FP70W
FP70P

Flow and Energy Computer
OPERATING AND INSTALLATION INSTRUCTIONS

OPERATING MANUAL

metronic

Safety notes

Before installing the device, you should carefully read the entire manual, in particular the points dedicated to the environment, health and safety.

The device has been manufactured in accordance with the requirements of European Union directives.

The instruction at all times should be stored in a safe place near the place of installation of the device.

Manufacturer's information

The manufacturer reserves the right to make changes to certain functions in connection with the continuous improvement of the design of the instrument.

MODBUS® is a registered trademark of Modbus Organization, Inc., North Grafton, MA 01536 USA

ILVA, Gilflo B, Gilflo SPOOL is a registered trademark of Spirax Sarco Ltd., Cheltenham GL51 9NQ, UK

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1   SAFETY INFORMATION

Safe use of the product can only be guaranteed if it is properly installed, used and maintained by qualified personnel (more information in the following sections), in accordance with the instruction manual.
In order to avoid risks, it is also necessary to comply with the general recommendations for safety tools and devices.

Markings used
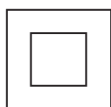
Equipment protected by double insulation or reinforcement of insulation.

The grounding clamp (ground) enables the correct operation of the product.
Do not use for electrical safety.

Attention, danger of electric shock.

Attention, risk of danger, see the accompanying documentation.

Attention, electrostatic discharge of sensitive circuits. Do not touch or operate the device without appropriate precautions against electrostatic discharge..

Important notes and information..

Remark
Misuse of the product or incorrect installation of the product, any modification of the product or repairs not in accordance with the following instructions may:
- cause damage to the product or property,
- cause injury or death to personnel,
- void the warranty, invalidate the designation C€.

> **! Disconnect the supply voltage before opening the product housing.**

Remark
The product complies with the following directives and harmonized standards:
Electromagnetic compatibility (2014/30/EC), meeting the following standards:

- Immunity in industrial environments according to EN 61326-1:2013 (Table 2).
- Class A conducted-radiated and radiated emissions according to EN 61326-1:2013.

The product may be affected beyond the limits of EN 61326 if:

- The product or its wiring is placed near the radio transmitter.
- Excessive interference occurs in the supply voltage. Supply line (AC) protection should be installed if supply voltage disturbances are likely. Protection should combine filtering, attenuation, surge and pulse limiters.
- Mobile phones and portable radios may cause interference when used within approximately 1 m of the product or its wiring. The actual necessary distance will vary depending on the installation and transmitter power.

Remark

This device is a Class A device. In a residential environment, it may cause radio interference. In such cases, its users may be required to take appropriate remedial measures.

Destiny

- Check that the product is suitable for your application.
- Determine the correct location of the installation.
- Before assembling Metronic AKP products, any environmental restrictions of the equipment specified in the instructions must be taken into account.

Access

Secure access and, if necessary, secure work platform (properly guarded) before working with the device.

Lighting

Adequate lighting must be provided, especially where detailed or complex work is required.

Dangerous environment around the product

Consider areas at risk of explosion, lack of oxygen (e.g. tanks, excavations), hazardous gases, extreme temperatures, hot surfaces, fire hazard (e.g. during welding), excessive noise, machine movements.

System

Consider the impact on the entire proposed working arrangement: whether any proposed actions will not create a danger to any other part of the system or personnel.

Hazards may include insulating openings or safety devices or rendering checks and alarms ineffective.

Tools & Consumables

Before you begin, make sure you have the right tools and/or consumables available.

Protective clothing

Consider whether people in the vicinity need protective clothing to protect against hazards such as chemicals, cold/high temperatures, radiation, noise, falling objects and hazards to the eyes and face.

Work permits

All work must be carried out or supervised by a suitably competent person. Assembly and operating personnel should be trained in the correct use of the product in accordance with the Installation and Maintenance Instructions. If a formal "work permit" system is implemented, it must be respected. If there is no such system, it is recommended that the responsible person knows what work is being carried out and, if necessary, organizes an assistant whose primary responsibility is to take care of safety.

If necessary, the words 'Warning, danger' shall be affixed.

Cleaning and maintenance

Metronic AKP products do not require any maintenance work other than periodic battery replacement. The battery life is expected to be 10 years, after which you should contact the manufacturer for a replacement.

From time to time it is necessary to clean the case of the device with dry, mint fabric. Do not use solvents or abrasives to clean the machine. They may cause discoloration or scratch the surface of the device.

Disposal

The device contains a battery. On disposal of the unit or component, appropriate precautions should be taken in accordance with Local/National regulations.

Unless otherwise stated in the Installation and Maintenance Instructions, with the exception of the battery, this product is recyclable and no ecological hazard is anticipated with its disposal providing due care is taken.

Returning a product

Customers and distributors must note that according to European Environment, Health and Safety Law, when returning products to Metronic ACP, information must be provided on any hazards and precautions to be taken due to residual contamination or mechanical damage that may pose a danger to health, safety or the environment. This information must be provided in writing, including safety data sheets for any substances considered to be of concern or of concern.

2   IDENTIFICATION, ACCESSORIES, STORAGE

> **!** **Before shipment, each Metronic AKP device is checked and calibrated to ensure correct operation. At the time of receipt, the contents of the package should be checked for possible damage to the shipment or lack of order items..**

2.1   Device name plate

The nameplate in the form of a sticker is located in the upper or side part of the device housing.

For unambiguous identification of the device, compare the data plate with the figure below.
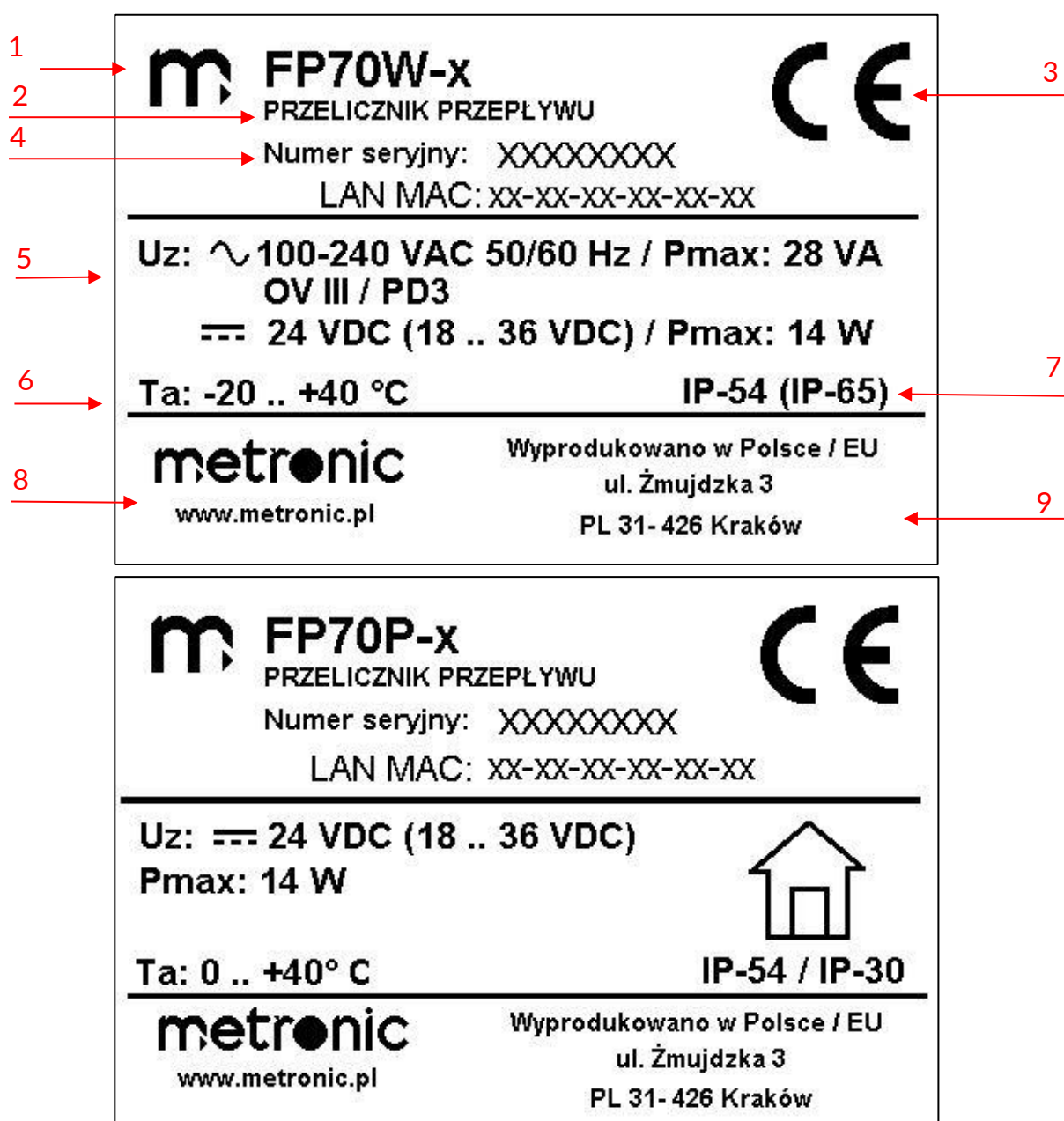
Description of the markings:
1. Manufacturer's logo
2. Name and type of device
3. CE marking
4. Serial number and MAC address
5. Supply voltage and maximum power consumption
6. Ambient temperature
7. Degree of protection
8. Name and website of the manufacturer
9. Place of manufacture of the instrument

2.2 Available versions

The flow computer can be equipped with an optional analogue output / outputs 4-20 mA. Offered versions of the device:

FP70			
	W		wall mount version
	P		panel mount version
		- 0	no analogue outputs installed
		- 1	one analogue 4-20mA output
		- 2	two analogue 4-20mA outputs

For example:
The device with one analog 4-20mA output has the purchase code: **FP70W-1**.

2.3 Equipment delivery

It is necessary to carefully compare the actual state of the contents of the package with the list of elements listed in the following subsections. In the event of damage or missing elements, an appropriate protocol should be drawn up in the presence of the carrier, which should bear the date of receipt and the signature of the delivery of the parcel.

2.3.1 Standard content
- Device FP70W
- Warranty card
- Calibration certificate

2.3.2 Optional accessories
- Convertor CONV485E
- Convertor CONV485USB-I
- Convertor CONVUSB
- Power supply
- Flash Memory Drive (Memory stick)
- Calibration report

2.4 Storage

If the device is to be stored for a certain period of time before the start of assembly, the conditions for proper storage must be observed. The device should be stored at temperatures in the range of -30°C to 70°C and with relative humidity maintained between 5% and 95% (without condensation).

Before installing and connecting the power supply, make sure that there is no condensation inside the device.

3   GENERAL INFORMATION

3.1   Product designation

The FP70W is a universal flow computer with electronic data recording.

The flow computer purpose is to measure:

- flow and thermal energy of steam and water according to IAPWS-IF97 in the operating range:
    - 52 °C to 800 °C and 0.02 MPa|a to 16.5 MPa|a for superheated steam,
    - 0 °C to 372 °C for saturated steam (with temperature measured),
    - 0.02 MPa|a to 16.5 MPa|a for saturated steam (with pressure measured),
    - 0 °C to 350 and 0.02 MPa|a to 20.0 MPa|a for water.
- flow and heat energy of liquids other than water according to the characteristics of the medium entered by the user,
- flow of technical gases according to the perfect gas equation or according to the characteristics of the medium entered by the user,
- flow and thermal energy of technical gases according to the characteristics of the medium entered by the user.

The computer may be configured to monitor one or two independent advanced measuring flow applications (pipelines) with data retention of 0.5 s. All data is measured, calculated and updated during this period.

The flow computer can support different types of flow meters:

- differential pressure flowmeter device according to an iterative algorithm in accordance to EN ISO 5167 (with some limits to other liquids and gases other then water or steam)
- small bore precision orifice in accordance to ASME MFC-14M-2003 (with some limits to other liquids and gases other then water and steam)
- differential pressure flowmeter device according or square root approximated characteristics
- differential pressure flowmeter device ILVA, Gilflo B, Gilflo SPOOL manufactured by Spirax Sarco Ltd., UK (only for steam and water and only based on manufacturer calibration table)
- mass
- volumetric

The device is designed for industrial applications in independent measuring systems or as a part of computer measurement and control systems. The device can be connected to a PC, PLC or supervising control system via the built-in Ethernet or RS485 communication ports. Four relay outputs enable alarm signalling and simple control of actuators.

The 7 inch (5 inch for panel version) colour display with touchscreen provides easy user interface and clear measured data presentation. The number of advanced functions, data presentation, and data acquisition make the device convenient as an electronic recorder and data analyser of technological processes and emergency states in plant.

There are seven language available for the device interface:

- English

- German
- Spanish
- French
- Italian
- Polish
- Portuguese.

The wall version device may be supplied from mains 110 to 240 VAC or 24 VDC. Panel version requires 24 VDC supply. More information is in chapter <u>Power supply</u> and technical specification.

3.2 Main functions

3.2.1 Main applications A and B

The device can be set up for two simultaneous and independent measuring applications: A and B. Each may be configured to one of available advanced flow and/or energy measurements:
- Liquid flow
- Liquid heat
- Liquid delta heat
- Steam net heat
- Steam and condensate delta heat
- Steam generator
- Gas flow
- Gas heat

3.2.2 Auxiliary application X, auxiliary channels

Auxiliary X application may use up to 24 free programmable channels. Channels in the application X can be used to measure other auxiliary process values or to copy channels values from system A and B in order to do some other calculations (e.g. sum of energy from A and B) as a math channels. In application X it is not possible to select the predefined flow and energy application.

3.2.3 Process values inputs

There are few available ways to input process value to the flow computer:
- as a binary signal (pulse or frequency),
- as an analogue signal (RTD or 0/4-20 mA),
- as an digital value read via Ethernet port (Modbus TCP protocol),
- as a computed value (user math formula based on other process channels values).

The input process value have to be assigned to a proper channel in the configured application. If required one input process value may be assigned to more channels, also in different applications, A, B or X. (E.g. the same temperature measured by RTD sensor at IN3 may be used as a process temperature in the applications A and B.)

3.2.3.1 F type binary inputs IN1, IN2

F type input may work in one of three available modes:
- Frequency – frequency measurement in range from 0.02 Hz to 12 kHz.
  (E.g. used for Vortex flowmeter with frequency output.)
- Pulse counting – low frequency input, when number of pulses is more important than frequency. (E.g. water rotary flowmeter with contact output.)
- State – on/off tracking with process value assigning for each state. (E.g. used for valve open state without flowmeter installed or flow direction indication.)

F type input can accept typical industrial standard signals, depending on chosen input signal type:
- OC – for transmitters with passive transistor OC output or contact output
- Voltage – for active voltage signal
- NAMUR – (simplified) for transmitters with so called NAMUR output
- E+H – for transmitters with current loop type output

Each input has independently selectable in configuration menu low pass filter for signals below 900 Hz.

3.2.3.2 RTD type analogue inputs IN3, IN4

There are two inputs for resistance sensors direct connection. A number of RTD type characteristics are available: Pt100, Pt200, Pt500, Pt1000, Ni100, Ni120, Ni1000, Cu50, Cu53, Cu100. User defined characteristic as an entered table is also possible. Each input can be independently selected for 2-wre, 3-wir or 4-wire configuration.

3.2.3.3 I type (0/4-20mA) analogue inputs IN5 to IN10

There are six current loop inputs IN5, IN6, IN7, IN8, IN9, and IN10. Each can accept signals 4 to 20 mA or 0 to 20 mA from passive or active current loop transmitter. Passive transmitters may be supplied directly from the flow computer.

3.2.3.4 Digital inputs via Modbus TCP protocol

The device allows remote reading of up to 40 values from 20 devices using Modbus TCP protocol. Detailed information in chapter Modbus TCP (Client).

3.2.3.5 Constant value inputs

In special situations, it may be necessary to enter a constant value as an input process value. As a consequence this constant value is used as an input value for all calculations in flow computer.

3.2.3.6 Computed inputs based on other channels values

The input process value may be defined as a result of other process or even as a result of math formula based on other process results. (E.g. mass flowrate in application B required as an input value may be taken from application A, where it was calculated as a result of compensated mass flow measurement.)

3.2.4   Process values channels

3.2.4.1 Channels organisation

All process values, measured and calculated are ordered into channels. In main applications A and B the number and types of channels are determined based on chosen application type. The symbols and naming are also determined. The auxiliary process values in application X are defined and named by the user.

Some process values, mainly input values have to be assigned to inputs, scaled and configured (e.g. pressure measured as a 4-20mA input signal). Other channels are result of internal calculation (e.g. steam power is result of calculation from flowrate, temperature and steam tables.)

More information is in chapter Channel types, process quantities and in chapter Types of measuring channels A and B.

3.2.4.2 Process units

For each channel it is possible or even required to select an engineering unit. The entered unit affects the other results in calculations process of flow computer. Units have been defined in the device (list of available units is in the chapter Process result units).

Due to the possibility of implementing various, also unusual measurement systems, for some channels it is possible to define user unit. Details are in the chapter User Units.

3.2.4.3 Computed channels, math formulas

Some channels may be defined as Computed. Selected mathematical operations are available within the calculation channels: addition, subtraction, division, multiplication, raising to 2, 3 or any power and root. The math formula is entered by user as a string, and may contain up to 200 characters. Also values from other channels and totalizer values can be used in formulas. More information, see the Computed Channels chapter.

3.2.4.4 Totalizers

For every flowrate type channel up to two independent totalizers can be configured. Every totalizer can be configured to non-resettable or resettable mode. Totalizer reset may be executed by the user on the touchscreen or set to be reset automatically daily, weekly or monthly (more information in the section Totalizers).

If required, the number of totalizers can be multiplied by creating the copy of the channel in system X using math functions.

For channels assigned to F-type input and configured to the "Pulse counting" mode, totalizing is determined on precisely summing the input pulses multiplied by the factor (weight) of a single pulse. (In this mode the flowrate value is only indicative.)

Selected totalizer values may also be periodically sent as an e-mail massage up to five different addresses at the indicated time every day, on the selected day of the week or on the selected day of the month.

3.2.4.5 Alarm notifications and control

Each channel can have two independent alarm thresholds. Each threshold can be defined as Low or High. There are two modes available for alarms:

- Alarm (latched, requiring confirmation)
- Control (non-latched, not requiring confirmation).

More details are described in the chapter Alarm acknowledgement (Alarm/Control mode).

Exceeding alarm thresholds is indicated by the alarm icon and can be signalled by beeper activation. (More information is in the chapter Alarm signalling on the device). Also assigned process value may change the colour to attract user attention.

Alarm information can be assigned to one of four output relays.

The device may also send an e-mail message at the beginning and end of the alarm alert. The message may be sent up to five different addresses.

3.2.5   Outputs

3.2.5.1 Relays (RL1 to RL4)

The device has 4 solid state relay outputs. The outputs can be active when the alarm thresholds are exceeded, which makes it possible to configure a simple control system. It is possible to assign the same relay output to several alarm thresholds.
There are three modes available for relay outputs:
- Normally open – output closed when active,
- Normally closed – output opened when active,
- Pulsation – 1 Hz pulses are generated when active.

In the event of a power failure or e.g. restarting the device, the relay outputs remain in the open state (regardless of configuration).

3.2.5.2 Analogue 4-20mA outputs (Optional, OUT1, OUT2)

Depending on the version of the device (more in the chapter Available versions), the device may have up to two type I outputs (4-20mA current loop).

The output have to be assigned to one of process value channels to retransmit its value in configured range. The output can indicate a failure with a user-defined current value (e.g. 3.6 mA).
The current loop of the output have to be powered from an external power source.

3.2.6   Data Archive

Process values and service information are saved using an advanced archiving system. The device has an internal 2 GB non-volatile memory.

Data is saved in form of three files groups: process data archive, totalizers archive, events archive.

Depending on the level of access, it is possible to display the event log saved in the service archive. The archive is displayed in the form of a table. The log contains all events and authorized actions performed since the first start of the device. Access to the register from the device screen allows the supervising staff to verify the changes made in device settings.

The data is saved as csv format text files with encrypted checksum to provide secure data control.

The archive files may be copied via build-in USB port or device www server via Ethernet port.

Detailed information may be found in the ARCHIVE chapter.

3.2.7   LCD display and data presentation

User interface (GUI) is based on colour graphic LCD with resistive touch panel. For wall mount version it is 7" size display and for panel mount version it is 5" size display. Both have the same resolution and all functions are the same for both versions. GUI is organised into screens groups for intuitive navigation and data presentation.

For more information see the chapter Front Panel and Graphical User Interface.

3.2.7.1 Screens for A and B applications

Main process data is available for in screens separately for application A and B. Data is presented as a synoptic graphical pictures. Touchscreen allows to switch over to detailed screens with data table detailed channel information with trend, maximum and minimum values, totalizers.

3.2.7.2 Screens for auxiliary X application

Data is presented as a 24 values table. Similarly as for A and B the touchscreen allows to switch over to detailed screens with data table detailed channel information with trend, maximum and minimum values, totalizers.

3.2.7.3 User tables and Trends

User may configure own Tables and Trends based on available process values from all three applications A, B and X. Up to six tables with maximum sixteen values may be configured for each table. Table may contain also totalizers, maximum and minimum values. Each table may contain mix of process values from application A, B, X ordered in user convenient way.

By analogy, there are available up to six screens with process values trends. Each screen may contain up to six channel values, mixed from all three applications.

3.2.7.4 Screens for Archive, Alarms and Info

Separate screens are available for information and control of archived data, alarms and general information on device. In Archive screen it is possible to view archived data in graphical form.

3.2.7.5 Service screens for Settings and I/O status

All settings may be configured using advanced settings interface. For current I/O status and quick view over hardware operation information on screen Info is available.

3.2.8 Communication with the master system (sharing results)

The instrument may be integrated into the plant supervising data system. There are two protocols available for process data sharing:

- MODBUS RTU over built-in RS485 serial port
- MODBUS TCP over built-in 100 tBase Ethernet port

The map of registry addresses and details of data formats are described in the chapter MODBUS RTU / MODBUS TCP TRANSMISSION PROTOCOL.

In addition user may have access for process data and archive files via build-in web server.

3.3 Supporting software

Additional software for the device can be downloaded from the manufacturer's website: www.metronic.pl.

3.3.1 Device configuration program

Dedicated *FP70 Config.exe* program allows user to configure the FP70 device using a standard PC computer. For safety reason settings are at first generated as a file. In next step new settings are uploaded to the device via USB port and standard memory flash drive. It is also possible to download settings from the device to the PC is the same way.

The program is characterized by intuitive operation and interface similar to the device interface. The program can be installed on computers with MS Win operating system.

For details see FP70 Config.

3.3.2 Software for archive data visualization

The *FP70-RP.exe* program may be used to simple analyse and visualize measurement results using a PC computer.

The extended version (optional), *FP70-RPplus.exe*, among others extra functions, enables selection of data in a file and downloading online archive files.

The program can be installed on computers with MS Win operating system. Detailed information is described in chapter [FP70-RP](#).

4   FRONT PANEL AND GRAPHICAL USER INTERFACE (GUI)

4.1   Front panel and function buttons

The front panel of the device has a built-in touch panel, colour 7" (5") LCD display, which is the main tool for communication with the user.
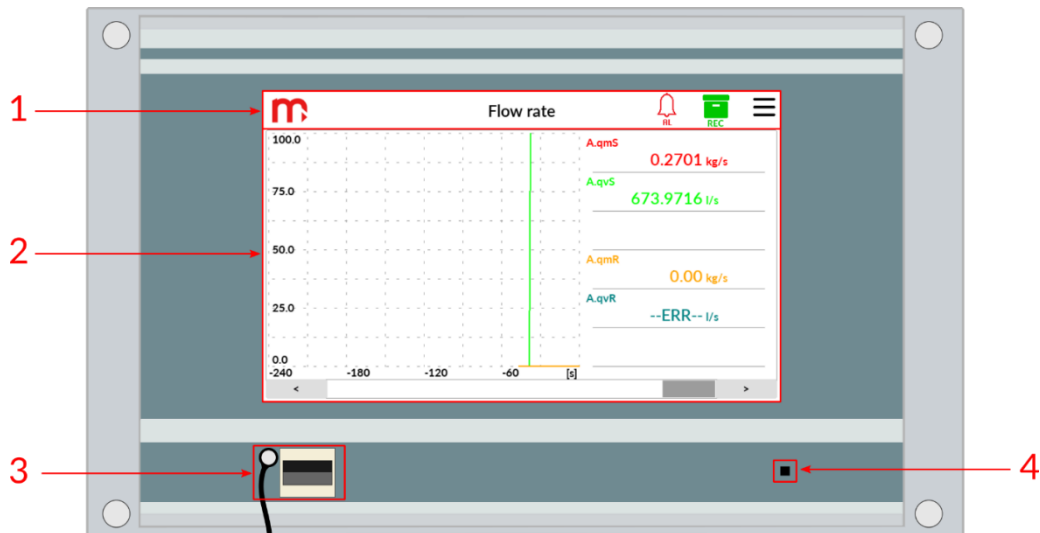
The display is divided into two areas:

1.   Title bar   with function icons; touching the icons allows to switch between screens and display a drop-down menu
2.   Main screen   for displaying all process data and screens, entering data using the on-screen keyboard

In addition, on the front panel of the device there is also:

3.   USB port   for connecting an external USB memory device (flash type) to transfer data stored in the internal memory of the device to a computer or to load user files (e.g. settings file, user media file)
4.   LED indicator   indicates extra device status information:
- Blue - lights up when starting the device, when the display is dimmed to 0%, when taking a screenshot, when reading / writing files (pulses when copying data between the internal memory and the external USB memory)
- Green - lights up / pulsates when creating a new file in internal memory (e.g. when creating a new archive file), lights up when the device is in bootloader mode (mode to change the firmware of the device)
- Red -   error information

!   **Do not use sharp or metal objects to operate the touch screen.**
Improper operation may damage the display.

4.1.1 Title bar

The title bar is located at the top of the screen and is always seen in the display with very few exceptions.
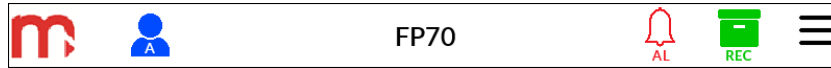
Manufacturer's logo.

Information about the login status: active icon, tapping opens the Login Window (more information in the chapter Access control, login and changing the user's password).
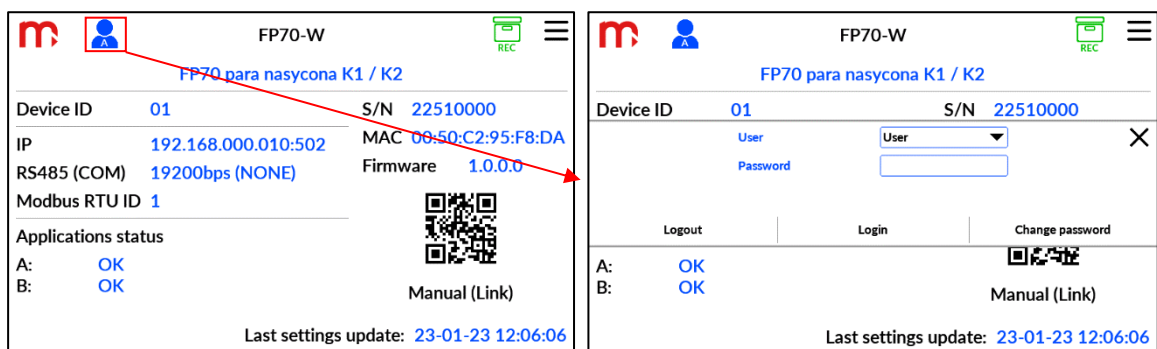
FP70 Title of the currently open window (for more information, see User screens).

Information about the failure of the measurement or remote input (status of the measurement inputs available in the Service Test Screen (IO TEST)).

Alarm status; A flashing icon indicates an unconfirmed alarm; a filled icon indicates that at least one alarm is active and all alarms are acknowledged; An empty icon indicates that at least one alarm is configured, but none are inactive; The absence of an icon indicates that not a single alarm is configured; Active icon, tapping opens the Alarm Screen (for more information, see Alarm Screen).
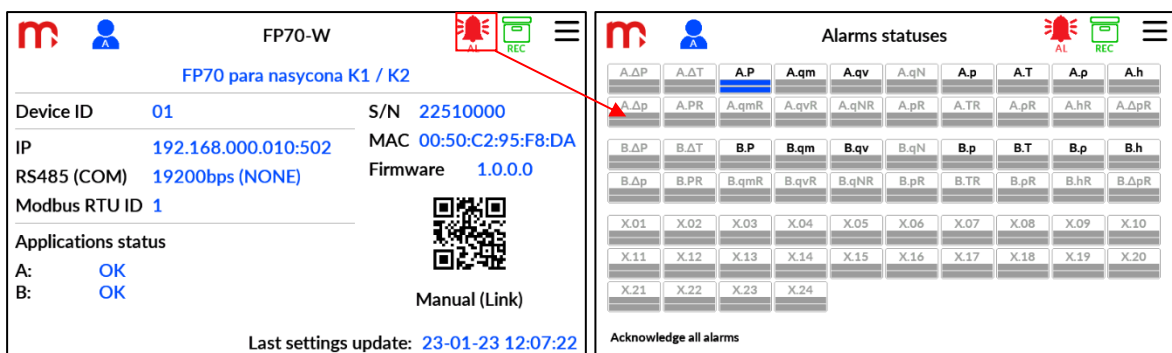
Archive status, filled icon indicates that the backup process is started. Active icon, tapping opens the Archive Screen.
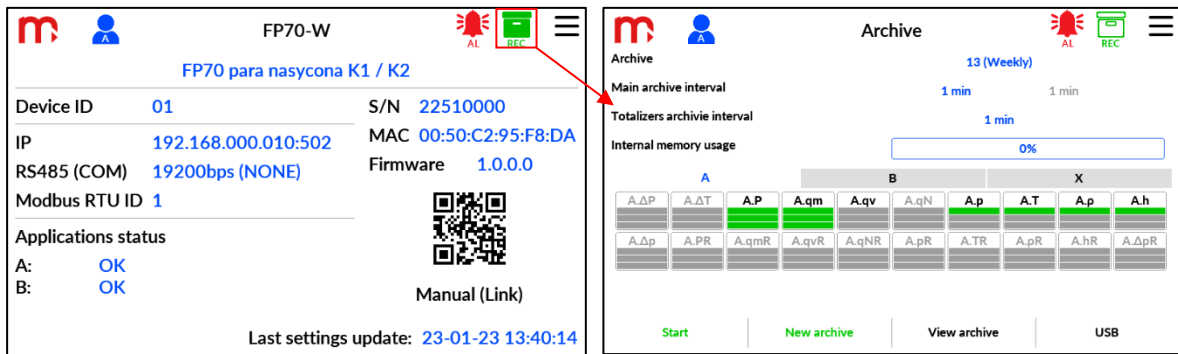
4.1.2 Drop-down Main Menu

Main Menu icon, tapping opens or closes its contents.
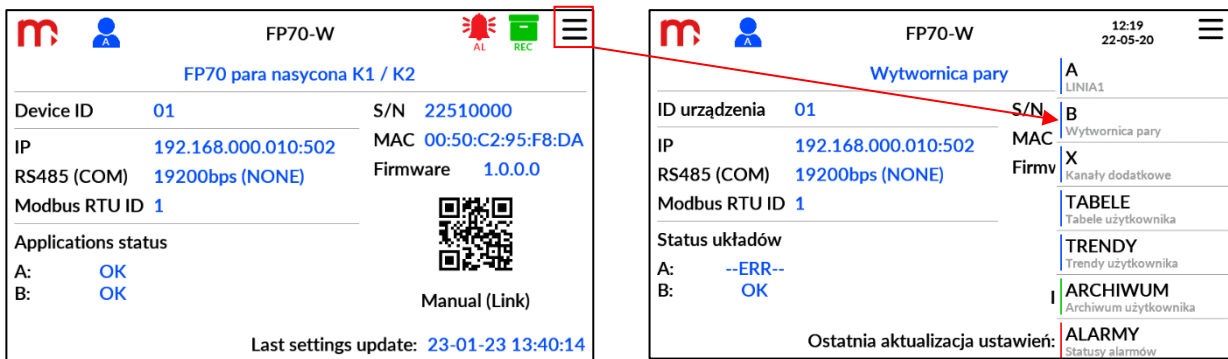
Swiping up or down allows to see all available buttons.
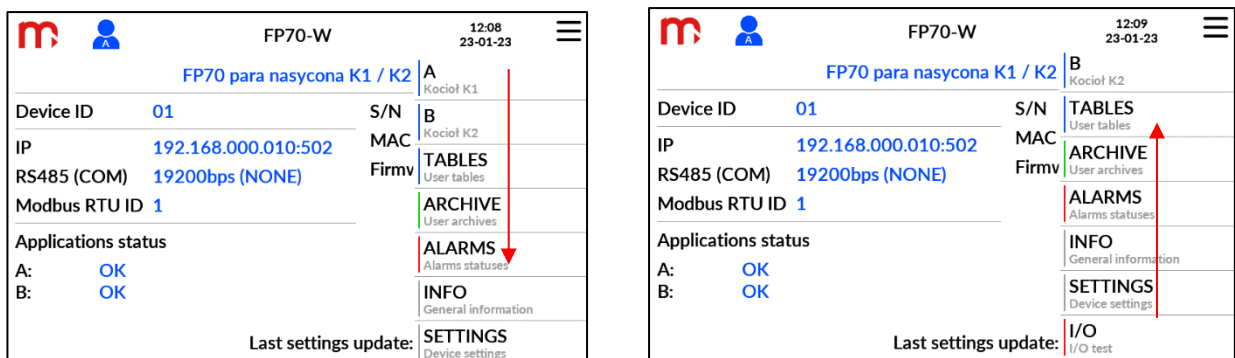
The drop-down menu contains a list of buttons with a current date and time indicator at the top. Buttons are used to switch over to other screens. The content of the drop-down menu depends on the enabled functions and device configuration.

A s-w open superheated	Opens the main screen of application A (for more information, see Application screens).
B Hall 2	Opens the main screen of application B (for more information, see Application screens).
X Additional Channels	Opens the application X (for more information, see Additional channels).
TABLES User Tables	Opens the Table screen (for more information, see User Tables).
TRENDS User Trends	Opens the Trends screen (for more information, see User Trends).
ARCHIVE User Archives	Opens the Archive screen (for more information, see Archive screen).
ALARMS Alarms Status	Opens the Alarms screen (for more information, see Alarm Screen).
INFO Device General Info	Opens the About Device screen (for more information, see About Device).
SETTINGS Device Settings	Opens the Main Menu screen (for more information, see Main Menu).
IO Test IO	Opens the service I/O test screen (for more information, see Service Test Screen).

4.2 Access control and passwords

4.2.1 Access control

The flow computer uses an access control module that limits the possibility of changing the operating parameters of the device and the ability to copy data from the device by unauthorized users.

The flow computer provides 5 levels of access. Identification of the login level is possible using the icon displayed in the title bar:

No logged-in user	User	Administrator	Service	Factory
👤	👤 (U)	👤 (A)	👤 (S)	👤 (F)
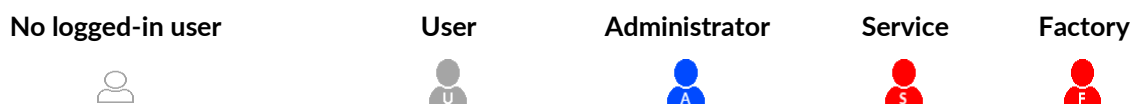
3 levels of access are sufficient to operate and configure the device: No logged in user, User and Administrator.

Below is a table showing access to the device's features depending on the level of access. The + sign indicates the functions normally available for the selected level, the * sign indicates the functions available depending on the settings.

Function Access level	No logged-in user	User	Administrator
Open the login window	+	+	+
Change a User's password		+	+
Change the Administrator password			+
Browse screens	+	+	+

Alarm confirmation		+	+
Resetting totalizers		+	+
Reset min. and max. values		+	+
Archive Control (stop/start archive)		*	+
Creating a new archive file		+	+
Copying archive files and print screen to USB		+	+
Deleting archive and print screen files			+
Displaying the event log (preview on the device screen)			+
Display the settings windows in the Main Menu		+	+
Displaying service windows in the Main Menu			+
Change settings			+
Copy the settings file to USB			+
Loading the settings file from USB			+
Saving the print screen		+	+
Displaying the Service Test Window (TEST IO)	+	+	+

The User access protection may be deactivated. More information in chapter Changing password).

The Service level access may be required to set a new Admin password, to set the starting totalizer(s) value or re-calibration of analogue measurement inputs. It is possible to get the Service password from manufacturer. For more information, see procedure Recover a lost password and obtain a service password).

The Factory level contains functions available only to the manufacturer service procedures.

4.2.2   Log-in and Log-out

Logging in is possible in the Login window. Tapping the login status icon in the title bar opens the window.
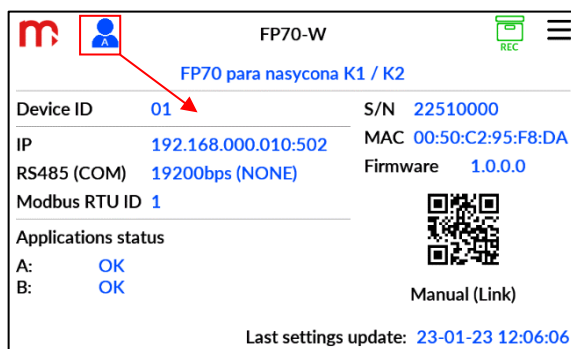
Appropriate access level from the drop-down list have to be selected and password entered. Tapping the 'Login' button confirms the operation.

The Administrator access is forbidden when LOCK2 hardware switch is activated. LOCK2 switch is located in rear panel for panel mount version device and in terminals compartment in panel mount version device.

Access level	Default password
User	0
Administrator	1

After the first login, it is recommended to change the default passwords.

Logout, regardless of access level, occurs automatically after 5 minutes of inactivity. When logged off, the lowest access level is enabled. Logout after a shorter period of time is possible, tapping the 'Logout' button in the login window.

4.2.3   Changing the password

The password can be changed in the login window tapping the 'Change password' button.

In the window that appears the required access level have to be selected and new password entered and confirmed. 'Set' button have to be tapped to accept the changes.

> **!●** The keyboard in the password change box allows to select only uppercase and lowercase letters and special characters. In the case of a password, it is not possible to enter letters specific to the selected language.

It is possible to disable the password for the User and/or Admin access level, when new password is left empty.

4.2.4   Recover of lost password and getting service password

When User password is lost, then Admin may set a new password. When Admin password is lost, then new password have to be set using Service level.

The Service password may be obtained from manufacturer. To generate new password the service code have to be delivered to manufacturer.

The Service Code field displays the 8-character unique code, when 'Generate new code' button is tapped. Manufacturer in response will generate matching password.

In similar way it is possible to get the One-time Factory password. It is valid to log-in once. When log-out, either manually or automatically after 5 minutes without activity, the password is deactivated. Device restart or power off-on does not affect the log-out.

> ! The Service password or One-time Factory password is valid until the new service code is generated.

4.3 Language change

Language change requires Administrator level (more information in the Login chapter).

The language selection is located in General settings screen (icon ⚙️ GENERAL) and tab General. In drop-down list there are available languages:
– EN (ENGLISH),
– DE (DEUTSCH),
– ES (ESPAÑOL),
– FR (FRANÇAIS),
– IT (ITALIANO),
– PL (POLISH),
– PT (PORTUGUÊS).
New settings require confirmation (✓), and saving (🔵).

4.4 First run

While starting the device for the first time with factory settings, the General Device Information screen appears. The drop-down menu contains only four buttons: ARCHIVE, INFO, SETTINGS, and I/O. All these screens are always available, regardless of the configuration of the settings. During factory settings, the screen of the device is dimmed after 5 minutes of inactivity. If the screen is dimmed, a blue LED on the front panel indicates that the device is operating.
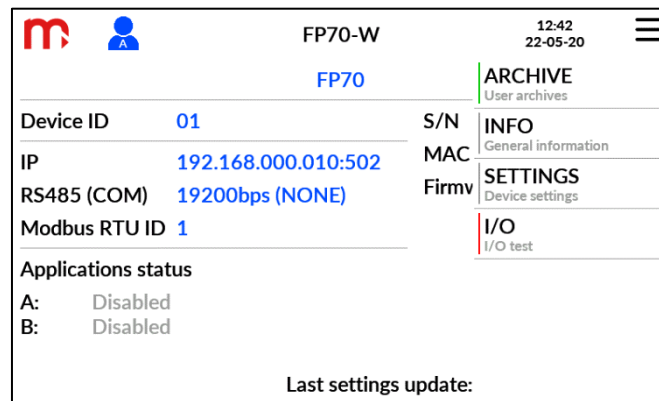
After delivery, the device has an English language set. After Restore factory settings, the device boots in the last used language. (See Restore Factory settings for more information).

In this state device is not ready for measurements and requires configuration as a next step (CONFIGURE SETTINGS).

4.5   Screens

The number of available screens and their details varies depending on the device configuration and settings. Some screens (main screens) are available from Main Menu buttons or title bar icons. Others (detailed information screens) are available by taping active areas in currently displayed screens.

4.5.1   Application A and B screens

The Application A or B screen is brought to display by tapping the A or B button from the Main Manu. The buttons A and/or B are available when application A and/or B is configured.

The Application Home Screen contains a simplified synoptic application schema. The process values displayed on the screen are defined automatically. Flowmeter, thermometer, and pressure gauge pictures are displayed if the corresponding channels are configured as input measurements.
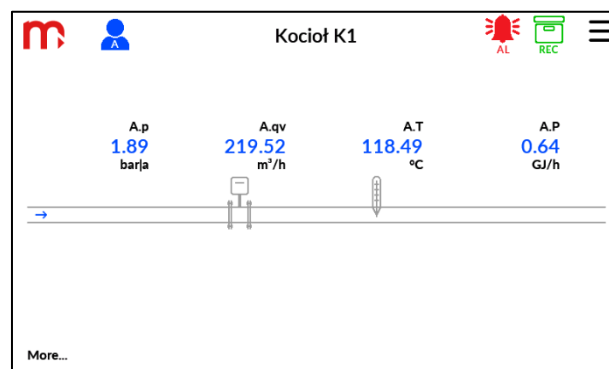
A detailed description of the available measuring systems and the corresponding simplified screens is described in the chapter Types of measuring systems A and B.

The screen contains a MORE…. button. Pressing the button displays Application Table window. The table contains all process values billed in the application. Tapping the × closes the window and returns to Application Home Screen.
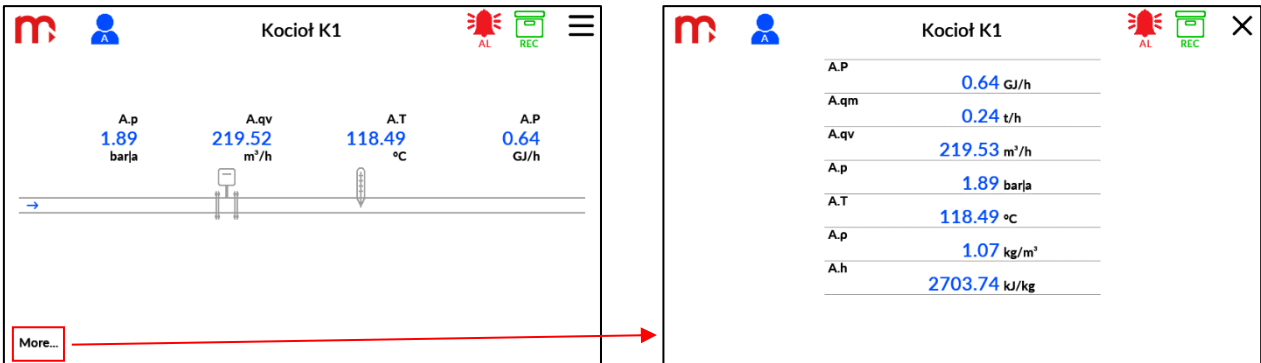
Tapping the process value pops up the Single Result window with more detailed information on this channel. To close the single result window, the x have to be tapped.
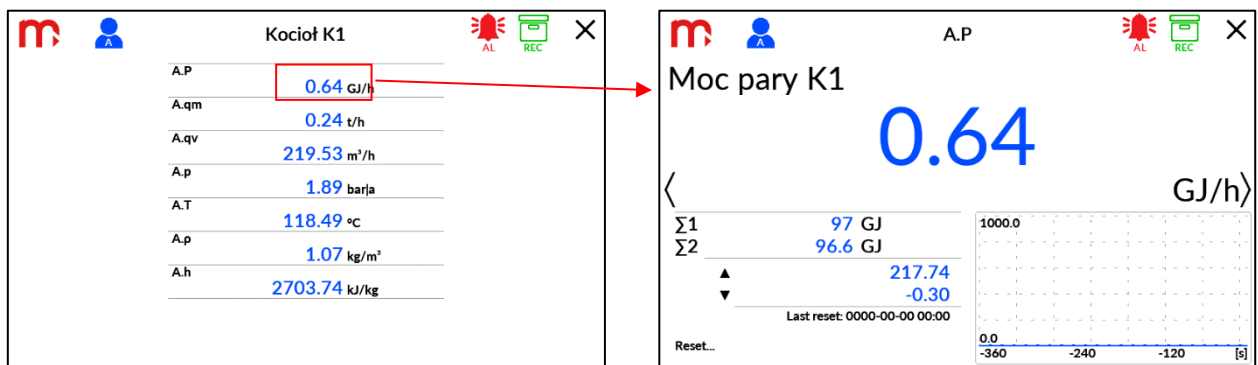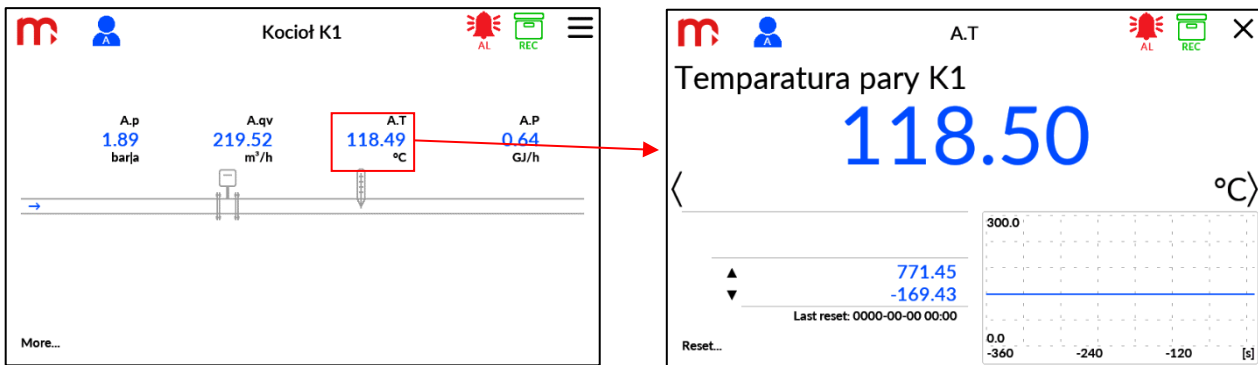
Only the channel symbol (e.g. A.T) is displayed in Application Home Screen and Application Table window. The symbol is unique for every process value in the device and cannot be edited. But every process value may be added an individual description and it is displayed in the Single Result window, in the User Table screens and in the User Trends screen.

4.5.2   Application X (auxiliary channels) screen

The Application X screen is brought to display by tapping the X button from the Main Manu. The button X is available when at least one auxiliary channel is configured.

The Application X Home Screen contains a table with all auxiliary channels (max. 24 channels may be configured). The order and arrangement of the channels in the table is fixed and cannot be edited. Only enabled channels 1 through 24 are displayed in the table. If the channel is not enabled, the space in the table will be left blank. If special order in the table is required, then it have to be foreseen during configuration process.
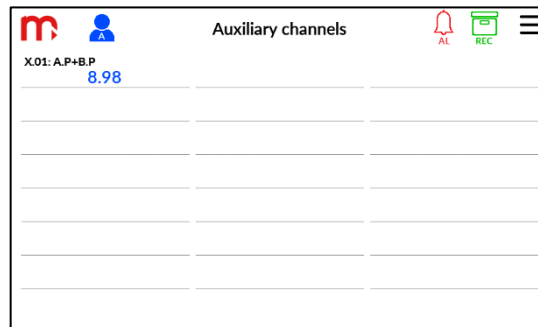
For auxiliary channels the Single Result is also available, in very similar way as for application A and B. To close the single result window, the × have to be tapped.
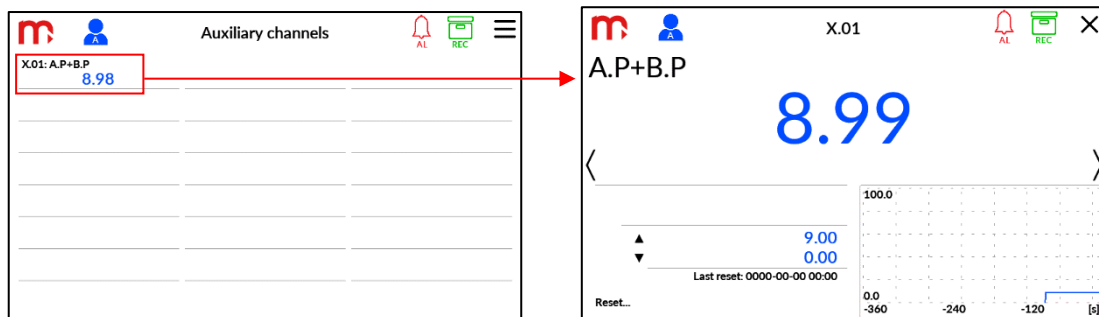
Only the channel symbol (e.g. X.01) is displayed in Application X Home Screen. The symbol is unique and cannot be edited. But it may be added an individual description and it is displayed in the Single Result window, in the User Table screens and in the User Trends screen.

4.5.3 Single Result window

The Single Result window is the most detailed screen displayed for a single process value.
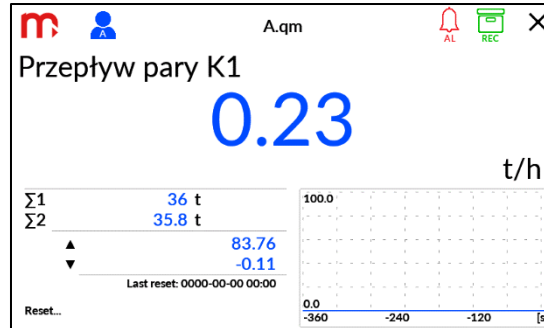
The channel symbol (e.g. A.qm) at the top allows to identify the application (e.g. A – application A) and process value (e.g. qm – mass flowrate).

The window displays all data for the selected channel: channel symbol, user channel description, value readout, channel unit, totalizer 1 and 2 values (if configured as active), minimum and maximum values and trend from the last 360 seconds.

At the bottom left corner of the screen there is a RESET.... button. Tapping it pops up the window with reset options for totalizers and maximum and minimum values: for current channel only, for all channels from current application or all channels from all applications. Only totalizers with configured manual reset permission are affected. For execution of this function User login is required. In the screen there is also a date and time stamp from last reset.
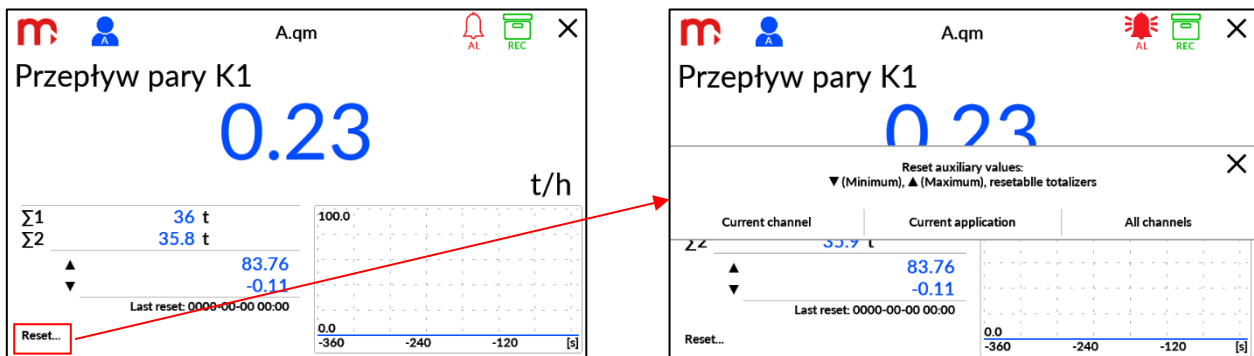
The trend chart box contains a graph from the last 360 seconds (minimized chart). Tapping the chart causes maximizing it to full screen size. Minimizing the chart back requires tapping the chart again.
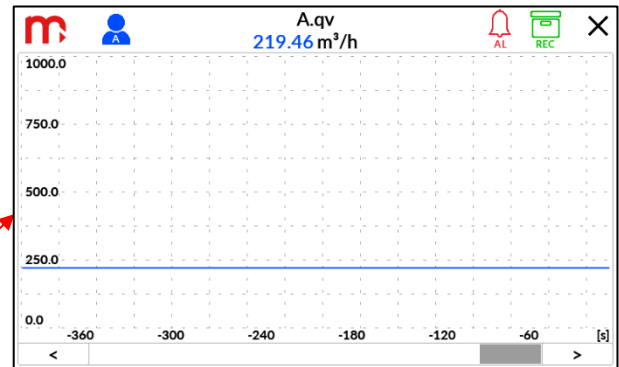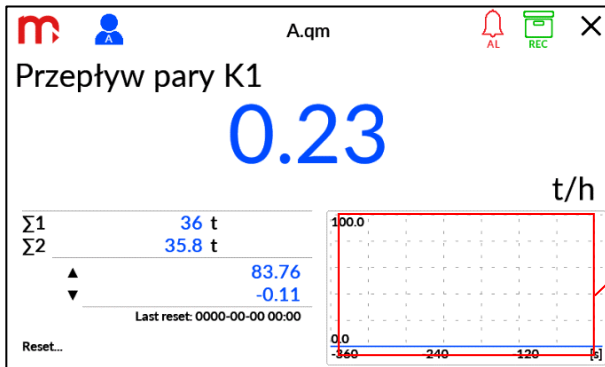
In full screen mode it is possible to display the trend line from the last hour with a slider at the bottom of the screen.
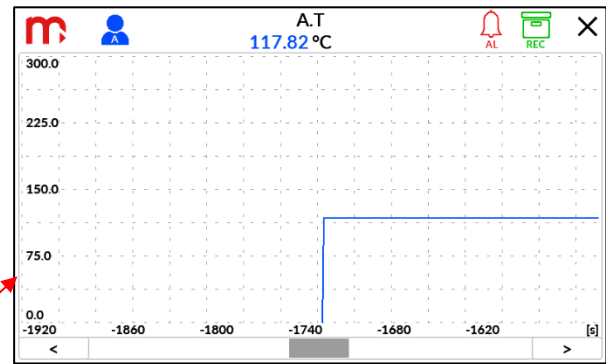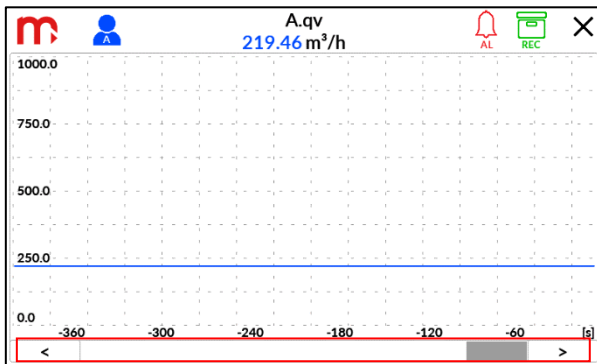
When the Single Result window is brought to the display, the two cursors are displayed at the sides: < (scroll left) and > (scroll right). Using the cursors it is possible to view other channels in Single Result mode within the current application. The cursors disappear after five seconds if not used. To recall them requires tapping the screen.
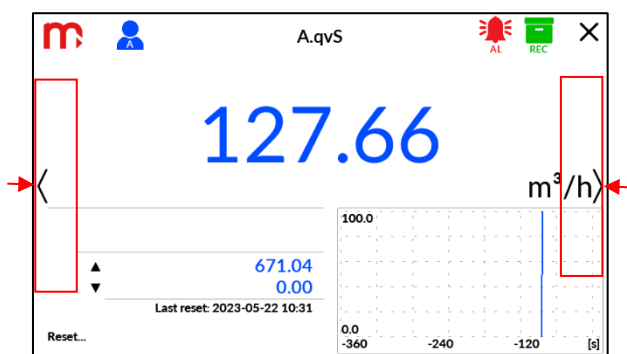
4.5.4   User Table Screens

The User Table screen is brought to display by tapping the TABLES button from the Main Manu. The button is available when at least one user table is configured.

Up to 6 user tables (6 table screens) may be configured. Each screen is built from a 16-element table in a 2x8 layout. The process values, totalizers, minimum or maximum values in the table may be displayed in any mixed configuration from applications A, B and X. Also empty cells may be left for clear readout and user preferences.

For each table element, the value, unit, and channel name are displayed. If channel name is not entered, then the channel symbol is displayed instead.

Tapping the value in the table pops up the Single Result window with more detailed information on this channel. To close the single result window, the x have to be tapped.


When User Table is displayed, there are also scroll left (<) and right (>) cursors available on the sides of the screen. Tapping the cursor allows scrolling among tables. The arrows disappear after five seconds if not used. To recall them requires tapping the screen.

4.5.5   User Trend Screens

In similar way as for User Tables, the User Trend screen is brought to display by tapping the TRENDS button from the Main Manu. The button is available when at least one user trend chart is configured.

Up to 6 user trends screens may be configured. Each screen may have up to 6 trends. Only process values may be shown as a trend. Any mixed configuration from applications A, B and X is possible. Also empty cells may be left for clear readout and user preferences.

User Trends screens display a time window of 360 seconds (if the legend is disabled) or 240 seconds (if the legend is enabled).
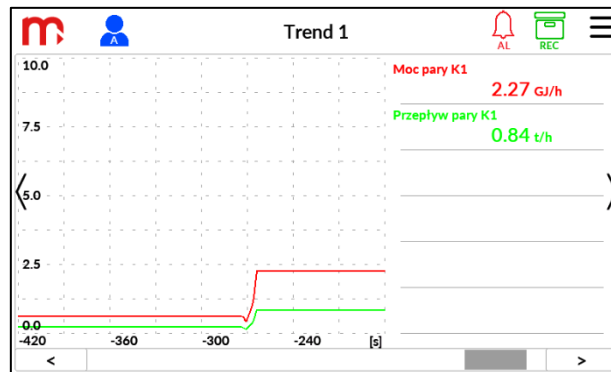
In the User Trends screens it is possible to display the trend line from the last hour using the slider at the bottom of the screen.
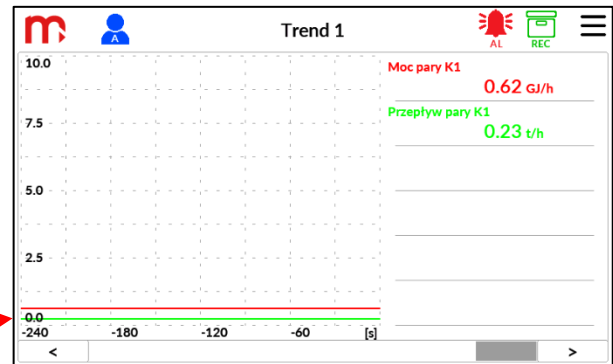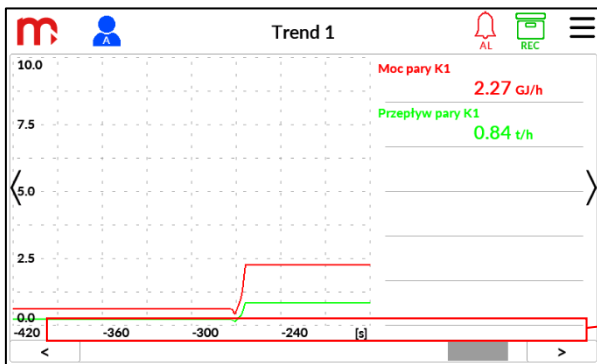
The legend displays the value, unit, and channel name. If channel name is not entered, then the channel symbol is displayed instead.

Displaying the legend is optional. Tapping on the chart field shows or hides the legend.
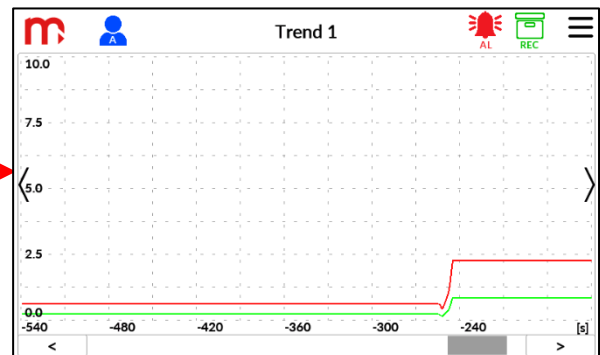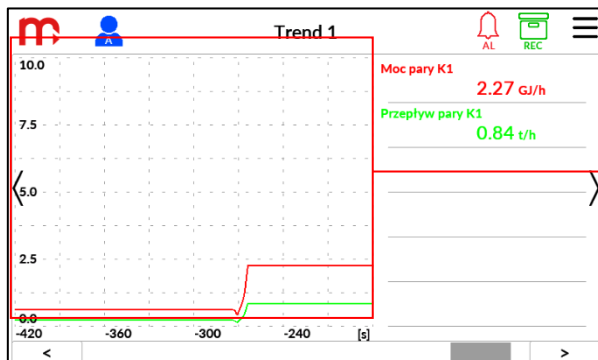
Tapping the value in the legend pops up the Single Result window with more detailed information on this channel. To close the single result window, the x have to be tapped.
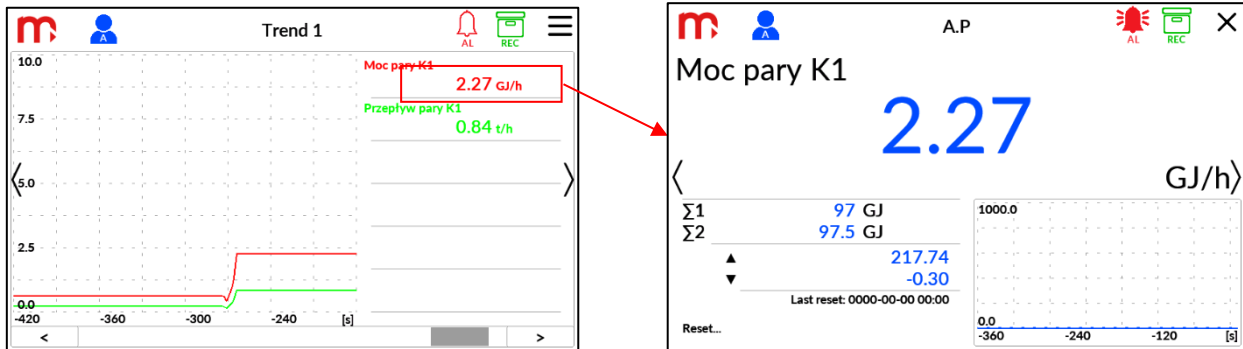
When User Trends is displayed, there are also < and > cursors on both sides of the screen available. Tapping the cursor allows scrolling among User Trends screens. The arrows disappear after five seconds if not used. To recall them requires tapping the screen.
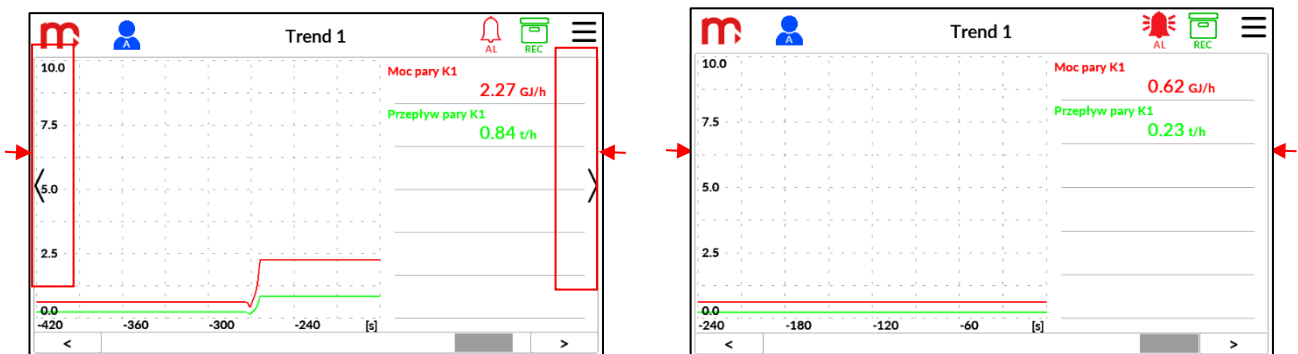
4.5.6   Archive screen

The Archive screen is brought to display by tapping the ARCHIVE button from the Main Manu or the Archive icon in the Title Bar. The button in Main Menu is always available, regardless of the device configuration. The description of the archiving processes are described in the ARCHIVE chapter.

The screen is divided into two parts. The upper part of the screen contains information on the archive configuration: the current archive file number and type of the archive (e.g. Weekly) and the two frequencies of archiving for process data (active in blue) and one for totalizers archive respectively. There is also an indicator of the internal memory usage. The capacity of the internal memory is 2 GB. For safety of archived data user should successively copy the archive files. It is also recommended to delete old files to keep enough free space for new data. (For more information, see Writing and reading files using the USB port). When there is no more free space in the memory, then indicator turns red. The archive files will be successively overwritten (more information in the ARCHIVE chapter).
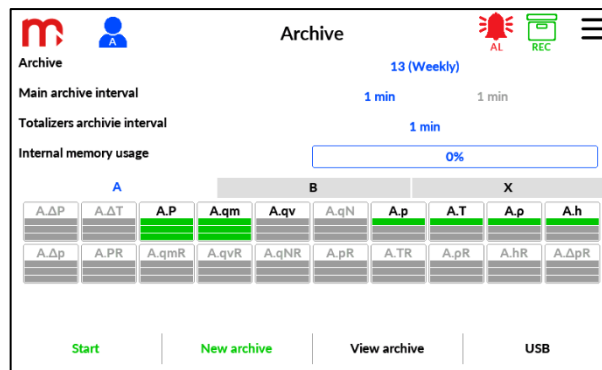
At the lower part of the screen there is information on archive configuration. Not every process value or totalizer have to be archived. The indicator gives status information in a glance. Each channel has archive status indicator with channel symbol and three bars beneath. Upper bar represents process value, two lower bars represent two totalizers corresponding to the process value. The status information is coded in colours:
- green for archived value,
- grey for not archived value.

If channel is not active or not used, the whole indicator is grey.

At the bottom of the Archive screen there are four control buttons:
- *Stop / Start* to stop / resume archiving
- *New archive* to create a new archive file
- *View archive* to view process values archive file
- *USB* to switch over to USB window (copy and manage archive files)

Above operations may require User or Admin login.

A new archive file cannot be created if the archiving process is ongoing. After creating a new archive file, it is necessary to start archiving.
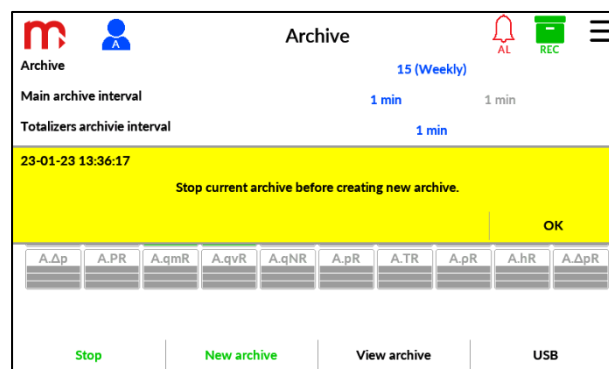
From the Archive screen it is possible to switch over directly to the USB window to copy selected archive files to external flash memory and delete old archive files from internal memory. (More information in chapter Writing and reading files using the USB port).
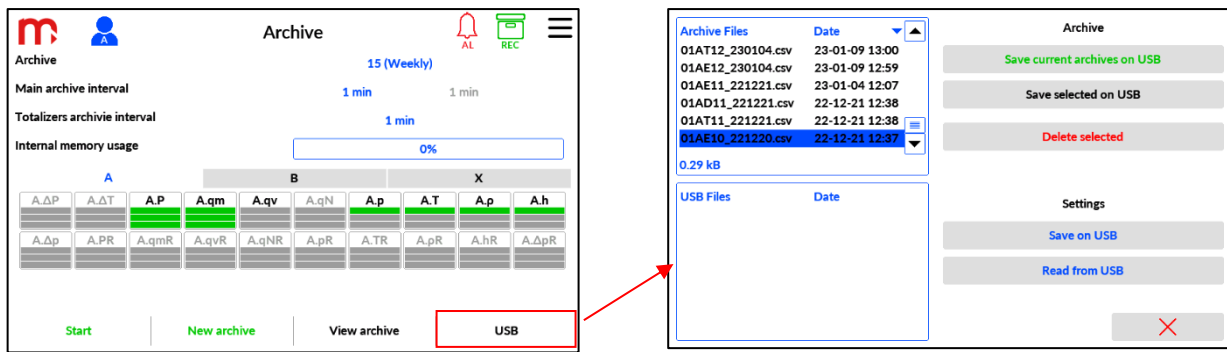
The X button closes the USB window and returns back to Archive screen.

4.5.7 Alarms status screen
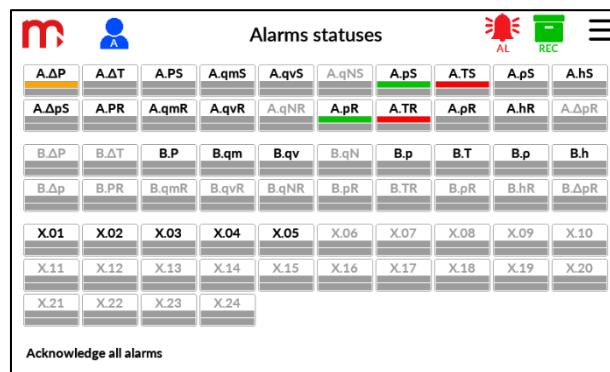
The Alarms status screen is brought to display by tapping the ALARMS button from the Main Manu. The button is available when at least one alarm threshold is configured.

The screen shows all possible alarm states for all channels in one screen. Each channel has its own indicator with channel symbol in the top.
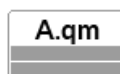
There are two bars in the indicator representing alarm thresholds I and II. Alarm status is coded in bar colour:

- white   - alarm threshold not activated (no alarm)
- blue, green, orange or red [*]   - alarm threshold activated (alarm on)
- grey   - alarm threshold disabled (not configured)

[*] To alarm threshold the extra alarm colour may be assigned: green, orange or red. Then this colour is shown in the indicator bar, when alarm is activated. If extra colour was not assigned, then standard blue colour is used to show alarm activation.

Not configured alarms have whole indicators including channel symbol coloured in grey.

4.5.7.1 Alarm acknowledgement (Alarm mode)

Every alarm threshold may work either in Control mode or in Alarm mode. Alarm mode requires Alarm acknowledge by user when activated. To attract user attention when alarm is activated, the alarm icon in the title bar is blinking. Also beeper is activated if configured. Source of alarm verification and alarm acknowledge is possible only in Alarm status screen. At the bottom of the screen there is *Acknowledge all alarms* button.
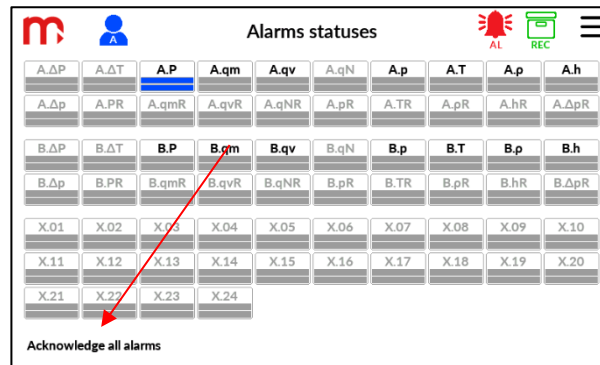
All recently activated alarms have their indicator bars blinking (blue, green, orange or red, depending on configuration). All other alarms already acknowledged or in control mode are on continually, if are still activated. In this way user may learn which alarms are new (blinking), and which of them are still activated (continuously on) or not activated (white). Tapping the *Acknowledge all alarms* button all blinking indicators stop blinking.

4.5.7.2 Alarms indication in other screens

All other screens have a Title bar in top of the screen. When the new alarm is activated, then alarm icon in the Title bar is also activated.

If extra colour (green, orange or red) is assigned to alarm threshold, then the related process value changes its colour when alarm threshold is crossed over (in both alarm and control modes).

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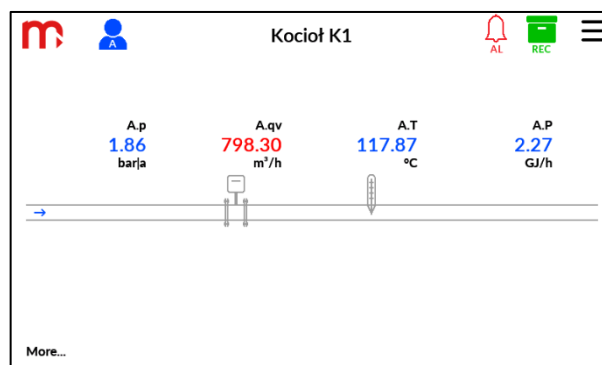
If an alarm has been configured, an additional dotted line is displayed in the chart field in the result window indicating the alarm level. The line is in the colour selected for the alarm.

4.5.8 Device Information screen

Device Information screen is selected by tapping the INFO button from the drop-down menu. The screen contains important information about the device: model, ID, serial number, MAC, firmware, IP address, RS485 (COM) communication parameters and Modbus address. The screen contains a QR code. After scanning the code, it is possible to download the current User Manual of the device (the manual is available on the manufacturer's website).

The screen also contains general information on the operating status on measuring applications A and B:

Disabled	The application is disabled (not configured and not used).
OK	The application is enabled and all values are calculated correctly.
OK	The application is enabled and has the correct status. The process values are calculated, but some deviations are detected. (E.g. failure value is used instead of measurement, cut-off for low flowrate activated, extrapolation of steam values is used out of steam tables, etc.).
--ERR--	The application is enabled and has an incorrect status. At least one process value has error status (--ERR--).

4.5.9   Settings screen

The Settings screen is brought to display by tapping the SETTINGS button from the Main Manu. The button in Main Menu is always available, regardless of the device configuration. The description of the archiving processes are described in details in the SETTINGS AND DEVICE CONFIGURATION chapter.
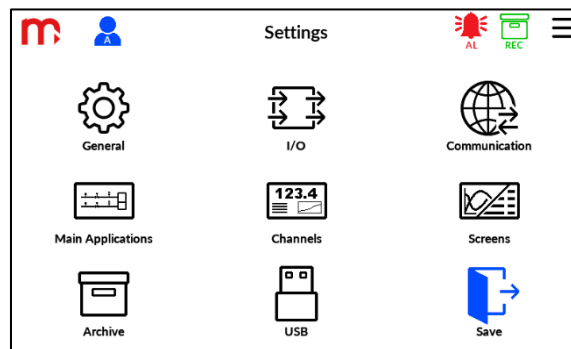
4.5.10   I/O Test Screen

The screen contains service information on all inputs and outputs:
- RL1 .. RL4   -   the state of the relay outputs, i.e. shorted output (X sign) or obtuse output (sign X)
- I_OUT1, I_OUT2   -   status of type I outputs (4-20mA), the current value is expected value, not measured
- IN1/F, IN2/F   -   status of type F inputs (PULSE), the frequency and number of pulses read from the inputs
- IN3/RTD, IN4/RTD   -   status of RTD inputs, the resistance measured in analogue inputs
- IN7/I, .., IN10/I   -   status of type I inputs (0/4-20mA), the current measured in analogue inputs
- In addition, information about the status of the switches is displayed:
- LOCK1, LOCK2   -   the state of the switches is displayed
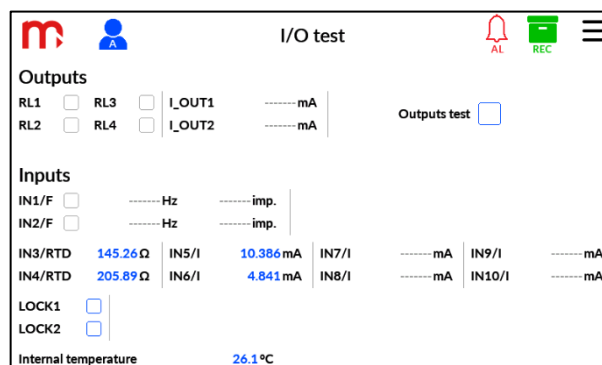
Values are displayed in blue or grey:
- blue   – input/output enabled,
- grey   – input/output not configured.

Error status symbols used:
    ---||---   – current loop 4-20mA circuit break (< 3.6 mA),
    ---E---   – over range value
    -------   – input/output in off state (not configured)
    ---W---   – waiting for valid data (e.g. after restart)
    --ERR--   – other error

The Test I/O screen allows also to force the outputs state for relays and analogue outputs values to check the correct operation. The tested outputs have to be configured and 'Outputs test' checkbox have to be selected.

4.6   Print Screen

Print Screen is a service function. It may be helpful during commissioning or tests. To take a screenshot, the BTL button has to be used. It is located in the rear panel in panel mount version or in the terminals compartment in wall mount version of the device.

During the operation, the screen will remain inactive for a few seconds, and the process will be signaled by a blue LED located on the front panel of the device. Screenshot is saved in internal memory as a bitmap with date, time and successive number as a file name. (rrmmdd_hhmm_00.bmp, rrmmdd_hhmm_01.bmp, rrmmdd_hhmm_02.bmp, …).

Files may be copied or deleted in Settings main menu, choosing USB function 🖴 .
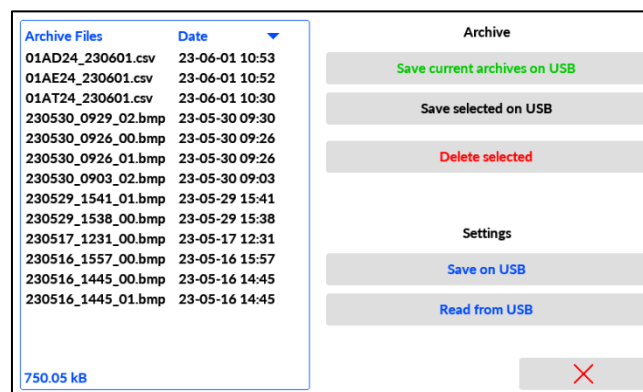
Note:
The bitmap counter (number 00 to 99 in the file name) is reset after every device restart. After reaching the value 99, the counter starts counting from 00.

4.7   Write and read files via USB port

Writing and reading files using the USB port is only possible in a USB window. There are two ways to go to the USB window:
 – in the Archive screen, selecting the USB button
 – in the Settings screen, selecting the USB icon

Return to the previously displayed window by pressing [×].

On the left side of the window there is a list of archive files and screenshots (print screen) saved in the internal memory of the device. On the right side of the window there are function buttons. Depending on the access level, it is possible saving archive files to USB, deleting archive files, saving or uploading the settings.
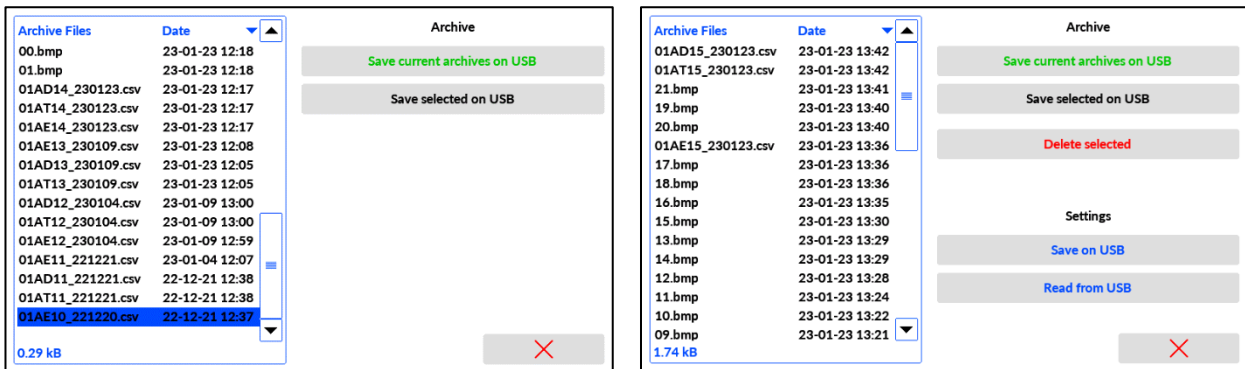
To write and read files via USB port, external flash memory in FAT format (not NTFS format) have to be used. It is not allowed to connect other devices, e.g. hard disk. Compatibility with all USB memory devices is not guaranteed. Extension cable is not allowed.

After connecting the external memory, on the left side of the window a box will be displayed containing the settings files recorded on the flash drive (files in *par* format).
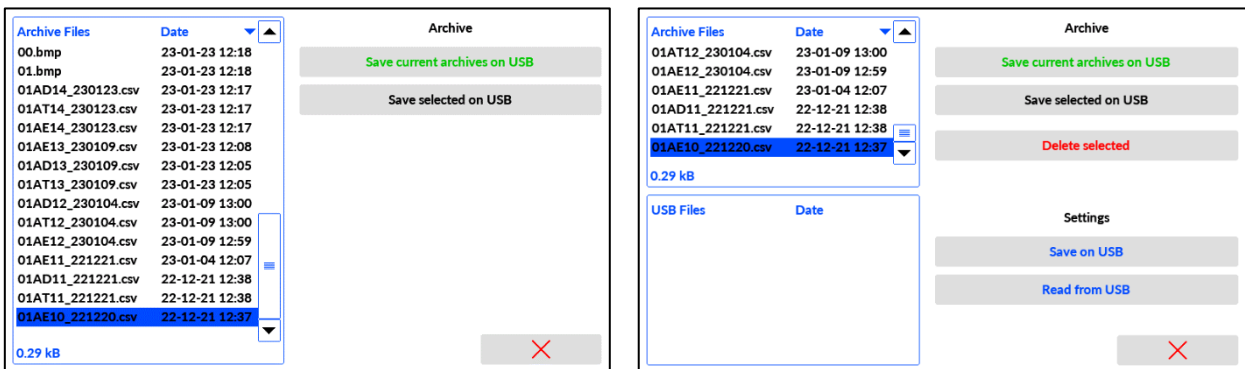
The capacity of the internal memory is 2 GB. User should successively copy the archive files and then delete old ones to provide enough space for new archive files.

To delete a file, se have to be selected and deleted by tapping the *Delete selected* button. It is possible to select only one file a time.

5   MEASUREMENTS APPLICATIONS

5.1   Medium Types

The device supports the following types of media: water, other liquid media, superheated steam, saturated steam and technical gases.

5.1.1   Water

The density and enthalpy of water are calculated according to IAPWS-IF97 for pressures of 0.02 MPa|a to 20.0 MPa|a and temperature 0 °C to 350 °C. The enthalpy is calculated relative to the entered reference point for pressure and temperature.

The water temperature should always be measured, while the pressure can be measured or it can be entered as a constant value. If due to measurement inaccuracies, the measured water temperature is slightly higher than the boiling point at a given pressure, the density and enthalpy is calculated for the boiling point. However, if the measured temperature is higher more than 20 °C above the boiling point, then the error is indicated instead of the density and enthalpy values, and all other results calculated on their basis in consequence. More information in chapter Hierarchy of process values and failure indication.

For steam applications with condensate return, the pressure of the condensate can be measured, be considered equal to the steam pressure, or entered as a constant value. The temperature of the condensate can be measured or it can be assumed be at boiling point. Then the temperature is taken from the steam saturation curve.

5.1.2   Other liquids

Other liquids measurements are always based on Medium User Table. Depending on needs, the table has data on density as a function of temperature or temperature and pressure. It also may contain enthalpy or specific heat, or calorific for energy of combustion measurements. Range of measurements is strictly defined by the table data.

5.1.3   Steam, superheated and saturated

The steam density and enthalpy are calculated according to IAPWS-IF97 in range
- 52 °C to 800 °C and 0.02 MPa|a to 16.5 MPa|a for superheated steam
- 0 °C to 372 °C for saturated steam (with temperature measured)
- 0.02 MPa|a to 16.5 MPa|a for saturated steam (with pressure measured)

The enthalpy is calculated relative to the entered reference point for pressure and temperature.

For superheated steam applications, both pressure and temperature have to be measured. If due to measurement inaccuracies, the measured steam temperature is slightly lower than the condensation temperature at a given pressure, then the density and enthalpy is calculated at the condensation temperature point. However, if the measured temperature is more than 20 °C lower than the condensation temperature, then the error is indicated instead of the density and enthalpy values, and all other results calculated on their basis in consequence. For more information, see chapter Hierarchy of process values and failure indication.

For saturated steam applications either pressure or temperature is measured. The other value is calculated using the saturation curve. If user need to have both, pressure and temperature measured, then only one value (p(T) or T(p)) is used for calculating steam parameters, and the other one may be displayed as auxiliary value.

5.1.4 Gas

The device may measure the flow or the flow and energy of technical gases. The gas pressure and temperature may be measured or entered as a constant value. The actual gas density is calculated according to the ideal gas equation relative to density at reference conditions (pressure and temperature). As another option, it is possible to determine density and enthalpy using User Medium Table. For heat or combustion energy User Medium Table have to be used with enthalpy, specific heat or calorific of the gas.

The fuel gas may also be measured if approximate measurement based on ideal gas equation or User Medium Table is accepted.

5.2 Process values symbols

Channel symbols are fixed and cannot be changed. Each symbol is unique and identifies process value measured or calculated in the device.
(To facilitate the identification of process value, the user may enter his own channel description. Description is displayed besides the symbol in most screens.)

5.2.1 Application identifier

Each channel symbol has a prefix indicating the layout A, B or X separated by a dot from the symbol indicating the process value. E.g. 'A.qm' means that process value qm belongs to application A.

5.2.2 Channel symbols in application A and B

Depending on the configuration, a certain list of channels are available in every application. The full list of possible symbols is as below:

ΔP   - heat flowrate difference between supply and return
ΔT   - temperature difference between supply and return
P/PS   - heat flowrate / heat flowrate at supply
qm/qmS - mass flowrate / mass flowrate at supply
qv/qvS   - volumetric flowrate / volumetric flowrate at supply
qN/qNS - volume standardized flowrate / volume standardized flowrate at supply
p/pS   - pressure / pressure at supply
T/TS   - temperature / temperature at supply
ρ/ρS   - density / density at supply
h/hS   - enthalpy / enthalpy at supply
Δp   - pressure difference at differential pressure device
ΔpS   - pressure difference at differential pressure device at supply
PR   - heat flowrate at return
qmR   - mass flowrate at return

qvR	- volume flowrate at return
qNR	- volume standardized flowrate at return
pR	- pressure at return
TR	- temperature at return
ρR	- density at return
hR	- enthalpy at return
ΔpR	- pressure difference at differential pressure device at return

5.2.3   Channel symbols in application X

There are 24 channels available in application X. Those auxiliary channels are user configurable and their symbols are numbers from 01 to 24. So, full symbol is X.01, X.02, ..., X.24.

5.2.4   Symbols for totalizers and min / max values

Each process value may have minimum or maximum value, some may also be totalized. In order to distinguish these values an additional symbol is used in the Single Result screen or in the User Tables and User Trends:

PV	- channel process value
MIN	- Minimum value (also marked by ▼)
MAX	- Maximum value (also marked by ▲)
Σ1	- Totalizer 1
Σ2	- Totalizer 2

E.g.   Σ1:A.qm – means mass flowrate totalizer in application A, and ▲:X.01 – means maximum value for auxiliary channel 01 in application X.

5.3   Available types of main measuring applications

The chapter presents sample screenshots of Main Application Screens. Screens may vary depending on how process values are measured.

The screens contain gauge icons. If the value is measured using the measurement inputs (IN1, ..., IN10), then there is the measurement gage icon displayed:

Temperature	Pressure	Flow

For each layout, an arrow is displayed indicating the flow direction, indicating a higher (red) or lower (blue) temperature. The arrows allow to verify the application: heating (supply: →, return: ←) or cooling (supply: →, return: ←).
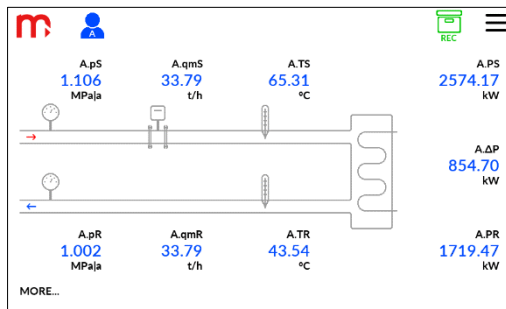
heating system – the supply temperature is higher than the return temperature
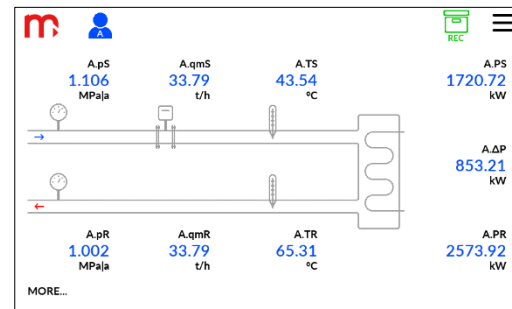
cooling system – the supply temperature is lower than the return temperature

The layout is a synoptic schematic of the application and doesn't show the real pipeline and sensors arrangement.

The following sections provide detailed information on the values determined in various types of systems.

5.3.1   Liquid Flow

Liquid flow allows to calculate compensated flow according to temperature and/or pressure measurements. Typical application for water uses build in density tables. For other medium than water, the user medium table have to be prepared and uploaded to the device.

SHORT NAME	Liquid flow
FULL NAME	Liquid flow measurement
TYPE OF MEDIUM	Liquid
ADDITIONAL SETTINGS	-
LAYOUT DIAGRAM	
INPUT PROCESS VALUES	- pressure (**p**) - temperature (**T**) - mass flowrate (**qm**) or volumetric flowrate (**qv**) or differential pressure (**Δp**)
COMPUTED PROCESS VALUES	- mass flowrate (**qm**) + optional totalizers - volumetric flowrate (**qv**) + optional totalizers - pressure (**p**) - temperature (**T**) - density (**ρ**) - differential pressure (**Δp**) – only if differential pressure device was chosen

5.3.2 Liquid Heat

Liquid heat allows to calculate compensated flow and heat according to temperature and/or pressure measurements. Typical application for water uses build in density and enthalpy tables. For other medium then water, the user medium table have to be prepared and uploaded to the device. For heat calculations enthalpy or specific heat have also to be entered in the user table. The application may also be used to calculate combustion heat. Then calorific of the liquid have to be entered instead of enthalpy.

SHORT NAME	Liquid heat
FULL NAME	Flow and liquid heat measurement
TYPE OF MEDIUM	Liquid
ADDITIONAL SETTINGS	-
LAYOUT DIAGRAM	
INPUT PROCESS VALUES	▪ pressure (**p**) ▪ temperature (**T**) ▪ mass flowrate (**qm**) or volumetric flowrate (**qv**) or differential pressure (**Δp**)
COMPUTED PROCESS VALUES	▪ heat flowrate (**P**) + optional totalizers ▪ mass flowrate (**qm**) + optional totalizers ▪ volumetric flowrate (**qv**) + optional totalizers ▪ pressure (**p**) ▪ temperature (**T**) ▪ density (**ρ**) ▪ differential pressure (**Δp**) – only if differential pressure device was chosen

5.3.3   Liquid delta Heat (Closed loop)

Liquid Δ Heat (Closed loop) allows to calculate compensated flow and heat according to temperature and/or pressure measurements. Flowrate is measured only at supply or return pipeline, assuming that there is no liquid loss in the application. Typical application for water uses build in density and enthalpy tables. For other medium then water, the user medium table have to be prepared and uploaded to the device. For heat calculations density and enthalpy or specific heat have also to be entered in the user table.

SHORT NAME	Liquid Δ Heat (closed loop)
FULL NAME	The flow and differential heat of a liquid in a closed installation
TYPE OF MEDIUM	Supply: Liquid Return: Liquid
ADDITIONAL SETTINGS	Heating system / Cooling system
LAYOUT DIAGRAM	

INPUT PROCESS VALUES	▪ pressure at supply (**pS**)
	▪ temperature at supply (**TS**)
	▪ mass flowrate at supply (**qmS**)
	   or volumetric flowrate at supply (**qvS**)
	   or differential pressure at supply (**ΔpS**)
	   or mass flowrate at return (**qmR**)
	   or volumetric flowrate at return (**qvR**)
	   or differential pressure at return (**ΔpR**)
	▪ pressure at return (**pR**)
	▪ temperature at return (**TR**)

COMPUTED PROCESS VALUES	▪ heat flowrate difference between supply and return (ΔP) + optional totalizers ▪ temperature difference between supply and return (ΔT) ▪ heat flowrate at supply (PS) + optional totalizers ▪ mass flowrate at supply (qmS) + optional totalizers ▪ volumetric rate flow at supply (qvS) + optional totalizers ▪ pressure at supply (pS) ▪ temperature at supply(TS), ▪ density at supply (ρS), ▪ enthalpy at supply (hS), ▪ differential pressure at supply (**Δps**) – only if differential pressure device was chosen ▪ heat flowrate at return (PR) + optional totalizers ▪ mass flowrate at return (qmR) + optional totalizers ▪ volumetric flowrate at return (qvR) + optional totalizers ▪ pressure at return (pR) ▪ temperature at return (TR) ▪ density at return (ρR) ▪ enthalpy at return (hR) ▪ differential pressure at return (**ΔpR**) – only if differential pressure device was chosen

5.3.4   Liquid delta Heat

Liquid Δ Heat allows to calculate compensated flow and heat according to temperature and/or pressure measurements. Flowrate is measured in both pipelines, at supply and return. Typical application for water uses build in density and enthalpy tables. For other medium then water, the user medium table have to be prepared and uploaded to the device. For heat calculations density and enthalpy or specific heat have also to be entered in the user table.

SHORT NAME	Liquid Δ Heat
FULL NAME	The flows and differential heat of a liquid with separate supply and return flowrates
TYPE OF MEDIUM	Supply: Liquid Return: Liquid
ADDITIONAL SETTINGS	Heating system / Cooling system
LAYOUT DIAGRAM	

INPUT PROCESS VALUES	▪ pressure at supply (pS),
	▪ temperature at supply (TS),
	▪ mass flowrate at supply (qmS)
	   or volumetric flowrate at supply (qvS)
	   or differential pressure at supply (ΔpS),
	▪ pressure at return (pR),
	▪ temperature at return (TR),
	▪ mass flowrate at return (qmR)
	   or volumetric flowrate at return (qvR)
	   or differential pressure at return (ΔpR)

COMPUTED PROCESS VALUES	▪ heat flowrate difference between supply and return (ΔP) + optional totalizers ▪ temperature difference between supply and return (ΔT) ▪ heat flowrate at supply (PS) + optional totalizers ▪ mass flowrate at supply (qmS) + optional totalizers ▪ volumetric flowrate at supply (qvS) + optional totalizers ▪ pressure at supply (pS) ▪ temperature at supply (TS), ▪ density at supply (ρS), ▪ enthalpy at supply (hS), ▪ differential pressure at supply (Δps) – only if differential pressure device was chosen ▪ heat flowrate at return (PR) + optional totalizers ▪ mass flowrate at return (qmR) + optional totalizers ▪ volumetric flowrate at return (qvR) + optional totalizers ▪ pressure at return (pR) ▪ temperature at return (TR) ▪ density at return (ρR) ▪ enthalpy return (hR) ▪ differential pressure at return (ΔpR) – only if differential pressure device was chosen

5.3.5 Steam net Heat

Steam net Heat allows to calculate compensated flow and heat for saturated or superheated steam.

SHORT NAME	Steam net heat	
FULL NAME	The flow and heat of steam measurement	
TYPE OF MEDIUM	Superheated steam (temperature and pressure measurement)	Saturated steam (temperature or pressure measurement)
ADDITIONAL SETTINGS	-	Dry steam should be introduced
LAYOUT DIAGRAM		

INPUT PROCESS VALUES	▪ pressure (p),
	▪ temperature (T)
	▪ mass flowrate (qm)
	   or volumetric flow rat (qv)
	   or differential pressure (Δp)
		▪ pressure (p)
		   or temperature (T)
		▪ mass flowrate (qm)
		   or volumetric flowrate (qv)
		   or differential pressure (Δp)

COMPUTED PROCESS VALUES	▪ heat flowrate of steam (P) + optional totalizers ▪ mass flowrate of steam (qm) + optional totalizers ▪ volumetric flowrate of steam (qv) + optional totalizers ▪ pressure (P) ▪ temperature (T) ▪ density (ρ) ▪ differential pressure (**Δp**) – only if differential pressure device was chosen	

5.3.6　Steam – Condensate delta Heat (Closed loop)

Steam – Condensate Δ Heat (Closed loop) allows to calculate compensated flow and heat for saturated or superheated steam including condensate billing. Closed loop application assumes no steam or condensate loss. Flowrate may be measured in supply (steam) or return (condensate) pipeline.

SHORT NAME	Steam-Cond. Δ Heat (closed loop)	
FULL NAME	The flow and differential heat in a closed steam-condensate installation	
TYPE OF MEDIUM	Supply: Superheated steam (temperature and pressure measurement) Return: Condensate	Supply: Saturated steam (temperature or pressure measurement) Return: Condensate
ADDITIONAL SETTINGS		Steam dryness may be entered
LAYOUT DIAGRAM		
INPUT PROCESS VALUES	- pressure at supply (pS) - temperature at supply (TS) - mass flowrate at supply (qmS) or volumetric flowrate at supply (qvS) or differential pressure at supply (ΔpS) or mass flowrate at return (qmR) or volumetric flowrate at return (qvR) or differential pressure at return (ΔpR) - pressure at return (pR) - temperature at return (TR)	- pressure at supply (pS) or temperature at supply (TS) - mass flowrate at supply (qmS) or volumetric flowrate at supply (qvS) or differential pressure at supply (ΔpS) or mass flowrate at return (qmR) or volumetric flowrate at return (qvR) or differential pressure at return (ΔpR) - pressure at return (pR) - temperature at return (TR)
COMPUTED PROCESS VALUES	- heat flowrate difference between supply and return (ΔP) + optional totalizers - temperature difference between supply and return (ΔT) - heat flowrate at supply (PS) + optional totalizers - mass flowrate at supply (qmS) + optional totalizers - volumetric flowrate at supply (qvS) + optional totalizers - pressure at supply (pS) - temperature at supply (TS) - density at supply (ρS) - enthalpy at supply (hS) - differential pressure at supply (**ΔpS**) – only if differential pressure device was chosen - heat flowrate at return (PR) + optional totalizers - mass flowrate return (qmR) + optional totalizers - volumetric flowrate at return (qvR) + optional totalizers - pressure at return (pR)	

	▪ temperature at return (TR) ▪ density at return (ρR) ▪ enthalpy at return (hR) ▪ differential pressure at return (**ΔpR**) – only if differential pressure device was chosen Return pressure difference (Δp) – only if differential pressure device was chosen

5.3.7 Steam – Condensate delta Heat

Steam – Condensate Δ Heat allows to calculate compensated flow and heat for saturated or superheated steam including condensate billing. Flowrates are measured in both, supply (steam) and return (condensate) pipeline.

SHORT NAME	Steam-Condensate △ Heat	
FULL NAME	The flows and differential heat in a steam-condensate installation with partial return of condensate	
TYPE OF MEDIUM	Power supply: Superheated steam (temperature and pressure measurement) Return: Condensate	Supply: Saturated steam (temperature or pressure measurement) Return: Condensate
ADDITIONAL SETTINGS	-	Steam dryness may be entered
LAYOUT DIAGRAM		

INPUT PROCESS VALUES	▪ pressure at supply (pS)
	▪ temperature at supply (TS)
	▪ mass flowrate at supply (qmS)
	   or volumetric flowrate at supply (qvS)
	   or differential pressure at supply(ΔpS)
	▪ pressure at return (pR),
	▪ temperature at return (TR),
	▪ mass flowrate at return (qmR)
	   or volumetric flowrate at return (qvR)
	   or differential pressure at return (ΔpR)
		▪ pressure at supply (pS)
		   or temperature at supply (TS)
		▪ mass flowrate at supply(qmS)
		   or volumetric flowrate at supply (qvS)
		   or differential pressure at supply (ΔpS)
		▪ pressure at return (pR)
		▪ temperature at return (TR)
		▪ mass flowrate at return (qmR)
		   or volumetric flowrate at return (qvR)
		   or differential pressure at return (ΔpR)

COMPUTED PROCESS VALUES	- heat flowrate difference between supply and return (ΔP) + optional totalizers - temperature difference between supply and return (ΔT) - heat flowrate at supply (PS) + optional totalizers - mass flowrate at supply (qmS) + optional totalizers - volumetric flowrate at supply (qvS) + optional totalizers - pressure at supply (pS) - temperature at supply (TS) - density at supply (ρS) - enthalpy at supply (hS) - differential pressure at supply (**ΔpS**) – only if differential pressure device was chosen - heat flowrate at return (PR) + optional totalizers - mass flowrate at return (qmR) + optional totalizers - volumetric flowrate at return (qvR) + optional totalizers - pressure at return (pR) - temperature at return (TR) - density at return (ρR) - enthalpy at return (hR) - differential pressure at return (**ΔpR**) – only if differential pressure device was chosen

5.3.8   Steam generator

Steam generator allows to calculate compensated flow and heat for saturated or superheated steam including supply water billing. Application may use flowrate measurements in supply and return pipeline, as well as only one measurement, either in supply or return pipeline.

SHORT NAME	Steam generator	
FULL NAME	The flow and differential heat in a steam-generating installation with the supplied water flowrate measured	
TYPE OF MEDIUM	Supply: Water Return: Superheated steam (temperature and pressure measurement)	Supply: Water Return: Saturated steam (temperature or pressure measurement)
ADDITIONAL SETTINGS	-	Steam dryness may be entered
LAYOUT DIAGRAM		

INPUT PROCESS VALUES	▪ pressure at supply (pS) ▪ temperature at supply (TS) ▪ mass flowrate at supply (qmS) or volumetric flowrate at supply (qvS) or differential pressure at supply (ΔpS) ▪ pressure at return (pR) ▪ temperature at return (TR) ▪ mass flow rat at return (qmR) or volumetric flowrate at return (qvR) or differential pressure at return (ΔpR)	▪ pressure at supply (pS) or temperature at supply (TS) ▪ mass flowrate at supply(qmS) or volumetric flowrate at supply (qvS) or differential pressure at supply (ΔpS) ▪ pressure at return (pR) ▪ temperature at return (TR) ▪ mass flowrate at return (qmR) or volumetric flowrate at return (qvR) or differential pressure at return (ΔpR)
COMPUTED PROCESS VALUES	▪ heat flowrate difference between supply and return difference (ΔP) + optional totalizers ▪ temperature difference between supply and return (ΔT) ▪ heat flowrate at supply (PS) + optional totalizers ▪ mass flowrate at supply (qmS) + optional totalizers ▪ volumetric flowrate at supply (qvS) + optional totalizers ▪ pressure at supply (pS) ▪ temperature at supply (TS) ▪ density at supply (ρS) ▪ enthalpy at supply (hS) ▪ differential pressure at supply (**ΔpS**) – only if differential pressure device was chosen ▪ heat flowrate at return (PR) + optional totalizers ▪ mass flowrate at return (qmR) + optional totalizers ▪ volumetric flowrate at return (qvR) + optional totalizers ▪ pressure at return (pR) ▪ temperature at return (TR) ▪ density at return (ρR) ▪ enthalpy at return (hR) ▪ differential pressure at return (**ΔpR**) – only if differential pressure device was chosen	

5.3.9   Gas Flow

Gas flow allows to calculate compensated flow according to pressure and/or temperature measurements. The ideal gas equation is used for the calculations, taking into account the compressibility factor (Z-factor). Instead of ideal gas equation user may define own table with density depending on temperature and pressure. The application is mainly suitable for technical gases.

SHORT NAME	Gas flow
FULL NAME	The flow of a gas measurement
TYPE OF MEDIUM	Gas / Technical gas
ADDITIONAL SETTINGS	-
LAYOUT DIAGRAM	
INPUT PROCESS VALUES	- pressure (p) - temperature (T) - mass flowrate (qm) or volumetric flowrate (qv) or differential pressure (Δp) or gas volume flowrate in standard units (qN)
COMPUTED PROCESS VALUES	- mass flowrate (qm) + optional totalizers - volumetric flowrate (qv) + optional totalizers - gas volume flowrate (qN) + optional totalizers - pressure (p) - temperature (T) - density (ρ) - differential pressure (**Δp**) – only if differential pressure device was chosen

5.3.10 Gas Heat

Gas flow allows to calculate compensated flow and heat according to pressure and/or temperature measurements. The ideal gas equation is used for the calculations, taking into account the compressibility factor (Z-factor). Instead of ideal gas equation user may define own table with density depending on temperature and pressure. Enthalpy always have to be entered as a user medium table. The application may also be used to calculate combustion heat. Then calorific of the gas have to be entered instead of enthalpy.

SHORT NAME	Gas heat
FULL NAME	The gas flow and heat measurement
TYPE OF MEDIUM	Gas
ADDITIONAL SETTINGS	-
LAYOUT DIAGRAM	
INPUT PROCESS VALUES	- pressure (p) - temperature (T) - mass flowrate (qm) or volumetric flowrate (qv) or differential pressure (Δp) or gas volume flowrate in standard units
COMPUTED PROCESS VALUES	- heat flowrate (P) + optional totalizers - mass flowrate (qm) + optional totalizers - volumetric flowrate (qv) + optional totalizers - gas volume flowrate (qN) + optional totalizers - pressure (p) - temperature (T) - density (ρ) - differential pressure (**Δp**) – only if differential pressure device was chosen

5.4 Summary of process values used in different types of applications

Below is a table showing process values measured and calculated depending on the type of application. The table contains information for water and steam. If a user characteristic is used, some values may not be calculated in the application.

+ process values always calculated.
• process values calculated when orifice type flowmeter is used.
* process values or totalizers calculated if configured (may not be calculated).

			Type of measuring application									
			Liquid Flow	Liquid Heat	Liquid delta Heat (closed loop)	Liquid delta Heat	Steam net Heat	Steam – Cond. delta Heat (closed loop)	Steam – Cond. delta Heat	Steam generator	Gas Flow	Gas Heat
Measuring application A and B	A.ΔP B.ΔP	PV			+	+		+	+	+		
		Min			+	+		+	+	+		
		Max			+	+		+	+	+		
		Σ1			*	*		*	*	*		
		Σ2			*	*		*	*	*		
	A.ΔT B.ΔT	PV			+	+		+	+	+		
		Min			+	+		+	+	+		
		Max			+	+		+	+	+		
		Σ1										
		Σ2										
	A.P/A.PS B.P/B.PS	PV		+	+	+	+	+	+	+		+
		Min		+	+	+	+	+	+	+		+
		Max		+	+	+	+	+	+	+		+
		Σ1		*	*	*	*	*	*	*		*
		Σ2		*	*	*	*	*	*	*		*
	A.qm/A.qmS B.qm/B.qmS	PV	+	+	+	+	+	+	+	+	+	+
		Min	+	+	+	+	+	+	+	+	+	+
		Max	+	+	+	+	+	+	+	+	+	+
		Σ1	*	*	*	*	*	*	*	*	*	*
		Σ2	*	*	*	*	*	*	*	*	*	*
	A.qv/A.qvS B.qv/B.qvS	PV	+	+	+	+	+	+	+	+	+	+
		Min	+	+	+	+	+	+	+	+	+	+
		Max	+	+	+	+	+	+	+	+	+	+
		Σ1	*	*	*	*	*	*	*	*	*	*
		Σ2	*	*	*	*	*	*	*	*	*	*
	A.qN/A.qNS B.qN/B.qNS	PV									+	+
		Min									+	+
		Max									+	+
		Σ1									*	*
		Σ2									*	*
	A.p/A.pS B.p/B.pS	PV	+	+	+	+	+	+	+	+	+	+
		Min	+	+	+	+	+	+	+	+	+	+
		Max	+	+	+	+	+	+	+	+	+	+
		Σ1										
		Σ2										
	A.T/A.TS B.T/B.TS	PV	+	+	+	+	+	+	+	+	+	+
		Min	+	+	+	+	+	+	+	+	+	+
		Max	+	+	+	+	+	+	+	+	+	+
		Σ1										
		Σ2										

A.ρ/A.ρS **B.ρ/B.ρS**	PV	+	+	+	+	+	+	+	+	+	
	Min	+	+	+	+	+	+	+	+	+	
	Max	+	+	+	+	+	+	+	+	+	
	Σ1										
	Σ2										
A.h/A.hS **B.h/B.hS**	PV		+	+	+	+	+	+	+		+
	Min		+	+	+	+	+	+	+		+
	Max		+	+	+	+	+	+	+		+
	Σ1										
	Σ2										
A.Δp/A.ΔpS **B.Δp/B.ΔpS**	PV	•	•	•	•	•	•	•	•	•	•
	Min	•	•	•	•	•	•	•	•	•	•
	Max	•	•	•	•	•	•	•	•	•	•
	Σ1										
	Σ2										
A.PR **B.PR**	PV			+	+		+	+	+		
	Min			+	+		+	+	+		
	Max			+	+		+	+	+		
	Σ1			*	*		*	*	*		
	Σ2			*	*		*	*	*		
A.qmR **B.qmR**	PV			+	+		+	+	+		
	Min			+	+		+	+	+		
	Max			+	+		+	+	+		
	Σ1			*	*		*	*	*		
	Σ2			*	*		*	*	*		
A.qvR **B.qvR**	PV			+	+		+	+	+		
	Min			+	+		+	+	+		
	Max			+	+		+	+	+		
	Σ1			*	*		*	*	*		
	Σ2			*	*		*	*	*		
A.qNR **B.qNR**	PV										
	Min										
	Max										
	Σ1										
	Σ2										
A.pR **B.pR**	PV			+	+		+	+	+		
	Min			+	+		+	+	+		
	Max			+	+		+	+	+		
	Σ1										
	Σ2										
A.TR **B.TR**	PV			+	+		+	+	+		
	Min			+	+		+	+	+		
	Max			+	+		+	+	+		
	Σ1										
	Σ2										
A.ρR **B.ρR**	PV			+	+		+	+	+		
	Min			+	+		+	+	+		
	Max			+	+		+	+	+		
	Σ1										
	Σ2										
A.hR **B.hR**	PV			+	+		+	+	+		
	Min			+	+		+	+	+		
	Max			+	+		+	+	+		
	Σ1										
	Σ2										
A.ΔpR **B.ΔpR**	PV			•	•		•	•	•		
	Min			•	•		•	•	•		
	Max			•	•		•	•	•		
	Σ1										
	Σ2										

5.5 Hierarchy of process values calculations and failure indication.

When all measurements and calculations are correct, then all process values digits are displayed in blue. Exception is intended change of result colour to red, green or orange, when alarm threshold is activated.

When critical error occurs or value cannot be figured, then the value is not displayed, and the result is exchanged by error symbol as listed below:

-------	(7x '-') Channel off, the symbol is displayed in User Trends Screens and User Table Screens. For a disabled channel, the Single Result Window is not displayed. The symbol is displayed for the disabled input.
-----	(5x '-') When the value is over range, is less than -99999999999999 or greater than 99999999999999.
---	(3x '-') Symbol used in the archive files for a disabled channel archived.
---W---	Wait, the process value is not ready. The symbol is displayed if the channel is connected to an input that has not been configured yet or is trying to connect to the remote sensor. The symbol is displayed in particular at the beginning of the device's operation.
---‖---	The current loop 4-20mA below 3.6 mA (break) or RTD sensor failure.
---E---	The current loop error (> 22 mA).
---R---	RTD sensor value out of measuring range or failure.
--ERR--	Measurement error for a reason other than those listed above.

When input detects failure (e.g. break in 4-20 mA loop), then failure value may be used instead of measurement. The value is displayed in black digits on yellow background to inform on failure status. But this failure value may be used for farther calculations. In such case as a consequence all results are displayed in black digits instead of blue. (Use of failure value have to be declared and value entered in settings for the input.) In this way the calculated process values inherits status from source value

Note: In RTD 4-wire connection not all break wire failures are detected by the device.

5.6 Process engineering units

5.6.1 Process values

The device has defined list of engineering units available by default for process values. In special cases, it is possible to add user defined units. More information in the chapter User unit.

Pressure values can be displayed in absolute units (with suffix "|a") or in gauge units (suffix "|g"), Gauge unit is calculated above barometric pressure entered as a constant value. The value of barometric pressure may be changed in the measurement system settings window.

Attention should be paid to choose the correct time base for flowrate units (/s – second, /min – minute, /h – hour). The time base determines flowrate calculations and totalizers calculations.

In the table below there are engineering units used in flow computer. (Description of the channels symbols are explained in the chapter Channel symbols in application A and B.)

Channel symbol	Defined units						
A.ΔP **B.ΔP**	W	kW	MW	GW	Btu/s	kBtu/s	cal/s
	kcal/s	kJ/h	MJ/h	GJ/h	Btu/h	kBtu/h	MBtu/h
	cal/h	kcal/h	J/min	kJ/min	MJ/min	GJ/min	Btu/min
	kBtu/min	MBtu/min	cal/min	kcal/min	Mcal/min		
A.ΔT **B.ΔT**	°C	K	°F	°R			
A.P/A.PS **B.P/B.PS**	W	kW	MW	GW	Btu/s	kBtu/s	cal/s
	kcal/s	kJ/h	MJ/h	GJ/h	Btu/h	kBtu/h	MBtu/h
	cal/h	kcal/h	J/min	kJ/min	MJ/min	GJ/min	Btu/min
	kBtu/min	MBtu/min	cal/min	kcal/min	Mcal/min		
A.qm/A.qmS **B.qm/B.qmS**	g/s	kg/s	kg/h	t/h	g/min	kg/min	t/min
	lb/s	lb/min	ton/min	lb/h	ton/h		
A.qv/A.qvS **B.qv/B.qvS**	cm^3/s	dm^3/s	m^3/s	l/s	in^3/s	ft^3/s	gal/s
	dbbl/s	cm^3/min	dm^3/min	m^3/min	l/min	in^3/min	ft^3/min
	gal/min	dbbl/min	cm^3/h	dm^3/h	m^3/h	l/h	in^3/h
	ft^3/h	gal/h	dbbl/h	Ndm^3/s	Nm^3/s	Nl/s	scf/s
	mcf/s	Ndm^3/min	Nm^3/min	Nl/min	scf/min	mcf/min	Ndm^3/h
	Nm^3/h	Nl/h	scf/min	mcf/min			
A.qN/A.qNS **B.qN/B.qNS**	cm^3/s	dm^3/s	m^3/s	l/s	in^3/s	ft^3/s	gal/s
	dbbl/s	cm^3/min	dm^3/min	m^3/min	l/min	in^3/min	ft^3/min
	gal/min	dbbl/min	cm^3/h	dm^3/h	m^3/h	l/h	in^3/h
	ft^3/h	gal/h	dbbl/h	Ndm^3/s	Nm^3/s	Nl/s	scf/s
	mcf/s	Ndm^3/min	Nm^3/min	Nl/min	scf/min	mcf/min	Ndm^3/h
	Nm^3/h	Nl/h	scf/min	mcf/min			
A.p/A.pS **B.p/B.pS**	kPa|a	MPa|a	bar|a	ksc|a	psi|a	Torr|a	atm|a
	kPa|g	MPa|g	bar|g	ksc|g	psi|g	Torr|g	atm|g
	Pa	kPa	MPa	mbar	bar	ksc	inAq
	psi	Torr	atm				
A.T/A.TS **B.T/B.TS**	°C	K	°F	°R			
A.ρ/A.ρS **B.ρ/B.ρS**	kg/m^3	g/cm^3	lb/ft^3				
A.h/A.hS **B.h/B.hS**	kJ/kg	Btu/lg					
A.Δp/A.ΔpS **B.Δp/B.ΔpS**	kPa|a	MPa|a	bar|a	ksc|a	psi|a	Torr|a	atm|a
	Pa	kPa	MPa	mbar	bar	ksc	inAq
	psi	Torr					

(Left vertical header spanning all rows: **CHANNEL A/B**)

A.PR **B.PR**	W	kW	MW	GW	Btu/s	kBtu/s	cal/s
	kcal/s	kJ/h	MJ/h	GJ/h	Btu/h	kBtu/h	MBtu/h
	cal/h	kcal/h	J/min	kJ/min	MJ/min	GJ/min	Btu/min
	kBtu/min	MBtu/min	cal/min	kcal/min	Mcal/min		
A.qmR **B.qmR**	g/s	kg/s	kg/h	t/h	g/min	kg/min	t/min
	lb/s	lb/min	ton/min	lb/h	ton/h		
A.qvR **B.qvR**	cm^3/s	dm^3/s	m^3/s	l/s	in^3/s	ft^3/s	gal/s
	dbbl/s	cm^3/min	dm^3/min	m^3/min	l/min	in^3/min	ft^3/min
	gal/min	dbbl/min	cm^3/h	dm^3/h	m^3/h	l/h	in^3/h
	ft^3/h	gal/h	dbbl/h	Ndm^3/s	Nm^3/s	Nl/s	scf/s
	mcf/s	Ndm^3/min	Nm^3/min	Nl/min	scf/min	mcf/min	Ndm^3/h
	Nm^3/h	Nl/h	scf/min	mcf/min			
A.qNR **B.qNR**	cm^3/s	dm^3/s	m^3/s	l/s	in^3/s	ft^3/s	gal/s
	dbbl/s	cm^3/min	dm^3/min	m^3/min	l/min	in^3/min	ft^3/min
	gal/min	dbbl/min	cm^3/h	dm^3/h	m^3/h	l/h	in^3/h
	ft^3/h	gal/h	dbbl/h	Ndm^3/s	Nm^3/s	Nl/s	scf/s
	mcf/s	Ndm^3/min	Nm^3/min	Nl/min	scf/min	mcf/min	Ndm^3/h
	Nm^3/h	Nl/h	scf/min	mcf/min			
A.pR **B.pR**	kPa|a	MPa|a	bar|a	ksc|a	psi|a	Torr|a	atm|a
	kPa|g	MPa|g	bar|g	ksc|g	psi|g	Torr|g	atm|g
	Pa	kPa	MPa	mbar	bar	ksc	inAq
	psi	Torr	atm				
A.TR **B.TR**	°C	K	°F	°R			
A.ρR **B.ρR**	kg/m^3	g/cm^3	lb/ft^3				
A.hR **B.hR**	kJ/kg	Btu/lg					
A.ΔpR **B.ΔpR**	kPa|a	MPa|a	bar|a	ksc|a	psi|a	Torr|a	atm|a
	Pa	kPa	MPa	mbar	bar	ksc	inAq
	psi	Torr					

For channels in the X application, it is possible to freely choose the unit from all the available units (table below). It is also possible to configure channel without specifying the unit. It is possible to define user engineering unit, if required. More information in the chapter User unit.

	Channel symbol	Defined units						
CHANNEL X	X.01 .. X.24	W	kW	MW	GW	Btu/s	kBtu/s	cal/s
		kcal/s	kJ/h	MJ/h	GJ/h	Btu/h	kBtu/h	MBtu/h
		cal/h	kcal/h	J/min	kJ/min	MJ/min	GJ/min	Btu/min
		kBtu/min	MBtu/min	cal/min	kcal/min	Mcal/min	kJ	MJ
		GJ	kWh	MWh	Btu	kBtu	MBtu	kcal
		Mcal	Gcal	g/s	kg/s	kg/h	t/h	g/min
		kg/min	t/min	lb/s	lb/min	ton/min	lb/h	ton/h
		g	kg	t	lb	ton	cm^3/s	dm^3/s
		m^3/s	l/s	in^3/s	ft^3/s	gal/s	dbbl/s	cm^3/min
		dm^3/min	m^3/min	l/min	in^3/min	ft^3/min	gal/min	dbbl/min
		cm^3/h	dm^3/h	m^3/h	l/h	in^3/h	ft^3/h	gal/h
		dbbl/h	cm^3	dm^3	m^3	l	in^3	ft^3
		gal	dbbl	Ndm^3/s	Nm^3/s	Nl/s	scf/s	mcf/s
		Ndm^3/min	Nm^3/min	Nl/min	scf/min	mcf/min	Ndm^3/h	Nm^3/h
		Nl/h	scf/min	mcf/min	Ndm^3	Nm^3	Nl	scf
		mcf	kPa|a	MPa|a	bar|a	ksc|a	psi|a	Torr|a
		atm|a	kPa|g	MPa|g	bar|g	ksc|g	psi|g	Torr|g
		atm|g	Pa	kPa	MPa	mbar	bar	ksc
		inAq	Psi	Torr	atm	°C	K	°F
		°R	kJ/kg	Btu/lb	kg/m^3	g/cm^3	lb/ft^3	m^3/kg
		ft^3/lb	Mm	in	ppm/K	ppm/°F	kJ/kg K	

5.6.2   Totalizers

The units listed below are available by default for totalizers. If required, it is also possible to add a user unit (for more information, see [User unit]).

Channel symbol	Defined units						
A.ΔP **B.ΔP**	kJ	MJ	GJ	kWh	MWh	Btu	kBtu
	MBtu	kcal	Mcal	Gcal			
A.P/A.PS **B.P/B.PS**	kJ	MJ	GJ	kWh	MWh	Btu	kBtu
	MBtu	kcal	Mcal	Gcal			
A.qm/A.qmS **B.qm/B.qmS**	g	kg	t	lb	ton		
A.qv/A.qvS **B.qv/B.qvS**	cm^3	dm^3	m^3	l	in^3	ft^3	gal
	dbbl	Ndm^3	Nm^3	Nl	scf	mcf	
A.qN/A.qNS **B.qN/B.qNS**	cm^3	dm^3	m^3	l	in^3	ft^3	gal
	dbbl	Ndm^3	Nm^3	Nl	scf	mcf	
A.PR **B.PR**	kJ	MJ	GJ	kWh	MWh	Btu	kBtu
	MBtu	kcal	Mcal	Gcal			
A.qmR **B.qmR**	g	kg	t	lb	ton		
A.qvR **B.qvR**	cm^3	dm^3	m^3	l	in^3	ft^3	gal
	dbbl	Ndm^3	Nm^3	Nl	scf	mcf	
A.qNR **B.qNR**	cm^3	dm^3	m^3	l	in^3	ft^3	gal
	dbbl	Ndm^3	Nm^3	Nl	scf	mcf	

(Leftmost vertical label: Σ1/Σ2 UKłAD A/B)

For channels in the X application, it is possible to freely choose the unit from the available list. It is also possible to configure totalizer without specifying a unit or define user unit (for more information, see in the chapter [User unit]).

Channel symbol	Defined units						
X.01 .. X.24	kJ	MJ	GJ	kWh	MWh	Btu	kBtu
	MBtu	kcal	Mcal	Gcal	g	kg	t
	lb	ton	cm^3	dm^3	m^3	l	in^3
	ft^3	gal	dbbl	Ndm^3	Nm^3	Nl	scf
	mcf	kPa|a	MPa|a	bar|a	ksc|a	psi|a	Torr|a
	atm|a	kPa|g	MPa|g	bar|g	ksc|g	psi|g	Torr|g
	atm|g	Pa	kPa	MPa	mbar	bar	ksc
	inAq	psi	Torr	atm	°C	K	°F
	°R	kJ/kg	Btu/lb	kg/m^3	g/cm^3	lb/ft^3	m^3/kg
	ft^3/lb	mm	in	ppm/K	ppm/°F	kJ/kg K	

(Leftmost vertical label: Σ1/Σ2 CHANNEL X)

6   ARCHIVE

Device has extensive data recording functions. There are two types of archive: process data (data, totalizers, events) and service (service log, settings log). Process data archive is configured and controlled by the user, service archive is updated automatically. All data is archived in internal non-volatile memory in file form.

Data archive and Totalizers archive need to be configured. The settings need two steps, general settings (chapter Archive settings) and assigning channels to be archived (chapter Channels settings).

Data archive records are saved with two possible frequencies, every: 1 s, 2 s, 5 s, 10 s, 15 s, 30 s, 1 min, 5 min, 10 min, 15 min, 30 min, 1 h, 2 h, 4 h or 12 h, according to the settings. Switching the frequency is controlled by alarm(s). The records in the Totalizers archive are saved every 1 min, 5 min, 10 min, 15 min, 30 min, 1 h, 2 h, 4 h, 12 h or 24 h, according to the settings (for more information I chapter Archive settings).

The record in the Events archive is saved when an event occurs (e.g. power on/off, alarm exceeded, device parameters change, user log in / log out).

6.1   Archive file types

The device saves three types of archive files:
- Data archive (file name: *YYADXX_yymmdd.csv*)
- Totalizers archive (file name: *YYATXX_yymmdd.csv*)
- Event archive (file name: *YYAEXX_yymmdd.csv*)

YY - Device ID, value consistent with user settings, if the ID changes, a new file will be created.

XX – Successive archive file number, numbering starts with 01 and ends with 99. If 99 is exceeded, the numbering starts again to 01.

Each archive is saved according to the *.csv format (the standard format for spreadsheet text).

yymmdd – date of archive file creation.

File modification date indicates the latest saved record.

Service archive files and settings archive files are available in settings menu and have auxiliary meaning form the user point of operation.

Note:

If available memory space is less than 5%, the oldest files are automatically deleted until minimum of 10% free space accessed. Even thou the memory space is 2 GB and is big enough to store quite large amount of archive data, it is recommended to copy archive files and delete old files periodically.

6.2   Creating new archive files

New archive files (data, totalizers, events) are created by user or automatically. At least one process value must be declared for archiving to create new data archive file. Similarly, at

least one totalizer have to be declared for archiving to create new totalizer archive file. Event archive file is always created when condition for new archive files occurs.

A new archive files is created in the following cases:

- by tapping New Archive button on the archive screen (at least User log in is required)
- automatically, when archive mode configured as 'daily', 'weekly' or 'monthly' when time condition occurs
- automatically, when changing and saving new settings (only setting having consequence for archiving)

6.3 Start, resume, and stop archiving

The Archive is controlled in Archive window. It is available from drop-down Main Menu or by tapping the icon REC on the title bar. Using the function button START/STOP it is possible to start, resume or stop the archiving process.

When new archive file is created, the archiving is not started automatically. It is required to start archiving as separate operation.

Archive control functions require at least User logged in.

6.4 View archive files on the device screen

Process data archived in the device memory may be scrolled back on the device front screen in *Archive* menu by tapping *View archive*. At one time it is possible view up to six selected process values.
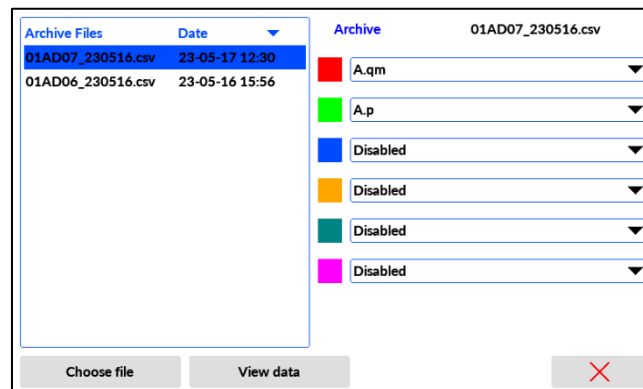
Data is presented as a trend lines with digital value pointed by the cursor. All trends are scaled 0 to 100% according to range entered for every channel in Channels setting. The range may be verified tapping *Legend* button.
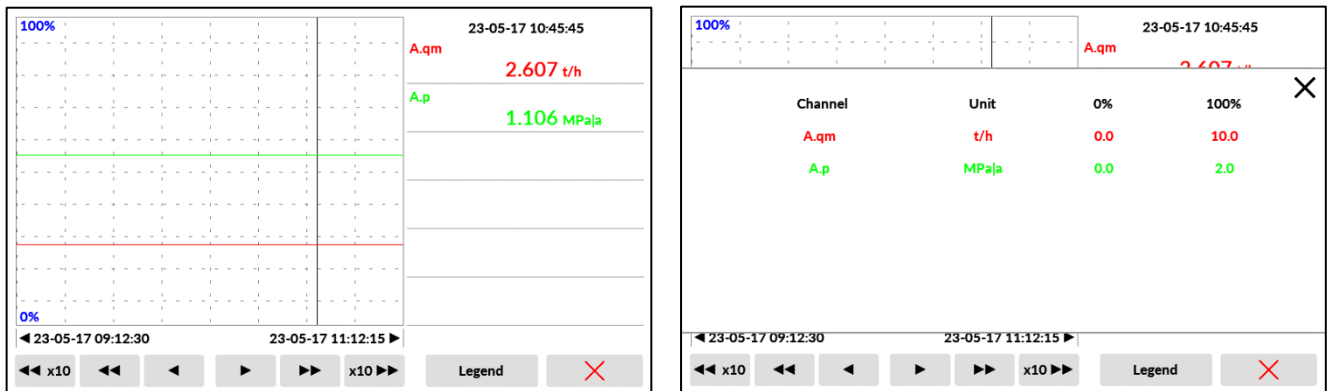
Note:

Only process data may be scrolled back. Totalizers are not available to browse on the device screen.

More detailed data analysis including totalizers may be done in the PC computer using *Report* software. (More details in chapter Supporting Software.)

6.5 Copy archive files from the device

Copying archive files from the device is possible using an external USB flash drive (pen drive) or using the Ethernet connection and the device's web server.

Copying archive files using the USB port is available in *USB* window accessed either from *Archive* screen or Settings main menu tapping *USB* icon. (More details in chapter Write and read files via USB port.)

Archive files may also be copied using the device's web server. The device have to be connected to LAN using build in Ethernet port. More information in the chapter Web Server.

6.6 Archive file organization

All archive files are saved in CSV format. Values are separated with comma, and as a digital separator is decimal point. This universal format allows to open file with simple text editor, spreadsheet or *Report* software. Every file is protected by encrypted CRC byte to protect against intentional or not intentional file modification. *Report* software can verify file and report such modifications.

Note:

In some local settings may be required to undertake extra action, like e.g. converting digital separator instead of point to comma.

Each archive file has a header containing DEVICE MODEL, FW VERSION, S/N, ID, N/R (number of rows), ARCHIVE TYPE and CRC1 value.

DEVICE MODEL	device model, for this device it is FP70
FW VERSION	firmware version in which the archive was created, firmware update always results in creation of a new archive file

S/N	device serial number
ID	device ID
N/R	information about the number of rows in the header
ARCHIVE TYPE	archive type: DATA (data archive), EVENT (event archive), TOT (totalizers archive)
CRC1	encrypted CRC control value

Data and totalizers archive files have an additional header containing information about the set of parameters (selected channels, description, unit, etc.).

6.6.1 Data archive

Data archive has additional header following the main header with settings information containing SYMBOL, DESCRIPTION, UNIT, INPUT NO, TREND MIN, TREND MAX.

SYMBOL	channel symbol
DESCRIPTION	channel description
UNIT	channel assigned unit
INPUT TYPE	measurement input type assigned to the channel: ME (measurement), CO (calculated), RE (remote, Modbus TCP)
INPUT NO	input specification (IN1, .. ,IN10, RE1, .. ,RE40 or -- (no physical input, e.g. disabled or calculated))
TREND MIN	trend chart range of Y axis, minimum value
TREND MAX	trend chart range of Y axis, maximum value

Data record has format: DATE, TIME, DST, CH1, CH2, .. CHn, CRC2

DATE	date stamp in format yy-mm-dd
TIME	time stamp in the format hh:mm:ss
DST	Daylight Saving Time marker (1 – summer, 0 - winter)
CHn	channel value (n – channel number from 1 to maximum 100)
CRC2	encrypted CRC control value

6.6.2 Totalizers archive

Totalizers archive has additional header following the main header with settings information containing SYMBOL, DESCRIPTION, TOT1 TYPE, TOT1 UNIT, TOT2 TYPE, TOT2 UNIT.

SYMBOL	channel symbol
DESCRIPTION	channel description
TOT1 TYPE TOT2 TYPE	totalizer type: ' ' – off; 1 – Unresattable; 2 – Rasattable; 3 – Daily; 4 – Weekly; '5' – Monthly
TOT1 UNIT TOT2 UNIT	Unit assigned to the totalizer

Totalizers record has format: DATE, TIME, DST, CH1:T1, CH1:T2, CH2:T1, CH2:T2, ... , CHn:T1, CHnT2, CRC2

DATE	date stamp in format yy-mm-dd
TIME	time stamp in the format hh:mm:ss
DST	Daylight Saving Time marker (1 – summer, 0 - winter)
CHn:T1, CHn:T2	totalizer value (n – channel number from 1 to maximum 100
CRC2	encrypted CRC control value

Note: If one totalizer is declared for archiving, then only the one is archived.

6.6.3   Events archive

Events archive has additional header following the main header with settings information containing DATE, TIME, DST, EVENT CODE, CRC2.

DATE	date stamp in format yy-mm-dd
TIME	time stamp in the format hh:mm:ss
DST	Daylight Saving Time marker (1 – summer, 0 - winter)
EVENT CODE	event code (more information below)
CRC2	encrypted CRC control value

The events codes meaning:

SYS:START	power on
SYS:STOP	power off
SYS:LOGIN: xxxxx	user log in (xxxxx – User / Admin / Servis / Factory
SYS:LOGOUT	user log out
SYS:NEW PARAMETERS	new settings have been saved
SYS:TIME CHANGED	RTC time has been changed
SYS:DATE CHANGED	RTC date has been changed
SYS:CHANNELx: AUXILIARY VALUES RESET	reset of auxiliary values (min, max, totalizer(s)) for selected channel (x – channel symbol)
SYS:APPLICATIONx: AUXILIARY VALUES RESET	reset of auxiliary values (min, max, totalizer(s)) for selected application (x – application A, B or X)
SYS: ALL CHANNELS: AUX VALUES RESET	reset of auxiliary values (min, max, totalizer(s)) for all channel
SYS:xxx ERROR ON	input failure detected (xxx – IN3 .. IN10)
SYS:xxx ERROR OFF	input failure cancelled (xxx – IN3 .. IN10)
SYS:REMOTE INPUTS ERROR ON	remote input (ModbusTCP) failure detected (one or more, no address specification)
REMOTE INPUTS: ERROR OFF	remote input (ModbusTCP) failure cancelled
SYS:RESET	User triggered device restart (menu *Settings > General > Service > Restart*)

ARCH:NEW	new archive file has been created
ARCH:START	start of data archiving
ARCH:STOP	stop of data archiving
AL:ACK	alarm(s) has been acknowledged
AL:x ALy ON	alarm has been activated (x - channel symbol, y - alarm I or II)
AL:x ALy OFF	alarm has returned to non-active state (x - channel symbol, y - alarm I or II)
EMAIL:OK	e-mail message has been sent
EMAIL:ERROR	e-mail message sent attempt not succeeded

6.6.4   Settings Archive

Every change of settings parameters is saved as a backup copy file in internal flash memory. The list of settings files is available for admin or service. The file name contains date and time in its name: *yymmdd_hhmmss_bkFP70.par*. It is possible to copy selected file to flash drive (pen drive) and open the file in dedicated software. (More information in Supporting Software chapter.) For the safety reason it is not possible to upload settings directly from the archive. It have to be copied to PC computer, read in *FP_Config* software, saved again to flash drive and then uploaded to the device.
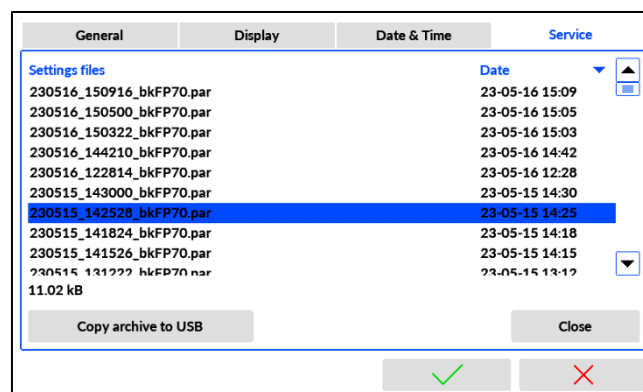
Note:

The list of backup files allows also to verify and control the previous changes in device configuration.

6.6.5   Service Archive

The service archive contains event codes important for authorized service. The archive is accessed in *Settings* menu in *Generals* for Admin or Service and may be browsed on the device display or copied to the *autoriezed.csv* file. The header differs from the other archive

files and contains DEVICE MODEL, FW VERSION, S/N, MAC ADDR, ID, ARCHIVE TYPE and CRC1 value.

DEVICE MODEL	device model, for this device it is FP70
FW VERSION	firmware version in which the archive was created, firmware update always results in creation of a new archive file
S/N	device serial number
MAC ADDR	MAC address
ID	device ID
ARCHIVE TYPE	archive type: SERVICE
CRC1	encrypted CRC control value

Service file record has format: DATE, TIME, DST, CODE, CRC2.

| DATE	date stamp in format yy-mm-dd
TIME	time stamp in the format hh:mm:ss
DST	Daylight Saving Time marker (1 – summer, 0 - winter)
CODE	service event code (more information below)
CRC2	encrypted CRC control value

The service events codes meaning:

1	power off
2	power on
3	device restart triggered by the user
4	new settings have been saved
5	settings have been restored to factory default
6	RTC date has been changed
7	RTC time has been changed
8	RTD type input(s) has been calibrated (IN3, IN4)
9	current loop type input(s) has been calibrated (IN4, .. IN10)
10	new value of totalizer(s) has been set
11	archive stopped due to error
12	device restart due to Watchdog timer
13	new firmware for the measuring processor has been uploaded
14	new device firmware has been uploaded
15	internal device temperature has exceeded upper limit of +70 °C
16	Internal device temperature has returned below +65 °C
17	internal device temperature has exceeded lower limit of -15 °C
18	Internal device temperature has returned above -10 °C
19	automatic archive flash memory clean up
20	automatic archive flash memory clean up error has been detected

7   WEB SERVER

Displaying the web server is possible only if the settings in the Ethernet tab are correctly configured. The device should be configured according to the LAN network in which it should work. The device must be connected to the network (RJ-45 port).

To view the device's web server, one have to enter the IP address of the device in his web browser.

The device's web server allows:
– to remote download of archive files
– to view process values in applications A, B and X
– to monitor measurement input values IN1 .. IN10
– to monitor relay outputs status RL1 .. RL4
– to monitor analogue output values OUT1 and OUT2 (computed, not measured)
– to check the temperature inside the device

The web server is designed for periodic check of process data or uploading archive files rather than for continuous monitoring. If the user doesn't refresh the page in the browser and have a 5-minute idle time, the device will log out automatically. (This timeout does not apply to process data monitoring in application A, B, X or IO.)

Note:
Correct configuration may require IT service help or consultation on local LAN operation limits.

7.1   Logging in to the web server

After entering the IP address in the web browser, the login window appears. The required password is the device User password. If the User password is deactivated, the log in window is not displayed and there is no password required. When the password is active, then only one user may be logged in. When password is deactivated, then more users may use the web server at the same time.

After logging in, the device's web server opens the *Archive* window by default. Below the menu bar there is information on device type, device description for identification in case of having more similar devices.
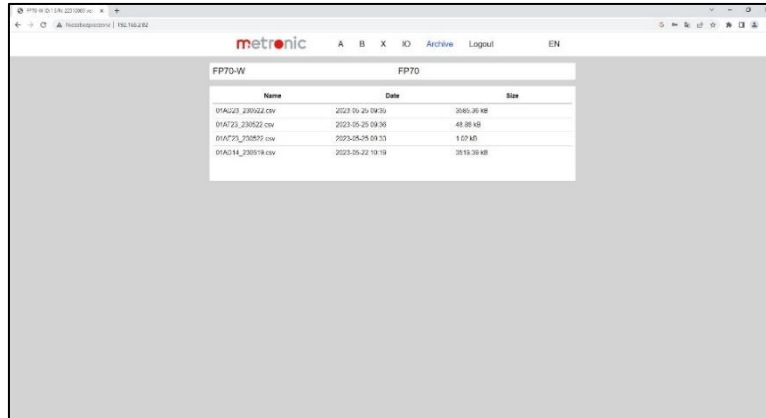
At the top menu bar allows to choose screens to be displayed:

metr●nic	- transfers to the manufacturer's website
A	- displays process values from application A
B	- displays process values from application B
X	- displays process values from application X
IO	- displays I/O values and output relays status (service screen)
Archive	- displays the list of archive files to be download
Logout	- Log out function
EN	- language selecting button
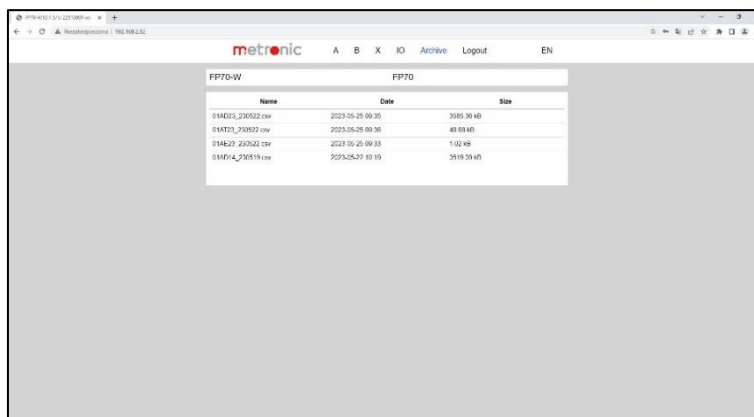
Note:

There are seven languages available: EN (English), DE (German), ES (Spanish), FR (French), IT (Italian), PL (Polish), PT (Portuguese). Language is selected according to user system configuration. If the user language is other than one of available, then English is set by default.

7.2 Downloading archive files

The list of archive files is available in the Archive tab. Files can be downloaded to user computer by clicking on the name of the archive file. The files may be sorted by clicking on the column header in the table.

The file name contains the archive type (AE – events archive, AD – data archive, AT – totalizers archive) and the date the archive was created. The *Date* column indicates the date and time of the latest saved record in the archive file. Details about archive files can be found in the Archive chapter.

7.3 Viewing process values and totalizers

The web server allows to view all process values and totalizers in table form grouped in applications A, B and X. It corresponds to display organization in the device. Switching among screens is possible from menu bar. The process values are refreshed every one to two seconds.

Measured values are displayed in few colors:
- blue – value is correct, normal operation, no alarms
- black - the value other status then normal operation (e.g. fixed channel value, active cut-off function, extrapolation out of range, the value is depended on another value with status indicated in black).
- green - green alarm activated for the process value
- orange - orange alarm activated for the process value
- red - red alarm activated for the process value

If the channel is in an error state, a failure symbol is displayed.
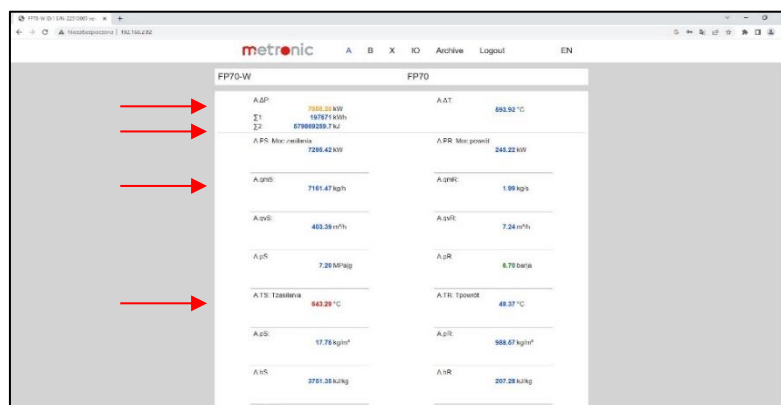
7.4 Displaying I/O status

The web server allows to display the values of inputs values IN1 to IN10, relay outputs RL1 to RL4 expected state, analog outputs OUT1 and OUT2 expected values and the temperature inside the device. The screen is displayed from choosing IO button in menu bar.

The screen is refreshed automatically. The status of the relay output can be indicated by:
– ○ - relay opened,
– • - relay closed.

For I_OUT1 and I_OUT2 outputs, the current value is in mA. For inputs IN1/F and IN2/F, the displayed data depends on the configured mode. It may be frequency (in Hz), number of pulses or input state. The state is displayed:
– ○ - open contact,
– • - closed contact.

For IN3/RTD and IN4/RTD inputs, the resistance value in Ω is displayed. And for inputs IN5/I to IN10/I the current value is in mA. The internal temperature is displayed in °C for metric selection or in °F for imperial unit selection.
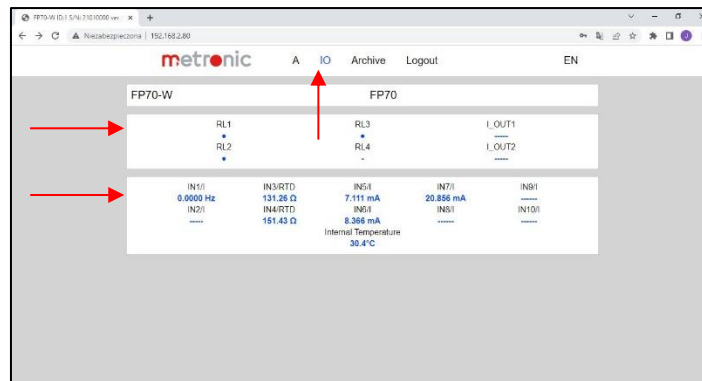
Fig. 11.6 Web server – display of measurement inputs/outputs (I/O test).

8   SUPPORTING SOFTWARE

On the manufacturer's website www.metronic.pl there are two programs dedicated to the device possible to be downloaded:
– FP70 Config, program to configure, check or modify the device settings (available free of charge),
– FP70-RP, program for reading archive files, to analyze and report data (available as an accessory).

8.1   FP70 Config

FP70 Config is a free program which helps to configure the device and allows it to be done at office on PC computer. In the program it is possible to create a new settings file or open and edit the setting file downloaded from the device. Program screens looks almost the same as screens in the device front panel, what makes configuration process similar on both. The program does not include service functions like the ability to change the time, the color of the screen background or passwords.

Prepared settings file may be uploaded to the device using USB memory flash drive (pen drive).
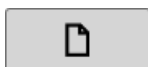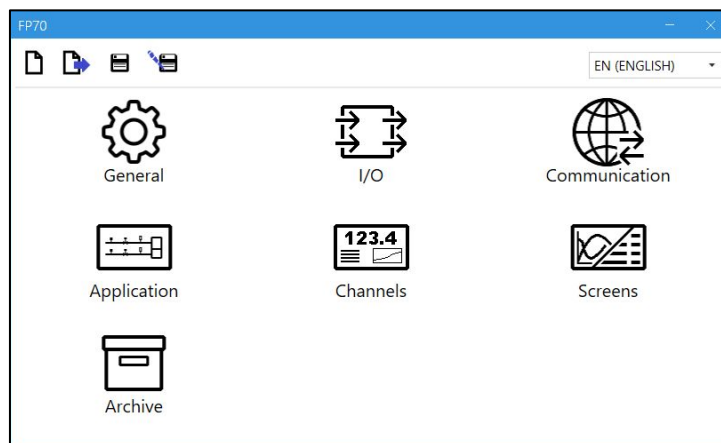
	Starts a new default settings
	Opens the settings file
	Save settings (settings will be saved in the currently opened file, if the settings file is opened, it will be overwritten)
	Save settings as a new file (create a new settings file)
EN (ENGLISH) ▾	Changes the language.
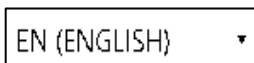
Notes:

Changing the firmware version of the device may require to download a new version of the configuration program. Before loading the settings file, compare the first two digits specifying the firmware version of the device with the first two digits specifying the version of the program to be configured (they must be the same).

Program allows also to open archived settings file, verify and edit it, and save as a setting file to upload it to the device.

8.2 FP70-RP (overview)

The FP70-RP report software extends of flow computer archive functionality and allows to analyze and report archived data.
Program main features:
- Opening the data archive, totalizers archive, events archive and service archive
- Combining archive files to get combined longer time scale in one file
- Data selection and filtering (smaller / larger than selected; from range; out of range; minimum / maximum / average in time interval)
- Generating a graph of archival data, printing chart, export chart to PDF, HTML, JPG
- Data table presentation, printing the table
- Online reading of process data from the device (Ethernet)
- Downloading archive files directly from the device (Ethernet)

The FP70-RP is available as an accessory. For normal operation requires registration and entering *Activation code*. Activation code is obtained from the manufacturer after sending the *Program code* by e-mail. The license is for one PC and cannot be transferred.
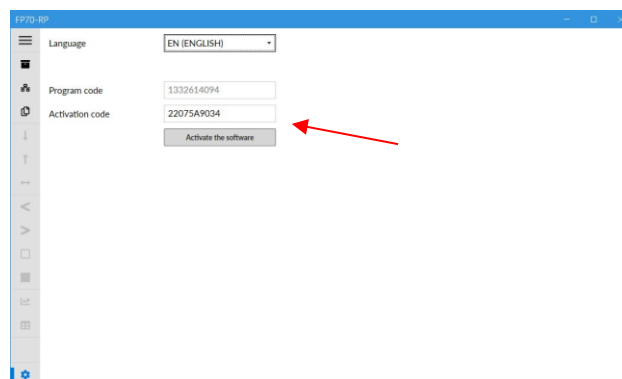
Without active license the program works for 10 minutes as a test version.

Typical use of the program is to analyze archive files as a table or chart. The use of program is intuitive. There are two bars with pictograms, vertical on the left side of the screen and horizontal at the top above the chart screen.
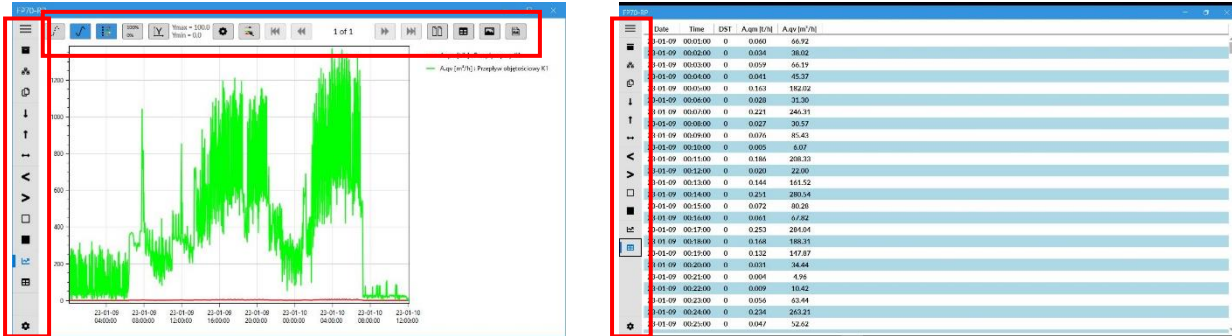
The left bar is menu bar for general program functions for archive files operations. Top bar includes pictograms with functions for chart view operations.

Horizontal menu bar:
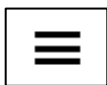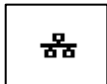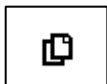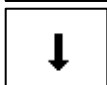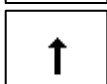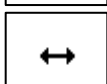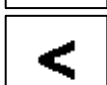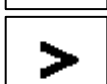
☰	On/off help information on menu pictograms.
▤	Archive file. Information on current file and loading a new file with archive data.
⬚	Remote connection. On-line data process overview or downloading archive file from the device archive memory.
⬚	Combine archives. Combining two archive files into new one file.
↓	Minimums... Creating a new data file containing minimum value of one minutes, one hours or one days of time interval.
↑	Maximums... Creating a new data file containing maximum value of one minutes, one hours or one days of time interval.
↔	Averages... Creating a new data file containing averaged value of one minutes, one hours or one days of time interval.
<	Find less then... Creating a new data file containing selected values below entered threshold.
>	Find greater then... Creating a new data file containing selected values above entered threshold.
□	Find outside range... Creating a new data file containing selected values outside entered range.
■	Find from range... Creating a new data file containing selected values inside entered range.

📈	Chart. Displays process data or totalizers as a chart.
⊞	Table. Displays all file data in table form.
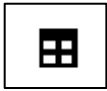
Chart top bar menu:

⠒⠊	Show/Hide markers. Each marker represents measuring point.
√	Show/Hide lines. Displays line connecting measuring points.
☰	Show/Hide legend. Displays the chart's legend on the right side of the chart window.
100% 0%	Normalized scale. Displays all trend lines normalized to 0-100% scale.
↑Y→	User scale. Displays chart in range of entered Y axis range.
✦	User scale settings. Setting for the user axis Y range.
☰	Trend color settings. User preferences settings for trend line colors, line thickness and markers size.
▯▮	Multi page mode. Divides chart into multi page in time scale.
⊞	Current view table. Displays data seen in the chart in table form.
🖼	Save trend to graphic file. Saves chart current view as a file in jpg format.
📄	Generate report. Creates chart and/or table report in pdf format.
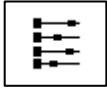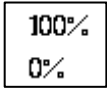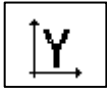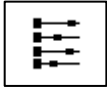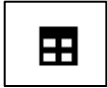
Mouse functions on chart area:
   CTRL + mouse reel - zoom in or out of the graph
   CTRL+ left mouse button - indication of fragments to enlarge
   CTRL+ right mouse button - return to the initial screen
   CTRL+ left mouse button along the X or Y axis – indication of the area to be zoomed in
   left mouse button - display information about the chart point
   right mouse button – moving the chart observation field

9   MECHANICAL INSTALLATION

!   **Before starting the installation work, read the information described in the section SAFETY INFORMATION.**

9.1   Wall mount version (FP70W-x)

The instrument should be installed in a place where it will not be exposed to direct heating from other devices. If installed outside, additional protection (roofing) against rain or direct sun exposure should be provided.
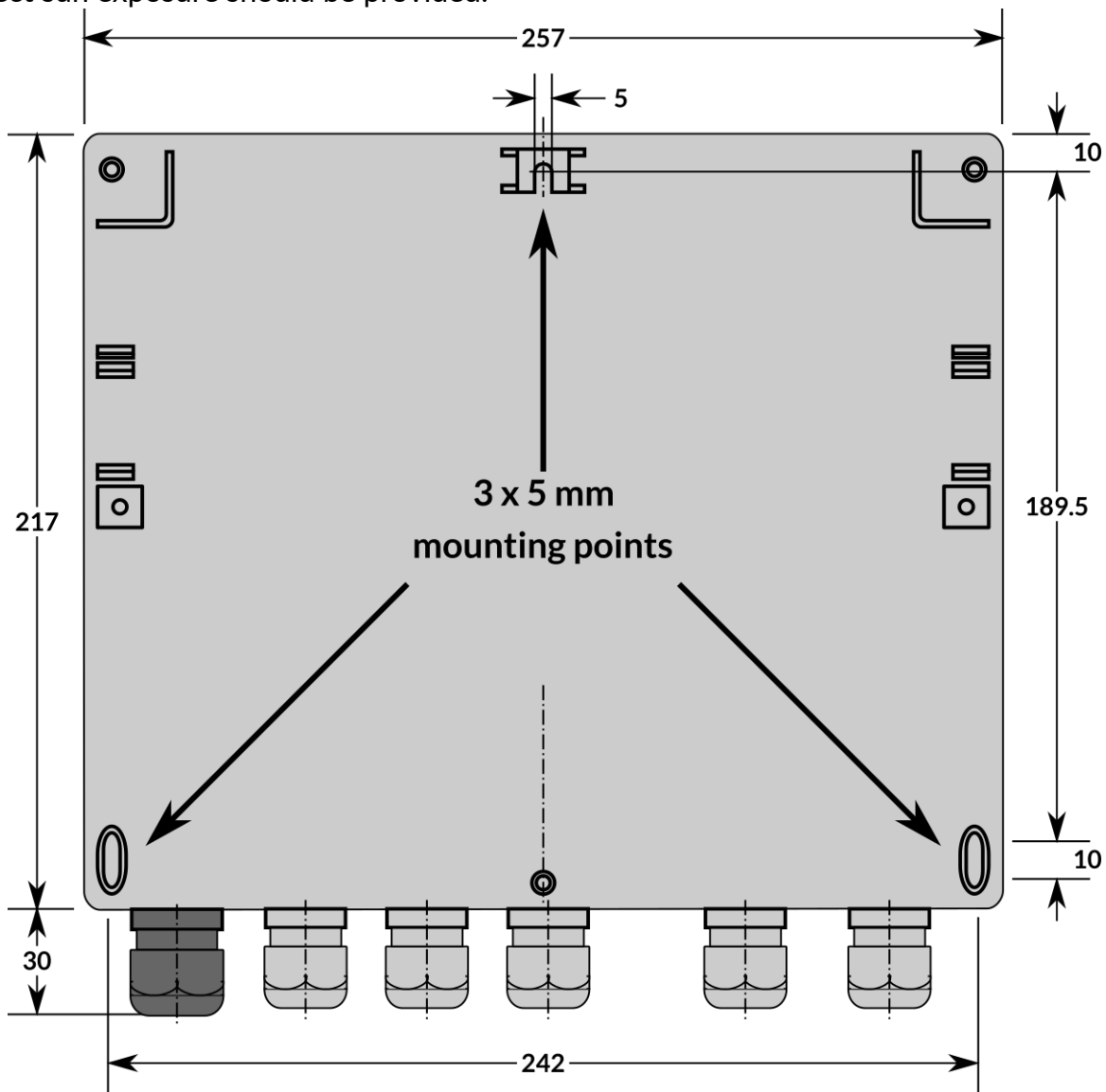
9.2   Panel mount version (FP70P-x)

The device should be mounted in boards of not less than 1mm wall thickness. The required cut-out size is $186^{+1.1}$ mm x $92^{+0.9}$ mm. Installation depth about 72 mm together with cable terminals, but ca. 10 to 20 mm space for cables should be foreseen. To maintain proper ventilation, a distance of at least 100 mm from other devices should be left.
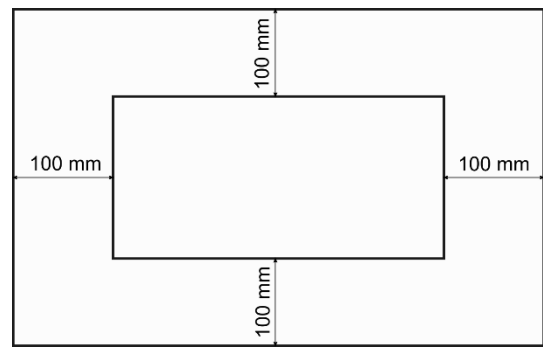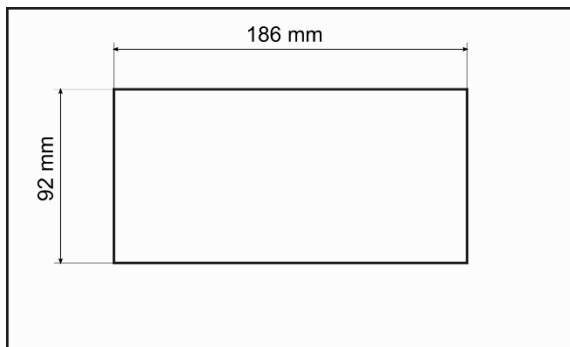
There are four fixing clamps included for device fastening.

80
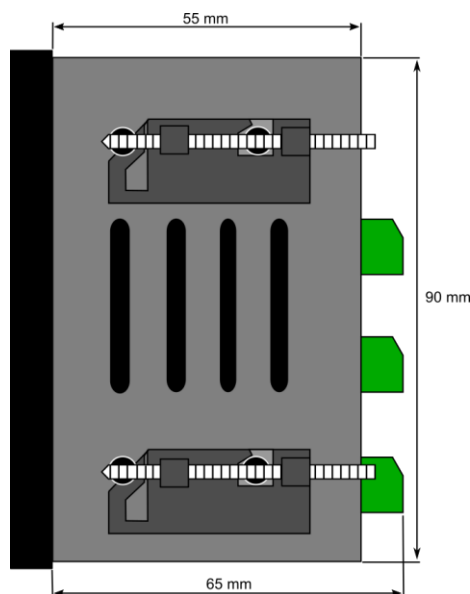
10   WIRING

> ! • **Before starting the assembly work, read the information described in the section SAFETY INFORMATION.**
>
> **Connection of signals shall only be carried out by trained personnel.**

In the FP70W the power supply and all signals are the spring connectors at the bottom part of the device. The terminals compartment is protected with the cover fastened with two screws.
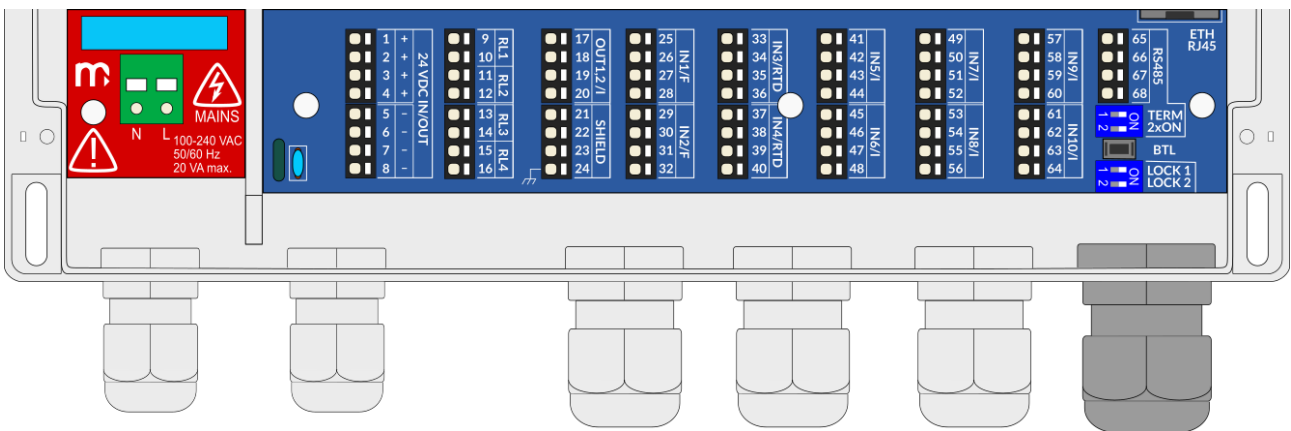
Cables with a maximum cross-section of 1.5 mm^2 may be connected to the connectors. Both stranded and solid wire cables can be used for connections. It is recommended to use 0.5 mm^2 or 0.75 mm^2 cable for power supply and 0.35 mm^2 to 0.5 mm^2 cable for I/O signals. The wires should be uninsulated over 8 to 10 mm at the end.

If required, the terminals compartment may be sealed.
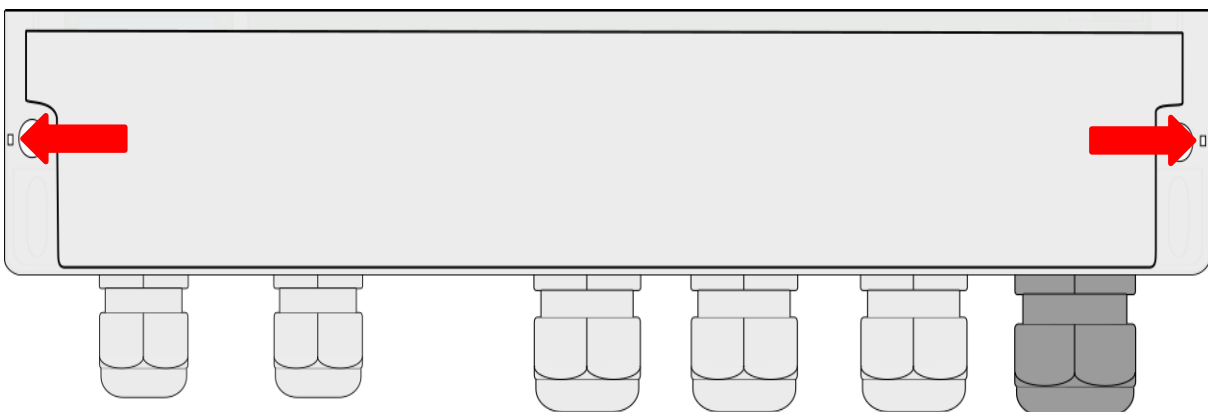
In the FP70P-x, the power supply and all other signals are wired to the plug-in screw terminals on the rear panel of the unit.
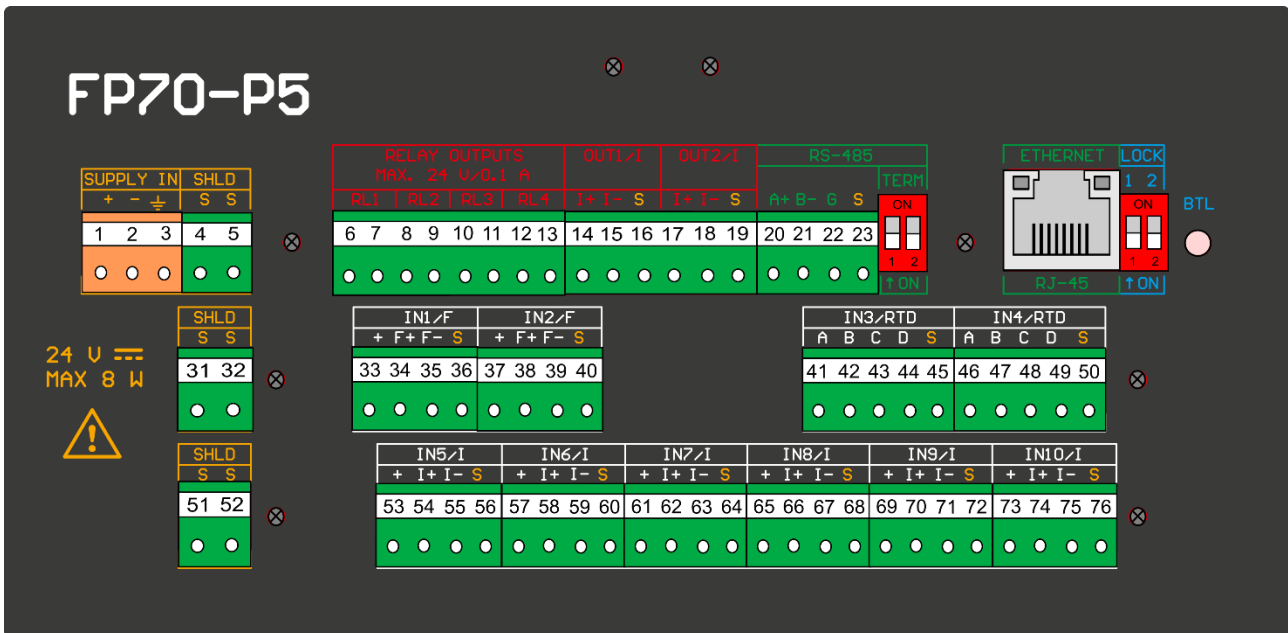
Cables with a maximum cross-section of 1.5 mm^2 may be connected to the connectors. Both stranded and solid wire cables can be used for connections. Stranded wires should be protected with bootlacase ferrules. It is recommended to use 0.35 to 0.5 mm^2 stranded wires with bootlacase ferrules.

10.1 Galvanic separation in the instrument

The galvanic separation shown below applies to the FP70W-x version. The FP70P-x version is identical, except it has no 100 .. 240 VAC power supply part.
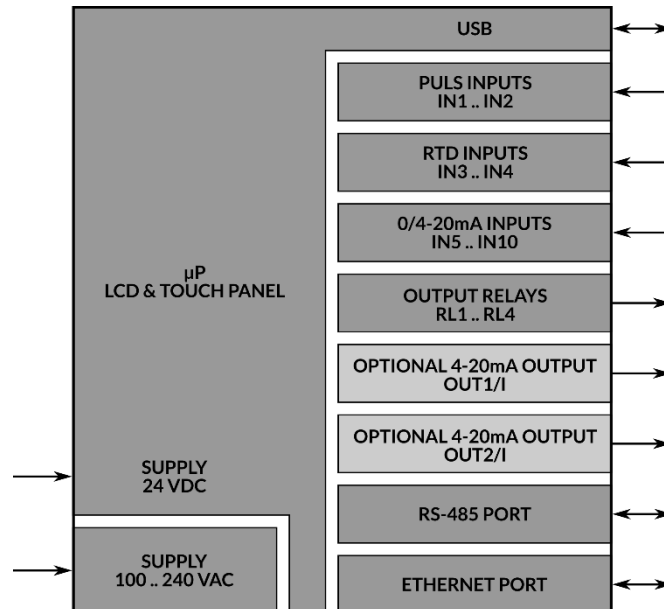
10.2 Power supply

The FP70W-x wall mount version device may be powered from a source of 100.. 240 VAC or 24 VDC.

The FP70P-x panel mount version device is supplied from 24 VDC source.

10.2.1 24 VDC power supply (FP70W-x and FP70P-x)

FP70W-x can be powered from 24VDC, then terminals 1 – 8 (24 VDC IN/OUT) have to be used.
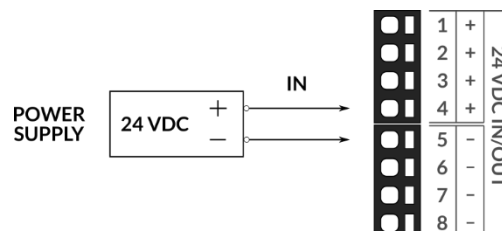
FP70P-x can only be powered from 24VDC source.
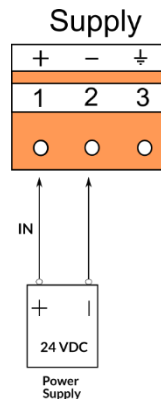
If the device is powered from a 24 VDC source, it is recommended to use high-efficiency industrial switched-mode power supplies with a minimum power of 15 W.

> **!** **To ensure safety, the power supply of the device must meet the conditions for SELV (Safety Extra Low-Voltage) low-voltage sources powered by 24 VDC in accordance with IEC60950-1.**

10.2.2 100 .. 240 VAC power supply (FP70W-x only)

Mains supply in range 100 to 240 VAC is applied to terminals L and N. Depending on local regulations it may be required to add external fuse and power switch close to the device. It is recommended to use the circuit breaker 2A C type for 230 VAC mains.

The FP70W automatically detects the type of supply source. When 100 .. 240 VAC supply is used, then extra 24 VDC is available on terminals 1 to 8 (24 VDC IN/OUT). It may be used as power supply for other devices (e.g. transducer) of maximum current consumption of 0.1 A.

10.3 Input and output signals

For both device versions cables with a maximum cross-section of 1.5 mm² , either stranded or solid wire may be used. In panel mount version with screw terminals stranded wires should be protected with bootlacase ferrules. It is recommended to use 0.35 or 0.5 mm² stranded wires for all I/O wiring. Signal cables have to be twisted pair type, shielded cable may be recommended is some harsh industrial environments.

10.3.1   F-type inputs (PULSE)

FP70W
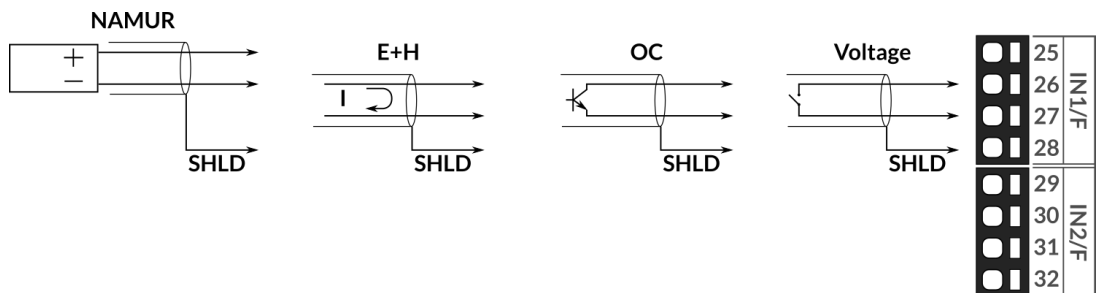
FP70P
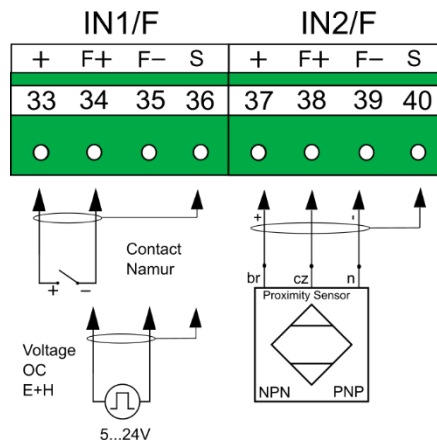
Terminal number				Description
FP70W		FP70P		
25	29	33	37	+12V OUT (22 mA max) NAMUR transmitter power supply. The input is protected by a resettable 50 mA polymer fuse.
26	30	34	38	F+ Digital signal input (+) for NAMUR and E+H inputs. F+ / +4.5V OUT (4.5 mA max) Digital signal input (+) and power supply for OC / PIN inputs.
27	31	35	39	F- Digital signal input (-).
28	32	36	40	Shield

10.3.2   RTD type inputs

FP70W
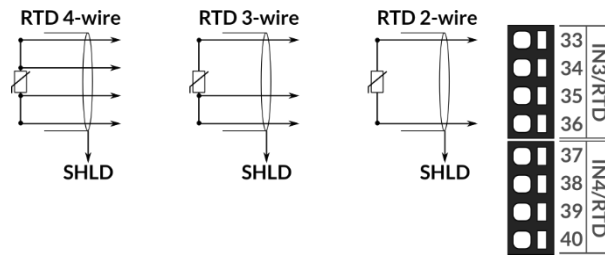
FP70P
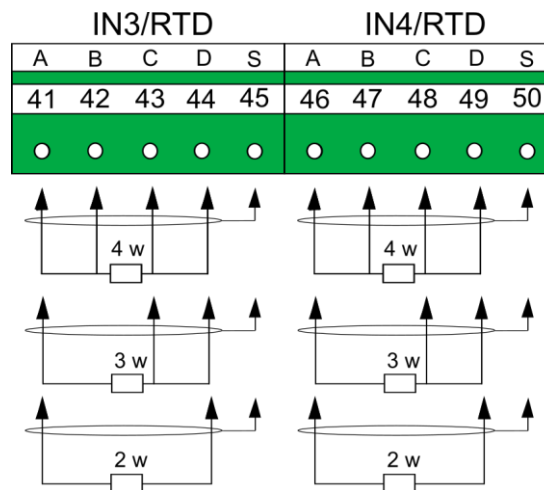
Terminal number				Description
FP70W		**FP70P**		
33	**37**	**41**	**46**	I+ Current output for 4-wire sensors. I+/U+ Current output and voltage input for 3-wire and 2-wire sensors.
34	**38**	**42**	**47**	U+ Voltage input for 4-wire sensors.
35	**39**	**43**	**48**	U- Voltage input for 4-wire sensors. I+/U- Current output and voltage input for 3-wire sensors.
36	**40**	**44**	**49**	I- Current loop return for 4-wire sensors. I-/U- Current loop return and voltage input for 3-wire sensors. I-/U- Current loop return and voltage input for 2-wire sensors.
21	**22**	**45**	**50**	Shield

10.3.3 0/4-20 mA current loop (I type)

FP70W
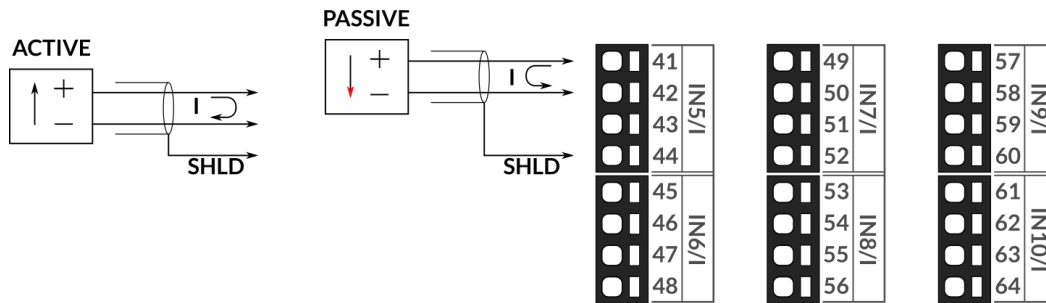
Terminal number						Description
41	45	49	53	57	61	+24V OUT (22 mA max) Transducer power supply.
42	46	50	54	58	62	I+ Current loop signal input (+).
43	47	51	55	59	63	I- Current loop signal output for active transducer (-).
44	48	52	56	60	64	shield

FP70P
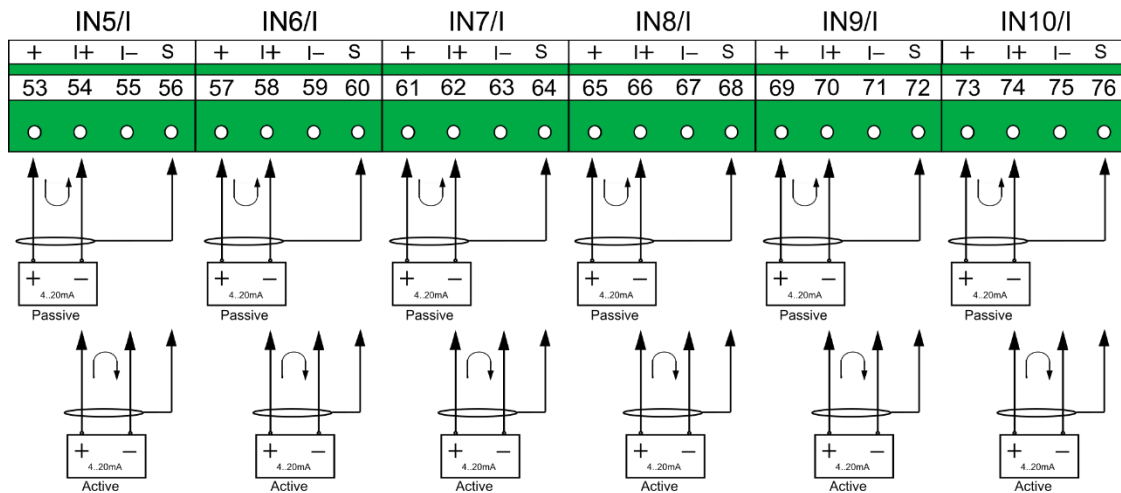
Terminal number						Description
53	57	61	65	69	73	+24V OUT (22 mA max), Transducer power supply.
54	58	62	66	70	74	I+ Current loop signal input (+).
55	59	63	67	71	75	I- Current loop signal output for active transducer (-).
56	60	64	68	72	76	shield

10.3.4 Relay outputs
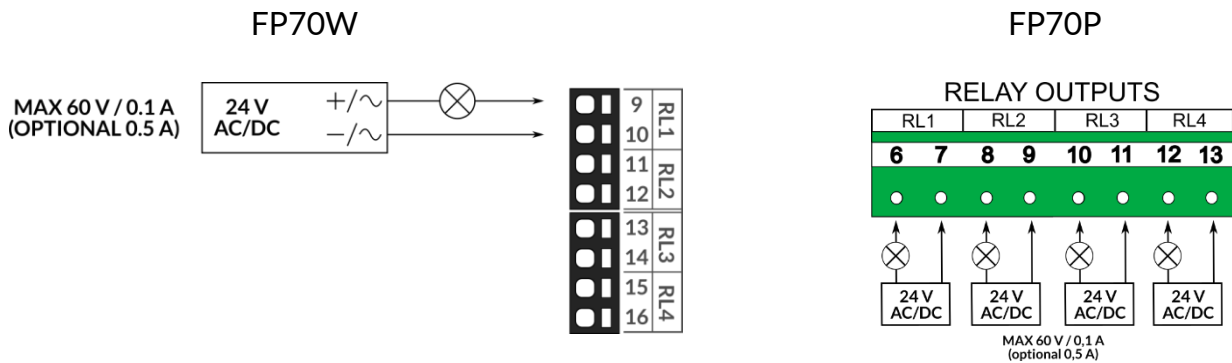
FP70W

FP70P

FP70W

Terminal number					Description
9	11	13	15	Relay output terminal (AC/DC).
10	12	14	16	Relay output terminal (AC/DC).

FP70P

Terminal number					Description
6	8	10	12	Relay output terminal (AC/DC).
7	9	11	13	Relay output terminal (AC/DC).

10.3.5 4-20 mA current loop (I type) outputs
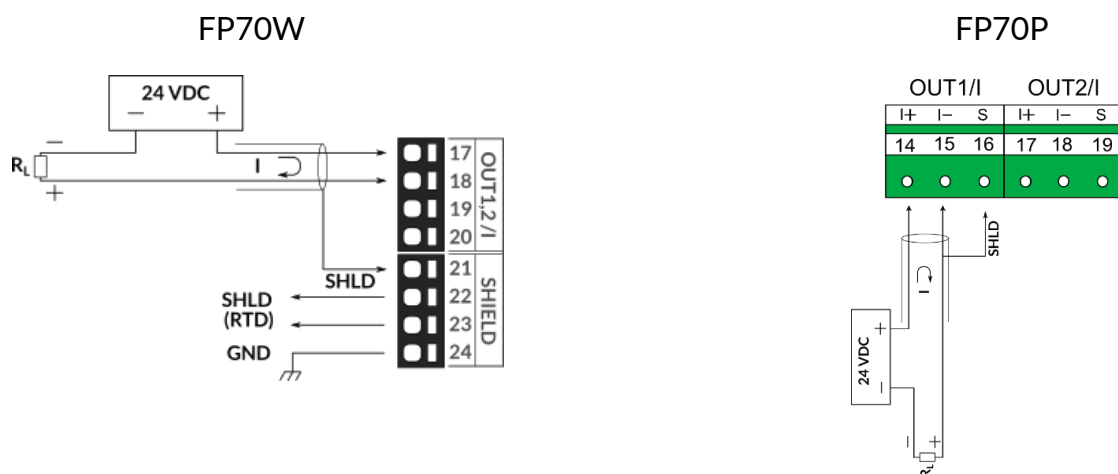
FP70W

FP70P

FP70W

Terminal number		Description	
17	19	I+	Current loop signal input (+).
18	20	I-	Current loop signal output (-).
21, 22, 23		shield	
24		GND	

FP70P

Terminal number		Description	
14	17	I+	Current loop signal input (+).
15	18	I-	Current loop signal output (-).
16, 19		shield	

Comments:

Analog outputs are passive current source and require external loop power.

10.4 Supervising system

10.4.1 RS485 port

FP70W   FP70P
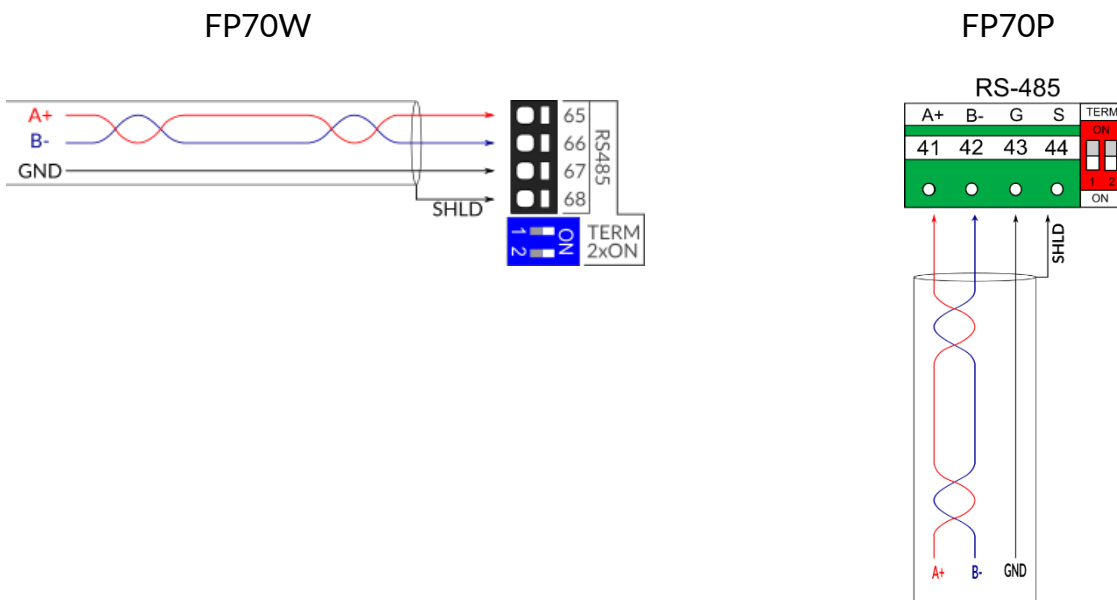
Comments:

The RS485 standard allows to connect up to 32 devices (transmitters/receivers). The driver used in the device allows to connect up to 256 receivers, if all other devices are the same type.

The RS485 must be bus configuration. Star configuration is not permitted. The maximum length of the bus depends on the transmission speed, the cable (dimension, capacitance or wave impedance), and the number of loads in the chain. For transmission rates of 9600 bps and 0.125 mm^2 (AWG26) or larger cross section, the maximum length is 1200 meters. It is recommended to use 0.25 or 0.35 mm^2 twisted pair cable. It is strictly recommended to use GND line among all devices for conditioning 0 V potential. It is recommended to use good quality cable for digital transmission. Shielded cable may be recommended is some harsh industrial environments.

To minimize signal reflections from the end of the RS485 line, it is required to place the termination near each of the ends of the bus. The device has an internal terminating system, activated by a DIP switch below the terminal block. Only two devises, located on the both ends of the bus should have termination on. Other devices should have termination in off

position. For the proper terminator operation, both switches must be set in the same position.

10.4.2 Ethernet/LAN port

The 100 Base-T Ethernet port has RJ45 socket with pins EIA/TIA-568A/B compliant. The standard RJ-45 plug patch cord may be connected to this socket. Wall mount version has special gland suitable to enter the patch cord with RJ-45 plug installed. This gland is located below the RJ-45- socket.

10.5 Shielding and grounding

In general there is no need to use shielded cables to connect input signals. It is strongly recommended to use signal cables and twisted pair cables for all input and output connections.

In some applications it may be required to use shielded cables to reduce the RF interferences.

It is recommended to connect ground terminals. The purpose of grounding is to reduce EMC emission and improve immunity. It is not protective grounding (PE).

10.5.1 Shielding and grounding in FP70W

Grounding should be connected to terminal 24.

If shielded cables are used they should be connected externally to ground or connected to terminals 21, 22, 23, 28, 32, 44, 48, 52, 56, 60, 64, 68.

10.5.2 Shielding and grounding in FP70P

Grounding should be connected to terminal 3.

If shielded cables are used they should be connected externally to ground or connected to terminals marked S: 16, 19, 23, 36, 40, 45, 50, 56, 60, 64, 68, 72, 76. Terminals 4 (or 5), 31 (or 32), 51 (or 52) should be shorted and connected to ground.

11 SETTINGS and DEVICE CONFIGURATION

11.1 Navigation in Settings menu

To go to the Settings menu screen, the SETTINGS button have to be tapped from the drop-down Main Menu. The Settings main screen has nine function icons to enter to detailed settings screens. Modifications of settings require ADMIN log in. USER has access only to view the settings.
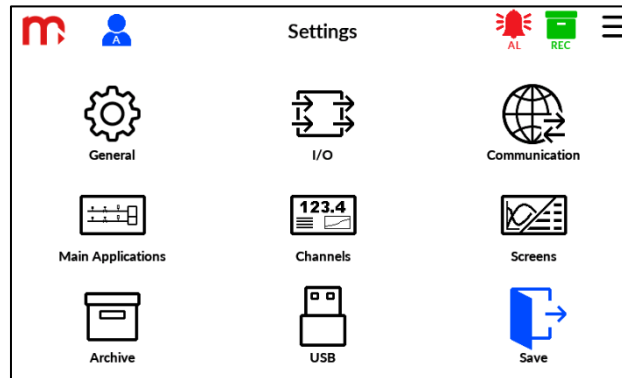
- Change of the language, device description, and device ID.
- Setting the sound of buttons and alarm sound.
- Activation of DST (daylight saving time).
- Screen brightness and dimmed level. Background colour setting (light / dark).
- Change the date and time.
- Service archive view (information about settings changes, device resets, etc.).
- Display touch panel calibration
- Service functions when SERVICE logged in (e.g. factory reset, meter value entry, calibration of analogue inputs IN1 .. IN10)..
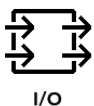
- Activation and configuration of the measurement input mode.
- Enabling and configuring the mode of operation of relay outputs.
- Activation and configuration of the mode of operation of optional Type I outputs (4-20 mA).

- Ethernet connection configuration (e.g. IP address).
- RS485 port configuration (e.g. Modbus address, transmission speed).
- Configuration of e-mail notifications (address of the sender, recipient of the message, frequency of the recurring report).
- Configuration of remote reading from Modbus TCP converters (server addresses, registers).

- Selection of the type of measuring system for measuring systems A and B.
- Enter a description for the application.
- Choosing the type of medium.
- Choice of flow measurement method.

- Optional addition of a table from the user's medium in the form of a file with the .csv extension (two-dimensional array containing density / enthalpy / specific heat / viscosity depending on temperature / temperature and pressure).

Channels

- Configuration of all channels in measuring systems A and B.
- Configuration of all secondary channels X.
- Set up channel descriptions.
- Channel unit selection.
- Enter a user entity.
- Select a filter for channel values.
- Change the resolution for channel values.
- Enter a user entity.
- Setting the emergency value and cut-off.
- Set the minimum and maximum values for the trench plot field in the Single Channel Window.
- Add channel values to archiving.
- Addition of an optional counter I and/or II (counting channel values based on the channel unit including the time base or counting the number of pulses multiplied by the weight of a single pulse).
- Select the type of counter (non-reset, resettable, daily, weekly, monthly).
- Unit configuration and resolution for the meter.
- Enter a user entity.
- Positive values of the counter for archiving.
- Positive counter values for a recurring aggregate report in the form of an e-mail message.
- Configure alarm settings (up to two different alarms for each channel).
- Adding information about exceeding the selected alarm threshold to the archiving.
- Set to change the frequency of archiving when the alarm threshold is exceeded.
- Assigning a relay output to an alarm.
- Adding information about exceeding the alarm threshold value to an e-mail notification.

Screens

- Configuration of User Tables screens (up to six screens containing 16-element tables).
- Configuration of User Trends screens (up to six screens containing 6-element trend charts).

Archive

- Archive type (daily, weekly, or monthly).
- Frequency of data recording for Main Archive (process values) and Totalizers Archive.
- Graphical information on channel values declared to be archived.

- ▪ Saving and reading files to an external flash memory (memory stick), settings, archive files, print screens.
- ▪ Deleting archive files and print screen files.

USB

- ▪ Exit the Main Menu window (save & exit, exit without saving, cancel).

Save
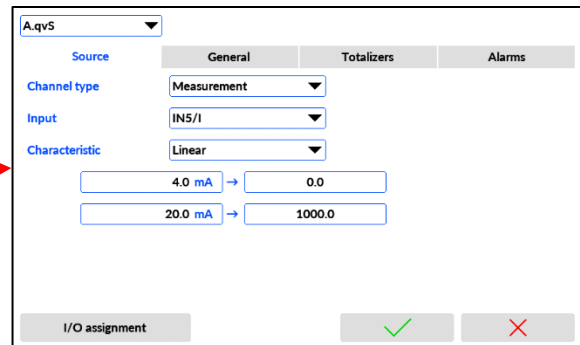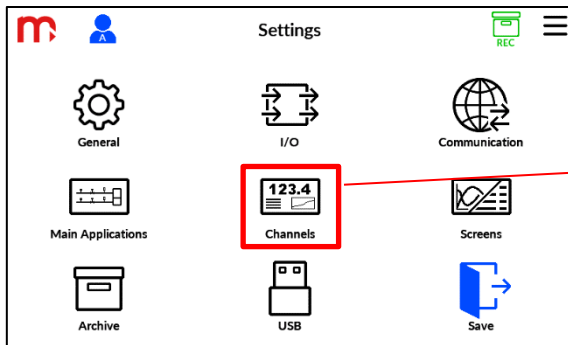
Individual sub windows can contain pages. Switching among pages in the selected settings sub window is possible using the tabs at the top.
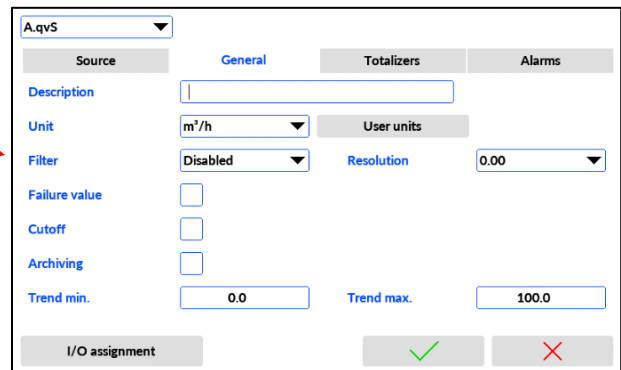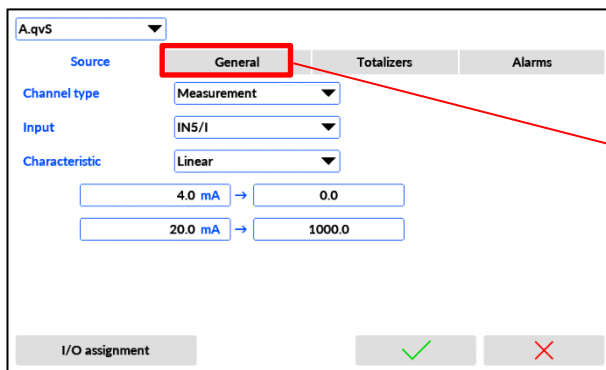
The settings screens may contain drop-down lists, which switch among the group of similar settings screens (e.g. channel screens for settings).
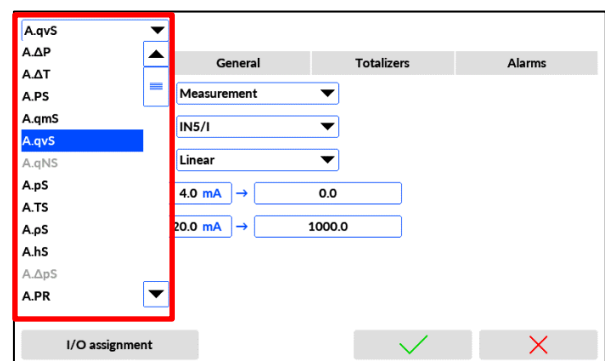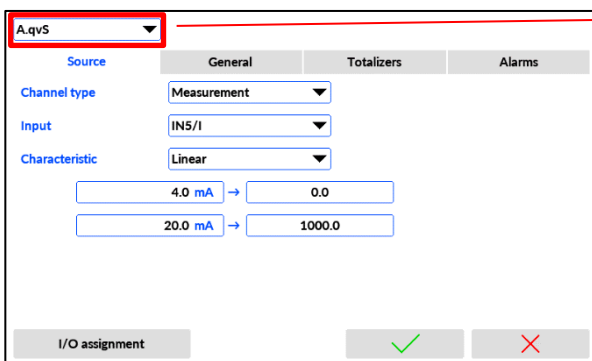
In the lower part of the sub window there are buttons:

✓	exit the sub window and confirm the changes
✗	cancel the changes and exit the sub window

If the settings screen has tabs, the buttons confirming / cancelling changes apply for all pages within the settings sub window.

11.2 Changes and save settings

Changes to settings are made in individual sub windows using drop-down selection lists, check-boxes, buttons and fill-in boxes for numbers or strings. For some, the on-screen keyboard is used to enter required data. The on-screen keyboard is displayed after tapping on editable fields.
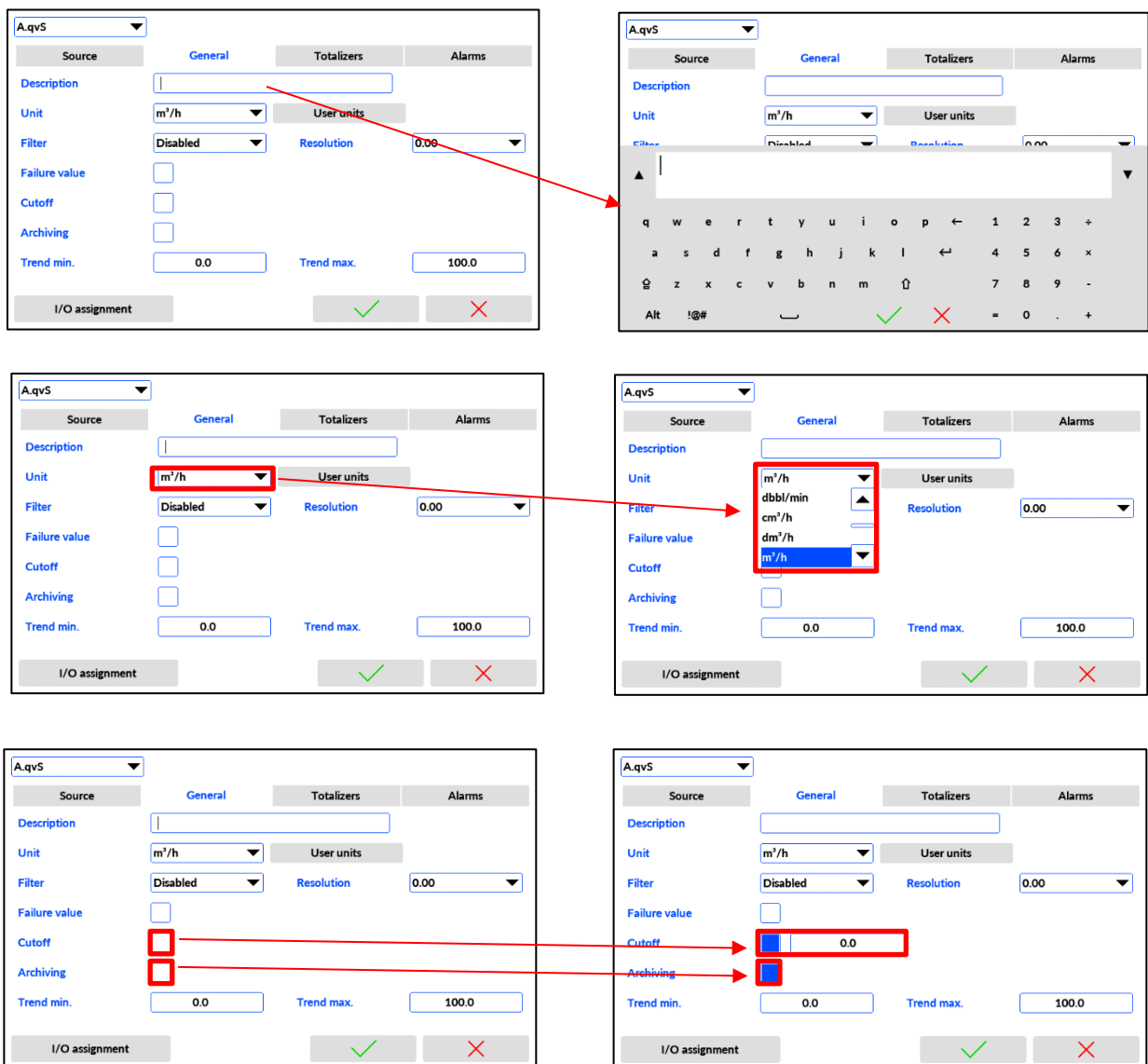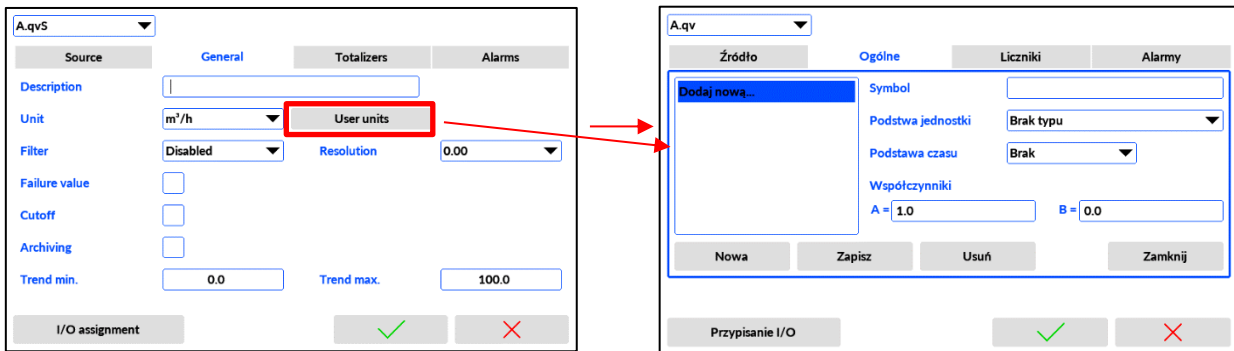
Depending on other settings, some lists / buttons / editable fields may be disabled and not possible to be edited, these are marked in grey then.
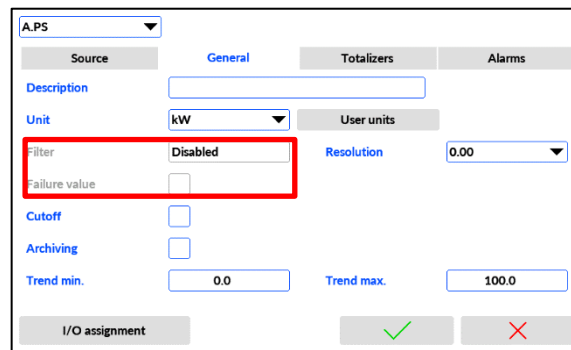
New settings are not immediately active when entered. Settings can be viewed and modified without impact on operation of the device. To activate new settings the Save icon have to be tapped and confirmed in pop-up window. Most of the changes make the device restart. In most cases also new archive file is created.

User logged in has an access to settings and may also modify them, but without permission to save.
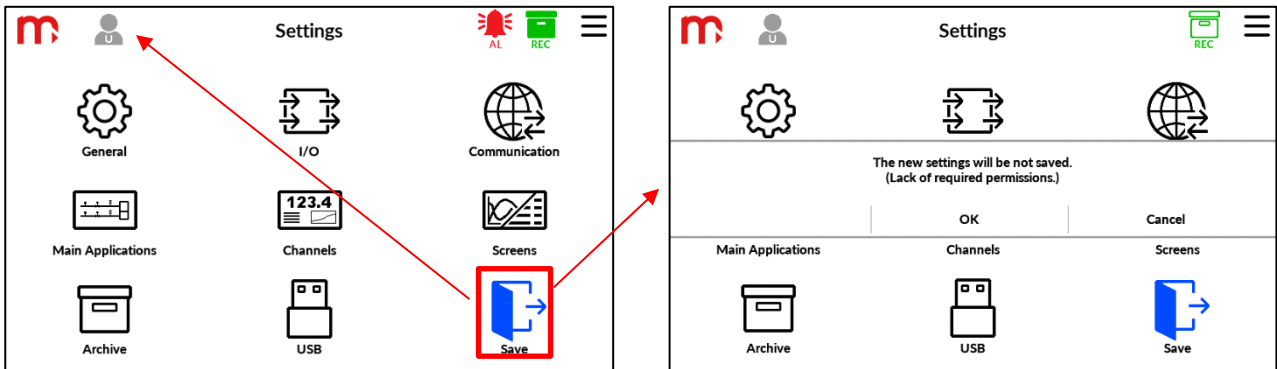
If still new settings are to be saved, then Cancel button should be tapped, Admin password should be logged in and again save process should be repeated.

11.3 Order of configuration process (suggested)

The brand new device is in factory reset state and has all functions disabled, it does not perform any measurements or calculations. It must be configured, so the appropriate settings must be entered. Some parameters are not available before other parameters are entered first. For this reason it is convenient to follow the suggested order while first configuration:

1. General
2. I/O
3. Communication
4. Main Application
5. Channels
6. Screens
7. Archive
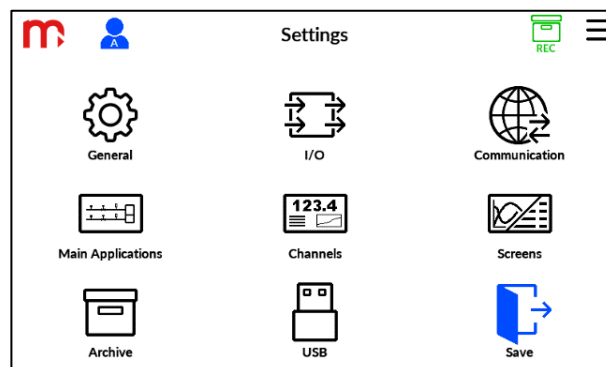
11.4 General settings

In the General settings window, it is possible to configure important settings for the operation of the device, like language, RTC (Real Time Clock - date and time), secondary settings like display, beeper. There are also service functions, like pre-set of totalizers, analogue inputs calibration, Service Archive or settings archive. Some of above are available for Admin, others require Service log in.
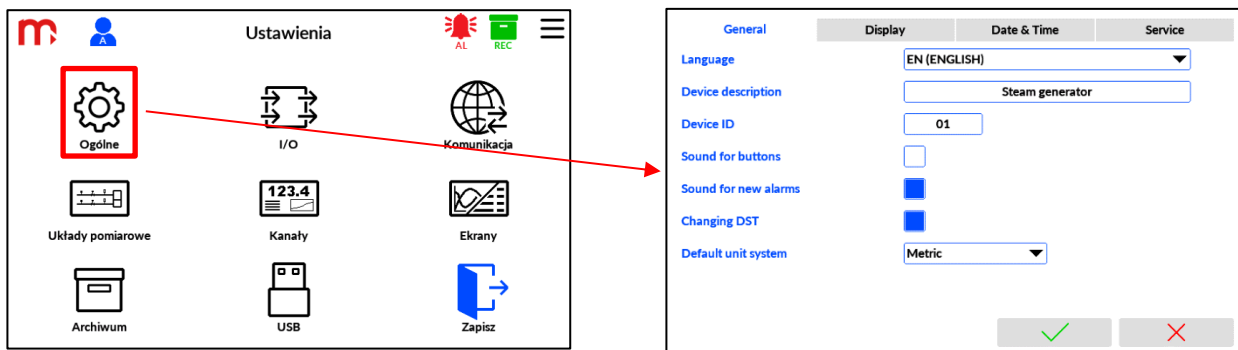
Language: EN (ENGLISH) (EN (ENGLISH), DE (DEUTSCH), ES (ESPAÑOL), FR (FRANÇAIS), IT (ITALIANO), PL (POLISH), PT (PORTUGUÊS)) [1]
Description of the device: [text] [2]
Device ID: [value] [3]
Sounds for buttons: Off (Off, On) [4]
Sounds for new alarms: Off (Off, On) [5]
Changing DST: Off (Off, On) [6]
Default unit system: Metric (Metric, Imperial) [7]

[1] Selecting language from the drop-down list. The device has seven languages available.
[2] Allows to enter user device description (tag). Max 40 characters string allowed.
[3] Allows to assign device ID. The ID number is used in the name of the archive files and in the name of the settings file copied from the device.

 NOTE: When using more than one device, it is recommended to assign unique ID number to every device. This will allow to recognize the source of the archive files by the ID number assigned.

[4] Enables beeper sound when button is tapped.
[5] Enables beeper sound a new alert notification from process values alarm thresholds.
[6] Enables automatic DST (Daylight Saving Time) time adjust.
[7] This selection affects barometric pressure units and pipeline diameter units. Some other units are prompt as first choice. All other units are available in both, metric and imperial systems.

11.4.1 Display
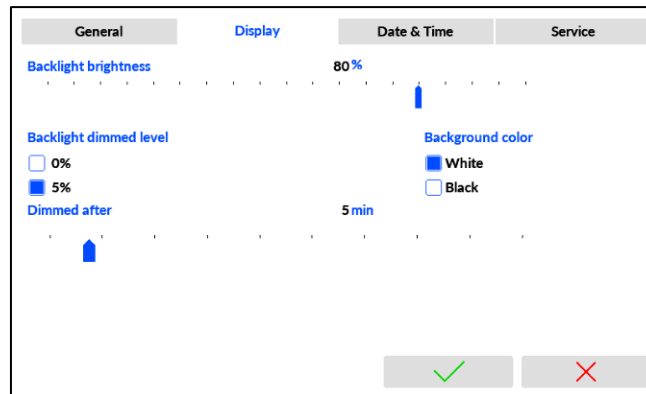
Brightness: 80% (10% ... 100%) [1]
Dimming brightness: 5% (0%, 5%) [2]
Background colour: White (White, Black) [3]
Dimmed after: Off (Off, 1 min ... 60 min) [4]

[1] Degree of backlight brightness during normal operation from 10 to 100% (slider).
[2] Dimmed level after inactivity time 0% or 5%. 0% means display backlight off. When backlight is off, the front panel LED lights in blue indicating that the device is powered on.
[3] Background colour may be set to white or black.
[4] Delay time after last touch panel operation before the dimming. When value is set to Off, the dimming will not be activated.

11.4.2 Date and Time
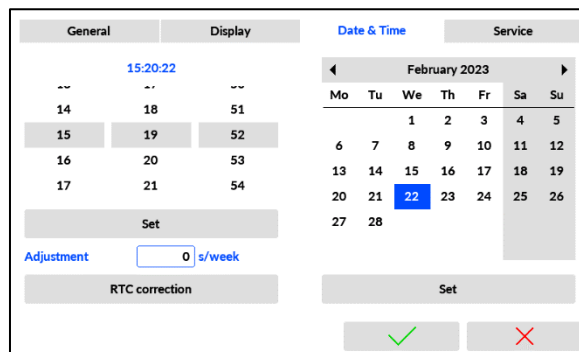
Time: [hour : minute : second][1]
Date: [day - month - year] [2]
RTC correction: [value] s/month [3]

[1] Time is in format: hour : minute : second. Changes are made using three separate sliders, for hours, minutes and seconds. The currently selected time is highlighted in grey. Changes are applied by tapping Set button.

[2] Date is in the format: day - month - year. The new date is selected from calendar. The currently selected date is highlighted in blue. Changes are applied by tapping Set button.

[3] RTC correction allows to adjust the internal clock (RTC) in long time scale. A positive value adds the indicated number of seconds within a month, a negative value subtracts the indicated number of seconds within a month. This function is available for Service only.

   NOTE: Time and date is updated immediately when set and do not require device restart. After changing the time or date, it is recommended to create a new archive file to avoid problems with data interpretation.

11.4.3 Service

Admin logged in

Service logged in
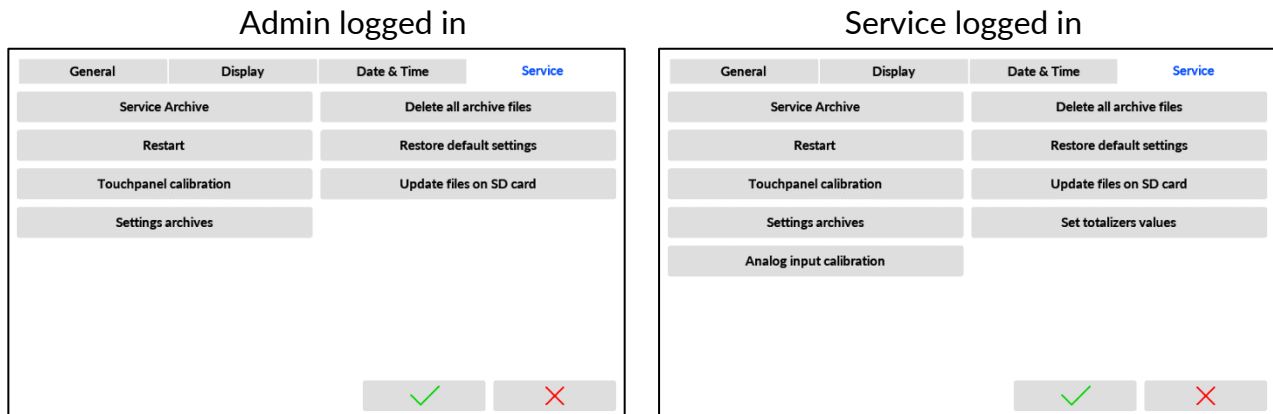
Service Archive [1]
Delete all archive files [2]
Restart [3]
Restore default settings [4]
Touch panel calibration   [5]
Update files on SD card [6]
Settings archives [7]
Set totalizers values [8]
Analog input calibration [9]

[1] The function to view and copy to USB device the service archive. For more information on the service archive (more in Archive chapter).
[2] Deletes all archived files except settings archive and service archive.
[3] Restarts the device without logging out the current user.
[4] Restore defaults settings clears all previously entered parameters but does not delete the archive files.
[5] Allows to recalibrate touch panel by tapping five appearing points on the screen. Automatically exits the window after completing the calibration procedure.
[6] Function for uploading new the update files to internal memory. Used only when firmware update required.
[7] List of files with previous settings with date and time. Function allows to copy selected settings file to USB memory device.
[8] Function to pre-set or clear selected totalizers, including Non-Erasing, Daily, Weekly and Monthly totalizers.

   NOTE: When tapped Set, new values are updated immediately and do not require device restart. Function available for Service only.

[9] Starts the calibration procedure for analogue inputs IN3 to IN10. Function available for Service only and is not used during normal device use.

11.5 I/O settings

The window allows configuration of analogue measurement inputs IN1... IN10, relay outputs RL1... RL4 and optional analogue outputs OUT1/I, OUT2/I. Digital inputs over RS485 or Ethernet port are configured in Communication window.

Tabs are used for switching between the I/O settings screens and individual inputs.
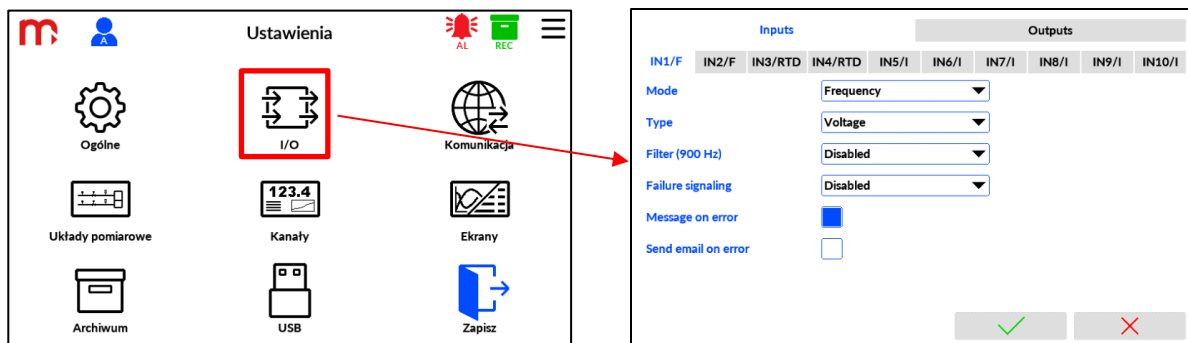
11.5.1 Inputs configuration

The device has 10 measurement inputs. The operating modes of the inputs can be changed only from the control panel of the device. The factory reset device has all inputs disabled.

All planned for use inputs at first should be configured to operate with input sensors or transducers. Enabling the input does not automatically assign it to process value channel. Moreover, other parameters typical for channels have to be configured in Channels settings (e.g. temperature characteristic Pt100 or Pt500).

F (PULS) type inputs – IN1, IN2

Mode: Disabled (Disabled, State, Frequency, Impulse counter) [1]
Type: Voltage (Voltage, OC, E+H, NAMUR) [2]
Filter (300 Hz): Disabled (Disabled, On) [3]
Failure signalling: Disabled (Disabled, RL1, RL2, RL3, RL4) [4]
Message on error: No (No, Yes) [5]
Sand email on error: No (No, Yes) [6]

[1] Depending on the configuration, the inputs can operate in state on-off detection, frequency measurement or pulse counting mode.
[2] Hardware type of transducer connected: with Voltage output, with OC (open-collector or contact) output, E+H (current type) output, NAMUR type output.
[3] For low-frequency signals, in particular signals coming from mechanical contact, it is possible to activate an additional low-pass filter at ca. 100 to 300 Hz cut-off frequency.
[4] Failure information may activate one of output relays RL1 to RL4.
[5] Failure may cause pop-up message on the screen.
[6] Information on failure may be send by e-mail message to defined address.

RTD type inputs – IN3, IN4

Mode: Disabled (Disabled, 2-wire, 3-wire, 4-wire) [1]
Adjustment: [value] Ω [2]
Failure signalling: Disabled (Disabled, RL1, RL2, RL3, RL4) [3]
Message on error: No (No, Yes) [4]
Sand email on error: No (No, Yes) [5]

[1] RTD sensors can be connected in a four-wire/three-wire configuration (with automatic resistance compensation of connection wires) or in a two-wire configuration (without compensation).

[2] Resistance correction allows to manually enter the resistance value of the wires in a two-wire configuration. When the sensor is connected in a three-wire or four-wire configuration, the resistance correction can be used to compensate the sensor error by shifting the characteristic by a positive or negative value of the resistance.

[3] Failure information may activate one of output relays RL1 to RL4.

[4] Failure may cause pop-up message on the screen.

[5] Information on failure may be send by e-mail message to defined address.

I (0/4-20 mA) type inputs – IN5 .. IN10

Mode: Disabled (Disabled, 0-20mA, 4-20mA) [1]
Adjustment: [value] mA [2]
Failure signalling: Disabled (Disabled, RL1, RL2, RL3, RL4) [3]
Message on error: No (No, Yes) [4]
Sand email on error: No (No, Yes) [5]

[1] Inputs can operate in the current loop signal range 0-20 mA or 4-20 mA.
[2] User entered correction (offset) to the measured current value.
[3] Failure signalling: Disabled (Disabled, RL1, RL2, RL3, RL4)[3]
[4] Message on error: No (No, Yes)[4]
[5] Sand email on error: No (No, Yes)[5]

11.5.2 Outputs configuration

The device has four relay outputs as a standard. Optionally one or two analogue outputs may be installed. The device configured in the factory has all outputs disabled.

Relay outputs RL1 .. RL4

Mode: Disabled (Disabled, Normally open, normally closed, Pulsation) [1]

[1] Relay mode selection: Off, Normally open, Normally closed, or Pulsation. Pulsation means, that when relay is activated, then it changes state closed-open with frequency of ca. 1 Hz.

  NOTE: During power-off the relay outputs remain open regardless of the selected Mode.

I (4-20 mA) analogue output

Mode: Disabled (Disabled, 4-20[mA]) [1]
Source: [drop-down list of channels] [2]
Failure value: Disabled (Disabled, Enabled + [value]) [3]

[1] If enabled, the output may output 4-20mA current loop signal.
[2] To the output the channel from the drop-down list have to be assigned. The range 4-20mA should be set as a subrange of the retransmitted channel range by entering values corresponding to 4 mA and 20 mA respectively.
[3] When source value is in error state, the output is set to 3.6 mA.

11.6 Communication settings

There are two independent hardware communication ports, Ethernet (with RJ45 connector) and serial RS485 port (with A and B terminals). Ethernet port supports Modbus TCP (client and server), WWW server and e-mail notification. RS485 supports Modbus RTU slave communication. Tabs for sub windows Ethernet, E-mail, Modbus TCP and RS485 (COM) are used for all communication settings.

When transducers with Modbus TCP are planned for use, it is recommended to configure Communication before Main Application and Channels configuration.
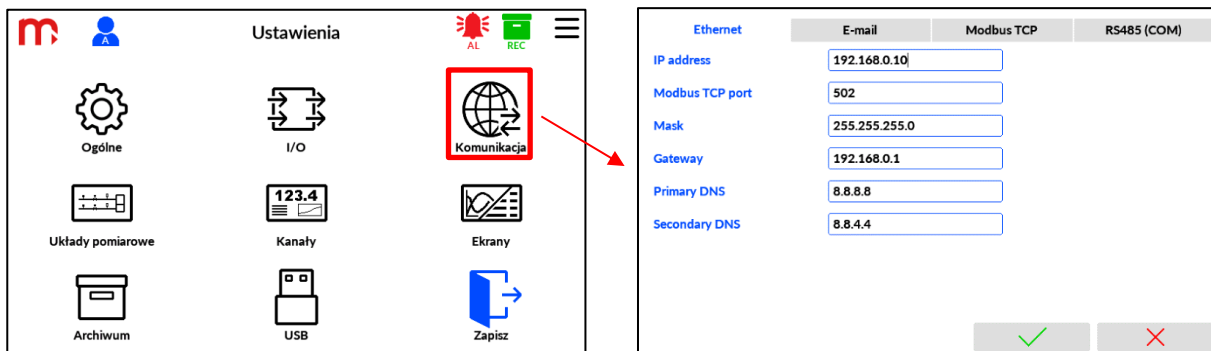
11.6.1 Ethernet
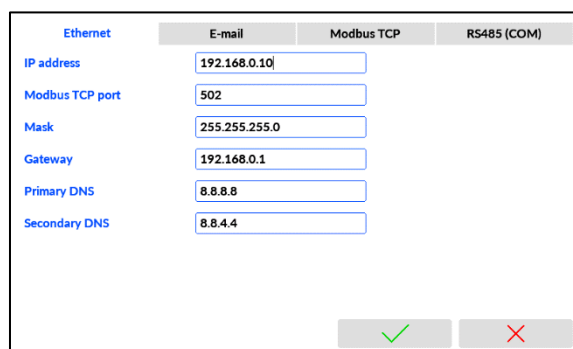
IP Address: [value] [1]
TCP Modbus Port: [value] [2]
Mask: [value] [1]
Gateway: [value] [1]
Primary DNS: [value] [3]
Backup DNS: [value] [3]

[1] The parameters should be set according to the network to which the device is to be connected.
[2] It is recommended to use port 502 as dedicated to Modbus TCP. Port 80 is not allowed – it is reserved for the device's web server.
[3] A DNS address is required when using the E-mail feature. Default DNS server settings: primary address: 8.8.8.8, backup address: 8.8.4.4.

11.6.2   E-mail

The device can send automatic e-mail notifications on alarm statuses and totalizers reports. The process value alarms and set of totalizers for e-mail notification are declared in Channels, for every value individually.

General tab

Email: [value] [1]
Login: [value] [2]
Password: [value] [3]
SMTP server: [value] [4]
SMTP Port: [value] [5]

[1]   The full address of the email account from which the messages will be sent.
[2]   Login used on the mail server to log in to the e-mail account.
[3]   Password used on the mail server to log in to the e-mail account.
[4]   The address of the SMTP server where the e-mail account is created
[5]   The SMTP server port (without SSL) must be verified with your mail provider (typical 587 or 25).

NOTE: The General tab configures the information for the e-mail account from which messages will be sent. The mail account must have the outgoing server (SMTP) enabled. The maximum number of messages sent per day have to be considered and verified with IT service.

Recipients tab

#1   [1st e-mail address] [1]
#2   [2nd e-mail address] [1]

....
#5   [5th e-mail address] [1]

[1] The recipient's full email address to which the messages is to be sent.
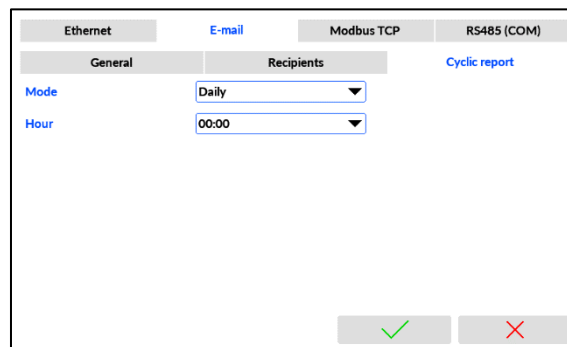
NOTES:
- It is recommended to verify the Connection configuration using the Test Connection button. The message appears on the display and the colour indicates the status:

  green – message sent correctly to specified recipients

  yellow – authorization error (check the entered data in the General tab and in the Recipients tab)

  red   – connection error (check the Ethernet cable, network connection and IP Address, mask and gateway settings in the Ethernet tab)

  The test email contains the model, firmware, serial number, ID number and description of the device. Message subject: FP70, TEST, ID number, device description.

- The Ethernet parameters must be configured, saved and the device restarted first, before triggering the Test Connection. The device must be connected to the network.

Cyclic Report tab

Mode: Disabled (Disabled, Daily, Weekly, Monthly) [1]
Hour: **0** (0:00, .., 23:00) [2]
Day of the week: Sunday (Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, Sunday) [3]
Day of the month: **0** (0, .., 28) [4]

[1] The e-mail messages containing the cyclic report can be sent in the following mode: Daily, Weekly or Monthly.
[2] The message is sent at the specified full time or each time the device is turned on within the specified hour.
[3] A day of the week have to be selected. (Only available in Weekly mode.)
[4] A day of the month have to be selected. (Only available in Monthly mode.)

   NOTE: The e-mail containing the cyclic report will be sent at the specified time and will contain the values and totalizers units at the time the message is sent (values sent in the form of a table).

11.6.3 Modbus TCP (Client)

The device can read up to 40 values from 20 different devices using the Ethernet connection and Modbus TCP protocol. In order to properly read the data, it is necessary to configure the parameters in the Servers tab and in the Registers tab.

Later on read data is assigned to a process value in Channels (channel type: Remote).

General tab
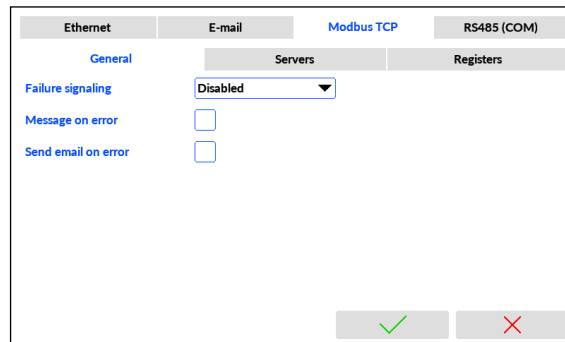
Failure signalling: Disabled (Disabled, RL1, RL2, RL3, RL4) [1]
Message on error: [checkbox] [2]
Send email on error: [checkbox] [3]

[1] Data read failure may activate one of the relays RL1, .. RL4. If the failure ceases, then relay returns to its initial state.
[2] Message on display appears when failure. User acknowledge required.
[3] E-mail notification is send

NOTE: The number of possible e-mails per day should be considered to avoid spam generating. Failure alerts may appear very frequently in some applications.

Servers tab
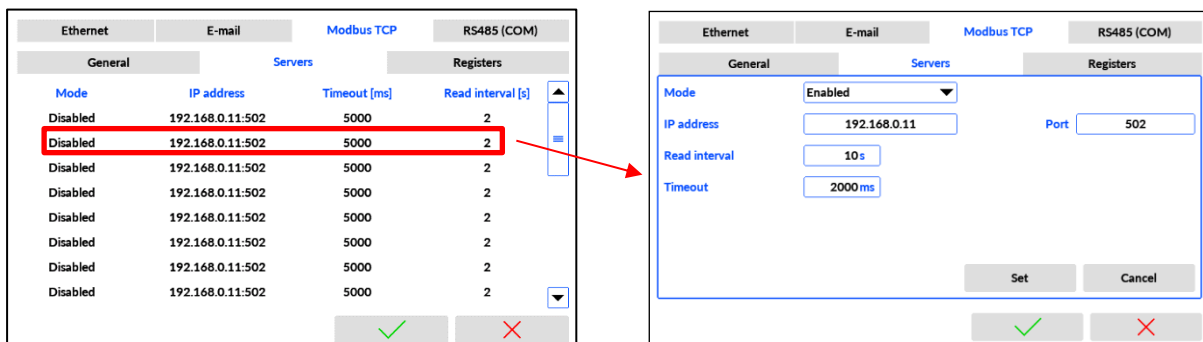
Mode: Disabled (Disabled, Enabled) [1]
IP Address: [IP address value] [2]
Port: [value] [3]

Read Interval: [value] s (1, .., 3600) [4]
Timeout: [value] ms (1000, .., 60000) [5]

[1] Activates the server address. Up to 20 independent servers/connections are possible. If the sensor or device (slave) connected to the server is disconnected, it is recommended to turn off the server to avoid timeout. (The change in the Channels settings and from the Registers tab is not required).
[2] The IP address uniquely identifies the server. The entered data is displayed in the format IP Address: Port, e.g.192.168.2.15:502.
[3] It is recommended to set port 502 as dedicated to Modbus TCP. Port 80 is not allowed – it is reserved for the device's web server.
[4] Time between queries to the specified server.
[5] Timeout for response.

Registers tab

Ethernet	E-mail	Modbus TCP	RS485 (COM)
General		Servers	Registers

#	Server	Device	Register	Type	
1	Disabled	1	300000	uint (16bit)	▲
2	Disabled	1	300000	uint (16bit)	≡
3	Disabled	1	300000	uint (16bit)	
4	Disabled	1	300000	uint (16bit)	
5	Disabled	1	300000	uint (16bit)	
6	Disabled	1	300000	uint (16bit)	
7	Disabled	1	300000	uint (16bit)	
8	Disabled	1	300000	uint (16bit)	▼

#: 1 (1, .., 20) [1]
Server: Disabled (Disabled, select from the list of added servers) [2]
Device: [device address] (1, .., 247) [3]
Address: [address of the register] [4]
Type: uint(16bit) (uint (16bit), int (16bit), uint (32bit), uint (32bit) sw, int (32bit), int (32bit) sw, float (32bit), float (32bit) sw, int (64bit), double (64bit)) [5]

[1] Serial number, number from 1 to 20. If several sensors are connected to a single server, the query to the sensors is sent in the order of the ordinal number.
[2] Select from the list of added servers (configuration in the Servers tab). You can assign a server to the registry in Disabled mode.
[3] Modbus RTU address of the sensor or device (slave device).
[4] Set the registry number of the device from which data will be read. Available format 3xxxx / 3xxxxx or 4xxxx / 4xxxxx, where: 3 – Input register, 4 – Holding register, xxxx / xxxxx – four-digit / five-digit address. The value must be specified in the decimal system. More information in the chapter MODBUS RTU / MODBUS TCP TRANSMISSION PROTOCOL.

NOTE: It is possible to group registers, which speeds up data transmission. If for one device the order of addresses for subsequent registers has been maintained and the value in the Type [5] field has been selected in such a way that the sum of the Address and Type values are consecutive numbers, then during one query you can get a value for several consecutive registers within one communication frame).

[5] Choose from the drop-down list of one of the 10 available formats, where: uint – unsigned integer, int – signed integer, float – single precision floating point, double – double precision floating point, sw – swapped format. For more information, see Data types. Choose a format that matches the specifications of the sensor or device you are reading.

11.6.4   RS485 (COM)

Baund Rate: 19200 (2400, 4800, 9600, 19200, 38400, 57600, 115200) [1]
Parity: NONE (NONE, EVEN, ODD) [2]
Modbus RTU address: [machine address] (1, .., 247) [3]

[1] The transmission baund rate is recommended to set to the highest possible value. In the event of long distances or high levels of interference, it may be necessary to reduce the speed. Low transmission speed increases data transmission time.
[2] Parity control setting.
[3] In the RS485 standard, up to 32 transmitters/receivers can be connected to the data transmission line. Each slave must be assigned a different address.

NOTE: The RS485 port settings of the machine must match those of the master. More information about data types, registers and Modbus addresses in the chapter MODBUS RTU / MODBUS TCP TRANSMISSION PROTOCOL.

11.7 Main Application settings

The Flow computer performs measurements and calculations for two independent measurement applications A and B of the plant installation. Both measuring applications are configured in the window, switching between sub windows using tabs A and B.

(X application with independent auxiliary channels is configured directly in Channels window.)
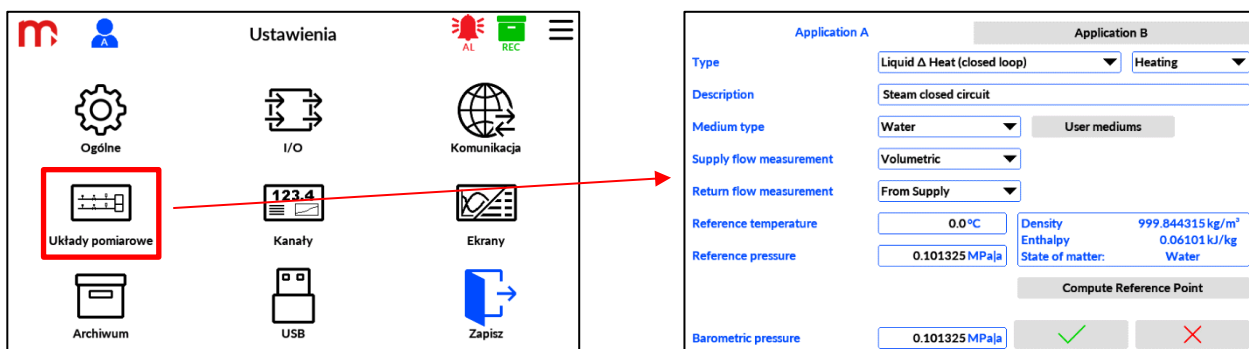
First application type have to be selected. The content of the application settings sub window varies depending on the selected application type. In brand new device or after returning to factory settings, by default, both measuring systems (A and B) are disabled.

11.7.1 Liquid Flow

Type: Liquid Flow (Disabled, Liquid Flow, Liquid Heat, Liquid Δ Heat (closed loop), Liquid Δ Heat, Steam net Heat, Steam-Cond. Δ Heat (closed loop), Steam-Cond. Δ Heat, Steam Generator, Gas Flow, Gas Heat)

Description: [text] [1]

Medium Type: Water (Water, User Medium) [2]

Supply Flow Measurement: Mass (Mass, Volumetric, Orifice) [3]

Barometric pressure [MPa|a]: [value] [4]

[1] User's entered text string for application identification. This description is displayed in the Application Main Screen, in the Application Table and in the drop-down menu. The description can be up to 20 characters long.

[2] For water, density tables are build-in in the device. For other mediums, the density table have to be prepared and downloaded. More details in chapter User Medium.

[3] Type of flow meter. For orifice, an extra information have to be entered. More details in chapter Differential pressure flow meters.

[4] The value of the average atmospheric absolute pressure in the area (default 0.101325 MPa|a).

11.7.2 Liquid Heat

Type: Liquid Heat (Disabled, Liquid Flow, Liquid Heat, Liquid Δ Heat (closed loop), Liquid Δ Heat, Steam net Heat, Steam-Cond. Δ Heat (closed loop), Steam-Cond. Δ Heat, Steam Generator, Gas Flow, Gas Heat)

Description: [text] [1]
Medium Type: Water (Water, User Medium) [2]
Supply Flow Measurement: Mass (Mass, Volumetric, Orifice) [3]
Reference temperature [°C]: [value] [4]
Reference pressure [MPa|a]: [value] [4]
Barometric pressure [MPa|a]: [value] [5]

[1] User's entered text string for application identification. This description is displayed in the Application Main Screen, in the Application Table and in the drop-down menu. The description can be up to 20 characters long.
[2] For water, density and enthalpy tables are build-in in the device. For other mediums, the density and enthalpy (or specific heat) table have to be prepared and downloaded. More details in chapter User Medium.
[3] Type of used flow meter.
For orifice, an extra information have to be entered. More details in chapter Differential pressure flow meters.
[4] Reference temperature and pressure is used to define the enthalpy level above which the liquid heat is calculated. For water, the reference enthalpy is calculated from build-in tables. For other medium it is calculated from user table.
Button Compute Reference Point allows user to verify the value of enthalpy for chosen p and T values. If instead of enthalpy the specific heat is used for calculation, then at reference point the specific heat is displayed. Reference point outside the table range is extrapolated.
[5] The value of the average atmospheric absolute pressure in the area (default 0.101325 MPa|a). This value is used to convert gauge and absolute pressure.

NOTE:
If the application uses User Tables and specific heat, the energy is calculated as a difference between reference point and actual measured point.
If User Table uses specific heat as a function of temperature, then for energy calculation the average value of specific heat at reference point and actual measured point is taken.

11.7.3 Liquid delta Heat (Closed loop)

Type: Liquid Δ Heat (closed loop) (Disabled, Liquid Flow, Liquid Heat, Liquid Δ Heat (closed loop), Liquid Δ Heat, Steam net Heat, Steam-Cond. Δ Heat (closed loop), Steam-Cond. Δ Heat, Steam Generator, Gas Flow, Gas Heat)
Heating (Heating, Cooling) [1]

Description: [text] [2]

Medium Type: Water (Water, User Medium) [3]

Supply Flow Measurement: Mass (Mass, Volumetric, Orifice, From Return) [4]

Return Flow Measurement: Mass (Mass, Volumetric, Orifice, From Supply) [4]

Reference temperature [°C]: [value] [5]

Reference pressure [MPa|a]: [value] [5]

Barometric pressure [MPa|a]: [value] [6]

[1] For liquid delta heat application it is possible to choose between heating or cooling application. The consequence is in power and energy calculation. In heating application it is assumed that the supply pipeline has higher temperature then the return one. In the cooling application, it is the other way around.

[2] User's entered text string for application identification. This description is displayed in the Application Main Screen, in the Application Table and in the drop-down menu. The description can be up to 20 characters long.

[3] For water, density and enthalpy tables are build-in in the device. For other mediums, the density and enthalpy (or specific heat) table have to be prepared and downloaded. More details in chapter User Medium.

[4] In this application only one flow meter is used. The second one is taken into calculation as a mass flowrate, after flow compensation calculations.
For orifice, an extra information have to be entered. More details in chapter Differential pressure flow meters.

[5] Reference temperature and pressure is used to define the enthalpy level above which the liquid heat is calculated. For water, the reference enthalpy is calculated from build-in tables. For other medium it is calculated from user table.
Button Compute Reference Point allows user to verify the value of enthalpy for chosen p and T values. If instead of enthalpy the specific heat is used for calculation, then at reference point the specific heat is displayed. Reference point outside the table range is extrapolated.

[6] The value of the average atmospheric absolute pressure in the area (default 0.101325 MPa|a). This value is used to convert gauge and absolute pressure.

NOTE:

If User Table uses specific heat as a function of temperature, then for energy calculation the average value of specific heat at supply and return is taken. Then only differential power and energy is displayed. When enthalpy is used for calculations, then also power and energy for supply and return is displayed in addition.

11.7.4   Liquid delta Heat

Type: Liquid Δ Heat (Disabled, Liquid Flow, Liquid Heat, Liquid Δ Heat (closed loop), Liquid Δ Heat, Steam net Heat, Steam-Cond. Δ Heat (closed loop), Steam-Cond. Δ Heat, Steam Generator, Gas Flow, Gas Heat)
Heating (Heating, Cooling) [1]
Description: [text] [2]
Medium Type: Water (Water, User Medium) [3]
Supply Flow Measurement: Mass (Mass, Volumetric, Orifice, From Return) [4]
Return Flow Measurement: Mass (Mass, Volumetric, Orifice, From Supply) [4]
Reference temperature [°C]: [value] [5]
Reference pressure [MPa|a]: [value] [5]
Barometric pressure [MPa|a]: [value] [6]

[1] For liquid delta heat application it is possible to choose between heating or cooling application. The consequence is in power and energy calculation. In heating application it is assumed that the supply pipeline has higher temperature then the return one. In the cooling application, it is the other way around.
[2] User's entered text string for application identification. This description is displayed in the Application Main Screen, in the Application Table and in the drop-down menu. The description can be up to 20 characters long.
[3] For water, density and enthalpy tables are build-in in the device. For other mediums, the density and enthalpy (or specific heat) table have to be prepared and downloaded. More details in chapter User Medium.
[4] In this application two flow meters are used, separately for supply and return pipeline.
For orifice, an extra information have to be entered. More details in chapter Differential pressure flow meters.
[5] Reference temperature and pressure is used to define the enthalpy level above which the liquid heat is calculated. For water, the reference enthalpy is calculated from build-in tables. For other medium it is calculated from user table.

Button Compute Reference Point allows user to verify the value of enthalpy for chosen p and T values. If instead of enthalpy the specific heat is used for calculation, then at reference point the specific heat is displayed. Reference point outside the table range is extrapolated.

[6] The value of the average atmospheric absolute pressure in the area (default 0.101325 MPa|a). This value is used to convert gauge and absolute pressure.

NOTE:

If User Table uses specific heat as a function of temperature, then for energy calculation the average value of specific heat at supply and return is taken. Then only differential power and energy is displayed. When enthalpy is used for calculations, then also power and energy for supply and return is displayed in addition.

11.7.5   Steam net Heat

Type: Steam net Heat (Disabled, Liquid Flow, Liquid Heat, Liquid Δ Heat (closed loop), Liquid Δ Heat, Steam net Heat, Steam-Cond. Δ Heat (closed loop), Steam-Cond. Δ Heat, Steam Generator, Gas Flow, Gas Heat)
Description: [text] [1]
Steam Type: Superheated (Saturated p(T), Saturated T(p)) [2]
Steam Dryness [%]: 100 [value] [3]
Supply Flow Measurement: Mass (Mass, Volumetric, Orifice) [4]
Reference temperature [°C]: [value] [5]
Reference pressure [MPa|a]: [value] [5]
Barometric pressure [MPa|a]: [value] [6]

[1] User's entered text string for application identification. This description is displayed in the Application Main Screen, in the Application Table and in the drop-down menu. The description can be up to 20 characters long.
[2] Superheated steam measurement requires both, pressure and temperature measurements. Then build-in steam tables are used to determine density and enthalpy of steam. Saturated steam may use temperature measurement, then pressure is function of temperature p(T) and is calculated form build-in saturation curve. Or it is possible to set pressure measurement and then temperature is function of pressure T(p).
[3] Dryness of steam may be entered for saturated steam. Typically it is in range 80 .. 100%. 100% means completely dry.
This parameter is not applicable and is hidden for superheated steam.
[4] Type of used flow meter.

For orifice, an extra information have to be entered. More details in chapter Differential pressure flow meters.

[5] Reference temperature and pressure is used to define the enthalpy level above which the heat is calculated. The reference enthalpy is calculated from build-in water and steam tables.
Button Compute Reference Point allows user to verify the value of enthalpy for chosen p and T values.

[6] The value of the average atmospheric absolute pressure in the area (default 0.101325 MPa|a). This value is used to convert gauge and absolute pressure.

11.7.6   Steam – Condensate delta Heat (Closed loop)

Type: Steam-Cond. Δ Heat (closed loop) (Disabled, Liquid Flow, Liquid Heat, Liquid Δ Heat (closed loop), Liquid Δ Heat, Steam net Heat, Steam-Cond. Δ Heat (closed loop), Steam-Cond. Δ Heat, Steam Generator, Gas Flow, Gas Heat)
Description: [text] [1]
Steam Type: Superheated (Saturated p(T), Saturated T(p)) [2]
Steam Dryness [%]: 100 [value] [3]
Supply Flow Measurement: Mass (Mass, Volumetric, Orifice, From Return) [4]
Return Flow Measurement: Mass (Mass, Volumetric, Orifice, From Supply) [4]
Reference temperature [°C]: [value] [5]
Reference pressure [MPa|a]: [value] [5]
Barometric pressure [MPa|a]: [value] [6]

[1] User's entered text string for application identification. This description is displayed in the Application Main Screen, in the Application Table and in the drop-down menu. The description can be up to 20 characters long.

[2] Superheated steam measurement requires both, pressure and temperature measurements. Then build-in steam tables are used to determine density and enthalpy of steam. Saturated steam may use temperature measurement, then pressure is function of temperature p(T) and is calculated form build-in saturation curve. Or it is possible to set pressure measurement and then temperature is function of pressure T(p).

[3] Dryness of steam may be entered for saturated steam. Typically it is in range 80 .. 100%. 100% means completely dry.
This parameter is not applicable and is hidden for superheated steam.

[4] In this application only one flow meter is used. The second one is taken into calculation as a mass flowrate, after flow compensation calculations.
For orifice, an extra information have to be entered. More details in chapter Differential pressure flow meters.

[5] Reference temperature and pressure is used to define the enthalpy level above which the heat is calculated. The reference enthalpy is calculated from build-in water and steam tables.
Button Compute Reference Point allows user to verify the value of enthalpy for chosen p and T values.
[6] The value of the average atmospheric absolute pressure in the area (default 0.101325 MPa|a). This value is used to convert gauge and absolute pressure.

NOTE:

For condensate both, temperature and pressure may be measured. If only one of them is measured, typically temperature, then the other one have to be entered as a constant value. In some application both may be entered as constant value. (It is configured in Channels settings.)

11.7.7   Steam – Condensate delta Heat

Type: Steam-Cond. Δ Heat (Disabled, Liquid Flow, Liquid Heat, Liquid Δ Heat (closed loop), Liquid Δ Heat, Steam net Heat, Steam-Cond. Δ Heat (closed loop), Steam-Cond. Δ Heat, Steam Generator, Gas Flow, Gas Heat)
Description: [text] [1]
Steam Type: Superheated (Saturated p(T), Saturated T(p)) [2]
Steam Dryness [%]: 100 [value] [3]
Supply Flow Measurement: Mass (Mass, Volumetric, Orifice) [4]
Return Flow Measurement: Mass (Mass, Volumetric, Orifice) [4]
Reference temperature [°C]: [value] [5]
Reference pressure [MPa|a]: [value] [5]
Barometric pressure [MPa|a]: [value] [6]

[1] User's entered text string for application identification. This description is displayed in the Application Main Screen, in the Application Table and in the drop-down menu. The description can be up to 20 characters long.
[2] Superheated steam measurement requires both, pressure and temperature measurements. Then build-in steam tables are used to determine density and enthalpy of steam. Saturated steam may use temperature measurement, then pressure is function of temperature p(T) and is calculated form build-in saturation curve. Or it is possible to set pressure measurement and then temperature is function of pressure T(p).
[3] Dryness of steam may be entered for saturated steam. Typically it is in range 80 .. 100%. 100% means completely dry.

This parameter is not applicable and is hidden for superheated steam.

[4] In this application two flow meters are used, separately for supply (steam) and return (condensate) pipeline.

For orifice, an extra information have to be entered. More details in chapter Differential pressure flow meters.

[5] Reference temperature and pressure is used to define the enthalpy level above which the heat is calculated. The reference enthalpy is calculated from build-in water and steam tables.

Button Compute Reference Point allows user to verify the value of enthalpy for chosen p and T values.

[6] The value of the average atmospheric absolute pressure in the area (default 0.101325 MPa|a). This value is used to convert gauge and absolute pressure.

NOTE:

For condensate both, temperature and pressure may be measured. If only one of them is measured, typically temperature, then the other one have to be entered as a constant value. In some application both may be entered as constant value. (It is configured in Channels settings.)

11.7.8 Steam generator

Type: Steam Generator (Disabled, Liquid Flow, Liquid Heat, Liquid Δ Heat (closed loop), Liquid Δ Heat, Steam net Heat, Steam-Cond. Δ Heat (closed loop), Steam-Cond. Δ Heat, Steam Generator, Gas Flow, Gas Heat)

Description: [text] [1]

Steam Type: Superheated (Saturated p(T), Saturated T(p)) [2]

Steam Dryness [%]: 100 [value] [3]

Supply Flow Measurement: Mass (Mass, Volumetric, Orifice) [4]

Return Flow Measurement: Mass (Mass, Volumetric, Orifice) [4]

Reference temperature [°C]: [value] [5]

Reference pressure [MPa|a]: [value] [5]

Barometric pressure [MPa|a]: [value] [6]

[1] User's entered text string for application identification. This description is displayed in the Application Main Screen, in the Application Table and in the drop-down menu. The description can be up to 20 characters long.

[2] Superheated steam measurement requires both, pressure and temperature measurements. Then build-in steam tables are used to determine density and enthalpy of steam. Saturated steam may use

temperature measurement, then pressure is function of temperature p(T) and is calculated form build-in saturation curve. Or it is possible to set pressure measurement and then temperature is function of pressure T(p).

[3] Dryness of steam may be entered for saturated steam. Typically it is in range 80 .. 100%. 100% means completely dry.

This parameter is not applicable and is hidden for superheated steam.

[4] In this application one or two flow meters may be used. If one flow meter is used (on supply or return pipeline), then the second flowrate is taken into calculation as a mass flowrate, after flow compensation calculations, from the first one. If two flowmeters are used, then calculations are processed separately for supply (water) and return (steam) pipeline.

For orifice, an extra information have to be entered. More details in chapter Differential pressure flow meters.

[5] Reference temperature and pressure is used to define the enthalpy level above which the heat is calculated. The reference enthalpy is calculated from build-in water and steam tables.

Button Compute Reference Point allows user to verify the value of enthalpy for chosen p and T values.

[6] The value of the average atmospheric absolute pressure in the area (default 0.101325 MPa|a). This value is used to convert gauge and absolute pressure.

NOTE:

For supply water both, temperature and pressure may be measured. If only one of them is measured, typically temperature, then the other one have to be entered as a constant value. In some application both may be entered as constant value. (It is configured in Channels settings.)

11.7.9   Gas Flow

Type: Gas Flow (Disabled, Liquid Flow, Liquid Heat, Liquid Δ Heat (closed loop), Liquid Δ Heat, Steam net Heat, Steam-Cond. Δ Heat (closed loop), Steam-Cond. Δ Heat, Steam Generator, Gas Flow, Gas Heat)

Description: [text] [1]

Medium type: [user tables list] [2]

Supply Flow Measurement: Mass (Mass, Volumetric, Orifice, Normalized vol.)[3]

Density calculation mode: Table / Equation (checkbox) [4]

Z-Factor: [value] [5]

Reference temperature [°C]: [value] [6]

Reference pressure [MPa|a]: [value] [6]

Density [kg/m^3]: [value] [6]

Reference Z-Factor: [value] [6]

Barometric pressure [MPa|a]: [value] [7]

[1] User's entered text string for application identification. This description is displayed in the Application Main Screen, in the Application Table and in the drop-down menu. The description can be up to 20 characters long.

[2] Medium type allows to choose the User Medium table using User Mediums button. The table have to be prepared and downloaded. More details in chapter User Medium.
This parameter is not applicable and is hidden when Density calculation mode is set to Equation.

[3] Type of used flow meter.
For orifice, an extra information have to be entered. More details in chapter Differential pressure flow meters.

[4] Mode set to 'Equation' means that all calculations are processed according to ideal gas equation relative to reference pressure and temperature.
Mode set to 'Table' means that density is get from table and interpolated.

[5] Z-factor is entered as a constant value for the gas at average working conditions of temperature and pressure. It is used in ideal gas equation. If the value is not known, it is best to enter 1.000.

[6] Reference conditions of temperature and pressure. For these values also 'Density' and 'Reference Z-Factor' have to be entered. Normalised flowrate calculations are related to these reference conditions.
If 'Density calculation mode' is set to 'Table', then by tapping the button 'Compute Reference Point' it is possible to calculate density at reference conditions of the gas using data get from the user medium table. But Z-factor for new reference conditions is taken from the table without any recalculations. The button is not available for 'Equation' mode.

[7] The value of the average atmospheric absolute pressure in the area (default 0.101325 MPa|a). This value is used to convert gauge and absolute pressure.

11.7.10 Gas Heat

Type: Gas Flow (Disabled, Liquid Flow, Liquid Heat, Liquid Δ Heat (closed loop), Liquid Δ Heat, Steam net Heat, Steam-Cond. Δ Heat (closed loop), Steam-Cond. Δ Heat, Steam Generator, Gas Flow, Gas Heat)

Description: [text] [1]

Medium type: [user tables list] [2]

Supply Flow Measurement: Mass (Mass, Volumetric, Orifice, Normalized vol.)[3]

Density calculation mode: Table / Equation (checkbox) [4]

Z-Factor: [value] [5]

Reference temperature [°C]: [value] [6]

Reference pressure [MPa|a]: [value] [6]

Density [kg/m^3]: [value] [6]

Reference Z-Factor: [value] [6]

Barometric pressure [MPa|a]: [value] [7]

[1] User's entered text string for application identification. This description is displayed in the Application Main Screen, in the Application Table and in the drop-down menu. The description can be up to 20 characters long.

[2] Medium type allows to choose the User Medium table using User Mediums button. The table have to be prepared and downloaded. More details in chapter User Medium.
For gas heat calculations always medium table have to be used to get enthalpy, specific heat or calorific of the gas.
This parameter is not applicable and is hidden when Density calculation mode is set to Equation.

[3] Type of used flow meter.
For orifice, an extra information have to be entered. More details in chapter Differential pressure flow meters.

[4] Mode set to 'Equation' means that all calculations are processed according to ideal gas equation relative to reference pressure and temperature. Exception are parameters for heat calculations, which are always get from the medium table.
Mode set to 'Table' means that density and heat values are get from the medium table and interpolated.

[5] Z-factor is entered as a constant value for the gas at average working conditions of temperature and pressure. It is used in ideal gas equation. If the value is not known, it is best to enter 1.000.

[6] Reference conditions of temperature and pressure. For these values also 'Density' and 'Reference Z-Factor' have to be entered. Normalised flowrate calculations are related to these reference conditions.
If 'Density calculation mode' is set to 'Table', then by tapping the button 'Compute Reference Point' it is possible to calculate density at reference conditions of the gas using data get from the user

medium table. But Z-factor for new reference conditions is taken from the table without any recalculations. The button is not available for 'Equation' mode.

[7] The value of the average atmospheric absolute pressure in the area (default 0.101325 MPa|a). This value is used to convert gauge and absolute pressure.

11.7.11 Mass flowmeters

To measure the mass flowrate typical mass flow meter may be configured with analogue 0/4-20 mA current loop output or with frequency output. Mass flowrate may be read as a Modbus TCP data from flow meter or another device. Flowrate may also be taken from another channel (e.g. auxiliary X.01) or as a math formula (e.g. sum of two other flowrates). Math formula may be applied to another channel value and result used as mass flowrate (e.g. square root of X.01).

Detailed configuration is entered in Channels settings. No extra settings are required in Main Application settings.

11.7.12 Volumetric flowmeters

To measure the volumetric flowrate typical volumetric flow meter may be configured with analogue 0/4-20 mA current loop output or with frequency output. Mass flowrate may be read as a Modbus TCP data from flow meter or another device. Flowrate may also be taken from another channel (e.g. auxiliary X.01) or as a math formula (e.g. sum of two other flowrates). Math formula may be applied to another channel value and result used as mass flowrate (e.g. square root of X.01).

Detailed configuration is entered in Channels settings. No extra settings are required in Main Application settings.

11.7.13 Differential pressure flowmeters

For differential pressure flowmeter some extra parameters have to be entered. The set of parameters depend on type of dp pressure device. When 'Orifice' flow meter is chosen in Main Application menu, then on the right side a button 'Set Orifice' appears. Tapping it a new sub window is opened with required settings to be entered.

First the type of orifice device have to be chosen:
- Square root approximation
- Flange tappings (EN ISO 5167)
- D-D/2 pressure tappings (EN ISO 5167)
- Corner tappings (EN ISO 5167)
- ISA1932 nozzle (EN ISO 5167)
- Long radius nozzle (EN ISO 5167)
- Venturi nozzle (EN ISO 5167)
- Venturi tube – cast (EN ISO 5167)
- Venturi tube – machined (EN ISO 5167)
- Venturi tube – rough welded sheet-iron (EN ISO 5167)
- Micro orifice for corner tap configuration (ASME MFC-14M)
- Micro orifice for flange tap configuration (ASME MFC-14M)
- ILVA, Gilflo B, Gilflo SPOOL (Spirax Sarco Ltd.)

The Square Root Approximation requires only three parameters to be entered as nominal values (working point or close to working point of orifice): Δp_0, ρ_0, q_{m0} and X

Δp0 – is nominal value of differential pressure for orifice.

ρ0 – is nominal density of gas or liquid. It have to be calculated or may be obtained main application screen at reference values of pressure and/or temperature.

qm0 – is mass flowrate at Δp0 and ρ0

User correction – user arbitrary flow correction factor. In most applications is set to 1.000.

The main screen Reference Point calculator may be used to calculate the density required for orifice ρ0 nominal density, but after that it must return back to reference point values. The reference point is required for other calculations, and should not be not confused with the nominal parameters for orifice.

For other medium than steam or water, the density is taken from User Medium table.

The square root approximation calculates mass flowrate corrected to pressure and/or temperature at working conditions.

The square root approximation is not as accurate as other differential pressure measurements.

The dp flow meters according to EN ISO 5167 or ASME MFC-14M require entering pipeline and orifice parameters: D0, d0, αD, αd and X

D0 – internal pipeline diameter
d0 – orifice bore diameter
αD – thermal expansion coefficient of the pipeline material
αd - thermal expansion coefficient of the orifice material
User correction – user arbitrary flow correction factor. In most applications is set to 1.000.

All additional required parameters for steam and water are build-in in the device. For other mediums the dynamic viscosity of the fluid is taken from User Medium table.

Limitations:
- According to the norms, all orifice type devices have limit for minimum and maximum D and d values, as well as for ratio d/D. For some very special applications that limits are not implemented in device. It is strongly recommended to enter orifice parameters based on orifice project documentation prepared by flowmeter designer, where all parameters, limits and accuracy considerations are taken into account.
- For other fluids than steam and water the dynamic viscosity is used as a constant value and should be entered as an average value close to working conditions of pressure and temperature. (For some fluids dynamic viscosity may strongly depend on temperature.)
- For technical gases isentropic exponent is assumed constant and equal to 1.3. This value variation have minor influence on accuracy of typical industrial applications.

The ILVA / GILFLO flow meters require entering water calibration table delivered by flowmeter manufacturer and choosing the flowmeter size.

The calibration table may also be imported as a .csv type file.
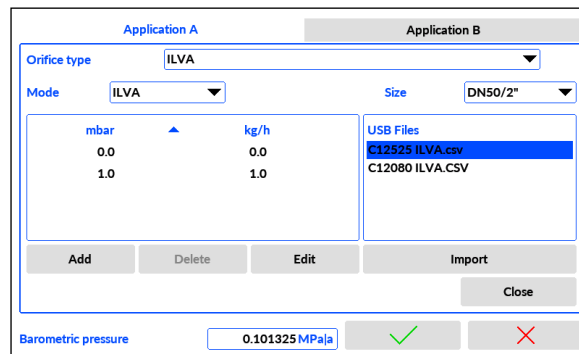
More details on preparing the table in chapter Ilva / Gilflo calibration table.

11.8 Channels settings
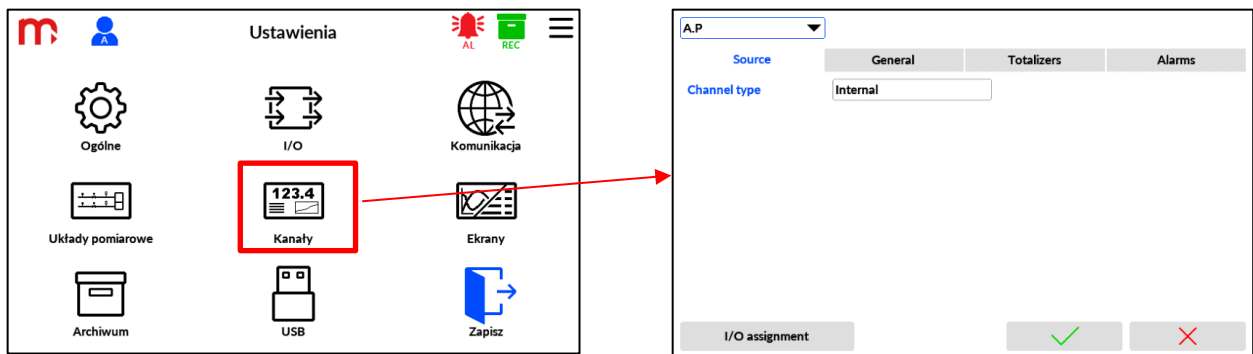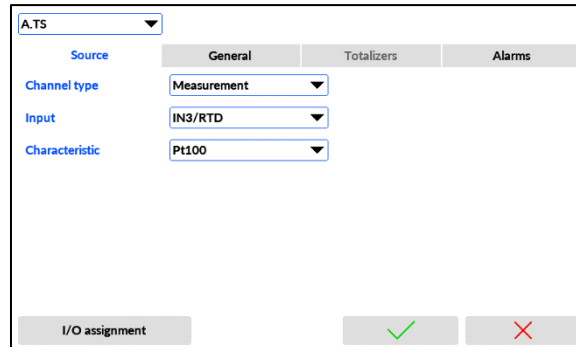
In the *Channels* settings window all process values parameters like units, resolution, alarms, related totalizers, measuring inputs assignments, etc., are configured.
All possible channels are listed in drop down menu.
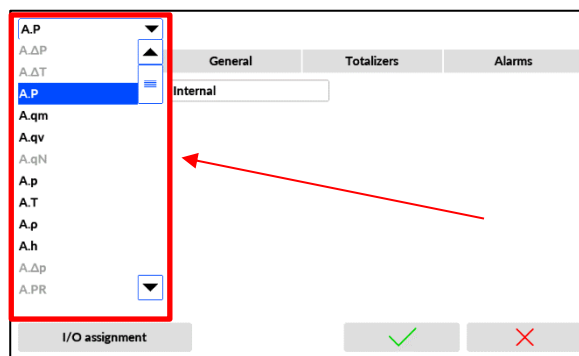
Not available channels for chosen application are dimmed automatically and are not accessed for configuration. Available channels are activated during *Main Applications* configuration process. Channels for auxiliary application X are always available. All parameters are grouped and configured in sub windows and are accessed by tapping *Source, General, Totalizers* and *Alarms* tabs. As a help during configuration process, I/O assignment may be verified by tapping *I/O assignment* button.

11.8.1 Input data source

Source: Disabled (Disabled, Internal, Measurement, Constant, Remote, Computed) [1]
Input: IN1/F (IN1/F, IN2/F, IN3/RTD, IN4/RTD, IN5/I, IN6/I, IN7/I, IN8/I, IN9/I, IN10/I) [2]
Value: [value] [3]
Register: 1. (1., .., 40.) [4]
Formula: [entered math formula] [5]
Characteristic: Linear (Linear, User, 1:1, depending on the type of input) [6]
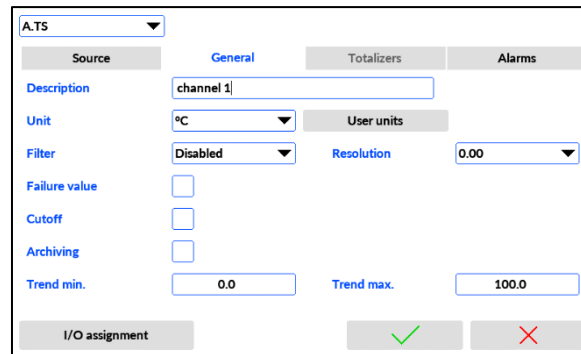
[1] Selecting the source of the channel value. The selection activates other settings displayed in this tab. Channels from application A and B are defined automatically and cannot be disabled. Some channels are result of application calculation and are marked *Internal*. Others may be defined as *Measurement*, *Constant*, *Remote* or *Computed*. *Measurement* means that the source is one of device inputs IN1 to IN10. *Constant* mean that the entered constant value is taken for calculations. It is used intentionally for the application or temporary e.g. when sensor is damaged or for test purpose. *Remote* means read via Modbus TCP. *Computed* means that the value is calculated based on a user-entered math formula, specifically one taken as a result from another channel.
[2] One of device inputs IN1 to IN10 can be selected and assigned.
[3] Value entered for *Constant* source.
[4] Selecting one of defined Modbus TCP registers. (Configured earlier in *Communication* settings menu.)
[5] Allows to enter user math formula. (More in chapter Computed channels.)
[6] For analogue inputs IN3 to IN10, *Remote* and *Computed* the user-defined linearization characteristic may be entered. (More in chapter User characteristics.)

11.8.2 General

Description: [text] [1]
Unit: GW (list of available units, option to add a user unit) [2]
Filter: Off (Off, 2 s, 5 s, 10 s, 20 s, 30 s, 1 min, 2 min, 3 min, 5 min)[3]
Resolution: 0.00 (0, 0.0, 0.00, 0.000, 0.0000) [4]
Failover value: Off (Off, On) [5]
Cut-off: Off (Off, On) [6]
 Cut-off level: [value] [6]
Archiving: Off (Off, On) [7]
Trend min: [value] [8]
Trend max: [value] [8]

[1] User's entered text for application identification, max 20 character. This description is displayed in the Single Result Window, in User Tables, in User Trends and is saved in archival files.
[2] For channels from application A and B, available list of units is determined by the process value. For channels in the X, there is available full list of units. In special cases, it is possible to define new user unit, using button *User unit*. (More in chapter User Unit.)
[3] For all measuring channels it is possible to set a low pass filter. It allows to "smooth" sudden jumps of the measured value or eliminate background measurement noise. Too high value may distort the shape of real changes of result.
[4] The resolution determines the number of decimal places in the displayed result. Setting the resolution too high is inexpedient.
[5] For all input channels a failure value may be activated. The failure value is a fixed value displayed instead of the measurement result, in the event of an input signal failure or when the calculation result is out of range.
[6] Enabling the cut-off function forces value 0 if the channel value measured or calculated is less than the entered level.
[7] Enables or disables archiving of a given channel. Enabling is equivalent to adding a channel to archiving.
[8] Sets the range of the displayed scale on the trend chart in the Single Result Window. If the chart is not set correctly, the trend line may not be visible (be out of scale).

11.8.3 Totalizers

Type: Disabled (Disabled, Non-resettable, Resettable, Daily, Weekly, Monthly) [1]
Unit: GWh (list of available units, option to add a user unit) [2]
Resolution: 0.00 (0, 0.0, 0.00, 0.000, 0.0000) [3]
Archiving: Off (Off, On) [4]
Email: Off (Off, On) [5]

[1] Each of two totalizers can be set in one of six modes: Disabled (no totalizer), Non resettable (user is not able to reset the totalizer), Resettable (user can reset totalizer on request at any time), Daily (reset automatically at midnight), Weekly (reset automatically at midnight from Sunday to Monday), Monthly (reset automatically at midnight during the month change).
[2] For channels from application A and B, available list of units is determined by the process value. For channels in the X, there is available full list of units. In special cases, it is possible to define new user unit, using button *User unit*. (More in chapter User Unit.)
[3] The resolution determines the number of decimal places in the displayed result. It can be changed at any time without affecting the meter status.
[4] Enables/disables totalizer archiving. Enabling is equivalent to adding the totalizer to archiving.
[5] Add the totalizer to the list for the cyclic e-mail report (More information in chapter E-mail).

11.8.4 Alarms

Type: Disabled (disabled, Bottom, Upper) [1]
Mode: Alarm (Alarm, Control) [2]
Level: [value] [3]
Hysteresis: [value] [4]
Color: Off (Disabled, Green, Orange, Red) [5]
Output: Off (Disabled, RL1, RL2, RL3, RL4) [6]
Log event: Off (Off, On) [7]
Change the frequency of archiving: Off (Off, On) [8]

Email: Off (Off, On) [9]

[1] The alarm type can be set to Upper (active above the level value) or Lower (active below the level value)).

[2] The mode 'Alarm' (latched type) when activated display alert, pulsing alarm pictogram 🔔 and beeper signal. Alert is active even the source of alarm returned to normal value. It requires acknowledge by the user on the front panel. (Beeper signal may be activated or deactivated in General settings.) The mode 'Control' (non-latched type) is active as long as the alarm level is exceeded. There is no extra alert on the display. But the status may be checked in the 'Alarm status' screen, by tapping the pictogram 🔔 .

[3] The value of the alarm threshold level is entered in units of measured process value for the channel. (The level is displayed as a horizontal dotted line in the single channel result window, in the trend chart box.)

[4] The hysteresis value is the difference between the level of threshold crossing and return. The value is entered in units of measured process value for the channel.

[5] The process value digits may change colour when alarm is active. There are three alarm colours: Green, Orange, and Red. The alarm colour is also visible on the chart in single result window.

[6] One of four relays may be assigned to alarm action. The same relay may be activated by more channels. (The relay operation is configured in Outputs configuration screen.)

[7] Alarm events may be logged in the Event File when declared.

[8] There are two speeds of archiving data available. Activated alarm may switch Main Alarm Interval from level I to level II.

[9] Alarms may cause sending an e-mail message. (More information how in chapter E-mail).

NOTE: The number of possible e-mails per day should be considered to avoid spam generating. Alarm alerts may appear very frequently in some applications.

11.9 Archive settings

Archive type: Daily (Daily, Weekly, Monthly) [1]
Main archive interval [2]
    I: 2 s (1 s, 2 s, 5 s, 10 s, 15 s, 30 s, 1 min, 5 min, 10 min, 15 min, 30 min, 1 h, 2 h, 4 h, 12 h) [2]
    II: 2 s (1 s, 2 s, 5 s, 10 s, 15 s, 30 s, 1 min, 5 min, 10 min, 15 min, 30 min, 1 h, 2 h, 4 h, 12 h) [2]
Totalizers archive interval: 1 min (1 min, 5 min, 10 min, 15 min, 30 min, 1 h, 2 h, 4 h, 12 h, 24h) [3]

[1] Archive files are created in Daily (a new archive files package created at midnight), Weekly (a new archive files package created at midnight from Sunday to Monday) or Monthly (a new archive files

package created at midnight between the last day of the month and the first day of the following month).

[2] For the Main archive there are two recording frequencies controlled by channel alarms: I and II.

[3] For totalizers there is one recording frequency.

Note:

The frequency of recording to the archive should be properly selected for the measurement process. Recording too often results in the accumulation of a large number of data, which makes it difficult to analyse. On the other hand, too rare recording may result in the loss of rapid changes in measured processes.

At the bottom half of the screen there are tabs A, B and X with information which channels are declared for archiving. The selecting is set in Channels.

Each rectangle contains three bars corresponding to archiving: the process value - the top bar, the first totalizer - middle bar and the second counter - bottom bar. Declared for archiving value is marked in green.

Channels not active are shadowed.

11.10 Screen settings

The configuration of user screens is highly recommended to facilitate the process values presentation in form of User tables and/or User trends. It is possible to put in one screen values mixed from A, B and X application. It is possible to create up to six tables of sixteen values each and up to six trend screens of six process values each. Each screen may have its own description for clarity of data presentation.

11.10.1 User tables
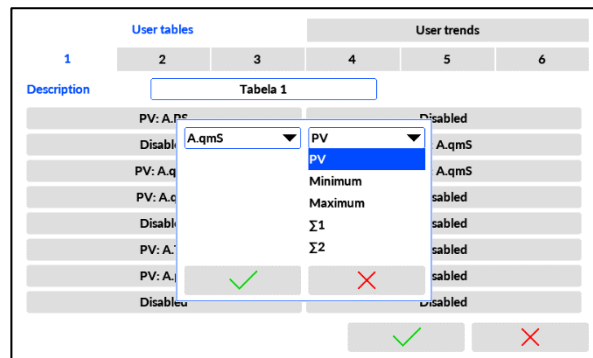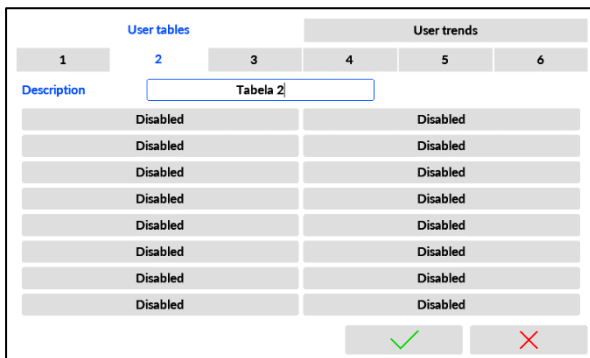
Tabs: 1 (1, 2, 3, 4, 5, 6) [1]
Description: [text] [2]
Table cell: Disabled (Disabled, channel symbol and value selection: PV, MIN, MAX, Σ1, Σ2) [3]

[1] Selects the table that to be modified.
[2] Each table screen can be given unique name up to 20 characters long.
[3] The window contains a pattern of a 16-element table (2x8 layout). Empty cells are marked with Disabled. One can change the displayed values by tapping table cell. The editing window contains two drop-down selection lists: to select a channel and the type of presented value: PV – process value, MIN – minimum value, MAX – maximum value, Σ1 – totalizer 1 and Σ2 – totalizer 2. (In the device, the minimum value is also marked as ▼, and maximum as: ▲.)

NOTE: If all cells are disabled, the table will not be available in the User Tables screen.

11.10.2 User trends
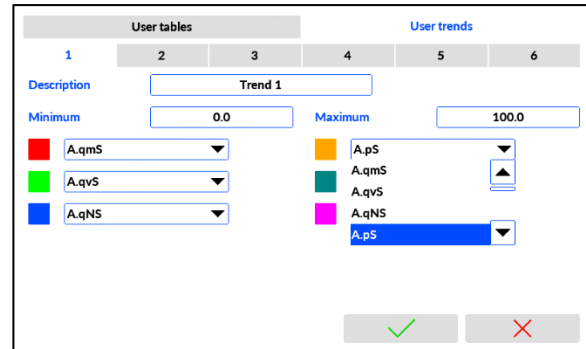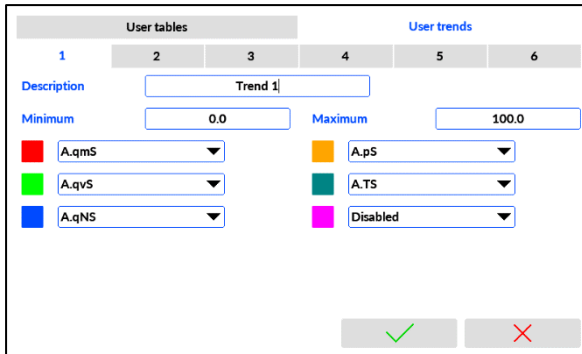
Tab: 1 (1, 2, 3, 4, 5, 6) [1]
Description: [text] [2]
Minimum: [value] [3]
Maximum: [value] [3]
Chart element: Disabled (Disabled, channel symbol selection) [4]

[1] Selects the trend screen to be modify.
[2] Each trend screen can be given a unique name up to 20 characters long.
[3] Sets the range of the displayed chart scale. All process values in one chart are displayed in the same scale. Each trend screen may have different scale. The time scale is fixed.
[4] For each trend screens it is possible to program up to 6 trend lines and assign process value from drop-down list. Trend line colours are fixed.

NOTE: If all trend lines are disabled, the trend screen will not be displayed in the User Trains screen.

11.11 USB screen, write and read settings file

Only a flash drive in FAT format can be connected to the device (according to the chapter Write and read files via USB). For the Administrator logged-in, it is possible to save and upload the settings to/from a USB flesh drive. The settings file have to be prepared in PC computer using dedicated software. It is also possible copy settings from another device.
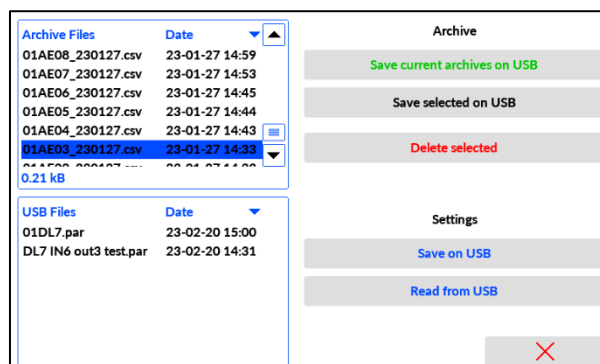
After uploading the new settings file from the external USB flash drive, the device will automatically restart with the new settings.

NOTE:

Removing the flash drive before completing the read/write procedure may damage the copied files.

It is recommended to make a copy of the settings file on a flash drive each time after updating the settings. If any parameters has been changed, the settings have to be saved first before making the backup copy.

11.12 Restore Factory settings

Factory settings may be restored for Administrator logged-in in the Service tab in the General Settings window. The device will automatically restart with the factory settings in the language used previously. Archive files will not be deleted. The Administrator password will not be changed. The User's password will be reset to the default.

Note:

Before restoring the device to factory settings, it is recommended to save the settings to a USB flash drive, otherwise they will be lost.

11.13 LOCK1, LOCK2 switches and BL service button.

LOCK1 switch deactivates remote configuration. (Available in future firmware version)

LOCK2 switch deactivates configuration and all ADMIN functions from the front panel or via USB port, even when ADMIN password was entered. Both switches work as a hardware protection against access to the settings change of the device. At the same time, all USER operations are available.

BL (bootloader) button is used in order to upload new firmware via USB. It is service function only.

12   EXTRA FEATURES

12.1 Computed channels

Auxiliary channels from application X and measuring channels from applications A and B may be configured to process computations according to entered mathematical formula. The formula may contain other channels results or constant values and perform selected mathematical operations: addition, subtraction, division, multiplication, raising to 2, 3 or any power and root. It is also possible to use totalizers results in the formula. The formula is entered as a text string and can be up to 200 characters long.

The formula can be entered when channel type is selected as *Computed* and by tapping the formula field.
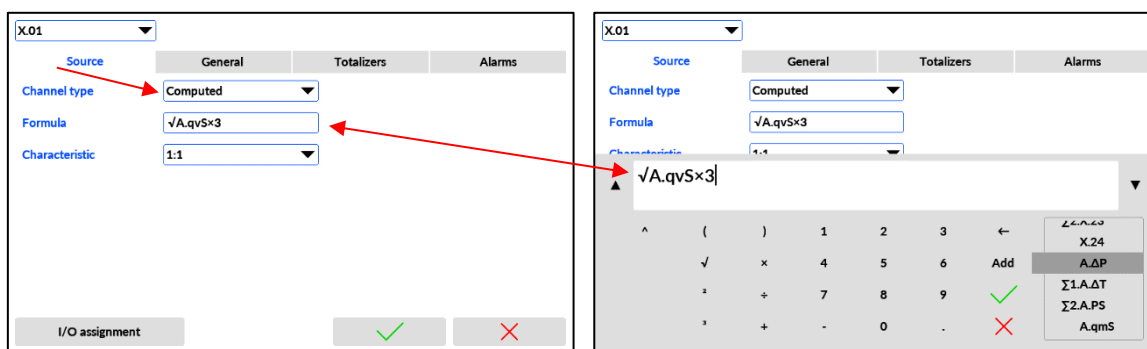
The device performs calculations according to the order in which the actions are performed (operations in parentheses, exponentiation, root, division, multiplication, addition, subtraction). Below there are examples explaining the idea of building the formulas in the device.

The use of process values or totalizers from different applications.
The use of totalizers in formulas require careful prediction of possible maximum values. The calculation result is a process value and has smaller maximum number then totalizers.
Example:

A.qm+B.qm   sums up the mass flow rates from application A and B
∑1.A.qm +∑1.B.qm   sums up two totalizers

In the case of root, only the first number entered after the √ sign is calculated. If the root is to be calculated from the value of several channels, the brackets have to be used.
Example:

√123   calculates the square root of constant value 123
√A.qv   calculates the square root of the flow rate A.qv
√Aq.v+10   calculates the square root of the flow rate A.qv and adds 10
√(A.qv+B.qv)   calculates the root of the sum of the two flowrates

By analogy, in the case of exponentiation (available the second or third power), only the first value entered before the exponent is taken into power calculation.

Example:

123^2	raises 123 to the power of 2
$A.P^2$	raises the process value A.P to the power of 2
$A.P+B.P^2$	raises the value of the B.P to the power of 2 and adds A.P
$(A.P+B.P)^2$	raises the sum of A.P and B.P to the power of 2

The device allows to raise a number to any power (^ symbol). In the case of an exponent that is not an integer, the basis must be positive.

Example:

$123^{\wedge}4$	raises 123 to the power of 4	
$123^{\wedge}(-4)$	raises 123 to the power of -4	
$123^{\wedge}4^{\wedge}3$	means	$123^{4\cdot3}$
$123^{\wedge}(4^{\wedge}3)$	means	$123^{4^3} = 123^{64}$
$A.T^{\wedge}(1\div3)$	raises to power $\frac{1}{3}$ channel value 1	
$A.T^{\wedge}(B.T)$	raises process value A.T to the power of the process value B.T	
$A.T+B.T^{\wedge}(1\div3)$	raises process value B.T to the power of $\frac{1}{3}$ and adds A.T	
$(A.T+B.T)^{\wedge}(1\div3)$	raises sum of A.T and B.T to the power $\frac{1}{3}$	

12.2 User characteristics

The user characteristic may be entered and applied to every channel except channels calculated by the flow algorithm (like e.g. compensated mass flow of steam). The characteristic may be entered in settings in the device from LCD touch panel or imported from .csv type file to FP70_Config software and uploaded to the device via USB memory flash drive (pen drive).

The characteristics of the user are given in the form of pairs of points: the value of measured resistance, current, voltage, etc. (x-value) and the value displayed in the engineering units (y value). The user may add (*Add point*), delete (*Delete point*) and edit (*Edit value*) characteristic points, with the maximum 100 points. The user has the ability to add up to 10 own characteristics.

To add a new characteristic, in the *Channels* settings window, *User* from the drop-down list in the characteristics field have to be selected. To edit existing or set new characteristic the button *Edit* have to be tapped to open characteristic table window. The own name also may be assigned for convenience.
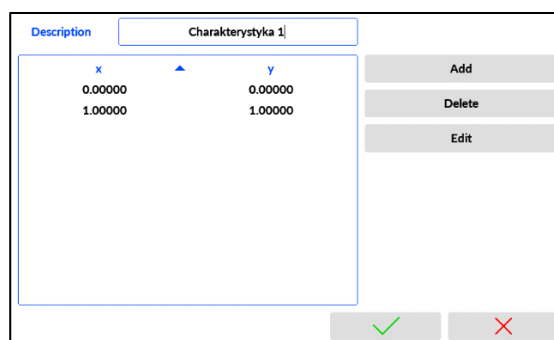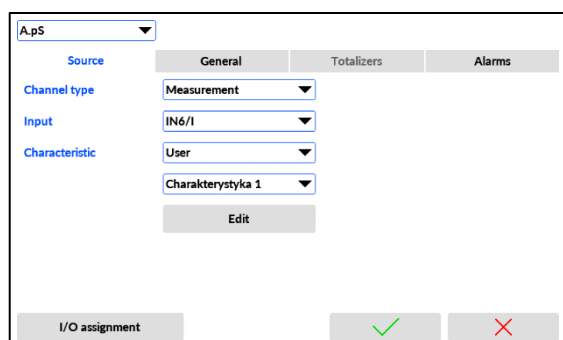
New points may be added in any order (*Add Point*) because they are automatically sorted against the measured value x. To delete a point, the value have to be selected (clicked), and then *Delete Point* tapped. To edit a point, the value have to be selected (clicked), and then *Edit Value* tapped.

Two identical measured values x may not be entered. The data entered in this way will be treated as incorrect and when attempting to save it will be marked in red as items to be corrected.

12.3 User Unit

The device has defined list of engineering units available by default for process values. In some cases, it may be required to add and define own units. To get in to unit edit window the button *User units* in tab *General* for *Channels* have to be tapped. Up to 30 user units may be added.
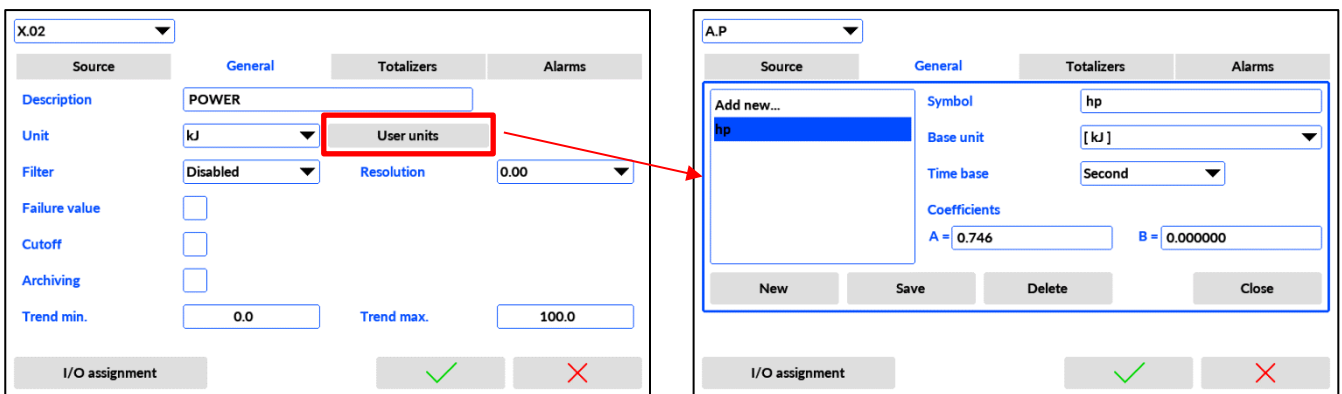
There are four parameters to be defined:

Symbol: [text] [1]
Base unit: No type (No type, kJ, °C, kg, m³, kg/m³, kJ/kg, kJ/kg*K, MPa|g, MPa) [2]
Time base: None (None, Second, Minute, Hour) [3]
Coefficients A= [value] B= [value] [4]

[1] Unit abbreviation, maximum 11 characters long
[2] Base unit is one of devices basic units to which the new unit refers to.
[3] Time coefficient for the unit
[4] Linear function coefficients (y=A*x+B) for new unit calculation from the base unit.

Below there are three examples of units, each has different usage in the measurement and is defined slightly in different way.

Example 1. Length or level, e.g. level in tank of water measured in [cm]

In this example the unit is only text information for the measured process value. Its abbreviation 'cm' is entered in *Symbol* field. *Base unit* is set to *No type* and *Time base* is set to *None. Coefficients A* and *B* are ignored.

Example 2. Flow rate and flow, e.g. fuel supply for boiler house in UK gallons per minute unit

In this example two units have to be defined, one for flow rate [gallons per minute, gpm(UK)], and another one for flow [gallons, g(UK)]. For flow rate *Base unit* is referred to m^3 and *Time base* is set to *Minutes*. Coefficient A refers to ratio 1 g(UK) = 0,004546 m^3. For flow *Time base* is set to *None*, and other parameters are the same. Unit [gpm(UK)] is used for process flow rate, and [g(UK)] for flow totalizer.

Example 3. Steam power in not typical unit horse power (hp)

In this example power is calculated in steam application and is not directly measured but is result of calculations based on e.g. temperature, pressure and differential pressure measurements.

Horse Power abbreviation 'hp' is entered in *Symbol* field. For power, *Base unit* is referred to kJ and *Time base* is set to *Seconds*. (One kJ per second means one kW.) Coefficient A refers to ratio 1 kW = 0,746 hp.

12.4 User Medium

The converter can also support installations with any other medium. For this purpose, the density and enthalpy tables of the medium shall be entered into the instrument as a function of temperature, temperature and pressure or for the gases temperature, pressure and viscosity in the form of a file. The file with information about the medium should be prepared on a computer in a text editor or spreadsheet with a .csv extension.

More information will be available in future edition of document.

12.5 In-Line Variable Area flowmeter calibration table

The use of a In-Line Variable Area flowmeter requires entering calibration table. The calibration documentation is delivered together with every flowmeter.

POINT	CUSTOMER D.P. OUTPUT	D.P.	% D.P.	WATER MASS FLOW AT 20°C	WATER VOL. FLOW AT 20°C	% FLOW
	mA	mbar		kg/h	l/min	
1	4.020	0.620	0.12	116.13	1.94	1.21
2	4.549	17.093	3.43	254.74	4.25	2.66
3	4.963	29.988	6.02	444.95	7.43	4.65
4	5.385	43.135	8.66	616.34	10.29	6.44
5	5.902	59.225	11.89	892.29	14.90	9.32
6	7.480	108.342	21.75	1,757.33	29.34	18.36
7	8.838	150.630	30.24	2,647.96	44.21	27.66
8	10.338	197.331	39.61	3,568.01	59.57	37.27
9	11.740	240.980	48.37	4,471.55	74.66	46.71
10	13.079	282.678	56.74	5,213.83	87.05	54.46
11	14.455	325.523	65.34	6,103.40	101.91	63.75
12	16.040	374.886	75.25	7,113.07	118.76	74.30
13	17.542	421.641	84.64	8,046.73	134.35	84.05
14	19.700	488.820	98.12	9,387.31	156.74	98.05

Example of calibration documentation

FP70W, FP70P

The calibration table consists of the differential pressure and the mass flow values of the water equivalent. The calibration table is supplied in two versions, in metric and imperial units. Only metric tables ([mbar] / [kg/h]) can be used in the FP70, even when process values are set to imperial units.

The calibration table have to be entered by hand in the edit window or may be uploaded via USB port from memory stick as a .csv type file with dot as a decimal point and coma as a separator between numbers.

```
mbar,kg/h
0,0
0.620,116.13
17.093,254.74
29.988,444.95
43.135,616.34
59.225,892.29
108.342,1757.33
150.630,2647.96
197.331,3568.01
240.980,4471.55
282.678,5213.83
325.523,6103.40
374.886,7113.07
421.641,8046.73
488.820,9387.31
498.18,9608.89
```

Example calibration table in .csv format

The information and order inside the file is critical. The first line must specify the units. The last line is the maximum flow rate value for 498.18 mbar. This value is specified in documentation as the corrected water flow (typically in [l/min] and have to be recalculated to [kg/h] units in respect to water density).

CALIBRATION CONDITIONS

Orientation	: Horizontal
Fluid	: WATER
Reference density at 20°C (68°F)	: 998.2 kg/m3 (62.31 lb/ft3)
Flow range	: 0 to 159.85 l/min (0 to 5.65 ft3/min)
Corrected water flow at 498.18 mbar**	: 159.86 l/min at 20°C (5.65 ft3/min at 68°F)
DP transmitter ranged 4-20 mA	: 0 to 498.18 mbar (200 inches water gauge)

Example of calibration documentation

Typical suggested by manufacturer differential pressure transmitter range is 0 to 498.18 mbar. (The FP70 device can accept dp transmitter in other range, as well.) If the pressure rises above the maximum value in the table, the flow rate value is extrapolated.
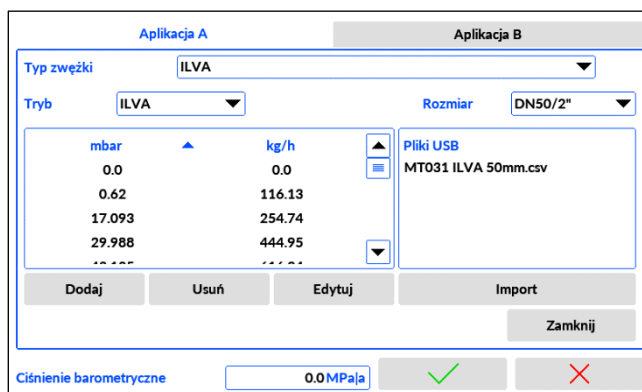
FP70 dialog window for entering or uploading calibration table

The entered calibration table may be used to calculate process values in steam or water applications.

13 MODBUS RTU / MODBUS TCP TRANSMISSION PROTOCOL

13.1 Basic information

Process values and counters are available as holding registers and input registers. It is only possible to read the registers.

13.1.1 Data types

uint/int 16bit	Reg (Bit 15...0)	
	HByte	LByte
	2.	1.

uint/int/float 32bit	Reg_L (Bit 15...0)		Reg_H (Bit 31...16)	
	HByte	LByte	HByte	LByte
	2.	1.	4.	3.

uint/int/float 32bit sw	Reg_H (Bit 31...16)		Reg_L (Bit 15...0)	
	HByte	LByte	HByte	LByte
	4.	3.	2.	1.

int/double 64bit	Reg_L (Bit 15...0)		Reg_H (Bit 31...16)		Reg_L (Bit 47...32)		Reg_H (Bit 63...48)	
	HByte	LByte	HByte	LByte	HByte	LByte	HByte	LByte
	2.	1.	4.	3.	6.	5.	8.	7.

13.2 Addresses of registers

Current results are available in an IEEE-754 standard floating point format for a 32-bit floating point single (32-bit floating point single). Float 32bit values occupy two registers.

The counters are available in an IEEE-754 compliant floating point format for a 64-bit floating point double. Values in double 64bit format occupy 4 registers.

The register address table contains a map of Modbus addresses for all channels in the device. Regardless of the layout selected and the configured meters or additional channels, the address space of the device is fixed and according to the table below.

When reading data from the device, the correct data format, the starting address and the number of logs to be read should be indicated. For example, for the current supply temperature value in system A, i.e. the present value of the A.TS channel, the correct reading settings are:
- Data format: *float 32 bit*,
- Start address: *14*,
- Size in registers: *2*.

	Channel symbol	Current values	Totalizer 1	Totalizer 2
		(float 32bit)	(double 64bit)	(double 64bit)
UKłAD A	A.ΔP	0 .. 1	128 .. 131	384 .. 387
	A.ΔT	2 .. 3	132 .. 135	388 .. 391
	A.P / A.PS	4 .. 5	136 .. 139	392 .. 395
	A.qm / A.qmS	6 .. 7	140 .. 143	396 .. 399
	A.qv / A.qvS	8 .. 9	144 .. 147	400 .. 403
	A.qN / A.qNS	10 .. 11	148 .. 151	404 .. 407
	A.p / A.pS	12 .. 13	152 .. 155	408 .. 411
	A.T / A.TS	14 .. 15	156 .. 159	412 .. 415
	A.ρ / A.ρS	16 .. 17	160 .. 163	416 .. 419
	A.h / A.hS	18 .. 19	164 .. 167	420 .. 423
	A.Δp / A.ΔpS	20 .. 21	168 .. 171	424 .. 427
	A.PR	22 .. 23	172 .. 175	428 .. 431
	A.qmR	24 .. 25	176 .. 179	432 .. 435
	A.qvR	26 .. 27	180 .. 183	436 .. 439
	A.qNR	28 .. 29	184 .. 187	440 .. 443
	A.pR	30 .. 31	188 .. 191	444 .. 447
	A.TR	32 .. 33	192 .. 195	448 .. 451
	A.roR	34 .. 35	196 .. 199	452 .. 455
	A.hR	36 .. 37	200 .. 203	456 .. 459
	A. ΔpR	38 .. 39	204 .. 207	460 .. 463
UKłAD B	B.ΔP	40 .. 41	208 .. 211	464 .. 467
	B.ΔT	42 .. 43	212 .. 215	468 .. 471
	B.P / B.PS	44 .. 45	216 .. 219	472 .. 475
	B.qm / B.qmS	46 .. 47	220 .. 223	476 .. 479
	B.qv / B.qvS	48 .. 49	224 .. 227	480 .. 483
	B.qN / B.qNS	50 .. 51	228 .. 231	484 .. 487
	B.p / B.pS	52 .. 53	232 .. 235	488 .. 491
	B.T / B.TS	54 .. 55	236 .. 239	492 .. 495
	B.ρ / B.ρS	56 .. 57	240 .. 243	496 .. 499
	B.h / B.hS	58 .. 59	244 .. 247	500 .. 503
	B.Δp / B.ΔpS	60 .. 61	248 .. 251	504 .. 507
	B.PR	62 .. 63	252 .. 255	508 .. 511
	B.qmR	64 .. 65	256 .. 259	512 .. 515
	B.qvR	66 .. 67	260 .. 263	516 .. 519
	B.qNR	68 .. 69	264 .. 267	520 .. 523
	B.pR	70 .. 71	268 .. 271	524 .. 527
	B.TR	72 .. 73	272 .. 275	528 .. 531
	B.roR	74 .. 75	276 .. 279	532 .. 535
	B.hR	76 .. 77	280 .. 283	536 .. 539
	B.ΔpR	78 .. 79	284 .. 287	540 .. 543

X.01	80 .. 81	288 .. 291	544 .. 547
X.02	82 .. 83	292 .. 295	548 .. 551
X.03	84 .. 85	296 .. 299	552 .. 555
X.04	86 .. 87	300 .. 303	556 .. 559
X.05	88 .. 89	304 .. 307	560 .. 563
X.06	90 .. 91	308 .. 311	564 .. 567
X.07	92 .. 93	312 .. 315	568 .. 571
X.08	94 .. 95	316 .. 319	572 .. 575
X.09	96 .. 97	320 .. 323	576 .. 579
X.10	98 .. 99	324 .. 327	580 .. 583
X.11	100 .. 101	328 .. 331	584 .. 587
X.12	102 .. 103	332 .. 335	588 .. 591
X.13	104 .. 105	336 .. 339	592 .. 595
X.14	106 .. 107	340 .. 343	596 .. 599
X.15	108 .. 109	344 .. 347	600 .. 603
X.16	110 .. 111	348 .. 351	604 .. 607
X.17	112 .. 113	352 .. 355	608 .. 611
X.18	114 .. 115	356 .. 359	612 .. 615
X.19	116 .. 117	360 .. 363	616 .. 619
X.20	118 .. 119	364 .. 367	620 .. 623
X.21	120 .. 121	368 .. 371	624 .. 627
X.22	122 .. 123	372 .. 375	628 .. 631
X.23	124 .. 125	376 .. 379	632 .. 635
X.24	126 .. 127	380 .. 383	636 .. 639

14 TECHNICAL SPECIFICATIONS

MEASUREMENT OF COMPENSATED FLOW AND THERMAL ENERGY	
Uncertainty of measurement of the flow of compensated steam, water, other liquid or technical gas	<2% (typically <0,5%)
Frequency of measurement and calculation of results	0,5 s

FRONT PANEL	
Display Type on FP70P	5" LCD TFT touch colour 800x480px
Display Type in FP70W	7" LCD TFT touch colour 800x480px
Display dimensions	152mm x 91mm 110mm x 65mm
Additional signalling	3 colour LED

ORGANIZATION OF INPUTS	
FP70P, FP70W	2 x PULS: WE1, WE2 2 x RTD: WE3, WE4 6 x I: WE5 – WE10

Analog inputs RTD	
Sensor type	Resistance (according to table)
Measuring range	-200 .. +850 °C for Pt100, Pt200, Pt500, Pt1000 -60 .. +150 °C for Ni100 -180 ..+200 °C for Cu100
How to connect the sensor	2, 3, and 4-wire
Wire resistance compensation	set in the range -99.99 .. +99.99 Ω
Max. Resistance of supply wires	20 Ω
Transducer resolution A/C	24 bit
Basic error (for T_a = +20 °C)	± 0,5 °C (typical ± 0,3 °C)
Temperature drift	Max ± 0,02 °C / °C
Galvanic separation between channels	None, common GND potential for all inputs
Galvanic separation from supply voltage	400 VAC (functional separation)

Analog inputs I (0/4-20mA)	
Measurement signal	0-20mA or 4-20mA
How to connect the transducer	Passive transducer (loop powered) or active transducer
Input resistance	12 Ω ±10%
Transducer power supply	24 VDC / max 22 mA
Transducer resolution A/C	24 bit
Basic error (for T_a = 20 °C)	±0,1% range (typically ±0,05% range)
Temperature drift	Max ±50 ppm / °C
Galvanic separation between channels	None, common GND potential for all inputs
Galvanic separation from supply voltage	400 VAC (functional separation)

PULS inputs (binary / pulse / frequency)	
Maximum input voltage	±28 VDC
Galvanic separation between channels	None, common GND potential for all inputs
Galvanic separation from supply voltage	400 VAC (functional isolation)
Features	Status detection Pulse counting Frequency measurement

Measuring range	0,02 Hz do 12,5 kHz
Minimum pulse width	20 μs (low pass filter off) 5 ms (low pass filter on)
Basic error (for T_a = 20 °C)	0,02%

Configuration: OC/contact [1]	
Opening state voltage	12 V
Short-circuit current	12 mA
On/off threshold	2,7 V / 2,4 V

[1] Default.

Configuration: voltage input	
Input resistance	>10 kΩ
On/off threshold	2,7 V / 2,4 V
Opening state voltage	12 V

Configuration: Namur	
High impedance state	0,4 .. 1 mA
Low impedance state	2,2 .. 6,5 mA

Analog output 4-20mA (Optional)	
Quantity	1 or 2
Output signal	4-20mA (3,6–22 mA)
Maximum voltage between I+ i I-	28 VDC
Loop resistance (for U_{supply} = 24 V)	0 .. 500 Ω
Transducer resolution C/A	16 bit
Accuracy	0,5%
Current loop circuit power supply	From the outside or the internal source 24 VDC / 22 mA
Galvanic separation between outputs	400 VAC (functional separation)
Galvanic separation from supply voltage	400 VAC (functional separation)

Binary outputs (relay))	
Quantity	4
Type of outputs	Solid State Relays
Maximum load current	100 mA DC/AC
Maximum voltage	60 V DC/AC
Galvanic separation between outputs	400 VAC (functional separation)
Galvanic separation from supply voltage	400 VAC (functional separation)

Serial port RS485	
Load	32 receivers/transmitters
Maximum line length	1200 m
Maximum differential voltage A(+) – B(-)	-7 .. +12 V
Maximum total voltage A(+) to GND or B(-) to GND	-7 .. +12 V
Minimum transmitter output signal	1,5 V (at R_0 = 54 Ω)
Minimum receiver sensitivity	200 mV / R_{IN} = 12 kΩ
Minimum impedance of data transmission lines	54 Ω
Internal system of terminating resistors	Yes, activated by shorting the pins on the connector
Short-circuit/thermal protection	Yes/Yes
Transmission protocol	Modbus RTU
Baud	2.4, 4.8, 9.6 ,19.2, 38.4, 57.6, 115.2 kbps
Parity check	Even, Odd, None
Frame	1 b START, 8 b data, 1 b STOP
Isolation	no

Port Ethernet	

Transmission protocol	Modbus TCP, ICMP (ping), DHCP server, http server
Interface	10BaseT Ethernet
Data buffer	300 B
Number of simultaneous open connections	4
Joint	RJ-45
LED Indicator Lights	2, Built into the socket RJ45

Port USB	
Port slot	Type-A socket, according to USB standard
Version	USB 2.0
Protection	IP54
Recording system	FAT16 (to a limited extent)
Record indication	LED on front panel

Power FP70P	
Supply voltage	24 VDC (15 .. 30 VDC)
Maximum input power	14 VA / 14 W

Power FP70W	
Supply voltage	100 .. 240 VAC 50/60 Hz 24 VDC (15 .. 30 VDC)
Maximum input power	20 VA / 20 W (for 100 .. 240 VAC) 14 VA / 14 W (for 24VDC)

Connecting wires	
Type	FP70P: plug-in screw connectors FP70W: spring terminals
Wire cross-section	FP70P: .max. wire cross-section 1,5 mm^2 FP70W: wire cross-section 0,2 .. 1,5 mm^2

Dimensions – FP70P chassis	
Enclosure type	For panel mounting, non-flammable plastic "Noryl"
Dimensions (W x H x D)	192 mm x 96 mm x 63,5 mm
Housing depth with connectors	ca. 72 mm
Panel cut-out dimensions (W x H)	186$^{+1,1}$ mm x 92$^{+0,9}$ mm
Maximum panel plate thickness	5 mm
Mass	ca. 0,7 kg

Dimensions – FP70W housing	
Enclosure type	Wall mount, PC plastic
Dimensions (W x H x D)	257 mm x217 mm x 125 mm (without cable glands) 257 mm x 247 mm x 125 mm (with cable glands)
Mass	ca. 2,1 kg

Environmental conditions – FP70P	
Operating temperature	0 .. +40 °C
Relative humidity	0 .. 75% (no condensation)
Storage temperature	-20 .. +80 °C
Degree of protection from the side of the front panel	IP54
Rear plate protection	IP30
Pollution degree	PD 3
LVD (safety)	EN 61010-1
EMC	Directive 2014/30/UE:

	resistance in industrial environments according to EN 61326-1:2013 (Table 2) Conduction and radiation emission Class A according to EN 61326-1:2013
RoHS	Directive 2011/65/UE
Installation location	For internal use only
Environmental conditions – FP70W	
Operating temperature	-20 .. +40 °C
Relative humidity	0 .. 75% (no condensation)
Storage temperature	-20 .. +80 °C
Protection	IP54 (IP65)
Overvoltage category	OV III
Degree of contamination	PD 3
LVD (safety)	EN 61010-1
EMC	Directive 2014/30/EU: immunity in industrial environments according to EN 61326-1:2013 (Table 2) Conduction and radiation emission Class A according to EN 61326-1:2013
RoHS	Directive 2011/65/UE
Installation location	For internal or external use [2]

[2] **If additional protection against precipitation is provided (roofing), the device can be installed outside the building.**

TABLE OF RTD SENSORS		
Sensor type	**Measuring range**	**Accuracy**
Pt100, Pt200, Pt500, Pt1000 (EN 60751+A2:1995)	-200 °C .. +850 °C -328 °F .. +1562 °F	±0,5 °C (typ. ±0,3 °C) ±0,9 °F (typ. ±0,5 °F)
Ni100, Ni120, Ni1000 (DIN43760 /08-1985)	-60 °C .. +250 °C -76 °F .. +482 °F	±0,5 °C (typ. ±0,3 °C) ±0,9 °F (typ. ±0,5 °F)
Cu50, Cu53, Cu100 (GOST6651-2009)	-180 °C .. +200 °C -292 °F .. +392 °F	±0,5 °C (typ. ±0,3 °C) ±0,9 °F (typ. ±0,5 °F)
KTY81 (NXP Rev05-25.04.2008)	-55 °C .. +150 °C -67 °F .. +302 °F	±0,5 °C ±0,9 °F
KTY83 (NXP Rev06-4.04.2008)	-55 °C .. +175 °C -67 °F .. +347 °F	±0,5 °C ±0,9 °F
KTY84 (NXP Rev06-8.05.2008)	-40 °C .. +300 °C -40 °F .. +572 °F	±0,8 °C ±1,5 °F

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