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May 15, 2017

Page 1 of 19

Prüfbericht / *Test Report*

Nr. / No. 20351-94952-3 (Edition 3)

Applicant: Endress + Hauser GmbH + Co. KG
Type of equipment: Level Probing Radar
Type designation: FMR 6x
Order No.: N/A
Test standards: Industry Canada Radio Standards Specifications
RSS-GEN Issue 4, Section 3.2 (RF Exposure)
RSS-102 Issue 5, Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)

ICNIRP GUIDELINES FOR LIMITING EXPOSURE TO TIME-VARYING ELECTRIC AND MAGNETIC FIELDS (1Hz – 100 kHz)
Published in: HEALTH PHYSICS 99(6):818-836; 2010

CFR 47 Part 1, section 1.1307(b)(1)
OET Bulletin 65

Note:

The test data of this report is related only to the individual item which has been tested. This report shall not be reproduced except in full extent without the written approval of the testing laboratory.

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1 Description of the Equipment Under Test (EUT)

General data of EUT

Type designation ¹ :	FMR 6x
Variants covered by this report	
Serial number(s):	Prototype
Manufacturer:	Endress + Hauser GmbH + Co. KG
Type of equipment:	Level Probing Radar
Version:	As delivered
Additional parts/accessories:	N/A

Technical data of EUT

Application frequency range:	75 - 85 GHz								
Frequency range:									
Operating frequency:	79 - 83 GHz								
Type of modulation:	FMCW								
Number of RF-channels:	1								
Channel spacing:	N/A								
Designation of emissions ² :									
Type of antenna:	Integrated								
Size/length of antenna:	N/A								
Connection of antenna:	☐ detachable ☒ not detachable								
Type of power supply:	DC supply								
Specifications for power supply:	<table> <tr> <td>nominal voltage:</td><td>24 V</td></tr> <tr> <td>minimum voltage:</td><td>10 V</td></tr> <tr> <td>maximum voltage:</td><td>36 V</td></tr> <tr> <td>nominal frequency:</td><td>DC Hz</td></tr> </table>	nominal voltage:	24 V	minimum voltage:	10 V	maximum voltage:	36 V	nominal frequency:	DC Hz
nominal voltage:	24 V								
minimum voltage:	10 V								
maximum voltage:	36 V								
nominal frequency:	DC Hz								

¹ Type designation of the system if EUT consists of more than one part.

² Also known as "Class of Emission".

Test Sample	FMR 6x_26	FMR 6x_27	FMR 6x_29	FMR 6x_25	FMR 6x_28	FMR 6x_30
Model	FMR62	FMR62	FMR 62	FMR60	FMR60F	FMR67
Antenna	¾" Thread PEEK	PTFE plated, DN50	PTFE plated, DN80	PTFE Thread 1.5"	1.5" Thread, PEEK	Flange
Enclosure	Plastic	Plastic	Plastic	Plastic	Alu	Alu
Test Overview						
Bandwidth of Emission					X	
Fundamental Emission Limits (boresight)			X	X	X	X
Frequency Stability					X	
Antenna beamwidth			X	X	X	X
Antenna side lobe gain			X	X	X	X
Radiated emissions					X	
Conducted AC powerline emissions					X	
FCC ID	LCGFMR6XE	LCGFMR6XE	LCGFMR6XE	LCGFMR6XEF	LCGFMR6XEF	LCGFMR6XEF
IC ID	2519A-6E	2519A-6E	2519A-6E	2519A-6EF	2519A-6EF	2519A-6EF

2 Administrative Data

Application details

Applicant (full address):	Endress + Hauser GmbH + Co. KG Hauptstrasse 1, 79690 Maulburg / Germany
Contact person:	Ralf Reimelt
Order number:	N/A
Receipt of EUT:	06 April 2016
Date(s) of test:	19 April 2016
Note(s):	

Report details

Report number:	20351-94952-3
Edition:	3
Issue date:	2017-05-15

3 Identification of the Test Laboratory

Details of the Test Laboratory

Company name:	TÜV SÜD Product Service GmbH
Address:	Aeussere Fruehlingstrasse 45 D-94315 Straubing Germany
Laboratory accreditation:	DAkkS Registration No. D-PL-11321-11-01
FCC test site registration number	90926
Industry Canada test site registration:	3050A-2
Contact person:	Mr. Markus Biberger
	Phone: +49 9421 5522-0 Fax: +49 9421 5522-99

4 Summary

Summary of test results

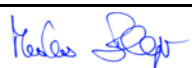
The tested sample complies with the requirements set forth in the

**Radio Standards Specifications
RSS-GEN Issue 4, Section 3.2 (RF Exposure)**

of Industry Canada (IC) and

**CFR 47 Part 1, section 1.1307(b)(1)
OET Bulletin 65.**

Die Prüfergebnisse beziehen sich ausschließlich auf das zur Prüfung vorgestellte Prüfmuster. Ohne schriftliche Genehmigung des Prüflabors darf der Prüfbericht auszugsweise nicht vervielfältigt werden. *The test results relate only to the individual item which has been tested. Without the written approval of the test laboratory this report may not be reproduced in extracts.*

Datum / Date	Geprüft von / Tested by	Freigabe durch / Checked by	Prüfergebnis / Test Result
2017-05-15	 Martin Steindl Responsible for testing	 Markus Bibberger Reviewer	☒ Erfüllt / Passed ☐ Nicht erfüllt / Not passed

5 Operation Mode and Configuration of EUT

Operation Mode(s)

Normal operation, after power up

Configuration(s) of EUT

Test samples mounted in test tank for all tests

List of ports and cables

Port	Description	Classification ³	Cable type	Cable length
1	DC input & measured signal	dc power	Unshielded	2 m
		signal/control port	Unshielded	

List of devices connected to EUT

Item	Description	Type Designation	Serial no. or ID	Manufacturer
1	Laboratory power Supply	EA-PS-3150-04 B	2275	EA

List of support devices

Item	Description	Type Designation	Serial no. or ID	Manufacturer
1	None			

³ Ports shall be classified as ac power, dc power or signal/control port

6 RF Exposure Limits

6.1 RF Exposure Limits according to RS-102, Issue 5

**Table 4: RF Field Strength Limits for Devices Used by the General Public
(Uncontrolled Environment)**

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m ²)	Reference Period (minutes)
0.003-10 ²¹	83	90	-	Instantaneous*
0.1-10	-	0.73/ f	-	6**
1.1-10	87/ $f^{0.5}$	-	-	6**
10-20	27.46	0.0728	2	6
20-48	58.07/ $f^{0.25}$	0.1540/ $f^{0.25}$	8.944/ $f^{0.5}$	6
48-300	22.06	0.05852	1.291	6
300-6000	3.142 $f^{0.3417}$	0.008335 $f^{0.3417}$	0.02619 $f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	616000/ $f^{1.2}$
150000-300000	0.158 $f^{0.5}$	4.21 x 10 ⁻⁴ $f^{0.5}$	6.67 x 10 ⁻⁵ f	616000/ $f^{1.2}$
Note: f is frequency in MHz. *Based on nerve stimulation (NS). ** Based on specific absorption rate (SAR).				

Table 6: RF Field Strength Limits for Controlled Use Devices (Controlled Environment)

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m ²)	Reference Period (minutes)
0.003-10 ²³	170	180	-	Instantaneous*
1-10	-	1.6/ f	-	6**
1.29-10	193/ $f^{0.5}$	-	-	6**
10-20	61.4	0.163	10	6
20-48	129.8/ $f^{0.25}$	0.3444/ $f^{0.25}$	44.72/ $f^{0.5}$	6
48-100	49.33	0.1309	6.455	6
100-6000	15.60 $f^{0.25}$	0.04138 $f^{0.25}$	0.6455 $f^{0.5}$	6
6000-15000	137	0.364	50	6
15000-150000	137	0.364	50	616000/ $f^{1.2}$
150000-300000	0.354 $f^{0.5}$	9.40 x 10 ⁻⁴ $f^{0.5}$	3.33 x 10 ⁻⁴ f	616000/ $f^{1.2}$
Note: f is frequency in MHz. *Based on nerve stimulation (NS). ** Based on specific absorption rate (SAR).				

6.2 RF Exposure Limits according to Directive 2004/40/EG

Table 2

Action values (Article 3(2)) (unperturbed rms values)

Frequency range	Electric field strength, E (V/m)	Magnetic field strength, H (A/m)	Magnetic flux density, B (μT)	Equivalent plane wave power density, S_{eq} (W/m ²)	Contact current, I_c (mA)	Limb induced current, I_l (mA)
0 — 1 Hz	—	$1,63 \times 10^5$	2×10^5	—	1,0	—
1 — 8 Hz	20 000	$1,63 \times 10^5 / f^2$	$2 \times 10^5 / f^2$	—	1,0	—
8 — 25 Hz	20 000	$2 \times 10^4 / f$	$2,5 \times 10^4 / f$	—	1,0	—
0,025 — 0,82 kHz	$500 / f$	$20 / f$	$25 / f$	—	1,0	—
0,82 — 2,5 kHz	610	24,4	30,7	—	1,0	—
2,5 — 65 kHz	610	24,4	30,7	—	$0,4 f$	—
65 — 100 kHz	610	$1\,600 / f$	$2\,000 / f$	—	$0,4 f$	—
0,1 — 1 MHz	610	$1,6 / f$	$2 / f$	—	40	—
1 — 10 MHz	$610 / f$	$1,6 / f$	$2 / f$	—	40	—
10 — 110 MHz	61	0,16	0,2	10	40	100
110 — 400 MHz	61	0,16	0,2	10	—	—
400 — 2 000 MHz	$3 f^{1/4}$	$0,008 f^{1/4}$	$0,01 f^{1/4}$	$f / 40$	—	—
2 — 300 GHz	137	0,36	0,45	50	—	—

7 Test Results

IC RSS-GEN Issue 4			
Section(s)	Test	Page	Result
3.2	Exposure of Humans to RF Fields	9	Exempted from SAR and RF evaluation

7.1 Exposure of Humans to RF Fields

Rules and specifications:	IC RSS-Gen Issue 4, section 3.2
Guide:	IC RSS-102 Issue 5, section 2.5

Exposure of Humans to RF Fields	Applicable	Declared by applicant	Measured	Exemption																				
The antenna is																								
☐ detachable																								
The conducted output power (CP in watts) is measured at the antenna connector: $CP = \dots\dots\dots \text{ W}$ The effective isotropic radiated power (EIRP in watts) is calculated using ☐ the numerical antenna gain: $G = \dots\dots\dots$ $EIRP = G \cdot CP \Rightarrow EIRP = \dots\dots\dots \text{ W}$ ☐ the field strength⁴ in V/m: $FS = \dots\dots\dots \text{ V/m}$ $EIRP = \frac{(FS \cdot D)^2}{30} \Rightarrow EIRP = \dots\dots\dots \text{ W}$ with: Distance between the antennas in m: $D = \dots\dots\dots \text{ m}$		☐	☐	☐																				
☒ not detachable																								
A field strength measurement is used to determine the effective isotropic radiated power (EIRP in watts) given by: <table border="1"> <thead> <tr> <th>Variant</th> <th>Antenna</th> <th>EIRP (dBm)</th> <th>EIRP (W)</th> </tr> </thead> <tbody> <tr> <td>FMR 6x_25</td> <td>PTFE Thread 1.5</td> <td>26.43</td> <td>0.440</td> </tr> <tr> <td>FMR 6x_28</td> <td>1.4 Thread PEEK</td> <td>26.82</td> <td>0.481</td> </tr> <tr> <td>FMR 6x_29</td> <td>PTFE plated, DN 80</td> <td>31.25</td> <td>1.334</td> </tr> <tr> <td>FMR 6x_30</td> <td>Flange</td> <td>31.25</td> <td>1.334</td> </tr> </tbody> </table>	Variant	Antenna	EIRP (dBm)	EIRP (W)	FMR 6x_25	PTFE Thread 1.5	26.43	0.440	FMR 6x_28	1.4 Thread PEEK	26.82	0.481	FMR 6x_29	PTFE plated, DN 80	31.25	1.334	FMR 6x_30	Flange	31.25	1.334			☒	☒
Variant	Antenna	EIRP (dBm)	EIRP (W)																					
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FMR 6x_28	1.4 Thread PEEK	26.82	0.481																					
FMR 6x_29	PTFE plated, DN 80	31.25	1.334																					
FMR 6x_30	Flange	31.25	1.334																					
Selection of output power																								
The output power TP is the higher of the conducted or effective isotropic radiated power (e.i.r.p.): $TP = 1.334 \text{ W}$																								

Exposure of Humans to RF Fields (continued)	Applicable	Declared by applicant	Measured	Exemption
Separation distance between the user and the transmitting device is				
☐ less than or equal to 20 cm		☒		
☒ greater than 20 cm				
Transmitting device is				
☐ in the vicinity of the human head		☐		
☐ body-worn				

SAR evaluation										
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. For controlled use devices where the 8 W/kg for 1 gram of tissue applies, the exemption limits for routine evaluation in the table are multiplied by a factor of 5. For limb-worn devices where the 10 gram value applies, the exemption limits for routine evaluation in the table are multiplied by a factor of 2.5. If the operating frequency of the device is between two frequencies located in the table, 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 implants 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.										
Frequency (MHz)	Exemption limits (mW) ⁵ 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 ⁶	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
Carrier frequency:	f = MHz									
Distance:	d = mm									
Transmitter output power:	TP = mW									
Limit:	TP_{limit} = mW									
										☒

⁵ The exemption limit in the table are based on measurements and simulations on half-wave dipole antennas at separation distances of 5 mm to 25 mm from a flat phantom, providing a SAR value of approximately 0.4 W/kg for 1 g of tissue. For low frequencies (300 MHz to 835 MHz), the exemption limits are derived from a linear fit. For high frequencies (1900 MHz and above), the exemption limits are derived from a third order polynomial fit.

⁶ Transmitters operating between 3 kHz and 10 MHz, meeting the exemption from routine SAR evaluation, shall demonstrate compliance to the instantaneous limits in IC RSS-102, issue 5, section 4.

7.2 RF exposure requirement

Rules and specifications:	CFR 47 Part 1, section 1.1307(b)(1)				
Guide:	OET Bulletin 65, Edition 97-01				
Limits:	Limits for general population / uncontrolled exposure				
	Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm ²)	Averaging Time (minutes)
	0.3 - 1.34	614	1.63	(100)*	30
	1.34 - 30	824 / f	2.19 / f	(180 / f ²)*	30
	30 - 300	27.5	0.073	0.2	30
	300 - 1500	---	---	f/1500	30
	1500 - 100000	---	---	1.0	30
	f = frequency in MHz				
	* Plane-wave equivalent power density				

Spectral power density		Declared by applicant	Measured
Prediction ⁸ :	$S = P G / 4 \pi R^2$		
Where:	S = Power density P = Power input of antenna G = Power gain of the antenna relativ to an isotropic radiator R = Distance to the center of radiation of the antenna		
Maximum output power:	P = 1.334 W e.i.r.p.		☒
Antenna gain:	G = <i>Not applicable</i>	☐	
Prediction distance:	R = 20 cm		
Power density at 20 cm:	S = 0.265 mW/cm²		
Limit	S_{lim} = 1.0 mW/cm²		

Test Result:	Test passed
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⁸ MPE Prediction of MPE according to equation from page 19 of OET Bulletin 65, Ed. 97-01

8 Referenced Regulations

All tests were performed with reference to the following regulations and standards:

☒	CFR 47 Part 2	Code of Federal Regulations Part 2 (Frequency allocation and radio treaty matters; General rules and regulations) of the Federal Communication Commission (FCC)	October 1, 2014
☒	CFR 47 Part 15	Code of Federal Regulations Part 15 (Radio Frequency Devices) of the Federal Communication Commission (FCC)	October 1, 2014
☐	ANSI C63.4	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz	June 13, 2014 (published on June 20, 2014)
☒	ANSI C63.10	American national Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices	June 27, 2013 (published on September 13, 2013)
☒	RSS-Gen	Radio Standards Specification RSS-Gen Issue 4 containing General Requirements for Compliance of Radio Apparatus, published by Industry Canada	November 2014
☒	RSS-210	Radio Standards Specification RSS-210 Issue 8 for Low Power Licence-Exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment, published by Industry Canada	December 2010
☐	RSS-310	Radio Standards Specification RSS-310 Issue 3 for Low-power Licence-exempt Radiocommunication Devices (All Frequency Bands): Category II Equipment, published by Industry Canada	December 2010
☒	RSS-102	Radio Standards Specification RSS-102 Issue 5: Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands), published by Industry Canada	March 2015
☐	ICES-003	Interference-Causing Equipment Standard ICES-003 Issue 6: Information Technology Equipment (Including Digital Apparatus) – Limits and methods of measurement, published by Industry Canada	January 2016
☒	CISPR 22	Third Edition of the International Special Committee on Radio Interference (CISPR), Pub. 22, "Information Technology Equipment – Radio Disturbance Characteristics – Limits and Methods of Measurement"	1997

☐	CAN/CSA CISPR 22-10	Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement (Adopted IEC CISPR 22:2008, sixth edition, 2008-09)	2010
☒	TRC-43	Designation of Emissions, Class of Station and Na- ture of Service, published by Industry Canada	November 2012

9 Revision History

Revision History			
<i>Edition</i>	<i>Date</i>	<i>Issued by</i>	<i>Modifications</i>
1	18 Nov 2016	J. Roidt	First Edition
2	2017-03-27	M. Steindl	Information about board of management and technical manager and updated. Inserted table of tested samples. Technical update of summary page. Re-evaluation of RF exposure.
3	2017-05-15	M. Steindl (lc)	Added estimation for human exposure to electromagnetic fields acc. to OET Bulletin 65.