

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:

F240018E5 2nd version

Equipment under Test (EUT):

**Bluetooth 5 LE Module BlueMod+S50 inside
Host SensorLink 1000 Cat-M1 - Global**

Applicant:

OTT Hydromet GmbH

Manufacturer:

OTT Hydromet GmbH



References

- [1] **ANSI C63.10-2020**, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
- [2] **FCC CFR 47 Part 15**, Radio Frequency Devices
- [3] **558074 D01 15.247 Meas Guidance v05r02 (April 2019)**, GUIDANCE FOR COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEM, FREQUENCY HOPPING SPREAD SPECTRUM SYSTEM, AND HYBRID SYSTEM DEVICES OPERATING UNDER SECTION 15.247 OF THE FCC RULES

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 [1]. However, the measurement uncertainty is calculated and shown in this test report.

Tested and written
by:

Signature

Reviewed and
approved by:

Signature

This test report is only valid in its original form.

Any reproduction of its contents in extracts without written permission of the accredited test laboratory PHOENIX TESTLAB GmbH is prohibited.

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 | 5 |
| 1.1 Applicant..... | 5 |
| 1.2 Manufacturer | 5 |
| 1.3 Test Laboratory | 5 |
| 1.4 EUT (Equipment under Test) | 6 |
| 1.5 Technical Data of Equipment | 7 |
| 1.5.1 Ancillary Equipment / Equipment used for testing..... | 8 |
| 1.6 Dates | 8 |
| 2 Operational States | 9 |
| 3 Additional Information | 9 |
| 4 Overview..... | 10 |
| 5 Results..... | 11 |
| 5.1.1 Radiated: 1 GHz to 40 GHz..... | 11 |
| 5.1.1.1 Preliminary and final measurement 1 GHz to 40 GHz | 11 |
| 5.1.2 Conducted: Antenna port..... | 12 |
| 5.2 DTS band-edge emission measurements..... | 13 |
| 5.2.1 Test method (Band edge – restricted bands) | 13 |
| 5.2.2 Test results (Band edge – restricted bands) | 13 |
| 5.2.2.1 Test results (radiated 1 GHz to 40 GHz) | 15 |
| 6 Measurement Uncertainties | 18 |
| 7 Test Equipment used for Tests | 19 |
| 8 Test site Verification..... | 20 |
| 9 Report History | 20 |
| 10 List of Annexes | 20 |

1 Identification

1.1 Applicant

| | |
|----------------------------------------------------------------|--------------------------------|
| Name: | OTT Hydromet GmbH |
| Address: | Ludwigstr. 16, 87437 Kempten |
| Country: | Germany |
| Name for contact purposes: | Mr. Manfred KÖNIG |
| Phone: | +49 831 5617 312 |
| eMail address: | manfred.koenig@otthydromet.com |
| Applicant represented during the test by the following person: | None |

1.2 Manufacturer

| | |
|-------------------------------------------------------------------|--------------------------------|
| Name: | OTT Hydromet GmbH |
| Address: | Ludwigstr. 16, 87437 Kempten |
| Country: | Germany |
| Name for contact purposes: | Mr. Manfred KÖNIG |
| Phone: | +49 831 5617 312 |
| eMail address: | manfred.koenig@otthydromet.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) according to DIN EN ISO/IEC 17025:2018. The accreditation is only valid for the scope of accreditation listed in the annex of the certificate D-PL-17186-01-00. 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: * | Bluetooth 5 LE Module BlueMod+S50 inside Host SensorLink 1000 Cat-M1 - Global | | |
| Model number: * | BlueMod+S50 | | |
| FCC ID: * | OA6-S50 | | |

| | Host number | | |
|---------------------|---------------------------------|---|---|
| | 1 | 2 | 3 |
| Model number: * | SensorLink 1000 Cat-M1 - Global | - | - |
| Serial number: * | SL1K-100016 | - | - |
| PCB identifier: * | 55.460.101.3.2 | - | - |
| Hardware version: * | B/0 | - | - |
| Software version: * | V0.00.007 | - | - |

* 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 | | | | |
|------------------------|----------------------------------------------|----------------------------------------------|----------------------------------------------|--|
| Power supply Host: * | DC NiMH Akku | | | |
| Supply voltage Host: * | $U_{\text{nom}} = 6.0 \text{ V}_{\text{DC}}$ | $U_{\text{min}} = 5.5 \text{ V}_{\text{DC}}$ | $U_{\text{max}} = 9.0 \text{ V}_{\text{DC}}$ | |
| Temperature range: * | -30 °C to +85 °C | | | |

* Declared by the applicant

| Ports / Connectors | | | | |
|--------------------|------------------|-------------|--------------------|----------------------|
| Identification | Connector | | Length during test | Shielding (Yes / No) |
| | EUT | Ancillary | | |
| Sensor | 7 pole connector | 7 pole plug | > 10 m | yes |
| Solar | 5 pole connector | 5 pole plug | 10 m | yes |
| - | - | - | - | - |

| Bluetooth® low energy frequencies | | | |
|-----------------------------------|----------|------------|----------|
| Channel 00 | 2402 MHz | Channel 01 | 2404 MHz |
| Channel 02 | 2406 MHz | Channel 03 | 2408 MHz |
| ... | ... | ... | ... |
| ... | ... | ... | ... |
| Channel 18 | 2438 MHz | Channel 19 | 2440 MHz |
| ... | ... | ... | ... |
| ... | ... | ... | ... |
| Channel 36 | 2474 MHz | Channel 37 | 2476 MHz |
| Channel 38 | 2478 MHz | Channel 39 | 2480 MHz |

| EUT | | |
|---------------------------------|---------------------------------------------|----------------------------|
| Fulfils radio specification: *1 | Bluetooth® low energy (BLE) 5.0 | |
| Radio Module: *1 | Bluemod+S50 | |
| Antenna type: *1 | Dual-Band WiFi External Panel-Mount Antenna | |
| Antenna name: *1 | ANT-2.4-CW-QW | |
| Antenna gain: *1 | Peak: 1.1 dBi | |
| Antenna connector: *1 | RP-SMA | |
| Supply voltage BT module: *1 | By host | |
| Type of modulation: *1 | BLE (2 Mbps PHY) | GFSK |
| Operating frequency range: *1 | BLE (2 Mbps PHY) | 2402 – 2480 MHz |
| Number of channels: *1 | BLE (2 Mbps PHY) | 40 (2 MHz channel spacing) |

*1 declared by the applicant

1.5.1 Ancillary Equipment / Equipment used for testing

| Equipment used for testing | |
|----------------------------|-------------------------------------|
| Test Laptop * ² | Fujitsu Lifebook SN:26391-K471-V100 |
| - | - |

*¹ Provided by the applicant

*² Provided by the laboratory

| Ancillary Equipment | |
|-----------------------------|------------------|
| Solar panel * ¹ | 5 W, 9 V, 540 mA |
| Hydro sensor * ¹ | PLS 500 |
| - | - |

*¹ Provided by the applicant

*² Provided by the laboratory

1.6 Dates

| | |
|---------------------------------|------------|
| Date of receipt of test sample: | 24.05.2024 |
| Start of test: | 17.09.2024 |
| End of test: | 18.09.2024 |

2 Operational States

A connection to the EUT was established with a Laptop via Bluetooth. The respective BLE test mode was enabled via a software called "OTT Water Logger Operating Program 2" provided by the applicant. This mode represents the worst-case test mode as per module certification as declared by the manufacturer.

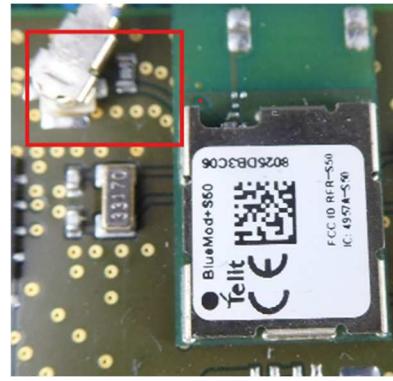
| Operation mode # | Radio technology | Frequency [MHz] | Channel / Band | Modulation / Mode | Data rate | Power setting |
|------------------|------------------|-----------------|----------------|-------------------|-----------|---------------|
| 1 | Bluetooth® LE | 2480 | 39 | GFSK | 2 Mbit/s | +3 dBm* |

The maximum output power of the radio chip is +4 dBm.

(*) The power settings have been reduced to comply with the limits of 15.209. The highest peak conducted output power has been verified with a value of 2.4 dBm, which complies with the power setting of 3 dBm used.

3 Additional Information

The applicant has integrated the already certified Bluetooth module with the FCC ID OA6-S50 in its host using a new trace design and the output power has been reduced to comply with the spurious emissions. Therefore, integration spot checks have been requested to apply for a class 2 permissive change.



EUT antenna trace design



Host SensorLink 1000 Cat-M1 – Global

At the time of testing, the EUT and the host device were not labeled as required by FCC.

4 Overview

| Application | Frequency range [MHz] | FCC 47 CFR Part 15 section [2] | RSS-247 [4] RSS-Gen [5] | Tested EUT | Status |
|-------------------------------------|-----------------------|----------------------------------------|-----------------------------|------------|----------------------------------|
| Maximum peak conducted output power | 2400.0 - 2483.5 | 15.247 (b) (3), (4) | 5.4 (d) [4] | - | Verified |
| Maximum conducted output power | 2400.0 - 2483.5 | 15.247 (b) (3), (4) | 5.4 (d) [4] | - | Not tested |
| DTS Bandwidth / 99% Bandwidth | 2400.0 - 2483.5 | 15.247 (a) (2) | 5.2 (a) [4] | - | Not tested |
| Peak Power Spectral Density | 2400.0 - 2483.5 | 15.247 (e) | 5.2 (b) [4] | - | Not tested |
| Average Power Spectral Density | 2400.0 - 2483.5 | 15.247 (e) | 5.2 (b) [4] | - | Not tested |
| Band edge compliance | 2400.0 - 2483.5 | 15.247 (d) 15.205 (a) 15.209 (a) | 5.5 [4] | 1 | Passed |
| Maximum unwanted emissions | 1,000 – 26,500* | 15.247 (d) 15.205 (a) 15.209 (a) | 8.9 [5] | 1 | Passed* |
| Antenna Requirement | - | 15.203 15.247 (b) | 6.8 [5] 5.4 (f) (ii) [4] | 1 | Passed |
| Conducted emissions on supply line | 0.15 – 30 | 15.207 (a) | 8.8 [5] | - | Not applicable (Battery powered) |

*: As declared by the applicant the highest operating frequency is 2.480 GHz.
Therefore, the radiated emission measurement must be carried out up to 10th in this case 26.5 GHz.

5 Results

5.1.1 Radiated: 1 GHz to 40 GHz

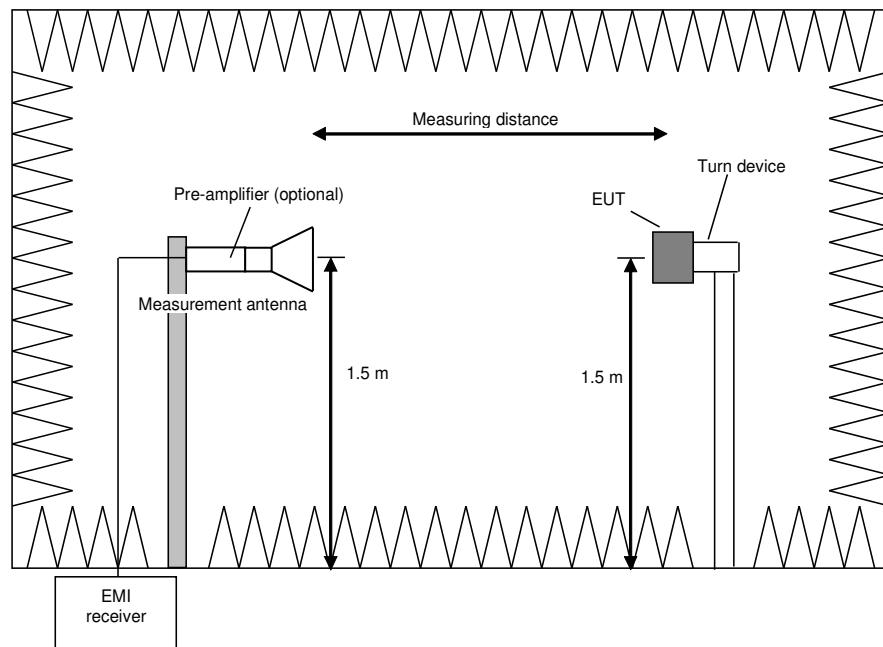
5.1.1.1 Preliminary and final measurement 1 GHz to 40 GHz

The preliminary and final measurements are performed in a fully anechoic chamber at a measuring distance of 3 meters. Table-top devices are set up on a non-conducting turn device at the height of 1.5 m. 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 ° and the measuring antenna is set to horizontal and vertical polarization to find the maximum level of emissions. After these steps, the measurement is repeated after reorientating the EUT in 30 ° steps.

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 GHz - 40 GHz | 250 kHz | 1 MHz | - | Peak Average |
| Final measurement | 1 GHz - 40 GHz | - | 1 MHz | 100 ms | Peak Average |



Procedure preliminary measurement:

The following procedure is used:

- 1) Monitor the frequency range at horizontal polarisation of the measuring antenna and an EUT / turntable azimuth of 0 °.
- 2) Rotate the EUT by 360° to maximize the detected signals.
- 3) Repeat steps 1 to 2 with the vertical polarisation of the measuring antenna.
- 4) Repeat steps 1 to 3 with the EUT reorientated by an angle of 30° (60°, 90°, 120° and 150°), according to 6.6.5.4 in [1].
- 5) The highest values for each frequency are saved by the software, including the measuring antenna polarization, the turntable azimuth and the turn device elevation for that value.

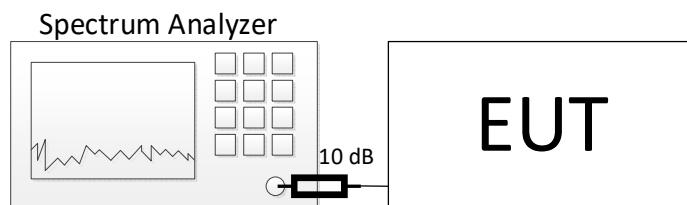
Procedure final measurement:

The following procedure is used:

- 1) Set the turntable and the turn device to the position which leads to the highest emission for the first frequency identified in the preliminary measurements.
- 2) Set the measurement antenna to the polarisation which leads to the highest emission for the first frequency identified in the preliminary measurements.
- 3) Set the spectrum analyser to EMI mode with Peak and Average detector activated.
- 4) 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.
- 5) The final measurement is performed at the worst-case turntable azimuth.
- 6) Repeat steps 1 to 5 for each frequency detected during the preliminary measurements.

5.1.2 Conducted: Antenna port

| Test setup (conducted) | | |
|--------------------------|-----------------------------|------------------------------|
| Used | Antenna connector | Comment |
| <input type="checkbox"/> | Temporary antenna connector | As provided by the applicant |
| <input type="checkbox"/> | Normal antenna connector | - |



The 10 dB external attenuation are considered in all relevant plots

5.2 DTS band-edge emission measurements

5.2.1 Test method (Band edge – restricted bands)

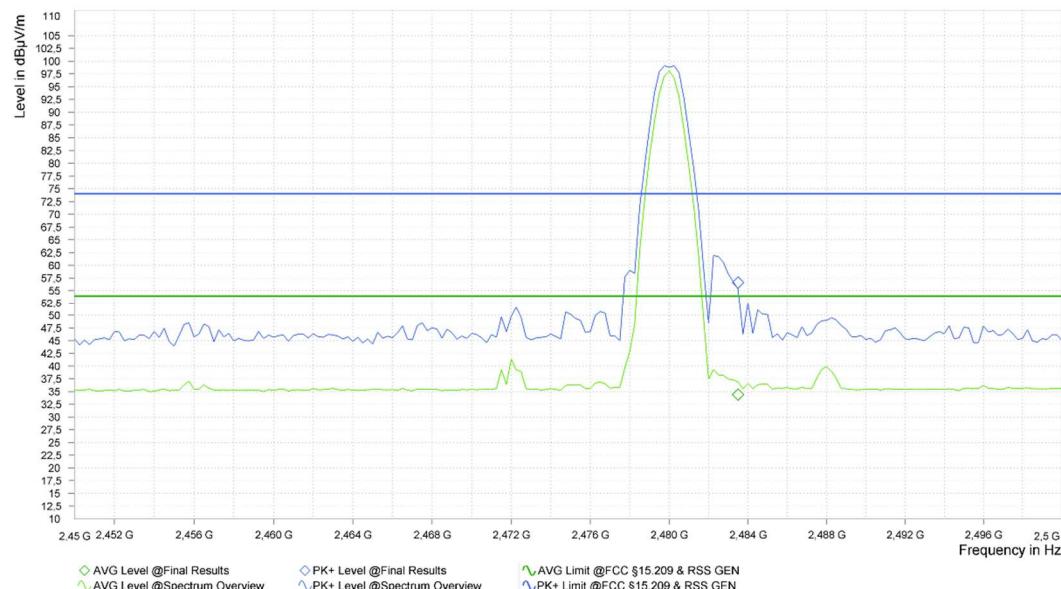
| Test method (Band edge – restricted bands) | | | | |
|--------------------------------------------|----------------|---------------------|----------------|-----------------------------------|
| Used | Sub-Clause [1] | Name of method | Applicability | Comment |
| <input checked="" type="checkbox"/> | 11.12.1 | Standard method | No limitations | |
| <input type="checkbox"/> | 11.12.3.1 | Marker-delta method | | See 6.10.6 [3] 2 MHz from band |
| <input type="checkbox"/> | 11.12.3.2 | Integration method | | 2 MHz from band |

5.2.2 Test results (Band edge – restricted bands)

| | |
|----------------------|-------|
| Ambient temperature: | 22 °C |
| Relative humidity: | 50 % |

| | |
|------------|------------|
| Date: | 16.09.2024 |
| Tested by: | Y. KHALEK |

Worst case plot upper band edge:



Upper band edge (operation mode 1):

| Frequency [MHz] | Result (Pk) [dB(µV/m)] | Result (Av) [dB(µV/m)] | Limit [dB(µV/m)] | Margin [dB] |
|--------------------|------------------------------|------------------------------|---------------------|----------------|
| 2483.500 | 56.60 | - | 74.00 | 17.40 |
| 2483.500 | - | 34.39 | 54.00 | 19.61 |

Test result: Passed

Test equipment (please refer to chapter 7 for details)

1-7, 9

5.2.2.1 Test results (radiated 1 GHz to 40 GHz)

| | |
|----------------------|-------|
| Ambient temperature: | 22 °C |
| Relative humidity: | 50 % |

| | |
|------------|------------|
| Date: | 16.09.2024 |
| Tested by: | Y. KHALEK |

Position of EUT: For tests for f between 1 GHz and the 10th harmonic, the EUT was set-up on a tower with a height of 150 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.

Test record: Plots for each frequency range are submitted below.

Remark: -

Calculation:

Max Peak [dB μ V/m] = Reading [dB μ V] + Correction [dB μ V/m]

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

Correction [dB μ V/m] = AF [dB/m] + Cable attenuation [dB] + optional preamp gain [dB] + DCCF* [dB]
* (if applicable – only for Average values, that are fundamental related)

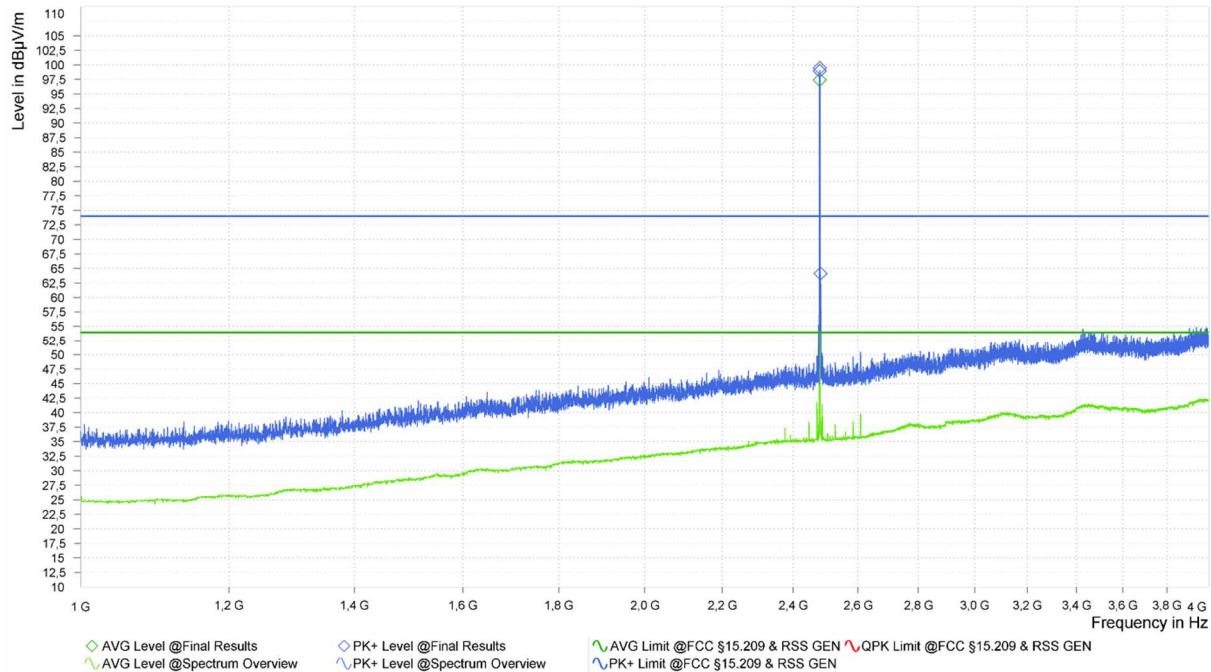
Margin [dB] = Limit [dB μ V/m] – Max Peak | Average [dB μ V/m]

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.

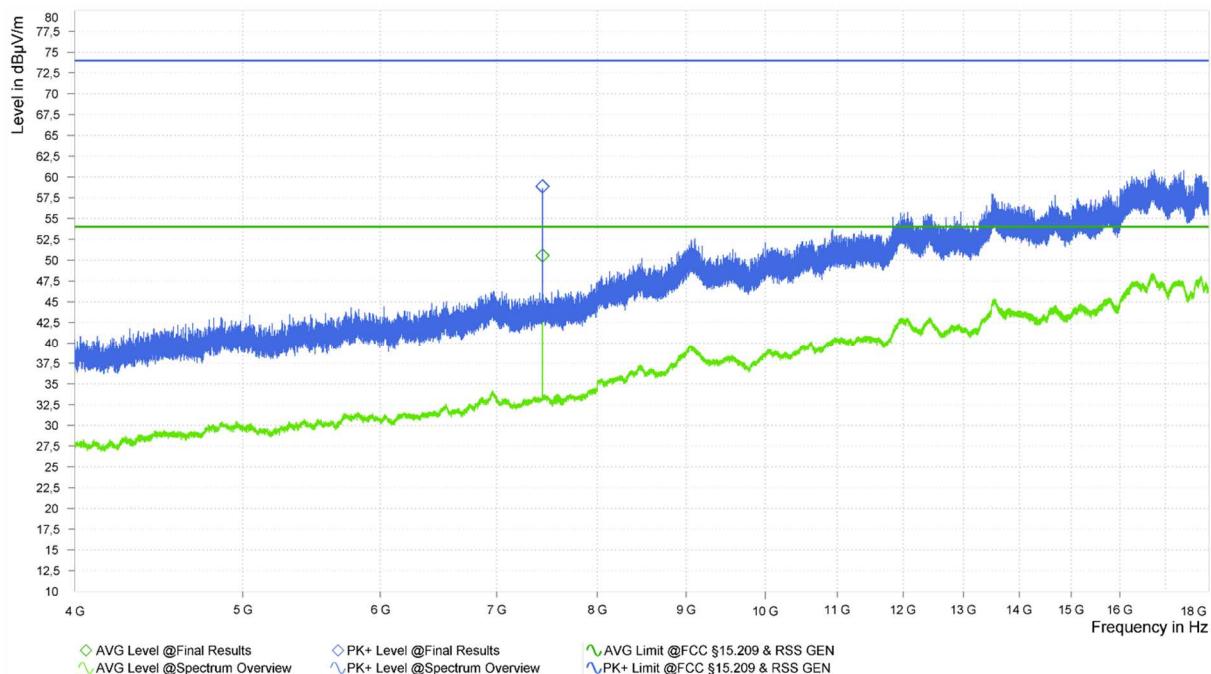
The top measured curve represents the peak measurement. The measured points marked with "◇" are frequency points for the final peak detector measurement. These values are indicated in the following table. The bottom measured curve represents the average measurement. The measured points marked with "◇" are frequency points for the final average detector measurement.

Worst case plots:

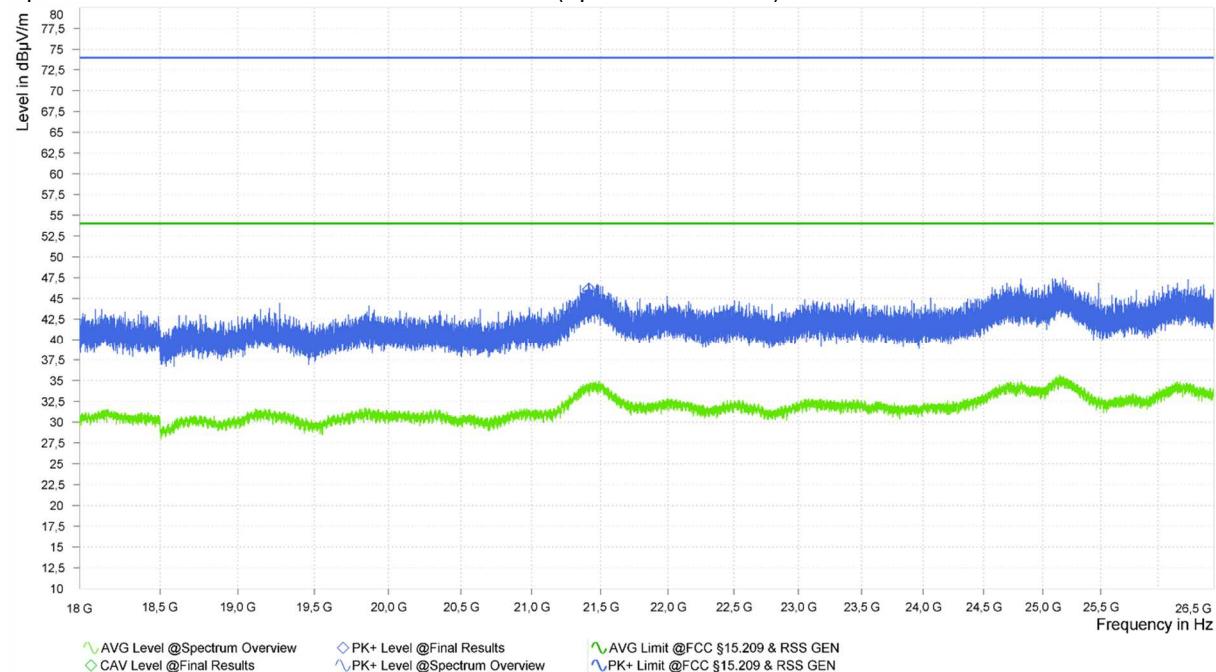
Spurious emissions from 1 GHz to 4 GHz (operation mode 1):



Spurious emissions from 4 GHz to 18 GHz (operation mode 1):



Spurious emissions from 18 GHz to 26.5 GHz (operation mode 1):



Result tables:

Operation mode 1:

| Frequency [MHz] | MaxPeak [dB(μV/m)] | PK Limit [dB(μV/m)] | PK Margin [dB(μV/m)] | Average [dB(μV/m)] | AVG Limit [dB(μV/m)] | AVG Margin [dB(μV/m)] | Pol [H/V] | Azimuth [deg] | Antenna Height [m] | Corr. [dB] |
|-----------------|--------------------|---------------------|----------------------|--------------------|----------------------|-----------------------|-----------|---------------|--------------------|------------|
| 7439.25 | - | - | - | 50.54 | 54.00 | 3.46 | V | 361 | 1.91 | 13.76 |
| 7439.25 | 58.84 | 74.00 | 15.16 | - | - | - | V | 360 | 1.80 | 13.76 |
| 7440.75 | - | - | - | 50.56 | 54.00 | 3.44 | V | 367 | 1.83 | 13.77 |
| 7440.75 | 58.90 | 74.00 | 15.10 | - | - | - | V | 364 | 1.90 | 13.77 |
| 21415.5 | 46.07 | 74.00 | 27.93 | - | - | - | V | 365 | 1.50 | 12.39 |

Test result: Passed

Test equipment (please refer to chapter 7 for details)

1-10

6 Measurement Uncertainties

| Conducted measurements | | |
|------------------------------------------------------|-------------------------------------------------------|---------------------------------------------------|
| Measurement method | Standard used for calculating measurement uncertainty | Expanded measurement uncertainty (95 %) U_{lab} |
| Frequency error | ETSI TR 100 028 | 4.5×10^{-8} |
| Bandwidth measurements | - | 9.0×10^{-8} |
| Conducted emissions using a spectrum analyzer | | |
| < 3.6 GHz | ETSI TR 100 028 | 2.3 dB |
| 3.6 – 8 GHz | ETSI TR 100 028 | 2.8 dB |
| 8 – 22 GHz | ETSI TR 100 028 | 3.2 dB |
| 22 – 40 GHz | ETSI TR 100 028 | 3.6 dB |
| Power measurements | | |
| Power meter | ETSI TR 100 028 | 0.9 dB |
| Conducted emissions from 150 kHz to 30 MHz with LISN | | |
| | CISPR 16-4-2 | 2.8 dB |

| Radiated measurements | | |
|-----------------------------------------------------------------------|-----------------|----------------------|
| Frequency error | | |
| (Semi-) Anechoic chamber | ETSI TR 100 028 | 4.5×10^{-8} |
| OATS | ETSI TR 100 028 | 4.5×10^{-8} |
| Test fixture | ETSI TR 100 028 | 4.5×10^{-8} |
| Bandwidth measurements | | |
| (Semi-) Anechoic chamber | - | 9.0×10^{-8} |
| OATS | - | 9.0×10^{-8} |
| Test fixture | - | 9.1×10^{-8} |
| Radiated field strength M20 | | |
| CBL6112B @ 3 m 30 MHz – 1 GHz | CISPR 16-4-2 | 5.3 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 12 – 40 GHz | - | 5.9 dB |
| 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 12 – 40 GHz | - | 5.9 dB |
| OATS | | |
| Field strength measurements below 30 MHz on OATS without ground plane | - | 4.4 dB |

7 Test Equipment used for Tests

| No. | Test equipment | Type | Manufacturer | Serial No. | PM. No. | Cal. Date | Cal Due |
|-----|--------------------------------------|------------------------|--------------------|--------------------------|---------|---------------------------|---------|
| 1 | RF Switch Matrix | OSP220 | Rohde & Schwarz | - | 482976 | Calibration not necessary | |
| 2 | Turntable | TT3.0-3t | Maturo | 825/2612/01 | 483224 | Calibration not necessary | |
| 3 | Antenna support | BAM 4.5-P-10kg | Maturo | 222/2612.01 | 483225 | Calibration not necessary | |
| 4 | Controller | NCD | Maturo | 474/2612.01 | 483226 | Calibration not necessary | |
| 5 | Semi Anechoic Chamber M276 | SAC5-2 | Albatross Projects | C62128-A540-A138-10-0006 | 483227 | Calibration not necessary | |
| 6 | Software M276 | Elektra version 5.05 | Rohde & Schwarz | 101381 | 483755 | Calibration not necessary | |
| 7 | EMI Test receiver | ESW44 | Rohde & Schwarz | 101828 | 482979 | 21.02.2024 | 02.2026 |
| 8 | Low Noise Amplifier 100 MHz - 18 GHz | LNA-30-00101800-25-10P | Narda-Mited | 2110917 | 482967 | 20.02.2024 | 02.2026 |
| 9 | Log.-Per. antenna | HL050 | Rohde & Schwarz | 100908 | 482977 | 22.09.2022 | 09.2025 |
| 10 | High-pass filter | WHKX4.0/18G-8SS | Wainwright | 1 | 480587 | Calibration not necessary | |

8 Test site Verification

| 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 C63.4-2014 ANSI C63.4a-2017 | 01.03.2023 | 28.02.2026 |
| Semi anechoic chamber M276 | 483227 | 1 -18 GHz | SVSWR | CISPR 16-1-4 + Cor1:2010 + A1:2012 +A2:2017 | 28.02.2023 | 27.02.2026 |

9 Report History

| Report Number | Date | Comment |
|-----------------------------------|------------|-------------------------------------------------------------------------|
| F240018E5 | 27.11.2024 | Initial Test Report |
| F240018E5 2 nd version | 16.12.2024 | Page 9: Added the information, that the output power has been verified. |
| - | - | - |

10 List of Annexes

Annex A Test Setup Photos 2 pages

----- end of test report -----