FP-3011(N)
FP-3021(N)
FP-3031(N)
version 1.31

**Flow and Energy Computer
for Steam, Liquids and Gases**

OPERATING MANUAL

Version: 200415EN

metr●nic

Safety notes

> **Before installation, carefully read all the instructions, especially those concerned with safety.**
>
> **The recorder has been manufactured according to the requirements of relevant EU directives.**
>
> **These instructions must be stored in a safe place near the installation of the steam flow computer at all times.**

Manufacturer note

> The manufacturer reserves the right to improve and update the technical details.
> For details of improvements or additions to these instructions, please contact your local sales representative.

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1. MARKING AND DOCUMENTATION

Equipment is protected throughout by double insulation or reinforced insulation.

Functional earth (ground) terminal, to enable the product to function correctly. Not used to provide electrical safety.

Caution, risk of electric shock.

Caution, risk of danger, refer to accompanying documentation.

Caution, Electrostatic Discharge (ESD) sensitive circuit. Do not touch or handle without proper electrostatic discharge precautions.

Important comments and information.

2. SAFETY INFORMATION

Safe operation of this product can only be guaranteed if it is properly installed, commissioned, used and maintained by qualified personnel in compliance with the operating instructions. General installation and safety instructions for pipeline and plant construction, as well as the proper use of tools and safety equipment must also be complied with.

Warning
This product is designed and manufactured to withstand the forces encountered during normal use. Use of the product other than as a steam flow computer, or failure to install the product in accordance with these Instructions, product modifications or repair could:
- Cause damage to the product/property,
- Cause injury or fatality to personnel,
- Void your warranty,
- Invalidate the $C\epsilon$ marking.

Isolate the mains supply before opening the product as hazardous voltages may be exposed.

Warning
This product complies with the requirements of the following directives and harmonized standards:

Electromagnetic Compatibility (2014/30/EU) by meeting the standards of:
- Immunity for industrial environments according to EN 61326-1:2013 Table 2
- Conductive and radiated emissions Class A equipment according to EN 61326-1:2013.

LVD Directive 2014/35/EC (for FP-3011N, FP-3021N, FP-3031N) to the following standards and specyfications:
- Overvoltage category II, pollution degree 2 equipment according to EN 61010-1_2010.

RoHS Directive 2011/65/EU.

The product may be exposed to interference above the limits of EN 61326 if:
- The product or its wiring is located near a radio transmitter.
- Excessive electrical noise occurs on the mains supply. Power line protectors (ac) should be installed if mains supply noise is likely. Protectors can combine filtering, suppression, surge and spike arrestors.
- Cellular telephones and mobile radios may cause interference if used within approximately 1 metre (39") of the product or its wiring. The actual separation distance necessary will vary according to the surroundings of the installation and the power of the transmitter.

Intended use

- Check that the product is suitable for use with the application.
- Determine the correct installation situation.
- Prior to installation Metronic AKP products should take into account any environmental limitations of devices, specified in the manual.

Access

Ensure safe access and if necessary a safe working platform (suitably guarded) before attempting to work on the product.

Lighting

Ensure adequate lighting, particularly where detailed or complicated work is required.

Hazardous environment around the product

Consider: explosion risk areas, lack of oxygen (e.g. tanks, pits), dangerous gases, extremes of temperature, hot surfaces, fire hazard (e.g. during welding), excessive noise, moving machinery.

The system

Consider the effect on the complete system of the work proposed. Will any proposed action put any other part of the system or any personnel at risk?

Dangers might include isolation of vents or protective devices or the rendering ineffective of controls or alarms.

Tools and consumables

Before starting work ensure that you have suitably required tools and/or consumables available at the work place.

Protective clothing

Consider whether you and/or others in the vicinity require any protective clothing to protect against the hazards of, for example, chemicals, high/low temperature, radiation, noise, falling objects, and dangers to eyes and face.

Permits to work

All work must be carried out or be supervised by a suitably competent person. Installation and operating personnel should be trained in the correct use of the product according to the Installation and Maintenance Instructions. Where a formal 'permit to work' system is in force it must be complied with. Where there is no such system, it is recommended that a responsible person should know what work is going on and, where necessary, arrange to have an assistant whose primary responsibility is safety.

Post 'warning notices' if necessary.

Storage

If an energy monitor is to be stored for a period prior to installation, the environmental storage conditions should be at a temperature between -30°C and 70°C (-22°F and 158°F), and between 5% and 95% relative humidity (non-condensing).

Before installing and connecting the power ensure there is no condensation within the unit.

Cleaning and maintenance

Metronic AKP products require no maintenance beyond periodic battery replacement. Expected battery life is 10 years after the expiry of which must be returned to the manufacturer for a replacement.

From time to time you should clean the casing with a dry, soft cloth. When cleaning machine, do not use solvents or abrasives. They may cause discoloration or scratch the surfaces of device.

Disposal

The FP-30x1(N) 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 products

Customers and stockists are reminded that under Environment Health and Safety Law (EHS), when returning products to Metronic AKP they must provide information on any hazards and the precautions to be taken due to contamination residues or mechanical damage which may present a health, safety or environmental risk. This information must be provided in writing including Health and Safety data sheets relating to any substances identified as hazardous or potentially hazardous.

3. PURPOSE AND APPLICATION SCOPE OF FLOW COMPUTER

3.1. Purpose

FP-30x1 and FP-30x1N devices are microprocessor based, universal flow computers designed for measurement of:
- flow and heat of steam and water according to IAPWS-IF97, in operating range of temperature 0 ... 800 °C and absolute pressure 0.05 ... 16.53 MPa
- flow and heat of liquids other than water according to characteristics provided by user,
- flow of technical gases according to the ideal gas equation.

FP-3011(N)/FP-3021(N) flow computers can be used for two different applications of an installation whereas the most advanced device FP-3031(N) for three of them. The flow computers are designated for industrial application in independent measurement applications and as component of computerized measurement and control systems. Implemented math functions enable calculation of flow and energy balances. Extended functions of events and process values recording make it possible to perform analysis of technological processes and emergency conditions. Data recording of process values enables to use this device in places beyond the reach of computer networks. Four output relays provide with signaling and simple controlling. The flow computers are a freely programmable in a broad range and enables configuration of displaying the results depending on user's needs. Comprehensive programming menu allows simple configuration of the instrument.

The device has a panel mount or wall mount construction for indoor industrial applications. If additional protection against atmospheric precipitation is provided (roofing), the device in wall mount construction can be installed outdoor.

Flow computers can work with following flow meters:
- mass flow meters,
- volume flow meters,
- differential pressure devices with approximation by square root curve,
- differential pressure devices (orifices and nozzles) according to iteration algorithm according to PN-EN ISO 5167 standard (only for water and steam).

Devices are available in four language versions:
- Polish,
- English,
- French,
- German.

Language change is available from the device keyboard.

3.2. Available options

Each of the FP-30x1(N) series instruments are available in two casings - for panel mounting (FP-30x1) and wall mounting (FP-30x1N). Both versions have the same functions and similar utilitarian metrology. Devices are powered by 24 V AC / DC, in addition FP-30x1N version is adapted to be powered from 230 VAC.

Additionally, each version can be optionally equipped with an analog output (outputs) 4-20 mA.

Offered versions of the instruments:

FP-3011	- x	- x	panel mount version
	- 0		basic option with one main application A
	- 1		extended option with A and B applications
		- 0	option without analog 4-20mA output
		- 1	option with analog 4-20mA output

FP-3011N	- x	- x	wall mount version
	- 0		basic option with one main application A
	- 1		extended option with A and B applications
		- 0	option without analog 4-20mA output
		- 1	option with analog 4-20mA output

FP-3021	- x	- x	panel mount version
	- 0		basic option with one main application A
	- 1		extended option with A and B applications
		- 0	option without analog 4-20mA output
		- 1	option with analog 4-20mA output

FP-3021N	- x	- x	wall mount version
	- 0		basic option with one main application A
	- 1		extended option with A and B applications
		- 0	option without analog 4-20mA output
		- 1	option with analog 4-20mA output

FP-3031	- x	- x	panel mount version
	- 0		basic option with one main application A
	- 1		extended option with A, B, C, X, Y, Z applications
		- 0	option without analog 4-20mA output
		- 1	option with one analog 4-20mA output
		- 2	option with two analog 4-20mA outputs

FP-3031N	- x	- x	wall mount version
	- 0		basic option with one main application A
	- 1		extended option with A, B, C, X, Y, Z applications
		- 0	option without analog 4-20mA output
		- 1	option with one analog 4-20mA output
		- 2	option with two analog 4-20mA outputs

3.3. Basic functions

- **Measuring channels**
  Depending on the version, FP-30x1(N) series devices allow reading and registration:

- FP-3011(N) - 5 measuring channels (**IN**puts**)**

	4-20mA	0-20mA	Pt100	Ni100	PULS*
IN1	+	+	+	+	
IN2	+	+	+	+	
IN3	+	+			
IN4	+	+			+
IN5	+	+			+

- FP-3021(N) - 7 measuring channels

	HART**	Modbus RTU***	PULS*
IN1	+	+	
IN2	+	+	
IN3	+	+	
IN4	+	+	
IN5	+	+	
IN6			+
IN7			+

- FP-3031(N) – 10 measuring channels (INputs)

	4-20mA	0-20mA	Pt100	Ni100	PULS*
IN1	+	+	+	+	
IN2	+	+	+	+	
IN3	+	+	+	+	
IN4	+	+			
IN5	+	+			
IN6	+	+			
IN7	+	+			
IN8	+	+			+
IN9	+	+			+
IN10	+	+			+

* **PULS** - **type inputs** can operate in three modes:
- state monitoring, can follow binary signal shorting(closing) / opening; each of the two binary states can be assigned to any analog value (e.g. -1.00 / 10.0); Value corresponding to the binary state can be used for simple control or as a value in the math functions (e.g. direction of flow);
- frequency measurement in the range 0,001 Hz …10 kHz; programmable frequency range allows calibration of the measured value to engineering units (e.g. flow);
- pulse counting; pulse counting should be chosen if a flow meter with a constant pulse value was connected to the binary input.

Inputs can work with a passive signals (reed-type contact, or OC transistor signals), active voltage signals and the NAMUR standard.

HART (only: PV – primary variable, SV – secondary variable, TV – third variable and FV – fourth variable; rev.4.; rev.5.; rev.6.)

***Modbus RTU protocol** via RS-485(1), read of the instantaneous values. (available functions: 03 - Read Holding Registers and 04 - Read Input Registers).

- **Math functions and additional measurements**

   There are 8 channels that can be assigned to an unassigned input as an additional measurement or value calculated from a formula in which can be used measurements value, other calculated values and constant values in the operations of additions, difference, multiplication, division and square root. This allows e.g. to make a balance of flows and energy , the calculation of the average value and the quotient of two values.

- **Totalisers**

   For each measurement inputs, both binary inputs and for each calculated value can be assigned two independent totalisers. Additionally can be attributed totaliser which reset itself every certain period of time (hour / day / month) and totaliser of exceedances triggered after exceeding the preset value.

- **Results registration**

   The results of measurements, calculations and the states of totalisers may be recorded in the device's internal memory with a capacity of 2 GB. The data are stored in text form and secure by encrypted checksum. Additionally can be recorded the events (power interruptions, change of settings, exceedance of alarm and control thresholds, etc.) and authorized activities. The internal memory may contain maximum of 250 files.

- **Results displaying**

   On the front panel there is backlit TFT LCD graphic display and three tri-color LEDs. Depending on the configuration, results of measurements and calculations are presented in digital form (big numbers), analog lines, the table of min / max / average value or in a graph. They can also be displayed collectively in the form of tables that are individually configurable. There is a possibility of sequential displaying screens.

- **Keypad - function keys**

   FP-3011/FP-3021 devices are equipped with seven buttons. The buttons have changeable functions, depending on the currently displayed information. They allow to fully configure the device. FP-3031 and FP-30x1N devices are equipped with an extended 19-button keypad.

- **Relay outputs**

   Four solid-state output relays which can be assigned to alarm and control thresholds, allow to implement a signalization of exceedance and a simple two-state control. Relays can also be configured to work as pulse outputs. Then a relay is assigned to one of the available totalisers. Number of pulses corresponds to totaliser incrementation.

- **Current loop output 4-20mA (optional)**

   FP-3011(N) / FP-3021(N) devices can be equipped with an analog current loop output 4-20mA, while the FP-3031 (N) may have two such outputs. These outputs allow to send a signal linearly dependent on any chosen value(measured or calculated). Outputs are optionally installed. The loop can be powered by the device's internal 24V voltage source or by an external voltage source plugged in circuit or by receiver (if its construction allows it). Current outputs are galvanically isolated from other circuits of a flow computer.

- **Communication with a computer system**

  The instrument can be incorporated into the master computer system by:
    - built-in serial RS485 (1) (RS485(2) in FP-3021); available ASCII (dedicated only for FP-3000-Raport software) and Modbus RTU protocol,
    - Ethernet port (web server, Modbus TCP).

In addition, the RS485 port can be used to connect the GSM module, it enables to transfer information about failures, alarms and measurement values in the form of SMS text message.

- **Additional software (optional)**

  Additional software - FP-3000-RAPORT, for easier viewing archived results, together with the basic mathematical processing and data selection.

4. DEVICE OPERATION
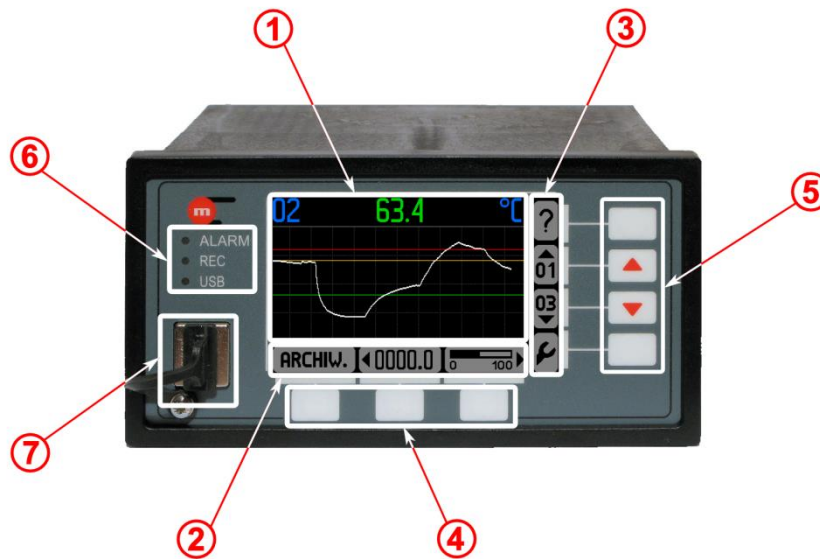
The front panel of the FP-30x1

4.1. Front panel

4.1.1. Display organization

The display along with buttons is a basic element of communication between the device and a user. It displays following information:

- results of measurements,
- messages,
- archive menu,
- settings menu,
- pictograms of the function buttons (keypad).

Display can be divided into three main areas:
1) area of results ①,
2) area of pictograms of three lower function buttons ②,
3) area of pictograms of four side function bottom③.

4.1.2. Function buttons

On a front panel of the FP-30x1(N) device are located 7 (19) function buttons. Each function button can perform different actions depending on an operational state of the flow computer and information displayed on the screen. To simplify a handling of the device, on the screen are displayed pictograms which symbolize buttons functions active at the moment.

4.1.3. LED indication

On a front panel are located three LEDs ⑥ marked as:

- ALARM – when the device is in an alarm state it lights up in red (constantly or blinking), it is accompanied by a message explaining the cause of the alarm, green color reminds to log out after completing authorized operation
- REC – constant green light indicates recording data into an internal memory, pulsing green light indicates opening/closing a file, red color indicates an error in the archive function.
- USB – it lights up in orange when USB controller is on, green-orange flashing indicates reading/recording data, red light indicates an error (e.g. lack of USB flash drive during reading/writing data).

4.1.4. USB port

The port is adapted to operate with USB flash drives. It allows to transfer data between a flow computer and USB flash drive. The device does not support advanced structures of directories and subdirectories, which can be stored in an external USB flash drive. We recommend using a flash drive dedicated to work with the flow computers.

4.1.4.1.   Writing data to flash drive

Data which can be transferred from the device:
- archive of the process (current) values,
- archive of hourly archived totalisers and average/minimum/maximum of process values,
- archive of daily archived totalisers and average/minimum/maximum of process values,
- event log, authorization log and settings log,
- set of device settings (see section 10.18).

To copy files to USB flash drive, go to 🔲 → **Main menu** → **Copy files**. Selecting **Current archives** copies the main archive file, the totalisers archive file, the event log file and the authorization log file. Selecting **Choose file** allows the user to select the files to be copied (see the table below). Copying the files can be the activity available only for selected users and requires the password.

Files can also be transferred (with simultaneous removal of copying file) or deleted, but in case of some files, these functions are only available to the user SERVICE.

List of file names:

File Name	File Type
ar[addr]_[count].txt	Main Archive file
artot[addr].txt	Hourly Archive file
ar24h[addr].txt	Daily Archive file
a_log[addr].txt	Authorization log file
e_log [addr].txt	Event log file
s_log.dat	Settings log file
SETT_[addr].txt *SETT_[addr].set*	Settings file

where *[addr]* is the two-digit address of the device in the RS-485 network, and *[count]* is the successive number of the created archive file.

! ■ To distinguish between files from different devices is recommended to configure different addresses even when the RS-485 transmission is not used.

4.1.4.2. Loading data from flash drive

Data which can be transferred (entered) to the device:
- characteristics of a liquid medium other than water (see section 10.4.3.1),
- characteristics of the non-linear transmitter (see section 10.8.7),
- set of device settings saved in a file (see section 10.18),
- firmware upgrades or license (see section 11.3).

! ■ FP-30x1(N) device does not support advanced structures of directories and subdirectories, which can be stored in an external USB flash drive. We recommend using a USB flash drive dedicated to work with the flow computers.

! ■ Removal of the USB flash drive from USB port when the USB LED is on (lights in orange or orange-green), may result in losing all the data stored in the flash drive.

4.2. Process values layout in A, B, C, X, Y and Z application

The FP-30x1(N) devices perform measurements and calculations according to their configuration. Each measurement or calculation value has its own symbol and belongs to one of the applications. In FP-3011(N)/FP-3021(N) devices there are two applications (measuring systems) marked with letters A and B whereas in FP-3031(N) six applications (measuring systems)   A, B, C, X, Y and Z. Each of the devices is also available in option with only one application A (see section 3.2).
Applications A, B, C are designated to group process values of separate measurement application of the installation. Each main application is determined with help of wizard and all necessary process values are loaded automatically.
Auxiliary values can also be loaded to the systems – measured values (if any measurement inputs were left) and calculated values (defined by formulas) - a total of up to 8. Each such auxiliary value can be entered to any system A to Z. It is recommended to load into systems A, B, C values linked with the given main application (e.g. water level or calculated efficiency) whereas other values (e.g. sum of heat flow rates of all main applications) – into systems X, Y, Z.

4.2.1. Process values symbols

Auxiliary values may be given any symbols consisting of one or two letters. Values loaded automatically into applications A, B and C have symbols assigned by the device. These symbols have the following meaning:

P   heat flow rate or difference of heat flow rates between supply and return

q   volumetric flow of gas in normalized units (volume referred to reference conditions)

q_m mass flow

q_v volumetric flow

p   measured pressure

p_c saturated steam or boiling water pressure determined theoretically based on measured temperature

T   measured temperature

T_c saturated steam or boiling water temperature determined theoretically based on measured pressure

ρ medium density

h   medium enthalpy

Δp pressure difference at the orifice in differential pressure device

ΔT temperature difference between supply and return

k   thermal coefficient of water.

To the above listed symbols a block letter in the upper index can be added which means:

- kind of medium to which this quantity refers (D - steam, W - water, G - gas, other letters may be used for other liquid media) or
- S - supply, R - return, if there is the same medium in both pipelines of main application.

If a process value does not refer strictly to one pipeline but to main application as a whole (e.g. difference of heat flow rates between supply and return, mass flow in closed system or common pressure in both pipelines), then this mark in the upper index is not added.

Examples of values symbols:

Steam – condensate closed system

P^D steam heat flow rate (refers only to steam – D in upper index)

P^W condensate heat flow rate (refers only to condensate – W in upper index)

P   difference of heat flow rates between steam and condensate (no mark in upper symbol because this quantity is relevant to the system as a whole and not to a given pipeline)

q_m mass flow of both steam or condensate (no mark in upper symbol because this quantity is common to both pipelines of main application)

Water – water system

T^S supply temperature (letter S in the upper index means that this quantity refers only to the supply pipeline; letter W would have no sense because water flows in both pipelines)

T^R return temperature (letter R in the upper index means that this quantity refers only to the return pipeline)

ΔT temperature difference between supply and return (no mark in upper symbol because this quantity is relevant to the system as a whole and not to a given pipeline)

p   common pressure in supply and return (no mark in upper symbol because this quantity is common to both pipelines of main application)

Groups of values for all types of measurement in different applications with their explanation are given in section 10.4.3.

Symbols may be displayed in abridged form (as above) or in full form i.e. with added information about application to which they belong , e.g.:

$A.P^D$ full form, heat flow rate of steam in application A
P^D abridged form.

Abridged form is used exclusively where it can be learned from context to which system the value belongs – e.g. on common screen (on the left at the figure below) where the application symbol is printed in title above the table. However on individual screen full form is used.
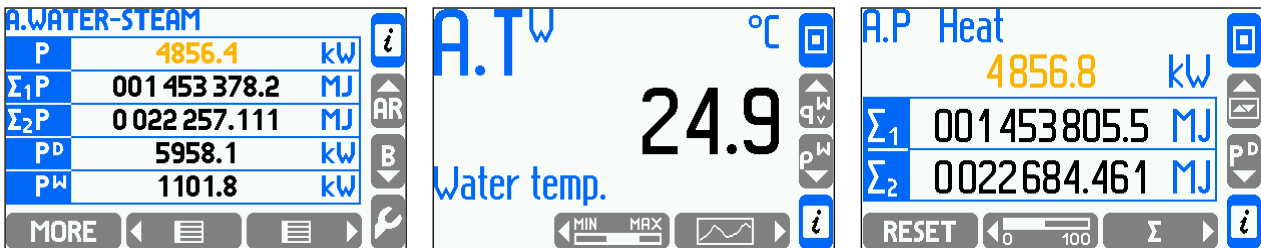
Both individual values and whole applications can be given text description – tags, as a one text line. The tag is displayed together with a symbol wherever it is possible. In examples above system A was given the tag „Steam-condensate" and $A.q_m$ – „Mass flow rate".

4.2.2. Totalisers symbols

Except of process values described above (of the last second) the device can display also statuses of heat energy and flow totalisers. For each value which is heat or flow rate, up to four totalisers marked as Σ_1, Σ_2, Σ_H and Σ_L can be used. For more details see section 10.10. Totalisers symbols are as follows:

$A.\Sigma_1P^D$ full form, main totaliser of steam heat energy in application A
Σ_1P^D abridged form
$B.\Sigma_2q_m$ full form, additional totaliser of steam mass flow in application B
Σ_2q_m abridged form

4.2.3. Process values assigned to the same transmitter

In some industrial installations two (or more) different process values may be assigned to the same measuring input i.e. physically to the same measuring transmitter. For more details see section 10.8.1.

Example:
Hot water flows through two heat exchangers in sequence and measurement of heat energy at each of exchangers was implemented in applications A (first exchanger) and B (second exchanger). Temperature at the outlet of the first exchanger is then equal (or rather assumed to be equal) to temperature at the second exchanger inlet. Therefore only one temperature transmitter can be used and two values can be assigned to it:

- A.T^R return temperature in system A (temperature at the first exchanger outlet)
- B.T^S supply temperature in system B (temperature at the second exchanger inlet).

Though both values given above are assigned to the same transmitter and always indicate the same value, they are treated by device as independent. Each may have its own caption, own alarm and control thresholds, can be separately archived etc.

4.3. Screens navigation

Information on all values and totalisers is organized in form of screens. Navigation between screens is performed using buttons or may be switched to automatic mode. While commissioning user should configure screens sets with all required process values. To simplified readout not used or not necessary data presentation should be deactivated. Display mode configuration was described in section 10.15.

4.3.1. Main and additional screens

Basic information is displayed in form of main screens and additional screens. Navigation between them is performed using vertical cursors (two central buttons on the right side:▲ and ▼).

Main screens contain up to 4 tables for every application A, B, C, X, Y and Z. Up to 5 or 3 process values and totalisers can be set into every table depending on the letter size. Navigation between tables within application is performed using horizontal cursors (button ◀▤ and ▤▶).
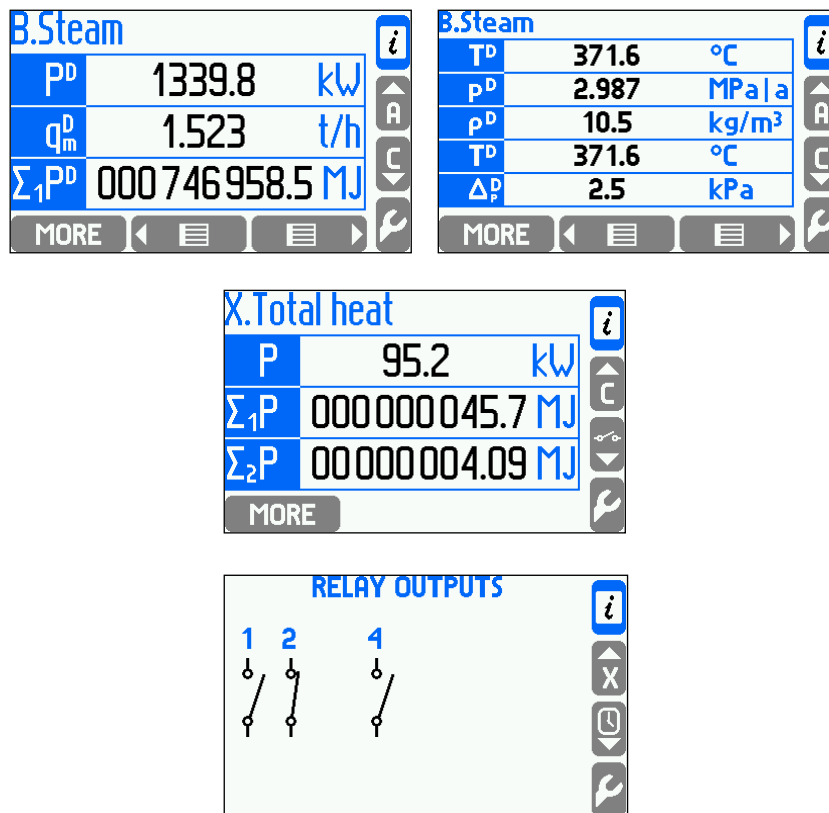
Additional screens are: relay outputs screen, date and time screen and main archive screen. Relay outputs screen informs about status of relays (closed or open, relays not used are not displayed). On date and time screen button **ADJUST** enables setting the clock and calendar. Main archive screen displays information about status of archiving. Bottom buttons enable to control archiving (archive operation is described in section 4.8).

Longer pressing (more than 1 sec.) one of the buttons ◀ ☰ and ☰ ▶ on any of the main screen will start the automatic scrolling of all tables of currently displaying application. When vertical cursor is kept pressed - automatic scrolling of all tables of all applications starts. Pressing any button interrupts automatic scrolling. It is also possible to configure the scrolling function to display only selected tables.

4.3.2. Detailed screens

Pressing button **MORE** while displaying the main screen (table) switches over detailed screens of process values within the application. Detailed screens show always only one process value with some additional information. With some exceptions detailed screens can preset data in various ways:

- **Large digits** – value printed with a capital letter
- **Trend graph** – last 140 values in form of a graphic diagram
- **Bargraph** – value in form of analog bargraph
- **Totalisers 1, 2** – value of main (Σ_1) and additional (Σ_2) totalisers
- **Totalisers H, L** – values of overflow and underflow totalisers (Σ_H and Σ_L)
- **Min, max** – minimum, maximum and average values
- **Min, max (bar)** – minimum, maximum and average values in form of bargraph.

Density(ρ), enthalpy(h), pressure difference (Δp) and water thermal coefficient (k) may be displayed only in form of **Large digits.** Screens **Totalisers 1, 2** and **Totalisers H, L** are available for values with active totalisers. A screen with all activated alarm and control thresholds for application is displayed as a detailed screen.

Example:
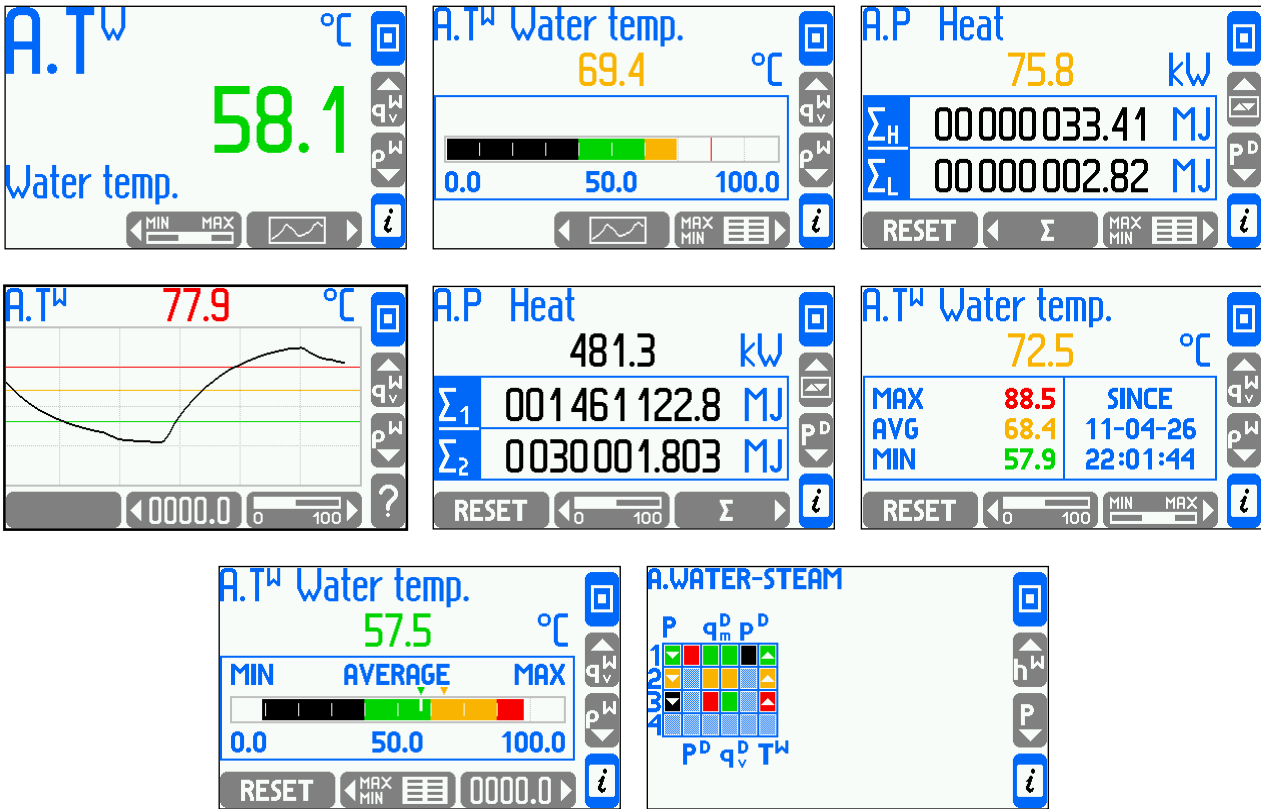
Above screens: Large digits; Bar graph; Totalisers H, L; Trend graph;
Totalisers 1, 2; Min, max; Min, max (bar); Alarm and Control thresholds.

Range of bargraph and trend diagram can be set separately for every value. Range of horizontal and vertical axis of **Trend graph** are displayed after pressing button [?].
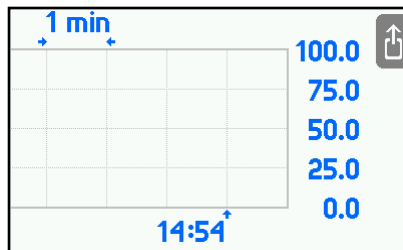
Navigation between various process values is executed with vertical cursors, while navigation between various data presentation of the same value – with horizontal cursors.

Longer pressing the vertical cursor starts automatic scrolling. Pressing [□] always return to the main screen.

The left bottom button on some detailed screens serves some special functions:

- **ARCHIVE** on **Trend graph screen** starts an archive browser if the value is archived (see section 4.10),
- **RESET** on screens **Totalisers 1, 2** and **Totalisers H, L** allows to reset resettable totalisers,

- **RESET** on **Min, max** and **Min, max (bar)** screens allows to reset and begin monitoring minimum, maximum and average values.

Before resetting totalisers or minimum, maximum and average values the device requires choosing the option and confirmation, as on the figure below.
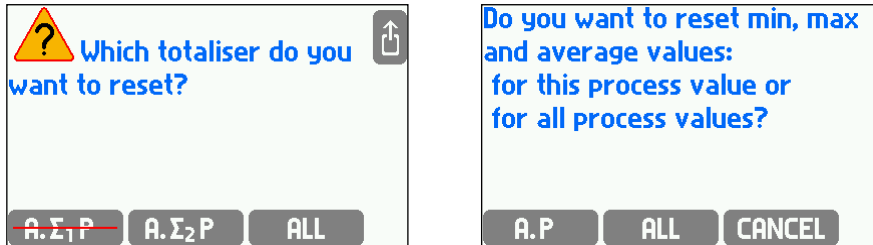
By pressing **ALL** button, all active resettable totalisers are simultaneously reset in all applications. Similarly **ALL** button starts monitoring of minimum, maximum and average values from the beginning for all values in all applications. Totalisers other than resettable (see section 10.10) cannot be reset in this way (symbols of such totalisers are marked of).

4.3.3. General information on status of all applications

The **i** button available on all screens with process values displays a screen with short informing about status of main and auxiliary applications, and about firmware version and the network address of the device.
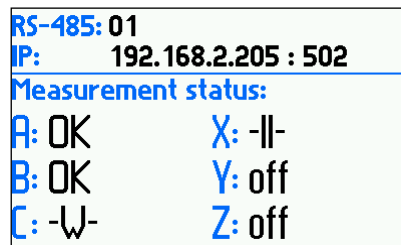
4.4. Main menu

All functions are accessed in **Main menu** except the overview of results and some actions described in section 4.3.2. Main menu can be entered from every main screen and additional screen with button **⚙**. Main menu cannot be entered from detailed screens, first one user have to return to the main screen by pressing **▣** button.
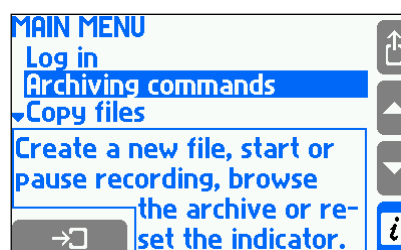
Basic contents of main menu:

Log in
Archiving commands
Copy files
Settings
Load or save settings
Media manager
Characteristic manager
RS-485 monitor
Change the language

Required menu item should be selected with the vertical cursor, then selected with the enter button [→⊐]. To quit main menu user should choose button [⬆].

Log in is performed to access the features that require authorization (password protected). After logging into the main menu there are displayed additional items. Information on the authorized operations are located in section 4.7.

Archiving commands allows to establish a new main archive file and hourly archive file, it allows to start, stop, resume recording, use an archive browser. Menu of archive commands can be entered directly from archive screen with [MENU] button. Archiving was described in section 4.9.

Copy files: the process values archives, the totalisers archive, the average values archive and the log files (for more information see section 4.1.4.1Writing data to flash drive).

Settings enable to configure the device. All settings can be viewed and changed in a hierarchical menu. Principles of moving around the settings, editing them, and the importance of the various settings are described together with relating to them functions, in section 10.

Load or save settings allows to load and save the settings from/to a memory device (for more information see section 10.18).

Media manager enables the flow computer to work with any liquid media, while **Characteristic manager** enables to work with any non-linear transmitter. This requires the appropriate characteristics of the liquid medium (see in section 10.4.1.3) or the characteristics of the transmitter (see in section 10.8.7). This information is stored in the media manager and the characteristic manager.

RS-485 monitor is a service purpose function. Every query and response on RS-485 lines is monitored with blinking of ALARM LED on front panel (in FP-3021 devices this feature applies to **RS-485 (2) monitor**).

Change the language function enables change of the language version in the device, it's available only for ADMIN user. After changing device is reset, all settings, archive data and totalisers are preserved.

4.5. Communication with the master system

4.5.1. RS-485 port

In case of the FP-3021 device this paragraph applies to the RS-485(2) port.
When using the RS-485 port it is possible to read:
- process values (ASCII and Modbus RTU),

- process values archive (only the last file, ASCII i Modbus RTU),
- last 500 events recorded by the flow computer (ASCII only),
- last 500 authorized activities registered by the device (ASCII only),
- totalisers files, the event log and the authorization log (ASCII only),
- information about the current results archive and its status (ASCII and Modbus RTU)
- archiving status (start, stop etc., ASCII only).

The FP-3000-RAPORT is optionally available software that allows data analysis (e.g. average values calculation, searching extremes values), preparation and printing of reports.

To the RS485 port can be connected the GSM module, which enables to transfer, in form of SMS text message, information about:

- selected alarms and failures when they occur,
- measurement values and totalisers; the list of process values to be sent is configured individually.

4.5.2.   Ethernet port

When using the Ethernet port it is possible to read:
- in Modbus TCP protocol,
- using built-in web server, which can be connected via a standard web browser.
  Modbus TCP protocol enables:
- readout of current process values,
- readout of totalisers,
- readout of main archive,
- readout and setting of the clock.

To turn on web server user must enter the IP address of the device in the browser address bar (IP configuration in the device: ⬚ → **Main menu** → **Settings** → **Ethernet port**). The web server allows to:

- read remotely all measurement channels (including the additional measurements and calculated values),
- read the totalisers (states of configured totalisers are displayed below the process value),
- check the output relay status (OUTPUTS RL 1..4), a black dot indicates a short circuit (closing) of the relay, a grey dot an open state),
- transform measured data into a chart (TREND tab).
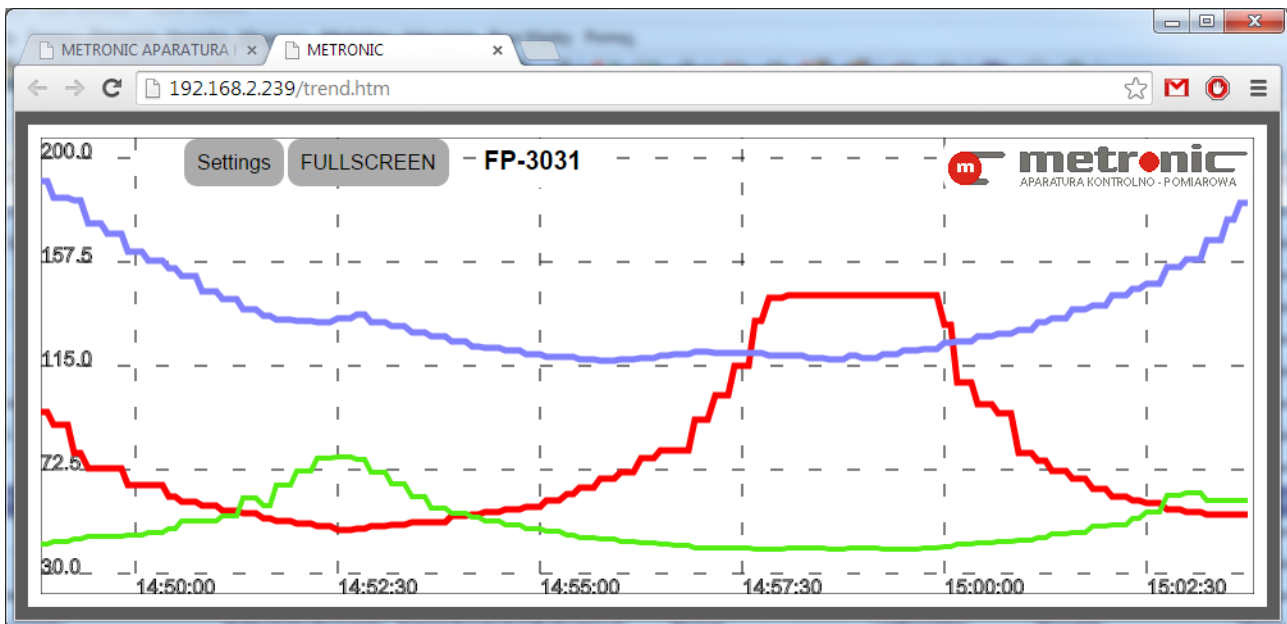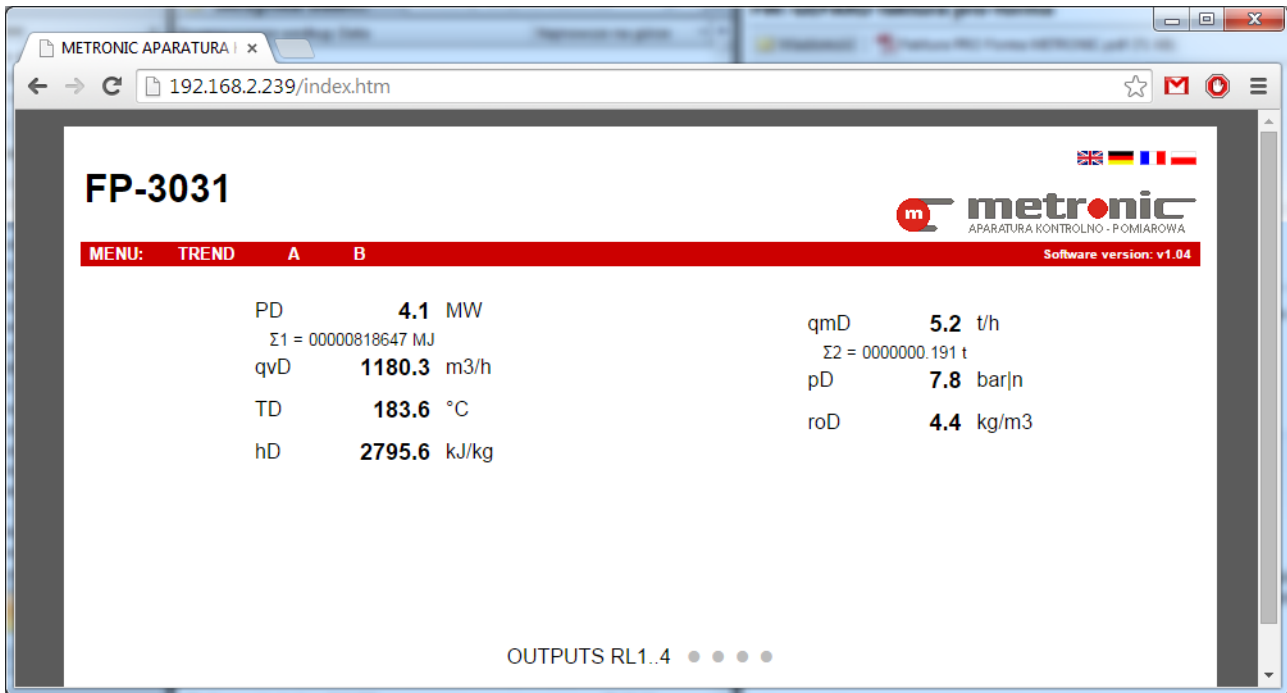
Readings sample of measurement inputs and visualization in a chart

After selecting *Settings* button user can:

- set a refresh time of a chart: 1 sec, 5 sec, 10 sec, 30 sec, 1 min (refresh delay are caused by delays in network communication and may vary depending on the network, from fraction of a second up to a few seconds),
- define time period from which the data are to be seen: 1 min, 15 min, 30 min, 1h,
- define which channels are displayed on the chart,
- change colors and thicknesses of lines.

> ! The network connection has been tested in: Internet Explorer 8, Opera, Mozilla Firefox, Chrome and Safari browsers.

4.6. Messages

The user interface in the FP-30x1 devices is designed for simple and easy handling. Many states of the device causes displaying messages on the screen. Messages require reading and pressing the confirmation button OK . Messages do not suspend the measurements except the emergency states.

4.7. Authorized functions, user login and logout

Some functions can be password protected. Depending on the flow computer application, for each user individually, can be programmed operations that will be available after entering a password. Software enables to define up to 25 users, each with its own password. The master user is an administrator (ADMIN), who has the entitlements to any activities excluding SERVICE operations.

ADMIN decide which function will be password protected for all users by selecting:

→ **Main menu → Administrative data → Protected commands .**

Execution of protected function is possible in two ways.
- Each time after calling protected function by giving username and password
- The user first logs in by entering username and password, which is signalized by ALARM LED (lights green). Then user can perform all protected functions, (to which he has the entitlements) without needing to type a password for each operation. After finished configuration user must logout. In case of forgetting to logout, device will do this automatically after a preset time (30 s, 1, 2, 3, 5 or 10 minutes).

User login:

After selecting button, in **Main menu** select **Log in,** then specify the user name and enter the password. Password consists of 3 to 6 digits from 1 to 9 (without 0). To enter password combination, use the buttons at the bottom of the front panel, each digit requires a double press of a button. For example, to select the number 4 first selects a group of three digits 4,5,6 , then the button labeled 4 . To logout, in **Main menu** select **Log out.**
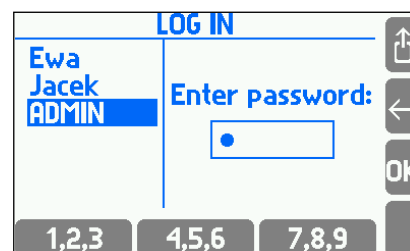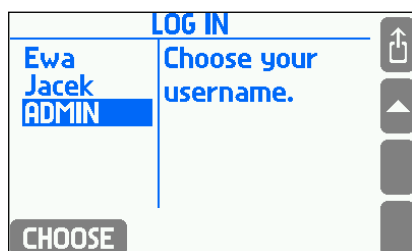
After logging into the main menu option **Log in** turns automatically into **Log out** and some additional items appear. The main menu is then as follows:

Logged-in user:

Log out
Archiving commands
Copy files
Settings
Load or save settings
Audit trail
Media manager
Characteristic manager
Change password
RS-485 monitor
Change the language

Logged-in ADMIN:

Log out
Archiving commands
Copy files
Settings
Load or save settings
Audit trail
Media manager
Characteristic manager
Change password
Administrative data
Test inputs and outputs
RS-485 monitor
Firmware and licences
Restore factory settings
Change the language

Only the administrator can define a protected activity, add new or delete existing users. ADMIN can also change user's password without its knowledge. The user can change only its own password.

Commands that can be password protected after proper programming:

- Archiving commands (creating a new file, starting and pausing recording, clearing indicator).
- Copy files (copying and removing files from the internal memory with the exception of the files that can be removed / transferred only by SERVICE).
- Resetting min, max (resetting tracing minimum, maximum and average value).
- Clock adjusting.
- Resetting totalisers (the resettable ones).
- Main settings (changing any settings except those three mentioned below).
- Threshold settings (changing the levels and hysteresis of alarm and control thresholds).
- Screen settings (configuring screens and changing display settings).
- Archiving settings (changing archive-related settings e.g. selecting recorded items).

The administrator decides which of the above actions require authorization and which users are allowed to perform them. If no user is given permission to the activity, the only legitimate is an administrator.

Features available only for the administrator (always password protected – see section 11):

- Administrative data (choosing password-protected commands, define users, their passwords and entitlements, for more information see section 11.2)
- Audit trials – browsing on the device screen (see section 4.17.5),
- Test of inputs and outputs (in FP-3011 and FP-3031, see section 12.1),
- Communication test (in FP-3021, see section 12.2),
- Firmware and licenses (installing new firmware and granting licenses, see section 11.3),
- Restoring factory settings (see section 11.4).
- Change the language

Features available only for the SERVICE (ADMIN with service privileges):

- Calibration of measuring inputs.
- Deleting/moving the event log, authorization log and calibration log.

! The administrator password (the user ADMIN) in the new device is: **1**. Only in the new device is a single-digit ADMIN password for ease the first programming of the device. This password should be changed by an administrator to another soon after programming the device.

SERVICE password: Obtaining the service password is possible after contacting the manufacturer. To do this, generate the same digital code as if you forget the ADMIN password and provide it to the manufacturer.

4.7.1. Changing password by the user / administrator

Each user can change their own password. For this purpose, after login, in the **Main menu**, select the **Change password** option, and then enter a new password twice. Changing the administrator password is similar.

4.7.2. Retrieving forgotten passwords and obtaining service password

If a wrong password is entered by a user or an administrator during logging or authorization one of the following messages is displayed:
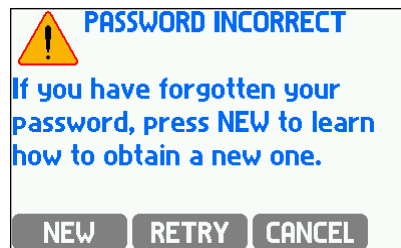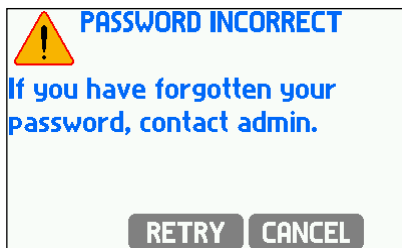
If a wrong password was entered by mistake press **RETRY** button and reenter the correct one.

If user forgot his password, the administrator can change it without knowing the forgotten password. However if administrator forgot his password he must contact the factory service. On screen, which is displayed after entering an incorrect password, press **NEW** button - a code will be displayed based on which manufacturer can generate a new password for the administrator.
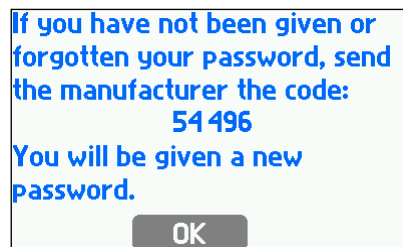
In the same way (i.e. by giving code) user can get a service password from manufacturer. To log in as a SERVICE select user **ADMIN** and enter a service password. Operator then has all entitlements of administrator and an access to calibration functions and can upload the service program to the device. However SERVICE user cannot change administrator's password.

4.7.3. Adding users and granting entitlements by the ADMIN

In the **Main menu → Administrative data** an administrator defines users and gives them entitlements, by selecting groups of features that the user will be able to perform after entering a password. After creating a new user, device generates a numerical password. The device does not allow to change the password to a very simple one (e.g. 11111). Each user has a separately-defined entitlements. Available to select are only those activities that previously had been declared as a password-protected. In this menu, the administrator can also change a user name and a user password or remove a user.

Users and entitlements submenu opens list of users and table of their entitlements.

Table rows correspond to users and columns to respective commands. Only those commands are displayed which require the authorization. In a frame under the table there is a command name corresponding to the column pointed with the cursor. Symbol **+** in the square means that the user is allowed for execution of a given command. To allow or forbid entitlement user have to point with a cursor the proper square and press the ALLOW or FORBID button. If a user is authorized to change main settings then automatically is also authorized for the remaining settings groups – then these squares are shadowed.

To add a new user the administrator has to place the cursor on the users list and press NEW ONE. After pressing MENU button, the bottom buttons change their function and enable to remove the user (REMOVE), to change the password (PASSWRD) and the user name (RENAME).

4.8. Archive screen

The information about archiving status is displayed on archive screen.
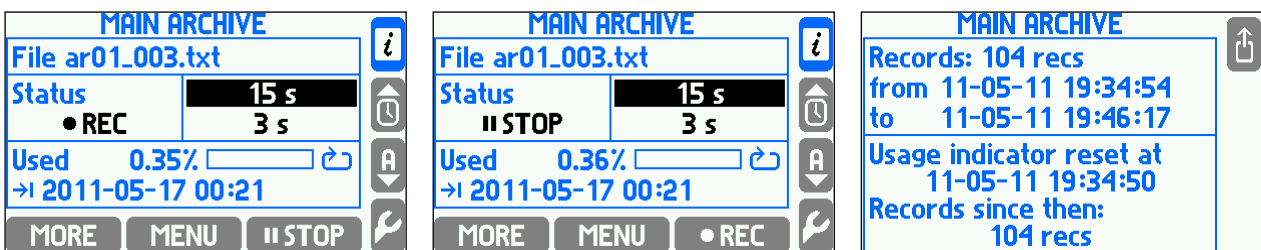
On the top the Main Archive file name is displayed. Below on left there is archiving status. It can be:

NO FILE   there is no current archive file,
STOP   the current archive file is in the internal memory but recording is stopped,
REC   data is being recorded,

FULL archiving has been stopped due to the maximum file size or lack of free space in the memory.

On the right there are displayed the first (higher) and the second (lower) recording speed. The actual speed is highlighted. Below there is a memory space usage indicator and expected date and time when the card space will be filled up. Usage forecast is always computed for the actual recording speed under the assumption that recording will be active all the time.

If the archive is set to overwrite mode the usage indicator may be reset. For this purpose **Reset usage indicator** command is used. It does not remove any records. After resetting indicator takes into account only these records which have been added to the archive since its resetting.

 MORE button allows to get the additional information: number of records in the archive, date and time of the youngest and the oldest record, date and time of usage indicator resetting as well as number of records saved since that time. If the indicator was not cleared, then the date and time of the reset is assumed as the time of the file creation.

4.9. Archiving control of the current results

The device has a 2GB internal memory, which is almost entirely allocated for the purpose of archiving results. The archiving control can be done at two locations in the menu:
- additional screen **MAIN ARCHIVE**
- → **Main menu** → **Archiving commands**

ARCHIVING COMMANDS menu includes:
- **Stop/Resume recording** of the results,
- **New file** – setting up a new Main Archive file,
- **Reset usage indicator** – memory full indicator,
- **Browse** archived results on the device screen
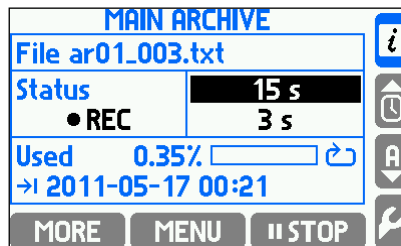
4.9.1. Creating a new Main Archive file

Creating a new data set for archiving can be done from two locations: the additional screen **MAIN ARCHIVE** or → **Main menu** → **Archiving commands**.

On the **MAIN ARCHIVE** screen select MENU → **New file** → →⌐ **.** Then appears the question: "Do you want to create a new Main Archive file?" Confirm with the button YES . After accepting the REC LED blinks green for a few seconds during the operation. In the internal memory of the device is created a text file: *ar[addr]_[count].txt.* The *addr* is a two-digit address of the device, and the *count* is the serial number of created file (in one

instrument it is impossible to create two archive files with identical name). An example of the file name: *ar01_004.txt.*

! ■   To distinguish between files from different devices is recommended to configure different addresses even when the RS-485 transmission is not used.

Then the message appears that the new archive has been created along with the estimated time of filling the internal memory, and question "*Do you want to START RECORDING ?*". To start archiving to the newly created file press button `YES` .
Function of creating a new archive can be password protected. User with entitlement to **Archiving commands** may not have permission to delete archived files.

Similarly, creation of the new archive file by pressing button `🔧` → **Main menu**→ **Archiving commands** → **New file**.

4.9.2.   Starting, resuming and stopping archiving

The most convenient way to start or stop the archiving process is using the **MAIN ARCHIVE** screen. When the archiving is stopped available is quick-start button `●REC` . If archiving is on, the same button takes the form of `⏸STOP` , and enables to stop the archiving. After stopping, user can resume recording by pressing the button `●REC` , then the archiving will continue, and the results are appended to the current file existing in the internal memory. Both, start and stop the archiving requires double confirmation. These functions can also be password protected.

Both functions can be also activated from the **MAIN ARCHIVE** screen: `MENU` → **Resume/Stop recording**
and from **Main menu**: `🔧` → **Archiving commands** → **Resume/Stop recording**.

4.9.3.   Memory usage indicator

The **MAIN ARCHIVE** screen provides information about percentage of data occupancy in the internal memory and the expected date and time of filling. This is only estimated time. In particular, when working with two recording speeds (for example, dependent on exceedances of alarm and control thresholds), this information may significantly fluctuate. Also archiving pause may extend that period.
In the **Successive files** archive mode, if a day / week / month limitation is selected, instead of the predictions device shows actual date and time of the next file creation.
In archive mode **Overwrite**, archive indicator can be reset. Using this, a user can marks the date and time when archive was read last time. Then the indicator means overwriting the results from the last reading. Resetting indicator index can be performed from the **MAIN ARCHIVE** screen: `MENU` → **Reset usage indicator** or from **Main menu**: `🔧` → **Archiving commands** → **Reset usage indicator**.

4.10. Browsing the archived measurement results

The results of measurements stored in the device's memory can be viewed on the display in the table or in graphical form. This feature is rather a preview. Advanced analysis of the results should be done on the computer using dedicated software, where the possibilities are much more extended.
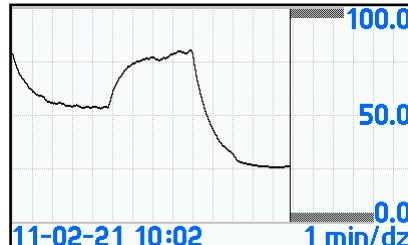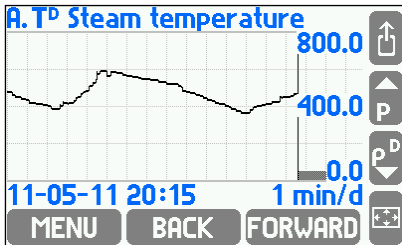
To enter results browser select: 🖋 → **Main menu** → **Archiving commands** → **Browse** or from detailed screen **Trend graph** with the button `ARCHIVE` or from the additional **MAIN ARCHIVE** screen with the button: `MENU`. Using the buttons `BACK` and `FORWARD` archive can be browse in time axis, and the buttons „▲" and „▼" can be changed subsequent archived results for the selected time interval.
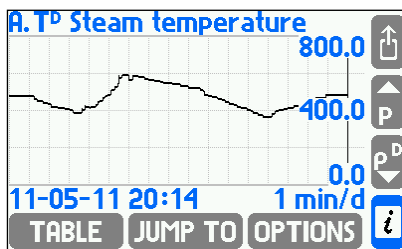
The scope of the presented time interval is dependent on the frequency of archived results (influenced by both of the frequency I and II) and cannot be changed while viewing.

Selected scope can be enlarged to full screen with the button 🔲(to return to the original size press any button). After pressing the button `MENU` additional browsing functions are available:

`JUMP TO` - searching the course of a specified date and time;

`TABLE` - presenting results in a table;

`OPTIONS` - following options:

- **Autoscaling** – automatic scaling of the y-axis plot, when values are out of defined range,
- **Substituted values** – show the assumed values during measurement failure (substituted measured values of the sensor while failure is detected, the correct function must also be enabled in the settings of measuring inputs),
- **Large chart legend**– axis scale in full screen mode (🔲).

4.11. Totaliser archive

Totalisers value are recorded in the Hourly Archive file which is created automatically if at least one totaliser or process value is declared for registration. There is always only one

Hourly Archive file even if settings were changed. When changes are completed only a new header is recorded to a file. When the file is deleted or moved from the internal memory, the device automatically creates a new one.

The name of totaliser archive file is *artot[addr].txt*, where *addr* is a double-digit device address in RS485 bus. The file can be copied or moved to an external USB memory device, and then transferred to a computer (see section 4.1.4). The data in the file are secured with control fields, that allow to determine whether they have been modified outside of the instrument.

> **!** To distinguish between files from different devices is recommended to configure different addresses even when the RS-485 transmission is not used.

4.12. Daily archive

Writing to the daily archive takes place once a day about the time selected in Nominal month beginning settings (see section 10.1). The name of totaliser archive file is *ar24h[addr].txt*, where *addr* is a double-digit device address in RS485 bus. The file can be copied or moved to an external USB memory device, and then transferred to a computer (see section 4.1.4).

4.13. Alarms and control

In the device can be set up to four alarm and control thresholds for most process values (exceptions - see section 10.9). Each threshold has the individually adjustable level of activation, hysteresis, "High" or "Low" mode and can realize the alarm function and / or the control function. Every threshold can be assigned also with a color (green, yellow, red). Exceeding the threshold is indicated by changing a color of the result to the color assigned with the alarm. When more thresholds are overrun the result color is changed to a color of the higher threshold.
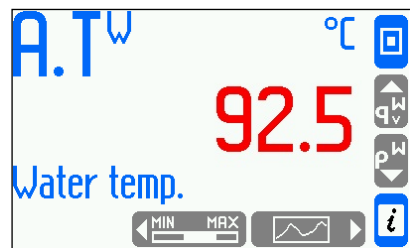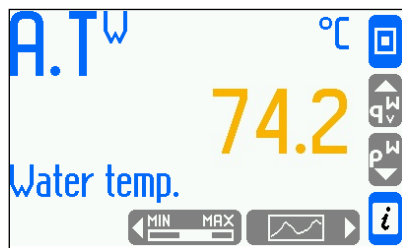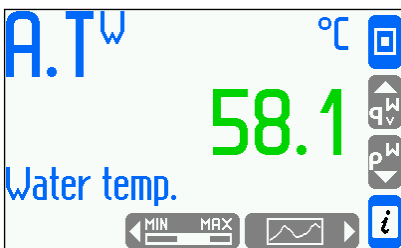
Alarm functions:
- Exceedances reporting – on the front panel the ALARM LED starts blinking in red, on the screen is displayed a message about the channel number and the date and time of the exceedance. If more exceedances are reported, the messages are queued. User can browse all notifications by pressing [OK] button or confirm all reports at once without browsing by pressing [ALL] button. After confirming all notifications the ALARM LED lights in red if at least one exceedance remains. If all exceedances are over, the ALARM LED turns off. If the notification of the same alarm reappears without previous confirmation, only the first message in the message queue is stored.

- Color change of a result for which the exceedance occurred (the result is displayed in a color assigned to the alarm and control thresholds).
- Excitation of the output relay – an alarm notification can be linked with excitation of the output relay (for example to connect the sound signalization). Confirmation of displayed notification ends the excitation of the relay. At the programming settings phase, user defines output relays and assign them to the appropriate alarm and control thresholds.
- Marking an exceedance on the "Alarm and control thresholds" screen – exceeding of the alarm and control thresholds is shown graphically on the screen in a form of symbols ▲ or ▼ respectively for the upper and lower excess and with the color assigned to a particular threshold. On this screen are shown simultaneously control exceedances.
- Recording the exceedances in the Event log - exceedances can be recorded in the Event log, depending on the programming, recorded can be just a notification about exceedance, the notification and its ending or just ending. Confirmation about the notification of message is not recorded.
- When GSM module is connected to RS485 port and alarm occurs text messages with information about it can be sent to the specified phone numbers.

4.14. Control functions

Using four alarms and control thresholds (with hysteresis) assigned to the results, and four freely programmable output relays, the device can perform simple "on / off" control functions. Control does not require user support. User can preview the status of the threshold on the detailed screen of the **ALARM AND CONTROL THRESHOLDS** and the state of output relays on the additional screen **RELAY OUTPUTS** if these screens have not been hidden when programming the device. Exceeding the thresholds during the control can also be recorded in the event log.

4.15. Failure notification

Failures associated with particular channels are marked with appropriate symbol on the display.
Symbols of failure:
- -F- RTD sensor failure, lack of communication via HART or RS485;
- -||- 4-20mA transducer failure, current below 3.6mA;
- -E- 4-20mA transducer failure, current above 22mA;
- -S- steam parameters below saturation curve (only when detection of steam saturation is on, see section 10.4.6);
- -R- exceeding the range;
- -W- wait;
- -C- internal communication error.

Symbols of failure are displayed instead of the result for all related channels, eg. for measurement input and the calculation channel in which the result is used.
No signal from the sensor (in FP-3011/FP-3031) or the lack of communication with the sensor (in FP-3021) assigned to the particular input is treated as a failure and marked on the display with the "-F-" (failure) symbol.
Detection of a failure may trigger displaying the appropriate message and then require confirmation by the user even if the cause of the failure ended earlier. Depending on the settings during programming the device, a failure may cause the excitation of

corresponding output relay till the confirmation or for the entire duration of failure. Failure and its disappearance may be recorded in the event log. When GSM module is connected to RS485 port and alarm occurs text messages with information about it can be sent to the specified phone numbers.

4.16. User defined characteristics

For 4-20mA analog inputs, and the PULS type inputs, it is possible to add the user's characteristics (for transmitters that are not linear nor square-root). The characteristic can be added to the device using an external memory. Uploading/deleting characteristics can be run as an authorized function and requires the password. The device can store up to 16 different characteristics. (see section 10.8.7).

4.17. Audit trial

The device has four logs to record various types of measuring events and activities performed by a user. These are: the totaliser log, the event log, the authorization log and the calibration log. The content of: the totaliser log, the event log, the authorization log and the calibration log can be viewed on the device display. In addition, the event log and the authorization log are available as text files.

4.17.1. Totaliser log

Once a month the totaliser log is saved for all enabled totalisers including information about the time in which the instrument was turned on during the month. The data is recorded on the day and the hour indicated in the settings in **Nominal month beginning**. In the log are stored 13 last records.

4.17.2. Event log

In the event log are recorded:
- power supply turning on and off,
- settings change,
- date or hour change,
- resetting of maximum, minimum and average values,
- resetting of totalisers,
- beginning and the end of declared thresholds crossing,
- beginning and the end of superheated steam saturation,
- beginning and the end of declared input signal failure,
- change of state of selected binary inputs.

The date and time of each event occurrence is recorded. The device display enables to view the last 500 events. The log is also available as a text file that can be copied and read on a computer (see section 4.1.4.1).

In settings a user should declare which thresholds crossing are to be recorded (submenu **Event**), in which systems steam saturation is to be recorded system (submenu **Steam saturation**), which analog inputs failure should be recorded and for which binary inputs shorting (closing) and opening should be recorded (submenu **Actions when failure**, **Actions when closed** and **Actions when open**).

```
A.Pᴰ - THRESHOLD 1        ⬆
▲Alarm       → None
  Control     → None
 Event       → Crossing
Crossing and releasing    ▲
may be recorded in the    ▼
          event log.
CHANGE                    i
```

```
STEAM SATURATION          ⬆
▲Alarm       → None
  Control     → None
 Event       → Both
The steam saturation      ▲
and superheating may      ▼
          be recorded in
CHANGE   the event log.   i
```

```
ACTIONS WHEN FAILURE      ⬆
  Alarm       → None
  Control     → None
 Event       → Recovery
A measurement failure     ▲
and its recovery may be   ▼
          recorded in
CHANGE   the event log.   i
```
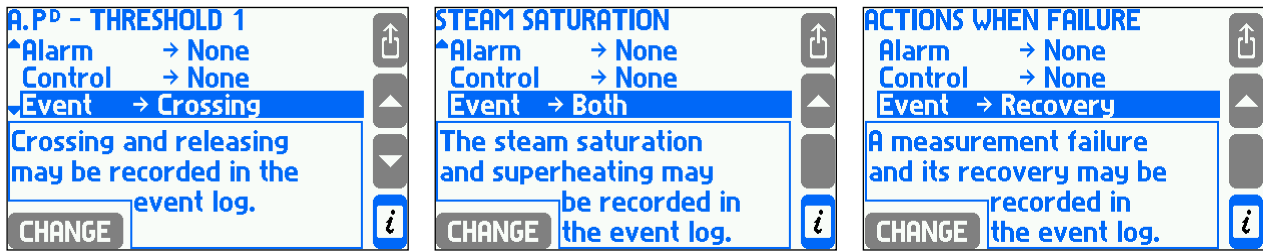
4.17.3. Authorization log

In authorization log is recorded each execution of one of commands listed below but only when the respective command requires authorization (is password protected), (see section 4.7). These are:

- creation of a new main archive file,
- resumption or stopping of archive recording
- resetting of maximum, minimum and average values,
- resetting of totalisers,
- date and hour change,
- change of main settings (all except of listed below),
- change of thresholds settings (value and hysteresis value),
- change of display settings (screens configuration, backlit and contrast of display),
- change of archiving settings (recording interval, set of archived values and recording mode),
- loading of new settings from a file,
- installation new firmware.

The date and time of each authorized activity is recorded. The device display enables to view the last 500 events. The log is also available as a text file that can be copied and read on a computer (see section 4.1.4.1).

4.17.4. Calibration log

In the calibration log each calibration procedure performed by the service or the manufacturer is recorded. Each record includes the following information:

- date and hour of execution,
- service executor (serviceman or manufacturer),
- type of procedure: analog input calibration, temperature drift calibration and removal of all previous calibration.

In the log are stored 50 last calibration procedures. The log is not available in the form of a text file, and can be viewed only on the device display.

4.17.5. Logs browsing on device display

To browse logs, user should log in first. Totaliser log and event log may be browsed by any user whereas authorization log and calibration log is available only for administrator. To browse logs user has to choose the **Audit trail** submenu from the main menu.
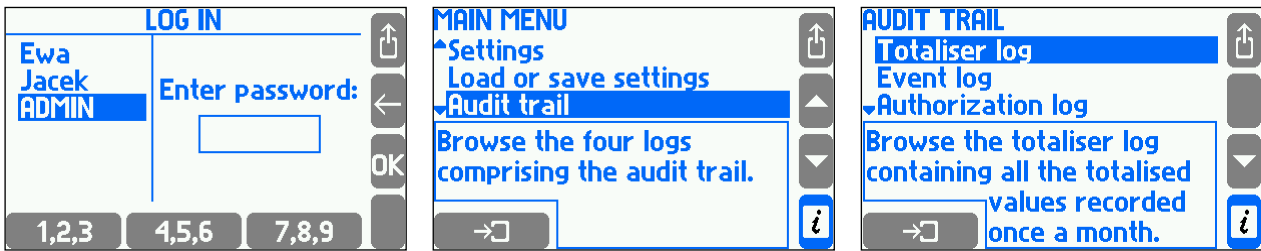
After selecting the totaliser log, the device displays a list of dates and times of available entries. The user should select the right entry and application, then device displays the symbols and states of totalisers in the list.
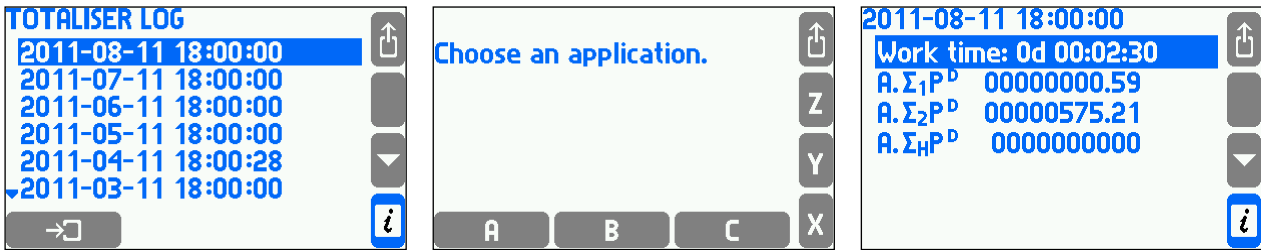
Other logs are displayed in form of a scrolled list. Each line corresponds to one record (event or action). Simultaneously on display there are visible three records. In a frame underneath, additional information about highlighted record is displayed.
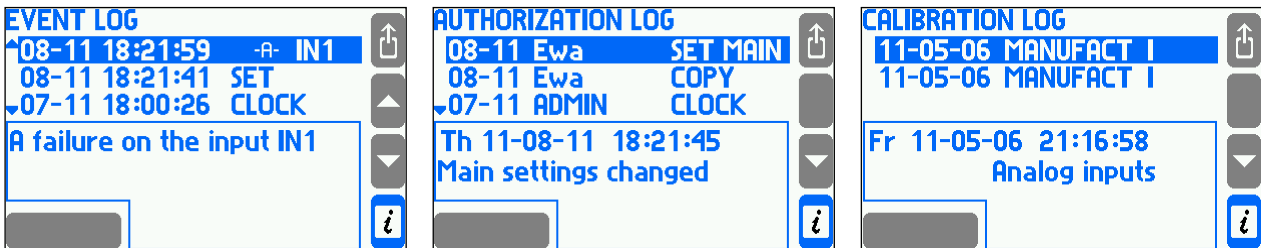
4.17.6. Event, authorization and settings logs

The Event log and Authorization log are available for the user in the form of a txt file. (where *addr* is a double-digit unit address in RS485 bus).

File name	Type of file
a_log[adr].txt	Authorization log file
e_log[adr].txt	Event log file
s_log.dat	Settings log file

! To distinguish between files from different devices is recommended to configure different addresses even when the RS-485 transmission is not used.

The files are created automatically, and their removal is possible only for the SERVICE user.

Log files can be copied to an external USB flash drive, and then transferred to a computer (see section 4.1.4.1). This feature may be password-protected activity. The data

in the file are secured with control fields, that allow to determine whether they have been modified outside of the instrument.

4.17.7. Remote logs browsing

The FP-3000-RAPORT program allows browsing the content of the event log and the authorization log using the RS-485 port. In this way can be read records and files from internal 2 GB data memory.

5. INTERNAL MEMORY

In the device data are recorded in the internal memory of 2 GB. This capacity provides a record of relatively large amounts of data (see table). The internal memory can hold up to 250 files.

It is necessary to make frequent backups of recorded data. To do this data must be periodically copied from the device to a PC hard drive, data carriers (e.g. CD) or as prints. In the internal memory are stored:

- the main archive (archive of process values),
- totalisers archive,
- event log and authorization log files.

Three modes of data recording to the main archive are available: **Overwrite, One file, Successive file.** In **Overwrite** mode the oldest files are overwritten. In **One file** mode archive is carried until the file reaches the size declared in **File Size. Successive file** continue recording after reaching the size declared in **File Size**. In this mode a new file is created automatically.

A **File size** of the main archive can be limited be a user (see section 10.12.1).

Data stored in the internal memory can be:

- read to computer using RS-485 port. Due to slow data transmission in this configuration, data should be read relatively often.
- data files (logs and archives of process values and) can be copied from the device to a USB flash drive and then read on a computer.

Table 3.1. Sample times of data recording in the internal memory of 2 GB.
Warning! The values are indicative.

Recording frequency	3 s	10 s	30 s	1 min	5 min	10 min
16 results	over a year	over 4 years	over 10 years	over 20 years	over 130 years	over 260 years
8 results	over 2 years	over 7 years	over 20 years	over 40 years		
4 results	over 3 years	over 10 years	over 30 years			
1 result	over 4 years	over 15 years	over 40 years			

6. TECHNICAL SPECIFICATION

Compensated flow and heat energy measurement (FP-3011(N); FP-3021(N); FP-3031(N))	
Accuracy of compensated steam, water, other liquid or technical gas flow	< 2% (typically < 0.5%)
Frequency of measurement and calculation results	1 s

User interface, front panel (FP-3011(N); FP-3021(N); FP-3031(N))	
Display type	LCD TFT colour, 272x480 px
Readout field size	43.8 mm x 77.4 mm
LED indication	3 LEDs, 3-colour, red-orange-green
Keyboard	FP-3011, FP-3021: 7 membrane buttons FP-3011N, FP-3021N, FP-3031, FP-3031N: 19 membrane buttons

Inputs organization		
FP-3011, FP-3011N	2 x RTD/I:	IN1, IN2
	1 x I:	IN3
	2 x I/PULS:	IN4, IN5
FP-3021, FP-3021N	1 x HART:	IN1, IN2, IN3, IN4, IN5
	1 x RS-485:	
	2 x PULS:	IN6, IN7
FP-3031, FP-3031N	3 x RTD/I:	IN1, IN2, IN3
	4 x I:	IN4, IN5, IN6, IN7
	3 x I/PULS:	IN8, IN9, IN10

RTD analogue inputs (FP-3011(N); FP-3031(N))	
Sensor types	Pt-100 x K, Ni-100 x K (K = 1..11) K – multiplier, e.g.: K = 2 for Pt-200
Measuring range	-200 .. +850 °C for Pt100 x K -60 .. +150 °C for Ni100 x K
Sensor connection	2- or 4-wire
Wire resistance compensation	Manual, in range -99.99 .. +99.99 Ω
Maximum resistance of connecting wires	50 Ω
A/D converter resolution	18 bits
Accuracy (at T_a = +20 °C)	± 0.5 °C (typically ± 0.3 °C)
Temperature drift	Max ± 0.02 °C / °C
Galvanic isolation between channels	No, common potential GND for all inputs
Galvanic isolation from supply voltage	400 VAC (functional isolation)

0/4-20 mA type analogue inputs (FP-3011(N); FP-3031(N))	
Signal type	0-20mA or 4-20mA
Transmitter connection	Passive transmitter (supplied from measuring loop) or active converter
Input resistance	100 Ω ±10%
Transmitters supply	24 VDC / max 22 mA

A/D converter resolution	18 bits
Accuracy (at T_a = 20 °C)	±0.1% of the range (typically ±0.05% of the range)
Temperature drift	Max ±50 ppm / °C
Galvanic isolation between inputs	No, common potential GND for all inputs
Galvanic isolation from supply voltage	400 VAC (functional isolation)
PULS type inputs (binary/pulse/frequency) **(FP-3011(N); FP-3021(N); FP-3031(N))**	
Maximum input voltage	±28 VDC
Galvanic isolation between inputs	No, common potential GND for all inputs
Galvanic isolation from supply voltage	400 VAC (functional isolation)
Functions	State detection Pulse counting Frequency measurement
Measuring range	0.001 Hz .. 10 kHz (0.001 Hz .. 1 kHz with filtrating capacitor)
Minimum impulse width	20 µs 0.5 ms, with filtrating capacitor
Accuracy (at T_a = 20 °C)	0.02%
Configuration: OC/contact[1]	
Open circuit voltage	12 V
Short circuit current	12 mA
On/off threshold	2.7 V / 2.4 V
[1]The default setting.	
Configuration: voltage input	
Input resistance	>10 kΩ
On/off threshold	2.7 V / 2.4 V
Open circuit voltage	12 V
Configuration: Namur	
High impedance state	0.4 .. 1 mA
Low impedance state	2.2 .. 6.5 mA
SERIAL PORT RS-485 (1) **(FP-3021(N))**	
Transmission protocol	Modbus RTU
Data format	Uns. Integer, Integer, Uns. Long, Uns. Long (sw), Long, Long (sw), Float, Float (sw)
Frequency of reading	3 s, 4 s, 5 s, 6 s, 10 s, 12 s, 15 s, 30 s, 1 min
Baud rate	1.2, 2.4, 4.8, 9.6, 19.2, 38.4, 57.6, 115.2 kbps
Transmitter address space	1 .. 247
Maximum load	32 receivers/transmitters
Maximum line length	1200 m
Maximum differential voltage A(+) – B(-)	-7 V .. +12 V
Maximum total voltage A(+) – 'ground' or B(-) – 'ground'	-7 V .. +12 V
Minimal output signal from transmitter	1.5 V (for R_0 = 54 Ω)
Minimum receiver sensitivity	200 mV / R_{IN} = 12 kΩ
Minimum impedance of data transmission line	54 Ω

Internal terminating resistor	Yes, activated by short-circuit pins on terminal block
Short-circuit/thermal protection	Yes/Yes
Lines derived in terminal block	A(+), B(-), GND RS, +5 V RS (max 10mA), T(+), T(-)
Galvanic isolation from supply voltage	400 VAC (functional isolation)

HART (FP-3021(N))	
Transmission protocol	Master type 0 or 1 rev.4, rev.5, rev.6.; FSK
Implemented features	Reading variables PV, SV, TV, FV Retrieve long address (rev.5., rev.6.) Change of short address
Multidrop mode	Yes, up to 12 devices
Loop power	24 VDC (max 50 mA)
Analog line 4-20mA reading	No
Galvanic isolation from supply voltage	400 VAC (functional isolation)

4-20 mA analogue output (optional)	
Number of outputs	FP-3011, FP-3011N: 1 FP-3021, FP-3021N: 1 FP-3031, FP-3031N: 1 or 2
Output signal	4-20 mA (3.6-22 mA)
Maximum voltage between I+ and I-	28 VDC
Loop resistance (at U_{cc} = 24 V)	0 .. 500 Ω
Converter resolution D/A	16 bits
Accuracy	0.5%
Current loop supply	External or internal power supply 24 VDC / 22 mA
Galvanic isolation from supply voltage	400 VAC (functional isolation)

Binary outputs – Solid State Relays (FP-3011(N); FP-3021(N); FP-3031(N))	
Number of outputs	4
Type of outputs	Solid State Relays
Maximum load current	100 mA DC/AC
Maximum voltage	60 V DC/AC
Galvanic isolation between outputs	400 VAC (functional isolation)
Galvanic isolation from supply voltage	400 VAC (functional isolation)

RS-485 serial port (FP-3011(N); FP-3031(N)) and RS-485 (2) serial port (FP-3021(N))	
Maximum load	32 receivers/transmitters
Maximum line length	1200 m
Maximum differential voltage A(+) – B(-)	-7 .. +12 V
Maximum total voltage A(+) – 'ground' or B(-) – 'ground'	-7 .. +12 V
Minimal output signal from transmitter	1.5 V (for R_0= 54 Ω)
Minimum receiver sensitivity	200 mV / R_{IN} = 12 kΩ
Minimum impedance of data transmission line	54 Ω
Internal terminating resistor	Yes, activated by short-circuit pins on

	terminal block
Short-circuit/thermal protection	Yes/Yes
Transmission protocol	ASCII Modbus RTU
Baud rate	2.4, 4.8, 9.6 ,19.2, 38.4, 57.6, 115.2 kbps
Parity control	Even, Odd, None
Frame	1 start bit, 8 data bits, 1 stop bit
Galvanic isolation	No
Ethernet port (FP-3011(N); FP-3021(N); FP-3031(N))	
Transmission protocol	Modbus TCP, ICMP (ping), DHCP server, http server
Interface	10BaseT Ethernet
Data buffer	300 B
Number of opened connections (simultaneously)	4
Connector type	RJ-45
LED indication	2 (build in RJ-45 socket)
USB port (FP-3011(N); FP-3021(N); FP-3031(N))	
Socket type	A type, according to USB standard
Version	USB 1.1
Socket protection class	IP54
Recording format	FAT16 (within a limited scope)
Recording indication	red-orange-green LED on the front panel
Internal data memory (FP-3011(N); FP-3021(N); FP-3031(N))	
Capacity	2 GB
Data format	Text, FAT16
Recording indication	red-orange-green LED on the front panel
FP-3011, FP-3021, FP-3031 power supply	
Supply voltage	24 VAC (+5%/-10%) or 24 VDC (15 .. 30 VDC)
Maximum power consumption	FP-3011: 6 VA / 6 W FP-3021: 5 VA / 5 W FP-3031: 14 VA / 14 W
FP-3011N, FP-3021N, FP-3031N power supply	
Supply voltage	100-240VAC 50/60 Hz or 24 VAC (+5%/-10%) or 24 VDC (15 .. 30 VDC)
Maximum power consumption FP-3011N	16 VA / 16 W (for 100 .. 240 VAC power supply) 6 VA / 6 W (for 24 VAC/VDC power supply)
Maximum power consumption FP-3021N	14 VA / 14 W (for 100 .. 240 VAC power supply) 5 VA / 5 W (for 24 VAC/VDC power supply)
Maximum power consumption FP-3031N	28 VA / 28 W (for 100 .. 240 VAC power supply) 14 VA / 14 W (for 24 VAC/VDC power supply)

FP-3011, FP-3021, FP-3031 enclosure – dimensions	
Enclosure type	Panel mount, nonflammable plastic material 'Noryl'
Dimensions (width x height x depth)	FP-3011: 144 mm x 72 mm x 130 mm FP-3021: 144 mm x 72 mm x 130 mm FP-3031: 192 mm x 96 mm x 63.5 mm
Enclosure depth with terminals	FP-3011: ca. 140 mm FP-3021: ca. 140 mm FP-3031: ca. 72 mm
Panel cut-out dimensions (width x height)	FP-3011: 138^{+1} mm X $68^{+0.7}$ mm FP-3021: 138^{+1} mm X $68^{+0.7}$ mm FP-3031: $186^{+1.1}$ mm X $92^{+0.6}$ mm
Panel maximum thickness	5 mm
Weight	FP-3011: ca. 0.5 kg FP-3021: ca. 0.5 kg FP-3031: ca. 0.7 kg
Protection class from the front panel	IP54
Protection class from the rear panel	IP30
FP-3011N, FP-3021N, FP-3031N enclosure – dimensions	
Enclosure type	Wall mount, PC material
Dimensions (width x height x depth)	257 mm X 217 mm X 125 mm (without cable glands) 257 mm X 247 mm X 125 mm (with cable glands)
Weight	ca. 2.1 kg
Protection class	IP54
Environmental conditions	
Ambient temperature	FP-3011: 0° .. +50°C FP-3021: 0° .. +50°C FP-3031: 0° .. +40°C FP-3011N: -20° .. +50°C FP-3021N: -20° .. +50°C FP-3031N: -20° .. +40°C
Relative humidity	0 .. 75% (without steam condensation)
Storage temperature	-20 .. +80 °C
Overvoltage category	OV II
Pollution degree	PD 2
LVD (safety)	EN 61010-1
EMC	EMC Directive 2014/30/EU: – immunity for industrial environments according to EN 61326-1:2013 (Table 2) – conductive and radiated emissions Class A equipment according to EN 61326-1:2013
RoHS	Directive 2011/65/EU
Installation location	FP-3011, FP-3021, FP-3031: solely indoor FP-3011N, FP-3021N, FP-3031N: indoor or outdoor[1]

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

7. COMPLETE DELIVERY AND ACCESSORIES

Prior to shipment, each product Metronic AKP is tested, calibrated and inspected to ensure proper operation.

Warning
Each carton should be unpacked carefully and its contents checked for damage. If it is found that some items have been damaged or are missing, notify Metronic AKP immediately and provide full details.

7.1.   Content of FP-3011

- Flow computer FP-3011 –x–y   1 pcs.
- Fixing clamps   2 pcs.
- Warranty   1 pcs.
- Calibration card   1 pcs.
- Terminal blocks   1 set
- Cartoon package   1 pcs.

7.2.   Content of FP-3021

- Flow computer FP-3021 –x–y   1 pcs.
- Fixing clamps   2 pcs.
- Warranty   1 pcs.
- Terminal blocks   1 set
- Cartoon package   1 pcs.

7.3.   Content of FP-3031

- Flow computer FP-3031 –x–y   1 pcs.
- Fixing clamps   4 pcs.
- Warranty   1 pcs.
- Calibration card   1 pcs.
- Terminal blocks   1 set
- Cartoon package   1 pcs.

7.4.   Content of FP-3011N

- Flow computer FP-3011N –x–y   1 pcs.
- Warranty   1 pcs.
- Calibration card   1 pcs.
- Cartoon package   1 pcs.

7.5.   Content of FP-3021N

- Flow computer FP-3021N –x–y   1 pcs.
- Warranty   1 pcs.

- Cartoon package　　　　　　　　　　　　　　　　　　　　1 pcs.

7.6.　Content of FP-3031N

- Flow computer FP-3031N –x–y　　　　　　　　　　　　1 pcs.
- Warranty　　　　　　　　　　　　　　　　　　　　　1 pcs.
- Calibration card　　　　　　　　　　　　　　　　　　1 pcs.
- Cartoon package　　　　　　　　　　　　　　　　　　1 pcs.

7.7.　Accessories

- Converter with galvanic isolation CONV 485USB-I (USB / RS-485)
- Service converter without galvanic isolation CONV 485USB (USB / RS-485)
- Converter CONV 485 E (Ethernet / RS-485)
- GSM Module
- Software for data processing and visualization FP-3000-RAPORT
- Software for setup configuration FP-30x1-PMU
- Power supply transformer, manufactured by Breve PSS 10 VA, 230 V AC / 24 V AC
- Power supply transformer, manufactured by Breve PSS 30 VA, 230 V AC / 24 V AC
- 6A/230V AC relay with LED indication designed to mount to the TS-35 profile type PI6-1P-24VAC/DC, manufactured by Relpol SA

Notes
The device operating manual, configuration software and visualization software can be downloaded from the manufacturer's website www.metronic.pl.

CONV485USB-I, CONV485USB and CONV485E convertors (Metronic AKP)

PSS30 230V /24V i PSS10 230V/24V transformers manufactured *by BREVE and PI6-1P 24VAC/DC relay* manufactured by *Relpol SA (all components* designed to mount to the *TS-35 profile)*

GSM Module

8. INSTALLATION AND ELECTRICAL CONNECTION

8.1. Mechanic installation

The flow computers FP-3011, FP-3021 and FP-3031 are devices designed for panel surface mounting. The device may be mounted on panels with wall thickness not less than 1 mm. Dimensions of rectangular hole needed for mounting the device in a wall panel are given in the table below.

	FP-3011 / FP-3021	FP-3031
Mounting cut-out in panel – width	138 $^{+1}$ mm	186 $^{+1,1}$ mm
Mounting cut-out in panel – height	68 $^{+0,7}$ mm	92 $^{+0,6}$ mm
Depth of mounting	ok. 127 mm	ok. 72 mm

For convenient installation of electric cables it is recommended to leave about 30 mm additional space at the rear side of the device. When mounting the device a seal between panel wall and the frame should be fixed. Once embedded, the mounting brackets should be latched on its side walls and then tighten with screws. Using detachable terminals allow to the electrical installation before mounting the device.

The FP-3011N, FP-3021N and FP-3031N devices are suitable for wall mounting. Housing dimensions without cable glands is 217 mm X 257 mm X 125 mm (height x width x depth).
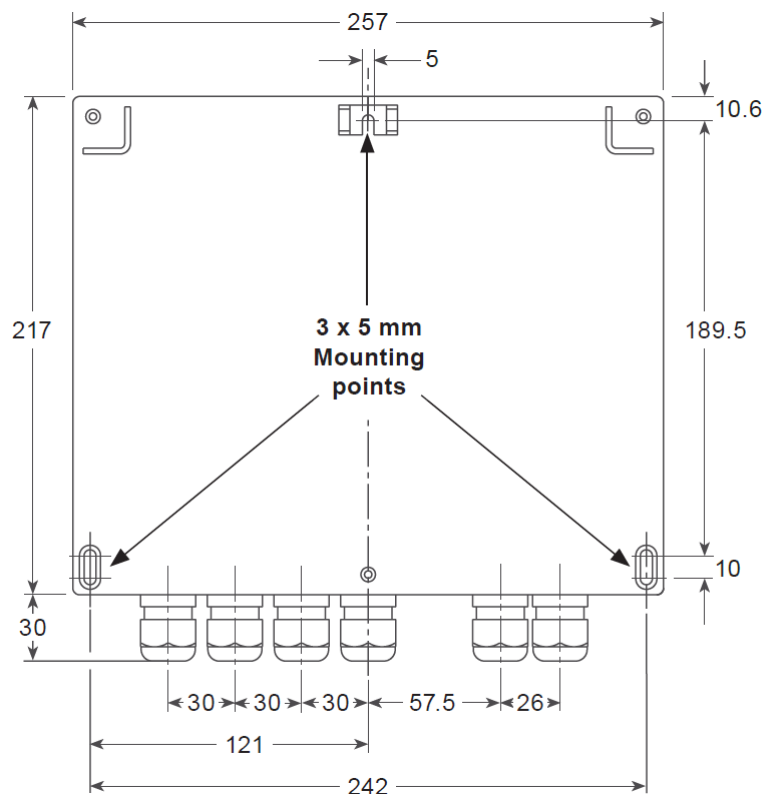
Mounting of wall-mounted devices

! The device should be mounted so as to avoid direct heating by other devices. It should be placed in a location distant from elements with high electromagnetic disturbance emission (power relays, frequency converters).

8.2. Galvanic isolation
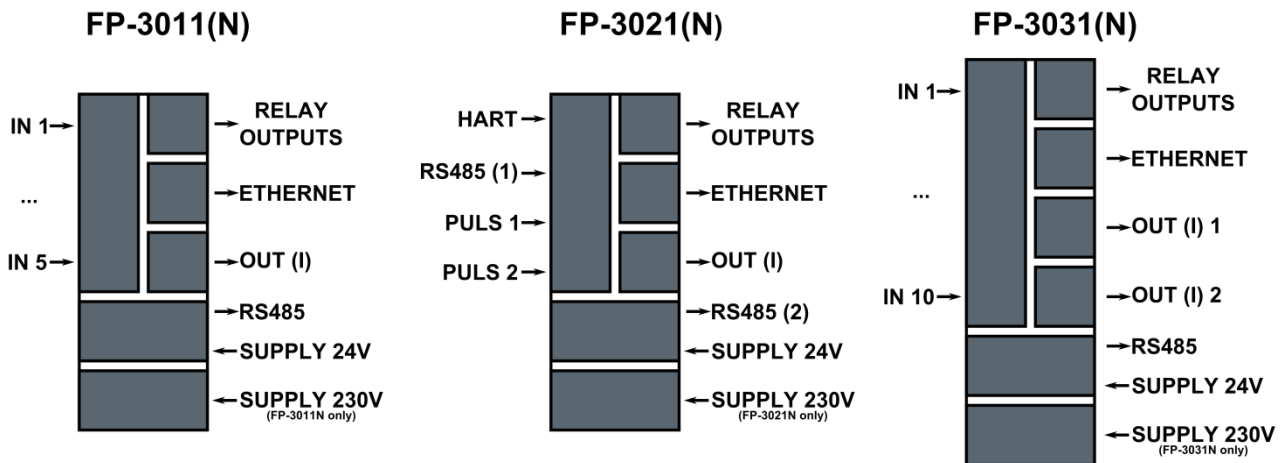
Galvanic isolation in FP-30x1(N) devices.

8.3. Electrical connection of FP-3011 and FP-3011N

In the FP-3011 device there are 21 plugged-in screw terminals at rear panel of the device. Terminals enable connection of wires up to 1.5 mm^2 cross section.

In FP-3011N all electrical terminals are located at the bottom in front of the device. The spring terminals allow to connect cables from 0,2 mm^2 to 1.5 mm^2 cross section. It is recommended to use cables with diameter as small as possible because of the need for pass a large number of cables through the cable glands.

Cables should be isolated on the section of 8 mm to 10 mm at the end. Terminals are adjusted to use cables either type of single thick wire and multiple thin wires. In case of use thicker field cabling it is necessary to apply an intermediate junction block between cables and the device.

Terminal no.	FP-3011(N) - terminal description		
1	RTD I+		
2	RTD U+	RTD	
3	RTD U-		
4	RTD I- /GND		IN 1
5	+24 V OUT		
6	I+	0/4-20mA	
7	I- /GND		
8	RTD I+		
9	RTD U+	RTD	
10	RTD U-		
11	RTD I- /GND		IN 2
12	+24 V OUT		
13	I+	0/4-20mA	
14	I- /GND		
15	+24 V OUT		
16	I+	0/4-20mA	IN 3
17	I- /GND		
18	+24 V OUT		
19	I+	0/4-20mA	IN 4
20	I- /GND		

21	F+	PULS	
22	F- /GND	PULS	
23	+24 V OUT	0/4-20mA	IN 5
24	I+	0/4-20mA	IN 5
25	I- /GND	0/4-20mA	IN 5
26	F+	PULS	IN 5
27	F- /GND	PULS	IN 5
28	+24 V OUT	4-20 mA ANALOG OUTPUT (optional)	
29	OUT I+	4-20 mA ANALOG OUTPUT (optional)	
30	OUT I-	4-20 mA ANALOG OUTPUT (optional)	
31	+/~	RELAY OUTPUT 60V/0,1A (PK1)	
32	-/~	RELAY OUTPUT 60V/0,1A (PK1)	
…	…	…	
37	+/~	RELAY OUTPUT 60V/0,1A (PK4)	
38	-/~	RELAY OUTPUT 60V/0,1A (PK4)	
39	+	RS-485 SERIAL PORT	
40	T+	RS-485 SERIAL PORT	
41	A+	RS-485 SERIAL PORT	
42	B-	RS-485 SERIAL PORT	
43	T-	RS-485 SERIAL PORT	
44	G	RS-485 SERIAL PORT	
45	PE	FP-3011 & FP-3011N POWER SUPPLY (24 V DC/AC)	
46	+24 VDC/ 24VAC	FP-3011 & FP-3011N POWER SUPPLY (24 V DC/AC)	
47	-24 VDC/ 24VAC	FP-3011 & FP-3011N POWER SUPPLY (24 V DC/AC)	
L (phase)		FP-3011N POWER SUPPLY (230 VAC)	
N (neutral)		FP-3011N POWER SUPPLY (230 VAC)	
PE (Protective earth/ground)		FP-3011N POWER SUPPLY (230 VAC)	
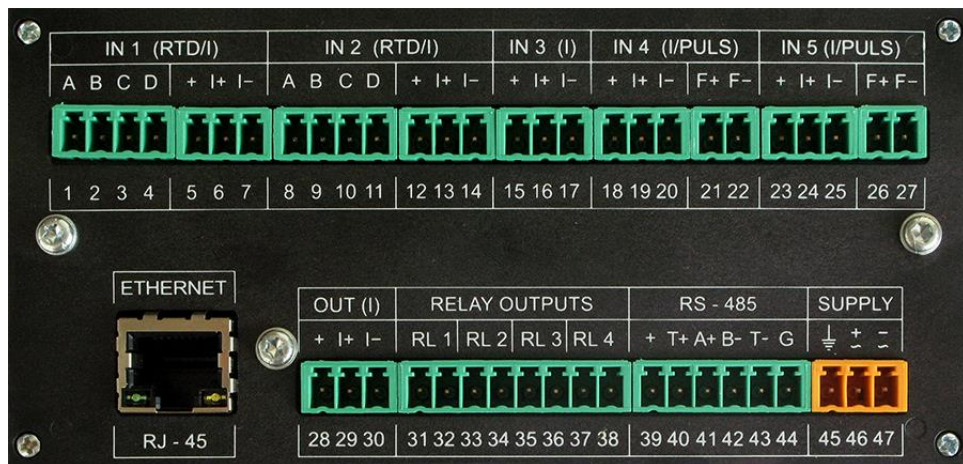
View of the rear plate of the FP-3011.

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View of the terminal block of the FP-3011N.

8.4. Electrical connection of FP-3021 and FP-3021N

In the FP-3021 device all electrical circuits are wired to screw terminals at rear panel of the device. Terminals enable connection of wires up to 1.5 mm^2 cross section.

In FP-3021N all electrical terminals are located at the bottom in the front of the device. The spring terminals allow to connect cables from 0,2 mm^2 to 1.5 mm^2 cross section. It is recommended to use cables with diameter as small as possible because of the need for pass a large number of cables through the cable glands.

Cables should be isolated on the section of 8 mm to 10 mm at the end. Terminals are adjusted to use cables either type of single thick wire and multiple thin wires. In case of use thicker field cabling it is necessary to apply an intermediate junction block between cables and the device.

Terminal no.	FP-3021 - terminal description	
1	+24V	HART
2	I+	
3	I-	
4	+	RS-485 (1) SERIAL PORT
5	T+	
6	A+	
7	B-	
8	T-	
9	G	
10	F+	PULS 1
11	F-	
12	F+	PULS 2
13	F-	
14	+24V	4-20 mA ANALOG OUTPUT (optional)
15	I+	
16	I-	
17	+/~RL1	RELAY OUTPUT RL 1 (0,1A/60V)
18	-/~ RL1	
19	+/~ RL2	RELAY OUTPUT RL 2 (0,1A/60V)
20	-/~ RL2	

21	+/~ RL3	RELAY OUTPUT RL 3 (0,1A/60V)
22	-/~ RL3	
23	+/~ RL4	RELAY OUTPUT RL 4 (0,1A/60V)
24	-/~ RL4	
25	+	RS-485 (2) SERIAL PORT
26	T+	
27	A+	
28	B-	
29	T-	
30	G	
31	PE	POWER SUPPLY
32	+/~ 24V	
33	-/~ 24V	
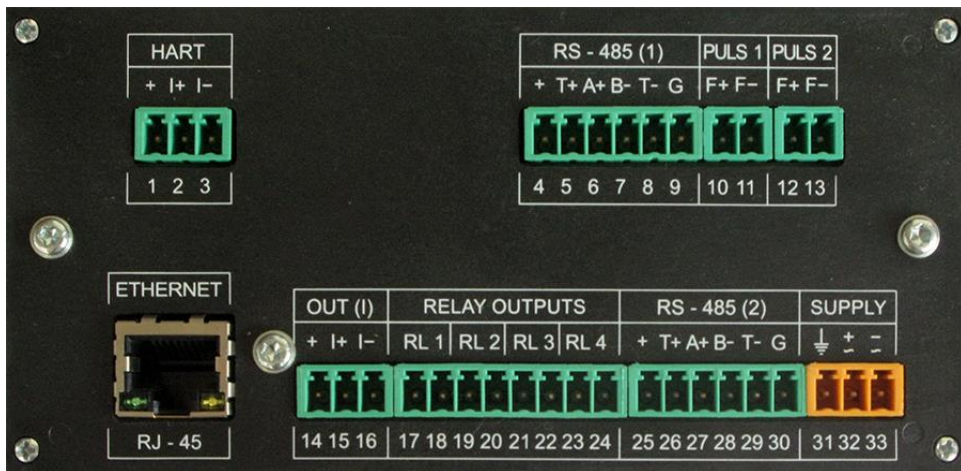
View of the rear plate of the FP-3021.

Terminal no.	FP-3021N - terminal description	
1	+24V	HART
2	I+	
3	I-	
4	+	RS-485 (1) SERIAL PORT
5	T+	
6	A+	
7	B-	
8	T-	
9	G	
10	F+	PULS 1
11	F-	
12	F+	PULS 2
13	F-	
16	+24V	4-20 mA ANALOG OUTPUT (optional)
17	I+	
18	I-	
19	+/~RL1	RELAY OUTPUT RL 1 (0,1A/60V)
20	-/~ RL1	

21	+/~ RL2	RELAY OUTPUT RL 2 (0,1A/60V)
22	-/~ RL2	
23	+/~ RL3	RELAY OUTPUT RL 3 (0,1A/60V)
24	-/~ RL3	
25	+/~ RL4	RELAY OUTPUT RL 4 (0,1A/60V)
26	-/~ RL4	
27	+	RS-485 (2) SERIAL PORT
28	T+	
29	A+	
30	B-	
31	T-	
32	G	
33	PE	POWER SUPPLY 24 V
34	+/~ 24V	
35	-/~ 24V	
L (phase)		POWER SUPPLY 230 VAC
N (neutral)		
PE (protective earth/ground)		
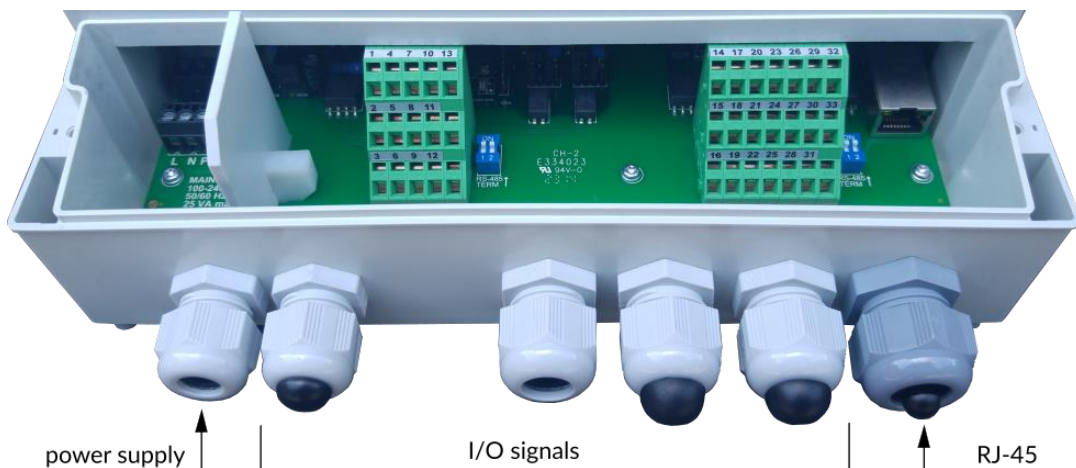
View of the terminal block of the FP-3021N.

8.5. Electrical connection of FP-3031 and FP-3031N

In the FP-3031 device all electrical circuits are wired to screw terminals at rear panel of the device. Terminals enable connection of wires up to 1.5 mm^2 cross section.

In FP-3031N all electrical terminals are located at the bottom in the front of the device. The spring terminals allow to connect cables from 0,2 mm^2 to 1.5 mm^2 cross section. It is recommended to use cables with diameter as small as possible because of the need for pass a large number of cables through the cable glands.

Cables should be isolated on the section of 8 mm to 10 mm at the end. Terminals are adjusted to use cables either type of single thick wire and multiple thin wires. In case of use thicker field cabling it is necessary to apply an intermediate junction block between cables and the device

Terminal no.	FP-3031(N) - terminal description		
1	RTD I+		
2	RTD U+	RTD	
3	RTD U-		
4	RTD I- /GND		IN 1
5	+24 V OUT		
6	I+	0/4-20mA	
7	I- /GND		
…	…	…	…
15	RTD I+		
16	RTD U+	RTD	
17	RTD U-		
18	RTD I- /GND		IN 3
19	+24 V OUT		
20	I+	0/4-20mA	
21	I- /GND		
22	+24 V OUT		
23	I+	0/4-20mA	IN 4
24	I- /GND		
…	…	…	…
31	+24 V OUT		
32	I+	0/4-20mA	IN 7
33	I- /GND		
34	+24 V OUT		
35	I+	0/4-20mA	
36	I- /GND		IN 8
37	F+	PULS	
38	F- /GND		
…	…	…	…
44	+24 V OUT		
45	I+	0/4-20mA	
46	I- /GND		IN 10
47	F+	PULS	
48	F- /GND		
49	+24 V OUT		
50	WY I+	4-20mA no. 1 ANALOG OUTPUT (optional)	
51	WY I-		
52	+24 V OUT		
53	WY I+	4-20mA no. 2 ANALOG OUTPUT (optional)	
54	WY I-		
55	+/~	RELAY OUTPUT 60V/0,1A (PK1)	
56	-/~		
…	…	…	
61	+/~	RELAY OUTPUT 60V/0,1A (PK4)	
62	-/~		
63	+		
64	T+		
65	A+	RS-485 SERIAL PORT	
66	B-		
67	T-		
68	G		

69	PE	FP-3031 & FP-3031N POWER SUPPLY (24 V DC/AC)
70	+24 VDC/ 24VAC	
71	-24 VDC/ 24VAC	
L (Phase)		
N (neutral)		FP-3031N POWER SUPPLY (230 VAC)
PE (Protective earth/ground)		

View of the rear plate of the FP-3031.
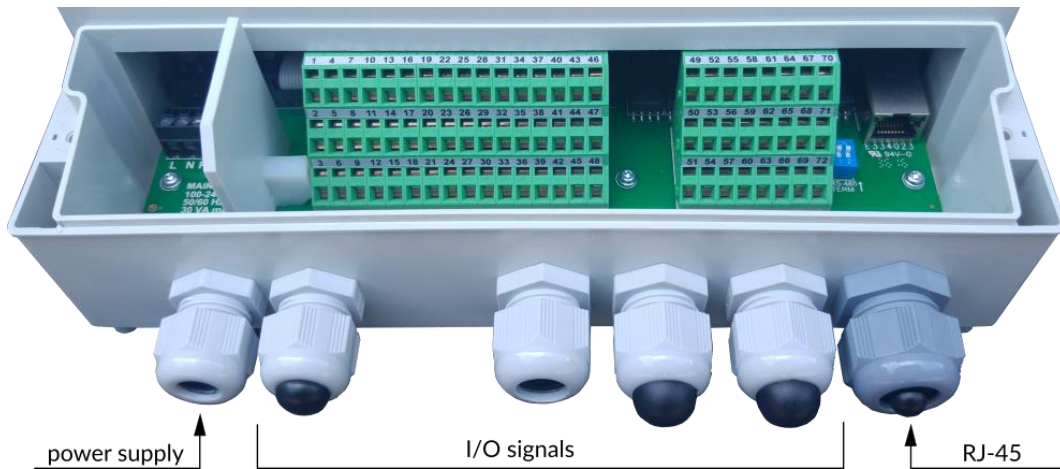
View of the terminal block of the FP-3031N.

8.6. Power supply connection

Construction of FP-3011(N), FP-3021(N) and FP-3031(N) allows to supply device with AC voltage or DC (stabilized or not stabilized) voltage. It is recommended to supply the flow computer using an isolation transformer 230 VAC / 24VAC. This type transformer is available as an accessory equipment. In case of DC voltage polarity is of no importance.

Devices are equipped with polymer fuses, which in case of emergency stop supply the power. Fuses return to initial state in a few minutes after the short circuit. Terminals marked with the ⏚ symbol are connected to the grounding. Because of EMC distortion suppression it is recommended to connect this terminal to reference potential of cabinet (PE or „GND / 0 V").

! Connecting the grounding to the terminal marked with symbol ⏚ is recommended but not required. In specific cases where the noise level on GND is high, it may has negative effect. In this case it is best to filter the reference potential through appropriate filters.

⚠ To ensure safety, the recorder's supply must satisfy the conditions applicable to lower voltage sources SELV (Safety Extra Low-Voltage), supplied with the 24 V DC as per the IEC60950-1.

In addition wall-mounted devices (FP-3011N, FP-3021N, FP-3031N) are adapted to be powered from 230 VAC.

8.7.   Connecting the RTD type sensors

RTD type inputs are designed for direct connection of temperature sensor. For high precision measurement sensors should be in 4-wire configuration. To connect 2-wire sensors inputs A, B and C, D respectively have to be shorted. A software correction of connecting wires resistance is possible too.
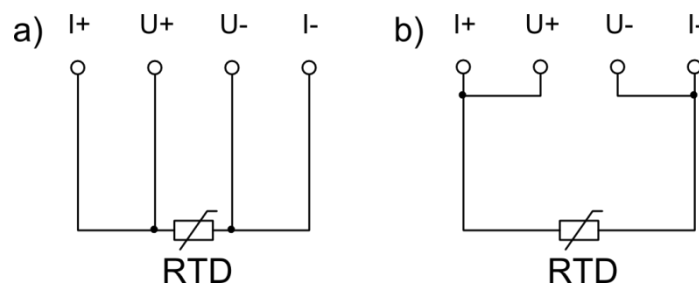
FP-3011(N), FP-3031(N). RTD sensor connection
a) 4-wire connection; b) 2-wire connection, terminals I+, U+ and U-, I- shorted outside the device

8.8.   Analog current loop transmitters 0/4-20 mA

The I type inputs are designed for connection of transmitters with output current loop with signal 0-20mA or 4-20mA. Each of the inputs has got a +24 V output voltage terminal that enables supply the transmitter. Voltage source supplying the transmitter loop cannot be loaded with current higher than 22 mA.
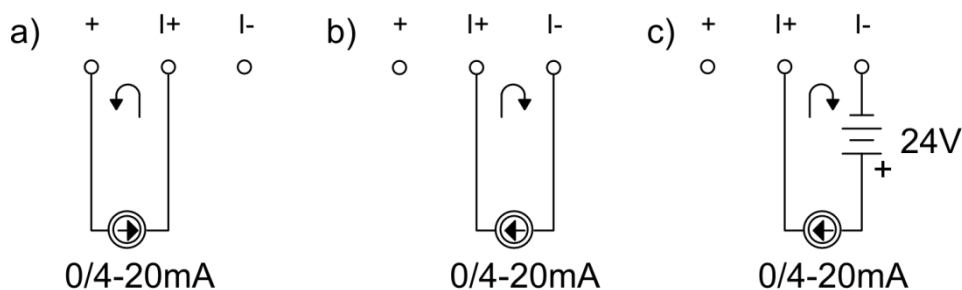
Connection of analog signals 0/4-20mA
a) transmitter supplied by the device; b) active transmitter; c) transmitter supplied by external voltage source

8.9. Connecting transmitters with PULS type inputs

Depending on the configuration the PULSE-type binary inputs can work as a state detector, a pulses counter or a frequency meter.

Typically, the flow computer is supplied in OC configuration (passive signals – the contact type or OC transistor signals). There is also a possibility to connect two other types of signals:

- active voltage signals - impedance input > 1 kΩ,
- NAMUR standard,

it requires changes in the hardware configuration and to do so refer information in section 14.

For contact/OC transistor type input, the voltage in disconnection state is 12 VDC, and the current value in short-circuit state is approx. 12 mA.

For high voltage input, the activation threshold is approx. 2.7 V, and deactivation level is approx. 2,4 V. The range of the input voltage is 5 VDC – 24 VDC. There is a +12 V potential for the voltage input on the F+ terminal (diagram below). Verify the possibility of using such an application with transmitter documentation.

For NAMUR standard:

- sensors high impedance state is 0.4 mA – 1 mA,
- low impedance state is 2.2 mA – 6.5 mA.

! Digital inputs are typically configured for passive contact type signals or OC transistors. If there is a need to change the input configuration, refer information in section 14.
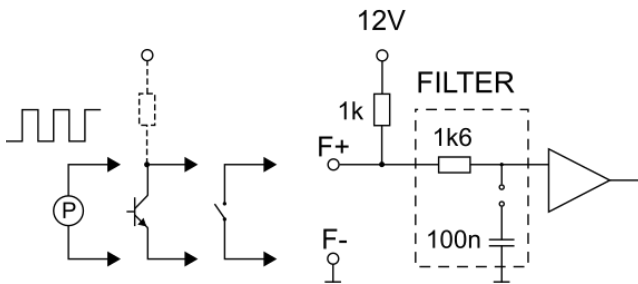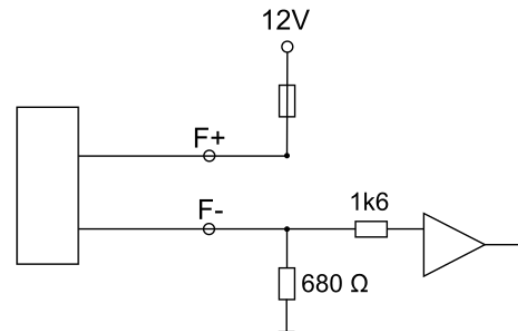
Signal forming circuit for PULS type inputs.

For low frequency signals (< 1 kHz) in particular for the contact type transmitters an additional low pass filter can be activated with a time jumper approx. 0.1 ms.

! If there is a need for additional low-pass filter, refer information in section 14.

8.10. Connecting transmitters to the RS-485 (1) port in the FP-3021

The RS-485(1) system is galvanically isolated from other circuits of the device. Transmission lines must be connected to terminals No. 6 and 7 (marked respectively A+ and B-). On the terminal block there are also lines marked as G (terminal No. 9) and + (terminal No. 4; +5V). The G terminal can be used i.e. to connect the reference potential or the screen of the data cable.

There is internal termination circuit inside the device. To activate it the "T+", "A+" and „T-", „B-" terminals should be adequately shorted. In wall-mounted device FP-3021N termination of RS485 bus can be connected using DIP-switches. However, note that removal of the plug disconnects the resistor from the line, which in extreme cases, can prevent the transmission between other devices connected to the same bus.
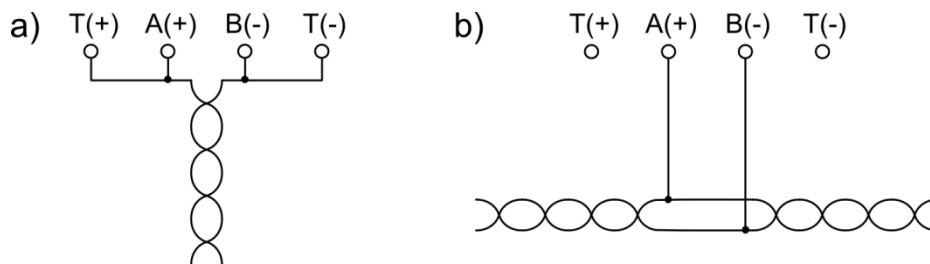
Connection to the RS-485 bus with the device:
a) when the bus is at the end of the bus using internal termination
b) when device is between other equipment connected to the bus

! All transmitters are connected parallel to one pair of wires. The RS-485 inputs should not create a star configuration. Devices should be connected sequentially (ends of RS-485 inputs must end with resistors matching the wave impedance). In industrial conditions strongly recommended is Twisted Pair (the best would be Shielded Twisted Pair). The screen should be grounded or connected to the reference potential at least in one end of the line. The RS-485 standard allows a connection of up to 32 devices, the maximum line length is 1200 m.
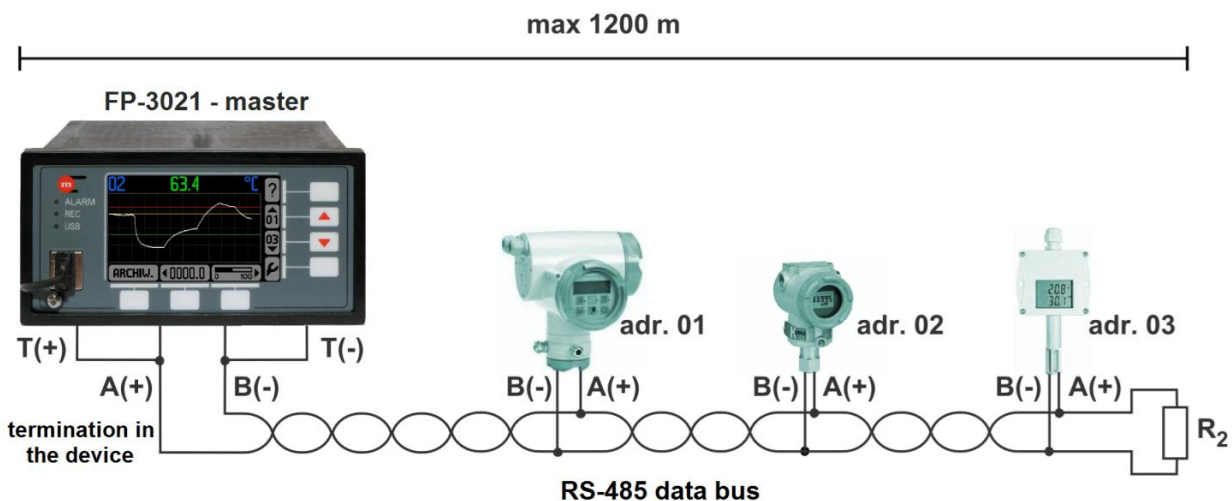
An example of connection of the FP-3021 flow computer and transmitters to the RS-485 bus.

8.11. Connecting transmitters to the HART port in the FP-3021

A current loop which is used to connect the transmitters that communicate in the HART standard has to be connected to:
- terminals No. 1 (+) and No. 2 (I+) if the loop is powered by the device (24V is derived on clamp No. 1 which enables to supply the loop);
- terminals No. 3 (+) and No. 4 (I+) if the loop is to be powered from an external voltage source
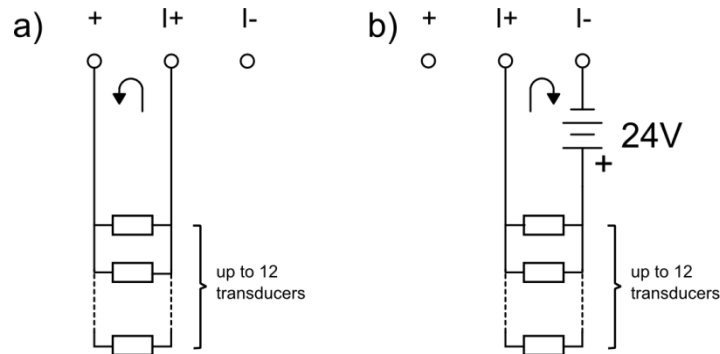
Connecting HART transducers to the flow computer

a) transducers powered by the device; b) transducers powered from an external voltage source

8.12. Connecting the FP-3021 device as Secondary Master

The FP-3021 device can operate either as a Primary Master and Secondary Master. If the flow computer is working in Secondary Master mode, the current loop is connected in parallel to terminals No. 2 (I+) and No. 3 (I-).
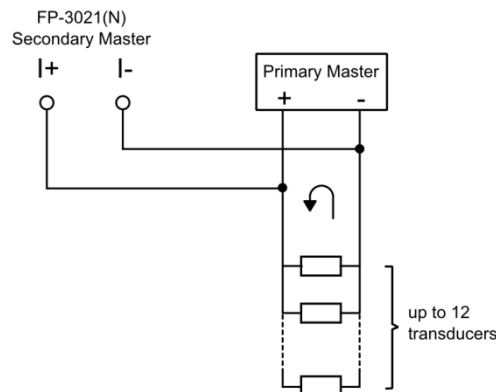
Connecting the FP-3021(N) flow computer as Secondary Master

8.13. Connecting the receiver to the 4-20mA analog output

The FP-3011(N) / FP-3021(N) can be optionally equipped with an analog output current loop 4-20mA. The FP-3031(N)) can be equipped with two such outputs. The current loops can be supplied by an internal 24V voltage source or by an external power supply (if the construction of the loop allows that). The current outputs are galvanically separated from other circuits of the device.
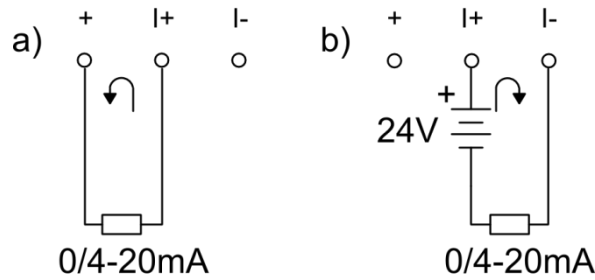
Connecting the receiver to the analog 4-20mA output.
a) current loop supplied from the flow computer;
b) current loop supplied from the external voltage supply

8.14. Connecting receivers to binary outputs (PK1 to PK4)

The FP-30x1(N) devices are equipped with 4 isolated solid state relays 100 mA / 60V DC with the possibility of controlling receivers powered by AC or DC voltage.

Solid state relays outputs are protected with capacitor (4,7 nF) and resistor (30 Ω) connected in series. It is designed to filter overvoltages suppression during inductive load switching (e.g. contactor coil). Nevertheless it is recommended to use additional inductive elements against overvoltages (e.g. protective diode, varistor).
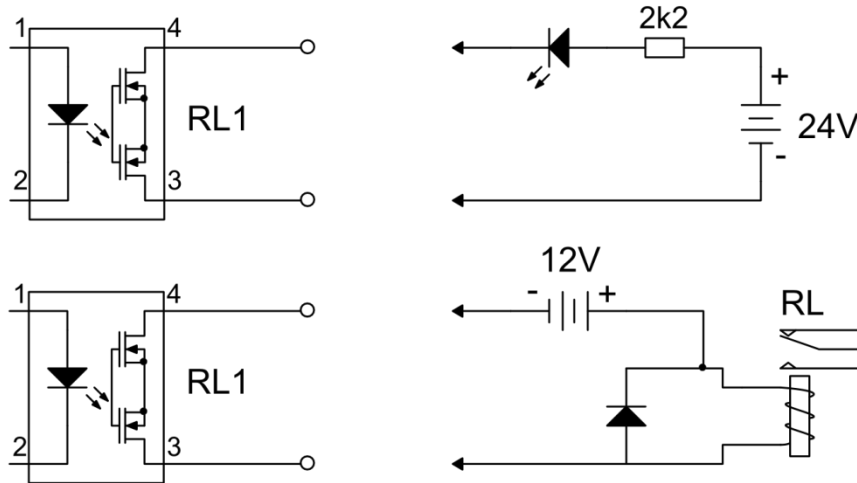
Connecting the receivers to the binary outputs

The intermediary relays should be used to control devices of higher power. In a range up to 6 A / 250 VAC it is recommended to install a relay with the LED indication (PI6-1P-24VAC/DC type) manufactured by Relpol S.A. This relay can be controlled from a DC or AC source, in particular, by the same power supply, which is used to power the device, i.e. transformer 230V/24V PSS-10's manufactured by Breve (both elements are available as additional accessories).
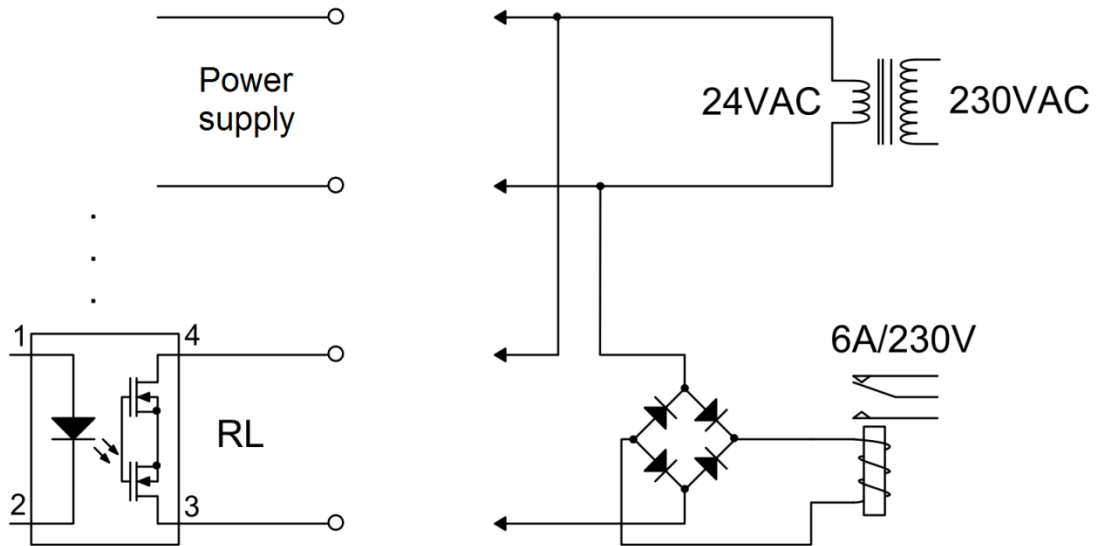
Connecting an additional external relay using transformer that supplies the device to power the relay circuit

8.15. Connecting data transmission lines to the RS-485 port in FP-3011/FP-3031 and the RS-485(2) port in the FP-3021

Depending on the device type the transmission lines can be connected to:
- RS-485 port in the FP-3011(N) and FP-3011 (N) devices,
- RS-485 (2) in the FP-3021(N) device

in parallel, i.e. the terminal marked with A (+) symbol to the line A and the terminal marked with the B (-)symbol to the line B. The port has also a terminal marked with symbols "G" and "+". The "G" terminal can be used e.g. to connect the reference potential or a screen of the data cable. To connect the terminator the following inputs must be shorted: A (+) with T (+) and B (-) with T (-).In wall-mounted device FP-3021N termination of RS485 bus can be connected using DIP-switches. However, note that removal of the plug disconnects the resistor from the line, which in extreme cases, can prevent the transmission between other devices connected to the same bus.
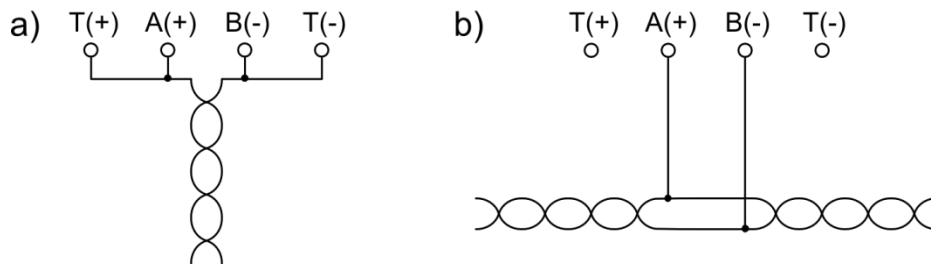
Connection to the RS-485 bus with the device:
a) when the bus is at the end of the bus using internal termination
b) when device is between other equipment connected to the bus

The RS-485 / RS-485(2) port is galvanically separated from other circuits of the device.

> **!** The RS-485 / RS-485(2) port should not create a star configuration. Devices should be connected sequentially (ends of RS-485 inputs must end with resistors matching the wave impedance). In industrial conditions strongly recommended is Twisted Pair (the best would be Shielded Twisted Pair). The screen should be grounded or connected to the reference potential at least in one end of the line. The RS-485 standard allows a connection of up to 32 devices, the maximum line length is 1200 m. It is recommended to use a cable to digital data transmissions (e.g. for the Profibus)

8.16. Connecting the device to the LAN using the Ethernet port

The flow computer can be connected to industrial Ethernet network (LAN) using the RJ-45, located on the rear panel.

RJ45

1	Tx +
2	Tx -
3	Rx +
6	Rx -
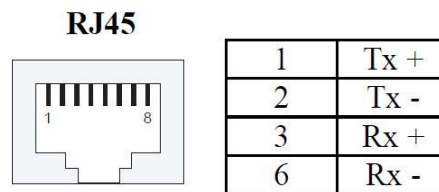
The RJ-45 socket

For successful communication between the device and the supervisory system it is necessary to configure all the parameters needed in the communication (see section 10.14).

8.17. USB port

The USB port type A is located on the front panel. It is designed for connecting an external flash drive that allows data transfer between the device and a PC. The socket has a high level of protection IP54 (protection against ingress of dust and water inside the socket).

9. ENTITY LAUNCHING THE PRODUCT ON EUROPEAN UNION MARKET

Manufacturer: METRONIC AKP sp. z o.o. sp. k.

st. Żmujdzka 3

PL 31- 426 Kraków, Poland

Tel.: (+48) 12 312 16 80

www.metronic.pl

Vendor:

10.   DEVICE CONFIGURATION

<u>In order to ensure convenient and clear readout of process values all functions and the way they are displayed should be properly configured.</u>

The FP-30x1(N) devices can work in a wide range of applications - can work with different types of installation and measurement converters, and perform various tasks depending on its configuration. The methods of conversion - the type of measurements and calculations, the form of displaying the results, how their archiving and other tasks – are defined by a set of settings.

A brand new flow computer has all functions deactivated – it does not execute any measurements or calculations. It merely displays date and time. To perform its relevant tasks the device must be configured or proper settings must be loaded. All settings are gathered in a hierarchic menu which is entered by selecting **Settings** option from the main menu.

At customer's request device can be initially configured by manufacturer as a separate service. For this purpose customer must deliver detailed information on installation, type of applied measurement transmitters etc. User can later modify delivered settings, in particular he can do some corrections e.g. activate and deactivate screens with results, adjust alarm thresholds or change archiving frequency. Manufacturer can initially configure device before its delivery to customer or he can deliver full set of settings later in file form e-mailed which user can upload to the device (see section 10.18).

10.1.   Content of the settings menu

All the menu items are listed below – most of which goes to the successive submenu containing next groups of settings. In brackets there are the numbers of sections, which describes in detail a particular group of settings.

Display	(section 10.15)
Relay outputs	(section 10.7)
Main applications	(section 10.4 and 10.5)
Aux applications	(section 10.5, in FP-3031(N) only)
Inputs	(section 10.8)
Alarms and control	(section 10.9)
Totalisers	(section 10.10)
Nominal month beginning	(section 10.1)
4-20mA output	(section 10.11)
Main archive	(section 10.12.1)
Hourly archive	(section 10.12.2)
RS485 port	(section 10.13, in FP-3021 it is called: **RS-485 port (2)**)
Ethernet port	(section 10.14)
Text messages	(section 10.15)
Device description	(section 10.1)
Barom. pres.	(section 10.6)
DST	(section 10.17)

Display. User can choose which from available screens are displayed and he can configure content of tables on the main (general) screens, resolution of displayed values (except totalisers) and ranges of bargraphs and diagrams. Also the automatic scrolling can be configured in this setting group.

Relay outputs. In this setting group an operation mode of respective outputs i.e. control or alarm function, their operation active state (normally open, closed or pulsing) can be set. Respective functions of relay outputs are determined in successive setting groups where they are assigned to selected events. For example if an output relay should signal a crossing of an alarm threshold, then the appropriate relay should be assigned to this threshold. To enable such assignment an output relay should be set to the proper mode first. The same relay output can be assigned to many different events (e.g. one relay can signal crossing threshold of few process values).

Main applications A, B, C (A, B in FP-3011(N) and FP-3021(N)). In the main applications group are determined measurement system types to perform measurement in respective physical systems. First of all user must answer questions asked by a wizard concerning a structure of the main application. Then required parameters for the chosen application should be entered (e.g. type and dimensions of used differential pressure device, etc.). After that the set of process values and calculated values are automatically generated. User can select their units and give them text descriptions (captions). Also additional measurements and calculations can be defined and entered here.

Aux applications X, Y, Z (only for FP-3031(N)). Only simple process values and calculated values can be entered as an aux application. It is not possible to set e.g. compensated steam flow measurement as an aux application.

Inputs. All process values, automatically generated by a wizard and auxiliary applications must be assigned to particular measurement inputs. Also all inputs operation mode (e.g. type of RTD sensor or current signal type), measurement parameters (e.g. values corresponding to the extreme currents of 4 mA and 20 mA) and action in case of transmitter failure (e.g. relay output alarm or event log) can be set here. In some cases more than one process value can be assigned to the same input.

Alarms and control. For each result except of density (ρ), enthalpy (h), differential pressure (Δp) and thermal coefficient of water (k), 1 to 4 control thresholds can be assigned. Thresholds level and hysteresis can be set, and can operate above (upper threshold) or below (lower thresholds) the indicated level. Activation of the threshold can cause various reactions of the device, such as relay output indication.

Each result of heat power or heat flow, and some additional results can be assigned with 4 **totalisers** (form 1 to 4, with some restrictions). Totalisers can be undeletable, resettable from the keyboard or may periodically reset itself. Each totaliser can be assigned with a unit and a number of decimal places.

Nominal month beginning. For the purpose of the periodically resettable totalisers and the monthly register totalisers user can determine the beginning of the month as any full hour on any day between 1 and 28 or the last day of the month.

Optionally, the device can be equipped with a **4-20 mA current output**. The output can be assigned to any result. Defining the principles for converting the value of this result to the current value is by assigning the result values to currents of 4 mA and 20 mA. User can also specify the behavior of output during the absence of the assigned result (eg, temporary failure of the transmitter).

Main archive and **Hourly archive.** User can select here process values, calculated values and totalisers to be archived, and also the results for which are to be recorded as average values. Also a frequency of archiving process values and procedure after memory filling is determined here.

RS485 port. User can set parameters of serial transmission: baud rate, parity control, device address and selects operation mode: Modbus RTU or ASCII (special protocol designed for communication with dedicated programs)

Port Ethernet. Parameters needed to communicate through this port: IP address, subnet mask, default gateway can be set in this group.

Device description. User can enter a text description of the device.

Barom. pres. allows to set the average atmospheric pressure in the area of the device, to enable the use of overpressure units.

DST - Daylight saving time to enable or disable the automatic conversion from summer to winter time and vice versa.

10.2. Basis of configuration

10.2.1. Navigation principles

All settings are in hierarchic menu which is entered by selection of **Settings** submenu in the main menu. Navigation is executed by entering successive submenus in order to find the required setting.
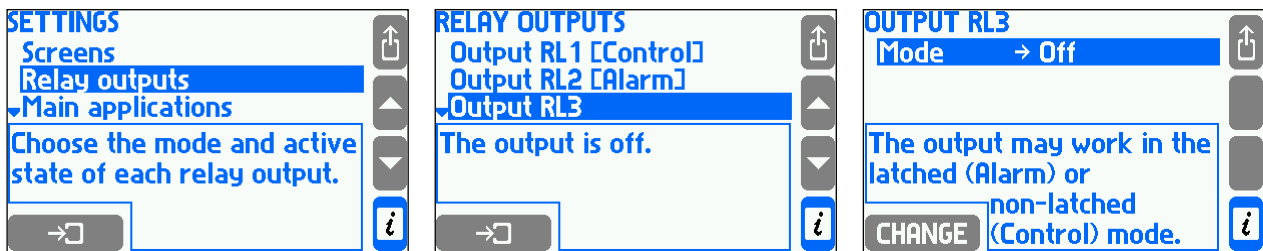
The example above shows step by step how to find a setting of output relay RL3 operation mode. From settings menu select **Relay outputs** submenu (placing cursor bar using vertical arrows and then pressing button). When new submenu appears the user should select **Output RL3** submenu. To return to previous menu user always have to press button . In the frame below menu some extra explanation information is displayed.

Settings may be viewed and changed without interrupting normal operation of the device. Changes made do not influence immediately on device operation. If some changes are made the device will display confirmation question as follows:
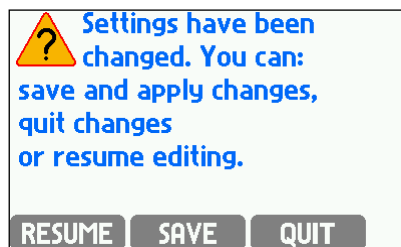
When **SAVE** button is pressed device operation is interrupted for a few seconds. Then the device resumes with the new settings. Pressing **QUIT** button denies all changes that were made. Pressing **RESUME** allows to continue edition of settings.

Meaning of respective settings is described with relevant functions in next sections.

10.2.2. Editing the settings

In this section method of editing numerical and text settings selected from a menu list is described. Entering few remaining settings which do not belong to any of these groups were described in sections explaining their meaning.

To change any setting place the cursor on it a and press CHANGE. If it is a one-from-the-list setting the cursor moves to the selected option and begins to blink. Choose required option using vertical arrows and confirm new selection with button OK.

Pressing ⬆ button interrupts edition returning to the previous selection.
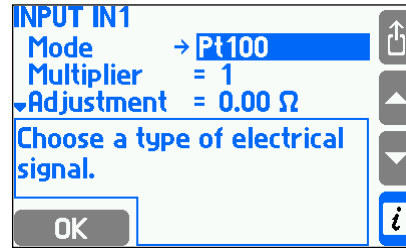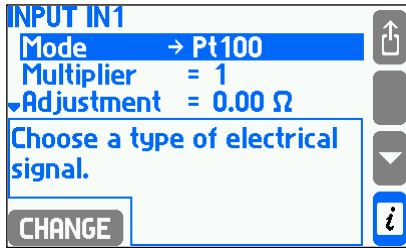
When button CHANGE is pressed after selecting a numerical setting the blinking cursor moves to the first digit or the sign of the number that is being changed.
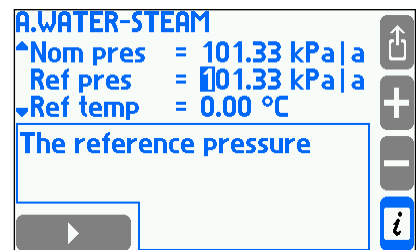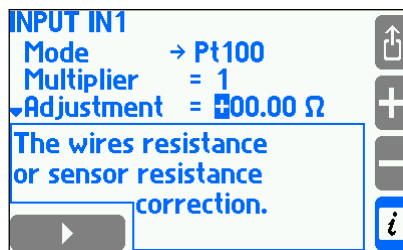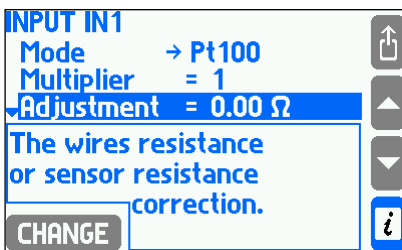
Select the digit value or sign with buttons ➕ or ➖ and confirm with the left bottom button. The cursor moves then to the next digit. In this way all digits can be changed. If the device has an extended keypad the digits are entered using corresponding buttons of the keyboard. Placing the digit automatically moves the cursor to the next position. With button ⬆ edition can be interrupted returning to the previous value. The entered number must be within the range, otherwise it is rejected.
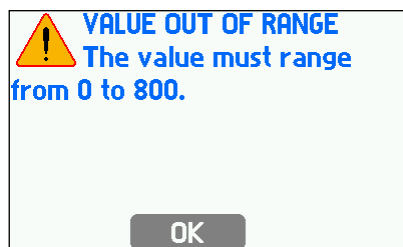
Some numerical settings have constant decimal point position and cannot be changed. Then the cursor moves over decimal point stopping at digits only. In other cases decimal point can be also set. Then dot (decimal point) is available during selection between digit 9 and 0. If the edited number must always be positive the sign will not be displayed and cursor moves to the first digit at once.

Some numerical settings have constant decimal point position and cannot be changed. Then cursor moves over decimal point stopping at digits only. In other cases decimal point can be also set. Then dot (decimal point) is available during selection between digit 9 and 0. If the edited number must be positive the sign is not displayed and cursor moves to the first digit at once.

More complicated settings require selection of values from a list, then entering a number or entering two different numbers in succession. In this case the above described operations should be executed in proper sequence.

For entering captions a separate screen is called:

Horizontal and vertical arrow buttons move cursor along the whole screen. Left bottom button, depending on cursor position, can insert or delete a mark from edited text or

change set of characters on keyboard. Button is used to leave edition confirming a new text description. There is no possibility to interrupt edition and return to previous text.

To insert a character from keyboard place cursor on it and press ENTER. Position in which the character will be inserted is indicated by vertical dash in a frame with edited text. This dash is in place where cursor was at the moment of leaving the frame. To shift the dash move cursor to the frame, put it (using horizontal arrow buttons) in proper place and then return to the keyboard using vertical arrow button. To delete a character from the edited text place cursor on it and press REMOVE button. To change set of characters on keyboard place cursor in **ABC** field (block letters), **abc** (small letters) or **12-?!.** (digits and symbols) and then press SELECT button.

Similarly to descriptions other text settings are loaded: symbols of auxiliary results, units (if they are not selected from list) and usernames. In these cases dimension of text in a frame and set of available characters may be different.

Entering text descriptions is much easier in devices with extended keyboard. Pressing one of the extra buttons on the keyboard starts it.

Using the extended keyboard is the same as in mobile phones.

10.3. Configuration sequence

Setting of some parameters may require previous setup of other settings. For example to assign alarm threshold to a relay output first the relay output has to be set to proper

mode. Therefore it is recommended to enter settings in sequence they are listed in menu except for **Screens** which should be configured at the end.

10.4. Selection of the measuring system

The FP-3011(N) and FP-3021(N) flow computers can operate in two (A, B) and FP-3031(N) in three (A, B, C) independent installation applications. Process values and calculations relevant to a single installation application are grouped in one system named main application.

To configure measurements user has to choose **Main applications** from settings menu. Configuration starts with help of a wizard leading through the possible structure of an application. This procedure consists of few questions one have to answer. After completing the wizard new items with specific settings for the selected type of a system appear in the menu. For example if wizard was declared that steam flow measurement is performed with differential pressure device then in the menu appears the parameter **Diff pres device for** Δp^D where some settings have to be entered. Steam or water heat energy measurement also require entering a reference pressure constant and a temperature constant referring to which enthalpy should be calculated.

In next steps user can choose units and enter text descriptions (**Units and tags** submenu), enter auxiliary values if needed (**Auxiliary values,** see section 10.6), assign calculated values to device inputs (**Assign to inputs**, see section 10.8.1) and enter a description to the application (**Tag**).

10.4.1. Media types

The device can be configured to the measurement of following types of media: superheated steam, saturated steam, technical gases due to ideal gas equation, hot and cold water and other user defined liquid media.

10.4.1.1. Superheated and saturated water stem

Steam density and enthalpy are calculated according to IAPWS-IF97 standard for pressures 0,05…16,52 MPa and temperatures up to 800 ºC. Enthalpy is given relative to a reference point selected by a user (see section 10.4.7).

In all applications with superheated steam, both pressure and temperature must be measured. Device can detect superheated steam approaching to the saturation state and alarm about such event (see section 10.4.6). If due to inaccurate measurement, measured steam temperature is slightly lower than condensation temperature at this pressure, density and enthalpy will be calculated for condensation temperature. However if measured temperature is lower than condensation temperature more than 20 ºC , an error (–E–) is displayed instead of density and enthalpy values and all other values calculated on their basis.

In systems with saturated steam user can choose if pressure or temperature is measured. The other quantity is always calculated theoretically based on saturation curve. Supervisory measurement of the second quantity can be entered as an auxiliary value within the application.

Limits of steam parameters conversion -> see a figure in section 10.4.1.2.

10.4.1.2. Water

Water density and enthalpy are calculated according to IAPWS-IF97 standard for pressures 0,05…16,52 MPa. Enthalpy is referred to a user selected reference point (see section 10.4.7).

Water temperature is always measured whereas pressure may be measured or can be assumed that is constant. Typically it is assumed to be constant and its value is entered in settings. If due to measurement inaccuracy water temperature is slightly higher than boiling temperature at given pressure, density and enthalpy will be calculated for boiling temperature. However if measured temperature exceeds boiling temperature by more than 20 ℃ an error (–E–) is displayed instead of density and enthalpy values as well as all other values calculated on their basis.

In steam with condensate loop systems, condensate pressure can be treated as equal to steam pressure or its constant value may be entered in settings. There is no possibility of separate steam and condensate pressure measurement in an application. In case of such need two separate applications must be used: one for steam measurement and the second for condensate measurement. Energy balance for both systems can be then implemented with help of auxiliary value (math formula). Condensate temperature may be measured or it may be assumed that condensate remains at boiling temperature – then its temperature is calculated theoretically based on measured steam pressure.
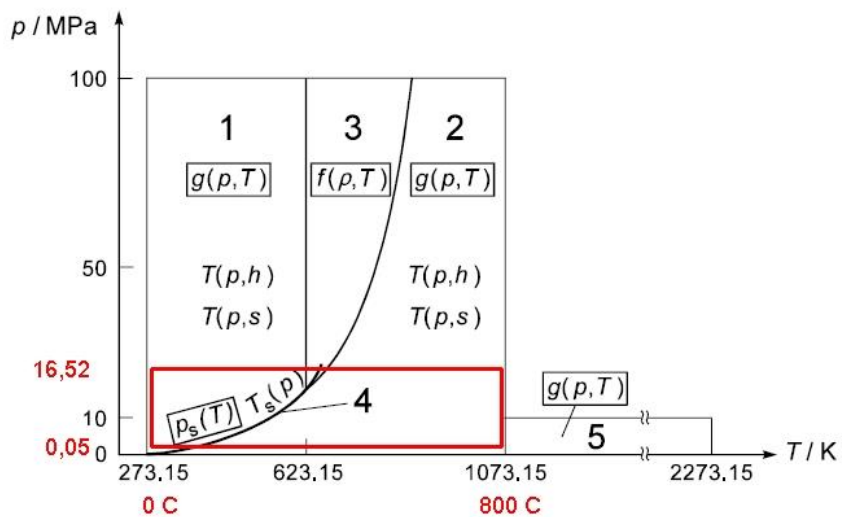
Limits of steam parameters conversion

10.4.1.3. Other liquid media

Flow computer can also measure and calculate process values in installations with any liquid medium other than water. For this purpose tables with medium density and enthalpy as function of temperature should be downloaded from a file using the USB Flash Memory. The pressure can be measured as an auxiliary value only.

A file with information on liquid medium should be prepared on a PC using a text editor or a spreadsheet program. Accepted file formats are .txt or .csv. Below there is an example of such file's contents:

```
#medium Liquid L
0.0     820.0
100.0   810.0
200.0   803.0
#
```

72

```
0.0    0.0
200.0  620.0
```

The file must begin with word `#medium` followed by name of medium (up to 12 characters, here `Liquid`) and its symbol (big Latin letter other than B, D, E, G, R, S, W, here `L`). After that begins a density table containing pairs of numbers (temperature in ºC and density in kg/m^3). The table ends with symbol `#` followed by an enthalpy table consisting of pairs of numbers (temperature in ºC and enthalpy in kJ/kg). Both tables must be ordered with temperature from lower to higher values. In the example at temperature 200 ºC medium density is 803 kg/m^3 and enthalpy 620 kJ/kg. Intermediate values between points are linearly interpolated. Therefore for this example density assumed by the device at temperature 50 ºC is 815 kg/m^3 and enthalpy 155 kJ/kg. Medium temperature cannot exceed range of the table (in this example 0…200 ºC); otherwise an error (–E–) is output instead of density or enthalpy values as well as all other values calculated on their base.

Information on liquid media are stored in a data base with all other settings. To view contents of the data base and to add or remove media table choose **Media manager** submenu from main menu.

On media list next to the names there are displayed symbols and occupied memory space. At the screen bottom there is displayed remaining free memory space. The database can store simultaneously up to 16 different media.

To add a new medium user has to insert a USB Flash Memory containing a relevant file in main directory and press button NEW ONE. A list will be displayed to select the file. On the list there are only files with extensions .txt or .csv. New medium can also be added during configuration a system with help of wizard without need of entering separately a media manager (see section 10.4.1.5). Pressing REMOVE button causes removal ALL media and ALL user's characteristics (see section 10.8.7).

10.4.1.4.   Technical gases

The flow computer can also measure and calculate process values in installations with technical gases. A gas pressure and temperature can be either measured or set as constant for one or both values. Actual gas density is calculated according to the ideal gas equation based on density in reference (standard) conditions.

The following flow rates are calculated: mass, actual volumetric and standard volumetric. Units of standard flow rate are preceded by letter C e.g. Cm^3/h. The reference conditions (pressure and temperature) are entered in the settings.

The density of measured gas at reference conditions should also be entered in the settings. User has to enter proper value or choose one of the gases from the list. Densities form the list are referred to 0 ºC and 101,33 kPa. For other entered reference conditions the density will be calculated automatically according to the ideal gas equation and displayed in a frame below settings.

Air	1,29300 kg/m^3
Oxygen	1,42895 kg/m^3
Nitrogen	1,25050 kg/m^3
Carbon dioxide	1,97700 kg/m^3
Hydrogen	0,08987 kg/m^3
Helium	0,17850 kg/m^3
Chlorine	3,21400 kg/m^3
Methane	0,71680 kg/m^3
Acetylene	1,17090 kg/m^3

10.4.1.5. Main application configuration wizard

New application setup should begin with supporting the wizard with information about the installation type, medium type and applied flowmeters. For this user should choose **Installation** from the menu. Wizard asks successive questions which must be answered. User selects the answer using arrow buttons and confirms the choice with NEXT button. BACK button is to return to the previous question. An example sequence of questions and answers for configuring measurement system is shown below:

A.[No tag] **Installation** Ref pres = 101.33 kPa|a Ref temp = 8.50 °C Enter basic information on the installation using a creator.	Choose the type of mea- surement and installation. The flows and delta heat in a steam-condensate instal- lation with different steam and condensate flowrates	Is the steam superheated or saturated? SUPERHEATED, its properties computed based on the temperature and pressure
Are the condensate and steam pressures equal? No. A NOMINAL value of the condensate pressure is to be assumed.	How the condensate flow- rate is measured? With a VOLUMETRIC flowmeter	Are the condensate and steam pressures equal? No. A NOMINAL value of the condensate pressure is to be assumed.

The wizard always asks question about method of flow rate measurement. The following answers are available:

- **With a MASS flowmeter**
- **With a VOLUMETRIC flowmeter**
- **With a DIFFERENTIAL PRESSURE device**
- **COMPUTED from the flowrates in other installations (by a formula)**

In some installations additionally user has to determine the place of flowmeter – on the supply or return pipeline. If a differential pressure device was selected, the wizard inserts automatically **Diff pres device for Δp** submenu in which parameters of this flowmeter should be entered (see section 10.4.4). If in a given main application no flowmeter has been installed its flow rate can be calculated based on other flowrates, and the last of the listed answers should be selected. This is the case for example when two main applications are connected in series and flow rate is measured only in one of them. Then to system menu **Formula for q_m** submenu is inserted where method of flow rate calculation should be determined (see section 10.4.5). If mass or volume flowmeter was selected there is no need to enter any additional settings to system menu. Flowmeter parameters should be then entered in the input settings.

If the installation was selected to liquid measurement then the next question wizard will ask about medium type. For selection there are always water and all liquid media in the data base (see section 10.4.1.3). To use a medium which is still not in the data base user has to select answer **Add on a new medium from a file**. This will display a list of available files with media characteristics. Medium of the selected file will be added to the database and immediately set as a medium of the configured system.

If the water or gas pressure or gas temperature is declared as constant, **Nom pres** (nominal pressure) or **Nom temp** (nominal temperature) is inserted to menu.

When the wizard is finished all necessary values are entered to the main application. In submenu **Units and tags** it is possible to choose the units (see section 10.6) and set tags. If user chooses answer **None,** when asked for installation type, the wizard will finish its work and all earlier entered values will be deleted. However wizard has no influence on auxiliary values which also can be entered to the main application even if the installation type was set to **None**.

10.4.2. Graphic schema

Configuration of an installation type can be presented as a graphic schema. To display the schema user should place a cursor on the application and press button SCHEMA.
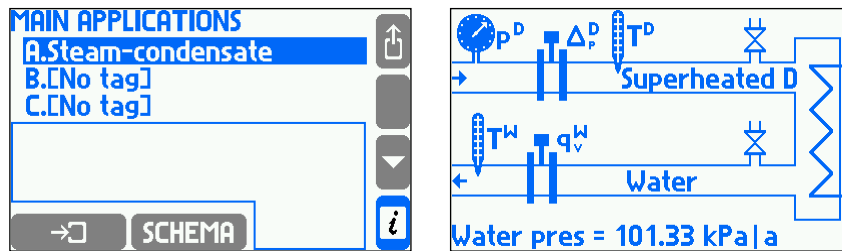
The schema can also be accessed by pressing SCHEMA button while using wizard. The schema contains only partial information as far as the wizard questions are answered. With new answers next elements are added to the schema. Schema does not contain information entered beyond wizard such as i.e. constant pressure value.
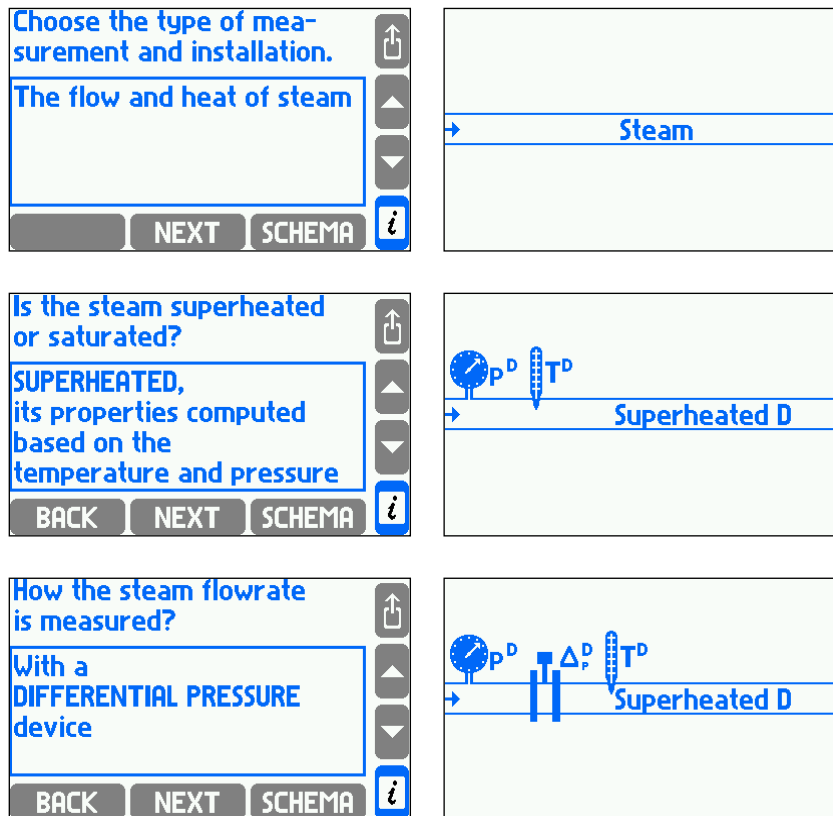
Pressing any button to leave schema and return back to wizard or application menu.

10.4.3. Installation types

10.4.3.1. Flow and heat measurements

In the wizard user must choose a kind of medium: water or other liquid medium. If water was chosen user should determine if the pressure is measured or entered as a constant.
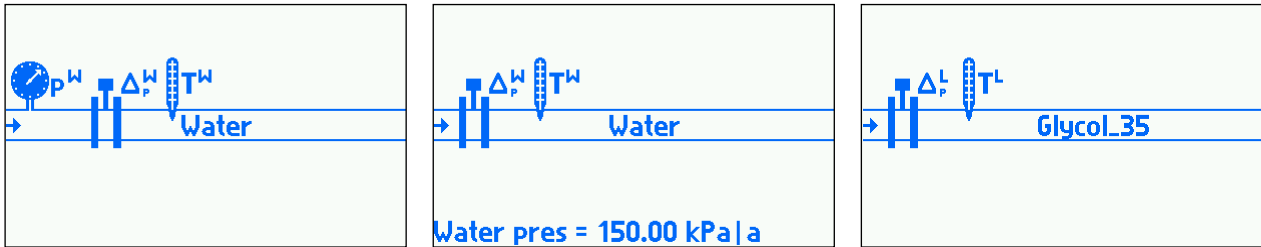
List of process values:

P^W heat flow rate
q_m^W mass flow rate
q_v^W volumetric flow rate
p^W pressure (only for water if pressure measurement was declared)
T^W temperature
ρ^W density
h^W enthalpy
Δp^W pressure difference at orifice in differential pressure device (only if differential pressure device was chosen).

The upper index letter means a kind of medium. Letter W used in the example above means water whereas other liquid media have their own symbols (see section 10.4.1.3).

10.4.3.2. The flow and differential heat of a liquid in a closed (supply-return) installation

In the wizard user must choose a kind of medium: water or other liquid medium. If water was chosen it should be determined if the pressure is measured or entered as a constant. It is assumed that water pressure at supply and return pipeline are the same.

It should be also declared if system fulfills heating (i.e. supplies energy thus supply temperature is higher than return temperature) or cooling (i.e. takes energy away thus supply temperature is lower than return temperature). Heat flow rate difference (P) and temperature difference (ΔT) will be calculated according to this selection. In the schema a principle was assumed that a pipeline with higher temperature is drawn on the top.
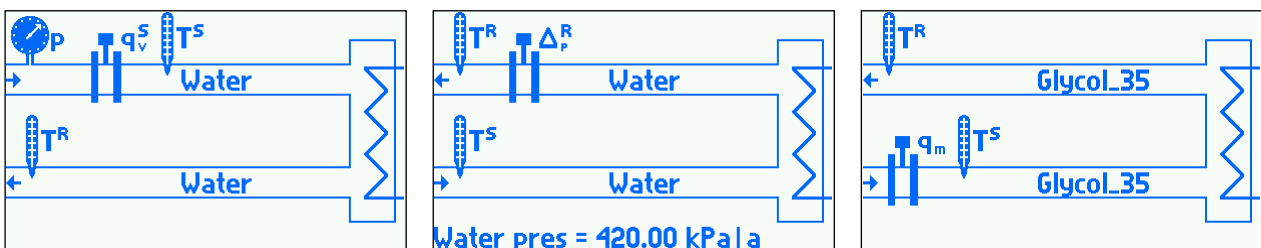
List of process values:

P   heat flow rate difference between supply and return
q_m mass flow
q_v^S volume flow at supply

p	pressure (only for water if pressure measurement was declared)
T^S	supply temperature
ρ^S	density at supply
h^S	enthalpy at supply
Δp^S	pressure difference at orifice in differential pressure device (only if differential pressure device installed at supply was chosen).
q_v^R	volume flow at return
T^R	temperature at return
ρ^R	density at return
h^R	enthalpy at return
Δp^R	pressure difference at orifice in differential pressure device (only if differential pressure device installed at return was chosen).
ΔT	temperature difference between supply and return
k^S	water thermal coefficient (only if volume flowmeter was installed at supply)
k^R	water thermal coefficient (only if volume flowmeter was installed at return)

10.4.3.3. The flows and differential heat of a liquid in an installation with separate supply and return flow rates

In the wizard user must choose a kind of medium: water or other liquid medium. If water was chosen it should be also determined if the pressure is measured or entered as a constant. It is assumed that water pressure at supply and return are the same.

It should be also declared if system fulfills heating (i.e. supplies energy thus supply temperature is higher than return temperature) or cooling (i.e. takes energy away thus supply temperature is lower than return temperature). Heat flow rate difference (P) and temperature difference (ΔT) will be calculated according to this selection. In the schema a principle was assumed that a pipeline with higher temperature is drawn on the top.
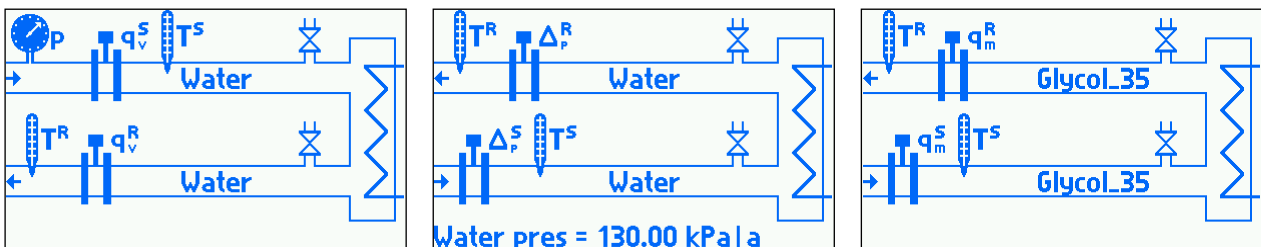
List of process values:

P	heat flow rate difference between supply and return
q_m^S	mass flow rate at supply
q_v^S	volume flow rate at supply
p	pressure (only for water if pressure measurement was declared)
T^S	temperature at supply
ρ^S	density at supply
h^S	enthalpy at supply
Δp^S	pressure difference at orifice in differential pressure device (only if differential pressure device was chosen).
q_m^R	mass flow rate at return
q_v^R	volume flow rate at return
T^R	temperature at return
ρ^R	density at return
h^R	enthalpy at return

Δp^R pressure difference at orifice in differential pressure device at return (only if differential pressure device was chosen)

ΔT temperature difference between supply and return

10.4.3.4.   The flow and heat of steam

In the wizard user must choose a kind of medium: : superheated or saturated. If saturated steam was chosen it should be determined if pressure or temperature is measured.
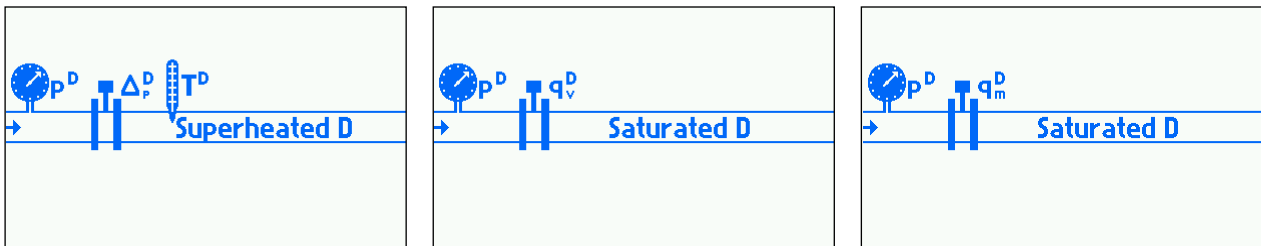
List of process values:

P^D heat flow rate of steam

q_m^D mass flow rate of steam

q_v^D volume flow rate of steam

p^D steam measured pressure (only for superheated or saturated steam with pressure measurement)

p_c^D saturated steam pressure calculated based on saturation curve (only for saturated steam with temperature measurement)

T^D steam measured temperature (only for superheated or saturated steam with temperature measurement)

T_c^D saturated steam temperature based on saturation curve (only for saturated steam with pressure measurement)

ρ^D steam density

h^D steam enthalpy

Δp^D pressure difference at orifice in differential pressure device (only if differential pressure device was chosen)

10.4.3.5.   The flow and differential heat in a closed steam-condensate installation

In this installation is assumed that condensate is returned continuously (condensate mass flow rate is equal to steam flow rate). If condensate is accumulated and periodically pumped out, system described in section 10.4.3.6 should be selected.

In the wizard user must choose a kind of medium: superheated or saturated. If saturated steam was chosen it should be determined if the pressure or temperature is measured.

It should also be declared if condensate pressure is equal to steam pressure or entered as a constant value. In some installations if steam and condensate pressures are equal user can skip condensate temperature measurement and assume calculations at the boiling temperature.

List of process values for condensate with constant (entered) pressure:

P	delta heat between steam and condensate
P^D	steam heat flow rate
q_m	mass flow rate
$q_v{}^D$	steam volume flow rate
p^D	steam measured pressure (only for superheated or saturated steam with pressure measurement)
$p_c{}^D$	saturated steam pressure calculated based on saturation curve (only for saturated steam with temperature measurement)
T^D	steam measured temperature (only for superheated or saturated steam with temperature measurement)
$T_c{}^D$	saturated steam temperature calculated based on saturation curve (only for saturated steam with pressure measurement)
ρ^D	steam density
h^D	steam enthalpy
Δp^D	pressure difference at orifice in differential pressure device (only if differential pressure device was chosen)
P^W	condensate heat flow rate
$q_v{}^W$	condensate volume flow rate
T^W	condensate temperature
ρ^W	condensate density
h^W	condensate enthalpy

List of process values for condensate with pressure equal to steam pressure and measured temperature:

P	delta heat between steam and condensate
P^D	steam heat flow rate
q_m	mass flow rate
$q_v{}^D$	steam volume flow rate
p^D	steam and condensate measured pressure (only for superheated or saturated steam with pressure measurement)
$p_c{}^D$	saturated steam and condensate pressure calculated based on saturation curve (only for saturated steam with temperature measurement)
T^D	steam measured temperature (only for superheated or saturated steam with temperature measurement)
$T_c{}^D$	saturated steam temperature calculated based on saturation curve (only for saturated steam with pressure measurement)
ρ^D	steam density
h^D	steam enthalpy
Δp^D	pressure difference at orifice in differential pressure device (only if differential pressure device was chosen)
P^W	condensate heat flow rate
$q_v{}^W$	condensate volume flow rate

T^W condensate temperature
ρ^W condensate density
h^W condensate enthalpy

List of process values for condensate remaining in boiling temperature:

P delta heat between steam and condensate
P^D steam heat flow rate
q_m mass flow rate
q_v^D steam volume flow rate
p^D steam and condensate measured pressure (only for superheated or saturated steam with pressure measurement)
p_c^D saturated steam and condensate pressure calculated based on saturation curve (only for saturated steam with temperature measurement)
T^D superheated steam measured temperature (only for superheated steam)
T_c saturated steam temperature calculated based on saturation curve; it is also boiling condensate temperature (only for saturated steam with pressure measurement)
ρ^D steam density
h^D steam enthalpy
Δp^D pressure difference at orifice in differential pressure device (only if differential pressure device was chosen)
P^W condensate heat flow rate
q_v^W condensate volume flow rate
T_c^W condensate temperature (only for superheated steam)
ρ^W condensate density
h^W condensate enthalpy

10.4.3.6. The flows and differential heat in a steam-condensate installation with partial return of condensate

This installation should be chosen also when condensate is accumulated and periodically pumped out.

In the wizard user must choose a kind of medium: superheated or saturated stem. If saturated steam was chosen it should be determined if the pressure or temperature is measured.
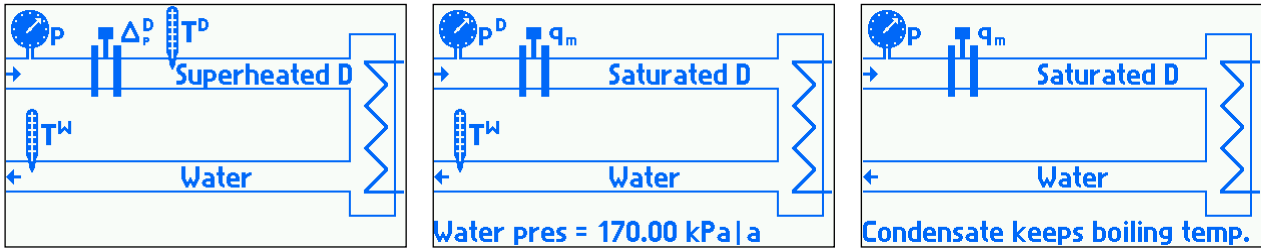
It should also be declared if condensate pressure is equal to steam pressure or entered as a constant value.

List of process values for condensate with constant (entered) pressure:

P delta heat between steam and condensate
P^D steam heat flow rate
q_m^D steam mass flow rate
q_v^D steam volume flow rate

p^D steam measured pressure (only for superheated or saturated steam with pressure measurement)

p_c^D saturated steam pressure calculated based on saturation curve (only for saturated steam with temperature measurement)

T^D steam measured temperature (only for superheated or saturated steam with temperature measurement)

T_c^D saturated steam temperature calculated based on saturation curve (only for saturated steam with pressure measurement)

ρ^D steam density

h^D steam enthalpy

Δp^D pressure difference at orifice in differential pressure device (only if differential pressure device was chosen)

P^W condensate heat flow rate

q_m^W condensate mass flow rate

q_v^W condensate volume flow rate

T^W condensate temperature

ρ^W condensate density

h^W condensate enthalpy.

List of process values for condensate with pressure equal to steam pressure:

P delta heat between steam and condensate

P^D steam heat flow rate

q_m^D steam mass flow rate

q_v^D steam volume flow rate

p steam and condensate measured pressure (only for superheated or saturated steam with pressure measurement)

p_c saturated steam and condensate pressure calculated based on saturation curve (only for saturated steam with temperature measurement)

T^D steam measured temperature (only for superheated or saturated steam with temperature measurement)

T_c^D saturated steam temperature calculated based on saturation curve (only for saturated steam with pressure measurement)

ρ^D steam density

h^D steam enthalpy

Δp^D pressure difference at orifice in differential pressure device (only if differential pressure device was chosen)

P^W condensate heat flow rate

q_m^W condensate mass flow rate

q_v^W condensate volume flow rate

T^W condensate temperature

ρ^W condensate density

h^W condensate enthalpy.

10.4.3.7. The flow and differential heat in a steam-generating installation with the supplied water flowrate measured

In the wizard user must choose a kind of medium: superheated or saturated. If saturated steam was chosen it should be determined if the pressure or temperature is measured.

It should also be declared if condensate pressure is equal to steam pressure or entered as a constant value.
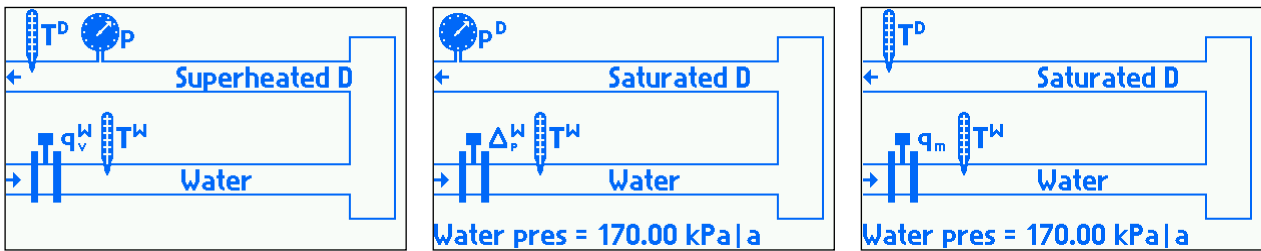
List of process values for water with constant (entered) pressure:

P	delta heat between generated steam and supplied water
P^D	steam heat flow rate
q_m	mass flow rate
q_v^D	steam volume flow rate
p^D	steam measured pressure (only for superheated or saturated steam with pressure measurement)
p_c^D	saturated steam pressure calculated based on saturation curve (only for saturated steam with temperature measurement)
T^D	steam measured temperature (only for superheated or saturated steam with temperature measurement)
T_c^D	saturated steam temperature calculated based on saturation curve (only for saturated steam with pressure measurement)
ρ^D	steam density
h^D	steam enthalpy
P^W	water heat flow rate
q_v^W	water volume flow rate
T^W	water temperature
ρ^W	water density
h^W	water enthalpy
Δp^W	pressure difference at orifice in differential pressure device (only if differential pressure device was chosen)

List of values for water with pressure equal to generated steam pressure:

P	delta heat between generated steam and supplied water
P^D	steam heat flow rate
q_m	mass flow rate
q_v^D	steam volume flow rate
p	steam and water measured pressure (only for superheated or saturated steam with pressure measurement)
p_c	saturated steam and water pressure calculated based on saturation curve (only for saturated steam with temperature measurement)
T^D	steam measured temperature (only for superheated or saturated steam with temperature measurement)
T_c^D	saturated steam temperature calculated based on saturation curve (only for saturated steam with pressure measurement)
ρ^D	steam density
h^D	steam enthalpy
P^W	water heat flow rate
q_v^W	water volume flow rate
T^W	water temperature
ρ^W	water density
h^W	water enthalpy

Δp^W pressure difference at orifice in differential pressure device (only if differential pressure device was chosen).

10.4.3.8. The flow of a gas

It must be declared if the pressure and temperature is measured or entered as a constant value.
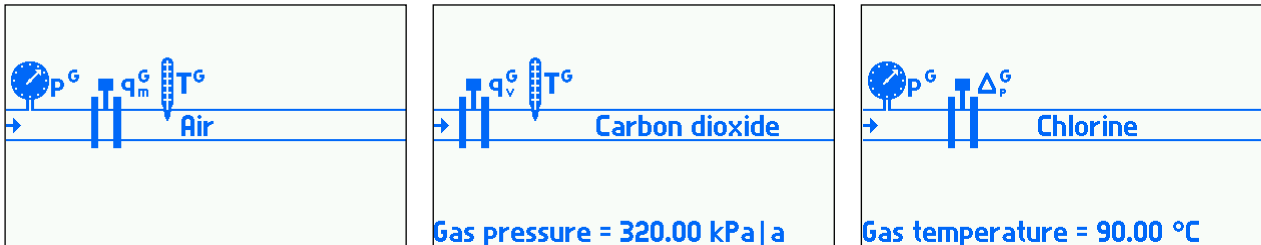
List of process values

q^G gas volume flow rate in standard units (volume calculated to reference conditions)

q_m^G gas mass flow rate

q_v^G gas actual volume flow rate

p^G gas pressure (only if pressure is measured)

T^G gas temperature (only if temperature is measured)

ρ^G gas density

Δp^G delta pressure at orifice in differential pressure device (only if differential pressure device was chosen).

10.4.4. Differential pressure device

If in the wizard differential pressure device was declared, then in installation menu **Diff pres device for Δp** submenu is set automatically. Parameters for this device should be entered here. If two differential pressure devices were chosen, one on supply and the second on return pipeline, two such submenus are set.
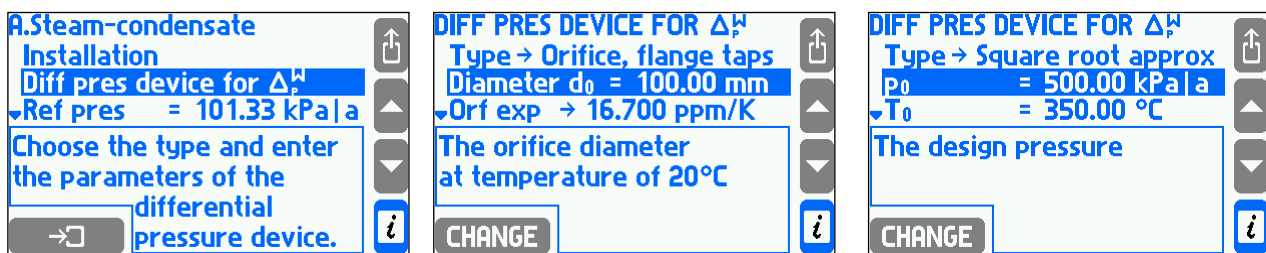
Flow computer can calculate flowrate for differential pressure devices according to PN-EN ISO 5167 standard (only for steam and water) or approximate the flowmeter characteristic with square root curve. It can also cooperate with flowmeter with a variable flow cross section ILVA type manufactured by Spirax Sarco.

According to PN-EN ISO 5167 standard one of differential pressure devices can be chosen:

Orifice, flange taps	Orifice – flange tappings
Orifice, D-D/2 taps	Orifice D-D/2 pressure tappings
Orifice, corner taps	Orifice – corner tappings
ISA1932 nozzle	ISA1932 nozzle

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Long radius nozzle	Long radius nozzle
Venturi nozzle	Venturi nozzle
Venturi tube, cast	Venturi tube - cast
Venturi tube, mach	Venturi tube - machined
Venturi tube, rough	Venturi tube – rough welded sheet iron

Then the pipeline and orifice diameters as well as their temperature expansion have to be entered. Instead of entering expansion user can choose one of the following materials for pipeline and orifice:

Acid-resist steel	16,7 ppm/K
Carbon steel	11,2 ppm/K
Stainless steel	10,0 ppm/K
Cast iron	10,6 ppm/K
Brass	20,0 ppm/K
Aluminium	22,4 ppm/K

To use an approximate square root algorithm user should choose **Square root approx** in **Type** menu, then enter nominal pressure and temperature for orifice calculations and delta pressure to flow rate conversion rate.

The device can accept delta pressure transmitters with both linear and square root characteristic (see section 10.8). But it is recommended to apply transmitters with linear characteristic, in this case extraction of square root is calculated in the device processor.

10.4.5. Flow rate calculation by a formula

If in application no flowmeter was installed (as its flow rate can be calculated based on other application flow rate) it is to be declared in wizard as a **Formula for q_m** . Formulas and the way of entering it was described in section 10.4.5 In a formula for flow rate calculation all values (including auxiliary ones) from all applications can be used but the result produced by formula must be mass flow.

Example: Main application A and B operate with two heat exchangers in series. In system B flow is the same thus in wizard question about flow rate measurement method is chosen **COMPUTED from the flowrates in other installations (by a formula).** In menu **Formula for q_m** the following formula has to be declared: $B.q_m^W = A.q_m^W$.
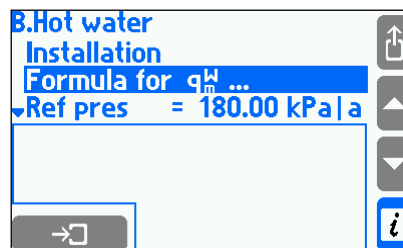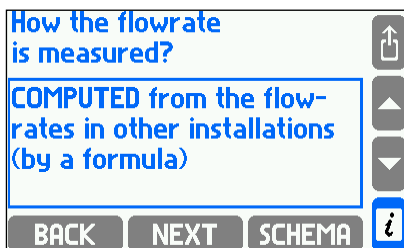
10.4.6. Superheated steam saturation detection

In installation with superheated steam there is possibility to detect saturation condition. To use this function user should choose **Yes** in **Detect** menu in **Steam saturation** submenu and enter minimal required margin over saturation temperature. Steam is recognized as saturated when temperature falls down below this margin. Hysteresis is alwaysm0,5 K.
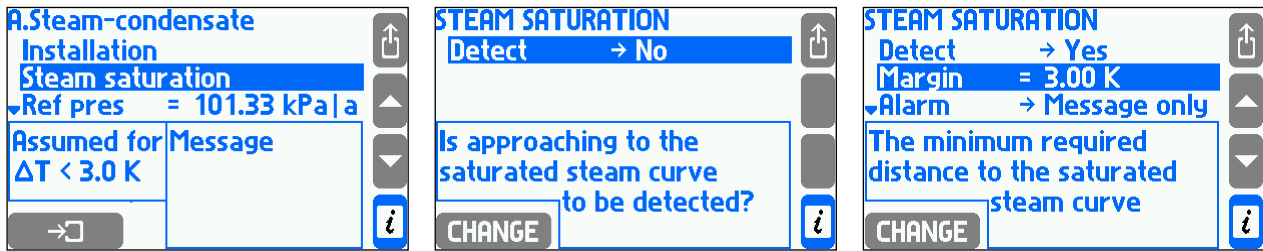
Example: Steam detection was activated and required margin was set to 3,0 K. Steam measured pressure is 1.7 MPa – at this pressure steam gets saturated in temperature about 204,3 ºC. The device will detect steam saturation when its temperature falls down below 207,3 ºC (= 204,3 ºC + 3,0 K). When temperature grows 0,5 K above this value i.e. to 207,8 ºC (= 204,3 ºC + 3,0 K + 0,5 K) the device will assume that saturation state is over.

Saturation detection results in stopping calculations and replacement values: steam density, enthalpy, flow rate and other calculated values based on them with **–S–** symbol. Combined totalisers also stop. Saturation condition can be announced by message on the display or can activate relay output alarm (see section 10.7) and be recorded to event log (see section 4.17.2).

Regardless of the saturation detection a saturation alarm thresholds can be also set. It gets active when the difference between measured steam temperature and saturation temperature falls down below preset level (see section 10.9).

If saturation detection is set to off, then the superheated steam is assumed to be even 20 ºC below saturation curve.

10.4.7. Reference point for enthalpy calculation

Water and steam enthalpy is calculated according to IAPWS-IF97 standard in reference to user chosen point. The reference point is entered relevant values in **Ref press** and **Ref temp** submenus. In order to displays the enthalpy and density at the selected point **Reference properties** must be highlighted.
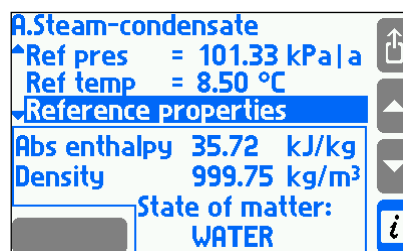
Example: As reference point 101,33 kPa and 8,5 ºC was chosen. According to the standard water the enthalpy in these conditions is 35,72 kJ/kg. Measured water temperature is 78,3ºC and pressure is entered as a constant and equals 250 kPa. According to the standard water enthalpy in these conditions is 327,98 kJ/kg. Therefore calculated water enthalpy (h^W) will be 292,26 kJ/kg (= 327,98 – 35,72). For installations with liquid media other than water reference point is not entered. Enthalpy is calculated only according to the entered table (see section 10.4.1.3).

10.4.8. Saturated steam dryness fraction

For systems with saturated steam dryness fraction can be entered. It determines what percentage of medium mass is saturated steam. It is assumed that the rest consists of water at boiling temperature in form of suspension small drops. Dryness fraction influences density and enthalpy calculation, it is entered in a range between 70 to 100%. 100% value means that saturated steam is completely dry.
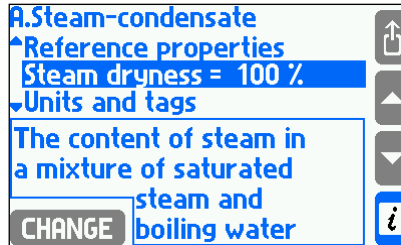
10.5. Auxiliary process values and auxiliary applications

Except of process values defined automatically in the main applications it is allowed to measure or calculate up to eight additional values in the flow computer. Those values can be displayed in the main or in auxiliary applications according to user's needs and convenience.

10.5.1. Adding and removing auxiliary values

To add, remove or edit auxiliary values user has to choose **Auxiliary values** submenu in the main application or in the auxiliary application menu.
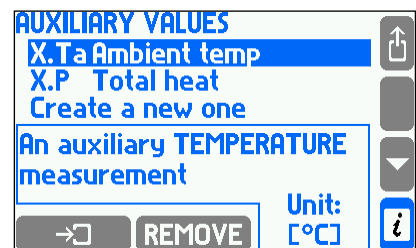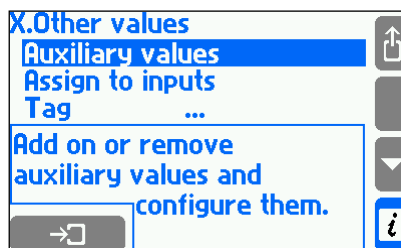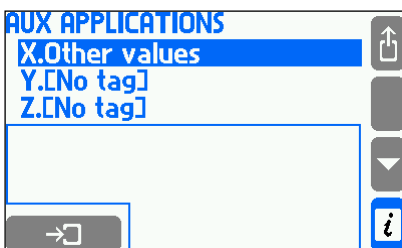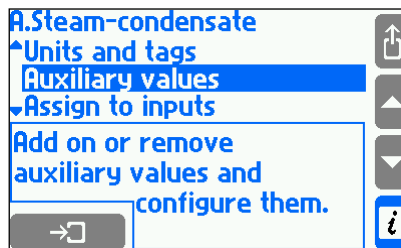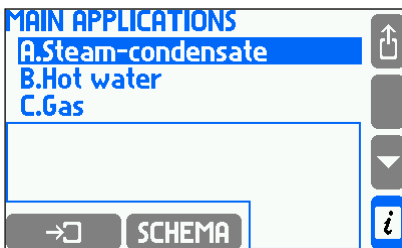
To add a new auxiliary value **Create a new one** function must be chosen and a type of the value and its symbol must be defined. A new item with the new value's setting will be added to the menu.
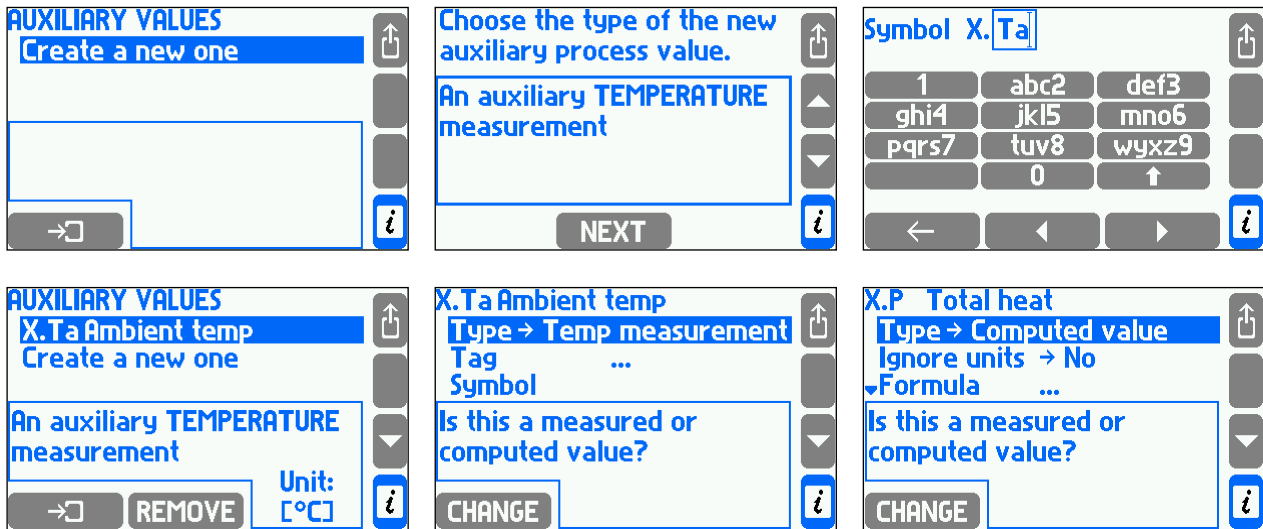
The following auxiliary values types are possible:
- **An auxiliary TEMPERATURE measurement**
- **An auxiliary PRESSURE measurement**
- **An auxiliary measurement of ANOTHER quantity**
- **A value COMPUTED by a given formula**

Once value type is set the symbol can still be changed and a tag can be entered. Other settings depend on value type and were described in sections 10.5.2 and 10.5.3.

To remove an auxiliary value place the cursor at a given position and press REMOVE button.

10.5.2. Auxiliary measured values

An auxiliary value which is set as a measurement of temperature has always unit ºC and does not require to enter any additional settings. Value which is set as a measurement of pressure or any other quantity requires to enter a unit. For pressure the unit can be chosen from the list (see section 10.6) whereas for other units a text string must be entered (up to 6 characters).

An auxiliary value must be assigned to a measurement input (see section 10.8).

10.5.3. Auxiliary values calculated according to formulas

Each value set as computed type requires a formula to be entered. In formulas user can use symbols of other process or computed values, numerical constants, four math operations, square roots and brackets.
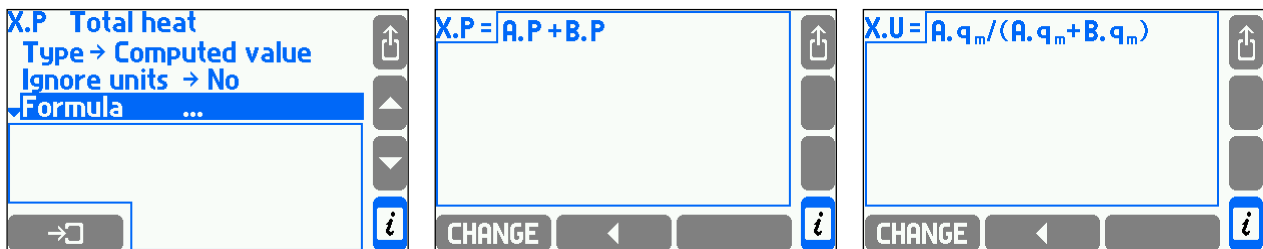
Calculations are performed taking units into account. Formula must have physical sense e.g. density cannot be added to power. Pressures and temperatures are brought to

absolute values before calculations. Formula result must be one of physical quantities listed in section 10.6 or a quantity without unit. If more than one unit is available for the result a proper unit should be taken from a **Unit** list.

In particular cases taking units into account can be deactivated by selecting **Yes** in **Ignore units** menu. In this case a physical sense of a formula is not checked and calculations are performed exclusively for numerical values. Unit of calculated result should be written in a text form (up to 6 characters). In the mass flow rate formula units cannot be deactivated in calculations (see section 10.5.3).

To enter or edit a formula, CHANGE button has to be pressed.
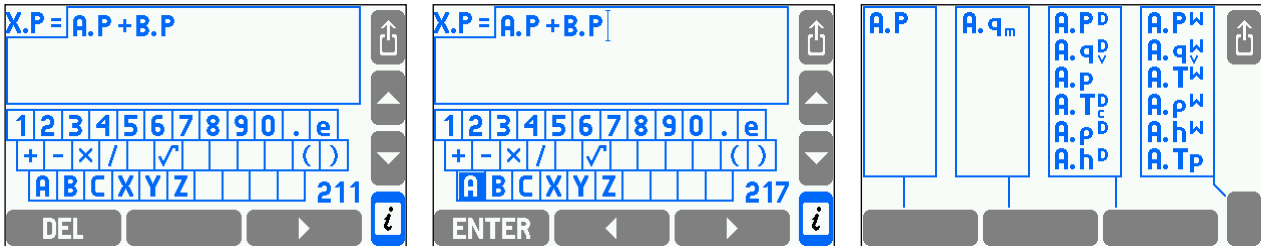
Formulas editor is similar to the tag editor (see section 10.2.2). To enter a new process value to a formula, first, an application symbol has to be chosen from the displayed keyboard, and then a process value symbol from the next screen. Total number of used symbols in all formulas is limited, the remaining number is displayed in the right bottom corner of the screen. In the FP-3011N, FP-3021N, FP-3031 and FP-3031N devices an extended keyboard can be used for editing formulas after pressing CHANGE button. When one of extended keyboard buttons is pressed the buttons meaning appears on the display. The "**# ()**" button allows also to enter math symbols. Usage of extended keyboard is intuitive.
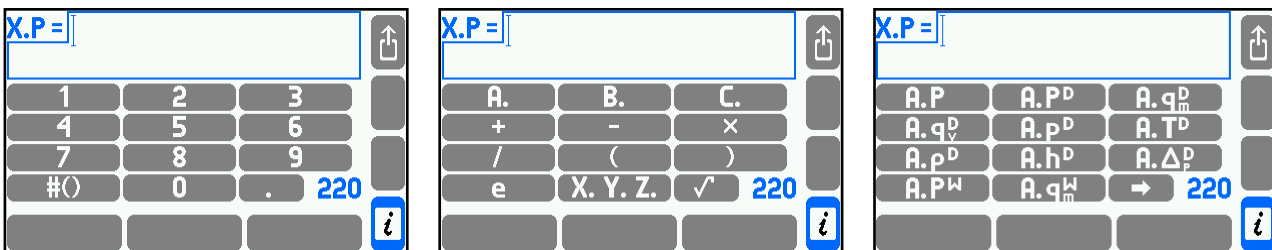
Total number of used symbols in all formulas is limited - the remaining amount of symbols to use is displayed in the bottom right corner of the screen.

10.6. Units

Each value representing any physical value and each totaliser has its own unit. For some physical quantities only one unit is available (e.g. temperature is always displayed in Celsius degrees), for others one of few options can be chosen. List of available units shows the table below.

Heat flow rate	kW	MW	MJ/h	GJ/h		
Heat energy	MJ	GJ				
Mass flow	g/s	kg/s	kg/h	t/h		
Mass	kg	t				

Volumetric flow	m³/s	dm³/s	m³/h	dm³/h		
Volume	dm³	m³				
Pressure	kPa|a	MPa|a	bar|a	kPa|n	MPa|n	bar|n
Pressure difference	kPa	MPa	bar			
Temperature	°C					
Temperature difference	K	°C				
Enthalpy	kJ/kg					
Density	kg/m³					
Specific volume	m³/kg					
Coefficient k	MJ/m³K					

Pressure may be displayed in absolute pressure (ended with „|a") or in gauge pressure (ended with „|g") which refers to an average atmospheric pressure. The value of average atmospheric pressure in the area of the device should be entered in settings – **Barom pres**. submenu.

For additional values also any unit may be entered in text form (up to 6 signs) but then the device will not understand its meaning and will not be able to recalculate it. An additional value without entered unit is treated as a quantity without a unit.

10.7. Relay outputs and event messages

The flow computer has four output relays named RL1…RL4. To be able to use these outputs they should be configured before entering other settings. Otherwise it will not be possible to assign them to events or totalisers when further settings are entered. However, if output relays are not dedicated for operation they should be left deactivated.

10.7.1. Outputs activating events

Relay outputs can react to the following events:
- alarm and control threshold over crossing,
- saturation of superheated steam,
- 4-20mA transmitter or RTD sensor failure or disconnection,
- close or open of binary input (in **State** mode operating).

If output should react to a selected event it must be assigned to this event in relevant settings. These are respectively: settings of alarm/control threshold, settings of measurement system (submenu **Steam saturation**) and settings of measurements inputs (submenus **Actions when failure**, **Actions when closed** and **Actions when open**). Each output can be assigned to any number of events. An output becomes active in case of occurrence of at least one of events it was assigned to. However to be able to assign an output relay to events it should be earlier activated by selection of one of two operation modes.

10.7.2. Control and alarm mode

Each output can operate in control or alarm mode. If it is deactivated or in pulse mode, it is hidden on the output relays screen and it cannot be assigned to events.

Relay output set to a control mode (non-latched) becomes active for a time of an event to which it was assigned. Relay output returns to his normal state when all events end.

Output set into alarm mode (latched) becomes active when one of assigned events occur. Simultaneously a message about the event is displayed and red ALARM diode starts pulsing.

MESSAGE	MESSAGE
2011-05-05 20:23:38 The threshold 1 [▼200.0] of A.P Heat has been crossed. OK SKIP ALL	2011-05-05 20:25:58 Failure on the input IN1 OK SKIP ALL
MESSAGE	MESSAGE
2011-05-05 20:35:18 Steam saturated in the applic A.WATER-STEAM OK SKIP ALL	2011-05-05 20:40:14 The threshold 1 [▼1.00] of A.Steam saturation (DS) has been crossed. OK SKIP ALL
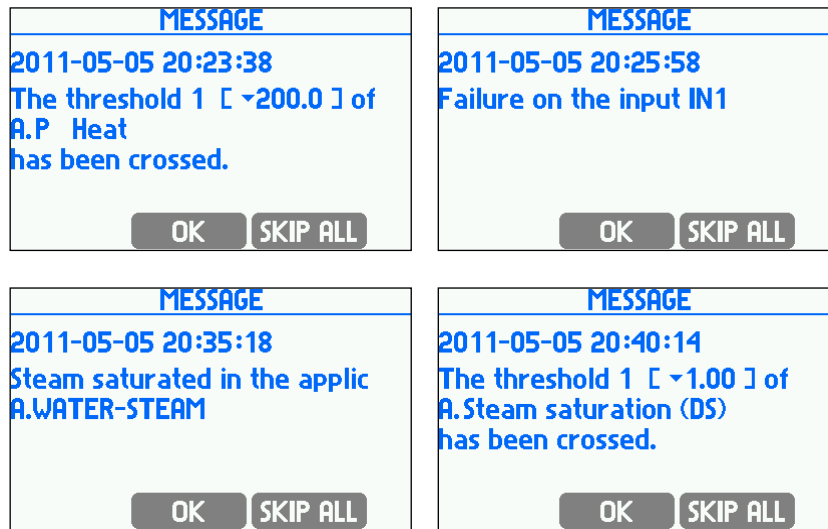
After confirming the message (by pressing OK button) the output becomes deactivated. Red ALARM diode stops pulsing but it remains on until the event disappears. If another event occurs before confirmation of the previous message then its message is displayed after confirmation of the previous one even if the new event itself disappeared to that moment. The output becomes deactivated after confirmation of the last waiting message. SKIP ALL button is used to confirm all waiting messages at one time.

10.7.3. Relay outputs assignment and alarm message activation

To assign a relay output to a selected event user has to choose **Alarm** or **Control** item from the menu.

A.P – THRESHOLD 1	STEAM SATURATION	ACTIONS WHEN FAILURE

▲Alarm   → RL4
  Control   → RL1
▼Event   → None
An output may be activated while the threshold is
         active.
CHANGE
	▲Alarm → Message only
	  Control → None
	  Event → None
	The steam saturation may be signalled by a
	         message and
	CHANGE an output.
		▲Alarm → RL4
		  Control → None
		  Event → Both
		The failure may be signalled by a
		         message and
		CHANGE an output.
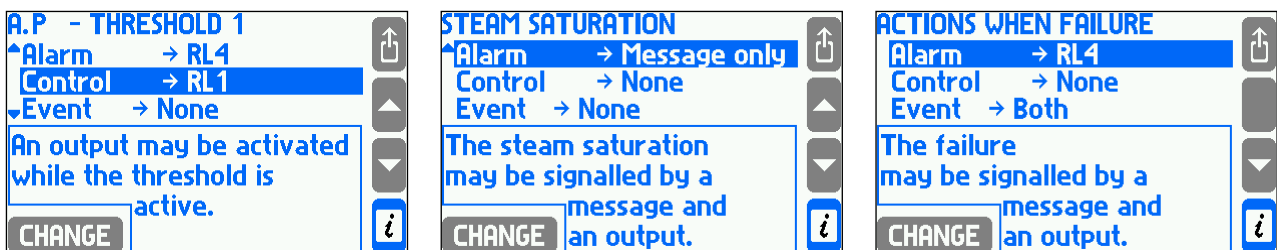
On the selection lists are available only outputs set into proper mode (alarm or control mode). In **Alarm** menu user can choose **Message only,** without relay output assignment. In this case an event will be signaled only by a message and ALARM diode on the front panel and no relay output will become active.

10.7.4. Relay outputs configuration

To configure a relay output (i.e. to set its operation mode and active state) user should select **Relay outputs** from the settings menu and then select corresponding output in the subsequent submenus.
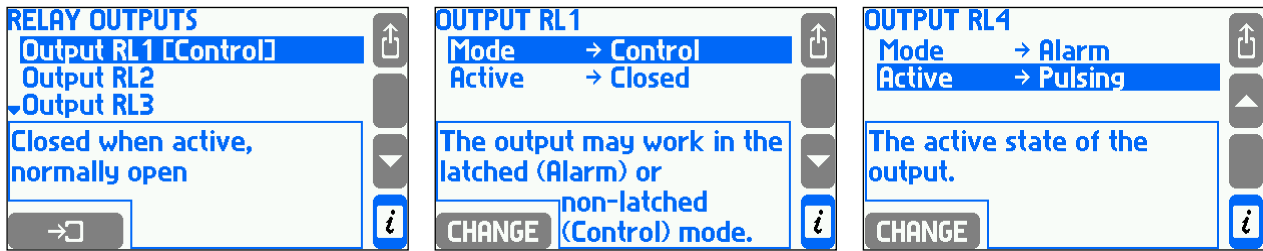
An active state may be closing, opening or pulsing (for alarm mode)

10.7.5. Pulse mode and assigning totaliser

If relay mode is set to pulse, then one of the available totalisers can be assigned to it. But first the totalisers have to be declared and configured. The pulse output can generate up to 100 pulses every second (2.5 msec pulse width). If the calculated number of pulses is greater, then surplus amount is buffered and generated in following periods. To prevent buffer overflow the proper multiplier has to be set. If the totaliser decreases its amount, the pulses are not generated. The buffer algorithm tries to keep the number of pulses corresponding to totaliser value. If the power is switched off, the buffer is reseted.

Mode impulse counter and an assignment if the relay mode is set to pulse dialing, you can assign one to the list of available counters (e.g., movement, or energy). This means that you must first define the performance counter. The output can generate up to 100 pulses within 1 s, if the quantity of pulses is greater, this exceeding amount is buffered and generated in seconds. Therefore, you must select the correct weight of the pulse. If the counter decreases its value, the signals are not generated. Action cache tends to generate a number of signals to match the numerator. If you disable power buffer is reset to 0.

10.8. Measuring inputs

10.8.1. Process values assignment to measuring inputs

Each process values must be assigned to measuring input. For this purpose an assignment table in settings menu is used. It is accessed in submenu **Inputs,** in **Assign** submenu. The assignment table can be also accessed from the main application or an auxiliary application menu (**Assign to inputs**), but in this case only process values for this application appear in the table.
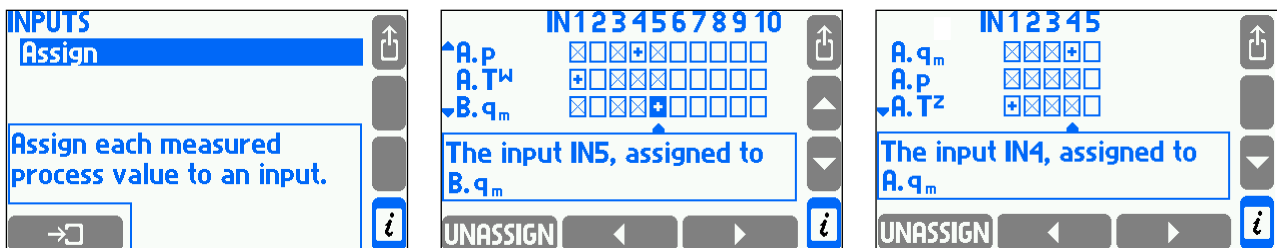
Rows in the table correspond to process values and columns to inputs. Symbol **+** in the check box means that a value is assigned to the input. **X** in the check box means that the assignment is impossible. To change the assignment state user has to place a cursor on the check box using arrows buttons and press ASSIGN or UNASSIGN button.

More than one temperature value or pressure value can be assigned to the same input. But they must be values from different applications and must have the same unit. Assigned inputs have to be configured using **INPUTS** submenu. Unassigned inputs are not accessible in this menu and cannot be configured.

Configuration of different input types was described in next sections.

10.8.2. Measuring inputs

The FP-3011 (FP-3011N) device has 5 inputs:

- **2x RTD/I (IN1, IN2)** – inputs for 2- or 4- wire RTD temperature sensors or 0/4-20mA current loop general purpose sensor,
- **1x I (IN3)** – inputs for 0/4-20mA current loop general purpose sensor,
- **2x I/PULS (IN4, IN5)** - inputs for 0/4-20mA current loop general purpose sensor or for puls, frequency or binary state sensor (OC transistor, passive contacts or NAMUR type sensor).

The FP-3021 (FP-3021N) device has 2 inputs:

- **1 x HART** – input can connect up to 12 transmitters. This number is limited by 5 system dedicated inputs,
- **1 x RS-485(1)** – input can connect up to 32 receiver / transmitters. This number is limited by 5 system dedicated inputs,
- **2 x I/PULS** – inputs for 0/4-20mA current loop general purpose sensor or for pulse, frequency or binary state sensor.

The FP-3031 (FP-3031N) device has 10 inputs:

- **3x RTD/I (IN1, IN2, IN3)** – inputs for 2- or 4- wire RTD temperature sensors (like Pt100 .. Pt1000) or 0/4-20mA current loop general purpose sensor,
- **4x I (IN4, IN5, IN6, IN7)** – inputs for 0/4-20mA current loop general purpose sensor,
- **3x I/PULS (IN8, IN9, IN10)** - inputs for 0/4-20mA current loop general purpose sensor or for puls, frequency or binary state sensor (OC transistor, passive contacts or NAMUR type sensor).

10.8.3. RTD inputs configuration (FP-3011 and FP-3031)

INPUT IN1	INPUT IN1	ACTIONS WHEN FAILURE
Mode → Pt100	Filter → Off	Alarm → Message only
Multiplier = 1	Fail value → None	Control → None
Adjustment = 0.00 Ω	Actions when failure	Event → Both
The number of sensors connected in series or the multiple of nominal resistance.	Message Event	The failure may be signalled by a message and an output.
CHANGE	→⌐	CHANGE
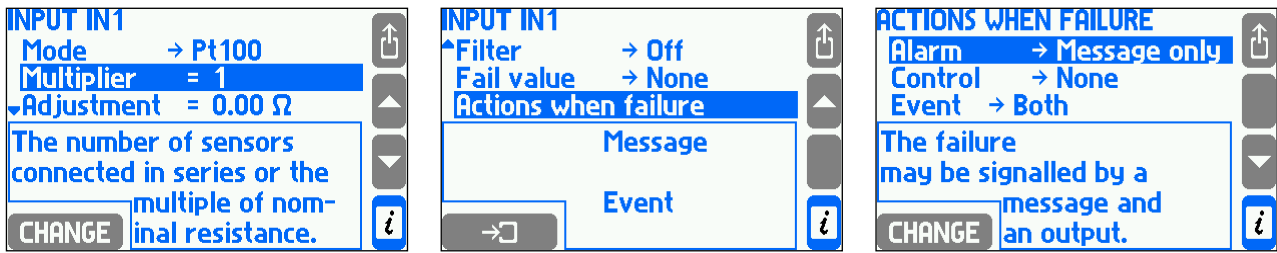
Platinum (Pt100 to Pt1000) or nickel (Ni100 to Ni1000) sensors can be connected to RTD inputs in 2- or 4- wire configuration. Sensor type is chosen in **Mode** submenu whereas resistance for 0 ºC is determined by selection in **Multiplier**, where value 1 designates Pt100 or Ni100, value 2 – Pt200 or Ni200 etc. In **Adjustment** submenu wires resistance can be entered to correct the temperature computation mainly for 2-wire connection. To correct sensor error a negative value of wires resistance can be entered.

Measured temperature can be filtered with a digital single-pole low-pass filter with time constant chosen in **Filter** submenu.

Pt100 sensor can work in the range between -200…850 ºC that corresponding to the resistance range of 18,52…390,48 Ω, whereas Ni100 sensor can work in the range between -60…250 ºC that corresponding to resistance between 69,5….289,2 Ω. Value which is out of the range is treated as a sensor failure and is displayed together with symbol **–F–** (failure) as the same to all other values calculated on its base. Failed measured value can be replaced by an emergency value (the last correctly measured value or a constant value set in **Emerg** submenu). Failure can be reported with a message on the display or with a relay output alarm (see section 10.7) and can be also recorded in the event log (see section 4.17.2) depending on settings in **Actions when failure** submenu. When choosing the emergency value as **Last result** the filter time constant should be set as big as possible for the application. When the GSM module is connected to RS485 port failure notification can be sent as a text message (see section 10.15). Appropriate settings are configurable in submenu **Action when failure**.

10.8.4. Current 4-20mA and 0-20mA inputs (FP-3011 and FP-3031)

INPUT IN3	INPUT IN3	INPUT IN3
Mode → 4-20mA	4 mA = 0.00 kg/h	Filter → 2 s
Unit → kg/h	20 mA = 100.00 kg/h	Fail value → None
Char → Linear	Cutoff = 3.50 kg/h	Actions when failure
Choose a type of electrical signal.	The minimum value: when a lower one is measured, then zero is substituted.	A first-order low-pass filter (20 dB/decade): choose the time constant or switch it off.
CHANGE	CHANGE	CHANGE
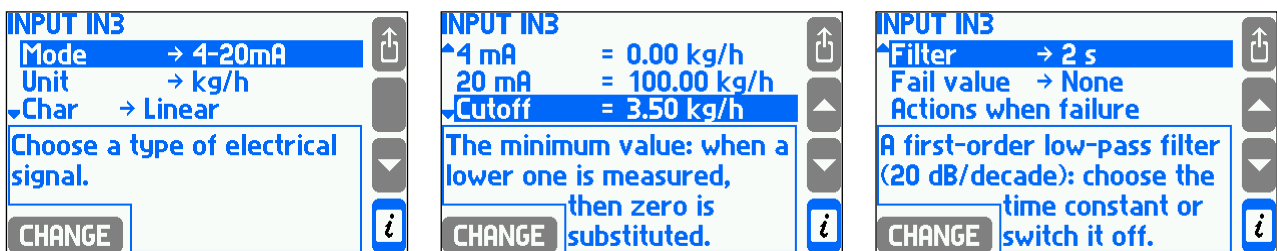
Transmitters with analog current loop signal 4-20mA or 0-20mA can be connected to a current input (I type). Signal type can be set in **Mode** submenu. Dependence between measured quantity and current signal is selected in **Char** submenu. It may be **Linear** , square root (**Transm** $\sqrt{\Delta p}$ - only for differential pressure sensors) or any other characteristic defined by user (see section 10.8.7). Square root curve is available only for differential pressure measurements and it means that output current signal is proportional to square root of measured value. If linear or square root transmitter characteristic was chosen then the signal range has to be entered for 0/4 mA and 20 mA. Entered here

resolution (number of decimal digits) does not influence on a displayed resolution which is selected in the display settings (see section 10.16.2).

A range is entered in a unit assignment to the input. However range of pressure transmitters can be entered in absolute or gauge units independently from displayed unit. Unit of this range depends on selection made in **Transmitter** submenu. It is recommended to set up gauge units for gauge pressure transmitter and absolute units for absolute pressure transmitter.

Measured value can be filtered with a digital one-pole low-pass filter with time constant chosen in **Filter** submenu. Additionally for values other than temperature and pressure **Cutoff** can be activated. In this case if measured value is lower than cutoff value it will be replaced by zero.

Current higher than 22 mA or lower than 3.6 mA (for 4-20mA signal) is interpreted as a measurement sensor failure and the value is displayed together with symbol –E– (over 22 mA) or –||– (less than 3.6 mA) as the same to all other values calculated on its base. Failed measured value can be replaced by an emergency value (the last correctly measured value or a constant value set in **Emerg** submenu). Failure can be reported with a message on the display or with a relay output alarm (see section 10.7) and can be also recorded in the event log (see section 4.17.2). depending When the GSM module is connected to RS485 port failure notification can be sent as a text message (see section 10.15). Appropriate settings are configurable in submenu **Action when failure**.

10.8.5. Configuration of HART and RS-485(1) inputs (FP-3021)

→ MAIN MENU → SETTINGS → INPUTS → TRANSMITTERS

RS-485 port(1) [1]
    Baud rate → **1200** (1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200) [2]
    Parity → **Even** (Even, Odd, None) [3]
    Timeout → **0.5 sec** (0.5, 1.0, 2.0, 5.0 secs, Enter…) [4]
    Query → **1x** (1x, 2x, 3x) [5]
HART port [6]
    Master → **Primary** (Primary, Secondary) [7]
    Preamble = 5 B ([value]) [8]
Input IN1 [9]
    Protocol → **Modbus RTU** (Modbus RTU, HART) [10]
    Address = 1 ([value]) [11]
    Function → **04** (04, 03) [12]
    Register → **0** ([value]) [13]
    Format → **Uns.integer** (Uns.integer, Integer, Uns.long, Uns.long(sw), Long, Long(sw), Float, Float(sw)) [14]
    Multiplier → **1** (1, 0.1, 0.01, 0.001, 0.0001) [15]
    Offset = 0 ([value]) [16]
    Delay → **0 sec** (0, 0.5, 1.0, 2.0, 5.0 secs, Enter…) [17]
    Unit → **[None]** ([text]) [18]
    Cutoff → **None** (None, Enter…) [19]
    Fail value → **None** (None, Last result, Enter...) [20]
    ACTION WHEN FAILURE [21]
        Alarm → **None** (None, Message only, RL1..RL4) [22]
        Control → **None** (None, RL1..RL4) [23]
        Event → **Both** (Both, Failure, Recovery) [24]
Input IN2 [9]
    Protocol → **HART** (Modbus RTU, HART) [25]
    Address = 1 (Short [value], Long [value], Fetch) [26]

Variable → 1.(PV) (1.(PV), 2.(SV), 3.(TV), 4.(FV)) [27]
Unit → [None] ([text]) [18]
Transmitter → Absolute (Absolute, Gauge) [28]
Fail value → None (None, Last result, Enter...) [20]
ACTION WHEN FAILURE[21]
    Alarm → None (None, Message only, RL1..RL4) [22]
    Control → None (None, RL1..RL4) [23]
    Event → Both (Both, Failure, Recovery) [24]
    Send a text → No (Yes, No) [29]

....

Input IN4 [9]
    Protocol → Modbus RTU (Modbus RTU, HART) [10]
    ....
Input IN5 [9]
    Protocol → HART (Off, Modbus RTU, HART) [25]
    ....

Explanations:
[1]: Submenu containing settings for the **RS-485(1)** designated for communication with the transmitters or devices.
[2]: **Baud rate** in communication with the transmitters or devices.
[3]: Setting **Parity** bit.
[4]: The device after sending the read command to the transmitter or the device, waits for a response by the time set in the **Timeout**. If the instrument does not receive a response from the sensor, the read command is not sent again and the device goes to poll the next sensor or device. At the channel the device sets a failure. Pay attention to the proper selection of **Timeout**. When is set too short a queried transmitter or the device may not get answered, setting the timeout too long can result in prolongation of time to scan all channels.
[5]: In case there is no response, the **Query** can be repeated. 1x means no repetition. Up to two repetitions are possible (3x query).
[6]: Submenu containing settings for the **HART** communication protocol.
[7]: FP-3021(N) device can be connected to the current loop as Primary **Master** or Secondary **Master**.
[8]: Determine number of bytes in the **Preamble**. Select a value from 3 to 20.
[9]: The channel number and a description of the measurement. A description given in brackets "[]" corresponds to programmed description text of the channel. Programming the description in **Tag** menu.
[10]: The **Protocol** selection in which user want to read the value assigned to the measuring channel. In this case, Modbus RTU protocol was selected.
[11]: Sensor or device **Address** from which the measurement results will be read.
[12]: Type of reading **Function**s. Available functions: 03 (Read Holding Registers) and 04 (Read Input Registers).
[13]: Set the initial **Register**'s address from which data will be read. The value must be given in decimal system.
[14]: There are available 8 **Format**s of read results:
- unsigned integer - 2 bytes without a sign
- signed integer - 2 bytes with sign,
- unsigned long integer - 4 bytes without a sign
- unsigned long integer swapped - 4 bytes without a sign
- signed long integer - 4 bytes with a sign,

- signed long integer swapped - 4 bytes without a sign
- float - 4 bytes,
- float swapped - 4 bytes

[15]: The **Multiplier** - this option is available for following variables type: unsigned integer, signed integer, unsigned long integer, unsigned long integer swapped, signed long integer and a signed long integer swapped.

[displays score] = [result read] x [multiplier]

[16]: The **Offset** - this option is available for following variables types: unsigned integer, unsigned long integer, unsigned long integer swapped.

[displays score] = ([result read] - [offset]) x [multiplier]

[17]: For some devices an extra **Delay** time is required between transactions Query-Response. This time is added before the query. Typically it should be set to 0.

[18]: The **Unit** is only informative, as well as a description of the channel. For units of flows the last unit characters "/ s", "/ min", "/ h" are recognized as the unit of measurement of flow in the settlement, respectively second, minute and hourly. Unit marked "Hz" is treated as a "pulses / s" and "kHz" - as "1000 pulses / s".

[19]: The **Cutoff** - the minimum value, when a lower one is measured, then zero is substituted

[20]: The **Fail value** - the value displayed as a result of the measurement in case of sensor failure. User can program the emergency value as constant or it may be set as the last measured value. This function is used in advanced applications (e.g. in process control mode), and typically it is disabled.

[21]: In this submenu user can set a proper action during transmitter failure.

[22]: The failure may be signaled by a message and an output relay in **Alarm** mode.

[23]: An output working in **Control** mode may be activated while the measurement fails.

[24]: A measurement failure and its recovery may be recorded in the **Event** log.

[25]: The **Protocol** selection in which user wants to read the value assigned to the measuring channel. In this case, HART protocol is selected.

[26]: The HART protocol allows two ways of **Address**ing the device: short addresses (1 to 15) and long addresses (unique for each transmitter). The user is able to enter a short address, enter a long address, and automatically get the long address from the transmitter. To get a long address, user must select **Fetch** (requires to stop the scan of transmitters) and then enter a short address of a device which long address he wants to download.

```
INPUT IN2
 Protocol      → HART
 Address  = Fetch
▾Variable      → 1.(PV)

The address of transmitter
for this value.

   OK
```

```
FETCHING ADDRESS
 Short address = 01



After entering the value the
long address will be read by
            command 0.

   ▶
```
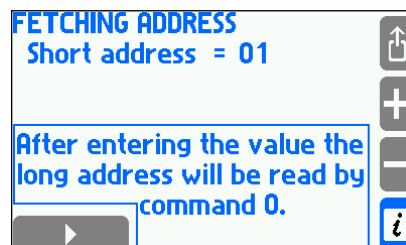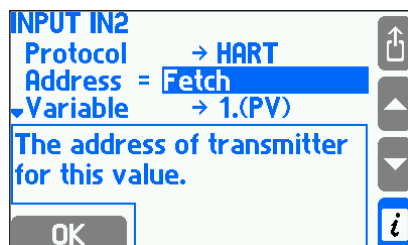
[27]: Selecting a **Variable** which user want to read:
- **1.(PV)** – primary variable,
- **2.(SV)** – secondary variable,
- **3.(TV)** – third variable,

- **4.(FV)** – fourth variable.

It is impossible to read data which the transmitter makes available outside the above-mentioned four variables.

[28]: Pressure may be measured in absolute pressure or in gauge pressure which refers to an average atmospheric pressure

[29]: When the GSM module is connected to RS485 port failure notification can be sent as a text message (see section 10.15).

10.8.6. Configuration of binary PULS type inputs

Digital inputs can operate in one of three modes: frequency measurement, pulse counting or state monitoring.

10.8.6.1.   Frequency measurement
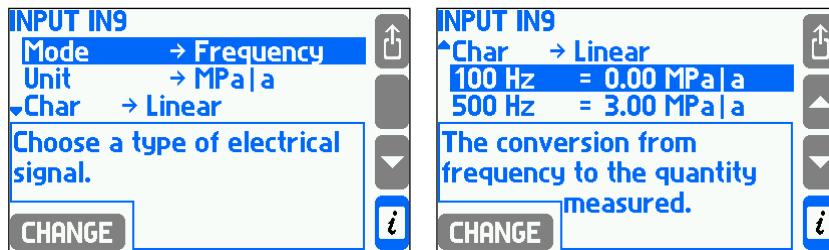
Measuring transmitters with frequency output in the range between 0,001 Hz …10 kHz can be connected to the binary inputs operating in a frequency measurement mode. Dependence between measured quantity and frequency signal is selected in **Char** submenu. It may be **Linear**, square root (**Transm √Δp**) or any other user defined characteristic (see section 10.8.7). Square root curve is available only for delta pressure transmitter and it means that output frequency value is proportional to square root of the measured value. If linear or square root transmitter characteristic is chosen then the lower and upper frequency range has to be entered. Entered resolution (number of decimal digits) does not influence on displayed resolution which is selected in the display settings (see section 10.16.2).

For physical quantities other than temperature and pressure user can activate **Cutoff**. In this case if measured value is lower than the cutoff value it is replaced by zero.

10.8.6.2.   Pulse counting
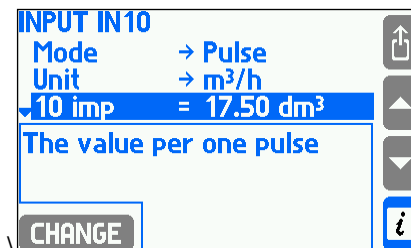
Pulse counting is chosen if a flow meter with a constant pulse value is connected to the binary input. The pulse value should be entered giving a flow value corresponding to the relevant number of pulses. Flow rate value is computed based on measured frequency

while the main (Σ_1) and additional (Σ_2) totalisers count input pulses multiplied by entered pulse value. In this way no pulse is lost even if a cutoff value is set for flow rate.

User can activate **Cutoff**. In this case if measured value is lower than the cutoff value it is replaced by zero.

10.8.6.3. State monitoring
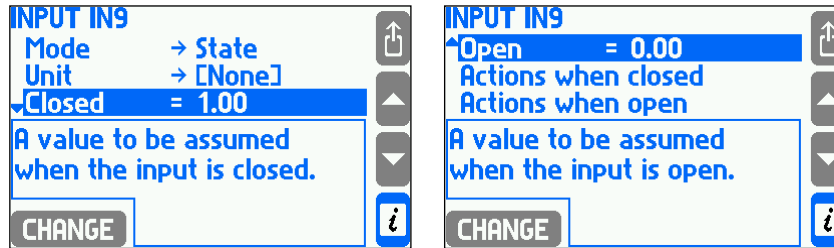
A process value assigned to the binary input in the state monitoring mode may have two values: one, when the input is closed and the other when it is opened (e.g. input closed equals -6,25, and opened +12,5). Both values can be entered in settings. This mode is available only for the inputs with auxiliary values assigned and can be used for indication of flow direction, as a multiplying factor in sophisticated applications.

Both closed and open state can be indicated with a message on the display or as a relay output alarm (see section 10.7), also can be recorded in the event log (see section 4.17.2) and it can be used to switch over to second archive speed (see section 10.12.1). Adequate settings are entered in **Actions when closed** and **Actions when open** submenus.

10.8.7. Nonlinear characteristics of measurement transmitters

The flow computer can also accept the current loop or frequency signal other than linear or square root. Transmitter's characteristic is upload to the device as a file. Such file should be prepared on a PC computer in a text editor or in a spreadsheet and copied to the USB Flash Memory (pendrive). Accepted extensions are .txt and .csv. An example of the file contents with the transmitter's characteristic with frequency signal is given below.

```
#char Nonlinear
100.0  30.0
200.0  40.0
300.0  52.0
```

A file must begin with string #char which is followed by the name (up to 12 characters, here Nonlinear). In the next line the table starts with two columns of numbers: transmitter signal in Hz (or mA for current loop transmitter) and corresponding measured value. The table must be ordered in sequence of growing signal values. In the example value 30.0 corresponds to 100 Hz frequency. Values between the table points are linearly interpolated (here in the example 35.0 corresponds to frequency 150 Hz). Values outside the table are linearly extrapolated (here in the example 25.0 corresponds to 50 Hz, and 64.0 to 400 Hz).

Transmitter's characteristics are stored in the data base in the settings. To view the base contents and to add or remove characteristic table user has to choose **Characteristic manager** submenu from the main menu.

MAIN MENU
▲Audit trail
Media manager
▼Characteristic manager
Add on or remove nonlinear transmitter characteristics.

CHARACTERISTIC MANAGER
Char1   64
Char2   128

Free memory   65280
NEW ONE REMOVE

Char: Freq
Required memory: 64
Available memory: 65472

Do you want to add on this characteristic?
YES   NO
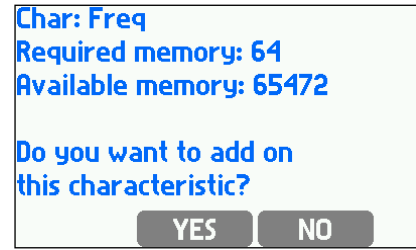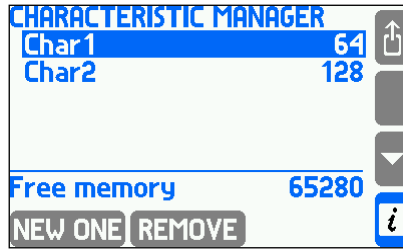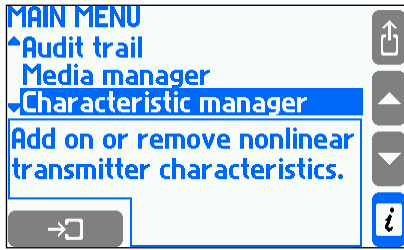
To add on a new characteristic the USB Flash Memory containing a relevant file has to be inserted. In **Characteristic manager** menu user has to press NEW ONE button. A list of files with .txt or .csv. extensions will be displayed and the highlighted file can be chosen with the LOAD button. A new characteristic can also be added during the input configuration without need of entering the characteristic database. For this purpose in **Char** submenu user should choose **From file…**. This will display a list of available files and it allows to add a characteristic table.

Pressing REMOVE button deletes all media (see section 10.4.1.3) and all user's characteristics. The occupied memory volume is displayed next to the name on the list of characteristic tables. At the bottom of the screen the remaining free memory space is displayed. The database can store up to 16 characteristics.

10.9. Alarm and control thresholds

For each process value except of density (ρ), enthalpy (h), differential pressure (Δp) and water thermal coefficient (k) up to four alarm and control thresholds can be set. It is configurable in the settings menu in **Alarms and control** submenu.

ALARMS AND CONTROL
A.Steam-condensate
B.[No tag]
▼C.[No tag]

ALARMS AND CONTROL (A)
▲A.q$_v^W$[No tag]
A.T^{W}Water temp.
▼A.Steam saturation (DS)
No thresholds defined

A.T^D [No tag]
Threshold 1 [▲300.00]
Threshold 2 [▼240.00]
▼Threshold 3
▲ 300.00
⊥ 5.00

A.T^D – THRESHOLD 1
Mode   → Upper
Level   = 300.00 °C
▼Hysteresis = 5.00 °C
Level
Hyster
              Releasing
CHANGE Crossing

A.T^D – THRESHOLD 2
Mode   → Lower
Level   = 240.00 °C
▼Hysteresis = 5.00 °C
Hyster
Level
              Releasing
CHANGE Crossing

A.T^D – THRESHOLD 2
▲Alarm   → Message only
Control   → None
▼Event   → Crossing
Crossing and releasing may be recorded in the event log.
CHANGE

To activate a threshold the first has to be selected the mode (**Upper** or **Lower**), and then the threshold value and the hysteresis value. Upper threshold actives when the value exceeds the threshold level and releases when the value declines below that level by at least as much as hysteresis. Lower threshold actives when the value declines below the level and releases when the value exceeds that level by at least as much as hysteresis.

In systems with superheated steam, thresholds may be set to a process value called **Steam saturation (DS)**. This special thresholds actives when difference between

measured steam temperature and saturation temperature at measured pressure is below the set level. It is used to indicate when superheated steam conditions are too close to its saturation.

Exceedance a threshold can be signaled with a text message on the display or with the relay output alarm (see section 10.7), it is reported in the event log (see section 4.17.2) and may switch over to the second archiving speed (see section 10.12.1). When the GSM module is connected to RS485 port alarm occurrence can cause sending an information about it in a form of text message (see section 10.15). To configure the sending text messages for particular threshold **Send a text** need be marked as **Yes**. Crossing a threshold is also signaled with a change of a color of the displayed value.

Information about exceedance of thresholds is displayed on the screen called the alarm and control thresholds (see section 4.3.2). A displayed symbol ▲ means crossing of an upper threshold while a symbol ▼ means crossing of a lower threshold. A shaded square means that a respective threshold is not defined

10.10. Totalisers

For process values of flow rate or heat flow rate and for additional values which unit end with **/h**, **/min** or **/s.** Up to four totalisers can be set:
- main totaliser (Σ_1),
- auxiliary totaliser (Σ_2),
- overrange or hourly totaliser (the ordered power) (Σ_H),
- underrange totaliser (Σ_L).

In the settings menu in **Totalisers** submenu user can set up totalisers for all active main and auxiliary applications.
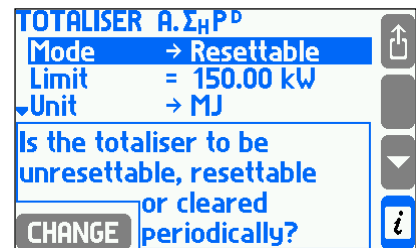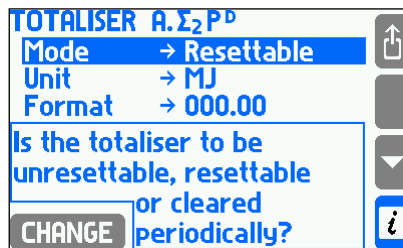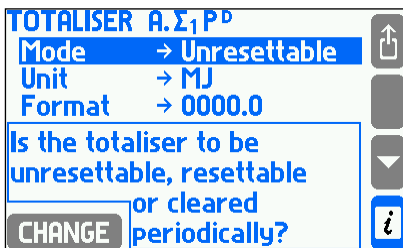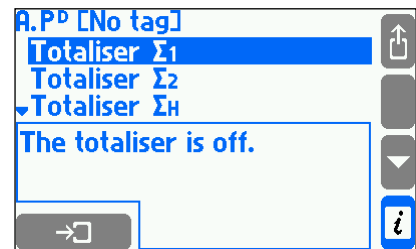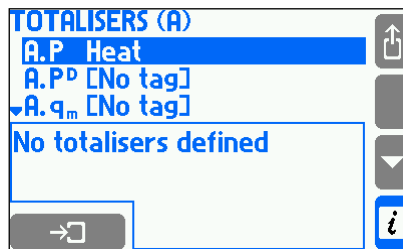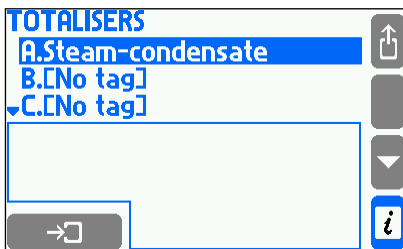
The main Σ_1 and the auxiliary Σ_2 totaliser add flow rate or heat values in one second periods. An exception is when process value is assigned to binary input operating in pulse counting mode. Then totalisers count pulses multiplied by their values.

Example 1: Flowrate value is 1800 kg/h. Each second 0,5 kg (=1800 kg/h / 3600 s $\times$ 1 s) is added to main and auxiliary totaliser.

Example 2. Volumetric flow rate is measured with pulse flowmeter where 1 pulse = 10 dm^3. The flowmeter is connected to the binary input and set to pulse counting mode. The flowmeter rotates with a speed of 1 pulse every 20 seconds (frequency is 0,05 Hz). Therefore the flowrate is 0,5 dm^3/s. However the main and auxiliary totalisers do

not totalise flow 0,5 dm^3 every second. They increase their value by 10 dm^3 every 20 seconds when a pulse comes.

The overrange totalizer Σ_H totalises only amount over a set limit. If the value is lower than the limit the totaliser stops.

Example. An overrange totaliser was activated for heat flow rate and a limit was set to 150 kW. Heat flow rate value is 162 kW. Each second a value of 12 kJ (= [162 kW − 150 kW] × 1 s) is totalised.

An underrange Σ_L totaliser totalises only amount under a set limit. If the value is higher than the limit the totaliser stops.

Example. An underrange totaliser is activated for heat flowrate and a limit was set to 20 kW. Heat flowrate value is 17 kW. Each second a value of 3 kJ (= [20 kW − 17 kW] × 1 s) is totalised.

A totaliser may operate in one of the following modes:

- **Unresettable**
- **Resettable** (this mode cannot be used for main totaliser)
- **Hourly**
- **Daily**
- **Monthly**

An unresettable totaliser operates constantly from the moment of its activation in settings. It cannot be reset from keyboard neither it is reset automatically. A resettable totaliser can be reset from keyboard on a totaliser screen (see section 4.3.2). Resetting can be executed for only one totaliser or for all resettable totalisers at once. An hourly, daily and monthly totaliser resets periodically:

- hourly - resets totaliser at full hours,
- daily - resets totaliser once a day at any full hour selected in **Hour** submenu in settings **Nominal month beginning** menu,
- monthly - resets totaliser at any day of a month between 1st and 28th or on the last day of the month (**Day** submenu in settings **Nominal month beginning** menu) at any full hour like daily reset totaliser.
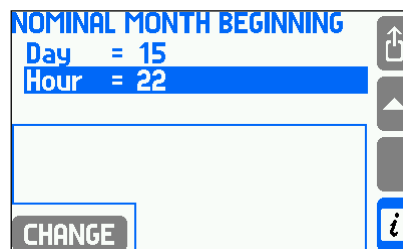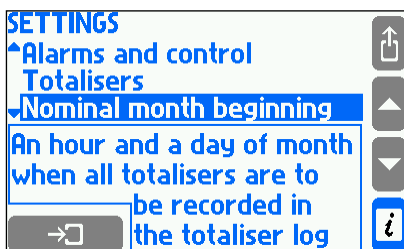
Each totaliser has its own unit. Energy, mass and volume unit can be selected from a list according to the table in section 10.6. A unit change causes a relevant rescaling of the totalised value. The totaliser value can be displayed with resolution from 0 to 4 decimal digits. The resolution does not influence on the accuracy of the totaliser and can be changed at any time.

Values of all active totalisers are recorded into a totaliser log at the end of each month according to settings in **Nominal month beginning** submenu (see section 4.17.1). Additionally, values of some user chosen totalisers may be recorded into hourly archive file in the internal memory at every full hour (see section 10.12.2).

An operator with service privileges can set the timers on any of the major initial values and reset all the other counters, including those that are not erasable.

10.11. 4-20 mA current loop output (optional)

The flow computer may be optionally equipped with one or two 4-20 mA current loop output, (see section 3.2). An output can generate a signal proportional to one selected process value. To configure the output user has to select **4-20mA Output** submenu from the settings menu.
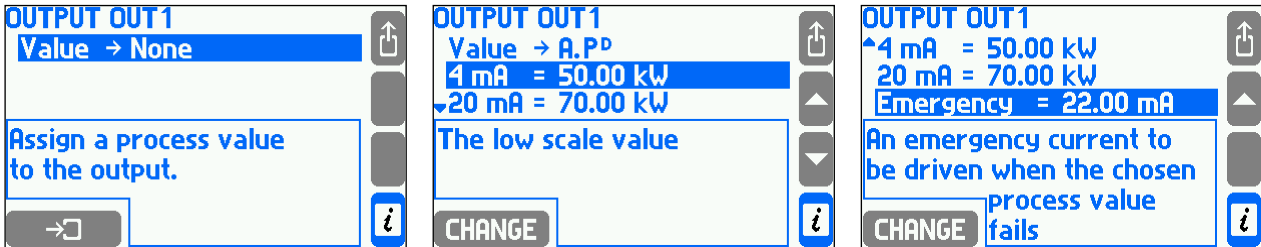
An activation of an output requires assigning selected process value from the list in **Value** submenu. In the next two positions are required values of extreme currents: 4 mA and 20 mA. Current signal is always in the range of 3,6…22 mA. For values smaller than 3.6 mA the output current stays at 3.6 mA. Similarly for current over 22 mA the output current stops at 22 mA.

If process value has no value (e.g. during transmitter failure when no emergency value was activated or during saturation of superheated steam), an output can generate a special current value informing about error situation. This value should be entered in **Emergency** submenu. If emergency value is deactivated the output current value remains unchanged if a fault is detected.

10.12. Archiving

Device has an internal memory of 2GB in which are stored:
- selected set of process values with the frequency chosen in the range from 3 seconds to 24 hours (see section 10.12.1)
- selected set of average, minimum and maximum values in the hour and totalizers (see section 10.12.2)
- events related to the measured objects, such as the alert and control thresholds excedance, failures of transmitters, saturation of superheated steam, etc. (see section 4.17.2)
- authorized activities (see section 4.7 and 4.17.3)

10.12.1. Main archive

Settings associated with this archive are gathered in **Main Archive** submenu.
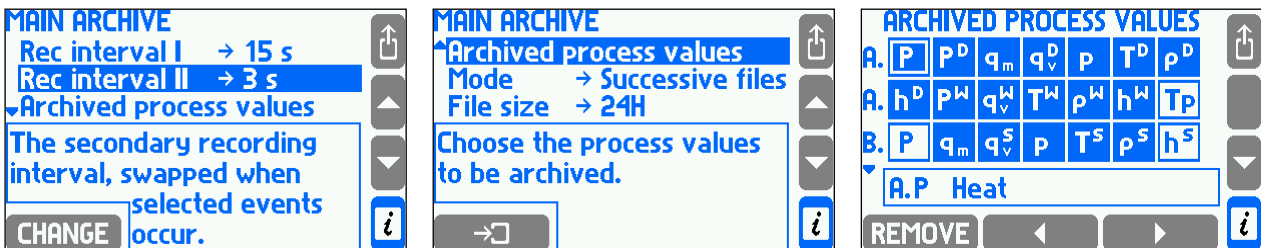
The first two menu items are to select the two archiving speeds(frequency). In normal operation the **Rec interval I** is used. **Rec interval II** may be swapped for the time of alarm and control thresholds activation or for time of closing or opening of output relays. Change of frequency of the recording by a given threshold or output relays must be declared it in its setting - **Swap intervals** item.
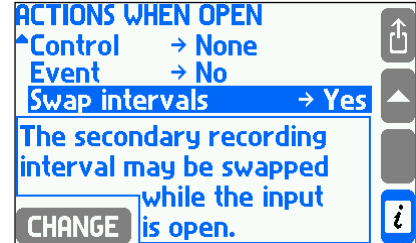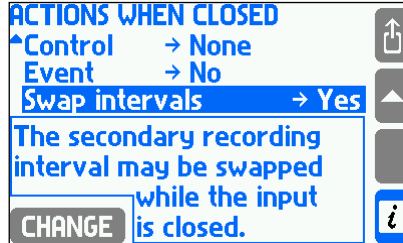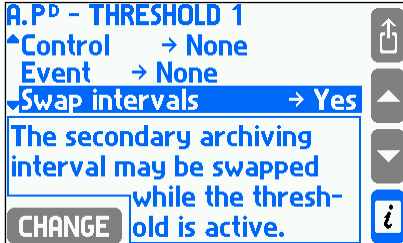
If the second archive speed is not used it is recommended to set it equal to the first one. This is important when using an archive browser in the device because the time scale is selected automatically based on both frequencies.

To determine archived set of process values user has to choose **Archived process values** submenu. A table with values of all applications will be displayed. Shaded squares mean that given process value is archived. To add on or remove value user has to place cursor on the square and press the left bottom button **ADD ON** or **REMOVE**.

Mode submenu allows to select archiving mode. **Overwrite** option means continuation of archiving by overwriting the new records on the oldest ones. **One file** option means that archiving will be stopped when the file size is reached. **Successive files** option allows for multiple files recording.

In **File size** submenu user can set the size of one Main Archive files from range between 2 and 256 MB or a time period (24H, Week, Month).

10.12.2. Archive of totalisers and the average values

This archive file records process values of selected totalisers (up to 15) and a set of hourly averages, minimums and maximums for chosen process values (up to 15) at full hours.

Configuration is accessed in submenu Hourly archive from Settings menu.
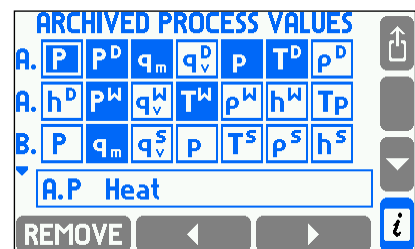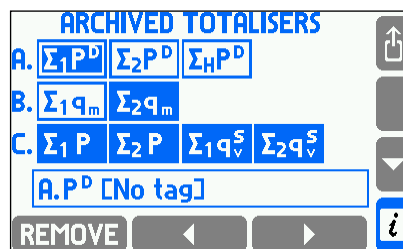
To choose a set of totalisers and process values to be archived the Archived totalisers and Archived process values submenu have to be selected from Hourly archive menu in Settings menu. After the operation a table with totalisers or process values available for all applications will be displayed. Shadowed value field means that the totaliser or value is declared for archiving. To add on or remove a value a user has to place the cursor on the check box and press the left bottom button **ADD ON** or **REMOVE**. There can be archived up to 15 totalisers and up to 15 process values at the same time.

10.13. RS-485 serial port (RS-485(2) in FP-3021)

Associated with RS485 transmission settings are in **RS-485 port** submenu.
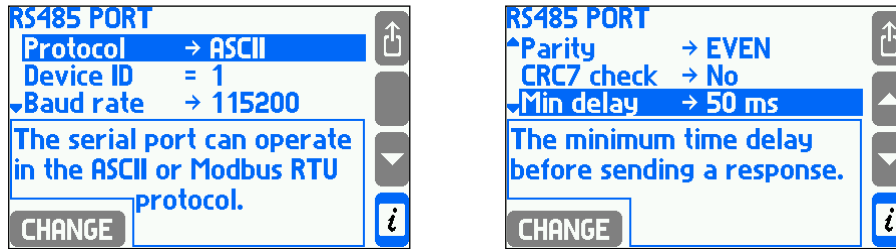
Communication can be done in two protocols: **ASCII** (only in FP-3000-Raport software) and **Modbus RTU**, in addition to the RS485 port can be connected **GSM** module (submenu **Protocol**).

ASCII protocol is dedicated for communication with programs delivered by a manufacturer e.g. FP-3000-Raport. Modbus RTU protocol serves for communication with universal visualization programs and enables readout of all process values and totalisers. Protocol details are described in sections 13.

Device ID identifies the flow computer in network and must be unique (no other device in the same network can have the same address). **Baud rate** and **Parity** must be set the same as in computer or controller which is the network master.

In ASCII protocol transmitted packages may be protected with CRC code. Device always attach a code to transmitted packages, and computer program can compute it but does not have to. When **CRC7 check** is disabled the device will not check code integrity in received packages.

In **Min delay** submenu minimum time interval between enquiry reception and answer transmission can be chosen. **Max delay** submenu applies only to ASCII protocol. If device does not manage to send an answer in the selected time then it sends a code "not ready".

Data read via the RS-485 has no impact on communication via the Ethernet port.

10.14. Ethernet port

A flow computer can operate in an industrial Ethernet network using Modbus TCP protocol. Associated with the transmission settings are grouped together in the submenu **Ethernet Port**.
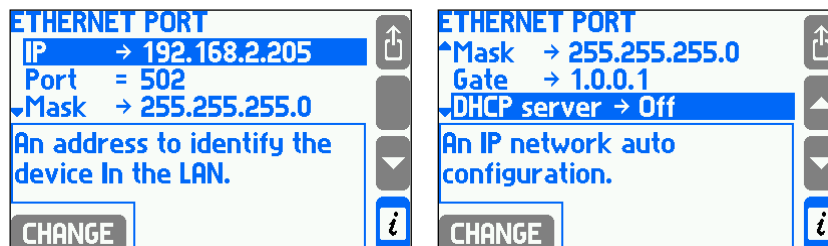
For successful communication between the device and the supervisory system all needed parameters have to be configured (menu: **Settings → Ethernet port**). The factory settings are as follows:

IP: 1.0.0.1
Port: 502
Mask: 255.255.255.0
Gateway: 1.0.0.1

DHCP Server: Off
Timeout: 60 sec.

The IP address, the subnet mask and the gateway must be entered in accordance with the network, in which the device is working. In typical application DHCP server should be off. It is recommended to use port 502, because this port is dedicated to Modbus TCP. Connection timeout specifies the maximum time with no exchange of data between the client and the server. After this time the connection is automatically closed (considered inactive, for example due to an emergency off of the master unit).

Ethernet server can handle up to 4 simultaneous clients with Modbus TCP. This allows simultaneous querying the device from four different computers, or by four different systems. Data from the measurement channels are available in two formats: Integer and Floating point.

The device has also a Web Server that allows to monitor the process data using standard Web browser. To do so, the IP address (configured in the device's menu: **Settings → Ethernet Port)** should be entered to the browser address bar. The Web Server allows to display process values and totalisers in table format and graphic trend chart (TREND tab) and the state of output relays. Switching between the values assigned to each of the measurement application is done using the tabs A, B, C, X, Y, Z. The archive data are not available with Web Server.

On the chart user has the ability to set the refresh time (refresh delay are the result of delays in communication over the Internet and may vary depending on the network, from fractions of seconds to several seconds). By pressing Settings button, users can define which measuring system (and which values for a given system) is to be presented in the graph and can change the color of the trend lines.

A web server is available in four languages: English, German, French and Polish.
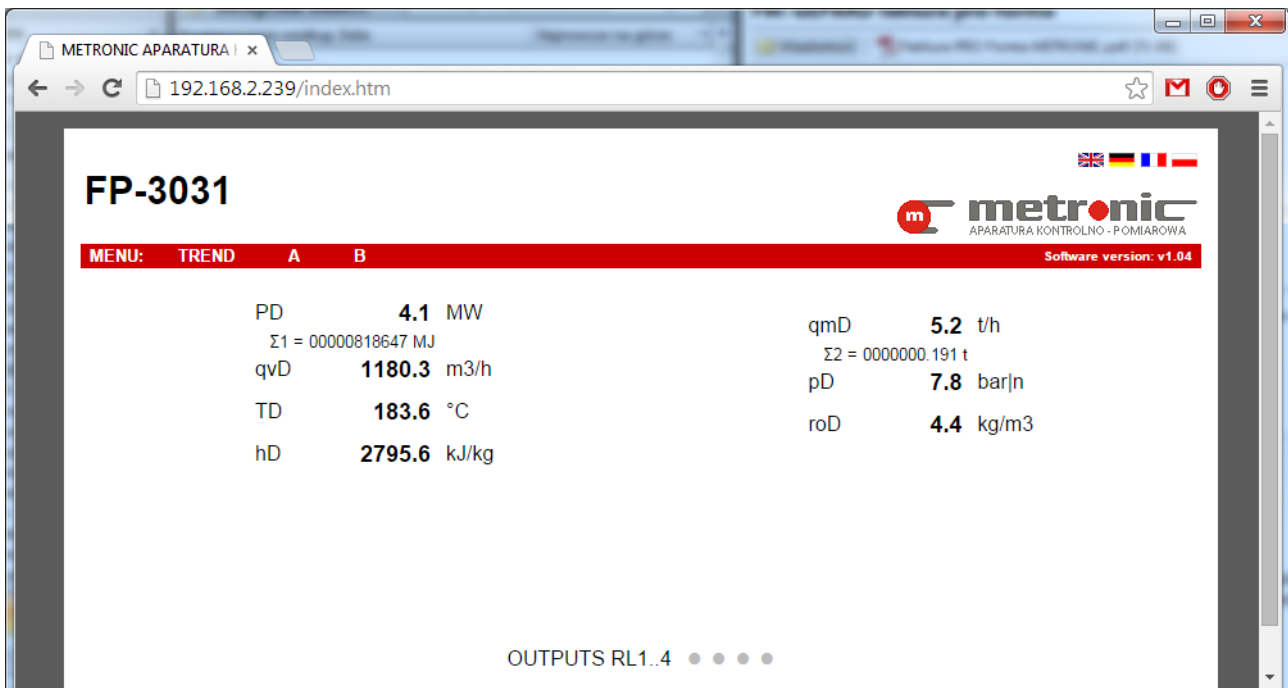
Readings sample via web server

Reading measurement data and the number of connected customers through the Ethernet port has no effect on communication via RS-485 port and vice versa.

10.15. Text messages

Main settings associated with sending text messages are in submenu **Text messages**.

→ MAIN MENU → SETTINGS → TEXT MESSAGES

Text messages
    PIN → None / Enter… [1]
    Mobile numbers [2]
    Unknown numbers → No / Yes [3]
    Combine → No / Yes [4]
    Header → No / Yes [5]
    Report [6]
        Process values to be sent [7]
        Totalisers to be sent [8]
        Send → On request / Daily / Weekly / Monthly [9]

[1]: The PIN code should be entered only if the SIM card installed in the GSM module is protected by the PIN code.

[2]: The phone numbers list (max 3) which will be sent the notifications of alarms, failures and periodic reports.
    NEW ONE - addition of the new phone number
    REMOVE - deletion the item from the list
    TEST - sending selected phone number (currently highlighted) a test SMS

[3]: If the option **Unknown numbers** is marked as **No**, the incoming queries from beyond the configured in the device list of phone numbers will be ignored.

[4]: If the option **Combine** is marked as **Yes** the simultaneous events will be combined in a single message.

[5]: If the option **Header** is marked as **Ye**s the header, which is consist with symbol, version and description of the device, will be attached to the message.

[6]: The submenu to configure the content and frequency of sending text messages with current process values and totalisers.

[7]: In the table the arrows are used to add (ADD ON) and remove (REMOVE) chosen current process values in the sent SMS.

[8]: In the table the arrows are used to add (ADD ON) and remove (REMOVE) chosen totalisers in the sent SMS.

[9]: If the option **On request** will be chosen the reports will be sent only as a response to the request from the user (a text message with the text "Report"). Otherwise the reports will be sent periodically, accordingly: daily (the hour which the SMS will be sent on should be specified), weekly (the hour and the day of week which the SMS will be sent on should be specified) and monthly (the hour and the day of month which the SMS will be sent on should be specified).

10.16. Display configuration

In this section was described configuration of screens for process values while the appearance of screens and navigation rules was presented in section 4.3. The display configuration allows to organize and present data in most convenient way for the user.

To configure the display choose **Display** submenu from settings menu.

```
SETTINGS
 Display
 Relay outputs
 Main applications

Screens for the data
presentation and
          LCD configuration.
   →⊐
```

```
DISPLAY
 Auto interval    → 2 s
 A.Steam-condensate
 B.[No tag]

A period of time to
present one screen in the
          "Auto-browse"
 CHANGE  mode
```

```
DISPLAY
 Relay outputs   → Visible
 Date and time   → Visible
 Main Archive    → Visible

The current date, time and
day of week.

 CHANGE
```
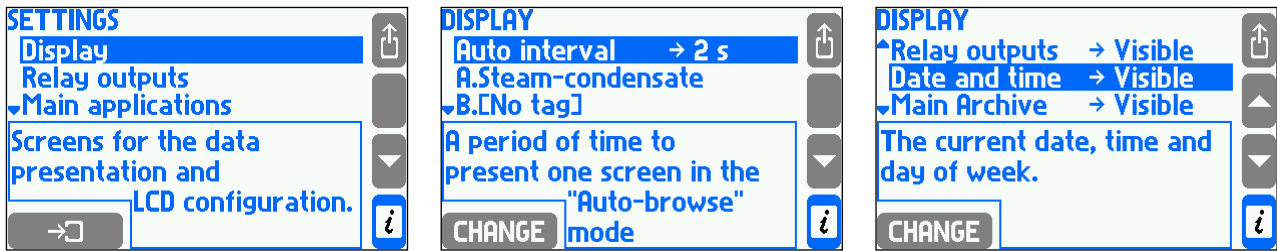
In **Auto interval** submenu time for single screen presentation during automatic scrolling is set. The last three items allow to activate or hide auxiliary screens: relay outputs screen, date and time screen and archive screen. The main screen and individual screens are set for each application separately. The last submenu item **LCD Display** allows to access the display settings menu.

```
DISPLAY
 Date and time    → Visible
 Main Archive     → Visible
 LCD display

Background colour and
backlight adjustment.

   →⊐
```

```
LCD DISPLAY
 Background colour→ White
 Backlight          → 3 mins
 Backlight brightness



 CHANGE
```

```
DIMMED BACKLIGHT



        35%


        TEST
```

User can set **Background colour** as a **White** or **Black**. The **Backlight** can be dimmed when keyboard is not used or can stay always on. The level of backlight can be adjusted in range of 50..100% and the dim level can also be set to 0..45%, both with step 5%. The lower backlight level saves the energy and increases the lifetime of the display. **TEST** button allows to see the effect of changes in the brightness when dimmed.

To configure the main screens and the detailed screens user must first select the appropriate menu system.

```
DISPLAY
 Auto interval    → 2 s
 A.Steam-condensate
 B.[No tag]




   →⊐
```

```
SCREENS (A)
 Main screen
 A.P  Heat
 A.P^D [No tag]

Choose the process values
and totalisers to be
          displayed on
   →⊐     the main screen.
```

```
SCREENS (A)
 A.h^W [No tag]
 A.Tp [No tag]
 Thresholds       → Visible

An overall table indicating
which thresholds are active.

 CHANGE
```
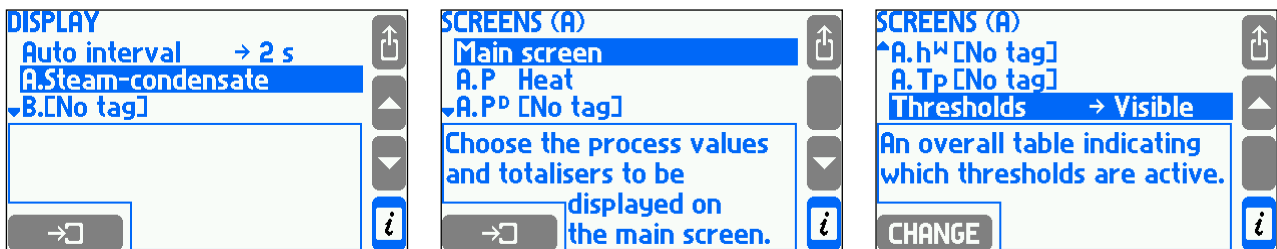
Main screen item opens the submenu where are configured the contents of the tables of the main screen of specific measuring application, see section 10.16.1. Next menu items allow to set detailed screens for process values (resolution of displayed value, range of diagrams and bargraphs and setting visible/hide detailed screens), see section 10.16.2. The last item **Thresholds** allows to present a thresholds screen.

10.16.1. Main screens

To configure the main screen user has to select measuring application and then **Main screen** submenu. In **Auto-browse** submenu user can determine whether the main screen of chosen system should be presented during automatic scrolling. **Page1** .. **Page4** submenus allow to configure table screens for process values.
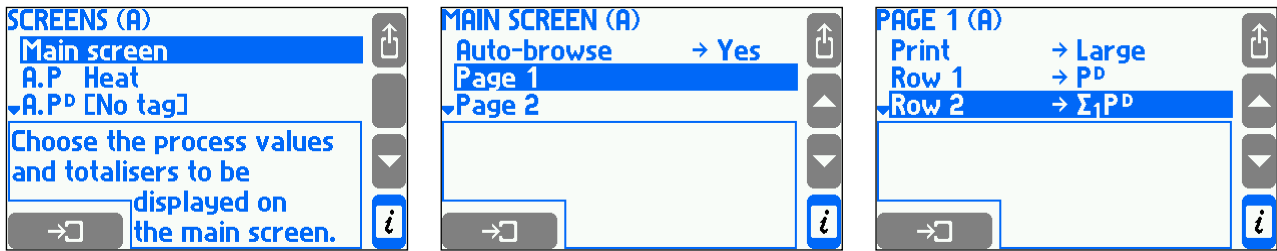
In **Print** submenu letter size may be chosen for the table – **Small** for 5 row table or **Big** – for 3 row table. **Row 1** .. **Row 5** submenu allow to choose the process values or totalisers for the table rows. The selection is based on choosing from the list. If the process value has an active totalisers, then in the next step user decides which value or which of totaliser should be displayed. The same process value or totaliser can be displayed in different tables and even few times in the same table. A table is considered to be activated if at least one of its rows is not empty.

10.16.2.Individual screens, resolution and range of diagrams

Below the **Main Screen** submenu a list of all process values allows to be set for individual data presentation.
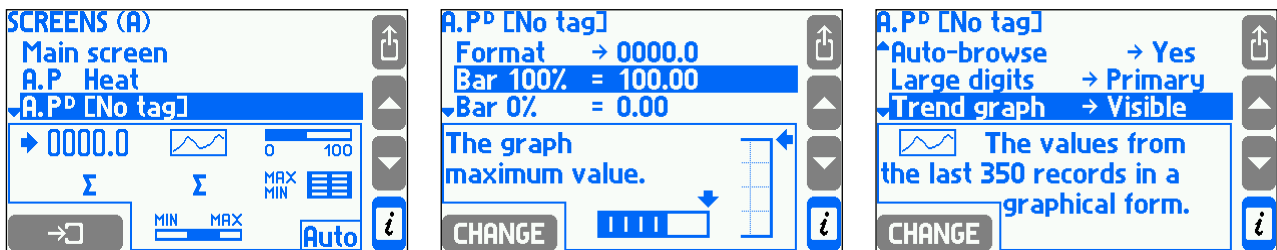
In **Format** submenu the number of decimal places of displayed and archived can be selected. A value is displayed with up to5 digits. If all decimal places cannot be displayed they are shorted with approximation. The selected resolution does not influence on the accuracy of calculations. In **Bar 100%** and **Bar 0%** items the range of bargraph and trend screen is set.

In **Auto-browse** user can determine if a given process value is to be presented during automatic scrolling. Subsequent submenu positions correspond to each available detailed screen. The totalizers positions are displayed only when the appropriate totalizer is enabled. Every process value (except density, enthalpy, pressure difference and water thermal coefficient) may be presented in form of **Large digits**, **Trend graph**, **Bar graph**, **Totalisers** (only for flow rates), **Min-Max-Avg**., **Min-Max-Avg (bar)**. User can choose which screens are to be **Visible** and which are **Hidden**. One screen may be set to **Primary** – it means that it will always be displayed as a first one when this value is reached. If no screen is selected as default one, then a screen which was viewed as the last one will be displayed at first.

10.17. Summer and winter time - automatic adjustment

The device automatically adjusts a clock between summer time (DST - daylight saving time) and standard (winter) time. It is performed on the last Sunday of October at 3:00 and on the last Sunday of March at 2:00.

Automatic time adjustment allows to maintain continuity of archiving. In each record the date and hour are marked with a letter S (summer time) or W (winter time).

```
2006-10-29;02:00:00;S
2006-10-29;02:30:00;S
2006-10-29;02:00:00;W
2006-10-29;02:30:00;W
2006-10-29;03:00:00;W

2007-03-25;01:00:00;W
2007-03-25;01:30:00;W
2007-03-25;03:00:00;S
2007-03-25;03:30:00;S
```

In particular situations when automatic clock adjustment is not required it can be deactivated in settings - **DST** feature.

10.18. Saving to and loading settings from a file

Full set of settings can be saved to a file using the external USB Flash Memory (pendrive) by selecting in the main menu **Load or save settings** function and then submenu **Save**.
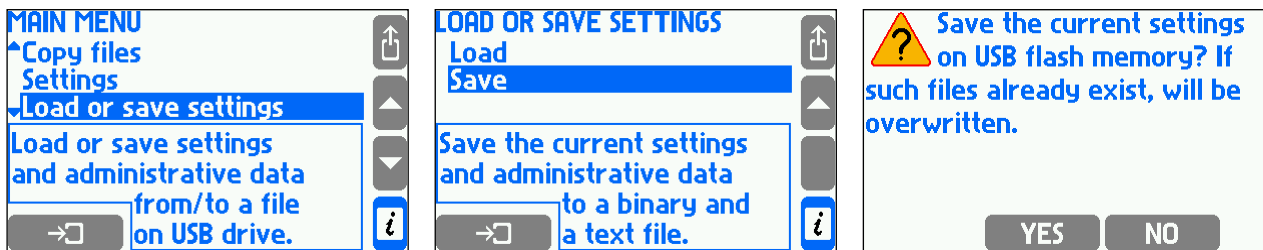
Two files (text and binary) will be created. Text file (extension .txt) allows to read settings on a PC computer using a typical text editor. Binary file (extension .set) enables to load settings to the same or the other device in the future. File name are generated automatically and contains device's RS-485 network address, e.g.: „s*ett_01.txt*" and "s*ett_01.set*". If files with these names already exist, they are overwritten. Files names created automatically can be changed only in PC computer.

Together with settings are saved data from administrator menu about users with passwords (see section 4.7.3) and databases for other media and user characteristics (see section 10.4.1.3Other liquid media and 10.8.7). Contents of databases are saved only in a binary file.

To download settings from a file into the device user has to select **Load** function from menu **Load or save settings** and then choose a relevant file.
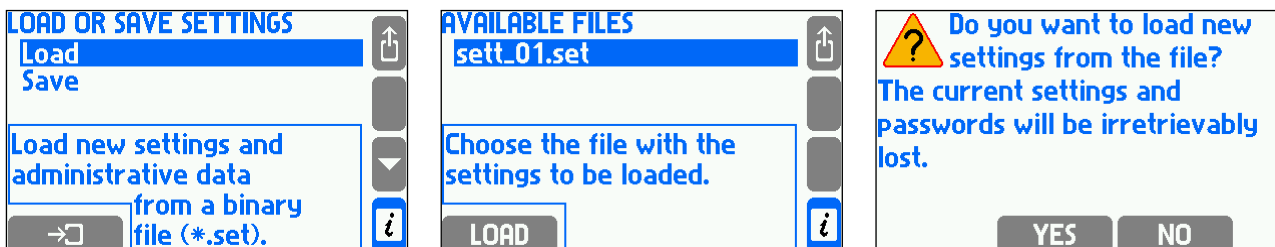
Files with extension ".set" are displayed on the list. All information from binary file will be loaded including administrator menu, passwords and databases. The previous data will be deleted irretrievably. Loading settings from a file is available only to the administrator. Only

setting from the device with the same hardware configuration may be downloaded to another device.

11.   FUNCTIONS AVAILABLE ONLY FOR AN ADMINISTRATOR

11.1. Changing the Administrator Password

 Changing the administrator password, see Section 4.7.1.

11.2. Administrator menu

The administrator decides which functions of the instrument should be password protected. Creates new users, give them names, and generates a password (number codes). "ADMIN" also defines permissions for each user to perform password protected activities.

During the first configuration of the device, protected activity should be defined at first and then users accounts and permission assignment.

→ MAIN MENU→ ADMINISTRATIVE DATA

ADMINISTRATIVE DATA
    PROTECTED COMMANDS [1]
        Archiving commands → **No** (Yes, No) [2]
        Copy files → **No** (Yes, No) [3]
        Resetting min, max → **No** (Yes, No) [4]
        Adjusting clock → **No** (Yes, No) [5]
        Resetting totalisers → **No** (Yes, No) [6]
        Main settings → **No** (Yes, No) [7]
        Threshold settings → **No** (Yes, No) [8]
        Screen settings → **No** (Yes, No) [9]
        Archiving settings → **No** (Yes, No) [10]
    USERS AND ENTITLEMENTS [11]
    LOG OUT AFTER → **5mins** (30secs, 1, 2, 3, 5, 10mins) [12]
    MIN PASS LENGTH → **3digs.** (3, 4, 5) [13]

Explanations:
[1]:   Actions are divided into groups. Each of them, may require entering a username and password. Thus, depending on the main application, it can be opt out completely of entering passwords (which always require additional operations on the keypad). It also allowed to select only specific operations that require passwords (e.g. changing the settings of the device), or to secure all possible actions (particularly when the recorded measurements are a document, and many people have access to the device). Selecting **Yes** means that the activities group will require a password.
[2]:   **Archiving commands** includes stopping (**‖STOP**), and resuming (**●REC**)recording and setting up a new archive file, if this action does not erase another archive located in the internal memory.
[3]:   **Copying files** include copy / move / delete operations of any file stored in the internal memory.
[4]:   **Resetting min, max** relates to the function of resetting maximum, minimum and average values stored and viewed on screens.
[5]:   Adjust clock refers to the entitlements to change the time and date clock (date and time is recorded in the archive along with the results of measurements).
[6]:   **Resetting the totalisers**.

[7]: **Main settings** includes the addition of user's characteristics and functions of changing instrument's settings except for setting alarm and control thresholds, setting displaying screens and the settings of archiving.

[8]: **Thresholds settings** - setting of alarm and control thresholds.

[9]: **Screen settings** refers to setting of displaying of the results – main screens, additional screens and detailed screens.

[10]: **Archiving settings** – setting frequency, process values and operating mode.

[11]: In the **Users and entitlements** menu, the administrator defines users and gives them entitlements (selecting group of functions that the user will be able to perform after entering a password). After creating a new user device generates the numeric password. The instrument does not allow to change the password to a very simple one (e.g. 11111). Each user has a separately defined entitlements. ADMIN can choose only those activities that had previously been declared as a password protected activities. In this menu, the administrator can also change a user's name and password or remove user.

[12]: **Log out after - –** defines idle time after which the device automatically logs out. This function is to prevent accidentally leaving the device in logged mode, and to make changes by unauthorized persons.

[13]: **Minimum password length** prevents users from changing password on too short. The longer the password is, the stronger it is, but more digits must be enter when logging on.

11.3. New firmware and licence granting

! The device firmware can be changed to a newer version or to the version with other features and possibilities. Substitution may be performed only by ADMIN user. This operation, if necessary, should be performed with extreme caution. The device can operate with a computer system or other devices and software change may affect it.

→ MAIN MENU → FIRMWARE AND LICENCES

FIRMWARE AND LICENCES
    Load and install [1]
    Licences granted [2]
    Firmware version [3]
    Serial number [4]

Explanations:

[1]: Installing new firmware or license granting is done via USB flash memory. After inserting the USB into the slot on the front panel of the device in main menu select **Load and install**. The device automatically detects files with the new firmware and license. Selecting the button [INSTALL] starts the process which takes a few minutes. Some versions of the program may not be compatible with the existing version, and in that case the instrument does not allow for the installation. Programs with special functions may require purchase of additional licenses.

[2]: A list of **licenses granted** to instrument. Some programs can be installed only in instruments with a specific license. Use of certain features may require additional licenses.

[3]: **Firmware version** - information about the version of firmware installed in the instrument.

[4]: The device in the internal non-volatile memory has inscribed its **serial number**. The same number is located on the nameplate of the device. This is the service information. The serial number is also stored in each archives, in order to identify the measurement data to the device.

11.4. Restoring factory settings

→ MAIN MENU → RESTORE FACTORY SETTINGS

MAIN MENU
   Restore factory settings [1]

Explanations:
[1]: This function can change the settings entered by a user to the factory settings. It applies to all parameters grouped within the **Settings** menu, the totalisers are also reset. The function should be used in special cases, for example, if user wants to set the device from the beginning, step by step.

11.5. Test of inputs and outputs in FP-3011 and FP-3031

Function **Test inputs and outputs** is described in section 12.1

11.6. Test of communication in FP-3021

Function **Communication test** is described in section 12.2.

11.7. Functions available only for service

User with the SERVICE permissions (ADMIN after entering the service code) has an additionally access to the calibration of the device, and remove / move of Event logs and Authorization log. Both of these features can be found at the end of the main menu.

> **!** Unlike the other users, SERVICE user (ADMIN with a service code) does not log off automatically after a set period of inactivity. Administrator - SERVICE must remember to log out by himself.

12.   TEST FUNCTIONS

12.1. Test of inputs and outputs in FP-3011 and FP-3031 devices

Test inputs and outputs function are available only for the ADMIN user. It allows you to track the electrical signals of all enabled inputs, the status of all output relays and the current output. It also enable to force certain states on the outputs. Before starting the test, flow computer must be configured.

→ MAIN MENU → TEST INPUTS AND OUTPUTS

At the top of the screen are displayed the signals on the activated inputs. At the bottom left are showed output relays status (O = open, C = closed), and at the right current outputs 4-20mA (**----** means that the output is off). Black color of inscriptions indicates that the state is not a result of normal operation of the device, but was forced for the test. To enforce the desired states of the output relays press `RL1...4`.

Using the horizontal arrows select an output, then force closing (pressing `C` button), opening (pressing `O` button) or normal work (pressing `WORK` button). The changes have an immediate effect.

To force the desire value of current output 4-20mA press `OUT1` or `OUT2`.

Then insert the value using ➕ and ➖ buttons, and then press the **OK** button. To restore normal operating of 4-20mA outputs press **OUT1** or **OUT2**.

12.2. Test of communication in FP-3021 device

Communication test function is available only for the ADMIN user, and requires to stop reading values from transmitters.

🔧 → MAIN MENU → TEST KOMUNIKACJI

COMMUNICATION TEST
    Modbus RTU [1]
        Baud rate → 1200 (1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200) [2]
        Parity → Even (Even, Odd, None) [3]
        Address = 1 ([value]) [4]
    HART [5]
        Master → Primary (Primary, Secondary) [6]
        Current address = 0 ([value]) [7]
        New address = 0 ([value]) [8]
    Detect HART transmitters [9]

[1]: Test of communication in Modbus RTU protocol. Diagnostic command 08 is sent.
[2]: Baud rate for communication with the transmitters or devices (only during the test)
[3]: Parity setting (only during the test).
[4]: Transmitter or device address to which is send diagnostic command. After entering this value 08 command is sent (Diagnostics).

RTU: Diagnostics (08)

Correct answer

OK

RTU: Diagnostics (08)

No answer

OK
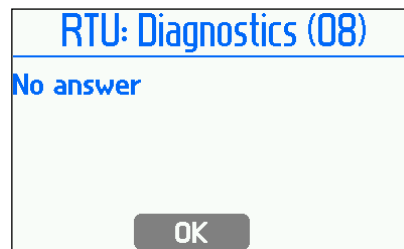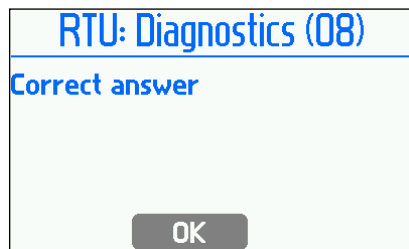
[5]: Test of HART communication (command 0 is sent) and the ability to change the address of the transmitter.
[6]: Selection of the device work mode.
[7]: A short address of transmitter to which is sent command 0 (command is sent after entering this value).

HART: Query 0

The answer is:
06 80 00 0E 00 64 FE BC 7B 05
05 01 01 08 01 A6 6E 22

OK

HART: Query 0

No answer

OK
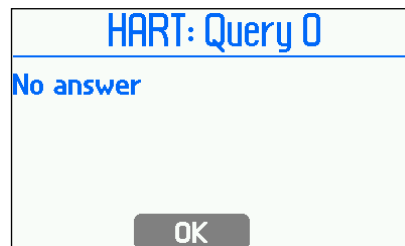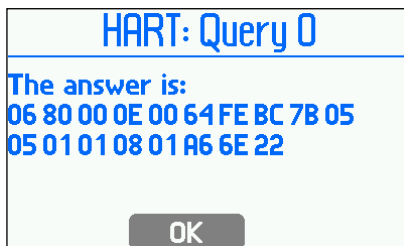
[8]: After entering this value, **New address** will be sent to the transmitter with the address given in the **Current address**.

[9]:   Detecting all connected transmitters by communicating with all possible addresses.

12.3. Port RS-485 (RS-485 (2) in FP-3021) monitor

Function **RS-485 monitor** (in FP-3021 **RS-485 (2) monitor**) is a service function. After selecting, the ALARM LED blinks when data exchange on the RS-485 bus. To end a function, press the button QUIT .

RS-485 (2) monitor activated.

ALARM LED blinks when data is received or transmitted.

QUIT
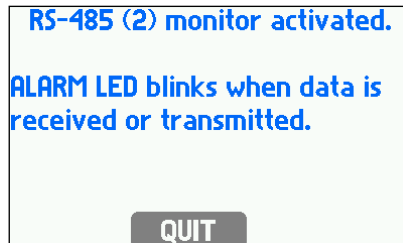
13. MODBUS RTU PROTOCOL

Modbus RTU protocol allows for readout only of process values and totalisers. Readout uses 04 function – Read Input Register, registers with addresses starting with 3xxxx. To simplify notation in the further part only registers addresses in decimal notation are used and not their full name (3xxxx) corresponding to MODBUS protocol.

Using Modbus functions user can transfer data to computer system:
* results of measuring process,
* date and time from RTC (Real Time Clock can also be set).

There are two Modbus functions implemented:
* 04 – Read Input Registers,
* 10 – Write Multiple Registers.

Modbus RTU is available at RS-485 port and Modbus TCP is available at Ethernet port.

13.1. Serial transmission parameters and general information

* Operation mode: Modbus RTU
* Address: 001 (001, .. , 099)
* Speed: 9600 (1200, .. , 115,2k)
* Parity EVEN (NONE, ODD, EVEN)
* Response delay (min): 50ms (10, 20, 30, 50, 70, 100, 150, 200,300, 400ms).

Transmission parameters do not allow to set maximum time („Response delay (max):") because in Modbus RTU mode response to a command is sent immediately. The maximum delay is not more than few ms.

According to MODBUS standard in RTU mode a frame (transmitted information) is as follows:

Start	Address	Function	Data	CRC control	End
T1 ... T4	1 byte	1 byte	n bytes	2 bytes	T1 ... T4

Information transmitted from the master computer to the device is a query whereas the device sends a response.

13.2. Ethernet port settings for Modbus TCP

* IP (IP address assigned to FP-30x1),
* Port (typically 502),
* Mask (subnet mask, e.g. 255.255.255.0),
* Gate (e.g. 1.0.0.1),
* DHCP server (OFF for normal operation),
* Timeout (typically 60 s).

Note: Using port 502 is recommended, since it is registered for Modbus TCP.
According to MODBUS standard in TCP/IP mode, the frame is as follows:

MBAP	Function	Data

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Header		
7 bytes	1 byte	n bytes

Information transmitted from the master computer to the device is a query whereas the device sends a response.

13.3. Readout of current results and totalisers

The FP-30x1 device accepts 04 command – process values readout function (current process values and totalisers).

Readout function (query) has a form:

Function (1B)	Initial address (2B)	Number of registers (2B)

Function – 04 HEX – process values and totalisers readout (input registers)
Initial address - an address of a device from which data are to be sent
Number of registers – two-byte registers for readout

In response the device transmits a sequence of characters in form of:

Function (1B)	Number of bytes (1B)	Data sequence (nB)

Function – acknowledge, in case of error 80 HEX value is added on to the command code
Number of bytes – n bytes transmitted in response (but not number of registers)
Data sequence – n bytes of register contents

13.4. Process values (main and auxiliary values) – register addresses

Process values are available in floating point format.
The following table contains register addresses for main values.

Designation of system types:

W	the flow and heat of a liquid
W-W (closed)	the flow and delta heat of a liquid in a closed supply-return installation
W-W (different)	the flows and delta heat of a liquid in an installation with separate supply and return flowrates
S	the flow and heat of steam
SS-W (up to cond.)	the flow and delta heat in a closed superheated steam-condensate installation (steam condensation without further condensate cooling)
ST.S(p)-W (up to cond.)	the flows and delta heat in a closed saturated steam-condensate installation (steam condensation without further condensate cooling, pressure measurement)
ST.S(T)-W (up to cond.)	the flows and delta heat in a closed saturated steam-condensate installation (steam condensation without further condensate cooling, temperature measurement)
SS-W (closed)	the flow and delta heat in a closed superheated steam-condensate installation
ST.S(p)-W (closed)	the flows and delta heat in a closed saturated steam-condensate installation (pressure measurement)
ST.S(T)-W (closed)	the flows and delta heat in a closed saturated steam-condensate installation (temperature measurement)
SS-W (different)	the flows and delta heat in a superheated steam-condensate installation with separate steam and condensate flow rates
ST.S(p)-W (different)	the flows and delta heat in a saturated steam-condensate installation with separate steam and condensate flow rates (pressure measurement)

ST.S(T)-W (different)   the flows and delta heat in a saturated steam-condensate installation with separate steam and condensate flow rates (temperature measurement)

S production   the flow and delta heat in a steam-generating installation with the supplied water flowrate measured

G   the flow of a gas

Explanations:
1. In brackets there are given values which appear only in some configurations
2. If water and steam pressures are equal the common pressure is marked with symbol p (or p_c). If only steam pressure is measured and water pressure is constant, then steam pressure is marked with symbol p^D (or p_c^D).
3. Upper index; D- means steam, W- water, S- supply, R – return (upper and lower indices are displayed one below another)

Designation of main and auxiliary values:
P   – heat flowrate
q_v / q_m – volumetric / mass flowrate
p / p_c / Δp – pressure / pressure in saturation conditions / delta pressure (in differential pressure measurement)
T/ T_c / ΔT – temperature / temperature in saturation conditions / temperature difference
ρ   – specific density
h   – enthalpy
k   – thermal coefficient of water

Register addresses for main values

W	W-W (closed)	W-W (different)	S	SS-W (up to cond.)	ST.S(p)-W (up to cond.)	ST.S(T)-W (up to cond.)	SS-W (closed)	ST.S(p)-W (closed)	ST.S(T)-W (closed)	SS-W (different)	ST.S(p)-W (different)	ST.S(T)-W (different)	S production	G	Application A	Application B	Application C
	P	P		P	P	P	P	P	P	P	P	P	P		0, 1	52, 53	104, 105
P^W			P^D	P^D	P^D	P^D	P^D	P^D	P^D	P^D	P^D	P^D	P^D	q^G	2, 3	54, 55	106, 107
q_m^W	q_m	q_m^S	q_m^D	q_m	q_m	q_m	q_m	q_m	q_m	q_m^D	q_m^D	q_m^D	q_m	q_m^G	4, 5	56, 57	108, 109
q_V^W	q_V^S	q_V^S	q_V^D	q_V^D	q_V^D	q_V^D	q_V^D	q_V^D	q_V^D	q_V^D	q_V^D	q_V^D	q_V^D	q_V^G	6, 7	58, 59	110, 111
(p^W)	(p)	(p)	p^D	p	p	p_c	$p^{(D)}$	$p^{(D)}$	$p_c^{(D)}$	$p^{(D)}$	$p^{(D)}$	$p_c^{(D)}$	$p^{(D)}$	(p^G)	8, 9	60, 61	112, 113
T^W	T^S	T^S	T^D	T^D	T_c	T	T^D	T_c^D	T^D	T^D	T_c^D	T^D	T^D	(T^G)	10, 11	62, 63	114, 115
ρ^W	ρ^S	ρ^S	ρ^D	ρ^D	ρ^D	ρ^D	ρ^D	ρ^D	ρ^D	ρ^D	ρ^D	ρ^D	ρ^D	ρ^G	12, 13	64, 65	116, 117
h^W	h^S	h^S	h^D	h^D	h^D	h^D	h^D	h^D	h^D	h^D	h^D	h^D	h^D		14, 15	66, 67	118, 119
(Δp^W)	(Δp^S)	(Δp^S)	(Δp^D)	(Δp^D)	(Δp^D)	(Δp^D)	(Δp^D)	(Δp^D)	(Δp^D)	(Δp^D)	(Δp^D)	(Δp^D)	(Δp^D)	(Δp^G)	16, 17	68, 69	120, 121
				P^W	P^W	P^W	P^W	P^W	P^W	P^W	P^W	P^W	P^W		18, 19	70, 71	122, 123
		q_m^R								q_m^W	q_m^W	q_m^W			20, 21	72, 73	124, 125
	q_V^R	q_V^R		q_V^W	q_V^W	q_V^W	q_V^W	q_V^W	q_V^W	q_V^W	q_V^W	q_V^W	q_V^W		22, 23	74, 75	126, 127
	T^R	T^R		T_c^P			T^W	T^W	T^W	T^W	T^W	T^W	T^W		24, 25	76, 77	128, 129
	ρ^R	ρ^R		ρ^W	ρ^W	ρ^W	ρ^W	ρ^W	ρ^W	ρ^W	ρ^W	ρ^W	ρ^W		26, 27	78, 79	130, 131
	h^R	h^R		h^W	h^W	h^W	h^W	h^W	h^W	h^W	h^W	h^W	h^W		28, 29	80, 81	132, 133
	(Δp^R)	(Δp^R)		(Δp^W)	(Δp^W)	(Δp^W)	(Δp^W)	(Δp^W)	(Δp^W)	(Δp^W)	(Δp^W)	(Δp^W)			30, 31	82, 83	134, 135
	ΔT	ΔT													32, 33	84, 85	136, 137
	(k^S, k^R)														34, 35	86, 87	138, 139

The following table contains register addresses for auxiliary values. Auxiliary values are in sequence as they were entered during set up of the device.

Auxiliary values	Register addresses (in decimal format)					
	Application A	Application B	Application C	Application X	Application Y	Application Z
1	36, 37	88, 89	140, 141	156, 157	172, 173	188, 189
2	38, 39	90, 91	142, 143	158, 159	174, 175	190, 191
3	40, 41	92, 93	144, 145	160, 161	176, 177	192, 193
4	42, 43	94, 95	146, 147	162, 163	178, 179	194, 195
5	44, 45	96, 97	148, 149	164, 165	180, 181	196, 197
6	46, 47	98, 99	150, 151	166, 167	182, 183	198, 199
7	48, 49	100, 101	152, 153	168, 169	184, 185	200, 201
8	50, 51	102, 103	154, 155	170, 171	186, 187	202, 203

13.4.1. Process value format.

All process values (main values and auxiliary values) are in floating point format requiring two Modbus RTU registers (4 bytes) according to IEEE-754 standard for 32-bit numbers.

IEEE-754 standard for 32-bit floating point single number of single precision :

Register	30002 (address 0001)				30001 (address 0000)	
Byte	4		3		2	1
Bit	31	30..24	23	22..16	15..08	07..00
IEEE-754	S	E (8b)		M (23b, only fraction part)		

where:
- M (mantissa): is a normalized value within the interval [1;2)- right side open interval. Only fraction part of mantissa is noted (e.g. for binary number 1,1011101 mantissa equals to 1011101, more precisely in notation on 23 bits: 10111010000000000000000).
- E (exponent): exponent value is shifted by 127 (bias)
- S (sign): 0 – positive number, 1 – negative number.

The number value can be calculated from the formula:

$$x = (-1)^S * M * 2^{(E-bias)} \qquad ; \text{ where bias: 127}$$

For example a sequence of response characters (HEX):

01 04 04 **9E E4 43 1C** A4 A2 (read from the device)

- acknowledgment of an address (01) and function (04), number of bytes (04),
- value 9E E4 43 1C, in sequence register 0000 and 0001,
- CRC (A4 A2).

Presenting the value in appropriate sequence (0001 and 0000): 43 1C 9E E4

and in binary form:

01000011 00011100 10011110 11100100

one can read

- mantissa: 1,0011100 10011110 11100100 (in decimal notation: approx. 1,22265625)
- exponent: 10000110 – 01111111 = 00000111 (in decimal notation: 7)
- sign: 0

what gives a decimal result: $(-1)^0 * 1,22265625 * 2^7 = 156,5$

13.5. Totalisers

For each flowrate or heat flowrate value up to 4 totalisers may be active:
- main totaliser (Σ_1),
- auxiliary totaliser (Σ_2),
- overrange totaliser (Σ_H),
- underrange totaliser (Σ_L).
    Totalisers are available in two formats: floating point and integer number.

NOTE!
Totalisers values in Modbus RTU registers are updated every 5 sec.

13.5.1. Register addresses for totalisers in floating point format

Each totaliser value is 4 registers long (8 bytes).

The following table contains register addresses for totalisers of the main values.

NOTE!
Symbols established in following table corresponds with the table in section 13.4.

Register addresses for totalisers of the main values (in 64-bit floating point double format).

W	W-W (closed)	W-W (different)	S	SS-W (up to cond.)	ST.S(p)-W (up to cond.)	ST.S(T)-W (up to cond.)	SS-W (closed)	ST.S(p)-W (closed)	ST.S(T)-W (closed)	SS-W (different)	ST.S(p)-W (different)	ST.S(T)-W (different)	S production	G	Totaliser type	Application A	Application B	Application C
																Main values		
	P	P		P	P	P	P	P	P	P	P	P	P		1	256...259	496...499	736...739
															2	260...263	500...503	740...743
															H	264...267	504...507	744...747
															L	268...271	508...511	748...751
P^W			P^D	P^D	P^D	P^D	P^D	P^D	P^D	P^D	P^D	P^D	P^D	q^G	1	272...275	512...515	752...755
															2	276...279	516...519	756...759
															H	280...283	520...523	760...763
															L	284...287	524...527	764...767
q_m^W	q_m	q_m^S	q_m^D	q_m	q_m	q_m	q_m	q_m	q_m	q_m^D	q_m^D	q_m^D	q_m	q_m^G	1	288...291	528...531	768...771
															2	292...295	532...535	772...775
															H	296...299	536...539	776...779
															L	300...303	540...543	780...783
q_v^W	q_v^S	q_v^S	q_v^D	q_v^D	q_v^D	q_v^D	q_v^D	q_v^D	q_v^D	q_v^D	q_v^D	q_v^D	q_v^D	q_v^G	1	304...307	544...547	784...787
															2	308...311	548...551	788...791
															H	312...315	552...555	792...795
															L	316...319	556...559	796...799
				P^W	P^W	P^W	P^W	P^W	P^W	P^W	P^W	P^W	P^W		1	320...323	560...563	800...803
															2	324...327	564...567	804...807
															H	328...331	568...571	808...811
															L	332...335	572...575	812...815
		q_m^R								q_m^W	q_m^W	q_m^W			1	336...339	576...579	816...819
															2	340...343	580...583	820...823
															H	344...347	584...587	824...827
															L	348...351	588...591	828...831
	q_v^R	q_v^R		q_v^W	q_v^W	q_v^W	q_v^W	q_v^W	q_v^W	q_v^W	q_v^W	q_v^W	q_v^W		1	352...355	592...595	832...835
															2	356...359	596...599	836...839
															H	360...363	600...603	840...843
															L	364...367	604...607	844...847

The following table contains register addresses for totalisers of the auxiliary values. Auxiliary values, as well as their totalisers are in sequence as they were entered during set up of the device.

Register addresses for totalisers of auxiliary values
(in 64-bit floating point double format).

Auxiliary values	Totaliser type	Register addresses (in decimal format)					
		Application A	Application B	Application C	Application X	Application Y	Application Z
1	1	368...371	608...611	848...851	976...979	1104…1107	1232…1235
	2	372...375	612...615	852...855	980...983	1108…1111	1236…1239
	H	376...379	616...619	856...859	984...987	1112…1115	1240…1243
	L	380...383	620...623	860...863	988...991	1116…1119	1244…1247
2	1	384...387	624...627	864...867	992...995	1120…1123	1248…1251
	2	388...391	628...631	868...871	996...999	1124…1127	1252…1255
	H	392...395	632...635	872...875	1000...1003	1128…1131	1256…1259
	L	396...399	636...639	876...879	1004...1007	1132…1135	1260…1263
3	1	400...403	640...643	880...883	1008...1011	1136…1139	1264…1267
	2	404...407	644...647	884...887	1012...1015	1140…1143	1268…1271
	H	408...411	648...651	888...891	1016...1019	1144…1147	1272…1275
	L	412...415	652...655	892...895	1020...1023	1148…1151	1276…1279
4	1	416...419	656...659	896...899	1024...1027	1152…1155	1280…1283
	2	420...423	660...663	900...903	1028...1031	1156…1159	1284…1287
	H	424...427	664...667	904...907	1032...1035	1160…1163	1288…1291
	L	428...431	668...671	908...911	1036...1039	1164…1167	1292…1295
5	1	432...435	672...675	912...915	1040...1043	1168…1171	1296…1299
	2	436...439	676...679	916...919	1044...1047	1172…1175	1300…1303
	H	440...443	680...683	920...923	1048...1051	1176…1179	1304…1307
	L	444...447	684...687	924...927	1052...1055	1180…1183	1308…1311
6	1	448...451	688...691	928...931	1056...1059	1184…1187	1312…1315
	2	452...455	692...695	932...935	1060...1063	1188…1191	1316…1319
	H	456...459	696...699	936...939	1064...1067	1192…1195	1320…1323
	L	460...463	700...703	940...943	1068...1071	1196…1199	1324…1327
7	1	464...467	704...707	944...947	1072...1075	1200…1203	1328…1331
	2	468...471	708...711	948...951	1076...1079	1204…1207	1332…1335
	H	472...475	712...715	952...955	1080...1083	1208…1211	1336…1339
	L	476...479	716...719	956...959	1084...1087	1212…1215	1340…1343
8	1	480...483	720...723	960...963	1088...1091	1216…1219	1344…1347
	2	484...487	724...727	964...967	1092...1095	1220…1223	1348…1351
	H	488...491	728...731	968...971	1096...1099	1224…1227	1352…1355
	L	492...495	732...735	972...975	1100...1103	1228…1231	1356…1359

13.5.2. Floating point format for totalisers

According to IEEE-754 standard for 64-bit floating point double (8 byte value or 4 register in Modbus RTU):

Register	30214 (address 0213)				30213		30212		30211	
Byte	8		7		6	5	4	3	2	1
Bit	63	62..56	55..52	51..48	47..40	39..32	31..24	23..16	15..8	7..0
IEEE	S	E (11b)		M (52b, fraction part only)						

Where:
- M (mantissa): is a normalized value within the interval [1;2)- right side open interval. Only fraction part of mantissa is noted

- E (exponent): exponent value is biased by 1023 (bias).
- S (character): 0 – positive number, 1 – negative number

The number value can be calculated from the formula:

$$x = (-1)^S * M * 2^{(E-bias)}$$

where bias: 1023

13.5.3. Register addresses for totalisers in integer format

The totaliser values are also available in double integer (4 byte) format. Only not rounded integer part of the totaliser value is available in this format in range from – 999 999 999 to 999 999 999.
Each totaliser value is 2 registers long (4 bytes).

The following table contains register addresses for totalisers of the main values.

NOTE!
Symbols established in following table corresponds with the table in section 13.4.

Register addresses for totalisers of the main values (in integer format).

W			S	SS-W (up to cond.)	ST.S(p)-W (up to cond.)	ST.S(T)-W (up to cond.)	SS-W (closed)	ST.S(p)-W (closed)	ST.S(T)-W (closed)	SS-W (different)	ST.S(p)-W (different)	ST.S(T)-W (different)	S production	G	Totaliser type	Application A	Application B	Application C
	P	P		P	P	P	P	P	P	P	P	P	P		1	1408, 1409	1528, 1529	1648, 1649
															2	1410, 1411	1530, 1531	1650, 1651
															H	1412, 1413	1532, 1533	1652, 1653
															L	1414, 1415	1534, 1535	1654, 1655
P^W			P^D	P^D	P^D	P^D	P^D	P^D	P^D	P^D	P^D	P^D	P^D	q^G	1	1416, 1417	1536, 1537	1656, 1657
															2	1418, 1419	1538, 1539	1658, 1659
															H	1420, 1421	1540, 1541	1660, 1661
															L	1422, 1423	1542, 1543	1662, 1663
q_m^W	q_m	q_m^S	q_m^D	q_m	q_m	q_m	q_m	q_m	q_m	q_m^D	q_m^D	q_m^D	q_m	q_m^G	1	1424, 1425	1544, 1545	1664, 1665
															2	1426, 1427	1546, 1547	1666, 1667
															H	1428, 1429	1548, 1549	1668, 1669
															L	1430, 1431	1550, 1551	1670, 1671
q_v^W	q_v^S	q_v^S	q_v^D	q_v^D	q_v^D	q_v^D	q_v^D	q_v^D	q_v^D	q_v^D	q_v^D	q_v^D	q_v^D	q_v^G	1	1432, 1433	1552, 1553	1672, 1673
															2	1434, 1435	1554, 1555	1674, 1675
															H	1436, 1437	1556, 1557	1676, 1677
															L	1438, 1439	1558, 1559	1678, 1679
				P^W	P^W	P^W	P^W	P^W	P^W	P^W	P^W	P^W	P^W		1	1440, 1441	1560, 1561	1680, 1681
															2	1442, 1443	1562, 1563	1682, 1683
															H	1444, 1445	1564, 1565	1684, 1685
															L	1446, 1447	1566, 1567	1686, 1687
		q_m^R								q_m^W	q_m^W	q_m^W			1	1448, 1449	1568, 1569	1688, 1689
															2	1450, 1451	1570, 1571	1690, 1691
															H	1452, 1453	1572, 1573	1692, 1693
															L	1454, 1455	1574, 1575	1694, 1695
	q_v^R	q_v^R		q_v^W	q_v^W	q_v^W	q_v^W	q_v^W	q_v^W	q_v^W	q_v^W	q_v^W	q_v^W		1	1456, 1457	1576, 1577	1696, 1697
															2	1458, 1459	1578, 1579	1698, 1699
															H	1460, 1461	1580, 1581	1700, 1701
															L	1462, 1463	1582, 1583	1702, 1703

Type of installation — Main values — Register addresses (in decimal format)

The following table contains register addresses for totalisers of the auxiliary values. Auxiliary values, as well as their totalisers are in sequence as they were entered during set up of the device.

Register addresses for totalisers of the auxiliary values (in integer format)

Auxiliary values	Totaliser type	Register addresses (in decimal format)					
		Application A	Application B	Application C	Application X	Application Y	Application Z
1	1	1464, 1465	1584, 1585	1704, 1705	1768, 1769	1832, 1833	1896, 1897
	2	1466, 1467	1586, 1587	1706, 1707	1770, 1771	1834, 1835	1898, 1899
	H	1468, 1469	1588, 1589	1708, 1709	1772, 1773	1836, 1837	1900, 1901
	L	1470, 1471	1590, 1591	1710, 1711	1774, 1775	1838, 1839	1902, 1903
2	1	1472, 1473	1592, 1593	1712, 1713	1776, 1777	1840, 1841	1904, 1905
	2	1474, 1475	1594, 1595	1714, 1715	1778, 1779	1842, 1843	1906, 1907
	H	1476, 1477	1596, 1597	1716, 1717	1780, 1781	1844, 1845	1908, 1909
	L	1478, 1479	1598, 1599	1718, 1719	1782, 1783	1846, 1847	1910, 1911
3	1	1480, 1481	1600, 1601	1720, 1721	1784, 1785	1848, 1849	1912, 1913
	2	1482, 1483	1602, 1603	1722, 1723	1786, 1787	1850, 1851	1914, 1915
	H	1484, 1485	1604, 1605	1724, 1725	1788, 1789	1852, 1853	1916, 1917
	L	1486, 1487	1606, 1607	1726, 1727	1790, 1791	1854, 1855	1918, 1919
4	1	1488, 1489	1608, 1609	1728, 1729	1792, 1793	1856, 1857	1920, 1921
	2	1490, 1491	1610, 1611	1730, 1731	1794, 1795	1858, 1859	1922, 1923
	H	1492, 1493	1612, 1613	1732, 1733	1796, 1797	1860, 1861	1924, 1925
	L	1494, 1495	1614, 1615	1734, 1735	1798, 1799	1862, 1863	1926, 1927
5	1	1496, 1497	1616, 1617	1736, 1737	1800, 1801	1864, 1865	1928, 1929
	2	1498, 1499	1618, 1619	1738, 1739	1802, 1803	1866, 1867	1930, 1931
	H	1500, 1501	1620, 1621	1740, 1741	1804, 1805	1868, 1869	1932, 1933
	L	1502, 1503	1622, 1623	1742, 1743	1806, 1807	1870, 1871	1934, 1935
6	1	1504, 1505	1624, 1625	1744, 1745	1808, 1809	1872, 1873	1936, 1937
	2	1506, 1507	1626, 1627	1746, 1747	1810, 1811	1874, 1875	1938, 1939
	H	1508, 1509	1628, 1629	1748, 1749	1812, 1813	1876, 1877	1940, 1941
	L	1510, 1511	1630, 1631	1750, 1751	1814, 1815	1878, 1879	1942, 1943
7	1	1512, 1513	1632, 1633	1752, 1753	1816, 1817	1880, 1881	1944, 1945
	2	1514, 1515	1634, 1635	1754, 1755	1818, 1819	1882, 1883	1946, 1947
	H	1516, 1517	1636, 1637	1756, 1757	1820, 1821	1884, 1885	1948, 1949
	L	1518, 1519	1638, 1639	1758, 1759	1822, 1823	1886, 1887	1950, 1951
8	1	1520, 1521	1640, 1641	1760, 1761	1824, 1825	1888, 1889	1952, 1953
	2	1522, 1523	1642, 1643	1762, 1763	1826, 1827	1890, 1891	1954, 1955
	H	1524, 1525	1644, 1645	1764, 1765	1828, 1829	1892, 1893	1956, 1957
	L	1526, 1527	1646, 1647	1766, 1767	1830, 1831	1894, 1895	1958, 1959

13.6. Clock readout and setting

Current time is read using 04 command.

Registers' addresses of clock

Registers' addresses (in DEC format)	Format	Description	
		High byte	Low byte
4128	Time	Year	Month
4129	Time	Day	Hour
4130	Time	Minute	Second

NOTE:
For instance, for 2 byte number AB:
B – low 8 bits (low byte),

A – high 8 bits (high byte).

Year, month, Day, hour, minute, second should be entered in HEX format. In the following table is an example for date 2009-12-25 and time 15:40:00:

Registers' addresses (dec)	Number
4128	090C
4129	190F
4130	2800

To adjust clock's settings user should use 10 command. This command have to contain strictly all three registers. In another time will be rejected with error code 02.

13.7. Error code

If error massage is sand as a response a value of 80 (hex) added on to the command code value.

Error codes possible for the device are:
- 01 HEX – incorrect function (in case of diagnostics also impermissible subfunction),
- 02 HEX – incorrect initial address,
- 03 HEX – incorrect number of points.

Queries are not confirmed by a response in case of:
- parity error,
- CRC errors,
- address error.

14.   CONFIGURATION OF JUMPERS INSIDE THE DEVICE

! **Configuration of inputs should be made before installation the device.**

Caution, Electrostatic Discharge for sensitive circuit. Do not touch or handle without proper electrostatic discharge precautions.

! **Make sure that the device is disconnected from any power supply. Disassembly of the enclosure should be made solely by a trained personnel.**

! **If in doubt, contact the authorized Metronic AKP service center.**

In order to configure PULS type inputs to a specific operating mode, the jumper connections inside the device must be changed. The jumper configuration should be changed before connecting sensors, programming settings and mechanical installation of the device. Disassembly of the enclosure is necessary (only trained personnel).

14.1. Configuration of jumpers in FP-3011, FP-3021 and FP-3031 devices

FP-3011 and FP-3021 devices
Unscrew the screws from the device's rear plate (4 screws located in the corners of the rear plate). Then remove the frame from the front panel (the frame is fastened with a latch). The front panel should be gently pry and disassembled. Disconnect the ribbon cable connecting the front panel with the PCB inside the device. The rear plate together with the screwed plates should be gently drawn out to a distance no more than necessary. Jumpers should be connected according to the information provided in the tables below. On the PCB containing the jumpers there is a hint on the correct connection (ON, NR, FILTER). After changing the configuration of the jumpers, insert the plates into the device, connect the front panel with the PCB inside the device using a ribbon cable, mount the front panel, fasten the frame and tighten the rear plate with screws.

FP-3031 device
Remove the frame from the front panel (the frame is fastened with a latch). The front panel should be gently pry and disassembled. Jumpers should be connected according to the information provided in the table below. On the PCB containing the jumpers there is a hint on the correct connection (ON, NR, FILTER). After changing the configuration of the jumpers, mount the front panel and fasten the frame.
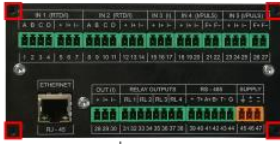
FP-3011

4 PHILLIPS SCREWS

CLICK

FP-3021

4 PHILLIPS SCREWS

CLICK

FP-3031

CLICK
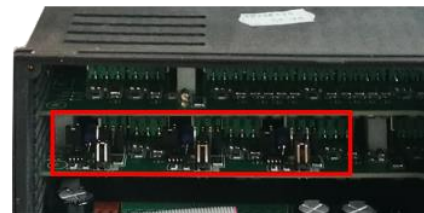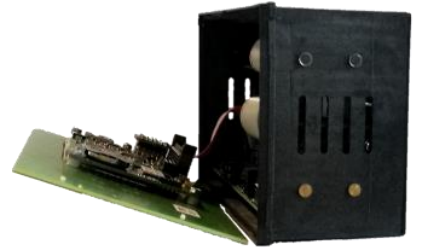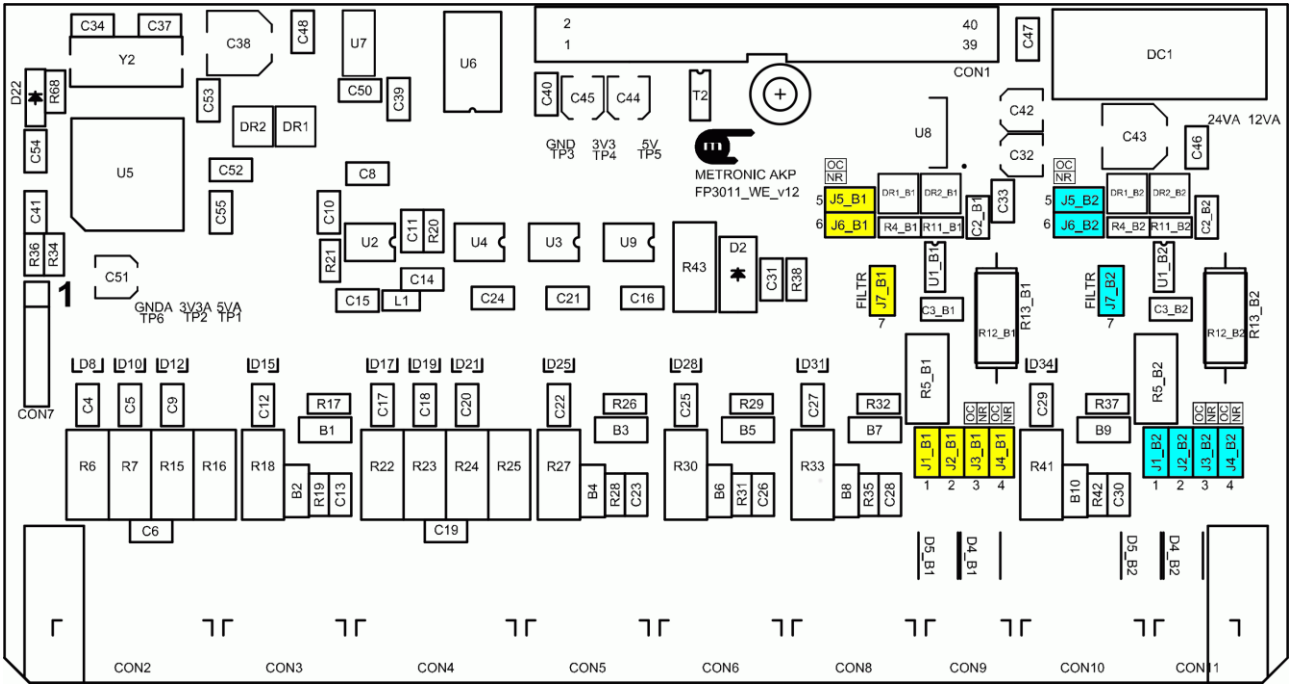
Layout of jumpers inside the FP-3011 device

FP-3011													
	IN 4 (I/PULS)							IN 5 (I/PULS)					
	J1_B1	J2_B1	J3_B1	J4_B1	J5_B1	J6_B1	J7_B1	J1_B2	J2_B2	J3_B2	J4_B2	J5_B2	J6_B2	J7_B2
OC/CONTACT, VOLTAGE INPUT	X		X		X			X		X		X		
NAMUR		X		X		X			X		X		X	
FILTR ON							X							X

Notes:

The 'X' sign means closed jumpers.

Layout of jumpers inside the FP-3021 device

FP-3021													
PULS 1							PULS 2						
J1_B1	J2_B1	J3_B1	J4_B1	J5_B1	J6_B1	J7_B1	J1_B2	J2_B2	J3_B2	J4_B2	J5_B2	J6_B2	J7_B2
OC/CONTACT, VOLTAGE INPUT													
X		X				X	X		X				X
NAMUR													
	X		X		X			X		X		X	
FILTR ON													
				X							X		

Notes:

The 'X' sign means closed jumpers.

Layout of jumpers inside the FP-3031 device

FP-3031																				
IN 8 (I/PULS)							IN 9 (I/PULS)							IN 10 (I/PULS)						
J1_B1	J2_B1	J3_B1	J4_B1	J5_B1	J6_B1	J7_B1	J1_B2	J2_B2	J3_B2	J4_B2	J5_B2	J6_B2	J7_B2	J1_B3	J2_B3	J3_B3	J4_B3	J5_B3	J6_B3	J7_B3
OC/CONTACT, VOLTAGE INPUT																				
X		X		X			X		X		X			X		X		X		
NAMUR																				
	X		X		X			X		X		X			X		X		X	
FILTR ON																				
						X							X							X

Notes:

The 'X' sign means closed jumpers.

14.2. Configuration of jumpers in FP-3011N, FP-3021N and FP-3031N devices

Unscrew the screws from the device's front panel (4 screws located in the corners of the front panel). Remove the front panel (pay attention to the length of the ribbon cable and do not draw out the front panel more than necessary). Jumpers should be connected according to the information provided in the tables below. On the PCB containing the jumpers there is a hint on the correct connection (ON, NR, FILTER). After changing the configuration of the jumpers, mount the front panel.

FP-3011N	**FP-3021N**	**FP-3031N**
4 PHILLIPS SCREWS	4 PHILLIPS SCREWS	4 PHILLIPS SCREWS
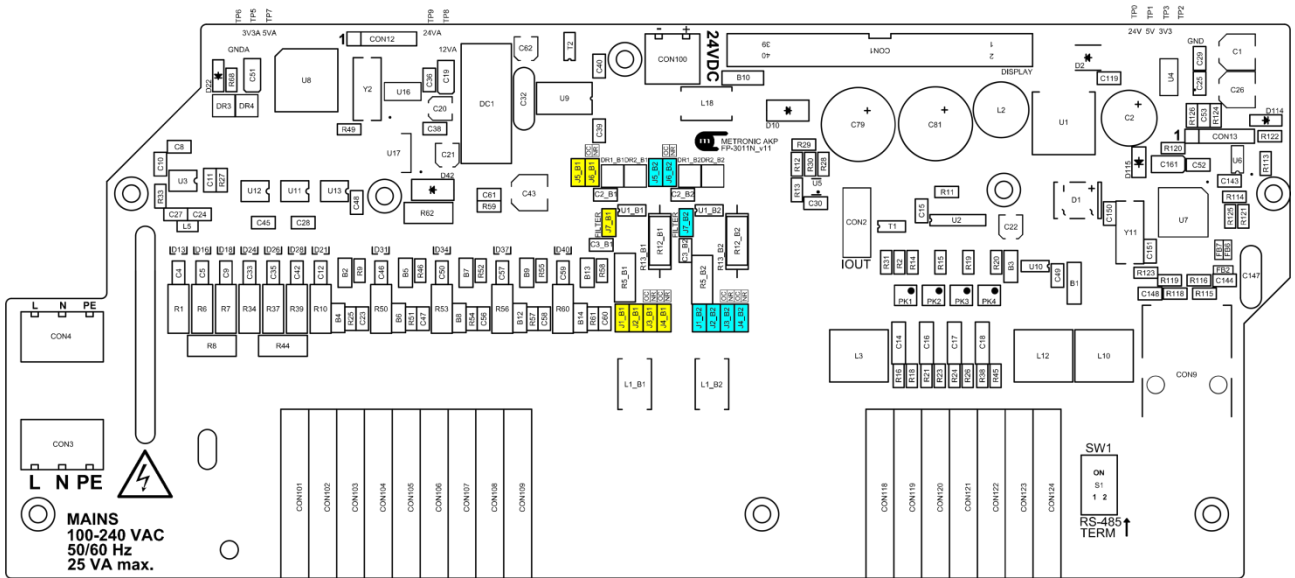
Layout of jumpers inside the FP-3011N device

FP-3011N													
IN 4 (I/PULS)							**IN 5 (I/PULS)**						
J1_B1	**J2_B1**	**J3_B1**	**J4_B1**	**J5_B1**	**J6_B1**	**J7_B1**	**J1_B2**	**J2_B2**	**J3_B2**	**J4_B2**	**J5_B2**	**J6_B2**	**J7_B2**
X		X		X			X		X		X		
	X		X		X			X		X		X	
						X							X

First row label: **OC/CONTACT, VOLTAGE INPUT**
Second row label: **NAMUR**
Third row label: **FILTR ON**

Notes:

The 'X' sign means closed jumpers.

Layout of jumpers inside the FP-3021N device

FP-3021N													
PULS 1							PULS 2						
J1_B1	J2_B1	J3_B1	J4_B1	J5_B1	J6_B1	J7_B1	J1_B2	J2_B2	J3_B2	J4_B2	J5_B2	J6_B2	J7_B2
OC/CONTACT, VOLTAGE INPUT	X		X		X			X		X		X		
NAMUR		X		X		X			X		X		X	
FILTR ON							X							X

Notes:

The 'X' sign means closed jumpers.

Layout of jumpers inside the FP-3031N device

FP-3031N																				
IN 8 (I/PULS)							IN 9 (I/PULS)							IN 10 (I/PULS)						
J1_B1	J2_B1	J3_B1	J4_B1	J5_B1	J6_B1	J7_B1	J1_B2	J2_B2	J3_B2	J4_B2	J5_B2	J6_B2	J7_B2	J1_B3	J2_B3	J3_B3	J4_B3	J5_B3	J6_B3	J7_B3
OC/CONTACT, VOLTAGE INPUT	X		X		X			X		X		X			X		X		X		
NAMUR		X		X		X			X		X		X			X		X		X	
FILTR ON							X							X							X

Notes:

The 'X' sign means closed jumpers.