

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



Deutsche
Akkreditierungsstelle
D-PL-17186-01-00

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:



Mohamed Yassine Khalek
16.12.2024

Signature

Reviewed and
approved by:



Manuel BASTERT
16.12.2024

Signature

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1 Identification

1.1 Applicant

Name:	OTT Hydromet GmbH
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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: *	$U_{nom} = 6.0 \text{ V}_{DC}$	$U_{min} = 5.5 \text{ V}_{DC}$	$U_{max} = 9.0 \text{ V}_{DC}$
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	
Fulfil 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.

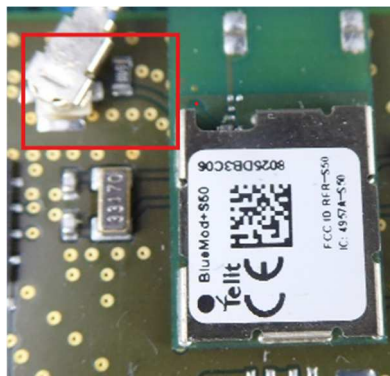
Operation mode #	Radio technology	Frequency [MHz]	Channel / Band	Modulation / Mode	Data rate	Power setting
1	Bluetooth® LE	2480	39	GFSK	2 Mbit/s	+3 dBm*

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

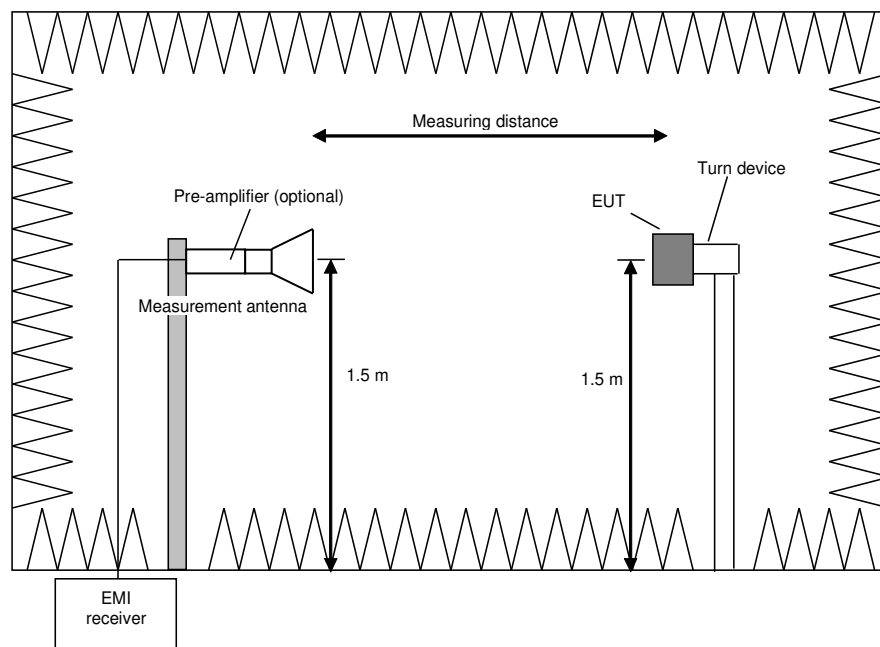
5.1.1.1 Preliminary and final measurement 1 GHz to 40 GHz

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.

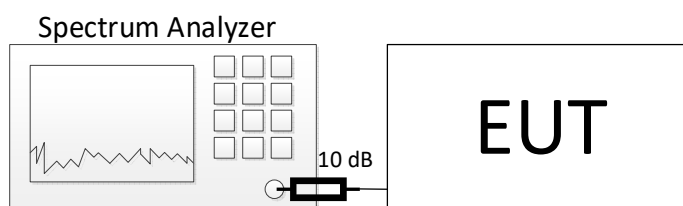
Procedure final measurement:

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
☐	Temporary antenna connector	As provided by the applicant
☐	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)

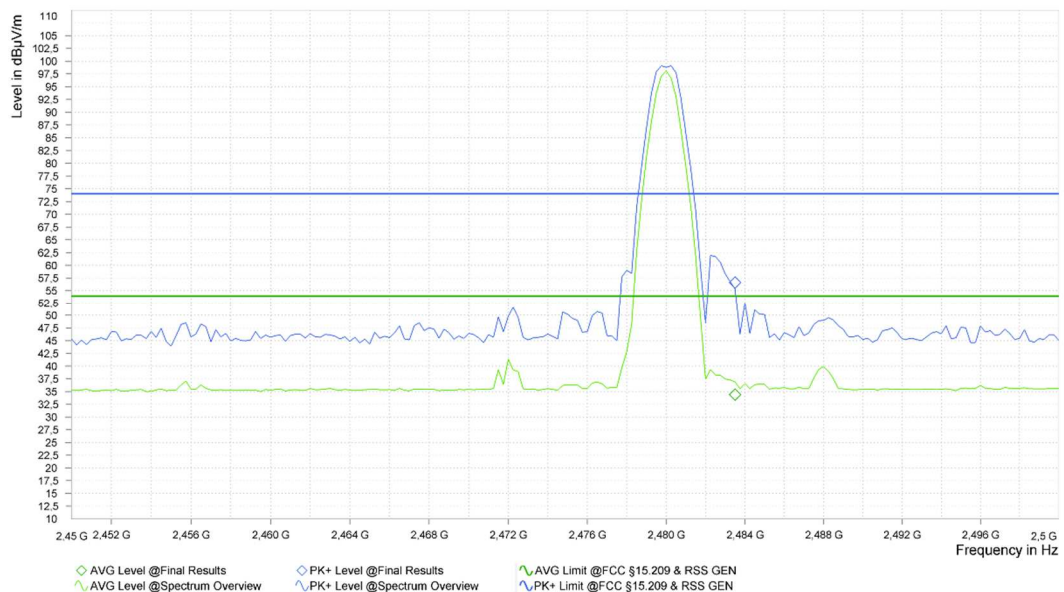
Test method (Band edge – restricted bands)				
Used	Sub-Clause [1]	Name of method	Applicability	Comment
☒	11.12.1	Standard method	No limitations	
☐	11.12.3.1	Marker-delta method		See 6.10.6 [3] 2 MHz from band
☐	11.12.3.2	Integration method		2 MHz from band

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 [dBμV/m] = Reading [dBμV] + Correction [dBμV/m]

Average [dBμV/m] = Reading [dBμV] + Correction [dBμV/m]

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

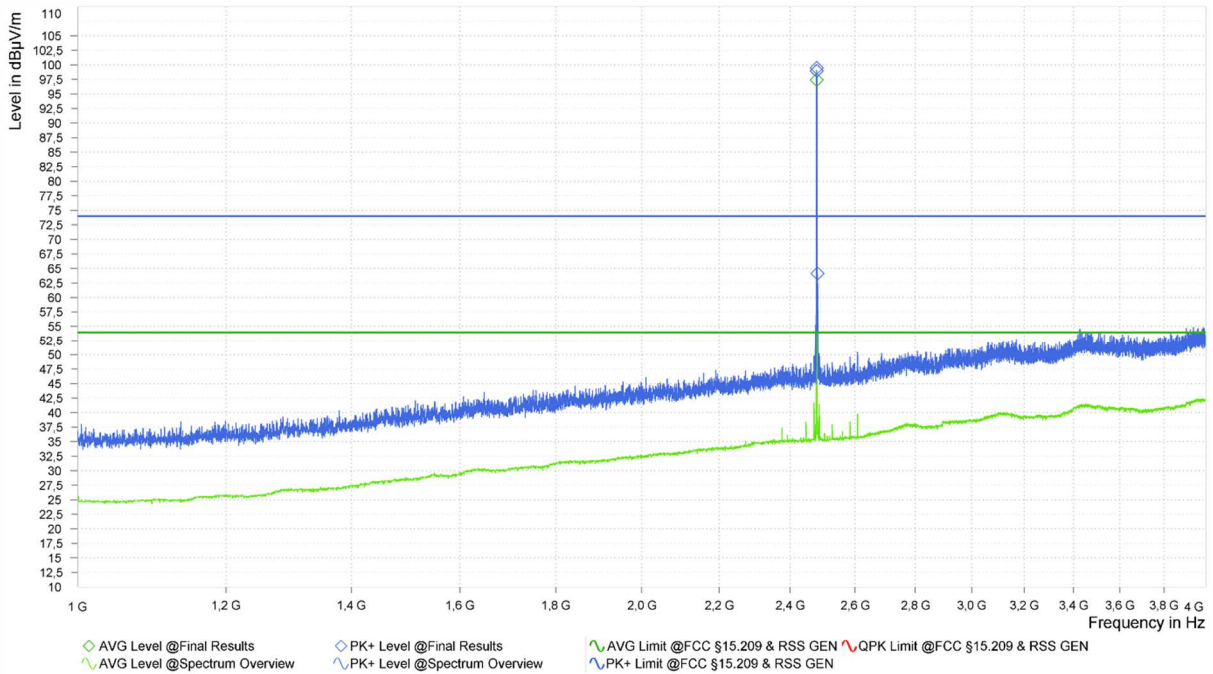
Margin [dB] = Limit [dBμV/m] – Max Peak | Average [dBμV/m]

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.

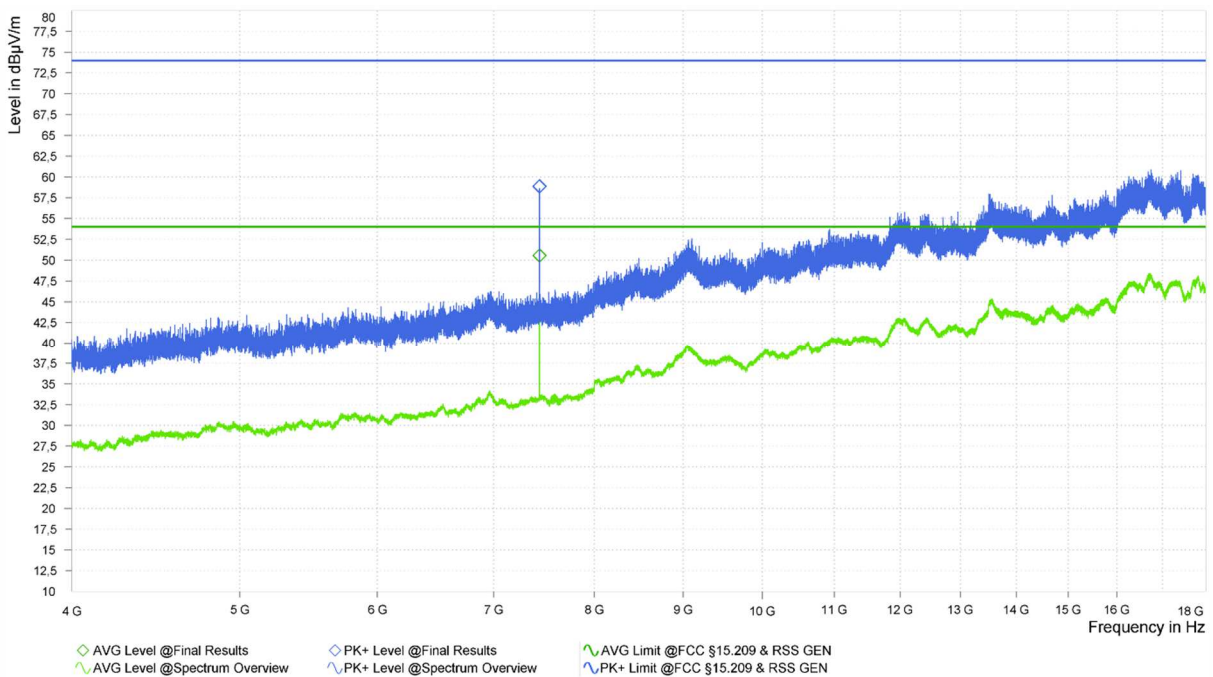
The top measured curve represents the peak measurement. The measured points marked with "◇" are frequency points for the final peak detector measurement. These values are indicated in the following table. The bottom measured curve represents the average measurement. The measured points marked with "◇"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

Worst case plots:

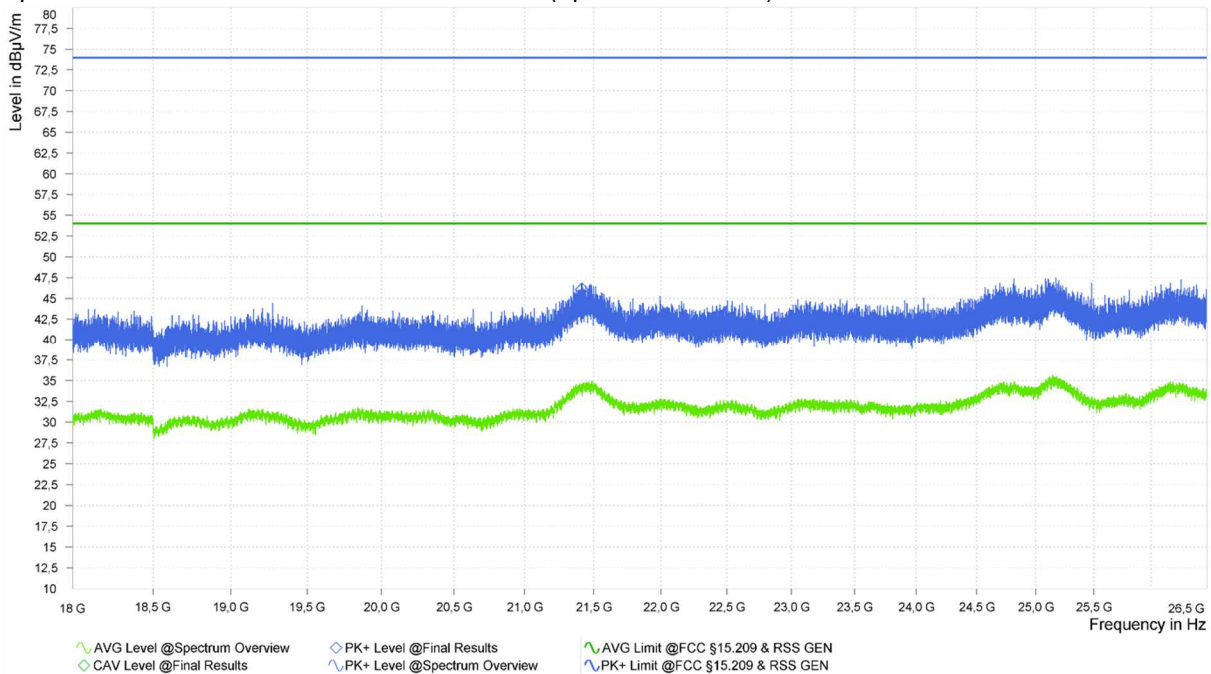
Spurious emissions from 1 GHz to 4 GHz (operation mode 1):



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-Miteq	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 -----