

MAAX-MAUX SERIES

PROFIBUS USER MANUAL



**Absolute Rotary Encoder
with Profibus-DP-Interface**

POSI+

User Manual

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IMPORTANT INFORMATION

Specifications are subject to change without notice
Technical specifications, which are described in this manual, are subject to change due to continuous effort to improve our products.

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1. General

This manual describes installation and configuration of an Absolute Rotary Encoder with Profibus DP interface. The device meets the requirements of a

Profibus Slave according to the PROFIBUS standard. It is certified by the “Profibus Nutzerorganisation” in Germany.

1.1 Absolute Rotary Encoder

The basic principle of the absolute measurement is optical scanning of a transparent disk with a code print. The code disk is connected to the shaft that is to be measured. By evaluating the code and two additional incremental signals the absolute position of the shaft can be determined with a resolution of up to 8192 steps (13 bits as a standard resolution) and 65536 steps per revolution (16 bits).

As an option, the absolute shaft position can be calculated internally up to 16 bits (65536 revolutions). The position value is calculated in an integrated microprocessor and transmitted over the Profibus.

1.2 Profibus technology

PROFIBUS is an international, open, non-proprietary fieldbus standard which is defined in the international standards IEC 61158. There are three different versions: Profibus DP, Profibus-FMS and Profibus-PA. Sensata – BEI absolute encoders are designed for the DP version V0. They support all usual baud rates up to 12 MBaud.

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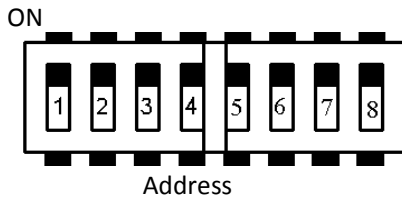
Besides manufacturer-specific functions, the devices support classes 1 and 2 according to the Profile for Absolute Encoders (this device profile can be ordered under part number 3.062 from the “Profibus Nutzerorganisation”). Further information about Profibus (functionality, manufacturer, products), standards and device profiles are available from the PNO:

2. Installation

The Encoder is connected through a terminal box, with dual conduit fittings for the cable to enter or exit the device.

2.1 Settings in the Termination Block

2.1.1 Station address



The station (node) address is set either by using the 8 DIP switches or by the Master (“Set_Slave_Add”). The DIP n°8 selects the mode.

With **DIP n°8 = OFF** : address is set by DIP switches :

Possible addresses are between 0 and 125. Each address can only be used once in the network. The station address is read in when switching on the power supply. An address change by the Master (“Set_Slave_Add”) is only valid if DIP #8 =ON
The address is coded with binary format: OFF=0
ON=1, DIP8=OFF

| Address | Dip 1 | Dip 2 | Dip 3 | Dip 4 | Dip 5 | Dip 6 | Dip 7 | Dip 8 |
|---------|-------|-------|-------|-------|-------|-------|-------|-------|
| 0 | OFF | OFF | OFF | OFF | OFF | OFF | OFF | OFF |
| 1 | ON | OFF | OFF | OFF | OFF | OFF | OFF | OFF |
| 2 | OFF | ON | OFF | OFF | OFF | OFF | OFF | OFF |
| 3 | ON | ON | OFF | OFF | OFF | OFF | OFF | OFF |
| ... | | | | | | | | |
| 124 | OFF | OFF | ON | ON | ON | ON | ON | OFF |
| 125 | ON | OFF | ON | ON | ON | ON | ON | OFF |

DIP n°8 = ON: address is set by the Master (“Set_Slave_Add”):

If the DIP n°8=ON, the address is set by the master and stored into an EEPROM.

DIP n° 1 to DIP n° 7 should be OFF.

If the address is locked by the master (No Add Change=TRUE), it is not allowed to change the address but it is possible to reset the device to the original state, address=126 and No Add Change=FALSE.

To reset the encoder to the original state:

- DIP n° 1=OFF and DIP n° 2 to DIP n° 8=ON
- Switch on the power supply
- Switch off the power supply
- DIP n° 1 to DIP n° 7 =OFF and DIP n° 8=ON
- Switch on the power supply, the address is 126 and can be changed by the master.

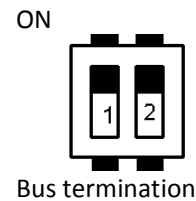
| Address | Dip 1 | Dip 2 | Dip 3 | Dip 4 | Dip 5 | Dip 6 | Dip 7 | Dip 8 |
|-------------------|-------|-------|-------|-------|-------|-------|-------|-------|
| Set by the master | OFF | OFF | OFF | OFF | OFF | OFF | OFF | ON |
| Default 126 | OFF | ON | ON | ON | ON | ON | ON | ON |

2.1.2 Bus termination

If the encoder is connected at the end or beginning of the bus line the termination resistor must be switched ON with DIP switches n°1 and n°2.

Note

If the encoder must be changed during operation, a separate active bus termination should be used.



2.2 Connecting bus lines and power supply

+ : +Power supply

- : 0V

A : Bus line A

B : Bus line B

2.3 Connecting the shield

To achieve the highest possible noise immunity shielded cables should be used for data transmission. The shield should be connected to ground on both

ends of the cable. In certain cases, a compensation current might flow over the shield. Therefore a potential compensation cable is recommended.

2.4 Instructions for mechanical installation and electrical connection of the encoder

The following points should be observed:

- Do not drop the encoder or subject it to excessive vibration. The encoder is a precision device.
- Do not open the encoder housing (this does not mean that you cannot remove the terminal box cap). If the device is opened and closed again, it can be damaged and dirt may enter the unit.
- The encoder shaft must be connected to the shaft to be measured through a suitable coupling (full shaft version). This coupling is used to dampen vibrations and imbalance on the encoder shaft and to avoid inadmissible high forces. Suitable couplings are available from SENSATA-BEI.
- Although SENSATA-BEI absolute encoders are rugged, when used in tough ambient conditions, they should be protected against damage using suitable protective measures. The encoder should not be used as handles or steps.
- Only qualified personnel may commission and operate these devices. These are personnel who are authorized to commission, ground and tag devices, systems and circuits according to the current state of safety technology.
- It is not permissible to make any electrical changes to the encoder.
- Route the connecting cable to the encoder at a considerable distance or completely separated from power cables with their associated noise. Completely shielded cables must be used for reliable data transfer and good grounding must be provided.
- Cabling, establishing and interrupting electrical connections may only be carried-out when the equipment is in a no-voltage condition. Short-circuits, voltage spikes etc. can result in erroneous functions and uncontrolled statuses which can even include severe personnel injury and material damage.
- Before powering-up the system, check all of the electrical connections. Connections, which are not correct, can cause the system to function incorrectly. Fault connections can result in severe personnel injury and material damage.

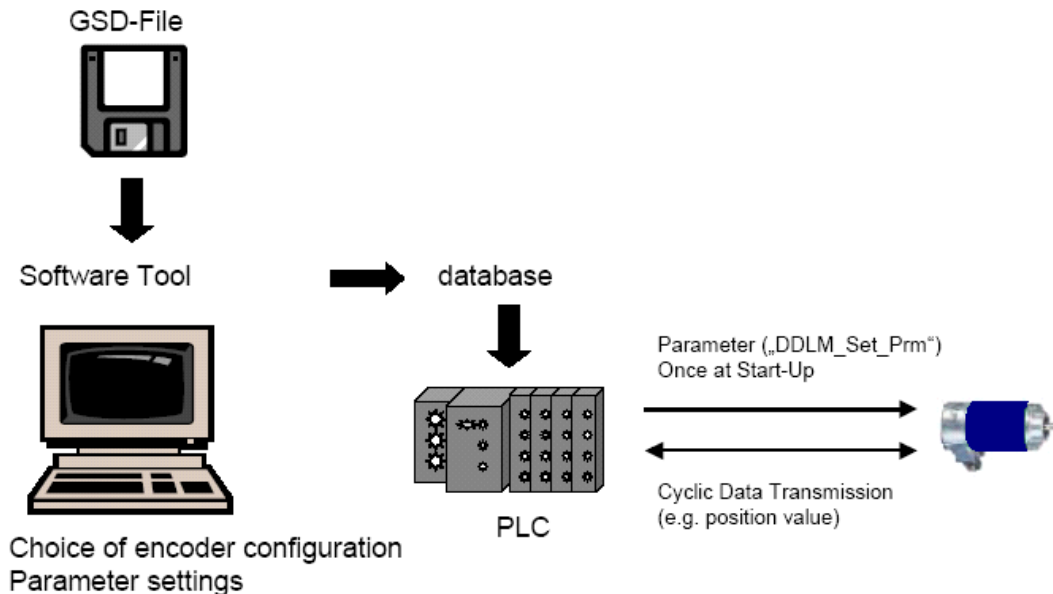
3. Device Configuration

The Absolute Encoder with Profibus-Interface can be programmed according to the needs of the user. The GSD-file first has to be installed using the software tool. The user has the possibility to choose different encoder configurations, parameters and functionality depending on the selected encoder configuration. SENSATA-BEI Absolute Encoders support all configurations described in the following, i.e. there is no functionality limitation due to the hardware. Additionally to the configurations „Class 1“ and „Class 2“ (according to the Profile for Encoders) the SENSATA-BEI Encoder offers configurations with manufacturer-specific functions. By choosing certain encoder configurations, the parameters and configuration data are determined

and saved. These data are stored in the Profibus master. They are transmitted to the slave (encoder) when the Profibus network is initiated („DDL_M_Set_Prm“). It is not possible to change parameters or configuration during the normal operation of the device (exception: “Commissioning Mode”, see chapter 5.3).

After receiving configuration and parameter data the absolute encoder enters the normal operating mode (cyclic data transmission – „DDL_M_Data_Exchange“). In this mode the process values (e.g. the position values) are transmitted. Data length and format are determined by the user when selecting a certain encoder configuration.

3.1 Overview – Configuration principle



3.2 Overview encoder configurations - functionality

| Designation | Cyclic communication(1) | Programmable parameters | Additional functions |
|----------------------------|--|---|---|
| Class 1 Singleturn | Position value –16 bit Input | Code sequence | - |
| Class 1 Multiturn | Position value - 32 bit Input | Code sequence | - |
| Class 2 Singleturn | Position value –16 bit Input Preset value – 16 bit Output | Code sequence Scaling factor | Preset function |
| Class 2 Multiturn | Position value - - 32 bit Input Preset value – 32 bit Output | Code sequence Scaling factor | Preset function |
| SENSATA-BEI 2.2 Singleturn | Position value (32 bit Input) Preset value / Teach-In (32 bit Output) Velocity (16 bit Input) | - Code sequence - Scaling factor - Shorter Diagnostics - Limit switches - Velocity time base | Preset function Commissioning mode Velocity Output |
| SENSATA-BEI 2.2 Multiturn | Position value (32 bit Input) Preset value / Teach-In (32 bit Output) Velocity (16 bit Input) | - Code sequence - Scaling factor - Shorter Diagnostics - Limit switches - Velocity time base | Preset function Commissioning mode Velocity Output |
| SENSATA-BEI 3.0 Multiturn | Position value (32 bit Input) Preset value / Teach-In (32 bit Output) Velocity (16 bit Input) Acceleration (16 bit Input) | - Code sequence - Scaling factor - Shorter Diagnostics - Limit switches - Velocity/acceleration time base | Preset function Commissioning mode Velocity Output Acceleration Output |

⁽¹⁾ Single-turn standard is 12 bits with 16 bits optional. Multiturn is 12 X 16 bits standard with 16 X 16 Bits (32 Bits) optional

3.3 Encoder configurations - data format

| Designation | Configuration | | Input words (Encoder -> Master) | Output words (Master ->Encoder) | Chapter |
|---|---------------|------|---------------------------------------|------------------------------------|---------|
| | Hex | Dec. | | | |
| Class 1 Singleturn (According to Profile) | D0 | 208 | 1 | 0 | 4 |
| Class 1 Multiturn (According to Profile) | D1 | 209 | 2 | 0 | |
| Class 2 Singleturn (According to Profile) | F0 | 240 | 1 | 1 | |
| Class 2 Multiturn (According to Profile) | F1 | 241 | 2 | 2 | |
| SENSATA-BEI 2.2 Singleturn | F1 | 241 | 2 | 2 | 5 |
| | D0 | 208 | 1 | | |
| SENSATA-BEI 2.2 Multiturn | F1 | 241 | 2 | 2 | |
| | D0 | 208 | 1 | | |
| SENSATA-BEI 3.0 Multiturn | F1 | 241 | 2 | 2 | 6 |
| | D0 | 208 | 1 | | |
| | D0 | 208 | 1 | | |

4. Class 1 and Class 2 profile

The encoder versions Class 1 and Class 2 are defined by the working group encoder in the „Profibus

Nutzerorganisation“ in the “Profile for Encoders” (available from the PNO, Order No. 3.062).

4.1 Parameter settings

The following table contains an overview of the parameters according to the Profile for Encoders and the structure of the parameter telegram. (Usually it

is not necessary for the user to know the details of the structure – the parameters are set in user-friendly forms in the operator software tool.)

| Octet (= byte) No. | Parameter | Bit Nr. | Details |
|--------------------|---|---------|---------------|
| 1 ... 8 | Profibus Standard Parameters | | |
| 9 | Code sequence | 0 | |
| | Class 2 functionality | 1 | Section 4.1.2 |
| | Commissioning Diagnostics | 2 | Section 4.1.3 |
| | Scaling function | 3 | Section 4.1.4 |
| | Reserved | 4 | |
| | Reserved | 5 | |
| | Not used for Class 1 and Class 2 | 6 7 | |
| 10 ... 13 | Measuring units per revolution | | Section 4.1.5 |
| 14 ... 17 | Total measuring range | | Section 4.1.6 |
| 18 ... 25 | Reserved (Profile) | | |
| 26 ... | Not used for Class 1 and Class 2 (Refer to versions SENSATA-BEI 2.2) | | |

4.1.1 Code sequence

The parameter „code sequence“ defines the counting direction of the position value. The code increases when the shaft is rotating clockwise (CW)

or counter-clockwise (CCW) (viewed from the shaft end). The code sequence is defined in bit 0 of octet 9:

| Octet 9 Bit 0 | Direction of rotation when viewing the shaft | Code |
|---------------|--|------------|
| 0 | Clockwise (CW) | Increasing |
| 1 | Counter-clockwise (CCW) | Increasing |

In Class 1 this is the only parameter that can be set.

4.1.2 Class 2 functionality

Using this switch Class 2 encoders can be restricted to the functionality of Class 1, i.e. the scaling parameters are disabled. To use the class 2 functionalities bit 1 in octet 9 has to be set.

| Octet 9 Bit 1 | Class 2 functionality |
|---------------|-----------------------|
| 0 | Switched off |
| 1 | Switched on |

4.1.3 Commissioning diagnostics

This function has no significance and should not be used. -

4.1.4 Scaling function

The parameter „scaling function“ enables the scaling parameters „resolution per revolution“ and „total resolution“. This switch should always be activated if functions of class 2 (or even higher classes (2.1 2.2) are to be used.

| Octet 9 Bit 3 | Scaling function |
|---------------|------------------|
| 0 | Switched off |
| 1 | Switched on |

4.1.5 Measuring units per revolution

The parameter „measuring units per revolution“ is used to program a desired number of steps over one revolution. If the value exceeds the basic (physical) resolution of the encoder, the output code is no longer in single steps. The encoder indicates a

parameter error (LED) and it will not enter the data exchange mode.

With high resolution encoders it may be necessary to divide the value into high and low word (depending on the software tool), refer to Section 8.4 “Setting the parameters”.

| | | | | |
|--------------|--|----------------------|-------------------|----------------|
| Octet | 10 | 11 | 12 | 13 |
| Bit | 31 - 24 | 23 - 16 | 15 - 8 | 7 - 0 |
| Data | 2^{31} to 2^{24} | 2^{23} to 2^{16} | 2^{15} to 2^8 | 2^7 to 2^0 |
| | Desired measuring units per revolution | | | |

4.1.6 Total measuring range

| | | | | |
|---|------------------------------------|------------------------------------|-----------------------------------|----------------------------------|
| Octet | 14 | 15 | 16 | 17 |
| Bit | 31 – 24 | 23 – 16 | 15 - 8 | 7 - 0 |
| Data | 2 ³¹ to 2 ²⁴ | 2 ²³ to 2 ¹⁶ | 2 ¹⁵ to 2 ⁸ | 2 ⁷ to 2 ⁰ |
| Programmed total measuring range in steps | | | | |

The parameter „total measuring range“ is used to adapt the measuring range of the encoder to the real measuring range of the application. The encoder counts up until the position value has reached the programmed total resolution and starts with 0 again. Example: 100 steps are programmed for each revolution (parameter „measuring units per revolution“) and the total resolution is set to 12800.

Then the encoder counts up to 11799, starts with “0” again after 128 revolutions, counts up to 11799, and so on.

Note: With many software tools it is necessary to divide the value into high and low word, refer to Section 8.4 “Setting the Parameters”

When choosing the total resolution the following rule has to be observed:

If “steps per revolution” are set to “n” the parameter total resolution must not cause periods longer than the maximum (physical) number of revolutions, i.e. that the programmed total resolution of a 65536 revolutions multiturn encoder must be less than 32768 x the programmed number of steps per revolution (the programmed total resolution of a 32768 revolution multiturn encoder must be less than 32768 x the programmed number of steps per revolution):

The following rules must be applied:

1) 16 bit turns counter : 65536 revolutions :

1.1) Total resolution < 2 147 483 648 (31 bit)

1.2) Total resolution <= measuring units per revolution x 32768 or

Total resolution = measuring units per revolution x 65536

2) 12 bit turns counter : 4096 revolutions :

2.2) Total resolution <= measuring units per revolution x 4096

If these rules are disregarded the encoder will indicate a parameter error and it will not enter the data exchange mode.

If the parameter “measuring units per revolution” or the parameter “total resolution” are not a power of 2, the number of revolutions (with the power supply off) is limited to maximum number of revolution/2 around the preset value.

12 bit turns counter : limited to 2048 revolutions around the preset value (with power supply off).

16 bit turns counter : limited to 32768 revolutions around the preset value with power supply Off).

4.2 Data exchange in normal operation

The „DDL_M_Data_Exchange mode“ is the normal operation mode of the device. On request the encoder transfers the current (position) value to the master. The encoder can also receive data from the master (e.g. the preset value in the class 2 configuration).

4.2.1 Transferring the process value

The multiturn encoder transmits the current position value as a 32-bit-value (double word) to the master.

| Word | Word 1 | | | | | | | | | | | | | | | | Word 0 | | | | | | | | | | | | | | | |
|----------|---------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|--------|----|----|----|----|----|---|---|---|---|---|---|---|---|---|---|
| Function | Process value | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bit | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | 0 | 0 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |

The singleturn encoder uses a 16-bit-value (word) for data transmission.

4.2.2 Preset function

Using the preset function it is possible to adapt the encoder zero point to the zero point of the application. When using this function the current encoder position value is set to the desired preset value. The integrated microcontroller calculates the internal zero point shift.

The preset value is activated if bit 31 in the (peripheral) output double word is set to 1 (rising edge). As the preset function is used after receiving the scaling parameters the preset value refers to the scaled position value.

| Bit | Data bits | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|----------------------|-----------|----|--|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|---|---|---|---|---|---|---|---|---|---|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Master → slave | 1 | 0 | Transfer of the required position value (= preset value) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Slave → slaver | 0 | 0 | New = required position value is transferred | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Master → slave | 0 | 0 | Reset bit 31 – normal mode | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Slave → Master | 0 | 0 | New = required position value is transferred | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

If high precision is required the preset function should only be executed if the encoder shaft is not moving. If the shaft moves quickly during the preset

procedure, this can result in unwanted offsets because of bus delay times.

Note for Singleturn devices

The procedure is similar with the singleturn-version: Here Bit 15 is used to activate the preset value. With high resolution singleturn encoders (16 Bit) it is not possible to set preset values > 32767 (15 bit), as the MSB is used to activate the preset. If this

functionality is needed the user has to choose one of the manufacturer specific encoder versions (in these classes the singleturn position is transmitted as 32-bit-value).

5. Special versions SENSATA-BEI 2.2

The manufacturer-specific encoder configurations Sensata-BEI 2.2 offer (in addition to the functions according to the Profile for Encoders) features such as commissioning mode, velocity output and software limit switches.

The following table gives an overview of the parameters used and the structure of the parameter telegram.

Usually it is not necessary to know these details as the parameters are set with user-friendly software tools.

| Octet (byte) No. | Parameter | Bit No. | Section |
|------------------|---|---------|---------|
| 1 .. 8 | Profibus Standard Parameters | | |
| 9 | Code sequence | 0 | 4.1.1 |
| | Class 2 functionality | 1 | 4.1.2 |
| | Commissioning Diagnostics | 2 | 4.1.3 |
| | Scaling function | 3 | 4.1.4 |
| | Reserved | 4 | |
| | Reserved | 5 | |
| | Activate manufacturer-specific parameters (octet 26) | 6 | 5.1.1 |
| | Reserved | 7 | |
| 10 .. 13 | Desired measuring units (refer to: octet 26 bit 0 and | | 5.1.2 |
| 14 .. 17 | Total measuring range | | 4.1.6 |
| 18 .. 25 | Reserved | | |
| 26 | Reference for the desired measuring steps | 0 | 5.1.3 |
| | | 1 | |
| | Activate commissioning mode | 2 | 5.1.4 |
| | Shorter Diagnostics | 3 | 5.1.5 |
| | Reserved set to 0 | 4 | |
| | Activate lower limit-switch | 5 | 5.1.6 |
| | Activate upper limit-switch | 6 | 5.1.6 |
| | Activate octets 27-39 | 7 | 5.1.1 |
| 27 .. 30 | Lower limit switch | | 5.1.6 |
| 31 .. 34 | Upper limit switch | | 5.1.6 |
| 35 .. 38 | Physical impulses | | 5.1.7 |
| 39 | Reserved | 0 | |
| | Encoder type (Single-/Multiturn) | 1 | 5.1.8 |
| | Reserved | 2 | |
| | Reserved | 3 | |
| | Time base velocity | 4 | 5.1.9 |
| | | 5 | |
| | Reserved | 6 | |
| | Reserved | 7 | |

5.1 Manufacturer – Specific Parameters

In the following, the manufacturer specific parameters are described in detail. The parameters

according to the Profile for Encoders are supported too, as described in chapter 4.

5.1.1 Activate manufacturer-specific parameters

The manufacturer-specific parameter byte 26 is activated with bit 6 in byte 9.

Bit 7 in byte 26 activates further parameter bytes (27-39).

Usually this happens automatically if the encoder version SENSATA-BEI 2.2 are selected. It is only important for the user to observe this if the parameters are entered manually (directly using hex-code).

| Byte 9 Bit 6 | Byte 26 |
|--------------|-------------|
| 0 | Deactivated |
| 1 | Activated |

| Byte 26 Bit 7 | Bytes 27 – 39 |
|---------------|---------------|
| 0 | Deactivated |
| 1 | Activated |

5.1.2 Desired measuring units

The parameter „desired measuring units“ is used to program any required number of steps over 1

revolution, over the whole measuring range or over a part of the measuring range.

| | | | | |
|-------------------------|------------------------------------|------------------------------------|-----------------------------------|----------------------------------|
| Octet | 10 | 11 | 12 | 13 |
| Bit | 31 - 24 | 23 - 16 | 15 - 8 | 7 - 0 |
| Data | 2 ³¹ to 2 ²⁴ | 2 ²³ to 2 ¹⁶ | 2 ¹⁵ to 2 ⁸ | 2 ⁷ to 2 ⁰ |
| Desired measuring units | | | | |

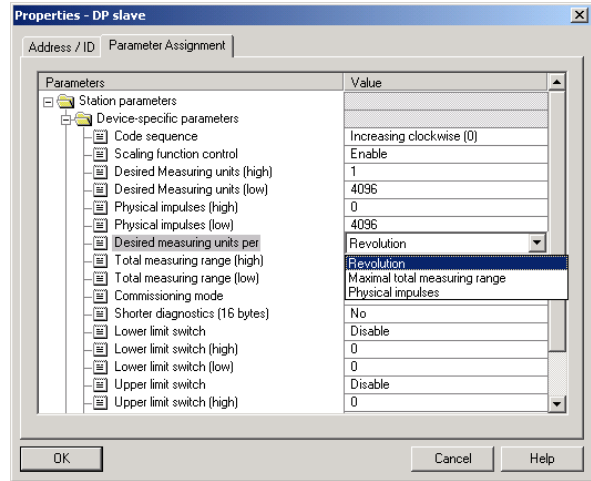
The reference for the desired measuring units is specified with the parameter „Desired measuring units reference“ (cp. 5.1.3). If “per revolution” is selected the measuring range can be adapted with the parameter “total measuring range”. Please observe the rules in section 4.1.6.

Note: With many software tools it is necessary to divide the value into high and low word, refer to Section 8.4 “Setting the Parameters”

5.1.3 Desired Measuring units reference

With this parameter the reference for the desired measuring units (cp. 5.1.2) is determined, either

- per revolution
- per maximum total resolution
- per number of physical impulses



Desired measuring units per revolution

In this case the position value increases by the programmed number of steps (desired measuring units) over one revolution.

Additionally the parameter “total resolution” is used to achieve an adaptation of the measuring range (cp. 4.1.6).

Desired measuring units per maximum total measuring range

The parameter „desired measuring units“ refers to the complete measuring range of the encoder, i.e.

the encoder gives out the programmed number of measuring units over the whole measuring range (4096 revolutions with the multiturn encoder).

Desired measuring units per physical impulses

The desired measuring units refer to the physical impulses entered in octets 35-39 (cp.5.1.7). Physical impulses means: The real value that is read internally from the code disc (e.g. 4096 steps per revolution with a standard 12-bit-encoder).

With that option it is possible to set gearing factors freely.

| Reference | Byte 26 Bit 0 | Byte 26 Bit 1 |
|--|---------------|---------------|
| Per revolution | 0 | 0 |
| Per maximum total measuring range | 1 | 0 |
| Per physical impulses (= steps specified in octets 35-38) | 0 | 1 |

5.1.4 Activate commissioning mode

Bit 2 in byte 26 activates the commissioning mode. This is a special mode with the option to set further parameters in the data-exchange –mode (additional to the preset value). In the commissioning mode a „Teach-In“ can be carried out, i.e. the gearing factor can be determined directly in the machine. In this special mode (indicated by the flashing green LED) the parameters set in the system configuration are ignored by the encoder. It uses parameters stored in an internal EEPROM instead. The commissioning mode can be used durably, but it is recommended to transfer the parameters

determined with the Teach-In into the system configuration. Then the encoder should be used in “normal” operation mode – so it is possible to exchange the device without a new Teach-In. A detailed description of the commissioning mode can be found in section 5.3.

| Byte 26 Bit 2 | Commissioning mode |
|---------------|--------------------|
| 0 | Switched off |
| 1 | Switched on |

5.1.5 Shorter Diagnostics

Some Profibus masters, especially older ones, have problems with the full diagnostic data length (57 bytes). The SENSATA-BEI encoder offers the option to reduce the diagnostic data length to 16 bytes. If Class 1 is used the standard diagnostic data length is 16 bytes.

| Byte 26 Bit 3 | Diagnostics |
|---------------|---------------------|
| 0 | Standard = 57 bytes |
| 1 | Reduced = 16 bytes |

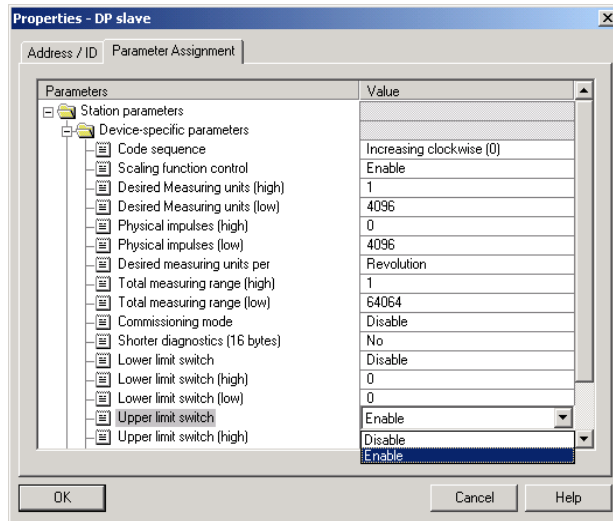
5.1.6 Software-limit switch

Two positions can be programmed. If the position value falls below the lower limit switch or exceeds the higher limit switch, bit 27 in the 32-Bit-process-value is set to 1. Between these limit switch values bit 27 is set to 0. The limit switches can be set to any value, but the parameter “total measuring range”

must not be exceeded. The limit switches are activated with bits 5 and 6 in byte 26. Note: With many software tools it is necessary to divide the values into high and low word, refer to Section 8.4 “Setting the Parameters”38.

| Octet (Byte) | 27 | 28 | 29 | 30 |
|--|----------------------|----------------------|-------------------|----------------|
| Bit | 31 - 24 | 23 - 16 | 15 – 8 | 7 - 0 |
| Data | 2^{31} to 2^{24} | 2^{23} to 2^{16} | 2^{15} to 2^8 | 2^7 to 2^0 |
| Lower limit switch (in measuring steps, related to the scaled value) | | | | |

| Octet (byte) | 31 | 32 | 33 | 34 |
|--|----------------------|----------------------|-------------------|----------------|
| Bit | 31 - 24 | 23 - 16 | 15 – 8 | 7 - 0 |
| Data | 2^{31} to 2^{24} | 2^{23} to 2^{16} | 2^{15} to 2^8 | 2^7 to 2^0 |
| Upper limit switch (in measuring steps, related to the scaled value) | | | | |



| Byte 26 Bit 5 | Lower limit switch |
|---------------|--------------------|
| 0 | Deactivated |
| 1 | Activated |

| Byte 26 Bit 6 | Upper limit switch |
|---------------|--------------------|
| 0 | Deactivated |
| 1 | Activated |

5.1.7 Physical impulses

| Byte | 35 | 36 | 37 | 38 |
|-------------------|----------------------|----------------------|-------------------|----------------|
| Bit | 31 - 24 | 23 - 16 | 15 - 8 | 7 - 0 |
| Data | 2^{31} to 2^{24} | 2^{23} to 2^{16} | 2^{15} to 2^8 | 2^7 to 2^0 |
| Physical impulses | | | | |

This parameter is evaluated if the reference for the „desired measuring units“ is „physical impulses“ (cp. 5.1.3).

With the „physical impulses“ it is possible to set a gearing factor freely. The user defines the output

steps („desired measuring steps“) over a part of the measuring range. This option is helpful to program scaling factors that result in a non-integer number of steps over 1 revolution.

Example

Problem: The position value has to increase by 400 steps over 3 revolutions. With the reference „steps per revolution“ it is impossible to program that scaling factor (it would be necessary to set the parameter „desired measuring steps“ to 133.33; this is not possible because the parameter must be an integer value).

Solution:

Choose „physical impulses“ as reference for the „desired measuring units“. Now the number of physical measuring steps over the desired measuring range is determined. For this the actual (physical) resolution of the encoder (type label) is used. For our example this would be (with a standard encoder, 12 Bit resolution): 4096 steps/revolution x 3 revolutions = 12288 steps. Enter this value (12288) as „physical impulses“ and set the „desired measuring units“ to 400. Now the encoder increases the position value by 400 steps on a measuring range of 12288 physical steps (3 revolutions). Note: With many software tools it is necessary to divide the value into high and low word, refer to Section 8.4 “Setting the Parameters”.

5.1.8 Encoder type

The encoder type (Singleturn or Multiturn) is specified in bit 1 byte 39. Generally this bit is set automatically if the encoder version is selected. The encoder type is set automatically with using parameters resolution and total range, if total range is equal to resolution, the encoder type is singleturn.

| Byte 39 Bit 1 | Type |
|---------------|------------|
| 0 | Singleturn |
| 1 | Multiturn |

5.1.9 Velocity time base

With this parameter the user can choose the time base for the velocity output (version SENSATA-BEI 2.2) and for the acceleration output (SENSATA-BEI 3.0). The time base is specified in bits 4 and 5 of octet 39.

| Time base | Bit 4 | Bit 5 |
|------------------------------|-------|-------|
| Steps / second | 0 | 0 |
| Steps / 100 ms | 1 | 0 |
| Steps / 10 ms | 0 | 1 |
| RPM (revolutions per minute) | 1 | 1 |

5.2 Data exchange in normal operation

With the manufacturer-specific versions SENSATA-BEI 2.2 the process value generally is transmitted as a 32-bit-value (peripheral double word). Apart from 25 bits used for the position value the 7 other bits are used as status bits. The output double word contains the preset value and control bits.

Absolute encoders model series might have (physical) position values > 25 Bit. The manufacturer specific SENSATA-BEI versions do not support the position values > 25 Bit. The upper digits will be

overwritten by the status bits. If the SENSATA-BEI versions are used with encoders with a total (physical) resolution > 25 Bit, the user has to assure that the position value is scaled to a maximum output value < 33554432. If position values > 25 Bit are necessary class 2 should be used.

If version SENSATA-BEI 2.2 is used the current velocity is transmitted as an additional (peripheral) input word.

| ID | F1 hex | | | | D0 hex | |
|----------------|-----------------------------|-----------------------------------|----------------------------------|---------------------------------|----------------------------------|---------------------------------|
| Slave → Master | Status + position value | | | | Velocity | |
| | Status + 2 ²⁴ | 2 ²³ - 2 ¹⁶ | 2 ¹⁵ - 2 ⁸ | 2 ⁷ - 2 ⁰ | 2 ¹⁵ - 2 ⁸ | 2 ⁷ - 2 ⁰ |
| Master → slave | Preset value + control bits | | | | | |
| | Control + 2 ²⁴ | 2 ²³ - 2 ¹⁶ | 2 ¹⁵ - 2 ⁸ | 2 ⁷ - 2 ⁰ | | |

Meaning of the different status bits:

| Bit 28 | Bit 27 | Bit 26 | Bit 25 | Meaning |
|--------|--------|--------|--------|---|
| | | | | Ready 0 = encoder is not ready for operation 1 = encoder is ready for operation |
| | | | | Mode 0 = commissioning mode 1 = normal mode |
| | | | | Software limit switch 0 = lower limit switch ≤ current position value ≤ upper limit switch 1 = current position value > upper limit switch or current position value < lower limit switch |
| | | | | Code sequence 0 = increasing clockwise (view onto the shaft) 1 = increasing counter clockwise (view onto the shaft) |

Velocity :

The speed output depends of the programmed resolution and of the velocity time base for the time bases 10 ms,100ms, 1s. The speed value is in rpm if the velocity time base=RPM.

Velocity Time Base : 10 ms / 100 ms /1000 ms

$$velocity\ output = (Resolution * T * U)/60000$$

Resolution: Desired measuring units per revolution (parameters 5.1.2 and 5.1.3)

T (ms) : velocity time base 10 ms /100 ms /1000 ms (parameters 5.1.9)

U : speed (rpm)

Speed value is returned as two's complement value. Negative values indicate a direction of rotation opposite to the programmed counting direction (parameters 4.1.1)

Velocity Time Base : RPM

$$velocity\ output = U$$

5.3 Commissioning mode

If the commissioning mode is activated in the encoder parameters, the scaling factor can be determined directly in the machine by a „Teach-In“. The commissioning mode is indicated by the flashing green LED and bit 26 in the input double word (bit 26 set to 0).

If the encoder starts up in commissioning mode the parameters in the system configuration (code sequence, scaling) are ignored. Parameters stored in an internal EEPROM are used instead. If code sequence or scaling factor are modified in commissioning mode, the new values will be stored non-volatile and the encoder works with these new parameters.

The proceeding in commissioning mode is as follows:

- The encoder is installed in the machine / system.

- The commissioning mode is activated (parameter settings, cp. 5.1.4)
- The counting direction is changed (if necessary).
- Machine / system is to be moved to the start position.
- The Teach-In-Start command is transmitted to the encoder.
- Machine / system is to be moved to the stop position.
- With the Teach-In-Stop command the desired number of steps is transferred to the encoder.
- Set the preset value.
- The parameters in the system configuration are set to the values determined with the Teach-In procedure.
- Commissioning mode is deactivated (parameter settings).

5.3.1 Setting the counting direction

If the encoder is operating in commissioning mode, the counting direction (code sequence) can be changed online. The current code sequence is indicated with bit 28 in the 32-bit-process value (0:

increasing clockwise / 1: increasing counter clockwise). With bit 28 in the output double word the counting direction can be changed.

| Bit | Status bits | | | | | | | Data bits | | | | | | | | | | | | | | | | | | | | | | | |
|----------------------|-------------|----|----|----------------|----|----|----|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|---|---|---|---|---|---|---|---|----------------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Master → slave | 0 | 0 | 0 | 1 | 0 | 0 | 0 | Changing the counting direction by setting bit 28 | | | | | | | | | | | | | | | | | | | | | | | |
| Slave → Master | 0 | 0 | 0 | 0 ₁ | 0 | 0 | 1 | Encoder sends acknowledgement (new counting direction) in bits 0 and 28 | | | | | | | | | | | | | | | | | | | | | | | 0 ₁ |
| Master → slave | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Changeover is completed by reset bit 28 | | | | | | | | | | | | | | | | | | | | | | | |
| slave → Master | 0 | 0 | 0 | 0 ₁ | X | 0 | 1 | Output process value with changed counting direction | | | | | | | | | | | | | | | | | | | | | | | |

The counting direction is stored non-volatile in an internal EEPROM.

5.3.2 Teach-In Start

After the machine / system has been moved to the start-position the Teach-In-Start command is transmitted to the encoder. The device now starts the internal calculation of a new scaling factor.

| Bit | Status bits | | | | | | | Data bits | | | | | | | | | | | | | | | | | | | | | | | |
|----------------------|-------------|----|----|----|----|----|----|--|----|----|----|----|----|----|----|----|----|----|----|----|----|----|---|---|---|---|---|---|---|---|---|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Master → slave | 0 | 1 | 0 | 0 | 0 | 0 | 0 | Start the Teach-In by setting bit 30 to 1 | | | | | | | | | | | | | | | | | | | | | | | |
| Slave → Master | 0 | 1 | 0 | X | X | 0 | 1 | Acknowledgement of the encoder by setting bit 30 to 1 | | | | | | | | | | | | | | | | | | | | | | | |
| Master → slave | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Reset bit 30 | | | | | | | | | | | | | | | | | | | | | | | |
| Slave → Master | 0 | 1 | 0 | X | X | 0 | 1 | Non-calculated position value is transmitted (gearing factor = 1, no offset) | | | | | | | | | | | | | | | | | | | | | | | |

Note: The scaling factor is set to 1; the zero point shift is set to zero.

5.3.3 Teach-In Stop

After moving the machine / system to the stop-position the Teach-In-Stop command is send. Together with this command the desired number of steps over the moved measuring range is transmitted. The user has to observe that the physical resolution is not exceeded (e.g. 20000 steps on a quarter of a revolution). Positive and negative directions are taken into account automatically, also the crossing of the physical zero point. Note: The measuring range must not exceed the half physical measuring range of the encoder (i.e. a maximum of

32767 revolutions for a multiturn device with 65536 revolutions.

After receiving the Teach-In-Stop command the encoder transmits the calculated total resolution. This value should be noted and later (when switching the device to normal mode) entered into the parameter settings.

After this Teach-In procedure the encoder operates with the new gearing factor (which is stored non-volatile in the internal EEPROM).

| Bit | Status bits | | | | | | | Data bits | | | | | | | | | | | | | | | | | | | | | | | |
|----------------------|-------------|----|----|----|----|----|----|--|----|----|----|----|----|----|----|----|----|----|----|----|----|----|---|---|---|---|---|---|---|---|---|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Master → SLAVE | 0 | 0 | 1 | 0 | 0 | 0 | 0 | Number of desired measuring steps (on the traversed measuring range) | | | | | | | | | | | | | | | | | | | | | | | |
| SLAVE → Master | 0 | 1 | 1 | X | X | 0 | 1 | Transfer of the total resolution (should be noted) | | | | | | | | | | | | | | | | | | | | | | | |
| Master → SLAVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Reset bit 29 | | | | | | | | | | | | | | | | | | | | | | | |
| SLAVE → Master | 0 | 0 | 0 | X | X | 0 | 1 | Output of the current position value, scaled with the new gearing factor | | | | | | | | | | | | | | | | | | | | | | | |

In order to replace the encoder later without a new Teach-In procedure, the total measuring range determined with the Teach-In should be transferred into the system configuration. For this the „total resolution“ must be entered into the parameter field „desired measuring units“ (cp. 5.1.2) and the reference (cp. 5.1.3) must be set to “maximum total

measuring range“. When setting the parameters it should be observed that the code sequence is correct (the setting of the counting direction in commissioning mode has to be transferred to the system configuration). Subsequently the commissioning mode can be switched off and the encoder can be used in normal mode.

5.3.4 Preset value

The preset function is similar to the procedure described in section 4.2.2. There is only one difference: When using the manufacturer-specific versions SENSATA-BE12.2 there is an

acknowledgement (bit 31 in the input double word is set to 1):

| Bit | Status bits | | | | | | | Data bits | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|----------------------|-------------|----|----|----|----|----|----|--|----|----|----|----|----|----|----|----|----|----|----|----|----|----|---|---|---|---|---|---|---|---|---|---|--|--|--|--|--|--|--|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | | | | | | | |
| Master → SLAVE | 1 | 0 | 0 | 0 | 0 | 0 | 0 | Transfer of the required position value (= preset value) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| SLAVE → Master | 1 | 0 | 0 | 0 | 0 | 0 | 1 | New = required position value is transferred | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Master → SLAVE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Reset bit 31 – normal mode | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| SLAVE → Master | 0 | 0 | 0 | 0 | 0 | 0 | 1 | New = required position value is transferred | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

6. Special versions SENSATA – BEI 3.0

The manufacturer-specific encoder configurations SENSATA-BEI 3.0 offer (in addition to the SENSATA-BEI 2.2 functions) acceleration output and the possibility to deactivate the status bits.

The following table gives an overview of the parameters used and the structure of the parameter telegram.

Usually it is not necessary to know these details as the parameters are set with user-friendly software tools.

| Octet (byte) No. | Parameter | Bit No. | Section |
|-----------------------|--|---------|---------|
| 1 .. 8 | Profibus Standard Parameters | | |
| 9 | Code sequence | 0 | 4.1.1 |
| | Class 2 functionality | 1 | 4.1.2 |
| | Commissioning Diagnostics | 2 | 4.1.2 |
| | Scaling function | 3 | 4.1.4 |
| | Reserved | 4 | |
| | Reserved | 5 | |
| | Activate manufacturer-specific parameters (octet 26) | 6 | 5.1.1 |
| | Reserved | 7 | |
| 10 .. 13 | Desired measuring units (refer to: octet 26 bit 0 and 1) | | 5.1.2 |
| 14 .. 17 | Total measuring range | | 4.1.6 |
| 18 .. 25 | Reserved | | |
| 26 | Reference for the desired measuring steps | 0 | 5.1.3 |
| | | 1 | |
| | Activate commissioning mode | 2 | 5.1.4 |
| | Shorter Diagnostics | 3 | 5.1.5 |
| | Without Status SENSATA-BEI 3.0 | 4 | |
| | Activate lower limit-switch | 5 | 5.1.6 |
| | Activate upper limit-switch | 6 | 5.1.6 |
| Activate octets 27-39 | 7 | 5.1.1 | |
| 27 .. 30 | Lower limit switch | | 5.1.6 |
| 31 .. 34 | Upper limit switch | | 5.1.6 |
| 35 .. 38 | Physical impulses | | 5.1.7 |
| 39 | Reserved | 0 | |
| | Encoder type (Single-/Multiturn) | 1 | 5.1.8 |
| | Reserved | 2 | |
| | Reserved | 3 | |
| | Time base velocity | 4 | 5.1.9 |
| | | 5 | |
| | Reserved | 6 | |
| Reserved | 7 | | |

6.1 Parameter

In the following the manufacturer specific parameters SENSATA-BEI 3.0 are described in detail. The main parameters according to the Profile for

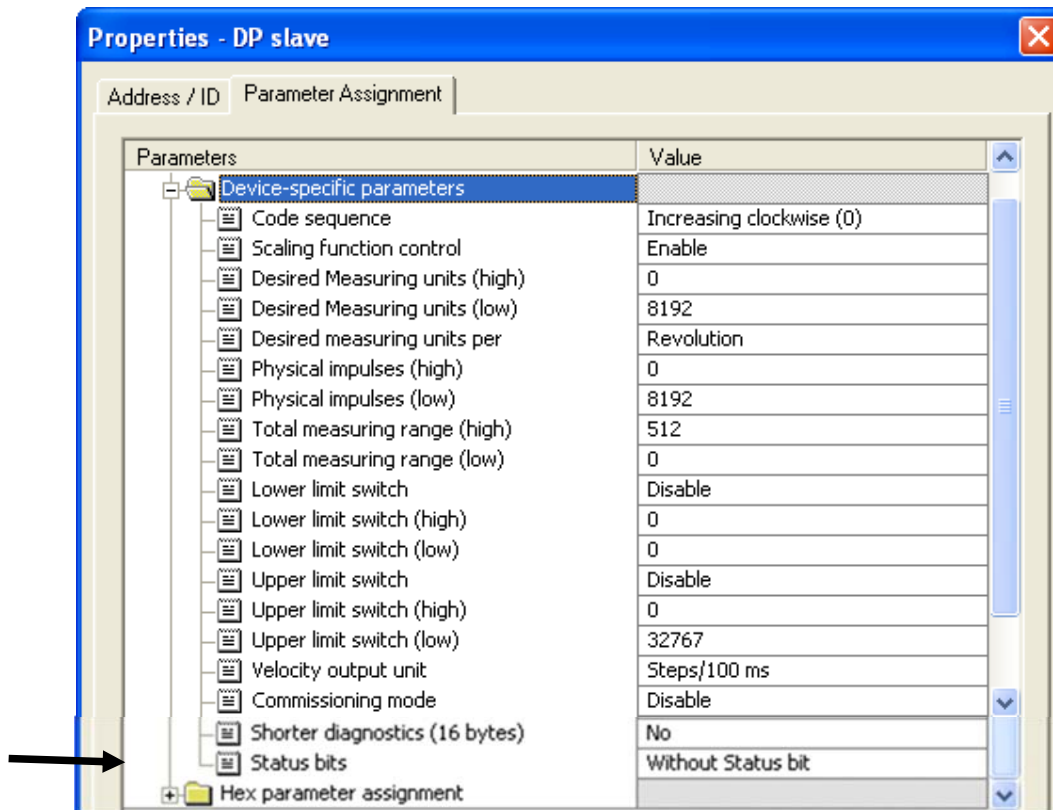
Encoders or SENSATA-BEI 2.2 are described in chapter 4 and 5.

6.1.1 Status bits

Bit 4 in byte 26 activates the status bits in the position value and control bits in the output value. With the status bits, the position value is limited to 25 bits and commissioning mode and limit switch are available.

Without the status bits, the position value is limited to 31 bits and commissioning mode and limit switch are not available.

| byte 26 Bit 4 | Status bits |
|---------------|---------------------|
| 0 | With Status bits |
| 1 | Without Status bits |



6.2 SENSATA-BEI 3.0 Data exchange

With the manufacturer-specific versions SENSATA-BEI 3.0 the process value is transmitted as a 25 bit or 31-bit value (peripheral double word). With status bits, 25 bits are used for the position value the 7 other bits are used as status bits. Without Status bits, 31 bits are used for the position value. With status

bits, the output double word contains the preset value and control bits. Without status bits, the output double word contains the preset value .

If version SENSATA-BEI 3.0 is used the current velocity and the acceleration are transmitted in two additional (peripheral) input words.

6.2.1 SENSATA-BEI 3.0 Data exchange without status bits

The process position value is transmitted as 31-bit-value (double word). The current velocity and

acceleration are transmitted in two additional (peripheral) input words.

| ID | F1 hex | | | | D0 hex | | D0 hex | |
|----------------|----------------|-------------------|----------------|-------------|----------------|-------------|----------------|-------------|
| Slave → Master | position value | | | | Velocity | | Acceleration | |
| | $0 + 2^{30}$ | $2^{23} - 2^{16}$ | $2^{15} - 2^8$ | $2^7 - 2^0$ | $2^{15} - 2^8$ | $2^7 - 2^0$ | $2^{15} - 2^8$ | $2^7 - 2^0$ |

| Master → slave | Preset value | | | |
|----------------|----------------|-------------------|----------------|-------------|
| | $0/1 + 2^{30}$ | $2^{23} - 2^{16}$ | $2^{15} - 2^8$ | $2^7 - 2^0$ |

Acceleration output : The difference between 2 speed samples. The period between the two samples is the velocity time base (parameters 5.1.9)

6.2.2 SENSATA-BEI 3.0 Data exchange with status bits

This SENSATA-BEI 3.0 version with status bits is equivalent to the SENSATA-BEI 2.2 version plus the acceleration input value.

| ID | F1 hex | | | | D0 hex | | D0 hex | |
|----------------|-------------------------|-------------------|----------------|-------------|----------------|-------------|----------------|-------------|
| Slave → Master | Status + position value | | | | Velocity | | Acceleration | |
| | Status + 2^{24} | $2^{23} - 2^{16}$ | $2^{15} - 2^8$ | $2^7 - 2^0$ | $2^{15} - 2^8$ | $2^7 - 2^0$ | $2^{15} - 2^8$ | $2^7 - 2^0$ |

| Master → slave | Preset value + control bits | | | |
|----------------|-----------------------------|-------------------|----------------|-------------|
| | Control + 2^{24} | $2^{23} - 2^{16}$ | $2^{15} - 2^8$ | $2^7 - 2^0$ |

Meaning of the different status bits:

| Bit 28 | Bit 27 | Bit 26 | Bit 25 | Meaning |
|--------|--------|--------|--------|---|
| | | | | Ready 0 = encoder is not ready for operation 1 = encoder is ready for operation |
| | | | | Mode 0 = commissioning mode 1 = normal mode |
| | | | | Software limit switch 0 = lower limit switch ≤ current position value ≤ upper limit switch 1 = current position value > upper limit switch or current position value < lower limit switch |
| | | | | Code sequence 0 = increasing clockwise (view onto the shaft) 1 = increasing counter clockwise (view onto the shaft) |

7. Diagnostic messages

7.1 Overview

On request of the master the encoder transmits diagnostic data ("DDLMSlave_Diag"). The diagnostic data length is 57 bytes (Exception: shorter diagnostics, cp. 5.1.5). The format of the diagnostic data is according to the Profibus Standard (octets 1-6) respectively according to the Profile for Encoders (starting from octet 7).

| Diagnostic function | Data type | Diagnostics - octet number | Class |
|---|--------------|----------------------------|-------|
| Station status 1 (ref. to: Profibus Standard) | Octet | 1 | 1 |
| Station status 2 (ref. to: Profibus Standard) | Octet | 2 | 1 |
| Station status 3 (ref. to: Profibus Standard) | Octet | 3 | 1 |
| Diagnostic master address | Octet | 4 | 1 |
| PNO identification number | Octet | 5, 6 | 1 |
| Extended diagnostic header | Octet String | 7 | 1 |
| Alarm messages | Octet String | 8 | 1 |
| Operating status | Octet String | 9 | 1 |
| Encoder type | Octet String | 10 | 1 |
| Resolution per revolution (Hardware) | Unsigned 32 | 11 - 14 | 1 |
| Number of revolutions (Hardware) | Unsigned 16 | 15, 16 | 1 |
| Additional alarm messages | Octet String | 17 | 2 |
| Supported alarm messages | Octet String | 18, 19 | 2 |
| Warnings | Octet String | 20, 21 | 2 |
| Supported warnings | Octet String | 22, 23 | 2 |

| Diagnostic function | Data type | Diagnostics - octet number | Class |
|--------------------------------------|--------------|----------------------------|-------|
| Profile version | Octet String | 24, 25 | 2 |
| Software version | Octet String | 26, 27 | 2 |
| Operating time | Unsigned 32 | 28 - 31 | 2 |
| Zero offset | Unsigned 32 | 32 - 35 | 2 |
| Manufacturer-specific: offset value | Unsigned 32 | 36 - 39 | 2 |
| Programmed resolution per revolution | Unsigned 32 | 40 - 43 | 2 |
| Programmed total resolution | Unsigned 32 | 44 - 47 | 2 |
| Serial number | ASCII String | 48 - 57 | 2 |

7.2 Supported diagnostic messages

In the following the different diagnostic messages are described in detail.

| | | |
|-------------|--------------|-------------|
| Byte | 24 | 25 |
| Bit | 15 – 8 | 7 – 0 |
| Data | $2^7 - 2^0$ | $2^7 - 2^0$ |
| | Revision No. | Index |

7.2.1 Extended diagnostics header

Byte 7 contains the length of the extended diagnostics (including header itself).

7.2.7 Software version

Diagnostic bytes 26 and 27 contain the software version of the encoder.

7.2.2 Operating status

Diagnostic byte 9 contains certain parameters (set in the system configuration).

| | | |
|--------------|----------------|----------------|
| Octet | 26 | 27 |
| Bit | 15 – 8 | 7 - 0 |
| Data | 2^7 to 2^0 | 2^7 to 2^0 |
| | Revision No. | Index |

| Bit | Definition | 0 | 1 |
|-----|-----------------------|-----|-----|
| 0 | Direction of rotation | CW | CCW |
| 1 | Class 2 functionality | Off | On |
| 2 | Diagnostic routine | Off | On |
| 3 | Scaling function | Off | On |

7.2.8 Operating time

The operating time of the encoder is not supported set to FFFFFFFF hex

7.2.3 Encoder type

Diagnostic byte 10 contains the encoder version (singleturn or multiturn).

7.2.9 Zero offset

The zero offset is output in diagnostic bytes 32 to 35.

| Byte 10 | Definition |
|---------|--------------------|
| 0 | Singleturn encoder |
| 1 | Multiturn encoder |

7.2.10 Programmed resolution

The programmed resolution per revolution is output in diagnostic bytes 40 to 43. The value is only valid if the scaling factor is based on the parameter „resolution per revolution“ (cp. 5.1.3).

7.2.4 Singleturn resolution

Diagnostic bytes 11-14 contain the real (physical) resolution per revolution of the encoder.

7.2.11 Programmed total resolution

The programmed, calculated total resolution is output in diagnostic bytes 44-47.

7.2.5 Number of revolutions

Diagnostic bytes 15 and 16 contain the real (physical) number of revolutions of the encoder. Standard values are 1 for singleturn and 4096, 65535 for multiturn devices.

7.2.12 Serial number

Diagnostic bytes 48-57 are intended for a serial number.

With the current version the serial number is not saved in the encoder, the bytes contain the default value 2A hex.

7.2.6 Profile version

Diagnostic bytes 24 and 25 contain the profile version of the encoder.

7.3 Status indication by the LEDs

Two LEDs indicate the status of the encoder in the profibus network.

The red LED is used to display errors, the green one displays the status of the encoder. Both LEDs can have one of three possible conditions: off, on and flashing. Five of the nine possible combinations are used to indicate a special condition.

If there are any problems with starting-up the system, the state of the LEDs can give important information about the error cause.

| No. | Red LED | Green LED | Status / possible cause |
|-----|----------|-----------|---|
| 1 | Off | Off | No power supply. |
| 2 | On | On | Encoder is ready for operation but it has not received any configuration data after power on. Possible causes: address setting incorrect, Bus lines not connected correctly. |
| 3 | Flashing | On | Parameter or configuration error. The encoder receives configuration or parameter data with incorrect length or inconsistent data. Possible cause: parameter value "total measuring range" too high |
| 4 | Off | On | Normal operation in data exchange mode |
| 5 | Off | Flashing | Commissioning mode |

8. Configuring with STEP 7

In the following the configuration of the SENSATA-BEI encoder with the configuration tool STEP 7 is in a screen shot.. In this example STEP 7 Version 5.1 and

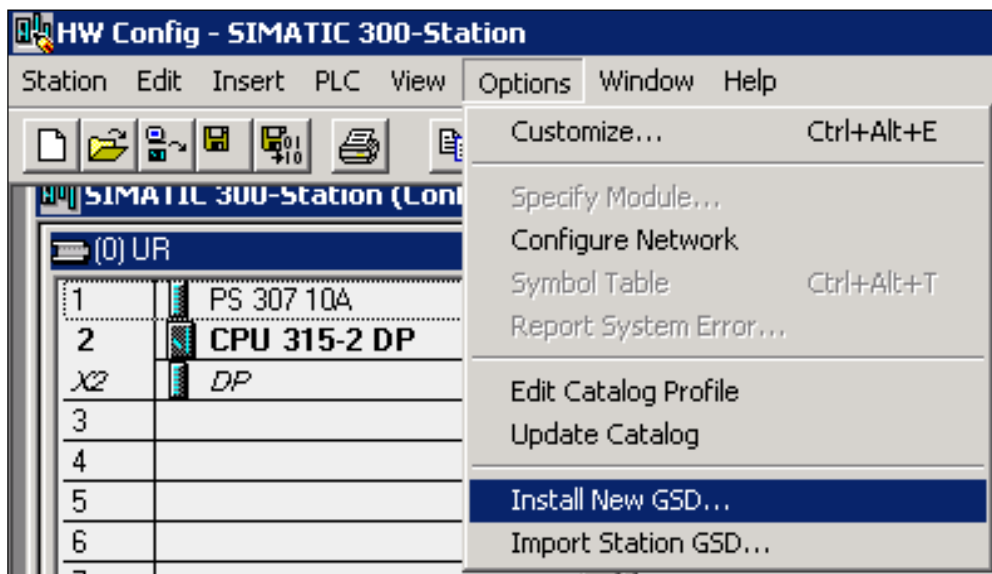
the CPU 315-2DP (profibus-master integrated) are used. If there are questions about other software tools please contact the manufacturer.

8.1 Installing the GSD file

If SENSATA-BEI encoders are used for the first time it is necessary to install the GSD file („MAUX1658.gsd“) to take over the encoder into the hardware catalogue of the tool:

Choose “Install New GSD” in the “HW Config”-window of the project (menu item “Options”) and select the GSD-file (“MAUX1658.gsd”).

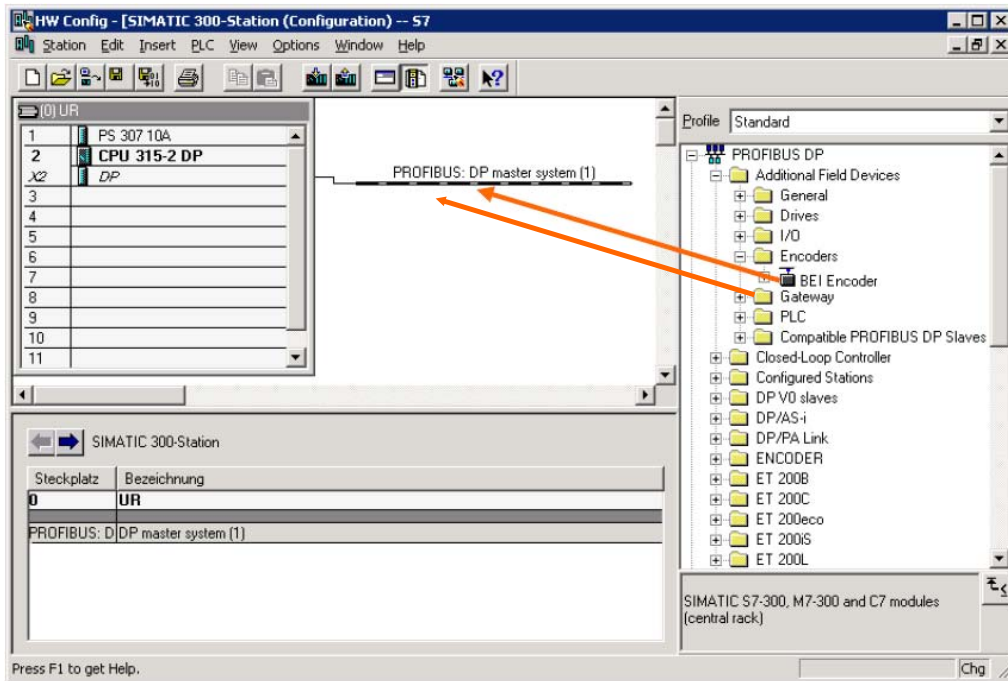
The GSD is available on the Sensata website in the downloads section of the MAAX product page.



After the successful installation of the GSD file the encoder can be found in the hardware catalogue under „PROFIBUS-DP“ – „Additional Field Devices“ – „Encoders“ – „ POSI+ “.

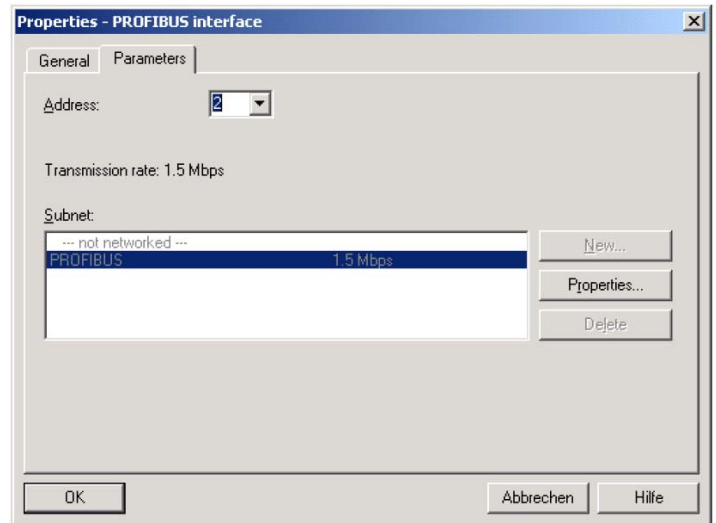
In order to represent the encoder with a bitmap in STEP7 the bitmap file „POSI.bmp“ has to be installed. The procedure is the same as with the GSD file.

8.2 Configuring the encoder



After inserting the Profibus master system in the hardware configuration (“Insert” – “Master System”) the encoder can be chosen from the hardware catalogue and added to the profibus network: Select the device “POSI+” and drag it with the mouse to the network (or choose the network and double click the “MHU9”).

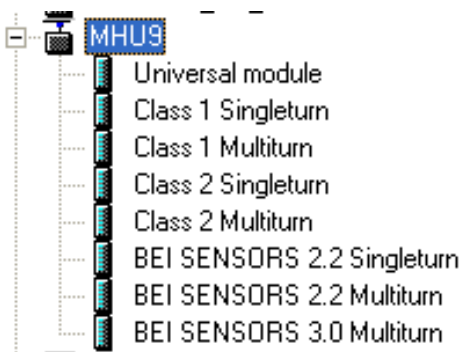
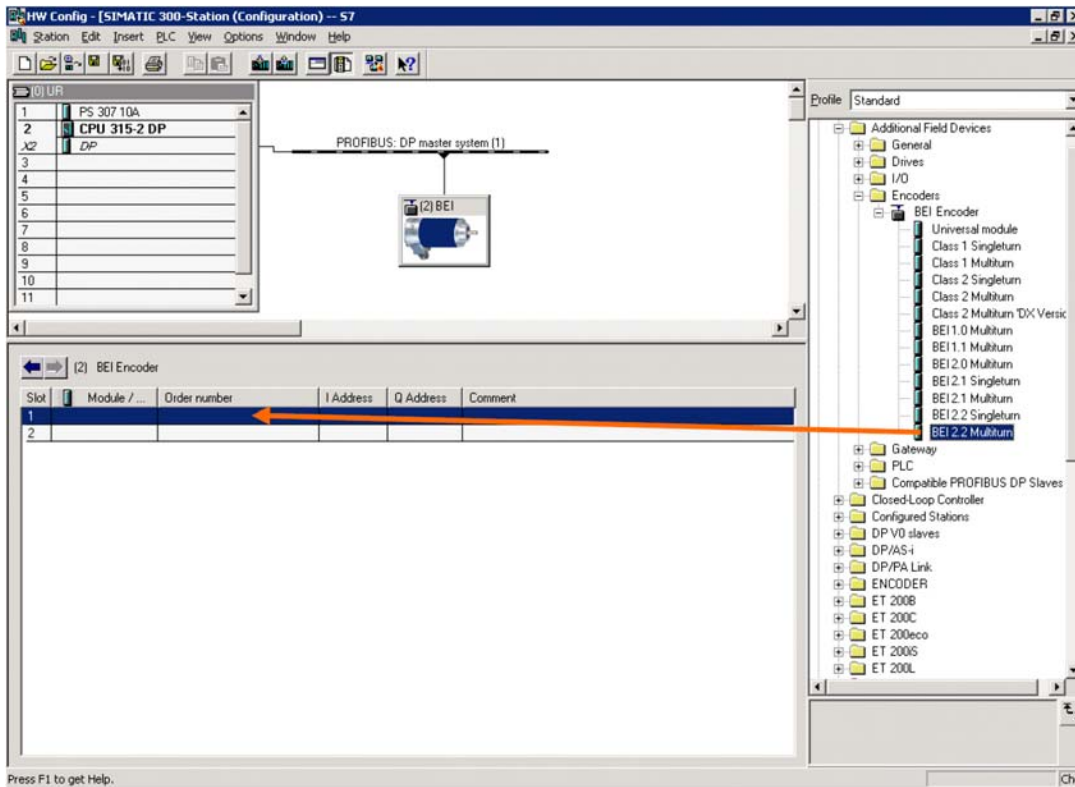
Now the slave address has to be entered (has to be equal to the address setting in the termination block).



8.3 Selecting the encoder version

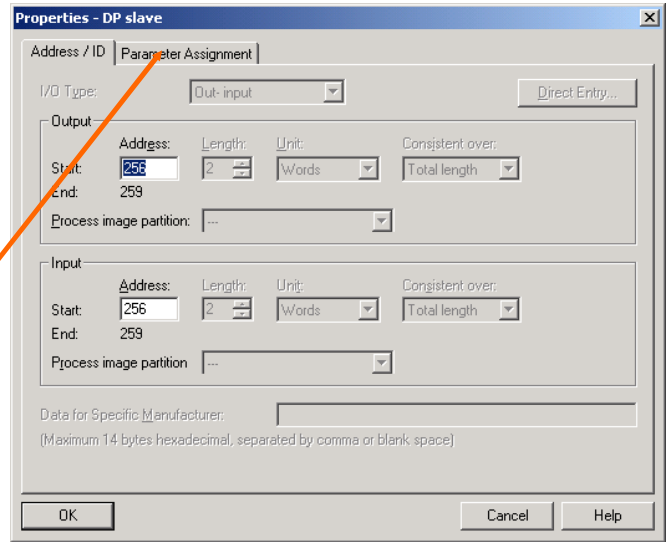
As described in chapter 3 the functionality of the encoder depends on the selected encoder version. After the “POSI+” encoder has been added to the network the desired encoder version can be

selected. For this, one of the modules listed under POSI+ encoder has to be dragged to Slot 1 in the displayed configuration table of the encoder.



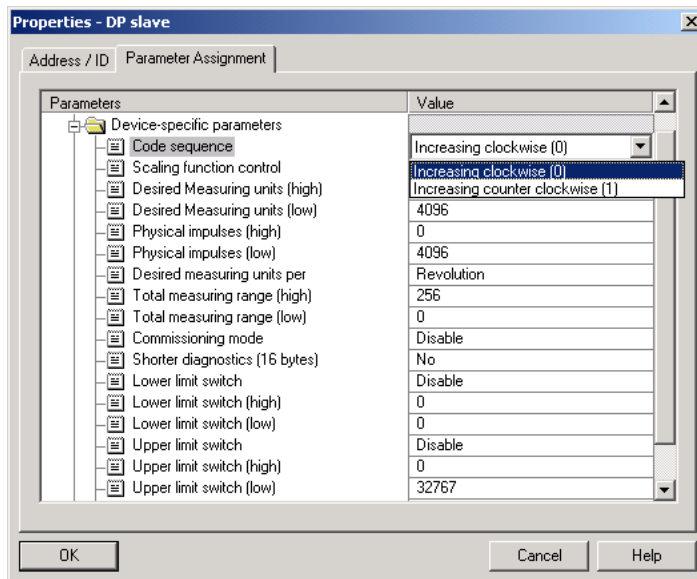
8.4 Setting the parameters

Select the encoder in the hardware configuration and double click slot one in the configuration table of the encoder. The dialog „Properties – DP slave“ appears. The input and output addresses can be changed (if desired). To set the encoder parameters the tab “Parameter Assignment” has to be selected.



After choosing the „Device-specific parameters“ the different parameters (depend on the encoder version) can be set. If several possibilities are offered for one parameter the parameters list is opened by double clicking on it.

Numerical values have to be entered directly. The example shows the parameters of encoder version SENSATA-BEI 2.2, the version with the highest functionality.



Due to the software tool STEP7 32-bit parameter values (e.g. total measuring range, software limit switches) have to be divided into high and low word.

Example:

| Decimal | Hexadecimal | | Hexadecimal | Decimal (to be entered) |
|---------|--------------------|-----------|-------------|-------------------------|
| 129600 | <u>00 01</u> FA 40 | High word | 00 01 | 1 |
| | | Low word | FA 40 | 64064 |

The decimal value „1“ has to be entered into the high word parameter field, the value 64064 into the low word parameter field.

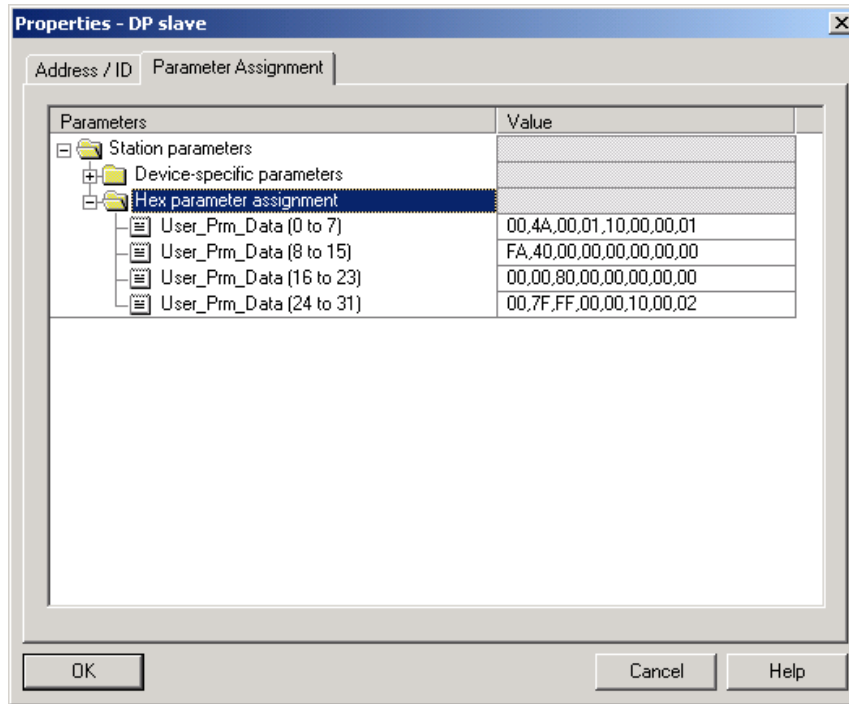
Or:

Divide the value by 65536; enter the integer part of the result into the high word parameter field, the remainder into the low word field.

$$129600 / 65536 = 1.977539 \rightarrow \text{integer part} = 1 \rightarrow \text{high word} = 1$$

$$(129600 - 1) \times 65536 = 64064 \rightarrow \text{remainder} = 64064 \rightarrow \text{low word} = 64064$$

It is also possible to enter the parameters directly as hexadecimal code. However this is very complicated and it should be avoided if possible.



9. Technical Data

See Datasheets.

10. Appendix

10.1 FAQ absolute encoder Profibus

Problem

There are potential issues with the profibus network (bus error, no answer from the encoder) if one of the following profibus masters is used:

- SIEMENS S5-95U
- Master Interface SIEMENS IM 308-B
- Softing PROFiboard
- Allen Bradley 1785 PFB/B
- Mitsubishi A1SJ 71PB92D

Possible cause

The masters do not support the full diagnostic data length (57 bytes).

Solution

If it is possible the maximum number of diagnostic data per slave should be increased in the master.

If this is not possible the encoder can either be used as a „class 1“ encoder (diagnostic data length 16 bytes) or one of the manufacturer-specific versions (SENSATA-BEI 2.1 or 2.2) can be used with reduced diagnostics (cp. 5.1.5).

Problem

If COM PROFIBUS Version 5.0 is used it is not possible to insert the POSI+ encoder into the hardware configuration if the PLC S5-95U is used.

Cause

The S5-95U does not support the full diagnostic data length (57 bytes). COM PROFIBUS V5.0 checks the GSD-parameter „Max_Diag_Data_Len=57“ and prevents the configuration of both devices together.

Solution

Use COM PROFIBUS Version 3.3, choose one of the manufacturer-specific SENSATA-BEI-versions (SENSATA-BEI 2.1 or 2.2) and activate the reduced diagnostics.

If COM PROFIBUS V5.0 is to be used the configuration of the SENSATA-BEI encoder is only possible with a modified GSD file (slave key „Max_Diag_Data_Len“ has to be changed).

Problem

PLC and master are switched on, bus is active, but there is no answer from the encoder.

Possible solutions

First of all the state of LEDs should be checked (cp. section 7.3). Possibly this can give hints to the cause of the problem.

Both LEDs Off: Check power supply!

Both LEDs On: Encoder is ready but receives no configuration or parameter telegrams. Check the address setting . Check the connection of the bus lines (BUS IN / BUS OUT). Check the hardware configuration in your software tool.

Green LED On, red LED flashing:

Parameter error! Check parameters, e.g. the rules for setting the total measuring range (cp. 4.1.6)

Problem

Sporadic bus errors

Possible cause

Terminating resistors not correct

Possible solution

Check terminating resistors!

The resistors of 220 Ω must be switched on at the beginning and at the end of the bus segment. Switch off the power supply and measure the resistance between the terminals A and B in the terminal block.

The resistance value must be about 110 Ω (220 Ω parallel 220 Ω).

Possible cause

EMC problems

Possible solutions

Is the baud rate acceptable for the length of the bus lines? Try to use lower baud rate if necessary. Check the connection of the cable shield in the terminal block. Are all cables and conductions laid according to EMC rules.

10.2 Definitions

| | |
|----------------------------|---|
| Address | A number, which is assigned to each node, no matter whether it is a master or slave. The address is set (non-volatile) in the connection cap using rotary switches. |
| Baud rate | Data transfer rate specified as the number of bits transferred per second (baud rate = bit rate). |
| Bus Node | Device, which can send, receive or amplify data via the bus. |
| DDL M | Direct Data Link Mapper. Interface between Profibus-DP functions and the encoder software. |
| DDL M_Data_Exchange | Operating status of the bus, for standard data transfer. |
| DDL M_Set_Prm | Operating status of the bus, configuration and parameter are transmitted |
| „DDL M_Slave_Diag“ | Operating status, diagnostic data are requested from the slave (e.g. encoder). |
| Diagnostics | Identification, localization, classification, display, additional evaluation of faults, errors and messages. |
| Freeze | This is a master command to the slave. This allows the master to freeze the states of the inputs (for example of the absolute angular encoder) to their current value. The input data are only updated again after reception of the UNFREEZE command. |
| GSD file | File that contains slave-specific characteristics. The GSD file is supplied by the manufacturer of the profibus slave. The GSD format is standardized (defined in GSD specifications), so configuration tools of various manufacturers can use the GSD files. |

| | |
|-----------------------------|--|
| Master | “Active” device in the network that can send data without request. Controls the data interchange. |
| Octet | Data unit of 8 bits = 1 byte |
| Profibus | Process Fieldbus, European fieldbus standard, which is defined in the PROFIBUS Standard (EN 50170). This specifies functional, electrical and mechanical characteristics for a bit-serial fieldbus system. |
| Slave | Bus node, that only sends data on request of the master. Absolute rotary encoders are always slaves. |
| Terminating resistor | Resistor that terminates the bus cable; terminating resistors are always required at the end of a cable or segment. |
| Word | Expression used for a data unit of two bytes. |

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