AQUAMETER

February 2026

Aquameter – A product for a specific need

Efficient water management is becoming a crucial ecological and economic challenge. This requires reliable and frequent readings of domestic meters in order to better understand consumption patterns, detect potential leaks as early as possible, and facilitate interventions by technical services.

Aquameter is a remote meter reading system perfectly suited to these constraints:

- **It can be easily and cost-effectively adapted to any type of meter** and enables retrofitting of existing meter fleets, even when they are highly heterogeneous (different meters from different manufacturers).
- **From a photo, it determines the absolute index displayed on the meter** and can transmit either the analyzed index or the photo itself.
- **It is highly configurable:** transmission period, day, time of image capture, etc. Configuration is done using a mobile app for simple and efficient deployment, and that can be customized for each network operator.
- **Its replaceable battery offers long autonomy** ranging from a few years to several decades depending on the configured reporting intervals.
- **It is available in LoRa and LTE-M versions.**

Adapter

Electronic module

Main unit

Architecture

Aquameter consists of two main components:

- **A plastic adapter** specific to the meter model. It is mounted on the meter with an intermediate foam layer that allows condensation to dissipate and prevents insects from entering.
- **The Aquameter main unit**, which integrates the battery, electronics, and a camera in a sealed enclosure. This unit is positioned on top of the adapter, which aligns it correctly for image capture.

The main unit with its electronics forms a generic, optimized module. Configuration and adaptation to a meter's characteristics are done with a mobile app.

Depending on production volumes, the adapters can easily be manufactured by 3D printing or produced in mass by plastic injection. Adapters are already available for the models of meters listed below, however adapters for other models can easily be created:

Brands	Supported models		
Baylan	*KK-2*	*KK-12*	*KK-13*
Diehl	*Aries*		
GMeters	*GRK*	*GMDX*	
Itron	*Aquadis+*	*Narval Cyble*	*Flodis*
Actaris (Itron)	*TU4*	*TUM15*	*Aquadis*
Regaber	*Gaer SDC Plus*		

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Principles

Installing an Aquameter on a meter typically takes around ten minutes, depending on the amount of information that needs to be entered in the mobile application.

Adding Aquameter onto the meter

Install the components in this order:

- ❶ **The polyurethane foam layer**, which ensures the evacuation of condensation and prevents the entry of insects,
- ❷ **The plastic adapter**,
- ❸ **The Aquameter main unit**, which is guided by the adapter to ensure correct positioning for image capture.

A hinged flap provides visual access to the meter index through a transparent window.

Two anti-theft cables ensure that the Aquameter is securely fastened to the meter.

Configuration by mobile app

This mobile app allows technicians to:

- **Select the meter model.** A wide range of standard meters is available in an online database.
- **Enter the data required for meter reading**, such as the meter model and serial number. Geolocation is automatically determined by the application.
- **Launch an automatic alignment procedure** for image capture in order to obtain real-time confidence in the image analysis.

Photo verification and data transmission

Once the Aquameter is configured, a test is performed to validate the correct analysis of the photos as well as the data transmission. Transmission quality is quantified using the received signal strength indicator (RSSI).

Configuration and activation

After the tests are completed, the Aquameter can be configured and activated with:

- **The desired interval for index readings**, and separately for photo transmissions,
- **The preferred transmission time**. For an Aquameter exposed to strong solar radiation, it may be preferable to select a nighttime transmission window. Time slots should also be distributed to avoid saturating a shared gateway when multiple Aquameters transmit simultaneously.

Radio protocols

In general, only uplink transfers from Aquameters to a server are considered here. However, it is easy to modify the device's configuration to allow it to receive commands from the server. In this case, Aquameter can only receive a command during a wake-up event followed by a connection.

The choice of radio protocol mainly depends on the available infrastructure.

LoRa / LoRaWAN

LoRa offers superior performance in terms of range and power consumption. However, the transmitted packets are much smaller (around fifty useful bytes per transmission), and sending a low-resolution photo will require roughly ten transmissions.

It is worth noting that it is easy to acquire a high-performance "personal" LoRa gateway at a reasonable cost, enabling management of devices over a geographic area of several square kilometers.

From a protocol perspective, LoRaWAN is used to secure transmissions.

LTE-M / NB-IoT

These network infrastructure generally belong to GSM operators. The electronics require a SIM (or eSIM) card, which adds to the operating cost. However, the main advantage of this transmission mode is data rate. Once a secure connection (TLS) is established, transmitting a high-resolution photo incurs only a small additional cost.

One characteristic of LTE-M / NB-IoT technologies is the relatively slow connection setup (compared to LoRa) and the significant amount of data exchanged to establish a secure TLS connection. The connection duration therefore negatively impacts energy consumption.

Analysis of the Index

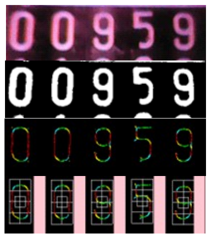
The Aquameter can send either photos or index readings:

- With LoRaWAN, sending a photo requires around ten packet transmissions for a low-resolution image, which remains energy-intensive.
- The analysis takes two to three seconds but then allows a single transmission to be sent.

The analysis is performed digit by digit. A confidence rating is provided for each digit. There is no risk in accepting the reported index when the confidence rating for each digit is between 90% and 100%. It may be questioned when the rating is between 80% and 90%, and must be challenged when the rating is below 80%.

The steps in the analysis are:

1. Initial photo:
2. Conversion to black & white:
3. Definition of segments:
4. Identification of digits:



For each "font" used for the index display, a reference table is created. Then, depending on the adapter, a configuration file is entered during installation to define the font, position, size, and spacing of the characters. Different cases have also been taken into account, for example:

- Displays where the digits appear black on white, whereas most meters display white characters on a black background.
- Displays where the digits are inverted (upside down).
- Displays where there is no subdivision (often shown in red). For these, the rightmost digit rotates continuously instead of aligning with the others.

Autonomy

The Aquameter has been designed to operate for several decades without any specific maintenance. However, battery life will vary depending on the configured transmission frequency.

It should be noted that the battery charge level is transmitted with radio messages, making it easy to monitor its evolution over time.

Battery type

A 3.7 V lithium battery with a length of 50 mm is required. Batteries with diameters of 18 mm or 14 mm (AA format) can be used, with reduced autonomy for the smaller diameter.

Non-rechargeable lithium batteries (spiral-wound $Li-SOCl_2$ technology) are generally used, offering high capacity with very low self-discharge.

Rechargeable batteries (Li-Ion) have lower capacity but allow multiple recharges. Their use is relevant in cases of very high transmission frequency, for example hourly transmissions.

Numbre of cycles for LoRa

Since both photos and/or index values can be transmitted, the number of transmissions will depend on the ratio between photos and index readings. Considering two 14 mm and 18 mm batteries from manufacturer FANSO, the following characteristics apply:

Reference	Dimensions	Capacity	Leakage
ER14505-M	14x50mm	2100 mAh	<1% / year
ER18505-M	18x50mm	3500 mAh	<1% / year

Self-discharge (<1% per year) means that approximately 90% of the charge remains after 10 years of storage (without any energy usage), and 80% after 20 years. If 20 years is considered a sufficient lifetime, allocating half of the available charge to actual usage is reasonable assumption. In a very conservative scenario, only 40% of the initial charge is allocated to "useful" consumption. This yields the following usable capacities:

- **840 mAh**, i.e. 3,000,000 mAs for a 14 mm battery
- **1400 mAh**, i.e. 5,000,000 mAs for an 18 mm battery

The following consumption figures were measured in the context of a spreading factor of SF12, which represents the worst-case scenario:

- **650 mAs for a full cycle** (photo+analysis+index transmission),
- **180 mAs for a simple transmission** (no photo capture). A compressed photo requires roughly ten transmissions.

Taking a photo requires approximately 300 mAs for image capture and compression, followed by about 9 packet transmissions. In total: $300 + 180 \times 9 = 1920$ mAs.

Thus, sending a photo can be considered equivalent (in energy consumption) to about three standard cycles (analysis and index transmission).If only simple cycles are performed, the following cycle counts are obtained:

- **4,600 cycles** with a 14500 battery (14 mm diameter),
- **7,700 cycles** with a 18500 battery (18 mm diameter).

Number of cycles for LTE-M / NB-IoT

Connection setup times are significant, leading to higher consumption than with LoRa. However, once the connection is established, the amount of data sent has little impact on overall consumption. Therefore, a full photo can be sent at each cycle with a measured consumption of about 1500 mAs.

This results in:

- **2,000 cycles** with a 14500 battery (14 mm diameter),
- **3,300 cycles** with a 18500 battery (18 mm diameter).

Battery lifespan

If only index transmission cycles are done (without photos), **the following lifetimes can be expected in LoRa mode**:

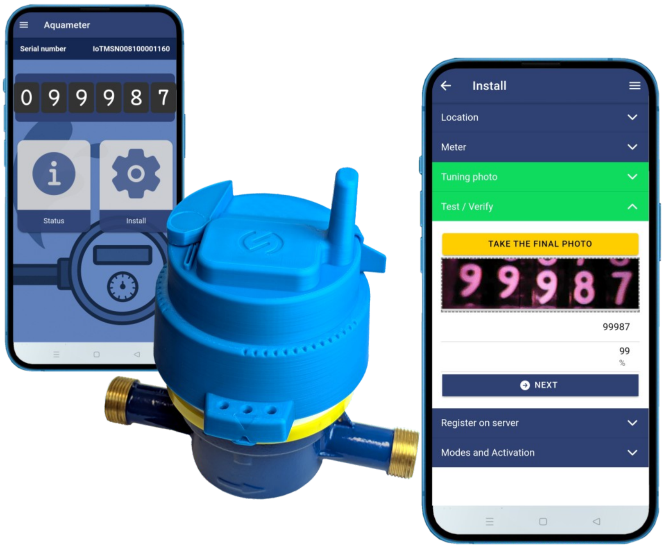
Battery format	Number of cycles	1 cycle per week	1 cycle per day
14500	4600	88 years	12.5 years
18500	7700	148 years	21 years

If one photo is added every three index transmissions, these lifetimes should be divided accordingly.

In LTE-M / NB-IoT mode, all cycles are considered to include photo transmission:

Battery format	Number of cycles	1 cycle per week	1 cycle per day
14500	2000	38 years	5.5 years
18500	3300	63 years	9 years

By default, 18 mm batteries are supplied with Aquameter.



Configuration

The Aquameter mobile app is built using Iotize's no-code / low-code design environment. It can therefore be easily modified and customized, both in its structure and in its features or "look and feel."

In addition to configuration and testing, the application allows users to:

- **Set the device to "transport mode**,"
- **Check the device status**: index value, information about possible errors (image capture or transmission), etc.,
- **Define cycle periods and their timing**. These settings independently control index transmissions and photo transmissions.

iOTize™

Waterproofing

Water meters are generally installed in harsh natural environments, and the Aquameter must withstand external disturbances associated with these conditions:

- Risks related to rain and flooding,
- Risks of ambient humidity and condensation,
- Risks related to insects and nesting.

Extreme temperatures could also be mentioned, but since water transport keeps the fluid in its liquid phase, meters are typically installed in locations where temperatures remain within the range **0 °C to 100 °C**.

Rain and flood protection

The cross-section below illustrates how the Aquameter's construction protects it from water and humidity.

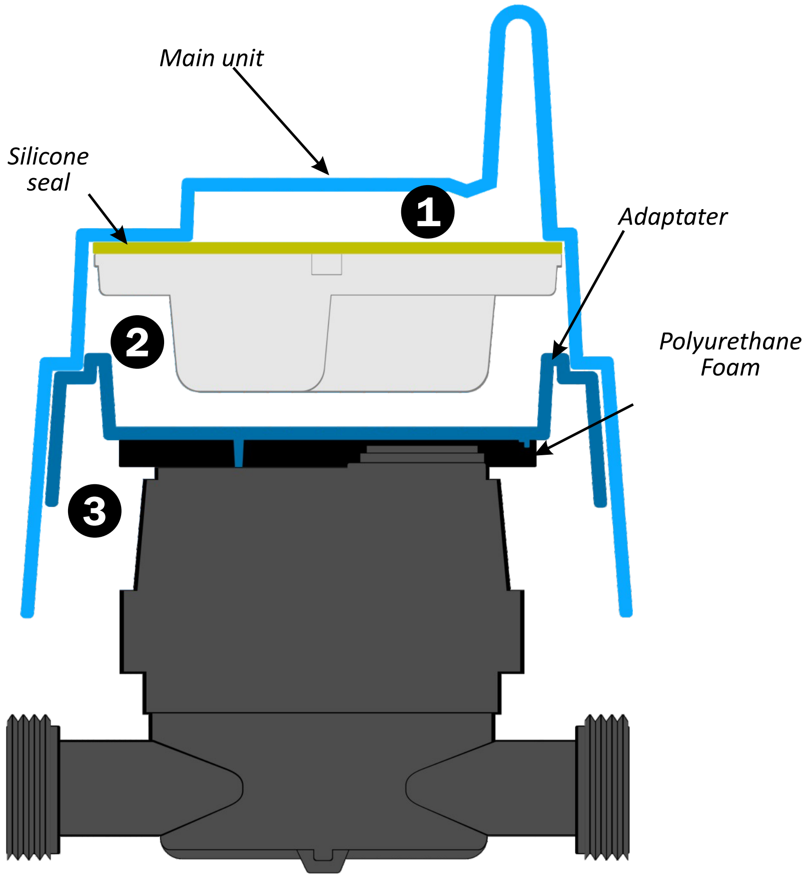
Three zones can be identified:

1. The top of the dome houses the electronics and the camera. It is isolated (IP68) from the rest of the enclosure by a silicone gasket that prevents humid air from entering the electronics compartment.

2. A zone in contact with the top of the water meter. This area is isolated from the bottom by the adapter and a polyurethane foam that blocks insects while allowing humid air to pass through.

3. The bottom of the dome, which is in contact with the external environment.

The entire assembly of zones 1 + 2 + 3 is protected against flooding by a bell effect (similar to a diving bell). Zone 2 breaths to evacuate water accumulation caused by condensation. It may be exposed to ambient humidity, but the polyurethane foam allows this moisture and condensate to be evacuated. Zone 1 is watertight by design.



Cybersecurity

Security protocols for authentication and encryption apply to both local communications (NFC) and long range communications (LoRaWAN / LTE-M / NB-IoT). In the case of LTE and NB-IoT, TLS communication can be based either on certificates or passwords in order to secure access to the broker. For LoRa, the security procedures are those defined by the LoRaWAN protocol.

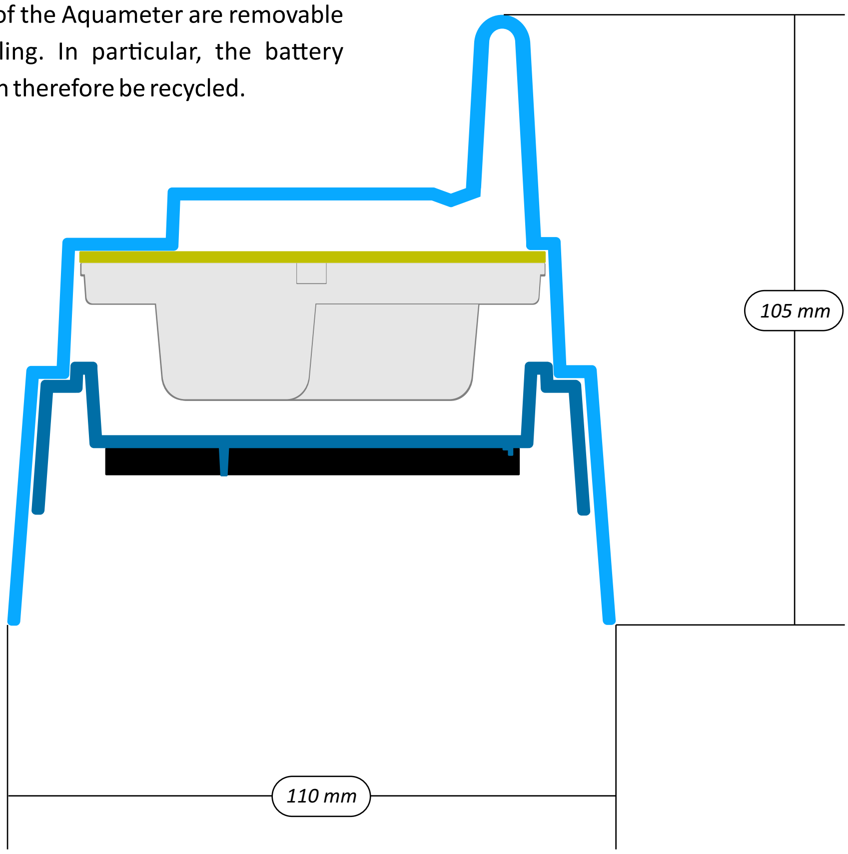
Dimensions

The overall dimensions of the Aquameter are 105 mm (height) by 110 mm (diameter). The typical weight is 150 g (slightly dependent on the adapter used).

These dimensions allow adaptation to standard domestic water meters available on the market. A specific housing will be required for large industrial meters.

Recycling

The various components of the Aquameter are removable to allow selective recycling. In particular, the battery remains accessible and can therefore be recycled.



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