Test Report
21-1-0120702T01a-C1

Number of pages:	36	**Date of Report:**	2022-Sep-20
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:**	ARESYS srl
Product: **Model:**	**Tank Level Probing Radar** **ScanBrick® W**		
FCC ID:	2A7GA-SCANBRICKW	**IC:**	28648-SCANBRICKW

Testing has been carried out in accordance with:

FCC Regulations
Title 47 CFR, Chapter I, Subchapter A, Part 15.31(q)
Subpart C Intentional Radiators
§ 15.207 Conducted limits
§ 15.209 Radiated emission limits

ISED-Regulations
Radio Standards Specification
RSS-Gen, Issue 5 + A1 + A2
RSS-211, Issue 1 (March 2015)
General Requirements for Compliance of Radio Apparatus

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

Tested Technology:	FMCW 77-81GHz
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 21-1-0120702T01a-C1 replaces the test report 21-1-0120702T01a dated 2022-Sep-07. The replaced test report is herewith invalid.

Signatures:

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

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1 General information

1.1 Disclaimer and Notes

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

1.2 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

Test case	Reference in FCC ☒	Reference in IC Gen ☒	Reference in RSS-211 ☒	Page	Remark	Result
AC-Power Lines Conducted Emissions	§15.107	RSS Gen, Issue 5, Chapter 8.8	--	11	--	Passed
Radiated field strength emissions 9kHz – 30MHz 30 MHz – 1 GHz	§15.109 §15.33 §15.35	RSS-Gen., Issue 5 Chapter 8.9, Chapter 7.3	RSS-211 Chapter 5.1+5.3	12	--	Passed
Radiated field strength emissions above 1 GHz	§15.109 §15.33 §15.35	RSS-Gen., Issue 5 Chapter 8.9, Chapter 7.3	RSS-211 Chapter 5.1+5.3	19	--	Passed
20dB bandwidth (nominal and extreme conditions)	§15.215(c)	RSS-Gen., Issue 5 Chapter 6.7	RSS-211 Chapter 5.1	30	--	FCC: For information only IC: 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.

*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.

1.4 Summary of Test Methods (FCC)

Test case	Test method
Duty-Cycle	ANSI C63.10:2013, §11.6(b)
Minimum Emission Bandwidth 6 dB/20dB	ANSI C63.10:2013, §6.9.2, §11.8
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

1.5 Summary of Test Methods (IC)

Test case	Test method
Duty-Cycle	ANSI C63.10:2013, §11.6(b)
Minimum Emission Bandwidth 6 dB/20dB	ANSI C63.10:2013, §6.9.2, §11.8
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
Maximum Average EIRP (in dBm/MHz) Outside Tank Enclosure Structure Inside the Operating Frequency Range	ETSI EN 302372, V2.1.1, §6.5.5
AC-Power Lines Conducted Emissions	ANSI C63.4-2014 §7, ANSI C63.10-2013 §6.2

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:	Dipl.-Ing. Christian Lorenz
Receipt of EUT:	
Date(s) of test:	08-16-2022 to
Version of template:	22.0602

2.5 Applicant's details

Applicant's name:	ARESYS srl
Address:	Via Flumendosa 16 20132 Milan Italy
Contact Person:	Luca Mereghetti
Contact Person's Email:	luca.mereghetti@aresys.it

2.6 Manufacturer's details

Manufacturer's name:	ARESYS srl
Address:	Via Flumendosa 16 20132 Milan Italien

2.7 Equipment under Test (EUT)

EUT No.*)	Sample No.	Product	Model	Type	SN	HW	SW
1	21-1-01207S02_C01	Tank level probing Radar	Scanbrick®W	W43	#1	1.1.0	2.1

*) 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
1	21-1-01207S03_C01	µUSB AC power adapter (for AE2)	MLF-A00060501000FB0021	1909012010	In: 100-240V AC 50/60Hz Out: 5V DC / 1A	--
2	21-1-01207S04_C01	PoE Adapter	mAP lite FCC-ID: TV7MAPL2ND ID: RBmAPL-2nD	SN: E0AA0F279554/136/r3	--	--

*) 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
1	--	CAT5	From AE2	2m

*) 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
1	--	TX CW Mode	CW Mode on 3 fixed frequencies: Low/Mid/High within FMCW sweep range	2.1_CW
2	--	Normal Op.Mode	Sweep Mode: Normal operating mode	2.1

*) 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	1	EUT 1 + AE1 + AE2

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

2.13 EUT operation modes

EUT operating mode no.*)	Operating modes	Additional information
1	1	3 Carrier CW Mode at Low/Mid/High frequencies within operating mode, WLAN 2.4GHz switched-on AE2
2	2	3 Carrier CW Mode at Low/Mid/High frequencies within operating mode, WLAN 2.4GHz switched-off on AE2
3	3	FMCW Mode: sweept mode for bandwidth measurements

*) 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

Firmware	☒ for normal use	☒ Special version for test execution: 2.1_CW	
Power supply	☒ AC Mains	single Line (L1/N) 120 V 60 Hz	
	☐ DC Mains	XX V DC via XX Connector	
	☐ Battery	-	
Operational conditions	T_{nom} =21 °C	T_{min} =-30 °C	T_{max} =+50 °C
EUT sample type	**Engineering Samples**		
Weight	24.9 kg		
Size [LxWxH]	42cm x 22 cm x 42cm		
Interfaces/Ports	1 (Ethernet)		
For further details refer Applicants Declaration & following technical documents: --			

3.2 Modifications on Test sample

Additions/deviations or exclusions	none

4 Measurements

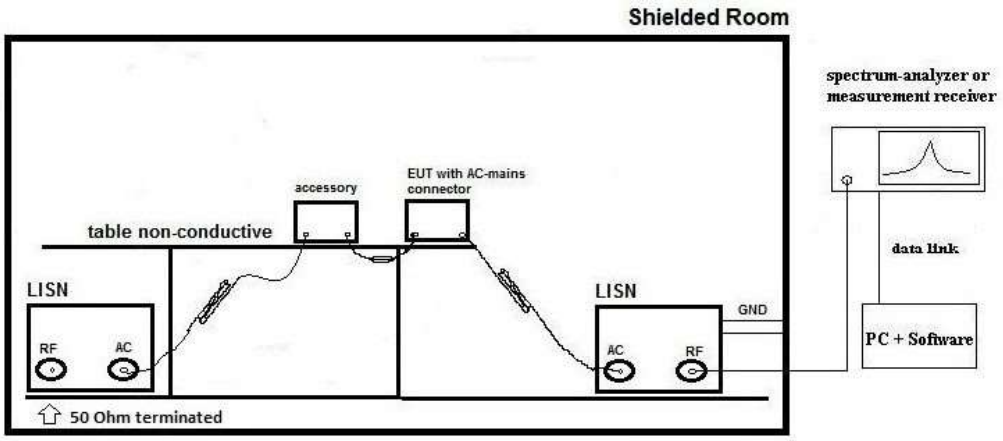
4.1 AC-Power Lines Conducted Emissions

4.1.1 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 5)

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.

4.1.2 Measurement Location

Test site	120919 – Conducted emissions

4.1.3 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

4.1.4 Result

Diagram	Set-up	Mode	Power Line	Max [dBµV]	Detector	Result
1.01	1	1	L1/N	4.67	QP	Passed

Remark: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0120702T01a_A1**

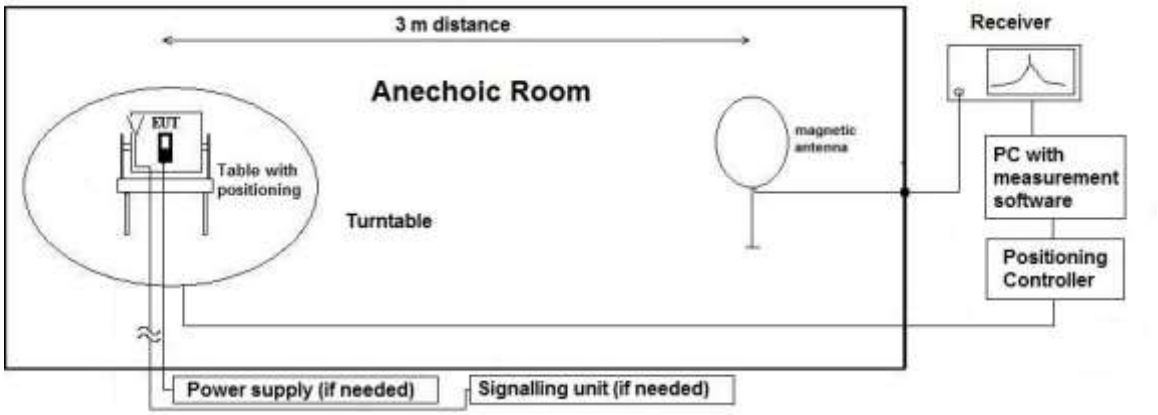
4.2 Radiated field strength emissions below 30 MHz

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

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

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

Schematic:



Testing method:

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

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

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

Final measurement on critical frequencies
Based on the exploratory measurements, the most critical frequencies are re-measured by 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.

4.2.2 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

4.2.3 Correction factors due to reduced meas. distance (f < 30 MHz):

The used correction factors when the measurement distance is reduced compared to regulatory measurement distance, are calculated according Extrapolation formulas valid for EUT's with maximum dimension of 0.625xLambda. 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

4.2.4 Measurement Location

Test site	120901 – SAC1 (Radiated emissions f < 1GHz)

4.2.5 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

4.2.6 Result

Diagram	**Mode**	**EUT position**	**Maximum Level [dBµV/m] Frequency Range 0.009 – 30 MHz**	**Result**
2.01a	1	standing	≤ 20	Passed
2.01b	1	laying	≤ 20	Passed

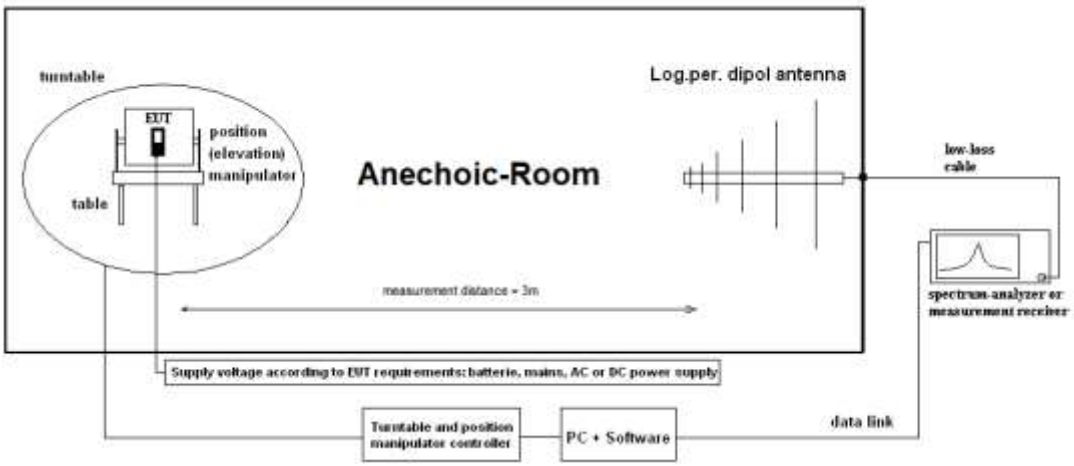
Remark: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0120702T01a_A1**

4.3 Radiated field strength emissions 30 MHz – 960 MHz

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

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

Schematic:



Testing method:

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

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

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

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

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

Formula:

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

$M = L_T - E_C$ (2)

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

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

4.3.2 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

4.3.3 Measurement Location

Test site	120901 – SAC1 (Radiated emissions f<1GHz)

4.3.4 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

4.3.5 Result

Diagram	Mode	EUT position	Maximum Level [dBµV/m] Frequency Range 30 – 960 MHz	Result
3.01	1	EUT laying	37.37@86.04MHz (not §15.205 frequency)	Passed
3.02b	1	EUT standing	38.56@86.04MHz (not §15.205 frequency)	Passed

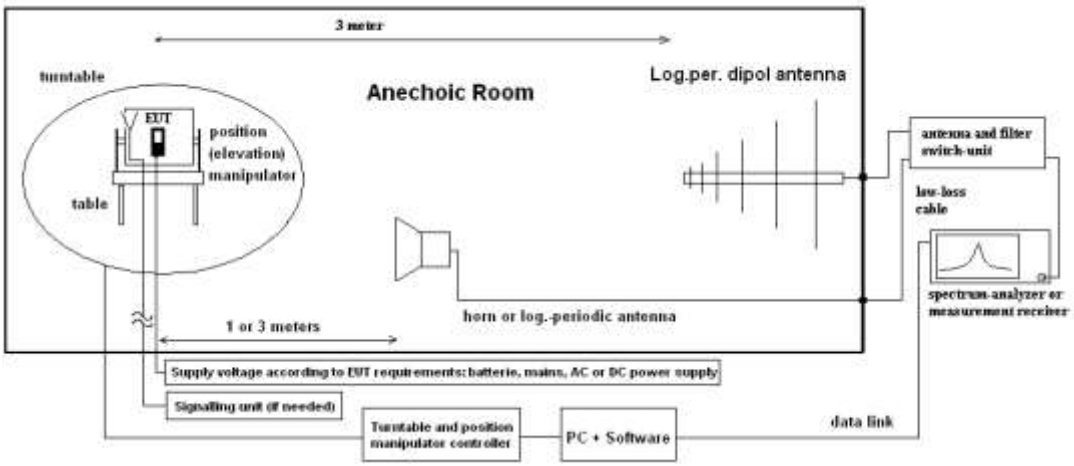
Remark: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0120702T01a_A1**

4.4 Radiated field strength emissions above 1 GHz

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

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

Schematic:



Testing method:

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

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

Final measurement on critical frequencies
Based on the exploratory measurements, the most critical frequencies are re-measured by 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 over 3-orthogonal axis and the height for EUT with large dimensions or three axis scan for portable/small equipment.

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

Formula:

$E_C = E_R + A_F + C_L + D_F - G_A$ (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.

4.4.2 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

4.4.3 Measurement Location

Test site	120907 – FAC2 (Radiated emissions)

4.4.4 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

4.4.5 Result

Diagram	Set-up	Mode	Maximum Level [dBµV/m] Frequency Range 1 – 2.8 GHz	Result
D127_01_EUT_laying	1	2	47.0	Passed
D127_04_EUT_standing	1	2	47.0	Passed

Remark: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0120702T01a_A1**

Diagram	Set-up	Mode	Maximum Level [dBµV/m] Frequency Range 2.8 – 15 GHz	Result
D127_07_EUT_standing	1	1	50.80	Passed
D127_08_EUT_laying	1	1	51.0	Passed

Remark:

1. WLAN 2.4GHz switched-of on AE1

Diagram	Set-up	Mode	Maximum Level [dBµV/m] Frequency Range 15 – 18 GHz	Result
D127_03_EUT_laying	1	1	41.0	Passed
D127_06_EUT_standing	1	1	41.0	Passed

Diagram	Set-up	Mode	Maximum Level [dBµV/m] Frequency Range 18 – 40 GHz	Result
D129_01_EUT_standing Antenna horizontal	1	1	60.50 (-34.65 dBm)	Passed
D129_02_EUT_laying Antenna horizontal	1	1	58.56 (-36.64 dBm)	Passed
D130_01_EUT_standing Antenna vertical	1	1	59.90 (-35.30 dBm)	Passed
D130_02_EUT_laying Antenna vertical	1	1	59.91 (-35.29dBm)	Passed

Remark:

1.) Measurement distance = 1m, AV-limit: 54dBuV/m@3m+20*log10(3m/1m)=63.54dBuV/m@1m (-31.7dBm EIRP)

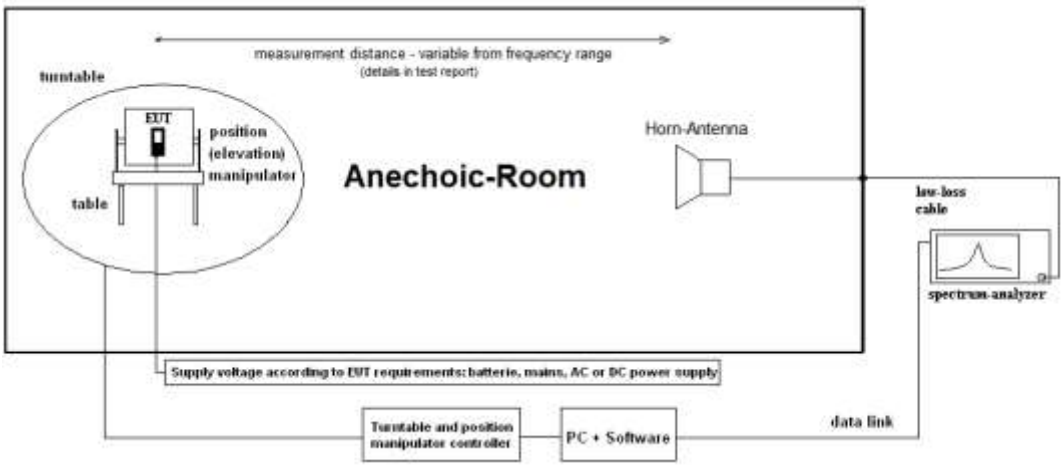
2.) Peak values below AV-limit

4.5 Radiated field strength emissions, above 40 GHz

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

Evaluating the emissions have to be done first by an exploratory emissions measurement and a final measurement for most critical frequencies. The tests are performed in a CISPR 18-1-4:2010 compliant fully anechoic room (FAR) recognized by the regulatory commission. The measurement distance was set to 3 meter for frequencies up to 18 GHz and 2 meter and lower 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:

Measurement is done for op. mode 1. The measuring sweeps are repeated with Maxhold function activated. Thus the measuring diagrams in annex 1 covers emissions of the EUT in all 3D directions. The alignment where the EUT transmits the maximum power is also determined.

The measurements are made with the mixer. There is a ref level line in all measurements. This line is not to be mistaken for limit line.

There are many image signals and mixer products to see on the measurement graphs. Signal ID function is used for the most measurement above 55 GHz for the purpose to distinguish these image signals and mixer products from the real signals. Here is the description of Signal ID function from user manual for R&S FSW Signal and Spectrum Analyzer (1173.9411.02 – 31):

two sweeps are performed alternately. Trace 1 shows the trace measured on the upper side band (USB) of the LO (the test sweep), trace 2 shows the trace measured on the lower side band (LSB), i.e. the reference sweep.

*The reference sweep is performed using an LO setting shifted downwards by 2*IF/<Harmonic order>. Input signals in the desired sideband that are converted using the specified harmonic are displayed in both traces at the same position on the frequency axis. Image signals and mixer products caused by other harmonics are displayed at different positions in both traces. The user identifies the signals visually by comparing the two traces.*

Since the LO frequency is displaced downwards in the reference sweep, the conversion loss of the mixer may differ from the test sweep. Therefore the signal level should only be measured in the test sweep (trace 1).

According to the description of the Signal ID function above the following measurement procedure was developed: the measurement was done with Signal ID function ON, when there are any emissions on the measurement graph or with Signal ID function OFF, when there are no emissions at all. On the measurement graph with Signal ID function ON there

are two traces at first, LSB and USB. These traces can cover each other. For this reason two more graphs are made and included in the test report for each measurement. One graph with only USB trace and one graph with only LSB trace. These two already saved graphs are opened and compared on the wide enough screen. The scaling of the both graphs is the same. So the graphs can be easily compared by the switching between them (at first one graph is showed on the screen and then the second one). Each area of both traces is compared manually in this way. When there is an emission at the same frequency at LSB as well as at USB trace then it is a real signal. Such signal will be flagged with a marker and later re-measured.

Calculation of the boundary near/far field:

The aperture dimensions of the antenna shall be small enough so that the measurement distance in m is equal to or greater than the Rayleigh (far-field) distance (i.e., Rm = 2D2 / λ), where D is the largest dimension of the antenna aperture in m and λ is the free-space wavelength in m at the frequency of measurement.

Antenna range [GHz]	D [m]	Highest frequency in the measurement [GHz]	Lowest wavelength λ in the measurement [m]	Boundary for near/far field [m]
40-54	0.039	54	0,005450772	0.55
54-75	0.032	75	0.003997233	0.51
75-110	0.0208	78	0.003944638	0.22
75-110	0.0208	100	0.002725386	0.29
90-140	0.0165	140	0.002141375	0.25
140-220	0.0107	220	0.001362693	0.17
220-243	0.00705	243	0.001297803	0.08

Measurement distance/far-field distance:

Measurement frequency range:	Measurement distance [m]	Boundary for near/far field [m]
40 GHz – 54 GHz	1.0	0.55
54 GHz – 75 GHz	0.5	0.51
75 GHz – 95 GHz	1.0	0.29
95 GHz – 100 GHz	1.0	0.29
100 GHz – 110 GHz	0.5	0.25
110 GHz – 122 GHz	0.5	0.25
121 GHz – 140 GHz	0.4	0.25
140 GHz -170 GHz	0.32	0.12
170 GHz – 200 GHz	0.32	0.17

4.5.2 Measurement Location

Test site	120907 – FAC2 (Radiated emissions above 1GHz)

4.5.3 Limit

Frequency range	Peak-Limit	AV-Limit	Remarks
Above 1GHz up to 200GHz	74 dBuV/m@3m	54 dBuV/m@3m	Limit re-caclulation for different measurement distances as shown below:
Limit conversion for different measurement distances between max. eirp allowed and dBuV/m unit:	**Examples:** Allowed Average limit at measurement distance: 54dBuV/m@3m+ 20*log10(Ref meas distance(3m)/concrete Meas.distance)-95.2dB 0.4m: 54dBuV/m+17.50dB=71.50dBuV/m@0.5m (-23.69dBm eirp) 0.5m: 54dBuV/m+15.56dB=69.56dBuV/m@0.5m (-25.63dBm eirp) 1m: 54dBuV/m@3m+9.54dB=63.54dBuV/m@1m (-31.66dBm eirp) 3m: 54dBuV/m@3m (-41.2dBm eirp)		

4.5.4 Spectrum-Analyzer Settings

Resolution Bandwidth (RBW)	1 MHz if dynamic range of measurement suitable otherwise decrease of RBW. Informations on screenshots of measurement.
Video Bandwidth (VBW)	Minimum 3 times the resolution bandwidth
Sweep time	Auto or according diagram
Detector	Peak/Max. detector.
Sweep mode	Single sweep, MAX-HOLD
Mixer settings	Signal-ID function activated

4.5.5 Results in frequency range 40-54GHz

Diagram no.	Op.Mode	Frequency [GHz]	Max level [dBm]	Limit [dBm]	Result
D133_01b EUT: 0deg (laying) Antenna: horizontal	1	40-54	≤ -23.97 (PK) ≤ - 37.38 (AV) Noise level	-11.65 (PK) -31.65 (AV)	Passed
D133_02b EUT: 0deg (laying) Antenna: vertical	1	40-54	≤ -24.03 (PK) ≤ - 37.40 (AV) Noise level	-11.65 (PK) -31.65 (AV)	Passed
D133_03b EUT: 90deg (standing) Antenna: vertical	1	40-54	≤ -24.77 (PK) ≤ - 37.39 (AV) Noise level	-11.65 (PK) -31.65 (AV)	Passed
D133_04b EUT: 90deg (standing) Antenna: horizontal	1	40-54	≤ -24.53 (PK) ≤ - 37.35 (AV) Noise level	-11.65 (PK) -31.65 (AV)	Passed

Remark: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0120702T01a_A1**

4.5.6 Results in frequency-range 54-75GHz

Diagram no.	Op.Mode	Frequency [GHz]	Max level [dBm]	Limit [dBm]	Result
D133_01 EUT: 90deg (standing) Antenna: vertical	1	Noise level	≤ -35.14 (PK)	-25.64 (AV)	Passed (Remark2)
D133_02 EUT: 0deg (laying) Antenna: vertical	1	Noise level	≤ -35.0 (PK)	-25.64 (AV)	Passed (Remark2)
D134_01 EUT: 90deg (standing) Antenna: horizontal	1	Noise level	≤ -35.0 (PK)	-25.64 (AV)	Passed (Remark2)
D134_02 EUT: 0deg (laying) Antenna: horizontal	1	Noise level	≤ -35.0 (PK)	-25.64 (AV)	Passed (Remark2)

Remark:

1. for more information and graphical plot see annex A1 **CETECOM_TR21-1-0120702T01a_A1**
2. Signal-ID function shows non-spurious components, only image/ghost frequencies

4.5.7 Results in frequency-range 77-81GHz – Carier Power

All tests have been performed in CW Mode stopped at 3 frequencies within operating range: Low, mid and high range.
The max. average value was determined with a correction factor applied to the peak value as shown in chapter below.

Channel low: 76GHz

Diagram no.	Op.Mode	Frequency [GHz]	Max level [dBm]	PK/AV-Limit [dBm]	Result
D003 EUT: laying Antenna horizontal	1	76.9947	-11.96 (PK)	PK:-11.65 AV: -31.65	Passed (Remark2)
D004 EUT: laying Antenna: vertical	1	76.9947	**-11.84 (PK) - MAX** **-70.16 (AV) - MAX**	PK:-11.65 AV: -31.65	**Passed** **(Remark2)**
D007 EUT: standing Antenna: horizontal	1	76.99485	-12.06 (PK)	PK:-11.65 AV: -31.65	Passed (Remark2)
D010 EUT:standing Antenna: vertical	1	76.99475	-12.23 (PK)	PK:-11.65 AV: -31.65	Passed (Remark2)

Channel Middle: 78.994GHz

D001 EUT: laying Antenna horizontal	1	78.994655	-12.35 (PK)	PK:-11.65 AV: -31.65	Passed (Remark2)
D005 EUT: laying Antenna vertical	1	78.9947	-13.19 (PK)	PK:-11.65 AV: -31.65	Passed (Remark2)
D008 EUT: standing Antenna: horizontal	1	78.99425	-13.10 (PK)	PK:-11.65 AV: -31.65	Passed (Remark2)
D011 EUT: standing Antenna: vertical	1	78.99425	-12.24 (PK)	PK:-11.65 AV: -31.65	Passed (Remark2)

Channel high: 81GHz

D002 EUT: laying Antenna horizontal	1	80.99445	-12.58 (PK)	PK:-11.65 AV: -31.65	Passed (Remark2)
D006 EUT: laying Antenna: vertical	1	80.99425	-15.44 (PK)	PK:-11.65 AV: -31.65	Passed (Remark2)
D009 EUT: standing Antenna: horizontal	1	80.99465	-12.63 (PK)	PK:-11.65 AV: -31.65	Passed (Remark2)
D012 EUT: standing Antenna: vertical	**1**	80.99425	-15.23 (PK)	PK:-11.65 AV: -31.65	Passed (Remark2)

Remark:

1. for more information and graphical plot see annex A1 **CETECOM_TR21-1-0120702T01a_A1**
2. Correction factor PK-AV calculated with Sweep-Time of radar

4.5.7.1 Average TX-carrier emission calculation

For frequency devices Part15, SubpartC specifies general emission limits in linear average detector and peak detector which is 20 dB above average limit, for all frequencies above 1GHz.
For swept frequency LPR devices, measurements can be made by stopping the swept frequency carrier and reporting values for 3 frequencies at low/middle/high range within the working frequency swept area.
When reporting average values the character of the signal should be investigated and a duty-cycle not only based TX_on time calculated. The exact aproach would consider the sweep-time per MHz as the RBW above 1GHz is 1MHz.
Paper TR14-1007 from 13 June, 2014 published by OET, gives indication and formulas how to calculate the exact factor:

Average factor$|_{dB}$ = 10*log10((Sweep-frequency time/Sweep Span$|_{1MHz}$)/Cycle Time of FMCW radar)

Applicant is declaring following parameters:

1. Sweep-Frequency time = 0.44ms
2. Sweep Span = 20dB BW around 4000 MHz
3. Cycle time = 74.74ms

With this data a peak to average reduction of 58.32dB can be calculated

All transmitter peak values can be reduced by 58.32 dB based on the sweept characteristic of the LPR.

4.5.8 Results in frequency-range 75-95GHz – Unwanted emissions

Diagram no.	Op.Mode	Frequency [GHz]	Max level [dBm]	AV-Limit [dBm]	Result
D135_14 EUT: 0deg (laying) Antenna: vertical TT-Position: 0-360°	1	Noise level	≤ - 24.0 (PK) ≤ - 37.0 (AV)	-31.65 AV -11.65 PK	Passed (Remark 2+3)
D135_19 EUT: 90deg (standing) Antenna: vertical TT-Position:0-360°	1	Noise level	≤ -24.0 (PK) ≤ -37.0 (AV)	-31.65 AV -11.65 PK	Passed (Remark 2+3)
D136_20 EUT: 90deg (standing) Antenna: horizontal TT-Position:0-360°	1	Noise level	≤ -24.0 (PK) ≤ -37.0 (AV)	-31.65 AV -11.65 PK	Passed (Remark 2+3)
D136_23 EUT: 0deg (laying) Antenna: horizontal TT-Position:0-360°	1	Noise level	≤ -32.0 (PK) ≤ -45.0 (AV)	-31.65 AV -11.65 PK	Passed (Remark 2+3)

Remark:

1. for more information and graphical plot see annex A1 **CETECOM_TR21-1-0120702T01a_A1**
2. Signal-ID function shows non-spurious components, only image/ghost frequencies
3. Carrier signals will be checked separately

4.5.9 Results in frequency-range 95-100GHz – Unwanted emissions

Diagram no.	Op.Mode	Frequency [GHz]	Max level [dBm]	AV-Limit [dBm]	Result
D135_15 EUT: 0deg (laying) Antenna: vertical TT-Position: 0-360°	1	Noise level	≤ - 22.25 (PK) ≤ - 35.77 (AV)	-31.65 AV -11.65 PK	Passed (Remark 2)
D136_34 EUT: 0deg (laying) Antenna: horizontal TT-Position:0-360°	1	Noise level	≤ -22.62 (PK) ≤ -35.81 (AV)	-31.65 AV -11.65 PK	Passed (Remark 2)
D136_21 EUT: 90deg (standing) Antenna: horizontal TT-Position:0-360°	1	Noise level	≤ -24.0 (PK) ≤ -37 (AV)	-31.65 AV -11.65 PK	Passed (Remark 2)
D135_20 EUT: 90deg (standing) Antenna: vertical TT-Position:0-360°	1	Noise level	≤ -22.01 (PK) ≤ - 35.78 (AV)	-31.65 AV -11.65 PK	Passed (Remark 2)

Remark:

1. for more information and graphical plot see annex A1 **CETECOM_TR21-1-0120702T01a_A1**
2. reduced RBW=500kHz used

4.5.10 Results in frequency-range 100-110GHz

Dmeas=0.5m

Diagram no.	Op.Mode	Frequency [GHz]	Max level [dBm]	AV-Limit [dBm]	Result
D138_03 EUT: 90deg (standing) TT-angle: 0°-360° Antenna: horizontal	1	100-110	≤ -36.0 (Noise level)	-5.63 (PK) -25.63 (AV)	Passed (Remark2)
D137_12 EUT: 90deg (standing) TT-angle: 0°-360° Antenna: vertical	1	100-110	≤ -36.0 (Noise level)	-5.63 (PK) -25.63 (AV)	Passed (Remark2)
D138_02 EUT: 0deg (laying) TT-angle: 0°-360° Antenna: horizontal	1	100-110	≤ -36.0 (Noise level)	-5.63 (PK) -25.63 (AV)	Passed (Remark2)
D137_10 EUT: 0deg (laying) TT-angle: 0°-360° Antenna: vertical	1	100-110	≤ -36.0 (Noise level)	-5.63 (PK) -25.63 (AV)	Passed (Remark2)

Remark:

1. for more information and graphical plot see annex A1 **CETECOM_TR21-1-0120702T01a_A1**
2. Signal-ID function shows non-spurious components, only image/ghost frequencies

4.5.11 Results in frequency-range 110-122GHz

Diagram no.	Op.Mode	Frequency [GHz]	Max level [dBm]	AV-Limit [dBm]	Result
D139_01 EUT: 90deg (standing) TT-angle: 0°-360° Antenna: vertical	1	110-122GHz	≤ -39.24 (PK) (Noise level)	-25.64	Passed (Remark 2+3)
D139_04 EUT: 0deg (laying) TT-angle: 0°-360° Antenna: vertical	1	110-122GHz	≤ -40.28 (PK) (Noise level)	-25.64	Passed (Remark 2+3)
D140_01 EUT: 90deg (standing) TT-angle: 0°-360° Antenna: horizontal	1	110-122GHz	-28.95 (PK) (Noise level)	-25.64	Passed (Remark 2+3)
D140_04 EUT: 0deg (laying) TT-angle: 0°-360° Antenna: horizontal	1	110-122GHz	≤ -31.02 (Noise level)	-25.64	Passed (Remark 2+3)

Remark:

1. for more information and graphical plot see annex A1 **CETECOM_TR21-1-0120702T01a_A1**
2. Signal-ID function shows non-spurious components, only image/ghost frequencies
3. Reduced RBW used

4.5.12 Results in frequency-range 121-140GHz

d_{meas}=0.4m

Diagram no.	Op.Mode	Frequency [GHz]	Max level [dBm]	AV-Limit [dBm]	Result
D139_06 EUT: 90deg (standing) TT-angle: 0°-360° Antenna: horizontal	1	121-140	≤ -30.0 (Noise level)	-3.7 (PK) -23.7 (AV)	Passed (Remark2)
D139_07 EUT: 90deg (standing) TT-angle: 0°-360° Antenna: vertical	1	121-140	≤ -30.0 (Noise level)	-3.7 (PK) -23.7 (AV)	Passed (Remark2)
D139_08 EUT: 0deg (laying) TT-angle: 0°-360° Antenna: vertical	1	121-140	≤ -30.0 (Noise level)	-3.7 (PK) -23.7 (AV)	Passed (Remark2)
D139_09 EUT: 0deg (laying) TT-angle: 0°-360° Antenna: horizontal	1	121-140	≤ -30.0 (Noise level)	-3.7 (PK) -23.7 (AV)	Passed (Remark2)

Remark:

3. for more information and graphical plot see annex A1 **CETECOM_TR21-1-0120702T01a_A1**
4. Signal-ID function shows non-spurious components, only image/ghost frequencies

4.5.13 Results in frequency-range 140-200GHz

d_{meas}=0.5m or 0.32m

Diagram no.	Op.Mode	Frequency [GHz]	Max level [dBm]	AV-Limit [dBm]	Result
D141_01 EUT: 90deg (standing) TT-angle: 0°-360° Antenna: vertical	1	140-170	≤ -28.43 (PK) (Noise level)	-21.76	Passed (remark3)
D141_02 EUT: 0deg (laying) TT-angle: 0°-360° Antenna: vertical	1	140-170	≤ -27.72 (PK) (Noise level)	-21.76	Passed (remark3)
D142_01 EUT: 90deg (standing) TT-angle: 0°-360° Antenna: horizontal	1	140-170	≤ -27.30 (PK) (Noise level)	-25.64	Passed (Remark 2+3)
D142_02 EUT: 0deg (laying) TT-angle: 0°-360° Antenna: horizontal	1	140-170	≤ -27.80 (Noise level)	-21.76	Passed (Remark3)
D143_01 EUT: 90deg (standing) TT-angle: 0°-360° Antenna: vertical	1	170-200	≤ -27.25 (Noise level)	-21.76	Passed (remark3)
D143_02 EUT: 0deg (laying) TT-angle: 0°-360° Antenna: vertical	1	170-200	≤ -27.66 (Noise level)	-21.76	Passed (remark3)
D144_01 EUT: 90deg (standing) TT-angle: 0°-360° Antenna: horizontal	1	170-200	≤ -27.32 (Noise level)	-21.76	Passed (Remark3)
D144_02 EUT: 0deg (laying) TT-angle: 270° Antenna: horizontal	1	170-200	≤ -27.53 (Noise level)	-21.76	Passed (remark3)

Remark:

1. for more information and graphical plot see annex A1 **CETECOM_TR21-1-0120702T01a_A1**
2. Signal-ID function shows non-spurious components, only image/ghost frequencies
3. Reduced RBW used

4.6 20dBc bandwidth

Testing method:

20dB bandwidth was measured for operating mode 3 under nominal and extreme conditions.
The EUT was placed inside a climatic chamber and set to normal operating mode. From outside a measurement horn antenna was put in front of the radom EUT antenna to capture the emission spectrum of interest.

EUT settings
The measurement is made radiated. The EUT was instructed to transmit continuously with maximum power (if adjustable) according applicants declared and applicable settings.

4.6.1 Measurement Location

Test site	Climatic chamber

4.6.2 Limit

Test limit [GHz]
75 - 85

4.6.3 Spectrum-Analyzer Settings

Span	> 1.5 * declared BW
Resolution Bandwidth (RBW)	1 MHz
Video Bandwidth (VBW)	3 MHz
Sweep time	coupled
Detector	Peak detector
Sweep mode	Continuous sweep, MAX-HOLD / repetitive sweep till trace stable

4.6.4 Result

Diagram no.	Voltage conditions	Temperature conditions [degree celsius]	Marker M1 (Max. Value) [GHz]	Marker M2 [GHz]	Marker M3 [GHz]	20dBc bandwidth [GHz]	Centre frequency: (f_{M2}-f_{M1})/2 [GHz]
D001	Vnom	Tnom	79.199129	77.035419	80.996499	3.96108	79.015959
D002	Vmin	Tnom	79.280009	77.035219	80.995739	3.96052	79.015479
D003	Vmax	Tnom	78.629489	77.035339	80.996359	3.96102	79.015849
D004	Vnom	30°	79.950449	77.033629	80.999569	3.96594	79.016599
D005	Vnom	50°	80.109209	77.030219	80.997169	3.96695	79.013694
D006	Vnom	40°	80.105489	77.031719	80.997169	3.96545	79.014444
D007	Vnom	20°	80.006009	77.032849	80.997049	3.9642	79.014949
D008	Vnom	10°	80.296649	77.034739	81.000039	3.9653	79.017389
D009	Vnom	0°	79.187249	77.036299	81.001479	3.96518	79.018889
D010	Vnom	-10°	80.296169	77.035589	80.995369	3.95978	79.015479
D011	Vnom	-20°	80.293289	77.036689	80.999719	3.96303	79.018204
D012	Vnom	-30°	79.922609	77.037879	80.999749	3.96187	79.018814

Remark: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0120702T01a_A1**

4.7 Equipment lists

ID	Description	Manufacturer	SerNo	CheckType	Last Check	Interval	Next Check
	120901 - SAC - Radiated Emission <1GHz			calchk	cal: 07-21-2015 chk: 07-27-2021	cal: 10Y chk: 12M	cal: July 2025 chk: July 2022
20574	Biconilog Hybrid Antenna BTA-L	Frankonia GmbH / Heideck	980026L	cal	cal: 06-15-2022	cal: 36M	cal: June 2025
20482	filter matrix Filter matrix SAR 1	CETECOM GmbH	-	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
25038	Loop Antenna HFH2-Z2	Rohde & Schwarz Messgerätebau GmbH / Memmingen	879824/13	cal	cal: 07-04-2022	cal: 24M	cal: July 2024
20885	Power Supply EA3632A	Agilent Technologies Deutschland GmbH	75305850	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20442	Semi Anechoic Chamber	ETS-Lindgren Gmbh / Taufkirchen	-	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20620	Test Receiver ESU26	Rohde & Schwarz Messgerätebau GmbH / Memmingen	100362	cal	cal: 06-08-2022	cal: 12M	cal: June 2023
	120904 - FAC1 - Radiated Emissions			chk	chk: 06-30-2022	chk: 12M	chk: June 2023
20341	Digital Multimeter Fluke 112	Fluke Deutschland GmbH / Glottertal	81650455	cal	cal: 05-18-2022	cal: 24M	cal: May 2024
20558	Fully Anechoic Chamber 1	ETS-Lindgren Gmbh / Taufkirchen	-	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20254	High Pass Filter 5HC 2600/12750-1.5KK	Trilithic	23042	chk	chk: 06-30-2022	chk: 12M	chk: June 2023
20302	Horn Antenna BBHA9170 (Meas 1)	Schwarzbeck Mess-Elektronik OHG / Schönau	155	cpu	chk: 04-15-2020	chk: 12M	
20549	Log. Per. Antenna HL025	Rohde & Schwarz Messgerätebau GmbH	1000060	calchk	cal: 08-18-2021	cal: 36M chk: 12M	cal: August 2024
20720	Measurement Software EMC32 [FAC]	Rohde & Schwarz Messgerätebau GmbH	V10.xx	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20611	Power Supply E3632A	Agilent Technologies Deutschland GmbH	KR 75305854	cpu			
20338	Pre-Amplifier 100MHz - 26GHz JS4-00102600-38-5P	Miteq Inc.	838697	chk	chk: 06-30-2022	chk: 12M	chk: June 2023
20484	Pre-Amplifier 2,5GHz - 18GHz AMF-5D-02501800-25-10P	Miteq Inc.	1244554	chk	chk: 06-30-2022	chk: 12M	chk: June 2023
20287	Pre-Amplifier 25MHz - 4GHz AMF-2D-100M4G-35-10P	Miteq Inc.	379418	chk	chk: 06-30-2022	chk: 12M	chk: June 2023
20690	Spectrum Analyzer FSU	Rohde & Schwarz Messgerätebau GmbH	100302/026	cal	cal: 05-20-2021	cal: 24M	cal: May 2023
20439	Ultrabroadband-Antenna HL562	Rohde & Schwarz Messgerätebau GmbH	100248	calchk	cal: 03-10-2017	cal: 72M chk: 12M	cal: March 2023
	120907 - FAC2 - Radiated Emissions			chk	chk: 08-30-2021	chk: 12M	chk: August 2022
20836	1-18 GHz Amplifier	Wright Technologies, Inc., Inc.	0001	chk		chk: 36M	
20005	AC - LISN 50 Ohm/50µH ESH2-Z5	Rohde & Schwarz Messgerätebau GmbH / Memmingen	861741/005	cal	cal: 05-19-2022	cal: 12M	cal: May 2023
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: -
20730	FS-Z110	Rohde & Schwarz Messgerätebau GmbH	101468	cal	cal: 06-19-2020	cal: 36M	cal: June 2023
20729	FS-Z140	Rohde & Schwarz Messgerätebau GmbH	101004	cal	cal: 05-26-2020	cal: 36M	cal: May 2023
20731	FS-Z75	Rohde & Schwarz Messgerätebau GmbH / Memmingen	101022	cal	cal: 05-18-2022	cal: 36M	cal: May 2025
20412	Fully Anechoic Chamber 2	ETS-Lindgren Gmbh / Taufkirchen	without	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20733	Harmonic Mixer FS-Z220	RPG-Radiometer Physics GmbH	101009	cal	cal: 05-27-2021	cal: 36M	cal: May 2024
20734	Harmonic Mixer FS-Z325	RPG-Radiometer Physics GmbH	101005	cal	cal: 05-27-2021	cal: 36M	cal: May 2024
20133	Horn Antenna 3115 (Meas 1)	EMCO Elektronik GmbH	9012-3629	cal	cal: 04-08-2020	cal: 36M	cal: April 2023
20811	Horn Antenna ASY-SGH-124-SMA	Antenna Systems Solutions S.L	29F14182337	cal	cal: 10-20-2021	cal: 36M	cal: October 2024
20877	JS42-08001800-16-8P Verstärker	Miteq Inc.	2079991 / 2079992	chk	chk: 02-27-2020	chk: 3M	chk: May 2020
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: -
20813	Pickett-Potter Horn Antenna FH-PP 075	RPG-Radiometer Physics GmbH / Meckenheim	10006	cal	cal: 09-09-2020	cal: 36M	cal: September 2023
20815	Pickett-Potter Horn Antenna FH-PP 110	RPG-Radiometer Physics GmbH	10014	cal	cal: 09-04-2020	cal: 36M	cal: September 2023
20814	Pickett-Potter Horn Antenna FH-PP 140	RPG-Radiometer Physics GmbH	10008	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20767	Pickett-Potter Horn Antenna FH-PP 140-220	RPG-Radiometer Physics GmbH / Meckenheim	010011	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20765	Pickett-Potter Horn Antenna FH-PP 40-60	RPG-Radiometer Physics GmbH / Meckenheim	010001	cal	cal: 09-15-2020	cal: 36M	cal: September 2023
20812	Pickett-Potter Horn Antenna FH-PP-325	RPG-Radiometer Physics GmbH	10024	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20816	SGH Antenna SGH-26-WR10	Anteral S.L.	1144	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20732	Signal- and Spectrum Analyzer FSW67	Rohde & Schwarz Messgerätebau GmbH / Memmingen	104023	cal	cal: 06-08-2022	cal: 12M	cal: June 2023
20909	Waveguide Horn Antenna PE9881-24	Pasternack Enterprises, Inc.	37/2016	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20817	Waveguide Rectangular Horn Antenna SAR-2309-22-S2	ERAVAN	13254-01	cal	cal: 07-29-2020	cal: 36M	cal: July 2023
	120919 - Conducted Emission			cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20468	Digital Multimeter Fluke 112	Fluke Deutschland GmbH	90090455	cal	cal: 06-01-2021	cal: 36M	cal: June 2024
20377	Test Receiver ESCS30	Rohde & Schwarz Messgerätebau GmbH / Memmingen	100160	cal	cal: 05-20-2022	cal: 12M	cal: May 2023
20556	Thermo-/Hygrometer WS-9400	Conrad Electronic GmbH	-	chk	chk: 07-15-2021	chk: 24M	chk: July 2023

Tools used in 'P1M1'

4.7.1 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-Sep-07
C1	References chapter for IC new and new limit calculation	2022-Sep-20
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End Of Test Report