PARTIAL Test Report
19-1-0137402T02a

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

Number of pages:	23	**Date of Report:**	2020-Dec-16
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:**	Bosch Healthcare Solutions GmbH
Test Object / Tested Device(s):	**System for quantitative measurement of fractional nitric oxide (FeNO) in human breath, Vivatmo pro (Base Station) Vivatmo pro (Handheld)**		
FCC ID of Base Station	2AVQ9VMPBS1	**IC ID of Base Station**	25928-VMPBS1
FCC ID of Handheld	2AVQ9VMPHH1	**IC ID of Handheld**	25928-VMPHH1
Testing has been carried out in accordance with:	**FCC 47 CFR Part 15.247 RSS-247: Issue 2 2017-02** Deviations, modifications or clarifications (if any) to above mentioned documents are written in each section under "Test method and limit".		
Tested Technologies:	2.4GHz W-LAN (IEEE 802.11) + Bluetooth, Bluetooth LE , Wireless Charging		
Test Results:	**☒ The EUT complies with the requirements in respect of selected parameters subject to the test.** The test results relate only to devices specified in this document		

Signatures:

Digital signiert von: patrick.marzotko@cetecom.com
Name: CN = patrick.marzotko@cetecom.com
Datum: 2020.12.16 14:06:20 +01'00'

Dipl.-Ing. Niels Jeß	M. Sc. Patrick Marzotko
Head of Compliance Testing	Test manager
Authorization of test report	Responsible of test report

Table of Contents

Table of Annex			
Annex No.	**Contents**	**Reference Description**	**Total Pages**
Annex 1	Test result diagrams	**CETECOM_TR19_1_0137402T02a_A1**	16
Annex 2	Internal photographs of EUT	**Please refer to external document provided by customer**	--
Annex 3	External photographs of EUT	**CETECOM_TR19_1_0137402T02a_A3**	6
Annex 4	Test set-up photographs	**CETECOM_TR19_1_0137401T05a_A4**	8
The listed attachments are separate documents.			

1 General information

1.1 Disclaimer and Notes

The test results of this test report relate exclusively to the test item specified in this test report as specified in chapter 2.7. CETECOM does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item.
The test report may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of CETECOM.
The testing service provided by CETECOM has been rendered under the current "General Terms and Conditions for CETECOM".
CETECOM will not be liable for any loss or damage resulting from false, inaccurate, inappropriate or incomplete product information provided by the customer.
Under no circumstances does the CETECOM test report include any endorsement or warranty regarding the functionality, quality or performance of any other product or service provided.
Under no circumstances does the CETECOM test report include or imply any product or service warranties from CETECOM, including, without limitation, any implied warranties of merchantability, fitness for purpose, or non-infringement, all of which are expressly disclaimed by CETECOM.
All rights and remedies regarding vendor’s products and services for which CETECOM has prepared this test report shall be provided by the party offering such products or services and not by CETECOM.
In no case this test report can be considered as a Letter of Approval.

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

The test report must always be reproduced in full; reproduction of an excerpt only is subject to written approval of the testing laboratory. The documentation of the testing performed on the tested devices is archived for 10 years at CETECOM.

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, BT & BT-LE transmitter and wireless charging. Other implemented wireless technologies were not considered within this test report.

Test case	Reference Clause FCC ☒	Reference Clause ISED ☒	Page	Remark	Result
Radiated field strength emissions below 30 MHz	§15.205(a) §15.209(a)	RSS-Gen: Issue 5 §8.9 Table 6	11	--	PASS
Radiated field strength emissions 30 MHz – 1 GHz	§15.209 §15.247(d)	RSS-Gen: Issue 5 §8.9 Table 5 RSS-247, § 5.5	15	--	PASS
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	17	--	PASS
AC-Power Lines Conducted Emissions	§15.207	RSS-Gen Issue 5: §8.8, Table 4	19	--	PASS

PASS	The EUT complies with the essential requirements in the standard.
FAIL	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.:	19-1-013740R02
Responsible test manager:	B. Sc. M. Ahmed
Receipt of EUT:	2019-Nov-06
Date(s) of test:	2020-Aug-20 – 2020-Sep-30
Version of template:	14.3

2.5 Applicant's details

Applicant's name:	Bosch Healthcare Solutions GmbH
Address:	Stuttgarter Str. 130 71332 Waiblingen Baden-Württemberg Germany
Contact Person:	Markus.Thürsam
Contact Person's Email:	Markus.Thuersam@de.bosch.com

2.6 Manufacturer's details

Manufacturer's name:	Bosch Healthcare Solutions GmbH
Address:	Stuttgarter Str. 130 71332 Waiblingen 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 1	19-1-01374S23_C01	Vivatmo pro (Base Station)	System for quantitative measurement of fractional nitric oxide (FeNO) in human breath	b827eb336d24	F09G100168	1.4.0

*) 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	19-1-01374S24_C01	Power Supply Vivatmo pro	UE36LCP-240150SPA	--	--	--
AE 2	--	CAT6, 1 m	Ethernet Cable	--	--	--
AE 3	--	Laptop	DELL Latitude E6430	CTC522013	--	Windows 7
AE 4	--	USB Stick	USB Data Stick	--	--	--
AE 5	--	USB Stick	USB Data Stick	--	--	--
AE 6	19-1-01374S21-C01	Vivatmo pro (Handheld)	System for quantitative measurement of fractional nitric oxide (FeNO) in human breath	44916009018D	F09F100078	--

*) 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 1	--	Ethernet Cable	--	1m

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

2.10 EUT set-ups

set-up no.*)	Combination of EUT and AE	Description
1	EUT 1 + AE1 + AE 2 + (AE 3)** + AE 4 + AE 5 + AE 6	Used for Radiated measurements and AC Powerlines Measurements

*) EUT set-up no. is used to simplify the identification of the EUT set-up in this test report.
**) AE 3 was placed outside the Chamber after setting the Test mode

2.11 EUT operation modes

EUT operating mode no.*)	Operating modes	Additional information
op. 1	Bluetooth **) + Wireless Charging	With help of special test Software TX-mode for Bluetooth was set-up. GFSK | Channel 39 | 1Mbps Wireless Charging was used in normal mode with AE 6. We refer to applicants information/papers for details about necessary commands.
op. 2	Wifi + Wireless Charging	With help of special test Software TX-mode for Wifi was set-up. b-mode | Channel 11 | 2Mbps Wireless Charging was used in normal mode with AE 6. We refer to applicants information/papers for details about necessary commands.

*) EUT operating mode no. is used to simplify the test report.
**) Bluetooth was worst case in comparison with Bluetooth LE.

2.12 Test Software

For setting the right test mode a terminal tool **putty v0.74** saved on Laptop DELL Latitude E6430 CTC522013 was used to enter the following commands:

HCI code single channel, Non-Hopping mode (PRBS9, GFSK, Max Output power)
This mode is the highest power output of the system, allows us to use the all hopping GFSK mode for power measurements.

hcitool cmd 3f 14 00 02 01 00 09 00 00 #"Set_Tx_Carrier_Frequency_ARM") for 2402MHz
hcitool cmd 3f 14 00 29 01 00 09 00 00 #"Set_Tx_Carrier_Frequency_ARM") for 2441MHz
hcitool cmd 3f 14 00 50 01 00 09 00 00 #"Set_Tx_Carrier_Frequency_ARM") for 2480MHz

HCI code single channel, Non-Hopping mode (PRBS9, 8PSK, Max Output power)

hcitool cmd 3f 14 00 02 01 02 09 00 00 #"Set_Tx_Carrier_Frequency_ARM") for 2402MHz
hcitool cmd 3f 14 00 29 01 02 09 00 00 #"Set_Tx_Carrier_Frequency_ARM") for 2441MHz
hcitool cmd 3f 14 00 50 01 02 09 00 00 #"Set_Tx_Carrier_Frequency_ARM") for 2480MHz

3 Equipment under test (EUT)

3.1 General Data of Main EUT as Declared by Applicant

Product name	Vivatmo pro (Base Station), Vivatmo pro (Handheld)	
Kind of product	System for quantitative measurement of fractional nitric oxide (FeNO) in human breath	
Firmware	☐ for normal use	☒ Special version for test execution
	☒ AC Mains	single Line (L1/N) 110 V 60 Hz
	☐ DC Mains	
	☐ Battery	-
EUT sample type	**Production**	
Weight	1350 g	
Size	265 x 213 x 160 mm	
Interfaces/Ports	Ethernet, USB	
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

2.4GHz W-LAN (IEEE 802.11)			
Frequency Band	2.4 GHz ISM Band (2400 MHz - 2483.5 MHz)		
MIMO	no		
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 | 10 | 11	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		
Antenna Type(s)	Chip Antenna		
Antenna Gain(s)	1.5 dBi		

Bluetooth LE		
Frequency Band	2.4 GHz ISM Band (2400 MHz - 2483.5 MHz)	
Number of Channels (USA/Canada -bands)	40 (37 Hopping + 3 Advertising)	
Nominal Channel Bandwidth	1 MHz	
Type of Modulation | Data Rate	☒ GFSK | 1 Mbit / s	☐ GFSK | 2 Mbit / s
	☐ GFSK | 500 kbit / s	☐ GFSK | 125 kbit / s
Antenna Type(s)	Chip Antenna	
Antenna Gain(s)	1.5 dBi	
Bluetooth		
Frequency Band	2.4 GHz ISM Band (2400 MHz - 2483.5 MHz)	
Number of Channels (USA/Canada -bands)	79	
Nominal Channel Bandwidth	1 MHz	
Type of Modulation | Data Rate	☒ GFSK | 1 Mbit / s	☒ π/4 DQPSK | 2 Mbit / s
	☒ 8DPSK | 3 Mbit / s	
Antenna Type(s)	Chip Antenna	
Antenna Gain(s)	1.5 dBi	
Wireless Charging		
Operating frequency range and channels (US/Canada -bands)	175 kHz (TX mode / ping mode) 148 kHz (TXRX mode / charging mode) (ideal TXRX coupling) 110 kHz – 205 kHz (TXRX mode / charging mode) (frequency shift depending on the coupling state)	
Type of modulation (packet types)	2-ASK (Amplitude Shift Keying)	
Occupied bandwidth	Ping-Mode: 564.1 Hz	
	Charge-Mode: Not applicable, continuous wave signal (no modulation)	
Number of channels (USA/Canada -bands)	☐ 1 nominal channel at 175 kHz ☒ range: 110 kHz – 205 kHz	
Antenna Type	☒ Integrated ☐ External, no RF- connector ☐ External, separate RF-connector	
Antenna Gain	No information from applicant	
Special EMI components	--	
EUT sample type	☒ Production	☐ Pre-Production ☐ Engineering
Firmware	☐ for normal use	☒ Special version for test execution
FCC/ISED label attached	☐ yes	☒ no

3.3 Worst case identification

Selected Parameter for Wifi and Blueooth were derived from the Reference Test Reports of the Basestation.
One Channel between Bluetooth and Bluetooth classic (2441 MHz) was used for testing.
For Wifi the Worst case was b-mode | Channel 11 | 2Mbps. For Details please refer to these Test Reports:

Technology	Reference Test Report
Wifi	CETECOM_TR19_1_0137401T05a
Bluetooth LE	CETECOM_TR19_1_0137401T06a
Bluetooth	CETECOM_TR19_1_0137403T02a
Wireless Charging	CETECOM_TR19_1_0137401T08a

3.4 Modifications on Test sample

Additions/deviations or exclusions	--

4 Measurements

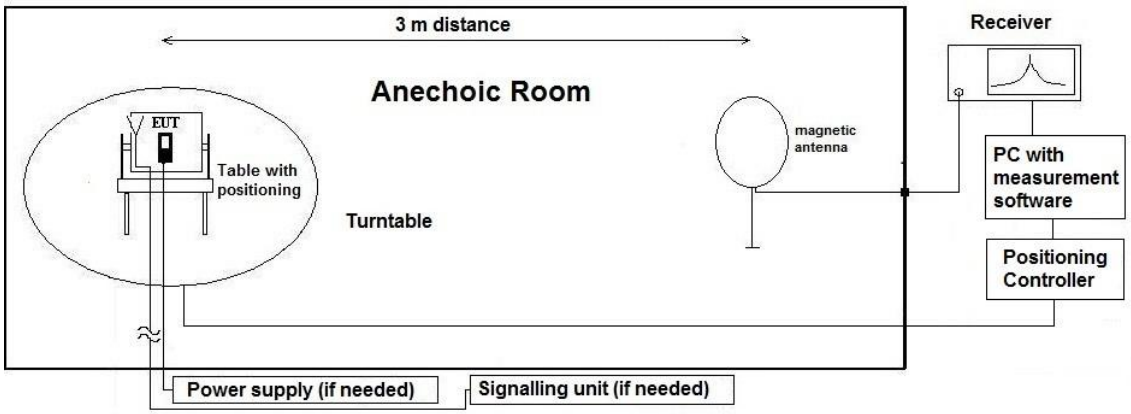
4.1 Radiated field strength emissions below 30 MHz

4.1.1 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.

4.1.2 Measurement Location

Test site	120901 – SAC1 – 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
kHz	9.00E+03	33333.33	5305.17	300		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
	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	30		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
MHz	1.00	300.00	47.75			fullfilled	not fullfilled	-40.00
	1.59	188.50	**30.00**			fullfilled	not fullfilled	-40.00
	2.00	150.00	23.87			fullfilled	fullfilled	-38.02
	3.00	100.00	15.92			fullfilled	fullfilled	-34.49
	4.00	75.00	11.94			fullfilled	fullfilled	-32.00
	5.00	60.00	9.55			fullfilled	fullfilled	-30.06
	6.00	50.00	7.96			fullfilled	fullfilled	-28.47
	7.00	42.86	6.82			fullfilled	fullfilled	-27.13
	8.00	37.50	5.97			fullfilled	fullfilled	-25.97
	9.00	33.33	5.31			fullfilled	fullfilled	-24.95
	10.00	30.00	4.77			fullfilled	fullfilled	-24.04
	10.60	28.30	4.50			fullfilled	fullfilled	-23.53
	11.00	27.27	4.34			fullfilled	fullfilled	-23.21
	12.00	25.00	3.98			fullfilled	fullfilled	-22.45
	13.56	22.12	3.52			fullfilled	fullfilled	-21.39
	15.00	20.00	3.18			fullfilled	fullfilled	-20.51
	15.92	18.85	**3.00**			fullfilled	fullfilled	-20.00
	17.00	17.65	2.81			not fullfilled	fullfilled	-20.00
	18.00	16.67	2.65			not fullfilled	fullfilled	-20.00
	20.00	15.00	2.39			not fullfilled	fullfilled	-20.00
	21.00	14.29	2.27			not fullfilled	fullfilled	-20.00
	23.00	13.04	2.08			not fullfilled	fullfilled	-20.00
	25.00	12.00	1.91			not fullfilled	fullfilled	-20.00
	27.00	11.11	1.77			not fullfilled	fullfilled	-20.00
	29.00	10.34	1.65			not fullfilled	fullfilled	-20.00
	30.00	10.00	1.59			not fullfilled	fullfilled	-20.00

4.1.3 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

4.1.4 Result

Diagram	Channel (MHz)	Mode	EUT Position	Maximum Level [dBµV/m] Frequency Range 0.009 – 30 MHz	Result
2.01a	2441	1	H	No peaks found	Pass
2.01b	2441	1	V	No peaks found	Pass
2.01a	2462	2	H	No peaks found	Pass
2.01b	2462	2	V	No peaks found	Pass

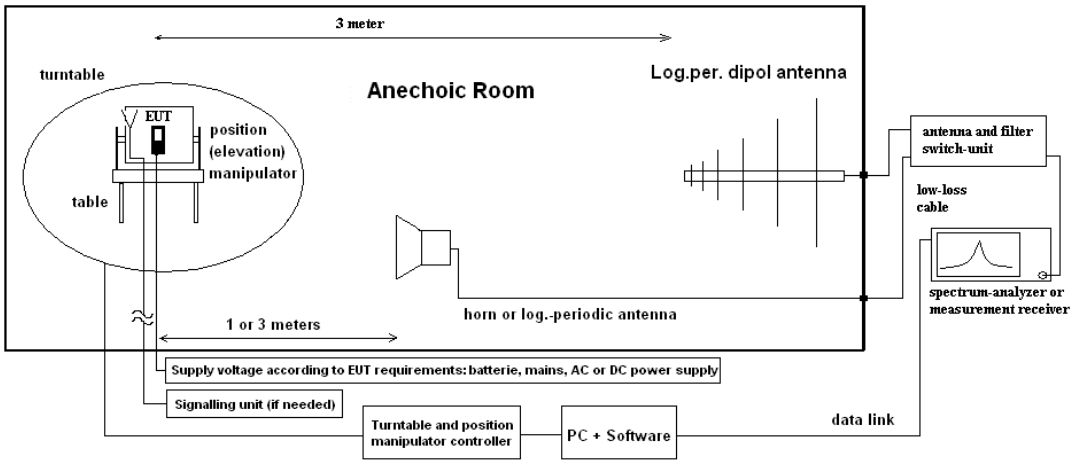
Remark: for more informations and graphical plot see annex A1 **CETECOM_TR19_1_0137402T02a_A1**

4.2 Radiated field strength emissions 30 MHz – 1 GHz

4.2.1 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.

4.2.2 Measurement Location

Test site	120901 – SAC1 – Radiated Emission < 1GHz

4.2.3 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

4.2.4 Result

Diagram	Channel (MHz)	Mode	EUT Position	Maximum Level [dBµV/m] Frequency Range 30 – 1000 MHz	Result
3.01a	2441	1	H	44.93	Pass
3.01b	2441	1	V	42.04	Pass
3.02a	2462	2	H	40.91	Pass
3.02b	2462	2	V	42.55	Pass

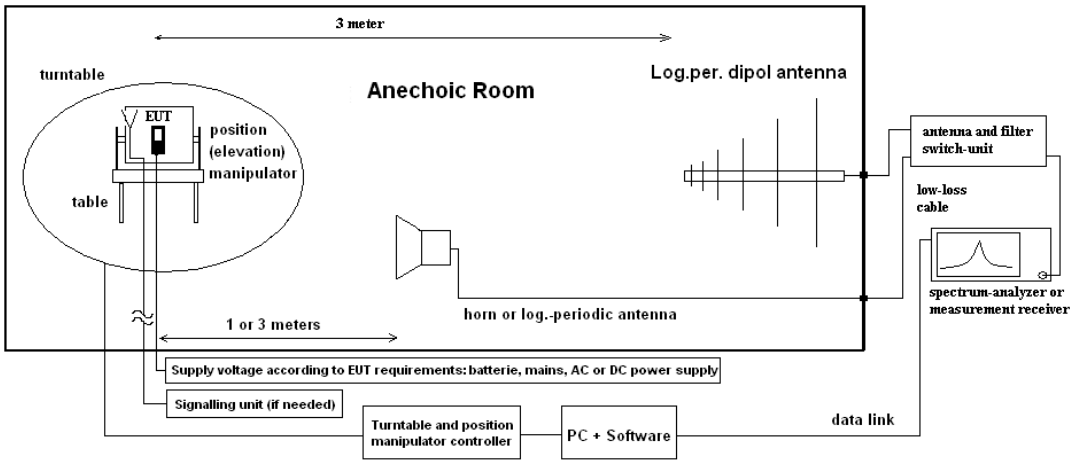
Remark: for more informations and graphical plot see annex A1 **CETECOM_TR19_1_0137402T02a_A1**

4.3 Radiated field strength emissions above 1 GHz

4.3.1 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.

4.3.2 Measurement Location

Test site	120904 - FAC1 - Radiated Emissions
Test site 18 – 26.5 GHz	120907 - FAC2

4.3.3 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

4.3.4 Result

Diagram	Channel	Mode	Maximum Level [dBµV/m] Frequency Range 1 – 18 GHz	Result
4.01a	39	1	51.33 (AV)	Pass
4.02a	11	2	40.05 (AV)	Pass

Remark: for more informations and graphical plot see annex A1 **CETECOM_TR19_1_0137402T02a_A1**

Diagram	Channel	Mode	Maximum Level [dBµV/m] Frequency Range 18 – 26.5 GHz	Result
4.01b	39	1	40.81 (AV)	Pass
4.02b	11	2	40.68 (AV)	Pass

Remark: for more informations and graphical plot see annex A1 **CETECOM_TR19_1_0137402T02a_A1**

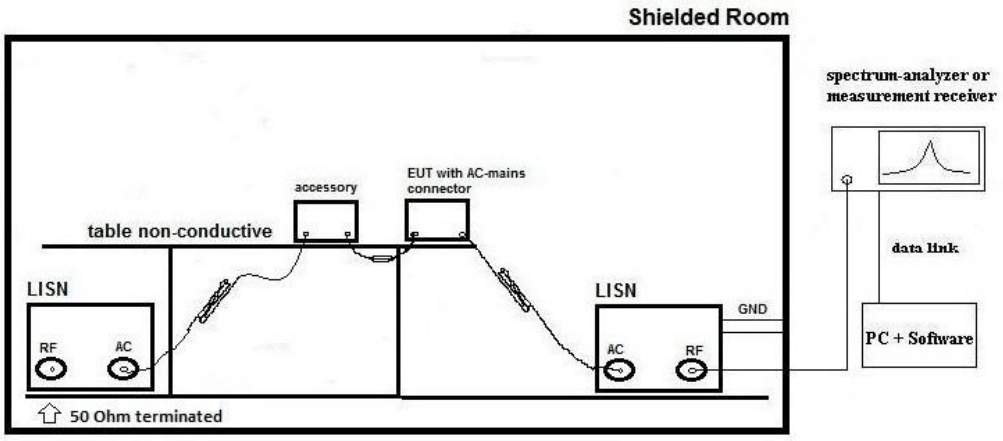
4.4 AC-Power Lines Conducted Emissions

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

The radio frequency voltage conducted back into the AC power line in the frequency range 150 kHz to 30 MHz has to be investigated.
Compliance should be tested by measuring the radio frequency voltage between each power line and ground at the power terminals in the stated frequency range.
A 50 Ohm / 50 µH line impedance stabilization network (LISN) is used coupling the interface to the measurement equipment.
The EUT power input leads are connected through the LISN to the AC-power source. The LISN enclosure is electrically connected to the ground plane. The measuring instrument is connected to the coaxial output of the LISN.

Tabletop devices were set-up on an 80 cm height above reference ground plane, floor standing equipment 10 cm raised above ground plane.
Measurements have been performed on each phase line and neutral line of the devices AC-power lines.
The EUT was power supplied with 120 V/60 Hz. The EUT was tested in the defined operating mode
and installed (connected) to accessory equipment according the general description of use given by the applicant.

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
As a first step, determines the worst-case phase line (neutral or phase) as well as the most critical operating mode of the equipment. A complete frequency-sweep with PK-Detector is performed on each current-carrying conductor.

Final measurement on critical frequencies
For power phases and critical frequencies (Margin to AV- or QP limit lower than 3 dB) as a second step includes measurements with receivers detector set to Quasi-Peak and Average.

Formula:

$V_C = V_R + C_L$ (1)
$M = L_T - V_C$ (2)

V_C = measured Voltage –corrected value
V_R = Receiver reading
C_L = Cable loss
M = Margin
L_T = Limit

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

4.4.2 Measurement Location

Test site	120919 – Conducted Emissions

4.4.3 Limit

Frequency Range [MHz]	QUASI-Peak [dBµV]	AVERAGE [dBµV]
0.15 – 0.5	66 to 56*	56 to 46*
0.5 – 5	56	46
5 – 30	60	50

4.4.4 Result

Diagram	Mode	Power Line	Max [dBµV]	Detector	Result
1.11	1	N/L1	42.36	QP	Pass
1.12	2	N/L1	46.72	QP	Pass

Remark: for more informations and graphical plot see annex A1 **CETECOM_TR19_1_0137402T02a_A1**

4.5 Results from external laboratory

None	-

4.6 Opinions and interpretations

None	-

4.7 List of abbreviations

None	-

5 Equipment lists

ID	Description	Manufacturer	SerNo	Cal due date
	120904 - FAC1 - Radiated Emissions			
20341	Digital Multimeter Fluke 112	Fluke Deutschland GmbH	81650455	2022-May-25
20720	EMC32 [FAC]	Rohde & Schwarz Messgerätebau GmbH	V10.xx	
20489	EMI Test Receiver ESU40	Rohde & Schwarz Messgerätebau GmbH	1000-30	2021-May-13
20254	High Pass Filter 5HC 2600/12750-1.5KK (GSM1800/1900/DECT)	Trilithic	23042	
20020	Horn Antenna 3115 (Subst 1)	EMCO Elektronik GmbH	9107-3699	2021-Jul-19
20302	Horn Antenna BBHA9170 (Meas 1)	Schwarzbeck Mess-Elektronik OHG	155	2023-Apr-15
20549	Log.Per-Antenna HL025	Rohde & Schwarz Messgerätebau GmbH	1000060	2021-Jul-31
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	
20439	UltraLog-Antenna HL 562	Rohde & Schwarz Messgerätebau GmbH	100248	2023-Mar-10
	120907 - FAC2			
20302	Horn Antenna BBHA9170 (Meas 1)	Schwarzbeck Mess-Elektronik OHG	155	2023-Apr-15
20732	Signal- and Spectrum Analyzer FSW67	Rohde & Schwarz Messgerätebau GmbH	104023	2021-May-27
	120919 - Conducted Emission			
20300	AC - LISN (50 Ohm/50µH, 1-phase) ESH3-Z5	Rohde & Schwarz Messgerätebau GmbH	892 239/020	2021-May-13
20005	AC - LISN 50 Ohm/50µH ESH2-Z5	Rohde & Schwarz Messgerätebau GmbH	861741/005	2021-May-13
20468	Digital Multimeter Fluke 112	Fluke Deutschland GmbH	90090455	2021-May-16
20377	EMI Test Receiver ESCS30	Rohde & Schwarz Messgerätebau GmbH	100160	2021-May-12
20536	Impedance Stabilization Network ISN ST08	Teseq GmbH	25867	2023-May-20
20533	Impedance Stabilization Network ISN T200A	Teseq GmbH	25706	2023-May-20
20534	Impedance Stabilization Network ISN T400A	Teseq GmbH	24881	2023-May-20
20541	Impedance Stabilization Network ISN T8-Cat6	Teseq GmbH	26373	2023-May-20
20535	Impedance Stabilization Network ISN T800	Teseq GmbH	26321	2023-May-20
20099	Passive Voltage Probe ESH2-Z3	Rohde & Schwarz Messgerätebau GmbH	299.7810.52	2021-May-16
20100	passive voltage probe TK 9416	Schwarzbeck Mess-Elektronik OHG	without	2021-May-16
20033	RF-current probe (100kHz-30MHz) ESH2-Z1	Rohde & Schwarz Messgerätebau GmbH	879581/18	2021-May-23
20373	Single-Line V-Network (50 Ohm/5µH) ESH3-Z6	Rohde & Schwarz Messgerätebau GmbH	100535	2021-May-13
20007	Single-Line V-Network (50 Ohm/5µH) ESH3-Z6	Rohde & Schwarz Messgerätebau GmbH	892563/002	2021-May-13
20556	Thermo-/Hygrometer WS-9400	Conrad Electronic GmbH	-	
20051	VHF-Current Probe 20-300 MHz ESV-Z1	Rohde & Schwarz Messgerätebau GmbH	872421	2021-May-16

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-Dec-16
--	--	--
--	--	--

End Of Test Report