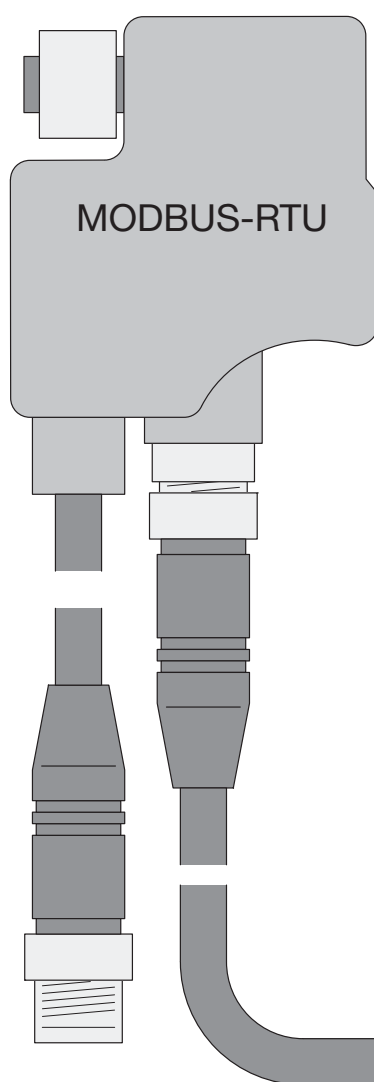




V6

**MODBUS-RTU FieldBusPlug  
MRP21-FBP**



**Please note the following****Target group**

This description is intended for the use of trained specialists in electrical installation and control and automation engineering, who are familiar with the applicable national standards.

**Safety requirements**

The responsible staff must ensure that the application or use of the products described satisfy all the requirements for safety, including all the relevant laws, regulations, guidelines and standards.

| What is new in this version?                                                                        | available from device version |
|-----------------------------------------------------------------------------------------------------|-------------------------------|
| Description of new commands to read-back the baud rate and the binary and analog output data added. | Index f                       |



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## Introduction

- Terminology
- Introduction to MODBUS FieldBusPlug

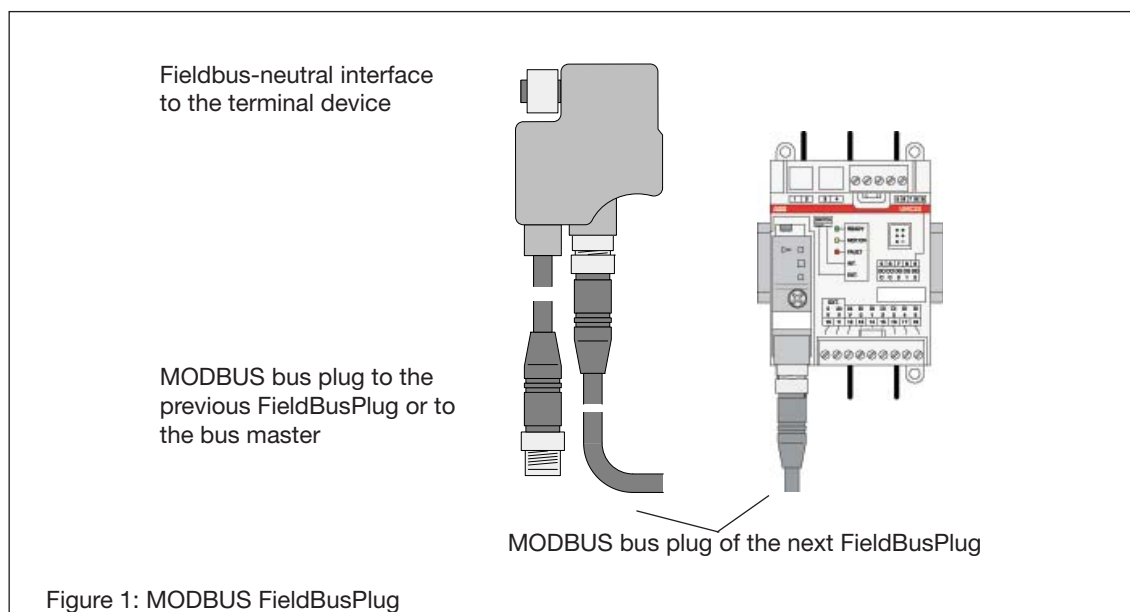
## Terminology

|        |                                                                          |
|--------|--------------------------------------------------------------------------|
| RTU    | MODBUS “ <b>R</b> emote <b>T</b> erminal <b>U</b> nit” transmission mode |
| PDU    | <b>P</b> rotocol <b>D</b> ata <b>U</b> nit                               |
| PLC    | <b>P</b> rogrammable <b>L</b> ogic <b>C</b> ontroller                    |
| CRC    | <b>C</b> yclical <b>R</b> edundancy <b>C</b> heck                        |
| LED    | <b>L</b> ight- <b>E</b> mitting <b>D</b> iode                            |
| FBP    | <b>F</b> ield <b>B</b> us <b>P</b> lug (FieldBusPlug)                    |
| MRP    | <b>M</b> ODBUS <b>R</b> TU FieldBus <b>P</b> lug                         |
| MSD    | <b>M</b> otor <b>S</b> tarter <b>D</b> irect                             |
| MSR    | <b>M</b> otor <b>S</b> tarter <b>R</b> everse                            |
| MFI    | <b>M</b> otor <b>S</b> tarter <b>F</b> ieldbus <b>I</b> nterface         |
| UMC    | <b>U</b> niversal <b>M</b> otor <b>C</b> ontroller                       |
| LB     | <b>L</b> ow <b>B</b> yte in a 16-bit word.                               |
| HB     | <b>H</b> igh <b>B</b> yte in a 16-bit word.                              |
| 0xyyyy | 0x defines that the number yyyy is a hexadecimal value                   |

## Definition of the terms “input” and “output”

An “output” is a data value sent to a MODBUS slave and an “input” is a monitoring value generated by the same MODBUS slave.

## Introduction to MODBUS FieldBusPlug



The MODBUS FieldBusPlug MRP21-FBP establishes the field bus connection between the MODBUS and the terminal devices connected to this bus. The MODBUS FieldBusPlugs are slaves (nodes) on the MODBUS network.

The terminal devices must have the field bus-neutral interface (e.g. as provided by the ABB FBP modules MSD11-FBP, MSR22-FBP, MFI21-FBP and UMC22-FBP).



The data exchange between the MODBUS FieldBusPlug and the terminal device can be performed in two ways:

- **Parallel communication**

The signals are exchanged directly via the connections of the field bus-neutral interface.

Scope of data: max. 1 digital output (1 control signal to terminal device) plus 2 digital inputs (2 feedback signals from terminal device). If the FieldBusPlug does not receive any telegram from the terminal device during power-on, this mode of data exchange will be set.

- **Serial communication**

The signals are exchanged with the help of a serial data protocol via the field bus-neutral interface. Binary, analog, parameter and diagnostic data is sent and received. As soon as the FieldBusPlug receives a valid telegram from the terminal device, this mode of data exchange will be set non-volatile.

The MODBUS FieldBusPlug MRP21-FBP behaves as an input/output module on the MODBUS.

During the initialization phase, the plug receives the device-specific (configuration) data from the terminal device. This data is equal to the corresponding data in the bus master, provided that the correct terminal device was selected there.

During start-up, an optional configuration data may be transferred from the bus master to the plug. To make sure that the right serial device is connected.

To make sure, that the bus master can access the slaves connected to the bus line, a setting of the slave addresses is always necessary. Generally and over the full address range, the CAS21-FBP addressing set can be used. But it is easier, if the terminal device has address setting switches or similar means for the address setting. In this case, the FieldBusPlug adopts the address from the terminal device during power-on.

Once the address is set, it is stored in the FieldBusPlug, even in case of supply voltage breakdown.

According to the MODBUS standard, the addresses 1 to 247 can be set. The address 0 is reserved and should not be used for slaves.

For diagnosis purposes, the MODBUS FieldBusPlugs are equipped with four LEDs (see Figure 25: Indicators and operating elements on the front plate).

In addition to the two signal cores, the MODBUS cable contains two cores for 24 V. This voltage is always necessary for supplying the FieldBusPlugs. The voltage can be fed-in at the bus master, for example.



Caution:

False polarity or reversal between bus lines and power supply lines can cause a destruction of the FieldBusPlug.



Supplying the terminal devices can be selected as follows:

**Internal supply** (switch position "INT"):

The terminal device is powered from the bus cable, too.

**External supply** (switch position „EXT“):

The terminal device is powered by a remote power supply. This is necessary, if the current consumption is high or if there are components installed to the terminal device, which are not nearby, e.g. proximity switches. There is an electrical isolation between the MODBUS signals and the field bus neutral interface.

**MODBUS data overview**

|                                    | Group                                    |        | Type / remark                          | Qty. / Presentation on the MODBUS              | Starting Address | Direction | MODBUS Function Code  |
|------------------------------------|------------------------------------------|--------|----------------------------------------|------------------------------------------------|------------------|-----------|-----------------------|
| Cyclic data                        | Monitored signals (inputs)               |        | DI = digital input serial device       | 0 – 256 bits                                   | 0x0000           | read      | 1, 2                  |
|                                    |                                          |        | DI = digital input parallel device     | 2 bits                                         | 0x1000           |           |                       |
|                                    |                                          |        | AI = analog input serial device        | 0 – 125 words                                  | 0x0200           | read      | 3, 4                  |
|                                    | Commands (outputs)                       |        | DO = digital output serial device      | 0 – 256 bits                                   | 0x0100           | write     | 15                    |
|                                    |                                          |        | DO = digital output parallel device    | 1 bit                                          | 0x1100           |           |                       |
|                                    |                                          |        | AO = analog output serial device       | 0 – 125 words                                  | 0x0300           | write     | 16                    |
| Acyclic data from / to device      | Diagnosis                                |        | Faults and warnings                    | free block length<br>0 – 8 words               | 0x2000           | read      | 3, 4                  |
|                                    | Parameters                               | block  | Control function...<br>trip class ...  | range 0 - 120 words,<br>qty. defined by device | 0x3000           | write     | 16                    |
|                                    |                                          | single | not possible                           | -                                              | -                | -         | -                     |
|                                    | Configuration *                          |        | qty. of DI, DO, ...<br>parameters, ... | fixed block 7 words                            | 0x4050           | write     | 16                    |
|                                    | Configuration **, Identification, others |        | dto.+ product<br>code..., baud rate... | free block length<br>0 – 51 words              | 0x4000<br>***    | read      | 3, 4                  |
| Acyclic data, not from / to device | Set baud rate                            |        | optional                               | 1 word                                         | 0x4064           | write     | 16                    |
|                                    | Return query data                        |        | optional,<br>life monitoring           | Function code 08,<br>Sub code 00               | -                |           | 08,<br>Sub code<br>00 |

\* The Configuration frame is optional, with this frame can be checked whether the correct device is connected.

\*\* Contains configuration, identification and other data.

\*\*\* Configuration data start with 0x4028.



### Hardware installation guide

- Bus topology
- MODBUS physical communication layer
- FieldBusPlug connector pin assignment
- Powering the FieldBusPlugs
- Connecting several FieldBusPlugs on the MODBUS network
- Connecting the MODBUS master via RS-232 to RS-485 converters
- MODBUS round cable, one cable end without plug

### Bus topology

#### General overview

The figure below gives a general overview of the serial bus infrastructure in a MODBUS multipoint serial line system.

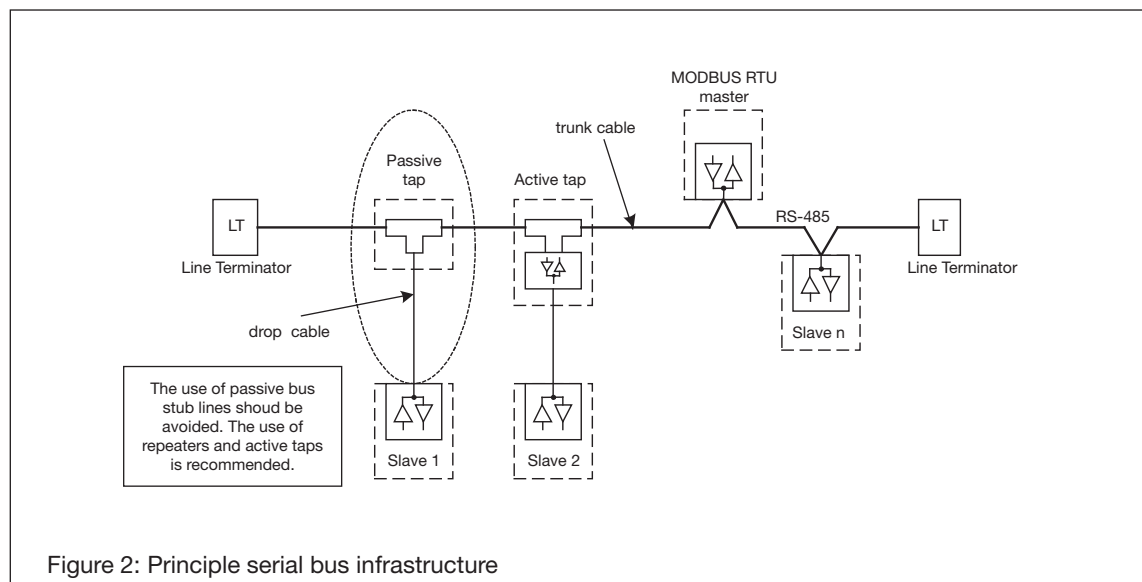


Figure 2: Principle serial bus infrastructure

### Two-wire MODBUS topology

A MODBUS solution over serial line is based on a "Two-wire" electrical interface in accordance with EIA/TIA-485.

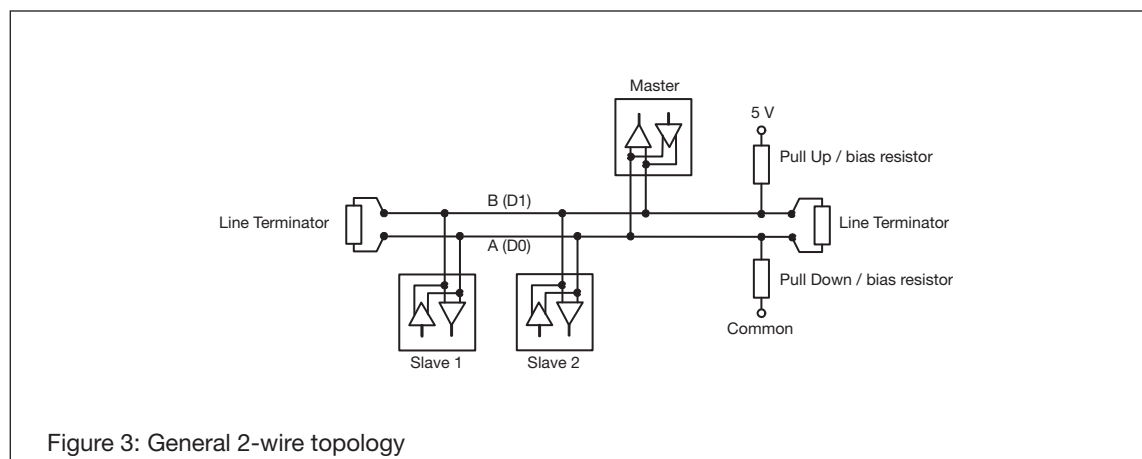
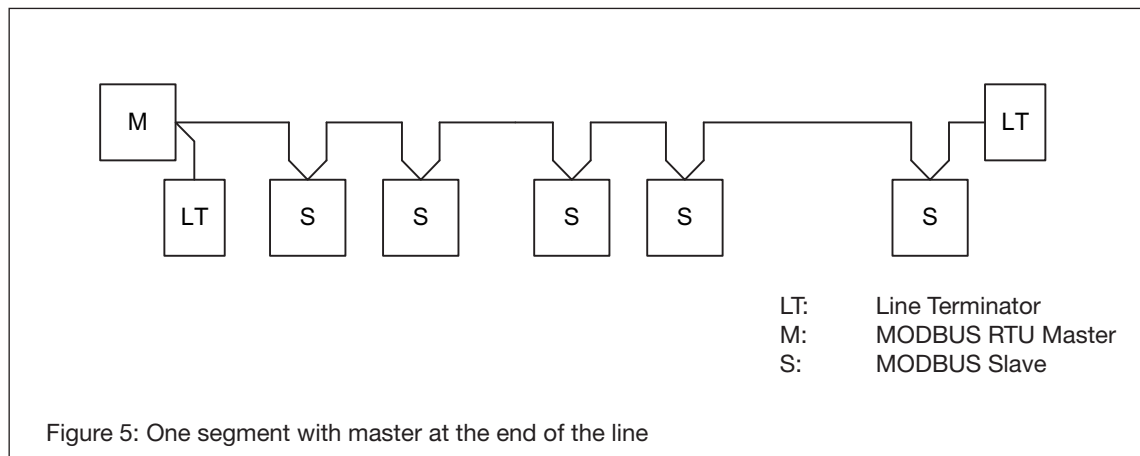
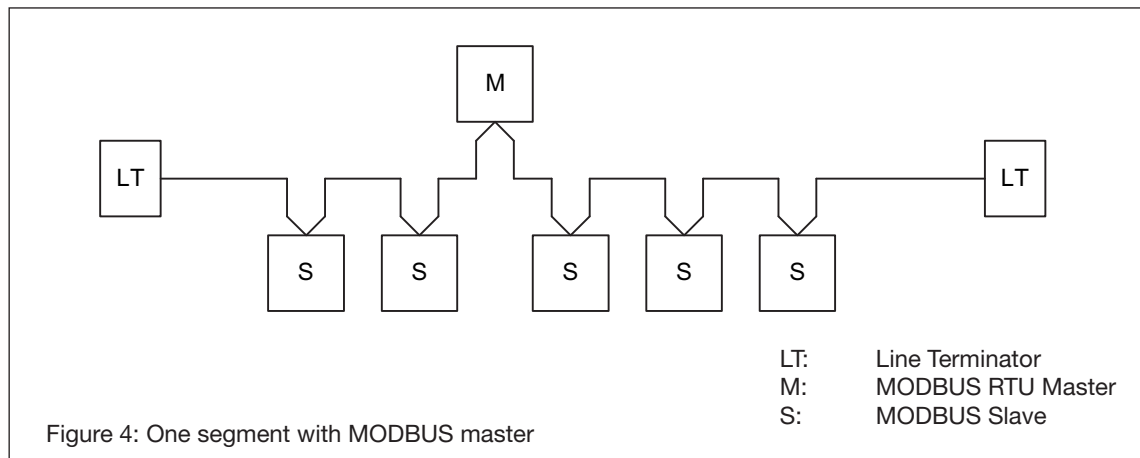


Figure 3: General 2-wire topology



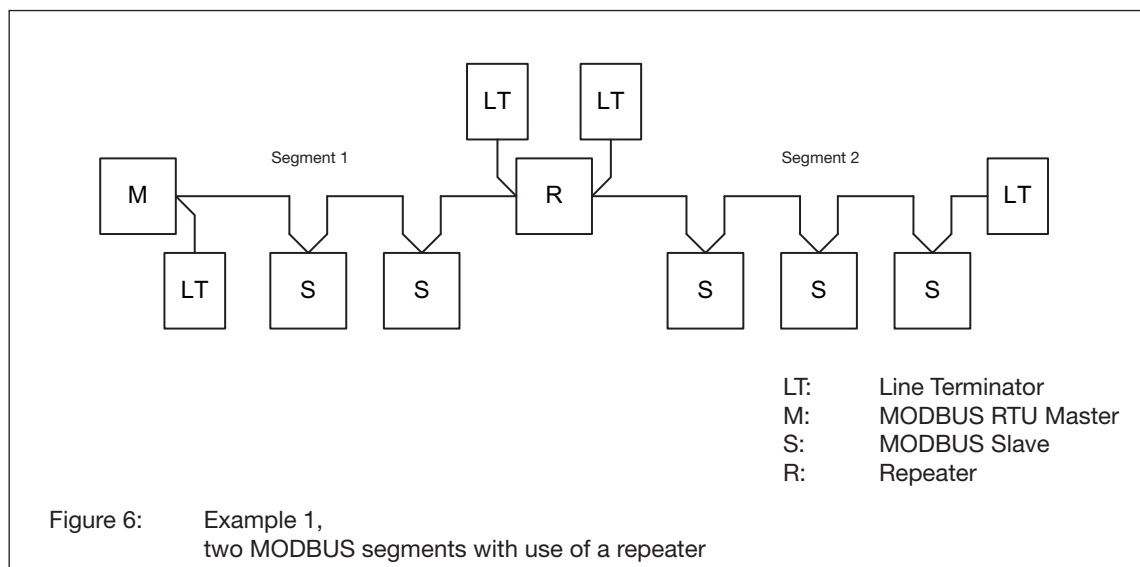


## Examples of MODBUS installations without segmentation



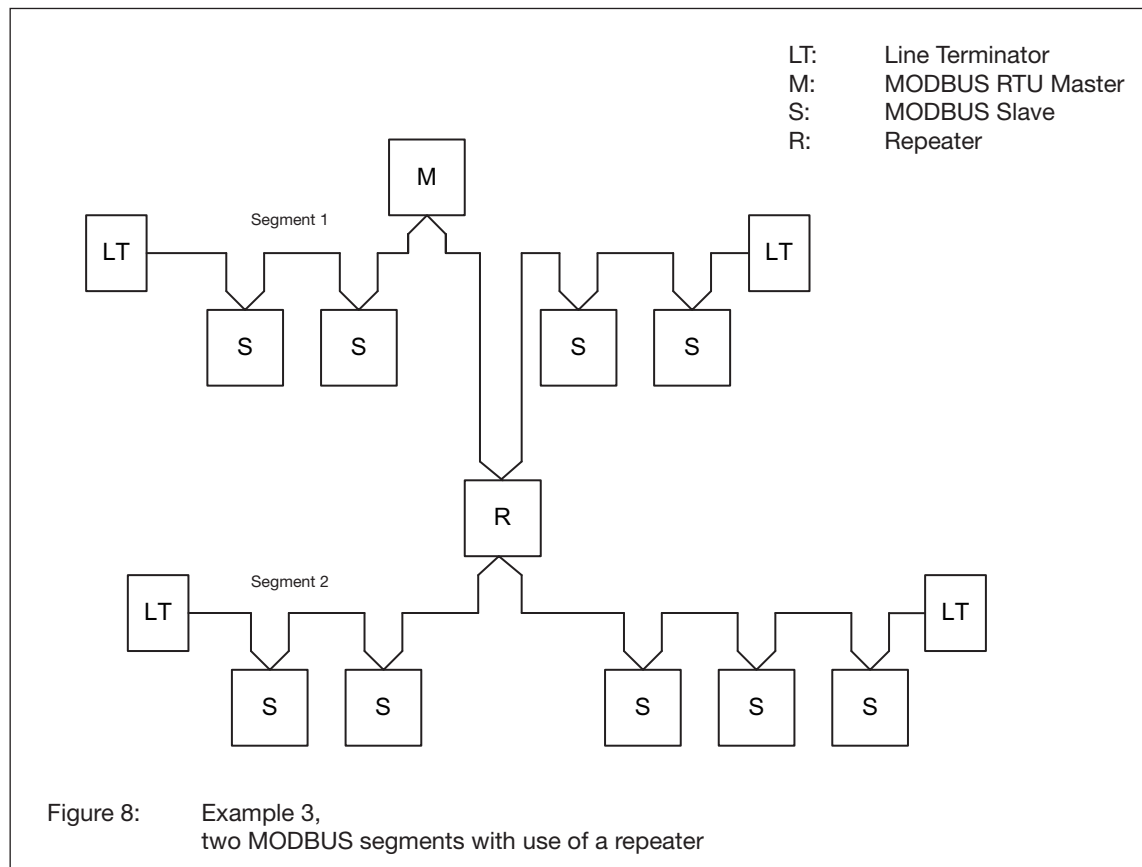
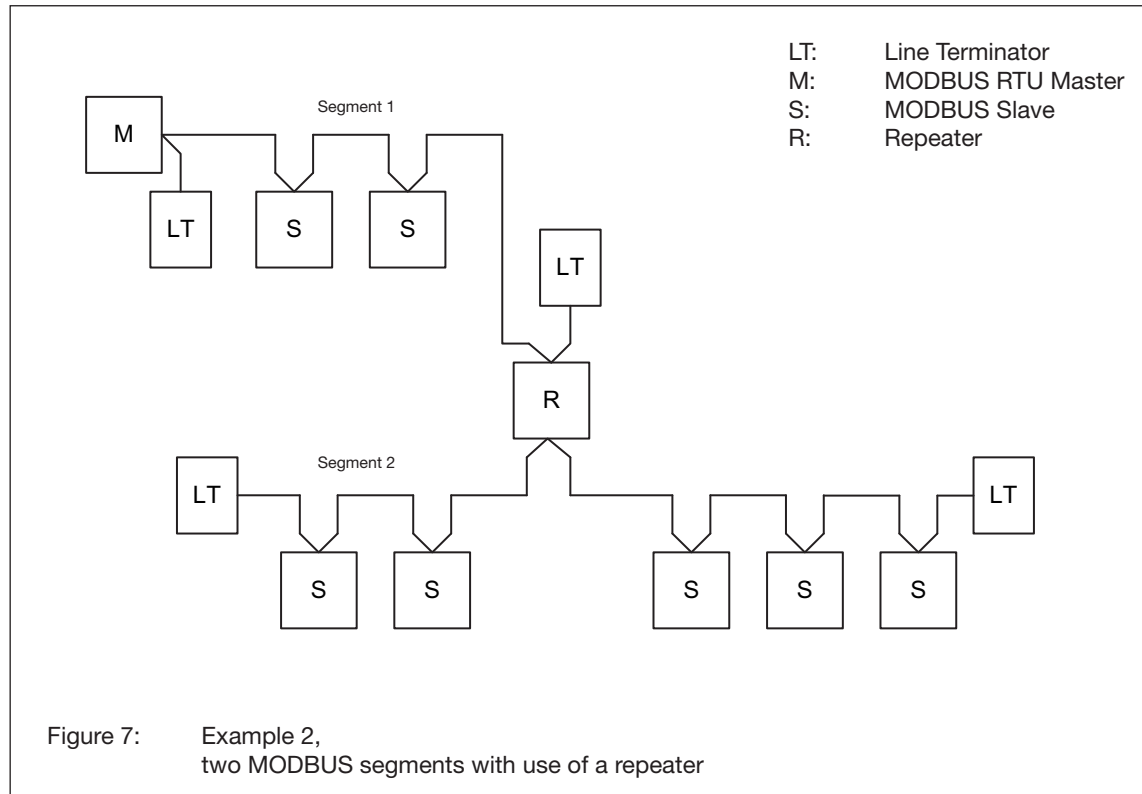
## Segmenting of MODBUS installation

The following figure illustrates the segmenting of an example MODBUS installation which uses a repeater.





There are two more figures which illustrate the segmenting of an example MODBUS installation using a repeater.





### MODBUS physical communication layer

#### Physical communication layer

At the physical level, the RS-485 (TIA/EIA-485) two-wire interface is used. This allows point to point and multipoint systems.

#### Maximum number of devices on a bus segment

Each bus segment can have a maximum of 32 active devices.

- MODBUS RTU master
- MODBUS slave
- Repeater

In order to be able to connect a larger number of MODBUS devices, a repeater is used. Repeaters interconnect the bus segments and refresh the data signals. Each repeater also allows to extend the maximum admissible cable length. Repeaters increase the signal propagation delay times, therefore a maximum of **four** repeaters are allowed between any two stations.

#### Length

Trunk cable:

The end-to-end length of the trunk cable is limited. The maximum length is 1000m.  
The bus length can be extended with repeaters (max. 4 repeaters in series).

Drop cable:

The use of passive bus stub lines should be avoided. The use of repeaters and active taps is recommended.

#### Line Termination

Termination resistors should be placed only at the ends of the bus line, and no more than 2 terminations should be placed in any system that does not use repeaters.

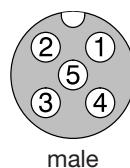
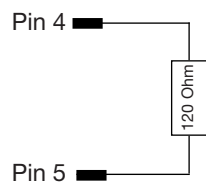
A switchable (on/off) terminal resistor (and bias resistors) are normally placed in:

- MODBUS master
- Repeater
- RS-232 to RS-485 converter (see Figure 9)

The terminal resistor DNR11-FBP.120 can be used (see Accessories) if the device at the end of the line has no built-in terminal resistor.

#### DNR11-FBP.120 Pin assignment

Pins 1- 3 = unused





### Biasing the line

When an RS-485 bus is in an idle state, all devices are in listen (receive) mode. Without anything driving the bus, the state of the line is unknown. In order to maintain a proper idle voltage state, **bias resistors must be applied** to force the data lines to the idle condition. Bias resistors are a pull-up resistor on the data B line (typically to 5V) and a pull-down (to ground) on the data A line.

Bias resistors are normally placed in:

- MODBUS master
- Repeater
- RS232 to RS485 converter

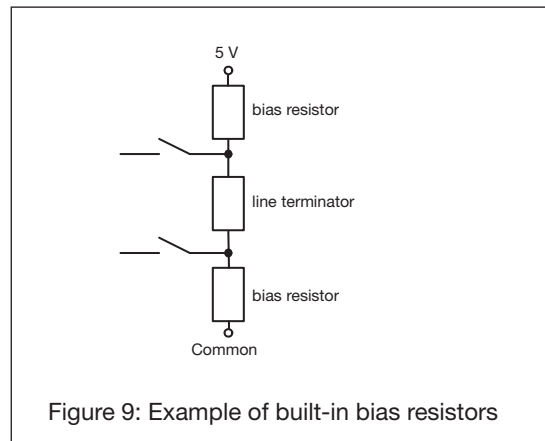


Figure 9: Example of built-in bias resistors

The MODBUS FieldBusPlug MRP21-FBP has build-in bias resistors of 22 k $\Omega$  each.

### Fail save biasing of the bus

The sum of all bias resistors, from the data B line typically to 5V respectively from the data A line to ground, in a bus segment shall be  $\leq 750 \Omega$ .

#### Example 1:

Mounting 31 FieldBusPlugs in a MODBUS segment the sum of the bias resistors is  $\sim 710 \Omega$ . In that case no additional bias resistors are necessary.

#### Example 2:

Mounting 5 FieldBusPlugs in a MODBUS segment the sum of the bias resistors is  $4400 \Omega$ .

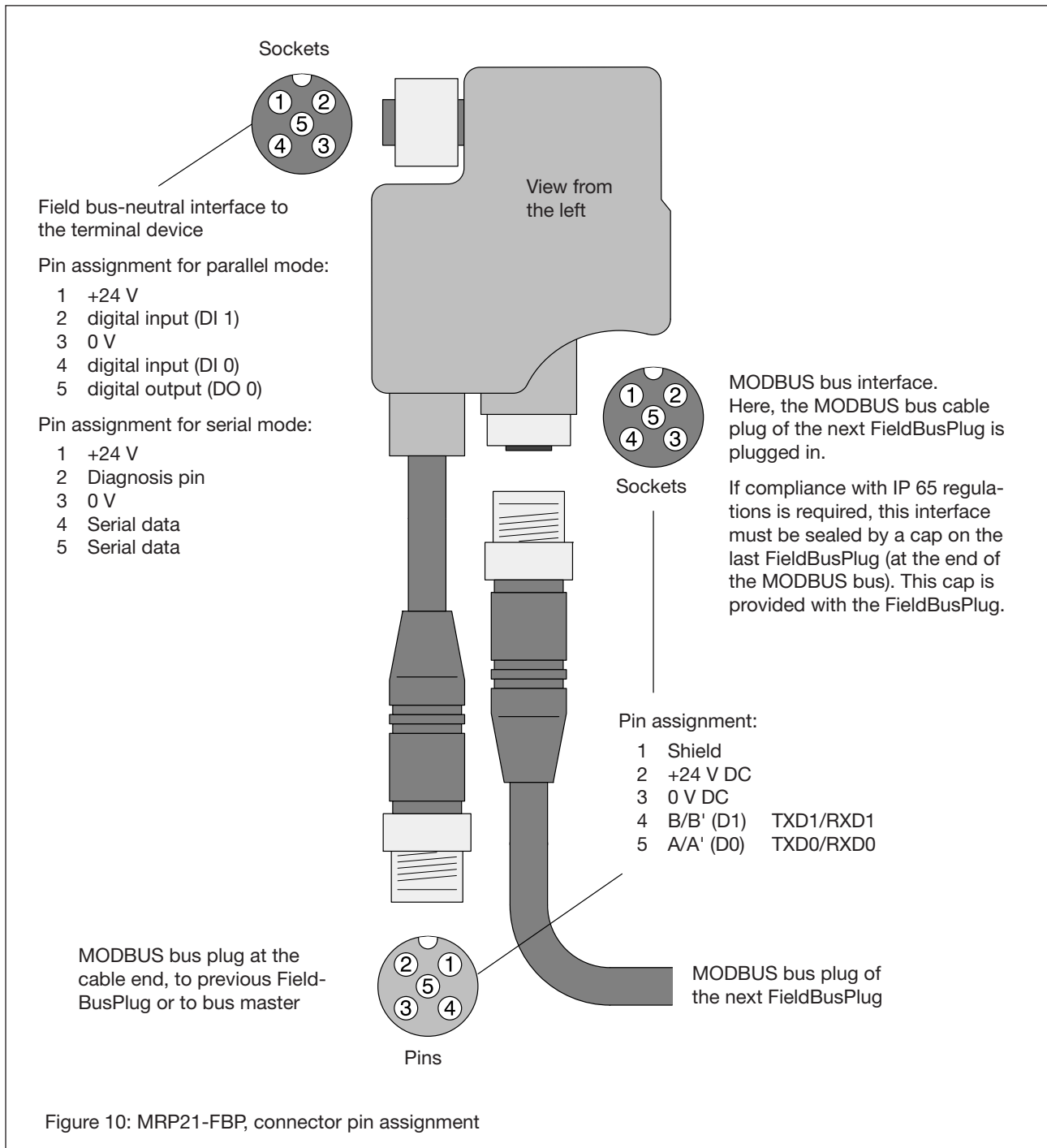
One pair of bias resistors are additionally necessary. Normally switch in bias resistors are placed in MODBUS master, repeater or RS-232 to RS-485 converter.



### FieldBusPlug connector pin assignment

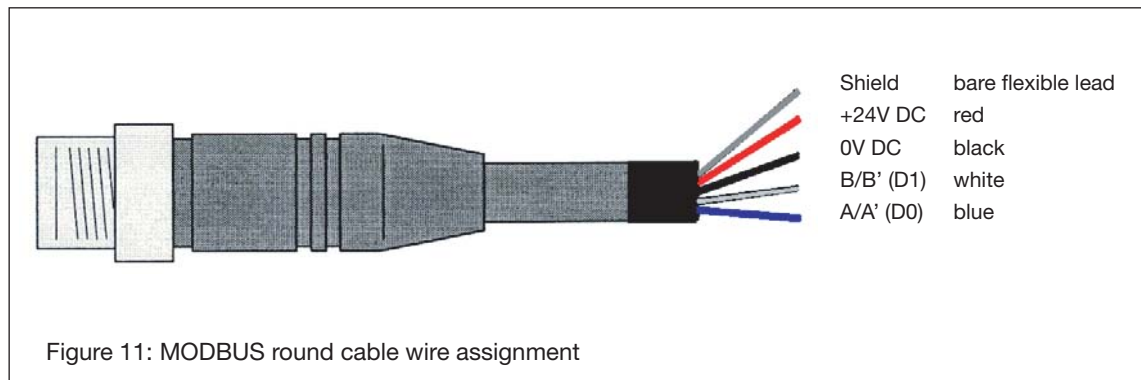
The connector pin assignment of the FieldBusPlugs for

- the MODBUS interface (plug at the cable end and bus interface to the next FieldBusPlug)
- the field bus-neutral interface to the terminal device





### MODBUS round cable, one cable end without plug



### Powering the FieldBusPlugs and the devices

#### Supply INT / EXT

The supply of the FieldBusPlug is always made via the bus cable. This enables the FieldBusPlug to monitor the actual -e.g. faulty- status to the control station even when it is removed from the device or when power down appears on the device.

With the switch EXT/INT set to EXT or the equivalent wiring on the device the supply is limited to the FieldBusPlug.

As an exception even some devices can be supplied via the bus. In this case the switch has to be set to position INT.

But normally the devices connected to the MODBUS are intelligent and have, therefore, inputs which are normally not insulated from the device supply. And these inputs can be connected to distant components such as push buttons or limit switches.

This means, with the supply of the devices via the bus a widely branched supply network would arise which cannot be surveyed and where a short circuit on an external component or lead wire paralyses the complete bus communication.

The loss of voltage bridging time from the FieldBusPlug is  $\leq 1\text{ms}$ . Therefore the 24 V DC power supply shall have a loss of voltage bridging time of  $\geq 10\text{ms}$ .

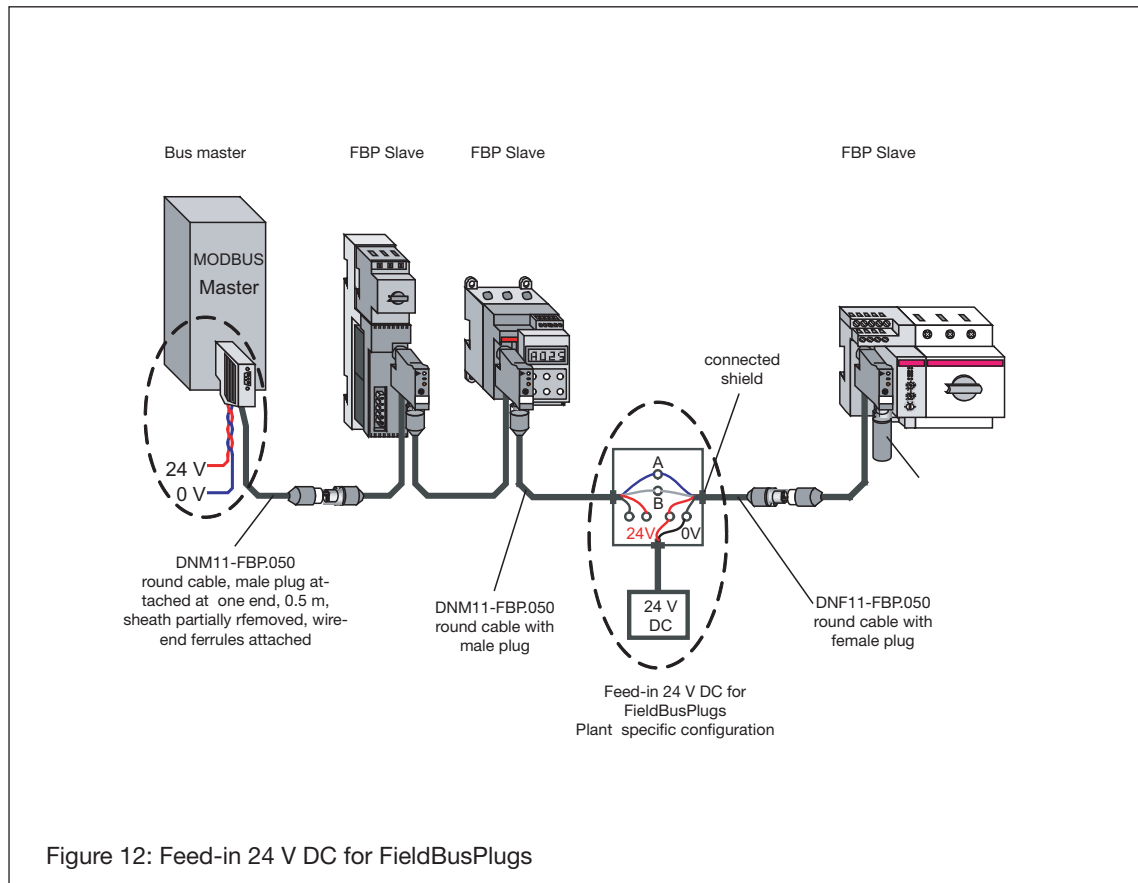
#### To be noticed

- Use separate supply units or separately fused supply circuits for the FieldBusPlug line and the devices.
- Use the INT position of the INT/EXT switch only during commissioning of single devices and only if inevitable.
- On the installation site use the INT position only for simple devices such as proximity switches or MSD11-FBP / MSR22-FBP. In this case also check the supply situation / voltage drops carefully.
- Check carefully whether the switches of the devices are set to EXT before delivering to the installation site.
- Check the supply situation. Don't forget to check the total bus length.

**Feed-in 24 V DC if the bus cable is long**

If the distance between the bus master and the slaves is longer, it may be necessary to feed-in 24 V DC for the FieldBusPlugs on a second place.

All slaves, also the most distant slave from the supply, need to be supplied with min. 19.2 V DC including ripple. That means that the power supply unit has to provide a higher voltage to compensate the voltage drops due to the line resistance.

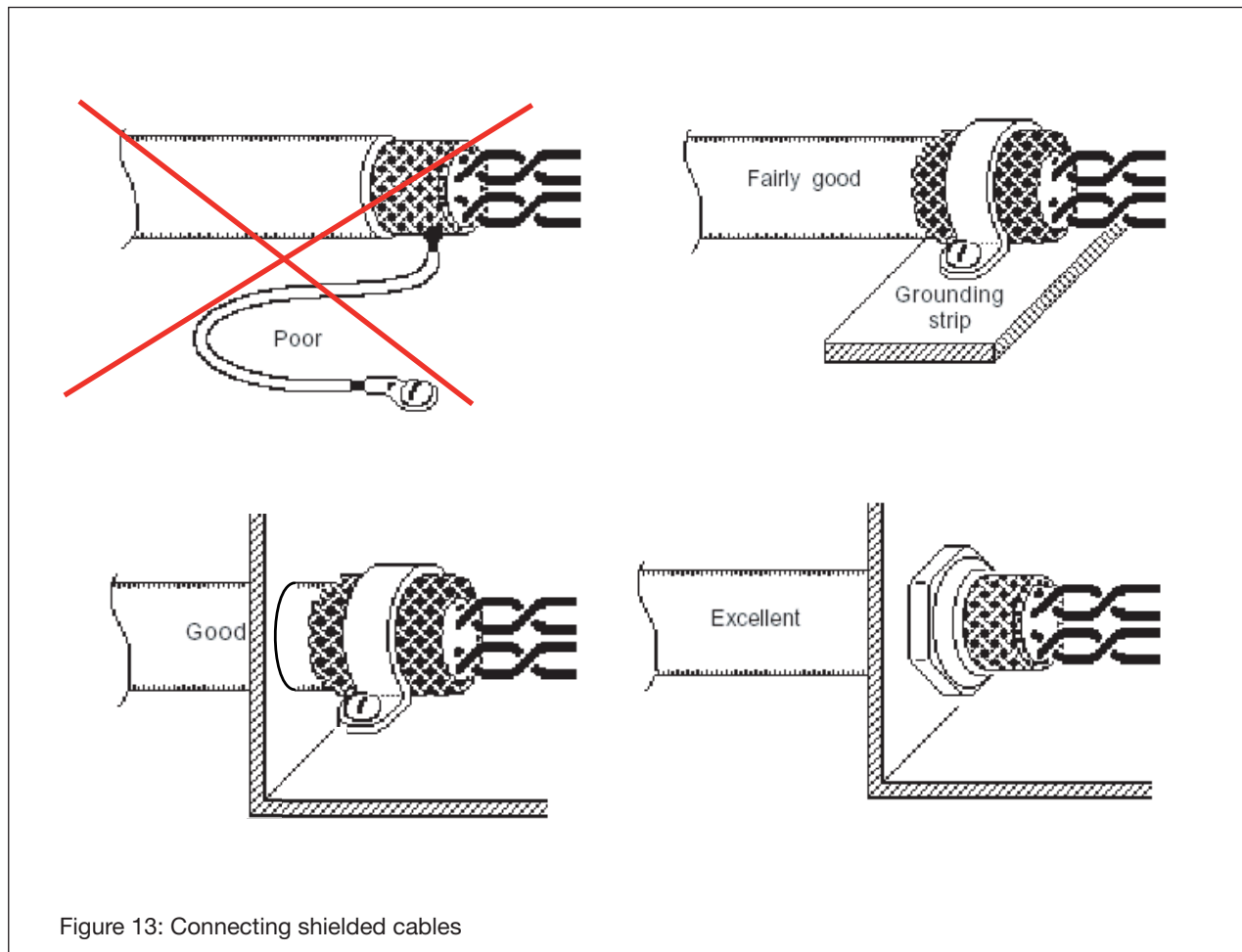




### Shielding

A shielded cable provides good protection against electromagnetic interference, particularly high frequencies. The effectiveness of a shielded cable depends on how it is installed.

#### Connecting shielded cables







## Principle shielding of the MODBUS FieldBusPlugs

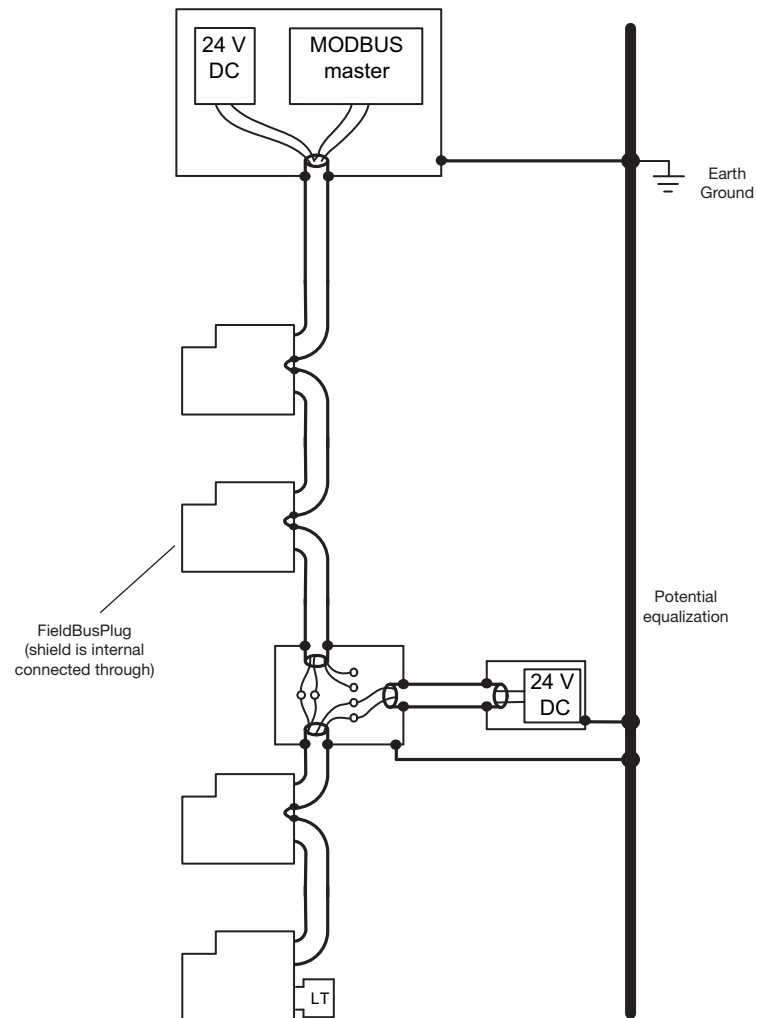


Figure 14: Principle shielding of the MODBUS FieldBusPlugs



### Connecting several FieldBusPlugs on the MODBUS network

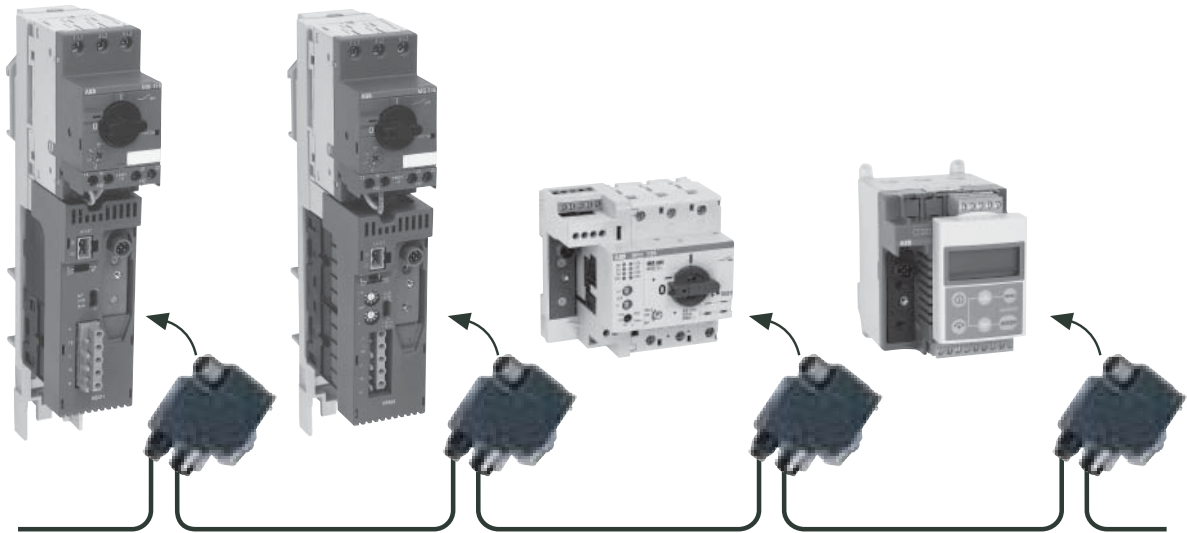


Figure 15: Connecting several FieldBusPlugs on the MODBUS network

### Connecting the MODBUS master via RS-232 to RS-485 converters

- Always use isolated converters!
- Use the types that enables the RS-485 transmitter by detecting a transmit signal on the RS-232 line (automatic controlled).  
It is important to note that the RS-485 transmit data line is disabled at a fixed interval after the last bit, typically one character length.
- Has the converter a pull-up and pull-down resistor included?
- Check that the termination resistor corresponds with the line impedance.

The figure below shows how to connect the MODBUS master via RS-232 to RS-485 converters.

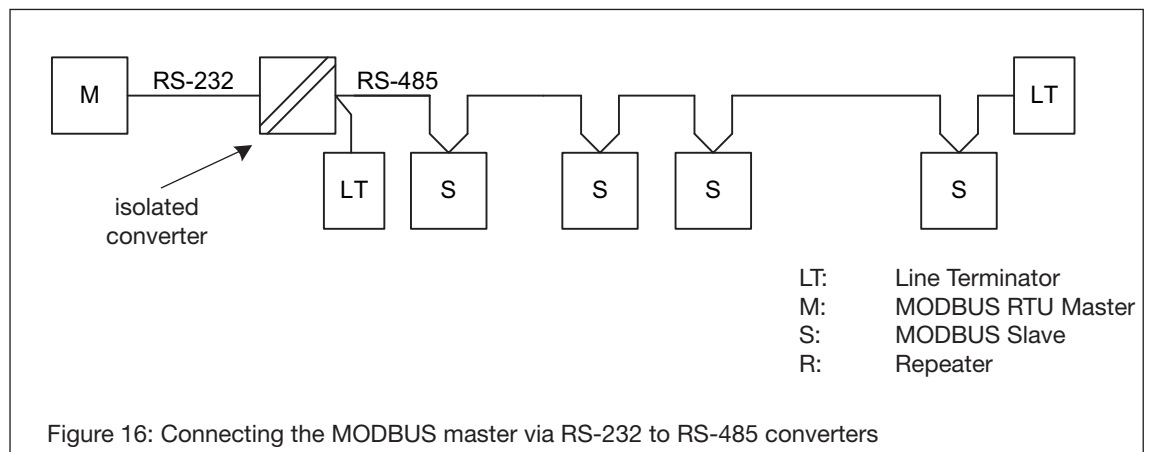
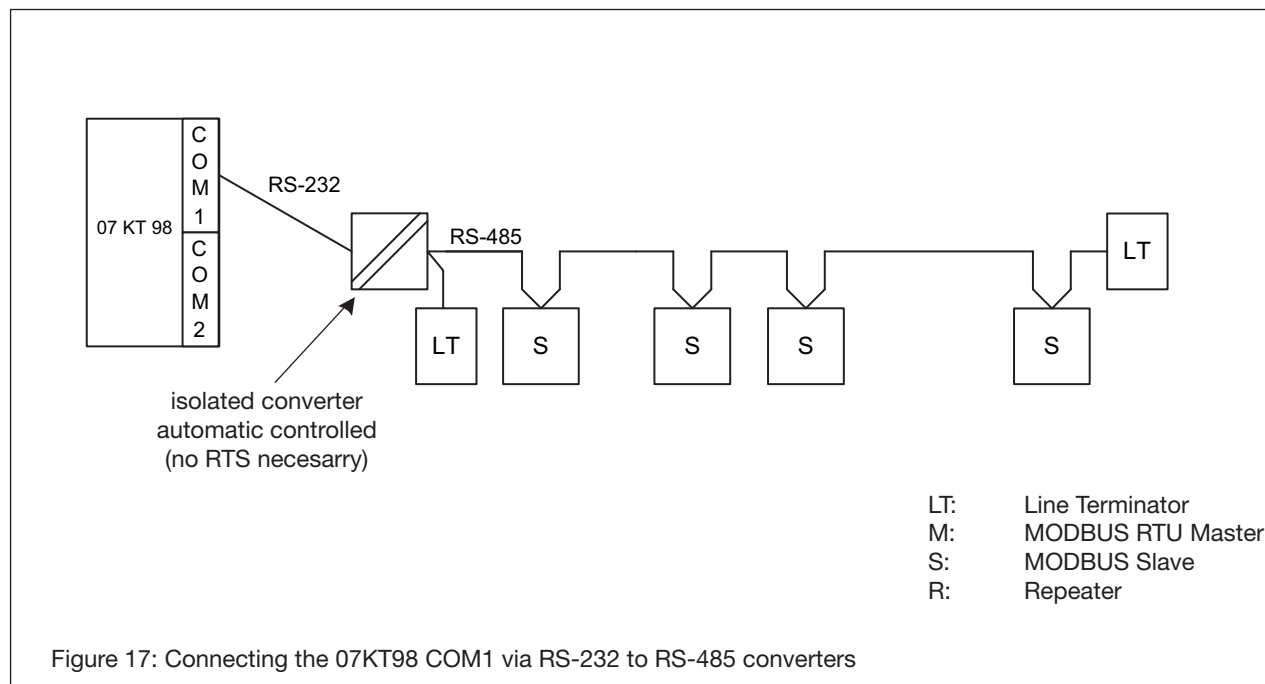


Figure 16: Connecting the MODBUS master via RS-232 to RS-485 converters



### How to connect the MODBUS FieldBusPlug on AC31 basic unit

The figure below shows how to connect the AC31 basic unit (e.g. 07KT97 / 07KT98) via COM1 or COM2 (RS-232) to MODBUS network.



The 07KT98 is configured as MODBUS master; the communication interface is - in this example - COM1 (RS-232).

The MODBUS RTU protocol is used, therefore a RS-232 to RS-485 converter must be connected between the 07KT98 and the MODBUS network.



### Software implementation of the FieldBusPlug

- Introduction to MODBUS application layer
- Important warning
- MODBUS master communication parameters
- Notes for the MODBUS master
- How to set the slave address
- Default baud rate mapping via device address
- How to adjust the parity and the stop bit on the FieldBusPlug
- Communication protocol
- Use of devices without a communication protocol
- MODBUS exception codes

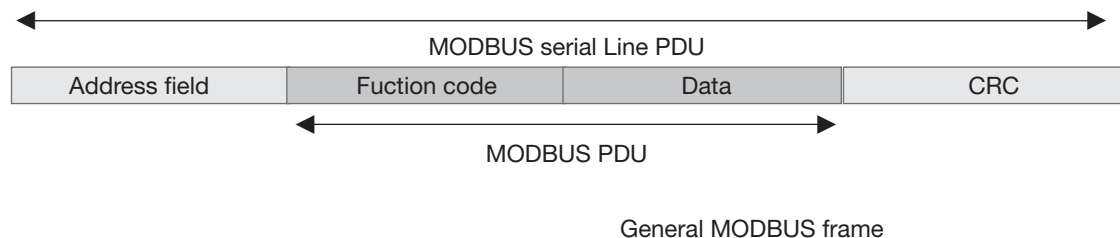
### Introduction to MODBUS application layer

MODBUS is an application layer messaging protocol that provides master/slave communication between devices connected on a network.

Only the master can initiate requests and only the addressed slave device responds. In case of a broadcast request none of the slaves will respond.

#### MODBUS frame description

The MODBUS application protocol defines a simple **Protocol Data Unit (PDU)**.



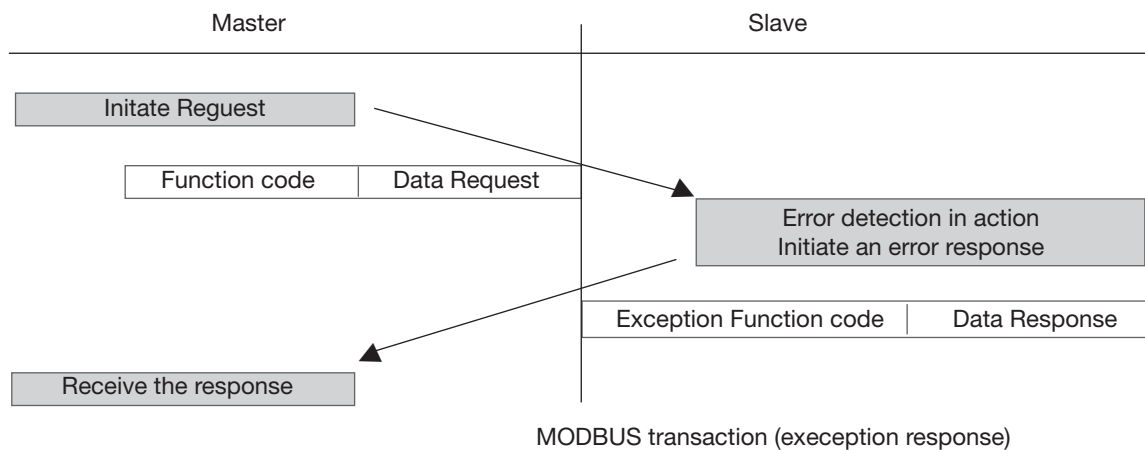
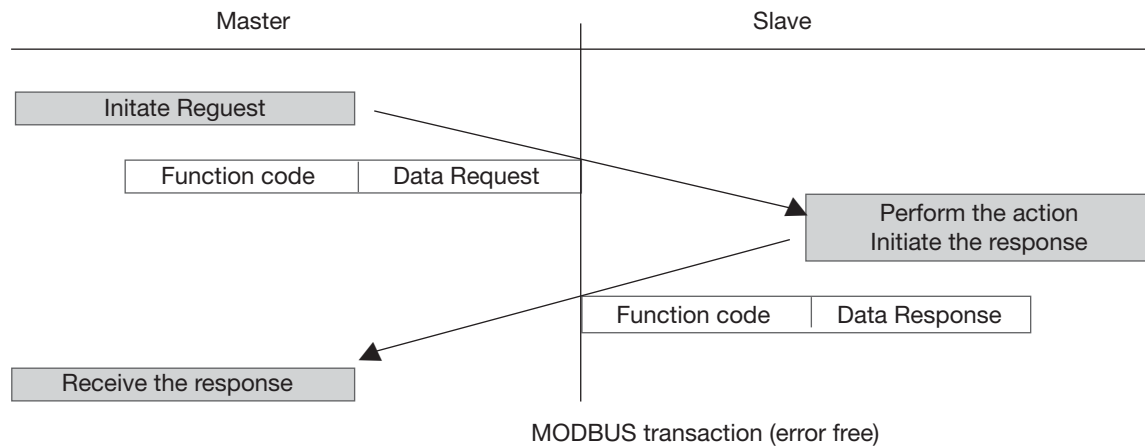
On MODBUS serial line, the address field only contains the slave address.

The CRC value is calculated by the sending device, which appends the CRC to the message. The receiving device recalculates a CRC during receipt of the message, and compares the calculated value to the actual value it received in the CRC field. If the two values are not equal, an error results.



## V 6 Technical Description

MODBUS master ↔ slave communication



### Important warning

It is of great importance to ensure, that all of the devices have a different address. Otherwise the serial bus can show an abnormal behaviour and the master is not able to communicate with all of the present slaves on the bus.



### MODBUS master communication parameters

For the MODBUS communication between the master and the FieldBusPlug several parameters have to be set. The parameters and their settings are shown in the following table:

| Serial Transmission code        | RTU (11 bits/character) |          |
|---------------------------------|-------------------------|----------|
| Serial communication parameters | Start bit               | 1        |
|                                 | Data bits               | 8        |
|                                 | Parity (see *1)         | Even/Odd |
|                                 | Stop bit                | 1        |
|                                 | Baud rate               | 1200     |
|                                 |                         | 2400     |
|                                 |                         | 4800     |
|                                 |                         | 9600     |
|                                 |                         | 19200    |
|                                 |                         | 57600    |

\*1: There is no parity setting on the FieldBusPlug necessary

### Notes for the MODBUS master

The following times have to be considered by the MODBUS master.

In RTU mode, message frames are separated by a silent interval of **at least 3.5** character times. The start of a new telegram is expected if the silent interval is > 3.5 character times.

| Baud rate | silent interval              |                   |
|-----------|------------------------------|-------------------|
|           | 3.5 character times          | 4 character times |
| 1200      | 32.08 ms                     | 36.67 ms          |
| 2400      | 16.04 ms                     | 18.33 ms          |
| 4800      | 8.02 ms                      | 9.17 ms           |
| 9600      | 4.01 ms                      | 4.58 ms           |
| 19200     | 2.01 ms                      | 2.29 ms           |
| 57600     | ≥ 1.75 ms recommended to use |                   |

1 character = 1 stop bit + 8 data bit + 1 parity bit + 1 stop bit

### How to set the slave address

The FieldBusPlug has the slave address 248 after distribution. In this case it is not possible to communicate with the FieldBusPlug via MODBUS.

To make sure, that the bus master can access the slaves connected to the bus line, a setting of the slave addresses is always necessary. Generally and over the full address range, the CAS21-FBP addressing set can be used. But it is easier, if the terminal device has address setting switches or similar means for the address setting. In this case, the FieldBusPlug adopts the address from the terminal device during power-on.

Once the address is set, it is stored in the FieldBusPlug, even in case of supply voltage breakdown.

According to the MODBUS standard, the addresses 1 to 247 can be set. The address 0 is reserved and should not be used for slaves.



### Default baud rate mapping via device address

During start-up phase the following baud rates are adjusted

| Device address | Baud rate<br>bits/s |
|----------------|---------------------|
| 1 to 32        | 9600                |
| 33 to 65       | 19200               |
| 66 to 98       | 57600               |
| 99 to 247      | 19200               |

Note:

An other baud rate can be chosen during commissioning via MODBUS, see chapter "Set baud rate via MODBUS".

### How to adjust the parity and the stop bit on the FieldBusPlug

There is no parity and stop bit setting on the FieldBusPlug necessary.

### Communication protocol

The following commands are implemented

| Commands                                   | MODBUS Function Codes                                    | Starting<br>address |
|--------------------------------------------|----------------------------------------------------------|---------------------|
| Set baud rate via MODBUS                   | FC 16 Write Multiple Registers                           | 4064 Hex            |
| Write configuration data                   | FC 16 Write Multiple Registers                           | 4050 Hex            |
| Write parameter data                       | FC 16 Write Multiple Registers                           | 3000 Hex            |
| Read binary input values serial device     | FC 1 Read Coils<br>FC 2 Read Discrete Inputs             | 0000 Hex            |
| Read binary input values parallel device   | FC 1 Read Coils<br>FC 2 Read Discrete Inputs             | 1000 Hex            |
| Write binary output values serial device   | FC 15 Write Multiple Coils                               | 0100 Hex            |
| Write binary output values parallel device | FC 15 Write Multiple Coils                               | 1100 Hex            |
| Read analog input values serial device     | FC 3 Read Holding Registers<br>FC 4 Read Input Registers | 0200 Hex            |
| Write analog output values serial device   | FC 16 Write Multiple Registers                           | 0300 Hex            |
| Read diagnostic data                       | FC 3 Read Holding Registers<br>FC 4 Read Input Registers | 2000 Hex            |
| Read additional data                       | FC 3 Read Holding Registers<br>FC 4 Read Input Registers | 4000 Hex            |
| Return query data                          | FC 8 Sub Function 00                                     |                     |

### Amount of process data

| Commands                   | Maximum amount of data,<br>depends on the terminal device |
|----------------------------|-----------------------------------------------------------|
| Write parameter data       | 120 Words                                                 |
| Read binary input values   | 256 Bits                                                  |
| Write binary output values | 256 Bits                                                  |
| Read analog input values   | 125 Words                                                 |
| Write analog output values | 125 Words                                                 |
| Read diagnostic data       | 16 Bytes                                                  |



### Set baud rate via MODBUS

The MODBUS function code 16 "Write Multiple Registers" is used.

#### Request

|                       |         |           |
|-----------------------|---------|-----------|
| MODBUS function code  | 1 Byte  | 0x10      |
| Starting Address      | 2 Bytes | 0x4064    |
| Quantity of Registers | 2 Bytes | 0x0001    |
| Byte Count            | 1 Byte  | 0x0002    |
| Register Value        | 2 Bytes | Baud rate |

#### Response

|                       |         |        |
|-----------------------|---------|--------|
| MODBUS function code  | 1 Byte  | 0x10   |
| Starting Address      | 2 Bytes | 0x4064 |
| Quantity of Registers | 2 Bytes | 0x0001 |

#### Error Response

|                |        |                      |
|----------------|--------|----------------------|
| Error code     | 1 Byte | 0x90                 |
| Exception code | 1 Byte | 01 or 02 or 03 or 04 |

### MODBUS frame over the serial line

#### Request

|               |               |                  |                       |            |                        |         |
|---------------|---------------|------------------|-----------------------|------------|------------------------|---------|
| 1 Byte        | 1 Byte        | 2 Bytes          | 2 Bytes               | 1 Byte     | Word 0                 | 2 Bytes |
| Slave Address | Function Code | Starting Address | Quantity of Registers | Byte Count | Baud rate              | CRC     |
| *             | 0x10          | 0x4064           | 0x0001                | 0x02       | e.g. 0x4B00 (19200dec) |         |

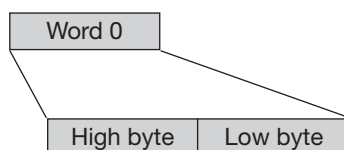
\* depends on the device

#### Response

|               |               |                  |                       |         |
|---------------|---------------|------------------|-----------------------|---------|
| 1 Byte        | 1 Byte        | 2 Bytes          | 2 Bytes               | 2 Bytes |
| Slave Address | Function Code | Starting Address | Quantity of Registers | CRC     |
| *             | 0x10          | 0x4064           | 0x0001                |         |

\* depends on the device

#### Baud rate





**Reading the Baudrate via MODBUS**

It is possible to use the MODBUS function codes 3 „Read Holding Registers“ or 4 „Read Input Registers“

**Request**

|                     |         |              |
|---------------------|---------|--------------|
| MODBUS-Functioncode | 1 Byte  | 0x03 or 0x04 |
| Startaddress        | 2 Bytes | 0x4064       |
| No Registers        | 2 Bytes | 0x0001       |

**Response**

|                     |         |              |
|---------------------|---------|--------------|
| MODBUS-Functioncode | 1 Byte  | 0x03 or 0x04 |
| Startaddress        | 1 Bytes | 2            |
| No Registers        | 2 Bytes |              |

N\* = Anzahl Eingangsregister

**Response in case of a fault**

|                            |         |                      |
|----------------------------|---------|----------------------|
| Errorcode                  | 1 Byte  | 0x83 or 0x84         |
| Errorcode (Exception Code) | 1 Bytes | 01 or 02 or 03 or 04 |



### Write configuration data

During the initialization phase, the plug receives the device-specific (configuration) data from the terminal device. This data is equal to the corresponding data in the bus master, provided that the correct terminal device was selected there.

During start-up, an optional configuration data may be transferred from the bus master to the plug

The MODBUS function code 16 "Write Multiple Registers" is used.

#### Request

|                       |          |                           |
|-----------------------|----------|---------------------------|
| MODBUS function code  | 1 Byte   | 0x10                      |
| Starting Address      | 2 Bytes  | 0x4050 see note 1)        |
| Quantity of Registers | 2 Bytes  | 0x0007                    |
| Byte Count            | 1 Byte   | 0x0E                      |
| Register Value        | 14 Bytes | Device configuration data |

Note 1)

Against the MODBUS specification it is not possible to write values with an address offset.

#### Response

|                       |         |        |
|-----------------------|---------|--------|
| MODBUS function code  | 1 Byte  | 0x10   |
| Starting Address      | 2 Bytes | 0x4050 |
| Quantity of Registers | 2 Bytes | 0x0007 |

#### Error Response

|                |        |                      |
|----------------|--------|----------------------|
| Error code     | 1 Byte | 0x90                 |
| Exception code | 1 Byte | 01 or 02 or 03 or 04 |

### MODBUS frame over the serial line

#### Request

|               |               |                  |                       |            |                           |     |        |         |
|---------------|---------------|------------------|-----------------------|------------|---------------------------|-----|--------|---------|
| 1 Byte        | 1 Byte        | 2 Bytes          | 2 Bytes               | 1 Byte     | Word 0                    | ... | Word 6 | 2 Bytes |
| Slave Address | Function Code | Starting Address | Quantity of Registers | Byte Count | Device configuration data |     |        | CRC     |
| *             | 0x10          | 0x4050           | 0x0007                | 0x0E       | *                         |     |        |         |

\* depends on the device

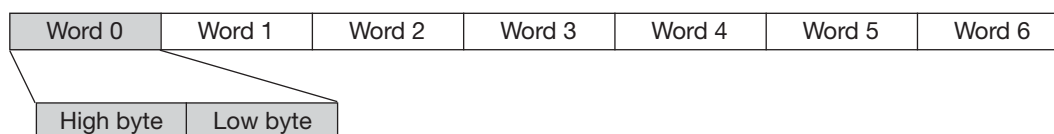
#### Response

|               |               |                  |                       |         |
|---------------|---------------|------------------|-----------------------|---------|
| 1 Byte        | 1 Byte        | 2 Bytes          | 2 Bytes               | 2 Bytes |
| Slave Address | Function Code | Starting Address | Quantity of Registers | CRC     |
| *             | 0x10          | 0x4050           | 0x0007                |         |

\* depends on the device



Device configuration data



|                   |                            |                                                         |
|-------------------|----------------------------|---------------------------------------------------------|
| Word 0, high byte | Number of binary inputs    | 0 ... 256 depends on the device                         |
| Word 0, low byte  | Number of binary outputs   | 0 ... 256 depends on the device                         |
| Word 1, high byte | Number of analog inputs    | 0 ... 125 depends on the device                         |
| Word 1, low byte  | Number of analog outputs   | 0 ... 125 depends on the device                         |
| Word 2            | Number of parameter        | 0 ... 120 depends on the device                         |
| Word 3, high byte | Number of diagnostic bytes | 0 ... 16 depends on the device                          |
| Word 3, low byte  | 0x00; Not used             |                                                         |
| Word 4            | Sum of all parameter bytes | 0 ... 240                                               |
| Word 5            | Device Product Code        | depends on the device                                   |
| Word 6            | MODBUS bus timeout         | 0x0000 no timeout<br>0x0001...0x1FFF<br>Unit is: ms *1) |

\*1) see chapter MODBUS bus timeout

### Reading configuration data

Use the MODBUS-Functioncodes 3 „Read Holding Registers“ or 4 „Read Input Registers“.

Request

|                     |         |              |
|---------------------|---------|--------------|
| MODBUS-Functioncode | 1 Byte  | 0x03 or 0x04 |
| Start address       | 2 Bytes | 0x4050       |
| No. Register        | 2 Bytes | 0x0007       |

Reply

|                     |          |                    |
|---------------------|----------|--------------------|
| MODBUS-Functioncode | 1 Byte   | 0x03 oder 0x04     |
| Start address       | 1 Bytes  | 0x0E               |
| Input registers     | 14 Bytes | Configuration data |

Reply on error

|                             |         |                      |
|-----------------------------|---------|----------------------|
| Error code                  | 1 Byte  | 0x83 or 0x84         |
| Error code (Exception Code) | 1 Bytes | 01 or 02 or 03 or 04 |



### MODBUS bus timeout for the FieldBusPlug

With the “MODBUS bus timeout”, the FieldBusPlug supervises the MODBUS master process data requests.

Deactivate the “MODBUS bus timeout”

The supervision is deactivated if the bus timeout is zero.

Activate the “MODBUS bus timeout”

The bus timeout can be specified in the configuration request (see chapter “Write configuration data”).

Within the monitoring time, the MODBUS master has to send a process data request to the slave. After receiving a process data request, the monitoring time is started / restarted.

Process data requests are:

- Read binary input values
- Write binary output values
- Read analog input values
- Write analog output values

If the supervision time has expired, the FieldBusPlug changes into the configuration state, there is no process data exchange between the FieldBusPlug and the terminal device.

Possible requests in configuration state are:

- Set baud rate
- Write configuration

The bus timeout depends on the following facts:

- Baud rate
- Number of MODBUS slaves
- Telegram length (data volume)
- MODBUS master processing cycle-time

It is good choice to use a multiple of the MODBUS master processing cycle-time.

Calculation of the MODBUS telegram duration:

$$\text{time (ms)} = \frac{(\text{amount of bytes} * 11)}{\text{baud rate}} * 1000$$

**Write parameter data**

The MODBUS function code 16 "Write Multiple Registers" is used.

Request

|                       |            |                       |
|-----------------------|------------|-----------------------|
| MODBUS function code  | 1 Byte     | 0x10                  |
| Starting Address      | 2 Bytes    | 0x3000 see note 1)    |
| Quantity of Registers | 2 Bytes    | 0x0001 to 0x0078      |
| Byte Count            | 1 Byte     | 2xN*                  |
| Register Value        | N*x2 Bytes | Device parameter data |

N\* = quantity of registers

Note 1)

Against the MODBUS specification, it is not possible to write values with an address offset.

Response

|                       |         |        |
|-----------------------|---------|--------|
| MODBUS function code  | 1 Byte  | 0x10   |
| Starting Address      | 2 Bytes | 0x3000 |
| Quantity of Registers | 2 Bytes | 2xN*   |

N\* = quantity of registers

Error Response

|                |        |                      |
|----------------|--------|----------------------|
| Error code     | 1 Byte | 0x90                 |
| Exception code | 1 Byte | 01 or 02 or 03 or 04 |

MODBUS frame over the serial line

Request

|               |               |                  |                       |            |                       |     |        |         |
|---------------|---------------|------------------|-----------------------|------------|-----------------------|-----|--------|---------|
| 1 Byte        | 1 Byte        | 2 Bytes          | 2 Bytes               | 1 Byte     | Word 0                | ... | Word N | 2 Bytes |
| Slave Address | Function Code | Starting Address | Quantity of Registers | Byte Count | Device parameter data |     |        | CRC     |
| *             | 0x10          | 0x3000           | *                     | *          | *                     |     |        |         |

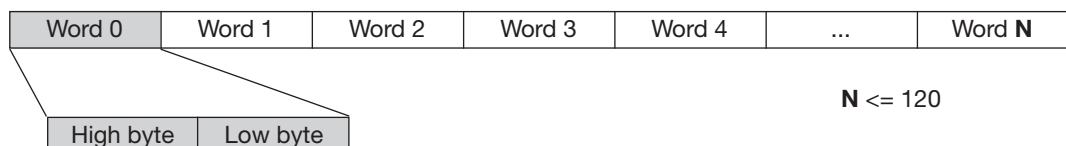
\* depends on the device

Response

|               |               |                  |                       |         |
|---------------|---------------|------------------|-----------------------|---------|
| 1 Byte        | 1 Byte        | 2 Bytes          | 2 Bytes               | 2 Bytes |
| Slave Address | Function Code | Starting Address | Quantity of Registers | CRC     |
| *             | 0x10          | 0x3000           | *                     |         |

\* depends on the device

Device parameter data



Example: Parameters of different lengths / different position in the parameter block

|        |        |         |        |        |         |     |
|--------|--------|---------|--------|--------|---------|-----|
| Word 0 | Word 1 | Word 2  | Word 3 | Word 4 | Word 5  | ... |
| HB LB  | HB LB  | byte HB |        | LB HB  | LB byte | ... |
| Par 1  | Par 2  | Par 3   | Par 4  | Par 5  | Par 6   | ... |

HB: High byte / LB: Low byte



### Read binary input values (serial device)

The MODBUS function code 1 “Read Coils” or function code 2 “Read Discrete Inputs” could be used.

#### Request

|                            |         |                                                        |
|----------------------------|---------|--------------------------------------------------------|
| MODBUS function code       | 1 Byte  | 0x01 or 0x02                                           |
| Starting Address           | 2 Bytes | 0x0000 ... 0x00FF                                      |
| Quantity of Coils / Inputs | 2 Bytes | 0x0001...0x0100 (256 inputs))<br>depends on the device |

#### Response

|                      |         |              |
|----------------------|---------|--------------|
| MODBUS function code | 1 Byte  | 0x01 or 0x02 |
| Byte count           | 1 Byte  | <b>N*</b>    |
| Coil / Input status  | n Bytes | n = N or N+1 |

**N\*** = Quantity of Inputs / 8, if the remainder is different of 0  $\Rightarrow$  N = N+1

#### Error Response

|                |        |                      |
|----------------|--------|----------------------|
| Error code     | 1 Byte | 0x81 or 0x82         |
| Exception code | 1 Byte | 01 or 02 or 03 or 04 |

Note: If a parallel device is connected an error response appears

### MODBUS frame over the serial line

#### Request

|               |               |                  |                            |         |
|---------------|---------------|------------------|----------------------------|---------|
| 1 Byte        | 1 Byte        | 2 Bytes          | 2 Bytes                    | 2 Bytes |
| Slave Address | Function Code | Starting Address | Quantity of Coils / Inputs | CRC     |
| *             | 0x01 or 0x02  | 0x0000           | *                          |         |

\* depends on the device

#### Response

|               |               |            |                               |     |        |         |
|---------------|---------------|------------|-------------------------------|-----|--------|---------|
| 1 Byte        | 1 Byte        | 1 Byte     | Byte 0                        | ... | Byte n | 2 Bytes |
| Slave Address | Function Code | Byte count | Binary input data from device |     |        | CRC     |
| *             | 0x10 or 0x02  | *          | *                             |     |        |         |

\* depends on the device

#### Device binary input data

|        |        |        |        |        |        |        |        |
|--------|--------|--------|--------|--------|--------|--------|--------|
| Byte 0 | Byte 1 | Byte 2 | ...    | ...    | ...    | Byte n |        |
| Byte 0 |        |        |        |        |        |        |        |
| Bit 7  | Bit 6  | Bit 5  | Bit 4  | Bit 3  | Bit 2  | Bit 1  | Bit 0  |
| Byte 1 |        |        |        |        |        |        |        |
| Bit 15 | Bit 14 | Bit 13 | Bit 12 | Bit 11 | Bit 10 | Bit 9  | Bit 8  |
| Byte 2 |        |        |        |        |        |        |        |
| Bit 23 | Bit 22 | Bit 21 | Bit 20 | Bit 19 | Bit 18 | Bit 17 | Bit 16 |

**Read binary input values (parallel device)**

The MODBUS function code 1 “Read Coils” or function code 2 “Read Discrete Inputs” could be used.

**Request**

|                            |         |                                                      |
|----------------------------|---------|------------------------------------------------------|
| MODBUS function code       | 1 Byte  | 0x01 or 0x02                                         |
| Starting Address           | 2 Bytes | 0x1000 ... 0x1007                                    |
| Quantity of Coils / Inputs | 2 Bytes | 0x0001...0x0008 (8 inputs))<br>depends on the device |

**Response**

|                      |         |              |
|----------------------|---------|--------------|
| MODBUS function code | 1 Byte  | 0x01 or 0x02 |
| Byte count           | 1 Byte  | <b>N*</b>    |
| Coil / Input status  | n Bytes | n = N or N+1 |

**N\*** = Quantity of Inputs / 8, if the remainder is different of 0  $\Rightarrow$  N = N+1

**Error Response**

|                |        |                      |
|----------------|--------|----------------------|
| Error code     | 1 Byte | 0x81 or 0x82         |
| Exception code | 1 Byte | 01 or 02 or 03 or 04 |

Note: If a serial device is connected an error response appears

**MODBUS frame over the serial line****Request**

|               |               |                  |                            |         |
|---------------|---------------|------------------|----------------------------|---------|
| 1 Byte        | 1 Byte        | 2 Bytes          | 2 Bytes                    | 2 Bytes |
| Slave Address | Function Code | Starting Address | Quantity of Coils / Inputs | CRC     |
| *             | 0x01 or 0x02  | 0x1000           | *                          |         |

\* depends on the device

**Response**

|               |               |            |                               |     |        |         |
|---------------|---------------|------------|-------------------------------|-----|--------|---------|
| 1 Byte        | 1 Byte        | 1 Byte     | Byte 0                        | ... | Byte n | 2 Bytes |
| Slave Address | Function Code | Byte count | Binary input data from device |     |        | CRC     |
| *             | 0x10 or 0x02  | *          | *                             |     |        |         |

\* depends on the device

**Device binary input data**

| Byte 0 |       |       |       |       |       |       |       |
|--------|-------|-------|-------|-------|-------|-------|-------|
| Bit 7  | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |



### Write binary output values (serial device)

The MODBUS function code 15 "Write Multiple Coils" is used.

#### Request

|                             |            |                                                          |
|-----------------------------|------------|----------------------------------------------------------|
| MODBUS function code        | 1 Byte     | 0x0F                                                     |
| Starting Address            | 2 Bytes    | 0x0100 ... 0x01FF                                        |
| Quantity of Coils / Outputs | 2 Bytes    | 0x0001 ... 0x0100 (256 outputs)<br>depends on the device |
| Byte Count                  | 1 Byte     | <b>N*</b>                                                |
| Output Value                | N* x1 Byte |                                                          |

**N\*** = Quantity of Outputs / 8, if the remainder is different of 0  $\Rightarrow N = N+1$

#### Response

|                             |         |                                                         |
|-----------------------------|---------|---------------------------------------------------------|
| MODBUS function code        | 1 Byte  | 0x0F                                                    |
| Starting address            | 2 Bytes | 0x0100 ... 0x017F                                       |
| Quantity of Coils / Outputs | 2 Bytes | 0x0001 ... 0x0100 (256 inputs)<br>depends on the device |

#### Error Response

|                |        |                      |
|----------------|--------|----------------------|
| Error code     | 1 Byte | 0x8F                 |
| Exception code | 1 Byte | 01 or 02 or 03 or 04 |

Note: If a parallel device is connected an error response appears

### MODBUS frame over the serial line

#### Request

|               |               |                  |                     |            |                           |     |        |         |
|---------------|---------------|------------------|---------------------|------------|---------------------------|-----|--------|---------|
| 1 Byte        | 1 Byte        | 2 Bytes          | 2 Bytes             | 1 Byte     | Byte 0                    | ... | Byte n | 2 Bytes |
| Slave Address | Function Code | Starting Address | Quantity of Outputs | Byte Count | Device binary output data |     |        | CRC     |
| *             | 0x0F          | 0x0100           | *                   | *          | *                         |     |        |         |

\* depends on the device

#### Response

|               |               |                  |                     |         |
|---------------|---------------|------------------|---------------------|---------|
| 1 Byte        | 1 Byte        | 2 Bytes          | 2 Bytes             | 2 Bytes |
| Slave Address | Function Code | Starting Address | Quantity of Outputs | CRC     |
| *             | 0x0F          | 0x0100           | *                   |         |

\* depends on the device

### Device binary output data

|        |        |        |        |        |        |        |        |
|--------|--------|--------|--------|--------|--------|--------|--------|
| Byte 0 | Byte 1 | Byte 2 | ...    | ...    | ...    | Byte n |        |
| Byte 0 |        |        |        |        |        |        |        |
| Bit 7  | Bit 6  | Bit 5  | Bit 4  | Bit 3  | Bit 2  | Bit 1  | Bit 0  |
| Byte 1 |        |        |        |        |        |        |        |
| Bit 15 | Bit 14 | Bit 13 | Bit 12 | Bit 11 | Bit 10 | Bit 9  | Bit 8  |
| Byte 2 |        |        |        |        |        |        |        |
| Bit 23 | Bit 22 | Bit 21 | Bit 20 | Bit 19 | Bit 18 | Bit 17 | Bit 16 |



**Read binary output values (serial device)**

Use the MODBUS functions 1 „Read Coils“ or 2 „Read Discrete Inputs“.

Request

|                     |         |                                                        |
|---------------------|---------|--------------------------------------------------------|
| MODBUS-Funktioncode | 1 Byte  | 0x01 or 0x02                                           |
| Startaddress        | 2 Bytes | 0x0100 ... 0x01FF                                      |
| No. Register        | 2 Bytes | 0x0001...0x0100 (256 Outputs)<br>depends of the device |

Response

|                     |          |              |
|---------------------|----------|--------------|
| MODBUS-Funktioncode | 1 Byte   | 0x01 or 0x02 |
| Startaddress        | 1 Bytes  | N*           |
| No. Register        | 14 Bytes | n = N or N+1 |

N\* = No. of inputs / 8, if division rest is different from 0 N = N+1

Response in case of an error

|                            |         |                      |
|----------------------------|---------|----------------------|
| Errorcode                  | 1 Byte  | 0x81 or 0x82         |
| Errorcode (Exception Code) | 1 Bytes | 01 or 02 or 03 or 04 |



### Write binary output values (parallel device)

The MODBUS function code 15 "Write Multiple Coils" is used.

#### Request

|                             |            |                                                        |
|-----------------------------|------------|--------------------------------------------------------|
| MODBUS function code        | 1 Byte     | 0x0F                                                   |
| Starting Address            | 2 Bytes    | 0x1100 ... 0x1107                                      |
| Quantity of Coils / Outputs | 2 Bytes    | 0x0001 ... 0x0008 (8 outputs)<br>depends on the device |
| Byte Count                  | 1 Byte     | <b>N*</b>                                              |
| Output Value                | N* x1 Byte |                                                        |

**N\*** = Quantity of Outputs / 8, if the remainder is different of 0  $\Rightarrow N = N+1$

#### Response

|                             |         |                                                       |
|-----------------------------|---------|-------------------------------------------------------|
| MODBUS function code        | 1 Byte  | 0x0F                                                  |
| Starting address            | 2 Bytes | 0x1100 ... 0x1107                                     |
| Quantity of Coils / Outputs | 2 Bytes | 0x0001 ... 0x0008 (8 inputs)<br>depends on the device |

#### Error Response

|                |        |                      |
|----------------|--------|----------------------|
| Error code     | 1 Byte | 0x8F                 |
| Exception code | 1 Byte | 01 or 02 or 03 or 04 |

Note: If a serial device is connected an error response appears

### MODBUS frame over the serial line

#### Request

|               |               |                  |                     |            |                           |     |        |         |
|---------------|---------------|------------------|---------------------|------------|---------------------------|-----|--------|---------|
| 1 Byte        | 1 Byte        | 2 Bytes          | 2 Bytes             | 1 Byte     | Byte 0                    | ... | Byte n | 2 Bytes |
| Slave Address | Function Code | Starting Address | Quantity of Outputs | Byte Count | Device binary output data |     |        | CRC     |
| *             | 0x0F          | 0x1100           | *                   | *          | *                         |     |        |         |

\* depends on the device

#### Response

|               |               |                  |                     |         |
|---------------|---------------|------------------|---------------------|---------|
| 1 Byte        | 1 Byte        | 2 Bytes          | 2 Bytes             | 2 Bytes |
| Slave Address | Function Code | Starting Address | Quantity of Outputs | CRC     |
| *             | 0x0F          | 0x1100           | *                   |         |

\* depends on the device

### Device binary input data

| Byte 0 |       |       |       |       |       |       |       |
|--------|-------|-------|-------|-------|-------|-------|-------|
| Bit 7  | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |

**Read analog input values**

The MODBUS function code 3 “Read Holding Registers” or function code 4 “Read Input Registers” could be used.

**Request**

|                             |         |                                            |
|-----------------------------|---------|--------------------------------------------|
| MODBUS function code        | 1 Byte  | 0x03 or 0x04                               |
| Starting Address            | 2 Bytes | 0x0200 ... 0x027C                          |
| Quantity of Input Registers | 2 Bytes | 0x0001 ... 0x007D<br>depends on the device |

**Response**

|                      |                      |                |
|----------------------|----------------------|----------------|
| MODBUS function code | 1 Byte               | 0x03 or 0x04   |
| Byte count           | 1 Byte               | 2 x <b>N</b> * |
| Input Register       | <b>N</b> * x 2 Bytes |                |

**N**\* = Quantity of Input Registers

**Error Response**

|                |        |                      |
|----------------|--------|----------------------|
| Error code     | 1 Byte | 0x83 or 0x84         |
| Exception code | 1 Byte | 01 or 02 or 03 or 04 |

**MODBUS frame over the serial line****Request**

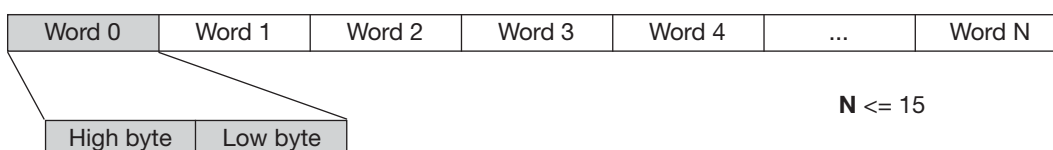
|               |               |                  |                       |         |
|---------------|---------------|------------------|-----------------------|---------|
| 1 Byte        | 1 Byte        | 2 Bytes          | 2 Bytes               | 2 Bytes |
| Slave Address | Function Code | Starting Address | Quantity of Registers | CRC     |
| *             | 0x03 or 0x04  | 0x0200           | *                     |         |

\* depends on the device

**Response**

|               |               |            |                               |     |        |         |
|---------------|---------------|------------|-------------------------------|-----|--------|---------|
| 1 Byte        | 1 Byte        | 1 Byte     | Word 0                        | ... | Word N | 2 Bytes |
| Slave Address | Function Code | Byte count | Analog input data from device |     |        | CRC     |
| *             | 0x03 or 0x04  | *          | *                             |     |        |         |

\* depends on the device

**Device analog input data**



### Write analog output values

The MODBUS function code 16 "Write Multiple Registers" is used.

#### Request

|                      |                      |                                            |
|----------------------|----------------------|--------------------------------------------|
| MODBUS function code | 1 Byte               | 0x10                                       |
| Starting Address     | 2 Bytes              | 0x0300 ... 0x037C                          |
| Quantity of Outputs  | 2 Bytes              | 0x0001 ... 0x007D<br>depends on the device |
| Byte Count           | 1 Byte               | 2 x <b>N</b> *                             |
| Output Value         | <b>N</b> * x 2 Bytes |                                            |

**N**\* = Quantity of Registers

#### Response

|                      |         |                   |
|----------------------|---------|-------------------|
| MODBUS function code | 1 Byte  | 0x10              |
| Byte count           | 2 Bytes | 0x0300 ... 0x037C |
| Quantity of Outputs  | 2 Bytes | 0x0001 ... 0x007D |

#### Error Response

|                |        |                      |
|----------------|--------|----------------------|
| Error code     | 1 Byte | 0x90                 |
| Exception code | 1 Byte | 01 or 02 or 03 or 04 |

### MODBUS frame over the serial line

#### Request

|               |               |                  |                     |            |                           |     |        |         |
|---------------|---------------|------------------|---------------------|------------|---------------------------|-----|--------|---------|
| 1 Byte        | 1 Byte        | 2 Bytes          | 2 Bytes             | 1 Byte     | Word 0                    | ... | Word N | 2 Bytes |
| Slave Address | Function Code | Starting Address | Quantity of Outputs | Byte Count | Device analog output data |     |        | CRC     |
| *             | 0x10          | 0x0300           | *                   | *          | *                         |     |        |         |

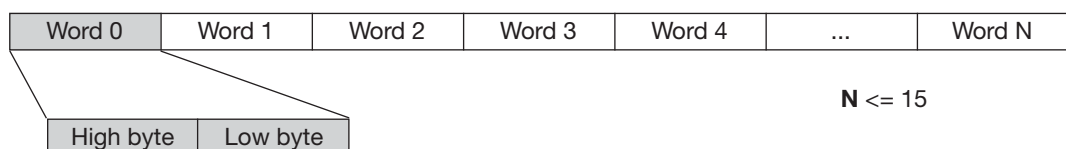
\* depends on the device

#### Response

|               |               |                  |                     |         |
|---------------|---------------|------------------|---------------------|---------|
| 1 Byte        | 1 Byte        | 2 Bytes          | 2 Bytes             | 2 Bytes |
| Slave Address | Function Code | Starting Address | Quantity of Outputs | CRC     |
| *             | 0x10          | 0x0300           | *                   |         |

\* depends on the device

### Device analog output data



**Read analog output values (serial device)**

Use the MODBUS functions 3 „Read Holding Registers“ or 4 „Read Input Registers“.

Request

|                     |         |                                     |
|---------------------|---------|-------------------------------------|
| MODBUS-Functioncode | 1 Byte  | 0x03 or 0x04                        |
| Startaddress        | 2 Bytes | 0x0200 ... 0x027C                   |
| No. Register        | 2 Bytes | 0x0001...0x007D (depends of device) |

Response

|                     |              |              |
|---------------------|--------------|--------------|
| MODBUS-Functioncode | 1 Byte       | 0x03 or 0x04 |
| Startaddress        | 1 Bytes      | 2 x N*       |
| No. Register        | N* x 2 Bytes |              |

N\* = No. of input registers

Response in case of an error

|                            |         |                      |
|----------------------------|---------|----------------------|
| Errorcode                  | 1 Byte  | 0x81 or 0x82         |
| Errorcode (Exception Code) | 1 Bytes | 01 or 02 or 03 or 04 |



### Read diagnostic data

The MODBUS function code 3 “Read Holding Registers” or function code 4 “Read Input Registers” could be used.

#### Request

|                             |         |                                            |
|-----------------------------|---------|--------------------------------------------|
| MODBUS function code        | 1 Byte  | 0x03 or 0x04                               |
| Starting Address            | 2 Bytes | 0x2000 ... 0x2007                          |
| Quantity of Input Registers | 2 Bytes | 0x0001 ... 0x0008<br>depends on the device |

#### Response

|                      |                     |               |
|----------------------|---------------------|---------------|
| MODBUS function code | 1 Byte              | 0x03 or 0x04  |
| Byte count           | 1 Byte              | 2 x <b>N*</b> |
| Input Register       | <b>N*</b> x 2 Bytes |               |

**N\*** = Quantity of Input Registers

#### Error Response

|                |        |                      |
|----------------|--------|----------------------|
| Error code     | 1 Byte | 0x83 or 0x84         |
| Exception code | 1 Byte | 01 or 02 or 03 or 04 |

### MODBUS frame over the serial line

#### Request

|               |               |                  |                       |         |
|---------------|---------------|------------------|-----------------------|---------|
| 1 Byte        | 1 Byte        | 2 Bytes          | 2 Bytes               | 2 Bytes |
| Slave Address | Function Code | Starting Address | Quantity of Registers | CRC     |
| *             | 0x03 or 0x04  | 0x2000           | *                     |         |

\* depends on the device

#### Response

|               |               |            |                             |     |        |         |
|---------------|---------------|------------|-----------------------------|-----|--------|---------|
| 1 Byte        | 1 Byte        | 1 Byte     | Word 0                      | ... | Word N | 2 Bytes |
| Slave Address | Function Code | Byte count | Diagnostic data from device |     |        | CRC     |
| *             | 0x03 or 0x04  | n          | *                           |     |        |         |

\* depends on the device

### Device diagnostic data

| Word 0       |              | Word 1        |               | Word 2        |               | Word 3        |               |
|--------------|--------------|---------------|---------------|---------------|---------------|---------------|---------------|
| HB           | LB           | HB            | LB            | HB            | LB            | HB            | LB            |
| Diag. Byte 1 | Diag. Byte 0 | Diag. Byte 3  | Diag. Byte 2  | Diag. Byte 5  | Diag. Byte 4  | Diag. Byte 7  | Diag. Byte 6  |
| Word 4       |              | Word 5        |               | Word 6        |               | Word 7        |               |
| HB           | LB           | HB            | LB            | HB            | LB            | HB            | LB            |
| Diag. Byte 9 | Diag. Byte 8 | Diag. Byte 11 | Diag. Byte 10 | Diag. Byte 13 | Diag. Byte 12 | Diag. Byte 15 | Diag. Byte 14 |

HB: High byte / LB: Low byte

**Read additional data**

The MODBUS function code 3 “Read Holding Registers” or function code 4 “Read Input Registers” could be used.

**Request**

|                             |         |                                            |
|-----------------------------|---------|--------------------------------------------|
| MODBUS function code        | 1 Byte  | 0x03 or 0x04                               |
| Starting Address            | 2 Bytes | 0x4000 ... 0x4032                          |
| Quantity of Input Registers | 2 Bytes | 0x0001 ... 0x0033<br>depends on the device |

By using this Request it is possible to define an address offset.

Example: Starting Address = 0x4028  
 Quantity of Registers = 0x000B  
 Verification: Starting Address + Quantity of Registers <= 0x4033  
 0x4028 + 0x000B = 0x4033

**Response**

|                      |              |              |
|----------------------|--------------|--------------|
| MODBUS function code | 1 Byte       | 0x03 or 0x04 |
| Byte count           | 1 Byte       | 2 x N*       |
| Input Register       | N* x 2 Bytes |              |

N\* = Quantity of Input Registers

**Error Response**

|                |        |                      |
|----------------|--------|----------------------|
| Error code     | 1 Byte | 0x83 or 0x84         |
| Exception code | 1 Byte | 01 or 02 or 03 or 04 |

**MODBUS frame over the serial line****Request**

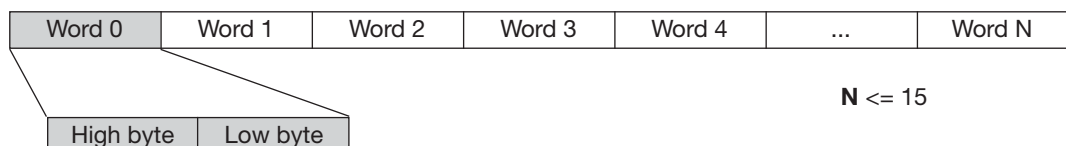
|               |               |                  |                       |         |
|---------------|---------------|------------------|-----------------------|---------|
| 1 Byte        | 1 Byte        | 2 Bytes          | 2 Bytes               | 2 Bytes |
| Slave Address | Function Code | Starting Address | Quantity of Registers | CRC     |
| *             | 0x03 or 0x04  | 0x4000           | *                     |         |

\* depends on the device

**Response**

|               |               |            |                 |     |        |         |
|---------------|---------------|------------|-----------------|-----|--------|---------|
| 1 Byte        | 1 Byte        | 1 Byte     | Word 0          | ... | Word N | 2 Bytes |
| Slave Address | Function Code | Byte count | Additional data |     |        | CRC     |
| *             | 0x03 or 0x04  |            | *               |     |        |         |

\* depends on the device

**Additional data**



| Address | Amount of data | Description                                                          |                                        |
|---------|----------------|----------------------------------------------------------------------|----------------------------------------|
| 0x4000  | 2 words        | Vendor name                                                          | MODBUS FieldBusPlug device information |
| 0x4002  | 6 words        | Product code                                                         |                                        |
| 0x4008  | 2 words        | Major.Minor Revision                                                 |                                        |
| 0x400A  | 6 words        | Vendor URL                                                           |                                        |
| 0x4010  | 8 words        | Product Name                                                         |                                        |
| 0x4018  | 8 words        | Not used                                                             |                                        |
| 0x4020  | 8 words        | Not used                                                             |                                        |
| 0x4028  | 7 words        | see chapter "Write configuration to the Device"                      | Device configuration data              |
| 0x402F  | 1 word         | MODBUS CRC-Error count                                               | MODBUS specific data                   |
| 0x4030  | 1 word         | MODBUS Request Slave Exception Error Count                           |                                        |
| 0x4031  | 1 word         | MODBUS slave address                                                 |                                        |
| 0x4032  | 1 word         | MODBUS baud rate unit is (baud rate / 100)<br>e.g. 192 == 19200 baud |                                        |

### Return query data

The MODBUS function code 8 sub function 00 could be used in the configuration and data exchange mode of the FieldBusPlug.

#### Request

|                      |         |                           |
|----------------------|---------|---------------------------|
| MODBUS function code | 1 Byte  | 0x08                      |
| Sub function         | 2 Bytes | 0x0000                    |
| Data                 | 2 Bytes | User defined request data |

#### Response

|                      |         |                   |
|----------------------|---------|-------------------|
| MODBUS function code | 1 Byte  | 0x08              |
| Sub function         | 2 Bytes | 0x0000            |
| Data                 | 2 Bytes | Echo request data |

#### Error Response

|                |        |      |
|----------------|--------|------|
| Error code     | 1 Byte | 0x88 |
| Exception code | 1 Byte | 01   |

### MODBUS frame over the serial line

#### Request

|               |               |              |         |         |
|---------------|---------------|--------------|---------|---------|
| 1 Byte        | 1 Byte        | 2 Bytes      | 2 Bytes | 2 Bytes |
| Slave Address | Function Code | Sub function | Data    | CRC     |
| *             | 0x08          | 0x0000       | **      |         |

\* depends on the device

\*\* User defined request data

#### Response

|               |               |            |         |         |
|---------------|---------------|------------|---------|---------|
| 1 Byte        | 1 Byte        | 2 Bytes    | 2 Bytes | 2 Bytes |
| Slave Address | Function Code | Byte count | Data    | CRC     |
| *             | 0x08          | 0x0000     | **      |         |

\* depends on the device

\*\* Echo request data





### Use of devices without a communication protocol (parallel device)

Examples for devices with parallel communication are:

- sensor
- pilot signal tower
- push button panels

Devices without a communication protocol are mapped with two binary input values and one binary output value.

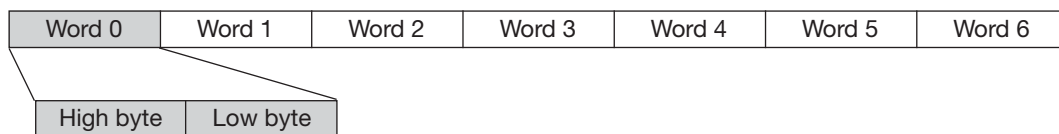
### Supported requests

The following requests are supported for these devices:

- Set baud rate via MODBUS
- Write configuration data
- Read binary input values (parallel device)
- Write binary output values (parallel device)
- Read additional data

### Optional device configuration data

For all devices without a communication protocol the following configuration data could be used.



|                   |                            |                                                                      |
|-------------------|----------------------------|----------------------------------------------------------------------|
| Word 0, high byte | Number of binary inputs    | 2                                                                    |
| Word 0, low byte  | Number of binary outputs   | 1                                                                    |
| Word 1, high byte | Number of analog inputs    | 0                                                                    |
| Word 1, low byte  | Number of analog outputs   | 0                                                                    |
| Word 2            | Number of parameter        | 0                                                                    |
| Word 3, high byte | Number of diagnostic bytes | 0                                                                    |
| Word 3, low byte  | 0x00; Not used             | 0                                                                    |
| Word 4            | Sum of all parameter bytes | 0                                                                    |
| Word 5            | Device Product Code        | 1                                                                    |
| Word 6            | MODBUS bus timeout         | 0x0000 no timeout<br>0x0001 ... 0x1FFF<br>unit ist ms <sup>*1)</sup> |

<sup>\*1)</sup> see chapter MODBUS bus timeout

Note: It is impossible to detect whether a parallel device is connected, defect or missing.

### Device address adjustment

These devices have no possibility to set a MODBUS slave address by hardware.

Therefore the Addressing Set CAS21-FBP.0 for PDP,DNP etc. can be used.

Order code: 1SAJ929003R0001

Once the address is set, it is stored in the FieldBusPlug, even in case of supply voltage breakdown.



### MODBUS exception codes

| Code | Name                 | Meaning                                                                                                                                                                                                                                                                                                                                                                                      |
|------|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 01   | ILLEGAL FUNCTION     | <p>The function code received in the request is not an allowable action for the slave.</p> <p>It could also indicate that the slave is in the wrong state to process a request of this type, for example because it is not configured</p>                                                                                                                                                    |
| 02   | ILLEGAL DATA ADDRESS | <p>The data address received in the request is not an allowable address for the slave.</p>                                                                                                                                                                                                                                                                                                   |
| 03   | ILLEGAL DATA VALUE   | <p>A value contained in the request data field is not an allowable value for slave. This indicates a fault in the structure of the remainder of a complex request, such as that the implied length is incorrect.</p>                                                                                                                                                                         |
| 04   | SLAVE DEVICE FAILURE | <p>An unrecoverable error occurred while the slave was attempting to perform the requested action.</p> <ul style="list-style-type: none"><li>- Wrong configuration</li><li>- Not supported baud rate</li><li>- Serial device connected, but parallel device addressed</li><li>- Parallel device connected, but serial device addressed</li><li>- Connected serial device defective</li></ul> |



### How to build an application program

- Application overview for the use of several devices
- Setting up an application program for one device

#### Application overview for the use of several devices

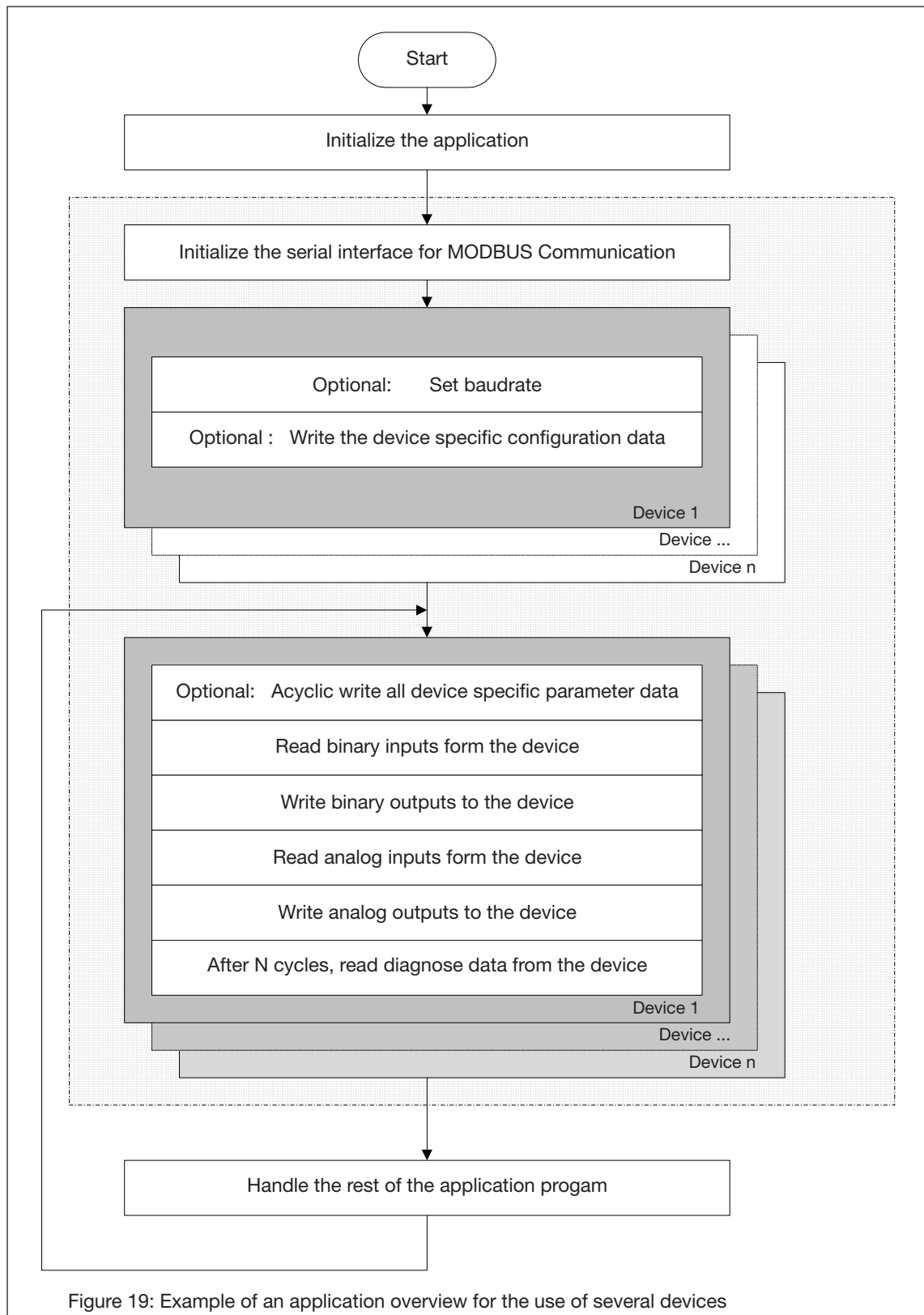


Figure 19: Example of an application overview for the use of several devices



### Setting up an application program for one device

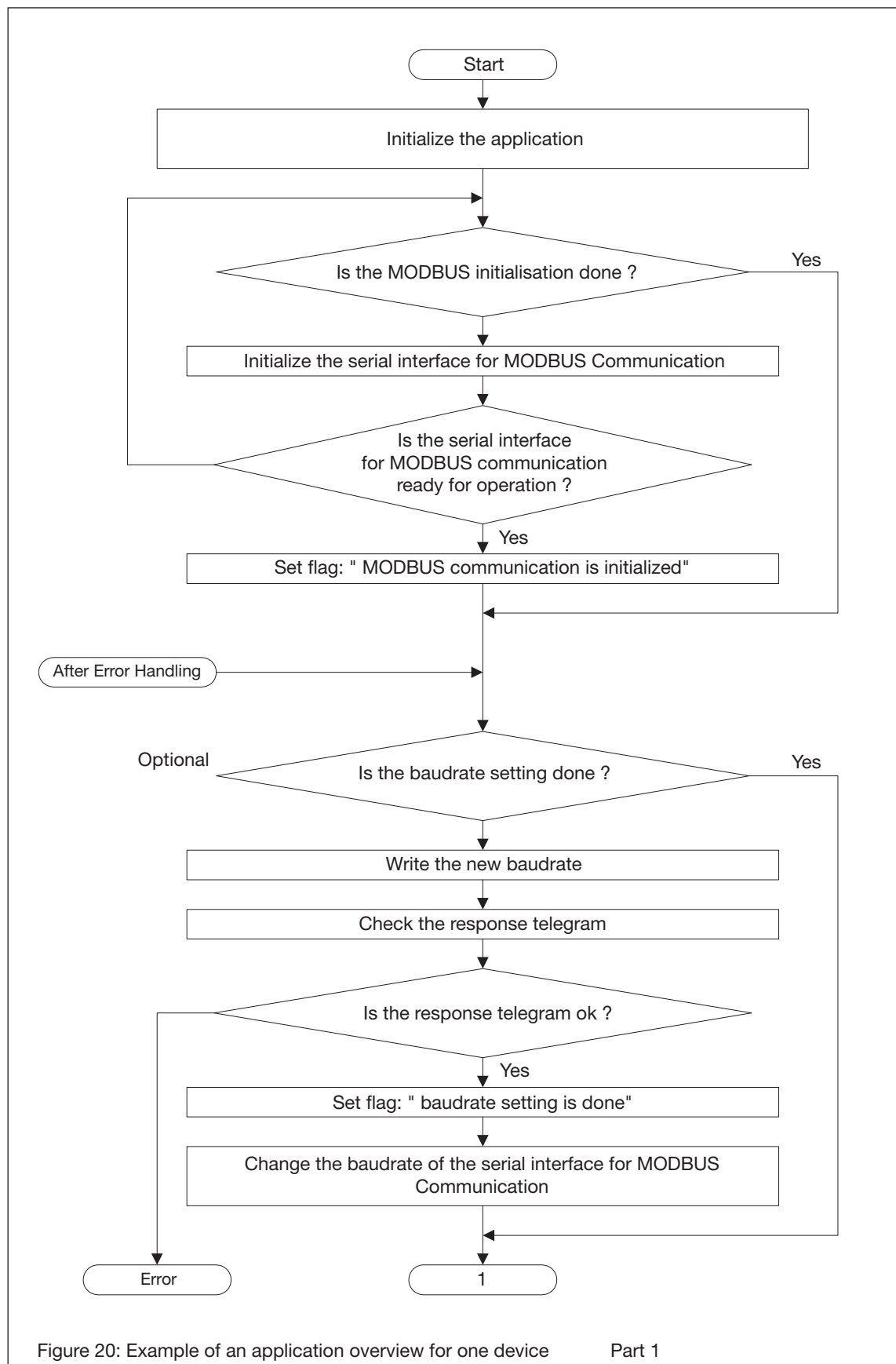


Figure 20: Example of an application overview for one device

Part 1

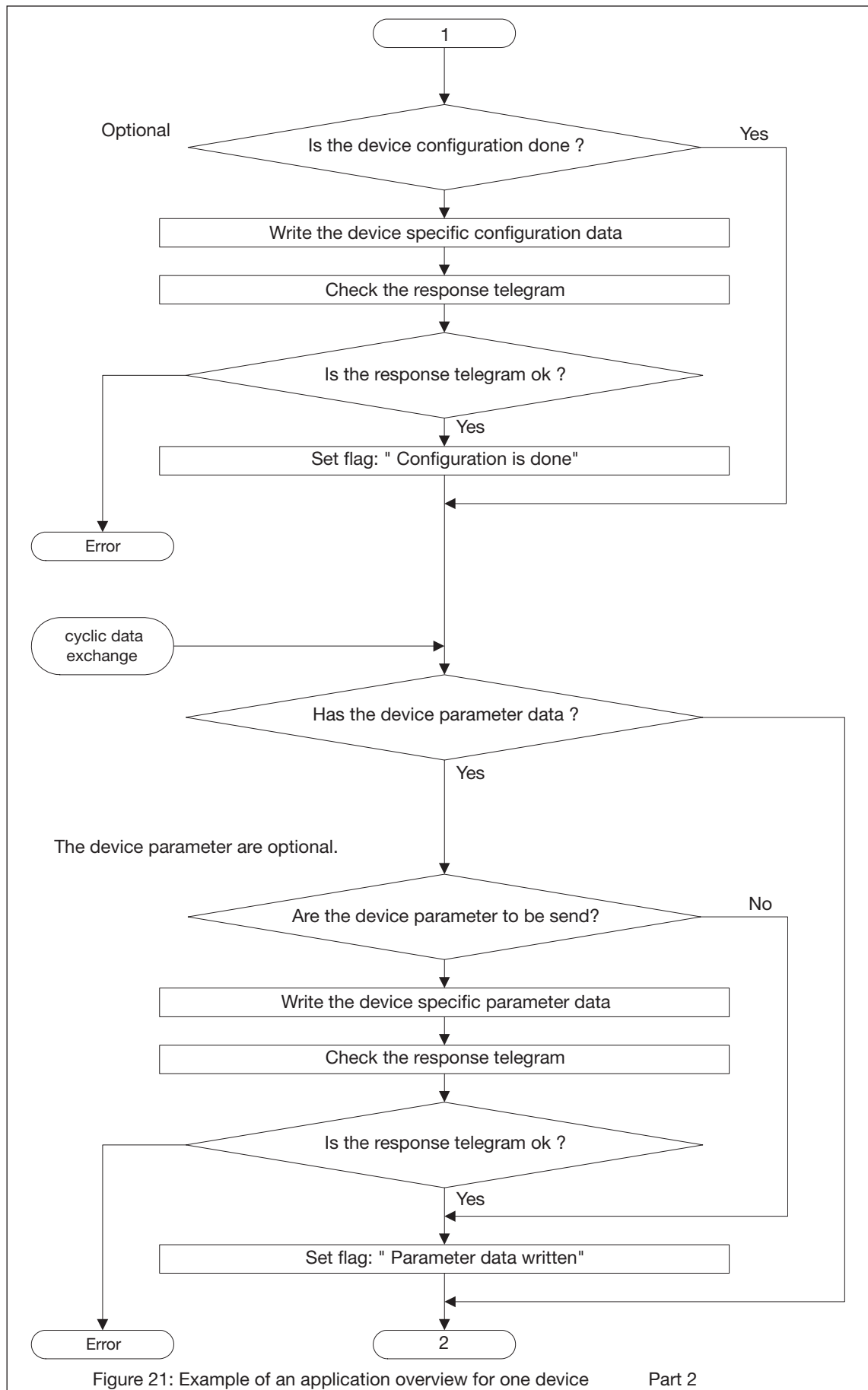


Figure 21: Example of an application overview for one device

Part 2

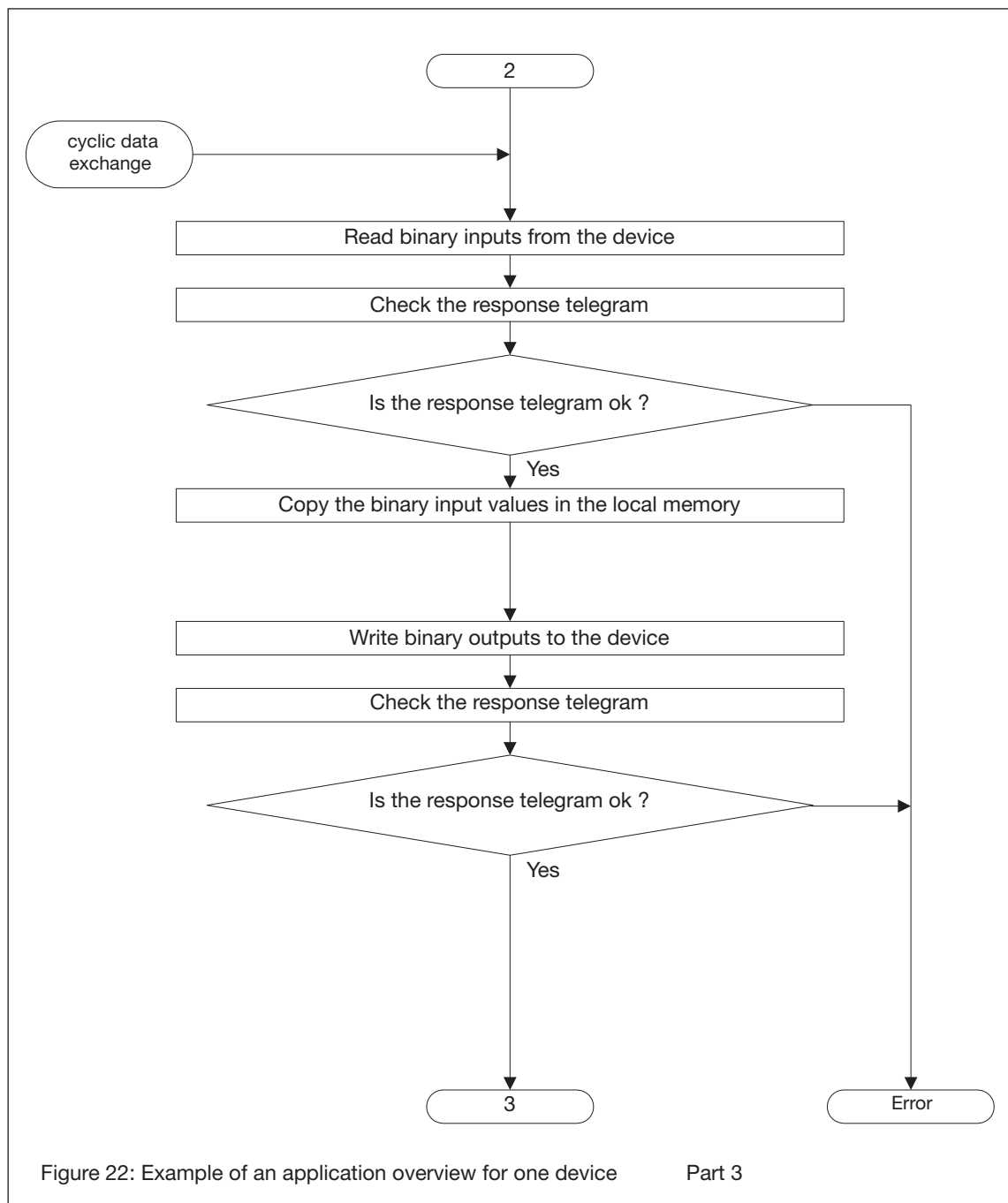


Figure 22: Example of an application overview for one device

Part 3

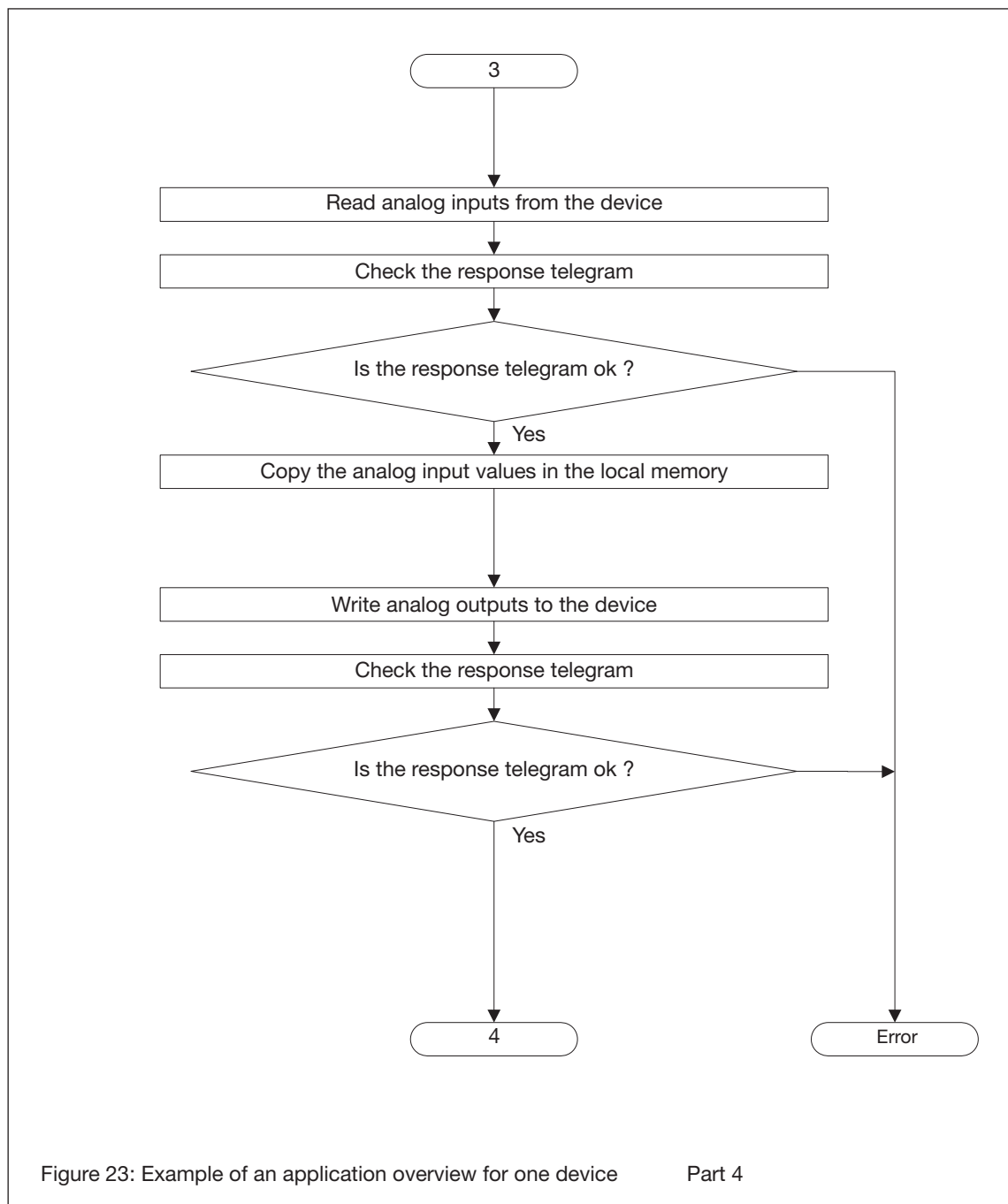
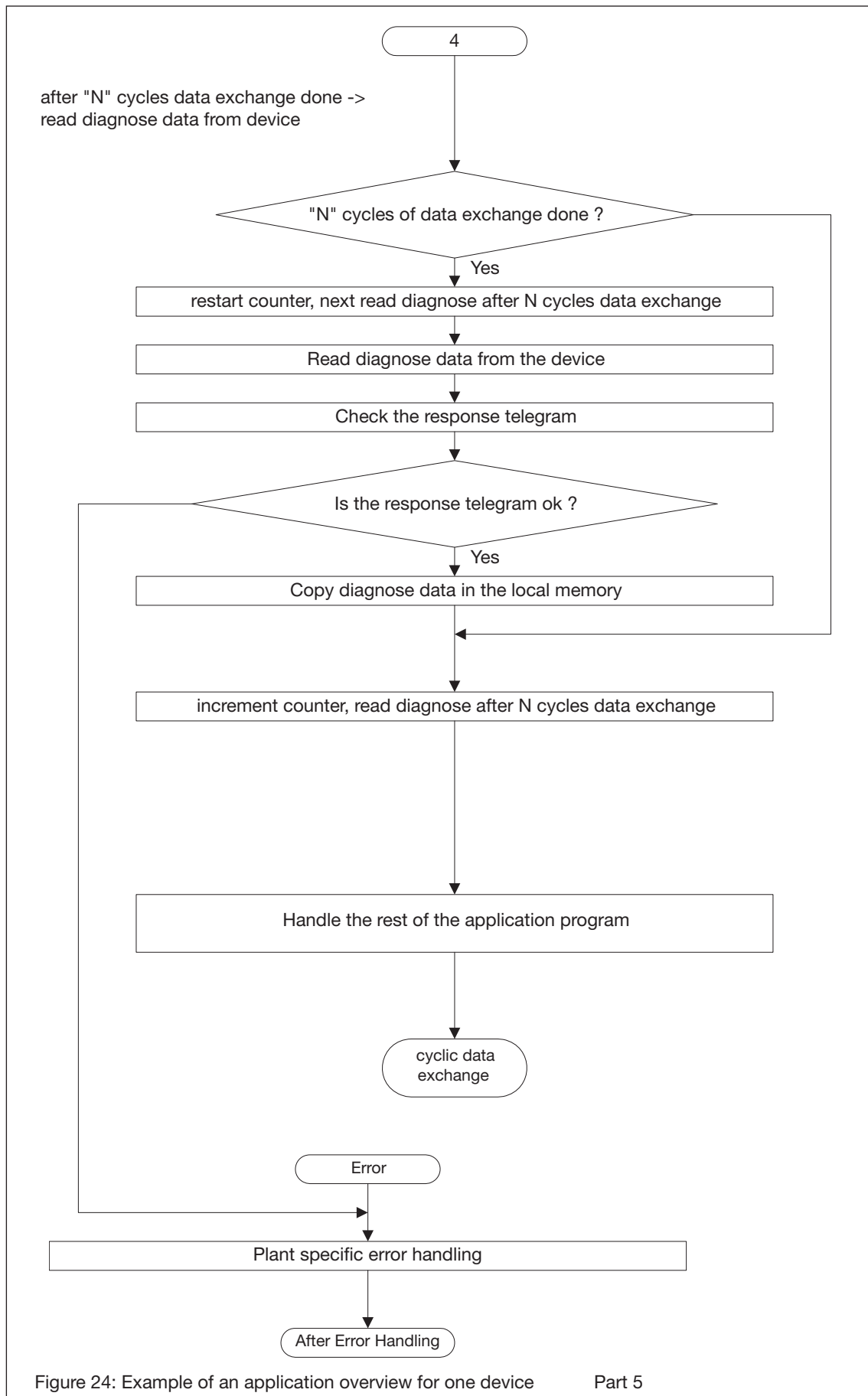


Figure 23: Example of an application overview for one device

Part 4



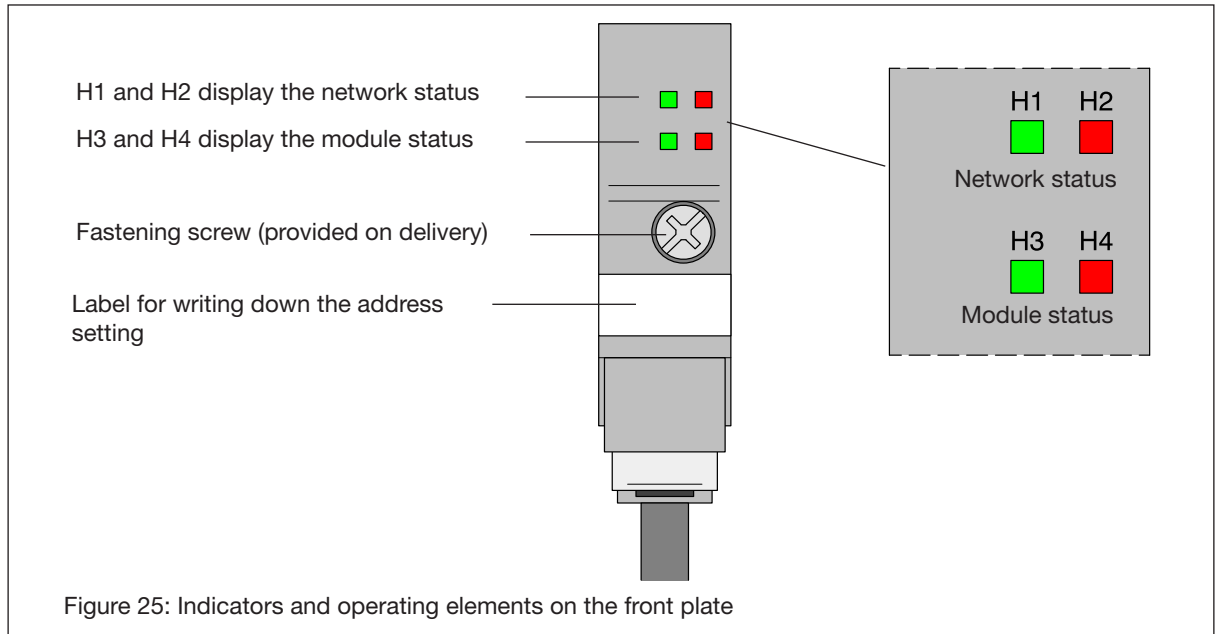




## Maintenance

- Indicators and operating elements on the front plate
- What can go wrong?

### Indicators and operating elements on the front plate



### Meaning of the LEDs

| Network status |            | Module status |            | Status / Cause                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|----------------|------------|---------------|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| LED green H1   | LED red H2 | LED green H3  | LED red H4 |                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| off            | off        | off           | off        | Power supply is missing                                                                                                                                                                                                                                                                                                                                                                                                                              |
| flashes        | flashes    | flashes       | flashes    | Plug is under self-test                                                                                                                                                                                                                                                                                                                                                                                                                              |
|                |            | flashes       | off        | Plug is waiting for configuration data, to be sent from the terminal device (number of input/output bytes, number of parameter bytes, data rate etc.).<br>Note:<br>If no data has been sent by the terminal device within 2 seconds, the plug switches to the parallel mode.                                                                                                                                                                         |
|                |            | on            | off        | The connection to the terminal device works properly.                                                                                                                                                                                                                                                                                                                                                                                                |
|                |            | off           | flashes    | Error: can be remedied, e.g.<br>- terminal device defective or.<br>- connection to the terminal device is broken                                                                                                                                                                                                                                                                                                                                     |
|                |            | off           | on         | Error: cannot be remedied, e.g. incorrect checksum in the flash, exchange plug                                                                                                                                                                                                                                                                                                                                                                       |
| on             | flashes    |               |            | Plug works properly but<br>- no cyclic data exchange (no read/write of binary or analog data)<br>- or waiting for cyclic data exchange (no read/write of binary or analog data) with MODBUS master, if the data exchange with terminal device was broken before.<br>- MODBUS bus-timeout (if configured): No cyclic data exchange between MODBUS master and the Plug.<br>Note:<br>The MODBUS bus-timeout is only detected if a timeout is configured |
| on             | off        |               |            | Normal data exchange.                                                                                                                                                                                                                                                                                                                                                                                                                                |



### What can go wrong?

#### RS485

- Are the termination resistors placed at the end of the line?
- Only 2 termination resistors in one segment?
- Are 2 termination resistors placed at each bus segment?
- Are bias resistors connected in each bus segment?
- Is the line polarity correct? Are the lines by accident swapped?
- Never place any termination resistors on a drop cable.
- Is the maximum line length exceeded?

#### MODBUS parameters

- Is the baud rate correctly adjusted?
- Is the parity and the stop bit correctly adjusted?
- Is the MODBUS master in RTU mode?
- Is the slave address correct?  
At start-up: The device baud rate is selected via the device address.
- Are there two devices with the same address in the system? If yes, fix it!

#### MODBUS master

- Is the request to response timeout correct?
- Is the MODBUS silent interval between two telegrams > 3.5 character times?
- Notice that the slave device will not give any response when it is addressed with a broadcast (slave address = 0).

#### MODBUS slave

- Has the device an unique MODBUS address?
- Is the function code supported by the device?
- Has the request an valid address?
- Has the request an valid quantity of coils, inputs, registers?
- Is the power supply turned on for the FieldBusPlug?
- Is the power supply turned on for the Terminal Device?



## V 6 Technical Description

### Technical data

|                                                                                                                                                     |                                                                                                                                                                                                                                      |
|-----------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>• Technical data</li> <li>• Ordering data</li> <li>• Accessories</li> <li>• Mechanical dimensions</li> </ul> |                                                                                                                                                                                                                                      |
| Supply voltages                                                                                                                                     |                                                                                                                                                                                                                                      |
| Standard power supply                                                                                                                               | 24 V DC                                                                                                                                                                                                                              |
| FieldBusPlugs work correctly at                                                                                                                     | supply voltage = 19.2 ... 31.2 V DC                                                                                                                                                                                                  |
| Current consumption                                                                                                                                 |                                                                                                                                                                                                                                      |
| from the MODBUS power supply                                                                                                                        | typ. 18.5 mA (24 V)                                                                                                                                                                                                                  |
| from the standard power supply                                                                                                                      | Only the terminal device is supplied from the standard power supply unit. The terminal device may not load the standard power supply unit with more than 200 mA.                                                                     |
| Loss of voltage bridging time                                                                                                                       | ≤ 1ms                                                                                                                                                                                                                                |
| Mounting                                                                                                                                            | on the terminal device, fixed with a screw (provided on delivery) or by M12 box nut fixing                                                                                                                                           |
| Building of a MODBUS bus (or a segment)                                                                                                             | by connecting the FieldBusPlugs in series (first bus plug to coupler/master, second bus plug to socket of the first FieldBusPlug, etc.)                                                                                              |
| Bus terminating resistors                                                                                                                           | at both ends of the bus line <b>120 Ω</b> each                                                                                                                                                                                       |
| Build-in bias resistors                                                                                                                             | Each MODBUS FieldBusPlug has: <ul style="list-style-type: none"> <li>- a pull-up resistor to a 5V Voltage on D1 circuit</li> <li>- a pull-down resistor to the common circuit on D0</li> </ul> The value of the resistors are 22 kΩ. |
| Bias resistors for the bus                                                                                                                          | Fail save biasing of the bus.<br>The sum of all bias resistors in a bus segment shall be ≤ 750 Ω.<br>Parallel connection of bias resistors from A+ -> 5V or B -> Common shall be ≤ 750 Ω in a bus segment.                           |
| Modes of data communication between FieldBusPlug and terminal device                                                                                | parallel and serial                                                                                                                                                                                                                  |
| Scope of data                                                                                                                                       | according to MODBUS specifications                                                                                                                                                                                                   |
| Construction of the FieldBusPlug cable                                                                                                              | round cable, black,     2 x 0.34 mm <sup>2</sup> for supply voltage<br>2 x 0.25 mm <sup>2</sup> for data lines<br>3 shields                                                                                                          |
| Load capacity of plugs and cables                                                                                                                   | max. 4 A                                                                                                                                                                                                                             |
| Pin assignment of the interfaces                                                                                                                    | see Figure 10                                                                                                                                                                                                                        |
| Degree of protection<br>(see also Figure 10)                                                                                                        | IP 65, if M12 box nut fixing is used at the terminal device (e.g. sensor)<br>IP 20, if mounting is performed using the supplied fastening screw (e.g. for MSD11-FBP)                                                                 |
| Ambient temperature                                                                                                                                 |                                                                                                                                                                                                                                      |
| storage                                                                                                                                             | -20 ... + 70 °C                                                                                                                                                                                                                      |
| operation                                                                                                                                           | 0 ... + 55 °C                                                                                                                                                                                                                        |
| Dimensions                                                                                                                                          | see Figure 26                                                                                                                                                                                                                        |
| Total power dissipation of the unit MRP21-FBP                                                                                                       | max. 0.525 W                                                                                                                                                                                                                         |
| Weight                                                                                                                                              |                                                                                                                                                                                                                                      |
| plug with cable 0.25 m                                                                                                                              | 0.09 kg                                                                                                                                                                                                                              |
| plug with cable 0.5 m                                                                                                                               | 0.10 kg                                                                                                                                                                                                                              |
| plug with cable 1 m                                                                                                                                 | 0.13 kg                                                                                                                                                                                                                              |
| plug with cable 5 m                                                                                                                                 | 0.35 kg                                                                                                                                                                                                                              |
| Bus address setting                                                                                                                                 | Over terminal Device, if the terminal device has address setting switches. Or CAS21-FBP addressing set can be used.                                                                                                                  |
| Possible addresses                                                                                                                                  | 1 to 247 (0 is reserved)                                                                                                                                                                                                             |
| Diagnosis (see Figure 25)                                                                                                                           | 4 LEDs on the front plate                                                                                                                                                                                                            |
| LED green, LED red                                                                                                                                  | network status                                                                                                                                                                                                                       |
| LED green, LED red                                                                                                                                  | module status                                                                                                                                                                                                                        |



### Ordering data

A fastening screw, an address label and a terminal cap for the bus are supplied along with the FieldBusPlug.

| Type          | Description                              | Order number       |
|---------------|------------------------------------------|--------------------|
| MRP21-FBP.025 | MODBUS FieldBusPlug, cable length 0.25 m | 1SAJ 250 000 R0003 |
| MRP21-FBP.050 | MODBUS FieldBusPlug, cable length 0.5 m  | 1SAJ 250 000 R0005 |
| MRP21-FBP.100 | MODBUS FieldBusPlug, cable length 1 m    | 1SAJ 250 000 R0010 |
| MRP21-FBP.500 | MODBUS FieldBusPlug, cable length 5 m    | 1SAJ 250 000 R0050 |

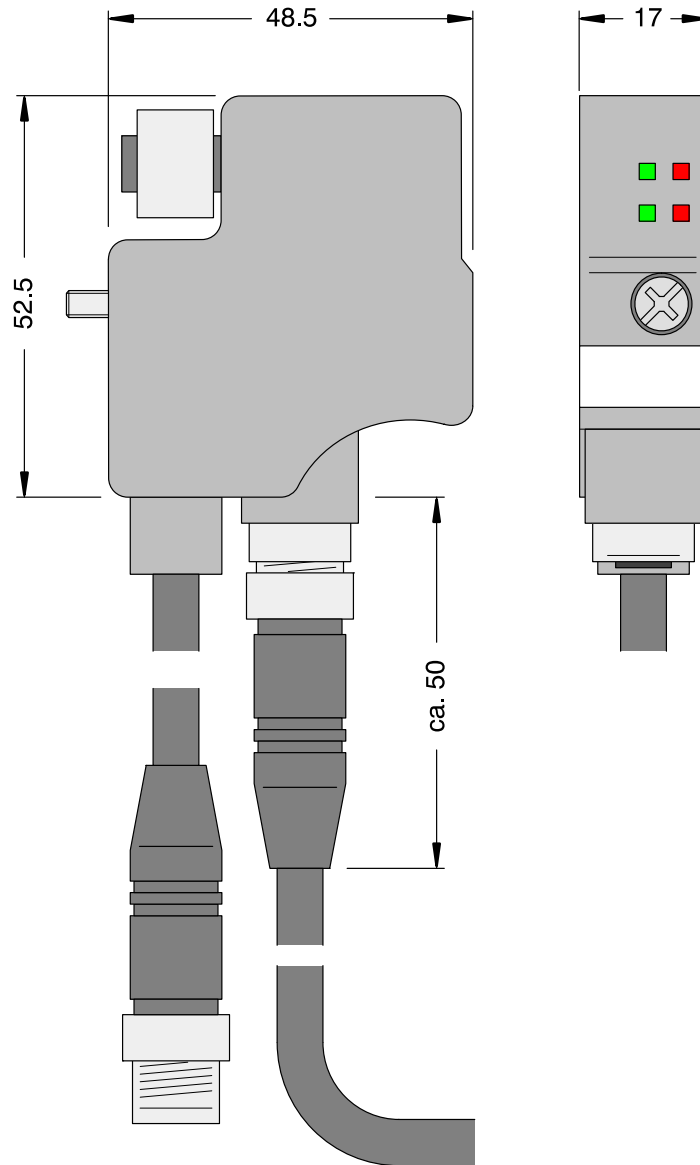
### Accessories

The MODBUS accessories are the same as for DeviceNet. Therefore the DeviceNet order numbers and descriptions may be used.

| Type          | Description                                                                                                         | Order number       |
|---------------|---------------------------------------------------------------------------------------------------------------------|--------------------|
| DNX11-FBP.100 | DeviceNet extension cable, length 1 m                                                                               | 1SAJ 923 001 R0010 |
| DNX11-FBP.300 | DeviceNet extension cable, length 3 m                                                                               | 1SAJ 923 001 R0030 |
| DNX11-FBP.500 | DeviceNet extension cable, length 5 m                                                                               | 1SAJ 923 001 R0050 |
| DNF11-FBP.050 | DeviceNet round cable, female plug attached at one end, 0.5 m, sheath partially removed, wire-end ferrules attached | 1SAJ 923 002 R0005 |
| DNM11-FBP.050 | DeviceNet round cable, male plug attached at one end, 0.5 m, sheath partially removed, wire-end ferrules attached   | 1SAJ 923 003 R0005 |
| DNC11-FBP.999 | DeviceNet round cable on 100 m coil                                                                                 | 1SAJ 923 004 R1000 |
| DNM11-FBP.0   | DeviceNet male connector for round cable                                                                            | 1SAJ 923 005 R0001 |
| DNF11-FBP.0   | DeviceNet female connector for round cable                                                                          | 1SAJ 923 006 R0001 |
| DNR11-FBP.120 | DeviceNet terminating resistor                                                                                      | 1SAJ 923 007 R0001 |



### Mechanical dimensions



All dimensions in mm

Figure 26: MRP21-FBP, mechanical dimensions







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Manual No.