FCC RF Exposure Assessment

on

Level Probing Radar
Optiwave 15xx series

FCC ID: 2AV6KH

Report Reference: MDE_KROHN_2102_MPE_01

Test Laboratory:
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Germany

Contents

1 Applied Standards

Type of Authorization
Certification for an Intentional Radiator

Applicable FCC Rules

Prepared in accordance with the requirements of FCC Rules and Regulations as listed in 47 CFR Ch.1 Parts 1 and 2 (10-1-23 Edition). The following subparts are applicable to the results in this test report.

Part 1, Subpart I	**Practice and Procedure, Procedures Implementing the National Environmental Policy Act of 1969**
§ 1.1307:	Actions that may have a significant environmental effect, for which Environmental Assessments (EAs) must be prepared.
Part 2, Subpart J	**Equipment Authorization Procedures, Certification**
§ 2.1091:	Radiofrequency radiation exposure evaluation: mobile devices.
§ 2.1093:	Radiofrequency radiation exposure evaluation: portable devices.

The following KDB is applied:

KDB 447498 D04, v01:	Interim General RF Exposure Guidance RF Exposure Procedures and Equipment Authorization Policies for Mobile and Portable Devices

2 Summary

This RF-exposure evaluation according to the – in chapter 1 - mentioned rule parts and KDB shows, that the worst-case RF exposure values of the assessed radio technologies and bands are below the exemption limits of the mentioned rule parts. The following exemption rule part(s) were selected:

☒	**1-mW Test Exemption, § 1.1307(b)(3)(i)(A)** 447498 D04 Interim General RF Exposure Guidance v01, 2.1.2 Per § 1.1307(b)(3)(i)(A), a single RF source is *exempt RF device* (from the requirement to show data demonstrating compliance to RF exposure limits, as previously mentioned) if the available maximum time-averaged power is no more than 1 mW, regardless of separation distance. This exemption applies to all operating configurations and exposure conditions, for the frequency range 100 kHz to 100 GHz, regardless of fixed, mobile, or portable device exposure conditions. This is a standalone exemption, and it cannot be applied in conjunction with any other test exemption.
☐	**MPE based test exemption, § 1.1307(b)(3)(i)(C)** 447498 D04 Interim General RF Exposure Guidance v01, 2.1.4 An alternative to the SAR-based exemption is provided in § 1.1307(b)(3)(i)(C), for a much wider frequency range, from 300 kHz to 100 GHz, applicable for separation distances greater or equal to λ/2π, where λ is the free-space operating wavelength in meters. The MPE-based test exemption condition is in terms of ERP, defined as the product of the maximum antenna gain and the delivered maximum time-averaged power.10 For this case, a RF source is an *RF exempt device* if its ERP (watts) is no more than a frequency-dependent value, as detailed tabular form in Appendix B. These limits have been derived based on the basic specifications on Maximum Permissible Exposure (MPE) considered for the FCC rules in § 1.1310(e)(1).
☐	**SAR based test exemption, § 1.1307(b)(3)(i)(B)** 447498 D04 Interim General RF Exposure Guidance v01, 2.1.3 A more comprehensive exemption, considering a variable power threshold that depends on both the *separation distance* and power, is provided in § 1.1307(b)(3)(i)(B). This exemption is applicable to the frequency range between 300 MHz and 6 GHz, with *test separation distances* between 0.5 cm and 40 cm, and for all RF sources in fixed, mobile, and portable device exposure conditions. Accordingly, a RF source is considered an *RF exempt device* if its available maximum time-averaged (matched conducted) power or its effective radiated power (ERP), whichever is greater, are below a specified threshold. This exemption threshold was derived based on general population 1-g SAR requirements.
☒	**1-mW Test Exemption for Multiple Sources, § 1.1307(b)(3)(ii)(A)** 447498 D04 Interim General RF Exposure Guidance v01, 2.2.1
☐	**Simultaneous Transmission with both SAR-based and MPE-Based Test Exemptions, § 1.1307(b)(3)(ii)(B)** 447498 D04 Interim General RF Exposure Guidance v01, 2.2.2

Declared separation distance by the customer: 20 cm

Final Result:

According to the checked 47 CFR rule parts and KDB 447498 v01 subchapters, the RF Exposure Test Exemptions apply.

All ratios – for the declared separation distances(s) - are below 1 (≤ 100 %).

Certification can be obtained without the need of showing data (measurements, or analytical/numerical modelling) to demonstrate RF Exposure compliance.

COMMENTS:

- None

(responsible for accreditation scope)
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3 Revision History

Report version control			
Version	**Release date**	**Change Description**	**Version validity**
initial	2025-08-28	--	valid
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4 Administrative Data

4.1 Testing Laboratory

Company Name:	7layers GmbH
Address:	Borsigstr. 11 40880 Ratingen Germany
Laboratory accreditation no:	DAkkS D-PL-12140-01-00
FCC Designation Number:	DE0015
FCC Test Firm Registration:	929146
Responsible for accreditation scope:	Dipl.-Ing Marco Kullik
Report Template Version:	2025-04-01

4.2 Project Data

Responsible for report:	Dipl.-Ing Sören Berentzen
Date of Report:	2025-08-28

4.3 Applicant Data

Company Name:	KROHNE Messtechnik GmbH
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Contact Person:	Mr. Charalambos Ouzounis

4.4 Manufacturer Data

Company Name:	KROHNE Messtechnik GmbH
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Contact Person:	Mr. Charalambos Ouzounis

5 Test object Data

Declared EUT data by the supplier	
Kind of Device product description	Level Probing Radar with BTLE
Product name	Optiwave 15xx series
Type	DN70
HW/SW	Converter: 4008475901d Converter: 23.07.01
Integrated transmitter	Radar 77 GHZ – 81 GHz, Bluetooth Low Energy
Bluetooth Low Energy	
supported Radio technologies	Bluetooth Low Energy
Supplied document(s)	FCC Test Report: MDE_KROHN_2103_FCC_05 Duty Cycle Calculation: Optiwave 15xx – BLE duty cycle.pdf
Antenna	Internal
Supplied document(s)	2450AT18D0100_BLE chip antenna_marking.pdf
FMCW Radar	
supported Radio technologies	FMCW-Radar 77 GHz – 81 GHz
Supplied document(s)	FCC Test Report: MDE_KROHN_2103_FCC_04
Antenna	Internal
Supplied document(s)	Datasheet DN70 lens antenna (80GHz)_v2.pdf

6 Assessment

6.1 Assessment method and technologies of assessment

Specific information:

- Output power values are based on the supplied test reports
- Antenna gain values are taken from the supplied data sheets.

Worst case considerations:

- Main beams of the antennas are directed to the same point in the prediction distance.
- Cable loss of internal antenna cables set to 0
- Duty factor Bluetooth low energy = 0.2
- Duty factor FMCW Radar = 0.000678
  Frequency sweep time: 339.68 µs
  Re-Trace time: 500 ms
- The integrated transmitters can transmit independently from each other:
  (Bluetooth low energy & FMCW Radar).

6.2 Single RF Source exemption limits

6.2.1 1 mw Blanket Exemption

The 1 mW Blanket Exemption of § 1.1307(b)(3)(i)(A) applies for single fixed, mobile, and portable RF sources with available maximum time-averaged power of no more than 1 mW, regardless of separation distance.
The 1 mW blanket exemption applies at separation distances less than 0.5 cm, including where there is no separation. This exemption shall not be used in conjunction with other exemption criteria other than those for multiple RF sources in paragraph § 1.1307(b)(3)(ii)(A).
The 1 mW exemption is independent of service type and covers the full range of 100 kHz to 100 GHz, but it shall not be used in conjunction with other exemption criteria or in devices with higher-power transmitters operating in the same time-averaging period. Exposure from such higher-power transmitters would invalidate the underlying assumption that exposure from the lower-power transmitter is the only contributor to SAR in the relevant volume of tissue.

6.2.2 MPE-based Exemption

General frequency and separation-distance dependent MPE-based effective radiated power (ERP) thresholds are in Table B.1 [Table 1 of § 1.1307(b)(1)(i)(C)] to support an exemption from further evaluation from 300 kHz through 100 GHz.

RF Source Frequency			**Minimum Distance**			**Threshold ERP**
f_L MHz		f_H MHz	$\lambda_L/2\pi$		$\lambda_H/2\pi$	W
0.3	-	1.34	159 m	-	35.6 m	1.920 R^2
1.34	-	30	35.6 m	-	1.6 m	3450 R^2/f^2
30	-	300	1.6 m	-	159 mm	3.83 R^2
300	-	1500	159 mm	-	31.8 mm	0.0128 R^2f
1500	-	100000	31.8 mm	-	0.5 mm	19.2 R^2
Subscripts L and H are low and high; λ is wavelength. From § 1.1307(b)(3)(i)(C), modified by adding Minimum Distance columns						

The table applies to any RF source (i.e., single fixed, mobile, and portable transmitters) and specifies power and distance criteria for each of the five frequency ranges used for the MPE limits. These criteria apply at separation distances from any part of the radiating structure of at least λ/2π. The thresholds are based on the general population MPE limits with a single perfect reflection, outside of the reactive near-field, and in the main beam of the radiator.
For mobile devices that are not exempt per Table B.1 [Table 1 of § 1.1307(b)(1)(i)(C)] at distances from 20 cm to 40 cm and in 0.3 GHz to 6 GHz, evaluation of compliance with the exposure limits in § 1.1310 is necessary if the ERP of the device is greater than ERP20cm in Formula (B.1) [repeated from § 2.1091(c)(1) and § 1.1307(b)(1)(i)(B)].

$$P_{th}\,(mW) = ERP_{20cm}\,(mW) = \begin{cases} 2040f & 0.3\,GHz \le f < 1.5\,GHz \\ 3060 & 1.5\,GHz \le f \le 6\,GHz \end{cases} \qquad \text{(B.1)}$$

If the ERP is not easily obtained, then the available maximum time-averaged power may be used (i.e., without consideration of ERP only if the physical dimensions of the radiating structure(s) do not exceed the electrical length of λ/4 or if the antenna gain is less than that of a half-wave dipole.
SAR-based exemptions are constant at separation distances between 20 cm and 40 cm to avoid discontinuities in the threshold when transitioning between SAR-based and MPE-based exemption criteria at 40 cm, considering the importance of reflections.

6.2.3 SAR-based Exemption

SAR-based thresholds are derived based on frequency, power, and separation distance of the RF source. The formula defines the thresholds in general for either available maximum time-averaged power or maximum time-averaged ERP, whichever is greater.
If the ERP of a device is not easily determined, such as for a portable device with a small form factor, the applicant may use the available maximum time-averaged power exclusively if the device antenna or radiating structure does not exceed an electrical length of λ/4.
As for devices with antennas of length greater than λ/4 where the gain is not well defined, but always less than that of a half-wave dipole (length λ/2), the available maximum time-averaged power generated by the device may be used in place of the maximum time-averaged ERP, where that value is not known.
The separation distance is the smallest distance from any part of the antenna or radiating structure for all persons, during operation at the applicable ERP. In the case of mobile or portable devices, the separation distance is from the outer housing of the device where it is closest to the antenna.
The SAR-based exemption formula of § 1.1307(b)(3)(i)(B), repeated here as Formula (B.2), applies for single fixed, mobile, and portable RF sources with available maximum time-averaged power or effective radiated power (ERP), whichever is greater, of less than or equal to the threshold P_{th} (mW).
This method shall only be used at separation distances from 0.5 cm to 40 cm and at frequencies from 0.3 GHz to 6 GHz (inclusive). P_{th} is given by Formula (B.2).

$$P_{th}\,(mW) = \begin{cases} ERP_{20cm}\,(\frac{d}{20cm})^{x} & d \le 20\ cm \\ ERP_{20cm} & 20\ cm < d < 40\ cm \end{cases} \qquad \text{(B.2)}$$

where

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

and f is in GHz, d is the separation distance (cm), and ERP_{20cm} is per Formula (B.1).

6.3 Multiple RF Source exemption limits

6.3.1 1-mW Test Exemption for Multiple Sources

The available maximum time-averaged power of each source is no more than 1 mW and there is a separation distance of two centimeters 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 is paragraph (b)(3)(i)(A) of this section. Medical implant devices may only use this exemption and that in paragraph (b)(3)(i)(A).

6.3.2 Simultaneous Transmission with both SAR-Based and MPE-Based exemption limits

Either SAR-based or MPE-based exemption may be considered for test exemption for fixed, mobile, or portable device exposure conditions; therefore, the contributions from each exemption in conjunction with the measured SAR (*Evaluated*$_k$ term) shall be used to determine exemption for simultaneous transmission according to Formula (C.1) [repeated from § 1.1307(b)(3)(ii)(B)].

$$\sum_{i=1}^{a} \frac{P_i}{P_{th,i}} + \sum_{j=1}^{b} \frac{ERP_j}{ERP_{th,i}} + \sum_{k=1}^{c} \frac{Evaluated_k}{Exposure\ Limit_k} \leq 1 \qquad (C.1)$$

a	number of fixed, mobile, or portable RF sources claiming exemption using the § 1.1307(b)(3)(i)(B) formula for P_{th}, including existing exempt transmitters and those being added.
b	number of fixed, mobile, or portable RF sources claiming exemption using the applicable § 1.1307(b)(3)(i)(C) Table 1 formula for Threshold ERP, including existing exempt transmitters and those being added.
c	number of existing fixed, mobile, or portable RF sources with known evaluation for the specified minimum distance
P_i	the available maximum time-averaged power or the ERP, whichever is greater, for fixed, mobile, or portable RF source i at a distance between 0.5 cm and 40 cm (inclusive).
$Pth,_i$	the exemption threshold power (P_{th}) according to the § 1.1307(b)(3)(i)(B) formula for fixed, mobile, or portable RF source i.
ERP_j	the available maximum time-averaged power or the ERP, whichever is greater, of fixed, mobile, or portable RF source j.
$ERP_{th,i}$	exemption threshold ERP for fixed, mobile, or portable RF source j, at a distance of at least λ/2π, according to the applicable § 1.1307(b)(3)(i)(C) Table 1 formula at the location in question.
$Evaluated_k$	the maximum reported SAR or MPE of fixed, mobile, or portable RF source k either in the device or at the transmitter site from an existing evaluation.
$Exposure\ Limit_k$	either the general population/uncontrolled maximum permissible exposure (MPE) or specific absorption rate (SAR) limit for each fixed, mobile, or portable sources, as applicable

The sum of the ratios of the applicable terms for SAR-based, MPE-based and measured SAR or MPE shall be less than 1, to determine simultaneous transmission exposure compliance.

6.4 Calculation

6.4.1 Calculation of single-frequency exposures

Single RF Sources Subject to Routine Environmental Evaluation

Limit: FCC §1.1307(b)(3)(i)(C), Table 1

Prediction Distance d in cm =>	**20**	TX frequ. band	Predictio n frequency .	Maximum Conducted Power during Transmissio n	Duty factor (lin.)	Duty factor (log.)	Average (temporal) power (log.)	Average (temporal) power (lin.)	Gain (log.)	Gain (log.)	Gain (lin.)	Minimum Distance	ERP Power	ERP Power limit at distance d & frequency f_i	Ratio to exposure reference level	Compl iance, if $ERP_i/ERP_{Thi} < 1$
		f_{Band}	f_i	P_{dBm}	-	-	P_{dBm}	$\mathbf{P_{mW}}$	g_{dBi}	g_{dBd}	$\mathbf{G_d}$	**R**	ERP_i	ERP_{Thi}	ERP_i/ERP_{Thi}	-
Radio technology	Band	MHz	MHz		-	dB	dBm	mW	dBi	dBd	-	m	mW	mW	-	-
Bluetooth LE	2.4 GHz ISM	2402 - 2480	2402.0	4.5	0.200	-7.0	-2.5	0.56	1.5	-0.6	0.86	0.02	0.486	768.000	0.000633	Pass
Radar	75 - 85 GHz	77000 - 81000	77000.0	-5.6*)	0.000678	-31.7	-39.0	0.000187	26.7	24.6	285.76	0.00	0.053	768.000	0.000069	Pass

*) The output power value was measured radiated. The declared antenna was subtracted from this value to get the conducted power.
Calculation:
Measured value (radiated): 21.1 dB EIRP
Conducted value: 21.1 dB EIRP – 26.7 dBi = -7.3 dB

Note: The value in the column "Maximum Conducted Power during Transmission" contains the maximum Tune-up tolerance, if applicable!

6.4.2 Calculation of multi-frequency exposures

Multi RF Sources Subject to Routine Environmental Evaluation (all MPE exempted)

Limit: FCC §1.1307(b)(3)(ii)(B)

Prediction Distance d in cm =>	**20**	TX frequ. band	Prediction frequency.	Maximum Conducted Power during Transmission	Duty factor (lin.)	Duty factor (log.)	Average (temporal) power (log.)	Average (temporal) power (lin.)	Gain (lin.)	ERP Power	ERP Power limit at distance d & frequency f_i	Ratio to exposure reference level	Sum of ERP_i/ ERP_{Thi}	Compliance, if Sum of ERP_i/ ERP_{Thi} < 1
		f_{Band}	f_i	P_{dBm}	-	-	P_{dBm}	**P_{mW}**	**G_d**	ERP_i	ERP_{Thi}	ERP_i/ ERP_{Thi}	-	-
Radio technology	Band	MHz	MHz		-	dB	dBm	mW	-	mW	mW	-	-	-
Bluetooth LE	2.4 GHz ISM	2402 - 2480	2402.0	4.5	0.200	-7.0	-2.5	0.56	0.86	0.486	768.000	0.000633	0.000703	Pass
Radar	75 - 85 GHz	77000 - 81000	77000.0	-5.6*)	0.000678	-31.7	-39.0	0.000187	285.76	0.053	768.000	0.000069		

*) The output power value was measured radiated. The declared antenna was subtracted from this value to get the conducted power.
Calculation:
Measured value (radiated): 21.1 dB EIRP
Conducted value: 21.1 dB EIRP – 26.7 dBi = -5.6 dB

**********END OF REPORT**********