

LUMEL

2-CHANNEL MODULE OF ANALOG INPUTS

SM1



USER'S MANUAL



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1. APPLICATION

The SM1 2-channel module of analog inputs is destined to convert standard signals, resistance or temperature signals into numerical data accessible via the RS-485 or RS-232 port by means of the MODBUS protocol.

The measurement is carried out independently in two channels. RS-485 and RS-232 output ports are galvanically insulated from input signals and the supply. The module programming is possible by means of the RS-485 or RS-232 port.

The SM1 module realises following functions:

- mathematical operations on channels and between measuring channels,
- conversion of measured or calculated quantities basing on the individual linear characteristic,
- storage of maximal and minimal values for both channels,
- programming of the measurement averaging time,
- servicing of RS-485 and RS-232 interfaces in MODBUS protocol, both in ASCII and RTU mode.

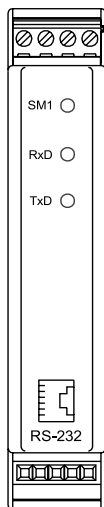


Fig. 1. View of the SM1 module

2. SET OF THE SM1 MODULE

The set consists of:

- SM1 module 1 pc.
- plug with screw terminals 2 pcs
- hole plug of the RS-485 and RS-232 sockets 1 pc

When unpacking the module, please check whether the type and execution code on the data plate correspond to the order.

3. BASIC REQUIREMENTS, SAFETY INFORMATION

Symbols located in this service manual mean:

WARNING!



Warning of potential, hazardous situations. Especially important. One must acquaint with this before connecting the module. The non-observance of notices marked by these symbols can occasion severe injuries of the personnel and the damage of the module.

CAUTION!



Designates a general useful note. If you observe it, handling of the module is made easier. One must take note of this, when the module is working inconsistently to the expectations. Possible consequences if disregarded!

In the security scope the module meets the requirements of the EN 61010 -1 standard.



Remarks concerning the operator safety:

1. General

- The SM1 module is destined to be installed in measuring systems.
- Non-authorized removal of the required housing, inappropriate use, incorrect installation or operation create the risk of injury to personnel or damage to equipment. For more detailed information please study the user's manual.

- All operations concerning transport, installation, and commissioning as well as maintenance must be carried out by qualified, skilled personnel and national regulations for the prevention of accidents must be observed.
- According to this basic safety information, qualified, skilled personnel are persons who are familiar with the installation, assembly, commissioning, and operation of the product and who have qualifications necessary for their occupation.

2. Transport, storage

Please observe the notes on transport, storage and appropriate handling. Observe the climatic conditions given in Technical Data.

3. Installation

- The module must be installed according to the regulation and instructions given in this user's manual.
- Ensure proper handling and avoid mechanical stress.
- Do not bend any components and do not change any insulation distances.
- Do not touch any electronic components and contacts.
- Modules may contain electrostatically sensitive components, which can easily be damaged by inappropriate handling.
- **Do not damage or destroy any electrical components since this might endanger your health!**

4. Electrical connection

- Before switching the module on, one must check the correctness of connection to the network.
- In case of the protection terminal connection with a separate lead one must remember to connect it before the connection of the module to the mains.
- When working on live modules, the applicable national regulations for the prevention of accidents must be observed.
- The electrical installation must be carried out according to the appropriate regulations (cable cross-sections, fuses, PE connection). Additional information can be obtained from the user's manual.
- Apply a two-wire cable for the connection to the network acc. to the EN 61010-1 standard.
- Do not connect the module to the network through an autotransformer.
- In the building installation, a cut-out or a circuit-breaker should exist, situated near the device and easy accessible to the operator. It should be marked as the element switching the device out.

- The documentation contains information about installation in compliance with EMC (shielding, grounding, filters and cables). These notes must be observed for all CE-marked products.
- The manufacturer of the measuring system or installed devices is responsible for the compliance with the required limit values demanded by the EMC legislation.

5. Operation

- Measuring systems including SM1 modules must be equipped with protection devices according to the corresponding standard and regulations for prevention of accidents.
- After the instrument has been disconnected from the supply voltage, live components and power connections must not be touched immediately because capacitors can be charged.
- The housing must be closed during operation.
- The RS-232 socket serves only to connect the device (Fig.5) working with the MODBUS protocol. When the module is not used place the hole plug in the RS-232 socket of the module.

6. Maintenance and servicing.

Please observe the manufacturer's documentation.

Read all product-specific safety and application notes in this user's manual.

- Before taking the module out, one must turn the supply off.
- The removal of the module housing during the warranty contract period may cause its cancellation.

4. INSTALLATION

4.1 Way of fixing

The SM1 module is fixed on a 35 mm rail in accordance with EN 60715. The module housing is made of a self-extinguishing plastic. Overall dimensions of the housing: 22.5 × 120 × 100 mm. One must connect to the module, external wires with cross-section up to 2.5 mm² (from the supply side) and 1.5 mm² (from the input signal side). Overall dimensions and the fixing way are presented on the fig. 2.

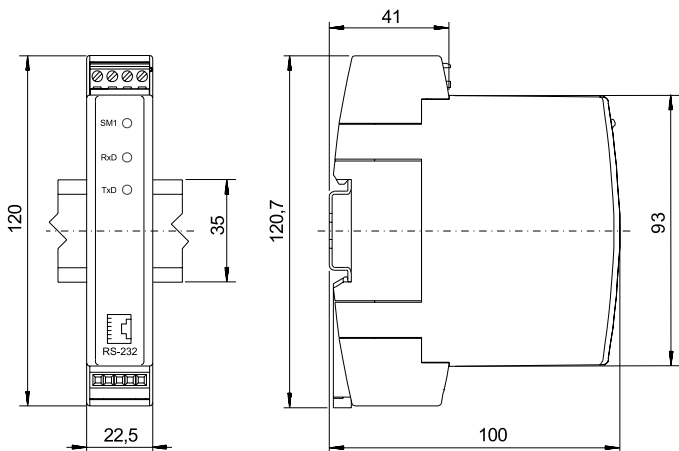


Fig.2. Overall dimensions and way of fixing the module

4.2. External connection diagrams

Make the connection of input signals, supply and interface acc. to the fig. 3, 4 and 5

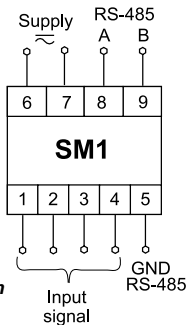


Fig.3

Connection way of external signals. The connection diagram is also placed on the module housing

The polarization is optional when supplying by c.d. voltage.

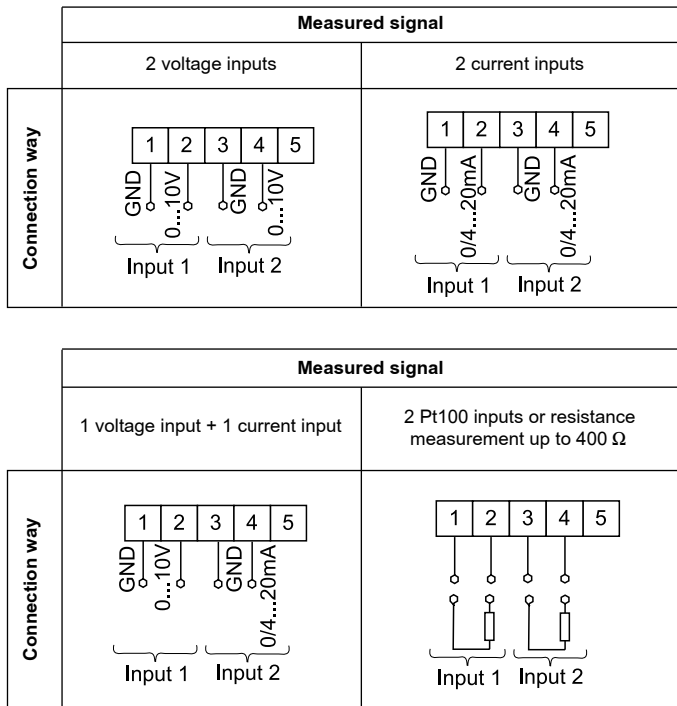


Fig. 4 Connection way of input signals

Taking in consideration electromagnetic interference one must use shielded wires to connect input signals and output signals. The supply must be connected by a two-wire cable, with the appropriate wire diameter ensuring its protection by means of a safety fuse.

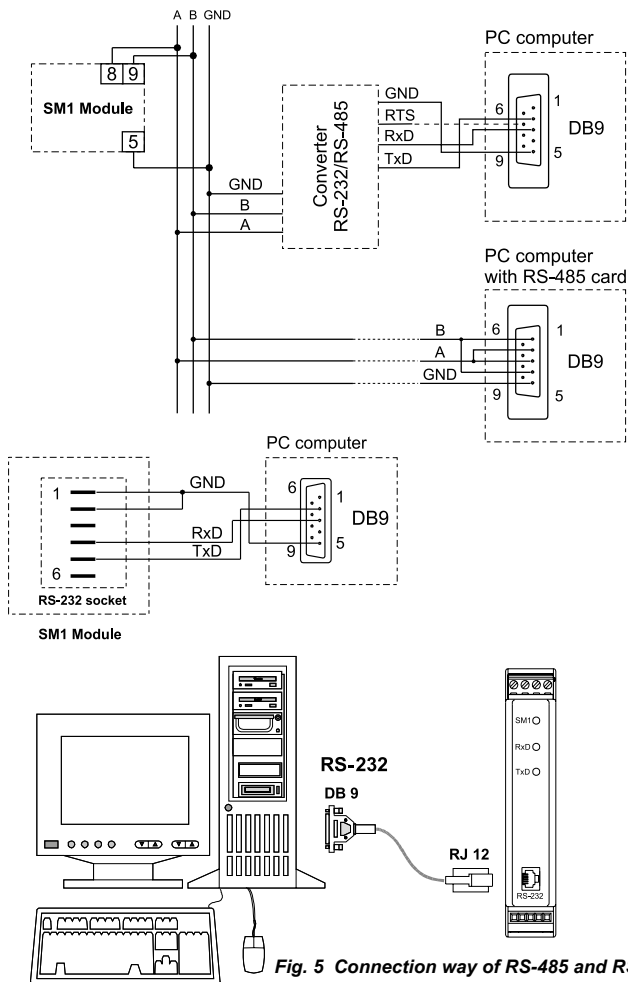


Fig. 5 Connection way of RS-485 and RS-232 interfaces

5. HANDLING

After connecting external signals and switching the supply on, the SM1 module is ready to work.

The lighted green diode signals the module work. The green (RxD) diode signals the module polling, however the yellow diode (TxD) signals the module response. Diodes should ignite in cycles during the data transmission, both through the RS-232 and the RS-485 interface. One can program all module parameters by means of RS-232 or RS-485.

The RS-232 port has constant transmission parameters in accordance with technical data, what enables the connection with the module even when programmed parameters of the RS-485 digital output are unknown (address, mode, rate). The RS-485 standard allows to the direct connection to 32 devices on a single serial link up to 1200 m. To connect a greater number of devices, it is necessary to use additional intermediate-separating systems.

The way of the interface connection is given in the user's manual (fig.5). To obtain the correct transmission, it is necessary to connect **A** and **B** lines in parallel with their counterparts in other devices. The connection must be carried out with a screened wire. The screen must be connect to the protective terminal in a single point. The **GND** line serves to the additional protection of the interface line at long connections. One must connect it to the protective terminal (it is not necessary for the correct interface work). To obtain the connection with the PC computer through the RS-485 port, an RS-232/RS-485 converter (e.g. PD51 of Lumel's production) or an RS-485 interface card is indispensable. The marking of transmission lines for the card in the PC computer depends on the card manufacturer. To obtain the connection through the RS-232 port, the wire added to the module is sufficient. The connection way of both ports (RS-232 and RS-485) is shown on the fig. 5.

The module can be connected to the device of master type only through one interface port. In case of a simultaneous connection of both ports, the module will work through the RS-232 interface.

5.1. Description of MODBUS protocol implementation

The transmission protocol describes ways of the information exchange between devices through serial links.

The MODBUS protocol has been implemented in the module in accordance with the PI-MBUS-300 Rev G specification of the Modicon company.

Set of parameters of the module serial link in the MODBUS protocol:

- Module address - 1...247
- Baud rate - 2400, 4800, 9600, 19200, 38400, 57600, 115200 bit/s
- Working modes - ASCII, RTU

- Information unit - ASCII: 8N1, 7E1, 7O1
 - RTU: 8N2, 8E1, 8O1, 8N1
- Maximal response time - 300 ms.

The parameter configuration of the serial link is described in the further part of the user's manual. It consists on establishing the baud rate (**Rate** parameter), device address (**Adres** parameter) and the information unit type (**Mode** parameter).

In case of the module connection with the computer through the RS-232 wire, the module set automatically following transmission parameters:

Baud rate: **9600 bps,**

Working mode: **RTU 8N1,**

Address: **1.**

Notice: Each module connected to the communication network must:

- have a unique address, different from addresses of other devices connected to the network,
- identical baud rate and information unit type,
- the message sent with the address „0" is identified as the data transmission mode (transmission to many devices).

5.2. Description of the MODBUS protocol function

Following functions of the MODBUS protocol have been implemented in the SM1 module

Opis funkcji

<i>Code</i>	<i>Signification</i>
03 (03 h)	Readout of n-register
06 (06 h)	Write of a single register
16 (10 h)	Write of n-registers
17 (11 h)	Slave device identification

Readout of n-registers (code 03h)

The function is not accessible in the broadcast mode.

Example: Readout of 2 registers beginning by the register with the 1DBDh address (7613). RTU mode.

Demand:

Device address	Function	Register address		Number of registers		Checksum CRC
		Hi	Lo	Hi	Lo	
01	03	1D	BD	00	02	52 43

Answer:

Device address	Function	Number of bytes	Value from the register 1DBD (7613)				Value from the register 1DBE (7614)				Checksum CRC
01	03	08	3F	80	00	00	40	00	00	00	42 8B

Writing of values in the register (code 06h)

The function is accessible in the broadcast mode.

Example: Write the register with 1DBDh (7613) address. RTU mode.

Demand:

Device address	Function	Register address		Value for the register 1DBD (7613)				Checksum CRC
		Hi	Lo					
01	06	1D	BD	3F	80	00	00	85 AD

Answer:

Device address	Function	Register address		Value from the register 1DBD (7613)				Checksum CRC
		Hi	Lo					
01	06	1D	BD	3F	80	00	00	85 AD

Writing in n-registers (code 10h)

The function is accessible in broadcast mode.

Example: Write of two registers beginning from the register with 1DBDh (7613) address

Demand:

Device address	Function	Register address		Number of registers		Number of bytes	Value for the register 1DBD (7613)				Value for the register 1DBE (7614)				Checksum CRC
		Hi	Lo	Hi	Lo										
01	10	1D	BD	00	02	08	3F	80	00	00	40	00	00	00	03 09

Answer:

Device address	Function	Register address		Number of registers		Checksum CRC
		Hi	Lo	Hi	Lo	
01	10	1D	BD	00	02	D7 80

Report identifying the device (code 11h)

Demand:

Device address	Function	Checksum (CRC)
01	11	C0 2C

Answer:

Device address	Function	Number of bytes	Device identifier	Device state	Field depending on the device type	Checksum
01	11	08	88	FF	XXXXXX	

Device address - depends on the set value

Function - function number: 0x11

Number of bytes - 0x08

Device identifier - 0x88

Device state - 0xFF

Field depended of the device - XXXXXX

Output of OC type - 0x00 - not occurs, 00 X X X X X

Type of input - Field depended on the module execution code:

- 0x00 - two 0...10 V voltage inputs, X 00 X X X X
- 0x01 - two 0/4...20 mA current input2, X 01 X X X X
- 0x02 - one 0...10 V voltage input,
one 0/4...20 mA current input2, X 02 X X X X
- 0x03 - two Pt100 inputs or two resistance
inputs up to 400 Ω, X 03 X X X X

Number of the software version - software version implemented in the module
X X _ _ _ 4 - byte variable of float

Checksum - 2 bytes in case of work in RTU mode
- 1 byte in case of work in ASCII mode

Example:

Work in **RTU** mode, e.g. **Mode = RTU 8N2** (value 0x02 in case of readout/write through the interface)

The device address is set on **Adr=0x01**

For the SM1 module the answer frame has the following shape:

Device address	Function	Number of bytes	Device identifier	Device state	Field depending on the device type	Check-sum
01	11	08	88	FF	00 01 3F 80 00 00	03 7D

It is the SM1 module:

- with two 0/4...20 mA current inputs
- software version: 1.00

5.3. Register map

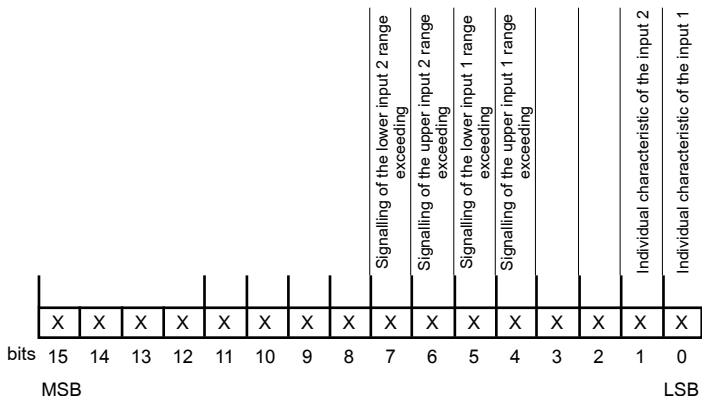
Register map of SM1 series modules

Address range	Value type	Description
7000-7200	float (32 bit)	The value is placed in two successive 16-bit registers. Registers contain the same data as 32-bit registers from the area 7500. The register is for readout only
7200-7400	float (32 bit)	The value is placed in two successive 16-bit registers. Registers contain the same data as 32-bit registers from the area 7600. Registers can be read out and written.
7500-7600	float (32 bit)	The value is placed in the 32-bit register. The register is for readout only.
7600-7700	float (32 bit)	The value is placed in the 32-bit register. Registers can be read out and written.

5.4. Registers only for read-out

The value is located in two successive 16-bit registers. These registers include the same data as 32-bit registers from the area 7500.	The value is placed into 32-bit registers.	Name	Write (w)/Readout (r)	Unit	Quantity name	
7000	7500	Identifier	r	-	Constant identifying the device	
					Value	
					0x88 - - h	SM1 identifier
					0x - - 00h	Two 0...10 V voltage inputs
					0x - - 01h	Two 0/4...20 mA current inputs
					0x - - 02h	One 0...10 V voltage input One 0/4...20 mA current input
					0x - - 03h	2 Pt100 inpus or 2 resistance inputs up to 400 Ω
7002	7501	Status 1	r	-	Status 1 is the register describing the present module state	
7004	7502	Status 2	r	-	Status 2 is the register describing the present module state	
7006	7503	W1	r	-	Measured value on the input 1	
7008	7504	W2	r	-	Measured value on the input 2	
7010	7505	W3	not occurs			
7012	7506	W4	not occurs			
7014	7507	WF	r	-	Calculated value basing on the function	
7016	7508	Min 1	r	-	Minimum of the measured value on the input 1	
7018	7509	Max 1	r	-	Maximum of the measured value on the input 1	
7020	7510	Min 2	r	-	Minimum of the measured value on the input 2	
7022	7511	Max 2	r	-	Maximum of the measured value on the input 2	
7024	7512	Min 3	not occurs			
7026	7513	Max 3	not occurs			
7028	7514	Min 4	not occurs			
7030	7515	Max 4	not occurs			
7032	7516	WF Min	r	-	Minimum of the calculated value	
7034	7517	WF Max	r	-	Maximum of the calculated value	

Description of the Status1 register



Bit-15...8 Not used

Bit value is always equal 0

Bit-7 Signalling of the lower range exceeding of input 2

0 - normal work

1 - range exceeding

Bit-6 Signalling of the upper range exceeding of input 2

0 - normal work

1 - range exceeding

Bit-5 Signalling of the lower range exceeding of input 1

0 - normal work

1 - range exceeding

Bit-4 Signalling of the upper range exceeding of input 1

0 - normal work

1 - range exceeding

Bit-3...2 Not used

Bit value is always equal 0

Bit-1 Individual characteristic of the input 2

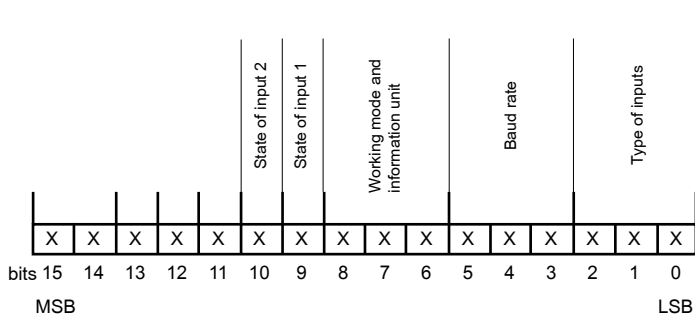
0 - individual characteristic switched off

1 - individual characteristic switched on

Bit-0 Individual characteristic of the input 1

0 - individual characteristic switched off

1 - individual characteristic switched on

Description of the Status 2 register**Bit-15...11 Not used**

Bit value is always equal 0

Bit-10 State of measuring input 2

0 - channel switched off (lack of measurement)

1 - channel switched on

Bit-9 State of measuring input 1

0 - channel switched off (lack of measurement)

1 - channel switched on

Bit-8...6 Working mode and information unit

000 - interface switched off

001 - 8N1 - ASCII

010 - 7E1 - ASCII

011 - 7O1 - ASCII

100 - 8N2 - RTU

101 - 8E1 - RTU

110 - 8O1 - RTU

111 - 8N1 - RTU

Bit-5...3 Baud rate

000 - 2400 bit/s

001 - 4800 bit/s

010 - 9600 bit/s

011 - 19200 bit/s

100 - 38400 bit/s

101 - 57600 bit/s

110 - 115200 bit/s

Bit-2...0 Type of inputs

000 - 2 x 0...10 V

001 - 2 x 0/4...20 mA

010 - 1 x 0...10 V, 1 x 0/4...20 mA

011 - 2 x Pt100 resistance thermometer inputs or
2 x resistance inputs up to 400 Ω

5.5. Registers for readout and write

Table 1

The value is placed in two successive 16-bytes registers. These registers include the same data as 32-bit registers from the area 7600.		The value is placed in 32-bit registers.		Symbol	Write (w)/Readout (r)	Range	Description
7200	7600	Identifier	r	-	Device identifier		
					Value		
					0x88 - - h	SM1 Identifier	
					0x - - 00h	Two 0...10 V voltage inputs	
					0x - - 01h	Two 0/4...20 mA current inputs	
					0x - - 02h	One 0...10 V voltage input One 0/4...20 mA current input	
					0x - - 03h	Two Pt100 inputs or two resistance inputs up to 400 Ω	
7202	7601	Rate	W/r	0... 3	Baud rate of the RS-485 interface (bit/s)		
					Value		
					0	2400	
					1	4800	
					2	9600	
					3	19200	
					4	38400	
					5	57600	
					6	115200	
7204	7602	Mode	W/r	0... 7	Kind of transmission through the RS-485 interface		
					Value		
					0	Interface switched off	
					1	ASCII 8N1	
					2	ASCII 7E1	
					3	ASCII 7O1	
					4	RTU 8N2	
					5	RTU 8E1	
					6	RTU 8O1	
					7	RTU 8N1	

7206	7603	Address	W/r	0... 247	Device address
7208	7604	Apply	W/r	0... 1	Acceptation of module transmission parameter changes
					Value
					0 Lack of reaction
					1 Acceptation of changes
7210	7605	Input 1	W/r	0... 1	Switching ON/OFF of the measuring input 1
					Value
					0 Measuring input switched off
					1 Measuring input switched on
					In case of the input off the value 0 is returned
7212	7606	W1 type	W/r	0... 1	Input 1 type
					Range
					0
					0...10 V for SM1-00XXX execution
					0...10 V for SM1-02XXX execution
					0/4...20 mA for SM1-01XXX execution
					0... 1
					0 - Pt100 1 - Resistance < 400 Ω
					Notice! The range change of this parameter depends on the execution code
7214	7607	Cnt W1, 2	W/r	0... 30	Averaging time of the input 1 and 2
					Value
					0
					The measurement is switched off (module does not measure on this input , the value 0 is returned)
					0.1...30 Measuring time in seconds
7216	7608	Ind W1	W/r	0... 1	Individual characteristic of the input 1
					Value
					0 Switched off
					1 Switched on

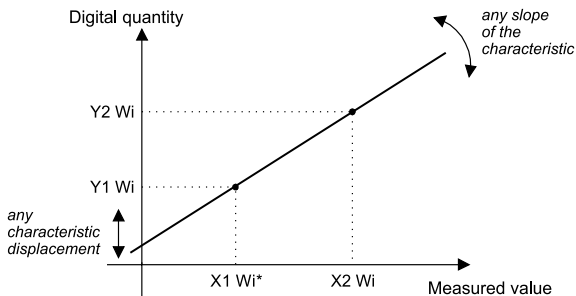
7218	7609	X1 W1	W/r	-99999...99999	Parameters of the individual characteristic of input 1	
7220	7610	Y1 W1	W/r	-99999...99999	<div>On the base of given co-ordinates of two points by the user the module determines (from the system of equations) coefficients a and b of the individual characteristic.</div> <div>$\begin{cases} Y1W1 = a \cdot X1W1 + b \\ Y2W1 = a \cdot X2W1 + b \end{cases}$</div> <div>where: X1 W1 and X2 W1 - measured value Y1 W1 and Y2 W1 - Expected value on the digital output. The graphical presentation of the individual characteristic is presented on the fig. 6. At output signal recalculations, at first the module recalculates the value on the base of the individual characteristic and then, this result is transmitted to the arithmetic function,</div>	
7222	7611	X2 W1	W/r	-99999...99999		
7224	7612	Y2 W1	W/r	-99999...99999		
7226	7613	Input 2	W/r	0... 1	Switching ON/OFF of the measuring input 2	
					Value	
					0	Measuring input switched off
					1	Measuring input switched on
					In case of the input off the value 0 is returned	
7228	7614	Typ W2	W/r	0... 1	Input 2 type	
					Range	
					0	0...10 V for SM1-00XXX execution
						0/4...20 mA for SM1-01XXX execution and SM1-02XXX
					0... 1	0 - Pt100
						1 - Resistance < 400 Ω
					Notice! The range change of this parameter depends on the execution code	
7230	7615	Not occurs				

7232	7616	Ind W2	W/r	0... 1	Individual characteristic of the input 2	
					Value	
					0	off
					1	on
7234	7617	X1 W2	W/r	-99999...99999	Parameters of the individual characteristic of input 2	
7236	7618	Y1 W2	W/r	-99999...99999	The range changes as for: X1 W1, Y1 W1, X2 W1, Y2 W1	
7238	7619	X2 W2	W/r	-99999...99999		
7240	7620	Y2 W2	W/r	-99999...99999		
7242	7621	Not occurs				
7244	7622	Not occurs				
7246	7623	Not occurs				
7248	7624	Not occurs				
7250	7625	Not occurs				
7252	7626	Not occurs				
7254	7627	Not occurs				
7256	7628	Not occurs				
7258	7629	Not occurs				
7260	7630	Not occurs				
7262	7631	Not occurs				
7264	7632	Not occurs				
7266	7633	Not occurs				
7268	7634	Not occurs				
7270	7635	Not occurs				
7272	7636	Not occurs				
7274	7637	A	W/r	0... 12	Arguments of the mathematical function	
7276	7638	B	W/r	0... 12	Value	
7278	7639	C	W/r	0... 12	0	Argument switched off
7280	7640	D	W/r	0... 12	1	Result 1 (input 1) (W1)
					2	Result 2 (input 2) (W2)
					5	Root of the result 1 $\sqrt{W1}$
					6	Root of the result 2 $\sqrt{W2}$
					9	Result 1 squared (W1 ²)
					10	Result 2 squared (W2 ²)

					11	No occurs
					12	No occurs
					Parameters of the mathematical function serves to recalculate the measured input quantity into the output quantity (WF) basing on the function: WF=A<Operator1>B<Operator2>C<Operator3>D When recalculating the input signal, the module recalculates at first the value basing on the individual characteristic and then, this result is transmitted to the arithmetical function. Examples of using mathematical functions are presented in the section „Examples of module programming”.	
7282	7641	Operator1	W/r	0... 3	Operators of the mathematical function	
7284	7642	Operator2	W/r	0... 3	Value	
7286	7643	Operator3	W/r	0... 3	0	Addition „+”
					1	Subtraction „-”
					2	Multiplication „*”
					3	Division „/”
					The calculation of the output value is carried out basing on the assumed operator weight i.e.: At first multiplication and division operations are realised and after addition and subtraction operations. „*” and „/” operators and „+” and „-” operators have the same importance weight. Examples of using mathematical functions are presented in the section „Examples of module programming”.	
7288	7644	WF Operator	W/r	0... 3	Mathematical operations on the result of WF function	
					Value	
					0	Operator switched off
					1	Extraction of roots $\sqrt{\text{WF}}$
					2	Squaring WF^2
					3	Inverse $1/\text{WF}$
					The module at first calculates the function programmed by the user and then, its result can be submitted to further operations described in this point. In the case of the WF operator switching on the final result is situated in the WF register, however the result from before this operation is not accessible.	
7290	7645	Not occurs				

7292	7646	Not occurs			
7294	7647	Not occurs			
7296	7648	Not occurs			
7298	7649	Not occurs			
7300	7650	Not occurs			
7302	7651	Not occurs			
7304	7652	Not occurs			
7306	7653	Not occurs			
7308	7654	Not occurs			
7310	7655	Del min 1	W/r	0... 1	Erasing of the input 1 minimal value
7312	7656	Del max 1	W/r	0... 1	Erasing of the input 1 maximal value
7314	7657	Del min 2	W/r	0... 1	Erasing of the input 2 minimal value
7316	7658	Del max 2	W/r	0... 1	Erasing of the input 2 maximal value
7318	7659	Not occurs			
7320	7660	Not occurs			
7322	7661	Not occurs			
7324	7662	Not occurs			
7326	7663	Del min WF	W/r	0... 1	Erasing of the function result minimal value
7328	7664	Del max WF	W/r	0... 1	Erasing of the function result maximal value
7330	7665	Del min max	W/r	0... 1	Erasing of minimal and maximal value
					Range
					0
					lack of operation
					1
					erasing
					Caution!
					After carrying out the erasing operation the value of this register is zero.
7332	7666	Comp W1	W/r	0... 40	Resistance value of wires connecting the sensor with the module input 1 The register is used only in the execution for the resistance or temperature measurement
7334	7667	Comp W2	W/r	0... 40	Resistance value of wires connecting the sensor with the module input 2 The register is used only in the execution for the resistance or temperature measurement

7236	7668	Not occurs			
7238	7669	Not occurs			
7340	7670	Standard	W/r	0... 1	Restoration of manufacturer's parameters
					Value
					0
					lack of operation
					1
					Write of manufacturer's parameters
Introduction of the value 1 will cause the write of manufacturer's parameters into the module acc. to the table. 2					



* $i = 1... 4$

$X1\ Wi$ value in the module input of systems $\Rightarrow Y1\ W1$ digital value
 $X2\ Wi$ value in the module input of systems $\Rightarrow Y2\ W1$ digital value
 Other points of the characteristic are calculated

Fig. 6. Individual user's characteristic



Caution!

- In the execution for the measurement of resistance or temperature (Pt100) only the two-wire method is accessible. The resistance of the wire connecting the sensor with the module must be introduced from the master device (e.g. PC). For this purpose we propose:
 - switch the module into the resistance measurement mode,

- short-circuit the ends of wires which the sensor is fixed to,
- read out the numeric value which represents the resistance of both wires,
- introduce the read out value into the Comp WX (X = 1... 2) register of the appropriate input.

Each input has a separate compensation register. The described procedure must be carried out for switched on measuring inputs. The resistance can be also measured by any meter (maximal error: 0.4Ω) and introduced into registers.

- In case on user's individual characteristic switched on, the measured result is linearly transformed in accordance with introduced **X** and **Y** parameters. Then, the calculated value is found in the result register.
- In case of mathematical operations switching on, the result in the **WF** register is calculated in accordance with the equation introduced to the module. Sequence of calculations: result recalculation basing on the user's individual characteristic (if it is switched on), calculation of the introduced function, carrying out the operation on the function result.
- The module supervises currently the value of the introduced parameter . In case when the introduced value is beyond the range of changes given in the table 1, the module does not make the parameter write.

Manufacturer' parameters of the SM1 module

Table 2

<i>Symbol</i>	<i>Manufacturer's value</i>
Input 1,2	1 (switched on)
Cnt W1, Cnt W2	1 s
Ind W1, Ind W2	0 (switched off)
X1 W1, X1 W2	0
Y1 W1, Y1 W2	0
X2 W1, X2 W2	0
Y2 W1, Y2 W2	0
A,B,C,D	0 (switched off)
Operator 1,2,3	0 („+")
Operator WF	0 (switched off)
Rate	2 (9600)
Mode	4 (RTU 8N2)
Address	1
Comp W1, Comp W2	0

6. TECHNICAL DATA

INPUTS:

Depending on the execution code for individual channels:

- voltage measurement 0...10 V input resistance > 1 M Ω
- current measurement 0...20 mA input resistance < 10 Ω
- resistance measurement 0... 400 Ω
- Pt100 (- 200... + 850) $^{\circ}\text{C}$

Current flowing through the Pt 100 sensor: < 250 μA

Resistance of leads connecting the

resistance thermometer with the module: max 20 Ω /wire

Pt100 characteristic acc. to EN 60751+A2

OUTPUTS:

– digital

a) RS-485 interface

transmission protocol	MODBUS
ASCII	8N1, 7E1, 7O1
RTU	8N2, 8E1, 8O1, 8N1
baud rate	2400, 4800, 9600, 19200, 38400, 57600, 115200 bauds

b) RS-232 interface

transmission protocol	MODBUS
RTU	8N1
baud rate	9600 bauds
address	1

maximal response time to the query frame: 300 ms.

Basic error $\pm 0.2\%$ of measuring range

Additional error from ambient temperature changes $\pm (0,1\% \text{ of range}/10\text{K})$

Measurement averaging time:

- when one input is switched on min 100 ms (programmable)
 - when two inputs are switched on min 200 ms (programmable)
- the sampling frequency of the input is 5 kHz. Total measurement averaging time is the sum of measurement times of both inputs.

Rated operation conditions:

- supply voltage depending on the execution code
85... 253 V a.c./d.c.
20... 50 V a.c./d.c.
- supply voltage frequency
40... 440 Hz
- ambient temperature
-10...23...55°C
- storage temperature
-25...+85°C
- relative humidity
< 95% (condensation inadmissible)
- preheating time
10 min

Sustained overload:

- resistance thermometers
1%
- measurement of voltage, current and resistance
10%

Short-duration overload (3 s):

- voltage input
10 Un
- current input
10 In

Ensured protection grade acc. to EN 60529:

- through the housing
IP 40
- electrical connections
IP 20

Dimensions 22.5 × 120 × 100 mm

Weight < 0.3 kg

Fixing on a 35 mm rail

Power consumption < 4 VA

Resistance against decays acc. to EN 61000-6-2

Electromagnetic compatibility:

- immunity acc. to EN 61000-6-2
- emission acc. to EN 61000-6-4
- additional error from electromagnetic hazard < 0.2%

Safety requirements acc. to EN 61010-1 standard:

- installation category III
- pollution grade 2
- phase-to-earth working voltage:
 - supply 300 V
 - input 50 V
 - output 50 V



7. BEFORE A FAILURE WILL BE DECLARED

In case of incorrect symptoms please to acquaint with the table below.

SYMPTOMS	PROCEDURE	REMARKS
1. The module diode is not illuminated.	Check the connection of the network cable	
2. The module does not communicate with the device master via the RS-232 port. Lack of transmission signalling on RxD and TxD diodes.	Check if the wire is connected to the appropriate module socket. Check if the device master is set on 9600 baud rate, 8N1 mode and address 1.	(RS-232 has constant transmission parameters)
3. The module does not communicate with the device master via the RS-485 port. Lack of transmission signalling on RxD and TxD diodes.	Check if the wire is connected to the appropriate module terminal. Check if the device master is set on the same transmission parameters as the module (baud rate, mode, address). In case of necessity to change transmission parameters when we cannot communicate through RS-485 one can use the RS-232 port which has constant transmission parameters (in case of further problems, see the section 2). After changing the RS-485 parameters into the required one, one can switch over on RS-485 port.	
4. The module returns the value 0 on the given input.	Check if the input which the value 0 is returned on, is not switched out and if the averaging time is > 0.1 s. Check if the user's individual characteristic with zero parameters is not switched on.	
5. The result in WF register (function result) is inconsistent with our expectations,	Check the correctness of the introduced formula. Check if the operation sequence is correct. The operator weight is essential - at first, multiplication and division are carried out and next, addition and subtraction. Perhaps it is sufficient to reorder results in the formula. See programming examples in the section 8	
6. In result registers the IE20 value is min or max (e.g. in Lumel Energy "****")	Check the correctness of the input signal connection. The IE20 value is set when the measured signal is beyond the measuring range. The recorded IE20 value in max and min registers remains till the time of its erasing by the user.	
7. The value of the measured resistance or temperature is overstated.	Check if correct values of the wires' resistance have been introduced to Comp W1, Comp W2, Comp W3 and Comp W4 registers. In case of necessity, one must introduce this value. See the user's manual under the description of the Status 2.	Concerns only the module for resistance measurement or for co-operation with a Pt100 sensor.

8. EXAMPLES OF SM1 MODULE PROGRAMMING

Example 1: Switching appropriate measuring inputs and averaging time on
Module operation with input 2. The second input has to average with a 100 ms time (0.1s).

One must program the parameter:

- Input 1 = 0
- Input 2 = 1
- Cnt W1, 2 = 0.1

The module will carry out the measurement on the input 2. In the register corresponding to the second input, the result will be refreshed every 100 ms.

Example 2: Programming the user's individual characteristic

One must program the module in such a way that it measures the water level in a tank with characteristic: 0 mA = 0 m., 20 mA = 3.6 m. in the input 1, whereas on the input 2, the temperature with characteristic: 4 mA = 0°C, 20 mA = 50 °C

One must program the parameter:

- Ind W1 = 1
- X1 W1 = 0
- Y1 W1 = 0
- X2 W1 = 20
- Y2 W1 = 3.6
- Ind W2 = 1
- X1 W2 = 4
- Y1 W2 = 0
- X2 W2 = 20
- Y2 W2 = 50

Example 3: Programming mathematical function

One must program the module in such a way that it measures the current on the input 1, the voltage on the input 2, and calculate the apparent power of the variable signal. The module is working with transducers of variable signal into a standard signal, e.g. P11Z transducer. The measurement of max current = 1200 A (0 \Rightarrow 4 mA; 1200 A \Rightarrow 20 mA), measurement of max voltage = 400 V (0 V \Rightarrow 0 V; 400 V \Rightarrow 10 V).

One must program the parameter:

- Ind W1 = 1
- X1 W1 = 4
- Y1 W1 = 0

- X2 W1 = 20
- Y2 W1 = 1200
- Ind W2 = 1
- X1 W2 = 0
- Y1 W2 = 0
- X2 W2 = 10
- Y2 W2 = 400

one must carry out the following equation: $S = U \cdot I$

- A = 1
- B = 2
- Operator 1 = 2

The apparent power 0...480 000 VA will be calculated in the WF register, whereas the 0...1200 A current in the result register 1, and the 0...400 V voltage in the result register 2.

9. ORDERING CODES

SM1 Module		XX	X	X
Input signal*:				
2 voltage inputs	0...10 V			00
2 current inputs	0/4...20 mA.....			01
1 voltage input + 1 current input	0...10V + 0/4...20 mA.....			02
2 resistance or Pt100 inputs	Pt100 or resistance < 400 Ω			03
on order**			XX
Supply:				
85... 253 V a.c./d.c.....				1
20... 50 V a.c./d.c.....				2
on order **				X
Acceptance tests:				
without a quality inspection certificate				8
with a quality inspection certificate				7
acc. customer's agreement**				X

* Possible optional combination of inputs .

** Code numbers must be agreed with the manufacturer.

EXAMPLE OF ORDER

When ordering, please respect successive code numbers.

Code: **SM1 01 1 8** means:

- SM1** - 2-channel module of analogue inputs,
- 01** - module with 2 current inputs 0/4...20 mA,
- 1** - supply voltage: 85...253 V a.c./d.c.
- 8** - without an extra quality inspection certificate.

10. MAINTENANCE AND WARRANTY

The SM1 module does not require any periodical maintenance.

In case of some incorrect operations:

1. After the dispatch date and within the period stated in the warranty card

One should return the instrument to the Manufacturer's Quality Inspection Dept. If the module has been used in compliance with the instructions, we warrants to repair it free of charge. The disassembling of the housing causes the cancellation of the granted warranty.

2. After the warranty period:

One should send the instrument to repair it in an authorized service workshop. Spare parts are available for the period of five years from the date of purchase.

Our policy is one of continuous improvement and we reserve the right to make changes in design and specifications of any products as engineering advances or necessity requires and revise the above specifications without notice.

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