iSMACONTROLLI

SfAR-S-16DO

User Manual

Expansion Module - 16 Digital Outputs

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-16DO module is an innovative device that provides a simple and cost-effective extension of the number of outputs in popular PLCs.

The module has 16 digital outputs. All outputs are isolated from the logic using optocouplers.

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 outputs, power supply, and communication, 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 and high state on all outputs)	2.4 W at 24 V DC
		3 VA at 24 V AC
Digital Outputs	No. of outputs	16
	Max Voltage	30 V
	Max current	500 mA
	Output Type	PNP
	Isolation	1500 Vrms
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
	Outputs	10 pin
	Quick connector	IDC10

Size	Configuration	mini USB
	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 IOs are at the bottom and top of the module. USB connector configuration and indicators are located on the front of the module.
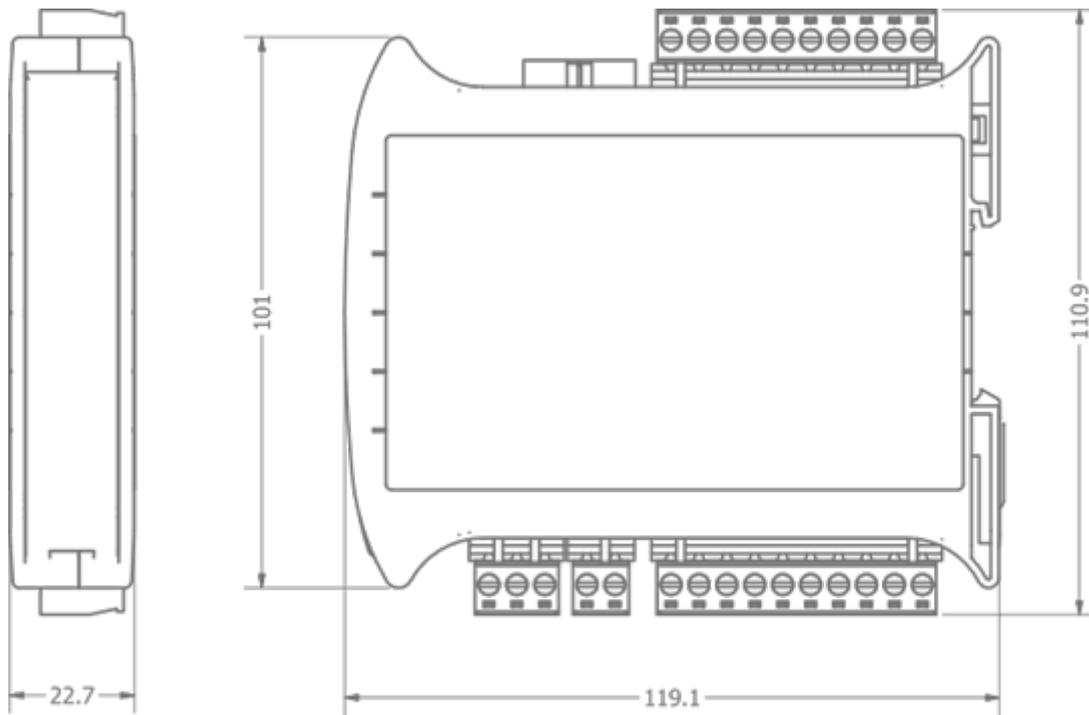

Figure 1. Dimensions

4 Communication

4.1 Grounding and Shielding

In most cases, I/O modules will be installed in an enclosure along with 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 Setting Module Address in RS485 Modbus Network

The following table shows how to set DIP switches 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

Addr	SW1	SW2	SW3	SW4	SW5
4	OFF	OFF	ON	OFF	OFF
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

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

Table 3. Setting Module address in RS485 Modbus network using DIP switches

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 DIP switch, SW6.

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

Table 5. Default settings

4.6 Restoring 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 the communication LED are lit, turn the switch SW6 off.

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

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

4.7 Watchdog

This 16-bits register specifies the time in milliseconds to watchdog reset. If module does not receive any valid message within that time, all Digital and Analog Outputs will be set to the default state.

This feature is useful if there is an interruption in data transmission and for security reasons. Output states must be set to the appropriate state in order to reassure the safety of persons or property.

The default value is 0 milliseconds which means the watchdog function is disabled.
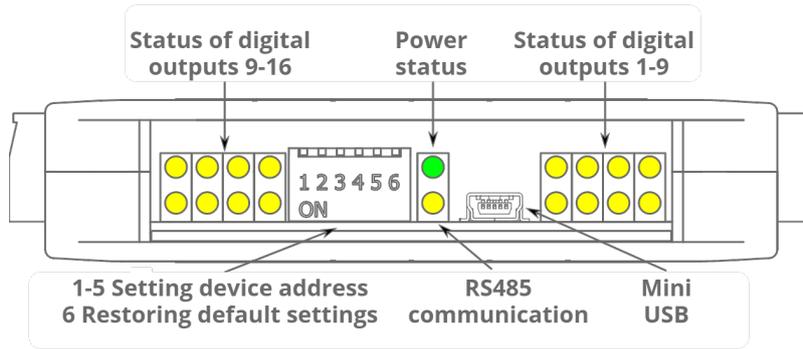
5 LED Indicators

Figure 2. Indicators

Indicator	Description
Power Supply	The LED indicates that the module is correctly powered
Communication	The LED lights up when the unit receives the correct packet and sends the answer
Outputs State	The LED indicates that the output is on

Table 7. Description of indicators

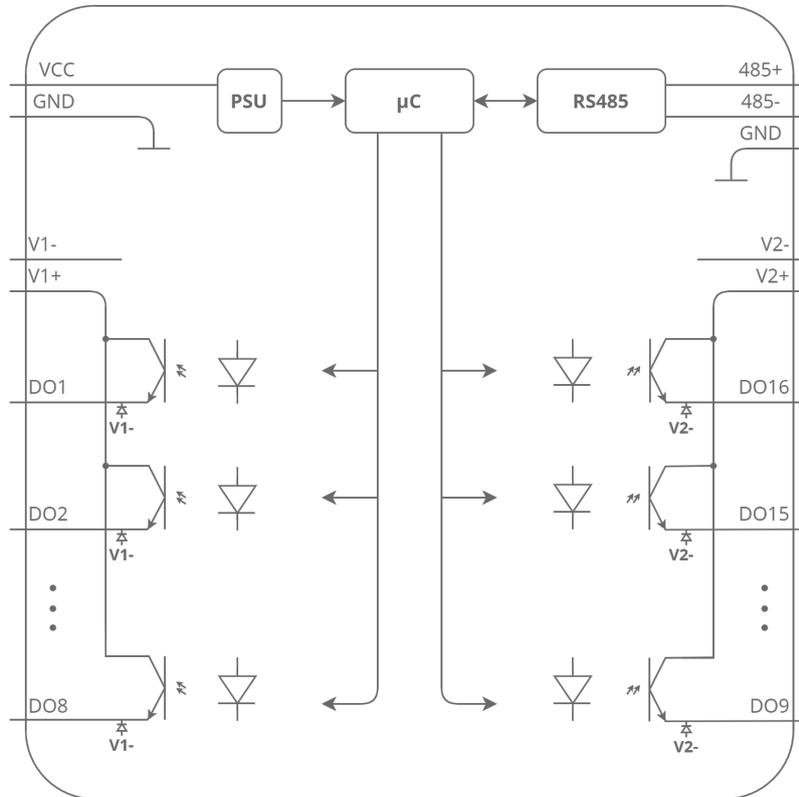# 6 Connections

6.1 Block Diagram

Figure 3. Block diagram

6.2 Power Supply Connection

6.2.1 DC Power Connection
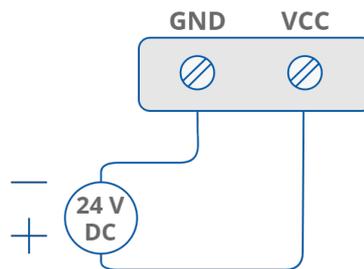

Figure 4. DC power connection
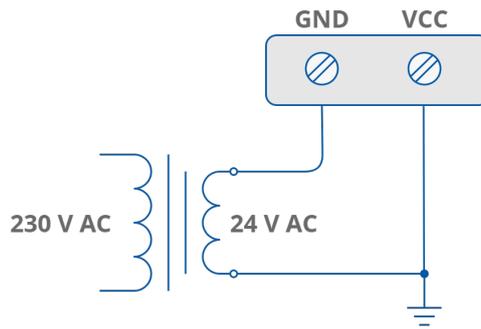
6.2.2 AC Power Connection

Figure 5. AC power connection
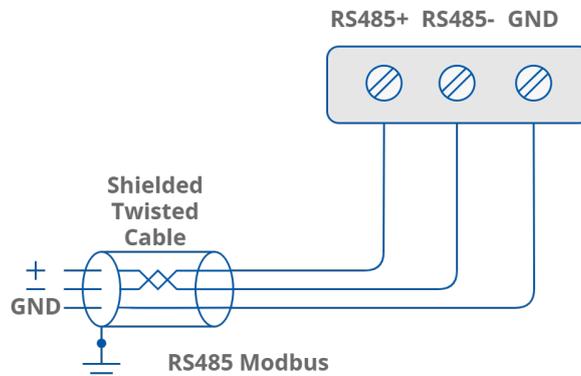
6.3 Communication Bus Connection

Figure 6. Communication bus connection

6.4 Connection of Digital Output
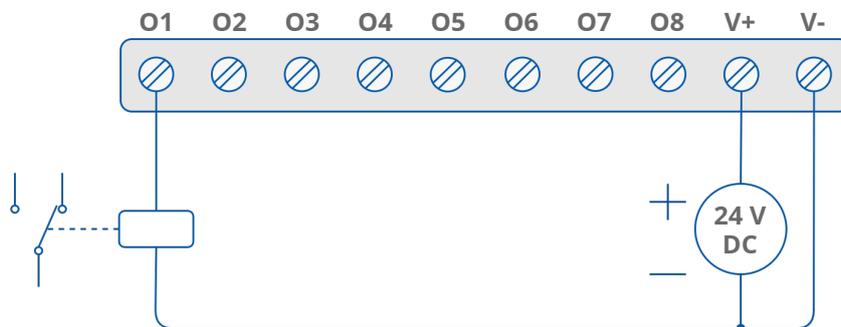
6.4.1 Connection of Relay

Figure 7. Connection of relay
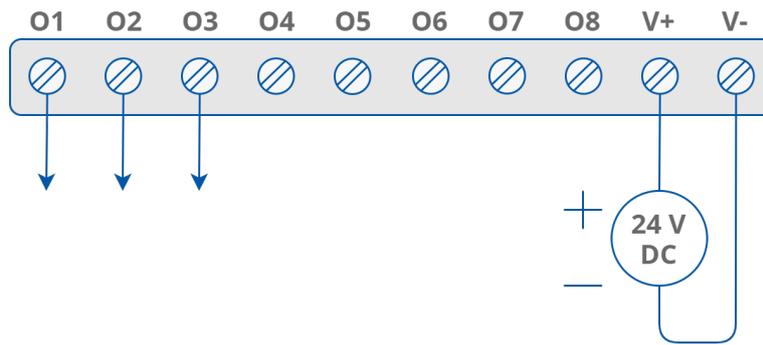
6.4.2 Connection of Output

Figure 8. Connection of output

6.5 Quick Connector

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.
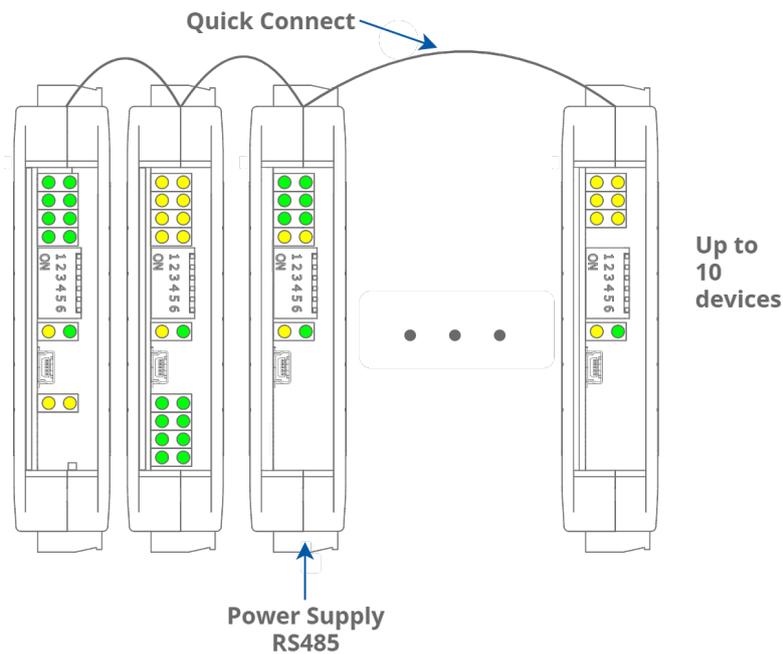
Figure 9. Quick connector

7 DIP Switch

Figure 10. 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 Modules Registers

8.1 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
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)
40009	8	0x08	Watchdog	Read/write	Watchdog
40013	12	0x0C	Default Output State	Read/write	Default output state (after power on or watchdog reset)
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	
40052	51	0x33	Outputs	Read/write	Output state

Table 9. Registered access

8.2 Bit Access

Modbus Address	Dec Address	Hex Address	Register Name	Access	Description
193	192	0x0C0	Default State of Output 1	Read/write	Default state of output 1
194	193	0x0C1	Default State of Output 2	Read/write	Default state of output 2

Modbus Address	Dec Address	Hex Address	Register Name	Access	Description
195	194	0x0C2	Default State of Output 3	Read/write	Default state of output 3
196	195	0x0C3	Default State of Output 4	Read/write	Default state of output 4
197	196	0x0C4	Default State of Output 5	Read/write	Default state of output 5
198	197	0x0C5	Default State of Output 6	Read/write	Default state of output 6
199	198	0x0C6	Default State of Output 7	Read/write	Default state of output 7
200	199	0x0C7	Default state of output 8	Read/write	Default state of output 8
201	200	0x0C8	Default State of Output 9	Read/write	Default state of output 9
202	201	0x0C9	Default State of Output 10	Read/write	Default state of output 10
203	202	0x0CA	Default State of Output 11	Read/write	Default state of output 11
204	203	0x0CB	Default State of Output 12	Read/write	Default state of output 12
205	204	0x0CC	Default State of Output 13	Read/write	Default state of output 13
206	205	0x0CD	Default State of Output 14	Read/write	Default state of output 14
207	206	0x0CE	Default State of Output 15	Read/write	Default state of output 15
208	207	0x0CF	Default State of Output 16	Read/write	Default state of output 16
817	816	0x330	Output 1	Read/write	Output 1 state
818	817	0x331	Output 2	Read/write	Output 2 state
819	818	0x332	Output 3	Read/write	Output 3 state
820	819	0x333	Output 4	Read/write	Output 4 state
821	820	0x334	Output 5	Read/write	Output 5 state
822	821	0x335	Output 6	Read/write	Output 6 state

Modbus Address	Dec Address	Hex Address	Register Name	Access	Description
823	822	0x336	Output 7	Read/write	Output 7 state
824	823	0x337	Output 8	Read/write	Output 8 state
825	824	0x338	Output 9	Read/write	Output 9 state
826	825	0x339	Output 10	Read/write	Output 10 state
827	826	0x33A	Output 11	Read/write	Output 11 state
828	827	0x33B	Output 12	Read/write	Output 12 state
829	828	0x33C	Output 13	Read/write	Output 13 state
830	829	0x33D	Output 14	Read/write	Output 14 state
831	830	0x33E	Output 15	Read/write	Output 15 state
832	831	0x33F	Output 16	Read/write	Output 16 state

Table 10. Bit access

9 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.

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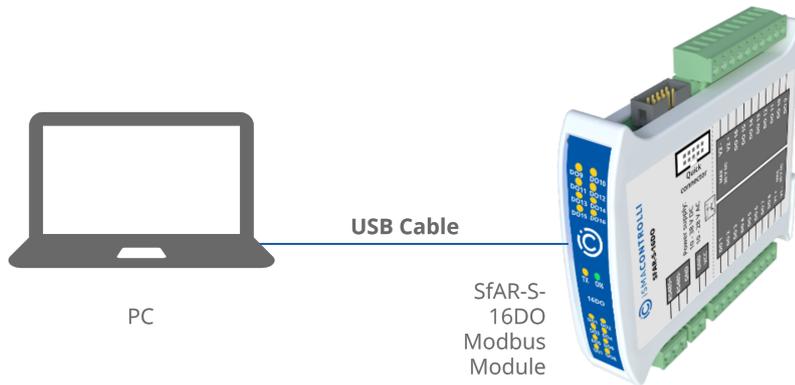

Figure 11. PC connection

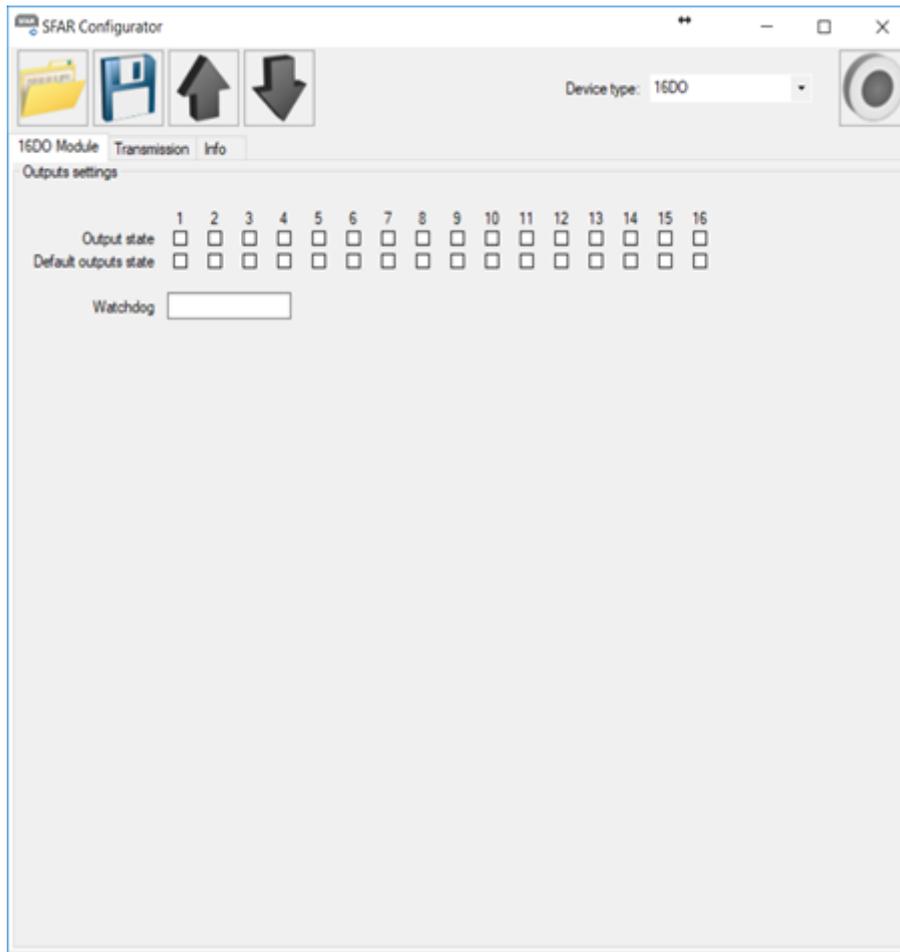The SfAR Configurator is a universal software, where it is possible to configure all available modules.

Figure 12. The SfAR Configurator