

Partial Test Report

21-1-0178701T028a-C01



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



Number of pages:	33	Date of Report:	2023-Apr-28
Testing company:	<p>cetecom advanced GmbH Im Teelbruch 116 45219 Essen Germany Tel. + 49 (0) 20 54 / 95 19-0 Fax: + 49 (0) 20 54 / 95 19-150</p>	Applicant:	Actia Nordic AB
Product:	Telematic Device		
Model:	104760201		
FCC ID:	2AGKK104760201		
Testing has been carried out in accordance with:	<p>FCC Regulations Title 47 CFR, Chapter I, Subchapter A, Part 15 Subpart E Unlicensed National Information Infrastructure Devices § 15.407 General technical requirements</p>		
Tested Technology:	5 GHz W-LAN (IEEE 802.11)		
Test Results:	<p><input checked="" type="checkbox"/> The EUT complies with the requirements in respect of selected parameters subject to the test.</p> <p>The test results relate only to devices specified in this document</p> <p>The current version of Test Report TR21-1-0178701T028a-C01 replaces the test report TR21-1-0178701T028a dated 2023-Mar-14. The replaced test report is herewith invalid.</p>		
Signatures:	<div></div> <div><p>Dipl.-Ing. Ninovic Perez Test Lab Manager Authorization of test report</p><p>Dipl.-Ing. Christian Lorenz (Senior) Test Manager Responsible of test report</p></div>		

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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.

The test report may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of cetecom advanced.

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In no case this test report can be considered as a Letter of Approval.

This test report is electronically signed and valid without handwritten signature. For verification of the electronic signatures, the public keys can be requested at the testing laboratory.

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Also we refer on special conditions which the applicant should fulfill according §2.927 to §2.948, special focus regarding modification of the equipment and availability of sample equipment for market surveillance tests.

1.2 Attestation

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

1.3 Summary of Test Results

The EUT integrates a 5 GHz W-LAN transmitter. Other implemented wireless technologies were not considered within this test report.

Test case	Reference Clause FCC	Page	Remark	Result
Duty Cycle	--	12	--	PASSED
Minimum Emission Bandwidth 6 dB	2.1049(h) §15.407(e)	--	--	NP
Emission Bandwidth 26 dB	2.1049(h)	--	--	NP
Occupied Channel Bandwidth 99%	2.1049(h)	--	--	NP
Frequency stability	§2.1055 §15.407(g)	--	--	NP
RF output power	§15.407(a) (1)(2)(3)(4)	13	--	PASSED
Power spectral density	§15.407(a) (1)(2)(3)(5)	--	--	NP
Antenna gain information	§15.407(a) (1)(2)(3)	--	--	NP
Radiated Band-Edge emissions	§15.209 §15.205 §15.407(b)(1)(2)(3)(4)	27	--	PASSED
Radiated field strength emissions below 30 MHz	§15.205 §15.209	16	--	PASSED
Radiated field strength emissions 30 MHz – 1 GHz	§15.205 §15.209 §15.407(6)(7)	20	--	PASSED
Radiated field strength emissions above 1 GHz	§15.407(6) §15.407(b)	22	--	PASSED
Transmit power control	§15.407 (h1)(h2)	--	--	NP
Dynamic frequency selection (DFS)	§15.407(h1)	--	--	NP
Discontinuous transmissions + Device security	§15.407(h2)	--	--	NP
AC-Power Lines Conducted Emissions	§15.407(i)	--	--	NP

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 \(Simple Acceptance Rule\)](#).

Remarks:

- Please check the module report “MDE_UBLOX_1701_FCCb_rev1” issued on 2018-Oct-30 by 7 layers GmbH for not performed measurements by the cetecom advanced laboratory.

1.4 Summary of Test Methods

Test case	Test method
Duty Cycle	ANSI C63.10:2013, §12.2(b)(2)
Emission Bandwidth 26 dB	ANSI C63.10:2013, §6.9.2, §11.8, §12.4.1
Occupied Channel Bandwidth 99%	ANSI C63.10:2013, §12.4.2
Frequency stability	ANSI C63.10:2013, §6.8.1, §6.8.2
RF output power	ANSI C63.10:2013, §12.3
Power spectral density	ANSI C63.10:2013, §12.5
Antenna gain information	ANSI C63.10:2013, §6.10.5, §6.10.6
Radiated Band-Edge emissions	ANSI C63.10:2013; "Marker-Delta method", §6.10.4, §12.7.4.4
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, §12.7
Radiated field strength emissions above 1 GHz	ANSI C63.4-2014 §8.3, ANSI C63.10-2013 §6.3, § 6.6, §12.7
Transmit power control	ANSI C63.10:2013, §12.3
Dynamic frequency selection (DFS)	See TR reported
Discontinuous transmissions + Device security	See Applicant's documentation
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:	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:	Im Teelbruch 116; 45219 Essen

2.2 General limits for environmental conditions

Temperature:	22±2 °C
Relative. humidity:	45±15% rH

2.3 Test Laboratories sub-contracted

Company name:	--
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2.4 Organizational Items

Responsible test manager:	Dipl.-Ing. Christian Lorenz
Receipt of EUT:	2022-Oct-31
Date(s) of test:	2022-Dec-14 to 2023-Feb-02
Version of template:	22.1101

2.5 Applicant's details

Applicant's name:	Actia Nordic AB
Address:	Datalinjen 3b 58330 Linköping Sweden
Contact Person:	Salah Alazawi
Contact Person's Email:	salah.alazawi@actia.se

2.6 Manufacturer's details

Manufacturer's name:	Actia Nordic AB
Address:	Datalinjen 3b 58330 Linköping Sweden

2.7 Equipment under Test (EUT)

EUT No. *)	Sample No.	Product	Model	Type	SN	HW	SW
EUT 1	21-1-01787S50_C01	Telematic Device	104760201	N/A	91000220000007	H1	1
EUT 2	21-1-01787S51_C01	Telematic Device	104760201	N/A	91000220000008	H1	1
EUT 3	21-1-01787S57_C01	Telematic Device	104760201	N/A	91000010000240	H1	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
AE 1	--	Laptop	DELL	CTC522013	--	WIN 7
AE 2	21-1-01787S31_C01	Cellular, GNSS and WIFI Antenna	SmartDisc II Combi	N/A	N/A	N/A

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

2.10 Connected cables (CAB)

CAB No. *)	Sample No.	Cable Type	Connectors / Details	Length
CAB 1	21-1-01787S37_C01	USB/CAN cable	--	< 3 m
CAB 2	21-1-01787S43_C01	Main Harness	--	< 3 m

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

2.11 Software (SW)

SW No. *)	Sample No.	SW Name	Description	SW Status
SW 1	21-1-01787S63_C01	ACU6	PC software application	V1.1.0.9

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

2.12 EUT set-ups

set-up no. *)	Combination of EUT and AE	Description
1	EUT 1 + AE 1 + AE 2 + CAB 1 + CAB 2	Used for Radiated measurements
2	EUT 2 + AE 1 + AE 2 + CAB 1 + CAB 2	Used for Radiated measurements
3	EUT 3 + AE 1 + CAB 1 + CAB 2	Used for Conducted measurements

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

2.13 EUT operation modes

EUT operating mode no. *)	Operating modes	Additional information
op. 1	WLAN_TX-Mode a-mode	With help of special test firmware TX-mode was set-up to a-mode, 6 Mbps. We refer to applicants information/papers for details about necessary commands.
op. 2	WLAN_TX-Mode n-mode HT20	With help of special test firmware TX-mode was set-up to n-mode, 20MHz BW, MCS0. We refer to applicants information/papers for details about necessary commands.
op. 3	WLAN_TX-Mode ac-mode VHT20	With help of special test firmware TX-mode was set-up to ac-mode, 20MHz BW, MCS0. We refer to applicants information/papers for details about necessary commands.
op. 4	WLAN_TX-Mode n-mode HT40	With help of special test firmware TX-mode was set-up to n-mode, 40MHz BW, MCS0. We refer to applicants information/papers for details about necessary commands.
op. 5	WLAN_TX-Mode ac-mode VHT40	With help of special test firmware TX-mode was set-up to ac-mode, 40MHz BW, MCS0. We refer to applicants information/papers for details about necessary commands.
op. 6	WLAN_TX-Mode ac-mode VHT80	With help of special test firmware TX-mode was set-up to ac-mode, 80MHz BW, MCS0. We refer to applicants information/papers for details about necessary commands.

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

2.1 Software commands

With help of SW 1 following power settings were used to set up test mode:

a-mode: 15
n-mode HT20: 15
ac-mode HT20: 15
n-mode HT40: 15
ac-mode HT40: 15
ac-mode HT80: 15

3 Equipment under test (EUT)

3.1 General Data of Main EUT as Declared by Applicant

Typical use	<input type="checkbox"/> portable	<input type="checkbox"/> fixed indoor	<input type="checkbox"/> fixed outdoor	<input checked="" type="checkbox"/> vehicular
Firmware	<input type="checkbox"/> for normal use	<input checked="" type="checkbox"/> Special version for test execution		
Power supply	<input type="checkbox"/> AC Mains	-		
	<input checked="" type="checkbox"/> DC Mains	12 V DC		
	<input type="checkbox"/> Battery	-		
Operational conditions	T _{nom} = 21 °C	T _{min} = -40 °C	T _{max} = +85 °C	
EUT sample type	Pre-Production			
Weight	0.540 kg			
Size [LxWxH]	15.4 cm x 15.1 cm x 4.0 cm			
Interfaces/Ports	--			
For further details refer Applicants Declaration & following technical documents				
For further details regarding radio parameters, please refer to IEEE802.11 Specification				

3.2 Detailed Technical data of Main EUT as Declared by Applicant

Frequency Channel B.W. (USA bands only)	U-NII 1: 5150-5250 MHz	<input checked="" type="checkbox"/> Ch 36 40 44 48	<input checked="" type="checkbox"/> BW 20 MHz
		<input checked="" type="checkbox"/> Ch 38 46	<input checked="" type="checkbox"/> BW 40 MHz
		<input checked="" type="checkbox"/> Ch 42	<input checked="" type="checkbox"/> BW 80 MHz
	U-NII2A: 5250-5350 MHz	<input type="checkbox"/> Ch 52 56 64	<input type="checkbox"/> BW 20 MHz
		<input type="checkbox"/> Ch 54 62	<input type="checkbox"/> BW 40 MHz
		<input type="checkbox"/> Ch 58	<input type="checkbox"/> BW 80 MHz
	U-NII 2C: 5470-5725 MHz	<input type="checkbox"/> Ch 100 108 116	<input type="checkbox"/> BW 20 MHz
		<input type="checkbox"/> Ch 120 124 128 (USA only)	
		<input type="checkbox"/> Ch 132 136 140	
		<input type="checkbox"/> Ch 102 110 118 126 134 (Ch 118 126 USA only)	<input type="checkbox"/> BW 40 MHz
	U-NII 3: 5725 -5850 MHz	<input type="checkbox"/> Ch. 106 122 (Ch 122 USA only)	<input type="checkbox"/> BW 80 MHz
		<input checked="" type="checkbox"/> Ch 149 153 157 165	<input checked="" type="checkbox"/> BW 20 MHz
		<input checked="" type="checkbox"/> Ch 151 159	<input checked="" type="checkbox"/> BW 40 MHz
		<input checked="" type="checkbox"/> Ch 155	<input checked="" type="checkbox"/> BW 80 MHz
802.11a – Mode OFDM Modulation Data Rates		<input checked="" type="checkbox"/> BPSK 6 Mbps / 9 Mbps <input checked="" type="checkbox"/> QPSK 12 Mbps / 18 Mbps <input checked="" type="checkbox"/> 16-QAM 24 Mbps / 36 Mbps <input checked="" type="checkbox"/> 64-QAM 48 Mbps / 54 Mbps	
802.11n – Mode OFDM Modulation Data Rates		<input checked="" type="checkbox"/> HT20 (MCS0 – MCS7) 7.2/14.4/21.7/28.9/43.3/57.8/65/72.2 Mbps <input checked="" type="checkbox"/> HT40 (MCS0 – MCS7) 15/30/45/60/90/120/135/150 Mbps	
802.11ac – Mode OFDM Modulation Data Rates		<input checked="" type="checkbox"/> HT20 (MCS0 – MCS7) 7.2/14.4/21.7/28.9/43.3/57.8/65/72.2 Mbps <input checked="" type="checkbox"/> HT40 (MCS0 – MCS7) 15/30/45/60/90/120/135/150 Mbps <input checked="" type="checkbox"/> HT80 (MCS0 – MCS7) 7.2/14.4/21.7/28.9/43.3/57.8/65/72.2 Mbps	
Other wireless options		<input checked="" type="checkbox"/> Cellular (2G/3G/4G) (not tested within this report) <input checked="" type="checkbox"/> b/g/n mode (not tested within this report) <input checked="" type="checkbox"/> Bluetooth LE (not tested within this report) <input checked="" type="checkbox"/> Bluetooth EDR (not tested within this report)	
MIMO		<input type="checkbox"/>	

Max. Conducted Output Power (Measured RMS Power) And EiRP (Calculated EIRP = RMS + Gain)	Band	Mode	RMS [dBm]	EiRP [dBm]
	U-NII 1	802.11a:	11.0	11.45
		802.11n20:	11.0	11.45
		802.11ac20:	10.9	11.35
		802.11n40:	11.3	11.75
		802.11ac40:	11.2	11.65
		802.11ac80:	10.6	11.05
	U-NII 3	802.11a:	9.9	10.35
		802.11n20:	9.8	10.25
		802.11ac20:	9.8	10.25
		802.11n40:	9.9	10.35
		802.11ac40:	10.0	10.45
802.11ac80:		9.3	9.75	
Path Loss Antenna Connector	2.55 dBm			
Antenna Type(s)	Internal			
Antenna Gain(s)	+3 dBi			
Calculation of EIRP: EIRP = RF Output Power + Antenna Gain – Path Loss Connector – Path Loss Cable				
FCC label attached	Yes			
Test firmware / software and storage location	EUT 1/2/3 ; AE 1			
For further details refer Applicants Declaration & following technical documents				
Description of Reference Document (supplied by applicant)		Version		Total Pages
ACU6 OH Test Setup for Certification Testing		1.1		21

3.3 Worst case identification

WLAN mode	Data rate
a	6 Mbps
n20	MCS0
ac20	MCS0
n40	MCS0
ac40	MCS0
ac80	MCS0

3.4 Modifications on Test sample

Additions/deviations or exclusions	--
------------------------------------	----

4 Measurements

4.1 Duty-Cycle

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)

The necessary duty-cycle correction factor is determined on nominal conditions on middle channel only. It is assumed that no noticeable changes occur when tested on other channels or climatic conditions.

EUT settings

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

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

A special firmware program is used for test purposes. In opposite to normal operating mode a higher duty-cycle is set in order to facilitate the measurements. This is maximized at the extent possible.

The necessary duty-cycle correction factor is determined on nominal conditions on one channel in each operable frequency-band. It is assumed that no noticeable changes occur when tested on other channels or climatic conditions. The Duty-Cycle was constant, means without variations.

Formula to calculate Duty-Cycle:

Duty cycle calculations: $x = TX_{ON} / (TX_{ON} + TX_{OFF})$	Duty cycle factor: DC=	Regarding power: $10 * \log(1/x)$ dB
		Regarding field strength: $20 * \log(1/x)$ dB

☐ The results were corrected in order to evaluate for worst-case result each time when average values are necessary for example average radiated emissions or similar

☒ No correction necessary: Duty-Cycle > 98%

(Remark: for more information and graphical plot see annex A1 **TR21-1-0178701T028a-C01-A1**)

4.1.1 Measurement Location

Test site	120910 - Radio Laboratory 1 (TS 8997)
------------------	---------------------------------------

4.2 RF output power

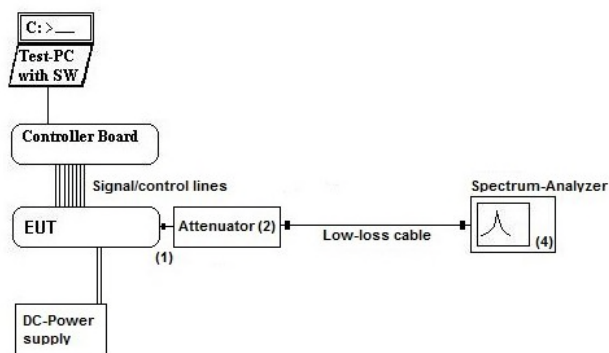
4.2.1 Description of the general test setup and methodology, see below example:

The EUT's RF-signal is coupled out by a suitable antenna coupling connector (1). The signal is first attenuated (2) then connected to spectrum-analyzer (4) for RF-conducted measurements. The specific attenuation loss is determined prior to the measurement within a set-up attenuation measurement. These are then taken into account by correcting the measurement readings of the spectrum-analyzer.

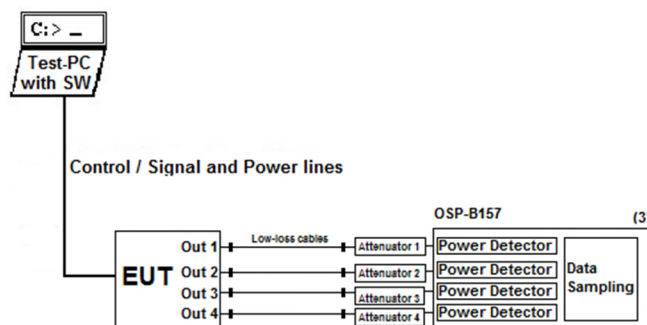
MIMO

The EUT use MIMO technology as it use multiple antennas for receive and transmit. The measurements are performed by using R&S TS8997 (Ref.No. 693) test system which is able to perform measurements simultaneously and time-synchronized on maximum 8 antenna conducted RF-ports. A common trigger ensures the sampling time is minimized so the total power represents a sampling value calculated for all 8-ports simultaneously for each time bin/frame. A high data sampling rate together with a wide band power measurement capability ensures that latest modulation schemes are correctly measured. Therefore testing method Subchapter E1 of KDB662911 is fulfilled. (measure-and-sum technique).

Schematic:



Schematic MIMO (if MIMO device):



Testing method:

The measurement is made according to relevant reference clauses:

(See Tables *Summary of Test Results* and *Summary of Test Methods* on page 7)

Measurement is made using Rohde & Schwarz TS8997 test system.

Test method	AVGSA-1 / AVGSA-1 alternative (duty-cycle > 98%)
SISO	<input checked="" type="checkbox"/>
MIMO	<input type="checkbox"/> Summation of values from two antenna ports
Remarks	--

The measurement was performed in non-hopping transmission mode with the carrier set to lowest/middle and highest channel.

EUT settings

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

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

4.2.2 Measurement Location

Test site	120910 - Radio Laboratory 1 (TS 8997)
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4.2.3 Limit

Frequency Range [MHz]	Application	FCC Limit [mW] / [dBm]
5150-5250	Outdoor access point	1000 + antenna gain max. 6dBi + Elevation > 30° 21 dBm EIRP
5150-5250	Indoor Access Point	1000 + antenna gain max. 6dBi
5150-5250	Mobile & Portable client	250 (24) + antenna gain max. 6dBi
5150-5250	Vehicle	--
5150-5250	--	--
5250-5350	--	250 (24) or 11dBm+10log10(B)
5250-5350	Vehicle	--
5470-5725	--	250 (24) or 11dBm+10log10(B) + Antenna gain < 6dBi
5725-5850	--	1000 (30) If Antenna gain more 6dBi (-> reduction necessary)

4.2.4 Result

U-NII 1

Mode	DUT Frequency (MHz)	Gated RMS (dBm)	Limit Max (dBm)	Result
Op.1	5180.000000	10.7	30.0	Passed
Op.1	5200.000000	10.8	30.0	Passed
Op.1	5240.000000	11.0	30.0	Passed
Op.2	5180.000000	10.6	30.0	Passed
Op.2	5200.000000	10.8	30.0	Passed
Op.2	5240.000000	11.0	30.0	Passed
Op.3	5180.000000	10.4	30.0	Passed
Op.3	5200.000000	10.6	30.0	Passed
Op.3	5240.000000	10.9	30.0	Passed
Op.4	5190.000000	10.9	30.0	Passed
Op.4	5230.000000	11.3	30.0	Passed
Op.5	5190.000000	10.7	30.0	Passed
Op.5	5230.000000	11.2	30.0	Passed
Op.6	5210.000000	10.6	30.0	Passed

Remark: for more information and graphical plot see annex A1 **TR21-1-0178701T028a-C01-A1**.

U-NII 3

Mode	DUT Frequency (MHz)	Gated RMS (dBm)	Limit Max (dBm)	Result
Op.1	5745.000000	8.9	30.0	Passed
Op.1	5785.000000	9.9	30.0	Passed
Op.1	5825.000000	9.5	30.0	Passed
Op.2	5745.000000	8.8	30.0	Passed
Op.2	5785.000000	9.8	30.0	Passed
Op.2	5825.000000	9.4	30.0	Passed
Op.3	5745.000000	8.7	30.0	Passed
Op.3	5785.000000	9.8	30.0	Passed
Op.3	5825.000000	9.4	30.0	Passed
Op.4	5755.000000	9.4	30.0	Passed
Op.4	5815.000000	9.9	30.0	Passed
Op.5	5755.000000	9.5	30.0	Passed
Op.5	5815.000000	10.0	30.0	Passed
Op.6	5775.000000	9.3	30.0	Passed

Remark: for more information and graphical plot see annex A1 **TR21-1-0178701T028a-C01-A1**.

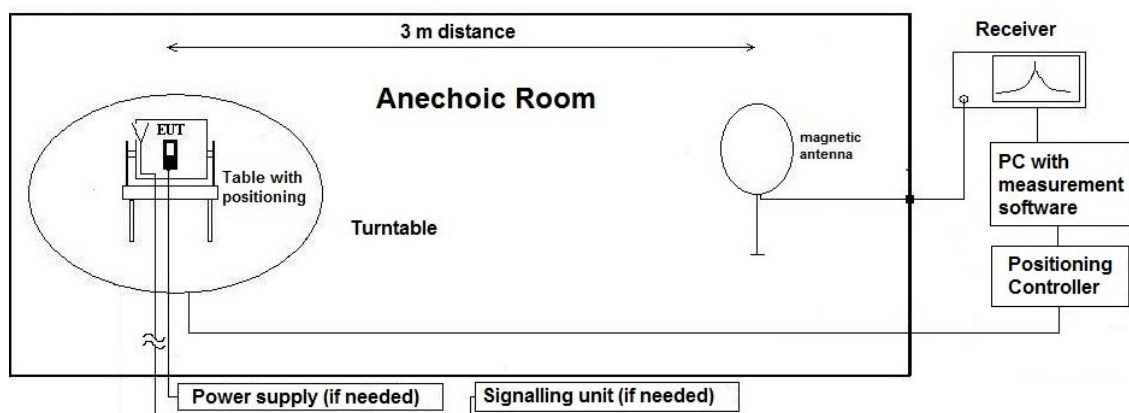
4.3 Radiated field strength emissions below 30 MHz

4.3.1 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 7)

Exploratory, preliminary measurements

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

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

Final measurement on critical frequencies

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

4.3.2 Sample calculation

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

4.3.3 Measurement Location

Test site	120901 - SAC - Radiated Emission <1GHz
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4.3.4 Correction factors due to reduced meas. distance ($f < 30$ MHz):

The used correction factors when the measurement distance is reduced compared to regulatory measurement distance, are calculated according Extrapolation formulas valid for EUT's with maximum dimension of $0.625 \times \text{Lambda}$. 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	fulfilled	not fulfilled	-80.00
	10	30000.00	4774.65		fulfilled	not fulfilled	-80.00
	20	15000.00	2387.33		fulfilled	not fulfilled	-80.00
	30	10000.00	1591.55		fulfilled	not fulfilled	-80.00
	40	7500.00	1193.66		fulfilled	not fulfilled	-80.00
	50	6000.00	954.93		fulfilled	not fulfilled	-80.00
	60	5000.00	795.78		fulfilled	not fulfilled	-80.00
	70	4285.71	682.09		fulfilled	not fulfilled	-80.00
	80	3750.00	596.83		fulfilled	not fulfilled	-80.00
	90	3333.33	530.52		fulfilled	not fulfilled	-80.00
	100	3000.00	477.47		fulfilled	not fulfilled	-80.00
	125	2400.00	381.97		fulfilled	not fulfilled	-80.00
	200	1500.00	238.73		fulfilled	fulfilled	-78.02
	300	1000.00	159.16		fulfilled	fulfilled	-74.49
	400	750.00	119.37		fulfilled	fulfilled	-72.00
	490	612.24	97.44		fulfilled	fulfilled	-70.23
	500	600.00	95.49	30	fulfilled	not fulfilled	-40.00
	600	500.00	79.58		fulfilled	not fulfilled	-40.00
	700	428.57	68.21		fulfilled	not fulfilled	-40.00
	800	375.00	59.68		fulfilled	not fulfilled	-40.00
	900	333.33	53.05		fulfilled	not fulfilled	-40.00
MHz	1.00	300.00	47.75		fulfilled	not fulfilled	-40.00
	1.59	188.50	30.00		fulfilled	not fulfilled	-40.00
	2.00	150.00	23.87		fulfilled	fulfilled	-38.02
	3.00	100.00	15.92		fulfilled	fulfilled	-34.49
	4.00	75.00	11.94		fulfilled	fulfilled	-32.00
	5.00	60.00	9.55		fulfilled	fulfilled	-30.06
	6.00	50.00	7.96		fulfilled	fulfilled	-28.47
	7.00	42.86	6.82		fulfilled	fulfilled	-27.13
	8.00	37.50	5.97		fulfilled	fulfilled	-25.97
	9.00	33.33	5.31		fulfilled	fulfilled	-24.95
	10.00	30.00	4.77		fulfilled	fulfilled	-24.04
	10.60	28.30	4.50		fulfilled	fulfilled	-23.53
	11.00	27.27	4.34		fulfilled	fulfilled	-23.21
	12.00	25.00	3.98		fulfilled	fulfilled	-22.45
	13.56	22.12	3.52		fulfilled	fulfilled	-21.39
	15.00	20.00	3.18		fulfilled	fulfilled	-20.51
	15.92	18.85	3.00		fulfilled	fulfilled	-20.00
	17.00	17.65	2.81		not fulfilled	fulfilled	-20.00
	18.00	16.67	2.65		not fulfilled	fulfilled	-20.00
	20.00	15.00	2.39		not fulfilled	fulfilled	-20.00
	21.00	14.29	2.27		not fulfilled	fulfilled	-20.00
	23.00	13.04	2.08		not fulfilled	fulfilled	-20.00
	25.00	12.00	1.91		not fulfilled	fulfilled	-20.00
	27.00	11.11	1.77		not fulfilled	fulfilled	-20.00
	29.00	10.34	1.65		not fulfilled	fulfilled	-20.00
	30.00	10.00	1.59		not fulfilled	fulfilled	-20.00

4.3.5 Limit

Radiated emissions limits (3 meters)					
Frequency Range [MHz]	Limit [$\mu\text{V}/\text{m}$]	Limit [$\text{dB}\mu\text{V}/\text{m}$]	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

4.3.6 Result

Diagram	Channel	Mode	Maximum Level [$\text{dB}\mu\text{V}/\text{m}$] Frequency Range 0.009 – 30 MHz	Result
2.01a	48	Op.1 laying	No peaks found	Passed
2.01b	48	Op.1 standing	No peaks found	Passed
2.02a	157	Op.1 laying	No peaks found	Passed

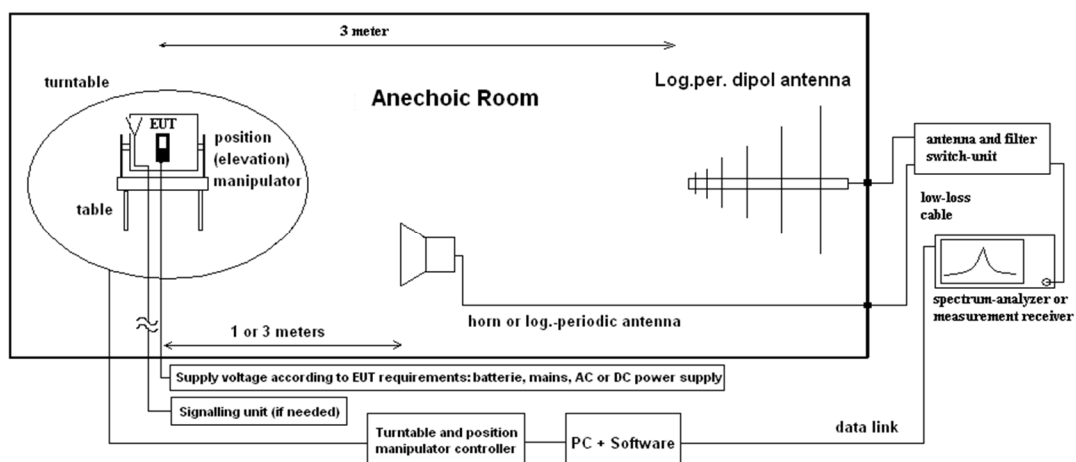
Remark: for more information and graphical plot see annex A1 **TR21-1-0178701T028a-C01-A1**

4.4 Radiated field strength emissions 30 MHz – 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 16-1-4:2010 compliant semi anechoic room (SAR) and fully anechoic room (FAR) recognized by the regulatory commission. The measurement distance was set to 3 meter for frequencies up to 18 GHz and 2 meter above 18 GHz. A logarithmic periodic antenna is used for the frequency range 30 MHz to 1 GHz. Horn antennas are used for frequency range 1 GHz to 40 GHz. The EUT is aligned within 3 dB beam width of the measurement antenna with three orthogonal axis measurements on the EUT.

Schematic:



Testing method:

The measurement is made according to relevant reference clauses:

(See Tables *Summary of Test Results* and *Summary of Test Methods* on page 7)

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:

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

$$M = L_T - E_C \quad (2)$$

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.

4.4.2 Sample calculation

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

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

4.4.3 Measurement Location

Test site	120901 - SAC - Radiated Emission <1GHz
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4.4.4 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

4.4.5 Result

Diagram	Channel	Mode	Maximum Level [dBμV/m] Frequency Range 30 – 1000 MHz	Result
3.01a	48	Op.1 laying	No peaks found	Passed
3.01b	48	Op.1 standing	No peaks found	Passed
3.02a	157	Op.1 laying	No peaks found	Passed

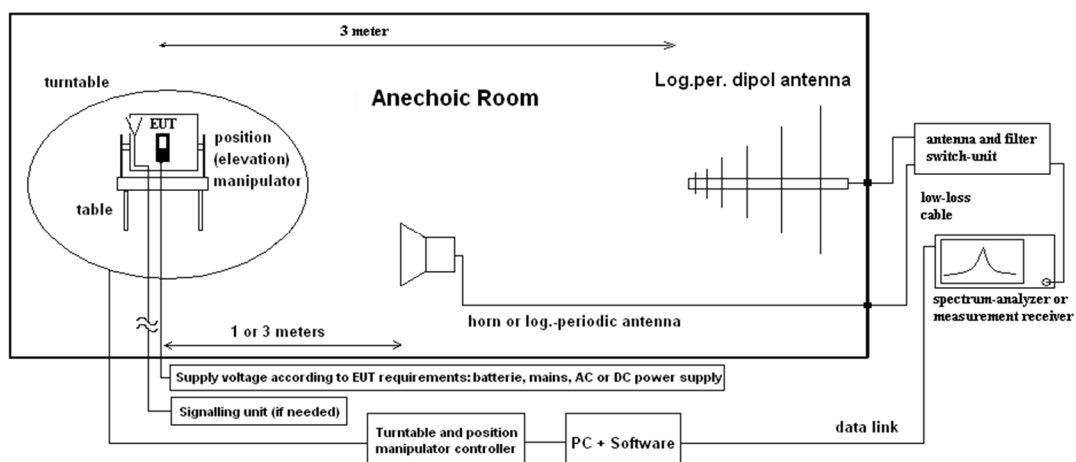
Remark: for more information and graphical plot see annex A1 **TR21-1-0178701T028a-C01-A1**

4.5 Radiated field strength emissions above 1 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 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 7)

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:

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

$$M = L_T - E_C \quad (2)$$

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.

4.5.2 Sample calculation

Raw-Value [dBuV/m]	Antenna factor	Distance Correction [dB]	Cable Loss + Preamplifier	Resulting correction value [dB]	Final result [dBuV/m]	Remarks
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

4.5.3 Measurement Location

Test site 1 – 7 GHz	120904 - FAC1 - Radiated Emissions
Test site 7– 18 GHz	120904 - FAC1 - Radiated Emissions
Test site 16 – 40 GHz	120907 - FAC2 - Radiated Emissions

4.5.4 Limit

Limit (3 meters)

Frequency Range [MHz]	AV Limit [μV/m]	AV Limit [dBμV/m]	Peak Limit [μV/m]	FCC Peak [dBμV/m] or [dBm/MHz]
Above 1000	500	54	5000	74
5150 – 5250	--	--	--	-27dBm eirp
5250 – 5350	--	--	--	-27dBm eirp
5470 – 5725	--	--	--	-27dBm eirp (-17dBm/MHz eirp
5725 - 5850	--	--	--	Spectrum mask
--	--	--	--	--
--	--	--	--	--

4.5.5 Results for Range 1-7 GHz

20 MHz Bandwidth

Mode	Channel	Diagram	Maximum Level [dB μ V/m] Frequency Range 1-7 GHz	Result
a-mode	36	4.01a	No peaks found	Passed
	36	4.01b	No peaks found	Passed
	149	4.04a	No peaks found	Passed
	149	4.04b	No peaks found	Passed
n20-mode	44	4.02a	No peaks found	Passed
	44	4.02b	No peaks found	Passed
	157	4.05a	No peaks found	Passed
	157	4.05b	No peaks found	Passed
ac20-mode	48	4.03a	No peaks found	Passed
	48	4.03b	No peaks found	Passed
	165	4.06a	No peaks found	Passed
	165	4.06b	No peaks found	Passed

Remark: for more information and graphical plot see annex A1 **TR21-1-0178701T028a-C01-A1**

40 MHz Bandwidth

Mode	Channel	Diagram	Maximum Level [dB μ V/m] Frequency Range 1-7 GHz	Result
n40-mode	38	4.07a	No peaks found	Passed
	38	4.07b	No peaks found	Passed
	151	4.09a	No peaks found	Passed
	151	4.09b	No peaks found	Passed
ac40-mode	46	4.08a	No peaks found	Passed
	46	4.08b	No peaks found	Passed
	159	4.10a	No peaks found	Passed
	159	4.10b	No peaks found	Passed

Remark: for more information and graphical plot see annex A1 **TR21-1-0178701T028a-C01-A1**

80 MHz Bandwidth

Mode	Channel	Diagram	Maximum Level [dB μ V/m] Frequency Range 1-7 GHz	Result
ac80-mode	42	4.11a	No peaks found	Passed
	42	4.11b	No peaks found	Passed
	155	4.12a	No peaks found	Passed
	155	4.12b	No peaks found	Passed

Remark: for more information and graphical plot see annex A1 **TR21-1-0178701T028a-C01-A1**

4.5.6 Results for Range 7-18 GHz

20 MHz Bandwidth

Mode	Channel	Diagram	Maximum Level [dB μ V/m] Frequency Range 7-18 GHz	Result
a-mode	36	4.01c	No peaks found	Passed
	36	4.01d	No peaks found	Passed
	149	4.04c	No peaks found	Passed
	149	4.04d	54.57 @ 11.490 GHz (PK) 47.72 @ 11.489 GHz (AV)	Passed
n20-mode	44	4.02c	No peaks found	Passed
	44	4.02d	53.56 @ 11.570 GHz (PK) 47.44 @ 11.570 GHz (AV)	Passed
	157	4.05c	No peaks found	Passed
	157	4.05d	53.97 @ 11.569 GHz (PK) 47.44 @ 11.569 GHz (AV)	Passed
ac20-mode	48	4.03c	No peaks found	Passed
	48	4.03d	51.74 @ 10.479 GHz (PK) 46.24 @ 10.480 GHz (AV)	Passed
	165	4.06c	No peaks found	Passed
	165	4.06d	55.02 @ 11.650 GHz (PK) 48.73 @ 11.650 GHz (AV)	Passed

Remark: for more information and graphical plot see annex A1 **TR21-1-0178701T028a-C01-A1**

40 MHz Bandwidth

Mode	Channel	Diagram	Maximum Level [dB μ V/m] Frequency Range 7-18 GHz	Result
n40-mode	38	4.07c	No peaks found	Passed
	38	4.07d	52.85 @ 10.380 GHz (PK) 46.85 @ 10.380 GHz (AV)	Passed
	151	4.09c	No peaks found	Passed
	151	4.09d	51.82 @ 10.460 GHz (PK) 45.87 @ 10.460 GHz (AV)	Passed
ac40-mode	46	4.08c	No peaks found	Passed
	46	4.08d	46.26 @ 11.510 GHz (AV)	Passed
	159	4.10c	No peaks found	Passed
	159	4.10d	46.99 @ 11.590 GHz (AV)	Passed

Remark: for more information and graphical plot see annex A1 **TR21-1-0178701T028a-C01-A1**

80 MHz Bandwidth

Mode	Channel	Diagram	Maximum Level [dB μ V/m] Frequency Range 7-18 GHz	Result
ac80-mode	42	4.11c	No peaks found	Passed
	42	4.11d	43.82 @ 10.420 GHz (AV)	Passed
	155	4.12c	No peaks found	Passed
	155	4.12d	45.54 @ 11.549 GHz (AV)	Passed

Remark: for more information and graphical plot see annex A1 **TR21-1-0178701T028a-C01-A1**

4.5.7 Results for Range 16-40 GHz

20 MHz Bandwidth

Mode	Channel	Diagram	Maximum Level [dB μ V/m] Frequency Range 16-40 GHz	Result
a-mode	36	4.01e	No peaks found	Passed
	149	4.04e	58.06 @ 17.231 GHz (PK) 45.62 @ 17.231 GHz (AV)	Passed
n20-mode	44	4.02e	No peaks found	Passed
	157	4.05e	No peaks found	Passed
ac20-mode	48	4.03e	No peaks found	Passed
	165	4.06e	No peaks found	Passed

Remark: for more information and graphical plot see annex A1 **TR21-1-0178701T028a-C01-A1**

40 MHz Bandwidth

Mode	Channel	Diagram	Maximum Level [dB μ V/m] Frequency Range 16-40 GHz	Result
n40-mode	38	4.07e	No peaks found	Passed
	151	4.09e	No peaks found	Passed
ac40-mode	46	4.08e	No peaks found	Passed
	159	4.10e	No peaks found	Passed

Remark: for more information and graphical plot see annex A1 **TR21-1-0178701T028a-C01-A1**

80 MHz Bandwidth

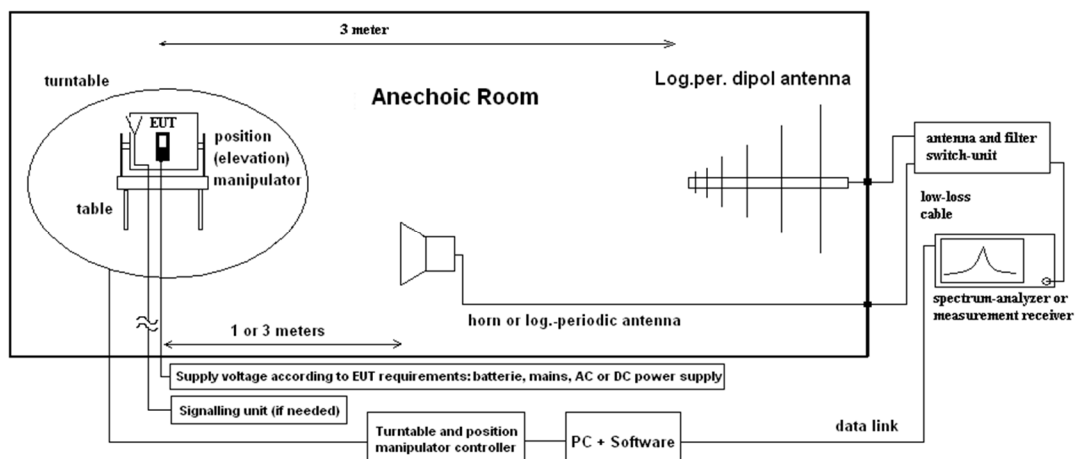
Mode	Channel	Diagram	Maximum Level [dB μ V/m] Frequency Range 16-40 GHz	Result
ac80-mode	42	4.11e	No peaks found	Passed
	155	4.12e	No peaks found	Passed

Remark: for more information and graphical plot see annex A1 **TR21-1-0178701T028a-C01-A1**

4.6 Band Edge

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

Schematic:



Testing method:

The measurement is made according to relevant reference clauses:

(See Tables Summary of Test Results and Summary of Test Methods on page 7)

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

For critical results a Marker-Delta marker method was used for showing compliance to restricted bands. The method is according ANSI C63.10:2013, Chapter 6.10.6 "Marker-Delta method", the method consists of three independent steps:

1. Step: Prior to the measurement the fundamental radiated In-Band field strength was performed. The determined value is used as reference value.
2. Step: Second step consist of finding the relative attenuation between the fundamental emission and the maximum local out-of-band emission (within 2 MHz range around the band edge either on the band-edge directly or some modulation product if the level is greater than that on the band-edge) when measured with lower resolution bandwidth.
3. .Step: The delta value recorded in step 2 will be subtracted from value recorded in step 1, thus giving the required field strength at the band-edge. This value must fulfil the requirements for radiated spurious emissions in restricted bands in FCC §15.205 with the general limits of FCC §15.209

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

4.6.2 Measurement Location

Test site	120904 - FAC1 - Radiated Emissions
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4.6.3 Limit

Frequency Range [MHz]	Pk Limit [dBc]	Detector	RBW / VBW [kHz]
5150 – 5250	≤ 5.150 GHz: 54 dBuV/m (avg), 74 dBuV/m (pk)	Average / Peak	100 / 300
5250 – 5350	≥ 5.350 GHz: 54 dBuV/m (avg), 74 dBuV/m (pk)	Average / Peak	1000 / 3000
5470 – 5725	≤ 5.460 GHz: 54 dBuV/m (avg), 74 dBuV/m (pk) 5.460 – 5.470 GHz: -27 dBm/MHz (pk) equals 68.23 dBuV/m @ 3m	Average / Peak	1000 / 3000
5725 - 5850	All emissions shall be limited to a level of -27 dBm/MHz at 75 MHz or more above or below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above or below the band edge, and from 25 MHz above or below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above or below the band edge, and from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge	Peak	1000 / 3000

4.6.4 Result

U-NII 1

Diagram	Channel	Mode	Result
9.01	36	Op.1	Passed
9.02	36	Op.2	Passed
9.03	36	Op.3	Passed
9.04	38	Op.4	Passed
9.05	38	Op.5	Passed
9.06	42	Op.6	Passed
9.13	48	Op.1	Passed
9.14	48	Op.2	Passed
9.15	48	Op.3	Passed
9.16	46	Op.4	Passed
9.17	46	Op.5	Passed
9.18	42	Op.6	Passed

Remark: for more information and graphical plot see annex A1 **TR21-1-0178701T028a-C01-A1**

U-NII 3

Diagram	Channel	Mode	Result
9.07	151	Op.4	Passed
9.08	151	Op.5	Passed
9.09	155	Op.6	Passed
9.10	149	Op.1	Passed
9.11	149	Op.2	Passed
9.12	149	Op.3	Passed
9.19	165	Op.1	Passed
9.20	165	Op.2	Passed
9.21	165	Op.3	Passed
9.22	159	Op.4	Passed
9.23	159	Op.5	Passed
9.24	155	Op.6	Passed

Remark: for more information and graphical plot see annex A1 **TR21-1-0178701T028a-C01-A1**

4.7 Equipment lists

ID	Description	Manufacturer	SerNo	CheckType	Last Check	Interval	Next Check
	120901 - SAC - Radiated Emission <1GHz			calchk	cal: 2015-Jul-21 chk: 2021-Jul-27	cal: 10Y chk: 12M	cal: 2025-Jul-21 chk: 2022-Jul-27
20442	Semi Anechoic Chamber	ETS-Lindgren GmbH / Taufkirchen	-	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20482	filter matrix Filter matrix SAR 1	CETECOM GmbH	-	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20574	Biconilog Hybrid Antenna BTA-L	Frankonia GmbH / Heideck	980026L	cal	cal: 2022-Jun-15	cal: 36M	cal: 2025-Jun-15
20620	Test Receiver ESU26	Rohde & Schwarz Messgerätebau GmbH / Memmingen	100362	cal	cal: 2022-Jun-08	cal: 12M	cal: 2023-Jun-08
20885	Power Supply EA3632A	Agilent Technologies Deutschland GmbH	75305850	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
25038	Loop Antenna FHF2-22	Rohde & Schwarz Messgerätebau GmbH / Memmingen	879824/13	cal	cal: 2022-Jul-04	cal: 24M	cal: 2024-Jul-04
	120904 - FAC1 - Radiated Emissions			chk	chk: 2022-Jun-30	chk: 12M	chk: 2023-Jun-30
20020	Horn Antenna 3115 (Subst 1)	EMCO Elektronik GmbH	9107-3699	calchk	cal: 2021-Aug-17 chk: 2013-Apr-20	cal: 36M chk: 12M	cal: 2024-Aug-17
20066	Notch Filter WRCT 1900/2200-5/40-10EEK	Wainwright Instruments GmbH	5	chk	chk: 2022-Jun-30	chk: 12M	chk: 2023-Jun-30
20121	Notch Filter WRCB 1879,5/1880,5EE	Wainwright Instruments GmbH	15	chk	chk: 2022-Jun-30	chk: 12M	chk: 2023-Jun-30
20122	Notch Filter WRCB 1747/1748	Wainwright Instruments GmbH	12	chk	chk: 2022-Jun-30	chk: 12M	chk: 2023-Jun-30
20254	High Pass Filter SHC 2600/12750-1.5KK	Trilithic	23042	chk	chk: 2022-Jun-30	chk: 12M	chk: 2023-Jun-30
20287	Pre-Amplifier 25MHz - 4GHz AMF-2D-100MAG-35-10P	Miteq Inc.	379418	chk	chk: 2022-Jun-30	chk: 12M	chk: 2023-Jun-30
20290	Notch Filter WRCA 901,9/903,1SS	Wainwright Instruments GmbH	3RR	chk	chk: 2022-Jun-30	chk: 12M	chk: 2023-Jun-30
20291	High Pass Filter WHJ 2200-4EE	Wainwright Instruments GmbH	14	chk	chk: 2022-Jun-30	chk: 12M	chk: 2023-Jun-30
20302	Horn Antenna BBHA9170 (Meas 1)	Schwarzbeck Mess-Elektronik OHG / Schönaun	155	cpu	chk: 2020-Apr-15	chk: 12M	
20338	Pre-Amplifier 100MHz - 26GHz IS4-00102600-38-5P	Miteq Inc.	838697	chk	chk: 2022-Jun-30	chk: 12M	chk: 2023-Jun-30
20341	Digital Multimeter Fluke 112	Fluke Deutschland GmbH / Glottertal	81650455	cal	cal: 2022-May-18	cal: 24M	cal: 2024-May-18
20439	Ultrabroadband-Antenna HL562	Rohde & Schwarz Messgerätebau GmbH	100248	calchk	cal: 2017-Mar-10	cal: 72M chk: 12M	cal: 2023-Mar-10
20448	Notch Filter WRCT 1850.0/2170.0-5/40-10SSK	Wainwright Instruments GmbH	5	chk	chk: 2022-Jun-30	chk: 12M	chk: 2023-Jun-30
20449	Notch Filter WRCT 824.0/894.0-5/40-8SSK	Wainwright Instruments GmbH	1	chk	chk: 2022-Jun-30	chk: 12M	chk: 2023-Jun-30
20484	Pre-Amplifier 2,5GHz - 18GHz AMF-5D-02501800-25-10P	Miteq Inc.	1244554	chk	chk: 2022-Jun-30	chk: 12M	chk: 2023-Jun-30
20489	Test Receiver ESU40	Rohde & Schwarz Messgerätebau GmbH / Memmingen	100030	cal	cal: 2022-Jul-20	cal: 12M	cal: 2023-Jul-20
20512	Notch Filter WRCA 800/960-02/40-6EEK (GSM 850)	Wainwright Instruments GmbH	24	chk	chk: 2022-Jun-30	chk: 12M	chk: 2023-Jun-30
20549	Log. Per. Antenna HL025	Rohde & Schwarz Messgerätebau GmbH	1000060	calchk	cal: 2021-Aug-18	cal: 36M chk: 12M	cal: 2024-Aug-18
20558	Fully Anechoic Chamber 1	ETS-Lindgren GmbH / Taufkirchen	-	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20611	Power Supply E3632A	Agilent Technologies Deutschland GmbH	KR 75305854	cpu			
20670	Radio Communication Tester CMU200	Rohde & Schwarz Messgerätebau GmbH / Memmingen	106833	cal	cal: 2022-May-10	cal: 24M	cal: 2024-May-10
20690	Spectrum Analyzer FSU	Rohde & Schwarz Messgerätebau GmbH	100302/026	cal	cal: 2021-May-20	cal: 24M	cal: 2023-May-20
20720	Measurement Software EMC32 [FAC]	Rohde & Schwarz Messgerätebau GmbH	V10.xx	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20868	High Pass Filter AFH-07000	AtlanTecRF	16071300004	chk	chk: 2021-Jun-11	chk: 12M	chk: 2022-Jun-11
	120907 - FAC2 - Radiated Emissions			chk	chk: 2023-Feb-21	chk: 12M	chk: 2024-Feb-21
20005	AC - LISN 50 Ohm/50µH ESH2-Z5	Rohde & Schwarz Messgerätebau GmbH / Memmingen	861741/005	cal	cal: 2022-May-19	cal: 12M	cal: 2023-May-19
20133	Horn Antenna 3115 (Meas 1)	EMCO Elektronik GmbH	9012-3629	cal	cal: 2020-Apr-08	cal: 36M	cal: 2023-Apr-08
20412	Fully Anechoic Chamber 2	ETS-Lindgren GmbH / Taufkirchen	without	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20729	FS-Z140	Rohde & Schwarz Messgerätebau GmbH	101004	cal	cal: 2020-May-26	cal: 36M	cal: 2023-May-26
20730	FS-Z110	Rohde & Schwarz Messgerätebau GmbH	101468	cal	cal: 2020-Jun-19	cal: 36M	cal: 2023-Jun-19
20731	FS-Z75	Rohde & Schwarz Messgerätebau GmbH / Memmingen	101022	cal	cal: 2022-May-18	cal: 36M	cal: 2025-May-18
20732	Signal- and Spectrum Analyzer FSW67	Rohde & Schwarz Messgerätebau GmbH / Memmingen	104023	cal	cal: 2022-Jun-08	cal: 12M	cal: 2023-Jun-08
20733	Harmonic Mixer FS-Z220	RPG-Radiometer Physics GmbH	101009	cal	cal: 2021-May-27	cal: 36M	cal: 2024-May-27
20734	Harmonic Mixer FS-Z325	RPG-Radiometer Physics GmbH	101005	cal	cal: 2021-May-27	cal: 36M	cal: 2024-May-27
20765	Pickett-Potter Horn Antenna FH-PP 40-60	RPG-Radiometer Physics GmbH / Meckenheim	010001	cal	cal: 2020-Sep-15	cal: 36M	cal: 2023-Sep-15
20767	Pickett-Potter Horn Antenna FH-PP 140-220	RPG-Radiometer Physics GmbH / Meckenheim	010011	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20811	Horn Antenna ASY-SGH-124-SMA	Antenna Systems Solutions S.L	29F14182337	cal	cal: 2021-Oct-20	cal: 36M	cal: 2024-Oct-20
20812	Pickett-Potter Horn Antenna FH-PP-325	RPG-Radiometer Physics GmbH	10024	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20813	Pickett-Potter Horn Antenna FH-PP 075	RPG-Radiometer Physics GmbH / Meckenheim	10006	cal	cal: 2020-Sep-09	cal: 36M	cal: 2023-Sep-09
20814	Pickett-Potter Horn Antenna FH-PP 140	RPG-Radiometer Physics GmbH	10008	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20815	Pickett-Potter Horn Antenna FH-PP 110	RPG-Radiometer Physics GmbH	10014	cal	cal: 2020-Sep-04	cal: 36M	cal: 2023-Sep-04
20816	SGH Antenna SGH-26-WR10	Antenal S.L.	1144	cnn	cal: -	cal: -	cal: -

ID	Description	Manufacturer	SerNo	CheckType	Last Check	Interval	Next Check
					chk: -	chk: -	chk: -
20817	Waveguide Rectangular Horn Antenna SAR-2309-22-S2	ERAVAN	13254-01	cal	cal: 2020-Jul-29	cal: 36M	cal: 2023-Jul-29
20836	1-18 GHz Amplifier	Wright Technologies, Inc., Inc. / Roseville	0001	chk		chk: 36M	
20877	JS42-08001800-16-8P Verstärker	Miteq Inc.	2079991 / 2079992	chk	chk: 2020-Feb-27	chk: 36M	chk: 2020-May-27
20907	Waveguide WR-15 attenuator STA-30-15-M2	SAGE Millimeter Inc.	13256-01	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20908	Waveguide WR 10 attenuator STA-30-10-M2	SAGE Millimeter Inc.	13256-01	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20909	Waveguide Horn Antenna PE9881-24	Pasternack Enterprises, Inc.	37/2016	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20910	Frequency Multiplier 936VF-10/385	MI-Wave, Millimeter Wave Products Inc.	142	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20911	Frequency Multiplier 938WF-10/387	MI-Wave, Millimeter Wave Products Inc.	141	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20912	Low noise Amplifier Module 0.5-4GHz	RF-Lambda Europe GmbH	19041200083	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
20913	Phase Amplitude Stable Cable Assembly DC-40GHz	RF-Lambda Europe GmbH	AC19040001	cnn	cal: - chk: -	cal: - chk: -	cal: - chk: -
25457	DRG Horn Antenna SAS-574	A.H. Systems, Inc. / Chatsworth	383	cal	cal: 2022-Mar-28	cal: 36M	cal: 2025-Mar-28
	120910 - Radio Laboratory 1 (TS 8997)			chk	chk: 2022-Mar-16	chk: 12M	chk: 2023-Mar-16
20559	Vector Signal Generator SMU200A	Rohde & Schwarz Messgerätebau GmbH / Memmingen	103736	cal	cal: 2021-May-20	cal: 24M	cal: 2023-May-20
20691	Open Switch and control Platform OSP120	Rohde & Schwarz Messgerätebau GmbH	101056	cal	cal: 2020-May-13	cal: 36M	cal: 2023-May-13
20805	Open Switch and control Platform OSP B157WX 40GHz 8Port Switch	Rohde & Schwarz Messgerätebau GmbH	101264	cal	cal: 2020-May-13	cal: 36M	cal: 2023-May-13
20866	Signal Analyzer FSV3030	Rohde & Schwarz Messgerätebau GmbH / Memmingen	101247	cal	cal: 2022-Jun-20	cal: 12M	cal: 2023-Jun-20
20871	NRP-Z81	Rohde & Schwarz Messgerätebau GmbH / Memmingen	104631	cal	cal: 2022-May-16	cal: 12M	cal: 2023-May-16
20872	NRX Power Meter	Rohde & Schwarz Messgerätebau GmbH / Memmingen	101831	cal	cal: 2022-May-17	cal: 24M	cal: 2024-May-17
20904	Climatic Chamber Climevent C/1000/70a/5	Weiss Umwelttechnik GmbH / Reiskirchen-Lindenstruth	58226223240010	cal	cal: 2022-Nov-29	cal: 24M	cal: 2024-Nov-29

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

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6 Opinions and interpretations

None

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7 List of abbreviations

None

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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 its 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	2023-Mar-14
C01	Updated annex 1 to one document and updated page number. Updated antenna typ, corrected RMS and EIRP values at chapter 3.2 and added channel 44 and channel 153.	2023-Apr-28
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End Of Test Report