TREBING + HIMSTEDT

SERIAL-PROFIBUS-INTERFACE | SPI 3

Doc. Version 4.0

for Fieldbus Devices with a Serial Interface

– MODBUS RTU

Contents SPI 3 – all Controls (up to SPI 3 Release 16)

Contents Online Documentation

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
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 4.0 | July 2006

Table of Contents

Introduction

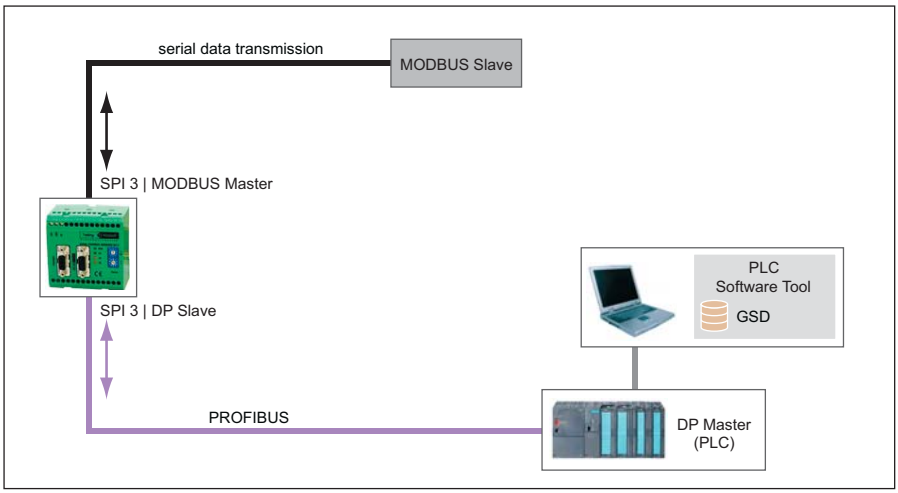
The SPI 3 (SERIAL-PROFIBUS-INTERFACE 3) allows a PROFIBUS-DP master to communicate with a fieldbus device with a serial interface (MODBUS slave). This allows the serial fieldbus device to function as a real PROFIBUS station, whereby the SPI 3 converts the data to be exchanged between the PROFIBUS-DP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

Data are exchanged between the DP master and the SPI 3 in the form of telegrams through a data channel, the size of which can be configured. Data exchange between MODBUS slave and SPI 3 (MODBUS master) is controlled by the SPI 3. Different MODBUS functions are executed depending on the configuration.

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:

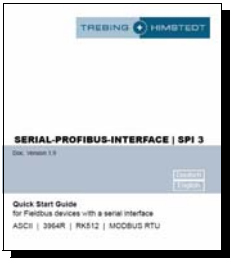
- DP slave at up to 12 Mbit/s
- Serial baud rates up to 19.2 kbit/s
- Versions available for RS232, RS422 or RS485 serial interface
- Does not require special configuration software
- Simple and fast integration in PROFIBUS-DP networks
- I/O range configurable



Example for SPI 3 interface module overview

Scope of delivery

SPI 3



Quick start guide

Documentation & Media Kit (optional, not included in delivery)

The documentation & media kit contains this online documentation, example projects for STEP 7, and the GSD file. You can download the documentation & media kit from the internet (www.t-h.de). You need the 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 IEC 61158.
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 PROFIBUS norm 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 use of 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 using 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.

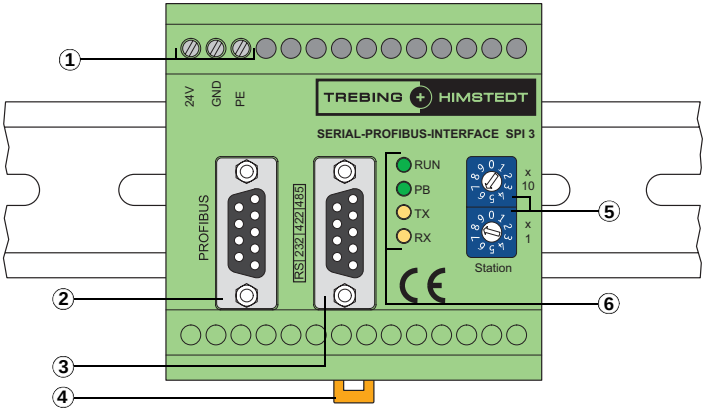
Danger!
Never open the case of the SPI 3 and do not make any modifications to the device.

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



1 Power supply connections
2 PROFIBUS interface
3 Serial interface
4 Stop lever for top-hat rail
5 Turn-switch for PROFIBUS address
6 Display elements

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

– Stop lever ④ for releasing/fixing the SPI 3 from/on a 35 mm DIN top-hat rail (top-hat rail not included in delivery)

Operating elements

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

Indicating elements

LEDs ⑥ to indicate operating states:

– RUN: lights continuously if supply voltage is present,
flashes in case of errors (see »Error diagnosis and remedies« on page 25)

– PB: lights up if the SPI 3 has been configured by the master and is operational,
flashes in case of errors (see »Error diagnosis and remedies« on page 25)

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

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

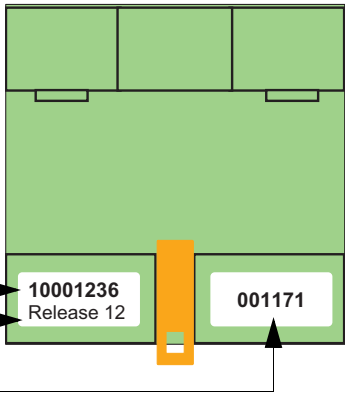
Release

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

– Article No.

– Release No.

– Serial No.



Implementation guideline

Please procede through the following steps for start-up:

– Mount the SPI 3 (see »Installing the SPI 3« on page 10).

– Connect the SPI 3 to power supply (see »Connecting up the power feed« on page 10).

– Connect the SPI 3 to the serial field device (see »Connecting up to a fieldbus device with serial interface (MODBUS slave)« on page 11).

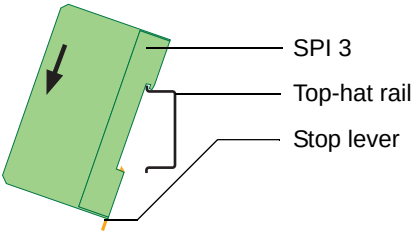
– Connect the SPI 3 to the PROFIBUS (see »Connecting up to the PROFIBUS« on page 11).

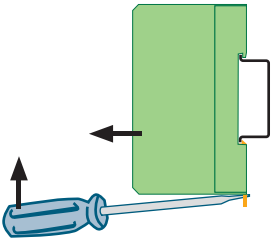
– Configure and parameterize the SPI 3 via PROFIBUS configurator (see »Starting up the SPI 3« on page 13).

Installing the SPI 3

Mounting the SPI 3

– Place the SPI 3 with the gap onto the top-hat rail and swivel the SPI 3 downward until the stop lever locks on the top-hat rail.





Warning!
Head space of 5 cm minimum for heat flow is required above and below the SPI 3.

Dismounting the SPI 3

– Remove the connected supply and signal wires (serial, PROFIBUS, voltage).
– Stick a screwdriver in the slot of the stop lever at the SPI 3.
– Press the screwdriver in the direction of the SPI 3 while at the same time swivelling the SPI 3 away from the top-hat rail.

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.

Connecting up to a fieldbus device with serial interface (MODBUS slave)

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 27 (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 the use of 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 using connectors from ERNI and Siemens.
To ensure that the SPI 3 functions without errors, you must ground the screen of the PROFIBUS cable.

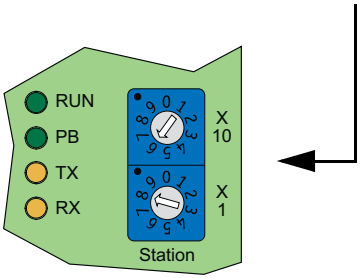
– Ensure that the PROFIBUS connector uses the pin assignments shown in »Technical specifications« on page 27.
– Attach the PROFIBUS connector to the PROFIBUS interface socket ② on the SPI 3 and secure the connector with the retaining screws.

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.
You should only use addresses between 01 and 99.

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

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.



Bus terminating resistor

Terminations of a PROFIBUS network must each be terminated with a bus terminating resistor. Use standardized plugs with integrated terminating resistors.

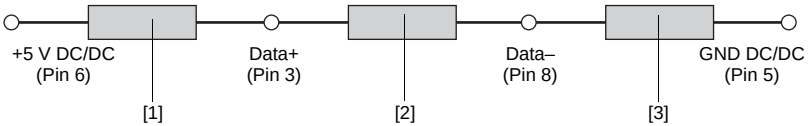


Figure: Bus termination configuration for PROFIBUS (see PROFIBUS Norm)

1 390 Ω Pull-up resistance from Pin 3 to positive supply voltage at Pin 6
2 220 Ω Cable terminating resistor between Pin 3 and Pin 8
3 390 Ω Pull-Down resistor from Pin 8 to data reception potential at Pin 5

Note!
Please observe the following when using the depicted passive terminating resistor: Is the feeding voltage (+5 V) supplied by the device (SPI 3), the PROFIBUS is shorted via the resistors when the device is disconnected from voltage. PROFIBUS communication can be interrupted or completely break down until the device is re-energized.
Use active resistors to avoid this problem, as in this case the terminating resistors are fed with +5 V and GND independently from the device.

Starting up the SPI 3

To start up the SPI 3, you need to configure the device and set parameters. Configuration and parameterization are done via PROFIBUS configurator (PLC programming tool).

– Start the PROFIBUS configurator of the DP master (PLC programming tool).

– Load the »THDP0091.GSD« GSD file for the SPI 3 into the configurator (GSD by download: www.t-h.de).

– Configure the SPI 3 and set the parameters as described in the configurator online help or user manual.
Select the respective modules for configuration. To set parameters, select specific parameters for each module configured.

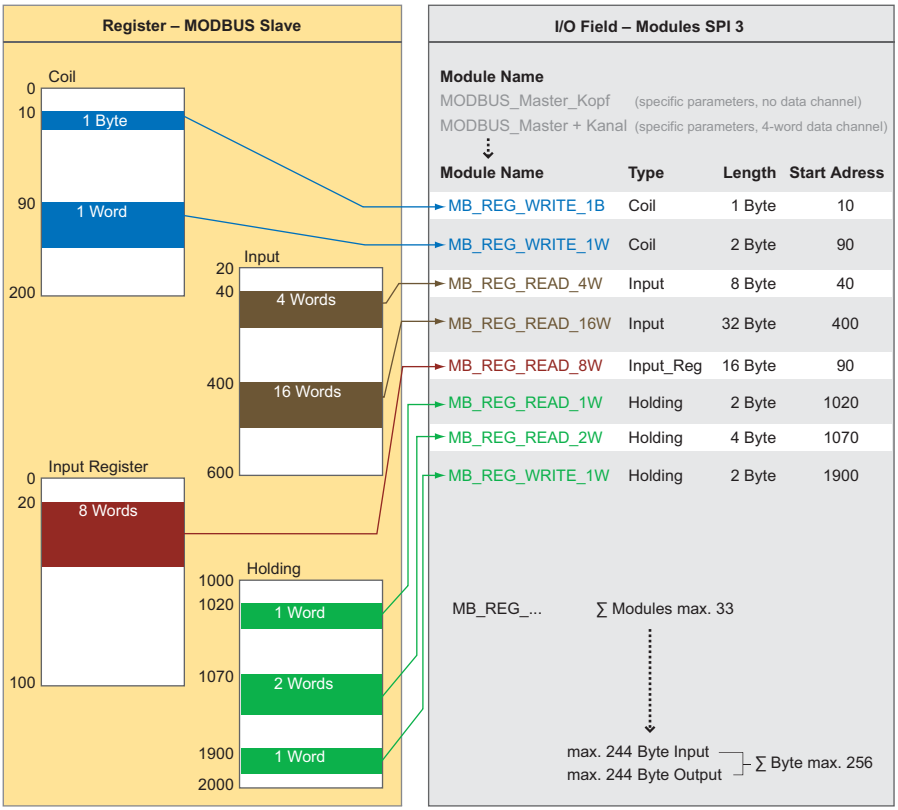


Figure: Display example of a MODBUS register in PROFIBUS DP I/O data blocks with the SPI 3

SPI 3 Configuration

The configuration telegram consists of the »MODBUS_Master_Kopf« or »MODBUS_Master + Kanal« module and further modules for the respective I/O fields listed in the table.
Always start with the »MODBUS_Master_Kopf« module (standard use) or »MODBUS_Master + Kanal«.
After module selection, you need to set the parameters specific for this module (see »SPI 3 Parameters« on page 15).
Now you can use the modules listed in the table (SPI 3 Release 15 and higher).

Module Name	I/O Field	Description
MODBUS_Master + Kanal	4 words	Specific SPI 3 parameters, 4-word data channel. Data channel can only be used in connection with function blocks.
MODBUS_Master_Kopf	–	Specific SPI 3 parameters, no data channel.
MB_REG_WRITE_1B	1 byte	Specific module parameters such as function (read/write) and size of the part to be depicted from the MODBUS register of the field device (see figure on page 13). You can set the different MODBUS functions for the selected module through parameterization (see next chapter).
MB_REG_WRITE_1W	1 word	
MB_REG_WRITE_2W	2 words	
MB_REG_WRITE_4W	4 words	
MB_REG_WRITE_8W	8 words	
MB_REG_WRITE_16W	16 words	
MB_REG_READ_1B	1 byte	
MB_REG_READ_1W	1 word	
MB_REG_READ_2W	2 words	
MB_REG_READ_4W	4 words	
MB_REG_READ_8W	8 words	
MB_REG_READ_16W	16 words	

Note!
You can insert a maximum of 33 modules (1 »MODBUS_Master...« and 32 »MODBUS_REG_...«). A maximum of 244 input bytes and/or 244 output bytes can be used. The total number of input and output bytes must not exceed the value of 256 bytes (memory limit in the SPI 3).
Observe data consistency when using I/O fields bigger than 2 words (depending on PLC used).
The SPI 3 always sends data for all configured modules in full length to the MODBUS slave. Module MB_REG_Write_1B is an exception. You can use

this module to send data bit by bit (see following figure).

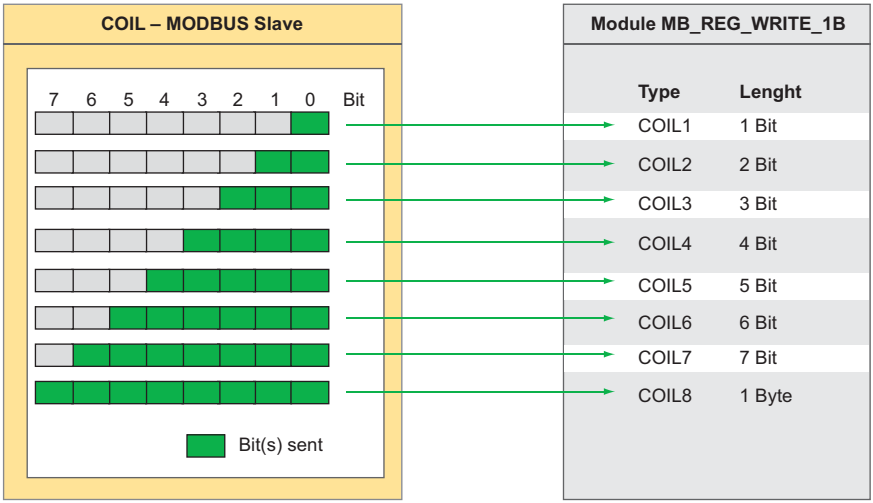


Figure: Bits sent with Module MB_REG_WRITE_1B from SPI 3

SPI 3 Parameters

You must set specific parameters for each configured module. The modules: »MODBUS_Master_Kopf« and »MODBUS_Master + Kanal« contain general parameters which you select depending on the connected MODBUS slave. You can look up required parameters in the MODBUS slave guide. For all other modules with I/O field, select the MODBUS register type (COIL [COIL1...COIL8], INPUT, INPUT REGISTER, HOLDING) as well as the corresponding start address.

SPI 3 specific parameters for the »MODBUS_Master_Kopf« and »MODBUS_Master + Kanal« modules

The first 7 bytes (bytes 0…6) of the parameter telegram contain bus-related parameters which are standardized in PROFIBUS norm. The following 10 bytes (byte 7 to byte 16) in the table of the parameterizing telegram contain SPI 3 specific parameters. When using the »MODBUS_Master + Kanal« module, an additional function block needs to be installed or generated (see »Installing the FB 127 function block« on page 17).

Byte	Parameter	Value	Hexacode	Default
7	Fixed parameter	No changes possible	0x0D	0x0D
8	MODBUS baud 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)
9	Parity	No parity Even parity Odd parity Mark parity Space parity	0x00 0x01 0x02 0x03 0x04	Even (0x01)
10+11	Timeout slave response Delay time of slave response in 10 ms (0-65535) × 10 ms)	0-65535	0x0000 to 0xFFFF	100 (0x00; 0x64)
12	Number of repeats (number of telegram repeats if slave fails to answer within timeout)	1-255	0x01 to 0xFF	3 (0x03)
13	Writing mode (Original data are sent to the MODBUS slave either always (repeated) or only in case of changes (single))	Repeated writing Single writing	0x00 0x01	Repeated writing (0x00)
14+15	Idle time in 10 ms (0-1000) × 10 ms (Delay time for telegram transmission to the MODBUS slave)	0-1000	0x0000 to 0x03E8	0 (0x00)
16	MODBUS slave address	1-247	0x01 0xF7	1 (0x01)

SPI 3 specific parameters for modules with I/O field

The following 3 bytes (byte 17 to byte 19) of the parameterizing telegram contain

SPI 3 specific parameters.

Byte	Parameter	Value	Hexacode	Default
14	MODBUS register type READ	COIL INPUT INPUT_REG HOLDING	0x01 0x02 0x04 0x03	COIL (0x01)
	MODBUS register type WRITE	COIL COIL1 COIL2 COIL3 COIL4 COIL5 COIL6 COIL7 COIL8 HOLDING	0x0F 0x2F 0x4F 0x6F 0x8F 0xAF 0xCF 0xEF 0x0F 0x10	HOLDING (0x10)
15+16	MODBUS register start address	0-9999	0x0000 to 0x270F	0 (0x00; 0x00)

Installing the FB 127 function block

Note!
You only need the function block when using the »MODBUS_Master + Kanal« module. A detailed FB description is included in the chapter »Using data channel with »MODBUS_Master + Kanal« module and FB 127« on page 20.
The FB 127 function block is only applicable for SIMATIC S7 controls. If you use other controls, you need to create the function block yourself (see appendix)..

You can either check the function block with the example project or directly install it in your existing project. You only need to open the example project with the PLC programming software (STEP 7):

1. Test example project (connection of MODBUS client required):

– Start PLC programming software.
– Open the example project.
– Adapt the applied PLC hardware.
– Execute PLC Erase Program.
– Load the project into the PLC.
After successful loading and subsequent SPS RUN, the LEDs RUN and PB will light on the SPI 3 (see also: »Checking PROFIBUS communication« on page 18).

2. Load function block in an existing project:

– Start PLC programming software.

– Open the example project.

– Copy the FB 127 into your PLC program. Enter FB command parameters (see »Using data channel with »MODBUS_Master + Kanal« module and FB 127« on page 20).

– Execute further steps for your PLC program (integrate SPI 3 in hardware catalog, select modules, adjust SPI 3-specific parameters, create DB, command FB etc.).

– Proceed further as described in the handbook or online support of the PLC programming software.

The SPI 3 is ready for use after installation of the function block.

Checking the SPI 3 for correct operation

Several checks should be run before using the SPI 3 for data transfer.

Checking 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 25 for details of how to locate the fault.

Checking PROFIBUS communication

– Connect up the PROFIBUS interface cable.

– Switch on the power feed for the SPI 3 (RUN-LED lights up).

– Start the DP master which has previously been configured for the SPI 3.

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 25 for details of how to locate the fault.

Checking serial interface communication

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

– Switch on the power feed for the SPI 3 (RUN-LED lights up).

– Start the DP master which has previously been configured for the SPI 3 (PB-LED lights up).

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 25 for details of how to locate the fault.

If no errors were detected, the SPI 3 is ready for use. During data transfer, the TX or RX LEDs will flash (see »Indicating elements« on page 9).

Evaluating PROFIBUS diagnosis telegrams

In case of communication failures (PROFIBUS and/or MODBUS), the SPI 3 sends a diagnosis telegram on DP master request. The diagnosis telegram contains general PROFIBUS diagnosis data (see PROFIBUS Norm) as well as manufacturer-specific diagnosis data.

Hexacode – Significance	Remedy
17 – Invalid MODBUS start address	Check the default start address for the parameterized module with the help of the data sheet for the MODBUS slave (MODBUS register).
21 – MODBUS no response	Check the cable connection to the MODBUS slave as well as the MODBUS slave address which is set and parameterized.
22 – MODBUS frame error	Check the cable connection to the MODBUS slave. Check the default start address for the parameterized module.

You can evaluate the diagnosis telegram through the DP master and/or a PROFIBUS diagnosis tool (e.g. the PROFIBUS Scope).

Using data channel with »MODBUS_Master + Kanal« module and FB 127

The additional data channel can be used with the »MODBUS_Master + Kanal« module and a function block (FB; FB for SIMATIC STEP 7 in the Media Kit, available per download: www.t-h.de). If you use another control/ configuration software, you need to create the FB yourself (see appendix).

Function block for SIMATIC S7

– FB 127 allows processing of MODBUS telegrams which have been sent or received via the SPI 3. This FB uses an I/O field with 4 words. SFC14 and 15 for data consistency are already included in the FB 127.

Parameters must be set for calling the FB 127 (you can also use the example project). The example project is intended as a guide only.

Note!
The FB is only applicable for SIMATIC S7 controllers.
The example project for SIMATIC S7 uses the following hardware: S7 315 2DP; order No. 6ES7 315-2AF01-0AB0.

The FB supports the following MODBUS functions:

Function 1	Read Coil Status
Function 2	Read Input Status
Function 3	Read Holding Registers
Function 4	Read Input Registers
Function 5	Force Single Coil
Function 6	Preset Single Register
Function 15	Force Multiple Coils
Function 16	Preset Multiple Register

Parameters for data transfer for SIMATIC S7

Upon data transfer, the user data to be exchanged are copied into a data area (data block or marker area) from where they are sent to the SPI 3 by the PLC through the DP master.

The structure of the data blocks or marker areas for the user data depends on the MODBUS function as follows:

Function	Data area for user data	Marker area for user data	Contents
Functions 1, 2, 15	DBB(n) DBB(n+1) :	MB(n) MB(n+1) :	Byte 1 Byte 2 :
Function 5	DBB(n) DBB(n)	MB(n) MB(n)	0xFF (set bit) 0x00 (reset bit)
Functions 3, 4, 6, 16	DBW(n) DBW(n+2) DBW(n+4) :	MW(n) MW(n+2) MW(n+4) :	Word 1 Word 2 Word 3 :

Note!
»n« is a byte or word address from the »Data« parameter.
The DB can contain data for several send or receive operations, but the data areas must not overlap.

Various parameters are available to call the FB:

Parameters for address information:
specify location and length of the SPI 3 address field in the PLC address space

Name	Type	Description / Function
A_Anfang	INTEGER	Start of address area for outputs (according to hardware configuration)
E_Anfang	INTEGER	Start of address area for inputs (according to hardware configuration)
EA_Laenge	INTEGER	Length of SPI 3 I/O field (in byte) - always use 8 (4 words) for this setting
Instanz_DB	INTEGER	Number of instance data block which is specified upon calling the FB127 (see example project)

Parameters for user data:
specify where received telegrams can be saved and where telegrams to be sent can be read

Name	Type	Description / Function
Slave	Byte	Slave address for MODBUS service (MODBUS-Slave-Adresse)
Funktion	Byte	MODBUS function
Adresse	Word	Start address of data area in MODBUS slave
Anzahl	Word	Length of user data in bits (function 1, 2, 15) or words (function 3, 4, 16)
Data	Pointer	DB with user data for sending or receiving, e.g. P#M30.0, P#DB40.DBX0.0

Parameters for return codes:
contain information on general status or processing results of the FB; also used to transfer commands (e.g. reset) to the FB.

Name	Type	Description / Function
TimeOUT	Word	Timeout – value is decremented with each call; example: cycle time SPS = 30 ms; TIME = 17 -> Timeout 30 ms × 17 = 510 ms (must be larger than the gateway timeout)
ANZW	Word	Display word for data transfer status

ANZW is used to display information on the status of the currently executing data transfer operation.
ANZW consists of 16 bits as follows:

Bit 0 = 1 Operation is executing

Bit 1 = 1 Operation completed without errors

Bit 2 = 1 Operation completed with errors

Bit 4 = 1 Reset the operation
Set bit 4 to 1 to reset the operation. Bit 4 is reset to 0 by the FB when the operation has been reset.

Bit 8…15 Error code (0x01 to 0x08 correspond to the MODBUS exception codes)

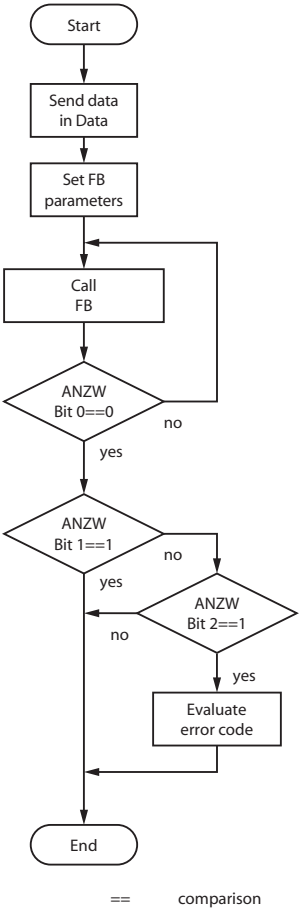
- 0x01 Invalid MODBUS function
- 0x02 Invalid MODBUS address
- 0x03 Invalid MODBUS data value
- 0x04 Slave device faulty
- 0x05 Acknowlegde, slave cannot process data immediately
- 0x06 Slave busy, repeat service later
- 0x07 Negative MODBUS receipt
- 0x08 Memory parity error
- 0xFF Timeout, slave did not respond within timeout range

Bit 3, 5…7 Internal use by the FB, do not change

Writing data

Proceed as follows to write data with the FB:

– Copy the data to be sent to the user data area »Data«.
– Initialize the parameters for the FB.
– Call the FB repeatedly while bit 0 (Operation is executing) is 1.
– If the operation completed without errors (ANZW bit 1==1), the data have been sent completely.
– If the operation completed with errors (ANZW bit 2==1), evaluate the error message and remedy the error.



Reading data

Proceed as follows to read data with the FB from a MODBUS slave:

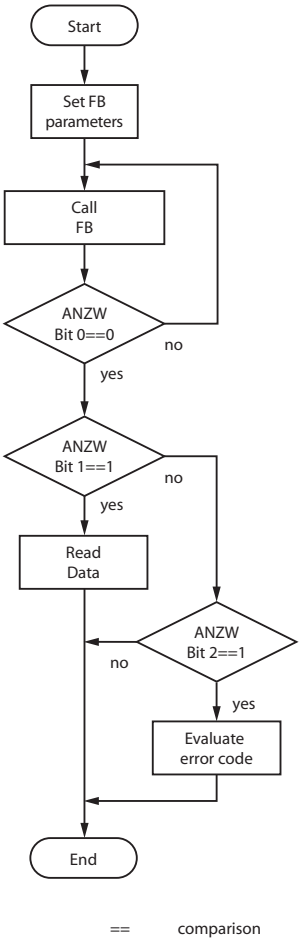
– Initialize the parameters for the FB.

– Call the FB repeatedly while bit 0 (Operation is executing) is 1.

– If the operation completed without errors (ANZW bit 1==1), the received data is now available in the user data area DATA.

– If the operation completed with errors (ANZW bit 2==1), evaluate the error messageand remedy the error.

Set ANZW bit 4 to 1 to reset the operation. Bit 4 is reset to 0 by the FB when the operation has been reset.



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:

LED off	LED short	LED medium	LED long	LED on
				
LED 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 diagnosis and error statuses are reset when the error is no longer present or when the slave gets new parameter and configuration values

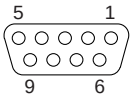
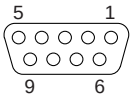
PB LED code	Status	Significance	Remedy
PB LED off	Correct data transfer rate could not be determined	– No PROFIBUS master in the network	– Connect up the DP master – Check the wiring
PB LED short	DP master available	– A master is available but communication is not taking place with SPI 3	– Check address setting on the SPI 3
PB LED medium	Incorrect parameter Incorrect configuration	– Parameter telegram faulty – Configuration telegram faulty	– Check the configured and parameterized modules
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 medium	Receive error No response from slave	– Error when receiving – MODBUS slave did not respond after max. number of repeats	– Check parameters of all modules (the SPI 3 is MODBUS master) – Check the address of the MODBUS slave – Check the wiring
RUN LED on	Communication OK	– MODBUS slave communicating correctly with the SPI 3	– SPI 3 working correctly

Note!

If errors occur during communication, the DP master runs a PROFIBUS diagnosis. Evaluation of this diagnosis depends on the used DP master. When using a bus monitor (e.g. the PROFIBUS Scope), you can additionally evaluate diagnosis telegrams. For data of this device-related diagnosis, see »Evaluating PROFIBUS diagnosis telegrams« on page 19.

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		
Weight	g	136		
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 Pin 2 Pin 3 Pin 4 Pin 5 Pin 6 Pin 7 Pin 8 Pin 9	Screen Unused B-line Request to Send (RTS) Ground for 5 V (M5) +5 V (galvanically isolated P5) Unused A-line 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				
Certifcates		CE		
Connectable field devices	units	1		

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

Appendix

The chapters in the appendix always refer to the use of the »MODBUS_Master + Kanal« module.

Creating function blocks

Data between DP master and SPI 3 are exchanged via data channel in the form of telegrams or telegram fragments. The size of the data channel between DP master and SPI 3 is defined as 4 words by the »MODBUS_Master + Kanal« module.

Note!
Telegram fragmentation is necessary if the number of the bytes to be transferred + 2 bytes (for control data and telegram length) is exceeding the data channel of the module (4 words) for the SPI 3.

A data channel contains reserved space for control data and user data:

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte n
Control data	(n - 1) User data						

User data:
contain the actual information in the form of MODBUS telegrams or telegram fragments. User data length is transferred in the first byte.

Control data:
control data exchange between DP master and SPI 3. They are used

– to highlight new data,
– to transfer telegrams exceeding the available data channel,
– to control the flow between DP master and SPI 3.

For control data, one byte is available:

– Command bits (stamp) to write commands to the SPI 3.
  The DP master uses this to highlight
  · the start of a new telegram,
  · the start of user data
  · or the end of a command.
– Status bits (mirror) to read status information from the SPI 3.
  The SPI 3 uses this to mirror the stamp as a signal that
  · it is ready for data transfer,
  · user data have been processed,

– the command is finished.

Control data (Byte 0 sending/receiving DP master)

OUT

Byte 0								…1	…n
Bit 7	…6	…5	…4	…3	…2	…1	…0		
irrelevant	irrelevant	irrelevant	Reset	Stamp Receive Fragment	Stamp Receive Telegram	Stamp Send Fragment	Stamp Send Telegram		

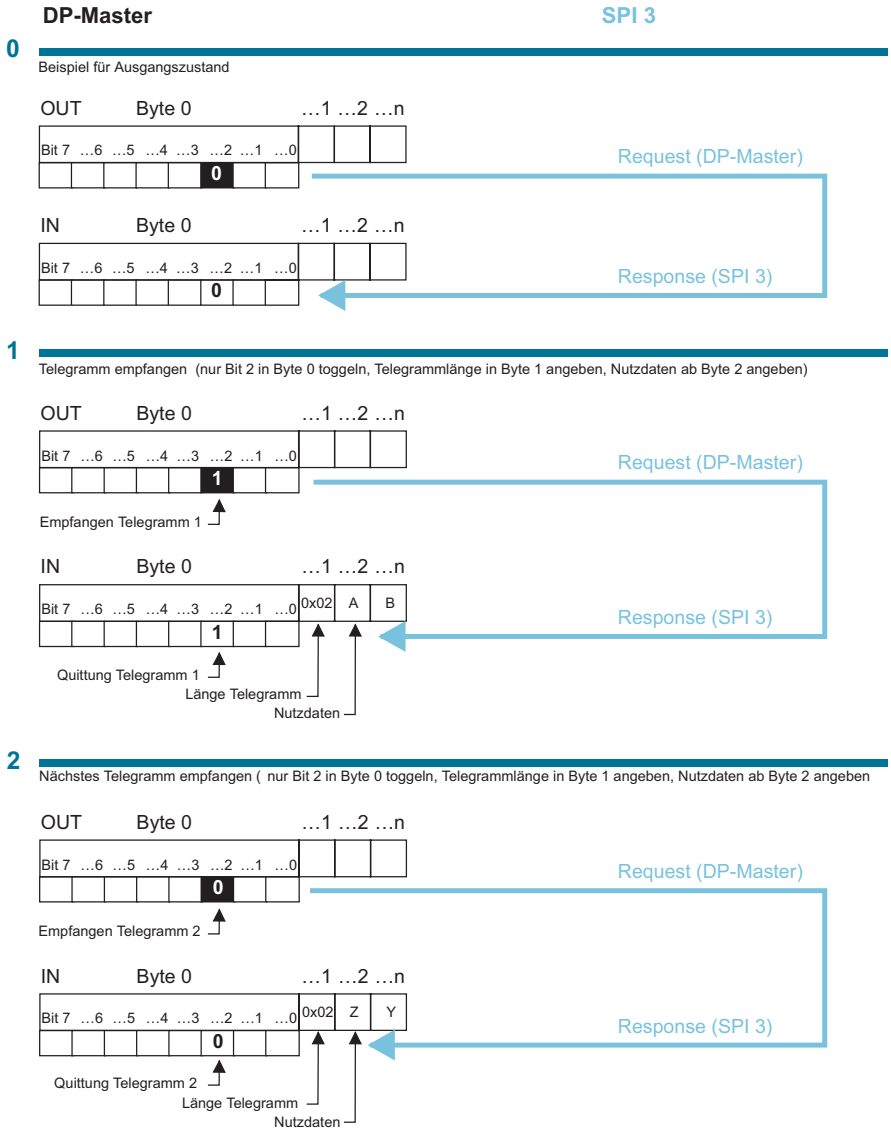
IN

Byte 0								…1	…n
Bit 7	…6	…5	…4	…3	…2	…1	…0		
irrelevant	irrelevant	irrelevant	Reset	Mirror Receive Fragment	Mirror Receive Telegram	Mirror Send Fragment	Mirror Send Telegram		

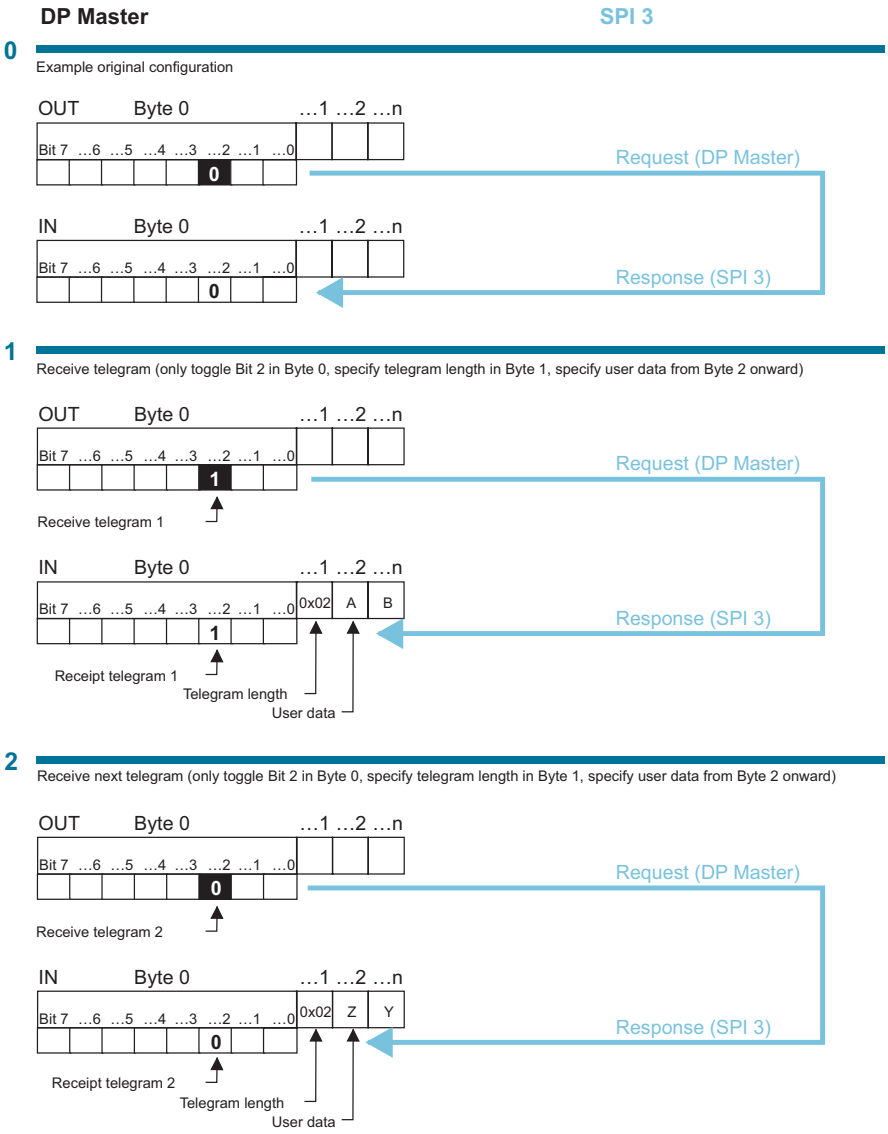
Telegram for data transfer without fragmentation

Precondition: The I/O range of the bytes to be transferred + 2 bytes (for control data and telegram length) must not exceed 4 words.

Send telegram without fragmentation



Acknowledge telegram without fragmentation

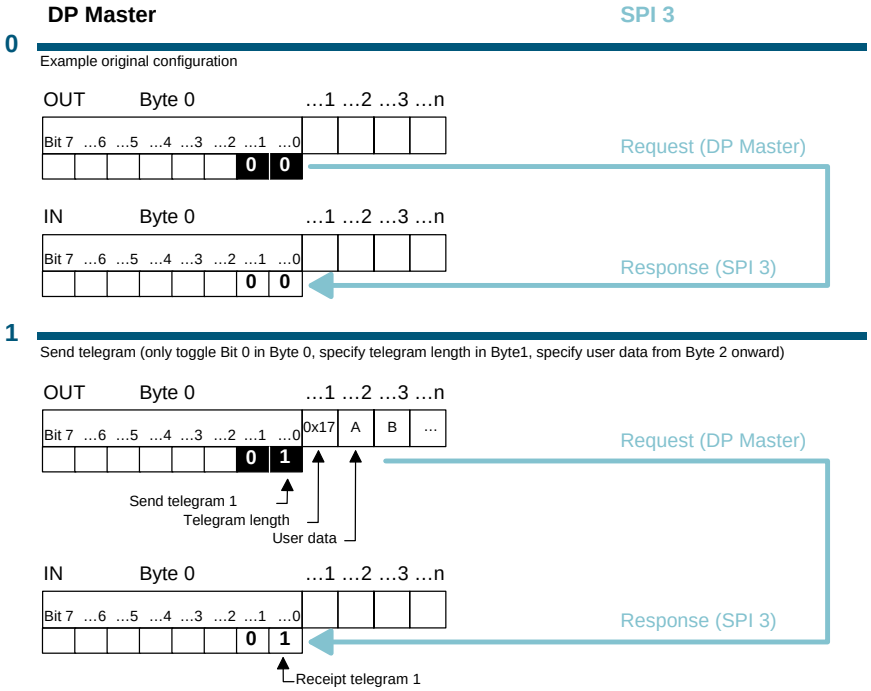


Telegram for data transfer with fragmentation

If you want to transfer telegrams that exceed the available data channel (4 words), the telegram has to be fragmented and transmitted in several parts (fragments). Bear in mind that, besides the user data, you need 2 additonal bytes for control data and telegram length.

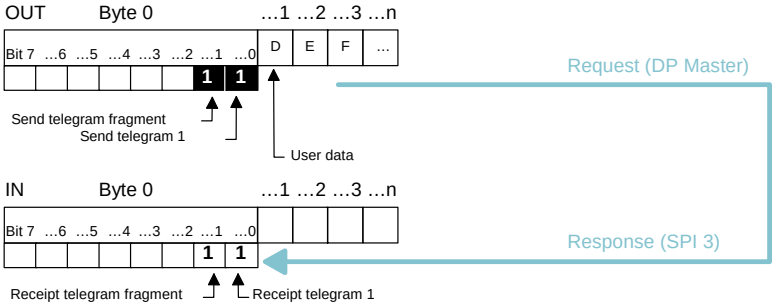
Note!
Telegram length is transmitted and received only in the first telegram fragment.

Send telegram with fragmentation



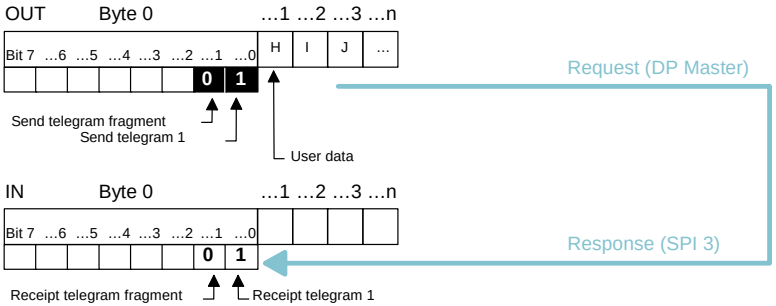
2

Send user data in telegram fragments (only toggle Bit 1 in Byte 0, specify further user data from Byte 1 onward)



3

Send further user data in telegram fragments (toggle only Bit 1 in Byte 0, specify further user data from Byte 1 onward)

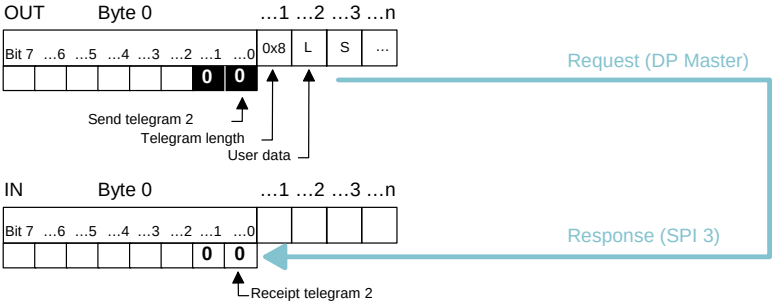


4

Send further user data in telegram fragments – until telegram 1 has been sent completely
(only toggle Bit 1 in Byte 0, specify further user data from Byte 1 onward)

5

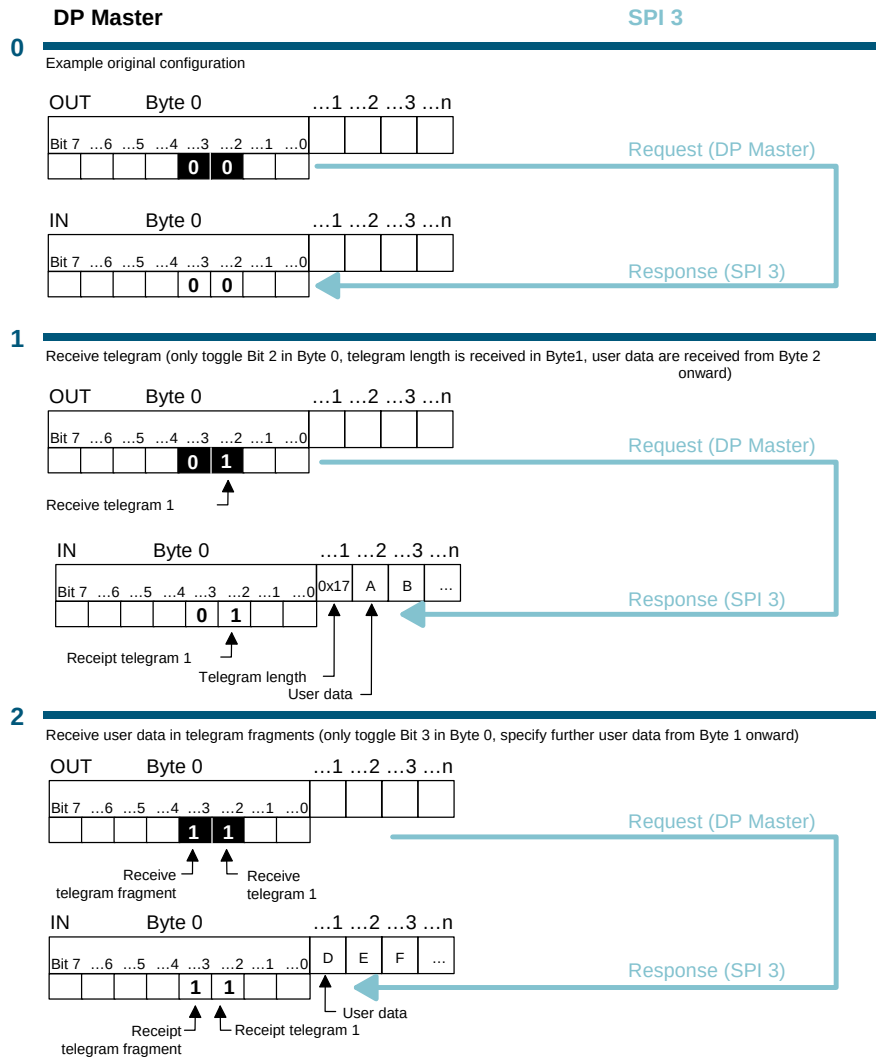
Send next telegram (only toggle Bit 0 in Byte 0, specify telegram length in Byte1, specify user data from Byte 2 onward)



6

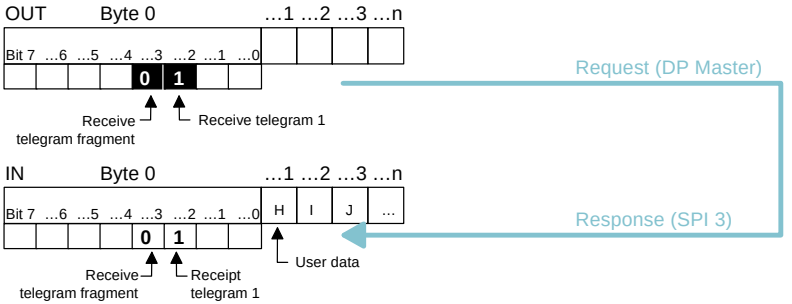
Send further user data in telegram fragments – until telegram 2 has been sent completely
(only toggle Bit 1 in Byte 0, specify further user data from Byte 1 onward)

Acknowledge telegram with fragmentation



3

Receive further user data in telegram fragments (only toggle Bit 3 in Byte 0, specify further user data from Byte 1 onward)

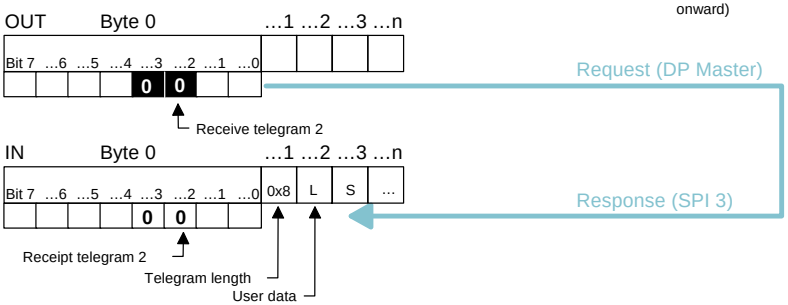


4

Receive further user data in telegram fragments – until telegram 1 has been received completely
(only toggle Bit 3 in Byte 0, specify further user data from Byte 1 onward)

5

Receive next telegram (only toggle Bit 2 in Byte 0, telegram length is received in Byte1, user data are received from Byte 2 onward)

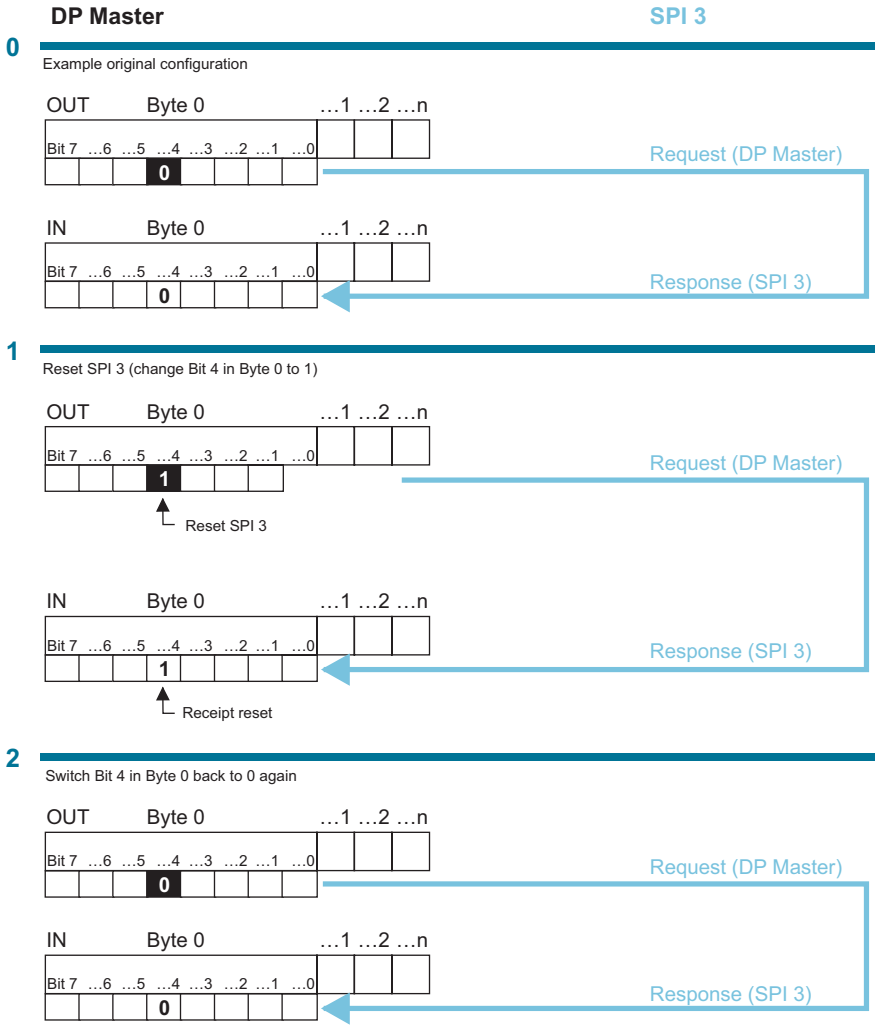


6

Receive further user data in telegram fragments – until telegram 2 has been received completely
(only toggle Bit 3 in Byte 0, specify further user data from Byte 1 onward)

SPI 3 Reset

When you re-set the SPI 3, any running send and receipt commands are interrupted. The 4-word I/O field for the data channel in the SPI 3 is deleted and re-initialized. To do so, set Bit 4 in Byte 0 to 1 and send this telegram to the SPI 3.



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 depends on the chosen MODBUS function as shown in the following tables.

Note!
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 High	00	–	–
Byte 9	Data Low	0A	–	–
Byte 10	Data High	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 MODBUS address
0x03 Invalid MODBUS 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
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.
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.
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.
Diagnosis	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
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.
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. You can download a GSD file for the SPI 3 from the internet (www.t-h.de); it 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.
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 identically 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.
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.
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.

Right to make Changes

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.

Liability and Guarantee

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.

ESD Guidelines

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.

Copyright

Product Observation Liability

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.

Warranty

Our products are subject to warranty in accordance with our general business and delivery terms.