# APLISENS®
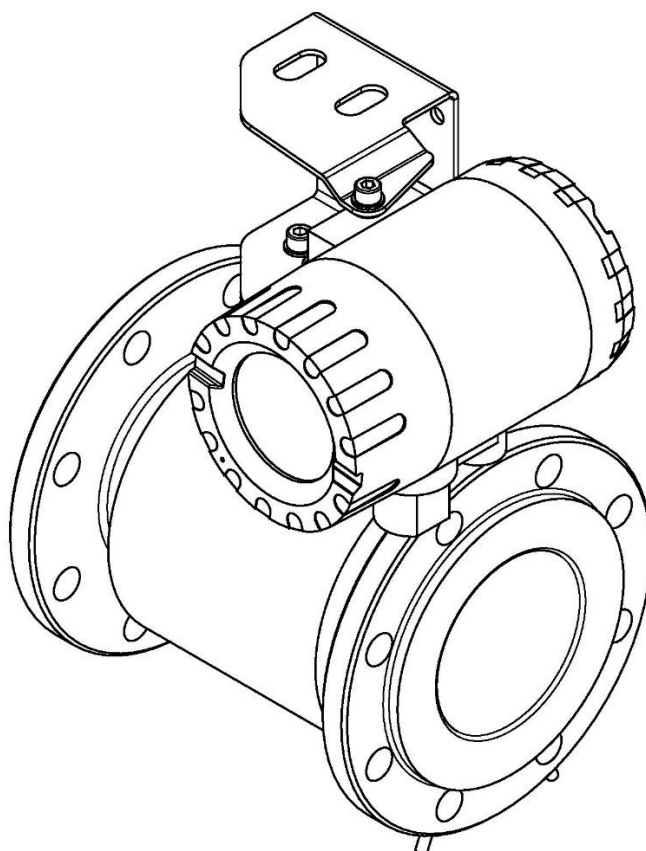
# MODBUS MANUAL

## ELECTROMAGNETIC FLOWMETER
# PEM-1000

Used markings:

| Symbol | Description |
|---|---|
| ⚠ | Warning signifying that it is necessary to follow the information in the documentation precisely in order to ensure device safety and complete functionality. |
| i | Information particularly useful during device installation and operation. |
| 🗑 | Information concerning dealing with used equipment. |

## BASIC REQUIREMENTS AND SAFETY OF OPERATION

⚠
- The manufacturer is not responsible for damage caused by improper installation of the device, not maintaining the device in good technical condition and operating the device contrary to its intended use.
- Installation should be carried out by qualified personnel authorized to install electrical devices and control and measuring equipment. The installer is responsible for carrying out the installation in accordance with this manual as well as safety and electromagnetic compatibility standards and regulations applicable to a given type of installation.
- In case of an installation with control and measuring equipment, in the event of a leak, medium under pressure causes a risk to the personnel. During device installation, operation and inspection all safety and precautionary requirements must be taken into account.
- If the device malfunctions, it should be disconnected and handed over to the manufacturer or to a body authorized by the manufacturer for repairs.

⚠
In order to minimize probability of failure and resultant danger to personnel, avoid installing the device under particularly unfavourable conditions when the following dangers are present:

- Danger of mechanical impacts, excessive shocks and vibrations.
- Excessive temperature variations.
- Vapour condensation, dust, icing.

Changes in product manufacture may precede an update to the user's paper documentation. Up-to-date operating manuals can be found on manufacturer's website at www.aplisens.pl

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# 1. MODBUS COMMUNICATION

## 1.1. Data of the MODBUS interface in the device

| Physical layer | RS485 half-duplex |
| --- | --- |
| Terminating resistor | Built-in, 130Ω, activated by switch on rear wall of electronics unit, item "2". |
| Specification of RS485 transceiver | Interface galvanically isolated from ground of the flow meter. Allowable voltage between the common wire and lines A, B:-7/+ 12V. "Fail-safe" receiver. Reduction of rate of rise ("slew-rate") during sending. Transceiver does not interfere with the operation of the bus without power to the flowmeter. |
| Transmission mode | MODBUS RTU, compatible with MODBUS over serial line specification and implementation guide V1.02 |
| Time relationships for transmission | Compatible with the requirements of MODBUS over serial line specification and implementation guide V1.02 |
| MODBUS electrical connection | Three screw terminals in terminal chamber at the back of the device. Interface with galvanic isolation, connection of the common wire is required. *Terminal 9 - line A RS485 (non-inversing);* *Terminal 10 - line B RS485 (inversing);* *Terminal 11 - common wire RS485.* |
| Range of digital transmission | 1200 mm (shielded twisted pair) |
| Address space | 1...247 device addresses |
| Maximum number of devices on the bus | 256 |
| Transmission rate | 4800, 9600, 19200, 38400, 57600, 115200 bps |
| Transmission parity check | no parity, odd, even |
| Number of bits of sign of transmission frame | 11 bits (8N2, 8E1, 8O1). Number of stop bits connected with parity check. For *no parity* there are 2 stop bits, 1 bit for the other cases. |
| Response time for the query | max. 20ms, typical 10ms, measured from the end of query frame to start of response frame. It does not depend on transmission rate. |
| Setting of transmission parameters | From the keyboard, from configuration menu or using the MODBUS interface by making entries into the corresponding registers. |

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## 1.2. Detailed information

*Physical layer*

MODBUS interface of the flowmeter is intended for connecting to two-wire RS485 bus. Because the interface is galvanically isolated it is also required to connect a common wire RS485. Method of its connection depends on system configuration and expected differences in potentials between the devices.

Connection diagram is presented on the below figure:
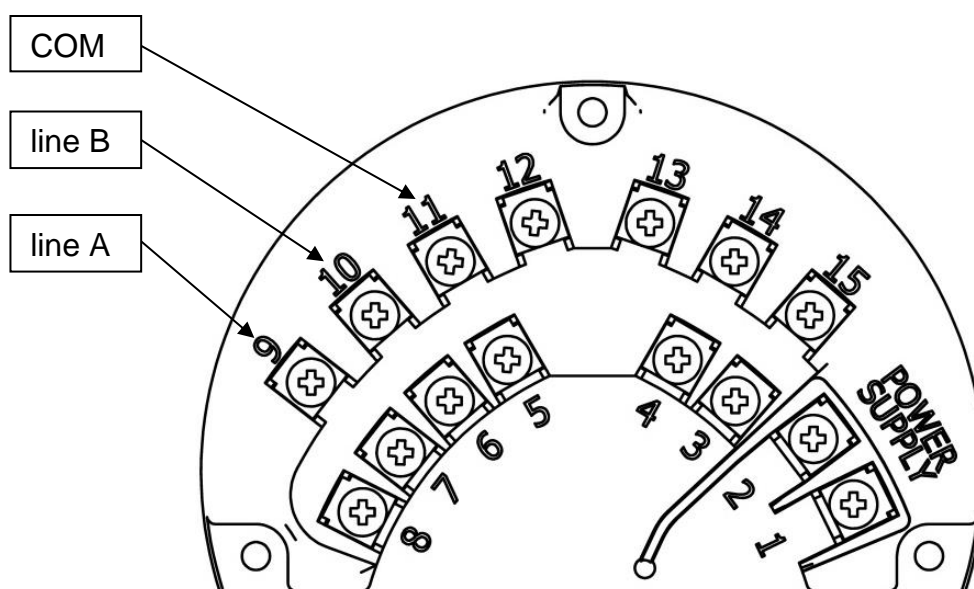


**Figure 1.**

ⓘ The most popular terminology of terminals markings acc. to RS485 is given; that is line A is non-reversing line of the interface while the line B is reversing line. This standard is used by the world's largest manufacturers of the RS485 transceivers. It is important to bear in mind that there is also contrary method of marking of these lines compatible with the TIA/EIA standard. The MODBUS standard also uses the contrary mehod.

ⓘ The flowmeter is equipped with galvanically isolated MODBUS interface.

Non-isolated RS485 interface allows difference of ground potentials for the individual interfaces not exceeding -7 to +12V, while each difference of potentials of the grounds causes flow of equalizing currents. Exceeding of the potentials difference may even cause damage of the interface. In case of an isolated interface the common wire is connected only to ground of the Master device (usually using cable screen) and is not connected with the other grounds therefore the potential difference is small and equalizing currents does not flow. Ground (enclosure) potential of the Slave device may considerably differ from the ground potential of the Master device without negative consequences.

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Typical connection diagram of two-wire RS485 bus is indicated on the below figure:
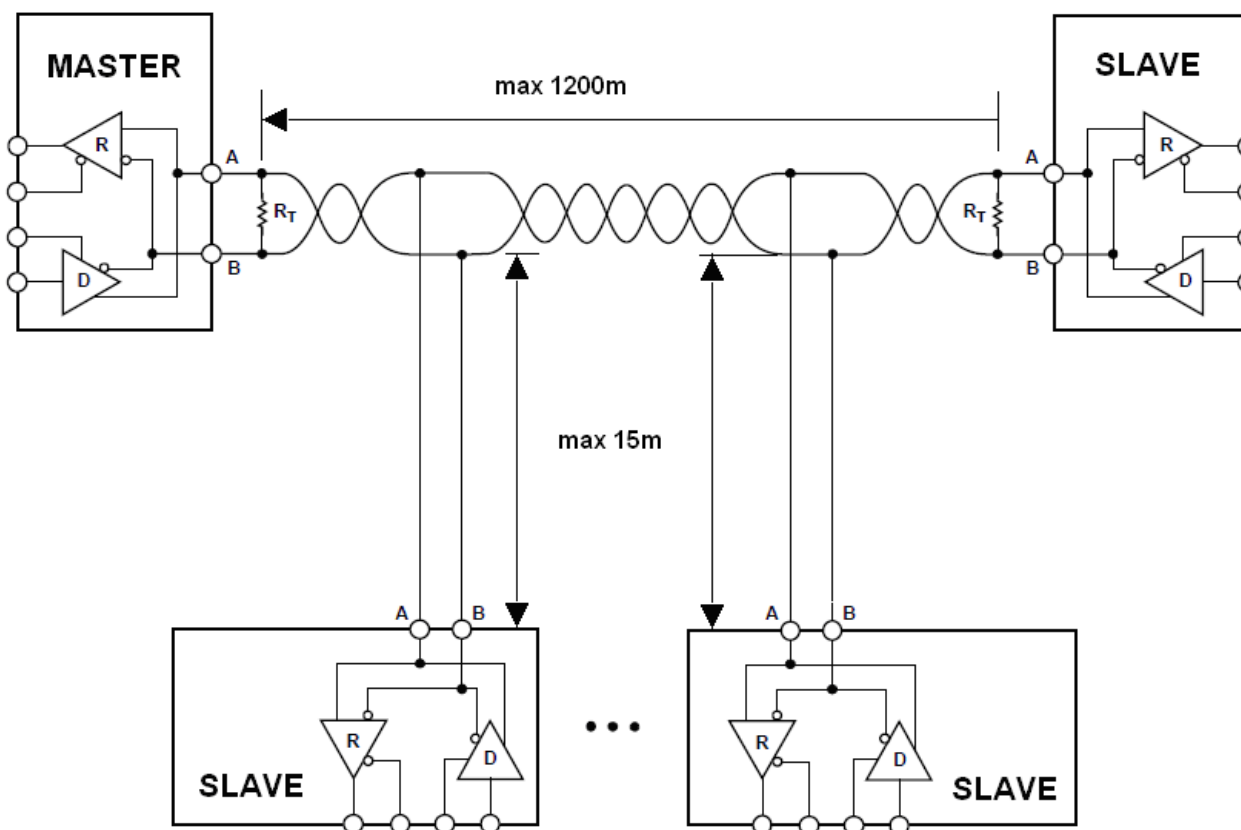


**Figure 2.** Connection diagram of two-wire RS485 bus

To ensure correct operation of many devices on one serial communication bus you should connect to it in series appropriate leads from the devices. Each device connected to the bus should have unique address assigned.

It is possible to configure network with max. length 1200 metres and maximum 247 Modbus devices. The bus should be led from the Master device, through successive devices (connected directly or through cable junction boxes) up to the last Slave device. Each stub of the conductor from the bus may be max. 15 meters long, while as far as it is possible you should avoid such long stubs. Do not led cables in "star" configuration. Use cables suitable for the RS485 bus that is screened twisted pair with suitable characteristic impedance compatible with EIA-485. Bus should be terminated with a terminating resistor $R_T$ at least from the side of the last Slave device or from both ends as presented on the figure. Flowmeter is equipped with a terminating resistor activated by a configuration switch located on the back wall of the electronics unit.

If the bus consists of at least one device without fail-safe type interface that is it does not interpret differential voltages A-B smaller than ±200mV as an inactive condition then it is required to connect a set of pull-up resistors to the line A, B, which are forcing voltages on lines when no transmitter is active. Flowmeter interface is equipped with such resistors, which may be activated using configuration switch located on the rear wall of the electronics unit.

Marking and operation of the switches is presented on the following figure:



activated position (active)

deactivated position (inactive)

DIP-switch
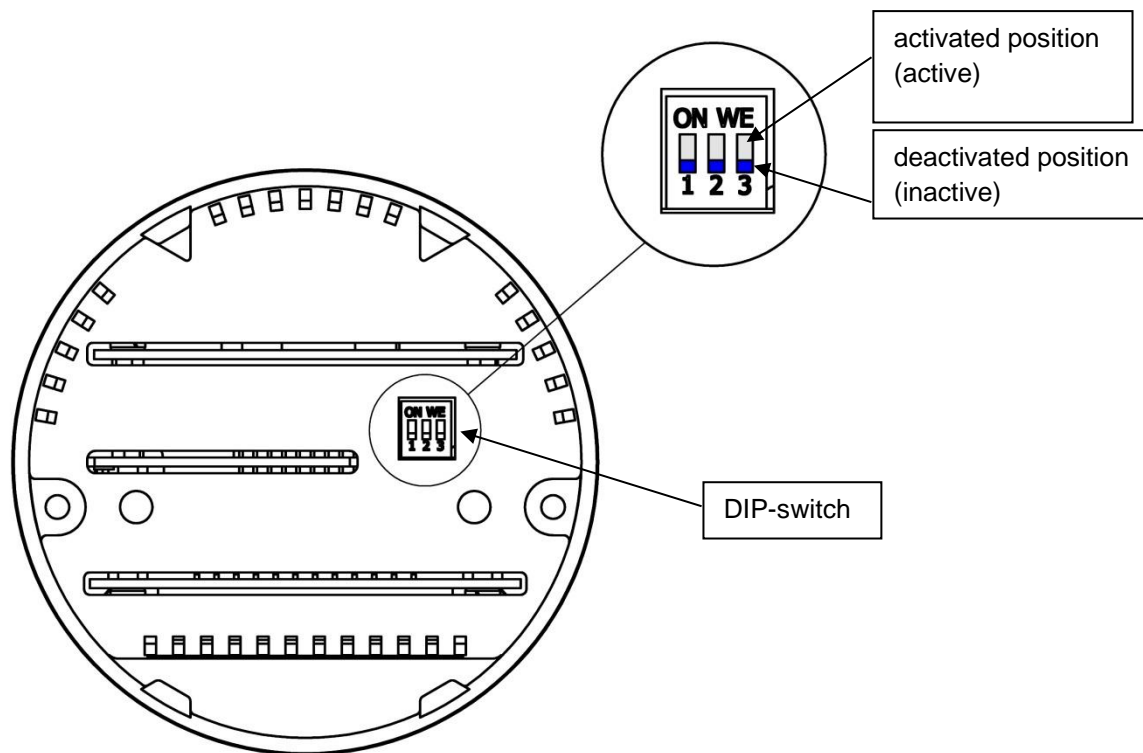
**Figure 3.**

Pos. 1, 3: "fail-safe" resistors, pos. 2: terminating resistors. Switch for the given position is enabled (switched on) when its slider is set in upper position.

> **i** Enable items 1 and 3 in case when the "fail-safe" resistors are activated. Flowmeter receiver does not require to enable the "fail-safe" resistors.
> Bus terminator may be located also in the junction box and therefore it is not necessary to manipulate configuration switch.
>
> All positions of the switch are disabled in new devices.

> **i** Removal of electronic components may only be performed after disconnecting the power supply!

## 1.3. Checking and setting the parameters of the transmission

Use MODBUS menu for this purpose which is located in: Configuration → Modbus.

In this way you can change the following parameters:

- Enable or disable MODBUS module.
- Switch on or switch off saving using the MODBUS interface.
- Own address of the device.
- Transmission rate.
- Configuration of stop bit parity.
- The format of transferred data.

> **i** Access to the menu requires logging in using the appropriate (administrator) code.

Change of transmission parameters is possible in any time also during the transmission and it takes place immediately after confirmation of the changes in the menu. It is important to bear in mind that change of configuration during the transmission will stop it (frame coming from the Master device will be ignored). In case of changing the transmission parameter via MODBUS, this change is postponed to the end of the current transmission (see section 1.3.1.).

All data sent through the MODBUS interface can have one of the four formats ("order") available (configured) in the menu.

Bytes "order" for the data send by the MODBUS interface (Little Endian coding in RAM) explained based on the example:

Given number: 0x22334455

Assumed description of its component bytes: 0xDDCCBBAA

[0] [1] [2] [3] (index)

This number is permanently located in RAM: 55 44 33 22

It can be located in the MODBUS frame as follows:

1) the simplest method - MRBO_AABBCCDD 55 44 33 22

2) Big Endian method for MODBUS - MRBO_DDCCBBAA 22 33 44 55 (NATURAL)

3) method changing the words MODBUS - MRBO_BBAADDCC 44 55 22 33 (REVERSED)

4) the least intuitive method - MBRO_CCDDAABB 33 22 55 44

Modbus interface operates in the unicast mode what means than it responds to correct MODBUS frames, with compatible address, send by the Master device.

### 1.3.1. Modification of the functionality of changing the transmission parameters (from version 3.0.1005)

The behavior of the MODBUS interface was changed in case of change of transmission parameters (registers in the area 545-5456). Currently any correctly performed change (entry) in this area causes the following sequence of actions:

- entry of new values of transmission parameters to the non-volatile memory,
- generating a request of deferred change of transmission,
- immediate change of the data format („byte order"), because the response sent back is not sensitive to this setting,
- sending back confirmation of entering new parameters on unchanged transmission settings,
- waiting for the end of the sending back confirmation,
- change of transmission parameters (on the above request),
- transition to waiting for a possible next frame (already with new settings).

Additionally, the functionality of "restarting transmission parameters", known from PEM-500, was introduced, consisting in an immediate change of transmission parameters and address to the default ones, in response to the frame 0x08 (diagnostics), sub-function 0x00 0x01 (communication restart), transmitted with broadcast address 0. The transmission parameters are changed to: 9600bps, parity EVEN, 1 stop bit, and the address is set to 5. The settings change is immediate because no response is sent to the broadcast frame. The "byte order" data format is not changed by this frame.

Sending the above frame on all possible transmission settings (currently there are 18) sets the above-mentioned transmission and address parameters. This change is temporary (until the flowmeter reset) and does not affect the transmission parameters saved in the non-volatile memory. The user, using these temporary settings can establish a transmission with the flowmeter and read the saved transmission settings and device address or change them to new ones.

$\boxed{i}$ The transmission parameters recovery mechanism is built into the Raport 2 program.

## 1.3.2. The Interface supports the following MODBUS functions (frame types)

| Function code | Name | Description |
|---|---|---|
| **0x03** | Read holding registers | Registers reading. Basic function used to read the measurement results and current parameters of the equipment. Implemented four address spaces are described in the following part of the manual. |
| **0x10** | Write Multiple Registers | Write registers. The function used for setting of device operation parameters both for these saved in the non-volatile memory and these set temporarily (to the moment of device restart). |
| **0x01** | Read Coils | Read of "coils" that is bit variables (ON or OFF state): <br> - intended for switching on the device operation parameters, both for this non-volatile and volatile <br> - indicating device system flags <br> - intended for calling device functions. <br> Implemented as one address field allowing free group readout. |
| **0x05** | Write Single Coil | Save of the single "coil" that is setting of bit output to ON or OFF. ON state is set by 0xFF00 value, OFF state by 0x0000 value. |
| **0x08** <br> **sub-functions** <br> **0x00 00,** <br> **0x00 01,** <br> **0x00 0A** <br> **÷** <br> **0x00 12** | Diagnostics | Selected set of diagnostic functions allowing checking transmission correctness through the "echo" frame and deleting and reading diagnostic meters compatible with the MODBUS standard. |
| **0x2B** <br> **sub-function** <br> **0x0E** | Encapsulated Interface Transport / Read Device Identification | Reading of text information identifying the equipment. |

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### 1.3.3. MODBUS exceptions

If MODBUS frame with compatible address and correct CRC control area but with incorrect data will be send to the device then the exception will be returned. For frames saving data to the device, that is frame types 0x05 and 0x10, the exception will be returned also if all data contained in the frame are correct and the option to execute write is not unlocked in the device menu.

Supported MODBUS exceptions are presented in the table:

| Error code | Name | Description |
|:---:|:---:|:---|
| 1 | Illegal function | This exception is returned when function code is not supported by the device. |
| 2 | Illegal data address | This exception is returned in case of query for non-implemented address or address, which is not a beginning of the logically coherent register (in case of data longer than 16-bit). Reading of long registers in batches is forbidden due to lack of guarantees of the accuracy of the data. |
| 3 | Illegal data value | This exception is returned in case of query for incorrect number of registers that is the end of read area is outside the implemented area or the end of read area divides the logically coherent register (longer than 16-bit). Reading of long registers in batches is forbidden due to lack of guarantees of the accuracy of the data. |
| 4 | Slave device failure | This exception is returned when the device is damaged. |
| 6 | Server device busy | This exception is returned when all data in the write frame are correct but the option to execute writing is locked in the device menu. |

Currently all data made available by the MODBUS interfaces are read-only. It is only possible to erase diagnostic meters.

Frame **0x03** allows reading and frame **0x10** allows writing registers of the device. The unicast mode is only permitted.

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## 1.3.4. Address fields

Address fields, as in the table (MODBUS addresses are given) are available:

| Address range: MODBUS* | Name | Description |
|---|---|---|
| 106-106 | Quick identification of the device - "reversed" order | This register is presented due to a backward compatibility with a previous version of the device. Size of area is one (1) 32-bit word. |
| 200-200 | Data allowing the identification of the order of data transfer set in the device | A fixed 32-bit data which reading allows identify the order of transmitted bytes that is set in the device. Hexadecimal value of this data - 0x11223344. Field size - one 32-bit word. |
| 2000-2010 | Measurement data in basic version corresponding to PEM-1000 | This field contains basic measurement data, in the form of 32-bit words and it is compatible with the previous version of the PEM-1000 device. Field size - six 32-bit words. |
| 4000-4030 | Extended measurement data | This field contains extended measurement data, in the form of 32-bit words, which, when read in the devices with an older version of the bus, were arranged in the "reversed" order that is younger 16-bit word first and then the older 16-bit word. Field maintained to ensure backward compatibility of the devices. All data contained in 4000-4030 and 5000-5030 fields are identical. Field size - sixteen 32-bit words. |
| 5000-5030 | Extended measurement data | This field contains extended measurement data, in the form of 32-bit words, which, when read in the devices with an older version of the bus, were arranged in the "big-endian" order that is older 16-bit word first and then the younger 16-bit word. All data contained in 4000-4030 and 5000-5030 fields are identical. Field size - sixteen 32-bit words. |
| 5032-5036 | Input and outputs states of the device | This field contains binary input test status, binary outputs status and also current loop output value in the form of 32-bit words. Field size- three 32-bit words. |
| 5100-5126 | General basic parameters of the device | This field contains basic parameters of device operation settings in the form of the 32-bit words. Field size - fourteen 32-bit words. |
| 5200-5218 | General advanced parameters of the device | This field contains advanced parameters of device operation settings in the form of the 32-bit words. Field size - ten 32-bit words. |
| 5300-5344 | Device output parameters | This field contains the operating parameters of device outputs, in the form of the 32-bit words. Field size - twenty three 32-bit words. |
| 5360-5362 | Device input parameters | This field contains the operating parameters of device inputs, in the form of the 32-bit words. Field size - two 32-bit words. |
| 5400-5416 | Device filters parameters | This field contains the operating parameters of the filters used in the device, in the form of the 32-bit words. Field size - eight 32-bit words. |
| 5450-5456 | Device MODBUS parameters | This field contains MODBUS operation parameters in the form of the 32-bit words. Field size - four 32-bit word. |
| 5500-5506 | Device archive parameters | This field contains archive operation parameters in the form of the 32-bit words. Field size - four 32-bit word. |
| 5550-5560 | Device time settings | This field contains time settings in the device, in the form of the 32-bit words. Field size - six 32-bit words. |

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| 5600-5626 | Device calibration parameters | This field contains device calibration parameters, in the form of the 32-bit words. Field size - fourteen 32-bit words. |
|---|---|---|
| 5650-5668 | Device dosing parameters | This field contains device dosing function, in the form of the 32-bit words. Field size - ten 32-bit words. |
| 5700-5720 | Device diagnostics parameters | This field contains device diagnostics variables, in the form of the 32-bit words. Field size - eleven 32-bit words. |
| 5800-5800 | Device status variables | This field contains device status variable, in the form of the 32-bit word. Field size - one 32-bit word. |
| 5850-5862 | Device version variables | This field contains device version and software variables and device serial number, in the form of the 32-bit words. Field size - seven 32-bit words. |
| 7000-7030 | Device screen view | This field contains characters displayed on the device screen, in the form of the 32-bit words. Field size - sixteen 32-bit words. |
| 8000-8032 | Variables of events archive for the device | This field contains variables of events archive for the device, in the form of the 32-bit words. Field size - seventeen 32-bit words. |
| 9000-9032 | Variables of device measurements archive | This field contains variables of readout of device measurement archive, in the form of the 32-bit words. Field size - seventeen 32-bit words. |
| 11000-11022 | The field related to the stored data entered in the variant software PEM1A(w) | This field contains non-volatile data entered in variant software PEM1A(w): flow display precision, prefiltering parameters, device calibration factor backup, start frame, error masks |

Frame **0x01** allows reading and frame **0x05** allows writing "coils" (bit variables) in the device. The unicast mode is only permitted.

One **continuous address field** is available; as in the table (MODBUS addresses are given):

| Coding | Description | Example |
|---|---|---|
| 1000-1061 | Device bit variables | This field contains bit variables, both saved and volatile as well as read-only bits and executable commands. Field size - 62 bits. |
| 1000-1073 | Device bit variables | Variables existing in the PEM-1000 before the changes. |
| 1074-1075 | Device bit variables | Variables added in the 3.0.1005. PEM-1000 version related to calibration. |
| 1076-1087 | Device bit variables | Variables added in the 3.0.1005. PEM-1000 version including "Keys over MODBUS" field.[1] |

⎡i⎤ Please remember that MODBUS registers addresses are bigger by 1 than the addresses sent in frames.

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[1] The areas related to KeysOverMODBUS are not compatible between the PEM-500 and PEM-1000 models.

Detailed explanation of **data coding** in the MODBUS registers are given in the below table:

| Coding | Description | Example |
|---|---|---|
| **int** | 32-bit integer, "big endian" coded. Entry in two MODBUS registers that is on 4 bytes. | Content (hexadecimal) of successive 16-bit registers: *08 F0, D1 80.* It corresponds to 0x08F0D180 that is 150.000.000 in decimal. |
| **float** | 32-bit floating-point number, conforming IEEE754, saved in the "big-endian" order. Entry in two MODBUS registers that is on 4 bytes. | Content (hexadecimal) of successive 16-bit registers: *42 E0, C4 19.* It corresponds to 0x42E0C419 that is 112,383 in floating-point format. |
| **short** | 16-bit integer, "big endian" coded. Entry in two MODBUS registers that is on 4 bytes. | Content (hexadecimal) of successive 16-bit registers: *00 00, 3A 98.* It corresponds to 0x3A98 that is 15.000 in decimal. |
| **uchar** | 8-bit integer, "big endian" coded. Entry in two MODBUS registers that is on 4 bytes. | Content (hexadecimal) of successive 16-bit registers: *00 00, 00 96.* It corresponds to 0x96 that is 150 in decimal. |
| **char table** | Table of four 8-bit integers, "big endian" coded. Entry in two MODBUS registers that is on 4 bytes. | Content (hexadecimal) of successive 16-bit registers: *31 32, 33 34.* It corresponds to 0x31323334 that is "1234" in ASCII format. |

$\boxed{i}$ Because 32-bit areas contains numbers constituting whole, it is not permissible to read/write this numbers in batches (single MODBUS registers) and if such an operation is attempted with an odd number of registers, a MODBUS exception will be returned. This is because the 32-bit number consisting of two 16-bit readings may be incorrect if value of such number is changed between the reading/writing.

*For example*

32-bit register contains increasing number. First value - 0x0000FFFF. Next value - 0x00010000 (bigger by 1). If the number is read in the order "older 16b word - younger 16b word" and the change occurs exactly between the readings then number 0x0000 (first reading) 0x0000 (second reading) will be obtained what will give incorrect number 0x00000000 that is 0.

Below you will find examples of correct and incorrect servicing of registers, illustrated in the 2000-2010 field. Colour fields indicate read/written registers:

| | MODBUS registers addresses | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1998 | 1999 | 2000-2001 | | 2002-2003 | | 2004-2005 | | 2006-2007 | | 2008-2009 | | 2010-2011 | | 2012 | 2013 |
| | X | X | C494 | 4189 | 0 | 0 | 1CAD | 42B9 | C419 | 42E0 | BE77 | 4083 | C494 | 4189 | X | X |
| correct | G | G | G | G | G | G | G | G | | | | | | | | |
| correct | | | | | G | G | | | | | | | | | | |
| correct | | | | | | | G | G | G | G | G | G | G | G | | |
| incorrect | | | | R | R | | | | | | | | | | | |
| incorrect | | | | | R | R | R | R | R | R | R | R | | | | |
| incorrect | | R | R | R | | | | | | | | | | | | |
| incorrect | | | | | | | | | R | R | R | R | R | R | R | R |
| incorrect | | | | | R | | | | | | | | | | | |
| incorrect | | | | | | | | | | | | | R | R | R | |

### 1.3.5. Description of the registers implemented in the flowmeter

Explanation of operations executed in the MODBUS registers is given in the below table:

| Operation | Description | Example |
|---|---|---|
| **RD_ONLY** | Read-only register. Reading using MODBUS function 0x03. | Reading frame for bytes order register (register 200): *0x05 0x03 0x00 0xC7 0x00 0x02*. |
| **RD/WR** | Register intended for both read and write function. Data is stored in the non-volatile memory of the device. Reading using MODBUS function 0x03, while saving using 0x10 function. | Reading and writing frame for user-specified PIN (register 5100, pin 0000). Read: *0x05 0x03 0x13 0xEB 0x00 0x02*. Write: *0x05 0x10 0x13 0xEB 0x00 0x02 0x04 0x00 0x00 0x00 0x00*. |
| **NO_MEM** | Register intended for both read and write function (unstable). Data is stored in the volatile memory of the device. Reading using MODBUS function 0x03, while saving using 0x10 function. | Diagnostic reading and writing frame for current loop (register 5700, current 10.0 mA). Read: *0x05 0x03 0x16 0x43 0x00 0x02*. Write: *0x05 0x10 0x16 0x43 0x00 0x02 0x04 0x41 0x20 0x00 0x00.* |

1.3.5.1. The contents of registers in 106-106 field

| Register | Address (hex) | Brief description | Extended description | Unit | Format | Operation |
|---|---|---|---|---|---|---|
| 106 | 0x0069 | Short identification | Contains decimal value 2000 indicating the version of the MODBUS interface. | - | short | RD_ONLY |

1.3.5.2. The content of registers in 200-200 field

| Register | Address (hex) | Brief description | Extended description | Unit | Format | Operation |
|---|---|---|---|---|---|---|
| 200 | 0x00C7 | Bytes order register | Contains fixed hexadecimal value 0x11223344. After reading it allows identifying the order of data bytes transmission set in the device. | - | int | RD_ONLY |

### 1.3.5.3.  The contents of the registers for 2000-2010 field

| Register | Address (hex) | Brief description | Extended description | Unit | Format | Operation |
|---|---|---|---|---|---|---|
| 2000 | 0x07CF | Current flow Q | Current flow, in litres per second. Filtration can be configured independently for this variable. | l/s | float | RD_ONLY |
| 2002 | 0x07D1 | Empty pipe error | The error is indicated on bit 0 of the number as the value of 1. The other bits are always 0. | - | int | RD_ONLY |
| 2004 | 0x07D3 | Total totalizer S | Counter for the volume of flowing liquid. The counter increases for positive flow and decreases for negative flow. Counter stored in the non-volatile memory. | $m^3$ | float | RD_ONLY |
| 2006 | 0x07D5 | Positive totalizer S+ | Counter for the volume of flowing liquid in accordance with the direction of the sensor. The counter increases for positive flow and does not change for negative flow. Counter stored in the non-volatile memory. | $m^3$ | float | RD_ONLY |
| 2008 | 0x07D7 | Negative totalizer S- | Counter for the volume of flowing liquid opposite to the direction of the sensor. The counter increases for negative flow and does not change for positive flow. Counter stored in the non-volatile memory. | $m^3$ | float | RD_ONLY |
| 2010 | 0x07D9 | Current flow Q2 - a copy of the register 2000 | Current flow, in litres per second. | l/s | float | RD_ONLY |

### 1.3.5.4.  The contents of registers in 4000-4030 field

| Register | Address (hex) | Brief description | Extended description | Unit | Format | Operation |
|---|---|---|---|---|---|---|
| 4000 | 0x0F9F | Current flow Q | Current flow expressed in cubic metres per hour (basic unit). Filtration can be independently configured for this variable | $m^3/h$ | float | RD_ONLY |
| 4002 | 0x0FA1 | Status / informational flags of the device | Bit meaning:<br>*bit 7* - measurement board error,<br>*bit 6* - sensor error,<br>*bit 5* - sensor coil error,<br>*bit 4* - memory error,<br>*bit 3* - empty pipe error,<br>*bit 2* - unfilled pipe error (for sensors with detection of unfilled pipe)<br>The other bits: 0 | - | int | RD_ONLY |
| 4004 | 0x0FA3 | Total totalizer S | Counter for the volume of flowing liquid. The counter increases for positive flow and decreases for negative flow. Counter stored in the non-volatile memory. | $m^3$ | float | RD_ONLY |

| 4006 | 0x0FA5 | Positive totalizer S+ | Counter for the volume of flowing liquid in accordance with the direction of the sensor. The counter increases for positive flow and does not change for negative flow. Counter stored in the non-volatile memory. | m$^3$ | float | RD_ONLY |
|---|---|---|---|---|---|---|
| 4008 | 0x0FA7 | Negative totalizer S- | Counter for the volume of flowing liquid opposite to the direction of the sensor. The counter increases for negative flow and does not change for positive flow. Counter stored in the non-volatile memory. | m$^3$ | float | RD_ONLY |
| 4010 | 0x0FA9 | User-specified total totalizer US | Counter for the volume of flowing liquid. The counter increases for positive flow and decreases for negative flow. Counter stored in the non-volatile memory. Counter erasable by the user. | m$^3$ | float | RD_ONLY |
| 4012 | 0x0FAB | User-specified positive totalizer US+. | Counter for the volume of flowing liquid in accordance with the direction of the sensor. The counter increases for positive flow and does not change for negative flow. Counter stored in the non-volatile memory. Counter erasable by the user. | m$^3$ | float | RD_ONLY |
| 4014 | 0x0FAD | User's negative totalizer US- | Counter for the volume of flowing liquid opposite to the direction of the sensor. The counter increases for negative flow and does not change for positive flow. Counter stored in the non-volatile memory. Counter erasable by the user. | m$^3$ | float | RD_ONLY |
| 4016 | 0x0FAF | Flow velocity V | Linear flow velocity expressed in metres per second (basic unit), allowing a quick assessment of the flow, independently of the pipe diameter. | m/s | float | RD_ONLY |
| 4018 | 0x0FB1 | Pipe diameter | The pipe diameter set in the device menu. This parameter makes flow Q dependent on the linear velocity of liquid flow. Values of diameters (in mm or in) are defined as a selection list: *DN2.5[mm]=0, DN4[mm]=1, DN6[mm]=2, DN10[mm]=3, DN15[mm]=4, DN20[mm]=5, DN25[mm]=6, DN32[mm]=7, DN40[mm]=8, DN50[mm]=9, DN65[mm]=10, DN80[mm]=11, DN100[mm]=12, DN125[mm]=13, DN150[mm]=14, DN200[mm]=15, DN250[mm]=16, DN300[mm]=17, DN350[mm]=18, DN400[mm]=19, DN450[mm]=20, DN500[mm]=21, DN600[mm]=22, DN700[mm]=23,* | - | int | RD_ONLY |

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| | | | *DN800[mm]=24, DN900[mm]=25, DN1000[mm]=26.*<br>DN 1/8[in] = 27, DN 1/4[in] = 28, DN 3/8[in] = 29, DN 1/2[in] = 30, DN 3/4[in] = 31, DN 1[in] = 32, DN 1-1/4[in] = 33, DN 1-1/2[in] = 34, DN 2[in] = 35, DN 2-1/2[in] = 36, DN 3[in] = 37, DN 4[in] = 38, DN 5[in] = 39, DN 6[in] = 40, DN 8[in] = 41, DN 10[in] = 42, DN 12[in] = 43, DN 14[in] = 44, DN 16[in] = 45, DN 18[in] = 46, DN 20[in] = 47, DN 24[in] = 48, DN 26[in] = 49, DN 28[in] = 50, DN 32[in] = 51, DN 40[in] = 52. | | | |
| 4020 | 0x0FB3 | Type of filter for flow Q | Type of filter used for the value of flow Q represented by the MODBUS (not applicable to values sent by a current loop or to the screen). Filter type:<br>*averaging filter = 0,*<br>*"dumping" filter = 1.* | - | int | RD_ONLY |
| 4022 | 0x0FB5 | Filtration time constant | Filtration time constant for the filter described above (set in the device). The value in seconds from 0 to 60. Value 0 means no filtration (switched off filter). | s | int | RD_ONLY |
| 4024 | 0x0FB7 | Cut-off of low flow | Value 1 means that the function for cutting off low flow is active, value 0 means that it is switched off. | - | int | RD_ONLY |
| 4026 | 0x0FB9 | Cut-off value for low flow | The cut-off value for low flow expressed in cubic metres per hour (basic unit). If the absolute value of current flow is lower than this value, the flow value is substituted with 0. | $m^3/h$ | float | RD_ONLY |
| 4028 | 0x0FBB | Device operation time counter | Device operation time - in units 0.5 s. | ½s | int | RD_ONLY |
| 4030 | 0x0FBD | User-specified device operation time counter | Device operation time - in units 0.5 s, option to delete by the user. | ½s | int | RD_ONLY |

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### 1.3.5.5. The contents of registers in 5000-5030 field

| Register | Address (hex) | Brief description | Extended description | Unit | Format | Operation |
|---|---|---|---|---|---|---|
| 5000 | 0x1387 | register 4000 copy | | m³/h | float | RD_ONLY |
| 5002 | 0x1389 | register 4002 copy | | - | int | RD_ONLY |
| 5004 | 0x138B | register 4004 copy | | m³ | float | RD_ONLY |
| 5006 | 0x138D | register 4006 copy | | m³ | float | RD_ONLY |
| 5008 | 0x138 F | register 4008 copy | | m³ | float | RD_ONLY |
| 5010 | 0x1391 | register 4010 copy | | m³ | float | RD_ONLY |
| 5012 | 0x1393 | register 4012 copy | | m³ | float | RD_ONLY |
| 5014 | 0x1395 | register 4014 copy | Detailed descriptions in the table for registers 4000-4030 | m³ | float | RD_ONLY |
| 5016 | 0x1397 | register 4016 copy | | m/s | float | RD_ONLY |
| 5018 | 0x1399 | register 4018 copy | | - | int | RD_ONLY |
| 5020 | 0x139B | register 4020 copy | | - | int | RD_ONLY |
| 5022 | 0x139D | register 4022 copy | | s | int | RD_ONLY |
| 5024 | 0x139 F | register 4024 copy | | - | int | RD_ONLY |
| 5026 | 0x13A1 | register 4026 copy | | m³/h | float | RD_ONLY |
| 5028 | 0x13A3 | register 4028 copy | | ½s | int | RD_ONLY |
| 5030 | 0x13A5 | register 4030 copy | | ½s | int | RD_ONLY |

### 1.3.5.6. The content of registers in 5032-5036 field

| Register | Address (hex) | Brief description | Extended description | Unit | Format | Operation |
|---|---|---|---|---|---|---|
| 5032 | 0x13A7 | Binary input status. | Binary input status assigned as a flag into bit 0 | - | uchar | RD_ONLY |
| 5034 | 0x13A9 | Binary outputs status. | Binary input status assigned as a flags into bit : bit 0 – binary output 1 bit 1 – binary output 2. | - | uchar | RD_ONLY |
| 5036 | 0x13AB | Value of the current exposed on the current loop. | Value of the current exposed on the current loop (without taking into account current loop calibration) expressed in milliamperes. | mA | float | RD_ONLY |

### 1.3.5.7. The content of registers in 5100-5132 field

| Register | Address (hex) | Brief description | Extended description | Unit | Format | Operation |
|---|---|---|---|---|---|---|
| 5100 | 0x13EB | User specified PIN | Four-digit access PIN for the menu specified by the user. Each pin digit is saved in one byte. The allowable byte value is limited in the range from 0 to 9. | - | Char table | RD/WR |
| 5102 | 0x13ED | Value of threshold for low flow | Value for low flow detection expressed in cubic metres per hour (basic unit). If the absolute value of current flow is lower than | m³/h | float | RD/WR |

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|---|---|---|---|---|---|---|
| | | | this value, it is signalled for activated detection function. The value of the parameter, which may be set, is limited in the range between 0.0000001 – 9999999 and 0. | | | |
| 5104 | 0x13EF | Empty pipe detection value | Resistance threshold value specifying the detection of an empty pipe (detection over the set threshold). The value of the parameter, which may be set is limited in the range between 0 – 999999999. | ohm | int | RD/WR |
| 5106 | 0x13F1 | Cut-off value for low flow | The cut-off threshold value for low flow expressed in cubic metres per hour (basic unit). If the absolute value of current flow is lower than this value, the flow value is substituted with 0. The value of the parameter, which may be set, is limited in the range between 0.0000001 – 9999999 and 0. | $m^3/h$ | float | RD/WR |
| 5108 | 0x13F3 | Totalizers unit | Type of unit of the totalizers displayed on the LCD. Values of unit type are defined as a selection list: $m^3$ = 0, $dm^3$ = 1, $cm^3$ = 2, Ml = 3 (megalitres), hl = 4 (hectolitres), l = 5, ml = 6 (millilitres), $in^3$ = 7 (cubic inch), $ft^3$ = 8 (cubic foot), af = 9 (height of 1 feet for 1-acre area), ozf = 10 (volume ounce), galUS = 11 (US Gallon), MgalUS = 12 (US mega-gallon), bblUS = 13 (US barrel), galUK = 14 (Imperial gallon), MgalUK = 15 (Imperial mega-gallon), bblUK = 16 (Imperial barrel), User = 17 (unit defined by the user). | - | uchar | RD/WR |
| 5110 | 0x13F5 | Flow unit | Type of flow unit displayed on the LCD. Values of unit type are defined as a selection list: $m^3/h$ = 0 (cubic metres per hour), $m^3/s$ = 1 (cubic metres per second), $m^3/min$ = 2 (cubic metres per minute), $m^3/day$ = 3 (cubic metres per day), | - | uchar | RD/WR |

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|---|---|---|---|---|---|---|
| | | | $dm^3/h = 4,$<br>$dm^3/s = 5,$<br>$dm^3/min = 6,$<br>$dm^3/day = 7,$<br>$cm^3/h = 8,$<br>$cm^3/s = 9,$<br>$cm^3/min = 10,$<br>$cm^3/day = 11,$<br>$Ml/h = 12,$<br>$Ml/s = 13,$<br>$Ml/min = 14,$<br>$Ml/day = 15,$<br>$hl/h = 16,$<br>$hl/s = 17,$<br>$hl/min = 18,$<br>$hl/day = 19,$<br>$l/h = 20,$<br>$l/s = 21,$<br>$l/min = 22,$<br>$l/day = 23,$<br>$ml/h = 24,$<br>$ml/s = 25,$<br>$ml/min = 26,$<br>$ml/day = 27,$<br>$in^3/h = 28,$<br>$in^3/s = 29,$<br>$in^3/min = 30,$<br>$in^3/day = 31,$<br>$ft^3/h = 32,$<br>$ft^3/s = 33,$<br>$ft^3/min = 34,$<br>$ft^3/day = 35,$<br>$af/h = 36,$<br>$af/s = 37,$<br>$af/min = 38,$<br>$af/day = 39,$<br>$ozf/h = 40,$<br>$ozf/s = 41,$<br>$ozf/min = 42,$<br>$ozf/day = 43,$<br>$galUS/h = 44,$<br>$galUS/s = 45,$<br>$galUS/min = 46,$<br>$galUS/day = 47,$<br>$MgalUS/h = 48,$<br>$MgalUS/s = 49,$<br>$MgalUS/min = 50,$<br>$MgalUS/day = 51,$<br>$bblUS/h = 52,$<br>$bblUS/s = 53,$<br>$bblUS/min = 54,$<br>$bblUS/day = 55,$<br>$galUK/h = 56,$<br>$galUK/s = 57,$<br>$galUK/min = 58,$<br>$galUK/day = 59,$<br>$MgalUK/h = 60,$<br>$MgalUK/s = 61,$<br>$MgalUK/min = 62,$<br>$MgalUK/day = 63,$ | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 22 | | | *bblUK/h = 64,*<br>*bblUK/s = 65,*<br>*bblUK/min = 66,*<br>*bblUK/day = 67,*<br>*User/h = 68,*<br>*User/s = 69,*<br>*User/min = 70,*<br>*User/day = 71.* | | | |
| 5112 | 0x13F7 | Flow velocity unit | Type of linear flow velocity displayed on the LCD.<br>Values of unit type are defined as a selection list:<br>*m/s = 0 (metres per second),*<br>*m/min = 1 (metres per minute),*<br>*m/h = 2 (metres per hour),*<br>*m/day = 3 (metres per day),*<br>*cm/s = 4,*<br>*cm/min = 5,*<br>*cm/h = 6,*<br>*cm/day = 7.* | - | uchar | RD/WR |
| 5114 | 0x13F9 | Description of user unit. | Three-character textual description of the user-defined unit displayed on the LCD screen.<br>ASCII characters from the range 0x20 (character ' ') - 0x7E (character '~') are permitted. | - | Char table | RD/WR |
| 5116 | 0x13FB | User unit coefficient. | The coefficient for recalculation of the user-specified unit - multiplication factor specifying how many cubic metres correspond to the unit specified by the user.<br>The value of the parameter, which may be set, is limited in the range between 0.00001 – 9999999. | $m^3$ | float | RD/WR |
| 5118 | 0x13FD | Totalizers display type. | Totalizers display type on the LCD.<br>Display type is defined as a selection list:<br>*FLOATING = 0 (float type e.g. +12.345),*<br>*SCIENTIFIC = 1 ("scientific" type e.g. +1.2345E+01).* | - | uchar | RD/WR |
| 5120 | 0x13FF | Flow Q display type. | Flow display type on the LCD.<br>Display type is defined as a selection list:<br>*FLOATING = 0 (float type e.g. +12.345),*<br>*SCIENTIFIC = 1 ("scientific" type e.g. +1.2345E+01).* | - | uchar | RD/WR |
| 5122 | 0x1401 | Flow velocity V display type. | The Linear velocity of flow display type on the LCD.<br>Display type is defined as a selection list:<br>*FLOATING = 0 (float type e.g. +12.345),*<br>*SCIENTIFIC = 1 ("scientific" type e.g. +1.2345E+01).* | - | uchar | RD/WR |

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| Register | Address (hex) | Brief description | Extended description | Unit | Format | Operation |
|---|---|---|---|---|---|---|
| 5124 | 0x1403 | Main screen | Type of the screen displayed as the main screen.<br>Screen selection is defined as a list:<br>*MAIN = 0* (screen containing flow, the main totalizer and status of the device),<br>*COUN = 1* (screen containing directional totalizers and linear velocity of flow and operation time of the device),<br>*USER = 2* (user screen containing totalizers and operation time). | - | uchar | RD/WR |
| 5126 | 0x1405 | Screen change time. | Time of an automatic change of the main screens (how many seconds for the switch of the screen). The function is deactivated for the time set to value 0.<br>The value of time, which may be set is limited in the range between 0 – 120. | sec. | uchar | RD/WR |
| 5128 | 0x1407 | Menu language | The language type of the flowmeter menu. The language type is defined as a selection list:<br>English = 0;<br>Polish = 1; | - | Uchar | RD/WR |
| 5130 | 0x1409 | The "Treshold" value of the quick empty pipe detection | Value of the parameter named "Threshold" used in the quick empty pipe detection algorithm. The value of the parameter, which can be set, is limited in the range 0.01-1.00 with step of 0.01. | - | Float | RD/WR |
| 5132 | 0x140B | The "Counter" value of the quick empty pipe detection | Value of the parameter named "Counter" used in the fast empty pipe detection algorithm. The value of the parameter, which can be set, is limited in the range 1-10 with step 1. | - | int | RD//WR |

## 1.3.5.8.  The content of registers in 5200-5218 field

| Register | Address (hex) | Brief description | Extended description | Unit | Format | Operation |
|---|---|---|---|---|---|---|
| 5200 | 0x144 F | Administrator PIN | Four-digit access PIN for the menu specified by the administrator.<br>Each pin digit is saved in one byte. The allowable byte value is limited in the range from 0 to 9. | - | Char table | RD/WR |
| 5202 | 0x1451 | Pipe diameter | Diameter of the pipe expressed in millimetres. This parameter makes flow Q dependent on the linear velocity of liquid flow. Values of diameters (in mm of in) are defined as a selection list:<br>*DN2,5[mm]=0, DN4[mm]=1, DN6[mm]=2, DN10[mm]=3, DN15[mm]=4, DN20[mm]=5, DN25[mm]=6, DN32[mm]=7, DN40[mm]=8,* | mm | uchar | RD/WR |

| | | | DN50[mm]=9, DN65[mm]=10, DN80[mm]=11, DN100[mm]=12, DN125[mm]=13, DN150[mm]=14, DN200[mm]=15, DN250[mm]=16, DN300[mm]=17, DN350[mm]=18, DN400[mm]=19, DN450[mm]=20, DN500[mm]=21, DN600[mm]=22, DN700[mm]=23, DN800[mm]=24, DN900[mm]=25, DN1000[mm]=26. DN 1/8[in] = 27, DN 1/4[in] = 28, DN 3/8[in] = 29, DN 1/2[in] = 30, DN 3/4[in] = 31, DN 1[in] = 32, DN 1-1/4[in] = 33, DN 1-1/2[in] = 34, DN 2[in] = 35, DN 2-1/2[in] = 36, DN 3[in] = 37, DN 4[in] = 38, DN 5[in] = 39, DN 6[in] = 40, DN 8[in] = 41, DN 10[in] = 42, DN 12[in] = 43, DN 14[in] = 44, DN 16[in] = 45, DN 18[in] = 46, DN 20[in] = 47, DN 24[in] = 48, DN 26[in] = 49, DN 28[in] = 50, DN 32[in] = 51, DN 40[in] = 52. | | | |
| 5204 | 0x1453 | Sensor type | Type of sensor connected to the flowmeter. Sensor type is defined as a selection list: *2 active electrodes = 0, 3 active electrodes = 1.* | - | uchar | RD/WR |
| 5206 | 0x1455 | Active alarms. | Alarms activity flags in the device. Setting of the corresponding bit to value 1 in a 32-bit word activates a given alarm, while setting the value to 0 deactivates it. Alarm flags assigned to the given bits: *bit 0 – empty pipe detection erroralarm, bit 1 – unfilled pipe detection erroralarm, bit 2 – low liquid flow detection alarm, bit 3 – measurement board error alarm (FrontEnd), bit 4 – measuring sensor error alarm, bit 5 – flowmeter's internal memory error alarm, bit 6 – measurement coil failure alarm, bit 7 – alarm for flow higher than the value set as a parameter, bit 8 – alarm for flow lower than the value set as a parameter, bit 9 – alarm for linear velocity of flow higher than the value set as a parameter, bit 10 – alarm for linear velocity of flow lower than the value set as a parameter, bit 11 – alarm indicating that absolute value of user's positive totalizer exceeds the value set as a parameter bit 12 – alarm indicating that absolute value of user's negative totalizer exceeds the value set as a parameter* The other bits have a value equal to 0 and do not have any alarms assigned. | - | int | RD/WR |

| 5208 | 0x1457 | Alarm $Q_{max}$ value. | Value of maximum flow as a parameter for alarm from exceeding the set threshold (bit 7 in register 5206) expressed in cubic metres per hour (basic unit). If the absolute value of current flow is higher than this value, it is signalled for the activated alarm function. The value of the parameter, which may be set, is limited in the range between 0.0000001 – 9999999 and 0. | $m^3/h$ | float | RD/WR |
|---|---|---|---|---|---|---|
| 5210 | 0x1459 | Alarm $Q_{min}$ value. | Value of minimum flow as a parameter for alarm from exceeding the set threshold (bit 8 in register 5206) expressed in cubic metres per hour (basic unit). If the absolute value of current flow is lower than this value, it is signalled for the activated alarm function. The value of the parameter, which may be set, is limited in the range between 0.0000001 – 9999999 and 0. | $m^3/h$ | float | RD/WR |
| 5212 | 0x145B | Alarm $V_{max}$ value. | Value of maximum linear velocity of flow as a parameter for alarm from exceeding the set threshold (bit 9 in register 5206) expressed in metres per second (basic unit). If the absolute value of the velocity of current flow is higher than this value, it is signalled for the activated alarm function. The value of the parameter, which may be set, is limited in the range between 0.0000001 – 9999999 and 0. | m/s | float | RD/WR |
| 5214 | 0x145D | Alarm $V_{min}$ value. | Value of minimum linear velocity of flow as a parameter for alarm from exceeding the set threshold (bit 10 in register 5206) expressed in metres per second (basic unit). If the absolute value of the velocity of current flow is lower than this value, it is signalled for the activated alarm function. The value of the parameter, which may be set, is limited in the range between 0.0000001 – 9999999 and 0. | m/s | float | RD/WR |
| 5216 | 0x145 F | TP alarm value. | Value of threshold for user's positive totalizer as a parameter for alarm from exceeding the set threshold (bit 11 in register 5206) expressed in cubic metres (basic unit). If the value of user-specified positive totalizer is higher than this value, it is signalled for the activated alarm function. The value of the parameter, which may be set, is limited in the range between 0.0000001 – 9999999 and 0. | $m^3$ | float | RD/WR |
| 5218 | 0x1461 | TM alarm value. | Value of threshold for user-specified negative totalizer as a parameter for alarm from exceeding the set threshold (bit 12 in register 5206) expressed in cubic metres (basic unit). If the value of user's negative totalizer is higher than this value, it is signalled for the activated alarm function. The value of the parameter, which may be set, is limited in the range between 0.0000001 – 9999999 and 0. | $m^3$ | float | RD/WR |

## 1.3.5.9. The content of registers in 5300-5344 field

The specified renamed registers within the contiguous area 5300-5344 are included in the table below. Noe the register 5328, which has lost its meaning and should not be displayed.

| Register | Address (hex) | Brief description | Extended description | Unit | Format | Operation |
|---|---|---|---|---|---|---|
| 5300 | 0x14B3 | Current loop 4-20mA operation mode | Current loop 4-20mA output operation mode. Operation modes are defined as a selection list: *NORMAL = 0* (normal operation mode of the current output, currents proportional to the flow), *INVERTED = 1* (negated operation mode of the current output, currents proportional to the flow multiplied by -1), *MODULO = 2* (absolute value mode of operation of the current output, currents proportional to the absolute value of the flow). | - | uchar | RD/WR |
| 5302 | 0x14B5 | Current loop 4-20mA alarm mode | Current loop 4-20mA output operation mode during setting of the alarm (alarm current type). Alarm current types are defined as a selection list: *LOW = 0* (low alarm current - current with value 3.75[mA]), *HIGH = 1* (high alarm current - current with value 21.6[mA]), *CUSTOM = 2* (user-specified alarm current - current with a value defined in the device by the user from the range between 3.6[mA] – 23.0[mA]). | - | uchar | RD/WR |
| 5304 | 0x14B7 | Flow value for current 4mA | Value of flow Q corresponding to the current 4[mA] set by the current loop expressed in cubic metres per hour (basic unit). The absolute value of flow, which may be set as a parameter is limited in the range between 0.0000001 – 9999999 and 0. | $m^3/h$ | float | RD/WR |
| 5306 | 0x14B9 | Flow value for current 20mA | Value of flow Q corresponding to the current 20[mA] set by the current loop expressed in cubic metres per hour (basic unit). The absolute value of flow, which may be set as a parameter is limited in the range between 0.0000001 – 9999999 and 0. | $m^3/h$ | float | RD/WR |
| 5308 | 0x14BB | Value of user-specified alarm current | Value of alarm current for the CUSTOM mode of the current loop alarm expressed in milliamperes (basic unit). The value of the current, which may be set as a parameter is limited in the range between 3.6[mA] – 23.0[mA]. | mA | float | RD/WR |

| 5310 | 0x14BD | Pulse output operation mode. | Pulse output operation mode. Operation modes are defined as a selection list: PULSE = 0 (output operation mode as pulse – generating an pulse as a result of flowing a volume of liquid), *FREQ. = 1 (*output operation mode as frequency – generating a waveform whose frequency is proportional to the value of the current flow*)*. | - | uchar | RD/WR |
|---|---|---|---|---|---|---|
| 5312 | 0x14BF | Pulse width | Duration of generated pulse expressed in milliseconds. The value of time, which may be set is limited in the range between 0 – 10000 [ms]. | ms | short | RD/WR |
| 5314 | 0x14C1 | Pulse polarization | The polarization of pulse output (generated pulse). Polarization type is defined as a selection list: *NEGATIVE = 0* (negative polarization), *POSITIVE = 1* (positive polarization). | - | uchar | RD/WR |
| 5316 | 0x14C3 | Liquid volume for a pulse | The value of the liquid corresponding to the pulse generated by the output pulse expressed in cubic meters (basic unit). The value of the liquid volume, which can be set as a parameter, is limited in the range 0.0000001 – 9999999 and 0. | $m^3$ | float | RD/WR |
| 5318 | 0x14C5 | Pulse generation mode | Pulse generation mode at the output. The operating modes are defined as a selection list: *POSITIVE = 2* (operating mode generating output pulses only for the negative direction of the liquid flow*)*, *NEGATIVE = 3* (operating mode generating output pulses only for the negative direction of the liquid flow*)*, *MODULO. = 4* (operating mode generating output pulses for both positive and negative liquid flow direction). | - | uchar | RD/WR |
| 5320 | 0x14C7 | Value of the minimum flow for the frequency output | Value of the minimum flow $Q_{min}$ (expressed in m3/h - basic unit) corresponding to the frequency of the frequency output equal to 1Hz. The flow value that can be set as parameter is limited in the range of 0.0000001 – 9999999 and 0. | $m^3/h$ | float | RD/WR |
| 5322 | 0x14C9 | Maximum flow value for frequency output | Value of maximum flow $Q_{max}$ (expressed in cubic metres per hour- basic unit) corresponding to the frequency of the frequency output equal to 2000Hz. The value of flow, which may be set as a parameter is limited in the range between 0.0000001 – 9999999 and 0. | $m^3/h$ | float | RD/WR |

| 5324 | 0x14CB | Value of frequency for frequency pulse output | The value of the frequency set by the frequency pulse output. | Hz | float | RD_ONLY |
|---|---|---|---|---|---|---|
| 5326 | 0x14CD | Polarization of pulse output frequency | The polarization of pulse output frequency. Polarization type is defined as a selection list: *NEGATIVE = 0* (negative polarization), *POSITIVE = 1* (positive polarization). | - | uchar | RD/WR |
| 5328 | 0x14CF | Value of duty cycle for PWM pulse output (register has lost its meaning) | A fixed value of duty cycle for the PWM pulse output operation mode. PWM output operating with a fixed set duty cycle. The frequency of this signal changes depending on the current flow. The value of the duty cycle is equal to 50[%]. | % | uchar | RD_ONLY |
| 5330 | 0x14D1 | Binary output 1 operation mode | Binary status output 1 operation mode. Output changes its state as a result of the occurrence of the functionality assigned to it. Operation modes are defined as a selection list: *Empty pipe = 0* (signalling of detection of an empty pipe), *Low flow = 1* (signalling detection of low level of flow), *Unfil. pipe = 2* (signalling detection of an unfilled pipe), *Errors all = 3* (signalling of errors detection - FrontEnd, sensor, memory), *Coil error = 4* (signalling detection of measurement coil error), *I saturat. = 5* (signalling saturation of the current loop), *Direction = 6* (signalling of liquid flow direction - setpoint of output for positive flow), *Q>value = 7* (signalling of current flow higher than the assumed value), *Q<value = 8* (signalling of current flow lower than the assumed value), *TP>value = 9* (signalling exceeding of the assumed value of flow by user's positive totalizer), *TP>value = 10* (signalling exceeding of the assumed value of flow by user's negative totalizer), *Dosing = 11* (dosing function, the setpoint of output depending on the dosing process). *Pulse dir. = 12 (signalling of flow direction for either flow directions pulse output operation mode (setpoint of output for positive flow))- that operating mode status output is synchronized with pulse output without delay time* | - | uchar | RD/WR |

| | | | | | | |
|---|---|---|---|---|---|---|
| 5332 | 0x14D3 | Binary output 2 operation mode | Binary status output 2 operation mode.<br>Output changes its state as a result of the occurrence of the functionality assigned to it.<br>Operation modes are defined as a selection list:<br>*Empty pipe = 0* (signalling of detection of an empty pipe),<br>*Low flow = 1* (signalling detection of low level of flow),<br>Unfil. pipe = 2 (signalling detection of an unfilled pipe),<br>*Errors all = 3* (signalling of errors detection - FrontEnd, sensor, memory),<br>*Coil error = 4* (signalling detection of measurement coil error),<br>*I saturat. = 5* (signalling saturation of the current loop),<br>*Direction = 6* (signalling of liquid flow direction - setpoint of output for positive flow),<br>*Q>value = 7* (signalling of current flow higher than the assumed value),<br>*Q<value = 8* (signalling of current flow lower than the assumed value),<br>*TP>value = 9* (signalling exceeding of the assumed value of flow by user's positive totalizer),<br>*TP>value = 10* (signalling exceeding of the assumed value of flow by user's negative totalizer),<br>*Dosing = 11* (dosing function, the setpoint of output depending on the dosing process).<br>*Pulse dir. = 12 (signalling of flow direction for either flow directions pulse output operation mode (setpoint of output for positive flow))- that operating mode status output is synchronized with pulse output without delay time* | - | uchar | RD/WR |
| 5334 | 0x14D5 | Value of parameter of binary output 1 | Value of a parameter correct for the selected operation mode of the binary status output 1.<br>The value of the parameter, which may be set, is limited in the range between 0.0000001 – 9999999 and 0. | m$^3$/h, m$^3$ | float | RD/WR |
| 5336 | 0x14D7 | Value of parameter of binary output 2 | Value of a parameter correct for the selected operation mode of the binary status output 2.<br>The value of the parameter, which may be set, is limited in the range between 0.0000001 – 9999999 and 0. | m$^3$/h, m$^3$ | float | RD/WR |
| 5338 | 0x14D9 | Delay time for binary output 1 | Delay time for activation of the binary status output 1 expressed in the seconds. The delay is turned off for time setting equal to 0 seconds.<br>The value of the time delay, which may be set as a parameter is limited in the range between 0 – 3600 [s]. | s | short | RD/WR |

| Register | Address (hex) | Brief description | Extended description | Unit | Format | Operation |
|----------|---------------|-------------------|----------------------|------|--------|-----------|
| 5340 | 0x14DB | Delay time for binary output 2 | Delay time for activation of the binary status output 2 expressed in the seconds. The delay is turned off for time setting equal to 0 seconds.<br>The value of the time delay, which may be set as a parameter is limited in the range between 0 – 3600 [s]. | s | short | RD/WR |
| 5342 | 0x14DD | Polarization of binary output 1 | The polarization of binary status output 1. Polarization type is defined as a selection list:<br>*NEGATIVE = 0* (negative polarization),<br>*POSITIVE = 1* (positive polarization). | - | uchar | RD/WR |
| 5344 | 0x14DF | Polarization of binary output 2 | The polarization of binary status output 2. Polarization type is defined as a selection list:<br>*NEGATIVE = 0* (negative polarization),<br>*POSITIVE = 1* (positive polarization). | - | uchar | RD/WR |

## 1.3.5.10. The content of registers in 5360-5362 field

| Register | Address (hex) | Brief description | Extended description | Unit | Format | Operation |
|----------|---------------|-------------------|----------------------|------|--------|-----------|
| 5360 | 0x14EF | Binary input operation mode | Binary input operation mode.<br>Operation modes are defined as a selection list:<br>Reset = 0 (function allowing deleting the values of the user-specified totalizers and counter of user working time using an input),<br>Dosing = 1 (dosing function allowing "reloading" of counters of set values of flow metered in a dosing operation mode using an input). | - | uchar | RD/WR |
| 5362 | 0x14F1 | Delay time for binary input | Delay time for activation of the binary status input expressed in the seconds. The delay is turned off for time set equal to 0 seconds.<br>The value of the time delay, which may be set as a parameter is limited in the range between 0 – 3600 [s]. | s | short | RD/WR |

## 1.3.5.11. The content of registers in 5400-5416 field

| Register | Address (hex) | Brief description | Extended description | Unit | Format | Operation |
|----------|---------------|-------------------|----------------------|------|--------|-----------|
| 5400 | 0x1517 | The operation mode of LCD filter | The operation mode of the filter used for data (current flow and the linear velocity of flow) displayed on the LCD screen.<br>Operation modes are defined as a selection list:<br>*AVERAGE = 0* (filter being an average value for a period of set time),<br>*DAMPING = 1* (filter taking into account the previous measurement values for a period of set time). | - | uchar | RD/WR |

| 5402 | 0x1519 | The time constant for LCD display filter | The filtering time (time constant) for measurements for data displayed on the LCD screen expressed in seconds. Filtering is turned off for time setting equal to 0 seconds. The value of filtering, which may be set as a parameter is limited in the range between 0 – 60 [s]. | s | short | RD/WR |
|---|---|---|---|---|---|---|
| 5404 | 0x151B | The operation mode of the filter of the current loop 4-20mA | The operation mode of the filter used for data (current flow) used by the current loop. Operation modes are defined as a selection list: *AVERAGE = 0* (filter being an average value for a period of set time), *DAMPING = 1* (filter taking into account the previous measurement values for a period of set time). | - | uchar | RD/WR |
| 5406 | 0x151D | The time constant of the filter of the current loop 4-20mA | Filtering time (time constant) for measurements used by the current loop and expressed in seconds. Filtering is turned off for time setting equal to 0 seconds. The value of filtering, which may be set as a parameter is limited in the range between 0 – 60 [s]. | s | short | RD/WR |
| 5408 | 0x151 F | The operation mode of filter of pulse output frequency | The operation mode of the filter used for data (current flow) used by the pulse output operating in the frequency mode. Operation modes are defined as a selection list: *AVERAGE = 0* (filter being an average value for a period of set time), *DAMPING = 1* (filter taking into account the previous measurement values for a period of set time). | - | uchar | RD/WR |
| 5410 | 0x1521 | The time constant of the filter of pulse frequency output | Filtering time (time constant) for measurements used by the frequency pulse output expressed in seconds. Filtering is turned off for time set equal to 0 seconds. The value of filtering, which may be set as a parameter is limited in the range between 0 – 60 [s]. | s | short | RD/WR |
| 5412 | 0x1523 | The operation mode of the MODBUS bus filter | The operation mode of the filter used for data (current flow and the linear velocity of flow) read using MODBUS. Operation modes are defined as a selection list: *AVERAGE = 0* (filter being an average value for a period of set time), *DAMPING = 1* (filter taking into account the previous measurement values for a period of set time). | - | uchar | RD/WR |

| Register | Address (hex) | Brief description | Extended description | Unit | Format | Operation |
|---|---|---|---|---|---|---|
| 5414 | 0x1525 | The time constant of the filter of MODBUS bus | Filtering time (time constant) for measurements used for data read using the MODBUS bus expressed in seconds. Filtering is turned off for time setting equal to 0 seconds. The value of filtering, which may be set as a parameter is limited in the range between 0 – 60 [s]. | s | short | RD/WR |
| 5416 | 0x1527 | Prefiltration level | Prefiltering level of measurement obtained from FrontEnd. For a setting of 0 filtering is disabled. The value of the filtering level, which can be set as a parameter, is limited in the range of 0-10. **Loss of function from PEM-100 version 3.0.1005. Replaced by registers 11002 and 11004.** | - | uchar | RD_ONLY |

## 1.3.5.12.　The content of registers in 5450-5456 field

| Register | Address (hex) | Brief description | Extended description | Unit | Format | Operation |
|---|---|---|---|---|---|---|
| 5450 | 0x1549 | MODBUS device address | Address of the device on the MODBUS bus. The value of the device address, which may be set as a parameter is limited in the range between 1 – 247. | - | uchar | RD/WR |
| 5452 | 0x154B | MODBUS transmission speed | Transmission speed on MODBUS expressed in bits per second. Transmission speeds are defined as a selection list: *4800 = 0, 9600 = 1, 19200 = 2, 38400 = 3, 57600 = 4, 115200 = 5.* | bit/s | uchar | RD/WR |
| 5454 | 0x154D | MODBUS transmission parameters | Transmission parameters on the MODBUS bus (parity, stop bits). Transmission parameters are defined as a selection list: *EVEN 1 STOP = 0* (with Even parity and a single stop bit), *ODD 1 STOP = 1* (with Odd parity and one stop bit), *NOPAR 2 STOP = 2* (without parity and with two stop bits). | - | uchar | RD/WR |
| 5456 | 0x154 F | MODBUS transmission data format | The format of data transferred through MODBUS. It specifies a sequence of transmitted bytes in the 32-bit words. The data format is defined as a selection list (for assumed hexadecimal number 0xDDCCBBAA): *AABBCCDD = 0, DDCCBBAA = 1, BBAADDCC = 2, CCDDAABB = 3.* | - | uchar | RD/WR |

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## 1.3.5.13.  The content of registers in 5500-5506 field

| Register | Address (hex) | Brief description | Extended description | Unit | Format | Operation |
|---|---|---|---|---|---|---|
| 5500 | 0x157B | Active events in the archive | Events activity flags archived in the device.<br>The setting of the corresponding bit to value 1 in a 32-bit word activates the event (option to record in the memory), while setting the value to 0 deactivates it. Event activity flags assigned to given bits:<br>*bit 0* – device start,<br>*bit 1* – log in to device menu,<br>*bit 2* – device "OK" status (return of the device to the correct state after the occurrence of an "erroneous" event),<br>*bit 3* - error of FrontEnd measurement board,<br>*bit 4* - measuring sensor error,<br>*bit 5* – error of internal memory of the flowmeter,<br>*bit 6* – empty pipe detection,<br>*bit 7* – unfilled pipe detection,<br>*bit 8* – deleting user specified totalizers, the counter of user time and device errors,<br>*bit 9* – recovery of default settings in the device,<br>*bit 10* – recovery of factory settings in the device,<br>*bit 11* – writing of a new calibration coefficient for the flowmeter,<br>*bit 12* – measurement coil error,<br>*bit 13* – detection of low liquid flow.<br>The other bits have a value equal to 0 and do not have any of the events assigned. | - | int | RD/WR |
| 5502 | 0x157D | The time interval for measurements archive | Time period expressed in minutes specifying the interval of saving of an average flow value into the device memory.<br>The value of the time period, which can be set as a parameter, is limited in the range between 10 minutes - 24 hours with a 10-minute step. | min | int | RD/WR |
| 5504 | 0x157 F | A number of writes of event archive | The counter of writes in the events archive memory. The 32-bit counter, where its sixteen younger bits (two younger bytes) indicate the number of events currently saved in the memory (maximum possible number of writes in the memory - 8128), while its sixteen older bits (two older bytes) are a counter of full writes of the memory (in case when the continuous write function is activated). | - | int | RD_ONLY |

| Register | Address (hex) | Brief description | Extended description | Unit | Format | Operation |
|---|---|---|---|---|---|---|
| 5506 | 0x1581 | A number of writes of measurement archive | The counter of writes in the measurements archive memory. The 32-bit counter, where its sixteen younger bits (two younger bytes) indicate the number of measurements currently saved in the memory (maximum possible number of writes in the memory - 8128), while its sixteen older bits (two older bytes) are a counter of full writes of the memory (in case when the continuous write function is activated). | - | int | RD_ONLY |

### 1.3.5.14. The content of registers in 5550-5560 field

| Register | Address (hex) | Brief description | Extended description | Unit | Format | Operation |
|---|---|---|---|---|---|---|
| 5550 | 0x15AD | Time - hour | RTC time hour of the device. The hour, which may be set as a parameter is limited in the range between 0 – 23. | h | uchar | RD/WR |
| 5552 | 0x15AF | Time - minute | RTC time minute of the device. The minute, which may be set as a parameter is limited in the range between 0 – 59. | min | uchar | RD/WR |
| 5554 | 0x15B1 | Time - second | RTC time second of the device. The second, which may be set as a parameter is limited in the range between 0 – 59. | sec. | uchar | RD/WR |
| 5556 | 0x15B3 | Time - year | RTC time year of the device. The year, which may be set as a parameter is limited in the range between 10 – 99. | - | uchar | RD/WR |
| 5558 | 0x15B5 | Time - month | RTC time month of the device. The month, which may be set as a parameter is limited in the range between 1 – 12. | - | uchar | RD/WR |
| 5560 | 0x15B7 | Time - day | RTC time day of the device. The day, which may be set as a parameter is limited in the range between 1 – 31. | - | uchar | RD/WR |

### 1.3.5.15. The content of registers in 5600-5626 field

| Register | Address (hex) | Brief description | Extended description | Unit | Format | Operation |
|---|---|---|---|---|---|---|
| 5600 | 0x15DF | Calibration status | Device electronics calibration status. Value 1 indicates that the calibration of flowmeter electronics has been executed, while value 0 informs about lack of calibration. | - | uchar | RD_ONLY |
| 5602 | 0x15E1 | Zero calibration time | Duration of the zeroing procedure (data collection) of the flowmeter sensor expressed in minutes. The time value of zeroing, which may be set as a parameter, is limited in the range between 1 – 60 [min]. | min | uchar | RD/WR |

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| 5604 | 0x15E3 | Electronics calibration coefficient - temporary | The calibration coefficient of the electronics of the device is calculated temporarily during the calibration procedure based on the collected data. | - | float | RD_ONLY |
|---|---|---|---|---|---|---|
| 5606 | 0x15E5 | Electronics calibration coefficient | Electronics calibration coefficient saved in the device memory and used during operation of the flowmeter. | - | float | RD_ONLY |
| 5608 | 0x15E7 | Current loop calibration coefficient – temporary | Parameter allowing the control of current loop 4-20mA during the loop calibration procedure or calibration of loop measurement. „Unsigned short int" type 16-bit value (two bytes) in the range between 0 - 65535. | - | short | NO_MEM |
| 5610 | 0x15E9 | Current loop calibration coefficient – 4[mA] | Calibration coefficient for the current loop for current 4mA. "Unsigned short int" type 16-bit value for which the current loop is set to current equal to 4mA. | - | short | RD_ONLY |
| 5612 | 0x15EB | Current loop calibration coefficient – 20[mA] | Calibration coefficient for current loop for current 20mA. "Unsigned short int" type 16-bit value for which the current loop is set to current equal to 20mA. | - | short | RD_ONLY |
| 5614 | 0x15ED | Current measurement calibration coefficient - 4[mA] | Calibration coefficient of the internal current measurement for 4 mA. The value of current in mA, for which the measurement of current indicates 4mA. | mA | float | RD_ONLY |
| 5616 | 0x15EF | Current measurement calibration coefficient - 20[mA] | Calibration coefficient of the internal current measurement for 20 mA. The value of current in mA, for which the measurement indicates 20mA. | mA | float | RD_ONLY |
| 5618 | 0x15F1 | Coefficient A of sensor calibration. | Coefficient A of measuring sensor calibration. Coefficient A for the calibration line obtained on the calibration stand for the flowmeters. The absolute value of the coefficient, which may be set as a parameter is limited in the range between 0.0000001 – 9999999. | - | float | RD/WR |
| 5620 | 0x15F3 | Coefficient B of sensor calibration - temporary. | The calibration coefficient B of the measuring sensor is calculated temporarily during the zeroing flowmeter procedure based on the collected data.Electronics calibration coefficient B for a measuring sensor calculated temporarily during the flowmeter zeroing procedure based on collected data. | m/s | float | RD_ONLY |
| 5622 | 0x15F5 | Coefficient B of sensor calibration | Coefficient B of measuring sensor calibration expressed in metres per second. Coefficient B for calibration line obtained during flowmeter zeroing procedure. The absolute value of the coefficient, which may be set as a parameter is limited in the range between 0.0000001 – 9999999 and 0. | m/s | float | RD/WR |

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| Register | Address (hex) | Brief description | Extended description | Unit | Format | Operation |
|---|---|---|---|---|---|---|
| 5624 | 0x15F7 | Coefficient V of sensor calibration | Coefficient V of measuring sensor calibration expressed in metres per second. Coefficient V specifies the point of the calibration line, where the characteristics can be "deflected". The absolute value of the coefficient, which may be set as a parameter is limited in the range between 0.0000001 – 9999999 and 0. | m/s | float | RD/WR |
| 5626 | 0x15F9 | Sensor characteristics "deflection" coefficient | The coefficient of percentage "deflection" of the calibration characteristics of the measuring sensor for point V, expressed in %. Coefficient specifies the percentage value of deflection of the measuring sensor calibration characteristics that should be applied in the point specified by the coefficient V. The absolute value of the coefficient, which may be set as a parameter is limited in the range between 0.1 – 10 % and 0. | % | float | RD/WR |

### 1.3.5.16. The content of registers in 5650-5668 field

| Register | Address (hex) | Brief description | Extended description | Unit | Format | Operation |
|---|---|---|---|---|---|---|
| 5650 | 0x1611 | Dosing - counter 1 | Value of first counter for dosing function. The counter counts the volume flowing in the dosing mode "backwards" (from the set value). | $m^3$ | float | RD_ONLY |
| 5652 | 0x1613 | Dosing - counter 2 | Value of second counter for dosing function. The counter counts the volume flowing in the dosing mode "backwards" (from the set value). | $m^3$ | float | RD_ONLY |
| 5654 | 0x1615 | Status flags for dosing | Informational flags containing current dosing status. Bit meaning: *bit 7* – active status output 2, *bit 6* – stopped dosing using channel no. 2 (status output 2), *bit 5* – activated dosing using channel no. 2 (status output 2), *bit 4* – readiness of dosing channel no. 2 ("overloaded" value of dosing counter 2), *bit 3* – active status output 1, *bit 2* – stopped dosing using channel no. 1 (status output 1), *bit 1* – activated dosing using channel no. 1 (status output 1), *bit 0* – readiness of dosing channel no. 1 ("overloaded" value of dosing counter 1), | - | uchar | RD_ONLY |

| 5656 | 01x167 | Dosing operation mode | Dosing function operation mode. Operation modes are defined as a selection list: *INDEPE = 0* (independent operation mode of both dosing channels - both status outputs used in the dosing), *DEPEND = 1* (related operation mode of both dosing channels - both status outputs used in the dosing are related with each other). | - | uchar | RD/WR |
|---|---|---|---|---|---|---|
| 5658 | 0x1619 | Dosing control mode | Dosing function control mode. Control modes are defined as a selection list: *INPUT = 0* (dosing control using a binary input), *BUTTON = 1* (dosing control using a keyboard), *BUTTON = 2* (dosing control using a MODBUS bus), | - | uchar | RD/WR |
| 5660 | 0x161B | The volume of dosed liquid V1 | Value of liquid volume V1 dosed using the first channel. The absolute value of the fluid volume, which may be set as a parameter is limited in the range between 0.0000001 – 9999999 and 0. | m$^3$ | float | RD/WR |
| 5662 | 0x161D | The volume of dosed liquid V2 | Value of liquid volume V2 dosed using the second channel. The absolute value of the fluid volume, which may be set as a parameter is limited in the range between 0.0000001 – 9999999 and 0. | m$^3$ | float | RD/WR |
| 5664 | 0x161 F | The volume of dosed liquid V3 | Value of liquid volume V3 used in the related dosing mode (volume after which occurs e.g. decrease of dosing speed). The absolute value of the fluid volume, which may be set as a parameter is limited in the range between 0.0000001 – 9999999 and 0. | m$^3$ | float | RD/WR |
| 5666 | 0x1621 | The volume of deactivation of dosing DP1 | Value of liquid volume DP1 for the advance of deactivation of dosing of the first channel. The absolute value of the fluid volume, which may be set as a parameter is limited in the range between 0.0000001 – 9999999 and 0. | m$^3$ | float | RD/WR |
| 5668 | 0x1623 | The volume of deactivation of dosing DP2 | Value of liquid volume DP2 for the advance of deactivation of dosing of the second channel. The absolute value of the fluid volume, which may be set as a parameter is limited in the range between 0.0000001 – 9999999 and 0. | m$^3$ | float | RD/WR |

## 1.3.5.17. The content of registers in 5700-5720 field

| Register | Address (hex) | Brief description | Extended description | Unit | Format | Operation |
|---|---|---|---|---|---|---|
| 5700 | 0x1643 | Diagnostic current of current loop | Parameter allowing a test control of current loop 4-20mA. The set value in mA is permitted in full performance range of the current loop. | mA | float | NO_MEM |
| 5702 | 0x1645 | The diagnostic operation mode of pulse output | Parameter allowing switching of the operation mode of the pulse output for testing purposes. Operation modes are defined as a selection list: *PULSE = 0* (operation mode as a pulse output - generation of a pulse with a specified length every 0.5 seconds), *FREQ = 1* (operation mode as a frequency output - generation of a function with a specified frequency). | - | uchar | NO_MEM |
| 5704 | 0x1647 | Diagnostic pulse width | Duration of generated test pulse expressed in milliseconds. The value of time, which may be set is limited in the range between 0 – 499 [ms]. | ms | short | NO_MEM |
| 5706 | 0x1649 | Diagnostic pulse polarization. | The polarization of pulse output (pulse generated for testing purposes). Polarization type is defined as a selection list: *NEGATIVE = 0* (negative polarization), *POSITIVE = 1* (positive polarization). | - | uchar | NO_MEM |
| 5708 | 0x164B | Diagnostic frequency of the PWM frequency output . | Fixed value of test frequency for PWM frequency pulse output operation mode with a specified duty cycle expressed in Hz. The value of the frequency, which may be set is limited in the range between 1.0 – 12000.0 [Hz]. | Hz | float | NO_MEM |
| 5710 | 0x164D | Diagnostic duty cycle of the PWM output (Register has lost its functionality) | Value of duty cycle of test signal for PWM pulse output operation mode with specified frequency expressed in %. The value of the duty cycle is equal to 50, which may be set is limited in the range between 0 – 100 [%]. | % | uchar | NORD_ME MONLY |
| 5712 | 0x164 F | Diagnostic polarization of the PWM frequency output. | The polarization of test PWM frequency output. Polarization type is defined as a selection list: *NEGATIVE = 0* (negative polarization), *POSITIVE = 1* (positive polarization). | - | uchar | NO_MEM |
| 5714 | 0x1651 | Diagnostic status of status output 1. | Test operation mode of binary status output 1. Output status may have only two states (values) 0 or 1. | - | uchar | NO_MEM |

| Register | Address (hex) | Brief description | Extended description | Unit | Format | Operation |
|---|---|---|---|---|---|---|
| 5716 | 0x1653 | Diagnostic status of status output 2. | Test operation mode of binary status output 2. Output status may have only two states (values) 0 or 1. | - | uchar | NO_MEM |
| 5718 | 0x1655 | Diagnostic status of binary input. | Binary input test status. Input state can have only two states (values) 0 or 1. | - | uchar | RD_ONLY |
| 5720 | 0x1657 | Diagnostic value of simulated flow. | Simulation value for flow expressed in cubic metres per hour for which operation of the flowmeter is checked. The absolute value of flow, which can be set, should not be lower than 0.0001 [m$^3$/h]. | m$^3$/h | float | NO_MEM |

### 1.3.5.18. The content of registers in 5800-5800 field

| Register | Address (hex) | Brief description | Extended description | Unit | Format | Operation |
|---|---|---|---|---|---|---|
| 5800 | 0x16A7 | Status / informational flags of the device | Informational flags containing current device status. Bit meaning: *bit 7* - error of (FrontEnd) measurement board, *bit 6* - measuring sensor error, *bit 5* - measuring sensor coil error, *bit 4* – error of the internal memory of the flowmeter, *bit 3* - empty pipe detection error, *bit 2* - unfilled pipe error (for sensors with detection of an unfilled pipe) The other bits: value 0. | - | uchar | RD_ONLY |

### 1.3.5.19. Thecontent of registers in 5850-5826 field

| Register | Address (hex) | Brief description | Extended description | Unit | Format | Operation |
|---|---|---|---|---|---|---|
| 5850 | 0x16D9 | Device serial number | Device serial number assigned during the production process. Value of the serial number is limited in the range between 1170000 – 12999999. | - | int | RD_ONLY |
| 5852 | 0x16DB | Hardware version | Flowmeter hardware version. | - | float | RD_ONLY |
| 5854 | 0x16DD | Software version | Flowmeter software version. | - | float | RD_ONLY |
| 5856 | 0x16DF | Revision | Revision of the flowmeter software version. | - | int | RD_ONLY |
| 5858 | 0x16E1 | FrontEnd hardware version | Hardware version of the measurement board (FrontEnd) of the flowmeter. | - | uchar | RD_ONLY |
| 5860 | 0x16E3 | FrontEnd software version | Software version of the measurement board (FrontEnd) of the flowmeter. | - | int | RD_ONLY |
| 5862 | 0x16E5 | CRC | CRC calculated from the Flash memory area containing the metrological function. | - | int | RD_ONLY |

### 1.3.5.20. The content of registers in 7000-7030 field

| Register | Address (hex) | Brief description | Extended description | Unit | Format | Operation |
|---|---|---|---|---|---|---|
| 7000 | 0x1B57 | Screen - digits 1-4 | A variable containing characters 1-4 displayed on the device screen. | - | Char table | RD_ONLY |
| 7002 | 0x1B59 | Screen - digits 5-8 | A variable containing characters 5-8 displayed on the device screen. | - | Char table | RD_ONLY |
| 7004 | 0x1B5B | Screen - digits 9-12 | A variable containing characters 9-12 displayed on the device screen. | - | Char table | RD_ONLY |
| 7006 | 0x1B5D | Screen - digits 13-16 | A variable containing characters 13-16 displayed on the device screen. | - | Char table | RD_ONLY |
| 7008 | 0x1B5F | Screen - digits 17-20 | Variable containing characters 17-20 displayed on the device screen. | - | Char table | RD_ONLY |
| 7010 | 0x1B61 | Screen - digits 21-24 | A variable containing characters 21-24 displayed on the device screen. | - | Char table | RD_ONLY |
| 7012 | 0x1B63 | Screen - digits 25-28 | A variable containing characters 25-28 displayed on the device screen. | - | Char table | RD_ONLY |
| 7014 | 0x1B65 | Screen - digits 29-32 | A variable containing characters 29-32 displayed on the device screen. | - | Char table | RD_ONLY |
| 7016 | 0x1B67 | Screen - digits 33-36 | A variable containing characters 33-36 displayed on the device screen. | - | Char table | RD_ONLY |
| 7018 | 0x1B69 | Screen - digits 37-40 | Variable containing characters 37-40 displayed on the device screen. | - | Char table | RD_ONLY |
| 7020 | 0x1B6B | Screen - digits 41-44 | A variable containing characters 41-44 displayed on the device screen. | - | Char table | RD_ONLY |
| 7022 | 0x1B6D | Screen - digits 45-48 | A variable containing characters 45-48 displayed on the device screen. | - | Char table | RD_ONLY |
| 7024 | 0x1B6F | Screen - digits 49-52 | A variable containing characters 49-52 displayed on the device screen. | - | Char table | RD_ONLY |
| 7026 | 0x1B71 | Screen - digits 53-56 | A variable containing characters 53-56 displayed on the device screen. | - | Char table | RD_ONLY |
| 7028 | 0x1B73 | Screen - digits 57-60 | Variable containing characters 57-60 displayed on the device screen. | - | Char table | RD_ONLY |
| 7030 | 0x1B75 | Screen - digits 61-64 | A variable containing characters 61-64 displayed on the device screen. | - | Char table | RD_ONLY |

## 1.3.5.21. The content of registers in 8000-8032 field

| Register | Address (hex) | Brief description | Extended description | Unit | Format | Operation |
|---|---|---|---|---|---|---|
| 8000 | 0x1F3F | Archive - address of events readout | Variable containing the base address for readout of eight successive events from the archive.<br>Writing to address register, from which we want to execute register readout, initiates a readout procedure for eight successive events and writing them in the corresponding registers.<br>The address, which can be set, is limited in the range between 1 - 8128 (maximum number of events, which can be saved in the archive) in case of completely written archive or to address value of the last executed entry at the moment (checking of the number of entries in the registers with address 5504). | - | int | NO_MEM |
| 8002 | 0x1F41 | Archive - event 1 part L | Variable containing four younger bytes of the event read from the address written to register 8000. | - | Char table | RD_ONLY |
| 8004 | 0x1F43 | Archive - event 1 part H | Variable containing four older bytes of the event read from the address written to register 8000. | - | Char table | RD_ONLY |
| 8006 | 0x1F45 | Archive - event 2 part L | Variable containing four younger bytes of the event read from the address written to register 8000 plus 1. | - | Char table | RD_ONLY |
| 8008 | 0x1F47 | Archive - event 2 part H | Variable containing four older bytes of the event read from the address written to register 8000 plus 1. | - | Char table | RD_ONLY |
| 8010 | 0x1F49 | Archive - event 3 part L | Variable containing four younger bytes of the event read from the address written to register 8000 plus 2. | - | Char table | RD_ONLY |
| 8012 | 0x1F4B | Archive - event 3 part H | Variable containing four older bytes of the event read from the address written to register 8000 plus 2. | - | Char table | RD_ONLY |
| 8014 | 0x1F4D | Archive - event 4 part L | Variable containing four younger bytes of the event read from the address written to register 8000 plus 3. | - | Char table | RD_ONLY |
| 8016 | 0x1F4F | Archive - event 4 part H | Variable containing four older bytes of the event read from the address written to register 8000 plus 3. | - | Char table | RD_ONLY |
| 8018 | 0x1F51 | Archive - event 5 part L | Variable containing four younger bytes of the event read from the address written to register 8000 plus 4. | - | Char table | RD_ONLY |
| 8020 | 0x1F53 | Archive - event 5 part H | Variable containing four older bytes of the event read from the address written to register 8000 plus 4. | - | Char table | RD_ONLY |
| 8022 | 0x1F55 | Archive - event 6 part L | Variable containing four younger bytes of the event read from the address written to register 8000 plus 5. | - | Char table | RD_ONLY |

| Register | Address (hex) | Brief description | Extended description | Unit | Format | Operation |
|---|---|---|---|---|---|---|
| 8024 | 0x1F57 | Archive - event 6 part H. | Variable containing four older bytes of the event read from the address written to register 8000 plus 5. | - | Char table | RD_ONLY |
| 8026 | 0x1F59 | Archive - event 7 part L. | Variable containing four younger bytes of the event read from the address written to the register 8000 plus 6. | - | Char table | RD_ONLY |
| 8028 | 0x1F5B | Archive - event 7 part H. | Variable containing four older bytes of the event read from the address written to register 8000 plus 6. | - | Char table | RD_ONLY |
| 8030 | 0x1F5D | Archive - event 8 part L. | Variable containing four younger bytes of the event read from the address written to register 8000 plus 7. | - | Char table | RD_ONLY |
| 8032 | 0x1F5F | Archive - event 8 part H. | Variable containing four older bytes of the event read from the address written to register 8000 plus 7. | - | Char table | RD_ONLY |

## 1.3.5.22. The content of registers in 9000-9032 field

| Register | Address (hex) | Brief description | Extended description | Unit | Format | Operation |
|---|---|---|---|---|---|---|
| 9000 | 0x2327 | Archive - measurement readout address | Variable containing the base address for readout of eight successive measurements from the archive. Saving to address register, from which we want to make archive readout, initiates a procedure of readout of eight successive measurements and writing them in the appropriate registers. The address, which can be set, is limited in the range between 1 - 8128 (maximum number of measurements, which can be saved in the archive) in case of completely written archive or to address value of the last executed entry at the moment (checking of the number of entries in the registers with address 5506). | - | int | NO_MEM |
| 9002 | 0x2329 | Archive - measurement 1 part L | Variable containing four younger bytes of the measurement read from the address written to register 9000. | - | Char table | RD_ONLY |
| 9004 | 0x232B | Archive - measurement 1 part H | Variable containing four older bytes of the measurement read from the address written to register 9000. | - | Char table | RD_ONLY |
| 9006 | 0x232D | Archive - measurement 2 part L | Variable containing four younger bytes of the measurement read from the address written to register 9000 plus 1. | - | Char table | RD_ONLY |
| 9008 | 0x232 F | Archive - measurement 2 part H | Variable containing four older bytes of the measurement read from the address written to register 9000 plus 1. | - | Char table | RD_ONLY |
| 9010 | 0x2331 | Archive - measurement 3 part L | Variable containing four younger bytes of the measurement read from the address written to register 9000 plus 2. | - | Char table | RD_ONLY |

| 9012 | 0x2333 | Archive - measurement 3 part H | Variable containing four older bytes of the measurement read from the address written to register 9000 plus 2. | - | Char table | RD_ONLY |
|---|---|---|---|---|---|---|
| 9014 | 0x2335 | Archive - measurement 4 part L | Variable containing four younger bytes of the measurement read from the address written to register 9000 plus 3. | - | Char table | RD_ONLY |
| 9016 | 0x2337 | Archive - measurement 4 part H | Variable containing four older bytes of the measurement read from the address written to register 9000 plus 3. | - | Char table | RD_ONLY |
| 9018 | 0x2339 | Archive - measurement 5 part L | Variable containing four younger bytes of the measurement read from the address written to register 9000 plus 4. | - | Char table | RD_ONLY |
| 9020 | 0x233B | Archive - measurement 5 part H | Variable containing four older bytes of the measurement read from the address written to register 9000 plus 4. | - | Char table | RD_ONLY |
| 9022 | 0x233D | Archive - measurement 6 part L | Variable containing four younger bytes of the measurement read from the address written to register 9000 plus 5. | - | Char table | RD_ONLY |
| 9024 | 0x233 F | Archive - measurement 6 part H | Variable containing four older bytes of the measurement read from the address written to register 9000 plus 5. | - | Char table | RD_ONLY |
| 9026 | 0x2341 | Archive - measurement 7 part L | Variable containing four younger bytes of the measurement read from the address written to register 9000 plus 6. | - | Char table | RD_ONLY |
| 9028 | 0x2343 | Archive - measurement 7 part H | Variable containing four older bytes of the measurement read from the address written to register 9000 plus 6. | - | Char table | RD_ONLY |
| 9030 | 0x2345 | Archive - measurement 8 part L | Variable containing four younger bytes of the measurement read from the address written to register 9000 plus 7. | - | Char table | RD_ONLY |
| 9032 | 0x2347 | Archive - measurement 8 part H | Variable containing four older bytes of the measurement read from the address written to register 9000 plus 7. | - | Char table | RD_ONLY |

## 1.3.5.23. The content of registers in 11000-11022 field

| Register | Address (hex) | Brief description | Extended description | Unit | Format | Operation |
|---|---|---|---|---|---|---|
| 11000 | 0x2AF7 | Display precision Q | The maximum number of significant places of the flow measurement result on the flowmeter screen, regardless of the units selected. | - | uchar | RD/WR |
| 11002 | 0x2AF9 | Prefiltration - strategy | The number specifying the operating mode of the flow prefiltration module. | - | uchar | RD/WR |
| 11004 | 0x2AFB | Prefiltration - value | The number specifying the range of operation of the flow prefiltration module. | - | uchar | RD/WR |
| 11006 | 0x2AFD | User calibration coefficient A | User calibration coefficient A. Additional calibration y=Ax+B has been entered into the setting, independent of production calibration. | - | float | RD/WR |
| 11008 | 0x2AFF | User calibration parameter B | User calibration parameter B. Additional calibration y=Ax+B has been entered into the setting, independent of production calibration. | m/s | float | RD/WR |
| 11010 | 0x2B01 | Reserve 1 | Reserved. Physical register present. | - | float | RD_ONLY |
| 11012 | 0x2B03 | Reserve 2 | Reserved. Physical register present. | - | float | RD_ONLY |
| 11014 | 0x2B05 | Calibration coefficient backup Device | Separately stored calibration coefficient backup (visible in the register 5606). Direct saving of the register via MODBUS is not possible. | - | float | RD_ONLY |
| 11016 | 0x2B07 | The content of the starting gate – younger 32 bytes | The content of data field electronic module starting gate, younger 32 bytes. For service purposes. Do not save! **Attention:: registry available from version 3.0.1008.** | - | uint32 | RD/WR |
| 11018 | 0x2B09 | The content of the starting gate – older 32 bytes | The content of data field electronic module starting gate, older 32 bytes. For service purposes. Do not save! **Attention:: registry available from version 3.0.1008.** | - | uint32 | RD/WR |
| 11020 | 0x2B0B | Service | For service and test purposes. Do not save! **Attention:: registry available from version 3.0.1008.** | - | uint16 | RD/WR |
| 11022 | 0x2B0D | Service | For service and test purposes. Do not save! **Attention:: registry available from version 3.0.1008.** | - | uint16 | RD/WR |

1.3.5.24. Registers, which has lost its functionality

The following registers have lost their use. „Loss of use" means that registry can still exist, so it can be operated as it was in earlier versions, moreover – it can be saved, and the entered value can be stored by the device, but:

- Its modification has no effect on the operation of the device and/or.
- The content of the register do not reflect the state of the device (it can be, for example, zeroed or undefined) and/or.
- Register operation is partially changed (e.g. trying to save will cause exception).

| Register | Address (hex) | Brief description | Extended description | Unit | Format | Operation |
|---|---|---|---|---|---|---|
| 5328 | 0x14CF | Value of duty cycle for PWM pulse output (register has lost its meaning) | A fixed value of duty cycle for the PWM pulse output operation mode. PWM output operating with a fixed set duty cycle. The frequency of this signal changes depending on the current flow. The value of the duty cycle is equal to 50[%]. **Loss of function from PEM-1000 version 3.0.1005.** | % | uchar | RD_ONLY |
| 5416 | 0x1527 | Prefiltration level | Prefiltering level of measurement obtained from FrontEnd. For a setting of 0 filtering is disabled. The value of the filtering level, which can be set as a parameter, is limited in the range of 0-10. **Loss of function from PEM-1000 version 3.0.1005 PEM-1000. Replaced by registers 11002 and 11004.** | - | uchar | RD_ONLY formerly RD/WR |

## 1.3.6.    Description of "coils" implemented in the flowmeter

Explanation of operations executed in the MODBUS "coils" is given in the table below:

| Operation | Description | Example |
|---|---|---|
| **RD_ONLY** | Read-only coil. Reading using MODBUS function 0x01. | Reading frame of calibration duration bit (coil 1028): *0x05 0x01 0x04 0x03 0x00 0x01*. |
| **RD/WR** | Coil intended for both the read and write function. Data is stored in the non-volatile memory of the device. Reading using MODBUS function 0x01, while saving using 0x05 function. | Bit reading and writing frame for detection of low flow (coil 1000, activation of options). Read: *0x05 0x01 0x03 0xE7 0x00 0x01*. Write: *0x05 0x05 0x03 0xE7 0xFF 0x00.* |
| **NO_MEM** | Coil intended for both the read and write function (unstable). Data is stored in the volatile memory of the device. Reading using MODBUS function 0x01, while saving using 0x05 function. | Bit reading and writing frame for diagnostic display mode (coil 1053, activation of options). Read: *0x05 0x01 0x04 0x1C 0x00 0x01*. Write: *0x05 0x05 0x04 0x1C 0xFF 0x00.* |
| **TRIGGER** | Tripping coil, entering bit 1 causes the appropriate function to be called. The read value is always equal to 0. Reading using MODBUS function 0x01, while saving using 0x05 function. | Bit reading and writing frame for deleting command for user-specified totalizers (coil 1016, activation of options). Read: *0x05 0x01 0x03 0xF7 0x00 0x01*. Write: *0x05 0x05 0x03 0xF7 0xFF 0x00.* |

## 1.3.6.1. The content of "coils" (bit variables) in 1000-1061 field

| Coil | Address (hex) | Brief description | Extended description | Operation |
|---|---|---|---|---|
| 1000 | 0x03E7 | Detection of low flow | Switching on & off the function for detection of low flow. | RD/WR |
| 1001 | 0x03E8 | Empty pipe detection | Switching on & off the function for detection of an empty pipe. | RD/WR |
| 1002 | 0x03E9 | Cut-off of low flow | Switching on & off the function for discrimination of zero (cut-off of low flow). | RD/WR |
| 1003 | 0x03EA | Current loop | Switching on & off the operation of the current loop. | RD/WR |
| 1004 | 0x03EB | Current loop alarm | Switching on & off the alarm mode using the current loop. | RD/WR |
| 1005 | 0x03EC | Pulse output | Switching on & off of the pulse output. | RD/WR |
| 1006 | 0x03ED | Binary output 1 | Switching on & off of the binary status output 1. | RD/WR |
| 1007 | 0x03EE | Binary output 2 | Switching on & off of the binary status output 2. | RD/WR |
| 1008 | 0x03EF | Binary input | Switching on & off the binary input. | RD/WR |
| 1009 | 0x03F0 | MODBUS bus | Switching on & off the MODBUS. | RD/WR |
| 1010 | 0x03F1 | Events archiving | Switching on & off of archiving (option to save in the non-volatile memory) of events occurring during operation of the device. | RD/WR |
| 1011 | 0x03F2 | Measurements archiving | Switching on & off of archiving (option to save in the non-volatile memory) of measurements of average values of flow. | RD/WR |
| 1012 | 0x03F3 | Continuous saving of events | Switching on & off the option for general (continuous) writing to events memory (when the entire events memory is written, that is 8128 items - replacing of the oldest entries with new ones). | RD/WR |
| 1013 | 0x03F4 | Continuous saving of the measurements | Switching on & off the option for general (continuous) writing to measurements memory (when the entire measurement memory is written, that is 8128 items - replacing of the oldest entries with new ones). | RD/WR |
| 1014 | 0x03F5 | Events erasing. | Command for deleting events memory. The setting of the bit to 1 results in deleting events saved in the device memory. The bit sets automatically to 0 after execution of the command. | TRIGGER |
| 1015 | 0x03F6 | Measurements erasing. | Command for deleting measurements memory. The setting of the bit to 1 results in deleting measurements saved in the device memory. The bit sets automatically to 0 after execution of the command. | TRIGGER |
| 1016 | 0x03F7 | Erasing of user-specified totalizers. | Command for deleting of user-specified totalizers. The setting of the bit to 1 results in deleting user-specified totalizers saved in the device memory. The bit sets automatically to 0 after execution of the command. | TRIGGER |
| 1017 | 0x03F8 | Erasing working time of the user. | Command for deleting working time of the user. The setting of the bit to 1 results in deleting the user's working time counter saved in the device memory. The bit sets automatically to 0 after execution of the command. | TRIGGER |
| 1018 | 0x03F9 | Errors erasing. | Command for deleting status errors from the device. The setting of the bit to 1 results in deleting status errors from the device. The bit sets automatically to 0 after execution of the command. | TRIGGER |

| 1019 | 0x03FA | .Default parameters. | Command for the setting of default parameters in the device (basic parameters of a correct operation with calibration saved in the production stage of the device). The setting of the bit to 1 results in writing of settings of the device with default parameters. The bit sets automatically to 0 after execution of the command, while the device restarts. | TRIGGER |
|------|--------|---------------------|-------------------------------------------------------------------------------------------------------------------------|---------|
| 1020 | 0x03FB | .Factory parameters. | Command for the setting of factory parameters of the device (parameter permanently saved in the device memory, without the possibility of any intervention in their value). The setting of the bit to 1 results in writing of settings of the device with factory parameters. The bit sets automatically to 0 after execution of the command, while the device restarts. The device is not calibrated after setting factory parameters. | TRIGGER |
| 1021 | 0x03FC | Electronics calibration. | Command for starting a procedure for calibration of the electronics. The setting of the bit to 1 results in starting of the calibration process (the procedure should be executed using an artificial measuring sensor). The bit sets automatically to 0 after execution of the command. | TRIGGER |
| 1022 | 0x03FD | The end of electronics calibration. | Command for ending a procedure for calibration of the electronics. The setting of the bit to 1 results in ending of the calibration process (leaving of the calibration menu). The bit sets automatically to 0 after execution of the command. | TRIGGER |
| 1023 | 0x03FE | Writing of electronics calibration. | Command for writing of an obtained coefficient of calibration of electronics. The setting of the bit to 1 results in saving to the newly obtained calibration coefficient. The bit sets automatically to 0 after execution of the command. Status of execution of electronics calibration using the artificial sensor will be set in the device. | TRIGGER |
| 1024 | 0x03FF | Erasing calibration of the electronics. | Command for deleting the electronics calibration coefficient. The setting of the bit to 1 results in deleting the calibration coefficient from the memory. The bit sets automatically to 0 after execution of the command. The calibration coefficient will be set to the value equal to 0.00011 as a result of the procedure. Status of execution of electronics calibration using the artificial sensor will be deleted from the device. | TRIGGER |
| 1025 | 0x0400 | Zero calibration. | Command for starting a procedure of calibration of zero of the flow. The setting of the bit to 1 results in starting of the calibration process (the procedure should be executed when the flow is missing that is on "lentic water"). The bit sets automatically to 0 after execution of the command. The procedure can be executed only after previously executed calibration of the electronics. | TRIGGER |
| 1026 | 0x0401 | The end of zero calibration. | Command for ending a procedure of calibration of zero of the flow. The setting of the bit to 1 results in ending of the calibration process (leaving of the calibration menu). The bit sets automatically to 0 after execution of the command. | TRIGGER |

| 1027 | 0x0402 | Save of zero calibration. | Command for the writing of the obtained coefficient of calibration of zero of the flow.<br>Setting of bit to 1 results in saving to the newly obtained calibration coefficient. The bit sets automatically to 0 after execution of the command. Saving of the coefficient is possible only when its value does not exceed 0.3 [m/s] (threshold protecting against zeroing during flow). | TRIGGER |
|------|--------|---------------------------|---|---------|
| 1028 | 0x0403 | Duration of calibration. | Flag indicating the duration of electronics calibration or calibration of zero of the flow.<br>The value of read bit equal to 1 means that the device is busy with the execution of calibration procedure. | RD_ONLY |
| 1029 | 0x0404 | Calibration 4mA. | Command for starting of calibration of the current loop for value 4 mA.<br>The setting of the bit to 1 results in starting of the calibration process (the calibration procedure requires the use of external reference measurement of the current). The bit sets automatically to 0 after execution of the command. | TRIGGER |
| 1030 | 0x0405 | Calibration saverange 4mA. | Command for the writing of the obtained coefficient of calibration of the current loop for value 4mA.<br>The setting of the bit to 1 results in saving to the newly obtained calibration coefficient. The bit sets automatically to 0 after execution of the command. | TRIGGER |
| 1031 | 0x0406 | Calibration 20mA. | Command for starting of calibration of the current loop for value 20 mA.<br>The setting of the bit to 1 results in starting of the calibration process (the calibration procedure requires the use of external reference measurement of the current). The bit sets automatically to 0 after execution of the command. | TRIGGER |
| 1032 | 0x0407 | Calibration save 20mA. | Command for the writing of the obtained coefficient of calibration of the current loop for value 20mA.<br>The setting of the bit to 1 results in saving to the newly obtained calibration coefficient. The bit sets automatically to 0 after execution of the command. | TRIGGER |
| 1033 | 0x0408 | Calibration of internal measurement 4mA. | Command for starting of calibration of the internal measurement of the current loop for value 4 mA.<br>The setting of the bit to 1 results in starting of the calibration process (the calibration procedure requires the use of external reference measurement of the current). The bit sets automatically to 0 after execution of the command. | TRIGGER |
| 1034 | 0x0409 | Write of calibration of internal measurement 4mA. | Command for the writing of the obtained coefficient of internal measurement of the current loop for value 4mA.<br>The setting of the bit to 1 results in saving to the newly obtained calibration coefficient. The bit sets automatically to 0 after execution of the command. | TRIGGER |
| 1035 | 0x040A | Calibration of internal measurement 20mA. | Command for starting of calibration of the internal measurement of the current loop for value 20 mA.<br>The setting of the bit to 1 results in starting of the calibration process (the calibration procedure requires the use of external reference measurement of the current). The bit sets automatically to 0 after execution of the command. | TRIGGER |

| 1036 | 0x040B | Write Calibration of internal measurement calibration 20mA. | Command for the writing of the obtained coefficient of internal measurement of the current loop for value 20mA. The setting of the bit to 1 results in saving to the newly obtained calibration coefficient. The bit sets automatically to 0 after execution of the command. | TRIGGER |
|---|---|---|---|---|
| 1037 | 0x040C | Dosing function. | Switching on & off the dosing function in the flowmeter. | RD/WR |
| 1038 | 0x040D | Dosing start. | Dosing function start command. The setting of the bit to 1 results in the start of dosing of both channels. The bit sets automatically to 0 after execution of the command. | TRIGGER |
| 1039 | 0x040E | Dosing stop. | Dosing function stop command. The setting of the bit to 1 results in the stop of dosing for both channels. The bit sets automatically to 0 after execution of the command. | TRIGGER |
| 1040 | 0x040 F | Overload of dosing value. | Command for overloading of the volume value and setting of readiness condition for the dosing function. The setting of the bit to value 1 results in loading of the set volume values dosed by both channels to dosing counters. The bit sets automatically to 0 after execution of the command. | TRIGGER |
| 1041 | 0x0410 | Backup bit 1The state of enabling the quick empty pipe detection. | Backup bit 1 which may be used in the future.A bit indicating the state of the quick empty pipe detection. | RD_ONLY |
| 1042 | 0x0411 | Backup bit 2Quick empty pipe detection state toggling. | Command to change the state of switching on the quick empty pipe detection. Setting the bit to 1 causes the switching on of the fast empty pipe detection state to change to the opposite one. After executing the command, the bit is automatically set to the value 0.Backup bit 2 which may be used in the future. | RD_ONLY |
| 1043 | 0x0412 | Backup bit 3Quick empty pipe detection switching process in progress. | Backup bit 3 which may be used in the future.Flag for the in progress of the fast empty pipe detection switching process. The value of the read bit equal to 1 means that the switching process continues (the maximum switching time may be 30 sconds). | RD_ONLY |
| 1044 | 0x0413 | Backup bit 4Configuration status of the measurement method. | Backup bit 4 which may be used in the future.Bit indicating the configuration status of the measurement method. | RD_ONLY |
| 1045 | 0x0414 | Backup bit 5.Switching the configuration status of the measurement method | Backup bit 5 which may be used in the future.Command to change the configuration state of the measurement method. Setting the bit to 1 causes the switching on of the fast empty pipe detection state to change to the opposite one. After executing the command, the bit is automatically set to the value 0. | RD_ONLY |
| 1046 | 0x0415 | Backup bit 6.Continuing the process of switching the measurement method | Backup bit 6 which may be used in the future.Flag of the process of switching the measurement method. The value of the read bit equal to 1 means that the switching process continues (the maximum switching time may be 30 sconds). | RD_ONLY |

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| 1047 | 0x0416 | Backup bit 7. | Backup bit 7 which may be used in the future. | RD_ONLY |
|------|--------|---------------|-----------------------------------------------|---------|
| 1048 | 0x0417 | Backup bit 8. | Backup bit 8 which may be used in the future. | RD_ONLY |
| 1049 | 0x0418 | Backup bit 9. | Backup bit 9 which may be used in the future. | RD_ONLY |
| 1050 | 0x0419 | LCD diagnostics. | Start of a test procedure for the LCD display.<br>The setting of the bit to 1 results in the start of LCD display testing. The bit sets automatically to 0 after execution of the command. | TRIGGER |
| 1051 | 0x041A | LCD diagnostics stop. | Stop of a test procedure for the LCD display.<br>The setting of the bit to 1 results in the stop of LCD display testing. The bit sets automatically to 0 after execution of the command. | TRIGGER |
| 1052 | 0x041B | Diagnostics of current loop. | Start of the test procedure of current loop 4-20mA.<br>The setting of the bit to 1 results in the start of current loop output testing. The bit sets automatically to 0 after execution of the command. | TRIGGER |
| 1053 | 0x041C | Stop of current loop diagnostics. | Stop of the test procedure of current loop 4-20mA.<br>The setting of the bit to 1 results in the stop of testing of the output of the current loop. The bit sets automatically to 0 after execution of the command. | TRIGGER |
| 1054 | 0x041D | Diagnostics of pulse output. | Start of a test procedure for pulse output.<br>The setting of the bit to 1 results in the start of pulse output testing. The bit sets automatically to 0 after execution of the command. | TRIGGER |
| 1055 | 0x041E | Stop of pulse output diagnostics. | Stop of a test procedure for pulse output.<br>The setting of the bit to 1 results in the stop of pulse output testing. The bit sets automatically to 0 after execution of the command. | TRIGGER |
| 1056 | 0x041 F | Diagnostics of status outputs. | Start of a test procedure for binary pulse outputs.<br>The setting of the bit to 1 results in the start of testing of the binary outputs. The bit sets automatically to 0 after execution of the command. | TRIGGER |
| 1057 | 0x0420 | Diagnostics Stop of status outputs diagnostics. | Stop of a test procedure for binary pulse outputs.<br>The setting of the bit to 1 results in the stop of binary outputs testing. The bit sets automatically to 0 after execution of the command. | TRIGGER |
| 1058 | 0x0421 | Input diagnostics. | Start of a test procedure for isolated binary input.<br>The setting of the bit to 1 results in the start of binary input testing. The bit sets automatically to 0 after execution of the command. | TRIGGER |
| 1059 | 0x0422 | Input diagnostics stop. | Stop of a test procedure for isolated binary input.<br>The setting of the bit to 1 results in the stop of binary input testing. The bit sets automatically to 0 after execution of the command. | TRIGGER |
| 1060 | 0x0423 | Diagnostics of measurement simulation. | Start of a test procedure for simulation of flow measurements.<br>The setting of the bit to 1 results in the start of flow simulation. The bit sets automatically to 0 after execution of the command. | TRIGGER |
| 1061 | 0x0424 | Stop of diagnostics of measurement simulation. | Stop of a test procedure for simulation of flow measurements.<br>The setting of the bit to 1 results in the end of flow simulation. The bit sets automatically to 0 after execution of the command, while the device restarts. | TRIGGER |

## 1.3.6.2. Sub-function 0x08 frame

Frame 0x08 allows you to perform diagnostic operations. This frame defines sub-functions described by 16-bit value. Majority of the diagnostic functions is based on the diagnostic meters defined by MODBUS. Only unicast mode is available. Available sub-functions of 0x08 frame with their description are presented in the following table.

| Code sub-function (hex) | Meter number | Name of function or meter acc. to MODBUS | Description of function |
|---|---|---|---|
| 00 00 | - | Return Query Data | In response to this query a frame is sent which is an accurate echo (copy) of query frame, including the data field. The data field can be of any type. |
| 00 01 | 1-8 | Restart Communications Options | This frame restarts serial port (with currently selected parameters in the menu) and zeroing of diagnostic meters. Data field of query frame can consist both 0x0000 and 0xFF00 values because this device does not run Communications Event Log. |
| 00 0A | 1-8 | Clear Counters and Diagnostic Register | This frames resets diagnostic meters. Data field of query frame: 0x0000. |
| 00 0B | 1 | Return Bus Message Count | This frame returns value of diagnostic meter Return Bus Message Count. This meter contains number of correct* frames detected on the bus. The data field of the query frame is always 0x0000. |
| 00 0C | 2 | Return Bus Communication Error Count | This frame returns values of diagnostic meter Return Bus Communication Error Count. This meter contains number of incorrect frames on bus, with incorrect CRC, with parity error, with lost characters or shorter than 3 bytes. The data field of the query frame is always 0x0000. |
| 00 0D | 3 | Return Slave Exception Error Count | This frame returns value of diagnostic meter Return Slave Exception Error Count. This meter contains number of exceptions in received, correct frames (incorrect code, address, data in frame). The data field of the query frame is always 0x0000. |
| 00 0E | 4 | Return Slave Message Count | This frame returns value of diagnostic meter Return Slave Message Count. This meter contains number of correct frames directed to this device, including broadcast frames. The data field of the query frame is always 0x0000. |

*) correct frame is a frame without parity errors, CRC error and frame length is correct, in other words: this is a frame, which structure (in ADU layer) is correct and therefore the frame can be directed for decoding and execution of the command. It does not mean correctness of data contained in PDU.

### 1.3.6.3. Sub-function 0x02B frame

Frame 0x2B allows data tunneling in various formats using MODBUS frames. One sub-function of this frame, 0x0E, is supported that is Read Device Identification. Only unicast mode is available. Response to this frame returns information about the device, organized in compact structure of objects with **byte** organization (what differs from the MODBUS data organization, which is usually 16-bit). Each object contains ID, byte informing about data field length and data field. Data field contains a string of text characters coded in ASCII standard, not terminated with zero. Returned objects are presented below:

| Object ID | Object length (hex.) | Object length (decimal) | Content of object data field |
|---|---|---|---|
| 00 | 0D | 13 | Aplisens S.A. |
| 01 | 08 | 8 | PEM-1000 |
| 02 | 0A | 10 | v0.01.0000<br>*Current software revision of the device e.g.:*<br>v2.08.0825 |

### 1.3.7. Examples of flowmeter servicing procedures using the MODBUS bus

Readout of the events archive from the device with address 5:

- Reading of number of events written in the device from register 5504 – 0x05 0x03 0x15 0x7F 0x00 0x02.
- For example, we obtain in response that 110 events are saved. We assume that we want to read events from 100 to 110.
- We write to register 8000 an event readout address from the archive equal to 100 – 0x05 0x10 0x1F 0x3F 0x00 0x02 0x04 0x00 0x00 0x00 0x64.
- While reading registers from 8002 to 8032, we take 8 successive events read from the device memory: 0x05 0x03 0x1F 0x41 0x00 0x20.
- We write to register 8000 an address of reading of successive events from the archive equal to 108 – 0x05 0x10 0x1F 0x3F 0x00 0x02 0x04 0x00 0x00 0x00 0x6C.
- Reading registers from 8002 to 8012 we take 3 successive lacking events read from the device memory: 0x05 0x03 0x1F 0x41 0x00 0x06. In addition, like the first time it is possible to read all 32 registers, but registers with the addresses 8014 – 8032 will have all bytes equal to 0x00 (because only three events for download are available during this readout and "empty" registers have a value equal to 0x00).

### 1.3.8. Calibration of the flowmeter electronics

Execution of calibration of the flowmeter electronics (when an artificial measuring head is connected) with the address of 5:

- Checking whether the device is not in the calibration state by readout of a busy bit with address 1028 – 0x05 0x01 0x04 0x03 0x00 0x01.
- If the value of the busy flag has a value of 0 (the device is not in the calibration mode) then the electronics calibration procedure is started by setting bit 1021 – 0x05 0x05 0x03 0xFC 0xFF 0x00.
- Waiting for the completion of data collection by the device. The busy bit has a value of 1 during collection of the data. Readout of the busy bit with address 1028 until it reaches value 0 – 0x05 0x01 0x04 0x03 0x00 0x01.
- Readout of the temporarily calculated coefficient from register 5604 after ending of data collection by the device – 0x05 0x03 0x15 0xE3 0x00 0x02. The applicable coefficient can be read from register 5606 - 0x05 0x03 0x15 0xE5 0x00 0x02.
- After analysis of the obtained value of a new parameter - possibility to end the procedure without writing a new coefficient by setting bit 1022 0x05 0x05 0x03 0xFD 0xFF 0x00 or writing a new coefficient in the non-volatile memory of the device by setting bit 1023 - 0x05 0x05 0x03 0xFE 0xFF 0x00 and then ending the procedure by setting bit 1022.

### 1.3.9. Decomposition of the data

Decomposition of the data read from the flowmeter archive using the MODBUS bus.

#### 1.3.9.1. Data of events archive

A single event read from the device through the MODBUS takes two (double) addresses, that is 8 data bytes. The variable read from the first address, e.g. 8002 contains younger four bytes of the event, while the variable read from successive address 8004 contains four older bytes of this event. The byte order send through the MODBUS interface during reading from the address has a format ("order", one of four) set in the device menu.

The data in the device memory is coded in Little Endian format. The structure of eight bytes describing the transferred event is as follows:

*typedef struct*
*{*
  *byte Data1;*
  *byte Data2;*
  *byte Data3;*
  *byte Data4;*
  *byte Data5;*
  *byte Type;*
  *byte Parameter;*
  *byte CRC;*
*}EventTypeDef;*

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Therefore, the four younger event bytes are: *Data1, Data2, Data3, Data4* and the four older bytes are: *Data5, Type, Parameter, CRC.*

Assuming that the data transfer method through the MODBUS interface is set as DDCCBBAA type (Big Endian), readout of the first address (e.g. 8002) will be as follows: *Data4, Data3, Data2, Data1* while for the second (address 8004 likewise): *CRC, Parameter, Type, Data5.*

1.3.9.2. The data mean

- *Type* – type of event saved in the archive. The following types of events assuming the following values are defined:
    - o 1 = Start – device start;
    - o 2 = Login – user log in to the device menu;
    - o 3 = Status OK – change of the device status to the correct value;
    - o 4 = Error FE – error of measurement board of FrontEnd;
    - o 5 = Error Sen – measuring sensor error;
    - o 6 = Error Mem – device internal memory error;
    - o 7 = Empty – detection of an empty pipe by the flowmeter;
    - o 8 = Unfilled – detection of an unfilled pipe by the flowmeter;
    - o 9 = Reset – reset of user counters;
    - o 10 = Default – setting of device parameters to the default values;
    - o 11 = Factory – setting of device parameters to the factory values;
    - o 12 = Calibrat. – saving of calibration parameters of the device;
    - o 13 = Coil Err – error of measurement coil of the flowmeter;
    - o 14 = Low Flow – detection of low liquid flow by the flowmeter.
- *Parameter* – event parameters. The following parameters (applying to given types) of events assuming the following values are defined:
    - o 0 = no parameter (applies to all types of events);
    - o 1 = User – logged in operator with user authorizations (applies to event type no. 2);
    - o 2 = Admin – logged in operator with administrator authorizations (applies to event type no. 2);
    - o 3 = Service – logged in operator with service authorizations (applies to event type no. 2);
    - o 4 = Off – operator log out (applies to event type no. 2);
    - o 5 = Total. – deleting of user totalizers (applies to event type no. 9);
    - o 6 = Count. – deleting of user time counter (applies to event type no. 9);
    - o 7 = Error. – deleting of device errors (applies to event type no. 9);
    - o 8 = Tot.in – deleting of user totalizers using binary input (applies to event type no. 9);
    - o 9 = Device – saving of electronics calibration (using a sensor of the artificial head, applies to event type no. 12);
    - o 10 = Zero – saving of zero calibration for the sensor (applies to event type no. 12);

- o 11 = Sensor – saving of sensor calibration (coefficients A, B and C, applies to event type no. 12);
- o XX = error code (one byte number saved in the hex format, applies to no. 4 event type);
- o YY = error code (one byte number saved in the hex format, applies to no. 5 event type);
- o ZZ = error code (one byte number saved in the hex format, applies to no. 6 event type) where bit 0 set to value 1 indicates an error of SRAM, while bit 4 set to value 1 indicates an error of EEPROM.
- *Data1* – data containing second of time of the event saved in the archive.
- *Data2* – data containing minute of time of the event saved in the archive.
- *Data3* – data containing an hour of time of the event saved in the archive.
- *Data4* – data containing the number of the day on bits 0 - 4, while three youngest bits of the year of the event time saved in the archive, on bits 5 - 7.
- *Data5* – data containing the number of the month on bits 0 - 3, while four older bits of the year of the event time saved in the archive, on bits 4 - 7.
- *CRC* – one byte checksum of the correctness of event writing in the device memory. CRC is counted as a 256 modulo sum of other bytes of the event (one byte operation 0 - the sum of all other bytes of the event).

An example of readout of the event from the archive:
- 0x3A|0x0F|0x1B|0x14  0x5C|0x04|0x02|0x26  -  readout of younger and older part of the event from the device that is 8 bytes (representing sequence: younger part *Data4|Data3|Data2|Data1* and older part *CRC|Parameter|Type|Data5*).
- After the decomposition, we obtain that this is the event: Login / Off (type 2 parameter 4) that is logout of the operator from the device menu, which occurred 26-06-2017 (five bits from 0x3A, four bits from 0x26 and 2000 plus composition from 0x10 and 0x01) at 15:27:20 (0x0F, 0x1B, 0x14).

## 1.3.9.3. Data of measurement archive

A single result of measurement of average flow read from the device through MODBUS takes two (double) addresses, that is 8 data bytes. The variable read from the first address, e.g. 9002 contains younger four bytes of the item, while the variable read from the successive address 9004 contains four older bytes of this item. The byte order send through the MODBUS interface during reading from the address has a format ("order", one of four) set in the device menu.

The data in device memory is coded in Little Endian format. The structure of eight bytes describing the transferred archive item is as follows:

*typedef struct*
*{*
  *byte Data1;*
  *byte Data2;*
  *byte Data3;*
  *float AverageFlow;*   (4-byte float data)

*byte CRC;*
*}MeasTypeDef;*

Therefore, four younger bytes of the archive item are: *Data1, Data2, Data3, AverageFlow (the youngest brother)* and older four bytes are: *AverageFlow (three older bytes), CRC.*

Assuming that the data transfer method through the MODBUS interface is set as DDCCBBAA type (Big Endian), readout of the first address (e.g. 9002) will be as follows: *AverageFlow (the youngest byte), Data3, Data2, Data1* while for the second (address 9004 likewise): *CRC, AverageFlow (three older bytes).*

The data mean:

- *AverageFlow* – average measurement of flow for a period of time set in the menu (four-byte floating point number).
- *Data1* – data containing minute of time of saving of measurement of average flow in the archive.
- *Data2* – data containing hour on bits 0 - 4, and two older bits of the number of the month on bits 5 - 6 for the time of saving of average measurement of flow in the archive.
- *Data3* – data containing a number of the day on bits 0 - 4, while two younger bits of the number of the month of the event time saved in the archive, on bits 5 - 6.
- *CRC* – one byte checksum of the correctness of measurement writing in the device memory. CRC is counted as a 256 modulo sum of other bytes of the measurement (one byte operation 0 - the sum of all other bytes of the measurement).

### 1.3.9.4. An example of readout of measurement from the archive

- 0xA1|0x38|0x2F|0x0E   0x99|0x42|0x9B|0x74  -  readout of younger and older part of the measurement from the device that is 8 bytes (representing sequence: younger part *AverageFlow (the youngest byte)|Data3|Data2|Data1* and older part *CRC|AverageFlow (three older bytes).*
- After the decomposition, we obtain that this is the average measurement of flow of the value equal to 77.7277908 m$^3$/h (0x42, 0x9B, 0x74, 0xA1), which was written as 24-05 (five bits from 0x38, two bits from 0x38 plus two bits from 0x2F) at 15:14 (five bits from 0x2F, 0x0E).

# 2. ADDITIONAL INFORMATION

## 2.1. Additional information

The manufacturer reserves the right to introduce design and process changes in the device not decreasing its performance parameters.

[i] User manual for the flow meter can be found on the manufacturer's website www.aplisens.pl

## 2.2. Revision log

| No. of revision | Document edition | Description of review |
|---|---|---|
| 1 | 01.A.001<br>24.10.17 | Changes related to software v. 2.7.<br>- Introduction of the full MODBUS. |
| 2 | 01.A.003<br>05.04.18 | Changes related to software v. 2.8. |
| 3 | 01.A.004<br>01.12.22 | Changes related to software v. 3.0.1009. |

01.A.004