Fault annunciator systems
Interface description

➔ Interface description Modbus RTU/TCP for BSM, USM and WAP

08.04.2021

➔ **Operating manual**

MSM-SMODB-BA-UK-002

Table of content

1 Validity

This description is valid for the Modbus interface of the following devices

BSM-P	from software version 3.5.0
USM	from software version 3.5.0
WAP	from software version 3.5.0

2 General notes

2.1 Additional instructions

Note!

This manual provides the safe and efficient use with the protocol interface of the annunciator series USM and WAP-K (in the following called “fault annunciator” or “device”). The manual is part of the device and must always be stored accessible for the personnel in direct proximity of the device.

The personnel is supposed to thoroughly read and fully understand this manual prior to starting any works. The major condition for secure handling is to obey to all security and usage procedures described in this manual.
Furthermore the local prevention advices and general security preventions at the installation site are obligatory.

The illustrations included in this manual serve for essential comprehension and are subject to modifications matching the application.

2.2 Usage

This manual is a prerequisite for secure mounting and safe operation of the product and must be read and understood before mounting.

2.3 Target group

This manual was written for qualified personnel which – based on their specific education and knowledge and experience as well as their knowledge of the relevant norms and regulations – are subject to deal with electrical sites and are able to recognize and prevent possible hazards.

The qualified personnel must be especially trained for the working environment and need to be familiar with the norms and regulations.

2.4 Symbol definition

Security advice

Security advices are indicated with symbols in this manual. The security advices are expressed through signal words that characterize the extent of the hazard.

Note!
This symbol warns of a situation which can lead to malfunction or dangerous situations if not taken into account.

ENVIRONMENTAL PROTECTION!
This combination of symbol and signal word warns of possible hazards for the environment.

Important passage

This symbol accentuates especially important passages.

Tips and recommendations

This symbol accentuates useful tips and recommendations for an efficient and failure-free operation.

Cross reference

This symbol refers to figures and other passages in this document or to further reading.

Further markings

To accentuate operation instructions, results, listings, cross references and other elements, the following markings are used in this manual:

Marking	Description
	Step-by-step operation instructions
	Results of operation steps
	Cross reference to sections of this manual and to further applicable documents
	Listings without fixed sequence
„Display“	Control elements (e.g. buttons, switches), Indication elements (e.g. signal lamps) Display elements (e.g. push buttons, assignment of function buttons)

2.5 Safety instructions

2.5.1 Appropriate use

The interface of the fault annunciators is intended for use according to the applications described in this manual only, it may only be used according to the conditions as described in the section “Technical Data”. Every use that exceeds the appropriate use or unauthorized use is considered as misuse.

WARNING!
Hazard of incorrect use!
Incorrect use of the annunciator can lead to hazardous situations.

- Do never use the annunciator in EX-areas.
- Do never use the annunciator within the range of irradiation sensitive devices without considering the special precautions therefor.
- The annunciators must never be opened or improperly modified.

2.5.2 Storage of the manual

The instructions must be deposited within easy reach of the device and be accessible to personnel.

2.6 Customer service

For further technical information please contact our customer service:

Address	Elektra Elektronik GmbH & Co Störcontroller KG Hummelbühl 7-7/1 71522 Backnang
Telephone	+ 49 (0) 7191/182-0
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Internet	www.ees-online.de

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3 Introduction

This documentation comprises the description of the Modbus-RTU and -TCP interface of the annunciator series BSM, USM and WAP. For information on the basic characteristics of the annunciators and the parameterisation of the annunciator functions, please refer to the separate documentation of the devices. In this manual only the interface and its parameterisation are explained.

This manual will only cover the possible settings of the annunciator will be explained. For detailed information about the Modbus protocol please see the normative specifications.

For communication with superior or inferior third party systems in the control or process level, the annunciator provides one or two interface cards. Either via serial or through one of the Ethernet interfaces (the respective interface can be chosen freely).

Depending on the device, the Modbus interface is implemented as follows:

- BSM-P - Protocol Modbus-RTU auf RS232 / RS485 (optional)
- USM, WAP - Modbus-TCP via interface card 1
  Modbus-TCP via optional interface card 2
  Modbus-RTU on RS232 / RS485 via optional interface card 2

The device always operates as a Modbus slave (passive Modbus) with a Modbus address between 1 and 255. If Modbus-TCP is used, the IP address of the communication partner (Modbus master) must be set in the configuration. The device can be connected by either Modbus-RTU or possibly –TCP. The usage of both interfaces at the same time is not possible.

Data is accessible via Modbus-registers or –coils. The assignment of device data to Modbus registers and coils is described in the following chapters.

This documentation describes all addresses of coils and registers as PLC-addresses (base 1).

3.1 Cascading of several fault annunciators

A cascaded fault alarm system can be formed from a WAP, USM or BSM-P and up to 3 BSM-C, which has common message processing (message sequence, formation of collective messages and horn control). The Modbus interface of the master device allows access to the messages and commands of all fault detectors of the cascaded fault alarm system.

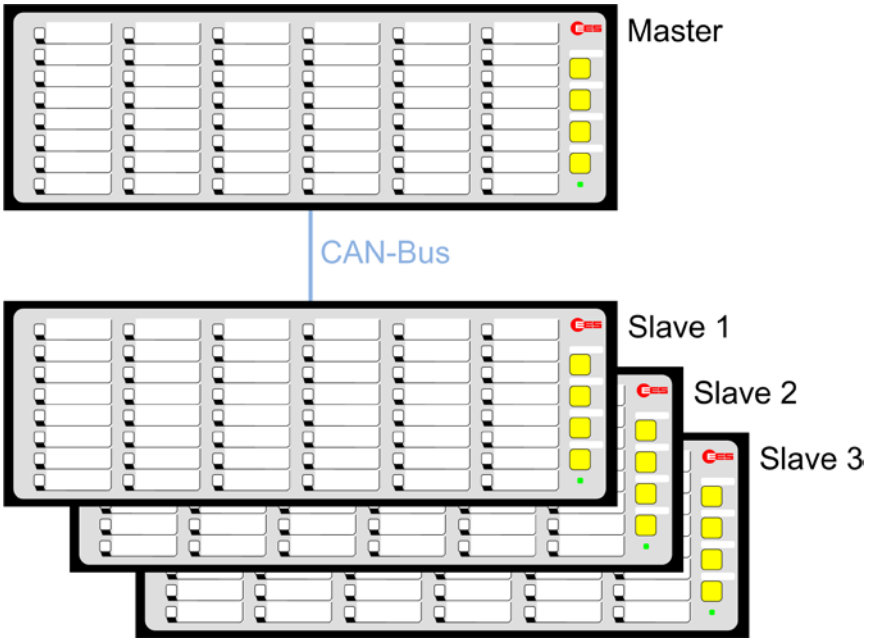

Fig 3.1: General design of a cascaded fault annunciator system

→ Further information about setting up a cascaded system can be found in the separate documentations for BSM, USM and WAP.

3.2 Available Modbus commands

According to the data type the following Modbus commands can be used:

Code	Name	Remark
01	Read Coil Status	Reading of several bit variables (coils)
02	Read Input Status	Reading of several bit variables (inputs)
03	Read Holding Registers	Reading of several word variables (inputs / input registers)
04	Read Input Registers	Reading of several word variables (inputs / input registers)
05	Write Single Coil	Writing of one bit variable (output / coil)
06	Write Single Holding Register	Writing of one word variable (output / register)
15	Write Multiple Coils	Writing of several bit variables (outputs / coils)
16	Write Multiple Registers	Writing of several word variables (outputs / registers)

Table SM-1: Available Modbus commands

It is important that the data is accessed with the function code defined for the specific object. Otherwise data can be misinterpreted.

4 Data structure

This chapter describes the data objects of the fault annunciator and their assignment to the Modbus registers and coils. There are objects which exist for every device in a cascade (master and slaves 1 … 3) and there are objects that are defined once for the complete system (which are assigned to the master-device).

- Data objects of master unit
- Data objects of slave unit 1 (only available in a cascade)
- Data objects of slave unit 2 (only available in a cascade)
- Data objects of slave unit 3 (only available in a cascade)

4.1 Reports

The following sections describe reports generated by the fault annunciator which are readable via Modbus.

4.1.1 Binary Inputs

For every input of the fault annunciator (channel) the following data objects exist:

Input undelayed	- Current state of the input of the reporting channel (a reporting delay is not considered – inputparallel)
Input delayed	- State of the input considering the delay (inputparallel delayed)
Alarm unacknowledged	- Alarm is recorded, the input can be still present on the input or is already gone but it is unacknowledged (recorded alarm)
Alarm	- Alarm is active and is recorded (output parallel) With 2 frequency reporting - not reset (recorded alarm acknowledged)
Status register	- Status of the alarm of the input

Byte	Word	Meaning	
Low Byte	Bit 1	Status of report channel	Input undelayed
	Bit 2		Input delayed
	Bit 3		Alarm unacknowledged
	Bit 4		Alarm
	Bit 5		Unused
	Bit 6		Unused
	Bit 7		Unused
	Bit 8		Unused
High Byte	Bit 9	Unused	
	Bit 10		
	Bit 11		
	Bit 12		
	Bit 13		
	Bit 14		
	Bit 15		
	Bit 16		

Table 4.1: Structure of the status registers for one input

Device	Channel	Status register	Input undelayed	Input delayed	Alarm unacknowledged	Alarm
		Register 16 Bit Word	Coil Single Bit	Coil Single Bit	Coil Single Bit	Coil Single Bit
Master	1	1	1	401	801	1201
	2	2	1	402	802	1202
	3	3	2	403	803	1203
	...					
	46	46	46	446	846	1246
	47	47	47	447	847	1247
	48	48	48	448	848	1248
Slave 1	1	49	49	449	849	1249
	2	50	50	450	850	1250
	3	51	51	451	851	1251
	...					
	46	94	94	494	894	1294
	47	95	95	495	895	1295
	48	96	96	496	896	1296
Slave 2	1	97	97	497	897	1297
	2	98	98	498	898	1298
	3	99	99	499	899	1299
	...					
	46	142	142	542	942	1342
	47	143	143	543	943	1343
	48	144	144	544	944	1344
Slave 3	1	145	145	545	945	1345
	2	146	146	546	946	1346
	3	147	147	547	947	1347
	...					
	46	190	190	590	990	1390
	47	191	191	591	991	1391
	48	192	192	592	992	1392

Table 4.2: Assignment of status registers and inputs

4.1.2 Analog Inputs

The fault indicators can be equipped with a maximum of 5 analog input cards, depending on the type of device. Each input card has 4 analog inputs. The presentation of the values in the Modbus register is a signed 16bit value (-32768 ... 32767). The relationship between register contents and analog value is specified by these two formulas:

$$Voltage\ [V] = \frac{\text{Content of the register}}{3276{,}7} \qquad Amperage\ [A] = \frac{\text{Content of the register}}{1638350}$$

Device	Input	Measured value	Quality		Measuring mode	
		Register 16 Bit Word	Register 16 Bit Word	Coil Single bit	Register 16 Bit Word	Coil Single bit
Master	1	5001	5201	5201	5401	5401
	2	5002	5201	5201	5401	5401
	3	5003	5202	5202	5402	5402
	...					
	18	5018	5218	5218	5418	5418
	19	5019	5219	5219	5419	5419
	20	5020	5220	5220	5420	5420
Slave 1	1	5021	5221	5221	5421	5421
	2	5022	5222	5222	5422	5422
	3	5023	5223	5223	5423	5423
	...					
	18	5038	5238	5238	5438	5438
	19	5039	5239	5239	5439	5439
	20	5040	5240	5240	5440	5440
Slave 2	1	5041	5241	5241	5441	5441
	2	5042	5242	5242	5442	5442
	3	5043	5243	5243	5443	5443
	...					
	18	5058	5258	5258	5458	5458
	19	5059	5259	5259	5459	5459
	20	5060	5260	5260	5460	5460
Slave 3	1	5061	5261	5261	5461	5461
	2	5062	5262	5262	5462	5462
	3	5063	5263	5263	5463	5463
	...					
	18	5078	5278	5278	5478	5478
	19	5079	5279	5279	5479	5479
	20	5080	5280	5280	5480	5480

Table 4.3: Assignment of measured value, quality and measuring mode of analog inputs

In addition to the measured value, quality and measuring mode of the analog inputs can also be transmitted.

Quality

The status of the analog values is displayed in accordance with IEC 61850-8-1:2004 Chapter 8.2 (IEC61850 Quality flags). The following states are used:

Quality	Meaning	Darstellung als	
		Register	Coil
Good	Analog value valid	0	0
Invalid + Out of Range	Value outside the measuring range	80	1
Invalid + Failure	Analog value invalid	66	1
Invalid + Bad Reference	No analog value available at the specified register address	72	1

Table 4.4: States of the register or Coils „Quality“

If the current input has been parameterized as 4 ... 20 mA input, the quality "Invalid + Out of Range" is generated in case of a wire break.

Measuring mode

In the register or coil "Measuring mode", this is displayed as follows:

0 – Measurement of voltage
1 – Measurement of current

4.1.3 Collective reports

The collective reports of all units in a cascade are combined.

Collective report	Register 16 Bit Word	Coil Single Bit
1	2001	2001
2	2002	2002
3	2003	2003

Table 4.5: Assignment of collective reports

Register as well as coils can only have the values „0“ or „1“

4.1.4 Horn signaling

The horn signaling of all units in a cascade is combined.

Horn signaling	Register 16 Bit Word	Coil Single Bit
1	2004	2004

Table 4.6: Assignment of horn signaling

Register as well as coil can only take the values „0“ or „1“,

4.1.5 Button pushed

If a button is pushed, a register or coil is set for 250ms to “1”. If the button is pushed longer than 250ms, register or coil is set to “1” only for 250ms. The Modbus master needs to use an appropriate polling rate.

Device	Button	Register 16 Bit Word	Coil Single Bit
Master	1	2101	2101
	2	2102	2102
	3	2103	2103
	4	2104	2104
	5*	2105*	2105*
	6*	2106*	2106*
Slave 1	1	2109	2109
	2	2110	2110
	3	2111	2111
	4	2112	2112
	5*	2113*	2113*
	6*	2114*	2114*
Slave 2	1	2117	2117
	2	2118	2118
	3	2119	2119
	4	2120	2120
	5*	2121*	2121*
	6*	2122*	2122*
Slave 3	1	2125	2125
	2	2126	2126
	3	2127	2127
	4	2128	2128
	5*	2129*	2129*
	6*	2130*	2130*

Table 4.7: Assignment of buttons pushed

* Buttons 5 and 6 are only present at the WAP and can therefore only be evaluated there.

4.1.6 Function inputs

As long as a voltage is detected at a function input, the appropriate register and coil are set to “1”.

Device	Function input	Register 16 Bit Word	Coil Single Bit
Master	1	2201	2201
	2	2202	2202
Slave 1	1	2213	2213
	2	2214	2214
Slave 2	1	2225	2225
	2	2226	2226
Slave 3	1	2237	2237
	2	2238	2238

Table 4.8: Assignment of function inputs

4.1.7 Relay states

In these registers and coils, the state of relays is presented. “1“ means the relay is powered and “0” means that the relay is de-energized. Function relays are present in all units. 1:1-relays are optional depending on the according equipment removal.

1:1 relays can only be controlled via Modbus if the option „interface“ is activated in the configuration menu (parameter/devices/…/1:1-relays). Otherwise the relay is controlled by the signal source that was selected over the column “Inputs”.

Device	Relays	Register 16 Bit Word	Coil Single Bit
Master	Function relay 1	3001	3001
	Function relay 2	3002	3002
	Function relay 3	3003	3003
	Function relay 4	3004	3004
	1:1 Relay 1	3009	3009
	1:1 Relay 2	3010	3010
	1:1 Relay 3	3011	3011
	...		
	1:1 Relay 38	3046	3046
	1:1 Relay 39	3047	3047
	1:1 Relay 40	3048	3048
Slave 1	Function relay 1	3049	3049
	Function relay 2	3050	3050
	Function relay 3	3051	3051
	Function relay 4	3052	3052
	1:1 Relay 1	3057	3057
	1:1 Relay 2	3058	3058
	1:1 Relay 3	3059	3059
	...		
	1:1 Relay 38	3094	3094
	1:1 Relay 39	3095	3095
	1:1 Relay 40	3096	3096
Slave 2	Function relay 1	3097	3097
	Function relay 2	3098	3098
	Function relay 3	3099	3099
	Function relay 4	3100	3100
	1:1 Relay 1	3105	3105
	1:1 Relay 2	3106	3106
	1:1 Relay 3	3107	3107
	...		
	1:1 Relay 38	3142	3142
	1:1 Relay 39	3143	3143
	1:1 Relay 40	3144	3144
Slave 3	Function relay 1	3145	3145
	Function relay 2	3146	3146
	Function relay 3	3147	3147
	Function relay 4	3148	3148
	1:1 Relay 1	3153	3153
	1:1 Relay 2	3154	3154
	1:1 Relay 3	3155	3155
	...		
	1:1 Relay 38	3190	3190
	1:1 Relay 39	3191	3191
	1:1 Relay 40	3192	3192

Table 4.9: Assignment of relays

4.1.8 Device errors

If the device self-monitoring detects an error, the error is signaled by blink codes through the operating status LED. The blink code is a sequence of long and short pulses.

The Modbus interface provides one object for the group error (any error has occurred) and one object for each individual error. In the objects, the states "1" and "0" indicate the presence or absence of the respective error.

Example:

Error 68 (two digit hexadecimal) - No connection to the NTP Server
Blink sequence of status LED - long, long, long, long, long, long, short, short, short, short, short, short, short, short, pause

The following registers or coils are set to "1":

Register / Coil 2401 - Collective error
Register / Coil 2468 - Error 68

Register or Coil address= 2400 + error number (decimal)

Error number	Register 16 Bit Word	Coil Single bit
1 (collective error)	2401	2401
2	2402	2402
3	2403	2403
4	2404	2404
...		
68	2468	2468
...		
98	2498	2498
99	2499	2499

Table 4.10: Assignment of device errors

→ A description of device errors is given within the operating manuals of the respective fault annunciator.

In a cascaded system, only the errors of the master device can be read.

4.1.9 Device events

The fault annunciator can be set into different states by events caused by fault reports, button activations or changes at the function inputs. If one of the events occurs the according register or coils are set for 250ms to “1” (the time is independent of the length of the event). A Modbus-master has to set an appropriate polling rate to detect all events.

The functions “lamp test”, “mute” and “unmanned” have an exceptional handling and are reported as states “1” or “0” if the function is active or not.

In a cascaded system only the state of the master device is signaled.

Event	Register 16 Bit Word	Coil Single Bit
Acknowledgement group 1	2301	2301
Acknowledgement group 2	2302	2302
Acknowledgement group 3	2303	2303
Reset group 1	2304	2304
Reset group 2	2305	2305
Reset group 3	2306	2306
Acknowledgement horn	2307	2307
Unused	2308	2308
Lamp test	2309	2309
Function test	2310	2310
Mute	2311	2311
Unmanned	2312	2312
Acknowledgement of ungrouped reports	2313	2313
Reset of ungrouped reports	2314	2314

Table 4.11: Assignment of events

→ The meaning of the functions and events can be found within the operating manuals of the fault annunciator.

The availability of functions depends on the type of device. Please refer to the operating manual of the respective fault annunciator.

4.2 Commands

Commands can control inputs to the report sequence, relays and functions.

4.2.1 Controlling inputs

The following commands can set or reset inputs by “1“ or “0“.

Device	Input	Register 16 Bit Word	Coil Single Bit
Master	1	10001	10001
	2	10002	10002
	3	10003	10003
	46	10046	10046
	47	10047	10047
	48	10048	10048
Slave 1	1	10049	10049
	2	10050	10050
	3	10051	10051
	46	10094	10094
	47	10095	10095
	48	10096	10096
Slave 2	1	10097	10097
	2	10098	10098
	3	10099	10099
	46	10142	10142
	47	10143	10143
	48	10144	10144
Slave 3	1	10145	10145
	2	10146	10146
	3	10147	10147
	46	10190	10190
	47	10191	10191
	48	10192	10192

Table 4.11: Assignment of inputs

Inputs can only be controlled via Modbus if the input source is set to „interface” in the menu “parameter/devices/…“.

4.2.2 Acknowledgement commands

Acknowledgement commands can, in addition to buttons, trigger some functions. A detailed description about the commands can be found in the operating manual of the fault annunciator. In cascaded systems acknowledgement commands can only be sent to the master.

Function	Register 16 Bit Word	Coil Single Bit
Acknowledgement group 1	12301	12301
Acknowledgement group 2	12302	12302
Acknowledgement group 3	12303	12303
Reset group 1	12304	12304
Reset group 2	12305	12305
Reset group 3	12306	12306
Acknowledgement horn	12307	12307
Unused	12308	12308
Lamp test	12309	12309
Function test	12310	12310
Mute	12311	12311
Unmanned	12312	12312
Acknowledgement of ungrouped reports	12313	12313
Reset of ungrouped reports	12314	12314

Table 4.13: Assignment of acknowledgement commands

The availability of the listed functions depends on the respective device. Please take of note the operating instructions of the fault annunciator.

4.2.3 Controlling relays (only USM and WAP)

With these registers or coils, relays of the USM and WAP series can be controlled. A “1“ means that the relay is powered, a “0” means that the relay is de-energized. Function relays are present in all devices. 1:1-relays are optional and only available depending on the optional device removal.

Device	Relay	Register 16 Bit Word	Coil Single Bit
Master	function relay 1	13001	13001
	function relay 2	13002	13002
	function relay 3	13003	13003
	1:1 relay 1	13009	13009
	1:1 relay 2	13010	13010
	1:1 relay 3	13011	13011
	...		
	1:1 relay 38	13046	13046
	1:1 relay 39	13047	13047
	1:1 relay 40	13048	13048
Slave 1	function relay 1	13049	13049
	function relay 2	13050	13050
	function relay 3	13051	13051
	1:1 relay 1	13057	13057
	1:1 relay 2	13058	13058
	1:1 relay 3	13059	13059
	...		
	1:1 relay 38	13094	13094
	1:1 relay 39	13095	13095
	1:1 relay 40	13096	13096
Slave 2	function relay 1	13097	13097
	function relay 2	13098	13098
	function relay 3	13099	13099
	1:1 relay 1	13105	13105
	1:1 relay 2	13106	13106
	1:1 relay 3	13107	13107
	...		
	1:1 relay 38	13142	13142
	1:1 relay 39	13143	13143
	1:1 relay 40	13144	13144
Slave 3	function relay 1	13145	13145
	function relay 2	13146	13146
	function relay 3	13147	13147
	1:1 relay 1	13153	13153
	1:1 relay 2	13154	13154
	1:1 relay 3	13155	13155
	...		
	1:1 relay 38	3190	3190
	1:1 relay 39	3191	3191
	1:1 relay 40	3192	3192

Table 4.14: Assignment of relay commands

Function relay 4 is defined as a live contact for the device self-monitoring. Therefore it cannot be controlled via Modbus.

4.3 System information

It is possible to read information about device configuration or software version via Modbus.

4.3.1 Device configuration

Device	Information	Register (16 Bit Word)
Master	Number of inputs	4051
	Number of 1:1 relays	4052
Slave 1	Number of inputs	4053
	Number of 1:1 relays	4054
Slave 2	Number of inputs	4055
	Number of 1:1 relays	4056
Slave 3	Number of inputs	4057
	Number of 1:1 relays	4058
Master	Number of analog inputs*	4071
Slave 1	Number of analog inputs*	4072
Slave 2	Number of analog inputs*	4073
Slave 3	Number of analog inputs*	4074

Table 4.15: Device configuration

*only for USM

4.3.2 Software versions

Version	Description	Register (16 Bit Word)
Firmware	digit 1	4001
	digit 2	4002
	digit 3	4003
	digit 4	4004
	digit 5	4005
	digit 6	4006
	digit 7	4007
	digit 8	4008
	Major version	4009
	Revision	4010
Packet	Major version	4013
	Minor version	4014
	Revision	4015
	Build Number	4016
Modbus	Major version	4021
	Minor version	4022
	Revision	4023
	Build Number	4024

Table 4.16: Software versions

5. Parameterisation

Parameters of the Modbus are set in two menus. Within the menu „Parameter / Protocol / Modbus" it can be defined whether Modbus is used as Modbus-TCP, Modbus-RTU or if the interface is deactivated.

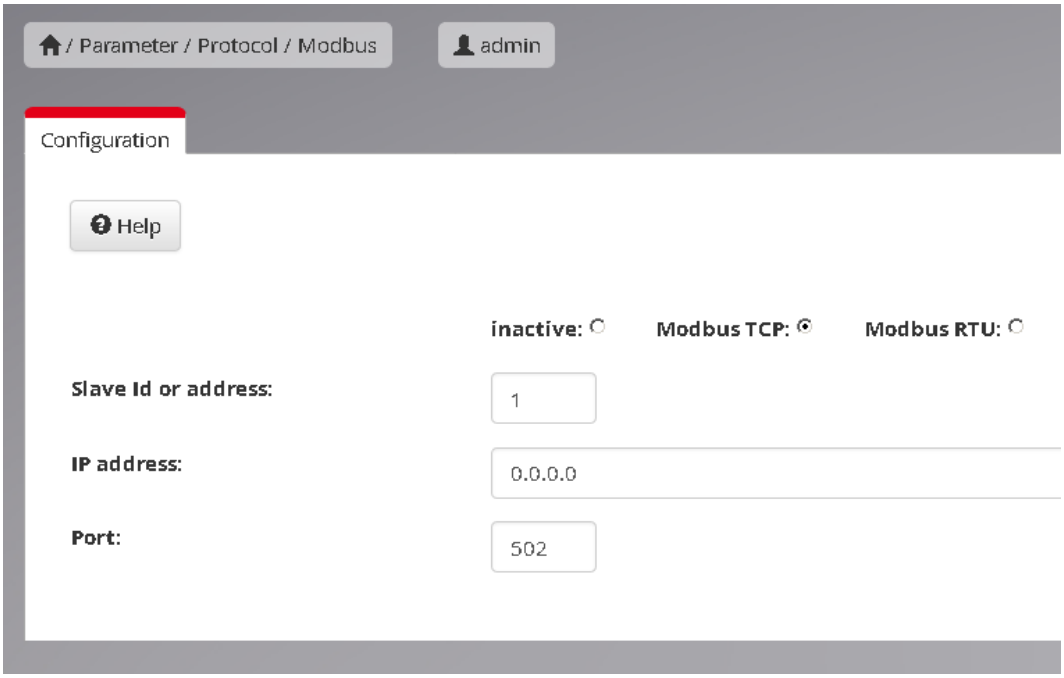

Image 5.1: Menu Modbus

For a TCP or RTU connection, the following parameters need to be set:

Parameter	Range of values	Standard setting
Slave Address	0, 1…255 "0" can only be set via Modbus-TCP. In that case, all commands and requests from the master are answered without checking the own slave address.	1
IP-Address (only for TCP)	IP-address of the Modbus master. In the standard setting 0.0.0.0, the device answers to all master telegrams without checking the IP address.	0.0.0.0
Port (only for TCP)	Port number for the TCP connection (the standard port for Modbus is 502)	502

Table 5.1: Modbus settings

If Modbus-RTU is used the serial interface needs to be configured. This can be done in the menu „Parameter / Devices / System“ in the tab „Serial”.

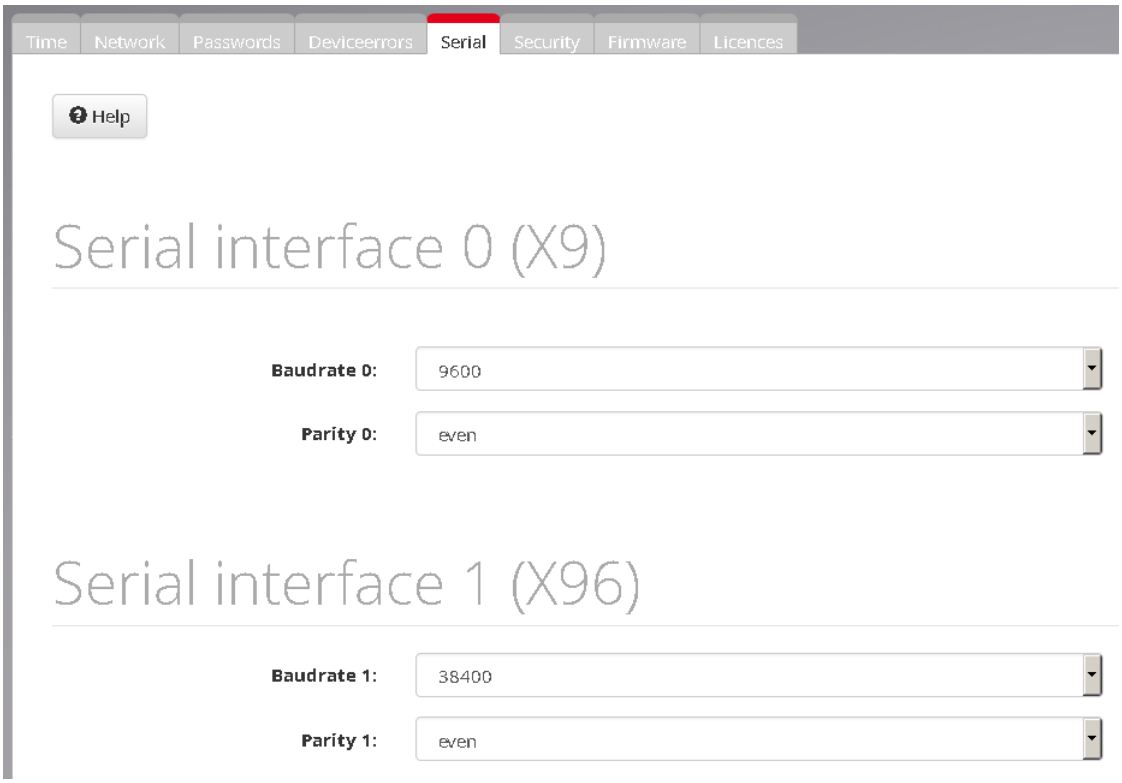

Image 5.2: Menu Serial

For the Modbus-RTU interface, the serial interface is used, depending on the device type up to 2 serial interfaces are available (only for USM), else one provided as default. The following parameters need to be set:

Parameter	Range of values	Standard setting
Baud rate	110, 300, 600, 1200, 2400, 4800, 9600, 38400, 57600 or 115200	38400
Parity	non, even or odd	even
Transceiver	The interface can be switched between RS232 and RS485.	RS485

Table 5.2: Settings for Modbus-RTU