

User manual

MODULE

SIAi-8

- Firmware: v.1.00 or higher
- Input type: voltage / current
- Dedicated for DAQ systems



Read the user's manual carefully before starting to use the unit or software.
Producer reserves the right to implement changes without prior notice.

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Explanation of symbols used in the manual:



- This symbol denotes especially important guidelines concerning the installation and operation of the device. Not complying with the guidelines denoted by this symbol may cause an accident, damage or equipment destruction.

IF THE DEVICE IS NOT USED ACCORDING TO THE MANUAL THE USER IS RESPONSIBLE FOR POSSIBLE DAMAGES.



- This symbol denotes especially important characteristics of the unit.
Read any information regarding this symbol carefully

1. BASIC REQUIREMENTS AND USER SAFETY



- **The manufacturer is not responsible for any damages caused by inappropriate installation, not maintaining the proper environmental conditions and using the unit contrary to its assignment.**
- Installation should be conducted by qualified personnel . During installation all available safety requirements should be considered. The fitter is responsible for executing the installation according to this manual, local safety and EMC regulations.
- The unit must be properly set-up, according to the application. Incorrect configuration can cause defective operation, which can lead to unit damage or an accident.
- **If in the case of a defect of a unit malfunction there is a risk of a serious threat to the safety of people or property additional, independent systems and solutions to prevent such a threat must be used.**
- Neighbouring and connected equipment must meet the appropriate standards and regulations concerning safety and be equipped with adequate overvoltage and interference filters.
- **Do not attempt to disassemble, repair or modify the unit yourself. The unit has no user serviceable parts. Defective units must be disconnected and submitted for repairs at an authorized service centre.**



The unit is designed for operation in an industrial environment and must not be used in a household environment or similar.

2. GENERAL CHARACTERISTICS

Module allows measurement of 8 analog channels (current or voltage, depending on version) and makes them accessible via RS-485 interface. SIAi-8 can be used as input block of scattered measurement and visualization systems. Standard Modbus RTU functions can be used for changing module settings (like address, baud rate, measurement ranges etc.) and read measurement results or identification data.

3. TECHNICAL DATA

Power supply voltage	16... 24 ...30V DC (separated)
External fuse (required)	T - type, max. 1 A
Current consumption	55 mA typically
Number of independent inputs	8
Inputs (depending on version)	
current:	0÷20 mA; 4÷20 mA
or voltage:	0÷10 V; 2÷10 V; 0÷5 V; 1÷5 V;
Measurement accuracy	± 0.25% ± one digit
Accepted prolonged inputs overload:	20%
Galvanic isolation	All inputs are galvanically isolated from module supply and RS-485 interface
Communication interface	RS 485, 8N1 / Modbus RTU
Baud rate	1200 ÷ 115200 bit/s
Number of modules in 1 network	maximum 128
Data memory	non-volatile memory, EEPROM type
Protection level	IP 20 (housing and connection clips)
Housing type	DIN rail mounted (35 mm rail)
Housing dimensions (L x W x D)	101 x 22.5 x 80 mm
Operating temperature (depending on version)	0°C to +50°C or -20°C to +50°C
Storage temperature (depending on version)	-10°C to +70°C or -20°C to +70°C
Humidity	5 to 90% no condensation
Altitude	up to 2000 meters above sea level
Screws tightening max. torque	0.5 Nm
Max. connection leads diameter	2.5 mm ²
EMC	according to: PN-EN 61326-1



This is a class A unit. In housing or a similar area it can cause radio frequency interference. In such cases the user can be requested to use appropriate preventive measures.

4. DEVICE INSTALLATION

The unit has been designed and manufactured in a way assuring a high level of user safety and resistance to interference occurring in a typical industrial environment. In order to take full advantage of these characteristics installation of the unit must be conducted correctly and according to the local regulations.



- Read the basic safety requirements on page 3 prior to starting the installation.
- Ensure that the power supply network voltage corresponds to the nominal voltage stated on the unit's identification label.
- The load must correspond to the requirements listed in the technical data.
- All installation works must be conducted with a disconnected power supply.

4.1. UNPACKING

After removing the unit from the protective packaging, check for transportation damage. Any transportation damage must be immediately reported to the carrier. Also, write down the unit serial number on the housing and report the damage to the manufacturer.

Attached with the unit please find:

- user's manual,
- warranty,

4.2. CONNECTION METHOD

Caution



- Installation should be conducted by qualified personnel . During installation all available safety requirements should be considered. The fitter is responsible for executing the installation according to this manual, local safety and EMC regulations.
- Wiring must meet appropriate standards and local regulations and laws.
- In order to secure against accidental short circuit the connection cables must be terminated with appropriate insulated cable tips.
- Tighten the clamping screws. The recommended tightening torque is 0.5 Nm. Loose screws can cause fire or defective operation. Over tightening can lead to damaging the connections inside the units and breaking the thread.
- In the case of the unit being fitted with separable clamps they should be inserted into appropriate connectors in the unit, even if they are not used for any connections.
- **Unused clamps (marked as n.c.) must not be used for connecting any connecting cables (e.g. as bridges), because this can cause damage to the equipment or electric shock.**

Due to possible significant interference in industrial installations appropriate measures assuring correct operation of the unit must be applied. To avoid the unit of improper indications keep recommendations listed below.

- Avoid common (parallel) leading of signal cables and transmission cables together with power supply cables and cables controlling induction loads (e.g. contactors). Such cables should cross at a right angle.
- Contactor coils and induction loads should be equipped with anti-interference protection systems, e.g. RC-type.
- Use of screened signal cables is recommended. Signal cable screens should be connected to the earthing only at one of the ends of the screened cable.
- In the case of magnetically induced interference the use of twisted couples of signal cables (so-called "spirals") is recommended. The spiral (best if shielded) must be used with RS-485 serial transmission connections.
- In the case of interference from the power supply side the use of appropriate anti-interference filters is recommended. Bear in mind that the connection between the filter and the unit should be as short as possible and the metal housing of the filter must be connected to the earthing with largest possible surface. The cables connected to the filter output must not run in parallel with cables with interference (e.g. circuits controlling relays or contactors).

External powers supply must be connected to the module (+U_z, -U_z, typically 24V DC) and two wires RS-485 (A+, B-) communication interface. Inputs are placed on bottom side of the module (see: Figure 4.1).

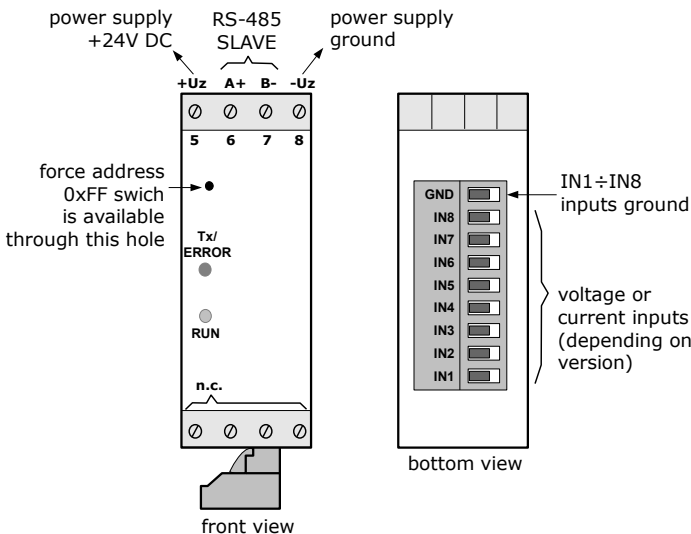


Figure 4.1. Terminals description



- When use of SMPS it is strongly recommended to connect PE wire.
- All connections must be made while power supply is disconnected !

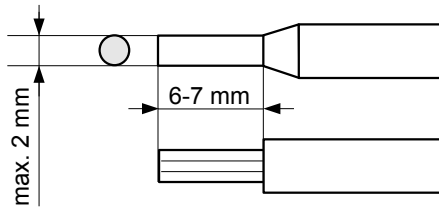


Figure 4.2. Method of cable insulation replacing and cable terminals

4.3. MAINTENANCE

The unit does not have any internal replaceable or adjustable components available to the user. Pay attention to the ambient temperature in the room where the unit is operating. Excessively high temperatures cause faster ageing of the internal components and shorten the fault-free time of unit operation.

In cases where the unit gets dirty do not clean with solvents. For cleaning use warm water with small amount of detergent or in the case of more significant contamination ethyl or isopropyl alcohol.

Using any other agents can cause permanent damage to the housing.



Product marked with this symbol should not be placed in municipal waste. Please check local regulations for disposal and electronic products.

5. PRINCIPLE OF OPERATION

The Module allows to measurement analog values from 8 current (or voltage) inputs with speed rate about 10 Hz (every channel). Measurement results can be internally recalculated due to one of available characteristics: linear, square or user definable multi-point (max.20 points length). The expansion of nominal range is defined by “Lo r” and “Hi r” parameters. They determine the permissible range of input signal (Figure 5.1).

The permissible range allow user to exceed the **nominal range** of input signal. If input signal exceeds the permissible range (defined by “Lo r” and “Hi r”), appropriate bit of **status register** (register 09h) will be set. This bit signalise exceeding of **permissible measurement range**.

The “Lo r” parameter is important if input is set to “4-20”, “1-5” or “2-10” mode only, and determines lower border of the permissible range. If input is set to “0-20”, “0-5” or “0-10” mode then lower border of the permissible range is always 0. For example if input is set to “4-20” mode, then lower border is calculated due to expression:

$$I_{\min} = 4 \text{ mA} - 4 \text{ mA} \times \text{“Lo r”} \%$$

The “Lo r” value can be set from 0 to 99.9%.

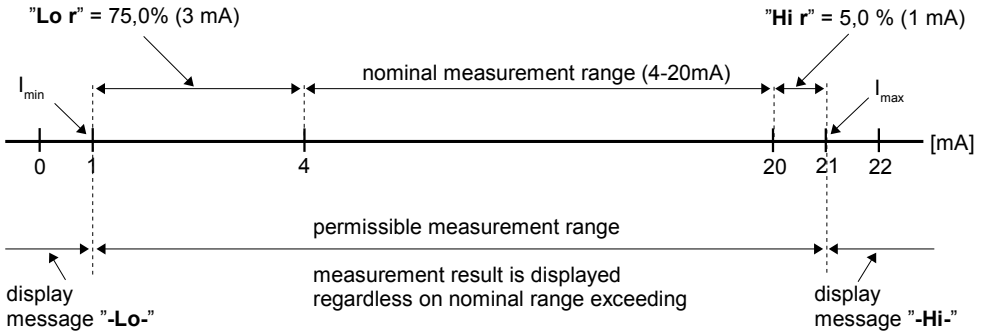


Figure 5.1 Example of definition of permissible range of input signal - "Lo r" and "Hi r" parameters ("4-20" mode)

Parameter "Hi r" determines the upper border of the permissible range accordingly to the expression (for all modes).

For example if input is set to "4-20" mode, then upper border is calculated due to expression:

$$I_{\max} = 20 \text{ mA} + 20 \text{ mA} \times \text{"Hi r"} \text{ \%}$$

The value of "Hi r" can be set from 0 to 19.9%.

In example no 1 of the **MEASURED VALUES CALCULATION** paragraph the procedure of the permissible input range determining is presented in details.

When linear, square or square root characteristic is chosen then the values returned in measurement registers (01h to 08h registers) are defined by "Lo CAL" and "Hi CAL" parameters. These parameters describe the values returned for minimum and maximum input value. For example, if input type is set to 4-20 mA, "Lo CAL" parameter defines the value returned when input current is equal 4 mA, and "Hi CAL" parameter defines the value returned for 20 mA of input current. Available range for these parameters: -999 ÷ 9999.

When user defined multipoint characteristic is chosen then the values returned in measurement registers (01h to 08h registers) are calculated according to coordinates defined by user (X, Y points, maximal 20 points). Coordinate „X” defines the percentage ratio of input value to selected measurement range. The „X” range: -99,9 ÷ 199,9. Coordinate „Y” defines the value (returned in measurement register) for particular „X” coordinate. The „Y” value can be changed in range: -999 ÷ 9999.

Settings of every channel are stored in nonvolatile EEPROM memory. Device signalizes overload of nominal measurement range (independently for every channel). All available device parameters can be set via RS-485 interface (see: **LIST OF REGISTERS** page 15).

Proper operation of the module is signalized by flashing green LED marked "RUN" and localized on front panel of the device. Red LED marked "Tx/ERROR" signalizes data transmission over serial interface by short flashes, when this diode lights constantly it means that some error occurred.

Forcing of 0xFF address

New devices has set to Modbus addresses 0xFE. To enhance system installation process special operation mode has been developed. It allows to force address 0xFF in single module using internal momentary switch mounted on module mainboard (Figure 4.1).

To change address of the device to FFh, wait for a moment after power up until green LED (RUN) starts flashes. Next press and hold push-button about 4 seconds until green LED will lights permanently, then release push-button.

The device changes its MODBUS address to FFh and waits for a new address (readdressing). Green LED (RUN) stay permanently on until readdressing via RS-485, or power off. While module is in this state it is possible to control its inputs, and communication is possible using temporal address FFh.

At this moment MASTER controller should find new device and readdress it (to address other than 0xFF and 0xFE). After remote readdressing green LED indicator starts to flashes again.

Simultaneously with change of device address, its baud rate is changed to 9600 bit/s. Required transmission speed (1200 bit/s. to 115200 bit/s.) can be set by write to register 22h. After change of transmission speed the device sends the answer with new baud rate. While installation of the new network it is recommended to readdress all devices using baud rate 9600 bit/s, and next change speed of all devices simultaneously, using BROADCAST query (with address 00h).

6. MEASURED VALUES CALCULATION

For simplicity of examples it's assumed that current input is selected, and all calculations are related to this input. When voltage input is selected calculations are similar (be sure of particular ranges and units).

The first step to compute the result of measure is the calculation of the normalized result (it means result of 0-1 range). To do it, the begin of the input range (0 mA for 0-20mA range, and 4mA for 4-20mA range) must be subtracted from measured value. Next, received result must be divided by the width of the input range (it means 20mA for 0-20mA range, and 16mA for 4-20mA range). So normalized result can be expressed by expressions:

$$I_n = \frac{I_{inp.} - 4}{16} \quad \text{for } 4 \div 20 \text{ mA range}$$

$$I_n = \frac{I_{inp.}}{20} \quad \text{for } 0 \div 20 \text{ mA range}$$

where $I_{inp.}$ Means input current (in mA), and I_n – normalized result.



If measured value exceeds the nominal input range (0-20mA or 4-20mA), and do not exceed the permissible input range, then received normalized I_n result will exceed 0-1 range, e.g. input range 4-20 mA, input current = 3 mA – the normalized result is equal -0,0625, and for input current = 22 mA, the normalized result is equal 1,125. In such cases presented expressions are still correct.

6.1. ADDITIONAL CALCULATIONS (USED CONVERSION CHARACTERISTIC)

The manner of the additional computation of the returned result depends on selected conversion characteristic. All presented charts are connected with the input range 4 - 20 mA.

Linear characteristic

The normalized result is converted by fixed coefficients determined by “Lo CAL” and “Hi CAL” parameters (when the normalized results is equal 0, then value “Lo CAL” is returned, and when the normalized results is equal 1, then value “Hi CAL” is returned). Expression presented below shows the manner of result calculation:

$$W = I_n \times ("Hi\ CAL" - "Lo\ CAL") + "Lo\ CAL",$$

where **W** means the value returned in measurement register.



The value of the “Lo CAL” parameter can be higher than the value of “Hi CAL” parameter. In such a case, for an increasing value of input current the returned value decreases.

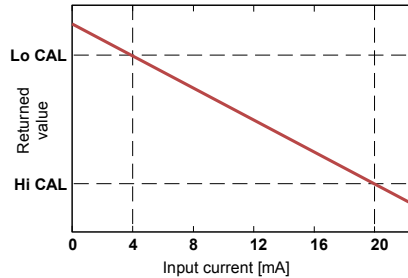
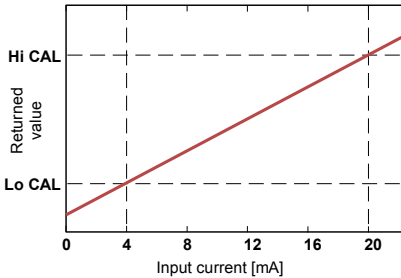


Figure. 6.1 Normal („Lo CAL” < ”Hi CAL”) and inverted („Lo CAL” > ”Hi CAL”) characteristic

Square characteristic

The normalized result is squared and further conversion is done as for linear characteristic. Conversion is made accordingly with the expression:

$$W = I_n^2 \times ("Hi\ CAL" - "Lo\ CAL") + "Lo\ CAL",$$

where **W** means the value returned in measurement register.

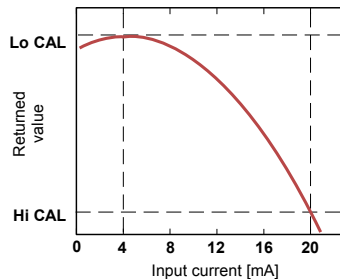
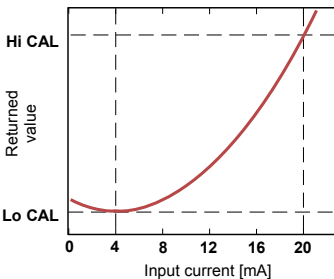


Figure. 6.2 Normal („Lo CAL” < ”Hi CAL”) and inverted („Lo CAL” > ”Hi CAL”) characteristic

Square root characteristic

The normalized result is rooted and further conversion is done as for linear characteristic. Conversion is made accordingly with the expression:

$$W = \sqrt{I_n} \times ("Hi\ CAL" - "Lo\ CAL") + "Lo\ CAL",$$

where W means the value returned in measurement register.



Shown above expression is not valid when normalized result is negative. It is possible for 4-20 mode only. In this case ($I_n < 0$) the returned result is equal "Lo CAL" (see graphs below).

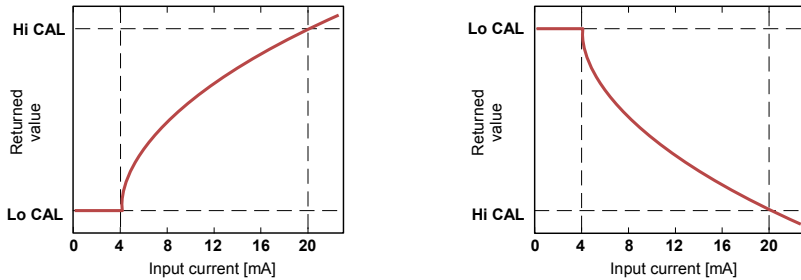


Figure. 6.3 Normal („Lo CAL” < ”Hi CAL”) and inverted („Lo CAL” > ”Hi CAL”) characteristic

User defined characteristic

User defined characteristic is defined as set of X-Y points. Number of the points is variable and may be set from 2 to 20 points which make linear segments (see graph and see **LIST OF REGISTERS**).

Due to the normalized result I_n , the device computes specific segment, e.g. for characteristic from figure below, and $I_n = 0,65$ the segment between points X = "50.0" and X = "70.0" will be chosen.

Let's mark those points as PL (point low) i PH (point high) - in this example PL= "50.0," and PH = "70.0," and the normalized result I_n for the point PL as I_p (in this example $I_p = I_n(PL) = 0,5$). The returned result is calculated accordingly to the expression:

$$W = (I_n - I_p) \times \frac{[Y(PH) - Y(PL)]}{[X(PH) - X(PL)]} \times 100 + Y(PL)$$

where Y(PH), X(PH), Y(PL), X(PL) mean values of X and Y coordinates of PH i PL points.



If the normalized result exceeds the user defined characteristic values, then specific utmost segment, defined by two next points, is used for calculations. If characteristic from figure below is used, and if $I_n > 1$ then segment defined by points X(PL) = "90.0," X(PH) = "100.0" will be used.

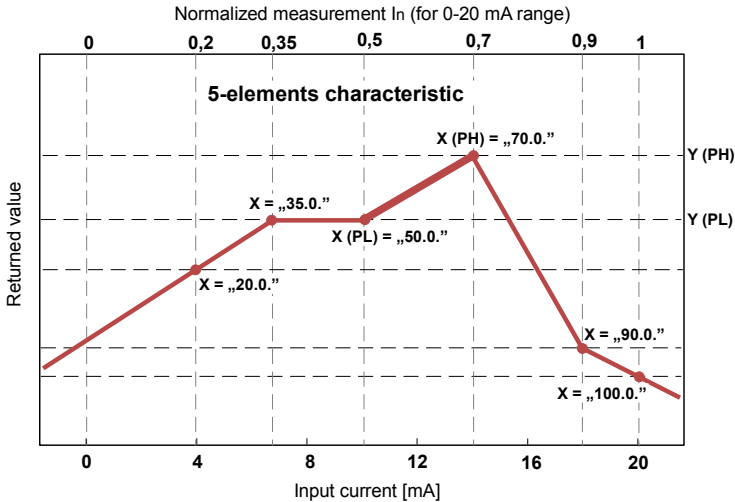


Figure. 6.4 Example of user defined characteristic

6.2. EXAMPLES OF CALCULATIONS

Example 1: Selection of the permissible input range (“4-20” mode)

If in “4-20” mode the user sets “Lo r” = 20,0% and “Hi r” = 10,0%, then permissible input currents range will be equal: 3,2 mA ÷ 22 mA. Lower border of the range is the result of calculations: 4 mA - 4 mA × 20%, and the higher : 20 mA + 20 mA × 10%.

Example 2: The normalized I_n result calculation

Let the input mode = 4-20 mA. The normalized I_n result is calculated accordingly to the expression on page 9, so if I_{in} = 10 mA then 10 mA - 4 mA = 6 mA, and this result should be divided by the width of input range (16 mA). Finally the normalized result: $I_n = 6/16 = 0,375$.

In case when input current exceeds nominal measurement range, calculations are similar. For example if input current is equal 2,5 mA then $I_n = (2,5 - 4)/16 \cong -0,0938$, and if input current is equal 20,5 mA then $I_n = (20,5 - 4)/16 \cong 1,0313$.

Example 3: The linear characteristic

Let the input mode = 4-20 mA, and parameters “Lo CAL” and “Hi CAL” equal to 300 and 1200 respectively. The calculations will be done for there different input currents from example 2.

a) $I_{in} = 10 \text{ mA}$ and $I_n = 0,375$

Accordingly to expression on page 10 for linear characteristic:

$0,375 \times [1200 - 300] \cong 337$ and next, the “**Lo CAL**” value is added to the result , so the returned value:

$$W \cong 337 + 300 = 637$$

b) $I_{in} = 2,5 \text{ mA}$ and $I_n = -0,0938$.

$$W \cong 216.$$

c) $I_{in} = 20,5 \text{ mA}$ and $I_n = 1,0313$.

$$W \cong 1228.$$

Example 4: The square characteristic

Let the input mode = 4-20 mA, and parameters “**Lo CAL**” and “**Hi CAL**” equal to 300 and 1200 respectively. The calculations will be done for there different input currents from example 2.

a) $I_{in} = 10 \text{ mA}$ and $I_n = 0,375$

Accordingly to expression on page 10 for linear characteristic: $(0,375)^2 \times [1200 - 300] \cong 127$. and next, the “**Lo CAL**” value is added to the result , so the returned value:

$$W \cong 127 + 300 = 427$$

b) $I_{in} = 2,5 \text{ mA}$ and $I_n = -0,0938$.

$$W \cong 308.$$

c) $I_{in} = 20,5 \text{ mA}$ and $I_n = 1,0313$.

$$W \cong 1257.$$

Example 5: The square root characteristic

Let the input mode = 4-20 mA, and parameters “**Lo CAL**” and “**Hi CAL**” equal to 300 and 1200 respectively. The calculations will be done for there different input currents from example 2.

a) $I_{in} = 10 \text{ mA}$ and $I_n = 0,375$

Accordingly to expression on page 11 for linear characteristic:

$$\sqrt{0,375} \times [1200 - 300] \cong 551.$$

and next, the “**Lo CAL**” value is added to the result , so the returned value:

$$W \cong 551 + 300 = 851$$

b) $I_{in} = 2,5 \text{ mA}$ and $I_n = -0,0938$, normalized result is negative , so the returned value is equal to “**Lo CAL**” parameter: $W \cong \text{“Lo CAL”} = 300$.

c) $I_{in} = 20,5 \text{ mA}$ and $I_n = 1,0313$.

$$W \cong 1214.$$

Example 6: The user defined characteristic

Let the input mode = 4-20 mA, and the user selected the 10 segment characteristic. To do this it is necessary to enter X and Y coordinates of 11 points (see **LIST OF REGISTERS**). The calculations will be done for three different input currents from example 2, so in calculations some of the segments will be used only.

Let the following points will be given:

X1 = "00.0.", Y1 = "10.0",
 X2 = "10.0.", Y2 = "20.0",

 X6 = "30.0.", Y6 = "30.0",
 X7 = "40.0.", Y7 = "80.0",

 X10 = "90.0.", Y10 = "900.0",
 X11 = "100.0.", Y11 = "820.0",

Additionally all other points must to be defined and stored in the device memory.

a) $I_n = 10$ mA and $I_p = 0,375$

The segment defined by X6 = "30.0." i X7 = "40.0." for this I_n will be selected. Accordingly to expressions given for user defined characteristic (see page 11) X6(PL) = 30, Y6(PL) = 30, X7(PH) = 40, Y7(PH) = 80 and $I_p = 0,3$, the returned value :

$$W = (I_n - I_p) \times \frac{[Y(PH) - Y(PL)]}{[X(PH) - X(PL)]} \times 100 + Y(PL) =$$

$$= (0,375 - 0,3) \times \frac{[80 - 30]}{[40 - 30]} \times 100 + 30 \simeq 67$$

b) $I_n = 2,5$ mA and $I_p = -0,0938$, because of the normalized I_n value is lower than 0, the segment defined by X1 and X2 will be selected. X1(PL) = 0, Y1(PL) = 10, X2(PH) = 10, Y2(PH) = 20 and $I_p = 0$. For these values the returned value $W \simeq 1$.

c) $I_n = 20,5$ mA and $I_p = 1,0313$, because of the normalized I_n value is higher than 1, the segment defined by X10 and X11 will be selected, and X10(PL) = 90, Y10(PL) = 900, X11(PH) = 100, Y11(PH) = 820 and $I_p = 0,9$ for these values the returned value $W \simeq 795$.

7. THE MODBUS PROTOCOL HANDLING

Transmission parameters: 1 start bit, 8 data bits, 1 stop bit, no parity control

Baud rate: selectable from: 1200 to 115200 bits/second

Transmission protocol: MODBUS RTU compatible

The device parameters and measurement values are available via RS-485 interface, as HOLDING-type registers (numeric values are given in U2 code) of Modbus RTU protocol. The registers (or groups of the registers) can be read by 03h function, and wrote by 06h (single registers) accordingly to Modbus RTU specification. Maximum group size for 03h function can not exceeds 12 registers (for single frame).



The device interprets the broadcast messages, but then do not sends the answers.

7.1. LIST OF REGISTERS

Register	Write	Range	Register description
01h	No	-10000÷ 10000	Result of channel 1
02h	No	-10000÷ 10000	Result of channel 2
03h	No	-10000÷ 10000	Result of channel 3
04h	No	-10000÷ 10000	Result of channel 4
05h	No	-10000÷ 10000	Result of channel 5
06h	No	-10000÷ 10000	Result of channel 6
07h	No	-10000÷ 10000	Result of channel 7
08h	No	-10000÷ 10000	Result of channel 8
09h	No	0000h - FFFFh	Status register for channels 1 - 8
20h ¹	Yes	1 ÷ FFh	Device address. New devices has default address = FEh
21h	No	see description	Device identification code (ID) 209Ah - current version 206Eh - voltage version
22h ²	Yes	0 ÷ 7	Baudrate: 0 - 1200 baud; 1 - 2400 baud; 2 - 4800 baud; 3 - 9600 baud; 4 - 19200 baud; 5 - 38400 baud; 6 - 57600 baud; 7 - 115200 baud
23h ³	Yes	0 ÷ 1	Permission to write registers via RS-485 interface: 0 - write denied ; 1 - write allowed
25h	Yes	0 ÷ 5	Additional response delay: 0 - no additional delay; 1 - 10 characters delay; 2 - 20 characters delay; 3 - 50 characters delay; 4 - 100 characters delay; 5 - 200 characters delay
27h	Yes	0 ÷ 99	Maximum delay between received frames: 0 - no delay checking;

Register	Write	Range	Register description
			1 ÷ 99 - maximum delay expressed in seconds
28h ÷ 2Fh 30h ÷ 37h 38h ÷ 3Fh 40h ÷ 47h 48h ÷ 4Fh 50h ÷ 57h 58h ÷ 5Fh 60h ÷ 67h			<div> Channel 1 parameters block Channel 2 parameters block Channel 3 parameters block Channel 4 parameters block Channel 5 parameters block Channel 6 parameters block Channel 7 parameters block Channel 8 parameters block </div> <div>See below</div>
70h ⁴	Yes	-999 ÷ 1999	The value of „X” coordinate of point no. 1 of the user defined characteristic, expressed in 0.1%
71h ⁴	Yes	-10000 ÷ 10000	The value of „Y” coordinate of point no. 1 of the user defined characteristic, no decimal point included
72h ⁴ ÷ 95h ⁴			Further pairs of „X” - „Y” coordinates of points no. 2 ÷ 19 of the user defined characteristic
96h ⁴	Yes	-999 ÷ 1999	The value of „X” coordinate of point no. 20 of the user defined characteristic, expressed in 0.1%
97h ⁴	Yes	-10000 ÷ 10000	The value of „Y” coordinate of point no. 20 of the user defined characteristic, no decimal point included

- 1 - after writing to register no 20h the device responds with an “old” address in the message.
2 - after writing to register no 22h the device responds with the new baud rate.
3 - the value of this parameter is also connected to write to this register, so it is possible to block a writes, but impossible to unblock writes via RS-485 interface. The unblocking of the writes is possible by device reset only (see “**Forcing of 0xFF address**”, page 9).
4 - the pairs of „X - Y” coordinates may be defined for any free point. The pair is “free” (it means that particular point is not defined) if „X” coordinate of this point is equal 8000h. After writing both X and Y coordinate the point is defined and used in calculation of result. The coordinates of any point can be changed at any time.

Content of channel parameters block:

Relative address	Write	Range	Description
+0	Yes	0 ÷ 1 (current version) 0 ÷ 3 (voltage version)	Measurement range: 0 - 0-20 mA (current version) or 0-10V (voltage version); 1 - 4-20 mA (current version) or 2-10V (voltage version); 2 - 0-5 V (voltage version only); 3 - 1-5 V (voltage version only);
+1	Yes	0 ÷ 3	Channel characteristic: 0 - linear ; 1 - square; 2 - square root; 3 - user defined
+2	Yes	0 ÷ 5	Digital filter (exponential): 0 – no filtration; 5 – maximum filtration.
+3	Yes	-10000 ÷ 10000	Parameter “ Lo CAL ” This value is returned as Channel Result when input

Relative address	Write	Range	Description
			current is equal to bottom border of the selected range
+4	Yes	-10000 ÷ 10000	Parameter " Hi CAL " This value is returned as Channel Result when input current is equal to upper border of the selected range
+5	Yes	0 ÷ 999	Parameter " Lo r ", expressed by 0,1% Percentage extension of measurement range below its bottom border
+6	Yes	0 ÷ 200	Parameter " Hi r ", expressed by 0,1% Percentage extension of measurement range over its upper border



It is possible to read up to 12 registers at once (see example no. 1).

Content of status register (no. 09h)

Bit no.	15, ... , 8	7, ... , 0
function	H8, ... , H1	L8, ... , L1

Bits H1 to H8 mean overflow of measurement range of particular channels

Bits L1 to L8 mean underflow of measurement range of particular channels

7.2. TRANSMISSION ERRORS DESCRIPTION

If an error occurs while write or read of single register, then the device sends an error code according to Modbus RTU specifications.

Error codes:

01h - illegal function (only functions 03h and 06h are available),

02h - illegal register address

03h - illegal data value

08h - no write permission (see: "mbAc" parameter)

A0h - exceeded of upper border of input range

60h - exceeded of lower border of input range

A0h and 60h codes can appear only during reg. 01h is reading by 03h function (read of a single register)

7.3. EXAMPLES OF QUERY/ANSWER FRAMES

Examples apply for device with address 1. All values are represent hexadecimal.

Field description:

ADDR Device address on modbus network

FUNC Function code

REG H,L Starting address (address of first register to read/write, Hi and Lo byte)

COUNT H,L No. of registers to read/write (Hi and Lo byte)

BYTE C Data byte count in answer frame
DATA H,L Data byte (Hi and Lo byte)
CRC L,H CRC error check (Hi and Lo byte)

1. Read of the registers 01h ÷ 09h in one message (example of reading a number of registries in one frame):

ADDR	FUNC	REG H,L		DATA		CRC L,H	
01	03	00	01	00	09	D4	0C

a) The answer:

ADDR	FUNC	BYTE C	DATA																CRC L,H	
01	03	12	00	96	EC	78	07	E4	00	00	00	00	00	00	00	00	04	00	3D	43
			Chanel 1		Chanel 2		Chanel 3		Chanel 4		Chanel 5		Chanel 6		Chanel 7		Chanel 8		Status	

Interpretation of the answer:

Channels 1,2,3 results respectively: 150, -5000, 2020 (negative numbers U2 coded). All other channels give 0. Status register signalizes overflow in channel 3.

2. Read of device ID code

ADDR	FUNC	REG H,L		COUNT H,L		CRC L,H	
01	03	00	21	00	01	D4	00

The answer:

ADDR	FUNC	BYTE C	DATA H,L		CRC L,H	
01	03	02	20	9A	21	EF

DATA - identification code (209Ah)

3. Change of the device address from 1 to 2 (write to reg. 20h)

ADDR	FUNC	REG H,L		DATA H,L		CRC L,H	
01	06	00	20	00	02	09	C1

DATA H - 0

DATA L - new device address (2)

The answer (the same as the message):

ADDR	FUNC	REG H,L		DATA H,L		CRC L,H	
01	06	00	20	00	02	09	C1

4. Change of baud rate of all devices connected to the net (BROADCAST message).

ADDR	FUNC	REG H,L		COUNT H,L		CRC L,H	
00	06	00	22	00	04	29	D2

DATA H - 0

DATA L - 4, new baud rate 19200 baud



Device do not reply to BROADCAST-type messages.

5. Try to write illegal data value into baud rate register

ADDR	FUNC	REG H,L		DATA H,L		CRC L,H	
01	06	00	22	00	09	E9	C6

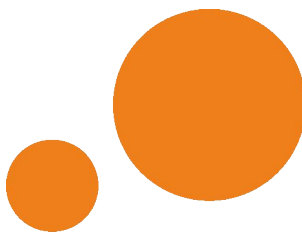
DATA L = 9 - value exceeds allowable range (0÷7)

The answer (exception code 03h - illegal data value):

ADDR	FUNC	ERR	CRC L,H	
01	86	03	02	61

ERROR - error code (in this case 03h, illegal data value)

**There is no full implementation of the Modbus Protocol in the device. The functions presented above are available only.**



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