intelligente Weg- und Winkelmess-Systeme

User Manual

Magnetic Absolute Rotary Encoders

with PROFIBUS

WV58M, WH58M

Table of contents

1 General remarks

This user manual is valid with firmware version 1.00 or later! It describes the software, parameterisation and commissioning of the rotary encoder.

1.1 Definitions

This symbol precedes passages in the text that should be read particularly carefully to ensure flawless use and to exclude dangers.

This symbol indicates important information for proper handling of the rotary encoder. Disregard of these hints may result in failures of functioning of the rotary encoder or its environment.

This symbol indicates instructions for actions.

LSB	Least significant bit/byte
MSB	Most significant bit/byte
DP	Distributed periphery
DPM1	DP master (class 1). he DPM1 is the central automation device with Profibus DP.
DPM2	DP master (class 2). The DPM2 is a configuration device with PROFIBUS DP.
GSD	Device database file. Electronic device data sheet in a pre-defined form.

Figures if not explicitly stated otherwise, decimal values are given as figures without an extension (e.g., 1234), binary values are marked with a **b** after the figure (e.g., 19011b), hexadecimal values with an **h** (e.g., 280h).

1.2 Documentation

This user manual is valid for the absolute, magnetic angle encoders WV58M or WH58M, respectively, and shall give the necessary information for handling these devices.

For information regarding guarantee, safety and mechanical mounting of the angle encoders WV/WH58M please refer to the User information accompanying these encoders.

1.3 Intended use

The said angle encoders are high-precision measuring instruments. They serve exclusively for sensing angle positions and revolutions, processing and providing measured values as electrical output signals for the downstream device. The angle encoders must be used exclusively for this purpose.

2 Magnetic angle encoders product family

At present, the product family of magnetic, absolute angle encoders consists of the following 4 types:

- **10bit singleturn (1024 measuring units/revolution).**
- **12bit singleturn (4096 measuring units/revolution),**
- **10+12bit multiturn (1024 measuring units/revolution, 4096 revolutions),**
- **12+12bit multiturn (4096 measuring units/revolution, 4096 revolutions)**

They are available either in solid shaft or in (blind hole) hollow shaft design in standard size with a diameter of 58mm. Although designed with a bus interface, the angle encoders are very compact.

The angle encoders are available with the following interfaces:

- **SN3 (serial RS485 interface with SIKONETZ3 protocol)**
- **SSI (synchronous serial interface)**
- **PB (Profibus-DP interface)**
- **CAN (CANopen interface)**

Below, only the angle encoder WV/WH58M with ***Profibus DP*** interface will be described.

3 General information on PROFIBUS DP

PROFIBUS is a multi-vendor, open fieldbus standard for diverse applications in manufacturing, process and building automation. Manufacturer independence and openness are guaranteed by the international standard EN 50170.PROFIBUS makes it possible for devices from different manufacturers to communicate, without special adaptation of the interfaces. PROFIBUS is suitable for both fast, time-critical data transmissions as well extensive and complex communication tasks.

The PROFIBUS communication system is divided into three versions:

- PROFIBUS FMS for data communication between control units in the areas of the production and process control level,
- PROFIBUS PA in the area of process engineering,
- PROFIBUS DP for fast data exchange between controls and distributed periphery devices in the area of automation technology. Data exchange with these distributed devices is mostly cyclical. The communication functions required for this purpose have been specified in the PROFIBUS DP basic functions in accordance with EN 50170.

A Profibus system distinguishes between the following device types:

- DP Master Class 1 (DPM1) is a control which cyclically exchanges information with a DP slave (e.g., a SPC),
- DP Master Class 2 (DPM2) are programming, configuration or operating devices,
- DP slave is a periphery device which reads output data and passes input data to a DP master.

Optionally, only one master (mono-master system) or several masters (multi-master system) can be active in a PROFIBUS system.

3.1 PROFIBUS DP features

- bus medium is a shielded twisted pair cable according to RS485,
- closed network on both sides,
- baud rates between 9,6 kbit/s and up to 12 Mbit/s,
- up to 31 slaves can be connected within one bus segment and up to 126 stations can be operated on a Profibus unit if repeaters are used,
- station-oriented message protocol based on cyclic master-slave communication,
- powerful diagnostic functions,
- safe transmission modes (Hamming distance 4),
- short reaction times (1ms for 32 stations and 12Mbit/s),
- easy handling and extensibility,
- many standardised system components available

PROFIBUS DP has been standardised in the standard EN 50170, vol. 2. The standard specifies the communication and user profiles.

The user profile for absolute rotary encoders is the Profibus Profile for Encoder Version 1.1. This user profile distinguishes between device classes 1 and 2 depending on the number of functions to be supported.

Device class 2 offers more functions and includes all functions of device class 1. Parameterisation as well as preset functions as well as a wide range of diagnostic possibilities are exclusively supported by class 2. The rotary encoder WV(WH)58M supports classes 1 and 2.

3.2 GSD file

The device database file (GSD file) serves for the unique description of a Profibus DP slave in a specified data format. It's availability is the precondition for configuring a Profibus system.

The GSD file is divided into two areas:

- The **general conventions** contain information on the manufacturer of the product (manufacturer name, device name, identification number, software and hardware version, supported transmission speeds, etc.).
- In the **slave-related part**, information is stored on possible input/output pin assignments, user parameters and diagnostic possibilities.

The GSD file assigned to the angle encoder WV/WH58M is named „**SIKO094D.GSD**“. This file can be provided on a data medium or downloaded from the homepage of SIKO GmbH (www.siko.de).

3.3 The Profibus device profile for encoders

The profile describes the functionality of rotary encoders that can be connected to a PROFIBUS DP system. The functionality is divided into two classes:

Class 1: This class describes a set of (basic) functions to be supported by any PROFIBUS DP encoder. Specified class-2 functions can be used as an option.

Class 2: The rotary encoder supports all functions of class 1 and all functions defined in class 2. Additionally, the manufacturer of the rotary encoder can add other parameter and/or diagnosis areas.

The position value provided by the rotary encoder is always output in the 2-complement format, i.e., the number range is from:

-1/2 total measuring range .. 0 .. +1/2 (total measuring range – 1)

The WV(WH)58M supports class 1 as well as class 2. Within the configuration tool used, the user can decide on the desired functionality of the encoder. The complete functionality of the angle encoder is only possible with class 2.

4 Data exchange between Profibus devices (master ⬅➡ slave)

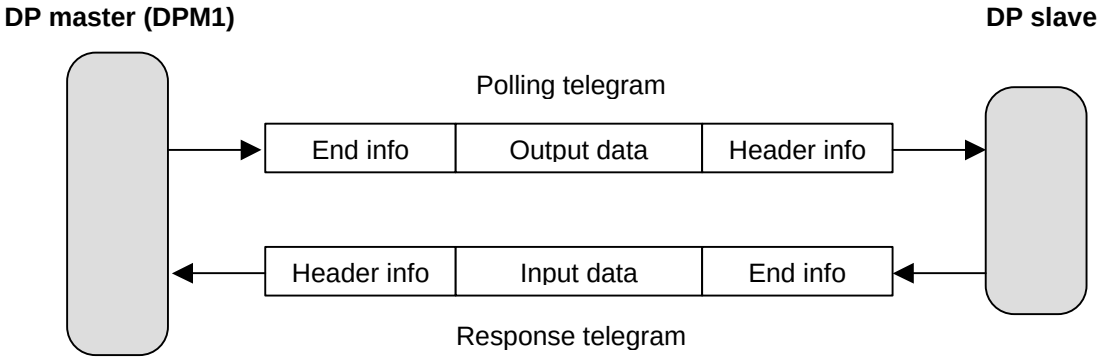
Data traffic between the DPM1 and the assigned DP slaves is automatically handled by the DPM1 in a repetitive sequence. When configuring the bus system, the user specifies the membership of a DP slave with the DPM1. Furthermore he defines the DP slaves to be included in cyclic user data traffic.

Data exchange between the DPM1 and the DP slaves is divided into parameterisation, configuration and data transfer phases. Before a DP slave is included into the data transfer phase, the DPM1 checks during the parameterisation and configuration phases whether or not the planned target configuration complies with the actual device configuration.

To pass this test, device type, format and length information as well as the number of inputs and outputs must tally. This procedure offers the user reliable protection from parameterisation errors. Besides user data transfer which is automatically handled by the DPM1, new parameterisation data can be sent to the DP slaves on request by the user.

4.1 Telegram structure

The following diagram shows the basic run of the telegram traffic.



4.2 Initialisation, user data traffic (data exchange)

Each slave is newly initialised prior to exchange of user data between master and slave. The master sends parameterisation and configuration data to the slave. User data cannot be exchanged unless parameterisation and configuration data correspond with those deposited in the slave. This occurs as described below:

4.2.1 Diagnosis request by the master

The master sends a „Slave Diagnosis Request" (Slave_Diag), the slave answers with a „Slave Diagnosis Response".

This way, the master checks whether the slave is present on the bus and ready to be parameterised and configured.

4.2.2 Parameterisation of the slave

The master sends a „Slave Parameter Request" (Set_Prm).

Via the parameterisation data, the slave gets bus parameters, monitoring periods and slave-specific parameters. During the configuration phase, the parameters are partly taken over by the GSD file either directly or indirectly. The slave compares this parameterisation data with its deposited data.

4.2.3 Configuration of the slave

The master sends a „Check Configuration Request" (Chk_Cfg).

The master informs the slave on the extent (number of data bytes) and the structure (data consistency) of the input and output areas to be exchanged. The slave compares this configuration with its own configuration.

4.2.4 Diagnosis request prior to data exchange

The master sends another Slave Diagnosis „Request_Slave_Diag", the slave answers with a „Slave Diagnosis Response".
Now, the master checks whether parameterisation and configuration correspond with the values deposited in the slave. The slave signals its readiness for user data transfer via the diagnosis data if the data requested by the master is legal and no errors are present.

4.2.5 Data Exchange

Now, the slave responds exclusively to the master by which it has been parameterised and configured. The master sends a „User data request" (Data_Exchange), the slave responds with a „User data response".
In this response, the slave informs the master whether there are current diagnosis events. The slave reports actual diagnosis and status information only after receiving the diagnosis telegram from the master.

5 Parameterisation and configuration

5.1 Overview of parameters

The parameters described below are sent from the master to the slave(s) (here: rotary encoder) during the initialisation phase. The parameters with the octet numbers 1 – 8 are defined by the configuration tool based on the data found in the GSD file; the use of parameters 9 – 17 depends on the configuration of the slave (class-1 or class-2 rotary encoder).

Besides parameters 1 – 8 which are always present, encoders configured with class-1 functionality only interpret the parameter „Code Sequence" (octet no. 9).

Parameter	Data type	Oct. no.	Device class	Meaning
Station status	octet string	1	1, 2	Specification of Profibus-specific data sync / freeze mode watchdog control master allocation
Watchdog factor1	octet string	2	1, 2	factor 1 for watchdog control
Watchdog factor2	octet string	3	1, 2	factor 2 for watchdog control
Min. Station Delay Responder	octet string	4	1, 2	time in bit time the DP slave must wait before returning its response telegrams to the DPM1
Ident number	octet string	5 - 6	1, 2	unique device identifier given by the PNO
Group-Ident	octet string	7	1, 2	Profibus-specific value
Operating parameter	octet string	8	1, 2	value depending on the protocol chip
Operating Parameter	octet string	9	1, 2	specification of user-specific data: sense of rotation maintenance diagnosis enabling class-2 functionality enabling scaling function
Measuring units per revolution	Unsigned 32	10 - 13	2	specification of the number of measuring units per revolution
Overall resolution in measuring units (total number of measuring units)	Unsigned 32	14 - 17	2	specification of overall resolution in measuring units overall resolution = number of measuring units per revolution * number of revolutions

5.2 Parameterisation

Within the configuration tool, the user-specific parameters can be entered via input forms depending on the class profile. These data is transferred from the master to the slave during start-up of the system.

At least the information specified by the standard (parameter octets 1 - 8: PNO ident number, the calculated periods for watchdog control, etc.) are deposited in this parameter telegram. Furthermore, the encoder-specific parameters described below are transmitted in this telegram.

The firmware of the rotary encoder checks the validity of the encoder-specific parameters. The master is notified of faulty parameterisation if an error occurs; changing to the Data Exchange mode is disabled in this case!

5.2.1 Operating Parameters

Octet 9 (Operating Parameters)			
Bit	**Designation**	**= 0**	**= 1**
0	Code sequence	ascending code values with clockwise (CW) rotation of the rotary shaft	ascending code values with counter-clockwise (CCW) rotation of the rotary shaft
1	Class-2 functionality	class-2 functionality disabled	class-2 functionality enabled
2	Maintenance diagnosis	is not supported	
3	Scaling function	encoder scaling disabled	encoder scaling enabled

5.2.1.1 Code sequence

The code sequence defines the direction in which the position code will be output in ascending sequence (clockwise – cw or counter-clockwise – ccw); view at the shaft. The code sequence is specified in the operating parameters via code sequence bit.

Standard setting: **Bit 0 = 0** – ascending code values with clockwise rotation of the encoder shaft.

The value is stored non-volatilely in the rotary encoder.

5.2.1.2 Class-2 functionality

This bit activates class-2 functionality. The DP master must set this bit in order that class-2 functionality can be used. The encoder operates with the (limited) class-1 functionality if this bit = 0.

Setting this bit results in the extension of manufacturer-specific diagnosis from 10 bytes to 63 bytes.

Standard setting: **Bit 1 = 0** – class-1 functionality is enabled.

The value is stored non-volatilely in the rotary encoder.

5.2.1.3 Maintenance diagnosis

This function is not used by the WV(WH)58M.

5.2.1.4 Scaling function

Resolution and overall number of measuring units of the rotary encoder can be changed by setting this bit. The respective scaling parameters are:

- measuring units per revolution (parameter octets 10 – 13),
- overall resolution in measuring units (parameter octet 14 – 17)

⇒ Class-2 functionality must be enabled to use the scaling function.

Standard setting: **Bit 3 = 0 –** class-1 functionality is enabled.

The value is saved non-volatilely in the rotary encoder.

5.2.2 Measuring units per revolution

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

This parameter sets the desired resolution (measuring units) per revolution (≦ physical resolution). Internally, the rotary encoder calculates the respective scaling factor.

$$\textit{Scaling factor} = \frac{\textit{Measuring units per revolution}}{\textit{Phys. resolution}}$$

Value range: 1 .. 1024 WV/WH58M (10+12bit), WV/WH58M (10bit ST):

Standard setting: **1024**

Value range: 1 .. 4096 WV/WH58M (10+12bit), WV/WH58M (12bit ST):

Standard setting: **4096**

The value is saved non-volatilely in the rotary encoder.

Example:

WV58M-12+12bit (resolution = 4096 measuring units per revolution) ➡ data content = 00 00 10 00h

Octet 10	Octet 11	Octet 12	Octet 13
00	00	10	00

5.2.3 Total measuring range in measuring units

Total measuring range in measuring units				
Octet	**14**	**15**	**16**	**17**
Bit	31 - 24	23 - 16	15 - 8	7 – 0
Data	2^{31} - 2^{24}	2^{23} - 2^{16}	2^{15} - 2^{8}	2^{7} - 2^{0}

This parameter serves for setting the overall number of measuring units.

Choose the values of this parameter so that they are divisible by 4096 without remainder! The encoder cannot change over to the DataExchange mode if a value does not meet this condition.

WV/WH58M (10+12bit) **Value range: 4096 .. 4194304**

Standard setting: **4194304**

WV/WH58M (12+12bit) **Value range: 4096 .. 16777216**

Standard setting: **16777216**

In the singleturn versions of the WV/WH58M, the total of measuring units is limited to the set number of measuring units per revolution (max. 1024 measuring units for the 10bit version, max. 4096 measuring units for the 12bit version).

Example:

WV58M-12+12bit (total measuring range = 4096 measuring units per revolution * 4096 revolutions):

➡ data content = **16777216** or **01 00 00 00**h, respectively

Octet 14	Octet 15	Octet 16	Octet 17
01	00	00	00

5.3 Configuration

The data type, length, data consistency and data direction of the process data to be transmitted (here: position value) are specified via the configuration telegram.

The setup of the identification byte is described in the standard EN 50170 vol. 2. With the WV(WH)58M this value is **F1**h.

This value indicates that:

- the process data is transmitted consistently over the whole length,
- the data type is of the **word** type,
- input and output data are processed and
- the data length is **2** (words).

From the view of the master, input data is the encoder's position values, output data is a max. 31bit-sized preset value.

The projecting tool takes the identifier byte from the GSD file. The encoder checks this byte during system start-up. If the configuration transferred does not comply with the configuration expected by the encoder, the encoder reports the error to the master and entering the Data Exchange mode will be disabled.

5.4 Data exchange

After correct acknowledgment of parameterisation and configuration telegrams, the encoder switches over to the Data Exchange mode. Now the yellow status LED lights permanently.

The master requests continuously the position data from the rotary encoder. If a diagnosis event has occurred, the encoder reports the event to the master as a high-priority response. Subsequently, the master requests the actual diagnosis information.

Furthermore, there is the possibility of setting the encoder to a defined value (preset value) during the data exchange phase (see *chapter 5.5*).

Format of the position data				
Octet	**1**	**2**	**3**	**4**
Bit	31 - 24	23 - 16	15 - 8	7 - 0
Data	2^{31} - 2^{24}	2^{23} - 2^{16}	2^{15} - 2^{8}	2^{7} - 2^{0}

5.5 Preset function

The preset function supports the adaptation of the rotary encoder's zero point to the mechanical zero point of the system. The preset function sets the current position value of the rotary encoder to the preset value.

In the data exchange function the preset value is stored as the initial value. The preset function is used after scaling, i.e., the preset value is given in the programmed measuring units. The MSB of the preset value checks the preset function as follows:

Normal operating state: **MSB=0 (bit 31)** the preset value is **not** taken over.

Preset mode: **MSB=1 (bit 31)** with MSB=1, the rotary encoder takes over the transmitted value (bit 0 – 30) as the preset value in binary code.

Now, the encoder provides the preset value as the position value in its response in the data exchange mode. Subsequently, the master can reset to 0 the bit 31 set in its initial data.

The preset function should only be used when the encoder shaft is at a standstill!

Other than with the encoder profile, using the preset function is also possible with an encoder configured with class 1.

Since taking over the new preset value and its storing in the encoder-internal EEPROM takes some time, the position value is undefined during this period. In the diagnosis octet „station status2", the encoder sets the bit „static diagnosis" to indicate that the position value is undefined. This bit is reset after taking over the preset value.

The preset value is stored in the non-volatile EEPROM of the rotary encoder so that it need not be reloaded after each restart of the system.

Format of the preset value					
Octet	**1**		**2**	**3**	**4**
Bit	31	30 - 24	23 - 16	15 - 8	7 - 0
Data	0 / 1	2^{30} - 2^{24}	2^{23} - 2^{16}	2^{15} - 2^{8}	2^{7} - 2^{0}
	Preset mode	preset value (max. 31 bit)			

Value range of the preset value:

WV/WH58M-10+12bit or 12+12bit, respectively: **-8388608 ... +8388607**

Sign bit of the 10+12bit or 12+12bit version, respectively, is **bit 2^{30}**

WV/WH58M-10bit singleturn: **-32768 ... +31744**

WV/WH58M-12bit singleturn: **-32768 ... +28672**

Sign bit of the 10bit singleturn or 12bit singleturn version is **bit 2^{15}**

6 Diagnosis messages

Diagnosis messages contain information on the actual state of the rotary encoder. The diagnosis messages consist of Profibus-relevant and device-specific information.

The Profibus master requests diagnosis data before parameterisation as well as after configuration of the slave. This ensures that the slave is present on the bus and that the data deposited during configuration of the system correspond with the data deposited in the slave. Furthermore, the slave can report a diagnosis event in the data exchange mode. Following this, the master requests the diagnosis data.

The Profibus-specific diagnosis data (octet 1 – 6) has been defined in the DP standard DIN 19245. Each Profibus station must always provide this data. The user-specific information is defined in standard EN 50170 under rotary encoder profile 1.1.

Diagnosis function	Data type	Diagnosis octet no.	Class
Station status 1	octet string	1	DIN 19245
Station status 2	octet string	2	DIN 19245
Station status 3	octet string	3	DIN 19245
Diag Master Address	octet string	4	DIN 19245
Ident number	octet string	5, 6	DIN 19245
Extended Diagnostic Header	octet string	7	1 and 2
Alarm messages	octet string	8	1 and 2
Operational state	octet string	9	1 and 2
Encoder type	octet string	10	1 and 2
Physical resolution singleturn	32bit	11 – 14	1 and 2
Number of revolutions	16bit	15, 16	1 and 2
Additional alarm messages	octet string	17	2
supported alarm messages	octet string	18, 19	2
Warnings	octet string	20, 21	2
supported warning messages	octet string	22, 23	2
Version number of the encoder profile	octet string	24, 25	2
Version number of the firmware status	octet string	26, 27	2
Operating time	octet string	28 – 31	2
Offset value	32bit	32 – 35	2
Preset value	32 bit, with arithm. sign	36 – 39	2
Parameterised number of measuring units per revolution	32bit	40 – 43	2
Parameterised total measuring range	32bit	44 – 47	2
Serial number	ASCII string	48 – 57	2
Reserved area	octet string	58, 59	2
Manufacturer-specific diagnosis area	octet string	60 – 63	2

6.1 Diagnosis functions, classes 1 and 2

6.1.1 Station status 1

The following states are displayed:

- Parameterisation,
- configuration and
- diagnosis data

Station status 1							
Bit 7 (MSB)	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0 (LSB)

Bit 7: Diag.Master_Lock

The DP slave has already been parameterised by another master, i.e., the own master cannot access this slave at present.

Bit 6: Diag.Prm_Fault

This bit is set by the slave if the last parameterisation telegram was faulty (e.g. invalid parameters).

Bit 5: Diag.Invalid_Slave_Response

This bit is set as soon as an implausible response is received by an addressed slave.

Bit 4: Diag.Not_Supported

This bit is set as soon as a function is requested that is not supported by this slave.

Bit 3: Diag.Ext_Diag

This bit is set by the slave. If this bit is set, a diagnosis entry **must** be present in the slave-specific diagnosis area (Ext_Diag_Data). If this bit is not set, a status message **can** be present in the slave-specific diagnosis area (Ext_Diag_Data).

Bit 2: Diag.Cfg_Fault

This bit is set as soon as the configuration data last sent by the DP master deviate from those preset by the slave, i.e., there is a configuration error.

Bit 1: Diag.Station_Not_Ready

This bit is set when the slave is not yet ready for data exchange.

Bit 0: Diag.station_Non_Existent

The DP master sets this bit if the slave cannot be accessed via the bus. If this bit is set, the diagnosis bits contain the status of the latest diagnosis message or the initial value. The slave fixes this bit to zero.

6.1.2 Station status 2

The following statuses are displayed:

- Watchdog control,
- sync / freeze mode and
- additional diagnosis data.

Station status 2							
Bit 7 (MSB)	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0 (LSB)

Bit 7: Diag.Deactivated

This bit is set as soon as the slave has been labelled inactive in the local parameter set and exempted from cyclic processing.

Bit 6: reserved

Bit 5: Diag.Sync-Mode

This bit is set by the slave as soon as it has received the Sync control command.

Bit 4: Diag.Freeze-Mode

This bit is set by the slave as soon as it has received the Freeze control command.

Bit 3: Diag.WD_on (Watchdog on)

This bit is set by the slave. If this bit is set to 1, watchdog control is set with the slave.

Bit 2:

This bit is fixed to 1 by the slave.

Bit 1: Diag.Stat_Diag (Static Diagnosis)

If the slave sets this bit, the DP master must retrieve diagnosis information until this bit has been deleted. The slave sets this bit when a serious error has occurred.

Bit 0: Diag.Prm_Req

If the slave sets this bit, it must be re-parameterised and re-configured. The bit remains set until after parameterisation.

Note: If bit 1 and bit 0 are set, bit 0 has higher priority.

6.1.3 Station status 3

Is not supported by the encoder application.

6.1.4 Diag-Master Address

The address of the DP master that has parameterised this slave is entered into this byte. If the slave has not been parameterised by any master, the slave enters address 255 into this byte.

6.1.5 Ident number

Manufacturer identifier of the DP slave. This is a unique identifier to be used for exact identification. The ident number of the WH(WV)58M is **094D**h

Ident number	
Octet 5 (ident number High)	**09h**
Octet 6 (ident number Low)	**4Dh**

6.1.6 Extended Diagnostic Header

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

Octet	7		
Bit	7	6	5 – 0
Data	0	0	xxh
	bit 7 and 6 = 0 indicates device-related diagnosis		length including header byte **10 (0Ah) class 1** **57 (39h) class 2**
	Extended Diagnostic Header		

6.1.7 Alarm messages

Malfunctions in the rotary encoder that may lead to an incorrect position value are indicated by setting bits in the byte **alarm messages** (octet 8). Additional alarm messages of class 2 are mapped on octet 17.

In case of an alarm message, bits **Ext_Diag** (station status 1) and **Stat_Diag** (station status 2) are set to 1 until after correcting the cause of the alarm.

The diagnosis function “Supported alarm messages” (octets 18 and 19, only class 2) provides information on which alarm messages are supported by the encoder.

Octet	8
Bit	7 - 0
	Alarm messages

Bit	Designation	= 0	= 1
0	position error	no	yes
1 – 6	not supported	-	-
7	communication with basic card via DIP switch interrupted	switch not actuated	communication interrupted, position value invalid

The bit „position error” is set if:

- the voltage of the battery that supplies voltage to the rotation counter has sunk to such an extent that the counter cannot safely maintain its value.
- communication with the basic encoder card via DIP switch no. 8 is interrupted: Additionally, bit 7 is set.

6.1.8 Operational state

Octet 9 of the diagnosis functions provides information on the internal parameters of the rotary encoder.

Octet	9
Bit	7 – 0
	Operational state

Bit	Designation	= 0	= 1
0	status of code sequence	ascending position values with clockwise (CW) shaft rotation	ascending position values with counter-clockwise (CCW) shaft rotation
1	class 2 functionality	no	yes
2	maintenance diagnosis	not supported, always 0	
3	scaling function	no	yes
4 – 7	not supported, always 0		

6.1.9 Rotary encoder type

The rotary encoder type is represented in octet 10 by a numerical value in hexadecimal code. The singleturn versions of the WV(WH)58M series are represented by code **00**h, the multiturn versions by code **02**h.

Octet	10
Code	0 – FFh
	Rotary encoder type

Code	Definition
00	Absolute encoder, singleturn
01	Absolute encoder, multiturn
02	Absolute encoder, singleturn with battery-buffered rotary counter (quasi-multiturn)

6.1.10 Physical singleturn resolution

The diagnosis octets 11 to 14 contain the maximum number of measuring units per revolution.

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

Default: **1024** measuring units/revolution (WV/WH58M-10+12bit, WV/WH58M-10ST)

4096 measuring units/revolution (WV/WH58M-12+12bit, WV/WH58M-12ST)

6.1.11 Number of revolutions

Octets 15 and 16 contain the maximum number of revolutions. For a multiturn rotary encoder, the measuring range results from the number of revolutions and the singleturn resolution based on the equation:

Measuring range = number of revolutions * singleturn resolution

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

With the rotary encoders of the WV/WH58M series (multiturn version), the maximum discernible number of revolutions **= 4096**. With the singleturn version the value **1** is always displayed at this position.

6.1.12 Additional alarm messages

Diagnosis octet 17 is intended for additional alarm messages that are not yet defined in the rotary encoder's profile.

The battery-buffered rotary encoders WV(WH)58M in the 10 and 12 bit versions mark a discharged battery via a bit within this octet.

Octet	17
Bit	7 – 0
	Additional alarm messages

Bit	Designation	= 0	= 1
0 – 5, 7	not supported, always value 0	-	-
6	battery status	battery not yet discharged	battery discharged

6.1.13 Supported alarm messages

The diagnosis octets 18 and 19 contain information on the alarm messages supported by the rotary encoders.

Alarm messages are displayed via octet 8 (classes 1 and 2) and octet 17 (only class 2 rotary encoders).

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

Bit	Designation	= 0 (not supported = 1 (supported)
0	Position error	1
1	Voltage supply error	0
2	Power consumption too high	0
3	Maintenance diagnosis	0
4	Memory error	0
5 – 6	Not supported	0
7	Communication with basic card	1
8 – 13	Not supported	0
14	Battery error	1
15	Not supported	0

6.1.14 Warnings

Warnings indicate that tolerances have been exceeded for certain internal parameters. In contrast to alarm messages they do not indicate wrong position values.

The diagnosis octets 20 and 21 contain the warnings. In case of a warning, the EXT_Diag bit is set to 1 until the warning has been deleted.

The diagnosis function „Supported warnings" (octets 22 to 23) provides information on which warnings are supported by the rotary encoder.

Octet	20	21
Bit	15 – 8	7 – 0
	Warnings	

Bit	Designation	= 0	= 1
0	Frequency exceeded	no	yes
1	Temperature exceeded	no	yes
2	LED reserve	not reached	exceeded

3	CPU watchdog	OK	reset executed
4	Operating-time warning	not reached	reached
5	Battery load	battery voltage OK	warning threshold reached
6	Reference point	reached	not reached
7 – 15	not defined	-	-

6.1.15 Supported warnings

The diagnosis octets 22 and 23 contain information on the warning messages supported by the rotary encoders.

Octet	**22**	**23**
Bit	15 – 8	7 – 0
	Supported warnings	

Bit	**Designation**	**= 0 (not supported = 1 (supported)**
0	Frequency	0
1	Temperature	0
2	LED reserve	0
3	CPU watchdog	0
4	Operating time	0
5	Battery load	1
7	Reference point	0
8 – 15	not supported	0

6.1.16 Profile version

The diagnosis octets 24 and 25 inform on the version of the rotary encoder's profile applied. The octets are divided into a revision number and an index.

Example:

Profile version: **1.1**

Octet no.:	24	25
	01h	**01**h

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

6.1.17 Firmware Version

Diagnosis octets 26 and 27 inform on the firmware version of the rotary encoder's bus card. The octets are divided into a revision number and an index.

Example:

Firmware version: **1.02**

Octet no.: 26 27

01h **02**h

Octet	26	27
Bit	15 – 8	7 – 0
Data	$2^7 – 2^0$	$2^7 – 2^0$
	Revision number	**Index**
	Profile version	

6.1.18 Operating time

This function is not implemented in the rotary encoders of the WV(WH)58M series. Requesting this diagnosis information results in the value **FFFFFFFF**h.

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

6.1.19 Offset value

This function is not implemented in the rotary encoders of the WV(WH)58M series. Requesting this diagnosis information results in the value **00000000**h.

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

6.1.20 Preset value

Instead of the „Manufacturer-specific offset value" intended in the encoder profile at this position, the „preset value" can be read out at this position. This value is available in octets 36 – 39 as a signed 32-bit binary value.

Octet	36	37	38	39
Bit	31 – 24	23 – 16	15 – 8	7 – 0
Data	2^{31} - 2^{24}	2^{23} - 2^{16}	2^{15} - 2^{8}	2^{7} - 2^{0}
	Preset value			

6.1.21 Measuring units per revolution / Overall number of measuring units

The scaling parameters are set via the parameters (octets 9 – 17). The parameters are stored and can be read out from the diagnosis octets 40 – 47. The parameters „Measuring units per revolution" and „Overall number of measuring units" indicate the set resolution of the encoder.

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

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

Octet	44	45	46	47
Bit	31 – 24	23 – 16	15 – 8	7 – 0
Data	2^{31} - 2^{24}	2^{23} - 2^{16}	2^{15} - 2^{8}	2^{7} - 2^{0}
	Overall number of measuring units			

6.1.22 Rotary encoder type

The serial number intended at this position in the encoder profile is replaced by the declaration of the rotary encoder's version in the ASCII format.

Octet	48 – 57
Bit	79 – 0
Data	ASCII
	Rotary encoder version

The versions are encoded as described below:

WV(WH)58M – 10+12bit version: „**W10+12MT M**"

WV(WH)58M – 12+12bit version: „**W12+12MT M**"

WV(WH)58M – 10bit singleturn version: „**W10bitST M**"

WV(WH)58M – 12bit singleturn version: „**W12bitST M**"

6.1.23 Reserved octets

Diagnosis octets 58 and 59 are reserved for future purposes. The content of these bytes is always 0.

Octet	58	59
Bit	15 – 8	7 – 0
	reserved	

6.1.24 Manufacturer-specific diagnosis messages

Diagnosis octets 60 – 63 provide access to special, encoder-specific status information. Partly, they can be found in previous octets; here they reappear in a compact form, however.

Octet	60
Bit	7 – 0
	SIKO_Diag_1

Bit	Designation	= 0	= 1
0	Sense of rotation	ascending position values with clockwise (CW) encoder shaft rotation	ascending position values with counter-clockwise (CCW) encoder shaft rotation
1 – 4	Not supported, always value 0	-	-
5	Battery warning	battery charge OK	battery charge has sunk below warning value
6	Battery alarm	battery OK or battery charge has sunk below the warning value	battery is discharged so far that voltage supply of the rotation counter cannot be longer guaranteed in the OFF state
7	Not supported, always value 0	-	-

Octet	61
Bit	7 – 0
	SIKO_Diag_2

Bit	Designation	= 0	= 1
0	Check of communication with basic card	basic card present, communication established	no basic card found
1	Monitoring of data transfer with basic card	no faulty data transfer	disturbed communication with basic card; time-outs have occurred
2	Monitoring of data transfer with basic card	no faulty data transfer	disturbed communication with basic card; checksum error

In diagnosis octets 62 and 63, the firmware of the basic card can be found. The octets are divided into a revision number and an index.

Example:

Firmware version: **2.07**

Octet no.:	62	63
	02h	**07**h

Octet	62	63
Bit	15 – 8	7 – 0
Data	$2^7 – 2^0$	$2^7 – 2^0$
	Revision number	**Index**
	Firmware version of the basic card	

7 Configuration example

The following configuration example aims at illustrating the integration of a WV58M with Profibus interface into a STEP7 Profibus environment.

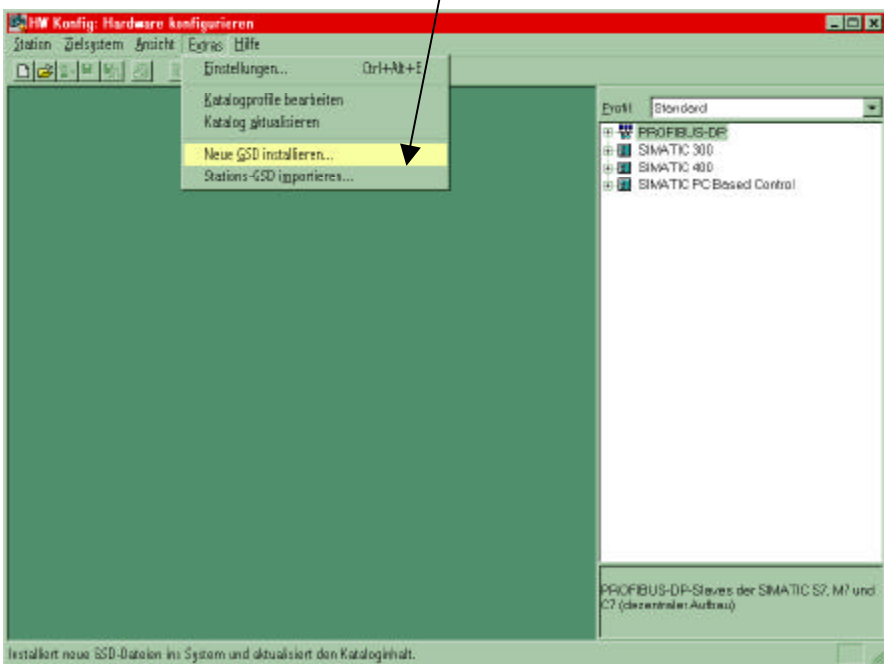
For integration it is imperative that the device database file **SIKO094D.GSD** is available, which can be downloaded from the homepage of the SIKO GmbH (www.siko.de). Together with the appropriate bitmap file the configuration tool is able to represent an icon of the rotary encoder.

The example is based on the *SIEMENS Simatic Manager V 5.0*®

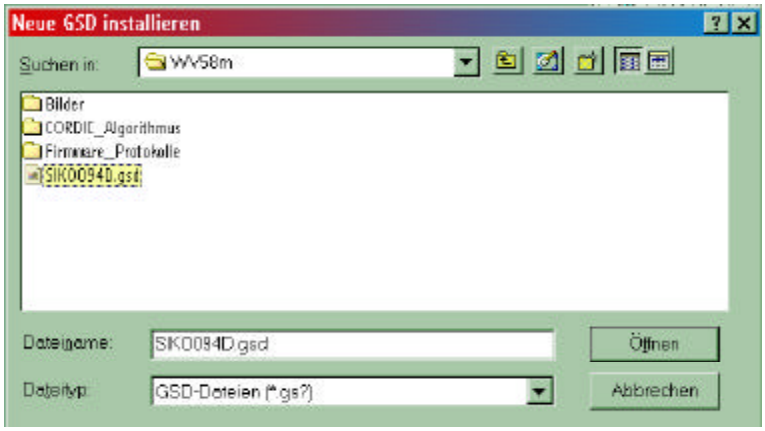
7.1 Integrate GSD file

To enable integration of a new GSD file, no hardware project must be opened in the *HW Configurator* program module.

- Start the *HW Configurator* of the STEP7 software.
- From the „Extras" menu, select the command „**Install new GSD**".



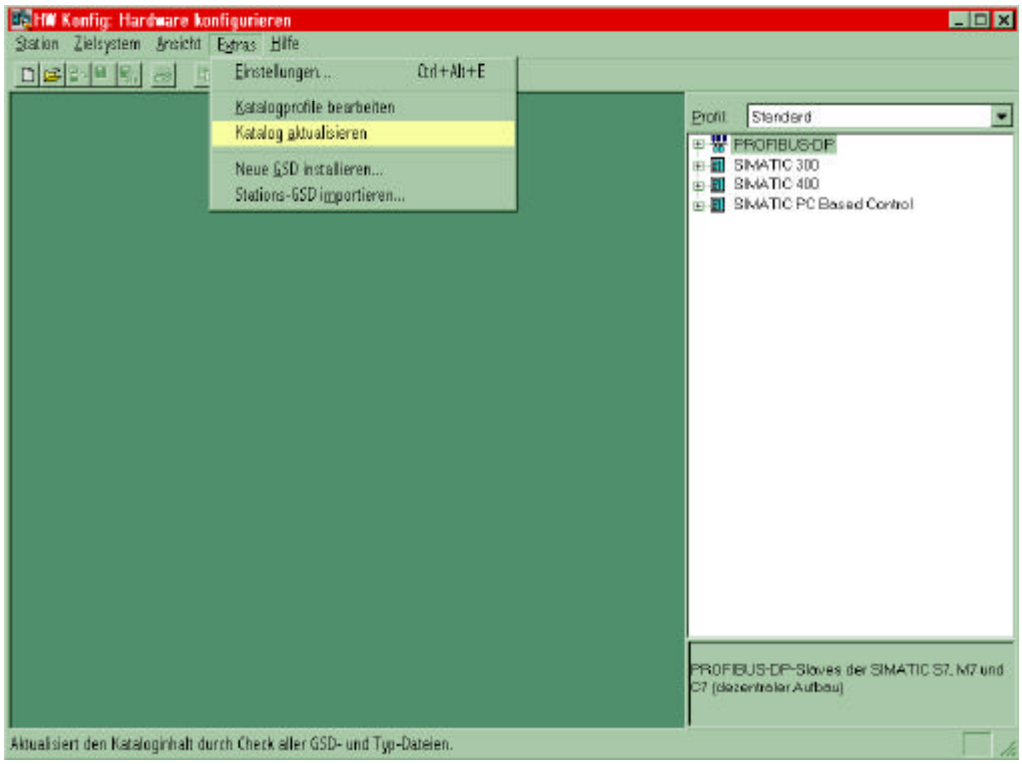
- Select and open file **SIKO094D.GSD**.



- Confirm the question whether the bitmap file should be installed.

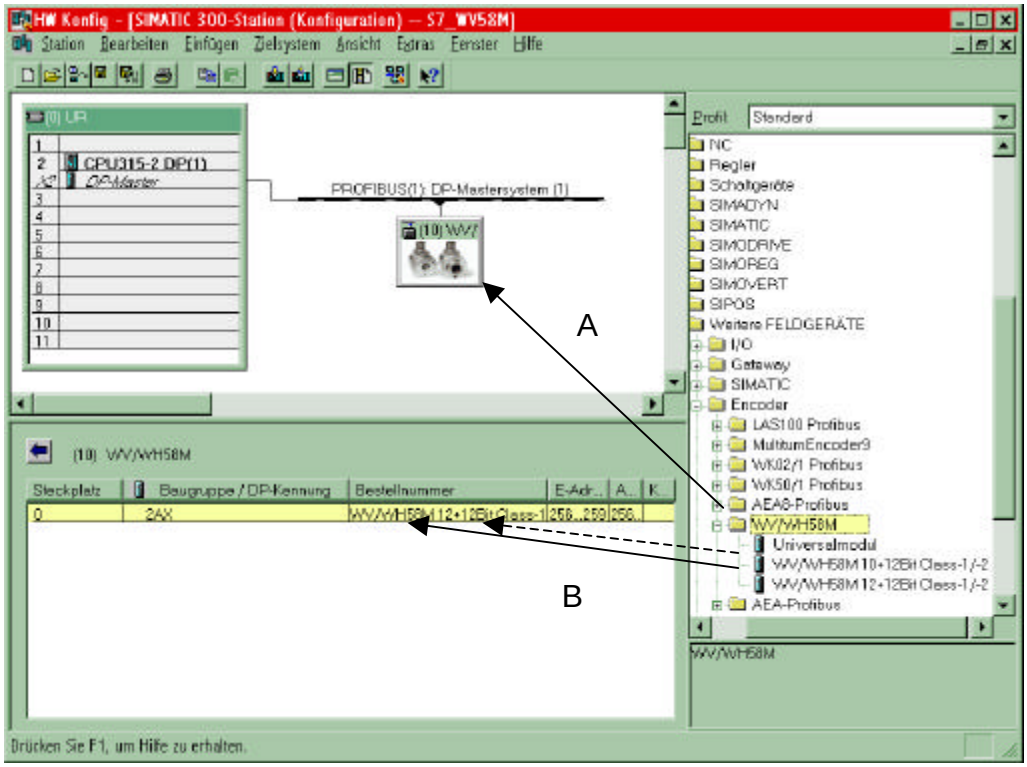
7.2 Update the catalogue

- From the „Extra" menu, select the command „**Update catalogue**".



7.3 Integrating the rotary encoder into the Profibus project

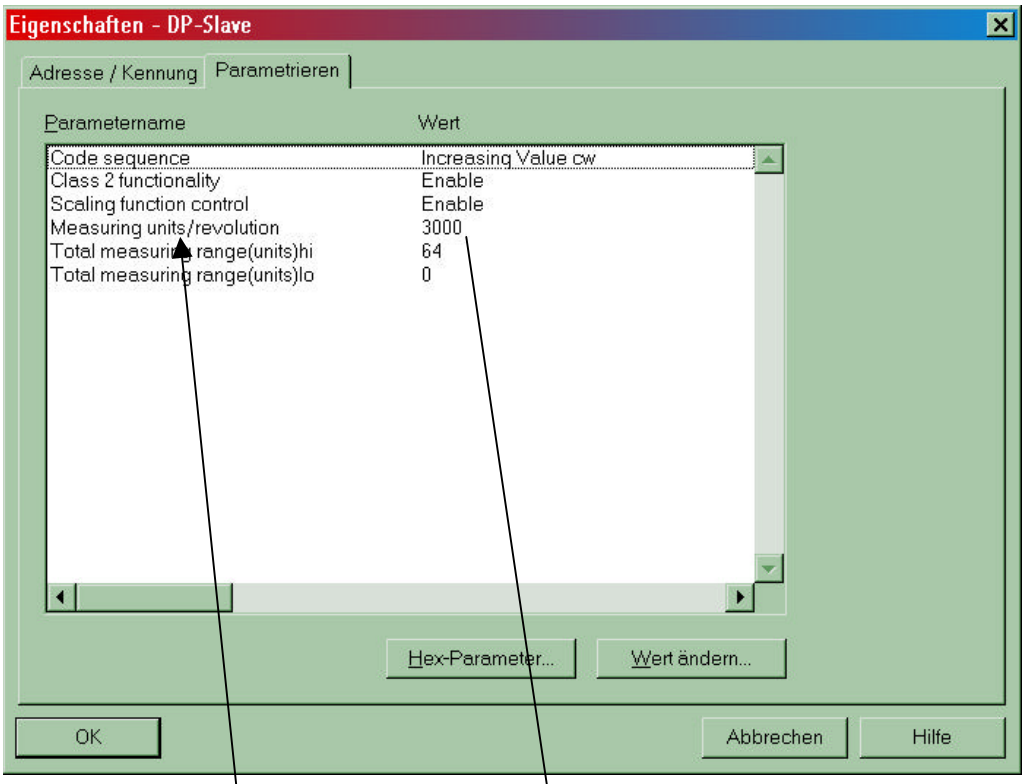
(Precondition: DP master has already been configured)



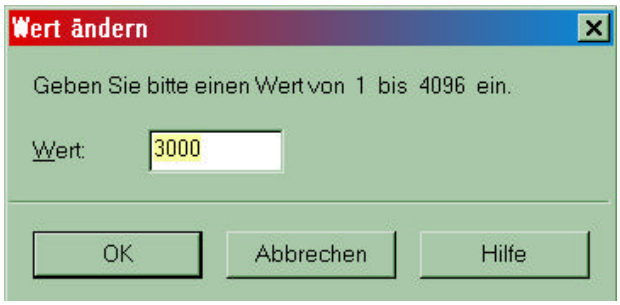
- Select WV/WH58M from the hardware catalogue window and in the upper station window attach it to the (symbolised) Profibus line (**A**) (by drag and drop).
- Click on the desired module and drag it into the lower window of station features (**B**).

7.4 Parameterising the encoder

- After a double-click on the entry displayed in the window of station features, the subsequent window containing the DP slave features opens:



- Another double click on one of the parameter names shown opens an additional window where the value can be changed.



Parameter name	Explanation in the manual	Chapter
Code sequence	Code sequence	5.2.1.1
Class 2 functionality	Class 2 functionality	5.2.1.2
Scaling function control	Scaling function	5.2.1.4
Measuring units / revolution	Measuring units per revolution	5.2.2
Total measuring range (units) hi	Total measuring range (units)	5.2.3
Total measuring range (units) lo	Total measuring range (units)	5.2.3

Actually, the parameter „Total measuring range" is a 32bit integer value. Many configuration programs (among them STEP7® by SIEMENS) do not support this word length for parameter input. Therefore, the upper and lower 16bits of this parameters (block „hi", block „lo") must be entered separately and, moreover, in the hexadecimal format.

For parameters that are smaller than 65535 (16 bit), simply enter the block „hi" = 0, and the parameter itself is entered decimally directly into the block „lo".

Parameters that are larger than 65535 (16 bit), must first be separated and converted according to the following schema; here a calculator with hexadecimals is helpful, such as the calculator contained in the „Windows Accessories"

- Conversion of the desired parameter value from the decimal format to the hexadecimal format.
- Division of the hexadecimal value into two blocks, „hi" and „lo". The block length is each two words.
- Conversion of the hexadecimal format of the two blocks, „hi" and „lo", into the decimal format.
- Input into the input mask in the decimal format.

Example:

Overall number of measuring units	3000 measuring units/revolution * 1024 revolutions	= 3072000
Conversion into hexadecimal format		= 2EE000h
Division into „hi"		= 002Eh
Conversion into decimal format		= 46
Division into „lo"		= E000h
Conversion into decimal format		= 57344
Total measuring range (units) hi		**= 46**
Total measuring range (units) lo		**= 57344**

When entering the overall resolution, take care that this value is divisible by 4096 without a remainder.

Generally speaking, the encoder cannot be integrated into cyclic data exchange if there are wrong parameter inputs. In the diagnosis message of the slave, this is indicated by the set bit „Diag.Prm_Fault" in the octet „Station status_1".

7.5 Adaptation of the S7 program modules

Diagnosis messages of the rotary encoder where the bit “Static diagnosis” is set (bit Diag.Stat_Diag in the diagnosis octet station status_2) will cause the master SPC to enter the bus stop state if no special precautions are taken.

To avoid this state, the organisation modules OB82 (diagnosis) and OB86 (station error) must be integrated into the SPC program.

8 Setting and diagnosing elements

8.1 Setting the slave address

After removing the screw cap on the encoder hood, an 8-pin DIP switch as well as two diagnosis LEDs (yellow and green) are visible.

Switches 2 to 8 serve for setting the slave address. The adjustable range is between 0 und 125. Setting address 126 or 127, respectively, is converted encoder-internally into address 125.

The encoding of the slave address via switches 2 to 8 is in the binary format. This is illustrated in the following table:

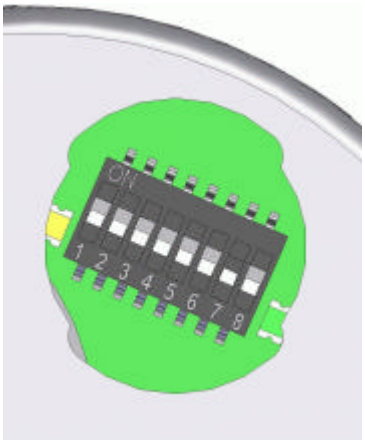


Fig. 1: DIP switches and diagnosis LEDs

Switch 2	Switch 3	Switch 4	Switch 5	Switch 6	Switch 7	Switch 8	set slave address
ON	ON	ON	ON	ON	ON	ON	0
ON	ON	ON	ON	ON	ON	OFF	1
ON	ON	ON	ON	ON	OFF	ON	2
ON	ON	ON	ON	ON	OFF	OFF	3
:	:	:	:	:	:	:	:
OFF	OFF	OFF	OFF	OFF	ON	ON	124
OFF	OFF	OFF	OFF	OFF	ON	OFF	125
OFF	OFF	OFF	OFF	OFF	OFF	ON	125 (!)
OFF	OFF	OFF	OFF	OFF	OFF	OFF	125 (!)

The Dip switch settings are read only during start-up of the encoder (Power-On). Changing the switch position during operation of the encoder has no effect. (Exception: DIP switch 1)

The ex works standard setting is slave address 10 (DIP switches 5 and 7 = OFF).

8.2 Diagnosis LEDs

Beside the DIP switch there is each a green and yellow LED. They serve for signalling different operational states:

	LED	Meaning
Power (green)	OFF	voltage supply missing
	ON	voltage supply is OK
Status (yellow)	blinking (pulse duty factor 1:4)	Encoder is not in the data exchange mode yet
	ON	Encoder is in the data exchange mode