AKU Smart Water Meter

Technical Description

Contains

1. Purpose

AKU smart water meter (hereinafter WM) is based on ultrasonic principle and intended for cold water consumption metering. Main technical characteristics are summarized in the table 1 below:

Table 1. WM technical characteristics

Characteristic	Value					
Model	AKU F15		AKU F20		AKU F25	
Nominal diameter	DN15		DN20		DN25	
Thread	G3/4”		G1”		G1¼”	
Permanent flow rate, Q3 (m^3/h)	1.6/2.5	2.5	2.5/4	4	4/6.3	6.3
Dynamic range Q3/Q1	R250 R400 R800	R250 R400 R800 R1600	R250 R400 R800	R250 R400 R800 R1600	R250 R400 R800	R250 R400 R800 R1600
Installation sensitivity class	U0/D0					
Sensitivity threshold (l/h)	1					
Temperature class	T50 (0.1 – 50 °C)					
Storage temperature	From -25 to 70 °C					
Metrological class	Class 2					
Maximum operation pressure	1.6 MPa					
Pressure loss	Δp40					
Protection class	IP68					
Environmental class	E1, M1, O					
Installation	Horizontal or vertical					
Battery	Lithium battery, up to 16 years lifetime in case of meter reading once per day					
Interfaces	Bluetooth					
WAN Communication	Dual stack LoRaWAN + Wireless M-Bus SigFox (optionally) Different frequency ranges (optionally): 433 MHz, 868 MHz, 915 MHz, 923 MHz.					
Metrological LED	10 000 imp/m^3					

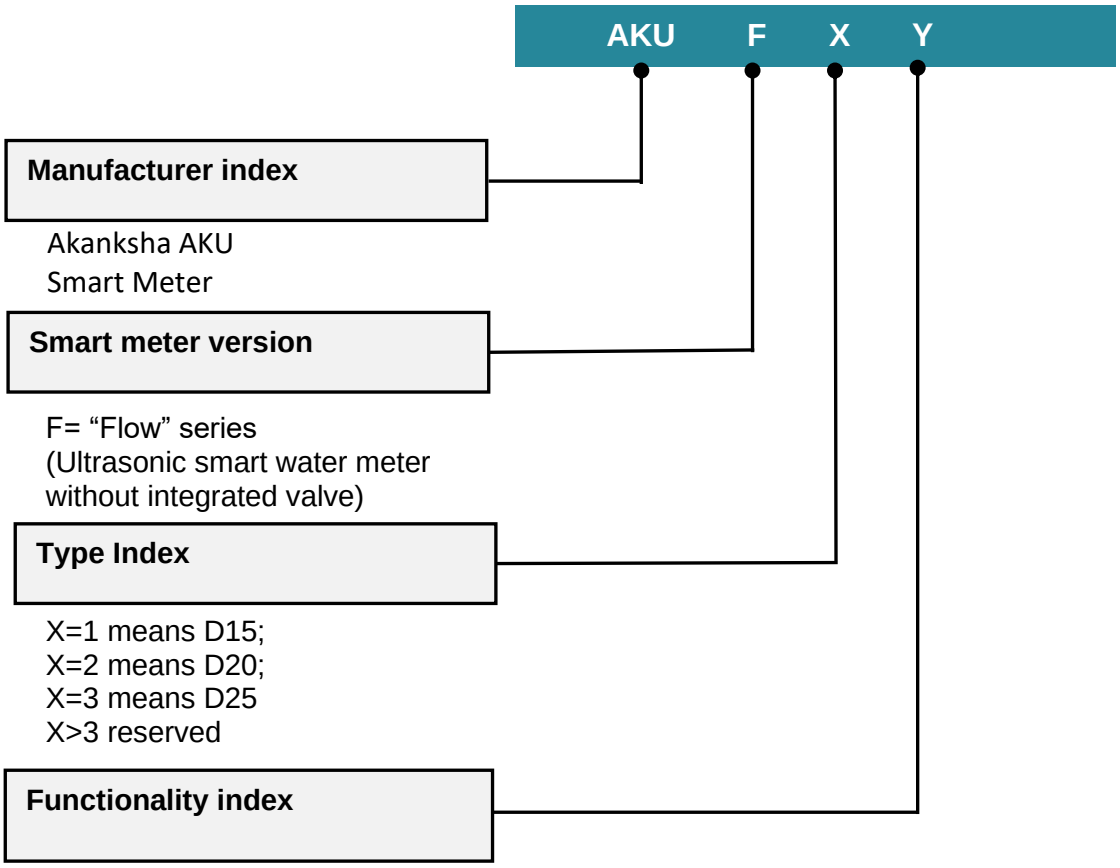
2. Standards

Table 2. Relevant standards

EN 14154-1:2005+A2:2011	Water meters - Part 1: General requirements
EN 14154-2:2005+A2:2011	Water meters - Part 2: Installation and conditions of use
EN 14154-3:2005+A2:2011	Water meters - Part 3: Test methods and equipment
EN 14154-4:2014	Water meters - P art 4: Additional functionalities
DIN EN 13757-3:2013-08	Communication systems for and remote reading of meters – Part 3: Dedicated application layer
ISO 4064-1:2014 (OIML R 49)	Water meters for cold potable water and hot water -- Part 1: Metrological and technical requirements
ISO 4064-2:2014 (OIML R 49)	Water meters for cold potable water and hot water -- Part 2: Test methods
ISO 4064-3:2014 (OIML R 49)	Water meters for cold potable water and hot water -- Part 3: Test report format
ISO 4064-4:2014 (OIML R 49)	Water meters for cold potable water and hot water -- Part 4: Non-metrological requirements not covered in ISO 4064-1
ISO 4064-5:2014 (OIML R 49)	Water meters for cold potable water and hot water -- Part 5: Installation requirements
MID Directive 2014/32/EC	Measuring Instruments Directive of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to the making available on the market of measuring instruments

3. Meters designation

AKU smart water meter family defines the family of portable water meters with different functionality developed by AKU. The following system is used to indicate the types of meters within the family:



Thus, type index is used to identify a series of meters with DN15, DN20 and DN25. Functionality index determines the meter body length L_B and meter RF communication protocol as follows in the table:

Y	DN15	DN20	DN25
0	*min_*L_B =110mm LoRa, Wireless M-bus	*min_*L_B =130mm LoRa, Wireless M-bus	*min_*L_B =190mm LoRa, Wireless M-bus
1	*min_*L_B =110mm NB-IoT	*min_*L_B =130mm NB-IoT	*min_*L_B =190mm NB-IoT
2	*max_*L_B =165mm LoRa, Wireless M-bus	*max_*L_B =195mm LoRa, Wireless M-bus	*max_*L_B =225mm LoRa, Wireless M-bus
3	*max_*L_B =165mm NB-IoT	*max_*L_B =195mm NB-IoT	*max_*L_B =225mm NB-IoT
numbers from 4 to 9	reserved for possible *modifications*	reserved for possible *modifications*	reserved for possible *modifications*

4. Measurement

4.1. Measurement principle

The meter features a flow sensor based on proven ultrasonic measurement. The flow sensor is used to measure the average flow rate and estimate the difference of measured transit time between the sound signals along with and against the direction of the flow.

The flow meter is equipped with 2 ultrasonic transducers used to send sound signals with/against the flow (see Figure 1).

The meter calculates the consumed water volume based on signals from flow sensor. Measured and calculated data are stored in the meter memory and can be presented on the meter display.

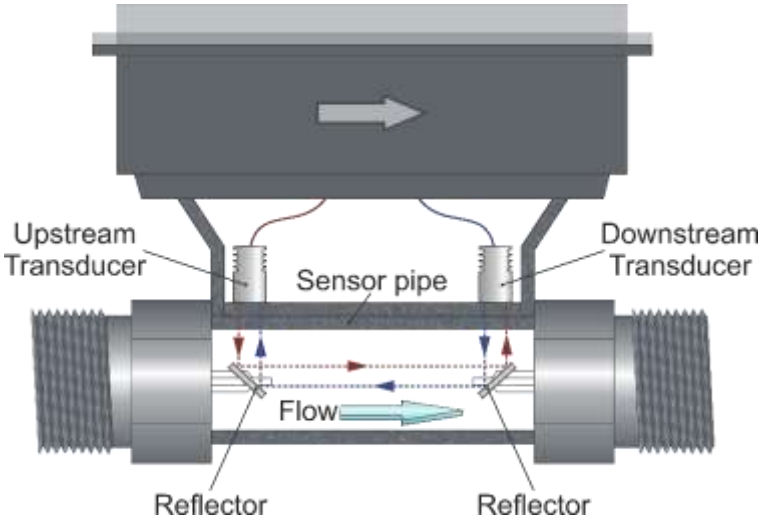


Fig.1. Measurement principle

The meter calculates water flow currently according to a fixed measuring cycle. The measurement data is captured each hour, for other measuring cycles (day, month, year) the volume is calculated. All data are saved in the appropriate register.

4.2. Registers

The following values are registered:

Table 3. WM values

Values	Description
Volume	Current reading of accumulated water volume
Clock	Actual date and time
Flow rate	Current velocity of water flow
Water temperature	Actual value of water temperature
Ambient temperature	Actual value of ambient temperature

Complete list of parameters is presented in the water meter Object model description [1].

The meter stores the historical data in three profiles. The parameter sets differ for different archives and can be negotiated as well as storage capacity. See an example below:

Monthly	36 months
Daily	90 days
Hourly	30 days

The water meter registers and records alarms as:

- info codes which represents water meter flags of certain alarm situations;
- alarm events in the event log with the relevant time stamp;
- special symbols on the meter display.

Event log stores up to 100 events (see details in [1]).

All parameters are secured due to hardware and software protection:

- Metrology MCU programming (JTAG) is disabled and meter is sealed;
- Legally non-relevant software has no any interface to change these parameters.

5. Meter States

Water meter can be in one of the states described in Table 4.

Table 4. WM states

State	Description
Off	There is no power.
Active	Powered. The water meter measures and displays the current parameter on the LCD. Can exchange data via BLE and WAN modem.

6. Alarms

Water meter records alarm situations as follows in Table 5.

Table 5. WM alarms

Alarm	Description
DRY	The water meter is not filled with water. In this case, there is no measurement of consumption.
REVERSE	Water flows in wrong direction. Reverse water flow more than Q1 detected
LEAK	Water flows continuously for more than 24 hours.
BURST	The water flow is constantly high for more than 30 minutes.
TAMPER	Indicates that the water meter has been opened.
LOWBAT	Indicates low battery.

In case any alarm is registered the WM sends alarm notification to the Control Center.

7. Design

The meter is made from durable components:

- Ultrasonic measuring pipe – Brass with 40% fiberglass GF (depending on the meter model).
- Housing – Polycarbonate (PC).

Overall dimensions of the meter are presented in Figure 2:

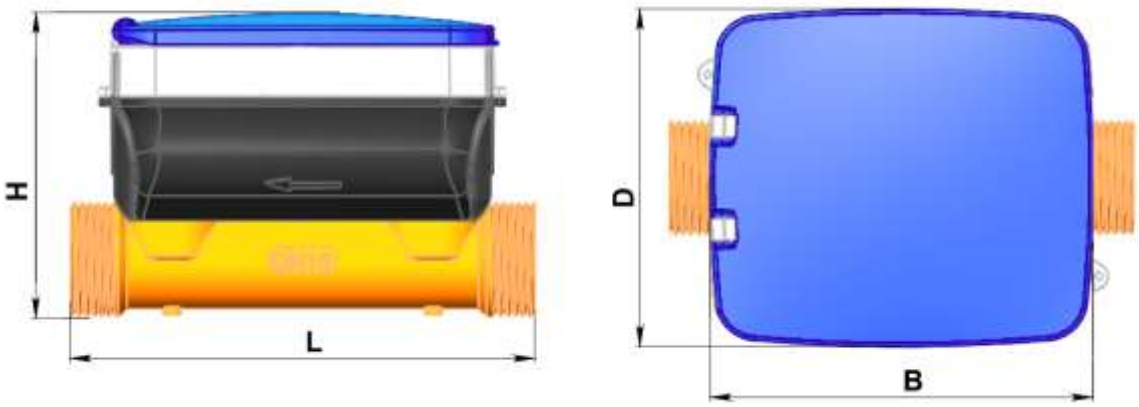


Fig.2. WM overall dimensions.

Table 6. WM dimensions for different pipe diameters

Pipe diameter	Dimensions	WM with long brass pipe	WM with short brass pipe
			
D15	**L**	165	110
	H	71	71
	D	80	80
	B	91	91
D20	**L**	195	130
	H	77	77
	D	80	80
	B	91	91
D25	**L**	225	190
	H	85	85
	D	80	80
	B	109	109

The meter basic parameters are placed on the face surface as illustrated below:

Fig.3. WM nameplate elements

Table 7. WM nameplate elements description

1	Meter model
2	Display to view consumption data and states
3	Metrological LED
4	Meter manufacturer
5	CE mark accompanied with the last two digits of the year of manufacture (YY after M sign) and identification number of the notified body XXXX
6	Manufacturer's postal address
7	Technical parameters
8	Place of manufacturing and date
9	Battery expiry date
10	Barcode with serial number

8. Sealing and secure features.

The meter body is closed by a non-separable cover to ensure the meter complete protection.

The meter cannot be accessed without visible damage of the enclosure such as breakage and cracks.

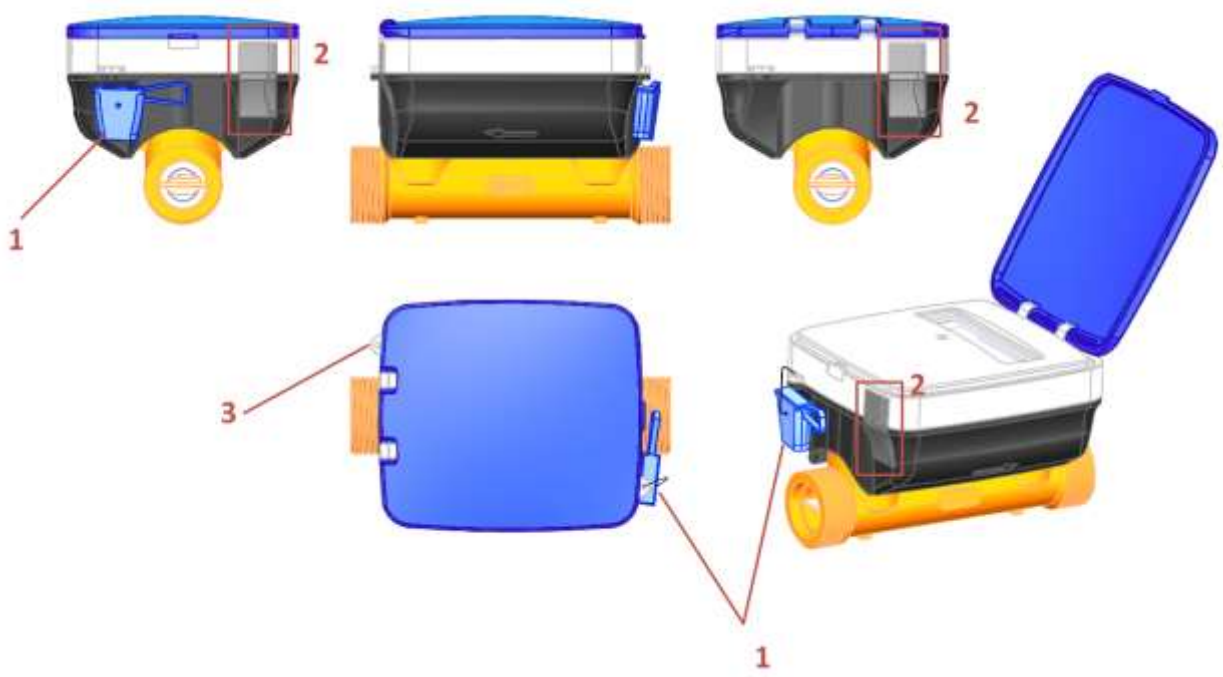


Fig.4. WM general view and sealing options.

There are several sealing options that allows the meter additional protection according to the local regulations:

- two optional security seals (pos. 1 in Fig.4). The meter design provides two holes to thread the security seal wires.
- two optional security self-destructive stickers (pos. 2 in Fig.4).

In Fig.4 see as an example of sealing positions: 3 with no seal and 1 with already installed security seal.

The meter is equipped with a meter opening tamper sensor. In case of tamper attempt, the relevant alarm is registered in the Event log and is indicated on the meter display. Information on alarms can be transmitted via WAN channel to a Control Center or can be obtained locally via BLE.

9. Meter installation position

The meter is placed on a pipe in horizontal or vertical mounting position. It is recommended to mount the meter in such a way that to read display easily.

10. Indication

The meter features easily readable LCD to visualize measurement data, states, info codes etc.:

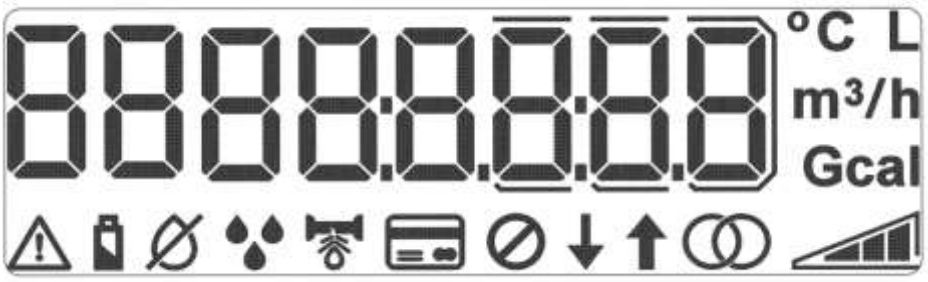


Figure 5. LCD display segments.

In fig.5 the display test mode is presented when all LCD segments are active. Test mode is set using Client's application via BLE, by selecting the special test screen from the configured list of screens.

Each measurement value is accompanied by its measurement unit.

The number of decimals is configurable. The volume resolution is 0.000001 m^3.

Measured values and states are cyclically displayed on the meter local LCD. The list of parameters to be displayed is configured and includes legally relevant data (consumed water volume).

Almost all the data (both screens and state symbols) are defined by legally relevant firmware. Display icons are described in Table 8. The symbols managed by legally relevant firmware are marked with an asterisk.

Table 8. Display icons

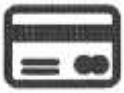
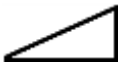
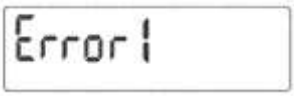
Icon	Description
 *	It is displayed in case of **TAMPER** event (attempts to open meter cover).
 *	Displayed when a **LOWBAT** alarm occurs (low battery).
 *	Appears when **DRY** alarm (water meter is not filled with water).
 *	Displayed in case of **LEAK** alarm (possible water leakage).
 *	It is displayed at the **BURST** alarm (possible breakthrough pipe).
	It is displayed when the **threshold** is reached in prepay-mode (small credit, you need to replenish the account).
	It is displayed when the water supply valve is **closed**. (For example, due to non-payment).
 *	Displayed in case **REVERSE** water flow is detected.
 *	It is displayed when detecting the flow rate of water above the **sensitivity threshold** of the water meter. The icon blinks in proportion to the flow rate (at least 4 distinct blink frequencies).
	It is displayed when there is **connection** with the external valve (via BLE).
	Communication indicator - displays the **status** and **level** of the WAN channel signal (see details in Table 9)
 *	Hardware fault (in this case the meter does not accumulate water volume).

Table 9. Indicator of WAN channel signal

Communication indicator		LoRaWAN 2G/3G/LTE
WAN symbol not displayed		WAN channel disabled (not configured)
Blinking empty frame		WAN modem hardware error
Empty frame		Not registered in the network
Frame and 1 segment		Registered in the network, signal level is low
Frame and 2 segments		Registered in the network, signal level is good
Frame and 3 segments		Registered in the network, signal level is high
Frame and 3 blinking segments		Data exchange with Control system in progress
Blinking frame and 3 segments		WAN modem configuration error

Some examples of LCD screens are presented in Table 10. The symbols managed by legally relevant firmware are marked with an asterisk.

Table 10. Water meter readings (examples)

Screen view	Description
 *	Software version
 *	CRC for legally relevant part (is followed by its value screen)
 *	Legally relevant part CRC value
 *	CRC for legally non-relevant part (is followed by its value screen)
 *	Hardware fault
 *	Legally non-relevant part CRC value
 *	Accumulated water volume, L
	Test mode – all sectors are activated

11. Communications

The water meter can be accessed locally (via BLE) or remotely via WAN channels LoRaWAN, WM-BUS.

The list of readout data is coordinated with the Client. See actual parameters below.

11.1 Bluetooth Low Energy

Bluetooth Low Energy (BLE) is used to communicate locally with flow control valve and WM software application and to update the WM firmware.

Standard	BLE specification v5.0
Frequency range	2.4 GHz
Data exchange rate	1 Mbps

11.2 LoRaWAN

LoRaWAN provides communication at long distances with very low battery usage and ensures data collection, remote monitoring and control.

Standard	LoRaWAN specification v1.1
Frequency range	868 MHz
Data exchange	Bidirectional: • Data from the meter • Control commands to the meter (for example, open/close the valve)
Data transmission interval	Configurable 12 hours recommended
Restrictions	To ensure the WM battery life span, data transmission interval should be more than 240 min

11.3 WM-Bus

Standard	EN13757-4:2005
Frequency range	868 MHz
Operation modes	Supported modes are configured: C1, S1 or T1
Data exchange	One-way mode
Data transmission interval	Configurable From 8 sec by default to 3600 sec
Restrictions	To ensure the WM battery life span, data transmission interval should be more than 60 seconds

12. Pressure loss

The pressure loss increases with flow rate as shown in Fig.6:

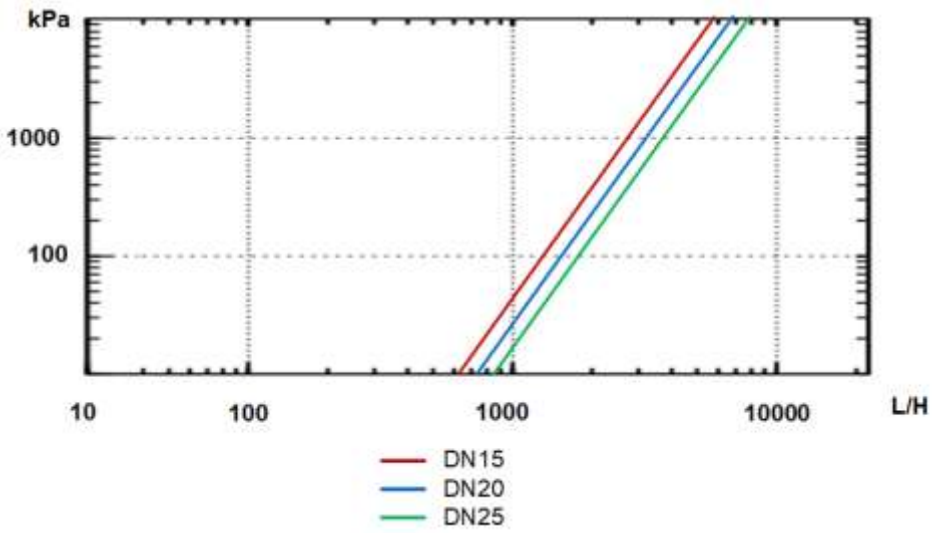


Fig.6 Pressure loss curve

13. Firmware update

Non-relevant part of the meter firmware can be updated locally (via BLE). Custom mechanism and image file format are used. The image file is digitally signed by manufacturer to exclude modification.

Before the update is started the meter checks that the image is complete, corresponds to meter type and the digital signature is valid.

References

[1]. AKU F. Object Model. Rev.2.x