

SfAR-S-8AI2DO

User Manual

Expansion Module - 8 Analog Inputs, 2 Digital Outputs



Table of Contents

1	Introduction	4
1.1	Revision History.....	4
2	Safety Rules.....	5
3	Module Features.....	6
3.1	Purpose and Description of the Module	6
3.2	Technical Specification	6
3.3	Dimensions	8
4	Communication.....	9
4.1	Grounding and Shielding.....	9
4.2	Network Termination.....	9
4.3	Setting Module Address in RS485 Modbus Network	9
4.4	Types of Modbus Functions.....	11
4.5	Communication Settings.....	11
4.5.1	Default Settings.....	11
4.6	Configuration Registers.....	12
5	Indicators.....	13
6	Connections.....	14
6.1	Block Diagram	14
6.2	Power Supply Connection	14
6.2.1	DC Power Connection	14
6.2.2	AC Power Connection.....	15
6.3	Communication Bus Connection.....	15
6.4	Connection of Analog Inputs	15
6.4.1	Connection of Current Measurement.....	15
6.4.2	Connection of Voltage Measurement.....	16
6.5	Connection of Digital Outputs.....	16
6.5.1	Connection of PNP Output	16
6.5.2	Connection of NPN Output.....	16
6.6	Quick Connector	16
7	Selecting Input Mode.....	18
7.1	Opening the Case	18
8	Analog Filtering.....	19
9	DIP Switch.....	20
10	Module Registers.....	21

10.1	Registered Access.....	21
10.2	Bit Access.....	24
11	Configuration Software	26

1 Introduction

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.

1.1 Revision History

Rev.	Date	Description
3.3	10 Apr 2024	<ul style="list-style-type: none"> Corrected voltage input range for analog inputs Corrected AC power supply diagram
3.2	25 May 2022	Rebranded

Table 1. Revision history

2 Safety Rules

- Improper wiring of the product can damage it and lead to other hazards. Make sure that the product has been correctly wired before turning the power on.
- Before wiring or removing/mounting the product, make sure to turn the power off. Failure to do so might cause an electric shock.
- Do not touch electrically charged parts such as power terminals. Doing so might cause an electric shock.
- Do not disassemble the product. Doing so might cause an electric shock or faulty operation.
- Use the product only within the operating ranges recommended in the specification (temperature, humidity, voltage, shock, mounting direction, atmosphere, etc.). Failure to do so might cause a fire or faulty operation.
- Firmly tighten the wires to the terminal. Failure to do so might cause a fire.
- Avoid installing the product in close proximity to high-power electrical devices and cables, inductive loads, and switching devices. Proximity of such objects may cause an uncontrolled interference, resulting in an instable operation of the product.
- Proper arrangement of the power and signal cabling affects the operation of the entire control system. Avoid laying the power and signal wiring in parallel cable trays. It can cause interferences in monitored and control signals.
- It is recommended to power controllers/modules with AC/DC power suppliers. They provide better and more stable insulation for devices compared to AC/AC transformer systems, which transmit disturbances and transient phenomena like surges and bursts to devices. They also isolate products from inductive phenomena from other transformers and loads.
- Power supply systems for the product should be protected by external devices limiting overvoltage and effects of lightning discharges.
- Avoid powering the product and its controlled/monitored devices, especially high power and inductive loads, from a single power source. Powering devices from a single power source causes a risk of introducing disturbances from the loads to the control devices.
- If an AC/AC transformer is used to supply control devices, it is strongly recommended to use a maximum 100 VA Class 2 transformer to avoid unwanted inductive effects, which are dangerous for devices.
- Long monitoring and control lines may cause loops in connection with the shared power supply, causing disturbances in the operation of devices, including external communication. It is recommended to use galvanic separators.
- To protect signal and communication lines against external electromagnetic interferences, use properly grounded shielded cables and ferrite beads.
- Switching the digital output relays of large (exceeding specification) inductive loads can cause interference pulses to the electronics installed inside the product. Therefore, it is recommended to use external relays/contactors, etc. to switch such loads. The use of controllers with triac outputs also limits similar overvoltage phenomena.
- Many cases of disturbances and overvoltage in control systems are generated by switched, inductive loads supplied by alternating mains voltage (AC 120/230 V). If they do not have appropriate built-in noise reduction circuits, it is recommended to use external circuits such as snubbers, varistors, or protection diodes to limit these effects.

3 Module Features

3.1 Purpose and Description of the Module

The SfAR-S-8AI2DO module allows for measuring voltages and currents. Values are read via RS485 (Modbus), so the module can be easily integrated 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 a 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. It also allows for changing the parameters using the Modbus protocol or set the Modbus address using the DIP switches under the front panel.

3.2 Technical Specification

Power Supply	Voltage	10-38 V DC; 10-28 V AC
	Power consumption (with active Modbus transmission, all outputs on and high state on all inputs)	2.4 W at 24 V DC
		3 VA at 24 V AC
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
		Resolution	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
Isolation		1000 V DC	
Digital Outputs	Maximum current and voltage		500 mA/55 V
	Isolation		1000 V DC
Temperature	Work	-10°C to +50°C (14°F to 122°F)	
	Storage	-40°C to +85°C (-40°F to 185°F)	
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 (4.689 in)
	Length		110.9 mm (4.366 in)
	Width		22.7 mm (0.894 in)

Interface	RS485	Up to 128 devices
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Table 2. Technical specification

3.3 Dimensions

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 I/Os are at the bottom and top of the module. USB connector configuration and indicators are located on the front of the module.

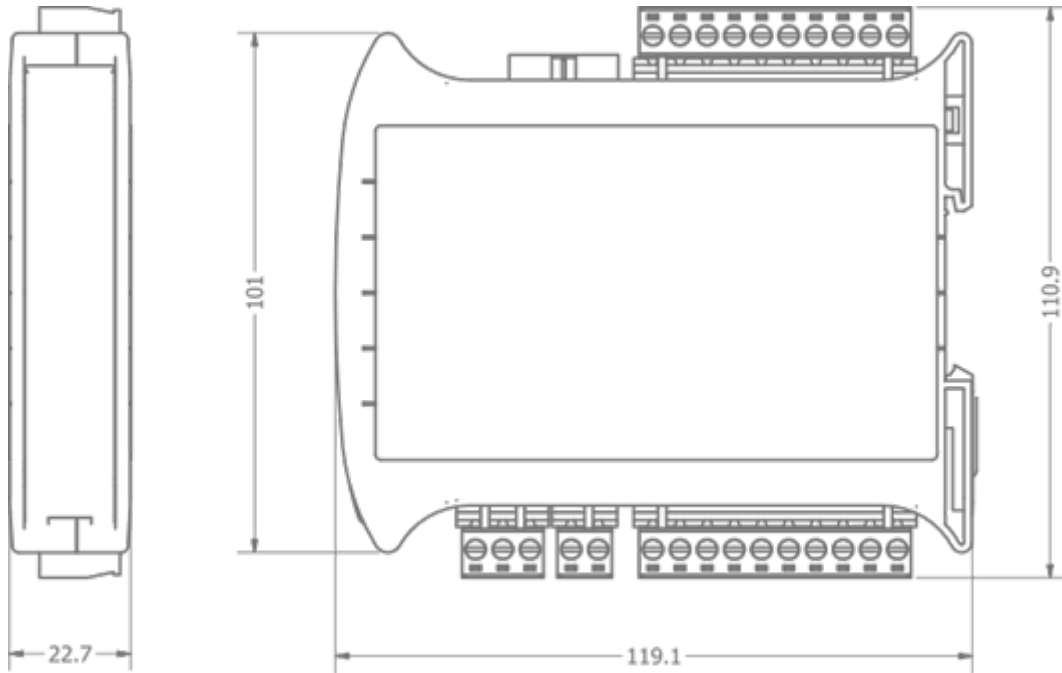


Figure 1. Dimensions

4 Communication

4.1 Grounding and Shielding

In most cases, I/O modules will be installed in an enclosure along with other devices, which generate electromagnetic radiation. Relays, contactors, transformers, motor controllers, etc. are examples of such devices. Radiation can induce electrical noise into both power and signal lines, as well as direct radiation into the module. Whether or not the SfAR modules are immune to such effects, the interferences must be suppressed at their source if possible to ensure the proper functioning of the entire system. Appropriate grounding, shielding and other protective steps should be taken at the installation stage to prevent these effects. It is recommended to at least follow the rules below:

- line power cables must be routed with spatial separation from signal and data transmission cables;
- analog and digital signal cables should also be separated;
- it is recommended to use shielded cables for analog signals, cable shields should not be interrupted by intermediate terminals;
- the shielding should be earthed directly after the cable enters the cabinet.

It is recommended to install interference suppressors when switching inductive loads (e.g., coils of contactors, relays, solenoid valves). RC snubbers or varistors are suitable for AC voltage and freewheeling diodes for DC voltage loads. The suppressing elements must be connected as close to the coil as possible.

4.2 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 adequate to its characteristic impedance. Both ends must be terminated since the direction of propagation is bidirectional. In case of RS485 twisted pair cable, this termination is typically 120 Ω .

4.3 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	SW1	SW2	SW3	SW4	SW5
0	OFF	OFF	OFF	OFF	OFF
1	ON	OFF	OFF	OFF	OFF
2	OFF	ON	OFF	OFF	OFF
3	ON	ON	OFF	OFF	OFF
4	OFF	OFF	ON	OFF	OFF

Addr	SW1	SW2	SW3	SW4	SW5
5	ON	OFF	ON	OFF	OFF
6	OFF	ON	ON	OFF	OFF
7	ON	ON	ON	OFF	OFF
8	OFF	OFF	OFF	ON	OFF
9	ON	OFF	OFF	ON	OFF
10	OFF	ON	OFF	ON	OFF
11	ON	ON	OFF	ON	OFF
12	OFF	OFF	ON	ON	OFF
13	ON	OFF	ON	ON	OFF
14	OFF	ON	ON	ON	OFF
15	ON	ON	ON	ON	OFF
16	OFF	OFF	OFF	OFF	ON
17	ON	OFF	OFF	OFF	ON
18	OFF	ON	OFF	OFF	ON
19	ON	ON	OFF	OFF	ON
20	OFF	OFF	ON	OFF	ON
21	ON	OFF	ON	OFF	ON
22	OFF	ON	ON	OFF	ON
23	ON	ON	ON	OFF	ON
24	OFF	OFF	OFF	ON	ON
25	ON	OFF	OFF	ON	ON
26	OFF	ON	OFF	ON	ON
27	ON	ON	OFF	ON	ON
28	OFF	OFF	ON	ON	ON
29	ON	OFF	ON	ON	ON
30	OFF	ON	ON	ON	ON

Addr	SW1	SW2	SW3	SW4	SW5
31	ON	ON	ON	ON	ON

Table 3. Setting module address in RS485 Modbus network, using DIP switch

4.4 Types of Modbus Functions

There are 4 types of Modbus functions supported by the SfAR modules:

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 4. Types of Modbus functions supported by the module

4.5 Communication Settings

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

4.5.1 Default Settings

The default configuration can be restored with the switch SW6.

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

Table 5. Default settings

Restore Default Configuration

To restore the default configuration, follow the steps below:

- turn the power off;
- turn the switch SW6 on;

- turn the power on;
- when power and communication LED is lit, turn the switch SW6 off

WARNING! After restoring the default configuration, all values stored in the registers will be cleared as well.

4.6 Configuration Registers

Modbus Address	Decimal Address	Hex Address	Name	Values
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 0 4 – always 1
40004	3	0x03	Stop Bits	1 – one stop bit 2 – two stop bits
40004	3	0x03	Data Bits	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 6. Configuration registers

5 Indicators

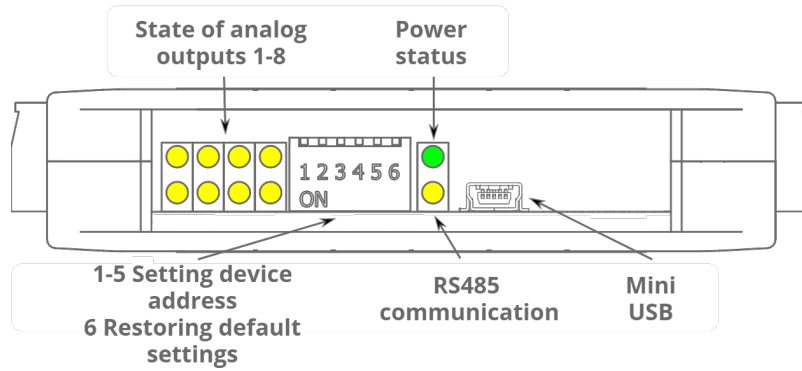


Figure 2. Indicators

Indicator	Description
Power Supply	The 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	The LED indicates that the signal to input is connected
Outputs State	The LED indicates that the output is on

Table 7. Description of indicators

6 Connections

6.1 Block Diagram

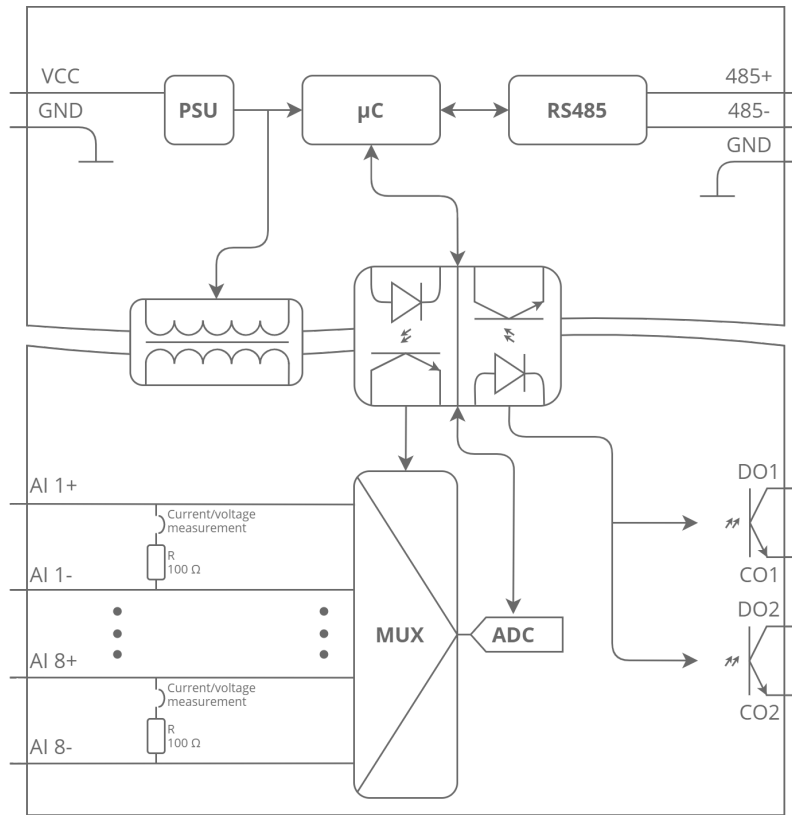


Figure 3. Block diagram

6.2 Power Supply Connection

6.2.1 DC Power Connection

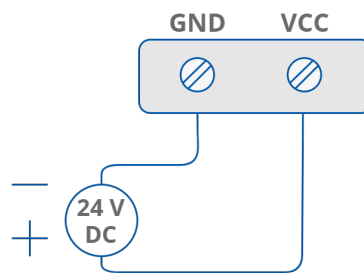


Figure 4. DC power connection

6.2.2 AC Power Connection

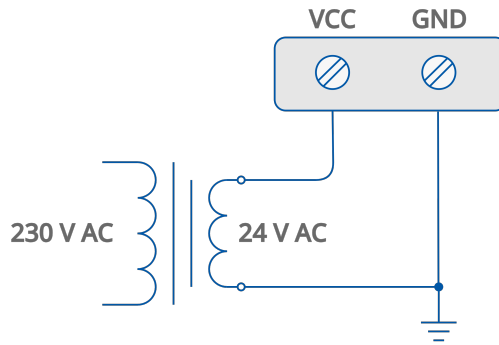


Figure 5. AC power connection

6.3 Communication Bus Connection

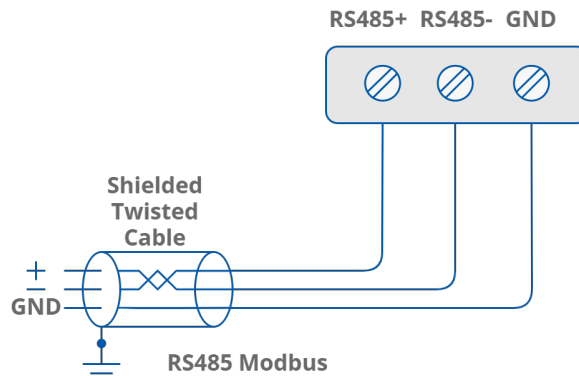


Figure 6. Communication bus connection

6.4 Connection of Analog Inputs

6.4.1 Connection of Current Measurement

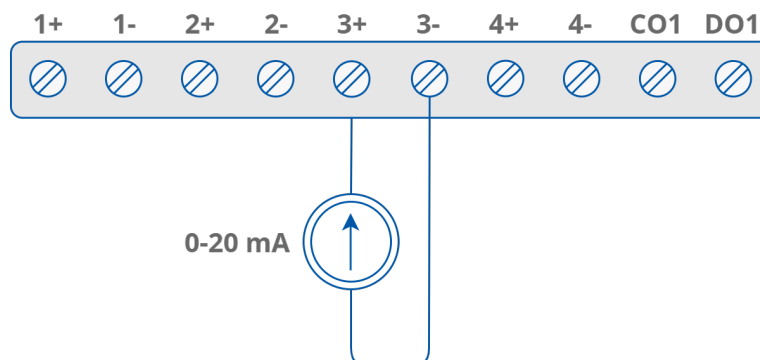


Figure 7. Connection of current measurement

6.4.2 Connection of Voltage Measurement

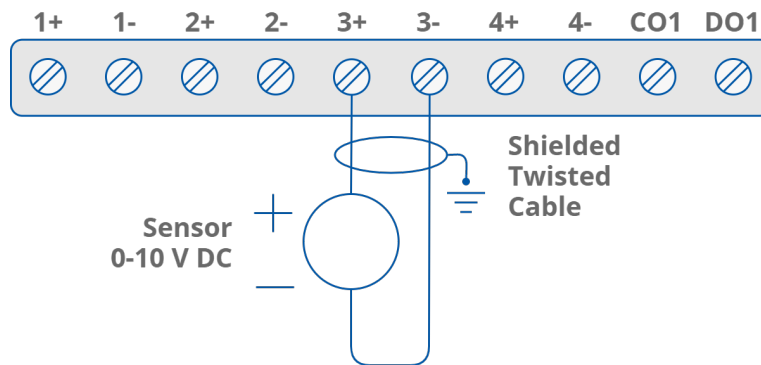


Figure 8. Connection of voltage measurement

6.5 Connection of Digital Outputs

6.5.1 Connection of PNP Output

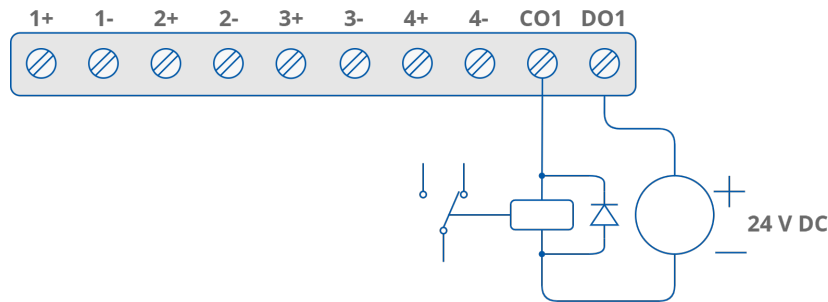


Figure 9. Connection of PNP output

6.5.2 Connection of NPN Output

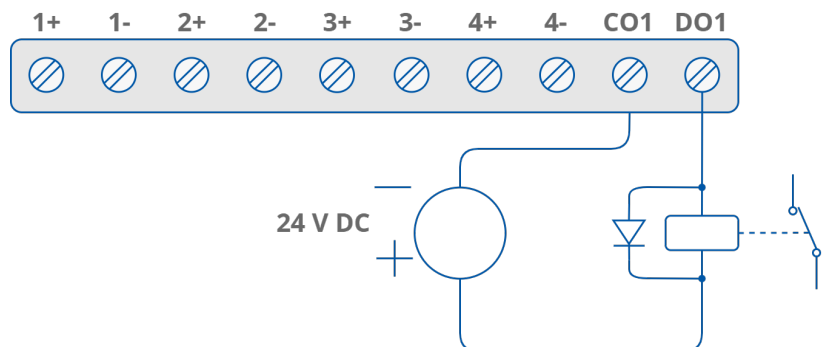


Figure 10. Connection of NPN output

6.6 Quick Connector

The Quick Connector is a unique feature of modules that allows for quickly connecting a group of devices with a flat ribbon cable.

Thanks to this solution, it is enough to the power supply and RS485 communication to one of the devices in the group, and the others will be powered and communicated with ribbon cable. The Quick Connector is sufficient to connect up to 10 devices next to each

other. It is important that the various types of modules in the SfAR-S family can be connected with the ribbon cable.

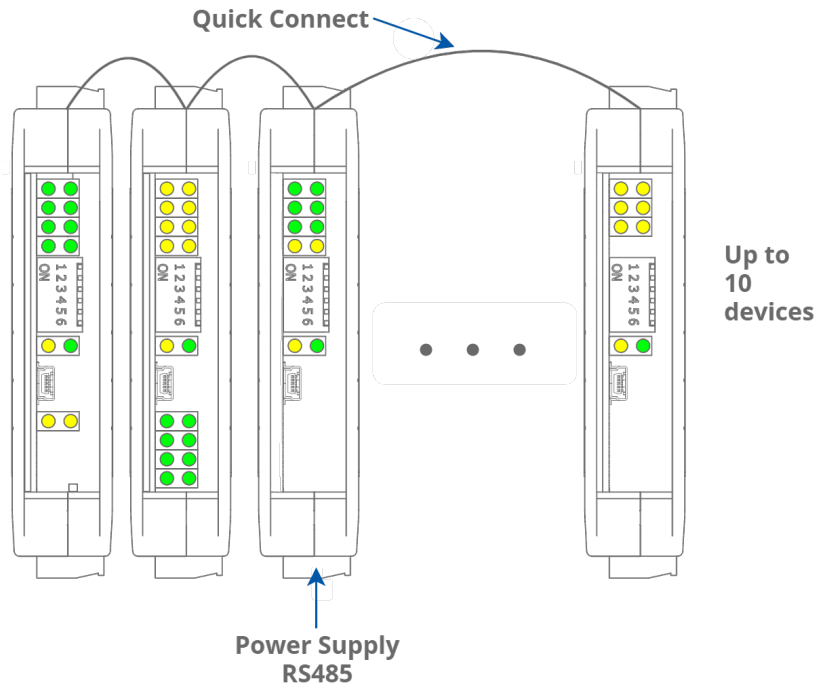


Figure 11. Quick Connector

7 Selecting Input Mode

Each input can be used to measure voltage (by default) or current. To change the operating mode, it is necessary to modify software settings and the position of jumpers inside the module as shown below.

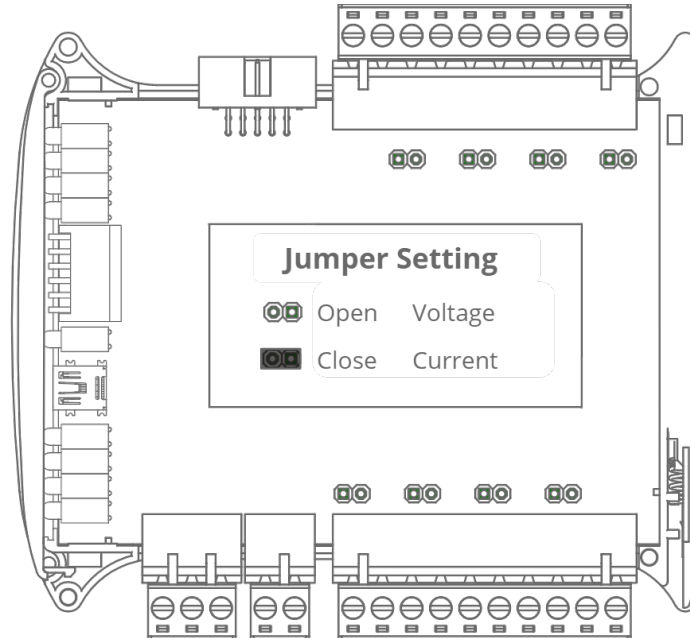


Figure 12. Jumper setting

7.1 Opening the Case

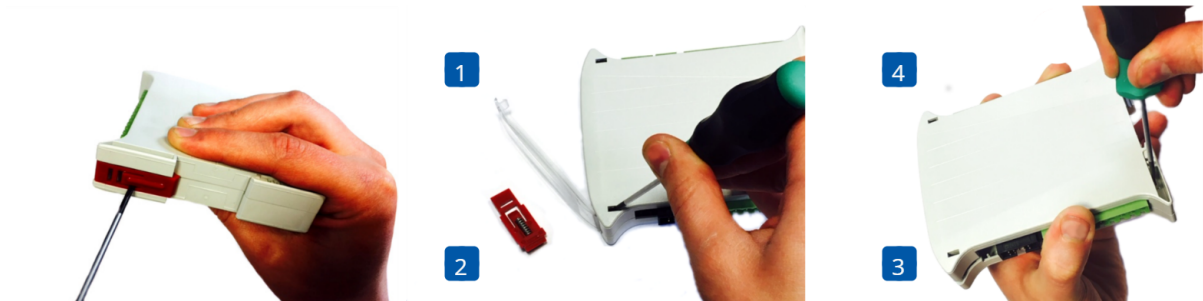


Figure 13. Opening the case

- Remove the catch by pressing it and moving it towards the center of the case. Mind the spring located under the catch.
- 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.

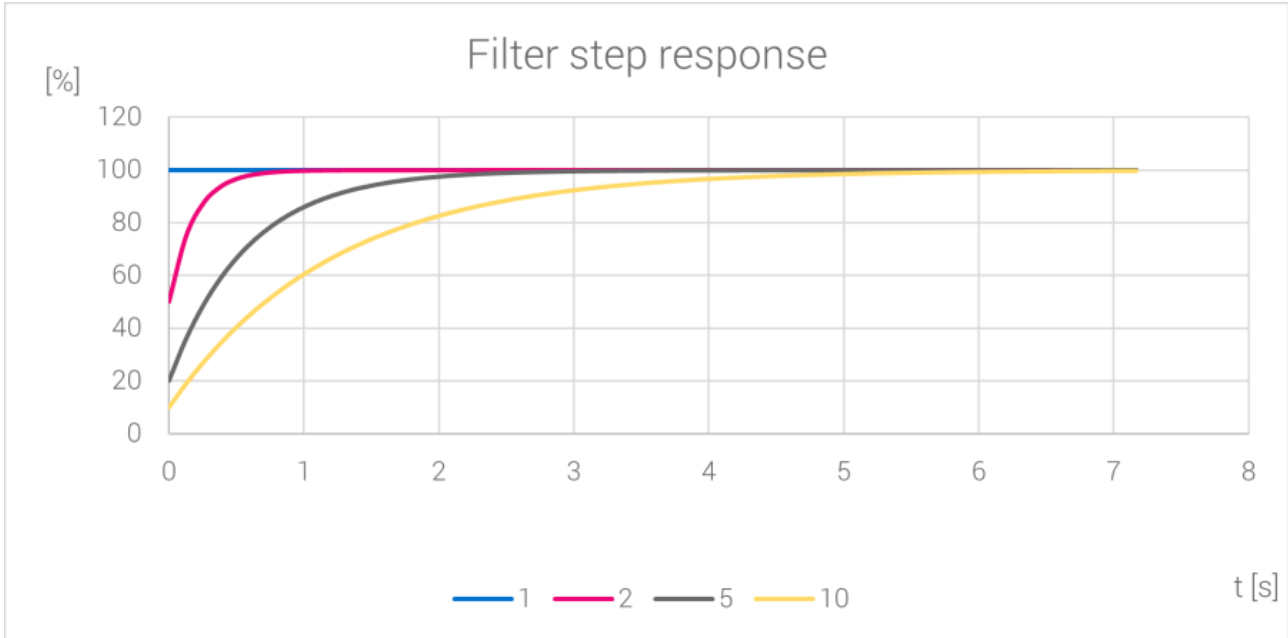


Figure 14. Step response and different coefficients

9 DIP Switch



Figure 15. DIP switch

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

Table 8. Description of switches

10 Module Registers

10.1 Registered Access

Modbus Address	Decimal Address	Hex Address	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
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
40033	32	0x20	Received Packets LSR (Least Significant Register)	Read/write	No. of received packets
40034	33	0x21	Received Packets MSR (Most Significant Register)	Read/write	
40035	34	0x22	Incorrect Packets LSR	Read/write	No. of received packets with error
40036	35	0x23	Incorrect Packets MSR	Read/write	
40037	36	0x24	Sent Packets LSR	Read/write	No. of sent packets
40038	37	0x25	Sent Packets MSR	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	

Modbus Address	Decimal Address	Hex Address	Register Name	Access	Description
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 corresponding alarm flag is set
40064	63	0x3F	MAX Alarm Level 2	Read/write	
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	If the analog signal is below this value corresponding alarm flag is set
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

Modbus Address	Decimal Address	Hex Address	Register Name	Access	Description
40080	79	0x4F	Alarm Settings 2	Read/write	1 – remember the value of the alarm, until reset by the master via Modbus
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	
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	
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 +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

Modbus Address	Decimal Address	Hex Address	Register Name	Access	Description
40096	95	0x5F	Output 2 settings	Read/write	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 9. 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

Modbus Address	Dec Address	Hex Address	Register Name	Access	Description
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
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 10. Bit access

11 Configuration Software

The SfAR Configurator is a 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.

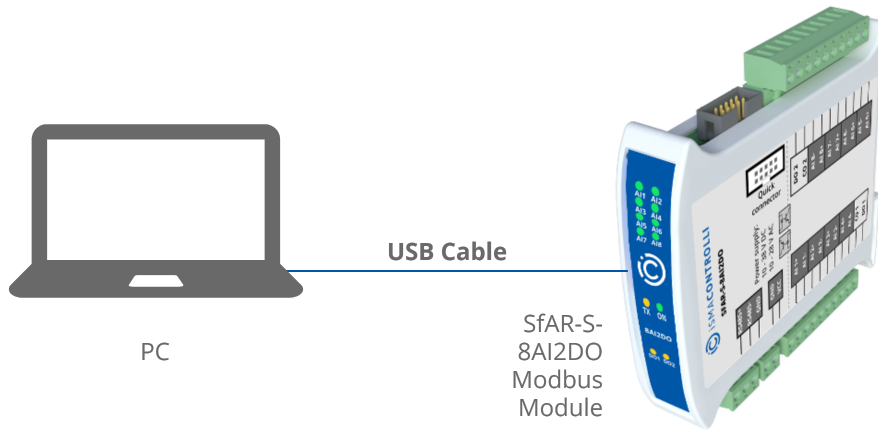


Figure 16. PC connection

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

The SfAR Configurator is a universal software, where it is possible to configure all available modules.

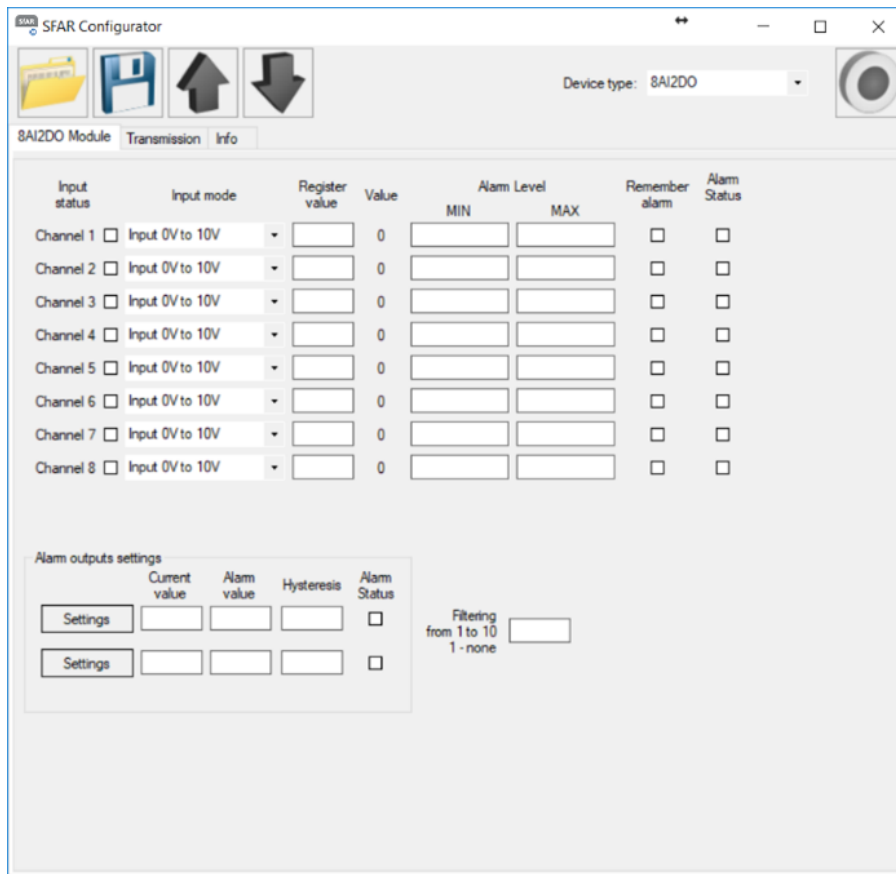


Figure 17. The SfAR Configurator