iSMA**CONTROLLI**

SfAR-S-6TI

User Manual

Expansion Module - 6 Temperature Inputs

Modbus

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
3.2	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-6TI module allows measuring temperature with popular sensors (PT100, PT500, PT1000, NI100, KTY81-110) and thermocouples (type J, K, T, N, S, R, B). In addition, it is possible to measure voltages in the range from 256 mV (10 μV resolution) to 2048 mV (100 μV resolution) as well as to measure resistance to 8 kΩ.

The device has a set of six inputs for the temperature measurement. 2- or 3-wire measurement of temperature is feasible with PT100, NI100, PT500, and PT1000 sensors , and 2-wire measurement is feasible with thermocouples and other sensors. In addition, the module is equipped with 2 configurable digital outputs.

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 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 high state on all inputs)	2,4 W at 24 V DC
		3 V.A at 24 V AC
Inputs	No. of inputs	6
	PT100 operation range	-200°C to +850°C
	PT500 operation range	-200°C to +850°C
	PT1000 operation range	-200°C to +850°C
	NI100 operation range	-60°C to +180°C
	KTY81-110 operation range	-55°C to +150°C
	J thermocouple operation range	-200°C to +1200°C
	K thermocouple operation range	-200°C to +1300°C

	T thermocouple operation range	-200°C to +400°C
	N thermocouple operation range	-200°C to +1300°C
	S thermocouple operation range	-0°C to +1700°C
	R thermocouple operation range	-0°C to +1700°C
	B thermocouple operation range	-0°C to +1800°C
	Resistance	From 0 to 8000 Ω (1 Ω resolution)
	Voltage	0 to 2048 mV (0.1 mV resolution) 0 to 256 mV (0.01 mV resolution)
	Voltage measurement error	±0.05 % of the measurement range
	Measuring current	~250 µA
	Measurement resolution	0.1°C
	Measurement error	±0.5°C
	Cold junction temperature measurement	-55°C to +100°C
	Measurement error of the cold junction temperature	±1°C
	DAC processing time	150 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 and 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

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 located on the front of the module.
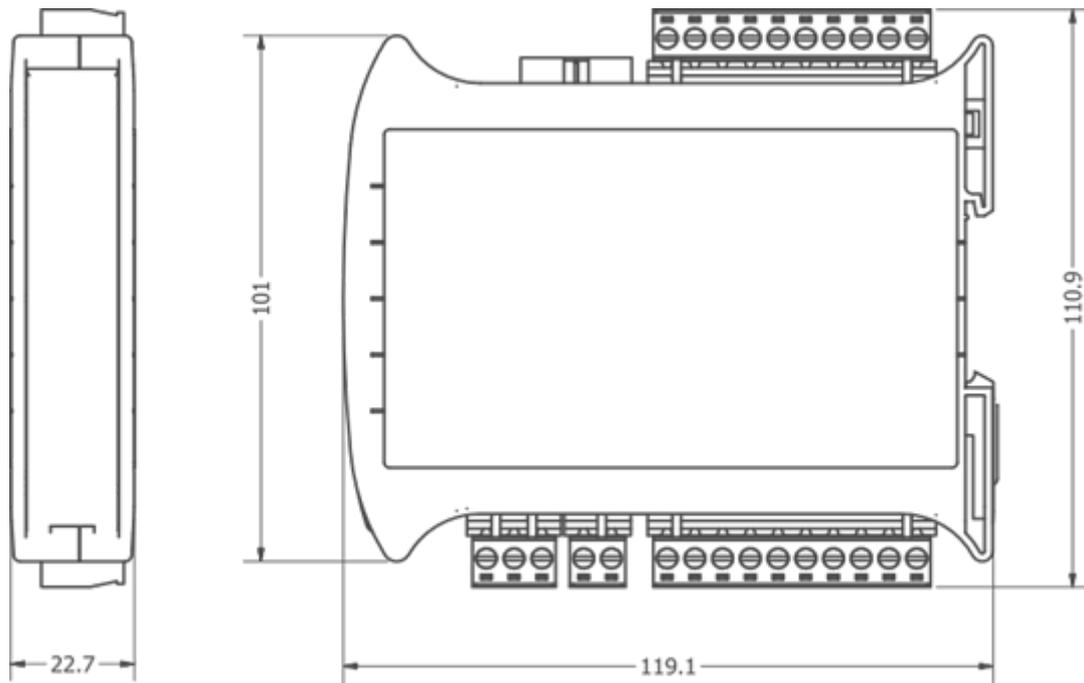

Figure 1. Dimensions

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 and using dedicated software tool.

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

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 Setting

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

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

Table 5. Default settings

4.6 Restore Default Configuration

To restore the default configuration, follow the steps below:

- turn the power off;

- turn the DIP 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.

4.7 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
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
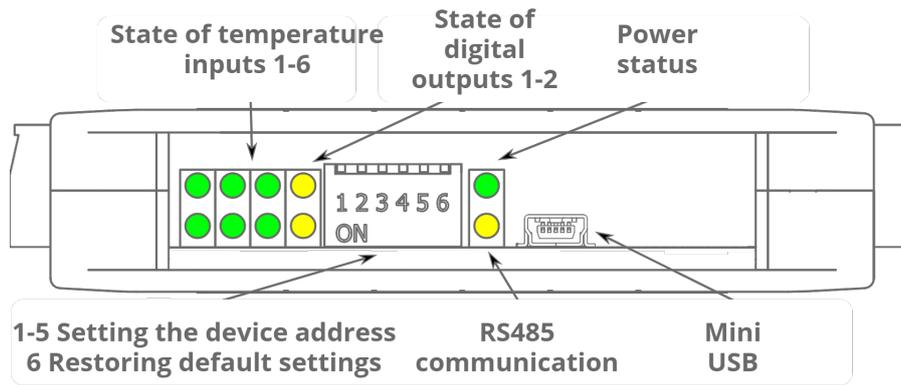
Figure 2. Indicators

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 sensor is connected
Outputs State	The LED indicates that the output is on

Table 7. Description of indicators

6 Connections

## 6.1 Block Diagram
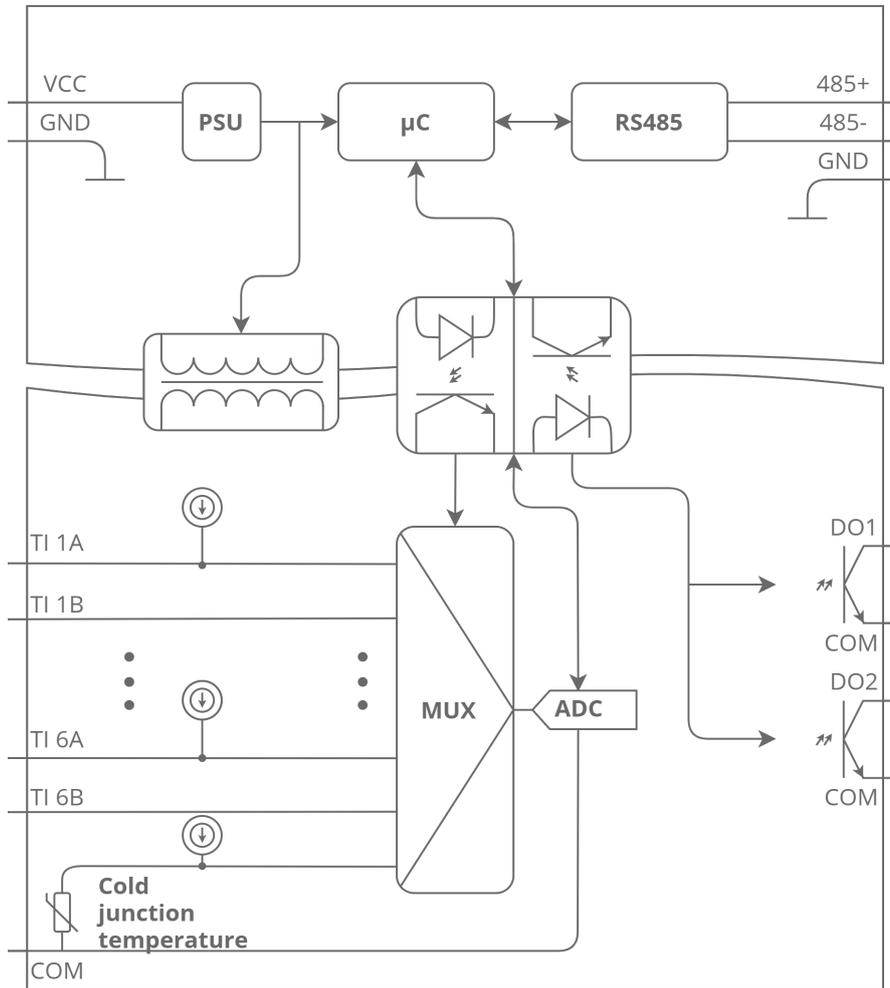
Figure 3. Block diagram

6.2 Power Supply Connection

6.2.1 DC Power Connection
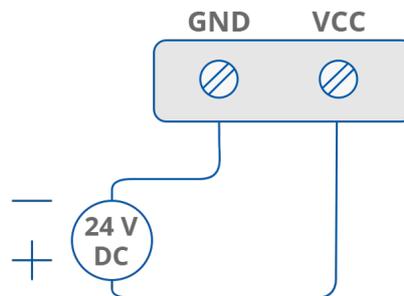
*Figure 4. DC power connection*

6.2.2 AC Power Connection
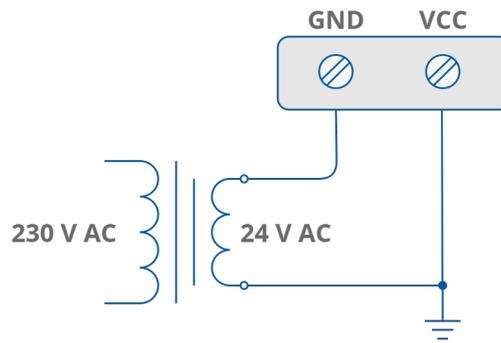
Figure 5. AC power connection

## 6.3 Communication Bus Connection
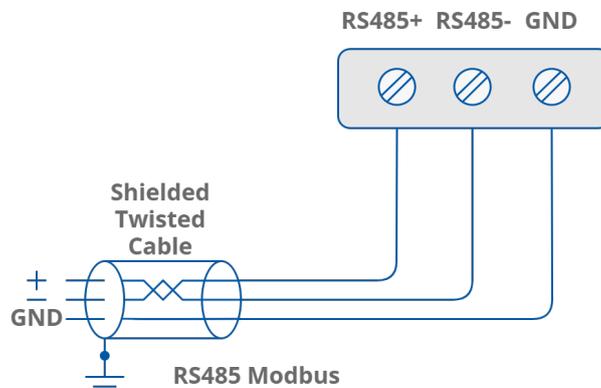
Figure 6. Communication bus connection

6.4 Connection of Temperature Inputs

## 6.4.1 Connection of 2-wire Sensor (PT100) and Resistance Input
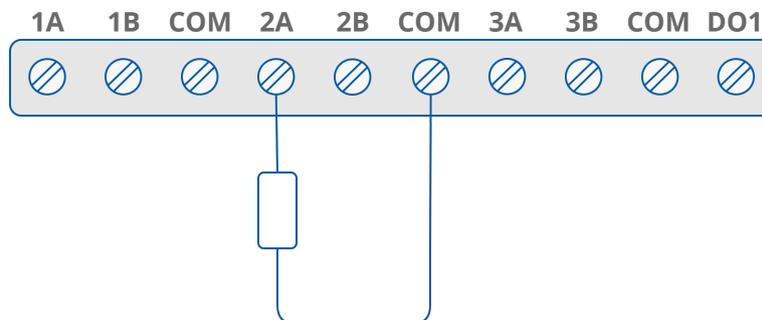
Figure 7. 2-wire connection of PT100

6.4.2 Connection of 3-wire Sensor (PT100)

| 1A | 1B | COM | 2A | 2B | COM | 3A | 3B | COM | DO1 |
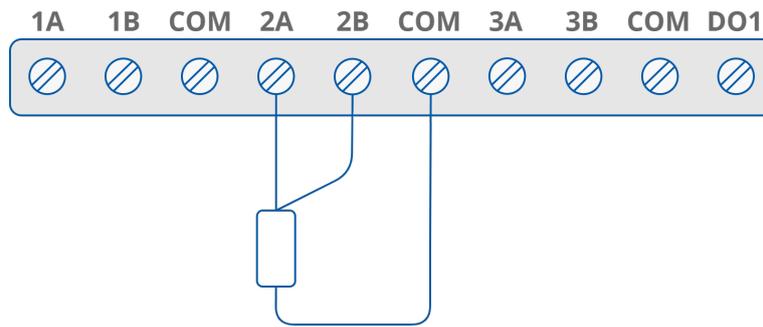
Figure 8. 3-wire connection of PT100

6.4.3 Connection of Thermocouple or Voltage Input

| 1A | 1B | COM | 2A | 2B | COM | 3A | 3B | COM | DO1 |
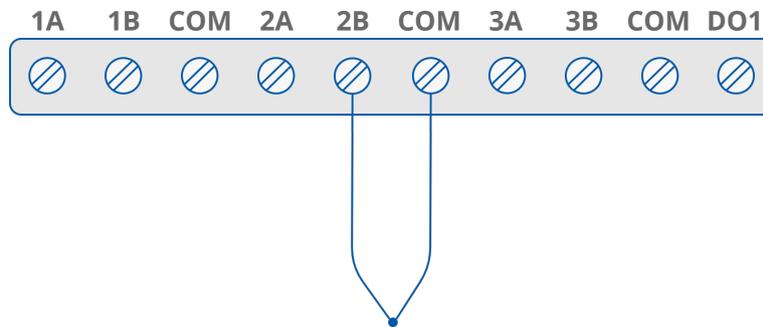
Figure 9. Connection of thermocouple

6.5 Connection of Digital Outputs

| 1A | 1B | COM | 2A | 2B | COM | 3A | 3B | COM | DO1 |

24 V DC

Max. 0,5 A
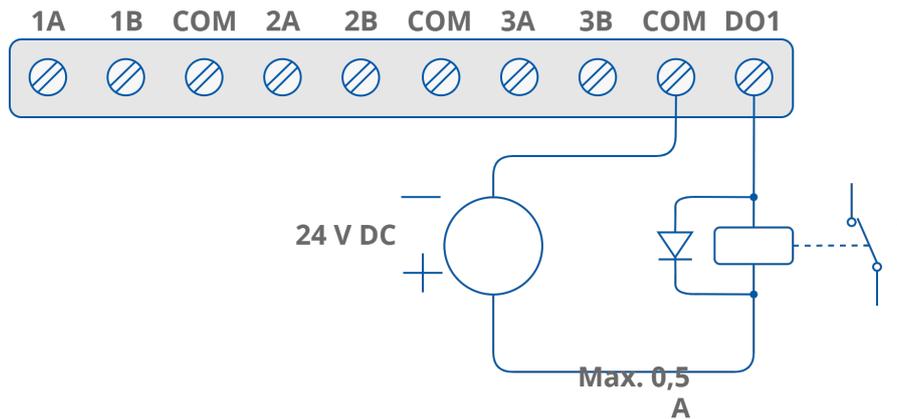
Figure 10. Connection of digital outputs

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 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 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.
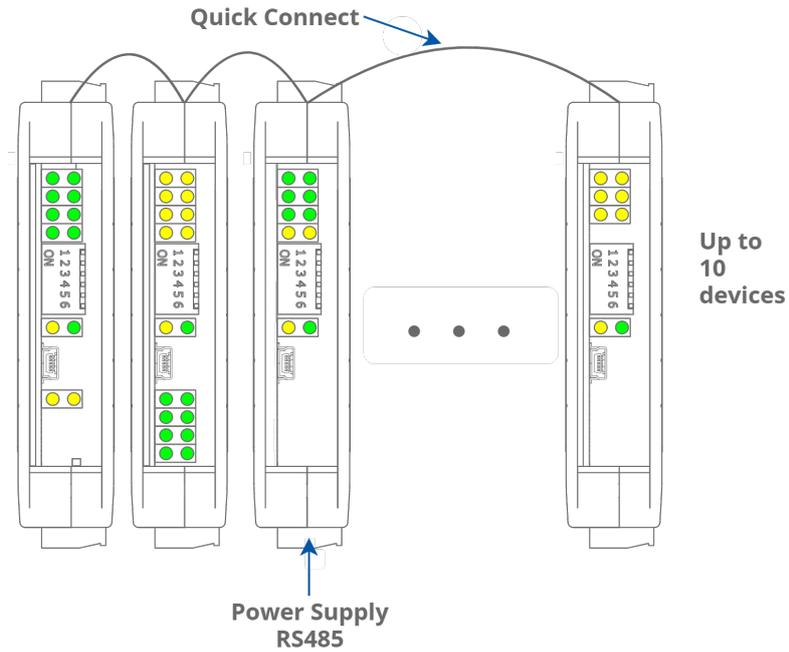
Figure 11. Quick Connector

7 DIP Switch
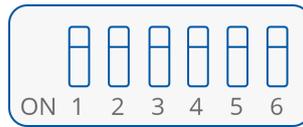
Figure 12. DIP switch

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

8 Analog Filtering

If the measured signal is noisy it is possible to eliminate the noise by switching on the lowpass filter. 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.
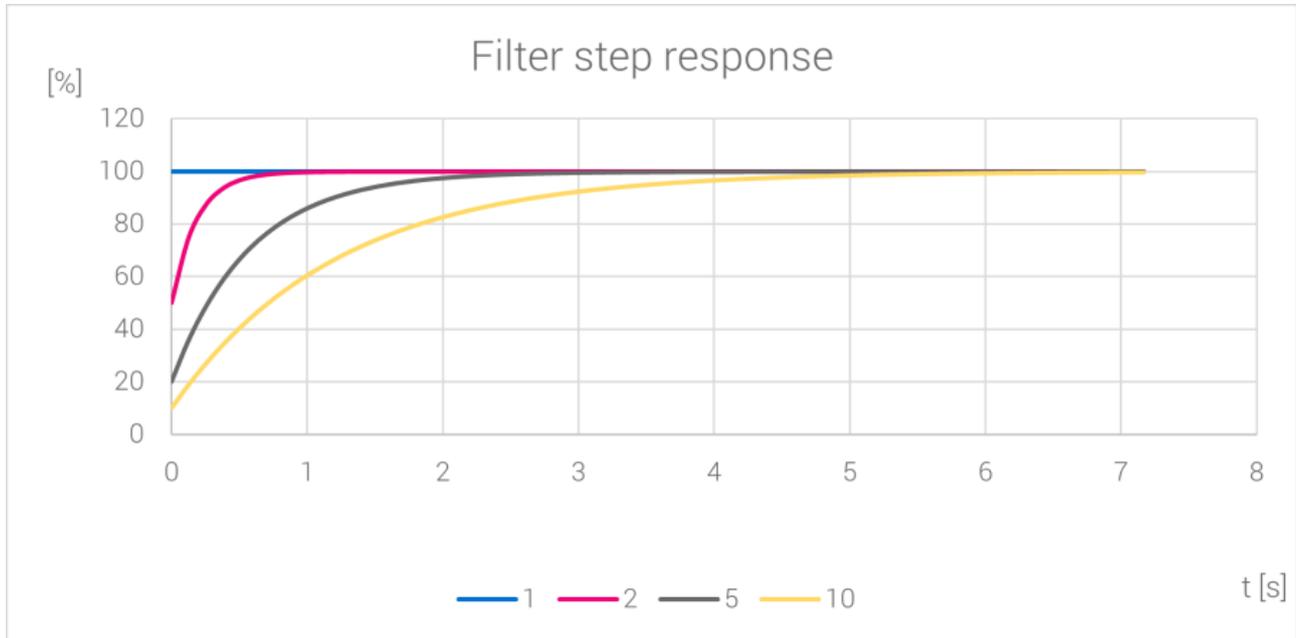
Figure 13. Step response and different coefficients

9 Module Registers

9.1 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	Configuration analog filtering
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 sensors bit in high state → sensor is connected
40052	51	0x33	Outputs	Read/write	Alarms state bit 6 and 7 alarm outputs
30053	52	0x34	Temperature 1	Read	Temperature or measured analog in mV·10 for voltage to 2048 mV in mV·100 for voltage to 256 mV

Modbus Address	Decimal Address	Hex Address	Register Name	Access	Description
30054	53	0x35	Temperature 2	Read	in °C·10 for temperature in Ω for resistance
30055	54	0x36	Temperature 3	Read	
30056	55	0x37	Temperature 4	Read	
30057	56	0x38	Temperature 5	Read	
30058	57	0x39	Temperature 6	Read	
30059	58	0x3A	Alarm Temperature 1	Read	Alarm temperature for alarm output 1
30060	59	0x3B	Alarm Temperature 2	Read	Alarm temperature for alarm output 2
30061	60	0x3C	Junction Temperature	Read	Module junction temperature
30062	61	0x3D	Measurement Current	Read	Measurement current
40063	62	0x3E	MAX Alarm Level 1	Read/write	If the temperature 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	MIN Alarm Level 1	Read/write	If the temperature is below this value corresponding alarm flag is set
40070	69	0x45	MIN Alarm Level 2	Read/write	
40071	70	0x46	MIN Alarm Level 3	Read/write	
40072	71	0x47	MIN Alarm Level 4	Read/write	
40073	72	0x48	MIN Alarm Level 5	Read/write	
40074	73	0x49	MIN Alarm Level 6	Read/write	
40075	74	0x4A	Alarm Settings 1	Read/write	Alarm Settings
40076	75	0x4B	Alarm Settings 2	Read/write	0 – alarm due to the current temperature
40077	76	0x4C	Alarm Settings 3	Read/write	1 – remember the value of the alarm, until reset by
40078	77	0x4D	Alarm Settings 4	Read/write	the master via Modbus

Modbus Address	Decimal Address	Hex Address	Register Name	Access	Description
40079	78	0x4E	Alarm Settings 5	Read/write	
40080	79	0x4F	Alarm Settings 6	Read/write	
40081	80	0x50	Constant Junction Temperature	Read/write	Value of junction temperature
40082	81	0x51	Junction Temperature Offset	Read/write	Junction temperature offset
40083	82	0x52	Input 1 Settings	Read/write	Analog input mode: 0 – input disabled 1 – voltage to 2048 mV 2 – voltage to 256 mV 3 – J thermocouple 4 – K thermocouple 5 – T thermocouple 6 – N thermocouple 7 – S thermocouple 8 – R thermocouple 9 – B thermocouple 10 – Pt100 3-wire 11 – Pt100 2-wire 12 – resistance to 8 kΩ 13 - Ni100 14 – KTY81-110 15 – Pt500 3-wire 16 – Pt500 2-wire 17 – Pt1000 3-wire 18 – Pt1000 2-wire +32 – junction temperature is taken from register 40081 "Constant junction temperature"
40084	83	0x53	Input 2 Settings	Read/write	
40085	84	0x54	Input 3 Settings	Read/write	
40086	85	0x55	Input 4 Settings	Read/write	
40087	86	0x56	Input 5 Settings	Read/write	
40088	87	0x57	Input 6 Settings	Read/write	
40089	88	0x58	Output 1 Settings	Read/write	Alarm output settings 0 – output is set by PLC +1 – temperature from input 1 +2 – temperature from input 2 +4 – temperature from input 3 +8 – temperature from input 4 +16 – temperature from input 5 +32 – temperature from input 6 +256 – Output is set if value is greater than Alarm Value (register 40091 or 40092) („cooling")

Modbus Address	Decimal Address	Hex Address	Register Name	Access	Description
40090	89	0x59	Output 2 Settings	Read/write	+512 – Output is set if value is less than Alarm Value (register 40091 or 40092) („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)
40091	90	0x5A	Alarm Value 1	Read/write	Alarm value for outputs
40092	91	0x5B	Alarm Value 2	Read/write	
40093	92	0x5C	Alarm Hysteresis 1	Read/write	The hysteresis value for alarm outputs
40094	93	0x5D	Alarm Hysteresis 2	Read/write	
40095	94	0x5E	Input Resistance 1	Read/write	Lead wire resistance for each input
40096	95	0x5F	Input Resistance 2	Read/write	
40097	96	0x60	Input Resistance 3	Read/write	
40098	97	0x61	Input Resistance 4	Read/write	
40099	98	0x62	Input Resistance 5	Read/write	
40100	99	0x63	Input Resistance 6	Read/write	

Table 9. Registered access

9.2 Bit Access

Modbus Address	Decimal Address	Hex Address	Register Name	Access	Description
801	800	0x320	Input 1	Read	Set when the sensor is connected
802	801	0x321	Input 2	Read	Set when the sensor is connected
803	802	0x322	Input 3	Read	Set when the sensor is connected
804	803	0x323	Input 4	Read	Set when the sensor is connected

Modbus Address	Decimal Address	Hex Address	Register Name	Access	Description
805	804	0x324	Input 5	Read	Set when the sensor is connected
806	805	0x325	Input 6	Read	Set when the sensor 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	Digital Output 1	Read/write	State of digital output 1
824	823	0x337	Digital Output 2	Read/write	State of digital output 2

Table 10. Bit access

10 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 is a convenient way to test the system as well as to observe real-time changes in the registers.
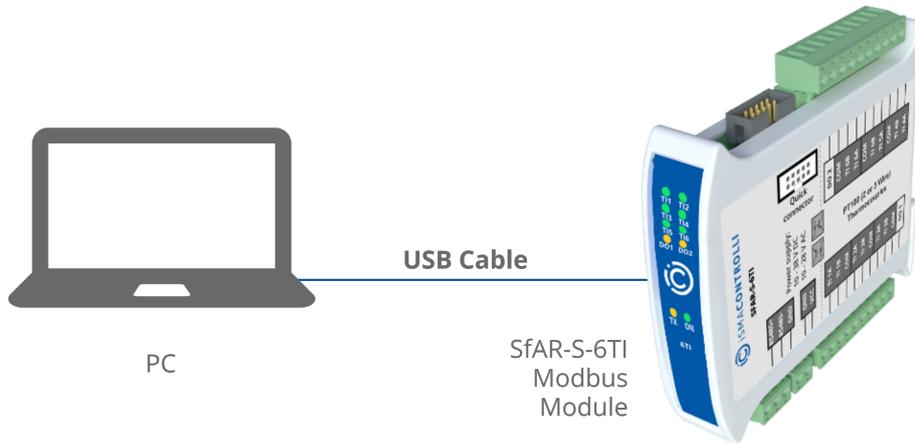
Figure 14. PC connection

Communication with the module is done via a 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.
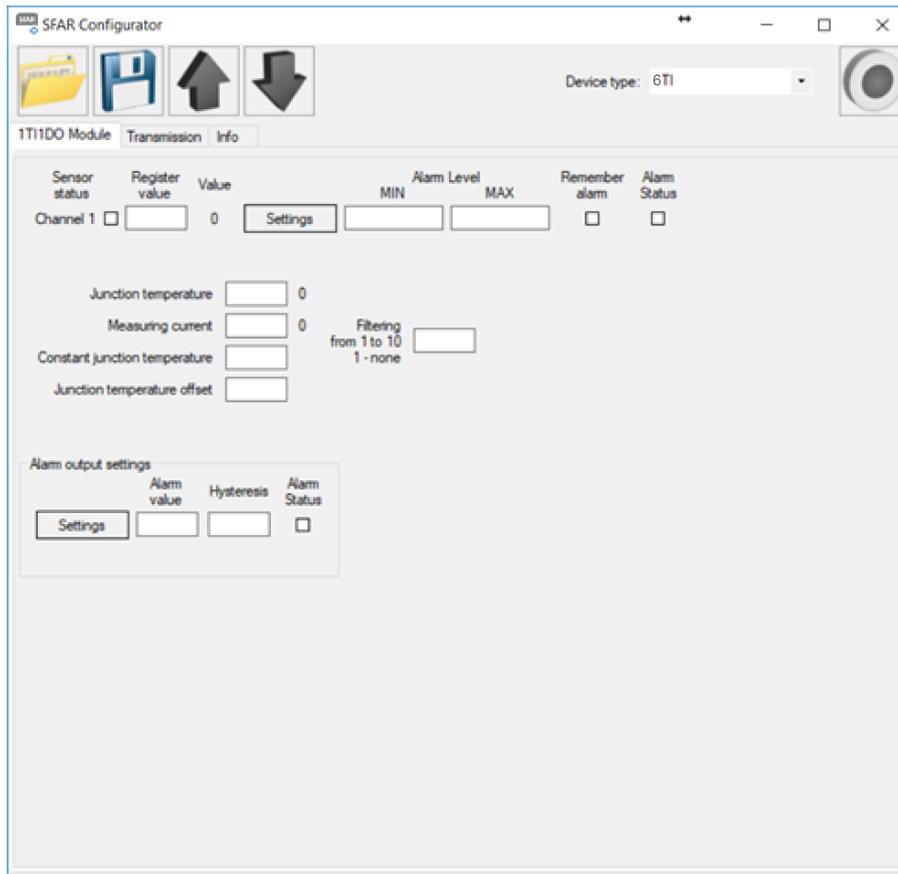
Figure 15. The SfAR Configurator