



RF - TEST REPORT

- Human Exposure -

Type / Model Name : ROX 12.1

Product Description : Bicycle Computer

Applicant : TQ Systems GmbH

Address : Gut Delling, Mühlstrasse 2
82229 SEEFELD, GERMANY

Manufacturer : SIGMA-ELEKTRO GmbH

Address : Dr.-Julius-Leber-Strasse 15
67433 NEUSTADT, GERMANY

Test Result according to the standards listed in clause 1 test standards:	POSITIVE
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Test Report No. : 80122879-08 Rev_1	23. February 2023 <hr/> Date of issue
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Deutsche
 Akkreditierungsstelle
 D-PL-12030-01-03
 D-PL-12030-01-04

FCC ID: M5LROX-12-1

IC ID: 7580A-ROX121

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ATTACHMENT A as separate supplement

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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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: mobile devices .
KDB 447498 D01	RF Exposure procedures and equipment authorisation policies for mobile and portable devices, April 20, 2021.
ANSI C95.1: 2005	IEEE Standard for Safety Levels with respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz

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EQUIPMENT UNDER TEST

1.1 Information provided by the Client

Please note, we do not take any responsibility for information provided by the client or his representative which may have an influence on the validity of the test results.

1.2 Sampling

The customer is responsible for the choice of sample. Sample configuration, start-up and operation is carried out by the customer or according his/her instructions.

1.3 Photo documentation of the EUT – See ATTACHMENT A

1.4 Equipment type, category

BLE device

WLAN - Client

ANT+ device

1.5 Short description of the equipment under test (EUT)

The EUT is a bicycle computer.

One SMD antenna is used within the system for BLE or ANT+ and one for WLAN. The EUT has only integrated antennas. The modulation used by the EUT for BLE is GFSK with a data rate of 1 Mbit/s or 2Mbit/s.

Number of tested samples	: 1 radiated sample DUT5	1 conducted sample DUT6
Serial number	: REV 0201	REV 0201
Firmware version	: Linux Test Software	Linux Test Software
	:	

Items	Description
BT type	5.3 Low Energy
BT chipset type	Nordic NRF 52832
Modulation	GFSK
Frequency range	2400 MHz to 2483.5 MHz
Channel numbers	40
Data rate (kbps)	1000, 2000
Antenna type	2.4 GHz SMD Antenna

WLAN 802.11bgn SiP transceiver radio module "WFM200S" with FCC ID QOQWFM200 and IC 5123A-WFM200

1.6 Variants of the EUT

There are no variants.

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1.7 Operation frequency range

The operating frequency is 2400 MHz to 2483.5 MHz.

1.8 Transmit operating modes

The EUT uses DSSS or OFDM modulation and may operate under operating mode 2 and provide following data rates with auto-fall-back:

- 802.11b	11, 5.5, 2, 1 Mbps	(Mbps = megabits per second)
- 802.11g	54, 48, 36, 24, 18, 12, 9, 6 Mbps	(Mbps = megabits per second)
- 802.11n	HT20, MCS 0 – 7	

The EUT uses GFSK for BLE with data rates 1 Mbps and 2 Mbps.

ANT+ Mode 2457 MHz

1.9 Antennas

The following antennas are used with the EUT:

Johanson Technology 2.4 GHz SMD Antenna 2450AT18D0100

The EUT is equipped with 1 internal WLAN antenna and 1 BLE internal antenna of the same type, which can also be used for ANT+.

1.10 Power supply system utilised

Power supply voltage, V_{nom} : 3.8V, battery supplied

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2 TEST RESULT SUMMARY

WLAN device using digital modulation:

Operating in the 2400 MHz – 2483.5 MHz:

FCC Rule Part	RSS Rule Part	Description	Result
KDB 447498, 7.1	RSS 102, 2.5.2	MPE	passed
KDB 447498, 4.3.1	RSS 102, 2.5.1	SAR exclusion consideration	not applicable
KDB 447498, 7.2	RSS102, 3.2	Co-location, Co-transmission	passed

SAR exclusion is not applicable, EUT is mobile device.

 The mentioned RSS Rule Parts in the above table are related to:
 RSS 102, Issue 5, March 2015

2.1 Revision history of test report

Test report No	Rev.	Issue Date	Changes
80122879-08	1	23 February 2023	ANT+ MPE added

The test report with the highest revision number replaces the previous test reports.

2.2 Final assessment

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

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

 Testing commenced on : 04 May 2022

 Testing concluded on : 17 February 2023

Checked by:

Tested by:

 Jürgen Pessinger
 Radio Team

 Christopher Thaller
 Radio Team

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3 TEST ENVIRONMENT

3.1 Address of the test laboratory

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

3.2 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

3.3 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 on basis of the ETSI Technical Report TR 100 028 Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics; Part 1 and Part 2. The results are documented in the quality system acc. to DIN EN ISO/IEC 17025. 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.

3.4 Conformity Decision Rule

The applied conformity decision rule is based on ILAC G8:09/2019 clause 4.2.1 Binary Statement for Simple Acceptance Rule ($w = 0$).

Details can be found in the procedure CSA_B_V50_29.

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4 HUMAN EXPOSURE

4.1 Maximum permissible exposure (MPE)

4.1.1 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).

4.1.2 Description of Determination

The maximum rated output power conducted included the tune up tolerance is used to calculate the EIRP. 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/cm²)

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. ($r = 20$ cm)

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4.1.3 Determination of MPE according FCC:
BLE:

BLE 1 Mbps							
Channel	measured cond. Power	Tune-up Tolerance + Ant. Gain	max. EIRP	P_d	Limit	Margin	Exposure ratio
No.	(dBm)	(dB)	(mW)	(mW/cm ²)	(mW/cm ²)	(mW/cm ²)	(%)
37	1.0	5.5	4.47	0.0009	1.0	-0.9991	0.09
17	1.5	5.5	5.01	0.0010	1.0	-0.9990	0.10
39	1.8	5.5	5.37	0.0011	1.0	-0.9989	0.11

BLE 2 Mbps							
Channel	measured cond. Power	Tune-up Tolerance + Ant. Gain	max. EIRP	P_d	Limit	Margin	Exposure ratio
No.	(dBm)	(dB)	(mW)	(mW/cm ²)	(mW/cm ²)	(mW/cm ²)	(%)
37	1.0	5.5	4.47	0.0009	1.0	-0.9991	0.09
17	1.2	5.5	4.68	0.0009	1.0	-0.9991	0.09
39	1.8	5.5	5.37	0.0011	1.0	-0.9989	0.11

WLAN:

802.11b							
Channel	measured EIRP	Tune-up Tolerance	max. EIRP	P_d	Limit	Margin	Exposure ratio
No.	(dBm)	(dB)	(mW)	(mW/cm ²)	(mW/cm ²)	(mW/cm ²)	(%)
1	16.1	4.0	101.62	0.0202	1.0	-0.9798	2.02
11	12.6	4.0	45.39	0.0090	1.0	-0.9910	0.90

802.11n HT20							
Channel	measured EIRP	Tune-up Tolerance	max. EIRP	P_d	Limit	Margin	Exposure ratio
No.	(dBm)	(dB)	(mW)	(mW/cm ²)	(mW/cm ²)	(mW/cm ²)	(%)
1	17.2	4.0	131.83	0.0262	1.0	-0.9738	2.62
11	15.2	4.0	83.18	0.0165	1.0	-0.9835	1.65

ANT+:

ANT+							
Channel	measured cond. Power	Tune-up Tolerance + Ant. Gain	max. EIRP	P_d	Limit	Margin	Exposure ratio
(MHz)	(dBm)	(dB)	(mW)	(mW/cm ²)	(mW/cm ²)	(mW/cm ²)	(%)
2457	-2.7	5.5	1.89	0.0004	1.0	-0.9996	0.04

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)
(B) Limits for General Population / Uncontrolled Exposure				
0.3 – 1.34	614	1.63	100	30
1.34 – 30	824/ <i>f</i>	2.19/ <i>f</i>	180/ <i>f</i> ²	30
30 - 300	27.5	0.073	0.2	30
300-1500	---	---	<i>f</i> /1500	30
1500-100000	---	---	1.0	30

f = Frequency in MHz

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4.1.4 Determination of MPE according ISED:

BLE:

BLE 1 Mbps							
Frequency	measured cond. Power	Tune-up Tolerance + Ant. Gain	max. EIRP	Factor	$f^{0.6834}$	Limit	Margin
MHz	(dBm)	(dB)	(mW)		(W)	(W)	(W)
2402	1.0	5.5	4.47	0.0131	204.3072	2.676	-2.6720
2440	1.5	5.5	5.01	0.0131	206.5105	2.705	-2.7003
2480	1.8	5.5	5.37	0.0131	208.8182	2.736	-2.7301

BLE 2 Mbps							
Frequency	measured cond. Power	Tune-up Tolerance + Ant. Gain	max. EIRP	Factor	$f^{0.6834}$	Limit	Margin
MHz	(dBm)	(dB)	(mW)		(W)	(W)	(W)
2402	1.0	5.5	4.47	0.0131	204.3072	2.676	-2.6720
2440	1.2	5.5	4.68	0.0131	206.5105	2.705	-2.7006
2480	1.8	5.5	5.37	0.0131	208.8182	2.736	-2.7301

WLAN:

802.11b							
Frequency	measured EIRP	Tune-up Tolerance	max. EIRP	Factor	$f^{0.6834}$	Limit	Margin
MHz	(dBm)	(dB)	(mW)		(W)	(W)	(W)
2412	16.1	4.0	101.62	0.0131	204.8881	2.684	-2.5824
2462	12.6	4.0	45.39	0.0131	207.7812	2.722	-2.6765

802.11n HT20							
Frequency	measured EIRP	Tune-up Tolerance	max. EIRP	Factor	$f^{0.6834}$	Limit	Margin
MHz	(dBm)	(dB)	(mW)		(W)	(W)	(W)
2412	17.2	4.0	131.83	0.0131	204.8881	2.684	-2.5522
2462	15.2	4.0	83.18	0.0131	207.7812	2.722	-2.6388

ANT+

ANT+							
Frequency	measured cond. Power	Tune-up Tolerance + Ant. Gain	max. EIRP	Factor	$f^{0.6834}$	Limit	Margin
MHz	(dBm)	(dB)	(mW)		(W)	(W)	(W)
2402	-2.7	5.5	1.89	0.0131	204.3072	2.676	-2.6745

Exemption limits for routine Evaluation – RF exposure evaluation according RSS102, 2.5.2:

At or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. 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 e.i.r.p. of the device is equal to or less than 5 W (adjusted for tune-up tolerance)

The requirements are **FULFILLED**.

Remarks: None

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4.2 Co-location and Co-transmission

Applicable standard:

OET Bulletin 65, Edition 97-01, Section 2: Multiple-transmitter sites and Complex Environments

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. MPE of BLE Module: $S = 0.0011 \text{ mW/cm}^2$
 Limit: 1 mW/cm^2
 Fraction of MPE: 0.11 %

2. MPE of WLAN-Module: $S = 0.0262 \text{ mW/cm}^2$
 Limit: 1 mW/cm^2
 Fraction of MPE: 2.62 %

MPE of ANT+: $S = 0.0004 \text{ mW/cm}^2$
 Limit: 1 mW/cm^2
 Fraction of MPE: 0.04 %

Calculation of the sum of MPE ratios
 $\text{Transmitter 1} + \text{Transmitter 2} \leq 100 \%$;
 $0.11 \% + 2.62 \% + 0.04 \% = \mathbf{2.77 \%} \leq \mathbf{100 \%}$;

The requirements are **FULFILLED**.

Remarks: WLAN module already certified.

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