

Report on the FCC and IC Testing of the
Marquardt GmbH
Electronic Control Unit
Model: ZE1
In accordance with FCC 47 CFR Part 15 C



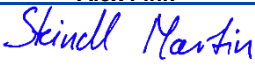
Prepared for: Marquardt GmbH
Schloss-Straße 16,
78604 Rietheim-Weilheim,
Germany

COMMERCIAL-IN-CONFIDENCE

FCC ID: IYZZE1

Date: 2026-06-18

Document Number: TR-713410383-00 | Revision: 1

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Project Management	Alex Fink	2026-06-18	 SIGN-ID 1136807 18.06.2026 Alex Fink
Authorised Signatory	Martin Steindl	2026-06-18	 SIGN-ID 1136818 18.06.2026 Martin Steindl

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 15 C.

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

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Testing	Alex Fink	2026-06-18	 SIGN-ID 1136807 18.06.2026 Alex Fink

Laboratory Accreditation

DAkkS Reg. No. D-PL-11321-11-00

Laboratory recognition

Registration No. BNetzA-CAB-16/21-15

Industry Canada test site registration

3050A-2

Executive Statement:

A sample of this product was tested and found to be compliant with FCC 47 CFR Part 15 C:2024.



DISCLAIMER AND COPYRIGHT

Any use for advertising purposes must be granted in writing. This technical report may only be quoted in full. This report is the result of a single examination of the object in question. It does not imply a general statement regarding the quality of products from regular production. For further details please see Testing, Certification, Validation and Verification Regulations, chapter A-3.3.
© 2026 TÜV SÜD Product Service.

Trade Register Munich
HRB 85742
VAT ID No. DE129484267
Information pursuant to Section 2(1)
DL-InfoV (Germany) at
www.tuvsud.com/imprint

Supervisory Board:
Holger Lindner (Chairman)
Board of Management:
Wolfgang Hübl (CEO)
Karl Meier
Patrick van Welij

Phone: +49 (0) 9421 56 82-0
Fax: +49 (0) 9421 56 82-199
www.tuvsud.com

TÜV SÜD Product Service GmbH
Äußere Frühlingsstraße 45
94315 Straubing
Germany



Content

1	Report Summary.....	2
1.1	Modification Report	2
1.2	Introduction.....	2
1.3	Brief Summary of Results	3
1.4	Product Information	4
1.5	Test Configuration	5
1.6	Modes of Operation.....	5
1.7	EUT Modifications Record	6
1.8	Test Location	6
2	Test Details.....	7
2.1	Bandwidth of Signal	7
2.2	Radiated Emissions	10
3	Measurement Uncertainty	19
Annex A:	Photographs of Test Setup	3 pages



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	---	2026-06-02
1	Addition of Peak and Average for the fundamental emission on page 15. Addition of correction factors for conversion from 300 m to 3 m distance on page 14. Addition of the fundamental emission at 3 m for comparison with unwanted emissions on page 15.	2026-06-18

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 15 C : 2024
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 15 C is shown below.

<i>Section</i>	<i>Specification Clause</i>	<i>Test Description</i>	<i>Result</i>
2.1	15.215(c)	Bandwidth of Signal	Complies
2.2	15.209	Radiated Emissions	Pass
---	15.107	Conducted Emissions at Mains Terminal	N/A (vehicle use)

Table 2: Results according to FCC 47 CFR Part 15 C



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 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

1.8 Test Location

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

Test Name	Name of Engineer(s)
Bandwidth of Signal	Alex Fink
Radiated Emissions	Alex Fink

Office Address:

Äußere Frühlingstraße 45
94315 Straubing
Germany



2 Test Details

2.1 Bandwidth of Signal

2.1.1 Specification Reference

FCC 47 CFR Part 15 C, Clause 15.215(c)

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

No explicit bandwidth limit is defined in FCC §15.215(c).

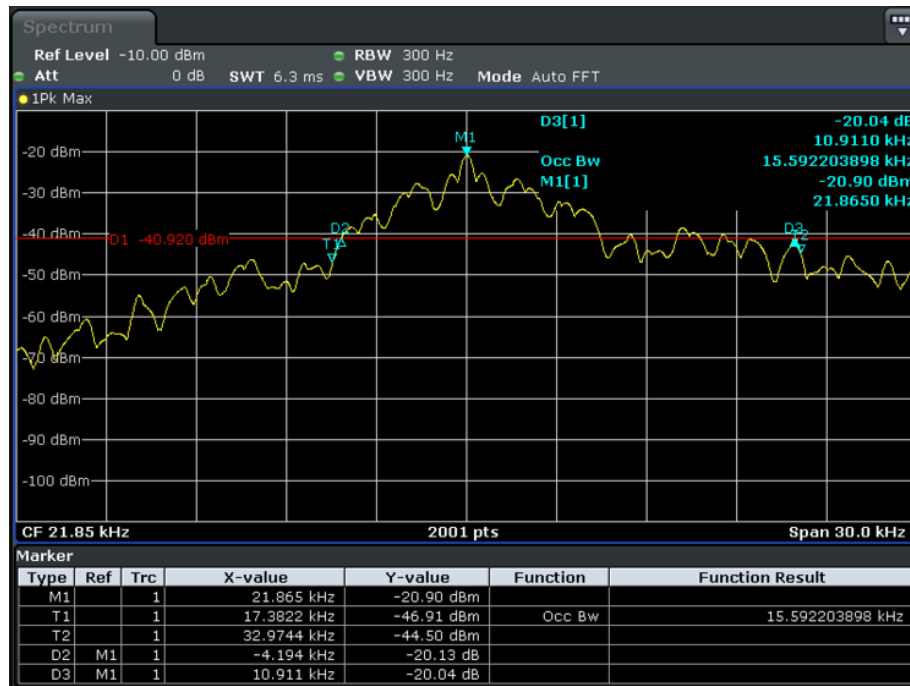
Compliance is ensured by meeting the applicable emission limits and band-edge requirements.
Bandwidth is recorded for informational purposes only.

2.1.6 Test Method

The test was performed according to ANSI C63.10, clauses 6.9
See section 2.2 of this test report for details.



2.1.7 Test Results



Center frequency	20 dB Bandwidth
21.85 kHz	15.105 kHz

Table 7: 20 dB bandwidth



2.1.8 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



2.2 Radiated Emissions

2.2.1 Specification Reference

FCC 47 CFR Part 15 C, Clauses 15.205, and 15.209

2.2.2 Equipment under Test and Modification State

ZE1, S/N: 1 - Modification State 0

2.2.3 Date of Test

2026-05-28

2.2.4 Environmental Conditions

Ambient Temperature	25 °C
Relative Humidity	37 %



2.2.5 Specification Limits

General radiated emission limits:					
Frequency Range (MHz)	Test distance (m)	Field strength		Field strength	
		($\mu\text{A/m}$)	($\text{dB}\mu\text{A/m}$)	($\mu\text{V/m}$)	($\text{dB}\mu\text{V/m}$)
0.009 – 0.49	300	$6.37 / f$	$20*\lg(6.37 / f)$	$2400 / f$	$20*\lg(2400 / f)$
0.49 – 1.705	30	$63.7 / f$	$20*\lg(63.7 / f)$	$24000 / f$	$20*\lg(24000 / f)$
1.705 - 30	30	0.08	$20*\lg(0.08 / f)$	30	$20*\lg(30 / f)$
30 – 88	3	---	---	100	40
88 – 216	3	--	---	150	43.5
126 – 960	3	--	---	200	46
above 960	3	--	---	500	54
Note 1: f in kHz					

Table 9 General radiated emission limits

At frequencies at or above 30 MHz, measurements may be performed at distance other than what is specified provided: measurements are not made in the near field except where it can be shown that near field measurements are appropriate due to the characteristics of the device; and it can be demonstrated that the signal levels needed to be measured at the distance employed can be detected by the measurement equipment. Measurements shall not be performed at a distance greater than 30 m, unless it can be further demonstrated that measurements at a distance of 30 m or less are impractical. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade (inverse linear-distance for field strength measurements; inverse-linear-distance-squared for power density measurements).

At frequencies below 30 MHz, measurements may be performed at a distance closer than that specified in the regulations; however, an attempts should be made to avoid making measurements in the near field. Pending the development of an appropriate measurement procedure for measurements performed below 30 MHz, when performing measurements at a closer distance than specified, the results shall be extrapolated to the specified distance by either making measurements at a minimum of two distances on at least one radial to determine the proper extrapolation factor or by using the square of an inverse linear distance extrapolation factor (40 dB/decade).

2.2.6 Test Method

The test was performed according to ANSI C63.10, sections 11.11 and 11.12

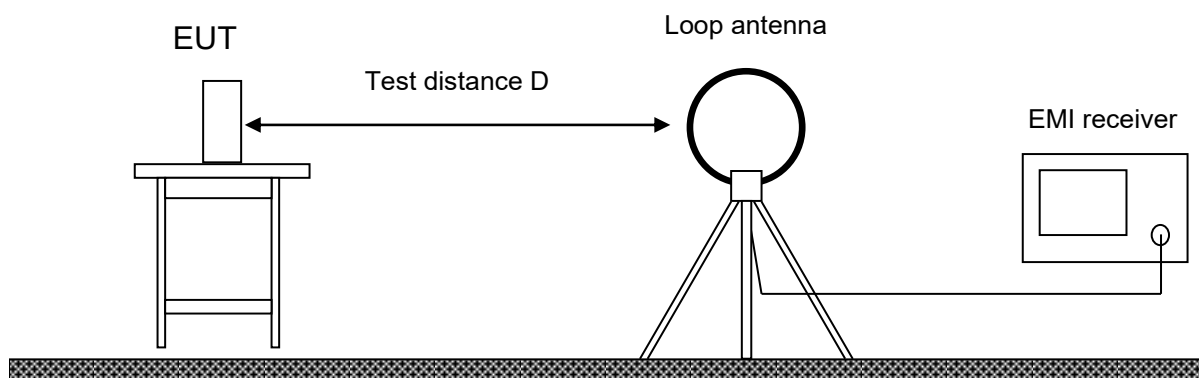
Prescans are performed in six positions of the EUT to get the full spectrum of emission caused by the EUT with the measuring antenna raised and lowered from 1 m to 4 m with vertical and horizontal polarisation to find the combination of table position, antenna height and antenna polarisation for the maximum emission levels.

Data reduction is applied to these results to select those levels having less margin than 10 dB or exceeding the limit using subranges and limited number of maximums.

Further maximisation for adjusting the maximum position is following.

Equipment and cables are placed and moved within the range of position likely to find their maximum emissions.

2.2.6.1 Frequency range 9 kHz – 30 MHz

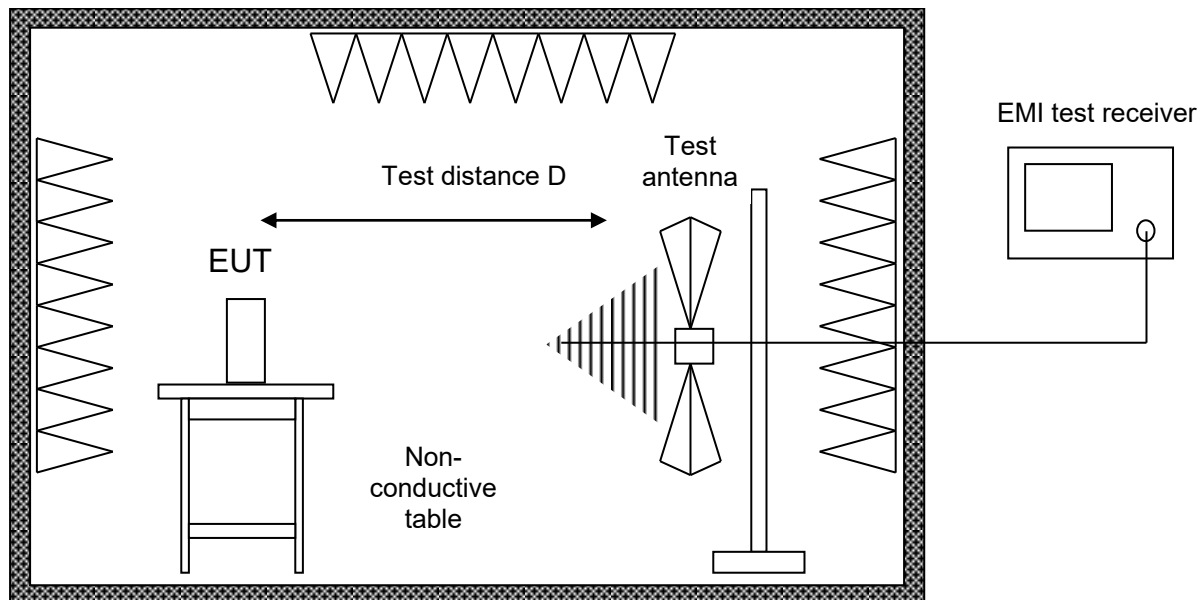


The EUT was placed on a non-conductive table, 0.8 m above the ground.

Radiated emissions in the frequency 9 kHz – 30 MHz is measured within a semi-anechoic room with an active loop antenna with the measurement detector set to peak. In addition in the frequency range 9 kHz to 490 kHz also an average detector was used. The measurement bandwidth of the receiver was set to 300 Hz in the frequency range 9 kHz to 150 kHz and 10 kHz in the frequency range 150 kHz to 30 MHz. Prescans were performed in six positions of the EUT.

For final measurements the detector was set to CISPR quasi-peak and in addition to CISPR average in the frequency range 9 kHz to 490 kHz with a resolution bandwidth 200 Hz in the frequency range 9 kHz to 150 kHz and 9 kHz in the frequency range 150 kHz to 30 MHz. Final tests were performed immediately after a final frequency and zoom (for drifting disturbances) and maximum adjustment.

2.2.6.2 Frequency range 30 MHz – 1 GHz



Alternate test site (semi anechoic room)

The EUT was placed on a non-conductive table, 0.8 m above the ground plane. Radiated emissions in the frequency range 30 MHz – 1 GHz are measured within a semi-anechoic room with a groundplane complying with the NSA requirements of ANSI C63.4. for alternative test sites. A linear polarised logarithmic periodic antenna combined with a 4:1 broadband dipole ("Trilog broadband antenna") is used.

For prescan tests the test receiver is set to peak-detector with a bandwidth of 120 kHz.

With the measurement bandwidth of the test receiver set to 120 kHz CISPR quasi-peak detector is selected for final measurements following immediately after a final frequency zoom (for drifting disturbances) and maximum adjustment.



2.2.7 Test Results

<i>Frequency range</i>	<i>Limit applied</i>	<i>Test distance</i>
9 kHz – 30 MHz	15.209	3 m
30 MHz – 1 GHz	15.209	3 m
1 GHz – 6 GHz	15.209	3 m

Table 10

Sample calculation:

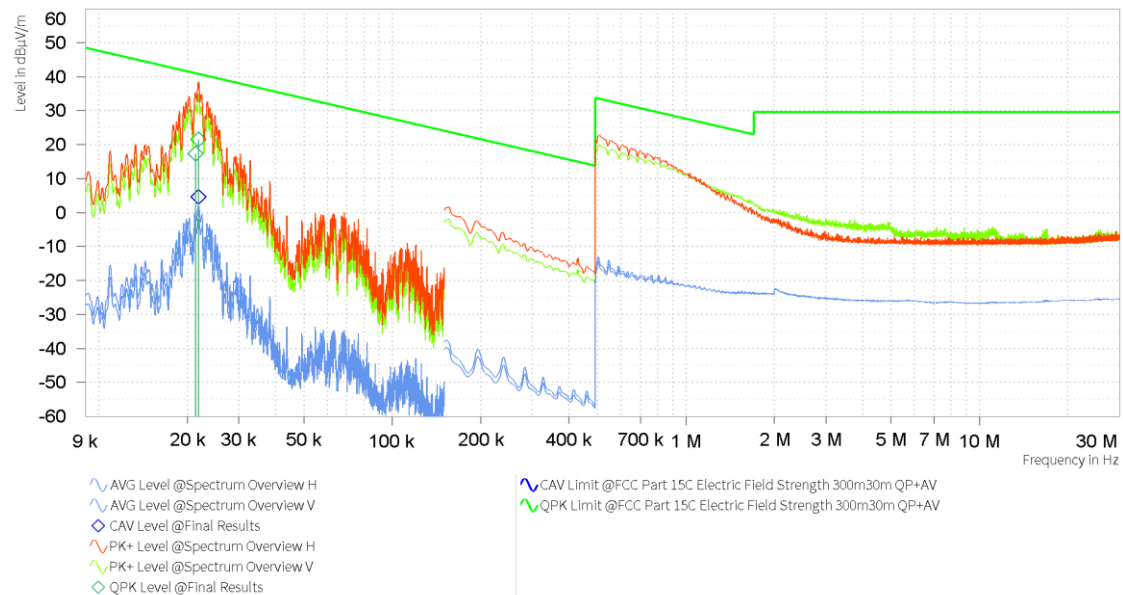
$$\text{Final Value (dB}\mu\text{V/m)} = \text{Reading Value (dB}\mu\text{V)} + (\text{Cable attenuation (dB)} \\ + \text{Antenna Transducer (dB(1/m)))}$$

Additional correction of limit in the frequency range 9 – 490 kHz (300 m to 3 m): +80.0 dB

Additional correction of limit in the frequency range 490 kHz – 30 MHz (30 m to 3 m): +40.0 dB



Frequency range 9 kHz – 30 MHz:



PK+ and AVG:

Rg	Frequency [MHz]	PK+ Level [dBµV/m]	PK+ Limit [dBµV/m]	PK+ Margin [dB]	AVG Level [dBµV/m]	AVG Limit [dBµV/m]	AVG Margin [dB]	Correction [dB]	Polarization	Azimuth [deg]	Antenna Height [m]	Meas. BW [kHz]	Meas. Time [s]
1	0.021	35.08	41.00	5.92	---	---	---	-60.47	H	93	1.00	0.200	1.000
1	0.022	38.60	40.82	2.22	5.83	40.82	34.99	-60.48	H	86	1.00	0.200	1.000

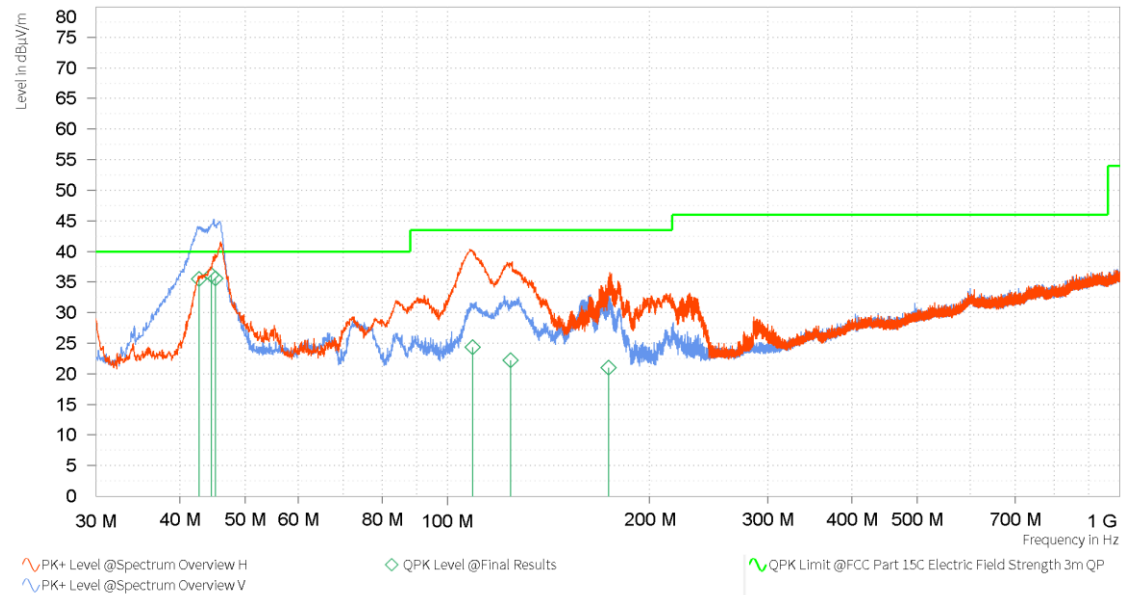
QPK and CAV:

Rg	Frequency [MHz]	QPK Level [dBµV/m]	QPK Limit [dBµV/m]	QPK Margin [dB]	CAV Level [dBµV/m]	CAV Limit [dBµV/m]	CAV Margin [dB]	Correction [dB]	Polarization	Azimuth [deg]	Antenna Height [m]	Meas. BW [kHz]	Meas. Time [s]
1	0.021	17.38	41.00	23.62	---	---	---	-60.47	H	93	1.00	0.200	1.000
1	0.022	21.54	40.82	19.28	4.61	40.82	36.21	-60.48	H	86	1.00	0.200	1.000

The fundamental emission level of 21.54 dBµV/m (QPK) at 300 meters corresponds to 101.54 dBµV/m at 3 meters. The spurious emission level at 44.58 MHz is 36.10 dBµV/m (QPK) at 3 meters and is therefore below the fundamental emission level.



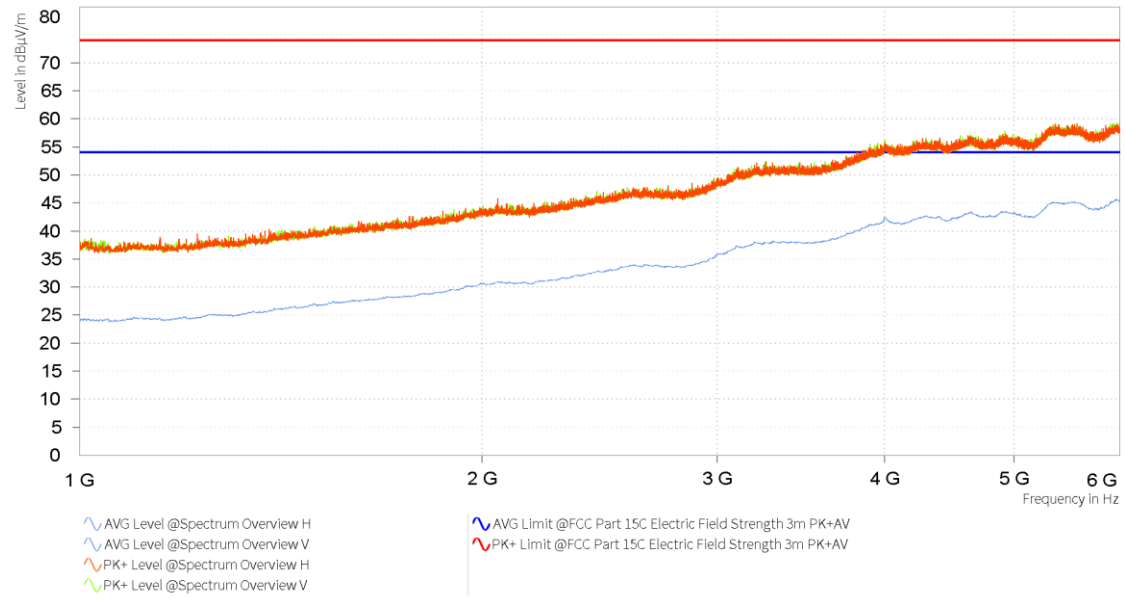
Frequency range 30 MHz – 1 GHz:



Rg	Frequency [MHz]	QPK Level [dBµV/m]	QPK Limit [dBµV/m]	QPK Margin [dB]	Correction [dB]	Polarization	Azimuth [deg]	Antenna Height [m]	Meas. BW [kHz]	Meas. Time [s]
1	42.720	35.47	40.00	4.53	19.70	V	-47	1.27	120.000	15.000
1	44.580	36.10	40.00	3.90	20.03	V	-127	1.00	120.000	15.000
1	45.180	35.62	40.00	4.38	20.11	V	-127	1.21	120.000	15.000
1	108.960	24.36	43.50	19.14	18.35	H	57	2.89	120.000	15.000
1	124.200	22.17	43.50	21.33	15.68	H	-109	3.33	120.000	15.000
1	173.580	21.02	43.50	22.48	15.99	H	-26	2.13	120.000	15.000



Frequency range 1 GHz – 6 GHz:





2.2.8 Test Location and Test Equipment

The test was carried out in semi anechoic room, cabin No. 11

Instrument	Manufacturer	Type No	TE No	Calibration Period (months)	Calibration Due
EMI test receiver	Rohde & Schwarz	ESW44	39897	12	2026-06-30
Double ridged horn antenna	Rohde & Schwarz	HF907	40089	24	2026-11-30
Loop antenna	Schwarzbeck	FMZB 1519 C	72526	36	2028-01-31
Semi anechoic room	Frankonia	Cabin no. 11	42961	---	---
ELEKTRA measurement software	Rohde & Schwarz	ELEKTRA K11 Emission – V5.11.1	68263	---	---
TRILOG Broadband Antenna	Rohde & Schwarz	VULB 9163	19589	36	2028-08-31
Fixed attenuator	Rohde & Schwarz	ATT 6dB	61491	36	2026-06-30

Table 11



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 12 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 13 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.



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 14 Decision Rule: Maximum allowed measurement uncertainty

End of Test Report