LUMEL
EVERYTHING COUNTS

MODULE OF ANALOG INPUTS
S4AI

USER'S MANUAL

CE

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1. APPLICATION

S4AI module is designed to measure the standard signal (voltage, current, temperature, resistance, etc.) and to provide the measured values in a digital form via the MODBUS protocol.
Input signals are divided into two groups of two inputs which are insulated with each other. RS485 interface and USB are isolated from the input, output signals and from the power supply. The module configuration is possible via the USB PORT or one of the available RS485 interfaces with the use of free e-Con software. e-Con software is available on the manufacturer's website.

S4AI module has the following features:

- analog inputs (current / voltage or resistance / shunt / thermocouple, depending on the ordering code)
- MODBUS protocol on RS485 interface,
- timers of lower and higher threshold overrun duration for each input of the module,

Fig. 1: View of S4AI module with detachable connectors

2. S4AI SET

The complete set of S4AI module includes:

- S4AI module 1 pc
- User's manual 1 pc
- upper terminal strip (9 terminals) 1 pc
- lower terminal strip (6 terminals) 2pcs

3. BASIC REQUIREMENTS, OPERATIONAL SAFETY

Meaning of the symbols used in this manual:

Warning!
Warning of potentially dangerous situations. It is especially important to read and understand these instructions before connecting the device. Failure to meet the instructions marked with this symbol can result in a serious injury of personnel and damage to the device.

Caution!
Generally useful notes. Following these instructions ensures easy operation of the device. The user must take them into account when the operation of the device does not meet the user's expectations.
Possible consequences when these instructions are not followed!

In terms of operational safety the meter meets the requirements of EN 61010-1.

Safety instructions:

- The assembly and the installation of the electrical connections may be carried out only by a duly qualified electrician.
- The person performing the installation is responsible for the safety of the system in which devices is to be installed.
- Before turning on the module verify the connections.
- Removal of the module housing during the warranty period voids the warranty. The module power supply must be turned off and the input circuits disconnected before opening the housing.
- The device is intended for installation and use in industrial electromagnetic environments.
- A switch or a circuit-breaker should be installed in the building or facility. It should be located near the device, easily accessible to the operator and properly marked.
- In the event of damage, the module can be repaired only by the service authorized by the manufacturer.
- Before using the repaired module make sure that it is working properly.
- Connection of the module and/or its usage inconsistently with this manual can reduce the operational safety of the module.

4. INSTALLATION

4.1. Installation

The RE62 controller is adapted for installation in a modular installation switchgears on a 35 mm support rail.
The housing is made of plastic. Housing dimensions are 53 x 110 x 60.5 mm. Detachable terminal blocks located outside the module allow for connection of power supply, RS482 interface and outputs, with conductors of cross section up to 2.5 mm^2, and also input cables of cross section up to 1.5 mm^2. The dimensions of the module are shown in Fig. 2.

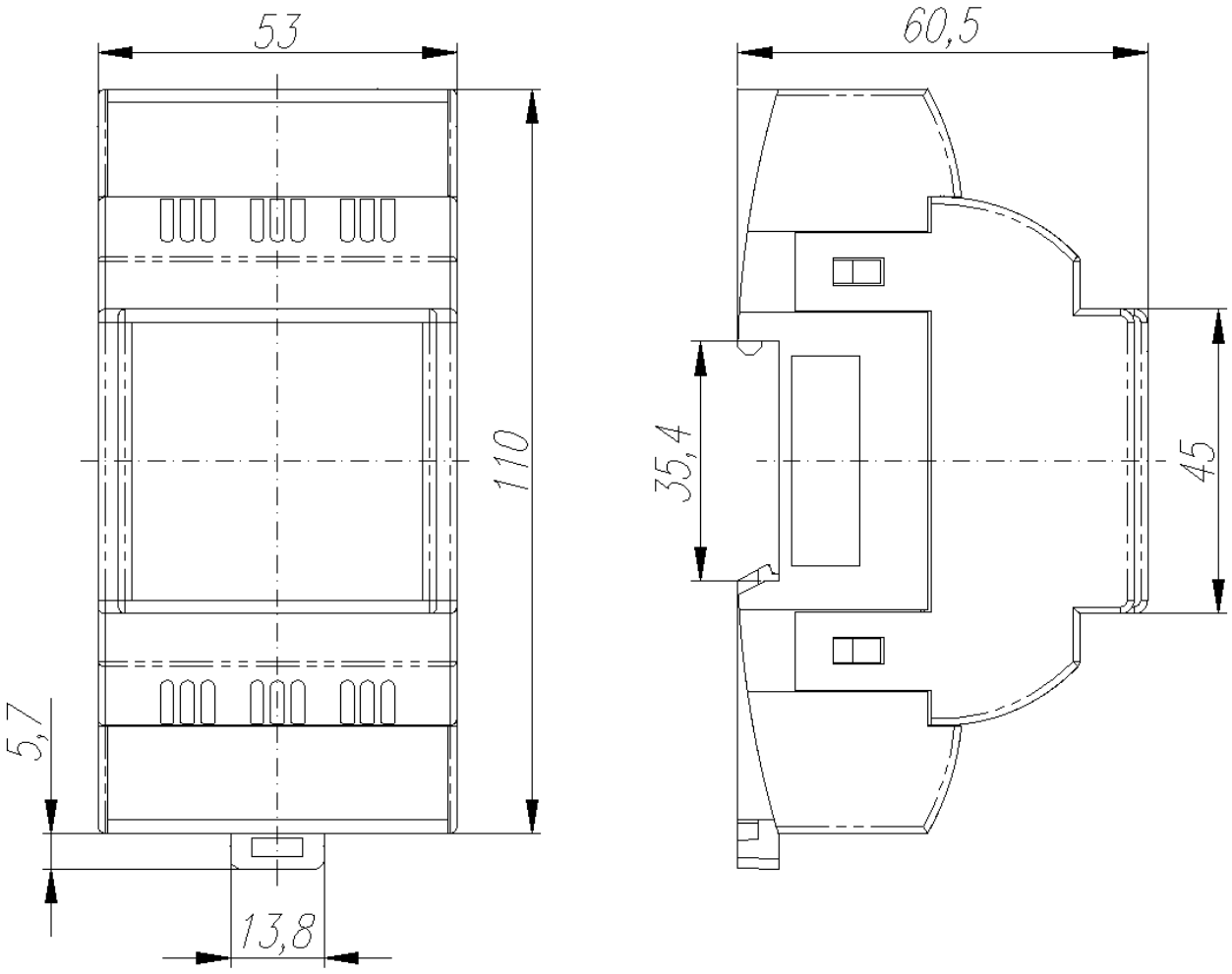


Fig. 2: Dimensions of the module

4.2. External connections diagram

Connections the module are shown in Fig. 3. In the event when the module is powered with DC voltage, the voltage polarity does not matter.

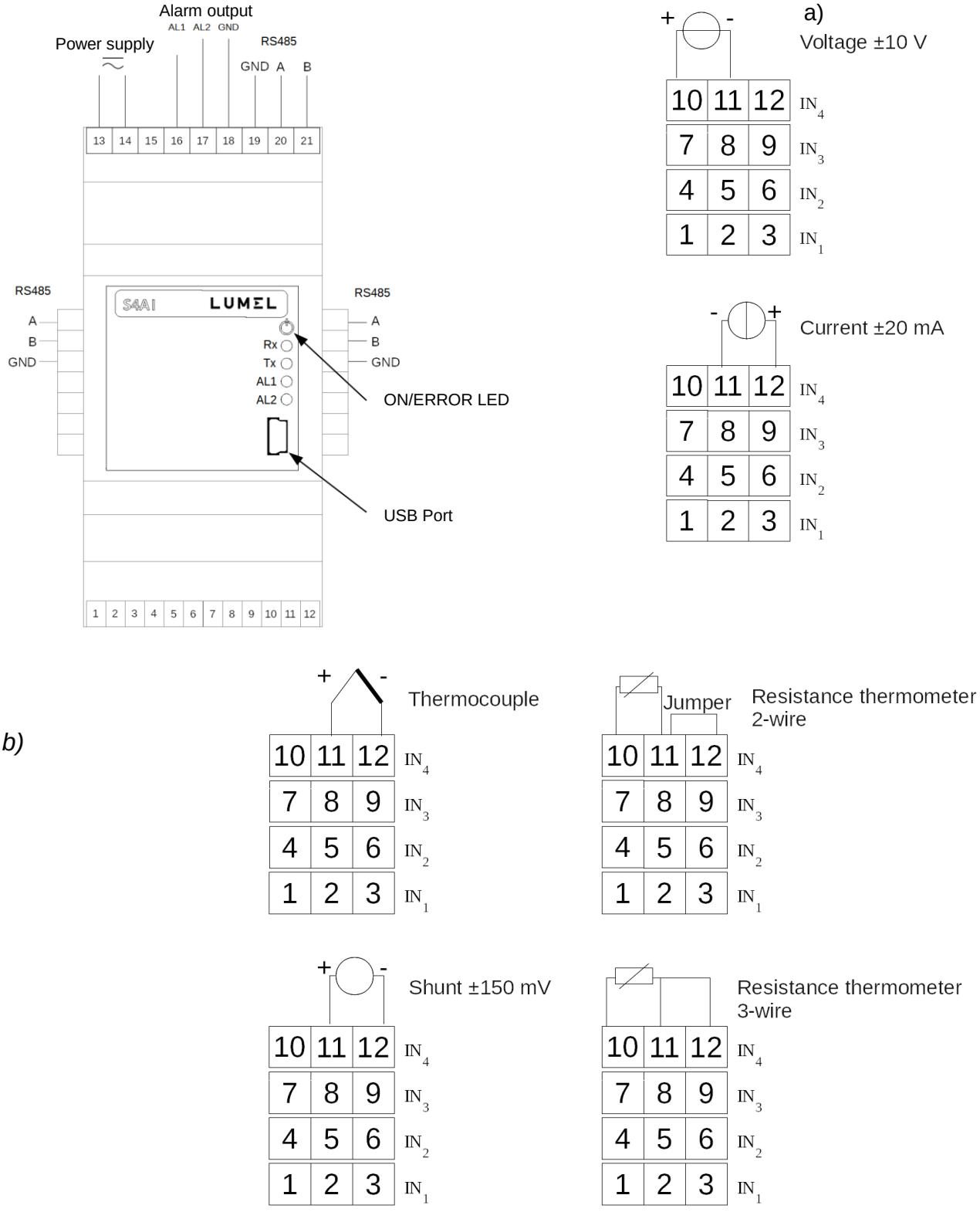


Fig. 3: Electrical connections of S4AI module a) with ±10 V, ±20 mA inputs

b) with Pt100, Pt500, Pt1000 inputs, JKS, ±150 mV thermocouples

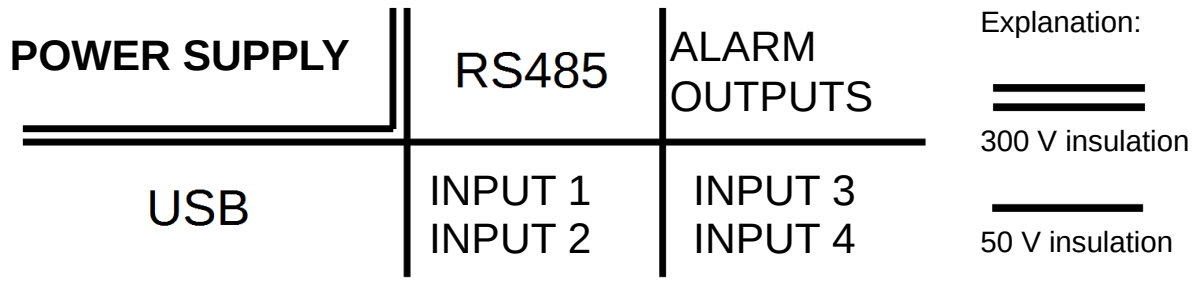


Fig. 4: Schematics of S4AI module insulation

Table 1: the meaning of LED signaling

LED	Description
ON / ERROR (green / red)	- continuous green: normal operation, - alternating green/red flashes: error or range exceeding of one or more active inputs. - continuous red: no main power supply (powered from USB interface), or an error, - flashing red: calibration error of the module
Rx (green)	Active data receipt via the RS485 interface.
Tx (red)	Active data transmission via the RS485 interface.
AL1 (red)	Active AL1 alarm output.
AL2 (red)	Active AL2 alarm output.

4.3. Side bus

To gain access to the side bus by means of, for example, a flat-blade screwdriver, it is necessary to break one or both caps located on the side of the module housing.

Fig. 5: Side bus

S4AI module is equipped with only one RS485 interface. Side bus and terminals 19, 20 and 21 are connected to the same RS485 interface.

When the caps are broken, S4AI module may be connected to other LUMEL devices equipped a side bus. In this way, many S4AI modules can create a multi-channel block of analog inputs.

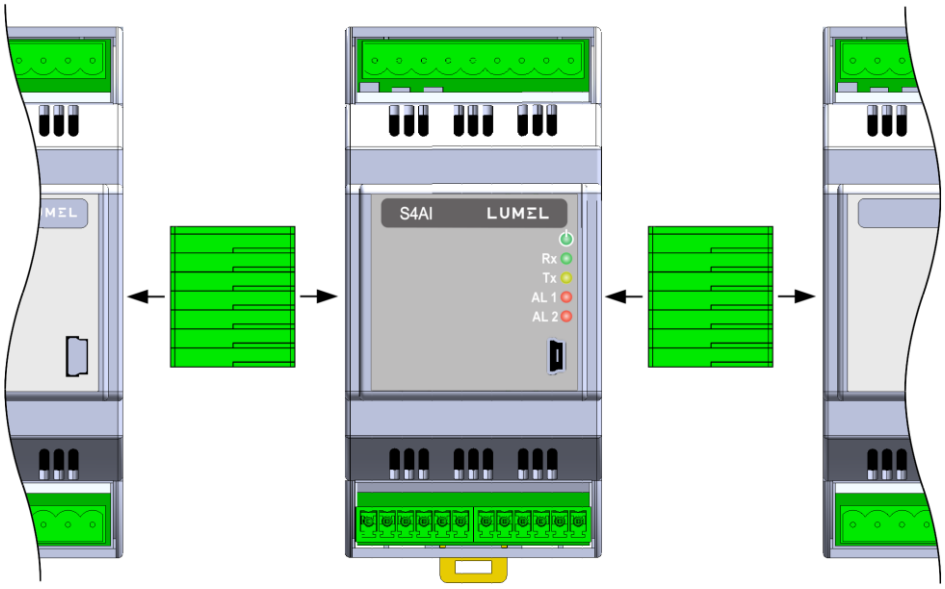


Fig. 6: Side bus connection

5. OPERATION

5.1 Configuration

S4AI module can be configured via MODBUS protocol on two interfaces:

- USB: the device responds to any address and requires no power supply (USB power).

If the module is powered only by USB, the analog inputs are switched off, the RS485 interface is inactive and the LED indicator ON / ERROR lights continuously red.

- RS485: the interface must be configured (registers 4004..4007) and the device must be powered on.

5.2 RS485 Modbus Slave

To use the S4AI module as a MODBUS SLAVE device on RS485 interface, the device must be configured as follows:

- Set the device address (register 4004), baud rate (register 4005), transmission mode (register 4006), upgrade the parameters (register 4007), and save the parameters in non-volatile memory (register 4036)
- Set the input type (registers 4000..4003) and, if required, set the following: the alarms (registers 4009.. 4018 and 6000..6006), manual compensation (registers 4019..4022) and set the compensation value (registers 6040..6046), individual characteristic (registers 4023..4026 and 6008..6038), delete the minimum and maximum values (register 4032), clear the timers (register 4033) and set thresholds for timers (registers 6048..6062), virtual channels (registers 4043..4054). Save the configuration to non-volatile memory (register 4036).
- The measured values, the calculated values in the virtual channels, minimum and maximum values, and the contents of the timers can be read from the registers 6600..6726.
- In the case when the range on one or more inputs is exceeded, the LED indicator ON / ERROR will light alternately in red and green, and the appropriate error value, according to the table shown below in this manual, will be set in the status register (register 4037).

5.3 Individual Characteristics

The values measured on each of the active inputs can be scaled in accordance with the two-point linear characteristics.
To enable this functionality, you must

- enter '1' in the appropriate register (registers 4023..4026),
- set the individual characteristic points (registers 6008..6038),
- scaled measurement results are presented in registers 6632..6646,
- save the parameters to non-volatile memory of the module (register 4036).

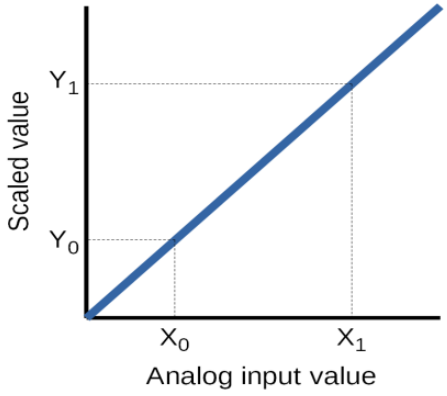


Fig. 7: Individual characteristic

The way the characteristic affects the operation of the module is shown in Fig. 8.

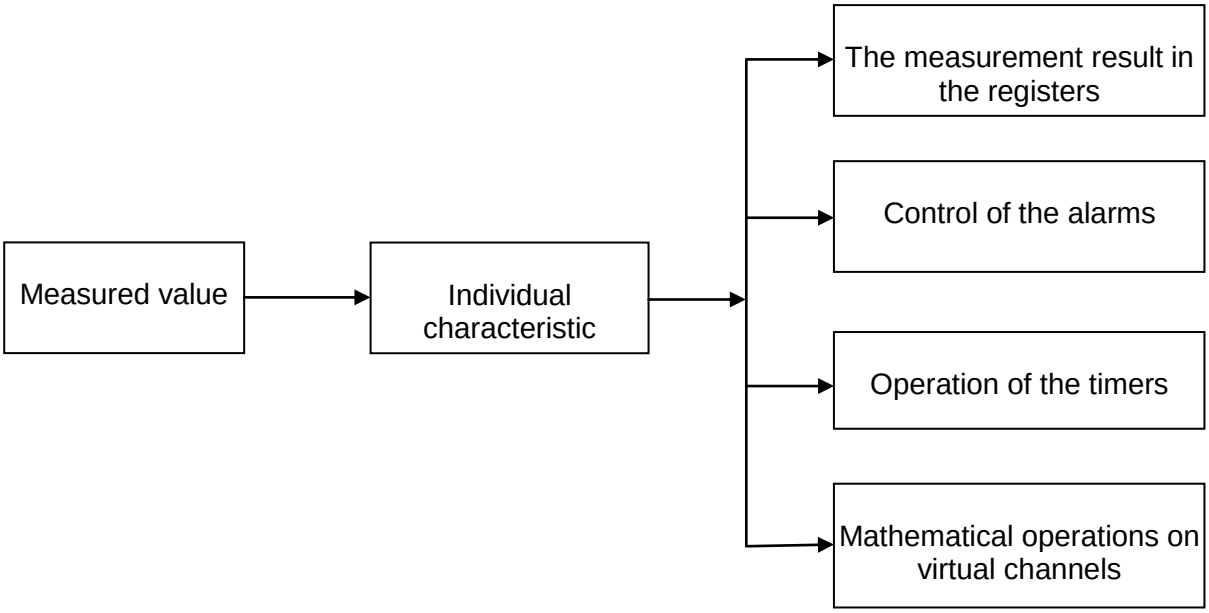


Fig. 8: Effects of the individual characteristics

Example of configuration: shunt with rated current 4A was connected. At rated current the voltage at the shunt is 150mV. To enable S4AI module calculation of the direct current flowing through the shunt, the individual characteristics should be set as follows:

- X_0 – 0 (lower value for analog input),
- X_1 – 150 (upper value for analog input),
- Y_0 – 0 (lower scaled value),
- Y_1 – 4 (upper scaled value),

Having the individual characteristics set in this way, the value corresponding directly to the value of the current flowing through the shunt will be presented in the relevant registers.

5.4 Virtual channels

Two virtual channels perform mathematical operations on the values measured by the analog inputs. Registers 6632 to 6646 contain the measured values scaled by the individual characteristics (if enabled), or directly the measured values when the individual characteristics function is switched off. For the first virtual channel the physical analog input involved in the performance of the mathematical function is selected in the registers 4043..4046, and for the second virtual channel in the registers 4049..4022, as follows:

- '0': the channel is off,
- '1': the value from the first analog input,
- '2': the value from the second analog input,
- '3': the value from the third analog input,
- '4': the value from the fourth analog input,
- '5': the first virtual channel (only available for the second virtual channel).

The performed mathematical function is selected by setting the proper value in the register 4047 for the first virtual channel, or in the register 4053 for the second virtual channel, as follows:

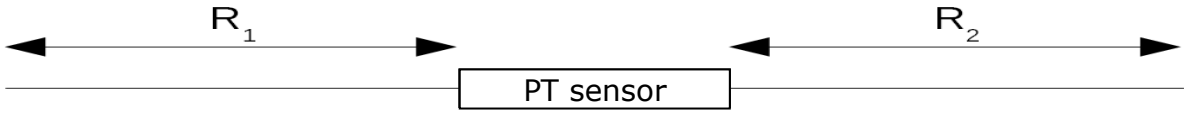
- '0': ADD – adding the values of all the analog inputs assigned to the function,
- '1': SUB – subtracting the values of all the analog inputs assigned to the function,

- '2': AVG – calculation of the average value of all the analog inputs assigned to the function,
- '3': MIN – selection of minimum value of all the analog inputs assigned to the function,
- '4': MAX – selection of maximum value of all the analog inputs assigned to the function,
- '5': MUL - multiplying the first assigned analog input by the value of the second argument of the function (register 4048 for the first virtual channel or 4054 for the second virtual channel)
- '6': DIV - dividing the first assigned analog input by the value of the second argument of the function (register 4048 for the first virtual channel or 4054 for the second virtual channel)

The value of the second argument in the register is the value multiplied x10 (e.g. the value in the register 15 is a value of argument 1.5). For DIV function the value of 0 for the second argument of the function is prohibited. Saving the set parameters is done by entering the value 1 into register 4036.

5.5 Auto-compensation

The sensor of PT type:
- In the case of a 3-wire connection it is recommended to use auto-compensation (value of 0 in the channel relevant register 4019 .. 4022),
- In the case of a 2-wire connection it is recommended to use manual compensation (value of 1 in the channel relevant register 4019 .. 4022). When manual compensation is activated, the sum of the resistance of the two supply leads (R1 + R2 in the figure) must be entered into the relevant register (registers 8020..8023).



Thermocouples:
- In case of automatic compensation the value of 0 must be entered in registers 4019..4022,
- In case of manual compensation, the value of 1 must be entered in registers 4019..4022 and the compensation value in Celsius in the registers 8020..8023.

5.6 Timers

Each analog input with individual characteristics and each virtual channel is monitored by 2 timers:
the first one counts seconds up when the monitored input or virtual channel reaches a value greater than a defined threshold,
the second one counts seconds up when the monitored input or virtual channel reaches a value lower than a defined threshold,

- thresholds are set in the registers 6048..6062,
- the value of each timer is located in the registers 6692 to 6706,
- the configuration of the timers should be stored in the non-volatile memory (register 4036).

For example, if you set the lower threshold value of 20 and the upper threshold value of 60, the values of both timers will count as shown in the figure below:

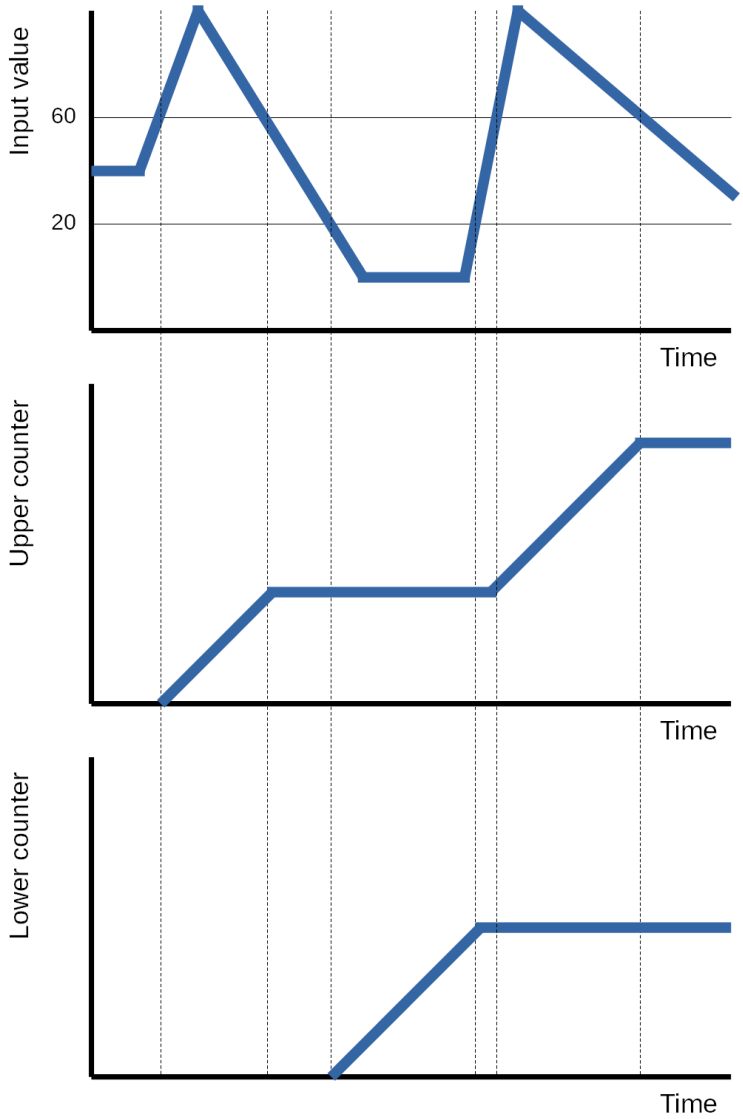


Fig. 9: Example of timers operation

.7 Alarms

S4AI module is equipped with two alarm outputs, which can be configured as follows:

- select the monitored input (registers 4009, 4014)
- select the operating mode of the alarm output (registers 4010, 4015) as shown in Figure 9,
- select the delay time of alarm activation (registers 4011, 4016)
- select the delay time of alarm deactivation (registers 4012, 4017)
- select maintaining the alarm signaling after the alarm condition is no longer present (registers 4013, 4018)
- delete, if necessary, the signaling of the alarm occurrence (register 4034)
- save the configuration to the memory (register 4036).

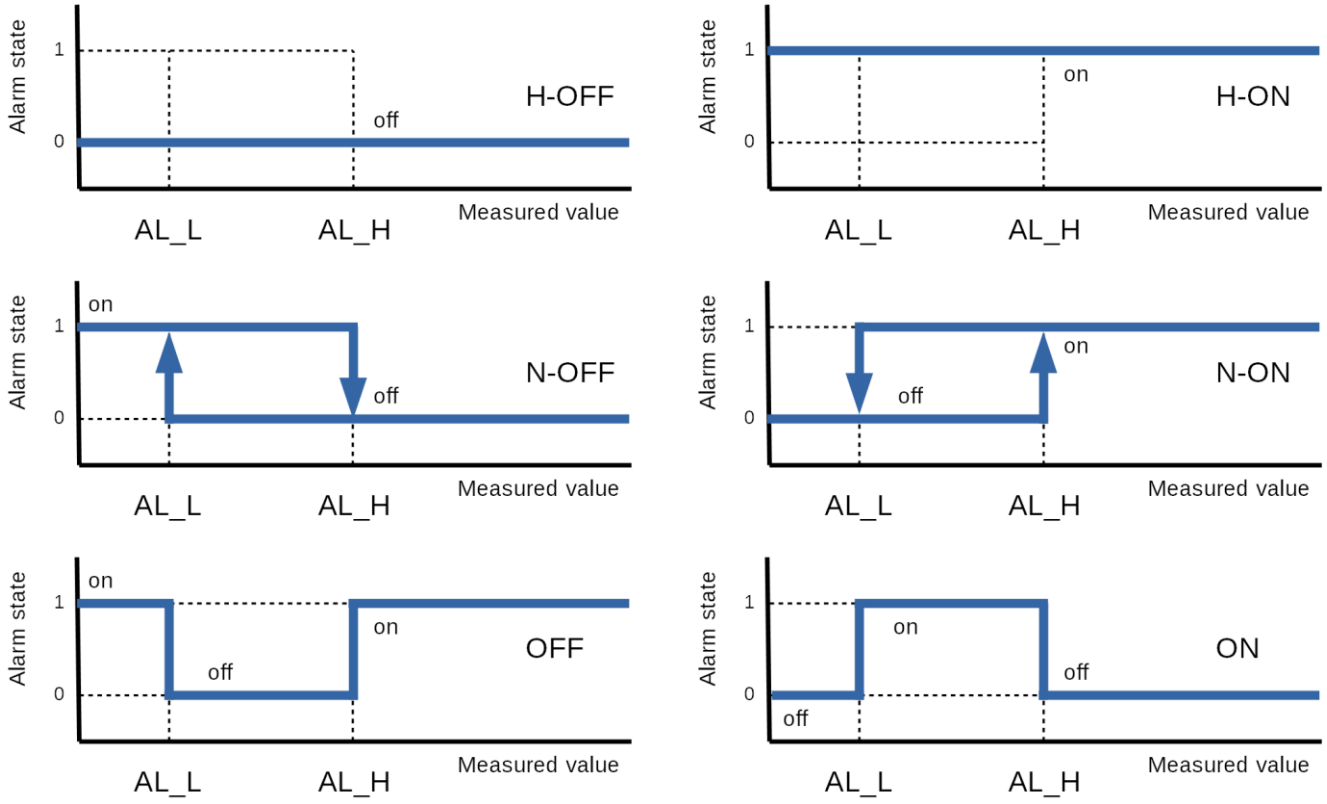


Fig. 10: Alarm outputs operating modes

When the module is turned on, the alarm outputs are automatically switched on for approximately 1 second.

5.8 Module configuration with E-Con software

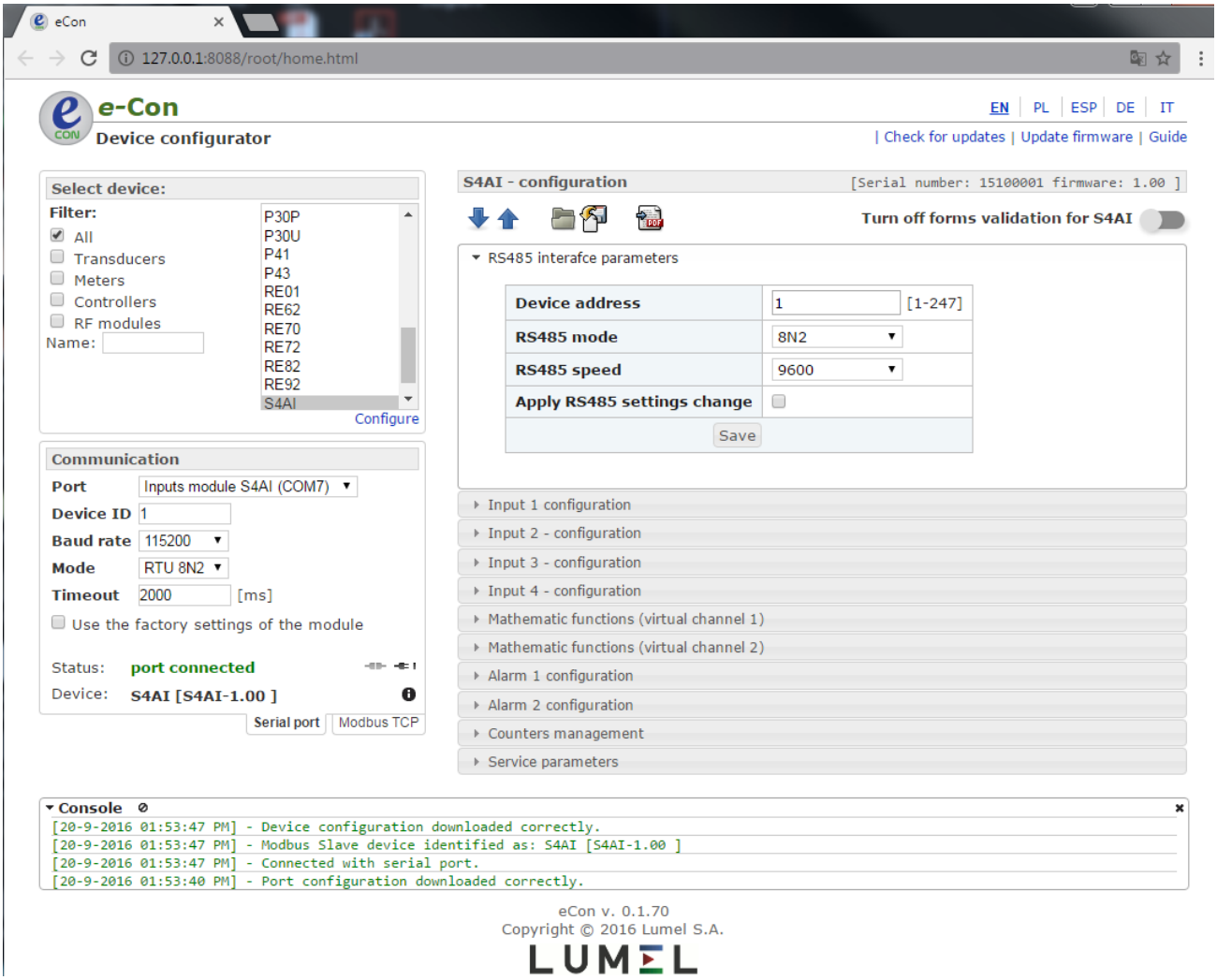


Fig 11: Window of E-Con software

S4AI module can be configured using the E-Con software. This program is a free application available from the manufacturer's website (www.lumel.com.pl). The module must be connected to a PC via USB or RS485 interface. After starting the program, select the serial port to which the module is installed. Available serial ports and connection configurations are available in the *"Communication"* tab.

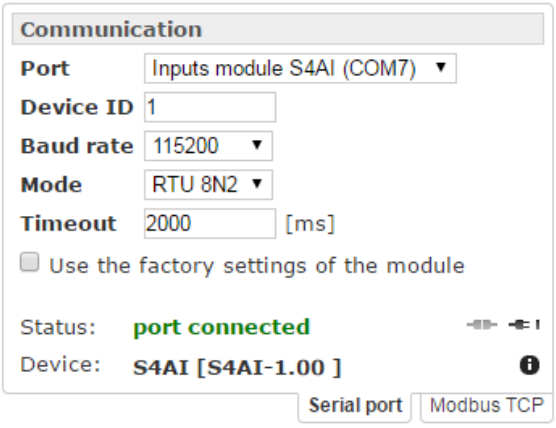


Fig 12: Setting connection with S4AI module

When connected via the RS485 interface, set the following transmission parameters: the address (device ID), the speed and mode. Factory settings of RS485 interface are as follows: Address 1, speed 9600, mode RTU 8N2. For USB connection the following must be set: address 1 (or any other), speed 115200, mode RTU 8N2.

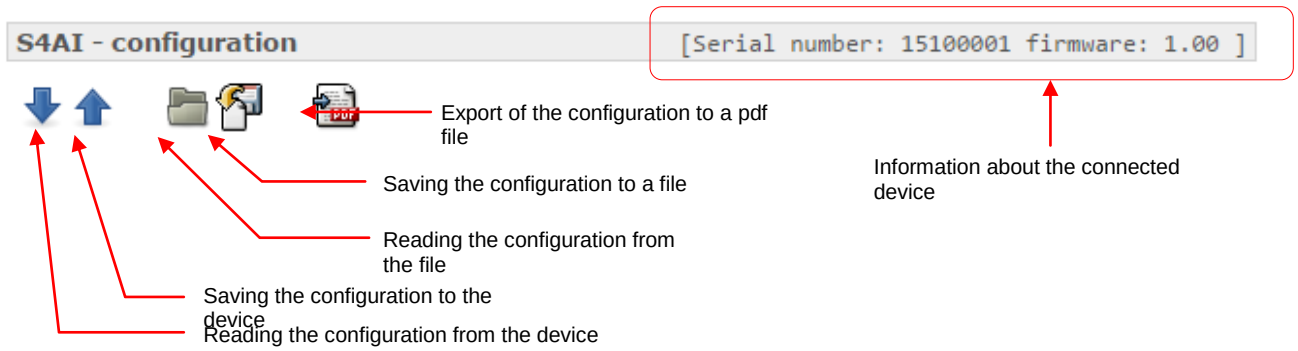


Fig 13: Configuration reading and saving from e-Con menu

After setting the parameters, select the *"connect"* button.

Before changing the configuration of the module, it is advisable to read and save the current configuration to a file to be able to restore the previous configuration. From e-Con application menu it is possible to save the configuration to a file, to read the file and also export the configuration to a pdf file.

5.8.1 Configuration parameters

After connection, e-Con automatically read the current configuration from the device. The parameters available for configuration, as well as a preview of the currently measured values at the inputs, are available in the right part of the main program window.

Table 2: Configuration parameters in E-Con

Parameter	Description	Range	Default value
Tab RS485 interface parameters			
Device address	Device address for MODBUS protocol	1..247	1
RS485 mode	RS485 interface baud rate	8N2 8E1 8O1 8N1	8N2
RS485 speed	RS485 interface baud rate	1200 2400 4800 9600 19200 38400 57600 115200	9600
Apply RS485 settings change	When checked, the communication takes place in accordance with the new settings after the settings are saved	-	-

Tabs *Input 1, 2, 3, 4 configuration*			
Measuring input type	Selecting the type of signal fed to the input	**Version S4AI-1xxxxx:** Disabled ±10 V ±20 mA **Version S4AI-2xxxxx:** Disabled PT100 PT500 PT1000 ±150 mV Thermocouple J Thermocouple K Thermocouple S	Disabled
Averaging time	Measurements averaging time at the input	0.5 s 1 s 3 s 5 s 10 s 15 s 20 s	0.5 s
Compensation mode	Automatic or manual compensation at the input	Autocompensation Manual compensation	Autocompensation
Low value timer threshold	Trigger lower threshold of activity timer for the input	-99999.99..99999.99	0
High value timer threshold	Trigger higher threshold of activity timer for the input	-99999.99..99999.99	100.00
Show measured values	Allows for the preview of currently measured values at the input. See point 5.8.3.	-	-
Delete input min/max values	Allows for clearing minimum and maximum values saved at the input	-	-
Individual characteristic	Enable/disable scaling of the measured value by user defined factors	Off On	Off
Point X0	Definition of individual characteristic (only when enabled). See point 5.3.	-99999.99..99999.99	0.00
Point Y0	Definition of individual characteristic (only when enabled). See point 5.3.	-99999.99..99999.99	0.00
Point X1	Definition of individual characteristic (only when enabled). See point 5.3.	-99999.99..99999.99	1.00
Point Y1	Definition of individual characteristic (only when enabled). See point 5.3.	-99999.99..99999.99	1.00
Tab Mathematic functions (virtual channel 1, 2)			
Argument 1	Selection of input engaged in the performance of mathematical function. See point 5.4.	Not used Analog input 1 Analog input 2 Analog input 3 Analog input 4 Virtual channel 1*) *) for virtual channel 2 only	Not used
Argument 2	Selection of input engaged in the performance of mathematical function. See point 5.4.	Not used Analog input 1 Analog input 2 Analog input 3 Analog input 4 Virtual channel 1*) *) for virtual channel 2 only	Not used
Argument 3	Selection of input engaged in the performance of mathematical function. See point 5.4.	Not used Analog input 1 Analog input 2 Analog input 3 Analog input 4 Virtual channel 1*)	Not used

		*) for virtual channel 2 only	
Argument 4	Selection of input engaged in the performance of mathematical function. See point 5.4.	Not used Analog input 1 Analog input 2 Analog input 3 Analog input 4 Virtual channel 1*) *) for virtual channel 2 only	Not used
Function selection	Mathematical function. See point 5.4.	Addition Subtraction Average Minimum Maximum Multiplication Division	Addition
Second argument (ratio)	Second argument for Multiplication or Division function	-3000.0..3000.0	0.0
Low value timer threshold	Trigger lower threshold of activity timer for the virtual channel	-99999.99..99999.99	0.00
High value timer threshold	Trigger higher threshold of activity timer for the virtual channel	-99999.99..99999.99	100.00
Virtual channel 1, 2 value	Preview of the currently calculated value for the virtual channel, and the saved minimum and maximum values	-	-
Delete channel min/max values	Allows for clearing the minimum and the minimum values for the virtual channel	-	-
Tab *Alarm 1, 2 configuration*			
Alarm control parameter	Selection of signal to be monitored by alarm	Not used Analog input 1 Analog input 2 Analog input 3 Analog input 4 Virtual channel 1 Virtual channel 2	Not used
Condition type	Alarm output operating mode. See point 5.7.	H-OFF H-ON N-OFF N-ON OFF ON	H-OFF
Low value alarm thres hold (AL_L)	Lower threshold of the value triggering alarm output. See point 5.7.	-99999.99..99999.99	0.00
High value alarm threshold (AL_H)	Higher threshold of the value triggering alarm output. See point 5.7.	-99999.99..99999.99	50.00
Alarm ON delay	Delay time of alarm output activation after event occurrence	0..3600 s	0
Alarm OFF delay	Delay time of alarm output deactivation after event is not longer present	0..3600 s	0
Alarm indication memory	This option allows an alarm indication after the alarm has stopped. Indication is done by signaling LEDs AL1/AL2 blinking on the front panel of the module. Resetting the alarm is done by an option in the *Service Parameters tab-> Delete alarm signaling*	-	-
Timer Management tab			
The tab allows the user to view the timers assigned to each of the analog inputs, virtual channels, and alarms. In this tab, the user can also reset all or selected timers.			
Service Parameters tab			
Module status	Preview of the device status. Displays information such as: - state of the alarm	-	-

	- upper overrun for inputs - lower overrun for inputs - errors See point 5.8.2.		
Delete alarms indication	Deleting an alarm indication when the option of alarm indication after its stop is enabled.	-	-
Reset all min/max values	Deleting the minimum and maximum values for all inputs and virtual channels	-	-
Factory parameters	Restoring factory settings of the device.	-	-

5.8.2 S4AI module status

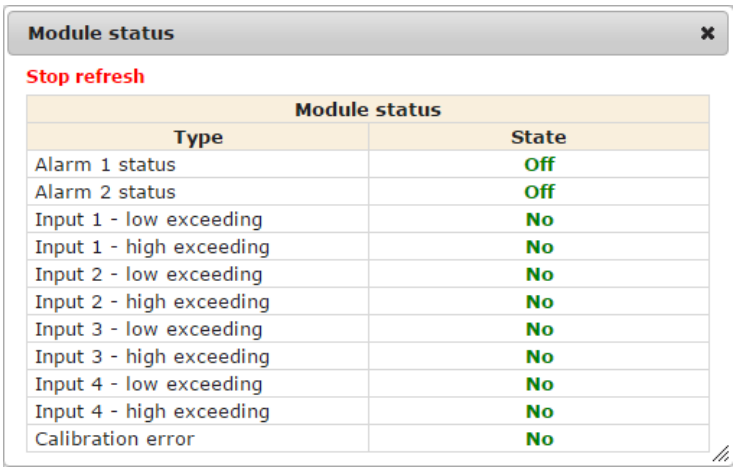


Fig 14: Preview of S4AI module status in e-Con program.

5.8.3 Measured values

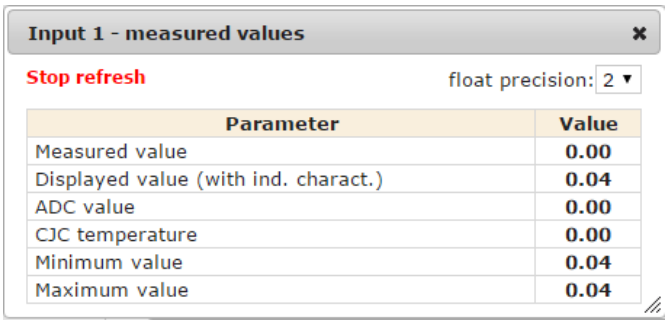


Fig 15: Preview of measured values in e-Con program.

5.8.4 Values of the timers

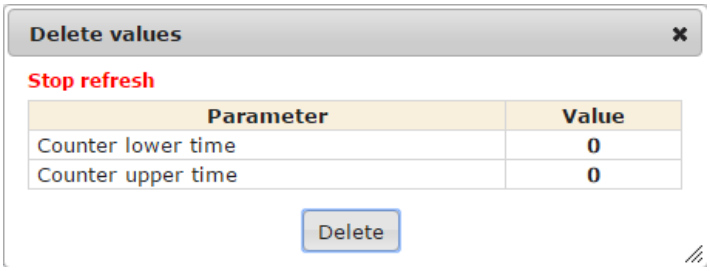


Fig 16: Preview and reset of upper and lower thresholds overruns duration timers in e-Con program.

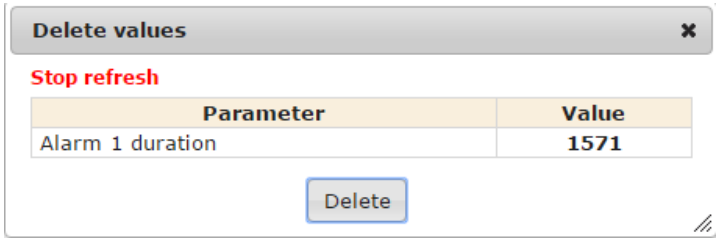


Fig 17: Preview and reset of alarm duration timers in e-Con program.

6. DIGITAL INTERFACES

6.1 RS485 interface - parameter list

RS485 interface is designed for communication with the module and for configuration of the module. Communication is done in MODBUS RTU protocol and allows for reading registers of the module containing the measurement and configuration data. The interface is characterized by the following parameters:

- ID 219 (0xDB)
- device address 1...247
- baud rate 1.2, 2.4, 4.8, 9.6, 19.2, 38.4, 57.6, 115.2 kbit/s
- transmission mode 8N2, 8E1, 8O1, 8N1
- protocol Modbus RTU
- time to response start 100 ms (reading)
  1000 ms (saving)
- supported Modbus functions
  - 03, 04 registers reading
  - 06 saving one register
  - 16 saving numerous registers
  - 17 device identification

Transmission factory settings: address 1, baud rate 9.6 kbit/s, mode 8N2.
Broadcast address: 253

6.2 USB interface - parameter list

The USB interface is dedicated only to S4AI module configuration.

- ID 219 (0xDB)
- device address any
- baud rate 115.2 kbit/s
- transmission mode 8N2
- protocol Modbus RTU
- time to response start 100 ms (reading)
  1000 ms (saving)
- supported Modbus functions
  - 03, 04 registers reading
  - 06 saving one register
  - 16 saving numerous registers
  - 17 device identification

Broadcast address: 253

6.3 Map of S4AI module registers

In S4AI module the data is placed in 16- and 32-bit registers. Process variables and operating parameters of the module are placed in the areas of register groups depending on the type of the variable. The values of the 16-bit registers are arranged in the order from the least significant bit to the most significant bit (b0-b15). The 32-bit registers contain the float type data according to IEEE-754. Addresses ranges of register groups are shown in Table 3. The 16-bit registers are described in Table 4.

The 2x16-bit registers with their 32-bit counterparts are described in Tables 5 and 6. Addresses presented in the tables are physical addresses.

Each input of the module has two measurement channels. Each of these channels is active depending on the selected input type, e.g. in the version with inputs ± 10 V and ± 20 mA, measurements take place in one or the other measuring channel. In the version with thermometric and voltage inputs from the shunt - voltage measurements are performed in one channel, and thermometric measurements in the other one. Each channel has its own assigned register from the register group 7500. For the calculation and processing, the data is retrieved from the channel relevant for the selected input type.

Table 3: Modbus registers

Address range	Value type	Description
4000 - 4054	Integer (16 bits)	Module configuration. Values placed in 16-bit registers.
6600 – 6726	Float (2x16 bit, byte order 3210)	Values placed in two successive 16-bit registers. Registers contain the same data as 32-bit registers of 7500 range. Read-only registers.
6800 – 6926	Float (2x16 bit, byte order 1032)	Values placed in two successive 16-bit registers. Registers contain the same data as 32-bit registers of 7500 range. Read-only registers.
7500 – 7563	Float (32 bits)	Values placed in 32-bit registers. Read-only registers. Depict the values measured and calculated for each input.
6000 – 6070	Float (2x16 bit, byte order 3210)	Configuration of module input Contain the same data as 32-bit registers of 8000 range.
6200 – 6270	Float (2x16 bit, byte order 1032)	Configuration of module input Contain the same data as 32-bit registers of 8000 range.
8000 – 8035	Float (32 bits)	Configuration of module input Values placed in 32-bit registers.

Table 4: Configuration registers

Address of the register	Access mode	Scope of changes	Description	Default value
4000	R/W	0...7*	Input type 1: 0 - off 1 – ±10V / PT100, 2 – ±20 mA / PT500 3 – unavailable / PT1000 4 – unavailable / ±150 mV 5 – unavailable / Thermocouple J 6 – unavailable / Thermocouple K 7 – unavailable / Thermocouple S	0
4001	R/W	0...7*	Input type 2: 0 - off 1 – ±10V / PT100, 2 – ±20 mA / PT500	0

			3 – unavailable / PT1000 4 – unavailable / ±150 mV 5 – unavailable / Thermocouple J 6 – unavailable / Thermocouple K 7 – unavailable / Thermocouple S	
4002	R/W	0...7*	Input type 3: 0 - off 1 – ±10V / PT100, 2 – ±20 mA / PT500 3 – unavailable / PT1000 4 – unavailable / ±150 mV 5 – unavailable / Thermocouple J 6 – unavailable / Thermocouple K 7 – unavailable / Thermocouple S	0
4003	R/W	0...7*	Input type 4: 0 - off 1 – ±10V / PT100, 2 – ±20 mA / PT500 3 – unavailable / PT1000 4 – unavailable / ±150 mV 5 – unavailable / Thermocouple J 6 – unavailable / Thermocouple K 7 – unavailable / Thermocouple S	0
4004	R/W	1...247	Address of the device	1
4005	R/W	0...7	RS485 communication speed 0 – 1200 1 – 2400 2 – 4800 3 – 9600 4 – 19200 5 – 38400 6 – 57600 7 – 115200	0
4006	R/W	0...3	Transmission mode 0 – 8N2 1 – 8E1 2 – 8O1 3 – 8N1	0
4007	R/W	0...1	Update transmission parameters 0 – do nothing 1 - update	0
4008	R	-	Reserved	-
4009	R/W	0...6	Source of alarm 1: 0 – no alarm (alarm off) 1 – input 1 2 – input 2 3 – input 3 4 – input 4 5 – virtual channel 1 (see point 5.4) 6 – virtual channel 2 (see point 5.4)	0
4010	R/W	0...5	Type of alarm 1 (see point 5.7): 0 – H-OFF 1 – H-ON 2 – N-OFF 3 – N-ON 4 – OFF 5 – ON	0
4011	R/W	0...3600	Delay of activation of alarm 1 (s): The time that must elapse from the alarm condition till the alarm activation. 0 – no delay	0

4012	R/W	0...3600	Delay of deactivation of alarm 1 (s): The time that must elapse from the alarm condition till the alarm deactivation. 0 – no delay	0
4013	R/W	0...1	Maintaining the signaling of alarm 1: The alarm is indicated also after the it is stopped (does not affect the alarm output signaling only). 0 – signaling not maintained 1 – signaling is maintained	0
4014	R/W	0...6	Source of alarm 2: 0 – no alarm (alarm off) 1 – input 1 2 – input 2 3 – input 3 4 – input 4 5 – virtual channel 1 (see point 5.4) 6 – virtual channel 2 (see point 5.4)	0
4015	R/W	0...5	Type of alarm 2 (see point 5.7): 0 – H-OFF 1 – H-ON 2 – N-OFF 3 – N-ON 4 – OFF 5 – ON	0
4016	R/W	0...3600	Delay of activation of alarm 2 (s): The time that must elapse from the alarm condition till the alarm activation. 0 – no delay	0
4017	R/W	0...3600	Delay of deactivation of alarm 2 (s): The time that must elapse from the alarm condition till the alarm deactivation. 0 – no delay	0
4018	R/W	0...1	Maintaining the signaling of alarm 2: The alarm is indicated also after the it is stopped (does not affect the alarm output signaling only). 0 – signaling not maintained 1 – signaling is maintained	0
4019	R/W	0...1	Manual compensation at input 1 (see point 5.5): 0 – automatic compensation 1 – manual compensation	0
4020	R/W	0...1	Manual compensation at input 2 (see point 5.5): 0 – automatic compensation 1 – manual compensation	0
4021	R/W	0...1	Manual compensation at input 3 (see point 5.5): 0 – automatic compensation 1 – manual compensation	0
4022	R/W	0...1	Manual compensation at input 4 (see point 5.5): 0 – automatic compensation 1 – manual compensation	0
4023	R/W	0...1	Enabling individual characteristics for input 1 (see point 5.3): 0 – characteristics disabled 1 – characteristics enabled	0
4024	R/W	0...1	Enabling individual characteristics for input 2 (see point 5.3): 0 – characteristics disabled 1 – characteristics enabled	0
4025	R/W	0...1	Enabling individual characteristics for input 3 (see point 5.3): 0 – characteristics disabled 1 – characteristics enabled	0

4026	R/W	0...1	Enabling individual characteristics for input 4 (see point 5.3): 0 – characteristics disabled 1 – characteristics enabled	0
4027	R/W	5, 10, 30, 50, 100, 150, 200	Time constant of the digital filter on input 1 in units of 0.1 second (5 = 0.5 s)	5
4028	R/W	5, 10, 30, 50, 100, 150, 200	Time constant of the digital filter on input 2 in units of 0.1 second (5 = 0.5 s)	5
4029	R/W	5, 10, 30, 50, 100, 150, 200	Time constant of the digital filter on input 3 in units of 0.1 second (5 = 0.5 s)	5
4030	R/W	5, 10, 30, 50, 100, 150, 200	Time constant of the digital filter on input 4 in units of 0.1 second (5 = 0.5 s)	5
4031	R	-	Reserved	-
4032	R/W	0..7	Deleting minimum/maximum values for the selected channel 0 – do not delete 1..4 – the number of physical input 5 – virtual channel 1, 6 – virtual channel 2, 7 – all channels.	0
4033	R/W	0..9	Resetting activity timers 0 – do not reset 1..4 – the number of physical input, 5,6 – virtual channels 1 i 2 7,8 – alarms 1 i 2 9 – all	0
4034	R/W	0...1	Clear alarm signaling 0 – do not clear 1 – clear	0
4035	R/W	0...1	Restoring default configuration 0 – do not restore 1 – restore configuration	0
4036	R	-	Reserved	-
4037	R	0...65535	Register of the module status (read-only): Bit 0 (Alarm 1): 0 – not active 1 – active Bit 1 (Alarm 2): 0 – not active 1 – active Bit 2 (Lower overrun on input 1): 0 – no overrun 1 – overrun Bit 3 (Upper overrun on input 1): 0 – no overrun 1 – overrun Bit 4 (Lower overrun on input 2): 0 – no overrun 1 – overrun Bit 5 (Upper overrun on input 2): 0 – no overrun 1 – overrun Bit 6 (Lower overrun on input 3): 0 – no overrun	-

			1 – overrun Bit 7 (Upper overrun on input 3): 0 – no overrun 1 – overrun Bit 8 (Lower overrun on input 4): 0 – no overrun 1 – overrun Bit 9 (Upper overrun on input 4): 0 – no overrun 1 – overrun Bit 15 (Calibration status): 0 – correct 1 – calibration error	
4038	R	-	Software version of the module (read-only):	-
4039	R	-	Special order version (read-only):	-
4040	R	-	Version of the module (read-only): 0 – S4AI-1-X-XX-X-X ±10 V - ±20 mA 1 – S4AI-2-X-XX-X-X Pt100 - Pt500 - Pt1000 - ±150 mV shunt - thermocouple J,K,S	-
4041	R	-	Older word of the serial number.	-
4042	R	-	Newer word of the serial number. Serial number YYMMxxxx, where: YY – year of production (2015 – as 15) MM – month of production xxxx – sequential number	-
4043	R/W	0...4	Virtual channel 1, mathematical function – argument 1: 0 – not used, 1 – input 1, 2 – input 2, 3 – input 3, 4 – input 4	0
4044	R/W	0...4	Virtual channel 1, mathematical function – argument 2: 0 – not used, 1 – input 1, 2 – input 2, 3 – input 3, 4 – input 4	0
4045	R/W	0...4	Virtual channel 1, mathematical function – argument 3: 0 – not used, 1 – input 1, 2 – input 2, 3 – input 3, 4 – input 4	0
4046	R/W	0...4	Virtual channel 1, mathematical function – argument 4: 0 – not used, 1 – input 1, 2 – input 2, 3 – input 3, 4 – input 4	0
4047	R/W	0...5	Virtual channel 1, function **: 0 – addition, 1 – subtraction, 2 – average, 3 – minimum value, 4 – maximum value, 5 – multiplication	0

			6 – division	
4048	R/W	-30000...30000	Virtual channel 1, the second argument for multiplying or dividing (x10) ***	0.0
4049	R/W	0...5	Virtual channel 2, mathematical function – argument 1: 0 – not used, 1 – input 1, 2 – input 2, 3 – input 3, 4 – input 4 5 – virtual channel 1	0
4050	R/W	0...5	Virtual channel 2, mathematical function – argument 2: 0 – not used, 1 – input 1, 2 – input 2, 3 – input 3, 4 – input 4 5 – virtual channel 1	0
4051	R/W	0...5	Virtual channel 2, mathematical function – argument 3: 0 – not used, 1 – input 1, 2 – input 2, 3 – input 3, 4 – input 4 5 – virtual channel 1	0
4052	R/W	0...5	Virtual channel 2, mathematical function – argument 4: 0 – not used, 1 – input 1, 2 – input 2, 3 – input 3, 4 – input 4 5 – virtual channel 1	0
4053	R/W	0...5	Virtual channel 2, function **: 0 – addition, 1 – subtraction, 2 – average, 3 – minimum value, 4 – maximum value, 5 – multiplication 6 – division	0
4054	R/W	-30000...30000	Virtual channel 2, the second argument for multiplying or dividing (x10) ***	0.0

*) The range of values change depends on the version of the module

**) Addition / subtraction - addition / subtraction of all active arguments of function, the average - average calculation of all active arguments of function, minimum value - returns the smallest value of the active arguments of function, maximum value - returns the greatest value of the active arguments of function, multiplication - multiplies the first active argument by the second argument of the function for multiplication or division, division - divides the first active argument of function by the second argument of the function for multiplication or division.

***) The second argument of function for division or multiplication. For the function of division the argument value of 0 is prohibited. The registry value is x10 times, so the actual value of the argument has a range of -3000.0 to 3000.0

Table 5: Module measurement registers

Address of 16-bit registers		Address of 32-bit registers	Access mode	Description
6600	6800	7500	R	Measurement at input 1 (channel 1), without individual characteristic
6602	6802	7501	R	Measurement at input 1 (channel 2), without individual characteristic
6604	6804	7502	R	Measurement at input 2 (channel 1), without individual characteristic
6606	6806	7503	R	Measurement at input 2 (channel 2), without individual characteristic
6608	6808	7504	R	Measurement at input 3 (channel 1), without individual characteristic
6610	6810	7505	R	Measurement at input 3 (channel 2), without individual characteristic
6612	6812	7506	R	Measurement at input 4 (channel 1), without individual characteristic
6614	6814	7507	R	Measurement at input 4 (channel 2), without individual characteristic
6616	6816	7508	R	Value read form converter for input 1 (channel 1)
6618	6818	7509	R	Value read form converter for input 1 (channel 2)
6620	6820	7510	R	Value read form converter for input 2 (channel 1)
6622	6822	7511	R	Value read form converter for input 2 (channel 2)
6624	6824	7512	R	Value read form converter for input 3 (channel 1)
6626	6826	7513	R	Value read form converter for input 3 (channel 2)
6628	6828	7514	R	Value read form converter for input 4 (channel 1)
6630	6830	7515	R	Value read form converter for input 4 (channel 2)
6632	6832	7516	R	Measurement at input 1 (channel 1), with individual characteristic
6634	6834	7517	R	Measurement at input 1 (channel 2), with individual characteristic
6636	6836	7518	R	Measurement at input 2 (channel 1), with individual characteristic
6638	6838	7519	R	Measurement at input 2 (channel 2), with individual characteristic
6640	6840	7520	R	Measurement at input 3 (channel 1), with individual characteristic
6642	6842	7521	R	Measurement at input 3 (channel 2), with individual characteristic
6644	6844	7522	R	Measurement at input 4 (channel 1), with individual characteristic
6646	6846	7523	R	Measurement at input 4 (channel 2), with individual characteristic
6648	6848	7524	R	Value for virtual channel 1
6650	6850	7525	R	Value for virtual channel 2
6652	6852	7526	R	Minimum value for virtual channel 1
6654	6854	7527	R	Maximum value for virtual channel 1
6656	6856	7528	R	Minimum value for virtual channel 2
6658	6858	7529	R	Maximum value for virtual channel 2
6660	6860	7530	R	Minimum value for input 1 (channel 1)
6662	6862	7531	R	Maximum value for input 1 (channel 1)
6664	6864	7532	R	Minimum value for input 1 (channel 2)
6666	6866	7533	R	Maximum value for input 1 (channel 2)
6668	6868	7534	R	Minimum value for input 2 (channel 1)
6670	6870	7535	R	Maximum value for input 2 (channel 1)
6672	6872	7536	R	Minimum value for input 2 (channel 2)
6674	6874	7537	R	Maximum value for input 2 (channel 2)
6676	6876	7538	R	Minimum value for input 3 (channel 1)
6678	6878	7539	R	Maximum value for input 3 (channel 1)
6680	6880	7540	R	Minimum value for input 3 (channel 2)
6682	6882	7541	R	Maximum value for input 3 (channel 2)
6684	6884	7542	R	Minimum value for input 4 (channel 1)
6686	6886	7543	R	Maximum value for input 4 (channel 1)
6688	6888	7544	R	Minimum value for input 4 (channel 2)
6690	6890	7545	R	Maximum value for input 4 (channel 2)
6692	6892	7546	R	Upper overrun timer of input 1
6694	6894	7547	R	Lower overrun timer of input 1
6696	6896	7548	R	Upper overrun timer of input 2
6698	6898	7549	R	Lower overrun timer of input 2
6700	6900	7550	R	Upper overrun timer of input 3
6702	6902	7551	R	Lower overrun timer of input 3
6704	6904	7552	R	Upper overrun timer of input 4
6706	6906	7553	R	Lower overrun timer of input 4

6708	6908	7554	R	Upper overrun timer of virtual channel 1
6710	6910	7555	R	Lower overrun timer of virtual channel 1
6712	6912	7556	R	Upper overrun timer of virtual channel 2
6714	6914	7557	R	Lower overrun timer of virtual channel 2
6716	6916	7558	R	Alarm 1 duration timer
6718	6918	7559	R	Alarm 2 duration timer
6720	6920	7560	R	Connector temperature of input 1
6722	6922	7561	R	Connector temperature of input 2
6724	6924	7562	R	Connector temperature of input 3
6726	6926	7563	R	Connector temperature of input 4

Table 6: Float type configuration registers

Address of 16-bit registers		Address of 32-bit registers	Access mode	Description
6000	6200	8000	RW	AL_L 1: Low threshold of alarm 1 triggering
6002	6202	8001	RW	AL_H 1: High threshold of alarm 1 triggering
6004	6204	8002	RW	AL_L 2: Low threshold of alarm 2 triggering
6006	6206	8003	RW	AL_H 2: High threshold of alarm 2 triggering
6008	6208	8004	RW	Individual characteristic of input 1 – point X0
6010	6210	8005	RW	Individual characteristic of input 1 – point X1
6012	6212	8006	RW	Individual characteristic of input 1 – point Y0
6014	6214	8007	RW	Individual characteristic of input 1 – point Y1
6016	6216	8008	RW	Individual characteristic of input 2 – point X0
6018	6218	8009	RW	Individual characteristic of input 2 – point X1
6020	6220	8010	RW	Individual characteristic of input 2 – point Y0
6022	6222	8011	RW	Individual characteristic of input 2 – point Y1
6024	6224	8012	RW	Individual characteristic of input 3 – point X0
6026	6226	8013	RW	Individual characteristic of input 3 – point X1
6028	6228	8014	RW	Individual characteristic of input 3 – point Y0
6030	6230	8015	RW	Individual characteristic of input 3 – point Y1
6032	6232	8016	RW	Individual characteristic of input 4 – point X0
6034	6234	8017	RW	Individual characteristic of input 4 – point X1
6036	6236	8018	RW	Individual characteristic of input 4 – point Y0
6038	6238	8019	RW	Individual characteristic of input 4 – point Y1
6040	6240	8020	RW	Manual compensation value of input 1
6042	6242	8021	RW	Manual compensation value of input 2
6044	6244	8022	RW	Manual compensation value of input 3
6046	6246	8023	RW	Manual compensation value of input 4
6048	6248	8024	RW	Hight level of input 1 timer triggering
6050	6250	8025	RW	Low level of input 1 timer triggering
6052	6252	8026	RW	Hight level of input 2 timer triggering
6054	6254	8027	RW	Low level of input 2 timer triggering
6056	6256	8028	RW	Hight level of input 3 timer triggering
6058	6258	8029	RW	Low level of input 3 timer triggering
6060	6260	8030	RW	Hight level of input 4 timer triggering
6062	6262	8031	RW	Low level of input 4 timer triggering
6064	6264	8032	RW	Hight level of virtual channel 1 timer triggering
6066	6266	8033	RW	Low level of virtual channel 1 timer triggering
6068	6268	8034	RW	Hight level of virtual channel 2 timer triggering
6070	6270	8035	RW	Low level of virtual channel 2 timer triggering

The default value for parameters from the above table is 0.0

7. BEFORE YOU NOTIFY OF A DEFECT

In the case of improper operation of the module, verify the fault in the following table:

Table 7: Description of error

Symptom	Procedure	Remarks
ON / ERROR LED is not illuminated	Check the power connection	
ON / ERROR LED is illuminated with continuous red light	Check the power connection	The module can be powered from the USB port only for configuration. Without main power supply, RS485 interface, analog inputs and alarm outputs are not available.
ON / ERROR LED flashes alternately in green and red	Error or overrun at one of the inputs. See the status register (4037).	
ON / ERROR LED flashes in red	Memory / Calibration error	Contact your dealer
The module does not communicate via the RS485 interface. Lack of transmission signaling through Rx LEDs and Tx.	Make sure that the interface cables are connected to the correct terminals of the module. Make sure that the transmission parameters of the devices on the bus are configured in the same way (baud rate, transmission mode, the correct device address).	

8. SOFTWARE UPDATE

S4AI module software update can be done via a PC with installed free e-Con program. e-Con program and the current update file are available on the website www.lumel.com.pl. Update can be performed only via the USB interface.

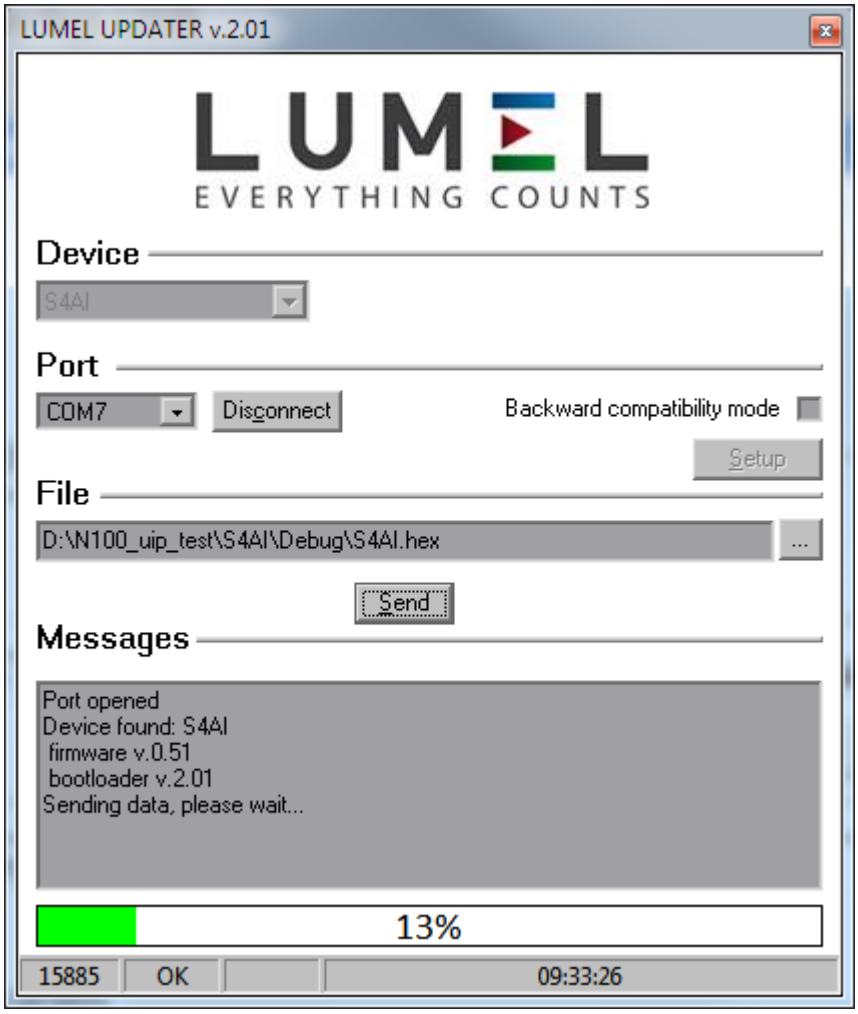


Fig 18: Software update

Caution! It is recommended that before updating the module software the user reads and saves the current configuration of the module to a file.

After starting the e-Con (see section 5.8), set the communication parameters in the *Communication* box on the left side of the main window then select *Connect*. The module will be automatically recognized.

When communication is established, it is recommended to read the current configuration of the module and save it to a file, for later restoration.

Then select *Firmware Update* on the right side of the program menu. LUMEL UPDATER (LU) will be launched (Fig. 17). S4AI module is supported by LU from version 2.01. Select the device (S4AI) in the program, the port on which the device is installed in Windows, set the appropriate transmission parameters (115200, 8n2) in the access window under *Setup*, and indicate the update file. Then establish connection using *Connect* button. The Messages window displays information about the detected device and the update progress. After the module is properly detected by LU, you must start

the update by selecting *Send* button. LU will show the progress bar indicating the percentage and throughout the update ON/ERROR LED on S4AI module will blink in green. After the update the module will restart, restore factory parameters and start normal operation. LU message box will display *Done* and the module update duration. LU program can be closed and then we can read the previous configuration from the file and save it to the module using e-Con.

Caution! If USB cable is disconnected during the software update, the module can be permanently damaged.

9. TECHNICAL DATA

Input ranges:

Input voltage:
- voltage (maximum range): -12...-10...0...10...12 V
- internal resistance: > 1 MΩ
- basic error: 0.1 % of the range

Current input:
- current (maximum range): -24...-20...0...20...24 mA
- internal resistance: 10 Ω ±1%
- basic error: 0.1 % of the range

Pt100 sensor input:
- range of measure temperature: -200 °C…850 °C
- basic error: 0.1 % of the range
- sensor current: 300 μA ±2%
- maximum lead resistance: < 20 Ω

Pt500 sensor input:
- range of measure temperature: -200 °C…850 °C
- basic error: 0.1 % of the range
- sensor current: 300 μA ±2%
- maximum lead resistance: < 20 Ω

Pt1000 sensor input:
- range of measure temperature: -200 °C…850 °C
- basic error: 0.1 % of the range
- sensor current: 300 μA ±2%
- maximum lead resistance: < 20 Ω

voltage input (shunt):
- voltage (maximum range): -180...-150...0...150...180 mV
- internal resistance: > 50 kΩ
- basic error: 0.1 % of the range

J type thermocouple input:
- range of measure temperature: -210 °C…1200 °C
- basic error: 0.1 % of the range

K type thermocouple input:
range of measure temperature: -250 °C…1372 °C
basic error: 0.1 % of the range

S type thermocouple input:
range of measure temperature: -50 °C…1768 °C
basic error: 0.1 % of the range

Additional errors:

- compensation of temperature changes of reference joints ≤ ±1 °C
- compensation of lead resistance changes

at lead resistance change, < 10 Ω ≤ ±0.5 °C

at lead resistance change, < 20 Ω ≤ ±1 °C

- from ambient temperature changes ≤ ±(0.1 % of the range / 10 K)

Averaging time: ≤0.5 s (default)

Duty cycle/activity timers:

resolution: 1 s

Range of alarm outputs (according to the TTL levels according to EIA JESD12-6)**:**

Off state: 0V

On state: 5V

maximum output current: 20 mA

Serial interfaces

RS485: address 1..247;
modes: 8N2, 8E1, 8O1,8N1;
baud rate: 1.2, 2.4, 4.8, 9.6, 19.2, 38.4, 57.6, 115.2 kbit/s,
broadcast address: 253
protocol mode: Modbus RTU

maximum time to commence the response:
100 ms (reading)
1000 ms (saving)

Use only shielded cables

USB for configuration: 1.1 / 2.0,
address: all,
mode: 8N2,
baud rate: 115.2 kbps,
broadcast address: 253
protocol mode: Modbus RTU

maximum time to commence the response:
100 ms (reading)
1000 ms (saving)

maximum length of USB cable:
3m

Test voltage:

2210 V a.c. rms 1 minute between housing / power supply and:

- RS485
- binary outputs
- USB
- analog inputs

1390 V a.c. rms 1 minute between:

- analog inputs / RS485
- analog inputs / binary outputs
- analog inputs / USB
- USB / RS485
- USB / binary outputs
- RS485 / binary outputs

Degree of protection IP:

from the front	IP 50
from the terminals	IP 00

Power consumption:	≤ 3 VA
Weight	< 0.2 kg
Dimensions	53 X 110 X 60 mm

Nominal operating conditions:

- supply voltage	85...253 V a.c. 40..400 Hz; 90...300 V d.c. 20...40 V a.c. 40...400 Hz, 20...60 V d.c.
- ambient temperature	-10...23...+55 °C
- storing temperature	-25...+70 °C
- humidity	< 95% (without condensation)
- external magnetic field	0..40..400 A/m
- operation position	vertical
- warm-up time	30 min.

EMC compatibility:

- immunity to interference in accordance with EN 61000-6-2
- interference emission in accordance with EN 61000-6-4

Safety requirements:

in accordance with the standard EN 61010-1

- insulation between circuits basic

- installation category III,
- degree of pollution 2,
- maximum voltage relative to earth:
  - for power circuit 300 V
  - for other circuits 50 V
- altitude < 2000 m

10. ORDERING CODES

Table 8: Ordering code

ANALOG INPUT MODULE S4AI -	X	X	XX	X	X
Inputs:					
4 programmable analog inputs: ±10 V - ±20 mA	1				
4 programmable analog inputs: Pt100, Pt500, Pt1000, J, K, S, ±150 mV	2				
According to the agreement with the customer*	X				
Power supply:					
85...253 V a.c. , 90...300 V d.c.		1			
20...40 V a.c. , 20...60 V d.c.		2			
Version:					
Standard			00		
special*			XX		
Language:					
Polish				P	
English				E	
other*				X	
Acceptance tests:					
Without additional requirements					0
With quality inspection certificate					1
According to the agreement with the customer*					X

*After agreement with the manufacturer

SAMPLE ORDER:

S4AI-1100E0 code means:

S4AI – S4AI module,

1 – 4 analog inputs: ±10 V - ±20 mA,

1 – 85..253 V a.c. / d.c.

00 – standard version,

E – English version,

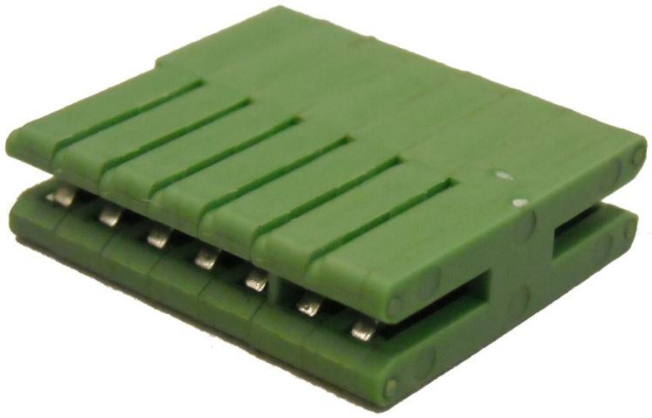
0 – without additional requirements.

AVAILABLE ACCESSORIES:

Accessories: the following accessories can be ordered together with input module S4AI:

- USB cable A/miniUSB-B - 1m black; order code 20-069-00-00150,

- modular connector of internal RS485 bus; order code 24-171-01-00016,



- transition connector from internal RS485 bus to cable connector; order code 24-171-01-00017.

LUMEL
EVERYTHING COUNTS

LUMEL S.A.
ul. Sulechowska 1, 65-022 Zielona Góra, POLAND
tel.: +48 68 45 75 100, fax +48 68 45 75 508
www.lumel.com.pl

Export department:
tel.: (+48 68) 45 75 139, 45 75 233, 45 75 321, 45 75 386
fax.: (+48 68) 32 54 091
e-mail: export@lumel.com.pl

S4AI-09