

Report on the FCC and IC Testing of the Marquardt GmbH

Model: YK2

In accordance with FCC 47 CFR Part 15 C and ISED RSS-102

Prepared for: Marquardt GmbH
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FCC ID: 2AHMVYK2
IC: 21263-YK2



Product Service

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Date: 2025-07-31
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RESPONSIBLE FOR	NAME	DATE	SIGNATURE
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Engineering Statement:

This measurement shown in this report were made in accordance with the procedures described on test pages.
All reported testing was carried out on a sample equipment to demonstrate limited compliance with with FCC 47 CFR Part 15 C, 2024 and ISED RSS-102 Issue 6 and RSS-GEN Issue 5.
The sample tested was found to not comply with the requirements in the tested parts

Laboratory Accreditation DAkKS Reg. No. D-PL-11321-11-03 DAkKS Reg. No. D-PL-11321-11-04	Laboratory recognition Registration No. BNetzA-CAB-16/21-15	Industry Canada test site registration 3050A-2
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1 Report Summary

1.1 Modification Report

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

<i>Revision</i>	<i>Description of changes</i>	<i>Date of Issue</i>
0	First Issue	2024-05-23
1	Updated to Issue 6 of RSS-102.	2025-07-11
2	Updated to RSS-102 in chapter 2 test details.	2025-07-31

Table 1: Report of Modifications

1.2 Introduction

Applicant	Marquardt GmbH
Manufacturer	Alpha Vehicle Security Solutions Czech s.r.o. V. Opatrného 1050 Týniště nad Orlicí CZ-517 21
Model Number(s)	YK2
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 6, 2023
Test Plan/Issue/Date	---
Order Number	6200659963-G61
Date	2023-11-29
Date of Receipt of EUT	2024-03-28
Start of Test	2024-04-04
Finish of Test	2024-04-04
Name of Engineer(s)	Alexander Deese
Related Document(s)	ANSI C63.10:2013 KDB 447498 D04 Interim General RF Exposure Guidance v01



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.

<i>Section</i>	<i>Specification Clause</i>	<i>Test Description</i>	<i>Result</i>
2.1	§ 1.1307(b)(3)	RF Exposure Exemption	Pass

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

<i>Section</i>	<i>Specification Clause</i>	<i>Test Description</i>	<i>Result</i>
2.1	2.5.1	RF Exposure Exemption	Pass

Table 3: Results according to ISED RSS-102



1.4 Product Information

1.4.1 Technical Description

The YK2 (vehicle key) is a component of a driving authorisation system of a car.

The component exchange encrypted data with the vehicle for car access, to start the engine and to locate the key. The YK2 contains four buttons for car access. By pressing the dedicated button, the YK2 sends over RF authorization data to the control unit to open the doors. The 2nd button releases data to lock the doors. A third button is dedicated to open the trunk deck. A fourth button opens the engine hood. An additional "PANIC" button is implemented optional for the US market.

Moreover, car access is also released after touching the door handles. The key is wakened by the magnetic field of the LF antennas, driven by the Body control unit of the vehicle. The YK2 sends over RF encrypted data in return for authentication.

In case the battery is low car access is possible by means of an integrated mechanic emergency key. The YK2 is then to be placed into a dedicated slot inside the centre console to be powered wireless by means of a magnetic field.

The RF Transmitter sends encrypted data to the vehicle modulated on an RF carrier of 433MHz. A version with 315MHz is available for the Japanese market only. When pressing a button on the YK2 a dedicated command with the encrypted data for authentication is sent:

Open-Button:

- Pressed short: unlocks the doors
- Pressed long: unlocks the doors and opens the windows

Close-Button:

- Pressed short: locks the doors
- Pressed long: locks the doors and closes the windows

Trunk-Button:

- to unlock the boot lid.

An LED indicates that appropriate data was sent.



Temperature range:

Working temperature: -20 ...+70 °C

RF-Part

Transmission mode: simplex

Multi channel Transmitter:

Frequencies: 433.47* / 433.92 / 434.37* MHz
*) optional configurable during training routine,
depending on the local regulations

Frequency tolerance:
(production, aging, temperature) +/- 80 ppm

Transmitter power (EIRP): typ. -14 dBm @433,92 MHz

Modulation: 2-FSK

Frequency deviation: +/- 20 kHz @ 20kBit/s
+/- 5 kHz @ 5kBit/s

Modulation content: digital data

Data rate: 5 kBit/s ; 20 kBit/s
Coding: Manchester

Antenna: PCB loop antenna

Passive Transponder (only active when placed into slot of centre console)

Transmission mode: simplex

Center frequency: 21,85 kHz

Modulation: BPSK-signal

Modulation content: digital data
Data rate: 5,4 kBit/s ; 2,7 kBit/s

Antenna: 3D coil



1.5 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

1.6 Test Location

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

Test Name	Name of Engineer(s)
RF Exposure	Alexander Deese

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 6, section 6

2.1.2 Equipment under Test and Modification State

YK2; S/N: ---; Modification state 0

2.1.3 Date of Test

2024-04-04



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 GHz (inclusive). P_{th} is given by

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

where

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

and

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

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:

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



RSS-102, section 6.3

Devices operating at or below the applicable output power levels (adjusted for tune-up tolerance) specified in table 11, based on the separation distance, are exempt from SAR evaluation. The separation distance, defined as the distance between the user and/or bystander and the antenna and/or radiating element of the device or the outer surface of the device, shall be less than or equal to 20 cm for these exemption limits to apply.

<i>f (MHz)</i>	<i>Exemption Limits (mW) at separation distance of</i>									
	<i>≤ 5 mm</i>	<i>10 mm</i>	<i>15 mm</i>	<i>20 mm</i>	<i>25 mm</i>	<i>30 mm</i>	<i>35 mm</i>	<i>40 mm</i>	<i>45 mm</i>	<i>≥ 50 mm</i>
≤ 300	45	116	139	163	189	216	246	280	319	362
450	32	71	87	104	124	147	175	208	248	296
835	21	32	41	54	72	96	129	172	228	298
1900	6	10	18	33	57	92	138	194	257	323
2450	3	7	16	32	56	89	128	170	209	245
3500	2	6	15	29	50	72	94	114	134	158
5800	1	5	13	23	32	41	54	74	102	128

The exemption limits in table 11 are based on measurements and simulations of half-wave dipole antennas at separation distances of 5 mm to 50 mm from a flat phantom, which provides a SAR value of approximately 0.4 W/kg for 1 g of tissue.

For limb-worn devices where the 10 gram of tissue applies, the exemption limits for routine evaluation in table 11 are multiplied by a factor of 2.5.

For controlled-use devices where the 8 W/kg for 1 gram of tissue applies, the exemption limits for routine evaluation in table 11 are multiplied by a factor of 5.

When the operating frequency of the device is between two frequencies located in table 11, linear interpolation shall be applied for the applicable separation distance. If the separation distance of the device is between two distances located in table 11, linear interpolation may be applied for the applicable frequency. Alternatively, the limit corresponding to the smaller distance may be employed. For example, in case of a 7 mm separation distance, either use the exception value for a 5 mm separation distance or interpolate between the limits corresponding to 5 mm and 10 mm separation distances.

For implanted medical devices, the exemption limit for routine SAR evaluation is set at an output power of 1 mW, regardless of frequency.

The SAR levels from exempted transmitters shall be included in the compliance assessment and the determination of the TER. Detailed guidance is included in sections 7.1.8 and 8.2.2.1.

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 “direct contact” as stated in the documentation of both modules.

Exemption calculations are based on the radiated emission tests as shown in Test Report TR-713316115-00 (FCC).



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2.1.6 Test Results

FCC 47 CFR Part §1.1307(b)(3)(i)(A)

<i>Fieldstrength at 3m distance:</i>	75.27 dBμV/m
<i>Transmit Power in dBm:</i>	-19.96 dBm
<i>Maximum output power:</i>	0.01010 mW
<i>Minimum test separation distance:</i>	direct contact
<i>Frequency:</i>	434.4 MHz
<i>Test Result:</i>	Pass

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

ISED RSS-Gen, Clause 3.4

<i>Frequency:</i>	434.4 MHz
<i>Test distance:</i>	3 m
<i>Carrier Power (e.i.r.p.):</i>	0.01010 mW
<i>Exemption limit:</i>	33.3 mW
<i>Test Result:</i>	Pass



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.

<i>Radio Interference Emission Testing</i>		
<i>Test Name</i>	<i>kp</i>	<i>Expanded Uncertainty</i>
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 CISPR16-4-2: 2011 + A1 + A2 + Cor1 is based on a standard uncertainty multiplied by a coverage factor of $k_p = 2$, providing a level of confidence of $p = 95.45\%$		

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



<i>Radio Interference Emission Testing</i>		
<i>Test Name</i>	<i>kp</i>	<i>Expanded Uncertainty</i>
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