



## Technical Manual

## Absolute Shaft Encoder

## ACURO<sup>®</sup> industry with Profibus-DP

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## 1 Definitions

This technical manual describes the software, parameter setting and initial operation of the shaft encoder.

### Explanation of symbols:



Passages to which special attention should be paid in order to ensure the correct use and to avoid **dangers** are marked by this symbol.



This Symbol indicates important directions for the **proper use** of the shaft encoder.  
*The non-observance of these instructions may lead to malfunctions in the shaft encoder or its surrounding parts.*



This symbol indicates instructions for action.

### Abbreviations used

<b>ASIC</b>	Application specific integrated circuit
<b>DP</b>	"Dezentrale Peripherie" (local I/O modules)
<b>DPM1</b>	DP master (Class 1) DPM1 is the central programmable controller for PROFIBUS DP
<b>DPM2</b>	DP master (Class 2) DPM2 is a project planning and configuration device for PROFIBUS DP
<b>GSD</b>	Device master data Electronic device data sheet
<b>HMI</b>	Human Machine Interface Operator panels and monitoring devices
<b>KBL</b>	"Kommunikationsbeziehungsliste" (list of communication relations) The KBL contains a list of all communication relations of a station.
<b>KR</b>	Local abbreviation for a communication relation
<b>MAC</b>	The MAC determines, when a device is granted the right to send data
<b>OV</b>	"Objektverzeichnis" (Object Directory) The OV contains the description of all communication objects of a device
<b>SAP</b>	Service Access Point Service access point in the PROFIBUS layer 2
<b>TSDI</b>	Station Delay Time Initiator Call delay time of the initiators

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**TSDR**      Station Delay Time Responder  
Response delay time of the responder

**VFD**      Virtual Field Device  
The VFD is the part of a real device which can be reached by communication

**Numerical data**    Unless indicated explicitly, decimal values are represented as figures without additional features (e.g. 1408), binary values are marked **b** (e.g. 1101b) hexadecimal values **h** (e.g. 680h) at the end of the figures.

## 2 Safety and Operating Instructions

The ACURO<sup>®</sup> model series' absolute shaft encoders are quality products that have been manufactured according to recognized electrical engineering regulations. The devices have left the manufacturing company's premises meeting all relevant safety requirements.

### **Therefore:**

- In order to preserve this condition and to ensure an interference-free Operation of the encoders, the technical specifications presented in this documentation must be observed.
- Electrical appliances may only be installed by skilled electricians!
- The devices may only be operated within the limits defined in the technical data.
- The maximum operating voltages must not be exceeded!!  
The devices have been constructed according to DIN EN 61010 Part 1, protection class III.  
In order to avoid dangerous electric shocks, the devices have to be operated with safety extra-low voltage (SELV) and be situated in a field with equipotential bonding.
- For better protection use an external fuse Field of application: industrial processes and control systems.  
Over voltages at the connection terminals have to be restricted to over voltage category II values.
- Shock effects on the housing, especially on the encoder shaft, as well as axial and radial overloading of the encoder shaft should be avoided.
- Only in case an appropriate coupling is used can the maximum precision and life time be guaranteed.
- The proper electromagnetic compatibility values (EMC) are only valid for standard cables and plugs. In the case of screened cables, the screen has to be connected on both sides as well as on large surface to ground. The lines for power supply should also be entirely screened. If this is not possible, appropriate filter methods should be applied.
- The neighbouring parts as well as the installation of the cable system have got a significant influence on the electromagnetic compatibility of the shaft encoder. As a consequence, the electrician has to ensure the EMC of the entire system (device).
- In regions endangered by electrostatic discharges, a good ESD protection for the plugs and the cable to be connected should be provided when installing the shaft encoder..

\*electromagnetic compatibility



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## **3 General Information**

In this manual, the basic functions of the PROFIBUS DP are only described in extracts. For additional information, please refer to the standards on PROFIBUS DP, i.e. DIN 19245-3 and EN 50170 respectively.

### **3.1 Introduction**

The ACURO industry is an absolute shaft encoder (encoder, angle encoder). The version described in this manual sends its current position to another station via the transmission medium "PROFIBUS DP" (physically: screened and twisted pair line). The ACURO INDUSTRY supports all class 1 and 2 functions listed in the encoder profile.

PROFIBUS is manufacturer independent, open field bus standard for a variety of applications in the field of production, process and building services automation. The requirements of openness and independence from the manufacturer are stipulated in the European standard EN 50 170. PROFIBUS permits the communication of devices produced by different manufacturers without any particular adaptations of the interfaces.

PROFIBUS DP is a special standard version for a quick data exchange within the field level which has been optimized in terms of speed and low connection costs. Central control systems like, for example SPC/ PC communicate via a quick, serial connection with local field devices like drives, valves, or encoders. The data exchange between these devices is predominantly cyclical. The communication functions required for this exchange are determined by the basic functions of the PROFIBUS DP according to the EN 50 170 European standard.

### **3.2 Field of Application**

In systems, where the position of a drive or of any other part of a machine has to be recorded and signaled to the control system, the ACURO industry can assume this function. The ACURO industry can resolve, for instance, positioning tasks by sending the check back signal concerning the present drive position via the PROFIBUS DP to the positioning unit.

### **3.3 Basic Functions of the PROFIBUS DP**

The central control system (master) cyclically reads out the input information from the slaves and writes the output information to the slaves. For this purpose, the bus cycle time has to be shorter than the program cycle time of the central SPC, which amounts to approx. 10 ms for various applications. Apart from the cyclical user data transfer, the PROFIBUS DP version also disposes of powerful functions for diagnosis and initial operation procedures. The data traffic is controlled by watchdog functions on both the slave and the master side.

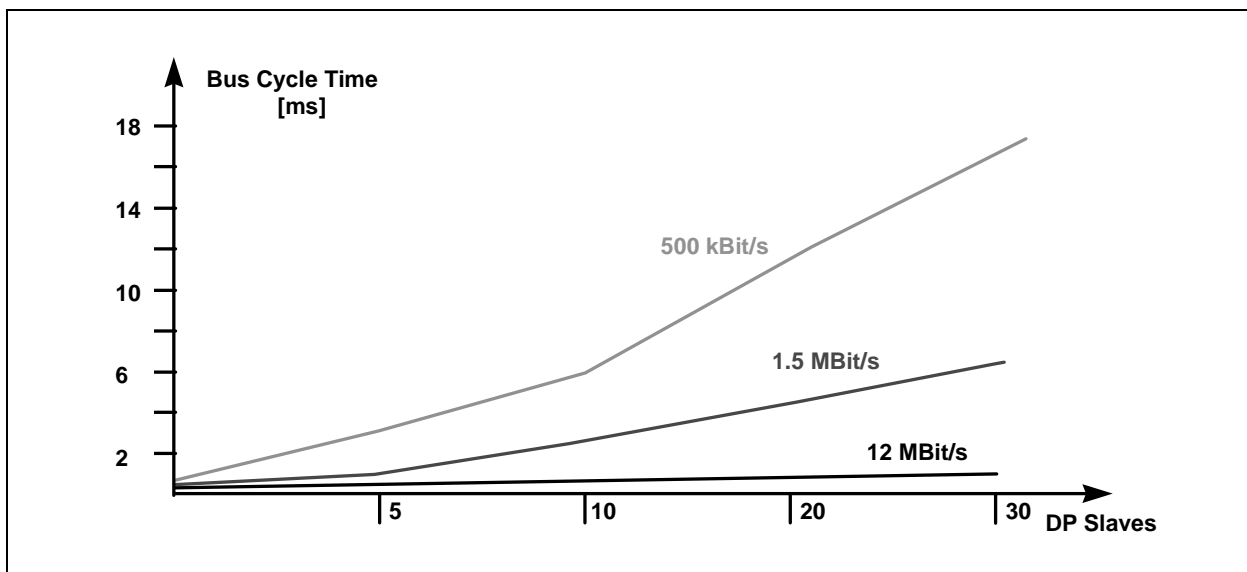
The following table summarizes the basic functions of the PROFIBUS DP.

Transmission technology:	<ul style="list-style-type: none"> <li>• RS-485 twisted pair line</li> <li>• Baud rates ranging from 9.6 kbit/s up to 12 Mbit/s</li> </ul>
Bus access:	<ul style="list-style-type: none"> <li>• Token passing procedure between the masters and master-slave procedures for slaves</li> <li>• Monomaster or multimaster systems possible</li> <li>• master and slave devices, max. of 126 stations at a single bus</li> </ul>
Communication:	<ul style="list-style-type: none"> <li>• Point-to-point (user data communication) or multicast (control commands)</li> <li>• cyclical master-slave user data communication and acyclical master-master data transfer</li> </ul>
Operating state:	<ul style="list-style-type: none"> <li>• Operate: cyclical transfer of input and output data</li> <li>• Clear: The input data are read, the output data remain in the safe status</li> <li>• Stop: only master-master data transfer is possible</li> </ul>
Synchronisation:	<ul style="list-style-type: none"> <li>• Control commands enable a synchronisation of the input and output data</li> <li>• Sync mode: Output data are being synchronised</li> </ul>
Functionality:	<ul style="list-style-type: none"> <li>• Cyclical user data transfer between DP master and DP slave(s)</li> <li>• Single DP slaves are dynamically activated or deactivated</li> <li>• Control of the DP slave's configuration. Powerful diagnostic functions, 3 stepped diagnostic message levels.</li> <li>• Synchronisation of in- and/ or output</li> <li>• Address assignment for the DP slaves via the bus</li> <li>• Configuration of the DP masters (DPM1) via the bus</li> <li>• Maximum of 246 byte input and output data per DP slave possible</li> </ul>
Protection functions:	<ul style="list-style-type: none"> <li>• All messages are transferred with a hamming distance of HD=4</li> <li>• Response control at the DP slaves</li> <li>• Access protection of the DP slaves' input/ output</li> <li>• Monitoring of the user data communication with adjustable control timer at the master</li> </ul>
Device types:	<ul style="list-style-type: none"> <li>• DP master class 2 (DPM2), e.g. programming/ project planning devices</li> <li>• DP master class 1 (DPM1), e.g. central automation devices like SPC, PC</li> <li>• DP slave e. g. devices with binary or analogue input/ output, drives, valves</li> </ul>

### 3.4 Essential Features/

The PROFIBUS DP only requires approx. 1 ms at a speed of 12 Mbit/s in order to transfer 512 bit input and 512 bit output data by means of 32 stations.

The following diagram shows the usual PROFIBUS DP transfer time interval in relation to the number of stations as well as the transmission speed. The high speed can be above all explained by the fact that the input and output data within a message cycle are transferred by using the layer 2 SRD service (Send and Receive Data Service).



Bus cycle time of a PROFIBUS DP monomaster system

Boundary conditions : Each slave has 2 byte input and 2 byte output data; the minimum slave interval time amounts to 200 microseconds; TSDI = 37 bit times, TSDR = 11 bit times

#### Diagnostic function:

The comprehensive diagnostic functions of PROFIBUS DP allow a quick localisation of the errors. The diagnostic messages are transferred by means of the bus and are assembled at the master. They are subdivided in three levels:

#### Station-related diagnosis

Messages on the general readiness for service of a station, like for example, overtemperature or undervoltage.

#### Module-related diagnosis

These messages indicate that a diagnosis within a certain I/O part (e.g. 8 bit output module) of a station is in hand.

#### Channel related diagnosis

The error cause in relation to a single input/ output bit (channel) is indicated here, like for example, a short-circuit at output line 7.

### 3.5 Configuration of the System and Device Types

By means of PROFIBUS DP, mono- and multimaster systems can be realised. For this reason, a high level of flexibility in terms of the system configuration can be achieved. A maximum of 126 devices (master or slaves) may be connected to a bus. The definitions for the system configuration contain the number of stations, the assignment of the station address to the I/O addresses, the data consistency of the I/O data, the format of the diagnostic messages and the bus parameters used. Each PROFIBUS DP system consists of different device types. There are three device types to be distinguished:

#### DP master class 1 (DPM1)

These devices are central control systems exchanging information with the local stations (DP slaves) during a fixed message cycle. Typical devices of this kind are stored-program controllers (SPC), PC or VME systems.

#### DP master class 2 (DPM2)

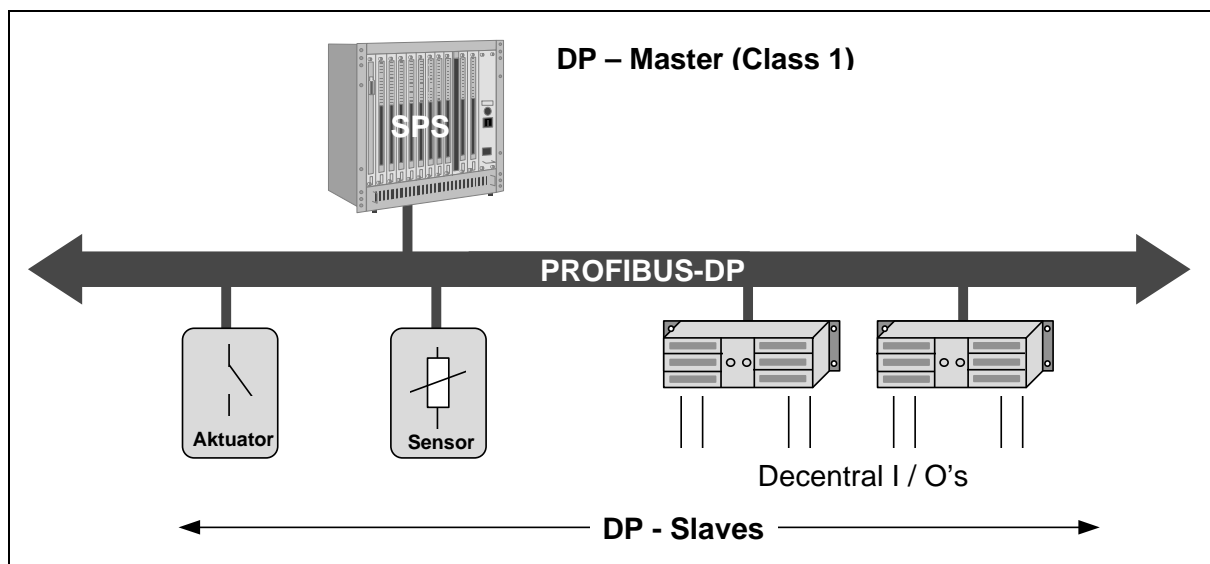
Programming, configuration devices, and operator panels belong to this category. They are used for the initial operation procedures in order to establish the configuration of the DP system, or to operate the plants in the course of operation.

#### DP slave

A DP slave is a peripheral I/O rack (I/O, drives, HMI, valves) that reads the input information and sends output information to the peripheral equipment. Devices which provide only input or only output information might also be used.

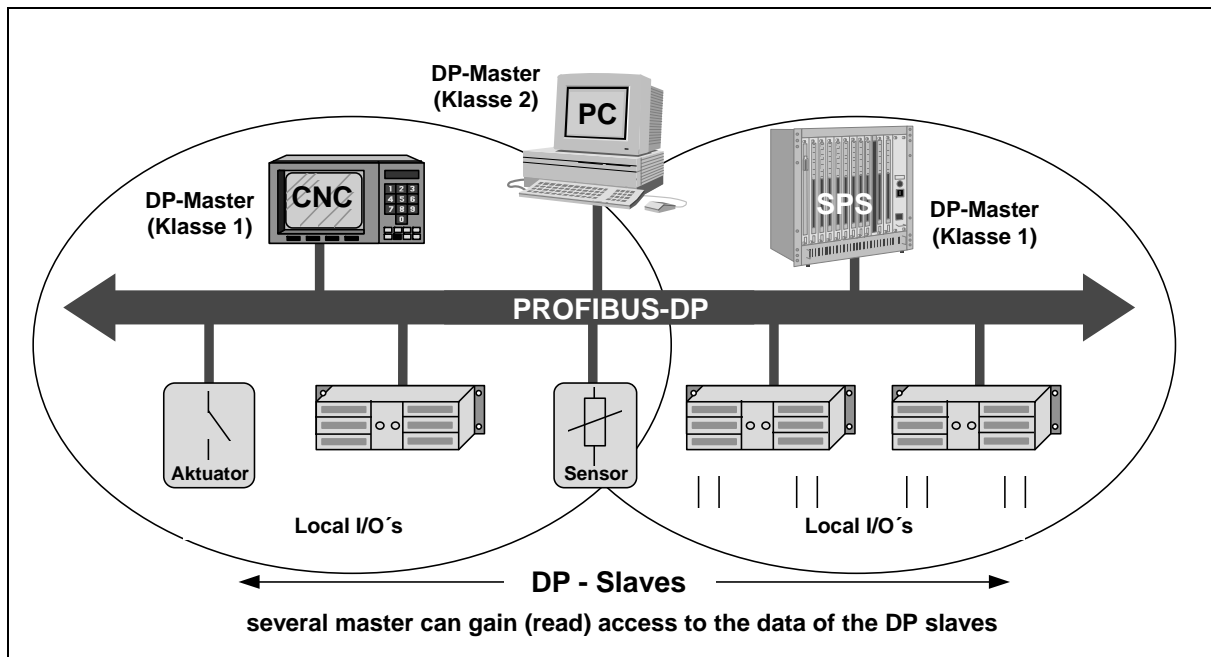
The amount of input and output information is device specific and must not exceed 246 byte for the input and 246 byte for the output data.

#### Profibus-DP monomaster system



In the case of monomaster bus systems, there is only one master active at bus during the on-line phase of the bus system. The above diagram shows the system configuration of a monomaster system. The SPC based control system is the central control element. By means of the transmission medium, the DP slaves are locally linked to the SPC control system. By using this system configuration, the shortest bus cycle time can be obtained.

### Profibus-DP multimaster system



In the multimaster mode, several masters are linked to a single bus. They either form independent subsystems consisting of one DPM1 and its corresponding DP slaves each, or additional configuration and diagnostic devices (see diagram above). The I/O maps of the DP slaves can be read by all DP masters, but only one DP master, the one which has been assigned DPM1 during project planning, is able to write the output information. Multimaster systems attain a medium bus cycle time.

### **3.6 System Performance**

In order to obtain a high level of exchangeability between the devices, the system performance of PROFIBUS DP has also been standardized. It is mainly determined by the operational status of the DPM1.

The DPM1 can either be controlled locally or via the bus by the project planning device. The following three main states can be distinguished:

#### **Stop**

There is no data traffic between DPM1 and the DP slaves.

#### **Clear**

The DPM1 reads the input information of the DP slaves and maintains the safe status of the DP slaves' output.

#### **Operate**

The DPM1 has entered the data transfer phase. In case of a cyclical data traffic, the input is read by the DP slaves while the output is transferred to the DP slaves.

By means of a multicast command, the DPM1 cyclically sends its local status to the assigned DP slaves within a configurable time interval.

After an error has occurred during the data transfer phase of the DPM1, like for example, the failure of a DP slave, the response of the system is determined by the operating parameter "Auto Clear".

If this parameter has been set to true, the DPM1 will set the output of all the respective DP slaves to the safe status, as soon as a DP slave is no longer available for user data communication. Afterwards, the DPM1 changes to the clear status.

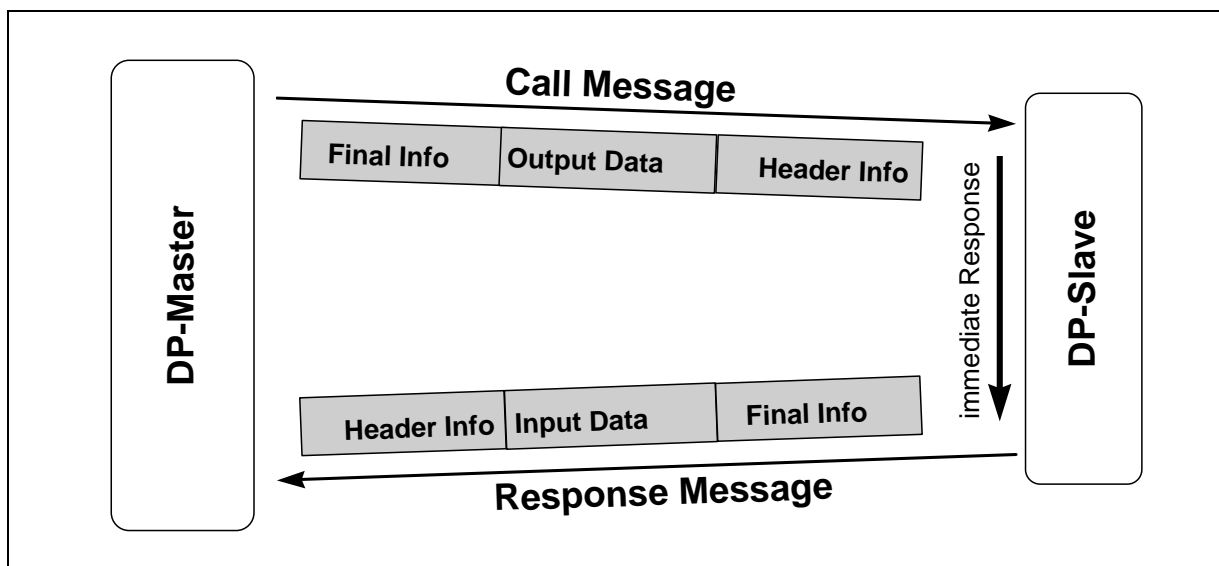
If this parameter is = false, the DPM1 remains, even if an error occurs, in the operate status, and the user can determine the response of the system at his own discretion.

### 3.7 Cyclical Data Transfer between DPM1 and the DP Slaves

The data traffic between the DPM1 and the respective DP slaves is automatically handled by the DPM1 in a fixed, recurring order. When configuring the bus system, the user assigns a DP slave to the DPM1. In addition, the slaves to be included in- or excluded from the user data communication are defined.

The data traffic between the DPM1 and the DP slaves is subdivided in parametrisation, configuration, and data transfer phases. Before including a DP slave in the data transfer phase, the DPM1 checks during the parametrisation and configuration phase, whether the planned set configuration corresponds to the actual configuration of the device. For this check, the device type, the information on the format and the length as well as the number of input and output lines have to be correct. The user thus obtains a reliable protection against parametrisation errors. In addition to the user communication, which is automatically executed by the DPM1, the user may request the new parametrisation data to be sent to the DP slaves.

#### User data communication for Profibus-DP



### 3.8 Data Traffic between DPM1 and Project Planning Devices

In addition to the functions between DP master and DP slaves, master-master communication functions are available. They support the project planning and diagnostic devices in projecting the system via the bus.

Besides the upload and download functions, the master-master functions offer the opportunity to switch the user data transfer between the DPM1 and the single DP slaves dynamically on or off as well as to modify the operating status of the DPM1.

Function	Meaning	DPM1	DPM2
<b>Get_master_Diag</b>	reads the diagnostic data of the DPM1 or the collective diagnosis of the DP slaves.	M	O
<b>Download / Upload Group (Start_Seq, Down- / Upload, End_Seq)</b>	reads or writes the entire configuration data of a DPM1 and of the respective DP slaves.	O	O
<b>Act_Para_Brct</b>	activates the bus parameters for all operating DPM1 devices.	O	O
<b>Act_Param</b>	activates parameters or modifies the operating status of the operating DPM1 device.	O	O

M: mandatory, O: optional

Functional overview for the master-master functions for PROFIBUS DP

### 3.9 Sync Mode

In addition to the station-related user data communication being automatically handled by the DPM1, the masters may send control commands to a single slave, a group of slaves or all slaves at the same time. These control commands are transferred as multicast. It is only by means of this multicast that the sync and freeze operating modes for the event-controlled synchronisation of the DP slaves have been enabled.

The **sync mode** is started by the slaves, as soon as they receive a sync command from the respective master. The output lines of the addressed slaves will then be frozen in their current state. The output data will be stored at the slaves during the following user data transfers; the state of the output lines, however, will remain unchanged. Unless the next sync command has been received, the stored output data will not be connected to the output lines. By selecting unsync, the sync mode is terminated.



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### 3.10 Protective Mechanisms

For reasons of safety, it is necessary to equip PROFIBUS DP with powerful protective functions against false parametrisation or failure of the transmission equipment. For this purpose, control mechanisms at the DP master and the DP slave have been realised, taking the form of time-out circuits. The monitoring interval is determined during project planning.

#### **At the DP master**

The DPM1 controls the data traffic of the slaves by means of the Data\_Control\_Timer. For each slave, a special timer is used. The time-out circuit will respond, if no proper user data transfer occurs during a control interval. In this case, the user will be informed. If the automatic response to an error (Auto\_Clear = True) has been released, the DPM1 will quit the operate status, switch the output lines of the respective slaves to the safe status and change to the clear status.

#### **At the DP slave**

In order to recognise errors by the master or transmission errors, the slave executes the response control. If there is no data traffic during the response control interval, the slave will automatically switch the output lines to the safe status.

When operating in multimaster systems, a supplementary access protection for the I/O lines of the slaves will be necessary. This is to make sure that direct access can only be gained by an authorised master. For all the other masters, the slaves will provide an I/O map which can be also be read without access authorisation.

### 3.11 Communication Interface

The communication interface corresponds to the PROFIBUS DP class 2 encoder profile.

Within this interface the class 1 functions are included. The manufacturer specific functions will be described separately in the following.

## 4 Overview Encoder Functions

Function	Octet no.	Data type	Designation	Class	Page
Chk_Cfg	1	Octet string	Configuration data exchange	1	20
Set_Prm	1	Octet	Station status	1	21
Set_Prm	2 - 3	16 Bit	Response check time ( $T_{WD}$ )	1	21
Set_Prm	4	Octet	Min. Station Delay Re-sponder (min. $T_{SDR}$ )	1	21
Set_Prm	5 - 6	16 Bit	PNO identity number	1	21
Set_Prm	7	Octet	Group identity	1	21
Set_Prm	8	Octet	Spezial functions	2	22
Set_Prm	9	Octet string	Operating parameters	1	23
Set_Prm	10 - 13	32 Bit	Measuring steps per revolution	2	24
Set_Prm	14 - 17	32 Bit	Total number of measuring steps	2	25
Data Exchange	1 - 8	16, 32, 64 Bit	Position value, preset	1/2	26
Slave_Diag	1	Octet string	Station status 1	1	30
Slave_Diag	2	Octet string	Station status 2	1	30
Slave_Diag	3	Octet string	Stations status 3	1	30
Slave_Diag	4	Octet string	Diagnosis master Add	1	30
Slave_Diag	5 - 6	Octet string	PNO identity number	1	30
Slave_Diag	7	Octet string	Extended diagnostic header	1	31
Slave_Diag	8	Octet string	Alarm messages	1	31
Slave_Diag	9	Octet string	Operating status	1	32
Slave_Diag	10	Octet string	Encoder type	1	33
Slave_Diag	11 - 14	32 Bit	Single turn resolution	1	33
Slave_Diag	15, 16	16 Bit	Multi turn resolution	1	33
Slave_Diag	17	Octet string	Additional alarm messages	2	34
Slave_Diag	18, 19	Octet string	Supported alarm messages	2	34
Slave_Diag	20, 21	Octet string	Warnings	2	35
Slave_Diag	22, 23	Octet string	Supported warnings	2	36
Slave_Diag	24, 25	Octet string	Profile version	2	36
Slave_Diag	26, 27	Octet string	Software version	2	37
Slave_Diag	28 - 31	32 Bit	Operating time	2	37
Slave_Diag	32 - 35	32 Bit, signed	Offset value	2	38

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Slave_Diag	40 - 43	32 Bit	Measuring steps per revolution	2	38
Slave_Diag	44 - 47	32 Bit	Total measuring range in measuring steps	2	38
Slave_Diag	48 - 57	ASCII string	Serial number	2	39
RD_Inp	1 - 4	32 Bit	Position value	1	40

## 5 Configuration (DDL\_M\_Chk\_Cfg)

By means of this routine, the DP master determines the number of bytes for the data exchange.

<b>Octet</b>	<b>1</b>
<b>Bit</b>	7 - 0
<b>Data</b>	D1h = 2 words of input data (standard configuration)
	F1h = 2 words of input data, output data (standard configuration)
	D0h = 1 word of input data (optional configuration)
	F0h = 1 word of input data, output data (optional configuration)
	D3h = 4 words of input data (manufacturer configuration)
	F3h = 4 words of input data, 4 words of output data (manufacturer specific configuration)

## 6 Operating parameters (DDL\_M\_Set\_Prm)

### 6.1 Overview

Parameter	Data type	Parameter Octet number	Class	GSD file standard value
Station status	Octet string	1	DIN 19245-3	88h
Response check time (T <sub>WD</sub> )	16 bit	2 - 3	DIN 19245-3	340 ms
Min. station delay responder (min. T <sub>SDR</sub> )	Octet string	4	DIN 19245-3	11
PNO identity number	16 bit	5 - 6	DIN 19245-3	00B7h
Group identity	Octet string	7	DIN 19245-3	0
Code sequence	Bit 0	9	1	0 = ascending for revolution cw
Class 2 functionality	Bit 1	9	2	1 = On
Maintenance diagnosis	Bit 2	9	Optional	0 = Off
Scaling function	Bit 3	9	2	1 = On
Sampling	Bit 7	9	2	1 ms
Measuring steps per revolution	32 bit	10 - 13	2	4096*
Total number of measuring steps	32 bit	14 - 17	2	2 <sup>26</sup> *

\* Entry must be set to a value less than or equal to the maximum possible resolution of your device

## 6.2 Definition of the special operating parameters


### DDL\_M\_Set\_Prm

Octet	8
Bit	2 - 0
Data	$2^2 - 2^0$
	Special operating parameters

Bit	Designation	= 0	= 1
0	Suppress operating time counter	inactive	Active
1	Always class 1 length	inactive	active
2	Suppress storing of preset	inactive	Active


### 6.2.1 Suppress operating time counter

The internal time counter is incremented every 6 minutes and the operating time is updated in the diagnosis. In consequence the master must fetch the diagnostic message. This may be disturbing in time-critical applications. By setting this bit, the internal time counter is incremented but the diagnosis is not updated.

 Default setting: bit= 0 – operating time counter is displayed (according to GSD-file)

### 6.2.2 Always class 1 length


In smaller applications the high data rate of class2 might be disturbing (size of buffer). For that reason the length of the diagnosis can be reduced to class1 length via this bit.

 Default setting: bit= 0 – length of diagnosis class2 (long) (according to GSD-file)

### 6.2.3 Suppress storing of preset

With every preset the preset value is stored to the internal EEPROM. That means the value is stored in case of a mains failure. You can write on the device for about a million times, which is usually enough.

In applications which make it necessary to change the preset value very often, no data will be lost.

 The storing of the preset value to the EEPROM can be suppressed via this bit. The preset value is taken over yet it is not stored.  
Default setting: bit= 0 – preset is stored (according to GSD-file)

### 6.3 Definition of the operating parameters


#### DDLML\_Set\_Prm

Octet	9
Bit	7 - 0
Data	$2^7 - 2^0$
	<b>Operating parameters</b>

Bit	Designation	= 0	= 1
0	Code sequence	ascending code sequence for clockwise revolution	ascending code sequence for counterclockwise revolution
1	Class 2 functionality	inactive	active
2	Maintenance diagnosis	inactive	active
3	Scaling function	inactive	active, sets scaling parameters to the transferred values
7	Sampling	1 ms	10 ms

#### 6.3.1 Code Sequence


The code sequence defines the counter direction, in which the position code is issued in ascending order (clockwise (cw) or counterclockwise (ccw), viewed from the shaft). The Code sequence is determined by the code sequence bit in the operating parameters.

 Standard setting: bit = 0 - ascending code sequence for clockwise revolution(according to GSD-file).

#### 6.3.2 Class 2 Functionality


This bit activates the „class 2 functionality“.

The DP master has to set the bit to „1 = active“, in order to be able to use the „class 2 functionality“. If the „class 2 functionality“ is inactive, the encoder operates like a class 1 encoder.

 Standard setting: bit = 1 - Class 2 functionality is switched on(according to GSD-file).

#### 6.3.3 Maintenance Diagnosis

By means of this diagnosis, the hardware of the encoder may be checked (at standstill). The diagnosis is activated via the respective bit within the operating parameters. Occurring errors are indicated by the alarm bit of the diagnostic function (see alarm).

 Standard setting: bit = 0 - Diagnosis switched off(according to GSD-file).

### 6.3.4 Scaling Function

By means of the scaling function, the internal position value of the encoder is calculated by the encoder software to modify the resolution of the shaft encoder.

The scaling parameters are:

„Measuring steps per revolution“ and „Total number of measuring steps“.

- i** For the scaling function bit = 0, the scaling function is not activated.
- i** To activate the scaling, the scaling function bit as well as the "class 2 functionality" bit have to be set (standard setting according to GSD-file).

### 6.3.5 Sampling

By means of this bit, the sampling cycle time of the internal encoder timer is set

bit=0 (standard setting according to GSD-file): Encoder disk is sampled every 1 ms

bit=1: Encoder disk is sampled every 10 ms (provides higher values for speed and acceleration with a lower rotational speed)

## 6.4 Measuring Steps per Revolution (Resolution)

This parameter sets the desired resolution ( $\leq$  physical resolution) per revolution. The encoder internally calculates the respective scaling factor.

- i** The total number of measuring steps is set by octet 14 - 17.
- i** The resulting scaling factor SCF (by which the physical value of position is multiplied) can be calculated according to the following equation:

$$SCF = \frac{\text{Measuring Steps per Revolution (Octet 10 - 13)}}{\text{phys.Resolution single turn (Octet 14 - 17)}}$$

#### DDL\_M\_Set\_Prm

Octet	10	11	12	13
Bit	31 - 24	23 - 16	15 - 8	7 - 0
Data	$2^{31} - 2^{24}$	$2^{23} - 2^{16}$	$2^{15} - 2^8$	$2^7 - 2^0$
Measuring steps per revolution				

Value range: 0 ... (max. physical resolution per revolution)

Standard value = 4096 (12 bit)

Example:

ACURO industry/1213 (Resolution = 13 bit per revolution): Data contents = 20 00h

Octet 10	Octet 11	Octet 12	Octet 13
00h	00h	20h	00



## 6.5 Total Number of Measuring Steps

This parameter sets the total number of measuring steps. After the given number of measuring steps, the encoder is reset to zero.



**The measuring steps per revolution (resolution) are set by octet 10 - 13 .**

**If the encoder is used in the continuous mode, the "total number of measuring steps must not exceed" only  $2^x \cdot \text{"measuring steps per revolution"}$  (with  $x=1 \dots 12$ ).**

### DDL\_M\_Set\_Prm

Octet	14	15	16	17
Bit	31 - 24	23 - 16	15 - 8	7 - 0
Data	$2^{31} - 2^{24}$	$2^{23} - 2^{16}$	$2^{15} - 2^8$	$2^7 - 2^0$
<b>Total number of measuring steps</b>				

Value range: 0 ... (max. physical total resolution)

**Standard value =  $2^{24}$  (24 bit)**

Example:

ACURO/1213 (Total resolution= 13 bit per revolution • 12 bit revolutions):

➔ This correspond to a data content of 8192(13 Bit) x 4096(12 Bit)

=33554432(dec.) or 2 00 00 00(hex.)

Octet 14	Octet 15	Octet 16	Octet 17
02h	00h	00h	00h

## 7 Data exchange (DDL\_M\_Data\_Exchange)

**i** The data exchange is configured by means of the DDL\_M\_Chk\_Cfg routine (see Chapter 5 Configuration of the System and Device Types).

### 7.1 Position value

The encoder input data amounting to a length of 32 bit (depending on the individual manufacturer, 64 bit are also possible) are used for the position value, the speed, and the acceleration. Optionally, the encoder also supports position values with a length of 16 bit. The value is positioned on the right side of the data field.

### 7.2 Preset function

The preset function supports the adaptation of the encoder zero point to the mechanical zero point of the system. The preset function sets the current position value of the encoder to the preset value. In the Data\_Exchange function, the preset value will be stored as default value. The preset function is used after the scaling, i. e. the preset value is indicated in programmed measuring steps.

The MSB of the preset value controls the preset function in the following way:

**Normal operating status:**     **MSB=0 (bit 31, optionally bit 15 or bit 63 respectively)**  
Preset value will **not** be taken on.

**Preset-Mode:**                     **MSB=1 /bit 31** (optionally bit 15 or bit 63, respectively)  
With MSB=1 the encoder takes on the transferred value  
(bit 0 - 30) as preset value in the binary code.

The encoder reads the current position value and calculates an offset value from the preset value and the read in position value. The position value is replaced by the preset value. If the default value and the preset value are identical, the preset value may be terminated and the MSB can be reset to zero by the master. By means of the diagnostic function, the offset value can be read. The value will be reloaded after a mains failure and each restart.

**i** The preset function may only be used if the encoder is at standstill.

**i** The scaling parameters have to be transferred beforehand (only if the scaling is to be set).

### 7.3 Standard Configuration:

#### Configuration data:

- Class 1: D1h (2 words of input data)
- Class 2: F1h (2 words of input data, 2 words of output data for preset value)

Octet	1	2	3	4
Bit	31 - 24	23 - 16	15 - 8	7 - 0
Data	$2^{31} - 2^{24}$	$2^{23} - 2^{16}$	$2^{15} - 2^8$	$2^7 - 2^0$
<b>Data_Exchange - 32 bits</b>				

#### Format preset value

Format preset value					
Octet	1		2	3	4
Bit	31	30 - 24	23 - 16	15 - 8	7 - 0
Data	0 / 1	$2^{30} - 2^{24}$	$2^{23} - 2^{16}$	$2^{15} - 2^8$	$2^7 - 2^0$
	Preset control*	Preset value - max. 31 bits			

\* The preset value will only be taken on if the bit 31 is set. If the encoder sends back the preset value, the master is able to reset the bit 31.

## 7.4 Optional Configuration

### Configuration data:

- Class 1: D0h (1 word of input data)
- Class 2: F0h (1 word of input data, 1 word of output data for preset value)

Octet	1	2
Bit	15 - 8	7 - 0
Data	$2^{15} - 2^8$	$2^7 - 2^0$
<b>Data_Exchange - 16 bits</b>		

### Format preset value

Octet	1		2
Bit	15	14 - 8	7 - 0
Data	0 / 1	$2^{14} - 2^8$	$2^7 - 2^0$
<b>Preset control*</b>		<b>Preset value - max. 15 bits</b>	

\* The preset value will only be taken on if the bit 15 is set. If the encoder sends back the preset value, the master is able to reset the bit 15.

## 7.5 Manufacturer Specific Configuration with Speed and Acceleration



Class 2 functionality must be switched on (see chapter 6.3.2)

### Configuration Data:

- D3h (4 words of input data: 2 words for position, 1 word for speed, 1 word for acceleration)  
F3h (4 words of input data: 2 words for position, 1 word for speed, 1 word for acceleration;  
4 words of output data for preset value)

Octet	1, 2	3, 4	5, 6	7, 8
Bit	43 - 48	47 - 32	31 - 16	15 - 0
Data	$2^{63} - 2^{48}$	$2^{47} - 2^{32}$	$2^{31} - 2^{16}$	$2^{15} - 2^0$
<b>Position</b>		<b>Speed</b>	<b>Acceleration</b>	

**Format preset value**

Octet	1, 2		3, 4	5, 6	7, 8
Bit	63	62 - 48	47 - 32	31 - 16	15 - 0
Data	0/1	$2^{62} - 2^{48}$	$2^{47} - 2^{32}$	$2^{31} - 2^{16}$	$2^{15} - 2^0$
	<b>Preset control*</b>	<b>Preset value</b>		<b>-</b>	

\* The preset value will only be taken on if the bit 31 is set. If the encoder sends back the preset value, the master is able to reset the bit 31.

**i** The preset value is only taken over if bit 63 is set. The master is able to reset bit 63, if the encoder returns the preset value.

**i** The **speed** is indicated independently from the physical resolution in:

$$\frac{2^{14}}{60000} \cdot T \cdot \frac{U}{\text{min}} \quad \text{with } T=1 \text{ or } 10 \text{ (Sampling; see Operating parameters Page 24).}$$

Example:  $T=10$ , rotation speed 100rpm; speed value=  $(2^{14}/60000) \cdot 10 \cdot 100 = 273$

Speed is returned as a two's complement display. Negative values indicate a direction of rotation, opposite to the programmed ascending counting direction. Displayed is an average value of the last 8 speed values.

**Acceleration:** The difference between 5 subsequent speed samples will be summed up.

## 8 Diagnostic Functions (DDLML\_slave\_Diag)

Diagnostic function	Data type	Diagnosis Octet number	Class
Station status 1	Octet string	1	DIN 19245-3
Station status 2	Octet string	2	DIN 19245-3
Station status 3	Octet string	3	DIN 19245-3
Diagnosis master Add	Octet string	4	DIN 19245-3
PNO identity number	Octet string	5 - 6	DIN 19245-3
Extended diagnostic header	Octet string	7	1
Alarm message	Octet string	8	1
Operating status	Octet string	9	1
Shaft encoder type	Octet string	10	1
Phys. resolution single turn	32 bit	11 - 14	1
Phys. resolution multi turn	16 bit	15, 16	1
Additional alarm messages	Octet string	17	2
Supported alarm messages	Octet string	18, 19	2
Warnings	Octet string	20, 21	2
Supported warnings	Octet string	22, 23	2
Profile version	Octet string	24, 25	2
Software version	Octet string	26, 27	2
Operating time	Octet string	28 - 31	2
Offset value	signed 32 bit	32 - 35	2
Measuring steps per revolution	32 bit	40 - 43	2
Total number of measuring steps	32 bit	44 - 47	2
Serial number	ASCII string	48 - 57	2

## 8.1 Diagnostic Functions Class 1

**i** The octets 1 - 6 are specified in the DP standard DIN 19245.

The length of the diagnostic information class 1 is 16 byte, for Class 2, it is 57 byte.

### 8.1.1 Diagnostic Header

The header byte indicates the length of the diagnostic message including the header byte. The format of the value is hexadecimal.

#### DDLm\_slave\_Diag

Octet	7		
Bit	7	6	5 - 0
Data	0	0	xxh
Restricted to 00 for the display of device specific diagnostic messages			Length including header
Extended diagnostic header			

### 8.1.2 Alarm Messages

In the case of a malfunction in the shaft encoder, which may lead to false position values, an alarm message will be sent. The alarm type is defined in Octet 8 of the diagnostic function within the DDLm\_slave\_Diag. dialog.

Additional class 2 alarm messages will be displayed in Octet 17 of the diagnostic function.

In the case of an alarm message the bits Ext\_Diag and Stat\_Diag are both set to 1 until

- the alarm message has been deleted and
- the encoder recognizes a precise position value.

Alarm messages will be deleted, if the functions have been restored according to the specifications and if the position value is correct.

**i** The diagnostic function „supported alarm messages“ (Octet 18 - 19) provides the information on which alarm messages are supported by the encoder.

#### DDLm\_slave\_Diag

Octet	8
Bit	7 - 0
Alarm messages	

Bit	Designation	= 0	= 1
0	Position error	no	yes
1	Error voltage supply	no	yes
2	Current too high	no	yes
3	Maintenance diagnosis	OK	error
4	Storage error	no	yes

### 8.1.3 Operating Status

Octet 9 of the diagnostic functions provides information on internal parameters of the encoder. The class 2 encoder sets the bit to „class 2 functionality“, in order to signal the DP master that the class 2 functions are entirely supported.

The DP master has to set the bit to „1 = active“ in „DDL\_M\_Set\_Prm“, to make the „class 2 functionality available“.

The bit for the status of the scaling function will be set, if the scaling function is activated and the resolution is controlled by the scaling parameters.

#### DDL\_M\_slave\_Diag

Octet	9
Bit	7 - 0
	<b>Operating status</b>

Bit	Designation	= 0	= 1
0	Status code sequence	ascending code sequence for clockwise rotation	ascending sequence for counterclockwise rotation
1	Class 2 functionality	inactive	active
2	Maintenance diagnosis	not supported	supported
3	Scaling function	inactive	active
7	Sampling	1 ms	10 ms



**8.1.4 Shaft Encoder Type**

The shaft encoder type is contained as hexadecimal code in Octet 10 of the diagnostic function.

**DDLML\_slave\_Diag**

Octet	10
Code	00/01
	Encoder type

Code	Designation
00	Absolute shaft encoder, single turn
01	Absolute shaft encoder, multi turn

**8.1.5 Physical Single Turn Resolution**

The diagnostic octets 11 through 14 contain the number of measuring steps per revolution.

**DDLML\_slave\_Diag**

Octet	11	12	13	14
Bit	31 - 24	23 - 16	15 - 8	7 - 0
Data	$2^{31} - 2^{24}$	$2^{23} - 2^{16}$	$2^{15} - 2^8$	$2^7 - 2^0$
	Single turn resolution			

**8.1.6 Physical Multi Turn Resolution**

The diagnostic octets 15 and 16 contain the number of revolutions. For a multi turn shaft encoder, the measuring range results from the number of revolutions and the single turn resolution according to the equation:

**Measuring range = Number of revolutions x single turn resolution.**

**DDLML\_slave\_Diag**

Octet	15	16
Bit	15 - 8	7 - 0
	Number of revolutions	

## 8.2 Diagnostic Functions Class 2

The length of the class 2 diagnostic information including header amounts to 51 byte (33h).

### 8.2.1 Additional Alarm Messages

Diagnostic octet 17 is reserved for further alarm messages, which have, however, not yet been defined in the profile.

#### DDLML\_slave\_Diag

Octet	17
Bit	7 - 0
Additional alarm messages (currently not assigned)	

### 8.2.2 Supported Alarm messages

The diagnostic octets 18 and 19 contain information on the supported alarm messages.



The alarm messages are displayed by means of octet 8

#### DDLML\_slave\_Diag

Octet	18	19
Bit	15 - 8	7 - 0
Supported alarm messages		

Bit	Designation	= 0 (not supported) = 1 (supported)
0	Position error	1
1	Error voltage supply	0
2	Current too high	0
3	Maintenance diagnosis	1
4	Memory error	0

### 8.2.3 Warnings

Warnings signal that some tolerances for certain internal parameters have been exceeded. In contrast to the alarm messages, they do not indicate false position values.

The diagnostic octets 20 and 21 contain the warnings.

In case of a warning, the EXT\_Diag bit is set to 1, until the warning has been deleted.

Warnings are deleted after the diagnostic message has been read. If the tolerance is still being exceeded, the message will come up again.

The warning „operating time limit“ (bit 4) only turns up again after a restart.

**i** The diagnostic function "supported warnings" (Octet 22-23) provides the information on which warnings are supported by the encoder.


#### DDL\_M\_slave\_Diag

Octet	20	21
Bit	15 - 8	7 - 0
	<b>Warnings</b>	

Bit	Designation	0	1
0	Frequency exceeded	no	yes
1	Temperature	no	yes
2	LED Reserve	not attained	attained
3	CPU Watchdog	OK	reset executed
4	Operating time warning (100.000 h)	not attained	attained
5	Battery charge	OK	too low
6	Point of reference	attained	not attained

## 8.2.4 Supported Warnings

The diagnostic octets 22 and 23 contain information on the supported warnings.

 The warnings are indicated by means of octet 20-21.

### DDLML\_slave\_Diag

Octet	22	23
Bit	15 - 8	7 - 0
Supported warnings		

Bit	Designation	= 0 (not supported) = 1 (supported)
0	Frequency	1
1	Temperature	0
2	LED Reserve	0
3	CPU Watchdog	1
4	Operating time warning (100.000 h)	1
5	Battery charge	0
6	Point of reference	0

## 8.2.5 Profile Version

The diagnostic octets 24 and 25 contain the DP encoder profile version. The octets are subdivided in a revision number and an index.

### Example:

Profile version: 1.10  
Octet no.: 24 25  
Binary code: 0000 0001 0001 0000  
Hex.: 01 10

### DDLML\_slave\_Diag

Octet	24	25
Bit	15 - 8	7 - 0
Data	$2^7 - 2^0$	$2^7 - 2^0$
Revision number		Index
Profile version		

## 8.2.6 Software Version

The diagnostic octets 26 and 27 contain information on the software version of the encoder. The octets are subdivided in a revision number and an index.

**example:**

Software version: 1.00  
 Octet no.: 26 27  
 Binary code: 0000 0001 0000 0000  
 Hex.: 01 00

### DDLML\_slave\_Diag

Octet	26	27
Bit	15 - 8	7 - 0
Data	$2^7 - 2^0$	$2^7 - 2^0$
	Revision number	Index
	Software version	

## 8.2.7 Operating Time

The operating time display stores the operating time of the shaft encoder in operating hours. The operating time is stored every 6 minutes, unless there is no breakdown in the voltage supply of the shaft encoder. The operating time is indicated as unsigned binary value, the unit being 0.1 hours. The fixed time limit is 100,000 hours.

In case the limit has been exceeded, the encoder issues the respective warning by means of bit 4, octet 21.

**i** Due to the increment of the internal operating time counter, the encoder generates a diagnostic message every 6 minutes. If a suppression of the diagnostic message is desired (e.g. in time-critical applications), switch the "Suppress timecounter in diag" option to "Yes" via the GSD-parameter.

### DDLML\_slave\_Diag

Octet	28	29	30	31
Bit	31 - 24	23 - 16	15 - 8	7 - 0
Data	$2^{31} - 2^{24}$	$2^{23} - 2^{16}$	$2^{15} - 2^8$	$2^7 - 2^0$
	Operating time			

## 8.2.8 Offset Value

The offset value is calculated in the preset function and shifts the position value by the calculated offset value. The offset value will be stored and may be read out from the diagnostic octets 32 to 35. The data type of the offset value is 32 bit signed in the binary code. The value range is valid for the set measuring range (total number of measuring steps).

### DDLML\_slave\_Diag

Octet	32	33	34	35
Bit	31 - 24	23 - 16	15 - 8	7 - 0
Data	$2^{31} - 2^{24}$	$2^{23} - 2^{16}$	$2^{15} - 2^8$	$2^7 - 2^0$
Offset Value				

## 8.2.9 Measuring Steps per Revolution

- i** The scaling parameters are set in the DDLML\_Set\_Prm (Octet 9-17) dialog.  
**i** The parameters are stored and may be read out from the diagnostic octets 40 through 47. The set resolution of the encoder is indicated by the parameters „measuring steps per revolution“ and „total number of measuring steps“.

The data type for both values is 32 bit, unsigned.

### DDLML\_slave\_Diag

Octet	40	41	42	43
Bit	31 - 24	23 - 16	15 - 8	7 - 0
Data	$2^{31} - 2^{24}$	$2^{23} - 2^{16}$	$2^{15} - 2^8$	$2^7 - 2^0$
Measuring steps per revolution				

## 8.2.10 Total Number of Measuring Steps

- i** The scaling parameters are set in the DDLML\_Set\_Prm (Octet 9-17) dialog.  
**i** The parameters are stored and may be read out from the diagnostic octets 40 through 47. The set resolution of the encoder is indicated by the parameters „measuring steps per revolution“ and „total number of measuring steps“.

### DDLML\_slave\_Diag

Octet	44	45	46	47
Bit	31 - 24	23 - 16	15 - 8	7 - 0
Data	$2^{31} - 2^{24}$	$2^{23} - 2^{16}$	$2^{15} - 2^8$	$2^7 - 2^0$
Total number of measuring steps				

---

### 8.2.11 Serial Number Encoder

The diagnostic octets 48 through 57 contain the serial number of the encoder as ASCII string with 10 characters.

#### DDL<sub>M</sub>\_slave\_Diag

<b>Octet</b>	<b>48 - 57</b>
<b>Bit</b>	79 - 0
<b>Data</b>	ASCII
	<b>Serial number</b>

## 9 Bus Connection

### 9.1 Bus Connection of the Encoder

The data are transferred according to RS-485. A bus line system meeting the requirements of the line type A specification of the EN 50170 standard is to be used.

**The line parameters are as follows**

Parameter	Line type A
Surge impedance in $\Omega$	135 ... 165 at a frequency of (3 ... 20 MHz)
Working capacitance (pF/m)	< 30
Loop resistance ( $\Omega$ /km)	< 110
Core diameter (mm)	> 0.64
Core-cross section (mm <sup>2</sup> )	> 0.34

Only by means of this cable can the following linear expansions be obtained:

Transmission speed in kbit/s	9.6	19.2	45.45	93.75	187.5	500	1500	3000	6000	12000
Segment length in m	1200	1200	1200	1200	1000	400	200	100	100	100

The bus structure permits to connect and disconnect stations without reactions or to start up the system step by step.

The transmission speed can be selected for the range of 9.6 kbits/s through 12 Mbits/s. The speed is selected at the bus for all devices.



At the beginning and at the end of each segment, the DP bus has to be terminated by an active bus termination!  
For an interference-free operation, the voltage supply of both bus terminations has to be ensured.



The screen has to be connected on both side with ground. The power supply lines should also be entirely screened. If this is impossible, appropriate filter methods should be applied



For data rates of more than 500 kbit/s spur lines are to be avoided!



## 9.2 Connection Types

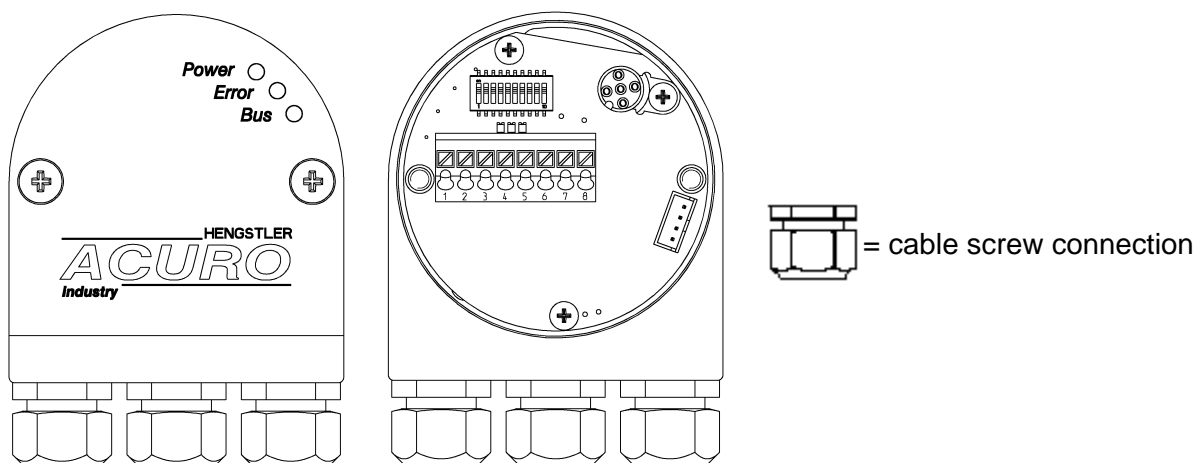
There are five connection types available for DP encoder. The following chapters are describing how to connect each connection type.

Connection type	page
Bus cover with three cable screw connetions	41/42
Bus cover with three M 12 connectors	43
Bus cover with two cable screw connections and M12 connector	44
Bus cover with two conin connectors	45/46
M23-Connector (Conin)	47/48

### 9.2.1 Bus cover with three cable screw connections

**i** There are two possibilities to connect the encoder

- **Possibility A: Connection with power supply in data cable**
- **Possibility B: Connection with power supply in only one cable**



#### Possibility A: Connection with power supply in data cable

⇒ Loosen the screws and draw off the bus cover from the encoder

⇒ **View: into the open bus cover**

⇒ **Replace middle cable screw connection by screw plug to ensure the encoder is sealed.**

⇒ Lead the encoder voltage supply and data cable through the left screw connection and connect it to terminal 1 (UB in), terminal 2 (0V in), terminal 5 (B in) and terminal 6 (A in) (see connection diagram, page 48). Put the cable screen on the PG screw connection (see cable connection diagram, page 48).

⇒ In case there are no other devices following within the same bus phase:

Activate the bus termination resistor in the bus cover (DIP switch 9 and 10 from S1 to „ON“)! **Replace right cable connection by screw plug to ensure the encoder is sealed.**

⇒ In case there are other devices following within the same bus phase:

Lead the continuing cable through the right screw connection and connect it to the terminal 7 (B out), terminal 8 (A out), terminal 3 (UB out) and terminal 4 (OV out) according to connection diagram (page 48). Put the cable screen on the cable screw connection (see cable connection diagram, page 48).

⇒ Attach the bus cover to the encoder and tighten the screws.

**Possibility B: Connection with power supply in only one cable**

⇒ Loosen the screws and draw off the bus cover from the encoder

⇒ **View: into the open bus cover**

⇒ Lead the encoder voltage supply through the middle screw connection and connect it to terminal 1 (UB in), terminal 2 (OV in) according to connection diagram (page 48). Put the cable screen on the cable screw connection (see cable connection diagram, page 48).

⇒ Lead the bus cable through the left screw connection and connect it to terminal 5 (B in) and terminal 6 (A in) (see connection diagram, page 48). Put the cable screen on the PG screw connection (see cable connection diagram, page 48).

⇒ In case there are no other devices following within the same bus phase:

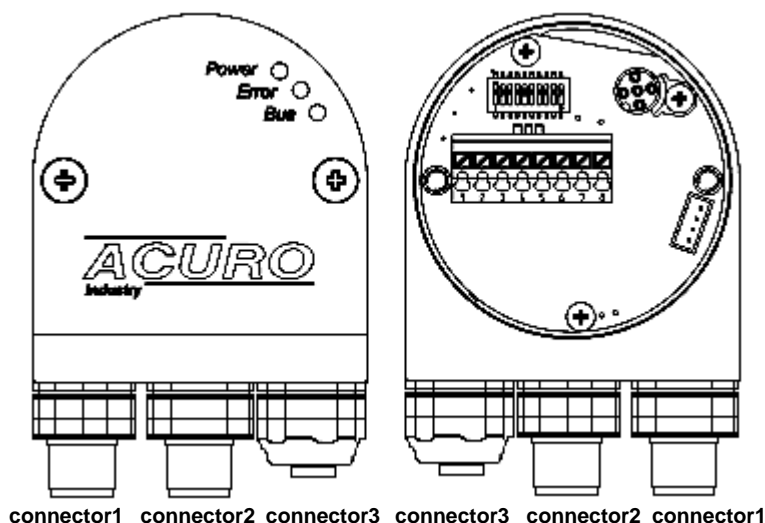
Activate the bus termination resistor in the bus cover (DIP switch 9 and 10 from S1 to „ON“)! **Replace right cable connection by screw plug to ensure the encoder is sealed.**

⇒ In case there are other devices following within the same bus phase:

Lead the continuing cable through the right screw connection and connect it to the terminal 7 (B out) and terminal 8 (A out) according to connection diagram (page 48). Put the cable screen on the cable screw connection (see cable connection diagram, page 48).

⇒ Attach the bus cover to the encoder and tighten the screws.

### 9.2.2 Bus cover with three M 12 connectors



⇒ Loosen the screws and draw off the bus cover from the encoder

⇒ **View: into the open bus cover**

⇒ Connect power supply (UB in; 0V in) on connector 2

⇒ Connect bus line (B in; A in) on connector 1

⇒ In case there are no other devices following within the same bus phase:  
Activate the bus termination resistor in the bus cover (DIP switch 9 and 10 from S1 to „ON“!)

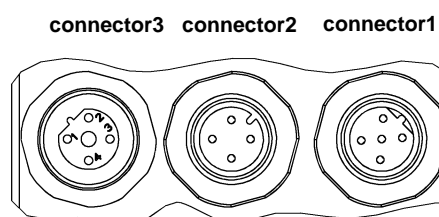
⇒ ***Tighten screw plug on connector 3***

⇒ In case there are other devices following within the same bus phase:  
Connect out coming bus line (B out; A out) on connector 3

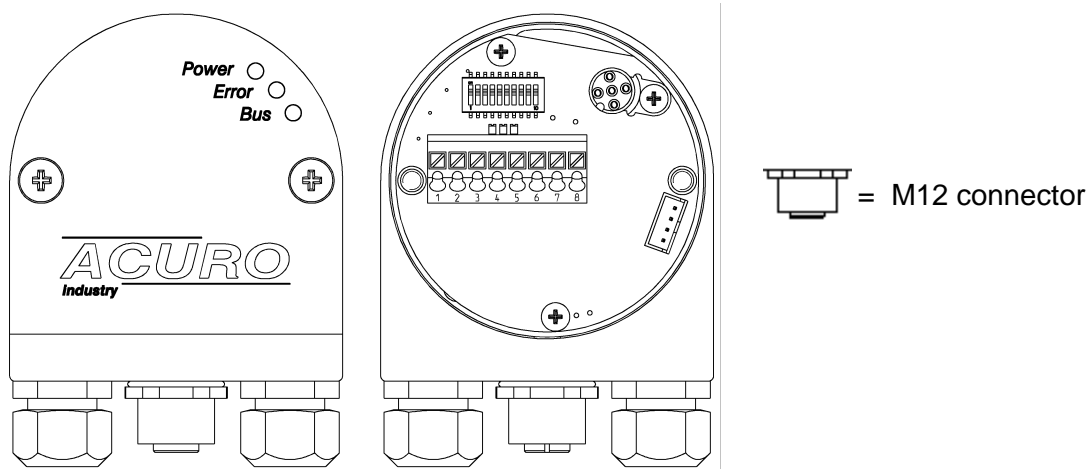
⇒ Attach the bus cover to the encoder and tighten the screws.

#### terminal assignments:

Pin	connector 1	connector 2	connector 3
1		UB in	
2	A in		A in
3		0V in	
4	B in		B out



## 9.2.3 Bus cover with two cable screw connections and M12 connector

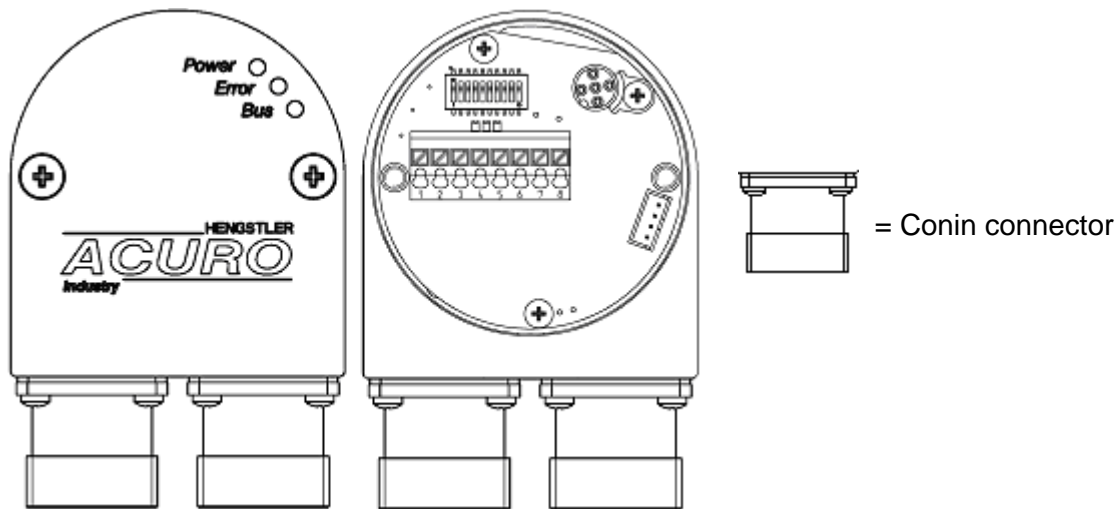


### Encoder last device in bus phase:

- ⇒ Loosen the screws and draw off the bus cover from the encoder
- ⇒ **View: into the open bus cover**
- ⇒ Activate the bus termination resistor in the bus cover (DIP switch 9 and 10 from S1 to „ON“!)
- ⇒ Lead power supply through the left screw connection and connect it to terminal 1 (UB in) and terminal 2 (0V in) according to connection diagram (page 48). Put the cable screen on the cable screw connection (see cable connection diagram, page 48)
- ⇒ Lead data cable through the right screw connection and connect it to terminal 5 (B in), terminal 6 (A in), terminal 7 (B out) and terminal 8 (A out) according to connection diagram (page 48). Put the cable screen on the cable screw connection (see cable connection diagram, page 48)
- ⇒ Attach the bus cover to the encoder and tighten the screws
- ⇒ Connect Tico-Display with M 12 connector (see 10.4)

### Following devices in bus phase:

- ⇒ Loosen the screws and draw off the bus cover from the encoder
- ⇒ **View: into the open bus cover**
- ⇒ Lead power supply and data cable through the left screw connection and connect it to terminal 1 (UB in), terminal 2 (0V in), terminal 5 (B in) and terminal 6 (A in) according to connection diagram (page 48). Put the cable screen on the cable screw connection (see cable connection diagram, page 48)
- ⇒ Lead continuing cable through the right screw connection and connect it to terminal 7 (B out), terminal 8 (A out), terminal 3 (UB out) and terminal 4 (0V out) according to connection diagram (page 48). Put the cable screen on the cable screw connection (see cable connection diagram, page 48)
- ⇒ Attach the bus cover to the encoder and tighten the screws
- ⇒ Connect Tico-Display with M 12 connector (see 10.4)

**9.2.4 Bus cover with two Conin connectors**

Since Line type A – according to specification – only includes the data lines, we recommend the following mode of connection:

- ⇒ Bus connection by stub cable to the encoder input (IN) – attention: Observe the maximum stub cable length!
- ⇒ Feed supply voltage via the second connection (OUT).



**In case line type A contains also power supply pay attention on maximum current intensity: 2 A via pin 7 and 8!**  
**Recommended external fuse for the entire bus supply voltage: T 2 A**

In case there are no other devices following within the same bus phase:

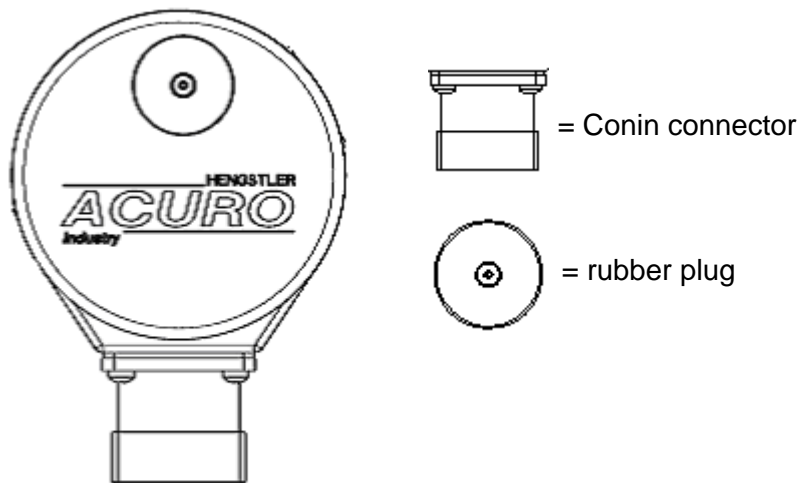
- ⇒ Loosen the screws and draw off the bus cover from the encoder.
- ⇒ **View: into the open bus cover**
- ⇒ Activate the bus termination resistor in the bus cover (DIP switch 9 and 10 from S1 to „ON“)!
- ⇒ Attach the bus cover to the encoder and tighten the screws.

**Connection assignment:**

Pin	IN (Pins)	OUT (liner)	Description
1		GND1	Data Ground (M5V)*
2	A	A	Receive/Transmit Data-Negative (A)
3			
4	B	B	Receive/Transmit Data-Positive (B)
5			
6		VCC1	+5 V Signal output (P5V)*
7	10....30 VDC	10....30 VDC	Supply voltage +U <sub>B</sub> (P24)
8	0 V	0 V	Supply voltage Ground (M24)
9			
10			
11			
12			
Screen	Screen	Screen	Screen connected to encoder housing

\* can be used for power supply of an external bus termination resistor

### 9.2.5 Flange Box 1-fold



⇒ Bus connection via spur line (attention: Observe the maximum stub cable length!) and feed supply voltage

In case there are no other devices following within the same bus phase:

- ⇒ Draw off rubber plug from the encoder. Now you have a free view on DIP switch and LED Display (10.3)
- ⇒ Activate the bus termination resistor in the bus cover (DIP switch 9 and 10 from S1 to „ON“!)
- ⇒ Insert rubber plug back (push the rubber plug several times for a tight fit in the bore)



**Warning!**

**Encoder can become leak, if rubber plug is inserted wrong or is damaged**

- IP Protection is not guaranteed!
- A total failure of the encoder is possible!

- ⇒ Pay attention when removing rubber plug!
- ⇒ push the rubber plug several times for a tight fit in the bore
- ⇒ damaged rubber plugs have to be replaced (Art. no. 2565007)

#### **Alternative: Termination about external resistive network**

- ⇒ Connect among P5V (Vcc1) and line B a resistor with 390 Ohm
- ⇒ Connect among line B and line A a resistor with 220 Ohm
- ⇒ Connect among line A and M5V (Gnd1) a resistor with 390 Ohm

**Connection assignment:**

Pin	liner	Description
1	GND1	Data Ground (M5V)*
2	A	Receive/Transmit Data-Negative (A)
3		
4	B	Receive/Transmit Data-Positive (B)
5		
6	VCC1	+5 V Signal output (P5V)*
7	10....30 VDC	Supply voltage +U <sub>B</sub> (P24)
8	0 V	Supply voltage Ground (M24)
9		
10		
11		
12		
Screen	Screen	Screen connected to encoder housing

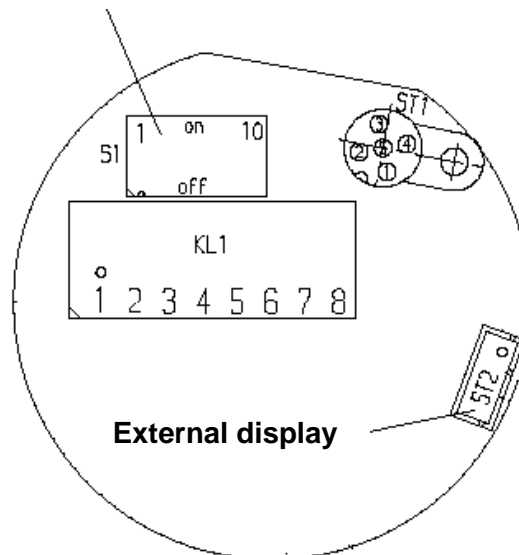
\* can be used for power supply of an external bus termination resistor



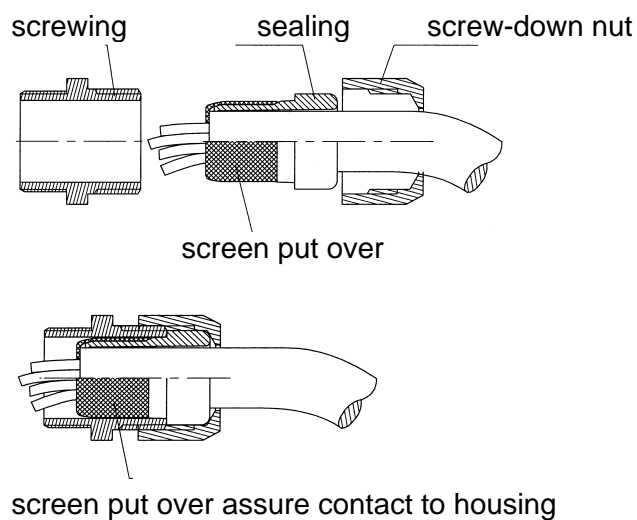
### 9.3 Connection diagram

Anschlussklemme KL1 (8-polig)	
No.	Signal
1	UB in (10...30V)
2	0V in
3	UB out
4	0V out
5	B in
6	A in
7	B out
8	A out

DIP switch S1

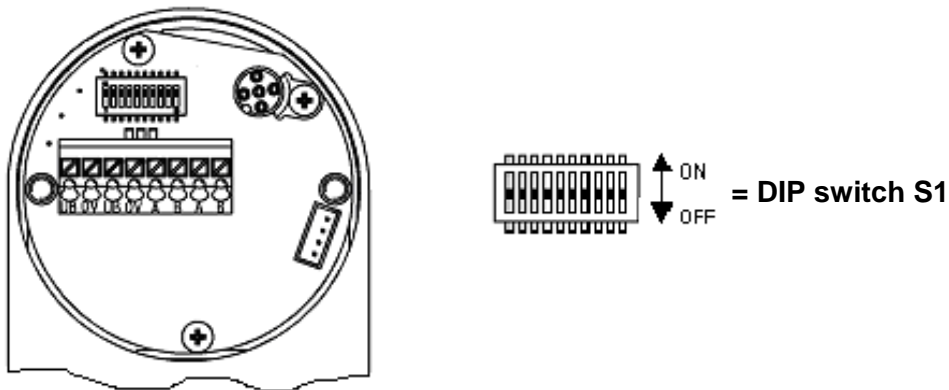


### 9.4 Cable connection diagramm



## 10 Control and display elements

### 10.1 DIP switch (S1)



⇒ The Version with Flange box 1-fold you can reach DIP switch when drawing off the rubber plug from the encoder (see 10.4)



#### Warning!

**Encoder can become leak, if rubber plug is inserted wrong or is damaged**

- IP Protection is not guaranteed!
- A total failure of the encoder is possible!

- ⇒ Pay attention when removing rubber plug!
- ⇒ push the rubber plug several times for a tight fit in the bore
- ⇒ damaged rubber plugs have to be replaced (Art. no. 2565007)

⇒ For the Version with bus cover the DIP switch will be accessible after bus cover has been drawn off.

**i** The DIP switches will only be evaluated when running up the encoder (after Reset or Power up). A modification of the switch position has no effect until the next Reset/ Power up. The modification will only be accepted if the position of the DIP switches has been modified since the previous Reset. Otherwise the address which has been stored in the EEPROM and which has been possibly programmed with a DPM2 device (class 2 master) via the bus will be preserved.

**The DIP switches :**

- 1 to 7 from S1 set the device address
- 9 and 10 activate the bus terminating resistor

**10.1.1 Setting the device address**

Setting the device address								
	DIP 1	DIP 2	DIP 3	DIP 4	DIP 5	DIP 6	DIP 7	DIP 8
	LSB						MSB	N.C.
Value	1	2	4	8	16	32	64	

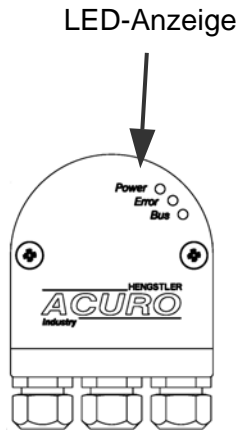
- i** Standard setting ex works: device address **125** has been stored into the EEPROM.  
 If a new address is to be set, the DIP switches must be modified correspondingly and the encoder must be run up (Reset or Power up) again.  
 Later, the device address may also be reprogrammed by a DPM2 device (Class 2 master) via the bus.

**10.1.2 Activate the bus terminating resistor**

⇒ DIP switches 9 and 10 to „ON“, if encoder is the last device in the bus phase.

- i** Using a terminator plug, the internal termination has to be turned off  
 (DIP 9 and DIP10 = OFF)

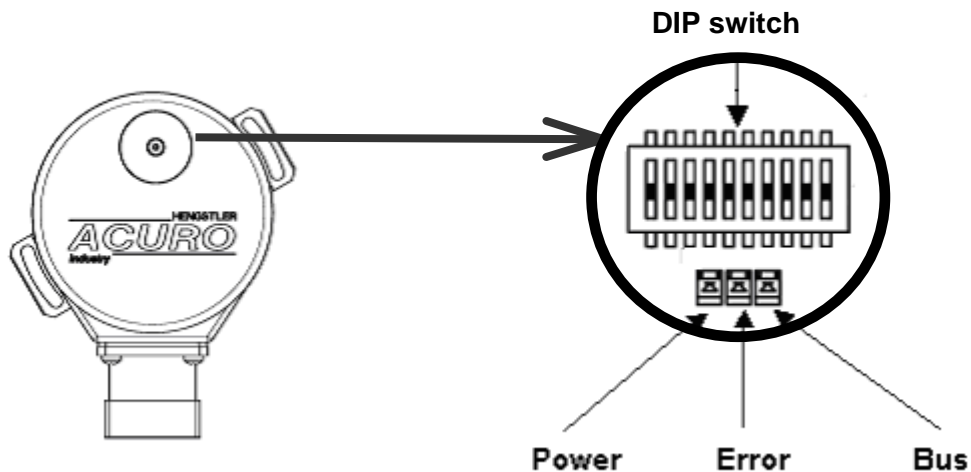
## 10.2 LED Display for the Version bus cover



	LED	Meaning	Potential reason
<b>Power (green)</b>	OFF	no Voltage supply	-under-voltage -polarity false
	ON	Voltage supply OK	
<b>Error (red)</b>	OFF	Encoder provides correct position data	
	blinking	Encoder provides wrong position data	- Bus to Encoder connection interrupted - Valid LED-current regulation range exceeded
<b>Bus (green)</b>	OFF	Connection to master interrupted ( baudrate not identified)	- Data line interrupted - Data line misconnected
	blinking	Connection to master not configured	
	ON	Connection to master, configured, data exchange is possible	

### 10.3 LED display for the Version flange box 1-fold

⇒ Remove the rubber plug. Then you will get a free view on the LED display



#### **Warning!**

**Encoder can become leak, if rubber plug is inserted wrong or is damaged**

- IP Protection is not guaranteed!
- A total failure of the encoder is possible!

⇒ Pay attention when removing rubber plug!  
⇒ push the rubber plug several times for a tight fit in the bore  
⇒ damaged rubber plugs have to be replaced (Art. no. 2565007)

**Meaning of LED Display see 10.2**

## 10.4 Tico display

With the Version bus cover and M 12 connector a Tico display can be delivered

### 10.4.1 Display with proper connection

- Connect Tico Bus display with M12 connector
- switch on

On the display appears every three seconds:

- Software-Permit-Date  
For ex. 15.01.03
- Bustype (Profibus)
- Device address  
For ex. 032
- Position value  
For ex. 4121980

### 10.4.2 Error message

- Communication problem of the  
encoder and bus interface
- Encoder reports hardware  
failure

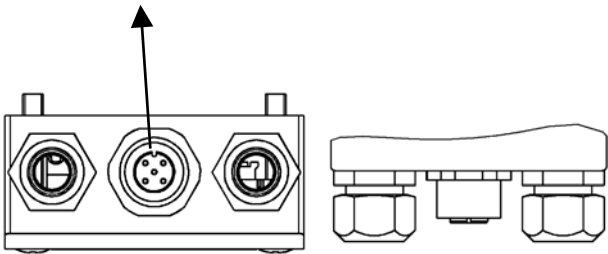
10.4.3 Pin out

Encoder

PIN	description
1	Ub+ (supply for tico)
2	Clock (Count input)
3	0V
4	Data (Preset input)
5	n.c.

Tico

PIN	description
4	Data
3	Clock
2	Ub-
1	Ub+



## 11 Start-up procedure

**i** As an aid for the use of standard Profibus-DP tools, there is a so-called GSD file (electronically data sheet) with device master information. It is available by download from our Internet homepage. The GSD file "HENx00B7.GSD" contains the available encoder parameters.

The bitmap files are also used by the configuration tools to show the encoder as an icon.

### 11.1 Example for configuration with Step 7:

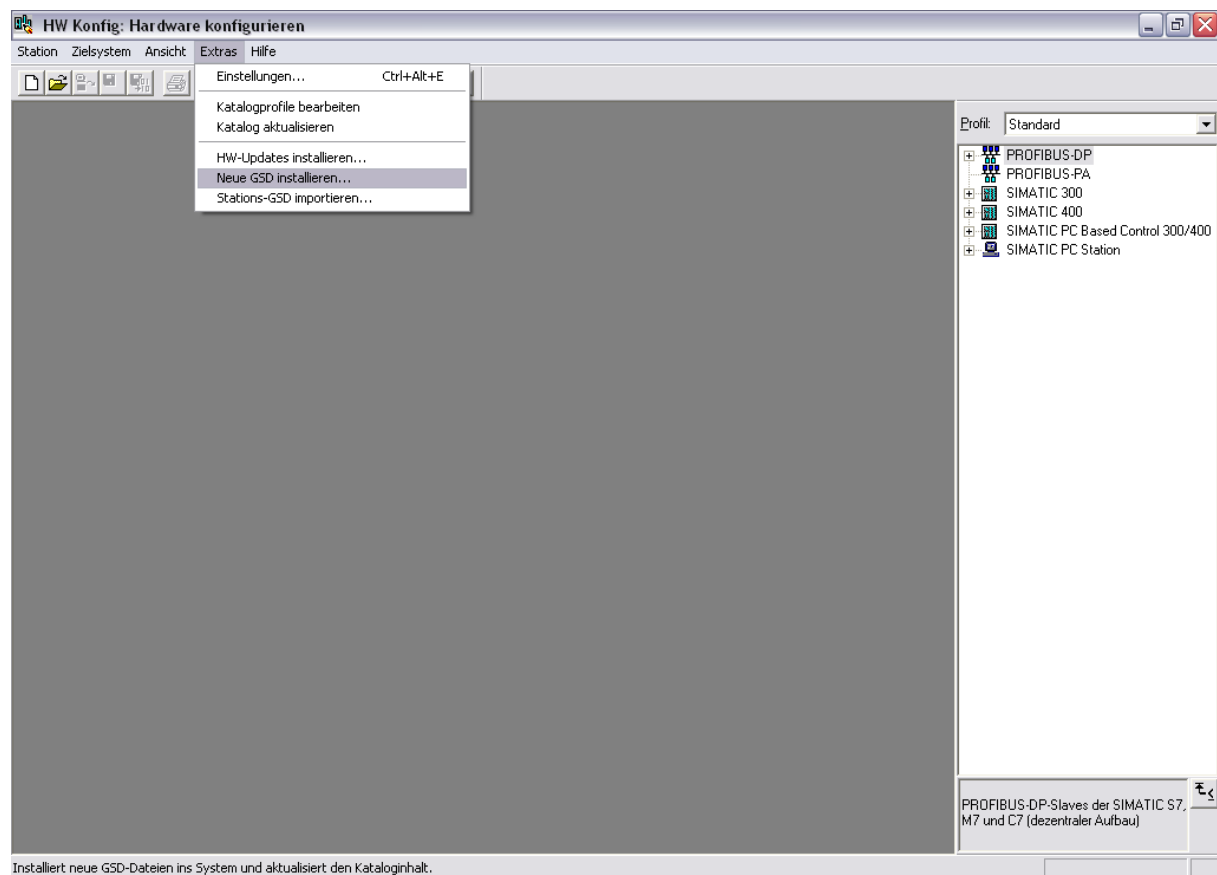
*All examples base on the Siemens Simatic Manager V 5.2<sup>®</sup>*

#### 1. read in GSD files

**i** All hardware projects have to be closed before starting the program HW-configurator

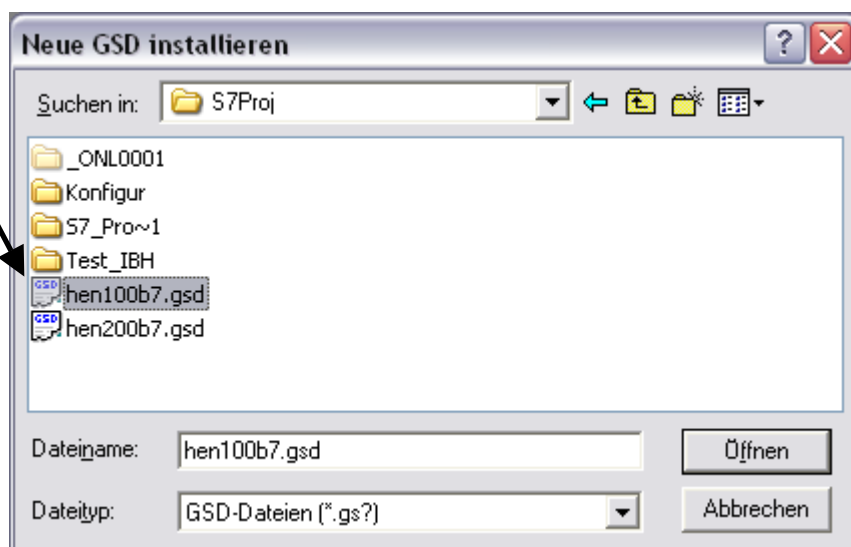
⇒ start **HW-configurator** of the Step 7 software

⇒ choose „**Install New GSE**“ from menu “options“





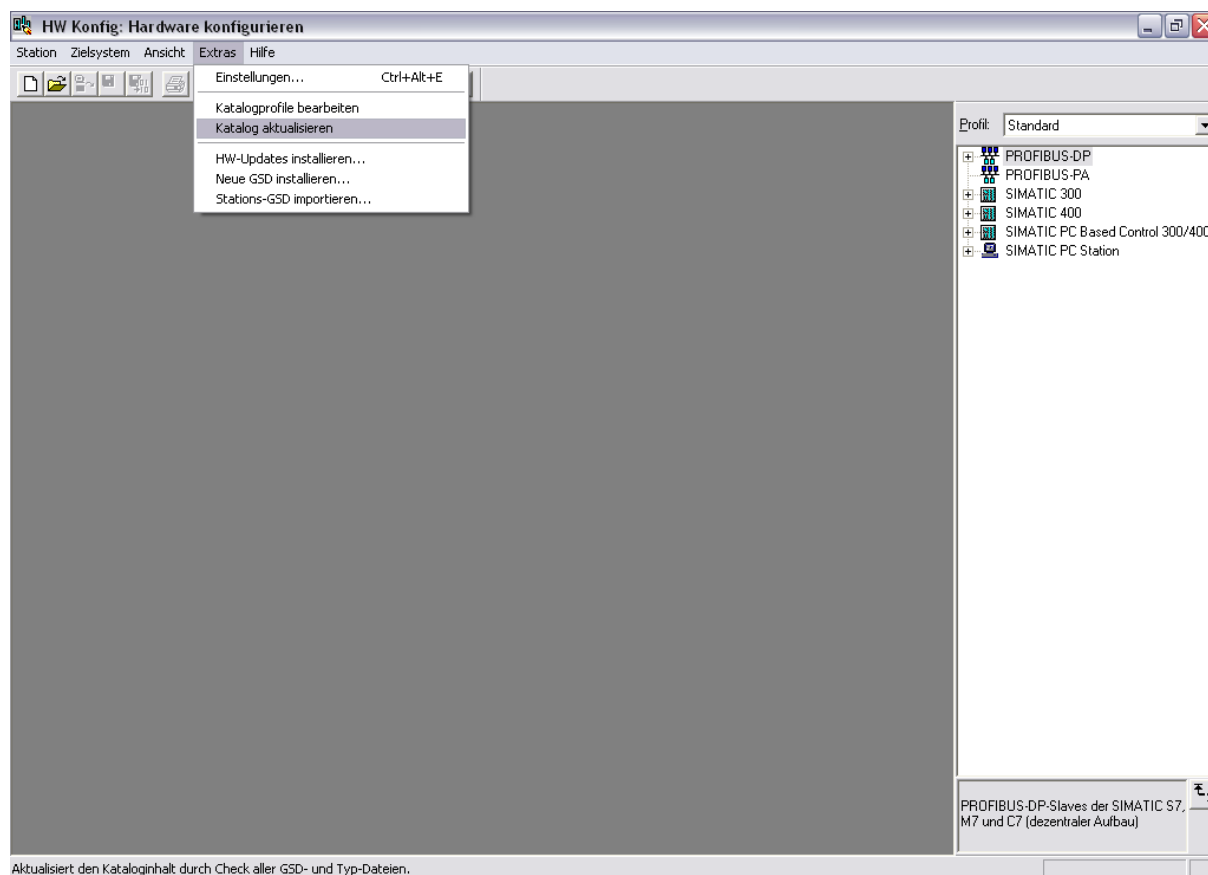
⇒ choose and open **hen100b7.gsd**



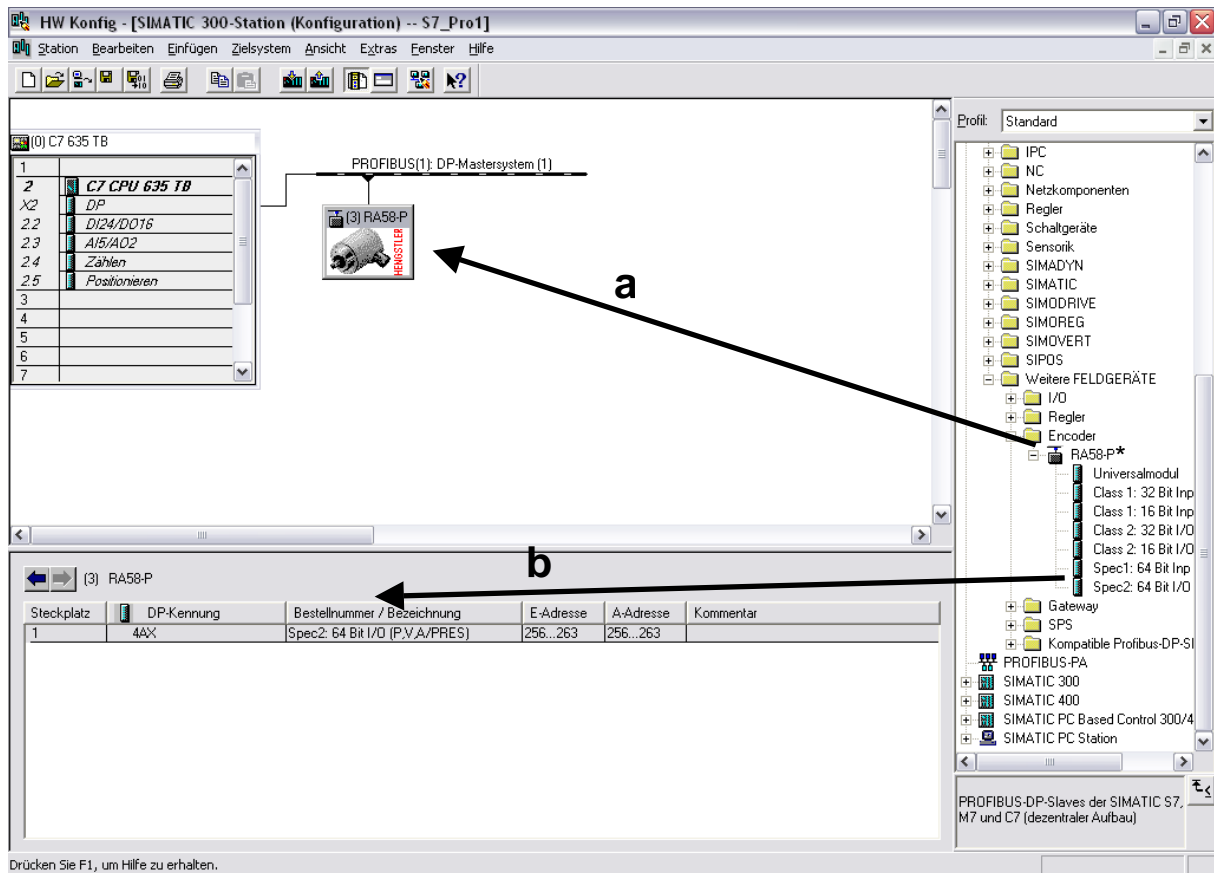
⇒ **confirm installation** of bitmap file

## 2. update catalogue

⇒ choose **“update catalogue”** from „Extras“



### 3. Integrate the encoder into the Profibus (requires that master is already configured)



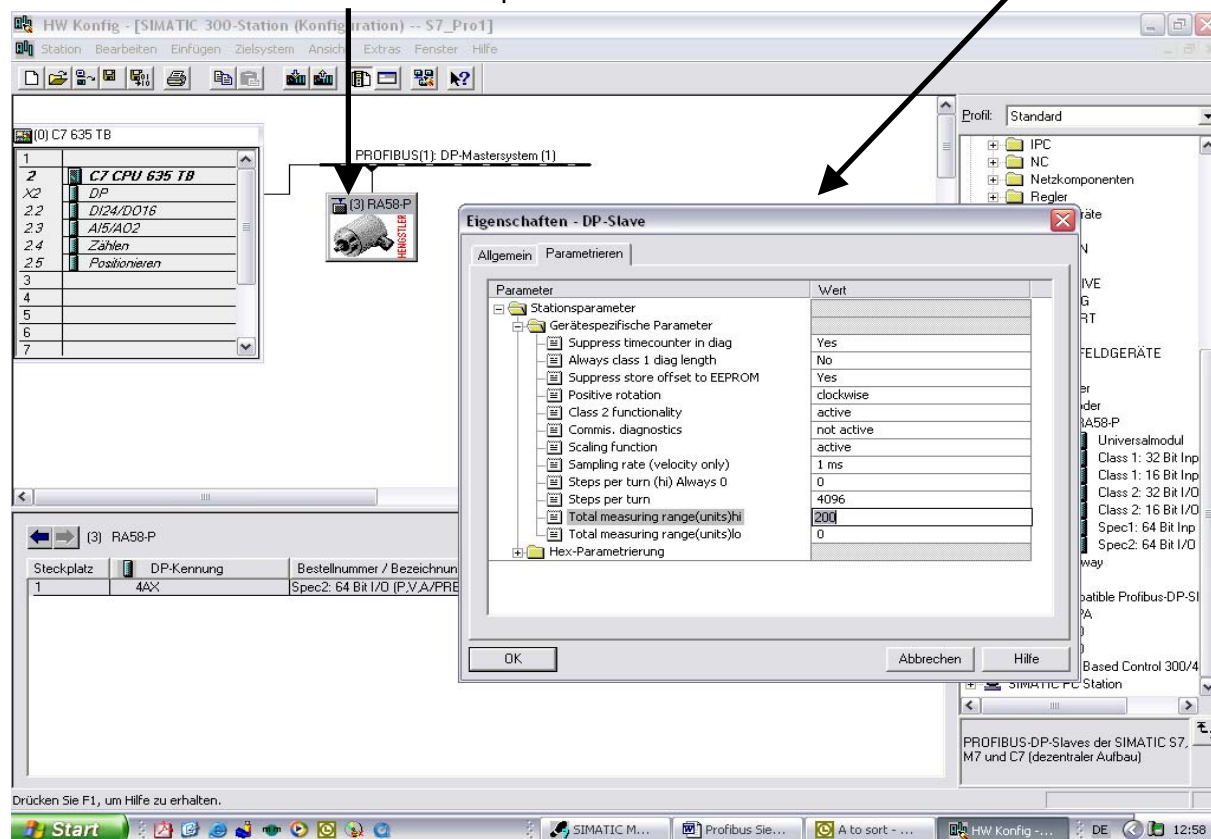
⇒ choose **RA58-P** (\*former product name for ACURO with Profibus) from the hardware catalogue window:

Path: Profibus DP – Additional Field Devices - Encoder - RA58-P  
and put in on the Profibus line the upper window (a)

⇒ click on selected module and draw it into lower window (b)

#### 4. Setting of the parameters

⇒ double-click the **encoder icon** to open the window with the **slave-characteristics**

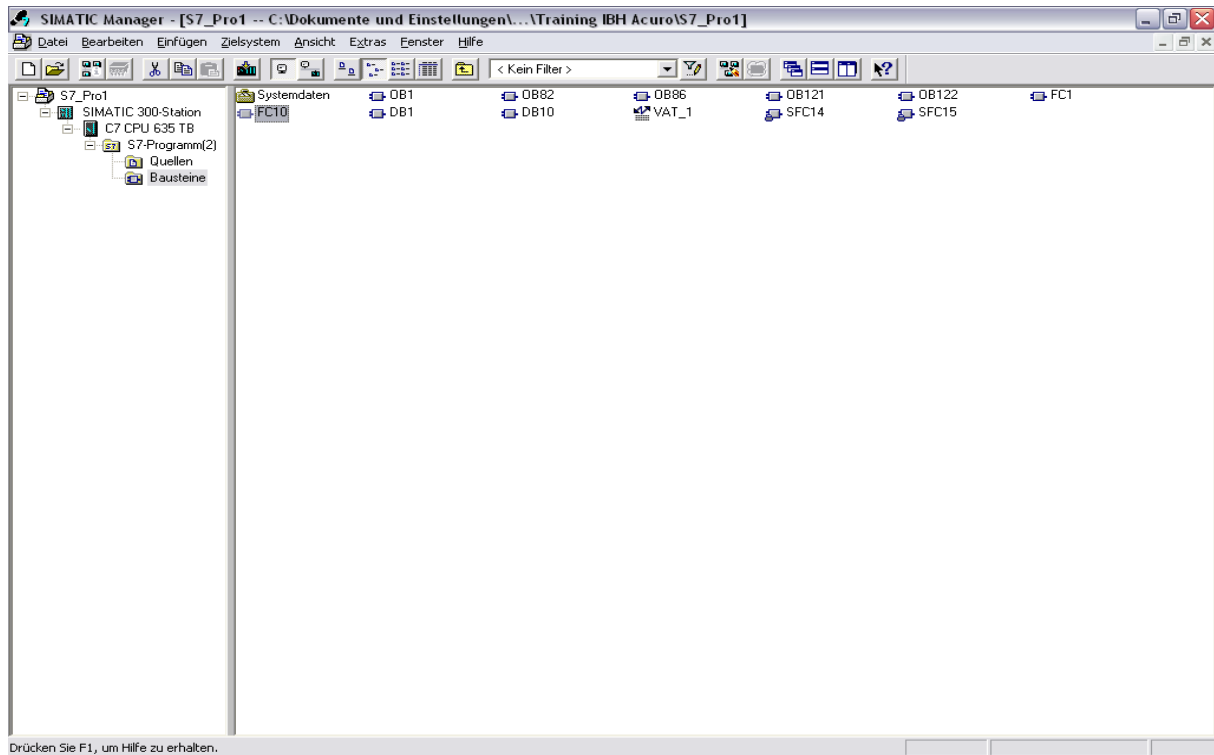


**i** For **changing the value** of a parameter double-click on the value and insert the new value in the opening window

Here you find the explanations of the parameters in the manual:

Parameters	Chapter
Suppress time counter in diag	6.2.1
Always class 1 diag length	6.2.2
Suppress store offset to EEPROM	6.2.3
Positive rotation	6.3.1
Class functionality	6.3.2
Commis, diagnostics	6.3.3
Scaling function	6.3.4
Sampling rate	6.3.5
Steps per turn (hi) Always 0	6.4
Steps per turn	6.4
Total measuring range (units) hi	6.5
Total measuring range (units) lo	6.5

## 5. Adjusting the S7-program-modules



If necessary integrate following OBs or functions:

### **OB82 (Diagnosis):**

For catching the encoder diagnosis, that is initiated every six minutes by the working time counter of the encoder.

### **OB86**

If fault or a breakdown occurs the SPS stops. Integrate OB86 to avoid this.

### **SFC14 (read data > 32 bit consistent)**

Must be integrated, if the encoder part is "Spec1:64 bit Inp (POS,VEL,AC)" or "Spec2: 64 bit I/O (P,V,A/PRES)", since normally the S7 only reads in 32 bit consistent.

### **SFC15 (write data > 32 bit consistent)**

Must be integrated, if the encoder part is "Spec2: 64 bit I/O (P,V,A/PRES)" and a preset value is to be written in the encoder.

## 5. Finishing



Configuration and the setting of the parameters is now completed.

⇒ **Save the project**

## 11.2 A summary of the GSD parameters:



For a detailed description of the parameters see chapter 6

**Suppress timecounter in diag:** Choose “Yes” to suppress that due to the increment of the internal timecounter a diagnostic message is generated every six minutes. This may be a problem in time-critical applications.

**Always class 1 diag length:** Choose “Yes” to shorten the class 2 data length to a class 1 length. Choose this setting, if your control unit does not support the full class 2 length (input buffer too small).

**Suppress store offset to EEPROM:** Choose “Yes” to suppress the saving of a preset/offset value to the EEPROM of the encoder. This way it is possible to submit a preset value as often as you like (e.g. cyclic encoder synchronization in a round table application), without limiting the lifetime of the EEPROM.



The preset value stored in the encoder RAM gets lost if the voltage supply is interrupted!

**Positive rotation:** Sets the counting direction of the encoder to incrementing values (view: on the encoder shaft)

**Class 2 functionality:** “active” activates this option

**Commis. diagnostics:** “active” activates an additional hardware testing of the encoder.

**Scaling function:** “active” enables the scaling function

**Sampling rate (velocity only):** By means of this bit the scanning loop time of the internal encoder timer is set to 1ms or 10ms. (At 10 ms the encoder returns higher speed and acceleration values)

**Steps per turn:** Setting the number of measuring steps per turn (resolution) is possible in a range from 1 step to the highest possible physical resolution.

**Total measuring range (units) hi / lo:** Put in the limit of total measuring steps. The encoder is reset to zero. The four Byte of the value are divided into low and high words. (picture page 45: encoder programming results from setting 1024 in high-word and 0 in low-word, total value  $67.108.864 = 26 \text{ bit}$ )

**Example:** As a total of measuring steps 1.000.000 is to be set  
Solution (decimal values):  $1.000.000 / 2^{16} = 15 \text{ rest } 16.960$ ;  
→High-word=15, Low-word=16960

## 11.3 Example for configuration with hexadecimal parameter setting

Hen200b7.gsd must be used with those configuration tool, who do not support 'Ext user parameters'. In this case the parameters have to be written as hexadecimal values.

	0	1	2	3	4	5	6	7	8	9
0	0	A	0	0	10	0	4	0	0	0

**Byte 6-9 (=Octet 14-17):**  
**Measuring steps in total**  
 Byte 6=MSB, Byte 9=LSB

**Byte 2-5 (=Octet 10-13):**  
**Measuring steps per rotation**  
 Byte 2=MSB, Byte 5=LSB

### Byte 1 (=Octet 9): Operating parameters

**Bit 0:** Code sequence (0=cw, 1=ccw)

**Bit 1:** Class 2 functionality (0=not active, 1=active)

**Bit 2:** Maintenance diagnosis (0=not active, 1=active)

**Bit 3:** Scaling function (0=not active, 1=active)

**Bit 7:** Sampling time for calculating speed (0=1 ms, 1=10 ms)

### Byte 0 (=Octet 8):

Special functions

**Bit 0:** Suppress time counter in diag (0=not active, 1=active)

**Bit 1:** Always class 1 diag length (0=not active, 1=active)

**Bit 2:** Suppress store preset to EEPROM (0= not active, 1=active)

## 12 Technical Data

### 12.1 Mechanical

Max. shaft load	axial 20 N, radial 40 N (6 mm shaft) axial 40 N, radial 60 N (10 mm shaft)
Revolution per minute	12000 min <sup>-1</sup> (short-time), 10000 min <sup>-1</sup> (permanent operation)
Torque	≤ 0,5 Ncm
Moment of inertia	Synchro flange: 14 gcm <sup>2</sup> ; clamping flange: 20 gcm <sup>2</sup>
Protection class (EN 60529)	IP64,IP67
Operating temperature	-40 ... +85 °C
Storage temperature	-40 ... +85 °C
Vibration resistance (IEC 68-2-6)	100 m/s <sup>2</sup> (10 - 500 Hz)
Shock resistance (IEC 68-2-27)	1000 m/s <sup>2</sup> (6 ms)
Connections	<ul style="list-style-type: none"> <li>• Bus cover with             <ul style="list-style-type: none"> <li>• 3 x screw connections</li> <li>• 2 x screw connections + M 12 connector for Tico</li> <li>• 2 x Conin connectors</li> </ul> </li> <li>• Flange box 1-fold</li> </ul>
Material shaft	High-grade steel
Housing	Aluminium
Weight	Multiturn approx. 400 g, Singleturn approx. 350 g

## 12.2 Electrical

General design	according to EN 61010-part 1, protection class III, contamination level 2, over voltage category II
Supply voltage	10 ... 30 V DC (SELV)
Induced current absorption	typ.200 mA, max. 230 mA
Recommended external fuse	T 0,25 A
Current fed-through supply voltage; Current fed-through supply voltage	max. 2 A über Pin 7 und 8 bei Flanschdose 2-fach max. 2 A über die Anschlussklemmen bei Bushaube T 2 A
EMC *	EN 61326 : class A
Interface	RS 485
Protocol	Profibus DP with class 2 encoder profile C2 (programmable)
Physical resolution**	1024 Increments (10 bit) single turn 4096 Increments (12 bit) single turn 8192 Increments (13 bit) single turn 16384 Increments (14 bit) single turn 4096 Increments/4096 revolutions (24 bit) multi turn 8192 Increments/4096 revolutions (25 bit) multi turn 16384 Increments/4096 revolutions (26 bit) multi turn
Linearity	$\pm \frac{1}{2}$ LSB ( $\pm 1$ LSB at a resolution of 13, 14, 25, 26 bit)

\* Important notice:

1. EMV values are only valid in case the instructions for screening have been observed (see Chapter 2 and 9.4)
2. The encoder is designed to be connected to a power supply unit. In case that the encoder is connected to DC voltage, it has to be protected against surge voltage
3. In an environment with strong pulsed interferences a validity check of the position values is recommended

\*\* resolution of the encoder disk; in addition, the desired resolution can be minimized by programming the encoder.



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**Continuation of electrical data**

Type of code	Binary
Baud rate	is automatically set within a range of 9.6 Kbit/s through 12 Mbit/s
Device address	set via DIP switches
Programmable functions	Code sequence (direction), resolution per revolution, total resolution, preset, speed, acceleration
Activate the bus terminating resistor	set via DIP switches

## 13 Dimensioned drawings

### 13.1 Synchro flange

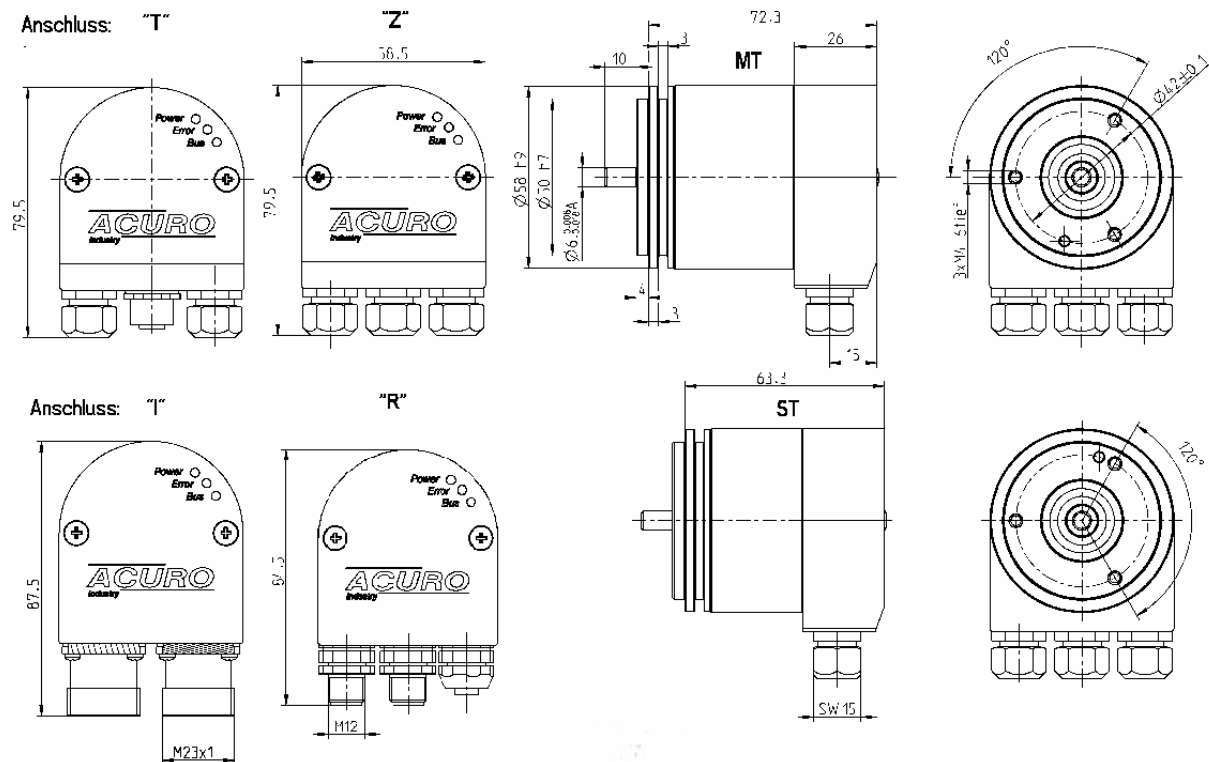
### 13.1.1 Connection with bus cover

I Bus cover, 12 pole, clockwise, radial

**Z** Bus cover with 3 x cable screws connectors

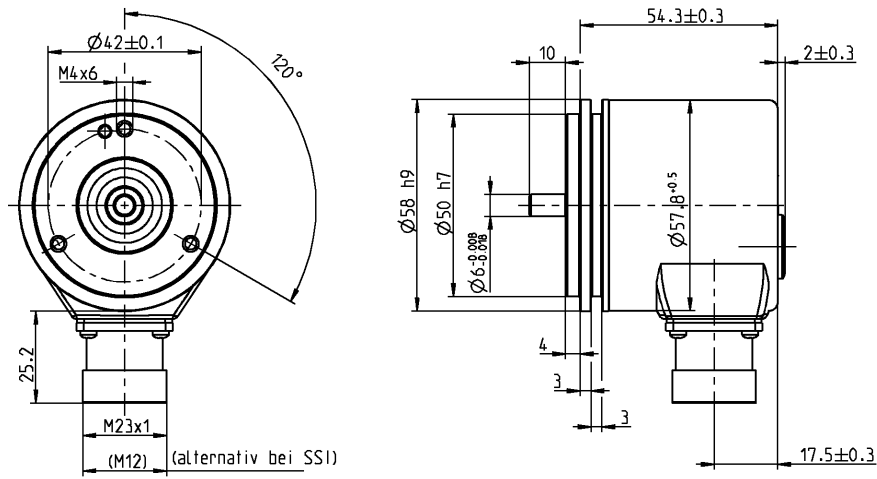
**T Bus cover with 4 pol. M12 for „Tico“ indicator + 2 x cable screws connectors**

**R** Bus cover with 3 x M12 connectors



**i** The cable screw connections require cable diameters in a range from:  
7.0 ... 7.4 mm;

**i** Bus cables with a diameter of 7.9 ... 8.7 mm can be used, if the standard sealing are replaced by the enclosed sealing, which have a larger diameter.

**13.1.2 Connection M23-Connector (Conin)****D M23-Connector (Conin), 12-pol., clockwise**

## 13.2 Clamping flange

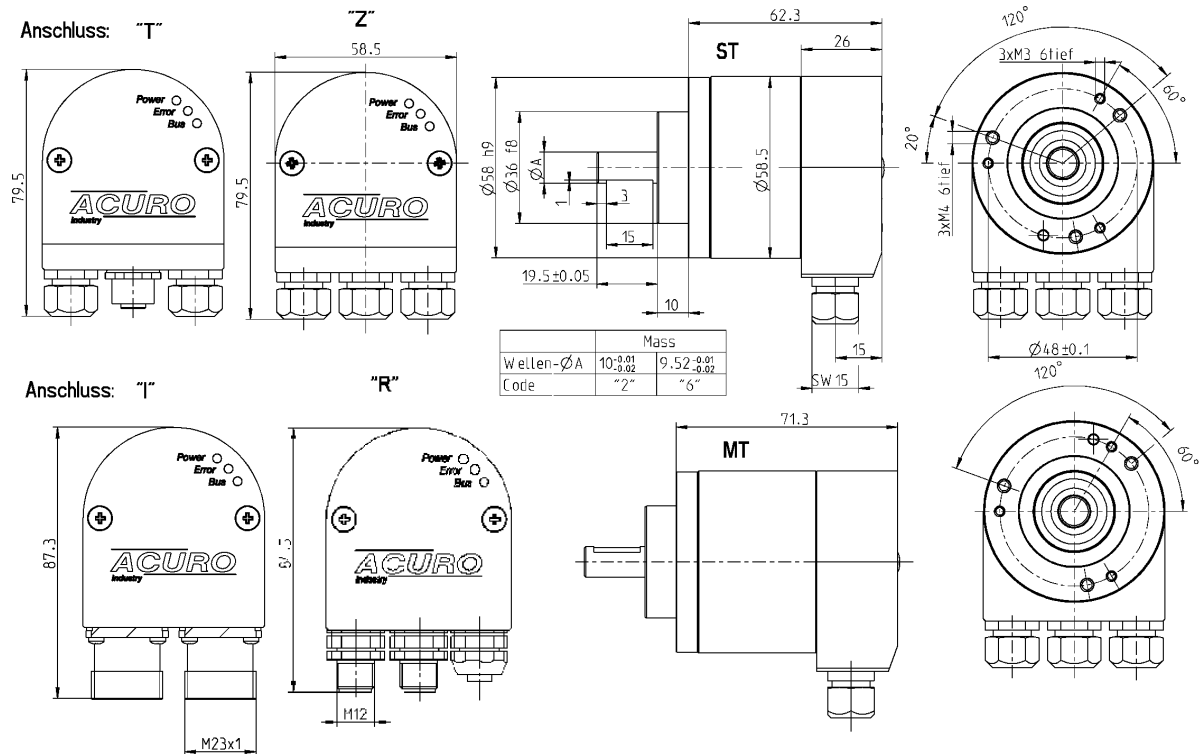
### 13.2.1 Connection with bus cover

I Bus cover, 12 pole, clockwise, radial

**Z** Bus cover with 3 x cable screws connectors

**T** Bus cover with 4 pol. M12 for „Tico“ indicator + 2 x cable screws connectors

### R Bus cover with 3 x M12 connectors

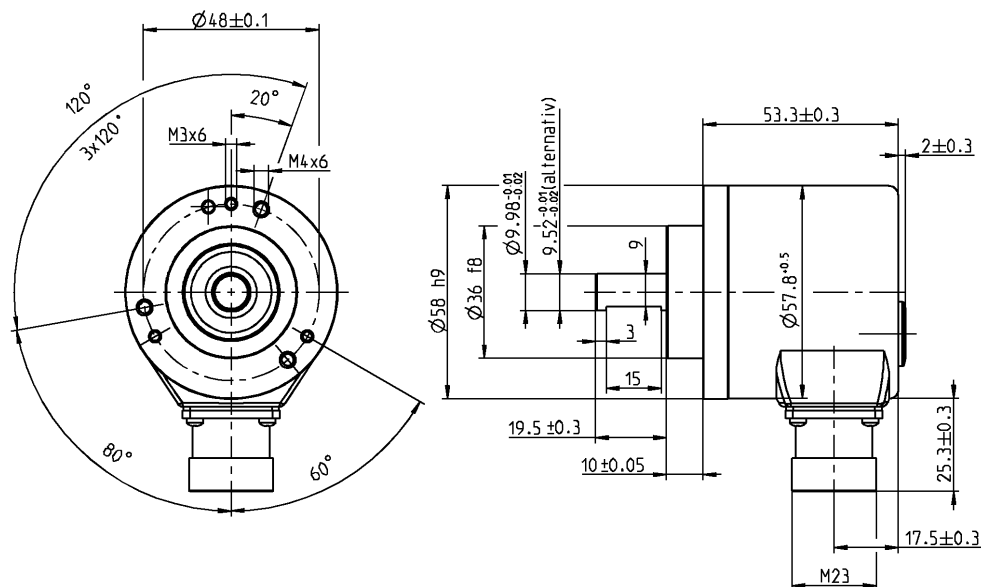


**i** The cable screw connections require cable diameters in a range from:  
7.0 ... 7.4 mm;

**i** Bus cables with a diameter of 7.9 ... 8.7 mm can be used, if the standard sealing are replaced by the enclosed sealing, which have a larger diameter.

### 13.2.2 Connection M23-Connector (Conin)

**D** M23-Connector (Conin), 12-pol., clockwise



### 13.3 Quadrat flange

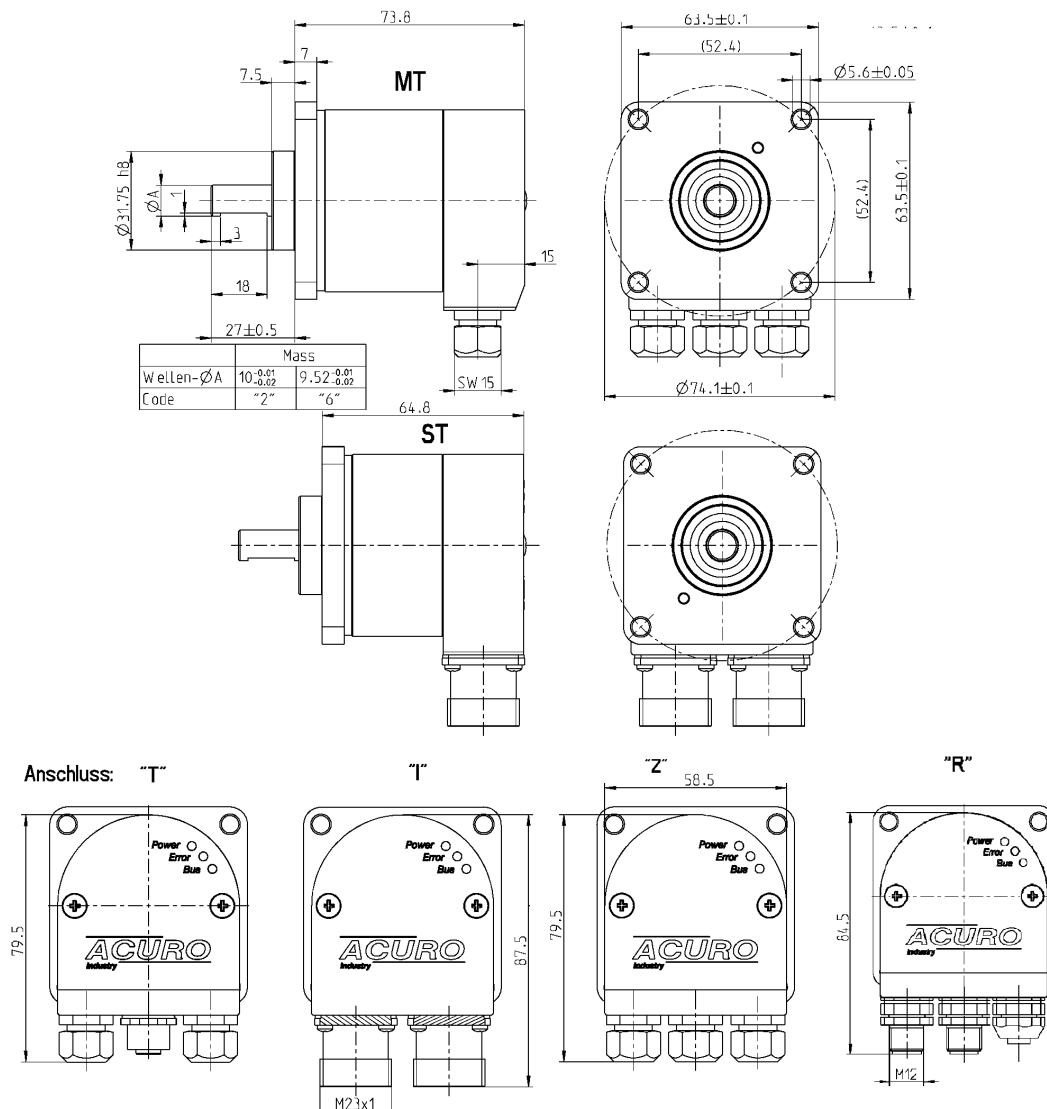
#### 13.3.1 Connection with bus cover

**I** Bus cover, 12 pole, clockwise, radial

**Z** Bus cover with 3 x cable screws connectors

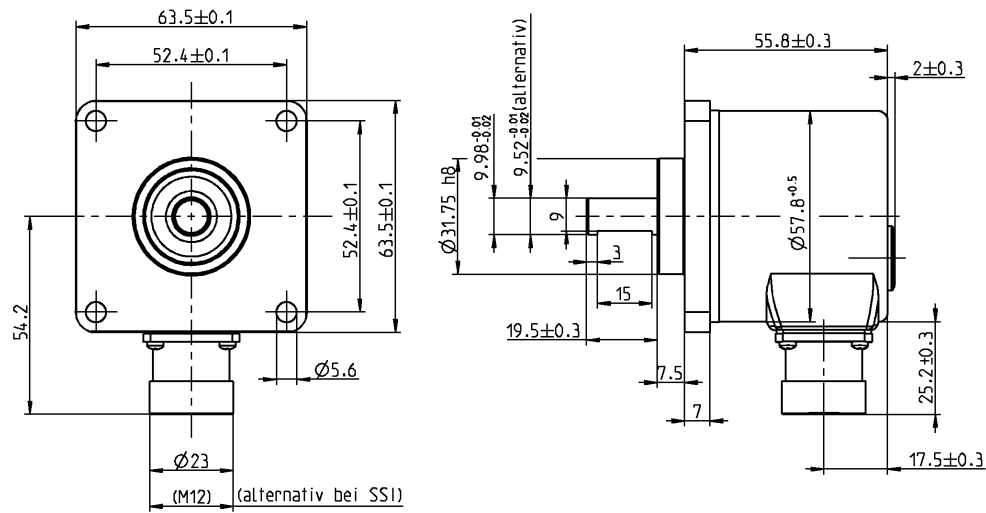
**T** Bus cover with 4 pol. M12 for „Tico“ indicator + 2 x cable screws connectors

**R** Bus cover with 3 x M12 connectors



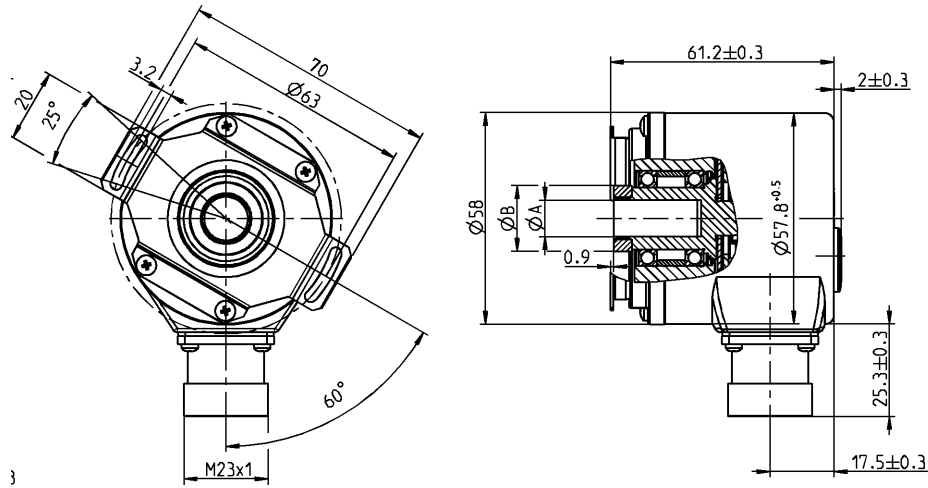
**i** The cable screw connections require cable diameters in a range from:  
7.0 ... 7.4 mm;

**i** Bus cables with a diameter of 7.9 ... 8.7 mm can be used, if the standard sealing are replaced by the enclosed sealing, which have a larger diameter.

**13.3.2 Connection M23-Connector (Conin)****D M23-Connector (Conin), 12-pol., clockwise**





**13.4.2 Connection M23-Connector (Conin)****D M23-Connector (Conin), 12-pol., clockwise**

## 14 Ordering data

En-coder	Resolution	Supply voltage	Flange, Shaft, Protection	Interface	Connection
<b>AC 58</b>	<b>0010</b> 10 Bit ST <b>0012</b> 12 Bit ST <b>0013</b> 13 Bit ST <b>0014</b> 14 Bit ST <b>1212</b> 12 Bit MT +12 Bit ST <b>1213</b> 12 Bit MT +13 Bit ST <b>1214</b> 12 Bit MT +14 Bit ST	E = 10-30V	<b>S.41</b> Synchro, IP64, 6x10mm <b>S.71</b> Synchro, IP67, 6x10mm <b>K.42</b> Clamping, IP64, 10x19,5mm <b>K.72</b> Clamping, IP67, 10x19,5mm <b>K.46</b> Clamping, IP64, 9,52x19,5mm <b>K.76</b> Clamping, IP67, 9,52x19,5mm <b>F.42</b> Spring tether, IP64, 10x19,5mm Hollow shaft <b>F.47</b> Spring tether, IP64, 12x19,5mm Hollow shaft <b>F.46</b> Spring tether, IP64, 9,52x19,5mm Hollow shaft <b>Q.42</b> Quadrat, IP64, 10x19,5mm <b>Q.72</b> Quadrat, IP67, 10x19,5mm <b>Q.46</b> Quadrat, IP64, 9,52x19,5mm <b>Q.76</b> Quadrat, IP67, 9,52x19,5mm	DP = Profibus	<b>I</b> Bus cover Doppelconin, 12-pol., clockwise, radial <b>Z</b> Bus cover with 3 x cable screws connectors <b>T</b> Bus cover with 4 pol. M12 for „Tico“ indicator + 2 x cable screws connectors <b>R</b> Bus cover with 3 x M12 connectors

Note:

- Protection only refers to the Shaft
- Bus cover with proper use: IP67
- Diagnose-Kit 230 VAC for encoder with bus cover, incl. ACURO soft and “Tico” indicator, Art. NO. 1 565 070
- “Tico” - indicator, Art. No. 0 731 205
- Connection cable bus cover (T) to “Tico”, 1.5m, Art. No. 3 539 575

**Accessories:** GSD file as download from our homepage

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