Absolute Encoder
ZE / ZH Series

_Safety informations
_Assembly
_Commissioning
_Parameterization
_Cause of faults and remedies

User Manual

TR - ECE - BA - GB - 0028 - 02 04/05/2016

TR-Electronic GmbH
D-78647 Trossingen
Eglishalde 6
Tel.: (0049) 07425/228-0
Fax: (0049) 07425/228-33
email: info@tr-electronic.de
www.tr-electronic.com

Copyright protection

Subject to modifications

The right to make any changes in the interest of technical progress is reserved.

Document information

Release date / Rev. date:	04/05/2016
Document / Rev. no.:	TR - ECE - BA - GB - 0028 - 02
File name:	TR-ECE-BA-GB-0028-02.docx
Author:	MÜJ

Font styles

Italic or **bold** font styles are used for the title of a document or are used for highlighting.

`Courier` font displays text, which is visible on the display or screen and software menu selections.

″ < > ″ indicates keys on your computer keyboard (such as <RETURN>).

Brand names

PROFIBUS-DP and the PROFIBUS logo are registered trademarks of PROFIBUS Nutzerorganisation e.V. (PNO) [PROFIBUS User Organization]

SIMATIC is a registered trademark of SIEMENS corporation

Contents

Download pin assignments ZE encoder:

- Design with 2-pole screw terminals and Preset www.tr-electronic.com/f/TR-ECE-TI-GB-0017
- Design with MINI-COMBICON terminals, Preset and SSI www.tr-electronic.com/f/TR-ECE-TI-GB-0018
- Design with 2-pole screw terminals (45°) and Preset www.tr-electronic.com/f/TR-ECE-TI-GB-0051
- Design with 2-pole screw terminals (45°) www.tr-electronic.com/f/TR-ECE-TI-GB-0052

Download pin assignments ZH encoder:

- Design with print spring force terminals, Preset, Incremental and SSI www.tr-electronic.com/f/TR-ECE-TI-GB-0060
- Design with print spring force terminals, Preset, Incremental (Push-Pull) and SSI www.tr-electronic.com/f/TR-ECE-TI-GB-0062

Download dimension drawings:

- Standard type ZE encoder www.tr-electronic.com/f/04-K171-V0007
- Standard type ZH encoder www.tr-electronic.com/f/04-734-007

Revision index

Revision	Date	Index
First release	02/26/02	00
New pin assignment TR-ECE-TI-GB-0062 for the ZH-Encoder, Incremental outputs: Push-Pull	06/14/02	01
General modifications	04/06/16	02

1 Safety

1.1 General hazard potential

The rotary encoder cannot function as a stand-alone unit, i.e. it is a component part that is intended to be installed in a complete system consisting of several such components working together. For this reason, the rotary encoder does not have a protective device of its own.

Warning

The encoder has, however, visual indicators which provide some error or status information (see chapter 5.1, page 34). In addition to the standard diagnostic information, via the PROFIBUS the encoder provides an extended diagnostic message according to Class 1 or Class 2 of the PNO encoder profile, depending on the nominal configuration. The implemented "TR modes" also supports the extended diagnostic possibility. Via the ***"Extended diagnosis"*** (chapter 5.2.2, page 38), it is therefore **important** to integrate the bits ***2^0=Position error***, ***2^3=Diagnosis*** and ***2^4=Memory error*** in **byte 8 "Alarms"** into your **own safety concept**, via an application software e.g. of a PLC (for more information, refer to section 5.2, "How to use the PROFIBUS diagnostics" as of page 35).
The corresponding measures must be taken in order to avoid person and property damages.

All persons involved in the assembly, start-up and operation of the device

- must be appropriately qualified
- must follow the instructions in this manual exactly.

This is for your own safety and the safety of your equipment!

1.2 Safety information

This operating manual contains information which must be complied with to ensure your personal safety and to avoid damage to property. The information is emphasized by warning triangles, which have different appearances according to the degree of danger:

Warning
Means that death, severe injury or considerable damage to property can occur if the relevant safety measures are ignored.

Caution
Means that slight injury or damage to property can occur if the relevant safety measures are ignored.

Note
Emphasizes important information about the product, its properties or helpful hints for using it.

1.2.1 Hints on installation

In view of the fact that the rotary encoder is normally used as a component part of a larger system, this information is intended as a guideline for the safe integration of the rotary encoder into its environment.

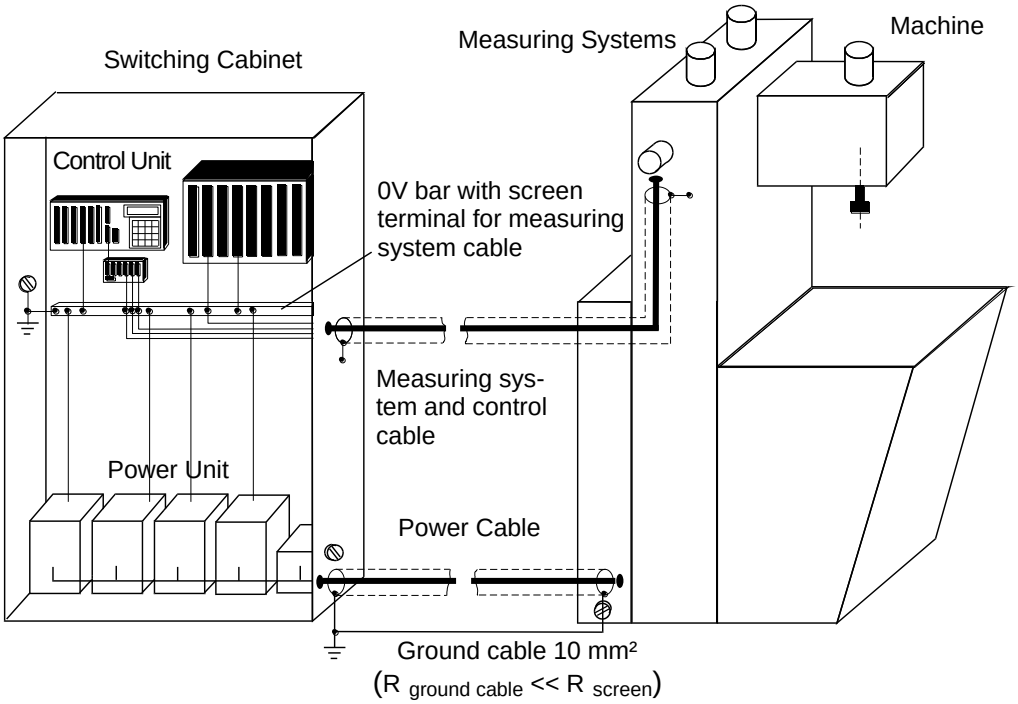
Warning

- Observe the safety and accident prevention regulations relevant to the specific application.
- In the case of equipment with a fixed connection (stationary installations/systems) without all-pole mains switches and/or fuses, you must install a mains switch or fuse in the system and connect the equipment to a protective earth conductor.
- Before starting up devices that are run on mains voltage, check to make sure the set rated voltage range matches the local mains voltage.
- With a 24-V supply, ensure safe electrical isolation of the extra-low voltage. Only use mains units that comply with the standards IEC 364-4-41 or HD 384.04.41 (VDE 0100 Part 410).
- Fluctuations or deviations from the rated mains voltage may not exceed the tolerances stated in the technical data. If they do, functional failures of the electrical components and hazardous conditions cannot be ruled out.
- You must take precautions to ensure that an interrupted program can be resumed normally following voltage dips and failures. In this context, no dangerous operating status conditions may occur even for a brief period of time. If necessary, you must force an **EMERGENCY STOP.**
- EMERGENCY STOP devices that comply with EN 60204/IEC 204 (VDE 0113) must remain effective in all the operating modes of the automation equipment. Unlocking the EMERGENCY STOP devices must not result in an uncontrolled or undefined restart.
- Install the connecting and signal lines so that inductive and capacitive interference does not adversely affect the automation functions.
- Install automation technology equipment and its operator input elements so that they are sufficiently protected against accidental actuation.
- Take appropriate hardware and software precautions in the I/O link to prevent possible cable or wire breakages on the signal side leading to undefined status conditions in the automation equipment.

1.2.1.1 Screening

The use of electronic sensor active systems in modern machines necessitates a consistent and correctly executed interference suppression and wiring strategy.
These conditions are the only guarantee that systems containing electronic measuring systems will function properly.

Recommended screened cable wiring



1.2.1.2 General interference suppression measures

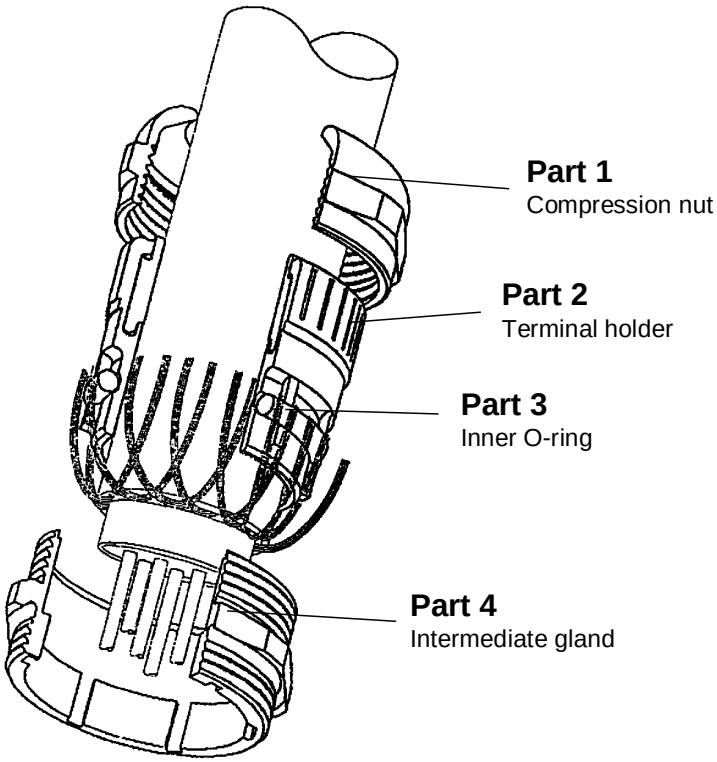
- Route (screened) lines connecting to the encoder either a long way from or completely physically separated from energy lines that carry disturbances.
- Only use completely screened lines for data transfer and ensure they are well earthed. In the case of differential data transfer, (RS422, RS485 etc.), you must use twisted-pair lines in addition.
- Use cables with a minimum cross-section of 0.22 mm² for data transfer**.**
- Use a ground cable with a minimum cross-section of 10 mm² to avoid equipotential bonding via the screen. Please note that the ground cable resistance must be much lower than that of the screen.
- Wire the screen continuously keeping a large area in contact with special screen connecting terminals.
- Avoid crossing cables. If this is not possible, the cables should only cross at right-angles.

1.2.1.3 Connecting the Cable Screening to the Bus-Cap

To prevent disturbance signals entering the encoder housing, we used cable screw glands with which it is possible to connect the screen on the inside. For this reason, **no** connection point for the screen is provided inside the cup-cap.

Procedure:

1. Screw the cable screw gland into the housing.
2. Dismount the compression nut (1) and the terminal holder (2).
3. Push the compression nut (1) and the terminal holder (2) over the cable.
4. Strip the cable; push back the braiding around the terminal holder (2) such that the braiding goes over the inner O-ring (3) and does not lie over the cylindrical section or the torsional bars.
5. Insert the terminal holder (2) into the intermediate gland (4) such that the torsional bars fit into the intended lengthwise grooves in the intermediate gland (4).
6. Screw the compression nut (1) to the intermediate gland (4).



See also notes in the appended pin assignment "TR-ECE-TI-GB-0052"

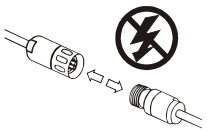
1.3 Intended use

The rotary encoder is used for registering angular movement and for pre-processing measuring data for a downstream controller.

The encoder is designed to be run on PROFIBUS-DP networks according to DIN 19245 Part 1-3 up to a maximum of 12 MBauds. The parameterization and equipment diagnostics are performed by the PROFIBUS master according to Version 1.1 of the PNO encoder profile.

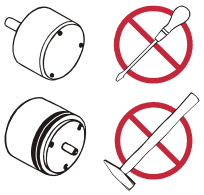
The PNO technical guidelines for setting up the PROFIBUS-DP network must be observed in all cases in order to ensure trouble-free operation.

Warning



De-energize the system before carrying out wiring or opening and closing electrical connections!
Short-circuits, voltage peaks etc. can lead to malfunctions and uncontrolled states in the system or to serious personal injury or damage to property.

Check all electrical connections before switching on the system!
Connections that are made incorrectly can lead to system malfunctions; wrong connections may result in serious personal injury or damage to property.



Mechanical or electrical modifications to the measuring systems ***are prohibited for safety reasons!***

Caution

****Avoid excessive bearing loads due to radial and axial deviations between the encoder and the drive shaft!***
When assembling, you must use couplings that can absorb these forces (ZE type).

****Protect the encoder from excessive vibrations, shocks and jolts, e.g. on presses!***
Use "shock modules" to cushion vibrations (ZE type).

Note
Always follow the start-up, operating and programming instructions specified in this manual.

***** Observe the mechanical ratings on page 44.

1.4 Authorised operators

The start-up and operation of this device may only be performed by qualified personnel. In the context of the safety-related information in this document, the term "qualified personnel" refers to persons who are authorized to commission, ground and mark circuits, equipment and systems in accordance with recognized safety standards.

1.5 Safety measures at the assembly site

Warning

Do not carry out welding if the encoder has already been wired up or is switched on!
Potential fluctuations can destroy the encoder or impair its operation.

Keep to the supply voltage range: 11-27 V DC (+/- 5 % residual ripple)

Note
Ensure that the area around the assembly site is protected from corrosive media (acid, etc.)

2 Transportation / storage

Notes on transportation

Do not drop the device or expose it to strong strokes!
Device contains an optical system.

Only use the original packaging!
The wrong packaging material can cause damage to the device during transportation.

Storage

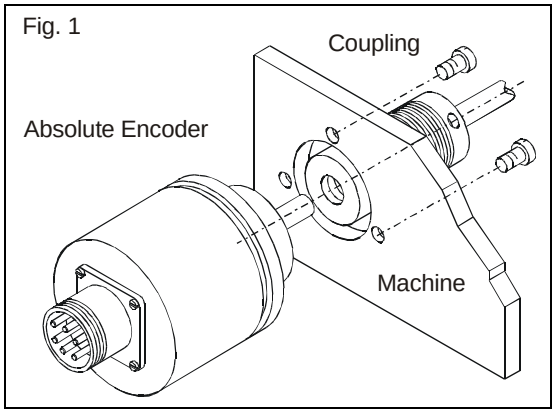
Storage temperature: -30 to +120 °C

Store in a dry place.

3 Assembly

3.1 Production series ZE

Fig. 1



Encoder shaft drive

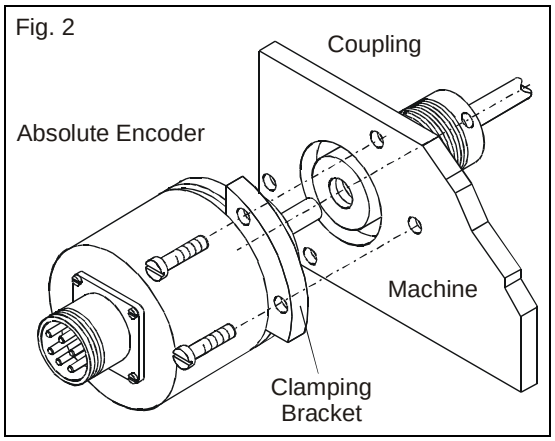
The absolute encoders are connected to the drive shaft via an elastic coupling, which compensates for any deviations in the axial and radial direction between the encoder and drive shaft. This avoids excessive strain on the bearings. Couplings can be ordered on request.

Types of mounting

Flange mounting

The centering collar with fit f7 centers the encoder in relation to the shaft. It is fixed to the machine by means of three screws in the flange (Fig. 1).

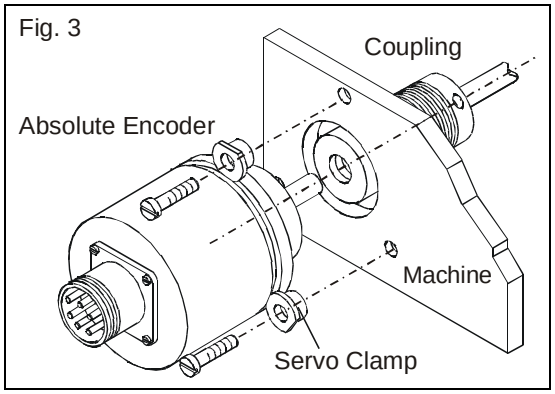
Fig. 2



Clamping brackets / Servo Clamp mounting

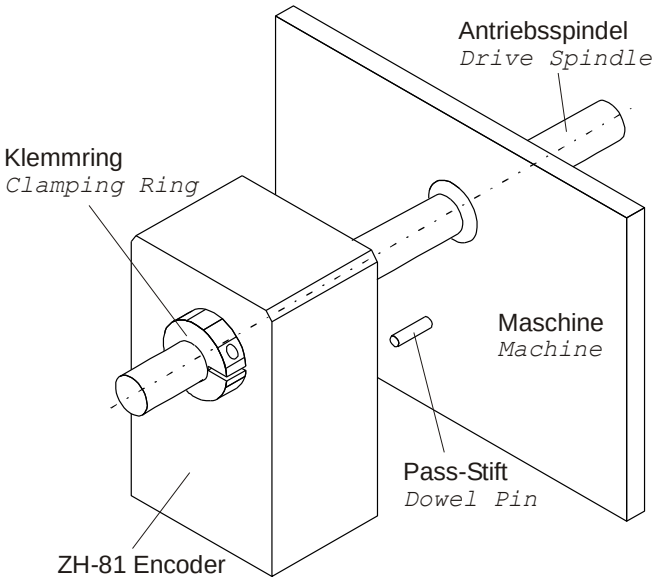
The centering collar with fit f7 centers the encoder in relation to the shaft. The encoder is fixed by means of 2 clamping brackets or 3 servo clamps (Fig. 2 and 3).

Fig. 3



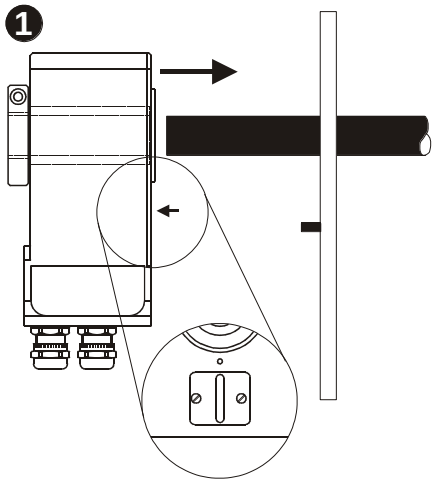
3.2 Production series ZH

Mounting via dowel pin

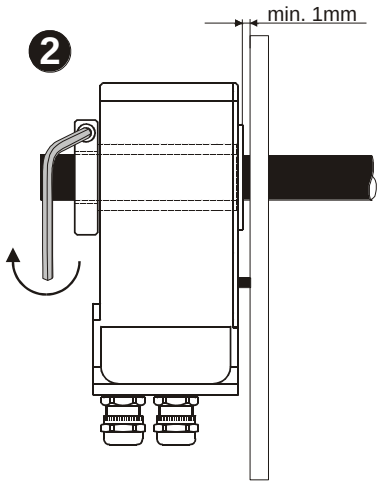


Movements of the encoder are prevented by a dowel pin on the machine side. For the mounting of the dowel pin the encoder on the rear side possesses a groove application 4H7, 7mm deep.

This way of mounting shouldn't be used for precision applications. Radial deviations of the shaft can cause an easy torsion of the encoder and cause thus an angular error.



Push encoder onto the machine shaft (groove insertion toward of the machine).

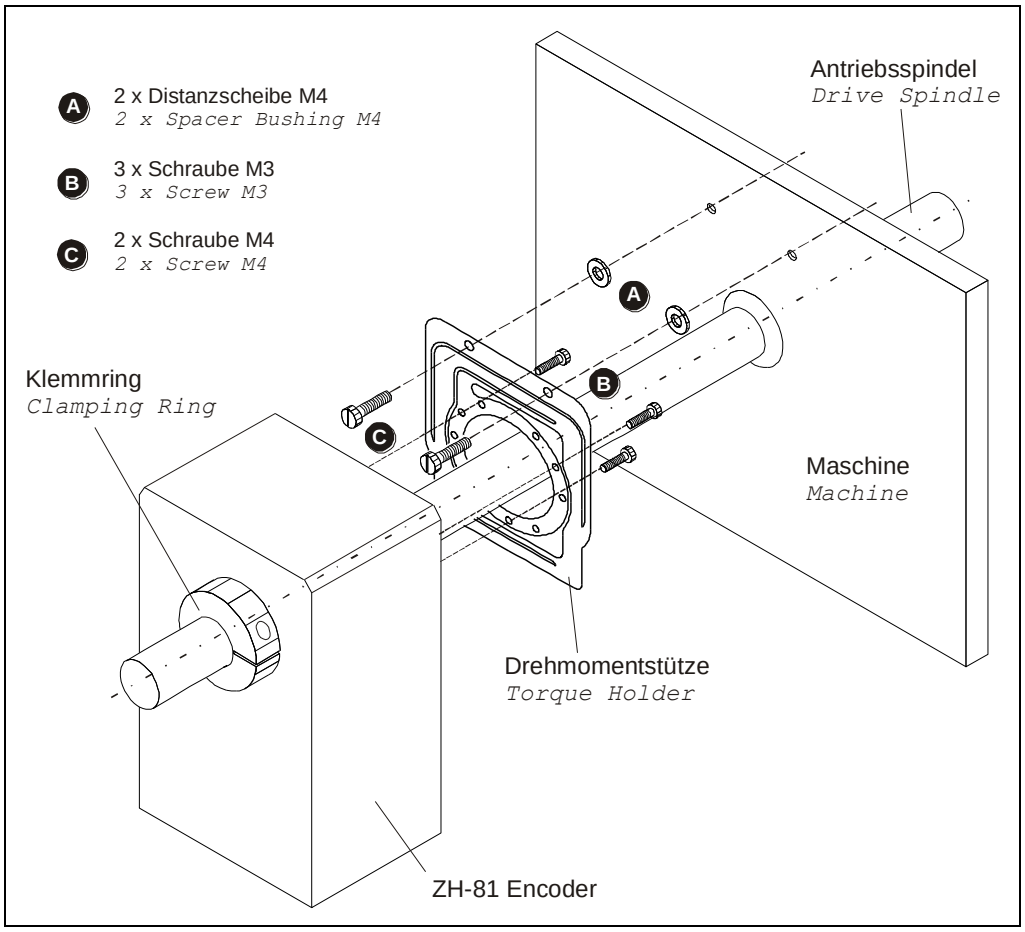


Position the encoder so that the pin fits in the seat of the groove insertion and a minimum distance of 1 mm is kept to the machine.

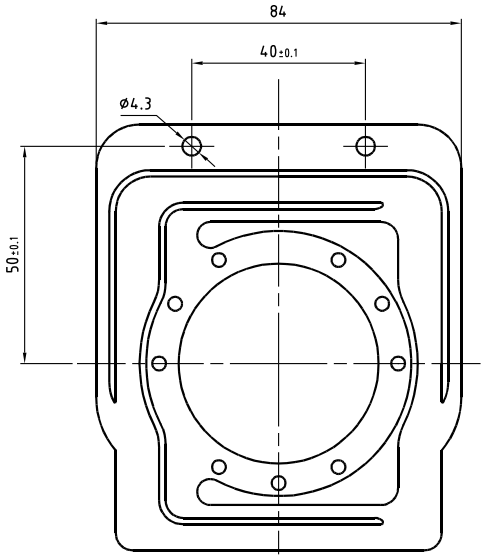
Protect encoder against slipping on the shaft and tighten clamping ring with the hexagon key (SW = 3).

Mounting via torque holder

The rotating of the encoder by the arising torque is prevented by a torque holder (sheet-metal spring). Additionally occurring axial or radial displacements of the drive shaft will be compensated and machine vibrations absorbed.

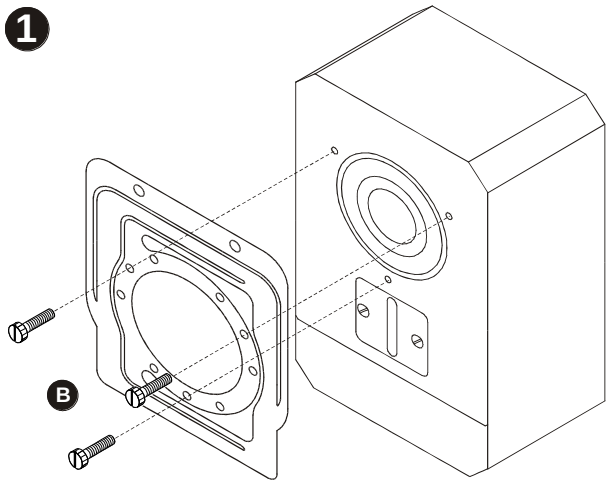
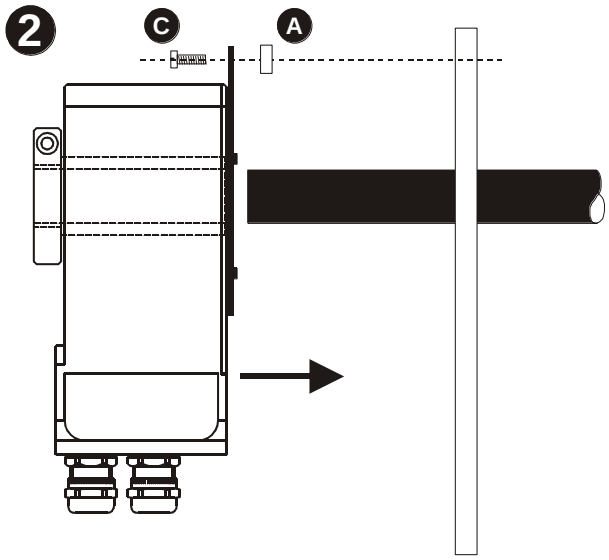
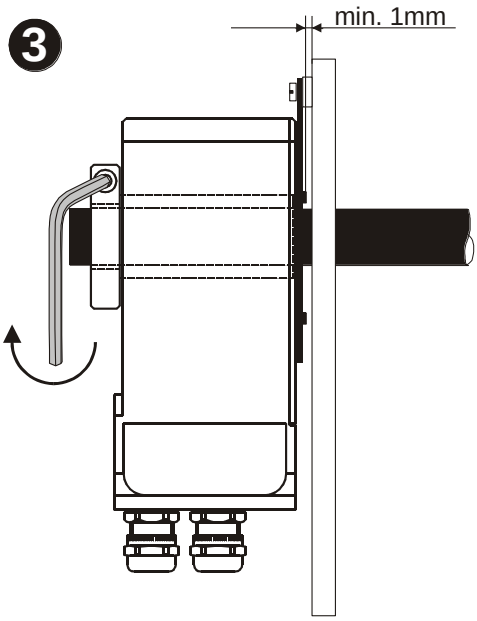


Mounting of the torque holder



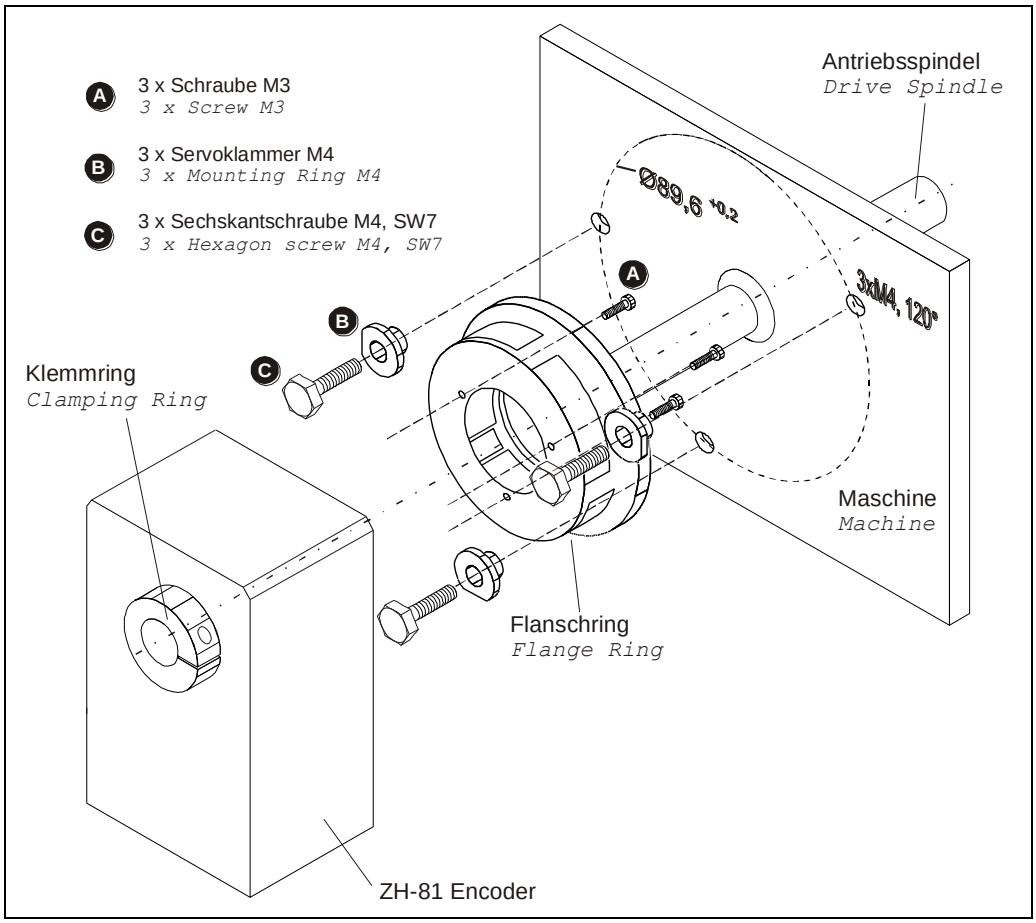
max. radial displacement V_r = R0,5 mm
max. axial displacement V_a = ±1 mm
Material: spring steel, t = 0,7 mm, stainless
Article-No.: page 45, chapter accessories

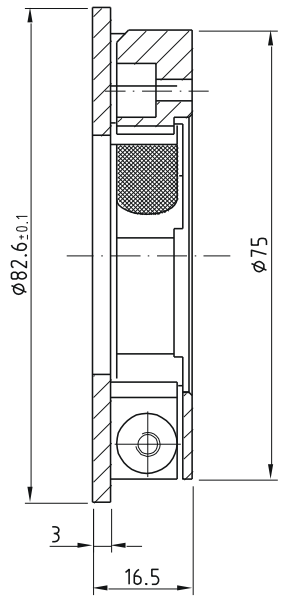
Note:
The indicated radial displacement is admissible as maximum value, but has tensions in the limits to the consequence. It must be guaranteed therefore that the continuous displacement is smaller than the indicated maximum value.

	Screw torque holder onto the rear side of the encoder.
	Push encoder onto the machine shaft. **Note:** The minimum thickness of the spacer bushing (A) corresponds to the screw head thickness (B) plus 1mm.
	Position the encoder so that the screws (C) can be screwed in easily into the machine part. Between the screw head end (B) and the machine a minimum distance of 1 mm must be kept. Protect encoder against slipping on the shaft and tighten clamping ring with the hexagon key (SW = 3).

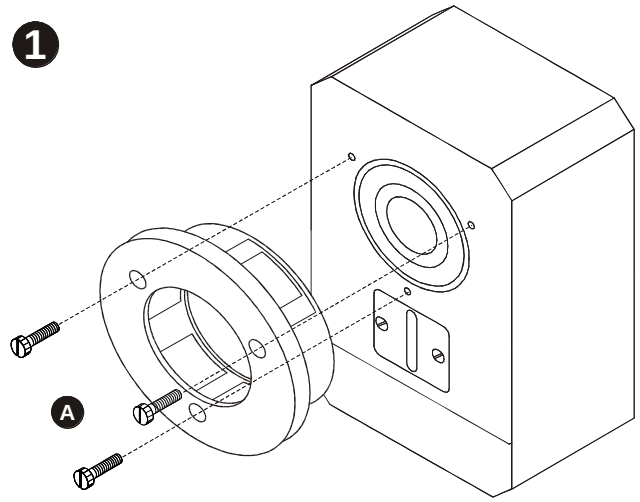
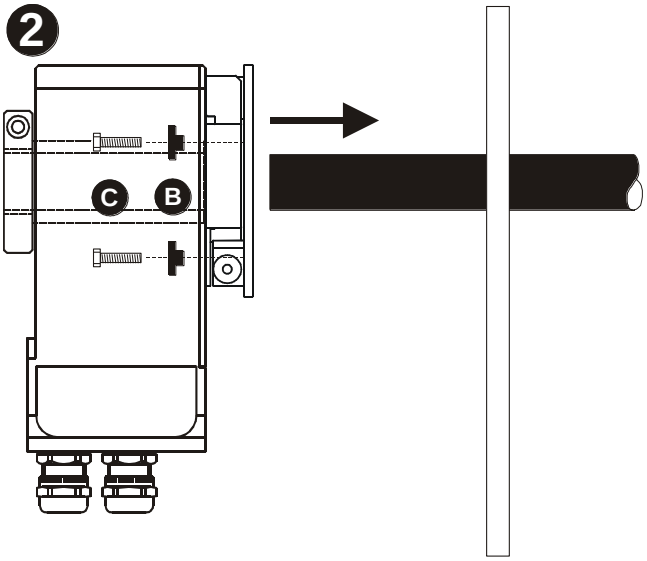
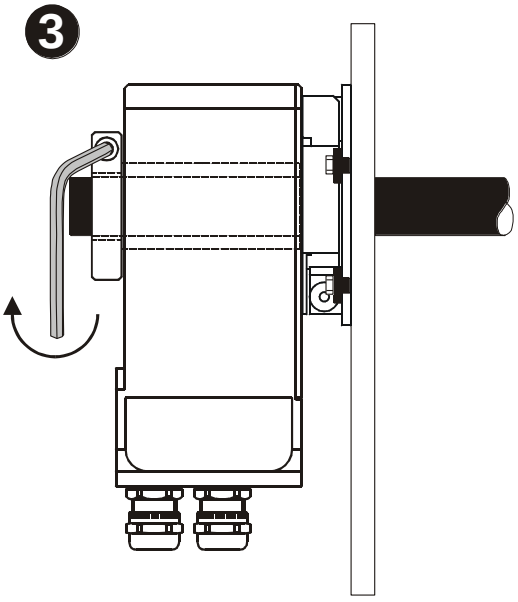
Mounting via flange ring

The rotating of the encoder by the arising torque is prevented by a flange ring. Additionally occurring axial or radial displacements of the drive shaft will be compensated and machine vibrations absorbed.





max. radial displacement V_r = R0,2 mm
max. axial displacement V_a = ±0,2 mm
Material: aluminium alloy
Article-No.: page 45, chapter accessories

	Screw flange ring onto the rear side of the encoder.
	Push encoder onto the machine shaft.
	Position the encoder so that the hexagonal screws (C) can be screwed in easily into the machine part. Protect encoder against slipping on the shaft and tighten clamping ring with the hexagon key (SW = 3).

4 Device description / start-up

4.1 PNO identification number

The encoder has the PNO ID number AAAB (hex). This number is reserved and filed with the PNO.

4.2 PNO encoder profile

The Profibus User Organization has issued an encoder profile defining the structure of an encoder on the Profibus. A copy of this profile can be obtained for a fee from the PNO office. Details of prices are available exclusively by the Profibus User Organization.

4.3 Operating requirements

Theoretically, the encoder can be connected to any Profibus-DP network, provided the PROFIBUS-DP master is capable of transmitting a parameter message. Similarly, the configuration software should be able to display the parameter structure specified in the device master file in order to allow the parameters to be entered. If this is not the case, the encoder cannot be programmed and runs on the bus with the maximum resolution, and without the possibility of scaling or adjustment as Class-1 encoder.

TR Electronic supplies a disk containing the device master file (.GSD). If the disk is not enclosed with this documentation, it can be ordered quoting reference number 490-00406.

For details of how to integrate the encoder into the interface of the DP master configuration software, please refer to the relevant documentation.

4.4 Setting the station address

The station address of the encoder is set exclusively via the rotary switch in the cover containing the connecting terminals. When the terminals are viewed from above (outgoing cable facing downwards), the left-hand switch sets the tens and the right-hand switch the units of the station address (see pin assignments in the appendix).
The addressing of the encoder is limited within the Profibus address area. Valid station addresses are 3 - 99.

Note
During adjustment of an invalid station address (0-2) the station address is set automatically via the encoder firmware to 3!
Possibly this circumstance can cause a duplicate of this station address and activate a bus conflict.

4.5 Bus termination

All PROFIBUS networks must be terminated by a resistor at the ends of the bus segments. The matching resistor and resistors for connecting to the data reference potential are located in the cover with the terminals, and can be connected via DIL switches if necessary, provided the encoder is the last station of a bus segment. As a general rule, both switches must always be switched on (if encoder is the last station) or switched off (if the encoder is not the last station), see also pin assignments in the appendix.

4.6 Baud rate

The Baud rate at which the PROFIBUS is operated may lie within the range of 9.6 kBaud to 12 Mbaud, and is detected automatically by the encoder.

4.7 Device master file

For devices with software version 5.2, the device master file of the encoder has the filename TR06AAAB.GSD.
To find out how to integrate these files into the system configuration, please refer to the documentation of the configuration program for the Profibus master.
The encoder also has two bitmap files named TRAAAB6N.BMP and TRAAAB6S.BMP which represent the encoder in the normal and faulty states respectively. These images also have to be integrated into the system configuration according to the instructions of the relevant documentation.

Download:

- TR06AAAB.GSD: www.tr-electronic.com/f/TR-ECE-ID-MUL-0007

The device master file is useable as of COMPROFIBUS version 5.0 (S5) or Simatic-Manager as of version 5.0 service pack 3 (S7).

4.8 Configuration and parameterization

4.8.1 Configuration

Configuration means specifying the length and type of process data and the manner in which they are to be handled. For this purpose, the configuration program usually provides an input list in which the user has to enter the appropriate identifiers.

Since the encoder supports several possible configurations, the identifier to be entered is preset depending on the required nominal configuration, so that all you have to do is enter the I/O addresses. The identifiers are deposited in the device master file.

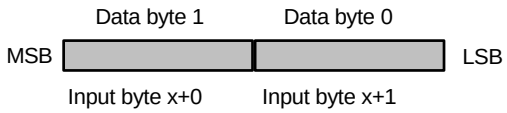
Depending on the required **nominal configuration**, the encoder will assign a different number of input and output words on the PROFIBUS.

In the following, the individual nominal configurations and the position of the communication bytes for the data transfer with the PROFIBUS-DP master are described.

4.8.1.1 PNO Class 1 16-bit resolution, identifier 0xD0

The encoder uses one input word only, which is consistently transferred via the bus.

Input word IW x



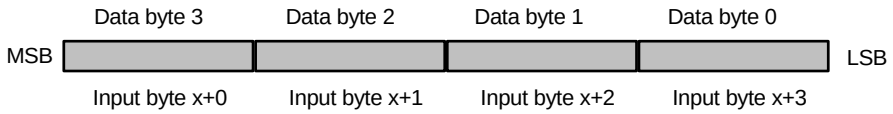
Relevant parameter data:

- Count sequence

4.8.1.2 PNO Class 1 32-bit resolution, identifier 0xD1

The encoder uses two input words only, which are consistently transferred via the bus.

Double input word ID x



Relevant parameter data:

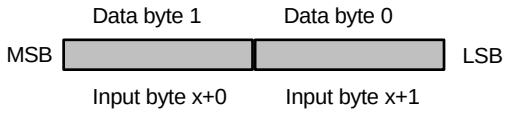
- Count sequence

Note:
In the case of configurations for CLASS 1, preset adjustment is not possible via the PROFIBUS, and only the code sequence can be changed. The encoder operates with the standard resolution specified on the rating plate. The diagnostic data are limited to 16 bytes.

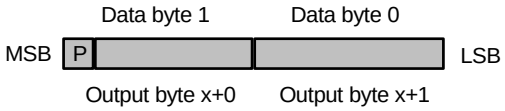
4.8.1.3 PNO Class 2 16-bit resolution, identifier 0xF0

The encoder uses one input word and one output word which are consistently transferred via the bus.

Input word IW x



Output word for preset adjustment OW x



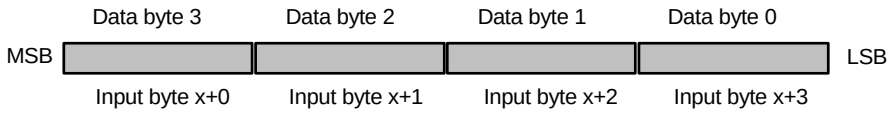
P = Preset adjustment

Relevant parameter data:
- Count sequence
- Class 2 functionality
- Commissioning diagnostics
- Scaling function
- Measuring units per revolution
- Total measuring range/units

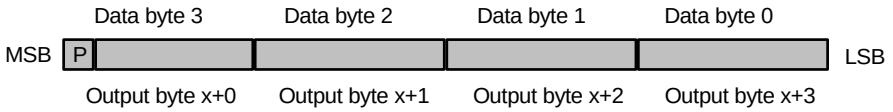
4.8.1.4 Class 2 32-bit resolution, identifier 0xF1

The encoder uses two input words and two output words which are consistently transferred via the bus.

Double input word ID x



Double output word for preset adjustment OD x



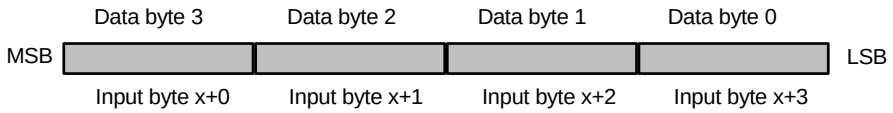
P = Preset adjustment

Relevant parameter data:
- Count sequence
- Class 2 functionality
- Commissioning diagnostics
- Scaling function
- Measuring units per revolution
- Total measuring range/units

4.8.1.5 TR-mode position, identifier 0xF1

The encoder uses two input words and two output words which are consistently transferred via the bus.

Double input word ID x



Double output word for preset adjustment OD x

P = Preset adjustment

Relevant parameter data:

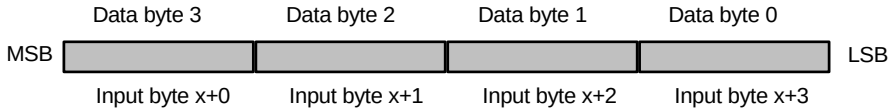
- Count sequence
- Commissioning diagnostics
- Commissioning function
- Short diagnostics (16 byte)
- Total measuring range/units
- Revolutions numerator
- Revolutions denominator
- SSI code[1]
- SSI data bit count
- Profibus code
- Preset value 1
- Preset value 2
- Limit switch lower limit
- Limit switch upper limit

[1] SSI on request, no standard

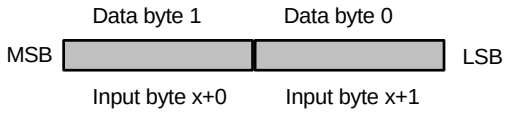
4.8.1.6 TR-mode position+Rpm., identifier 0xF1, 0xD0

The encoder uses two input words for the position plus a separate input word for the velocity, and two output words which are consistently transferred via the bus. The velocity is output with a sign in revolutions per minute and has an accuracy of +/- 1 rpm.

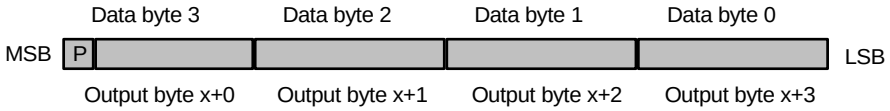
Double input word ID x



Input word IW x



Double output word for preset adjustment OD x



P = Preset adjustment

Relevant parameter data:

- Count sequence
- Commissioning diagnostics
- Commissioning function
- Short diagnostics (16 byte)
- Total measuring range/units
- Revolutions numerator
- Revolutions denominator
- SSI code[2]
- SSI data bit count
- Profibus code
- Preset value 1
- Preset value 2
- Limit switch lower limit
- Limit switch upper limit
- Rpm. multiplier [1/n rpm]

Important note:
The configurations designated "TR-mode" are not compatible with the PNO encoder profile in terms of the parameter record. The scaling function prescribed by the PNO profile is a simple special case of a general gear. Due to the extended 'gear' scaling function, additional parameters are therefore necessary in order to describe the gear fully.
In other words, the TR-specific modes represent an extension of the encoder function which is not restricted by its compatibility with the PROFIBUS-DP and certification.

[2] SSI on request, no standard

4.8.2 Parameterization

Parameterization means providing a PROFIBUS-DP slave with certain information required for operating purposes before it begins the cyclical exchange of process data. For example, the encoder requires data concerning the resolution, count direction, preset values, etc.
The configuration program for the PROFIBUS-DP master usually provides an input mask via which the user can enter the parameter data or select from lists. The structure of the input mask is stored in the device master file. The number and type of the parameters to be entered by the user depend on the chosen nominal configuration.

4.8.2.1 Code sequence

Defines the count direction of the encoder.

Selection	Default
• **Increasing clockwise** (with view on the shaft)	X
• Increasing counter clockwise	

4.8.2.2 Class 2 functionality

Defines the encoder's range of functions.
"Class 2 deactivated" means that the encoder only performs Class 1 functions, does not scale the position value and is not adjustable.

Selection		Default
• No	Class 2 functions deactivated	
• **Yes**	Class 2 activated	X

4.8.2.3 Commissioning diagnostics

Defines whether the encoder outputs an extended diagnostic message.

Selection		Default
• **Disabled**	Commissioning diagnostics deactivated	X
• Enabled	Commissioning diagnostic control activated	

4.8.2.4 Scaling function

Defines whether the encoder scales the position on the basis of the subsequent parameter. If Class 2 is deactivated, it does not scale the position value and is not adjustable.

Selection		Default
• Disabled	scaling deactivated	
• **Enabled**	scaling activated	X

4.8.2.5 Measuring units per revolution

Defines the number of increments displayed by the encoder for each revolution of the encoder shaft.

Input, 16-Bit resolution Class 2

• Lower limit	1 increment / revolution
• Upper limit	65536 increments per revolution (max.-value see rating plate)
• Default	**4096**

Input, 32-Bit resolution Class 2, TR-modes

• Lower limit	1 increment / revolution
• Upper limit	131072 increments per revolution (max.-value see rating plate)
• Default	**4096**

4.8.2.6 Total measuring range / units

Defines the total number of increments displayed by the encoder before it starts again from zero.

Input, 16-Bit resolution Class 2

• Lower limit	1 increment
• Upper limit	65536 increments (depending on the total capacity: max. Number of increments per rev. * max. Number of revolutions, see rating plate)
• Default	**4096**

Input, 32-Bit resolution Class 2, TR-modes

• Lower limit	1 increment
• Upper limit	2 147 483 647 increments (depending on the total capacity: max. Number of increments per rev. * max. Number of revolutions, see rating plate)
• Default	**4096**

4.8.2.7 Revolutions numerator

This parameter (together with the parameter "Revolutions denominator") defines the total number of revolutions displayed by the encoder before it starts again from zero.

Input

• Lower limit	1
• Upper limit	2 147 483 647
• Default	**1**

4.8.2.8 Revolutions denominator

This parameter (together with the parameter "Revolutions numerator") defines the total number of revolutions displayed by the encoder before it starts again from zero.

Input

• Lower limit	1
• Upper limit	65 535
• Default	**1**

4.8.2.9 SSI code

Defines the output code for the (optional) SSI interface.

Selection		**Default**
• **Gray**	Encoder outputs gray code	X
• Binary	Encoder outputs binary code	
• Shifted Gray	Encoder outputs shifted gray code	

4.8.2.10 SSI data bit count

Defines the number of data bits on the SSI interface.
Output format: MSB left-justified

Input

• Lower limit	8
• Upper limit	32
• Default	**24**

4.8.2.11 Profibus code

Defines the output code for the PROFIBUS interface.

Selection		Default
• Gray	Encoder outputs gray code	
• **Binary**	Encoder outputs binary code	X
• Shifted Gray	Encoder outputs shifted gray code	

4.8.2.12 Preset value 1

Defines the position value to which the encoder is adjusted with the leading edge of the 1st preset input. To suppress interference, however, the preset is only carried out if the preset signal is present without interruption during the entire response time of 30 ms. A re-execution of the preset is not possible until the input signal has been reset again and a filter time of 30 ms has been waited.

Input, depend on the total measuring length in increments

• Lower limit	0
• Upper limit	Programmed total measuring length in increments - 1
• Default	**0**

4.8.2.13 Preset value 2

Defines the position value to which the encoder is adjusted with the leading edge of the 2nd preset input. To suppress interference, however, the preset is only carried out if the preset signal is present without interruption during the entire response time of 30 ms. A re-execution of the preset is not possible until the input signal has been reset again and a filter time of 30 ms has been waited.

Input, depend on the total measuring length in increments

• Lower limit	0
• Upper limit	Programmed total measuring length in increments - 1
• Default	**0**

4.8.2.14 Commissioning function

Until now, function not implemented!

This parameter defines the setting of the commissioning function. In the standard setting "Disabled, no status" the encoder is compatible to encoders with version 3.x.

Selection	Default
• **Disabled no status (V3.x)**	X
• * Disabled with status	
• * Enabled with status	

*** Until now, function not implemented!**

4.8.2.15 Short diagnostics (16 byte)

With this parameter in the TR operation modes the number of diagnostic bytes can be limited from 6+51 bytes to 6+10 bytes. Therefore the encoder can be operated also to Profibus masters with older issue numbers in these modes.

Selection	Default
• **No**	X
• Yes	

4.8.2.16 Limit switch lower and upper limit

Is the status switched on (see commissioning function) the encoder can inform the master via a bit whether the actual value is within the limits.
It is valid:

Limit switch bit = 0 if lower limit < actual value < upper limit
Limit switch bit = 1 if actual value < lower limit or actual value > upper limit

Input lower limit, depend on the total measuring length in increments

• Lower limit	0
• Upper limit	Programmed total measuring length in increments - 1
• Default	**0**

Input upper limit, depend on the total measuring length in increments

• Lower limit	0
• Upper limit	Programmed total measuring length in increments - 1
• Default	**16 777 215**

4.8.2.17 Rpm. multiplier [1/n rpm]

With this parameter the information of the rotation speed can be scaled in arbitrary increments between 1/1 and 1/100 rpm.

Input

• Lower limit	1
• Upper limit	100
• Default	**1**

4.8.3 Scaling function

4.8.3.1 Nominal configurations PNO Class 2

The encoder supports the gear function for circulating applications, if the encoder is a multi-turn with 65536 revolutions (see rating plate). In this case the number of revolutions and the number of increments per revolution must be an integer. Otherwise the number of revolutions must be a power-of-two and can not exceed the value which is note on the rating plate.

The position value is decoded in binary form and balanced against a zero offset and the code sequence.

The position is calculated according to the following formula:

$$\text{Number of increments per revolution}^{*} = \frac{\text{Measuring length in increments}^{*}}{\text{Number of revolutions}}$$

Important Notes

If the number of revolutions is not a divisor of 65536, after switching off of the supply voltage may not be driven-on any more than 23000 revolutions. Otherwise the zero mark can be moved away and it is necessary to execute a new adjustment. In this maximum distance a safety margin is already contained. That applies to ***both*** driving directions and to ***any*** positions.

Reason:

With the integrated gear function the encoder measures directly 65536 revolutions. If the desired measuring length isn't a divisor of it, the encoder must shift the zero mark around the rest and save the zero mark permanently in time before exceeding its final value. Since the encoder in addition saves the number of shifts and is working with "Long Integer" numbers, measuring lengths up to 2147483647 (2^{31}-1) revolutions are possible.

Examples:

All powers-of-two, which are not larger than 65536, are divisors of it, e.g. 1, 4, 16, 256, 4096 or 65536 itself.
262144 is not a divisor of 65536, because the value is larger.
7 or 3600 aren't divisors of 65536, because these aren't powers-of-two.

If the Encoder can measure only 4096 or 1 revolution according to the rating plate instead of 65536, the gear function is not available. In this case the number of revolutions must be a power of two and can't exceed the value on the rating plate.

* Operator input

4.8.3.2 Nominal configuration TR-mode position and TR-mode position+Rpm.

The encoder supports the gear function for circulating applications, if the encoder is a multi-turn with 65536 revolutions (see rating plate). In this case the number of revolutions and the number of increments per revolution may be a proper fraction. Otherwise the number of revolutions must be a power-of-two and can not exceed the value which is note on the rating plate.

The position value is balanced against a zero offset, the code sequence and the entered gear parameters.

The number of increments per revolution is calculated according to the following formula:

$$\text{Number of increments per revolution} = \frac{\text{Measuring length in increments}^{*}}{\dfrac{\text{Number of revolutions numerator}^{*}}{\text{Number of revolutions denominator}^{*}}}$$

Gear limits:

Revolutions total:	max. 2 147 483 647 (2^{31}-1), min. ½
Revolutions numerator:	max. 2 147 483 647 (2^{31}-1), min. 1
Revolutions denominator:	max. 65 535 (2^{16}-1), min. 1
Increments total:	max. 2 147 483 647 (2^{31}-1), min. 5

Note

If the Encoder can measure only 4096 or 1 revolution according to the rating plate instead of 65536, the gear function is not available. In this case the number of revolutions must be a power of two and can't exceed the value on the rating plate.

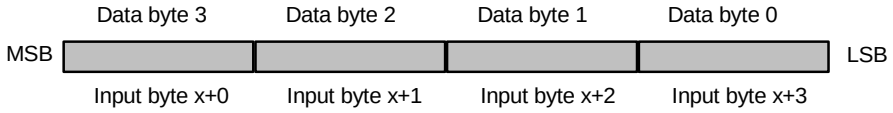
* Operator input

4.9 Preset adjustment

In 'Class 2' mode and in the 'TR - operation modes', the PROFIBUS can be used to adjust the encoder to any position value within a range of 0 to (measuring length in increments - 1).
This is done by setting the most significant bit "P" of the output data (2^{31} for configuration Class 2 - 32 bits or 2^{15} for configuration Class 2 - 16 bits).

Outputs

Inputs



The preset adjustment value transferred in data bytes 0 - 3 is accepted as the position value with the leading edge of bit 32 "P" (=bit 7 of data byte 3).
To suppress interference, however, the new position value is only carried out if the control bit 32 is present without interruption during the entire response time of 30 ms. A re-adjustment is not possible until the control bit has been reset again and a filter time of 30 ms has been waited.

4.10 Optional SSI interface

The encoder has a separate Synchronous Serial Interface via which its position value can be made available to a further evaluation unit (e.g. drive controller).
The position value output at this interface is identical to the value output on the PROFIBUS in terms of conversion and code sequence. In order to use this interface, a special cover with terminals for the SSI interface is necessary.

5 Trouble-shooting and diagnostic facilities

5.1 Visual indicators

The encoder is equipped with two LEDs in the bus cover: one red LED (BF) for indicating errors and one green LED (STAT) for indicating status information.
When the encoder is started up, both LEDs flicker briefly. Thereafter, the indications depend on the operational status of the encoder.

Red LED	Green LED	Cause	Remedy
off	off	Absence of voltage supply	Check voltage supply, wiring
		Bus cover not mounted and screwed on correctly	Check bus cover for correct seating
		Hardware error, encoder defective	Replace encoder
		Bus cover defective	Replace bus cover
on	flashing with a frequency of 10 Hz	Receiving incorrect parameters of the master. False parameter setting or false device-master-file embedded.	Check parameter setting and configuration. Valid device-master-files are: TR03AAAB, TR05AAAB or TR06AAAB.
off	flashing with a frequency of 10 Hz	Encoder defective and "Commission diagnostics" switched on.	Note on-line diagnosis of the station and exchange. For test purposes the "Commissioning diagnostics" can be switched off temporarily, to suppress the error message. But it is not recommendable to drive with these position data!
flashing with a frequency of 1 Hz	on	Connection to the Profibus master is missing or configuration is invalid: Profibus cable defective, not connected, polarized, false station address, false device-master-file.	- Check adjusted station address - Check configuring and operational status of Profibus master - Valid device-master-files are: TR03AAAB, TR05AAAB or TR06AAAB.
off	on	Parameter setting and configuration were successful, the bus is running. Normal operation, the encoder is in status DATA_EX.	

5.2 How to use the PROFIBUS diagnostics

In a Profibus system, the Profibus masters supply the process data to a so-called host system, e.g. a PLC-CPU. If a slave is not accessible, or no longer accessible, on the bus, or if the slave itself reports a fault, the master must communicate this fault to the host system in some form or other. There are several possible ways of doing this, the evaluation of which depends entirely on the application in the host system.
As a general rule, a host system cannot be stopped following the failure of only one component on the bus, but must respond appropriately to the failure as prescribed by the safety regulations. The master normally provides the host system initially with a summary diagnosis, which the host system reads cyclically from the master, and which serves to report the states of the individual bus stations to the application. If a station is reported to be faulty in the summary diagnosis, the host can request further data from the master (slave diagnostics), which then allow a more detailed evaluation of the causes. The indications thus obtained may either have been generated by the master, if the relevant slave does not respond (or no longer responds) to the master's requests, or they may come directly from the slave, if the slave itself reports a fault. The generation or reading of the diagnostic message between the master and slave takes place automatically, and does not have to be programmed by the user.
In addition to the standard diagnostic information, the encoder provides an extended diagnostic message according to Class 1 or Class 2 of the PNO encoder profile, depending on the nominal configuration.

5.2.1 Standard diagnosis

The standard DP diagnosis is structured as follows (always from the point of view of the master in relation to the slave).

	Byte no.	Meaning	
Standard diagnosis	Byte 1	Station status 1	General part
	Byte 2	Station status 2	
	Byte 3	Station status 3	
	Byte 4	Master address	
	Byte 5	Manufacturer's identifier HI byte	
	Byte 6	Manufacturer's identifier LO byte	
Extended diagnosis	Byte 7	Length (in bytes) of extended diagnosis, inclusively this byte	
	Byte 8 to Byte 241 (max)	Other device-specific diagnoses	Device-specific extensions

5.2.1.1 Station status 1

Standard diagnosis, byte 1	Bit 7	Master_Lock	Slave has been parameterized by another master (bit is set by master)
	Bit 6	Parameter_Fault	The last parameterization message to have been sent was rejected by the slave
	Bit 5	Invalid_Slave_Response	Set by the master if the slave does not respond
	Bit 4	Not_Supported	Slave does not support the requested functions
	Bit 3	Ext_Diag	Bit = 1 means that there is an extended diagnostic message from the slave
	Bit 2	Slave_Cfg_Chk_Fault	The configuration identifier(s) sent by the master was/were rejected by the slave
	Bit 1	Station_Not_Ready	Slave is not ready to exchange cyclical data
	Bit 0	Station_Non_Existent	The slave has been configured but is not present on the bus

5.2.1.2 Station status 2

Standard diagnosis, byte 2	Bit 7	Deactivated	Slave has been deleted from the poll list by the master
	Bit 6	Reserviert	
	Bit 5	Sync_Mode	Set by slave on receipt of SYNC command
	Bit 4	Freeze_Mode	Set by slave on receipt of FREEZE command
	Bit 3	WD_On	Slave watchdog is activated
	Bit 2	Slave_Status	Always set for slaves
	Bit 1	Stat_Diag	Static diagnosis
	Bit 0	Prm_Req	The slave sets this bit if it has to be re-parameterized and re-configured.

5.2.1.3 Station status 3

Standard diagnosis, byte 3

Bit 7	Ext_Diag_Overflow	Overflow in extended diagnosis
Bit 6 - 0	Reserviert	

5.2.1.4 Master address

Standard diagnosis, byte 4

In this byte, the slave enters the station address of the first master to have sent a valid parameterization message. If several masters access the bus simultaneously, their configuration and parameterization information must coincide exactly in order to ensure correct operation of the Profibus.

5.2.1.5 Manufacturer's identifier

Standard diagnosis, byte 5+6

In this bytes, the slave enters the manufacturer-specific identification number, an unambiguous number for each device type which is reserved and filed with the PNO. The identifier number of the encoder is AAAB(h).

5.2.1.6 Length (in byte) of extended diagnosis

Standard diagnosis, byte 7

If additional diagnostic information is available, the slave enters the number of bytes following the standard diagnosis here.

5.2.2 Extended diagnosis

In addition to the standard DP diagnostic message, the encoder also provides an extended diagnostic message according to the PNO encoder profile. This message varies in length depending on the chosen nominal configuration. In the configurations designated "TR-mode", the diagnostic message corresponds to PNO Class 2.
The following pages provide a general overview of the available diagnostic information. Which individual options your encoder actually supports can be read out from the device itself.

	Byte no.	Meaning	Class
Extended diagnosis	Byte 7	Length (in bytes) of extended diagnosis	1/2/TR
	Byte 8	Alarms	1/2/TR
	Byte 9	Operating status	1/2/TR
	Byte 10	Encoder type	1/2/TR
	Byte 11-14	Encoder resolution in increments per revolution (rotary) Encoder resolution in measuring increments (linear)	1/2/TR
	Byte 15-16	Number of resolvable revolutions	1/2/TR
	Byte 17	Additional alarms	2/TR
	Byte 18-19	Supported alarms	2/TR
	Byte 20-21	Warnings	2/TR
	Byte 22-23	Supported warnings	2/TR
	Byte 24-25	Profile version	2/TR
	Byte 26-27	Software version (firmware)	2/TR
	Byte 28-31	Operating hour counter	2/TR
	Byte 32-35	Offset value	2/TR
	Byte 36-39	Manufacturer's offset value	2/TR
	Byte 40-43	Number of increments per revolution	2/TR
	Byte 44-47	Measuring length in increments	2/TR
	Byte 48-57	Serial number	2/TR
	Byte 58-59	Reserved	Optional
	Byte 60-63	Manufacturer-specific diagnostics	Optional

5.2.2.1 Alarms

Extended diagnosis, byte 8

Bit	Meaning	= 0	= 1
Bit 0	Position error	No	Yes
Bit 1	Supply voltage faulty	No	Yes
Bit 2	Current consumption too high	No	Yes
Bit 3	Diagnosis	OK	Error
Bit 4	Memory error	No	Yes
Bit 5	Not applicable		
Bit 6	Not applicable		
Bit 7	Not applicable		

5.2.2.2 Operating status

Extended diagnosis, byte 9

Bit	Meaning	= 0	= 1
Bit 0	Code sequence	Increasing CW	Increasing CCW
Bit 1	Class-2 functions	No, not supported	Yes
Bit 2	Diagnosis	No, not supported	Yes
Bit 3	Status scaling function	No, not supported	Yes
Bit 4	Not applicable		
Bit 5	Not applicable		
Bit 6	Not applicable		
Bit 7	Not applicable		

5.2.2.3 Encoder type

Extended diagnosis, byte 10

Code	Meaning
00	Single-turn absolute encoder (rotary)
01	Multi-turn absolute encoder (rotary)

See encoder profile for other codes

5.2.2.4 Single-turn resolution

Extended diagnosis, byte 11 - 14

Via this bytes the hardware single-turn resolution of the encoder can be read out.

5.2.2.5 Number of resolvable revolutions

Extended diagnosis, byte 15 - 16

Via this bytes the maximum number of encoder revolutions can be read out. Single-turn encoders report 1 revolution. Multi-turn encoder can measure 12 or 16 revolution bits (see rating plate). If this value with 16 bits is not representable, 0 is reported.

5.2.2.6 Additional alarms

This byte is reserved for additional alarms, although no other alarms are implemented.

Extended diagnosis, byte 17

Bit	Meaning	= 0	= 1
Bit 0-7	Reserved		

5.2.2.7 Supported alarms

Extended diagnosis, byte 18 - 19

Bit	Meaning	= 0	= 1
Bit 0	Position error	Not supported	Supported
Bit 1	Supply voltage monitoring	Not supported	Supported
Bit 2	Current consumption monitoring	Not supported	Supported
Bit 3	Diagnostic routine	Not supported	Supported
Bit 4	Memory error	Not supported	Supported
Bit 5-15	Not applicable		

5.2.2.8 Warnings

Extended diagnosis, byte 20 - 21

Bit	Meaning	= 0	= 1
Bit 0	Frequency exceeded	No	Yes
Bit 1	Permissible temp. exceeded	No	Yes
Bit 2	Control reserve light	Not reached	Reached
Bit 3	CPU watchdog status	OK	Reset performed
Bit 4	Operating time warning	No	Yes
Bit 5-15	Battery charge	OK	Too low

5.2.2.9 Supported warnings

Extended diagnosis, byte 22 - 23

Bit	Meaning	= 0	= 1
Bit 0	Frequency exceeded	Not supported	Supported
Bit 1	Permissible temp. exceeded	Not supported	Supported
Bit 2	Control reserve light	Not supported	Supported
Bit 3	CPU watchdog status	Not supported	Supported
Bit 4	Operating time warning	Not supported	Supported
Bit 5-15	Reserved		

5.2.2.10 Profile version

Diagnostic bytes 24-25 indicate the version of the PNO encoder profile supported by the encoder. They consist of the revision number and revision index (e.g. 1.40 corresponds to 0000 0001 0100 0000 or 0140 (hexadecimal code))

Extended diagnosis, byte 24 - 25

Byte 24	Revision number
Byte 25	Revision index

5.2.2.11 Software version

Diagnostic bytes 26-27 indicate the internal software version of the encoder. They consist of the revision number and revision index (e.g. 1.40 corresponds to 0000 0001 0100 0000 or 0140 (hexadecimal code))

Extended diagnosis, byte 26 - 27

Byte 26	Revision number
Byte 27	Revision index

5.2.2.12 Operating hour counter

Extended diagnosis, byte 28 - 31

The diagnostic bytes represent an operating hour counter which is incremented by one digit every 6 minutes. The measuring unit for operating hours is thus 0.1 hours.
If this function is not supported, the operating hour counter is set to the maximum value FFFFFFFF(hexadecimal code).
ZE encoders count the operation hours. To keep the bus load small, a diagnostic telegram is sent with the latest counter state after every parameter setting or if an error must be reported. If everything is correct and only the counter has changed, no new diagnosis telegram is sent. Therefore at the on-line diagnosis the status is always displayed by the last parameter setting.

5.2.2.13 Offset value

Extended diagnosis, byte 32 - 35

The diagnostic bytes indicate the offset in relation to the absolute scanning position which is calculated during the execution of the preset function.

5.2.2.14 Manufacturer-specific offset value

Extended diagnosis, byte 36 - 39

The diagnostic bytes indicate an additional manufacturer-specific offset in relation to the absolute scanning position which is calculated during the execution of the preset function.

5.2.2.15 Number of increments per revolution

Extended diagnosis, byte 40 - 43

The diagnostic bytes indicate the configured increments per revolution of the encoder.

5.2.2.16 Measuring length in increments

Extended diagnosis, byte 44 - 47

The diagnostic bytes indicate the configured measuring lengths in increments of the encoder.

5.2.2.17 Serial number

Extended diagnosis, byte 48 - 57

The diagnostic bytes indicate the serial number of the encoder. If this function is not supported, asterisks are used (hexadecimal code 0x2A) ********** to indicate the configured measuring length in increments of the encoder.

5.2.2.18 Manufacturer-specific diagnostics

The encoder does not support any other manufacturer-specific diagnostics.

Important note

According to the PNO encoder profile, an encoder must set the bits 'Ext.diag' (extended diagnostic information available) and 'Stat.diag' (static error) in the event of an internal error being detected in the station status. This means that, in case of error, the encoder stops providing position data and is removed from the process image by the PROFIBUS master until the error bits are reset. It is not possible for the user to acknowledge the error via the PROFIBUS in this way.
This function is only guaranteed provided the "Commissioning diagnostics" function is activated.

5.3 Other faults

Fault	Cause	Remedy
Encoder step changes	Strong vibrations	Vibrations, shocks and jolts, e.g. on presses, are cushioned by so-called "shock modules". If the error persists despite these precautions, the encoder must be replaced.
	Electrical faults EMC	Electrical faults can be countered by means of insulating plastic flanges and couplings, and by data and power supply cables with twisted-pair conductors. The screening and wiring arrangement must conform to the assembly guidelines for PROFIBUS.
	Excessive axial and radial loading of shaft or scanning defect.	Couplings prevent mechanical strain on the shaft. If the error persists despite this precaution, the encoder must be replaced..
Profibus operates when the encoder is not connected, but indicates a fault when the bus cover is mounted on the encoder	PROFIBUS Data-A and Data-B reversed	Inspect all connections and conductors relating to the wiring of the encoder.

6 Appendix

6.1 Technical data

6.1.1 Electrical ratings

Operating voltage:	11-27 V DC
power consumption (without load):	≤ 3 watt
*** Output capacity:**	max. 31 bit
*** Resolution:**	1 - max. 131 072
Measurement range:	1 - max. 65 536 revolutions
*** Output code:**	Binary, Gray, shifted Gray
Standard baud rates:	9,6 kBaud to max. 12 Mbaud
*** Station addresses:**	3 - 99 with BCD-switches adjustable
Encoder interface:	PROFIBUS-DP according to DIN 19245 part 1-3
Special features:	Programming is performed via the parameterization message at the start-up of the encoder or PROFIBUS-DP master

Inputs (dependent on pin assignment)

* Preset 1:	electronic adjustment
* Preset 2:	electronic adjustment
Switching level:	"0" < +2 VDC, "1" > +8 VDC, max. 30 V DC

SSI-OUT data interface (optional)

Clock input:	Optocoupler
Data output:	RS422 (2-wire)
Clock rate:	80 kHz – 1 MHz
* Code:	Binary, Gray, shifted Gray, left-justified
* Number of data bits:	8 - 32

Operating temperature range

ZE encoder:	-20 to +80 °C
ZH encoder:	0 to +60 °C
Optional:	-30 to +100 °C

* programmable parameters

6.1.2 Mechanical ratings

6.1.2.1 ZE-Encoder

Mechanically permissible speed:	12 000 min^{-1}
Permissible shaft load:	40 N axial, 60 N radial (at end of shaft)
Minimum bearing lifetime:	3,9 x 10^{10} revolutions at:
Operating speed:	6000 min^{-1}
Shaft loading:	20 N axial, 30 N radial (at end of shaft)
Operating temperature:	60 °C
Mass:	ca. 0,7 kg
Max. angular acceleration:	≤ 10^4 rad/s^2
Moment of inertia:	2,5 x 10^{-6} kg m^2
Starting torque at 20 °C:	2 Ncm
Vibration, DIN IEC 68-2-6 (Sine 50-2000Hz):	≤ 100 m/s^2 (10 g)
Shock, DIN IEC 68-2-27 (11 ms):	≤ 1000 m/s^2 (100 g)

6.1.2.2 ZH-Encoder

Hollow shaft:	∅ 20 mm H7
Mechanically permissible speed:	3000 min^{-1}
Permissible shaft load:	dead-weight
Permissible parallel disalignment of the customer shaft:	± 0,2 mm
Minimum bearing lifetime:	3,9 x 10^{10} revolutions at:
Operating speed:	3000 min^{-1}
Operating temperature:	60°C
Mass:	ca. 1,3 kg
Max. angular acceleration:	≤ 10^4 rad/s^2
Moment of inertia:	57,2 x 10^{-6} kg m^2
Vibration, DIN IEC 68-2-6 (Sine 50-2000Hz):	≤ 100 m/s^2 (10g)
Shock, DIN IEC 68-2-27 (11 ms):	≤ 500 m/s^2 (50g)

6.2 Mounting accessories, ZH

Article name	Art-No.
Torque holder	49 - 740 - 024
Flange ring	85-900-059
Servo clamp	3 x 49-115-001