SICK AG
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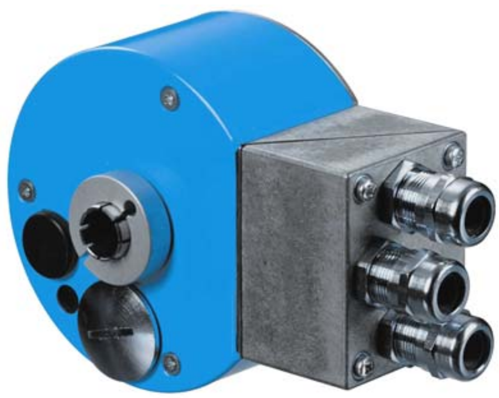
# Commissioning Instructions

## ATM60 / ATM90 / KHK53

## with Profibus DP Interface to EN 50170 Vol. 2



The data in this documentation describes the product. The properties, however, are not guaranteed.

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Version: Dec 2021

We reserve the right to make technical changes to the documentation and the products at any time.

# Contents

# Schedule of Revisions

The following information lists the revisions made by the company since the first edition.

**New information (N)**

New properties and additional information on existing properties.

**Revised information (R)**

Revisions to the previous edition, which require a different procedure during commissioning.

| Inf. | Revisions | Chapter | Rev | Date |
|---|---|---|---|---|
| | First edition of the document | | 1.00 | Jan 2005 |
| | Change of address and addition of UK Declaration of Conformity | | 1.00 | Dec 2021 |
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| | | | | |

# 1 Introduction

## 1.1 Using these Commissioning Instructions

These instructions give an overview of the ATM60/ATM90/KHK53 encoders with Profibus interface and describe configuration, installation, operation and maintenance of the devices in the Profibus network.

These instructions have been written for trained persons who are responsible for installation, assembly and operation of the ATM60/ATM90/KHK53 encoders in industrial environments.

The commissioning staff should understand Profibus network operations and know how slave devices function in a network and communicate with a Bus Master. There should be basic understanding of and experience in electrical terminology, programming procedures, networks, the devices and software required as well as knowledge of applicable safety regulations.

## 1.2 Documentation

The complete documentation comprises of:

- Commissioning Instructions ATM60/ATM90/KHK53 with Profibus DP Interface (*)
- Assembly instructions for the particular encoder
- Device master file (GSD, GSE)

(*) This documentation

## 1.3 Definition of the Symbols Used in the Document

| | |
|---|---|
| | This symbol identifies text which must be given special attention, to ensure correct use of devices and prevent dangers resulting from this. Non-compliance may lead to bodily harm and/or damage or destruction of the system. |

| | |
|---|---|
| | This symbol identifies text with important information on the correct use of the encoders. Non-compliance may lead to encoder malfunctions. |

| | |
|---|---|
| | This symbol identifies text with useful details or explanations for the better understanding of this documentation. |

## 1.4 Conformity

### 1.4.1 Profibus

- DP Protocol to EN 50170 Vol. 2
- Encoder profile (V1.1)

### 1.4.2 European Union Directive Compliance

**Declaration of Conformity**

### 1.4.3 UK statutory instruments

**UK Declaration of Conformity**

# 2 Designations and Abbreviations

## 2.1 Profibus DP-Specific

| | |
|---|---|
| PNO | Profibus user organisation [“Profibus-Nutzerorganisation”] |
| DP | Profibus decentralised periphery |
| ID | Identifier |
| GSD | Device master file – An electronic data sheet is a template provided by the manufacturer, which stipulates how to present information and which matching entries can be made. |
| | |
| DPM1 | DP Master Class 1 – Central control which, in a set message cycle, exchanges information with the decentralised stations (DP slaves). Typical devices are e.g. programmable logic controllers (PLCs), PC systems or VME systems. |
| DPM2 | DP Master Class 2 – Programming, projection or operating devices. They are used during commissioning, to produce the configuration of the DP system or to operate the running system. |
| Node | A node is a hardware unit with a unique address in the network (also known as device). |
| MAC ID | Address of a Profibus node (Medium Access Control). |
| SAP | Service Access Point – in Profibus layer 2 |
| FDL | Fieldbus Data Link – Profibus data link layer 2. |
| DDLM | Direct Data Link Mapper – the interface between basic DP functions and the user interface (also known as profiles). |
| | |
| IO (I/O) | Input and output data. |
| Input data | This data is produced by a Profibus device (slave device) and collected by a master device and made available for reading by the processor of the PLC. |
| Output data | This data is produced by a PLC processor and written to the memory of the master device. The master device sends this data to other Profibus devices (slave devices). |

## 2.2 Data Type Specifications

| | | |
|---|---|---|
| BOOL | Boolean | 1 bit |
| BYTE | Bit String | 1 byte (8 bits) |
| WORD | Bit String | 2 bytes (16 bits) |
| USINT | Unsigned Short Integer | Int (1 byte) - (0...255) |
| UINT | Unsigned Integer | Int (2 bytes) - (0...65,535) |
| UDINT | Unsigned Double Integer | Int (4 bytes) - (0...+$2^{32}$.-1) |
| SINT | Signed Short Integer | Int (1 byte) - (-128...+127) |
| INT | Signed Integer | Int (2 bytes) - (-32,768...+32,767) |
| DINT | Signed Double Integer | Int (4 bytes) - (-$2^{31}$...+$2^{31}$ - 1) |

| | | | |
|---|---|---|---|
| LSB | Least Significant Bit / Byte, | Bsp: $81{,}938_D$ == | $[00.01.40.12]_{hex}$ |
| MSB | Most Significant Bit / Byte, | | $[00.01.40.12]_{hex}$ |
| Little Endian | In a sequence of data packets requested/sent, the LSB is transmitted first. – also see LSB above: { 12.40.01.00 } | | |
| Big Endian | In a sequence of data packets requested/sent, the MSB is transmitted first. – also see MSB above: { 00.01.40.12 } | | |

| | |
|---|---|
| | The Profibus protocol always transmits the data in the “Big Endian” format. |

## 2.3 Encoder-Specific

| | |
|---|---|
| CPR (cpr) | Counts (steps) per Revolution (per span for linear ones). – *customer-specified* -- |
| CMR | Counts (steps) over the total Measuring Range. – *customer-specified* -- |
| R | Ratio (R) = [CMR] / [CPR]. – limited to values $2^{**N}$, (N=0,1,...13) |
| Scaling parameters | Scaling parameters: [CMR], [CPR] |

| | |
|---|---|
| PRS | Physical Resolution Span: max. number of steps per revolution/span supported by the encoder – *specified by manufacturer.* --<br>Allocated value for rotary encoders: -- [8,192] steps<br>Allocated value for linear encoders: -- [100,000] nanometres / step |
| PnumRev | Physical Number of Revolutions: Max. number of revolutions supported by the encoder – *specified by manufacturer. --*<br>Allocated value for rotary encoders: -- [8,192] steps. |
| PMR | Physical Measuring Range (PRS x PnumRev): Total number of steps across all revolutions or across the entire span – *specified by manufacturer* --<br>Allocated value for rotary encoders: -- [8,192 x 8,192] steps.<br>Allocated value for linear encoders: -- [16,777,216] steps. |
| PM_Bit | According to 'PMR', as bit mapping with basis ($2^{**PM\_Bit}$). Corresponds to (26) for rotary encoders, to (24) for linear ones. |
| PmaxVal | Maximum position value corresponds with 'PMR' minus one (1). |

| | |
|---|---|
| ScF | Scaling factor = [CPR] / [PRS] |
| Pos_Scal | Scaled position value after conversion by the scaling parameters, offset and preset values. |
| Pos_Phy | Physical (numerical) position value prior to conversion. |
| | |
| CPS | Encoder speed:<br>Counts (steps) per sec. – hence (cps, CpS) |
| RPS | Encoder speed:<br>Revolutions per sec. – hence (rps, RpS) |
| RPM | Encoder speed:<br>Revolutions per min. – hence (rpm, RpM) |
| METpM | Encoder speed:<br>Metres per min. |
| 01METpM | Encoder speed:<br>0.1 metres per min. |

# 3 Safety Precautions

## 3.1 Responsibilities of the Commissioning Staff

Due to the various possible applications of the products described in this documentation, those responsible for the application and use of the devices must personally ensure that all necessary measures are taken so that the application and use of devices meets the performance and safety requirements. The applicable laws, regulations, guidelines and standards shall be taken into account.

The devices described in this documentation are intended for use under industrial conditions. Non-compliance with applicable safety regulations, process-related and other instructions can lead to bodily harm and/or damage to the devices or the system. Qualified users of/commissioning staff for these devices are personally responsible for the selection of suitable products for the intended application. SICK AG accepts no liability and no re-sponsibility for direct or indirect consequential damage due to improper handling or incorrect se-lection of products. Proper handling assumes that the instructions in this documentation are fol-lowed.

Qualified users or commissioning staff are those familiar with the safety requirements and their application to installation, operation and maintenance of the devices.

It is advisable for persons operating or maintaining electrical or mechanical devices, to have ba-sic knowledge of First Aid.

## 3.2 Validity and Application

The absolute ATM60/ATM90/KHK53 encoders are measuring devices manufactured according to the known industrial regulations and meet the ISO 9001 quality requirements.

An encoder is a device to be fitted and cannot be independently operated according to its in-tended function. Consequently, an encoder is not equipped with direct safety features. The de-signer must provide measures for the safety of persons and systems, in accordance with statu-tory requirements.

The ATM60/ATM90/KHK53 must be operated according to their type-specific purposes and only within a Profibus DP network.

The Profibus DP specifications and guidelines for the construction of a Profibus DP network must be complied with.

Mechanical or electrical modifications of the devices are not permitted.

Encoders must be protected from heavy vibrations, impacts and shocks! -- Suitable **shock ab-sorbers** must be used.

| | |
|---|---|
| ☞ | **The safety precautions and instructions for installation and op-eration in this document, are binding.** |

## 3.3 Authorised Users

| | |
|---|---|
| | Installation and maintenance of the encoders must be performed by trained and qualified staff with knowledge of electronics, precision engineering and controller programming. The appropriate standards of technical safety requirements must be met. |

## 3.4 Safety Guidelines and Personal Protection

| | |
|---|---|
| | The safety guidelines must be observed by all persons charged with installation, operation or maintenance of the devices:<br>• The system and safety documentation must always be available and observed.<br>• During installation and maintenance, non-qualified staff must not be near the system.<br>• The system must be installed in accordance with applicable safety requirements and instructions.<br>• The installation must meet the accident prevention regulations of the professional/trade associations in the country/countries concerned.<br>• Non-compliance with the relevant safety and accident prevention regulations can lead to bodily harm or system damage.<br>• The current and voltage sources in the encoders must comply with applicable technical guidelines. |

## 3.5 Encoder Safety Precautions for Installation, Operation and Maintenance

| | |
|---|---|
|  | • The ATM60/ATM90/KHK53 encoders must only be fitted or maintained when free from voltage. Consequently, for any electrical or electronic devices, machine and system parts linked to installation, operation or maintenance, the voltage must previously have been switched off. Also check that they are voltage-free.<br>• Cabling, earthing, screening and overvoltage protection are of particular importance.<br>• Check whether switching off devices, machines or system parts causes dangers.<br>• If necessary, place warning signs to prevent unauthorised persons from entering the danger area.<br>• The correct functioning of safety features shall be checked (e.g. emergency stop). |
| | • EMC-compliant earthing and screening must be performed with particular care, to ensure satisfactory operation of the devices.<br>• The safe assembly of all components must be checked prior to switching back on.<br>• Avoid impacts on shaft and collet. |
| | • Programs which frequently use Explicit Messages, to write parameters to the EEPROM (non-volatile memory) of the encoders, should be avoided. This could significantly reduce the lifetime.<br>• During commissioning of the encoders via a configuration tool, there must be no connection to a running network. |

# 4 Introduction

## 4.1 Profibus Standardisation

Profibus is based on known international standards. The protocol architecture follows the ISO/OSI layer model. Since 2000, Profibus is specified in IEC 61158 Type 3 and IEC 61784. IEC 61158 Type 3 includes the whole range of Profibus consisting of the DP-V0, DP-V1 and DP-V2 versions. IEC 61784 specifies the properties of the CPF 3 communication series, in which the profiles used under Profibus are summarised.

Profibus achieved national standardisation in 1993 through DIN 19245, Part 1-3 and pan-European standardisation in 1996 through EN 50170.

The Profibus range consists of three compatible versions (DP, PA, FMS). All three versions use the same type of protocol for bus access. This protocol is integrated via layer 2 in the OSI reference model. It also includes data integrity and handling of the transmission protocols and telegrams. The 'DP' and 'FMS' versions also use the same transmission technology, which is integrated via layer 1.

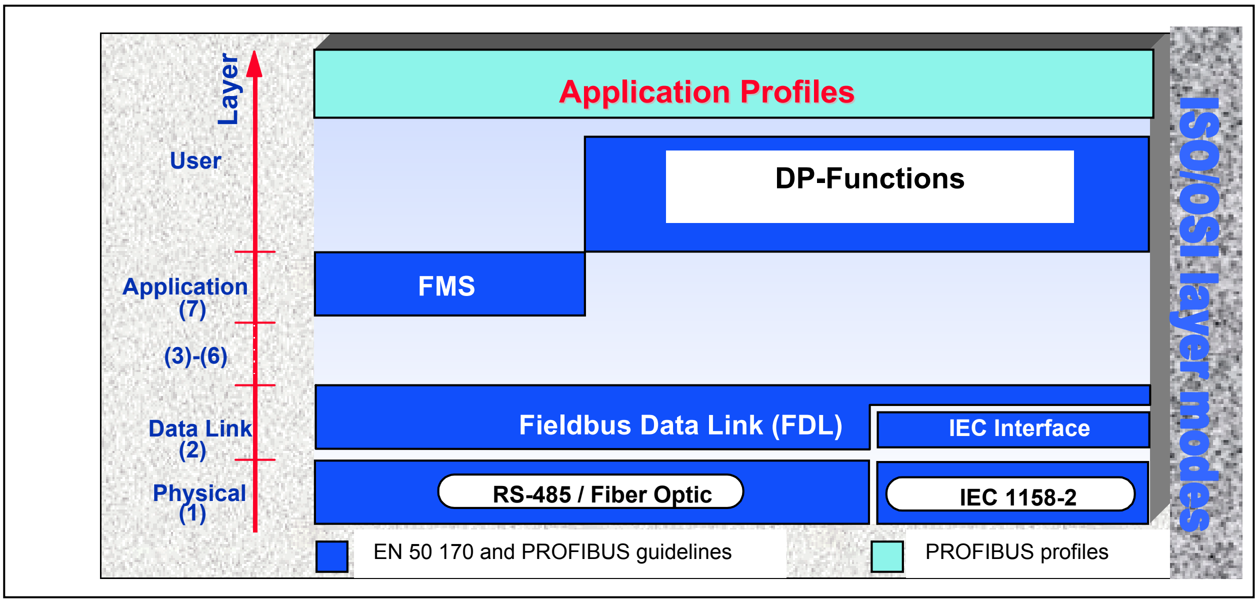


**Figure 4–1: Protocol Architecture**

## 4.2 Profibus DP

This version is intended for high-speed data communication at device level. Central controllers (e.g. PLCs/PCs) thus communicate with their distributed field devices (input/output units, drives, encoders etc.) via a special serial high-speed link.

Profibus DP uses layer 1, layer 2 and the user interface. The DDLM offers the user interface easy access to layer 2. The functions of the application are defined in this part of the interface.

Profibus DP only uses a part of the services of layer 2. These services are called via Service Access Points (SAPs) of layer 2 through higher layers (user interface). For Profibus DP, each SAP is allocated a precisely defined function.

The following services are used by the DP version:

- SRD Send and request data with reply.
- SDN Send Data with No Acknowledgement -- Broadcast, Multicast telegrams.

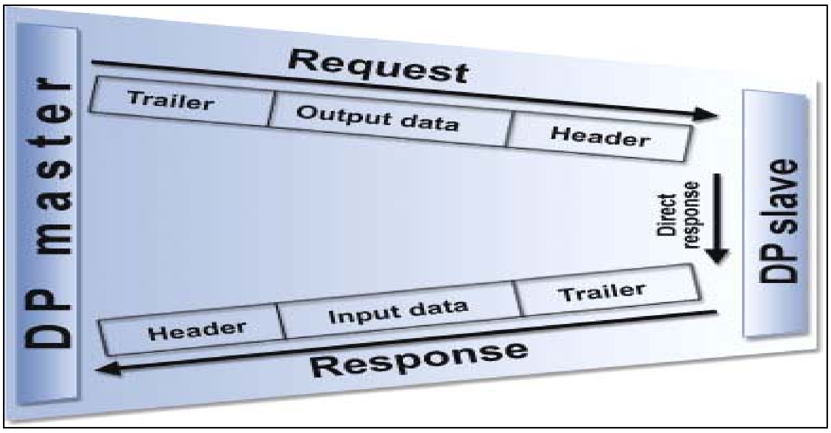


**Figure 4–2: Master/Slave Principle of the SRD Service**

Three types of communication protocols are currently available:

- Cyclical data exchange between master and slave (most common type of communication, to date) -- DP-V0 protocol.
- Acyclical data exchange between master and slave -- DP-V1 protocol.
- Deterministic data exchange between different slaves -- DP-V2 protocol.

The ATM60, ATM90 and KHK53 encoders with Profibus interface support the DP-V0 communication mode.

### 4.2.1 DP-V0 Communication Protocol

This version provides the basic functionality of DP including the cyclical data exchange, as well as different types of diagnostics.

Comprehensive overview of the basic functions:

| Technology | • Detailed description |
|---|---|
| Bus access | • Token Passing procedure between masters and master-slave procedure for slaves.<br>• Mono-master or multi-master systems are possible.<br>• Master and slave devices, max. 126 stations on a bus. |
| Communication | • Peer-to-peer (user data traffic) or multicast through Global Control Commands (GCC).<br>• Cyclical master-slave user data transmission |
| Operations conditions | • Operate: cyclical transmission of input/output data.<br>• Clear: inputs are read, outputs remain in a failsafe status.<br>• Stop: no transmission of user data. |
| Synchronisation | • Global control commands enable the synchronisation of inputs and outputs.<br>• Sync Mode: outputs are synchronised.<br>• Freeze Mode: inputs are synchronised. |
| Functionality | • Cyclical user data traffic between master(s) and slave(s).<br>• Dynamic activation/deactivation of individual slaves, testing the slave configuration.<br>• Diagnostic functions (3 hierarchical levels).<br>• Synchronisation of inputs and/or outputs.<br>• Address assignment for slaves over the bus.<br>• Maximum possible 246 bytes of input/output per slave. |
| Safety functions | • Message transmission with Hamming distance HD = 4.<br>• Watchdog timer of the DP slave detects errors of the master allocated.<br>• Access protection for the inputs/outputs of the slaves.<br>• Monitoring of user data traffic using an adjustable monitoring timer for the master. |
| Device types | • Class 1 DP Master (DPM1): central programmable controllers such as PLCs or PCs.<br>• Class 2 DP Master (DPM2): developmental or diagnostic tools.<br>• DP Slave: device with binary or analogue inputs/outputs. |

## 4.3 Physical Profibus Network Link

### 4.3.1 Network Topology

The cabling and some specific features such as bus termination, are shown.

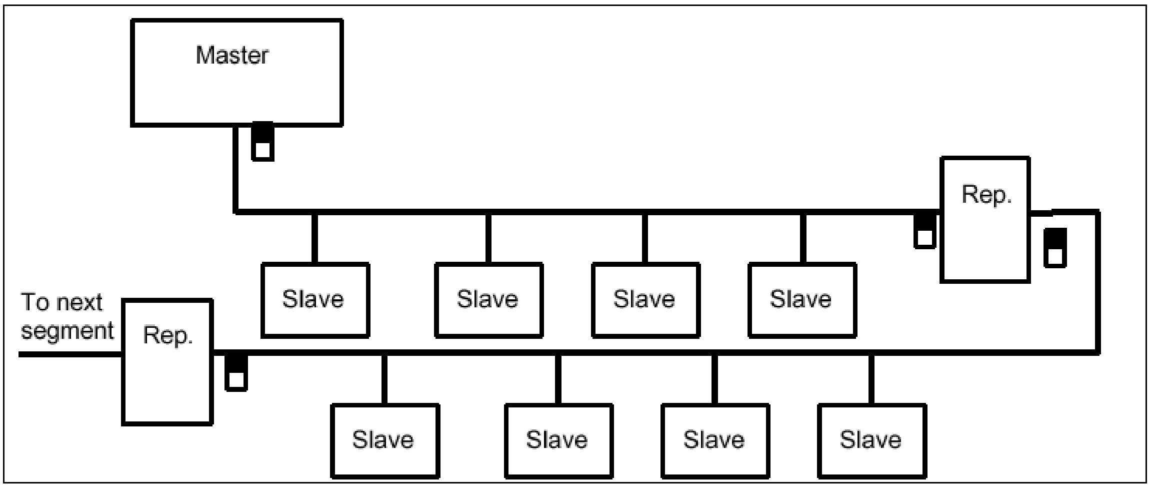


**Figure 4–3: Topology of Profibus DP**

### 4.3.2 RS485 Transmission Technology

The ATMxx and KHK53 encoders with Profibus interface use RS485 transmission technology. This is the most frequently used technology for Profibus DP, and is very easy to handle. The installation of the twisted pair cable does not require expert knowledge. The bus structure permits the addition and removal of stations as well as step-by-step commissioning of the system, without affecting the other stations concerned.

The transmission speed is between 9.6 KBits/s and MBits/s (selectable). During commissioning, the same transmission speed is selected for all devices on the bus (the encoders automatically adjust).

Basic functions when using RS485 technology:

| | |
|---|---|
| Network topology | • Linear bus, active bus termination at both ends.<br>• Stub lines are only permitted for baud rates ≤ 1.5 MBit/s. |
| Signal transmission | • NRZ (non-return to zero) format.<br>• 11 bits/character with: start, 8 x data, parity [even], stop. |
| Station numbers | • 32 stations in each segment without repeater[s].<br>• With repeaters: expandable to 127. |
| Connectivity | • 9-pin D-Sub connection plug (preferred).<br>• M12 round connector.<br>• Han-Brid plug acc. to DESINA recommendation. |

### 4.3.3 Installation Notes re: RS485

All devices are connected in a line bus structure. Up to 32 stations (masters or slaves) can be interconnected in a segment. At the beginning and end of each segment, the bus is terminated using a terminating resistor. Trouble-free operation requires that the two bus terminations always be supplied with voltage.

For more than 32 subscribers, repeaters (line amplifiers) must be used to connect the individual bus segments.

The encoders contain connectable bus terminations - (see DIP switch-n).

At the bus connector or at the bus terminal block, a 5 V supply voltage is available for the bus termination via external resistors. – See also Figure 4–4 (VP, DGND).

The maximum cable length depends on the transmission speed. The specified length can be extended using repeaters. The use of more than 3 successive repeaters is not recommended.

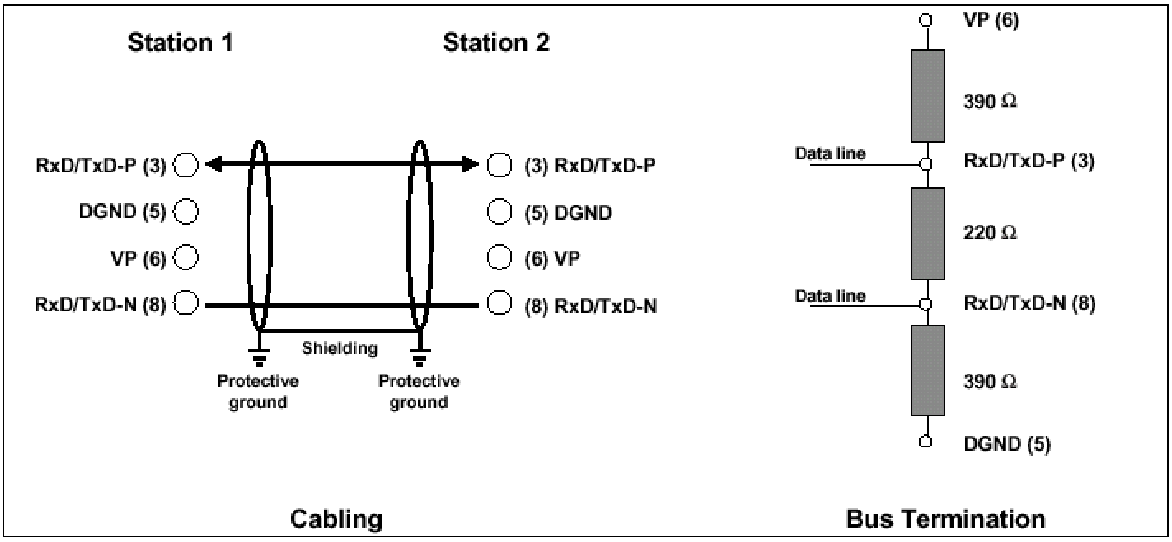


**Figure 4–5: Cabling (9-Pin D-Sub Connector) and Bus Termination.**

The cores of the data cables are identified by 'A' and 'B' (terminals (3) and (8)). It is not defined which core must be connected to a particular terminal on the bus terminal block. The handling, however, must be identical throughout the system. The following allocations are used:

- Data line 'A' green
- Data line 'B' red

### 4.3.4 Profibus Cabling for RS485

Two basic cable types are available for copper-based Profibus DP networks. According to the electrical properties, they are called 'cable type A' and 'cable type B' (not to be confused with the cores ‘A’ and ‘B’ at 4.3.3).

| | |
|---|---|
| ☞ | Cables of type A are the only permitted cables for new installations. |

The following specifications relate to a cable of type A:

| Parameter | Cable properties type A |
|---|---|
| Wave impedance | 135 ... 165 Ω |
| Distributed capaci-tance | < 30 pF/m |
| Loop resistance | < 110 Ω/km |
| Core diameter | 0.64 mm |
| Core cross-section | > 0.34 mm$^2$ |

- The cumulative length of all spurs is limited to 6 m (depending on how the stations are arranged).

- Stub lines must have no bus termination.

| Baud rate (kBit/s) | 9.6 | 19.2 | 93.75 | 187.5 | 500 | 1,500 | 12,000 |
|---|---|---|---|---|---|---|---|
| Distance/Segment (m | 1200 | 1200 | 1000 | 1000 | 400 | 200 | 100 |

| | |
|---|---|
| ☞ | The length of a spur also includes the distance between the plug socket and the RS485 line driver within a device. |

I/O bus cables should be laid in their own cable ducts or in metallic, electrically conductive conduits. This improves the EMC properties. The following conditions must be met:

- The cables must not be twisted, stretched or crushed.
- The temperature range for the laying and operation.
- The max. permitted stretching and bending stresses.

### 4.3.5 Cable Screening

Screening is to weaken (reduce) magnetic, electrical or electromagnetic interference fields.

Interference currents on the cable screening are dissipated to the functional earth via a screen rail conductively linked to the housing. It is particularly important to ensure a low-resistance link to the functional earth. Otherwise interference currents themselves become a possible source of interference.

The following points shall be observed:

- Only use bus cables with braided screen, and connect the braided screen at both cable ends.
- To ensure optimum protection, the outer braided screen and the inner screen foil must be placed, over a large area, via a cable clamp on the functional earth.
- It is recommended that the data cable be laid separate from the power cables.
- Also use screened cables for the connection of external power supplies.

| | |
|---|---|
| ☞ | In case of potential differences between the screen connection points, an equalising current can flow via the braided screen connected on both sides. An additional potential equalising conductor must then be installed. |

## 4.4 Device Profiles

Applications using Profibus combine standard objects and application-specific objects together in device profiles. The device profile fully defines the device from the network perspective.

The PNO co-ordinates the work of industrial experts on developing both new object specifications and device profile specifications. Hence there are Special Interest Groups (SIGs). Profiles provide a summary specification of how Profibus DP is used in individual areas of application. When using the profiles, system operators and end users have the benefit of being able to interchange different manufacturers' devices. The profiles thus lead to a significant reduction in development costs.

The Encoder SIG has, in agreement with the PNO, produced a device profile (Version 1.1), to ensure the interoperability of their devices.

The following issues were defined:

- Measuring principle of absolute and incremental encoders.
- Functionality of two device classes (Device Class 1, Class 2).

## 4.5 Further Information

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http://www.profibus.de

Further literature and guidelines (partly available in English only, but partly also in German):

- Profibus DP Specification
- Guideline for Profibus DP/FMS (V1.0), Order No. 2.112
- Profibus RS485 User & Installation Guideline (V1.1), Order No. 2.262
- Profibus Profile for Encoders (V1.1), Order No. 3.062
- M. Popp, Profibus DP/DPV1, (Huethig, 2000), ISBN 3-7785-2781-9
- New Rapid Way to Profibus DP (2002), Order No. 4.072
- Profibus System Description (Vers. 10/ 2002), Order No. 4.002

# 5 Encoder Modes

The Profibus DP specification, level DP-V0, only defines the cyclical data traffic between a master and a slave. Each download/upload of the parameter data must be complete before the cyclical data exchange is started. The checking of diagnostic data, in case of error[s], is also embedded in the cyclical data traffic.

The encoders only support the basic DP functions according to DP-V0 specification.

There are three main states:

- Stop: No data transmission between DPM1 and encoder.
- Clear: DPM1 reads the input information from the encoder and holds the outputs in failsafe condition.
- Operate: cyclical data traffic operation, via polling

## 5.1 Cyclical Data Transmission

Data transmission between the DPM1 and the encoder is divided into three phases:

- Parameterisation
- Configuration
- Transmission of the I/O data (data exchange)

### 5.1.1 Parameterisation

The encoder receives a set of parameterisation data according to the encoder profile (see 8.3.2)

### 5.1.2 Configuration

The encoder receives one (1 byte), which contains the configuration setup, according to the encoder profile (see 8.4).

This setup, also called Module Config, determines how the data is ultimately put together once I/O data transmission has started.

### 5.1.3 I/O Data Transmission

Further information see „Data Types” 6.4 and “Data Exchange Mode” 8.5.

## 5.2 Specification of the Encoder Data

Essentially, the encoder is an **input/output device**. This means that the master’s encoder data is used by the bus and itself produces data for the bus. The functionality of the output data is reduced to the ‘Preset value' data type.

The table shows the properties of all data types supported across the different module configurations, also called Data Assemblies.

| Data type | Data size | Assembly (Ax) | Prod_Update (x1) |
|---|---|---|---|
| Position value | 4 bytes | 1, 2, 3, 4, 5, 6 | 0.250 ms |
| Speed value | 2 bytes | 3, 4, 5, 6 | 50.000 ms |
| Time stamp | 2 bytes | 5, 6 | 0.250 ms |
| | | | **Cons_Update** |
| Preset value | 4 bytes | 2, 4, 6 | ~ 20 ms - (x2) |

(*1) Time for generating a new data value (input to bus).

(*2) Time for the correct processing of the output data (writing to EEPROM).

# 6 Encoder Parameters/Attributes

## 6.1 General Conditions for Using the Scaling Function

### 6.1.1 Specification for Using the Encoder in "Continuous Mode"

If a rotary absolute encoder exceeds the physical measuring range [PMR], it continues to count either with its minimum value [PminVal] (0) or its maximum value [PmaxVal], depending on the direction of rotation (i.e. it wraps around). Successful counting, relating to position readout, is only ensured if the scaled measuring range [CMR] is an integer multiple of [PMR]. The mapping of the [CMR] on the [PMR] with an offset (residual value through non-integer multiple) leads to an incorrectly scaled position value (no monotonous counting sequence). – Possible solutions:

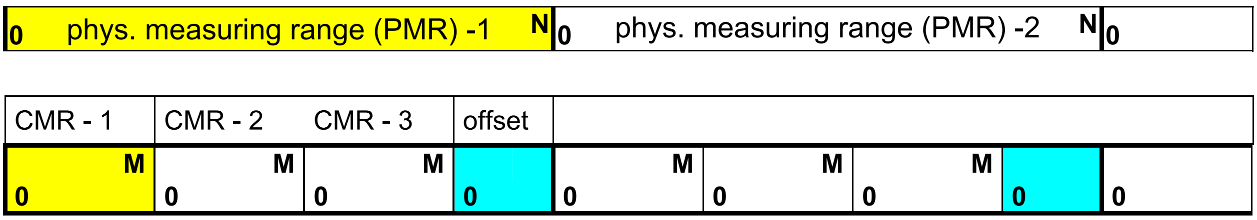
a) Mapping the scaled measuring range in the physical measuring range and adapting the resulting **offset**. The physical measuring range exceeds the limits or falls within the limits. The offset value must be stored in a non-volatile RAM (EEPROM), to ensure – after switching off and on again – the correct conversion of the physical position value to the scaled position value.

b) Selecting the scaled measuring range such that it can be mapped completely in the physical measuring range (without resulting **offset**). This means a possible adaptation of the configured CMR value.

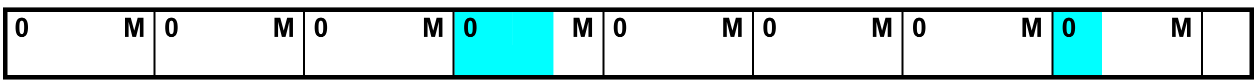
The following illustration shows an example of the relationship between the two measuring ranges.

[0...N] = Minimum/maximum values of the physical measuring range [PMR].

[0...M] = Minimum/maximum values of the scaled measuring range [CMR].




Without considering the resulting offset, the scaled position values are no longer correct. The encoder changes from one physical measuring range to the next.




The offset is used to calculate a correctly scaled position value. When changing from one physical measuring range to the next, the offset value itself must be adapted.

### 6.1.2 Case a) Scaling Function without Limitation to the Measuring Range (with Offset)

The scaled measuring range is mapped into the physical measuring range. A (possibly resulting) **offset** is used to ensure the correct conversion of physical position values to scaled position values. The customer-specified value for CMR is not matched to obtaining a $2^N$ value for the relationship between CMR and CPR. -- The following limitations are defined:

- Relationship (quotient) between CMR and CPR (R) must be greater than or equal to **1**.

- CMR must be smaller than or equal to the physical measuring range supported by the encoder.

| | |
|---|---|
| | This function is currently **not** implemented for the ATM60/ATM90 encoders. |

### 6.1.3 Case b) Adapted Scaling Functions (without Offset)

The scaled measuring range is mapped completely in the physical measuring range. The customer-specified value for CMR is matched to obtaining a $2^N$ value for the relationship between CMR and CPR (there is no **offset**). – The following settings are also valid:

- R = $\mathbf{2^{**N}}$, with N = {0,1, …13}, R= CMR/ CPR (with CMR being a multiple of CPR
- CMR ≤ PMR.

The table below shows some configurations for adhering to the limits defined:

| **Customer-specified value** | | **Adapted values (device-side)** | | **ScF** | **R = $2^N$** |
|---|---|---|---|---|---|
| CPR | CMR | CPR | CMR | | |
| 8,192 | 67,108,864 | 8,192 | 67,108,864 | 1 | $2^{13}$ |
| 8,192 | 67,108,863...<br>33,544,432 | 8,192 | 33,544,432 ($2^{25}$) | 1 | $2^{12}$ |
| 8,192 | 33,544,431...<br>16,777,216 | 8,192 | 16,777,216 ($2^{24}$) | 1 | $2^{11}$ |
| 8,192<br>8,192 | 16,383... 8,192<br>8,191... 1 | 8,192<br>8,192 | 8,192 ($2^{13}$)<br>8,192 ($2^{13}$) | 1<br>1 | 1<br>1 |
| | | | | | |
| 4,096<br>4,096 | 67,108,864<br>67,108,863...<br>33,544,432 | 4,096<br>4,096 | 33,544,432 ($2^{25}$)<br>33,544,432 ($2^{25}$) | 1/2<br>1/2 | $2^{13}$<br>$2^{13}$ |
| 4,096 [(B1)] | 33,544,431...<br>16,777,216 | 4,096 | 16,777,216 ($2^{24}$) | 1/2 | $2^{12}$ |
| | | | | | |
| 2,730 [(x1)]<br><br>2,730 [(x1); (B2)] | 67,108,864...<br>33,544,432<br>33,544,431...<br>22,364,160 | 2,730<br><br>2,730 | 22,364,160<br><br>22,364,160 | 1/3 (*)<br><br>1/3 (*) | $2^{13}$<br><br>$2^{13}$ |
| 2,730 [(x1)] | 22,364,179...<br>11,182,080 | 2,730 | 11,182,080 | 1/3 (*) | $2^{12}$ |
| | | | | | |
| 2,048<br>2,048 | 67,108,864<br>67,108,863…<br>16,777,216 | 2,048<br>2,048 | 16,777,216 ($2^{24}$)<br>16,777,216 ($2^{24}$) | 1/4<br>1/4 | $2^{13}$<br>$2^{13}$ |
| 2,048 | 16,777,215…<br>8,388,608 | 2,048 | 8,388,608 ($2^{23}$) | 1/4 | $2^{12}$ |
| | | | | | |

| Customer-specified value | | Adapted values (device-side) | | ScF | $R = 2^N$ |
|---|---|---|---|---|---|
| CPR | CMR | CPR | CMR | | |
| 1,000 (x1)<br>1,000 (x1) | 67,108,864<br>67,108,863...<br>8,192,000 | 1,000<br>1,000 | 8,192,000<br>8,192,000 | 1/n (*)<br>1/n (*) | $2^{13}$<br>$2^{13}$ |
| 1,000 (x1) | (8,192,000-1)...<br>4,096,000 | 1,000 | 4,096,000 | 1/n (*) | $2^{12}$ |

(*1) Value is not $2^N$; thus, the scaling factor never gives an integer result.

**Examples of the conversion to a scaled position value:**

- physical position value (Pos_Phy): >>67,108,863<< (max. value)

| |
|---|
| Pos_Scal = (Pos_Phy **x** ScF) **%** CMR_a |

| | |
|---|---|
| (B1) | Pos_Scal = (67,108,863 **x** 1/2 ) **%** 16,777,216 = <u>16,777,215</u> |
| (B2) | Pos_Scal = (67,108,863 **x** **[2,730/ 8,192]** ) **%** 22,364,160 = <u>22,364,159</u> |

This means that the max. physical position value supported by the encoder also corresponds with the max. value within the scaled measuring range.

| | |
|---|---|
| ☞ | To operate a **rotary** encoder in 'Continuous Mode' (so-called rotary axis), CMR must be a multiple ($R = 2^N$) based on parameter 'CPR'. The device automatically adapts the factor 'R' to the next possible lower value.<br>Factor R (N = 0,1,...13) is limited to **8192** (max. number of revolutions). |

## 6.2 Data Storage

The profile-specific operating parameters of the encoder are generally saved in an EEPROM. Since, for Profibus DP, the parameter data (DDLM_Set_Prm) is re-transmitted for each start, there will be only partial storage in the EEPROM.

The following data is stored in the EEPROM.

| Parameter | Function |
|---|---|
| "Offset value"<br>"Preset value" | Preset button was pressed or the number of the 'Preset value' was changed via the Protocol, to set a new position value. |
| Operating mode | Giving the address setting (EEPROM/switch). -- DDLM_Set_Prm. |
| Node ID | Giving the address. -- DDLM_Set_Slave_Adr. |

**Storing the encoder parameters in the EEPROM.**

The time for storage depends on the data length (8 bytes, blockwise) and is **10 ms** approx. per parameter.

The measurement-specific operating parameters of the encoder system are defined by the manufacturer, and are stored in the EEPROM. This data is read out within the initialisation phase (power-on) by the EEPROM, and checked for validity. A faulty data set is replaced by its corresponding default value. Simultaneously, an appropriate ID is set within the error flag (alarm). -- see also 9.4.3.

## 6.3 Encoder Attributes/Parameters

### 6.3.1 Fundamental Explanations

The properties (attributes) can be configured via a configuration tool or set to a default value by the manufacturer.

The values are needed to define the behaviour of the encoder (producing or using process data). This description only shows the typical (basic) attributes supported by an encoder, without reference to the configuration via the field bus protocol. – Further information see (Parameterisation 8.3).

- All parameter values with position details must lie within the overall working area which, at the time, is defined by the CMR value.
- If several parameters are changed online, there may be secondary effects. The user needs to take this into account.

### 6.3.2 Counting Direction/Code Sequence

This attribute defines whether ascending or descending position values are output when the encoder shaft rotates clockwise (CW) or counter-clockwise (CCW), looking at the shaft end.

### 6.3.3 Scaling Function Control -- [SFC]

If this parameter is set to ON (1), the physical (numerical) position value of the encoder is converted – by the software – to a scaled value. If the parameter is set to OFF (0), the scaling function is not active.

### 6.3.4 Measuring Units per Revolution -- [CPR]

This parameter defines the number of steps per revolution produced by the encoder. The default factory setting corresponds with the physical resolution per revolution/span.

This value generates an internal scaling factor (ScF) as well as the manufacturer-specific parameter "Physical Resolution per Span" (PRS) according to:

scaling factor (ScF) = [CPR] / [PRS]

### 6.3.5 Total Measuring Range in Measuring Units -- [CMR]

This parameter defines the number of steps over the total measuring range produced by the encoder and corresponds with the scaled measuring range.

| | |
|---|---|
| | Due to the implementation of the '**Set-up scaling functions**' (see 6.1.3) this parameter is internally adapted by the system. The adapted value is always smaller than or the same as the configured value. |

### 6.3.6 Position Value

Current position value. The scaled numerical value is calculated according to the following equation. If the 'Scaling Function Control' is not activated, the value for ScF is set to one (1); the value CMR also corresponds with PMR. The offset is determined by the configured preset value.

| |
|---|
| Pos_Scal = (Pos_Phy **-** "Offset value") **x** ScF **+** "Preset value" |

| | |
|---|---|
| | For the encoder types described, this parameter is used as **process data**, implemented as a basic part of the input data. -- (see DDLM_Data_Exch). |

### 6.3.7 Preset Value

The preset function supports the adaptation of the datum from the encoder to the mechanical datum of the system.

For the current mechanical position of the encoder, the preset value is set as the new, current position value. The preset value and the resulting "offset value" (difference between the current and the physical position value) are both **automatically** stored in the EEPROM.

| | |
|---|---|
| | For the encoder types described, this parameter is used as **process data**, implemented as a basic part of the input data. -- (see DDLM_Data_Exch). |

| | |
|---|---|
| | The preset is not matched to the current measuring range if the scaling parameters (CPR, CMR) are changed. A numerical value outside the measuring range is replaced by the default factory setting – zero (0). |

| | |
|---|---|
| | Constant activation results in the current position value (process data) constantly and repeatedly being set to the preset value.<br>• Meanwhile, the input data (position value) in the Master Module remains unchanged.<br>• The EEPROM in the encoder can be destroyed by this! |

## 6.4 Data Assemblies/Data Components

This part describes the individual data components which the encoder can support. Each of the data components is allocated a certain processing mode.

- Input data is ‘produced’ by the encoder.
- Output data is ‘consumed’ by the encoder.

The individual data components are combined to a so-called data assembly and selected via the configuration required.

Overview of the data components - (I: input, O: output)

| | | | |
|---|---|---|---|
| I-1 | UDINT | Position value (4 bytes) | Encoder profile |
| I-2 | INT | Speed value (2 bytes – signed) | Manufacturer-specific |
| I-3 | UINT | Time stamp (2 bytes) | Manufacturer-specific |
| | | | |
| O-1 | UDINT | Preset value (4 bytes) | Encoder profile |

### 6.4.1 Position Value

The scaled numerical value is calculated according to the equation below. If the scaling function is not active, the value for Scf is set to one (1), and the value CMR corresponds with PMR. The offset value is stored in the EEPROM and always adapted by activating the preset function.

| |
|---|
| Pos_Scal = (Pos_Phy **-** "Offset value") **x** ScF **+** "Preset value" |

Definition from the position value (4 bytes) with a maximum resolution of 'nn' bits. -- (2**$^{nn}$).

| Byte_1 (MSB) | | Byte_2 | Byte_3 | | Byte_4 (LSB) |
|---|---|---|---|---|---|
| 31 30 29 28 27 26 | 25 24 | 23 22 21 20 19 18 17 16 | 15 14 13 | 12 11 10 09 08 | 07 06 05 04 03 02 01 00 |
| | Number of revolutions (1...8192) | | | CPR (1...8192)-[steps per rev.] | |
| | [CMR] | | | | |

Example: -- Seen as UDINT value in the "Big Endian" data format.

| Byte_1 (MSB) | | Byte_2 | | Byte_3 | | Byte_4 (LSB) | | |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 1 | 4 | 0 | 1 | 2 | 81,938$_D$ == [00.01.40.12]$_{hex}$ |

### 6.4.2 Speed Value

The calculation of the speed value is based on the physical position value and is performed in cycles of 50 ms.

To prevent short-time variations, an integration time of 1 sec. is used. For this, a mean value is calculated from a data table of the respective last 20 position values. A new position value is entered in the same cycle.

The display format of the current value and limit values (minimum, maximum) are defined as standard. A change in the general display format causes an adaptation of the limit values.

Overview of the different format settings – (depending on the device type).

| | Display format | Limit value (min.) | Limit value (max.) |
|---|---|---|---|
| ATM60-P | RPM | 0 | 6,000 |
| ATM90-P | RPM | 0 | 6,000 |
| KHK53-P | 01METpM (0.1 m/min.) | 0 | 3,600 |

Changing the display format and limit value is not supported! -- The 'default' values apply!

The speed value is signed. Changes in direction of rotation or changes to the 'counting direction' parameter affect the display value.

Example: Seen as INT value (signed 16-bit) in the "Big Endian" data format.

| | | Byte_1 | | Byte_2 (LSB) | | Format/value | |
|---|---|---|---|---|---|---|---|
| | | 0 | 0 | 0 | 0 | | 0 |
| | | 1 | 7 | 7 | 0 | RPM | 6,000 (max.) |
| | | E | 8 | 9 | 0 | RPM | -6,000 (max.) |
| | | | | | | | |
| | | E | 8 | 9 | 0 | 01METpM | 3,600 (max.) |
| | | F | 1 | 1 | 0 | 01METpM | -3,600 (max.) |

### 6.4.3 Time Stamp

2-byte counter for external time measurement. The value is updated in **time pulses of 1 ms**. Range of values of { 0...65,535 }, corresponding with 65,535 seconds.

Example: Seen as UINT value (16-bit) in the "Big Endian" data format.

| | | Byte_1 | | Byte_2 (LSB) | | Format/value | |
|---|---|---|---|---|---|---|---|
| | | 0 | 0 | 0 | 0 | | 0 |
| | | F | F | F | F | MS | 65,535 |

### 6.4.4 Preset Value

The encoder supports, as a Class 2 function, electronic adjustment (preset) to a user-defined position value.

Definition of the preset value (4-bytes) with a max. resolution of 'nn' bits. -- (2**$^{nn}$).

<table>
<tr><td colspan="2">Byte_1 (MSB)</td><td>Byte_2</td><td colspan="2">Byte_3</td><td>Byte_4 (LSB)</td></tr>
<tr><td>31 30 29 28 27 26</td><td>25 24</td><td>23 22 21 20 19 18 17 16</td><td>15 14 13</td><td>12 11 10 09 08</td><td>07 06 05 04 03 02 01 00</td></tr>
<tr><td>m x x x . x x</td><td colspan="3">Number of revolutions (1...8192)</td><td colspan="2">CPR (1...8192)-[steps per rev.]</td></tr>
<tr><td></td><td colspan="5">[CMR]</td></tr>
</table>

To activate the preset value, set bit_31 to one (**1**) (marked as **m**). The actual preset value is predetermined as an nn-bit value. -- (here: 26)

The time needed for a valid activation is determined by the cycle time of the transmission, and is dependent on the arrangement of all subscribers in the entire network.

After a valid activation of the preset value, the current position value is set to this value (see display in module of the DP Master).

Disabling the function: - Set bit_31 to zero (**0**).

Example: Seen as UDINT value ($81,938_D$) in the "Big Endian" data format.

<table>
<tr><td colspan="2">Byte_1 (MSB)</td><td colspan="2">Byte_2</td><td colspan="2">Byte_3</td><td colspan="2">Byte_4 (LSB)</td><td>Active</td></tr>
<tr><td>8</td><td>0</td><td>0</td><td>1</td><td>4</td><td>0</td><td>1</td><td>2</td><td>[80.01.40.12]$_{hex}$</td></tr>
</table>

<table>
<tr><td colspan="2">Byte_1 (MSB)</td><td colspan="2">Byte_2</td><td colspan="2">Byte_3</td><td colspan="2">Byte_4 (LSB)</td><td>not active</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>1</td><td>4</td><td>0</td><td>1</td><td>2</td><td>[00.01.40.12]$_{hex}$</td></tr>
</table>

| | |
|---|---|
| | Activation by Bit_31 in the master device can lead to a display format with negative numerical value! |

| | |
|---|---|
| | Activation of a new preset value always results in a diagnostic message with low priority being triggered. This detail is contained in the FDL header of the data exchange response message. The Master can then request a diagnostic message, to obtain information on the 'offset' value of the encoder! |

| | |
|---|---|
| | The preset function is not intended for dynamic adjustment processes. The function is meant for electronic adjustment during commissioning, to allocate a certain position value to any mechanical shaft position of the encoder. In case of constantly recurring activation of the preset function, the corresponding memory locations in the EEPROM are destroyed, over time!<br>The use of the preset function leads to a change in the position value output. This could cause an unexpected movement which may lead to damage of the system, other objects or bodily harm. |

# 7 Device Integration/Projecting

## 7.1 System Requirements

To integrate a Profibus DP slave into a system, the following requirements must be met:

- Electronic data sheet for the device – made available as a GSD/GSE file, by the device manufacturer.
- Class 1 Master module (PLC, PC).
- Engineering system (Class 2 master module) with a network configuration tool.

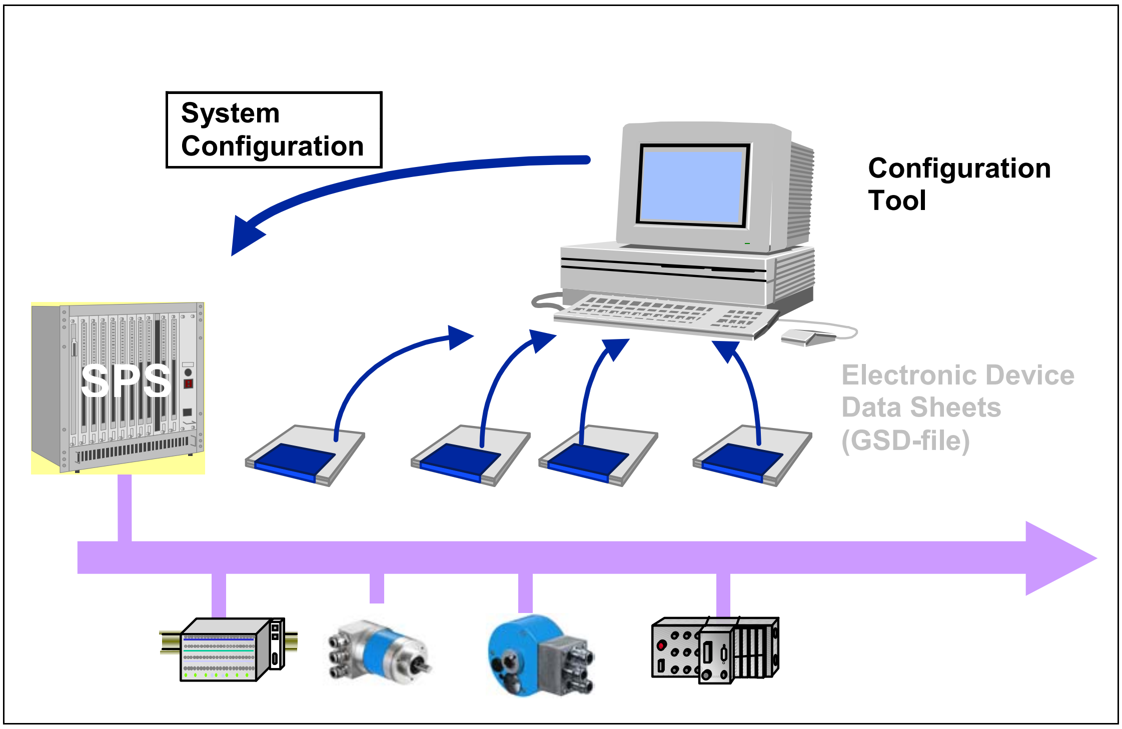



**Figure 7–1: Device Integration**

## 7.2 Description

The GSD alone is sufficient for device integration, for data exchange between field devices and automation systems. It is used and interpreted in the network configuration tool (CFG-X) – a projecting tool for the master engineering system. - The basic functionality is:

- Simple text description of the device properties for DP communication.

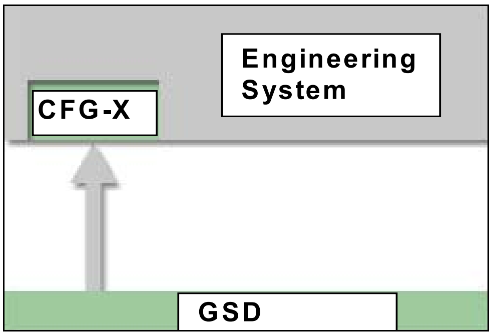



**Figure 7–2: GSD Implementation**

The configuration tool used produces a so-called parameter set for each subscriber in the network. This data set is stored in a file. This file thus is a logical image of the physical network and is used by the Master PLC for the correct control of the complete system.

The following data must be configured/confirmed by the user:

- Parameter data.
- Configuration format for the data exchange (Data_Exchange).
- Station address.

On the basis of all implemented subscribers, the configuration tool supplements the data set with DP protocol-specific data of the complete network.

Using the DP-V0 protocol allows no changes of parameter values during cyclical data traffic.

## 7.3 Data Mapping of a UINT32 (UDINT) Value

According to the GSD specification, numerical values 32 bits in length are defined as "Unsigned32" (UDINT). This data format is not supported by all configuration tools, especially not by the older ones. – See example with COM Profibus V3.3 on the following pages (value mapping for measuring range [steps] and steps per turn).

To support correct parameterisation when using simple configuration tools, the numerical value is divided into a High word (bits 31_16) and a Low word (bits 15_00).

The two individual values are formed according to the following procedure:

- Conversion of the entire numerical value from decimal to hex. format. -- { byte 1 to byte 4 }.
- Conversion of the hex. value byte {1 and 2 } back to decimal. – value 1 "....--(31_16)".
- Conversion of the hex. value byte {3 and 4 } back to decimal. – value 2 "....--(15_00)".

This type of mapping affects the following parameters:

- Steps per measuring unit (for rotary encoders: also steps per rev.) -- (CPR).
- Steps over the total measuring range (CMR).

The following examples show more details:

| | | |
|---|---|---|
| Whole numerical value (32-bit view)<br>{ (01.CA x 1.00.00) + 0.11.A0 } | 30 020 000 (d) | 01.CA.11.A0 (h) |
| Value 1 ".... --(31_16)"<br>Value 2 ".... --(15_00)" | 458 (d)<br>4512 (d) | 1.CA (h)<br>11.A0 (h) |

| | | |
|---|---|---|
| Whole numerical value (32-bit view)<br>{ (00.0C x 1.00.00) + 0.00.00 } | 786 432 (d) | 00.0C.00.00 (h) |
| Value 1 ".... --(31_16)"<br>Value 2 ".... --(15_00)" | 12 (d)<br>0 (d) | 00.0C (h)<br>00.00 (h) |

## 7.4 Use of the 'COM Profibus' Configuration Tool

### 7.4.1 Module Configuration

Only one (1) module can be selected for each encoder.

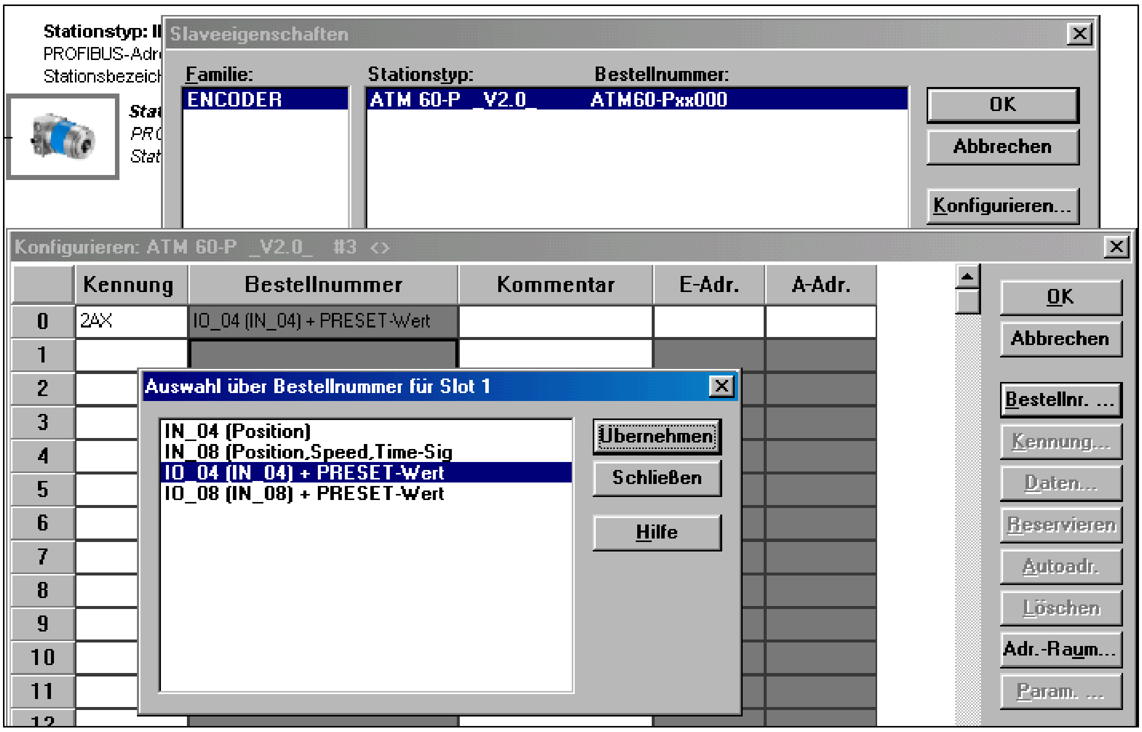



Figure 7–3: Module Configuration

### 7.4.2 Parameter Settings – Rotary Encoders

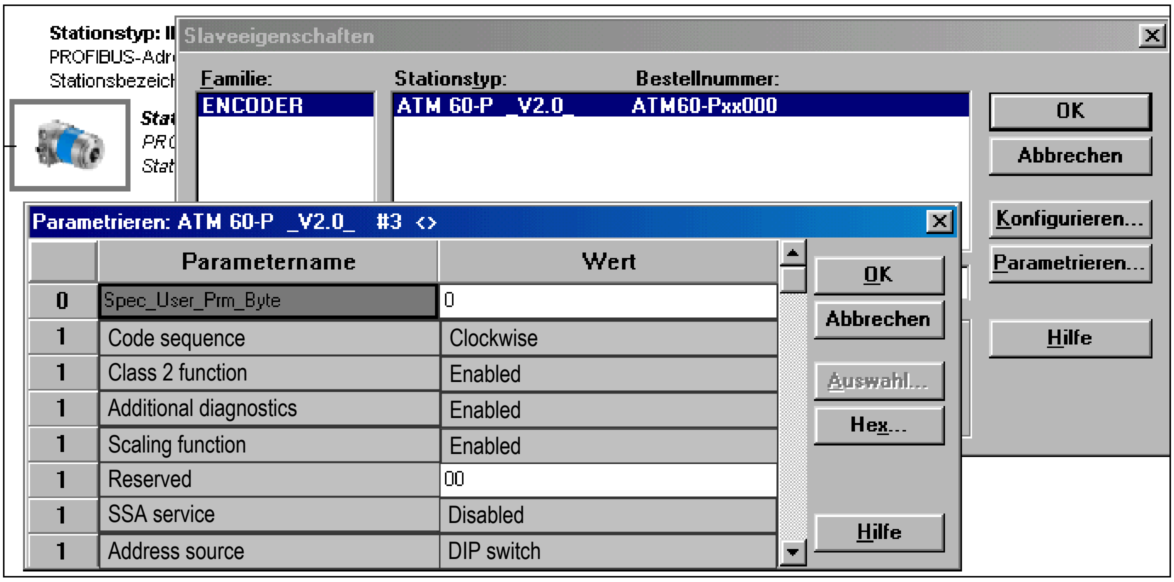



**Figure 7–4: Parameter Data – Operating Mode**

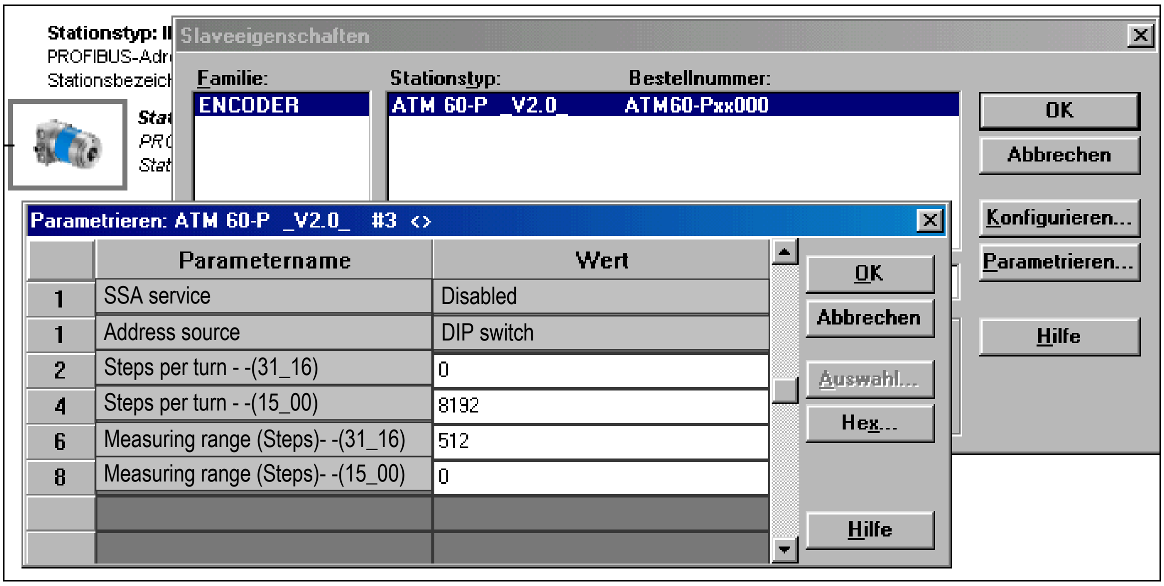



**Figure 7–5: Parameter Data – Scaling**

The factory default setting of the parameters is shown:

- Operating mode addressed at position byte 1.
- Measuring units per revolution addressed at position byte 2…5.
- Measuring range addressed at position byte 6…9.

### 7.4.3 Parameter Settings – Linear Encoders

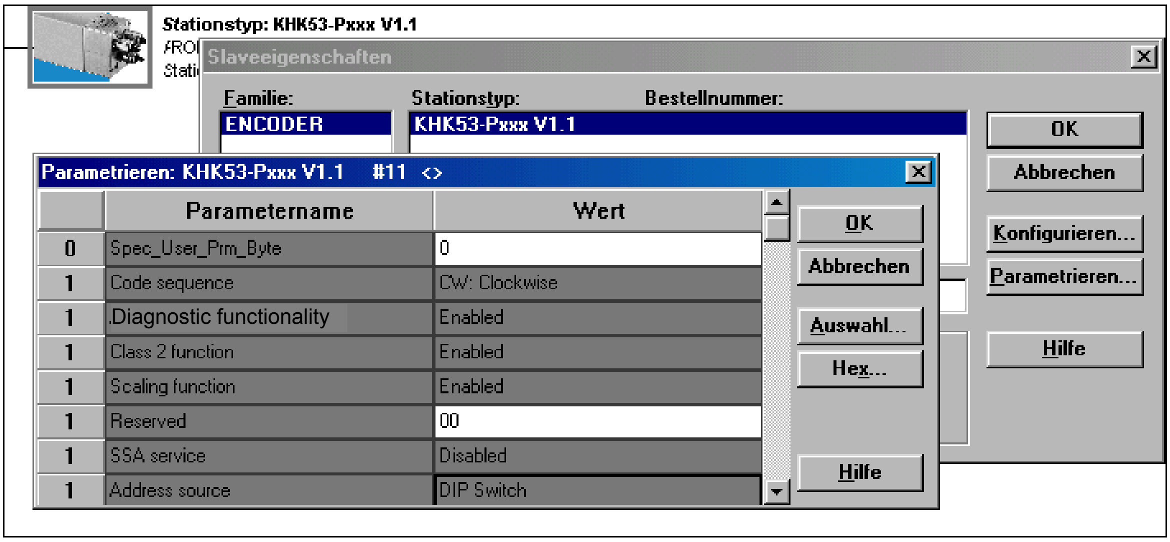



**Figure 7–6: Parameter Data – Operating Mode**

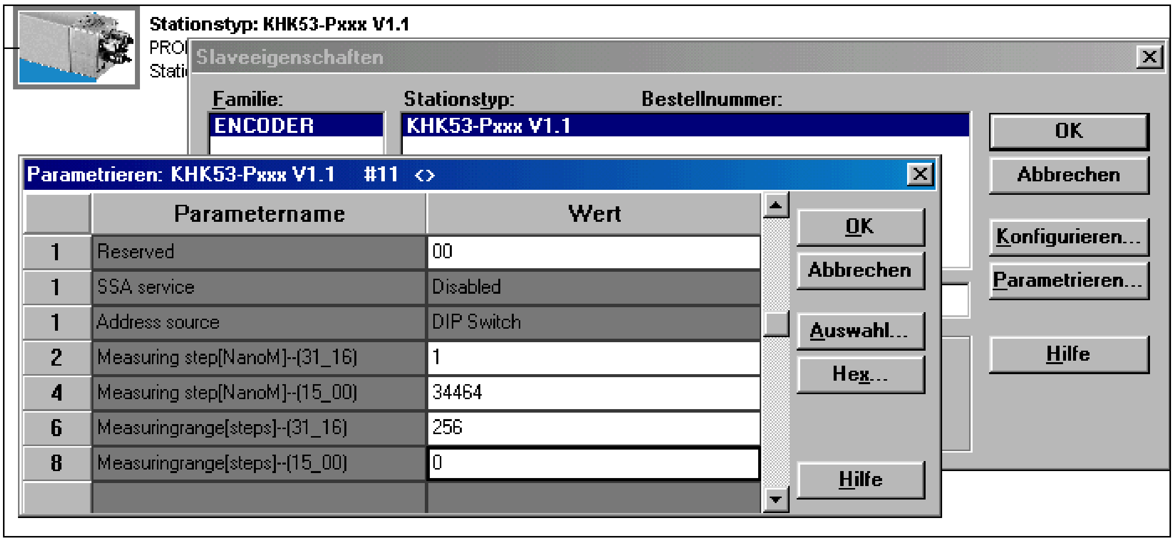



**Figure 7–7: Parameter Data – Scaling**

The factory default setting of the parameters is shown:

- Operating mode addressed at position byte 1.
- Measuring units per revolution addressed at position byte 2…5.
- Measuring range addressed at position byte 6…9.

For linear encoders, the 'Measuring Step' parameter corresponds with bytes 2/3 and 4/5 of the 'Measuring Units per Revolution' (CPR) parameter for rotary encoders.

The value is given in nanometres (nm) [32-bit unsigned].

The KHK53 linear encoder has a physical resolution of **0.1mm** per measuring step.

For the max. encoder resolution, the factory (default) setting from the GSD file of **100 000** (d) according to the physical resolution, must be retained.

The original numerical UINT32 value is mapped as a 2 word value.

| | | |
|---|---|---|
| Value (32-bit view)<br>{ (00.01 x 1.00.00) + 0.86.A0 } | 100 000 (d) | 00.01.86.A0 (h) |
| Value ".... --(31_16)" | 1 (d) | 00.01 (h) |
| Value ".... --(15_00)" | 34 464 (d) | 86.A0 (h) |

**Lower device resolutions** can be set on request. For this, the measuring step parameter must be set, within predetermined limits, to **higher values**.

| Resolution (mm/step) | Measuring step | Val "... --(31_16)" | Val "... --(15_00)" |
|---|---|---|---|
| 0.1 (default), = max. | 100 000 | 1 (d) | 34 464 (d) |
| 1.0 | 1 000 000 | 15 (d) | 16 960 (d) |
| 10.0 | 10 000 000 | 152 (d) | 38 528 (d) |
| | | | |
| 1000.0 (1 m), = min. | 1 000 000 000 | | |

For linear encoders, the setting of the 'Measuring Range' parameter – bytes 6/7 and 8/9 – must not be changed. A max. range of $2^{24}$ and 16,777,216 steps, resp., must always be supported / [01.00.00.00]h.

Within the factory (default) setting for the encoder resolution ['Measuring Step' parameter], a measuring range of **1,677 metres** max. is supported according to the equation below.

Max. measuring range: 16,777,216 steps x (0.1 mm/step)

# 8 System Configuration

## 8.1 Master-Slave Communication

With the DP protocol (V0) supported by the encoder, a subscriber (DP slave) behaves according to the following flow diagram scheme (State Machine). The mode of operation of the State Machine is fully defined in a hardware component (DP controller ASIC).

To start a data exchange with the slave the master must, during run-up, adhere to the following order of telegrams:

- DDLM_Slave_Diag (diagnostic request).
- DDLM_Set_Slave_Adr (optional telegram, Master Class 2 only).
- DDLM_Set_Prm.
- DDLM_Chk_Cfg.
- DDLM_Slave_Diag (diagnostic request to ensure initialisation).
- DDLM_DATA_EXCH (cyclical data exchange)

Via a diagnostic telegram DDLM_Slave_Diag, the master can request an appropriate diagnosis from the slave, at any time.

Further services may be activated via "Global Control Command (GCC)" telegrams.

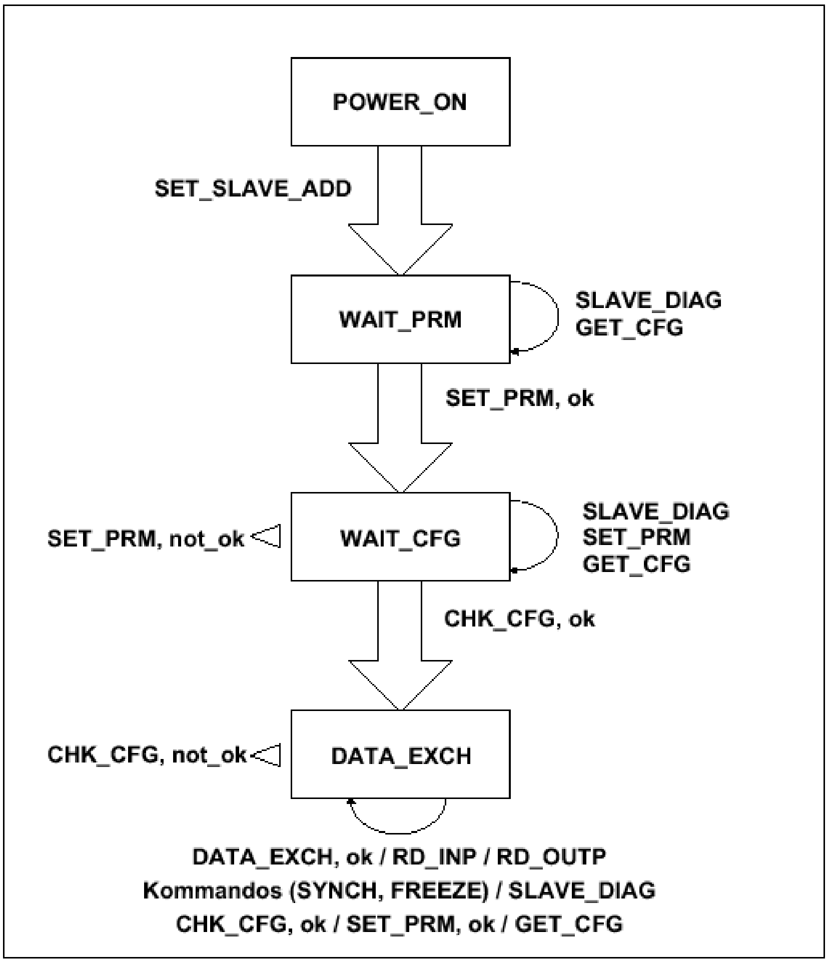



**Figure 8–1: DP State Machine**

## 8.2 Stipulations/Definitions

The term "**octet**", in the Profibus literature (profile definitions), designates a "**BYTE**" within a Profibus DP data telegram. The following allocation applies:

| Octet | 1 | 2 | 3 | ... | n |
|---|---|---|---|---|---|
| BYTE | 0 | 1 | 2 | ... | n-1 |

## 8.3 Parametrisation

In the 'Wait_Param' state, the parameterisation telegram generates an identification with the master. The number and format of the telegram data result from the definition in the GSD file and are checked by the slave, through the DP controller and the application software, resp.

The acknowledgement will be a response telegram to the master. The next state within the 'State Machine' is achieved only by recognising a valid telegram.

### 8.3.1 DP-Specific Standard Data

The DP-specific standard data (octet-1..7) is relevant to all DP slaves. This data is generated by means of a projecting tool using the GSD file. The telegram data is checked directly in the DP controller (ASIC) of the slave.

| **Service DDLM_SET_Prm** | | | |
|---|---|---|---|
| **Octet** | **Type** | **Explanation** | **Value (default)** |
| 1 | BYTE | DP protocol-specific allocations. | |
| 2 | BYTE | WD_Fact_1 | (*n1) |
| 3 | BYTE | WD_Fact_2 | (*n1) |
| 4 | BYTE | TSDR | (*n2) |
| 5 | BYTE | Device ID, high byte<br>-- Device 'Ident_Number' (high) | (*n3) |
| 6 | BYTE | Device ID, low byte<br>-- Device 'Ident_Number' (low) | (*n3) |
| 7 | BYTE | Group ID -- 'Group_Ident' number | |

| | |
|---|---|
| (*n1) | Defines the time of the Watchdog timer (10 ms based). The overall time results from:<br>{ 10 ms x WD_Fact_1 x WD_Fact_2 }. |
| (*n2) | Earliest slave response time in { TBit }. -- (11 x TBit <--> max. TSDR). |
| (*n3) | Ident. number of the slaves (2 bytes, allocated by PNO) |

### 8.3.2 Device-Specific Data

Allocation and content of this data (octet-8..n) are predefined via the GSD file and can be changed by projecting. Format and content are checked after receipt of the complete telegram by the application software.

| Service DDLM_SET_Prm | | | |
|---|---|---|---|
| **Octet** | **Type** | **Explanation** | **Value (Default)** |
| 8 | BYTE | Spec_User_Prm_BYTE (x1) | [00]h |
| 9 | BYTE | Operating mode | [0E]h |
| | | Bit 7 Selection node address source (m1) | 0 |
| | | Bit 6 Activation of the 'SSA' service (m1) | 0 |
| | | Bit 5..4 Reserved | 0 |
| | | Bit 3 Scaling function (ON, OFF). | 1 |
| | (p1) | Bit 2 Commissioning diagnostics control (m2) | 1 |
| | (p1) | Bit 1 Class 2 functionality (ON, OFF). | 1 |
| | | Bit 0 Code sequence (0: ascending, 1: descending) | 0 |
| 10..11 | UINT16 | Measuring units per rev. (CPR). -- (31-16) | [00.00]h (p2) |
| 12..13 | UINT16 | Measuring units per rev. (CPR). -- (15-00) | [20.00]h (p2) |
| 14..15 | UINT16 | Total measuring range (CMR). -- (31-16) | [20.00]h (p2) |
| 16..17 | UINT16 | Total measuring range (CMR). -- (15-00) | [00.00]h (p2) |

| | |
|---|---|
| (x1) | Defines the system behaviour of the DP_Controller ASIC. – Not adjustable in the config. tool. |
| (m1) | Manufacturer-specific function. – Not defined in the encoder profile. |
| (m2) | Value has no meaning for **ATM60-P/ATM90-P** rotary encoders. Function is always enabled.<br>For linear encoders of the **KHK53-P** type, the function is optionally adjustable (default setting = enabled (1)) – see following pages. |
| (p1) | For the **ATM90-P**, the functions of bit 1 and bit 2 are interchanged. |
| (p2) | Device-dependent – see below. |

### 8.3.3 Operating Mode

#### 8.3.3.1 Code Sequence

Definition of the counting direction for the position value:

| | | | |
|---|---|---|---|
| 0 | CW | clockwise ascending | Default setting |
| 1 | CCW | counter-clockwise ascending | |

Setting per telegram is only possible if setting by hardware via DIP switch S1-(8) is **OFF**.

The view to determine the counting direction is device-dependent:

For the ATM90-P: looking at the baseplate; for the ATM60-P: looking at the shaft; and for the KHK53-P: beginning from the first measuring element (X0001).

#### 8.3.3.2 Class 2 Functionality

This attribute controls the Class 2 functionality regarding diagnostic data and operating mode.

| | | | |
|---|---|---|---|
| 0 | Disable | Not enabled (Class 1) | |
| 1 | Enable | Enabled (Class 2) | Default setting |

Mode Class 1 resets any scaling enabled. The encoder then uses the default setting for the scaling parameter.

#### 8.3.3.3 Commissioning Diagnostics Control

Encoder profile-specific designation for the behaviour of the device at standstill, regarding additional diagnostic data (extended DP diagnostics). The input value for rotary encoders remains without importance, since the diagnostic function is always enabled. For linear encoders, the value is optionally adjustable (default setting is (1) = enabled).

#### 8.3.3.4 Scaling Function

The physical resolution of the encoder can be changed, using the scaling parameters

- Measuring Units per Revolution -- (Octet 10-13)
- Total Measuring Range -- (Octet 14-17)

if this attribute is enabled. Otherwise, there will be no scaling.

| | | | |
|---|---|---|---|
| 0 | Disable | not enabled | |
| 1 | Enable | enabled | Default setting |

#### 8.3.3.5 Enabling the SSA Service

Optional function to change the subscriber address by telegram "DDLM_Set_Slave_Address" (SAP 55).

| | | | |
|---|---|---|---|
| 0 | OFF | Function not enabled | Default setting |
| 1 | ON | Function enabled | |

A change of address by telegram is only accepted if "**EEPROM**" is selected as the address source (see octet 9, bit 7).

#### 8.3.3.6 Selection of the Address Setting

This attribute defines the source of the address of the slave (encoder). The information is only evaluated during power-up. The setting is stored in the EEPROM.

A change of the attribute only becomes effective at next power-up.

| | | | |
|---|---|---|---|
| 0 | OFF | DIP switch | Default setting |
| 1 | ON | EEPROM | |

A change of the value to "**EEPROM**" may cause the allocation of a new address for this subscriber at next power-up. This depends on which value was parameterised before (Set_Slave_Address) and stored in the EEPROM. -- The default address is **"1"**.

A reset of the address source to "DIP switch[es]" can only be implemented via a further telegram. If the subscriber address stored in the EEPROM is no longer known, valid communication with the device cannot be established via the DP master. -- (see Error Correction 9.4.3.4).

### 8.3.4 Measuring Units per Revolution -- [CPR]

Number of steps within a revolution (SpU). – Represented by 2 words { high, low }.

| Min. value (h) | | Max. value (h) | | Default value (h) | | Device |
|---|---|---|---|---|---|---|
| Word_Hi | Word_Lo | Word_Hi | Word_Lo | Word_Hi | Word_Lo | Word_Hi |
| 00.00 | 00.01 | 00.00 | 20.00 | 00.00 | 00.01 | 00.00 |
| 00.00 | 00.01 | 00.00 | 20.00 | 00.00 | 00.01 | 00.00 |
| 00.01 | 86.A0 | 3B.9A | CA.00 | 00.01 | 86.A0 | 3B.9A |

The default value depends on the device type used.

For linear encoders, this parameter is termed 'Measuring Step'. The value is given in nanometres (nm) as a 32-bit value (unsigned).

### 8.3.5 Total Measuring Range -- [CMR]

Number of steps over the total measuring range. – Represented by 2 words { high, low }.

| Min. value (h) | | Max. value (h) | | Default value (h) | | Device |
|---|---|---|---|---|---|---|
| Word_Hi | Word_Lo | Word_Hi | Word_Lo | Word_Hi | Word_Lo | |
| 00.00 | 00.01 | 04.00 | 00.00 | 04.00 | 00.00 | ATM60-P |
| 00.00 | 00.01 | 04.00 | 00.00 | 02.00 | 00.00 | ATM90-P |
| | | | | 01.00 | 00.00 | KHK53-P |

The default value depends on the device type used.

For **linear** encoders, this parameter value is always set such that the default value (which corresponds with the physical measuring range [PMR] defined as 16,777,216 steps), is used.

To operate a **rotary** encoder in 'Continuous Mode', this value must be a multiple ($R = 2^N$) based on parameter 'CPR'. There will be an automatic matching of the factor 'R' to the next possible lower value.

Factor R (N = 0,1,…13) is limited to **8192** (max. number of revolutions).

Rotary encoders of the **ATM90-P** type are (historically) supplied with different physical total resolutions. The default scaling values in the GSD file are set for the max. resolution (8192 x 8192). The scaling parameters are automatically matched to the upper physical limit values if, during projecting, no matching takes place.

## 8.4 Configuration

In the 'Wait_Config' state, the configuration telegram defines the format for the cyclical data traffic (I/O data for every network subscriber).

All formats supported by the slave are defined in the GSD file with the keyword "Module". Using the configuration tool, at least one of these modules must be selected for projecting the device to be integrated.

According to the encoder profile, the encoder supports the data consistency with a max. of one (1) module.

The general ID format (specified with '1' byte) is used.

The modules are defined by number and content of the ID formats.

One (1) ID format (byte) per module is specified in the GSD file.

Specification of the general ID format (byte):

| | |
|---|---|
| Bit 7 | Consistency { 0: No, 1: Yes } |
| Bit 6 | Format data length { 0: byte, 1: word } |
| Bit 5 \| 4 | Mode { 1\|1: Input+Output, 1\|0: Output, 0\|1: Input, 0\|0: Specific Format } |
| Bit 3...0 | Code length { 0000 = 1, 0001 = 2, ...1111 = 16 } |

The specification only defines the data length (in word and bytes) produced or consumed by a network subscriber, however not the content of the input/output data. Definition and allocation of the data assemblies (data components) for the individual modules are based on the application, and are defined by a profile or by the manufacturer. -- see Data Assemblies (6.4).

Number and content of the transmitted ID formats, and the length of the INPUT/OUTPUT data resulting from the content, are checked by the slave and acknowledged as positive or negative responses. The next state within the 'State Machine' is reached only when a valid telegram is recognised.

The following modules can be selected via the ID format in the Chk_Cfg telegram.

| **Service DDLM_Chk_Cfg** | | | |
|---|---|---|---|
| **Module** | **Assembly** | **ID format** | **Value (hex)** |
| IN_04 | 1 | Encoder Class 1 -- 2 word input | D1 |
| IO_04 | 2 | Encoder Class 2 -- 2 word input/2 word output | F1 (Default) |
| | | | |
| IN_06 (c1) | 3 | Manufacturer-specific -- 3 word input | D2 |
| IO_06 (c1) | 4 | Manufacturer-specific -- 3 word input/3 word output | F2 |
| IN_08 (c2) | 5 | Manufacturer-specific-- 4 word input | D3 |
| IO_08 (c2) | 6 | Manufacturer-specific-- 4 word input/4 word output | F3 |

| | |
|---|---|
| (c1) | This function is not supported by the **ATM60-P**, **ATM90-P** encoders. |
| (c2) | This function is not supported by the **KHK53-P** encoder. |

The composition of the input/output modules is described on the following pages.

## 8.5 Cyclical Data Traffic (Data Exchange Mode)

The data is exchanged by means of default SAP in the Profibus telegram header. The master sends the output data to the slave and receives (if existing) the input data in return. In this mode, the telegram header consists of 9 bytes. The amount of nett data is limited to 244 bytes max.

The data telegram to be transmitted between master and slave, is defined in a 'DDLM_Chk_Cfg' telegram previously initiated by the master.

| WORD_1 | | WORD_2 | | ....... | | WORD_n | |
|---|---|---|---|---|---|---|---|
| Byte_1 | Byte_2 | Byte_3 | Byte_4 | ....... | ....... | Byte_n-1 | Byte_n |
| Output_Data 1 | | Output_Data 2 | | ....... | | Output_Data n (*1) | |
| Input_Data 1 | | Input_Data 2 | | ....... | | Input_Data n | |

Note the specific configuration of the output data:

| | |
|---|---|
| (*1) | The configuration of the 'output data' is reduced, as is the data component 'Preset value'. The content of Word_3, Word_4 remains unused, although the protocol transmits the complete data set. |

### 8.5.1 DDLM_Data_Exchange. – Data Assembly (A1). – Module IN_04

**Class 1** configuration according to encoder profile: - data components { I-1 }.

| WORD_1 | | WORD_2 | | | | | |
|---|---|---|---|---|---|---|---|
| Byte_1 | Byte_2 | Byte_3 | Byte_4 | | | | |
| **Position value (I-1)** | | | | | | | |
| (Bit 31..24)<br>Byte_1 | (Bit 23..16)<br>Byte_2 | (Bit 15..8)<br>Byte_3 | (Bit 7..0)<br>Byte_4 | | | | |

### 8.5.2 DDLM_Data_Exchange. - Data Assembly (A2). - Modul IO_04

**Class 2** configuration according to encoder profile: - data components { I-1, O-1 }.

| WORD_1 | | WORD_2 | | | | | |
|---|---|---|---|---|---|---|---|
| Byte_1 | Byte_2 | Byte_3 | Byte_4 | | | | |
| **Position value (I-1)** | | | | | | | |
| (Bit 31..24)<br>Byte_1 | (Bit 23..16)<br>Byte_2 | (Bit 15..8)<br>Byte_3 | (Bit 7..0)<br>Byte_4 | | | | |

| WORD_1 | | WORD_2 | | | | | |
|---|---|---|---|---|---|---|---|
| Byte_1 | Byte_2 | Byte_3 | Byte_4 | | | | |
| **Preset value (O-1)** | | | | | | | |
| (Bit 31..24)<br>Byte_1 | (Bit 23..16)<br>Byte_2 | (Bit 15..8)<br>Byte_3 | (Bit 7..0)<br>Byte_4 | | | | |

### 8.5.3 DDLM_Data_Exchange. - Data Assembly (A3). - Modul IN_06

**Class 1** configuration = manufacturer-specific: - data components { I-1, I-2 }.

| WORD_1 | | WORD_2 | | WORD_3 | | | |
|---|---|---|---|---|---|---|---|
| Byte_1 | Byte_2 | Byte_3 | Byte_4 | Byte_5 | Byte_6 | | |
| **Position value (I-1)** | | | | **Speed (I-2)** | | | |
| (Bit 31..24)<br>Byte_1 | (Bit 23..16)<br>Byte_2 | (Bit 15..8)<br>Byte_3 | (Bit 7..0)<br>Byte_4 | (Bit 15..8)<br>Byte_1 | (Bit 7..0)<br>Byte_2 | | |

### 8.5.4 DDLM_Data_Exchange. - Data Assembly (A4). - Modul IO_06

**Class 2** configuration = manufacturer-specific: - data components { I-1, I-2, O-1 }

| WORD_1 | | WORD_2 | | WORD_3 | | | |
|---|---|---|---|---|---|---|---|
| Byte_1 | Byte_2 | Byte_3 | Byte_4 | Byte_5 | Byte_6 | | |
| **Position value (I-1)** | | | | **Speed (I-2)** | | | |
| (Bit 31..24)<br>Byte_1 | (Bit 23..16)<br>Byte_2 | (Bit 15..8)<br>Byte_3 | (Bit 7..0)<br>Byte_4 | (Bit 15..8)<br>Byte_1 | (Bit 7..0)<br>Byte_2 | | |

| WORD_1 | | WORD_2 | | WORD_3 | | | |
|---|---|---|---|---|---|---|---|
| Byte_1 | Byte_2 | Byte_3 | Byte_4 | | | | |
| **Preset value (O-1)** | | | | **(*1 – see 8.5)** | | | |
| (Bit 31..24)<br>Byte_1 | (Bit 23..16)<br>Byte_2 | (Bit 15..8)<br>Byte_3 | (Bit 7..0)<br>Byte_4 | | | | |

### 8.5.5 DDLM_Data_Exchange. - Data Assembly (A5). - Modul IN_08

**Class 1** configuration = manufacturer-specific: - data components { I-1, I-2, I-3 }.

| WORD_1 | | WORD_2 | | WORD_3 | | WORD_4 | |
|---|---|---|---|---|---|---|---|
| Byte_1 | Byte_2 | Byte_3 | Byte_4 | Byte_5 | Byte_6 | Byte_7 | Byte_8 |
| **Position value (I-1)** | | | | **Speed (I-2)** | | **Time stamp (I-3)** | |
| (Bit 31..24)<br>Byte_1 | (Bit 23..16)<br>Byte_2 | (Bit 15..8)<br>Byte_3 | (Bit 7..0)<br>Byte_4 | (Bit 15..8)<br>Byte_1 | (Bit 7..0)<br>Byte_2 | (Bit 15..8)<br>Byte_1 | (Bit 7..0)<br>Byte_2 |

### 8.5.6 DDLM_Data_Exchange. - Data Assembly (A6). - Module IO_08

**Class 2** configuration = manufacturer-specific: data components { I-1, I-2, I-3, O-1 }

| WORD_1 | | WORD_2 | | WORD_3 | | WORD_4 | |
|---|---|---|---|---|---|---|---|
| Byte_1 | Byte_2 | Byte_3 | Byte_4 | Byte_5 | Byte_6 | Byte_7 | Byte_8 |
| **Position value (I-1)** | | | | **Speed (I-2)** | | **Time stamp (I-3)** | |
| (Bit 31..24)<br>Byte_1 | (Bit 23..16)<br>Byte_2 | (Bit 15..8)<br>Byte_3 | (Bit 7..0)<br>Byte_4 | (Bit 15..8)<br>Byte_1 | (Bit 7..0)<br>Byte_2 | (Bit 15..8)<br>Byte_1 | (Bit 7..0)<br>Byte_2 |

| WORD_1 | | WORD_2 | | WORD_3 | | WORD_4 | |
|---|---|---|---|---|---|---|---|
| Byte_1 | Byte_2 | Byte_3 | Byte_4 | | | | |
| **Preset value (O-1)** | | | | **(*1 – see 8.5)** | | | |
| (Bit 31..24)<br>Byte_1 | (Bit 23..16)<br>Byte_2 | (Bit 15..8)<br>Byte_3 | (Bit 7..0)<br>Byte_4 | | | | |

# 9 Diagnostic Information

## 9.1 Evaluation at Control Level

If the special Profibus diagnostic function is to be used, using a Siematic S7 control program, a diagnostic address needs to be set.

The special Profibus diagnostic function uses the OB82 component and thus organises the CPU behaviour of the control. This component is run through once a DP slave makes a diagnostic request (setting or resetting of events). Within the OB82, the complete diagnostic data of the slave is read out through the SFC13 functional component.

If the OB82 component is not present, and a diagnostic request is received from the slave, the CPU of the control goes to the operating mode 'STOP'.

Profibus DP offers a comfortable and multi-layered facility for processing diagnostic messages due to error conditions.

## 9.2 Diagnostic Messages

The diagnostic information of a DP slave consists of:

- Standard diagnosis (6 bytes)
- User-specific data (optional).

The maximum number of octets (bytes) of user-specific diagnostic data is described in the GSD file.

The ATM60/ATM90/KHK53 encoders support user-specific diagnostic data according to Class 1 and Class 2, resp., of the profile in the format:

- 'Device-specific' with a length of 63 bytes max..

The class is selected:

- Explicitly using ‘Operating Mode’ parameter – see Class 2 functionality (8.3.3.2).
- Implicitly via selecting the module configuration (Data Assembly).

| Op. Mode 'Class 2 function' | Assembly (Ax) | Class | Length of diagnostic data (bytes) |
|---|---|---|---|
| No - (0) | X | 1 | 10 |
| Yes - (1) | 1, 3, 5 | 1 | 10 |
| Yes - (1) | 2, 4, 6 | 2 | 59 / 63 (*a1) |

| | |
|---|---|
| (*a1) | Real Class 2 (59), manufacturer-specific option (63). |

## 9.3 Standard Diagnostics

The standard data is binding for all DP slaves.

| Service DDLM_Slave_Diag | | | |
|---|---|---|---|
| **Octet** | **Type** | **Explanation** | **Value (Default)** |
| 1 | BYTE | Status-1 | |
| 2 | BYTE | Status-2 | |
| 3 | BYTE | Status-3 | |
| 4 | BYTE | Master address | |
| 5 | BYTE | Device ID (device 'Ident_Number') - (high byte) | (d1) |
| 6 | BYTE | Device ID (device 'Ident_Number') - (low byte) | (d1) |

| | |
|---|---|
| (d1) | also see device ID 9.4.5. |

### 9.3.1 Status-1

| | | |
|---|---|---|
| Bit 7 | Master_Lock | Slave was parameterised by another master. |
| Bit 6 | Parameter_Fault | Incorrect parameter setting (invalid telegram message). |
| Bit 5 | Invalid_Slave_Response | Slave is permanently set to zero (0). |
| Bit 4 | Not_Supported | Requested function is not supported by the slave. |
| Bit 3 | Ext_Diag | Slave supports external diagnostic data. (p-1) |
| Bit 2 | Cfg_Fault | Slave refuses the configuration data setting. |
| Bit 1 | Station_Not_Ready | Slave not ready for data traffic mode (data_exchange mode). |
| Bit 0 | Station_Not_Existent | Slave does not exist on the bus. |

### 9.3.2 Status-2

| | | |
|---|---|---|
| Bit 7 | Deactivated | Slave was deactivated by the master. |
| Bit 6 | Reserved | |
| Bit 5 | Synch_Mode | Slave has received 'Sync' command. |
| Bit 4 | Freeze_Mode | Slave has received 'Freeze' command. |
| Bit 3 | WD_ON | Response monitoring activated. |
| Bit 2 | State | Always set to One (1). |
| Bit 1 | Stat_Diag | Static diagnostics -- Slave can support no valid process data. The master requests diagnostic data only until the slave resets this detail. (p-1) |
| Bit 0 | Prm_Req | Slave must be re-configured / new parameter setting. |

| | |
|---|---|
| (p-1) | If, for the KHK53-P, the Commissioning Diagnostics Control is deactivated (0), the master is not allerted by the slave to retrieve diagnostic data. The diagnostic data, however, is ready in the appropriate registers if the master itself wants to collect the diagnostic data. Further explanations see Sections 9.4.3 to 9.4.3.3. |

### 9.3.3 Status-3

| | | |
|---|---|---|
| Bit 7 | Ext_Diag_Overflow | Data overflow within external diagnostics. |
| Bit 6..0 | reserved | Reserved |

### 9.3.4 Master Address

| | |
|---|---|
| Bit 7..0 | Master address after parameter setting. -- Value before parameterisation: [FF]h. |

## 9.4 Device-Specific Diagnostics – Class 1

### 9.4.1 Class 1 Diagnostic Data – Overview

| **Service DDLM_Slave_Diag** | | | |
|---|---|---|---|
| **Octet** | **Type** | **Explanation** | **Value (Default)** |
| 7 | BYTE | Diagnostic header -- contains diagnostic data length | 10 / 63 |
| 8 | BYTE | Alarms | |
| 9 | BYTE | Operating state according to the Operating Mode | |
| | | Bit 7..4 Reserved | 0 |
| | | Bit 3 Status of the scaling function (‘On’, ‘Off’) (s1) | 1 |
| | | Bit 2 Commissioning diagnostics (s2) | 1 |
| | | Bit 1 Class 2 functionality (‘On’, ‘Off’) | 1 |
| | | Bit 0 Counting direction '0: CW, 1: CCW'<br>CW = clockwise<br>CCW = counter-clockwise | 0 |
| 10 | BYTE | Device ID – encoder type | |
| 11..14 | UINT32 | Physical Resolution Span (number of steps per rev. resp. span) which the encoder supports -- (PRS) | [8,192] rotary enc.<br>[4,096] linear enc. |
| 15..16 | UINT16 | Physical Number of Revolutions (number of revo-lutions resp. span) which the encoder supports | [8,192] rotary enc.<br>[4,096] linear enc. |

### 9.4.2 Diagnostic Header

The header information shows the length of the diagnostic data (including the header byte) in hex format. Octets 7 to 16 = user diagnostic data.

### 9.4.3 Alarms

Alarms are triggered when a serious error occurs in the encoder system. The message is deleted when the master has read the complete diagnostic data. The error display, too, will then no longer be present.

Each correct detail within the supported alarms/additional alarms also triggers the alarm-specific Commissioning Diagnostics Alarm Bit.

| | | Value '1' |
|---|---|---|
| Bit 7..5 | Not allocated | -- |
| Bit 4 | EEPROM memory error | See detail |
| Bit 3 | Commissioning Diagnostics Alarm | Device error |
| Bit 2..1 | Not allocated | -- |
| Bit 0 | Error in the position value | See detail |

The following applies to all alarms and warnings: True logic (value '1' means reference to an error).

#### 9.4.3.1 Commissioning Diagnostics Alarm

Applicable (TRUE) if one of the supported alarms (incl. additional alarms) or warnings displays an error.

This error leads to the provision of external diagnostic data 'Ext_Diag'. – See DP Standard Diagnostic Status-1 (0).

#### 9.4.3.2 EEPROM Memory Error

An EEPROM error which is found through reading out the general encoder parameters, when the encoder is used again following power-off.

#### 9.4.3.3 Error in the Position Value

There can be different reasons for this error message:

- EEPROM error which is found during reading operations of encoder parameters relating to position (e.g. when reading out the EEPROM after switching the encoder off and on again).
- The correct position cannot be determined using the algorithm for position calculation, because the scanner in the encoder supplies no valid signals.
- The distance between 'reading head' and 'material measure' is outside the permitted position tolerance (for linear encoders).

This error triggers a 'Stat_Diag'. – See DP Standard Diagnostic Status-2 (0).

The DP communication is in the Data_Exchange mode; the encoder, however, provides no valid data. The **red LED** is illuminated.

This state continues for as long as the existing cause of error is present.

#### 9.4.3.4 Error Correction Measures

These measures only lead to a result when the EEPROM data is inconsistent. For this, the EEPROM content must be re-configured to the factory setting (default values).

- Turn off operating voltage.
- Set node (device) address to zero (0) (DIP switch).
- Turn operating voltage back on, keeping the preset pushbutton (under the screw cap of the connection adapter) pressed for 2 seconds approx.
- Wait for about 10 seconds. The EEPROM is now re-configured.
- Turn off operating voltage and re-set to original node address.
- Turn operating voltage back on and check the device for faulty behaviour.

### 9.4.4 Operating Status

Shows the ‘Operating Mode’ parameter. -- (see 8.3.3), DDLM_Set_Prm.

| | |
|---|---|
| (s1) of 9.4.1 | Status of the scaling function - The value is reset to zero '0' in the following cases:<br>• The scaling parameters (CPR, CMR) are configured such that the default value is used, also when the control bit 'DDLM_Set_Prm' is set to one ('1').<br>• The Class 2 functionality control bit 'DDLM_Set_Prm' is set to zero (0) (not enabled). |

| | |
|---|---|
| (s2) of 9.4.1 | If, during configuration, the diagnostic control of the Operating Mode for the linear encoder KHK53-P was disabled {(0) set} then, in case of a position error, the master is not allerted by the slave to retrieve a diagnostic data set. Thus, the control (PLC) remains in a trouble-free state.<br>However, the diagnostic data is formed, ready in the slave’s corresponding output registers, and could be retrieved at the DP master’s request (until the fault condition for the position error no longer exists).<br>A position error can, for instance, be triggered by briefly exceeding the positional tolerance (excessive distance between measuring element and reading head). A fault message at the control, due to this event, is however not always wanted. |

### 9.4.5 Device Identification

The encoder type can be queried via this diagnostic byte.

| Device/model | Ident_Number (hex) | Encoder type | |
|---|---|---|---|
| ATM60-P | 59.52 | 1 (rotary, absolute) | |
| ATM90-P | 00.FE | 1 (rotary, absolute) | |
| KHK53-P | 05.F6 | 2 (linear, absolute) | |

### 9.4.6 Physical Resolution Span (PRS)

For rotary encoders, the parameter shows the max. number of measuring steps per revolution.

- The ATM60-P supports a resolution of { 8,192 } steps/rev.
- The ATM90-P supports a resolution of { 2,048, 4,096 or 8,192 } steps/rev.

For linear encoders, this parameter shows the smallest measuring step supported by the encoder (max. physical resolution), which is given in nanometres (nm).

- The KHK53-P supports a resolution of **0.1 mm**. This corresponds to the value 100,000.

### 9.4.7 Physical Number of Revolutions (PNumR)

For rotary encoders, this parameter shows the max. number of revolutions which can be distinguished.

- The ATM60-P supports a resolution of { 8,192 } revolutions.
- The ATM90-P supports a resolution of { 2,048, 4,096 or 8,192 } revolutions.

This parameter is irrelevant to linear encoders -- Display [FF.FF](h).

## 9.5 Device-Specific Diagnostics – Class 2

### 9.5.1 Class 2 Diagnostic Data – Overview

| Service DDLM_Slave_Diag | | | |
|---|---|---|---|
| **Octet** | **Type** | **Explanation** | **Value (Default)** |
| 7 | BYTE | Diagnostic header (data length) | 63 |
| 8...16 | | -- see Class 1 diagnostic data (9.4.1 ff) -- | |
| | | | |
| 17 | BYTE | Additional alarms | 0 |
| 18..19 | UINT16 | Supported alarms | 00.19 $_{hex}$ |
| 20..21 | UINT16 | Warnings | |
| 22..23 | UINT16 | Supported warnings | 00.01 $_{hex}$ |
| 24..25 | UINT16 | Profile version | 01.10 $_{hex}$ |
| 26..27 | UINT16 | Software version | 01.01 $_{hex}$ |
| 28..31 | UINT32 | Operating time – is not supported | FF.FF.FF.FF $_{hex}$ |
| 32..35 | UINT32 | Offset value | |
| 36..39 | UINT32 | Manufacturer's offset value – is not supported | 0 |
| 40..43 | UINT32 | Counts per Revolution (steps per rev.) – *Customer-specified*. – Measuring units/rev. | |
| 44..47 | UINT32 | Steps (number of counts) over the total Measuring Range -- (CMR) | |
| 48..57 | ASCII | Serial number – 10 characters | |
| 58..59 | | -- reserved -- | 0 |
| | | -- manufacturer-specific -- | |
| 60 | BYTE | Station address stored in the EEPROM | 1 |
| 61 | BYTE | Encoder status, acc. to 'Operating Mode' | |
| 62..63 | UINT16 | DP controller status | |

### 9.5.2 Diagnostic Header

The header information shows the length of the diagnostic data (including the header byte) in hex format. Octets 7 to 63 = user diagnostic data.

### 9.5.3 Additional Alarms

| | | |
|---|---|---|
| Bit 15..8 | Reserved for future use – not allocated | -- |

### 9.5.4 Supported Alarms

The settings control the display behaviour of the parameters 'Additional Alarms' and 'Alarms'.

| | | |
|---|---|---|
| Bit 15..8 | Reference to 'Additional Alarms' – not allocated -- | -- |
| Bit 7..0 | Reference to 'Alarms' | |
| Bit 7..5 | -- not allocated -- | -- |
| Bit 4 | EEPROM Memory Error | Yes |
| Bit 3 | Commissioning Diagnostics | Yes |
| Bit 2 | Overcurrent | -- |
| Bit 1 | Operating voltage error | -- |
| Bit 0 | Error in the position value | Yes |

### 9.5.5 Warnings

Warnings show that non-significant parameters of the encoder system are outside the tolerance. Contrary to the alarms, warnings do not state that there are incorrect position values.

The display is deleted after the master has read complete diagnostic data set and the triggering error signal no longer exists.

Each true display within the supported warnings triggers an alarm-specific bit (Commissioning Diagnostics Alarm). -- see (Alarms 9.4.3).

| | | Value allocation '1' |
|---|---|---|
| Bit 15..7 | -- not allocated -- | -- |
| Bit 6 | Reference point reached | not reached |
| Bit 5 | Battery charge | under limit |
| Bit 4 | Defined operating time limit | Limit exceeded |
| Bit 3 | CPU Watchdog status | Reset triggered |
| Bit 2 | Optical power reserve (for optoelectronics) | under limit |
| Bit 1 | Temperature warning | Yes |
| Bit 0 | Frequency warning (max. speed) | Limit exceeded |

### 9.5.6 Supported Warnings

The settings control the display behaviour of the parameter 'Warnings'.

| | | |
|---|---|---|
| Bit 15..7 | -- not allocated -- | -- |
| Bit 6 | Reference point warning | -- |
| Bit 5 | Battery charge warning | -- |
| Bit 4 | Operating time limit warning | -- |
| Bit 3 | CPU Watchdog status | -- |
| Bit 2 | Optical power reserve warning (for optoelectronics) | -- |
| Bit 1 | Temperature warning | -- |
| Bit 0 | Frequency warning (max. speed) | Yes |

### 9.5.7 Profile Version

Shows the implemented encoder profile version (1.10), divided into two numbers.

| Octet 24 | Octet 25 |
|---|---|
| Revision number | Index number |
| $01_{hex}$ | $10_{hex}$ |

### 9.5.8 Software Version

Shows the implemented encoder software version (rr.nn), divided into two numbers.

| Octet 26 | Octet 27 |
|---|---|
| Revision Number | Index Number |
| $rr_{hex}$ | $nn_{hex}$ |

### 9.5.9 Operating Time

Gives the number of hours that the encoder was in operation since first commissioning or since last power-up. The value is shown as units of [0.1 hours].

The function is not supported. Display value FF.FF.FF.FF $_{hex}$..

### 9.5.10 Offset Value

The offset value is calculated by the PRESET function and displaces the actual position value by the value calculated. The offset value is **automatically** stored in the EEPROM, after each operation, either by the PRESET pushbutton or by setting the preset value via the protocol.

### 9.5.11 Counts per Revolution -- [CPR]

This scaling parameter shows the number of configured, distinguishable steps per revolution. The factory setting (default) corresponds with the physical resolution per span.

For **rotary encoders** the value range (hex) is specified as:

| Octet 40 | Octet 41 | Octet 42 | Octet 43 | |
|---|---|---|---|---|
| 00<br>00 | 00<br>00 | 00<br>20 | 01<br>00 | min.<br>max. |

For **linear encoders** this parameter shows the ‘measuring step’ (= physical resolution to which the encoder is configured) in nanometres (nm). -- (see also 8.3.4).

Based on the max. physical resolution of **0.1 mm**, which the KHK53-P supports, the resolution can be reduced by increasing the 'measuring step’ value.

Specification of the data range (hex):

| Octet 40 | Octet 41 | Octet 42 | Octet 43 | |
|---|---|---|---|---|
| 00<br>00<br><br>3B | 01<br>0F<br><br>9A | 86<br>42<br><br>CA | A0<br>40<br><br>00 | 0.1 mm<br>1. 0 mm<br><br>1.0 m |

### 9.5.12 Number of counts per Measuring Range -- [CMR]

This scaling parameter shows the number of distinguishable steps over the total measuring range and corresponds with the scaled measuring range.

For **rotary encoders** the data range (hex) is specified for:

| Octet 44 | Octet 45 | Octet 46 | Octet 47 | |
|---|---|---|---|---|
| 00<br>04 | 00<br>00 | 00<br>00 | 01<br>00 | min.<br>max. |

The **linear encoder** KHK53-P always supports a max. range of 16,777,216 steps. This corresponds with a resolution of 2**24 or [01.00.00.00] in hex format.

### 9.5.13 Serial Number

The encoder serial number is given as an ASCII string with ten (10) characters. If the number is not used, the string only contains asterisks (*) --- hex code: [2A].

## 9.6 Manufacturer-Specific Diagnostics (Manufacturer Class)

This part is contained in the Class 2 diagnostics (table 9.5.1 from entry “manufacturer-specific) as an extension of 4 bytes.

### 9.6.1 Station Address

Gives the device address number (station or device address number) which is stored in the EEPROM and must not match with the setting shown for the external DIP switches.

### 9.6.2 Encoder Status

Displays the encoder status. Bit no. 0-3 corresponds with the parameter value 'Operating Mode’. The remaining bits are used for internal settings.

> The value is different for the individual encoder types and corresponds – with few exceptions – to diagnostic octet 9 (operating status).

| | | Value allocation '1' |
|---|---|---|
| Bit 7 | Selection of the node address source (EEPROM, DIP switch[es]) | EEPROM |
| Bit 6 | Activation of the 'SSA' service. - (Enabled, Disabled) | enabled |
| Bit 5 | Class 2 diagnostic mode | activated |
| Bit 4 | Scaling with 'default resolution’ (No, Yes) | No |
| Bit 3 | Status of the scaling function (ON, OFF) | ON |
| Bit 2 [(m1)] | Commissioning diagnostics | Yes |
| Bit 1 [(m1)] | Class 2 functionality (ON, OFF) | ON |
| Bit 0 | Counting direction (CW – clockwise, CCW – counter-clockwise). | CCW |

| | |
|---|---|
| [(m1)] | The **ATM90-P** provides these bits swapped, according to the Set_Param telegram. |

### 9.6.3 DP Controller Status

Identifies the general status of the implemented DP controller (SPC3 Asic Register #04,05). Further details see Controller Manual. The figures below result from the normal operating state of the controller.

Allocation for the **rotary encoders** ATM60-P, ATM90-P.

| | | |
|---|---|---|
| Bit 15..12 | Release number – always zero | |
| Bit 11..8 | Baud rate selection { 0...9 } | |
| Bit 7..6 | Watchdog State Machine | 10 |
| Bit 5..4 | DP Mode State Machine | 10 |
| Bit 3..0 | Specific details (diagnostics, mode) | 0101 |

Allocation for the **linear encoder** KHK53-P.

| | | |
|---|---|---|
| Bit 15..8 | Not allocated – always zero | 00 |
| Bit 7..6 | Watchdog State Machine | 10 |
| Bit 5..4 | DP mode State Machine | 10 |
| Bit 3..0 | Baud rate selection { 0...9 } | 0101 |

The baud rate selection is defined as follows:

| | | |
|---|---|---|
| 0000 (0) | 12 MBaud | |
| 0001 (1) | 6 MBaud | |
| 0010 (2) | 3 MBaud | |
| 0011 (3) | 1.5 MBaud | |
| 0100 (4) | 500.0 kBaud | |
| 0101 (5) | 187.5 kBaud | |
| 0110 (6) | 93.75 kBaud | |
| 0111 (7) | 45.45 kBaud | |
| 1000 (8) | 19.20 kBaud | |
| 1001 (9) | invalid | |

# 10 Encoder – Mounting and Connection

## 10.1 Mounting

See the mounting instructions supplied with the particular encoder.

## 10.2 Screening

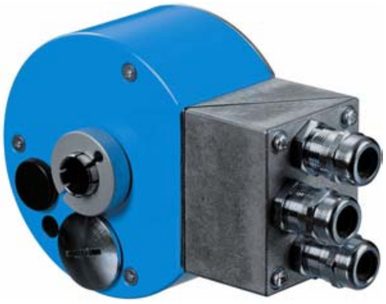
According to the Profibus DP specification, it is always recommended to use screened cables and to attach the screen on both sides. For detailed information see 'Cable Screening' (4.3.5) in in this document.

To achieve optimum screening effectiveness and to prevent mass equalisation currents from flowing across the screen, note the following:

- It must be ensured that there is a good electrical connection between the metal housing of the encoder and the earthed metal parts of the system/machine. This is usually achieved by the metallic connection across the encoder flange.
- If the fixing method used does not have a well-conducting electrical connection, additional measures in the form of an earthing cable must be taken.

| | |
|---|---|
| ☞ | Encoders of the type **ATM 90-P** may, due to their internal arrangement, require additional earthing even with a good metallic connection. |

### 10.2.1 Screen Connection at the Bus Link Adapter with Cable Fitting ATM60-P/ATM90-P/ KHK53-P



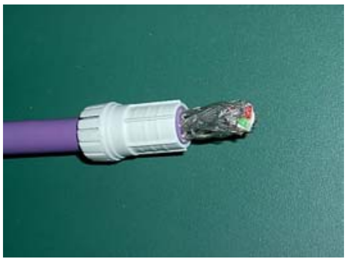
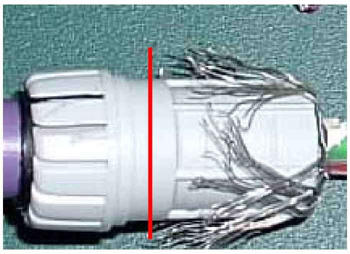
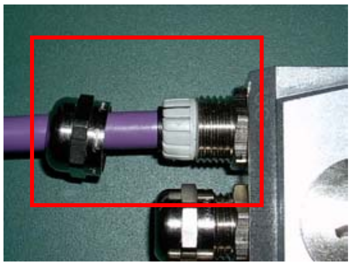
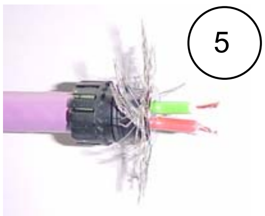
| | | |
|---|---|---|
|  |  |  |
| Components of the cable fitting | Insert Profibus cable through the inlay | Strip sheathing |
|  |  |  |
| Bend braided screen back and strip cores | Observe the max. length of the braided screen | Plug cable fitting together and pull tight |
|  | | |
| Finished cable fitting | | |

**Figure 10–1: Screen Connection at the Bus Link Adapter with Cable ATM60-P/ATM90-P/ KHK53-P.**

### 10.2.2 Screen Connection at the Bus Link Adapter with Screw-in System ATM90-P


Only insert cable into the inlay, up to the stop (arrow point)

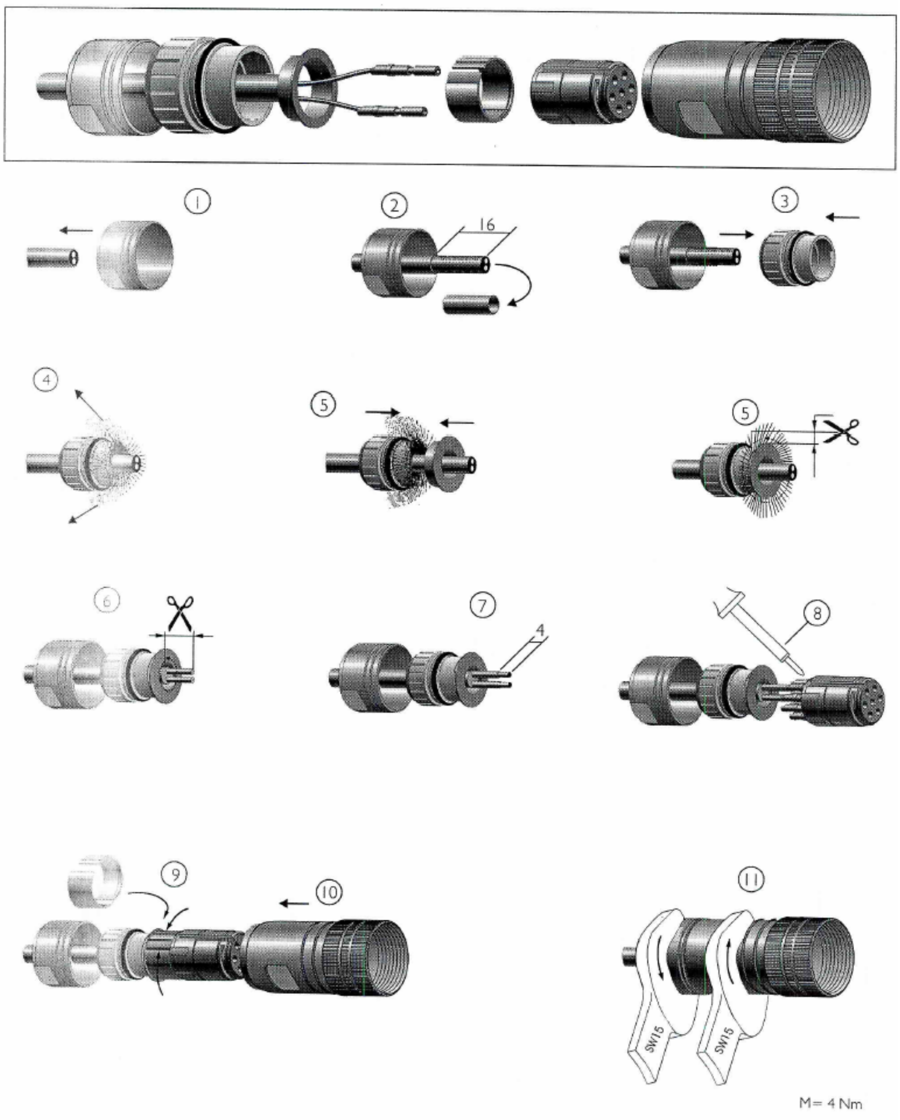




**Figure 10–2: Screen Connection with Screw-in System ATM90-P.**

## 10.3 Connection to the Network

There are the following different versions:

- Encoder with link adapter – connection via cable fitting (*1)
- Encoder with bus link adapter – connection via screw-in system M12 (*1)
- Encoder without bus link adapter – connection directly via screw-in system M14 (*1)

| | |
|---|---|
| (*1) | Not all versions are available for each encoder type |

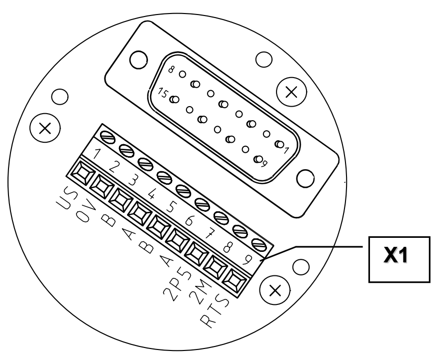
### 10.3.1 Installation Notes re: Voltage Supply

The operating voltage is generally supplied via a separate line and is not designed as a line structure. If, for the voltage supply, the same cabling arrangement as used by the bus is implemented, the following limitation applies:

| | |
|---|---|
| ⚠ | Max. current flow across the plugs or terminal block in the bus link adapter is limited to 2 A. |
| | Max. number of encoders [series connection] is 10. |

### 10.3.2 ATM 60 with Bus Link Adapter – Cable Fitting

ATM 60 with bus link adapter – connection via 3 cable fittings. The electrical wiring is via the internal terminal block (X1).



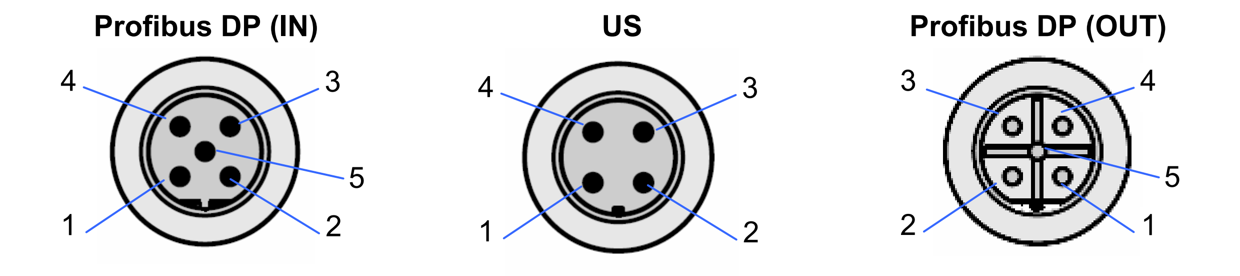

| X1 | Signal | Description |
|---|---|---|
| 1 | US (24V) | Operating voltage 10-32 V |
| 2 | GND | 0 V (Gnd) |
| 3 | B | B line Profibus DP (out) |
| 4 | A | A line Profibus DP (out) |
| 5 | B | B line Profibus DP (in) |
| 6 | A | A line Profibus DP (in) |
| 7 | 2P5 | +5 V (potential separated) (1) |
| 8 | 2M | 0 V (potential separated) (1) |
| 9 | RTS | Request to Send (2) |
| | | |

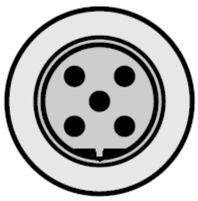
**Figure 10–3: Pinout ATM 60 with Bus Link Adapter – Cable Fitting.**

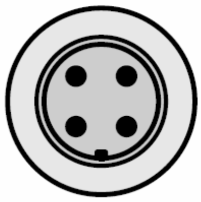
| | |
|---|---|
| (1) | For external bus termination or supplying the transmitter/receiver of a fibre-optic connection. |
| (2) | Signal is optional, serves to detect the direction of a fibre-optic connection. |

### 10.3.3 ATM 60 with Bus Link Adapter – Screw-in System M12

ATM 60 with bus link adapter – connection via 3 x screw-in system M12.




| Profibus DP (IN) | | Signal | Description |
|---|---|---|---|
|  | 1 | nc | |
| | 2 | A | A line Profibus DP |
| | 3 | nc | |
| | 4 | B | B line Profibus DP |
| | 5 | Screen | Housing potential |
| | | | |

| US | | Signal | Description |
|---|---|---|---|
|  | 1 | US (24V) | Operating voltage (10-32) V |
| | 2 | nc | |
| | 3 | GND | 0 V (ground) |
| | 4 | nc | |
| | | | |
| | | | |

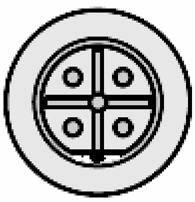
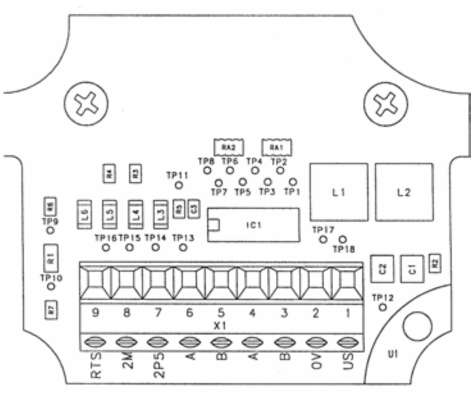
| Profibus DP (OUT) | | Signal | Description |
|---|---|---|---|
|  | 1 | 2P5 | +5 V (potential separated) (1) |
| | 2 | A | A line Profibus DP |
| | 3 | 2M | 0 V (potential separated) (1) |
| | 4 | B | B line Profibus DP |
| | 5 | Screen | Housing potential |
| | | | |

**Figure 10–4: Pinout ATM 60 Direct with Bus Link Adapter – Screw-in System M12.**

| | |
|---|---|
| (1) | For external bus termination or supplying the transmitter/receiver of a fibre-optic connection. |

### 10.3.4 ATM 90 with Bus Link Adapter – Cable Fitting

ATM 90 with bus link adapter – connection via 3 cable fittings. The electrical wiring is via the internal terminal block (X1).



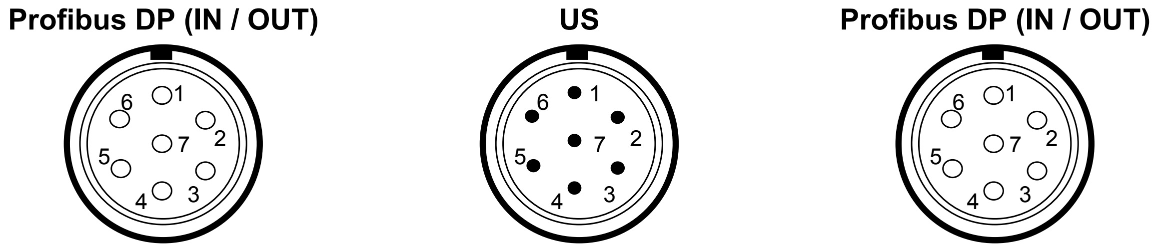

| X1 | Signal | Description |
|---|---|---|
| 1 | US (24V) | Operating voltage 10-32 V |
| 2 | GND | 0 V (Gnd) |
| 3 | B | B line Profibus DP (out) |
| 4 | A | A line Profibus DP (out) |
| 5 | B | B line Profibus DP (in) |
| 6 | A | A line Profibus DP (in) |
| 7 | 2P5 | +5 V (potential separated) (1) |
| 8 | 2M | 0 V (potential separated) (1) |
| 9 | RTS | Request to Send (2) |
| | | |

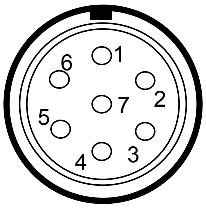
**Figure 10–5: Pinout ATM 90 with Bus Link Adapter.**

| | |
|---|---|
| (1) | For external bus termination or supplying the transmitter/receiver of a fibre-optic connection. |
| (2) | Signal is optional, serves to detect the direction of a fibre-optic connection. |

### 10.3.5 ATM 90 with Screw-in System M14 – without Bus Link Adapter

ATM 90 (without bus link adapter) – connection directly via 3 x screw-in system M14 (**Minitec, 7-pin**).




| Profibus DP (IN / OUT) | | Signal | Description |
|---|---|---|---|
|  | 1 | RTS | Request to Send [(2)] |
| | 2 | A | A line Profibus DP |
| | 3 / 7 | nc | |
| | 4 | B | B line Profibus DP |
| | 5 | 2M | 0 V (potential separated) [(1)] |
| | 6 | 2P5 | +5 V (potential separated) [(1)] |

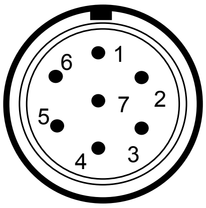
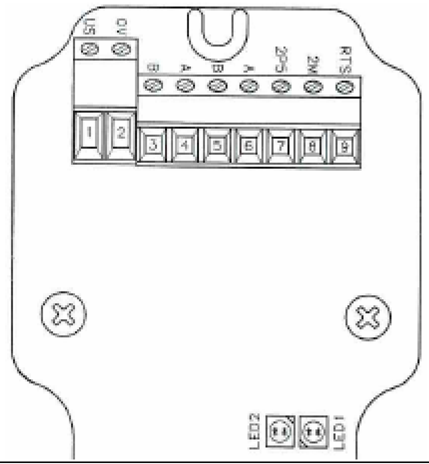
| US | | Signal | Description |
|---|---|---|---|
|  | 1 | US (24V ) | Operating voltage (10-32) V |
| | 3 | GND | 0 V (Gnd) |
| | 5 | RTS | Request to Send [(2)] |
| | 2 / 4 / 6 / 7 | nc | |
| | | | |
| | | | |

**Figure 10–6: Pinout ATM 90 Direct with Screw-in System M14 – without Bus Link Adapter.**

| | |
|---|---|
| (1) | For external bus termination or supplying the transmitter/receiver of a fibre-optic connection. |
| (2) | Signal is optional, serves to detect the direction of a fibre-optic connection. |

### 10.3.6 Linear Encoder KHK53 with Bus Link Adapter – Cable Fitting

KHK53 with bus link adapter – connection via 3 cable fittings. The electrical wiring is via the internal terminal block (X1).




| X1 | Signal | Description |
|---|---|---|
| 1 | US (24V) | Operating voltage 10-32 V |
| 2 | GND | 0 V (Gnd) |
| 3 | B | B line ProfiBus DP (out) |
| 4 | A | A line ProfiBus DP (out) |
| 5 | B | B line ProfiBus DP (in) |
| 6 | A | A line ProfiBus DP (in) |
| 7 | 2P5 | +5 V (potential separated) (1) |
| 8 | 2M | 0 V (potential separated) (1) |
| 9 | RTS | Request to Send (2) |
| | | |

**Figure 10–7: Pinout Linear Encoder KHK53 with Bus Link Adapter**

| | |
|---|---|
| (1) | For external bus termination or supplying the transmitter/receiver of a fibre-optic connection. |
| (2) | Signal is optional, serves to detect the direction of a fibre-optic connection. |

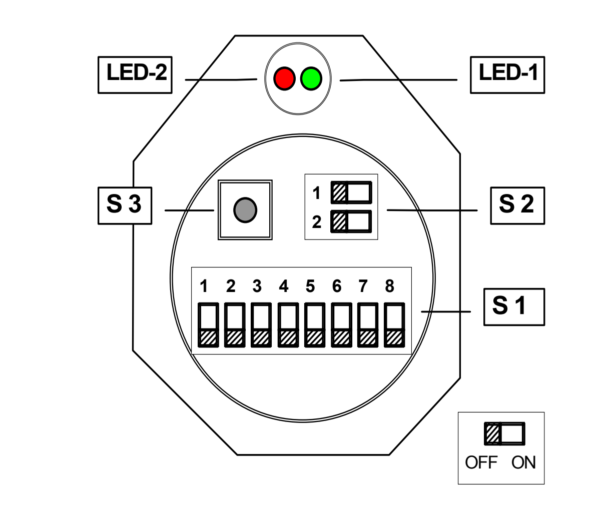
## 10.4 Device Handling in the Network

The following encoder features are configured via the hardware:

- Station address (node ID).
- Counting direction.
- Bus termination.
- Preset function.

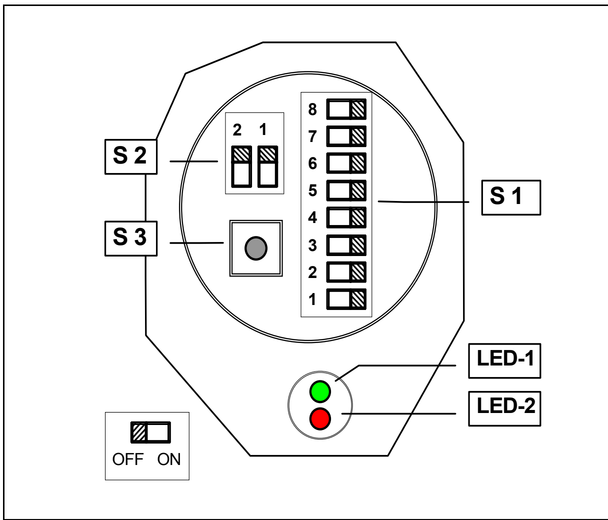
The following measures are required to execute one of these functions (model-dependent):

- Remove screw cap on the back of the bus link adapter housing (ATM 60 with cable fitting or screw-in system M12).
- Remove screw cap on the front of the encoder housing (ATM 90 with screw-in system M14).
- Pull off bus link adapter housing (ATM 90 with bus link adapter/KHK53 with bus link adapter).




| | |
|---|---|
| Switch settings | |
| S 1 (7-1) | Address setting (0..127) |
| S 1 (8-8) | Counting direction (CW/CCW) |
| S 2 | Bus termination |
| S 3 | Preset pushbutton (number SET) |
| | |
| | |
| Status information | |
| LED-1 | Operating voltage (green) |
| LED-2 | Bus activity (red) |
| | |

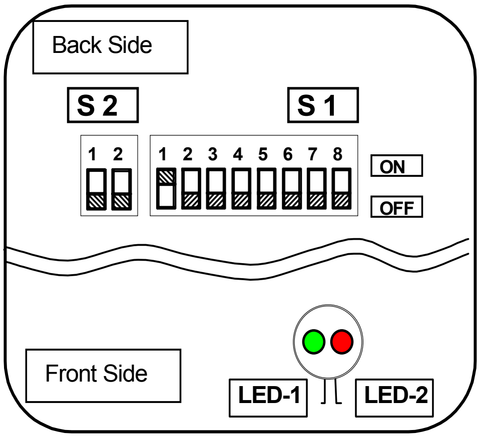
**Figure 10–8: Device Handling in the Network 'ATM 60' (DIP Switch in the Bus Link Adapter).**




| | |
|---|---|
| Switch settings | |
| S 1 (7-1) | Address setting (0..127) |
| S 1 (8-8) | Counting direction (CW/CCW) |
| S 2 | Bus termination |
| S 3 | Preset pushbutton (number SET) |
| | |
| | |
| Status information | |
| LED-1 | Operating voltage (green) |
| LED-2 | Bus activity (red) |
| | |

**Figure 10–9: Device Handling in the Network 'ATM 90' (Aperture for DIP Switch in the Encoder).**

In the version with a bus link adapter (ATM 90), the switches S1 and S2 are also inside the bus link adapter.




| Switch settings | |
|---|---|
| S 1 (7-1) | Address setting (0..127) |
| S 1 (8-8) | Counting direction (CW/CCW) |
| S 2 | Bus termination |
| | |
| | |
| | |
| **Status information** | |
| LED-1 | Operating voltage (green) |
| LED-2 | Bus activity (red) |
| | |

**Figure 10–10: Device Handling in the Network 'KHK53' (DIP Switch in the Bus Link Adapter).**

### 10.4.1 Address Setting

The station (node) address (NODE ID) can be set using DIP switch S1 (7-1). The factory setting (default) is "1". The address must not be the same as for another subscriber in the network.

| DIP-7 | DIP-6 | DIP-5 | DIP-4 | DIP-3 | DIP-2 | DIP-1 | Address |
|---|---|---|---|---|---|---|---|
| $2^6$ (msb) | $2^5$ | $2^4$ | $2^3$ | $2^2$ | $2^1$ | $2^0$ (lsb) | |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| ... | ... | ... | ... | ... | ... | ... | ... |
| 1 | 1 | 1 | 1 | 1 | 1 | 0 | 126 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 127 |

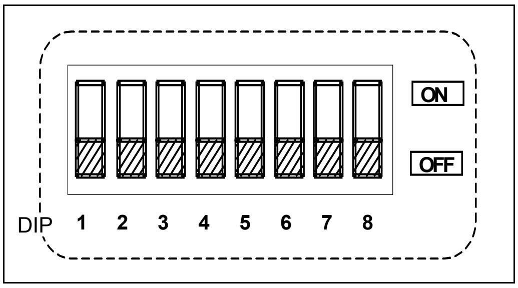



**Figure 10–11: DIP Switch S1 Setting**

| Address table | | | | | | | |
|---|---|---|---|---|---|---|---|
| decimal | binary | decimal | binary | decimal | binary | decimal | binary |
| 0 | 0000000 | 32 | 0100000 | 64 | 1000000 | 96 | 1100000 |
| 1 | 0000001 | 33 | 0100001 | 65 | 1000001 | 97 | 1100001 |
| 2 | 0000010 | 34 | 0100010 | 66 | 1000010 | 98 | 1100010 |
| 3 | 0000011 | 35 | 0100011 | 67 | 1000011 | 99 | 1100011 |
| 4 | 0000100 | 36 | 0100100 | 68 | 1000100 | 100 | 1100100 |
| 5 | 0000101 | 37 | 0100101 | 69 | 1000101 | 101 | 1100101 |
| 6 | 0000110 | 38 | 0100110 | 70 | 1000110 | 102 | 1100110 |
| 7 | 0000111 | 39 | 0100111 | 71 | 1000111 | 103 | 1100111 |
| 8 | 0001000 | 40 | 0101000 | 72 | 1001000 | 104 | 1101000 |
| 9 | 0001001 | 41 | 0101001 | 73 | 1001001 | 105 | 1101001 |
| 10 | 0001010 | 42 | 0101010 | 74 | 1001010 | 106 | 1101010 |
| 11 | 0001011 | 43 | 0101011 | 75 | 1001011 | 107 | 1101011 |
| 12 | 0001100 | 44 | 0101100 | 76 | 1001100 | 108 | 1101100 |
| 13 | 0001101 | 45 | 0101101 | 77 | 1001101 | 109 | 1101101 |
| 14 | 0001110 | 46 | 0101110 | 78 | 1001110 | 110 | 1101110 |
| 15 | 0001111 | 47 | 0101111 | 79 | 1001111 | 111 | 1101111 |
| 16 | 0010000 | 48 | 0110000 | 80 | 1010000 | 112 | 1110000 |
| 17 | 0010001 | 49 | 0110001 | 81 | 1010001 | 113 | 1110001 |
| 18 | 0010010 | 50 | 0110010 | 82 | 1010010 | 114 | 1110010 |
| 19 | 0010011 | 51 | 0110011 | 83 | 1010011 | 115 | 1110011 |
| 20 | 0010100 | 52 | 0110100 | 84 | 1010100 | 116 | 1110100 |
| 21 | 0010101 | 53 | 0110101 | 85 | 1010101 | 117 | 1110101 |
| 22 | 0010110 | 54 | 0110110 | 86 | 1010110 | 118 | 1110110 |
| 23 | 0010111 | 55 | 0110111 | 87 | 1010111 | 119 | 1110111 |
| 24 | 0011000 | 56 | 0111000 | 88 | 1011000 | 120 | 1111000 |
| 25 | 0011001 | 57 | 0111001 | 89 | 1011001 | 121 | 1111001 |
| 26 | 0011010 | 58 | 0111010 | 90 | 1011010 | 122 | 1111010 |
| 27 | 0011011 | 59 | 0111011 | 91 | 1011011 | 123 | 1111011 |
| 28 | 0011100 | 60 | 0111100 | 92 | 1011100 | 124 | 1111100 |
| 29 | 0011101 | 61 | 0111101 | 93 | 1011101 | 125 | 1111101 |
| 30 | 0011110 | 62 | 0111110 | 94 | 1011110 | 126 | 1111110 |
| 31 | 0011111 | 63 | 0111111 | 95 | 1011111 | 127 | 1111111 |

### 10.4.2 Counting Direction

The counting direction can be set with DIP switch S1 (8-8).

| | | | |
|---|---|---|---|
| OFF (0) | CW | ascending | Factory setting (default) |
| ON (1) | CCW | descending | |

The setting 'ON' always has priority over the setting via software. Only the DIP switch setting 'OFF' permits a change by telegram.

The view for determining the counting direction is device-dependent:

- ATM90 looking at the baseplate
- ATM60 looking at the shaft
- KHK53 from the first material measure

### 10.4.3 Preset Function

The encoder is set to a special, predefined value if the PRESET function is executed by pressing pushbutton S3. –- The factory default value is zero (0).

The preset function is not intended for dynamic adjustment processes. The function is meant for electronic adjustment during commissioning, to allocate a certain position value to any mechanical shaft position of the encoder. In case of constantly recurring activation of the preset function, the corresponding memory locations in the EEPROM are destroyed, with time lapsing!

The use of the preset function leads to a change in the position value output by the encoder. This could cause an unexpected movement which may lead to damage of the system, other objects or bodily harm.

### 10.4.4 Bus Termination

The bus termination can be performed with DIP switch S2. The factory preset (default) is 'OFF'.

If the encoders are wired in 'line topology', the internal termination resistor must only be switched at the two **end points of the line** (the two – physically – most distant points). Thus, in this configuration, the switches for the bus termination resistor shall be switched to 'ON' **always at the last bus subscriber of the line**.

If the bus is terminated externally, the DIP switches S2 must generally be in the 'OFF' position.

## 10.5 Status/Display Information

The devices have two LEDs displaying the status information.

<table>
<tr><th colspan="2">LED</th><th>Zustand</th><th>Erklärung</th></tr>
<tr><td rowspan="2">green</td><td rowspan="2">Operating voltage</td><td>OFF</td><td>Device is not – or not sufficiently – supplied with voltage.</td></tr>
<tr><td>ON</td><td>Operating voltage is applied —Operating Mode.</td></tr>
<tr><td rowspan="2">red</td><td rowspan="2">Bus activity</td><td>OFF</td><td>Valid data communication (Data_Exchange_Mode) (C-1)</td></tr>
<tr><td>ON</td><td>NO valid data communication --- Data_Exchange_ Mode was not started or cancelled:<br>- during the configuration sequence<br>- due to incorrect parameter data or configuration data<br>- due to incorrect hardware settings (bus termination, address, pin-out, cable breakage, ...).</td></tr>
</table>

| | |
|---|---|
| (C-1) | Valid data communication only means that master and slave can communicate with one another via telegrams. It does not mean that the data within the remote telegrams is also correct --- e.g. incorrect position value, incorrect offset, ... . |

# 11 Technical Description

## 11.1 Description of the Rotary Encoders

The absolute rotary encoders ATM 60-P/ATM 90-P have a total resolution of 26 bits. The single-turn position value is transmitted with 13 bits (8192 steps/rev.). The number of revolutions in the multi-turn range also is 13 bits (8192 rev.). The revolutions are determined via a gearbox mechanism.

The Profibus DP interface is an integral part of the encoder. The encoder is configured as a slave, with cyclical data transmission mode (DP-V0).

The encoder functionality is implemented by the profile for encoders.

## 11.2 Description of the Linear Encoder

The KHK53-P is a real absolute length measuring system with a resolution of 100 µm and supports a measuring length of up to 1700 m.

A – non-contact – reading head determines the absolute position from a series of scale sections (material measures) fitted along the measurement path.

The reading head itself consists of a number of magnetoresistive sensors, which can always evaluate the position of at least three permanent magnets (fitted inside the material measure elements) to always determine – from their coded relative distances – the absolute position.

The material measure elements are made from an aluminium sections. These are mounted at fixed intervals – in a row, using a mounting aid, until the required measuring length is achieved. The reading head moves parallel along the material measure elements.

The distance between the reading head and a material measure is nominally 25 mm .

The Profibus DP interface is an integral part of the encoder. The encoder is configured as a slave, with cyclical data transmission mode (DP-V0).

The encoder functionality is implemented by the profile for encoders.

## 11.3 Profibus Interface – Brief Overview of Specific Features

- Profibus DP according to EN 50 170-2 (RS485), implemented with ASIC SPC3 by Siemens.
- Electrical isolation of the bus interface.
- Functionality according to 'encoder profile' (profile for encoders).
- Configuration using hardware settings (DIP switches) in the bus connection adapter housing:
  - ❖ Electronic pushbutton adjustment (PRESET)
  - ❖ Address setting (NODE ID)
  - ❖ Counting direction (cw, ccw)
- Status information of the message link via LED (red).
- Configurable parameters of the encoder via the protocol:
  - ❖ Profile-specific parameters:
    Counting direction, scaling function, scaling parameters (CPR, CMR).
  - ❖ Manufacturer-specific settings:
    Enabling the SSA Service, selecting the address setting (switch or protocol), extended I/O data transmission (speed, time stamp).

Storage of all important data parameters in the EEPROM.

- Formation of new position values at **intervals of 0.250 ms**.

## 11.4 Profibus Interface – Specification

| **Profibus DP interface** | | |
|---|---|---|
| Electrical interface | RS485 according to EN 50170-2 (DIN 19245, 1-3), DC isolated via opto-coupler[s]. | |
| Protocol | Profibus DP, with 'profile for encoders' ($07_{hex}$) | |
| Address setting (node number) | 0...127 | Address setting (node number) |
| Data transmission rate (baud rate) | 9.6 kBaud - 12 MBaud | Data transmission rate (baud rate) |
| Electronic adjustment | Via PRESET pushbutton or protocol | |
| Status information | Operating voltage (green), bus activity (red). | |
| Bus termination | Via DIP switch. -- (for terminal only). | |
| Electrical connection | [1] PG-9 or metric cable fitting (3x).<br>[2] M14 screw-in system (3x).<br>[3] M12 screw-in system (3x) | |

| | |
|---|---|
| [1] | Encoder model: ATM 60, ATM 90, KHK 53 |
| [2] | Encoder model: ATM 90 |
| [3] | Encoder model: ATM 60 |

# List of Figures

## Notes

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