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Test Report

Report Number:

F240018E6

Equipment under Test (EUT):

**Flood warning data logger
SensorLink 1000 Cat-M1 – Global**

Applicant:

OTT Hydromet GmbH

Manufacturer:

OTT Hydromet GmbH



References

- [1] **CFR 47 Rule part 1** Practice and Procedure
- [2] **CFR 47 Rule part 2** Frequency Allocations and Radio Treaty Matters; General Rules and Regulations
- [3] **KDB 447498 D04 Interim General RF Exposure Guidance v01**

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. 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:	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
Applicant 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: *	Flood warning data logger
Model name: *	SensorLink 1000 Cat-M1 - Global
Order number: *	5546000190
Product ID: *	55460ID002

	EUT number		
	1	2	3
Serial number: *	SL1K-100016	-	-
PCB identifier: *	55.460.101.3.2	-	-
Hardware version: *	B/0	-	-
Software version: *	V0.00.007	-	-

* Declared by the manufacturer

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.

1.1 Technical Data of Equipment

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

* Declared by the applicant

Cellular part			
Manufacturer: *	Sierra Wireless		
Model name: *	HL7800-M		
Power supply module: *	4 V _{DC} by host		
Supply voltage module: *	$U_{\text{nom}} = 3.7 \text{ V}_{\text{DC}}$	$U_{\text{min}} = 3.2 \text{ V}_{\text{DC}}$	$U_{\text{max}} = 4.35 \text{ V}_{\text{DC}}$
Serial Number: *	T6152541140210		
IMEI: *	353771212392145		
Hardware version: *	-		
Firmware version: *	HL7800-M.4.6.9.4		
Supported bands: *	LTE Cat-M1: Band 1, 2, 3, 4, 5, 8, 12, 13 14, 18 19, 20, 25, 26, 27, 28, 66		
Max. output power: *	LTE Cat-M1: Class 3 (23 dBm)		
Antenna type: *	PCQ-TNC-BADEP3G		
Antenna connector: *	TNC		
Antenna gain: *	2 dBi		

* Declared by the applicant

** Not all bands are used in the end application.

* Declared by the applicant

Bluetooth® low energy radio mode		
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)

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

1.2 Dates

Date of receipt of test sample:	24.05.2024
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2 Evaluation Methods

2.1 RF exposure test exemptions for single sources

2.1.1 General Exemption CFR 47 §1.1307(b)(3)(i)(A)

The available maximum time-averaged power is no more than 1 mW, regardless of separation distance. This exemption may not be used in conjunction with other exemption criteria other than those in paragraph (b)(3)(ii)(A) of this section. Medical implant devices may only use this exemption and that in paragraph (b)(3)(ii)(A);

2.1.2 SAR Based Exemption CFR 47 §1.1307(b)(3)(i)(B)

The available maximum time-averaged power of effective radiated power (ERP), whichever is greater, is less than or equal to the threshold P_{th} (mW) described in the following formula. This method shall only be used at separation distances (cm) from 0.5 cm to 40 cm and at frequencies from 0.3 GHz to 6 GHz inclusive.

For the following separation distances [d] and frequency ranges P_{th} is given by the following formulas

	0.5 cm ≤ d ≤ 20cm	20 cm < d ≤ 40 cm
0.2 GHz ≤ f < 1.5 GHz	$P_{th}(mW) = ERP_{20cm} \left(\frac{d}{20} \right)^x$ $ERP_{20cm} (mW) = 2040f$ $x = -\log_{10} \left(\frac{60}{ERP_{20cm}\sqrt{f}} \right)$	$P_{th}(mW) = ERP_{20cm}$ $ERP_{20cm} (mW) = 2040f$
1.5 GHz ≤ f ≤ 6 GHz	$P_{th}(mW) = ERP_{20cm} \left(\frac{d}{20} \right)^x$ $ERP_{20cm} (mW) = 3060$ $x = -\log_{10} \left(\frac{60}{ERP_{20cm}\sqrt{f}} \right)$	$P_{th}(mW) = ERP_{20cm}$ $ERP_{20cm} (mW) = 3060$

2.1.3 MPE Based Exemption CFR 47 §1.1307(b)(3)(i)(C)

By using Table 1 and the minimum separation distance (d in meters) from the body of a nearby person for the frequency (f in MHz) at which the source operates, the ERP (watts) is no more than the calculated value prescribed for that frequency. For the exemption in Table 1 to apply, d must be at least $\lambda/2\pi$, where λ is the free-space operating wavelength in meters. If the ERP of a single RF source is not easily obtained, then the available maximum time-averaged power may be used in lieu of ERP if the physical dimensions of the radiating structure(s) do not exceed the electrical length of $\lambda/4$ or if the antenna gain is less than that of a half-wave dipole (1.64 linear value).

RF Source frequency [MHz]	Threshold ERP [W]
0.3 -1.34	1920 d ²
1.34 – 30	3450 d ² /f ²
30 – 300	3.83 d ²
300 – 1500	0.0128 d ² /f
1500 - 100000	19.2 d ²

d: Minimal separation distance from antenna to the user

2.1.4 Stand alone MPE evaluation limits

The human exposure to RF emissions from such devices could be evaluated based on the MPE limits adopted by the FCC for electric and magnetic field strength and / or power density. The limits for General Population / Uncontrolled Exposure are given in the following table from CFR 47 §1.1310(e):

Frequency range [MHz]	Electric field strength (E) [V/m]	Magnetic field strength (H) [A/m]	Power density (S) [mW/cm ²]	Averaging time [min]
(i)Limits for Occupational/Controlled Exposure				
0.3 – 3.0	614	1.63	*(100)	≤6
3.0 – 30	1842/f	4.89/f	*(900/f ²)	<6
30 – 300	61.4	0.163	1.0	<6
300 – 1,500			f/300	<6
1,500 – 100,000			5	<6
(ii)Limits for General Population / Uncontrolled Exposure				
0.3 – 1.34	614	1.63	*(100)	< 30
1.34 – 30	824/f	2.19/f	*(180/f ²)	< 30
30 – 300	27.5	0.073	0.2	< 30
300 – 1500			f/1500	< 30
1500 – 100,000			1.0	< 30

Note: f = frequency in MHz; * Plane – wave equivalent power density

The power density is calculated as follows:

$$S = \frac{P \cdot G \cdot D}{4 \cdot \pi \cdot d^2}$$

Where:

P: conducted power

G: Antenna gain (linear)

D: Duty Cycle

d: Minimal separation distance from antenna to the user

2.2 RF exposure test exemptions for simultaneous transmission sources

2.2.1 1 mW Test Exemption for simultaneous transmission sources

As discussed in CFR 47 §1.1307(b)(3)(ii)(A) [1] the 1 mW exemption intended for single transmitters may be also applied to simultaneous transmission conditions, within the same host device, according one of the following criteria:

- a. When the maximum available power each individual transmitting antenna with the same time averaging period is ≤ 1 mW, and the nearest parts of the antenna structures of the simultaneously operating transmitters are separated by at least 2 cm
- b. When the aggregate maximum available power of all transmitting antennas is ≤ 1 mW in the same time-averaging period

This exemption may not be combined with any other exemption.

2.2.2 Simultaneous transmission SAR based and MPE based test exemptions

Although this is not a module integration in the sense of product approval, the procedure for simultaneous transmission specified in KDB 447498 D04 Interim General RF Exposure Guidance v01 [3] in chapter 2.2 was taken into account:

According to the RF exposure KDB 447498 D04 General RF Exposure Guidance v01 [3] in chapter 2.2.2: This case is described in detail in CFR 47 §1.1307(b)(3)(ii)(B) and covers the situations where both SAR-based and MPE-based exemption may be considered for test exemption in fixed, mobile, or portable device exposure conditions. For these cases, a device with multiple RF sources transmitting simultaneously will be considered an RF exempt device if the condition of the following formular is satisfied.

$$\sum_{i=1}^a \frac{P_i}{P_{th,i}} + \sum_{i=1}^b \frac{ERP_j}{ERP_{th,j}} + \sum_{k=1}^c \frac{Evaluated_k}{Exposure\ Limit_k} \leq 1$$

For these test exemptions to apply, the maximum output power, duty factor, and other applicable parameters used in the standalone ERP determination tests, must be the same, or corresponding to a more conservative choice, than those required for simultaneous transmission.

Simultaneous transmission MPE test exclusion applies when the sum of the MPE ratios for all simultaneously transmitting antennas incorporated in a host device is ≤ 1.0 , according to calculated/estimated, numerically modelled, or measured field strengths or power density. The MPE ratio of each antenna is determined at the minimum test separation distance required by the operating configurations and exposure conditions of the host device, according to the ratio of field strengths or power density to the MPE limit at the test frequency.

2.2.3 Test exemption based on the SAR to Peak Location Separation Ratio

When the ERP-based condition in the previous section does not apply, a test exemption may be still applicable based on the SAR to peak location separation ratio (SPLSR) procedure.

In this case, the simultaneously transmitting antennas in each operating mode and exposure condition combination must be considered one pair at a time to determine the SPLSR that qualifies for the additional test exemption.

This ratio is defined as:

$$SPLSR = (SAR_1 + SAR_2)^{\frac{1.5}{R_i}}$$

Where: SAR_1 and SAR_2 = highest reported SAR or estimated SAR values for the two sources in the pair i , and R_i is their distance in mm.

When $SPLSR \leq 0.0.4$ (rounded to two decimal digits), for all antenna pairs in the configuration, then the device qualifies for 1 g SAR test exemption.

When 10 g SAR applies (e.g. for extremities) the corresponding test exemption condition is $SPLSR \leq 0.10$.

If any antenna pair does not qualify for simultaneous transmission SAR test exemption, then the device must be tested for SAR compliance, according to the enlarged zoom scan and volume scan post-processing procedures in KDB Pub. 865664 D01.

3 Results of evaluation

3.1 Used evaluation methods

RF Exposure test exemptions for single sources			
Used	Method	See sub-clause	Comment
<input type="checkbox"/>	General Exemption acc. CFR 47 §1.1307(b)(3)(i)(A)	2.1.1	-
<input type="checkbox"/>	SAR Based Exemption acc. CFR 47 §1.1307(b)(3)(i)(B)	2.1.2	-
<input checked="" type="checkbox"/>	MPE Based Exemption acc. CFR 47 §1.1307(b)(3)(i)(C)	2.1.3	For BLE
<input checked="" type="checkbox"/>	MPE Calculation	2.1.4	For Cellular

RF Exposure test exemptions for simultaneous transmission sources			
Used	Method	See sub-clause	Comment
<input checked="" type="checkbox"/>	Not applicable	-	No simultaneous TX possible
<input type="checkbox"/>	1 mW test Exemption acc. 2.2.1 [3]	2.2.1	-
<input type="checkbox"/>	SAR Based Exemption acc. 2.2.2 [3]	2.2.2	-
<input type="checkbox"/>	MPE Based Exemption acc. 2.2.2 [3]	2.2.2	-
<input type="checkbox"/>	SAR to Peak location separation ratio acc. 2.2.3 [3]	2.2.3	-

3.2 Evaluation Distance

According to the CFR47 §2.1091 the device as declared by the applicant is a fixed installed device which is used at least with the following separation distances between the device and the users.

Radio part	Min separation distance as declared by the applicant
Bluetooth LE	20 cm
Cellular	20 cm

3.3 BLE 2.4 GHz Emissions

MPE Based Exemption CFR 47 §1.1307(b)(3)(i)(C)

P_{con} [dBm] incl. Tuneup	P_{con} [mW] incl. Tuneup	Ant. Gain [dBi]	Cable Antenuation [dB]	$P_{e.i.r.p}$ [dBm]	$P_{e.i.r.p}$ [mW]	$P_{e.r.p}$ [dBm]	$P_{e.r.p}$ [mW]
3	2.00	1.1	0	4.1	2.57	1.95	1.57
<hr/>							
Frequency [GHz]	Wavelength λ [cm]	$\lambda/2\pi$ [cm]	d [cm]	$d > \lambda/2\pi$			
2.402	12.4809516	1.9864051	20	fulfilled			
<hr/>							
Frequency [GHz]	d [cm]	Threshold ERP [mW]		$P_{e.r.p.}$ [mW]	Result		
2.402	20	768		1.57	exempted		

The separation distance d is larger than the wavelength divided by 2π . Therefore, the MPE Exemption could be used.

Due to the fact that for separation distances larger than d the value for $P_{e.r.p}$ is lower than the threshold ERP this emission is exempted from MPE Evaluation

3.4 Cellular emissions MPE Calculation

P_{con} [dBm] incl. Tuneup	P_{con} [mW] incl. Tuneup	Ant. Gain [dBi]	Cable Antenuation [dB]	$P_{e.i.r.p}$ [dBm]	$P_{e.i.r.p}$ [mW]	$P_{e.r.p}$ [dBm]	$P_{e.r.p}$ [mW]
24.5	281.84	2	0	26.5	446.68	24.35	272.37
Frequency [GHz]	Wavelength λ [cm]	$\lambda/2\pi$ [cm]	d [cm]	$d > \lambda/2\pi$			
1.71	17.5317227	2.7902603	20	fulfilled			
Frequency [GHz]	d [cm]	Threshold ERP [mW]		$P_{e.r.p.}$ [mW]	Result		
1.71	20	768		272.37	exempted		

Due to the fact that for separation distances larger than d the Power Density S is below S_{limit} this emission is exempted from SAR Evaluation

Band	Frequency [MHz]	Highest RF conducted output power [dBm]	Power + Tune up tol. [dBm]	Duty cycle [dB]	Antenna Gain [dBi]	Distance [cm]	Power Density [mW/cm ²]	Limit of Power Density [mW/cm ²]	Reference
LTE Bd 5	824	23.44	24.5	0	2	20	0.08887	0.549	module report ¹
LTE Bd 26	814	23.54	24.5	0	2	20	0.08887	0.543	module report ¹
LTE Bd 2	1850	22.94	24.5	0	2	20	0.08887	1	module report ¹
LTE Bd 25	1850	22.93	24.5	0	2	20	0.08887	1	module report ¹
LTE Bd 4	1710	22.88	24.5	0	2	20	0.08887	1	module report ¹
LTE Bd 7	2505	22.79	24.5	0	2	20	0.08887	1	module report ¹
LTE Bd 12	699	23.31	24.5	0	2	20	0.08887	0.466	module report ¹
LTE Bd 17	704	23.32	24.5	0	2	20	0.08887	0.471	module report ¹
LTE Bd 66	1710	22.95	24.5	0	2	20	0.08887	1	module report ¹
LTE Bd 14	788	23.17	24.5	0	2	20	0.08887	0.527	module report ¹

¹ Module report SA180425C07A issued by Bureau Veritas Taiwan 2018-07-18.

4 Conclusion

The OTT SensorLink 1000 Cat-M1 - Global complies in all operational modes to the limits given in CFR 47 §1.1310(e)1 with a separation distance of 20 cm.

5 Report History

Report Number	Date	Comment
F240018E6	27.11.2024	Initial Test Report
-	-	-
-	-	-

--- end of test report ---