

# SFAR-S-8AI2DO

User Manual

## Expansion Module – 8 Analog Inputs, 2 Digital Outputs



Global Control 5 Sp. z o.o.  
Warsaw, Poland  
[www.gc5.pl](http://www.gc5.pl)

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Thank you for choosing our product.

This manual will help you with proper handling and operating of the device.

The information included in this manual have been prepared with utmost care by our professionals and serve as a description of the product without incurring any liability for the purposes of commercial law.

This information does not discharge you from the liability of your own judgement and verification.

We reserve the right to change product specifications without notice.

Please read the instructions carefully and follow the recommendations concluded therein.

**WARNING!**

Failure to follow instructions can result in equipment damage or impede the use of the hardware or software.

## 1. Safety rules

1. Refer to this manual before the first use.
2. Make sure that all cables are connected properly before the first use.
3. Please ensure proper working conditions, according to the device specifications (e.g., supply voltage, temperature, maximum power consumption)
4. Turn the power supply off before making any modifications to wiring connections, turn off the power supply

## 2. Module features

### 2.1. Purpose and description of the module

SFAR-S-8AI2DO module allows measurement of voltages and currents. Values are read via RS485 (Modbus), so we can easily integrate the module with popular PLCs, HMI or PC equipped with the appropriate adapter.

The device has a set of 8 Analog Inputs measurements. In addition, the module is equipped with 2 configurable Digital Outputs.

This module is connected to the RS485 bus with twisted-pair wire. Communication is via Modbus RTU or Modbus ASCII. The use of 32-bit ARM core processor provides fast processing and quick communication. The baud rate is configurable from 2400 to 115200.

The module is designed for mounting on a DIN rail in accordance with DIN EN 5002.

The module is equipped with a set of LEDs to indicate the status of inputs and outputs which is useful for diagnostic purposes and helping to find errors.

Module configuration is done via USB by using a dedicated computer program. You can also change the parameters using the Modbus protocol.

## 2.2. Technical specifications

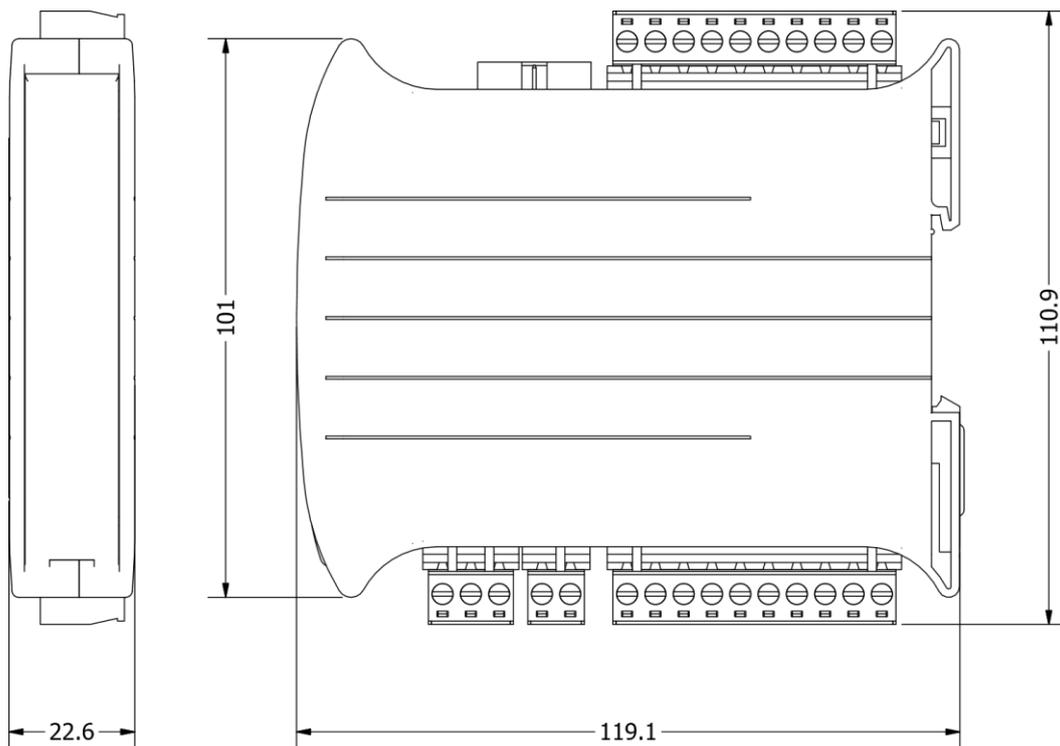
Power Supply	Voltage	10-38 V DC; 10-28 V AC	
	Power consumption <sup>1</sup>	2.4 W @ 24 V DC	
		3 VA @ 24 V AC	
Isolation	Isolation between power supply and I/O	1000 V DC	
Inputs	No of inputs	8	
	Absolute maximum input voltage	± 30 V	
	Voltage input impedance	120 kΩ	
	Voltage measurement accuracy	± 0.2 %	
	Voltage input mode 0 – 10 V -10 – 10 V	Max voltage	± 12.288 V
		Resolution	1.5 mV
	Voltage input mode 0 – 1 V -1 – 1 V	Max voltage	± 3.072 V
		Max voltage	1 mV
	Absolute maximum input current	± 35 mA	
	Current input impedance	100 Ω	
	Current measurement accuracy	± 0.2 %	
	Current input mode 0 – 20 mA -20 – 20 mA	Max current	± 30.72 mA
		Resolution	3.75 μA
	Current input mode 4 – 20 mA	Max current	20 mA
		Resolution	1 ‰
ADC processing time	16 ms / channel		
Digital outputs	Maximum current and voltage	500 mA / 55 V	
Temperature	Work	-20°C - +65°C	
	Storage	-40°C - +85°C	
Connectors	Power Supply	2 pin	
	Communication	3 pin	
	Inputs & Outputs	2 x 10 pin	
	Quick connector	IDC10	
	Configuration	Mini USB	
Size	Height	119.1 mm	
	Length	101 mm	
	Width	22.6 mm	
Interface	RS485	Up to 128 devices	

<sup>1</sup> Power consumption with active Modbus transmission, all outputs on and high state on all inputs

Table 1 - Technical specifications

## 2.3. Dimensions of the product

The appearance and dimensions of the module are shown below. The module is mounted directly to the rail in the DIN industry standard. Power connectors, communication and IOs are at the bottom and top of the module. USB connector configuration and indicators are located on the front of the module.



Picture 1 - Dimensions of the product

## 3. Configuring of the communication

### 3.1. Grounding and shielding

In most cases, IO modules will be installed in an enclosure along with other devices which generate electromagnetic radiation. Examples of these devices are relays and contactors, transformers, motor controllers etc. This electromagnetic radiation can induce electrical noise into both power and signal lines, as well as direct radiation into the module causing negative effects on the system. Appropriate grounding, shielding and other protective steps should be taken at the installation stage to prevent these effects. These protective steps include control cabinet grounding, module grounding, cable shield grounding, protective elements for electromagnetic switching devices, correct wiring as well as consideration of cable types and their cross sections.

### 3.2. Network termination

Transmission line effects often represent the problem of data communication networks. These problems include reflections and signal attenuation.

To eliminate the presence of reflections at the end of the cable, the cable must be terminated at both ends with a resistor across the line equal to its characteristic impedance. Both ends must be terminated since the direction of propagation is bi-directional. In the case of RS485 twisted pair cable this termination is typically 120  $\Omega$ .

### 3.3. Setting Module Address in RS485 Modbus Network

The following table shows how to set switch to determine the address of the module. The module address is set with the switches in the range of 0 to 31. Addresses from 32 to 255 can be set via RS485 or USB.

Addr	SW5	SW4	SW3	SW2	SW1
0	OFF	OFF	OFF	OFF	OFF
1	OFF	OFF	OFF	OFF	ON
2	OFF	OFF	OFF	ON	OFF
3	OFF	OFF	OFF	ON	ON
4	OFF	OFF	ON	OFF	OFF
5	OFF	OFF	ON	OFF	ON
6	OFF	OFF	ON	ON	OFF
7	OFF	OFF	ON	ON	ON
8	OFF	ON	OFF	OFF	OFF
9	OFF	ON	OFF	OFF	ON
10	OFF	ON	OFF	ON	OFF
11	OFF	ON	OFF	ON	ON
12	OFF	ON	ON	OFF	OFF
13	OFF	ON	ON	OFF	ON
14	OFF	ON	ON	ON	OFF
15	OFF	ON	ON	ON	ON

Addr	SW5	SW4	SW3	SW2	SW1
16	ON	OFF	OFF	OFF	OFF
17	ON	OFF	OFF	OFF	ON
18	ON	OFF	OFF	ON	OFF
19	ON	OFF	OFF	ON	ON
20	ON	OFF	ON	OFF	OFF
21	ON	OFF	ON	OFF	ON
22	ON	OFF	ON	ON	OFF
23	ON	OFF	ON	ON	ON
24	ON	ON	OFF	OFF	OFF
25	ON	ON	OFF	OFF	ON
26	ON	ON	OFF	ON	OFF
27	ON	ON	OFF	ON	ON
28	ON	ON	ON	OFF	OFF
29	ON	ON	ON	OFF	ON
30	ON	ON	ON	ON	OFF
31	ON	ON	ON	ON	ON

Table 2 – Setting Module Address in RS 485 Modbus Network

### 3.4. Types of Modbus registers

There are 4 types of variables available in the module

Type	Beginning address	Variable	Access	Modbus Command
1	00001	Digital Outputs	Bit Read & Write	1, 5, 15
2	10001	Digital Inputs	Bit Read	2
3	30001	Input Registers	Registered Read	3
4	40001	Output Registers	Registered Read & Write	4, 6, 16

Table 2 - Types of variables

### 3.5. Communication settings

The data stored in the module's memory is given in the 16-bit registers. The access to registers happens via Modbus RTU or Modbus ASCII.

#### 3.5.1. Default settings

You can restore the default configuration by the switch SW6 (see 3.5.2 - Restore the default configuration)

Baud rate	19200
Parity	No
Data bits	8
Stop bits	1
Reply Delay [ms]	0
Modbus Type	RTU

Table 3 - Default settings

#### 3.5.2. Restore the default configuration

To restore the default configuration:

- turn the power off
- turn the switch SW6 on
- turn the power on
- when power and communication LED flash turn the switch SW6 off

**WARNING!** After restoring the default configuration all values stored in the registers will be

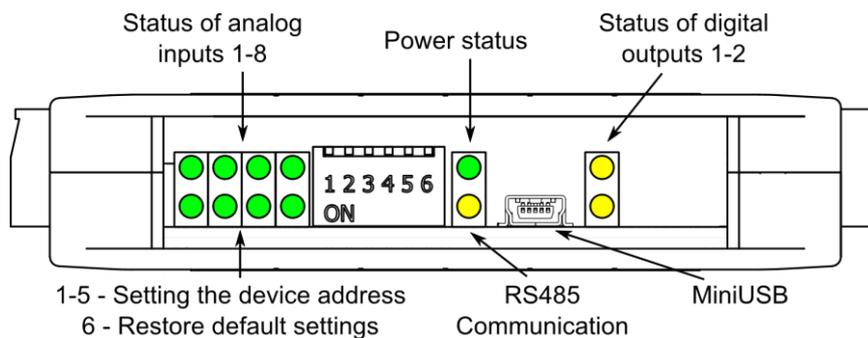
cleared as well.

### 3.5.3. Configuration registers

Modbus	Dec	Hex	Name	Values
Address				
40003	2	0x02	Baud rate	0 – 2400 1 – 4800 2 – 9600 3 – 19200 4 – 38400 5 – 57600 6 – 115200 other – value * 10
40005	4	0x04	Parity	0 – none 1 – odd 2 – even 3 – always 1 4 – always 0
40004	3	0x03	Stop Bits LSB	1 – one stop bit 2 – two stop bits
40004	3	0x03	Data Bits MSB	7 – 7 data bits 8 – 8 data bits
40006	5	0x05	Response delay	Time in ms
40007	6	0x06	Modbus Mode	0 – RTU 1 – ASCII

Table 4 - Configuration registers

## 4. Indicators



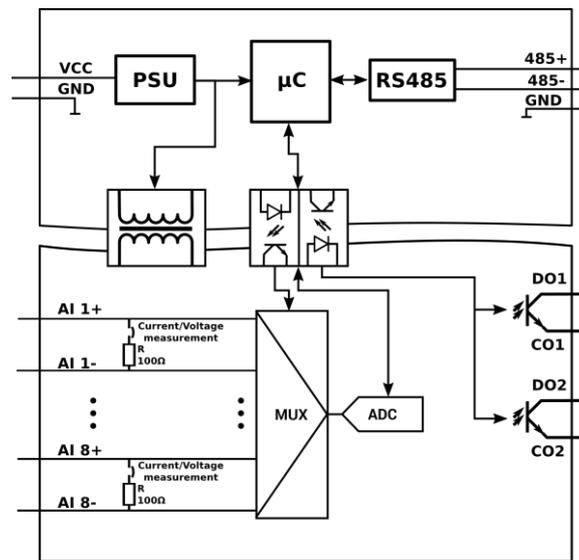
Picture 2 - Indicators

Indicator	Description
Power supply	LED indicates that the module is correctly powered.
Communication	The LED lights up when the unit received the correct packet and sends the answer.
Inputs state	LED indicates that the signal to input is connected.
Outputs state	LED indicates that the output is on.

Table 5 - Description of indicators

## 5. Module connection

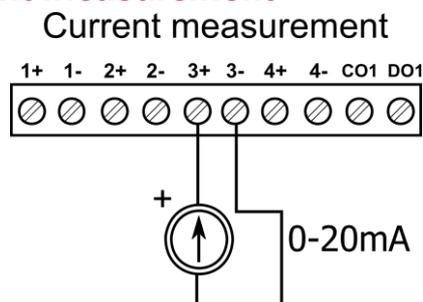
### 5.1. Block diagram



Picture 3 – Block diagram

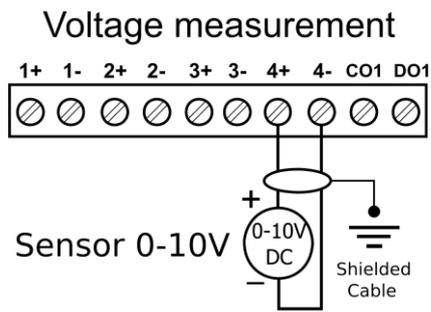
### 5.2. Connection of analog inputs

#### 5.2.1. Connection of current measurement



Picture 4 – Connection of current measurement

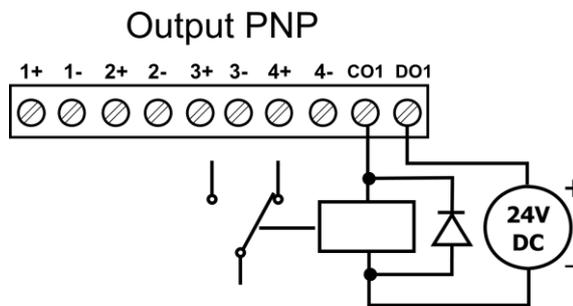
## 5.2.2. Connection of voltage measurement



Picture 5 – Connection of voltage measurement

## 5.3. Connection of digital outputs

### 5.3.1. Connection of PNP output



Picture 6 – Connection of PNP output

### 5.3.2. Connection of NPN output

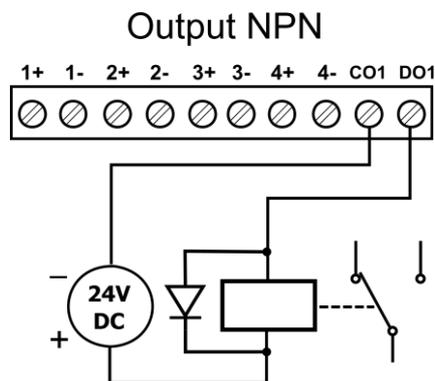
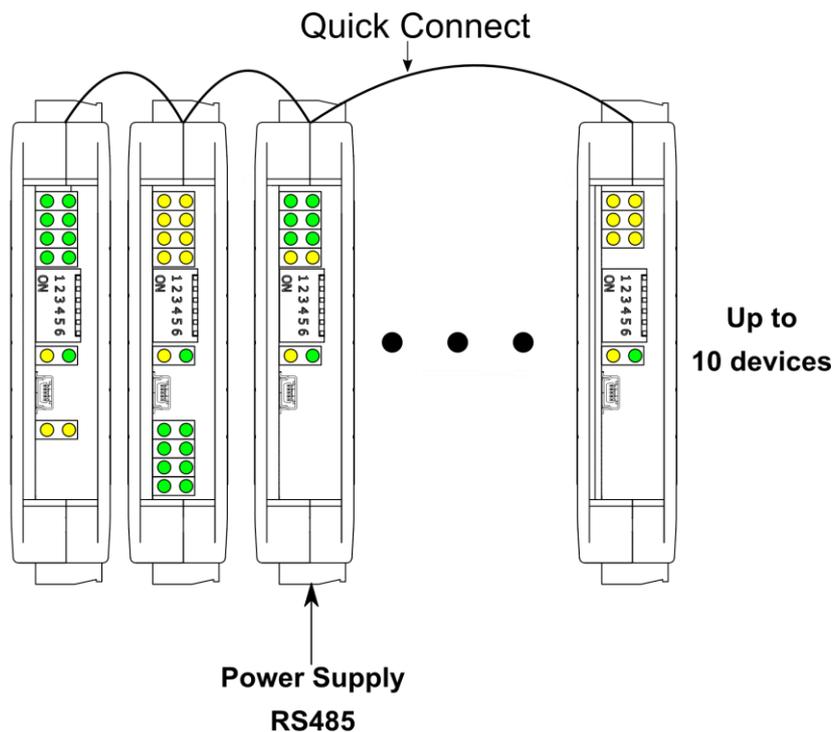


Table 6 – Connection of NPN output

## 5.4. Quick Connect

Quick Connect is a unique feature of modules that allows you to quickly connect a group of devices with a flat ribbon cable. Thanks to this solution, it is enough to connect power and RS485 communication to one of the devices in the group and the others will be powered and communicated with ribbon cable.

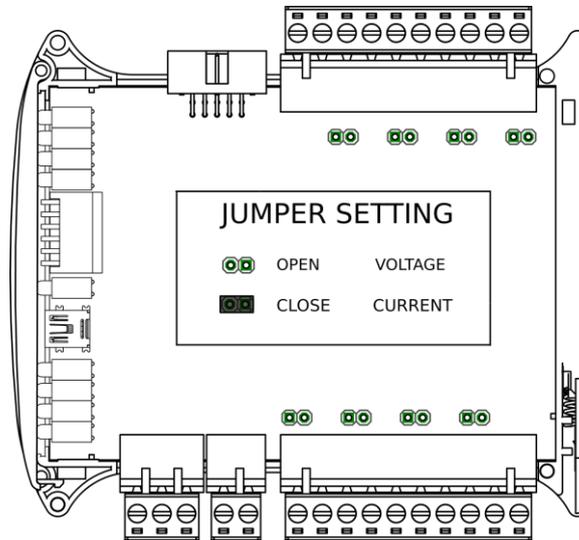
The Quick Connect is sufficient to connect up to 10 devices next to each other. What is important is that the various types of modules in the SFAR-S family can be connected with the ribbon cable.



Picture 8 – Connection of quick connect

## 6. Selecting the input mode

Each input can be used to measure the voltage - the default or the current one. To change the operating mode it is necessary to modify software settings as well as position of the jumpers inside the module as shown below.



Picture 9 – Jumper setting

## 7. Opening the case



Picture 10 – Opening the case

1. Remove the catch by pressing it and moving it towards the center of the case. Mind the spring located under the catch.
2. Separate parts of the case by gently tilting catches located as shown in the picture using thin tool.

## 8. Analog filtering

If the measured signal is interrupted it is possible to eliminate the disruptions by switching the lowpass filter on. It is possible to configure the filter for all inputs (it is not possible to enable the filter for only one input). The filter parameter corresponds to the filter time constant. Step response of the filter is shown in the graph below.

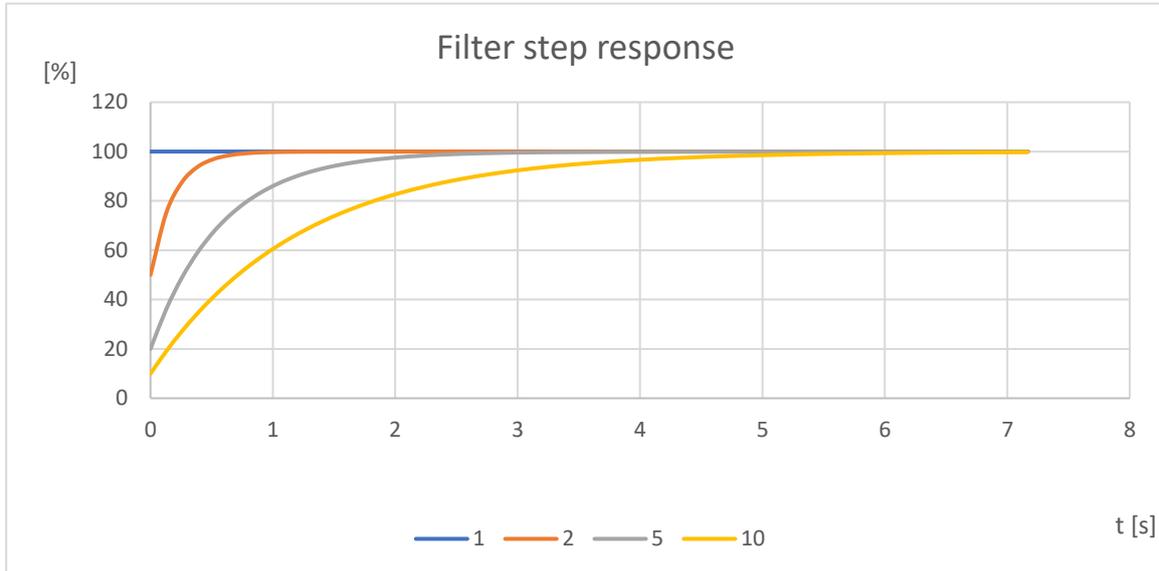
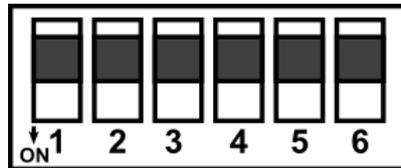


Chart 1- Step response add different coefficients

## 9. Switches



Picture 11- Switches

Switch	Function	Description
1	Module address +1	Setting module address from 0 to 31
2	Module address +2	
3	Module address +4	
4	Module address +8	
5	Module address +16	
6	Restoring default settings	Restoring default settings ( see 3.5.1 - Default settings and 3.5.2 - Restore the default configuration).

Table 7 - Description of switches

## 10. Modules Registers

### 10.1. Registered access

Modbus	Dec	Hex	Register Name	Access	Description
30001	0	0x00	Version/Type	Read	Version and Type of the device
30002	1	0x01	Switches	Read	Switches state
40003	2	0x02	Baud rate	Read & Write	RS485 baud rate
40004	3	0x03	Stop Bits & Data Bits	Read & Write	No of Stop bits & Data Bits (see 3.5.3)
40005	4	0x04	Parity	Read & Write	Parity bit
40006	5	0x05	Response Delay	Read & Write	Response delay in ms
40007	6	0x06	Modbus Mode	Read & Write	Modbus Mode (ASCII or RTU)
40010	9	0x09	Analog filtering	Read & Write	Analog filtering configuration see <a href="#">8.Analog filtering</a>
40033	32	0x20	Received packets MSB	Read & Write	No of received packets
40034	33	0x21	Received packets LSB	Read & Write	
40035	34	0x22	Incorrect packets MSB	Read & Write	No of received packets with error
40036	35	0x23	Incorrect packets LSB	Read & Write	
40037	36	0x24	Sent packets MSB	Read & Write	No of sent packets
40038	37	0x25	Sent packets LSB	Read & Write	
30051	50	0x32	Inputs	Read	Connected inputs Bit in high state → signal is connected
40052	51	0x33	Outputs	Read & Write	Alarms state bit 9 and 10 alarm outputs
30053	52	0x34	Analog 1	Read	Value of Analog Input  in mV for voltage inputs in µA for current inputs
30054	53	0x35	Analog 2	Read	
30055	54	0x36	Analog 3	Read	
30056	55	0x37	Analog 4	Read	
30057	56	0x38	Analog 5	Read	
30058	57	0x39	Analog 6	Read	
30059	58	0x3A	Analog 7	Read	
30060	59	0x3B	Analog 8	Read	
30061	60	0x3C	Value of 1. alarm input	Read	Current values of voltage / current for alarm inputs
30062	61	0x3D	Value of 2. alarm input	Read	
40063	62	0x3E	MAX alarm level 1	Read & Write	If the analog signal exceeds this value the

Modbus	Dec	Hex	Register Name	Access	Description
40064	63	0x3F	MAX alarm level 2	Read & Write	corresponding alarm flag is set
40065	64	0x40	MAX alarm level 3	Read & Write	
40066	65	0x41	MAX alarm level 4	Read & Write	
40067	66	0x42	MAX alarm level 5	Read & Write	
40068	67	0x43	MAX alarm level 6	Read & Write	
40069	68	0x44	MAX alarm level 7	Read & Write	
40070	69	0x45	MAX alarm level 8	Read & Write	
40071	70	0x46	MIN alarm level 1	Read & Write	
40072	71	0x47	MIN alarm level 2	Read & Write	
40073	72	0x48	MIN alarm level 3	Read & Write	
40074	73	0x49	MIN alarm level 4	Read & Write	
40075	74	0x4A	MIN alarm level 5	Read & Write	
40076	75	0x4B	MIN alarm level 6	Read & Write	
40077	76	0x4C	MIN alarm level 7	Read & Write	
40078	77	0x4D	MIN alarm level 8	Read & Write	
40079	78	0x4E	Alarm settings 1	Read & Write	Alarm settings  0 – alarm due to the current analog signal value 1 – Remember the value of the alarm, until reset by the master via Modbus
40080	79	0x4F	Alarm settings 2	Read & Write	
40081	80	0x50	Alarm settings 3	Read & Write	
40082	81	0x51	Alarm settings 4	Read & Write	
40083	82	0x52	Alarm settings 5	Read & Write	
40084	83	0x53	Alarm settings 6	Read & Write	
40085	84	0x54	Alarm settings 7	Read & Write	
40086	85	0x55	Alarm settings 8	Read & Write	
40087	86	0x56	Input 1 settings	Read & Write	Analog input mode:  0 – input disabled 1 – voltage 0 V to 10 V 2 – voltage -10 V to 10 V 3 – voltage 0 V to 1 V 4 – voltage -1 V to 1 V 5 – current 4 mA to 20 mA 6 – current 0 mA to 20 mA 7 – current -20 mA to 20 mA  To change the input mode you must to set jumper inside of module (see <a href="#">6. Selecting the input mode</a> )
40088	87	0x57	Input 2 settings	Read & Write	
40089	88	0x58	Input 3 settings	Read & Write	
40090	89	0x59	Input 4 settings	Read & Write	
40091	90	0x5A	Input 5 settings	Read & Write	
40092	91	0x5B	Input 6 settings	Read & Write	
40093	92	0x5C	Input 7 settings	Read & Write	
40094	93	0x5D	Input 8 settings	Read & Write	

Modbus	Dec	Hex	Register Name	Access	Description
40095	94	0x5E	Output 1 settings	Read & Write	Alarm output settings 0 – output is set by PLC +1 – value from input 1 +2 – value from input 2 +4 – value from input 3 +8 – value from input 4 +16 – value from input 5 +32 – value from input 6 +64 – value from input 7 +128 – value from input 8
40096	95	0x5F	Output 2 settings	Read & Write	+256 – Output is set if value is greater than Alarm Value (register 40097 or 40098) („cooling“) +512 – Output is set if value is less than Alarm Value (register 40097 or 40098) („heating“)  +1024 – The lowest value from selected inputs +2048 – The greatest value from selected inputs (if not select either of the two above options than is used average value of selected inputs)
40097	96	0x60	Alarm Value 1	Read & Write	Alarm value for outputs
40098	97	0x61	Alarm Value 2	Read & Write	
40099	98	0x62	Alarm hysteresis 1	Read & Write	The hysteresis value for alarm outputs
40100	99	0x63	Alarm hysteresis 2	Read & Write	

Table 8 - Registered access

## 10.2. Bit access

Modbus Address	Dec Address	Hex Address	Register name	Access	Description
801	800	0x320	Input 1	Read	Set when the input is connected
802	801	0x321	Input 2	Read	Set when the input is connected
803	802	0x322	Input 3	Read	Set when the input is connected
804	803	0x323	Input 4	Read	Set when the input is connected
805	804	0x324	Input 5	Read	Set when the input is connected
806	805	0x325	Input 6	Read	Set when the input is connected
807	806	0x326	Input 7	Read	Set when the input is connected
808	807	0x327	Input 8	Read	Set when the input is connected
817	816	0x330	Alarm 1	Read	Alarm state 1
818	817	0x331	Alarm 2	Read	Alarm state 2
819	818	0x332	Alarm 3	Read	Alarm state 3
820	819	0x333	Alarm 4	Read	Alarm state 4
821	820	0x334	Alarm 5	Read	Alarm state 5
822	821	0x335	Alarm 6	Read	Alarm state 6
823	822	0x336	Alarm 7	Read	Alarm state 7

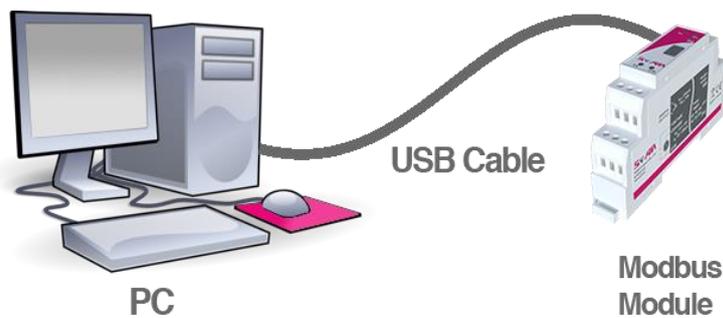
Modbus Address	Dec Address	Hex Address	Register name	Access	Description
824	823	0x337	Alarm 8	Read	Alarm state 8
825	824	0x338	Digital output 1	Read & Write	State of digital output 1
826	825	0x339	Digital output 1	Read & Write	State of digital output 2

Table 9 - Bit access

## 11. Software configuration

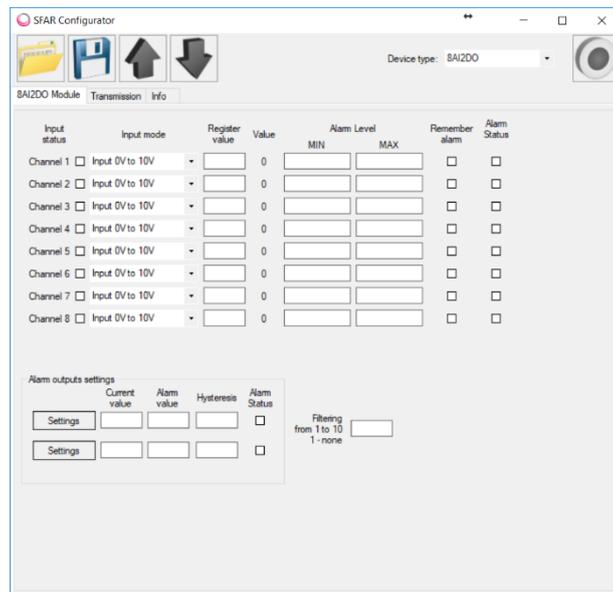
Modbus Configurator is the type of software which is designed to set the communication module registers over Modbus network as well as to read and write the current value of other registers of the module. It's a convenient way to test the system as well as to observe real-time changes in the registers.

Communication with the module happens via the USB cable. The module does not require any drivers.



Picture 11- Configuration process

Configurator is an universal software, whereby it is possible to configure all available modules



Picture 12 - Configurator