WACHENDORFF
Automation GmbH & Co. KG

Technical Manual

WDGA absolute rotary encoders with Profibus interface

EnDra® Technology

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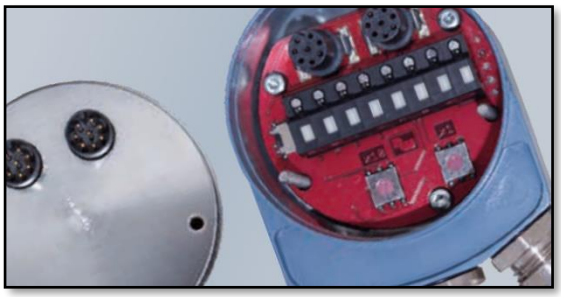

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1 Introduction

1.1 About this manual

This technical manual describes the configuration and mounting possibilities for absolute-value encoders with a PROFIBUS interface produced by Wachendorff Automation. It supplements the other publicly available Wachendorff automation documents, e.g. data sheets, assembly instructions, leaflets, catalogues and flyers.

Ensure that you read the manual before commissioning — check beforehand that you have the latest version of the manual.

When reading, pay particular attention to the information, important notices and warnings that are marked with the corresponding symbols (see 1.1.1).

This manual is intended for persons with technical knowledge in the handling of sensors, PROFIBUS-DP interfaces and automation elements. If you do not have any experience in this field, request the assistance of experienced personnel before proceeding.

Keep the information provided with our product in a safe place so that you can refer to it at a later date as necessary.

- The contents of this manual are arranged in a practice-oriented manner.
- For optimum use of the device, all information in the following sections is important and should be read.

1.1.1 Symbols

	• The INFO symbol indicates a section that contains particularly important information for advanced use of the device.
	• The IMPORTANT symbol is shown next to a section of text that describes a method for solving a particular problem.
	• The WARNING symbol indicates that the adjacent instructions must be observed to ensure correct use of the device and to protect the user against hazards.

1.1.2 You will not find the following in this manual:

- Basic information about automation technology
- System planning
- Risks (availability, safety)
- Shielding concepts
- Reflections
- Repeaters
- Network configuration
- Bus cycle times
- FMA management services
- Transmission services
- Telegram types

1.2 Product assignment

This manual relates to the following encoder types produced by Wachendorff Automation:

Solid shaft absolute encoders:

- WDGA 58A PROFIBUS-DP (BP1, BP2) - (with bus cover)
- WDGA 58A PROFIBUS-DP (DB4, SD9, SE9) - (without bus cover)
- WDGA 58B PROFIBUS-DP (BP1, BP2) - (with bus cover)
- WDGA 58B PROFIBUS-DP (DB4, SD9, SE9) - (without bus cover)
- WDGA 58D PROFIBUS-DP (BP1, BP2) - (with bus cover)
- WDGA 58D PROFIBUS-DP (DB4, SD9, SE9) - (without bus cover)

End hollow shaft absolute encoders:

- WDGA 58E PROFIBUS-DP (BP1, BP2) - (with bus cover)
- WDGA 58E PROFIBUS-DP (DB4, SD9, SE9) - (without bus cover)

- Wachendorff's Profibus product range can be found on our website: www.wachendorff-automation.com

1.3 Specifications

An encoder is a sensor that is designed to detect angular positions (singleturn) and revolutions (multiturn). The measured data and variables are processed by the encoder and provided as electrical output signals for the connected peripherals.

The patented technology EnDra® (for multiturn) is used in the WDGA series. As a result, the WDGA-series encoders from Wachendorff are maintenance-free and very eco-friendly.

The encoders whose article descriptions are listed in section 1.2 communicate via the Profibus-DP interface.

1.4 Scope of delivery

The scope of delivery depends on the product variants and the details of your order. Before commissioning, check the contents of the delivery for completeness.

As a rule, the WDGA product range with a Profibus-DP interface includes the following items:

- WDGA with PROFIBUS-DP (with or without bus cover)
- assembly instruction
- Pluggable connection terminal for the BP1 variant (see section 4.4.4.1)

- The corresponding GSD file and data sheet can be downloaded from the internet:

  www.wachendorff-automation.com

2 Safety information

2.1 General safety information

- When commissioning the encoder, ensure that you observe the assembly instructions, manual and data sheet.
- Failure to observe the safety instructions may lead to malfunctions, property damage and personal injury!
- Observe the operating instructions provided by the machine's manufacturer.

2.2 Intended use

Rotary encoders are components that are intended for installation in machines. Before commissioning (operation in accordance with the intended use), it must be determined that the machine as a whole corresponds to the EMC and Machine Directive.

A rotary encoder is a sensor that is designed to detect angular positions and revolutions and must only be used for this purpose! Wachendorff Automation manufactures and distributes encoders for use in non-safety-relevant industrial applications.

- The encoder must not be operated outside the specified limit parameters (see data sheet).

2.3 Safe working

The installation and mounting of the encoder must only be carried out by a qualified electrician.

For the construction of electrical installations, all relevant national and international regulations must be strictly observed.

Failure to commission the encoder correctly may result in malfunction or failure.

- All electrical connections must be tested before commissioning.
- Appropriate safety measures must be taken to ensure that no persons are harmed and no damage to the system or operating equipment occurs in the event of a failure or malfunction.

2.4 Disposal

Devices that are no longer needed or are defective must be disposed by the user in proper compliance with the country-specific laws. It must be taken into consideration that this is a special waste of electronics and that disposal is not permitted via normal household waste.

There is no obligation by the manufacturer to take the device back. If you have any questions regarding proper disposal, contact a disposal specialist in your area.

3 Device description

3.1 General information

There are various mechanical variants for the WDGA series with PROFIBUS-DP. The decisive factors here are the design, with or without bus cover, the type of flange shape and the type of shaft (solid or end hollow shaft). The size is determined by the diameter of the flange with 58 mm. Figure 3.1 shows examples for the WDGA series with PROFIBUS-DP.

Figure 3.1: WDGA with PROFIBUS-DP

The solid or end hollow shaft is connected to the rotating part whose angular position or speed is to be measured. Cable or connector outlets form the interface for connection to the PROFIBUS network (see sections 3.5, 3.6 or 3.8). Status LEDs in the cover indicate various states of the encoder during operation. They support the configuration of the encoder or troubleshooting in the field (see section 3.4). The flange holes or the supplied spring plates are used for fastening to the machine or in the application.

3.2 WDGA – Basics

In the following sections, the basic functions of an absolute encoder are described.

In contrast to incremental encoders, absolute encoders output their position value as a digital number via a fieldbus. A distinction is made between singleturn and multiturn encoders.

In addition to the simple output of the position value, most rotary encoders allow a certain degree of parameterization, such as the selection of the positive direction of rotation, the setting of the position value to a reference value at a defined physical position and the scaling of the position value to any resolution and a limited measuring range. In this way, the development effort in the control program is reduced and the computing capacity of the control is relieved.

3.2.1 Singleturn - ST

Measuring the angle from 0° to 360° using a shaft is the minimum function of a rotary encoder. The sensor system is based on the optical or magnetic scanning of a measuring standard on the encoder shaft.

3.2.2 Multiturn - MT (EnDra®)

A multiturn encoder allows the number of revolutions to be counted. This is realized via a revolution counter. EnDra® technology is used for the WDGA encoders to ensure that the corresponding information is retained even when the encoder is de-energized. Buffer batteries and gearboxes, which require a comparatively large installation space and require corresponding maintenance, can thus be replaced.

3.2.3 Direction of rotation

By a simple two's complement (invert each bit and add "1") of the position value, the positive direction of rotation can be reversed.

3.2.4 Preset

At a certain physical position, the encoder can be assigned a desired position value. This must lie within the measuring range so that the position value is correlated with a physical reference position. The difference between the current position value and the desired value is calculated. This is stored in a non-volatile memory and added to the position value as an offset.

3.2.5 Scaling

The scaling parameters can be used to adjust the position value to exactly match the physical quantity to be measured. The scalable parameters are "Measuring units per revolution (MUPR)" and "Total measuring range in measuring units (TMR)".

The scaling parameter "Measuring units per revolution (MUPR)" - increments per revolution - indicates the resolution of the position value per revolution (also: ST resolution). The value corresponds to 360°. This means that if a value of 3600 Cts is parameterized, the encoder outputs the position in 0.1° steps (see equation (2)).

$$MUPR = ST = 3600\ Cts \tag{1}$$

$$angular\ steps = \frac{angle\ of\ one\ revolution}{MUPR} = \frac{360°}{3600\ Cts} = 0{,}1°/Cts \tag{2}$$

The scaling parameter "Total measuring range in measuring units (TMR)" - maximum total measuring range of the position value (singleturn and multiturn multiplied) - indicates the total resolution of the encoder. If the position value TMR reaches - 1, it jumps back to 0 and vice versa.

As a rule, the parameter TMR is selected so that it is an integer multiple of the "Measuring units per revolution (MUPR)" (see equation (4)), so that the zero point is always on the same position of the encoder shaft.

$$TMR = 36000\ Cts \tag{3}$$

$$MT = \frac{TMR}{MUPR} = \frac{36000\ Cts}{3600\ Cts} = 10 \tag{4}$$

In exceptional cases it is adequate that TMR is not an integer multiple of MUPR. For example, if in a plant a transmission ensures that the desired measured variable moves 10% faster in relation to the encoder shaft than the encoder shaft.

Then a setting of MUPR = 3960 Cts and TMR = 36000 Cts would ensure that the faster but not directly measurable wave can be measured with a resolution of 0.1° and over a range of 10 revolutions. Normally, the number of revolutions could be calculated by dividing the position value by MUPR. In this case, however, it is necessary to divide by 3600 Cts, otherwise the result would be the number of revolutions of the encoder shaft and not that of the faster shaft of the system.

- Note that measurement errors occur if the result of this formula is a comma separated number.

3.3 Default settings

3.3.1 General information

At factory default, the PROFIBUS address is always set to "126".

- The PROFIBUS address can be set by Wachendorff according to customer requirements. Please contact our technical application support (see section 9).

The default parameterization can be found in the **Fehler! Verweisquelle konnte nicht gefunden werden.**.

3.3.2 Rotary encoder - with bus cover

- By default, the decimal rotary encoding switches are set to "00". The change of the address can be found in section 4.4.2.

The termination is set to "ON" by default. See section 4.4.3 for more information.

The connection terminal is included with the BP1 variant. This enables user-friendly installation of the supply and signal lines. Section 4.4.4.1 describes how to mount the cables to the terminal.

3.3.3 Rotary encoder - without bus cover

The change of the default PROFIBUS address "126" can be found in section 4.4.1.

3.4 LED signalling

Two status LEDs in the cover signal different encoder states and support diagnostics and troubleshooting in the field (see Table 3.1). The BUS LED signals the status of the fieldbus and the DEV LED signals the status of the encoder.

BUS LED bicolour	**DEV LED** bicolour	**significance**	**cause**
○	○	no power	Power supply is missing.
●	●	No connection to another device Criterion: No data exchange	- Bus not connected - Master not available/ switched off - The encoder is ready for operation, but has not yet received any configuration data after switching on the supply voltage. Possible causes: - Address incorrectly set - Bus cables connected incorrectly
●●●*	●	Parameterization or configuration error. If master-slave communication is functioning. Criterion: Data exchange correct The slave does not switch to the data exchange mode.	- Slave is parameterized incorrectly - Slave is incorrectly configured
●	●	system outage	Diagnosis available, slave in data exchange mode
●	●	Normal operation: exchange of data Slave and operation ok	

Table 3.1: LED signalling

Explanation of symbols and asterisks:

○ LED off ●/● LED on

*Flashing frequency 0.5 Hz, minimum display time 3 s

3.5 BP1 - Bus cover with 3x PG screw connection

The character string "BP1" in the order code identifies an encoder with bus cover (see Figure 3.2). The electrical connection is made in the bus cover via the three PG cable glands on the connection terminal. The pin assignment of the connection terminal can be found in the Table 3.2.

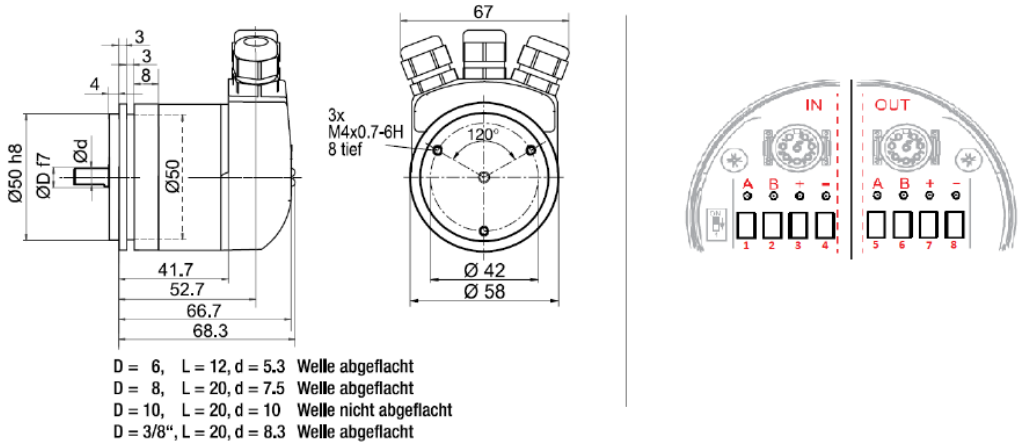
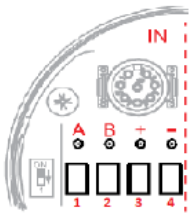


Figure 3.2: WDGA58A, BP1 - 3x PG screw connection

pin assignment	
BP1	
	
A	1
B	2
+UB	3
GND	4

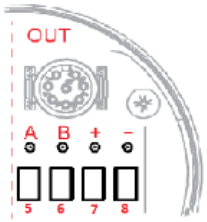
pin assignment	
BP1	
	
A	5
B	6
+UB	7
GND	8

Table 3.2: Pin assignment - BP1

- Further details can be found in the corresponding data sheet: www.wachendorff-automation.com

3.6 BP2 - Bus cover with 3x M12

The character string "BP2" in the order code identifies an encoder with bus cover (see Figure 3.3). The electrical connection is made to the bus cover via the 2x M12 plug and 1x M12 socket. The pin assignments of the plugs or sockets can be found in the Table 3.3.

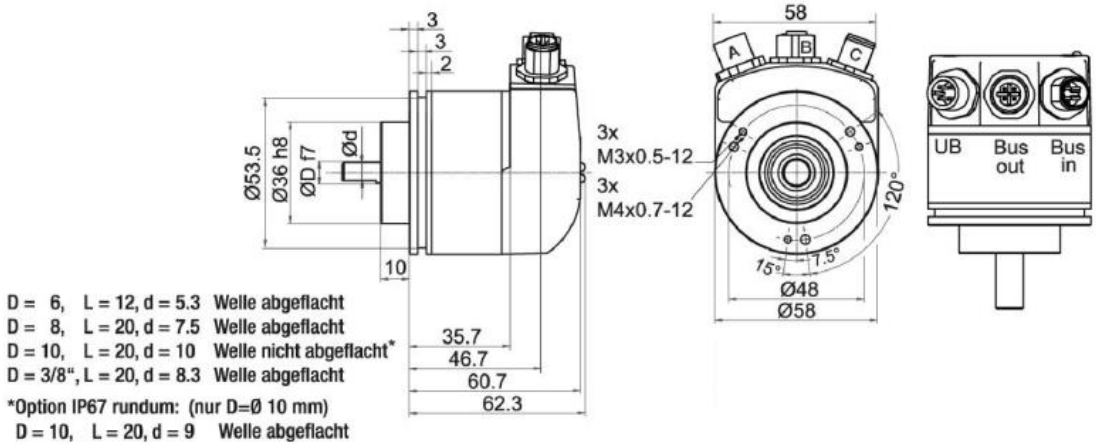
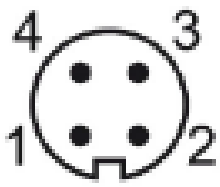
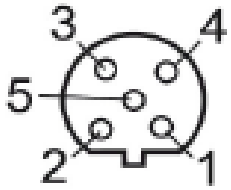


Figure 3.3: BP2 - 3x M12

pin assignment	
BP2	
	
Plug (A)	M12x1, 4-pole, A-coded
+UB	1
n.c.	2
Signal 3	3
n.c.	4

pin assignment	
BP2	
	
Socket (B)	M12x1, 5-pole, B-coded
BUS	OUT
n.c.	1
A	2
n.c.	3
B	4
n.c.	5

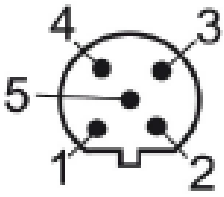
pin assignment	
BP2	
	
Plug (C)	M12x1, 5-pole, B-coded
BUS	IN
n.c.	1
A	2
n.c.	3
B	4
n.c.	5

Table 3.3: Pin assignment - BP2

- Further details can be found in the corresponding data sheet: www.wachendorff-automation.com

3.7 DB4 - without bus cover 2x M12, 1x M8

The character string "DB4" in the order code identifies an encoder without bus cover (see Figure 3.4). The electrical connection is made via 2x M12 and 1x M8. The pin assignments of the plugs or sockets can be found in the Table 3.4.

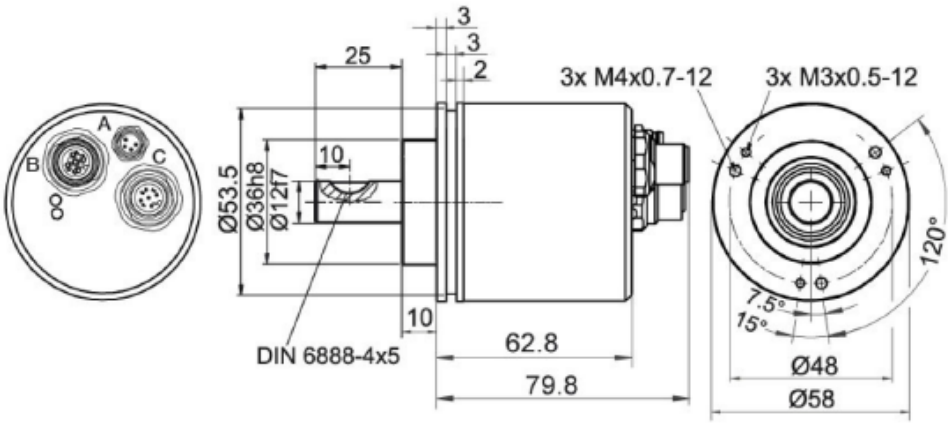


Figure 3.4: DB4 - 2x M12, 1x M8

pin assignment	
DB4	
	
Plug (A)	M8x1, 4-pole
+UB	1
n.c.	2
GND	3
GND	4

pin assignment	
DB4	
	
Socket (B)	M12x1, 5-pole, B-coded
BUS	OUT
5 V DP	1
A	2
GND DP	3
B	4
n.c.	5

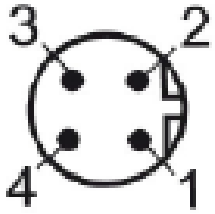
pin assignment	
DB4	
	
Plug (C)	M12x1, 4-pole, B-coded
BUS	IN
n.c.	1
A	2
n.c.	3
B	4

Table 3.4: Pin assignment - DB4

- Further details can be found in the corresponding data sheet: www.wachendorff-automation.de

3.8 SD9/SE9 - without bus cover, D-Sub

The character string "SD9 or SE9" in the order code identifies an encoder without bus cover with D-Sub socket. The electrical connection is made via a 9-pin D-Sub female connector. The D-Sub female connector is arranged axially (SD9) or radially (SE9) (see Figure 3.5). The pin assignment of the socket can be found in the Table 3.5.

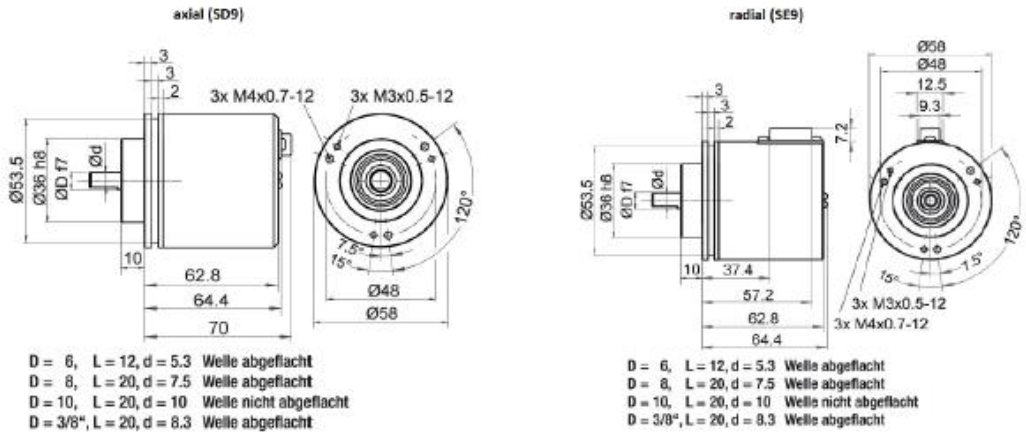


Figure 3.5: SD9/SE9 - D-Sub

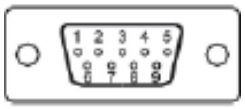
pin assignment	
SE9 / SD9	
	
socket	D-SUB
n.c.	1
GND	2
B	3
n.c.	4
GND DP	5
5 V DP	6
+UB	7
A	8
n.c.	9
shade	case

Table 3.5: Terminal assignment - SD9/SE8

- Further details can be found in the corresponding data sheet: www.wachendorff-automation.com

3.9 Rotary encoder and bus cover label

The Figure 3.6 shows an example of the encoder label. Table 3.6 shows the meaning and the corresponding field position.

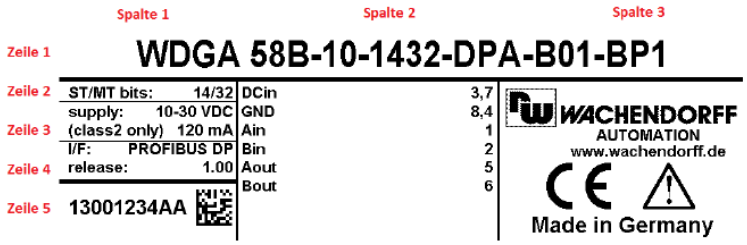


Figure 3.6: Encoder label for BP1

field position	significance
1st line	order code
1st column, 1st row	Singleturn and multiturn resolution
1st column, 2nd row	permissible voltage supply
1st column, 3rd row	Interface + software version
1st column, 4th row	Serial number of the encoder
2nd column	Terminal assignment of the connection terminals

Table 3.6: Encoder label

If you have a rotary encoder with bus cover, further information can be found on the bus cover label (see Figure 3.7). Among other things, you will also find the serial number of the encoder, the software version of the bus cover, the pin assignment and the accessible line connections (see Table 3.7). In the BP2 version, the pin assignment of the plugs or sockets is preceded by the identification of the cable connection (e.g. A1: cable connection A, pin 1 of the M12x1 plug).

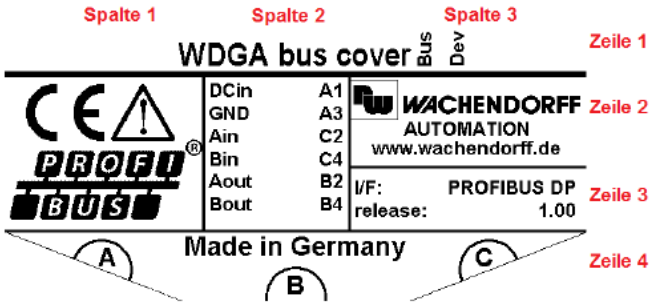


Figure 3.7: Encoder label for BP2

field position	significance
2nd column, 2nd row + 3rd row	Pin assignment (here: BP2)
3rd column, 1st row	LED designation
3rd column, 3rd row	Interface + software version
4th line	Accessible line connections

Table 3.7: Bus cover label

3.10 GSD file

The properties and functionalities of the encoder are described in the GSD file. For the user, there are project planning tools (see chapter 5 Project planning) available to enable the desired settings to be made on the encoder in a user-friendly manner.

In Table 3.8 you will find an overview of the available GSD files and the corresponding classes of WDGA encoders.

WDGA Encoder Functionality	GSD file
Class 4 (DP-V1/V2 functions)	WDGA0DD2

Table 3.8: Overview - GSD files

- You can find the GSD file on our website: www.wachendorff-automation.com

4 Installation

4.1 General information

The safety instructions must be observed when installing the encoder (see chapter 2.3).

- When electrically connecting the encoder, a distinction must be made between whether the encoder is designed with or without bus cover (see section 4.4 or 4.5).

- For the mechanical and electrical connection, please observe the safety instructions (see chapter 2 Safety information).

4.2 Mechanical connection

4.2.1 Shaft encoder

- Always connect encoder shaft and drive shaft via a suitable coupling. The coupling compensates the play of both shafts in radial and axial direction.
- The encoder shaft and drive shaft must never touch each other.
- The maximum axle loads of the drive and the encoder must be observed.
- The encoder can simply be screwed to a suitable plate via the four holes in the flange on the shaft side.
- Another way of mounting the encoder is to use clamping eccentrics.

- Suitable accessories can be found on our website: www.wachendorff-automation.com

4.2.2 Hollow shaft encoders

- Plug the encoder completely onto the drive shaft.
- Lock with the setscrews in the encoder shaft by screwing on the drive shaft.
- The encoder has a spring plate which absorbs the torque generated in the flange. It is attached to the machine with two screws. The spring plate is "spring-loaded" to compensate for vibrations and play on the drive shaft and to avoid overloading the encoder bearings.

- Suitable accessories can be found on our website: www.wachendorff-automation.com

4.3 Shielding

Suitable measures must be taken to ensure that the system structure of the system is EMC-compatible.

Electromagnetic interference is mainly caused by switching operations, power converters and circuit breakers. In addition, overvoltage and lightning may damage a field device. This can lead to a system failure of the system. The PROFIBUS stations, PROFIBUS cable shields and other components must be connected to the equipotential bonding rail so that electromagnetic interference can be dissipated. With PROFIBUS-DP, earthing is done via a common equipotential bonding rail.

- The encoder and the connection cables must be completely shielded.
- The cable shields must be connected on both sides and connected to the protective earth (PE).
- The encoder housing must also be connected to protective earth PE).

Detailed information on cabling and shielding can be found, among other things, in special PNO documents. For example, the PROFIBUS Mounting Directive (Order No: 8.021); PROFIBUS Technical Directive - Installation Directive PROFIBUS-DP/FMS Version 1.0 (September 1998) and the PROFIBUS Planning Directive Version 1.0 (August 2009).

- If necessary, please refer to the relevant literature for information on intended EMC measures.

4.4 Connecting the encoder - with bus cover

4.4.1 General information

The bus cover of the rotary encoder (see Figure 4.1) is loosened using two fastening screws and a screwdriver. The bus cover can then be removed axially from the rotary encoder. The PROFIBUS address and the PROFIBUS termination are set accordingly via the bus cover (see section 4.4.2 or 4.4.3). Once the settings have been made, the bus cover is reattached to the rotary encoder. For this purpose, the M12 sockets of the bus cover and the M12 plugs of the encoder are joined together. Finally the screws of the bus cover are tightened again in the same direction.

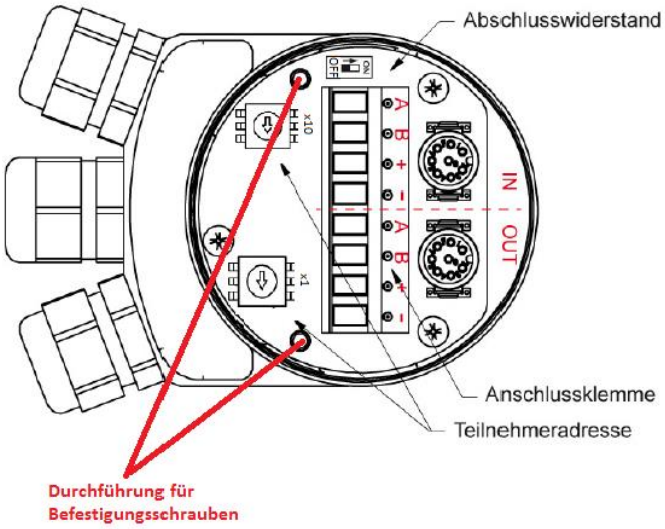


Figure 4.1: PROFIBUS bus cover

	• In order for the shielding to be optimally connected, the bus cover must sit completely flat all around and be screwed down.

4.4.2 Setting the slave address

- To prevent collisions on the bus, it is recommended to connect the encoder to an independent PROFIBUS master first. This does not endanger the availability of an operational system.
- Each PROFIBUS address may only be assigned once.
- The PROFIBUS address 126 can only be used for commissioning purposes (not for data exchange).
- When assigning the PROFIBUS address between 0 and 2, it should be noted that these are frequently used for PROFIBUS masters.

The slave address is set via the two decimal rotary coding switches. The permissible address range is between 0 and 99. For a more significant address (100 - 126), the setting must be made by software (see 4.5.1). The decimal rotary encoding switches must be set to x10 = 0 and x1 = 0.

The value of the decimal rotary encoding switches works as shown in the following example (Figure 4.2). The decimal rotary coding switch on the bus cover board indicates the values. The x10 mark indicates the tens digit and the x1 mark indicates the units digit.

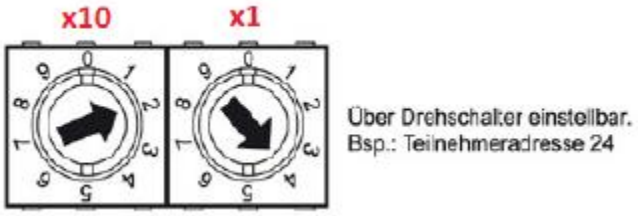


Figure 4.2: Rotary decimal encoding switch - bus cover

- The slave address is read in and accepted exclusively during the start of the encoder.

4.4.3 Termination

If the encoder is the last PROFIBUS station, termination must be switched on (see also section 7.3.3). Switching on takes place via the dip switch in the bus cover. The label of the switch position is located above or below the dip switch on the bus cover board. If the encoder is not the last PROFIBUS station, the termination must be switched off. Figure 4.3 shows an example of the dip switch.

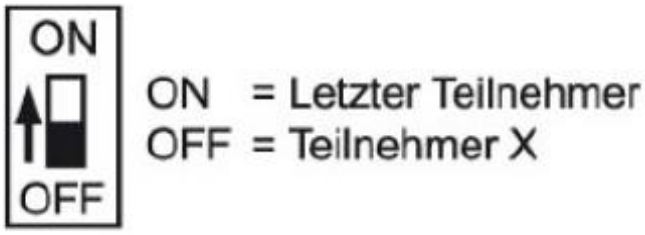


Figure 4.3: Dip switch - Bus cover

If the termination is switched on, then the PROFIBUS-DP is completed, i.e. further PROFIBUS stations behind it are then disconnected.

	• In this case, only the PROFIBUS bus "IN" is connected (see 4.4.4.1 or 4.4.4.2). • The continuing PROFIBUS bus "OUT" is disconnected.

4.4.4 Connecting the signal and supply lines

4.4.4.1 BP1 - 3x PG screw connection

	• The pin assignment of the terminal is shown in Table 3.2.

The supply line must be connected once in the connection terminal. The supply "+" (also: +UB) and "-" (also: GND) in the "IN" and "OUT" marked area of the terminal are internally looped through. The positive voltage +UB (see encoder label) is applied to the connection with the "+"-marked area of the connection terminal. GND is connected to the connection with the "-" marked area of the connection terminal.

The incoming PROFIBUS cables A (green) and B (red) are connected to the terminal in the "IN" marked area. The further PROFIBUS lines (A and B), if required, are connected to the terminal with the "OUT" marked area. A-"IN" and A-"OUT" or B-"IN" and B-"OUT" are internally looped through when termination is off.

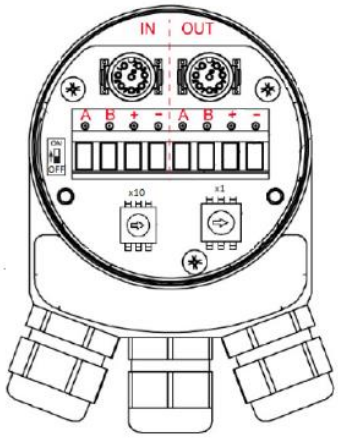


Figure 4.4: BP1 connections - PG screw fitting

	• Prevent the supply voltage from coming into contact with the data lines A and B. This can damage the electronics. • Avoid crossing the PROFIBUS cable and the supply cable. • Close unused PG connections with sealing caps.

An installation example is shown below:

Figure 4.5 shows the recommendation for the lengths of stripping of the wires for connection to the terminal.

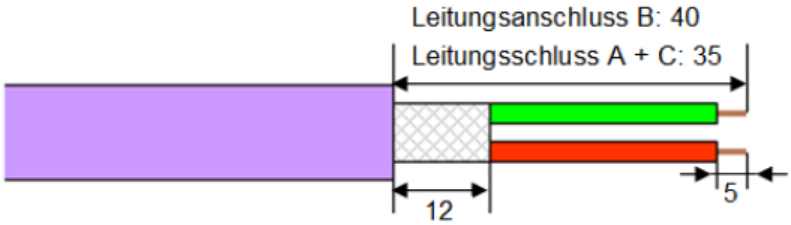


Figure 4.5: Lengths for stripping - Schematic

Figure 4.6 shows a stripped PROFIBUS standard cable with the contact sleeve for the braided shield. The wires are stripped according Figure 4.5.

Figure 4.6: Stripped PROFIBUS standard cable

The shortened braided shield (length see Figure 4.5) is put over the contact sleeve (see Figure 4.7).

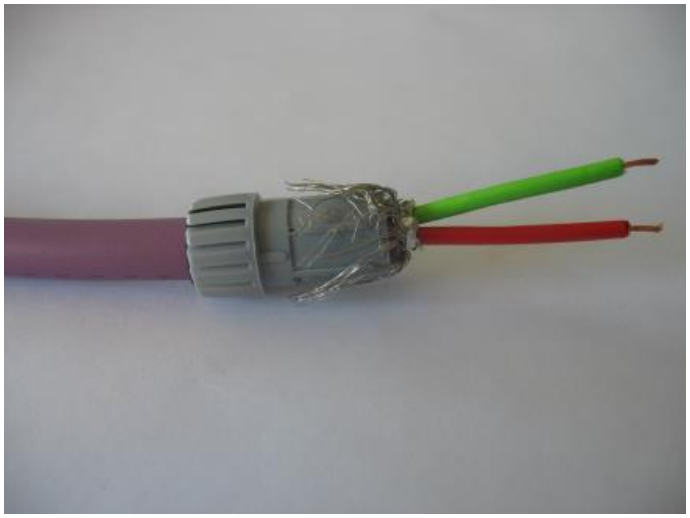


Figure 4.7: Shielding, stripped cores

The pre-assembled PROFIBUS standard cable is inserted through the PG screw connection (see Figure 4.8).

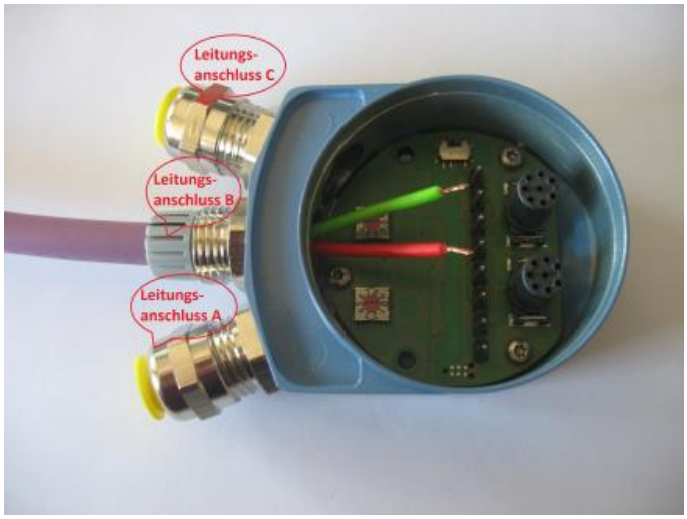


Figure 4.8: Preconfigured PROFIBUS standard cable through PG cable gland

The wires are connected to the according connection terminal. The connection terminal is plugged into the bus cover. The standard PROFIBUS cables are screwed to the cap nut (see Figure 4.9).

The supply line is connected according to a similar principle.

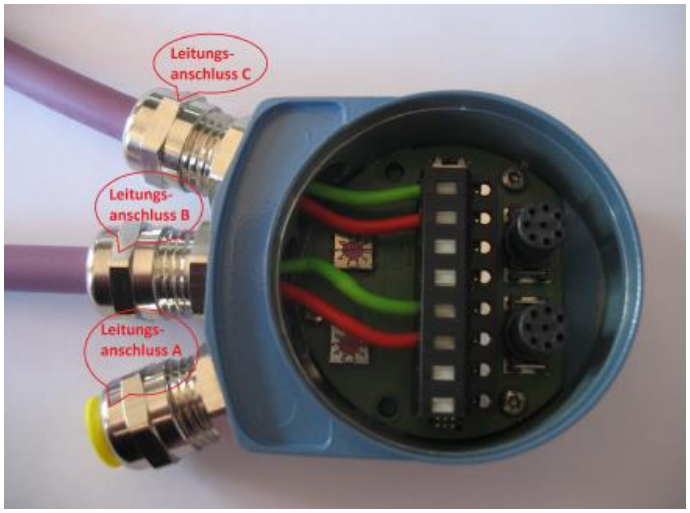


Figure 4.9: Installation example - PROFIBUS standard cable

4.4.4.2 BP2 - 3x M12

- The pin assignment for the BP2 variant can be found in Table 3.3.

A 4-pole M12 socket with A coding is required for the supply line. Pin 1 has +UB (see encoder label) and pin 3 has GND. Shielding should rest on the union nut.

The PROFIBUS cable for the incoming bus requires a 5-pin M12 socket with B coding. Pin 2 contains the A signal and pin 4 contains the B signal. The other pins are unused.

A 5-pin M12 connector with B coding is required for the PROFIBUS cable. The A signal is on pin 2 and the B signal on pin 4. All other pins are not assigned.

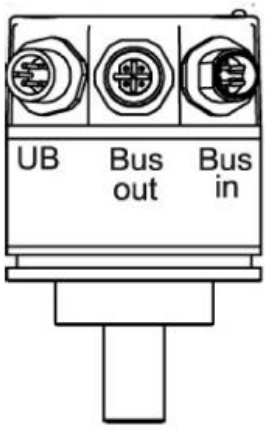


Figure 4.10: BP2 connections - 3x M12

- If the termination is set to "ON", the continuing PROFIBUS is disconnected.
- The shield should rest on the union nut of the plugs or sockets for both the supply and PROFIBUS cables.

4.5 Connecting the encoder - without bus cover

4.5.1 Setting the slave address

- To prevent collisions on the bus, it is recommended to connect the encoder to an independent PROFIBUS master first. This does not endanger the availability of an operational system.
- Each PROFIBUS address may only be assigned once.
- The PROFIBUS address 126 can only be used for commissioning purposes (not for data exchange).
- When assigning the PROFIBUS address between 0 and 2, it should be noted that these are frequently used for PROFIBUS masters.

The slave address is set exclusively via the PROFIBUS master.

How you can set the slave address via a PROFIBUS master is shown in the example in Figure 4.11. Software: Simatic Manager - Step7).

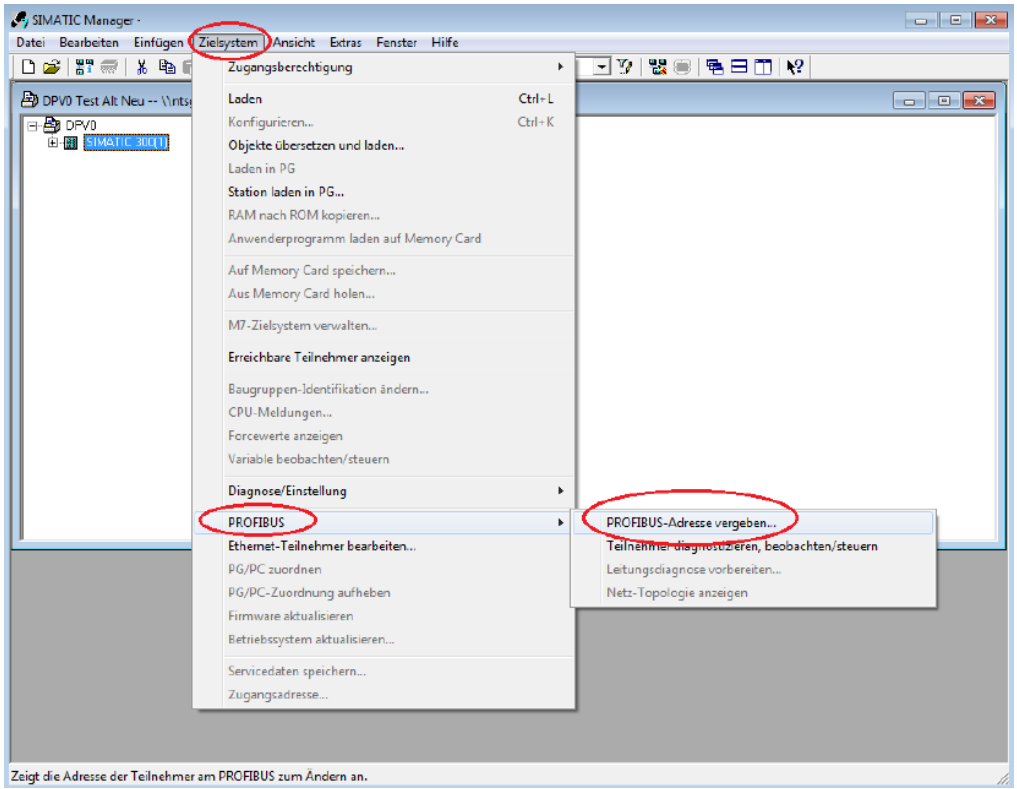


Figure 4.11: Step7 - "Assign PROFIBUS Address..."

- The PROFIBUS address set here is assigned in the hardware configurator (see section 5.3.1).
- If the PROFIBUS is terminated on both sides, the PROFIBUS address can be assigned via a programming adapter (USB to PROFIBUS). No control is required for this.

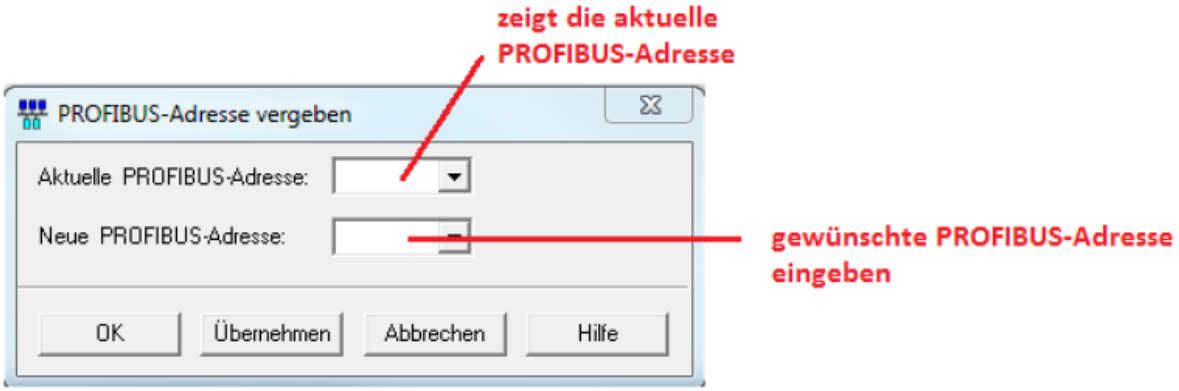


Figure 4.12: Step7 - Assign PROFIBUS address

4.5.2 Termination

The encoder does not provide an internally adjustable termination. If the encoder is the last PROFIBUS station, you must perform an external termination. The exemplary external termination (see Figure 4.13) is carried out by connecting this termination to the continuing PROFIBUS bus "OUT" (line connection B) (see section 4.5.3.1).

Figure 4.13: External PROFIBUS termination

- Suitable accessories can be found on our website: www.wachendorff-automation.com

4.5.3 Connecting the signal and supply lines

4.5.3.1 DB4 - 2x M12, 1x M8

- The pin assignment for the DB4 variant can be found in Table 3.4.

A 4-pole M8x1 socket with A coding is required for the supply line. Pin 1 has +UB (see encoder label) and pin 3 and 4 have GND. Shielding should rest on the union nut.

For the incoming PROFIBUS, a PROFIBUS cable with a 4-pin M12 socket with B coding is connected. The A signal is on pin 2 and the B signal on pin 4. Pin 1 and 2 are not assigned.

The continuing PROFIBUS is connected with a PROFIBUS cable with a 5-pin M12 connector with B coding. Pin 2 contains the A signal and pin 4 the B signal.

If the rotary encoder is connected as the last PROFIBUS station, an M12 PROFIBUS termination can be connected to this connection (BUS-OUT) (see Figure 4.13). The required galvanic isolated 5 V voltage (signal designation: 5 V DP) is applied to pin 1. The corresponding ground GND DP is on pin 3.

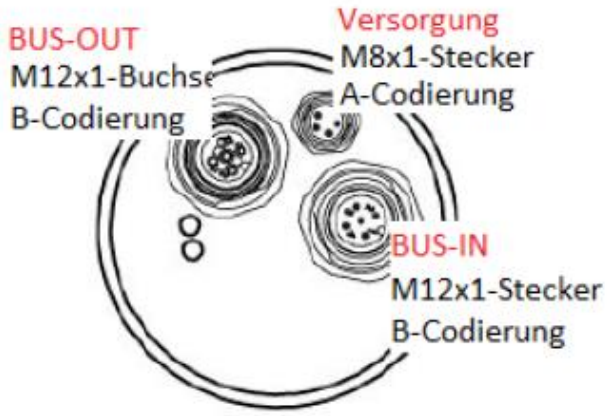


Figure 4.14: DB4 connections - 2x M12, 1x M8

4.5.3.2 SD9/SE9 - D-Sub

- The pin assignment for the SD9/SE9 variant can be found in Table 3.5.

Connect a 9-pin PROFIBUS D-Sub plug to the D-Sub socket. These are available in various versions on the market (e.g. as diagnostic plugs, with or without bus termination, etc.).

5 Project planning

5.1 General information

The following examples are based on the program "STEP 7" (version 5.5). If not already available, you need the corresponding hardware, a DPM1 master, DPM2 master, DP slave (WDGA encoder with PROFIBUS) and the corresponding GSD file (see section 3.10).

5.2 Installing the GSD file

The GSD file of the WDGA encoder with PROFIBUS is installed in the hardware configurator "HW Config" (see Figure 5.1). Further information on the GSD file can be found in section 3.10.

The GSD file for class 4 can be found on our website: Download - GSD file - Close the opened hardware projects.

At "Extras" -> "Install GSD-files..." Select your corresponding storage location.

GSD file "Install".

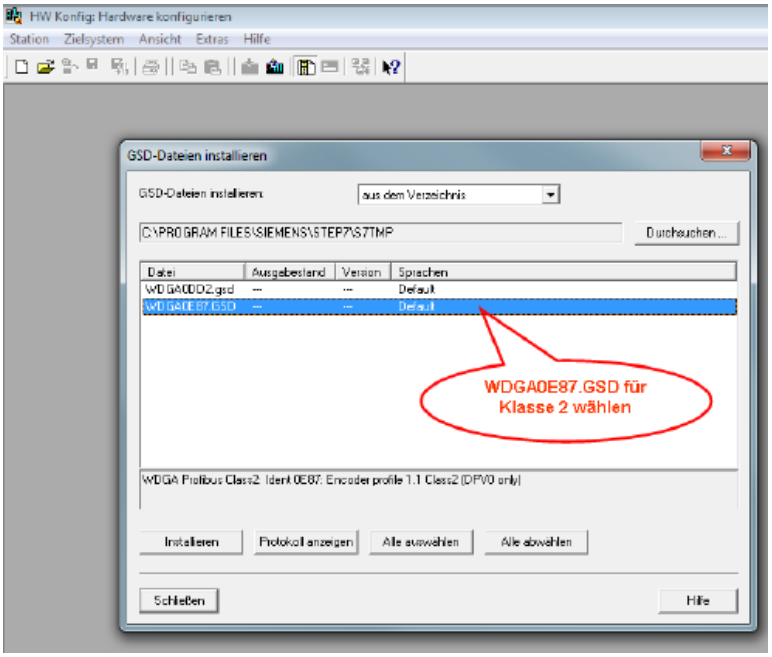


Figure 5.1: GSD file - STEP 7

Then update the "Hardware Catalogue".

- In the "Hardware Catalogue" at "PROFIBUS-DP", "Other field devices", "Encoder", "Wachendorff Automation", "WDGA PROFIBUS ClassX" (X = 2 or 4), the WDGA encoder appears (see Figure 5.2).
- There appear the "WDGA PROFIBUS ClassX" modules (X = 2 or 4).
- Modules according to the configuration data of class 4 (see Table 6.1) can be selected here.

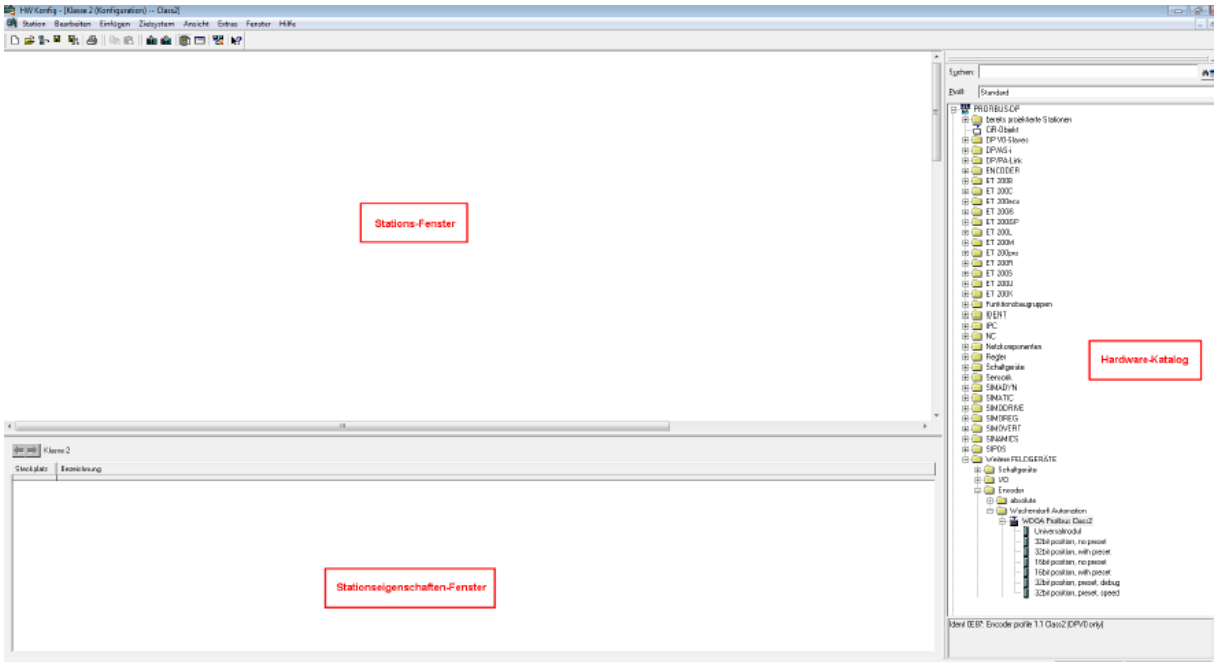


Figure 5.2: Hardware Configurator - STEP 7

5.3 Integration of the WDGA

If not already available, configure a DPM1 master in the hardware configurator.

In Figure 5.3 different areas of the "HW Configurator" are marked.

At "Hardware Catalog" click on the "WDGA PROFIBUS ClassX" module (X = 2 or 4) and drag it into the "Station Window" to the fieldbus (here: "PROFIBUS(1): DP master system(1)").

Then click once on the "WDGA icon". The assembly is displayed in the Station Properties window.

Drag your desired "WDGA PROFIBUS ClassX" module (X = 2 or 4) from the "Hardware Catalog" into the "Station Properties Window" to "Slot 1".

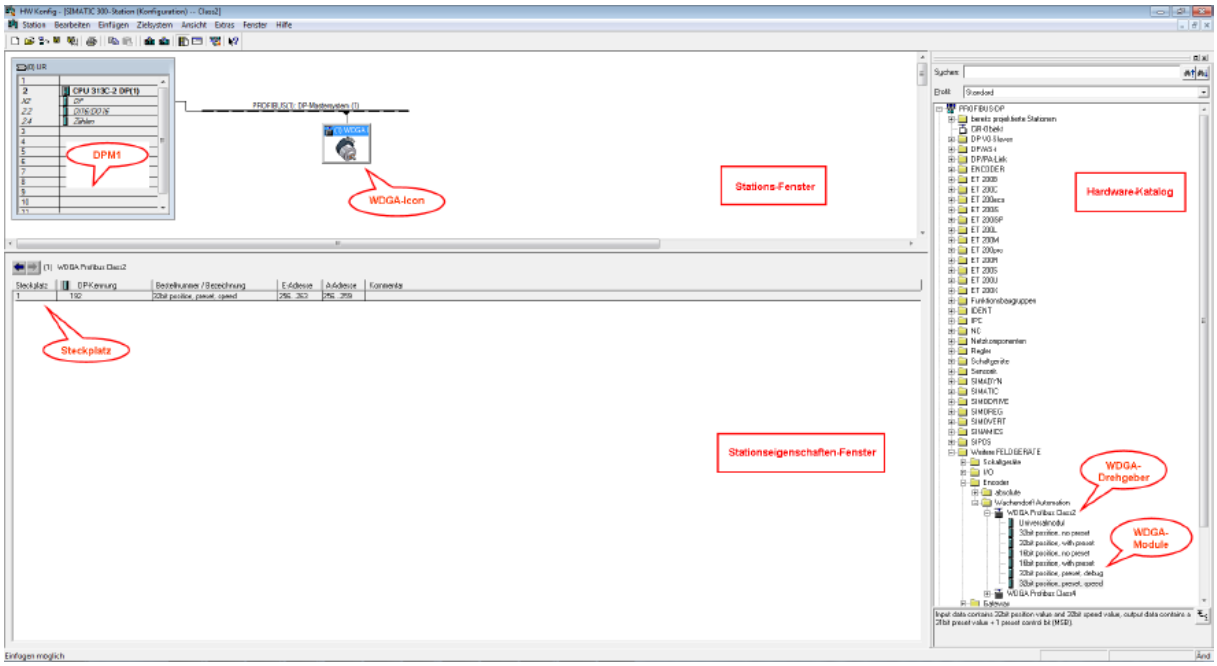


Figure 5.3: HW configuration - STEP 7

5.3.1 Communicating the slave address

The slave address previously set in the WDGA (with bus cover: see section 4.4.2; without bus cover: see section 4.5.1) must be communicated in the hardware configuration (see Figure 5.4).

Double click on the "WDGA-Icon".

Under "General", "PROFIBUS. . . "Enter the corresponding slave address in the "Parameters" field.

Select your configured PROFIBUS in the "Subnet" and confirm with "OK".

- If you have a WDGA encoder with bus cover, make sure that the display of the rotary coding switches is consistent with the display in the "Station window".

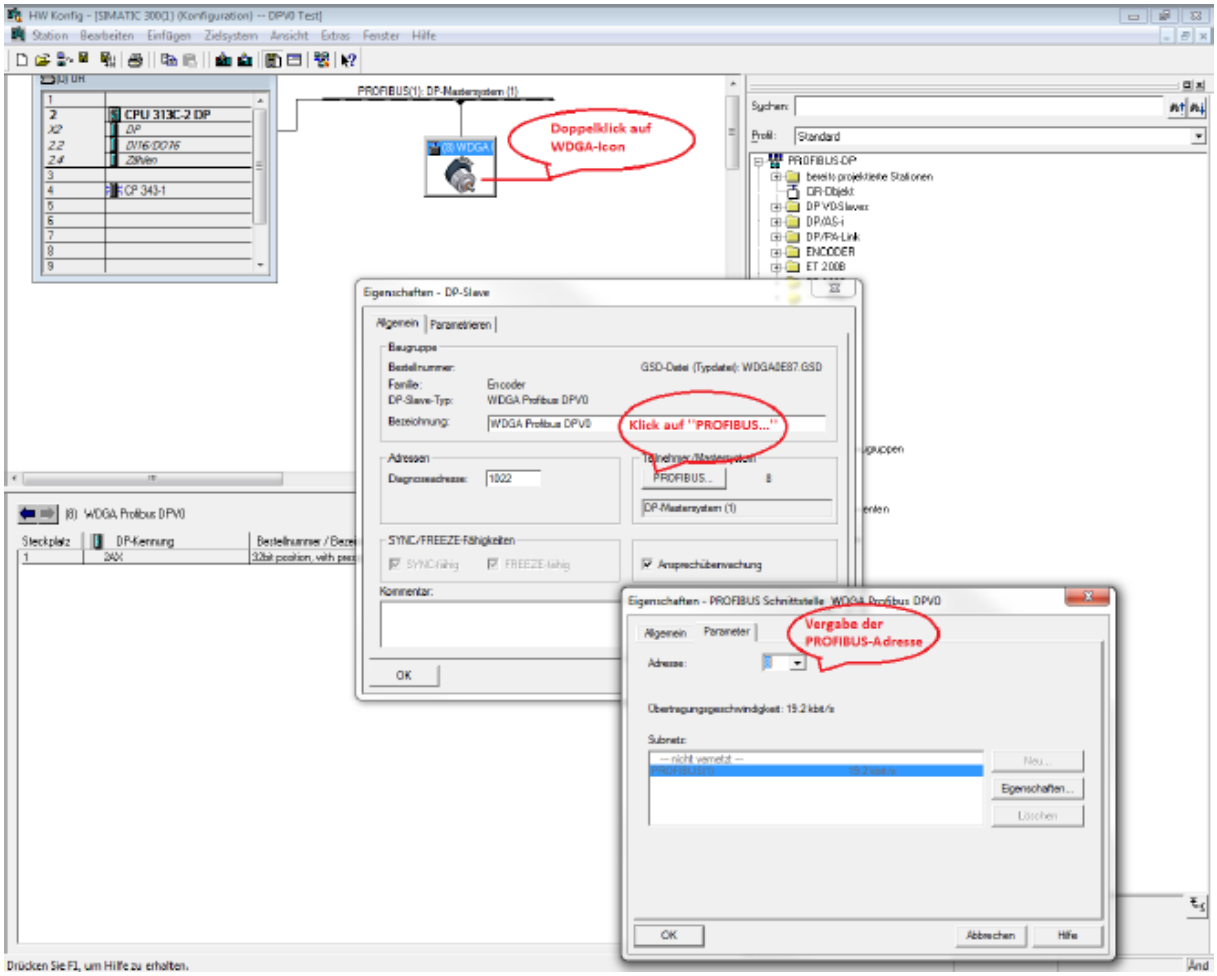


Figure 5.4: Address assignment - "HW configuration" STEP 7

5.3.2 Setting I/O addresses

The I/O addresses are the S7 addresses under which the encoder is addressed in the controller. The controller uses these to access the input and output data of the encoder. The I/O addresses are assigned via the "Properties-DP-Slave" window (see Figure 5.5).

Double click on the line of the attached "WDGA Module" in the "Station Properties Window".

Enter the desired I/O address in the "Properties - DP Slave" window and confirm with "OK".

Identical addresses are permitted for the I/O addresses.

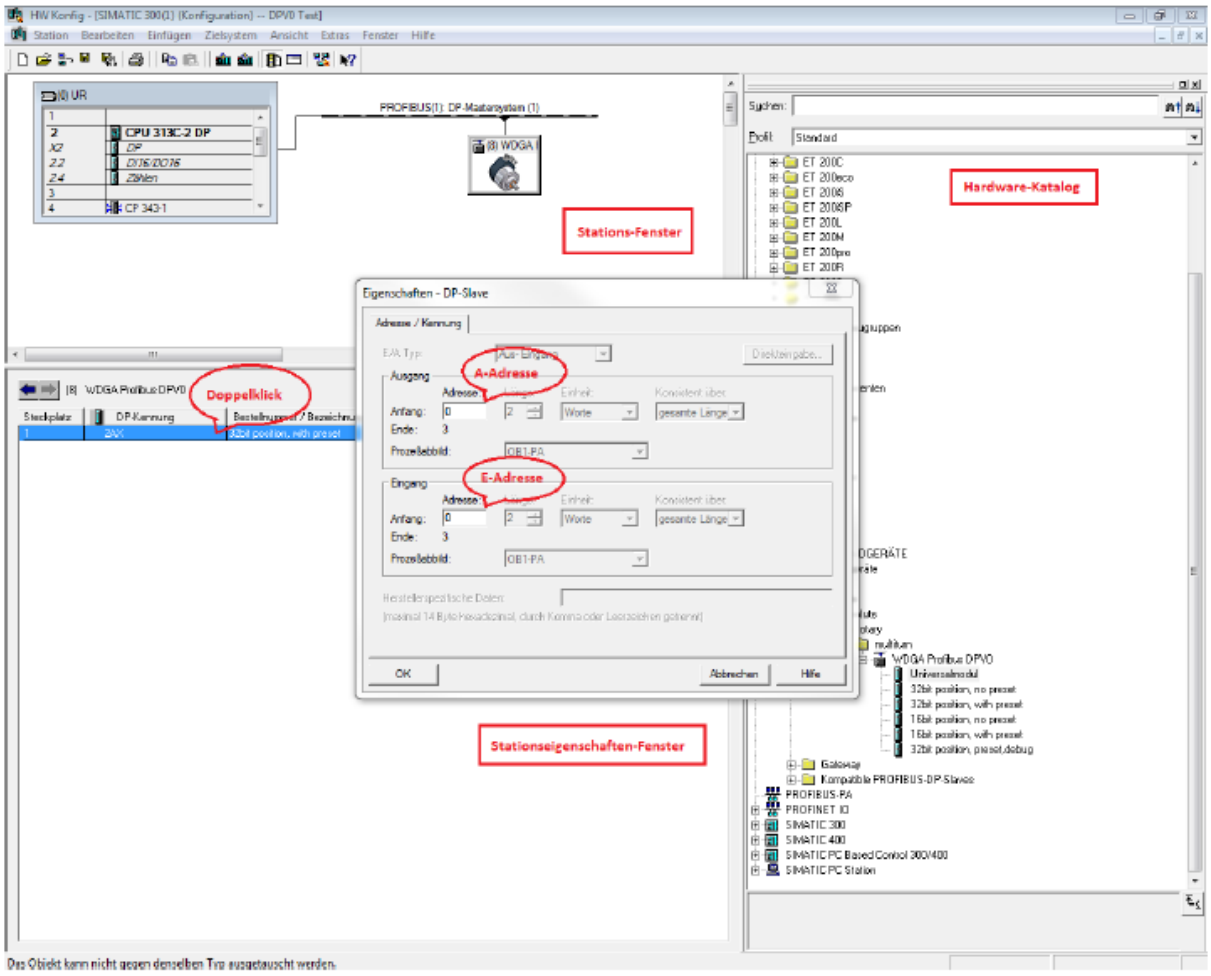


Figure 5.5: I/O addresses - STEP 7

- Depending on the controller type, there may be restrictions for the permissible value range of the I/O addresses that do not directly lead to error messages. If the access to the data is not possible via the addresses Exxx or Axxx, but only via PExxx and PAxxx, too high values may have been entered here. Avoid overlapping with other slaves!

5.3.3 Parameterization - Class 4

Via the "Properties - DP Slave" window the parameterization can be carried out (see Figure 5.6).

Click on the parameters to carry out your parameterization:

- "code sequence" - change of the direction of rotation (see section 6.3.1).
- "class 4 functionality" - Activation of class 4 functionalities (see section 6.3.2).
- "G1_XIST1 preset control" - Effect of the preset on the position value in G1_XIST1 (see section 6.3.3).
- "scaling function control" - Activation of scaling (see section 6.3.4).
- "Alarm channel control" - If "Alarm channel control" is deactivated, only the 6 byte long standard diagnosis is output via the diagnosis (only has an effect in compatibility mode, see section 6.3.5).
- "Compatibility mode" - compatibility with the older encoder profile version 3.1 (see section 6.3.6).
- "Measuring units per revolution" - Enter ST resolution (see section 6.3.7).
- "total measuring range" - Enter the total resolution (see section 6.3.8).
- "Maximum master sign-Of-life failures" - This parameter sets the upper limit of the isochronous mode error counter to 10 times the value (only has an effect in compatibility mode, see section 6.3.9).
- "Speed measuring unit" - Define the unit of the speed value (see section 6.3.10).
- "64 bit MUPR (lower half)" - 0-31 bit part of the ST resolution; always the same MUPR (see section 6.3.7).
- "64-bit MUPR (upper half)" - 32-64-bit part of the ST resolution; Always 0 (see section 6.3.7).
- "64Bit-TMR (lower half)" - 0-31 bit part of the total resolution (see section 6.3.8).
- "64Bit-TMR (upper half)" - 32-64 bit part of the total resolution (see section 6.3.8).

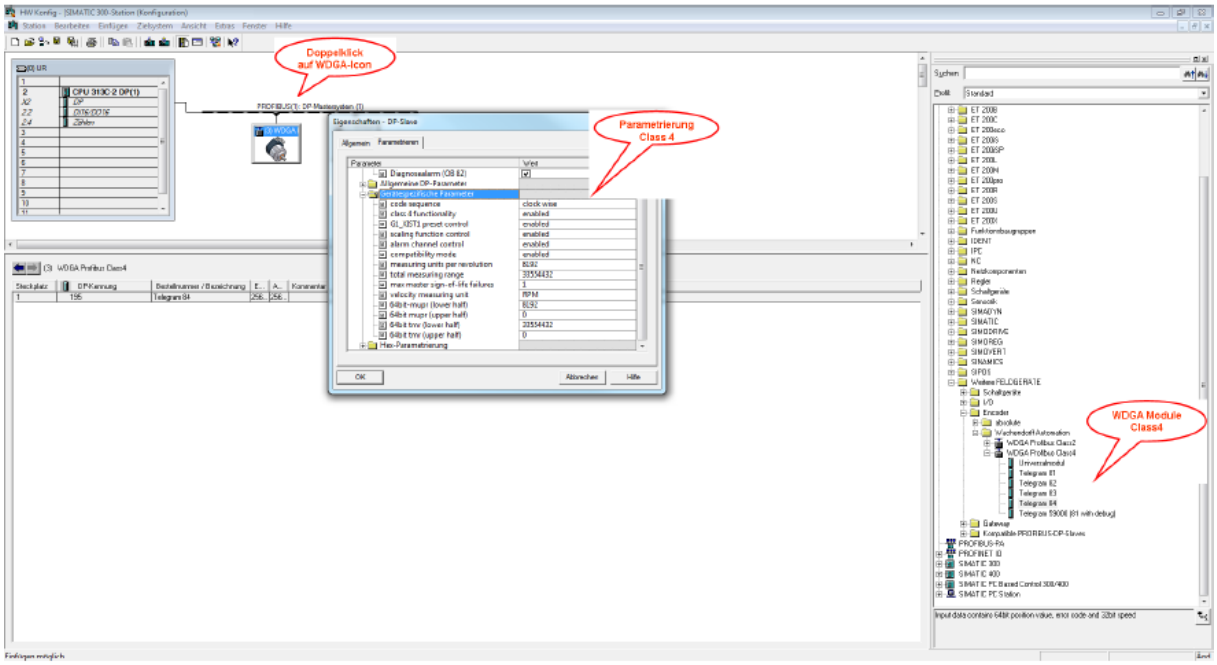


Figure 5.6: Parameterization - STEP 7

- Once the hardware configuration has been completed, it can be translated and loaded into the target system (DPM1).
- Make sure that you have also translated and not only saved.

5.3.4 Set diagnostic address

To evaluate diagnostic messages from the encoder, a diagnostic address must be assigned (see Figure 5.7).

Enter the diagnostic address in the "Properties - DP Slave" window.

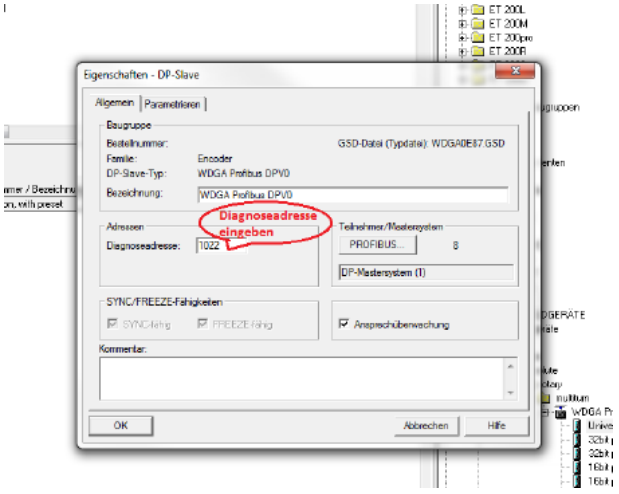


Figure 5.7: Diagnostic addresses - STEP 7

- The diagnostic address can be located in the entire peripheral area of the controller.
- The diagnostic address does not occupy an I/O address.
- The assignment of the diagnostic address is only necessary if the diagnostic functions are used.
- Reading the diagnosis see section 5.8.

5.4 Creating the Symbol Table

Create your symbol table or complete your existing one if necessary.

Open the symbol table as shown in Figure 5.8.

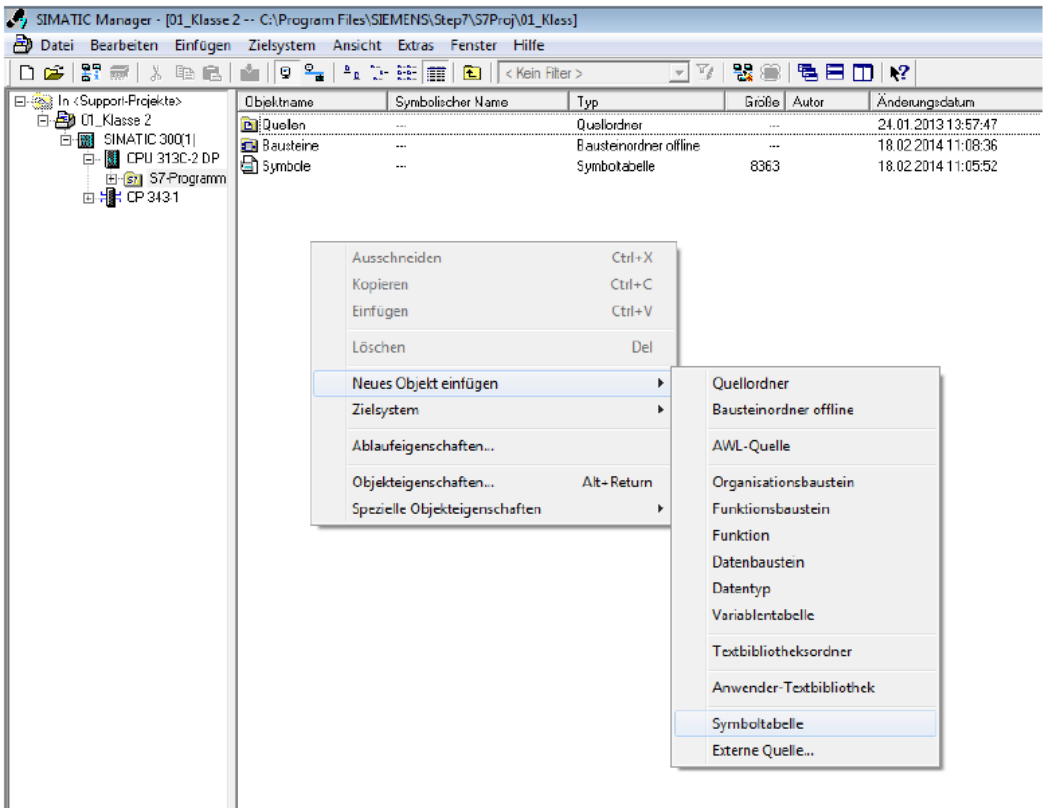


Figure 5.8: Opening the symbol table - STEP 7

Enter your own symbol name under "Symbol".

Enter your specified I/O address range under "Address". Make sure that you select the word sizes according to the sizes of the words to be addressed (e.g. 32-bit position value see PROFIBUS manual or **Fehler! Verweisquelle konnte nicht gefunden werden.**). See example in Figure 5.9.

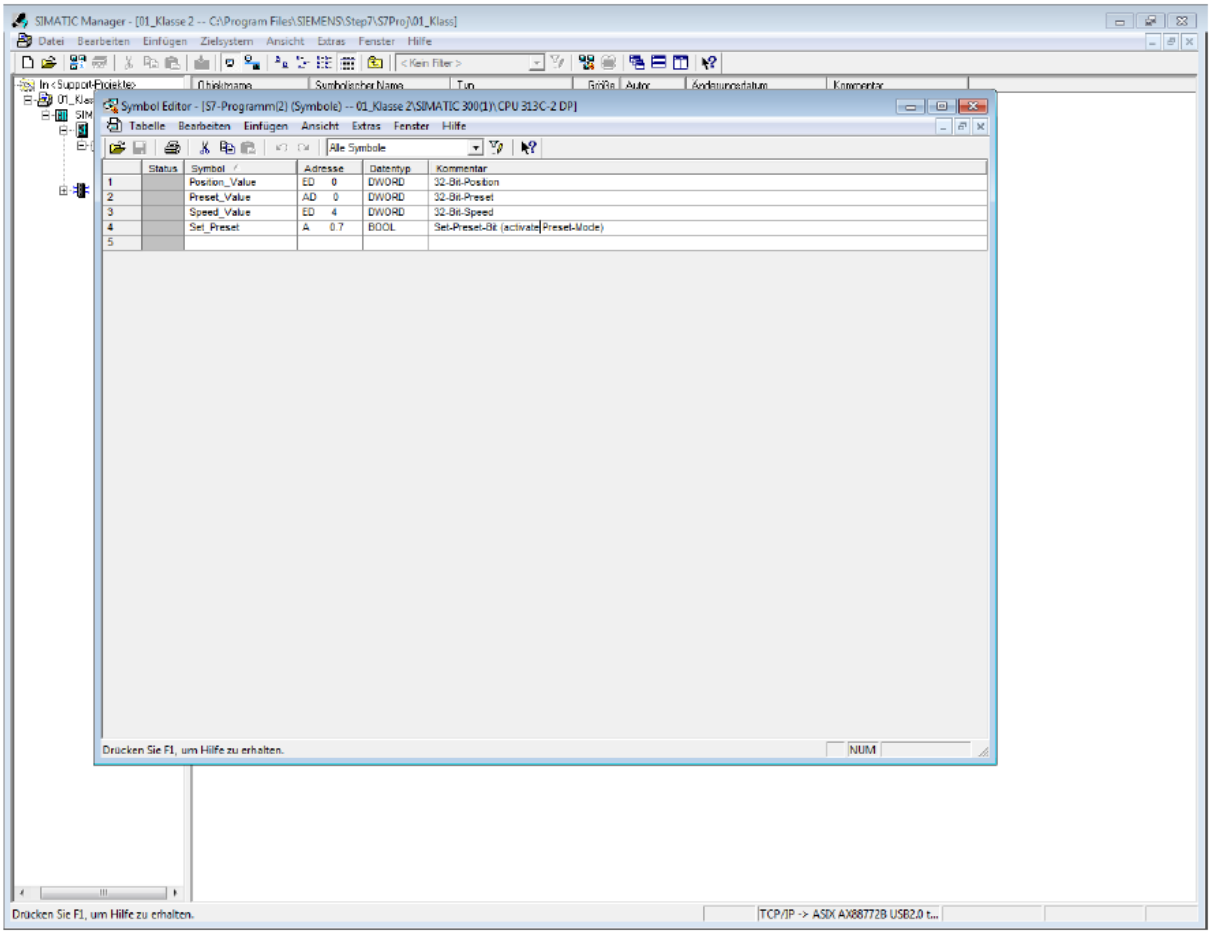


Figure 5.9: Create symbol table - STEP 7

5.5 Position & Speed

- Details on the position value class 4: see section 6.4.4 or 6.4.6.

Observe position and speed:

Open the variable table (as shown in Figure 5.10).

Enter your symbol names under "Symbol".

Select the desired "display format".

At "Status value" the current values appear (e.g. position and speed), which you can observe with the "glasses icon".

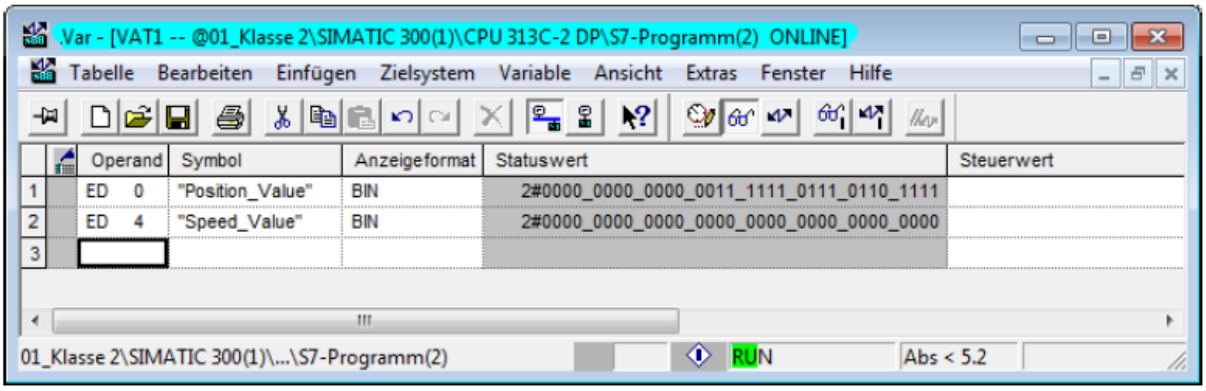


Figure 5.10: Variable table - STEP 7

Load position and velocity into a control program:

Open your control program ("LAD/SAWL/FUP" window).

Load with "L" the position/speed with the symbol name assigned by you and transfer it with "T" into a marker selected by you.

See the example in the Figure 5.11.

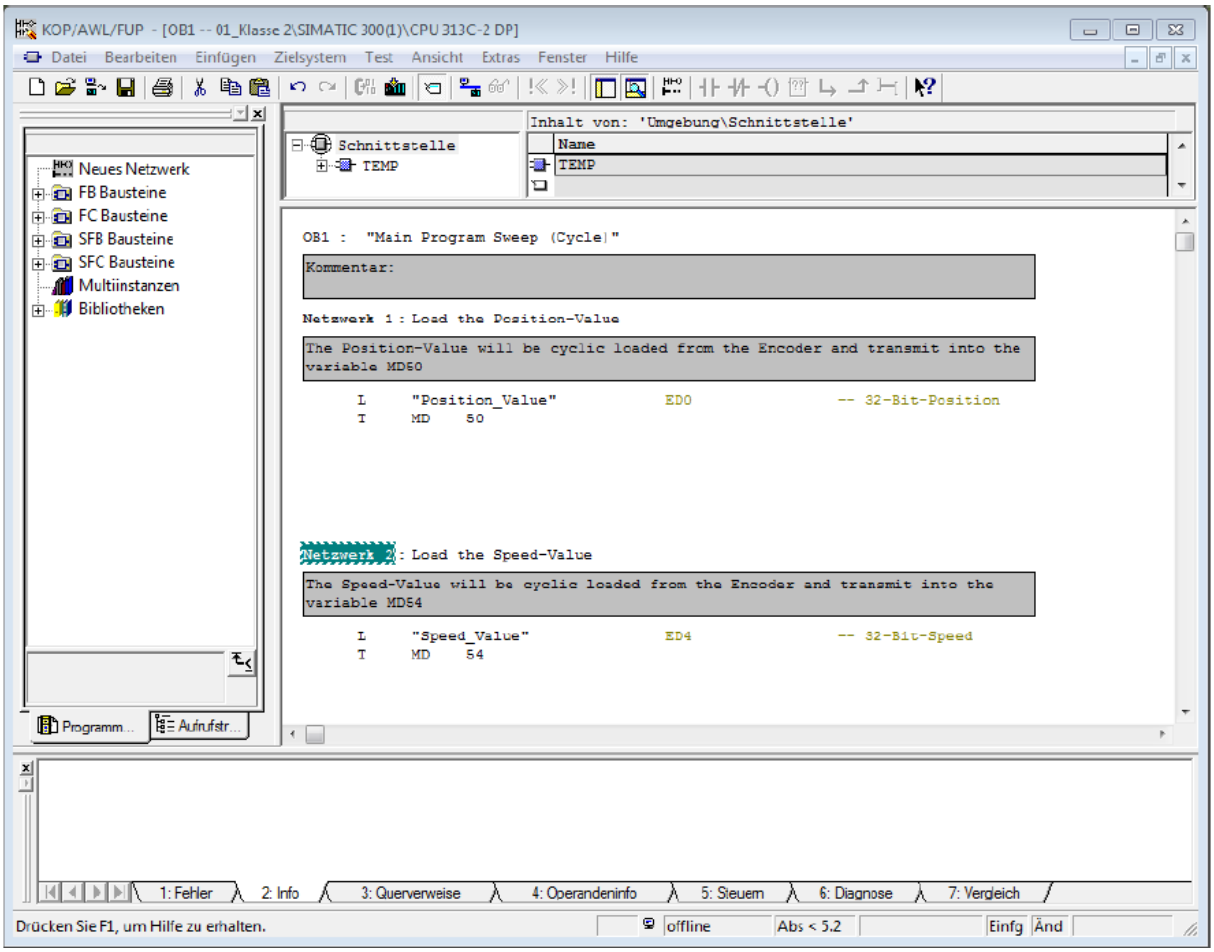


Figure 5.11: Loading values into a control program - STEP 7

5.6 Set preset value - Class 4

To set a preset, you first need the S7 example. The preset routine is performed within the FC2. Several steps are required to set the preset value:

Step one:

Open the variable table "VAT_Control" (see Figure 5.12).

Set the control value of "STW2_ENC" to the hex value 0400 ("STW2_ENC" - bit 10). The encoder is now in "Control by PLC" mode (see Table 6.9 or section 6.4.9.1).

Use the "control variable" button to control the value.

- Valid value range for the preset: TMR-1.
- The value of G1_XIST1 and G1_XIST2 must be identical, otherwise there is an error (see section 5.7).

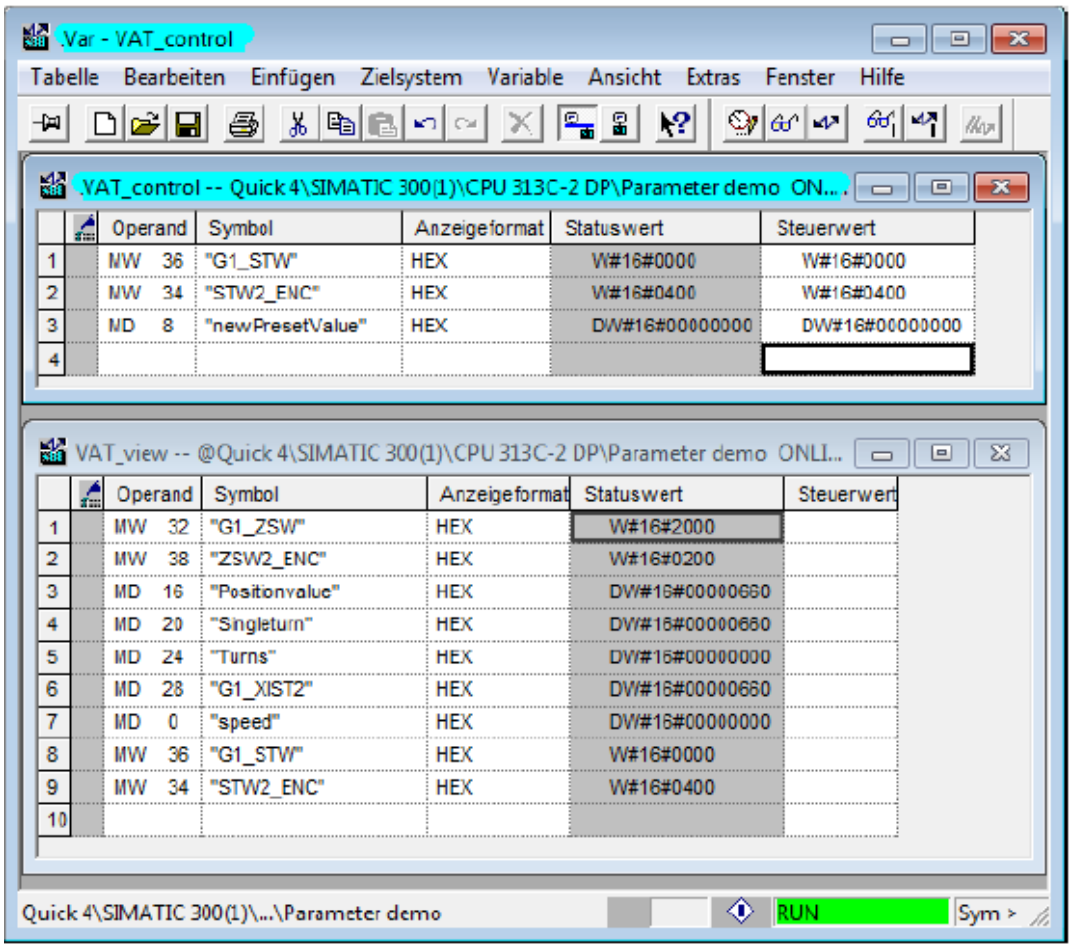


Figure 5.12: Variable table "VAT_Control" - "STW2_ENC" = 400

Step two:

Enter the desired preset value for the control value with the symbol name "newPresetValue" (Figure 5.13).

- Use the "control variable" button to control the value.

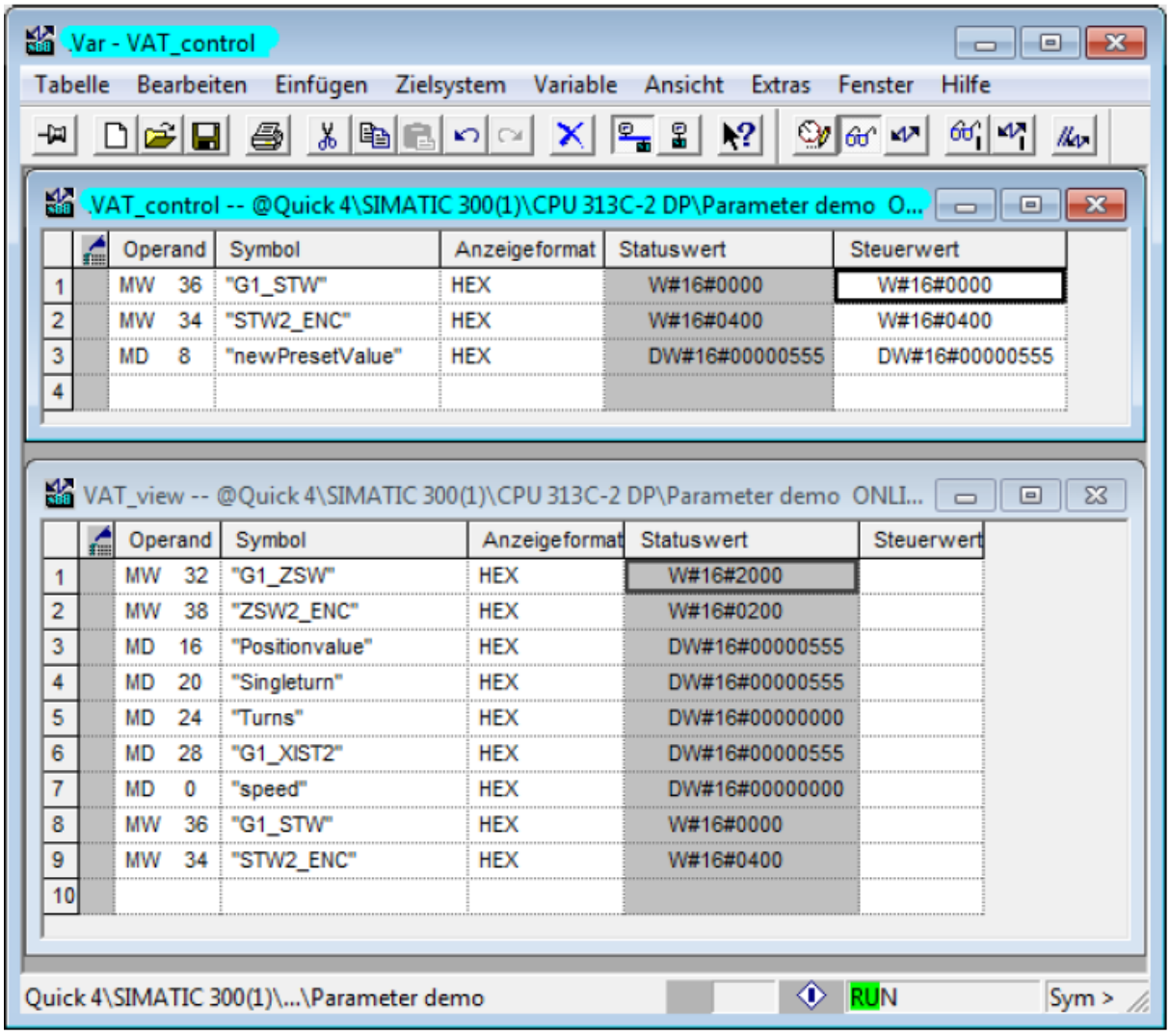


Figure 5.13: Table of variables "VAT_Control" - "newPresetValue"

- With the "Observe" button you can observe the changing status values.

Step three:

Set the control value of "G1_STW" to the hex value: 1000 (see Figure 5.14).

Meaning of hex value: 1000 (set bit 12 to "1") see Table 6.7.

Use the "control variable" button to control the value.

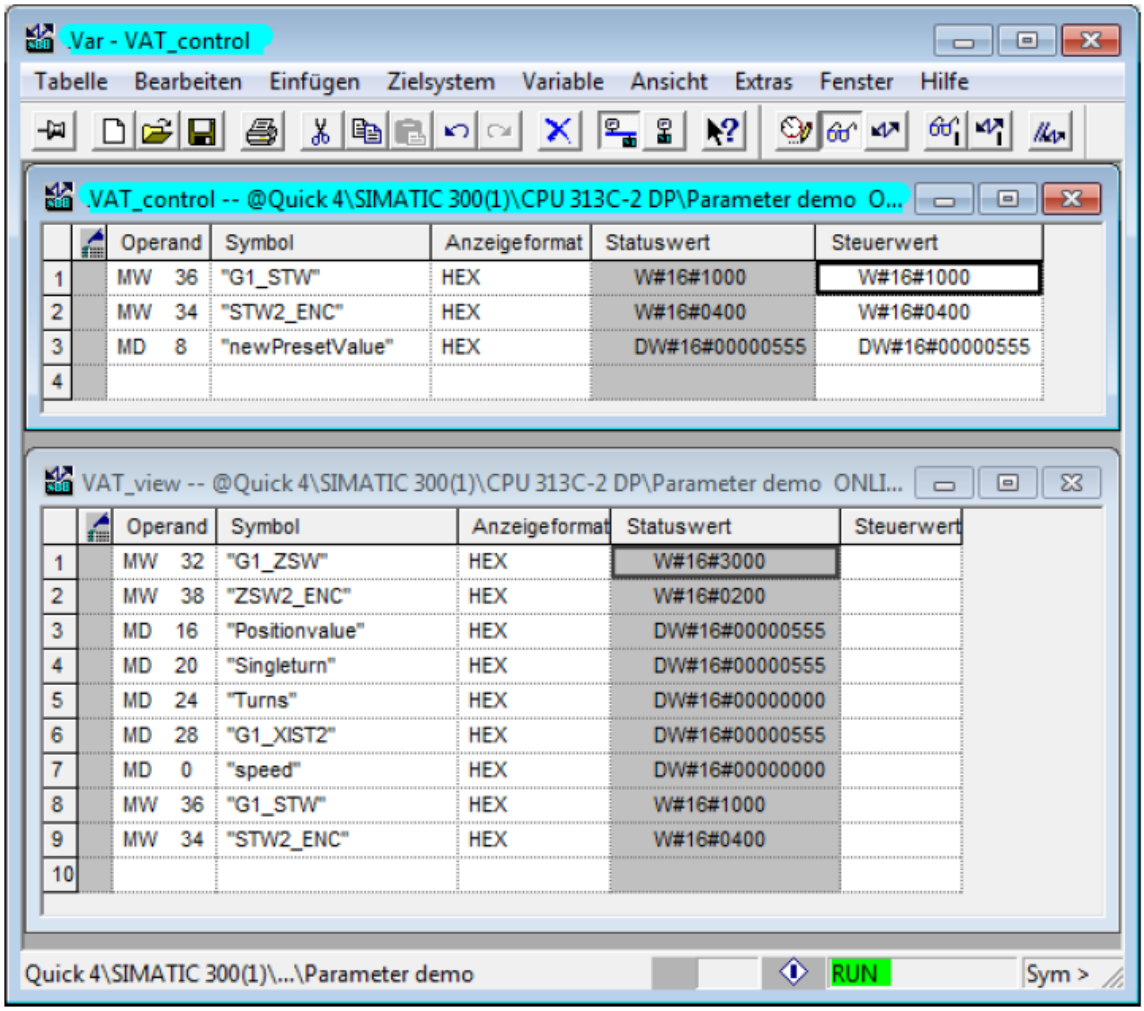


Figure 5.14: Variable table "VAT_Control" - "G1_STW" = 1000

Step four:

Step 3 changes the status value in the variable table "VAT_View" (see Figure 5.14) from hex value: 2000 to hex value: 3000.

Meaning of hex value: 3000 (bits 12 and 13 set to "1") see Table 6.8.

Step five:

Set the control value of "G1_STW" to the hex value: 0000 (see Figure 5.13).

This changes the status value in the variable table "VAT_View" (see Figure 5.13) from hex value: 3000 back to hex value: 2000 (bit 13 set to "1").

5.7 Error management

- If the value of G1_XIST1 is not equal to the value of G1_XIST2, an error has occurred.
- The status value in the variable table "VAT_View" (see Figure 5.15) changes from hex value: 2000 to hex value: 9000 (bits 15 and 12 set to "1"). Meaning see Table 6.8.
- For further details see section 6.4.5.1.
- Note the valid value range of: TMR-1.

If there is an error (see Figure 5.15), it must be acknowledged.

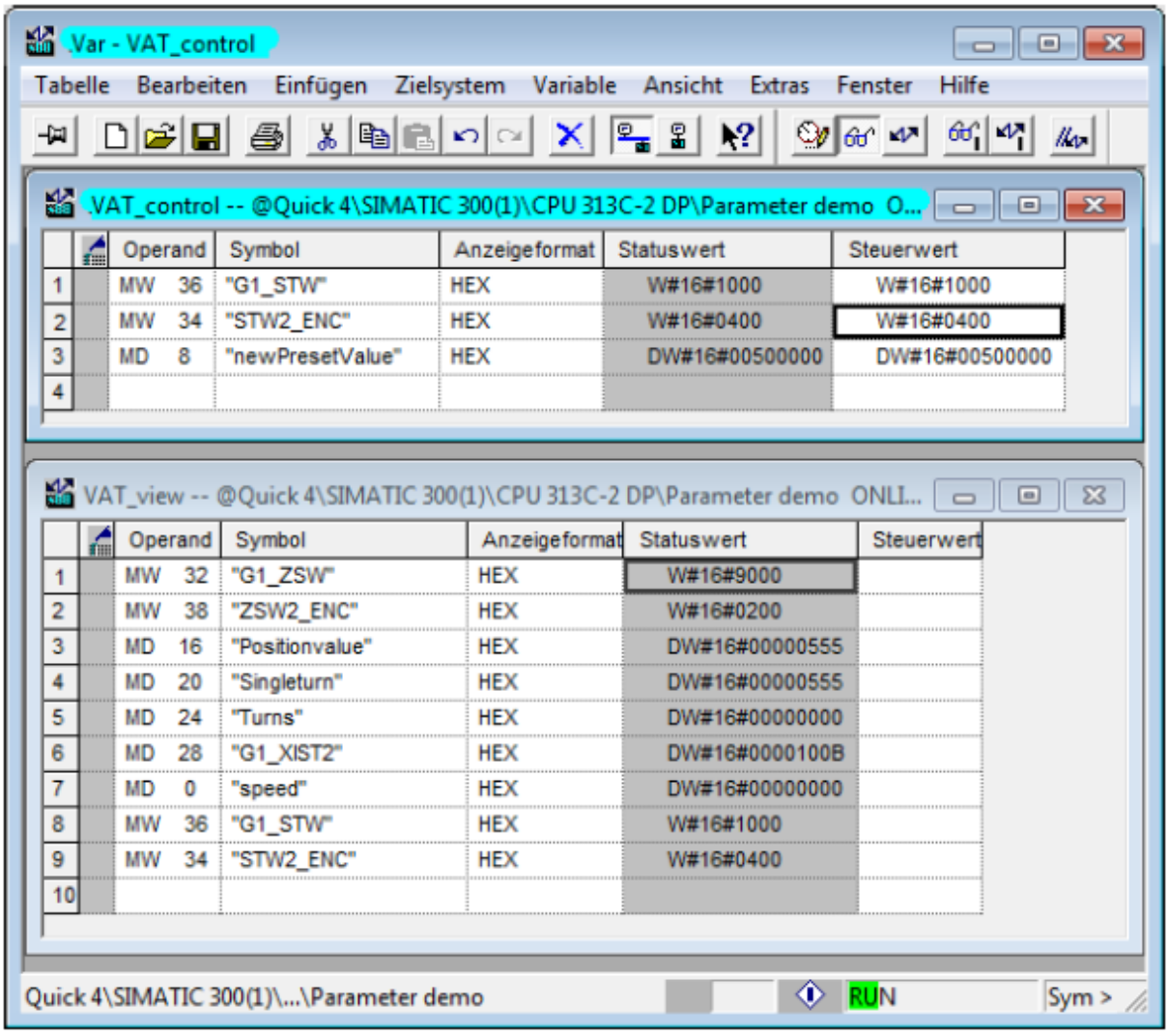


Figure 5.15: Variable table "VAT_View" - Error code in G1_XIST2

Set the control value of "G1_STW" to the hex value: 8000 (see Figure 5.16). Repeat this procedure until all errors have been confirmed.

Meaning of hex value: 8000 (set bit 15 to "1") see Table 6.7.

Finally, set the control value of "G1_STW" back to the hex value: 0000.

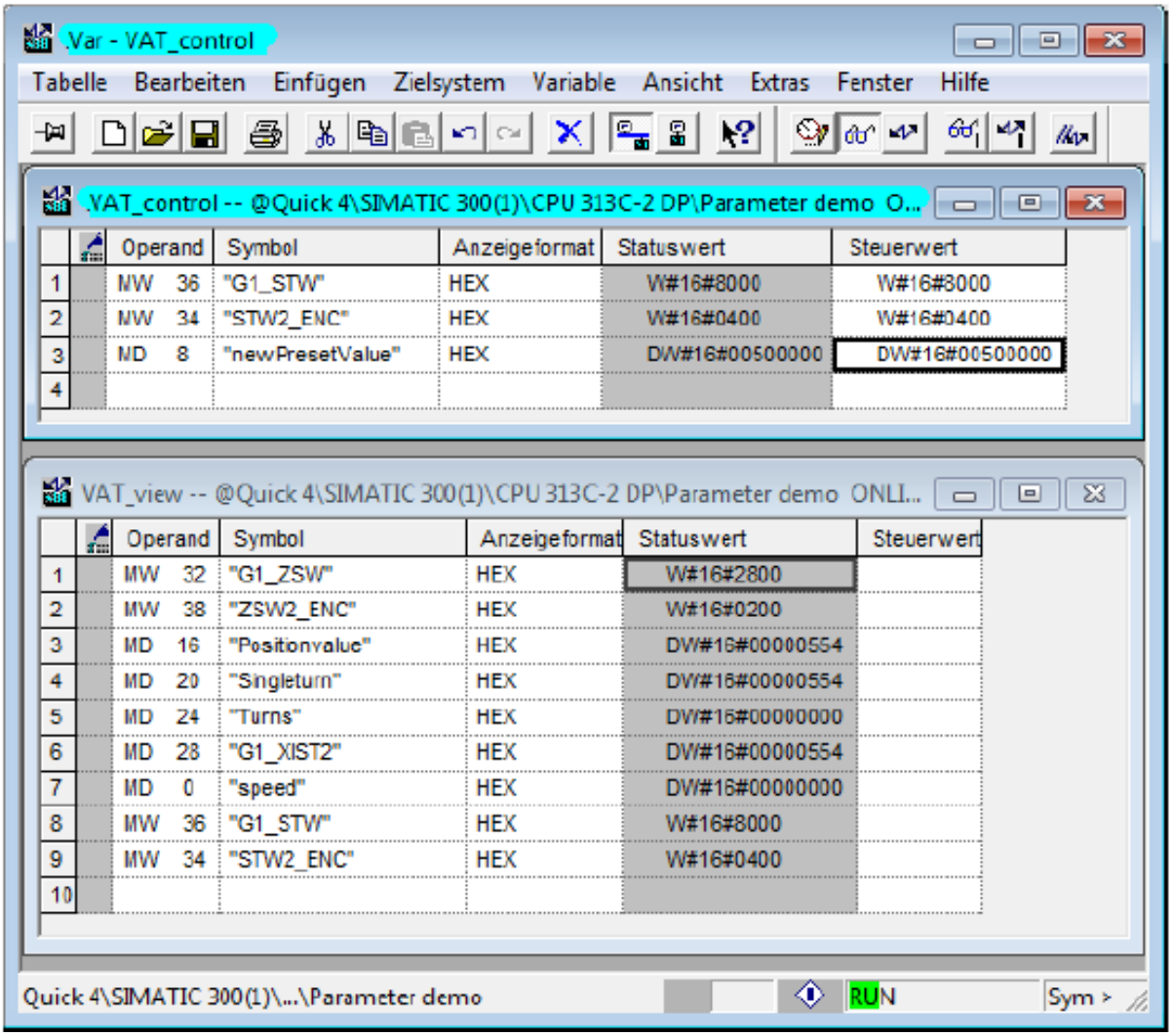


Figure 5.16: Variable table "VAT_View" - error in G1_XIST2 acknowledged

- In the variable table VAT_View, "Positonvalue" (G1_XIST1) and "G1_XIST2" are the same again. The errors were acknowledged.
- This changes the status value in the variable table "VAT_View" (see Figure 5.13) from hex value: 9000 to hex value: 2800 (bits 13 and 11 set to "1").
  Meaning see Table 6.8

5.8 Reading the diagnosis

As a rule, the DP master retrieves the diagnosis automatically without any programming being necessary. However, the processing and logging of errors must be done in the control program. If this is not done, the controller may automatically switch to a safe state.

- It is not recommended to simply discard the diagnostic data to avoid stopping the control. If necessary, measures must be taken to ensure the safe operation of a system.
- Ensure that your diagnostic evaluation is carried out so that the validity of the values is guaranteed.

- Set diagnostic address see section 5.3.4.
- Further details on diagnostics within the control program can be found in the example programs (see section 5.9).
- Further information:
  - General diagnostics: see section 7.10
  - Diagnosis class 4: see section 6.5

5.9 S7 sample program

- S7 sample programs can be downloaded from our website: www.wachendorff-automation.com

6 Encoders - Class 4

6.1 General information

Encoder profile 4.1 describes encoder classes 3 and 4. Like class 1, class 3 contains only the basic functionality required for an encoder. Class 4 functions are optional in a Class 3 device, whereas a Class 4 encoder must support all Class 4 functions.

The encoder profile 4.1 is based on the drive profile PROFIdrive 4.1. The relevant encoder functions from PROFIdrive were incorporated into the encoder profile almost unchanged, so that extensive compatibility was achieved. Since PROFIdrive was designed for compatibility with PROFINET, porting the control software from PROFIBUS-DP to PROFINET is made easier.

- The encoder profile 4.1 uses DP-V0 as well as DP-V1 and DPV2 functions.

6.2 Configuration

The corresponding configuration data for a class 4 encoder can be found in Table 6.1.

designation	telegram	significance
Telegram 81	81	Input data (6 words): Slave sign of life, preset + sensor parking, 32-bit position, 32-bit position or error code Output data (2 words): Master sign of life, preset + sensor parking
Telegram 82	82	Input data (7 words): 81 + 16-bit speed Output data (2 words): Master sign of life, preset + sensor parking
Telegram 83	83	Input data (8 words): 81 + 32-bit speed Output data (2 words): Master sign of life, preset + sensor parking
Telegram 84	84	Input data (10 words): Slave sign of life, preset + sensor parking, 64-bit position, 32-bit position or error code, 32-bit speed Output data (2 words): Master sign of life, preset + sensor parking
Telegram 59000 (81 with debug)	59000	Input data (7 words): 81 + Debug Output data (3 words): Master Life Sign, Preset + Sensor parking Debug

Table 6.1: Configuration data

- WDGA encoders support all 5 configurations

6.2.1 Telegram structures

The telegram structures that can be used for the configuration of the class 4 encoder are shown in Table 6.2.

- For the meaning of the control and status words see section 6.4.
- The configuration telegrams are reflected in the "HW Config" window of STEP7 (see section 5.3).

Nr.	Dir.	Datenwort									
		1	2	3	4	5	6	7	8	9	10
81	SPS -> ENC	STW2_ ENC	G1_ STW								
	ENC -> SPS	ZSW2_ ENC	G1_ ZSW	G1_XIST1		G1_XIST2					
82	SPS -> ENC	STW2_ ENC	G1_ STW								
	ENC -> SPS	ZSW2_ ENC	G1_ ZSW	G1_XIST1		G1_XIST2		NIST_A			
83	SPS -> ENC	STW2_ ENC	G1_ STW								
	ENC -> SPS	ZSW2_ ENC	G1_ ZSW	G1_XIST1		G1_XIST2		NIST_B			
84	SPS -> ENC	STW2_ ENC	G1_ STW								
	ENC -> SPS	ZSW2_ ENC	G1_ ZSW	G1_XIST3				G1_XIST2		NIST_B	
860	SPS -> ENC	G1_XIST_ PRESET_A									
	ENC -> SPS	G1_XIST1		NIST_B							
59000	SPS -> ENC	STW2_ ENC	G1_ STW	DEBUG _STW							
	ENC -> SPS	ZSW2_ ENC	G1_ ZSW	G1_XIST1		G1_XIST2		DEBUG _ZSW			

Table 6.2: Telegram structure 81-84 and 59000

- Standard telegrams (81-84) from the PROFIdrive profile (see section 7.15.2).
- Device manufacturer specific telegram (59000). See PROFIdrive profile under section 7.15.2).
- The debug control word is additionally implemented here (see Section 7.16).

6.2.2 Signal list

The following Table 6.5 shows an overview of the control and status words. Refer to the following sections under 6.4 details.

abbreviation	significance	data	Length [bit]
G1_STW	control word Sensor 1 control word	initial data	16
STW2_ENC	master vital signs Encoder Control word 2	initial data	16
G1_ZSW	status word Sensor 1 status word	input data	16
G1_XIST1	32-bit position value Sensor 1 position actual value 1	input data	32
G1_XIST2	32-bit position value or error code Sensor 1 position actual value 2	input data	32
G1_XIST3	64-bit position value Sensor 1 position actual value 3	input data	64
NIST_A	16-bit speed Speed actual Value A	input data	16
NIST_B	32-bit speed Speed actual Value B	input data	32
ZWS2_ENC	slave life signs Encoder Status word 2	input data	16

Table 6.3: Signal List - Overview

6.3 Parameterisation

Since the order of the parameter blocks can be selected arbitrarily, the octet number also depends on the order. To determine the actual octet number of a parameter, add the corresponding offset. For example 11, if this block directly follows the DP-V1 parameters. The individual parameters are explained below.

Table 6.6 and Table 6.7 show the parameter block for the encoder parameters.

parameter	data type	octet	range of values
block length	Unsigned 8	1	21 or 41
block type	Unsigned 8	2	always 129
slot	Unsigned 8	3	always 2
Reserved		4	always 0
Class 4 functionality	bit	5 / bit 1	Enabled disabled
G1_XIST1 Preset control	bit	5 / bit 2	Enabled disabled
Scaling function control	bit	5 / bit 3	Enabled disabled
Alarm channel control	bit	5 / bit 4	Enabled disabled
Compatibility mode	bit	5 / bit 5	Enabled disabled

Table 6.4: Parameter block for encoder parameters - Part 1

parameter	data type	octet	range of values
Reserved		5 / bit 5	0
Measuring units per revolution	Unsigned 32	6 – 9	2 ... 214 for rotary encoders with 14 bit physical resolution
Total measuring range	Unsigned 32	10 – 13	Multiturn: 2 ... 232 - 1 Singleturn: always the same MUPR
Maximum Master Sign-Of-Life failures	Unsigned 8	14	1 … 255
Speed measuring unit	Unsigned 8	15	Steps / s Steps/100 ms Steps/10 ms RPM
Reserved		16 – 21	always 0
Measuring units per revolution 64Bit (upper half)	Unsigned 32	22 – 25	Always 0 (for encoders with a physical resolution of less than 32 bits)
Measuring units per revolution 64Bit (lower half)	Unsigned 32	26 – 29	Always the same MUPR (for encoders with a physical resolution of less than 32 bits)
Total measuring range 64Bit (upper half)	Unsigned 32	30 – 33	Multiturn: 2 ... 232 - 1 Singleturn: always 0
Total measuring range 64Bit (lower half)	Unsigned 32	34 – 37	Multiturn: 2 ... 232 - 1 Singleturn: always the same MUPR
Reserved		38 – 41	always 0

Table 6.5: Parameter block for encoder parameters - Part 2

6.3.1 Code sequence

The direction of rotation of the encoder shaft (facing the shaft), where the position value increases, can be set clockwise (CW) or counter clockwise (CCW).

- The class 4 functions must be switched on, otherwise this parameter has no function. Thus the positive direction of rotation would always be clockwise.
- The positive direction of rotation always applies when looking at the encoder shaft.

6.3.2 Class 4 functionality

Class 4 functions can be turned on or off. If class 4 functions are disabled, no preset can be performed. The positive counting direction is clockwise and the scaling corresponds to the standard setting according to the encoder designation.

6.3.3 G1_XIST1 preset control

If the class 4 functions are active, the preset affects the position values in G1_XIST2 and G1_XIST3. The effect on the position value in G1_XIST1 can be switched on or off separately by this parameter.

6.3.4 Scaling function control

If the class 4 functions are switched on, the scaling function can be switched on and off. If class 4 functions are deactivated, the scaling always remains inactive. When scaling is deactivated, the standard scaling according to the encoder designation applies.

6.3.5 Alarm channel control

This parameter only has a function in Compatibility mode. If the "Alarm channel control" is deactivated, only the 6 byte long standard diagnosis is output via the diagnosis in order to reduce the bus load. Without compatibility mode, the full diagnosis is always output.

6.3.6 Compatibility mode

The compatibility mode can be switched on or off, which ensures compatibility with the older encoder profile version 3.1. The corresponding functionalities can be found in Table 6.6.

Function	Compatibility	Compatibility from
Control by PLC (STW2_ENC bit 10)	Ignored	The control words are only evaluated if the bit is 1.
Control requested (ZWS2_ENC bit 9)	Always 0	Always 1
Maximum Master Sign-Of-Life failures	The value can be changed in the parameterization.	value can only be changed in P925
Alarm channel control	Can be deactivated	Always active
P965 - Profile version	3.1	4.1

Table 6.6: Compatibility mode

6.3.7 Measuring units per revolution

"Measuring units per revolution" determines the number of increments per revolution of the encoder shaft. If the total measuring range has been set large enough, the rotary encoder displays a position value increased by this value after 360. See also section 3.2.5.

The value must be greater than or equal to 2 and can be no greater than the physical ST resolution of the encoder or 2^{32} - 1.

If the value for TMR_{max} is to be set greater than 2^{32} - 1, the parameter "64bit-MUPR" must be used. For this the telegram 84 with the 64-bit position value must be selected (see Table 6.1).

Since 64-bit values do not have to be supported by the project engineering tools, the parameter in the GSD file was divided into two parts. The upper half part is calculated from the integer division of the actually desired value by 2^{32}. The lower half part is the remainder of the integer division. The parameterization is rejected if the 64-bit value and the 32-bit value are not equal to zero and different, or if both values are equal to zero.

- The maximum physical value for the ST resolution of the encoder is 14 bits.
- See the example for the desired resolution in section **Fehler! Verweisquelle konnte nicht gefunden werden.**.

6.3.8 Total measuring range

The parameter "Total measuring range" determines the total measuring range of the encoder. If the position value exceeds the total measuring range, counting starts again from zero. See also section 3.2.5.

The value must be greater than or equal to 2 and can be a maximum of 2^{32} - 1.

If the value for TMR_{max} is to be set greater than 2^{32} - 1, the parameter "64Bit-TMR" must be used. For this the telegram 84 with the 64-bit position value must be selected (see Table 6.1).

Since 64-bit values do not have to be supported by the project engineering tools, the parameter in the GSD file was divided into two parts. The upper half part is calculated from the integer division of the actually desired value by 2^{32}. The lower half part is the remainder of the integer division. The parameterization is rejected if the 64-bit value and the 32-bit value are not equal to zero and different, or if both values are equal to zero.

The default settings for the "Measuring units per revolution (MUPR)" and "Total measuring range in measuring units (TMR)" are customer-specific (resolution according to the order key; ST: 1 . . 14 bits; MT: 1 . . 39 bit).

- For singleturn encoders, the total measuring range must be equal to the number of increments per revolution.
- Scalable ST resolution ≤ physical ST resolution
- The maximum physical value for the ST resolution of the encoder is 14 bits.
- Scalable MT resolution ≤ physical MT resolution
- The maximum physical value for the MT resolution of the encoder is 39 bits.
- Class 4: $TMR_{max} = 2^{32} - 1$ or $2^{64} - 1$ for 64-bit parameterization (for MT: 39-bit resolution)

Default settings: MUPR = ST / TMR = ST x MT

- See the example for the desired resolution in section **Fehler! Verweisquelle konnte nicht gefunden werden.**.

6.3.9 Maximum Master Sign-Of-Life failures

The parameter "Maximum Master Sign-Of-Life failures" only works in compatibility mode. If the compatibility mode is inactive, P925 can be used instead. The parameter is used to set the upper limit of the isochronous mode error counter to 10 times this value. See section 7.14.

6.3.10 Speed measuring unit

By means of the parameter "Speed measuring unit" the unit of the speed value can be defined in NIST_A or NIST_B. The settings "Steps/xx" (xx = s, 10ms or 100ms) cause the speed value to indicate the number of increments in the corresponding time interval. "RPM" causes the speed value to indicate the number of revolutions per minute.

- With the settings "Steps/s", "Steps/10ms", "Steps/100ms" the scaling of the speed value depends on the scaling of the position value.

6.4 Exchange of data

6.4.1 Telegram structure

The telegram structure is different depending on the configuration. See section 6.2.

6.4.2 G1_STW

The output data G1_STW are transmitted cyclically from the controller to the WDGA encoder. The structure of G1_STW is shown in Table 6.7.

output data															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Ack sensor error	Activate parking	Req abs value	Req preset	Relative preset mode	0	0	0	0	0	0	0	0	0	0	0

Table 6.7: G1_STW - Output data

Bit "Ack sensor error":

Acknowledging a sensor error - If bit "1", the error code is acknowledged by G1_XIST2.

Bit "Activate parking":

Activate parking sensor - If the bit is "1", the "Parking sensor" function is activated (suppression of error output).

Bit "Req abs value":

Request absolute value cyclically - If the bit is "1", the position is output in G1_XIST2.

Bit "Req preset":

Request Preset - By setting the bit to "1", the preset process is carried out. If "Preset executed" is set, "Req preset" is to be deleted again.

Bit "Relative preset mode":

Relative preset mode - If the bit is "1", the preset is executed relatively. This adds the "Preset value" as "Offset value" to the current "Position value".

If the bit is "0", the preset is executed absolutely. The "Position value" is set to the "Preset value".

6.4.2.1 "Activate parking" - Park sensor

With the help of "Activate parking" of the control word (G1_STW - Bit 14) the DP master can park the sensor. In this state, "Parking active" of the status word (G1_ZSW - Bit 14) is set. The position value is always invalid and the error handling of the encoder is deactivated.

This function is used to replace the sensor during operation without interrupting the fieldbus or causing errors.

- This function is intended for DP slaves that encapsulate the fieldbus logic in the bus cover so that the sensor can be separated from the bus cover without impairing bus communication.
- With WDGA encoders, the fieldbus logic is located in the sensor housing.
- If the bus cover is removed, the encoder no longer responds to requests and the active termination no longer works. However, the data lines A and B remain intact.

6.4.2.2 "Relative preset mode" - Preset absolute/relative

After a reference run to a reference point, the DP master can set the scaled position value of the encoder to a specific value. The preset function should only be executed at standstill to ensure that the reference position matches the physical reference as closely as possible. In addition to the classic absolute preset function, the Encoder Profile 4.1 also contains a relative preset function that understands the preset value as a signed number and adds it to the position value.

The mode of the preset function is determined with "Relative preset mode" of the control word (G1_STW - Bit 11). To trigger the function, the DP master sets "Req preset" (G1_STW - Bit 12). As soon as the rotary encoder sets "Preset executed" of the status word (G1_ZSW -Bit 12), the DP master can delete "Req preset" of the control word (G1_STW - Bit 12) again.

The encoder then deletes G1_STW - bit 12, which terminates the function. See Figure 6.1.

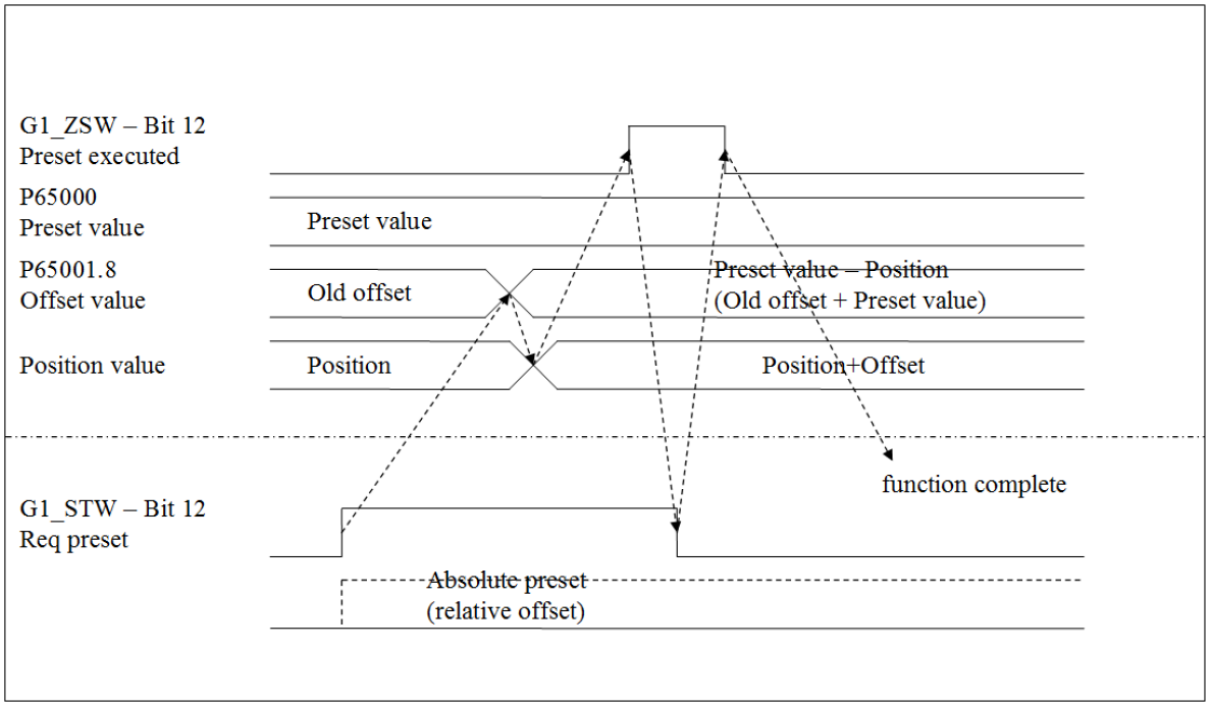


Figure 6.1: Preset function mode - "Relative preset mode

The preset and offset values can be accessed with the acyclic parameters P65000 and P65001.8.

The offset value cannot be written directly, since it is always calculated from the preset value and the current position.

The 64-bit variants can be found under P65002 and P65003.1.

The 64-bit variant always has the same value as the 32-bit parameter, but has an extended value range.

6.4.3 G1_ZSW

The input data G1_ZSW are transmitted cyclically from the WDGA encoder to the controller. The structure of G1_ZSW is shown in Table 6.8.

input data															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Sensor error	Parking active	Transm abs value	Preset executed	Error ack-req detected	0	0	0	0	0	0	0	0	0	0	0

Table 6.8: G1_ZSW - Input data

Bit "Sensor error":

Sensor error - If the bit is "1", G1_XIST2 contains an error code instead of the position value.

Bit "Parking active":

Parking sensor active - If bit "1", the "Parking sensor" function is active.

Bit "Transm abs value":

Transmit absolute value cyclically - If the bit is "1", the position value is output in G1_XIST2.

Bit "Preset executed":

Preset executed - If the bit is "1", the preset process has taken place in the rotary encoder. This bit inverts the "Req preset" of G1_STW and is then automatically reset.

Bit "Error ack-req detected":

Requirement of error acknowledgement detected - If the bit is "1", an error must be acknowledged.

6.4.4 G1_XIST1

- This value displays the position value as a 32-bit value.

The parameter "G1_XIST1 Preset Control" (see section 6.3.3) can be used to prevent the preset function from affecting G1_XIST1.

6.4.5 G1_XIST2

- G1_XIST2 has a dual function and displays either the 32-bit position value or an error code depending on "Transm abs value" (G1_ZSW - Bit 13) and "Sensor error" (G1_ZSW - Bit 15).

For acknowledgement of errors, see section 6.4.3. For a TMR greater than 32 bits and without error situation, this value and "Transm abs value" (G1_ZSW - Bit 13) are 0. The preset function always affects the position value in G1_XIST2.

6.4.5.1 G1_XIST2 - Error management

"Request absolute value" (G1_STW - Bit 13) is used to request the additional transmission of the position value in G1_XIST2. This bit is ignored because the encoder outputs the position permanently via this word, except in the event of an error.

An existing error is indicated by "Sensor error" (G1_ZSW - Bit 15). "Acknowledge sensor error" (G1_STW - Bit 15) is used to acknowledge the error currently displayed in G1_XIST2. In response to the request, the encoder sets "Error acknowledge request detected" (G1_ZSW - Bit 11). The DP master can now delete the request in "Acknowledge sensor error" (G1_STW - Bit 15) again.

The function is completed when the encoder deletes "Error acknowledge request detected" (G1_ZSW - Bit 11). In the error-free case, the encoder also clears "Sensor error" (G1_ZSW - bit 15), sets "Transmit absolute value" (G1_ZSW - bit 13) and displays the position value again in G1_XIST2. See Figure 6.2.

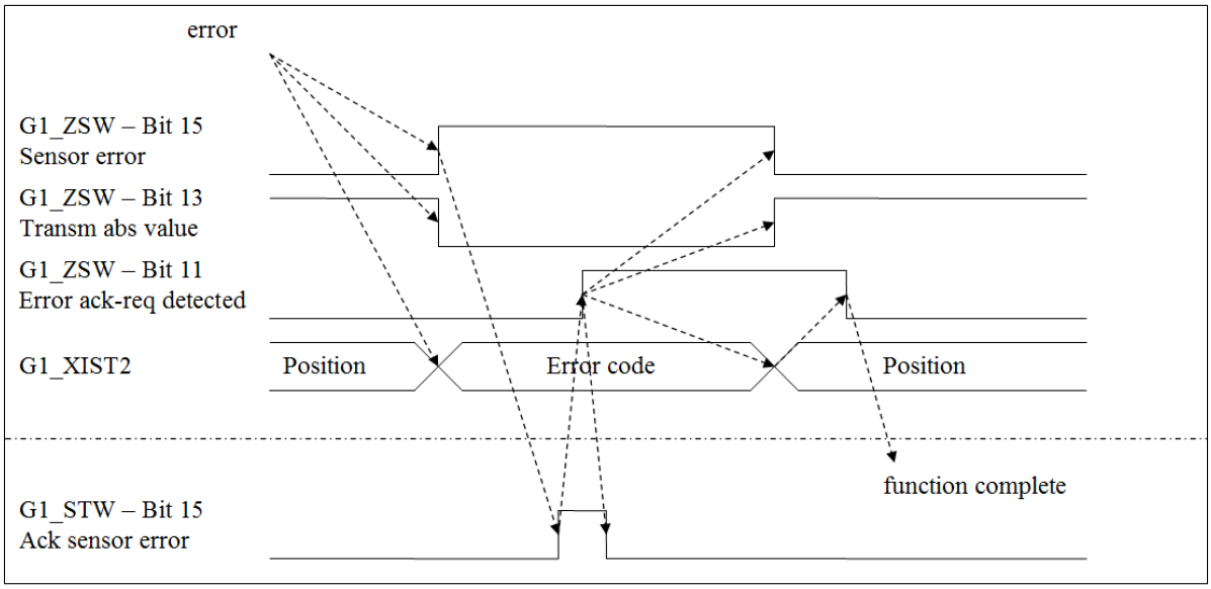


Figure 6.2: State diagram G1-XIST2 error control - error-free case

If the error persists, nothing changes. If there are other errors, only the error code changes (see Figure 6.3).

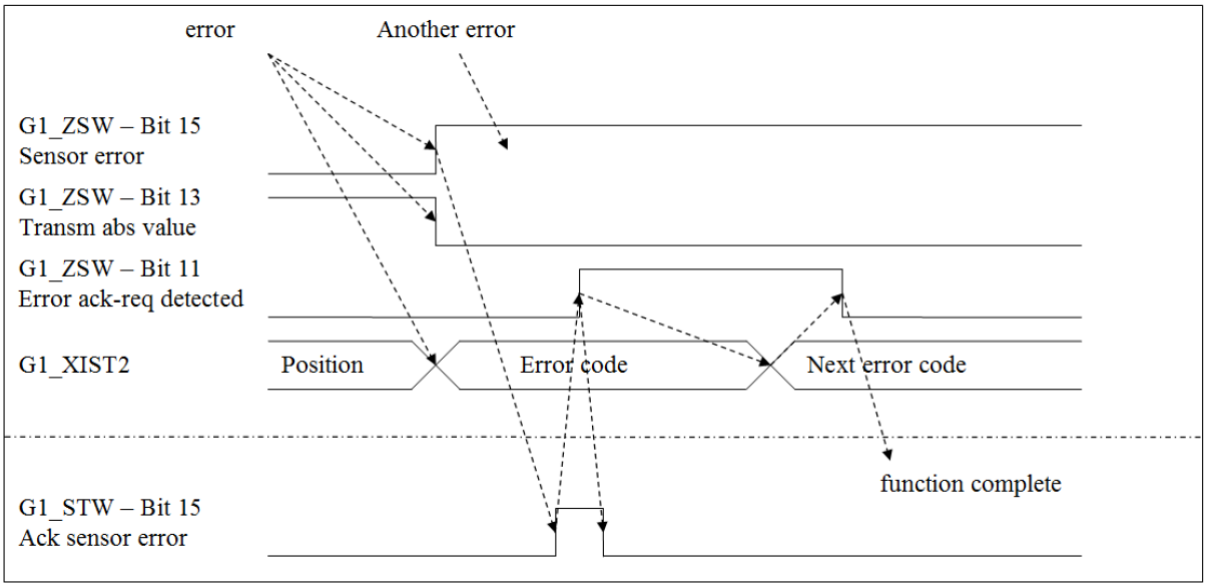


Figure 6.3: State diagram G1_XIST2 error control - error case

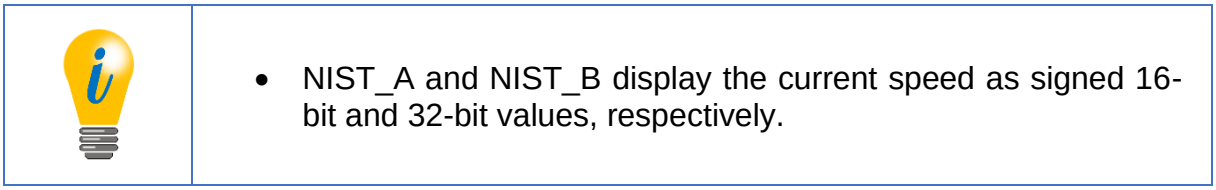
- An absolute position value in G1_XIST2 is indicated by "Transmit absolute value" (G1_ZSW - Bit 13).
- An error code in G1_XIST2 is indicated by "Sensor error" (G1_ZSW - Bit 15).
- If "Sensor error" and "Transmit absolute value" are 0, G1_XIST2 contains no valid value.
- Sensor error" and "Transmit absolute value" are never set simultaneously.

6.4.6 G1_XIST3

- This value displays the position value as a 64-bit value.

The preset function always affects this value.

6.4.7 NIST_A & NIST_B



- NIST_A and NIST_B display the current speed as signed 16-bit and 32-bit values, respectively.

If the shaft rotates in the positive direction, the speed value is also positive. The speed unit can be set in the parameterization (see section 6.3.10).

6.4.8 Debug_STW & Debug_ZSW

See section 7.16.

6.4.9 STW2_ENC & ZSW2_ENC

In STW2_ENC (output data), bits 12-15 contain the "master sign of life" of the isochronous mode (see Table 6.9).

output data															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Master Vital signs				0	Control by PLC	0	0	0	0	0	0	0	0	0	0

Table 6.9: STW2_ENC

The "slave sign of life" (input data) for IsoM is located in bits 12-15 of ZSW2_ENC (see Table 6.10).

input data															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Slave sign of life				0	0	Control requested	0	0	0	0	0	0	0	0	0

Table 6.10: ZSW2_ENC

- See sections 7.14 and 6.9 further details.

6.4.9.1 Control by PLC/request - Control priority

An optional function for a class 4 encoder is to change the control priority to another channel. Normally the control priority of the DPM1 is via the channel of the cyclic data exchange. Via this channel, the DP master can specify via "Control by PLC" (STW2_ENC - Bit 10) whether its control words are valid and should therefore be evaluated. On the other hand, the DP slave indicates to the DP master via "Control requested" of the status word whether its control words are evaluated.

This function does not exist in compatibility mode, therefore "Control by PLC" of the control word (STW2_ENC - Bit 10) is ignored and "Control requested" of the status word (ZSW2_ENC - Bit 9) is always 0. The control words are therefore always evaluated.

- Changing the control priority to another channel is not supported by the WDGA encoder.

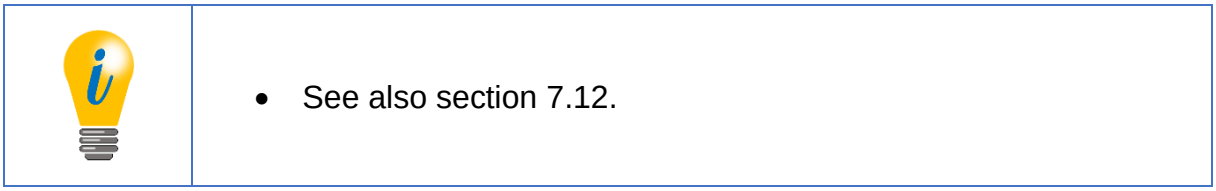
6.5 Diagnosis

Details to the diagnostic telegram can be found in Table 6.11.

data block	octet	Description of the
standard diagnosis	1 … 6	DP-V0 diagnosis.
Identifier related diagnosis	7 … 8	Identifier-related diagnosis, where only bit 1 is used.
Modules status	9 … 13	Module status, where only bits 2 and 3 are used.
Channel related diagnosis	14 … 16	Channel-related diagnosis, whereby the block can only be seen in the event of an incoming error. Error codes in octet 15: 5: Temperature too high 9: Error 16: Maximum speed exceeded 22: Position error 24: EEPROM error 25: Test error (see section 7.16)
Diagnosis alarm	17 … 21 (coming) 14 … 18 (walking)	diagnostic interrupt Error codes in octet 20 (17): 1: Singleturn communication disturbed 2: Multiturn communication disturbed 3: EEPROM communication disturbed 4: Internal singleturn error 5: Internal multiturn error 6: CRC error in EEPROM 7: Magnetic field strength too weak 8: Magnetic field strength too high 9: Test error (see section 7.16)

Table 6.11: Diagnostic telegram

6.6 I&M functions



- See also section 7.12.

6.6.1 I&M0

The I&M0 data block is the only one mandatory for all DP-V1 devices. It is the only one that cannot be changed by the user. The Table 6.12 shows the corresponding functions.

name	data type	octet	Description of the
Reserved	Octet string [10]	1 … 10	Always 0
MANUFACTURER_ID	Unsigned 16	11 … 12	For Wachendorff Automation: 0x027B
ORDER_ID	Visible string [20]	13 … 32	The order number of the device. Since the order number has more than 20 digits, "WDGA-MT-DP" or "WDGA-ST-DP" always stands for singleturn variants.
SERIAL_NUMBER	Visible string [16]	33 … 48	The serial number of the encoder in ASCII code.
HARDWARE_VERSION	Unsigned 16	49 … 50	The revision number of the encoder in ASCII code.
SOFTWARE_VERSION	1 Char, 3 Unsigned 8	51 … 54	The software version. 3 e.g: V1.0.0. The letter is supplied in ASCII code but the digits are not.
REVISION_COUNTER	Unsigned 16	55 … 56	This counter is incremented by one each time one of the writeable I&M data blocks is changed.
PROFILE_ID	Unsigned 16	57 … 58	For encoder profile 4.1: 0x3D00
PROFILE_SPECIFIC_TYPE	Unsigned 16	56 … 60	Multiturn: 1 Singleturn: 0
IM_VERSION	2 Unsigned 8	61 … 62	Always 1.1
IM_SUPPORTED	Unsigned 16 (bit array)	63 … 64	Each bit represents a supported I&M data block. For WDGA: 0x001A

Table 6.12: I&M0

6.6.2 I&M1

name	data type	octet	Description of the
Reserved	Octet string [10]	1 … 10	Always 0
TAG_FUNCTION	Visible string [32]	11 … 42	A description of the function or task of the device.
TAG_LOCATION	Visible string [22]	43 … 64	Describes where to find the device.

Table 6.13: I&M1

6.6.3 I&M2

Not supported due to a specification conflict between the Profile Guideline for I&M of the PNO and the ISO standard for Profibus that was not clarified at the time of development.

6.6.4 I&M3

name	data type	octet	Description of the
Reserved	Octet string [10]	1 … 10	Always 0
DESCRIPTOR	Visible string [54]	11 … 64	Customer-specific meaning.

Table 6.14: I&M3

6.6.5 I&M4

name	data type	octet	Description of the
Reserved	Octet string [10]	1 … 10	Always 0
SIGNATURE	Visible string [54]	11 … 64	Customer-specific meaning. Does not have to be ASCII coded. Unused bytes should be 0.

Table 6.15: I&M4

6.7 Acyclic parameter access

6.7.1 Basics

The acyclic parameter access of the encoder uses the "Base Mode Parameter Access - Global" function from the PROFIdrive specification and is equivalent to the function of drives or inverters with PROFIdrive. In PROFIBUS-DP, parameter access takes place via the MS1 or MS2 communication relationship, whereby the MS1 connection is optional.

As a rule, these parameters should not have to be changed by the parameterization master. Parameters are always divided into those with global or local validity.

The local parameters can only be addressed via slot 1, since they refer to the encoder module virtually plugged in there.

The global parameters refer to the complete device and can therefore also be accessed via slot 0 of the basic device.

Each parameter has a unique parameter number (PNU) and a data type. If the data type is an array, a subindex is used to address the individual fields in addition to the PNU. Here it is possible to read out several fields of the array with one query.

With character strings, the subindex is used to address the individual characters.

Thus long character strings can also be read out distributed over several queries.

For simple data types, the subindex is 0.

Multi-parameter access also allows multiple PNUs to be accessed with a single query. For this purpose, a corresponding number of parameter addresses and, in the case of a write access, the values must be transferred.

- In addition to its value, a parameter also has a structured description. However, this is not supported by the encoder.
- Since these parameters are not set automatically at every start-up, they will be lost if they are not permanently stored via P971 or P977.

Asynchronous parameter access is implemented using the DP-V1 functions DS_WRITE and DS_READ. The following Table 6.16 shows the coding.

significance DP-V1	significance BMPA-G	significance parameter	Size (Octets)	value	statement
Function_num			1	0x5F 0x5E	DS_WRITE DS_READ
Slot_num			1	0, 1	Encoder unit
index			1	0x2F	Process Data ASE
length			1	X	Length of data
data Max 238	ReqRef		1	X	Slave mirrors value sent from master
	ReqID		1	0x01 0x02 0x81 0x82	request change Neg req res Neg chg res
	EO		1	0 1	Global Global + Local
	Num Param		1	1 … 39	Number of parameters in multi parameter access
	1st Param Address	Attr	1	0x10 0x20 0x30	value description text
		Num Elem	1	0, 1 1 … 234	value Array + string
		PNU	2	1 … 65535	paramnumber
		subindex	2	0 … 65535	index of array
	Nth Param Address	…	(N – 1) … 6		
	1st Param Value	size	1	X	zero datatype error
		Num values	1	X	Number of values from array (equal to Num Elem)
		Mth value	X	X	
		1st value	(M – 1) · M		
	Nth Param Value	…			
				X	Arithmetic sum from DA to DU (only lowest byte)
				0x16	End delimiter

Table 6.16: Coding of asynchronous parameter requests

The data type of a parameter value is encoded in the octet "Format". The following Table 6.17 shows the possible values.

size	data type	Description of the
0x04	Integer 32	Signed 32-bit integer.
0x06	Unsigned 16	Unsigned 16-bit integer
0x07	Unsigned 32	Unsigned 32-bit integer
0x09	VisibleString	ASCII encoded characters in an array. Unused characters have the value 0x20, this corresponds to a blank character.
0x0A	OctetString	Array of bytes
0x37	Integer 64	Signed 64-bit integer
0x40	zero	The value has a size of 0 bytes and no meaning. Used to skip the error-free accesses in case of a negative response to a multi-parameter access, so that the error message can be assigned to the correct parameter.
0x44	error	The value returned is not the value of the parameter, but an error message.

Table 6.17: Coding - Format

The possible error messages that can be sent instead of the parameter value can be found in the Table 6.18.

code	name	significance
0x0000	InvalidParamNum	Invalid PNU: the requested PNU is not implemented.
0x0001	ReadOnly	An attempt has been made to write to a PNU that can only be read.
0x0002	ValueRangeExceeded	The written value is not within the valid value range.
0x0004	NoArray	A subindex greater than 1 was specified, although the parameter is not an array.
0x0005	IncorrectDatatype	The data type of the value to be written does not match the data type of parameter
0x0006	SetToZeroOnly	Only the value "0" may be written to the parameter.
0x0007	DescripionReadOnly	The parameter description can only be read
0x0009	DescriptionNotAvailable	The parameter description cannot be read.
0x000F	Text ArrayNotAvailable	The text description of the parameter cannot be read.
0x0011	WrongState	Parameter access cannot be carried out in the current state of the encoder. If, for example, a 64-bit preset value was set, it cannot be read out via the 32-bit parameter.
0x0015	ResponseTooLong	The answer does not fit into the remaining free space in the telegram.
0x0016	InvalidParamAddr	The parameter address in the request telegram is invalid. The Attr field must have the value 0x10.
0x0018	ValueNumbersInconsistent	The number of transferred values during write access must match the number of elements in the parameter address. If the parameter is not an array, the number of transmitted values must be 1.
0x0019	InvalidEO	Access to local parameters only possible via slot 1. The field EO in the request telegram must be one.

Table 6.18: Error codes

6.7.2 Read parameters

Figure 6.4 shows an example of reading the first two elements of PNU 980 (see Table 6.27). The printed octets highlighted are the user data of the DS_READ or DS_WRITE service.

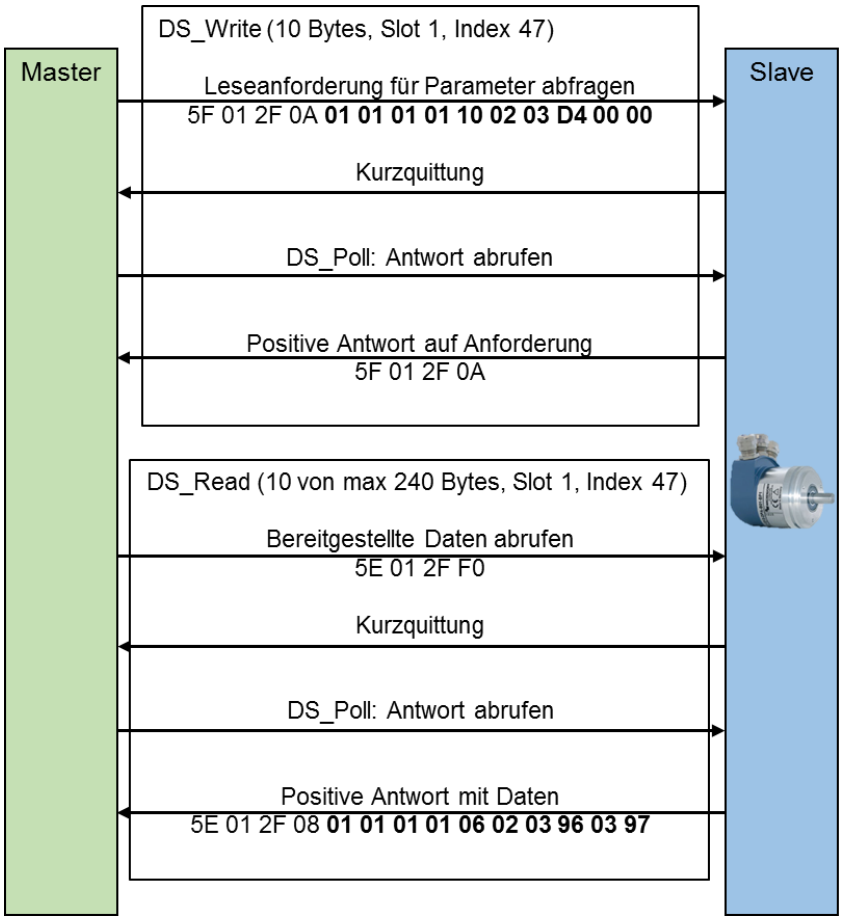


Figure 6.4: Reading parameters - PNU 980

Table 6.19 shows the read request of the DP master. The meaning of the highlighted printed octets from Figure 6.4 is described here.

significance BMPA-G	significance texture	Size	value	statement
ReqRef		1	1	No meaning. Master specifies any value
ReqID		1	0x01	read request
EO		1	1	Access to global and local data
Num Param		1	1	Read a parameter
Param Address	Attr	1	0x10	Read the value of the parameter
	Num Elem	1	2	Read two elements of the array
	PNU	2	03D4h = 980d	The parameter number
	subindex	1	0	The start index of the elements to be read out

Table 6.19: DS_Write - Master

Table 6.20 shows the response of the DP slave. The meaning of the highlighted printed octets from Figure 6.4 is described here.

significance BMPA-G	significance texture	Size	value	statement
ReqRef		1	1	No meaning. Slave mirrors the value from the request
ReqID		1	0x01	read request
EO		1	1	Access to global and local data
Num Param		1	1	Read a parameter
1st Param Value	size	1	6	Unsigned integer 16 bits
	Num values	1	2	Number of the following values
	1st value	2	0x0396	Subindex 0: 918
	2nd value	2	0x0397	Subindex 1: 919

Table 6.20: DS_Read - Slave

6.7.3 Write parameters

Figure 6.5 shows an example of writing a new preset value. The printed octets highlighted are the user data of the DS_READ or DS_WRITE service.

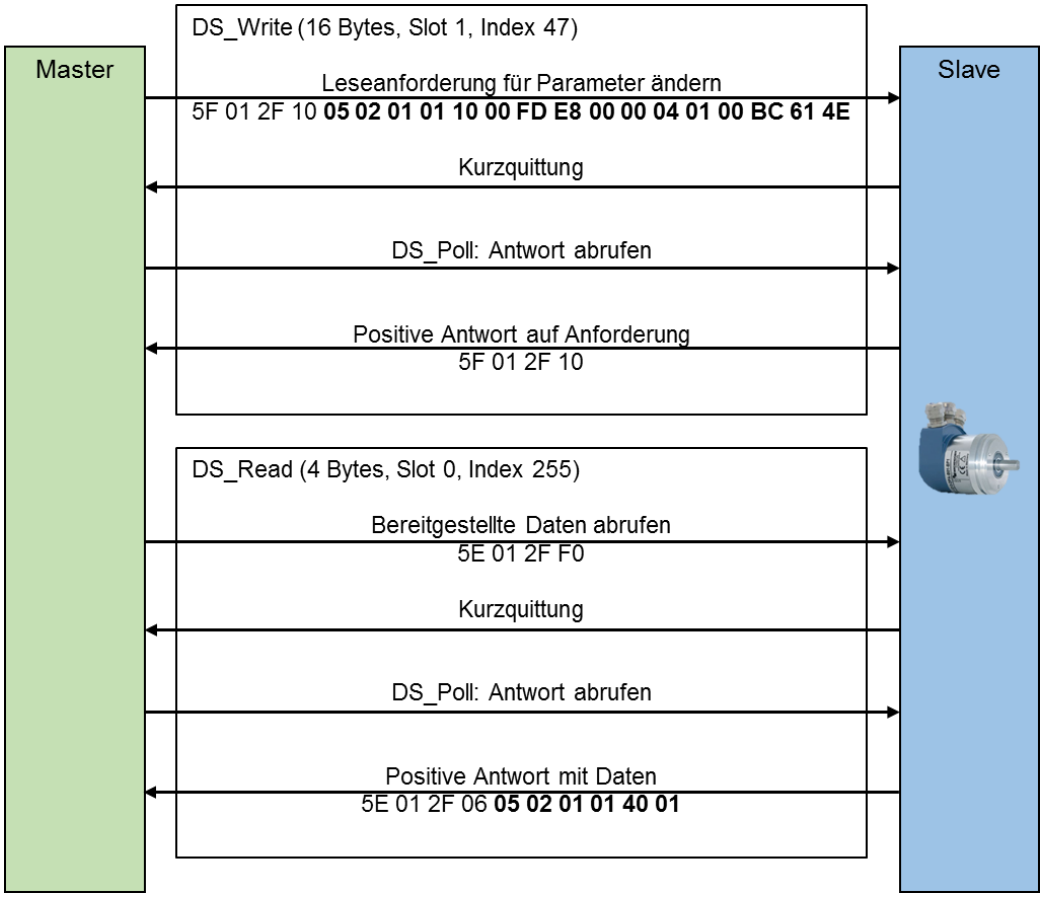


Figure 6.5: Setting the preset value to 12345678d via P65000

Table 6.21 shows the read request of the DP master. The meaning of the highlighted printed octets from Figure 6.5 is described here.

significance BMPA-G	significance texture	Size	value	statement
ReqRef		1	5	No meaning. Master specifies any value
ReqID		1	0x02	write request
EO		1	1	Access to global and local data
Num Param		1	1	Read a parameter
Param Address	Attr	1	0x10	Read the value of the parameter
	Num Elem	1	0	P65000 is not an array
	PNU	2	FDE8h = 65000d	The parameter number
	subindex	2	0	The start index of the elements to be read out
1st Param Value	size	1	4	Signed integer 32 bits
	Num values	1	1	Number of the following values
	1st value	2	00BC614Eh = 12345678d	preset value

Table 6.21: DS_Write - Master

Table 6.22 shows the response of the DP slave. The meaning of the highlighted printed octets from Figure 6.5 is described here.

significance BMPA-G	significance texture	Size	value	statement
ReqRef		1	5	No meaning. Slave mirrors the value from the request
ReqID		1	0x02	write request
EO		1	1	Access to global and local data
Num Param		1	1	Read a parameter
1st Param Value	size	1	40	Zero: No values follow after the number
	Num values	1	01	Number of written values

Table 6.22: DS_Read - Slave

6.7.4 Error handling

Assuming the total measuring range of the encoder would be less than 12345678d. In this case, the encoder would respond to the request of the last example 6.7.3 with an error message. The preset value must be smaller than TMR.

The requirement is identical to the example from 6.7.3 following Table 6.23 response of the encoder.

significance BMPA-G	significance texture	Size	value	statement
ReqRef		1	5	No meaning. Slave mirrors the value from the request
ReqID		1	0x82	Write request not successful
EO		1	1	Access to global and local data
Num Param		1	1	Read a parameter
1st Param Value	size	1	44	The following is an error code
	Num values	1	01	Number of values
	1st value	2	0x0002	Error code: Value outside the valid range.

Table 6.23: Error handling - Slave

6.7.5 PROFIdrive parameters

The PROFIdrive parameters can be found in Table 6.24 to Table 6.27.

PNU	significance	type	R/W	L/G	subindex	bit	function	Description of the
918	Node address	Unsigned 16	R	G				The PROFIBUS slave address of the encoder
919	Encoder Unit system number	Visible String [16]	R	L				Always "WDGA-MT-DP".
922	Telegram selection	Unsigned 16	R	L				Number of the configured I/O telegram
925	Max. Master Sign-Of-Life failures	Unsigned 16	RW	L				The limit of the error counter is set to ten times this value.
964	Encoder Unit identification	Unsigned 16	R	G	0		manufacturer	PNO manufacturer ID as I&M: Always 0x027B
					1		Encoder Unit Type	Always 0
					2		Software version	e.g.0x0102 for version 1.2
					3		Firmware date (year)	Year of firmware creation: yyyy
					4		Firmware date (day/month)	Day and month of firmware creation: ddmm
					5		Number of Encoder Objects	Number of EO within the EU: Always 1

Table 6.24: Telegram Structure - Part 1

PNU	significance	type	R/W	L/G	sub index	bit	function	Description of the
965	Profile identification number	Octet String [1]	R	G				Byte 1: 61d (encoder profile) Byte 2: Version: 41d (Compatibility mode: 31d)
971	Transfer to NVM	Unsigned 16	RW	G				To start saving write a 1. The value is set to 0 as soon as the saving is completed. The values of P65000, P65002 and P925 are stored.
972	Device reset	Unsigned 16	RW	G				Default value: 0. Writing 2 has no effect. Write 1 executes a device reset, whereby the value jumps back to 0.
974	base fashion parameter access service identification	Unsigned 16	R	G	0		Max block length	Maximum length of the parameter request: 240 bytes
					1		Max number of parameter requests per multi-parameter request	Number of possible parameter accesses per parameter request: 39
					3		Max latency per request	0: not specified X: Multiply by 10ms to obtain the maximum processing time in the worst case, without line delay on the bus. Takes into account the case of multi-parameter access.

Table 6.25: Telegram Structure - Part 2

PNU	significance	type	R/W	L/G	sub index	bit	function	Description of the
975	Encoder object identification	Unsigned 16	R	L	0		Manufac-turer	PNO manufacturer ID like I&M: always 0x027B
					1		EO type	Always 0
					2		Software version	e.g.: 0x0102 for version 1.2
					3		Firmware date (year)	Year of firmware creation: 2014d for the year 2014
					4		Firmware date (day/month)	Day and month of firmware creation: 0x0a09 for September 10th
					5		EO type class	Always 5: Encoder Interface
					6		EO sub class	Always 0xC000 Encoder Class 3 and 4 supported
						0…5		Always 0
						6…13		Always 0
						14		Always 1
						15		Always 1
					7		EO-ID	The number of the encoder object to which the parameter request was addressed. Always 1
977	Transfer to NVM	Unsigned 16	RW	G				To start saving write a 1. The value is set to 0 as soon as the saving is completed. The values of P65000, P65002 and P925 are stored.
979	Sensor format	Unsigned 32	R	L	0		header	Describes the structure of the parameter. Always 0x00005111
						0…3	version	This version is incremented when compatible changes are made to the structure. Always 1
						4…7	version	This version is incremented if the structure is changed in an incompatible way. Always 1

Table 6.26: Telegram Structure - Part 3

PNU	significance	type	R/W	L/G	sub index	bit	function	Description of the
979	Sensor format	Unsigned 32	R	L	0	8…11	Number of sensors	Number of sensors described: Always 1
						12…15	Number of indices per sensor	Number of subindices per sensor: Always 5
						16…31	Reserved	Always 0
					1		Sensor type	
						0	Linear sensor	Always 0: rotary sensor (rotary encoder)
						1	Absolute sensor	Always 1: The Ab-solute value is available immediately.
						2	64-bit position	Always 1: 64-bit position information is available
						3…30	Reserved	Always 0
						31	Data valid	1: Data of the sensors are valid
					2		Sensor resolution	Current resolution in steps per revolution
					3		Shift factor G1_XIST1	Always 0 The position value in G1_XIST1 is always aligned to the right.
					4		Shift factor G1_XIST2	Always 0. The position value in G1_XIST2 is always aligned to the right.
					5		Determinable revo-lutions	Number of distinguishable revolutions of the rotary encoder
980	Number List of defined parameters		R	L	0…18			List of all available parameters. Each element contains a PNU. The end of the list contains the 0

Table 6.27: Telegram Structure - Part 4

6.7.6 Manufacturer specific parameters

The manufacturer-specific parameters can be found in Table 6.28.

PNU	significance	R/W	L/G	Description of the
1000	Test 1	RW	G	For production purposes only, not described
1001	Test 2	RW	G	For production purposes only, not described

Table 6.28: Manufacturer-specific parameters

6.7.7 Encoder-specific parameters

The encoder-specific parameters can be found in Table 6.29 to Table 6.31.

PNU	significance	type	R/W	L/G	sub index	bit	function	Description of the
65000	Preset value	Integer 32	RW	G				The preset function of the cyclic data exchange sets the position value to this value. With an absolute preset, this value is considered unsigned.
65001	operating parameters	Array [12] Integer 32	RO	G	0		header	Describes the structure of the parameter. Always 0x000C0101.
						0...7	version	This version is incremented when compatible changes are made to the structure.
						8...15	version	This version is incremented if the structure is changed in an incompatible way. Always one.
						16…23	Number of indices	Number of existing subindexes. Always: 12
						24…31	Reserved	Always 0
					1	0	code sequence	Shows whether class 4 functions have been activated.
						1	Class 4 function	Shows whether class 4 functions have been activated.
						2	G1_XIST1 preset control	Shows whether the preset function affects the position value G1_XIST1.
						3	Scaling function control	Shows whether the full diagnosis is output.

Table 6.29: Encoder-specific parameters - Part 1

PNU	significance	type	R/W	L/G	sub index	bit	function	Description of the
65001	operating parameters	Array [12] Integer 32	RO	G	1	4	Alarm channel control	Shows whether the full diagnosis is output.
						5	Compatibility mode	Shows whether the compatibility mode is active.
						6, 7	Reserved	Always 0
					2		sloth	Shows errors that can affect the position value.
						0	Position error	The position value is not correct
						1	undervoltage	Always 0
						2	overvoltage	Always 0
						3	shortcircuit	Always 0
						4	Commissioning diagnostic	Always 0
						5	Memory error	The EEPROM does not work.
						6…31	Reserved	Always 0
					3		Supported faults	Occupancy like Faults. Always 0x00000021
					4		warnings	Warnings have no effect on the position value
						0	Frequency exceeded	Maximum speed is exceeded
						1	overtemperature	Temperature too high
						2	Light control reserve	Always 0
						3	CPU Watchdog status	Always 0
						4	Operating time limit warning	Always 0
						5	Battery voltage low	Always 0
						6	Reference point not reached	Always 0
						7…31	Reserved	Always 0
					5		Supported warnings	Assignment of warnings Always: 0x00000003
					6		Encoder profile version	Always 0x0041

Table 6.30: Encoder-specific parameters - Part 2

PNU	significance	type	R/W	L/G	sub index	bit	function	Description of the
65001	operating parameters	Array [12] Integer 32	RO	G	7		operating time	Operating hours counter in 0.1 hour intervals. P65001.6: independent of compatibility mode
					8		Offset value	The offset calculated by the preset function.
					9		Measuring unit per revolution	The parameterized resolution
					10		Total measuring range	The parameterized total measuring range
					11		Speed measuring unit	The parameterized unit of the velocity value
65002	Preset value 64-bit	Integer 64	RW	G				The 64-bit version of the preset value
65003	Operating status 64 bit	Array [] Integer 64	RO	G	0	0	header	Always 0x40101
						1	Offset value 64 bit	The 64-bit ion of the offset value
						2	Measuring unit per revolution 64 bit	The 64-bit version of the parameterized resolution
						3	Total measuring range 64 bit	The 64-bit version of the parameterized total measuring range

Table 6.31: Encoder-specific parameters - Part 3

6.8 Slave cross traffic - DxB

Slave cross-traffic is supported by the encoder as a publisher. See chapter Profibus 7.13.

6.9 Isochronous mode - IsoM

6.9.1 State machine

In order to start the isochronous mode completely, the encoder runs through further states, which only affect the isochronous mode, in addition to the normal PROFIBUS-DP states. The sequence for WDGA encoders is specified by the PROFIdrive specification. For other DP slaves the sequence may differ.

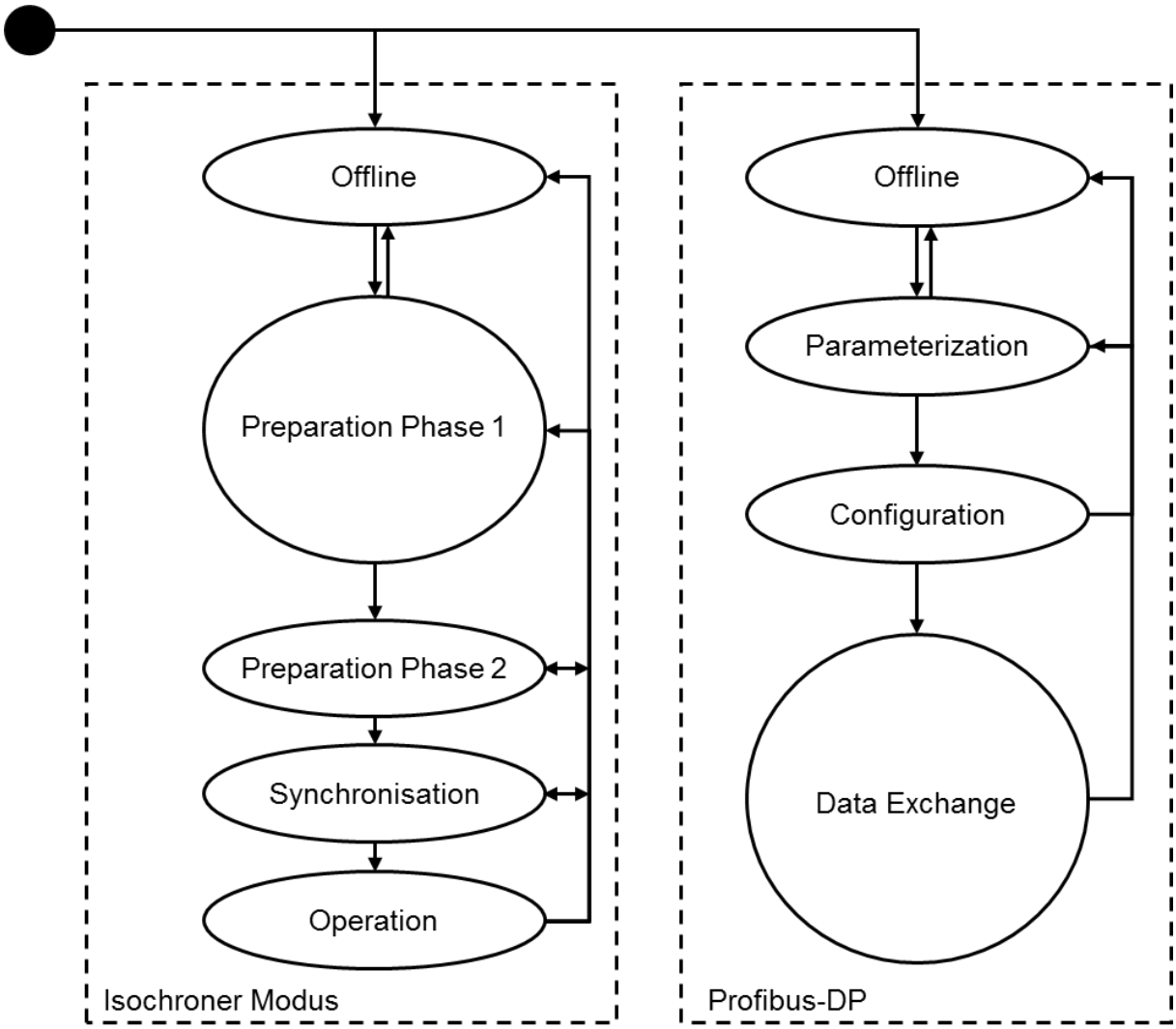


Figure 6.6: Isochronous State Machine and DP State Machine

6.9.2 Offline

The "Offline" state corresponds to the PROFIBUS-DP state and indicates the case in which the encoder is switched off.

6.9.3 Preparation Phase 1

The "Preparation Phase 1" state includes the parameterization and configuration from PROFIBUSDP. The encoder then switches to cyclic data exchange with the DP master and simultaneously to the "Preparation Phase 2" state.

6.9.4 Preparation Phase 2

In the "Preparation Phase 2" state, the encoder synchronizes its internal clock with the clock beat telegram of the DP master. After that it is synchronous with the DP cycle and switches to the synchronisation of the life sign counter.

6.9.5 Synchronisation

The "Master Sign of Life" is located in STW2_ENC (see section 6.4.9). The "Slave Sign of Life" is activated as soon as the "Master Sign of Life" is incremented by one. I.e. in an isochronous application, the control program must automatically begin to increase the sign of life after initialization. The valid value range is from 1 to 15. The value 0 indicates an invalid sign of life. Incrementing a sign of life with the value 15 therefore leads to the value 1.

Figure 7.10 shows the synchronization process. When the system is started, the DP master usually requires more time than the DP slaves. The DP slaves first initialize themselves and then wait for parameterization and configuration to switch to cyclic data exchange. As soon as the cyclic data exchange begins, they synchronize with the clock beat telegram. Afterwards, an incrementation of the "master sign of life" is waited for. Since each DP slave was informed during parameterization how many DP cycles per DP master cycle are run through, it is now clear when the "master sign of life" has to change again and when the new "slave sign of life" has to be transmitted to the DP master.

The DP slaves permanently monitor the synchronization with the clock beat telegram on the bus. If the DP slave detects that it is no longer running synchronously, this is indicated by an error message in G1_XIST2 and a reset of the "slave sign of life" to 0. After the error has been acknowledged with bit x in STWx, the DP slave tries to synchronize again. In order for the synchronization of the DP slaves to function reliably, the control software must process and acknowledge any error messages that may occur.

6.9.6 Surgery

In the "Operation" state, the DP slave is synchronous with the DP master application cycle. The DP master can use the input data for control tasks and set them in relation to the input data of other synchronous DP slaves.

At the beginning of each DP master cycle, the encoder checks the "master sign of life". If it was not incremented correctly, an internal error counter is incremented by 10. If a correct "master sign of life" is received, however, it is reduced by one. If the error counter exceeds the permissible upper limit, the encoder switches back to the "synchronization state", reports the error via G1_XIST2 and sets the "slave sign of life" to 0. As soon as the error has been acknowledged, synchronization is carried out again and the encoder returns to the "operation state".

The permissible upper limit of the error counter can be set in compatibility mode via parameterization. Otherwise the acyclic parameter P925 must be used. The upper limit is calculated from the parameterized value times ten. It is quite possible that with a value of 3 allowed life sign errors, even more life sign errors will not reset the "slave life sign" if the error counter has been reduced again in the meantime by correct "master life signs".

7 PROFIBUS

7.1 General information

PROFIBUS was developed in 1987 by various companies and research institutes. PROFIBUS has been the world's leading fieldbus in the automation of plants and machines since 1989. PROFIBUS is characterized in particular by its wide range of applications. Application-specific requirements are implemented in corresponding application protocols.

Communication can be classified as follows in the ISO-OSI model (ISO standard 7498). The relevant layers for PROFIBUS are the first layer (Physical Layer - Layer 1), the second layer (Data Link Layer - Layer 2) and the seventh layer (Application Layer - Layer 7). Table 7.1 shows the ISO-OSI model with the PROFIBUS protocols.

ISO-OSI layer	PROFIBUS		Description of the
Layer 7 application layer	PROFIBUS DP (DP-V0, DP-V1, DP-V2)		communication protocols
Layer 3 - 6			
Layer 2 Data Link Layer	FDL (Fieldbus Data Link)		FDL: Data transmission - Services for data transmission - FMA: Management Services - MAC: Medium access (master-slave principle, Token Passing Principle)
Layer 1 Physical Layer	EIA-485 (also: RS485)	Optical	physical realization of the bit transmission: - UART coding

Table 7.1: ISO-OSI Model - PROFIBUS-DP

PROFIBUS is available in three different versions:

- PROFIBUS-FMS (Fieldbus Message Specification)
- PROFIBUS-DP (Distributed Peripherals)
- PROFIBUS-PA (Process Automation)

Historically, PROFIBUS-FMS was the first PROFIBUS to be replaced by PROFIBUS-DP due to its complexity and low transmission efficiency. PROFIBUSFMS is no longer part of IEC61158. PROFIBUS-DP is the most widely used PROFIBUS and covers about 90% of the market share. In IEC61158-2, PROFIBUS-DP and PROFIBUS-PA are standardized.

PROFIBUS-DP is primarily designed for fast data exchange at the actuator/sensor level. It is mainly used in production automation.

PROFIBUS-PA is characterized by intrinsic safety and remote supply of bus stations. It is therefore mainly used in potentially explosive atmospheres. The field of application is process automation.

The user organization is the "Profibus Nutzerorganisation e.V.". (PNO)" and the international umbrella organisation is "Profibus & Profinet International (PI)".

- The manual refers exclusively to PROFIBUS-DP.

7.2 Attendee

PROFIBUS distinguishes between different PROFIBUS stations (often also called stations) (see Table 7.2).

On the one hand there are the masters and on the other hand the slaves. The masters (also called active participants) determine the data traffic in the PROFIBUS bus. The slaves (also called passive participants) are peripheral devices, such as a rotary encoder. You may acknowledge received messages or transmit messages at the request of a master. Details on the bus access procedure can be found in section 7.4.2.

Since PROFIBUS supports different versions (FMS, DP or PA), the corresponding abbreviation is often prefixed to the master or slave, such as DP master and DP slave.

attendee	class	Short	Description of the	communication relation
DP master	1	DPM1	- PLC (en: PLC) cyclic data traffic and acyclic data traffic	MS0 (DP slave: DP-V0) MS1 (DP slave: DP-V1) MM (DPM2, rather rare)
DP master	2	DPM2	- Configuration and diagnostic device - Diagnosis and parameterization of the DP slave - Engineering station (mostly PC-based system) only acyclic data traffic	MS2 (DP slave: DP-V1) MM (DPM1, rather rare)

Table 7.2: Master variants in the DP system

- The rotary encoder is a DP slave.
- Communication relationships see section 7.6

7.3 Physical Layer - Layer 1

7.3.1 Bus line

The PROFIBUS cables are shielded and twisted two-wire copper cables. There are different types of design, which can differ in the structure of the cores (flexible/rigid) and/or in the sheathing.

The PROFIBUS standard cables usually have a purple outer sheath. The signal line A, is usually green, and the signal line B, is usually red isolated.

- PROFIBUS cables can also be found on our website under the following link:
  www.wachendorff-automation.com

In Table 7.3 you find an overview of the different execution types. Hybrid cables are also available for all version types. These additionally contain a variable number of copper wires for the supply.

PROFIBUS-DP version types	**typ. Coat colour**	**Use of the**
standard cable	violet	Indoor and/or outdoor area
Cable with PE-jacket	black	Food and luxury food industry
underground pipeline (additional outer sheath)	black	direct laying in the ground
Trailing cable / for garland suspension (Cable type A often not fulfilled, no maximum network expansion possible)	turquoise	Use with moving machine parts Special cables are available for drag chains, garland suspension or torsion movements.

Table 7.3: PROFIBUS cables - version types

- Make sure that you use correct PROFIBUS cables according to your application.

The specification of the bus cable is defined in IEC 61158. The electrical properties (line parameters) of the bus line for line type A are shown in Table 7.4.

parameter		limit
characteristic impedance [Ω]		135 - 165 (from 3 - 20 MHz)
capacity flooring	[pF/m]	≤ 30
loop resistance	[Ω/km]	≤ 110
wire diameter	[mm]	> 0,64
wire cross-section	[mm²]	> 0,34

Table 7.4: Line parameters - Line type A

- Only use cable type A

Further properties that may be relevant to your application can be found in Table 7.5.

demand	property
mechanical	bending radius
mechanical	bending frequency
mechanical	tensile strength
chemically	UV resistance
chemically	absence of silicone
chemically	Resistance to mineral oils and greases
chemically	Permissible temperatures
reaction to fire	absence of halogen
reaction to fire	flame retardancy
reaction to fire	smoke density

Table 7.5: Possible requirements for the bus line

7.3.2 Transmission speed

A total of 126 participants can participate in a PROFIBUS system. When the maximum number of stations is reached, the PROFIBUS is divided into individual segments. The segments can be coupled to the PROFIBUS via repeaters. 32 subscribers can be connected per segment (the repeater is also a subscriber).

Theoretically, the maximum transmission speed depends on the longest segment. However, there are further possibilities to increase the transmission speed with the use of additional repeaters.

If the line parameters of line type A are complied with, the transmission speeds apply to the maximum segments (see Table 7.6).

Transmission speed [kBit/s]	max. segment length [m]
9,6	1200
19,2	1200
45,45	1200
93,75	1200
187,5	1000
500	400
1500	200
3000	100
6000	100
12000	100

Table 7.6: Transmission speeds - Line type A

- At transmission rates > 1500kbit=s no stubs are allowed.
- For transmission rates < 1500kbit=s different spur line lengths are permissible depending on the transmission rate (in case you use spur lines, please inform yourself about this).
- No termination is carried out for stub lines.

7.3.3 Termination

Termination prevents reflections during data transmission. In addition, it ensures a defined rest potential on the data line if no subscribers are active. An active termination must be present at the beginning and end of an RS-485 segment. The active scheduling is shown in Figure 7.1.

- Please refer to section 4.4.3 or 4.5.2 termination for the WDGA.
- 5 V DP and GND DP are galvanically isolated from the supply voltage.

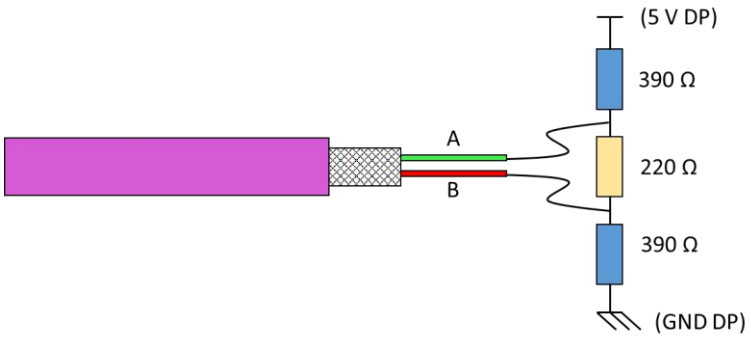


Figure 7.1: Termination - Line type A

- Incorrect scheduling leads to communication problems

7.4 Data Link Layer - Layer 2

7.4.1 General information

The "Data Link Layer" generally describes the bus access procedure, data backup and transmission services. The "Data Link Layer" is called "Field Data Link" (FDL) on PROFIBUS.

7.4.2 Bus access method

With PROFIBUS, the bus access procedure is carried out via the token passing procedure (master-master procedure) or via a combination with the master-slave procedure.

In the token-pasing procedure, the bus access authorization (token) is passed from one DP master to the next within a specified time. The token message contains the send authorization for the corresponding DP master. The token ring is the connection between different DP masters (see Figure 7.2). The token message is passed on to each other in a given order.

In the master-slave procedure, the request of a DP master authorizes the DP slave to send to the bus for a certain time. DP slaves are only allowed to respond to DP master requests. The DP master with the send authorization can send messages to the DP slaves.

With the token-passing and the master-slave procedure it is possible to realize three different system configurations. A pure master-slave system (MS system), a pure master-master system (MM system) or a hybrid access method from the MS and MM systems.

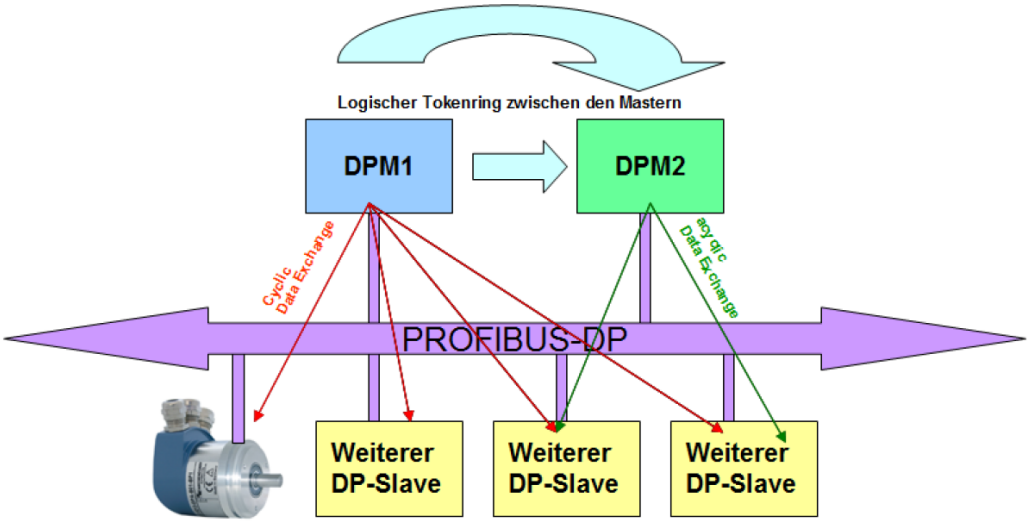


Figure 7.2: PROFIBUS-DP station

7.5 Application Layer - Layer 7

7.5.1 Communication protocol - DP-V0, DP-V1, DP-V2

Historically, there are different DP communication protocols. The original version is DP-V0 (PROFIBUS DP Version 0, 1991: DIN 19245, later: EN 50170). This was extended in DP-V1 (PROFIBUS DP Version 1) and defined in a new standard (IEC 61158). There are further additions to this version (PROFIBUS DP Version 2), which have been adopted into IEC 61158 since 2002.

In practice, the term DP-V2 is often used in this context, although these are merely additions to DP-V1. The main functions of the individual versions are shown in Figure 7.3.

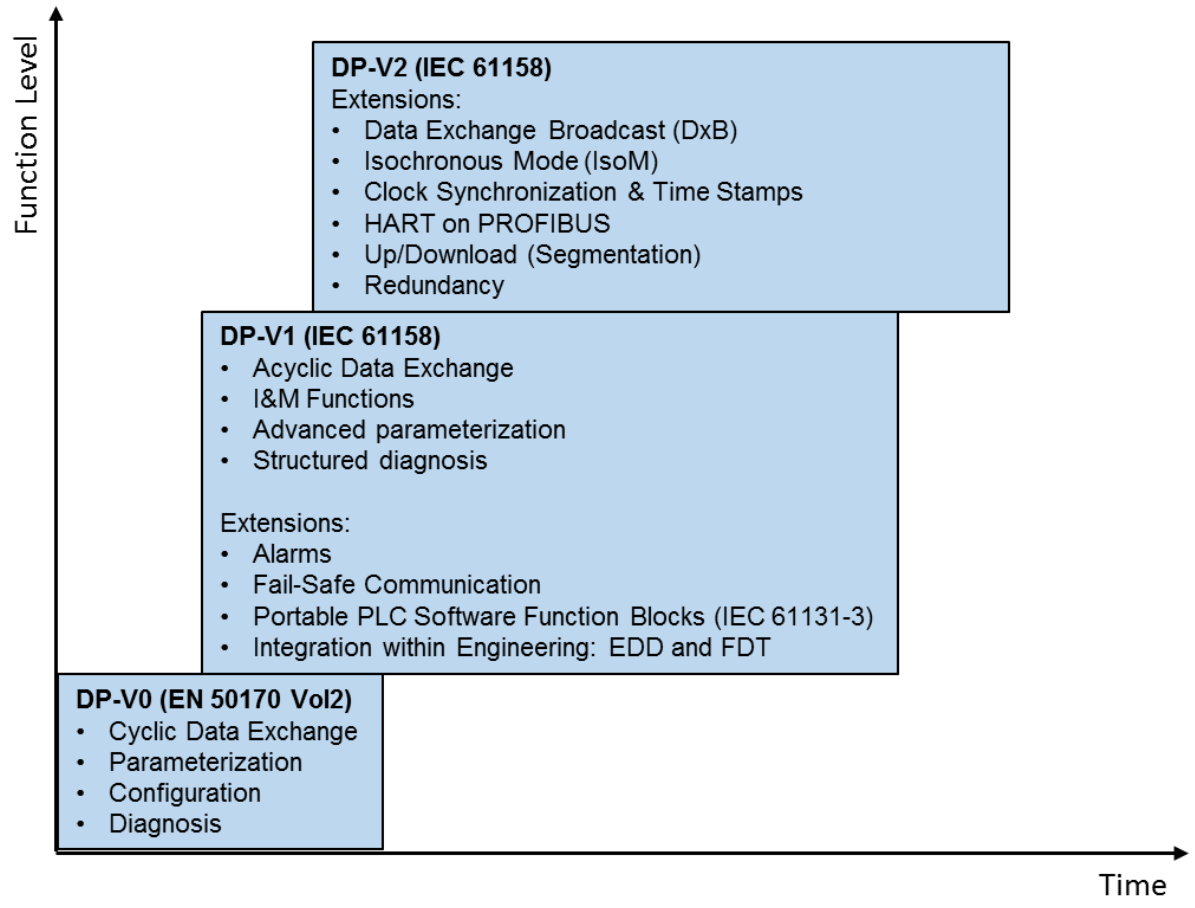


Figure 7.3: Power levels PROFIBUS-DP

The power level DP-V0 provides the basic functions of the communication protocol. The "cyclic data exchange" of the process data is possible between DP master and DP slave. Parameterization, configuration and various diagnostic functions are also available.

DP-V1 is the addition to DP-V0. In addition, an "acyclic data exchange" between DP master and DP slave is possible. This enables parameterization, diagnosis, operation, monitoring and alarm handling of the DP slaves in parallel with cyclic user data traffic.

The I&M functions are higher services using the acyclic communication channels (MS1 and MS2). In this way, the manufacturer and the serial number can be retrieved in a uniform format. These services originally belonged to the DP V2 service level. Today, however, it is necessary that these services are supported by every new DP-V1 subscriber. Other acyclic services depend on the device profile.

DP-V2 is a further addition to the functions of DP-V0 and DP-V1. The extensions include "Slave Cross Traffic (DxB)" and "Isochronous Mode (IsoM)". The "slave cross traffic" enables direct data exchange between the DP slaves. This is only possible if this function is also supported by the DP master. The "Isochronous Mode" enables the synchronization of the acquired input and output values with the master clock. Thus the process data of the plant have the same age across slaves. This is mainly required for servo drives. Further functions, such as time guidance, can be available.

7.6 Communication relationships

There are various communication relationships between the participants (see Figure 7.4). A distinction is made between MS0, MS1 and MS2 communication relationships.

Depending on the communication relationship, different services are available (see sections 7.6.1, 7.6.2 and 7.6.3).

- MS0: Cyclic data transmission between a DPM1 and a DP slave using the DP-V0 protocol.
- MS1: Acyclic data transmission between a DPM1 and a DP slave using the DP-V1 protocol.
- MS2: Acyclic data transmission between a DPM2 and a DP slave using the DP-V1 protocol.

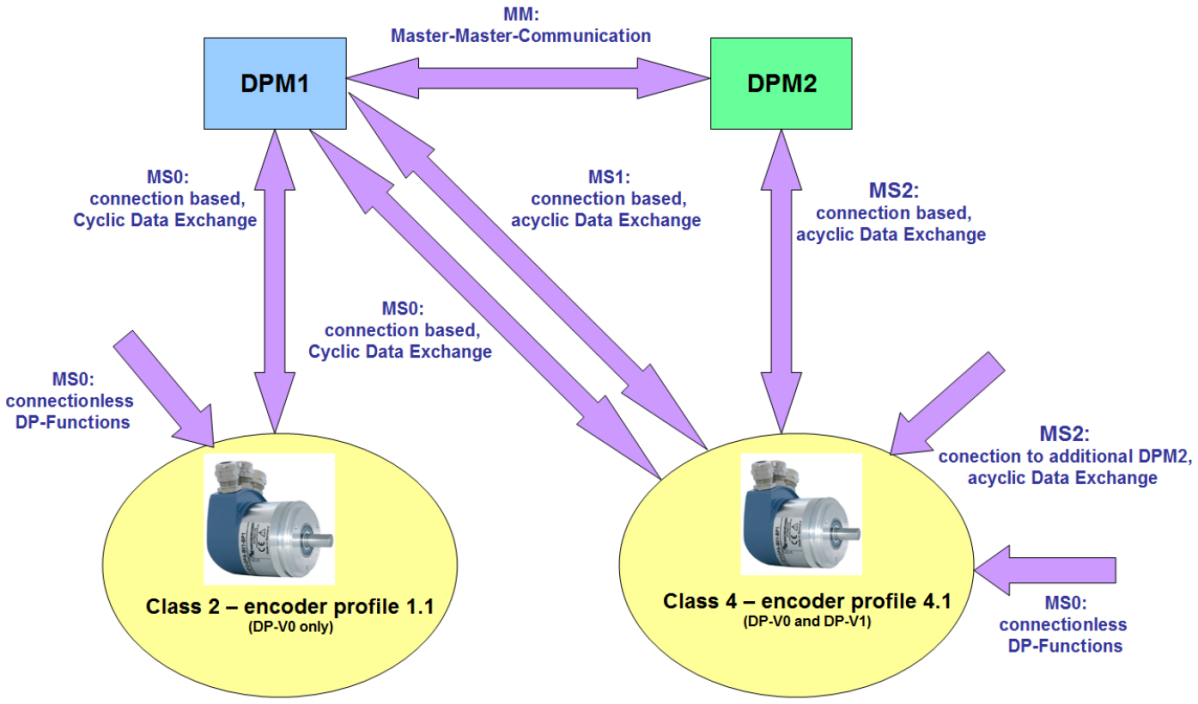


Figure 7.4: Communication relationships

7.6.1 MS0 communication relationship

The telegrams for the MS0 communication relationship are coded by the corresponding SAPs (Service Access Points). The following SAPs are used in the MS0 communication relationship (see Table 7.7).

SAP from DP slave	duty	function	DU from master to slave	DU from slave to master
default	SRD	Data_Exchange	output data	input data
55 (0x37)	SRD	Set_Slave_Adr	Address	SC
56 (0x38)	SRD	Rd_Inp	Empty	input data
57 (0x39)	SRD	Rd_Outp	Empty	output data
58 (0x3A)	SRD	Global_Control	control	-
59 (0x3B)	SRD	Get_Cfg	Empty	configuration
60 (0x3C)	SRD	Slave_Diag	Empty	diagnosis
61 (0x3D)	SRD	Set_Prm	parameter	SC
62 (0x3E)	SRD	Chk_Cfg	configuration	SC

Table 7.7: SAP - MS0 Communication Relationship (Master - SAP 0x3E)

7.6.2 MS1 communication relationship

Like the MS0 communication relationship, the MS1 communication relationship is also established through parameterization by a DPM1. The connection is not established when required, but is permanent.

The telegrams for the MS1 communication relationship are coded by the corresponding SAPs. The following SAPs are used in the MS1 communication relationship (see Table 7.8).

SAP from DP slave	duty	function	DU from master to slave	DU from slave to master
50 (0x32)	SRD	Alarm_SAP	DS_Alarm_ack	
51 (0x33)	SRD	Server_SAP DS_Write_REQ	DS_Read_REQ DS_Write_RES	DS_Read_RES
53 (0x35)	SRD	Ext_User_Prm	Ext. parameter	SC

Table 7.8: SAP - MS1 Communication Relationship (Master - SAP 0x33)

7.6.3 MS2 communication relationship

The MS2 communication relationship is used by DPM2. If necessary, the DPM2 can be used to set up and dismantle the system. Several DPM2s may be available, but the slave cannot provide any number of MS2 channels.

The telegrams for the MS2 communication relationship are coded by the corresponding SAPs. The following SAPs are used in the MS2 communication relationship (see Table 7.9).

SAP from DP slave	duty	function	DU from master to slave	DU from slave to master
≤ 48 (0x30)	SRD	Communication_SAP	DS_xxx_REQ MS2_Abort_REQ	DS_xxx_RES
49 (0x31)	SRD	Resource_Manager_SAP	MS2_Initiate_REQ	Resource_Manager_REQ

Table 7.9: SAP - MS2 Communication Relationship (Master - SAP 0x32)

- WDGA encoders provide two MS2 connections.

7.7 DP slave state machine

A DP slave can have four states: "Offline", "Parameterization", "Configuration" and "Data Exchange" (see Figure 7.5).

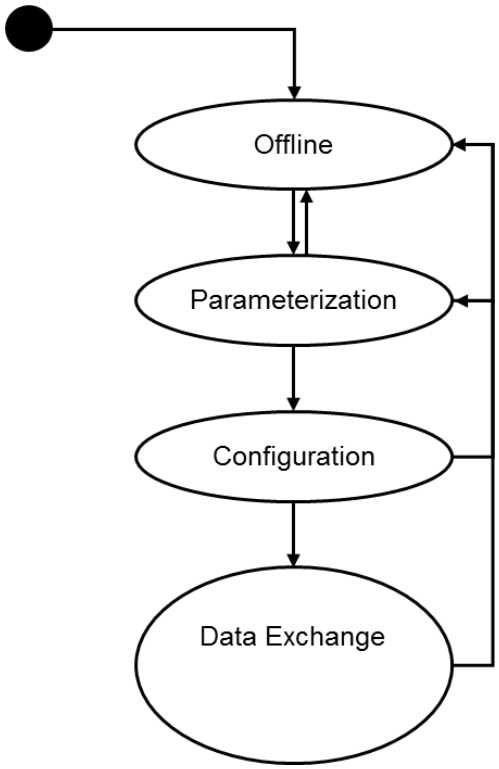


Figure 7.5: State machine - DP slave

There is only one DPM1 for each DP slave. The MS0 communication relationship is established by parameterization and configuration. The encoder assumes various states. The mode of operation of the rotary encoder is briefly explained using the state machine (see Figure 7.6). The initialization sequence of the MS0 communication relationship of the encoder can be found in the Table 7.10.

Telegram sequence	Description of the
1	(Change of participant address; optional)
2	Diagnostic request, diagnostic response
3	Parameterizing the encoder
4	Configuration of the encoder
5	Diagnostic request, diagnostic response Ensuring that everything is correctly initialized
6	Cyclic data exchange of the encoder

Table 7.10: Initialization sequence - MS0

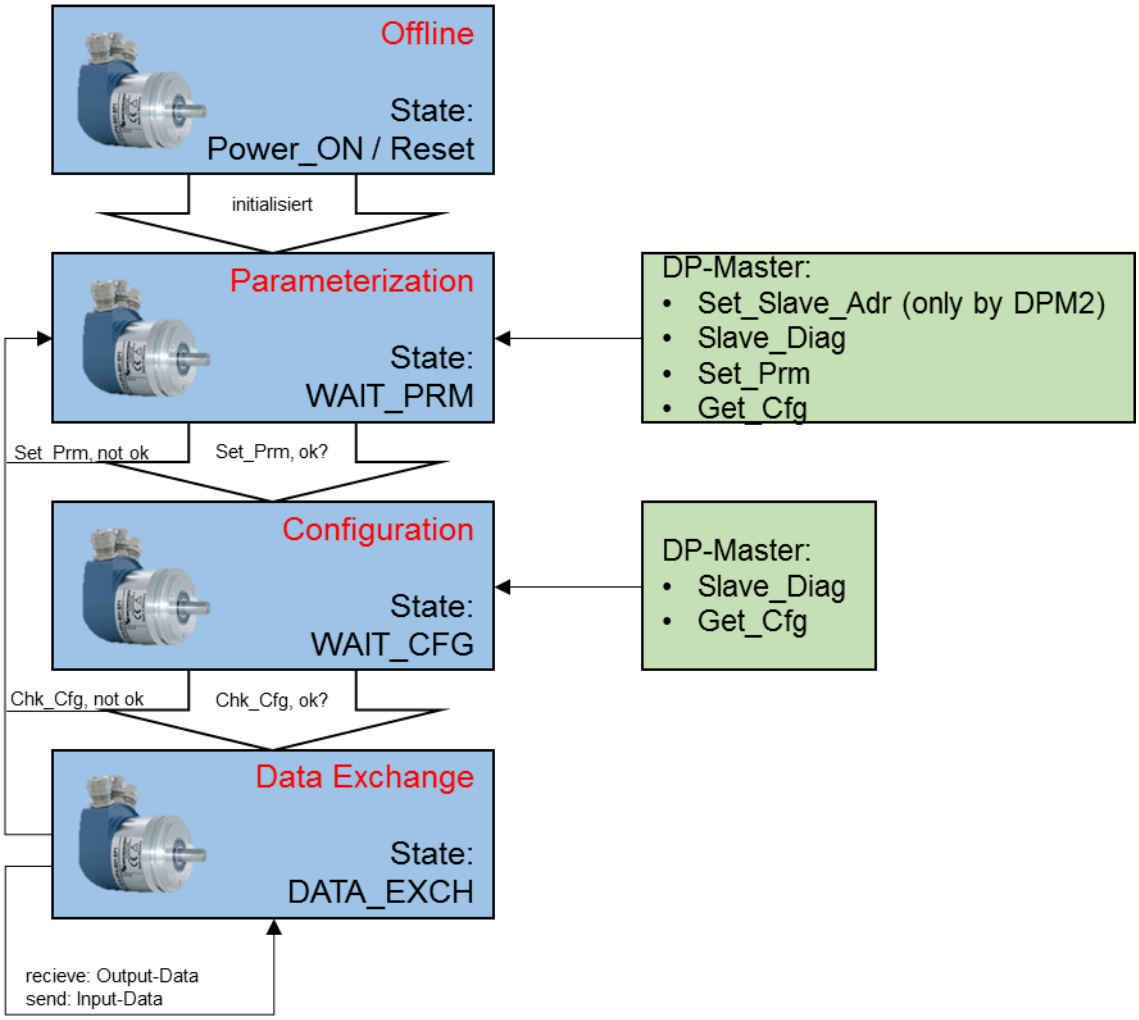


Figure 7.6: State machine - WDGA rotary encoder

- The corresponding functionalities for Slave_Diag, Set_Prm or Chk_Cfg can be found in chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**.

The meaning of the different states can be found in the Table 7.11.

states	significance
Power_On / Reset	Encoder was switched on or a reset carried out
Wait_Prm	Wait for Parameter: Encoder waits for parameters from DP master
Wait_Cfg	Wait for Configuration: Encoder waits for Chk_Cfg telegram from master
Data_Exch	Data Exchange: Encoder cyclically exchanges user data and responds to diagnostic request

Table 7.11: States - state machine

- A cyclic data exchange (e.g. sending the position value) can only take place in the DATA_EXCH state.
- In order for the encoder to change to the DATA_EXCH state, it expects a certain initialization sequence of the MS0 communication relationship from the DP master (see Table 7.10).
- Diagnostic requests can be queried at any time by any DP master.
- Each DP master can query the configuration of each DP slave via "Get_Cfg" in any state.

7.8 Parameterisation

7.8.1 General information

With PROFIBUS-DP, parameterization is part of the standardized start-up phase and is performed by the controller each time the DP slave is started. This means that each parameter is newly described by the controller during operation. These values are configured in the project engineering tool. Normally it is not necessary to know the exact structure of the parameter telegram. However, it can be useful for advanced applications or for bus diagnostics.

- Not to be confused with the acyclic parameter access of encoder class 4!

7.8.2 Telegram structure - Standard parameterization

The Table 7.12 shows the telegram structure of the standard parameterization. The first seven octets of the parameterization have the same meaning for each DP slave.

parameter	data type	octet	range of values
Reserved	bit	1 / Bit 0...2	Always 0
WD_on	bit	1 / Bit 3	0, 1
Freeze_Req	bit	1 / Bit 4	0, 1
Sync_Req	bit	1 / bit 5	0, 1
Unlock_Req	bit	1 / bit 6	0, 1
Lock_Req	bit	1 / bit 7	0, 1
WD_Fact_1	Unsigned 8	2	1…255
WD_Fact_2	Unsigned 8	3	1…255
minTSDR	Unsigned 8	4	
IdentNumber	Unsigned 16	5, 6	Always 0x0DD2
Group_Ident	Unsigned 8	7	0…255

Table 7.12: Telegram structure - standard parameterization

Class 4 is followed first by the DP-V1 parameters and then by the parameter blocks for the encoder-specific and possibly isochronous parameters (see Table 7.13or Table 7.14). For the assignment of encoder-specific parameters, see chapter **Fehler! Verweisquelle konnte nicht gefunden werden.** or 6.

7.8.3 Telegram structure - DP-V1 parameter

Three octets following the standard parameterization, these have a fixed meaning only for DP-V1 devices. Please refer to the relevant literature for an explanation of the individual DP-V1 parameters.

parameter	data type	octet	range of values
Dis_Start_Control	bit	8 / Bit 0	0, 1
Dis_Stop_Control	bit	8 / Bit 1	0, 1
WD_Base	bit	8 / bit 2	0, 1
Reserved	bit	8 / Bit 3, 4	ignored
Publisher_Enable	bit	8 / bit 5	0, 1
Fail_Safe	bit	8 / Bit 6	Always 1
DPV1_Enable	bit	8 / Bit 7	0, 1
Chk_Cfg_Mode	bit	9 / Bit 0	
Reserved	bit	9 / bit 1	Always 0
Enable_Update_Alarm	bit	9 / bit 2	Always 0
Enable_Status_Alarm	bit	9 / bit 3	Always 0
Enable_Manufacturer_Specific_Alarm	bit	9 / bit 4	Always 0
Enable_Diagnostic_Alarm	bit	9 / bit 5	DVP1_Enable 1: 0, 1 DVP1_Enable 0: Always 0
Enable_Process_Alarm	bit	9 / bit 6	Always 0
Enable_Pull_Plug_Alarm	bit	9 / bit 7	Always 0
Alarm_Mode	Unsigned3	10 / Bit 0...2	Always 0
Prm_Structure	bit	10 / Bit 3	Always 1
IsoM_Req	bit	10 / bit 4	0, 1
Reserved	bit	10 / Bit 5...6	Always 0
PrmCmd	bit	10 / bit 7	Always 0

Table 7.13: Telegram Structure - DPV1 Parameters

7.8.4 Parameter block for isochronous parameters

If a slave is parameterized for isochronous mode, the parameter block for isochronous mode is appended to the parameter telegram. Since further parameter blocks may lie between the end of the DPV1 parameters and the beginning of the isochronous parameters, a corresponding offset must be added to the specified octet numbers.

For an explanation of the individual parameters, reference is also made here to the relevant literature and the documentation of the control project planning. See section 7.14.

parameter	data type	octet	Value range WDGA
block length	Unsigned 8	1	28
block type	Unsigned 8	2	Always 4
slot	Unsigned 8	3	Always 0
Reserved		4	Always 0
version	Unsigned 8	5	Always 1
TBase_DP	Unsigned 32	6 – 9	375 [·1/12µs] 750 [·1/12µs] 1500 [·1/12µs] 3000 [·1/12µs] 6000 [·1/12µs] 12000 [·1/12µs]
TDP	Unsigned 16	10 – 11	1...216 - 1 [·T_{Base_DP}]
TMAPC	Unsigned 8	12	1...14 [·TDP]
TBase_IO	Unsigned 32	13 – 16	375 [·1/12µs] 750 [·1/12µs] 1500 [·1/12µs] 3000 [·1/12µs] 6000 [·1/12µs] 12000 [·1/12µs]
TI	Unsigned 16	17 – 18	1...216 - 1 [·T_{Base_IO}]
TO	Unsigned 16	19 – 20	1...216 - 1 [·T_{Base_IO}]
TDX	Unsigned 32	21 – 24	1...232 - 1 [·1/12µs]
TPLL_W	Unsigned 16	25 – 26	1...216 - 1 [·1/12µs]
TPLL_D	Unsigned 16	27 – 28	1...216 - 1 [·1/12µs]

Table 7.14: Parameter block for isochronous parameters

7.9 Configuration

With PROFIBUS-DP, the configuration, like the parameterization, is part of the standardized start-up phase and is carried out by the controller each time the DP slave is started. It serves to define the format and the content of the telegrams of the data exchange. The configuration is carried out in the configuration program.

Basically, there are two types of DP slaves: modular and non-modular.

Modular DP slaves consist of a basic device with several slots and the Profibus connection. Several modules can be inserted into the basic unit in different order. The format of the cyclic data exchange may then depend on the sequence of the inserted modules. The configuration determines the size of the input and output values of the individual modules, which are lined up to form the data exchange telegrams.

Non-modular DP slaves have only one specific task and therefore only one valid configuration.

- A class 4 rotary encoder is not a modular device on the outside. However, since the telegram structure is selected during configuration, for example to output a speed value, the different telegrams can be imagined as virtual modules.
- These are automatically plugged into a single available slot for configuration by the encoder.
- Telegram formats for class 4 encoders see section 6.2.

7.10 Diagnosis

The diagnostic function of a DP slave plays a role in the start-up phase, since the DP master can monitor the change of the PROFIBUS states and other error events in the cyclic data exchange.

The DP slave can mark the presence of updated diagnostic data in the "function code" of the response telegram of the data exchange. If the DP master recognizes such a telegram, the DP master can request the diagnosis. The first 6 octets of the diagnostic response have a constant structure across all DP slaves. For clarity the SD2 telegram frame is not explained.

As a rule, the DP master retrieves the diagnosis automatically without any programming being necessary. However, the processing and logging of errors must be done in the control program. If this is not done, the controller may automatically switch to a safe state.

- It is not recommended to simply discard the diagnostic data to avoid stopping the control. If necessary, measures must be taken to ensure the safe operation of a system.

- The diagnosis can basically be requested by any DP master with bus access.
- For more details see: Profile-Guidelines-Diagnostic_3522_V10_Jul04.pdf

Table 7.15 and Table 7.16 show the standard diagnosis of a DP slave.

name	data type	octet	Description of the
Station_Non_Existent	bit	1 / Bit 0	Is set by the master and passed on to the control program if the slave does not respond.
Station_Not_Ready	bit	1 / Bit 1	The slave is not in cyclic data exchange.
Cfg_Fault	bit	1 / bit 2	Error in the configuration of the telegram structure.
Ext_Diag	bit	1 / Bit 3	1: A serious error has occurred. I.d.R there are extended diagnostic data. 0: There is no serious error. Nevertheless, extended diagnostic data may be available.
Not_Supported	bit	1 / Bit 4	The slave was parameterized with a function that it does not support.
Invalid_Slave_Response	bit	1 / bit 5	Is reported by the master to the control program if the slave response could not be processed.
Prm_Fault	bit	1 / bit 6	Error in the parameterization.
Master_Lock	bit	1 / bit 7	The slave cannot send valid data. The master repeats the diagnostic request as long as this bit is set.
Prm_Req	bit	2 / Bit 0	The slave is not parameterized.
Stat_Diag	bit	2 / bit 1	The slave cannot send valid data. The master repeats the diagnostic request as long as this bit is set.
DP	bit	2 / bit 2	Always 1
WD_on	bit	2 / bit 3	A watchdog was parameterized.
Freeze_Fashion	bit	2 / bit 4	The slave is in freeze mode.
Sync_Mode	bit	2 / bit 5	The slave is in sync mode.
Reserved	bit	2 / bit 6	ignore sb./sth.
deactivated	bit	2 / bit 7	Is set by the master and reported to the control program when the diagnostic function as a whole has been switched off.
Reserved	bit	3 / Bit 0...6	ignore sb./sth.
Ext_Diag_Overflow	bit	3 / bit 7	The slave has more diagnostic data than can be transferred.
Master_Add	Unsigned 8	4	The PROFIBUS address of the DPM1 is 255 if no master has yet parameterized the slave.
Ident_Number	Unsigned 16	5, 6	PNO identification number of the slave.

Table 7.15: Standard diagnostics

- Ident number of the
  Class 4 encoder: 0x0DD2

7.10.1 Extended Diagnosis

The extended diagnosis follows the standard diagnosis in the diagnostic response telegram. There are three types of extended diagnosis, all of which can occur one after the other in any order.

7.10.1.1 Identifier related diagnosis

For modular DP slaves with several pluggable modules, the telegram structure can be described for each module during configuration. The identifier-related diagnosis refers to the sequence of the configured modules to indicate which module has an error.

name	data type	octet	Description of the
Block_Length	Unsigned 6	1 / Bit 0...5	The length of the diagnostic block including octet 0. Value range: 2...32 parameterized
selection	Unsigned 2	1 / Bit 6, 7	1: Identifier related diagnosis
Identifier_Diagnosis_Entry_1	bit	2 / Bit 0	1: Module 1 has diagnostic data. 0: Module 1 has no diagnosis
Identifier_Diagnosis_Entry_2	bit	2 / bit 1	1: Module 1 has diagnostic data. 0: Module 1 has no diagnosis
Identifier_Diagnosis_Entry_3	bit	2 / bit 2	1: Module 1 has diagnostic data. 0: Module 1 has no diagnosis
…			

Table 7.16: Identifier related diagnosis

7.10.1.2 Channel related diagnosis

Each module of a modular DP slave can have several inputs and outputs. For example, channel-related diagnostics are suitable for indicating a short circuit on the analogue output of an IO module. Since only one channel can be mapped per diagnostic block, a channel-related diagnostic block must be inserted for each channel with diagnostic information.

name	data type	octet	Description of the
identification number	Unsigned 6	1 / Bit 0...5	The identification number of the affected module (the block length is always 3).
selection	Unsigned 2	1 / Bit 6, 7	2: channel related diagnosis.
Channel_Number	Unsigned 6	2 / Bit 0...5	The number of the affected channel.
Input_Output_Selection	Unsigned 2	2 / Bit 6, 7	0: reserved 1: Input 2: Output 3: Input and output

Table 7.17: Channel related diagnosis - Part 1

name	data type	octet	Description of the
Error_Type	Unsigned 5	3 / Bit 0...4	The nature of the error: 0: Reserved 1: Short circuit 2: Voltage too low 3: Voltage too high 4: Overload 5: Temperature too high 6: Line break 7: Value range exceeded 8: Value range undershot 9: Error 10-15: Reserved 16-31: Manufacturer specific
Channel_Type	Unsigned 3	1 / Bit 5...7	The data type of the channel: 0: not known 1: Bit 2: 2 bits 3: 4 bits 4: Octet 5: Word 6: Double word 7: Reserved

Table 7.18: Channel related diagnosis - Part 2

7.10.1.3 Device related diagnosis

The device-related diagnosis is not further specified for pure DP-V0 slaves and is manufacturer-specific structured.

name	data type	octet	Description of the
block length	Unsigned 6	1 / Bit 0...5	The length of the diagnostic block including octet 0. Value range: 2...59.
selection	Unsigned 2	1 / Bit 6, 7	0: device related diagnosis
Any data	Unsigned 2	2…59	The content and number of octets depends on the manufacturer and the device.

Table 7.19: Device related diagnosis

For DP-V1 slaves, on the other hand, there is a fixed structure of the device-related diagnostics. Several status messages and alarms are defined, of which only those relevant for the WDGA encoders are presented below.

The difference between alarms and status messages is that alarms indicate serious errors, whereas status messages are to be interpreted as pure information without error character. In addition, alarms must be acknowledged via a DP-V1 service. Status messages, on the other hand, disappear automatically as soon as they are no longer applicable. The control system usually acknowledges the alarms automatically, without the control program having to be provided for this purpose. The advantage of this mechanism is that no important error messages can escape the DP master.

7.10.2 Modules status

Module status is similar to identifier-related diagnostics, but the sender of the status message is the basic device, not the module itself. For each module it is specified here whether the input data are valid. In addition, it can be read here whether the correct module is plugged into the corresponding position of the basic unit, or whether it is completely missing.

- Only relevant for class 4 encoders

name	data type	octet	Description of the
block length	Unsigned 6	1 / Bit 0...5	The length of the diagnostic block including octet 0. Value range: 2...59.
selection	Unsigned 2	1 / Bit 6, 7	0: device related diagnosis
Status_Type	Unsigned 7	2 / Bit 0...6	Specifies the type of status message. 2: Module_Status
identifier	bit	2 / bit 7	Indicates whether it is a status message or an alarm. 1: Status
slot	Unsigned 8	3	Slot of the module causing the status message. Always 0 (basic unit).
Status_Specifier	Unsigned 2	4 / Bit 0, 1	Specifies whether the status comes or goes. Always 0: not differentiable
Reserved		4 / Bit 2...7	ignore sb./sth.
Module_Status_Entry_1	Unsigned 2	5 / Bit 0, 1	0: Module ok, data valid. 1: correct module inserted, data invalid due to an error. 2: wrong module inserted, data invalid. 3: no module inserted, data invalid.
Module_Status_Entry_2	Unsigned 2	5 / Bit 2, 3	see above
...			

Table 7.20: Module status

7.10.3 Diagnosis alarm

The diagnostic interrupt is used to transmit any manufacturer-specific error codes. The meaning of these error codes is usually stored in the GSD file. The sender can be either the basic device or any module of a slave.

- Only relevant for class 4 encoders

name	data type	octet	Description of the
block length	Unsigned 6	1 / Bit 0...5	The length of the diagnostic block including octet 0. Value range: 2...59.
selection	Unsigned 2	1 / Bit 6, 7	0: device related diagnosis
Alarm_Type	Unsigned 7	2 / Bit 0...6	Specifies the type of status message: 1: Diagnosis_Alarm.
identifier	bit	2 / bit 7	Indicates whether it is a status message or an alarm. 0: Alarm
slot	Unsigned 8	3	Slot of the module causing the alarm. 0 . . . 254 0: Basic unit
Alarm_Specifier	Unsigned 2	4 / Bit 0, 1	Indicates whether the alarm is coming or going. 0: not differentiable. 1: Error is coming. 2: Error goes, no further error. 3: Error goes, further errors exist.
Additional_Acknowledge		4 / bit 2	Indicates whether a manufacturer-specific acknowledgement is required in addition to the standard acknowledgement. 0: no further acknowledgement required.
Sequence_Number	Unsigned 2	4 / Bit 3...7	The sequence number is given when the alarm is acknowledged if several alarms can be active at the same time. Always 0, if only one alarm can be active at a time.
Alarm_Data_Description		5…	Manufacturer specific area describing the error. The meaning can be stored in the GSD file.

Table 7.21: Diagnosis alarm

- With the class 4 encoder, one byte Alarm_Data_Description is sent in the diagnostic interrupt (see Table 6.11).

7.11 Exchange of data

After parameterization and configuration of the DP slave, it is in cyclic data exchange with the DP master. The format of the exchanged telegrams corresponds to the configuration by the DP master.

7.12 I&M functions

The I&M functions serve to uniquely identify the DP slave as well as the manufacturer of the device. This allows diagnostic tools to retrieve manufacturer information from the Internet. In addition, they also offer the option of storing customer-specific data such as purpose and location of use.

- For more information see:
  Profile Guideline I_M_3502_V12_Oct09.pdf
  and Profibus standard

The I&M functions are implemented using the acyclic DP-V1 services DS_READ and DS_WRITE. For these services, the development environments of the controllers already have prefabricated functions, so that only the user data of the telegrams must be implemented correctly.

First, the request for parameter access is sent to the DP slave via DS_WRITE. This person processes and acknowledges the request. The master then checks the result of the request via DS_READ. The DP slave will respond either with a short acknowledgement as long as the result is not yet available, or with the result telegram when the processing is completed. If I&M data is read, the response contains the I&M data block.

In the event of an error, the response of the DP slave to the DS_Read or DS_WRITE request contains an error code.

- Only relevant for class 4 encoders.
- See also section 6.6.

The following Figure 7.7 shows an example for reading I&M0 data. For clarity only the user data of the SD2 telegrams are shown. The printed octets highlighted are the user data of the DS_READ or DS_WRITE service. These must be sent to slot 0, index 255.

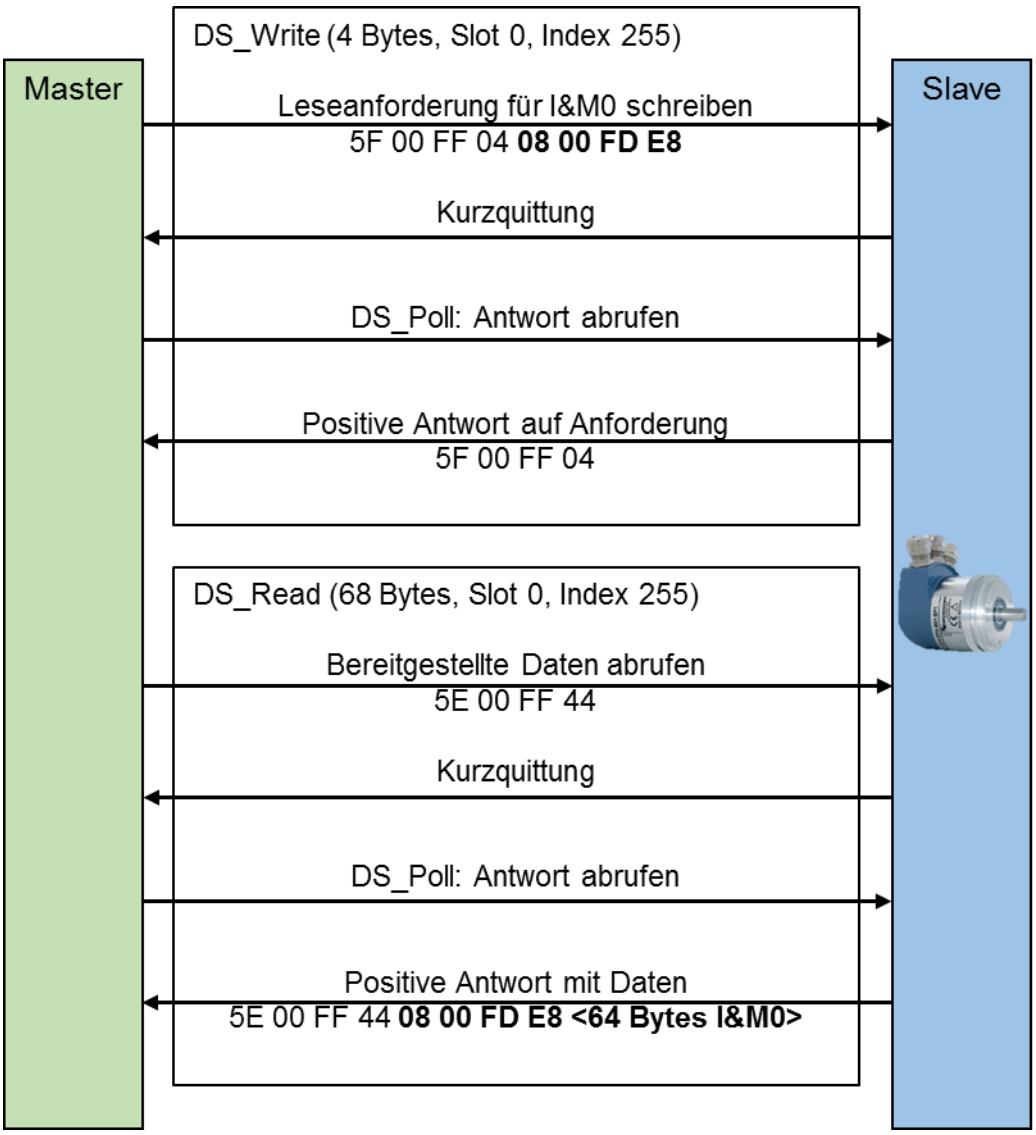


Figure 7.7: Read - I&M0 Data

The following Figure 7.8 shows an example for writing I&M1 data. For clarity only the user data of the SD2 telegrams are shown.

The printed octets highlighted are the user data of the DS_READ or DS_WRITE service.

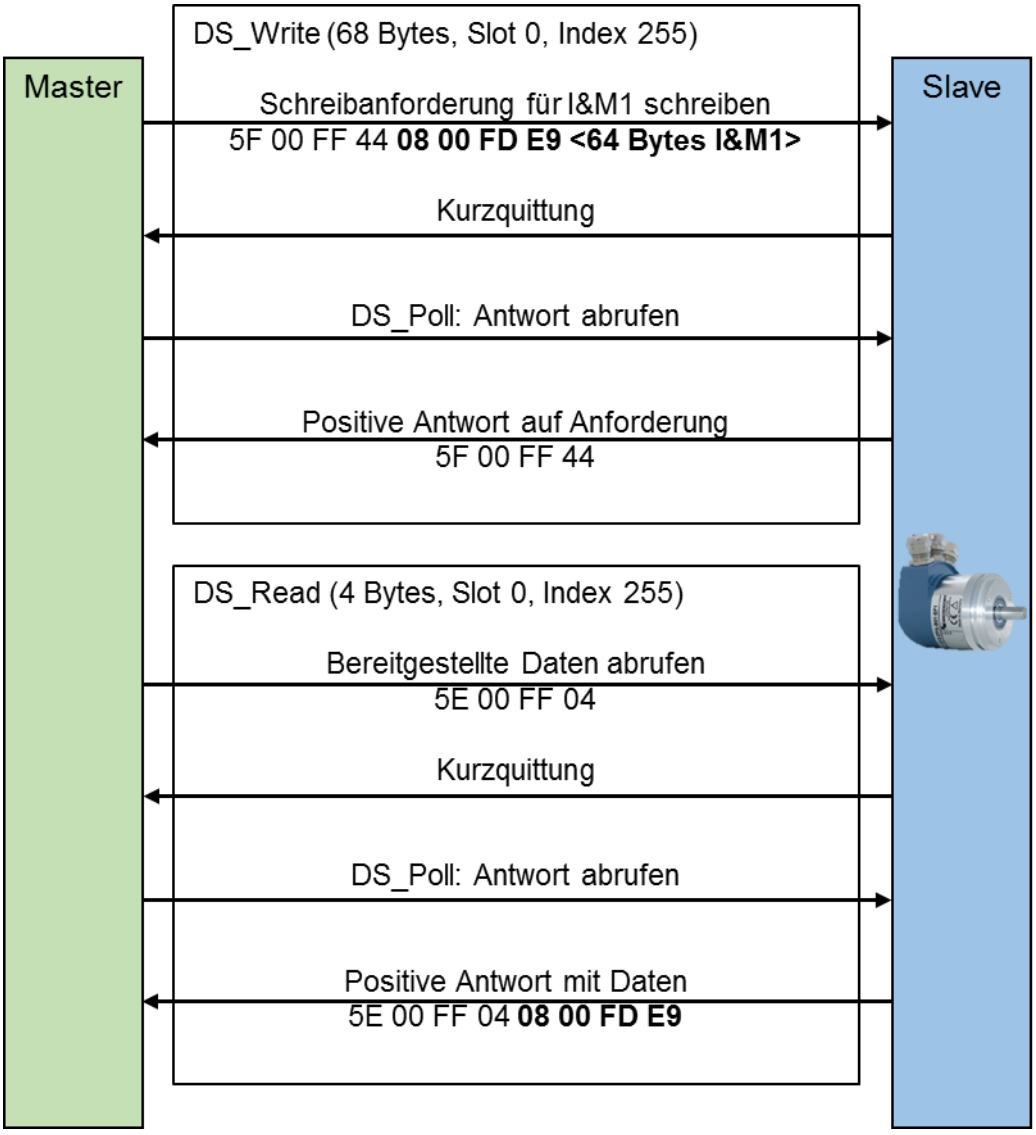


Figure 7.8: Writing - I&M1 data

The example in the Figure 7.9 shows the error handling. Error messages are issued in the event that an attempt is made to access a non-existent I&M data block, or an attempt is made to write to I&M0.

The highlighted printed octets are the user data of the DS_WRITE service.

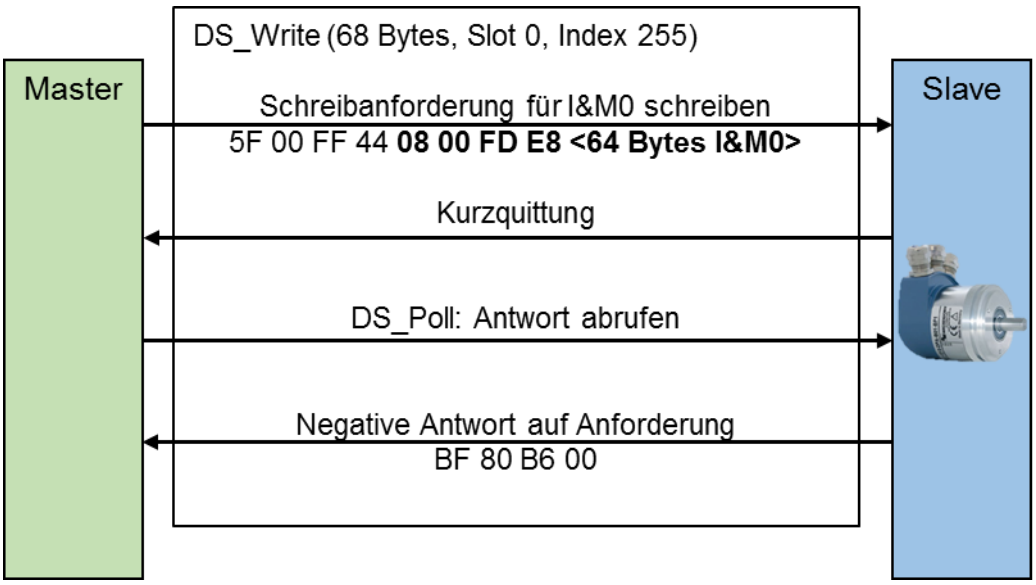


Figure 7.9: Error handling

The error messages listed in Table 7.22 are possible.

error code	significance
80 B8 00	Error message from DS_Write when trying to write to I&M0 or the data length of the write request is unequal 68.
80 B6 00	Error message from DS_Write if "extended FN" is not equal to 8.
80 B5 00	Error message from DS_Read, if no request was previously written with DS_Write.
80 B0 00	Error message from DS_Write when trying to access invalid slot-index-IM_Index combinations.

Table 7.22: Error messages

7.13 Slave cross traffic - DxB

Slave cross-traffic is an extension of cyclic data exchange. It is used to send the process data of a DP slave directly to one or more other DP slaves. DP-V2 slaves can be parameterized as publishers or as subscribers. Publishers publish their input data and subscribers subscribe to the data of one or more publishers. The configuration of a DP slave as a publisher is trivial. In the configuration tool the DP slave is defined as Publisher, this causes the DP master to set Octet 7 Bit 7 (Publisher_Enable) in the parameterization telegram.

During data exchange, the DP slave responds with a broadcast receiver address which can be received by any subscriber. Each subscriber contains its own table that defines which publishers should be subscribed to. How this table is configured and how the subscriber's data is processed is not covered in this manual.

- As sensors, WDGA encoders only support the Publisher function.
- Only relevant for class 4 encoders

7.14 Isochronous mode - IsoM

The isochronous mode is an operating mode in which the DP master specifies the time at which the input data is to be collected and the output data is to be output to the DP slaves. This ensures that despite sequential communication of the DP master with the individual DP slaves, all process data were valid (input data) or will be valid (output data) at a certain time.

The time T_i determines the age of the input data. This must not be longer than the DP cycle time. However, it must be greater than the minimum required data acquisition time of the slowest DP slave in the network.

The time T_o determines the time offset of the output value. This must also not be longer than the DP cycle time. It must be greater than the time required for data exchange with all DP slaves. This depends on the number of DP slaves to be addressed and the configuration of the bus transmission.

The configuration of these times is performed by the configuration tool of the controller and is based on the information in the GSD files of the individual DP slaves.

- Only relevant for class 4 encoders

To synchronize the DP slaves to a common clock, the DP master sends a clock beat telegram at the beginning of each DP cycle. The DP slaves monitor the clock beat telegram and adjust their internal clocks accordingly, so that all data acquisition and data output are exactly within one microsecond of each other.

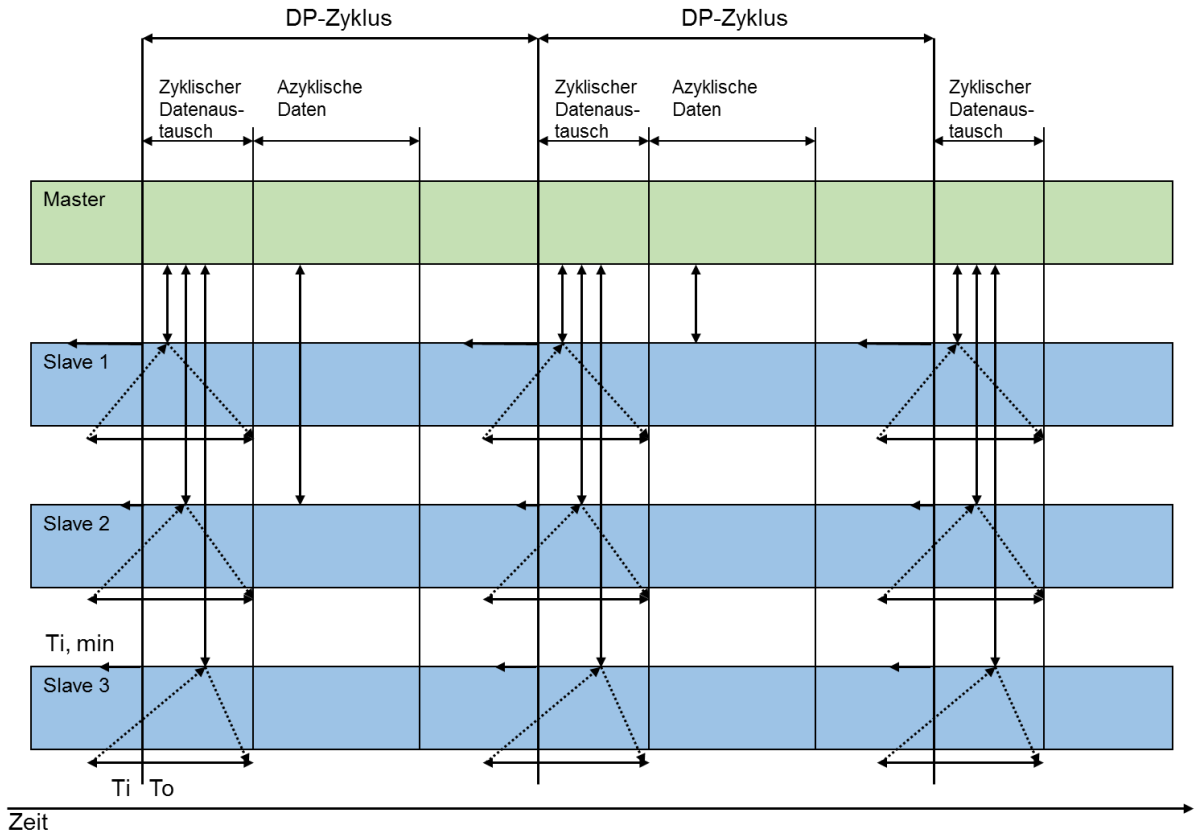


Figure 7.10: Synchronization - Clock beat telegram

Since the cyclically running control program usually requires more time than a DP cycle, it may be necessary to run through several DP cycles per master cycle (see Figure 7.11). It must be assumed that the controller will not send any valid data in the subsequent DP cycles. The DP slaves must therefore determine which DP cycle coincides with the start of a DP master cycle. For this purpose, the DP master sends a "master sign of life" as part of the output data, which is increased by one by the control program with each pass. As soon as a DP slave detects that the "master sign of life" has been incremented, it also increases its "slave sign of life". Since the "slave sign of life" is also part of the cyclic data exchange, the control program can determine when the entire system is synchronized with the DP master cycle. This enables mutual monitoring of the DP master and DP slave applications and measures can be taken in the event that the real-time requirements of the overall system are no longer met.

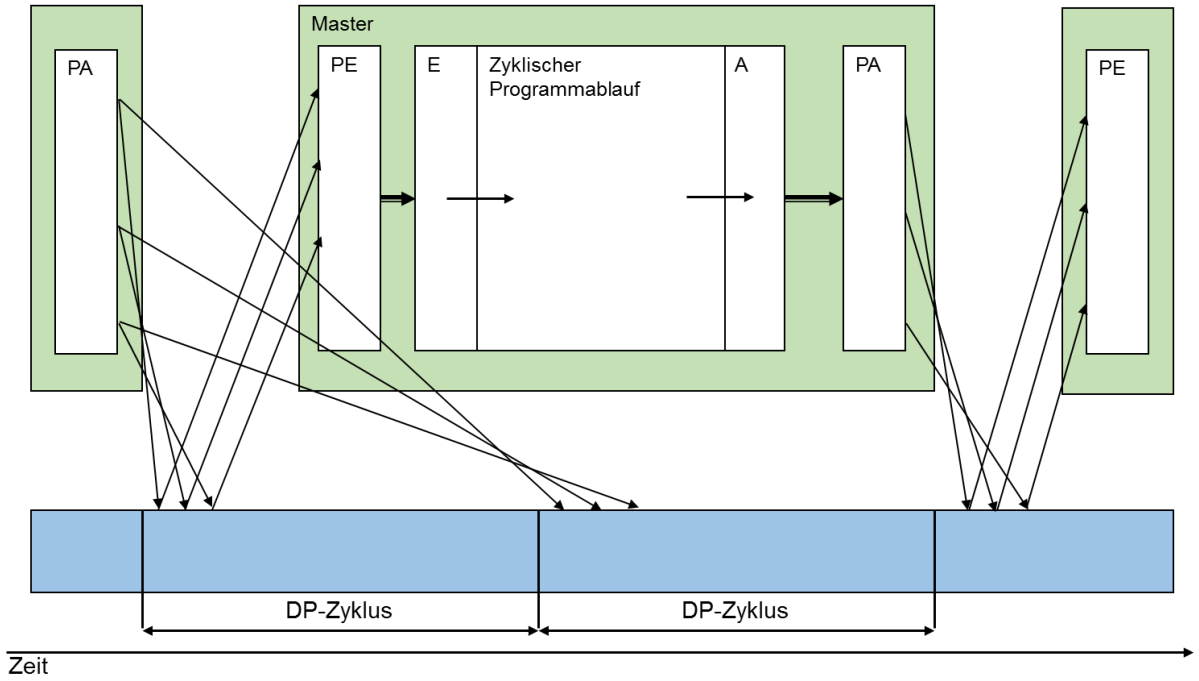


Figure 7.11: DP master and DP cycle

7.15 Application profiles

For a failure-free system between the automation solution and the bus participants, the basic functions and services must match. The prerequisites for this are the same terminology and data formats for communication, device functions and industry solutions. This standardization takes place via the "application profiles". A distinction is made between device profiles, industry profiles and integration profiles.

The application profiles used by Wachendorff are listed in Table 7.26

General application profile	profile content	device class	PNO-No.:
Identification & Maintenance (I&M) V1.2 (Oct., 2009)	Specifies the concept for storing device-specific data of the PROFIBUS device. Enables uniform access of the operator to all device-specific data	class 3 + 4	3.502
Special application profile	**profile content**	**device class**	**PNO-No.:**
Encoder profiles 1.1 (May, 1997)	Coupling of encoders with ST and MT resolution; based on DP-V0 functions	class 1 + 2	3.062
Encoder profiles 4.1 (Dec., 2008)	Coupling of encoders with ST and MT resolution; Based on DP-V1/V2 functions	class 3 + 4	3.162
PROFIdrive 4.1 (May, 2006)	Device behavior and data access method for variable speed electronic drives on PROFIBUS	class 3 + 4	3.172

Table 7.23: Application profiles

The application profile "I&M" is contained in a class 3 or 4 encoder. This makes it possible to read out the profiles used, the encoder type, the manufacturer, the serial number, etc.

7.15.1 Encoder profiles

Encoder profile 4.1 is the device profile for rotary encoders. Encoder Profile 4.1 implements class 3 and 4.

The standard profile for drive technology with PROFIBUS and PROFINET is PROFIdrive (only for: DP-V1/V2, see Figure 7.12). This allows a simple coupling of drives and controls independent of the manufacturer.

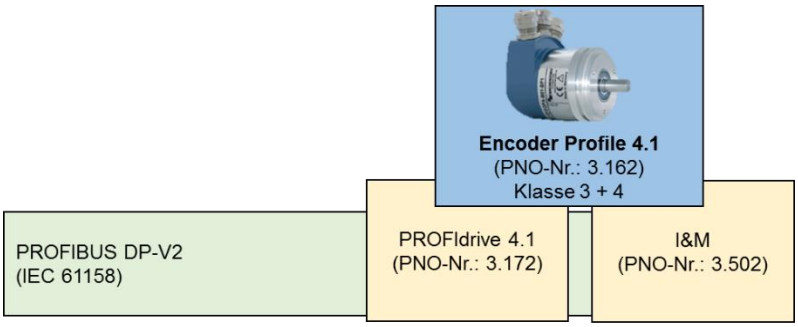


Figure 7.12: Overview - Encoder Profiles

Depending on the power level (see section 7.5.1), different functions and additional extensions are available. Table 7.24 shows the different services depending on the power level (DP-V0, DP-V1 and DP-V2) and the device classes of the encoder.

power level	**rotary encoder Class 3**	**rotary encoder Class 4**
DP-V0		
cyclic data exchange	P	P
parameterisation	P	P
configuration	P	P
diagnosis	P	P
DP-V1		
acyclic data exchange	P	P
I&M	P	P
acyclic parameter access	P	P
DP-V2		
Data Exchange Broadcast (DxB)	O	P
Isochronous Mode (IsoM)	O	P
time synchronization	O	O
redundancy	O	O

Table 7.24: Power level and class division

- An encoder is divided into four classes.
- The WDGA encoders contain mandatory Class 4 functionalities.

7.15.2 PROFIdrive

PROFIdrive is an application-oriented standard profile for drive technology and is standardized in IEC 61800-7 for PROFIBUS and PROFINET. The standardization enables the drive user to communicate between different drive components independent of the manufacturer.

The PROFIdrive architecture describes the communication-independent functions in the basic, parameter and application model. If PROFIdrive is mapped to PROFIBUS-DP, the PROFIdrive communication model (see Figure 7.13) is transferred to the PROFIBUS-DP communication model (see Figure 7.14).

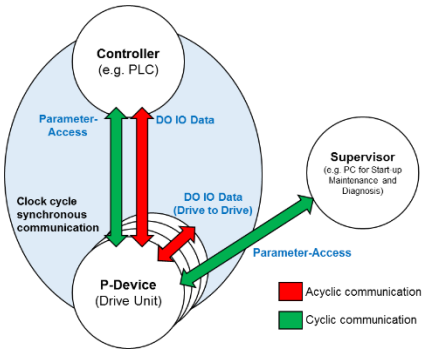


Figure 7.13: Communication model - PROFIdrive

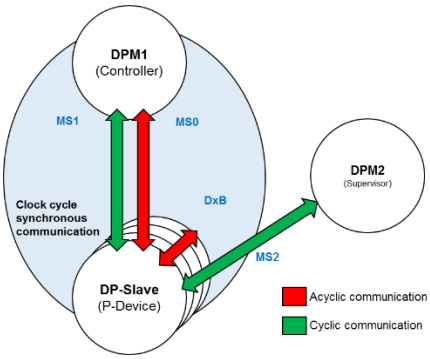


Figure 7.14: Communication Model - Illustration on PROFIBUS-DP

The PROFIBUS standard profile specifies, for example, that the standard telegram 81 - 98 (PNU922) is reserved for the encoder profiles. In addition, the structure of the status and control words is defined therein. Device manufacturer-specific telegrams are reserved under the standard telegram number 100 - 60000.

- Details on PROFIdrive can be found in the PROFIdrive profile.

7.16 Debug control word

As a special feature of the WDGA encoders, there is an additional manufacturer-specific telegram for both encoder profiles, which contains a debug control and status word (see Table 7.25 and Table 7.26).

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	Enable slave address	test error

Table 7.25: Debug_STW

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	Slave address fixed	test error active

Table 7.26: Debug_ZSW

The "test error" is useful when testing the error handling of a control program. With a rotary encoder it is not possible to provoke an error without further ado. Test error" simulates an error in which bit 0 of "Debug_STW" is set (see Table 7.25). Bit 0 of "Debug_ZSW" indicates whether the "test error" is currently active (see Table 7.26).

- It should be noted that the diagnostic interrupt triggered by this must be acknowledged at class 4, even if the test error has been reset to inactive.

When setting the DP slave address on the software side, it is possible to block the future change of the DP slave address via a configuration tool. A manufacturer-specific solution is required to remove this lock. Since there are no physical switches on the encoder that can be reached during operation, the lock can only be released via the debug control word (see Table 7.25). If the "Slave address is fixed", this can be recognized by bit 1 of "Debug_ZSW". To release the lock "Slave address fixed", bit 1 - "Enable slave address" - of "Debug_STW" must be set until bit 1 of "Debug_ZSW" is reset.

8 FAQ

8.1 Project planning

- How is the resolution of the encoder set?

  Class 4:
  The resolution is set via the parameterization (see section 5.3.3).

- How is the encoder preset set and saved?

  Class 4:
  see section 5.6

- How is the position of the encoder read out?

  Class 4:
  see section 5.5

- How can the direction of rotation of the encoder be changed?

  Class 4:
  The direction of rotation is set via the parameterization.
  (see section 5.3.3).
  The class 4 function must be active.

- How can diagnostic messages from the encoder be read?

  Class 4:
  see section 5.8

8.2 LED signalling - Rotary encoder

The BUS LED lights red and the DEV LED lights green?

This is due to the installation:

- Are all PROFIBUS cables correctly connected in the network?

  Check your system planning with regard to PROFIBUS cabling.

- PROFIBUS cable is connected, but has no connection:

Is there a wire break?

Exclude loose contacts etc.
(Note also: self-assembled plugs)

Are A and B switched in the bus cover?

- Is the PROFIBUS address of the rotary coding switches consistent with the parameterization of the PROFIBUS system?

  Check the setting of the rotary coding switches or the assignment of the PROFIBUS address in the "HW konfig".

- Is the PROFIBUS address unique?

  See also 4.4.2 and 4.5.1

- Was the scheduling carried out correctly?

  Termination at the last participant of the segment (see also 7.3.3)

The cause lies in the project engineering:

- Has the encoder been correctly integrated into the control system?

  Check your hardware configuration and S7 programming

- The encoder was correctly integrated into the control system:

  Has the project been translated and transferred to the target system?

The BUS LED flashes red and the DEV LED flashes green?

- Have you set the parameters correctly?

  Are the values for "Measuring units per revolution" and "Total measuring range in measuring units" within the permissible value range?

  Were both values for "Measuring units per revolution" and "Total measuring range in measuring units" adjusted accordingly (see example under **Fehler! Verweisquelle konnte nicht gefunden werden.**)?

- Further information can be found in section 3.4

- For more information, see the Table 3.1

9 Technical support

Technical application advisor

Do you have any questions about this product?

Our technical application advisor will be pleased to help you.

Tel.: +49 (0) 67 22 / 99 65 414
E-Mail: support-wa@wachendorff.de

Notes: