



# EMI - T E S T R E P O R T

## - Human Exposure -

**Type / Model Name** : Track Box

**Product Description** : Tracking system with 2.4 GHz standard IEEE 802.15.4,  
UMTS and GNSS

**Applicant** : Race Result AG

Address : Joseph-von-Fraunhofer-Str. 11  
76327 Pfinztal, GERMANY

**Manufacturer** : Race Result AG

Address : Joseph-von-Fraunhofer-Str. 11  
76327 Pfinztal, GERMANY

**Test Result** according to the standards  
listed in clause 1 test standards:

**POSITIVE**

**Test Report No. :**

**T43520-00-04KS**

16. August 2018

Date of issue



Deutsche  
Akkreditierungsstelle  
D-PL-12030-01-01  
D-PL-12030-01-02

The test report merely corresponds to the test sample.  
It is not permitted to copy extracts of these test results  
without the written permission of the test laboratory.

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ATTACHMENT A as separate supplement

## 1 TEST STANDARDS

The tests were performed according to following standards:

**FCC Rules and Regulations Part 1, Subpart I - Procedures Implementing the National Environmental Policy**

**Act of 1969**

Part 1, Subpart I, Section 1.1310	Radiofrequency radiation exposure limits
Part 1, Subpart 2, Section 2.1091	Radiofrequency radiation exposure evaluation: <b>mobile devices</b> .
Part 1, Subpart 2, Section 2.1093	Radiofrequency radiation exposure evaluation: <b>portable devices</b> .

**OET Bulletin 65, 65A, 65B Edition 97-01, August 1997 – Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields.**

KDB 447498 D01 v06	Mobile and portable devices RF Exposure procedures and equipment authorisation policies, October 23, 2015.
KDB 865664 D01 v01r04	SAR Measurement Requirements for 100 MHz to 6 GHz, August 7, 2015.
ANSI C95.1: 2005	IEEE Standard for Safety Levels with respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz
ETSI TR 100 028 V1.3.1: 2001-03,	Electromagnetic Compatibility and Radio Spectrum Matters (ERM); Uncertainties in the Measurement of Mobile Radio Equipment Characteristics—Part 1 and Part 2

## 2 EQUIPMENT UNDER TEST

### 2.1 Photo documentation of the EUT – See ATTACHMENT A

### 2.2 Equipment type, category

IEEE 802.15.4, GNSS receiver, 3G Modul, fixed equipment

### 2.3 Short description of the equipment under test (EUT)

The EUT is part of a tracking system. The Track Box receives pings from tracking-enabled transponders and is also equipped with a GNSS receiver to locate itself and a cellular modem to report its position to a server. The EUT is not compatible with other IEEE 802.15.4 technologies and can only communicate with the transponders and other Track Boxes.

Number of tested samples: 1  
Serial number: 20241  
Firmware version: 1.0

### 2.4 Variants of the EUT

None.

### 2.5 General remarks

No separate measurements were performed to generate test results for the present document. The maximum output power of IEEE 802.15.4 is defined by the manufacturer.

This test report is also based on the already certified UMTS/GNSS radio module Quectel UC20. In this case only worst case considerations for the highest radiated output power of all emitters are taken into consideration to calculate the maximum permissible exposure for fixed equipment devices. Therefore, the absolute maximum power of the UMTS-Module is assumed to have an EIRP of 0.25 W (24 dBm) for UMTS 850 and 0.22 W (23.5 dB) for UMTS 1900 to calculate the worst case conditions for MPE.

## 2.6 Operation frequency and channel plan

## IEEE 802.15.4:

- The operating frequency range 2400 MHz to 2483.5 MHz
- Channel plan 2405/2415/2425/2435/2450/2460/2475/2480 MHz
- Output power 3.5dBm
- Modulation O-QPSK
- Data rate 250 kbps

### GNSS receiver (Quectel UC20 UMTS/HSPA+ Module):

- Receiver type Qualcomm gpsOne Gen8
- SBAS WAAS, EGNOS, MSAS

### 3G Module (Quectel UC20 UMTS/HSPA+ Module):

- Bands UMTS 800/850/900/1900/2100 MHz  
Output power
  - Class 3 (24dBm) for UMTS bands

## 2.7 Antennas

The following antennas shall be used with the EUT:

Type	Certification name	Plug	Frequencyrange	Gain (dBi)
Omni	Laird Technologies RD2458-5	SMA	2.4 - 2.4835 GHz	3.0
SMD	Taoglas PA.700.A Viking	None	700-960 MHz	2.0
SMD	Taoglas PA.700.A Viking	None	1710-2200 MHz	4.1
Patch	Amotech A25-4102920-AMT03	None	1576 - 1608 MHz	4.5

## 2.8 Power supply system utilised

Power supply voltage,  $V_{nom}$  : 3.7 VDC Battery  
Power supply voltage (alternative) : Input: 110-240 VAC,  
Output: 10-15 VDC.

### 3 TEST RESULT SUMMARY

Operating in the 2400 MHz – 2483.5 MHz:

FCC Rule Part	Description	Result
15.247(i)	MPE	passed
KDB 447498	SAR exclusion consideration	not applicable
OET Bulletin 65	Co-location, Co-transmission	passed

#### 3.1 Final assessment

The equipment under test fulfills the EMI requirements cited in clause 1 test standards.

Date of receipt of test sample : acc. to storage records

Testing commenced on : 14 March 2018

Testing concluded on : 14 March 2018

Checked by:

Tested by:

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Klaus Gegenfurtner  
Teamleader Radio

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Kathrin Schiebl  
Radio Team

## 4 TEST ENVIRONMENT

### 4.1 Address of the test laboratory

**CSA Group Bayern GmbH**  
**Ohmstrasse 1-4**  
**94342 STRASSKIRCHEN**  
**GERMANY**

### 4.2 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature: 15-35 °C

Humidity: 30-60 %

Atmospheric pressure: 86-106 kPa

### 4.3 Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. It is noted that the expanded measurement uncertainty corresponds to the measurement results from the standard measurement uncertainty multiplied by the coverage factor  $k = 2$ . The true value is located in the corresponding interval with a probability of 95 %. The measurement uncertainty was calculated for all measurements listed in this test report acc. to CISPR 16-4-2 / 11.2003 „Uncertainties, statistics and limit modelling – Uncertainty in EMC measurements“ and is documented in the quality system acc. to DIN EN ISO/IEC 17025. For all measurements shown in this report, the measurement uncertainty of the test laboratory, CSA Group Bayern GmbH, is below the measurement uncertainty as defined by CISPR. Therefore, no special measures must be taken into consideration with regard to the limits according to CISPR. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

Measurement Type	Range	Confidence Level	Calculated Uncertainty
AC power line conducted emissions	0.15 MHz to 30 MHz	95%	$\pm 3.29$ dB
EBW and OBW	2400 MHz to 3000 MHz	95%	$\pm 2.5 \times 10^{-7}$
Maximum peak conducted output power	2400 MHz to 3000 MHz	95%	$\pm 0.62$ dB
Power spectral density	2400 MHz to 3000 MHz	95%	$\pm 0.62$ dB
Conducted Spurious Emissions	9 kHz to 10000 MHz	95%	$\pm 2.15$ dB
Conducted Spurious Emissions	10000 MHz to 40000 MHz	95%	$\pm 3.47$ dB
Radiated Spurious Emissions	9 kHz to 30 MHz	95%	$\pm 3.53$ dB
Radiated Spurious Emissions	30 MHz to 1000 MHz	95%	$\pm 3.71$ dB
Radiated Spurious Emissions	1000 MHz to 10000 MHz	95%	$\pm 2.34$ dB
Field strength of the fundamental	100 kHz to 100 MHz	95%	$\pm 3.53$ dB

## 5 TEST CONDITIONS AND RESULTS

### 5.1 Maximum peak conducted output power

#### IEEE 802.15.4

Rated output power: 2.2 mW  
Tune-up tolerance: 2.5 dB  
Maximum output power:  $3.5 \text{ dBm} + 2.5 \text{ dB} = 6.0 \text{ dBm} = \mathbf{4.0 \text{ mW}}$   
Antenna gain max: 3.0 dBi

Maximum EIRP:  $6.0 \text{ dBm} + 3.0 \text{ dBi} = \mathbf{7.9 \text{ mW}}$

#### 3G Module (Quectel UC20 UMTS/HSPA+ Module)

##### UMTS 850

Rated output power: 251 mW  
Tune-up tolerance: 1 dB  
Maximum output power:  $24 \text{ dBm} + 1 \text{ dB} = 25 \text{ dBm} = \mathbf{316 \text{ mW}}$   
Antenna gain max: 2.0 dBi

Maximum EIRP:  $25 \text{ dBm} + 2.0 \text{ dBi} = \mathbf{501 \text{ mW}}$

##### UMTS 1900

Rated output power: 224 mW  
Tune-up tolerance: 1 dB  
Maximum output power:  $23.5 \text{ dBm} + 1 \text{ dB} = 24.5 \text{ dBm} = \mathbf{282 \text{ mW}}$   
Antenna gain max: 4.1 dBi

Maximum EIRP:  $24.5 \text{ dBm} + 4.1 \text{ dBi} = \mathbf{724 \text{ mW}}$

Remarks: \_\_\_\_\_

\_\_\_\_\_

## 6 HUMAN EXPOSURE

### 6.1 Maximum permissible exposure (MPE)

#### 6.1.1 Description of the test location

Test location:                    NONE

#### 6.1.2 Applicable standard

According to FCC Part 15, Section 15.247(i):

Systems operating under the provisions of this section shall be operated in a manner that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.

The test methods used comply with ANSI/IEEE C95.1, "IEEE Standard for Safety Levels with respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz".

This test report shows the compliance with the limits for Maximum Permissible Exposure (MPE) specified in FCC Part 1, Section 1.1310 and the criteria to evaluate the environmental impact of human exposure to radio frequency (RF) radiation as specified in FCC Part 1, Section 1.1307(b).

#### 6.1.3 Description of Measurement

The maximum total power input to the antenna has been measured radiated as described in clause 5.3 of this document. Through the Friis transmission formula, the known maximum gain of the antenna and the maximum power, can be calculated the MPE in a defined distance away from the product.

Friis transmission formula:

$$P_d = \frac{P_{out} * G}{4 * \pi * r^2}$$

Where:

$P_d$  = power density (mW/cm<sup>2</sup>)

$P_{out}$  = output power to antenna (mW)

G = gain of antenna (linear scale)

r = distance between antenna and observation point (cm)

According to FCC Rules 47CFR 2.1093(b) the EUT is not a portable device. The EUT is designed to be used that radiating structures are 20 cm outside of the body of the user. (**r = 40 cm**)

**6.1.4 Test result**
**IEEE 802.15.4**

Channel frequency (MHz)	EIRP (dBm)	P (mW)	P (W)	P <sub>d</sub> (mW/cm <sup>2</sup> )	Limit P <sub>d</sub> (mW/cm <sup>2</sup> )	Exposure Ratio (%)
2405	9.0	7.94	0.007943	0.000395	1.0	0.0395
2435	9.0	7.94	0.007943	0.000395	1.0	0.0395
2480	9.0	7.94	0.007943	0.000395	1.0	0.0395

**3G Module (Quectel UC20 UMTS/HSPA+ Module)**

Radio standard	Channel frequency (MHz)	EIRP	EIRP	EIRP	P <sub>d</sub>	Limit P <sub>d</sub>	Exposure ratio
	(MHz)	(dBm)	(mW)	(W)	(mW/cm <sup>2</sup> )	(mW/cm <sup>2</sup> )	(%)
UMTS	826.4	27.0	501.2	0.50	0.02	0.55	4.52
UMTS	1852.4	28.6	724.4	0.72	0.04	1.00	3.60

Limits for maximum permissible exposure (MPE):

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm <sup>2</sup> )	Averaging time (minutes)
<b>(B) Limits for General Population / Uncontrolled Exposure</b>				
0.3 – 3.0	614	1.63	100	30
3.0 – 30	824/f	2.19/f	180/f <sup>2</sup>	30
30 - 300	27.5	0.073	0.2	30
300-1500	---	---	f/1500	30
<b>1500-100000</b>	<b>---</b>	<b>---</b>	<b>1.0</b>	<b>30</b>

f = Frequency in MHz

The requirements are **FULFILLED**.

**Remarks:** The EUT is a fixed equipment and the distance between the antenna and the user is more than 20 cm. Therefore, the MPE is calculated.  
 According to the customer, the Track Box is used at the side of a street with participants running/cycling by. It is typically mounted to a street sign, lamp post or on a tripod.

## 6.2 Co-location and Co-transmission

### Applicable standard:

KDB 447498, Edition 15-10, Section 7.2: Transmitters used in mobile device exposure conditions for simultaneous transmission operations

The FCC's MPE limits vary with frequency. Therefore, in mixed or broadband RF fields where several sources and frequencies are involved, the fraction of the recommended limit (in terms of power density or square of the electric or magnetic field strength) incurred within each frequency interval should be determined, and the sum of all fractional contributions should not exceed 1.0, or 100 % in terms of percentage.

1. IEEE 802.15.4:  $P_d = 0.000395 \text{ mW/cm}^2$   
Limit:  $1.0 \text{ mW/cm}^2$   
Fraction of MPE 0.0395 %

2. 3G radio Module (UMTS):  $P_d = 0.02 \text{ mW/cm}^2$   
Limit:  $0.55 \text{ mW/cm}^2$   
Fraction of MPE: 4.52 %

Maximum power density ratio IEEE 802.15.4	Maximum power density ratio GSM	Sum of exposure ratios	Limit of exposure ratios
(%)	(%)	(%)	(%)
0.040	4.52	4.56	100

The requirements are **FULFILLED**.

Remarks: \_\_\_\_\_

\_\_\_\_\_

## 6.3 SAR test exclusion considerations

### 6.3.1 Applicable standard

According to RF exposure guidance:

Systems operating under the provisions of this section shall be operated in a manner that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.

**Remarks:** The EUT is a fixed equipment and the distance between the antenna and the user is more than 20 cm. Therefore, the MPE is calculated.