PHOENIX TESTLAB

Königswinkel 10
32825 Blomberg, Germany
Phone: +49 (0) 52 35 / 95 00-0
Fax: +49 (0) 52 35 / 95 00-10
office@phoenix-testlab.de
www.phoenix-testlab.de

Test Report

Report Number:

F200549E3

Equipment under Test (EUT):

Tag for indoor localization
SmartAntenna

Applicant:

BeSpoon SAS

Manufacturer:

BeSpoon SAS

ilac-MRA

DAkkS
Deutsche
Akkreditierungsstelle
D-PL-17186-01-01
D-PL-17186-01-02
D-PL-17186-01-03

References

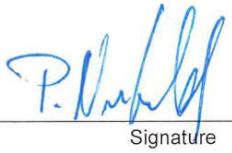
[1] **ANSI C63.4:2014** American National Standard for Methods of Measuring of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.

[2] **FCC 47 CFR Part 2:** General Rules and Regulations

[3] **FCC 47 CFR Part 15:** Radio Frequency Devices (Subpart B)

Test Result

The requirements of the tests performed as shown in the overview (clause 4) were fulfilled by the equipment under test. The complete test results are presented in the following.

Tested and written by:	Paul NEUFELD Name	 Signature	02.02.2021 Date
Reviewed and approved by:	Bernd STEINER Name	 Signature	02.02.2021 Date

This test report is only valid in its original form.

The test results herein refer only to the tested sample. PHOENIX TESTLAB GmbH is not responsible for any generalisations or conclusions drawn from these test results concerning further samples. Any modification of the tested samples is prohibited and leads to the invalidity of this test report. Each page necessarily contains the PHOENIX TESTLAB Logo and the TEST REPORT NUMBER.

Contents: Page

1 Identification

1.1 Applicant

Name:	BeSpoon SAS
Address:	17 rue du lac Saint-André - Savoie Technolac – BP10402 73372 Le Bourget du Lac
Country:	France
Name for contact purposes:	Mr. Franck LAINE
Phone:	+33 458 82 88 86
eMail address:	fla@bespoon.com
Applicant represented during the test by the following person:	None

1.2 Manufacturer

Name:	BeSpoon SAS
Address:	17 rue du lac Saint-André - Savoie Technolac – BP10402 73372 Le Bourget du Lac
Country:	France
Name for contact purposes:	Mr. Franck LAINE
Phone:	+33 458 82 88 86
eMail address:	fla@bespoon.com
Manufacturer represented during the test by the following person:	None

1.3 Test Laboratory

The tests were carried out by:

PHOENIX TESTLAB GmbH
Königswinkel 10
32825 Blomberg
Germany

Accredited by Deutsche Akkreditierungsstelle GmbH (DAkkS) in compliance with DIN EN ISO/IEC 17025 under Reg. No. D-PL-17186-01-06 and D-PL-17186-01-05, FCC Test Firm Designation Number DE0004, FCC Test Firm Registration Number 469623, CAB Identifier DE0003 and ISED# 3469A.

1.4 EUT (Equipment under Test)

Test object: *	Tag for indoor localization
Model name: *	omlox SmartAntenna
FCC ID: *	2AVYU-OMLOX-ST
Model number: *	-
Serial number: *	0000000132
PCB identifier: *	OMLOX SmartAntenna 1910154B00400285
Hardware version: *	Rev F
Software version: *	3.0.3

* Declared by the applicant

Note: PHOENIX TESTLAB GmbH does not take samples. The samples used for tests are provided exclusively by the applicant.

1.5 Technical Data of Equipment

EUT						
Fulfills specifications: *	Bluetooth 4.2 low energy only					
Radio chip: *	Nordic nRF52840					
Antenna type: *	Internal PCB antenna					
Antenna gain: *	2 dBi					
Antenna connector: *	None					
Supply voltage EUT: *	U_{nom}=	5.0 V_{DC}	U_{min}=	3.1 V_{DC}	U_{max}=	5.5 V_{DC}
Type of modulation: *	GFSK					
Operating frequency range: *	2402 – 2480 MHz					
Number of channels: *	40					
Temperature range: *	-10 °C to +55 °C					
Lowest / highest Internal frequency: *	32 kHz / 4500 MHz					

* Declared by the applicant

Ancillary Equipment	
Cables (connected to the EUT): *2	USB cable (~ 1 m)
Laptop PC:*1	Lenovo X201 Tablet

*1 Provided by the laboratory
*2 Provided by the applicant

1.6 Dates

Date of receipt of test sample:	03.08.2020
Start of test:	04.08.2020
End of test:	14.08.2020

2 Operational States

Description of function of the EUT:

The EUTs are UWB tags with Bluetooth capability. The function of the EUTs is spatial indoor positioning with the aid of received UWB signals, transmitted by indoor UWB transmitters called anchors. The BLE connection is used for data transfer between the EUTs and the anchors.

The following states were defined as the operating conditions:

For the 15B tests the UWB and the BLE interfaces were deactivated by the applicant.
During the tests the EUT was connected to a laptop computer type “X201 Tablet” by Lenovo via USB interface. When connected to the laptop PC a serial connection is established between EUT and Laptop computer. Via this serial interface / USB connection, data is transmitted continuously from the EUT to the Laptop computer. The data stream is a test mode that was realized by the applicant to enable the worst case data communication for the EUT to the ancillary device. The received data is visualized on the Laptop computer using a terminal application called “Tera Term”.

During all tests the laptop PC was powered with 120 V AC and 60 Hz.

3 Additional Information

General information:

- none

4 Overview

Conducted emissions FCC 47 CFR Part 15 section 15.107 (b) [3]					
Application	Frequency range	Limits	Reference standard	Remark	Status
AC supply line	0.15 to 0.5 MHz 0.5 to 30 MHz	79 dBµV (QP) 66 dBµV (AV) 73 dBµV (QP) 60 dBµV (AV)	ANSI C63.4	Class A	-
AC supply line	0.15 to 0.5 MHz 0.5 to 5 MHz 5 to 30 MHz	66 to 56 dBµV (QP)* 56 to 46 dBµV (AV)* 56 dBµV (QP) 46 dBµV (AV) 60 dBµV (QP) 50 dBµV (AV)	ANSI C63.4	Class B	Passed
*: Decreases with the logarithm of the frequency					
Radiated emissions FCC 47 CFR Part 15 section 15.109 (b) [3]					
Application	Frequency range	Limits	Reference standard	Remark	Status
Radiated Emission	30 to 88 MHz 88 to 216 MHz 216 to 960 MHz 960 to 1000 MHz above 1000 MHz	39.0 dBµV /m QP at 10 m 43.5 dBµV /m QP at 10 m 46.5 dBµV /m QP at 10 m 49.5 dBµV /m QP at 10 m 49.5 dBµV /m AV at 10 m and 69.5 dBµV /m PK at 10 m	ANSI C63.4	Class A	-
Radiated Emission	30 to 88 MHz 88 to 216 MHz 216 to 960 MHz 960 to 1000 MHz above 1000 MHz	40.0 dBµV/m QP at 3 m 43.5 dBµV/m QP at 3 m 46.0 dBµV/m QP at 3 m 54.0 dBµV/m QP at 3 m 54.0 dBµV/m AV at 3 m and 74.0 dBµV/m PK at 3 m	ANSI C63.4	Class B	Passed

* Not tested, because not ordered by the applicant.

Remark: As declared by the applicant the highest internal frequency is 4500 MHz.
Therefore the radiated emission measurement must be carried out up to 5th of the highest internal clock frequency in this case 22.5 GHz.

The EUT was classified by the applicant as CLASS B equipment.

5 Results

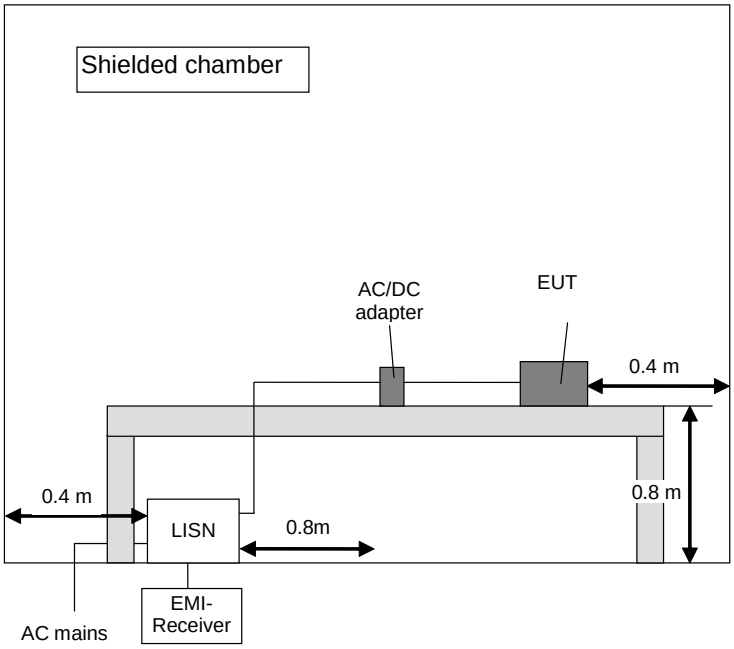
5.1 Conducted emissions on power supply lines

5.1.1 Test method

This test will be carried out in a shielded chamber. Tabletop devices will set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm above the ground plane. Floor-standing devices will be placed directly on the ground plane. The setup of the Equipment under test will be in accordance to [1].

The frequency range 150 kHz to 30 MHz will be measured with an EMI Receiver set to MAX Hold mode with peak and average detector and a resolution bandwidth of 9 kHz. A scan will be carried out on the phase (or plus pole in case of DC powered devices) of the AC mains network. If levels detected 10 dB below the appropriable limit, this emission will be measured with the average and quasi-peak detector on all lines.

Frequency range	Resolution bandwidth
150 kHz to 30 MHz	9 kHz

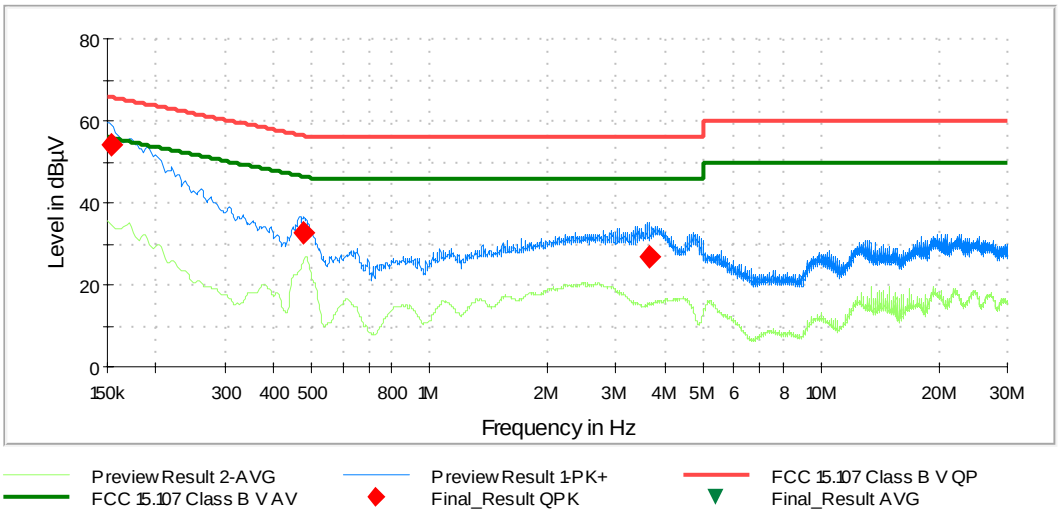


5.1.2 Results conducted emission measurement on AC mains

Ambient temperature:	22 °C	Relative humidity:	48%

Test description:	Radiated emission measurement according to FCC PART 15
EUT:	omlox SmartAntenna
Manufacturer:	BeSpoon SAS
Operating conditions:	BLE + UWB off, Data transmission between EUT and Laptop computer
Test site:	PHOENIX TESTLAB GmbH, shielded room M4
Operator:	P. NEUFELD
Comment:	Laptop computer Lenovo X201 Tablet connected to EUT Laptop computer supplied by 120 V 60 Hz AC
Date of test	01.02.2021

The curves in the diagrams below only represent for each frequency point the maximum measured value of all preliminary measurements which were made for each power supply line. The top measured curve represents the peak measurement and the bottom measured curve the average measurement. The quasi-peak measured points are marked by ◆ and the average measured points by ▼.



Final_Result

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	PE	TDF (dB)
0.154000	53.98	---	65.78	11.81	5000.0	9.000	L1	GND	9.9
0.474750	32.44	---	56.43	23.99	5000.0	9.000	N	GND	9.8
3.651750	26.84	---	56.00	29.16	5000.0	9.000	N	GND	10.3
Measurement uncertainty				**+2.76 dB / -2.76 dB**					

Test result Passed

Test equipment (please refer to chapter 6 for details)
1 - 6

5.2 Radiated emissions

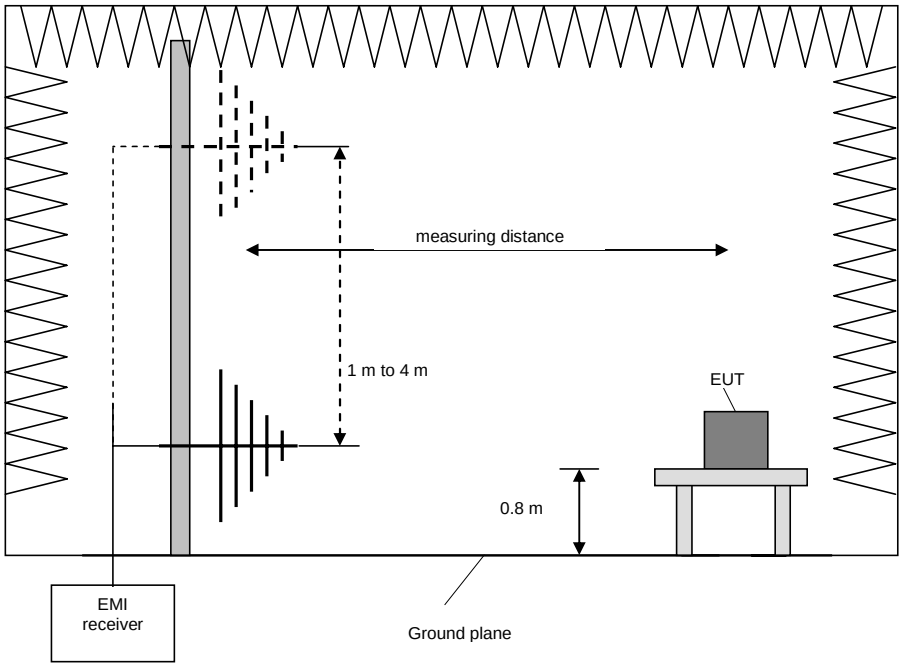
5.2.1 Test method

Preliminary and final measurement (30 MHz to 1 GHz)

The preliminary and final measurements were conducted in a semi-anechoic chamber with a metal ground plane in a 3 m distance.
During the test the EUT will be rotated in the range of 0 ° to 360 °, the measuring antenna will be set to horizontal and vertical polarization and raised and lowered in the range from 1 m to 4 m to find the maximum level of emissions.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Test	Frequency range	Resolution bandwidth
Preliminary measurement	30 MHz to 1 GHz	100 kHz
Frequency peak search	+ / - 1 MHz	10 kHz
Final measurement	30 MHz to 1 GHz	120 kHz



Procedure preliminary measurement:

The following procedure is used:

1. Set the measurement antenna to 1 m height.
2. Monitor the frequency range at vertical polarisation and a EUT azimuth of 0 °.
3. Rotate the EUT by 360° to maximize the detected signals.
4. Repeat 1) to 2) with the vertical polarisation of the measuring antenna.
5. Increase the height of the antenna for 0.5 m and repeat steps 2 – 4 until the final height of 4 m is reached.
6. The highest values for each frequency will be saved by the software, including the antenna height, measurement antenna polarization and turntable azimuth for that value.

Procedure final measurement:

The following procedure is used:

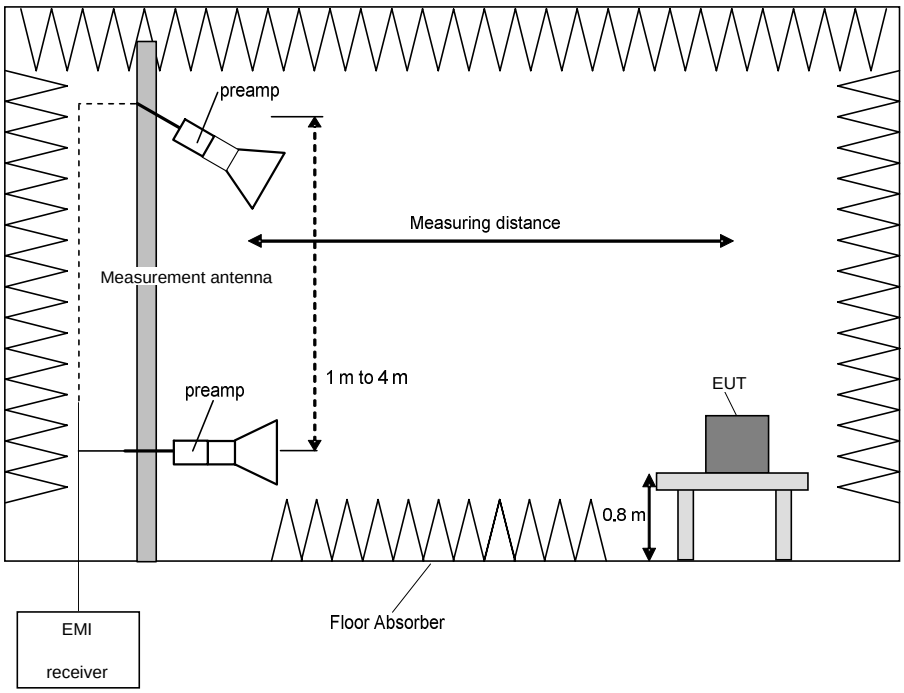
1. Select the highest frequency peaks to the limit for the final measurement.
2. The software will determine the exact peak frequencies by doing a partial scan with reduced RBW with +/- 10 times the RBW of the pre-scan of the selected peaks.
3. If the EUT is portable or ceiling mounted, find the worst case EUT position (x,y,z) for the final test.
4. The worst measurement antenna height is found by the measurement software by varying the measurement antenna height by +/- 0.5 m from the value obtained in the preliminary measurement, and to monitor the emission level.
5. The worst azimuth turntable position is found by varying the turntable azimuth by +/- 30° from the value obtained in the preliminary measurement, and to monitor the emission level.
6. The final measurement is performed at the worst-case antenna height and the worst case turntable azimuth
7. Steps 2 – 6 will be repeated for each frequency peak selected in step 1.

Preliminary and final measurement (1 – 40 GHz)

The preliminary and final measurements were conducted in a semi-anechoic chamber with floor absorbers between EUT and measurement antenna in a 3 m distance.
During the test the EUT will be rotated in the range of 0 ° to 360 °, the measuring antenna will be set to horizontal and vertical polarization and raised and lowered in the range from 1 m to 4 m to find the maximum level of emissions. For each height the angle of the antenna will be tilted so that the measurement antenna is always aiming at the EUT.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Test	Frequency range	Resolution bandwidth
Preliminary measurement	1 - 40 GHz	1 MHz
Frequency peak search	+ / - 10 MHz	100 kHz
Final measurement	1 - 40 GHz	1 MHz



Procedure preliminary measurement:

The following procedure is used:

1. Set the measurement antenna to 1 m height.
2. Monitor the frequency range at vertical polarisation and a EUT azimuth of 0 °.
3. Rotate the EUT by 360° to maximize the detected signals.
4. Repeat 1) to 2) with the vertical polarisation of the measuring antenna.
5. Increase the height of the antenna for 0.5 m and repeat steps 2 – 4 until the final height of 4 m is reached.
6. The highest values for each frequency will be saved by the software, including the antenna height, measurement antenna polarization and turntable azimuth for the highest value.

Procedure final measurement:

The following procedure is used:

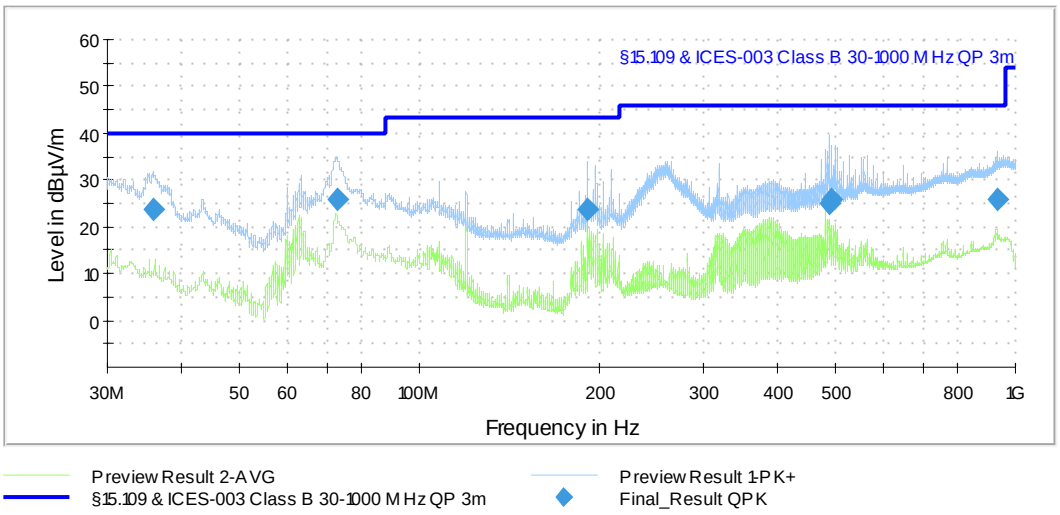
1. Select the highest frequency peaks to the limit for the final measurement.
2. The software will determine the exact peak frequencies by doing a partial scan with reduced RBW with +/- 10 times the RBW of the pre-scan of the selected peaks.
3. If the EUT is portable or ceiling mounted, find the worst case EUT orientation (x,y,z) for the final test.
4. The worst measurement antenna height is found by the measurement software by varying the measurement antenna height by +/- 0.5 m from the worst-case value obtained in the preliminary measurement, and to monitor the emission level.
5. The worst azimuth turntable position is found by varying the turntable azimuth by +/- 30° from the worst-case value obtained in the preliminary measurement, and to monitor the emission level.
6. The final measurement is performed at the worst-case antenna height and the worst case turntable azimuth.
7. Steps 2 – 6 will be repeated for each frequency peak selected in step 1.

5.2.2 Result final measurement from 30 MHz to 1 GHz

Ambient temperature	23 °C	Relative humidity	40 %

Test description:	Radiated emission measurement according to FCC PART 15
EUT:	omlox SmartAntenna
Manufacturer:	BeSpoon SAS
Operating conditions:	BLE + UWB off, Data transmission between EUT and Laptop computer
Test site:	PHOENIX TESTLAB GmbH, semi anechoic chamber M276
Operator:	P. NEUFELD
Comment:	Laptop computer Lenovo X201 Tablet connected to EUT Laptop computer supplied by 120 V 60 Hz AC
Date of test	29.01.2021

The measured points and the limit line in the following diagram refer to the standard measurement of the emitted interference in compliance with the above-mentioned standard. The measured points marked with "◆" are the measured results of the standard subsequent measurement in a semi anechoic chamber.



The results of the standard subsequent measurement in a semi anechoic chamber are indicated in the table below. The limits as well as the measured results (levels) refer to the above-mentioned standard while taking account of the specified requirements for a 3 m measuring distance.

Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
35.760000	23.84	40.00	16.16	1000.0	120.000	103.0	V	191.0	25.1
72.925000	25.94	40.00	14.06	1000.0	120.000	106.0	V	229.0	13.1
192.000000	23.81	43.52	19.71	1000.0	120.000	103.0	V	160.0	14.5
485.900000	24.99	46.02	21.03	1000.0	120.000	145.0	H	123.0	23.5
491.990000	25.90	46.02	20.12	1000.0	120.000	145.0	H	115.0	23.7
929.525000	25.69	46.02	20.33	1000.0	120.000	100.0	H	49.0	30.0
Measurement uncertainty				+/- 4.8 dB					

Test: Passed

The correction factor was calculated as follows.

Corr. (dB/m) = cable attenuation (dB) + 6 dB attenuator (dB) + antenna factor (dB/m)

Therefore, the reading can be calculated as follows:

Reading (dBµV) = result QuasiPeak (dBµV/m) - Corr. (dB/m)

Test equipment (please refer to chapter 6 for details)
7 - 15

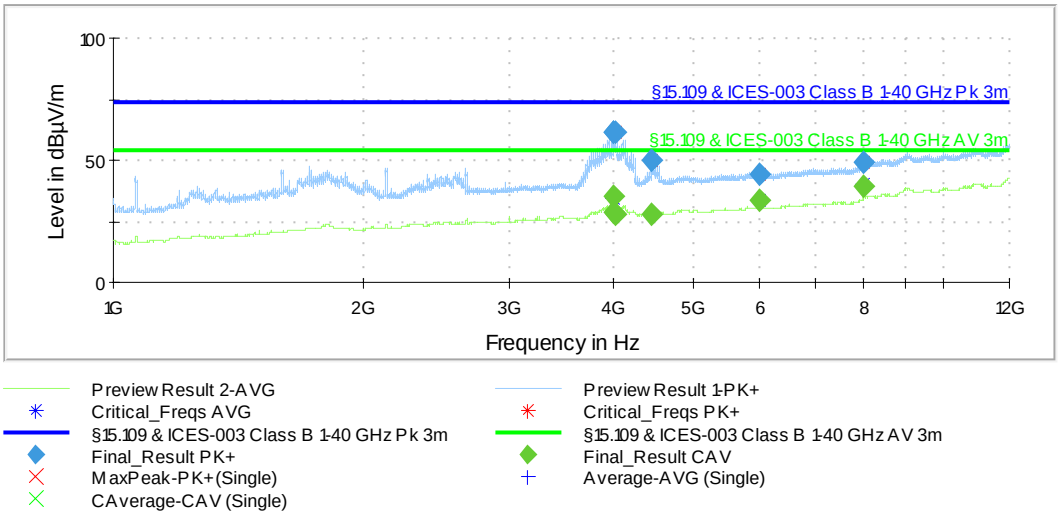
5.2.3 Result final measurement above 1 GHz

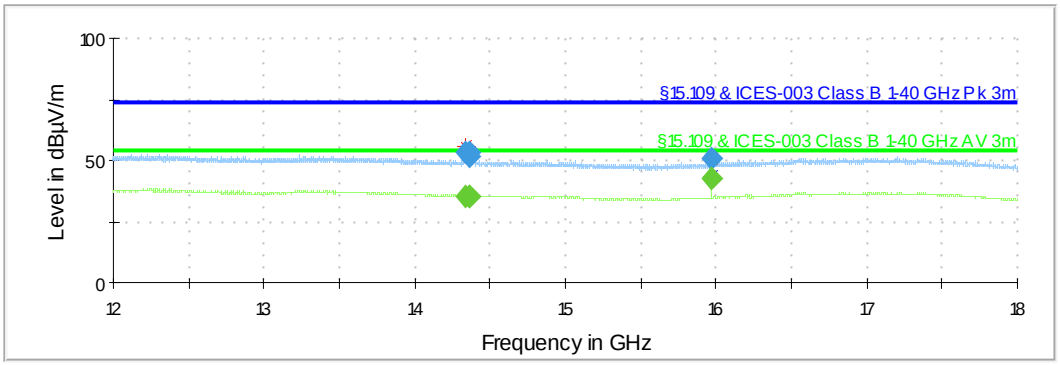
Ambient temperature	23 °C	Relative humidity	40 %

Test description:	Radiated emission measurement according to FCC PART 15
EUT:	omlox SmartAntenna
Manufacturer:	BeSpoon SAS
Operating conditions:	BLE + UWB off, Data transmission between EUT and Laptop computer
Test site:	PHOENIX TESTLAB GmbH, semi anechoic chamber M276
Operator:	P. NEUFELD
Comment:	Laptop computer Lenovo X201 Tablet connected to EUT Laptop computer supplied by 120 V 60 Hz AC
Date of test	25.01.2021

The curves in the diagram only represent the maximum measured value for each frequency point of all preliminary measurements, which were carried out with various EUT and antenna positions.
The top measured curve represents the peak measurement. The measured points marked with "◆" are frequency points for the final peak detector measurement. These values are indicated in the following table. The bottom measured curve represents the average measurement. The measured points marked with "◆" are frequency points for the final average detector measurement.

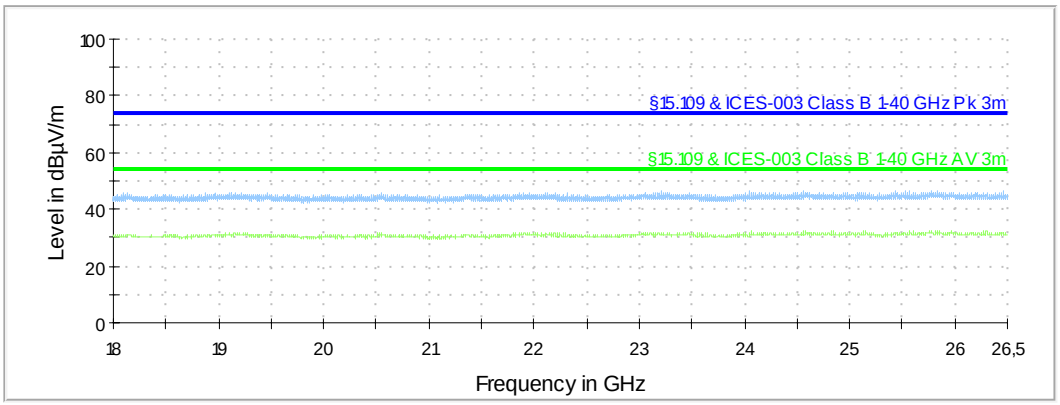
Since the EUT was in idle mode and the advertisements were only transmitted randomly, the peak frequency was not always measured during the final measurements.





Preview Result 2-AVG
Critical_Freqs AVG
§15.109 & ICES-003 Class B 1-40 GHz Pk 3m
Final_Result PK+
MaxPeak-PK+(Single)
CAverage-CAV (Single)

Preview Result 1-PK+
Critical_Freqs PK+
§15.109 & ICES-003 Class B 1-40 GHz AV 3m
Final_Result CAV
Average-AVG (Single)



Preview Result 2-AVG
Critical_Freqs AVG
§15.109 & ICES-003 Class B 1-40 GHz Pk 3m
Final_Result PK+

Preview Result 1-PK+
Critical_Freqs PK+
§15.109 & ICES-003 Class B 1-40 GHz AV 3m
Final_Result CAV

The results of the standard subsequent measurement above 1 GHz in a semi anechoic chamber are indicated in the table below. The limits as well as the measured results (levels) refer to the above-mentioned standard while taking account of the specified requirements for a 3 m measuring distance.

Final_Result

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m) PK/AV	Margin (dB)	Meas. Time (ms)	Band-width (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
3993.650	61.38	---	74.00	12.62	100.0	1000	342.0	H	30.0	5.8
3993.650	---	34.98	54.00	19.02	100.0	1000	342.0	H	30.0	5.8
4009.200	---	28.41	54.00	25.59	100.0	1000	378.0	H	50.0	5.9
4009.200	61.82	---	74.00	12.18	100.0	1000	378.0	H	50.0	5.9
4024.850	61.31	---	74.00	12.69	100.0	1000	377.0	H	48.0	5.9
4024.850	---	28.18	54.00	25.82	100.0	1000	377.0	H	48.0	5.9
4446.050	49.79	---	74.00	24.21	100.0	1000	311.0	H	52.0	7.2
4446.050	---	27.86	54.00	26.14	100.0	1000	311.0	H	52.0	7.2
5999.800	44.05	---	74.00	29.95	100.0	1000	410.0	V	101.0	11.1
5999.800	---	33.77	54.00	20.23	100.0	1000	410.0	V	101.0	11.1
7987.250	---	39.23	54.00	14.77	100.0	1000	203.0	V	334.0	15.2
7987.250	49.19	---	74.00	24.81	100.0	1000	203.0	V	334.0	15.2
14331.350	---	35.39	54.00	18.61	100.0	1000	286.0	V	293.0	17.7
14331.350	53.49	---	74.00	20.51	100.0	1000	286.0	V	293.0	17.7
14358.250	52.01	---	74.00	21.99	100.0	1000	119.0	V	1.0	17.7
14358.250	---	35.50	54.00	18.50	100.0	1000	119.0	V	1.0	17.7
14367.050	---	35.49	54.00	18.51	100.0	1000	112.0	V	1.0	17.8
14367.050	52.97	---	74.00	21.03	100.0	1000	112.0	V	1.0	17.8
15974.300	50.78	---	74.00	23.22	100.0	1000	153.0	V	349.0	17.1
15974.300	---	42.81	54.00	11.19	100.0	1000	153.0	V	349.0	17.1
Measurement uncertainty				+/- 5.1 dB						

The correction factor was calculated as follows.

Corr. (dB/m) = cable attenuation (dB) + preamplifier (dB) + antenna factor (dB/m)

Therefore, the reading can be calculated as follows:

Reading (dBµV) = result Peak or Avarage (dBµV/m) - Corr. (dB/m)

Test result: Passed

Test equipment (please refer to chapter 6 for details)
9 - 22

6 Test Equipment used for Tests

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal Due
1	EMC test system	EMC D 30000 / PAS	Spitzenberger & Spies	A4507 00/1 1110	481301	Calibration not necessary	
2	Software	EMC32	Rohde & Schwarz	100619	483182	Calibration not necessary	
3	Shielded chamber M155	B83117-S1-X158	Siemens	190075	480088	Calibration not necessary	
4	EMI Receiver	ESR7	Rohde & Schwarz	101939	482558	18.02.2020	02.2022
5	Transient Filter Limiter	CFL9206A	Ametek CTS Europe	56222	483263	12.02.2020	02.2022
6	LISN	NSLK8128RC	Schwarzbeck	0412	483186	Calibration not necessary	
7	Attenuator 6 dB	WA2-6	Weinschel	8254	410119	Calibration not necessary	
8	Antenna (Bilog)	CBL6111D	Schaffner	25761	480894	09.10.2020	10.2023
	Antenna (Bilog)	CBL6111D	Schaffner	25761	480894	19.10.2017	10.2020
9	System software	EMC32	Rohde & Schwarz	100970	482972	Calibration not necessary	
10	RF Switch Matrix	OSP220	Rohde & Schwarz	-	482976	Calibration not necessary	
11	Turntable	TT3.0-3t	Maturo	825/2612/.01	483224	Calibration not necessary	
12	Antenna support	BAM 4.5-P-10kg	Maturo	222/2612.01	483225	Calibration not necessary	
13	Controller	NCD	Maturo	474/2612.01	483226	Calibration not necessary	
14	Semi Anechoic Chamber M276	SAC5-2	Albatross Projects	C62128-A540-A138-10-0006	483227	Calibration not necessary	
15	EMI Receiver	ESW44	Rohde & Schwarz	101828	482979	14.11.2019	11.2021
16	Low Noise Amplifier 100 MHz - 18 GHz	LNA-30-00101800-25-10P	Narda-Miteq	2110917	482967	18.02.2020	02.2022
17	Log Per Antenna	HL050	Rohde & Schwarz	4062.4063.02-100908	482977	13.08.2019	08.2022
18	Highpass Filter	WHKX8.0/18G-8SS	Wainwright Instruments	4	480586	Calibration not necessary	
19	Standard Gain Horn 12 GHz-18 GHz	18240-20	Flann	267220	483025	Calibration not necessary	
20	Low Noise Amplifier 12 GHz - 18 GHz	LNA-30-12001800-13-10P	Narda MITEQ	2089798	482968	17.02.2020	02.2022
21	Standard Gain Horn 18 GHz -26 GHz	20240-20	Flann	266399	483026	Calibration not necessary	
22	Low Noise Amplifier 18 GHz - 26.5 GHz	LNA-30-18002650-20-10P	Narda MITEQ	2110911	482969	17.02.2020	02.2022

7 Test site Validation

Test equipment	PM. No.	Frequency range	Type of validation	According to	Val. Date	Val Due
Semi anechoic chamber M276	483227	30 – 1000 MHz	NSA	ANSI C63.4a-2017	19.09.2019	18.09.2021
Semi anechoic chamber M276	483227	1 -18 GHz	SVSWR	CISPR 16-1-4 + Cor1:2010 + A1:2012 +A2:2017	01.10.2019	30.09.2021

8 Report History

Report Number	Date	Comment
F200549E3	02.02.2021	Initial Test Report
-	-	-
-	-	-

9 List of Annexes

Annex A	Test Setup Photos	6 pages