

**RF-EXPOSURE REPORT****FCC 47 CFR Part 2.1091****Maximum permissible exposure**

<b>Report Reference No</b>	G0M-2211-1783-TFC091MP-V01
<b>Testing Laboratory</b>	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
<b>Applicant</b>	Kamstrup A/S
<b>Address</b>	Industrivej 28 8660 Skanderborg DENMARK
<b>Test Specification</b>	According to FCC rules
Standard	FCC 47 CFR 2.1091
Non-Standard Test Method	None
<b>Equipment under Test (EUT):</b>	
Product Description	Ultrasonic water meter
Model(s)	KW2220
Additional Model(s)	None
Brand Name(s)	Kamstrup
Hardware Version(s)	Unit: 620-210-04; RF PCB BOM: 5550-2066; Flow PCB BOM: 5550-2080
Software Version(s)	RF: 50981789; meter: 50981812; Flow: 50981813
FCC ID	OUY-KWMX220
IC	22376-KWMX220
<b>Test Result</b>	<b>PASSED</b>

<b>Possible test case verdicts:</b>	
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)
<b>Testing:</b>	
Test Lab Temperature	20 °C - 30 °C
Test Lab Humidity	25 % - 55 %
Date of receipt of test item	2023-02-20
<b>Report:</b>	
Compiled by	Odai Qawasmeh
Tested by (+ signature) (Responsible for Test)	Odai Qawasmeh 
Approved by (+ signature) (Test Lab Engineer)	Burkhard Pudell 
Date of Issue	2023-04-05
Total number of pages	16
<b>General Remarks:</b>	
<p>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.</p>	
This report shall not be reproduced, except in full, without the written approval of the issuing testing laboratory.	
<b>Additional Comments:</b>	

**ADDITIONAL VARIANTS**

<b>Additional Variants</b> <b>(not tested and not evaluated variants)</b>		
<b>Not-tested Variant</b>	<b>Description</b>	
1	Product Type Description	Ultrasonic water meter
	Model name	KWM2220
	Brand name	Kamstrup
	Hardware Version	Unit: 6201-210-01 RF PCB BOM: 5550-2066 Flow PCB BOM: 5550-2080
	Software Version	RF: 50981789 Meter: 50981812 Flow: 50981813
2	Product Type Description	Ultrasonic water meter
	Model name	KWM2220
	Brand name	Kamstrup
	Hardware Version	Unit: 6201-210-02 RF PCB BOM: 5550-2066 Flow PCB BOM: 5550-2080
	Software Version	RF: 50981789 Meter: 50981812 Flow: 50981813
3	Product Type Description	Ultrasonic water meter
	Model name	KWM2220
	Brand name	Kamstrup
	Hardware Version	Unit: 6201-210-03 RF PCB BOM: 5550-2066 Flow PCB BOM: 5550-2080
	Software Version	RF: 50981789 Meter: 50981812 Flow: 50981813
4	Product Type Description	Ultrasonic water meter
	Model name	KWM3220
	Brand name	Kamstrup
	Hardware Version	Unit: 6201-204-01 RF PCB BOM: 5550-2066 Flow PCB BOM: 5550-2094
	Software Version	RF: 50981789 Meter: 50981812 Flow: 50981813
5	Product Type Description	Ultrasonic water meter
	Model name	KWM3220
	Brand name	Kamstrup
	Hardware Version	Unit: 6201-205-01 RF PCB BOM: 5550-2066 Flow PCB BOM: 5550-2094
	Software Version	RF: 50981789 Meter: 50981812 Flow: 50981813

6	Product Type Description	Ultrasonic water meter
	Model name	KWM3220
	Brand name	Kamstrup
	Hardware Version	Unit: 6201-204-02 RF PCB BOM: 5550-2066 Flow PCB BOM: 5550-2094
	Software Version	RF: 50981789 Meter: 50981812 Flow: 50981813
7	Product Type Description	Ultrasonic water meter
	Model name	KWM3220
	Brand name	Kamstrup
	Hardware Version	Unit: 6201-204-03 RF PCB BOM: 5550-2066 Flow PCB BOM: 5550-2094
	Software Version	RF: 50981789 Meter: 50981812 Flow: 50981813
8	Product Type Description	Ultrasonic water meter
	Model name	KWM3220
	Brand name	Kamstrup
	Hardware Version	Unit: 6201-204-04 RF PCB BOM: 5550-2066 Flow PCB BOM: 5550-2094
	Software Version	RF: 50981789 Meter: 50981812 Flow: 50981813
9	Product Type Description	Ultrasonic water meter
	Model name	KWM3220
	Brand name	Kamstrup
	Hardware Version	Unit: 6201-204-05 RF PCB BOM: 5550-2066 Flow PCB BOM: 5550-2080
	Software Version	RF: 50981789 Meter: 50981812 Flow: 50981813
10	Product Type Description	Ultrasonic water meter
	Model name	KWM3220
	Brand name	Kamstrup
	Hardware Version	Unit: 6201-204-06 RF PCB BOM: 5550-2066 Flow PCB BOM: 5550-2080
	Software Version	RF: 50981789 Meter: 50981812 Flow: 50981813
11	Product Type Description	Ultrasonic water meter
	Model name	KWM3220
	Brand name	Kamstrup
	Hardware Version	Unit: 6201-204-07 RF PCB BOM: 5550-2066 Flow PCB BOM: 5550-2080
	Software Version	RF: 50981789 Meter: 50981812 Flow: 50981813

12	Product Type Description	Ultrasonic water meter
	Model name	KWM3220
	Brand name	Kamstrup
	Hardware Version	Unit: 6201-204-08 RF PCB BOM: 5550-2066 Flow PCB BOM: 5550-2080
	Software Version	RF: 50981789 Meter: 50981812 Flow: 50981813
Comment: Those named additional variants above have not been tested. Those additional variants of the series have been declared by the manufacturer. The test report explicitly states that those variants were neither tested nor assessed nor evaluated.		

**VERSION HISTORY**

<b>Version History</b>			
Version	Issue Date	Remarks	Revised By
01	2023-04-05	Initial Release	

**ABBREVIATIONS AND ACRONYMS**

<b>Acronyms</b>	
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	KW2220
Additional Model(s)	None
Brand Name(s)	Kamstrup
Serial Number(s)	Prototype
Hardware Version(s)	Unit: 620-210-04; RF PCB BOM: 5550-2066; Flow PCB BOM: 5550-2080
Software Version(s)	RF: 50981789; meter: 50981812; Flow: 50981813
PMN	KWM2220
HVIN	02K02D18R8UB
FVIN	50981789
HMN	N/A
FCC ID	OUY-KWMX220
IC	22376-KWMX220
Equipment type	End Product
Environment	General public

## 1.1 Reference Documents

Document Type	Document No.	Issued by	Date
Radio Test Report FCC 47 CFT Part 15C	G0M-2002-8859- TFC247DT-V02	Eurofins Product Service GmbH	2020-07-28
Radio Test Report FCC 47 CFR Part 90I	G0M-2002-8859- TFC090PMR-V02	Eurofins Product Service GmbH	2020-07-28

## 1.2 Power density radiation sources

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	915	13.121	15.321	100	2.2	N/A
PMR 450 MHz	450.25	30.41	31.41	0.2	1.0	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					
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 <sup>2</sup> ]	Averaging time [min]
0.3 – 1.34	614	1.63	1000	30
1.34 – 30	824/f	2.19/f	1800/f <sup>2</sup>	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 <sup>2</sup> ]	Averaging time [min]
0.3 – 3.0	614	1.63	1000	6
3.0 – 30	1842/f	4.89/f	9000/f <sup>2</sup>	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	
<b>Transmission Mode</b>	
Transmission Frequency (f) [MHz]	915
<b>Antenna far-field distance</b>	
Maximum antenna diameter (D) [m]	N/A
Transmission wavelength ( $\lambda$ ) [m]	N/A
Antenna far-field distance ( $R_{FF}$ ) [m]	N/A
<b>Source average power</b>	
Peak radiated power (PR) [dBm EIRP]	15.321
Maximum transmission duty cycle (DC)	1.00
Duty cycle correction (DCC) [dB]	0.00
Average radiated power (PRAVG) [dBm EIRP]	15.32
<b>Power density</b>	
Compliance power density limit [W/m <sup>2</sup> ]	6.100
Power density (S) @ Antenna far-field distance [W/m <sup>2</sup> ]	N/A
Power density (S) @ 0.20 m [W/m <sup>2</sup> ]	0.068
Power density ratio @ 0.20 m	0.01
Distance for compliance power density (S=SL) [m]	0.021
<b>Compliance</b>	
Verdict	PASS
Comment:	

PMR 450 MHz	
<b>Transmission Mode</b>	
Transmission Frequency (f) [MHz]	450.25
<b>Antenna far-field distance</b>	
Maximum antenna diameter (D) [m]	N/A
Transmission wavelength ( $\lambda$ ) [m]	N/A
Antenna far-field distance ( $R_{FF}$ ) [m]	N/A
<b>Source average power</b>	
Peak radiated power (PR) [dBm EIRP]	31.41
Maximum transmission duty cycle (DC)	0.00
Duty cycle correction (DCC) [dB]	-26.99
Average radiated power (PRAVG) [dBm EIRP]	4.42
<b>Power density</b>	
Compliance power density limit [W/m <sup>2</sup> ]	3.002
Power density (S) @ Antenna far-field distance [W/m <sup>2</sup> ]	N/A
Power density (S) @ 0.20 m [W/m <sup>2</sup> ]	0.005
Power density ratio @ 0.20 m	0.00
Distance for compliance power density (S=SL) [m]	0.009
<b>Compliance</b>	
Verdict	PASS
Comment:	

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