.247(d)	RSS-247, § 5.5		1*)	NP
Conducted Band-Edge emissions	§15.205(b) §15.247(d)	RSS-Gen: Issue 5 §8.9, §8.10 RSS-247, § 5.5	27	--	PASSED
Power spectral density	§15.247(e)	RSS-247, § 5.2(b)		1*)	NP
Radiated field strength emissions below 30 MHz	§15.205(a) §15.209(a)	RSS-Gen: Issue 5 §8.9 Table 6	19	--	PASSED
Radiated field strength emissions 30 MHz – 1GHz	§15.209 §15.247(d)	RSS-Gen: Issue 5 §8.9 Table 5 RSS-247, § 5.5	23	--	PASSED
Radiated field strength emissions above 1 GHz	§15.209(a) §15.247(d)	RSS-Gen: Issue 5: §8.9 Table 5+7 RSS-247, § 5.5	25	--	PASSED
AC-Power Lines Conducted Emissions	§15.207	RSS-Gen Issue 5: § 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.

N/A

Not applicable

*1) For test results and information please refer to Test Report no. **R1606202-247** issued by Bay Area Compliance Laboratories Corp., 17th August, 2016; FCC ID: **YOPGS2200M** and IC: **9154A-GS2200M**

*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)
Minimum Emission Bandwidth 6 dB	ANSI C63.10:2013, §6.9.2, §11.8
Occupied Channel Bandwidth 99%	ANSI C63.10:2013, §6.9.3
RF output power	ANSI C63.10:2013, §11.9
Power spectral density	ANSI C63.10:2013, §11.10
Emissions in non-restricted frequency bands	ANSI C63.10:2013, §11.11, §6.10.5
Radiated Band-Edge emissions	ANSI C63.10-2013; "Marker-Delta method", §6.10.5, §11.13
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:	Dipl.-Ing. Ninovic Perez
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:	M. Sc. Patrick Marzotko
Receipt of EUT:	2020-Feb-25
Date(s) of test:	2020-Nov-26 – 2021-Jan-13
Version of template:	14.4

2.5 Applicant's details

Applicant's name:	Eppendorf AG
Address:	Barkhausenweg 1 22339 Hamburg
	Germany
Contact Person:	Lutz Metterhausen
Contact Person's Email:	Metterhausen.L@eppendorf.de

2.6 Manufacturer's details

Manufacturer's name:	Eppendorf AG
Address:	Barkhausenweg 1 22339 Hamburg
	Germany

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

Short description*)	PMT Sample No.	Product	Model	Type	S/N	HW status	SW status
EUT 01	19-1-02026S08_C01**)	WiFi-extension for handheld electronic pipettes of Eppendorf Xplorer® family	Eppendorf Xplorer® connect	--	H39077J	"1" equals "4861 490.500 00" Eppendorf intern	SW: n/a FW: 01.00.04
EUT 02	19-1-02026S22_C01 **)	Handheld electronic pipette of Eppendorf Xplorer®	Xplorer® plus	--	M27571I	Current model version	SW: n/a FW: 03.10.62
EUT 03	19-1-02026S63_C01 **)	WiFi-extension for handheld electronic pipettes of Eppendorf Xplorer® family	Eppendorf Xplorer® connect	--	-	"1" equals "4861 490.500 00" Eppendorf intern	SW: n/a FW: 01.00.04

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

**) EUT 02 and EUT 03 are part of EUT 01

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 01	19-1-02026S29_C01	Battery	Lithium-Polymer	--	--	--
AE 02	--	PC	--	--	--	Windows 10

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	Length
CAB 01	19-1-02006S04_C01 **)	USB cable	-	-

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

**) From project no. 19-1-02006

2.10 Software

Short description*)	Software	SW status
SW 01	rf_test	1.0.0.0

*) 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
1	EUT 01 + EUT 02 + AE 01 + AE 02 + CAB 01**	Used for Radiated measurements
2	EUT 01 + EUT 03 + AE 01 + AE 02 + CAB 01**	Used for Conducted measurements

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

**) CAB 1 + AE 02 were only used to set up test mode and disconnected during testing.

2.12 EUT operation modes

EUT operating mode no.*)	Operating modes	Additional information
op. 1	WLAN_TX-Mode	With help of special test firmware TX-mode was set-up. We refer to applicants information/papers for details about necessary commands.

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

2.13 Test mode setting

The following power settings were used in test software **rf_test v1.0.0.0** to set up test modes:

b-mode: PWR 15 / Tx100 mode

g-mode: PWR 21 / Tx100 mode

n-mode HT20: PWR 21 / Tx100 mode

3 Equipment under test (EUT)

3.1 General Data of Main EUT as Declared by Applicant

Product name	Eppendorf Xplorer® connect					
Kind of product	WiFi-extension for handheld electronic pipettes of Eppendorf Xplorer® family					
Firmware	<input checked="" type="checkbox"/> for normal use <input type="checkbox"/> Special version for test execution					
	<input type="checkbox"/> AC Mains <input type="checkbox"/> DC Mains		-			
	<input checked="" type="checkbox"/> Battery		3.7 V Lithium Ion battery			
Operational conditions	$T_{\text{nom}} = +21^{\circ}\text{C}$	$T_{\text{min}} = \text{n/a}$	$T_{\text{max}} = \text{n/a}$			
EUT sample type	Pre-Production					
Weight	-					
Size	-					
Interfaces/Ports	-					
For further details refer Applicants Declaration & following technical documents						
For further details regarding radio parameters, please refer to IEEE802.11 Specification						

3.2 Detailed Technical data of Main EUT as Declared by Applicant

Frequency Band	2.4 GHz ISM Band (2400 MHz - 2483.5 MHz)		
MIMO	<input type="checkbox"/>		
Frequency Channel B.W. (USA bands only)	<input checked="" type="checkbox"/> WLAN 2.4 GHz 802.11b g n (SISO)	Ch 1 2 3 4 5 6 7 Ch. 8 9 10 11	Bandwidth 20 MHz
	<input type="checkbox"/> WLAN 2.4 GHz 802.11n (SISO)	Ch 3 4 5 6 7 8 9	Bandwidth 40 MHz
802.11b – Mode OFDM Modulation Data Rates	<input checked="" type="checkbox"/> DBPSK 1 Mbps <input checked="" type="checkbox"/> DQPSK 2 Mbps <input checked="" type="checkbox"/> CCK-PBCC 5.5 Mbps / 11 Mbps <input type="checkbox"/> ERP-PBCC 22 Mbps		
802.11g – Mode OFDM Modulation Data Rates	<input checked="" type="checkbox"/> BPSK 6 Mbps / 9 Mbps <input checked="" type="checkbox"/> QPSK 12 Mbps / 18 Mbps <input checked="" type="checkbox"/> 16-QAM 24 Mbps / 36 Mbps <input checked="" type="checkbox"/> 64-QAM 48 Mbps / 54 Mbps		
802.11n – Mode OFDM Modulation Data Rates	<input checked="" type="checkbox"/> HT20(MCS0 to MCS7) 7.2 / 14.4 / 21.7 / 28.9 / 43.3 / 57.8 / 65 / 72.2 Mbps <input type="checkbox"/> HT40(MCS0 to MCS15) 15/30/45/60/90/120/135/150/180/240/270/300 Mbps		
Other wireless options	<input type="checkbox"/> WLAN 5 GHz 802.11 a/n/ac mode ((not tested within this report) <input type="checkbox"/> Bluetooth LE (not tested within this report) <input type="checkbox"/> Bluetooth EDR (not tested within this report) <input type="checkbox"/> Cellular transceiver (2G/3G/4G/5G/GPS, not tested in this report)		
Max. Conducted Output Power	b-mode: 14.7 dBm g-mode: 17.3 dBm n-mode(20 MHz): 18.8 dBm		
EIRP WLAN (Calculated EIRP)	b-mode: 14.7 dBm + 3.35 dBi = 18.05 dBm g-mode: 17.3 dBm + 3.35 dBi = 20.65 dBm n-mode(20 MHz): 18.8 dBm + 3.35 dBi = 22.15 dBm		
Antenna Type(s)	Chip Antenna		
Antenna Gain(s)	+3.35 dBi		
FCC label attached	No		
Test firmware / software and storage location	Stored on EUT		
For further details refer Applicants Declaration & following technical documents			
Description of Reference Document (supplied by applicant)	Version	Total Pages	
Xplorer connect - start up guide for testing	18-12-2020	11	
Power Level Xplorer connect	--	1	

3.3 Worst case identification

WLAN mode	Data rate
802.11b	1 Mbps
802.11g	6 Mbps
802.11n, 20 MHz bandwidth	MCS0

3.4 Modifications on Test sample

Additions/deviations or exclusions	
------------------------------------	--

4 Measurements

4.1 Duty-Cycle

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)

The necessary duty-cycle correction factor is determined on nominal conditions on middle channel only. It is assumed that no noticeable changes occur when tested on other channels or climatic conditions.

EUT settings

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

A special firmware program is used for test purposes. In opposite to normal operating mode a higher duty-cycle is set in order to facilitate the measurements. This is maximized at the extent possible.

The necessary duty-cycle correction factor is determined on nominal conditions on one channel in each operable frequency-band. It is assumed that no noticeable changes occur when tested on other channels or climatic conditions. The Duty-Cycle was constant, means without variations.

Formula to calculate Duty-Cycle:

Duty cycle calculations: $x = \frac{TX_{ON}}{(TX_{ON} + TX_{OFF})}$	Duty cycle factor: DC=	Regarding power: $10 * \log(\frac{1}{x})$ dB Regarding field strength: $20 * \log(\frac{1}{x})$ dB
--	------------------------	--

- The results were corrected in order to evaluate for worst-case result each time when average values are necessary for example average radiated emissions or similar
- No correction necessary: Duty-Cycle > 98%

4.1.1 Measurement Location

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

4.1.2 Result

Duty-Cycle [%]	Duty-Cycle correction Power [dB]	Duty-Cycle correction Field Strength [dB]
-	-	-

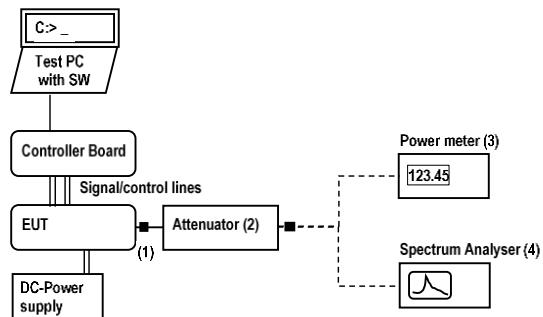
4.2 RF output power

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

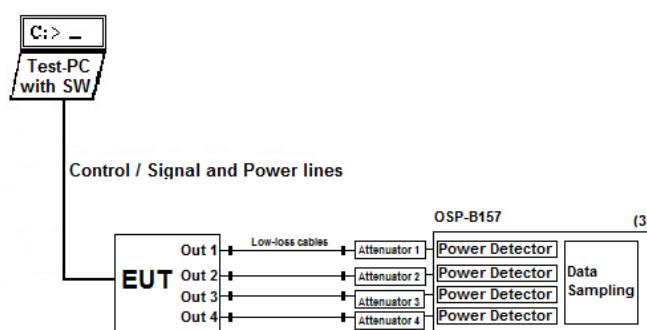
The EUT's RF-signal is coupled out by a suitable antenna coupling connector (1). The signal is first attenuated (2) then connected to power meter (3) or spectrum-analyzer (4) for RF-conducted measurements. The specific attenuation loss is determined prior to the measurement within a set-up attenuation measurement. These are then taken into account by correcting the measurement readings.

The measurements are performed by using R&S TS8997 (Ref.No. 693) test system which is able to perform measurements simultaneously and time-synchronized on maximum 8 antenna conducted RF-ports. A common trigger ensures the sampling time is minimized so the total power represents a sampling value calculated for all 8-ports simultaneously for each time bin/frame. A high data sampling rate together with a wide band power measurement capability ensures that latest modulation schemes are correctly measured. Therefore testing method Subchapter E1 of KDB662911 is fulfilled. (measure-and-sum technique).

Schematic:



Schematic MIMO:



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)

Measurement is made using Rohde & Schwarz TS8997 test system.

Test method	PKPM1 Peak reading power meter (broadband PK RF-power meter)
SISO	<input checked="" type="checkbox"/>
MIMO	<input type="checkbox"/> Summation of values from two antenna ports
Remarks	-

The measurement was performed in non-hopping transmission mode with the carrier set to lowest/middle and highest channel.

EUT settings

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

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

4.2.2 Measurement Location

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

4.2.3 Limit

Frequency Range [MHz]	Limit [W]	Limit [dBm]	Detector	RBW / VBW [MHz]
2400 - 2483.5	1	30	RMS	20 / 30

4.2.4 Result

Mode	Channel	Frequency [MHz]	Max Peak Power [dBm]	Result
b-mode 1Mbps	1	2412	14.7	PASSED
b-mode 1Mbps	6	2437	14.4	PASSED
b-mode 1Mbps	11	2462	14.1	PASSED
g-mode 6Mbps	1	2412	17.1	PASSED
g-mode 6Mbps	6	2437	17.2	PASSED
g-mode 6Mbps	11	2462	17.3	PASSED
n-mode MCS0	1	2412	18.5	PASSED
n-mode MCS0	6	2437	18.8	PASSED
n-mode MCS0	11	2462	18.0	PASSED

Remark: -

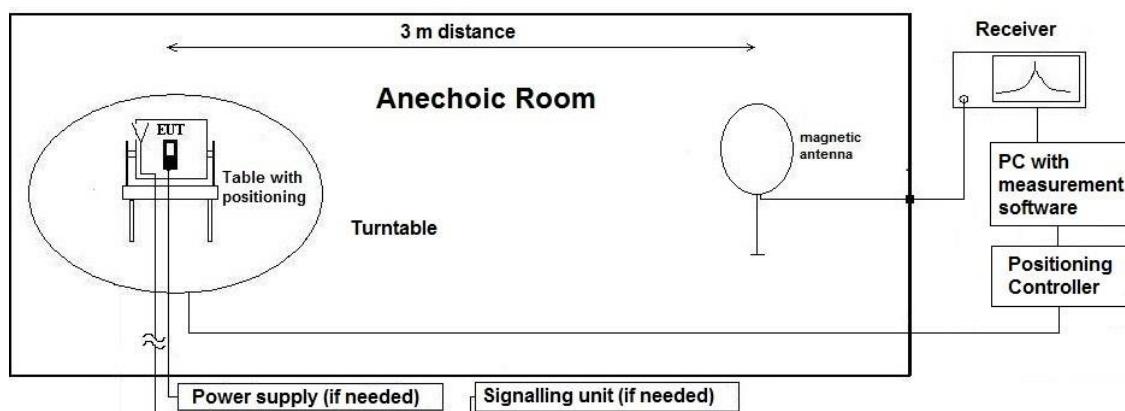
4.3 Radiated field strength emissions below 30 MHz

4.3.1 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 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 (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:

$$E_C = E_R + AF + C_L + D_F - G_A$$

AF = Antenna factor

$$M = L_T - E_C$$

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.

4.3.2 Measurement Location

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

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< 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	30		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

4.3.3 Limit

Radiated emissions limits (3 meters)					
Frequency Range [MHz]	Limit [μ V/m]	Limit [dB μ V/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

4.3.4 Result

Diagram	Channel	Mode	Maximum Level [dB μ V/m] Frequency Range 0.009 – 30 MHz	Result
2.01a	06	n-mode MCS0 laying	19.564	PASSED
2.01b	06	n-mode MCS0 standing	19.521	PASSED

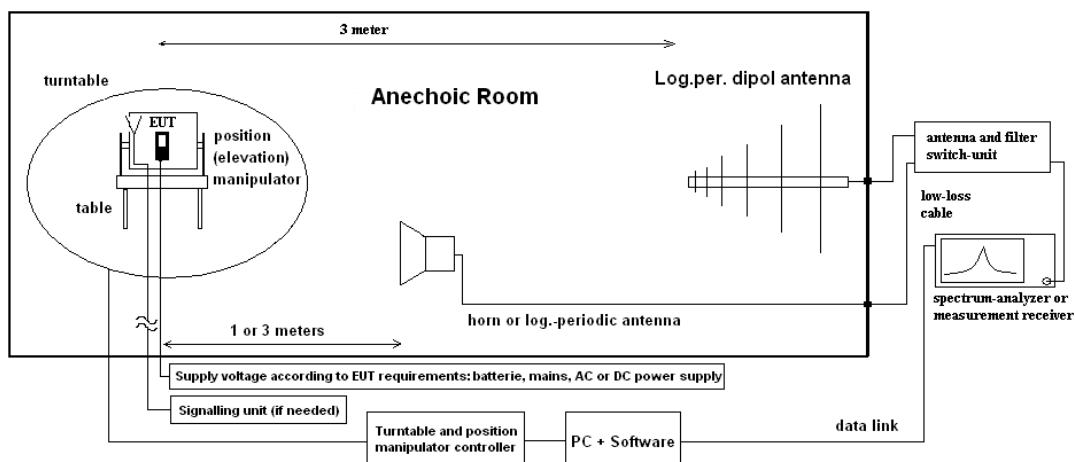
Remark: for more information and graphical plot see annex A1 **CETECOM_TR19_1_0202601T04a_C1_A1**

4.4 Radiated field strength emissions 30 MHz – 1 GHz

4.4.1 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 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 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.

4.4.2 Measurement Location

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

4.4.3 Limit

Radiated emissions limits (3 meters)				
Frequency Range [MHz]	Limit [μV/m]	Limit [dBμV/m]	Detector	RBW / VBW [kHz]
30 - 88	100	40.0	Quasi peak	100 / 300
88 - 216	150	43.5	Quasi peak	100 / 300
216 - 960	200	46.0	Quasi peak	100 / 300
960 - 1000	500	54.0	Quasi peak	100 / 300

4.4.4 Result

Diagram	Channel	Mode	Maximum Level [dBμV/m] Frequency Range 30 – 1000 MHz	Result
3.01a	06	n-mode MCS0 laying	34.170	PASSED
3.01b	06	n-mode MCS0 standing	33.359	PASSED

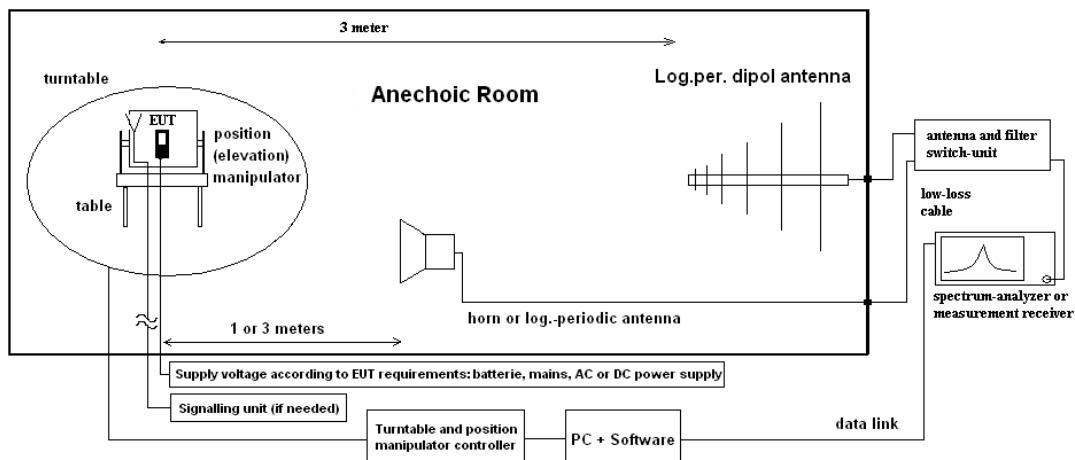
Remark: for more information and graphical plot see annex A1 **CETECOM_TR19_1_0202601T04a_C1_A1**

4.5 Radiated field strength emissions above 1 GHz

4.5.1 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 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 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:

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

E_C = Electrical field – corrected value

E_R = Receiver reading

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

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.

4.5.2 Measurement Location

Test site 1 – 18 GHz	120904 - FAC1 - Radiated Emissions
Test site 18 – 26.5 GHz	120907 - FAC2 - Radiated Emissions

4.5.3 Limit

Radiated emissions limits (3 meters)				
Frequency Range [MHz]	Limit [µV/m]	Limit [dBµV/m]	Detector	RBW / VBW [kHz]
Above 1000	500	54	Average	1000 / 3000
Above 1000	5000	74	Peak	1000 / 3000

4.5.4 Result

Diagram	Channel	Mode	Maximum Level [dBµV/m] Frequency Range 1 – 18 GHz	Result
4.01a	06	n-mode MCS0	59.048 *)	PASSED

*) Noise level

Remark: for more information and graphical plot see annex A1 CETECOM_TR19_1_0202601T04a_C1_A1

Diagram	Channel	Mode	Maximum Level [dBµV/m] Frequency Range 18 – 26.5 GHz	Result
4.01b	06	n-mode MCS0	58.710 *)	PASSED

*) Noise level

Remark: for more information and graphical plot see annex A1 CETECOM_TR19_1_0202601T04a_C1_A1

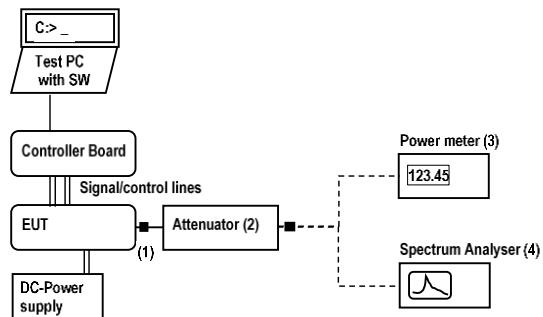
4.6 Conducted Band-Edge emissions

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

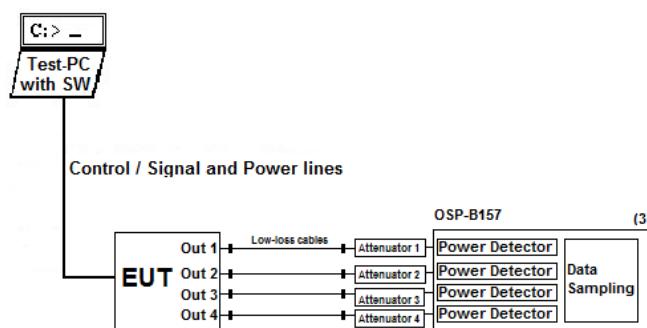
The EUT's RF-signal is coupled out by a suitable antenna coupling connector (1). The signal is first attenuated (2) then connected to power meter (3) or spectrum-analyzer (4) for RF-conducted measurements. The specific attenuation loss is determined prior to the measurement within a set-up attenuation measurement. These are then taken into account by correcting the measurement readings.

The measurements are performed by using R&S TS8997 (Ref.No. 693) test system which is able to perform measurements simultaneously and time-synchronized on maximum 8 antenna conducted RF-ports. A common trigger ensures the sampling time is minimized so the total power represents a sampling value calculated for all 8-ports simultaneously for each time bin/frame. A high data sampling rate together with a wide band power measurement capability ensures that latest modulation schemes are correctly measured. Therefore testing method Subchapter E1 of KDB662911 is fulfilled. (measure-and-sum technique).

Schematic:



Schematic MIMO:



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)

For uncritical results where a measurement resolution bandwidth of 1MHz can clearly show the compliance without influencing the results, a field strength measurement was performed to show compliance.

For critical results a Marker-Delta marker method was used for showing compliance to restricted bands.

The method consists of three independent steps:

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

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

4.6.2 Measurement Location

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

4.6.3 Limit

Frequency Range [MHz]	Pk Limit [dBc]	Avg Limit [dBc]	Avg Limit [dB μ V/m]	Pk Limit [dB μ V/m]	Detector	RBW / VBW [kHz]
Below 2390	-	-	54	74	Average / Peak	100 / 300
Above 2483.5	-	-	54	74	Average / Peak	1000 / 3000
2390 - 2400	-20	-	-	-	Peak	100 / 300
2390 - 2400	-	-30	-	-	Average	100 / 300

4.6.4 Result

Non-restricted bands near-by

Diagram	Channel	Mode	Peak [dBc]	Result
9.01 *)	1	n-mode MCS0	30.04	PASSED

*) Performed due to bad radio performance of radiated sample (EUT 01 + EUT 02)

Remark: for more information and graphical plot see annex A1 **CETECOM_TR19_1_0202601T04a_C1_A1**

Restricted bands near-by

Diagram	Channel	Mode	Peak [dB μ V/m]	Average [dB μ V/m]	Result
9.02 *)	11	n-mode MCS0	62.940	43.600	PASSED

*) Performed due to bad radio performance of radiated sample (EUT 01 + EUT 02)

Remark1: Average value corrected with Duty Cycle - Factor

Remark2: for more information and graphical plot see annex A1 **CETECOM_TR19_1_0202601T04a_C1_A1**

4.7 Results from external laboratory

None	-
------	---

4.8 Opinions and interpretations

None	-
------	---

4.9 List of abbreviations

None	-
------	---

5 Equipment lists

ID	Description	Manufacturer	SerNo	Cal due date
	120901 - SAC - Radiated Emission <1GHz			2025-Jul-21
20574	Biconilog Hybrid Antenna BTA-L	Frankonia GmbH	980026L	2022-May-03
20487	CETECOM Semi Anechoic Chamber < 1GHz	ETS-Lindgren GmbH	-	2025-Jul-15
20620	EMI Test Receiver ESU26	Rohde & Schwarz Messgerätebau GmbH	100362	2021-May-13
20482	filter matrix Filter matrix SAR 1	CETECOM GmbH	-	
25038	Loop Antenna HFH2-ZZ	Rohde & Schwarz Messgerätebau GmbH	879824/13	2022-Apr-07
20885	Power Supply EA3632A	Agilent Technologies Deutschland GmbH	75305850	
	120904 - FAC1 - Radiated Emissions			
20341	Digital Multimeter Fluke 112	Fluke Deutschland GmbH	81650455	2022-May-25
20720	EMC32 [FAC]	Rohde & Schwarz Messgerätebau GmbH	V10.xx	
20489	EMI Test Receiver ESU40	Rohde & Schwarz Messgerätebau GmbH	1000-30	2021-May-13
20868	High Pass Filter AFH-07000	AtlanTecRF	16071300004	
20020	Horn Antenna 3115 (Subst 1)	EMCO Elektronik GmbH	9107-3699	2021-Jul-19
20302	Horn Antenna BBHA9170 (Meas 1)	Schwarzbeck Mess-Elektronik OHG	155	2023-Apr-15
20549	Log.Per-Antenna HL025	Rohde & Schwarz Messgerätebau GmbH	1000060	2021-Jul-31
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	

ID	Description	Manufacturer	SerNo	Cal due date
20287	Pre-Amplifier 25MHz - 4GHz AMF-2D-100M4G-35-10P	Miteq Inc.	379418	
20670	Radio Communication Tester CMU200	Rohde & Schwarz Messgerätebau GmbH	106833	2022-Jun-16
20690	Spectrum Analyzer FSU	Rohde & Schwarz Messgerätebau GmbH	100302/026	2021-May-23
20439	UltraLog-Antenna HL 562	Rohde & Schwarz Messgerätebau GmbH	100248	2023-Mar-10
120910 - Radio Laboratory 1 (TS 8997)				
20904	Climatic Chamber ClimeEvent C/1000/70a/5	Weiss Umwelttechnik GmbH	58226223240010	09-May-2021
20871	NRP-Z81	Rohde & Schwarz Messgerätebau GmbH	101247	10-Sep-2021
20872	NRX Power Meter	Rohde & Schwarz Messgerätebau GmbH	101264	13-May-2021
20805	Open Switch and control Platform OSP B157WX 40GHz 8Port Switch	Rohde & Schwarz Messgerätebau GmbH	101056	13-May-2021
20691	Open Switch and control Platform OSP120	Rohde & Schwarz Messgerätebau GmbH	102073	07-Feb-2021
20866	Signal Analyzer FSV3030	Rohde & Schwarz Messgerätebau GmbH	103736	22-May-2021
20687	Signal Generator SMF 100A	Rohde & Schwarz Messgerätebau GmbH	104631	24-Mar-2021
20559	Vector Signal Generator SMU200A	Rohde & Schwarz Messgerätebau GmbH	101831	28-Jan-2022
20873	WTS-80 Schirmbox	CETECOM GmbH	P3101	

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 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	--	--	
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	5.01 dB							Magnetic field strength
		30 MHz - 1 GHz	5.83 dB							Electrical Field strength
		1 GHz - 18 GHz	4.91 dB							
		18-26.5 GHz	5.06 dB							

7 Versions of test reports (change history)

Version	Applied changes	Date of release
--	Initial release	2021-Jan-25
C1	Updated EUT information and applicant name	2021-Jan-27
--	--	--

End Of Test Report