

RF-EXPOSURE REPORT FCC 47 CFR Part 2.1091 Maximum permissible exposure	
Report Reference No	G0M-2311-2314-TFC091MP-V03
Testing Laboratory	Eurofins Product Service GmbH
Address	Storkower Str. 38c 15526 Reichenwalde Germany
Accreditation	 A2LA Accredited Testing Laboratory, Certificate No.: 1983.01 FCC Test Firm Designation Number: DE0008
Applicant	Kamstrup A/S
Address	Industrivej 28 8660 Skanderborg DENMARK
Test Specification	According to FCC rules
Standard	FCC 47 CFR 2.1091
Non-Standard Test Method	None
Equipment under Test (EUT):	
Product Description	Ultrasonic water meter
Model(s)	KWM4220
Additional Model(s)	None
Brand Name(s)	Kamstrup
Hardware Version(s)	Type number: 02E02G1FR8UB Assembly: 6202-006-06 RF PCB BOM: 55502066, rev. C4 Flow PCB BOM: 55502116, rev. B3
Software Version(s)	RF: 50981789 rev. C Meter: 50981812 rev. E Flow: 50981829 rev. A
FCC-ID	OUY-KWM4220
Test Result	PASSED

Possible test case verdicts:		
required by standard but not tested	N/T	
not required by standard	N/R	
test object does meet the requirement	P(PASS)	
test object does not meet the requirement	F(FAIL)	
Testing:		
Test Lab Temperature	20 °C - 30 °C	
Test Lab Humidity	25 % - 55 %	
Date of performance	2024-06-17	
Date of receipt of test item	2024-01-09	
Report:		
Compiled by	Burkhard Pudell	
Tested by (+ signature) (Responsible for Test)	Burkhard Pudell	
Approved by (+ signature) (Senior Radio Expert)	Radwan Jaafar	
Date of Issue	2024-06-25	
Total number of pages	17	
General Remarks:		
The test results presented in this report relate only to the object tested. The results contained in this report reflect the results for this particular model and serial number. It is the responsibility of the manufacturer to ensure that all production models meet the intent of the requirements detailed within this report. This report shall not be reproduced, except in full, without the written approval of the Issuing testing laboratory.		
Additional Comments:		
None		

VERSION HISTORY

Version History			
Version	Issue Date	Remarks	Revised By
01	2024-05-06	Initial Release	--
02	2024-06-17	Replaced document: G0M-2311-2314-TFC091MP-V01 Replaced by: G0M-2311-2314-TFC091MP-V02 Changes: Update antenna gain and re-calculation	St. Liebich
03	2024-06-25	Replaced document: G0M-2311-2314-TFC091MP-V02 Replaced by: G0M-2311-2314-TFC091MP-V03 Changes: Update of Reference Documents	St. Liebich

ADDITIONAL VARIANTS

Additional Variants (not tested and not evaluated variants)		
Not-tested Variant	Description	
1	Product Type Description	Ultrasonic water meter
	Model name	KWM4220
	Brand name	Kamstrup
	Hardware Version	Type number: 02E02G1FR8FM Assembly: 6202-006-06 RF PCB BOM: 55502066, rev. C4 Flow PCB BOM: 55502116, rev. B3
	Software Version	RF: 50981789 rev. C Meter: 50981812 rev. E Flow: 50981829 rev. A
2	Product Type Description	Ultrasonic water meter
	Model name	KWM4220
	Brand name	Kamstrup
	Hardware Version	Type number: 02E02G1GA8UB Assembly: 6202-006-07 RF PCB BOM: 55502066, rev. C4 Flow PCB BOM: 55502116, rev. B3
	Software Version	RF: 50981789 rev. C Meter: 50981812 rev. E Flow: 50981829 rev. A
3	Product Type Description	Ultrasonic water meter
	Model name	KWM4220
	Brand name	Kamstrup
	Hardware Version	Type number: 02E02G1GA8FM Assembly: 6202-006-07 RF PCB BOM: 55502066, rev. C4 Flow PCB BOM: 55502116, rev. B3
	Software Version	RF: 50981789 rev. C Meter: 50981812 rev. E Flow: 50981829 rev. A
4	Product Type Description	Ultrasonic water meter
	Model name	KWM4220
	Brand name	Kamstrup
	Hardware Version	Type number: 02E02G1GJ8UB Assembly: 6202-006-08 RF PCB BOM: 55502066, rev. C4 Flow PCB BOM: 55502116, rev. B3
	Software Version	RF: 50981789 rev. C Meter: 50981812 rev. E Flow: 50981829 rev. A

5	Product Type Description	Ultrasonic water meter
	Model name	KWM4220
	Brand name	Kamstrup
	Hardware Version	Type number: 02E02G1GJ8FM Assembly: 6202-006-08 RF PCB BOM: 55502066, rev. C4 Flow PCB BOM: 55502116, rev. B3
	Software Version	RF: 50981789 rev. C Meter: 50981812 rev. E Flow: 50981829 rev. A
6	Product Type Description	Ultrasonic water meter
	Model name	KWM4220
	Brand name	Kamstrup
	Hardware Version	Type number: 02E02G1GS8UB Assembly: 6202-006-09 RF PCB BOM: 55502066, rev. C4 Flow PCB BOM: 55502116, rev. B3
	Software Version	RF: 50981789 rev. C Meter: 50981812 rev. E Flow: 50981829 rev. A
7	Product Type Description	Ultrasonic water meter
	Model name	KWM4220
	Brand name	Kamstrup
	Hardware Version	Type number: 02E02G1GS8FM Assembly: 6202-006-09 RF PCB BOM: 55502066, rev. C4 Flow PCB BOM: 55502116, rev. B3
	Software Version	RF: 50981789 rev. C Meter: 50981812 rev. E Flow: 50981829 rev. A

ABBREVIATIONS AND ACRONYMS

Acronyms	
Acronym	Description
EIRP	Equivalent Isotropic Radiated Power
EUT	Equipment Under Test
MPE	Maximum Permissible Exposure

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1 Equipment (Test Item) Under Test

Description	Ultrasonic water meter		
Model	KWM4220		
Additional Model(s)	None		
Brand Name(s)	Kamstrup		
Sample Identification	EUT #	Sample-ID	Serial Number
	EUT 1	38837	Prototyp
Hardware Version(s)	Type number: 02E02G1FR8UB Assembly: 6202-006-06 RF PCB BOM: 55502066, rev. C4 Flow PCB BOM: 55502116, rev. B3		
Software Version(s)	RF: 50981789 rev. C Meter: 50981812 rev. E Flow: 50981829 rev. A		
FCC ID	OUY-KWM4220		
Equipment type	End Product		
Environment	Workers		

1.1 Reference Documents

Document Type	Document No.	Issued by	Date
Test-Report	G0M-2201-1256-TFC247DT-V01	Eurofins Product Service GmbH	2022-05-10
Test-Report	G0M-2201-1256-TFC90PMR-V01	Eurofins Product Service GmbH	2022-05-11
Test-Report	G0M-2311-2314-TFC247DT-V03	Eurofins Product Service GmbH	2024-06-25
Test-Report	G0M-2311-2314-TFC090PMR-V02	Eurofins Product Service GmbH	2024-06-25

1.2 Power density radiation sources

Helix antenna						
Mode	Operating Frequency [MHz]	Maximum conducted power [dBm]	Maximum radiated power [dBm EIRP]	Maximum duty cycle [%]	Maximum antenna gain [dBi]	Maximum antenna diameter [cm]
SRD 915 MHz	912.5	13.008	11.008	100	-2	N/A
PMR 450 MHz	450	29.91	27.91	100	-2	N/A
Comment: -						

Wall antenna						
Mode	Operating Frequency [MHz]	Maximum conducted power [dBm]	Maximum radiated power [dBm EIRP]	Maximum duty cycle [%]	Maximum antenna gain [dBi]	Maximum antenna diameter [cm]
SRD 915 MHz	912.5	13.008	12.008	100	-1	N/A
PMR 450 MHz	450	29.91	30.91	100	1	N/A
Comment: -						

Pit antenna						
Mode	Operating Frequency [MHz]	Maximum conducted power [dBm]	Maximum radiated power [dBm EIRP]	Maximum duty cycle [%]	Maximum antenna gain [dBi]	Maximum antenna diameter [cm]
SRD 915 MHz	912.5	13.008	11.008	100	-2	N/A
PMR 450 MHz	450	29.91	20.91	100	-9	N/A
Comment: -						

1.3 Field strength radiation sources

None

1.4 Concurrent Sources

No concurrent radiation sources

2 Result Summary

FCC MPE Evaluation - Single radiation sources – Helix anenna					
Product Standard Reference	Requirement	Reference Method	Mode	Distance [m]	Verdict
47 CFR 2.1091	Maximum permissible exposure	FCC KDB 447498	SRD 915 MHz	0.20	PASS
47 CFR 2.1091	Maximum permissible exposure	FCC KDB 447498	PMR 450 MHz	0.20	PASS
Comment: -					

FCC MPE Evaluation - Single radiation sources – Wall anenna					
Product Standard Reference	Requirement	Reference Method	Mode	Distance [m]	Verdict
47 CFR 2.1091	Maximum permissible exposure	FCC KDB 447498	SRD 915 MHz	0.20	PASS
47 CFR 2.1091	Maximum permissible exposure	FCC KDB 447498	PMR 450 MHz	0.20	PASS
Comment: -					

FCC MPE Evaluation - Single radiation sources – Pit anenna					
Product Standard Reference	Requirement	Reference Method	Mode	Distance [m]	Verdict
47 CFR 2.1091	Maximum permissible exposure	FCC KDB 447498	SRD 915 MHz	0.20	PASS
47 CFR 2.1091	Maximum permissible exposure	FCC KDB 447498	PMR 450 MHz	0.20	PASS
Comment: -					

3 RF-Exposure classification

RF-Exposure Categories	
Fixed	A fixed device is defined as a device physically secured at one fixed location and cannot be easily re-located.
Mobile	A mobile device is defined as a transmitting device designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimeters is normally maintained between the transmitter's radiating structure(s) and the body of the user or nearby persons.
Portable	A portable device is defined as a transmitting device designed to be used so that the radiating structure(s) of the device is/are within 20 centimeters of the body of the user.

RF-Exposure Categories	
Occupational / Controlled	Limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.
General population / Uncontrolled	Exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or cannot exercise control over their exposure.

4 RF-Exposure limits

FCC Limits – General Population / Uncontrolled Exposure				
Frequency range [MHz]	Electric field strength [V/M]	Magnetic field strength [A/M]	Power density [W/m ²]	Averaging time [min]
0.3 – 1.34	614	1.63	1000	30
1.34 – 30	824/f	2.19/f	1800/f ²	30
30 – 300	27.5	0.073	2	30
300 – 1500	-	-	f/150	30
1500 – 100000	-	-	10.0	30

FCC Limits – Occupational / Controlled Exposure				
Frequency range [MHz]	Electric field strength [V/M]	Magnetic field strength [A/M]	Power density [W/m ²]	Averaging time [min]
0.3 – 3.0	614	1.63	1000	6
3.0 – 30	1842/f	4.89/f	9000/f ²	6
30 – 300	61.4	0.163	10.0	6
300 – 1500	-	-	f/30	6
1500 – 100000	-	-	50	6

5 RF-Exposure Evaluation

Evaluation Relations
$\lambda[m] = \frac{c \left[\frac{m}{s} \right]}{f[Hz]} ; R_{FF}[m] \geq \frac{2 \cdot D[m]^2}{\lambda[m]}$ $S[W/m^2] = \frac{P_{E.I.R.P.}[W]}{4\pi R[m]^2} ; R[m] = \sqrt{\frac{P_{E.I.R.P.}[W]}{4\pi S[W/m^2]}}$ $DCC [dB] = 10 \cdot \log_{10} \left(\frac{DC[\%]}{100} \right)$ $\sum_{i=1}^N \frac{S_i \left[\frac{W}{m^2} \right]}{S_{Li} \left[\frac{W}{m^2} \right]} + \sum_{j=1}^M \left(\frac{E_j \left[\frac{V}{m} \right]}{E_{Lj} \left[\frac{V}{m} \right]} \right)^2 + \sum_{k=1}^O \left(\frac{H_k \left[\frac{A}{m} \right]}{H_{Lk} \left[\frac{A}{m} \right]} \right)^2 < 1$

Evaluation Procedure
<u>Standalone operation evaluation:</u> For each radio and frequency band the worst case transmission mode with the highest peak conducted or radiated power is evaluated at the frequency that results in the most restrictive rf-exposure limit. From the peak power values, antenna gains and duty cycles taken from the reference documents, the source average radiated power values are calculated. From the average radiated power the power densities at antenna far-field distance is calculated. The distance from the radiation source for compliance power density is calculated. If the separation distance is lower than the far-field distance, the far-field distance is given as compliance separation distance because the plane wave power density assessment is only valid in the far-field of the radiation source. For radiation sources for which the average electric and magnetic fields are measured using field probes, the measured field strength values are compared to the reference limits. For those sources no calculations are performed. Compliance with the reference values is determined with the near field measurements. <u>Concurrent operation evaluation:</u> First the evaluation distance is set to an appropriate value. For all radiation sources for which power densities are calculated, the power densities at the evaluation distance are calculated and for all other sources the electric or magnetic field strengths are measured using field probes. Finally the ratios of the power densities and/or field strength values and the corresponding limits are calculated and summed and the sum is compared to the maximum of 1.

6 Single Source Evaluation Results - FCC

SRD 915 MHz - Helix antenna	
Transmission Mode	
Transmission Frequency (f) [MHz]	912.5
Antenna far-field distance	
Maximum antenna diameter (D) [m]	N/A
Transmission wavelength (λ) [m]	N/A
Antenna far-field distance (R_{FF}) [m]	N/A
Source average power	
Peak radiated power (PR) [dBm EIRP]	11.008
Maximum transmission duty cycle (DC)	1.00
Duty cycle correction (DCC) [dB]	0.00
Average radiated power (PRAVG) [dBm EIRP]	11.01
Power density	
Compliance power density limit [W/m ²]	30.417
Power density (S) @ Antenna far-field distance [W/m ²]	N/A
Power density (S) @ 0.20 m [W/m ²]	0.025
Power density ratio @ 0.20 m	0.00
Distance for compliance power density (S=SL) [m]	0.006
Compliance	
Verdict	PASS
Comment: --	

PMR 450 MHz - Helix antenna	
Transmission Mode	
Transmission Frequency (f) [MHz]	450
Antenna far-field distance	
Maximum antenna diameter (D) [m]	N/A
Transmission wavelength (λ) [m]	N/A
Antenna far-field distance (R_{FF}) [m]	N/A
Source average power	
Peak radiated power (PR) [dBm EIRP]	27.91
Maximum transmission duty cycle (DC)	1.00
Duty cycle correction (DCC) [dB]	0.00
Average radiated power (PRAVG) [dBm EIRP]	27.91
Power density	
Compliance power density limit [W/m ²]	15.000
Power density (S) @ Antenna far-field distance [W/m ²]	N/A
Power density (S) @ 0.20 m [W/m ²]	1.230
Power density ratio @ 0.20 m	0.08
Distance for compliance power density (S=SL) [m]	0.057
Compliance	
Verdict	PASS
Comment: --	

SRD 915 MHz - Wall antenna	
Transmission Mode	
Transmission Frequency (f) [MHz]	912.5
Antenna far-field distance	
Maximum antenna diameter (D) [m]	N/A
Transmission wavelength (λ) [m]	N/A
Antenna far-field distance (R_{FF}) [m]	N/A
Source average power	
Peak radiated power (PR) [dBm EIRP]	12.008
Maximum transmission duty cycle (DC)	1.00
Duty cycle correction (DCC) [dB]	0.00
Average radiated power (PRAVG) [dBm EIRP]	12.01
Power density	
Compliance power density limit [W/m ²]	30.417
Power density (S) @ Antenna far-field distance [W/m ²]	N/A
Power density (S) @ 0.20 m [W/m ²]	0.032
Power density ratio @ 0.20 m	0.00
Distance for compliance power density (S=SL) [m]	0.006
Compliance	
Verdict	PASS
Comment: --	

PMR 450 MHz - Wall antenna	
Transmission Mode	
Transmission Frequency (f) [MHz]	450
Antenna far-field distance	
Maximum antenna diameter (D) [m]	N/A
Transmission wavelength (λ) [m]	N/A
Antenna far-field distance (R_{FF}) [m]	N/A
Source average power	
Peak radiated power (PR) [dBm EIRP]	30.91
Maximum transmission duty cycle (DC)	1.00
Duty cycle correction (DCC) [dB]	0.00
Average radiated power (PRAVG) [dBm EIRP]	30.91
Power density	
Compliance power density limit [W/m ²]	15.000
Power density (S) @ Antenna far-field distance [W/m ²]	N/A
Power density (S) @ 0.20 m [W/m ²]	2.453
Power density ratio @ 0.20 m	0.16
Distance for compliance power density (S=SL) [m]	0.081
Compliance	
Verdict	PASS
Comment: --	

SRD 915 MHz - Pit antenna	
Transmission Mode	
Transmission Frequency (f) [MHz]	912.5
Antenna far-field distance	
Maximum antenna diameter (D) [m]	N/A
Transmission wavelength (λ) [m]	N/A
Antenna far-field distance (R_{FF}) [m]	N/A
Source average power	
Peak radiated power (PR) [dBm EIRP]	11.008
Maximum transmission duty cycle (DC)	1.00
Duty cycle correction (DCC) [dB]	0.00
Average radiated power (PRAVG) [dBm EIRP]	11.01
Power density	
Compliance power density limit [W/m ²]	30.417
Power density (S) @ Antenna far-field distance [W/m ²]	N/A
Power density (S) @ 0.20 m [W/m ²]	0.025
Power density ratio @ 0.20 m	0.00
Distance for compliance power density (S=SL) [m]	0.006
Compliance	
Verdict	PASS
Comment: --	

PMR 450 MHz - Pit antenna	
Transmission Mode	
Transmission Frequency (f) [MHz]	450
Antenna far-field distance	
Maximum antenna diameter (D) [m]	N/A
Transmission wavelength (λ) [m]	N/A
Antenna far-field distance (R_{FF}) [m]	N/A
Source average power	
Peak radiated power (PR) [dBm EIRP]	20.91
Maximum transmission duty cycle (DC)	1.00
Duty cycle correction (DCC) [dB]	0.00
Average radiated power (PRAVG) [dBm EIRP]	20.91
Power density	
Compliance power density limit [W/m ²]	15.000
Power density (S) @ Antenna far-field distance [W/m ²]	N/A
Power density (S) @ 0.20 m [W/m ²]	0.245
Power density ratio @ 0.20 m	0.02
Distance for compliance power density (S=SL) [m]	0.026
Compliance	
Verdict	PASS
Comment: --	

== = END OF TEST REPORT == =