Report on the FCC and IC Testing of the Marquardt GmbH Passive Entry Car key Model: BK1 In accordance with FCC 47 CFR Part 15 C and ISED RSS-102

Product Service

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Prepared for: Marquardt GmbH
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Germany

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COMMERCIAL-IN-CONFIDENCE

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Engineering Statement:

This measurement shown in this report were made in accordance with the procedures described on test pages.
All reporded testing was carried out on a sample equipment to demonstrate limited compliance with with FCC 47 CFR Part 15 C and ISED RSS-102 and RSS-GEN.
The sample tested was found to not comply with the requirements in the tested parts

Laboratory Accreditation	Laboratory recognition	Industry Canada test site registration
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1 Report Summary

1.1 Modification Report

Alternations and additions of this report will be issued to the holders of each copy in the form of a complete document.

Revision	*Description of changes*	*Date of Issue*
0	First Issue	2022-07-25

Table 1: Report of Modifications

1.2 Introduction

Applicant	Marquardt GmbH Schloss-Str. 16 78604 Rietheim-Weilheim Germany
Manufacturer	Marquardt GmbH
Model Number(s)	BK1
Serial Number(s)	---
Hardware Version(s)	---
Software Version(s)	---
Number of Samples Tested	1
Test Specification(s) / Issue / Date	FCC 47 CFR, Part 1, § 1.1307: 2021 and ISED RSS-102, Issue 5, Amd. 1: 2021
Test Plan/Issue/Date	---
Order Number	---
Date	2022-07-20
Date of Receipt of EUT	2022-07-20
Start of Test	2022-07-21
Finish of Test	2022-07-22
Name of Engineer(s)	Alex Fink
Related Document(s)	ANSI C63.10:2013 KDB 447498 D04 Interim General RF Exposure Guidance v01

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1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with FCC 47 CFR, Part 1, § 1.1307 and ISED RSS-102 is shown below.

Section	*Specification Clause*	*Test Description*	*Result*
2.1	§ 1.1307(b)(3)	RF Exposure Exemption	Pass

Table 2: Results according to FCC 47 CFR, Part 1

Section	*Specification Clause*	*Test Description*	*Result*
2.1	2.5.1	RF Exposure Exemption	Pass

Table 3: Results according to ISED RSS-102

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1.4 Product Information

1.4.1 Technical Description

The BK1, as a passive entry vehicle key, is part of a driving authorisation system, which further consists of a Body Control Unit.
The Body Control Unit sends an LF signal for wake up. The BK1 corresponds in return over RF bidirectionally for authentication.
The components exchange encrypted data for car access, to start the engine and to locate the key.

User manual
The BK1 will have some variations in the housing design depending on the variant.
The BK1 has up to four buttons. Open, Close, Trunk and Panic (optional for North American market). On each button press it initiates the communication to the Body Control Module.

Open Button
- To unlock the vehicles doors when the button is pressed short.
- In case the button is pressed long the windows will open additionally.

Close Button
- Locks the vehicles doors when the button is pressed short.
- When the button is pressed long the windows will close additionally.
- To activate the power save mode when pressed twice. This mode is deactivated by pressing any button.

Trunk Button
To unlock and open the vehicles trunk lid.

Optional the car can be accessed without handling the key. In this case RF signals are exchanged bidirectional when touching the door handle.

In case the battery is low car access is possible by means of an integrated mechanic emergency key. The BK1 is then to be placed into a dedicated slot inside the vehicles centre console to be powered wireless by means of a magnetic field for passive Transponder communication.

Working temperature: -20° to +60° C (UHF)
Rough mechanical dimensions: 87 X 44 X 13 mm
Weight: 50 g

Data of UHF-Part

Transmission mode:	bidirectional RF 2 channels

Receiver

Channel frequencies (center):	Channel 1: 433.20 MHz Channel 2: 434.64 MHz
Frequency tolerance: (production, aging, temperature)	+/- 10 kHz
Sensitivity:	-88 dBm
Modulation:	BFSK
Frequency deviation:	+/- 10 kHz
Antenna:	integrated PCB antenna, combined for Rx / Tx
Antenna gain:	0 dBi

Transmitter:

Center frequency:	see Rx
Frequency tolerance: (production, aging, temperature)	+/- 10 kHz
Modulation:	BFSK
Frequency deviation:	+/- 20 kHz
Antenna:	integrated PCB antenna, combined for Rx / Tx
Antenna gain:	0 dBi

1.5 Test Configuration

The EUT was battery operated.

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1.6 EUT Modifications Record

The table below details modifications made to the EUT during the test program.
The modifications incorporated during each test are recorded on the appropriate test pages.

Modification State	Description of Modification still fitted to EUT	Modification Fitted By	Date Modification Fitted
0	As supplied by the customer	Not Applicable	Not Applicable

Table 4

1.7 Test Location

TÜV SÜD Product Service conducted the following tests at our Straubing test laboratory:

Test Name	Name of Engineer(s)
RF Exposure	Alex Fink

Office Address:
Äußere Frühlingstraße 45
94315 Straubing
Germany

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2 Test Details

2.1 RF Exposure Exemption

2.1.1 Specification Reference

47 CFR, Part 1, § 1.1307(b)(3)
RSS-102, Issue 5 (2015-03-19) + Amendment 1 (2021-02-02)

2.1.2 Equipment under Test and Modification State

BK1; S/N: ---; Modification state 0

2.1.3 Date of Test

2022-07-21 and 2022-07-22

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2.1.4 Specification Limits

47 CFR, Part 1, § 1.1307(b)(3)

(i) For single RF sources (i.e. any single fixed RF source, mobile device, or portable device, as defined in paragraph(b)(2) of this section): A single RF source is exempt if:

(A) The available maximum time-averaged power is no more than 1 mW, regardless of separation distance. This exemption may not be used in conjunction with other exemption criteria other than those in paragraph (b)(3)(ii)(A) of this section. Medical implant devices may only use this exemption and that in paragraph (b)(3)(ii)(A);

(B) Or the available maximum time-averaged power or effective radiate power (ERP), whichever is greater, is less than or equal to the threshold P_{th} (mW) described in the following formula. This method shall only be used at separation distances (cm) from 0.5 cm to 40 cm and at frequencies from 0.3 GHz to 6 GHzu (inclusive). P_{th} is given by

$$P_{th}(\text{mW}) = \begin{cases} ERP_{20\text{cm}}\,(d/20\ cm)^{x}, & d \le 20\ \text{cm}; \\ ERP_{20\text{cm}}, & 20\ \text{cm} < d \le 40\ \text{cm} \end{cases}$$

where

$$x = -\log_{10}\left(\frac{60}{ERP_{20\text{cm}}\sqrt{f}}\right);\ f \text{ in GHz}$$

and

$$ERP_{20\text{cm}}(mW) = \begin{cases} 2040\,f, & 0.3\ \text{GHz} \le f < 1.5\ \text{GHz} \\ 3060, & 1.5\ \text{GHz} \le f \le 1.5\ \text{GHz} \end{cases}$$

d = the test separation distance (cm);

(C) Or using the table below 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 described for that frequency. For the exemption in the table 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	1920 R^2
1.34 – 30	3450 R^2 / f^2
30 – 300	3.83 R^2
300 – 1500	0.0128 $R^2 f^2$
1500 – 100000	19.2 R^2

(ii) For multiple RF sources: Multiple RF sources are exempt if:

(A) The available maximum time-averaged power of each source is no more than 1 mW and there is a separation distance of 2 cm between any portion of a radiating structure operating and the nearest portion of any other radiating structure in the same device, except if the sum of multiple sources is less than 1 mW during the time-averaging period, in which case they may be treated as a single source (separation is not required). This exemption may not be used in conjunction with other exemption criteria other than those in paragraph (b)(3)(i)(A) of this section. Medical implant devices may only use this exemption and that in paragraph (b)(3)(i)(A).

(B) In case of fixed RF sources operating in the same time-averaging period, or of multiple or portable RF sources within a device in the same time averaging period, if the sum of the fractional contributions to the applicable thresholds is less than or equal to 1 as indicated in the following equation:

$$\sum_{i=1}^{a}\frac{P_i}{P_{th,i}} + \sum_{j=1}^{b}\frac{ERP_j}{ERP_{th,j}} + \sum_{k=1}^{c}\frac{Evaluated_k}{ExposureLimit_k} \le 1$$

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RSS-102, section 2.5.1
SAR evaluation is required if the separation distance between the user and/or bystander and the antenna and/or radiating element of the device is less than or equal to 20 cm, except when the device operates at or below the applicable output power level (adjusted for tune-up tolerance) for the specified separation distance defined in the table below:

f (MHz)	*Exemption Limits (mW) at separation distance of*									
	≤ 5 mm	*10 mm*	*15 mm*	*20 mm*	*25 mm*	*30 mm*	*35 mm*	*40 mm*	*45 mm*	*≥ 50 mm*
≤ 300	71	101	132	162	193	223	254	284	315	345
450	52	70	88	106	123	141	159	177	195	213
835	17	30	42	55	67	80	92	105	117	130
1900	7	10	18	34	60	99	153	225	316	431
2450	4	7	15	30	52	83	123	173	235	309
3500	2	6	16	32	55	86	124	170	225	290
5800	1	6	15	27	41	56	71	85	97	106

Output power level shall be the higher of the maximum conducted or equivalent isotropically radiated power (e.i.r.p.) source-based, time-averaged output power. For controlled use devices where the 8 W/kg for 1 gram of tissue applies, the exemption limits for route evaluation are multiplied by a factor of 5. For limb-worn devices where the 10 grams value applies, the exemption limits for routine evaluation are multiplied by a factor of 2.5.
If the operating frequency of the device is between two frequencies located, linear interpolation shall be applied for the applicable separation distance. For test separation distance less than 5 mm, the exemption limits for a separation distance of 5 mm can be applied to determine if a routine evaluation is required.

For medical implants devices, the exemption limit for routine evaluation is set at 1 mW. The output power of a medical implant device is defined as the higher of the conducted or e.i.r.p. to determine whether the device is exempt from the SAR evaluation.

2.1.5 Test Method

The RF Exposure is based on a 1 mW exemption calculation for a test separation distance less than or equal to 0.2 cm as stated in the documentation of both modules.
Exemption calculations are based on the radiated emission tests as shown in Test Report TR-713266457-00 (FCC).

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2.1.6 Test Results

FCC 47 CFR Part §1.1307(b)(3)(i)(A)

Fieldstrength at 3m distance	82.78 dBµV/m
Transmit Power in dBm	-12.45 dBm
Maximum output power:	0.057 mW
Minimum test separation distance:	2 mm
Frequency:	433.2 MHz
Test Result:	Pass

1 mW “Blanket” Exemption according to §1.1307(b)(3)(i)(A)

ISED RSS-Gen, Clause 3.4

Frequency:	433.2 MHz
Test distance:	3 m
Carrier Power (e.i.r.p.):	0.057 mW
Exemption limit:	52 mW
Test Result:	Pass

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3 Measurement Uncertainty

For a 95% confidence level, the measurement uncertainties for defined systems are:

The measurement uncertainty in the laboratory is less than or equal to the maximum measurement uncertainty according to CISPR16-4-2: 2011 + A1 + A2 + Cor1 (U_{CISPR}). This normative regulation means that the measured value is also the value to be assessed in relation to the limit value.

Radio Interference Emission Testing		
Test Name	*kp*	*Expanded Uncertainty*
Conducted Voltage Emission		
9 kHz to 150 kHz (50Ω/50µH AMN)	2	± 3.8 dB
150 kHz to 30 MHz (50Ω/50µH AMN)	2	± 3.4 dB
100 kHz to 200 MHz (50Ω/5µH AMN)	2	± 3.6 dB
Discontinuous Conducted Emission		
9 kHz to 150 kHz (50Ω/50µH AMN)	2	± 3.8 dB
150 kHz to 30 MHz (50Ω/50µH AMN)	2	± 3.4 dB
Conducted Current Emission		
9 kHz to 200 MHz	2	± 3.5 dB
Magnetic Field strength		
9 kHz to 30 MHz (with loop antenna)	2	± 3.9 dB
9 kHz to 30 MHz (large-loop antenna 2 m)	2	± 3.5 dB
Radiated Emission		
30 MHz to 300 MHz	2	± 4.9 dB
300 MHz to 1 GHz	2	± 5.0 dB
1 GHz to 6 GHz	2	± 4.6 dB
Test distance 10 m		
30 MHz to 300 MHz	2	± 4.9 dB
300 MHz to 1 GHz	2	± 4.9 dB
The expanded uncertainty reported according to to CISPR16-4-2: 2011 + A1 + A2 + Cor1 is based on a standard uncertainty multiplied by a coverage factor of kp = 2, providing a level of confidence of p = 95.45%		

Table 5 Measurement uncertainty based on CISPR 16-4-2

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Radio Interference Emission Testing		
Test Name	*kp*	*Expanded Uncertainty*
Occupied Bandwidth	2	± 5 %
Conducted Power		
9 kHz ≤ f < 30 MHz	2	± 1.0 dB
30 MHz ≤ f < 1 GHz	2	± 1.5 dB
1 GHz ≤ f ≤ 40 GHz	2	± 2.5 dB
1 MS/s power sensor (TS8997)	2	± 1.5 dB
Occupied Bandwidth	2	± 5 %
Power Spectral Density	2	± 3.0 dB
Radiated Power		
9 kHz ≤ f < 26.5 GHz	2	± 5.6 dB
26.5 GHz ≤ f < 60 GHz	2	± 8.0 dB
60 GHz ≤ f < 325 GHz	2	± 10 dB
Conducted Spurious Emissions	2	± 3.0 dB
Radiated Spurious Emissions	2	± 6.0 dB
Voltage		
DC	2	± 1.0 %
AC	2	± 2.0 %
Time (automatic)	2	± 5 %
Frequency	2	± 10^{-7}
The expanded uncertainty reported according to to ETSI TR 100 028:2001 is based on a standard uncertainty multiplied by a coverage factor of kp = 2, providing a level of confidence of p = 95.45%		

Table 6 Measurement uncertainty based on ETSI TR 100 028