Test Report
21-1-0039901T01a-C2

D-PL-12047-01-01
D-PL-12047-01-03
D-PL-12047-01-04

Number of pages:	44	**Date of Report:**	2021-Nov-11
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:**	IMST GmbH
Product:	**LoRa radio module**		
Model:	**iM980B**		
FCC ID:	Q9B-IM980B	**IC:**	10740A-IM980B

Testing has been carried out in accordance with:

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

ISED-Regulations
RSS-247, Issue 2 (DTS & FHSS)
RSS-Gen., Issue 5

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

Tested Technology: LoRa

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
This test report CETECOM_TR21-1-0039901T01a_C2 substitutes test report CETECOM_TR21-1-0039901T01a_C1 dated on 2021-Oct-12, which herewith gets invalid.

Signatures:

Dipl.-Ing. Ninovic Perez	Guangcheng Huang
Test Lab Manager	Test manager
Authorization of test report	Responsible of test report

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1 General information

1.1 Disclaimer and Notes

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

1.2 Attestation

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

1.3 Summary of Test Results

DTS mode

Test case	Reference Clause FCC ☒	Reference Clause ISED ☒	Page	Remark	Result
Occupied Channel Bandwidth 99%	2.1049(h)	RSS-Gen Issue 5, § 6.7	12	--	PASSED
Minimum Emission Bandwidth 6 dB	§15.247 5.2(a)	RSS-247, § 5.2(a) RSS-Gen Issue 5, § 6.7	13	--	PASSED
RF output power conducted	§15.247(b)(3)	RSS-247, § 5.4(d)	14	--	PASSED
Emissions in non-restricted frequency bands	§15.247(d)	RSS-247, § 5.5	17	--	PASSED
Band-Edge emissions	§15.205(b) §15.247(d)	RSS-Gen: Issue 5 §8.9, §8.10 RSS-247, § 5.5	17	--	PASSED
Power spectral density	§15.247(e)	RSS-247, § 5.2(b)	16	--	PASSED
Radiated field strength emissions below 30 MHz	§15.205(a) §15.209(a)	RSS-Gen: Issue 5 §8.9 Table 6	19	--	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	23	--	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	25	--	PASSED
AC-Power Lines Conducted Emissions	§15.207	RSS-Gen Issue 5: § 8.8, Table 4	-	--	N/A

FHSS mode

Test case	Reference Clause FCC ☒	Reference Clause ISED ☒	Page	Remark	Result
Occupied Channel Bandwidth 99%	2.1049(h)	RSS-Gen Issue 5, § 6.7	27	--	PASSED
Maximum Emission Bandwidth 20 dB	§15.247 (a)(1)(i)	RSS-247, § 5.1(c) RSS-Gen Issue 5, § 6.7	28	--	PASSED
Minimum channel separation	§15.247 (a)(1)	RSS-247, § 5.1(b)	29		PASSED
Number of hopping frequencies	§15.247 (a)(1)(i)	RSS-247, § 5.1(c)	30		PASSED
Time of occupancy	§15.247 (a)(1)(i)	RSS-247, § 5.1(c)	31		PASSED
Maximal peak conducted power	§15.247(b)(2)	RSS-247, § 5.4(d)	32	--	PASSED
Power spectral density	§15.247(e)	RSS-247, § 5.2(b)	34	--	PASSED
Emissions in non-restricted frequency bands	§15.247(d)	RSS-247, § 5.5	35	--	PASSED
Band-Edge emissions	§15.205(b) §15.247(d)	RSS-Gen: Issue 5 §8.9, §8.10 RSS-247, § 5.5	35	--	PASSED
Radiated field strength emissions below 30 MHz	§15.205(a) §15.209(a)	RSS-Gen: Issue 5 §8.9 Table 6	37	--	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	38	--	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	39	--	PASSED
AC-Power Lines Conducted Emissions	§15.207	RSS-Gen Issue 5: § 8.8, Table 4	-	--	N/A

PASSED	The EUT complies with the essential requirements in the standard.
FAILED	The EUT does not comply with the essential requirements in the standard.
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.

1.4 Summary of Test Methods

Test case	Test method
Duty-Cycle	ANSI C63.10:2013, §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: FCC ISED**
Test location:	CETECOM GmbH; Im Teelbruch 116; 45219 Essen - Kettwig

2.2 General limits for environmental conditions

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

2.3 Test Laboratories sub-contracted

Company name:	--

2.4 Organizational Items

Responsible test manager:	Guangcheng Huang
Receipt of EUT:	2021-Jul-01
Date(s) of test:	2021-Jul-01 – 2021-Sep-13
Version of template:	14.7

2.5 Applicant's details

Applicant's name:	IMST GmbH
Address:	Carl-Friedrich-Gauß Str. 2-4 47475 Kamp-Lintfort North Rhine-Westphalia Germany
Contact Person:	Heinz Syrzisko
Contact Person's Email:	wimod@imst.de

2.6 Manufacturer's details

Manufacturer's name:	IMST GmbH
Address:	Carl-Friedrich-Gauß Str. 2-4 47475 Kamp-Lintfort Deutschland

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

Short description*)	PMT Sample No.	Product	Model	Type	S/N	HW status	SW status
EUT 1	21-1-00399S02_C01	LoRa radio module	iM980B	-	No.00000066	B	V3.0
EUT 2	21-1-00399S03_C01	LoRa radio module	iM980B	-	No.00000067	B	V3.0

*) 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 1	CTC522013	laptop	DELL LATITUDE E6430	-	-	-

*) 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	Length
CAB 1	21-1-00399S06_C01	Configuration cable	FTDI TTL232R-3.3V	1.5 m

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

2.10 Software

Short description*)	PMT Sample No.	Software	Type	S/N	HW status	SW status
SW 1	-	WiMOD LoRaWAN EndNode Studio	Approval Test	-	-	-

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

2.11 EUT set-ups

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

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

Remark: the devices in the parentheses are only used before the test for setting up the EUT.

2.12 EUT operation modes

EUT operating mode no.*)	Operating modes	Additional information
Op. 1	DTS-Mode	With help of special test software TX-DTS-mode is set-up. We refer to applicants information/papers for details about necessary commands.
Op. 2	FHSS-Mode (hopping on)	With help of special test software TX-FHSS-mode is set-up. The frequency hopping is activated. We refer to applicants information/papers for details about necessary commands.
Op. 3	FHSS-Mode (hopping off)	With help of special test software TX-FHSS-mode is set-up. The frequency hopping is deactivated. We refer to applicants information/papers for details about necessary commands.

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

3 Equipment under test (EUT)

3.1 General Data of Main EUT as Declared by Applicant

Product name	LoRa radio module		
Kind of product	iM980B		
Firmware	☐ for normal use	☒ Special version for test execution	
Power supply	☐ AC Mains	Wählen Sie ein Element aus.	
	☒ DC Mains	**4.5** V DC via **battery slot** Connector	
	☒ Battery	(4.5 V DC)	
Operational conditions	T_{nom} =+21 °C	T_{min} =- °C	T_{max} =- °C
EUT sample type	**Pre-Production**		
Weight	50 g		
Size [LxWxH]	25 x 20 x 3.3 mm		
Interfaces/Ports	USB		
For further details refer Applicants Declaration & following technical documents **21-1-00399_MSOI_IMST.pdf** **FCC Test Setup HowTo for iM980B_V0.1.pdf**			

3.2 Detailed Technical data of Main EUT as Declared by Applicant

Frequency Band (DTS mode)	902 MHz -928 MHz (16 channels) Channel low: 903 MHz Channel middle: 914.2 MHz Channel high: 927.1 MHz
Frequency Band (FHSS mode)	902 MHz -928 MHz (128 channels) Channel low: 902.3 MHz Channel middle: 914.9 MHz Channel high: 927.8 MHz
Max. Conducted Output Power	DTS-mode: **18.27** dBm (max. peak) FHSS-mode: **-4.52** dBm (AVGSA-1)
Antenna Type	Printed PCB antenna
Antenna Gain	(not reported)
FCC label attached	No
Test firmware / software and storage location	Test laptop AE1
For further details refer Applicants Declaration & following technical documents	

Description of Reference Document (supplied by applicant)	Version	Total Pages
See section 3.2	-	-

3.3 Worst case identification

Mode	Data rate / spreading factor
DTS mode	SF = 8
FHSS mode	SF = 10

3.4 Modifications on Test sample

Additions/deviations or exclusions	

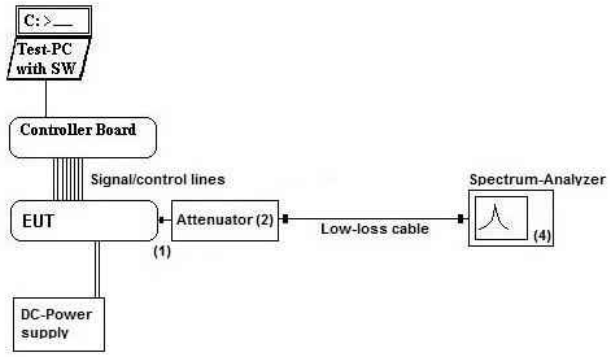
4 Measurements

4.1 Occupied Channel Bandwidth 99% (DTS mode)

4.1.1 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)

4.1.2 Measurement Location

Test site	120910 - Radio Laboratory 1 (TS 8997)

4.1.3 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.

4.1.4 Result

Diagram No.	Setup / Mode	Channel	Frequency [MHz]	99% Occupied bandwidth [kHz]
1	Set.2 / Op.1	low	903.0	676.923
2	Set.2 / Op.1	Middle	914.2	675.000
3	Set.2 / Op.1	high	927.1	673.077

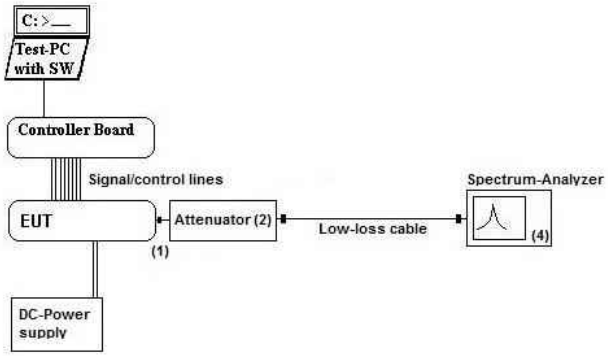
Remark 1: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0039901T01a_A1_C2**
Remark 2: The spreading factor is set to 8.

4.2 Minimum Emission Bandwidth 6 dB (DTS mode)

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.

Schematic:



Testing method:

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

4.2.2 Measurement Location

Test site	120910 - Radio Laboratory 1 (TS 8997)

4.2.3 Limit

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

4.2.4 Result

Diagram No.	Setup / Mode	Channel	Frequency [MHz]	6 dB bandwidth [kHz]	Result
4	Set.2 / Op.1	low	903.0	850.000	PASSED
5	Set.2 / Op.1	Middle	914.2	843.750	PASSED
6	Set.2 / Op.1	high	927.1	834.615	PASSED

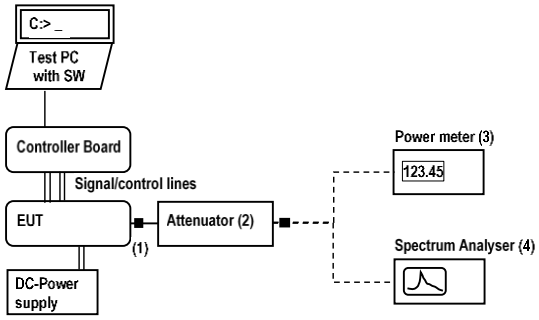
Remark 1: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0039901T01a_A1_C2**
Remark 2: The spreading factor is set to 8.

4.3 RF output power conducted (DTS mode)

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 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.

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)

Test method	Maximum peak conducted output power(RBW = DTS-bandwidth of the signal)
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

4.3.2 Measurement Location

Test site	120910 - Radio Laboratory 1 (TS 8997)

4.3.3 Limit

Frequency Range [MHz]	Limit [W]	Limit [dBm]	Detector	RBW / VBW [MHz]
902-928	1	30	PK	1 / 3

4.3.4 Result

Diagram No.	Setup / Mode	Channel	Frequency [MHz]	Max Peak Power [dBm]	Result
7	Set.2 / Op.1	low	903.0	18.18	PASSED
8	Set.2 / Op.1	Middle	914.2	18.12	PASSED
9	Set.2 / Op.1	high	927.1	18.27	PASSED

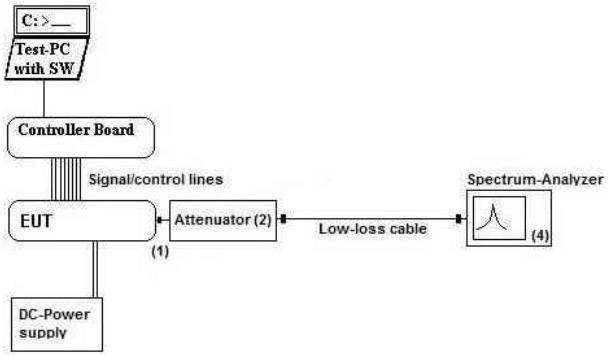
Remark: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0039901T01a_A1_C2**

4.4 Power spectral density (DTS mode)

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)

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.

4.4.2 Measurement Location

Test site	120910 - Radio Laboratory 1 (TS 8997)

4.4.3 Limit

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

4.4.4 Result

Diagram No.	Setup / Mode	Channel	Frequency [MHz]	PSD [dBm]	Result
10	Set.2 / Op.1	low	903.0	7.71	PASSED
11	Set.2 / Op.1	Middle	914.2	7.93	PASSED
12	Set.2 / Op.1	high	927.1	7.97	PASSED

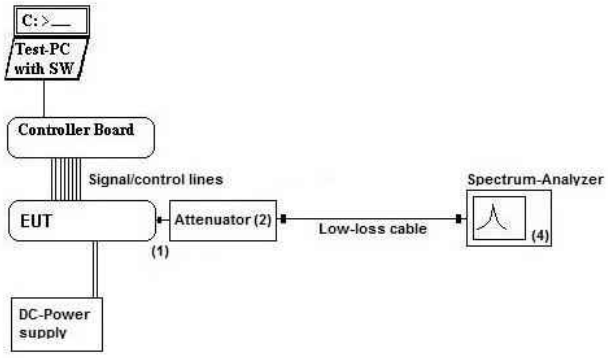
Remark: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0039901T01a_A1_C2**

4.5 Emissions in non-restricted frequency bands (DTS mode)

4.5.1 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 9.5 GHz in many 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.

4.5.2 Measurement Location

Test site	120910 - Radio Laboratory 1 (TS 8997)

4.5.3 Limit

Frequency Range [MHz]	Limit [dBc]
0.15 – 9500	**-20 / -30**

4.5.4 Result

Spurious domain: Maximum Level Peak [dBc]

Diagram No.	Setup / Mode	Channel	Frequency [MHz]	Result
15-22	Set.2 / Op.1	low	903.0	PASSED
23-30	Set.2 / Op.1	Middle	914.2	PASSED
31-38	Set.2 / Op.1	high	927.1	PASSED

Remark: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0039901T01a_A1_C2**

At the band edge: Maximum Level Peak [dBc]

Diagram No.	Setup / Mode	Channel	Frequency [MHz]	Result
13	Set.2 / Op. 1	low	903.0	PASSED
14	Set.2 / Op. 1	high	927.1	PASSED

Remark: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0039901T01a_A1_C2**

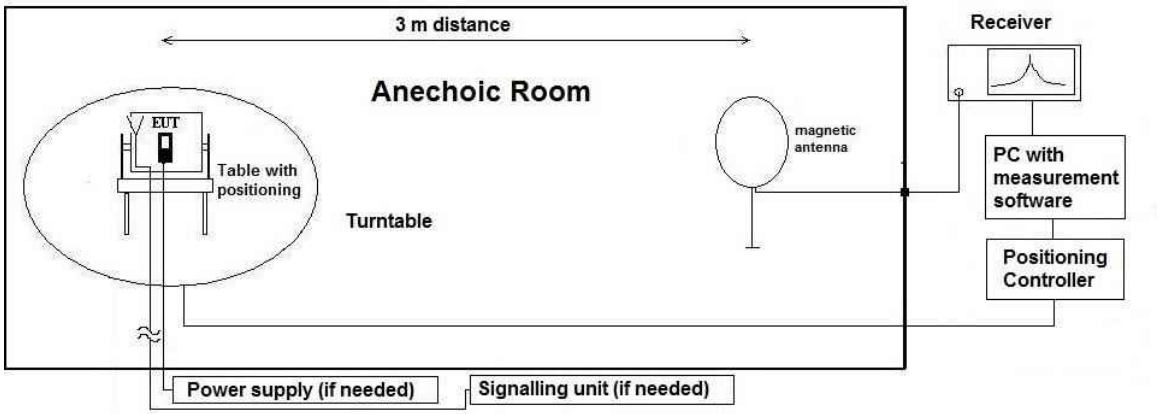
4.6 Radiated field strength emissions below 30 MHz (DTS mode)

4.6.1 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.

4.6.2 Measurement Location

Test site	120901 - SAC - Radiated Emission <1GHz

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

The used correction factors when the measurement distance is reduced compared to regulatory measurement distance, are calculated according Extrapolation formulas valid for EUT's with maximum dimension of 0.625xLambda. Formula 2+3+4 as presented in ANSI C63.10, Chapter 6.4.4 are used for the calculations of proper extrapolation factors

Frequency Range	f [kHz/MHz]	Lambda [m]	Far-Field Point [m]	Distance Limit accord. 15.209 [m]	1st Condition (dmeas < Dnear-field)	2nd Condition (Limit distance bigger dnear-field)	Distance Correction accord. Formula
kHz	9	33333.33	5305.17	300	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

4.6.4 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

4.6.5 Result

Diagram	Channel	Setup / Mode	Maximum Level [dBµV/m] Frequency Range 0.009 – 30 MHz	Result
2.04	Low	Set.1 / Op.1	20 (noise level)	PASSED
2.05	Middle	Set.1 / Op.1	20 (noise level)	PASSED
2.06	High	Set.1 / Op.1	20 (noise level)	PASSED

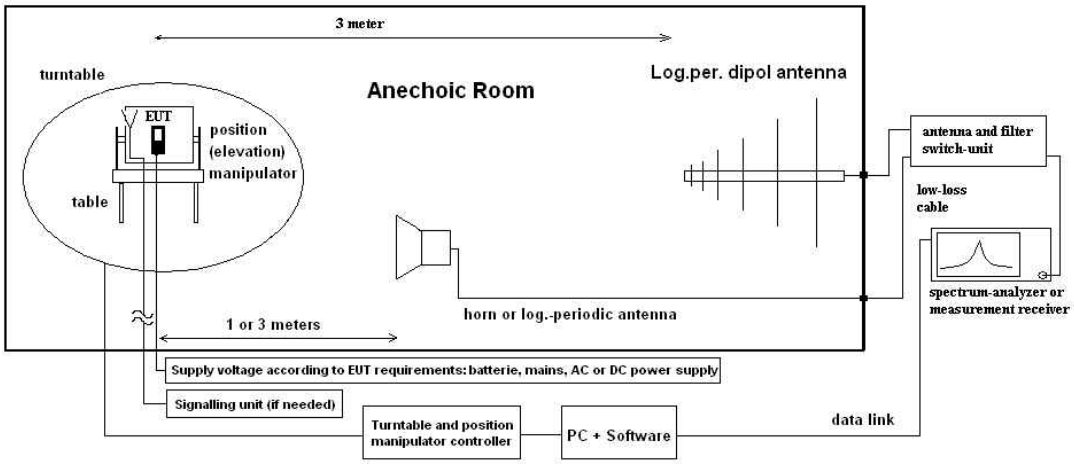
Remark 1: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0039901T01a_A1_C2**
Remark 2: the worst case EUT position is the lying position, which is determined in section 4.18, see diagrams in annex 1, diagram 3.01 and 3.02.

4.7 Radiated field strength emissions 30 MHz – 1 GHz (DTS mode)

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

Evaluating the emissions have to be done first by an exploratory emissions measurement and a final measurement for most critical frequencies. The tests are performed in a CISPR 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.

4.7.2 Measurement Location

Test site	120901 - SAC - Radiated Emission <1GHz

4.7.3 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

4.7.4 Result

Fundamental emission

Diagram	Channel	Setup / Mode	Maximum Level [dBµV/m] Frequency Range 902 – 928 MHz	Result
3.05	Low	Set.1 / Op.1	115.87	Remark 2)
3.06	Middle	Set.1 / Op.1	114.24	Remark 2)
3.07	High	Set.1 / Op.1	113.84	Remark 2)

Remark 1: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0039901T01a_A1_C2**
Remark 2: for information only.

Emissions in the spurious domain

Diagram	Channel	Mode	Maximum Level [dBµV/m] Frequency Range 30 – 1000 MHz	Result
3.13	Low	Set.1 / Op.1	41.26 (noise level)	PASSED
3.14	Middle	Set.1 / Op.1	40.67 (noise level)	PASSED
3.15	High	Set.1 / Op.1	40.55 (noise level)	PASSED

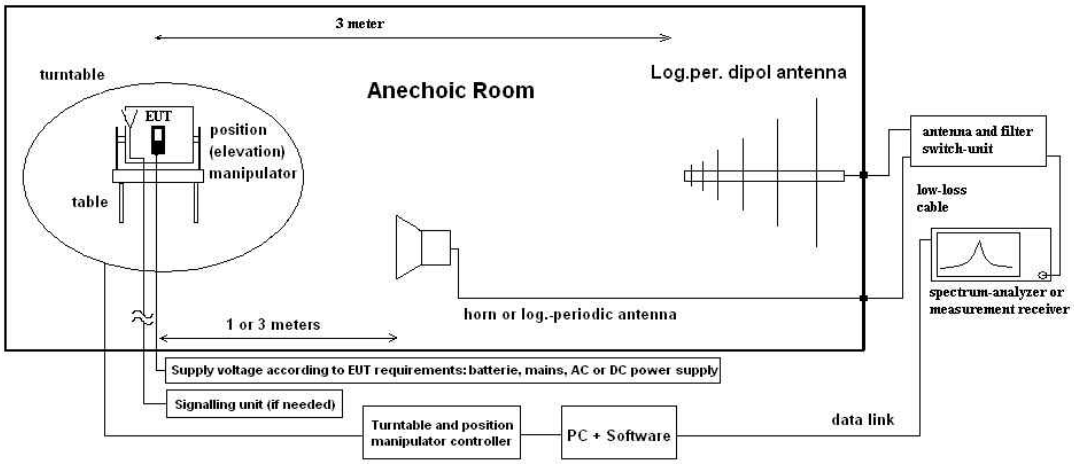
Remark: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0039901T01a_A1_C2**

4.8 Radiated field strength emissions above 1 GHz (DTS mode)

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

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

4.8.2 Measurement Location

Test site 1 – 9.5 GHz	120904 - FAC1 - Radiated Emissions

4.8.3 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

4.8.4 Result

Diagram	Channel	Setup / Mode	Maximum Level [dBµV/m] Frequency Range 1 – 9.5 GHz	Result
8.04a	Low	Set.1 / Op.1	60.67 (PK noise level)	PASSED
8.04b	Low	Set.1 / Op.1	57.38 (PK noise level)	PASSED
8.06	Middle	Set.1 / Op.1	61.54 (PK noise level)	PASSED
8.05	High	Set.1 / Op.1	61.29 (PK noise level)	PASSED

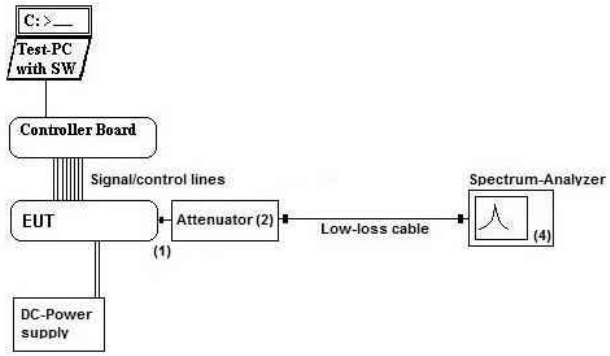
Remark: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0039901T01a_A1_C2**

4.9 Occupied Channel Bandwidth 99% (FHSS mode)

4.9.1 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)

4.9.2 Measurement Location

Test site	120910 - Radio Laboratory 1 (TS 8997)

4.9.3 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.

4.9.4 Result

Diagram No.	Setup / Mode	Channel	Frequency [MHz]	99% Occupied bandwidth [kHz]
39	Set.2 / Op.3	low	902.3	125.801
40	Set.2 / Op.3	Middle	914.9	125.801
41	Set.2 / Op.3	high	927.8	125.401

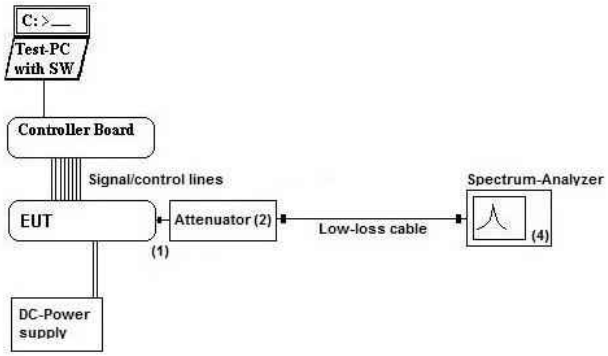
Remark 1: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0039901T01a_A1_C2**
Remark 2: The spreading factor is set to 10.

4.10 Maximum Emission Bandwidth 20 dB (FHSS mode)

4.10.1 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)

4.10.2 Measurement Location

Test site	120910 - Radio Laboratory 1 (TS 8997)

4.10.3 Limit

Limit [kHz]	Detector [MaxHold]	RBW / VBW [kHz]
<= 500	**MaxPeak**	**3 / 10**

4.10.4 Result

Diagram No.	Setup / Mode	Channel	Frequency [MHz]	20 dB bandwidth [kHz]	Result
42	Set.2 / Op.3	low	902.3	139.744	PASSED
43	Set.2 / Op.3	Middle	914.9	138.904	PASSED
44	Set.2 / Op.3	high	927.8	139.615	PASSED

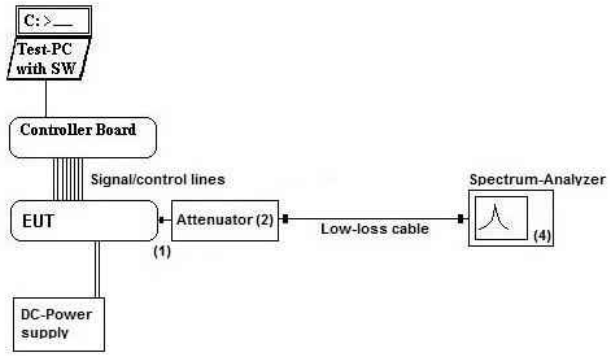
Remark 1: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0039901T01a_A1_C2**
Remark 2: The spreading factor is set to 10.

4.11 Minimum channel separation (FHSS mode)

4.11.1 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)

4.11.2 Measurement Location

Test site	120910 - Radio Laboratory 1 (TS 8997)

4.11.3 Limit

Limit [kHz]	Detector [MaxHold]	RBW / VBW [kHz]
>= 20 dB bandwidth	MaxPeak	30 / 100

4.11.4 Result

Diagram No.	Setup / Mode	Channel	Channel separation [kHz]	Limit: 20 dB bandwidth [kHz]	Result
45	Set.2 / Op.2	Hopping on	205.961	139.744	PASSED

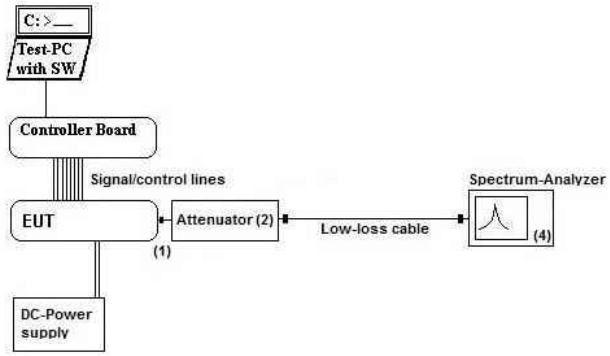
Remark 1: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0039901T01a_A1_C2**

4.12 Number of hopping frequencies (FHSS mode)

4.12.1 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)

4.12.2 Measurement Location

Test site	120910 - Radio Laboratory 1 (TS 8997)

4.12.3 Limit

Limit	Detector [MaxHold]	RBW / VBW [kHz]
If the 20 dB BW is less than 250 kHz, the hopping frequencies should be at least 50.	**MaxPeak**	**30 / 100**

4.12.4 Result

Diagram No.	Setup / Mode	Channel	Frequency range [MHz]	Number of hopping frequencies	Result
46	Set.2 / Op.2	Hopping on	902-905	14	-
47	Set.2 / Op.2	Hopping on	905-910	25	-
48	Set.2 / Op.2	Hopping on	910-915	25	-
49	Set.2 / Op.2	Hopping on	915-920	25	-
50	Set.2 / Op.2	Hopping on	920-925	25	-
51	Set.2 / Op.2	Hopping on	925-928	14	-
In total			902-928	128	PASSED

Remark 1: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0039901T01a_A1_C2**

4.13 Time of occupancy (FHSS mode)

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 time of occupancy of a frequency is measured at random frequency within the hopping frequency range. This test is done under nominal condition.

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

4.13.1 Measurement Location

Test site	120910 - Radio Laboratory 1 (TS 8997)

4.13.2 Result

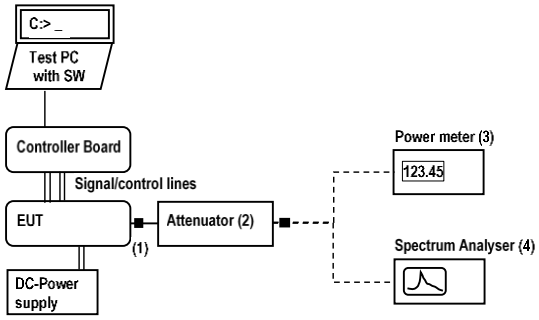
Diagram No.	Pulse width (single pulse)	Limit	Result
52	369.5 ms	400 ms	PASSED
Diagram No.	**Cycle time at a frequency**	**Limit**	**Result**
53	> 25 s	Min. 20 s	PASSED

4.14 RF output power conducted (FHSS mode)

4.14.1 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.

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)

Test method	AVGSA-1 / AVGSA-1 alternative (duty-cycle > 98%)
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

4.14.2 Measurement Location

Test site	120910 - Radio Laboratory 1 (TS 8997)

4.14.3 Limit

Frequency Range [MHz]	Limit [W]	Limit [dBm]	Detector	RBW / VBW [kHz]
902-928	1	30	RMS	3 / 30

4.14.4 Result

Diagram No.	Setup / Mode	Channel	Frequency [MHz]	Max Peak Power [dBm]	Result
54	Set.2 / Op.3	low	902.3	-23.42	PASSED
55	Set.2 / Op.3	Middle	914.9	-4.52	PASSED
56	Set.2 / Op.3	high	927.8	-25.37	PASSED

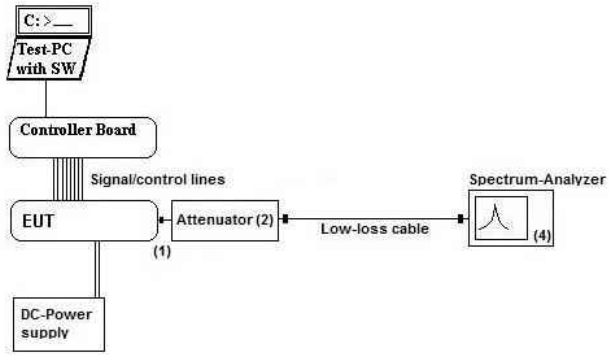
Remark: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0039901T01a_A1_C2**

4.15 Power spectral density (FHSS mode)

4.15.1 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)

Test method	AVGPSD 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.

4.15.2 Measurement Location

Test site	120910 - Radio Laboratory 1 (TS 8997)

4.15.3 Limit

Limit [dBm] @ 3 kHz	Detector [MaxHold]	RBW / VBW [kHz]
<= 8	**RMS**	**3 / 30**

4.15.4 Result

Diagram No.	Setup / Mode	Channel	Frequency [MHz]	PSD [dBm]	Result
57	Set.2 / Op.3	low	902.3	-34.28	PASSED
58	Set.2 / Op.3	Middle	914.9	-35.92	PASSED
59	Set.2 / Op.3	high	927.8	-34.77	PASSED

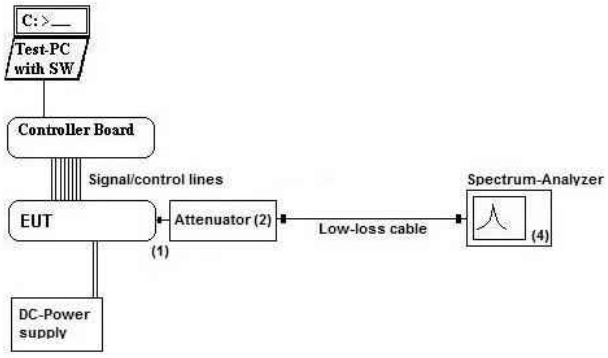
Remark: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0039901T01a_A1_C2**

4.16 Emissions in non-restricted frequency bands (FHSS mode)

4.16.1 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 9.5 GHz in many 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.

4.16.2 Measurement Location

Test site	120910 - Radio Laboratory 1 (TS 8997)

4.16.3 Limit

Frequency Range [MHz]	Limit [dBc]
0.15 – 9500	**-20 / -30**

4.16.4 Result

Spurious domain: Maximum Level Peak [dBc]

Diagram No.	Setup / Mode	Channel	Frequency [MHz]	Result
64-71	Set.2 / Op.3	low	902.3	PASSED
72-79	Set.2 / Op.3	Middle	914.9	PASSED
80-87	Set.2 / Op.3	high	927.8	PASSED

Remark: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0039901T01a_A1_C2**

At the band edge: Maximum Level Peak [dBc]

Diagram No.	Setup / Mode	Fixed channel / frequency hopping	Band edge level to peak level [dBc]	Limit [dBc]	Result
60	Set.2 / Op. 2	Hopping on	-48	-20	PASSED
61	Set.2 / Op. 3	Low (hopping off)	-47	-20	PASSED
62	Set.2 / Op. 2	Hopping on	-20.84	-20	PASSED
63	Set.2 / Op. 3	High (hopping off)	-20.36	-20	PASSED

Remark: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0039901T01a_A1_C2**

4.17 Radiated field strength emissions below 30 MHz (FHSS mode)

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

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

4.17.2 Measurement Location

Test site	120901 - SAC - Radiated Emission <1GHz

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

See section 4.6.3 Correction factors due to reduced meas. distance (f < 30 MHz):.

4.17.4 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

4.17.5 Result

Diagram	Channel	Setup / Mode	Maximum Level [dBµV/m] Frequency Range 0.009 – 30 MHz	Result
2.01	Low	Set.1 / Op.3	20 (noise level)	PASSED
2.02	Middle	Set.1 / Op.3	20 (noise level)	PASSED
2.03	High	Set.1 / Op.3	20 (noise level)	PASSED

Remark 1: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0039901T01a_A1_C2**
Remark 2: the worst case EUT position is the lying position, which is determined in section 4.18, see diagrams in annex 1, diagram 3.01 and 3.02.

4.18 Radiated field strength emissions 30 MHz – 1 GHz (FHSS mode)

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

See section 4.7.1Description of the general test setup and methodology, see below example:.

4.18.2 Measurement Location

Test site	120901 - SAC - Radiated Emission <1GHz

4.18.3 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

4.18.4 Result

Fundamental emission

Diagram	Channel	Setup / Mode	Maximum Level [dBµV/m] Frequency Range 902 – 928 MHz	Result
3.01	Low	Set.1 / Op.3 (EUT stands)	113.53	Remark 2)
3.02	Low	Set.1 / Op.3 (EUT lies)	115.73	Remark 2)
3.03	Middle	Set.1 / Op.3	114.29	Remark 2)
3.04	High	Set.1 / Op.3	113.79	Remark 2)

Remark 1: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0039901T01a_A1_C2**
Remark 2: for information only.

Emissions in the spurious domain

Diagram	Channel	Mode	Maximum Level [dBµV/m] Frequency Range 30 – 1000 MHz	Result
3.10	Low	Set.1 / Op.3	40.85 (noise level)	PASSED
3.11	Middle	Set.1 / Op.3	41.11 (noise level)	PASSED
3.12	High	Set.1 / Op.3	41.14 (noise level)	PASSED

Remark: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0039901T01a_A1_C2**

4.19 Radiated field strength emissions above 1 GHz (FHSS mode)

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

See section 4.8.1Description of the general test setup and methodology, see below example:

4.19.2 Measurement Location

Test site 1 – 9.5 GHz	120904 - FAC1 - Radiated Emissions

4.19.3 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

4.19.4 Result

Diagram	Channel	Setup / Mode	Maximum Level [dBµV/m] Frequency Range 1 – 9.5 GHz	Result
8.01	Low	Set.1 / Op.3	62.11 (PK noise level)	PASSED
8.03a	Middle	Set.1 / Op.3	61.23 (PK noise level)	PASSED
8.03b	Middle	Set.1 / Op.3	57.88 (PK noise level)	PASSED
8.02	High	Set.1 / Op.3	60.72 (PK noise level)	PASSED

Remark: for more information and graphical plot see annex A1 **CETECOM_TR21-1-0039901T01a_A1_C2**

4.20 Results from external laboratory

None	-

4.21 Opinions and interpretations

None	-

4.22 List of abbreviations

None	-

5 Equipment lists

ID	Description	Manufacturer	SerNo	Cal due date
	120901 - SAC - Radiated Emission <1GHz			**2025-Jul-21**
20574	Biconilog Hybrid Antenna BTA-L	Frankonia GmbH	980026L	2022-May-03
20487	CETECOM Semi Anechoic Chamber < 1GHz	ETS-Lindgren Gmbh	-	2025-Jul-15
20620	EMI Test Receiver ESU26	Rohde & Schwarz Messgerätebau GmbH	100362	2022-May-21
20482	filter matrix Filter matrix SAR 1	CETECOM GmbH	-	
25038	Loop Antenna HFH2-Z2	Rohde & Schwarz Messgerätebau GmbH	879824/13	2022-Apr-07
20885	Power Supply EA3632A	Agilent Technologies Deutschland GmbH	75305850	
	120904 - FAC1 - Radiated Emissions			
20341	Digital Multimeter Fluke 112	Fluke Deutschland GmbH	81650455	2022-May-25
20489	EMI Test Receiver ESU40	Rohde & Schwarz Messgerätebau GmbH	100030	2022-May-19
20254	High Pass Filter 5HC 2600/12750-1.5KK	Trilithic	23042	
20868	High Pass Filter AFH-07000	AtlanTecRF	16071300004	
20291	High Pass Filter WHJ 2200-4EE	Wainwright Instruments GmbH	14	
20020	Horn Antenna 3115 (Subst 1)	EMCO Elektronik GmbH	9107-3699	2024-Aug-17
20302	Horn Antenna BBHA9170 (Meas 1)	Schwarzbeck Mess-Elektronik OHG	155	
20549	Log. Per. Antenna HL025	Rohde & Schwarz Messgerätebau GmbH	1000060	2024-Aug-18
20720	Measurement Software EMC32 [FAC]	Rohde & Schwarz Messgerätebau GmbH	V10.xx	
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	
20690	Spectrum Analyzer FSU	Rohde & Schwarz Messgerätebau GmbH	100302/026	2023-May-20
20439	Ultrabroadband-Antenna HL562	Rohde & Schwarz Messgerätebau GmbH	100248	2023-Mar-10
	120911 - Radio Laboratory 2			
20869	Climatic Chamber VT4002	Vötsch Industrietechnik GmbH, a schunk company	521/79152	

ID	Description	Manufacturer	SerNo	Cal due date
20457	DC-Power supply, 0-5A EA-3013 S	EA Elektro-Automatik GmbH & Co. KG	9624680	
20468	Digital Multimeter Fluke 112	Fluke Deutschland GmbH	90090455	2024-Jun-01
20431	Model 7405 Near-Field Probe Set	EMCO Elektronik GmbH	9305-2457	

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 GHz - 26.5 GHz	N/A	0.82	--	N/A	N/A	--	
Conducted emissions on RF-port	-	9 kHz - 2.8 GHz	0.70	N/A	0.70	N/A	0.69	--	N/A - not applicable
		2.8 GHz - 12.75 GHz	1.48	N/A	1.51	N/A	1.43	--	
		12.75 GHz – 18 GHz	1.81	N/A	1.83	N/A	1.77	--	
		18 GHz - 26.5 GHz	1.83	N/A	1.85	N/A	1.79	--	
Occupied bandwidth	-	9 kHz - 4 GHz	0.1272 ppm (Delta Marker)						Frequency error
			1.0 dB						Power
Emission bandwidth	-	9 kHz - 4 GHz	0.1272 ppm (Delta Marker)						Frequency error
	-		See above: 0.70 dB						Power
Frequency stability	-	9 kHz - 20 GHz	0.0636 ppm						-
Radiated emissions Enclosure	-	150 kHz - 30 MHz	5.01dB						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	2021-Oct-06
C1	Correction of the typing error in the cover page	2021-Oct-12
C2	FCC ID and ISED number corrected	2021-Nov-11

End of Test Report