SERIAL-PROFIBUS-INTERFACE | SPI 3

for Fieldbus devices with a serial interface

MODBUS RTU

Contents SPI 3 – Controls other than SIMATIC S5/S7 (up to SPI 3 Release 12)

Contents Online Documentation

Doc. Version 3.2

TREBING + HIMSTEDT

Dear customer

This online documentation is designed to help you with engineering, connecting up, configuration and parameter setting of the SPI 3. Please feel free to contact our Technical Support department if you need further help:

Trebing & Himstedt Prozessautomation GmbH & Co. KG
Technical Support Dept.
Wilhelm-Hennemann-Str. 13
D-19061 Schwerin, Germany

Telephone: +49 385 39572-500
Telefax: +49 385 39572-22

e-mail: support@t-h.de
homepage: http://www.t-h.de

Doc. Version 3.2 / January 2005

Table of Contents

Introduction

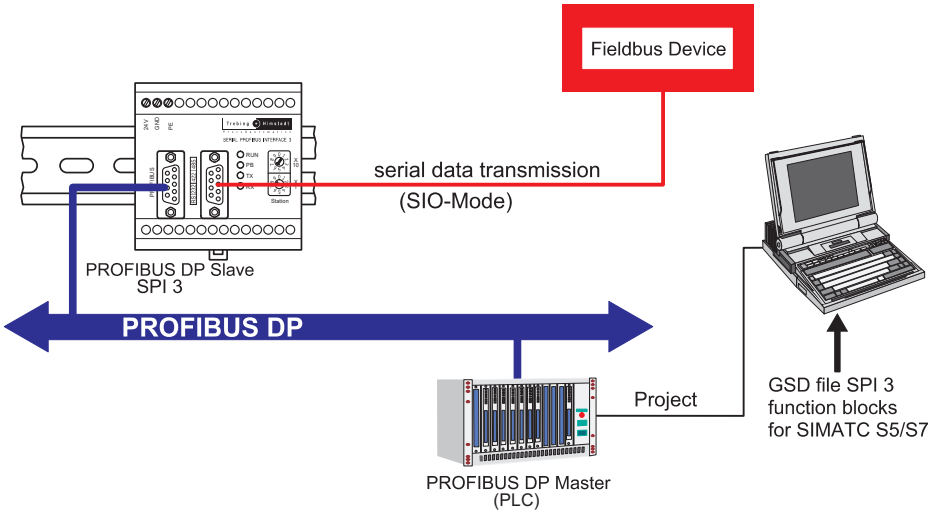
The SPI 3 (SERIAL-PROFIBUS-INTERFACE 3) allows a PROFIBUS-DP master to communicate with a fieldbus device with a serial interface. This allows the fieldbus device to function as a real PROFIBUS station, whereby the SPI 3 converts the data to be exchanged between the PROFIBUS-DP master and the fieldbus device into a format which is compatible with the other device.

Data is exchanged between the DP master and the SPI 3 in the form of telegrams or telegram fragments through a data channel, the size of which can be configured to adapt it to the telegram length and the size of the PLC I/O area. The data channel consists of a send channel and a receive channel.

The SPI 3 is easy to install and configure and a separate program for configuration or parameter setting is not necessary. Configuration is done using the respective PROFIBUS-DP master.

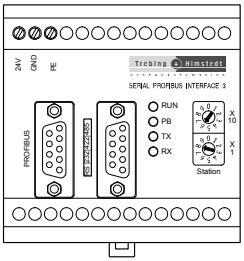
Features of the SPI 3:

- DP slave at up to 12 Mbit/s
- Serial baud rates up to 57.6 kbit/s
- Versions available for RS232, RS422 or RS485 serial interface
- Function blocks for SIMATIC S5/S7 (Included in Documentation & Media-Kit)
- Does not require special configuration software
- Simple and fast Integration in PROFIBUS-DP networks
- I/O range configurable from 2 or 4 data words

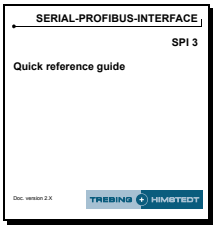


Example for SPI 3 interface module overview

Scope of delivery



SPI 3



Quick start guide

Documentation & Media kit (optional)

The documentation & media kit contains this online documentation, function blocks for SIMATIC S5 and S7, GSD file and example files. You can download the documentation & media kit (www.t-h.de). You need GSD file for the PLC project.

About this Online Documentation

Please read this online documentation before starting the installation work. It contains important information on planning your system, connecting up and configuring the SPI 3 and on parameter setting.

The online documentation uses the following keywords and symbols:

Danger!
Risk of injury to personnel due to electric shock.

Warning!
Risk of damage to equipment.

Note!
Indicates useful tips.

Safety notes

Safety notes for the planning stage

Observe the general rules for PROFIBUS components when planning the SPI 3 installation.

Please observe the following to avoid risk to personnel and damage to equipment and to ensure that the SPI 3 functions correctly:

Safety regulations	– Observe the guidelines in the VDE 0100 regulations for handling electrical components, – Observe the applicable safety and accident prevention regulations.
Assembly personnel	The SPI 3 must only be installed or de-installed by qualified technical personnel with appropriate electrotechnical qualifications.
PROFIBUS standard	Observe the guidelines in the PROFIBUS standard EN 50 170.
Bus cable	Bus wiring should only take place using special screened, twisted pair PROFIBUS cable. The high data transfer rates can only be guaranteed with the correct cable type.
Cable lengths	Refer to the manual for the DP master for information on maximum cable lengths for PROFIBUS.
Terminating resistors	Terminating resistors must be used if the SPI 3 is installed at the beginning or end of the PROFIBUS cable segment. In this case, you should use PROFIBUS connectors which contain an integrated terminating resistor. We recommend you to use connectors from ERNI and Siemens. If the bus is incorrectly terminated, this can lead to errors in data transfer or to damage to other stations on the bus.
Bus connectors	You should only use commercially available PROFIBUS connectors for connecting the bus. We recommend you to use connectors from ERNI and Siemens.
Cable screen	Screened cables are less sensitive to interference due to electromagnetic fields. With screened cables, the interference currents are led to ground through the screening rail, which is electrically connected to the case. To ensure that the interference currents which flow through the screening do not themselves interfere with other devices, it is important to provide a low impedance connection to the protective ground. Observe the following rules for the screens of the PROFIBUS cable and the serial interface cable: – The braiding of the screening should have a degree of coverage of more than 80 %.

– The screening should include a braided screen and should not consist solely of foil screening, since the latter can be easily damaged by cable tension and pressure.
– To ensure good immunity to interference at high frequencies as well, the screening of the cable should be attached to the screening rail at both ends of the cable.

Safety notes for installation and operation of the SPI 3

Please observe the following before connecting up the SPI 3 to avoid risk to personnel and damage to equipment and to ensure that the SPI 3 functions correctly:

– The SPI 3 is designed as an interface between fieldbus devices with serial interfaces and the PROFIBUS. Do not use the SPI 3 for any other purpose.
– The SPI 3 may only be installed or de-installed by qualified technical personnel with appropriate electrotechnical qualifications. When connecting up the SPI 3, you must observe the guidelines in the VDE 0100 regulations for handling electrical equipment.
– Always mount the SPI 3 on a suitable top-hat rail.
– The cables used to connect up the SPI 3 should not apply any mechanical forces to the device.

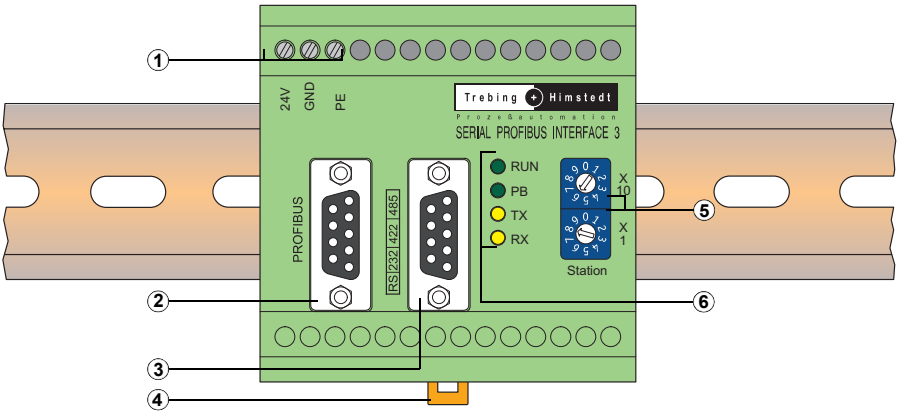
Danger!
Never open the case of the SPI 3 and do not make any modifications to the device.

Warning!
Small objects or liquids must not be allowed to enter the case of the SPI 3 (e.g. through the ventilation slots) since this could damage the device.

Never cover up the ventilation slots in the case.

Large temperature differences between the storage location and installation site can cause condensation to form within the case of the SPI 3, which can damage the device. If large temperature differences are present, you should wait at least 3-4 hours after installing the SPI 3 and before switching on the power.

Overview of the SPI 3



Connections and interfaces

– Power feed ①
  · 24 V Screw terminal for external 24 V power supply
  · GND Signal ground terminal
  · PE Protective ground terminal

– PROFIBUS interface ②

– Serial interface ③ (RS232, RS422 or RS485 see label on SPI 3)

Mounting the device

– Spring-loaded orange clip ④ for releasing the SPI 3 from the top-hat rail

Operating elements

– Two rotary switches ⑤ for setting the PROFIBUS address
  · Switch for setting the tens value
  · Switch for setting the units value

Indicating elements

LEDs ⑥ to indicate operating states (see »Error diagnosis and remedies« on page 18):

– RUN: lights continuously if supply voltage is present, flashes in case of errors

– PB: lights up if the SPI 3 has been configured by the master and is operational, flashes in case of errors

– TX: flashes if data is being sent to the serial interface

– RX: flashes if data is being received from the serial interface

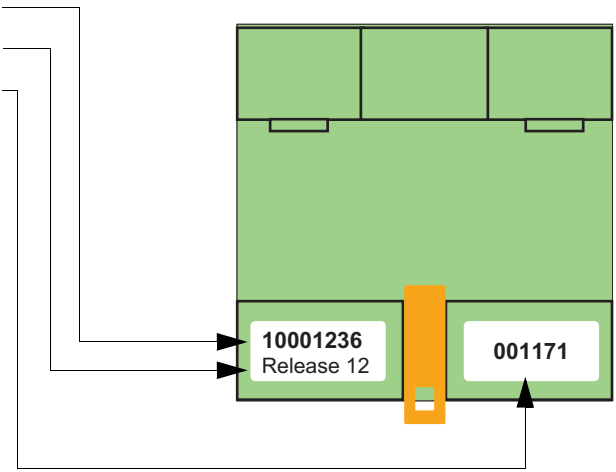
Release

The following information is indicated on the SPI 3 back-panel:

– Article No.

– Release No.

– Serial No.



Mounting and connecting up the SPI 3

Attaching the SPI 3 to the top-hat rail

– Hook the SPI 3 onto the top-hat rail and snap it into place.

In order to remove the SPI 3 from the top-hat rail, pull out the orange locking clip ④ with a suitable tool.

Connecting up the power feed

Danger!
Incorrect grounding of the SPI 3 can injure personnel and damage equipment. Make sure that the SPI 3 is correctly grounded.

Warning! Although the SPI 3 is protected against polarity reversal, connecting up the power feed with incorrect polarity for extended periods can damage the device. Make sure that the power feed is connected with correct polarity.

– Connect the cables for 24 V power feed, ground and protective ground to the corresponding screw terminals 24 V, GND and PE (①).

Connecting up to a fieldbus device with serial interface

Note!
To ensure that the SPI 3 functions without errors, you should use a screened cable for connecting to the serial fieldbus device.

– Ensure that the Sub-D connector for the serial interface uses the pin assignments shown in »Technical specifications« on page 20 (connect the cable screen to the case of the sub-D connector).
– Attach the sub-D connector for the serial interface to the serial interface socket ③ on the SPI 3.

Connecting up to the PROFIBUS

Note!
You should only use commercially available PROFIBUS connectors for connecting to the bus. We recommend you to use connectors from ERNI and Siemens.
If the SPI 3 is installed at the beginning or end of the PROFIBUS cable segment, you should use PROFIBUS connectors which contain an integrated terminating resistor. We recommend you to use connectors from ERNI and Siemens.
To ensure that the SPI 3 functions without errors, you must ground the screen of the PROFIBUS cable.

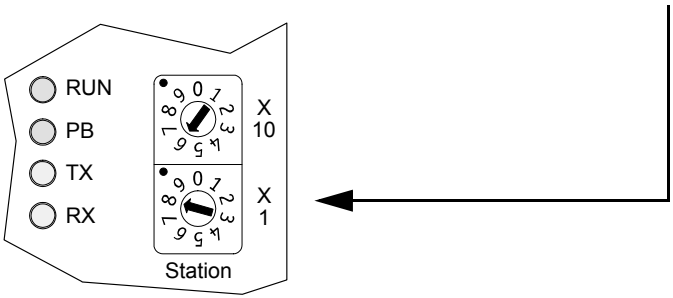
– Ensure that the PROFIBUS connector uses the pin assignments shown in »Technical specifications« on page 20.
– Attach the PROFIBUS connector to the PROFIBUS interface socket ② on the SPI 3 and secure the connector with the retaining screws.

Setting the PROFIBUS address

Note!
The SPI 3 only updates its PROFIBUS address during a restart. Set the PROFIBUS address on the SPI 3 before switching on the power, or turn off the power briefly after changing the PROFIBUS address.
PROFIBUS addresses 00 to 02 are reserved. You should only use addresses between 03 and 99.

– The PROFIBUS address is set with the two rotary switches ⑤.

Example: In order to set the PROFIBUS address 68, turn the rotary switch for the 10's to 6, and the rotary switch for the units to 8.



Setting up the SPI 3

In order to set up the SPI 3, you need to configure it, set the parameters and install the function blocks in your PLC programming software or, if you do not use SIMATIC control, establish the function blocks (see following chapter).

When configuring the SPI 3 from the DP master using a commercially-available PROFIBUS configurator program, refer to the on-line help for information on specifying the parameters. Since there are a large number of different PROFIBUS configurators on the market, it is only possible to give a general overview of the process of configuration and parameter setting:

– Start the PROFIBUS configurator on the DP master.
– Insert the diskette with the device database files (GSD) into the diskette drive of the programming device (usually a PC).
– Load the GSD file THDP0091.GSD in the configurator.
– Configure the SPI 3 and set the parameters as described in the configurator's on-line help or user manual.

Note!
If you do not want to use a PROFIBUS configurator program, you need to create your own configuration and/or parameter telegram. See »Creating a configuration telegram« on page 21 for more information.

Configuring the SPI 3

When configuring the SPI 3 with the PROFIBUS configurator, you will be prompted to choose a firmware module from the menu. Choose a module from the following list according to the required I/O area and data transfer protocol:

Module name	I/O area	Data transfer protocol
MODBUS RTU modules (control data stamp/mirror in byte 0 and byte 1)		
MODBUS_Prm____2W_i/o	2 words	MODBUS RTU
MODBUS_Prm____4W_i/o	4 words	MODBUS RTU

Note!
You should only configure one module for the SPI 3 device.
After configuring the SPI 3, you need to set the parameters. This is described in »Setting parameters for the SPI 3« on page 11.
Only the above-stated modules can be used for MODBUS.

Setting parameters for the SPI 3

When you configure the SPI 3 with the PROFIBUS configurator, you will be prompted to choose the required parameters from a menu.

You can set the following parameters:

MODBUS RTU see »SPI 3-specific parameters« on page 22

Data transfer rate
Parity
Timeout for slave response
Number of repeats

Choose the parameter values according to the serial fieldbus device you are using. If necessary, refer to the descriptions of the required parameters in this manual.

Creating function blocks

Data is exchanged between the DP master and the SPI 3 in the form of telegrams or telegram fragments through a data channel. The size of the data channel can be configured to match the telegram length and the size of the PLC I/O area. The size of the data channel can be configured as 2 or 4 words. The examples in this chapter are for a 4-word I/O buffer. For a 2-word I/O area, only bytes 2 and 3 are available for user data.

Note!
You can find an example block for ABB Freelance 2000 control on the Internet under: http://www4.abb.de/downloads/freelance.

The I/O buffer contains both control data and user data as follows:

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
Control data		User data (fragment)					

User data:
contains the usable information in the form of MODBUS telegrams or telegram fragments.

Control data:
controls the exchange of data between the DP master and the SPI 3. It is used to:

– Indicate new data,

– control the exchange of telegrams which are larger than the configured data channel,

– handle flow control between the DP master and the SPI 3.

Two bytes are available for the control data:

– The command byte (“stamp”) is used to send commands to the SPI 3:
  The DP master uses it to indicate:
  · the start of a new telegram,
  · the start of user data, or
  · the end of the job.

– The status byte (“mirror”) is used to receive status information from the SPI 3:
  The SPI 3 places a copy of the stamp in the mirror to indicate:
  · that it is ready for data exchange,
  · that the user data is being processed,
  · the end of the job.

If it is required to exchange a telegram which is larger than the available data channel (2 or 4 words), it must be split up and transferred in several parts (fragments).

The data channel consist of a send and a receive channel.

The send channel
consists of an input byte (input byte 0) for the send mirror and 7 output bytes consisting of the send stamp (output byte 0) and the user data (output bytes 2…7).

Input byte:

Byte 0							
Send mirror							

Output bytes:

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
Send stamp		User data					

The receive channel:
consists of an output byte for the receive stamp (output byte 1) and 7 input bytes consisting of the receive mirror (input byte 1) and the user data (input bytes 2…7).

Output byte:

Byte 0	Byte 1						
	Receive stamp						

Input byte:

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
	Receive mirror	User data					

Output byte 0 contains the send stamp:

– Send stamp = 0 indicates that the DP master is ready to send,

– Send stamp ≠ 0 indicates that user data now follows or that the job is completed.

Output byte 1 contains the receive stamp

– Receive stamp = 0 indicates that the DP master is ready to receive,

– Receive stamp ≠ 0 indicates that user data has been requested or that the job is completed.

Output byte 2 contains:

– At the start of the send job (send stamp = 0): information on the length of the user data,

– Following that (send stamp ≠ 0): user data.

Output bytes 3 to 7 contain:

– At the start of the send job (send stamp = 0): no data,

– Following that (send stamp ≠ 0): user data (user data fragments).

Output byte for send stamp = 0

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0x00	0x01	0x06					
Send stamp	Receive stamp	Length of user data					

Output byte for send stamp ≠ 0

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0x01	0x01	a	b	c	d	e	f
Send stamp	Receive stamp	User data 6 bytes					

Input byte 0 contains the send mirror:

– Send mirror = 0 indicates that the SPI 3 is ready for data exchange,

– Send mirror ≠ 0 indicates that user data now follows or that the job is completed.

Input byte 1 contains the receive mirror:

– Receive mirror = 0 indicates that the SPI 3 is ready for data exchange,

– Receive mirror ≠ 0 indicates that user data is being processed or that the job is completed.

Input byte 2 contains:

– At the start of the data exchange (receive mirror = 0): information on the length of the user data,

– Following that (receive mirror ≠ 0) user data.

Input bytes 3…7 contain:

– At the start of the data exchange (receive mirror = 0): no data,

– Following that (receive mirror ≠ 0): user data (user data fragments).

Input byte for receive mirror = 0

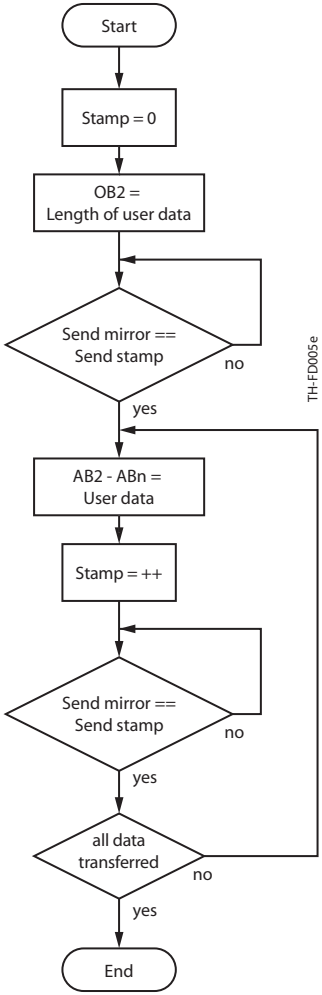
Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0x01	0x00	0x06					
Send stamp	Receive stamp	Length of user data					

Input byte for receive mirror ≠ 0

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0x01	0x01	a	b	c	d	e	f
Send stamp	Receive stamp	User data 6 bytes					

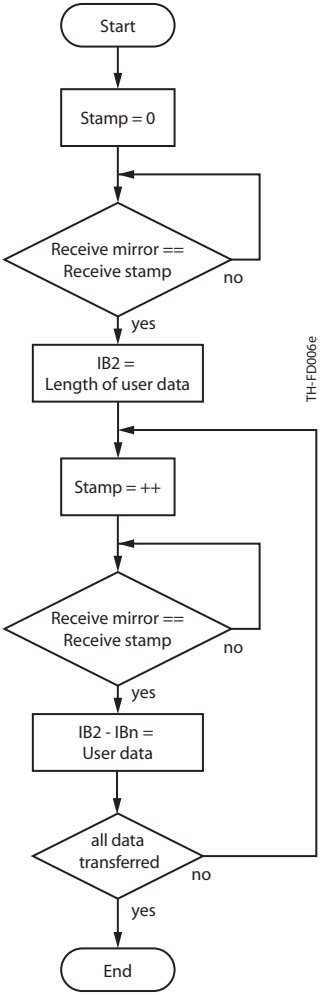
The following flow diagrams illustrate the steps necessary for data exchange:

Sending data



= set to
== compare with
++ increment by 1
OB Output byte

Receiving data



= set to
== compare with
++ increment by 1
IB Input byte

Checking the SPI 3 for correct operation

Several checks should be made before using the SPI 3 to transfer data.

Checking the SPI 3 power feed

– At this stage, do not attach either the PROFIBUS interface or the serial interface,

– switch on the power feed for the SPI 3.

The RUN LED should light continuously. If this is not the case, there is a fault in the 24 V power feed. Refer to »Error diagnosis and remedies« on page 18 for details of how to locate the fault.

Checking the PROFIBUS communication

– Connect up the PROFIBUS interface cable,

– switch on the power feed for the SPI 3,

– start the DP master, which has been configured previously.

The PB LED should light continuously. If this is not the case, there is an error in the PROFIBUS communication. Refer to »Error diagnosis and remedies« on page 18 for details of how to locate the fault.

Checking the serial interface communication

– Connect up the PROFIBUS interface cable and the serial interface cable,

– switch on the power feed for the SPI 3,

– start the DP master, which has been configured previously,

– start the communication with the serial device.

The RUN LED should light continuously. If it does not light, or it only flashes, there is an error in the communication with the serial device. Refer to »Error diagnosis and remedies« on page 18 for details of how to locate the fault.

If no errors were detected, the SPI 3 is ready for use and you can use it for transferring data.

The TX LED should flash when data is being transmitted over the serial interface and the RX LED should flash when data is being received over the serial interface (see »Indicating elements« on page 7).

Error diagnosis and remedies

If errors are detected, the pattern of flashing of the PB and RUN LED's on the SPI 3 can be used for error diagnosis. The LED's can flash with the following patterns (this is called the "LED code"):

LED off	LED short	LED medium	LED long	LED on
				
LED always off	LED is ¾ off ¼ on	LED is ½ off ½ on	LED is ¼ off ¾ on	LED always on

Note!
If the PB LED ("PROFIBUS") is off, the RUN LED is on continuously and no longer indicates a valid LED code. Accordingly, the RUN LED can only be used for diagnosis when the PB LED is lit. The PROFIBUS diagnostics and error statuses are reset when the error is no longer present or when the slave gets new parameter and configuration values

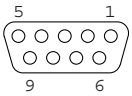
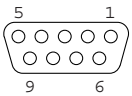
PB LED code	Status	Significance	Remedy
PB LED off	Correct data transfer rate could not be determined	– No PROFIBUS master in the network	– Connect up the DP master – Check the wiring
PB LED short	No DP master available	– A master is available but it is not a DP master – A master is available but communication is not taking place with PROFIBUS-DP	– Check DP configuration of the master – Check address setting on the SPI 3
PB LED medium	Incorrect parameter	– Parameter telegram faulty	– Check the DP parameter telegram, use the correct GSD file
PB LED long	Incorrect configuration	– Configuration telegram faulty	– Check the number of modules (only one module is allowed in the configuration)
PB LED on	Data exchange OK	– Data exchange is currently taking place	– SPI 3 working correctly

RUN LED code	Status	Significance	Remedy
RUN LED off	SPI 3 not ready	– 24 V supply not present	– Check external power supply – Check the wiring
RUN LED short	No response from slave	– MODBUS slave did not respond after max. number of repeats	– Check interface parameters if a receive error also occurred – Check the address of the MODBUS slave – Check the wiring
RUN LED medium	Receive error	– Error when receiving	– Check character format and data transfer rate of partner station
RUN LED on	Communication OK	– Serial partner communicating correctly with the SPI 3	– SPI 3 working correctly

If errors occur during communication, you can also carry out PROFIBUS diagnostics with the DP master. The device-specific diagnostics data contains the following information:

1 byte header for device-related diagnostics	0x02
1 byte bit-mapped to indicate the error	Bit 0 = 1 Error, no slave response Bit 1 = 1 Receive error

Technical specifications

Electrical data				
Nominal supply voltage	V DC	24 (20.4…28.8)		
Current consumption	mA	200		
Galvanic isolation, PROFIBUS interface	V DC	500		
Ambient conditions				
Operating temperature	°C	0…60		
Case				
Protection class	IP	20		
Dimensions W × H × D	mm	75 × 75 × 53		
PROFIBUS interface				
Interface type		RS 485		
Data transfer rate	Bit/s	9.600; 19.200; 93.750; 187.500; 0,5M; 1,5M; 3M; 6M; 12M, automatic detection of the data transfer rate		
Pin assignment Sub-D connector 	Pin 1	Screen		
	Pin 2	Unused		
	Pin 3	B-line		
	Pin 4	Request to Send (RTS)		
	Pin 5	Ground for 5 V (M5)		
	Pin 6	+5 V (galvanically isolated P5)		
	Pin 7	Unused		
	Pin 8	A-line		
	Pin 9	Unused		
Serial interface				
Interface type		RS 232* / /RS 422 / RS 485*		
Data transfer rate**	Bit/s	110; 300; 600; 1.200; 2.400; 4.800; 9.600; 19.200		
Data frame**	Bit	7 / 8		
Parity**		Even, odd, none, mark, space		
Pin assignment Sub-D connector 		RS 232	RS 422	RS 485
	Pin 1	Screen	Screen	Screen
	Pin 2	TXD (out)	Unused	Unused
	Pin 3	RXD (in)	REC-P	BUS-P
	Pin 4	Unused	TRANS-P	Unused
	Pin 5	GND	GND	GND
	Pin 6	+5 V	+5 V	+5 V
	Pin 7	CTS (in)	Unused	Unused
	Pin 8	RTS (out)	REC-N	BUS-N
	Pin 9	Unused	TRANS-N	Unused
Other				
I/O area (PROFIBUS-DP)**	words	2, 4		
Certification		CE		
Max. number of fieldbus devices**		32 (RS 485); 1 (RS 232, RS 422)		

* See label on the SPI 3 for information on the serial interface which is fitted
** Depends on the protocol

Appendix

Creating a configuration telegram

Depending on the number and size of the inputs and outputs, the configuration telegram contains one or more module codes. The module codes are used to select the operating mode of the SPI 3 (see »Configuring the SPI 3« on page 10).

The module codes in the configuration telegram should be specified as follows:

– 2 words I/O area: MODBUS_Prm____2W_i/o

– 4 words I/O area: MODBUS_Prm____4W_i/o

Creating a parameter telegram

If you cannot or do not want to use a configurator for setting the SPI3 parameters, you will need to create a parameter telegram. The parameter telegram contains both standardized bus-related parameters and device-specific parameters for the SPI 3.

Standard bus-related parameters

The first 7 bytes (bytes 0…6) of the parameter telegram contain bus-related parameters which are standardized in EN 50 170. Bytes 4 and 5 contain the vendor ID (Trebing & Himstedt = hex 0x0091). The settings of the other 5 bytes depend on your network configuration (see EN 50 170).

SPI 3-specific parameters

The following 9 bytes of the parameter telegram (bytes 7 to 15) contain SPI 3-specific parameters (see table).

Note!
The hex value for slave response timeout must be specified in Motorola format (high byte first).

Byte	Parameter	Value	Hex code	Default
7…9	Constant	Cannot be changed	0x00	0x00
10	Constant	Cannot be changed	0x05	0x05
11	Data transfer rate	110 Bit/s 300 Bit/s 600 Bit/s 1200 Bit/s 2400 Bit/s 4800 Bit/s 9600 Bit/s 19200 Bit/s	0x00 0x01 0x02 0x03 0x04 0x05 0x06 0x07	9600 (0x06)
12	Parity	none even odd mark space	0x00 0x01 0x02 0x03 0x04	even (0x01)
13+14	Max. delay of slave response	Timeout in 10 ms (0-65535) × 10 ms	0x0000 to 0xFFFF	100 (0x00, 0x64)
15	Max. number of telegram repeats if slave does not respond within “timeout”	Repeat (1-255)	0x01 to 0xFF	3 (0x03)

Creating a MODBUS telegram

In order to send a MODBUS telegram, you need to:

– create the MODBUS telegram,

– store the MODBUS telegram in the user data area.

The structure of the MODBUS telegram is dependent on the chosen MODBUS function as shown in the following tables:

Note!
The SPI 3 is MODBUS-Master.
The checksum (CRC) is calculated automatically by the SPI 3.

You find the description of the MODBUS functions e.g. in »MODBUS Protocol Reference Guide« (see http://www.modicon.com).

Function 01: Read Coil Status

	Request to the slave		Slave response	
Byte	Contents	Hex code (e.g.)	Contents	Hex code (e.g.)
Byte 1	Slave Address	11	Slave Address	11
Byte 2	Function	01	Function	01
Byte 3	Starting Address High	00	Byte Count	05
Byte 4	Starting Address Low	13	Data (Coils 27-20)	CD
Byte 5	No. of Points High	00	Data (Coils 35-28)	6B
Byte 6	No. of Points Low	25	Data (Coils 43-36)	B2
Byte 7	–	–	Data (Coils 51-44)	0E
Byte 8	–	–	Data (Coils 56-52)	1B

Function 02: Read Input Status

	Request to the slave		Slave response	
Byte	Contents	Hex code (e.g.)	Contents	Hex code (e.g.)
Byte 1	Slave Address	11	Slave Address	11
Byte 2	Function	02	Function	02
Byte 3	Starting Address High	00	Byte Count	03
Byte 4	Starting Address Low	C4	Data (Inputs 10204-10197)	AC
Byte 5	No. of Points High	00	Data (Inputs 10212-10105)	DB
Byte 6	No. of Points Low	16	Data (Inputs 10218-10113)	35

Function 03: Read Holding Register

	Request to the slave		Slave response	
Byte	Contents	Hex code (e.g.)	Contents	Hex code (e.g.)
Byte 1	Slave Address	11	Slave Address	11
Byte 2	Function	03	Function	03
Byte 3	Starting Address High	00	Byte Count	06
Byte 4	Starting Address Low	6B	Data High (Register 40108)	02
Byte 5	No. of Points High	00	Data Low (Register 40108)	2B
Byte 6	No. of Points Low	03	Data High (Register 40109)	00
Byte 7	–	–	Data Low (Register 40109)	00
Byte 8	–	–	Data High (Register 40110)	00
Byte 9	–	–	Data Low (Register 40110)	64

Function 04: Read Input Register

	Request to the slave		Slave response	
Byte	Contents	Hex code (e.g.)	Contents	Hex code (e.g.)
Byte 1	Slave Address	11	Slave Address	11
Byte 2	Function	04	Function	04
Byte 3	Starting Address High	00	Byte Count	02
Byte 4	Starting Address Low	08	Data High (Register 30009)	00
Byte 5	No. of Points High	00	Data Low (Register 30009)	0A
Byte 6	No. of Points Low	01	–	–

Function 05: Force Single Coil

	Request to the slave		Slave response	
Byte	Contents	Hex code (e.g.)	Contents	Hex code (e.g.)
Byte 1	Slave Address	11	Slave Address	11
Byte 2	Function	05	Function	05
Byte 3	Coil Address High	00	Coil Address High	00
Byte 4	Coil Address Low	AC	Coil Address Low	AC
Byte 5	Force Data High	FF	Force Data High	FF
Byte 6	Force Data Low	00	Force Data Low	00

Function 06: Preset Single Register

	Request to the slave		Slave response	
Byte	Contents	Hex code (e.g.)	Contents	Hex code (e.g.)
Byte 1	Slave Address	11	Slave Address	11
Byte 2	Function	06	Function	06
Byte 3	Register Address High	00	Register Address High	00
Byte 4	Register Address Low	01	Register Address Low	01
Byte 5	Preset Data High	00	Preset Data High	00
Byte 6	Preset Data Low	03	Preset Data Low	03

Function 15: Force Multiple Coils

	Request to the slave		Slave response	
Byte	Contents	Hex code (e.g.)	Contents	Hex code (e.g.)
Byte 1	Slave Address	11	Slave Address	11
Byte 2	Function	0F	Function	0F
Byte 3	Coil Address High	00	Coil Address High	00
Byte 4	Coil Address Low	13	Coil Address Low	13
Byte 5	Quantity of Coils High	00	Quantity of Coils High	00
Byte 6	Quantity of Coils Low	0A	Quantity of Coils Low	0A
Byte 7	Byte Count	02	–	–
Byte 8	Force Data High (Coils 27-20)	CD	–	–
Byte 9	Force Data Low (Coils 29-28)	01	–	–

Function 16: Preset Multiple Regs

	Request to the slave		Slave response	
Byte	Contents	Hex code (e.g.)	Contents	Hex code (e.g.)
Byte 1	Slave Address	11	Slave Address	11
Byte 2	Function	10	Function	10
Byte 3	Starting Address High	00	Starting Address High	00
Byte 4	Starting Address Low	01	Starting Address Low	01
Byte 5	No. of Registers High	00	No. of Registers High	00
Byte 6	No. of Registers Low	02	No. of Registers Low	02
Byte 7	Byte Count	04	–	–
Byte 8	Data Hi	00	–	–
Byte 9	Data Low	0A	–	–
Byte 10	Data Hi	01	–	–
Byte 11	Data Low	02	–	–

Response with error code (Exception Response)

	Request to the slave		Slave response	
Byte	Contents	Hex code (e.g.)	Contents	Hex code (e.g.)
Byte 1	Slave Address	0A	Slave Address	0A
Byte 2	Function	01	Function	81
Byte 3	Starting Address High	04	Exception code	02
Byte 4	Starting Address Low	A1	–	–
Byte 5	No. of Coils High	00	–	–
Byte 6	No. of Coils Low	01	–	–

If the MODBUS slave generates an exception code, the MS bit in byte 2 is set to 1. The exception code is used to indicate the following errors:

0x01 Invalid MODBUS function
0x02 Invalid data address
0x03 Invalid data value
0x04 Slave device faulty
0x05 Acknowledge, slave cannot process data immediately
0x06 Slave Busy, repeat the service later
0x07 Negative acknowledge
0x08 Memory parity error

Glossary

Address	→ Station address
ANZW	16 bit in-out variable for sending commands to an FB and receiving return values.
Bit	Abbreviation for **bi**nary digi**t**, the smallest unit in the binary system; it can have the value 0 or 1.
Bus	Cable with two defined ends which is used for exchanging data between the connected bus stations.
Bus connector	Plug used to connect the bus stations to the bus cable.
Bus segment	→ Segment
Bus station	Device attached to the bus which can send data over the bus (e.g. DP master), receive data over the bus (e.g. DP slave), or amplify signals (e.g. repeater).
Byte	A byte consists of eight bits and is the smallest addressable amount of memory.
Character timeout	Used to detect the end of a telegram in the case of an unstructured flow of ASCII data. The telegram currently being received is considered to be completed when the time between two received characters is larger than the specified character timeout.
Command byte	→ Stamp
Configuration	During configuration, the modules and the addresses of the DP slave are assigned. The actual configuration describes the modules which are actually present in the slave. the required configuration describes the modules which should be present in the slave. This approach allows an incorrect configuration to be detected when the system is booted.
Configurator	Software for configuring PROFIBUS devices and for setting parameters.
Control information	Used to synchronize and fragment the exchange of telegrams via PROFIBUS DP. Control information is always contained in the first byte (byte 0) of the DP data channel.

CPU	**C**entral **P**rocessing **U**nit
Data block	Special memory area in a PLC which is optimized for storing data; it consists of a specified number of words (or bytes) of memory.
Data channel	A logical channel for exchanging data with the SPI 3. The size of the data channel (i.e. I/O area) is dependent on the SPI 3 configuration. If a telegram is larger than the data channel, it needs to be fragmented.
Data transfer rate	Measurement for the speed of data transfer, specified in bits per second.
Data word	16 bit area of memory in a data block.
Diagnostics	Detection, localization, classification and display of errors, faults and messages.
DP	→ PROFIBUS
DP address	ID number used to uniquely identify each bus device (station) in PROFIBUS DP.
DP standard	Bus protocol for PROFIBUS DB which is standardized in EN 50 170.
Floating	Indicates that a component or circuit is not electrically connected to ground
Fragment	Part of a telegram which is transferred through a data channel.
FREEZE	Control command that a DP slave receives from the DP master. It causes the slave to store (freeze) the current states of its inputs and to transfer the frozen values cyclically to the master. The slave only starts to transfer the cyclically updated values to the master again after it receives the UNFREEZE command.
Function block	Used to control the asynchronous exchange of data between PROFIBUS and a Fieldbus device with serial interface via the SPI 3.

Function code	Used to uniquely specify a function that can be executed in the controller.
Galvanically isolated	With galvanically isolated I/O devices, the reference potentials of control circuits and power circuits are not electrically interconnected.
Ground	Conductive material (e.g. ground wire) whose electrical potential is considered to be zero; all interconnected inactive components of a device which cannot assume dangerous voltages even in case of faults.
GSD	Device Data Base file (DDB), i.e. electronic device data sheet which describes the features of the PROFIBUS device uniquely and completely in a clearly specified syntax. A GSD file for the SPI 3 you can download from the internet (www.t-h.de) and is required to set up the device.
Handshake	Method used to synchronize data exchange. For example, data can only be exchanged between a master and slave after the master and the slave have “agreed” that the exchange should take place.
ID byte	Configures the number and size of the bytes to be transferred in a module.
Input byte	PLC address area which contains the data that the DP slave sends to the DP master.
IP 20	Protection class specification to DIN 40 050. Components of the device which carry voltages are protected against touching with the fingers and against the penetration of solid objects with a diameter of more than 12 mm.
Master	Active bus station that can send data to other bus stations and request data from other bus stations.
Mirror	The input byte 0 of a data channel is called the mirror. The SPI 3 mirrors (returns a copy of) the stamp (q.v.) to confirm the operation or when user data is being processed. Mirror = 0 indicates that the DP slave is ready for data exchange. If mirror = 0, input byte 2 contains information on the length of the following user data. Mirror $\neq$ 0 indicates that user data will now follow or that the operation is completed.

MODBUS	MODBUS RTU is implemented according to the Reference Guide “Modicon PI-MBUS-300, Rev. D”.
Module	Selecting a module during device configuration determines the configuration telegram and thus the size of the PLC I/O area.
MSB	**M**ost **S**ignificant **B**it
Non-floating	With non-floating I/O devices, the reference potentials of control circuits and power circuits are electrically interconnected and are not galvanically isolated.
Non-isolated	With non-isolated I/O devices, the reference potentials of control circuits and power circuits are electrically interconnected.
Output byte	PLC address area which contains data which the DP master sends to the DP slave.
Parameter	Variable used to specify the behavior of a device
Parameter master	When the system is booted, the parameter master passes parameter information to the DP slave. The parameter master can write to and read from the slave and change the configuration of the slave.
Parameter setting	To set the behavior of a DP slave and its modules.
Parameter telegram	Contains all parameters which can be set for a DP slave
Parity	Even parity: The sum of all 1’s in a byte must be an even number. Odd parity: the sum of all 1’s in a byte must be an odd number. The parity bit which can be 1 or 0 is used to create an even or odd parity to allow detection of errors due to lost bits.
PII (Ger: PAE)	Process input image (PII)
PLC	Programmable logic controller, electronic controller whose control function is controlled by the program in its memory.
POI (Ger: PAA)	Process output image (POI)
Potential equalization	Electrical connection between conducting bodies to bring them to an identical or practically identical potential and thus prevent interfering or dangerous voltages between the bodies.

PROFIBUS	**Pro**cess **Fi**eld **Bus** is an open Fieldbus system used to network PROFIBUS compatible devices. PROFIBUS works with three different protocols: PROFIBUS-DP (Decentral Peripheral), PROFIBUS-FMS (Fieldbus Message Specification), and PROFIBUS-PA (Process Automation). PROFIBUS is standardized in EN 50 170.
Protocol	A set of rules and regulations which control the flow of information in a communication system. The term protocol can refer to either hardware or software.
Receive	The Fieldbus device receives a telegram from the DP master through the SPI 3.
Receive channel	Data channel for data which the SPI 3 receives.
Remote peripheral	I/O device which is not directly integrated in the PLC CPU, but is accessed remotely via the bus.
Response monitoring	If a slave is not accessed within the response monitoring timeout, it switches automatically to a safe status by setting all outputs to 0. The response monitoring timeout is specified during parameter setting.
Response timeout	The duration of time within which the partner device must respond. The response timeout must be configured the same for both partner devices.
Segment	Section of the bus cable between two terminating resistors. A bus segment can support up to 32 bus stations, and several bus segments can be connected together with RS 485 repeaters.
Send	The DP master sends a telegram to a Fieldbus device through the SPI 3.
Send channel	Data channel for data which is sent to the SPI 3.
Slave	Bus station which is only allowed to exchange data with a master, and only on request of the master.

Stamp	The output byte 0 of a data channel is called the stamp. Stamp = 0 indicates that the master is ready for data exchange. If stamp = 0, output byte 2 contains information on the length of the following user data. Stamp ≠ 0 indicates that user data now follows or that the operation is completed.
Station address	Address with which the DP master accesses the PROFIBUS DP slave.
Status byte	→ Mirror
Step 5	Programming language used for user programs for SIMATIC S5 controllers.
Step 7	Programming language used for user programs for SIMATIC S7 controllers.
Step 7 tool	Tool for Step 7 which automates particular programming tasks.
SYNC	Control command that a DP slave receives from the DP master. It causes the slave to store (freeze) the current states of its outputs. When following telegrams are received, it stores the output data, but the states of the outputs remain unchanged. The outputs are only cyclically updated again after the slave receives the UNSYNC command.
Telegram	A data flow which is sent or received through the serial interface (SIO), e.g. when you send a text to a text display or receive a bar code from a bar code scanner.
Telegram fragment	Part of a send or receive telegram. A telegram must be fragmented when it is so large that it cannot be transferred within a single PLC cycle
Terminating resistor	Used to stop electrical reflections and thus signal distortion at the end of the bus cable. Terminating resistors are required at each end of the bus cable.
Tool	Software tool used to specify and change the parameters of a parameter block.

Version code	Indicates the version of a product and is always incremented when the hardware or software in the product is updated or modified. The version code can be seen on the first and second page of this online documentation at the bottom left.
Word	→ Data word
Xon	With software flow control, the Xon control character indicates readiness to receive; complement of Xoff.
Xoff	With software flow control, the Xoff control character indicates unreadiness to receive; complement of Xon.

Änderungsrecht / *Right to make changes*

Trebing & Himstedt Prozessautomation GmbH & Co. KG behält sich das Recht vor, das vorliegende Handbuch sowie die Eigenschaften der Hard- und Software jederzeit weiterzuentwickeln, auch ohne dieses vorher anzukündigen oder über Änderungen zu berichten.
Trebing & Himstedt Prozessautomation GmbH & Co. KG reserves the right to make changes to this manual and to the specifications of the hardware and software at any time and without warning or prior notice.

Haftungsausschluss / *Liability and Guarantee*

Trebing & Himstedt Prozessautomation GmbH & Co. KG übernimmt keine Garantie dafür, dass die Hard- und Software unter allen Einsatzfällen ordnungsgemäß arbeitet. Mit heutigen technischen Mitteln ist es nicht möglich, Software so zu entwickeln, dass sie für alle Anwendungsanforderungen fehlerfrei ist. Trebing & Himstedt Prozessautomation GmbH & Co. KG lehnt darum jede Haftung für direkte und indirekte Schäden, die sich aus dem Betrieb der Hard- und Software und der im Handbuch beschriebenen Verwendbarkeit ergeben, ab.
Trebing & Himstedt Prozessautomation GmbH & Co. KG assumes no warranty that the hardware and software will perform correctly in all conceivable situations. With technical aids and methods currently available , it is not possible to develop software which is completely free of errors in all conceivable applications. Accordingly, Trebing & Himstedt Prozessautomation GmbH & Co. KG does not accept any liability for damage, both direct and indirect, arising from the use of the hardware and software and/or the information contained in this manual.

Elektrostatische Gefährdung von Baugruppen (EGB) / *ESD Guidelines*

Die Hardware enthält elektronische Bauelemente, die gegen elektrostatische Entladung empfindlich sind. Sie sollten darum die elektronischen Bauelemente niemals direkt berühren. Bei Einstellarbeiten an der Platine ist darauf zu achten, den eigenen Körperwiderstand ausreichend zu erden. Dieses kann durch ein Erdungsarmband oder Erdungsschutzstreifen an ESD-gerechten Schuhen in Verbindung mit ESD Boden erfolgen. Im einfachsten Fall muss ein elektrisch leitfähiger, geerdeter Gegenstand berührt werden (Heizung, Wasserleitung, blankes Metallteil eines geerdeten Schaltschrankes). Beschädigungen durch elektrostatische Entladung müssen sich nicht sofort fehlerhaft auswirken. Beim späteren Betrieb können folgende Fehler auftreten:
– vorzeitiger Ausfall von Bauelementen und Baugruppen,
– Schwankung typischer Leistungsparameter,
– zeitweilig auftretende Fehler,
– temperaturabhängige Fehler.
Eine elektrostatische Entladung wird vom Menschen erst bei verhältnismäßig hohen Spannungen wahrgenommen. Entladungen unterhalb der Wahrnehmungsgrenze können aber bereits zu Schäden oder Zerstörung der Bauelemente führen.
The hardware contains electronic components which are sensitive to electrostatic discharge. Before touching the printed circuit board, you should first discharge electrostatic voltages from your body by using a grounded anti-static wristband or anti-static shoes and a grounded anti-static carpet. A simple precaution is to touch a grounded, electrically conducting surface such as a heating radiator, water pipe or unpainted surface of a grounded control cabinet. Damage due to electrostatic discharge may not be immediately apparent, and can lead to the following types of fault at a later stage:
– premature failure of components and modules,
– fluctuation of typical performance characteristics,
– intermittent faults,
– temperature-dependent faults.
An electrostatic discharge can only be perceived by humans in case of high-level voltage. However, lower electrostatic voltages which are below the limits of perception can still damage or destroy electronic components.

Urheberrecht / Copyright

Das vorliegende Handbuch enthält Informationen, die geistiges Eigentum der Trebing & Himstedt Prozessautomation GmbH & Co. KG sind. Der Benutzer verpflichtet sich, die im Handbuch enthaltenen Informationen ausschließlich für den Betrieb der Hard- und Software zu nutzen. Die Weitergabe von Informationen an Dritte, soweit sie nicht als allgemein bekannt anzusehen sind, ist nicht gestattet. Weitergabe, Vervielfältigung, Verwertung und Auszüge des Inhalts sind nur nach ausdrücklicher Genehmigung durch Trebing & Himstedt Prozessautomation GmbH & Co. KG gestattet.
The information contained in this manual is the copyright of Trebing & Himstedt Prozessautomation GmbH & Co. KG. Users of the manual agree to use the information contained solely for the operation of the hardware and software. The information contained must not be forwarded to third parties, except that it is clearly part of the public domain. The transmission, reproduction or use of this documentation or parts thereof is not permitted without expressly written authority from Trebing & Himstedt Prozessautomation GmbH & Co. KG.

Produktbeobachtungspflicht / *Product observation liability*

Im Rahmen unserer Produktbeobachtungspflicht versuchen wir, vor von uns zu erkennenden Gefahren durch das Zusammenwirken von Hard- und Software sowie beim Einsatz von Produkten Dritter zu warnen. Eine Beobachtung ist nur nach ausreichender Information des Endkunden über den geplanten Einsatzzweck und die vorhandenen Hardware-/Softwarekomponenten möglich. Bei Veränderungen der Einsatzbedingungen oder/und durch Austausch von Hardware/Software ist es uns auf Grund der komplexen Beziehungen nicht mehr möglich, alle Gefahren konkret zu beschreiben und auf ihre Wirkung im Gesamtsystem, insbesondere auf unsere Hard- und Software, zu überprüfen. Dieses Handbuch beschreibt nicht sämtliche technischen Eigenschaften der Hard- und Software und seiner Varianten. Für weitere Informationen wenden Sie sich bitte an Trebing & Himstedt Prozessautomation GmbH & Co. KG.
Within the framework of our product observation liability, we do our best to warn third parties of dangers we have identified which can result from the interaction of hardware and software and the usage of our products. This is only possible if we receive sufficient information from our customers on the planned application(s) and the existing hardware and software components. As a result of the complex interactions, it is no longer possible for us to accurately identify all dangers and to check the effect on the overall system and in particular on our hardware and software if the conditions of application have changed and/or hardware or software has been exchanged. This manual does not describe all technical characteristics of the hardware and software and the available versions. Please contact Trebing & Himstedt Prozessautomation GmbH & Co. KG for further information.

Gewährleistung / *Warranty*

Wir gewähren für unsere Produkte eine Garantie gemäß unseren Allgemeinen Geschäfts- und Lieferbedingungen.
Our products are subject to warranty in accordance with our general business and delivery terms.