

Exposure Test Report
Marquardt GmbH
Electronic Control Unit
Model: ZE1
In accordance with FCC 47 CFR Part 1 I



Prepared for: Marquardt GmbH
Schloss-Straße 16,
78604 Rietheim-Weilheim,
Germany

COMMERCIAL-IN-CONFIDENCE

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Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD Product Service document control rules.

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 1 I.

The sample tested was found to comply with the requirements defined in the applied rules.

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Testing	Alex Fink	2026-06-29	 SIGN-ID 1140070 30.06.2026 Alex Fink

Laboratory Accreditation DAkS Reg. No. D-PL-11321-11-03 DAkS 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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Executive Statement:

A sample of this product was tested and found to be compliant with FCC 47 CFR Part 1 I:2023.



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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. Current version replaces all previous versions.

Revision	Description of changes	Date of Issue
0	First Issue	2026-06-29

Table 1: Report of Modifications

1.2 Introduction

Applicant	Marquardt GmbH
Manufacturer	Marquardt GmbH Schloss-Straße 16, 78604 Rietheim-Weilheim, Germany
Model Number(s)	ZE1
Serial Number(s)	1
Hardware Version(s)	---
Software Version(s)	---
Number of Samples Tested	1
Test Specification(s) / Issue / Date	FCC 47 CFR Part 1 I : 2023
Test Plan/Issue/Date	ZE1_Testmode Description V1.1
Order Number	6200821556
Date	2026-05-05
Date of Receipt of EUT	2026-05-26
Start of Test	2026-05-28
Finish of Test	2026-05-29
Name of Engineer(s)	Alex Fink
Related Document(s)	ANSI C63.10:2020



1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with FCC 47 CFR Part 1 I is shown below.

<i>Section</i>	<i>Specification Clause</i>	<i>Test Description</i>	<i>Result</i>
2.1	1.1307	RF Exposure	Not applicable – fundamental is at 21.85 kHz

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



1.4 Product Information

1.4.1 Technical Description

Supply Voltage:	12 V DC
Supply Frequency:	N/A
Highest clock frequency:	433.92 MHz
Type of equipment:	The ZE1(ECU) is the wireless control unit of a driving authorization system, which further comprises of the vehicle key ZK1 (KEY), with following functions: Management of CAN communication for keyless Go functionality of a vehicle. It drives one LF antenna authentication of the vehicle key.
Transmitter:	Frequency: 21.85 kHz Power: < 6mA/m @3m Modulation: BPSK Modulation content: digital data Data rate: 5.4 kBit/s Antenna: Serial capacity and inductivity resonance circuit 1 Antenna Antenna connection: twisted pair cable with two pole connectors
Receiver:	Frequency: 433.92 MHz 3 dB bandwidth: 165 kHz Frequency tolerance: +/- 80 ppm Sensitivity -100 dBm typ. Modulation: 2-FSK Frequency deviation: +/- 20 kHz @ 433.92 MHz Modulation content: digital data Data rate: 5 kBit/s ; 20 kBit/s Coding: Manchester Antenna: PCB antenna



1.4.2 EUT Ports / Cables identification

Port	Max Cable Length specified	Usage	Type	Screened
DC power	---	2 m	DC power (+/-)	unshielded

Table 3

1.5 Test Configuration

Configuration	Description
12 V DC powered	The EUT was powered with 12 V DC via external source.

Table 4

1.6 Modes of Operation

Mode	Description
LF Continuous Transmission Mode	After power-on, the LF transmitter drives each LF antenna for approximately 11 ms, followed by an off time of approximately 412 ms. This cycle repeats automatically until power-off.

Table 5

1.7 Deviations from Standard



1.8 EUT Modifications Record

The table below details modifications made to the EUT during the test programme.
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 6

1.9 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



Product Service

2 Test Details

2.1 RF Exposure

2.1.1 Specification Reference

FCC 47 CFR Part 1, § 1.1307(b)(3)

2.1.2 Equipment under Test and Modification State

ZE1; S/N 1 - Modification state 0

2.1.3 Date of Test

2026-05-29

2.1.4 Environmental Conditions

Ambient Temperature	24 °C
Relative Humidity	36 %



2.1.5 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

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

where

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

and

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

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).

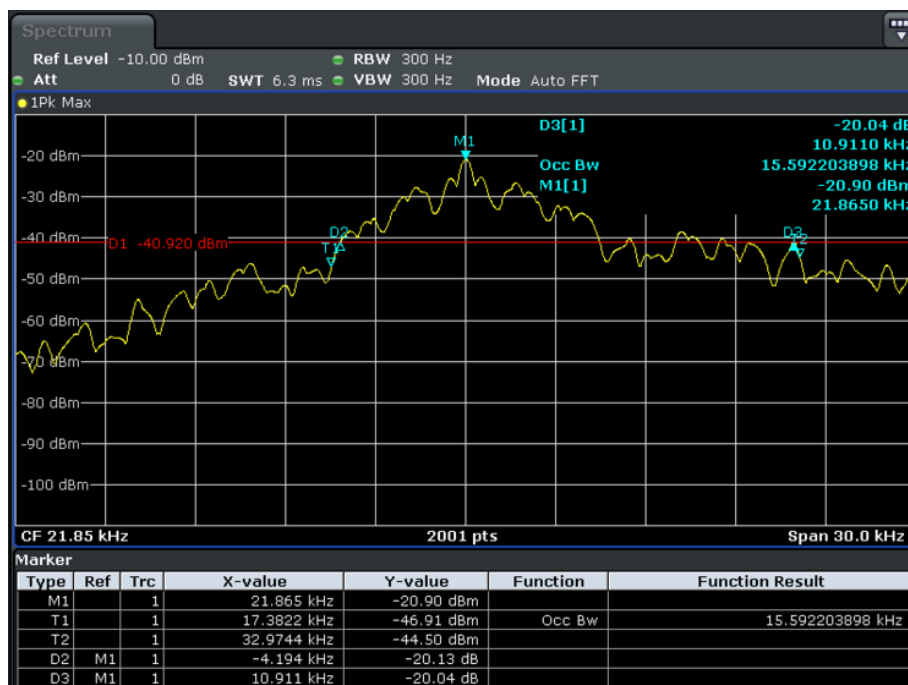
RF source frequency (MHz)	Threshold ERP (Watts)
0.3 – 1.34	$1920 R^2$
1.34 – 30	$3450 R^2 / f^2$
30 – 300	$3.83 R^2$
300 – 1500	$0.0128 R^2 f$
1500 – 100000	$19.2 R^2$

- (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:

$$\sum_{i=1}^a \frac{P_i}{P_{th,i}} + \sum_{j=1}^b \frac{ERP_j}{ERP_{th,j}} + \sum_{k=1}^c \frac{\text{Evaluated}_k}{\text{ExposureLimit}_k} \leq 1$$



2.1.6 Test Results



Center frequency	Applicable Limit
21.85 kHz	---

Table 7: Fundamental frequency

The device operates at a fundamental frequency of 21.85 kHz, which is below the frequency range of 0.3 MHz to 100000 MHz where RF exposure limits are defined.

Based on the above evaluation, the device is not subject to RF exposure requirements and is considered exempt from RF exposure assessment.



2.1.7 Test Location and Test Equipment

The test was carried out in radio test laboratory

<i>Instrument</i>	<i>Manufacturer</i>	<i>Type No</i>	<i>TE No</i>	<i>Calibra- tion Pe- riod (months)</i>	<i>Calibration Due</i>
Signal and spectrum analyzer	Rohde & Schwarz	FSV40	20219	24	2028-04-30
Climatic test chamber	ESPEC	PL-4J	38958	24	2027-03-31

Table 8



3 Measurement Uncertainty

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

<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 Fieldstrength		
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 9 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		
25 MHz – 6 GHz	1.96	±4.4 dB
1 GHz – 18 GHz	1.96	±4.7 dB
18 GHz – 40 GHz	1.96	±4.9 dB
40 GHz – 325 GHz	1.96	±6.1 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 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 10 Measurement uncertainty based on ETSI TR 100 028

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}) and as specified in the test report below. This normative regulation means that the measured value is also the value to be assessed in relation to the limit value.



Product Service

Test Name	Expanded Uncertainty
Occupied Bandwidth	±5 %
Conducted Power	
9 kHz ≤ f < 30 MHz	±1.0 dB
30 MHz ≤ f < 1 GHz	±1.5 dB
1 GHz ≤ f ≤ 40 GHz	±2.5 dB
1 MS/s power sensor (2.4 / 5 GHz band)	±1.5 dB
Power Spectral Density	±3.0 dB
Radiated Power	
25 MHz – 26.5 GHz	±6.0 dB
26.5 GHz – 66 GHz	±8.0 dB
40 GHz – 325 GHz	±10.0 dB
Conducted Spurious Emissions	±3.0 dB
Radiated Field Strength 9 kHz – 40 GHz	±6.0 dB
Voltage	
DC	± 1.0 %
AC	± 2.0 %
Time (automatic)	± 5 %
Frequency	± 10 ⁻⁷

Table 11 Decision Rule: Maximum allowed measurement uncertainty

End of Test Report