

May 15, 2017

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Prüfbericht / Test Report

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

Applicant: Type of equipment:	Endress + Hauser GmbH + Co. KG 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.

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

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Description of the Equipment Under Test (EUT) 1

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	imes not detachable
Type of power supply:	DC supply	
Specifications for power supply:	nominal voltage: minimum voltage: maximum voltage:	24 V 10 V 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 Samp- le	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 Over- view						
Bandwidth of Emission					х	
Fundamental Emission Limits (boresight)			x	X	X	x
Frequency Stability					х	
Antenna beamwidth			x	х	х	x
Antenna side lobe gain			x	х	х	x
Radiated emissions					х	
Conducted AC powerline emissions					х	
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		
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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
	Skindl Martin	KG Point	· ·
2017-05-15	Jana Martin	Tadas Stat	Erfüllt / Passed
	Martin Steindl Responsible for testing	Markus Biberger Reviewer	□ 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 o	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 o	of devices connected to EUT			
ltem	Description	Type Designation	Serial no. or ID	Manufacturer
1	Laboratory power Supply	EA-PS-3150-04 B	2275	EA

List of sup	port devices			
<i>Item Desc</i> 1 None	pription	Type Designation	Serial no. or ID	Manufacturer

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



RF Exposure Limits 6

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

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	$0.158 f^{0.5}$	$4.21 \ge 10^{-4} f^{0.5}$	6.67 x 10 ⁻⁵ f	$616000/f^{1.2}$	
Note: <i>f</i> is frequency in MHz.					
*Based on nerve stimulation (NS).					
** Based on specific absorption rate (SAR).					

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

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	$0.354 f^{0.5}$	$9.40 \ge 10^{-4} f^{0.5}$	$3.33 \ge 10^{-4} f$	$616000/f^{1.2}$
Note: f is frequency	in MHz.			

*Based on nerve stimulation (NS). ** Based on specific absorption rate (SAR).

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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 — 1Hz	_	1,63x105	2x105	_	1,0	_
1 — 8 Hz	20 000	1,63x105/f2	2x105/f2	_	1,0	_
8 — 25 Hz	20 000	2x104/f	2,5x104/f	—	1,0	—
0,025 — 0,82kHz	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	3f ^{is}	0,008f ⁱ ∕	0,01f∞	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 eval- uation						



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	o RF Fields		Applicable	Declared by applicant	Measured	Exemption
The antenna is							
detachable							
The conducted ou	tput power (CP in watts) is r	neasured at the anten	na connector:				
	<i>CP</i> =	W					
The effective isotr	opic radiated power (EIRP in	n watts) is calculated u	sing				
the nui	merical antenna gain:	<i>G</i> =					
	$EIRP = G \cdot CP$	$P \Rightarrow EIRP = \dots$	W				
the fiel	d strength ⁴ in V/m:	<i>FS</i> =	V/m				
	$EIRP = \frac{(FS \cdot D)^2}{30} =$	\Rightarrow EIRP =	w				
with:							
Distan	ce between the antennas in	m: <i>D</i> =	m				
Not detachable							
A field strength me power (EIRP in wa	easurement is used to deter atts) given by:	mine the effective isotr	ropic radiated				
Variant	Antenna	EIRP (dBm)	EIRP (W)				
FMR 6x_25	PTFE Thread 1.5	26.43	0.440			\square	
FMR 6x_28	1.4 Thread PEEK	26.82	0.481			\square	
FMR 6x_29	PTFE plated, DN 80	31.25	1.334			\square	
FMR 6x_30	Flange	31.25	1.334			\square	
Selection of output powe	r						
The output power power (e.i.r.p.):	opic radiated						
	<i>TP</i> = 1.33 4	I W					



Exposure of Humans to	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		\boxtimes		
Transmitting device is		•	·		•
in the vicinity of the human head	🗌 body-worn				

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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		
	VI	-	-	N	2	က	က	4	4	λĭ		
≤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 fre	equency	<i>'</i> :	f	=		. MHz						
Distance:	e: d			=		. mm						
Transmitt	itter output power: TP			=		. mW						
Limit:			TP _{limit}	=		. mW						\boxtimes

⁵ The excemption limit in the table are based on measurements and simulations on half-wave dipole antennas at separaton 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 alinear fit. For high frequencies (1900 MHz and above), the exemption limits are derived from athird 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.

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Exposure of Humans to RF Fields (continued)	Applicable	Declared by applicant	Measured	Exemption
RF exposure evaluation				
RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates as follows:				
below 20 MHz ⁷ and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1 W (adjusted for tune-up tolerance).				
between 3 kHz and 10 MHz exposure limits apply as following:				
☐ In a uncontrolled environment the basic restriction for the instantaneous internal electric field strength is equal to or less than 2.7 · 10-4 f V/m _{rms} at any part of the body where f is in Hz. The instantaneous RF field strength is equal or less than 83 V/m _{rms} and equal or less than 90 A/m _{rms} .				
☐ In a controlled environment the basic restriction for the instantaneous internal electric field strength is equal to or less than 1.35 · 10-4 <i>f</i> V/m _{rms} at any part of the body where <i>f</i> is in Hz. The instantaneous RF field strength is equal or less than 170 V/m _{rms} and equal or less than 180 A/m _{rms} .				
at or above 20 MHz and below 48 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $4,49/t^{0.5}$ W (adjusted for tune-up tolerance, where <i>f</i> is in MHz.				
at or above 48 MHz and below 300 MHz and the source-based, time-averaged maxi- mum e.i.r.p. of the device is equal to or less than 0.6 W (adjusted for tune-up toler- ance).				
at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $1.31 \cdot 10^{-2} f^{0.6834}$ W (adjusted for tune-up tolerance), where <i>f</i> is in MHz.				
at or above 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the de- vice is equal to or less than 5 W (adjusted for tune-up tolerance).	\boxtimes		\boxtimes	
In these cases, the information contained in the RF exposure technical brief may be lim- ited to information that demonstrates how the e.i.r.p. was derived.				
Carrier frequency: f = 79 GHz – 83 GHz				
Transmitter output power: TP = 1.334 W				
Limit: $TP_{limit} = 5 W$				\boxtimes

⁷ Transmitters operating between 3 kHz and 10 MHz, meeting the exemption from routine RF Exposure evaluation, shall demostrate compilance tot he instanteneous limits in IC RSS-102, issue 5, section 4.



7.2 RF exposure requirement

Rules and specifications:	CFR 47 Part	CFR 47 Part 1, section 1.1307(b)(1)								
Guide:	OET Bulletin	OET Bulletin 65, Edition 97-01								
Limits:	Limits for ger	neral population /	uncontrolled e	xposure						
	Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Den- sity (S) (mW/cm²)	Averaging Time (minutes)					
	0.3 - 1.34	614	1.63	(100)*	30					
	1.34 - 30	824 / f	2.19 / f	(180 / f²)*	30					
	30 - 300	27.5	0.073	0.2	30					
	300 - 1500			f/1500	30					
	1500 - 100000			1.0	30					
	f = frequency * Plane-wave	n MHz equivalent powe	er density							

	ę	Spectral power density	Declared by applicant	Measured
Prediction ⁸ :	S	$= PG/4\pi R^{2}$		
Where:	S	= Power density		
	Р	 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:	Ρ	= 1.334 W e.i.r.p.		\boxtimes
Antenna gain:	G	= Not applicable		
Prediction distance:	R	= 20 cm		
Power density at 20 cm:	S	= 0.265 mW/cm ²		
Limit	Slim	= 1.0 mW/cm ²		

Test Result:

Test passed

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 allo- cation and radio treaty matters; General rules and regulations) of the Federal Communication Commis- sion (FCC)	October 1, 2014
CFR 47 Part 15	Code of Federal Regulations Part 15 (Radio Fre- quency Devices) of the Federal Communication Commission (FCC)	October 1, 2014
ANSI C63.4	American National Standard for Methods of Meas- urement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz	June 13, 2014 (pub- lished on June 20, 2014)
ANSI C63.10	American national Standard of Procedures for Compilance Testing of Unlicensed Wireless Devices	June 27, 2013 (pub- lished on September 13, 2013)
RSS-Gen	Radio Standards Specification RSS-Gen Issue 4 containing General Requirements for Compilance 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 Equip- ment, 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 (Includ- ing Digital Apparatus) – Limits and methods of meas- urement, 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 Charac- teristics – Limits and Methods of Measurement"	1997

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	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
\boxtimes	TRC-43	Designation of Emissions, Class of Station and Na- ture of Service, published by Industry Canada	November 2012



9 Revision History

Revision History			
Edition	Date	lssued by	Modifications
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.