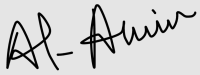
Test Report
21-1-0126102T01a

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

Number of pages:	34	**Date of Report:**	2022-Mar-30
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:**	Hella GmbH & Co. KGaA
Product: **Model:**	**Advanced Driver Assistance System** **RS6.0**		
FCC ID:	NBG01RS60B1	**IC:**	2694A-RS60B1
Testing has been carried out in accordance with:	**47 CFR Part 95** **RSS-Gen, Issue 5 + Amendment 2** **RSS-251, Issue 2** Deviations, modifications or clarifications (if any) to above mentioned documents are written in each section under "Test method and limit".		
Tested Technology:	Radar		
Test Results:	☒ **The EUT complies with the requirements in respect of all parameters subject to the test.** The test results relate only to devices specified in this document		
Signatures:			
	Dipl.-Ing. Ninovic Perez Test Lab Manager Authorization of test report		B.Sc. Al-Amin Hossain Test manager Responsible of test report

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The listed attachments are separate documents.			

1 General information

1.1 Disclaimer and Notes

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

1.2 Summary of Test Results

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

Test case	Reference Clause FCC ☒	Reference Clause ISED ☒	Page	Remark	Result
Power density	FCC §95.3367 (a) (b)	RSS-251 (Section 8 and 9)	10	--	Passed
Modulation characteristics	FCC §2.1047 (d)	RSS-251 (Section 6b)	12	--	Passed
Occupied bandwidth	FCC §95.3379 (b)	RSS-251 (Section 7)	13	--	Passed
Field strength of emissions (band edge)	FCC §95.3379 (a)(2)(i)	RSS-251 (Section 10)	15	--	Passed
Field strength of emissions (radiated spurious)	FCC §95.3379 (a)	RSS-251 (Section 10)	16 20 22	--	Passed
Frequency stability	FCC §95.3379 (b)	RSS-251 (Section 11)	29	--	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.

1.3 Summary of Test Methods

Test case	Test method
Power density	ANSI C63.10-2013
Modulation characteristics	--
Occupied bandwidth	ANSI C63.10-2013 §6.3, §6.4
Field strength of emissions (band edge)	ANSI C63.10-2013 §6.3, §6.5
Field strength of emissions (radiated spurious)	ANSI C63.10-2013 §6.3, §6.6
Frequency stability	ANSI C63.10-2019 §6.8

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:	B.Sc. Al-Amin Hossain
Receipt of EUT:	03.Nov.2021
Date(s) of test:	09-Mar-2022 to 16-Mar-2022
Version of template:	22.0301

2.5 Applicant's details

Applicant's name:	Hella GmbH & Co. KGaA
Address:	Rixbecker Str. 75 59552 Lippstadt North Rhine-Westphalia Germany
Contact Person:	Dan Mihai Berinde
Contact Person's Email:	info@hella.com

2.6 Manufacturer's details

Manufacturer's name:	Hella GmbH & Co. KGaA
Address:	Rixbecker Str. 75 59552 Lippstadt Deutschland

2.7 Equipment under Test (EUT)

EUT No.*)	Sample No.	Product	Model	Type	SN	HW	SW
1	21-1-01261S02_C01	Advanced Driver Assistance System	RS6.0	n/a	01197380	H21/25.00 (B1)	AvR 1.80
2	21-1-01261S05_C01	Advanced Driver Assistance System	RS6.0	n/a	01197402	H21/25.00 (B1)	AvR 1.80

*) 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 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	21-1-01261S06_C01	Communication cable	Serial/PBT-GF10	50 cm
CAB 2	21-1-01261S07_C01	Communication cable	Serial/PBT-GF10	50 cm
CAB 3	21-1-01261S08_C01	Power cable	Banana Connector	50 cm
CAB 4	21-1-01261S09_C01	Power cable	Banana Connector	50 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 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 01 + CAB 01 + CAB 03	Used for Radiated measurements
2	EUT 02 + CAB 02 + CAB 04	Used for Radiated measurements

*) 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
op. 1	TX-Mode 1	Bandwidth approx. 900 MHz We refer to applicants information/papers for details about necessary commands.
op. 2	TX-Mode 2	Bandwidth approx. 1700 MHz We refer to applicants information/papers for details about necessary commands.

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

3 Equipment under test (EUT)

3.1 General Data of Main EUT as Declared by Applicant

Firmware	☐ for normal use	☒ Special version for test execution	
Power supply	☐ AC Mains	--	
	☒ DC Mains	**12** V DC via Banana Connector	
	☐ Battery	--	
Operational conditions	T_{nom} =20 °C	T_{min} =(-)40 °C	T_{max} =+85 °C
Power Supply	V_{nom} = 12 V DC	V_{min} = 9 V DC	V_{max} = 18 V DC
EUT sample type	**Pre-Production**		
Weight	0.1 kg		
Size [LxWxH]	9.5 cm x 6.5 cm x 2.0 cm		
Interfaces/Ports	Check Annex 3 (External photographs of EUT)		
For further details refer Applicants Declaration & following technical documents ➢ **RS 6.0 description for radio licensing B1-sample SWxxxxx_updated3** ➢ **RS 6.0 description for radio licensing B1-sample SWxxxxx_updated4**			

3.2 Detailed Technical data of Main EUT as Declared by Applicant

TX Frequency range [MHz]	76 GHz to 81 GHz		
Type of modulation used	FMCW		
Antenna polarization	Horizontal		
Modulation method	FMCW (fast chirps) plus phase-coding		
Bandwidth	Op 1: approx.900 MHz Op 2: approx 1700 MHz		
Emission classification	F0N		
Coaxial antenna connector available	☒ No connector	☐ Only for testing purpose	☐ Regular use
Antenna Type	☒ Integrated – Waveguide slot array ☐ External, no RF- connector ☐ External, separate RF-connector		
Antenna Gain	Tx1: 11 dBi Tx2: 11 dBi Tx3: 11 dBi Effective gain of all three Tx Antenna: 15.77 dBi	☒ Declared by applicant	☐ Measured
For further details refer Applicants Declaration & following technical documents			

Description of Reference Document (supplied by applicant)	**Version**	**Total Pages**
RS 6.0 description for radio licensing B1-sample SWxxxxx_updated3	--	**5**
RS 6.0 description for radio licensing B1-sample SWxxxxx_updated4	--	**5**

3.3 Modifications on Test sample

Additions/deviations or exclusions	--

4 Measurements

4.1 The maximum peak power EIRP / peak EIRP spectral density. The maximum power EIRP/ average EIRP.

Testing method:

All the measurements are done according to standards and rules listed in subsection 1.2 and 1.3 (See Tables *Summary of Test Results* and *Summary of Test Methods* on page 5). The measured power is EIRP*.
The EUT is ON and set to default mode: FMCW modulation. At first the EUT is tested under nominal condition. Then it is tested under extreme conditions (extreme temperatures and voltages) with the help of a climate cabinet and a variable power supply.
For the maximum peak power EIRP / peak EIRP spectral density test function Signal-ID is activated to exclude ghost signals (product of the mixer).
*EIRP: Equivalent Isotropic Radiated Power

4.1.1 Measurement Location

Test site	120907 - FAC2 - Radiated Emissions

4.1.2 Limit

Average [dBm]	Peak [dBm]
50	55

4.1.3 Spectrum-Analyzer Settings

Span	≥ 1 GHz
Resolution Bandwidth (RBW)	1 MHz
Video Bandwidth (VBW)	Minimum 3 times the resolution bandwidth
Sweep time	≥ 2 * (Span / RBW) * Cycle time
Detector	Peak detector with max peak search. RMS with channel power measurement.
Sweep mode	Single sweep
Detector mode	RMS / Clear Write
Detector mode	PEAK / Max Hold

Remarks:
Measurements distance: 2 meter.
Extreme Temperature Condition:
Tnom:20°C
Tmin:(-)40°C
Tmax:+85°C
Extreme Voltage Condition:
Vnom: 12 V DC
Vmin: 9 V DC
Vmax: 18 V DC

4.1.4 Result

Setup / Mode / Diagram No. / Sample No.	Peak detector, max peak search (marker) [dBm]	Peak detector, max peak search (marker frequency) [GHz]	RMS detector, channel power measurement [dBm], @ < 1 GHz	Voltage [V]	Temperature [°C]	Result
1/op.1/D108/S02	26.80	76.089	--	12	20	Passed
1/op.1/D113/S02	--	--	16.83	12	20	Passed
1/op.1/D109/S02	29.15	76.543	--	12	-40	Passed
1/op.1/D114/S02	--	--	18.35	12	-40	Passed
1/op.1/D110/S02	26.65	76.098	--	12	85	Passed
1/op.1/D115/S02	--	--	16.62	12	85	Passed
1/op.1/D111/S02	27.15	76.097	--	9	20	Passed
1/op.1/D116/S02	--	--	16.55	9	20	Passed
1/op.1/D112/S02	27.09	76.067	--	18	20	Passed
1/op.1/D117/S02	--	--	16.54	18	20	Passed

Remark: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0126102T01a-A1**

Setup / Mode / Diagram No. / Sample No.	Peak detector, max peak search (marker) [dBm]	Peak detector, max peak search (marker frequency) [GHz]	RMS detector, channel power measurement [dBm], @ < 2 GHz	Voltage [V]	Temperature [°C]	Result
2/op.2/D108/S05	29.39	78.644	--	12	20	Passed
2/op.2/D113/S05	--	--	19.41	12	20	Passed
2/op.2/D109/S05	28.61	78.206	--	12	-40	Passed
2/op.2/D114/S05	--	--	18.43	12	-40	Passed
2/op.2/D110/S05	26.48	78.203	--	12	85	Passed
2/op.2/D115/S05	--	--	16.10	12	85	Passed
2/op.2/D111/S05	27.91	78.081	--	9	20	Passed
2/op.2/D116/S05	--	--	16.04	9	20	Passed
2/op.1/D112/S05	27.70	78.056	--	18	20	Passed
2/op.1/D117/S05	--	--	16.26	18	20	Passed

Remark: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0126102T01a-A1**

*** Op. mode 2 shows the highest value of the power measurement among all op. modes. Therefore, all other tests are performed with op. mode 2 as well as Sample S05.**

4.2 Modulation characteristics

Testing method:

Start and stop frequency was measured for all operating modes and all frequency bands with nominal conditions.
Wave form and sweep characteristics were supplied by applicant

4.2.1 Measurement Location

Test site	120907 - FAC2 - Radiated Emissions

4.2.2 Limit

Limit
--

4.2.3 Spectrum-Analyzer Settings

Span	≥ 1 GHz
Resolution Bandwidth (RBW)	1 MHz
Video Bandwidth (VBW)	Minimum 3 times the resolution bandwidth
Sweep time	≥ 2 * (Span / RBW) * Cycle time
Detector	Peak detector
Sweep mode	Single sweep

4.2.4 Result

Remark: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0126102T01a-A1**

4.3 Occupied bandwidth

Testing method:

Occupied bandwidth was measured for operating mode 1 under nominal and extreme conditions. Occupied bandwidth (99 %) function is activated in spectrum analyzer for this measurement.

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.
Different characteristics have been checked, e.g. data rates which EUT can operate if applicable.

4.3.1 Measurement Location

Test site	120907 - FAC2 - Radiated Emissions

4.3.2 Limit

Test limit [GHz]
76 - 81

4.3.3 Spectrum-Analyzer Settings

Span	≥ 1 GHz
Resolution Bandwidth (RBW)	FCC: 1 MHz ISED: 10 MHz, 20 MHz RSS-Gen Issue 5 March 2019 Amendment 1 Section 6.7.: “The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / x dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value.” Actual occupied bandwidth (99% emission bandwidth) of op. mode 1 (Sample_S02) is approx. 900 MHz. So RBW = 10 MHz was chosen. Actual occupied bandwidth (99% emission bandwidth) of op. mode 2 (Sample_S05) is approx. 1700 MHz. So RBW = 20 MHz was chosen.
Video Bandwidth (VBW)	FCC: 3 MHz ISED: 40 MHz, 80 MHz
Sweep time	≥ 2 * (Span / RBW) * Cycle time
Detector	PEAK / Max Hold
Sweep mode	Single sweep

4.3.4 Result

Setup / Mode / Diagram No. / Sample No.	Low edge [GHz]	High edge [GHz]	Voltage [V]	Temperature [°C]	Occ. bandwidth [MHz]	Result
1/op.1/D108/S02	76.064203	76.921758	12	20	857.555	Passed
1/op.1/D108/S02	76.048993	76.944402	12	20	895.409	Passed RBW:10 MHz, VBW:40 MHz "Only for ISED"
1/op.1/D109/S02	76.066605	76.925099	12	-40	858.495	Passed
1/op.1/D110/S02	76.062216	76.923044	12	85	860.828	Passed
1/op.1/D111/S02	76.061292	76.921675	9	20	860.383	Passed
1/op.1/D112/S02	76.061383	76.921739	18	20	860.356	Passed

Remark: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0126102T01a-A1**

Setup / Mode / Diagram No. / Sample No.	Low edge [GHz]	High edge [GHz]	Voltage [V]	Temperature [°C]	Occ. bandwidth [GHz]	Result
2/op.2/D108/S05	77.138113	78.846821	12	20	1.709	Passed
2/op.2/D108/S05	77.101388	78.999773	12	20	1.898	Passed RBW:20 MHz, VBW:80 MHz "Only for ISED"
2/op.2/D109/S05	77.146122	78.850987	12	-40	1.705	Passed
2/op.2/D110/S05	77.138577	78.847280	12	85	1.709	Passed
2/op.2/D111/S05	77.135830	78.847258	9	20	1.711	Passed
2/op.2/D112/S05	77.136612	78.847268	18	20	1.711	Passed

Remark: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0126102T01a-A1**

4.4 Field strength of emissions (band edge)

Testing method:

For low and high band edge see “Field strength of emission (radiated spurious)” in the corresponding frequency range.

4.4.1 Measurement Location

Test site	120907 - FAC2 - Radiated Emissions

4.4.2 Limit

FCC	ISED
600 pW/cm2 ~ -1.7 dBm	lower BE: 0 dBm upper BE: -30 dBm

4.4.3 Spectrum-Analyzer Settings

Span	≥ 1 GHz
Resolution Bandwidth (RBW)	1 MHz
Video Bandwidth (VBW)	Minimum 3 times the resolution bandwidth
Sweep time	≥ 2 * (Span / RBW) * Cycle time
Detector	RMS detector
Sweep mode	Single/continuous sweep, MAX-HOLD

4.4.4 Result

For Result Table please check Diagram
D123_01,
D124_01,
D123_02,
D124_02 for Out of Band Emission under Chapter 4.8.5.

Remark: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0126102T01a-A1**

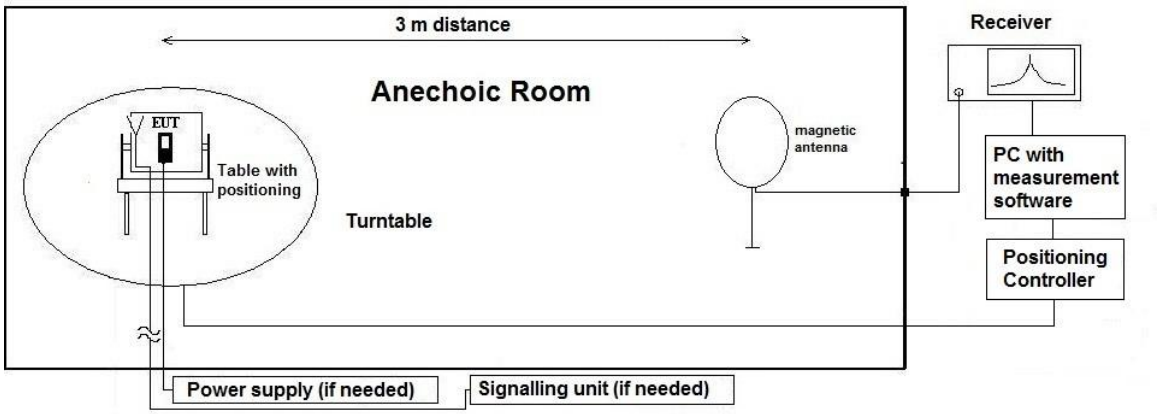
4.5 Radiated field strength emissions below 30 MHz

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

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

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

Schematic:



Testing method:

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

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

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

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

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

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

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

Formula:

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

$M = L_T - E_C$

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

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

4.5.2 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

4.5.3 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

4.5.4 Measurement Location

Test site	120901 - SAC - Radiated Emission <1GHz

4.5.5 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

4.5.6 Result

Diagram	Channel	Mode	Maximum Level [dBµV/m] Frequency Range 0.009 – 30 MHz	Result
2.01	78 GHz	Op mode 2	No critical frequency found	Passed
2.02	78 GHz	Op mode 2	No critical frequency found	Passed

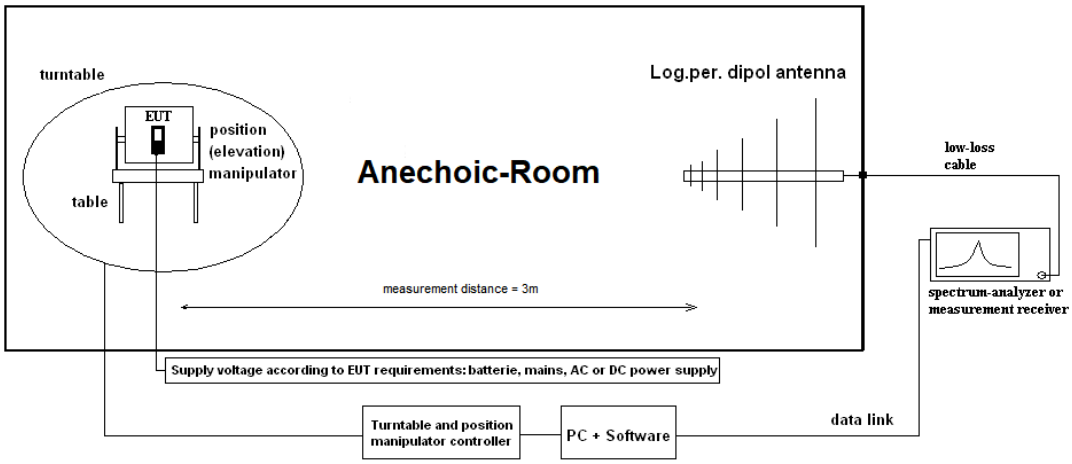
Remark: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0126102T01a-A1**

4.6 Radiated field strength emissions 30 MHz – 1 GHz

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

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

Schematic:



Testing method:

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

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

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

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

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

Formula:

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

$M = L_T - E_C$ (2)

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

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

4.6.2 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

4.6.3 Measurement Location

Test site	120901 - SAC - Radiated Emission <1GHz

4.6.4 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

4.6.5 Result

Diagram	Channel	Mode	Maximum Level [dBµV/m] Frequency Range 30 – 960 MHz	Result
3.01	78 GHz	Op mode 2	No critical frequency found	Passed
3.02	78 GHz	Op mode 2	33.11	Passed

Remark 1: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0126102T01a-A1**

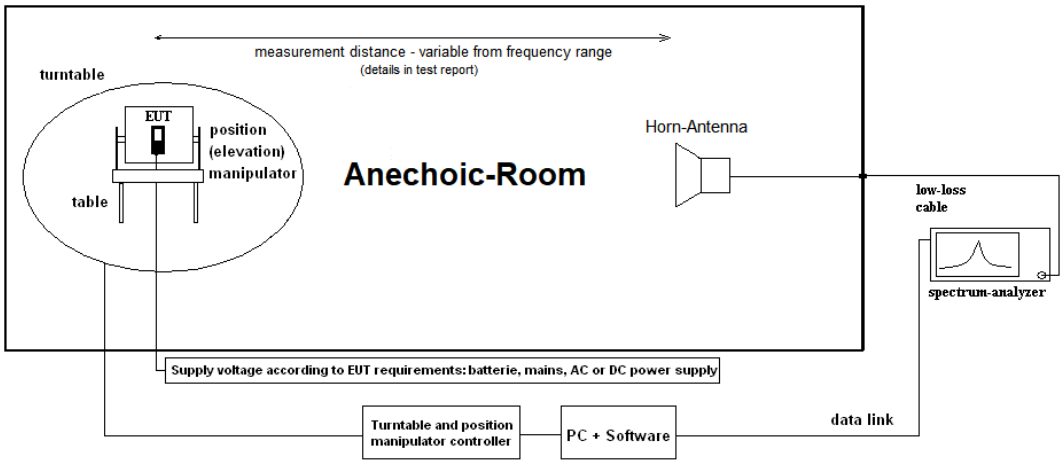
Remark 2: Limit line for FCC and ISED are same in the Frequency range 30 M to 1 GHz.

4.7 Radiated field strength emissions 1 GHz – 40 GHz

4.7.1 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 1 meter above 18 GHz. A logarithmic periodic antenna is used for the frequency range 30 MHz to 1 GHz. Horn antennas are used for frequency range 1 GHz to 40 GHz. The EUT is aligned within 3 dB beam width of the measurement antenna with three orthogonal axis measurements on the EUT.

Schematic:



Testing method:

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

Exploratory, preliminary measurements

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

Final measurement on critical frequencies

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

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

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

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

Formula:

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

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

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

$M = L_T - P_{EIRP}$

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

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

4.7.2 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

4.7.3 Measurement Location

Test site	120907 - FAC2 - Radiated Emissions

4.7.4 Limit

Frequency Range [MHz]	EIRP [dBm]	Field strength [dBµV/m]	RBW / VBW [kHz]
960-40000	−41.23	54	1000 / 3000

EIRP limit was calculated according to the equation (38) in ANSI C63.10-2013:

EIRP[dBm] = E[dBµV/m]+ 20log(d [m])−104.77

EIRPlimit = [54 + 20log(3)−104.77] dBm

= [54 + 9.54−104.77] dBm

= -41.23 dBm

4.7.5 Measurement distance

Frequency Range [GHz]	Measurement distance [m]
1 – 10	3
10 - 18	3
18 - 40	1

4.7.6 Result

Diagram	Antenna Polarization	Mode	Frequency [GHz]	Max level [dBm]	Result
D127a	Vertical	Op mode 2	1 – 10GHz	-43.38*	Passed
D127b	Vertical	Op mode 2	10 – 18GHz	-44.50*	Passed
D128a	Horizontal	Op mode 2	1 – 10GHz	-43.51*	Passed
D128b	Horizontal	Op mode 2	10 – 18GHz	-44.03*	Passed
D129	Horizontal	Op mode 2	18 – 40GHz	-44.18(Premeasurement value with 88 ms) -59.83*(Final measurement value with 200 s)	Passed
D130	Vertical	Op mode 2	18 – 40GHz	-48.29(Premeasurement value with 88 ms) -59.85*(Final measurement value with 200 s)	Passed

Remark 1: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0126102T01a-A1**

Remark 2: Limit line for FCC and ISED are same in the Frequency range 1 G to 40 GHz.

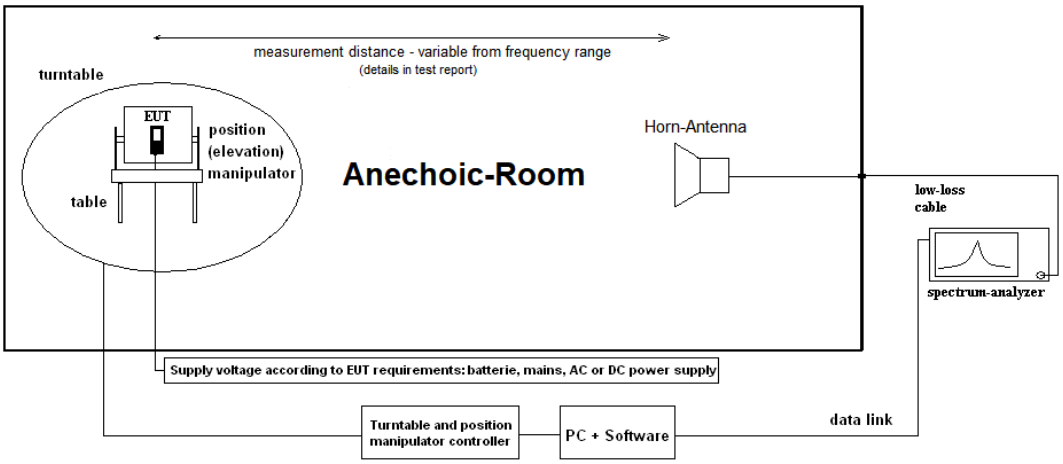
*** No critical value, only noise level**

4.8 Radiated field strength emissions, above 40 GHz

4.8.1 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 1 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:

Measurement is done for op. mode 2. 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]
40-60	0.0384	55	0,005450772	0.54
55-75	0.0307	75	0.003997233	0.47
75-110	0.0208	78	0.003944638	0.22
75-110	0.0208	96	0.002725386	0.28
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:

Measurement frequency range:	Measurement distance [m]	Boundary for near/far field [m]
40 GHz – 55 GHz	2	0.54
55 GHz – 75 GHz	0.5	0.47
75 GHz – 76 GHz	0.5	0.22
81 GHz – 97 GHz	0.5	0.28
97 GHz – 110 GHz	0.5	0.28
110 GHz – 140 GHz	0.25	0.25
140 GHz – 162 GHz	0.12	0.12
162 GHz – 220 GHz	0.5	0.17
220 GHz – 243 GHz	0.5	0.08

4.8.2 Measurement Location

Test site	120907 - FAC2 - Radiated Emissions

4.8.3 Limit

FCC Frequency [GHz]	FCC EIRP [dBm]	ISED Frequency [GHz]	ISED EIRP [dBm]
40 - 200	600 pW/cm2 ~ -1.7	40 - 162	-30
200 - 243	1000 pW/cm2 ~ 0.5	73.5 - 76	0
Limit conversion (pW/cm2 to dBm):	P[dBm]=10*log(4*pi*d2*P[W/m2]) d- distance of the limit defined in W/m2. Here: 3 m. --- 600 pW/cm2: P[dBW]= 10*log(4*pi*(3m)2*6*10-6W/m2) 600 pW/cm2: P[dBW]= -31.7 dBW P[dBm] = P[dBW] + 30 600 pW/cm2: P[dBm]= -31.7 dBW + 30 600 pW/cm2: P[dBm]= -1.7 dBm --- 1000 pW/cm2: P[dBW]= 10*log(4*pi*(3m)2*1*10-5W/m2) 1000 pW/cm2: P[dBW]= -29.5 dBW P[dBm] = P[dBW] + 30 1000 pW/cm2: P[dBm]= -29.5 dBW + 30 1000 pW/cm2: P[dBm]= +0.5 dBm		

4.8.4 Spectrum-Analyzer Settings

Resolution Bandwidth (RBW)	1 MHz
Video Bandwidth (VBW)	Minimum 3 times the resolution bandwidth
Sweep time	≥ 2 * (Span / RBW) * Cycle time
Sweep time	≤ 1 s / auto / 120 s @ 1 GHz
Detector	RMS detector.
Sweep mode	Single sweep, MAX-HOLD
Sweep mode	Continuous sweep, MAX-HOLD

4.8.5 Result

Diagram	Antenna Polarization	Mode	Frequency [GHz]	Max level [dBm]	FCC Limit [dBm]	ISED Limit[dBm]	Result
D131	Vertical	Op mode 2	40 – 55GHz	-37.83*	-1.7	-30	Passed
D132	Horizontal	Op mode 2	40 – 55GHz	-36.99*	-1.7	-30	Passed
D133	Vertical	Op mode 2	55 – 75GHz	-48.06*	-1.7	-30	Passed
D134	Horizontal	Op mode 2	55 – 75GHz	-42.22*	-1.7	-30	Passed
D123_01	Horizontal Vertical	Op mode 1	73.5 – 75GHz Out of Band Emission	-48.75	-1.7	0	Passed
D124_01	Horizontal Vertical	Op mode 1	75 – 76GHz Out of Band Emission	-44.05	-1.7	0	Passed
D123_02	Horizontal Vertical	Op mode 2	73.5 – 75GHz Out of Band Emission	-43.17	-1.7	0	Passed
D124_02	Horizontal Vertical	Op mode 2	75 – 76GHz Out of Band Emission	-40.52	-1.7	0	Passed
D000_01	Horizontal	Op mode 1	75 – 90GHz	Only for information regarding Carrier 76.5 GHz, not for assessment			
D001_01	Horizontal	Op mode 1	75 – 80GHz				
D000_02	Horizontal	Op mode 2	75 – 90GHz	Only for information regarding Carrier 78 GHz, not for assessment			
D001_02	Horizontal	Op mode 2	75 – 80GHz				
D135	Vertical	Op mode 2	81 – 97GHz	-42.77*	-1.7	-30	Passed
D136	Horizontal	Op mode 2	81 – 97GHz	-40.12*	-1.7	-30	Passed
D137	Vertical	Op mode 2	97 – 110GHz	-40.20*	-1.7	-30	Passed
D138	Horizontal	Op mode 2	97 – 110GHz	-37.89*	-1.7	-30	Passed
D139	Vertical	Op mode 2	110 – 140GHz	-36.55*	-1.7	-30	Passed
D140	Horizontal	Op mode 2	110 – 140GHz	-35.90*	-1.7	-30	Passed
D141	Vertical	Op mode 2	140 – 162GHz	-36.84*	-1.7	-30	Passed
D142	Horizontal	Op mode 2	140 – 162GHz	-36.82*	-1.7	-30	Passed
D143	Vertical	Op mode 2	162 – 200GHz 200 – 220GHz	-21.32*	-1.7 +0.5	**	Passed
D144	Horizontal	Op mode 2	162 – 200GHz 200 – 220GHz	-21.26*	-1.7 +0.5	**	Passed
D145	Vertical	Op mode 2	220 – 243GHz	-14.38*	+0.5	**	Passed
D146	Horizontal	Op mode 2	220 – 243GHz	-16.14*	+0.5	**	Passed

Remark: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0126102T01a-A1**

*** No critical value, only noise level**

**** After 162 GHz there is no more ISED Limit.**
According to ISED Standard (RSS 251) measurements should be performed untill 162 GHz
Therefore measurements from 162 GHz is irrelevant for ISED.

4.9 Frequency stability

Testing method:

Frequency stability was measured for operating mode 2 under nominal and extreme conditions. One marker was set on the low and high edge of the signal in each measurement. The frequency of the markers was compared for all measurements.

4.9.1 Measurement Location

Test site	120907 - FAC2 - Radiated Emissions

4.9.2 Limit

Test limit
The radar device's occupied bandwidth (i.e. 99% emission bandwidth) shall be maintained within the 76-81 GHz frequency band while subjected to all conditions of operation specified in RSS-Gen.

4.9.3 Spectrum-Analyzer Settings

Span	≥ 1 GHz
Resolution Bandwidth (RBW)	1 MHz
Video Bandwidth (VBW)	Minimum 3 times the resolution bandwidth
Sweep time	≥ 2 * (Span / RBW) * Cycle time
Detector	Peak detector
Sweep mode	Single sweep, MAX-HOLD

4.9.4 Result

Setup / Mode / Diagram No. / Sample No.	Low edge [GHz]	High edge [GHz]	Voltage [V]	Temperature [°C]	Result
1/op.1/D108/S02	76.064203	76.921758	12	20	Passed
1/op.1/D109/S02	76.066605	76.925099	12	-40	Passed
1/op.1/D110/S02	76.062216	76.923044	12	85	Passed
1/op.1/D111/S02	76.061292	76.921675	9	20	Passed
1/op.1/D112/S02	76.061383	76.921739	18	20	Passed

Remark: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0126102T01a-A1**

Setup / Mode / Diagram No. / Sample No.	Low edge [GHz]	High edge [GHz]	Voltage [V]	Temperature [°C]	Result
2/op.2/D108/S05	77.138113	78.846821	12	20	Passed
2/op.2/D109/S05	77.146122	78.850987	12	-40	Passed
2/op.2/D110/S05	77.138577	78.847280	12	85	Passed
2/op.2/D111/S05	77.135830	78.847258	9	20	Passed
2/op.2/D112/S05	77.136612	78.847268	18	20	Passed

Remark: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0126102T01a-A1**

4.10 Equipment lists

ID	Description	Manufacturer	SerNo	CheckType	Last Check	Interval	Next Check
	120901 - SAC - Radiated Emission <1GHz			calchk	cal: 07-21-2015 chk: 05-19-2020	cal: 10Y chk: 12M	cal: July 2025 chk: May 2021
20574	Biconilog Hybrid Antenna BTA-L	Frankonia GmbH	980026L	cal	cal: 05-03-2019	cal: 36M	cal: May 2022
20341	Digital Multimeter Fluke 112	Fluke Deutschland GmbH	81650455	cal	cal: 05-25-2020	cal: 24M	cal: May 2022
20620	EMI Test Receiver ESU26	Rohde & Schwarz Messgerätebau GmbH	100362	cal	cal: 05-21-2021	cal: 12M	cal: May 2022
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	879824/13	cal	cal: 04-07-2020	cal: 24M	cal: April 2022
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: -
	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	861741/005	cal	cal: 05-20-2021	cal: 12M	cal: May 2022
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	101022	cal	cal: 07-05-2019	cal: 36M	cal: June 2022
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
20302	Horn Antenna BBHA9170 (Meas 1)	Schwarzbeck Mess-Elektronik OHG / Schönau	155	cpu	chk: 04-15-2020	chk: 12M	
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	RPG-Radiometer Physics GmbH	10006	cal	cal: 09-09-2020	cal: 36M	cal: September 2023
20765	Pickett-Potter Horn Antenna	RPG-Radiometer Physics GmbH	010001	cal	cal: 09-15-2020	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	010011	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
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	104023	cal	cal: 05-27-2021	cal: 12M	cal: May 2022
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
20908	Waveguide WR 10 attenuator STA-30-10-M2	SAGE Millimeter Inc.	13256-01	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20907	Waveguide WR-15 attenuator STA-30-15-M2	SAGE Millimeter Inc.	13256-01	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -

Tools used in 'P1M1'

4.10.1 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.

RF-Measurement	Reference	Frequency range	Calculated uncertainty based on a confidence level of 95%						Remarks
Conducted emissions (U_{CISPR})	CISPR 16-2-1	9 kHz - 150 kHz 150 kHz - 30 MHz	4.0 dB 3.6 dB						-
Radiated emissions Enclosure	CISPR 16-2-3	30 MHz - 1 GHz 1 GHz - 18 GHz	4.2 dB 5.1 dB						E-Field
Disturbance power	CISPR 16-2-2	30 MHz - 300 MHz	-						-
Power Output radiated	-	30 MHz - 4 GHz	3.17 dB						Substitution method
Power Output conducted	-	Set-up No.	Cel-C1	Cel-C2	BT1	W1	W2	--	-
		9 kHz - 12.75 GHz	N/A	0.60	0.7	0.25	N/A	--	-
		12.75 GHz - 26.5 GHz	N/A	0.82	--	N/A	N/A	--	
Conducted emissions on RF-port	-	9 kHz - 2.8 GHz	0.70	N/A	0.70	N/A	0.69	--	N/A - not applicable
		2.8 GHz - 12.75 GHz	1.48	N/A	1.51	N/A	1.43	--	
		12.75 GHz – 18 GHz	1.81	N/A	1.83	N/A	1.77	--	
		18 GHz - 26.5 GHz	1.83	N/A	1.85	N/A	1.79	--	
Occupied bandwidth	-	9 kHz - 4 GHz	0.1272 ppm (Delta Marker)						Frequency error
			1.0 dB						Power
Emission bandwidth	-	9 kHz - 4 GHz	0.1272 ppm (Delta Marker)						Frequency error
	-		See above: 0.70 dB						Power
Frequency stability	-	9 kHz - 20 GHz	0.0636 ppm						-
Radiated emissions Enclosure	-	150 kHz - 30 MHz	5.0 dB						Magnetic field
		30 MHz - 1 GHz	4.2 dB						E-field
		1 GHz - 18 GHz	3.17 dB						Substitution Method
		18 GHz -33 GHz	3.60 dB						
		33 GHz -50 GHz	3.99 dB						
		40 GHz -60 GHz	3.95 dB						
		50 GHz -75 GHz	3.24 dB						External Mixer
		75 GHz -90 GHz	3.32 dB						
		90 GHz -140 GHz	4.94 dB						
		140 GHz -225 GHz	5.42 dB						
		225 GHz -243 GHz	6.67 dB						

9 Versions of test reports (change history)

Version	Applied changes	Date of release
--	Initial release	2022-Mar-30
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End Of Test Report