LUMEL
EVERYTHING COUNTS

MODULE OF 4 ANALOG OUTPUTS
S4AO

USER'S MANUAL

CE

1. APPLICATION

The 4-channels analog outputs module is designed to convert numerical data to standard (voltage or current) signals, by means of the MODBUS protocol.
The output signals are divided into 2 sets of 2 outputs, which are isolated between themselves. RS-485 and USB ports are isolated from outputs signals and the supply. The module setting can be done through USB or one of the RS-485 interface using the available for free eCon program.

The S4AO module performs the following functions:

- analog output (current and / or voltage, according to the ordering code),
- 2 independent interfaces RS-485 Modbus. Each can be configured as Slave or Master, which set to output a signal proportionally to a value read from another Slave device,
- short-circuit detection on voltage outputs,
- timer counting time work over an upper threshold and beneath a lower threshold,

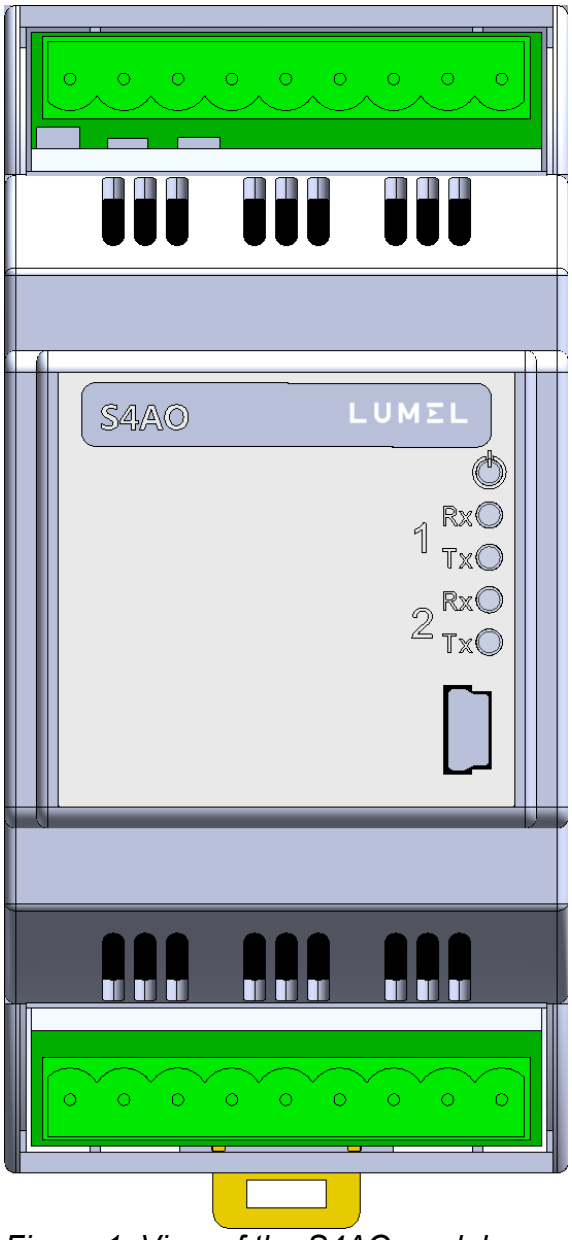


Figure 1: View of the S4AO module

2. MODULE SET

Complete set of the meter includes:

- S4AO 1 pc
- user's manual 1 pc
- guarantee card 1 pc

3. BASIC REQUIREMENTS, OPERATIONAL SAFETY

The symbols in the manual mean:

Warning!
Warning of potentially hazardous situations. Especially important to be aware of before connecting the device. Failure to follow the directions marked by this symbol could result in serious injuries of the personnel and damage of the device.

Caution!
Useful notes. The notes should facilitate the operation of the device. Should pay attention, if the device is not working as expected.
Possible consequences in case of ignoring information!

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

Comments concerning safety:

- Assembly and installation of the electrical connections should be conducted only by people authorized to perform assembly of electric devices.
- The person installing the device is responsible for ensuring the safety of the implemented system.
- Always check the connections before turning the device on.
- Opening the device housing gives access to the live parts. The supply must be switched off and the output circuits disconnected before removing the device housing.
- Removal of the device housing cover during the warranty period voids the warranty.
- The device is designed to be installed and used in the industrial electromagnetic environment conditions.
- The building installation should have a switch or a circuit-breaker installed. This switch should be located near the device, easy accessible by the operator and suitably marked.
- In case of damage, the module can to repaired only by manufacturer's authorized service.
- Check the correct operation of the device after a repair. before using it for operation.
- Connection and/or using the device in a way which is not compliant with the user's manual, may cause deterioration of the degree of protection.
- Maintaining a voltage output on short-cicuit state will make an overheating of the module, and can cause troubles on RS-485 communications.

4. INSTALLATION

4.1. Mounting

The S4AO module can be installed in modular distribution devices on the 35 mm rail bracket.
The module enclosure is made of plastic and its dimensions are 53 x 110 x 60.5 mm.
There are pluggable terminal blocks on the outside of the module to connect the power supply, the RS-485 port 1 and the analog outputs signals using leads up to 2.5 mm^2. The module dimensions are shown in Figure 2.

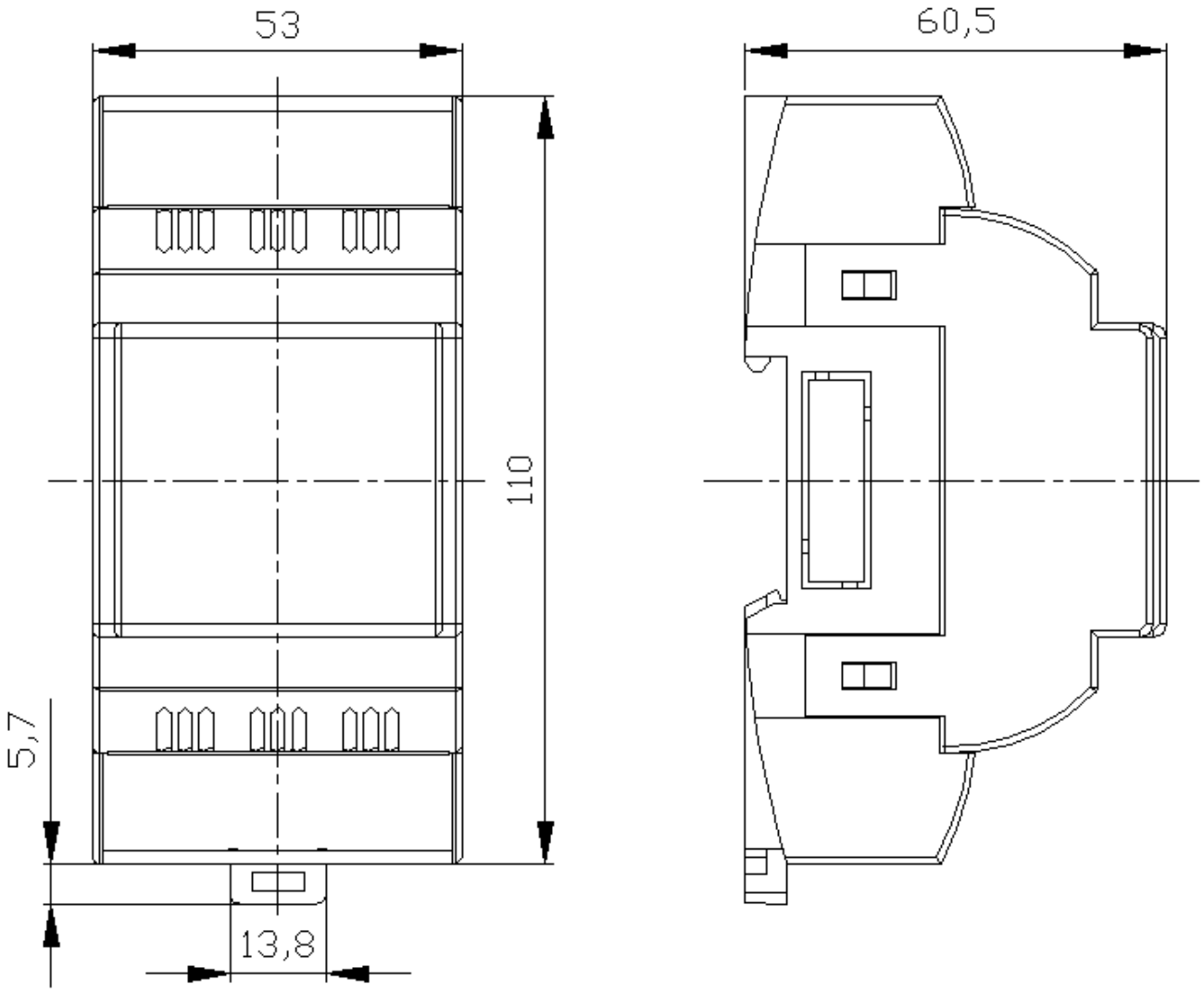


Figure 2: Module dimensions

4.2. External Connection Diagrams

The module connections are shown in Figure 3. The polarization of the power supply is not needed when the module is supplied by a d.c. voltage.

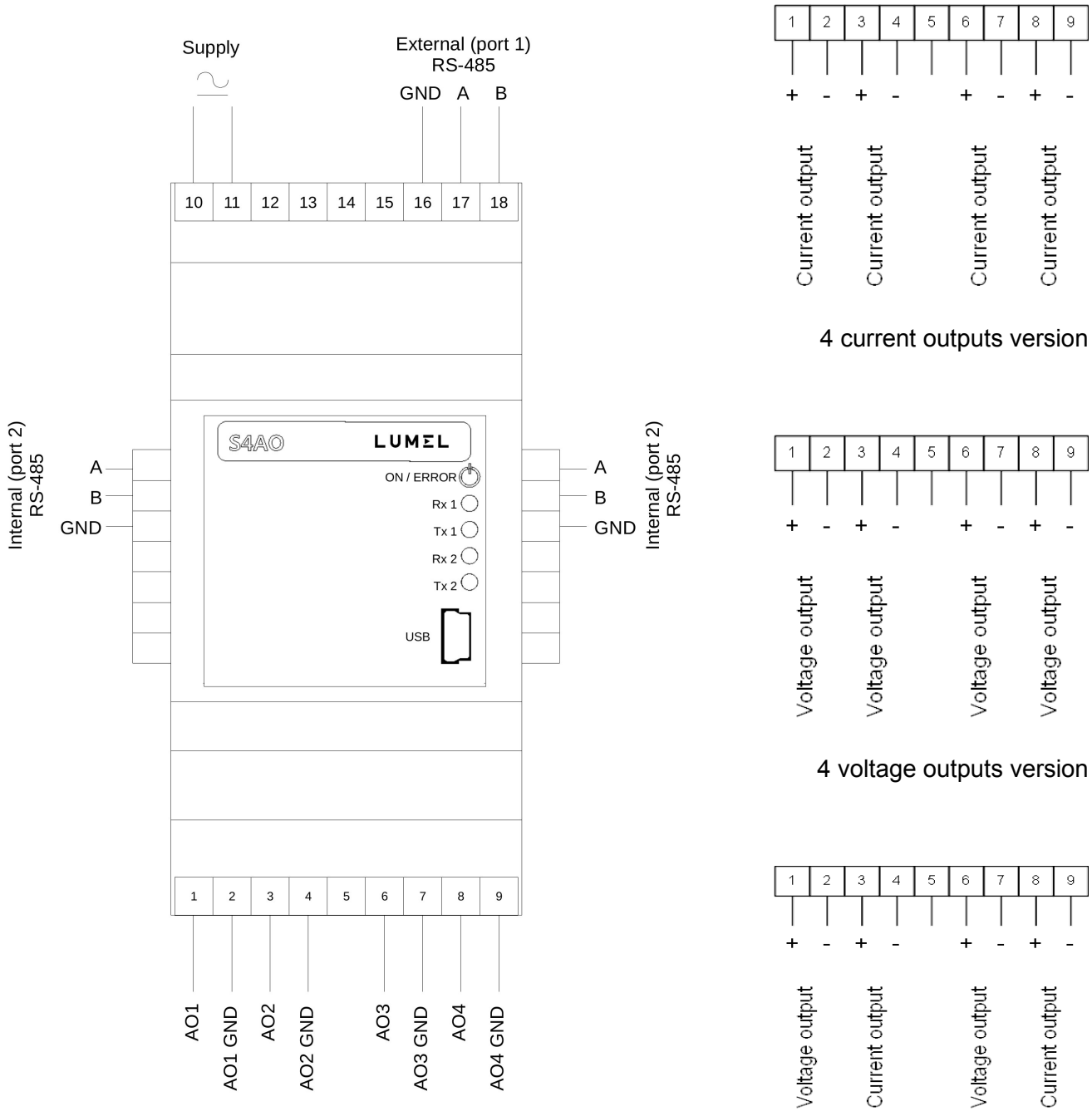


Figure 3: Electrical connections of the S4AO module.

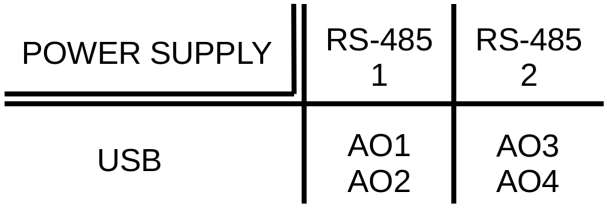


Figure 4: Isolation scheme of the S4AO module.

Table 1: LED description

LED	Description
ON / ERROR (green / red)	- Light continuously in green: normal operation, - Blink alternatively in green / red: short-circuit detected on one or several voltage outputs. - Light continuously in red: power supply unplugged (self-powered by USB) or error, - Blink in red: calibration error
Rx 1 (green)	Data receive through RS-485 port 1.
Tx 1 (orange)	Data transmit through RS-485 port 1.
Rx 2 (green)	Data receive through RS-485 port 2.
Tx 2 (orange)	Data transmit through RS-485 port 2.

4.3. Lateral bus

To access to the lateral bus, 2 traps must be opened by mean of a screwdriver.

Figure 5: Lateral bus traps

5. OPERATION

5.1 Configuration

The S4AO module can be configured by Modbus protocol through 3 interfaces:

- USB: the device will reply to all address and does not requires power supply. If only USB is plugged without power supply, the analog outputs will stay to 0, the RS-485 interfaces will not be available and the POWER / ERROR led will light continuously in red. This interface is dedicated to configuration and should be unplugged during normal operation.
- RS-485 port 1 and port 2: must be configured (Table 4: 4000 Modbus registers) and the

device must be powered.

5.2 Slave operations

In order to use the S4AO module as a Slave device on a RS-485 interface, it has to be configured as follow:

- RS-485 port 1 mode (register 4010). (or RS-485 port 2 mode.(register 4017)) set to '0' (Slave), set transmission mode, baudrate address and update changes (register 4016 for port 1, 4023 for port 2),
- The outputs values have to be multiplied by 100 and written on 4100 to 4103 registers. For example, to get 5,00 V on a voltage output, write “500” on the corresponding register,
- Note that on start, each output is set to its alarm value (register 4112 to 4115),
- Eventually, set the high and low value threshold to start the high and low value counters (registers 4104 to 4111), and reset them (registers 4162 to 4170).

5.3 Master operations

In order to use the S4AO module as a Slave device on a RS-485 interface, it has to be configured as follow:

- RS-485 port 1 mode (register 4010). (or RS-485 port 1 mode.(register 4017)) set to '1' (Master), set transmission mode, baudrate address, the scanning period and the timeout (register 4011 to 4022) and update changes (register 4016 for port 1, 4023 for port 2),
- For each selected output, set the scaling parameters (register 4116 to 4131), the Master controlled mode (register 4132 to 4135), the address, the register, the timeout and the type to read (register 4136 to 4159),
- The read value as displayed as floats on the 6000 to 6003 registers.
- Eventually, set the high and low value threshold to start the high and low value counters (registers 4104 to 4111), and reset them (registers 4162 to 4170).

For each interface, the Master server will check if the interface has to work as Master, and if yes, it will check each slave device and address for each analog output which is set to be controlled by the proper RS-485 interface.

5.4 Cooperation with other devices (lateral bus)

Once the traps opened (see chapter 4.3. Lateral bus on page 7), the S4AO can be connected to to others LUMEL devices which are also equipped by a lateral bus. All devices can be RS-485 and the Master is connected at an extremity, or one device is set as RS-485 Master and monitors others devices.

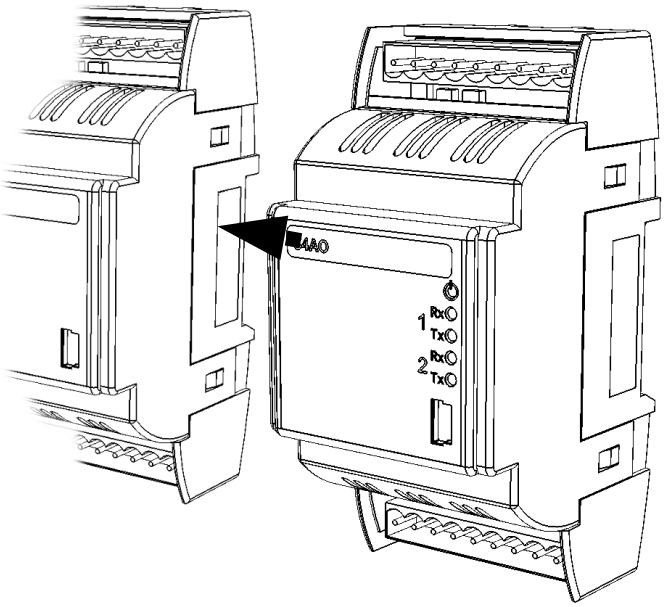


Figure 6: lateral bus connection

5.5 Counters

In all version, each output is monitored by 2 counters: one which is incremented on each second if the output value is below a defined level (4104, 4106, 4108 and 4110), and a second which is incremented on each second if the output value is upper a defined level(4105, 4107, 4109 and 4111).
The value of each counter is displayed on 2 floats registers: one which show value between 0 and 1,000,000, and a second which is incremented every 1,000,000.
The registers are addressed from 6072 to 6110 (see Table 6: Floats Modbus registers p. 25).
As example, if the low level threshold of an output is set to 2 (200 on 41xx register) and the high level threshold is set to 10 (1000 on 41xx register), both counters will set up according to the output value:

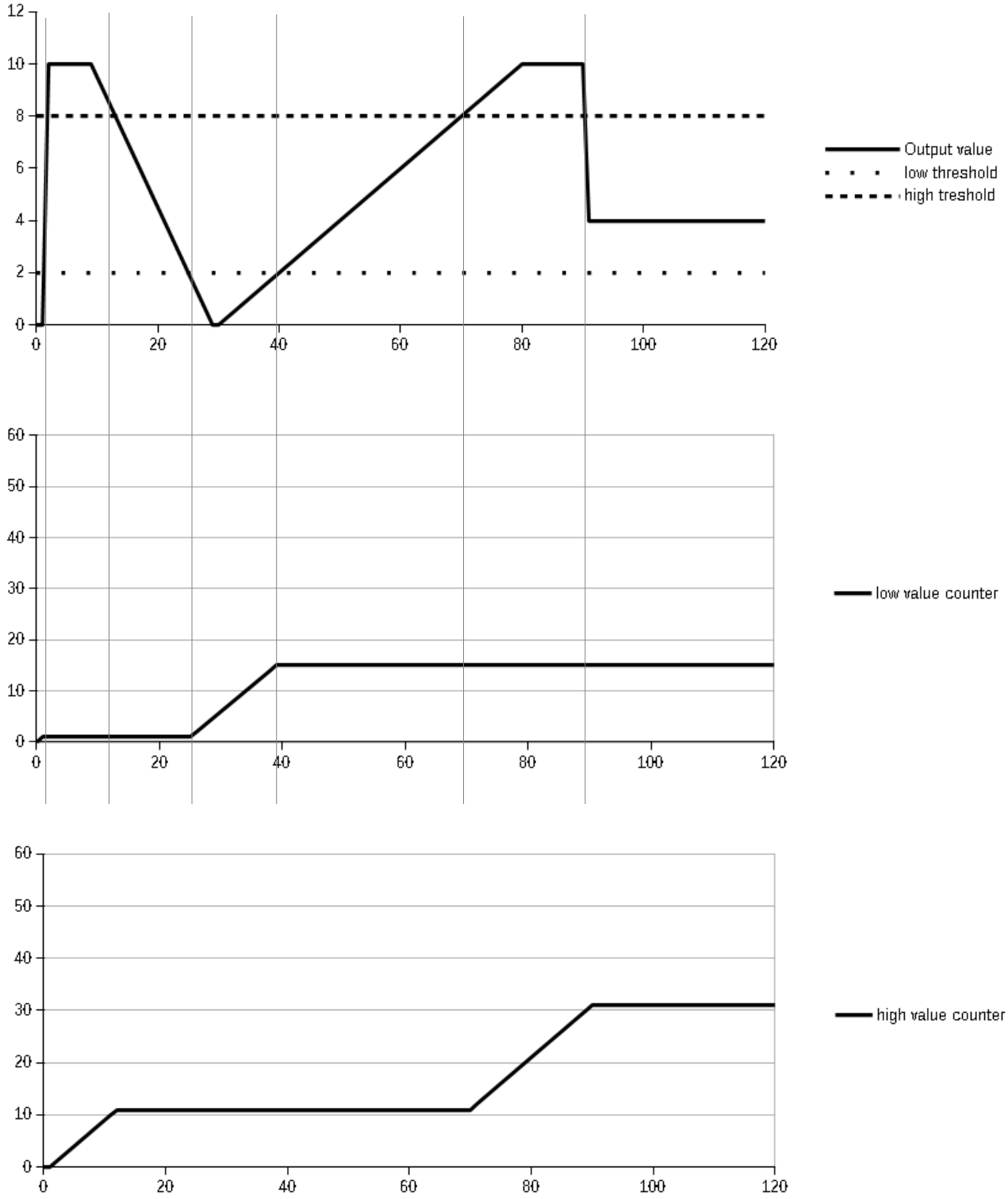


Figure 7: High / low value timers thresholds

5.6 Individual characteristic

When S4AO Master function is enabled, the individual characteristic allows the conversion of a read value to an analogical value. It is used for imaging the measurements coming from third Slave device to a standard value which can be generated by the S4AO module. The conversion is done by an approximation of a straight line passing through the characteristic parameters points.

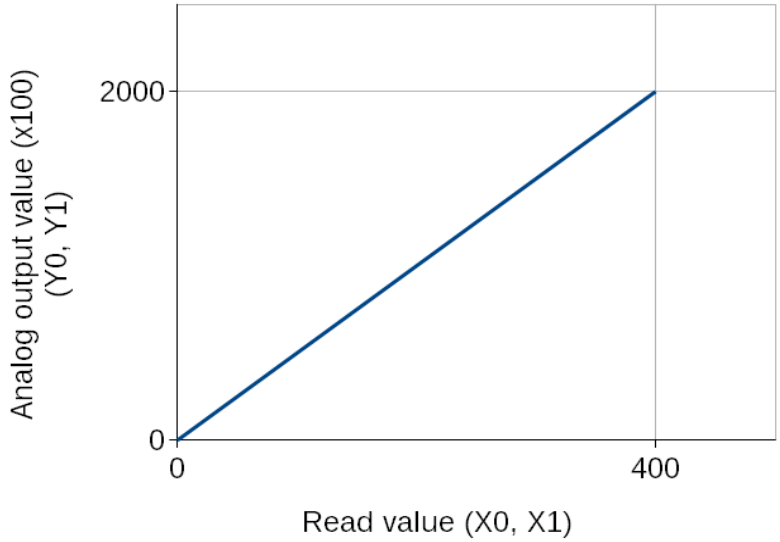


Figure 8: Individual characteristic

Example: Convert a voltage value from an energy meter (range 0 to 400 V) to a 0 to 20 mA (“2000” in the 4100 to 4103 register) signal.
Set the individual characteristic as follows:
X0 – 0 (lower value of the measuring range Slave meter)
X1 – 400 (upper value of the measuring range Slave meter)
Y0 – 0 (lower value of the analog output)
Y1 – 2000 (upper value of the analog output).
After enabling the Master feature, the module read out the value and issues proportional signal.

5.7 Short circuits

A function is available on SAO-2XXXXX and SAO-3XXXXX to report a low impedance plugged to a voltage output. It launches if the impedance is less than 430 Ω. If one is discovered, the ON / ERROR led will blink alternatively in green and red, register 4160 and 4161 will report it and the corresponding counter register (6072 / 6074) or (6076 / 6078) will be incremented on each second. These registers can not be reset.
The short-circuit detection is very sensitive and can also detect a 0 Ohms impedance between a voltage output and the ground, even if this voltage output is set to 0 Volts.

5.8 Timeout

Each analog output has a dedicated register which sets a timeout value (in ms x 100) on 4140, 4146, 4152 and 4158 registers. It is disabled when a '0' is set. When enabled, a timer is reset after updating (by an external Modbus Master or when S4AO is set as RS-485 Master). When the counter reaches the set timeout, it switches automatically the output to its alarm value, which is set on the 4112 to 4115 registers. When S4AO is set to Modbus Master, it is important to set the timeout according to the number of channel to control and to the scan parameters (registers 4013 and 4014 for Port 1, registers 4020 and 4021 for Port 2).

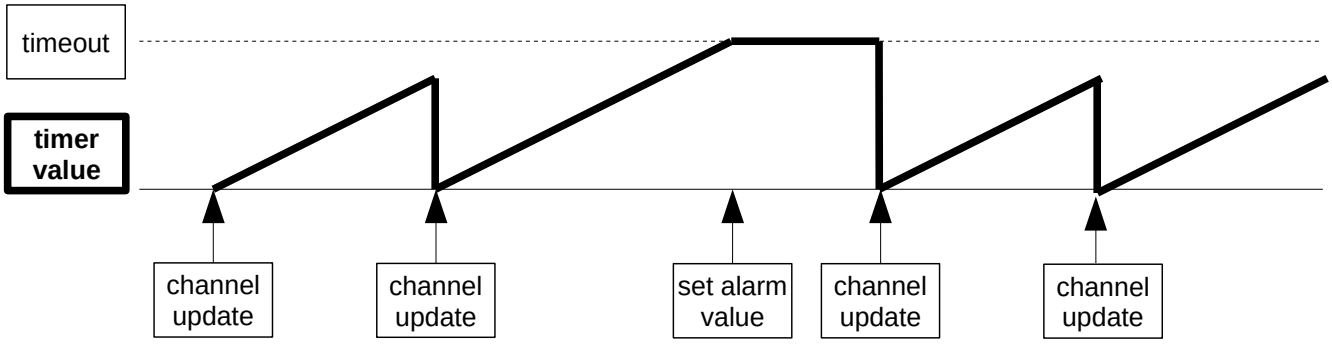


Figure 9: Slave timeout example

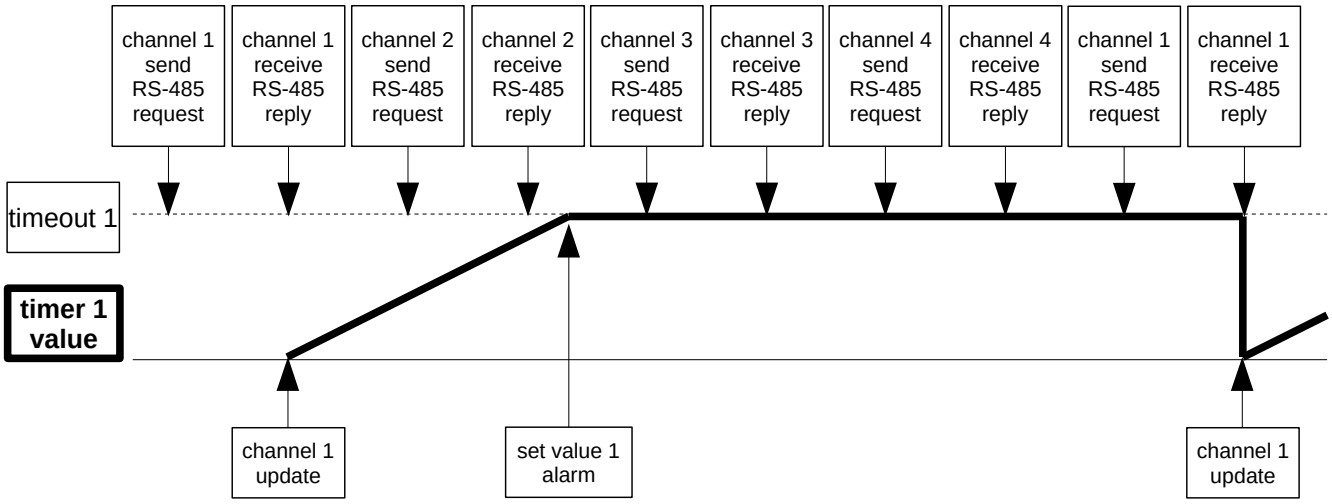
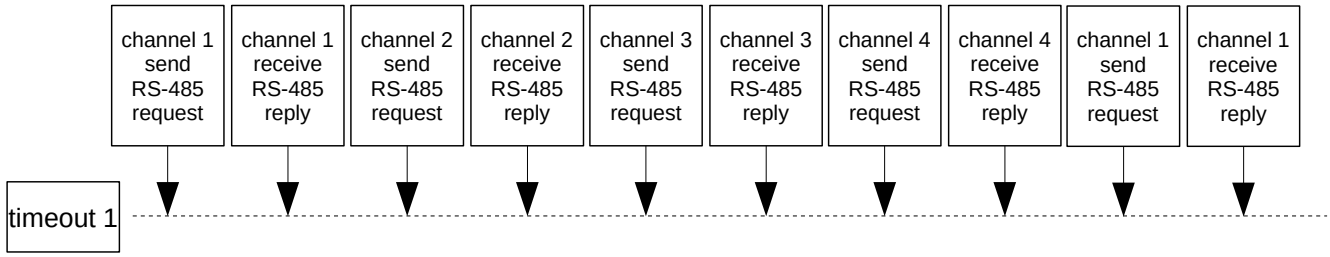


Figure 10: Master Modbus - too short timeout



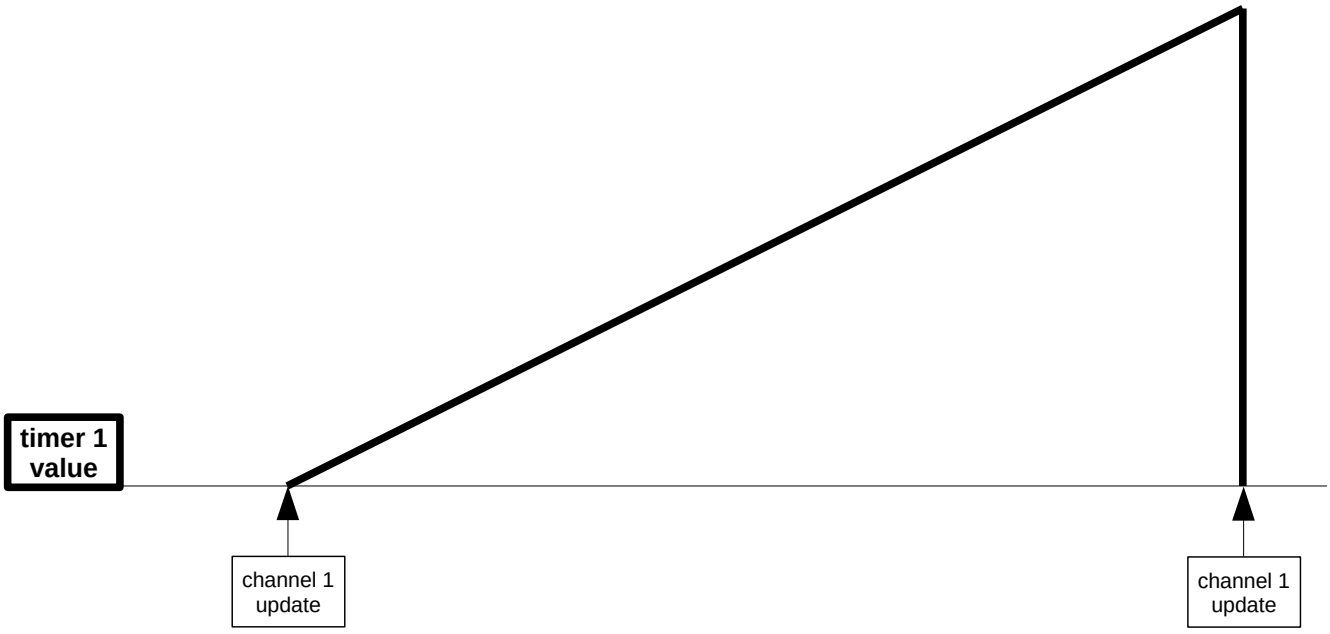


Figure 11: Master Modbus – Analog output timeout setting

When an analog output is controlled by the internal Master feature, its timeout has to be set taking into consideration:

- the scanning period of the Master RS-485 (4014/4023 register),

- the Master RS-485 timeout (4013/4022 register),

- the transmission time, especially if the module works at a low baudrate,

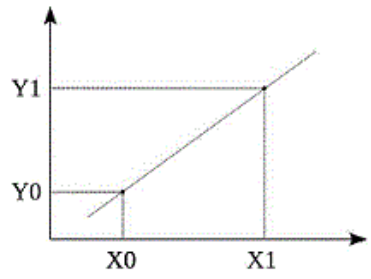
- the number of outputs which are controlled by the Master feature (4132/4133/4134/4135 register),

- the number of unreplied requests to tolerate before set the timeout value, which depend of the external noise which the module is exposed,

- the Slave timeout, which is the time which Slave needs to begin to send its response.

$$Transmission\ time\,[ms] = \frac{320000}{(baudrate\,[bps])}$$

$$response\ timeout\,[ms] = Slave_{timeout}\,[ms] + Transmissio\ time\,[ms]$$

Mode	Master mode (Read out through int. RS-485)		
All mode	Low value timer threshold	0.00	
	High value timer threshold	24.00	
	Alarm value (power on and timeout)	20.00	
	Timeout (0 - disabled)	23	[1 - 30 000] x 100ms
	Output current range	0 ... 20 mA Set	
Master mode	Slave address to check	10	
	Slave register to check	6000	Select parameter from device
	Modbus function	03	
	Data type	swapped float 2x16	
	Individual characteristic		
	X0 Input value read through RS-485	0	
	X1 Input value read through RS-485	1	
	Y0 Expected value	0.00	
	Y1 Expected value	1.00	
Save			

$$Analog\ output_{Timeoutmin} =$$

$$\text{Number of channels to scan} \times (\text{Number of tolerated unreply} + 1) \times (scanning\ period + response\ timeout + transmission\ time)$$

Mode	Master
Transmission mode	8N2
Baud rate	9600
Modbus Master : slave response timeout	4 [1 - 50] x 100ms
Modbus Master : slave scanning period	1 [1 - 30 000] x 100ms
Modbus slave address	2 [1 - 247]
Save	

Always round your results to the upper value. For example, if you calculate a value equal to 811 ms, enter “9” [x 100ms] to the field.

5.9 Device configuration using e-Con program

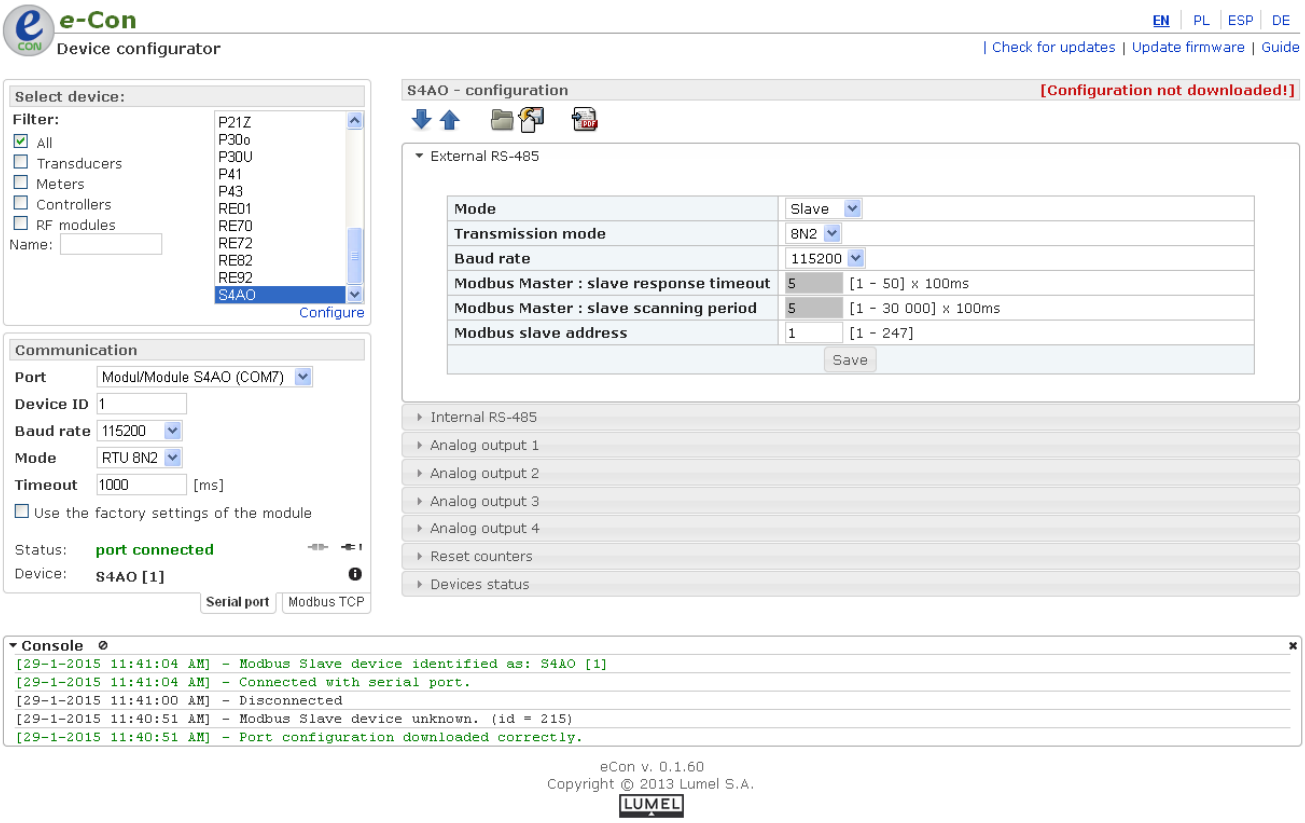


Figure 12: e-Con program window

The e-Con program designed for configuration of the S4AO module is available at the manufacturer's website (www.lumel.com.pl) for free. The module should be connected to a PC via USB cable or one of the RS-485 interface. When the e-Con program starts, select the port on which the device is installed in the area "***Communication***", set the transmission parameters (baud rate 9600, mode RTU 8N2 by default), and then click the icon "***connect***".

Before changing a configuration you should read and save the current configuration for future restoring of the settings. You can save the parameters to a file, read from a file, as well as export the configuration to a pdf file using the eCon menu (Figure 13).

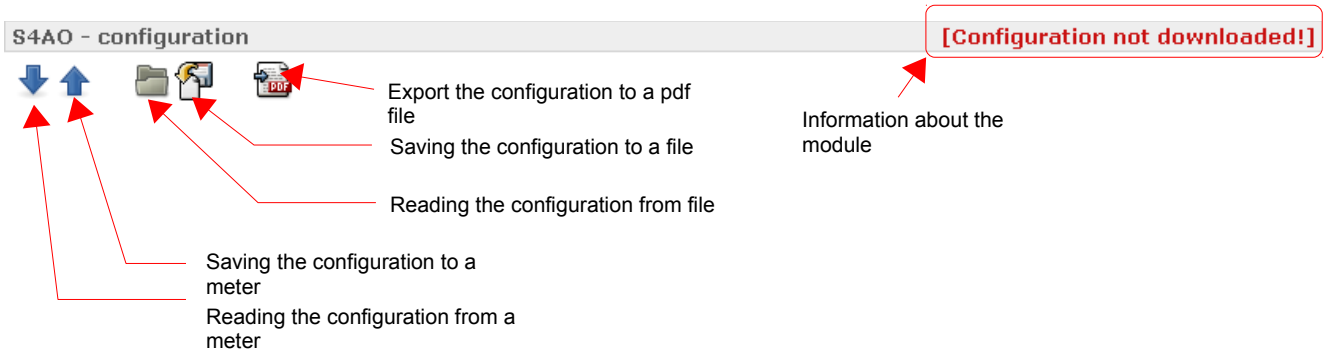


Figure 13: Read, write and export settings

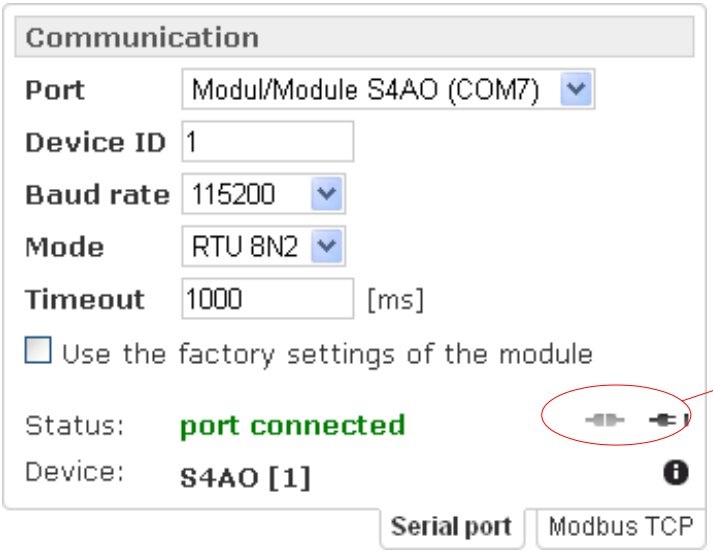


Figure 14: Establishing connection to S4AO module

5.8.1 Configuration parameters

After establishing a connection, there are configuration parameters of the module on the right side of the program window.

Table 2: e-Con configuration parameters

Parameter name	Parameter description	Range of parameter change	Manufacturer setting
***External RS-485** tab*			
Mode	Choice of the external RS-485 (Port 1) operation mode: Slave or Master	Slave / Master	Slave
Transmission mode	Choice of the external RS-485 (Port 1) transmission mode	8N2 8E1 8O1 8N1	8N2
Baud rate	Choice of the baud rate of the external RS-485 (Port 1) baud rate	1200 2400 4800 9600 19200 38400 57600 115200	9600
Modbus Master: slave response timeout	Timeout after which the Master server considers that the interrogated device will not reply	0.1 – 5 s	0.5 s
Modbus Master: slave scanning period	Time between each pool from the Master server	0.1 – 30,000 s	0.5 s
Modbus slave address	Modbus address of the interface when used as Slave	1 - 247	1
***Internal RS-485** tab*			
Mode	Choice of the internal RS-485 (Port 1) operation mode: Slave or Master	Slave / Master	Slave
Transmission mode	Choice of the internal RS-485 (Port 1) transmission mode	8N2 8E1 8O1 8N1	8N2
Baud rate	Choice of the baud rate of the internal RS-485 (Port 1) baud rate	1200 2400	9600

		4800 9600 19200 38400 57600 115200	
Modbus Master: slave response timeout	Timeout after which the Master server considers that the interrogated device will not reply	0.1 – 5 s	0.5 s
Modbus Master: slave scanning period	Time between each pool from the Master server	0.1 – 30,000 s	0.5 s
Modbus slave address	Modbus address of the interface when used as Slave	1 - 247	2
***Analog output 1,2,3 and 4** tab*			
Mode	Settings the way which the output is controlled: directly by an Modbus interface as Slave or by an integrated RS-485 Modbus server. In the second case, the chosen interface has to be prior set as Master.	Slave mode Master mode (Read out through ext. RS-485) Master mode (Read out through int. RS-485)	Slave mode
Low value timer threshold	When the analog output is lower that this value, the corresponding counter is incremented on each second.	0.00 – 24.00 mA (current) 0.00 – 12.00 V (voltage)	0.00
High value timer threshold	When the analog output is higher that this value, the corresponding counter is incremented on each second.	0.00 – 24.00 mA (current) 0.00 – 12.00 V (voltage)	0.00 – 24.00 mA (current) 0.00 – 12.00 V (voltage)
Alarm value (power on and timeout)	Output value in case of power on and timeout. The analog output will take this value when the module turns on, or if the output is not refreshed (by an external Modbus Master or an integrated Master server) after a time specified in the “Timeout” field.	0.00 – 24.00 mA (current) 0.00 – 12.00 V (voltage)	0.00
Timeout	Timeout value. The analog output will take the alarm value if is not updated after the set time. This feature is disable is a '0.0' value is set.	0.0 – 3,000.0 s	0.0 s
Output current range	Current output only. Define the current range of the output.	0...20 mA 4...20 mA	0...20 mA (current output only)
Slave address to check	Master mode only. Set the address of the Slave to read.	0...247	0
Slave register to check	Master mode only. Set the register of the Slave to read.	0...65535	0
Modbus function	Master mode only. Set the Modbus function to use to read the Slave device.	3...4	3
Data type	Master mode only. Set the type of data to read on the Slave.	char 8 uchar 8 short 16 ushort 16 long 32 ulong 32 float 32 float 2x16 (3210) float 2x16 (1010) long 2x16	char 8

		swapped long 2x16 ulong 2x16 u swapped long 2x16	
X0	Master mode only. Individual characteristic, point X0 (read through Modbus RS-485 Master).	-32768...32767	0
X1	Master mode only. Individual characteristic, point X1 (read through Modbus RS-485 Master).	-32768...32767	1
Y0	Master mode only. Individual characteristic, output value corresponding to the X0 point.	-327.68...327.67	0.00
Y1	Master mode only. Individual characteristic, output value corresponding to the X1 point.	-327.68...327.67	0.01
***Reset Counters** tab*			
This tab allows to check and reset the low and high value timers. Version equipped with voltage output can also indicate the time during which a short circuit was detected on each output set.			
***Device** status*			
This tab is used to show on one window the parameters of the S4AO.			
Status values	This window show the current voltage / current value at the outputs, the value read by RS-485 Master (if enabled) and allow also to update manually each output.		
Configured values	This window shows for each output the read value through Master (if enabled), the timers thresholds, the alarm values, the individual characteristic parameters and the timer values.		

5.8.2 Status value

Status value

Stop refresh float precision: 2

Analog output	Read value	Output value	Save
Analog output 1	0.00	4.00	Ok
Analog output 2	0.00	4.00	Ok
Analog output 3	0.00	4.00	Ok
Analog output 4	0.00	4.00	Ok

Figure 15: eCon: Status values

5.8.3 Configured values

Configured values

Stop refresh float precision: 2

Parameter	Analog output 1	Analog output 2	Analog output 3	Analog output 4
Read value form external device (master mode)	0.00	0.00	0.00	0.00
Value	4.00 mA	4.00 mA	4.00 mA	4.00 mA
Low value: threshold to start the low value time	2.00 mA	2.00 mA	2.00 mA	2.00 mA
High value: threshold to start the high value time	10.00 mA	10.00 mA	10.00 mA	10.00 mA
Output value in case of timeout	4.00 mA	4.00 mA	4.00 mA	4.00 mA
Input of individual characteristic of value read through RS-485 X0	0.00	0.00	0.12	0.49
Expected value for individual characteristic Y0	0.00	0.00	0.00	0.00
Input of individual characteristic of value read through RS-485 X1	0.01	0.01	0.22	0.51
Expected value for individual characteristic Y1	0.10	0.10	10.00	10.00
Time during which the analog output issued a signal lower than specified in low value	0.00 s	0.00 s	0.00 s	0.00 s
Time during which the analog output issued a signal upper than specified in high value	0.00 s	0.00 s	0.00 s	0.00 s

Parameter	Analog outputs 1 and/or 2	Analog outputs 3 and/or 4
Short circuit duration	0.00 s	0.00 s

Figure 16: eCon: configured values

6. SERIAL INTERFACES

6.1 RS-485Interfaces – list of parameters

Both RS-485 interfaces (Port 1 and Port 2) are intended for the configuration and the operations of the module.

- identifier — 215 (0xD7)
- 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
- operating mode — Modbus RTU
- maximum response time — 100 ms (read)
1000 ms (write)
- implemented functions
  - 03 Read Holding Registers
  - 04 Read Input Registers
  - 06 Write Single Register
  - 16 Write Multiple registers
  - 17 Device identification

Factory settings for both interfaces: speed 9.6 kbit/s, mode RTU 8N2.
Factory address for Port 1: 1
Factory address for Port 2: 2
Broadcast address: 253

6.2 USB Interface – list of parameters

The USB interface is intended only for the configuration of the module.

- identifier — 215 (0xD7)
- device address — reply to all adress
- baud rate — compatible with all virtual baud rate, without settings
- transmission mode — compatible with all virtual mode, without settings
- operating mode — Modbus RTU
- maximum response time — 100 ms (read)
1000 ms (write)
- implemented functions
  - 03 Read Holding Registers
  - 04 Read Input Registers
  - 06 Write Single Register
  - 16 Write Multiple registers
  - 17 Device identification

Broadcast address: 253

6.3 Map of S4AO module registers

In the S4AO module, data are placed in 16 and 32-bit registers. Process variables and module parameters are placed in the address area of registers in a way depended on the variable value type. Bits in 16-bit registers are numbered from the least significant to the most significant bit (b0-b15). The 32-bit registers contain float numbers compliant with IEEE-754 standard. Range of the registers is shown in Table 3. The 16-bit registers are shown in Table 4 and Table 5.

The 2x16-bits registers with their 32-bit equivalent registers are shown in Table 6. The register addresses shown in the tables are their physical addresses.

Table 3: Modbus registers

Address range	Value type	Description
4000 - 4025	Integer (16 bits)	Module interfaces configuration. Value set in the 16-bit register.
4100 - 4170	Integer (16 bits)	Module operation configuration.
6000 - 6110	Float (2x16 bits, the byte order of 3210)	Value is set in the two following 16-bit registers. Registers contain exactly the same data, as 32-bit registers of 7500 range. Read only registers.
7000 – 7110	Float (2x16 bits, the byte order of 1032)	Value is set in the two following 16-bit registers. Registers contain exactly the same data, as 32-bit registers of 7500 range. Read only registers.
7600 – 7655	Float (32 bits)	Value set in the 32-bit register. Read only registers.

Table 4: 4000 Modbus registers

Register address	Read/Write	Range	Description	Default
4000	R	0xD7	Device identifier	0xD7
4001	R	1...3	Output signals: 1: 4 current, 2: 4 voltage, 3: 2 set of 1 voltage + 1 current	*
4002	R		Software version	
4003	R		Bootloader version	
4004	R		Serial number (MSB)	
4005	R		Serial number (LSB)	
4006	R		RESERVED	
4007	R		RESERVED	
4008	R	0,1	Power supply state. 0: device not supplied 1: device supplied and ready for operation	1
4009	R		RESERVED	
4010	RW	0...1	Port 1 RS-485 mode. 0: Slave 1: Master	0
4011	RW	0...3	Port 1 RS-485 transmission mode. 0: 8N2 1: 8E1 2: 8O1 3: 8N1	0
4012	RW	1...7	Port 1 RS-485 baud rate. 0: 1200 1: 2400 2: 4800	3

			3: 9600 4:19200 5: 38400 6: 57600 7: 115200	
4013	RW	1...50	Port 1 RS-485 Modbus Master. Slave response timeout (ms*100)	5
4014	RW	1...30000	Port 1 RS-485 Modbus Master: Slave scanning period (ms*100)	5
4015	RW	1...247	Port 1 RS-485 Modbus slave address	1
4016	RW	0...1	Port 1 RS-485 parameters update	0
4017	RW	0...1	Port 2 RS-485 mode. 0: Slave 1: Master	0
4018	RW	0...3	Port 2 RS-485 transmission mode. 0: 8N2 1: 8E1 2: 8O1 3: 8N1	0
4019	RW	0...7	Port 2 RS-485 baud rate. 0: 1200 1: 2400 2: 4800 3: 9600 4:19200 5: 38400 6: 57600 7: 115200	3
4020	RW	1...50	Port 2 RS-485 Modbus master. Slave response timeout (ms*100)	5
4021		1...30000	Port 2 RS-485 Modbus Master: Slave scanning period (ms*100)	5
4022	RW	0..247	Port 2 RS-485 Modbus slave address	2
4023	R	0,1	Port 2 RS-485 parameters update	0
4024			RESERVED	
4025	RW	0,1	Reset all parameters	0

*) Depends of the outputs version.

Table 5: 4100 Modbus registers

Register address	Read/Write	Range	Description	Default
4100	RW	**	Analog Output 1 value *100	0
4101	RW	**	Analog Output 2 value *100	0
4102	RW	**	Analog Output 3 value *100	0
4103	RW	**	Analog Output 4 value *100	0
4104	RW	**	Analog Output 1 low value *100: threshold to start the AO1 low value timer (6080/6082)	0
4105	RW	**	Analog Output 1 high value *100: threshold to start the AO1 high value timer (6084/6086)	**
4106	RW	**	Analog Output 2 low value *100: threshold to start the AO2 low value timer (6088/6090)	0
4107	RW	**	Analog Output 2 high value *100: threshold to start the AO2 high value timer (6092/6094)	**
4108	RW	**	Analog Output 3 low value *100: threshold to start the AO3 low value timer (6096/6098)	0
4109	RW	**	Analog Output 3 high value *100: threshold to start the AO3 high value timer (6100/6102)	**
4110	RW	**	Analog Output 4 low value *100: threshold to start the AO4 low value timer (6104/6106)	0
4111	RW	**	Analog Output 4 high value *100: threshold to start the AO4 high value timer (6108/6110)	**
4112	RW	**	Analog output 1: Output value in case of timeout. If	0

			S4AO is Master, AO1 will take this value after value specified in AO1_timeout without slave communication. If S4AO is Slave, AO1 will take this value after a specified time without write.	
4113	RW	**	Analog output 2: Output value in case of timeout. If S4AO is Master, AO2 will take this value after value specified in AO2_timeout without slave communication. If S4AO is Slave, AO2 will take this value after a specified time without write.	0
4114	RW	**	Analog output 3: Output value in case of timeout. If S4AO is Master, AO3 will take this value after value specified in AO3_timeout without slave communication. If S4AO is Slave, AO3 will take this value after a specified time without write.	0
4115	RW	**	Analog output 4: Output value in case of timeout. If SA4O is Master, AO4 will take this value after value specified in AO4_timeout without slave communication. If S4AO is Slave, AO4 will take this value after a specified time without write.	0
4116	RW	-32768 … 32767	Analog output 1, input of individual characteristic of value read through RS-485, point 0	0
4117	RW	-32768 … 32767	Analog output 1, expected value for individual characteristic, point 0 (x 100)	0
4118	RW	-32768 … 32767	Analog output 1, input of individual characteristic of value read through RS-485, point 1	1
4119	RW	-32768 … 32767	Analog output 1, expected value for individual characteristic, point 1 (x 100)	1
4120	RW	-32768 … 32767	Analog output 2, input of individual characteristic of value read through RS-485, point 0	0
4121	RW	-32768 … 32767	Analog output 2, expected value for individual characteristic, point 0 (x 100)	0
4122	RW	-32768 … 32767	Analog output 2, input of individual characteristic of value read through RS-485, point 1	1
4123	RW	-32768 … 32767	Analog output 2, expected value for individual characteristic, point 1 (x 100)	1
4124	RW	-32768 … 32767	Analog output 3, input of individual characteristic of value read through RS-485, point 0	0
4125	RW	-32768 … 32767	Analog output 3, expected value for individual characteristic, point 0 (x 100)	0
4126	RW	-32768 … 32767	Analog output 3, input of individual characteristic of value read through RS-485, point 1	1
4127	RW	-32768 … 32767	Analog output 3, expected value for individual characteristic, point 1 (x 100)	1
4128	RW	-32768 … 32767	Analog output 4, input of individual characteristic of value read through RS-485, point 0	0
4129	RW	-32768 … 32767	Analog output 4, expected value for individual characteristic, point 0 (x 100)	0
4130	RW	-32768 … 32767	Analog output 4, input of individual characteristic of value read through RS-485, point 1	1
4131	RW	-32768 … 32767	Analog output 4, expected value for individual characteristic, point 1 (x 100)	1
4132	RW	0...2	Analog output 1 mode. 0: No Master control 1: read out through Port 1 RS-485 2: read out through Port 2 RS-485	0
4133	RW	0...2	Analog output 2 mode. 0: No Master control 1: read out through Port 1 RS-485 2: read out through Port 2 RS-485	0
4134	RW	0...2	Analog output 3 mode. 0: No Master control 1: read out through Port 1 RS-485 2: read out through Port 2 RS-485	0

4135	RW	0...2	Analog output 4 mode. 0: No Master control 1: read out through Port 1 RS-485 2: read out through Port 2 RS-485	0
4136	RW	0...1	0-20 mA / 4-20 mA mode. The minimum value of the output is 0 mA register value is set to 0, and 4 mA when register value is set to 1 ****	0
4137	RW	0...247	Analog output 1, Modbus Master: Slave address to check	0
4138	RW	0...65535	Analog output 1, Modbus Master: Slave register to check	0
4139	RW	3...4	Analog output 1, Modbus Master: Function to use to read the Slave	3
4140	RW	0...30000	Analog output 1: Time out after which AO1 is set to alarm value (register4112). Disabled if set to 0 (ms x 100)	0
4141	RW	0...12	Analog output 1, Modbus Master: Slave data type. 0: char 8 1: uchar 8 2: short 16 3: ushort 16 4: long 32 5: ulong 32 6: float 32 7: float 2x16 8: swapped float 2x16 9: long 2x16 10: swapped long 2x16 11: ulong 2x16 12: u swapped long 2x16	0
4142	RW	0...1	0-20 mA / 4-20 mA mode. The minimum value of the output is 0 mA register value is set to 0, and 4 mA when register value is set to 1 ****	0
4143	RW	0...247	Analog output 2, Modbus Master: Slave address to check	0
4144	RW	0...65535	Analog output 2, Modbus Master: Slave register to check	0
4145	RW	3...4	Analog output 2, Modbus Master: Function to use to read the Slave	3
4146	RW	0...30000	Analog output 2: Time out after which AO1 is set to alarm value (register4113). Disabled if set to 0 (ms x 100)	0
4147	RW	0...12	Analog output 2, Modbus Master: Slave data type. 0: char 8 1: uchar 8 2: short 16 3: ushort 16 4: long 32 5: ulong 32 6: float 32 7: float 2x16 8: swapped float 2x16 9: long 2x16 10: swapped long 2x16 11: ulong 2x16 12: u swapped long 2x16	0
4148	RW	0...1	0-20 mA / 4-20 mA mode. The minimum value of the output is 0 mA register value is set to 0, and 4 mA when register value is set to 1 ****	0
4149	RW	0...247	Analog output 3, Modbus Master: Slave address to check	0
4150	RW	0...65535	Analog output 3, Modbus Master: Slave register to check	0

4151	RW	3...4	Analog output 3, Modbus Master: Function to use to read the Slave	3
4152	RW	0...30000	Analog output 3: Time out after which AO1 is set to alarm value (register4114). Disabled if set to 0 (ms x 100)	0
4153	RW	0...12	Analog output 3, Modbus Master: Slave data type. 0: char 8 1: uchar 8 2: short 16 3: ushort 16 4: long 32 5: ulong 32 6: float 32 7: float 2x16 8: swapped float 2x16 9: long 2x16 10: swapped long 2x16 11: ulong 2x16 12: u swapped long 2x16	0
4154	RW	0...1	0-20 mA / 4-20 mA mode. The minimum value of the output is 0 mA register value is set to 0, and 4 mA when register value is set to 1 ****	0
4155	RW	0...247	Analog output 4, Modbus Master: Slave address to check	0
4156	RW	0...65535	Analog output 4, Modbus Master: Slave register to check	0
4157	RW	3...4	Analog output 4, Modbus Master: Function to use to read the Slave	3
4158	RW	0...30000	Analog output 4: Time out after which AO1 is set to alarm value (register4115). Disabled if set to 0 (ms x 100)	0
4159	RW	0...12	Analog output 4, Modbus Master: Slave data type. 0: char 8 1: uchar 8 2: short 16 3: ushort 16 4: long 32 5: ulong 32 6: float 32 7: float 2x16 8: swapped float 2x16 9: long 2x16 10: swapped long 2x16 11: ulong 2x16 12: u swapped long 2x16	0
4160	R	0,1	Short circuit detected on analog outputs 1 and / or 2 ***	0
4161	R	0,1	Short circuit detected on analog outputs 3 and / or 4 ***	0
4162	RW	0,1	Analog output 1: reset the low value timer	0
4163	RW	0,1	Analog output 1: reset the high value timer	0
4164	RW	0,1	Analog output 2: reset the low value timer	0
4165	RW	0,1	Analog output 2: reset the high value timer	0
4166	RW	0,1	Analog output 3: reset the low value timer	0
4168	RW	0,1	Analog output 3: reset the high value timer	0
4168	RW	0,1	Analog output 4: reset the low value timer	0
4169	RW	0,1	Analog output 4: reset the high value timer	0
4170	RW	0,1	Reset all counters except Short Circuit Counters	0

*) 0...1200 for voltage output, 0...2400 for current output.
**) 1200 for voltage output, 2400 for current output.
***) Unavailable on 4 current outputs version.
****) Available only if the output is a current output.

Table 6: Floats Modbus registers

Address of 16-bit registers	Address of 32-bit register	Read/ Write	Description	Unit
6000/7000	7600	R	Analog output 1 Master mode. Read value from external device	
6002/7002	7601	R	Analog output 2 Master mode. Read value from external device	
6004/7004	7602	R	Analog output 3 Master mode. Read value from external device	
6006/7006	7603	R	Analog output 4 Master mode. Read value from external device	
6008/7008	7604	R	Analog Output 1 value	V / mA *
6010/7010	7605	R	Analog Output 2 value	V / mA *
6012/7012	7606	R	Analog Output 3 value	V / mA *
6014/7014	7607	R	Analog Output 4 value	V / mA *
6016/7016	7608	R	Analog Output 1 low value: threshold to start the low value timer (6080/6082)	V / mA *
6018/7018	7609	R	Analog Output 1 high value: threshold to start the high value timer (6084/6086)	V / mA *
6020/7020	7610	R	Analog Output 2 low value: threshold to start the low value timer (6088/6090)	V / mA *
6022/7022	7611	R	Analog Output 2 high value: threshold to start the high value timer (6092/6094)	V / mA *
6024/7024	7612	R	Analog Output 3 low value: threshold to start the low value timer (6096/6098)	V / mA *
6026/7026	7613	R	Analog Output 3 high value: threshold to start the high value timer (6100/6102)	V / mA *
6028/7028	7614	R	Analog Output 4 low value: threshold to start the low value timer (6104/6106)	V / mA *
6030/7030	7615	R	Analog Output 4 high value: threshold to start the high value timer (6108/6110)	V / mA *
6032/7032	7616	R	Analog output 1: Output value in case of timeout. If S4AO is Master, AO1 will take this value after value specified in 4112 without slave communication. If S4AO is Slave, AO1 will take this value if the analog output 1 is not update after this timeout.	V / mA *
6034/7034	7617	R	Analog output 2: Output value in case of timeout. If S4AO is Master, AO2 will take this value after value specified in 4113 without slave communication. If S4AO is Slave, AO2 will take this value if the analog output 1 is not update after this timeout.	V / mA *
6036/7036	7618	R	Analog output 3: Output value in case of timeout. If S4AO is Master, AO3 will take this value after value specified in 4114 without slave communication. If S4AO is Slave, AO3 will take this value if the analog output 1 is not update after this timeout.	V / mA *
6038/7038	7619	R	Analog output 4: Output value in case of timeout. If S4AO is Master, AO4 will take this value after value specified in 4115 without slave communication. If S4AO is Slave, AO4 will take this value if the analog output 1 is not update after this timeout.	V / mA *
6040/7040	7620	R	Analog output 1, input of individual characteristic of value read through RS-485, point 0	
6042/7042	7621	R	Analog output 1, expected value for individual characteristic, point 0	
6044/7044	7622	R	Analog output 1, input of individual characteristic of value read through RS-485, point 1	
6046/7046	7623	R	Analog output 1, expected value for individual characteristic, point 1	
6048/7048	7624	R	Analog output 2, input of individual characteristic of value read through RS-485, point 0	
6050/7050	7625	R	Analog output 2, expected value for individual characteristic, point 0	
6052/7052	7626	R	Analog output 2, input of individual characteristic of value read through RS-485, point 1	
6054/7054	7627	R	Analog output 2, expected value for individual characteristic, point 1	
6056/7056	7628	R	Analog output 3, input of individual characteristic of value read	

			through RS-485, point 0	
6058/7058	7629	R	Analog output 3, expected value for individual characteristic, point 0	
6060/7060	7630	R	Analog output 3, input of individual characteristic of value read through RS-485, point 1	
6062/7062	7631	R	Analog output 3, expected value for individual characteristic, point 1	
6064/7064	7632	R	Analog output 4, input of individual characteristic of value read through RS-485, point 0	
6066/7066	7633	R	Analog output 4, expected value for individual characteristic, point 0	
6068/7068	7634	R	Analog output 4, input of individual characteristic of value read through RS-485, point 1	
6070/7070	7635	R	Analog output 4, expected value for individual characteristic, point 1	
6072/7072	7636	R	Short circuit duration on analog outputs 1 and / or 2 (value incremented after 6074/7274 overflows)	s * 1 000 000
6074/7074	7637	R	Short circuit duration on analog outputs 1 and / or 2 (value up to 999 999)	s
6076/7076	7638	R	Short circuit duration on analog outputs 3 and / or 4 (value incremented after 6078/7278 overflows)	s * 1 000 000
6078/7078	7639	R	Short circuit duration on analog outputs 3 and / or 4 (value up to 999 999)	s
6080/7080	7640	R	Analog output 1: time during which the analog output issued a signal lower than specified in the 4104 register (value incremented after 6082/7282 overflows)	s * 1 000 000
6082/7082	7641	R	Analog output 1: time during which the analog output issued a signal lower than specified in the 4104 register (value up to 999 999)	s
6084/7084	7642	R	Analog output 1: time during which the analog output issued a signal upper than specified in the 4105 register (value incremented after 6086/7286overflows)	s * 1 000 000
6086/7086	7643	R	Analog output 1: time during which the analog output issued a signal upper than specified in the 4105 register (value up to 999 999)	s
6088/7088	7644	R	Analog output 2: time during which the analog output issued a signal lower than specified in the 4106 register (value incremented after 6090/7290 overflows)	s * 1 000 000
6090/7090	7645	R	Analog output 2: time during which the analog output issued a signal lower than specified in the 4106 register (value up to 999 999)	s
6092/7092	7646	R	Analog output 2: time during which the analog output issued a signal upper than specified in the 4107register (value incremented after 6094/7294 overflows)	s * 1 000 000
6094/7094	7647	R	Analog output 2: time during which the analog output issued a signal upper than specified in the 4107 register (value up to 999 999)	s
6096/7096	7648	R	Analog output 3: time during which the analog output issued a signal lower than specified in the 4108 register (value incremented after 6098/7298 overflows)	s * 1 000 000
6098/7098	7649	R	Analog output 3: time during which the analog output issued a signal lower than specified in the 4108 register (value up to 1 000 000)	s
6100/7100	7650	R	Analog output 3: time during which the analog output issued a signal upper than specified in the 4109 register (value incremented after 6102/7102 overflows)	s * 1 000 000
6102/7102	7651	R	Analog output 3: time during which the analog output issued a signal upper than specified in the 4109 register (value up to 1 000 000)	s
6104/7104	7652	R	Analog output 4: time during which the analog output issued a signal lower than specified in the 4110 register (value incremented after 6106/7106 overflows)	s * 1 000 000
6106/7106	7653	R	Analog output 4: time during which the analog output issued a	s

			signal lower than specified in the 4110 register (value up to 999 999)	
6108/7108	7654	R	Analog output 4: time during which the analog output issued a signal upper than specified in the 4111 register (value incremented after 6110/7110 overflows)	s * 1 000 000
6110/7110	7655	R	Analog output 4: time during which the analog output issued a signal upper than specified in the 4111 register (value up to 999 999)	s

*) according to the device version
**) Unavailable on 4 current outputs version. This alarm is activated when a load lower than 430 Ω is applied to a voltage output.

7. BEFORE DECLARING A DAMAGE

The following table must be checked in case of incorrect symptoms:

Table 7: Error description

Symptom	Procedure	Remarks
The ON / ERROR led is not lightning	Check the connection of the power supply cable	
The ON / ERROR led is continuously red lightning	Check the connection of the power supply cable	The module can be supplied via USB for configuration, and analog outputs features are not active
The ON / ERROR led is blinking alternatively red / green	A short-circuit was detected on a voltage output	2 counters monitor the overall short-circuit time (6072/6074 and 6076/6078)
The ON / ERROR led is blinking red	Memory / calibration error	Contact your retailer
The module does not communicate with the device master via the RS-485 port. Lack of transmission signaling on Rx 1, Tx 1, Rx 2 or Tx 2 leds.	Check if the wire is connected to the appropriate module terminal. Check if the other device is set on the same transmission parameters as the module (baud rate, mode, address).	

8. SOFTWARE UPDATE

The features implemented in the S4AO module enable to upgrade its software using a PC with e-Con software installed. Free e-Con software and the update files are available at the website www.lumel.com.pl. Updating is done via the external RS-485 interface, so the module must be powered.

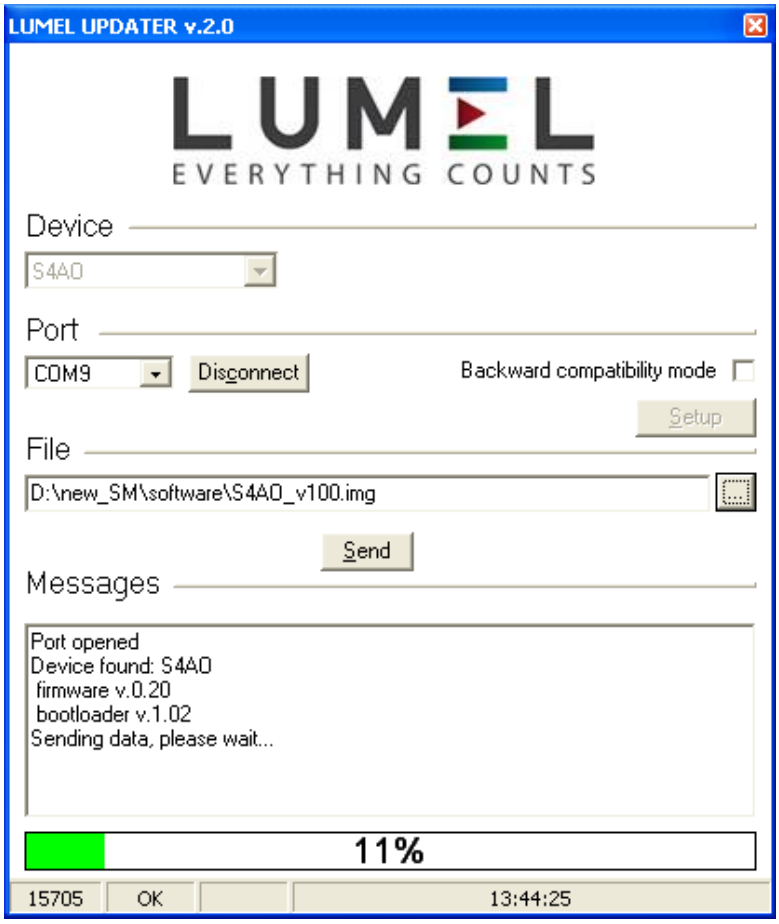


Figure 17: Program window for updating the software

Caution! It is recommended to save module settings using e-Con software before upgrading.

The Software update features is enabled only on the RS-485 port 1, and the module must be supplied during the update process.

When you start the e-Con program (Figure 12), set the communication parameters in the *Communication* field at the left side of e-Con window, and then click *connect* button. The module will be automatically recognized.

The parameters should be read and saved to a file for later restoration using the S4AO – *configuration* field.

Next select *Update firmware* from the menu at the top. The window of the LUMEL UPDATER (LU) program will open (Figure 17). S4AO module is supported with LU from version 1.17. Using this program, select the correct port on which the S4AO module was installed and press the *Connect* button. The informations about the progress of the update process are available in the *Messages* window. The message *Port opened* is displayed when the port is open properly. The LU program will display information about the software version and the version of the bootloader when the meter is properly detected. At this point, you should select the correct module upgrade file by pressing the […] button. If the correct file is selected, the LU program will display a message *File opened*. Press *Send* button. The LU program shows a progress bar and the S4AO will blink with green diode during the software update. The module restarts, restores the manufacturer settings and goes to normal operation after the upgrade process is successfully completed. Information *Done* and duration of the update will appear in the LU program window. In the next step, you can restore previously saved settings of the module using e-Con software.

Caution! Turning module supply off during upgrade process may result in permanent damage!

9. TECHNICAL DATA

Output values ranges:

Current output

programmable:
current (maximal range) 0...20...24 mA or 3.75...4...20...24 mA
load resistance: 0...500 Ω
disposable voltage: 15V
basic error: 0.2 % of range
resolution: 0.05 % of range

Voltage output

programmable:
voltage (maximal range) 0...10...12 V
load resistance: > 500 Ω
disposable voltage: 15V
basic error: 0.2 % of range
resolution: 0.1 % of range
Short-circuit endurance: 15 min. max

Additional errors:
in % of the basic error

- from ambient temperature changes < 0,1% / 10 °C

Serial interfaces

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

Use only shielded cable

USB for configuration: 1.1 / 2.0,
address: all;
mode: all;
baud rate: all;
maximal USB wire length: 3m

broadcasting address: 253
transmission mode: Modbus RTU

max time to start response: 400 ms (read)
1000 ms (write)

Counters

resolution: ± 1s on each launch
Pulses which hold less than 1 s can be uncounted

Test voltages:

2210 V a.c. rms:

For 1 minute between:

Enclosure / Power Supply, RS-485 ports, USB and Analog Outputs

Power Supply / RS-485 ports, USB and Analog Outputs

1390 V a.c. rms:

For 1 minute between:

Analog Outputs / RS-485 ports

Analog Outputs / USB

USB / RS-485 ports

RS-485 port 1 / RS-485 port 2

Protection grade IP:

from frontal side	IP 50
from terminals	IP 00

Power input in the supply circuit:	≤ 7 VA
Weight	< 0.2 kg
Overall dimensions	53 X 110 X 60 mm

Rated 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
- storage temperature	- 25 ... +85 °C
- humidity	< 95% (condensation not permissible)
- external magnetic field	0..40 ..400 A/m
- working position	vertical
- warm-up time	30 min.

Electromagnetic compatibility:

- noise immunity acc. to EN 61000-6-2
- noise emission acc. to EN 61000-6-4

Safety requirements:

according to EN 61010-1 standard

- isolation between circuits: basic
- installation category: III,
- pollution grade: 2,
- maximum phase-to-earth operating voltage:
  - for supply circuit: 300 V
  - for remaining circuits: 50 V
- altitude a.s.l. < 2000 m

10. ORDERING CODE

Table 8: Ordering code

Rail-mounted analog outputs module S4AO -	X	X	XX	X	X
Outputs:					
4 current outputs: 0/4...20 mA	1				
4 voltage outputs: 0...10V	2				
2 sets of 1 voltage + 1 current output: 0...10V and 0/4...20mA	3				
acc.to customer's requirements*	X				
Supply voltage:					
85...253 V a.c. , 90...300 d.c.		1			
20...40 V a.c. , 20...60 V d.c.		2			
Version:					
standard			00		
custom-made*			XX		
Language:					
Polish				P	
English				E	
other*				X	
Acceptance tests:					
without extra quality requirements					0
with an extra quality inspection certificate					1
acc.to customer's requirements*					X

* After agreeing with the manufacturer

ORDER EXAMPLE:

Code S4AO-1100E0 means:

S4AO - S4AO module,

1 – 4 current outputs, 0..20 mA,

1 – 85..253 V a.c. / d.c.

00 – standard version,

E – English version,

0 – no additional requirements.

AVAILABLE ACCESSORIES:

Accessories: For the S4AO module, you can order:

- USB CABLE A/miniUSB-B - 1m BLACK; Order code 20-069-00-00150,
- lateral bus inter-module connector; Order code 24-171-01-00016,
- lateral bus to cable connector; Order code 24-171-01-00017.

LUMEL
EVERYTHING COUNTS

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S4AO-09