element

Safety Safety Safety Safety Safety Safety Safety Safety Safety Safety

Applicant:

ELATEC GmbH

Zeppelinstraße 1

82178 Puchheim

Tel.: +49 89 5529961-0

Test report no.:

240337-AU01+W09

for:

ELATEC GmbH

RFID reader / writer

TWN4 Slim LEGIC MK2

according to:

47 CFR Part 1

RSS-102

ilac-MRA DAkkS Deutsche Akkreditierungsstelle D-PL-12155-01-00

Accreditation:

FCC test firm accreditation expiration date: 2025-09-19
MRA US-EU, FCC designation number: DE0010
Test firm registration number: 997268
FCC Registration Number (FRN): 0032245045
BNetzA-CAB-02/21-02/7 Valid until 2028-11-26

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:

Element Materials Technology Straubing GmbH
Tel.: +49 9421 56868-0
Fax: +49 9421 56868-100
Email: info.straubing@element.com
Gustav-Hertz-Straße 35
94315 Straubing, Germany

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

Table of contents

List of pictures

List of tables

1 Summary of test results

1.1 FCC standard

FCC standard	*Requirement*	*Result*	*Page*
Part 1, § 1.1310(e)(1)	Maximum permissible exposure, except WPT, measurement	Passed	10
Part 1, § 1.1310(e)(1)	Maximum permissible exposure, except WPT, calculation	Passed	14

1.2 IC standard

IC standard	*Requirement*	*Result*	*Page*
RSS-102 Issue 6, section 6.2.2	NS exemption limits - calculation	Passed	17
RSS-102 Issue 6, section 6.6	Evaluation for separation distance > 20 cm, except 3 kHz – 10 MHz	Passed	20

Straubing, November 26, 2024

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 1.1310 October 2024	Radiofrequency radiation exposure limits
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 6 (December 15, 2023)	Spectrum Management and Telecommunications Radio Standards Specification Radio Frequency (RF) Exposure Compliance of Radio communication Apparatus (All Frequency Bands)

3 Equipment under Test

All Information in this clause is declared by customer.

3.1 General information

Product type:	RFID reader / writer		
Model name:	TWN4 Slim MK2 LEGIC		
Serial number(s):	R2024235691		
Applicant:	ELATEC GmbH		
Manufacturer:	ELATEC GmbH		
Hardware version:	A		
Software version:	B1.08/NKD4.81/CONT2.02 (Beta 1)		
Short description:	EUT is a RFID reader / writer operating at the frequencies 125 kHz and 13.56 MHz. Additionally BLE is integrated.		
Additional modifications:	None		
FCC ID:	WP5TWN4F30		
IC registration number:	7948A-WP5TWN4F30		
Designation of emissions:	29K2K1D--		
Power supply:	DC supply		
	Nominal voltage: Minimum voltage: Maximum voltage:	5.0 V 4.3 V 5.5 V	
Temperature range:	-20 °C to +60 °C (customer defined)		
Device type:	☐ Portable	☒ Mobile	☐ Fixed

3.2 Radio specifications

Radio technology 1:

System type:	RFID Reader		
Application frequency band:	n/a		
Operating frequency:	125 kHz		
Number of RF channels	1		
Modulation	ASK		
Antenna:	Type:	Coil antenna	
	Inductance:	490 µH ± 5%	
	Diameter of wire:	0.15 mm	
	Turns:	132, min 125, max 140 Coil is fixed by using backed wire Leadfree and RoHS conform	
	Connector:	☐ external	☐ internal
		☐ temporary	☒ none (integral antenna)

Radio technology 2:

System type:	RFID Reader		
Application frequency band:	13.110 MHz – 14.010 MHz		
Operating frequencies:	13.56 MHz		
Number of RF channels	1		
Modulation	ASK		
Antenna:	Type:	PCB antenna, 1 Layers	
	Outer dimension:	56 x 42 mm ± 1%	
	Inductance	950 nH ± 5%	
	Width of wire	1 mm	
	Turns:	3	
	Connector:	☐ external	☐ internal
		☐ temporary	☒ none (integral antenna)

Radio technology 3:

System type (see note 1):	Digital transmission system (DTS)		
Application frequency band:	2400.0 MHz - 2483.5 MHz		
Number of RF channels:	40		
Nominal bandwidth:	2 MHz		
Modulation(s):	GFSK		
Antenna:	Type:	Mini ceramic SMT Antenna	
	Gain:	0.5 dBi (maximum)	
	Part number:	2450AT18A100	
	Manufacturer:	Johanson Technology, Inc.	
	Connector:	☐ external	☐ internal
		☐ temporary	☒ none (integral antenna)

Note(s):
1. "DTS" is the equipment class for digital transmission systems, "DSS" for all other Part 15 spread spectrum transmitters as used for equipment authorization system form 731.

3.3 Human exposure specifications

Exposure tier:	Body
Separation distance:	> 20 cm
Evaluated against exposure limits:	General public use
Simultaneous transmissions:	no

3.4 Photographs of EUT

See Annex B of test report 240337-AU01+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 4.

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

Ambient temperature	*Ambient humidity*	*Ambient pressure*
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 1, § 1.1310(e)(1)

Performed by:	Patricio Montenegro, M.Sc.-Ing	Date of test:	November 21, 2024
Result:	☒ Test passed	☐ Test not passed	

4.1.1.1 Test configuration

Device	*Type designation*	*Serial or inventory no.*	*Manufacturer*
RFID reader / writer	TWN4 Slim MK2 LEGIC	R2024235691	ELATEC GmbH

Table 1: EUT used for testing

Device	*Type designation*	*Serial or inventory no.*	*Manufacturer*
RFID tag	125 kHz	---	ELATEC GmbH
Laptop	Latitude 3410	9BDY103	DELL
Power supply for laptop	LA65NS2-01	---	DELL
USB cable	---	---	---

Table 2: Support equipment used for testing

4.1.1.2 Mode of operation

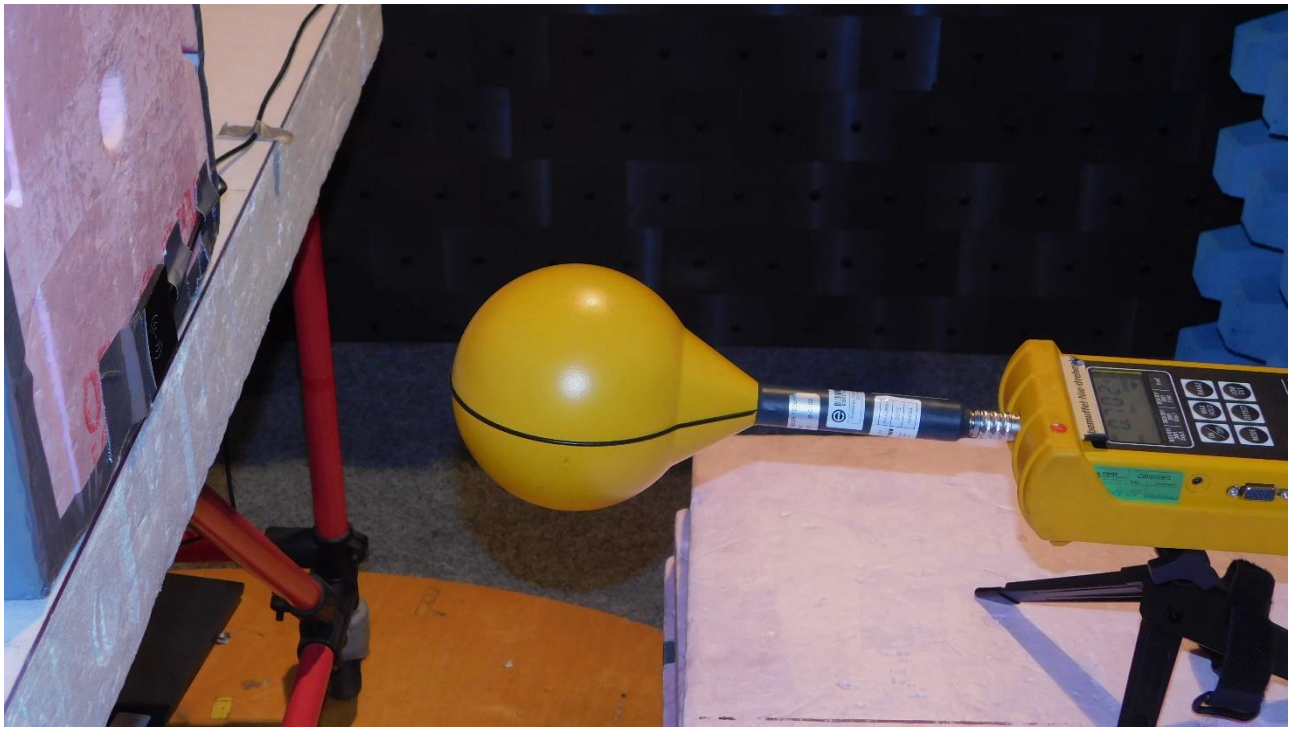
- The EUT was powered via USB connection to the laptop
- By means of the software “Approval Commander V-2.00” the EUT was set on continuous interrogation mode at 125 kHz.

4.1.1.3 Test equipment

Description	*Designation*	*Manufacturer*	*Inventory number*	*Last check*	*Next check*	*Check type*
Exposure level tester with magnetic field probe 100 cm^2	ELT-400	Narda Safety Test Solutions	E00276	2024-03-12	2026-03-12	C
Broadband field meter with electric field probe	NBM-550 EF0691	Narda Safety Test Solutions	E00900 E00902	2023-09-18	2025-09-18	C

Note(s)
1. C = Calibration

4.1.1.4 Test setup



Picture 1: Setup of magnetic field test at a measurement distance of 20 cm, without RFID tag

Picture 2: Setup of electric field test at a measurement distance of 20 cm, without RFID tag

4.1.1.5 Requirements and limits maximum permissible exposure

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 densitiy (mW/cm^2)*	*Averaging time (minutes)*
0.3-3.0	614	1.63	(100)(see note 1)	<30

Table 3: Table 1 to § 1.1310(e)(1), limits for general population/ uncontrolled exposure

Note:
1. 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

Application:	RFID
Operation frequency:	125 kHz

Information related to Exposure:

Separation distance:	200 mm
Exposure:	general public

Note(s):
1 Averaging time over 6 minutes was applied.
2 Worst case: without RFID tag

Type of measurement	*Operating frequency of EUT*	*Measured average value*	*Limit*	*Ratio of limit*	*Result*
E-Field	125 kHz	0.3200 V/m	614.0000 V/m	0.0005	Passed
H-Field	125 kHz	0.4469 A/m	1.6300 A/m	0.2742	Passed

Table 4: Test results for electric, magnetic and electromagnetic fields

4.1.2 Maximum permissible exposure, except WPT, calculation

Requirement:	Part 1, § 1.1310(e)(1)
Reference:	---

Performed by:	Konrad Graßl	Date of test:	November 25, 2024
Result:	☒ Limits kept	☐ Limits not kept	

4.1.2.1 Requirements and limits maximum permissible exposure

According to §1.1310(e)(1):
Table 1 to § 1.1310(e)(1) sets forth limits for Maximum Permissible Exposure (MPE) to radiofrequency electromagnetic fields.

Frequency range (MHz)	*Electric field strength (V/m)*	*Magnetic field strength (A/m)*	*Power densitiy (mW/cm^2)*	*Averaging time (minutes)*
1.34-30	824/f	2.19/f	$180/f^2$ (see note 2)	<30
1500-100000	---	---	1.0	<30

Table 5: Table 1 to §1.1310(e)(1) Limits for Maximum Permissible Exposure (MPE) for General Population/Uncontrolled Exposure

Notes:
1. F = frequency in MHz
2. Plane-wave equivalent power density

4.1.2.2 Results

Radio technology 2:

The following data are based on applicants document: Test report 240337-AU01+W05 of the test laboratory Element Materials Technology Straubing GmbH.

Operation frequency:	13.56 MHz
Field strength:	45.0 dBµV/m at 30 m

Information related to Exposure:

Tune-up tolerance (according to the manufacturer):	0 dB
Separation distance:	20 cm
Exposure:	general public
Power averaging over time:	not applied

Operation frequency (MHz)	*EIRP + tune-up tolerance (dBm)*	*Power densitiy (mW/cm^2)*	*Limit (mW/cm^2)*	*Ratio of limit*	*Result*
13.56	-30.2	0.0000002	0.9789334	0.0000002	Passed

Table 6: Result of evaluation of compliance

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

EIRP = E + 20log(d) - 104.7

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

Radio technology 3:

The following data are based on applicants document: Test report 240337-AU01+W10 of the test laboratory Element Materials Technology Straubing GmbH

Conducted power:	-6.3 dBm at 2402 MHz

Information related to Exposure:

Antenna gain:	0.5 dBi
Tune-up tolerance (according to the manufacturer):	0 dB
Separation distance:	20 cm
Exposure:	general public
Power averaging over time:	not applied

Operation frequency (MHz)	*EIRP + tune-up tolerance (dBm)*	*Power densitiy (mW/cm^2)*	*Limit (mW/cm^2)*	*Ratio of limit*	*Result*
2402	-5.8	0.00005	1.00000	0.00005	Passed

Table 7: Result of evaluation of compliance

4.2 Canada

4.2.1 NS exemption limits - calculation

Requirement:	RSS-102 Issue 6, section 6.2.2
Reference:	n/a

Performed by:	Konrad Graßl	Date of test:	November 21, 2024
Result:	☒ Limits kept	☐ Limits not kept	

4.2.1.1 NS exemption limits for inductive systems

According to RSS-102, section 6.2.2.1:
Section 6.2.2 of RSS-102 applies to inductively-coupled systems, which deliver current to a transmission coil to couple energy through the magnetic field to a receiver (e.g. for wireless power transfer).

An inductively coupled system is exempt from routine NS evaluation when the product of the number of turns, n, and RMS current, IRMS (in amperes), in the transmission coil is less than or equal to the result on the right-hand side of equation (1), where x represents the separation distance in millimetres between the coil and exposed tissue.

$$nI_{RMS} \leq 24\left(\frac{7.827}{(x+0.2786)^{0.1557}} - 3.953\right)^{-1} \quad (1)$$

The exemption is only valid when:

the geometry of the transmission coil is circular or square

the outer dimension (diameter for circular coils or edge length for square coils) of the transmission coil is less than or equal to 100 mm

the minimum separation distance x is greater than or equal to 0.15 mm and

the maximum separation distance x is less than or equal to 50 mm

The thickness of the enclosure is permitted to be included in the separation distance x.

This equation is based on an approximation of internal E-fields resulting from general magnetic field sources determined through computational electromagnetic simulations.

Equation (1) is plotted in Figure 1. Devices with ampere-turns less than or equal to the curve are deemed exempt for the specific separation distances where this occurs. Similarly, the required separation distance for a fixed ampere-turn value corresponds to the appropriate intersection point. Note that the transmitting device might increase the current when the separation distance increases (e.g. based on feedback sent by the receiving device) as such, compliance with the exemption limit needs to be verified for all separation distances allowed in the device's instructions of use.

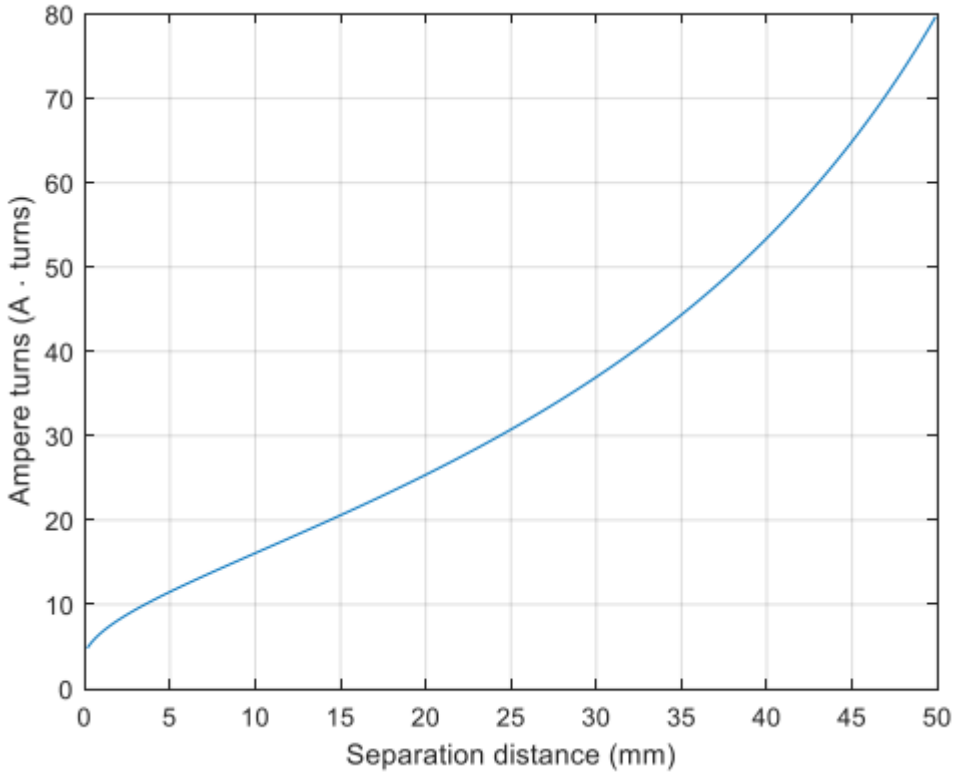


Figure 1: Ampere-turns versus separation for NS exemption limits

The applicable exemption limits for the maximum allowable ampere-turns at specific separation distances are summarized in Table 8.

Separation distance (mm)	0.15	5	10	15	20	25	30	35	40	45	50
Maximum ampere-turns (A turns)	4.8	11.4	16.0	20.5	25.3	30.7	36.9	44.3	53.4	64.8	80.0

Table 8: NS evaluation exemption limits for routine evaluation

4.2.1.2 Results

Radio technology 1:

The following data are based on applicants information:

Transmission coil:	circular
Outer dimension:	16.2 mm
Number of turns n:	125
RMS current I_{RMS}:	44 mA
Separation distance x:	1.275 mm

Geometry	Outer dimension (mm)	Number of turns *n*	RMS current I_{RMS} (mA)	Separation distance x (mm)	Ampere-turns $n \cdot I_{RMS}$ (A)	Limit for $n \cdot I_{RMS}$ (A)	Result
circular	16.2	125	44	1.275	5.500	7.153	Limit kept

Table 9: Result of application of NS exemption limits

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

Requirement:	RSS-102 Issue 6, section 6.6
Reference:	n/a

Performed by:	Konrad Graßl	Date of test:	November 25, 2024
Result:	☒ Limits kept	☐ Limits not kept	

4.2.2.1 Exemption Limits for Routine Evaluation – RF Exposure Evaluation

According to RSS 102, section 6.6:
Field reference level (FRL) 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 (i.e. mobile devices), except when the device operates as follows:

- below 20 MHz and the source-based, time-averaged maximum EIRP 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 EIRP 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 EIRP 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 EIRP of the device is equal to or less than $1.31\times10^{-2}\ f^{0.6834}$ W (adjusted for tune-up tolerance), where f is in MHz
- at or above 6 GHz and the source-based, time-averaged maximum EIRP 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 EIRP was derived.

4.2.2.2 Results

Radio technology 2:

The following data are based on applicants document: Test report 240337-AU01+W05 of the test laboratory Element Materials Technology Straubing GmbH.

Operation frequency:	13.56 MHz
Field strength:	45.0 dBµV/m at 30 m

Information related to Exposure:

Tune-up tolerance (according to the manufacturer):	0 dB
Separation distance:	20 cm
Exposure:	general public
Power averaging over time:	not applied

Channel Frequency (MHz)	*EIRP + tuneup tolerance (dBm)*	*EIRP (W)*	*EIRP limit (W)*	*Ratio of limit*	*Result*
13.56	-30.2	0.000001	1.000000	0.000001	Passed

Table 10: 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 + 20log(d) - 104.7

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

Radio technology 3:

The following data are based on applicants document: Test report 240337-AU01+W10 of the test laboratory Element Materials Technology Straubing GmbH

Conducted power:	-6.3 dBm at 2402 MHz

Information related to Exposure:

Antenna gain:	0.5 dBi
Tune-up tolerance (according to the manufacturer):	0 dB
Separation distance:	20 cm
Exposure:	general public
Power averaging over time:	not applied

Channel Frequency (MHz)	*EIRP + tuneup tolerance (dBm)*	*EIRP (W)*	*EIRP limit (W)*	*Ratio of limit*	*Result*
2402	-5.8	0.0003	2.6764	0.0001	Passed

Table 11: Result of exemption for routine evaluation of RF exposure

5 Measurement uncertainty

Test	*Frequency range*	*Equipment used*	*Expanded uncertainty*	U_{Limit}	*k=*
Magnetic field	1 Hz – 10 kHz	ELT 400 + probe	± 28.147 %	+58.% / -37 %	2
Magnetic field	10 kHz – 400 kHz	ELT 400 + probe	± 28.147 %	+41.% / -30 %	2
H-field	300 kHz – 800 kHz	NBM 550 + HF3061	± 25.602 %	+41.% / -30 %	2
H-field	800 kHz – 1 MHz	NBM 550 + HF3061	± 25.245 %	+41.% / -30 %	2
H-field	1 MHz – 30 MHz	NBM 550 + HF3061	± 25.245 %	+41.% / -30 %	2
E-field	100 kHz – 1 MHz	NBM 550 + EF0691	± 28.467 %	+41.% / -30 %	2
E-field	1 MHz – 30 MHz	NBM 550 + EF0691	± 27.324 %	+41.% / -30 %	2
E-field	30 MHz – 1 GHz	NBM 550 + EF0691	± 27.324 %	+100.% / -50 %	2
E-field	1 GHz – 4 GHz	NBM 550 + EF0691	± 30.244 %	+100.% / -50 %	2
E-field	4 GHz – 6 GHz	NBM 550 + EF0691	± 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 calculated according to
   a) ETSI TR 100 028-1 V1.4.1 and ETSI TR 100 028-2 V1.4.1
   b) CISPR 16-4-2:2011-06 + A1:2014-02 + A2:2018-08

3 The limits for the measurement uncertainty as listed above are
   a) derived from ETSI EN 300 328 V2.1.1
   b) equal to U_{CISPR} taken from CISPR 16-4-2:2011-06 + A1:2014-02 + A2:2018-08
   c) defined by the test laboratory

4 Simple acceptance is applied as the decision rule while keeping the specified limits (U_{Limit}) for the expanded measurement uncertainty (i.e. Test Uncertainty Ratio TUR ≥ 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. For details on simple acceptance and the level of risk (such as false accept, false reject and false statistical assumptions) associated with this decision rule see ISO/IEC Guide 98-4:2012 and ILAC G8:09/2019 “Guidelines on Decision Rules and Statements of Conformity” (“Binary Statement for Simple Acceptance Rule” according to clause 4.2.1).

5 All used test instruments as well as the test accessories are calibrated at regular intervals.

6 Revision history

Revision	*Date*	*Issued by*	*Description of modifications*
0	2024-11-26	Konrad Graßl	First edition

Template: RF_FCC_IC_Human Exposure_V1.10