Manual

07/09 MN03407002Z-EN
replaces 07/09 AWB1251-1616en

Connection System SmartWire
SWIRE-GW-MB

Powering Business Worldwide

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Original Operating Instructions
The German-language edition of this document is the original operating manual.

Translation of the original operating manual
All editions of this document other than those in German language are translations of the original German manual.

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2nd edition 07/09,
See revision protocol in the "About this manual" chapter

Production: René Wiegand
Translation: globaldocs GmbH

Danger!
Dangerous electrical voltage!

Before commencing the installation

- Disconnect the power supply of the device.
- Ensure that devices cannot be accidentally restarted.
- Verify isolation from the supply.
- Earth and short circuit.
- Cover or enclose neighbouring units that are live.
- Follow the engineering instructions (IL/AWA) of the device concerned.
- Only suitably qualified personnel in accordance with EN 50110-1/-2 (VDE 0105 Part 100) may work on this device/system.
- Before installation and before touching the device ensure that you are free of electrostatic charge.
- The functional earth (FE) must be connected to the protective earth (PE) or to the potential equalisation. The system installer is responsible for implementing this connection.
- Connecting cables and signal lines should be installed so that inductive or capacitive interference does not impair the automation functions.
- Install automation devices and related operating elements in such a way that they are well protected against unintentional operation.
- Suitable safety hardware and software measures should be implemented for the I/O interface so that a line or wire breakage on the signal side does not result in undefined states in the automation devices.
- Ensure a reliable electrical isolation of the low voltage for the 24 volt supply. Only use power supply units complying with IEC 60364-4-41 (VDE 0100 Part 410) or HD 384.4.41 S2.
- Deviations of the mains voltage from the rated value must not exceed the tolerance limits given in the specifications, otherwise this may cause malfunction and dangerous operation.
- Emergency stop devices complying with IEC/EN 60204-1 must be effective in all operating modes of the automation devices. Unlatching the emergency-stop devices must not cause restart.
- Devices that are designed for mounting in housings or control cabinets must only be operated and controlled after they have been installed with the housing closed. Desktop or portable units must only be operated and controlled in enclosed housings.

- Measures should be taken to ensure the proper restart of programs interrupted after a voltage dip or failure. This should not cause dangerous operating states even for a short time. If necessary, emergency-stop devices should be implemented.
- Wherever faults in the automation system may cause damage to persons or property, external measures must be implemented to ensure a safe operating state in the event of a fault or malfunction (for example, by means of separate limit switches, mechanical interlocks etc.).

Contents

	About this manual	**3**
	List of revisions	3
	Target group	3
	Additional device manuals	3
	Reading conventions	4
1	**Gateway MODBUS RTU SWIRE-GW-MB**	**5**
	System overview	6
	Design of the SWIRE-GW-MB	7
	Functional description	7
	Example for SmartWire Module	8
	– SmartWire module for DILM	8
	– SmartWire-I/O module	9
2	**Installation**	**11**
	MODBUS RTU station addresses and protocol parameters	11
	Connect SmartWire connection cable	13
	Connecting the power supply	14
	Connecting MODBUS RTU	16
	– Data transfer with RS232	16
	– Data transfer with RS485	17
	Terminating resistors	19
	EMC-conformant wiring of the network	19
	Potential separation	21
	Max. cable lengths	21
3	**Commissioning**	**23**
	Initial starting	23
	Meaning of the status LEDs	24
	– Ready-LED	24
	– U-Aux-LED	24
	– SmartWire LED	25
	– MODBUS-RTU-LED	25

4	**Operation through MODBUS RTU**	**27**
	Incorporation in the field bus configuration	27
	Data mapping of SmartWire stations	28
	– Data diagram	29
	– Abbreviated and full bit representation	31
	– Control data areas	38
	– Check bits	38
	– Life bits	39
	– Status bits	39
	– Manufacturer and device ID of SmartWire station	40
	– Hardware and software version	41
	– Number of SmartWire stations	43
	– Setting the watchdog timer	43
	Access methods to the register areas	44
	MODBUS-functions	45
	– Structure of a MODBUS message	45
	– Write commands	46
	– Read commands	48
	MODBUS diagnostic functions (0x08)	49
	– Polling device information for SWIRE-GW-MB	51
	– Diagnostic data	51
	– Checking the SmartWire configuration	52
	Fault-finding	53
5	**Appendix**	**55**
	Technical data	55
	– General	55
	LED indicators	57
	MODBUS-RTU	57
	Connection system SmartWire	58
	Dimensions	59
	Index	**61**

About this manual

List of revisions

The following significant amendments have been introduced since previous issues:

Edition date	Page	Key word	New	Modification	Deleted
07/09	Imprint	Emergency On Call Service		✓	
	6	section "System overview"		✓	

Target group

This manual is intended for automation technicians and engineers. Extensive knowledge regarding the MODBUS-RTU fieldbus and programming of a MODBUS-RTU master are assumed. Furthermore, you should also be familiar with the handling of the SmartWire system.

Additional device manuals

Further information concerning the SmartWire topic can be found in:

- Connection system SmartWire, modules
  MN03402001Z-EN
  (previously AWB1210+1251-1591GB),
- Connection system SmartWire, EASY223-SWIRE
  MN05006003Z-EN
  (previously AWB2528+1251-1589GB),
- Connection system SmartWire SWIRE-GW-DP
  MN03407001Z-EN
  (previously AWB1210+1251-1590GB).

The manuals are available for download as PDF files from the Eaton website.

To find the document quickly go to
http://www.moeller.net/en/support/index.jsp
and enter the document number as a search term.

Reading conventions

Symbols used in this manual have the following meanings:

▶ Indicates instructions to be followed.

Caution!
Warns of a hazardous situation that could result in damage to the product or components.

Warning!
Warns of the possibility of serious damage and slight injury.

Danger!
Warns of the possibility of a hazardous situation that could result in major damage and serious or fatal injury or even death.

Draws your attention to interesting tips and supplementary information

For greater clarity, the name of the current chapter is shown in the header of the left-hand page and the name of the current section in the header of the right-hand page. This does not apply to pages at the start of a chapter and empty pages at the end of a chapter.

1 Gateway MODBUS RTU SWIRE-GW-MB

The communication module SWIRE-GW-MB has been developed for automation tasks with the PROFIBUS-DP field bus. SWIRE-GW-MB provides a gateway between the MODBUS RTU field bus system and the SmartWire connection system and can be used only in combination with SmartWire. The MODBUS RTU gateway always works as a modular slave within the MODBUS RTU network.

System overview

The SmartWire connection system is integrated into a MODBUS-RTU network as a modular slave.

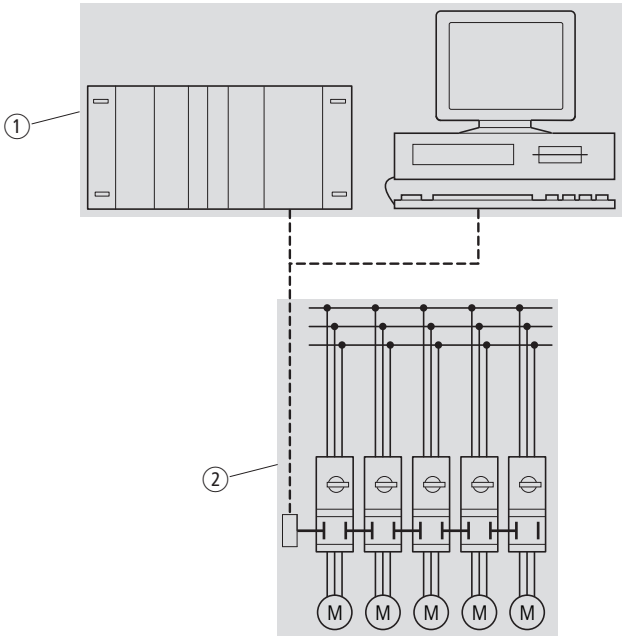


Figure 1: Gateway MODBUS SWIRE-GW-MB in network

① Master area (PLC or PC)
② Slave area with SmartWire system

→ The SWIRE-GW-MB gateway and the components of the SmartWire system are built-in devices. They must be installed in an enclosure, switch cabinet or distribution board with protection to IP54 or higher.

Design of the SWIRE-GW-MB

The illustration below shows the SWIRE-GW-MB.

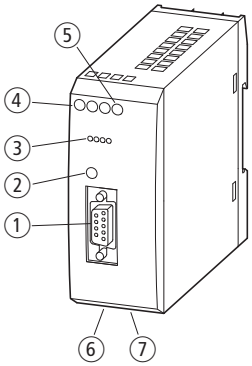


Figure 2: Device view

① MODBUS-RTU connection through 9-pole SUB-D socket
② Configuration button
③ Status LEDs
④ Gateway power supply terminals
⑤ Contactor coil (Aux) power supply terminals
⑥ Socket OUT for SmartWire connection cable
⑦ DIP switch for address and logging settings

Functional description

The gateway SWIRE-GW-MP enables the connection of the SmartWire system to a MODBUS RTU communication network. The SmartWire system can consist of a rung with up to 16 stations. Stations can be, for example, SmartWire modules for DILM or SmartWire I/O modules. In general, the SmartWire stations can transmit up to four bits of control data (station's output data) and up to eight bytes of status data (station's input data).

Example for SmartWire Module

SmartWire module for DILM

The illustration below shows the SmartWire module for DILM.

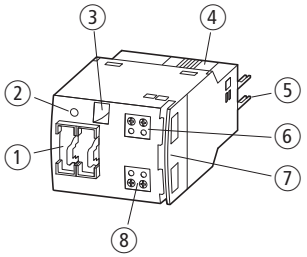


Figure 3: Surface mounting of SmartWire-Modul for DILM

① IN and OUT sockets for the connection cable
② Green LED
③ Mechanical switching position indicator
④ Catch slider
⑤ Connection pins
⑥ Connection terminals X1-X2
⑦ Cableway
⑧ Connection terminals X3-X4

Status data

- Switching state feedback for contactor and PKZM0 (read data, as viewed from MODBUS RTU master)

Control data:

- Switching signal for contactor actuation On/Off (write data, as viewed from MODBUS RTU master)

SmartWire-I/O module

The illustration below shows the SmartWire I/O module.

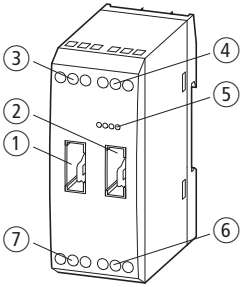


Figure 4: SWIRE-4DI-2DO-R

① Socket In for SmartWire connection cable
② Socket Out for SmartWire connection cable
③ Terminals for elay output Q1
④ Terminals for Inputs I1 and I2
⑤ Green LEDs
⑥ Terminals for Inputs I3 and I4
⑦ Terminals for relay output Q2

Status data

- State of digital inputs (four bits) (read data, as viewed from MODBUS RTU master)

Control data:

- Actuation of SmartWire module's relay outputs (two bits) (write data, as viewed from MODBUS RTU master)

2 Installation

This section tells you how to set up the station addresses and protocol parameters for MODBUS RTU.

MODBUS RTU station addresses and protocol parameters

To be able to use the gateway SWIRE-GW-MB within a MODBUS RTU network, its station address, parity and baud rate must be set before use. These settings are made using DIP switches 2 to 10 on the device's underside.

DIP switch 1 is not assigned with a function.

The MODBUS RTU station address for the SWIRE-GW-MB is set in binary format with DIP switches 6 to 10, providing a total of 32 addresses from 0 to 31. Valid addresses for the SWIRE-GW-MB are 1 to 31.

The baud rate of the MODBUS RTU network is set with DIP switches 2 and 3.

Possible baud rates, in kbits/s, are 9.6, 19.2, 38.4 and 57.6. The corresponding DIP switch settings are are shown below.

Table 1: Setting the baud rate

Transmission rate [kBit/s]	DIP switch 3	DIP switch 2
9.6	OFF	OFF
19.2	OFF	ON
38.4	ON	OFF
57.6	ON	ON

The parity is set with DIP switches 4 and 5, as shown in the table below.

Table 2: Parity settings

Number of stop bits	Parity	DIP switch 5	DIP switch 4
2	NO	OFF	OFF
1	NO	OFF	ON
1	ODD	ON	OFF
1	EVEN	ON	ON

No Parity (NO) is obtained with two different DIP switch positions, which differ in the number of stop bits (1 or 2).

The illustration below shows the DIP switches on the gateway device's underside.

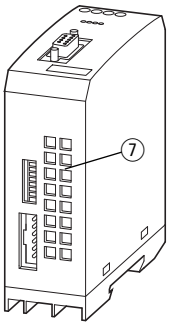


Figure 5: Bottom of device SWIRE-GW-MB

The following illustration shows the gateway's default (factory set) DIP switch positions.

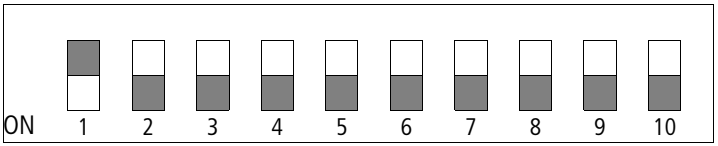


Figure 6: Initial DIP switch positions of SWIRE-GW-MB (address 31, even parity, one stop bit, baud rate = 57.6 kbits/s)

▶ On the DIP switch (Fig. 7) on the device underside, set the gateway's station address, parity and baud rate.

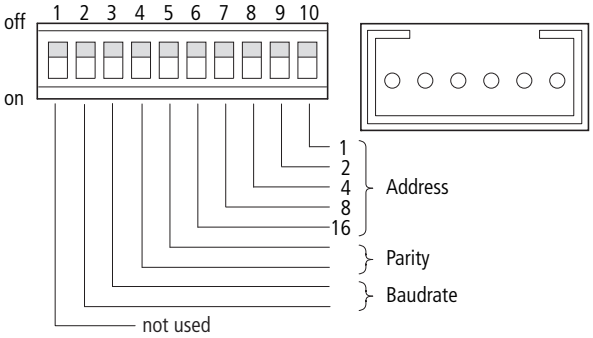


Figure 7: Setting the station address, parity and baud rate

Connect SmartWire connection cable

The slaves in the SmartWire system are connected unsing 6-pole connection cables available in different lengths. The cable is fitted with plugs at both ends.

▶ Connect the 6-pole SmartWire connection cable to the OUT socket on the device underside.

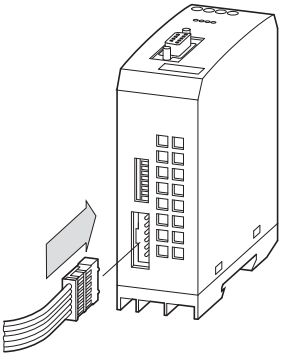


Figure 8: Connecting SWIRE-GW-MB

▶ Connect the other SmartWire stations.

Caution!
The overall length of the SmartWire line may not exceed a maximum of 4 m.

Connecting the power supply

The gateway SWIRE-GW-MB is operated with a 24 V DC supply voltage. An additional 24 V DC control voltage is provided for the contactor coils.

▶ Connect the SWIRE-GW-MB via the connection terminals 24 V and 0 V(-Gateway-) to the 24 V DC power supply.

▶ Connect the 24 V DC control voltage for the contactor coils via the connection terminals Aux 0 V and 24 V e.

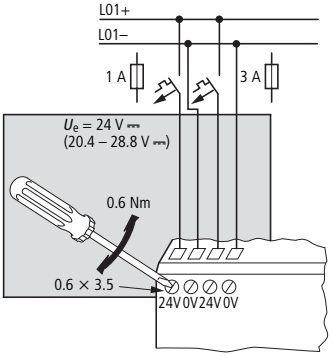


Figure 9: Connecting the power supply

The terminals are suitable for AWG22 to AWG16 cables and for flexible cables with a cross-section of 0.5 to 1.5 mm². Tighten the terminals to 06 Nm.

→ The gateway is protected by a 1 A gG/gL line protection fuse or a 1 A miniature circuit-breaker featuring characteristic C. The fusing of the incoming supply for the contactor coils is implemented using 3 A gG/gL fuses or a 3 A miniature circuit-breake featuring characteristic Z.

Danger!
In safety-relevant applications the power supply providing power to the SmartWire system must feature a PELV power supply unit (protective extra low voltage).

Connecting MODBUS RTU

The MODBUS RTU gateway SWIRE-GW-MB transfers data through the two communication standards RS232 and RS485. The pin assignment of the 9-pin D-sub plug for connection to the MODBUS RTU gateway's 9-pin D-sub socket must correspond with the communication standard used.

Data transfer with RS232

If you are using the RS232 communication standard, pins 2, 3 and 5 of the gateway's D-sub socket are used for data transfer.

Caution!
RS232 should be used only for point-to-point connections between the SWIRE-GW-MB and a PLC or PC.

Caution!
For communication through RS232 use only pins 2, 3 and 5!

Using preassembled data cables that use pins 6, 8 and 9 can damage the SWIRE-GW-MB or the other connected device.

Pin assignment of the gateway's port for RS232

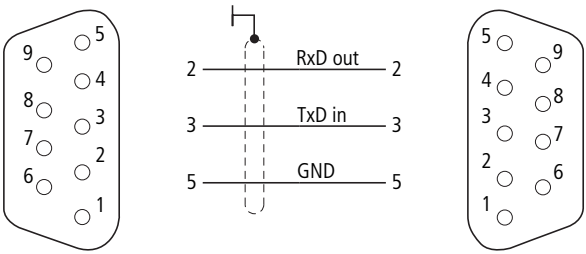


Figure 10: Pin assignment RS232

The following table lists the signals of SWIRE-GW-MB.

Table 3: Signals SWIRE GW-MB

Pin	Signal name	Designation
1	Not used	–
2	**RxD out**	**RS232 transmit**
3	**TxD in**	**RS232 receive**
4	Not used	–
5	**GND**	**Reference potential**
6	+ 5V	+ 5V, electrically isolated
7	Not used	–
8	Rx/Tx – (A-Line)	RS485 receive/Send data N
9	Rx/Tx + (B-Line)	RS485 receive/Send data P

Data transfer with RS485

If you are using the RS485 communication standard, pins 5,6, 8 and 9 of the gateway's D-sub socket are used for data transfer. The Table 4 below lists the pin functions and assignments of the 9.pin D-sub connector.

Caution!
For communication through RS485 use only pins 5,6,8 and 9! Using preassembled data cables that use pins 2 and 3 can damage the SWIRE-GW-MB or the other connected device.

Pin functions RS485 SWIRE-GW-MB

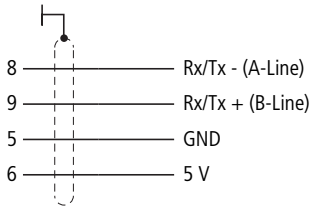


Figure 11: Terminal assignment RS485

Table 4: SWIRE-GW-MB signals

Pin	Signal name	Designation
1	Not used	–
2	RxD out	RS232 transmit
3	TxD in	RS232 receive
4	Not used	–
5	**GND**	**Reference potential**
6	**+ 5V**	**+ 5V, electrically isolated**
7	Not used	–
8	**Rx/Tx – (A-Line)**	**RS485 receive/Send data N**
9	**Rx/Tx + (B-Line)**	**RS485 receive/Send data P**

For data transfer, only pins 8, 9 and screen are required.

▶ Connect the 9-pin D-sub cable to the gateway's D-sub socket.

→ The cable type has an influence on the available bus cable length and thus on the data transfer rate (→ section "Max. cable lengths", page 21).

Terminating resistors

If the RS485 communication standard is used, the first and last station in a MODBUS RTU field bus segment must terminate the field bus with an energized termination resistor. The bus termination resistor is connected externally, either as a separate terminating resistor or through a special D-sub connector with built-in bus termination. Connect the terminating resistor, which should have a resistance of 150 Ω (0.5 W) between the two signal lines RxD/TX (A-line) and Rx/Tx+ (B-line).

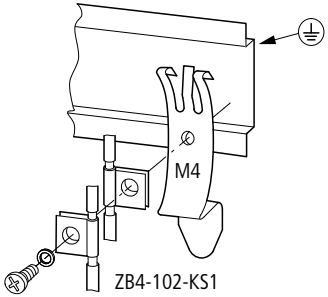
EMC-conformant wiring of the network

Electromagnetic interference can cause faults in the field bus. Their influence can be limited by implementing suitable EMC measures, such as:

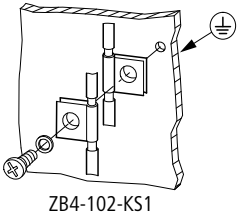
- EMC-conformant system configuration
- EMC compliant cable installation and
- Avoiding high potential differences
- correct installation of the MODBUS systems (cables, bus plug connection, etc.)

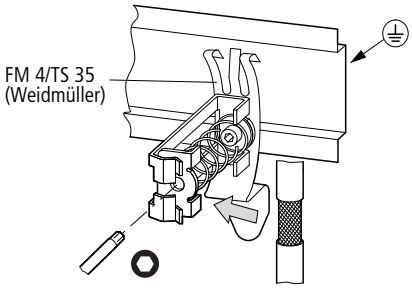
The electromagnetic interference can be significantly reduced by the use of a cable screen (shield). The following illustrations indicate the correct method for connecting the shield.

for top-hat rail



for mounting plate





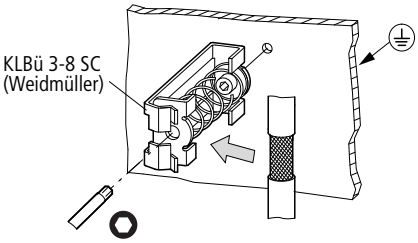


Figure 12: Shielding of network cable

Caution!
Potential equalisation currents may not flow on the shield. A safe method of equipotential bonding must be provided to ensure this.

Potential separation

The following electrical isolation measures apply for the SWIRE-GW-MB interfaces:

- Potential isolation of the MODBUS-RTU to the supply voltage and to the SmartWire system
- No isolation between the supply voltage for the gateway and the supply voltage for the contactor coils
- No electrical isolation between the supply voltages and the SmartWire system.

Max. cable lengths

For each communication standard (RS232 and RS485) maximum bus cable lengths are specified.

RS485

When RS485 is used, the maximum cable length depends on the cross-section of the data cable. At a conductor cross-section of 0.25 mm² (AWG24) or greater, the maximum cable length is 1000 m. With data cables of category 5, the bus length can be up to 600 m.

RS232

For the RS232 standard and a cable capacitance of u to 2500 pF the following maximum cable lengths are specified.

Table 5: Maximum cable lengths for RS232

Baud rate [kBit/s]	Max. cable length [m]
9.6	152
19.2	15
38.4	7.5
57.6	5

3 Commissioning

This section tells you how to take the gateway into operation.

▶ Before switching on the supply voltage for the gateway ensure that the contactor coils, the bus connection and the SmartWire system are correctly connected.

Initial starting

▶ Make sure that the gateway's MODBUS RTU address, the parity and the baud rate for the MODBUS RTU network are set correctly with the DIP switches on the gateway's underside.

▶ Switch on the supply voltages for the contactors and the gateway.

Die gateway's LEDs now indicate the following states:

- The ready LED of the SWIRE-GW-MB flashes.
- The U-Aux LED of the SWIRE-GW-MB is permaneltly ON.
- The MODBUS-RTU-LED is OFF (no communication via MODBUS-RTU).
- The SmartWire LED flashes as the SmartWire slaves have not yet been configured.
- The first SmartWire module flashes the ready LED.
- The ready LEDs on all other SmartWire modules flash in pulses.

▶ Press the configuration button on the gateway and keep it pressed for about 2 s until the ready LED switches from flow flashing to fast flashing.

The actual configuration of the SmartWire system, i.e. all connected SmartWire modules, are now automatically read into the gateway. An address is assigned in turn to each SmartWire station, starting with address 1 and incrementing in steps of 1. When the configuration has been read in to the SmartWire system, the SWIRE status LED on the MODBUS RTU gateway and the Ready LEDs on the SmartWire module change from slow flashing to continually lit. The SmartWire

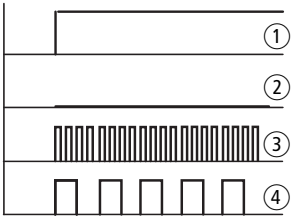
system then continually keeps the saved hardware configuration synchronized with the existing configuration. Any discrepancies identified by the system are indicated by a slowly flashing SmartWire LED (→ section "Fault-finding", page 53).

▶ Switch the MODBUS RTU master to Run. As soon as the gateway is incorporated in the MODBUS RTU field bus, the SWIRE-GW-MB indicates send and receive data transfer activity with a yellow flashing or constantly lit MODBUS RTU LED.

Meaning of the status LEDs

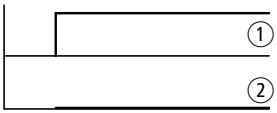
The gateway SWIRE-GW-MB has four status LEDs. These are green (UAUX, Ready and SmartWire) and yellow (MODBUS RTU).

Ready-LED



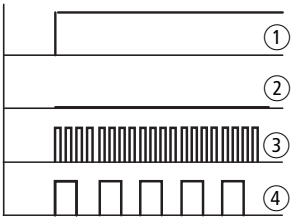
①	continuous light	Power present, communication through MODBUS active.
②	OFF	No supply voltage available for the gateway and the SmartWire or internal fault in the gateway
③	Fast flashing	New configuration has been activated via the configuration button
④	Slow flashing	MODBUS communication not active

U-Aux-LED



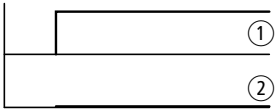
①	continuous light	Supply voltage available for the contactor coils
②	OFF	No supply voltage available

SmartWire LED



①	continuous light	SmartWire system is ok
②	OFF	No supply voltage available on the MODBUS gateway
③	Fast flashing	Transmission error in the SmartWire system
④	Slow flashing	Error in the configuration of the SmartWire system, target and actual configuration do not match

MODBUS-RTU-LED



①	continuous light	MODBUS communication active (control data being transmitted). The watchdog timer is running.
②	OFF	No supply voltage present; no data transfer through MODBUS RTU MODBUS timer timeout

4 Operation through MODBUS RTU

Incorporation in the field bus configuration

To configure the higher-level MODBUS RTU master, perform the following steps.

- ▶ Include a function block for a MODBUS RTU master in the configuration of the used PLC.
- ▶ Assign the communications port to be used for MODBUS RTU communications to this function block.
- ▶ In the MODBUS RTU function block make the required MODBUS network settings, in particular the MODBUS RTU gateway settings (baud rate, parity stop bits and address).
- ▶ Specify the size of the register areas for the MODBUS network, taking into account the data to be transferred.

The MODBUS gateway SWIRE-GW-MB has a built-in adjustable watchdog timer (see section "Setting the watchdog timer", page 43), which triggers a fault state in the gateway if MODBUS communication fails. To prevent timeouts, the control data from the SWIRE-GW-MB should be written periodically.

Data mapping of SmartWire stations

Within each MODBUS RTU device, the input and output level data are stored in various registers (input register and holding register).

For the MODBUS RTU gateway the status and control data for the connected SmartWire stations are saved to the holding register of the SWIRE-GW-MB, which contains the following data:

- Status information (input data) of the SmartWire stations
- Control data (output data) of the SmartWire stations
- Parity bits of the SmartWire stations
- Device and manufacturer's ID of the SmartWire stations
- Life bits of the SmartWire stations
- Number of connected SmartWire station
- Time value of the built-in MODBUS timer

This data is saved to the registers as follows:

Table 6: Data mapping in the SWIRE-GW-MB

Designation	Register area	Data width:	Diagram
Abbreviated control data	40001 - 40002	4 bytes	two bits per SmartWire stations
Complete control data	40003 - 40006	8 bytes	four bits per SmartWire station
Abbreviated status data 1	40007 - 40008	4 bytes	two bits per SmartWire stations
Check bits	40009	2 bytes	1bit per SmartWire station
Abbreviated status data 2	40010 - 40013	8 bytes	four bits per SmartWire station
Complete status data	40014 - 40077	128 bytes	eight bits per SmartWire station
Life bits	40078	2 bytes	1bit per SmartWire station
Station ID	40079 - 40142	128 bytes	eight bits per SmartWire station

Designation	Register area	Data width:	Diagram
Number of SmartWire stations	40143	2 bytes	binary diagram
Watchdog timer (non-retentive)	44097	2 bytes	Low byte: Time = value × 10 ms High byte: not assigned
Watchdog-Timer (remanent)	44098	2 bytes	Low byte: Time = value × 10 ms High byte: not assigned

Data diagram

The MODBUS RTU gateway always outputs its data according to the physical location of the SmartWire stations. The first data bits within each register area are for the first SmartWire station next to the MODBUS RTU gateway.

The following table provides an example with abbreviated status data area 1 (register area 40007 to 40008).

Table 7: Arrangement of register contents

Register area	Bit no.	Data content	No. of SmartWire station
40007	0 (LSB)[1)]	Status bit 1	1 slave
	1	Status bit 2	1 slave
	2	Status bit 1	2 slave
	3	Status bit 2	2 slave
	4	Status bit 1	3 slave
	5	Status bit 2	3 slave
	…	…	…
	14	Status bit 1	8 slave
	15 (MSB)[2)]	Status bit 2	8 slave
40008	0 (LSB)[1)]	Status bit 1	9 slave
	1	Status bit 2	9 slave
	2	Status bit 1	10 slave
	3	Status bit 2	10 slave
	4	Status bit 1	11 slave
	5	Status bit 2	11 slave
	…	…	…
	14	Status bit 1	16 slave
	15 (MSB)[2)]	Status bit 2	16 slave

1) LSB = Least Significant Bit,

2) MSB = Most Significant Bit

Abbreviated and full bit representation

Depending on the register data area, the status data (input data of the SmartWire stations) and control data (output data of the SmartWire stations) are output either in an abbreviated form or in full.

Abbreviated views show only the first status/control bits of each SmartWire station. For SmartWire stations with a higher number of status/control bits than shown in the abbreviated representation, only the allowed number of bits is shown. In the full view, all of the data of the SmartWire station is shown. Depending on the SmartWire station, this view may contain unused bit fields that are also transferred through MODBUS RTU.

The example below illustrates the abbreviated representation of status and control data for the stations SWIRE-DIL and SWIRE-4DI-2DO-R.

Example:
Status and control data of SWIRE-DIL and SWIRE-4DI-2DO-R

SWIRE-DIL has the following status and control data:

Table 8: Control data (write data, as seen from MODBUS RTU masters)

SWIRE-DIL	Bit 3	Bit 2	Bit 1	Bit 0
Contactor actuation				0/1

The values 0 and 1 have the following meanings (Table 9):

Table 9: Definition of the bit

Value	Meaning
0	Switch off contactor
1	Switch on contactor

Table 10: Status data (read data, as seen from MODBUS RTU master)

SWIRE-DIL	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Contactor status								0/1
PKZ status							0/1	
SWIRE-DIL status bit	0/1							

The values 0 and 1 have the following meanings (Table 11):

Table 11: Definition of the bit

Value	Contactor status	PKZ status	SWIRE-DIL status bit
0	OFF	OFF	OK
1	ON	ON	Fault

SWIRE-4DI-2DO-R has the following status and control data:

Table 12: Control data (write data, as seen from MODBUS RTU masters)

SWIRE-DIL	Bit 3	Bit 2	Bit 1	Bit 0
Actuation output Q1				0/1
Actuation output Q2			0/1	

The values 0 and 1 have the following meanings (Table 13):

Table 13: Definition of the bit

Value	Meaning
0	Switch off relay
1	Switch on relay

Table 14: Status data (read data, as seen from MODBUS RTU master)

SWIRE-4DI-2DO-R	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Status input I1								0/1
Status input I2							0/1	
Status input I3						0/1		
Status input I4					0/1			
Status bit SWIRE-4DI-2DO-R	0/1							

The values 0 and 1 have the following meanings (Table 15):

Table 15: Definition of the bit

	Status input	SWIRE-4DI-2DO-R status bit
0	Input 0	OK
1	Input 1	Fault

The display format for status and control data depends on the selected register area.

For the status data you can select two different abbreviated representations:

- Abbreviated status data 1: Two bits per SmartWire station, register area 40007 to 40008
- Abbreviated status data 2: Four bits per SmartWire station, register area 40010 to 40013

Abbreviated control data can be shown only in one representation (register area 40001 to 40002) and contain two bits per SmartWire station. The table below lists the status and control data shown in each abbreviated representation.

Table 16: Register view, abbreviated status and control data

Register	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
40001	S8 Q2	S8 Q1	S7 Q2	S7 Q1	S6 Q2	S6 Q1	S5 Q2	S5 Q1	S4 Q2	S4 Q1	S3 Q2	S3 Q1	S2 Q2	S2 Q1	S1 Q2	S1 Q1
40002	S16 Q2	S16 Q1	S15 Q2	S15 Q1	S14 Q2	S14 Q1	S13 Q2	S13 Q1	S12 Q2	S12 Q1	S11 Q2	S11 Q1	S10 Q2	S10 Q1	S9 Q2	S9 Q1
40007	S8 I2	S8 I1	S7 I2	S7 I1	S6 I2	S6 I1	S5 I2	S5 I1	S4 I2	S4 I1	S3 I2	S3 I1	S2 I2	S2 I1	S1 I2	S1 I1
40008	S16 I2	S16 I1	S15 I2	S15 I1	S14 I2	S14 I1	S13 I2	S13 I1	S12 I2	S12 I1	S11 I2	S11 I1	S10 I2	S10 I1	S9 I2	S9 I1
40010	S4 I4	S4 I3	S4 I2	S4 I1	S3 I4	S3 I3	S3 I2	S3 I1	S2 I4	S2 I3	S2 I2	S2 I1	S1 I4	S1 I3	S1 I2	S1 I1
40011	S8 I4	S8 I3	S8 I2	S8 I1	S7 I4	S7 I3	S7 I2	S7 I1	S6 I4	S6 I3	S6 I2	S6 I1	S5 I4	S5 I3	S5 I2	S5 I1
40012	S12 I4	S12 I3	S12 I2	S12 I1	S11 I4	S11 I3	S11 I2	S11 I1	S10 I4	S10 I3	S10 I2	S10 I1	S9 I4	S9 I3	S9 I2	S9 I1
40013	S16 I4	S16 I3	S16 I2	S16 I1	S15 I4	S15 I3	S15 I2	S15 I1	S14 I4	S14 I3	S14 I2	S14 I1	S13 I4	S13 I3	S13 I2	S13 I1

Sx = number of SWIRE station, Qy = control bit y of station x, Iy = status bit y of station x

Table 17: Abbreviated status and control data views

SmartWire station	Abbreviated control data (40001 – 40002)		Abbreviated status data (40010 – 40013)			
			Abbreviated status data (40007 – 40008)			
	Bit 0	Bit 1	Bit 0	Bit 1	Bit 2	Bit 3
SWIRE-DIL	Contactor actuation		Contactor status	PKZ status		
SWIRE-4DI-2DO-R	Output Q1	Output Q2	Input I1	Input I2	Input I3	Input I4

In the full representation all status and control bits of each SmartWire station are output. The complete control data use four bits of register area 40003 to 40006 for each SmartWire station. The complete status data use eight bits per SmartWire station within register area 40014 to 40077. The table below shows the structure of the status data bytes of a SmartWire station within register area 40014 to 40017.

Table 18: Status bytes for register area 40014 – 40017

Register	High byte
40014	Low byte | status data byte 2
	High byte | status data byte 1
40015	Low byte | status data byte 4
	High byte | status data byte 3
40016	Low byte | status data byte 6
	High byte | status data byte 5
40017	Low byte | status data byte 8
	High byte | status data byte 7

The table below shows the data contained within this register for a SWIRE-4DI-2DO-R.

Table 19: SWIRE-4DI-2DO-R status data, register area 40014 – 40017

Register		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
40014	Low byte	-	-	-	-	-	-	-	-
	High byte	SWIRE-4DI-2DO-R status	-	-	-	Input I4	Input I3	Input I2	Input I1
40015	Low byte	-	-	-	-	-	-	-	-
	High byte	-	-	-	-	-	-	-	-
40016	Low byte	-	-	-	-	-	-	-	-
	High byte	-	-	-	-	-	-	-	-
40017	Low byte	-	-	-	-	-	-	-	-
	High byte	-	-	-	-	-	-	-	-

→ Whether it is best to select an abbreviated or a full data representation depends on the type of SmartWire station: An abbreviated representation is best suited for stations with a small number of status or control bits, as this reduces the number of unused bit fields within the MODBUS RTU protocol; a full representation is best used for stations with a large number of status or control bits.

Control data areas

The control (output) data of the SmartWire stations are located in two different register areas, one for the abbreviated representation (two control bits per SmartWire station, register area 40001 to 40002) and one for the full representation (four control bits per SmartWire station, register area 40003 to 40006). The MODBUS RTU gateway does not support the simultaneous use of both of these data areas, since this could cause inconsistencies between the control data in the two register areas. To switch between the two control data areas, you must switch the MODBUS RTU gateway off and on again.

Check bits

The register area for parity bits is used to determine whether a station on the SmartWire has failed or has an internal fault state. Each SmartWire station has a parity bit. Within the register area, the parity bits are arranged according to the physical arrangement of the SmartWire stations. The parity bits are defined as follows:

Table 20: Definition of parity bits

Parity bit	SmartWire station status
0	Station connected and working correctly
1	Station has failed or is defective

Each parity bit represents a logic OR link of the status and life bit of its SmartWire station. It therefore contains the key diagnostic information about its SmartWire station, so that an additional evaluation of status and life bits may not be necessary.

Life bits

Register area 40078 is used for evaluating connected or failed SmartWire stations. It contains a life bit for each station for this purpose. Within the register area, the life bits are arranged according to the physical arrangement of the SmartWire stations. The life bits are defined as follows:

Table 21: Definition of life bits

Life bit	Communication status of SmartWire station
0	The SmartWire station has failed
1	The SmartWire station is communicating correctly

Status bits

Each SmartWire station sends status bits to the MODBUS RTU gateway. The status bit indicates whether the station is working correctly or has changed to a fault state. Status bits are contained only in the full representation (register area 40014 to 40077). Within this register area the status bit is the highest bit of the lowest status data byte of its station. The status bits are defined as follows:

Table 22: Definition of status bits

Status bit	State of SmartWire station
0	OK
1	Fault

Manufacturer and device ID of SmartWire station

The manufacturer and device ID data field (register area 40079 to 40142) allows the arrangement of SmartWire device types identified by the gateway as well as their hardware and software versions can be read out through MODBUS RTU. Each SmartWire station occupies eight bytes for manufacturer and device ID within the register area. These bytes contain the following information:

Table 23: Manufacturer and device ID of a SmartWire station

Data byte	Meaning	Value range	Remark
1	Node address	0x01 - 0x10	Node address 1 to 16 of station within SmartWire system
2	Slave part no./device identification:	0x00 - 0xFF	Slave type (bit 7), device ID (bit 0 to 6)
3	Hardware version	0x00 - 0xFF	Hardware version of station
4	Software version	0x00 - 0xFF	Software version of station
5	CFG-byte	0x00 - 0xFF	Read configuration identifier
6	Free	0x00 - 0xFF	Not used
7	Lifeguarding time	0x00 - 0xFF	Lifeguarding time of SmartWire system (value × 10 ms)
8	Manufacturer ID	0x00 - 0xFF	0 = No ID (reserved) 1 = Eaton 2 – 255 = unused; available for assignment

Device identification:
The SmartWire stations have the following device IDs (data byte 2):

Table 24: Device type codes

Data bit 0 to 6	Device type
0x20	SWIRE-DIL
0x21	SWIRE-4DI-2DO-R

Hardware and software version

The hardware and software versions (data bytes 3 and 4) are given as a decimal number (for example version 1.5). The corresponding data byte is split into the two indices for pre-decimal and decimal places as follows:

Table 25: Hardware and software version data bytes

Data bytes one and four	Hardware/software version
Bit 0 - 3	Decimal places
Bit 4 - 7	Pre-decimal place

→ The hardware and software version code is not supported by all SmartWire device types.

CFG-byte
A description of the status data for each SmartWire stations is contained in the the station's CFG byte (data byte 5). This byte contains information about the station's number and format of status data bytes. The CFG byte has the following structure:

Table 26: Structure of the CFG byte

Bit	Meaning	Value range
0 (LSB)[1)]	Length of status data	00 = 1 byte (one word) 01 = 2 bytes (two words) 02 = 3 bytes (three words) 03 = 4 Bytes (four words) 04 = 5 bytes 05 = 6 bytes 06 = 7 bytes 07 = 8 bytes
1		
2		
3		
4	Type of status data	00 = no status data 01 = Input data
5		
6	Data structure	0 = Byte structure 1 = Word structure
7 (MSB)[2)]	Data consistency	0 = consistency through byte or word 1 = consistency through entire length

[1)] LSB = Least Significant Bit, [2)] MSB = Most Significant Bit

The status data length is described with data bits 0 to 3 of the CFG byte. Each SmartWire station can have up to eight status data bytes. These are contained in the station with either a byte structure (eight status bytes) or a word structure (four data words). The status data structure (word or byte) is defined with bit 6.

→ The register area for manufacturer and device ID is written once during initialization of the SWIRE-GW-MB. Any failed SmartWire stations remain in this representation and are removed only at the next startup of the SWIRE-GW-MB.

Number of SmartWire stations

The number of device types connected to the SmartWire is given in register area 40143. Up to 16 SmartWire stations can be connected for each gateway.

The register area for the number of SmartWire stations is written once during initialization of the SWIRE-GW-MB. Any failed SmartWire stations remain in this representation and are removed only at the next startup of the SWIRE-GW-MB.

Setting the watchdog timer

The MODBUS RTU gateway has a built-in watchdog timer, which monitors the data traffic within the MODBUS RTU network. The watchdog timer monitors the interval between two control data write operations. If the interval exceeds the set value, the watchdog triggers an internal error state in the SWIRE-GW-MB, which causes all control data of the SmartWire station to be deleted (logic 0). The control data status (logic 0) remains active until it is set by new write signal.

The timeout value of the watchdog timers can be set with the two register areas 44097 and 44098. Valid time values are written to the least significant byte of the respective register. The watchdog timer has a polling interval of 10 ms. Timeout values of 10 to 2550 ms can be set.

The set time interval is temporarily written to register area 44097. In the event of a power failure ($U_{Gateway}$) this data is deleted. Any data written to the non-retentive memory area (register area 44097) of the SWIRE-GW-MB are also copied to register area 44098, where they are available as read information.

Within register area 44098 the set time interval is retentively stored to remain available after a power failure. The default timeout value is 100 ms.

Access methods to the register areas

The data of the SmartWire stations are mapped to the holding register of the SWIRE-GW-MB. Normally, the holding register area can be both read and written to. Some data areas (such as the SmartWire stations' status data) are read-only. For any write operations to read-only areas the MODBUS RTU gateway returns an error code.

Table 27: Access methods to the register areas

Designation	Register area	Access method
Abbreviated control data	40001 - 40002	write/read access
Complete control data	40003 - 40006	write/read access
Abbreviated status data 1	40007 - 40008	read access
Check bits	40009	read access
Abbreviated status data 2	40010 - 40013	read access
Complete status data	40014 - 40077	read access
Life bits	40078	read access
Manufacturer and device ID	40079 - 40142	read access
Number of SmartWire units	40143	read access
MODBUS timer (non-retentive)	44097	write/read access
MODBUS-Timer (remanent)	44098	write/read access

MODBUS-functions

This section describes the MODBUS functions and the structure of a MODBUS message.

Structure of a MODBUS message

The MODBUS RTU communication system is based on the master-slave principle: The MODBUS master sends a request message to the MODBUS slave, which – if it is fault-free – returns a response message. Request and response messages in MODBUS have the same format.

ID	FC	B_0	…	…	B_n	CRC_{low}	CRC_{high}

Figure 13: Structure of a MODBUS message

Slave address (ID)	Address of the MODBUS slave. Broadcast messages (request to all MODBUS slaves) have slave address 0 (zero).
Function code (FC)	Command from the MODBUS master to be executed by the MODBUS slave. For function codes that are not supported,the response message from the MODBUS slave contains the function code of the request message increased by 128 (0x80).
Data bytes ($B_0 – B_n$)	User data field For Read commands, the response message contains the content of the queried register area in this field. For Write commands, the request message contains the content of the register to be written in this field.
Checksum (CRC_{low} CRC_{high})	Contains the checksum. The checksum is generated with the CRC 16 method from all previous message bytes (ID to B_n). It is calculated as follows: CRC-16 = ((ID…B_n) × 0x100000) mod 0x18005

Write commands

Write Single Register (0x06)

Request message

ID	0x06	REG_{high}	REG_{low}	D_{high}	D_{low}	$CRC_{low,req}$	$CRC_{high,req}$

Response message

ID	0x06	REG_{high}	REG_{low}	D_{high}	D_{low}	$CRC_{low,res}$	$CRC_{high,res}$

0x06	Write Single Register – Writes to a single read/write register
REG	Register address of the register to be written to (register = register address-40001; "minus")
D	Data bytes to be written to the register
CRC_{req}	Checksum of the request message
CRC_{res}	Checksum of the response message

Write Multiple Registers (0x16)

Request message

ID	0x10	REG_{high}	REG_{low}	N_{high}	N_{low}	B	$D_{1,high}$	…

D_{high}	D_{low}	$CRC_{low,req}$	$CRC_{high,req}$

Response message

ID	0x10	REG_{high}	REG_{low}	N_{high}	N_{low}	$CRC_{low,res}$	$CRC_{high,res}$

0x10	Write Multiple Register – Writes to one or more read/write registers
REG	Register address of the lowest register to be written to (register = register address-40001)
N	Number of registers to be written to
B	Number of data bytes to be written ($D_{1,high}$ - $D_{n,low}$)
D	Data bytes to be written to the registers. The register with the lowest address is written to first.
CRC_{req}	Checksum of the request message
CRC_{res}	Checksum of the response message

Read commands

Read Holding Register (0x03)

Request message

ID	0x03	REG_{high}	REG_{low}	N_{high}	N_{low}	$CRC_{low,req}$	$CRC_{high,req}$

Response message

ID	0x10	REG_{high}	REG_{low}	$D_{n,high}$	…	$D_{n,low}$	$CRC_{low,res}$	$CRC_{high,res}$

0x03	Read Holding Register
REG	Register address of the lowest register to be read out (register = register address-40001)
N	Number of registers to be read out
D	Content of registers to be read out. The register with the lowest address is read out first.
CRC_{req}	Checksum of the request message
CRC_{res}	Checksum of the response message

MODBUS diagnostic functions (0x08)

Diagnostic functions are used to test MODBUS RTU communications. These functions are used with a separate function code (0x08). With additional sub-function codes various diagnostic function codes can be applied to test communications. The MODBUS message for diagnostic functions has the following structure:

Request message

ID	0x08	FC_{high}	FC_{low}	$D_{high,req}$	$D_{low,req}$	$CRC_{low,req}$	$CRC_{high,req}$

Response message

ID	0x08	FC_{high}	FC_{low}	$D_{high,res}$	$D_{low,res}$	$CRC_{low,res}$	$CRC_{high,res}$

0x08	Diagnostics
FC	Function code of diagnostic function
D_{req}	Data field of request message, which can contain additional data
D_{res}	Data field of response message, which can contain return values for the requested diagnostic function

The MODBUS RTU gateway supports the following MODBUS diagnostic functions:

0x00 Return Query Data
With this command the SWIRE-GW-MB returns the message sent by the MODBUS master.

0x01 Restart Communications Option
With this command the MODBUS port of the SWIRE-GW-MB is restarted. If the gateway is in Listen Only state, it is taken out of this state. With additional code 0xFF in data byte $D_{high,res}$ the error states are reset in addition. If power is interrupted, the error counters are reset to zero.

0x02 Return Diagnostic Register
The SWIRE-GW-MB does not support diagnostic code 0x02. It responds to this message with a zero.

0x04 Force Listen Only Mode
In Listen Only mode, the MODBUS RTU gateway does not respond to messages from the MODBUS master.

0x0A Clear Counters
This command resets the counters for protocol send or receive errors to zero.

0x0B Return Bus Message Count
Returns the number of recognized MODBUS messages in data field D_{res} of the response message.

0x0C Return Bus Communication Error Count
Returns the count for received messages with incorrect CRC checksum.

0x0D Return Bus Exception Error Count
Returns the count for messages that the SWIRE-GW-MB has identified as incorrect (for example message with unsupported function codes) and has responded to with an error message.

0x0E Return Slave Message Count
Returns the number of messages sent to the SWIRE-GW-MB.

0x0F Return Slave No Response Count
Returns the the number of messages that the SWIRE-GW-MB has received but not responded to (for example messages received in Listen Only mode or messages with incorrect checksum).

0x10 Return Slave NAK Count
Returns the number of messages that the gateway has received and responded to with a negative acknowledge (NAK).

0x11 Return Slave Busy Count
Returns the number of messages that the gateway was unable to answer because it was busy processing other instructions.

0x12 Return Bus Character Overrun Count
Returns the number of messages that the gateway was unable to answer due to a receive buffer overrun.

The type and number of supported function codes depend on the device used as MODBUS master. The function and diagnostic codes listed here can be called up only if the MODBUS master supports them.

Polling device information for SWIRE-GW-MB

You can call up device information about the MODBUS RTU gateway with function code 0x2B/0x0E. The SWIRE-GW-MB returns the following values in ASCII format:

Vendor name	Eaton
Device Code	SW-GW-MB
MajorMinor Revision	VXX.XX

Diagnostic data

Diagnostics of the SmartWire stations can be performed in a number of ways:

- As long as the SmartWire modules communicate with the gateway they send a status bit, which is included in the full status data. (section "Status bits", page 39)
- The SWIRE-GW-MB monitors the SmartWire stations. It recognizes the failure of any stations and sets the corresponding life bit.
- Failed or faulty SmartWire modules are also included in the parity bits' register area.

Checking the SmartWire configuration

The SmartWire connection system initializes when the configuration key on the MODBUS RTU gateway is pressed. During this process, addresses are automatically assigned to all stations and their device files are read in to the MODBUS RTU gateway. A correct system initialization can be verified through register areas 40079 to 40142 (manufacturer and device ID) and register 40143 (number of SmartWire stations). Within the manufacturer and device ID register area all stations are listed with the device data that the gateway read during initialization. The number of SmartWire stations that the gateway recognized during its initialization is contained in register 40143. Incorrectly initialized SmartWire stations are not included in the register areas for manufacturer and device ID and for the number of SmartWire stations.

Before operation, read out both register areas and compare them with the physical layout of the SmartWire rung. This will help you identify any faulty modules of communication connections before starting operation.

Fault-finding

In addition to diagnostic inspection through the MODBUS RTU field bus the LEDs of the SmartWire modules and the MODBUS RTU gateway can be used to locate the fault.

Table 28: Error messages

No.	Components	Event	Explanation	Remedy
1	Gateway	SmartWire LED Flashing	The station's configuration is incorrect.	• Check plug connection • After replacing devices, press configuration key
	SmartWire module	Ready-LED Flashing		
	Following SmartWire modules	Ready-LED Pulse flashing		
2	Gateway	Ready-LED OFF	Internal error	Exchange gateway
		MODBUS-LED Lit or flashing		
3	Gateway	Ready-LED Flashing	No communication through MODBUS RTU, timeout of watchdog timer or PLC in Stop	• Check MODBUS RTU connection • Switch PLC to RUN • Match watchdog timer to application
		MODBUS-LED OFF		
4	Gateway	U-Aux-LED OFF	No voltage on the U-Aux terminal	Check the power supply, wiring and fusing for the supply voltage to the contactor coils

5 Appendix

Technical data	General		
Standards			
General			IEC/EN 60947, EN 55011, EN 55022 IEC/EN 61000-4, IEC/EN 60068-2-27
Mounting			Top-hat rail IEC/EN 60715 (35 mm)
Dimensions (W × H × D)		mm	35 × 90 × 109
Weight		kg	0.14
Terminal capacity			
solid		mm^2	0.5 - 1.5
flexible with ferrule		mm^2	0.5 - 1.5
Solid or stranded		AWG	22 - 16
Standard screwdriver		mm	3.5 × 0.8
Max. tightening torque		Nm	0.6
Ambient climatic conditions			
Ambient temperature			
Operation		°C	–25 - +55
Storage		°C	–25 - +70
Condensation			Prevent condensation by means of suitable measures
Relative humidity, non-condensing (IEC/EN 60068-2-30)		%	5 - 95
Air pressure (in operation)		hPa	795 - 1080
Ambient mechanical conditions			
Protection type (IEC/EN 60529)			IP20
Pollution degree			2
Mounting position			Vertical

Electromagnetic compatibility (EMC)			
Electrostatic discharge (IEC/EN 61000-4-2, Level 3, ESD)			
Air discharge		kV	8
Contact discharge		kV	6
Electromagnetic fields (IEC/EN 61000-4-3, RFI)	V/m		10
Radio interference suppression (EN 55011, EN 55022)			Class A
Burst pulses (IEC/EN 61000-4-4, level 3)			
Supply cables		kV	2
Signal cables		kV	2
High-energy pulses (surge) (IEC/EN 61000-4-5, Level 2)		kV	0.5 (supply cables, symmetrical)
Immunity to line-conducted interference to (IEC/EN 61000-4-6)		V	10
Insulation resistance			
Clearance in air and creepage distances			EN 50178, EN 60947-1, UL 508, CSA C22.2 No 142
Insulation resistance			EN 50178, EN 60947-1
Voltage supply, Gateway electronic and Smart-Wire station electronics $U_{Gateway}$			
Rated operating voltage $U_{Gateway}$		V DC	24 (-15 %, +20 %)
permissible range			20.4 - 28.8
Residual ripple		%	≦ 5
Maximum current consumption at 24 V DC		mA	350 (typically 110 gateway + typically 15 per SmartWire module)
Voltage dips (IEC/EN 61131-2)		ms	10
Heat dissipation at 24 V DC		W	normally 6
Protection against polarity reversal			yes
Short-circuit protection SmartWire side			yes

Power supply U_{AUX} (power supply for switching SmartWire elements, e.g. contactor coils)			
Rated operational voltage U_{AUX}		V DC	24 (15 %, +20 %) (Derating from > 40 °C)
permissible range		V DC	20.4 - 28.8 at 45 °C: 21 - 28.8 at 50 °C: 21.6 - 28.8 at 55 °C: 22.2 - 27.6
Input current U_{AUX} at 24 V DC		A	Normally 3
Residual ripple		%	≦ 5
Voltage dips (IEC/EN 61131-2)		ms	10
Protection against polarity reversal			yes
Short-circuit protection SmartWire side			No, external fuse 3 A or FAZ-Z3 necessary

LED indicators

Ready for operation	Ready: green
Power supply SmartWire contactors	U_{Aux}: green
MODBUS-RTU status	MODBUS RTU: yellow
Status SmartWire	SmartWire: green

MODBUS-RTU

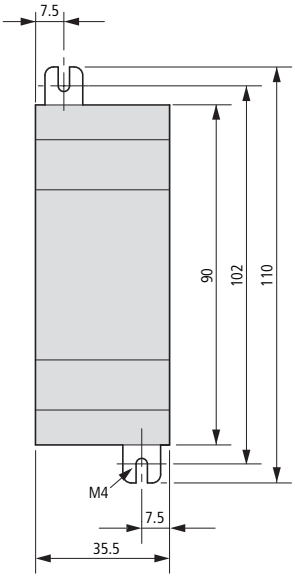
Connection	SUB-D 9-pole, socket
Communication standard	RS232 or RS485
Station address	1 - 125
Address allocation	DIP switches
Protocol settings	DIP switches

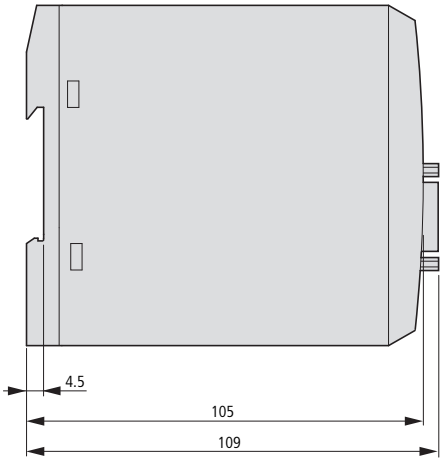
Potential isolation	
for supply voltage U_{AUX}	yes
for supply voltage $U_{Gateway}$	yes
To SmartWire	yes
Function	MODBUS master slave
Bus protocol	MODBUS-RTU
Bus terminating resistors	External connection
Baud rate	9.6, 19.2, 38.4 or 57.6 kbits/s, set with DIP switch

Connection system SmartWire

Connection			Plug, 6-pole
Data/power cable			6 core flat-band cable
maximum cable length, SmartWire system		m	4 m
Bus termination			no
Station address			Automatic assignment
Station			max. 16
Address allocation			None
Potential isolation			
for supply voltage U_{AUX}			no
for supply voltage $U_{Gateway}$			no

Dimensions





Index

B Baud rate
Setting 11
Baud rates 21
Bit representation
Abbreviated 31
Complete 31

C Cable lengths 21
CFG-byte 41
Check bits 38
Connect connection cable 13
Control data 38

D Diagnostics functions 49
DIP switches 11

E EMC compliance 19
EMC-conformant wiring of the network 19
Error messages 53

F Fault-finding 53
Function codes 49

H Holding register 28

I Input-register 28

L LEDs 9
Life bits 39

M
Manufacturer and device ID 40
MODBUS
diagnostics functions 49
MODBUS telegram 45
MODBUS-RTU 5
MODBUS-RTU-LED 25
MODBUS-RTU-Master
configuration 27

P
Parity
setting 11
Pin functions 18
Potential separation 21

R
Read commands 48
Ready-LED 24
Register areas 44
RS232
max. cable length 21
RS485 17
max. cable length 21

S
Set station address 11
Shielding 20
SmartWire 5
SmartWire LED 25
SmartWire module I/O 9
Standards 55
Starting
First time 23
Station address 11
Status bits 39
Status data for SWIRE-4DI-2DO-R 37
Status LEDs 24
Supply voltage, Connecting 14
SWIRE-GW-MB 5

T Technical data 55
Terminating resistor 19

U U-Aux-LED 24

W Watchdog-timer 43
Write commands 46