

# PARTIAL Test Report

## 20-1-0194901T12a



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

Number of pages:	25	Date of Report:	2021-Nov-18
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:	OÜ Eliko Tehnoloogia Arenduskeskus
Product:	Positioning device		
Model:	ELIKO ANCHOR		
FCC ID:	2AF2I-ANCHOR Contains FCC ID: 2AC7Z- ESPWROOM32D	IC:	--
Testing has been carried out in accordance with:	CFR Title 47, Chapter I, Subchapter A, Part 15, Subpart C, §15.247 and Subpart F, §15.517 (Simultaneous transmissions)  Deviations, modifications or clarifications (if any) to above mentioned documents are written in each section under "Test method and limit".		
Tested Technology:	Wifi + UWB Co-location		
Test Results:	<input checked="" type="checkbox"/> 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		
Signatures:	<div></div> <div>Dipl.-Ing. Ninovic Perez Test Lab Manager Authorization of test report</div> <div>Dipl.-Ing. Christian Lorenz Senior Test manager Responsible of test report</div>		

## Table of Contents

Table of Annex.....	3
1 General information .....	4
1.1 Disclaimer and Notes.....	4
1.2 Summary of Test Results .....	5
1.3 Summary of Test Methods .....	6
2 Administrative Data .....	6
2.1 Identification of the Testing Laboratory .....	6
2.2 General limits for environmental conditions .....	6
2.3 Test Laboratories sub-contracted.....	6
2.4 Organizational Items .....	6
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 .....	8
3 Equipment under test (EUT) .....	9
3.1 General Data of Main EUT as Declared by Applicant .....	9
3.2 Detailed Technical data of Main EUT as Declared by Applicant .....	9
3.3 Detailed Technical data of Main EUT as Declared by Applicant .....	10
3.4 Modifications on Test sample.....	10
4 Measurements.....	11
4.1 Duty-Cycle .....	11
4.2 Radiated field strength emissions below 30 MHz .....	12
4.3 Radiated field strength emissions 30 MHz – 1 GHz .....	16
4.4 Radiated field strength emissions above 1 GHz .....	18
4.5 Results from external laboratory.....	21
4.6 Opinions and interpretations .....	21
4.7 List of abbreviations .....	21
5 Equipment lists .....	22
5.1 Legend .....	23
6 Measurement Uncertainty valid for conducted/radiated measurements .....	24
7 Versions of test reports (change history) .....	25

Table of Annex			
Annex No.	Contents	Reference Description	Total Pages
<b>Annex 1</b>	Test result diagrams	<b>CETECOM_TR20_1_0194901T12a_A1</b>	15
<b>Annex 2</b>	Internal photographs of EUT	--	--
<b>Annex 3</b>	External photographs of EUT	<b>CETECOM_TR20_1_0194901T12a_A3</b>	4
<b>Annex 4</b>	Test set-up photographs	<b>CETECOM_TR20_1_0194901T12a_A4</b>	6
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.

## 1.2 Summary of Test Results

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

Test case	Reference Clause FCC <input checked="" type="checkbox"/>	Reference Clause ISCED <input type="checkbox"/>	Page	Remark	Result
<a href="#">Duty-Cycle</a>	§15.35(c)	RSS-Gen Issue 5, §8.2	11	--	--
<a href="#">Minimum Emission Bandwidth 6 dB</a>	§15.247 5.2(a)	RSS-247, §5.2(a) RSS-Gen Issue 5, §6.7		--	NP
<a href="#">Occupied Channel Bandwidth 99%</a>	2.1049(h)	RSS-Gen Issue 5, §6.7		--	NP
<a href="#">Peak output power (Sweep)</a>	§15.247(b)(3)	RSS-247, §5.4(d)		--	NP
Transmitter Peak output power radiated	§15.247(b)(4)(c)(i)	RSS-247, §5.4(d)	--	--	NP
<a href="#">Emissions in non-restricted frequency bands</a>	§15.247(d)	RSS-247, §5.5		--	NP
<a href="#">Radiated Band-Edge emissions</a>	§15.205(b) §15.247(d)	RSS-Gen: Issue 5 §8.9, §8.10 RSS-247, §5.5	--	--	NP
<a href="#">Power spectral density</a>	§15.247(e)	RSS-247, §5.2(b)	--	--	NP
<a href="#">Radiated field strength emissions below 30 MHz</a>	§15.205(a) §15.209(a)	RSS-Gen: Issue 5 §8.9 Table 6	15	--	PASSED
<a href="#">Radiated field strength emissions 30 MHz – 1 GHz</a>	§15.209 §15.247(d)	RSS-Gen: Issue 5 §8.9 Table 5 RSS-247, §5.5	17	--	PASSED
<a href="#">Radiated field strength emissions above 1 GHz</a>	§15.209(a) §15.247(d)	RSS-Gen: Issue 5: §8.9 Table 5+7 RSS-247, §5.5	19	--	PASSED
<a href="#">AC-Power Lines Conducted Emissions</a>	§15.207	RSS-Gen Issue 5: §8.8 Table 4	--	--	NP

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

\*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.

### 1.3 Summary of Test Methods

Test case	Test method
Duty-Cycle	ANSI C63.10:2013, §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
Peak output power (Sweep)	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. Niels Jeß
Accreditation scope:	<b>DAkkS Webpage:</b> <a href="#">FCC ISSED</a>
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

Responsible test manager:	Christian Lorenz
Receipt of EUT:	2021-Apr-08
Date(s) of test:	2021-Sep-28 – 2021-Nov-02
Version of template:	21.1001

## 2.5 Applicant's details

Applicant's name:	OÜ Eliko Tehnoloogia Arenduskeskus
Address:	Aiandi 13/1 12918 Tallinn  Estonia
Contact Person:	Inderk Ruiso
Contact Person's Email:	info@eliko.ee

## 2.6 Manufacturer's details

Manufacturer's name:	OÜ Eliko Tehnoloogia Arenduskeskus
Address:	Aiandi 13/1 12918 Tallinn Estland

## 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	20-1-01949S51_C02	Positioning device	ELIKO ANCHOR	Standard	0009D2	4.9	3.1.0

\*) 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 01	20-1-01949S13_C01	Laptop	NP900X3C	J9VZ91DCB00064B	--	Win10

\*) 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	20-1-01949S69_C01	Cable	N/A	CAT 5e POE DC Supply cable for Anchor

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

## 2.10 Software

Short description*)	PMT Sample No.	Software	Type	S/N	HW status	SW status
SW 01	20-1-01949S62_C01	ESP_RF_test_tool_v2.5				
SW 02	20-1-01949S61_C01	KioRfconfUI				

\*) 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 1 + CAB01 + (AE1)	Used for Radiated measurements. AE1 used temporary to set-up the device to operating mode. Use of SW1+SW02 therefore.

\*) 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	UWB Ch4	With help of special test firmware TX-mode was set-up. Ch4 UWB power setting: 0x23232323
	Wifi Ch.6	We refer to applicants information/papers for details about necessary commands.

\*) 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	Positioning device		
Kind of product	ELIKO ANCHOR		
Firmware	<input type="checkbox"/> for normal use	<input checked="" type="checkbox"/> Special version for test execution	
	<input type="checkbox"/> AC Mains	-	
	<input checked="" type="checkbox"/> DC Mains	48 V DC via – DC Connector and cables	
	<input type="checkbox"/> Battery	-	
Operational conditions	T <sub>nom</sub> =21 °C	T <sub>min</sub> =-- °C	T <sub>max</sub> =-- °C
EUT sample type	Pre-Production		
Weight	0.1kg		
Size [LxWxH]	80x75x15		
Interfaces/Ports	USB/LAN		
For further details refer Applicants Declaration & following technical documents			
For further details regarding radio parameters, please refer to Core Specification			

#### 3.2 Detailed Technical data of Main EUT as Declared by Applicant

Frequency Band	2.4 GHz ISM Band (2412 MHz – 2462 MHz)		
Number of Channels (USA/Canada -bands)	Ch1 to Ch11		
Nominal Channel Bandwidth	20/40 MHz		
Type of Modulation   Data Rate	802.11b – Mode DSSS 802.11g – Mode OFDM 802.11g – Mode OFDM 802.11n – Mode OFDM		
Other wireless options	<input type="checkbox"/> a/n/ac mode <input checked="" type="checkbox"/> b/g/n mode <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	--		
EIRP Power (Calculated EIRP)	--		
Antenna Type	integrated		
Antenna Gain	3.7dBi		
FCC label attached	No		
Test firmware / software and storage location	EUT1		
For further details refer Applicants Declaration & following technical documents			
Description of Reference Document (supplied by applicant)		Version	Total Pages
Annex E Achor		--	7
ESP32&ESP8266_RF_Performance_Test_Demonstration__EN		3.0	42

### 3.3 Detailed Technical data of Main EUT as Declared by Applicant

<b>Main function</b>	Positioning System	
<b>Frequency range [MHz]</b>	Channel 3: 4243.2 – 4742.4, center 4492.8 Channel 4: 3328.0 – 4659.2, center 3993.6	
<b>Type of modulation used</b>	pulse-position modulation, PPM	
<b>Number of channels</b>	2	
<b>Equipment type</b>	<input type="checkbox"/> Imaging Short-Range communication device <input checked="" type="checkbox"/> a) Indoor <input type="checkbox"/> b) Outdoor <input type="checkbox"/> Field disturbance sensor <input type="checkbox"/> Short-Range automotive radar	
<b>Antenna Type(s)</b>	<input checked="" type="checkbox"/> Integrated <input type="checkbox"/> External, no RF- connector <input type="checkbox"/> External, separate RF-connector	
<b>FCC label attached</b>	No	
<b>For further details refer Applicants Declaration &amp; following technical documents</b>		
<b>Description of Reference Document (supplied by applicant)</b>	<b>Version</b>	<b>Total Pages</b>
--	--	--

### 3.4 Modifications on Test sample

<b>Additions/deviations or exclusions</b>	Access to programming tool – wires + Switches
---	---

## 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: $10 * \log(1/x)$ dB
		Regarding field strength: $20 * \log(1/x)$ 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

<b>Test site</b>	120910 - Radio Laboratory 1 (TS 8997)
------------------	---------------------------------------

#### 4.1.2 Result

Duty-Cycle [%]	Op.Mode	Duty-Cycle correction Field Strength [dB]
100	UWB	0
>98%	Wifi Channel 6	0

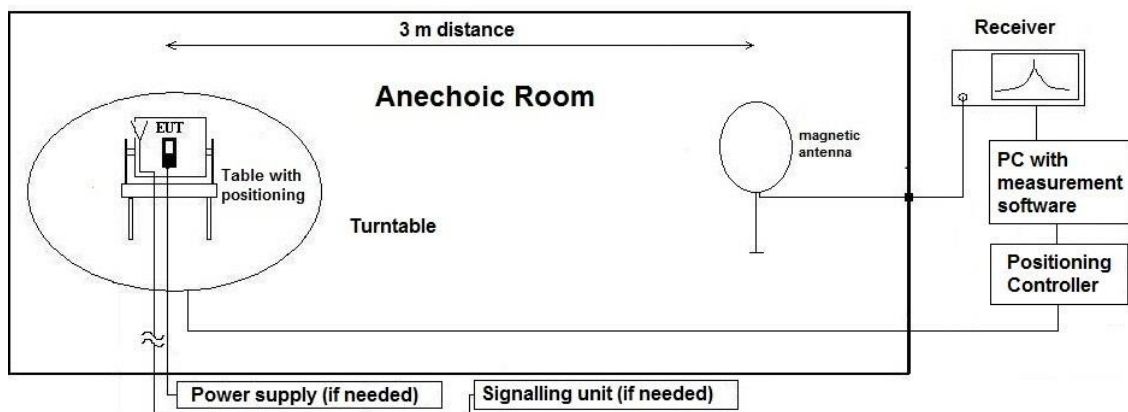
## 4.2 Radiated field strength emissions below 30 MHz

### 4.2.1 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:

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

$$M = L_T - E_C$$

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.

#### 4.2.2 Measurement Location

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

#### 4.2.3 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)	2nd Condition (Limit distance bigger dnear-field)	Distance Correction accord. Formula
kHz	9	33333.33	5305.17	300	fulfilled	not fulfilled	-80.00
	10	30000.00	4774.65		fulfilled	not fulfilled	-80.00
	20	15000.00	2387.33		fulfilled	not fulfilled	-80.00
	30	10000.00	1591.55		fulfilled	not fulfilled	-80.00
	40	7500.00	1193.66		fulfilled	not fulfilled	-80.00
	50	6000.00	954.93		fulfilled	not fulfilled	-80.00
	60	5000.00	795.78		fulfilled	not fulfilled	-80.00
	70	4285.71	682.09		fulfilled	not fulfilled	-80.00
	80	3750.00	596.83		fulfilled	not fulfilled	-80.00
	90	3333.33	530.52		fulfilled	not fulfilled	-80.00
	100	3000.00	477.47		fulfilled	not fulfilled	-80.00
	125	2400.00	381.97		fulfilled	not fulfilled	-80.00
	200	1500.00	238.73		fulfilled	fulfilled	-78.02
	300	1000.00	159.16		fulfilled	fulfilled	-74.49
	400	750.00	119.37		fulfilled	fulfilled	-72.00
	490	612.24	97.44		fulfilled	fulfilled	-70.23
	500	600.00	95.49	30	fulfilled	not fulfilled	-40.00
	600	500.00	79.58		fulfilled	not fulfilled	-40.00
	700	428.57	68.21		fulfilled	not fulfilled	-40.00
	800	375.00	59.68		fulfilled	not fulfilled	-40.00
	900	333.33	53.05		fulfilled	not fulfilled	-40.00
MHz	1.00	300.00	47.75		fulfilled	not fulfilled	-40.00
	1.59	188.50	30.00		fulfilled	not fulfilled	-40.00
	2.00	150.00	23.87		fulfilled	fulfilled	-38.02
	3.00	100.00	15.92		fulfilled	fulfilled	-34.49
	4.00	75.00	11.94		fulfilled	fulfilled	-32.00
	5.00	60.00	9.55		fulfilled	fulfilled	-30.06
	6.00	50.00	7.96		fulfilled	fulfilled	-28.47
	7.00	42.86	6.82		fulfilled	fulfilled	-27.13
	8.00	37.50	5.97		fulfilled	fulfilled	-25.97
	9.00	33.33	5.31		fulfilled	fulfilled	-24.95
	10.00	30.00	4.77		fulfilled	fulfilled	-24.04
	10.60	28.30	4.50		fulfilled	fulfilled	-23.53
	11.00	27.27	4.34		fulfilled	fulfilled	-23.21
	12.00	25.00	3.98		fulfilled	fulfilled	-22.45
	13.56	22.12	3.52		fulfilled	fulfilled	-21.39
	15.00	20.00	3.18		fulfilled	fulfilled	-20.51
	15.92	18.85	3.00		fulfilled	fulfilled	-20.00
	17.00	17.65	2.81		not fulfilled	fulfilled	-20.00
	18.00	16.67	2.65		not fulfilled	fulfilled	-20.00
	20.00	15.00	2.39		not fulfilled	fulfilled	-20.00
	21.00	14.29	2.27		not fulfilled	fulfilled	-20.00
	23.00	13.04	2.08		not fulfilled	fulfilled	-20.00
	25.00	12.00	1.91		not fulfilled	fulfilled	-20.00
	27.00	11.11	1.77		not fulfilled	fulfilled	-20.00
	29.00	10.34	1.65		not fulfilled	fulfilled	-20.00
	30.00	10.00	1.59		not fulfilled	fulfilled	-20.00

#### 4.2.4 Limit

Radiated emissions limits, (3 meters)					
Frequency Range [MHz]	Limit [ $\mu\text{V/m}$ ]	Limit [ $\text{dB}\mu\text{V/m}$ ] *	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

#### 4.2.5 Result

Diagram	Channel	Mode	Maximum Level [ $\text{dB}\mu\text{V/m}$ ] Frequency Range 0.009 – 30 MHz	Result
D12_002a	Ch4 UWB	Op. Mode 1	Max value: 19.13	Passed
D12_002b	Ch6 Wifi		< 20.0	Passed

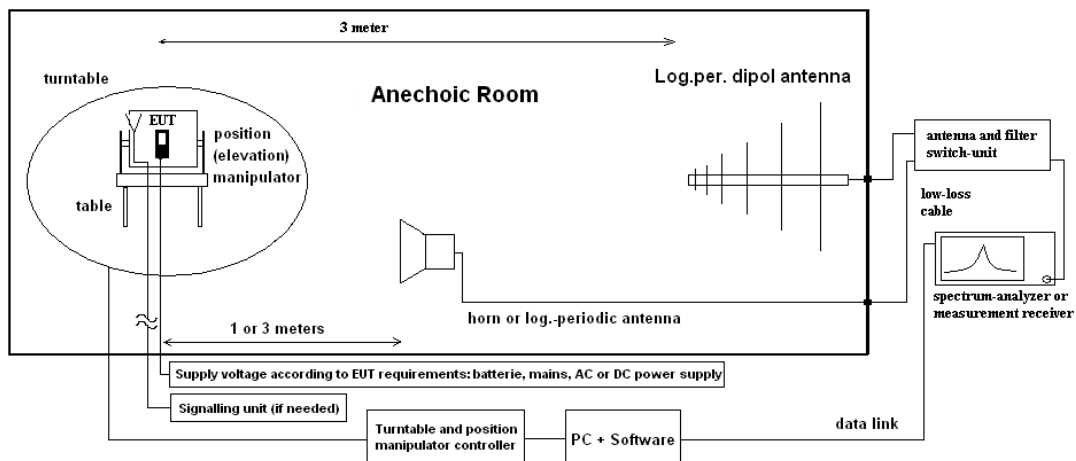
Remark: for more information and graphical plot see annex A1 **CETECOM\_TR20\_1\_0194901T12a\_A1**

### 4.3 Radiated field strength emissions 30 MHz – 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 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 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:

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

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

$A_F$  = 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.

### 4.3.2 Measurement Location

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

### 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]
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

### 4.3.4 Result

Diagram	Channel	Mode	Maximum Level [ $\text{dB}\mu\text{V}/\text{m}$ ] Frequency Range 30 – 1000 MHz	Result
D13_001a	Ch4 UWB	1	35.25	Passed
D13_001b	Ch6 Wifi		33.69	Passed

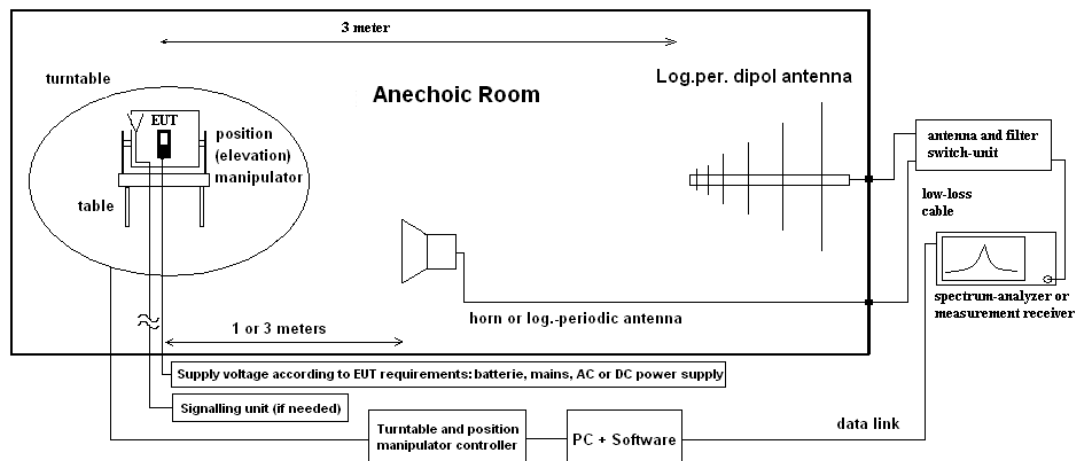
Remark: for more information and graphical plot see annex A1 **CETECOM\_TR20\_1\_0194901T12a\_A1**

## 4.4 Radiated field strength emissions above 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 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:

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

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

$E_C$  = 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.

#### 4.4.2 Measurement Location

Test site 1 – 12.4 GHz	120904 - FAC1 - Radiated Emissions
Test site 12.4 – 40 GHz	120907 - FAC2

#### 4.4.3 Limit

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

#### 4.4.4 Result

Diagram	Channel	Mode	Maximum Level [dB $\mu$ V/m] Frequency Range 1 – 12.4 GHz	Result
D12_003	Ch4 UWB Ch6 Wifi	Op.Mode1	52.30 (AV)@4.874GHz	PASSED

Remark:

1. UWB carrier and Wifi carrier visible on diagram -> not relevant for judgement
2. for more information and graphical plot see annex A1 **CETECOM\_TR20\_1\_0194901T12a\_A1**

Diagram	Channel	Mode	Maximum Level [dB $\mu$ V/m] Frequency Range 12.4 – 18 GHz	Result
D12_002a D12_002b	Ch4 UWB Ch6 Wifi	Op.Mode1	57.05 (PK)@16773.75GHz	PASSED

Remark: for more information and graphical plot see annex A1 **CETECOM\_TR20\_1\_0194901T12a\_A1**

Diagram	Channel	Mode	Maximum Level [dB $\mu$ V/m] Frequency Range 18 – 25 GHz	Result
D12_001a D12_001b	Ch4 UWB Ch6 Wifi	Op.Mode1	59.47(PK)@24538.75GHz 47.34(AV)@24889.25GHz	PASSED

Remark: for more information and graphical plot see annex A1 **CETECOM\_TR20\_1\_0194901T12a\_A1**

Diagram	Channel	Mode	Maximum Level [dBμV/m] Frequency Range 25 – 33 GHz	Result
D12_006a D12_006b	Ch4 UWB Ch6 Wifi	Op.Mode1	64.56(PK)@30994.75GHz 51.66(AV)@30999.75GHz	PASSED

Remark: for more information and graphical plot see annex A1 **CETECOM\_TR20\_1\_0194901T12a\_A1**

Diagram	Channel	Mode	Maximum Level [dBμV/m] Frequency Range 18 – 26.5 GHz	Result
D12_005a D12_005b	Ch4 UWB Ch6 Wifi	Op.Mode1	64.19(PK)@39421.25GHz 51.47(AV)@39989.75GHz	PASSED

Remark: for more information and graphical plot see annex A1 **CETECOM\_TR20\_1\_0194901T12a\_A1**

#### 4.5 Results from external laboratory

None	-
------	---

#### 4.6 Opinions and interpretations

None	-
------	---

#### 4.7 List of abbreviations

None	-
------	---

## 5 Equipment lists

ID	Description	Manufacturer	SerNo	CheckType	Interval	Next Check
	<b>120901 - SAC - Radiated Emission &lt;1GHz</b>			calc hk	cal: 10Y chk: 12M	cal: July 2025 chk: May 2021
20574	Biconilog Hybrid Antenna BTA-L	Frankonia GmbH	98002 6L	cal	cal: 36M	cal: May 2022
20487	CETECOM Semi Anechoic Chamber < 1GHz	ETS-Lindgren GmbH	-	calc hk	cal: 10Y chk: 12M	cal: July 2025 chk: May 2021
20620	EMI Test Receiver ESU26	Rohde & Schwarz Messgerätebau GmbH	10036 2	cal	cal: 12M	cal: May 2022
20482	filter matrix Filter matrix SAR 1	CETECOM GmbH	-	cnn		
25038	Loop Antenna HFH2-Z2	Rohde & Schwarz Messgerätebau GmbH	87982 4/13	cal	cal: 24M	cal: April 2022
20885	Power Supply EA3632A	Agilent Technologies Deutschland GmbH	75305 850	cnn		
	<b>120904 - FAC1 - Radiated Emissions</b>			chk	chk: 12M	chk: June 2022
20341	Digital Multimeter Fluke 112	Fluke Deutschland GmbH	81650 455	cal	cal: 24M	cal: May 2022
20489	EMI Test Receiver ESU40	Rohde & Schwarz Messgerätebau GmbH	10003 0	cal	cal: 12M	cal: May 2022
20254	High Pass Filter 5HC 2600/12750-1.5KK	Trilithic	23042	chk	chk: 12M	chk: June 2022
20291	High Pass Filter WHJ 2200-4EE	Wainwright Instruments GmbH	14	chk	chk: 12M	chk: June 2022
20020	Horn Antenna 3115 (Subst 1)	EMCO Elektronik GmbH	9107- 3699	calc hk	cal: 36M chk: 12M	cal: August 2024
20302	Horn Antenna BBHA9170 (Meas 1)	Schwarzbeck Mess-Elektronik OHG	155	calc hk	cal: 36M chk: 12M	
20549	Log. Per. Antenna HL025	Rohde & Schwarz Messgerätebau GmbH	10000 60	calc hk	cal: 36M chk: 12M	cal: August 2024
20720	Measurement Software EMC32 [FAC]	Rohde & Schwarz Messgerätebau GmbH	V10.xx	cnn		
20611	Power Supply E3632A	Agilent Technologies Deutschland GmbH	KR 75305 854	cpu		
20338	Pre-Amplifier 100MHz - 26GHz JS4-00102600-38-5P	Miteq Inc.	83869 7	chk	chk: 12M	chk: June 2022
20484	Pre-Amplifier 2,5GHz - 18GHz AMF-5D-02501800-25-10P	Miteq Inc.	12445 54	chk	chk: 12M	chk: June 2022
20287	Pre-Amplifier 25MHz - 4GHz AMF-2D-100M4G-35-10P	Miteq Inc.	37941 8	chk	chk: 12M	chk: June 2022
20690	Spectrum Analyzer FSU	Rohde & Schwarz Messgerätebau GmbH	10030 2/026	cal	cal: 24M	cal: May 2023

ID	Description	Manufacturer	SerNo	Check Type	Interval	Next Check
20439	Ultrabroadband-Antenna HL562	Rohde & Schwarz Messgerätebau GmbH	100248	calchk	cal: 72M chk: 12M	cal: March 2023
	120907 - FAC2			chk	chk: 12M	chk: August 2022
20836	1-18 GHz Amplifier	Wright Technologies, Inc., Inc.	0001	chk	chk: 36M	
20133	Horn Antenna 3115 (Meas 1)	EMCO Elektronik GmbH	9012-3629	cal	cal: 36M	cal: April 2023
20811	Horn Antenna ASY-SGH-124-SMA	Antenna Systems Solutions S.L	29F14182337	cal	cal: 36M	cal: October 2024
20877	JS42-08001800-16-8P Verstärker	Miteq Inc.	2079991 / 2079992	chk	chk: 3M	chk: May 2020
20913	Phase Amplitude Stable Cable Assembly DC-40GHz	RF-Lambda Europe GmbH	AC19040001	cnn		
20813	Pickett-Potter Horn Antenna	RPG-Radiometer Physics GmbH	10006	cal	cal: 36M	cal: September 2023
20765	Pickett-Potter Horn Antenna	RPG-Radiometer Physics GmbH	010001	cal	cal: 36M	cal: September 2023
20816	SGH Antenna SGH-26-WR10	Antenal S.L.	1144	cnn		
20732	Signal- and Spectrum Analyzer FSW67	Rohde & Schwarz Messgerätebau GmbH	104023	cal	cal: 12M	cal: May 2022
20817	Waveguide Rectangular Horn Antenna SAR-2309-22-S2	ERAVAN	13254-01	cal	cal: 36M	cal: July 2023

## 5.1 Legend

Note / remarks	Interval of calibration & Verification
12M	12 months
24M	24 months
36M	36 months
10Y	10 Years

Abbreviation Check Type	Description
cnn	Calibration and verification not necessary
cal	Calibration
calchk	Calibration plus intermediate Verification
chk	Verification
cpu	Verification before usage

## 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 <sub>CISPR</sub> )	-	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	5.01dB							Magnetic field strength
		30 MHz - 1 GHz	5.83 dB							Electrical Field strength
		1 GHz - 18 GHz	4.67dB							
		18-33 GHz	4.79 dB							
		33-50GHz	4.02 dB							



## 7 Versions of test reports (change history)

Version	Applied changes	Date of release
--	Initial release	2021-Nov-18
--	--	--
--	--	--

**End Of Test Report**