Test Report

22-1-0081701T008a

Number of pages:	23	**Date of Report:**	2023-Oct-17
Testing company:	cetecom advanced GmbH Untertürkheimer Str. 6-10 66117 Saarbrücken, Germany Tel. + 49 (0) 681 598 0 Fax: + 49 (0) 681 598 9075	**Applicant:**	WITTE-Velbert GmbH & Co.KG
Product: **Model:**	**Automotive NFC Outer Door Handle** **DH501**		
FCC ID:	V2T-DH501	**IC:**	7575A-DH501
Testing has been carried out in accordance with:	Title 47 CFR, Chapter I **FCC Regulations, Subchapter A** Subpart C: §15.225 (NFC) **ISED regulations:** RSS-Gen, Issue 5 + Amendment 2 RSS-210, Issue 10: B.6		
Tested Technology:	NFC (13.56MHz)		
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:

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Head of Compliance Testing	Lab Manager
Authorization of test report	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 advanced does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item.
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Also we refer on special conditions which the applicant should fulfill according §2.927 to §2.948, special focus regarding modification of the equipment and availability of sample equipment for market surveillance tests.

1.2 Attestation

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

1.3 Summary of Test Results

The EUT integrates **RFID** technology. Other implemented wireless technologies were not considered within this test report.

Test case	Reference Clause FCC ☒	Reference Clause ISED ☒	Page	Remark	Result
Radiated field strength emissions 30 MHz – 1 GHz	§15.209(a)	RSS-Gen: Issue 5 §8.9 Table 5	11	--	PASSED
Radiated field strength emissions below 30 MHz	§15.209(a)	RSS-Gen: Issue 5 §8.9 Table 6	13	--	PASSED
Radiated field strength emissions and emission mask	§15.225(a)(b)(c)(d)	RSS-210, Issue 10, Annex B.6 (a)	16	--	PASSED
Occupied Channel Bandwidth 99%	§2.202(a) §2.1049(h)	RSS-Gen, Issue 5, §6.6	17	--	PASSED
Frequency stability	§2.1055 §15.225(e)	RSS-210, Issue 10, Annex B.6 (b)	18	--	PASSED
AC-Power Lines Conducted Emissions	§15.207	RSS-Gen Issue 5: §8.8, Table 4	--	--	N/A

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

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

1.4 Summary of Test Methods

Test case	Test method
Occupied Channel Bandwidth 99%	ANSI C63.10:2013, §6.9
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
Frequency stability tests	ANSI C63.10-2013; §6.8
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 advanced GmbH
Address:	Untertürkheimer Str. 6-10 66117 Saarbrücken, Germany Tel. + 49 (0) 681 598 0
Responsible for testing laboratory:	Mr. Andreas Luckenbill
Accreditation scope:	**DAkkS Webpage: FCC ISED**
IC Lab company No. / CAB ID:	3462D / DE0005
Test location 1:	Im Teelbruch 116; 45219 Essen
Test location 2:	Untertürkheimer Str. 6-10; 66117 Saarbrücken

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:	2023-Aug-23
Date(s) of test:	2023-Aug-23, 2023-Sept-29, 2023-Oct-11
Version of template:	23.0901

2.5 Applicant's details

Applicant's name:	WITTE-Velbert GmbH & Co.KG
Address:	Höferstr. 3 - 15 42551 Velbert North Rhine-Westphalia Germany
Contact Person:	Mr. Kay Lackmann
Contact Person's Email:	kay.lackmann@witte-automotive.de

2.6 Manufacturer's details

Manufacturer's name:	WITTE-Velbert GmbH & Co.KG
Address:	Höferstr. 3 - 15 42551 Velbert Deutschland

2.1 Equipment under Test (EUT)

EUT No.*)	Sample No.	Product	Model	Type	SN	HW	SW
1	S09 _C01	Automotive NFC Outer Door Handle	DH501	DH501	20230817-06	D6.1	23.16.19
2	S12_C01	Automotive NFC Outer Door Handle	DH501	DH501	20230817-01	D6.1	23.16.19
3	S13_C01	Automotive NFC Outer Door Handle	DH501	DH501	20230817_02	D6.1	23.16.19

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

2.2 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.

2.3 Auxiliary Equipment (AE)

AE No.*)	Sample No.	Auxiliary Equipment	Model	SN	HW	SW
1	S23	Handle holder and NFC Card Holder	--	#1	--	--
2	S20	NFC card	W003589072200	#1	--	--

*) 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

2.4 Connected cables (CAB)

CAB No.*)	Sample No.	Cable Type	Connectors / Details	Length
1	S17	Shielded both ends	--	1m

*) 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

2.5 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.

2.6 EUT set-ups

set-up no.*)	Combination of EUT and AE	Description
1	EUT 1 + CAB 1	Used for radiated measurements, Op.Mode 1
2	EUT 2 + AE1 + AE2 + CAB1	Used for radiated measurements, Op.Mode 2 distance EUT to Tag = 3cm
3	EUT 3 + AE 1+ AE 2 + CAB 1	Used for climatic chamber measurements, Op.Mode 3

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

2.7 EUT operation modes

EUT operating mode no.*)	Operating modes	Additional information
1	TX continuous	Unmodulated carrier, 100% transmission duty-cycle
2	TX/RX continuous with Tag	Modulated carrier, 100% transmission duty-cycle
3	TX/RX normal mode with Tag	Modulated carrier with RFID Tag, Continuous Read out of tag

*) 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	**13.5** V DC via **DC** Connector	
	☐ Battery	-	
Operational conditions	T_{nom} =21 °C	T_{min} =-40 °C	T_{max} =+85 °C
EUT sample type	**Pre-Production**		
Weight	See aplicants papers		
Size [LxWxH]	See pictures		
Interfaces/Ports	DC port		
For further details refer Applicants Declaration & following technical documents:			

3.2 Detailed Technical data of Main EUT as Declared by Applicant

Frequency Band	13.110 MHz – 14.010 MHz
Number of Channels (USA/Canada -bands)	1 nominal at 13.56 MHz
Channel Bandwidth (99%OBW)	549.8kHz
Type of Modulation | Data Rate	ASK
Other installed options	None
Emission classification	A1D
Protocol	Accord. ISO/IEC 14443-2 standard
Antenna Type	Loop antenna: 4cmx2cm
Antenna Gain	n/a for loop antennas
FCC label attached	No
Test firmware / software and storage location	EUT

For further details refer Applicants Declaration & following technical documents

Description of Reference Document (supplied by applicant)	Version	Total Pages
--	--	--

3.3 Modifications on Test sample

Additions/deviations or exclusions	--

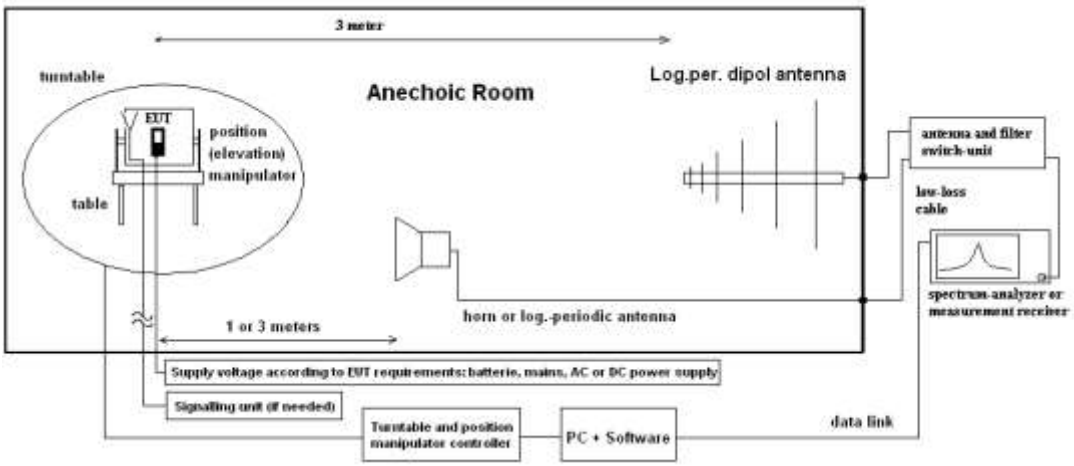
4 Measurements

4.1 Radiated field strength emissions 30 MHz – 1 GHz

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

Evaluating the field 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 NSA-compliant semi anechoic room (SAR) recognized by the regulatory commissions.

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 its characteristics was recorded with an EMI-receiver, broadband antenna and software.

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

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

4.1.2 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

4.1.3 Measurement Location

Test site	120901 - SAC3 - Radiated Emission <1GHz

4.1.4 Limit

Frequency Range [MHz]	Class B ☒ (3 meters)		Class A ☒ (10 meters)			
	Limit [µV/m]	Limit [dBµV/m]	Limit [µV/m]	Limit [dBµV/m]	Detector	RBW / VBW [kHz]
30 - 88	100	40.0	90	39.0	Quasi peak	100 / 300
88 - 216	150	43.5	150	43.5	Quasi peak	100 / 300
216 - 960	200	46.0	210	46.4	Quasi peak	100 / 300
960 - 1000	500	54.0	300	49.5	Quasi peak	100 / 300

4.1.5 Result

Diagram	Set-up	Mode	Maximum Level [dBµV/m] Frequency Range 30 – 1000 MHz	Result
3.01	1	TX, Op.Mode1	42.31@325.43MHz	Passed
3.02	2	TX/RX, Op.Mode2	41.59@927.07MHz	Passed

Remark: for more information and graphical plot see annex A1 **TR22-1-0081701T008a_A1**

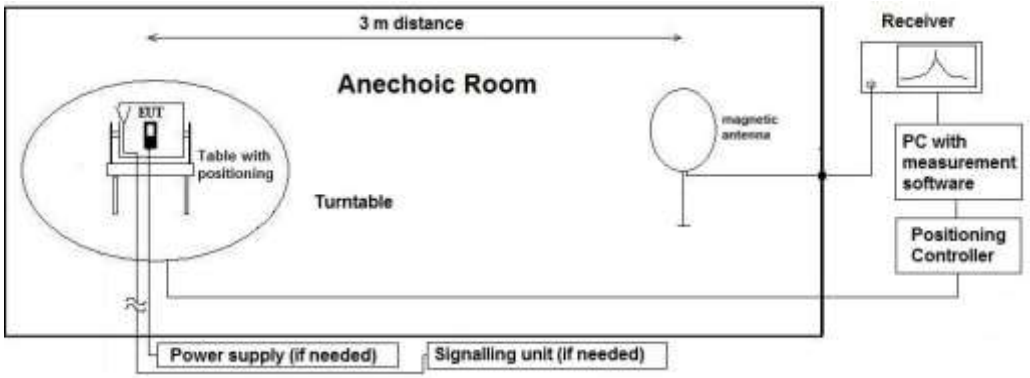
4.2 Radiated field strength emissions below 30 MHz

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 - SAC3 - Radiated Emission <1GHz

4.2.5 Limit spurious emissions, §15.209

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 Limits spectrum-mask, §15.225

Frequency Range [MHz]	Limit [µV/m]	Limit [dBµV/m]	Detector	RBW [kHz]	Remark
13.553 – 13.567	15.848	84	PEAK	10	PEAK, TRACE max-hold mode, repetitive scan for exploratory measurements Quasi-Peak, for final measurement on critical frequencies (f<1GHz)
13.410 – 13.553 and 13.567 – 13.710	334	50.47			
13.110 – 13.410 and 13.710 – 14.010	106	40.5			
f ≤ 13.110 – 14.010 ≥ f	30	29.5			

4.2.7 Results for Carrier field strength within 13.553 – 13.567MHz

Diagram	Band	Mode	Maximum Level [dBµV/m] Frequency Range 0.009 MHz – 30 MHz	Result
2.01a	13.110-14.010	TX, Op.Mode1	44.18	Passed
2.01b			39.80	Passed
2.02a		TX/RX, Op.Mode 2	46.25	Passed
2.02b			39.93	Passed

Remark: for more information and graphical plot see annex A1 **TR22-1-0081701T008a_A1**

4.2.8 Results spurious radiation, §15.209

Diagram	Band	Mode	Maximum Level [dBµV/m] Frequency Range 0.009 MHz – 30 MHz	Result
2.03	Outside 13.110-14.010	TX, Op.Mode 1	20.16	Passed
2.04		TX/RX, Op.Mode 2	≤ 20.0	Passed

Remark:

1.) Carrier on diagram at around 13.558MHz, not relevant for verdict

2.) for more information and graphical plot see annex A1 **TR22-1-0081701T008a_A1**

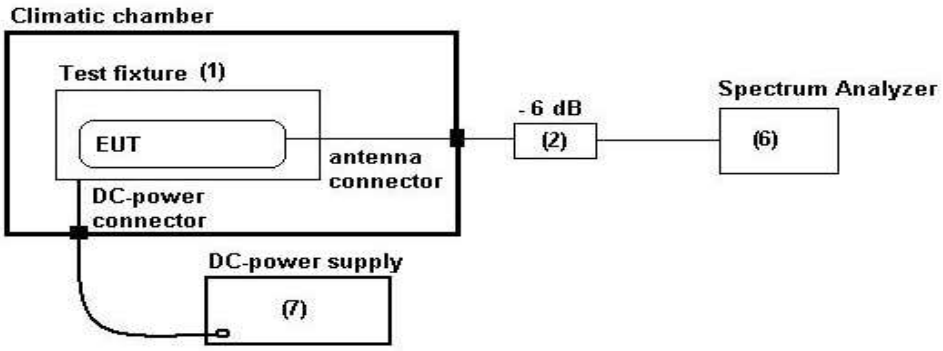
4.3 Occupied Channel Bandwidth 99%

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

The EUT's RF-signal is coupled out by a suitable antenna coupling connector (1). The signal is then directly connected to the spectrum – analyzer (4) for specific RF-measurements. The specific attenuation losses for both signal paths/branches are determined prior to the measurement within a set-up calibration. These are then taken into account by correcting the measurement readings on the spectrum-analyzer.

In case an external connector is not available, the coupling unit consists of a near-field antenna which is directly connected to the spectrum analyser. The power level calibration of the spectrum analyser is related to the power levels (field strengths) of the carrier determined in the anechoic-chamber.

Schematic:



Testing method:

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

4.3.2 Measurement Location

Test site 2 Location 2	SRD/004	RC1G lab

4.3.3 Limit

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

4.3.4 Result

Diagram	Channel	Mode	Frequency [MHz]	99% Occupied bandwidth [kHz]
See Annex 1	nominal	Op. Mode 3	13.5597	549.8

Remark: for more information and graphical plot see annex A1**TR22-1-0081701T008a_A1**

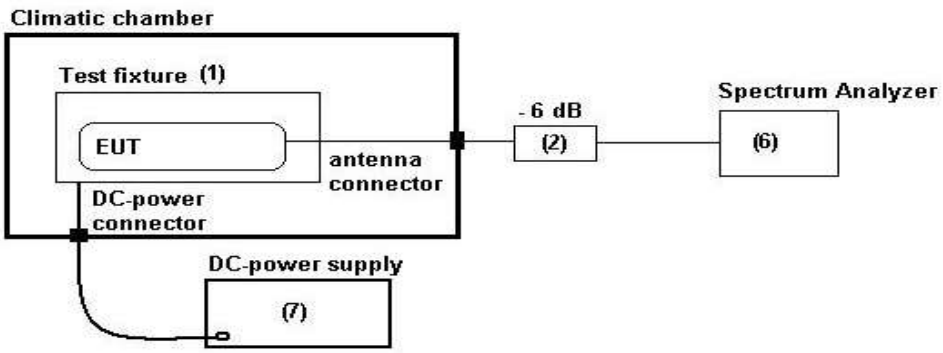
4.4 Frequency stability

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

A sniffer antenna acts like a coupling antenna for measuring the fundamental frequency. This is placed at about 20cm away from the equipment. Also connecting cables at the equipment are avoided on the extent possible in order not to degrade the resonance frequency of the equipment and integral antenna.

If the equipment is capable of producing an un-modulated carrier then a trace with max-hold function was recorded. The maximum peak within the span was found, then the frequency deviation was recorded with the build-in frequency counter within the spectrum-analyzer. The maximum resolution was chosen on the settings.
The frequency deviation was recorded at switching on point of the equipment and on 2 minutes, 5 minutes and 10 minutes after at in accordance with ANSI 63.10: 2013, Chapter 6.8
All measurements data are enclosed in annex measurements. Here only maximum frequency error is reported.

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)

4.4.2 Measurement Location

Test site 2, location 2	SRD/004

4.4.3 Limit

Frequency Range [MHz]	Frequency tolerance			Remarks
	%	[ppm]	[Hz]	
13.553 – 13.567	±0.01	±100	±1355.992235	For voltage variation and temperature variations

Remark: for more information and graphical plot see annex A1 **TR22-1-0081701T008a_A1**

4.4.4 Results for temperature variations

Nominal condition								
Vnom = 13.5V (DC Supply) Tnom = 21°C	Measured Reference frequency [MHz]	13.55992335	Limit-> 100 ppm:	1355.992335	Hz	f_{MIN}:	13.558567	MHz
						f_{MAX}:	13.561279	MHz

Extreme conditions								
Temperature	Measurement period after power-up the EUT	Frequency measured	Values for Frequency Error			Abs. Maximum Value	Absolute Maximum value	Verdict
			[Hz]	[%]	[ppm]			
Tmax=85°C	--	13.55977765	-145.7000000	-0.001074	-10.74	10.74	15.58	Pass
Tmax=80°C	--	13.55976305	-160.3000000	-0.001182	-11.82	11.82		
Tmax=70°C	--	13.55972685	-196.5000000	-0.001449	-14.49	14.49		
Tmax=60°C	--	13.55971215	-211.2000000	-0.001558	-15.58	**15.58**		
Tmax=50°C	--	13.55973955	-183.8000000	-0.001355	-13.55	13.55		
T=40°C	--	13.55978165	-141.7000000	-0.001045	-10.45	10.45		
T=30°C	--	13.55986465	-58.7000000	-0.000433	-4.33	4.33		
T=21°C (nominal conditions)	on StartUp	13.55997110	47.7500000	0.000352	3.52	3.52		
	2 Minutes	13.55995660	33.2500000	0.000245	2.45			
	5 Minutes	13.55992335	0.0000000	0.000000	0.00			
	10 Minutes	13.55993340	10.0500000	0.000074	0.74			
T=10°C	--	13.56001025	86.9000000	0.000641	6.41	6.41		
T=0°C	--	13.56006895	145.6000000	0.001074	10.74	10.74		
T=-10°C	--	13.56010615	182.8000000	0.001348	13.48	13.48		
T=-20°C	--	13.56011785	194.5000000	0.001434	14.34	14.34		
T=-30°C	--	13.56009435	171.0000000	0.001261	12.61	12.61		
T=-40°C	--	13.56000735	84.0000000	0.000619	6.19	6.19		

4.4.5 Results for voltage variations

Nominal voltage condition						
Vnom = 13.5 V Tnom = 21°C	13.559923350	MHz	Limit-> 100ppm:	1355.992335	Hz	
			f_{MIN}:	13.55856736	MHz	
			f_{MAX}:	13.56127934	MHz	

Extreme voltage conditions					
	Voltage	Frequency measured	Values for Frequency Error		
	[V]	[MHz]	[Hz]	[%]	[ppm]
V_{MAX}	16.0	13.559924250	0.9	-0.000007	-0.07
V_{NOM}	13.5	13.559923350	0.0	0.000000	0.00
V_{MIN}	8.0	13.559922350	-1.0	0.000007	0.07

4.5 Equipment lists, location 1

ID	Description	Manufacturer	SerNo	CheckType	Last Check	Interval	Next Check
	120901 - SAC3 - Radiated Emission <1GHz			calchk	cal: 2015-Jul-21 chk: 2021-Jul-27	cal: 10Y chk: 12M	cal: 2025-Jul-21 chk: 2022-Jul-27
20341	Digital Multimeter Fluke 112	Fluke Deutschland GmbH / Glottertal	81650455	cal	cal: 2022-May-18	cal: 24M	cal: 2024-May-18
20442	Semi Anechoic Chamber	ETS-Lindgren Gmbh / Taufkirchen	-	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20482	filter matrix Filter matrix SAR 1	CETECOM GmbH	-	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20574	Biconilog Hybrid Antenna BTA-L	Frankonia GmbH / Heideck	980026L	cal	cal: 2022-Jun-15	cal: 36M	cal: 2025-Jun-15
20620	Test Receiver ESU26	Rohde & Schwarz Messgerätebau GmbH / Memmingen	100362	cal	cal: 2023-May-24	cal: 12M	cal: 2024-May-24
20885	Power Supply EA3632A	Agilent Technologies Deutschland GmbH	75305850	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
25038	Loop Antenna HFH2-Z2	Rohde & Schwarz Messgerätebau GmbH / Memmingen	879824/13	cal	cal: 2022-Jul-04	cal: 24M	cal: 2024-Jul-04

Tools used in 'P1M2'

4.6 Equipment list, location 2

No.	Setup	Equipment	Type	Manufacturer	Serial No.	INV. No.	Kind of Calibration	Last Calibration	Next Calibration
1	A	Loop Antenna		ZEG TS Steinfurt		400001208	ev	-/-	-/-
2	A	RF Cable BNC	RG58	Huber & Suhner		400001209	ev	-/-	-/-
3	A	Temperature Test Chamber	VT 4011	Voetsch Industrietechnik	585662306000 10	300005363	ev	09.05.2022	31.05.2024
4	A	Signal analyzer	FSV30	Rohde&Schwarz	104365	300005923	k	13.12.2022	31.12.2023
5	A	Power Supply	HMP2020	Rohde & Schwarz	102219	300006192	k	15.12.2022	31.12.2024

4.6.1 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.

Issue No.	Measurement type	Reference	Frequency range of measurement		Calculated Uncertainty based on confidence level of 95.54%	Remarks
			Start [MHz]	Stop [MHz]		
1	Magnetic field strength	FCC15/18/22/ 24/27/90, ISED	0.009	30	4.86	Magnetic loop antenna, Pre-amp on
2	RF-Output power (eirp) Unwanted emissions (eirp) [dB]	FCC15/18 / ISED	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)
3	Radiated Blocking [dB]	EN303883	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
4	Frequency Error / UWB+FMCW [kHz]	EN303883 FCC 15	40000	77000	276.19	calculated for 77 GHz (FMCW) carrier
			6000	7000	33.92	calculated for 6.5GHz UWB Ch.5
	Frequency Error / NFC [Hz]	FCC 15	11.00	14.00	20.76	calculated for 13.56MHz NFC carrier
5	TS 8997 conducted Parameters	FCC15/18 / ISED	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
6	Conducted emissions	EN303883 FCC 15	0.009	30	3.57	

9 Versions of test reports (change history)

Version	Applied changes	Date of release
--	Initial release	2023-Oct-17
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End Of Test Report