Test Report
20-1-0101901T01a-C1

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

Number of pages:	39	**Date of Report:**	2020-Dec-08
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:**	Miele & Cie. KG
Test Object / Tested Device(s):	**Wireless Communication Module, WLAN Module**		
FCC ID:	2ACUWEK047	**IC:**	5669C-EK047

Testing has been carried out in accordance with:

Title 47 CFR, Chapter I
FCC Regulations, Subchapter A
§15.247 (DTS)

ISED-Regulations
RSS-Gen, Issue 5
RSS 247, Issue 2

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

Tested Technology: 2.4GHz W-LAN (IEEE 802.11)

Test Results: ☒ **The EUT complies with the requirements in respect of all parameters subject to the test.**
The test results relate only to devices specified in this document

The current version of the Test Report CETECOM_TR20-1-0101901T01a_C1 replaces the test report CETECOM_TR20-1-0101901T01a dated 2020-Nov-24. The replaced test report is herewith invalid.

Signatures:

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1 General information

1.1 Disclaimer and Notes

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

1.1. Summary of Test Results

The EUT integrates a 2.4 GHz W-LAN transmitter. Other implemented wireless technologies were not considered within this test report.

Test case	Reference Clause FCC ☒	Reference Clause ISED ☒	Page	Remark	Result
Duty-Cycle	§15.35(c)	RSS-Gen Issue 5, §8.2	10	--	PASSED
Minimum Emission Bandwidth 6 dB	§15.247 5.2(a)	RSS-247, § 5.2(a) RSS-Gen Issue 5,: § 6.7	13	--	PASSED
Occupied Channel Bandwidth 99%	2.1049(h)	RSS-Gen Issue 5, § 6.7	14	--	PASSED
RF output power	§15.247(b)(3)	RSS-247, § 5.4(d)	11	--	PASSED
Transmitter Peak output power radiated	§15.247(b)(4)(c)(i)	RSS-247, § 5.4(d)	--	NP	--
Emissions in non-restricted frequency bands	§15.247(d)	RSS-247, § 5.5	16	--	PASSED
Radiated Band-Edge emissions	§15.205(b) §15.247(d)	RSS-Gen: Issue 5 §8.9, §8.10 RSS-247, § 5.5	24	--	PASSED
Power spectral density	§15.247(e)	RSS-247, § 5.2(b)	12	--	PASSED
Radiated field strength emissions below 30 MHz	§15.205(a) §15.209(a)	RSS-Gen: Issue 5 §8.9 Table 6	18	--	PASSED
Radiated field strength emissions 30 MHz – 1GHz	§15.209 §15.247(d)	RSS-Gen: Issue 5 §8.9 Table 5 RSS-247, § 5.5	20	--	PASSED
Radiated field strength emissions above 1 GHz	§15.209(a) §15.247(d)	RSS-Gen: Issue 5: §8.9 Table 5+7 RSS-247, § 5.5	22	--	PASSED
AC-Power Lines Conducted Emissions	§15.207	RSS-Gen Issue 5: § 8.8, Table 4	26	--	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.
NP	The test was not performed by the CETECOM Laboratory.
N/A	Not applicable

*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.

1.2. Summary of Test Methods

Test case	Test method
Duty-Cycle	ANSI 63.10:2013, §11.6(b)
Minimum Emission Bandwidth 6 dB	ANSI C63.10:2013, §6.9.2, §11.8
Occupied Channel Bandwidth 99%	ANSI C63.10:2013, §6.9.3
RF output power	ANSI C63.10:2013, §11.9
Power spectral density	ANSI C63.10:2013, §11.10
Emissions in non-restricted frequency bands	ANSI C63.10:2013, §11.11, §6.10.5
Radiated Band-Edge emissions	ANSI C63.10-2013; "Marker-Delta method", §6.10.5, §11.13
Transmitter Peak output power radiated	Result calculated with measured conducted RF-power value and stated/measured antenna gain for band of interest
Radiated field strength emissions below 30 MHz	ANSI C63.10-2013 §6.3, §6.4
Radiated field strength emissions 30 MHz- 1 GHz	ANSI C63.4-2014 §8.2.3, ANSI C63.10-2013 §6.3, § 6.5
Radiated field strength emissions above 1 GHz	ANSI C63.4-2014 §8.3, ANSI C63.10-2013 §6.3, § 6.6
AC-Power Lines Conducted Emissions	ANSI C63.4-2014 §7, ANSI C63.10-2013 § 6.2

And reference also to Test methods in KDB558074

2 Administrative Data

2.1 Identification of the Testing Laboratory

Company name:	CETECOM GmbH
Address:	Im Teelbruch 116 45219 Essen - Kettwig Germany
Responsible for testing laboratory:	Dipl.-Ing. Ninovic Perez
Accreditation scope:	DAkkS Webpage
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

Order No.:	1
Responsible test manager:	B.Sc. M. Ahmed
Receipt of EUT:	2020-Sep-28
Date(s) of test:	2020-Oct-05 – 2020-Oct-15
Version of template:	14.3

2.5 Applicant's details

Applicant's name:	Miele & Cie. KG
Address:	Carl-Miele-Str. 29 33332 Gütersloh Nordrhein-Westfalen Germany
Contact Person:	Gunnar Borgelt
Contact Person's Email:	gunnar.borgelt@miele.com

2.6 Manufacturer's details

Manufacturer's name:	Miele & Cie. KG
Address:	Carl-Miele-Str. 29 33332 Gütersloh Deutschland

2.7 EUT: Type, S/N etc. and short descriptions used in this test report

Short description*)	PMT Sample No.	EUT	Type	S/N	HW status	SW status
EUT 01	20-1-01019S08_C01	WLAN Module	Wireless communication module	n/a	EK047 151118	RF-Measurement-Software v1.0
EUT 02	20-1-01019S09_C01	WLAN Module	Wireless communication module	n/a	EK047 151118	RF-Measurement-Software v1.0

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

2.8 Auxiliary Equipment (AE): Type, S/N etc. and short descriptions

Short description*)	PMT Sample No.	Auxiliary Equipment	Type	S/N	HW status	SW status
AE 01	20-1-01019S11_C01	Battery	--	--	--	--
AE 02	--	Laptop	--	--	--	--

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

2.9 Connected cables

Short description*)	PMT Sample No.	Cable type	Connectors	Lenght
CAB 01	20-1-01019S04_C01	Cable	--	--

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

2.10 Softwares

Short description*)	Software	Build Date
SW 1	WL-Tool (wl43909b0.exe)	05-Jun-2018

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

2.11 EUT set-ups

set-up no.*)	Combination of EUT and AE	Description
1	EUT 01 + AE 01 + AE 02 + CAB 01	Used for Radiated measurements (AE 02 was placed outside the chamber during the measurements)
2	EUT 02 + AE 01 + AE 02 + CAB 01	Used for Conducted measurements

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

2.12 EUT operation modes

EUT operating mode no.*)	Operating modes	Additional information
op. 1	WLAN_TX-Mode	With help of special test firmware TX-mode was set-up. We refer to applicants information/papers for details about necessary commands.

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

2.13 Test Software

For setting the right test mode special test software **WL-Tool (wl43909B0.exe)** saved on AE 2 was used to execute provided test scripts with following Power levels [quarter dBm]:
802.11b: 58
802.11g: 52
802.11n (HT20): 58
802.11n (HT40): 52

3 Equipment under test (EUT)

3.1 General Data of Main EUT as Declared by Applicant

Product name	WLAN Module EK047		
Kind of product	Wireless Communication Module		
Firmware	☐ for normal use	☒ Special version for test execution	
	☐ AC Mains	-	
	☒ DC Mains	3.3 V	
	☐ Battery	-	
Operational conditions	T_{nom} = +21 °C	T_{min} = n/a	T_{max} = n/a
EUT sample type	**Pre-Production**		
Weight	--		
Size	--		
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 Band	2.4 GHz ISM Band (2400 MHz - 2483.5 MHz)		
MIMO	☐		
Frequency | Channel | B.W. (USA bands only)	☒ WLAN 2.4 GHz 802.11b g n (SISO)	Ch 1 | 2 | 3| 4 | 5 | 6 | 7 Ch. 8| 9| 10 | 11	Bandwidth 20 MHz
	☒ WLAN 2.4 GHz 802.11n (SISO)	Ch 3| 4 | 5 | 6 | 7| 8| 9	Bandwidth 40 MHz
802.11b – Mode OFDM Modulation | Data Rates	☒ DBPSK | 1 Mbps ☒ DQPSK | 2 Mbps ☒ CCK-PBCC | 5.5 Mbps / 11 Mbps ☒ ERP-PBCC | 22 Mbps		
802.11g – Mode OFDM Modulation | Data Rates	☒ BPSK | 6 Mbps / 9 Mbps ☒ QPSK | 12 Mbps / 18 Mbps ☒ 16-QAM | 24 Mbps / 36 Mbps ☒ 64-QAM | 48 Mbps / 54 Mbps		
802.11n – Mode OFDM Modulation | Data Rates	☒ HT20(MCS0 to MCS7) | 7.2 / 14.4 / 21.7 / 28.9 / 43.3 / 57.8 / 65 / 72.2 Mbps ☒ HT40(MCS0 to MCS15) | 15/30/45/60/90/120/135/150/180/240/270/300 Mbps		
Other wireless options	☐ WLAN 5 GHz 802.11 a/n/ac mode ((not tested within this report) ☐ Bluetooth LE (not tested within this report) ☐ Bluetooth EDR (not tested within this report) ☐ Cellular transceiver (2G/3G/4G/5G/GPS, not tested in this report)		
Max. Conducted Output Power	b-mode: **15.1** dBm g-mode: **13.5** dBm n-mode(20 MHz): **14.7** dBm n-mode(40 MHz): **13.6** dBm		
EIRP WLAN (Calculated EIRP)	b-mode: **15.1** dBm + **7** dBi = **22.1** dBm g-mode: **13.5** dBm+ **7** dBi = **20.5** dBm n-mode(20 MHz): **14.7** dBm + **7** dBi = **21.7** dBm n-mode(40 MHz): **13.6** dBm + **7** dBi = **20.6** dBm		
Antenna Type(s)	Chip antenna		
Antenna Gain(s)	+7 dBi		
FCC label attached	No		
Test firmware / software and storage location	EUT 01 / EUT 02		
For further details refer Applicants Declaration & following technical documents			
Description of Reference Document (supplied by applicant)		**Version**	**Total Pages**
Miele EK047 TestSetup Introduction		**n/a**	**4**

3.3 Worst case identification

WLAN mode	Data rate
802.11b	2 Mbps
802.11g	6 Mbps
802.11n, 20 MHz bandwidth	MCS0
802.11n, 40 MHz bandwidth	MCS1

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%

4.1.1 Measurement Location

Test site	120910 - Radio Laboratory 1 (TS 8997)

4.1.2 Result

Data rate	Duty-Cycle [%]	Duty-Cycle correction Power [dB]	Duty-Cycle correction Field Strength [dB]	Correction
2 Mbps	99.837	0.012	0.023	Not necessary
6 Mbps	98.969	0.045	0.090	Not necessary
MCS0 [HT20]	98.894	0.048	0.097	Not necessary
MCS1 [HT40]	95.962	0.179	0.358	Necessary

4.2 RF output power

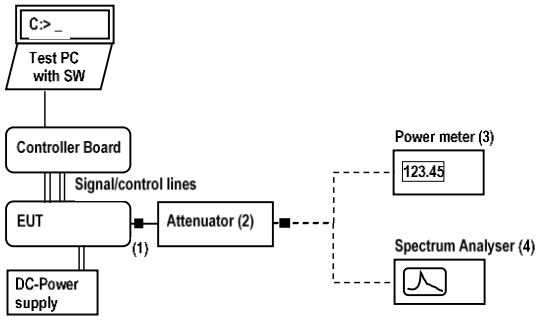
4.2.1 Description of the general test setup and methodology, see below example:

The EUT's RF-signal is coupled out by a suitable antenna coupling connector (1). The signal is first attenuated (2) then connected to power meter (3) or 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.

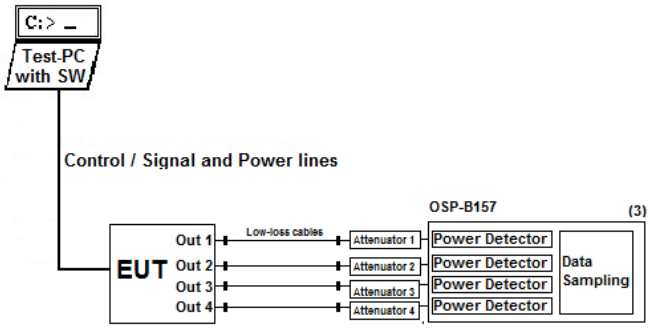
MIMO

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 simultanuously 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 simultanuously 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:



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)

Measurement is made using Rohde & Schwarz TS8997 test system.

Test method	AVGPM-G
SISO	☒
MIMO	☐ 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)

4.2.3 Limit

Reduction of Limit necessary since Antenna gain is 7dBi. 1dB reduction applied to following Table

Frequency Range [MHz]	Limit [W]	Limit [dBm]	Detector
2400 - 2483.5	0.79433	29.0	RMS

4.2.4 Result

Mode	DUT Frequency [MHz]	Gated RMS (dBm)	Limit Max (dBm)	Gated EIRP (dBm)	DutyCycle (%)	Result
b-mode[11Mbps] (15.5; 2412 MHz)	2412.000000	14.8	29.0	21.8	98.89100	PASS
b-mode[11Mbps] (15.5; 2437 MHz)	2437.000000	14.7	29.0	21.7	98.89500	PASS
b-mode[11Mbps] (15.5; 2462 MHz)	2462.000000	14.3	29.0	21.3	98.89000	PASS
b-mode[1Mbps] (15.5; 2412 MHz)	2412.000000	14.2	29.0	21.2	99.83700	PASS
b-mode[1Mbps] (15.5; 2437 MHz)	2437.000000	14.2	29.0	21.2	99.84000	PASS
b-mode[1Mbps] (15.5; 2462 MHz)	2462.000000	13.9	29.0	20.9	99.84000	PASS
b-mode[2 Mbps] (15.5; 2412 MHz)	2412.000000	15.1	29.0	22.1	99.73600	PASS
b-mode[2 Mbps] (15.5; 2437 MHz)	2437.000000	14.7	29.0	21.7	99.73500	PASS
b-mode[2 Mbps] (15.5; 2462 MHz)	2462.000000	14.6	29.0	21.6	99.73600	PASS
b-mode[5,5Mbps] (15.5; 2412 MHz)	2412.000000	14.8	29.0	21.8	99.39400	PASS
b-mode[5,5Mbps] (15.5; 2437 MHz)	2437.000000	14.9	29.0	21.9	99.39300	PASS
b-mode[5,5Mbps] (15.5; 2462 MHz)	2462.000000	14.5	29.0	21.5	99.39100	PASS
g-mode[6 Mbps] (15.5; 2412 MHz)	2412.000000	13.5	29.0	20.5	98.96900	PASS
g-mode[6 Mbps] (15.5; 2437 MHz)	2437.000000	13.2	29.0	20.2	98.96700	PASS
g-mode[6 Mbps] (15.5; 2462 MHz)	2462.000000	12.7	29.0	19.7	98.96100	PASS
g-mode[9Mbps] (15.5; 2412 MHz)	2412.000000	13.3	29.0	20.3	98.48700	PASS
g-mode[9Mbps] (15.5; 2437 MHz)	2437.000000	13.1	29.0	20.1	98.48000	PASS
g-mode[9Mbps] (15.5; 2462 MHz)	2462.000000	12.8	29.0	19.8	98.49100	PASS
g-mode[12 Mbps] (15.5; 2412 MHz)	2412.000000	13.2	29.0	20.2	98.00600	PASS
g-mode[12 Mbps] (15.5; 2437 MHz)	2437.000000	13.2	29.0	20.2	98.01500	PASS
g-mode[12 Mbps] (15.5; 2462 MHz)	2462.000000	12.8	29.0	19.8	98.01900	PASS
g-mode[18Mbps] (15.5; 2412 MHz)	2412.000000	13.3	29.0	20.3	97.13500	PASS
g-mode[18Mbps] (15.5; 2437 MHz)	2437.000000	13.2	29.0	20.2	97.12900	PASS
g-mode[18Mbps] (15.5; 2462 MHz)	2462.000000	12.7	29.0	19.7	97.13600	PASS
g-mode[24Mbps] (15.5; 2412 MHz)	2412.000000	13.2	29.0	20.2	96.27500	PASS
g-mode[24Mbps] (15.5; 2437 MHz)	2437.000000	13.1	29.0	20.1	96.29500	PASS
g-mode[24Mbps] (15.5; 2462 MHz)	2462.000000	12.7	29.0	19.7	96.28500	PASS
g-mode[36 Mbps] (15.5; 2412 MHz)	2412.000000	13.2	29.0	20.2	94.71700	PASS
g-mode[36 Mbps] (15.5; 2437 MHz)	2437.000000	13.0	29.0	20.0	94.72600	PASS
g-mode[36 Mbps] (15.5; 2462 MHz)	2462.000000	12.7	29.0	19.7	94.73600	PASS
g-mode[48Mbps] (15.5; 2412 MHz)	2412.000000	13.3	29.0	20.3	93.14800	PASS
g-mode[48Mbps] (15.5; 2437 MHz)	2437.000000	13.1	29.0	20.1	93.11200	PASS
g-mode[48Mbps] (15.5; 2462 MHz)	2462.000000	12.8	29.0	19.8	93.17100	PASS
g-mode[54Mbps] (15.5; 2412 MHz)	2412.000000	13.3	29.0	20.3	92.43800	PASS
g-mode[54Mbps] (15.5; 2437 MHz)	2437.000000	13.1	29.0	20.1	92.49200	PASS
g-mode[54Mbps] (15.5; 2462 MHz)	2462.000000	12.6	29.0	19.6	92.47700	PASS
n20-mode[MCS0] (15.5; 2412 MHz)	2412.000000	14.7	29.0	21.7	98.89400	PASS
n20-mode[MCS0] (15.5; 2437 MHz)	2437.000000	14.7	29.0	21.7	98.89400	PASS
n20-mode[MCS0] (15.5; 2462 MHz)	2462.000000	14.1	29.0	21.1	98.89500	PASS
n20-mode[MCS1] (15.5; 2412 MHz)	2412.000000	14.6	29.0	21.6	97.90800	PASS
n20-mode[MCS1] (15.5; 2437 MHz)	2437.000000	14.7	29.0	21.7	97.91700	PASS
n20-mode[MCS1] (15.5; 2462 MHz)	2462.000000	14.1	29.0	21.1	97.92000	PASS
n20-mode[MCS2] (15.5; 2412 MHz)	2412.000000	14.6	29.0	21.6	96.96100	PASS
n20-mode[MCS2] (15.5; 2437 MHz)	2437.000000	14.6	29.0	21.6	96.97900	PASS
n20-mode[MCS2] (15.5; 2462 MHz)	2462.000000	14.1	29.0	21.1	96.96500	PASS
n20-mode[MCS3] (15.5; 2412 MHz)	2412.000000	14.6	29.0	21.6	96.09300	PASS
n20-mode[MCS3] (15.5; 2437 MHz)	2437.000000	14.7	29.0	21.7	96.05800	PASS
n20-mode[MCS3] (15.5; 2462 MHz)	2462.000000	14.0	29.0	21.0	96.06700	PASS
n20-mode[MCS4] (15.5; 2412 MHz)	2412.000000	14.6	29.0	21.6	94.45100	PASS
n20-mode[MCS4] (15.5; 2437 MHz)	2437.000000	14.7	29.0	21.7	94.47100	PASS
n20-mode[MCS4] (15.5; 2462 MHz)	2462.000000	14.0	29.0	21.0	94.45000	PASS

n20-mode[MCS5] (15.5; 2412 MHz)	2412.000000	14.6	29.0	21.6	92.98100	PASS
n20-mode[MCS5] (15.5; 2437 MHz)	2437.000000	14.7	29.0	21.7	92.95200	PASS
n20-mode[MCS5] (15.5; 2462 MHz)	2462.000000	14.0	29.0	21.0	92.97900	PASS
n20-mode[MCS6] (15.5; 2412 MHz)	2412.000000	14.6	29.0	21.6	92.39100	PASS
n20-mode[MCS6] (15.5; 2437 MHz)	2437.000000	14.7	29.0	21.7	92.39900	PASS
n20-mode[MCS6] (15.5; 2462 MHz)	2462.000000	14.1	29.0	21.1	92.34700	PASS
n20-mode[MCS7] (15.5; 2412 MHz)	2412.000000	14.6	29.0	21.6	91.75200	PASS
n20-mode[MCS7] (15.5; 2437 MHz)	2437.000000	14.6	29.0	21.6	91.69000	PASS
n20-mode[MCS7] (15.5; 2462 MHz)	2462.000000	14.1	29.0	21.1	91.70500	PASS
n40-mode[MCS0] (13; 2422 MHz)	2422.000000	13.4	29.0	20.4	97.82500	PASS
n40-mode[MCS0] (13; 2437 MHz)	2437.000000	13.4	29.0	20.4	97.82500	PASS
n40-mode[MCS0] (13; 2452 MHz)	2452.000000	13.0	29.0	20.0	97.82500	PASS
n40-mode[MCS1] (13; 2422 MHz)	2422.000000	13.5	29.0	20.5	95.96200	PASS
n40-mode[MCS1] (13; 2437 MHz)	2437.000000	13.6	29.0	20.6	95.97300	PASS
n40-mode[MCS1] (13; 2452 MHz)	2452.000000	13.1	29.0	20.1	95.98100	PASS
n40-mode[MCS2] (13; 2422 MHz)	2422.000000	13.5	29.0	20.5	94.29800	PASS
n40-mode[MCS2] (13; 2437 MHz)	2437.000000	13.4	29.0	20.4	94.30300	PASS
n40-mode[MCS2] (13; 2452 MHz)	2452.000000	13.1	29.0	20.1	94.29500	PASS
n40-mode[MCS3] (13; 2422 MHz)	2422.000000	13.5	29.0	20.5	92.78100	PASS
n40-mode[MCS3] (13; 2437 MHz)	2437.000000	13.3	29.0	20.3	92.77800	PASS
n40-mode[MCS3] (13; 2452 MHz)	2452.000000	13.0	29.0	20.0	92.79700	PASS
n40-mode[MCS4] (13; 2422 MHz)	2422.000000	13.2	29.0	20.2	90.19500	PASS
n40-mode[MCS4] (13; 2437 MHz)	2437.000000	13.4	29.0	20.4	90.22900	PASS
n40-mode[MCS4] (13; 2452 MHz)	2452.000000	13.0	29.0	20.0	90.23100	PASS
n40-mode[MCS5] (13; 2422 MHz)	2422.000000	13.2	29.0	20.2	88.19900	PASS
n40-mode[MCS5] (13; 2437 MHz)	2437.000000	13.3	29.0	20.3	88.17900	PASS
n40-mode[MCS5] (13; 2452 MHz)	2452.000000	13.0	29.0	20.0	88.19000	PASS
n40-mode[MCS6] (13; 2422 MHz)	2422.000000	13.1	29.0	20.1	87.30900	PASS
n40-mode[MCS6] (13; 2437 MHz)	2437.000000	13.2	29.0	20.2	87.34000	PASS
n40-mode[MCS6] (13; 2452 MHz)	2452.000000	12.9	29.0	19.9	87.35500	PASS
n40-mode[MCS7] (13; 2422 MHz)	2422.000000	13.1	29.0	20.1	86.34600	PASS
n40-mode[MCS7] (13; 2437 MHz)	2437.000000	13.2	29.0	20.2	86.30400	PASS
n40-mode[MCS7] (13; 2452 MHz)	2452.000000	13.0	29.0	20.0	86.35900	PASS

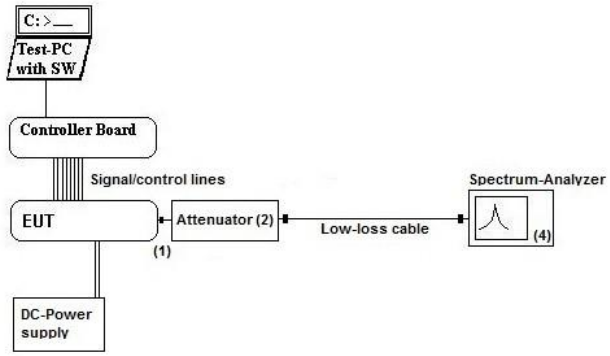
Remark: for more informations and graphical plot see annex A1 **CETECOM_TR20_1_0101901T01a_C1_A1**

4.3 Power spectral density

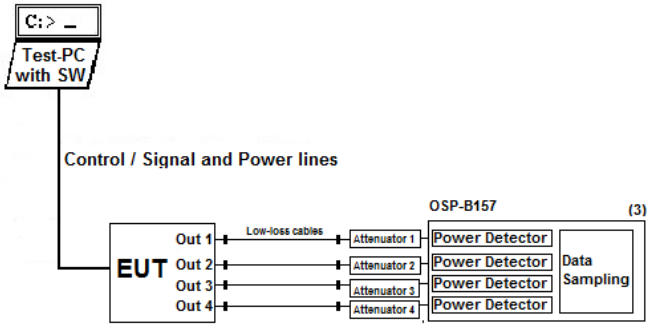
4.3.1 Description of the general test setup and methodology, see below example:

The EUT's RF-signal is coupled out by a suitable antenna coupling connector (1). The signal is first attenuated (2) then 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.

Schematic:



Schematic MIMO:



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)

Measurement is made using Rohde & Schwarz TS8997 test system.

Test method	PKPSD-Method
SISO	☒
MIMO	☐ Summation of values from two antenna ports
Remarks	--

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

4.3.2 Measurement Location

Test site	120910 - Radio Laboratory 1 (TS 8997)

4.3.3 Limit

Limit [dBm] @ 3 kHz	Detector [MaxHold]	RBW / VBW [kHz]
<= 8	Peak	3 / 10

4.3.4 Result

Mode	Channel	Frequency [MHz]	PSD [dBm]	Result
b-mode[2 Mbps] (15.5; 2412 MHz)	1	2412	3.461	PASS
b-mode[2 Mbps] (15.5; 2437 MHz)	6	2437	2.780	PASS
b-mode[2 Mbps] (15.5; 2462 MHz)	11	2462	2.820	PASS
g-mode[6 Mbps] (15.5; 2412 MHz)	1	2412	-1.514	PASS
g-mode[6 Mbps] (15.5; 2437 MHz)	6	2437	-2.128	PASS
g-mode[6 Mbps] (15.5; 2462 MHz)	11	2462	-2.212	PASS
n20-mode[MCS0] (15.5; 2412 MHz)	1	2412	0.361	PASS
n20-mode[MCS0] (15.5; 2437 MHz)	6	2437	-0.554	PASS
n20-mode[MCS0] (15.5; 2462 MHz)	11	2462	-0.186	PASS
n40-mode[MCS1] (13; 2422 MHz)	3	2422	-3.941	PASS
n40-mode[MCS1] (13; 2437 MHz)	6	2437	-4.046	PASS
n40-mode[MCS1] (13; 2452 MHz)	9	2452	-4.591	PASS

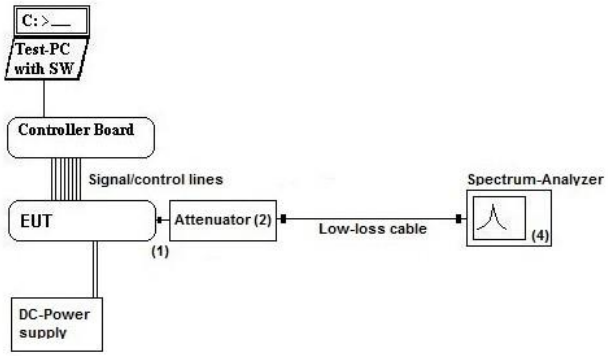
Remark: for more informations and graphical plot see annex A1 **CETECOM_TR20_1_0101901T01a_C1_A1**

4.4 Minimum Emission Bandwidth 6 dB

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

The EUT's RF-signal is coupled out by a suitable antenna coupling connector (1). The signal is first attenuated (2) then 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.

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)

Measurement is made using Rohde & Schwarz TS8997 test system.

4.4.2 Measurement Location

Test site	120910 - Radio Laboratory 1 (TS 8997)

4.4.3 Limit

Limit [kHz]	Detector [MaxHold]	RBW / VBW [kHz]
>= 500	MaxPeak	100 / 300

4.4.4 Result

Mode	Channel	Frequency [MHz]	6 dB bandwidth [MHz]	Result
b-mode[2 Mbps] (15.5; 2412 MHz)	1	2412	8.200000	PASS
b-mode[2 Mbps] (15.5; 2437 MHz)	6	2437	8.300000	PASS
b-mode[2 Mbps] (15.5; 2462 MHz)	11	2462	9.450000	PASS
g-mode[6 Mbps] (15.5; 2412 MHz)	1	2412	16.400000	PASS
g-mode[6 Mbps] (15.5; 2437 MHz)	6	2437	16.450000	PASS
g-mode[6 Mbps] (15.5; 2462 MHz)	11	2462	16.400000	PASS
n-mode[MCS0] (15.5; 2412 MHz)	1	2412	17.700000	PASS
n-mode[MCS0] (15.5; 2437 MHz)	6	2437	17.650000	PASS
n-mode[MCS0] (15.5; 2462 MHz)	11	2462	17.700000	PASS
n-mode[MCS1] (13; 2422 MHz)	3	2422	36.450000	PASS
n-mode[MCS1] (13; 2437 MHz)	6	2437	36.500000	PASS
n-mode[MCS1] (13; 2452 MHz)	9	2452	36.550000	PASS

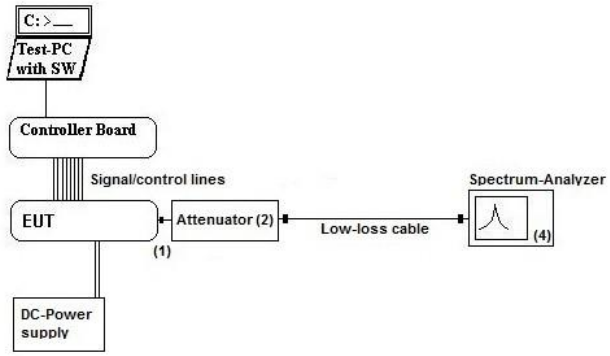
Remark: for more informations and graphical plot see annex A1 **CETECOM_TR20_1_0101901T01a_C1_A1**

4.5 Occupied Channel Bandwidth 99%

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

The EUT's RF-signal is coupled out by a suitable antenna coupling connector (1). The signal is first attenuated (2) then 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.

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)

Measurement is made using Rohde & Schwarz TS8997 test system.

4.5.2 Measurement Location

Test site	120910 - Radio Laboratory 1 (TS 8997)

4.5.3 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.

4.5.4 Result

Mode	Channel	Frequency [MHz]	99% Occupied bandwidth [MHz]
b-mode[2 Mbps] (15.5; 2412 MHz)	1	2412	11.900000
b-mode[2 Mbps] (15.5; 2437 MHz)	6	2437	11.900000
b-mode[2 Mbps] (15.5; 2462 MHz)	11	2462	11.900000
g-mode[6 Mbps] (15.5; 2412 MHz)	1	2412	16.700000
g-mode[6 Mbps] (15.5; 2437 MHz)	6	2437	16.700000
g-mode[6 Mbps] (15.5; 2462 MHz)	11	2462	16.700000
n20-mode[MCS0] (15.5; 2412 MHz)	1	2412	17.900000
n20-mode[MCS0] (15.5; 2437 MHz)	6	2437	18.000000
n20-mode[MCS0] (15.5; 2462 MHz)	11	2462	17.900000
n40-mode[MCS1] (13; 2422 MHz)	3	2422	36.500000
n40-mode[MCS1] (13; 2437 MHz)	6	2437	36.500000
n40-mode[MCS1] (13; 2452 MHz)	9	2452	36.750000

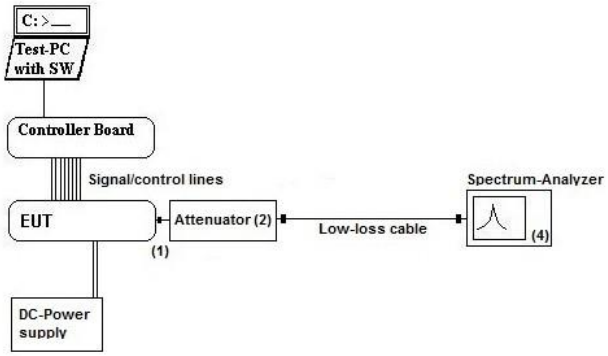
Remark: for more informations and graphical plot see annex A1 **CETECOM_TR20_1_0101901T01a_C1_A1**

4.6 Emissions in non-restricted frequency bands

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

The EUT's RF-signal is coupled out by a suitable antenna coupling connector (1). The signal is first attenuated (2) then 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.

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)

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

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

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

EUT settings
The EUT was instructed to send with maximum power (if adjustable) according applicants instructions.
Different modulation characteristics have been checked. e.g. data rates which EUT can operate.

4.6.2 Measurement Location

Test site	120910 - Radio Laboratory 1 (TS 8997)

4.6.3 Limit

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

4.6.4 Result

Maximum Level Peak [dBc]

Mode	Channel	Frequency [MHz]	Result
b-mode[2 Mbps] (15.5; 2412 MHz)	1	2412	PASSED
b-mode[2 Mbps] (15.5; 2437 MHz)	6	2437	PASSED
b-mode[2 Mbps] (15.5; 2462 MHz)	11	2462	PASSED
g-mode[6 Mbps] (15.5; 2412 MHz)	1	2412	PASSED
g-mode[6 Mbps] (15.5; 2437 MHz)	6	2437	PASSED
g-mode[6 Mbps] (15.5; 2462 MHz)	11	2462	PASSED
n20-mode[MCS0] (15.5; 2412 MHz)	1	2412	PASSED
n20-mode[MCS0] (15.5; 2437 MHz)	6	2437	PASSED
n20-mode[MCS0] (15.5; 2462 MHz)	11	2462	PASSED
n40-mode[MCS1] (13; 2422 MHz)	3	2422	PASSED
n40-mode[MCS1] (13; 2437 MHz)	6	2437	PASSED
n40-mode[MCS1] (13; 2452 MHz)	9	2452	PASSED

Remark1: every RF-Port tested separatelly in case on MIMO device
Remark2: for more informations and graphical plot see annex A1 **CETECOM_TR20_1_0101901T01a_C1_A1**

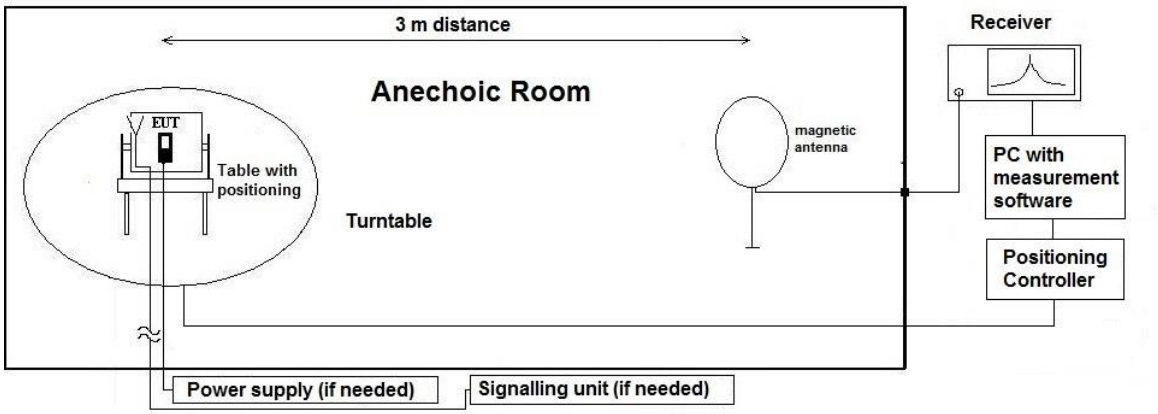
4.7 Radiated field strength emissions below 30 MHz

4.7.1 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 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.

4.7.2 Measurement Location

Test site	120902 – SAC – Radiated Emission < 1GHz

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)	2'te Condition (Limit distance bigger dnear-field)	Distance Correction accord. Formula
	9.00E+03	33333.33	5305.17		fullfilled	not fullfilled	-80.00
	1.00E+04	30000.00	4774.65		fullfilled	not fullfilled	-80.00
	2.00E+04	15000.00	2387.33		fullfilled	not fullfilled	-80.00
	3.00E+04	10000.00	1591.55		fullfilled	not fullfilled	-80.00
	4.00E+04	7500.00	1193.66		fullfilled	not fullfilled	-80.00
	5.00E+04	6000.00	954.93		fullfilled	not fullfilled	-80.00
	6.00E+04	5000.00	795.78		fullfilled	not fullfilled	-80.00
	7.00E+04	4285.71	682.09		fullfilled	not fullfilled	-80.00
	8.00E+04	3750.00	596.83		fullfilled	not fullfilled	-80.00
	9.00E+04	3333.33	530.52		fullfilled	not fullfilled	-80.00
kHz	1.00E+05	3000.00	477.47		fullfilled	not fullfilled	-80.00
	1.25E+05	2400.00	381.97		fullfilled	not fullfilled	-80.00
	2.00E+05	1500.00	238.73		fullfilled	fullfilled	-78.02
	3.00E+05	1000.00	159.16		fullfilled	fullfilled	-74.49
	4.00E+05	750.00	119.37		fullfilled	fullfilled	-72.00
	4.90E+05	612.24	97.44		fullfilled	fullfilled	-70.23
	5.00E+05	600.00	95.49		fullfilled	not fullfilled	-40.00
	6.00E+05	500.00	79.58		fullfilled	not fullfilled	-40.00
	7.00E+05	428.57	68.21		fullfilled	not fullfilled	-40.00
	8.00E+05	375.00	59.68		fullfilled	not fullfilled	-40.00
	9.00E+05	333.33	53.05		fullfilled	not fullfilled	-40.00
	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
MHz	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

4.7.3 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

4.7.4 Result

Diagram	Channel	Mode	Maximum Level [dBµV/m] Frequency Range 0.009 – 30 MHz	Result
2.01a	1	b-mode | 2 Mbps| ch01 | laying	19.440 @ 26.818 MHz	Passed
2.01b	1	b-mode | 2 Mbps| ch01 | standing	19.728 @ 23.586 MHz	Passed
2.02a	6	g-mode | 6 Mbps| ch06 | laying	19.556 @ 25.290 MHz	Passed
2.02b	6	g-mode | 6 Mbps| ch06 | standing	19.962 @ 24.266 MHz	Passed
2.03a	11	n20-mode | MCS0 | ch11 | laying	19.880 @ 25.150 MHz	Passed
2.03b	11	n20-mode | MCS0 | ch11 | standing	19.583 @ 26.574 MHz	Passed
2.04a	3	n40-mode | MCS1 | ch03 | laying	19.567 @ 23.330 MHz	Passed
2.04b	3	n40-mode | MCS1 | ch03 | standing	19.683 @ 28.074 MHz	Passed
2.05a	9	n40-mode | MCS1 | ch09 | laying	20.156 @ 29.518 MHz	Passed
2.05b	9	n40-mode | MCS1 | ch09 | standing	20.157 @ 26.326 MHz	Passed

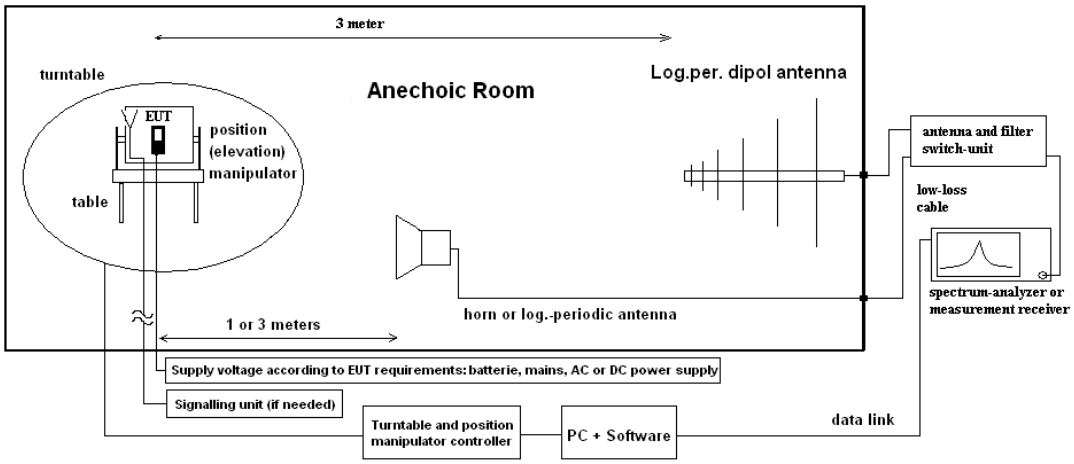
Remark: for more informations and graphical plot see annex A1 **CETECOM_TR20_1_0101901T01a_C1_A1**

4.8 Radiated field strength emissions 30 MHz – 1 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 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 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 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.

4.8.2 Measurement Location

Test site	120902 – SAC – Radiated Emission < 1GHz

4.8.3 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

4.8.4 Result

Diagram	Channel	Mode	Maximum Level [dBµV/m] Frequency Range 30 – 1000 MHz	Result
3.01a	1	b-mode | 2 Mbps| ch01 | laying	No peaks found	Passed
3.01b	1	b-mode | 2 Mbps| ch01 | standing	No peaks found	Passed
3.02a	6	g-mode | 6 Mbps| ch06 | laying	No peaks found	Passed
3.02b	6	g-mode | 6 Mbps| ch06 | standing	No peaks found	Passed
3.03a	11	n20-mode | MCS0 | ch11 | laying	No peaks found	Passed
3.03b	11	n20-mode | MCS0 | ch11 | standing	No peaks found	Passed
3.04a	3	n40-mode | MCS1 | ch03 | laying	No peaks found	Passed
3.04b	3	n40-mode | MCS1 | ch03 | standing	No peaks found	Passed
3.05a	9	n40-mode | MCS1 | ch09 | laying	No peaks found	Passed
3.05b	9	n40-mode | MCS1 | ch09 | standing	No peaks found	Passed

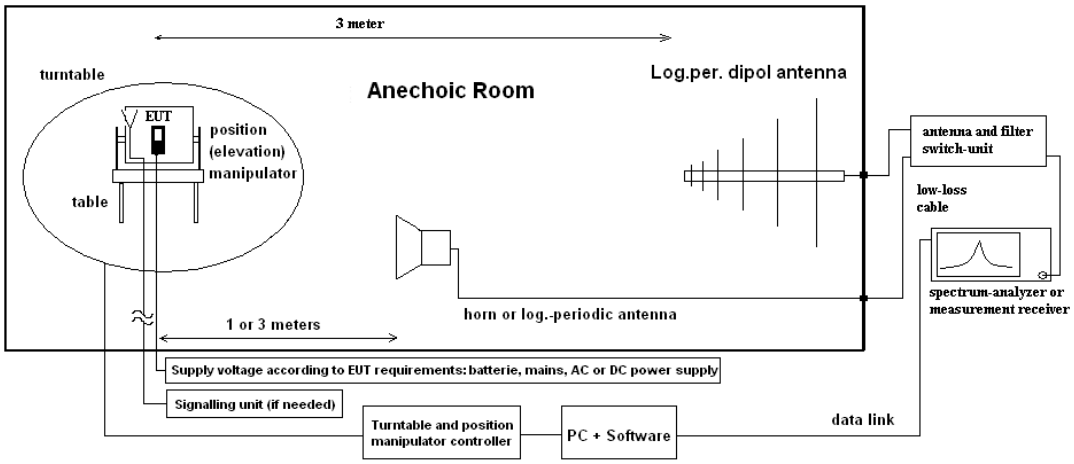
Remark: for more informations and graphical plot see annex A1 **CETECOM_TR20_1_0101901T01a_C1_A1**

4.9 Radiated field strength emissions above 1 GHz

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

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

Schematic:



Testing method:

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

Exploratory, preliminary measurements

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

Final measurement on critical frequencies

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

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

$M = L_T - E_C$ (2)

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

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

4.9.2 Measurement Location

Test site 1 – 15 GHz	120904 – FAC1 – Radiated Emissions
Test site 15 – 26.5 GHz	120907 – FAC2

4.9.3 Limit

Radiated emissions limits (3 meters)				
Frequency Range [MHz]	**Limit [µV/m]**	**Limit [dBµV/m]**	**Detector**	**RBW / VBW [kHz]**
Above 1000	500	54	Average	1000 / 3000
Above 1000	5000	74	Peak	1000 / 3000

4.9.4 Result

Diagram	Channel	Mode	Maximum Level [dBµV/m] Frequency Range 1 – 15 GHz	Result
4.01a	1	b-mode | 2 Mbps| ch01	62.08 @ 14.758 GHz	Passed
4.02a	6	g-mode | 6 Mbps| ch06	62.78 @ 14.824 GHz	Passed
4.03a	11	n20-mode | MCS0| ch11	61.96 @ 14.205 GHz	Passed
4.04a	3	n40-mode | MCS1 | ch03	62.09 @ 14.160 GHz	Passed
4.05a	9	n40-mode | MCS1 | ch09	61.76 @ 14.132 GHz	Passed

Remark: for more informations and graphical plot see annex A1 **CETECOM_TR20_1_0101901T01a_C1_A1**

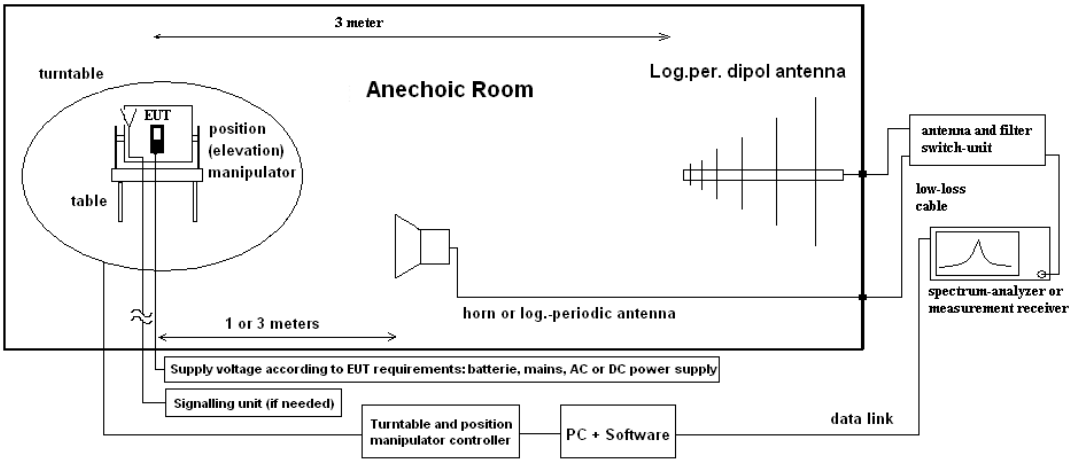
Diagram	Channel	Mode	Maximum Level [dBµV/m] Frequency Range 15 – 26.5 GHz	Result
4.01b	1	b-mode | 2 Mbps| ch01	59.00 @ 25.209 GHz	Passed
4.02b	6	g-mode | 6 Mbps| ch06	58.90 @ 25.510 GHz	Passed
4.03b	11	n20-mode | MCS0| ch11	50.13 @ 25.671 GHz	Passed
4.04b	3	n40-mode | MCS1 | ch03	59.00 @ 25.831 GHz	Passed
4.05b	9	n40-mode | MCS1 | ch09	59.25 @ 25.625 GHz	Passed

Remark: for more informations and graphical plot see annex A1 **CETECOM_TR20_1_0101901T01a_C1_A1**

4.10 Radiated Band-Edge emissions

4.10.1 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 5)

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

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

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

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

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

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

4.10.2 Measurement Location

Test site	120904 – FAC1 – Radiated Emissions

4.10.3 Limit

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

4.10.4 Result

Non-restricted bands near-by

Diagram	Channel	Mode	Peak [dBc]	Average [dBc]	Result
9.01a	1	b-mode | 2 Mbps| ch01	43.88	42.71	PASSED
9.02a	1	g-mode | 6 Mbps| ch01	36.05	36.94	PASSED
9.03a	1	n20-mode | MCS0| ch11	35.18	35.40	PASSED
9.04a	3	n40-mode | MCS1 | ch03	35.07	30.00	PASSED

Remark: for more informations and graphical plot see annex A1 **CETECOM_TR20_1_0101901T01a_C1_A1**

Restricted bands near-by

Diagram	Channel	Mode	Peak [dBµV/m]	Average [dBµV/m]	Result
9.01b	11	b-mode | 2 Mbps| ch11	57.86	46.67	PASSED
9.02b	11	g-mode | 6 Mbps| ch11	62.11	48.34	PASSED
9.03b	11	n20-mode | MCS0 | ch11	68.33	50.58	PASSED
9.04b	9	n40-mode | MCS1 | ch09	63.94	51.398*	PASSED

* Average value of Diagramm 9.04b corrected with Duty Cycle - Factor

Remark2: for more informations and graphical plot see annex A1 **CETECOM_TR20_1_0101901T01a_C1_A1**

4.11 Results from external laboratory

None	-

4.12 Opinions and interpretations

None	-

4.13 List of abbreviations

None	-

5 Equipment lists

ID	Description	Manufacturer	SerNo	Cal due date
	120901 - SAC - Radiated Emission <1GHz			
20574	Biconilog Hybrid Antenna BTA-L	Frankonia GmbH	980026L	03.05.2022
20620	EMI Test Receiver ESU26	Rohde & Schwarz Messgerätebau GmbH	100362	13.05.2021
20482	filter matrix Filter matrix SAR 1	CETECOM GmbH	-	
20885	Power Supply EA3632A	Agilent Technologies Deutschland GmbH	75305850	
20487	System CTC NSA-Verification SAR-EMI System EMI field (SAR) NSA	ETS-Lindgren Gmbh	-	23.03.2021
25038	Loop Antenna HFH2-Z2	Rohde & Schwarz Messgerätebau GmbH	879824/13	07.04.2022
	120904 - FAC1 - Radiated Emissions			
20341	Digital Multimeter Fluke 112	Fluke Deutschland GmbH	81650455	25.05.2022
20720	EMC32 [FAC]	Rohde & Schwarz Messgerätebau GmbH	V10.xx	
20489	EMI Test Receiver ESU40	Rohde & Schwarz Messgerätebau GmbH	1000-30	13.05.2021
20254	High Pass Filter 5HC 2600/12750-1.5KK (GSM1800/1900/DECT)	Trilithic	23042	
20868	High Pass Filter AFH-07000	AtlanTecRF	16071300004	
20291	High Pass Filter WHJ 2200-4EE (GSM 850/900)	Wainwright Instruments GmbH	14	
20020	Horn Antenna 3115 (Subst 1)	EMCO Elektronik GmbH	9107-3699	19.07.2021
20302	Horn Antenna BBHA9170 (Meas 1)	Schwarzbeck Mess-Elektronik OHG	155	15.04.2023
20549	Log.Per-Antenna HL025	Rohde & Schwarz Messgerätebau GmbH	1000060	31.07.2021
20512	Notch Filter WRCA 800/960-02/40-6EEK (GSM 850)	Wainwright Instruments GmbH	24	
20290	Notch Filter WRCA 901,9/903,1SS (GSM 900)	Wainwright Instruments GmbH	3RR	
20122	Notch Filter WRCB 1747/1748 (GSM 1800)	Wainwright Instruments GmbH	12	

ID	Description	Manufacturer	SerNo	Cal due date
20121	Notch Filter WRCB 1879,5/1880,5EE (GSM 1900)	Wainwright Instruments GmbH	15	
20448	Notch Filter WRCT 1850.0/2170.0-5/40-10SSK (WCDMA-FDD II)	Wainwright Instruments GmbH	5	
20066	Notch Filter WRCT 1900/2200-5/40-10EEK (WCDMA - FDDI)	Wainwright Instruments GmbH	5	
20449	Notch Filter WRCT 824.0/894.0-5/40-8SSK (WCDMA FDD V)	Wainwright Instruments GmbH	1	
20611	Power Supply E3632A	Agilent Technologies Deutschland GmbH	KR 75305854	
20338	Pre-Amplifier 100MHz - 26GHz JS4-00102600-38-5P	Miteq Inc.	838697	
20484	Pre-Amplifier 2,5GHz - 18GHz AMF-5D-02501800-25-10P	Miteq Inc.	1244554	
20287	Pre-Amplifier 25MHz - 4GHz AMF-2D-100M4G-35-10P	Miteq Inc.	379418	
20670	Radio Communication Tester CMU200	Rohde & Schwarz Messgerätebau GmbH	106833	16.06.2022
20690	Spectrum Analyzer FSU	Rohde & Schwarz Messgerätebau GmbH	100302/026	23.05.2021
20439	UltraLog-Antenna HL 562	Rohde & Schwarz Messgerätebau GmbH	100248	10.03.2023
20828	Netgear Nighthawk x4S	NETGEAR Ireland International Ltd	5K5188590067B	
20732	Signal- and Spectrum Analyzer FSW67	Rohde & Schwarz Messgerätebau GmbH	104023	27.05.2021
	120910 - Radio Laboratory 1 (TS 8997)			
20904	Climatic Chamber ClimeEvent C/1000/70a/5	Weiss Umwelttechnik GmbH	58226223240010	09.05.2021
20866	FSV3030 Signal Analyzer 30GHz	Rohde & Schwarz Messgerätebau GmbH	101247	10.09.2021
20805	Open Switch and control Platform OSP B157WX 40GHz 8Port Switch	Rohde & Schwarz Messgerätebau GmbH	101264	13.05.2021
20691	Open Switch and control Platform OSP120	Rohde & Schwarz Messgerätebau GmbH	101056	13.05.2021
20687	Signal Generator SMF 100A	Rohde & Schwarz Messgerätebau GmbH	102073	07.02.2021
20559	Vector Signal Generator SMU200A	Rohde & Schwarz Messgerätebau GmbH	103736	22.05.2021
20873	WTS-80 Schirmbox	CETECOM GmbH	P3101	

6 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})	-	9 kHz - 150 kHz 150 kHz - 30 MHz	4.0 dB 3.6 dB						-
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 - 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	5.01dB						Magnetic field strength
		30 MHz - 1 GHz 1 GHz - 18 GHz 18-26.5 GHz	5.83 dB 4.91 dB 5.06 dB						Electrical Field strength

7 Versions of test reports (change history)

Version	Applied changes	Date of release
--	Initial release	2020-Nov-24
C1	Chapter 3.2 supported Channels updated Chapter 4.2.3 Limit updated	2020-Dec-08
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End Of Test Report