RF Exposure Exemption Report

Trackunit ApS
Model: TU700-5

In accordance with FCC CFR 47 Pt 1.1307

Prepared for: Trackunit ApS
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FCC ID: ZMF-TUBLEWIM01, ZMF-TUCELLM01

Document 75958850-13 Issue: 02

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FCC Accreditation
294497/UK2010 Octagon House, Fareham Test Laboratory

EXECUTIVE SUMMARY
The wireless devices described within this report are compliant with the exemption criteria related to human exposure to electromagnetic fields laid out in FCC CFR Title 47 Part 1.1307.

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1 Report Summary

1.1 Report Modification Record

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

Issue	Description of Change	Date of Issue
1	First Issue	21-December-2023
2	Change FCC ID and correction to BLE and 2.4GHz WLAN ant gains	14-March-2024

Table 1

1.2 Introduction

Applicant	Trackunit ApS
Manufacturer	Trackunit ApS
Model Number(s)	TU700-5
Hardware Version(s)	Prototype 3, revision F
Software Version(s)	1.0.1
Specification/Issue/Date	FCC 47 CFR Part 1.1307: 2021
Order Number Date	TU700 EMC + RF Compliance Tests 23-June-2023
Related Document(s)	KDB 447498 D04 v01

1.3 Brief Summary of Results

The wireless devices described within this report are compliant with the exemption criteria related to human exposure to electromagnetic fields laid out in FCC CFR Title 47 Part 1.1307.

The calculations shown in this report were made in accordance with the procedures specified in the applied test specification(s).

1.4 Product Information

1.4.1 Technical Description

Telematic unit for Fleet Management.
This equipment is a telematic device to be mounted in and on construction machines / vehicles.
The equipment contains technologies 4G LTE Cat M1, Narrow band IoT NB2, 2G GPRS/EGPRS, BLE, Wi-Fi, and GNSS.
This equipment is intended to be connected to power lines of the host equipment.

1.4.2 Transmitter Description

The following radio access technologies and frequency bands are supported by the equipment under test.

Radio Access Technology	Frequency Band (MHz)	Minimum Frequency (MHz)	Output Power (dBm)	Antenna Gain [dBi]	Duty Cycle (%)
2.4 GHz Wi-Fi	2412-2462	2412	16	1.66	100
Bluetooth Low Energy	2402-2480	2402	14	1.66	<100
GSM-850	824-849	824.2	33	4.7	12.5
PCS-1900	1850-1910	1850.2	30	5.4	12.5
LTE FDD2 Cat M1 Cat NB2	1850-1910	1850.0	21	5.4	100
LTE FDD4 Cat M1 Cat NB2	1710-1755	1710	21	5.4	100
LTE FDD5 Cat M1 Cat NB2	824-849	824.0	21	4.7	100
LTE FDD12 Cat M1 Cat NB2	699-716	699.0	21	3.9	100
LTE FDD13 Cat M1 Cat NB2	777-787	777.0	21	3.0	100
LTE FDD25 Cat M1 Cat NB2	1850-1915	1850.0	21	5.4	100
LTE FDD26 Cat M1	814-824 824-849	814.0	21	4.7	100
LTE FDD27 Cat M1	807-824	807.0	21	3.0	100
LTE FDD66 Cat M1 Cat NB2	1710-1780	1710.0	21	5.4	100
LTE FDD85 Cat M1 Cat NB2	698-716	698.0	21	3.9	100

Table 2 – Transmitter Description- FCC

Note: Transmitter power includes upper bounds of uncertainty therefore maximum values are used.

1.4.3 Antenna Description

The following antennas are supported by the equipment under test.

Radio Access Technology	Antenna Model	Gain (dBi)	Antenna length (cm)	Minimum Separation Distance (mm)
Cellular	Inverted F antenna on PCB	5.4 (PCS-1900, LTE B2, B4, B25, B66) 4.7 (GSM-850, LTE B5, B26) 3.9 (LTE B12, B85) 3.0 (LTE B13, B27)	Appr. 108 mm, on PCB	200
BLE/Wi-Fi	Antenna on module	1.66	6 x 9 mm	200
GNSS	Inverted F antenna on PCB	4.8	Appr. 40 mm, on PCB	200

Table 3 – Antenna description

In the case of more than one type of antenna being supported by the equipment, the calculation is based on the maximum of the antenna gains. If other antennas can be used that have greater gains, the minimum separation distances will need to be recalculated.

Note: Antenna gain includes upper bounds of uncertainty therefore maximum values are used.

1.4.4 Equipment Configuration

Simultaneous transmission:

- One cellular band (LTE CAT M1 or NB-IOT NB2 or GPRS)
- Either 2.4 GHz WLAN or Bluetooth Low Energy

Notes: For the simultaneous transmission calculations the worst case combination was identified as 2.4 GHz WLAN in combination with GSM-850.

2 Assessment Details

2.1 Single RF Source options for determination of exemption.

<table>
<tr><th>Option</th><th>Reference</th><th>RF Exposure Test Exemptions for Single Source</th></tr>
<tr><td>A
(1-mW Test Exemption)</td><td>FCC
1.1307(b)(3)(i)(A)</td><td>The available maximum time averaged power is no more than 1 mW, regardless of separation distance.</td></tr>
<tr><td>B
(SAR-Based Exemption)</td><td>FCC
1.1307(b)(3)(i)(B)</td><td>The available maximum timeaveraged power or effective radiated power (ERP), whichever is greater, is less than or equal to the threshold Pth (mW) described in the following formula. This method shall only be used at separation distances (cm) from 0.5 centimeters to 40 centimeters and at frequencies from 0.3 GHz to 6 GHz (inclusive). Pth is given by:
$$P_{th}\ (\text{mW}) = \begin{cases} ERP_{20\ cm}(d/20\ \text{cm})^{x} & d \le 20\ \text{cm} \\ ERP_{20\ cm} & 20\ \text{cm} < d \le 40\ \text{cm} \end{cases}$$
Where
$$x = -\log_{10}\left(\frac{60}{ERP_{20\ cm}\sqrt{f}}\right)$$ and f is in GHz;
and
$$ERP_{20\ cm}\ (\text{mW}) = \begin{cases} 2040f & 0.3\ \text{GHz} \le f < 1.5\ \text{GHz} \\ 3060 & 1.5\ \text{GHz} \le f \le 6\ \text{GHz} \end{cases}$$
d = the separation distance (cm);</td></tr>
<tr><td>C
(MPE-Based Exemption)</td><td>FCC
1.1307(b)(3)(i)(C)</td><td>Or using Table 1 and the minimum separation distance (R 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, R must be at least λ/2π, 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 λ/4 or if the antenna gain is less than that of a half-wave dipole (1.64 linear value).
TABLE 1 TO § 1.1307(b)(3)(i)(C)—SINGLE RF SOURCES SUBJECT TO ROUTINE ENVIRONMENTAL EVALUATION
<table>
<tr><th>RF Source frequency (MHz)</th><th>Threshold ERP (watts)</th></tr>
<tr><td>0.3–1.34</td><td>1,920 R².</td></tr>
<tr><td>1.34–30</td><td>3,450 R²/f².</td></tr>
<tr><td>30–300</td><td>3.83 R².</td></tr>
<tr><td>300–1,500</td><td>0.0128 R²f.</td></tr>
<tr><td>1,500–100,000</td><td>19.2R².</td></tr>
</table></td></tr>
</table>

2.2 Multiple RF Sources options for determination of exemption.

Option	Reference	
A 1-mW Test Exemption for Multiple Sources	FCC 1.1307(b)(3)(ii)(A)	The available maximum time averaged power of each source is no more than 1 mW and there is a separation distance of two centimeters between any portion of a radiating structure operating and the nearest portion of any other radiating structure in the same device, except if the sum of multiple sources is less than 1 mW during the time-averaging period, in which case they may be treated as a single source (separation is not required). This exemption may not be used in conjunction with other exemption criteria other than those is paragraph (b)(3)(i)(A) of this section. Medical implant devices may only use this exemption and that in paragraph (b)(3)(i)(A).
B Simultaneous Transmission with both SAR-based and MPE-Based Test Exemptions	FCC 1.1307(b)(3)(ii)(B)	in the case of fixed RF sources operating in the same time-averaging period, or of multiple mobile or portable RF sources within a device operating in the same time averaging period, if the sum of the fractional contributions to the applicable thresholds is less than or equal to 1 as indicated in the following equation. $\sum_{i=1}^{a} \frac{P_i}{P_{th,i}} + \sum_{j=1}^{b} \frac{ERP_j}{ERP_{th,j}} + \sum_{k=1}^{c} \frac{Evaluated_k}{Exposure\ Limit_k} \leq 1$

2.3 Individual Antenna Port Exposure Results

2.3.1 Single Source Calculation of Exposure at Specified Separation Distance FCC 1.1307(b)(3)(i)(B) 'Option B' (SAR Based Exemption)

RAT	Frequency (MHz)	Conducted Power Output mW	Duty Cycle %	Time Average Conducted Power Output mW	Antenna Gain Ratio	Maximum Power (EIRP) mW	Maximum Power (ERP) mW	Minimum Antenna to User Separation Distance (mm)	Pth (mW) 1.1307 (b)(3)(i)(B)	Greater of Max time averaged conducted power or ERP?	1.1307(b)(3)(i)(B) Exemption (Yes/No) (300 MHz to 6 GHz, 0.5 cm to 20 cm)
GSM-850	824.2	1995.3	12.5	249.41	2.951	736.02	448.79	200	1681.4	Yes	Yes

Table 4 –Transmitter Result

The calculations show that the individual transmitters comply with FCC 1.1307(b)(3)(i)(B) SAR-based exemption at a minimum distance of 200 mm.

2.3.2 Single Source Calculation of Exposure at Specified Separation Distance FCC 1.1307(b)(3)(i)(C) 'Option C' (MPE Based Exemption)

RAT	Frequency (MHz)	Conducted Power Output (mW)	Duty Cycle %	Time Average Conducted Power Output (mW)	Antenna Gain Ratio	Maximum Power (EIRP) mW	Maximum Power (ERP) mW	Minimum separation distance for MPE evaluation λ/2 π mm	Actual Distance (mm)	Threshold ERP (W)	1.1307(b)(3)(i)(C) Exemption (Yes/No) (300 kHz to 100 GHz)
2.4 GHz WLAN	2412.0	39.8	100.0	39.8	1.47	58.506	35.67	19.8	200	0.768	Yes
Bluetooth Low Energy	2402.0	25.1	100.0	25.1	1.47	36.90	22.50	19.9	200	0.768	Yes
PCS-1900	1850.2	1000	12.5	125	3.467	433.375	264.25	25.8	200	0.768	Yes
LTE FDD2 Cat M1 Cat NB2	1850.0	125.9	100.0	125.9	3.467	436.4953	266.16	25.8	200	0.768	Yes
LTE FDD4 Cat M1 Cat NB2	1710.0	125.9	100.0	125.9	3.467	436.4953	266.16	27.9	200	0.768	Yes
LTE FDD5 Cat M1 Cat NB2	824.0	125.9	100.0	125.9	2.951	371.5309	226.54	57.9	200	0.422	Yes
LTE FDD12 Cat M1 Cat NB2	699.0	125.9	100.0	125.9	2.455	309.0845	188.47	68.3	200	0.3579	Yes
LTE FDD13 Cat M1 Cat NB2	777.0	125.9	100.0	125.9	1.995	251.1705	153.15	61.4	200	0.3978	Yes
LTE FDD18 Cat M1 Cat NB2	815.0	125.9	100.0	125.9	2.291	288.4369	175.88	58.6	200	0.4173	Yes
LTE FDD19 Cat M1 Cat NB2	830.0	125.9	100.0	125.9	2.884	363.0956	221.40	57.5	200	0.425	Yes
LTE FDD25 Cat M1 Cat NB2	1850.0	125.9	100.0	125.9	3.467	436.4953	266.16	25.8	200	0.768	Yes
LTE FDD26 Cat M1	814.0	125.9	100.0	125.9	2.951	371.5309	226.54	58.7	200	0.4168	Yes
LTE FDD27 Cat M1	807.0	125.9	100.0	125.9	1.995	251.1705	153.15	59.2	200	0.4132	Yes
LTE FDD66 Cat M1	1710.0	125.9	100.0	125.9	3.467	436.4953	266.16	27.9	200	0.768	Yes

Cat NB2											
LTE FDD85 Cat M1 Cat NB2	698.0	125.9	100.0	125.9	2.455	309.0845	188.47	68.4	200	0.3574	Yes

Table 5 –Transmitter Result

The calculations show that the individual transmitters comply with FCC 1.1307(b)(3)(i)(C) MPE-based exception at a minimum distance of 200 mm.

2.4 Combined Antenna Port RF Exposure Results FCC 1.1307(b)(3)(ii)(B)

2.4.1 Combination 1 – Option B Summation

RAT	Frequency (MHz)	Conducted Power Output mW	Duty Cycle %	Time Average Conducted Power Output mW	Antenna Gain Ratio	Maximum Power (EIRP) mW	Maximum Power (ERP) mW	Test Separation Distance (mm)	Pi / Pth	Sum of the fractional contributions to the applicable thresholds is less than or equal to 1. Compliant? (Yes/No)
2.4 GHz WLAN	2412.0	39.8	100.0	39.8	1.47	58.506	35.67	200	0.01300	Yes
GSM-850	824.2	1995.3	12.5	249.41	2.951	736.02	448.79	200	0.26692	Yes
Calculated RF exposure level at minimum compliance boundary of 0.2 m as a fraction of the limit									0.27993	Yes

Table 6 –Transmitter Result

The calculations show that the multiple transmitters comply with FCC 1.1307(b)(3)(ii)(B) summation-based exemption. Combination shown is the worst case example.