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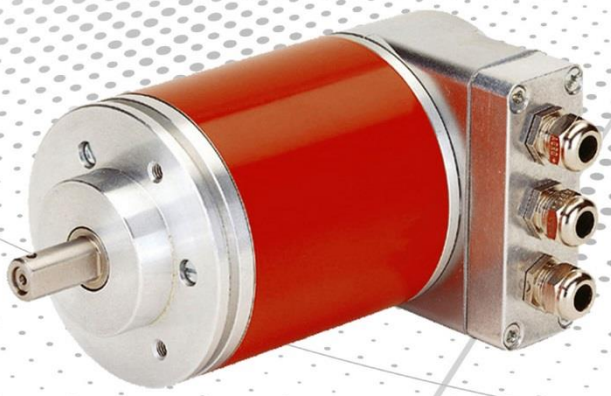
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# Absolute rotary encoder series CE-65



_Additional safety instructions
_Installation
_Commissioning
_Parameterization
_*Cause of faults and remedies*

**User Manual**

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# Revision index

| Revision | Date | Index |
|---|---|---|
| First release | 09/19/11 | 00 |
| New design | 02/10/16 | 01 |


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# 1 Basic safety instructions

## 1.1 Definition of symbols and instructions

| | |
|---|---|
| **⚠ WARNING** | means that death or serious injury can occur if the required precautions are not met. |
| **⚠ CAUTION** | means that minor injuries can occur if the required precautions are not met. |
| ***NOTICE*** | means that damage to property can occur if the required precautions are not met. |
|  | indicates important information or features and application tips for the product used. |
|  | means that appropriate ESD-protective measures are to be considered according to DIN EN 61340-5-1 supplementary sheet 1. |

## 1.2 Obligation of the operator before start-up

As an electronic device the measuring system is subject to the regulations of the EMC Directive.

It is therefore only permitted to start up the measuring system if it has been established that the system/machine into which the measuring system is to be fitted satisfies the provisions of the EC EMC Directive, the harmonized standards, European standards or the corresponding national standards.

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## 1.3 General risks when using the product

The product, hereinafter referred to as ***"measuring system"***, is manufactured according to state-of-the-art technology and accepted safety rules. ***Nevertheless, improper use can pose a danger to life and limb of the user or third parties, or lead to impairment of the measuring system or other property!***

Only use the measuring system in a technically faultless state, and only for its designated use, taking safety and hazard aspects into consideration, and observing this ***User Manual***! Faults which could threaten safety should be eliminated without delay!

## 1.4 Intended use

The measuring system is used to measure angular motion and to condition the measurement data for the subsequent control of industrial control processes.

**Intended use also includes:**

- observing all instructions in these user manual and the interface-specific User Manual,
- observing the nameplate and any prohibition or instruction symbols on the measuring system,
- observing the enclosed documentation, e.g. product insert, connector configurations etc.,
- observing the operating instructions from the machine or system manufacturer,
- operating the measuring system within the limit values specified in the technical data.

## 1.5 Non-intended use

***Danger of death, physical injury and damage to property in case of non-intended use of the measuring system!***

**⚠ WARNING**

- As the measuring system **does not constitute a safety component** according to the EC machinery directive, a plausibility check of the measuring system values must be performed through the subsequent control system.

***NOTICE***

- It is mandatory for the operator to integrate the measuring system into his own safety concept.
- The following area of use is especially forbidden:
  - In environments where there is an explosive atmosphere
  - for medical purposes


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## 1.6 Warranty and liability

The General Terms and Conditions ("Allgemeine Geschäftsbedingungen") of TR-Electronic GmbH always apply. These are available to the operator with the Order Confirmation or when the contract is concluded at the latest. Warranty and liability claims in the case of personal injury or damage to property are excluded if they result from one or more of the following causes:

- Non-designated use of the measuring system.
- Improper assembly, installation, start-up and programming of the measuring system.
- Incorrectly undertaken work on the measuring system by unqualified personnel.
- Operation of the measuring system with technical defects.
- Mechanical or electrical modifications to the measuring systems undertaken autonomously.
- Repairs carried out autonomously.
- Third party interference and Acts of God.

## 1.7 Organizational measures

- The User Manual must always be kept accessible at the place of use of the measuring system.
- In addition to the User Manual, generally applicable legal and other binding accident prevention and environmental protection regulations are to be observed and must be mediated.
- The respective applicable national, local and system-specific provisions and requirements must be observed and mediated.
- The operator is obliged to inform personnel on special operating features and requirements.
- The personnel instructed to work with the measuring system must have read and understood the User Manual, especially the chapter “Basic safety instructions” prior to commencing work.
- The nameplate and any prohibition or instruction symbols applied on the measuring system must always be maintained in a legible state.
- Do not undertake any mechanical or electrical modifications on the measuring system, apart from those explicitly described in this User Manual.
- Repairs may only be undertaken by the manufacturer or a facility or person authorized by the manufacturer.

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## 1.8 Personnel qualification; obligations

- All work on the measuring system must only be carried out by qualified personnel.

  Qualified personnel includes persons, who, through their training, experience and instruction, as well as their knowledge of the relevant standards, provisions, accident prevention regulations and operating conditions, have been authorized by the persons responsible for the system to carry out the required work and are able to recognize and avoid potential hazards.

- The definition of “Qualified Personnel” also includes an understanding of the standards VDE 0105-100 and IEC 364 (source: e.g. Beuth Verlag GmbH, VDE-Verlag GmbH).

- Define clear rules of responsibilities for the assembly, installation, start-up and operation. The obligation exists to provide supervision for trainee personnel !


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## 1.9 Safety information's

**⚠ WARNING**

**NOTICE**

- ***Destruction, damage or malfunctions of the measuring system and risk of physical injury!***
  - ➢ De-energize the system before carrying out wiring work or opening and closing electrical connections.
  - ➢ Do not carry out welding if the measuring system has already been wired up or is switched on.

**NOTICE**

- ➢ Ensure that the area around the assembly site is protected from corrosive media (acid, etc.).
- ➢ Avoid any shocks (e.g. hammer-blow) on the shaft while mounting.
- ➢ Do not open the measuring system.



- ***The measuring system contains electrostatically endangered circuit elements and units which can be destroyed by an improper use.***
  - ➢ Contacts of the measuring system connection contacts with the fingers are to be avoided, or the appropriate ESD protective measures are to be applied.



- ***Disposal***

  If disposal has to be undertaken after the life span of the device, the respective applicable country-specific regulations are to be observed.
- ***Device designs***

  The technical details for customer-specific device designs, including connection technology, may differ from the designs described here. In case of doubt, the manufacturer should be consulted, specifying the item number.

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# 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.

## Notes on transportation

Storage temperature: -30 to +80 °C
Store in a dry place


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# 3 Technical data



The information specified in the Technical Data refers to the TR standard devices.

The nameplate and any datasheet included with the device are therefore to be observed!

All dimensions are to be found in the customer-specific drawings.

## 3.1 Electrical characteristics

| | |
|---|---|
| **Operating voltage:** | 11-27 V DC (+/- 5% residual ripple) |
| **Max. current consumption:** | < 350 mA at 11 V DC, < 150 mA at 27 V DC |
| **Output capacity:** | Max. 25 bits |
| **Resolution:** | Max. 8192 increments per revolution (13 bits) |
| **Measuring range:** | 8192 revolutions |
| **Output code:** | Binary |
| **Baud rate:** | 12 Mbps |
| **Encoder interface:** | PROFIBUS-DP acc. 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 |
| **CAM level:** | Low: 0…1 V, High: VDC – 2 V |
| **CAM current:** | 30 mA |
| **Operating temperature range:** | 0 to +60 °C |

## 3.2 Mechanical characteristics

| | |
|---|---|
| **Mechanically permissible speed:** | 6000 rpm |
| **Permissible shaft load:** | 40 N axial, 60 N radial (at end of shaft) |
| **Minimum bearing lifetime:** | $3.9 \times 10^{10}$ revolutions at: |
| Operating speed: | 3000 rpm |
| Shaft loading: | 20 N axial, 30 N radial (at end of shaft) |
| Operating temperature: | 60 °C |
| **Max. angular acceleration:** | $\leq 10^4$ rad/s$^2$ |
| **Moment of inertia:** | 2.5 x 10-$^6$ kg m$^2$ |
| **Starting torque at 20°C:** | 2 Ncm |
| **Vibration loading (50-2000Hz):** | $\leq$ 100 m/s$^2$ |
| **Shock loading (11ms):** | $\leq$ 1000 m/s$^2$ |

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# 4 Mounting

### Encoder shaft drive

Encoders of the CE series are connected to the drive shaft by 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.

### 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).

### Clamping bracket mounting

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

Fig. 1

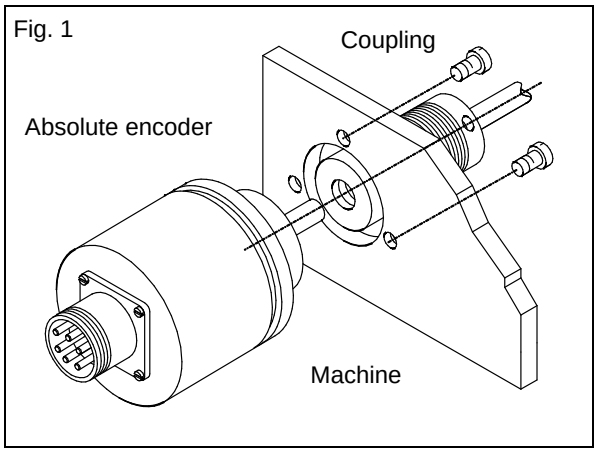
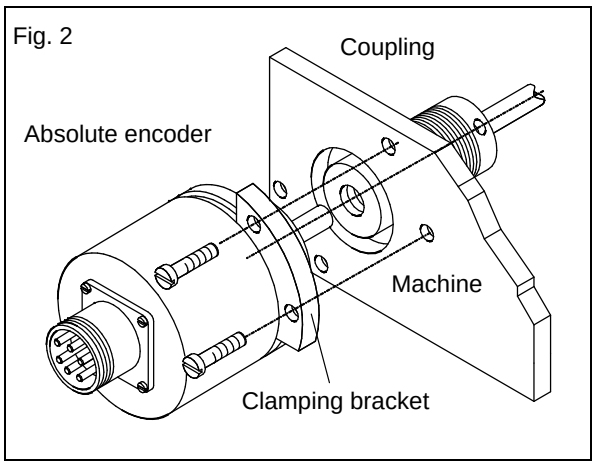



Fig. 2





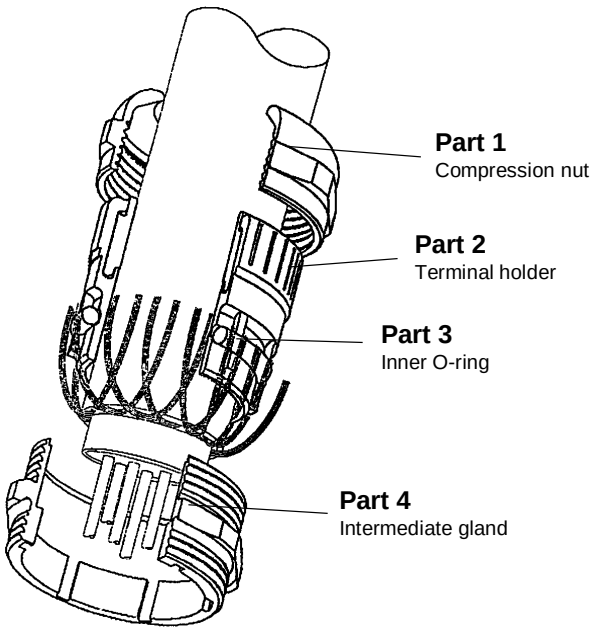
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## 4.1 Connecting the Cable Screening to the Bus-Cap

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).




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# 5 Device description / start-up

## 5.1 PNO identification number

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

## 5.2 PNO certificate

The encoder has passed a certification test by an independent test laboratory of the Profibus User Organization and is certified under the number Z00319. The relevant documents are held by TR Electronic and the PNO.

## 5.3 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.

## 5.4 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.

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

## 5.5 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.
The addressing of the encoder is limited within the Profibus address area. Valid station addresses are 3 - 99.
If an invalid station address is set, the device will not start up and the LEDs will not be illuminated.


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## 5.6 PROFIBUS – interface

All devices are connected in a bus structure (line). Up to 32 subscribers (master or slaves) can be connected together in a segment.
The bus is terminated with an active bus termination at the beginning and end of each segment. For stable operation, it must be ensured that both bus terminations are always supplied with voltage. The bus termination can be switched in the measuring system connector hood. 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).

Repeaters (signal amplifiers) have to be used with more than 32 subscribers or to expand the network scope in order to connect the various bus segments.

All cables used must conform with the PROFIBUS specification for the following copper data wire parameters:

| **Parameter** | **Cable type A** |
|---|---|
| Wave impedance in Ω | 135...165 at a frequency of 3...20 MHz |
| Operating capacitance (pF/m) | 30 |
| Loop resistance (Ω/km) | ≤ 110 |
| Wire diameter (mm) | > 0.64 |
| Wire cross-section (mm²) | > 0.34 |

The PROFIBUS transmission speed may be set between 9.6 kBit/s and 12 Mbit/s and is automatically recognized by the measuring system. It is selected for all devices on the bus at the time of commissioning the system.

The range is dependent on the transmission speed for cable type A:

| ***Baud rate (kbits/s)*** | 9.6 | 19.2 | 93.75 | 187.5 | 500 | 1500 | 12000 |
|---|---|---|---|---|---|---|---|
| ***Range / Segment*** | 1200 m | 1200 m | 1200 m | 1000 m | 400 m | 200 m | 100 m |

A shielded data cable must be used to achieve high electromagnetic interference stability. The shielding should be connected with low resistance to protective ground using large shield clips at both ends. It is also important that the data line is routed separate from power current carrying cables if at all possible. At data speed ≥ 1.5 Mbit, drop lines should be avoided under all circumstances.

The measuring system connector hood offers the possibility of connecting the inward and outward data cables directly to the removable connector hood. This avoids drop lines and the bus connector can be connected to and disconnected from the bus at any time without interruption of data traffic.



***The PROFIBUS guidelines and other applicable standards and guidelines are to be observed to insure safe and stable operation!***

***In particular, the applicable EMC directive and the shielding and grounding guidelines must be observed!***

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## 5.7 Device master file

The device master file of the encoder has the filename ***"TR08AAAB.GSE"***. To find out how to integrate this file into the system configuration, please refer to the documentation of the configuration program for the Profibus master. The encoder also has a bitmap file named ***"TRAAAB5N.BMP"***.

* Usable as of COMPROFIBUS version 5.0 (S5) or STEP7 as of version 5.0 service pack 3 (S7).

**Download:**

- www.tr-electronic.de/f/TR-ECE-ID-MUL-0009


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## 5.8 Configuration and parameterization

### 5.8.1 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.

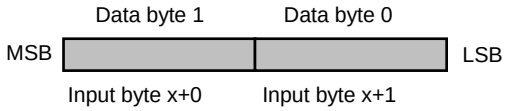
Depending on the required **nominal configuration**, the encoder will assign a different number of input and output words on the PROFIBUS.

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.

#### 5.8.1.1 Class 1 16-bit resolution, identifier D0 (HEX):

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

*Input word IW x*



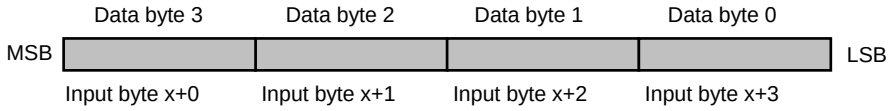

Relevant parameter data:

- Count direction (Zählrichtung)

#### 5.8.1.2 Class 1 32-bit resolution, identifier D1 (HEX):

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

*Double input word ID x*




Relevant parameter data:

- Count direction (Zählrichtung)

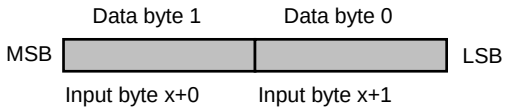
***In the case of configurations for CLASS 1, preset adjustment is not possible via the PROFIBUS, and only the code sequence can be changed. The encoder operates with the standard resolution specified on the rating plate. The diagnostic data are limited to 16 bytes.***

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#### 5.8.1.3 Class 2 16-bit resolution, identifier F0 (HEX):

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*



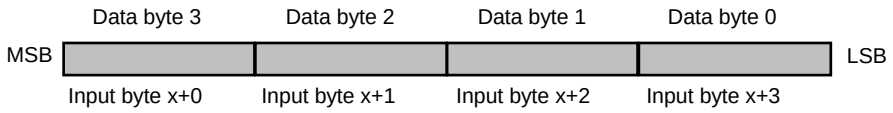

Relevant parameter data:

- Count direction (Zählrichtung)
- Class 2 functionality (on/off) (Klasse 2 ein/ausschalten)
- Scaling function (on/off) (Skalierungsfunktion ein/ausschalten)
- Commissioning diagnostic control (on/off) (Selbstmeldende Diagnose ein/ausschalten)
- Measuring units per revolution (Schritte pro Umdrehung)
- Total measuring range (Messlänge in Schritten)

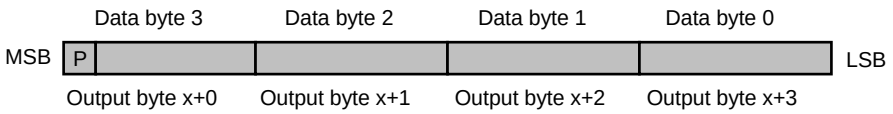
#### 5.8.1.4 Class 2 32-bit resolution, identifier F1 (HEX):

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*




Relevant parameter data:

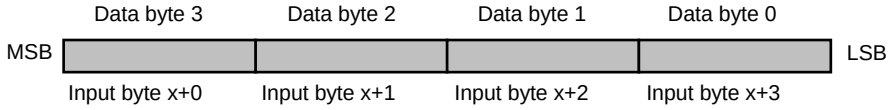
- Count direction (Zählrichtung)
- Class 2 functionality (on/off) (Klasse 2 ein/ausschalten)
- Scaling function (on/off) (Skalierungsfunktion ein/ausschalten)
- Commissioning diagnostic control (on/off) (Selbstmeldende Diagnose ein/ausschalten)
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- Total measuring range (Messlänge in Schritten)


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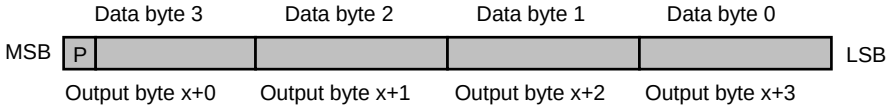
### 5.8.1.5 TR-mode position, identifier F1 (HEX):

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*




Relevant parameter data:

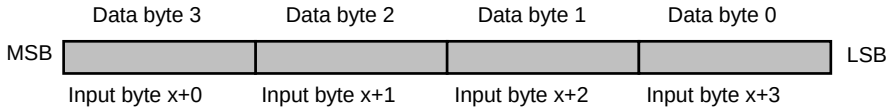
- Count direction (Zählrichtung)
- Comissioning diagnostic control (Diagnose Meldemodus ein/ausschalten)
- Total measuring range (Messlänge in Schritten)
- Revolutions numerator (Umdrehungen Zähler)
- Revolutions denominator (Umdrehungen Nenner)
- Code PROFIBUS interface (Ausgabecode der PROFIBUS-Schnittstelle)
- Preset 1 value (1. Presetvorwahlwert für 24V Eingänge)
- Preset 2 value (2. Presetvorwahlwert für 24V Eingänge)
- Short Diagnostics (Kurze Diagnose)

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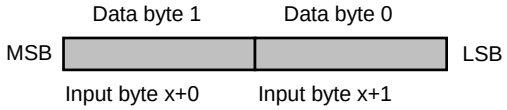
### 5.8.1.6 TR-mode position + cam + velocity, identifier F1 (HEX):

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.

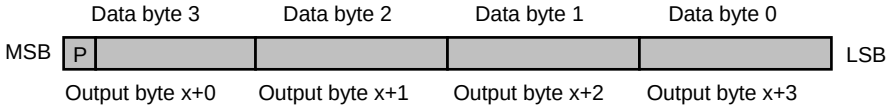
*Double input word ID x*




*Input word IW x*




*Double output word for preset adjustment OD x*




Relevant parameter data:

- Count direction (Zählrichtung)
- Comissioning diagnostic control (Diagnose Meldemodus ein/ausschalten)
- Total measuring range (Messlänge in Schritten)
- Revolutions numerator (Umdrehungen Zähler)
- Revolutions denominator (Umdrehungen Nenner)
- Cam programming see chapter “Cams”, page 24
- Code PROFIBUS interface (Ausgabecode der PROFIBUS-Schnittstelle)
- Preset 1 value (1. Presetvorwahlwert für 24V Eingänge)
- Preset 2 value (2. Presetvorwahlwert für 24V Eingänge)
- Short Diagnostics (Kurze Diagnose)
- Speed [1/n rpm] (Geschwindigkeit [1/n U/min])



***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.***


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### 5.8.2 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.

#### 5.8.2.1 Code sequence (Zählrichtung):

Defines the count direction of the encoder.

**Selection**

- Increasing clockwise (steigend im Uhrzeigersinn) = default
- Increasing counter-clockwise (fallend im Uhrzeigersinn)

#### 5.8.2.2 Class 2 functionality (Klasse 2 Funktionen):

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**

- No (Class 2 functions deactivated) = default
- Yes (Class 2 activated)

#### 5.8.2.3 Commissioning diagnostic control:

Defines whether the encoder outputs an extended diagnostic message.

**Selection**

- Disabled (Commissioning diagnostic control deactivated) = default
- Enabled (Commissioning diagnostic control activated)

#### 5.8.2.4 Scaling function control (Skalierungsfunktion):

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**

- Disabled (scaling deactivated) = default
- Enabled (scaling activated)

#### 5.8.2.5 Measuring units per revolution (Anzahl Schritte pro Umdrehung):

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

**Input**

- Lower limit: 1 increment / revolution
- Upper limit: 8192 increments per revolution (depending on capacity - marked on rating plate)
- Default value: 4096

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#### 5.8.2.6 Total measuring range [units] (Messlänge in Schritten)

This parameter defines the total number of increments displayed by the encoder before it starts again from zero.

**Inputs**

- Lower limit 16
- Upper limit 33554432 (depending on the total capacity, which is calculated by multiplying the max. number of increments per revolution and the maximum number of revolutions. These details are marked on the rating plate.)
- Default value: 16777216

#### 5.8.2.7 Revolutions numerator (Umdrehungen Zähler)

Together with the parameter Revolutions denominator, these parameters define the total number of revolutions displayed by the encoder before it starts again from zero.

**Inputs**

- Lower limit 1
- Upper limit 62464
- Default value: 4096

#### 5.8.2.8 Revolutions denominator (Umdrehungen Nenner)

Together with the parameter Revolutions numerator, these parameters define the total number of revolutions displayed by the encoder before it starts again from zero.

- Lower limit 1
- Upper limit 100
- Default value: 1

#### 5.8.2.9 Code PROFIBUS interface (Code für PROFIBUS-Schnittstelle):

Defines the output code for the PROFIBUS interface.

**Selection**

- Gray (encoder supplies Gray code)
- Binary (encoder supplies binary code) = default

#### 5.8.2.10 Preset 1 value [units]

This parameter 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.

The inputs depend on the total measuring length in increments

- Lower limit 0
- Upper limit total measuring length in increments - 1
- Default value 1


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### 5.8.2.11 Preset 2 value [units]

This parameter 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.

The inputs depend on the total measuring length in increments

- Lower limit 0
- Upper limit total measuring length in increments - 1
- Default value 2

### 5.8.2.12 Short diagnostic (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**
- No = default
- Yes

### 5.8.2.13 Cams (Nocken)

Default value = 0
Output 1, Cam 1, start = x
Output 1, Cam 1, stop = x
: : :
Output 1, Cam 5, start = x
Output 1, Cam 5, stop = x

Output 2, Cam 1, start = x
Output 2, Cam 1, stop = x
: : :
Output 2, Cam 5, start = x
Output 2, Cam 5, stop = x
etc up to :
Output 4, Cam 1, start = x
Output 4, Cam 1, stop = x
: : :
Output 4, Cam 5, start = x
Output 4, Cam 5, stop = x

### 5.8.2.14 Speed [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.

- Lower limit 1
- Upper limit 100
- Default value 1

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## 5.8.3 Scaling function

### 5.8.3.1 Nominal configurations PNO Class 1+2

The encoder does not support a gear function. 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:

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



***When entering the parameterization data, make sure the parameters 'Measuring length in increments' and 'Number of increments per revolution' are chosen so that the quotient of the two parameters is a second power.***
***If this is not the case, the encoder will correct the measuring length in increments to the next smallest second power in revolutions. The number of increments per revolution remains constant.***
***The re-calculated measuring length in increments can be read out via the extended diagnostic information for Class 2 and is always smaller than the predefined measuring length. Therefore it can be that the actually needed total increment number is exceeded and the encoder generates a zero-point changeover before reaching the maximum mechanical displacement distance.***

***Since the internal absolute position (before the encoder was scaled and a zero-point adjustment was executed) recurs periodically after 4096 revolutions, at rotating applications (endless driving to the same direction, the number of revolutions is not a power of two) it comes inevitably to offsets.***
***For such applications, one of the TR - nominal configurations has to be used.***

* Operator input


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### 5.8.3.2 Nominal configuration TR-mode position and TR-mode position+cam+velocity

The encoder supports the gear function for rotating applications. 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:

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

Gear limits:

| | |
|---|---|
| Maximum no. of revolutions | 62464 |
| Minimum no. of revolutions | 1 |
| Maximum no. of increments per revolution | 8192 |
| Minimum denominator | 1 |
| Maximum denominator | 100 |



***For rotating applications (endless driving to the same direction, the number of revolutions must not to be a power of two), one of the TR - nominal configurations must to be used.***

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## 5.9 Preset adjustment

**⚠ WARNING**

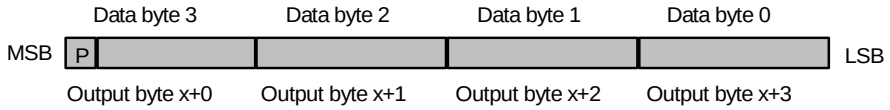
***NOTICE***

***Risk of injury and damage to property by an actual value jump when the Preset adjustment function is performed!***

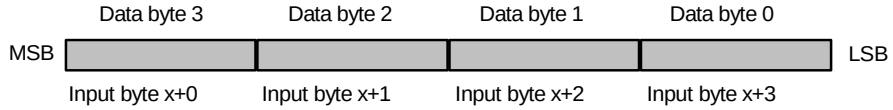
- The preset adjustment function should only be performed when the measuring system is at rest, otherwise the resulting actual value jump must be permitted in the program and application!

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 bits of the output data ($2^{31}$ for configuration Class 2 - 32 bits or $2^{15}$ for configuration Class 2 - 16 bits).

**Outputs**




**Inputs**

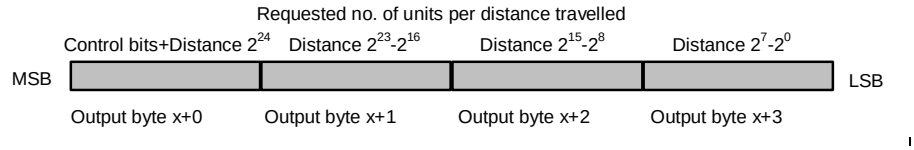



The preset adjustment value transferred in data bytes is accepted as position value with the leading edge of bit 32 (=bit 7 of data byte 3) or bit 16 (=bit 7 of data byte 1).
To suppress interference, however, the new position value is only carried out if the control bit is present without interruption 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.
In the Class 2 mode this process is not acknowledged via the inputs.

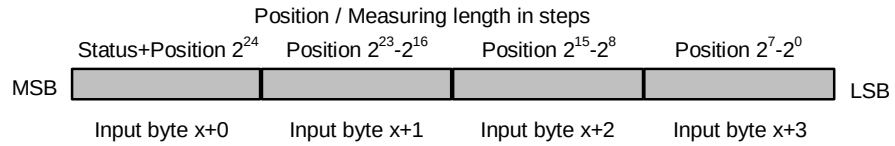

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## 5.10 Input/output configuration for teach-in

### Outputs




### Inputs




***Only the features Counting direction and Adjustment request are supported!***

### 5.10.1 Assignment of the status byte

At activated status the status bits $2^{25}$ to $2^{31}$ have the following meaning:

| | |
|---|---|
| Bit 25 | Ready status<br>0 = Encoder not ready-to-operate<br>1 = Encoder ready-to-operate |
| Bit 26 | Operating mode<br>0 = Commissioning mode<br>1 = Normal mode |
| Bit 27 | No meaning |
| Bit 28 | Counting direction (at the moment)<br>Bit 28 = 0: Counting direction cw (with look on the shaft)<br>Bit 28 = 1: Counting direction ccw (with look on the shaft) |
| Bit 29 | No meaning |
| Bit 30 | No meaning |
| Bit 31 | Adjustment acknowledgement<br>0 = No adjustment requested<br>1= Requested adjustment was executed |

### 5.10.2 Assignment of the control byte

| | |
|---|---|
| Bit 25 | No meaning |
| Bit 26 | No meaning |
| Bit 27 | No meaning |
| Bit 28 | Change counting direction<br>0 = Keep counting direction<br>1 = Invert present counting direction |
| Bit 29 | No meaning |
| Bit 30 | No meaning |
| Bit 31 | Adjustment request<br>0 = No adjustment requested<br>1 = Adjust encoder to the preset value |

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The following tables display the processes schematically again:

### Setting of the counting direction

| M = Master | | Status-/Control bits | | | | | | | Data bits | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S = Slave | Bit | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| M→S | | 0 | 0 | 0 | 1 | 0 | 0 | 0 | The selected direction of rotation is changed over from 0 to 1 or 1 to 0 using bit 28 | | | | | | | | | | | | | | | | | | | | | | | | |
| S→M | | 0 | 0 | 0 | 0/1 | 0/1 | 0 | 1 | The encoder now acknowledges the newly selected direction of ro. in bit 0 and bit 28 | | | | | | | | | | | | | | | | | | | | | | | 0/1 |
| M→S | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Changeover is completed by setting bit 28 to 0 | | | | | | | | | | | | | | | | | | | | | | |
| S→M | | 0 | 0 | 0 | 0/1 | 0/1 | 0 | 1 | The process actual value is now output again | | | | | | | | | | | | | | | | | | | | | | |

### Preset-Adjustment

| M = Master | | Status-/Control bits | | | | | | | Data bits | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S = Slave | Bit | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| M→S | | 1 | 0 | 0 | 0 | 0 | 0 | 0 | Here the preset value is transferred as desired new actual value | | | | | | | | | | | | | | | | | | | | | | | | |
| S→M | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | The encoder acknowledges the takeover in bit 7 of the status byte | | | | | | | | | | | | | | | | | | | | | | | | |
| M→S | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | By setting the bit 31 to 0, the adjustment is finished | | | | | | | | | | | | | | | | | | | | | | | | |
| S→M | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | The process actual value is now output again | | | | | | | | | | | | | | | | | | | | | | | | |


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# 6 Trouble-shooting and diagnostic facilities

## 6.1 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.

### 6.1.1 Indicator states, green LED (STAT)

| Green LED | Cause | Remedy |
|---|---|---|
| Off | Absence of voltage supply | Check voltage supply wiring |
| | Station address incorrectly set | Set station address (valid values 3-99 !) |
| | Bus cover not mounted and screwed on correctly | Check bus cover for correct seating |
| | Bus cover defective | Replace bus cover |
| | Hardware error, encoder defective | Replace encoder |
| Flashing at a frequency of 10 Hz | Irreparable parameterization or configuration error. | Check parameterization and configuration<br>See section 5.8 from page 18 |
| Flashing at a frequency of 1 Hz | Parameterization or configuration error in PNO-compatible nominal configuration<br>Data have been corrected<br>or<br>Teach-in mode active | Check configuring and operational status of PROFIBUS master<br>Deactivate teach-in mode |
| On | Encoder ready for operation | |

### 6.1.2 Indicator states, red LED (BF)

| Red LED | Cause | Remedy |
|---|---|---|
| Off | No error, bus in cycle | |
| Flashing at a frequency of 1 Hz | Encoder not yet addressed by master | Check set station address<br>Check configuring and operational status of PROFIBUS master |
| On | Irreparable encoder fault | Check parameter data |

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## 6.2 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.

### 6.2.1 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 | |
|---|---|---|
| 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 | |
| Byte 7 | Length (in bytes) of extended diagnosis | Device-specific extensions |
| Byte 8<br>to<br>Byte 241 (max) | Other device-specific diagnoses | |


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#### 6.2.1.1 Station status 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 |

#### 6.2.1.2 Station status 2

| | | |
|---|---|---|
| Bit 7 | Deactivated | Slave has been deleted from the poll list by the master |
| Bit 6 | Reserved | |
| 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. |

#### 6.2.1.3 Station status 3

| | | |
|---|---|---|
| Bit 7 | Ext_Diag_Overflow | Overflow in extended diagnosis |
| Bit 6 - 0 | Reserved | |

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#### 6.2.1.4 Master address

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.

#### 6.2.1.5 Manufacturer's identifier

In bytes 5+6, 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).

#### 6.2.1.6 Length (in byte) of extended diagnosis

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


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### 6.2.2 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 |
|---|---|---|
| Byte 7 | Length (in bytes) of extended diagnosis | 1 |
| Byte 8 | Alarms | 1 |
| Byte 9 | Operating status | 1 |
| Byte 10 | Encoder type | 1 |
| Byte 11-14 | Encoder resolution in increments per revolution (rotary)<br>Encoder resolution in measuring increments (linear) | 1 |
| Byte 15-16 | Number of resolvable revolutions | 1 |
| Byte 17 | Additional alarms | 2 |
| Byte 18-19 | Supported alarms | 2 |
| Byte 20-21 | Warnings | 2 |
| Byte 22-23 | Supported warnings | 2 |
| Byte 24-25 | Profile version | 2 |
| Byte 26-27 | Software version (firmware) | 2 |
| Byte 28-31 | Operating hour counter | 2 |
| Byte 32-35 | Offset value | 2 |
| Byte 36-39 | Manufacturer's offset value | 2 |
| Byte 40-43 | Number of increments per revolution | 2 |
| Byte 44-47 | Measuring length in increments | 2 |
| Byte 48-57 | Serial number | 2 |
| Byte 58-59 | Reserved | 2 |
| Byte 60-63 | Manufacturer-specific diagnostics | Optional |

#### 6.2.2.1 Alarms

| 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 | | |

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#### 6.2.2.2 Operating status

| Bit | Meaning | = 0 | = 1 |
|---|---|---|---|
| Bit 0 | Code sequence | Increasing clockwise | Increasing counter-clockwise |
| 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 | | |

#### 6.2.2.3 Encoder type

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

See encoder profile for other codes

#### 6.2.2.4 Single-turn resolution

The hardware single-turn resolution of the encoder can be read out via bytes 11-14.

#### 6.2.2.5 Number of resolvable revolutions

The maximum number of encoder revolutions can be read out via diagnostic bytes 15-16.

#### 6.2.2.6 Additional alarms

Byte 17 is reserved for additional alarms, although no other alarms are implemented.

| Bit | Meaning | = 0 | = 1 |
|---|---|---|---|
| Bit 0-7 | Reserved | | |


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#### 6.2.2.7 Supported alarms

| 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 | | |

#### 6.2.2.8 Warnings

| 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 |

#### 6.2.2.9 Supported warnings

| 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 | | |

#### 6.2.2.10 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) )

| | |
|---|---|
| Byte 24 | Revision number |
| Byte 25 | Revision index |

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#### 6.2.2.11 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) )

| | |
|---|---|
| Byte 26 | Revision number |
| Byte 27 | Revision index |

#### 6.2.2.12 Operating hour counter

Diagnostic bytes 28-31 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).

#### 6.2.2.13 Offset value

Diagnostic bytes 32-35 indicate the offset in relation to the absolute scanning position which is calculated during the execution of the preset function.

#### 6.2.2.14 Manufacturer-specific offset value

Diagnostic bytes 36-39 indicate an additional manufacturer-specific offset in relation to the absolute scanning position which is calculated during the execution of the preset function.

#### 6.2.2.15 Number of increments per revolution

Diagnostic bytes 40-43 indicate the configured increments per revolution of the encoder.

#### 6.2.2.16 Measuring length in increments

Diagnostic bytes 44-47 indicate the configured measuring lengths in increments of the encoder.

#### 6.2.2.17 Serial number

Diagnostic bytes 48-57 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.

#### 6.2.2.18 Manufacturer-specific diagnostics

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


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***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 Diagnostic function is activated.***

## 6.3 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. |

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