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Otodata RF EXPOSURE REPORT

SCOPE OF WORK

RF EXPOSURE CALCULATION
ON THE TM5040 TANK MONITOR

REPORT NUMBER

105820250LEX-008

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RF EXPOSURE TEST REPORT

Report Number: 105820250LEX-008

Project Number: G105820250

Report Issue Date: 9/20/2024

Product Name: TM5040 Tank Monitor

Product Model: TM5040 C024-2R1

Standards: FCC Title 47 CFR Part 1.1310(e)(1) Limits for
Maximum Permissible Exposure (MPE)

RSS-102 Issue 6 RF Field Strength Limits for
Devices Used by the General Public

Tested by:
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Client:
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1 Introduction and Conclusion

The tests indicated in section 2 were performed on the product constructed as described in section 4. The remaining test sections are the verbatim text from the actual data sheets used during the investigation. These test sections include the test name, the specified test Method, a list of the actual Test Equipment Used, documentation Photos, Results and raw Data. No additions, deviations, or exclusions have been made from the standard(s) unless specifically noted.

Based on the results of our investigation, we have concluded the product tested **complies** with the requirements of the standard(s) indicated. The results obtained in this test report pertain only to the item(s) tested. Intertek does not make any claims of compliance for samples or variants which were not tested.

2 Test Summary

Section	Test full name	Result
11	FCC Title 47 CFR Part 1.1310(e)(1) Limits for Maximum Permissible Exposure (MPE) (Limits for General Population / Uncontrolled Exposure)	Pass
	RSS-102 Issue 6 RF Field Strength Limits (For Devices Used by the General Public)	Pass



3 Client Information

This product was tested at the request of the following:

Client Information	
Client Name:	Otodata
Address:	1180 De Louvain Street West Montreal, QC H4N 1G5 Canada
Contact:	Julien Renaud
Telephone:	514-673-0244
Email:	jrenaud@otodata.ca
Manufacturer Information	
Manufacturer Name:	Otodata
Manufacturer Address:	1180 De Louvain Street West Montreal, QC H4N 1G5 Canada



4 Description of Equipment under Test

Equipment Under Test	
Product Name	TM5040 Tank Monitor
Model Number	TM5040 C024-2R1
Hardware Version	C024
Software Version	ZR1
Embedded Module(s)	BLE: TM5040 C024-2R1 Cellular: EG91-AUXGA-128-3GNS
FCC ID	BLE: N/A Cellular: XMR202106EG91AUX
Wireless Technology	BLE Cellular LTE
Supported Transmit Bands	BLE: 2402MHz – 2480MHz Cellular: LTE B2, B4, B12, B13, B26
Antenna Gain	BLE: 3.16dBi ¹ Cellular: 8.51dBi ¹
Maximum Output Power	BLE: 3.86dBm ¹ Cellular: 23dBm ²
Ratings	Battery, 3.6VDC
Description of Equipment Under Test (provided by client)	
<p>The MT4ADS is a remote tank level monitoring device. It is intended to be powered by a non-rechargeable lithium battery pack for a predicted average lifetime of at least 10 years</p> <p>The unit uses a BLE (Bluetooth Low Energy) microcontroller which manages all wireless communications. BLE advertising is also used to allow infield testing and diagnostics as well as enabling possible firmware upgrade. A 1.98dBi PCB (Printed Circuit Board) antenna over a ground plane is used as main BLE antenna.</p> <p>The device reads the tank level sensor every few minutes. When a significant level change is detected, the microcontroller (MCU) activates the BLE transceiver to advertise the tank's level. If there is no level change after 24 hours, the unit performs a daily report using the same procedure on the cellular module.</p>	

¹ Value taken from Intertek report 105195808LEX-006

² Values were provided by the client and may affect compliance. Intertek does not make any claims of compliance for values other than those shown.



5 Cellular Radio

5.1 Output Power

The output power was provided by the client. Any deviations from the below stated values may affect compliance. Intertek does not make any claims of compliance for values other than shown below. The excerpt was taken from the EG91-AUX technical specifications.

LPWA modules

Table with 5 columns: Product, B696, B695 Series 1, B695XA-GL Series, B6950S-GL. Rows include Form factor, Dimensions, RAT, Frequency bands, Weight, Operating temperature, Data transmission, SMS, Protocols, Interfaces, Enhanced features, Electrical features, and Recommended applications.



5.2 Antenna Gain

The antenna gain was taken from Intertek report number 105195808LEX-006 section 6.

Baknor 180115-02 Antenna for the Cellular Module	
Frequency (MHz)	Gain (dBi)
700	6.63
850	6.63
1700	6.00
1800	8.51



6 BLE Radio

6.1 Output Power/Antenna gain

The output power and antenna gain was taken from Intertek report number 105820250LEX-001 section 7.8.

BLE, 1 Mbps

Frequency (MHz)	Measured (dBm)	Attenuation (dB)	Output Power (dBm)	Output Power (mW)	Antenna Gain (dBi)	EIRP (dBm)	EIRP (W)	Output Power Limit (W)	EIRP Limit (W)
2402	-6.14	10	3.86	2.432	3.16	7.02	.005	1	4
2440	-6.14	10	3.86	2.432	3.16	7.02	.005	1	4
2480	-6.19	10	3.81	2.404	3.16	6.97	.005	1	4

BLE, 2 Mbps

Frequency (MHz)	Measured (dBm)	Attenuation (dB)	Output Power (dBm)	Output Power (mW)	Antenna Gain (dBi)	EIRP (dBm)	EIRP (W)	Output Power Limit (W)	EIRP Limit (W)
2402	-6.14	10	3.86	2.432	3.16	7.02	.005	1	4
2440	-6.14	10	3.86	2.432	3.16	7.02	.005	1	4
2480	-6.20	10	3.80	2.398	3.16	6.96	.005	1	4



7 FCC RF Exposure Limits

Title 47 CFR Part 1.1310(d)(2):

For operations within the frequency range of 300 kHz and 6 GHz (inclusive), the limits for maximum permissible exposure (MPE), derived from whole-body SAR limits and listed in Table 1 in paragraph (e)(1) of this section, may be used instead of whole-body SAR limits as set forth in paragraphs (a) through (c) of this section to evaluate the environmental impact of human exposure to RF radiation as specified in § 1.1307(b) of this part, except for portable devices as defined in § 2.1093 of this chapter as these evaluations shall be performed according to the SAR provisions in § 2.1093.

Table 1 to § 1.1310(e)(1)–Limits for Maximum Permissible Exposure (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
(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
300–1,500			f/1500	<30
1,500–100,000			1.0	<30

f = frequency in MHz. * = Plane-wave equivalent power density.



8 RSS-102 Issue 6 RF Exposure Limits

RSS-102 Issue 6 § 6.6:

Field reference level (FRL) exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm (i.e. mobile devices), except when the device operates as follows:

- below 20 MHz and the source-based, time-averaged maximum EIRP of the device is equal to or less than 1 W (adjusted for tune-up tolerance)
- at or above 20 MHz and below 48 MHz and the source-based, time-averaged maximum EIRP of the device is equal to or less than $4.49/f^{0.5}$ W (adjusted for tune-up tolerance), where f is in MHz
- at or above 48 MHz and below 300 MHz and the source-based, time-averaged maximum EIRP of the device is equal to or less than 0.6 W (adjusted for tune-up tolerance)
- at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum EIRP of the device is equal to or less than $1.31 \times 10^{-2} f^{0.6834}$ W (adjusted for tune-up tolerance), where f is in MHz
- at or above 6 GHz and the source-based, time-averaged maximum EIRP of the device is equal to or less than 5 W (adjusted for tune-up tolerance)

In these cases, the information contained in the RF exposure technical brief may be limited to information that demonstrates how the EIRP was derived.

RSS-102 Issue 6 § 5.3.2:

The electric and magnetic field strength reference levels, power density reference levels, and associated reference period for devices employed by the general public (uncontrolled environment) and controlled-use devices (controlled environment) are specified in table 7 and table 8. Note that the power density limits specified in these tables apply to whole body exposure conditions.

Table 7: RF field strength and power density limits for devices used by the general public (uncontrolled environment)

Frequency range (MHz)	Electric field (V_{RMS}/m)	Magnetic field (A_{RMS}/m)	Power density (W/m^2)	Reference period (minutes)
10-20	27.46	0.0728	2	6
20-48	$58.07 / f^{0.25}$	$0.1540 / f^{0.25}$	$8.944 / f^{0.5}$	6
48-300	22.06	0.05852	1.291	6
300-6000	$3.142 f^{0.3417}$	$0.008335 f^{0.3417}$	$0.02619 f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	$616000 / f^{1.2}$
150000-300000	$0.158 f^{0.5}$	$4.21 \times 10^{-4} f^{0.5}$	$6.67 \times 10^{-5} f$	$616000 / f^{1.2}$

Note: f is frequency in MHz.



10 Test Procedure

An RF exposure calculation was performed to show that the device was compliant with the general population exposure limits from FCC Title 47 CFR Part 1.1310(e)(1), RSS-102 Issue 6, and ICNIRP Guidelines (2020). The maximum power density was calculated for each transmitter at a separation distance of 20cm using the maximum conducted output power (including tune up tolerance) plus antenna gain, or measured EIRP.

For each transmitter the maximum power density at a 20cm distance using the formula:

$$EIRP(dBm) = \text{Conducted Power}(dBm) + \text{Antenna Gain}(dBi)$$

$$EIRP(mW) = 10^{EIRP(dBm)/10}$$

$$\text{Power Density} \left(\frac{mW}{cm^2} \right) = \frac{EIRP(mW)}{4\pi \cdot (20cm)^2}$$

$$\text{Power Density} \left(\frac{W}{m^2} \right) = \left(\frac{100cm}{1m} \right)^2 \left(\frac{1W}{1000mW} \right) \text{Power Density} \left(\frac{mW}{cm^2} \right)$$

For transmitters that could operate simultaneously, the ratio of calculated power density to the corresponding limit for each transmitter was calculated and then summed. If the sum of the ratios was less than 1, that specific combination of transmitters was deemed to comply.



11 Results:

The calculated maximum power density at 20cm was less than or equal to the limits for general population exposure in FCC Title 47 CFR Part 1.1310(e)(1), RSS-102 Issue 6, and ICNIRP Guidelines (2020).

Additionally, to demonstrate compliance during simultaneous transmission, the worst-case power density to limit ratios for each transmitter were summed. Since the sum was less than 1 that combination of transmitters is deemed to comply with the simultaneous transmission RF exposure criteria.



11.1 FCC RF Exposure Data

Radio	Band / Modulation	Channel	Frequency (MHz)	Declared Max Cond. Power (Inc. Tolerance) (dBm)	Duty Cycle (%)	Duty Cycle Adjusted Cond. Output Power (dBm)	Antenna Gain (dB)	MPE Value @ 20cm (mW/cm ²)	MPE Limit (mW/cm ²)	MPE / Limit Ratio (for Co-Location)
BLE	BLE	37	2402	3.86	100.0%	3.86	3.16	0.0010	1.0000	0.0010
		17	2440	3.86	100.0%	3.86	3.16	0.0010	1.0000	0.0010
		39	2480	3.86	100.0%	3.86	3.16	0.0010	1.0000	0.0010
Cellular	LTE B2 (FDD)	18000	1920.0	23	100.0%	23.00	8.51	0.2817	1.0000	0.2817
		18299	1949.9	23	100.0%	23.00	8.51	0.2817	1.0000	0.2817
		18599	1979.9	23	100.0%	23.00	8.51	0.2817	1.0000	0.2817
	LTE B4 (FDD)	19950	1710.0	23	100.0%	23.00	6.00	0.1580	1.0000	0.1580
		20174	1732.4	23	100.0%	23.00	6.00	0.1580	1.0000	0.1580
		20399	1754.9	23	100.0%	23.00	6.00	0.1580	1.0000	0.1580
	LTE B12 (FDD)	23010	699.0	23	100.0%	23.00	6.63	0.1827	0.4660	0.3921
		23094	707.4	23	100.0%	23.00	6.63	0.1827	0.4716	0.3874
		23179	715.9	23	100.0%	23.00	6.63	0.1827	0.4773	0.3828
	LTE B13 (FDD)	23180	777.0	23	100.0%	23.00	6.63	0.1827	0.5180	0.3527
		23229	781.9	23	100.0%	23.00	6.63	0.1827	0.5213	0.3505
		23279	786.9	23	100.0%	23.00	6.63	0.1827	0.5246	0.3483
	LTE B26 (FDD)	26690	814.0	23	100.0%	23.00	6.63	0.1827	0.5427	0.3367
		26864	831.4	23	100.0%	23.00	6.63	0.1827	0.5543	0.3296
		27039	848.9	23	100.0%	23.00	6.63	0.1827	0.5659	0.3228
Sum:										0.3931

**11.2 RSS-102 Issue 6 RF Exposure Data**

Radio	Band	Channel	Frequency (MHz)	Declared Max Cond. Power (Inc. Tolerance) (dBm)	Duty Cycle (%)	Duty Cycle Adjusted Cond. Output Power (dBm)	Antenna Gain (dB)	MPE Value @ 20cm (W/m ²)	MPE Limit (W/m ²)	MPE / Limit Ratio (for Co-Location)
BLE	BLE	37	2402	3.86	100.0%	3.86	3.16	0.0100	5.3508	0.0019
		17	2440	3.86	100.0%	3.86	3.16	0.0100	5.4085	0.0019
		39	2480	3.86	100.0%	3.86	3.16	0.0100	5.4689	0.0018
Cellular	LTE B2 (FDD)	18000	1920.0	23	100.0%	23.00	8.51	2.8166	4.5914	0.6135
		18299	1949.9	23	100.0%	23.00	8.51	2.8166	4.6401	0.6070
		18599	1979.9	23	100.0%	23.00	8.51	2.8166	4.6888	0.6007
	LTE B4 (FDD)	19950	1710.0	23	100.0%	23.00	6.00	1.5803	4.2419	0.3725
		20174	1732.4	23	100.0%	23.00	6.00	1.5803	4.2798	0.3692
		20399	1754.9	23	100.0%	23.00	6.00	1.5803	4.3178	0.3660
	LTE B12 (FDD)	23010	699.0	23	100.0%	23.00	6.63	1.8270	2.3017	0.7937
		23094	707.4	23	100.0%	23.00	6.63	1.8270	2.3206	0.7873
		23179	715.9	23	100.0%	23.00	6.63	1.8270	2.3396	0.7809
	LTE B13 (FDD)	23180	777.0	23	100.0%	23.00	6.63	1.8270	2.4743	0.7384
		23229	781.9	23	100.0%	23.00	6.63	1.8270	2.4849	0.7352
		23279	786.9	23	100.0%	23.00	6.63	1.8270	2.4958	0.7320
	LTE B26 (FDD)	26690	814.0	23	100.0%	23.00	6.63	1.8270	2.5542	0.7153
		26864	831.4	23	100.0%	23.00	6.63	1.8270	2.5914	0.7050
		27039	848.9	23	100.0%	23.00	6.63	1.8270	2.6285	0.6950
Sum:										0.7956



12 Revision History

Revision Level	Date	Report Number	Prepared By	Reviewed By	Notes
0	9/20/2024	105820250LEX-008	JP	MC	Original Issue