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Test report no.:

200023-AU01+W04

for:

Uhlmann & Zacher GmbH
Radio module with BLE
FSMBLE

according to:

Part 2

RSS-102



Deutsche
Akkreditierungsstelle
D-PL-12155-01-04



Deutsche
Akkreditierungsstelle
D-PL-12155-01-03

Accreditation:



FCC test firm accreditation expiration date: 2021-05-30
MRA US-EU, FCC designation number: DE0010
FCC registration number: 97268
BnetzA-CAB-02/21-02/5 Valid until 2023-11-26



Recognized until 2023-03-16 by the
Department of Innovation, Science and Economic Development Canada (ISED)
as a recognized testing laboratory
CAB identifier: DE0011
Company number: 3472A

Location of Testing:

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The technical accuracy is guaranteed through the quality management of
Element Materials Technology Straubing GmbH.

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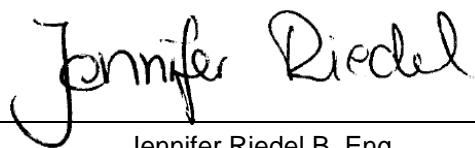
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1 Summary of test results

<i>FCC standard</i>	<i>Requirement</i>	<i>Page</i>	<i>Result</i>	<i>Note(s)</i>
Part 2, § 2.1091	Maximum permissible exposure, except WPT	9	Passed	---

<i>IC standard</i>	<i>Requirement</i>	<i>Page</i>	<i>Result</i>	<i>Note(s)</i>
RSS-102 Issue 5, section 2.5.2	Evaluation for separation distance > 20 cm, except 3 kHz – 10 MHz	12	Passed	---

Straubing, July 26, 2021



Jennifer Riedel B. Eng.
Radio Test Engineer



Konrad Graßl
Department Manager Radio

2 Test regulations

<i>Standard</i>	<i>Title</i>
RSS-102 Issue 5 March 2015	Spectrum Management and Telecommunications Radio Standards Specification Radio Frequency (RF) Exposure Compliance of Radio communication Apparatus (All Frequency Bands)
Notice 2016-DRS001 September 20, 2016 Updated July 2020	Applicability of Latest FCC RF Exposure KDB Procedures and Other Procedures
IEEE C95.3-2002 (R2008) Approved December 11, 2002 Reaffirmed June 12, 2008	IEEE Recommended Practice for Measurements and Computations of Radio Frequency Electromagnetic Fields With Respect to Human Exposure to Such Fields, 100 kHz–300 GHz
OET Bulletin 65, 65A, 65B Edition 97-01, August 1997	Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields
Part 1, Subpart I, Section 1.1307	Actions that may have a significant environmental effect, for which Environmental Assessments (EAs) must be prepared.
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 v06	Mobile and portable devices RF Exposure procedures and equipment authorisation policies, October 23, 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

3 Equipment under test (EUT)

3.1 General information

Product type:	Radio module with BLE
Model Name:	FSMBLE
Manufacturer:	Uhlmann & Zacher GmbH
Serial number:	000D35AE
Version:	Hardware: 4.1.2 Software: fsm_nrf5_DTM.hex
Short description:	The EUT is a radio module with an integrated RF module using Bluetooth Low Energy (BLE) technique in the 2.4 GHz band.
FCC ID:	2APV6FSMBLE
IC certification number:	24382-FSMBLE
Application frequency band:	2400 MHz to 2483.5 MHz
Frequency range:	2402 MHz to 2480 MHz
Technology:	Bluetooth low energy
Antenna types:	PCB antenna <input type="checkbox"/> detachable <input checked="" type="checkbox"/> not detachable
Power supply:	DC supply Nominal voltage: 12 V
Exposure tier:	<input type="checkbox"/> Head <input checked="" type="checkbox"/> Body <input type="checkbox"/> Limbs <input type="checkbox"/> other <input type="checkbox"/> See appropriate results
Separation distance:	<input type="checkbox"/> ≤ 20 cm <input checked="" type="checkbox"/> > 20 cm <input type="checkbox"/> See appropriate results
Evaluated against exposure limits:	<input checked="" type="checkbox"/> General public use <input type="checkbox"/> Controlled use

3.2 Photographs of EUT

See Annex B of test report 200023-AU01+W03 of test laboratory Element Materials Technology Straubing GmbH.

4 Test results

This clause gives details about the test results as collected on page 5.

4.1 FCC

4.1.1 Maximum permissible exposure, except WPT

Requirement: Part 2, §2.1091

Reference: KDB 447498

Performed by:	Jennifer Riedel B. Eng.	Date of test:	July 26, 2021
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Result:	<input checked="" type="checkbox"/> Limits kept	<input type="checkbox"/> Limits not kept
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4.1.1.1 Requirements and limits maximum permissible exposure

This estimation follows the general guidelines for RF Exposure according to KDB 447498.

According to §2.1091(b):

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.”

According to §2.1091(c)(1):

Evaluation of compliance with the exposure limits in §1.1310 of this chapter, and preparation of an EA if the limits are exceeded, is necessary for mobile devices with single RF sources having either more than an available maximum time-averaged power of 1 mW or more than the ERP listed in Table 1 to §1.1307(b)(3)(i)(C), whichever is greater. For mobile devices not exempt by §1.1307(b)(3)(i)(C) at distances from 20 centimeters to 40 centimeters and frequencies from 0.3 GHz to 6 GHz, evaluation of compliance with the exposure limits in §1.1310 of this chapter is necessary if the ERP of the device is greater than ERP_{20cm} in the formula below. If the ERP of a single RF source at distances from 20 centimeters to 40 centimeters and frequencies from 0.3 GHz to 6 GHz is not easily obtained, then the available maximum time-averaged power may be used (i.e., without consideration of ERP) in comparison with the following formula only if the physical dimensions of the radiating structure(s) do not exceed the electrical length of $\lambda/4$ or if the antenna gain is less than that of a half-wave dipole (1.64 linear value).

$$P_{th}(\text{mW}) = ERP_{20\text{ cm}}(\text{mW}) = \begin{cases} 2040f & 0.3\text{ GHz} \leq f < 1.5\text{ GHz} \\ 3060 & 1.5\text{ GHz} \leq f \leq 6\text{ GHz} \end{cases}$$

According to §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.

According to §1.1310(d)(4):

Both the MPE limits listed in Table 1 in paragraph (e)(1) of this section and the SAR limits as set forth in paragraphs (a) through (c) of this section are for continuous exposure, that is, for indefinite time periods. Exposure levels higher than the limits are permitted for shorter exposure times, as long as the average exposure over a period not more than the specified averaging time in Table 1 in paragraph (e)(1) is less than (or equal to) the exposure limits. Detailed information on our policies regarding procedures for evaluating compliance with all of these exposure limits can be found in the most recent edition of FCC's OET Bulletin 65, "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields," and its supplements, all available at the FCC's internet website: <https://www.fcc.gov/general/oet-bulletins-line>, and in the Office of Engineering and Technology (OET) Laboratory Division Knowledge Database (KDB) (<https://www.fcc.gov/kdb>).

RF Source frequency (MHz)	Threshold ERP (watts)
0.3-1.34	$1,920 R^2$.
1.34-30	$3,450 R^2/f^2$.
30-300	$3.83 R^2$.
300-1,500	$0.0128 R^2 f$.
1,500-100,000	$19.2R^2$.

Table 1: Table 1 to §1.1307(b)(3)(i)(C)—Single RF Sources Subject to Routine Environmental Evaluation

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
(A) 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 - 1500			f/300	<6
1500 - 100000			5	<6
(B) 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 - 1500			f/1500	<30
1500 - 100000			1.0	<30

Table 2: Limits for maximum permissible exposure (MPE) according to table 1 of §1.1310(e)

Note(s):

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

4.1.1.2 Results

The following data are based on applicants document: 200023-AU01+W03 of the test laboratory Element Materials Technology Straubing GmbH

Application:	Bluetooth low energy
Operation frequency range:	2400 MHz – 2483.5 MHz
Antenna model	PCB antenna
Antenna connector:	none
Antenna type:	internal not detachable
Antenna gain:	0.1 dBi
Maximum conducted output power:	-2.06 dBm at 2402 MHz -1.95 dBm at 2440 MHz -1.19 dBm at 2480 MHz

Information related to Exposure:

Tune-up tolerance (according to the manufacturer):	± 4 dB
Separation distance:	200 mm
Exposure:	general public
Power averaging over time:	not applied

Channel Frequency (MHz)	EIRP + tuneup tolerance (dBm)	P (mW)	Pd (mW/cm ²)	Limit Pd (mW/cm ²)	Fraction of limit (%)	Result
2402	2.0	1.6	0.0003	1.0	0.03	Passed
2440	2.2	1.6	0.0003	1.0	0.03	Passed
2480	2.9	2.0	0.0004	1.0	0.04	Passed

Table 3: Result of MPE

4.2 Canada

4.2.1 Evaluation for separation distance > 20 cm, except 3 kHz – 10 MHz

Requirement: RSS-102 Issue 5, section 2.5.2

Reference: n/a

Performed by:	Jennifer Riedel B. Eng.	Date of test:	July 26, 2021
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Result:	<input checked="" type="checkbox"/> Limits kept	<input type="checkbox"/> Limits not kept
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4.2.1.1 Exemption Limits for Routine Evaluation – RF Exposure Evaluation

According to RSS 102 Clause 2.5.2:

RF 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, except when the device operates as follows:

- below 20 MHz and the source-based, time-averaged maximum e.i.r.p. 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 e.i.r.p. 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 e.i.r.p. 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 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).

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

5 Revision history

<i>Revision</i>	<i>Date</i>	<i>Issued by</i>	<i>Description of modifications</i>
0	2021-07-26	Jennifer Riedel B. Eng.	First edition

Template: RF_FCC_IC_Human Exposure_V1.3