PARTIAL Test Report
20-1-0017102T03a-C01

D-PL-12047-01-01
D-PL-12047-01-03
D-PL-12047-01-04

Number of pages:	26	**Date of Report:**	2021-Jun-04
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:**	SICK AG
Product: **Model:**	**UWB Tag** **LOCU111-0020**		
FCC ID:	WRMLOCU1	**IC:**	10066A-LOCU1

Testing has been carried out in accordance with:

Title 47 CFR, Chapter I
FCC Regulations, Subchapter A
§15.250

ISED-Regulations
RSS-Gen, Issue 5
RSS-220, Issue 1, Amendment 1

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

Tested Technology: UWB

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

The current version of the Test Report CETECOM_TR20-1-0017102T03a-C1 replaces the Test Report CETECOM_TR20-1-0017102T03a dated 2021-May-17. The replaced test report is

Signatures:

Ninovic Perez
2021.06.09
16:10:20 +
02'00'

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Dipl.-Ing. Ninovic Perez	B.Sc. Mohamed Ahmed
Team and Test Lab Manager	Test manager
Authorization of test report	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.

1.2 Summary of Test Results

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

Test case	Reference Clause FCC ☒	Reference Clause ISED ☒	Page	Remark	Result
10 dB bandwidth	§15.250(a)	RSS-220 2 RSS-220 5.1	--	**1**	NP
Radiated field strength emissions below 30 MHz	§15.205(a) §15.209(a)	RSS-220 3.4	10	--	Passed
Radiated field strength emissions 30 MHz – 960 MHz	§15.209 §15.250(c)	RSS-220 3.4	14	--	Passed
Radiated field strength emissions above 960 MHz	§15.250(c)	RSS-220 5.3.1(d)	16	--	Passed
Radiated emissions in the GPS bands	§15.250(d)	RSS-220 5.3.1(e)	19	--	Passed
Fundamental emission peak power	§15.250(e)	RSS-220 5.3.1(g)	21	--	Passed
Antenna requirement	§15.203	RSS-220 5.1(d)		**1**	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.

Remark:

1) Please refer to modules Test Report issued on **02-10-2018** with FCC ID **2AQ33-DWM1001** and IC: **23794-DWM1001.**

1.1. Summary of Test Methods

Test case	Test method
10 dB bandwidth	ANSI 63.10-2013 §10.1
Radiated field strenght emissions below 30 MHz	ANSI C63.10-2013 §6.3, §6.4
Radiated field strenght emissions 30 MHz- 1 GHz	ANSI C63.10-2013 §6.3, § 6.5
Radiated field strenght emissions above 1 GHz	ANSI C63.10-2013 §6.3, § 6.6
Radiated emissions in the GPS bands	ANSI C63.10-2013 §6.3, § 6.6
Fundamental emission peak power	ANSI C63.10-2013 §6.3, § 6.6
Antenna requirement	--

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.:	
Responsible test manager:	B.Sc. Mohamed Ahmed
Receipt of EUT:	2020-Jun-18
Date(s) of test:	2020-Aug-24 – 2021-Feb-19
Version of template:	14.5

2.5 Applicant's details

Applicant's name:	SICK AG
Address:	Erwin-Sick-Straße 1 79183 Waldkirch Germany
Contact Person:	Tobias Hofmann
Contact Person's Email:	Tobias.Hofmann@sick.de

2.6 Manufacturer's details

Manufacturer's name:	SICK AG
Address:	Erwin-Sick-Straße 1 79183 Waldkirch 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	20-1-00171S08_C01	UWB Tag	LOCU111-0020	--	1949 0124	v1r3	3.125.7
EUT 02 **	20-1-00171S08_C01	UWB Tag	LOCU111-0020	--	1949-0124	v1r3.1	3.125.7

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

**)The listed additional variants/models are not tested nor object of evaluated of compliance. For further information please see annex 5.

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	20-1-00171S15_C01	Mobile Phone	Samsung Galaxy J5Mobile Phone	RF8HC1SFX6H	SM-J510FN	Android 7.1.1

*) 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	20-1-00171S41_C01	Power Supply Cable	--	1 m
CAB 02	20-1-00171S09_C01	Power Supply Cable	--	2 m

*) 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	SW status
SW 01	--	Android App - Tag Configurator	Version 1.1.3

*) 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 + AE 01**+ CAB 01	Used for Radiated measurements in the Frequency Range 960 MHz to 3.1 GHz
1	EUT 01 + AE 01**+ CAB 02	Used for all Radiated measurements for all Frequency ranges except from 960 MHz to 3.1 GHz

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

**) AE 01 was only used to set the Test Settings for the EUT

2.12 EUT operation modes

EUT operating mode no.*)	Operating modes	Additional information
op. 1	TX-Mode 1	With help of special test firmware TX-mode was set-up. We refer to applicants information/papers for details about necessary commands. Power Code Used in SW 01 is 8DADCDC8= -2 dBm

*) 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	UWB Tag		
Kind of product	LOCU111-0020		
Firmware	☐ for normal use	☒ Special version for test execution	
	☐ AC Mains	-	
	☒ DC Mains	12 V DC via **CAB 01** Connector (7-35 V DC)	
	☐ Battery		
Operational conditions	T_{nom} =23 °C	T_{min} =-20 °C	T_{max} =60 °C
EUT sample type	**Pre-Production**		
Weight	43g		
Size	90.5mmx42.9mmx22mm		
Interfaces/Ports	--		
For further details refer Applicants Declaration & following technical documents			
For further details regarding radio parameters, please refer to IEEE15.4.1 Specification			

3.2 Detailed Technical data of Main EUT as Declared by Applicant

Main function	Taggable - Localization		
Frequency range [MHz]	6490 MHz		
Type of modulation used	Pulse Modulation		
Number of channels	Channel 5		
	Short-Range comunication device ☒ a) Indoor ☐ b) Outdoor		
Antenna Type(s)	☒ Integrated ☐ External, no RF- connector ☐ External, separate RF-connector		
FCC label attached	Yes		
SW Storage location	Saved on AE 01		
For further details refer Applicants Declaration & following technical documents			
Description of Reference Document (supplied by applicant)		**Version**	**Total Pages**
LOCU UWB tag-operating instructions for certification testing issued on 11.09.2020		**V1.3**	**23**
8024844__Quickstart_A4-tag_v2.3		**V2.3**	**3**

3.3 Modifications on Test sample

Additions/deviations or exclusions	--

4 Measurements

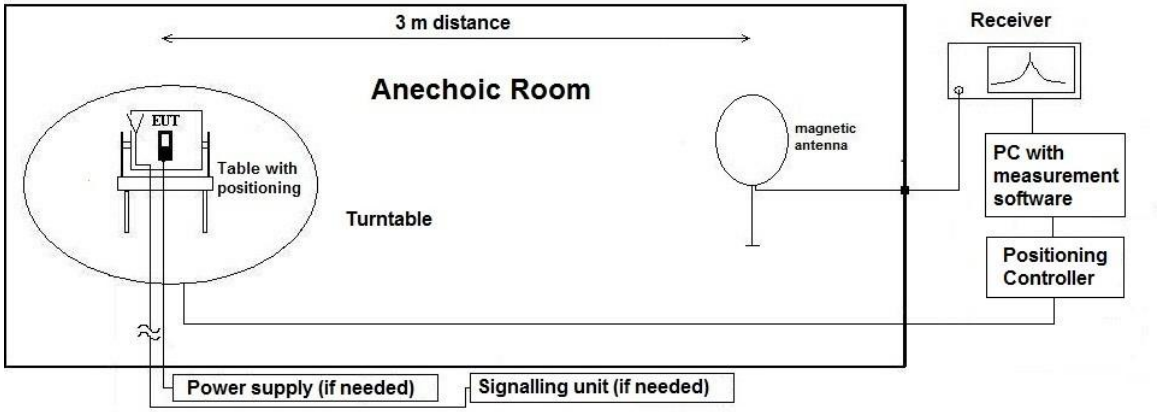
4.1 Radiated field strength emissions below 30 MHz

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

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

The loop antenna was placed at 1 m height above ground plane and 3 m measurement distance from set-up for investigations. Because of reduced measurement distance, correction data were applied, as stated in chapter "General Limit - Radiated field strength emissions below 30 MHz". The tests are performed in the semi anechoic room recognized by the regulatory commission.

Schematic:



Testing method:

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

Exploratory, preliminary measurements

The EUT and it's associated accessories are placed on a non-conductive position manipulator (tipping device) of 0.8 m height which is placed on the turntable. By rotating the turntable (step 90°, range 0°to 360°) and the EUT itself either on 3-orthogonal axis (portable equipment) or 2-orthogonal axis (defined operational position of EUT), the emission spectrum was recorded.

The loop antenna was moved at least to 2-perpendicular axes (antenna vector in direction of EUT and parallel to EUT) in order to maximize the emissions. The results are documented in a diagram. Critical frequencies (low margin to limit) are saved within a data reduction table for further investigations. If various operating modes are supported, further investigations are made to find the worst-case. Also the interconnection cables and equipment position were varied in order to maximize the emissions.

Final measurement on critical frequencies

Based on the exploratory measurements, the most critical frequencies are re-measured by maintaining the EUT's worst-case operation mode, cable position, etc.

First a frequency zoom around the critical frequency is done to locate the frequency more precisely. After this step, for all identified critical frequencies, the maximum peak was determined.

Following parameters were varied: the turntable angle continuously in the range 0 to 360 degree, the EUT itself either over 3-orthogonal axis (not defined usage position) or 2-orthogonal axis (defined usage position).

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

Formula:

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

$M = L_T - E_C$

AF = Antenna factor
C_L = Cable loss
D_F = Distance correction factor (if used)
E_C = Electrical field – corrected value
E_R = Receiver reading
G_A = Gain of pre-amplifier (if used)
L_T = Limit
M = Margin

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

4.1.2 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)	2nd Condition (Limit distance bigger dnear-field)	Distance Correction accord. Formula
kHz	9	33333.33	5305.17	300		fullfilled	not fullfilled	-80.00
	10	30000.00	4774.65			fullfilled	not fullfilled	-80.00
	20	15000.00	2387.33			fullfilled	not fullfilled	-80.00
	30	10000.00	1591.55			fullfilled	not fullfilled	-80.00
	40	7500.00	1193.66			fullfilled	not fullfilled	-80.00
	50	6000.00	954.93			fullfilled	not fullfilled	-80.00
	60	5000.00	795.78			fullfilled	not fullfilled	-80.00
	70	4285.71	682.09			fullfilled	not fullfilled	-80.00
	80	3750.00	596.83			fullfilled	not fullfilled	-80.00
	90	3333.33	530.52			fullfilled	not fullfilled	-80.00
	100	3000.00	477.47			fullfilled	not fullfilled	-80.00
	125	2400.00	381.97			fullfilled	not fullfilled	-80.00
	200	1500.00	238.73			fullfilled	fullfilled	-78.02
	300	1000.00	159.16			fullfilled	fullfilled	-74.49
	400	750.00	119.37			fullfilled	fullfilled	-72.00
	490	612.24	97.44			fullfilled	fullfilled	-70.23
	500	600.00	95.49	30		fullfilled	not fullfilled	-40.00
	600	500.00	79.58			fullfilled	not fullfilled	-40.00
	700	428.57	68.21			fullfilled	not fullfilled	-40.00
	800	375.00	59.68			fullfilled	not fullfilled	-40.00
	900	333.33	53.05			fullfilled	not fullfilled	-40.00
MHz	1.00	300.00	47.75			fullfilled	not fullfilled	-40.00
	1.59	188.50	**30.00**			fullfilled	not fullfilled	-40.00
	2.00	150.00	23.87			fullfilled	fullfilled	-38.02
	3.00	100.00	15.92			fullfilled	fullfilled	-34.49
	4.00	75.00	11.94			fullfilled	fullfilled	-32.00
	5.00	60.00	9.55			fullfilled	fullfilled	-30.06
	6.00	50.00	7.96			fullfilled	fullfilled	-28.47
	7.00	42.86	6.82			fullfilled	fullfilled	-27.13
	8.00	37.50	5.97			fullfilled	fullfilled	-25.97
	9.00	33.33	5.31			fullfilled	fullfilled	-24.95
	10.00	30.00	4.77			fullfilled	fullfilled	-24.04
	10.60	28.30	4.50			fullfilled	fullfilled	-23.53
	11.00	27.27	4.34			fullfilled	fullfilled	-23.21
	12.00	25.00	3.98			fullfilled	fullfilled	-22.45
	13.56	22.12	3.52			fullfilled	fullfilled	-21.39
	15.00	20.00	3.18			fullfilled	fullfilled	-20.51
	15.92	18.85	**3.00**			fullfilled	fullfilled	-20.00
	17.00	17.65	2.81			not fullfilled	fullfilled	-20.00
	18.00	16.67	2.65			not fullfilled	fullfilled	-20.00
	20.00	15.00	2.39			not fullfilled	fullfilled	-20.00
	21.00	14.29	2.27			not fullfilled	fullfilled	-20.00
	23.00	13.04	2.08			not fullfilled	fullfilled	-20.00
	25.00	12.00	1.91			not fullfilled	fullfilled	-20.00
	27.00	11.11	1.77			not fullfilled	fullfilled	-20.00
	29.00	10.34	1.65			not fullfilled	fullfilled	-20.00
	30.00	10.00	1.59			not fullfilled	fullfilled	-20.00

4.1.3 Measurement Location

Test site	120901 - SAC - Radiated Emission <1GHz

4.1.4 Limit

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

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

4.1.5 Result

Diagram	Channel	Mode	Maximum Level [dBµV/m] Frequency Range 0.009 – 30 MHz	Result
2.01	5	1, EUT Standing	No critical Peaks within 20 dB Margin	Passed
2.02	5	1, EUT laying	No critical Peaks within 20 dB Margin	Passed

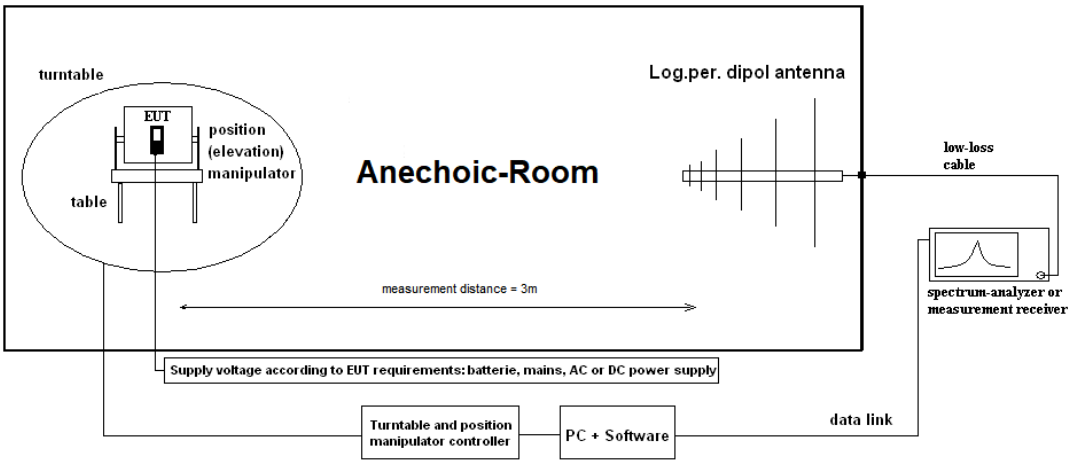
Remark: for more information and graphical plot see annex A1 **CETECOM_TR20-1-0017102T03a_C01_A1**

4.2 Radiated field strength emissions 30 MHz – 960 MHz

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

Evaluating the emissions have to be done first by an exploratory emissions measurement and a final measurement for most critical frequencies. The tests are performed in a CISPR 16-1-4:2010 compliant 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 it's 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:

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

$M = L_T - E_C$ (2)

AF = Antenna factor
C_L = Cable loss
D_F = Distance correction factor (if used)
E_C = Electrical field – corrected value
E_R = Receiver reading
G_A = Gain of pre-amplifier (if used)
L_T = Limit
M = Margin

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

4.2.2 Measurement Location

Test site	120901 - SAC - Radiated Emission <1GHz

4.2.3 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

4.2.4 Result

Diagram	Channel	Mode	Maximum Level [dBµV/m] Frequency Range 30 – 960 MHz	Result
3.01	5	1, EUT Standing	No critical Peaks within 20 dB Margin	Passed
3.02	5	1, EUT laying	No critical Peaks within 20 dB Margin	Passed

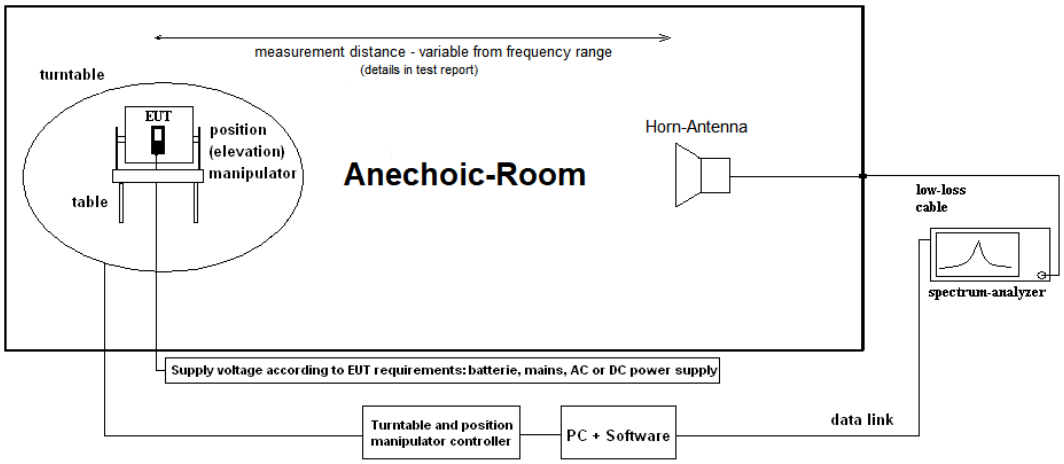
Remark: for more information and graphical plot see annex A1 **CETECOM_TR20-1-0017102T03a_C01_A1**

4.3 Radiated field strength emissions above 960 MHz

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

Evaluating the emissions have to be done first by an exploratory emissions measurement and a final measurement for most critical frequencies. The tests are performed in a CISPR 18-1-4:2010 compliant fully anechoic room (FAR) recognized by the regulatory commission. The measurement distance was set to 3 meter for frequencies up to 18 GHz and 2 meter above 18 GHz. A logarithmic periodic antenna is used for the frequency range 30 MHz to 1 GHz. Horn antennas are used for frequency range 1 GHz to 40 GHz. The EUT is aligned within 3 dB beam width of the measurement antenna with three orthogonal axis measurements on the EUT.

Schematic:



Testing method:

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

$P_{EIRP} = P_{MEAS} + C_L + FSL - G_A$ (1)

P_{MEAS} = measured power at instrument
M = Margin
L_T = Limit

FSL = Free Space loss = Function(frequency, measurement distance)

$M = L_T - P_{EIRP}$

C_L= cable loss
G_A = Gain of pre-amplifier (if used)

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

4.3.2 Measurement Location

Test site	120907 - FAC2
Test site	120904 - FAC1 - Radiated Emissions

4.3.3 Limit

4.3.3.1 Limits according to FCC 15.250

Frequency Range [MHz]	EIRP [dBm]	Detector	RBW / VBW [kHz]
960-1610	−75.3	RMS	1000 / 3000
1610-1990	−63.3	RMS	1000 / 3000
1990-3100	-61.3	RMS	1000 / 3000
3100-5925	−51.3	RMS	1000 / 3000
5925-7250	−41.3	RMS	1000 / 3000
7250-10600	−51.3	RMS	1000 / 3000
Above 10600	−61.3	RMS	1000 / 3000

4.3.3.2 Limits according to RSS 220 5.3.1

Frequency Range [MHz]	EIRP [dBm]	Detector	RBW / VBW [kHz]
960-1610	−75.3	RMS	1000 / 3000
1610-4750	−70.0	RMS	1000 / 3000
4750-10600	−41.3	RMS	1000 / 3000
Above 10600	−61.3	RMS	1000 / 3000

4.3.4 Measurement distance

Frequency Range [MHz]	Measurement distance [m]
960-3100	1
3100-4750	1.6
3100-5750	3
5750-7250	3
10600- 12400	2
12400-18000	2
18000-40000	0.5

4.3.5 Result

Diagram	Frequency range [MHz]	Mode	Remark	Result
4.01	960-3100	1	Horizontal polarization, CAB 02 used	Passed
4.02	960-3100	1	Vertical polarization, CAB 02 used	Passed
4.03	3100-4750	1	All polarizations, EUT laying	Passed
4.04	3100-4750	1	All polarizations, EUT Standing	Passed
4.05	3100-5750	1	All polarizations, EUT Standing, EUT laying	Passed
4.06	5750-7250	1	All polarizations, EUT Standing, EUT laying	Passed
4.07	7250-10600	1	All polarizations, EUT Standing, EUT laying	Passed
4.08	10600-12400	1	Horizontal polarization	Passed
4.09	10600-12400	1	Vertical polarization	Passed
4.10	12400-18000	1	Vertical polarization	Passed
4.11	12400-13500	1	Zoom Measurement on 12.95 GHz	Passed
4.12	12400-18000	1	Horizontal polarization	Passed
4.13	12400-13500	1	Zoom Measurement on 12.95 GHz	Passed
4.14	18000-33000	1	All polarizations, EUT Standing, EUT laying	Passed
4.15	33000-40000	1	All polarizations, EUT Standing, EUT laying	Passed

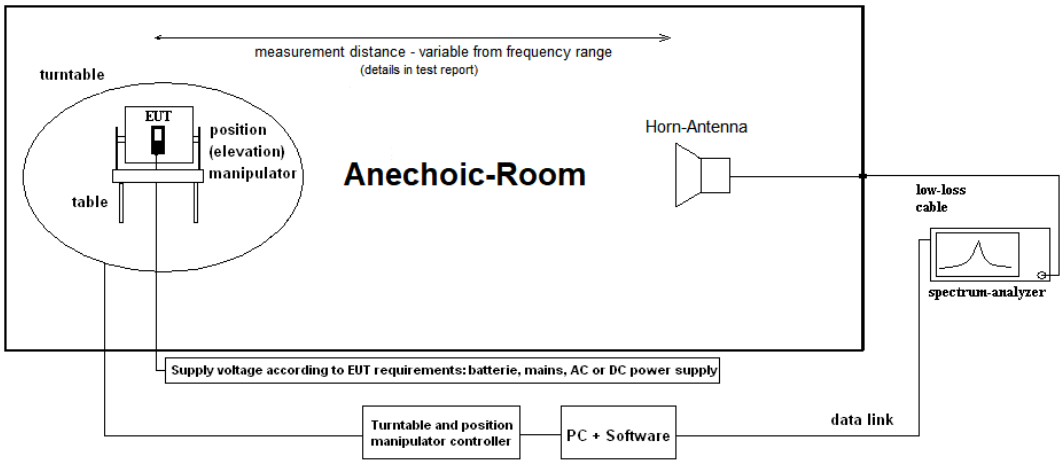
Remark: for more information and graphical plot see annex A1 **CETECOM_TR20-1-0017102T03a_C01_A1**

4.4 Radiated emissions in the GPS bands

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 it's 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:

$P_{EIRP} = P_{MEAS} + C_L + FSL - G_A$ (1)

P_{MEAS} = measured power at instrument
M = Margin
L_T = Limit

FSL = Free Space loss = Function(frequency, measurement distance)

$M = L_T - P_{EIRP}$

C_L= cable loss
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	120907 - FAC2

4.4.3 Limit

Radiated emissions limits (3 meters)			
Frequency Range [MHz]	EIRP [dBm]	Detector	RBW / VBW [kHz]
1164-1240	−85.3	RMS	1 / 3
1559-1610	−85.3	RMS	1 / 3

4.4.4 Result

Diagram	Frequency range [MHz]	Mode	Remark	Result
4.16	1164-1240	1	Horizontal amd Vertical polarization, EUT Standing, EUT laying	Passed
4.17	1559-1610	1	Horizontal amd Vertical polarization, EUT Standing, EUT laying	Passed

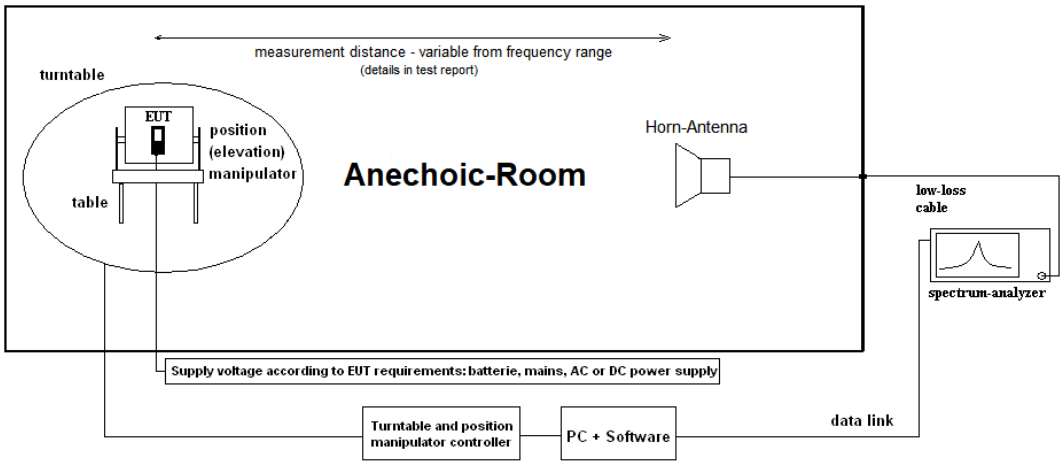
Remark: for more information and graphical plot see annex A1 **CETECOM_TR20-1-0017102T03a_C01_A1**

4.5 Fundamental emission peak power

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 it's 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. 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:

$P_{EIRP} = P_{MEAS} + C_L + FSL - G_A$ (1)

P_{MEAS} = measured power at instrument
M = Margin
L_T = Limit

FSL = Free Space loss = Function(frequency, measurement distance)

$M = L_T - P_{EIRP}$

C_L= cable loss
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	120907 - FAC2

4.5.3 Measurement distance

Measurement distance [m]
1

4.5.4 Limit

Radiated emissions limits (3 meters)			
Frequency Range [MHz]	EIRP [dBm]	Detector	RBW / VBW [MHz]
Frequency with the highest radiated emission contained within a 50 MHz bandwidth	0	MaxPeak	50 / 80

4.5.5 Result

Diagram	fc [MHz]	fmax [MHz]	Pmax [dBm]	Mode	Remark	Result
7.01	6490 MHz	6485.9 MHz	-2.37	1	--	Pass

Remark1: frequency with the highest radiated emission contained within a 50 MHz bandwidth from the measurement is the frequency inside of the fundamental emission.

Remark2: for more information and graphical plot see annex A1 **CETECOM_TR20-1-0017102T03a_C01_A1**

4.6 Results from external laboratory

None	-

4.7 Opinions and interpretations

None	-

4.8 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-Z2	Rohde & Schwarz Messgerätebau GmbH	879824/13	2022-Apr-07
20885	Power Supply EA3632A	Agilent Technologies Deutschland GmbH	75305850	-
	120904 - FAC1 - Radiated Emissions			
	120907 - FAC2 - Radiated Emissions			
20341	Digital Multimeter Fluke 112	Fluke Deutschland GmbH	81650455	2022-May-25
20489	EMI Test Receiver ESU40	Rohde & Schwarz Messgerätebau GmbH	1000-30	2021-May-13
20254	High Pass Filter 5HC 2600/12750-1.5KK (GSM1800/1900/DECT)	Trilithic	23042	-
20868	High Pass Filter AFH-07000	AtlanTecRF	16071300004	-
20836	1-18 GHz Amplifier	Wright Technologies, Inc., Inc.	0001	-
20811	Horn Antenna ASY-SGH-124-SMA	Antenna Systems Solutions S.L	29F14182337	2021-Oct-08
20877	JS42-08001800-16-8P Verstärker	Miteq Inc.	2079991 / 2079992	-
20912	Low noise Amplifier Module 0.5-4GHz	RF-Lambda Europe GmbH	19041200083	-
20913	Phase Amplitude Stable Cable Assembly DC-40GHz	RF-Lambda Europe GmbH	AC19040001	-
20816	SGH Antenna SGH-26-WR10		1144	-

ID	Description	Manufacturer	SerNo	Cal due date
20732	Signal- and Spectrum Analyzer FSW67	Rohde & Schwarz Messgerätebau GmbH	104023	2021-May-27
20832	Horn Antenna WR90, 90-HA20	TACTRON ELEKTRONIK GmbH & Co. KG	J202064946	
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
20338	Pre-Amplifier 100MHz - 26GHz JS4-00102600-38-5P	Miteq Inc.	838697	-
20484	Pre-Amplifier 2,5GHz - 18GHz AMF-5D-02501800-25-10P	Miteq Inc.	1244554	-
20287	Pre-Amplifier 25MHz - 4GHz AMF-2D-100M4G-35-10P	Miteq Inc.	379418	-
20376	Horn Antenna BBHA9120	Schwarzbeck Mess-Elektronik		-
25378	Low Noise Amplifier 1GMHz – 18 GHz	B&Z Tehcnologies	16695-16511	-
	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-Z2	Rohde & Schwarz Messgerätebau GmbH	879824/13	2022-Apr-07
20885	Power Supply EA3632A	Agilent Technologies Deutschland GmbH	75305850	-

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 (U_{CISPR})	CISPR 16-2-1	9 kHz - 150 kHz 150 kHz - 30	4.0 dB 3.6 dB						-
Radiated emissions Enclosure	CISPR 16-2-3	30 - 1 GHz 1 GHz - 18 GHz	4.2 dB 5.1 dB						E-Field
Disturbance power	CISPR 16-2-2	30 - 300	-						-
Power Output radiated	-	30 - 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 30 MHz - 1 GHz 1 GHz - 18 GHz 18 GHz – 26.5 GHz 26.5 GHz – 40 GHz	5.0 dB 4.2 dB 4.91 dB 5.06 dB 5.52 dB						Magnetic field E-field Substitution

7 Versions of test reports (change history)

Version	Applied changes	Date of release
--	Initial release	2021-May-17
C01	Chapter 4.4 added	2021-Jun-04

End Of Test Report