

SMI2-M.02

RS485 Multi-Color Display

User guide

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1 Introduction

1.1 Terms and abbreviations

– **akYtec Tool Pro** – configuration software
– **Modbus** – application layer messaging protocol for client/server communication between devices connected on different types of buses or networks, originally published by Modicon (now Schneider Electric), currently supported by an independent organization Modbus-IDA (*www.modbus.org*)
– **TTL** – transistor–transistor logic

1.2 Symbols and key words

DANGER
WARNING indicates a potentially dangerous situation that could result in death or serious injuries.

CAUTION
CAUTION indicates a potentially dangerous situation that could result in minor injuries.

NOTICE
NOTICE indicates a potentially dangerous situation that could result in damage to property.

NOTE
NOTE indicates helpful tips and recommendations, as well as information for efficient and trouble-free operation.

1.3 Intended use

The device has been designed and built solely for the intended use described here, and may only be used accordingly. The technical specifications contained in this document must be observed.
The device may be operated only in a properly installed condition.

Improper use

Any other use is considered improper. Especially to note:
– The device may not be used for medical applications.
– The device may not be used in an explosive environment.
– The device may not be used in an atmosphere in which there are chemically active substances.

1.4 Limitation of liability

Our company does not bear any responsibility with respect to breakdowns or damages caused by using the product in a manner other than described in the manual or in violation of the current regulations and technical standards.

1.5 Safety

DANGER
Ensure the mains voltage matches the voltage marked on the nameplate. Ensure the device is provided with its own power supply line and electric fuse.

DANGER
The device terminals may be under a dangerous voltage. De-energize the device before working on it. Switch on the power supply only after completing all work on the device.

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NOTICE
Supply voltage may not exceed 48 V DC. Higher voltage can damage the device.
If the supply voltage is lower than 10 V DC, the device cannot operate properly but will not be damaged.

NOTICE
If the device is brought from a cold to a warm environment, condensation may form inside the device. To avoid damage to the device, keep the device in the warm environment for at least 1 hour before powering on.

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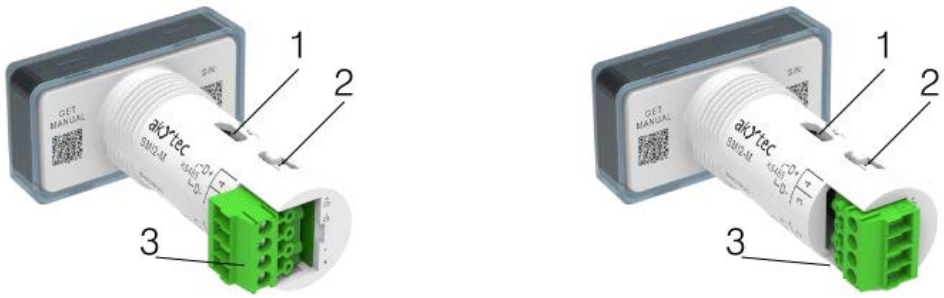
2 Overview

SMI2-M.02 is a universally applicable LED display that receives data from a network over RS485 interface using Modbus RTU / ASCII protocols and can be operated in slave, master or spy mode.
For details on Modbus working see *Appendix B.*
For Modbus protocol specifications see *Modbus specifications*.
The device can be configured with the configuration software *akYtec Tool Pro* (free) over USB. The software is available for download on www.akytec.de.

2.1 Basic features

– Slave mode: receiving data from Master
– Master mode: querying data from Slave
– Spy mode: listening-in to data requested by the Master from another Slave
– Displaying received data according to display settings
– Extended display control
– Display safe state (see *Section 4.3.1*)
– Error indication if no master activity or variable cannot be displayed
– Configuration with the *akYtec Tool Pro* software over USB interface
– Modification of configuration parameters over Modbus network

2.2 Design



1. Micro-USB programming interface
2. Service button
3. Two plug positions of terminal block

Fig. 2.1 External design

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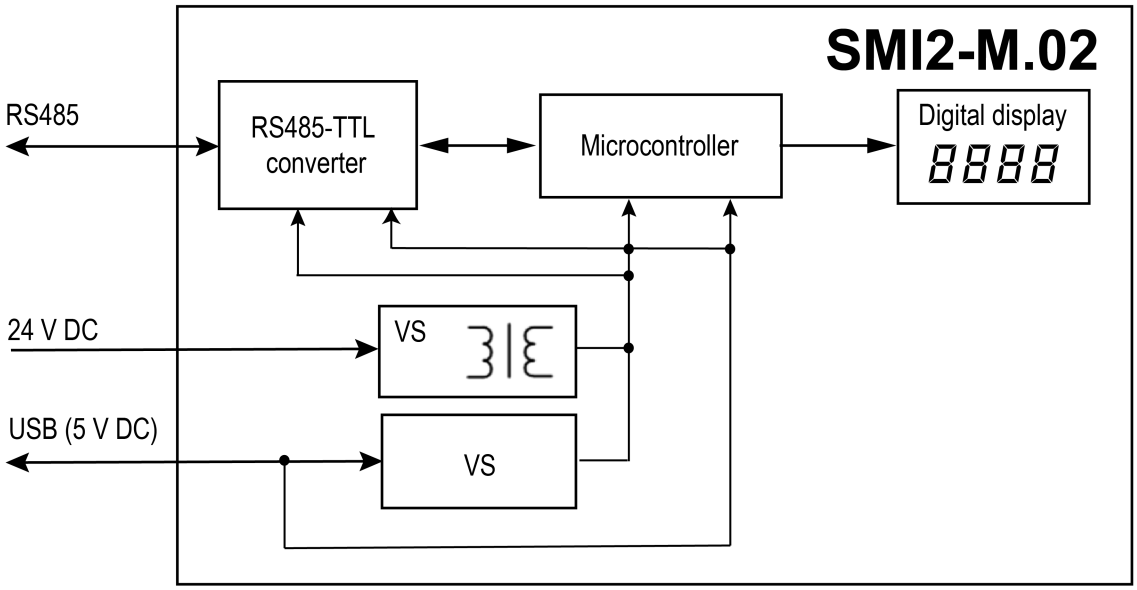


Fig. 2.2 Hardware block diagram

RS485-TTL converter - Converts RS485 network signals into TTL signals used by the **microcontroller**.
Microcontroller - Processes the data received over the RS485 network.
Digital display - Displays the variable received over the RS485 network and error / alarm messages.
VS - Secondary voltage source with galvanic isolation hat provides stable power supply and protection against polarity reversal.

NOTE
When the device is powered from USB, the display brightness is by 50% reduced compared to 24 V power supply.

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3 Specifications

3.1 Specifications

Table 3.1 Technical data

Parameter	Value
Power supply	24 (10…48) V DC
Power consumption, max.	1.6 W
Display	4 digits with sign, 7 segments
Colors	green, yellow, red
Character height	14 mm
Data interface	RS485
Protocol	Modbus ASCII, Modbus RTU
Mode	Master, Slave, Spy
Baud rate	2.4…115.2 kbit/s
Galvanic isolation to power supply	500 V / 1 min
Configuration interface	USB 2.0 (Micro-USB)
Configuration software	akYtec Tool Pro
Flash memory write cycles, min.	10000
Enclosure	panel mounting in Ø22.5 mm borehole
Dimensions	48 × 26 × 65 mm
IP Code	front IP65, rear IP20
Appliance class according to IEC 61140	III
Weight	approx. 30 g

3.2 Environmental conditions

The device is designed for natural convection cooling which should be taken into account when choosing the installation site.
The following environmental conditions must be observed:

– clean, dry and controlled environment, low dust level
– closed non-hazardous areas, free of corrosive or flammable gases

Table 3.2 Environmental conditions

Condition	Permissible range
Ambient temperature	-40…+70 °C
Transportation and storage	-40…+70 °C
Relative humidity	up to 80 % (at +25 °C or below, non-condensing)
Altitude	up to 2000 m ASL
Vibration / shock resistance	conforms to IEC 61131-2
EMC emission / immunity	

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4 Configuration

The device parameters can be set with *akYtec Tool Pro* or in the Slave mode by commands from a network Master.
The complete parameter list is presented in *Appendix B.* You can also read it out from the device using the toolbar item ***Parameter list*** in *akYtec Tool Pro*.
Parameter groups:

– RS485 interface (see *Section 4.2*)
– Device settings (see *Section 4.7*)
  – Modbus Master (see *Section 4.5*)
  – Modbus Spy (see *Section 4.6*)
  – Modbus common (see *Section 4.3*)
  – Display (see *Section 4.7.1*)
  – Displayed value (see *Section 4.7.2*)
  – Extended control (see *Section 4.7.3*)
– Device status (see *Section 4.8*)

Configuration order:

– Establish connection to the *akYtec Tool Pro* software (see *Section 4.1*)
– Select the operation mode (Slave, Master or Spy) in the parameter ***Device settings > Operation mode***
– Set the common communication parameters in the groups ***RS485 interface*** and ***Modbus common***
– Set the parameters of the selected mode
– Set the display parameters

4.1 Connection to akYtec Tool Pro

The connection to *akYtec Tool Pro* software running on the PC can be established over the Micro-USB interface. The main power supply is not required.
To configure the device:

– Connect the Micro-USB programming connector on the device (see *Fig. 2.1*, *Pos. 1*) to PC over a USB-to-Micro-USB connection cable (not included).
– Start *akYtec Tool Pro*.
– In a new project, click the toolbar item ***Add devices*** .
– In the open dialog, select the interface ***STMicroelectronics Virtual COM Port.***
– Select the protocol ***akYtec Autodetection Protocol***.
– Select ***Find device*** and click ***Search*** (device address is 1 and cannot be changed).
– If the correct device is found, select it and click the button ***Add devices*** to add the device to the project.
– If the device is password protected, enter the correct password.

If you forgot the password, restore the factory settings (see *Section 4.9* and *Section 6*).

4.2 RS485 interface

The parameters in this group define the physical layer of data exchange over the RS485 port for all operating modes.

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Table 4.1 RS485 interface

Parameter	Description	Range	Default value	Access
Baud rate	Data transfer speed in bits per second	2400…115200	9600	RW
Data bits	Length of frames sent over Modbus network	8	8	RW
Stop bits	Number of stop bits	1 / 2	1	RW
Parity	Error detection	**none / even / odd**	**none**	RW
Silent interval	***IDLE frame*** - Message frames are separated by a silent interval of at least 1-character time. ***t3.5*** - Message frames are separated by a silent interval of at least 3.5-character time (Modbus standard).	**IDLE frame / t3.5**	**IDLE frame**	RW

4.3 Modbus common

Open the node ***Device settings > Modbus common***.
The parameter ***Address in Slave mode*** in this node is relevant only for the Slave mode. Other parameters are common for all modes.

Table 4.2 Modbus common

Parameter	Description	Range	Default value	Access
Address in Slave mode	Device address in the Slave mode	1...255	1	RW
Byte order	Inverse byte / register order of the received variable (Example 1)	***Unchanged / Swap bytes / Swap registers / Swap bytes and registers***	***Unchanged***	RW
Safe state timeout	Safe state activation delay after interruption of data transmission	0…60 s	0	RW
Safe state display bitmask	Image displayed in the safe state (HEX input)	0…FFFFFFFF	70404046	RW
Safe state color	Display color in the safe state	***Green / Red / Yellow***	***Green***	RW
Safe state blinking	Display blinking in the safe state	***On / Off***	***Off***	RW

Example 1. Parameter ***Byte order***		
Initial byte order	**Parameter value**	**Final byte order**
0xAABBCCDD	***Unchanged***	0xAABBCCDD
0xAABBCCDD	***Swap bytes***	0xBBAADDCC
0xAABBCCDD	***Swap registers***	0xCCDDAABB
0xAABBCCDD	***Swap bytes and registers***	0xDDCCBBAA

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4.3.1 Safe state

Safe state is a state of the display after communication interruption, activated with the time delay (***Safe state***, see *Table 4.2*). In the safe state, a variable of type IMAGE (***Safe state display bitmask***, see *Table 4.2*) is displayed.
If ***Safe state timeout*** is set to 0, the device does not enter the safe state and displays the last received value.
After power-up, the device remains in a safe state until it receives a valid request.

4.4 Modbus Slave

Set the parameter ***Device settings > Operation mode*** to ***SLAVE*** (see *Table 4.5*).
In the Slave mode, the device receives data from the Master. The exchange protocol (Modbus RTU or Modbus ASCII) is detected automatically.
The parameter ***Modbus common > Address in Slave mode*** defines the device address (see *Table 4.2*).

NOTE
Saving of configuration parameters to flash memory

- *The configuration parameters are all writable parameters, except those in the node **Displayed value**.*
- *The number of flash memory write cycles is limited (≥ 10000 cycles). Therefore, frequent (cyclic) saving of configuration parameters is not recommended.*
- *If the new configuration parameters are not written to the flash memory, they will be lost after turning off the device. After powering on, the device will start with the parameter values previously stored in the flash memory.*
- *In case of configuration over Micro-USB interface, the configuration parameters are saved to the flash memory.*
- *In case of configuration over RS485 interface, the configuration parameters are not automatically saved to the flash memory. If it is necessary, the user has to do it manually, calling the command **Save-to-Flash Trigger** (see Table 4.5). The command is a single pulse , that triggers on rising edge the saving of the configuration parameters to the flash memory.*
- *During the recording of configuration parameters, the brightness of the display decreases by 50% and the response time of the device increases for a short time up to 200 ms. This should be considered when setting the timeout in the Master device.*
- *To estimate the remaining number of write cycles in %, use the parameter **Device status > Remaining flash write cycles** (see Table 4.10).*

4.5 Modbus Master

Set the parameter ***Device settings > Operation mode*** to ***MASTER*** (see *Table 4.5*).
In the Master mode, only one Slave device can be connected. The Master device sends requests with a reading function to the Slave at a certain frequency. After each request, the Master waits for response from the Slave for a predetermined time interval (Response timeout, see *Table 4.3*). The received variable will be displayed.
If no response is received within the response timeout, the Master sends the next request and starts the ***Safe state timeout*** countdown (see *Table 4.2*). If there is no response from the Slave during ***Safe state timeout***, the Master switches to the safe state (see *Section 4.3.1*).

Table 4.3 Modbus Master

Parameter	Description	Range	Default value	Access
Protocol	Data transmission protocol	***RTU / ASCII***	***RTU***	RW
Target device address	Address of Slave as data source	1…255	1	RW
Response timeout	Time the Master waits for response from the Slave	300…10000 ms	1000	RW
Modbus function	Function in the request	***0x03 / 0x04***	***0x03***	RW

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Start register	Address of the initial register in request. The number of requested registers depends on the selected data type (see *Section 4.7.2*)	0…65535	0	RW
Request period	Period of Master request	100…65535 ms	200	RW

4.6 Modbus Spy

Set the parameter ***Device settings > Operation mode*** to ***SPY*** (see *Table 4.5*).
In the Spy mode, the device listens to the RS485 interface, waiting for requests with the specified parameters (see *Table 4.4*). If a request with the specified parameters is detected, the variable in this request is displayed.
The exchange protocol (Modbus RTU or Modbus ASCII) is automatically detected.

Table 4.4 Modbus Spy

Parameter	Description	Range	Default value	Access
Target device address [1, 2]	Address of Slave as data source	0…255	1	RW
Modbus function	Function in the request	***0x03 / 0x04 / 0x06 / 0x10***	***0x04***	RW
Start register [3]	Address of the initial register in request. The number of requested registers depends on the selected data type (see *Section 4.7.2*)	0…65535	1	RW

[1] ***Target device address*** and the device address specified in the parameter ***Modbus common > Address in Slave mode*** must be different.

[2] If ***Target device address*** = 0, the device monitors broadcast packets from the Master. Connecting several Spy devices with the ***Target device address*** = 0 to the network, you can display different data on different devices by specifying the ***Start register*** corresponding to the desired data for each device.

[3] The register address must be within the range of registers in request:
$[SR_{SPY}; SR_{SPY}+Q_{TYPE}-1] \in [SR_{REQ}; SR_{REQ}+Q_{REQ}-1]$
where
SR_{SPY} – in parameter **Start register** specified register
Q_{TYPE} – number of registers occupied by a variable, depending on its type
SR_{REQ} – start register specified in request
Q_{REQ} – number of registers specified in request (Example 2)

Example 2.
If SR_{REQ} = 40 and Q_{REQ} are specified in the request, registers from 40 to 59 are requested. For different variables, the following reactions are expected:
– SR_{SPY} = 59, INT variable (Q_{TYPE} = 1) – The received variable is displayed.
– SR_{SPY} = 59, DINT variable (Q_{TYPE} = 2) – The received variable is not displayed because the data from registers 59 - 60 is required, but register 60 is not requested.

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4.7 Device settings

The first parameter to be set in this group is ***Operation mode***. It defines the behavior of the device in the network.
The flowchart that describes the display behavior depending on other parameters is shown in *Fig. 4.1*.

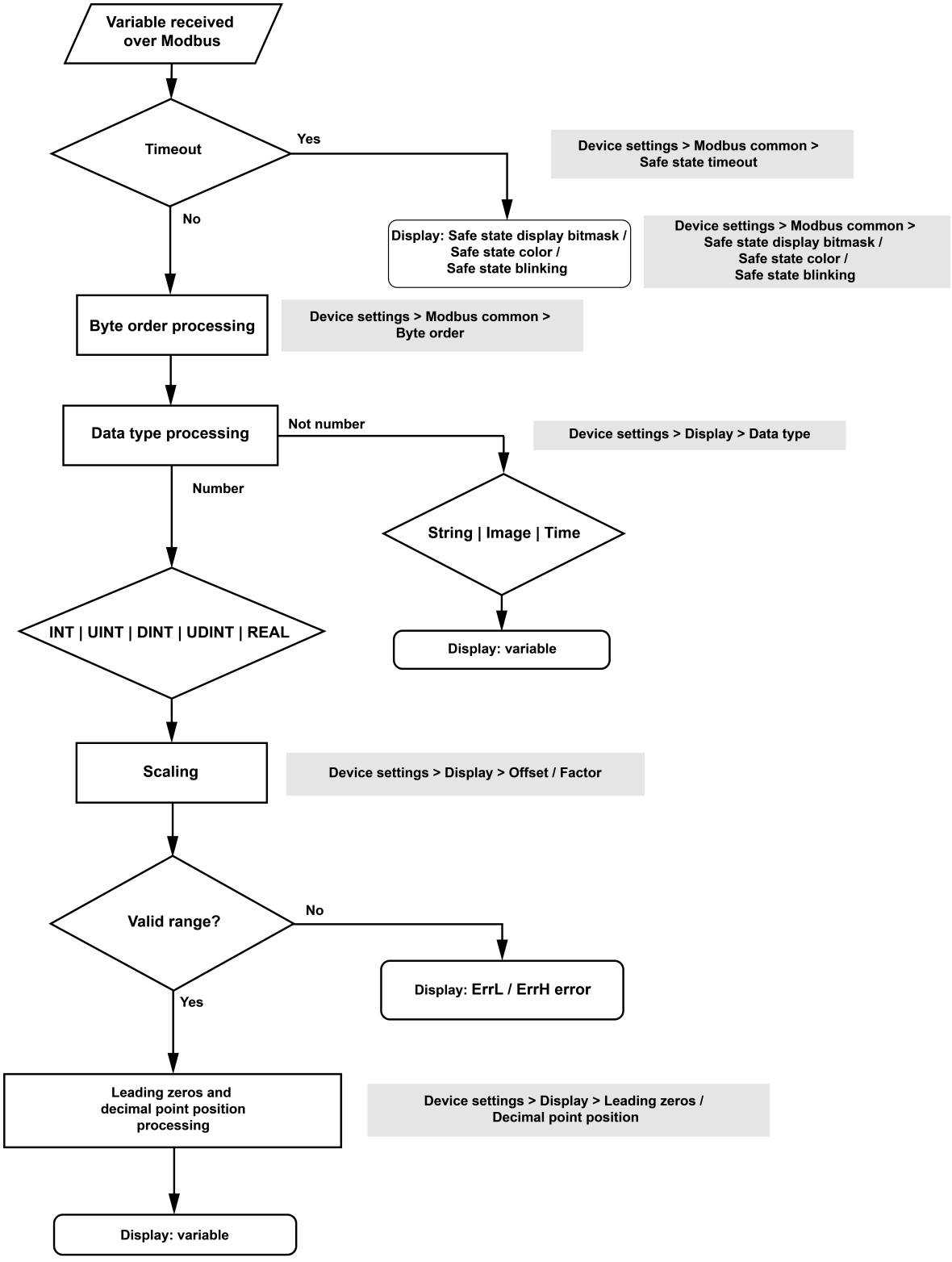


Fig. 4.1 Display operation flowchart

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Table 4.5 Device settings

Parameter	Description	Range	Default value	Access
Operation mode	Operation mode in Modbus network	***MASTER / SLAVE / SPY***	***SLAVE***	RW
Save-to-Flash Trigger	Command used to trigger the saving of the configuration parameters to the flash memory (see Section 4.4)	0 / 1	0	RW

4.7.1 Display

The parameters in this node determine how the variable is displayed.

Table 4.6 Display

Parameter	Description	Range	Default value	Access
Data type	Type of variable to display	***INT / UINT / DINT / UDINT / REAL / STRING / IMAGE / TIME***	***INT***	RW
Color	Display color – Can be affected also by Safe state (see Section 4.3.1) or Extended control (see Section 4.7.3).	**Green / Red / Yellow**	***Green***	RW
Brightness	Display brightness	0…100 %	75	RW
Leading zeros	Number of leading zeros before the first significant digit (integer variables only, ***Offset*** = 0, ***Factor*** = 1) (Example 3).	0 / 1 / 2 / 3	0	RW
Decimal point position	Position of the decimal point on the display (integer and floating-point variables only) (Example 4).	– – – – – – – .– – – .– – – .– – –	– – – –	RW
Offset [1)]	The variable is increased by ***Offset*** before being displayed (integer and floating-point variables only). If ***Offset*** ≠ 0, an integer will be converted to a floating-point (Example 5).	-999…9999	0	RW
Factor [1)]	The variable is multiplied by the ***Factor*** before being displayed (integer and floating-point variables only). If ***Factor*** ≠ 0, an integer will be converted to a floating-point (Example 6).	-999…9999	1	RW
Blinking	Enable display blinking. Can be affected also by Safe state (see Section 4.3.1) or Extended control (see Section 4.7.3).	***On / Off***	***Off***	RW
Blinking period	Display blinking period (50 % duty cycle)	250…3000 ms	1000	RW

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Display mode [2)]	Display mode selection	***Static / Text ticker / Number ticker***	***Static***	RW
Tick time	Time interval with which the displayed variable is shifted one position to the left.	100…1500 ms	100	RW

[1)] Using an offset or factor may cause the value to go out of range for the selected data type. Out-of-range error will be displayed (see *Table 4.11*).

[2)] - In the **Static** mode, the value does not move across the display.
- In the **Text ticker** mode, the value is scrolled left continuously, character by character.
- In the **Number ticker** mode, the values of types INT, UINT, DINT, UDINT and REAL are displayed without range check (-999… 9999). In this way, values with a number of digits greater than 4 can be displayed. The precision of floating-point values (REAL) in this case is limited to 3 decimal places. If the total number of digits does not exceed 4, the value is displayed as in the **Static** mode.

Example 3.
Displaying the integer "1" with different values of ***Leading zeros***:

Leading zeros = 0	1
Leading zeros = 1	01
Leading zeros = 2	001
Leading zeros = 3	0001

Example 4.

Displaying the integer "5000" with different values of ***Decimal point position***:

Decimal point position = – – – – -	5000
Decimal point position = – – – .–	500.0
Decimal point position = – – .– –	50.00
Decimal point position = – .– – –	5.000

Displaying the floating-point "1.234" with different values of ***Decimal point position***:

Decimal point position = – – – – -	1.234
Decimal point position = – – – .–	1.2
Decimal point position = – – .– –	1.23
Decimal point position = – .– – –	1.234

Example 5.

Displaying the integer "5" with different values of ***Offset***:

Offset = 1.0	6.000
Offset = -1.0	4.000
Offset = 5.0	10.00
Offset = -5.0	0.000

Displaying the floating-point "5.678" with different values of ***Offset***:

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Offset = 1.0	6.678
Offset = -1.0	4.678
Offset = 5.0	10.67
Offset = -5.0	0.678

Example 6.

Displaying the integer "5" with different values of ***Factor***:

Factor = 1.0	5
Factor = -1.0	-5.00
Factor = 5.0	25.00
Factor = -5.0	-25.0

Displaying the integer "5.678" with different values of ***Factor***:

Factor = 1.0	5.678
Factor = -1.0	-5.67
Factor = 5.0	28.38
Factor = -5.0	-28.3

4.7.2 Displayed value

To test how variable will be displayed:

– Select ***Data type*** in the node ***Device settings > Display***.
– Open the node ***Device settings > Displayed value***, set the test value of the selected data type in the corresponding row and click the toolbar icon ***Write parameters***.
– Check the desired value on the display.

For data type descriptions see *Table 4.7*.
For segment addressing for the data type IMAGE see *Table 4.8*.

Table 4.7 Displayed value

Parameter	Description	Size		Range	Default value	Access
		registers	bytes			
INT	Signed integer	1	2	-32768…32767	0	RW
UINT	Unsigned integer	1	2	0…65535	0	RW
DINT	Signed integer	2	4	-2147483648… 2147483647	0	RW
UDINT	Unsigned integer	2	4	0…4294967295	0	RW
REAL	Floating-point number, single-precision (IEE 754)	2	4	-3.402823E+38… 3.402823E+38	0	RW
STRING[1)]	String of 2…16 characters (Latin alphabet, numbers, point)	2…16	4…32	—	—	RW

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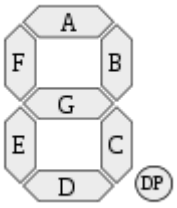
Parameter	Description	Size		Range	De-fault value	Access
		regis-ters	bytes			
String length	Length of String variable	1	1	4…32	4	RW
IMAGE [2)]	Bitmask of display segments (HEX)	2	4	0…FFFFFFFF	0	RW
TIME [3)]	Time in format XX:YY	2	4	5999	0	RW

1) The parameter ***String length*** determines the length of string in Master and Spy modes.
In the Slave mode, ***String length*** is assumed to be 32 characters (16 registers). The data size of 16 registers must be specified in the Master request; read / write of a string fragment is not possible.
The data size of 16 registers must be specified in the Master request. Read/write of a string fragment is not possible.

2) For IMAGE-type variables, the correspondence of the bits in the mask to the display segments is shown in *Table 4.8*. The least significant byte of the mask corresponds to the right most digit. The input is in hexadecimal format.

3) The displayed value XX:YY is calculated using integer division. The integer variable N is divided by 60. XX = N / 60 (integer quotient), YY = N / 60 (remainder). If N = 1000, 16:40 is displayed.

Table 4.8 Addressing of display segments

	Segment	Bit
	A	0
	B	1
	C	2
	D	3
	E	4
	F	5
	G	6
	DP	7

4.7.3 Extended control

Extended control can be used only with integer and floating-point variables.
With extended control, you can divide the valid range of displayed variable into zones (up to 5). A display color and a blinking option can be selected for each zone. Additionally, a value upper limit and a hysteresis can be set for zones 1…4.
Open the node ***Device settings > Extended control***.

Table 4.9 Extended control

Parameter	Description	Range	Default value	Access
Enable	Enable extended control for all zones	***On / Off***	***Off***	RW
Zone 5				
Color	Display color when variable is within the zone	***Green / Red / Yellow***	***Green***	RW

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Blinking	Display blinks when variable is within the zone	***On / Off***	***Off***	RW
Zone 1…4				
Enable	Enable extended control for the zone	***On / Off***	***Off***	RW
Upper limit [1)]	Zone upper limit	-999…9999	0	RW
Hysteresis [2)]	Value relative to the upper limit of the zone, after decreasing below which: - current zone becomes active again (if ***Upper limit*** > 0) - next zone becomes active (if ***Upper limit*** < 0)	0…9999	0	RW
Color	Display color when variable is within the zone.	***Green / Red / Yellow***	***Red***	RW
Blinking	Display blinks when variable is within the zone.	***On / Off***	***Off*** (2, 4) ***On*** (1, 3)	RW

1) If multiple zones are used, the ***Upper limit*** of the higher numbered zone must be greater than the ***Upper limit*** of the lower numbered zone: $UL_{Z1} < UL_{Z2} < UL_{Z3} < UL_{Z4}$. Otherwise, an error message is displayed (see *Table 4.11*). The ***Upper limit*** of the zone 5 is not specified and is assumed to be equal to the upper limit of the whole valid range (9999).

2) The ***Hysteresis*** cannot be greater than the difference between the ***Upper limits*** of adjacent zones, otherwise the device displays an error message (see *Table 4.11*). There is no ***Hysteresis*** in the zone 5, since this zone is the highest on the number line.
For practical use see examples 7-12:

Example 7. Extended control with one zone

Zone 5:

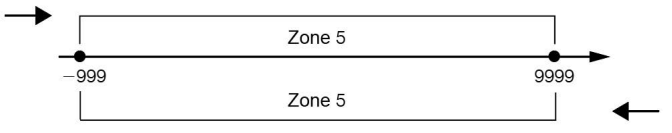
Range -999…9999

Color green

Blinking off



If the variable is changed, the visual parameters do not change.

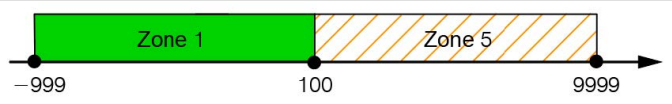


Example 8. Extended control with two zones, $UL_{Z1} > 0$

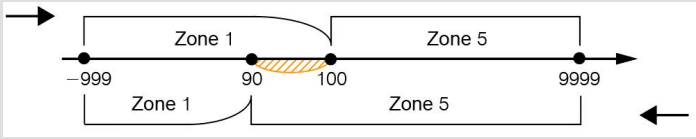
Zone 1		Zone 5	
Upper limit:	100	Upper limit:	9999
Hysteresis:	10		
Color:	green	Color:	yellow

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Blinking:	off	Blinking:	on

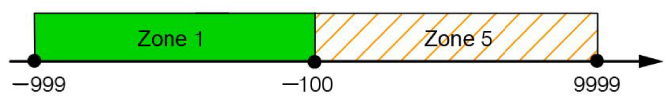


If the variable increases, zone 1 is active in the range [-999; 100), and zone 5 in the range [100; 9999].
If the variable decreases, zone 1 is active in the range [-999; 90), and zone 5 in the range [90; 9999].

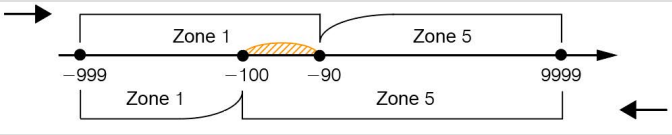


Example 9. Extended control with two zones, $UL_{Z1} < 0$

Zone 1		Zone 5	
Upper limit:	–100	Upper limit:	9999
Hysteresis:	10		
Color:	green	Color:	yellow
Blinking:	off	Blinking:	on

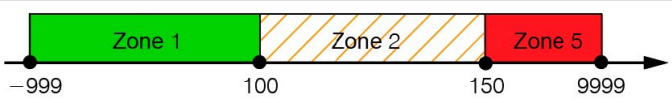


If the variable increases, zone 1 is active in the range [-999; -90], and zone 5 in the range (-90; 9999].
If the variable decreases, zone 1 is active in the range [–999; -100), and zone 5 in the range [-100; 9999].



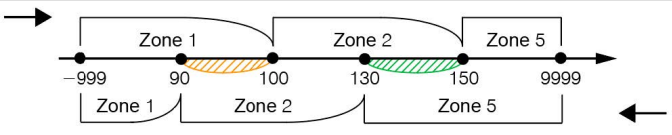
Example 10. Extended control with three zones, $UL_{Z1} > 0$, $UL_{Z2} > 0$

Zone 1		Zone 2		Zone 5	
Upper limit:	100	Upper limit:	150	Upper limit:	9999
Hysteresis:	10	Hysteresis:	20		
Color:	green	Color:	yellow	Color:	red
Blinking:	off	Blinking:	on	Blinking:	off



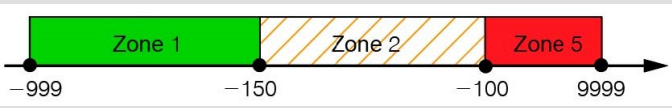
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If the variable increases, zone 1 is active in the range [–999; 100), zone 2 in [100; 150), and zone 5 in [150; 9999].
If the variable decreases, zone 1 is active in the range [–999; 90), zone 2 in [90; 130), and zone 5 in [130; 9999].

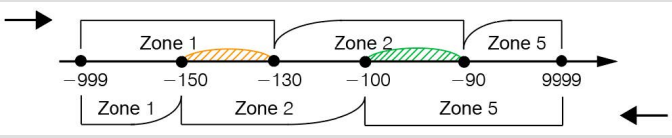


Example 11. Extended control with three zones, $UL_{Z1} < 0$, $UL_{Z2} < 0$

Zone 1		Zone 2		Zone 5	
Upper limit:	–150	Upper limit:	–100	Upper limit:	9999
Hysteresis:	20	Hysteresis:	10		
Color:	green	Color:	yellow	Color:	red
Blinking:	off	Blinking:	on	Blinking:	off

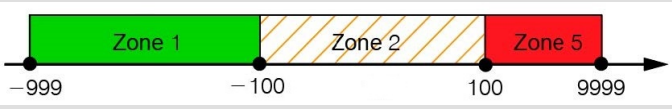


If the variable increases, zone 1 is active in the range [–999; 130), zone 2 in [-130; -90), and zone 5 in [-90; 9999].
If the variable decreases, zone 1 is active in the range [–999; 150), zone 2 in [-150; -100), and zone 5 in [-100; 9999].

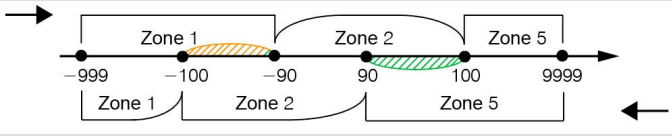


Example 12. Extended control with three zones, $UL_{Z1} < 0$, $UL_{Z2} > 0$

Zone 1		Zone 2		Zone 5	
Upper limit:	–100	Upper limit:	100	Upper limit:	9999
Hysteresis:	10	Hysteresis:	10		
Color:	green	Color:	yellow	Color:	red
Blinking:	off	Blinking:	on	Blinking:	off



If the variable increases, zone 1 is active in the range [–999; -90), zone 2 in [-90; 100), and zone 5 in [100; 9999].
If the variable decreases, zone 1 is active in the range [–999; -100), zone 2 in [-100; 90), and zone 5 in [90; 9999].



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4.8 Device status and errors

The status of the device can be read in the group ***Device status*** (see *Table 4.10*).
The displayed errors are listed in *Table 4.11*.

Table 4.10 Device status

Parameter	Description	Range	Default value	Access
Status	32-bit status code	0…4294967295	-	R
Remaining flash write cycles	Remaining flash memory write cycles in %	0…100 %	-	R

Table 4.11 Displayed errors

Displayed errors	Description	Bit number in Status register
ErrL	Variable is below the lower limit for the selected data type.	27
ErrH	Variable is above the upper limit for the selected data type.	28
ErrE	The ***Upper limit*** of the zone with a higher number is equal or less than the ***Upper limit*** of the zone with a lower number.	26
	The ***Hysteresis*** is greater than the difference between the ***Upper limits*** of adjacent zones.	
Safe state display bitmask	Display timeout exceeds the sum of ***Response timeout*** (see *Table 4.2*) and the subsequent ***Safe state timeout*** (see *Table 4.3*).	—

4.9 Password

You can use password to protect the configuration parameters of the device from an unauthorized access over *akYtec Tool Pro*.

To set the password, use the toolbar item ***Password*** *** or the same item in the device context menu.
There is no password by default.
If you forgot the password, restore the factory settings (see *Section 6*).

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5 Installation

The safety requirements from *Section 1.5* must be observed.

NOTE
Before mounting, it is recommended to configure the device over the Micro-USB interface (see *Section*).

5.1 Mounting

The device is designed for switch panel mounting in a borehole of Ø22.5 mm.
To prevent the device spinning in the borehole, make a special cut-out according to *Fig. 5.3*.
Mounting sequence:

– Apply the included gasket on the rear surface of the display.
– Insert the device into the cut-out and tighten the nut from the rear side of the switch panel.
– Plug the terminal block in one of the two plug positions.
– Connect the power and signal cables in accordance with *Section 5.2*.

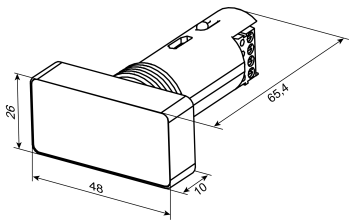


Fig. 5.1 External dimensions

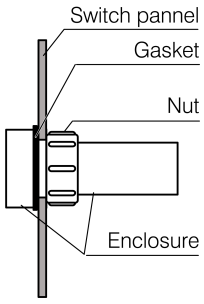


Fig. 5.2 Mounting

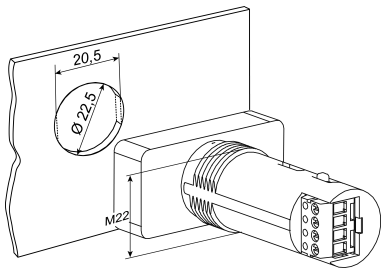


Fig. 5.3 Cut-out dimensions

5.2 Wiring

NOTE
To ensure the compliance with EMC requirements, it is recommended:
– lay signal lines separately or screened from the power lines
– use shielded cable for signal lines

Maximum conductor cross-section is 1.0 mm².

Table 5.1 Terminal assignments

No.	Marking	Description
1	24 V (+)	Power supply
2	0 V (-)	Power supply
3	RS485 -	RS485 interface
4	RS485 +	RS485 interface

5.3 RS485 network

A common standard RS485 is used for data exchange. The RS485 serial interface is based on two-wire technology and half-duplex mode. The protocols Modbus RTU and Modbus ASCII are supported.
Devices are connected to a network according to linear (bus) topology. It means that the line goes from the first device to the second one, from the second one to the third one, etc. Star connections and spur lines are not allowed. The maximum distance between the first and last device along the line is 1200 m.

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The network consists of a master device and can contain up to 32 slave devices. The number of slave devices and the network length can be increased using a RS485 interface repeater.
Line reflections always occur at the open bus ends (the first and the last node). The higher the data transmission rate, the stronger they are. Terminating resistors on the both ends of line can be useful to minimize reflections. Terminating resistors of 120…150 Ω, 0.25 kW are recommended.
The RS485 interface is also active if the device is powered over USB.

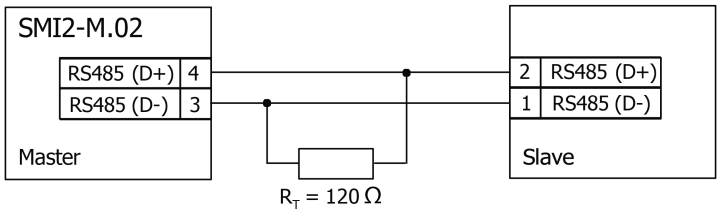


Fig. 5.4 Two SMI2-M.02 in Master-Slave connection

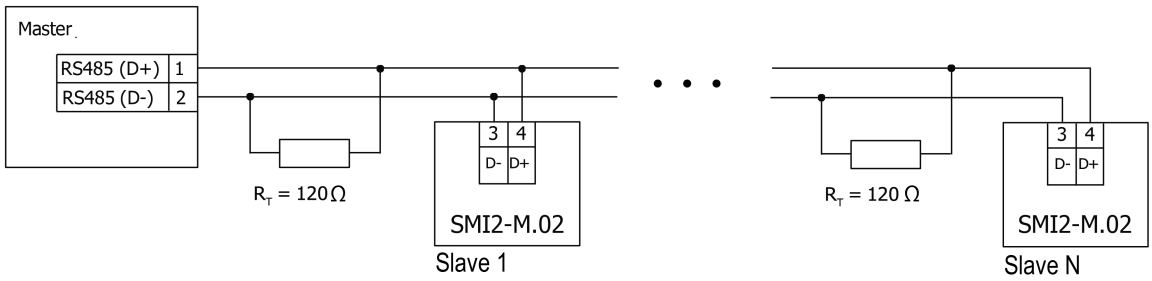


Fig. 5.5 Several SMI2-M.02 as Slaves

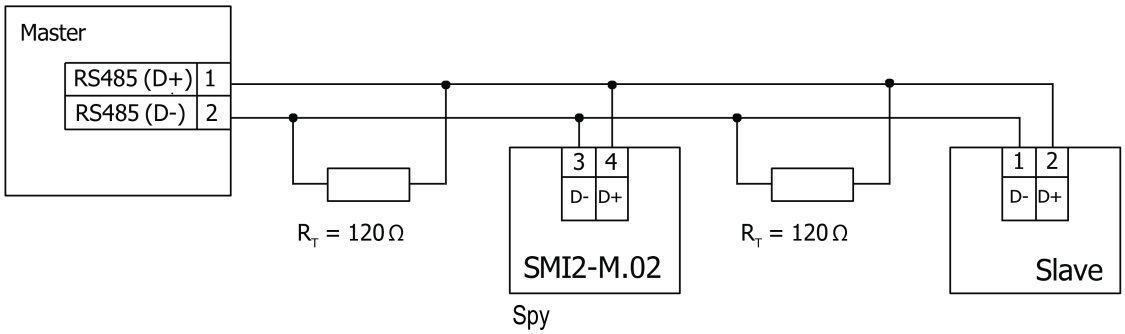


Fig. 5.6 SMI2-M.02 as a Spy

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6 Factory settings restoration

To restore the factory settings:

– connect the device to the PC over USB
– start *akYtec Tool Pro*
– open a project with the connected SMI2-M.02
– click the toolbar item ***Factory settings*** 
– ensure the parameters are reset to the default values
– click the toolbar item ***Write parameters*** 
– wait for a pop-up message about successful writing
– click the toolbar item ***Restart device*** 

After a pop-up message about successful restart, the device will operate with the default parameters.

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7 Maintenance

The safety requirements must be observed when the maintenance is carried out.



DANGER
Cut off all power before maintenance.

The maintenance includes:

– cleaning the housing and terminal blocks from dust, dirt and debris
– checking the device fastening
– checking the wiring (connecting wires, terminal connections, absence of mechanical damages).



NOTICE
The device should be cleaned with a dry or slightly damp cloth only. No abrasives or solvent-containing cleaners may be used.

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8 Transportation and storage

Pack the device in such a way as to protect it reliably against impact for storage and transportation. The original packaging provides optimum protection.
If the device is not taken immediately after delivery into operation, it must be carefully stored at a protected location. The device should not be stored in an atmosphere with chemically active substances.
The environmental conditions must be taken into account during transportation and storage.

NOTICE
The device may have been damaged during transportation.
Check the device for transport damage and completeness!
Report the transport damage immediately to the shipper and akYtec GmbH!

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9 Scope of delivery

– SMI2-M.02	1 pc.
– Gasket	1 pc.
– Mounting nut	1 pc.
– 4-pole plug-in terminal block	1 pc.
– Short guide	1 pc.

NOTE
The manufacturer reserves the right to make changes to the scope of delivery.

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Appendix A. Galvanic isolation

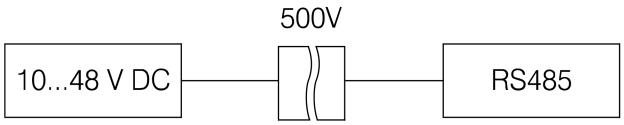


Fig. A.1 Galvanic isolation

NOTE
The test voltages correspond to the tests carried out under normal operating conditions with 1-minute exposure time.

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Appendix B. Modbus application

Table B.1 – device parameters with register addresses (default values in bold)
Table B.2 – applicable Modbus functions
Table B.3 – data types in memory
Table B.4 – displayable characters with ASCII-codes
The complete list of parameters with addresses can also be read out from the device using the toolbar item ***Parameter list***  in *akYtec ToolPro*.

Table B.1 Modbus registers

Parameter	Value	Unit	Access	Address		Data type
				hex	dec	
RS485 interface						
Baud rate	3 – 2.4 4 – 4.8 5 – 9.6 6 – 14.4 7 – 19.2 8 – 38.4 9 – 57.6 10 – 115.2	kbit/s	RW	0x0209	521	ENUM14
Data bits	**0 – 8**	bit	RW	0x020A	522	ENUM2
Stop bits	0 – 1 1 – 2	-	RW	0x020B	523	ENUM2
Parity	**0 – none** 1 – even 2 – odd	-	RW	0x020C	524	ENUM3
Silent interval	**0 – IDLE frame** 1 – t3.5	-	RW	0x0210	528	UINT8
Modbus common						
Address in Slave mode	**1**…255	-	RW	0x020F	527	UINT8
Byte order	**0 – Unchanged** 1 – Swap bytes 2 – Swap registers 3 – Swap bytes and registers	-	RW	0x0FDD	4061	ENUM4
Safe state timeout	**0**…60	s	RW	0x0FDE	4062	UINT16
Safe state display bitmask	0…**70404046**… 4294967295	-	RW	0x0FDF	4063	UINT32
Safe state color	**0 – green** 1 – red 2 – yellow	-	RW	0x0FE1	4065	ENUM3
Safe state blinking	**0 – Off** 1 – On	-	RW	0x0FE2	4066	ENUM2
Modbus Master						
Protocol	**0 – RTU** 1 – ASCII	-	RW	0x0FB4	4020	ENUM2

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Target device address	**1**…255	-	RW	0x0FB5	4021	UINT8
Response timeout	300…**1000**…10000	ms	RW	0x0FB6	4022	UINT16
Modbus function	**0 – 0x03** 1 – 0x04	-	RW	0x0FB7	4023	ENUM2
Start register	**0**…65535	-	RW	0x0FB8	4024	UINT16
Request period	100…**200**…65535	ms	RW	0x0FB9	4025	UINT16
Modbus Spy						
Target device address	0…**1**…255	-	RW	0x0FC8	4040	UINT8
Modbus function	0 – 0x03 **1 – 0x04** 2 – 0x06 3 – 0x10	-	RW	0x0FC9	4041	ENUM4
Start register	0…**1**…65535	-	RW	0x0FCA	4042	UINT16
Device settings						
Operation mode	**0 – SLAVE** 1 – MASTER 2 – SPY	-	RW	0x0FA0	4000	ENUM3
Save-to-Flash Trigger	**0** / 1	-	RW	0x1388	5000	ENUM2
Display						
Data type	**0 – INT** 1 – UINT 2 – DINT 3 – UDINT 4 – REAL 5 – STRING 6 – IMAGE 7 – TIME	-	RW	0x100B	4107	ENUM8
Color	**0 – green** 1 – red 2 – yellow	-	RW	0x1004	4100	ENUM3
Brightness	0…**75**…100	%	RW	0x1005	4101	UINT8
Leading zeros	**0**…3	-	RW	0x1008	4104	ENUM4
Decimal point position	**0 – «– – – – »** 1 – «– – – . – » 2 – «– – . – – » 3 – «– . – – – »	-	RW	0x100C	4108	ENUM8
Offset	-999…**0**…9999	-	RW	0x100D	4109	REAL32
Factor	-999…**1**…9999	-	RW	0x100F	4111	REAL32
Blinking	**0 – Off** 1 – On	-	RW	0x1006	4102	ENUM2
Blinking period	250…**1000**…3000	ms	RW	0x1007	4103	UINT16
Display mode	**0 – Static** 1 – Text ticker	-	RW	0x100A	4106	ENUM3

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	2 – Number ticker					
Tick time	**100**…1500	ms	RW	0x1009	4105	UINT16
Displayed value						
INT	-2768…**0**…32767	-	RW	0x1068	4200	INT16
UINT	**0**…65535	-	RW	0x1069	4201	UINT16
DINT	-2147483648…**0**… 2147483647	-	RW	0x106A	4202	INT32
UDINT	**0**…4294967295	-	RW	0x106C	4204	UINT32
REAL	-3.402823E+38… 3.402823E+38	-	RW	0x106E	4206	REAL32
STRING	-	-	RW	0x1070	4208	STRING
String length	**4**…32	byte	RW	0x1099	4249	UINT8
IMAGE	**0**…4294967295	-	RW	0x109A	4250	UINT32
TIME	**0**…5999	-	RW	0x109C	4252	UINT32
Extended control						
Enable	**0 – Off** 1 – On	-	RW	0x10CC	4300	ENUM2
Zone 5						
Color	**0 – green** 1 – red 2 – yellow	-	RW	0x10CD	4301	ENUM3
Blinking	**0 – Off** 1 – On	-	RW	0x10CE	4302	ENUM2
Zone 4						
Enable	**0 – Off** 1 – On	-	RW	0x10F4	4340	ENUM2
Upper limit	-999…**0**…9999	-	RW	0x10F5	4341	REAL32
Hysteresis	**0**…9999	-	RW	0x10F7	4343	REAL32
Color	0 – green **1 – red** 2 – yellow	-	RW	0x10F9	4345	ENUM3
Blinking	**0 – Off** 1 – On	-	RW	0x10FA	4346	ENUM2
Zone 3						
Enable	**0 – Off** 1 – On	-	RW	0x10EA	4330	ENUM2
Upper limit	-999…**0**…9999	-	RW	0x10EB	4331	REAL32
Hysteresis	**0**…9999	-	RW	0x10ED	4333	REAL32
Color	0 – green **1 – red** 2 – yellow	-	RW	0x10EF	4335	ENUM3
Blinking	0 – Off **1 – On**	-	RW	0x10F0	4336	ENUM2

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Zone 2						
Enable	**0 – Off** 1 – On	-	RW	0x10E0	4320	ENUM2
Upper limit	-999…**0**…9999	-	RW	0x10E1	4321	REAL32
Hysteresis	**0**…9999	-	RW	0x10E3	4323	REAL32
Color	0 – green **1 – red** 2 – yellow	-	RW	0x10E5	4325	ENUM3
Blinking	**0 – Off** 1 – On	-	RW	0x10F6	4326	ENUM2
Zone 1						
Enable	**0 – Off** 1 – On	-	RW	0x10D6	4310	ENUM2
Upper limit	-999…**0**…9999	-	RW	0x10D7	4311	REAL32
Hysteresis	**0**…9999	-	RW	0x10D9	4313	REAL32
Color	0 – green **1 – red** 2 – yellow	-	RW	0x10DB	4315	ENUM3
Blinking	0 – Off **1 – On**	-	RW	0x10DC	4316	ENUM2
Device status						
Status	0…4294967295	-	R	0xF0B4	61620	REAL32
Remaining flash write cycles	0…100	%	R	0xF0B8	61624	REAL16

Table B.2 Modbus functions

Code	Name	Description
03 (0x03)	Read Holding Registers	Read the contents of a contiguous block of holding registers
04 (0x04)	Read Input Registers	Read from 1 to 125 contiguous input registers
06 (0x06)	Write Single Register	Write a single holding register
16 (0x10)	Write Multiple Registers	Write a block of contiguous registers (1 to 123 registers)

Table B.3 Data types in memory

Data type	Size		Description
	registers	bytes	
UINT8	1	1	Unsigned integer
UINT16	1	2	Unsigned integer
UINT32	2	4	Unsigned integer
INT16	1	2	Signed integer
INT32	2	4	Signed integer

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REAL16	1	2	Floating-point number
REAL32	2	4	Floating-point number
STRING	16	32	String of 32 characters
ENUM	1	2	Unsigned integer

Table B.4 ASCII codes

ASCII code	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9	.A	.B	.C	.D	.E	.F
2.														–	.	
3.	0	1	2	3	4	5	6	7	8	9						
4.		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
5.	P	Q	R	S	T	U	V	W	X	Y	Z					
6.		a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
7.	p	q	r	s	t	u	v	w	x	y	z					

Example 13. The device with the address 100 should display the text **WORD**

Request:	64 10 00 1D 00 02 04 57 4F 52 44 C0 07
Device address:	0x64 (100)
Function code:	0x10 (16)
Start register:	0x1D (29)
Number of registers:	0x02 (2)
Data length (byte):	0x04 (4)
Data:	0x57(W) 0x4F(O) 0x52(R) 0x44(D)
CRC:	0xC0 0x07

Example 14. The device with the address 100 should display the text **W.O.R.D.**

Request:	64 10 00 1D 00 04 08 57 2E 4F 2E 52 2E 44 2E 90 3
Device address:	0x64 (100)
Function code:	0x10 (16)
Start register:	0x1D (29)
Number of registers:	0x04 (4)
Data length (byte):	0x08 (8)
Data:	0x57(W) 0x2E(.) 0x4F(O) 0x2E(.) 0x52(R)0x2E(.) 0x44(D) 0x2E(.)
CRC:	0x90 0x31

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