iSMACONTROLLI

SfAR-1M-1AI1DO

User Manual

Expansion Module - 1 Analog Input, 1 Digital Output

Modbus

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Table of Contents

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
3.1	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-1M-1AI1DO module allows voltage or current measurement and has one digital output. Values are read via the RS485 (Modbus), so it can be easily integrated with popular PLCs, HMI, or PC equipped with the appropriate adapter.

The device has 1 analog input for voltage measurement and 1 analog input for current measurement (both inputs can be used at the same time). In addition, the module is equipped with 1 configurable digital output (PNP or NPN type).

The 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.

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)	1 W at 24 V DC
		2 VA at 24 V AC
Isolation	Isolation between power supply and I/O	1000 V DC

Inputs	No. of inputs		2
	Absolute maximum input voltage		±60 V
	Voltage input impedance		100 k Ω
	Voltage measurement accuracy		±0.2%
	Voltage input mode 0-10 V -10-10 V	Max. voltage	±16.386 V
		Resolution	1 mV
	Voltage input mode 0-1 V -1-1 V	Max. voltage	±2.048 V
		Resolution	1 mV
	Absolute maximum input current		±35 mV
	Current input impedance		100 Ω
	Current measurement accuracy		± 0.1%
	Current input mode 0-20 mV -20-20 mV	Max. current	± 20.048 mV
		Resolution	1 µA
	Current input mode 4-20 mV	Max. current	20.048 mV
		Resolution	1‰
	Measurement resolution		16 bits
	ADC processing time		70 ms/channel
Digital Outputs	Maximum current and voltage		250 mA/50 V
Temperature	Work		-20 °C to +65°C
	Storage		-40 °C to +85°C
Connectors	Power supply		2 pin
	Communication		3 pin
	Inputs & Outputs		2 x 3 pin
	Configuration		mini USB
Size	Height		90 mm
	Length		56.4 mm
	Width		17.5 mm

Interface	RS485	Up to 128 devices

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.

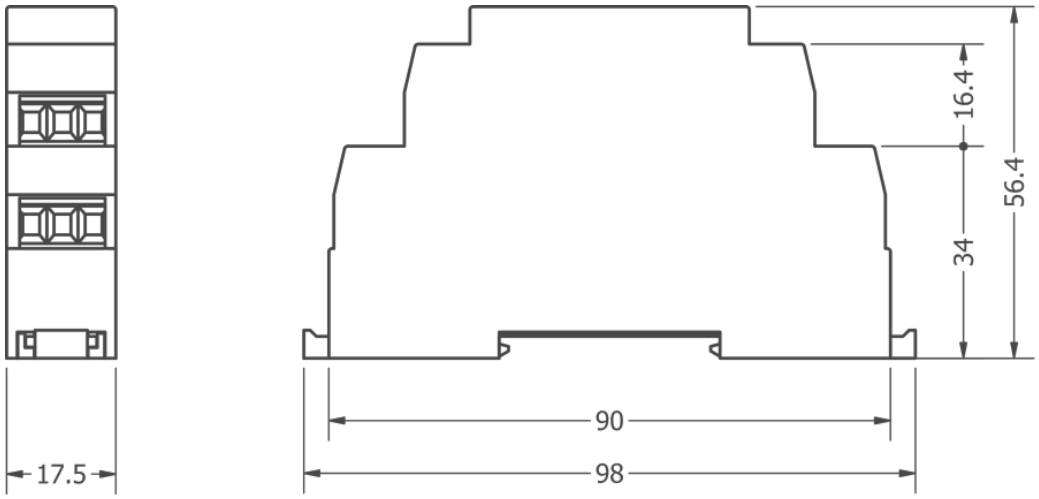

Figure 1. Dimensions

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 present problems for data communication networks. These problems include reflections and signal attenuation. To eliminate the presence of reflections of signal from 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 propagation is bidirectional. In case of an RS485 twisted pair cable, this termination is typically 120 Ω.

4.3 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

Type	Beginning Address	Variable	Access	Modbus Command
4	40001	Output Registers	Registered Read/write	4, 6, 16

Table 3. Types of Modbus functions supported by the module

4.4 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 Default Settings

Parameter Name	Value
Address	1
Baud rate	19200
Parity	No
Data bits	8
Stop bits	1
Reply delay [ms]	0
Modbus type	RTU

Table 4. Default settings

4.6 Configuration Registers

Modbus Address	Decimal Address	Hex Address	Name	Values
40002	1	0x01	Address	From 0 to 255
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

Modbus Address	Decimal Address	Hex Address	Name	Values
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 5. Configuration registers

5 Indicators

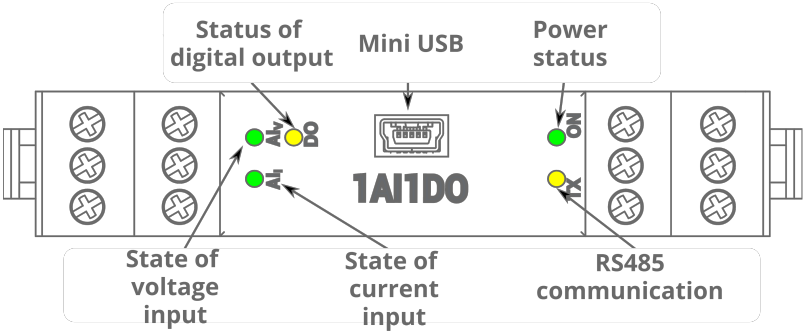

Figure 2. Indicators

Indicator	Description
ON	The LED indicates that the module is correctly powered
TX	The LED lights up when the unit received the correct packet and sends the answer
VIN IIN	The LED indicates that the signal to input is connected and is different from 0
DO	The LED indicates that the output is on

Table 6. Description of indicators

6 Connections

6.1 Block Diagram

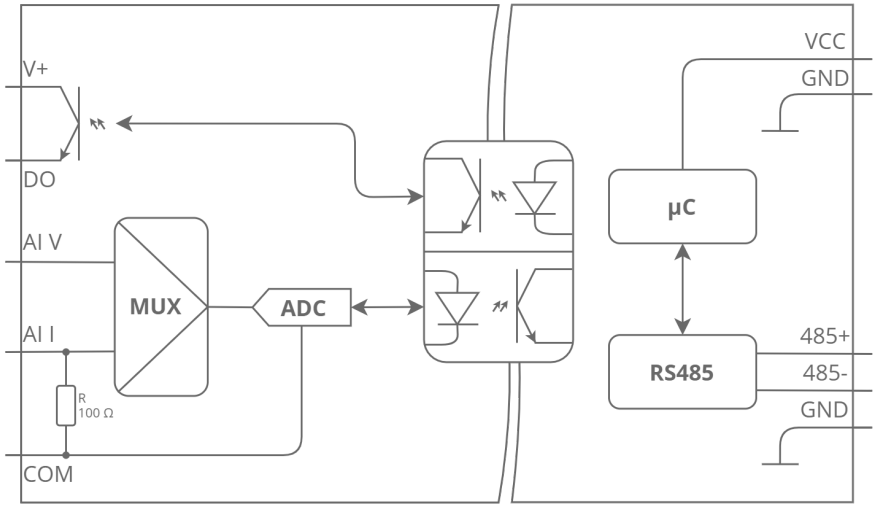

Figure 3. Block diagram

6.2 Power Supply Connection

6.2.1 DC Power Connection

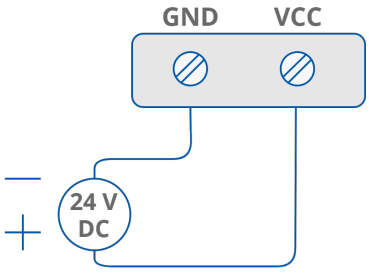

Figure 4. DC power connection

6.2.2 AC Power Connection

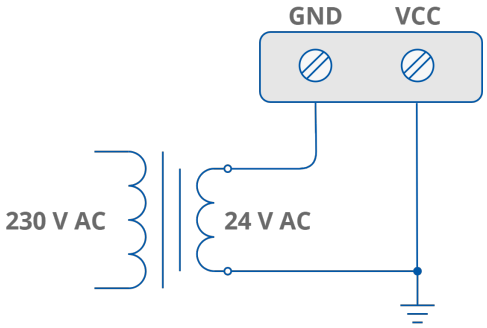

Figure 5. AC power connection

6.3 Communication Bus Connection

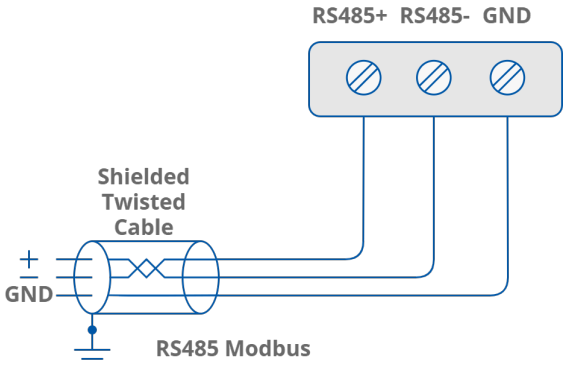

Figure 6. Communication bus connection

6.4 Connection of Analog Inputs

6.4.1 Connection of Voltage Measurement

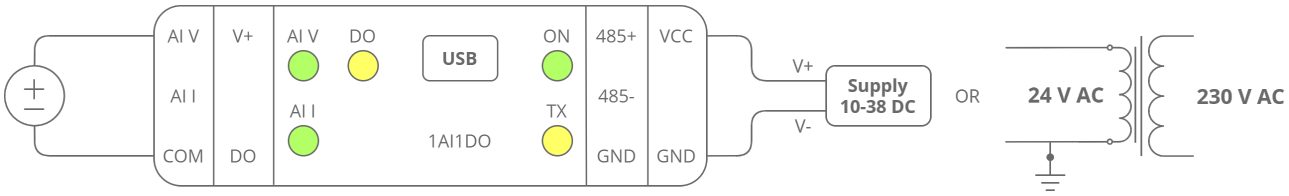

Figure 7. Connection of voltage measurement

6.4.2 Connection of Current Measurement

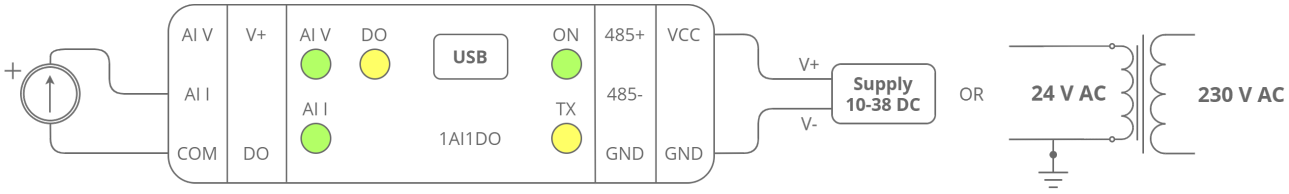

Figure 8. Connection of current measurement

6.5 Connection of Digital Output

6.5.1 PNP Type

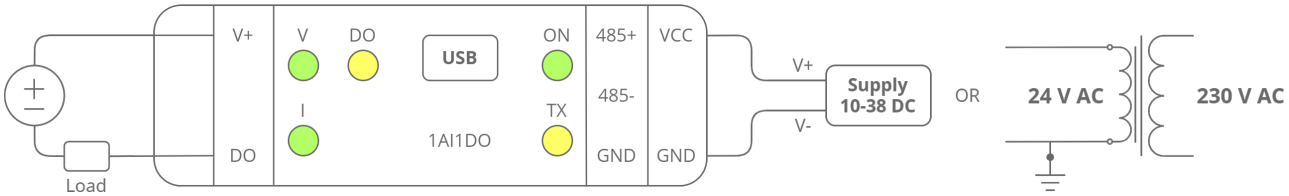

Figure 9. Connection of PNP type digital output

6.5.2 NPN Type

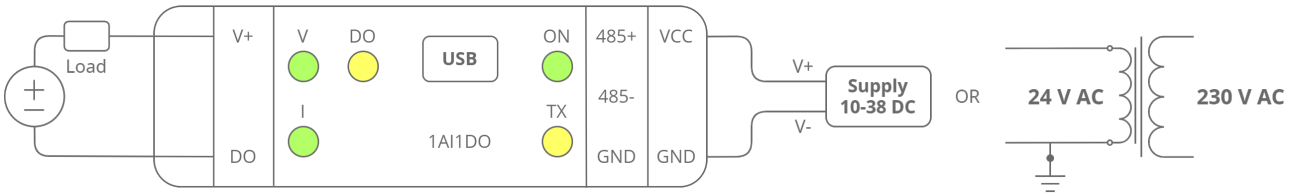

Figure 10. Connection of NPN type digital output

7 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.

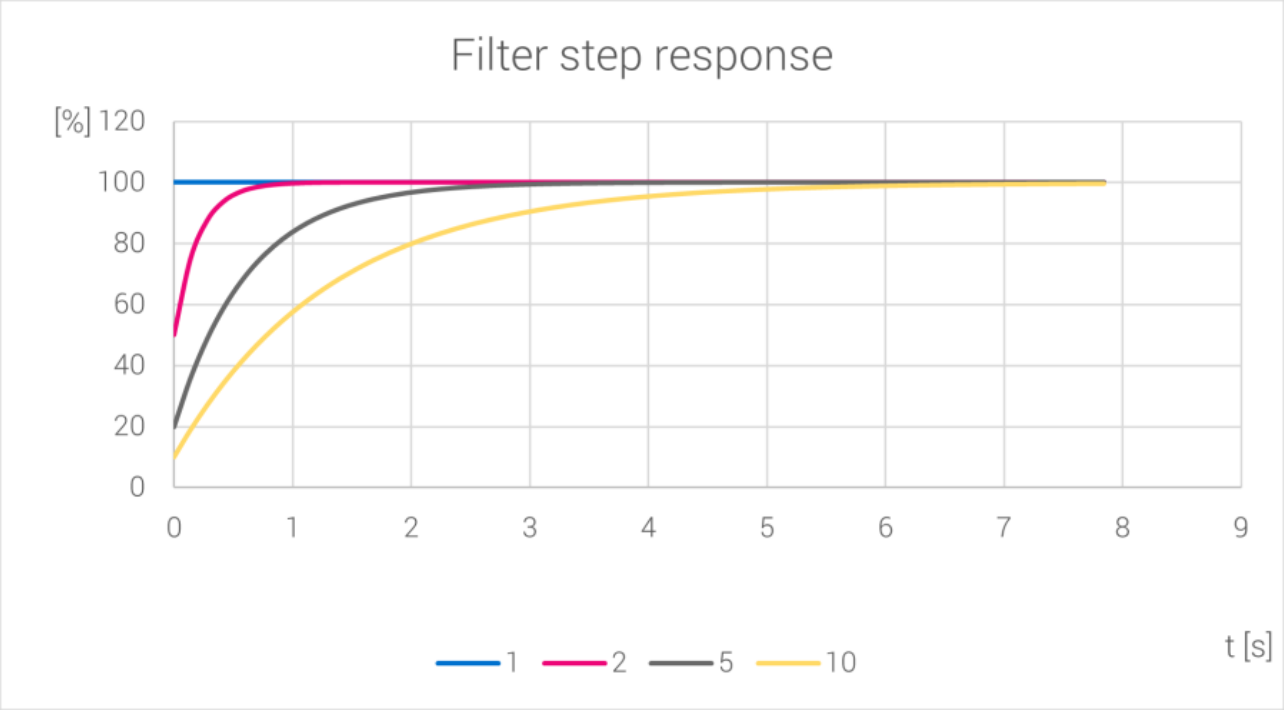

Figure 11. Analog filtering chart

8 Module Registers

8.1 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	Address	Read	Module Address
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 .ode (ASCII or RTU)
40010	9	0x09	Filter	Read/write	Measurement filtering, value from 1 to 10
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 no. 3 digital output
30053	52	0x34	Voltage	Read	Voltage in mV
30054	53	0x35	Current	Read	Current in µA or ‰
40055	54	0x36	Alarm – Max Voltage	Read/write	Maximum value of voltage excess which causes set

Modbus Address	Decimal Address	Hex Address	Register Name	Access	Description
					bit no 1 in the register 40052
40056	55	0x37	Alarm – Min Voltage	Read/write	Minimum value of voltage. If voltage drops below this voltage bit no 1 in the register 40052 is set
40057	56	0x38	Alarm – Max Current	Read/write	Maximum value of current excess which causes set bit no 1 in the register 40052
40058	57	0x39	Alarm – Min Current	Read/write	Minimum value of current. If current drops below this voltage bit no 1 in the register 40052 is set
40059	58	0x3A	Voltage Alarm Configuration	Read/write	Alarms configuration 0 – alarms state depends on actual values 1 – alarms state need to clear by master
40060	59	0x3B	Current Alarm Configuration	Read/write	
40061	60	0x3C	Voltage Input Configuration	Read/write	0 – OFF 1 – 0 .. 10 V 2 – -10 .. 10 V 3 – 0 .. 1 V 4 – -1 .. 1 V
40062	61	0x3D	Current Input Configuration	Read/write	0 – OFF 1 – 0 .. 20 mA (in µA) 2 – 4 .. 20 mA (in ‰) 3 – -20 mA .. 20 mA (in µA)
40063	62	0x3E	Digital Output Configuration	Read/write	Digital output configuration 0 – output controlled by master 1 – output state depends on voltage 2 – output state depends on current +256 – output set if value is greater than alarm value (40065 register) („cooling") +512 – output set if value is below than alarm value (40065 register) („warming")
40064	63	0x3F	Alarm Value	Read/write	Alarm value

Modbus Address	Decimal Address	Hex Address	Register Name	Access	Description
40065	64	0x40	Alarm Hysteresis	Read/write	Hysteresis for alarm

Table 7. Registered access

8.2 Bit Access

Modbus Address	Dec Address	Hex Address	Register Name	Access	Description
801	800	0x320	Voltage Input	Read	Voltage input state
802	801	0x321	Current Input	Read	Current input state
10817	816	0x330	Voltage Alarm	Read/write	Voltage alarm state
10818	817	0x331	Current Alarm	Read/write	Current alarm state
10819	818	0x332	Digital Output	Read/write	Digital Output state

Table 8. Bit access

9 Configuration Software

The SfAR 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 is a convenient way to test the system as well as to observe real-time changes in the registers.

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

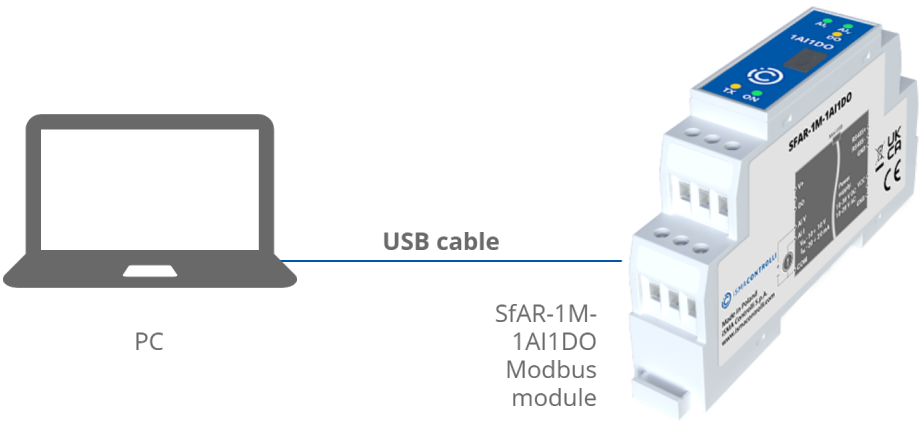

Figure 12. PC connection

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

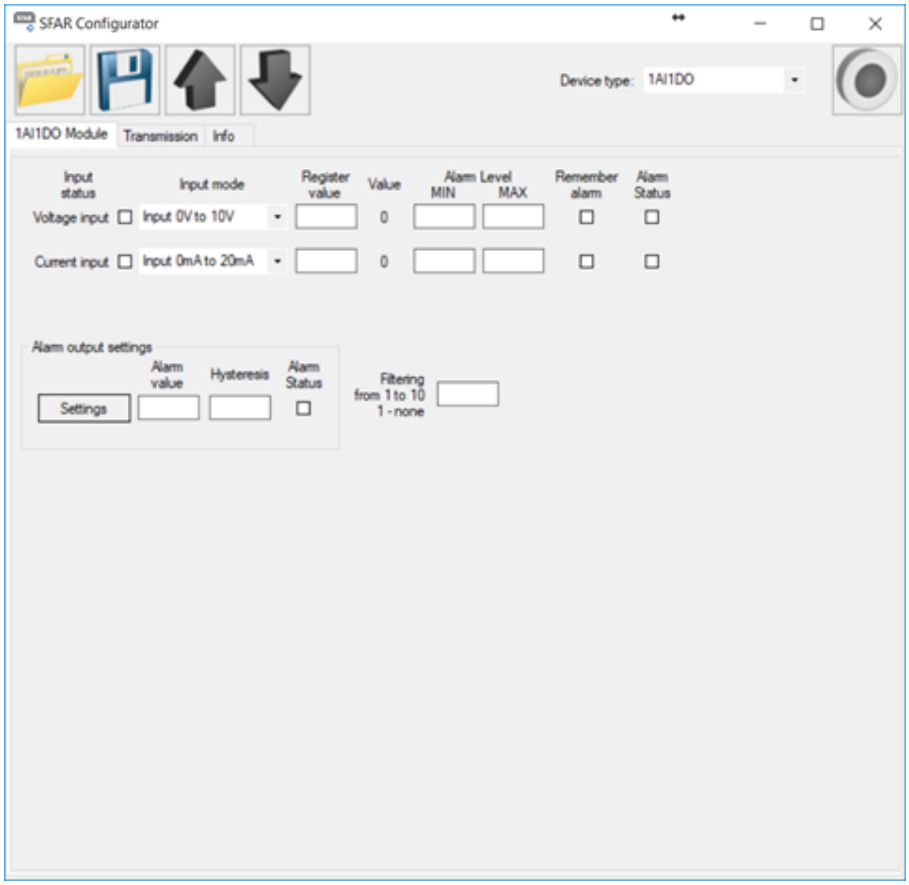

Figure 13. SfAR Configurator