POSITAL
FRABA

PROFI® PROCESS FIELD BUS

Absolute Inclinometer with Profibus-DP-Interface

ANS XX-DP223PG

User Manual

Imprint
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Technical specifications, which are described in this manual, are subject to change due to our permanent strive to improve our products.

Document information

Revision: January 2007
Version number: 2.1
Part number: 99998141
Author: DJU

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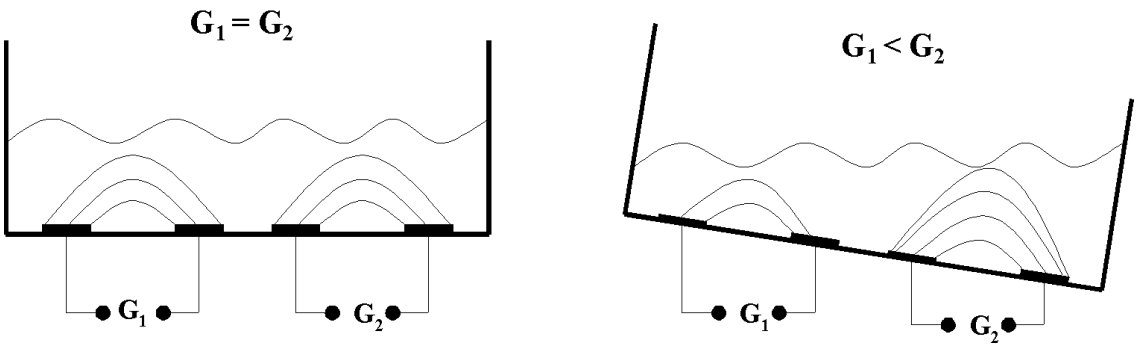
Contents

1 Introduction

1.1 Mode of operation of the absolute inclinometer

The determination of the angle of inclination is based on the measurement of conductivity over plane electrode structures. On the bottom of a cell, partly filled with a conductive fluid, electrodes are applied parallel to the axes. An electrical stray field is formed out by applying an AC-voltage to the planar electrode structures. By tilting the sensor the fluid level over the different electrodes and in consequence the conductivity, respectively the stray field changes.

Now the tilt angle and the tilt direction can be measured using a differential measurement principle.



1.2 The Profibus Interface

Profibus was the first international, open non-proprietary fieldbus standard for building management, production and process automation. There are three different versions: Profibus-FMS, Profibus-PA and Profibus-DP. The FRABA inclinometers are designed for the DP-version.

The competent contact partner for the Profibus system in general, with a broad spectrum of information about the technology, manufacturers and suppliers is

PROFIBUS - Trade Organization
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Germany
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The FRABA absolute inclinometers fulfill all of the requirements according to Profibus-DP from DIN 19245 parts 1 and 3. The integrated Profibus-DP interface of the inclinometer is designed for a maximum data transfer rate of 12 MBaud.

We leave out a detailed description of telegram structure and data communication. You can get those information at the Profibus-Trade Organization if necessary.

1.3 Structure of a Profibus-DP network

In order to be able to use an absolute inclinometer as Slave with the Profibus-DP interface, an interface board is required in the control system which works as Profibus master.

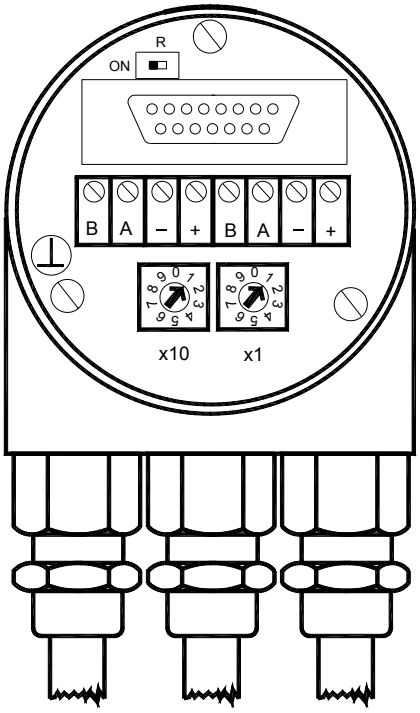
The inclinometer is connected to the master by a two-wire Profibus cable which is connected in the connection cap. A detailed description of the cap can be found in chapter 2.

2 Installation

The inclinometer is connected with a connection cap. This cap is connected to the sensor with a 15-pin-D-Sub connector and can be removed by loosening two screws on the backside of the device. Bus lines and power supply are led into the cap via cable glands and connected to terminal blocks.

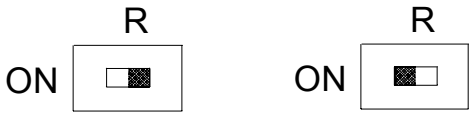
2.1 Setting the station address

The station (node) address is set by using the rotary switches in the cap. The values (x 10 or x 1) for the switches are marked at the switch. Possible addresses are between 0 and 99. 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 not supported.



2.2 Bus termination

If the inclinometer is connected at the end or beginning of the bus line the termination resistor must be switched on (slide switch in position “ON”).



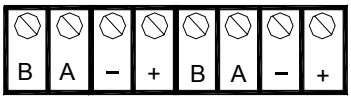
device X last device

Note

The outgoing bus line is disconnected if the resistor is switched on!

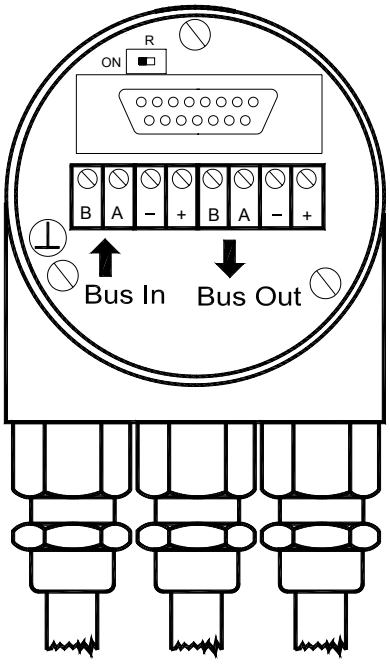
The bus is only correctly terminated when the sensor is connected to the connection cap. If the device must be changed during operation, a separate active bus termination should be used.

2.3 Connecting bus lines and power supply



Clamp	Description
B (left)	Bus line B (Bus in)
A (left)	Bus line A (Bus in)
-	0 V
+	10 – 30 V
B (right)	Bus line B (Bus out)
A (right)	Bus line A (Bus out)
-	0 V
+	10 – 30 V

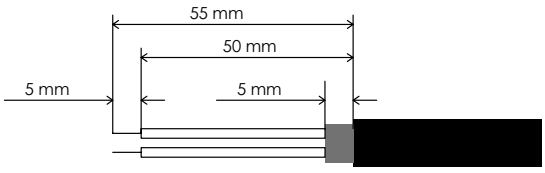
The power supply has to be connected once (no matter which clamps). If the terminating resistor is switched on, the outgoing bus lines are disconnected.

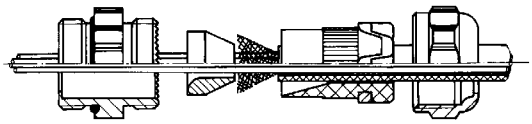


2.4 Connecting-up the connection cap

Remove screw, sealing and cone from the cable gland. Remove 55 mm of the cable sheath and 50 mm of the shielding. About 5 mm of the wires should be stripped. Put screw and sealing on the cable. The cone should be mounted under the shielding according to the figure. Put the whole cable into the cable gland and tighten the screw.

Note: If a combined cable (power supply and bus lines in one cable) is used the large cable diameter can lead to problems. For these cases FRABA offers connection caps with larger cable glands (refer to product catalogue).



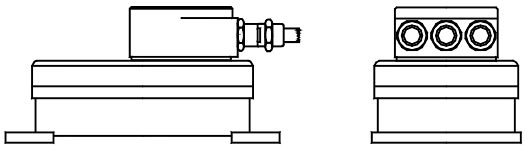


2.5 Connecting the screen

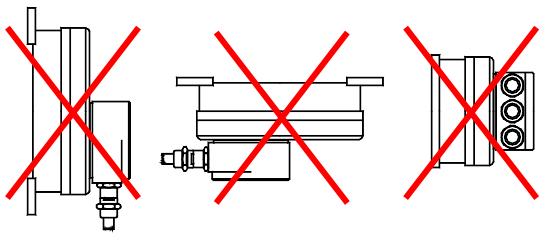
To achieve the highest possible noise immunity shielded cables should be used for data transmission. The shield should be connected to ground on both ends of the cable. In certain cases, a compensation current might flow over the shield. Therefore a potential compensation cable is recommended.

2.6 Instructions to mechanically install and electrically connect the inclinometer

The inclinometer has to be mounted as shown in the picture:



The device cannot be used in the following mounting positions:



The following points should be observed:

- Do not drop the inclinometer or subject it to excessive vibration. The inclinometer is a precision device.
- Do not open the inclinometer housing (this does not mean that you cannot remove the connection cap). If the device is opened it can be damaged and dirt may enter the unit.
- Only qualified personnel may commission and operate the inclinometer. This is personnel who is 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 inclinometer.
- Route the connecting cable to the inclinometer at a considerable distance away or completely separated from power cables with their associated noise. Completely screened 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 cause erroneous functions and uncontrolled statuses which can even result in severe personnel injury and material damage.
- Before powering-up the system, check all of the electrical connections. Connections, which are incorrect, can cause the system to function incorrectly and may result in severe personnel injury and material damage.

3 Configuration

To put a Profibus network into operation it is necessary to define a database for the master which contains the characteristics of the different devices (e.g. station-address, Profibus ID number) and the bus parameters (e.g. Baudrate). This database is generated with a software tool (see the example in chapter 4). Additionally the configuration and parameter data of the individual slaves are determined. These data are transmitted to the different slaves once when starting up the system (the properties of the slave depend on the configuration and parameter data). By using the GSD-file the parameter data can be entered into user-friendly forms with most control software tools.

3.1 Configuration

The configuration data contain information about number and length of the input and output data of the different slaves. There are two possibilities to configure the FRABA-inclinometer:

Inclinometer: not programmable
Inclinometer programmable: Possibility to set preset values, exceeding of the measuring range can be detected by an additional status byte.

Overview

Designation	Configuration		Number of input data (inclinometer -> control)	Number of output data (control -> inclinometer)
	hex.	dec.		
Inclinometer	D0	208	1 input word (x-axis)	-
	D0	208	1 input word (y-axis)	-
Inclinometer programmable	F0	240	1 input word (x-axis)	1 output word (preset x)
	F0	240	1 input word (y-axis)	1 output word (preset y)
	30	48	1 input byte (status)	1 output byte (control)

Attention:
If the configuration of the inclinometer is changed the power supply should be switched of to guarantee a faultless function!

3.2 Parameter data

Additionally to the configuration data, parameter data will be transferred to the slave when starting up the system. Generally this is realized automatically and the parameters are entered into a mask of the operation control software (see chapter 4). However sometimes it can be necessary to individually process the different bits. The meaning of the parameter bits can be found in the following table. For the non-programmable inclinometer there are no user-specific parameter data.

Octet (= byte) No.	Parameter	Bit No.	Description
1- 8	Reserved for profibus-specific data		-
9	Overflow detection X-axis	0	1 = enabled
	Overflow detection Y-axis	1	1 = enabled
	-	2	-
	-	3	-
	Shorter diagnostics (16 bytes)	4	1 = short (16 bytes)
	-	5	-
	-	6	-
	-	7	-

3.3 Parameter description

Overflow detection X-axis
If the overflow-detection is enabled bit 1 in the status byte will be set if the measuring range of the X-axis is exceeded.

Overflow detection Y-axis
If the overflow-detection is enabled bit 0 in the status byte will be set if the measuring range of the Y-axis is exceeded.

Shorter diagnostics (16 bytes)
Some (older) Profibus masters can not operate with the full number of diagnostic bytes (57). In this case the number of diagnostic bytes can be reduced to 16 by setting this parameter.

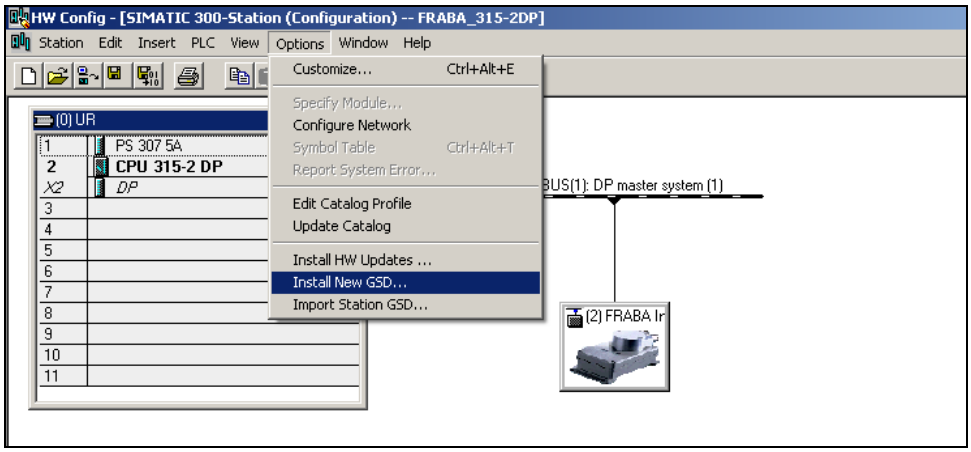
4 Configuring with SIMATIC Manager

In the following the configuration of the FRABA inclinometer with the configuration tool STEP 7 (is shown exemplarily. In this example STEP 7 Version 5.2 and the CPU 315-2DP (Profibus-master integrated) are used. If there are questions about other software tools please contact the manufacturer.

4.1 Installing the GSD file

If FRABA inclinometers are used for the first time it is necessary to install the GSD file („FRAB056A.gsd“) to take over the encoder into the hardware catalogue of the tool:

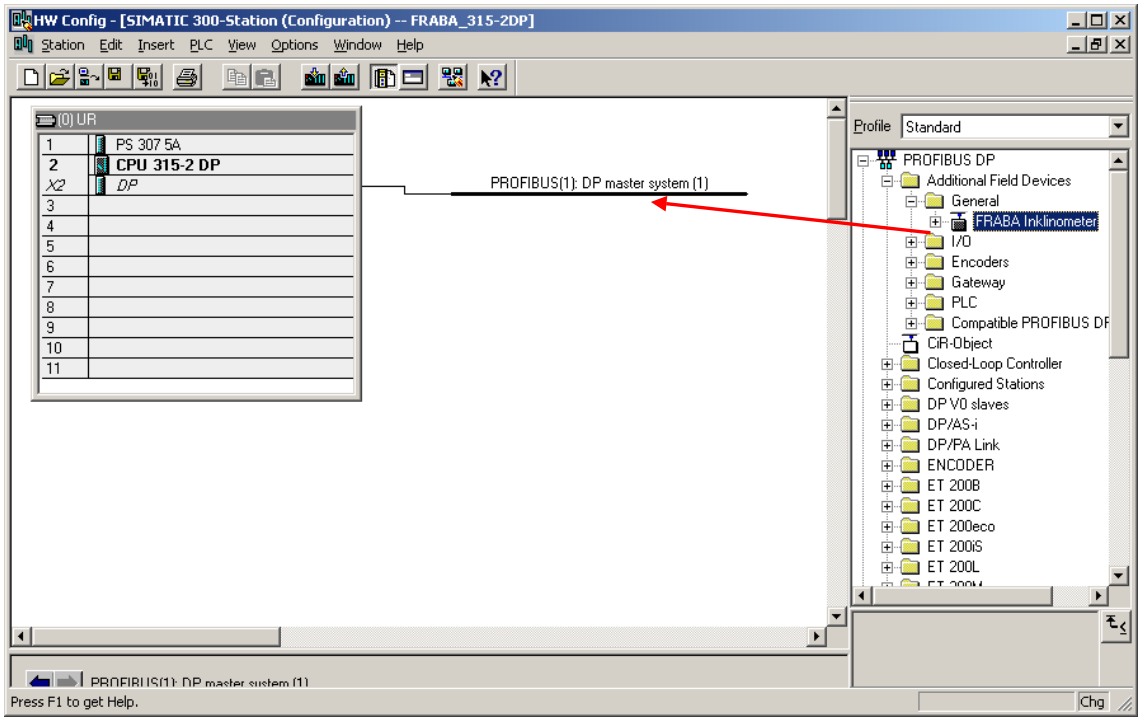
Choose “Install New GSD” in the “HW Config”-window of the project (menu item “Options”) and select the GSD-file (“FRAB056A.gsd”).
The GSD file can be downloaded from our homepage www.posital.de.



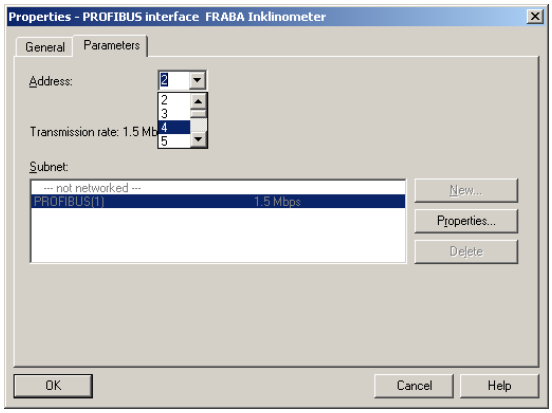
After the successful installation of the GSD file the FRABA inclinometer can be found in the hardware catalogue under „PROFIBUS-DP“ – „Additional Field Devices“ – „General“.

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

4.2 Configuring the Inclinometer

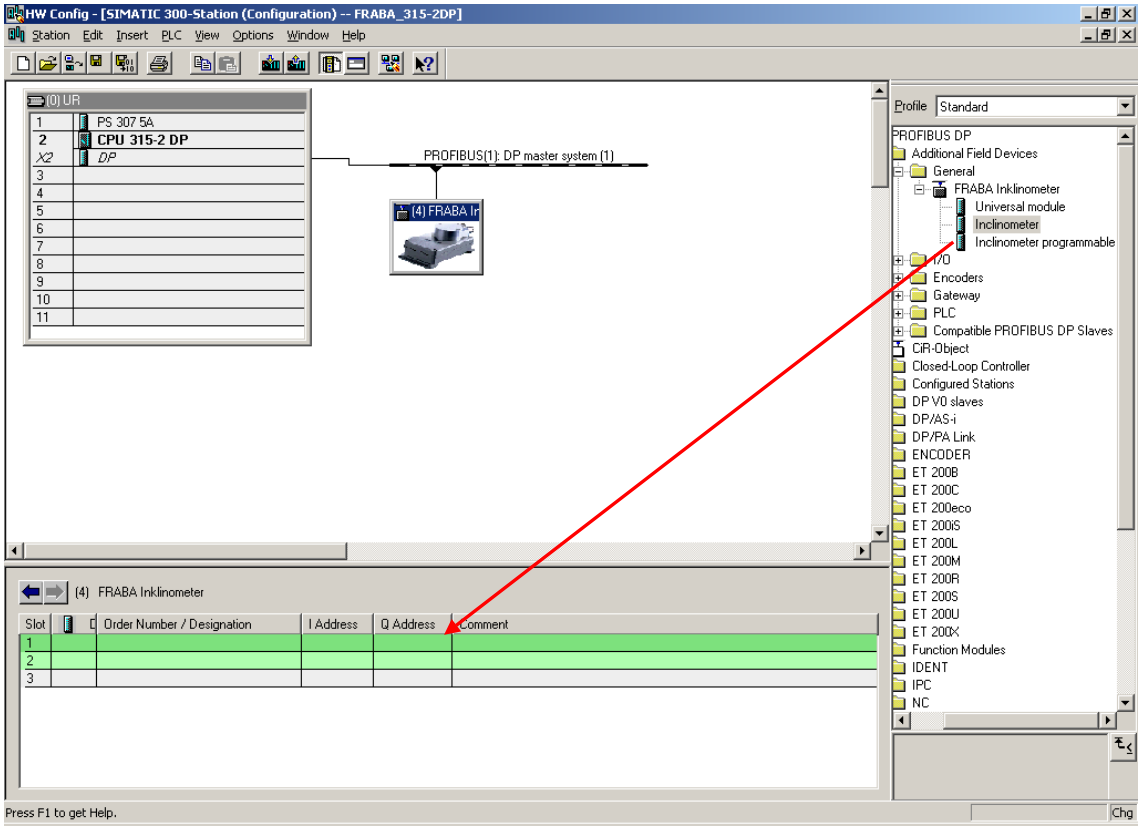


After inserting the Profibus master system in the hardware configuration (“Insert” – “Master System”) the FRABA encoder can be chosen from the hardware catalogue and added to the Profibus network: Select the device “FRABA Inclinometer” and drag it with the mouse to the network (or choose the network and double click the “FRABA Inclinometer”).
Now the slave address has to be entered (has to be equal to the address setting in the connection cap).



4.3 Selecting the device configuration

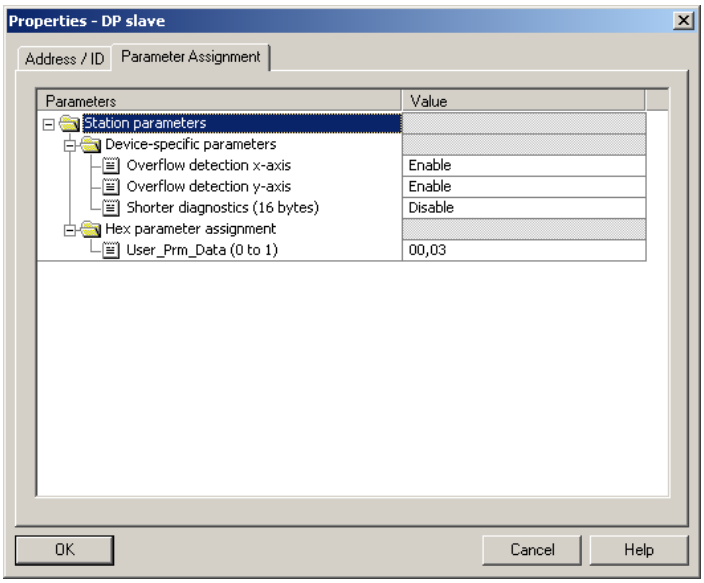
As described in chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**.1 the functionality of the inclinometer depends on the selected configuration. After the “FRABA Inclinometer” has been added to the network the desired configuration “Inclinometer” or “Inclinometer programmable” can be chosen For this, one of the modules listed under FRABA Inclinometer has to be dragged to Slot 1 in the displayed configuration table of the device:



4.4 Parameter settings (only “Inclinometer programmable”

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.

Device Parameter can be set in the following dialog box. For a detailed description of the parameters please refer to chapter 3.3.



5 Data Exchange in normal operation mode

5.1 Configuration “Inclinometer“

If „Inclinometer” was selected in the configuration there is no possibility to program the device. The unchanged inclinations of both axes are output (no calculation by the controller)

Format of the input data:
1 input word (16 bits, signed) inclination X-Axis
1 input word (16 bits, signed) inclination Y-Axis
The address setting is done with the software tool (refer to chapter 4).

Measuring range, resolution:
ANS 15: -15000 ... +15000
ANS 30: - 4500 ... +4500

Note: Output values of ANS 30 are up to +/- 45°. Specified accuracy is only valid for the measuring range of +/- 30°.

5.2 Configuration “Inclinometer programmable“

If “Inclinometer programmable” was chosen the sensor can be programmed. Independent preset values for both axes can be send to the inclinometer. They are activated by an additional control byte. Further information (e.g. exceeding of the measuring range) are transferred in a status byte.

Format of the input/output data:
1 input word (16 bits, signed) inclination X-axis
1 input word (16 bits, signed) inclination Y-axis
1 output word (16 bits, signed) preset value X-axis
1 output word (16 bits, signed) preset value Y-axis
1 input byte (8 bits) status
1 output byte (8 bits) control

The address setting is done with the software tool (see chapter 4).

5.2.1 Transmission if the inclination values

The inclination values can be read in by the control system in two input words. With the programmable version these values have been calculated with the internal zero point shift. The zero point shift is calculated by the inclinometer when a new preset value is set. The default zero point shift is 0 (inclinations are given out without changes). If the measuring range is exceeded the maximum value is output.

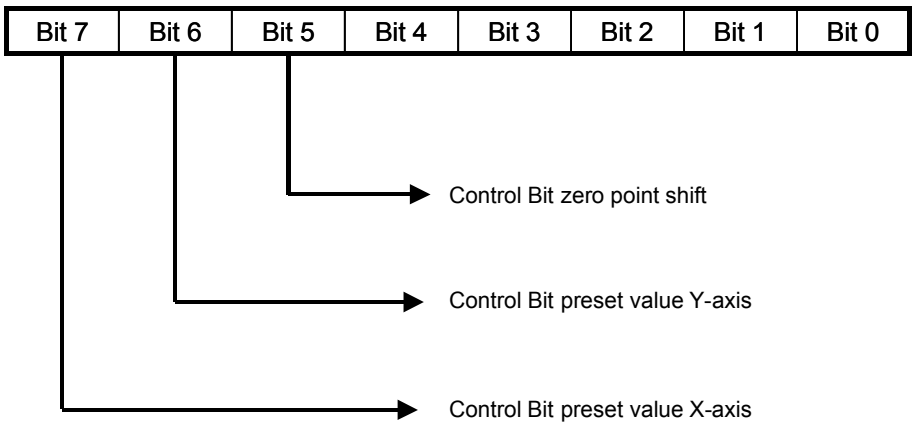
5.2.2 Transmission of the preset values

The preset value is the inclination value that should be reached at a certain physical inclination of the sensor axis. It is possible to set independent preset values for both axes. These values are transmitted to the sensor in two output words. The presets are activated by setting the preset-bits in the control byte.

Please note: The preset setting works only if the resulting zero point shift (calculated by the inclinometer from physical inclination and preset value) does not exceed the maximum inclination (e.g. the value for the zero point shift of the 15°-sensor must lie between –15° and +15°; preset values that lead to a zero point shifting outside these limits will be ignored).

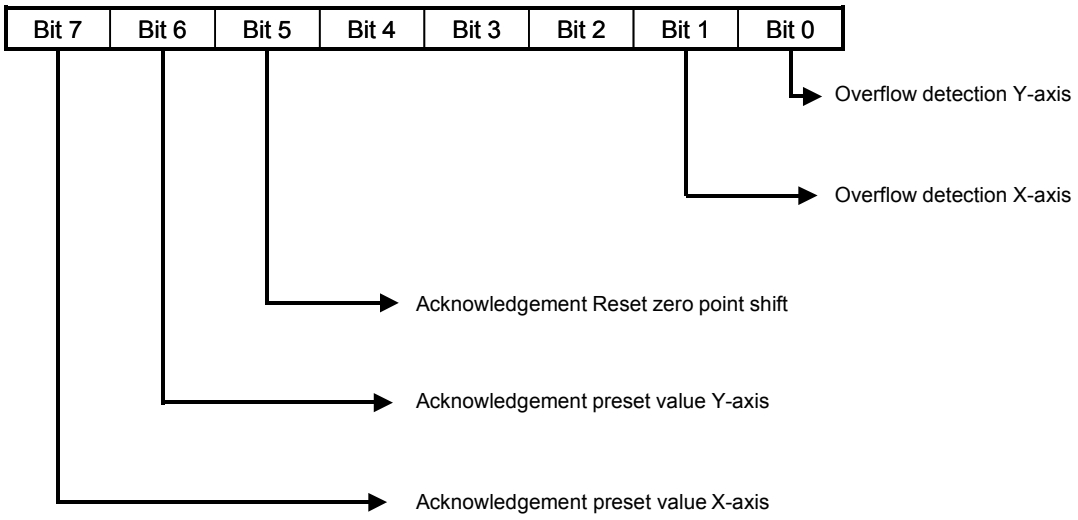
5.2.3 The control byte

The preset values are activated by setting bits in the control byte. Additionally the control byte gives the possibility to reset the zero point shift.



5.2.4 The status byte

The status byte acknowledges the transfer of preset values. Additionally measuring range exceeding can be indicated if necessary.



5.2.5 Setting preset values

Preset value X-axis:

	control/statusbyte (POB/PIB)								data (POW/PIW)															
Bit	7	6	5	4	3	2	1	0	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	0	required process value (preset value) is transferred here															
Slave -> Master	1	0	0	0	0	0	0	0	New = required process actual value is transferred here															
Master -> Slave	0	0	0	0	0	0	0	0	Reset to normal mode															
Slave -> Master	0	0	0	0	0	0	0	0	New = required process actual value is transferred here															

Preset value Y-axis :

	control/statusbyte (POB/PIB)								data (POW/PIW)															
Bit	7	6	5	4	3	2	1	0	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Master -> Slave	0	1	0	0	0	0	0	0	required process value (preset value) is transferred here															
Slave -> Master	0	1	0	0	0	0	0	0	New = required process actual value is transferred here															
Master -> Slave	0	0	0	0	0	0	0	0	Reset to normal mode															
Slave -> Master	0	0	0	0	0	0	0	0	New = required process actual value is transferred here															

Reset zero offset:

	control/statusbyte (POB/PIB)								data (POW/PIW)															
Bit	7	6	5	4	3	2	1	0	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Master -> Slave	0	0	1	0	0	0	0	0																
Slave -> Master	0	0	1	0	0	0	0	0	process actual value is transferred here (zero point shift = 0)															
Master -> Slave	0	0	0	0	0	0	0	0	Reset to normal mode															
Slave -> Master	0	0	0	0	0	0	0	0	process actual value is transferred here (zero point shift = 0)															

5.2.6 Overflow detection

Bit 0 and bit 1 of the status byte indicate an exceeding of the measuring range (if this function was not disabled in the parameter setting).

Bit	value	meaning
0	0	Measuring range Y-axis not exceeded
0	1	Measuring range Y-axis exceeded
1	0	Measuring range X-axis not exceeded
1	1	Measuring range X-axis exceeded

6 Diagnosis

6.1 Overview of the diagnostics data output

When requested by the master in the DDLM_Slave_Diag mode a series of data is transferred. There are 57 bytes of diagnostics data (exception: shorter diagnostics, refer to 3.3). The diagnostic data are output as follows:

Diagnostics function	Data type	Diagnostics Octet No.
Station status 1 (refer to Profibus standard)	Octet	1
Station status 2 (refer to Profibus standard)	Octet	2
Station status 3 (refer to Profibus standard)	Octet	3
Diagnostics Master Address	Octet	4
PTO identification number	Octet	5, 6
Extended diagnostics header	Octet String	7
Alarm messages	Octet String	8
Number of axes	Unsigned 16	9, 10
Measuring range	Unsigned 16	11,12
-		13-16
Additional alarm messages		17
Supported alarm messages		18, 19
Warnings		20, 21
Supported warnings		22, 23
Version	Octet String	24, 25
Software version	Octet String	26, 27
Operating time	Unsigned 32	28-31
Zero point shift X-Axis	Signed 16	32, 33
Zero point shift Y-Axis	Signed 16	34, 35
-		36-47
Serial number	ASCII String	48-57

6.2 Description of the diagnostics messages supported

The implemented diagnostics messages are described in more detail below. A description of the diagnostics bytes 1 – 3 can be taken from the Profibus standard.

6.2.1 Extended diagnostics header

The length of the extended diagnostics header (including diagnostics header) is contained in diagnostics byte 7:

6.2.2 Memory error

Bit 4 in diagnostics byte 8 is used to display whether a memory error has occurred. Memory error means in this case that the inclinometer EEPROM no longer functions correctly and the preset values are no longer kept during power outages (non-volatile data save).

Byte	Bit	Definition	= 0	= 1
8	4	Memory error (defect in EEPROM)	No	Yes

6.2.3 Inclinometer type

Number of axes and measuring range of the inclinometer can be interrogated using diagnostics bytes 9 – 12:

Byte	Format	Description
9, 10	Unsigned 16	Number of axes
11, 12	Unsigned 16	Measuring range (in positive direction)

6.2.4 Operating time alarm

When the operating time is exceeded the alarm signal is output in bit 4 of diagnostic byte 20. This bit is set after 10^5 hours.

Byte	Bit	Definition	= 0	= 1
20	4	Operating time alarm	No	Yes

6.2.5 Version (hardware)

The version number of the inclinometer is saved in diagnostics bytes 24 and 25.

Octet	24	25
Bit	15 - 8	7 - 0
Data	2^7 to 2^0	2^7 to 2^0
	Revision-No.	Index

6.2.6 Software version

The version number of the inclinometer software is saved in diagnostics bytes 26 and 27.

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

6.2.7 Operating time

The inclinometer operating time is kept in diagnostic bytes 28 to 31. When the power supply voltage is connected the operating time is saved every 6 minutes in 0.1 h steps in the inclinometer.

6.2.8 Zero offset

The zero offset values are output in diagnostics bytes 32 – 35.

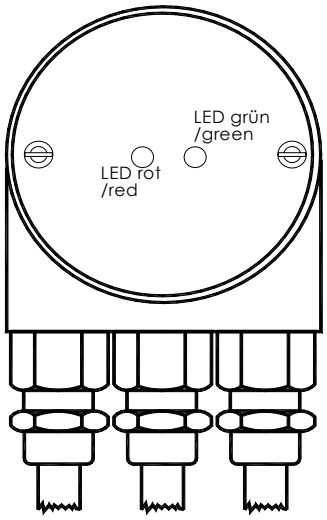
Byte	Format	Description
32, 33	Signed 16	Zero offset X-Axis
34, 35	Signed 16	Zero offset Y-Axis

6.2.9 Serial number

Diagnostics bytes 48 – 57 are provided for a serial number. This signal has presently not been implemented. The bytes are pre-assigned hex 2A (default value).

6.3 Status messages using the LEDs in the connection cap

The connection cap has two LEDs which optically represent the status of the inclinometer. Each LED can have one of three conditions: dark, bright, flashing. From the nine possible combinations six are used to display a special status.



The connection cap from outside

Overview of the various conditions displayed using the LEDs

No.	Red LED	Green LED	Status signal / possible cause
1	dark	dark	Power supply missing
2	bright	bright	Sensor ready, but has not received any configuration data after power on
3	bright	flashing	Parameter or configuration error, i.e. the sensor receives configuring or parameter data with the incorrect length or inconsistent data
4	flashing	bright	Sensor ready, but is not addressed from the master (for example incorrect address was addressed)
5	bright	dark	Sensor does not receive data for a longer period of time (approx. 40 sec.) (for example the data line has been interrupted)
6	dark	bright	Standard operation in the Data Exchange mode

7 Technical data

7.1 Electrical data

Model	ANS 15	ANS 30
Measuring range	+/- 15°	+/- 30°
Resolution	0.001°	0.01°
Accuracy (T = 0 °C .. +55 °C)	0.15°	0.2°
Accuracy (T = -25 °C .. +85 °C)	0.3°	0.4°
Damping period (0° -> 15°, t=90%)	typ. 2.5 s	on request
Supply voltage	10 - 30 V DC	
Power consumption	3 Watts	
Electrical Lifetime	> 10^5 h	
EMC	EN 61000-6-4, EN 61000-6-2	
Bus connection	Line-driver according to RS 485 Galvanically isolated by opto couplers	
Connection	Accessory connection cap, IP 66	
Cycle time	Typ. 4 measurements / second (because of measuring principle)	
Device addressing	Programmable by rotary switches in connection cap	

7.2 Environmental conditions

Operating temperature	- 25 °C … + 85 °C
Storage temperature	- 40 °C … + 85 °C
Humidity	98 % (without liquid state)
Protection class (EN 60529)	IP 66 (with connection cap connected)

7.3 Dimension drawings