Test Report
17-1-0202201T01a

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

Number of pages:	26	**Date of Report:**	2021-Mar-11
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:**	Ovesco Endoscopy AG
Product:	**HemoPill acute / HemoPill Receiver / HemoPill Printer (no wireless communication)**		
Type:	**medical swallowable capsule / Medical device to receiving and displaying values measured by the HemoPill acute / HemoPill Printer**		
Model:	**HemoPill acute / HemoPill Receiver / HemoPill Printer (no wireless communication)**		
FCC ID:	2AYFH-OVE-HP	**IC:**	-
Testing has been carried out in accordance with:	**FCC Regulations: Title 47, Subpart 15.231(e)** **ISED Regulations: RSS-210, Issue 10 (2019-12), chapter A1.4; RSS-Gen, Issue 5 (2018-04)** Deviations, modifications or clarifications (if any) to above mentioned documents are written in each section under "Test method and limit".		
Tested Technology:	SRD		
Test Results:	**☒ The EUT complies with the requirements in respect of all parameters subject to the test.** The test results relate only to devices specified in this document		

Signatures:

Digital signiert von: Christian Lorenz
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Dipl.-Ing. Christian Lorenz	M.Sc. Guangcheng Huang
Senior Test 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.

1.1. Summary of Test Results

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

Test case	Reference Clause FCC ☒	Reference Clause ISED ☒	Page	Remark	Result
Radiated field strength fundamental at 3 m	§2.1046 §15.205 §15.231(e)	RSS-210, Issue 10, Chapter A1.4	15	-	PASSED
20 dBc bandwidth	§15.231(c)	RSS Gen, Issue 5, Chapter 6.7	20	-	PASSED
99% bandwidth	§2.202(a) §2.1049	RSS Gen, Issue 5, Chapter 6.7	21	-	PASSED
General field strength emissions (radiated 9 kHz to 30 MHz)	§15.209(a)	RSS-Gen, Issue 5 Chapter 8.9, Table 6	11	-	PASSED
Radiated field strength spurious emissions	§2.1046 §15.205 §15.231(e)	RSS-210, Issue 10, Chapter A1.4	15	-	PASSED
Transmitter timing: 1. Deactivation of transmissions 2. Periodic transmissions	§15.231(e)	RSS-210, Issue 10, Chapter A1.4	22	-	PASSED
Conducted emissions	§15.207	RSS-Gen, Issue 5: Chapter 8.8, Table 4	-	-	N/A

PASSED	The EUT complies with the essential requirements in the standard.
FAILED	The EUT does not comply with the essential requirements in the standard.
NP	The test was not performed by the CETECOM Laboratory.
N/A	Not applicable

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

1.2. Summary of Test Methods

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

And reference also to Test methods in KDB558074

2 Administrative Data

2.1 Identification of the Testing Laboratory

Company name:	CETECOM GmbH
Address:	Im Teelbruch 116 45219 Essen - Kettwig Germany
Responsible for testing laboratory:	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:	M.Sc. Guangcheng Huang
Receipt of EUT:	2020-Nov-27
Date(s) of test:	2021-Jan-06 – 2021-Jan-26
Version of template:	14.4

2.5 Applicant's details

Applicant's name:	Ovesco Endoscopy AG
Address:	Friedrich-Miescher-Strasse 9 72076 Tuebingen Germany
Contact Person:	Mario Fode
Contact Person's Email:	mario.fode@ovesco.com

2.6 Manufacturer's details

Manufacturer's name:	Ovesco Endoscopy AG
Address:	Friedrich-Miescher-Strasse 9 72076 Tuebingen 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
EUT1	17-1-02022S17_C01	medical swallowable capsule	HemoPill acute	--	--	Rev02	ContinousTXMode_05 (Build 401)
EUT2	17-1-02022S15_C01	medical swallowable capsule	HemoPill acute	--	102	Rev02	HPA9 (Build109)
EUT3	17-1-02022S02_C01	Medical device to receiving and displaying values measured by the HemoPill acute	HemoPill Receiver	--	113	Mainboard Rev01 RF-Modul Rev01	2.3.0 (build 102)

*) 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
AE1	17-1-02022S07_C01	Battery pack	4.65 V DC	--	--	--
AE2	17-1-02022S03_C01	Net power supply	SMPS / FSP025M-DPA	--	--	--
AE3	17-1-02022S04_C01	Power cord USA	0L06821	N/A	--	--
AE4	17-1-02022S06_C01	net power supply cable	CB-US04-18A-E	N/A	--	--
AE5	17-1-02022S08_C01	net power supply	PW-0904-W2-E	N/A	--	--
AE6	17-1-02022S05_C01	Mobile Printer	DPU-S245	n/a	DPU-S245-00C-E	3.01

*) 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 1	17-1-02022S09	USB Cable	USB A to USB micro B	--

*) 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 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
Set.1	EUT1 + AE1	Used for Radiated measurements. TX CW mode
Set.2	EUT2 + EUT3 + AE2 + AE3 + AE4 + AE5 + AE6	Used for Radiated measurements. Normal mode

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

2.12 EUT operation modes

EUT operating mode no.*1)	Operating modes	Additional information
op. 1	TX CW	Modified EUT with DC power supply to guarantee continuous transmission
op. 2	Normal mode	Intermittent one-way communication from the EUT 2 (acute/TX) to the EUT 3 (receiver)

*1) 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	HemoPill acute HemoPill Receiver HemoPill Printer (no wireless communication)		
Kind of product	medical swallowable capsule Medical device to receiving and displaying values measured by the HemoPill acute HemoPill Printer		
Firmware	☒ for normal use	☒ Special version for test execution	
HemoPill acute	☐ AC Mains	-	
	☐ DC Mains	-- V DC via -- Connector	
	☒ Battery	- (not reported)	
HemoPill Receiver	☒ AC Mains	single Line (L1/N) 120 V 60 Hz	
	☐ DC Mains	-- V DC via -- Connector	
	☒ Battery	- (not reported)	
HemoPill Printer (no wireless communication)	☒ AC Mains	single Line (L1/N) 120 V 60 Hz	
	☐ DC Mains	-- V DC via -- Connector	
	☐ Battery	-	
Operational conditions	T_{nom} =25 °C	T_{min} =20 °C	T_{max} =40 °C
EUT sample type	**Pre-Production**		
Weight	-		
Size	-		
Interfaces/Ports	-		
For further details refer Applicants Declaration & following technical documents **OVE_HP_RF_Overview_US_Rev01_2021-01-12.pdf** **OVE_Report_Questionnaire_HemoPill_acute_V2_WIP.xlsx** **OVE_Report_Questionnaire_HemoPill_Receiver_V2.xlsx** **OVE_ Report_Questionnaire_HemoPill_Printer_V2.xlsx**			

3.2 Detailed Technical data of Main EUT as Declared by Applicant

Frequency Band	434.4 MHz
Number of Channels (USA/Canada -bands)	1 (434.4 MHz) Range of operation < 1 MHz
Number of antenna ports	1
Nominal Channel Bandwidth	100 kHz
Max. 20dB bandwidth (measured)	62.98 kHz
Max. 99% bandwidth (measured)	61.54 kHz
Type of Modulation | Data Rate	☒ FSK (Frequency shift keying) ☐ π/4 DQPSK | 2 Mbit / s ☐ 8DPSK | 3 Mbit / s
Max. field strength (measured)	61 dBµV/m AV@3m distance (Calculated from Peak value with Duty-Cycle Correction)
Max. ERP Power (Calculated EIRP)	-34.16 dBm (0.00038 mW)
Installed options (Not tested within this report)	☒ None (No other wireless functionality)
Antenna Type	Internal, no separate RF-connector
Antenna Gain	Not reported
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
OVE_HP_RF_Overview_US_Rev01_2021-01-12.pdf	**-**	**7**
OVE_Report_Questionnaire_HemoPill_acute_V2_WIP.xlsx	**V2**	**1**
OVE_Report_Questionnaire_HemoPill_Receiver_V2.xlsx	**V2**	**1**
OVE_ Report_Questionnaire_HemoPill_Printer_V2.xlsx	**V2**	**1**

3.3 Modifications on Test sample

Additions/deviations or exclusions	

4 Measurements

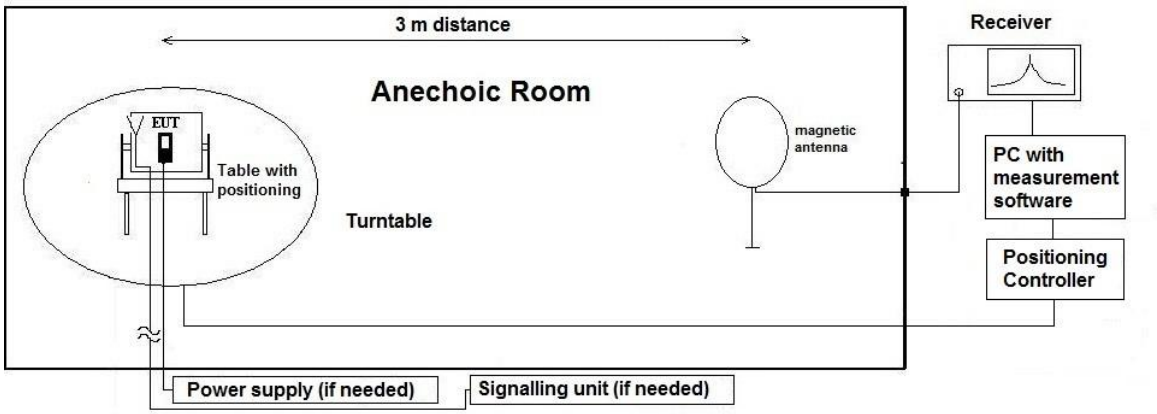
4.1 Radiated field strength emissions below 30 MHz

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 3
0 MHz“. The tests are performed in the semi anechoic room recognized by the regulatory commission.

Schematic:



Testing method:

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

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

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

Final measurement on critical frequencies
Based on the exploratory measurements, the most critical frequencies are re-measured by main-taining the EUT’s worst-case operation mode, cable position, etc.

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

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

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

Formula:

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

$M = L_T - E_C$

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

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

4.1.2 Measurement Location

Test site	120901 - SAC - Radiated Emission <1GHz

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
	9.00E+03	33333.33	5305.17			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	**300**		fullfilled	not fullfilled	-80.00
	9.00E+04	3333.33	530.52			fullfilled	not fullfilled	-80.00
kHz	1.00E+05	3000.00	477.47			fullfilled	not fullfilled	-80.00
	1.25E+05	2400.00	381.97			fullfilled	not fullfilled	-80.00
	2.00E+05	1500.00	238.73			fullfilled	fullfilled	-78.02
	3.00E+05	1000.00	159.16			fullfilled	fullfilled	-74.49
	4.00E+05	750.00	119.37			fullfilled	fullfilled	-72.00
	4.90E+05	612.24	97.44			fullfilled	fullfilled	-70.23
	5.00E+05	600.00	95.49			fullfilled	not fullfilled	-40.00
	6.00E+05	500.00	79.58			fullfilled	not fullfilled	-40.00
	7.00E+05	428.57	68.21			fullfilled	not fullfilled	-40.00
	8.00E+05	375.00	59.68			fullfilled	not fullfilled	-40.00
	9.00E+05	333.33	53.05			fullfilled	not fullfilled	-40.00
	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	**30**		fullfilled	fullfilled	-24.04
	10.60	28.30	4.50			fullfilled	fullfilled	-23.53
MHz	11.00	27.27	4.34			fullfilled	fullfilled	-23.21
	12.00	25.00	3.98			fullfilled	fullfilled	-22.45
	13.56	22.12	3.52			fullfilled	fullfilled	-21.39
	15.00	20.00	3.18			fullfilled	fullfilled	-20.51
	15.92	18.85	**3.00**			fullfilled	fullfilled	-20.00
	17.00	17.65	2.81			not fullfilled	fullfilled	-20.00
	18.00	16.67	2.65			not fullfilled	fullfilled	-20.00
	20.00	15.00	2.39			not fullfilled	fullfilled	-20.00
	21.00	14.29	2.27			not fullfilled	fullfilled	-20.00
	23.00	13.04	2.08			not fullfilled	fullfilled	-20.00
	25.00	12.00	1.91			not fullfilled	fullfilled	-20.00
	27.00	11.11	1.77			not fullfilled	fullfilled	-20.00
	29.00	10.34	1.65			not fullfilled	fullfilled	-20.00
	30.00	10.00	1.59			not fullfilled	fullfilled	-20.00

4.1.3 Limit

Radiated emissions limits, (3 meters)					
Frequency Range [MHz]	Limit [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

4.1.4 Result

Set.1+2

Diagram	Antenna port / Channel	Mode	Setup	Maximum Level [dBµV/m] Frequency Range 0.009 – 30 MHz	Result
2.01	Ch1	TX CW	Standing position	19.85 (Noise floor)	PASSED
2.02	Ch1	Normal	Lying position	20.06 (Noise floor)	PASSED

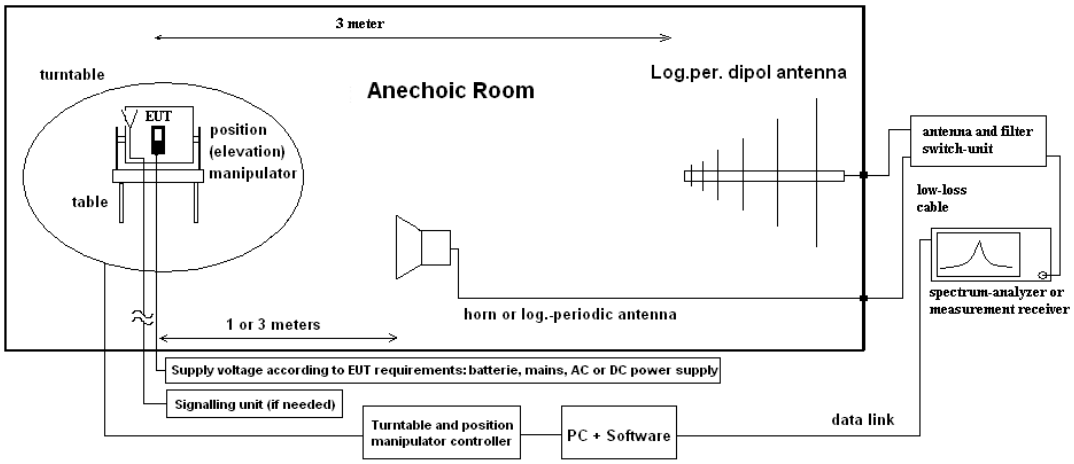
Remark: for more information and graphical plot see annex A1 **CETECOM_TR17_1_0202201T01a_A1**
Remark 2: Due to the small size of the EUT, either standing or lying position is tested under each operation mode.

4.2 Radiated field strength emissions 30 MHz – 1 GHz

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

Evaluating the emissions have to be done first by an exploratory emissions measurement and a final measurement for most critical frequencies. The tests are performed in a CISPR 16-1-4:2010 compliant semi anechoic room (SAR) and fully anechoic room (FAR) recognized by the regulatory commission. The measurement distance was set to 3 meter for frequencies up to 18 GHz and 2 meter above 18 GHz. A logarithmic periodic antenna is used for the frequency range 30 MHz to 1 GHz. Horn antennas are used for frequency range 1 GHz to 40 GHz. The EUT is aligned within 3 dB beam width of the measurement antenna with three orthogonal axis measurements on the EUT.

Schematic:



Testing method:

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

Exploratory, preliminary measurements
The EUT and its associated accessories are placed on a non-conductive position manipulator (tipping device) of 0.8 m height which is placed on the turntable. By rotating the turntable (range 0° to 360°, step 90°) and the EUT itself either on 3-orthogonal axis (portable equipment) or 2-orthogonal axis (defined operational position of EUT) the emission spectrum and its characteristics was recorded with an EMI-receiver, broadband antenna and software.

Measurement antenna: horizontal and vertical, heights: 1,0 m and 1,82 m as worst-case determined by an exploratory emission measurements. The results are documented in a diagram. Critical frequencies (low margin to limit) are saved within a table for further investigations. If various operating modes are supported, further investigations are made to find the worst-case of them. Also the interconnection cables and equipment position were varied in order to maximize the emissions.

Final measurement on critical frequencies
Based on the exploratory measurements, the most critical frequencies are re-measured by maintaining the EUT's worst-case operation mode, cable position, etc. either on 10m OATS or 3m semi-anechoic room.
First a frequency zoom around the critical frequency is done to locate the frequency more precisely. After this step, for all identified critical frequencies, the maximum peak was determined.

Following parameters were varied: the turntable angle continuously in the range 0 to 360 degree, the EUT itself either over 3-orthogonal axis (not defined usage position) or 2-orthogonal axis (defined usage position). The measurement antenna height between 1 m and 4 m.
On the determined worst-case position, a final measurement with necessary bandwidth and detector according standard has been carried out

Formula:

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

Fundamental: Radiated emissions limits, (3 meters)				
Frequency Range [MHz]	**Limit [µV/m]**	**Limit [dBµV/m]**	**Detector**	**RBW / VBW [kHz]**
40.66-40.70 (Only USA)	1000	60	Quasi peak	100 / 300
70-130	500	53.98	Quasi peak	100 / 300
130-174	500 to 1500	53.98 to 63.52	Quasi peak	100 / 300
174-260	1500	63.52	Quasi peak	100 / 300
260-470	1500 to 5000	63.52 to 73.98	Quasi peak	100 / 300
Above 470	5000	73.98	Quasi peak	100 / 300

Spurious: Radiated emissions limits, (3 meters)				
Frequency Range [MHz]	**Limit [µV/m]**	**Limit [dBµV/m]**	**Detector**	**RBW / VBW [kHz]**
40.66-40.70 (Only USA)	100	40	Quasi peak	100 / 300
70-130	50	33.98	Quasi peak	100 / 300
130-174	50 to 150	33.98 to 43.52	Quasi peak	100 / 300
174-260	150	43.52	Quasi peak	100 / 300
260-470	150 to 500	43.52 to 53.98	Quasi peak	100 / 300
Above 470	500	53.98	Quasi peak	100 / 300

4.2.4 Result

Fundamental emissions, set.1

Diagram	Channel / Antenna port	Mode	Setup	Max. PK Level [dBµV/m]	Max. AV Level [dBµV/m]	Limit AV level [dBµV/m]	Result
3.02	Ch1	TX CW	lying position	86.27	61.00	72.88	PASSED

Remark 1: for more information and graphical plot see annex A1 **CETECOM_TR17_1_0202201T01a_A1**

Remark 2: Due to the small size of the EUT, only lying position is tested.

Remark 3: Duty cycle correction factor is -25.27 dB.

Spurious emissions, set.1+2

Diagram	Channel / Antenna port	Mode	Setup	Maximum Level [dBµV/m] Frequency Range 30 – 1000 MHz	Result
3.11	Ch1	TX CW	lying position	33 (Noise floor)	PASSED
3.12	Ch1	normal	lying position	34 (QP)	PASSED

Remark: for more information and graphical plot see annex A1 **CETECOM_TR17_1_0202201T01a_A1**

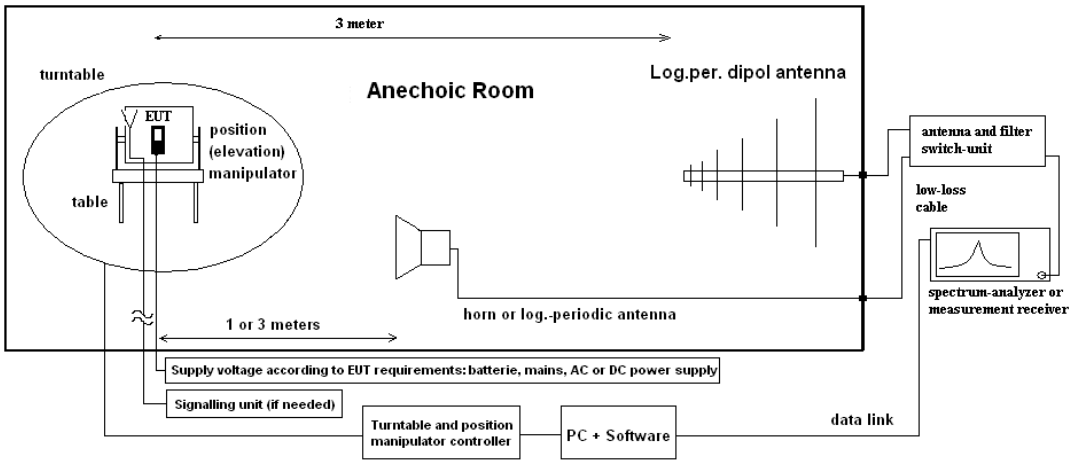
Remark 2: Due to the small size of the EUT, only lying position is tested.

4.3 Radiated field strength emissions above 1 GHz

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

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

Schematic:



Testing method:

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

Exploratory, preliminary measurements
The EUT and its associated accessories are placed on a non-conductive position manipulator (tipping device) of 1.55 m height which is placed on the turntable. By rotating the turntable (range 0° to 360°, step 15°) and the EUT itself either on 3-orthogonal axis (portable equipment) or 2-orthogonal axis (defined operational position of EUT) the emission spectrum and its characteristics was recorded with an EMI-receiver, broadband antenna and software.
The measurements are performed in horizontal and vertical polarization of the measurement antennas. The results are documented in a diagram. Critical frequencies (low margin to limit) are saved within a table for further investigations. If various operating modes are supported, further investigations are made to find the worst-case of them. Also the interconnection cables and equipment position were varied in order to maximize the emissions.

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

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

Following parameters were varied: the turntable angle continuously in the range 0 to 360 degree, the EUT itself over 3-orthogonal axis, the antenna height and tilting or three axis scan for portable/small equipment.

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

Formula:

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

$M = L_T - E_C$ (2)

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

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

4.3.2 Measurement Location

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

4.3.3 Limit

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

4.3.4 Result

Set.1+2

Diagram	Channel / Antenna port	Mode	Setup	Maximum Level [dBµV/m] Frequency Range 1 – 5 GHz	Result
4.01	Ch1	Op.1	Standing + lying	56 (PK)	PASSED
4.02	Ch1	Op.2	Standing + lying	60 (Noise floor)	PASSED

Remark: for more information and graphical plot see annex A1**CETECOM_TR17_1_0202201T01a_A1**

4.4 Emission Bandwidth 20 dB

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

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

Testing method:

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

EUT settings
The continuous transmission is set in each channel and measured individually.
The EUT was instructed to send with maximum power (if adjustable) according applicants instructions.
Different modulation characteristics have been checked, e.g. data rates which EUT can operate.

4.4.2 Measurement Location

Test site	120910 - Radio Laboratory 1 (TS 8997)

4.4.3 Limit

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

Remark: fc is the center frequency. RBW is between 1% and 5% of the bandwidth.
Remark 2: 0.25% of center frequency is 1086 kHz.

4.4.4 Result

Mode	Channel / Antenna port	Frequency [MHz]	20 dB bandwidth [kHz]	Limit [kHz]	Result
Normal	Ch1	434.4	62.98	1086	PASSED

Remark: for more information and graphical plot see annex A1 **CETECOM_TR17_1_0202201T01a_A1**

4.5 Occupied Channel Bandwidth 99%

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

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

Testing method:

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

EUT settings
For FHSS-systems hopping mode was switched-off so fixed three different channels could be measured.
The EUT was instructed to send with maximum power (if adjustable) according applicants instructions.
Different modulation characteristics have been checked, e.g. data rates which EUT can operate.

4.5.2 Measurement Location

Test site	120910 - Radio Laboratory 1 (TS 8997)

4.5.3 Limit

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

4.5.4 Result

Mode	Channel / Antenna port	Frequency [MHz]	99% Occupied bandwidth [kHz]
Normal	Ch1	434.4	61.54

Remark: for more information and graphical plot see annex A1**CETECOM_TR17_1_0202201T01a_A1**

4.6 Timing requirements

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

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

Testing method:

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

EUT settings
The EUT is set to normal operating mode.

4.6.2 Measurement Location

Test site	120910 - Radio Laboratory 1 (TS 8997)

4.6.3 Limit

§15.231(a)

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

§15.231(e)

(1) Duration of each transmission < 1 s
(2) Silent period between transmissions > 30 times the duration of the transmission
(3) Silent period between transmissions > 10 s

4.6.4 Result

Activation of transmitter	De-activation of transmitter
☒ manual activation of transmitter	☒ automatic de-activation of transmitter
☐ automatic activation of transmitter	
Verdict	
Operating mode 2 (normal mode): PASSED	

Remark: for more information and graphical plot see annex A1**CETECOM_TR17_1_0202201T01a_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-Z2	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
20254	High Pass Filter 5HC 2600/12750-1.5KK (GSM1800/1900/DECT)	Trilithic	23042	
20291	High Pass Filter WHJ 2200-4EE (GSM 850/900)	Wainwright Instruments GmbH	14	
20020	Horn Antenna 3115 (Subst 1)	EMCO Elektronik GmbH	9107-3699	2021-Jul-19
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	
20287	Pre-Amplifier 25MHz - 4GHz AMF-2D-100M4G-35-10P	Miteq Inc.	379418	
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

ID	Description	Manufacturer	SerNo	Cal due date
	120911 - Radio Laboratory 2			
20431	Model 7405 Near-Field Probe Set	EMCO Elektronik GmbH	9305-2457	

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})	-	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 1 GHz - 18 GHz 18-26.5 GHz	5.83 dB 4.91 dB 5.06 dB						Electrical Field strength

7 Versions of test reports (change history)

Version	Applied changes	Date of release
--	Initial release	2021-Mar-11
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End of Test Report