RF-EXPOSURE REPORT

FCC 47 CFR Part 2.1091

Maximum permissible exposure

Report Reference No	G0M-2401-2381-TFC091MP-nRF-V03
Testing Laboratory	Eurofins Product Service GmbH
Address	Storkower Str. 38c 15526 Reichenwalde Germany
Accreditation	A2LA Accredited Testing Laboratory, Certificate No.: 1983.01 FCC Test Firm Designation Number: DE0008 ISED Testing Laboratory site: 3470A
Applicant	Treon Oy
Address	Visiokatu 3 33720 Tampere FINLAND
Test Specification	According to FCC rules
Standard	FCC 47 CFR 2.1091
Non-Standard Test Method	None
Equipment under Test (EUT):	
Product Description	Tracker TR4111000
Model(s)	4111000
Additional Model(s)	None
Brand Name(s)	None
Hardware Version(s)	05
Software Version(s)	5.3
FCC-ID	2AR86-TR41
Test Result	**PASSED**

Possible test case verdicts:		
required by standard but not tested	N/T	
not required by standard	N/R	
test object does meet the requirement	P(PASS)	
test object does not meet the requirement	F(FAIL)	
Testing:		
Test Lab Temperature	20 °C - 30 °C	
Test Lab Humidity	25 % - 55 %	
Date of performance	2024-06-27	
Date of receipt of test item	2024-05-02	
Report:		
Compiled by	Burkhard Pudell	
Tested by (+ signature) (Responsible for Test)	Burkhard Pudell	
Approved by (+ signature) (Test Lab Engineer)	Radwan Jaafar	
Date of Issue	2024-12-13	
Total number of pages	17	
General Remarks:		
The test results presented in this report relate only to the object tested. **The results contained in this report reflect the results for this particular model and serial number. It is the responsibility of the manufacturer to ensure that all production models meet the intent of the requirements detailed within this report.** This report shall not be reproduced, except in full, without the written approval of the Issuing testing laboratory.		
Additional Comments:		
None		

VERSION HISTORY

Version History			
Version	Issue Date	Remarks	Revised By
01	2024-06-27	Initial Release	--
02	2024-08-15	Replaced document: G0M-2401-2381-TFC091MP-nRF-V01 Replaced by: G0M-2401-2381-TFC091MP-nRF-V02 Reason: Reference documents corrected.	B. Pudell
03	2024-12-13	Replaced document: G0M-2401-2381-TFC091MP-nRF-V02 Replaced by: G0M-2401-2381-TFC091MP-nRF-V03 Reason: Reference documents updated.	St. Liebich

ABBREVIATIONS AND ACRONYMS

Acronyms	
Acronym	Description
EIRP	Equivalent Isotropic Radiated Power
EUT	Equipment Under Test
MPE	Maximum Permissible Exposure

REPORT INDEX

1 Equipment (Test Item) Under Test

Description	Tracker TR4111000		
Model	4111000		
Additional Model(s)	None		
Brand Name(s)	None		
Sample Identification	EUT #	Sample-ID	Serial Number
	EUT 1	see Ref-Docs	see Ref-Docs
Hardware Version(s)	05		
Software Version(s)	5.3		
FCC ID	2AR86-TR41		
Equipment type	End Product		
Environment	Workers		

1.1 Reference Documents

Document Type	Document No.	Issued by	Date
Test-Report	59675RRF	DEKRA Testing and Certification, S.A.U.	2019-05-15
Test-Report	59675RRF	DEKRA Testing and Certification, S.A.U.	2019-06-03
Test-Report	59675RRF	DEKRA Testing and Certification, S.A.U.	2019-05-15
Test-Report	59675RRF	DEKRA Testing and Certification, S.A.U.	2019-05-15
Test-Report	64610RRF001A1	DEKRA Testing and Certification, S.A.U.	2020-08-31
Test-Report	64610RRF002A1	DEKRA Testing and Certification, S.A.U.	2020-08-25
Test-Report	64610RRF003A2	DEKRA Testing and Certification, S.A.U.	2020-08-31
Test-Report	64610RRF004A1	DEKRA Testing and Certification, S.A.U.	2020-08-25
Test-Report	F160785E3	PHOENIX TESTLAB GmbH	2016-06-27
FCC TEST REPORT	G0M-2401-2381-TFCCOLOC-V02	Eurofins Product Service GmbH	2024-12-13
Radio Test-Report	3955RER001A2	Eurofins Electric & Electronics Finland Oy	2024-08-14
Radio Test-Report	3955RER002A2	Eurofins Electric & Electronics Finland Oy	2024-08-14

1.2 Power density radiation sources

Mode	Operating Frequency [MHz]	Maximum conducted power [dBm]	Maximum radiated power [dBm EIRP]	Maximum duty cycle [%]	Maximum antenna gain [dBi]	Maximum antenna diameter [cm]
LTE FDD5	824.0	23.38	28.11	100	4.83	N/A
LTE FDD13	782.0	23.26	28.09	100	4.83	N/A
LTE FDD25	1882.5	23.38	28.21	100	4.83	N/A
LTE FDD66	1779.0	23.39	28.22	100	4.83	N/A
IEEE 802.11 (2.4 GHz)	2437.0	17.70	18.67	100	0.97	N/A
Bluetooth LE	2402.0	5.10	10.14	100	5.04	N/A
Comment: --						

1.3 Field strength radiation sources

None

1.4 Concurrent Sources

Concurrent operating conditions
LTE FDD5 + IEEE 802.11 (2.4 GHz) + Bluetooth LE
LTE FDD13 + IEEE 802.11 (2.4 GHz) + Bluetooth LE
LTE FDD25 + IEEE 802.11 (2.4 GHz) + Bluetooth LE
LTE FDD66 + IEEE 802.11 (2.4 GHz) + Bluetooth LE
Comment: --

2 Result Summary

FCC MPE Evaluation - Single radiation sources					
Product Standard Reference	**Requirement**	**Reference Method**	**Mode**	**Distance [m]**	**Verdict**
47 CFR 2.1091	Maximum permissible exposure	FCC KDB 447498	LTE FDD5	0.20	PASS
47 CFR 2.1091	Maximum permissible exposure	FCC KDB 447498	LTE FDD13	0.20	PASS
47 CFR 2.1091	Maximum permissible exposure	FCC KDB 447498	LTE FDD25	0.20	PASS
47 CFR 2.1091	Maximum permissible exposure	FCC KDB 447498	LTE FDD66	0.20	PASS
47 CFR 2.1091	Maximum permissible exposure	FCC KDB 447498	IEEE 802.11 (2.4 GHz)	0.20	PASS
47 CFR 2.1091	Maximum permissible exposure	FCC KDB 447498	Bluetooth LE	0.20	PASS
Comment: --					

FCC MPE Evaluation - Multi-transmitter sources					
Product Standard Reference	**Requirement**	**Reference Method**	**Mode**	**Distance [m]**	**Verdict**
47 CFR 2.1091	Maximum permissible exposure	FCC KDB 447498	LTE FDD5 + IEEE 802.11 (2.4 GHz) + Bluetooth LE	0.20	PASS
47 CFR 2.1091	Maximum permissible exposure	FCC KDB 447498	LTE FDD13 + IEEE 802.11 (2.4 GHz) + Bluetooth LE	0.20	PASS
47 CFR 2.1091	Maximum permissible exposure	FCC KDB 447498	LTE FDD25 + IEEE 802.11 (2.4 GHz) + Bluetooth LE	0.20	PASS
47 CFR 2.1091	Maximum permissible exposure	FCC KDB 447498	LTE FDD66 + IEEE 802.11 (2.4 GHz) + Bluetooth LE	0.20	PASS
Comment: --					

3 RF-Exposure classification

RF-Exposure Categories	
Fixed	A fixed device is defined as a device physically secured at one fixed location and cannot be easily re-located.
Mobile	A mobile device is defined as a transmitting device designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimeters is normally maintained between the transmitter's radiating structure(s) and the body of the user or nearby persons.
Portable	A portable device is defined as a transmitting device designed to be used so that the radiating structure(s) of the device is/are within 20 centimeters of the body of the user.

RF-Exposure Categories	
Occupational / Controlled	Limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.
General population / Uncontrolled	Exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or cannot exercise control over their exposure.

4 RF-Exposure limits

FCC Limits – General Population / Uncontrolled Exposure				
Frequency range [MHz]	**Electric field strength [V/M]**	**Magnetic field strength [A/M]**	**Power density [W/m²]**	**Averaging time [min]**
0.3 – 1.34	614	1.63	1000	30
1.34 – 30	824/f	2.19/f	1800/f²	30
30 – 300	27.5	0.073	2	30
300 – 1500	-	-	f/150	30
1500 – 100000	-	-	10.0	30

FCC Limits – Occupational / Controlled Exposure				
Frequency range [MHz]	**Electric field strength [V/M]**	**Magnetic field strength [A/M]**	**Power density [W/m²]**	**Averaging time [min]**
0.3 – 3.0	614	1.63	1000	6
3.0 – 30	1842/f	4.89/f	9000/f²	6
30 – 300	61.4	0.163	10.0	6
300 – 1500	-	-	f/30	6
1500 – 100000	-	-	50	6

5 RF-Exposure Evaluation

Evaluation Relations

$$\lambda[m] = \frac{c\left[\frac{m}{s}\right]}{f[Hz]} \; ; \; R_{FF}[m] \geq \frac{2 \cdot D[m]^2}{\lambda[m]}$$

$$S[W/m^2] = \frac{P_{E.I.R.P.}[W]}{4\pi R[m]^2} \; ; \; R[m] = \sqrt{\frac{P_{E.I.R.P.}[W]}{4\pi S[W/m^2]}}$$

$$DCC\ [dB] = 10 \cdot Log_{10}\left(\frac{DC[\%]}{100}\right)$$

$$\sum_{i=1}^{N} \frac{S_i\left[\frac{W}{m^2}\right]}{S_{Li}\left[\frac{W}{m^2}\right]} + \sum_{j=1}^{M} \left(\frac{E_j\left[\frac{V}{m}\right]}{E_{Lj}\left[\frac{V}{m}\right]}\right)^2 + \sum_{k=1}^{O} \left(\frac{H_k\left[\frac{A}{m}\right]}{H_{Lk}\left[\frac{A}{m}\right]}\right)^2 < 1$$

Evaluation Procedure

Standalone operation evaluation:

For each radio and frequency band the worst case transmission mode with the highest peak conducted or radiated power is evaluated at the frequency that results in the most restrictive rf-exposure limit. From the peak power values, antenna gains and duty cycles taken from the reference documents, the source average radiated power values are calculated. From the average radiated power the power densities at antenna far-field distance is calculated. The distance from the radiation source for compliance power density is calculated. If the separation distance is lower than the far-field distance, the far-field distance is given as compliance separation distance because the plane wave power density assessment is only valid in the far-field of the radiation source.

For radiation sources for which the average electric and magnetic fields are measured using field probes, the measured field strength values are compared to the reference limits. For those sources no calculations are performed. Compliance with the reference values is determined with the near field measurements.

Concurrent operation evaluation:

First the evaluation distance is set to an appropriate value. For all radiation sources for which power densities are calculated, the power densities at the evaluation distance are calculated and for all other sources the electric or magnetic field strengths are measured using field probes. Finally the ratios of the power densities and/or field strength values and the corresponding limits are calculated and summed and the sum is compared to the maximum of 1.

6 Single Source Evaluation Results - FCC

LTE FDD5	
Transmission Mode	
Transmission Frequency (f) [MHz]	824.0
Antenna far-field distance	
Maximum antenna diameter (D) [m]	N/A
Transmission wavelength (λ) [m]	N/A
Antenna far-field distance (R_{FF}) [m]	N/A
Source average power	
Peak radiated power (PR) [dBm EIRP]	28.11
Maximum transmission duty cycle (DC)	1.00
Duty cycle correction (DCC) [dB]	0.00
Average radiated power (PRAVG) [dBm EIRP]	28.11
Power density	
Compliance power density limit [W/m^2]	27.467
Power density (S) @ Antenna far-field distance [W/m^2]	N/A
Power density (S) @ 0.20 m [W/m^2]	1.287
Power density ratio @ 0.20 m	0.05
Distance for compliance power density (S=SL) [m]	0.043
Compliance	
Verdict	PASS
Comment: --	

LTE FDD13	
Transmission Mode	
Transmission Frequency (f) [MHz]	782.0
Antenna far-field distance	
Maximum antenna diameter (D) [m]	N/A
Transmission wavelength (λ) [m]	N/A
Antenna far-field distance (R_{FF}) [m]	N/A
Source average power	
Peak radiated power (PR) [dBm EIRP]	28.09
Maximum transmission duty cycle (DC)	1.00
Duty cycle correction (DCC) [dB]	0.00
Average radiated power (PRAVG) [dBm EIRP]	28.09
Power density	
Compliance power density limit [W/m^2]	26.067
Power density (S) @ Antenna far-field distance [W/m^2]	N/A
Power density (S) @ 0.20 m [W/m^2]	1.282
Power density ratio @ 0.20 m	0.05
Distance for compliance power density (S=SL) [m]	0.044
Compliance	
Verdict	PASS
Comment: --	

LTE FDD25	
Transmission Mode	
Transmission Frequency (f) [MHz]	1882.5
Antenna far-field distance	
Maximum antenna diameter (D) [m]	N/A
Transmission wavelength (λ) [m]	N/A
Antenna far-field distance (R_{FF}) [m]	N/A
Source average power	
Peak radiated power (PR) [dBm EIRP]	28.21
Maximum transmission duty cycle (DC)	1.00
Duty cycle correction (DCC) [dB]	0.00
Average radiated power (PRAVG) [dBm EIRP]	28.21
Power density	
Compliance power density limit [W/m^2]	50.000
Power density (S) @ Antenna far-field distance [W/m^2]	N/A
Power density (S) @ 0.20 m [W/m^2]	1.317
Power density ratio @ 0.20 m	0.03
Distance for compliance power density (S=SL) [m]	0.032
Compliance	
Verdict	PASS
Comment: --	

LTE FDD66	
Transmission Mode	
Transmission Frequency (f) [MHz]	1779.0
Antenna far-field distance	
Maximum antenna diameter (D) [m]	N/A
Transmission wavelength (λ) [m]	N/A
Antenna far-field distance (R_{FF}) [m]	N/A
Source average power	
Peak radiated power (PR) [dBm EIRP]	28.22
Maximum transmission duty cycle (DC)	1.00
Duty cycle correction (DCC) [dB]	0.00
Average radiated power (PRAVG) [dBm EIRP]	28.22
Power density	
Compliance power density limit [W/m^2]	50.000
Power density (S) @ Antenna far-field distance [W/m^2]	N/A
Power density (S) @ 0.20 m [W/m^2]	1.320
Power density ratio @ 0.20 m	0.03
Distance for compliance power density (S=SL) [m]	0.033
Compliance	
Verdict	PASS
Comment: --	

IEEE 802.11 (2.4 GHz)	
Transmission Mode	
Transmission Frequency (f) [MHz]	2437.0
Antenna far-field distance	
Maximum antenna diameter (D) [m]	N/A
Transmission wavelength (λ) [m]	N/A
Antenna far-field distance (R_{FF}) [m]	N/A
Source average power	
Peak radiated power (PR) [dBm EIRP]	18.67
Maximum transmission duty cycle (DC)	1.00
Duty cycle correction (DCC) [dB]	0.00
Average radiated power (PRAVG) [dBm EIRP]	18.67
Power density	
Compliance power density limit [W/m^2]	50.000
Power density (S) @ Antenna far-field distance [W/m^2]	N/A
Power density (S) @ 0.20 m [W/m^2]	0.146
Power density ratio @ 0.20 m	0.00
Distance for compliance power density (S=SL) [m]	0.011
Compliance	
Verdict	PASS
Comment: --	

Bluetooth LE	
Transmission Mode	
Transmission Frequency (f) [MHz]	2402.0
Antenna far-field distance	
Maximum antenna diameter (D) [m]	N/A
Transmission wavelength (λ) [m]	N/A
Antenna far-field distance (R_{FF}) [m]	N/A
Source average power	
Peak radiated power (PR) [dBm EIRP]	10.14
Maximum transmission duty cycle (DC)	1.00
Duty cycle correction (DCC) [dB]	0.00
Average radiated power (PRAVG) [dBm EIRP]	10.14
Power density	
Compliance power density limit [W/m^2]	50.000
Power density (S) @ Antenna far-field distance [W/m^2]	N/A
Power density (S) @ 0.20 m [W/m^2]	0.021
Power density ratio @ 0.20 m	0.00
Distance for compliance power density (S=SL) [m]	0.004
Compliance	
Verdict	PASS
Comment: --	

7 Concurrent Evaluation Results - FCC

LTE FDD5 + IEEE 802.11 (2.4 GHz) + Bluetooth LE	
Information	
Number of concurrent modes	3
Evaluation distance [m]	0.20
Maximum MPE Ratios	
LTE FDD5	0.05
IEEE 802.11 (2.4 GHz)	0.00
Bluetooth LE	0.00
Sum of MPE Ratios	
Sum	0.05
Compliance	
Verdict	PASS

LTE FDD13 + IEEE 802.11 (2.4 GHz) + Bluetooth LE	
Information	
Number of concurrent modes	3
Evaluation distance [m]	0.20
Maximum MPE Ratios	
LTE FDD13	0.05
IEEE 802.11 (2.4 GHz)	0.00
Bluetooth LE	0.00
Sum of MPE Ratios	
Sum	0.05
Compliance	
Verdict	PASS

LTE FDD25 + IEEE 802.11 (2.4 GHz) + Bluetooth LE	
Information	
Number of concurrent modes	3
Evaluation distance [m]	0.20
Maximum MPE Ratios	
LTE FDD25	0.03
IEEE 802.11 (2.4 GHz)	0.00
Bluetooth LE	0.00
Sum of MPE Ratios	
Sum	0.03
Compliance	
Verdict	PASS

LTE FDD66 + IEEE 802.11 (2.4 GHz) + Bluetooth LE	
Information	
Number of concurrent modes	3
Evaluation distance [m]	0.20
Maximum MPE Ratios	
LTE FDD66	0.03
IEEE 802.11 (2.4 GHz)	0.00
Bluetooth LE	0.00
Sum of MPE Ratios	
Sum	0.03
Compliance	
Verdict	PASS

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