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Test report no.:

220511-AU02+W07

for:

Sesamsec GmbH
RFID reader / writer
SECUSTOS SQ80 K LEGIC

according to:

47 CFR Part 2
RSS-102



Deutsche
Akkreditierungsstelle
D-PL-12155-01-04



Deutsche
Akkreditierungsstelle
D-PL-12155-01-03

Accreditation:

Deutsche
Akkreditierungsstelle
D-PL-12155-01-04

FCC test firm accreditation expiration date: 2024-05-17
MRA US-EU, FCC designation number: DE0010
Test firm registration number: 997268
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BnetzA-CAB-02/21-02/6 Valid until 2023-11-26



Deutsche
Akkreditierungsstelle
D-PL-12155-01-03

Recognized until 2025-03-16 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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1 Summary of test results

1.1 FCC standard

<i>FCC standard</i>	<i>Requirement</i>	<i>Result</i>	<i>Page</i>
47 CFR Part 2, § 2.1091	Maximum permissible exposure, except WPT, measurement	Passed	11
47 CFR Part 2, § 2.1091	Maximum permissible exposure, except WPT, calculation	Passed	17

1.2 IC standard

<i>IC standard</i>	<i>Requirement</i>	<i>Result</i>	<i>Page</i>
RSS-102 Issue 5, section 2.5.1	Frequency range 3 kHz up to 10 MHz	Passed	20
RSS-102 Issue 5, section 2.5.2	Evaluation for separation distance > 20 cm, except 3 kHz – 10 MHz	Passed	30

Straubing, October 18, 2023



Tested by
Konrad Graßl
Department Manager Radio



Approved by
Christian Kiermeier
Reviewer

2 Test regulations

2.1 FCC standards

Standard	Title
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
Part 1, Subpart I, Section 1.1307 October 2021	Actions that may have a significant environmental effect, for which Environmental Assessment (EAs) must be prepared.
Part 1, Subpart I, Section 1.1310 October 2022	Radiofrequency radiation exposure limits
Part 2, Subpart J, Section 2.1091 October 2022	Radiofrequency radiation exposure evaluation: mobile devices.
KDB 447498 D04 v01 November 29, 2021	RF Exposure Procedures and Equipment Authorization Policies for Mobile and Portable Devices
ANSI C63.10 June, 2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

2.2 IC standards

Standard	Title
RSS-102 Issue 5 (March 19, 2015) Amendment 1 (February 2, 2021)	Spectrum Management and Telecommunications Radio Standards Specification Radio Frequency (RF) Exposure Compliance of Radio communication Apparatus (All Frequency Bands)
SPR-002 Issue 2 (October 2022)	Spectrum Management and Telecommunications Supplementary Procedure Supplementary Procedure for Assessing Compliance with RSS-102 Nerve Stimulation Exposure Limits
Safety Code 6 (2015)	Limits of Human Exposure to Radiofrequency Electromagnetic Energy in the Frequency Range from 3 kHz to 300 GHz
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

3 Equipment under Test

3.1 General information

Product type:	RFID reader / writer		
Model name:	SECUSTOS SQ80 K LEGIC		
Serial number(s):	Prototype		
Manufacturer:	Sesamsec GmbH		
Version:	Hardware:	Prod C	
	Software:	C/B1.50/NKD4.70/CONT1.26	
Short description:	EUT is a RFID reader / writer operating at the frequencies 125 kHz and 13.56 MHz The EUT employs also a BLE module operating at 2.4 GHz.		
Additional modifications:	None		
FCC ID of EUT:	2BAACSQ80KLE		
IC registration number of EUT:	30098-SQ80KLE		
Power supply:	DC supply		
	Nominal voltage:	12 V	
Device type:	☐ Portable	☐ Mobile	☒ Fixed

3.2 Radio specifications

RF technology 1:

System type:	RFID Reader		
Operating frequency:	125 kHz		
Number of RF channels	1		
Modulation	ASK		
Antenna:	Type:	Loop antenna	
	Connector:	☐ external	☐ internal
		☐ temporary	☒ none (integral antenna)

RF technology 2:

System type:	RFID Reader		
Operating frequency:	13.56 MHz		
Number of RF channels	1		
Modulation	ASK		
Antenna:	Type:	Loop antenna	
	Connector:	☐ external	☐ internal
		☐ temporary	☒ none (integral antenna)

RF technology 3:

System type:	Digital transmission system (DTS) (BLE)		
Application frequency band:	2400.0 MHz - 2483.5 MHz		
Number of RF channels:	40		
Nominal bandwidth:	2 MHz		
Modulation(s):	GFSK		
Antenna:	Type:	Chip antenna	
	Gain:	0.5 dBi (maximum)	
	Connector:	☐ external	☐ internal
		☐ temporary	☒ none (integral antenna)

3.3 Human exposure specifications

Exposure tier:	Body
Separation distance:	> 20 cm
Evaluated against exposure limits:	General public use
Simultaneous transmissions:	yes

3.4 Photographs of EUT

See Annex B of test report 220511-AU02+W05 of test laboratory Element Materials Technology Straubing GmbH.

4 Test results

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

The climatic conditions are recorded during the tests. It is ensured that the climatic conditions are within the following ranges:

<i>Ambient temperature</i>	<i>Ambient humidity</i>	<i>Ambient pressure</i>
15°C to 35°C	30 % to 75 %	86 kPa to 106 kPa

4.1 FCC

4.1.1 Maximum permissible exposure, except WPT, measurement

Requirement: Part 2, §2.1091

Performed by:	Konrad Graßl	Date of test:	October 18, 2023
Result:	☒ Limits kept	☐ Limits not kept	

4.1.1.1 Test configuration

Device	Type designation	Serial or inventory no.	Manufacturer
RFID reader / writer	SECUSTOS SQ80 K LEGIC	Prototyp	Sesamsec GmbH

Table 1: EUT used for testing

Device	Type designation	Serial or inventory no.	Manufacturer
RFID-tag	125 kHz	---	Sesamsec GmbH
Laptop	Lifebook A531	E001053	FUJITSU
Power supply for laptop	AC adapter	E001053	FUJITSU
RS485 adapter	---	---	Sesamsec GmbH
Wiegand adapter	---	---	Sesamsec GmbH

Table 2: Support equipment used for testing

4.1.1.2 Mode of operation

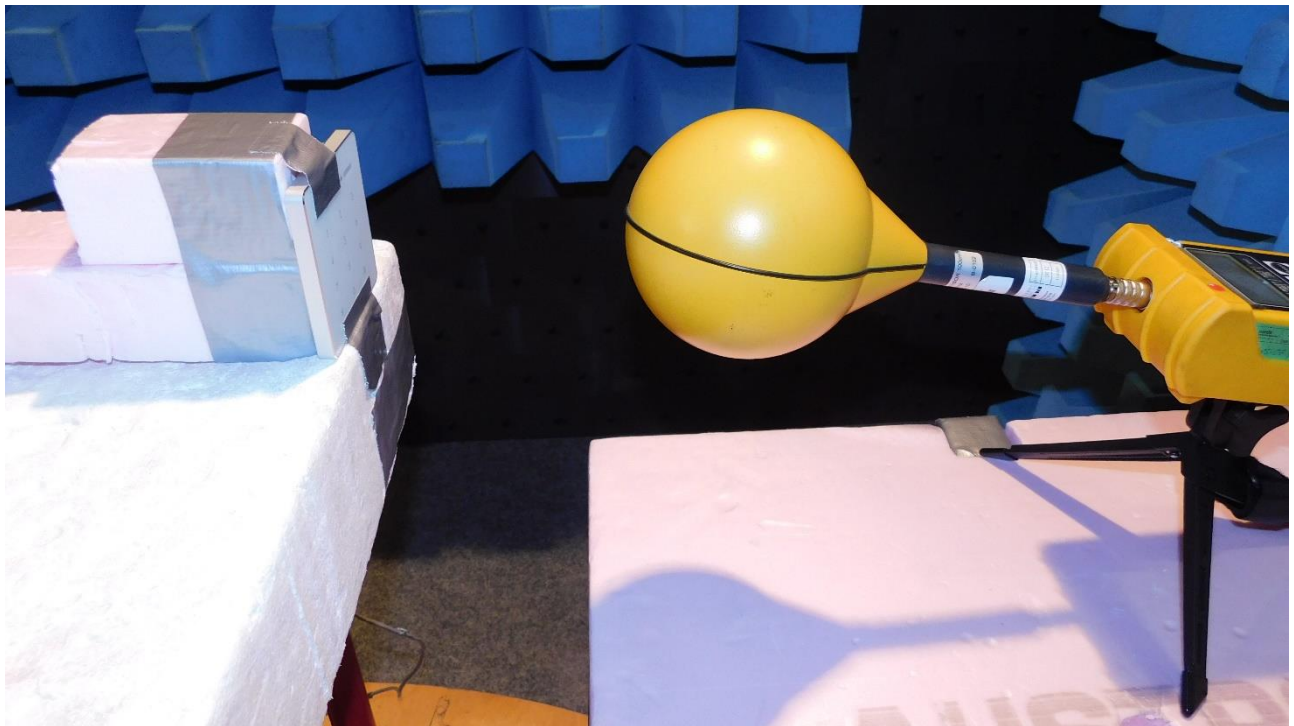
- The EUT was in continuous interrogation mode at 125 kHz.
- The integrated BLE was set in idle mode.

4.1.1.3 Test equipment

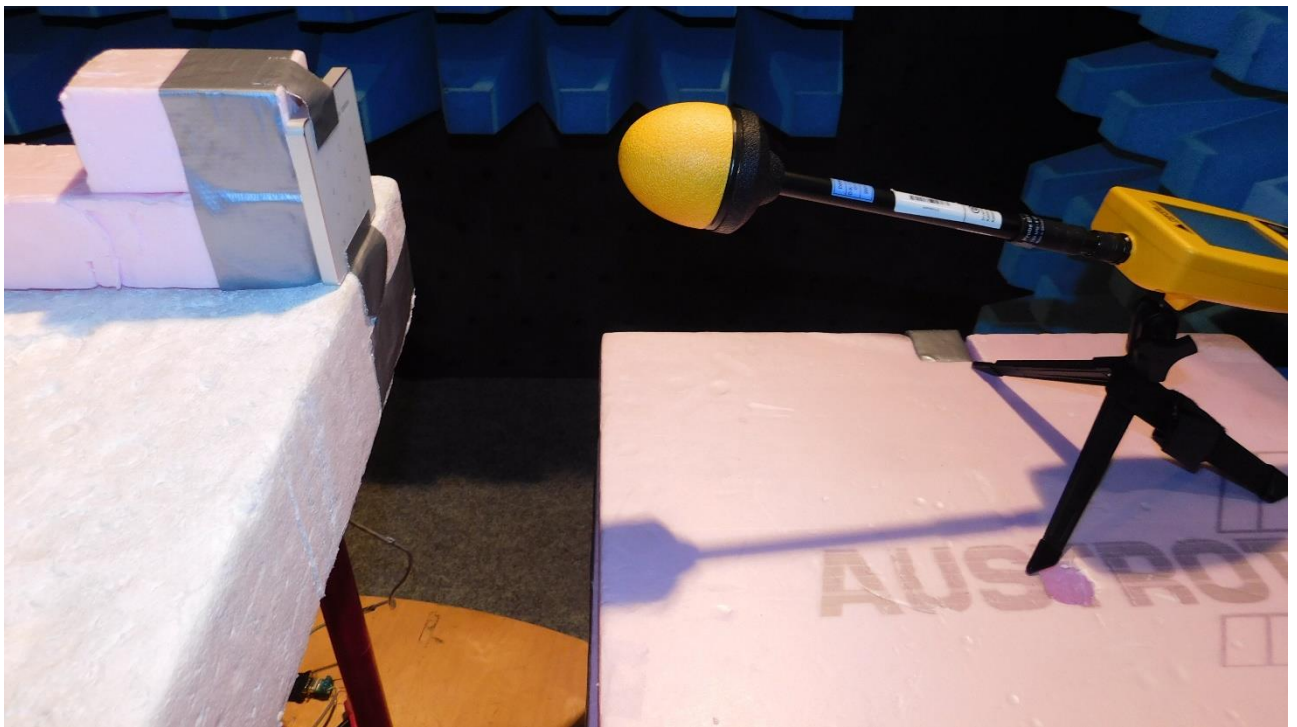
Type	Designation	Manufacturer	Inventory no.
Exposure level tester with magnetic field probe 100 cm ²	ELT-400 with BN 2300/90.10	Narda Safety Test Solutions GmbH	E00276
Broadband field meter	NBM-550	Narda Safety Test Solutions GmbH	E00900
Electric field probe	EF0691	Narda Safety Test Solutions GmbH	E00902

4.1.1.4 Test setup

RS-485

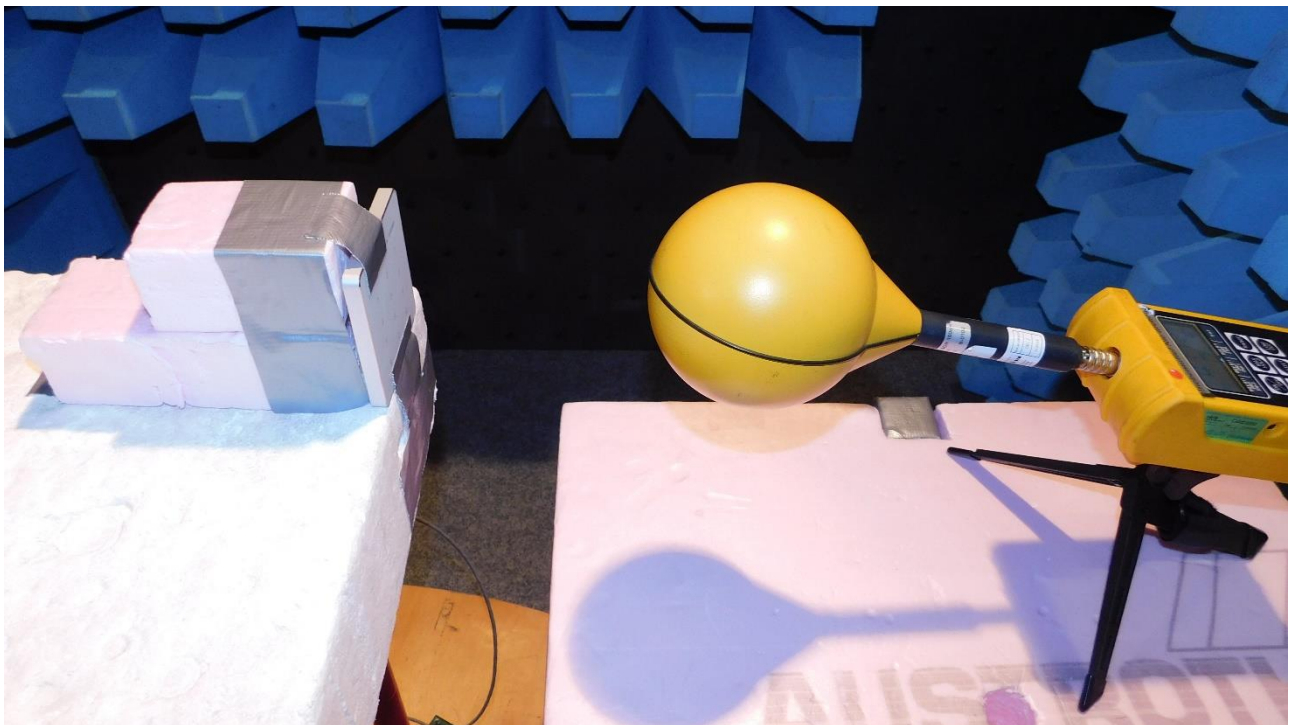


Picture 1: Setup of magnetic field test at a measurement distance d_{meas} of 20 cm, without tag

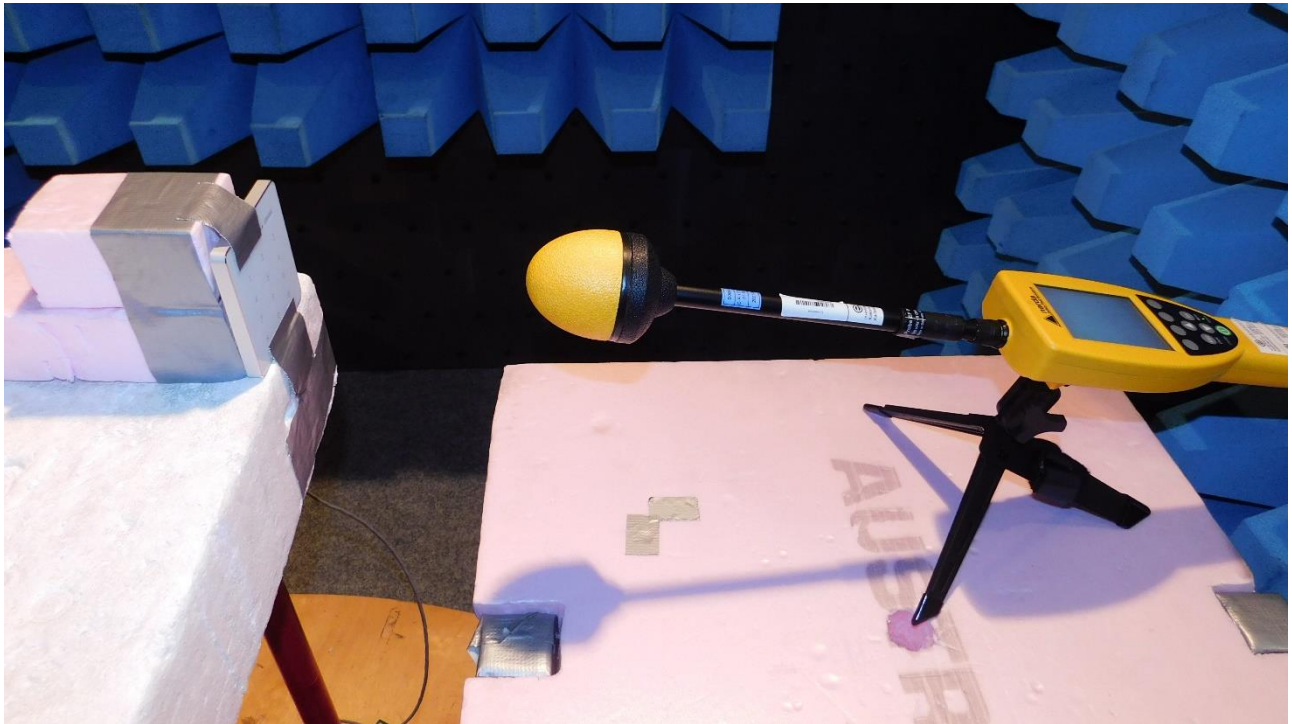


Picture 2: Setup of electric field test at a measurement distance d_{meas} of 20 cm, without tag

Wiegand



Picture 3: Setup of magnetic field test at a measurement distance d_{meas} of 20 cm, without tag



Picture 4: Setup of electric field test at a measurement distance d_{meas} of 20 cm, without tag

4.1.1.5 Requirements and limits maximum permissible exposure

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 $ERP_{20\text{cm}}$ 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 §1.1307(b)(3)(i)(C):

Or using Table 9 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 $\lambda/2\pi$, 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 $\lambda/4$ or if the antenna gain is less than that of a half-wave dipole (1.64 linear value).

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	$19.2 R^2$.

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

Note:

- According to the TCB Workshop on April 27, 2022 regarding the frequency range from 100 kHz to 300 kHz the limit for the frequency 300 kHz in table 1 to § 1.1310(e)(1) is applicable: E = 614 V/m and H = 1.63 A/m

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
0.3-3.0	614	1.63	(100)(see note 1)	<30

Table 4: Table 1 to § 1.1310(e)(1), limits for general population/ uncontrolled exposure

Note:

- Plane-wave equivalent power density

4.1.1.6 Test procedure

The RF exposure test is performed by the direct measurement method using a Broadband probe.

To find the worst case emissions, the field probe is moved over all sides of the EUT at the separation distance of 20 cm, while observing the display of the field meter. At the worst case position, the final value is measured and recorded.

The test distance is measured from the center of the probe(s) to the edge of the device.

4.1.1.7 Results

RF technology 1:

Application:	RFID
Operation frequency:	125 kHz
Separation distance:	200 mm
Exposure:	general public

Note(s):

1. Premeasurements were performed to determine the worst case which is documented below.
2. Separation distance to the edge of the EUT: 20 cm
3. As worst case an averaging time over 6 minutes was not applied.

RS-485

<i>Frequency (kHz)</i>	<i>Measured value (V/m)</i>	<i>Limit (V/m)</i>	<i>Ratio of limit</i>	<i>Result</i>
125	0.44	614.00	0.0007	Passed

Table 5: Electrical field strength at a measurement distance d_{meas} of 20 cm, nerve stimulation of the body, without tag

<i>Frequency (kHz)</i>	<i>Measured value (A/m)</i>	<i>Limit (A/m)</i>	<i>Ratio of limit</i>	<i>Result</i>
125	0.45	1.63	0.27	Passed

Table 6: Magnetic field strength at a measurement distance d_{meas} of 20 cm, nerve stimulation of the body, without tag

Wiegand

<i>Frequency (kHz)</i>	<i>Measured value (V/m)</i>	<i>Limit (V/m)</i>	<i>Ratio of limit</i>	<i>Result</i>
125	0.57	614.00	0.0009	Passed

Table 7: Electrical field strength at a measurement distance d_{meas} of 20 cm, nerve stimulation of the body, without tag

<i>Frequency (kHz)</i>	<i>Measured value (A/m)</i>	<i>Limit (A/m)</i>	<i>Ratio of limit</i>	<i>Result</i>
125	0.45	1.63	0.27	Passed

Table 8: Magnetic field strength at a measurement distance d_{meas} of 20 cm, nerve stimulation of the body, without tag

4.1.2 Maximum permissible exposure, except WPT, calculation

Requirement: Part 2, §2.1091
Reference: KDB 447498 D04 v01

Performed by:	Konrad Graßl	Date of test:	July 26, 2023
Result:	☒ Limits kept ☐ Limits not kept		

4.1.2.1 Requirements and limits maximum permissible exposure

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).

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

According to §1.1307(b)(3)(i)(C):

Or using Table 9 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 $\lambda/2\pi$, 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 $\lambda/4$ or if the antenna gain is less than that of a half-wave dipole (1.64 linear value).

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	$19.2 R^2$

Table 9: Table 1 to §1.1307(b)(3)(i)(C)—Single RF Sources Subject to Routine Environmental Evaluation

4.1.2.2 Process to Determine RF Exposure Compliance

According to Appendix A of KDB 447498 D04 Interim General RF Exposure Guidance V01:
Generally, the sequence to apply for single portable RF sources includes the following steps:

- 1) Determination of 1 mW blanket exemption under § 1.1307(b)(3)(i)(A)
- 2) Determination of exemption under the MPE-based § 1.1307(b)(3)(i)(C) if 1) is not met
- 3) Determination of exemption under the SAR-based § 1.1307(b)(3)(i)(B) if both 1) and 2) are not met

4.1.2.3 Results

RF technology 2:

The following data are based on applicants document: Test report 220511-AU02+W05 of the test laboratory Element Materials Technology Straubing GmbH

Application:	RFID
Operation frequency:	13.56 MHz
Maximum field strength:	32.7 dBµV/m at 30 m (QP)

Information related to Exposure:

Tune-up tolerance (according to the manufacturer):	5 dB
Separation distance:	200 mm
Exposure:	general public
Power averaging over time:	not applied

<i>Channel Frequency (MHz)</i>	<i>EIRP + tune-up tolerance (dBm)</i>	<i>EIRP (mW)</i>	<i>Result</i>
13.56	-37.5	0.0002	Recorded

Table 10: Result of evaluation of compliance

EIRP is calculated using the formula of ANSI C63.10-2013 clause 9.5:

$$EIRP = E + 20\log(d) - 104.7$$

Where: EIRP = equivalent isotropically radiated power in dBm
E = electric field strength in dBµV/m
d = measurement distance in meters (m)

Statement:

The EUT is transmitting with a very low field strength and has a very low calculated EIRP. For this operation frequency no limit exists.

RF technology 3:

The following data are based on applicants document: Test report 220511-AU06+W01 of the test laboratory Element Materials Technology Straubing GmbH

Application: Bluetooth low energy
 Conducted output power: -9.3 dBm at 2402 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

Note(s): The determination according to point 1 in clause 4.1.2.2 was used for evaluation.

<i>Channel Frequency (MHz)</i>	<i>P + tune-up tolerance (dBm)</i>	<i>P (mW)</i>	<i>Limit threshold P (mW)</i>	<i>Ratio of limit</i>	<i>Result</i>
2402	-5.3	0.3	1.0	0.3	Passed

Table 11: Result of evaluation of compliance

4.2 Canada

4.2.1 Frequency range 3 kHz up to 10 MHz

Requirement: RSS-102 Issue 5, section 2.5.1
 Basic standard: SPR-002
 IEEE C95.3

Performed by:	Konrad Graßl	Date of test:	July 19, 2023
Result (Note 1):	☒ Test passed	☐ Test not passed	

Note(s):

1. For information about measurement uncertainties see page 34.

4.2.1.1 Test configuration

Device	Type designation	Serial or inventory no.	Manufacturer
RFID reader / writer	SECUSTOS SQ80 K LEGIC	Prototyp	Sesamsec GmbH

Table 12: EUT used for testing

Device	Type designation	Serial or inventory no.	Manufacturer
RFID-tag	125 kHz	---	Sesamsec GmbH
Laptop	Lifebook A531	E001053	FUJITSU
Power supply for laptop	AC adapter	E001053	FUJITSU
RS485 adapter	---	---	Sesamsec GmbH
Wiegand adapter	---	---	Sesamsec GmbH

Table 13: Support equipment used for testing

4.2.1.2 Mode of operation

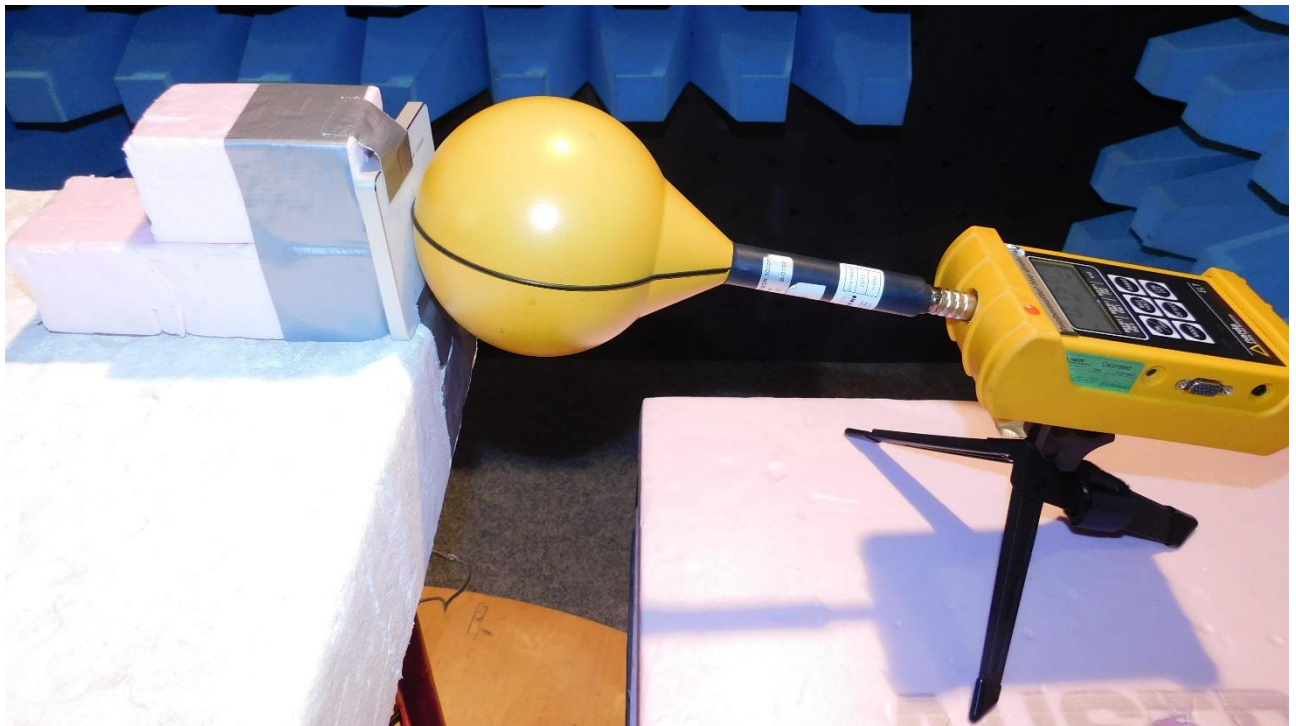
- The EUT was in continuous interrogation mode at 125 kHz.
- The integrated BLE was set in idle mode.

4.2.1.3 Test equipment

Type	Designation	Manufacturer	Inventory no.
Exposure level tester with magnetic field probe 100 cm ²	ELT-400 with BN 2300/90.10	Narda Safety Test Solutions GmbH	E00276
Broadband field meter	NBM-550	Narda Safety Test Solutions GmbH	E00900
Electric field probe	EF0691	Narda Safety Test Solutions GmbH	E00902

4.2.1.4 Test setup

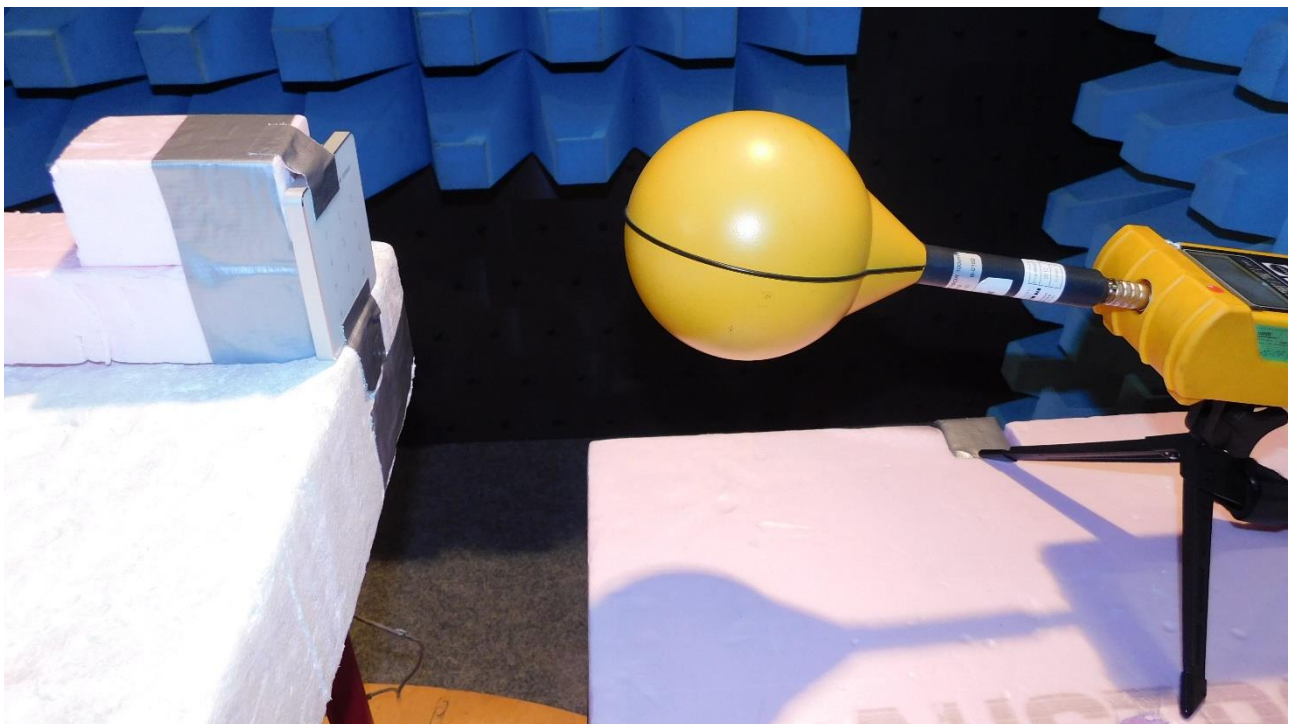
RS-485



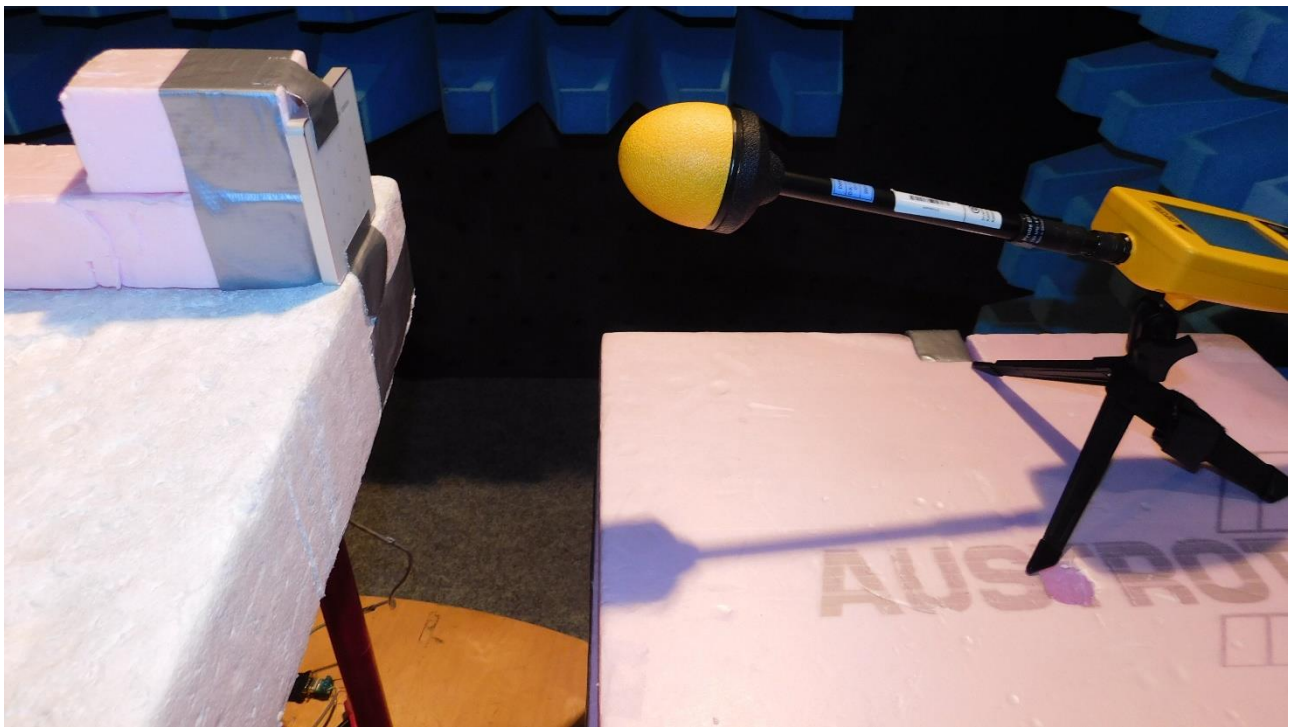
Picture 5: Setup of magnetic field test at touch position, without tag



Picture 6: Setup of electric field test at touch position, with tag



Picture 7: Setup of magnetic field test at a measurement distance d_{meas} of 20 cm, without tag



Picture 8: Setup of electric field test at a measurement distance d_{meas} of 20 cm, without tag

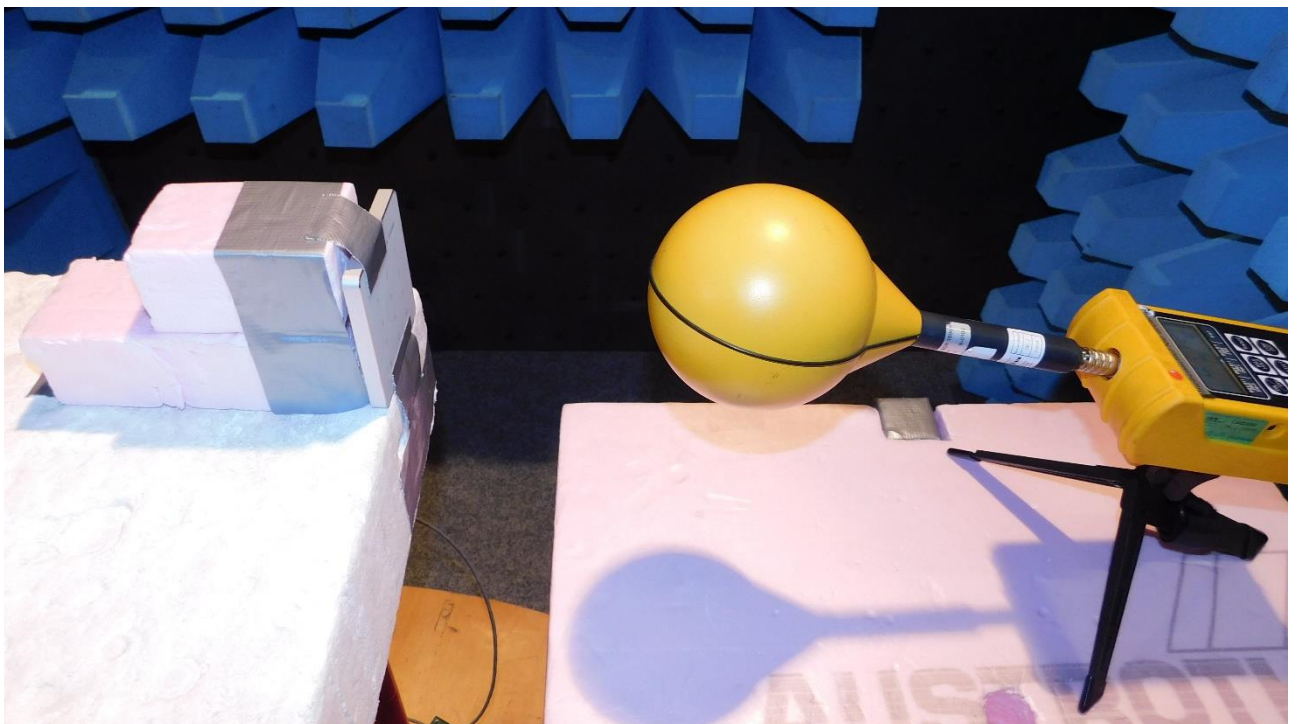
Wiegand



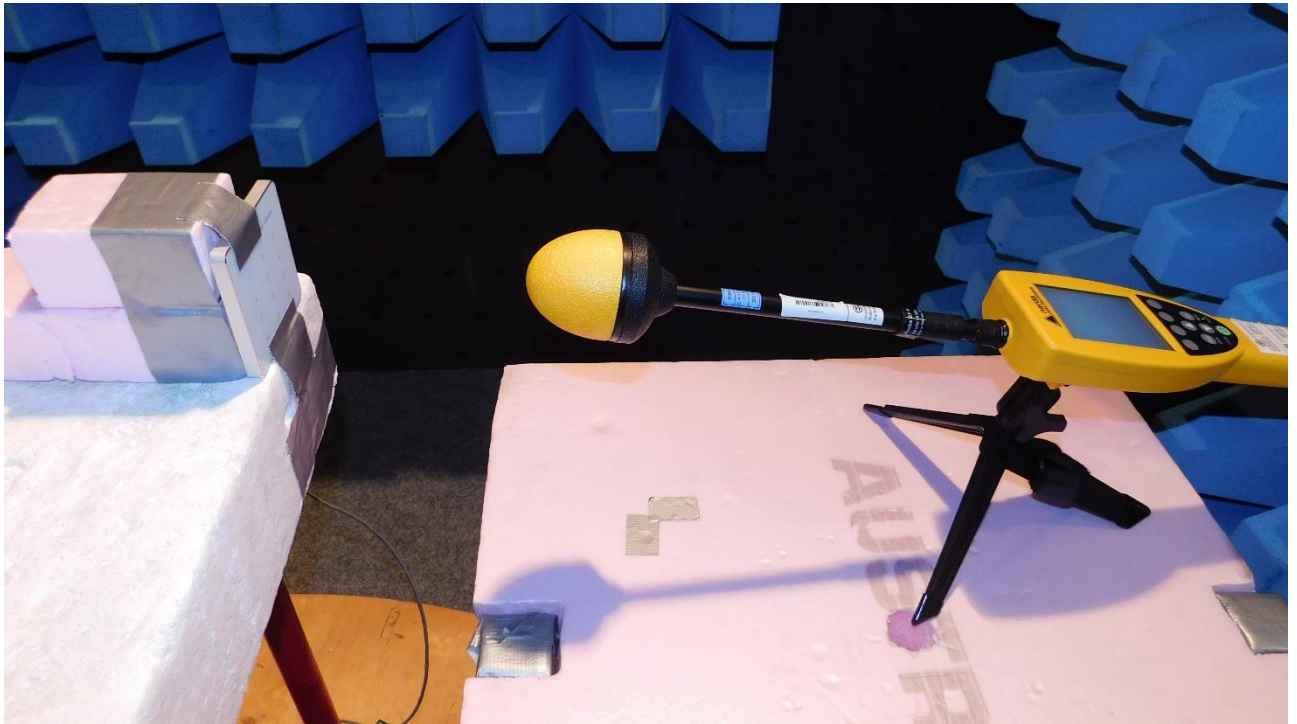
Picture 9: Setup of magnetic field test at touch position, without tag



Picture 10: Setup of electric field test at touch position, without tag



Picture 11: Setup of magnetic field test at a measurement distance d_{meas} of 20 cm, without tag



Picture 12: Setup of electric field test at a measurement distance d_{meas} of 20 cm, without tag

4.2.1.5 Limits

According to note 5 in section 2.5.1 of RSS-102:

Transmitters operating between 3 kHz and 10 MHz, meeting the exemption from routine SAR evaluation, shall demonstrate compliance to the instantaneous limits in section 4 of RSS-102. Therefore, these limits apply irrespective of the separation distance between the user or bystanders and the device.

According to section 4 of RSS-102:

The exposure limits in section 4 of RSS-102 are adopted from Health Canada's Safety Code 6.

According to section 2.1.1 of Safety Code 6:

Limits for internal electric field strength are intended to prevent the occurrence of nerve stimulation (NS). At frequencies between 3 kHz and 10 MHz, basic restrictions for internal electric field strength in excitable tissues as shown in table 1 of Safety Code 6 (i.e. table 2 of RSS-102) shall not be exceeded. For conditions where the determination of internal electric field strength is not possible or practical (e.g. by measurement or modelling), external unperturbed field strength assessment shall be carried out and the reference levels outlined in section 2.2 of Safety Code 6 shall be respected.

For transmitters operating between 3 kHz and 10 MHz, the requirements of table 4 and table 6 in section 4 of RSS-102 apply which are adopted from table 3 and table 4 of Safety Code 6, section 2.2:

<i>Electric Field Strength Reference Levels</i>				
<i>Frequency Range (MHz)</i>	<i>Reference Level Basis</i>	<i>Reference Level (E_{RL}), (V/m, RMS)</i>		<i>Reference Period</i>
		<i>Uncontrolled Environment</i>	<i>Controlled Environment</i>	
0.003 – 10	NS	83	170	Instantaneous (Note 1)

Table 14: Electric field strength reference levels

<i>Magnetic Field Strength Reference Levels</i>				
<i>Frequency Range (MHz)</i>	<i>Reference Level Basis</i>	<i>Reference Level (H_{RL}), (A/m, RMS)</i>		<i>Reference Period (minutes)</i>
		<i>Uncontrolled Environment</i>	<i>Controlled Environment</i>	
0.003 – 10	NS	90	180	Instantaneous (Note 1)

Table 15: Magnetic field strength reference levels

Notes:

- 1 According to note 1 of table 3 of Safety Code 6: At no point in time shall the RMS values for electric- and magnetic-fields exceed the reference levels with an instantaneous reference period in table 14 and table 15. In the case of RF fields with amplitude modulation, the RMS value during the maximum of the modulation envelope shall be compared to the reference level.

According to section 5.5.3.5. of SPR-002:

When employing the relaxed H-field reference levels for limb exposure, compliance shall also be demonstrated at the head/torso position without relaxation, i.e. a relaxation factor of 1.0 in accordance with Table 16. Refer to annex E of SPR-002 for examples involving various device types.

<i>Exposure condition</i>	<i>Relaxation factor</i>
Whole Body / Torso / Head	1.0
Leg	1.5
Arm	2.5
Hand / foot	5.0

Table 16: H-field level relaxation for local exposure

A second exposure evaluation must be taken at the distance at which the trunk of the body would rest in relation to the device under test.

4.2.1.6 Test procedure

The RF exposure test is performed by the direct measurement method using a Broadband probe as described in clause 7 of the supplementary procedure SPR-002.

To find the worst case emissions, the field probe is moved over all sides of the EUT at the separation distances as noted in clause 4.2.1.7 while observing the display of the field meter. At the worst case position, the final value is measured and recorded.

According to section 3.2 of RSS-102:

RF exposure evaluation of devices shall be made in accordance with the latest version of IEEE C95.3. Definition 3.95 in clause 3 of IEEE C95.3 specifies the separation distance applied to the measurement of electric and magnetic fields as the “distance between a source and the nearest point on the probe sensing elements”.

According to clause 7.1.1. of SPR-002:

The distance corresponding to a given field measurement, denoted by d_{meas} in figure 2 of SPR-002, is defined as the distance separating the EUT enclosure and the measurement location associated with the probe antenna(s), i.e. the precise location in space that corresponds to the field measurement. If this location is not indicated by the probe manufacturer, the geometric centre of the probe antenna(s) or the probe enclosure may be used.

The enclosure distance, denoted by d_{enc} in figure 2 of SPR-002, is the distance between the EUT and the nearest surface of the field probe enclosure.

4.2.1.7 Test results

RF technology 1:

Application: RFID
 Operation frequency: 125 kHz
 Environment: Uncontrolled

Note(s):

4. Premeasurements were performed to determine the worst case which is documented below.
5. Annex E.4. of SPR-002 was selected for the test.

RS-485

<i>Frequency (kHz)</i>	<i>Measured value (V/m)</i>	<i>Relaxation factor</i>	<i>Limit (V/m)</i>	<i>Ratio of limit</i>	<i>Result</i>
125	0.69	1.00	83.00	0.0083	Passed

Table 17: Electrical field strength at touch position, nerve stimulation of the limbs, with tag

<i>Frequency (kHz)</i>	<i>Measured value (A/m)</i>	<i>Relaxation factor</i>	<i>Limit (A/m)</i>	<i>Ratio of limit</i>	<i>Result</i>
125	0.48	5.00	450.00	0.0011	Passed

Table 18: Magnetic field strength at touch position, nerve stimulation of the limbs, without tag

<i>Frequency (kHz)</i>	<i>Measured value (V/m)</i>	<i>Relaxation factor</i>	<i>Limit (V/m)</i>	<i>Ratio of limit</i>	<i>Result</i>
125	0.44	1.00	83.00	0.0053	Passed

Table 19: Electrical field strength at a measurement distance d_{meas} of 20 cm, nerve stimulation of the body, without tag

<i>Frequency (kHz)</i>	<i>Measured value (A/m)</i>	<i>Relaxation factor</i>	<i>Limit (A/m)</i>	<i>Ratio of limit</i>	<i>Result</i>
125	0.45	1.00	90.00	0.0050	Passed

Table 20: Magnetic field strength at a measurement distance d_{meas} of 20 cm, nerve stimulation of the body, without tag

Wiegand

<i>Frequency (kHz)</i>	<i>Measured value (V/m)</i>	<i>Relaxation factor</i>	<i>Limit (V/m)</i>	<i>Ratio of limit</i>	<i>Result</i>
125	0.71	1.00	83.00	0.0086	Passed

Table 21: Electrical field strength at touch position, nerve stimulation of the limbs, without tag

<i>Frequency (kHz)</i>	<i>Measured value (A/m)</i>	<i>Relaxation factor</i>	<i>Limit (A/m)</i>	<i>Ratio of limit</i>	<i>Result</i>
125	0.48	5.00	450.00	0.0011	Passed

Table 22: Magnetic field strength at touch position, nerve stimulation of the limbs, without tag

<i>Frequency (kHz)</i>	<i>Measured value (V/m)</i>	<i>Relaxation factor</i>	<i>Limit (V/m)</i>	<i>Ratio of limit</i>	<i>Result</i>
125	0.57	1.00	83.00	0.0069	Passed

Table 23: Electrical field strength at a measurement distance d_{meas} of 20 cm, nerve stimulation of the body, without tag

<i>Frequency (kHz)</i>	<i>Measured value (A/m)</i>	<i>Relaxation factor</i>	<i>Limit (A/m)</i>	<i>Ratio of limit</i>	<i>Result</i>
125	0.45	1.00	90.00	0.0050	Passed

Table 24: Magnetic field strength at a measurement distance d_{meas} of 20 cm, nerve stimulation of the body, without tag

4.2.2 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:	Konrad Graßl	Date of test:	July 19, 2023
Result:	☒ Limits kept	☐ Limits not kept	

4.2.2.1 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.

4.2.2.2 Results

RF technology 2:

The following data are based on applicants document: Test report 220511-AU02+W05 of the test laboratory Element Materials Technology Straubing GmbH

Application: RFID
 Operation frequency: 13.56 MHz
 Maximum field strength: 32.7 dBμV/m at 30 m (QP)

Information related to Exposure:

Tune-up tolerance (according to the manufacturer): 5 dB
 Separation distance: 200 mm
 Exposure tier: general public
 Power averaging over time: not applied

<i>Channel Frequency (MHz)</i>	<i>EIRP + tuneup tolerance (dBm)</i>	<i>EIRP (W)</i>	<i>EIRP limit (W)</i>	<i>Ratio of limit</i>	<i>Result</i>
13.56	-37.5	0.0000002	1.0000000	0.0000002	Passed

Table 25: Result of exemption for routine evaluation of RF exposure

EIRP is calculated using the formula of ANSI C63.10-2013 clause 9.5:

$$EIRP = E + 20\log(d) - 104.7$$

Where: EIRP = equivalent isotropically radiated power in dBm
 E = electric field strength in dBμV/m
 d = measurement distance in meters (m)

RF technology 3:

The following data are based on applicants document: Test report 220511-AU06+W01 of the test laboratory Element Materials Technology Straubing GmbH

Application: Bluetooth low energy
Conducted output power: -9.3 dBm at 2402 MHz
Antenna gain: 0.5 dBi

Information related to Exposure:

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

<i>Channel Frequency (MHz)</i>	<i>EIRP + tuneup tolerance (dBm)</i>	<i>EIRP (W)</i>	<i>EIRP limit (W)</i>	<i>Ratio of limit</i>	<i>Result</i>
2402	-4.8	0.33	2.68	0.00	Passed

Table 26: Result of exemption for routine evaluation of RF exposure

5 Equipment calibration status

Description	Modell number(s)	Serial number(s)	Inventory number(s)	Last calibration	Next calibration
Exposure level tester with magnetic field probe 100 cm ²	ELT-400 with BN 2300/90.10	B-0087 B-0102	E00276	2022-11	2023-11
Broadband field meter with magnetic field probe	NBM-550 with HF3061	H-0015 D-0595	E00900 E00901	2021-06	2023-12
Broadband field meter with electric field probe	NBM-550 with EF0691	H-0015 H-0318	E00900 E00902	2021-06	2023-12

6 Measurement uncertainty

Test	Frequency range	Equipment used	Expanded uncertainty	U_{Limit}	k=
Magnetic field	1 Hz – 10 kHz	ELT 400 + probe	$\pm 28.147 \%$	+58.% / -37 %	2
Magnetic field	10 kHz – 400 kHz	ELT 400 + probe	$\pm 28.147 \%$	+41.% / -30 %	2
H-field	300 kHz – 800 kHz	NBM 550 + HF3061	$\pm 25.602 \%$	+41.% / -30 %	2
H-field	800 kHz – 1 MHz	NBM 550 + HF3061	$\pm 25.245 \%$	+41.% / -30 %	2
H-field	1 MHz – 30 MHz	NBM 550 + HF3061	$\pm 25.245 \%$	+41.% / -30 %	2
E-field	100 kHz – 1 MHz	NBM 550 + EF0691	$\pm 28.467 \%$	+41.% / -30 %	2
E-field	1 MHz – 30 MHz	NBM 550 + EF0691	$\pm 27.324 \%$	+41.% / -30 %	2
E-field	30 MHz – 1 GHz	NBM 550 + EF0691	$\pm 27.324 \%$	+100.% / -50 %	2
E-field	1 GHz – 4 GHz	NBM 550 + EF0691	$\pm 30.244 \%$	+100.% / -50 %	2
E-field	4 GHz – 6 GHz	NBM 550 + EF0691	$\pm 32.150 \%$	+100.% / -50 %	2
Contact current	0 Hz – 110 MHz	EZ 17	+41.25 % / -29.21.%	+100.% / -50 %	2

Note(s):

1. The uncertainty stated is the expanded uncertainty obtained by multiplying the standard uncertainty by the coverage factor k. For a confidence level of 95 % the coverage factor k is 2.
2. The values of the measurement uncertainty as listed above are equal to or lower than the required ones stated in table 3 of EN 62369-1 2009 and listed as (U_{Limit}) in the table above.
3. Simple acceptance is applied as the decision rule while keeping the specified limits (U_{ETSI}) for the expanded measurement uncertainty (i.e. Test Uncertainty Ratio $TUR \geq 1:1$). That means, compliance is based on the recorded level by the lab irrespective of the expanded measurement uncertainty value but with a limitation to it.
4. All used test instrument as well as the test accessories are calibrated at regular intervals.

7 Revision history

<i>Revision</i>	<i>Date</i>	<i>Issued by</i>	<i>Description of modifications</i>
0	2023-10-18	Konrad Graßl	First edition

Template: RF_FCC_IC_Human Exposure_V1.8