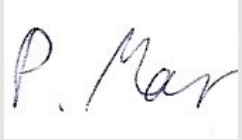
Test Report
22-1-0025001T04a-C01

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

Number of pages:	40	**Date of Report:**	2023-Jan-05
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:**	Giraffe360 SIA
Product: **Model:**	**360 Degree Camera** **GRF-400**		
FCC ID:	2A8A7-V599	**IC:**	28899-3Q30
Testing has been carried out in accordance with:	**FCC Regulations** **Title 47 CFR, Chapter I, Subchapter A, Part 15** **Subpart C Intentional Radiators** § 15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz **ISED-Regulations** **Radio Standards Specification** **RSS-Gen, Issue 5** General Requirements for Compliance of Radio Apparatus **RSS-247, Issue 2** Digital Transmission Systems (DTSS), Frequency Hopping Systems (FHSS) and Licence-Exempt Local Area Network (LE-LAN) Device		
Tested Technology:	Bluetooth		
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 The current version of test report 22-1-0025001T04a-C01 replaces the test report 22-1-0025001T04a dated 2022-Nov-04. The replaced test report is herewith invalid.		
Signatures:			
	Dipl.-Ing. Ninovic Perez Test Lab Manager Authorization of test report		M.Sc. Patrick Marzotko Test Manager Responsible of test report

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1 General information

1.1 Disclaimer and Notes

The test results of this test report relate exclusively to the test item specified in this test report as specified in chapter 2.7. CETECOM does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item.
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Also we refer on special conditions which the applicant should fulfill according §2.927 to §2.948, special focus regarding modification of the equipment and availability of sample equipment for market surveillance tests.

1.2 Attestation

I declare that all measurements were performed by me or under my supervision and that all measurements have been performed and are correct to my best knowledge and belief to Industry Canada standards. All of the above requirements are met in accordance with enumerated standards.

1.3 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
Duty cycle	§15.35(c)	RSS-Gen Issue 5, §8.2	11	--	PASSED
Emission Bandwidth 20 dB	§15.247(a)(1)	RSS-247, Issue 2, §5.1(a)	15	--	PASSED
Occupied Channel Bandwidth 99%	2.1049(h)	RSS-Gen, Issue 5, §6.7	20	--	PASSED
Carrier Frequency Separation	§15.247(a)(1)	RSS-247, Issue 2, §5.1(b)	16	--	PASSED
Number of Hopping Channels	§15.247(a)(1)(iii)	RSS-247, Issue 2, §5.1(d)	17	--	PASSED
Time of Occupancy	§15.247(a)(1)(iii)	RSS-247, Issue 2, §5.1(d)	18	--	PASSED
Peak output power (Sweep)	§15.247(b)(1)	RSS-247, Issue 2: §5.1(b)	13	--	PASSED
Transmitter Peak output power radiated	§15.247(b)(4)	RSS-247, Issue 2: §5.1(b)	--	--	NP
Emissions in non-restricted frequency bands	§15.247(d)	RSS-247, §5.5	22	--	PASSED
Radiated Band-Edge emissions	§15.247(d)	RSS-247, §5.5 RSS-Gen: Issue 5: §8.9 Table 5+6+7	33	--	PASSED
Radiated field strength emissions below 30 MHz	§15.205(a) §15.209(a)	RSS-Gen: Issue 5 §8.9 Table 6	26	--	PASSED
Radiated field strength emissions 30 MHz – 1 GHz	§15.209 §15.247(d)	RSS-Gen: Issue 5 §8.9 Table 5 RSS-247, §5.5	28	--	PASSED
Radiated field strength emissions above 1 GHz	§15.209(a) §15.247(d)	RSS-Gen: Issue 5: §8.9 Table 5+7 RSS-247, §5.5	31	--	PASSED
AC-Power Lines Conducted Emissions	§15.207	RSS-Gen Issue 5: §8.8, Table 4	35	--	PASSED

PASSED	The EUT complies with the essential requirements in the standard.
FAILED	The EUT does not comply with the essential requirements in the standard.
N/A	Test case does not apply to the test object.
NP	The test was not performed by the CETECOM Laboratory.

Decision Rule: CETECOM GmbH follows ILAC G8:2019 chapter 4.2.1 (Simple Acceptance Rule).

1.4 Summary of Test Methods

Test case	Test method
Duty-Cycle	ANSI C63.10:2013, §11.6(b)
Peak output power (Sweep)	ANSI C63.10:2013, §6.10.1
Emission Bandwidth 20 dB	ANSI C63.10:2013
Carrier Frequency Separation	ANSI C63.10:2013
Number of Hopping Channels	ANSI C63.10:2013
Time of Occupancy	ANSI C63.10:2013
Occupied Channel Bandwidth 99%	ANSI C63.10:2013, §6.9.3
Power spectral density	ANSI C63.10:2013, §6.9.2, §11.8
Transmitter Peak output power radiated	Result calculated with measured conducted RF-power value and stated/measured antenna gain for band of interest
Emissions in non-restricted frequency bands	ANSI C63.10:2013, §11.11, §6.10.5
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
Radiated Band-Edge emissions	ANSI C63.10-2013; “Marker-Delta method”, §6.10.5, §11.13
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: FCC ISED**
IC Lab company No. / CAB ID:	3462D / DE0005
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:	M.Sc. Patrick Marzotko
Receipt of EUT:	2022-Sep-01
Date(s) of test:	2022-Sep-13 to 2022-Oct-27
Version of template:	22.0901

2.5 Applicant's details

Applicant's name:	Giraffe360 SIA
Address:	Delu iela 4 LV-1004 Riga Latvia
Contact Person:	Ricards Porins
Contact Person's Email:	ricards.porins@giraffe360.com

2.6 Manufacturer's details

Manufacturer's name:	Giraffe360 SIA
Address:	Delu iela 4 LV-1004 Riga Latvia

2.7 Equipment under Test (EUT)

EUT No.*)	Sample No.	Product	Model	Type	SN	HW	SW
EUT 1	22-1-00250S04_C02	360 Degree Camera	GRF-400	N/A	N/A	V1.0	G0-105-06-09-2022
EUT 2	22-1-00250S03_C02	360 Degree Camera	GRF-400	N/A	N/A	V1.0	G0-105-06-09-2022

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

2.8 Untested Variant (VAR)

VAR No.*)	Sample No.	Product	Model	Type	SN	HW	SW

*) The listed additional untested model variant(s) (VAR) is/are not object of evaluation of compliance. For further information please see Annex 5: Declaration of applicant of model differences.
If the table above does not show any other line than the headline, no untested variants are available.

2.9 Auxiliary Equipment (AE)

AE No.*)	Sample No.	Auxiliary Equipment	Model	SN	HW	SW
AE 1	22-1-00250S05_C01	USB-C PD Charger	N/A	N/A	V1.0	N/A
AE 2	22-1-00250S09_C01	Laptop	Lenovo ThinkPad	PF-2LT3A9	N/A	N/A

*) AE short description is used to simplify the identification of the auxiliary equipment in this test report. If the table above does not show any other line than the headline, no AE was used during testing nor was taken into account for evaluation.

2.10 Connected cables (CAB)

CAB No.*)	Sample No.	Cable Type	Connectors / Details	Length
CAB 1	22-1-00250S06_C01	USB Cable	USB-C	100 cm
CAB 2	22-1-00250S07_C01	USB Cable	USB-C	100 cm

*) CAB short description is used to simplify the identification of the connected cables in this test report. If the table above does not show any other line than the headline, no cable was used during testing nor was taken into account for evaluation.

2.11 Software (SW)

SW No.*)	Sample No.	SW Name	Description	SW Status
SW 1	--	MobaTerm	Personal Edition	V22.1 Build 4888

*) SW short description is used to simplify the identification of the used software in this test report. If the table above does not show any other line than the headline, no SW was used during testing nor was taken into account for evaluation.

2.12 EUT set-ups

set-up no.*)	Combination of EUT and AE	Description
1	EUT 1 + AE 1 + AE 2 + CAB 1 + CAB 2	Used for Radiated measurements
2	EUT 2 + AE 1 + AE 2 + CAB 2 + CAB 2	Used for Conducted measurements

*) EUT set-up no. is used to simplify the identification of the EUT set-up in this test report.
**) AE 2 and CAB 2 were used to set up Test mode and placed outside chamber during measurements.

2.13 EUT operation modes

EUT operating mode no.*1)	Operating modes	Additional information
op. 1	Bluetooth BDR/EDR Modes* TX-Fixed Channel (Modulated)	The EUT was put to Fixed Channel (Modulated) Continuous transmissions mode in following worst case configurations: - BR DH5, default power setting 0 - EDR 2-DH5, default power setting 0 - EDR 3-DH3, default power setting 0 *Other supported wireless technologies were put in idle mode using special test software *2)
op. 2	Bluetooth BDR/EDR Modes* Normal operating mode	The EUT was put into normal hopping mode. *Other supported wireless technologies were put in idle mode using special test software *2)

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

*2) Please refer to document xxx

2.14 Software commands

With help of SW 1 a special script named “BT_Test_Tool” was used for 1 Mbps data rate with following settings:

1. Test Mode: Carrier Wave
2. Carrier State: On
3. Select Frequency
4. Select Modulation mode: PRBS9
5. Select Modulation type: GFSK
6. Select Transmit Power – Specify power in dBm [0]

For 2Mbps data rate following commands were used:

sudo hciattach /dev/ttyUSB1 bcm43xx 19200 noflow
sudo hciconfig hci0 up
sudo hcitool cmd 0x08 0x00 34 0A 25 00 02

3 Equipment under test (EUT)

3.1 General Data of Main EUT as Declared by Applicant

Firmware	☐ for normal use	☒ Special version for test execution	
Power supply	☒ AC Mains	single Line (L1/N) 120 V 60 Hz	
	☐ DC Mains	-	
	☒ Battery	Lithium Ion battery	
Operational conditions	T_{nom} = +21 °C	T_{min} = n/a	T_{max} = n/a
EUT sample type	**Pre-Production**		
Weight	1.600 kg		
Size [LxWxH]	22.0 cm x 15.0 cm x 9.0 cm		
Interfaces/Ports	USB-C		
For further details refer Applicants Declaration & following technical documents			
For further details regarding radio parameters, please refer to Bluetooth Core Specification			

3.2 Detailed Technical data of Main EUT as Declared by Applicant

Frequency Band	2.4 GHz ISM Band (2400 MHz - 2483.5 MHz)	
Number of Channels (USA/Canada -bands)	79	
Nominal Channel Bandwidth	1 MHz	
Type of Modulation | Data Rate	☒ GFSK | 1 Mbit / s ☒ 8DPSK | 3 Mbit / s	☒ π/4 DQPSK | 2 Mbit / s
Other installed options	☒ a/n/ac mode ☒ b/g/n mode ☒ Bluetooth LE (not tested within this report) ☐ Cellular transceiver (2G/3G/4G/5G/GPS, not tested in this report)	
Max. Conducted Output Power	GFSK: +0.1 dBm	
	8DPSK: -2.7 dBm	
	π/4 DQPSK -1.3 dBm	
EIRP Power (Calculated EIRP)	GFSK: +0.1 dBm + 2.7 dBi = +2.8 dBm	
	8DPSK: -2.7 dBm+ 2.7 dBi = 0 dBm	
	π/4 DQPSK : -1.3 dBm + 2.7 dBi = +1.4 dBm	
Antenna Type	Integrated	
Antenna Gain	+2.7 dBi	
FCC label attached	No	
Test firmware / software and storage location	EUT 1, EUT 2 , AE 1	
For further details refer Applicants Declaration & following technical documents		

Description of Reference Document (supplied by applicant)	Version	Total Pages
BT RF Test Commands for Linux	**0.8**	**14**
Infineon Wi-Fi CLM Regulatory Manual	**2022-06-10**	**79**
Giraffe360 Go Cam Test manual	**V1**	**7**

3.3 Modifications on Test sample

Additions/deviations or exclusions	--

4 Measurements

4.1 Duty-Cycle

Testing method:

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: $x = {TX_{ON}}/{(TX_{ON} + TX_{OFF})}$	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

Test site	120910 - Radio Laboratory 1 (TS 8997)

4.1.2 Result

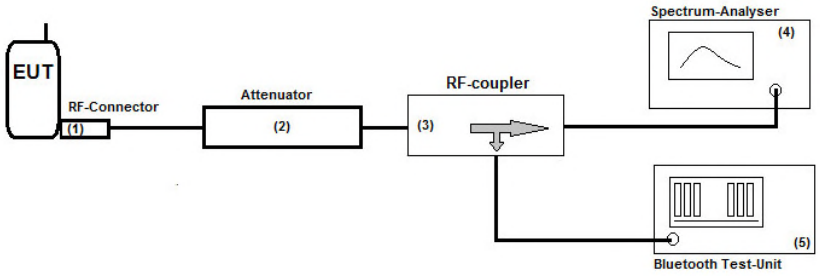
Data Rate	Duty-Cycle [%]	Duty-Cycle correction Power [dB]	Duty-Cycle correction Field Strength [dB]
BDR DH5	77.036	1.133	2.266
EDR-2 DH5	77.097	1.129	2.259
EDR-3 DH3	65.680	1.825	3.651

4.2 Peak output power (Sweep)

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

The EUT's RF-signal is coupled out by a suitable antenna coupling connector (1). The signal is first attenuated (2) then on the RF-coupler the coupled RF-path is connected to a Bluetooth test unit communication tester (5). The direct RF-path is connected to the spectrum – analyzer (4) 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.

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)

Measurement is made using Rohde & Schwarz TS8997 test system.

EUT settings
Hopping mode was switched offso 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

4.2.2 Measurement Location

Test site	120910 - Radio Laboratory 1 (TS 8997)

4.2.3 Limit

Frequency Range [MHz]	Limit [W]	Limit [dBm]	Detector	RBW / VBW [MHz]
2400 - 2483.5	1	30	MaxPeak	3 / 10

4.2.4 Result

Mode	Channel	Frequency [MHz]	Max Peak Power [dBm]	Result
BDR DH5	00	2402	-3.6	PASSED
BDR DH5	39	2441	0.1	PASSED
BDR DH5	78	2480	-0.5	PASSED
EDR 2-DH5	00	2402	-3.5	PASSED
EDR 2-DH5	39	2441	-3.3	PASSED
EDR 2-DH5	78	2480	-2.7	PASSED
EDR 3-DH3	00	2402	-4.8	PASSED
EDR 3-DH3	39	2441	-1.3	PASSED
EDR 3-DH3	78	2480	-3.6	PASSED

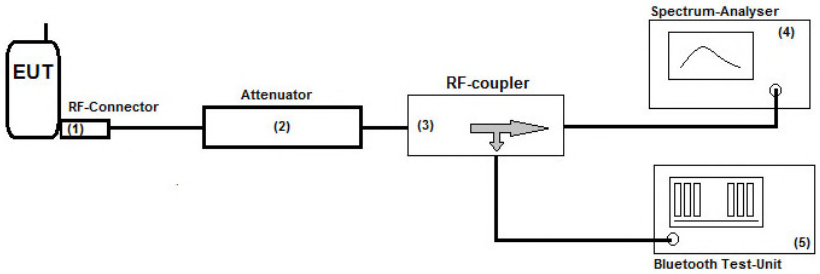
Remark: Only worst case results are listed. for more information and graphical plot see annex A1 **CETECOM_TR22-1-0025001T04a-C01-A1**

4.3 Emission Bandwidth 20 dB

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

The EUT's RF-signal is coupled out by a suitable antenna coupling connector (1). The signal is first attenuated (2) then on the RF-coupler the coupled RF-path is connected to a Bluetooth test unit communication tester (5). The direct RF-path is connected to the spectrum – analyzer (4) 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.

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)

Measurement is made using Rohde & Schwarz TS8997 test system.

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.

4.3.2 Measurement Location

Test site	120910 - Radio Laboratory 1 (TS 8997)

4.3.3 Limit

Limit [kHz]	Detector [MaxHold]	RBW / VBW [kHz]
--	MaxPeak	10 / 30

4.3.4 Result

Mode	Channel	Frequency [MHz]	20 dB bandwidth [MHz]	Result
BDR DH5	00	2402	0.965000	PASSED
BDR DH5	39	2441	0.960000	PASSED
BDR DH5	78	2480	0.975000	PASSED
EDR 2-DH5	00	2402	1.320000	PASSED
EDR 2-DH5	39	2441	1.320000	PASSED
EDR 2-DH5	78	2480	1.320000	PASSED
EDR 3-DH3	00	2402	1.340000	PASSED
EDR 3-DH3	39	2441	1.320000	PASSED
EDR 3-DH3	78	2480	1.345000	PASSED

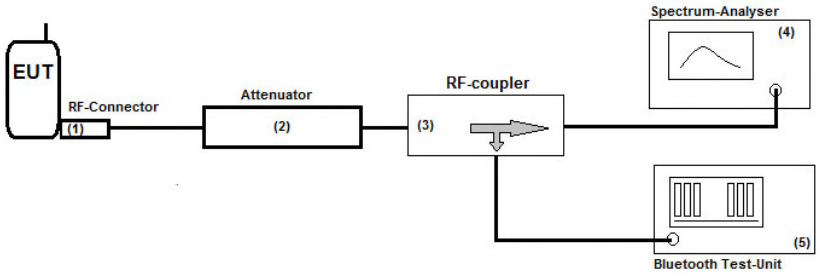
Remark: for more information and graphical plot see annex A1**CETECOM_TR22-1-0025001T04a-C01-A1**

4.4 Carrier Frequency Separation

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 (1). The signal is first attenuated (2) then on the RF-coupler the coupled RF-path is connected to a Bluetooth test unit communication tester (5). The direct RF-path is connected to the spectrum – analyzer (4) 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.

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)

Measurement is made using Rohde & Schwarz TS8997 test system.

EUT settings
For FHSS-systems hopping mode was switched-on.
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 [MHz]	Detector [MaxHold]	RBW / VBW [kHz]
>= 0.025 or 2/3 of the 20 dB bandwidth	MaxPeak	300 / 300

4.4.4 Result

Mode	Channel	Frequency [MHz]	Frequency Separation [MHz]	Result
Op.2	00	2402	1.009901	PASSED
Op.2	39	2441	1.009901	PASSED
Op.2	78	2480	1.009901	PASSED

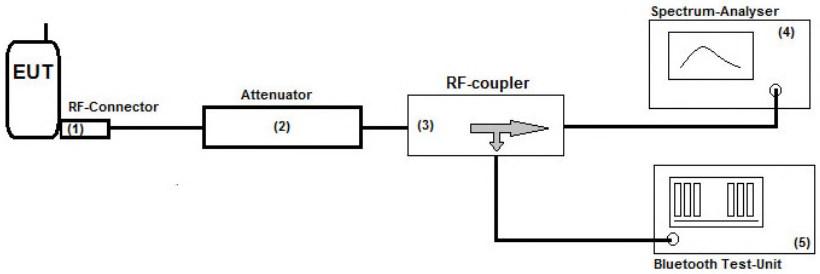
Remark: for more information and graphical plot see annex A1**CETECOM_TR22-1-0025001T04a-C01-A1**

4.5 Number of Hopping Channels

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 (1). The signal is first attenuated (2) then on the RF-coupler the coupled RF-path is connected to a Bluetooth test unit communication tester (5). The direct RF-path is connected to the spectrum – analyzer (4) 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.

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)

Measurement is made using Rohde & Schwarz TS8997 test system.

EUT settings
For FHSS-systems hopping mode was switched-on.
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

Limit [number]	Detector [MaxHold]	RBW / VBW [kHz]
15	MaxPeak	200 / 200

4.5.4 Result

Mode	Number of hopping channels	Result
Op.2	79	PASSED

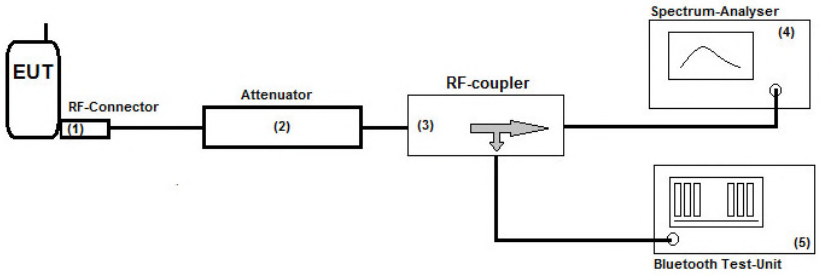
Remark: for more information and graphical plot see annex A1**CETECOM_TR22-1-0025001T04a-C01-A1**

4.6 Time of Occupancy

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

The EUT's RF-signal is coupled out by a suitable antenna coupling connector (1). The signal is first attenuated (2) then on the RF-coupler the coupled RF-path is connected to a Bluetooth test unit communication tester (5). The direct RF-path is connected to the spectrum – analyzer (4) 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.

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)

Measurement is made using Rohde & Schwarz TS8997 test system.

EUT settings
For FHSS-systems hopping mode was switched-on.
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.

4.6.2 Measurement Location

Test site	120910 - Radio Laboratory 1 (TS 8997)

4.6.3 Limit

Limit [s]	Detector [MaxHold]	RBW / VBW [kHz]
<= 0.4	MaxPeak	200 / 200

4.6.4 Result

Mode	Transmission time [ms]	Time of occupancy	Result
Op.2	2.889	14.447	PASSED
Op.2	2.891	8.673	PASSED
Op.2	2.891	11.564	PASSED

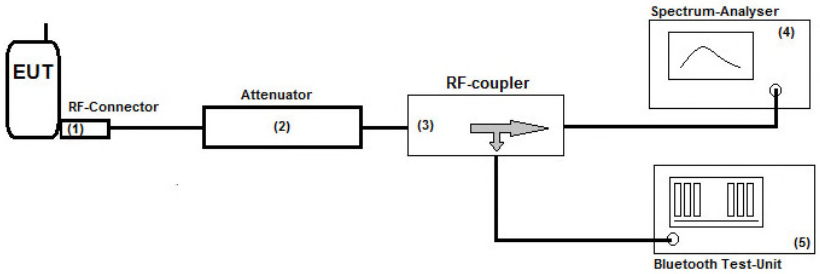
Remark: for more information and graphical plot see annex A1**CETECOM_TR22-1-0025001T04a-C01-A1**

4.7 Occupied Channel Bandwidth 99%

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

The EUT's RF-signal is coupled out by a suitable antenna coupling connector (1). The signal is first attenuated (2) then on the RF-coupler the coupled RF-path is connected to a Bluetooth test unit communication tester (5). The direct RF-path is connected to the spectrum – analyzer (4) 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.

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)

Measurement is made using Rohde & Schwarz TS8997 test system.

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.

4.7.2 Measurement Location

Test site	120910 - Radio Laboratory 1 (TS 8997)

4.7.3 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.

4.7.4 Result

Mode	Channel	Frequency [MHz]	99% Occupied bandwidth [MHz]	Result
BDR DH5	00	2402	0.900000	PASSED
BDR DH5	39	2441	0.910000	PASSED
BDR DH5	78	2480	0.900000	PASSED
EDR 2-DH5	00	2402	1.210000	PASSED
EDR 2-DH5	39	2441	1.205000	PASSED
EDR 2-DH5	78	2480	1.205000	PASSED
EDR 3-DH3	00	2402	1.210000	PASSED
EDR 3-DH3	39	2441	1.210000	PASSED
EDR 3-DH3	78	2480	1.210000	PASSED

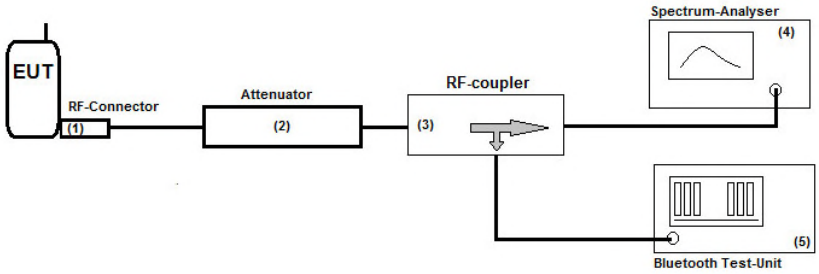
Remark: for more information and graphical plot see annex A1**CETECOM_TR22-1-0025001T04a-C01-A1**

4.8 Emissions in non-restricted frequency bands

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

The EUT's RF-signal is coupled out by a suitable antenna coupling connector (1). The signal is first attenuated (2) then on the RF-coupler the coupled RF-path is connected to a Bluetooth test unit communication tester (5). The direct RF-path is connected to the spectrum – analyzer (4) 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.

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)

Measurement is made using Rohde & Schwarz TS8997 test system.

The measurements were performed with the RBW set to 100 kHz & maximum carrier level was indicated with MAX-Hold positive peak detector using markers. Then a frequency line was set 20 or 30 dB below this measured maximum carrier level.

Then using RBW 100 kHz & spectrum analyzer span from 150 kHz to 25 GHz in three steps spurious emissions were measured with MAX-Hold positive peak detector.

The sweep time set as long as necessary to capture the full signal burst per hopping channel. The burst on-period is captured by setting appropriate markers in the rising and falling edges.

EUT settings
Fixed Channel Mode:
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.

Hopping Mode:
For FHSS-systems Hopping mode was switched- ON so emissions from hopping 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.

4.8.2 Measurement Location

Test site	120910 - Radio Laboratory 1 (TS 8997)

4.8.3 Limit

Frequency Range [MHz]	Limit [dBc]
0.15 – 25000	-20 / -30

4.8.4 Result

Maximum Level Peak [dBc]

Mode	Channel	Frequency [MHz]	Result
BDR DH5	00	2402	PASSED
BDR DH5	39	2441	PASSED
BDR DH5	78	2480	PASSED
EDR 2-DH5	00	2402	PASSED
EDR 2-DH5	39	2441	PASSED
EDR 2-DH5	78	2480	PASSED
EDR 3-DH3	00	2402	PASSED
EDR 3-DH3	39	2441	PASSED
EDR 3-DH3	78	2480	PASSED

Remark: for more information and graphical plot see annex A1**CETECOM_TR22-1-0025001T04a-C01-A1**

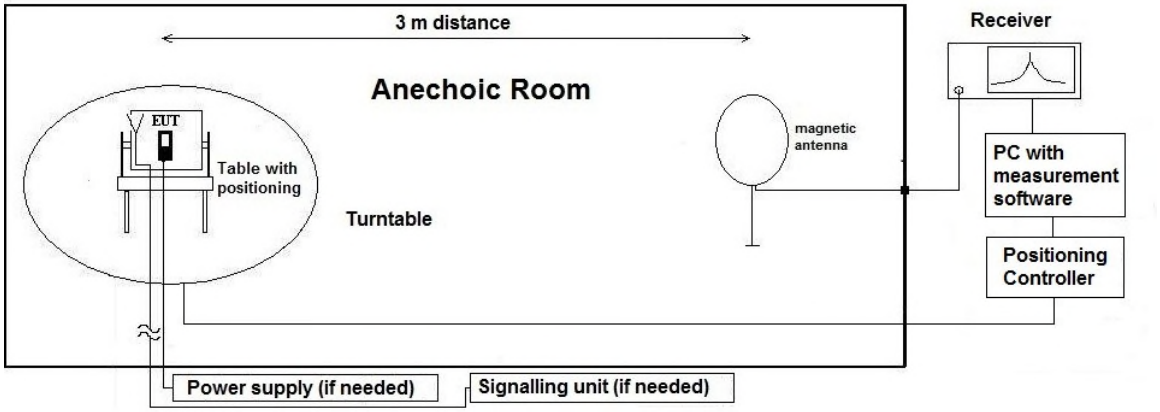
4.9 Radiated field strength emissions below 30 MHz

4.9.1 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 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.

4.9.2 Sample calculation

Raw-Value [dBuV/m]	Antenna factor	Distance Correction [dB]	Cable Loss	Preamplifier	Resulting correction value [dB]	Final result [dBuV/m]	Remarks
19.83	18.9	-70.75	0.18	--	-51.67	-31.83	30 to 3 m correction used according ANSI C63.10-2013

Remark: This calculation is based on an example value at 458 kHz

4.9.3 Measurement Location

Test site	120901 - SAC - Radiated Emission <1GHz

4.9.4 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

4.9.5 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

4.9.6 Result

Diagram	Channel	Mode	Maximum Level [dBµV/m] Frequency Range 0.009 – 30 MHz	Result
2.01a	39	TX EDR 3-DH5	No peaks found	Passed
2.01b	39	TX EDR 3-DH5	No peaks found	Passed
2.02a	78	TX BDR DH5	No peaks found	Passed
2.02b	78	TX BDR DH5	No peaks found	Passed
2.03a	0	TX EDR 2-DH5	No peaks found	Passed
2.03b	0	TX EDR 2-DH5	No peaks found	Passed

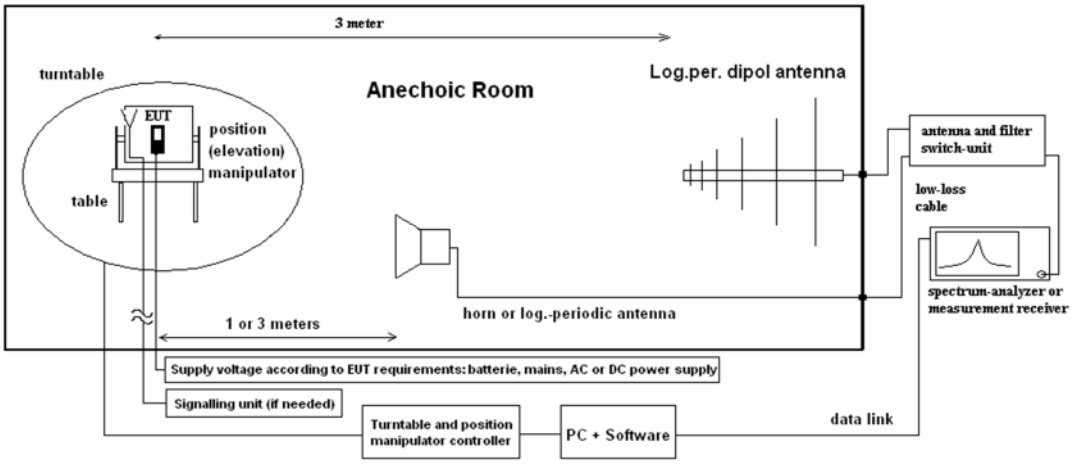
Remark: for more information and graphical plot see annex A1**CETECOM_TR22-1-0025001T04a-C01-A1**

4.10 Radiated field strength emissions 30 MHz – 1 GHz

4.10.1 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.

4.10.2 Sample calculation

Raw-Value [dBuV/m]	Antenna factor	Distance Correction [dB]	Cable Loss	Preamplifier	Resulting correction value [dB]	Final result [dBuV/m]	Remarks
32.7	22.25	--	3.1	--	25.35	58.05	--

Remark: This calculation is based on an example value at 800.4 MHz

4.10.3 Measurement Location

Test site	120901 - SAC - Radiated Emission <1GHz

4.10.4 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

4.10.5 Result

Diagram	Channel	Mode	Maximum Level [dBµV/m] Frequency Range 30 – 1000 MHz	Result
3.01a	39	TX EDR 3-DH5	No peaks found	Passed
3.01b	39	TX EDR 3-DH5	No peaks found	Passed
3.02a	78	TX BDR DH5	No peaks found	Passed
3.02b	78	TX BDR DH5	No peaks found	Passed
3.03a	0	TX EDR 2-DH5	No peaks found	Passed
3.03b	0	TX EDR 2-DH5	No peaks found	Passed

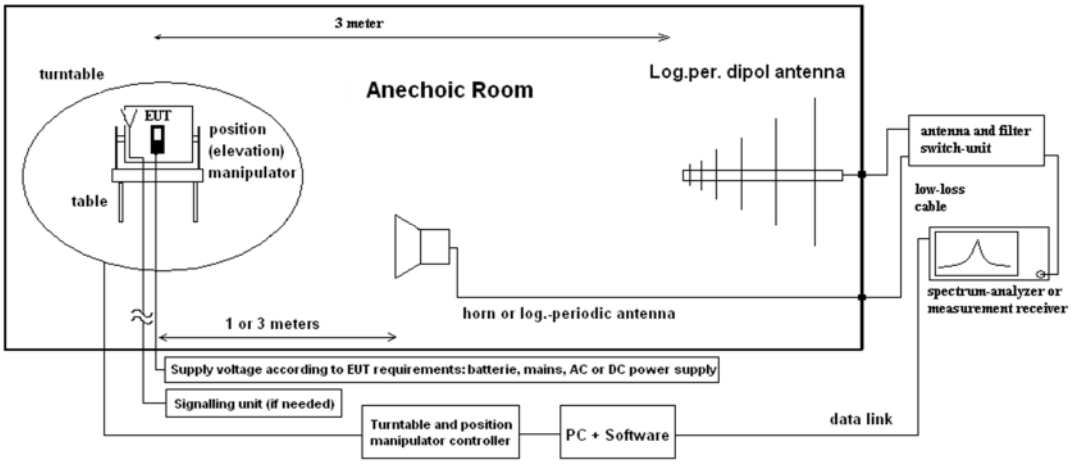
Remark: for more information and graphical plot see annex A1**CETECOM_TR22-1-0025001T04a-C01-A1**

4.11 Radiated field strength emissions above 1 GHz

4.11.1 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.

4.11.2 Sample calculation

Raw-Value [dBuV/m]	Antenna factor	Distance Correction [dB]	Cable Loss + Preamplifier	Resulting correction value [dB]	Final result [dBuV/m]	Remarks
29.37	41.20	--	24.28	16.92	46.3	CableLoss and PreAmp data in one data correction file

Remark: This calculation is based on an example value at 10 GHz

4.11.3 Measurement Location

Test site 1 – 15 GHz	120907 - FAC2
Test site 15 – 26.5 GHz	120907 - FAC2

4.11.4 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

4.11.5 Result

Diagram	Channel	Mode	Maximum Level [dBµV/m] Frequency Range 1 – 15 GHz	Result
4.01a	39	TX EDR 3-DH5	No peaks found	Passed
4.01b	39	TX EDR 3-DH5	No peaks found	Passed
4.02a	78	TX BDR DH5	No peaks found	Passed
4.02b	78	TX BDR DH5	No peaks found	Passed
4.03a	0	TX EDR 2-DH5	No peaks found	Passed
4.03b	0	TX EDR 2-DH5	No peaks found	Passed

Remark: for more information and graphical plot see annex A1**CETECOM_TR22-1-0025001T04a-C01-A1**

Diagram	Channel	Mode	Maximum Level [dBµV/m] Frequency Range 15 – 18 GHz	Result
4.01ef	39	TX EDR 3-DH5	No peaks found	Passed
4.02ef	78	TX BDR DH5	No peaks found	Passed
4.03ef	00	TX EDR 2-DH5	No peaks found	Passed

Remark: for more information and graphical plot see annex A1**CETECOM_TR22-1-0025001T04a-C01-A1**

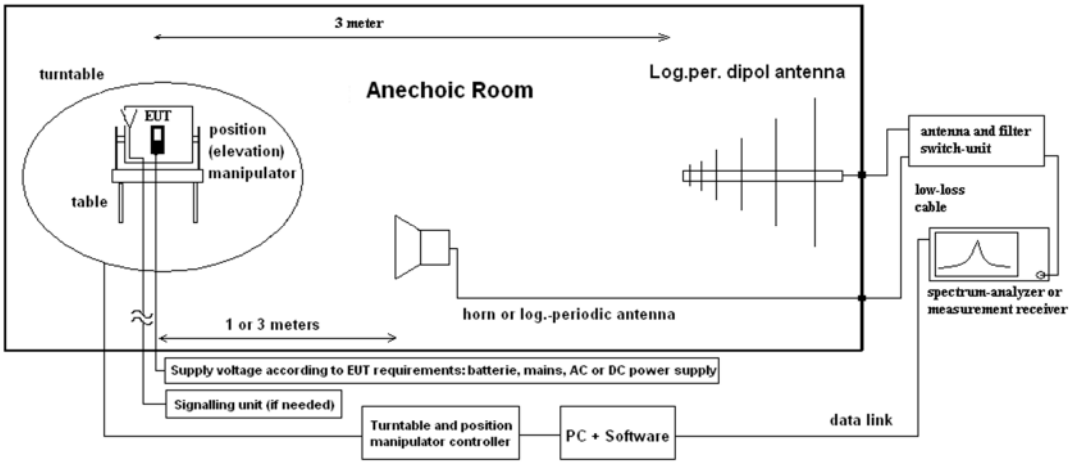
Diagram	Channel	Mode	Maximum Level [dBµV/m] Frequency Range 18 – 26.5 GHz	Result
4.01ij	39	TX EDR 3-DH5	No peaks found	Passed
4.02ij	78	TX BDR DH5	No peaks found	Passed
4.03ij	00	TX EDR 2-DH5	No peaks found	Passed

Remark: for more information and graphical plot see annex A1**CETECOM_TR22-1-0025001T04a-C01-A1**

4.12 Radiated Band-Edge emissions

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

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)

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

For critical results a Marker-Delta marker method was used for showing compliance to restricted bands.
The method consists of three independent steps:

1. Step: Prior to the measurement the fundamental radiated In-Band field strength was performed. The determined value is used as reference value.

2. Step: Second step consist of finding the relative attenuation between the fundamental emission and the maximum local out-of-band emission (within 2 MHz range around the band edge either on the band-edge directly or some modulation product if the level is greater than that on the band-edge) when measured with lower resolution bandwidth.

3. .Step: The delta value recorded in step 2 will be subtracted from value recorded in step 1, thus giving the required field strength at the band-edge. This value must fulfil the requirements for radiated spurious emissions in restricted bands in FCC §15.205 with the general limits of FCC §15.209

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

4.12.2 Measurement Location

Test site	120907 - FAC2

4.12.3 Limit

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

4.12.4 Result

Non-restricted bands near-by

Diagram	Channel	Mode	Peak [dBc]	Average [dBc]	Result
9.01a	00	BT | EDR | 3-DH3 | 2402 MHz	26.98	32.50	PASSED
9.01b	00	BT | EDR | 3-DH3 | 2402 MHz	25.74	30.59	PASSED
9.02a	00	BT | BR | DH5 | 2402 MHz	46.84	45.31	PASSED
9.02b	00	BT | BR | DH5 | 2402 MHz	42.65	48.03	PASSED
9.03a	00	BT | EDR | 2-DH5 | 2402 MHz	37.44	36.81	PASSED
9.03b	00	BT | EDR | 2-DH5 | 2402 MHz	38.94	38.51	PASSED
9.04a	00	BT | BR | DH5 | Hopping mode	39.32	45.05	PASSED
9.04b	00	BT | BR | DH5 | Hopping mode	40.38	44.24	PASSED

Remark: for more information and graphical plot see annex A1**CETECOM_TR22-1-0025001T04a-C01-A1**

Restricted bands near-by

Diagram	Channel	Mode	Peak [dBµV/m]	Average [dBµV/m]	Result
9.05a	78	BT | EDR | 3-DH3 | 2402 MHz	58.63	46.35	PASSED
9.05b	78	BT | EDR | 3-DH3 | 2402 MHz	58.39	46.33	PASSED
9.06a	78	BT | BR | DH5 | 2402 MHz	53.28	39.62	PASSED
9.06b	78	BT | BR | DH5 | 2402 MHz	47.89	37.51	PASSED
9.07a	78	BT | EDR | 2-DH5 | 2402 MHz	59.32	47.95	PASSED
9.07b	78	BT | EDR | 2-DH5 | 2402 MHz	67.60	48.53	PASSED
9.08a	78	BT | BR | DH5 | Hopping mode	58.61	47.62	PASSED
9.08b	78	BT | BR | DH5 | Hopping mode	59.19	47.67	PASSED

Remark1: No Duty cycle correction necessary because of noise.
Remark2: for more information and graphical plot see annex A1**CETECOM_TR22-1-0025001T04a-C01-A1**

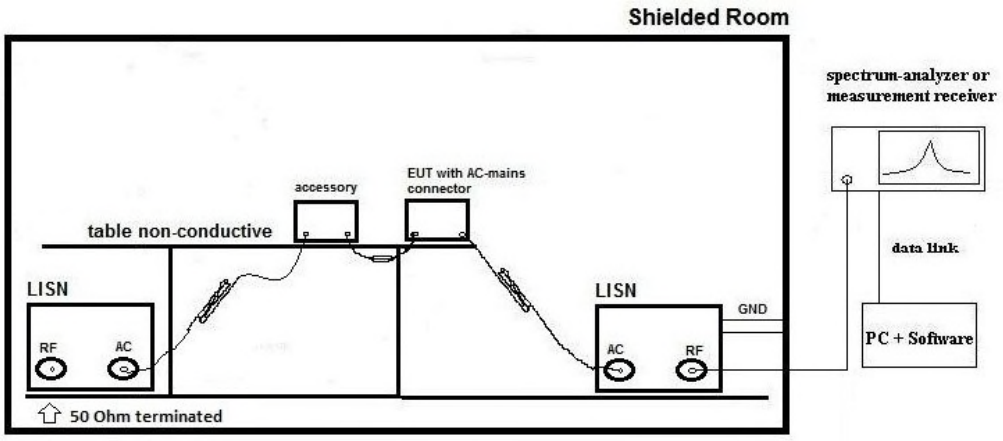
4.13 AC-Power Lines Conducted Emissions

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

The radio frequency voltage conducted back into the AC power line in the frequency range 150 kHz to 30 MHz has to be investigated.
Compliance should be tested by measuring the radio frequency voltage between each power line and ground at the power terminals in the stated frequency range.
A 50 Ohm / 50 µH line impedance stabilization network (LISN) is used coupling the interface to the measurement equipment.
The EUT power input leads are connected through the LISN to the AC-power source. The LISN enclosure is electrically connected to the ground plane. The measuring instrument is connected to the coaxial output of the LISN.

Tabletop devices were set-up on an 80 cm height above reference ground plane, floor standing equipment 10 cm raised above ground plane.
Measurements have been performed on each phase line and neutral line of the devices AC-power lines.
The EUT was power supplied with 120 V/60 Hz. The EUT was tested in the defined operating mode
and installed (connected) to accessory equipment according the general description of use given by the applicant.

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
As a first step, determines the worst-case phase line (neutral or phase) as well as the most critical operating mode of the equipment. A complete frequency-sweep with PK-Detector is performed on each current-carrying conductor.

Final measurement on critical frequencies
For power phases and critical frequencies (Margin to AV- or QP limit lower than 3 dB) as a second step includes measurements with receivers detector set to Quasi-Peak and Average.

Formula:

$V_C = V_R + C_L$ (1)
$M = L_T - V_C$ (2)

V_C = measured Voltage –corrected value
V_R = Receiver reading
C_L = Cable loss
M = Margin
L_T = Limit

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

4.13.2 Measurement Location

Test site	120919 – Conducted Emission

4.13.3 Limit

Frequency Range [MHz]	QUASI-Peak [dBµV]	AVERAGE [dBµV]
0.15 – 0.5	66 to 56*	56 to 46*
0.5 – 5	56	46
5 – 30	60	50

4.13.4 Result

Diagram	Mode	Power Line	Max [dBµV]	Detector	Result
1.01	Op.1	N/L1	49.03	QP	Passed

Remark: see more in diagrams in separate document **CETECOM_TR22-1-0025001T04a-C01-A1**

4.14 Equipment lists

ID	Description	Manufacturer	SerNo	CheckType	Last Check	Interval	Next Check
	120901 - SAC - Radiated Emission <1GHz			calchk	cal: 2015-Jul-21 chk: 2021-Jul-27	cal: 10Y chk: 12M	cal: 2025-Jul-21 chk: 2022-Jul-27
20442	Semi Anechoic Chamber	ETS-Lindgren Gmbh / Taufkirchen	-	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20482	filter matrix Filter matrix SAR 1	CETECOM GmbH	-	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20574	Biconilog Hybrid Antenna BTA-L	Frankonia GmbH / Heideck	980026L	cal	cal: 2022-Jun-15	cal: 36M	cal: 2025-Jun-15
20620	Test Receiver ESU26	Rohde & Schwarz Messgerätebau GmbH / Memmingen	100362	cal	cal: 2022-Jun-08	cal: 12M	cal: 2023-Jun-08
20885	Power Supply EA3632A	Agilent Technologies Deutschland GmbH	75305850	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
25038	Loop Antenna HFH2-Z2	Rohde & Schwarz Messgerätebau GmbH / Memmingen	879824/13	cal	cal: 2022-Jul-04	cal: 24M	cal: 2024-Jul-04
	120904 - FAC1 - Radiated Emissions			chk	chk: 2022-Jun-30	chk: 12M	chk: 2023-Jun-30
20020	Horn Antenna 3115 (Subst 1)	EMCO Elektronik GmbH	9107-3699	calchk	cal: 2021-Aug-17 chk: 2013-Apr-20	cal: 36M chk: 12M	cal: 2024-Aug-17
20066	Notch Filter WRCT 1900/2200-5/40-10EEK	Wainwright Instruments GmbH	5	chk	chk: 2022-Jun-30	chk: 12M	chk: 2023-Jun-30
20121	Notch Filter WRCB 1879,5/1880,5EE	Wainwright Instruments GmbH	15	chk	chk: 2022-Jun-30	chk: 12M	chk: 2023-Jun-30
20122	Notch Filter WRCB 1747/1748	Wainwright Instruments GmbH	12	chk	chk: 2022-Jun-30	chk: 12M	chk: 2023-Jun-30
20254	High Pass Filter 5HC 2600/12750-1.5KK	Trilithic	23042	chk	chk: 2022-Jun-30	chk: 12M	chk: 2023-Jun-30
20287	Pre-Amplifier 25MHz - 4GHz AMF-2D-100M4G-35-10P	Miteq Inc.	379418	chk	chk: 2022-Jun-30	chk: 12M	chk: 2023-Jun-30
20290	Notch Filter WRCA 901,9/903,1SS	Wainwright Instruments GmbH	3RR	chk	chk: 2022-Jun-30	chk: 12M	chk: 2023-Jun-30
20291	High Pass Filter WHJ 2200-4EE	Wainwright Instruments GmbH	14	chk	chk: 2022-Jun-30	chk: 12M	chk: 2023-Jun-30
20302	Horn Antenna BBHA9170 (Meas 1)	Schwarzbeck Mess-Elektronik OHG / Schönau	155	cpu	chk: 2020-Apr-15	chk: 12M	
20338	Pre-Amplifier 100MHz - 26GHz JS4-00102600-38-5P	Miteq Inc.	838697	chk	chk: 2022-Jun-30	chk: 12M	chk: 2023-Jun-30
20341	Digital Multimeter Fluke 112	Fluke Deutschland GmbH / Glottertal	81650455	cal	cal: 2022-May-18	cal: 24M	cal: 2024-May-18
20439	Ultrabroadband-Antenna HL562	Rohde & Schwarz Messgerätebau GmbH	100248	calchk	cal: 2017-Mar-10	cal: 72M chk: 12M	cal: 2023-Mar-10
20448	Notch Filter WRCT 1850.0/2170.0-5/40-10SSK	Wainwright Instruments GmbH	5	chk	chk: 2022-Jun-30	chk: 12M	chk: 2023-Jun-30
20449	Notch Filter WRCT 824.0/894.0-5/40-8SSK	Wainwright Instruments GmbH	1	chk	chk: 2022-Jun-30	chk: 12M	chk: 2023-Jun-30
20484	Pre-Amplifier 2,5GHz - 18GHz AMF-5D-02501800-25-10P	Miteq Inc.	1244554	chk	chk: 2022-Jun-30	chk: 12M	chk: 2023-Jun-30
20489	Test Receiver ESU40	Rohde & Schwarz Messgerätebau GmbH / Memmingen	100030	cal	cal: 2022-Jul-20	cal: 12M	cal: 2023-Jul-20
20512	Notch Filter WRCA 800/960-02/40-6EEK (GSM 850)	Wainwright Instruments GmbH	24	chk	chk: 2022-Jun-30	chk: 12M	chk: 2023-Jun-30
20549	Log. Per. Antenna HL025	Rohde & Schwarz Messgerätebau GmbH	1000060	calchk	cal: 2021-Aug-18	cal: 36M chk: 12M	cal: 2024-Aug-18
20558	Fully Anechoic Chamber 1	ETS-Lindgren Gmbh / Taufkirchen	-	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20611	Power Supply E3632A	Agilent Technologies Deutschland GmbH	KR 75305854	cpu			
20670	Radio Communication Tester CMU200	Rohde & Schwarz Messgerätebau GmbH / Memmingen	106833	cal	cal: 2022-May-10	cal: 24M	cal: 2024-May-10
20690	Spectrum Analyzer FSU	Rohde & Schwarz Messgerätebau GmbH	100302/026	cal	cal: 2021-May-20	cal: 24M	cal: 2023-May-20
20720	Measurement Software EMC32 [FAC]	Rohde & Schwarz Messgerätebau GmbH	V10.xx	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20868	High Pass Filter AFH-07000	AtlanTecRF	16071300004	chk	chk: 2022-Jun-11	chk: 12M	chk: 2023-Jun-11
	120907 - FAC2 - Radiated Emissions			chk	chk: 2022-Aug-30	chk: 12M	chk: 2023-Aug-30
20005	AC - LISN 50 Ohm/50µH ESH2-Z5	Rohde & Schwarz Messgerätebau GmbH / Memmingen	861741/005	cal	cal: 2022-May-19	cal: 12M	cal: 2023-May-19
20133	Horn Antenna 3115 (Meas 1)	EMCO Elektronik GmbH	9012-3629	cal	cal: 2020-Apr-08	cal: 36M	cal: 2023-Apr-08
20412	Fully Anechoic Chamber 2	ETS-Lindgren Gmbh / Taufkirchen	without	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20729	FS-Z140	Rohde & Schwarz Messgerätebau GmbH	101004	cal	cal: 2020-May-26	cal: 36M	cal: 2023-May-26
20730	FS-Z110	Rohde & Schwarz Messgerätebau GmbH	101468	cal	cal: 2020-Jun-19	cal: 36M	cal: 2023-Jun-19
20731	FS-Z75	Rohde & Schwarz Messgerätebau GmbH / Memmingen	101022	cal	cal: 2022-May-18	cal: 36M	cal: 2025-May-18
20732	Signal- and Spectrum Analyzer FSW67	Rohde & Schwarz Messgerätebau GmbH / Memmingen	104023	cal	cal: 2022-Jun-08	cal: 12M	cal: 2023-Jun-08
20733	Harmonic Mixer FS-Z220	RPG-Radiometer Physics GmbH	101009	cal	cal: 2021-May-27	cal: 36M	cal: 2024-May-27
20734	Harmonic Mixer FS-Z325	RPG-Radiometer Physics GmbH	101005	cal	cal: 2021-May-27	cal: 36M	cal: 2024-May-27
20765	Pickett-Potter Horn Antenna FH-PP 40-60	RPG-Radiometer Physics GmbH / Meckenheim	010001	cal	cal: 2020-Sep-15	cal: 36M	cal: 2023-Sep-15
20767	Pickett-Potter Horn Antenna FH-PP 140-220	RPG-Radiometer Physics GmbH / Meckenheim	010011	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20811	Horn Antenna ASY-SGH-124-SMA	Antenna Systems Solutions S.L	29F14182337	cal	cal: 2021-Oct-20	cal: 36M	cal: 2024-Oct-20
20812	Pickett-Potter Horn Antenna FH-PP-325	RPG-Radiometer Physics GmbH	10024	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20813	Pickett-Potter Horn Antenna FH-PP 075	RPG-Radiometer Physics GmbH / Meckenheim	10006	cal	cal: 2020-Sep-09	cal: 36M	cal: 2023-Sep-09
20814	Pickett-Potter Horn Antenna FH-PP 140	RPG-Radiometer Physics GmbH	10008	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -

ID	Description	Manufacturer	SerNo	CheckType	Last Check	Interval	Next Check
20815	Pickett-Potter Horn Antenna FH-PP 110	RPG-Radiometer Physics GmbH	10014	cal	cal: 2020-Sep-04	cal: 36M	cal: 2023-Sep-04
20816	SGH Antenna SGH-26-WR10	Anteral S.L.	1144	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20817	Waveguide Rectangular Horn Antenna SAR-2309-22-S2	ERAVAN	13254-01	cal	cal: 2020-Jul-29	cal: 36M	cal: 2023-Jul-29
20836	1-18 GHz Amplifier	Wright Technologies, Inc., Inc.	0001	chk		chk: 36M	
20907	Waveguide WR-15 attenuator STA-30-15-M2	SAGE Millimeter Inc.	13256-01	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20908	Waveguide WR 10 attenuator STA-30-10-M2	SAGE Millimeter Inc.	13256-01	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20909	Waveguide Horn Antenna PE9881-24	Pasternack Enterprises, Inc.	37/2016	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20910	Frequency Multiplier 936VF-10/385	MI-Wave, Millimeter Wave Products Inc.	142	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20911	Frequency Multiplier 938WF-10/387	MI-Wave, Millimeter Wave Products Inc.	141	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20912	Low noise Amplifier Module 0.5-4GHz	RF-Lambda Europe GmbH	19041200083	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20913	Phase Amplitude Stable Cable Assembly DC-40GHz	RF-Lambda Europe GmbH	AC19040001	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
	120910 - Radio Laboratory 1 (TS 8997)			chk	chk: 2022-Mar-16	chk: 12M	chk: 2023-Mar-16
20559	Vector Signal Generator SMU200A	Rohde & Schwarz Messgerätebau GmbH / Memmingen	103736	cal	cal: 2021-May-20	cal: 24M	cal: 2023-May-20
20691	Open Switch and control Platform OSP120	Rohde & Schwarz Messgerätebau GmbH	101056	cal	cal: 2020-May-13	cal: 36M	cal: 2023-May-13
20805	Open Switch and control Platform OSP B157WX 40GHz 8Port Switch	Rohde & Schwarz Messgerätebau GmbH	101264	cal	cal: 2020-May-13	cal: 36M	cal: 2023-May-13
20866	Signal Analyzer FSV3030	Rohde & Schwarz Messgerätebau GmbH / Memmingen	101247	cal	cal: 2022-Jun-20	cal: 12M	cal: 2023-Jun-20
20871	NRP-Z81	Rohde & Schwarz Messgerätebau GmbH / Memmingen	104631	cal	cal: 2022-May-16	cal: 12M	cal: 2023-May-16
20872	NRX Power Meter	Rohde & Schwarz Messgerätebau GmbH / Memmingen	101831	cal	cal: 2022-May-17	cal: 24M	cal: 2024-May-17

Tools used in 'P1M1'

4.14.1 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

5 Results from external laboratory

None	-

6 Opinions and interpretations

None	-

7 List of abbreviations

None	-

8 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.

Measurement type	Frequency range of measurement		Calculated Uncertainty based on confidence level of 95.54%	Remarks
	Start [MHz]	Stop [MHz]		
Magnetic field strength	0.009	30	4.86	Magnetic loop antenna, Pre-amp on
RF-Output power (eirp) Unwanted emissions (eirp) [dB]	30	100	4.57	without Pre-Amp
	30	100	4.91	with PreAmp
	100	1000	4.02	without Pre-Amp
	100	1000	4.26	with PreAmp
	1000	18000	4.36	without Pre-Amp
	1000	18000	5.23	with PreAmp
	18000	33000	4.92	Schwarzbeck BBHA9170 (#20302) Antenna set-up non-waveguide antenna)
	33000	50000	4.17	Set-up for Q-Band (WR-22), non-wave guide antenna
	40000	60000	4.69	Set-up U-Band (WR-19), non-waveguide antenna
	50000	75000	4.06	External Mixer set-up V-Band (WR-15)
	75000	110000	4.17	External Mixer set-up W-Band (WR-6)
	90000	140000	5.49	External Mixer set-up F-Band (WR-8)
	140000	225000	6.22	External Mixer set-up G-Band (WR-5)
	225000	325000	7.04	External Mixer set-up (WR-3)
	325000	500000	8.84	External Mixer set-up (WR-2.2)
Radiated Blocking [dB]	1000	18000	2.85	Typical set-up with microwave generator and antenna, value for 7GHz calculated
	18000	33000	4.66	Typical set-up with microwave generator and antenna
	33000	50000	3.48	WR-22 set-up
	50000	75000	3.73	WR-15 set-up
	75000	110000	4.26	WR-6 set-up
Frequency Error [kHz]	40000	77000	276.19	calculated for 77 GHz (FMCW) carrier
	6000	7000	33.92	calculated for 6.5GHz UWB Ch.5
TS 8997 conducted Parameters	30	6000	1.11	1. Power measurement with Fast-sampling-detector
	30	6000	1.20	2. Power measurement with Spectrum-Analyzer
	30	6000	1.20	3. Power Spectrum-Density measurement
	30	7500	1.20	4. Conducted Spurious emissions:
	0.009	30	2.56	5. Conducted Spurious emissions:
	2.4	2.48	1.95 ppm	6a. Bandwidth / 2-Marker Method for 2.4GHz ISM
	5.18	5.825	7.180 ppm	6b. Bandwidth / 2-Marker Method for 5GHz WLAN
	5.18	5.825	1.099 ppm	7 Frequency (Marker method) for 5GHz WLAN
	30	6000	0.11561µs	8 Medium-Utilization factor / Timing
	30	6000	1.85	9 Blocking-Level of companion device
	30	6000	1.62	9 Blocking Generator level
Conducted emissions	0.009	30	3.57	

9 Versions of test reports (change history)

Version	Applied changes	Date of release
--	Initial release	2022-Nov-04
C01	Changed EUT model name, hardware version, software version, FCC ID and IC. Updated annex 1 page number.	2023-Jan-05
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End Of Test Report