iSMACONTROLLI

# SfAR-1M-1TI1DO

User Manual

## Expansion Module - 1 Temperature Input, 1 Digital Output


Modbus

iSMA CONTROLLI S.p.A. - Via Carlo Levi 52, 16010 Sant'Olcese (GE) - Italy | support@ismacontrolli.com

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# 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-1TI1DO module allows the measurement of the temperature with attached popular sensor (PT100, PT500, PT1000, NI100, KTY81-110) or thermocouple (J, K, T, N, S, R, or B type). 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 the resistance to 8 kΩ. The module has one configurable digital output (PNP or NPN).

Values are read via RS485 (Modbus), so the module can be easily integrated with popular PLCs, HMI, or PC equipped with an 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.

## 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 | 1 |
| | 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)<br>0 to 256 mV (0.01 mV resolution) |
| | Resistance 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 | ±2°C |
| | ADC processing time | 150 ms |
| 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 and 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. 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.

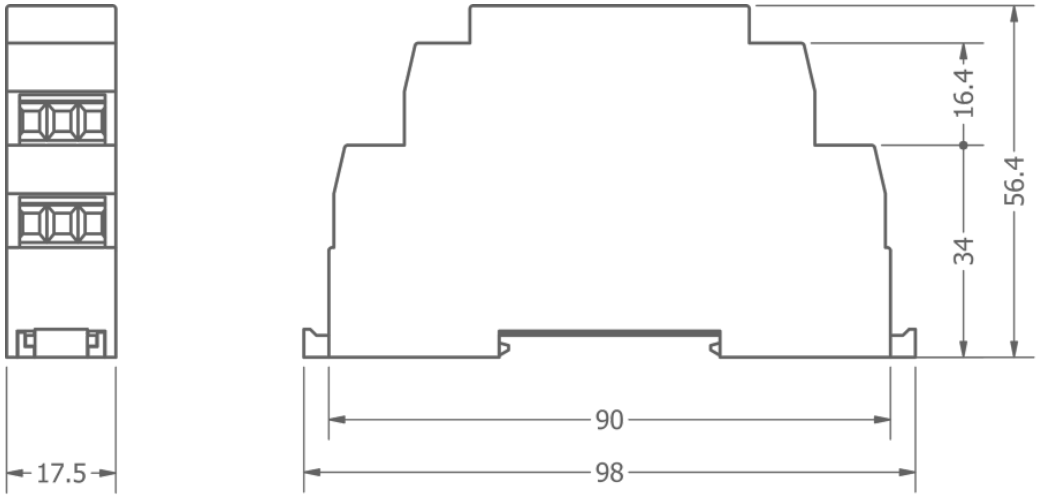


*Figure 1. Dimensions*

# 4 Communication

## 4.1 Grounding and Shielding

In most cases, I/O modules will be installed in an enclosure along with the other devices, which generate electromagnetic radiation. Relays, contactors, transformers, motor invertors, 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<br>Read/write | 1, 5, 15 |
| 2 | 10001 | Digital Inputs | Bit<br>Read | 2 |
| 3 | 30001 | Input Registers | Registered<br>Read | 3 |

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

*Table 3.*

## 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.*

## 4.6 Configuration Registers

| Modbus Address | Decimal Address | Hex Address | Name | Values |
|---|---|---|---|---|
| 40003 | 2 | 0x02 | Baud rate | 0 – 2400<br>1 – 4800<br>2 – 9600<br>3 – 19200<br>4 – 38400<br>5 – 57600<br>6 – 115200<br>other – value * 10 |
| 40005 | 4 | 0x04 | Parity | 0 – none<br>1 – odd<br>2 – even<br>3 – always 0<br>4 – always 1 |
| 40004 | 3 | 0x03 | Stop Bits | 1 – one stop bit<br>2 – two stop bits |

| Modbus Address | Decimal Address | Hex Address | Name | Values |
|---|---|---|---|---|
| 40004 | 3 | 0x03 | Data Bits | 7 – 7 data bits<br>8 – 8 data bits |
| 40006 | 5 | 0x05 | Response Delay | Time in ms |
| 40007 | 6 | 0x06 | Modbus Mode | 0 – RTU<br>1 – ASCII |

*Table 5. Configuration registers*

# 5 Indicators

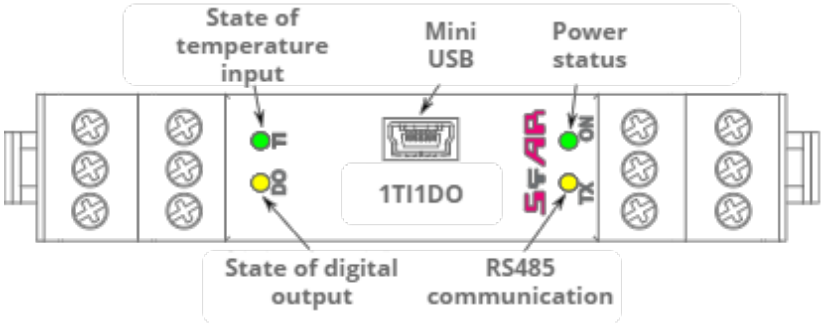


*Figure 2. Indicators*

| 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 |
| IN | The LED indicates that the sensor is connected |
| DO | The LED indicates that the output is on |

*Table 6. Description of indicators*

# 6 Connections

## 6.1 Block Diagram

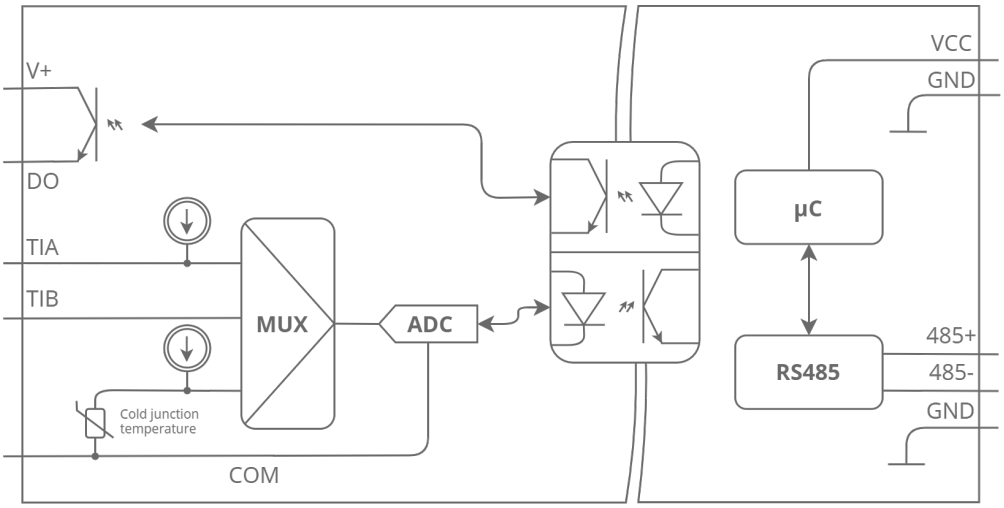


*Figure 3. Block diagram*

## 6.2 Power Supply Connection

### 6.2.1 DC Power Connection

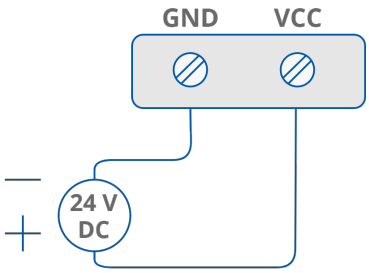


*Figure 4. DC power connection*

### 6.2.2 AC Power Connection

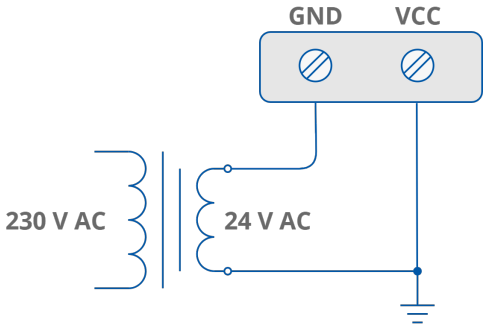


*Figure 5. AC power connection*

## 6.3 Communication Bus Connection

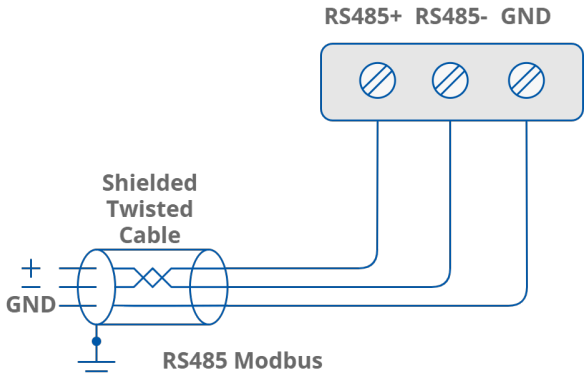


*Figure 6. Communication bus connection*

## 6.4 Connection of Temperature Input

### 6.4.1 Connection of 2-wire Sensor (PT100)

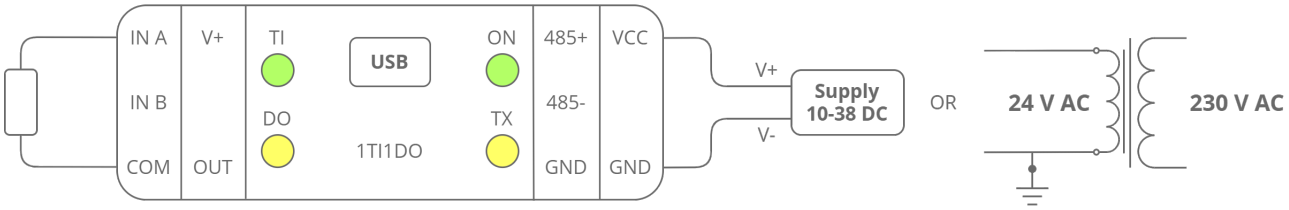


*Figure 7. Connection of the 2-wire sensor*

### 6.4.2 Connection of 3-wire Sensor (PT100)

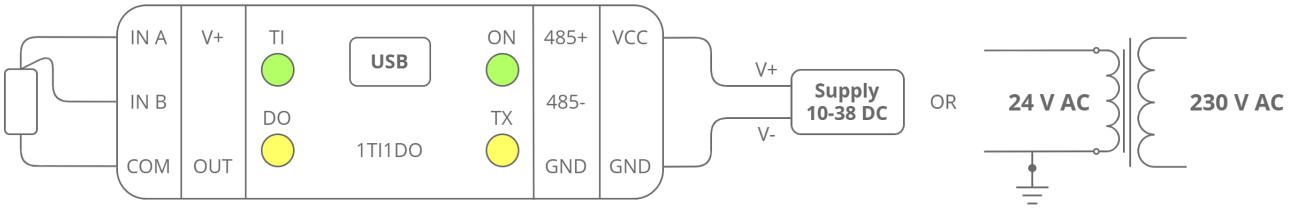


*Figure 8. Connection of the 3-wire sensor*

### 6.4.3 Connection of Thermocouple

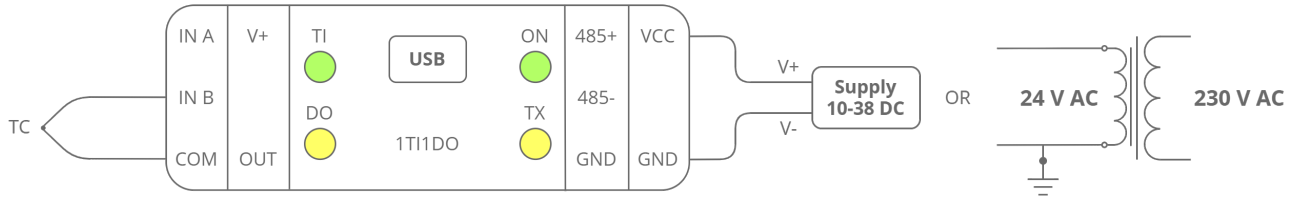


*Figure 9. Connection of thermocouple*

## 6.5 Connection of Digital Output

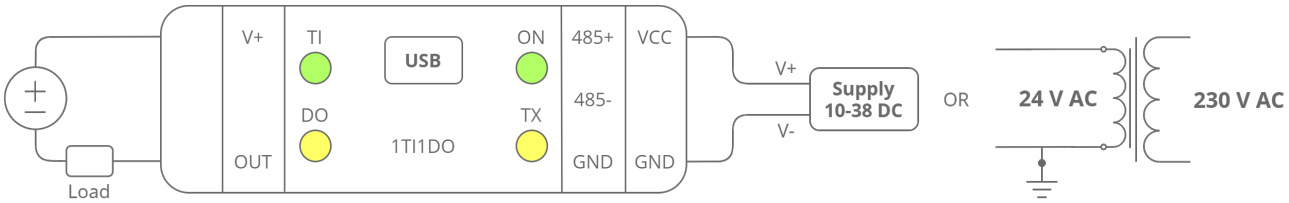


*Figure 10. Connection of digital output*

# 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.

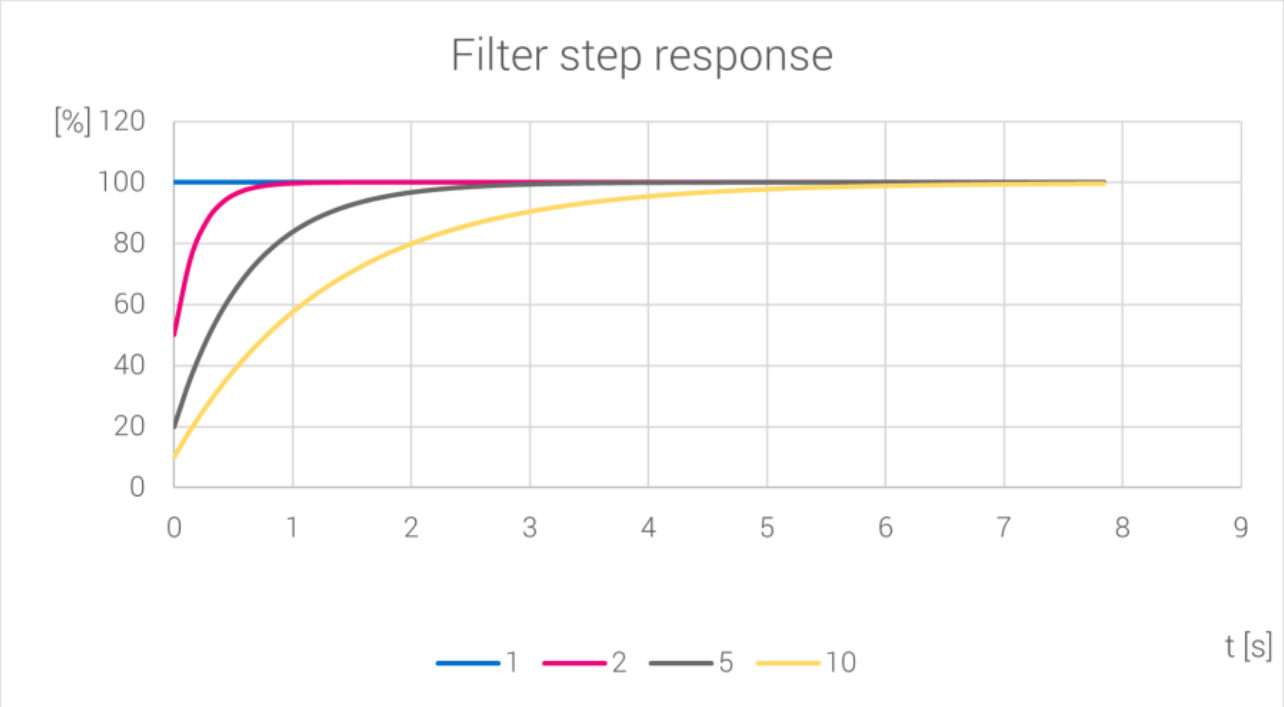


*Figure 11. Step response and different coefficients*

# 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 Mode (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 sensors<br>Bit in high state → sensor is connected |
| 40052 | 51 | 0x33 | Outputs | Read/write | Alarms state<br>Bit 2 alarm output |
| 30053 | 52 | 0x34 | Temperature | Read | Temperature or measured analog<br><br>in mV·10 for voltage to 2048 mV<br>in mV·100 for voltage to |

| Modbus Address | Decimal Address | Hex Address | Register Name | Access | Description |
|---|---|---|---|---|---|
| | | | | | 256 mV<br>in °C·10 for temperature<br>in Ω for resistance |
| 30054 | 53 | 0x35 | Junction Temperature | Read | Module junction temperature |
| 30055 | 54 | 0x36 | Measurement Current | Read | Measurement current |
| 40056 | 55 | 0x37 | MAX Alarm Level | Read/write | If the temperature exceeds this value the corresponding alarm flag is set |
| 40057 | 56 | 0x38 | MIN Alarm Level | Read/write | If the temperature is below this value corresponding alarm flag is set |
| 40058 | 57 | 0x39 | Alarm Settings | Read/write | Alarm settings<br>0 – alarm due to the current temperature<br>1 – Remember the value of the alarm, until reset by the master via Modbus |
| 40059 | 58 | 0x3A | Constant Junction Temperature | Read/write | Value of junction temperature |
| 40060 | 59 | 0x3B | Junction Temperature Offset | Read/write | Junction temperature offset |
| 40061 | 60 | 0x3C | Input Settings | Read/write | Analog input mode:<br><br>0 – input disabled<br>1 – voltage to 2048 mV<br>2 – voltage to 256 mV<br>3 – J thermocouple<br>4 – K thermocouple<br>5 – T thermocouple<br>6 – N thermocouple<br>7 – S thermocouple<br>8 – R thermocouple<br>9 – B thermocouple<br>10 – Pt100 3-wire<br>11 – Pt100 2-wire<br>12 – resistance to 8 kΩ<br>13 - Ni100<br>14 – KTY81-110<br>15 – Pt500 3-wire<br>16 – Pt500 2-wire<br>17 – Pt1000 3-wire<br>18 – Pt1000 2-wire<br><br>+32 – junction |

| Modbus Address | Decimal Address | Hex Address | Register Name | Access | Description |
|---|---|---|---|---|---|
| | | | | | temperature is taken from register 40081 "Constant junction temperature" |
| 40062 | 61 | 0x3D | Output Settings | Read/write | Alarm output settings<br>0 – output is set by PLC<br>+256 – Output is set if value is greater than Alarm Value (register 40065) („cooling")<br>+512 – Output is set if value is less than Alarm Value ( register 40065) („heating") |
| 40063 | 62 | 0x3E | Alarm Value | Read/write | Alarm value for outputs |
| 40064 | 63 | 0x3F | Alarm Hysteresis | Read/write | The hysteresis value for alarm outputs |
| 40065 | 64 | 0x40 | Input Resistance | Read/write | Lead wire resistance for each input |

*Table 7. Registered access*

## 8.2 Bit Access

| Modbus Address | Dec Address | Hex Address | Register Name | Access | Description |
|---|---|---|---|---|---|
| 801 | 800 | 0x320 | Input | Read | Set when the sensor is connected |
| 817 | 816 | 0x330 | Alarm | Read | Alarm state |
| 818 | 817 | 0x331 | Digital Output | Read/write | State of digital output |

*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.

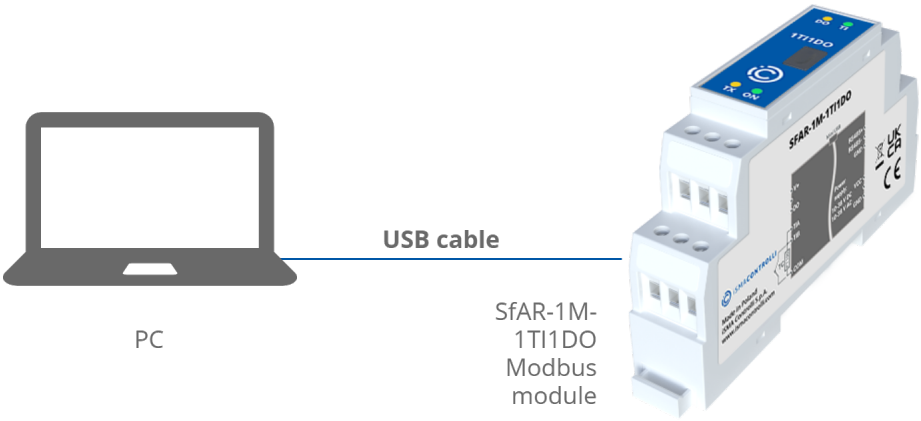


*Figure 12. PC connection*

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

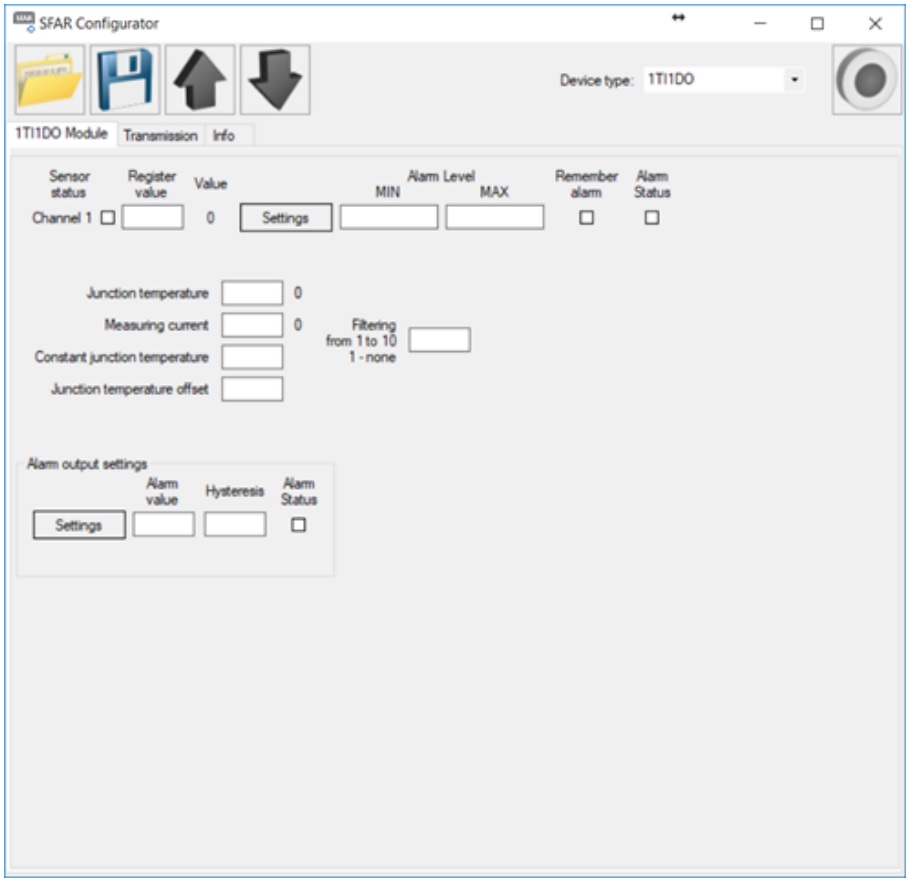


*Figure 13. The SfAR Configurator*