

RADIO REPORT FCC 47 CFR Part 90I	
Report Reference No	G0M-2002-8859-TFC090PMR-V02
Testing Laboratory	Eurofins Product Service GmbH
Address	Storkower Str. 38c 15526 Reichenwalde Germany
Accreditation	    DAKKS - Registration number : D-PL-12092-01-03 (ISED) ISED Testing Laboratory site: 3470A-2 DAKKS - Registration number : D-PL-12092-01-04 (FCC) FCC Filed Test Laboratory, Reg.-No.: 96970
Applicant	Kamstrup A/S
Address	Industrivej 28 8660 Skanderborg DENMARK
Test Specification	47 CFR Part 90I
Non-Standard Test Method	None
Equipment under Test (EUT):	
Product Description	Ultrasonic water meter
Model(s)	KWM2220
Additional Model(s)	None
Brand Name(s)	Kamstrup
Hardware Version(s)	Unit: 6201-210-04, rev. 00; RF PCB BOM: 55501823, rev. C1; Flow PCB BOM: 55501813, rev. B3
Software Version(s)	RF: 50981336, rev. N1; Meter: 50981595, rev. 00
FCC-ID	OUY-KWMX220
IC	n/a
Test Result	PASSED

Possible test case verdicts:		
Required by standard but not tested	N/T	
Not required by standard	N/R	
Not applicable to EUT	N/A	
Test object does meet the requirement	P(PASS)	
Test object does not meet the requirement	F(FAIL)	
Testing:		
Test Lab Temperature	20 °C – 23 °C	
Test Lab Humidity	32 % – 38 %	
Date of receipt of test item	2020-05-28	
Report:		
Compiled by	Toralf Jahn	
Tested by (+ signature) (Responsible for Test)	Toralf Jahn	
Approved by (+ signature) (Head of Lab)	Christian Weber	
Date of Issue	2020-07-28	
Total number of pages	50	
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:		

ADDITIONAL VARIANTS

Additional Variants (not tested and not evaluated variants)		
Not-tested Variant	Description	
1	Product Type Description	Ultrasonic water meter
	Model name	KWM2220
	Brand name	Kamstrup
	Hardware Version	Unit: 6201-210-01, rev. 00 RF PCB BOM: 55501823, rev. C1 Flow PCB BOM: 55501813, rev. B3
	Software Version	RF: 50981336, rev. N1 Meter: 50981595, rev. 00
2	Product Type Description	Ultrasonic water meter
	Model name	KWM2220
	Brand name	Kamstrup
	Hardware Version	Unit: 6201-210-02, rev. 00 RF PCB BOM: 55501823, rev. C1 Flow PCB BOM: 55501813, rev. B3
	Software Version	RF: 50981336, rev. N1 Meter: 50981595, rev. 00
3	Product Type Description	Ultrasonic water meter
	Model name	KWM2220
	Brand name	Kamstrup
	Hardware Version	Unit: 6201-210-03, rev. 00 RF PCB BOM: 55501823, rev. C1 Flow PCB BOM: 55501813, rev. B3
	Software Version	RF: 50981336, rev. N1 Meter: 50981595, rev. 00
4	Product Type Description	Ultrasonic water meter
	Model name	KWM3220
	Brand name	Kamstrup
	Hardware Version	Unit: 6202-205-01, rev. 00 RF PCB BOM: 55501823, rev.C1 Flow PCB BOM: 55501523, rev B1
	Software Version	RF: 50981336, rev. N1 Meter: 50981595, rev. 00
5	Product Type Description	Ultrasonic water meter
	Model name	KWM3220
	Brand name	Kamstrup
	Hardware Version	Unit: 6202-103-02, rev. 00 RF PCB BOM: 55501823, rev.C1 Flow PCB BOM: 55501523, rev B1
	Software Version	RF: 50981336, rev. N1 Meter: 50981595, rev. 00
6	Product Type Description	Ultrasonic water meter
	Model name	KWM3220
	Brand name	Kamstrup
	Hardware Version	Unit: 6202-103-03, rev. 00 RF PCB BOM: 55501823, rev.C1 Flow PCB BOM: 55501523, rev B1
	Software Version	RF: 50981336, rev. N1 Meter: 50981595, rev. 00

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7	Product Type Description	Ultrasonic water meter
	Model name	KWM3220
	Brand name	Kamstrup
	Hardware Version	Unit: 6202-103-04, rev. 00 RF PCB BOM: 55501823, rev.C1 Flow PCB BOM: 55501523, rev B1
	Software Version	RF: 50981336, rev. N1 Meter: 50981595, rev. 00
8	Product Type Description	Ultrasonic water meter
	Model name	KWM3220
	Brand name	Kamstrup
	Hardware Version	Unit: 6202-103-06, rev. 00 RF PCB BOM: 55501823, rev.C1 Flow PCB BOM: 55501523, rev B1
	Software Version	RF: 50981336, rev. N1 Meter: 50981595, rev. 00
9	Product Type Description	Ultrasonic water meter
	Model name	KWM3220
	Brand name	Kamstrup
	Hardware Version	Unit: 6202-103-07, rev. 00 RF PCB BOM: 55501823, rev.C1 Flow PCB BOM: 55501523, rev B1
	Software Version	RF: 50981336, rev. N1 Meter: 50981595, rev. 00
10	Product Type Description	Ultrasonic water meter
	Model name	KWM3220
	Brand name	Kamstrup
	Hardware Version	Unit: 6202-103-05, rev. RF PCB BOM: 55501823, rev.C1 Flow PCB BOM: 55501523, rev B1
	Software Version	RF: 50981336, rev. N1 Meter: 50981595, rev. 00
11	Product Type Description	Ultrasonic water meter
	Model name	KWM3220
	Brand name	Kamstrup
	Hardware Version	Unit: 6202-103-08, rev. RF PCB BOM: 55501823, rev.C1 Flow PCB BOM: 55501523, rev B1
	Software Version	RF: 50981336, rev. N1 Meter: 50981595, rev. 00
12	Product Type Description	Ultrasonic water meter
	Model name	KWM3220
	Brand name	Kamstrup
	Hardware Version	Unit: 6201-204-01, rev. 00 RF PCB BOM: 55501823, rev.C1 Flow PCB BOM: 55501523, rev B1
	Software Version	RF: 50981336, rev. N1 Meter: 50981595, rev. 00
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

Version History			
Version	Issue Date	Remarks	Revised By
01	2020-06-30	Initial Release	
02	2020-07-28	Replaced document: G0M-2002-8859-TFC090PMR-V01 Replaced by: G0M-2002-8859-TFC090PMR-V02 Reason: Antenna 1 model changed Additional antenna 5 added	T.Jahn

ABBREVIATIONS AND ACRONYMS

Acronyms	
Acronym	Description
EUT	Equipment Under Test
FCC	Federal Communications Commission
ISED	Innovation, Science and Economic Development Canada
RBW	Resolution bandwidth
RMS	Root mean square
VBW	Video bandwidth
V _{NOM}	Nominal supply voltage
V _{MIN}	Miminal supply voltage
V _{MAX}	Maximal supply voltage
T _{NOM}	Nominal temperature
T _{MIN}	Miminal temperature
T _{MAX}	Maximal temperature
N/A	Not Applicable

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1 Equipment (Test Item) Under Test

Description	Ultrasonic water meter	
Model	KWM2220	
Additional Model(s)	None	
Brand Name(s)	Kamstrup	
Serial Number(s)	KAM21142842/20 (sample ID 29577)	
Hardware Version(s)	Unit: 6201-210-04, rev. 00; RF PCB BOM: 55501823, rev. C1; Flow PCB BOM: 55501813, rev. B3	
Software Version(s)	RF: 50981336, rev. N1; Meter: 50981595, rev. 00	
PMN	n/a	
HVIN	n/a	
FVIN	n/a	
HMN	n/a	
IC	n/a	
FCC-ID	OUY-KWMX220	
Equipment type	End Product	
Radio type	Transceiver	
Radio technologies	PMR	
Assigned frequency band	421 - 512 MHz	
Operating frequency range	450.25 - 469.9875 MHz	
Channels	Low: : Frequency 450.25 MHz Mid: : Frequency 460.11875 MHz High: : Frequency 469.9875 MHz	
Modulation(s)	4-GFSK, 4.8 kbps	
Emission designator	F1D	
Channel bandwidth	12.5 kHz	
Authorized bandwidth	11.25 kHz	
Channel spacing	11.25 kHz	
Number of modules	0	
Radio Module	Type	N/A
	Model	N/A
	Manufacturer	N/A
	HW Version	N/A
	SW Version	N/A
	FCC-ID	N/A
	IC	N/A
Number of antennas	5	
Antenna 1	Type	external, helix antenna
	Model	30261216 A1
	Manufacturer	Kamstrup A/S
	Gain	-0.6 dBi
Antenna 2	Type	external, wall antenna 2 meters cable length
	Model	6699490
	Manufacturer	Kamstrup A/S
	Gain	0.5 dBi
Antenna 3	Type	external, pit antenna (small) 0.6 meters cable length
	Model	6697916
	Manufacturer	Kamstrup A/S
	Gain	-5.3 dBi

Antenna 4	Type	external, pit antenna 2 meters cable length
	Model	6697902
	Manufacturer	Kamstrup A/S
	Gain	0.0 dBi
Antenna 5	Type	external, helix antenna
	Model	30261216 B1
	Manufacturer	Kamstrup A/S
	Gain	-2.9 dBi
Supply Voltage	V _{NOM}	3.66 V
	V _{MIN}	3.0 V
	V _{MAX}	3.66 V
Operating Temperature	T _{NOM}	25 °C
	T _{MIN}	-30 °C
	T _{MAX}	65 °C
Battery supply	Yes	
AC/DC-Adaptor	Model	N/A
	Vendor	N/A
	Input	N/A
	Output	N/A
Manufacturer	Kamstrup A/S Industrivej 28 8660 Skanderborg DENMARK	

1.1 Photos – Equipment External

1.2 Photos – Equipment Internal



1.3 Photos – Test Setup



1.4 Support Equipment

Product Type	Device	Manufacturer	Model	Comment
AE	Optical readout head	Kamstrup	14071	Programming interface
AE	Laboratory power supply	KORAD	KD6005P	The EUT battery does not last to perform the tests. Therefore an external power supply was necessary.
CBL	Auxillary cable			To connect EUT and power supply.
SFT	Device Control Tool	Kamstrup	ver. 0.05	Tool for controlling RF modules and meters
Description:				
AE	Auxiliary Equipment			
SIM	Simulator			
CBL	Connecting Cable			
SFT	Software			
Comment:				

1.5 Test Modes

Mode	Description
Unmodulated	Mode = Transmit Modulation = None
Transmit	Mode = Transmit Modulation = 4-GFSK, 4.8 kbps Duty cycle = 100 %

1.6 Test Frequencies

Designator	Mode	Frequency [MHz]
F1	Tx / Rx	450.25
F2	Tx / Rx	460.11875
F3	Tx / Rx	469.9875

1.7 Sample emission level calculation

The following is a description of terms and a sample calculation, as appears in the radiated emissions data table. The numbers used in the calculation are for example only. There is no direct correlation to the specific data taken for the product described in this document:

Reading:

This is the reading obtained on the spectrum analyzer in dBμV. Any external preamplifiers used are taken into account through internal analyzer settings.

A.F.:

This is the antenna factor for the receiving antenna. It is a conversion factor, which converts electric fields strengths to voltages, which can be measured directly on the spectrum analyzer. It is treated as a loss in dB. Cable losses have been included with the A.F. to simplify the calculations. The antenna factor is used in calculations as follows:

$$\text{Reading on Analyzer (dB}\mu\text{V)} + \text{A.F. (dB)} = \text{Net field strength (dB}\mu\text{V/m)}$$

Net:

This is the net field strength measurement (as shown above).

Limit:

This is the FCC Class B radiated emission limit (in units of dBμV/m). The FCC limits are given in units of μV/m. The following formula is used to convert the units of μV/m to dBμV/m:

$$\text{Limit (dB}\mu\text{V/m)} = 20 \cdot \log (\mu\text{V/m})$$

Margin:

This is the margin of compliance below the FCC limit. The units are given in dB. A negative margin indicates the emission was below the limit. A positive margin indicates that the emission exceeds the limit.

Example only:

Reading + AF	= Net Reading	:	Net reading	- FCC limit	= Margin
+21.5 dBμV	+ 26 dB = 47.5 dBμV/m	:	47.5 dBμV/m	- 57.0 dBμV/m	= -9.5 dB

2 Result Summary

Test Summary				
Product Standard Reference	Requirement	Reference Method	Result	Remarks
FCC 90.205 FCC 2.1046 RSS-119 5.4	Power	ANSI C63.26:2015 5.2	PASS	
FCC 90.209 FCC 90.210 FCC 2.1049 RSS-119 4.2,5,5.5,5.8	Authorized bandwidth Emission masks Occupied bandwidth	FCC 90.210 ANSI C63.26:2015 5.4	PASS	
FCC 90.210 FCC 2.1051 RSS-119 4.2,6.13	Spurious emissions at antenna terminal	FCC 90.210 ANSI C63.26:2015 5.7	PASS	
FCC 90.210 FCC 2.1053 RSS-119 4.2,6.13	Spurious emissions radiated	FCC 90.210 ANSI C63.26:2015 5.7	PASS	
RSS-Gen 7.1	Receiver spurious emissions	ANSI C63.26:2015 5.7	N/T	
FCC 90.213 FCC 2.1055 RSS-119 5.3	Frequency Stability	ANSI C63.26:2015 5.6	PASS	
FCC 90.214 RSS-119 5.9	Transient Frequency behavior	ANSI C63.26:2015 6.5	PASS	
Comment:				

Possible Test Case Verdicts	
PASS	Test object does meet the requirements
FAIL	Test object does not meet the requirements
N/T	Required by standard but not tested
N/R	Not required by standard for the test object

3 Test Conditions and Results

3.1 Test Conditions and Results - Power

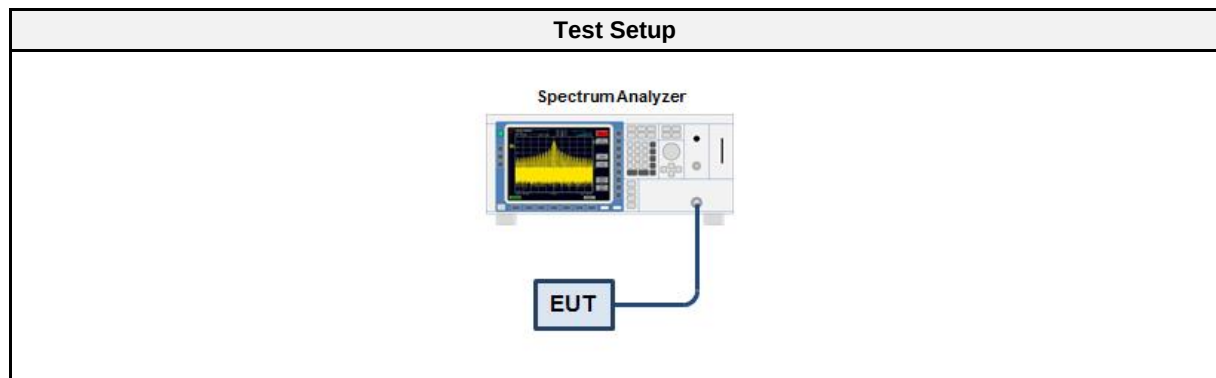
3.1.1 Information

Test Information	
Reference	FCC 90.205, FCC 90.2.1046 ISED RSS-119, Issue 12 (Section 5.4)
Measurement Method	ANSI C63.26:2015 5.2
Test Method	Conducted
Test Mode	Unmodulated
Maximum antenna gain	0.5 dBi (-1.65 dBd)
Operator	Toralf Jahn
Date	2020-06-03

3.1.2 Limits

Limits	
Device	Power [W ERP]
Base / Fixed	110 (50.41 dBm)
Mobile	60 (47.78 dBm)

3.1.3 Setup



3.1.4 Equipment

Test Equipment					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Spectrum analyzer	R&S	FSU43	EF01631	2019-12	2020-12

3.1.5 Procedure

Test Procedure	
1.	EUT transmitter is activated in test mode under normal conditions
2.	The spectrum analyzer is set to peak detection and maximum hold with a span twice the emission spectrum
3.	The resolution bandwidth is set to 3 MHz
4.	Peak power is determined from peak of spectrum envelope
5.	EIRP power is calculated by adding the antenna gain in dBi
6.	ERP power is calculated by subtracting 2.15 from EIRP power

3.1.6 Results

Test Results					
Channel [MHz]	Conducted Power [dBm]	ERP Peak Power [dBm]	ERP Peak Power [W]	ERP Power Limit [dBm]	Margin [dB]
450.25	30.41	28.76	0.75	47.78	-19.02
460.11875	30.28	28.63	0.73	47.78	-19.15
469.9875	30.14	28.49	0.71	47.78	-19.29

3.2 Test Conditions and Results - Emission mask and authorized bandwidth

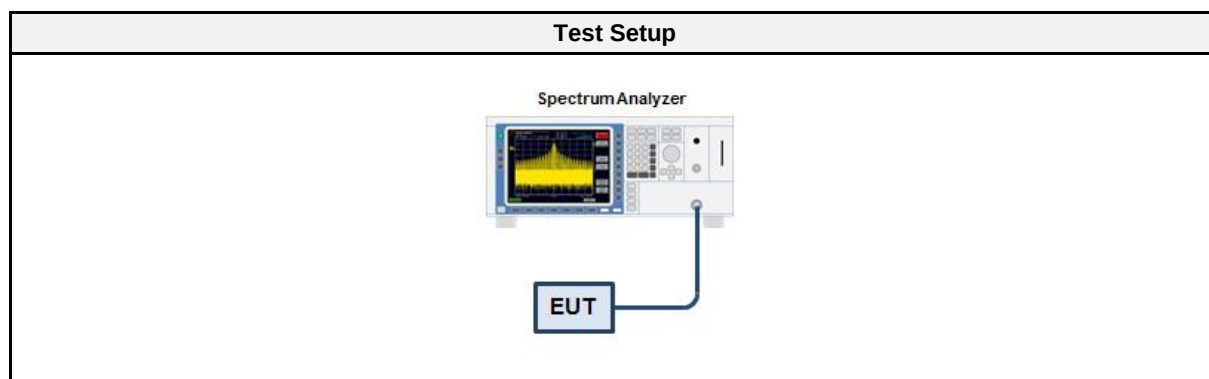
3.2.1 Information

Test Information	
Reference	FCC 90.209, FCC 90.210, FCC 2.1049 ISED RSS-119, Issue 12 (Sections 4.2,5.5,5.8)
Measurement Method	FCC 90.210, ANSI C63.26:2015 5.4
Test Method	Conducted
Test Mode	Modulated
Operator	Toralf Jahn
Date	2020-06-03

3.2.2 Limits

Limits
Emission Mask D
Necessary bandwidth (Occupied bandwidth) < 11.25 kHz (Authorized bandwidth)

3.2.3 Setup



3.2.4 Equipment

Test Equipment					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Spectrum analyzer	R&S	FSU43	EF01631	2019-12	2020-12

3.2.5 Procedure

Test Procedure
1. EUT set to test mode 2. Span set in order to cover the emission spectrum and emission mask 3. Resolution bandwidth set to 100 Hz and VBW to 300 Hz 4. Detector is set to peak max hold

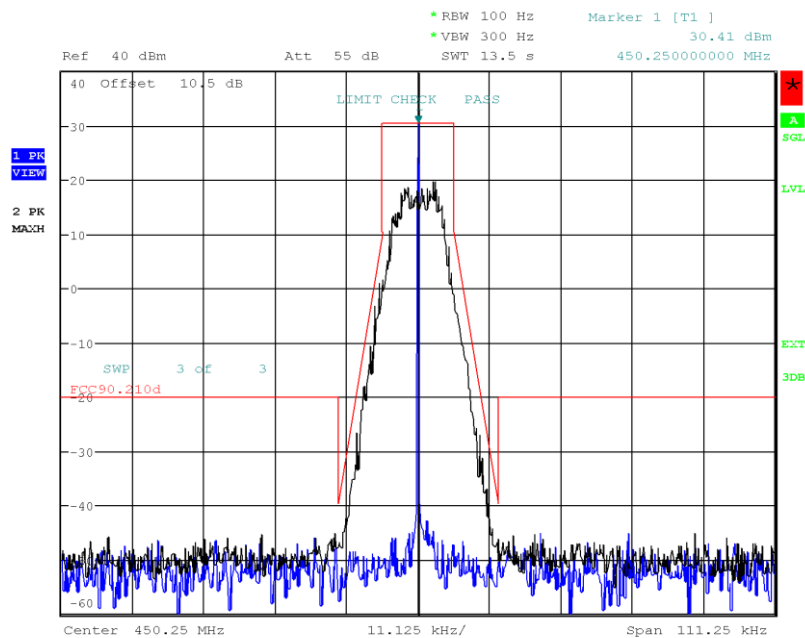
3.2.6 Results

Test Results - Emission Mask	
Channel [MHz]	Verdict
450.25	PASS
460.11875	PASS
469.9875	PASS

Test Results - Authorized bandwidth			
Channel [MHz]	Bandwidth [kHz]	Limit [kHz]	Verdict
450.25	9.660	11.25	PASS
460.11875	9.610	11.25	PASS
469.9875	9.710	11.25	PASS

Emission mask

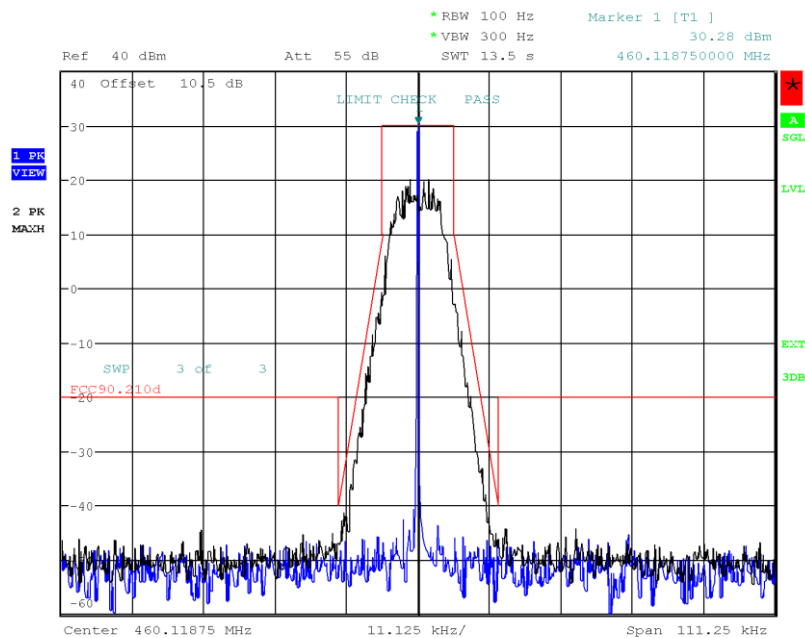
Project Number: G0M-2002-8859
 Applicant: Kamstrup A/S
 Model Description: Ultrasonic water meter
 Model: KWM2220
 Test Sample ID: 29577
 Operator: Toralf Jahn
 Test Site: Eurofins Product Service GmbH
 Test Date: 2020-06-03
 Operating Conditions: Tnom/Vnom
 Mode: 450.25 MHz



Date: 3.JUN.2020 12:43:13

Emission mask

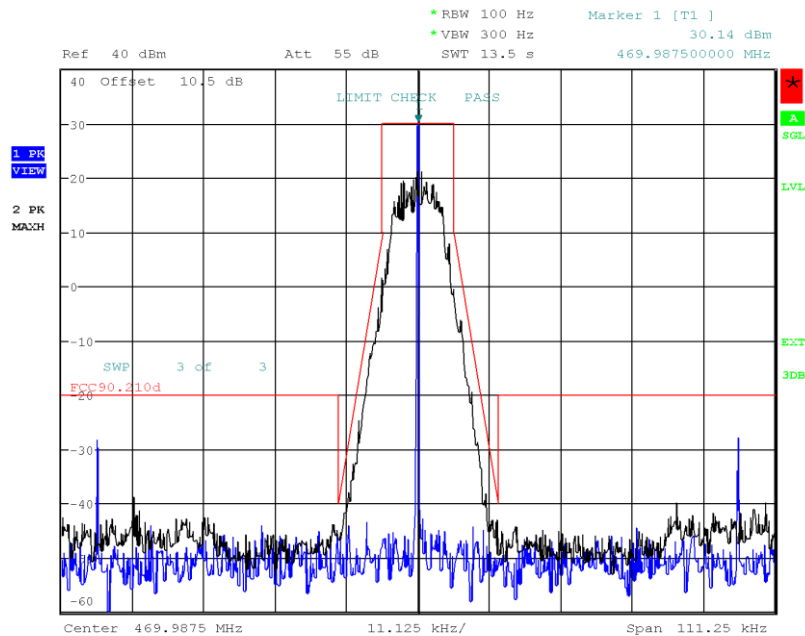
Project Number: G0M-2002-8859
 Applicant: Kamstrup A/S
 Model Description: Ultrasonic water meter
 Model: KWM2220
 Test Sample ID: 29577
 Operator: Toralf Jahn
 Test Site: Eurofins Product Service GmbH
 Test Date: 2020-06-03
 Operating Conditions: Tnom/Vnom
 Mode: 460.11875 MHz



Date: 3.JUN.2020 12:47:15

Emission mask

Project Number: G0M-2002-8859
 Applicant: Kamstrup A/S
 Model Description: Ultrasonic water meter
 Model: KWM2220
 Test Sample ID: 29577
 Operator: Toralf Jahn
 Test Site: Eurofins Product Service GmbH
 Test Date: 2020-06-03
 Operating Conditions: Tnom/Vnom
 Mode: 469.9875 MHz



Date: 3.JUN.2020 12:52:53

3.3 Test Conditions and Results - Spurious emissions at antenna terminal

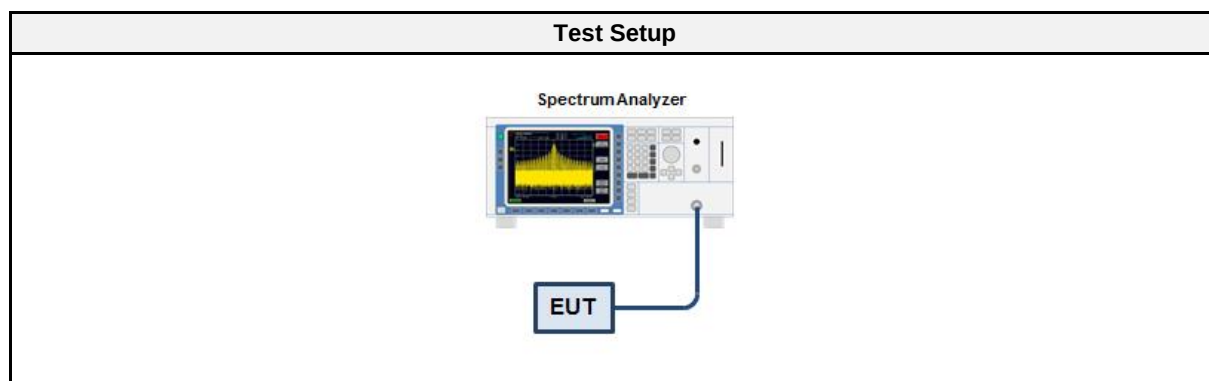
3.3.1 Information

Test Information	
Reference	FCC 90.210, FCC 2.1051 ISED RSS-119, Issue 12 (Sections 4.2,6.13)
Measurement Method	FCC 90.210 ANSI C63.26:2015 5.7
Test Method	Conducted
Test Mode	Unmodulated
Test Range	10 MHz to 10th Harmonic
Operator	Toralf Jahn
Date	2020-06-03

3.3.2 Limits

Limits
-20 dBm

3.3.3 Setup



3.3.4 Equipment

Test Equipment					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Spectrum analyzer	R&S	FSU43	EF01631	2019-12	2020-12

3.3.5 Procedure

Test Procedure
1. EUT set to test mode 2. Span is set according to measurement range 3. Resolution bandwidth is set to 100 kHz below 1 GHz and 1 MHz above 1 GHz 4. Detector is set to peak and trace mode to max hold

3.3.6 Results

Test Results	
Channel [MHz]	Verdict
450.25	PASS
460.11875	PASS
469.9875	PASS

3.4 Test Conditions and Results - Transmitter radiated emissions

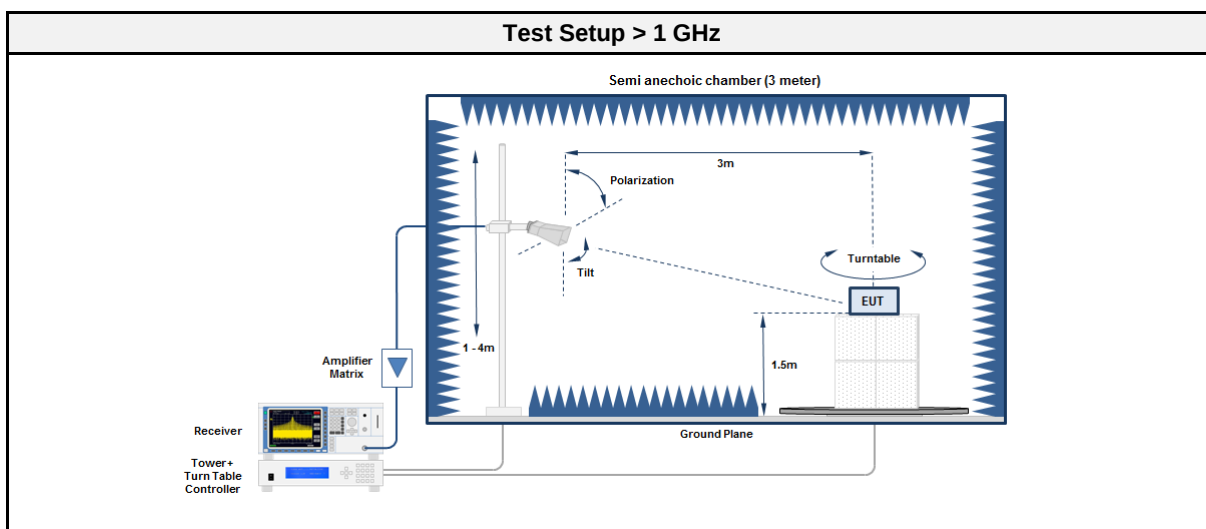
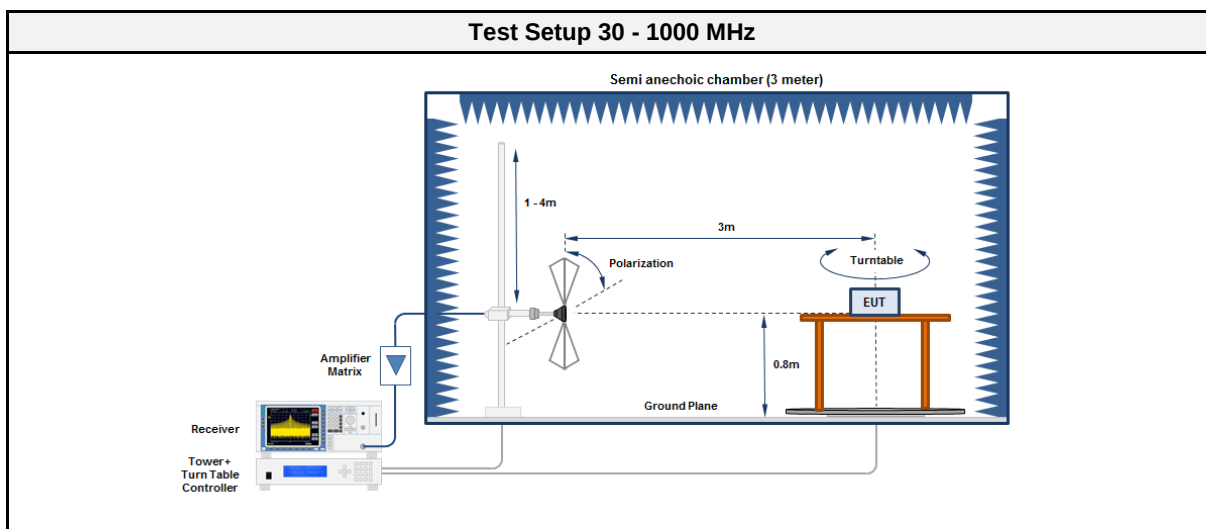
3.4.1 Information

Test Information	
Reference	FCC 90.210 FCC 2.1053 ISED RSS-119, Issue 12 (Sections 4.2,6.13)
Measurement Method	FCC 90.210 ANSI C63.26:2015 5.7
Test Method	Radiated
Test Mode	Unmodulated
Test Range	30 MHz to 10th Harmonic
Operator	Toralf Jahn
Date	2020-06-02

3.4.2 Limits

Limits
-20 dBm

3.4.3 Setup



Test Report No.: G0M-2002-8859-TFC090PMR-V02

Eurofins Product Service GmbH
Storkower Str. 38c, D-15526 Reichenwalde, Germany

3.4.4 Equipment

Test Software			
Description	Manufacturer	Name	Version
EMC Software	DARE Instruments	RadiMation	2016.1.1

Test Equipment 30 - 1000 MHz					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Anechoic Chamber	Frankonia	AC1	EF00062	2018-07	2021-07
EMI Test Receiver	R&S	ESR7	EF00943	2019-10	2020-10
Antenna	R&S	HK 116	EF00030	2019-04	2022-04
Antenna	R&S	HL 223	EF00187	2019-05	2022-05

Test Equipment > 1 GHz					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Anechoic Chamber	Frankonia	AC1	EF00062	2018-07	2021-07
Spectrum analyzer	R&S	FSU26	EF01003	2019-07	2020-07
Antenna	Schwarzbeck	BBHA 9120D	EF00018	2019-10	2022-10

3.4.5 Procedure

Test Procedure 30 - 1000 MHz	
1. EUT is placed on a non conducting support at the center of a turn table 0.8 m above the ground 2. EUT set to test mode 3. The receiver is set to peak detection with max hold 4. The EUT is rotated through 360° and the height of the antenna is varied from 1 m to 4 m 5. All significant emissions are measured again using the corresponding final detector	

Test Procedure > 1 GHz	
1. EUT is placed on a non conducting support at the center of a turn table 1.5 m above the ground 2. EUT set to test mode 3. The receiver is set to peak detection with max hold 4. The EUT is rotated through 360° and the height of the antenna is varied from 1 m to 4 m 5. All significant emissions are measured again using the corresponding final detector	

3.4.6 Results

Test Results						
Channel [MHz]	Emission [MHz]	Level [dBm]	Det.	Pol.	Limit [dBm]	Margin [dB]
450.25	900.5	-61.00	pk	hor	-20.00	-41.00
450.25	900.5	-61.00	pk	ver	-20.00	-41.00
450.25	1350.75	-64.50	pk	hor	-20.00	-44.52
450.25	1350.75	-62.20	pk	ver	-20.00	-42.22
450.25	1801	-61.40	pk	hor	-20.00	-41.43
450.25	1801	-58.30	pk	ver	-20.00	-38.27
450.25	2251.25	-49.40	pk	hor	-20.00	-29.36
450.25	2251.25	-49.30	pk	ver	-20.00	-29.29
460.11875	920.2375	-61.00	pk	hor	-20.00	-41.00
460.11875	920.2375	-61.00	pk	ver	-20.00	-41.00
460.11875	1380.35625	-64.50	pk	hor	-20.00	-44.55
460.11875	1380.35625	-62.70	pk	ver	-20.00	-42.73
460.11875	1840.475	-58.00	pk	hor	-20.00	-37.98
460.11875	1840.475	-59.00	pk	ver	-20.00	-39.02
460.11875	2300.59375	-47.60	pk	hor	-20.00	-27.64
460.11875	2300.59375	-51.50	pk	ver	-20.00	-31.48
469.9875	939.975	-61.00	pk	hor	-20.00	-41.00
469.9875	939.975	-61.00	pk	ver	-20.00	-41.00
469.9875	1409.9625	-65.00	pk	hor	-20.00	-45.02
469.9875	1409.9625	-62.30	pk	ver	-20.00	-42.25
469.9875	1879.95	-54.20	pk	hor	-20.00	-34.15
469.9875	1879.95	-53.80	pk	ver	-20.00	-33.82
469.9875	2349.9375	-52.80	pk	hor	-20.00	-32.84
469.9875	2349.9375	-54.10	pk	ver	-20.00	-34.05

3.5 Test Conditions and Results - Frequency stability

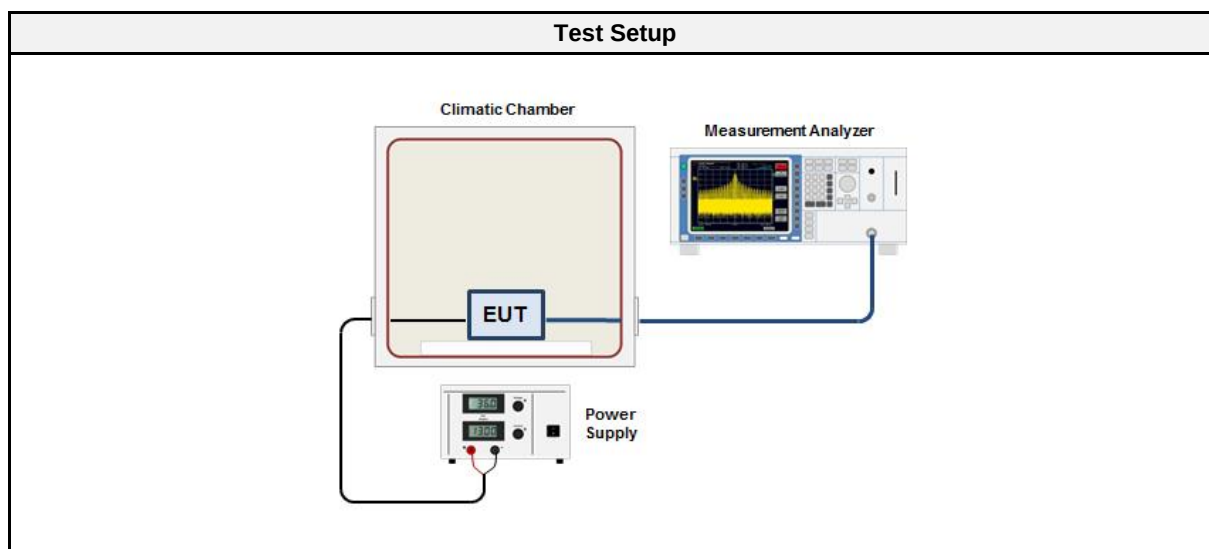
3.5.1 Information

Test Information	
Reference	FCC 90.213, FCC 2.1055 ISED RSS-119, Issue 12 (Sections 5.3)
Measurement Method	ANSI C63.26:2015 5.6
Test Method	Conducted
Test Mode	Unmodulated
Operator	Toralf Jahn
Date	2020-06-09

3.5.2 Limits

Limits		
Device Type	Channel bandwidth	Limit
Base / Fixed	12.5	1.5 ppm
Base / Fixed	6.25	0.5 ppm
Mobile	12.5	2.5 ppm
Mobile	6.25	1.0 ppm

3.5.3 Setup



3.5.4 Equipment

Test Equipment					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Spectrum analyzer	R&S	FSU43	EF01631	2019-12	2020-12
Climatic chamber	Vötsch	VT 4010	EF00134	2019-08	2020-08

3.5.5 Procedure

Test Procedure with respect to ambient temperature	
1.	The EUT is turned off and placed inside the temperature chamber
2.	The temperature chamber is set to the highest operating temperature
3.	The EUT is turned on at nominal supply voltage and the carrier frequency is measured at startup, at 2 minutes, 5 minutes and 10 minutes after EUT is energized
4.	The EUT is turned off again
5.	The temperature of the chamber is lowered by 10 °C
6.	The carrier frequency measurement is repeated after temperature has stabilized
7.	The procedure is repeated until the lowest operating frequency is reached

Test Procedure when varying supply voltage	
1.	The EUT is supplied with nominal supply voltage or a fully charged battery at room temperature (15 to 25 °C)
2.	The carrier frequency is measured
3.	The procedure is repeated at 85 % and 115 % of the nominal supply voltage or at the battery endpoint for battery operated equipment

Test Procedure of carrier frequency measurement	
1.	The emission spectrum is measured using a resolution band width of 100 kHz with peak detection and maximum hold
2.	The peak of the emission spectrum is determined
3.	The left most frequency f_1 10 dB below the peak emission is searched
4.	The right most frequency f_2 10 dB below the peak emission is searched
5.	The center frequency is calculated from $f_c = (f_1 + f_2) / 2$
6.	The center frequency and the deviation from the nominal center frequency are recorded

3.5.6 Results

Test Results - Variation of temperature						
Channel [MHz]	Voltage [V]	Temperature [°C]	Time after activation	Frequency [MHz]	Deviation [kHz]	Deviation [ppm]
460.11875	3.66	65	0	460.118737	0.136	0.30
460.11875	3.66	60	0	460.118715	0.114	0.25
460.11875	3.66	50	0	460.118673	0.072	0.16
460.11875	3.66	40	0	460.118614	0.013	0.03
460.11875	3.66	30	0	460.118565	-0.036	-0.08
460.11875	3.66	20	0	460.118601	reference	reference
460.11875	3.66	10	0	460.118690	0.098	0.21
460.11875	3.66	0	0	460.118813	0.212	0.46
460.11875	3.66	-10	0	460.118797	0.196	0.43
460.11875	3.66	-20	0	460.118785	0.184	0.40
460.11875	3.66	-30	0	460.118790	0.189	0.41
Comment: The EUT transmits in normal operation mode only for a few milli seconds.						

Test Results - Variation of supply voltage					
Channel [MHz]	Voltage [V]	Temperature [°C]	Frequency [MHz]	Deviation [kHz]	Deviation [ppm]
460.11875	3.66	20	460.118601	reference	reference
460.11875	3.0	20	460.118582	-0.019	-0.04

3.6 Test Conditions and Results - Transient frequency behavior

3.6.1 Information

Test Information	
Reference	FCC 90.214 ISED RSS-119, Issue 12 (Sections 5.9)
Measurement Method	ANSI C63.26:2015 6.5
Test Method	Conducted
Test Mode	Unmodulated
Operator	Toralf Jahn
Date	2020-06-09

3.6.2 Limits

Limits

Transmitters designed to operate in the 150-174 MHz and 421-512 MHz frequency bands must maintain transient frequencies within the maximum frequency difference limits during the time intervals indicated:

Time intervals ^{1 2}	Maximum frequency difference ³	All equipment	
		150 to 174 MHz	421 to 512 MHz
Transient Frequency Behavior for Equipment Designed to Operate on 25 kHz Channels			
t ₁ ⁴	±25.0 kHz	5.0 ms	10.0 ms
t ₂	±12.5 kHz	20.0 ms	25.0 ms
t ₃ ⁴	±25.0 kHz	5.0 ms	10.0 ms
Transient Frequency Behavior for Equipment Designed to Operate on 12.5 kHz Channels			
t ₁ ⁴	±12.5 kHz	5.0 ms	10.0 ms
t ₂	±6.25 kHz	20.0 ms	25.0 ms
t ₃ ⁴	±12.5 kHz	5.0 ms	10.0 ms
Transient Frequency Behavior for Equipment Designed to Operate on 6.25 kHz Channels			
t ₁ ⁴	±6.25 kHz	5.0 ms	10.0 ms
t ₂	±3.125 kHz	20.0 ms	25.0 ms
t ₃ ⁴	±6.25 kHz	5.0 ms	10.0 ms

¹ t_{on} is the instant when a 1 kHz test signal is completely suppressed, including any capture time due to phasing.

t₁ is the time period immediately following t_{on}.

t₂ is the time period immediately following t₁.

t₃ is the time period from the instant when the transmitter is turned off until t_{off}.

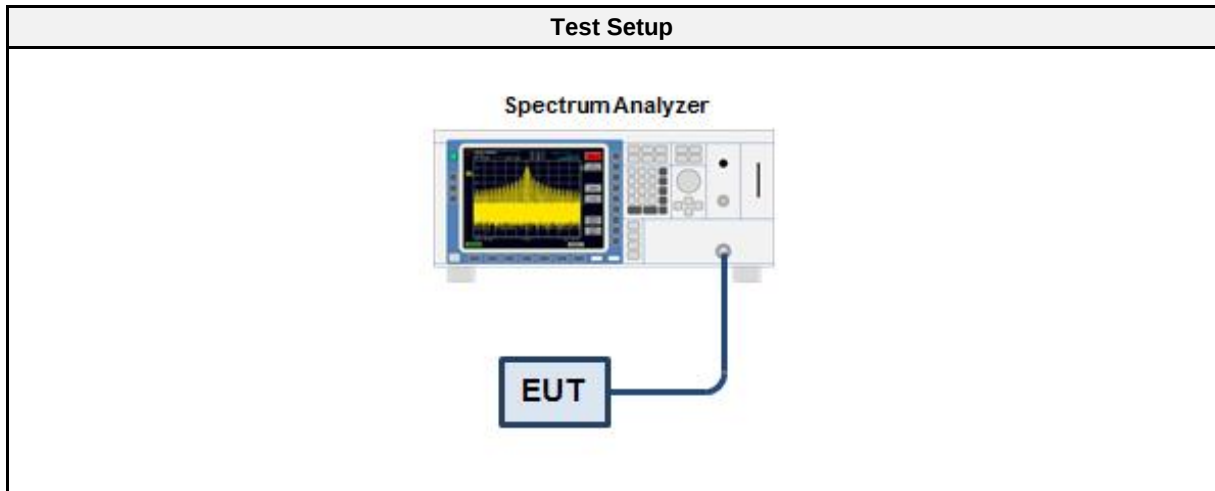
t_{off} is the instant when the 1 kHz test signal starts to rise.

² During the time from the end of t₂ to the beginning of t₃, the frequency difference must not exceed the limits specified in §90.213.

³ Difference between the actual transmitter frequency and the assigned transmitter frequency.

⁴ If the transmitter carrier output power rating is 6 watts or less, the frequency difference during this time period may exceed the maximum frequency difference for this time period.

3.6.3 Setup



3.6.4 Equipment

Test Equipment					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Spectrum Analyzer	R&S	FSW 43	EF00896	2019-07	2020-07

3.6.5 Procedure

Test Procedure
1. The EUT is set to test frequency 2. The EUT is connected to modulation analyzer 3. The EUT is switched on and off in order to determine the transient switching behavior

3.6.6 Results

Test Results		
Channel [MHz]	State	Verdict
450.25	Tx Off	PASS
460.11875	Tx Off	PASS
469.9875	Tx Off	PASS
450.25	Tx On	PASS
460.11875	Tx On	PASS
469.9875	Tx On	PASS

Transient frequency behavior

Project Number: G0M-2002-8859
 Applicant: Kamstrup A/S
 Model Description: Ultrasonic water meter
 Model: KWM2220
 Test Sample ID: 29577
 Operator: Toralf Jahn
 Test Site: Eurofins Product Service GmbH
 Test Date: 2020-06-09
 Operating Conditions: Tnom/Vnom
 Mode: Ton 450.25 MHz



10:48:27 09.06.2020

Transient frequency behavior

Project Number: G0M-2002-8859
 Applicant: Kamstrup A/S
 Model Description: Ultrasonic water meter
 Model: KWM2220
 Test Sample ID: 29577
 Operator: Toralf Jahn
 Test Site: Eurofins Product Service GmbH
 Test Date: 2020-06-09
 Operating Conditions: Tnom/Vnom
 Mode: Ton 460.11875 MHz



Transient frequency behavior

Project Number: G0M-2002-8859
 Applicant: Kamstrup A/S
 Model Description: Ultrasonic water meter
 Model: KWM2220
 Test Sample ID: 29577
 Operator: Toralf Jahn
 Test Site: Eurofins Product Service GmbH
 Test Date: 2020-06-09
 Operating Conditions: Tnom/Vnom
 Mode: Ton 469.9875 MHz



10:55:26 09.06.2020

Transient frequency behavior

Project Number: G0M-2002-8859
 Applicant: Kamstrup A/S
 Model Description: Ultrasonic water meter
 Model: KWM2220
 Test Sample ID: 29577
 Operator: Toralf Jahn
 Test Site: Eurofins Product Service GmbH
 Test Date: 2020-06-09
 Operating Conditions: Tnom/Vnom
 Mode: Toff 450.25 MHz



11:23:42 09.06.2020

Transient frequency behavior

Project Number: G0M-2002-8859
 Applicant: Kamstrup A/S
 Model Description: Ultrasonic water meter
 Model: KWM2220
 Test Sample ID: 29577
 Operator: Toralf Jahn
 Test Site: Eurofins Product Service GmbH
 Test Date: 2020-06-09
 Operating Conditions: Tnom/Vnom
 Mode: Toff 460.11875 MHz



11:26:18 09.06.2020

Transient frequency behavior

Project Number: G0M-2002-8859
 Applicant: Kamstrup A/S
 Model Description: Ultrasonic water meter
 Model: KWM2220
 Test Sample ID: 29577
 Operator: Toralf Jahn
 Test Site: Eurofins Product Service GmbH
 Test Date: 2020-06-09
 Operating Conditions: Tnom/Vnom
 Mode: Toff 469.9875 MHz

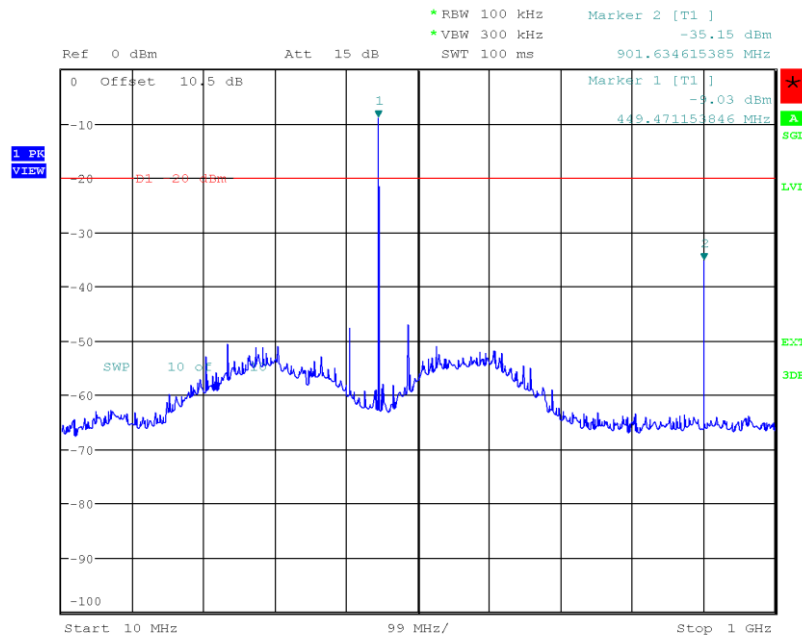


11:31:02 09.06.2020

ANNEX A Transmitter conducted emissions

Spurious emissions at antenna terminal

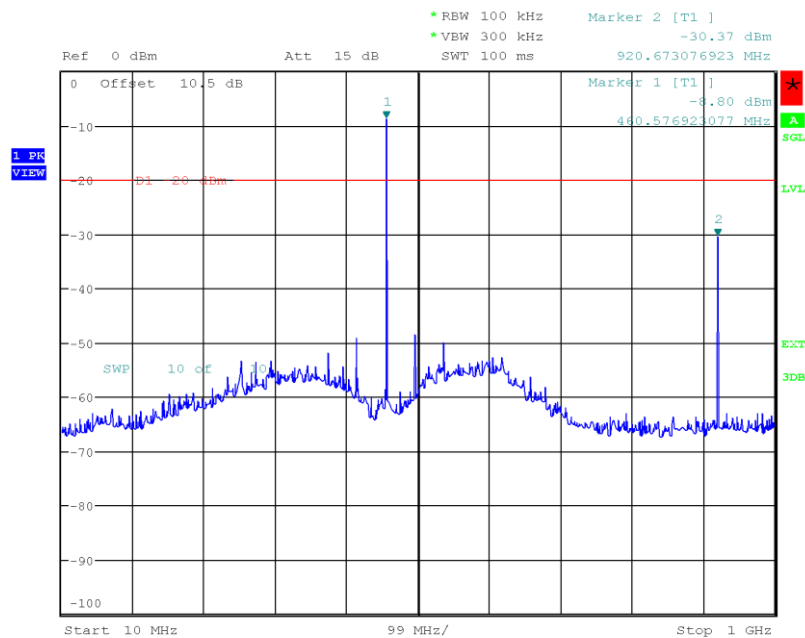
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 Applicant: Kamstrup A/S
 Model Description: Ultrasonic water meter
 Model: KWM2220
 Test Sample ID: 29577
 Operator: Toralf Jahn
 Test Site: Eurofins Product Service GmbH
 Test Date: 2020-06-03
 Operating Conditions: Tnom/Vnom
 Mode: 450.25 MHz



Date: 3.JUN.2020 13:24:39

Spurious emissions at antenna terminal

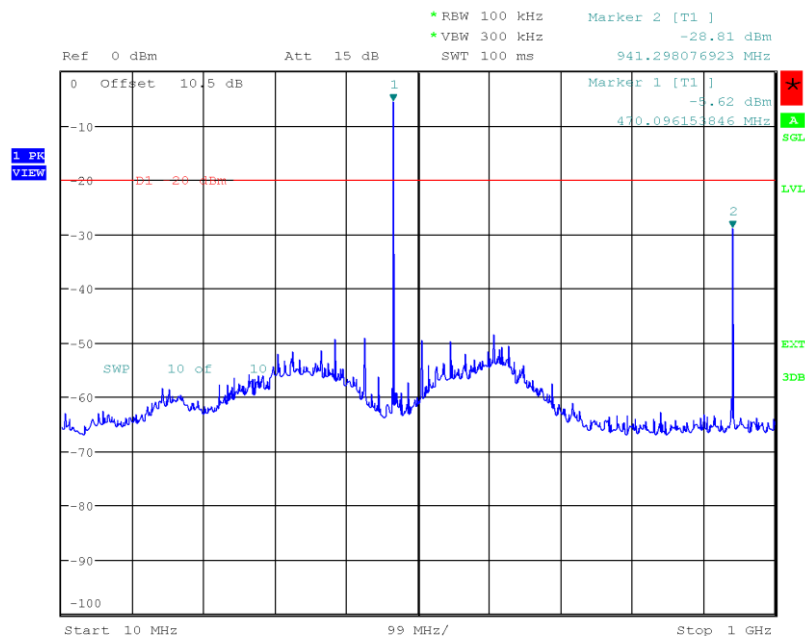
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 Applicant: Kamstrup A/S
 Model Description: Ultrasonic water meter
 Model: KWM2220
 Test Sample ID: 29577
 Operator: Toralf Jahn
 Test Site: Eurofins Product Service GmbH
 Test Date: 2020-06-03
 Operating Conditions: Tnom/Vnom
 Mode: 460.11875 MHz



Date: 3.JUN.2020 13:26:50

Spurious emissions at antenna terminal

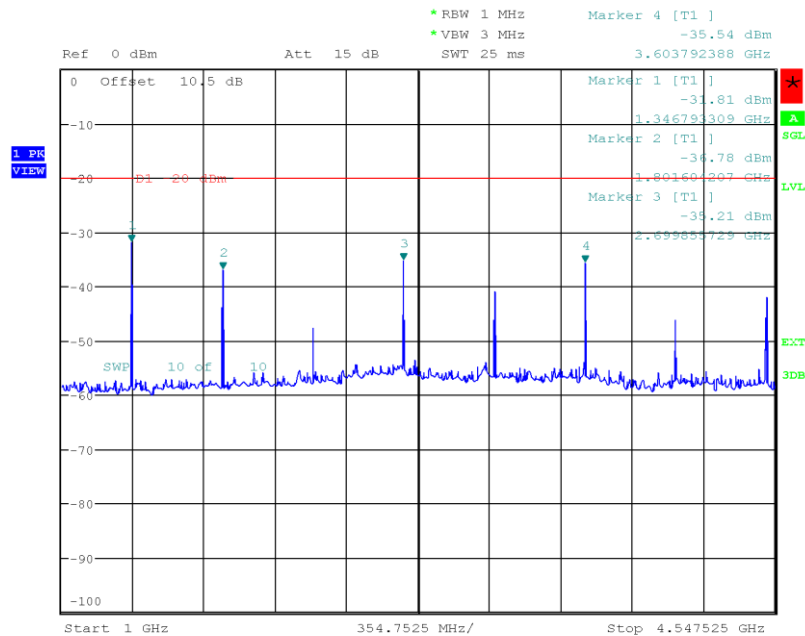
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 Applicant: Kamstrup A/S
 Model Description: Ultrasonic water meter
 Model: KWM2220
 Test Sample ID: 29577
 Operator: Toralf Jahn
 Test Site: Eurofins Product Service GmbH
 Test Date: 2020-06-03
 Operating Conditions: Tnom/Vnom
 Mode: 469.9875 MHz



Date: 3.JUN.2020 13:29:09

Spurious emissions at antenna terminal

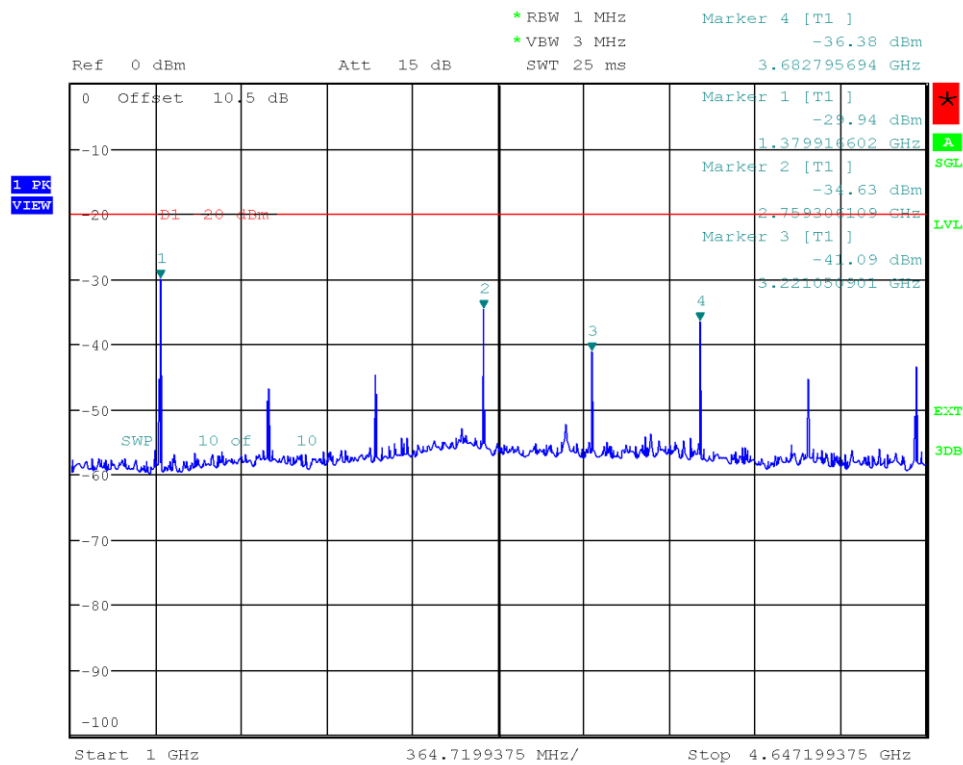
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 Applicant: Kamstrup A/S
 Model Description: Ultrasonic water meter
 Model: KWM2220
 Test Sample ID: 29577
 Operator: Toralf Jahn
 Test Site: Eurofins Product Service GmbH
 Test Date: 2020-06-03
 Operating Conditions: Tnom/Vnom
 Mode: 450.25 MHz



Date: 3.JUN.2020 13:34:08

Spurious emissions at antenna terminal

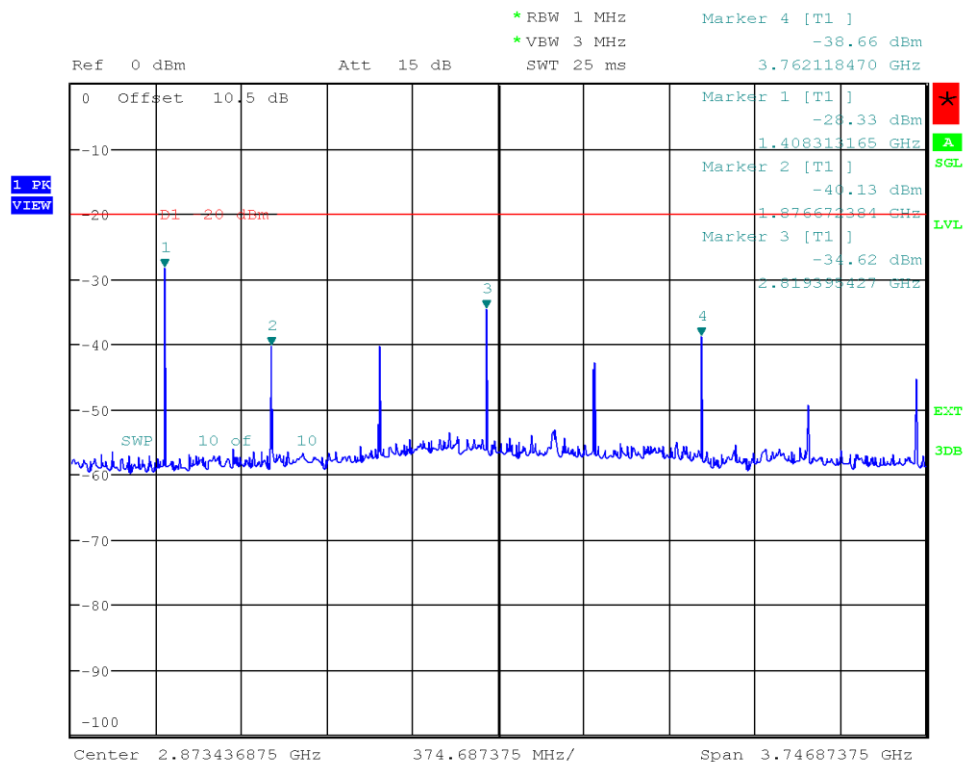
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 Applicant: Kamstrup A/S
 Model Description: Ultrasonic water meter
 Model: KWM2220
 Test Sample ID: 29577
 Operator: Toralf Jahn
 Test Site: Eurofins Product Service GmbH
 Test Date: 2020-06-03
 Operating Conditions: Tnom/Vnom
 Mode: 460.11875 MHz



Date: 3.JUN.2020 13:36:37

Spurious emissions at antenna terminal

Project Number: G0M-2002-8859
 Applicant: Kamstrup A/S
 Model Description: Ultrasonic water meter
 Model: KWM2220
 Test Sample ID: 29577
 Operator: Toralf Jahn
 Test Site: Eurofins Product Service GmbH
 Test Date: 2020-06-03
 Operating Conditions: Tnom/Vnom
 Mode: 469.9875 MHz



Date: 3.JUN.2020 13:38:49