kamstrup

Technical Description

flowIQ® 2200

Water Meter

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Copyright

Trademarks

flowIQ® 2200 is a registered trademark for Kamstrup A/S.

1. Nomenclature

Explanatory list of product names and other terms used in this Technical Description

[1] Acoustic Leak Detection Also referred as ALD
A feature integrated in the water meter for indication of leaks in the pipe system/ service connections.

[2] Kamstrup Analytics
Analysis tool for better understanding of what is happening in the distribution network
for analysis and visualization for a complete overview and use the data you have collected.

[3] READy
A solution for reading meters remotely and optimizing the distribution network.

[4] Kamstrup Water Intelligence
Water Intelligence gives you an overview of your distribution network split into districts with detailed information on inlet flow, consumption and water loss.

[5] General Data Protection Regulation (GDPR)
GDPR is a regulation in EU law on data protection and privacy for all individuals within the European Union (EU). The GDPR aims primarily to give control to individuals over their personal data and to simplify the regulatory environment for international business by unifying the regulation within the EU.

2. General description

2.1 Introduction

flowIQ® 2200 covers a series of battery powered ultrasonic water meters, intended for measurement of drinking water consumption in residential, light commercial and multi-unit buildings.

The meter features a uniquely integrated [1] Acoustic Leak Detection (ALD) feature, which allows the meter to give an indication of leaks in service connections – upstream from the water meter.

This water meter provides a large improvement in efficiency of finding upstream leaks, which today are difficult and manpower intensive to detect. In combination with [2] Kamstrup Analytics, it is easier to identify and map approximate locations of underground pipe breaks.

The meter employs an ultrasonic measurement principle, based on Kamstrup's experiences since 1991 on ultrasonic flow measurement, in water systems and central heating installations. The ultrasonic measurement principle has a longtime industry proven track record for more than 50 years, being the basis of stable, reliable and pinpoint accurate measuring devices. flowIQ® meters, which have industry-leading accuracy, ensures that even very low flows are measured down to the very last drop.

With the emergence of smart cities and digitalization of utilities, there is an ever-increasing demand on data availability and quality. Beyond flow measurement, the meter also provides indication of other irregularities which could have detrimental effects on the distribution grids, such as bursts, leaks, extreme temperatures or tampering.

With this meter you will be in a better position than ever before, to manage and optimize your water distribution grid, secure correct billing and reduce non-revenue water.

[1.] See Nomenclature on *page 6*

[2.] "

2.2 Highlights

- Compact water meter design with up to 16 years of life time
- No moving parts ensures low maintenance and a long-term reliable device with a low cost of ownership
- Market leading water ingress protection – IP68
- 9 digits for volume and 4 digits flow rate available in display
- Acoustic Leak Detection
- Low start flow, starting at 2 l/h
- Temperature measurements on both water and ambient conditions
- Leak, burst, tampering, no-flow, low battery and radio-off alarms in display
- Internal data logger with storage for up to 1440 hourly values, 460 daily values, 36 monthly values and 20 yearly values
- Type tested in accordance with requirements for custody transfer MI-001 & the OIML R49 recommendations
- All wetted materials are compliant with international drinking water regulations
- Manufactured under strict hygienic control and calibrated in Kamstrup in-house laboratories that are accredited according to ISO 17025 standard.
- Available with Wireless M-Bus radio communication
- Infrared interface to read onboard loggers and update the meter configuration

flowIQ® 2200 can be used as a stand-alone meter or an integrated solution combined with [3.]READy and [4.]Kamstrup Water Intelligence.

[3.] See Nomenclature on *page 6*

[4.] "

2.3 Applications

- Measurement of potable water
- Monitoring and optimization of pipe network
- Leak detection
- Water consumption and billing.

2.4 Additional information

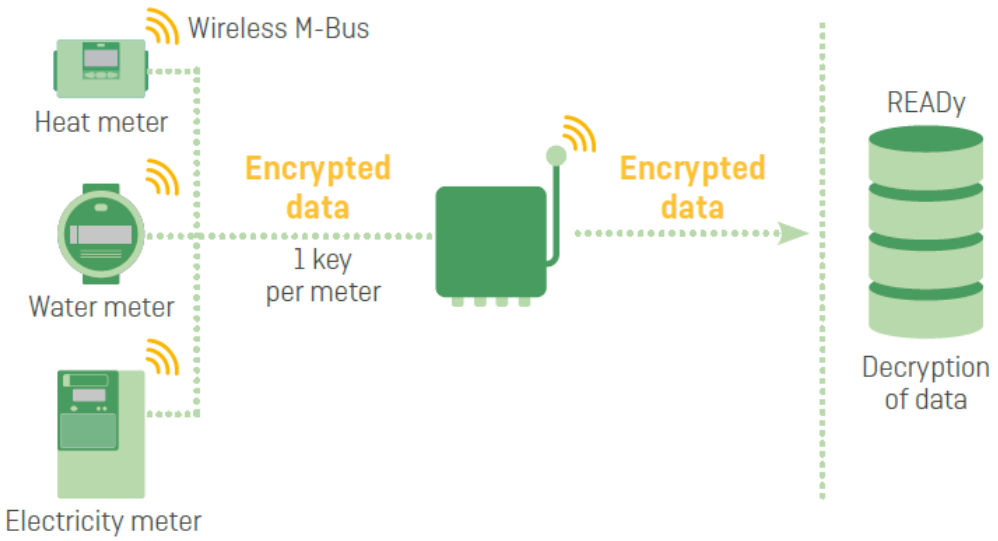
2.4.1 General Data Protection Regulation

[5] General Data Protection Regulation, also referred as in abbreviation GDPR

All metering solutions deliver data that are both confidential and in their original form the following security principles are followed:

- Data encryption
- Role-based access to data
- Logging of activity
- Multiple security layers
- Contingency plan

All metering devices have individual encryption keys to protect data from meter to collection unit and to the server. Data storage and decryption happen solely behind firewalls etc., where the rest of the chain is also protected.



Above, you see how data is protected throughout the chain.

[5.] See Nomenclature on *page 6*

2.4.2 Relevant links

GDPR compliance	Brochure 5811-5823 GB at products.kamstrup.com/
Accessories	for Kamstrup water meters Document 5810-1270_GB at products.kamstrup.com/
Kamstrup homepage	link to the webpage here: https://www.kamstrup.com
My Kamstrup	link to the portal here: https://apps.kamstrup.com/
Encryption Key Service	https://www.kamstrup.com/en-en/my-kamstrup-guides
ISO certificates	Contact Kamstrup A/S
Type approvals	Contact Kamstrup A/S
Technical Description	for METERTOOL & LogView Document 5512-1653 GB at products.kamstrup.com/
Technical Description	for Pulse Interface 5512-2502 GB at products.kamstrup.com/

3. Technical data

3.1 Mechanical data

Water temperature	Cold water 0.1...30 °C (T30) or 0.1...50 °C (T50)
Climatic environment	5...55 °C, condensing humidity (Mounted indoors in utility rooms and outdoors in meter pits)
Storage temperature	-25…60 °C (Empty meter) A packaged water meter must not, (for the sake of the APET packaging), be stored at temperatures higher than 40 °C for periods exceeding 24 hours
Pressure stage	PN16 (approved for PN6, PN10 and PN16)
Flow sensitivity	Sensitivity to irregularity (acc. to OIML R49-1 2013 section 6.3.5)
Velocity field class (sensivity)	Upstream: U0 Downstream: D0
Accuracy class	2
Protection class	IP68 – Immersion depth 25 meters, duration 30 minutes
Orientation requirements	None – the meter can be oriented as needed

3.2 Electrical data

Battery	3.65 VDC, C-cell lithium
Battery lifetime	Up to 16 years at tBAT < 30 °C – depending on choise data packet Up to 8 years at tBAT < 55 °C
EMC DATA (OIML)	Fulfils MID class E1 and E2

3.3 Materials

Meter housing and pipe	PPS with 40 % fibreglass and PSU
Reflectors	Stainless steel, W.no. 1.4401 and 1.4404 (316 / 316L)
Cover	Glass
Top ring	Polycarbonate (dyed)

3.4 Approvals

The water meter has been approved for the European markets according to the Measurement Instruments Directive MID2014/32EU, based on OIML R49* with 'FORCE Certification' as notified body.

*OIML: 'International Organization of Legal Metrology'

CE marking according to MID	CE M18 0200	
Designations according to MID classifications	OIML R49-2013	
MID Cert.:	B-Module:	DK-0200-MI001-022
	D-Module:	DK-0200-MIQA-001
Low Voltage Directive	Mechanical:	M1
Ambient class	B / O	(in-/out-doors)
Radio/Communication	RE-D	(Radio Equipment Directive)
Hygienic/Drinking Water	KTW, W270	

3.5 Communications overview

The water meters are available with integrated data communication:

Meter type	Frequency	Settings (Wireless M-Bus)	Standard
Europe	868 MHz	Mode C1/T1 OMS	EN 13757-4 European standard for remote reading of meters

4. Design & user interface

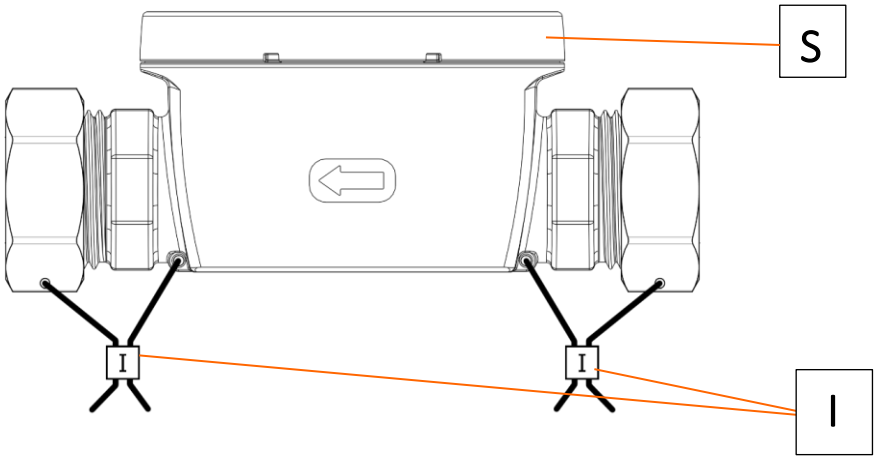
4.1 Front plate – flowIQ® 2200

4.1.1 Meter face details

The meter face plate contains permanent laser engraved information on type number, serial number, temperature range, maximum allowable pressure (MAP), production year, rated flow, IP rating and approvals.

4.1.2 Seals and marking

D	Module D label (behind the front glass)
S	Security seal (void sealing ring)
T	Type label (behind the front glass)
I	Installation seals (wire and seals)



4.2 Information in display

The information codes are shown in the figure below – detailed description follows.

The info codes count 7 separate symbols. Each of these indicates a special condition in the meter. See meaning and way of appearance in the following table.

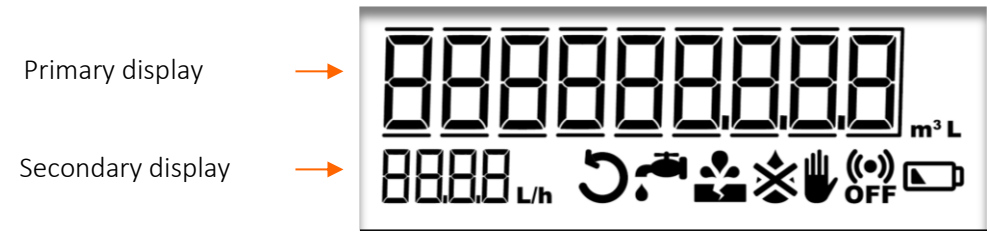
Info code	Icon/symbol	Meaning
Reverse flow		An arrow appears if there is reverse flow
Leak		Symbol appears if the water has not been stagnant in the meter during the past 24 hours. (relative to a pre-programmed value). This may be a sign of a leaky faucet or toilet
Burst		Symbol appears if the water flow has exceeded a pre-programmed limit for a minimum of 30 minutes, which is a sign of a pipe burst
Dry		Symbol appears if the meter is not water-filled
Tamper		Icon appears by attempt of fraud. The meter is no longer valid for billing purposes
Battery		Icon appears when the expected capacity left is 6 months (or when the voltage drops below 2.9V)
Radio OFF	OFF	Symbol appears if the meter is still in transport mode, with the built-in radio transmitter turned off. The transmitter turns on automatically when the first ½ liter of water have run through the meter

All info codes disappear when the condition is no longer met for the activation of the info code, except for 'Tamper'. Once activated 'Tamper' will always be active.

For futher details on info codes, see chapter 7.9 *Info codes – general*.

4.3 Display

The meter display includes the following details:



- 9 digits – for volume measurement – configurable selection of decimal points
- 4 digits – for flow measurement (bottom left corner)
- Measuring units – for volume and flow
- Pictograms – showing meter information codes or warnings
- Lines above and below the digitis behind the decimal point.

The value shown in the display, and thereby the measured quantity, can be maximum 999.999.999. If the meter reaches the maximum value, the display will roll over and the meter continues counting from 000.000.000.

4.3.1 Volume and flow in display

The unit of measure for volume and flow, together with the desired number of decimals, will be defined when ordering the meter.

It is possible to change these choices subsequently, by means of METERTOOL.

	Volume	Flow
Number of decimals displayed	0-3	0-2

All available display options can be found in section *5.3 Configuration overview*.

4.3.2 Display views

It is possible to toggle through all views by means of the Kamstrup meter reader head, part no. 6699-099, placed on the optical eye at the meter front. For more details on the meter reader head/optical eye, please see chapter *11 Tools and programs.*

The magnet needs to be removed, and applied again on the optical eye, to switch display view.

As standard the display will show totalized legal volume and actual flow. Furthermore, the meter counts several alternate display views as shown in the table below.

Menu order	Description	Primary display	Secondary display
1	Legal volume view	Volume	Flow
2	User test view	Volume	Flow
3	Adjust log entries	Shows number of adjustments	02-2
4	Display segment test	All segments ON	All segments ON

**Flow measurement is shown, in the bottom left corner of the display, applying for 'legal volume view' and 'user test view'. For other views it is used to highlight the view ID (Adjust log entries = ID 02) + menu order*

4.3.2.1 User test view

This mode is the same as the legal display view, but with a higher volume resolution. This mode is intended for users who wish to test the meters on a flow verification rig, which has a lower max flow capacity, than typical accredited laboratories.

See table below:

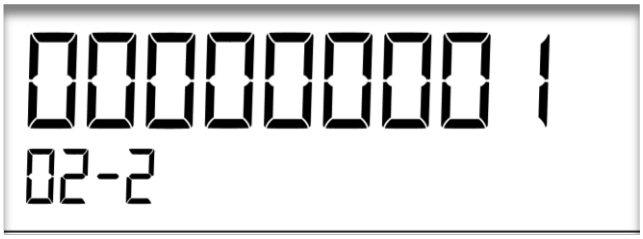
Unit	Normal mode	User test view
m^3	x,xxx m^3	x,x liter
	x,xx m^3	x,xxx m^3
	x,x m^3	x,xx m^3
	x m^3	x,x m^3

When the meter is in test mode every second line, above and below the volume digits, will be flashing as shown on the figure to the left.

The meter will automatically revert, back to normal display view after 8 seconds.

4.3.2.2 Meter adjustment log entries

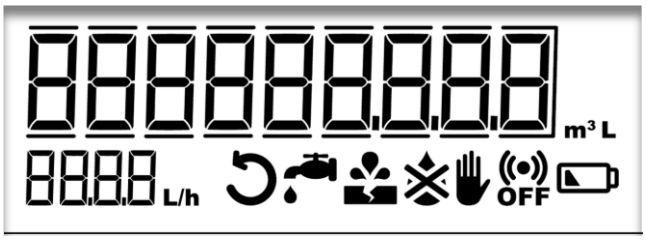
Shows the number of adjustments made by Kamstrup or accredited partners.



The primary display shows that the meter has been re-verified once.

The secondary display shows table entry 2 and page 2

4.3.2.3 Display segment test



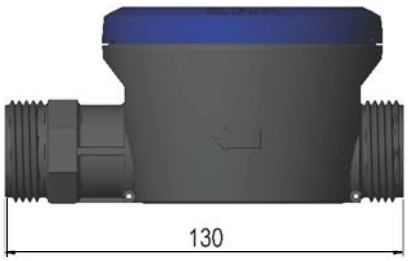
Test to ensure that all segments in the display are working as intended.

4.4 Dimensioned sketches

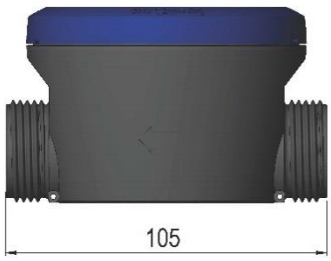
Type	1A / 1B	2B	2A	2C	1C	1D / 1E	2D / 2E
Size	G¾B (R½) x 110 mm	G1B (R¾) x 130 mm	G1B (R¾) x 105 mm	G1B (R¾) x 130 mm	G1B (R¾) x 115 mm	G¾B (R½) x170 mm	G1B (R¾) x 190 mm
Q_3 [m^3/h]	1.6 / 2.5	2.5	2.5	4.0	2.5	1.6 / 2.5	2.5 / 4.0

Type: 1A and 1B

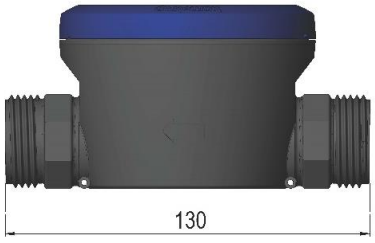
Type: 2B



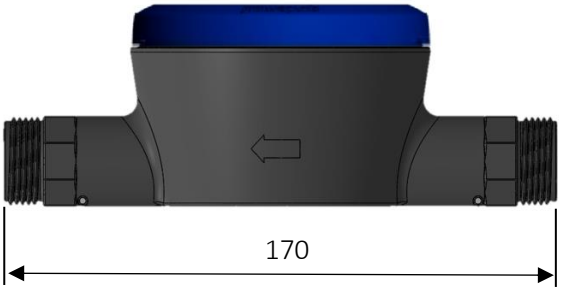
Type: 2A



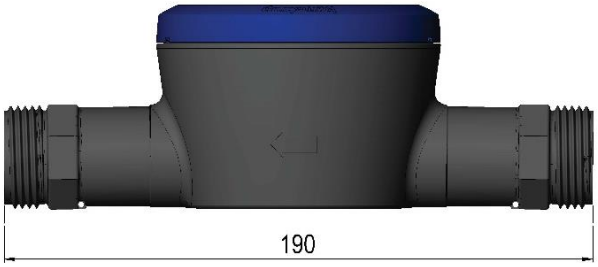
Type: 2C



Type: 1D and 1E

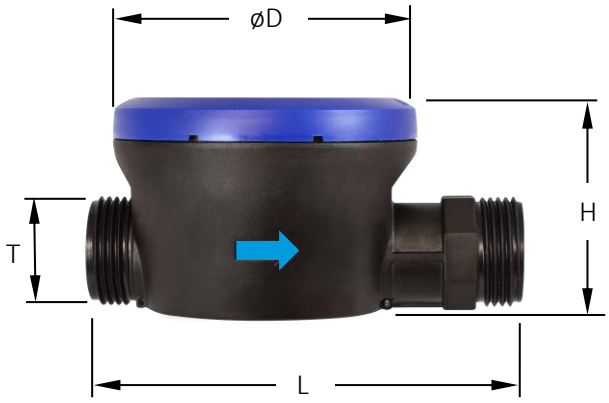


Type: 2D and 2E



4.4.1 Dimensions, connections, weight

Referring to the sketch,
see dimensions and weights in the table below.



Q_3 [m³/h]	Meter type	T ISO 228-1 Thread	L [mm]	H [mm]	D [mm]	Weight approx. [g]
1.6	1A	G3/4B	110	60	91.6	370
2.5	1B	G3/4B	110	60	91.6	370
2.5	1D	G3/4B	170	60	91,6	370
1.6	1E	G3/4B	170	60	91,6	370
2.5	2A	G1B	105	64	91.6	390
2.5	2B	G1B	130	64	91.6	400
4.0	2C	G1B	130	66	91.6	400
2.5	2D	G1B	190	64	91.6	455
4.0	2E	G1B	190	66	91.6	470

5. Ordering information

5.1 Configuration table

	Nom. flow Q_3	Min. flow Q_1	Max flow Q_4	Dynamic range Q_3/Q_1	Min. cut-off	Max cut-off **)	Pressure loss Δp at Q_3	Connec-tion on meter	Length	Non-re-turn valve	Strainer
Type number	[m^3/h]	[l/h]	[m^3/h]		[l/h]	[m^3/h]	[bar]		[mm]		
02-x-xx-x-C-1A-x-xx	1.6	6.4	2.0	250	2	4.6	0.17	G¾B	110	Yes	Yes
02-x-xx-x-C-1B-x-xx	2.5	10	3.1	250	2	4.6	0.4	G¾B	110	Yes	Yes
02-x-xx-x-C-1E-x-xx	1.6	6.4	2.0	250	2	4.6	0.17	G¾B	170	Yes	Yes
02-x-xx-x-C-1D-x-xx	2.5	10	3.1	250	2	4.6	0.4	G¾B	170	Yes	Yes
02-x-xx-x-C-2A-x-xx	2.5	10	3.1	250	2	4.6	0.4	G1B	105	*)No	Yes
02-x-xx-x-C-2B-x-xx	2.5	10	3.1	250	2	4.6	0.4	G1B	130	Yes	Yes
02-x-xx-x-C-2C-x-xx	4.0	16	5.0	250	3.2	8.5	0.4	G1B	130	Yes	Yes
02-x-xx-x-C-2D-x-xx	2.5	10	3.1	250	2	4.6	0.4	G1B	190	Yes	Yes
02-x-xx-x-C-2E-x-xx	4.0	16	5.0	250	3.2	8.5	0.4	G1B	190	Yes	Yes

*) *Non-return valve is not possible because of the short overall length*

**) *At flows above 'Maximum cut-off' measurement continues corresponding to a constant flow at this value.*

5.2 Type number overview

Type	KWM2210 -	□□	□	□□	□	□	□□	□	□□
Meter generation									
Second generation		**02**							
Mechanical design									
1-part PPS body			**K**						
Communication									
Wireless M-Bus 868MHz				**13**					
Power supply									
C-cell					**C**				
Dynamic range									
100						**A**			
250						**C**			
Meter size									
¾" 110mm, 1.6m³/h							**1A**		
¾" 110mm, 2.5m³/h							**1B**		
¾" 170mm, 1.6m³/h							**1E**		
¾" 170mm, 2.5m³/h							**1D**		
1" 105mm, 2.5m³/h							**2A**		
1" 130mm, 2.5m³/h							**2B**		
1" 130mm, 4.0m³/h							**2C**		
1" 190mm, 2.5m³/h							**2D**		
1" 190mm, 4.0m³/h							**2E**		
Meter type									
Cold water								**8**	
Country code									
Denmark									**DK**
Germany									**DE**
Sweden									**SE**
Norway									**NO**
Finland									**FI**

The properties included in the type number cannot be changed once the meter has been produced.

5.3 Configuration overview

Config	DDD	JJ	KK	LLL	MMMM	N	P	S	U	RR	CCC	V	T	YY	ZZZ
	□□	□□	□□	□□□	□□□□	□	□	□	□	□□	□□□	□	□	□□	□□□
Display views															
Default (See section *4.3.2*)	**803**														
GMT offset – time zone															
(GMT+1)		**52**													
(GMT+2)		**56**													
Target date															
1st of the month			**01**												
Max values – average over time (1…120 min.)															
2 minutes				**002**											
Customer label															
2060-MMMM					**MMMM**										
Leakage message limit															
Flow continuously…															
> 0.1% of Q_3/max flow (US)						**1**									
> 0.25% of Q_3/max flow(US)						**2**									
> 0.5% of Q_3/max flow(US)						**3**									
> 1.0 % of Q_3/max flow(US)						**4**									
> 2.0 % of Q_3/max flow(US)						**5**									
OFF (no leakage limit)						**0**									
Pipe burst limit															
OFF (no burst limit)							**0**								
Flow > 5 %							**1**								
Flow > 10 %							**2**								
Flow > 20 %							**3**								
…of max flow for 30 minutes															
Ambient Temperature low limit															
Ambient temp. < 3 °C								**3**							
Ambient temp. < 6 °C								**6**							
OFF								**0**							
Ambient Temperature high limit															
Ambient temp. > 35 °C									**3**						
Ambient temp. > 45 °C									**6**						
OFF									**0**						

To be continued on next page…

Config	DDD	JJ	KK	LLL	MMMM	N	P	S	U	RR	CCC	V	T	YY	ZZZ
Continued from previous page															
Data logger profile															
Standard & Accoustic Leak Detection										**03**					
Display resolution (alphanumeric) – Decimal markings															
000000,001 m^3 – 0000 l/h											**010**				
0000000,01 m^3 – 0000 l/h											**020**				
00000000,1 m^3 – 0000 l/h											**030**				
000000001 m^3 – 0000 l/h											**040**				
Temperature units of measure															
Celcius												**0**			
Encryption level															
Encryption with separately forwarded key													**3**		
Encryption with separately key, with encrypted access to logs													**4**		
Transmission behavior															
See note below**														**YY**	
RADIO OFF														**90**	
Data packages															
See below**															**ZZZ**

	DDD	JJ	KK	LLL	MMMM	N	P	S	U	RR	CCC	V	T	YY	ZZZ
Unless otherwise stated in the order, Kamstrup supplies this configuration:	803	JJ	01	002	0000	3	3	3	3	03	CCC	1	3	YY	ZZZ

Note! [1] *JJ (timezone), CCC (unit, display resolution and billing units) and YYZZZ (datagram) are not pre-defined and has to be chosen in the ordering system.*

*** Overview of Datagrams, see Package Overview in document 5512-2521*

5.4 My Kamstrup – post ordering data

'My Kamstrup' is an online customer portal, where the customer can access a wide range of information. The portal offers access to following:

- Encryption key service, where customers can register and overview their Kamstrup devices, as well as download encryption keys for their products
- Download drivers for Kamstrup accessories
- Download software tools, such as the reading software READy or the diagnostic tool, METERTOOL
- Kamstrup Helpdesk
- Kamstrup Self Service portal and FAQ
- Kamstrup Engineering tools, to help the customer picking the best device
- Training courses and links to informational videos, on the topics of electricity, heat and water measurements.

How to get to My Kamstrup – please see *2.4.2 Relevant links*

6. Communication

flowIQ® always come with integrated radio communication. Several possibilities are available to suit every need from a yearly drive-by scenario for billing purposes to an optimized network solution for billing, customer service, asset management, leakage detection and optimization possibilities.

6.1 Reading data

As described, all logged data can be accessed via the IR interface. In addition, a flowIQ® 2200 meter includes a radio interface with a number of configurable options.

6.1.1 Remote communication

Following remote communication options are available for the flowIQ® 2200 products:

- Wireless M-Bus, which is a European standard (EN 13757-4) for reading utility devices, such as water, electricity or energy.

The Wireless M-Bus radio can be configured for:

- Low power primarily intended for receiving the Wireless M-bus radio signal with a handheld device
- High power for transmitting to an established receiver network.

Details regarding each of above options can be found in following chapters.

6.2 Wireless M-Bus

Wireless M-bus is a mature and proven technology for remote reading of smart meters. Wireless M-Bus provides a robust, simple and secure reading of meters, which requires a small start investment, and is flexible enough to be expanded, when so desired. Wireless M-Bus is based on a European standard (EN 13757-4) for reading utility devices, such as water, electricity or energy.

Main technical highlights for Kamstrup Wireless M-Bus:

- Walk-by/drive-by or Fixed-net mode; wireless m-Bus radio signal optimised for different data collections methods.
- Transmissions modes: C1, T1-OMS and T1-BSI, all encryptable.
- Transmission frequency of 868 MHz. Note that frequency is part of the hardware type number and cannot be reconfigured after ordering.
- Optimized one-way communication that secures the designed lifetime of the meter.

Transmission protocols

There are several transmission protocols available for wireless mBus;

C1

Improved version of the standard T1-OMS protocol, with a better data compression. This offer more data, while keeping the power consumption down and thereby extending the durability of the battery.

T1-OMS (Open Metering System).

This protocol is a manufacturer and utilities independent protocol for wireless mBus. The protocol is created in order to provide the utility and smart meter market with a standardized and interoperable communications interface.

T1-BSI

This protocol contains an additional encryption layer on top of the standard encryption offered by Kamstrup. The additional encryption is following the *'Bundesamt für Sicherheit in der Informationstechnik'*, however additional encryptions provides addition limits the amount of data possible to transfer, compared to regular T1-OMS.

Encryption

Encryption for Wireless M-Bus is done in accordance with the AES 128 standard.

6.2.1 Transmission mode

The wireless M-Bus has two different transmission modes. A rapid short-range mode trading range for responsiveness and a long-range mode with a slower transmission rate.

Transmission mode	Base transmission rate	Transmission power	Typical application
Drive-by	16 sec	10 mW	If the meter is supposed to be read by users walking or driving past the metering point, the radio communicates often at a lower effect setting. This is done to give fast, responsive and reliable reading of the meter, when passing by.
Fixed-net	96 sec	25 mW	If the meter is going to be part of a fixed network, this power setting is preferred. The radio communicates with a higher effect, increasing the range, thereby reduces the the need and cost of infra structure.

Please note that the transmission mode does not restrict the use of the meter to either drive by solutions or fixed networks. Fixed-net can also be picked up by a handheld device, however it may take up to 96 before the data is collected. The can be useful for remote and hard to reach locations

For Drive-by mode, a transmission profile, must be selected during the ordering process. The profile ensures that transmission rate is only at its maximum, when needed. Variable transmission rate is not available for High powered transmission rate.

The transmission profiles are predefined by Kamstrup. It is possible to switch between the available profiles on installed meters via the IR interface and METERTOOL.

Transmission profile	Full transmission rate	Reduced transmission rate	Low transmission rate
Full	Continuous 16s	--	--
Daily	Daytime 16s 08:00 to 16:00	--	Nights 64s

The radio will never be turned off, however during the low transmission rate period, it may take additional time to acquire a data package.

Depending on the choice of transmission profile and data packages, battery lifetime budget of the meter may vary.

6.3 Radio disabled

For Kamstrup flowIQ® water meters there are 2 situations where, where the onboard radio is disabled.

Radio disabled	
Radio Off (ordered)	Can be selected from the radio transmission behaviour. For Wireless M-Bus this is done by choosing YY = 99. When 'Radio Disabled' is selected, the radio will not be activated in normal operation. The only way of enabling the radio is by changing the transmission behaviour of the device.
Radio Off (transport mode)	When the water meter leaves the Kamstrup factory, it is (as part of the production process) placed in 'transport mode' and therefore the 'Radio Off' info code is active in the display. This is to conserve battery life, and limited extraneous radio transmission indicates that the meter is still in 'transport mode' and that the built-in radio transmitter has not yet been activated. In transport mode the meter displays info codes, if any, and these will be available in the respective registers, but they are not saved in the info code log during transport mode.

The radio transmitter is activated and turns on automatically (as part of the installation process) when water starts flowing and approximately 0.5 liter of water has run through the meter.

The radio transmitter remains active.

6.4 Encryption key

When configuring and ordering the flowIQ® 2200, it is possible to select, 'No encryption', 'Encrypted' or 'Encrypted, with encrypted access to logs'.

When ordering devices for European countries, 'Encryption with encrypted access to logs' is selected as default, to ensure that the device, and thereby the customer, complies with the GDPR regulation. It is possible to de-select this configuration option; however, warnings will be in the order text and any penalties for non-compliance with GDPR will fall to the owner of the device.

During the manufacturing of the the meter, an encryption key that correspond to the specific water meter is generated. The key is stored directly in the customers 'Encryption Key Service', commonly referred to as 'EKS'. EKS is a part of 'My Kamstrup' – the online portal where the customers can log in, and from here download the keys for their meters.

In case of direct purchase from Kamstrup, the key storage is an automated process, however, it is also possible to use EKS, if the devices are purchased via 3rd vendor. See the link below for more details.

The encryption keys can be downloaded from EKS, either in Kamstrup's own KMP file format, or as an XML file, where the encryption key is written in. Please note, that these KMP/XML will also contain other information, such as the devices serial number and name.

The encryption keys are used to ensure that only the owner of the device can read the radio communication from the device. For customers using Kamstrup reading software, it is possible to link EKS to the reading software, for ease of use.

If 'Encryption of log access' is selected, the encryption key is also required in order to access the log. The Kamstrup log-reading software, can use the encryption files from EKS, however, this and the encryption key will need to be downloaded.

For more information – see 2.4.2 *Relevant links*

7. Core Functions

7.1 Measuring principle

7.1.1 Background

Flow meter manufacturers have over decades been working on various alternative technologies to replace mechanical measuring principle. Research and development at Kamstrup have proven that ultrasonic flow measuring is an accurate and reliable solution.

Within ultrasonic flow measuring there are two main principles:
The transit time method and the Doppler method.

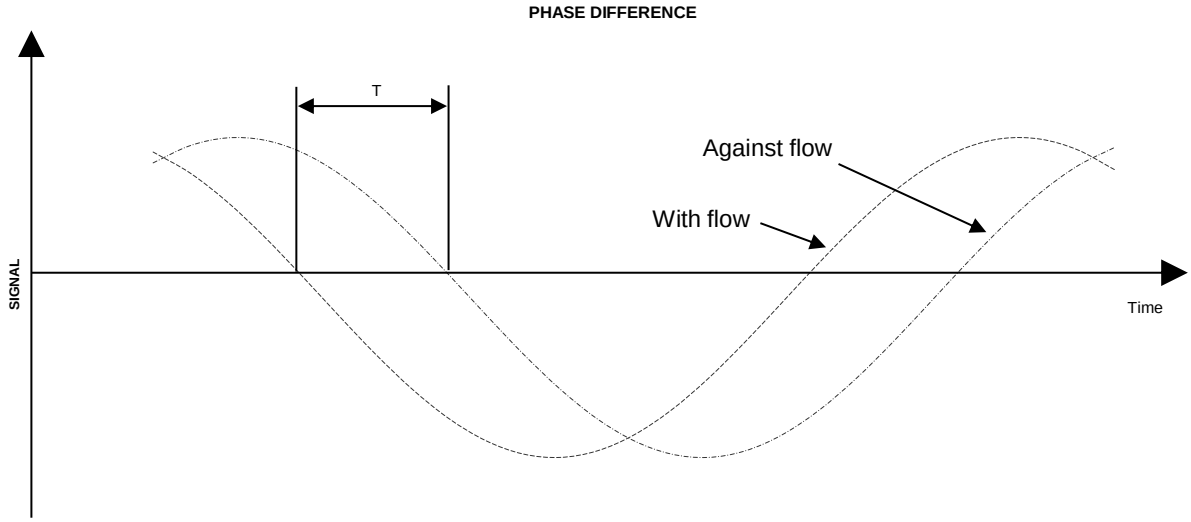
For the purpose of flow measurement, **Kamstrup uses the Transit time method.**

7.1.2 Transit time method

The used transit time method, utilizes the fact that it takes an ultrasonic signal, sent in the opposite direction of the flow, longer to travel from sender to receiver than it takes for a signal sent in the same direction as the flow.

The transit time difference is, however, very small (as little as nanoseconds). Therefore, the time difference is measured as a phase difference between the two 1 MHz sound signals, in order to obtain the necessary accuracy.

The measurement of the actual velocity of sound in water is also used to determine the temperature of the water, as there is a correlation between these two values.



For reference; The Doppler method is based on the frequency change which occurs when sound is reflected by a moving particle. This is very similar the effect you experience when a car drive by. The sound (the frequency) decreases when the car passes by.

7.1.3 Ultrasound generation

The ultrasonic signals are generated using piezo ceramic elements mounted in the meter. The thickness of a piezo ceramic element changes when exposed to an electric field (voltage). When the element is mechanically influenced, a corresponding electric charge is generated. Therefore, the piezo ceramic element can function as both sender and receiver.

The piezo ceramics elements are activated and measure by the onboard microprocessors, which calculates the flow based on the time transient time, as well as the pipe geometry and physical constants.

7.1.4 Flow calculations

In principle, flow is determined by measuring the flow velocity and multiplying it by the area of the measuring pipe:

$$Q = F \times A$$

where:

Q is the flow
F is the flow velocity
A is the area of the measuring pipe

The area and the length which the signal travels in the sensor are well-known factors. The length which the signal travels can be expressed by $L = T \times V$, which can also be written as:

$$T = \frac{L}{V}$$

where:

L is the measuring distance
V is the sound propagation velocity
T is the time

$$\Delta T = L \times \left(\frac{1}{V_1} - \frac{1}{V_2} \right)$$

In connection with ultrasonic flow sensors the velocities V_1 and V_2 can be stated as:

$V_1 = C - F$ and $V_2 = C + F$ respectively

where: C is velocity of sound in water.

Using the above formula, you get:

$$\Delta T = L \times \frac{1}{C - F} - \frac{1}{C + F}$$

which can also be written as:

$$\Delta T = L \times \frac{(C + F) - (C - F)}{(C - F) \times (C + F)}$$

$$\Downarrow$$

$$\Delta T = L \times \frac{2F}{C^2 - F^2}$$

As $C \rangle\rangle F$, F^2 can be omitted and the formula reduced as follows:

$$F = \frac{\Delta T \times C^2}{L \times 2}$$

To minimize the influence from variations of the velocity of sound in water, the latter is measured via absolute time measurements between the two transducers. These measurements are subsequently converted into the current velocity of sound, which is used in connection with flow calculations.

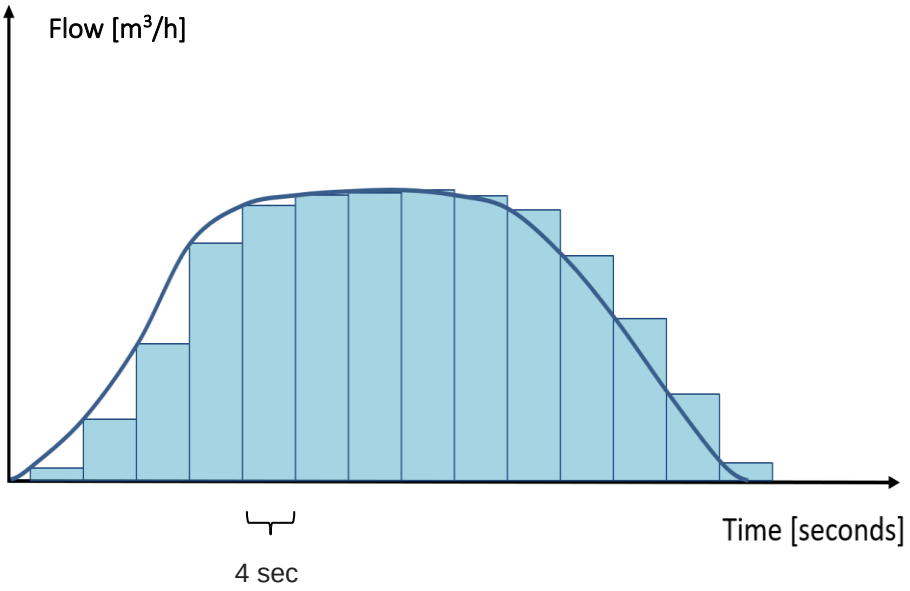
7.2 Calculation of flow volume

Flow is calculated, as mentioned above, by multiplying the flow rate and the cross-sectional area:

$$Q = F \times A$$

The velocity measurement and volume calculation itself only takes a few milliseconds. The measurement is therefore a 'snapshot' of the current flow. Measurement and calculations are performed at intervals of 4 seconds.

The measurement interval is chosen by Kamstrup to get the ideal balance between power consumption and measurement performance.



Similarly, to most types of digital sampling, each 4 second segment is then integrated over time, leading to the calculation of the total volume.

How can this information be useful?

Monitoring the reverse flow can indicate possible network contamination, as ‘foreign’ water moves in to the distribution grid. This may be either due to a leak or water being forced back in to the network.

Tampering scenarios have been observed, where end consumer has tried turning the water meter, in order to avoid billing. In such scenarios the totalized reverse volume, can be a simple indication of fraud.

Please note that the flowIQ® 2200 accuracy specifications only cover the forward flow direction.

7.2.1 Maximum and minimum flow

Maximum and minimum flow are calculated as the highest and the lowest value respectively, of a number of current flow measurements. The averaging-period used for all calculations can be selected when ordering.

By default, the value is 2 minutes if no choices are made, when submitting the order. It is possible to change this later with METERTOOL.

How can this information be useful?

Changes in maximum flow may indicate an error in the water installation. E.g. if max flow decreases over a longer period, it could be a sign of a leakage in the supply pipe or a blocking in the installation before the meter's location.

7.3 Acoustic Leak Detection

All Kamstrup flowIQ® 2200 inline composite meters, will have Acoustic Leak Detection (ALD) enabled.

At regular intervals, during the day, the meter records the ambient noise level in the surrounding pipes. A sudden increase in the lowest measured ambient noise level, is an indication of a pipe leak has occurred. A leak within a pipe will change the volume and frequency of the ambient noise, as the water exits – somewhat similar blowing in a flute.

The noise level measurement covers part of both the upstream pipes, such as service connections and district lines, as well as the downstream pipes, such as internal plumbing.

With multiple meters in proximity of each other, it is possible to map approximate locations of underground pipe breaks.

The noise measurements are accessible in:

- Internal log read via IR interface.
- Datagrams in wireless communication
- Exportable from the Kamstrup READy (separate software)
- Kamstrup Analytics (separate software)

Very high sensitivity is required to perform the noise measurement. To keep internal interference to a minimum, the display will be turned off shortly every hour.

How can this information be useful?

Due to the meter's placement, leaks which may not be detected by conventional means, will be picked up by the acoustic leakdetection and it enables the approximate location of underground pipe leaks and bursts in service connections.

7.4 Water temperature measurements

Every 32 seconds an indirect measurement of water temperature is made, using the ultrasound signal. The maximum and minimum values are calculated every 2 minutes, based on a volume weighted mean value, made since the last minimum/maximum temperature calculation.

Measurement of water temperature naturally requires that the meter is filled with water.

During periods of very low water consumption, the water temperature approaches the ambient tempera-ture. During periods without water flow, the weighted average cannot be calculated and then a code 128 is stored, indicating that there is no consumption.

The water meter measures water and ambient/meter temperature continuously, storing minimum, mean and maximum temperatures hourly, daily, monthly and yearly.

The following accuracy limits apply, as a function of temperature:

Water temperature measurement	*(only available for composite meters)*		
Celsius		Fahrenheit	
Temperature	Tolerance	Temperature	Tolerance
0°C – 20°C	± 1°C	32°F – 68°F	± 2°F
20°C – 30°C	± 2.5°C	68°F – 86°F	± 5°F
> 30°C – No valid measurement		> 86°F – No valid measurement	

How can this information be useful?

Monitoring the water temperature can be helpful to get an indication of the water quality when it reaches the consumer.

Furthermore, it may indicate undesired long retention time in certain parts of the pipe system and thereby, contribute to optimizing simulation models of the pipe system.

7.5 Ambient temperature measurements

The measurements of the ambient temperature are made inside the meter housing, which corresponds to the ambient temperature for the environment where the meter is installed.

The minimum and maximum values are average values based on the period used to determining minimum and maximum flow. This means, if the period for measuring flow is changed it will also affect the temperature measurements.

Ambient/meter temperature measurement		*(temperature within meter housing)*	
Celsius		Fahrenheit	
Temperature	Tolerance	Temperature	Tolerance
-5°C – 50°C	± 1°C	23°F - 127°F	± 2°F

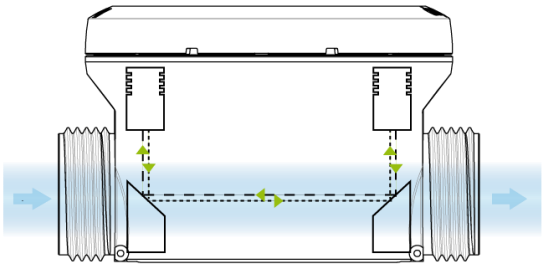
How can this information be useful?

Monitoring ambient/meter temperatures in the installation can be used for warnings of freezing or unintended high temperatures.

7.6 Signal paths

The ultrasonic signal path through the water meter.

From piezo –> reflector –> reflector –> piezo – in both directions.



7.6.1 Measuring sequences

During flow measuring the meter passes through a number of sequences which are repeated at fixed intervals. A typical sequence is a number of ultrasonic signals, followed by a volume and temperature calculation, update of the display/logs and finally a check, whether any alarms needs to be generated, based on the latest information collected.

These sequences remain the same, when the meter is in user test mode (is selected in the onboard menu.) Deviations only occur when the meter is in verification mode, but this must be triggered with METERTOOL via the IR interface.

7.7 Flow limits

In the water meter working range, from start flow/'minimum cut-off' to saturation flow/'maximum cut-off' the flow through the meter will be registered with an accuracy reflecting the legal requirements in OIML R49.

If the flow exceeds max cut-off the water meter registers a constant flow (as maximum cut-off level). If the flow value gets lower than minimum cut-off, the meter does not register any flow.

See table in section *4.1 Front plate – flowIQ® 2200*

In the meter's working range, from 'minimum cut-off' to 'maximum cut-off', there is a linear connection between the quantity of water which has passed through the meter and the measured water flow.

According to metrological and technical requirements (OIML R49), the upper flow limit (Q_4 /max flow) is the highest flowrate, at which the water meter is required to operate (for a short period) within its maximum permissible error, whilst maintaining its metrological performance – when it, subsequently, is operated within its rated operating conditions.

In practice, the highest possible water flow through the meter will be limited by the installation output capacity and sustainable working pressure, as too low downstream working pressure will result in cavitation.

!

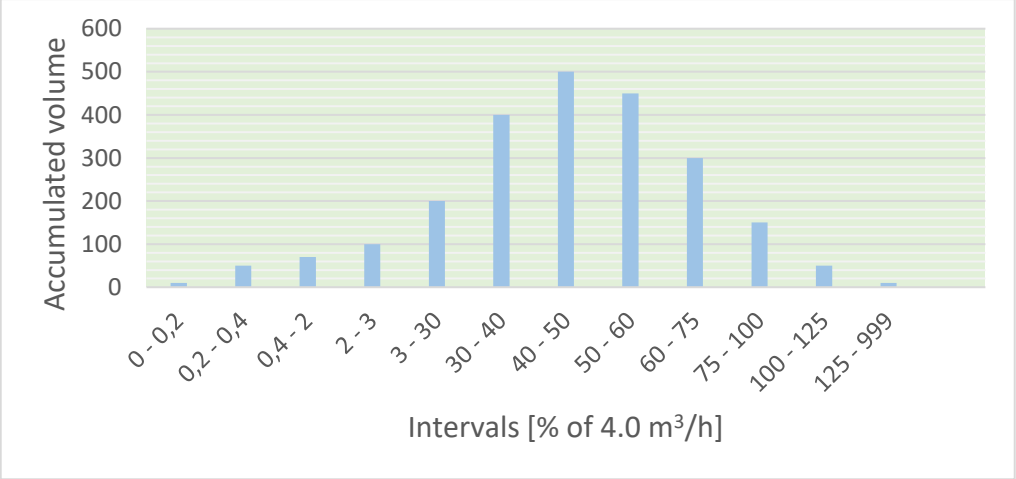
Running at high flow velocities bigger than Q_4 (max flow) may cause risk of cavitation especially at low working pressures below 0.03 MPa (0.3 bar) after the meter.

7.8 Consumption profile

This meter tracks volume integrations in a histogram, called consumption profile. In the histogram, the delta volume of each integration period gets accumulated dependent on the flow. With the consumption profile, it is possible to see how much water, at a given flow, has run through the meter – in relation to other flows.

Below is how the default consumption profile looks like based on a 4.0 m^3/h water meter.

When the data is loaded into a diagram it could look like the diagram below, where the intervals are shown on the x-axis and the accumulated volume for each interval shown on the y-axis.



Each column of the histogram can have a maximum value of 999 m^3. When one of the columns reaches that value, the whole histogram will lock. The histogram can be reset by means of METERTOOL.

When reset, the histogram will get a new starting time, making it easier to keep track of how long the histogram has been active.

If a different consumption profile is chosen in METERTOOL it will clear the existing histogram.

How can this information be useful?

The histogram can be used to get a view of consumption behaviour in a specific installation, providing dianostic data for optimising the distribution grid.

7.9 Info codes – general

With the introduction of flowIQ® 2200, a Kamstrup water meter will be adding several new info codes and code combinations in info code registers. These combinations are used as a part of the data packages available for the remote communication options.

The following info code register are available for use in the radio packages:

(1) Legacy	The legacy register is identical to the info code register in previous generations of Kamstrup water meters and behaves in completely the same way. The register is included to ensure backwards compatibility, where the water meters are upgraded to newer generations of flowIQ®
(2a) Hot environment	This register is intended for drive by applications in warm environments, where high ambient temperatures could be a potential hazard for the water meter or water quality.
(2b) Cold environment	This register is intended for drive-by applications in cold environments, where low ambient temperatures could be a potential hazard for the water meter or surrounding piping.
(3) Fixed network	This register is intended for fixed networks, where data is collected at a fixed rate and historical data is stored in collection software (such as Kamstrup READy). This register leaves out the hour counter, in favour of including all alarms.

Info codes	Alarm				Hour counter			
	(1)	(2a)	(2b)	(3)	(1)	(2a)	(2b)	(3)
DRY	✓	✓	✓	✓	✓	✓	✓	
REVERSE	✓	✓	✓	✓	✓	✓	✓	
LEAK	✓	✓	✓	✓	✓	✓	✓	
BURST	✓	✓	✓	✓	✓	✓	✓	
TAMPER	✓	✓	✓	✓				
Low Battery		✓	✓	✓				
Low Ambient Temp.			✓	✓			✓	
High Ambient Temp.		✓		✓		✓		
Flow above Q_4		✓	✓	✓		✓	✓	
No consumption		✓	✓	✓				

7.10 Info codes – elaboration

An info code indicates a special condition in the meter. If the info code is available in the display, the related symbol flashes or is permanently on when it has been activated. If the 'condition' is not active, the sign is OFF.

Hour counters

In order to keep radio packages sizes to a minimum, Kamstrups hour counters are created as low-resolution indicator. The hour counter is split in to 7 intervals, indicating how long the info code has been active. The intervals are elaborated in the table below.

Interval	Hours
0	0
1	1-8
2	9-24
3	25-72 (2-3 days)
4	73-168 (4-7 days)
5	169-336 (8-14 days)
6	337-504 (15-21 days)
7	≥505 (22-31 days)

Info event and logging

When an enabled info code changes, it results in a new entry in the info logger, an update of the accumulated info code for the interval loggers and an increment of the info code counter (InfoEvent).

The latest 50 info code events are saved in the info logger. Furthermore, an entry will be made in the info log, when the info code condition occurs and again when it disappears.

Info hour counter

The meter includes a register (InfoHR) which holds the number of hours where an info code has been active. The register has hour as unit. The register is incremented when at least one info code has been active within an hour, no matter how long the info code has been present. This register is not incremented if the meter is in transport mode.

Info code handling during transport

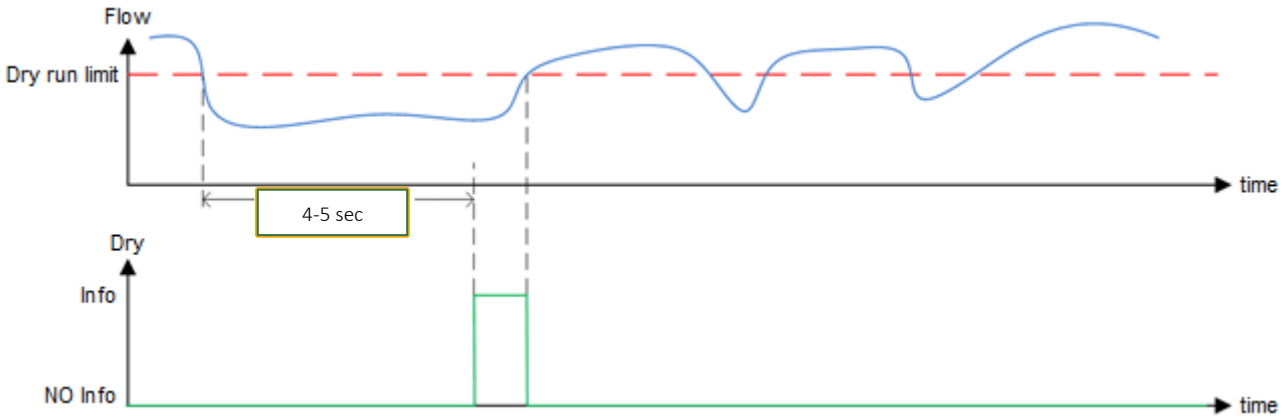
Info codes set when the meter is in transport state, will NOT result in a log entry neither in the info log nor in the interval logs. When the meter leaves transport state an info logging is forced if any info bits are set.

7.10.1 DRY

This info code indicates that there is air in the meter. The ultrasonic measuring principle implies that the meter must be water-filled. If there is air in the meter, nothing is measured.

The info code DRY is activated in the display when 8 successive measurements have shown that there is air in the meter, which is between 4 and 5 seconds. The code disappears after one measurement without air, i.e. after 1 second – see illustration after the table.

Present at	Occurs after	Disappears
Display	60 seconds	instantly
Optical eye	60 seconds	instantly
Logs	60 seconds	instantly
Info hour counter (RF)	60 seconds	instantly



In order to avoid false alarms, due to short-term air build-up in the meter, the info code DRY is not added to the relevant registers and the wireless M-Bus signal, until it has been continuously active for 30 minutes.

7.10.2 REVERSE FLOW

This info code indicates that the water in the meter flows in the wrong direction.

The code is turned on (not flashing) when the water is flowing backwards. It disappears from the display when the water is stagnant, or again runs in the right direction in the meter.

Present at	Occurs after	Disappears
Display	5 minutes	instantly
Optical eye	5 minutes	instantly
Logs	5 minutes	instantly
Info hour counter (RF)	5 minutes	instantly

The reverse flow, required for the info code to appear, depends on the nominal flowrate (Q_3)

See the table below.

Q_3	Reverse flow detection limit
1.6 m^3/h	6.4 L/h
2.5 m^3/h	10 L/h
4.0 m^3/h	16 L/h

Reverse flow is counted and logged in separate internal registers in the water meter according to the logger profile.

The total reverse volume is measured and recorded whether the info code has been activated or not.

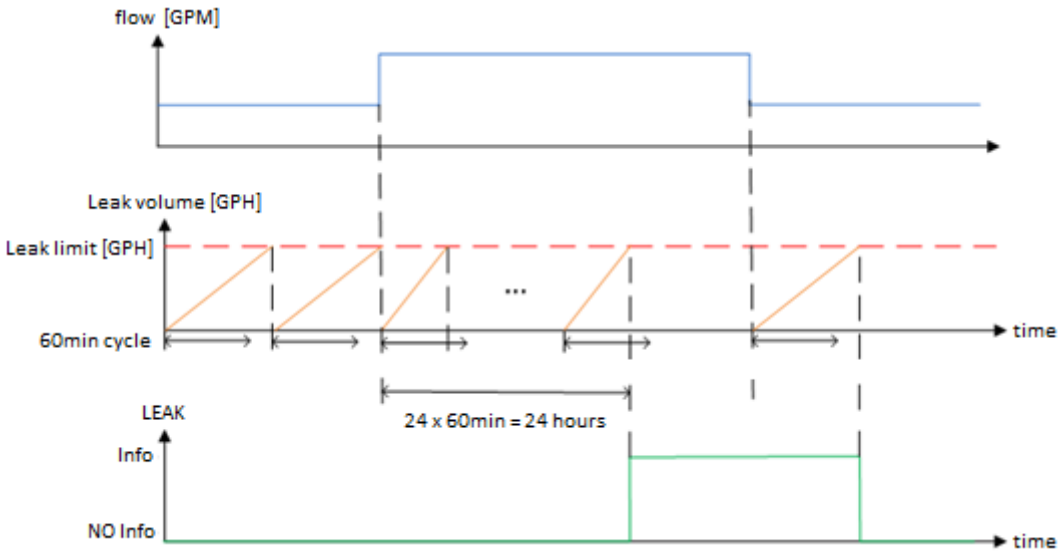
7.10.3 LEAK

This info code is activated if the water is never stagnant in the meter. Possible untight connections, running cisterns, untight safety valves in water tanks, or other untightneses will cause that the water meter registers water flow 24 hours a day.

If the water meter has not, within the latest 24 hours, registered minimum one continuous hour without water flow – corresponding to the values in the table below – this could be a sign of a leakage in the water installation. The alarm automatically disappears after one hour without flow in the meter.

The sensitivity of the leak surveillance can be selected by the customer when submitting the order, or later with METERTOOL. The following options are available:

Leakage message limits		Continuous L/h for 24 hours		
		Q_3 = 1.6 m^3/h	Q_3 = 2.5 m^3/h	Q_3 = 4.0 m^3/h
N =	Constant minimum flow alarm is activated at:			
0	OFF	---	---	---
1	Flow continuously > 0.1 % of Q_3	1.6	2.5	4
2	Flow continuously > 0.25 % of Q_3	4	6.25	10
3	Flow continuously > 0.5 % of Q_3	8	12.5	20
4	Flow continuously > 1.0 % of Q_3	16	25	40
5	Flow continuously > 2.0 % of Q_3	32	50	80



Present at	Occurs after	Disappears after
Display	24 hours	1 hour without leak
Optical eye	24 hours	1 hour without leak
Logs	24 hours	1 hour without leak
Info hour counter (RF)	24 hours	1 hour without leak

The utility must be aware that there may be water consumption all 24 hours in households with many residents. This means, there will not be an hour without flow, and the water meter will set an alarm for this 24-hour period. Users and water utilities must, therefore, be critical of a leakage alarm.

7.10.4 BURST

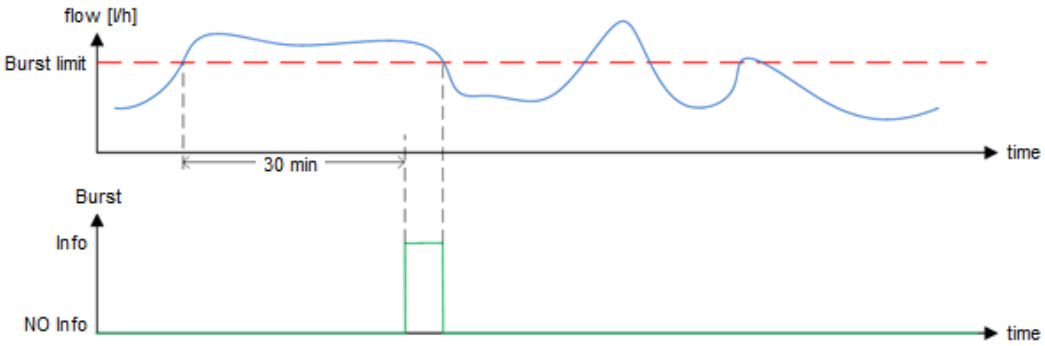
This info code is activated if the flow exceeds a given value for a continuous period of 30 minutes and may be a sign of a burst in the pipe installation, which requires prompt action.

The size of the 30-minute flow (which prompts the info code BURST) can be determined by the customer when submitting the order. The following options are available:

Pipe burst limits		Total L/h within 30 minutes		
		Q_3 = 1.6 m^3/h	Q_3 = 2.5 m^3/h	Q_3 = 4.0 m^3/h
p =	Constantly high flow alarm is activated at:			
0	OFF	---	---	---
1	Flow > 5 % of Q_3 in 30 minutes	80	125	200
2	Flow > 10 % of Q_3 in 30 minutes	160	250	400
3	Flow > 20 % of Q_3 in 30 minutes	320	500	800

Be aware, that a large water consumption, which activates the pipe BURST alarm in the water meter, may occur without being a pipe break, in systems where many households are connected. Users and water utilities must, therefore, be critical of a burst alarm.

Present at	Occurs after	Disappears
Display	30 minutes	Instantly
Optical eye	30 minutes	Instantly
Info log	30 minutes	Instantly
Info hour counter (RF)	30 minutes	Instantly



7.10.5 TAMPER

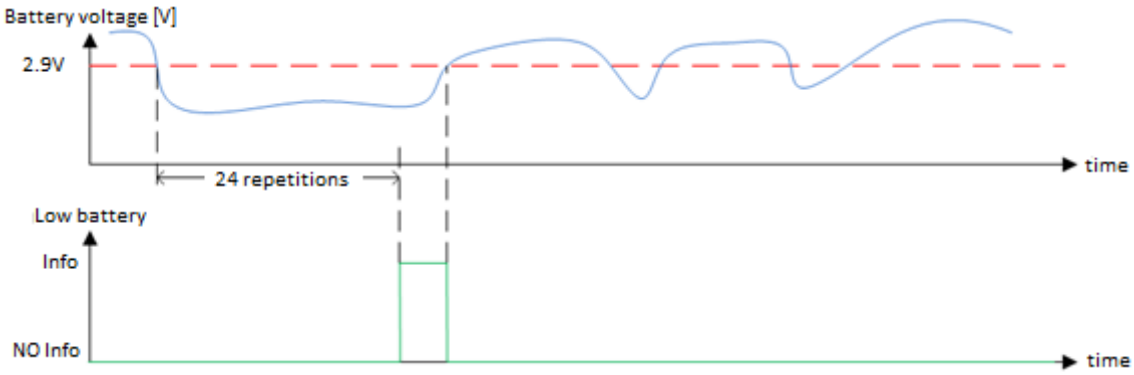
This info code becomes active if the water meter has been exposed to unauthorized access, i.e. an attempt to cheat. This means that the meter is no longer valid for billing purposes.

The info code TAMPER cannot be removed, once it has been shown.

7.10.6 Low battery

This info code becomes active if the battery voltage drops too low. Replacement of device is recommended as quickly as possible.

The battery voltage is measured once per hour. Info code 'Low Battery' is set when a voltage below 2.9V has been measured 24 consecutive times, 24 hours in a row.



Present at	Occurs after	Disappears after
Display	24 hours	2 hours
Optical eye	24 hours	2 hours
Info log	24 hours	2 hours
Info hour counter (RF)	24 hours	2 hours

7.10.7 Temperature ambient low

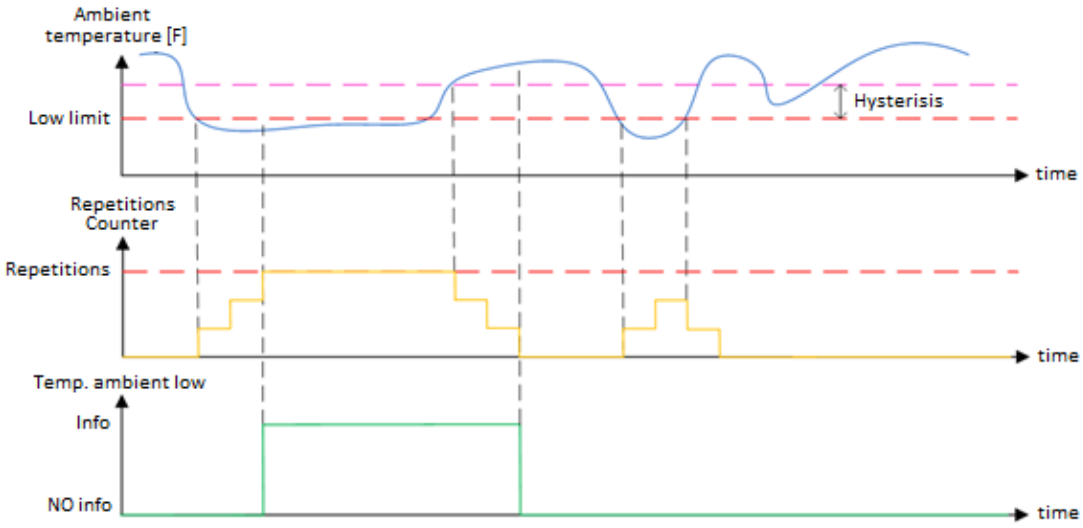
This info code becomes active if the ambient temperature is below the trigger level selected in the configuration. This is a possible indicator that there may an increased risk of frost burst piping. For areas where the water is stagnant for parts of the year, such as summer houses, this can be valuable.

Each time the ambient temperature is measured, an evaluation on setting or clearing the info code is executed. When a temperature below 'low limit' has been measured, 3 repetitions in a row, the info code is set. The info code is then cleared again when a temperature above 'low limit' has been measured 3 repetitions in a row.

In order to avoid constant setting and clearing the info code, a hysteresis is added to the limit. To set the info code the ambient temperature must be below the 'low limit'; in order to clear the info code, the temperature must raise above the 'low limit' + 'hysterisis' – See the figure below for further details.

Temperature measurement is executed continuously, every minute, meaning that for the info code to be set, 3 measurements, and therefore also 3 minutes, has to pass before the info code becomes active.

See the following illustration and table:



Present at	Occurs after	Disappears
Display	N/A	N/A
Optical eye	5 minutes	Instantly
Info log	5 minutes	Instantly
Info hour counter (RF)	5 minutes	Instantly

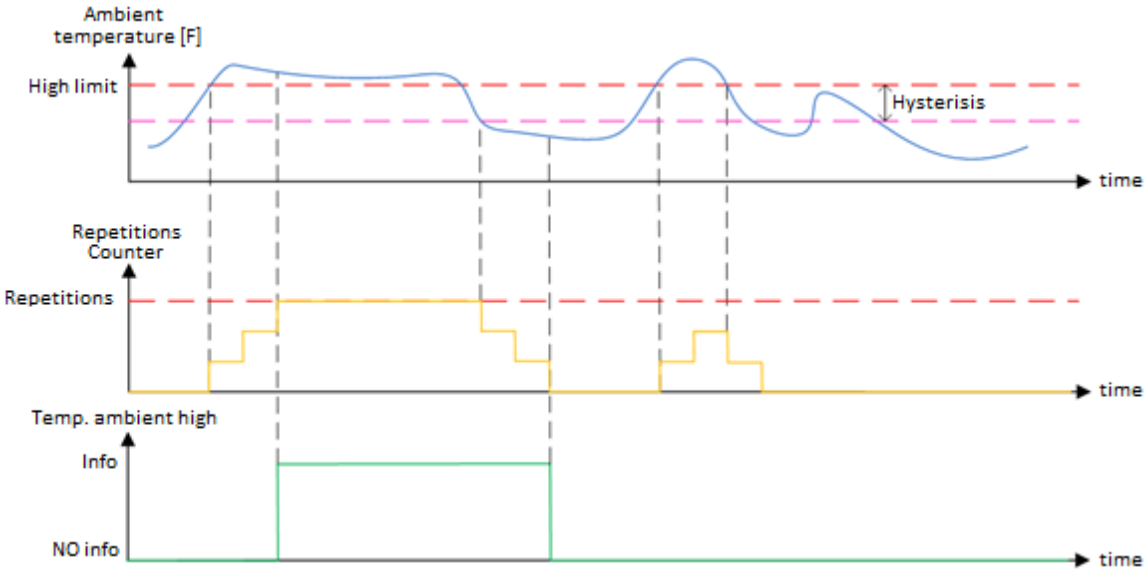
7.10.8 Temperature ambient high

This info code becomes active if the ambient temperature is above the trigger level selected in the configuration. This is a possible indicator that the temperature have reached a point where undesirable organic growth may be present in the water or the water quality is otherwise negatively affected.

Each time the ambient temperature is measured, an evaluation on setting or clearing the info code is executed. When a temperature above 'high limit' has been measured 3 repetitions in a row, the info code is set. The info code is then cleared again when a temperature below 'high limit' has been measured 3 repetitions in a row.

In order to avoid constant setting and clearing the info code, a hysteresis is added to the limit. To set the info code the ambient temperature must be above the 'high limit'; in order to clear the info code, the temperature must fall below the 'high limit' + 'hysterisis' – See figure below for further details.

Temperature measurement is executed continuously, every minute, meaning that for the info code to be set, 3 measurements, and therefore also 3 minutes, must pass before the info code becomes active.

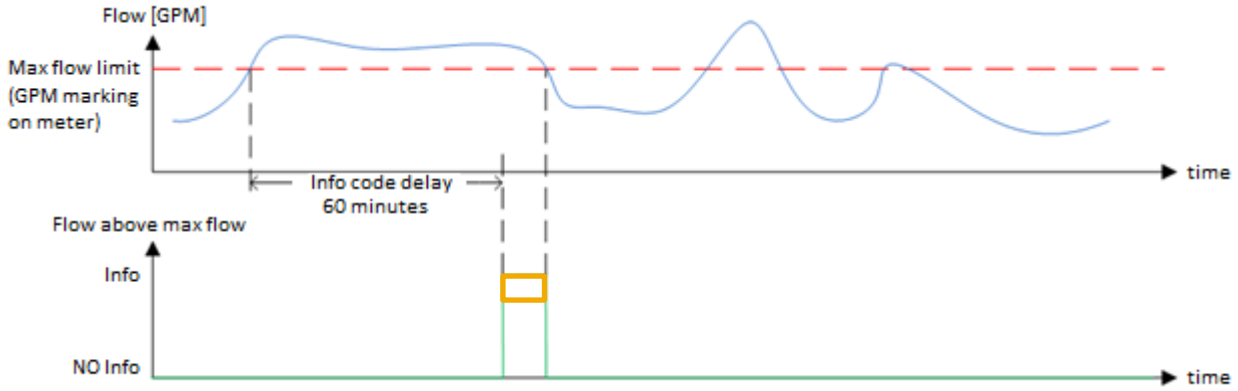


Present at	Occurs after	Disappears
Display	N/A	N/A
Optical eye	5 minutes	Instantly
Info log	5 minutes	Instantly
Info hour counter (RF)	5 minutes	Instantly

7.10.9 Flow above max flow

This info code becomes active if that the flow in the piping system is bigger than the maximum flow which the meter is able of measuring. This is a likely indicator that either an error situation has occurred in the pipe system or in repeated cases, then the meter is under dimensions for the application.

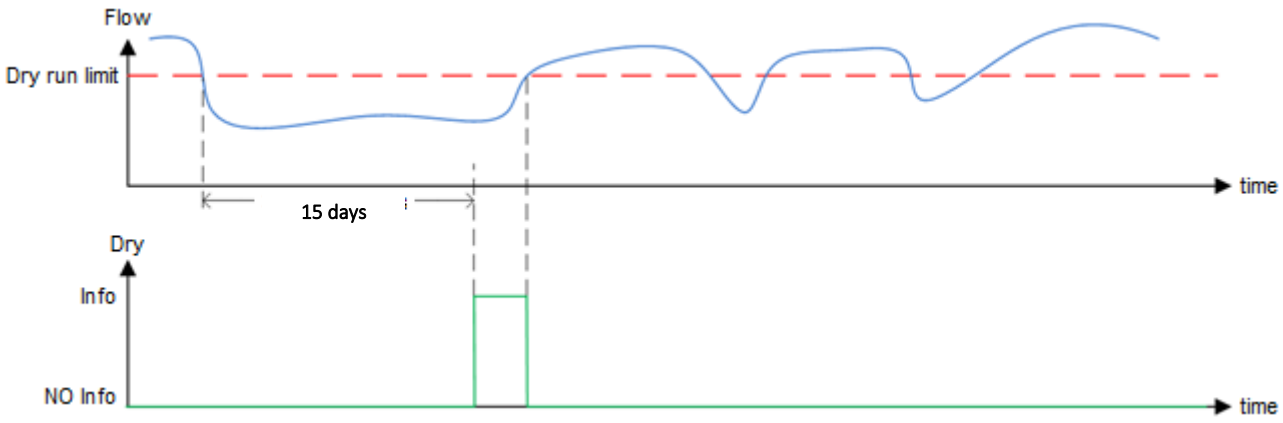
Each time the flow is calculated, the flow value is validated. If the flow, for a period, is above the max flow limit, and stays active for longer than the 'info code delay', the info code is set.



Present at	Occurs after	Disappears
Display	N/A	N/A
Optical eye	5 minutes	Instantly
Info log	5 minutes	Instantly
Info hour counter (RF)	5 minutes	Instantly

7.10.10No consumption

'No consumption' indicates that no flow in the piping system has occurred in the last 15 days.



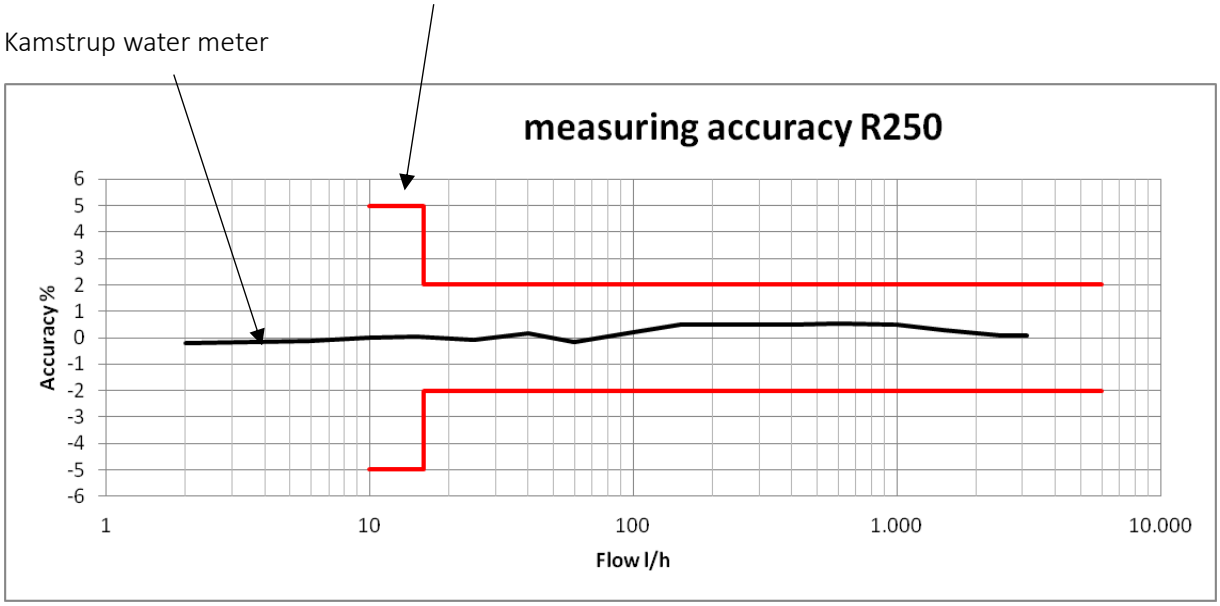
Present at	Occurs after	Disappears
Display	N/A	N/A
Optical eye	< 15 days	Instantly
Info log	< 15 days	Instantly
Info hour counter (RF)	< 15 days	Instantly

8. Metrology

8.1 Accuracy – MID / Measurement accuracy

MPE (maximum permissible error range – according to OIML R49)

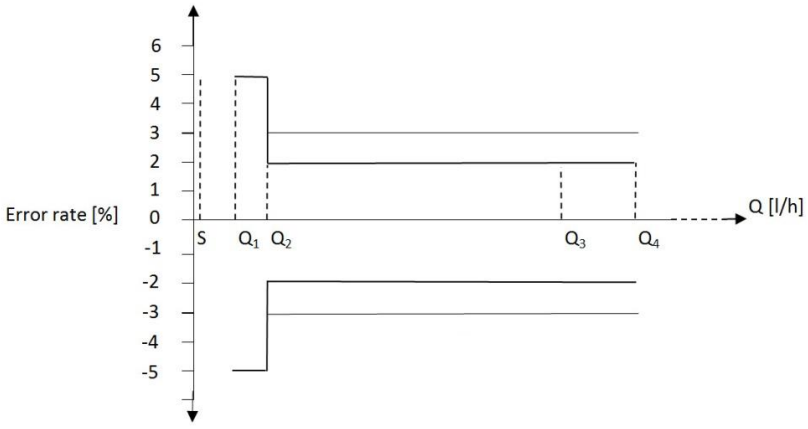
Kamstrup water meter



8.2 MPE according to OIML R49

MPE according to OIML R49	MPE (maximum permissible error range) – see figure below.
Meter approved 0.1…30 °C	± 5 % in range $Q_1 \leq Q < Q_2$, ± 2 % in range $Q_2 \leq Q \leq Q_4$
30…70 °C	± 5 % in range $Q_1 \leq Q < Q_2$, ± 3 % in range $Q_2 \leq Q \leq Q_4$

S: Start/stop flow
Q_1: Minimum flow (Q_3/Dynamic range)
Q_2: Transition flow (1.6 x Q_1)
Q_3: Permanent flow
Q_4: Overload flow (1.25 x Q_3)



9. Data

The data inside the water meter and how it works.

flowIQ® 2200 collects different types of data besides the water consumption. The data can, together with 'Kamstrup Water Intelligence', be used for both improved customer service, leakage detection, asset management and improved maintenance of the distribution system.

These data are descriped in the following sections.

9.1 Data loggers – General

9.1.1 Onboard logs

The water meter includes several loggers, in which various data is stored.

Data logger	Data logging depth	Logged values
Interval logger	Yearly = 20 years	Configurable
	Monthly = 36 months	
	Daily = 460 days	
	Hourly = 1440 hours (60 days)	
Info logger	50 events	Info codes Meter reading Date
Service log	Service log Year depth = 25 Service log Month depth = 12 Config log depth = 26 Adjust Log depth = 10 Tamper Log depth = 10 Software download progress depth = 100 Software download success log depth = 10	Operating hours IR Tokens Spend IR Packages send Number of Resets Reset Cause Radio transmit counter Min. Amb. Temp. year/month Max. Amb. Temp. year/month Avg. Amb. Temp. year/month Stacks used

When the log is full, according to the above table, and the latest record has been written into the memory the oldest one will be overwritten.

9.1.2 Reading loggers

The loggers can be accessed using IR interface. Please note that the service logs are only available for Kamstrup service personnel.

9.1.3 Target periods

Several register and logged values based on a time period, for when they are updated or saved. The following behavior is to be expected when a time period is stated in a register name or logger profile.

- The **yearly** values are stored the first day of the year
- The **monthly** values are stored the first day of the month
- The **daily** values are stored just after midnight
- The **hourly** values are stored at the beginning of every hour

9.2 Data loggers – default interval

The matrix below shows the default data logging profile for flowIQ® 2200. The checkmarks indicate the stored data which can be read by means of LogView.

This profile corresponds to configuration option 'Data logger profile' = 10.

Description	Years	Months	Days	Hours
Logger depth	20	36	460	1440
Operating hours	✓	✓	✓	✓
Info codes incl. hour counter	✓	✓	✓	✓
Volume	✓	✓	✓	✓
Volume reverse	✓	✓	✓	✓
Volume net	✓	✓	✓	✓
Acoustic Noise Value Day			✓	
Flow max year incl. Date	✓			
Flow min year incl. Date	✓			
Flow max month incl. Date		✓		
Flow min month incl. Date		✓		
Flow max day incl. Timestamp			✓	
Flow min day incl. Timestamp			✓	
Water temp. Max. Year	✓			
Water temp. Min. Year	✓			
Water temp. Avg. Year	✓			
Ambient temp. Max. Year	✓			
Ambient temp. Min. Year	✓			
Ambient temp. Avg. Year	✓			
Water temp. Max. Month		✓		
Water temp. Min. Month		✓		
Water temp. Avg. Month		✓		
Ambient temp. Max. Month		✓		
Ambient temp. Min. Month		✓		
Ambient temp. Avg. Month		✓		
Water temp. Max. Day			✓	
Water temp. Min. Day			✓	
Water temp. Avg. Day			✓	
Ambient temp. Max. Day			✓	
Ambient temp. Min. Day			✓	
Ambient temp. Avg. Day			✓	

9.3 Registers – general

Kamstrup flowIQ® contain several data registers in the meter. These registers can be read directly via the optical interface, and more of them are stored in the onboard data log for later review. This can be done via the IR interface.

Some of the registers are also available either on the display view or transmitted via one of the remote reading options. See chapter *4.3.2 Display views* or the relevant remote reading sub section chapter *6 Communication*
Below an overview of the registers in the meter available for reading, interval-logging or transmission.

Register Overview	
Name	**Short description**
RID_Flow1	Current water flow of the meter
IRID_V1_Plus1Dec	Volume with an extra decimal compared to the resolution, the meter is configured for
RID_Flow1Max_Day	Max water flow of the current day
RID_Flow1Max_Hour	Max water flow of the current hour
RID_Flow1Max_Month	Max water flow of the current month
RID_Flow1Max_Year	Max water flow of the current year
RID_Flow1MaxClock_Day	Clock time of the max flow of the current day
RID_Flow1MaxClock_Hour	Clock time of the max flow of the current hour
RID_Flow1MaxDate_Month	Date time of the max flow of the current month
RID_Flow1MaxDate_Year	Date time of the max flow of the current year
RID_Flow1Min_Day	Min water flow of the current day
RID_Flow1Min_Hour	Min water flow of the current hour
RID_Flow1Min_Month	Min water flow of the current month
RID_Flow1Min_Year	Min water flow of the current year
RID_Flow1MinClock_Day	Clock time of the min flow of the current day
RID_Flow1MinClock_Hour	Clock time of the min flow of the current hour
RID_Flow1MinDate_Month	Date time of the min flow of the current month
RID_Flow1MinDate_Year	Date time of the min flow of the current year
RID_Info	Legacy info codes
RID_InfoBitsHourCounter	Hour counter intervals for the water info bits for the last 30 days
RID_InfoWarmEnvironment	Info codes for warm environments
RID_InfoColdEnvironment	Info codes for cold environments
RID_InfoFull	Info codes for fixed net, no hour counter
RID_InfoEvent	Number of times the info codes have changed in meter.

Register Overview	
RID_InfoHR	Number of hours where at least one info code has been set. Incrementation happens every hour no matter how long info codes have been active
RID_HR	Operating hours
RID_MBusManufacturerID	ASCII string indicating manufacturer ID KAW - Kamstrup Water
RID_SerialNo	Serial number of the meter
RID_RFTransmitCounter	Number of packages send over the radio
IRID_AdjustLogEntries	Shows number of adjustments
RID_SWRevision	Software revision
RID_CheckSum1	Software checksum, calculated by meter itself
RID_BatteryDaysLeft	Number of estimated days left of the battery life
RID_TempAmbientAvgDay	Ambient temperature average for current day
RID_TempAmbientAvgHour	Ambient temperature average for current hour
RID_TempAmbientAvgMonth	Ambient temperature average for current month
RID_TempAmbientAvgYear	Ambient temperature average for current year
RID_TempAmbientMaxDay	Ambient temperature max for current day
RID_TempAmbientMaxHour	Ambient temperature max for current hour
RID_TempAmbientMaxMonth	Ambient temperature max for current month
RID_TempAmbientMaxYear	Ambient temperature max for current year
RID_TempAmbientMinDay	Ambient temperature min for current day
RID_TempAmbientMinHour	Ambient temperature min for current hour
RID_TempAmbientMinMonth	Ambient temperature min for current month
RID_TempAmbientMinYear	Ambient temperature min for current year
RID_TempMediaAvgDay	Water temperature average for current day
RID_TempMediaAvgHour	Water temperature average for current hour
RID_TempMediaAvgMonth	Water temperature average for current month
RID_TempMediaAvgYear	Water temperature average for current year
RID_TempMediaMaxDay	Water temperature max for current day
RID_TempMediaMaxHour	Water temperature max for current hour
RID_TempMediaMaxMonth	Water temperature max for current month
RID_TempMediaMaxYear	Water temperature max for current year
RID_TempMediaMinDay	Water temperature min for current day
RID_TempMediaMinHour	Water temperature min for current hour
RID_TempMediaMinMonth	Water temperature min for current month
RID_TempMediaMinYear	Water temperature min for current year

Register Overview	
RID_V1	Current accumulated volume
RID_V1Last24Hours	Volume for the last calendar day, since midnight
RID_V1Netto	Current accumulated net volume
RID_V1Reverse	Current accumulated reverse volume
RID_WaterInfoBits	Info code bits
RID_XDay_Month1	Target date – month
RID_XDay_Year1	Target date – year
RID_AcousticNoise	Noise value for yesterday, 7,14 & 21 days ago
RID_AcousticNoiseLastDay	Noise value for yesterday

9.4 Water infobits

flowIQ® meters can include other and more info codes than visible in the info registers provided in the radio packges. Therefore two other registers are added. Opposite the info registers, info bits are split in 2 registers – one register holding all available info codes and one holding the info code hour counters.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Info code															

MSB								LSB
47	46	…	9	…	3	2	1	0
NA	NA	…	Internal	…	Burst	Leak	Reverse	Dry

RID_InfoBitsHourCounter 409/199h 6 bytes.

MSB													LSB								
47	46	45	44	43	42	…	29	28	27	…	11	10	9	8	7	6	5	4	3	2	1	0
NA			NA				Internal				Burst			Leak			Reverse			Dry		

The interpretation of the hour counters is equal to interpretation for info registers.

10. Laboratory testing and meter adjustment

10.1 Legal changes outside seal

This paragraph describes the legal changes, which can be carried out without disassembling the meter and thereby breaking the legal seal.

All legal changes are fully traceable in an adjust log, which cannot be deleted. The number of legal changes appears in the display. Maximum 9 changes are possible.

The adjust log can only be deleted if the meter is disassembled and the legal seal is broken.

10.1.1 Corrective flow curve adjustment

The meter is initially verified from the factory. After the final step in production it is possible to make a percentage correction of the flow curve at three individual points. This is called re-adjustment.

!

IMPORTANT:
A new factory adjustment requires disassembling of the meter and can and MUST only be carried out by Kamstrup A/S

10.1.1.1 Readjustment

A re-adjustment can be made without disassembling the meter – not breaking the legal seal. Here the following restrictions apply:

- Maximum 9 readjustments are possible
- Maximum adjustment compared to the factory adjustment is +/-10%
- Each readjustment is logged in the meter.

During a readjustment the flow curve is corrected at three fixed points and the curve will be re-adjusted to these new points.

!

IMPORTANT: The laboratory, which makes the re-adjustment, must attach an adjustment label with the valid adjustment number to the meter.

Naturally, this number must be identical with the number (AX) in the meter display.

10.1.2 Reset

The meter can be reset via the optical eye. This is used under re-verification by authorized laboratories. All loggers and registers including the legal volume register are reset. Only the adjust log and the clock are not reset. At the same time the meter is set to 'transport mode' and the radio is then switched off.

The following restrictions apply to reset:

- The meter can be reset at maximum 9 times
- Each reset is logged in the meter.

!

IMPORTANT: The laboratory, which resets the meter, must attach an adjustment label with the valid adjustment number to the meter.

Naturally, this number must be identical with the number (AX) in the meter display.

10.2 Meter modes (settings)

Verification mode is only used by authorised laboratories during verification. The meter has 2 modes.

Meter mode:	Normal	Verification
Second per measurement	4 seconds	0,06 second
Flow display update rate	4 seconds	0,5 second
Volume display update rate	4 seconds*	0,5 second*
Unit	m^3	L x 10^{-3}
Mode, time out	No	Yes (9 hours)

**The accumulated volume, since last display update, must exceed cut-off before the next update.*

10.3 Normal mode

Normal mode is meant for normal operation. In normal mode, the volume unit symbol m^3 displays.

The flow is measured every four seconds and new values (flow, volume, etc.) are calculated.

10.4 Verification mode

Verification mode is meant for verification of the meter. In the display, verification mode will be indicated by the volume unit symbol 'L'.

The flow is measured ½ a second and new values (flow, volume, etc.) are calculated every four seconds.

When the meter switches to 'verification mode', the wireless M-Bus radio transmitter turns off. At the same time, a time-out starts. When the time-out period has expired the meter switches back to 'normal mode'.

The time-out period is 9 hours.

11. Tools and programs

11.1 Optical eye

The water meter is fitted with an optical eye, which gives access to the external meter interface, and with which all the data registers in the meter can be read. For instance, data can be read using Kamstrup's optical reading head. The reading head includes a permanent magnet, which switches on the optical eye.

In order to limit current consumption, the default setting of the optical eye is OFF.

By means of a magnet sensor the optical eye will automatically switch ON, if an optical reading unit with magnet is placed on the meter. The start-up time for the optical eye (from the magnet is attached to the meter until the optical eye switches on) depends on the meter mode, as shown in the table below.

Normal mode	4 sec.
Verification mode	0.5 sec.

Note! Water meters are not polarity neutral when detecting the optical eye; that means the optical eye magnet must be orientated right, otherwise the optical interface will not be activated.

A holder is available for Kamstrup's optical reading head. It fits the water meter and must be clicked onto the meter.

11.2 METERTOOL

METERTOOL* is a PC-program that gives access to change the customer selected parameters of a water meter configuration, and the possibility to read the data memory, without dismounting the meter from the installation.

11.3 LogView

LogView HCW* is used for readout of logging data from Kamstrup meters as well as for carrying out interval logging. The read data can be used for analysis and diagnostic test of the installation. Data can be presented in tables or as graphics. Tables can be exported directly to ´Microsoft Office Excel´.

*Further information and technical details can be found in the Technical Description for METERTOOL & LogView – see table in section *2.4.2 Relevant links.*

11.4 Pulse Interface

To bring the meters into a diagnostic test mode, and during calibration and verification in test stands with pulse interface, the Pulse Interface, type 66-99-143, is used.

The optical reading head is retained on the meter, by means of a transparent plastic holder:
Optical support, type 6561-331 – for Wireless meters

Data from the water meter is read by the optical reading head and are converted in the pulse interface unit into high-resolution volume pulses, which can be registered by a pulse receiver. When the optical reading head is removed it takes 9 hours before the meter returns to normal mode.

*Pulse Interface, type 66-99-143, with Optical Support type 6561-331 on flowIQ® **wireless***

Supply: 3.5-30 VDC < 15 mA
Standby: < 0.2 mA
Pulse width: = 3.9ms
Frequency: Max frequency of 128 Hz

Meter size Q_3 [m^3/h]	Volume [Pulses/litre]
1.6	100
2.5	100
4.0	50

11.4.1 Connection Pulse Interface

An external pulse interface can be mounted at the meter. Each pulse gives an indication of 10 liters consumption.

For further details – see document no. 5512-2502 GB at products.kamstrup.com/

11.5 DataTool

As mentioned above it is possible to reconfigurate the meter. Reconfiguration of communication modules can in certain cases change the lifetime of the meter. In these cases, the software DataTool is needed for reconfiguration.

DataTool can be downloaded by contacting service@kamstrup.com

12. Installation

12.1 General recommendations

When installing the water meter, consider how to orient it, as it makes sense to position the meter, so the display is easy to read. Prior to installation of the water meter, the system should be flushed, while a fitting piece replaces the meter. Install the meter. Always use new gaskets in original quality.

Place the meter as required, however, it must be installed correctly in relation to the flow direction.

Also see following sections.

Flow direction is indicated by an arrow on the side of the of the meter.

When mounting the water meter, you must ensure that the length of the meter threads will not prevent enough tightening of the sealing surface, and make sure that connections of correct pressure rating are used.

It is recommended, in order to facilitate future replacement of the meter, that closing valves should be mounted on both sides of the meter.

The water meter has built-in data communication, which enables remote reading of the meter.

If installed in pits or basements, the meter must in some cases be fitted with an external antenna in order to secure optimum communication. This antenna must be placed outside the pit or basement.

Kamstrup A/S recommends EPDM-gaskets for cold water installations.

Kamstrup A/S supplies such gaskets.

See separate Accessories List: Doc. no. 5810-1270_GB

and following sections.

12.2 Installation requirements

12.2.1 Tightening torque

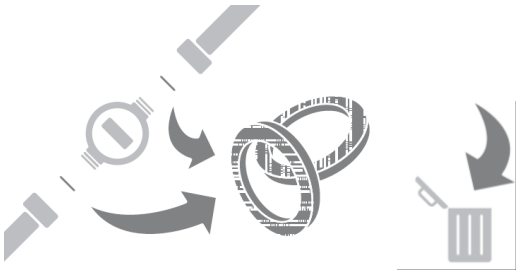
Meter couplings must be tightened with maximum the torque mentioned in the table below:

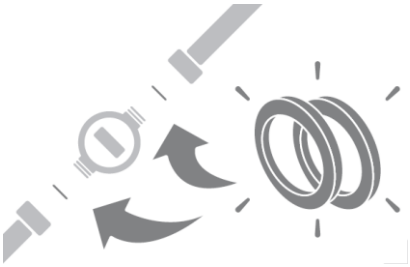
Meter thread	Min. tightening torque	Max tightening torque
¾”	7.5 Nm	15 Nm
1”	15 Nm	30 Nm

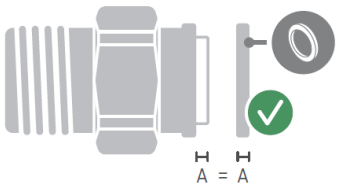
!

Mount the water meter with matching couplings, if needed.

12.2.2 Gaskets



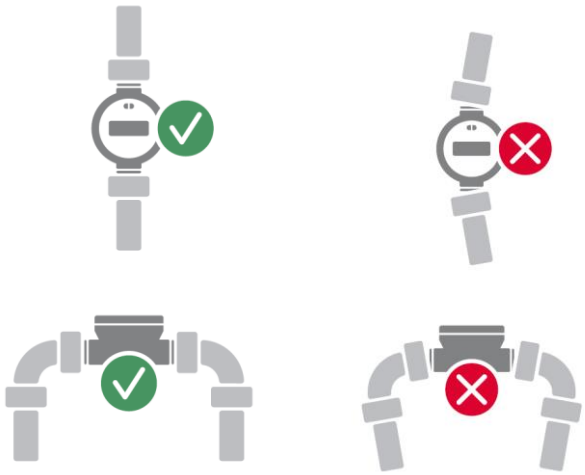




- ALWAYS use new gaskets
- Replace gaskets when installing a new water meter
- The sealing surface of the threaded connection must be clean and level
- Gaskets in original quality is of crucial importance.

12.2.3 Pipe alignment

The adjacent pipes must be parallel and fit the meter. Skewness of pipes often makes it difficult to obtain a watertight connection, if the above torques must be observed. Furthermore, it can be difficult to estimate the mounting time in advance.

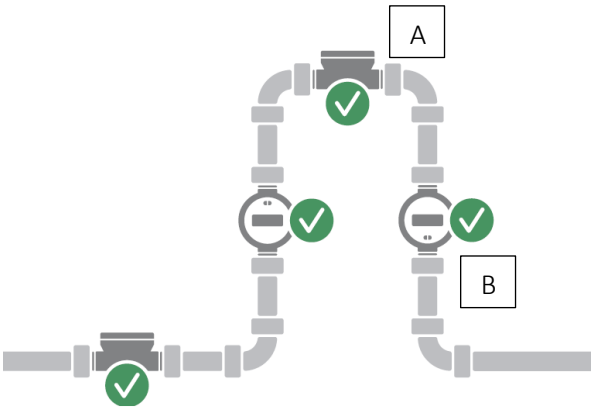


In such cases, Kamstrup A/S recommends installing the meter by means of a special coupling with telescopic function. The coupling can be displaced up to 17 mm – to be able to compensate for differences and inaccuracies of pipe installations, both in the longitudinal direction and, to lesser extent, also against oblique angles. **Kamstrup A/S supplies such couplings.**

12.2.4 Installation angle

The meter can be mounted at all angles and in all positions.

12.2.5 Straight inlet



A Recommended for well installation. Air build-up may occur

B The meter functions optimally, but the display is 'upside down'

The meter requires neither straight inlet nor outlet to meet the Measuring Instruments Directive (MID) 2014/32/EC and OIML R49:2013.

A straight inlet section will only be necessary in case of heavy flow disturbances before the meter.

13. Operating conditions

13.1 Pressure loss

According to OIML R49 maximum pressure loss must not exceed 0.63 bar (0.063 MPa)

in the range Q_1 - Q_3. At Q_4 this results in a pressure loss of max 0.1 MPa (1 bar).

The pressure loss in a meter increases with the square of the flow and can be stated as:

$$Q = kv \times \sqrt{\Delta p}$$

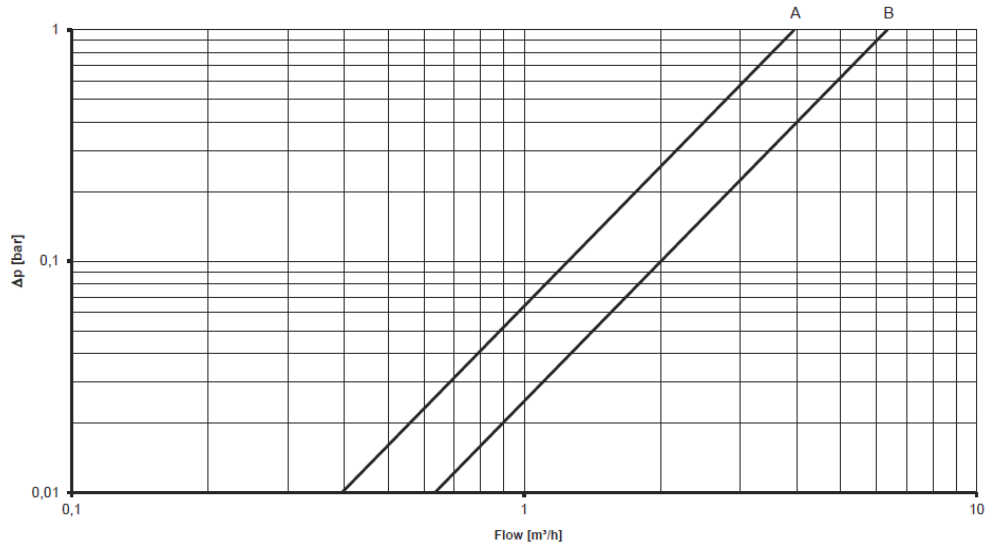
where:

Q = volume flow rate [m^3/h]
kv = volume flow rate at 1 bar (0.1 MPa) pressure loss
Δp = pressure loss [bar]

Pressure loss table

Graph	Q_3 [m^3/h]	Nom. diame-ter[mm]	K_v	Q at 0.63 bar [m^3/h]
A	1.6 & 2.5	DN15 & DN20	3.95	3.1
B	4.0	DN20	6.3	5.0

Pressure loss diagram Δp



13.2 Pressure and temperature

Ambient temperature	5…55 °C	indoors or outdoors Installation in direct sunlight ought to be avoided
Water temperature	0.1…50 °C	
System pressure	0.3 …16 bar	(depending on couplings/gaskets)

13.2.1 Minimum pressure

In order to avoid formation of air bubbles or vapour in the meter (cavitation) – and to ensure correct measurement under all circumstances – the operating pressure in the pipe installation must observe the test conditions of OIML R49, which means that the static pressure downstream, immediately after the meter (the downstream) must always be minimum 0.03 MPa (0.3 bar).

13.3 EMC conditions

The water meter is designed for installation in housing and meter pits, as well in commercial and industrial buildings. The water meter meets the following conditions:

- CE-marked* according to MID, based on OIML R49 type test, class E1 and E2 for wireless M-Bus version
- Follows the Low Voltage Directive.

**Please note: CE-marking applies to Europe only.*

13.4 Pipes & Service

!

The water meter MUST NOT be installed in such a way, that it is focus of pipeline stress.

When the water meter has been mounted in the system, neither welding nor freezing is allowed. This means that you must dismount the meter before starting such work.

14. Additional info

14.1 Troubleshooting

The meter has been designed with usability and durability in focus for a long a stable operation. Any repair requires that the sealing is broken. Therefore, **repairs MUST only be carried out by Kamstrup A/S**.
Should you, however, experience an issue with the meter, the following can be used for troubleshooting.
If this does not resolve the issue, please contact service@kamstrup.com

Note! If there is no display functions (empty display) it could be because of a flat battery or faults on the electronics. If this is the case you have to send the meter to Kamstrup A/S.

14.1.1 Troubleshooting overview

Symptom	Icon/symbol	Possible reason	Proposal for correction
Info code 'battery' is present in the display		Battery capacity is low, and less than 6 months of lifetime is left	Replace the meter at earliest opportunity. For ease of reorder, note serial and type number of the meter
Info code 'reverse flow' is present in the display		The meter is mounted with water flow in the wrong direction	Mount the meter in accordance with the flow arrow on the side of the meter housing
Info code 'LEAK' is present in the display		The water has been flowing in the meter for the past 24 hours. This may be a sign of a leaky faucet or toilet or a leak somewhere in the pipework	Locate and repair the leakage. When the leak has been repaired the info code will disappear from the display within 6 minutes
Info code 'BURST' is present in the display		The water has been flowing above the defined burst limit in the meter for a minimum of 30 minutes, which is a sign of a broken pipe	Locate and repair the broken pipe. The info code will disappear within 2 minutes, if the flow is yet again below the burst limit set up in the meter
Info code 'DRY' is shown in the display		The meter is not filled with water	Air in the installation. The info code disappears when the meter is water-filled
Info code 'TAMPER' is present in the display		Attempt of fraud. The meter is no longer valid for billing purposes	Replace the meter or contact Kamstrup for guidance
Info code 'RADIO OFF' **flashes** in the display		The meter is still in 'transport mode' with the built-in radio transmitter turned off	The radio switches on and the info code disappears when the first ½ liter of water has run through the meter
Shown **permanently**		THE RADIO IS SWITCHED OFF	Can be activated with METERTOOL or DataTool

Info codes:  and  switch off automatically, when the conditions that activated them no longer exist:

 disappears when the water has been stagnant for one hour

 disappears when the the consumption falls to normal level

 disappears when the meter (again) is filled with water

 disappears when the water no longer flows in the wrong direction.

14.2 Disposal

Kamstrup holds an environmental certification according to ISO 14001, and as part of our environment policy we use materials which can be recovered environmentally correct to the greatest possible extent.

• Disposal by Kamstrup

Kamstrup accept worn-out meters for environmentally correct disposal according to previous agreement. The disposal is free of charge to the customer, except for the cost of transportation to Kamstrup.

• The customer sends for disposal

The meters must not be disassembled prior to dispatch. The complete meter is handed in for approved national/local disposal. Enclose a copy of this page in order to inform the recipient of the contents.

• Disposal by the customer

The water meters should be disassembled as described below and the separate parts must be handed in for approved destruction. The batteries must not be exposed to mechanical impact and the lead-in wires must not be short-circuited during transport.

See instruction table next page.

14.2.1 Instruction for disposal

Item	Material	Recommended disposal	
Lithium cells	Lithiumthionylcloride >UN 3090< 2xA-cells: 1.8 g in total	Approved deposit of lithium cells	
Battery tap	DIN 1.4310 / (SUS) 301 Part nickel plated	Metal recovery	
O-ring	FKM	Ordinary disposal	
LCD Display	Glass and liquid crystals	Approved processing of LCD-displays	
Sight glass	Soda Lime - tempered	Glass recovery	
Meter housing	PPS FORTRON 9141L4 SD3039 black	Plastic recovery	
Snap ring seal	PC10%GF	Plastic recovery	
Desiccant box	PC10%GF – RAL7035	Plastic recovery	
Top cover	PC10%GF – RAL7035	Plastic recovery	
Transducer bracket	PC10%GF – RAL7035	Plastic recovery	
Transducer shoe	PC10%GF – RAL7035	Plastic recovery	
Spring	ø1.0mm 10270-1 with anti-rust oil coating	Metal recovery	
Antenna strip	DIN 1.4310 / (SUS) 301	Metal recovery	
Moisture-absorbent	98% Bentonite 2% Quarz	Ordinary disposal	
Measuring pipe	Ultrason S3010 NAT	Plastic recovery	
Reflector plates (mirrors)	Stainless steel AISI 316, 1.4306, 1.4401	Metal recovery	
Printed circuits (remove LCD-display)	Coppered epoxy laminate, compo-nents soldered on	PCB scrap for metal recovery	
Packing option 1	APET - (Amorphous Polyethylene Terephthalate) Also used for storage of food	Plastic recycling 'Combustible'	
Packing option 2	Environmental cardboard	Cardboard recycling