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Test Report

Report Number:

F221512E4

Equipment under Test (EUT):

TrackView Pro Access Point

Applicant:

Ellab A/S

Manufacturer:

Ellab A/S



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)
- [4] **ICES-003 Issue 7: (October 2020)** Spectrum Management and Telecommunications. Interference-Causing Equipment Standard. Information Technology Equipment (Including Digital Apparatus) —Limits and Methods of Measurement
- [5] **RSS-Gen, Issue 5 Amendment 2 (2021-02)** General Requirements for Compliance of Radio Apparatus

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.

“Passed” indicates that the equipment under test conforms with the relevant limits of the testing standard without taking any measurement uncertainty into account as stated in clause 10.2.8.2 of ANSI C63.4 (2014). However, the measurement uncertainty is calculated and shown in this test report.

Tested and written
by:

Signature

Reviewed and
approved by:

Signature

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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.

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1 Identification

1.1 Applicant

Name:	Ellab A/S
Address:	Trollemindsalle 25 3400 Hilleroed
Country:	Denmark
Name for contact purposes:	Mr. Michael LAU SØRENSEN
Phone:	+45 44 52 05 00
eMail address:	mls@ellab.com
Applicant represented during the test by the following person:	-

1.2 Manufacturer

Name:	Ellab A/S
Address:	Trollemindsalle 25 3400 Hilleroed
Country:	Denmark
Name for contact purposes:	Mr. James JACOBSSON
Phone:	+45 4452 0500
eMail address:	info@ellab.com
Manufacturer represented during the test by the following person:	-

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-17186-01-05 and D-PL-17186-01-06 , 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: *	Ellab TrackView Pro Access Point - 915 MHz
Model name: *	TrackView Pro Access Point
Model number: *	33002741
Order number: *	N/A
FCC ID: *	XUS-TVPAP1
IC certification number: *	8758A-TVPAP1
PMN: *	TrackView Pro Access Point
HVIN: *	66315000
FVIN: *	N/A
Serial number: *	80877831
PCB identifier: *	610000129-06
Hardware version: *	N/A
Software version: *	N/A

* Declared by the applicant

One EUT was used for all tests.

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

General EUT data			
Power supply EUT: *	Dedicated AC/DC adaptor or PoE		
Supply voltage EUT (with AC/DC adaptor): *	$U_{\text{nom}} = 120 \text{ V}_{\text{AC}}$	$U_{\text{min}} = 100 \text{ V}_{\text{AC}}$	$U_{\text{max}} = 240 \text{ V}_{\text{AC}}$
Supply voltage EUT (with PoE): *	$U_{\text{nom}} = 48 \text{ V}_{\text{DC}}$	$U_{\text{min}} = 36 \text{ V}_{\text{DC}}$	$U_{\text{max}} = 57 \text{ V}_{\text{DC}}$
Temperature range: *	-20°C to $+60^{\circ}\text{C}$		
Lowest / highest internal clock frequency: *	32.768 kHz / 927.5 MHz		

*: Declared by the applicant

Ports / Connectors				
Identification	Connector		Length during test	Shielding (Yes / No)
	EUT	Ancillary		
Power in	2.1 mm DC power socket	-	3.0 m	No
Ethernet (with PoE)	RJ45	RJ45	3.0 m	Yes
USB (service interface only)	USB type B	USB type A	3.0 m	Yes
Relay output	MDC-036-R	-	Not used	-
Relay output	MDC-036-R	-		-

LoRa frequencies			
Channel 64	903.0 MHz	Channel 65	904.6 MHz
Channel 66	906.2 MHz	Channel 67	907.8 MHz
Channel 68	909.4 MHz	Channel 69	911.0 MHz
Channel 70	912.6 MHz	Channel 71	914.2 MHz
Channel (8)0	923.3 MHz	Channel (8)1	923.9 MHz
Channel (8)2	924.5 MHz	Channel (8)3	925.1 MHz
Channel (8)4	925.7 MHz	Channel (8)5	926.3 MHz
Channel (8)6	926.9 MHz	Channel (8)7	927.5 MHz

LoRa radio mode		
Fulfils radio specification: * ¹	LoRa WAN	
Radio chip: * ¹	SEMTECH SX1276	
Antenna type: * ¹	Internal screw type antenna for each transmitter	
Antenna name: * ¹	Adactus ADA-901-868-925	
Antenna gain: * ²	-13.8 dBd	
Antenna connector: * ¹	Internal UFL	
Type of modulation: * ¹	LoRa WAN	LoRa-CSS
Operating frequency range: * ¹	LoRa WAN	903.0 – 927.5 MHz
Number of channels: * ¹	LoRa WAN	16

*¹: Declared by the applicant

*²: Based on the antenna test as documented under PHOENIX TESTLAB GmbH test report reference F221512E3.

1.5.1 Ancillary Equipment / Equipment used for testing

Equipment used for testing		
Laptop: * ¹	Type Lenovo 20KH-006FMD18/08 with software Trackview Pro Link	
AC/DC adaptor (dedicated) * ¹	Ideal power model DYS818-120150W	

*¹: Provided by the applicant

1.6 Dates

Date of receipt of test sample:	02.02.2023
Start of test:	21.02.2023
End of test:	06.03.2023

2 Operational States

Description of function of the EUT:

The EUT is a gateway for multiple data loggers to data to a cloud-based software solution. It contains two transceivers with internal antennas, operating independent from each other.

The following states were defined as the operating conditions:

- The EUT is a running in normal operation mode, data transfer on the Ethernet line was realized with fping from the laptop PC.
- The EUT is a running in service mode, data transfer on the USB line with the laptop PC.
- Receive with transceiver A.
- Receive with transceiver B.

If not otherwise stated, during the tests the EUT was supplied with 12 V_{DC} by the dedicated AC/DC adaptor, which was supplied by an AC mains network with 120 V_{AC} / 60 Hz.

3 Additional Information

The results of the transmitters are documented under PHONIX TESTLAB GmbH test report reference F221512E3.

The EUT was not labeled as required by FCC / IC.

4 Overview

Conducted emissions FCC 47 CFR Part 15 section 15.107 (a), (b) [3] ICES-003 Issue 7 section 3.2.1[4]				
Application	Frequency range	Limits	Reference standard	Status
AC supply line Class B	0.15 to 0.5 MHz	66 to 56 dB(µV) QP* 56 to 46 dB(µV) AV*	ANSI C63.4	Passed
	0.5 to 5 MHz	56 dB(µV) QP 46 dB(µV) AV		
	5 to 30 MHz	60 dB(µV) QP 50 dB(µV) AV		

*: Decreases with the logarithm of the frequency

Radiated emissions FCC 47 CFR Part 15 section 15.109 (a), (b) [3] FCC 47 CFR Part 15 section 15.111 [3] RSS-Gen 7.3 [5]				
Application	Frequency range	Limits	Reference standard	Status
Radiated Emission Class B	30 to 88 MHz	40.0 dB(µV/m) QP at 3 m	ANSI C63.4	Passed
	88 to 216 MHz	43.5 dB(µV/m) QP at 3 m		
	216 to 960 MHz	46.0 dB(µV/m) QP at 3 m		
	960 to 1000 MHz	54.0 dB(µV/m) QP at 3 m		
	above 1000 MHz	54.0 dB(µV/m) AV at 3 m and 74.0 dB(µV/m) PK at 3 m		

Radiated emissions ICES-003 Issue 7 section 3.2.2 [4]				
Application	Frequency range	Limits	Reference standard	Status
Radiated Emission Class B	30 to 88 MHz	40.0 dB(µV/m) QP at 3 m	ANSI C63.4	Passed
	88 to 216 MHz	43.5 dB(µV/m) QP at 3 m		
	216 to 230 MHz	46.0 dB(µV/m) QP at 3 m		
	230 to 960 MHz	47.0 dB(µV/m) QP at 3 m		
	960 to 1000 MHz	54.0 dB(µV/m) QP at 3 m		
	above 1000 MHz	54 dB(µV/m) AV at 3 m and 74 dB(µV/m) PK at 3 m		

Remark: As declared by the applicant the highest internal clock frequency is 0.928 GHz.

Therefore the radiated emission measurement must be carried out up to 5th of the highest internal clock frequency in this case 5 GHz.

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

5 Results

5.1 Test setups

5.1.1 Radiated: 30 MHz to 1 GHz

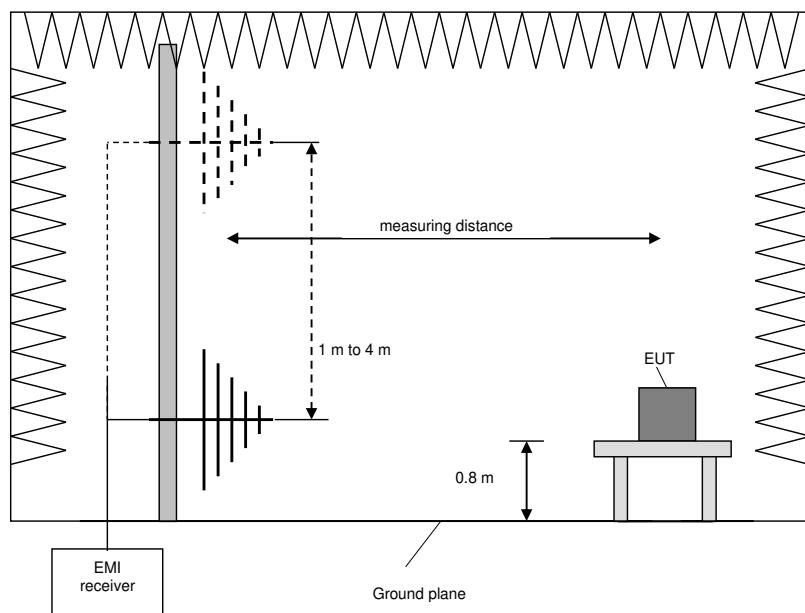
5.1.1.1 Preliminary and final measurement 30 MHz to 1 GHz

The preliminary and final measurements are performed in a semi-anechoic chamber with a metal ground plane at a measuring distance of 3 meters. Table-top devices are set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm. Floor-standing devices are placed directly on the turntable / ground plane. The setup of the equipment under test is in accordance with [1].

During the tests the EUT is rotated in the range of 0 ° to 360 °, the measuring antenna is 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 is set to the following values:

Test	Frequency range	Step-size	Resolution bandwidth	Measuring time	Detector
Preliminary measurement	30 MHz to 1 GHz	30 kHz	120 kHz	-	Peak Average
Frequency peak search	± 120 kHz	10 kHz	120 kHz	1 s	Peak
Final measurement	30 MHz to 1 GHz	-	120 kHz	1 s	QuasiPeak



Procedure preliminary measurement:

The following procedure is used:

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

Procedure final measurement:

The following procedure is used:

- 1) Select the highest frequency peaks (lowest margin to the limit) for the final measurement.
- 2) The software determines the exact peak frequencies by doing a partial scan with reduced step size 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-case measuring antenna height is found via varying the height by +/- 0.5 m from the value obtained in the preliminary measurement while monitoring the emission level.
- 5) The worst-case turntable position is found via varying the turntable azimuth by +/- 30° from the value obtained in the preliminary measurement while monitoring the emission level.
- 6) The final measurement is performed at the worst-case measuring antenna height and the worst-case turntable azimuth.
- 7) Steps 2 to 6 are repeated for each frequency peak selected in step 1.

5.1.2 Radiated: 1 GHz to 40 GHz

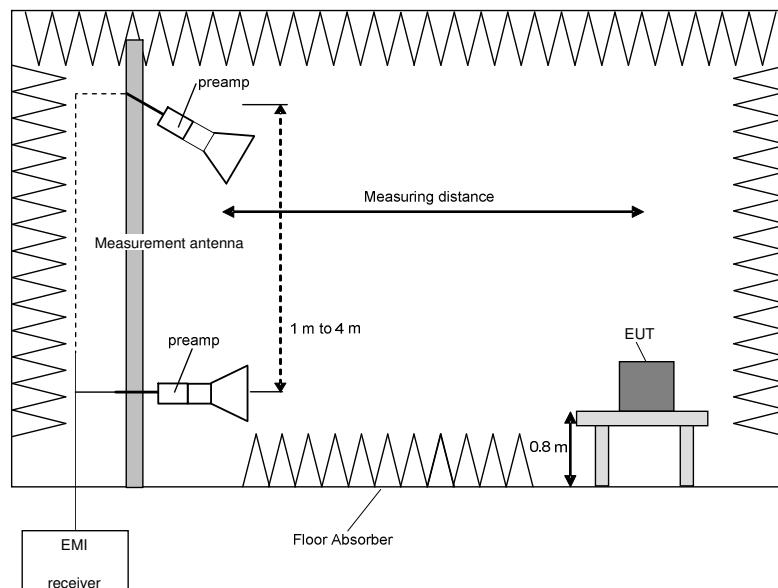
5.1.2.1 Preliminary and final measurement 1 to 40 GHz

The preliminary and final measurements are performed in a semi-anechoic chamber at a measuring distance of 3 meters, with floor absorbers between EUT and measuring antenna. Table-top devices are set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm. Floor-standing devices are placed directly on the turntable / ground plane. The setup of the equipment under test is in accordance with [1].

During the tests the EUT is rotated in the range of 0 ° to 360 °, the measuring antenna is 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. While changing the height, the measuring antenna gets tilted so that it is always aiming at the EUT.

The resolution bandwidth of the EMI receiver is set to the following values:

Test	Frequency range	Step-size	Resolution bandwidth	Measuring time	Detector
Preliminary measurement	1 - 40 GHz	250 kHz	1 MHz	-	Peak Average
Frequency peak search	+ / - 1 MHz	50 kHz	1 MHz	100 ms	Peak
Final measurement	1 - 40 GHz	-	1 MHz	100 ms	Peak Average



Procedure preliminary measurement:

The following procedure is used:

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

Procedure final measurement:

The following procedure is used:

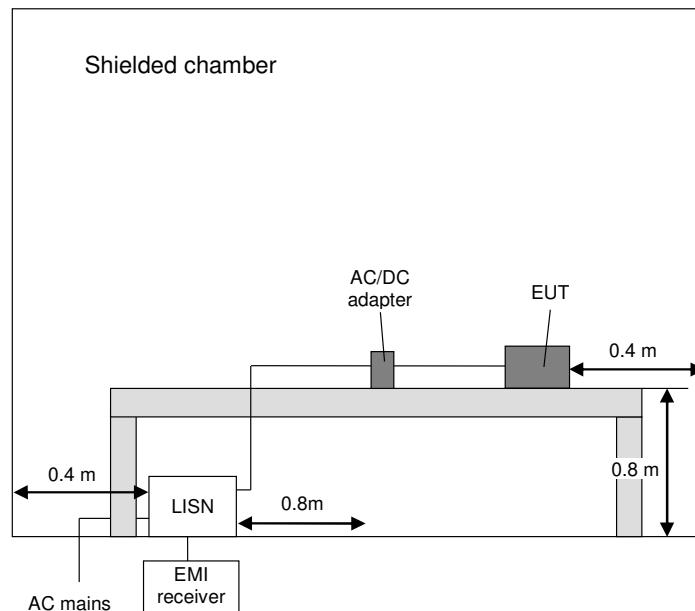
- 1) Select the highest frequency peaks (lowest margin to the limit) for the final measurement.
- 2) The software determines the exact peak frequencies by doing a partial scan with reduced step size of the pre-scan of the selected peaks.
- 3) If the EUT is portable or ceiling mounted, find the worst-case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

5.1.3 Conducted: AC power line

The test is carried out in a shielded chamber. Table-top devices are 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 are placed directly on the ground plane. In case of DC powered equipment, which is not exclusively powered by a battery, it is connected to the LISN via a suitable AC/DC adaptor. The setup of the equipment under test is in accordance with [1].

The frequency range 150 kHz to 30 MHz is measured with an EMI receiver set to MAX hold mode with Peak and Average detectors and a resolution bandwidth of 9 kHz. A scan is carried out on the phase and neutral line of the AC mains network. If emissions less than 10 dB below the appropriable limit are detected, these emissions are measured with an Average and Quasi-Peak detector on all lines.

Frequency range	Resolution bandwidth	Measuring time
150 kHz to 30 MHz	9 kHz	5 s



5.2 Radiated emissions

5.2.1 Test setup (Maximum unwanted emissions)

Test setup (Maximum unwanted emissions)			
Used	Setup	See sub-clause	Comment
<input checked="" type="checkbox"/>	Radiated: 30 MHz to 1 GHz / 1 GHz to 40 GHz	5.1.1 / 5.1.2	Tested in dedicated position (wall mounted EUT)

5.2.2 Test method (Maximum unwanted emissions)

Test method (radiated) see sub-clause 5.1.1 / 5.1.2 as described here in

5.2.3 Test results (Maximum unwanted emissions)

5.2.3.1 Test results (30 MHz – 1 GHz)

Ambient temperature:	22 °C	Date:	21.02.2023
Relative humidity:	36 %	Tested by:	Th. KÜHN

Position of EUT: For tests for f between 30 MHz to 1 GHz, the EUT was set-up on a table with a height of 80 cm. The distance between EUT and antenna was 3 m.

Cable guide: For detail information of test set-up and the cable guide refer to the pictures in the annex A in the test report.

Remark: The EUT was only tested in the dedicated position (wall mounted – see test setup photographs).

Calculations:

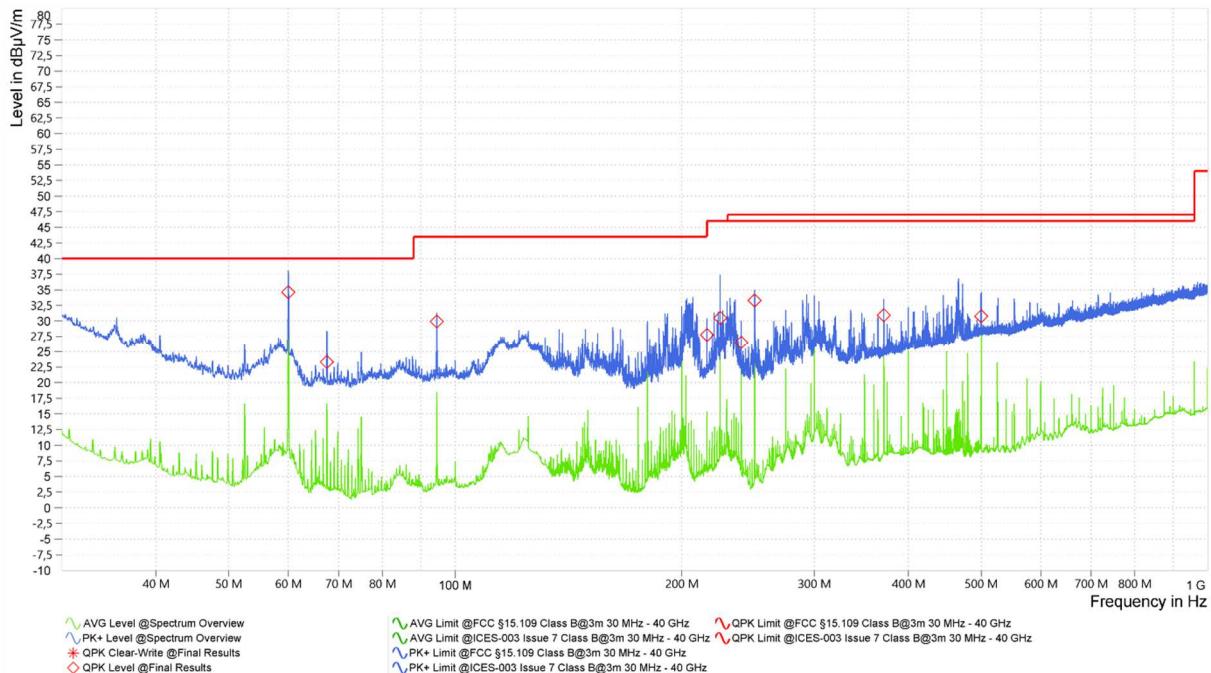
Result [dB μ V/m] = Reading [dB μ V] + Correction [dB/m]

Correction [dB/m] = AF [dB/m] + Cable attenuation [dB] + optional preamp gain [dB]

Margin [dB] = Limit [dB μ V/m] - Result [dB μ V/m]

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.

Spurious emissions from 30 MHz to 1 GHz (fping, supplied by dedicated AC/DC adaptor):



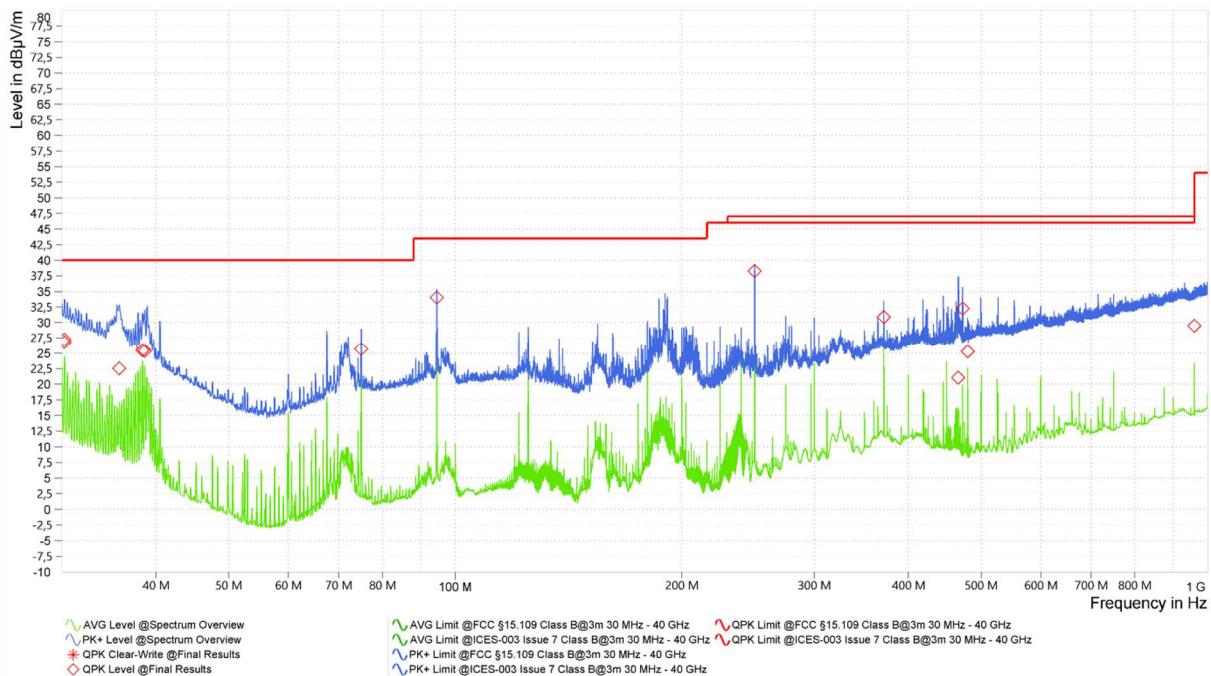
Result table (fping, supplied by dedicated AC/DC adaptor):

Frequency [MHz]	Result (QP) [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Readings [dBμV]	Correction [dB/m]	Height [cm]	Azimuth [deg]	Pol. (H/V)
60.000	34.6	40.0	5.4	22.2	12.4	142	141	Vert.
67.500	23.3	40.0	16.7	9.1	14.2	147	148	Vert.
94.500	29.9	43.5	13.6	12.8	17.1	100	294	Vert.
216.000	27.8	43.5	15.7	11.6	16.2	117	141	Hor.
225.000	30.5	46.0	15.5	14.2	16.3	135	116	Hor.
240.000	26.5	46.0	19.5	9.3	17.2	100	111	Hor.

Test result: Passed

Test equipment (please refer to chapter 7 for details)
1 – 10

Spurious emissions from 30 MHz to 1 GHz (fping, supplied via PoE):



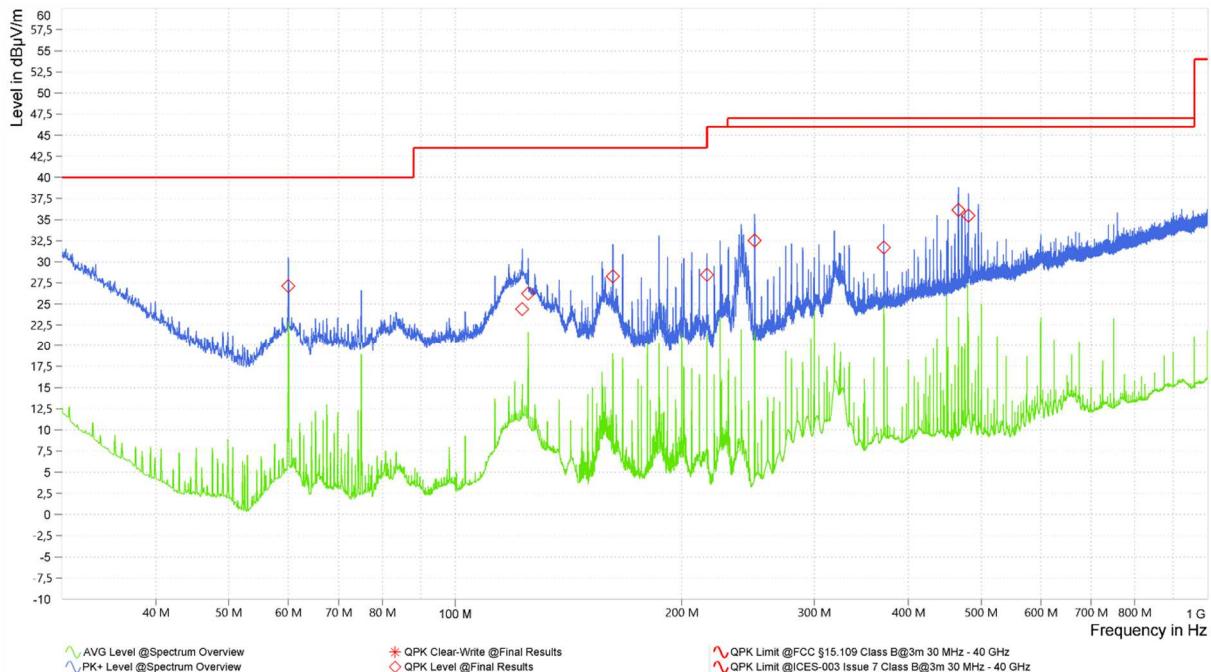
Result table (fping, supplied via PoE):

Frequency [MHz]	Result (QP) [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Readings [dBμV]	Correction [dB/m]	Height [cm]	Azimuth [deg]	Pol. (H/V)
30.240	27.2	40.0	12.8	1.4	25.8	100	50	Vert.
35.760	22.5	40.0	17.5	-0.1	22.6	111	22	Vert.
38.400	25.5	40.0	14.5	4.4	21.0	103	230	Vert.
75.000	25.7	40.0	14.3	10.1	15.6	127	231	Vert.
94.500	34.0	43.5	9.5	16.9	17.1	262	291	Hor.
250.020	38.3	46.0	7.7	21.0	17.3	117	248	Hor.
371.280	30.9	46.0	15.1	9.7	21.2	100	36	Vert.
465.960	21.1	46.0	25.0	-2.7	23.8	161	168	H
472.530	32.3	46.0	13.7	8.4	23.9	106	64	Vert.
480.000	25.3	46.0	20.7	1.3	24.0	113	220	Vert.
960.000	29.5	46.0	16.5	-1.0	30.4	193	176	Hor.

Test result: Passed

Test equipment (please refer to chapter 7 for details)
1 – 10

Spurious emissions from 30 MHz to 1 GHz (service mode, USB data exchange):



Result table (service mode, USB data exchange):

Frequency [MHz]	Result (QP) [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Readings [dBμV]	Correction [dB/m]	Height [cm]	Azimuth [deg]	Pol. (H/V)
60.000	27.1	40	12.9	14.7	12.4	156	-8	Vert.
122.730	24.4	43.5	19.1	6.9	17.5	111	186	Vert.
125.010	26.2	43.5	17.3	9.0	17.2	209	178	Hor.
162.000	28.3	43.5	15.2	12.9	15.4	177	199	Vert.
216.000	28.5	43.5	15.0	12.3	16.2	113	158	Hor.
250.020	32.5	46.0	13.5	15.2	17.3	169	218	Vert.
371.280	31.7	46.0	14.3	10.5	21.2	108	228	Vert.
466.380	36.2	46.0	9.8	12.4	23.8	141	178	Hor.
481.110	35.5	46.0	10.5	11.5	24.0	102	222	Vert.

Test result: Passed

Test equipment (please refer to chapter 7 for details)
1 – 10

5.2.3.2 Test results (radiated 1 GHz to 5 GHz)

Ambient temperature:	22 °C
Relative humidity:	36 %

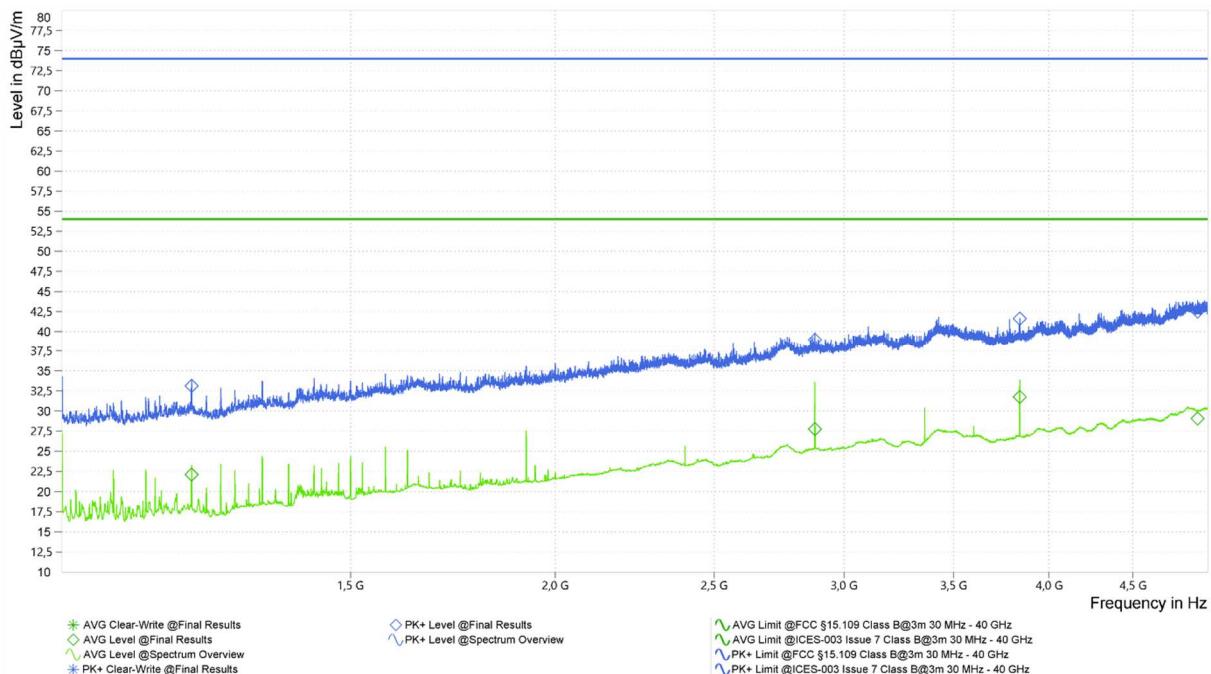
Date:	21.02.2023
Tested by:	Th. KÜHN

Position of EUT:	For tests for f between 1 GHz and the 5 th harmonic, the EUT was set-up on a table with a height of 80 cm. The distance between EUT and antenna was 3 m.
Cable guide:	For detail information of test set-up and the cable guide refer to the pictures in the annex A in the test report.
Remark:	The EUT was only tested in the dedicated position (wall mounted – see test setup photographs).
Calculation:	
Max Peak [dB μ V/m]	= Reading [dB μ V] + Correction [dB/m]
Average [dB μ V/m]	= Reading [dB μ V] + Correction [dB/m]
Correction [dB/m]	= AF [dB/m] + Cable attenuation [dB] + optional preamp gain [dB] + DCCF* [dB] * (if applicable – only for Average values, that are fundamental related)
Margin [dB]	= Limit [dB μ V/m] – Max Peak Average [dB μ V/m]

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.

Spurious emissions from 1 GHz to 5 GHz (fping, supplied by dedicated AC/DC adaptor):



Result table (fping, supplied by dedicated AC/DC adaptor):

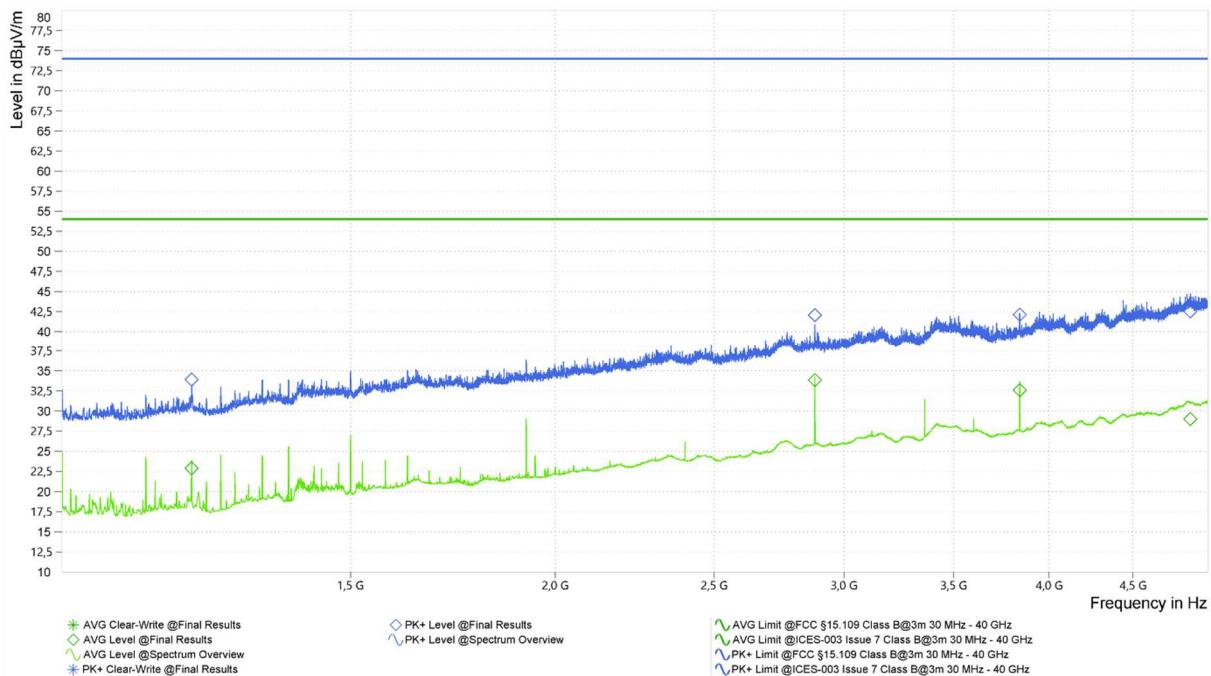
Frequency [MHz]	PK+ Level [dBμV/m]	PK+ Limit [dBμV/m]	PK+ Margin [dB]	AVG Level [dBμV/m]	AVG Limit [dBμV/m]	AVG Margin [dB]	Correction [dB]	Polarization	Azimuth [deg]	Antenna Height [cm]	Meas. BW [kHz]
1200.000	33.1	74.0	40.9	22.1	54.0	31.9	-9.1	Vert.	173	353	1000
2880.000	39.0	74.0	35.1	27.8	54.0	26.2	2.1	Hor.	162	102	1000
3840.000	41.6	74.0	32.4	31.7	54.0	22.3	5.4	Vert.	182	175	1000
4930.250	42.5	74.0	31.5	29.1	54.0	24.9	10.1	Hor.	234	407	1000

Test result: Passed

Test equipment (please refer to chapter 7 for details)

1 – 8, 11, 12

Spurious emissions from 1 GHz to 5 GHz (fping, supplied via PoE):



Result table (fping, supplied via PoE):

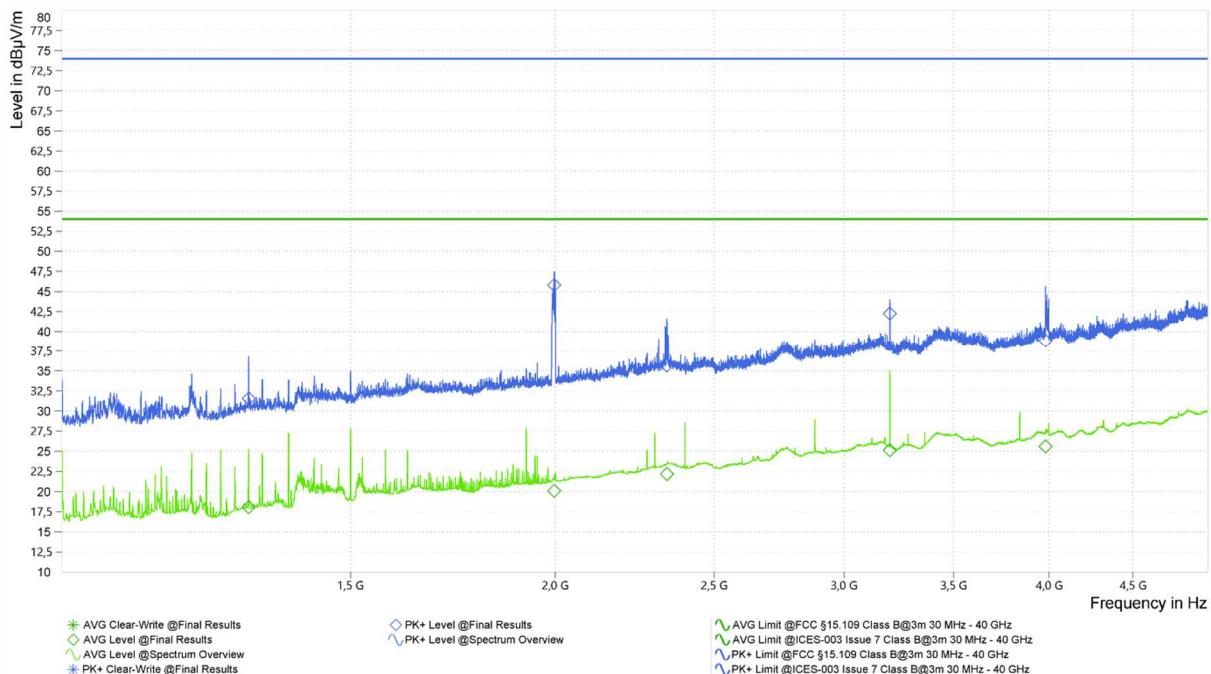
Frequency [MHz]	PK+ Level [dBµV/m]	PK+ Limit [dBµV/m]	PK+ Margin [dB]	AVG Level [dBµV/m]	AVG Limit [dBµV/m]	AVG Margin [dB]	Correction [dB]	Polarization	Azimuth [deg]	Antenna Height [cm]	Meas. BW [kHz]
1200.000	33.9	74.0	40.1	22.9	54.0	31.1	-9.1	Vert.	171	310	1000
2880.000	42.1	74.0	32.0	33.8	54.0	20.2	2.1	Vert.	187	397	1000
3840.000	42.1	74.0	31.9	32.6	54.0	21.4	5.4	Vert.	179	293	1000
4879.750	42.5	74.0	31.5	29.0	54.0	25.0	9.9	Hor.	70	217	1000

Test result: Passed

Test equipment (please refer to chapter 7 for details)

1 – 8, 11, 12

Spurious emissions from 1 GHz to 5 GHz (service mode, USB data exchange):



Result table (service mode, USB data exchange):

Frequency [MHz]	PK+ Level [dBµV/m]	PK+ Limit [dBµV/m]	PK+ Margin [dB]	AVG Level [dBµV/m]	AVG Limit [dBµV/m]	AVG Margin [dB]	Correction [dB]	Polarization	Azimuth [deg]	Antenna Height [cm]	Meas. BW [kHz]
1300.000	31.6	74.0	42.4	18.0	54.0	36.0	-8.0	V	294	173	1000
1997.250	45.8	74.0	28.2	20.1	54.0	33.9	-3.3	V	19	32	1000
2339.750	35.6	74.0	38.4	22.2	54.0	31.8	-0.5	H	346	223	1000
3200.000	42.2	74.0	31.8	25.1	54.0	28.9	3.4	V	20	275	1000
3982.000	38.8	74.0	35.2	25.6	54.0	28.4	6.5	V	368	225	1000

Test result: Passed

Test equipment (please refer to chapter 7 for details)
1 – 8, 11, 12

5.3 Antenna power for receivers

5.3.1 Test setup (Antenna power for receivers)

Test setup (Maximum unwanted emissions)			
Used	Setup	See sub-clause	Comment
<input checked="" type="checkbox"/>	Radiated: 30 MHz to 1 GHz / 1 GHz to 5 GHz	5.1.1 / 5.1.2	-
<input type="checkbox"/>	Conducted: Antenna port	-	-

5.3.2 Test method (Antenna power for receivers)

- As described in [1] §15.111, [5] 7.5

5.3.3 Test results (Antenna power for receivers)

5.3.3.1 Test results (30 MHz – 1 GHz)

Ambient temperature:	22 °C
Relative humidity:	36 %

Date:	21.02.2023
Tested by:	Th. KÜHN

Position of EUT: For tests for f between 30 MHz to 1 GHz, the EUT was set-up on a table with a height of 80 cm. The distance between EUT and antenna was 3 m.

Cable guide: For detail information of test set-up and the cable guide refer to the pictures in the annex A in the test report.

Remark: The EUT was only tested in the dedicated position (wall mounted – see test setup photographs).

Calculations:

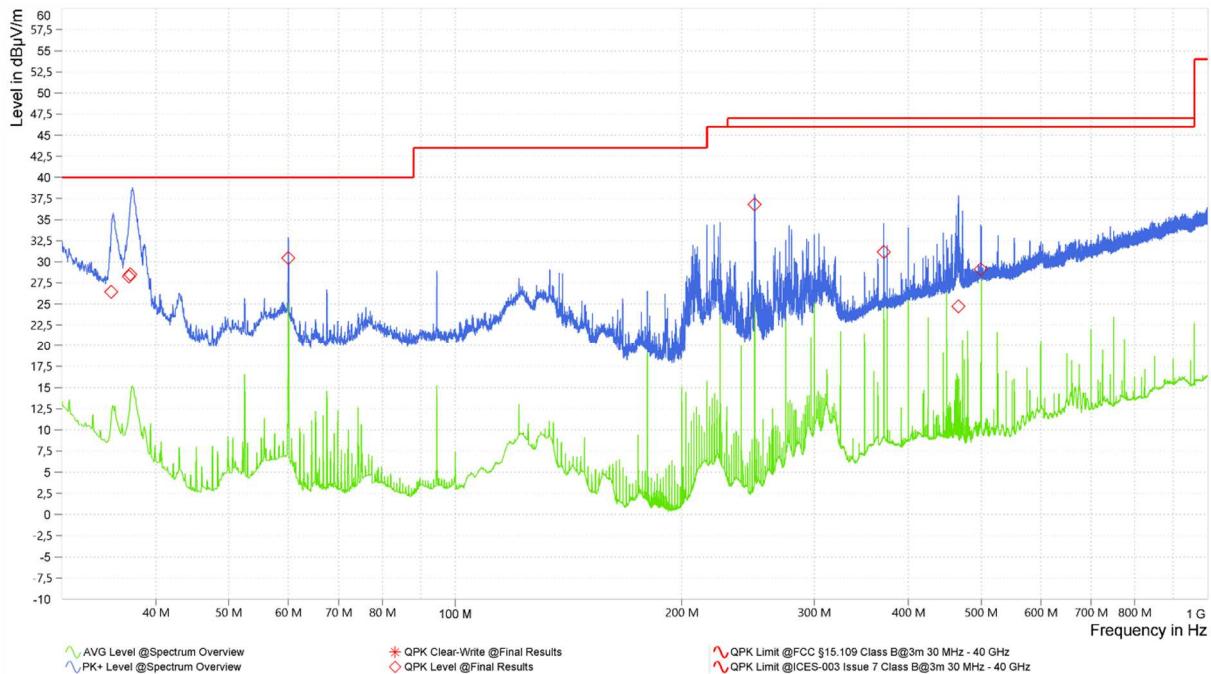
Result [$\text{dB}\mu\text{V}/\text{m}$] = Reading [$\text{dB}\mu\text{V}$] + Correction [dB/m]

Correction [dB/m] = AF [dB/m] + Cable attenuation [dB] + optional preamp gain [dB]

Margin [dB] = Limit [$\text{dB}\mu\text{V}/\text{m}$] - Result [$\text{dB}\mu\text{V}/\text{m}$]

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.

Spurious emissions from 30 MHz to 1 GHz (receive with receiver A):



Result table (receive with receiver A):

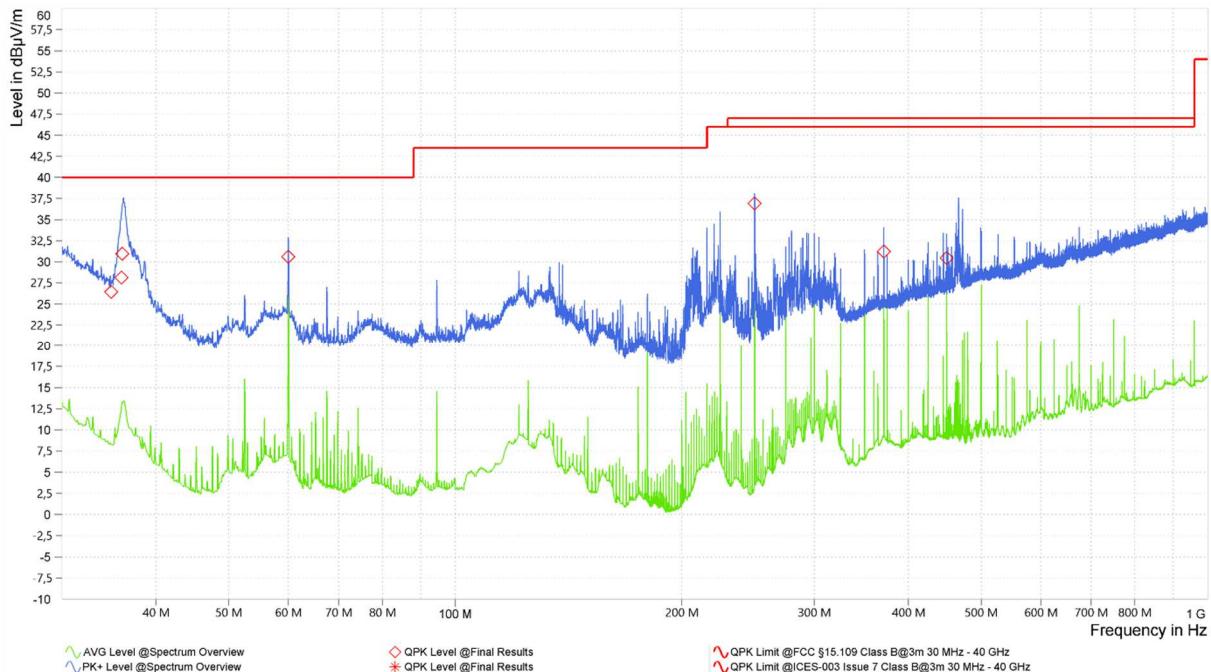
Frequency [MHz]	Result (QP) [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Readings [dBμV]	Correction [dB/m]	Height [m]	Azimuth [deg]	Pol. (H/V)
34.890	26.5	40.0	13.6	3.4	23.1	1.29	22	Hor.
36.840	28.3	40.0	11.7	6.3	22.0	1.66	74	Vert.
36.990	28.5	40.0	11.5	6.6	21.9	1.66	262	Vert.
60.000	30.4	40.0	9.6	18.1	12.4	1.58	194	Vert.
250.020	36.8	46.0	9.2	19.5	17.3	1.08	254	Hor.
371.280	31.2	46.0	14.9	10.0	21.2	1.03	204	Vert.
466.350	24.7	46.0	21.3	0.9	23.8	1.59	152	Hor.
499.530	29.1	46.0	16.9	4.6	24.5	1.11	242	Vert.

Test result: Passed

Test equipment (please refer to chapter 7 for details)

1 – 10

Spurious emissions from 30 MHz to 1 GHz (receive with receiver B):



Result table (receive with receiver B):

Frequency [MHz]	Result (QP) [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Readings [dBμV]	Correction [dB/m]	Height [m]	Azimuth [deg]	Pol. (H/V)
34.890	26.4	40	13.6	3.3	23.1	1.29	22	Hor.
36.000	28.1	40	11.9	5.6	22.5	1.43	56	Hor.
36.090	30.9	40	9.1	8.5	22.4	1.47	-7	Hor.
60.000	30.6	40	9.4	18.2	12.4	1.87	192	Vert.
250.020	36.9	46	9.1	19.6	17.3	1.06	250	Hor.
371.280	31.2	46	14.8	10	21.2	1.02	202	Vert.
450.060	30.4	46	15.6	7.3	23.1	1.15	252	Vert.

Test result: Passed

Test equipment (please refer to chapter 7 for details)

1 – 10

5.3.3.2 Test results (radiated 1 GHz to 5 GHz)

Ambient temperature:	22 °C
Relative humidity:	36 %

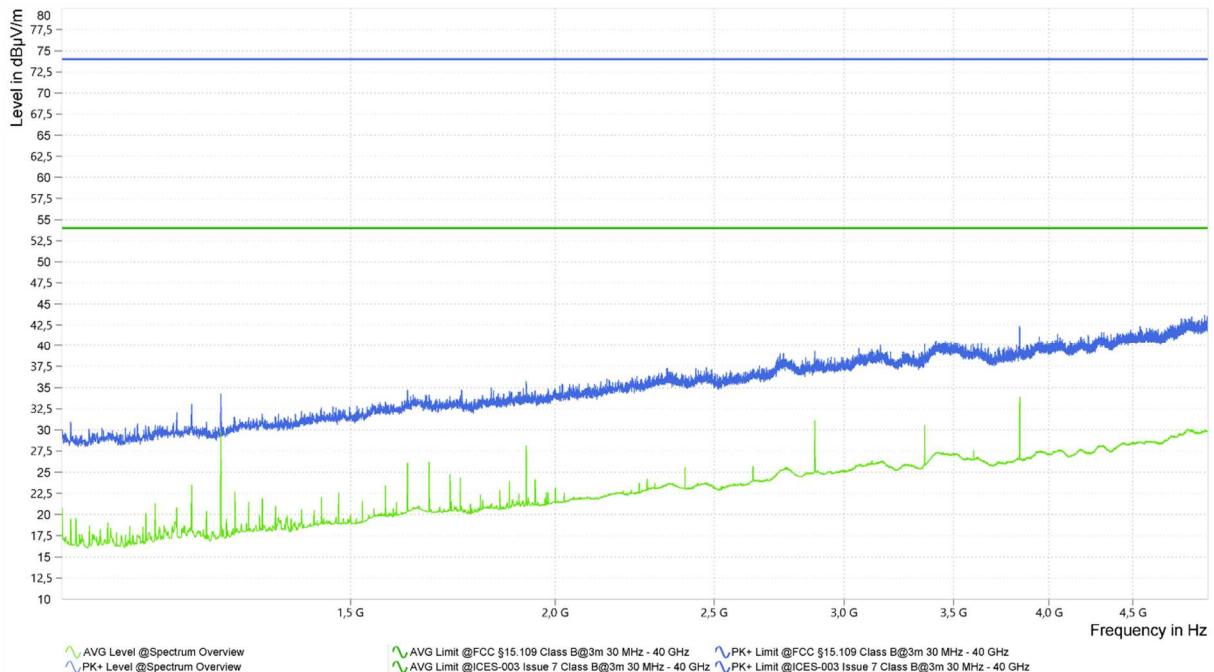
Date:	21.02.2023
Tested by:	Th. KÜHN

Position of EUT:	For tests for f between 1 GHz and the 5 th harmonic, the EUT was set-up on a table with a height of 80 cm. The distance between EUT and antenna was 3 m.
Cable guide:	For detail information of test set-up and the cable guide refer to the pictures in the annex A in the test report.
Remark:	The EUT was only tested in the dedicated position (wall mounted – see test setup photographs).
Calculation:	
Max Peak [dB μ V/m]	= Reading [dB μ V] + Correction [dB/m]
Average [dB μ V/m]	= Reading [dB μ V] + Correction [dB/m]
Correction [dB/m]	= AF [dB/m] + Cable attenuation [dB] + optional preamp gain [dB] + DCCF* [dB] * (if applicable – only for Average values, that are fundamental related)
Margin [dB]	= Limit [dB μ V/m] – Max Peak Average [dB μ V/m]

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.

Spurious emissions from 1 GHz to 5 GHz (receive with receiver A):

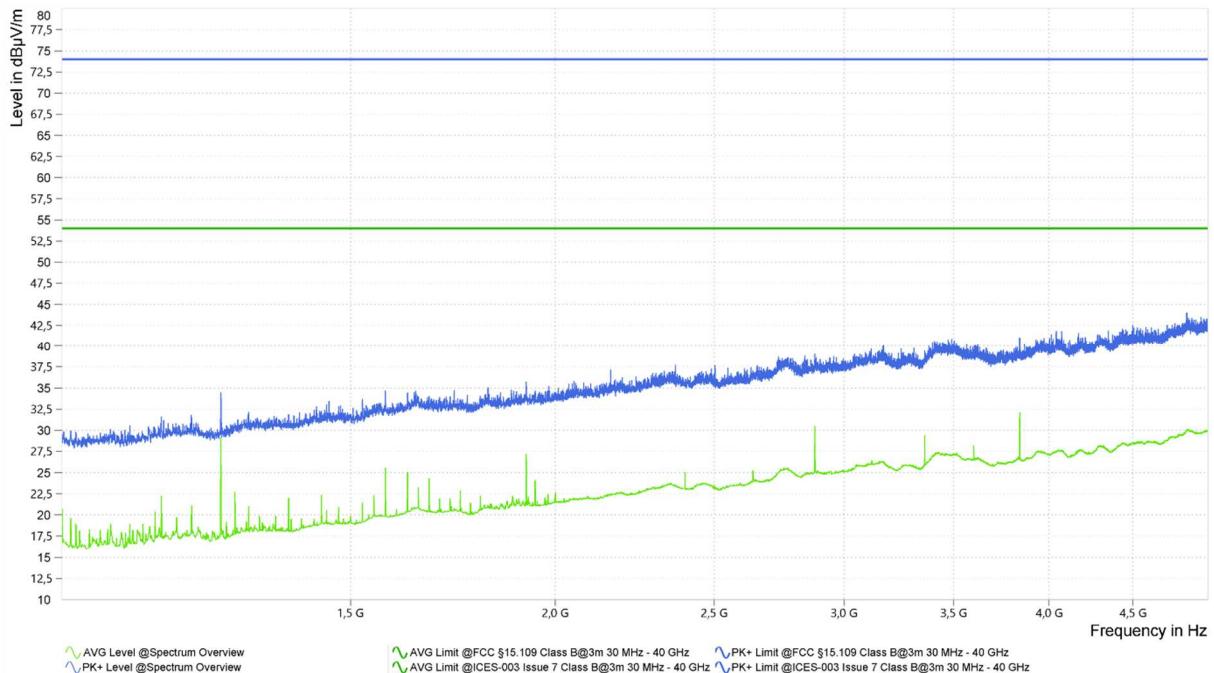


No final measurement was carried out because the peak level is already below average limit.

Test result: Passed

Test equipment (please refer to chapter 7 for details)
1 – 8, 11, 12

Spurious emissions from 1 GHz to 5 GHz (receive with receiver B):



No final measurement was carried out because the peak level is already below average limit.

Test result: Passed

Test equipment (please refer to chapter 7 for details)
1 – 8, 11, 12

5.4 AC power-line conducted emissions

5.4.1 Test setup (AC power-line conducted emissions)

Test setup (Conducted emissions on power supply lines)			
Used	Setup	See sub-clause	Comment
<input checked="" type="checkbox"/>	Conducted: AC power line	5.1.3	-
<input type="checkbox"/>	Not applicable, because ...	-	-

5.4.2 Test method (AC power-line conducted emissions)

Test setup (Conducted emissions on power supply lines)				
Used	Clause [1]	Name of method	Sub-clause	Comment
<input checked="" type="checkbox"/>	6.2	Tabletop equipment testing	5.1.3	-
<input type="checkbox"/>	6.2	Floor-standing equipment testing	-	-

Because the EUT could be supplied either by the dedicated AC/DC adaptor or via PoE, both variants were tested. The EUT was supplied either by the dedicated AC/DC adaptor Ideal power model DYS818-120150W or by an PoE injector type PowerDesine 3001. Additionally, the EUT was tested in service mode, were a USB communication was done between the EUT and the laptop PC – for this test case the measurement was carried out on the AC/DC adaptor of the laptop PC. All devices were supplied by an AC mains network with 120V_{AC} 60Hz.

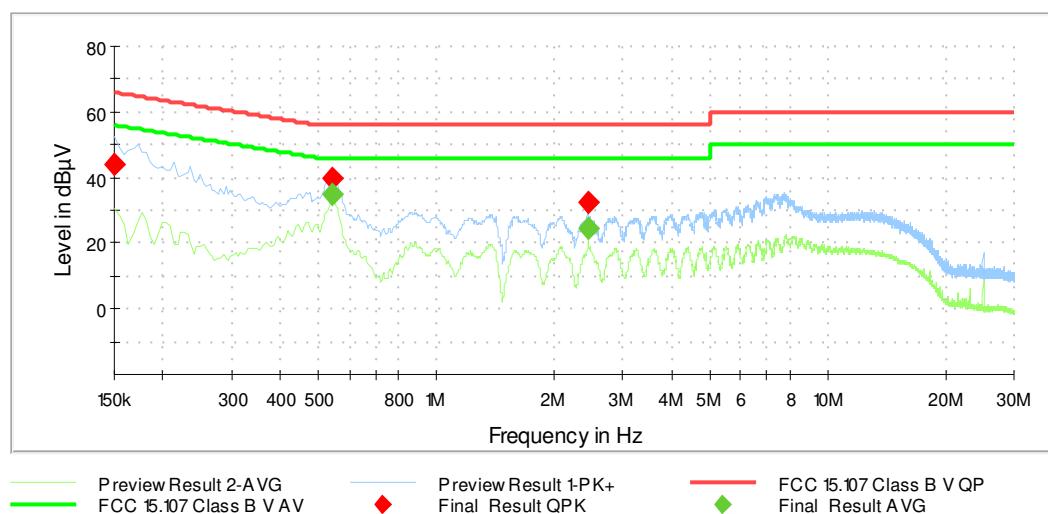
5.4.3 Test results (AC power-line conducted emissions, supplied by dedicated AC/DC adaptor)

Ambient temperature:	22 °C
Relative humidity:	36 %

Date:	22.02.2022
Tested by:	Th. KÜHN

The dedicated AC/DC adaptor provided by the applicant was used for the tests.

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 ♦.



Frequency [MHz]	QuasiPeak [dB(µV)]	Average [dB(µV)]	Limit [dB(µV)]	Margin [dB]	Line	PE	Corr. [dB]
0.150000	43.8	---	66.0	22.2	N	GND	9.8
0.539700	39.7	---	56.0	16.3	N	FLO	9.9
0.543300	---	34.8	46.0	11.2	N	FLO	9.9
2.437800	---	24.8	46.0	21.2	L1	FLO	10.2
2.438700	32.7	---	56.0	23.3	L1	FLO	10.2

Test result: Passed

Test equipment (please refer to chapter 7 for details)
13 – 17, 20

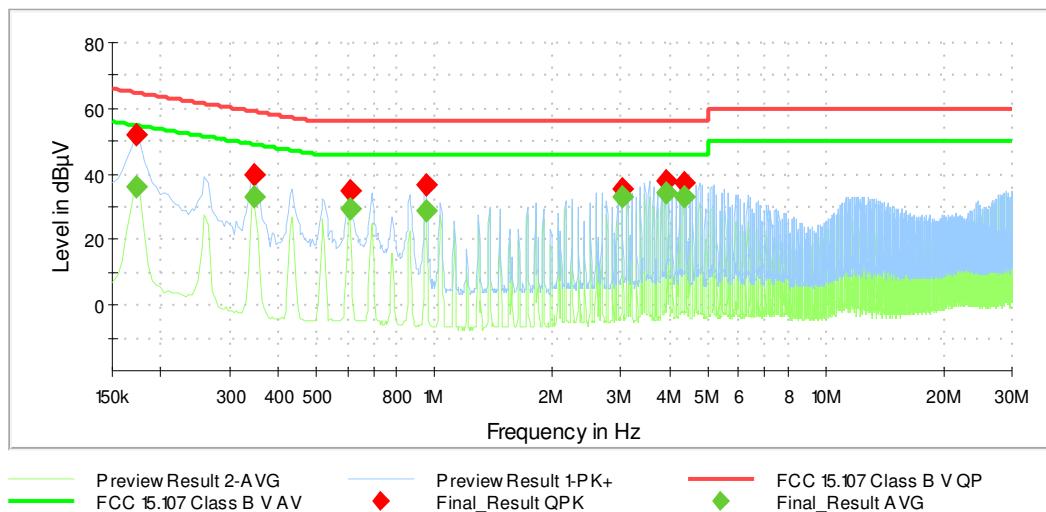
5.4.4 Test results (AC power-line conducted emissions, supplied via PoE)

Ambient temperature:	22 °C
Relative humidity:	36 %

Date:	22.02.2022
Tested by:	Th. KÜHN

A PoE injector was used for the tests.

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 .



Frequency [MHz]	QuasiPeak [dB(μV)]	Average [dB(μV)]	Limit [dB(μV)]	Margin [dB]	Line	PE	Corr. [dB]
0.172500	---	35.9	54.8	18.91	L1	FLO	9.8
	51.9	---	64.8	12.98	L1	FLO	9.8
0.346200	---	33.0	49.1	16.10	L1	FLO	9.9
	39.5	---	59.1	19.5	L1	FLO	9.9
0.605400	34.6	---	56.0	21.4	L1	FLO	9.9
	---	29.7	46.0	16.3	N	GND	9.9
0.951900	---	29.1	46.0	16.9	L1	FLO	9.9
	36.5	---	56.0	19.5	N	FLO	9.9
3.027300	35.5	---	56.0	20.5	L1	FLO	10.2
3.028200	---	32.8	46.0	13.2	L1	FLO	10.2
3.891300	37.7	---	56.0	18.3	L1	FLO	10.3
3.894000	---	34.1	46.0	11.9	L1	FLO	10.3
4.325100	37.6	---	56.0	18.4	L1	FLO	10.3
4.326900	---	33.2	46.0	12.8	L1	FLO	10.3

Test result: Passed

Test equipment (please refer to chapter 7 for details)
13 – 18, 20

5.4.5 Test results (AC power-line conducted emissions, service mode, USB communication)

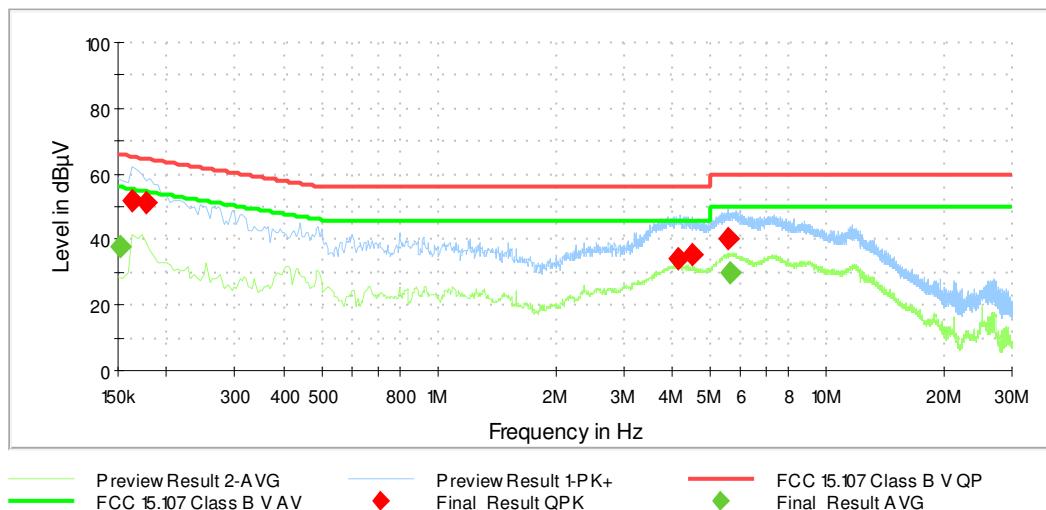
Ambient temperature:	22 °C
Relative humidity:	25 %

Date:	06.03.2023
Tested by:	Th. KÜHN

The dedicated AC/DC adaptor of the laptop PC and of the EUT were used. The measurement was carried out on the AC supply line of the PCs AC/DC adaptor.

Both adaptors were supplied by 120V_{AC} 60Hz.

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 ♦.



Frequency [MHz]	QuasiPeak [dB(μV)]	Average [dB(μV)]	Limit [dB(μV)]	Margin [dB]	Line	PE	Corr. [dB]
0.150900	---	37.7	56.0	18.3	L1	FLO	9.8
0.163500	51.6	---	65.3	13.7	L1	FLO	9.8
0.177900	51.3	---	64.6	13.3	N	GND	9.8
4.160400	34.4	---	56.0	21.6	L1	FLO	10.3
4.505100	35.1	---	56.0	20.9	N	GND	10.3
5.590500	40.4	---	60.0	19.6	L1	FLO	10.3
5.653500	---	29.7	50.0	20.3	L1	GND	10.4

Test result: Passed

Test equipment (please refer to chapter 7 for details)
13 – 17, 19, 20

6 Measurement Uncertainties

Conducted measurements		
Measurement method	Standard used for calculating measurement uncertainty	Expanded measurement uncertainty (95 %) U_{lab}
Conducted emissions from 150 kHz to 30 MHz with LISN	CISPR 16-4-2	2.8 dB

Radiated measurements		
Radiated field strength M276		
R&S HL562E @ 3 m 30 MHz – 1 GHz	CISPR 16-4-2	4.8 dB
R&S HL050 @ 3 m	-	
1 – 6 GHz	CISPR 16-4-2	5.1 dB
6 – 18 GHz	CISPR 16-4-2	5.4 dB
Flann Standard Gain Horns 18 – 40 GHz	-	5.9 dB

7 Test Equipment used for Tests

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal Due
1	Signal & Spectrum Analyzer	FSW43	Rohde & Schwarz	100586 & 100926	481720	19.11.2021	11.2023
2	RF Switch Matrix	OSP220	Rohde & Schwarz	-	482976	Calibration not necessary	
3	Turntable	TT3.0-3t	Maturo	825/2612/01	483224	Calibration not necessary	
4	Antennasupport	BAM 4.5-P-10kg	Maturo	222/2612.01	483225	Calibration not necessary	
5	Controller	NCD	Maturo	474/2612.01	483226	Calibration not necessary	
6	Semi Anechoic Chamber M276	SAC5-2	Albatross Projects	C62128-A540-A138-10-0006	483227	Calibration not necessary	
7	EMI Testreceiver	ESW44	Rohde & Schwarz	101828	482979	08.12.2021	12.2023
8	Test software M276	Elektra	Rohde & Schwarz	101381	483755	Calibration not necessary	
9	Attenuator 6 dB	WA2-6	Weinschel	-	482793	Calibration not necessary	
10	Ultralog Antenna	HL562E	Rohde & Schwarz	101079	482978	18.03.2021	03.2024
11	Low Noise Amplifier 100 MHz - 18 GHz	LNA-30-00101800-25-10P	Narda-Miteq	2110917	482967	18.02.2022	02.2024
12	Log.-Per. antenna	HL050	Rohde & Schwarz	100908	482977	22.09.2022	09.2025
13	Transient Filter Limiter	CFL 9206A	Teseq	38268	481982	15.02.2022	02.2024
14	LISN	NSLK8128	Schwarzbeck	8128161	480138	15.02.2022	02.2024
15	Software	EMC32	Rohde & Schwarz	100061	481022	Calibration not necessary	
16	Shielded chamber M4	B83117-S1-X158	Siemens	190075	480088	Calibration not necessary	
17	EMI Receiver / Spectrum Analyser	ESIB 26	Rohde & Schwarz	100292	481182	16.02.2022	02.2024
18	Coupling / decoupling network	CDN EMV-ETH S B	PHOENIX TESTLAB	-	480449	Calibration not necessary	
19	LISN	MN2050B	Chase	1133	480146	15.02.2022	02.2024
20	Shielded chamber M4	B83117-S1-X158	Siemens	190075	480088	Calibration not necessary	

8 Test site Verification

Test equipment	PM. No.	Frequency range	Type of validation	According to	Val. Date	Val Due
Shielded chamber M4	480088	9 kHz – 30 MHz	GND-Plane	ANSI C63.4-2014	12.05.2020	11.05.2023
Semi anechoic chamber M276	483227	30 – 1000 MHz	NSA/RSM	CISPR 16-1-4 + Cor1:2010 + A1:2012 +A2:2017	03.03.2021	02.03.2023
Semi anechoic chamber M276	483227	1 -18 GHz	SVSWR	CISPR 16-1-4 + Cor1:2010 + A1:2012 +A2:2017	25.02.2021	24.02.2023

9 Report History

Report Number	Date	Comment
F221513E4	15.03.2023	Initial Test Report
-	-	-
-	-	-

10 List of Annexes

Annex A

Test Setup Photos

9 pages