POSITAL
FRABA

PROFI PROCESS FIELD BUS

Absolute Rotary Encoder with Profibus-DP Interface

AWC 581x-xxxx-xBA1DPx3PG

User Manual

POSITAL
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Contents

Imprint

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Specifications are subject to change without notice

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

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Note:
Readers, who already have sufficient experience in handling Profibus and absolute angular encoders and who use the COM Profibus or another comparable configuring software, can skip the introductory section and start with section 6, Page 34.

1 Introduction

In recent years, a wide spectrum of various fieldbus systems for industrial automation has appeared, and Profibus is one of the most successful. FRABA was from the beginning one of the leading manufacturers of absolute rotary encoders with Profibus interface. The version from 1999, for which this manual was written, represents another step forward. Several new features have been integrated and the user friendliness has been further improved without sacrificing the backwards compatibility. The new GSD-Files allows the direct input of device parameters in the menu fields of COM Profibus and other project tools.
FRABA absolute value encoders fulfill all of the requirements of a node (station) for a Profibus-DP network, and they are appropriately certified. This Manual is intended to provide the user with an overview of the various functions of the absolute angular encoder, and support when it comes to solving user problems. We always appreciate feedback regarding improvements and suggestions.

1.1 Definitions and abbreviations

Terminating resistor	Resistor to adapt bus cables; terminating resistors are always required at the end of a cable or segment.
Address	A number, which is assigned to each node, no matter whether it is a master or slave. The setting is realized in the connecting cover using rotary switches so that it is non-volatile.
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.
Configuring	When configuring, the master signals the angular encoder how it is to behave, e.g. the number of input- and output words. (also refer to→ DDLM_Set_Prm).
Diagnostics	Identification, localization, classification, display, additional evaluation of faults, errors and messages.
DDLM	Direct Data Link Mapper. Interface between Profibus-DP functions and the encoder software.
DDLM_Data_Exchange	Operating status of the bus, for standard data transfer.
DDLM_Set_Prm	Operating status of the bus, in which configuration data is sent.
DDLM_Slave_Diag	Operating status of the bus, in which diagnostics data are requested from the slave (for example the absolute angular encoder).
DP	Distributed peripherals

Encoder	Alternative designation f. (angular) encoders or absolute value encoders
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 instantaneous value. The input data are only updated again, when the master sends the UNFREEZE command.
GSD file	Master device data file, in which the slave-specific properties and characteristics are defined. The GSD is a file, which is made available for most Profibus nodes (stations) by the manufacturer. The GSD formats are unified, so that the corresponding control software can access it. (also refer to → Type file).
Master	Bus nodes, which can send data on their own initiative, and define which slave should send data. → Slave
Octet	Data unit of 8 bits = 1 byte
Profibus	**Pro**cess **Fi**eld**bus**, 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.
Parameterization	Transfers specific values, such as resolution per revolution, direction of rotation etc. from the master to the encoder. This is realized when the system runs-up.
Slave	Bus node, which essentially only sends data when instructed to do so by the →Masters. Absolute rotary encoders are always slaves.
Type file	Associated with the GSD and is mainly used for Siemens devices and software (also refer to → 9.2 **Special encoder profile-versions**).
Word	Is frequently used, but not in a unified fashion, for a data unit of 2 bytes.

Further, the following abbreviations are used in this
User Manual:

API	Absolute position actual value
AU	Resolution per revolution
CW	Clockwise. Clockwise direction of rotation (when viewing the shaft)
CCW	Counter-clockwise. Counter-clockwise direction of rotation (when viewing the shaft)
GGA	Selected total resolution
MGA	Maximum total resolution (i.e. resolution specified from the hardware, generally 2^{24})
PW	Preset value
PI	Process actual value
VC	Velocity

1.2 Mode of operation of an absolute angular encoder

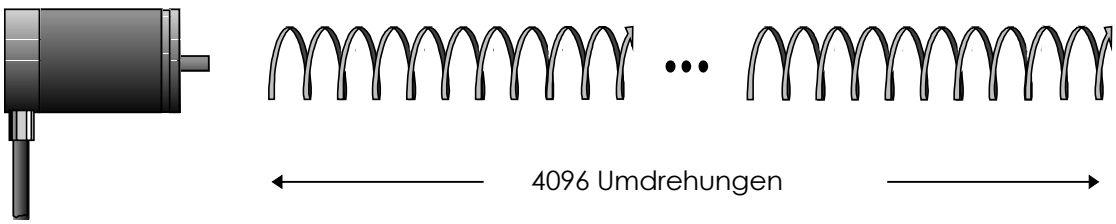
Angular encoders have the task of converting the position (angular position) of a shaft into a number. This number is then transferred onwards in a digital form.
The basic principle is that light from an LED is radiated through a transparent disc (coding disk) which is coded, and the bright-dark pattern is converted into digital signals.

Coding disk with Gray code

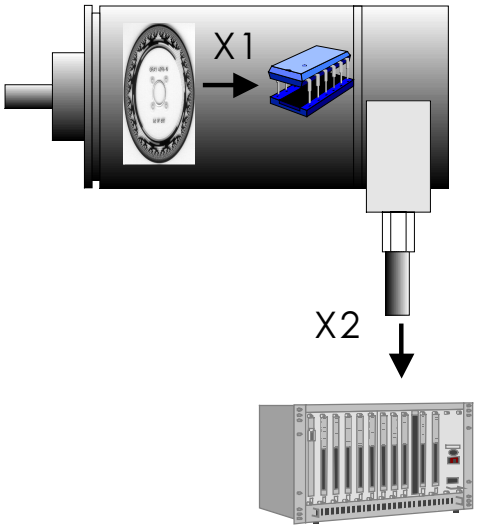
Each angular position corresponds to another sequence of zeros of ones, which uniquely defines the position as a result of the angular encoder hardware. This is also the decisive difference to incremental angular encoders, which only sense the *change* in the angular position, but not the absolute position.

If an incremental angular encoder is rotated, without it being operational (e.g. it is in a no-voltage condition), when the equipment is powered-up again, the angular position information is lost, and it is necessary to re-reference the machine which can be complex. For an absolute angular encoder, in such a case, position changes are also sensed without a power supply voltage being available, and, after the operating voltage is switched-in again, transferred to the higher-level control system. The coding disk allows individual revolutions to be coded. The standard resolutions are 4096 steps (= 2^{12}) and 8192 steps (= 2^{13}) per revolution.

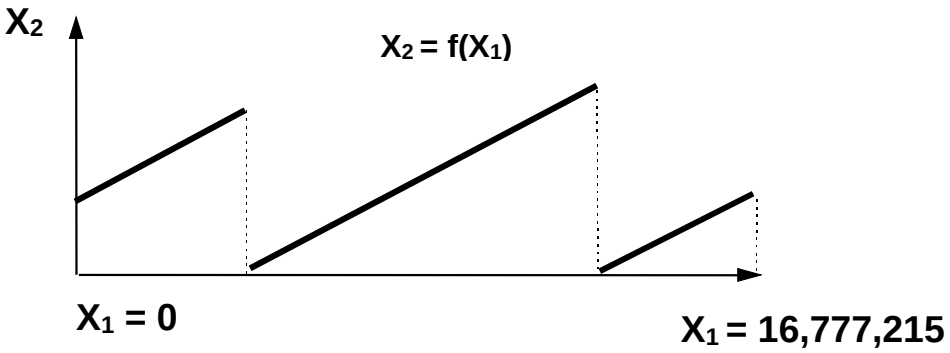
For so-called multi-turn versions, a gearbox with additional coding discs is integrated in the angular encoder. This means that up to 4096 revolutions can be sensed. As a result of the hardware, there is also an absolute assignment to the angular range (4096 steps / revolution) x (4096 revolutions) = 16.777.215 steps. These values are absolute, i.e. there is an absolute zero point, and after 4096 revolutions, the same values are read-out again. Sensors are used to read-out the data, which then convert the bright-dark pattern into digital electrical signals.



This „code value“ is now converted in the angular encoder. The user can influence this conversion in various ways, and therefore adapt the output values to his requirements. Value x_1, read-out from the coding discs, is therefore assigned a new numerical value $x_1 \rightarrow x_2=f(x_1)$. This relationship is always linear.



Here is an example of how this relationship could look like:



This represents a decisive advantage. The control system is relieved by shifting this conversion process out of the control system into the encoder. The output values can be influenced as follows:

Direction of rotation (complement)	This defines whether the angular encoder counts up when rotating clockwise, or when rotating counter-clockwise.
Resolution per revolution (*AU*)	Number of steps by which the value increases by for each revolution.
Total resolution (*GA*)	This parameter specifies the highest number, which the output position values can assume.
Preset value (*PW*)	The user can assign a value to any position of the angular encoder shaft – the preset value. The preset value must lie within the total resolution.
Gear factor	A factor x_1 / x_2 can be entered; this defines the ratio between the physical resolution and the required resolution. The gear factor can be alternatively entered to the value „Resolution per revolution“.

Note

As the position values are periodically repeated after 4096 revolutions, the function dependent on this f(x_1) must also be repeated, at the latest after 4096 revolutions. This has important consequences when using “Endless operation” , i.e. the shaft rotates an unlimited number of times in a specific direction, and at some time, exceeds the 4096 revolutions.

With former encoder versions this problem resulted in restrictions regarding the programming of resolution per revolution and total resolution when using the device in endless operation. From software version 3 on the problem which occurs when crossing the physical zero point is solved by an internal software routine. So there are no more restrictions for the use in endless operation.

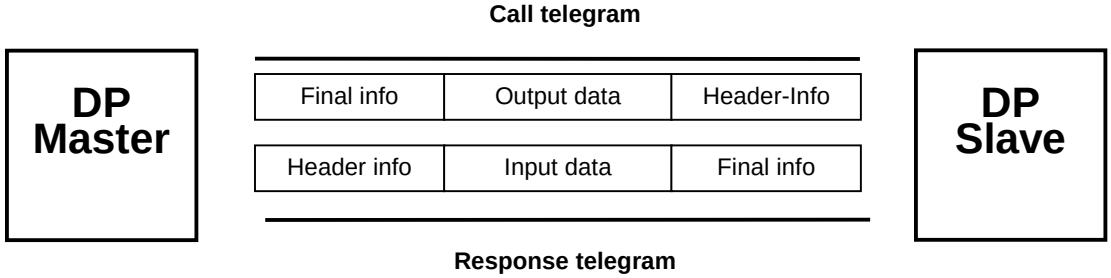
1.3 General information about Profibus

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 absolute rotary encoders 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, manufacturer, and suppliers is

PROFIBUS - Trade Organization (PTO)
Haid-und-Neu-Straße 7
D-76131 Karlsruhe
Germany
Tel.: ++49 / 721 / 96 58 59 0
Fax.: ++49 / 721 / 96 58 58 9

The FRABA absolute rotary encoders fulfill all of the requirements according to Profibus-DP from DIN 19245 Parts 1 and 3. The integrated Profibus-DP interface of the absolute value encoder is designed for a maximum data transfer rate of 12 MBaud. The integrated software supports all of the functions of the official encoder profile for Profibus-DP. Data is always output in the binary code.

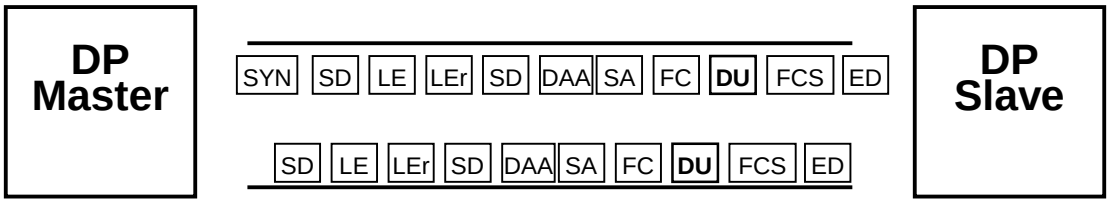


Schematic overview of data transfer for Profibus-DP

A basic differentiation is made between the following states when exchanging data:

1. Configuring- and parameterizing phase (DDLM_Set_Prm). This is active when the system runs-up.
2. DDLM_Data_Exchange mode: „Standard operation„, the masters sends an inquiry, which the angular encoder responds with the actual position (process actual value) and additional data, for example, velocity.
3. DDLM_Slave_Diag: In this status, the slave sends diagnostics data to the master.

SRD-Request variable information field length



SRD-Response variable information field length

Telegram formats

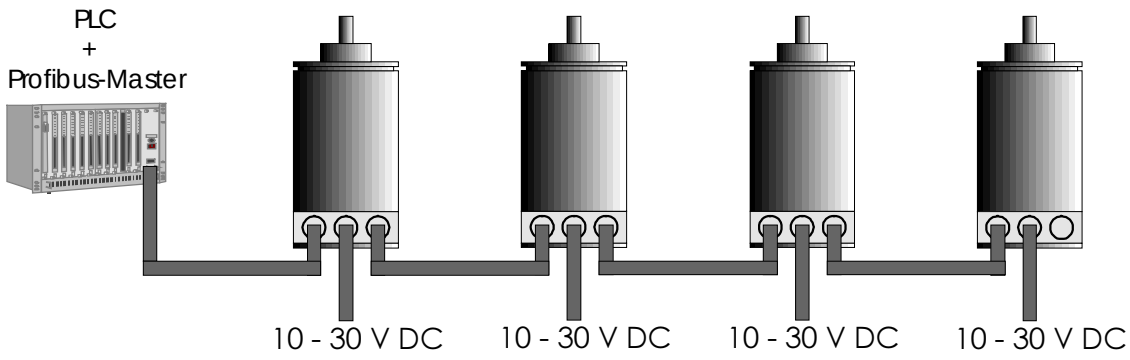
SRD	Send and request data with acknowledge (Data are sent and received in a message cycle)		
Syn	Synchronisation Time	SA	Source Address
SD	Start Delimiter	FC	Function Code
LE	Length	DU	Data Unit
Ler	repeated Length	FCS	Frame Check Sequence
DA	Destination Address	ED	End Delimiter (always 16 hex)

For PROFIBUS-DP a differentiation is made between four various telegram types. A differentiation is made by the value of the Start Delimiter (SD):

1. Request_FDL_Status (FDL= **F**ieldbus **D**ata **L**ink, also known as Layer 2). The Start Delimiter has the value 10 hex. This telegram is also sent from an active station, always after the GAP time has expired in order to search for new active nodes on the bus.
2. Data telegram with variable data length. This used in the SRD utility (send and request data with acknowledge). SD = 68 hex.
3. Telegram with a fixed data length. SD = A2 hex.
4. Token telegram (only between masters). SD = DC hex

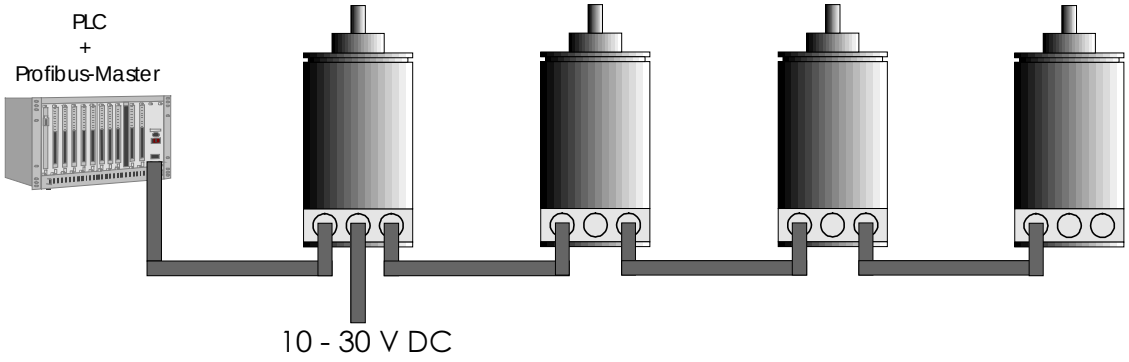
1.4 Configuring a Profibus-DP network

The interface of the absolute angular encoder is based on the PROFIBUS-DP Standard (EN 50170). In order to be able to use an absolute angular encoder as SLAVE with the Profibus-DP interface, an interface board is required in the control system which acts as PROFIBUS master.



Schematic PROFIBUS network with separate power supply

As a result of the connection cap design of FRABA absolute value encoders, the power supply can also be fed via the bus cable.



Schematic of a PROFIBUS network with power supply looped-through

2 Encoder profile classification

The absolute value encoder with Profibus-DP interface transfers the process actual value, and if required, the velocity in the binary code. In addition, a preset value, and with the manufacturer-specific profiles, FRABA 2.1 and FRABA 2.2, additional information can be transferred by setting special bits in the DDLM_Data_Exchange mode.
The Profibus Trade Organization (PTO) has defined encoder profiles, which are designated as Class 1 and Class 2. These are available as documentation from the PTO (Order No. 3.062). A differentiation is made between non-parameterizable (Class 1) and parameterizable (Class 2) absolute angular encoders. When configuring the FRABA absolute value encoder the user specifies if the encoder should operate as Class 1 or Class 2. In addition FRABA manufacturer specific functions can be selected.

Note
Class 1 and Class 2 encoders have nothing to do with Class 1 and Class 2 Masters. It is quite possible to use a Class 2 encoder with a Class 1 Master.

To choose between the different profile versions a GSD-File is used. The user can select the version that fits his hard and software. Generally, a differentiation should be made between *Type files* and *GSD* files. The GSD file should always be used as standard. This is available from FRABA on a floppy disk (Order type: Disk with Profibus GSD-Files) or in the Internet (www.fraba.com). The *Type* files should only be used for older types of masters, which cannot process any GSD files. In this case, only Class 1 and Class 2 profiles are supported. The hardware of the absolute encoder, apart form the difference between multi and single turn encoders, is always the same. This allows the same encoder to be used in a wide filed of applications.

2.1 Selecting the encoder configuration

The user has a full range of possibilities with the profile, Version 2.1 and Version 2.2. Version 2.2 differs from 2.1 in so much that in addition, the velocity can be output. Two software limit switches can be set, reduced diagnostics activated (this is important for some of the older masters) and the on-line parameterization (or „Commissioning mode“) enabled. This mode allows, in addition to the preset value, also the direction of rotation to be changed on-line. It also offers a very user-friendly technique in which the gear factor can be directly set at the system (teach-in procedure). For some applications, the simple profile, Class 2 or even Class 1 are sufficient. FRABA is also still providing this profile for this particular case.
Further, FRABA is providing other versions, which are described in Section 9.2. These involve, especially older versions, which for reasons of compatibility, should still be available. For new projects we recommend that profile FRABA 2.1 or FRABA 2.2 is used. The later if the velocity output is required.

Overview of the various encoder classes and configurations (Part 1)

FRABA 2.2 (Single/Multiturn)	This is the configuration, which offers most functions. In addition to be able to set preset values and to change the direction of rotation in standard operation, there is a special start-up mode with which the gear factor can be set using a teach-in technique. Two software limit switches are available and the velocity can be output in selectable units. There is an option to output a reduced number of diagnostic bytes. Refer to Section 4
FRABA 2.1 (Single/Multiturn)	As for FRABA 2.2 (Single/Multiturn), or without velocity output. Refer to Section 4
Class 1 (Single/Multiturn)	This only allows the direction of rotation to be adjusted. Refer to Section 3
Class 2 (Single/Multiturn)	The direction of rotation, gear factor, preset value can be set Refer to Section 3
FRABA 2.0 (Multiturn)	Special version (as for FRABA 2.2, but with fewer fields in the COM Profibus mask – this should only be used in special cases, refer to the Appendix)
FRABA 1.1 (Multiturn)	Manufacturers-specific version (refer to the Appendix)
FRABA 1.0 (Multiturn)	Manufacturers-specific version (refer to the Appendix)
Class 2 (Multiturn) 'DX-Version'	Manufacturers-specific version (refer to the Appendix)

(Highlighted = Standard)

Overview of the various encoder classes and configurations (Part 2)

Designation	Configuration		Number of input words (encoder → control)	Number of output words (control → encoder)	Description refer to section
	hexa-deci-mal	deci-mal			
Class 1 Singleturn	D0	208	1	0	3
Class 1 Multiturn	D1	209	2	0	
Class 2 Singleturn	F0	240	1	1	
Class 2 Multiturn	F1	241	2	2	
FRABA 2.2 Singleturn - with velocity -	F1 D0	241 208	2 1	2	4
FRABA 2.2 Multiturn - with velocity -	F1 D0	241 208	2 1	2	
FRABA 2.1 Multiturn - without velocity -	F1	241	2	2	
FRABA 2.1 Singleturn - without velocity -	F1	241	2	2	
FRABA 2.0 Multiturn	F1 D0	241 208	2 1	2	9.2.1
FRABA 1.1 Multiturn + velocity + preset	D3 E1	211 225	4 0	0 2	9.2.2
FRABA 1.0 Multiturn + velocity	D3	211	4	0	9.2.3
Class 2 Multiturn 'DX-Version'	F1	241	2	2	9.2.4

3 Class 1 and Class 2 profile

These versions are the „classic“ versions, which were defined by the encoder working group in the Profibus User Organization in the *Profile for encoder* (this can be obtained from the PNO, Order No. 3.062). FRABA 2.2 and FRABA 2.1 also belong to Class 2, but offer additional functions. If these functions are not required for the particular application, then the standard Class 1 and Class 2 versions allow angular encoders to be used without having to struggle with detailed information.

3.1 Parameterization

A differentiation must be made between two statuses when it comes to data transfer. On one hand, the phase when the system runs-up, when the angular encoder is parameterized (DDLM_Set_Prm mode), and on the other hand, standard operation (DDLM_Data_Exchange mode). Some information is transferred at run-up, however the preset value is only transferred during normal operation.

The control system *configures* the angular encoder when the system runs-up, i.e. the encoder profile, selected by the user, is transferred to the angular encoder (also refer to Section 2 Encoder profile classification). Depending on the version which was selected, the parameter data, defined by the user, is transferred to the angular encoder (*parameterization)*. Generally, this is realized automatically and the parameters are entered into a mask in the operator control software (e.g. COM Profibus, refer to Section 7). However, in some cases it is necessary to individually process the bits and bytes. Data is transferred according to the Profibus profile as shown in the schematic in the following table.

Overview of the significance of the various bits and bytes when the bus runs-up

Octet (=byte) No.	Parameter	Bit No.	Details refer to
1 ... 8	Reserved for PROFIBUS-specific data		- -
9	Code sequence	0	section: 3.1.1 page: 16
	Class 2 functionality	1	section: 3.1.2 page: 17
	Commissioning, diagnostics	2	section: 3.1.3 page: 17
	Scaling function control	3	section: 3.1.4 page: 17
	Reserved	4	- -
	Reserved	5	- -
	Is not used for Class 1 and Class 2	6	- -
	(refer to optional versions FRABA 2.1 and 2.2	7	
10 ... 13	Measuring units per revolution		section: 3.1.5 page: 17
14 ... 17	Total measuring range		section: 3.1.6 page: 18
18 ... 25	Reserved for the encoder profile		- -
26 ...	Is not used for Class 1 and Class 2 (refer to optional Versions FRABA 2.1 and 2.2)		- -

3.1.1 Code sequence

The code sequence defines the counting direction when the process actual value is output as the shaft rotates clockwise **CW** or counter-clockwise **CCW** when viewing the shaft. The count direction is defined by bit 0 in octet 9:

Octet 9 Bit 0	Direction of rotation when viewing the shaft	Output code
0	Clockwise **CW**	increasing
1	Counter-clockwise **CCW**	increasing

For Class 1, this is the only parameter, which can be set. It should be observed that when the direction of rotation is possibly changed, in the start-up mode (this is only available for FRABA 2.1 and FRABA 2.2), this is overwritten when re-commissioning. For example, if the angular encoder is no longer used in the commissioning mode, but in the standard mode.

3.1.2 Class 2 functionality

Using this switch, Class 2 angular encoders can be restricted to the functionality of Class 1, i.e. the parameterizing capability is disabled. Bit 1 in octet 9 is set in order to use the functions of a Class 2 encoder.

Octet 9 Bit 1	Class 2 functionality
0	switched out
1	switched in

3.1.3 Commissioning diagnostics

This function has no significance for the FRABA absolute value encoder.

3.1.4 Scaling function

The scaling function enables the resolution per revolution (AU) and the selected total resolution (GGA) to be parameterized. This switch should always be switched-in, if the functions of Class 2 are to be used, or even higher classes (FRABA 2.1, FRABA 2.2).

Octet 9 Bit 3	Scaling function
0	switched out
1	switched in

3.1.5 Measuring units per revolution

The 'Measuring units per revolution' parameter is used to program the angular encoder so that a required number of steps can be realized, referred to one revolution.
If a value greater than the basic resolution of the absolute value encoder is selected as resolution per revolution, the output code is no longer in single steps. **Thus, it should be observed, that the required resolution does not exceed the resolution of the absolute value encoder defined by the hardware.**

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}
	Measuring units per revolution			

3.1.6 Total measuring range

Using the 'Total measuring range' parameter, the user can program the angular encoder so that after a specific number of revolutions it starts to count again at zero. Normally, this would be 4096 revolutions, however using the 'Total measuring range' parameter, even shorter periods can be selected.
Example:
100 steps are selected for each revolution, total resolution 12 800, and then the angular encoder starts again at zero after 128 revolutions and then counts up to 11799.

With older versions certain rules had to be observed when selecting the total resolution (because of the encoder principle, refer to 1.1). In the case of ignoring the following rules problems occurred when using the device in endless operation (when crossing the physical zero point). With new devices (Software version 3 or higher) this problem is solved by an internal software routine. Therefore rule number 2 can be ignored.

The angular encoder configurations, FRABA 2.2 and FRABA 2.1 offer a user-friendly technique so that, for example, gear factors can be simply entered and the total resolution, associated with the gear factor is automatically set. The period length is always 4096 revolutions. However, also when using rotary axes, a sequence can repeat itself after a defined number of revolutions, and the angular encoder should start again after this number of revolutions (= periods). If another period length is required (e.g. the process always repeats itself after 8 revolutions), the following rules should be observed (with new devices rule no. 2 can be ignored):

1. If **n** steps per revolution were selected, then the selected total resolution **GGA** cannot cause the periods to be longer than the maximum 4096 revolutions. This means that the selected total resolution must be less than 4096 times the number of steps per revolution:

   GGA < 4096 x n

   If this is not observed, then the LEDs in the connecting cover display **parameterizing error** (refer to **5.3**)

---

2. The periods, i.e. **GGA/ n** must be an integer number. This must fit an integer number of times (integer multiple) in 4096. Thus, the following equation must apply:

   4096 / (GGA/ n) = 4096 x n / GGA = integer number

   This function is not monitored. No error message is output.

   Note: Must only be observed with devices older than Software version 3

The value for the selected total measuring range is saved in octets 14 to 17:

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}
	Selected total measuring range in measuring steps			

Note

In order that the resolution can be parameterized to be effective per revolution, Class 2 functionality **and** the scaling function must be switched-in.

If the parameterizing is changed, then it maybe necessary to set earlier set presets, in standard operation, as they now refer to the modified scaling.

3.2 Data exchange in normal operation

This is the normal status when the system is operational. When requested to do so, the angular encoder sends the actual values to the control system. It can then also receive data. This is the preset value for Class 2 angular encoders. Other values can also be transferred with the configuration FRABA 2.1 and FRABA 2.2 configurations (refer to Section 1). The versions below, refer to multi-turn versions, but can be considered exactly like single-turn encoders.

3.2.1 Transferring the process actual value

In the standard operating mode, MSB = 0 (bit 31, bit 15 for single-turn versions)

The angular encoder does not change the preset value.

Word	Word 1							Word 0																						
Function	Status bits							Process actual 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	0	0	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

3.2.2 Preset value

The preset value is the process actual value, which should then be output when the axis is in a certain physical position. Using the preset value parameter, the value output from the angular encoder, is defined at a specific angular position. The preset value may not exceed the total resolution parameter. The preset value is set after the scaling parameter 'Resolution per revolution' is transferred, and 'Total resolution' is set and refers to these scaled quantities. The preset value is transferred in the Data_Exchange mode by setting bit 31.

It takes less than 40 ms to save the preset so that it is not lost when the power fails. After the preset value has been received, bit 31 is set as acknowledgment, and the actual process actual value is immediately re-output. The procedure is shown below as table.

M = Master		Status bits							Data bits																				
S = Slave	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
M -> S		**1**	0	0	0	0	0	0	required process actual value = preset value is transferred here																								
S -> M		**1**	0	0	0	0	0	0	new = required process actual value is transferred here																								
M -> S		0	0	0	0	0	0	0	Reset to normal mode																								
S -> M		0	0	0	0	0	0	0	new = required process actual value is transferred here																								

Note

If high precision is required, the preset mode should only be executed when the encoder shaft is at a standstill. If the shaft moves quickly during this time, offsets can occur, as even when the preset value is set, bus propagation times occur (bus delay times).

4 FRABA 2.2 and FRABA 2.1 - Profile

With these versions, FRABA offers a multitude of functions, which shift the intelligence from the control into the slave devices, in the sense of distributed peripherals. The user can use these functions, but he does not have to. The system is fully harmonized to the users requirements and features which are not required, can be disabled.

4.1 Manufacturer-specific functions

This version is especially characterized by the ability to parameterize on-line and the so-called 'Teach-in'. In the DDLM_Data_Exchange mode, this on-line parameterization not only allows the preset value to be set, but in addition also the direction of rotation and the capability of automatically calculating the resolution. An overview of the individual bytes for FRABA 2.1 and FRABA 2.2 is provided in the following table.

Overview of the significance of the various bits and bytes when running-up the bus, versions FRABA 2.2 and FRABA 2.1

Octet (= byte) No.	Parameter	Bit No.	Details refer to Section:	Page:
1 ... 8	Reserved for PROFIBUS-specific data			
9	Code sequence	0	3.1.1	16
	Class 2 functionality	1	3.1.2	17
	Activate „Commissioning Diagnostics“	2	3.1.3	17
	Scaling function control	3	3.1.4	17
	Reserved	4		
	Reserved	5		
	Activate octet 26	6	4.1.1	22
	Reserved	7	-	-
10 ... 13	Desired measuring units per xxx (refer to octet 26 bit 0 and 1)		4.1.2	22
14 ... 17	total measuring range		3.1.6	18
18 ... 25	Reserved for the encoder profile			
26	Desired measuring units: reference	0	4.1.3	23
		1		
	Activate commissioning mode	2	4.1.4	23
	Shorter diagnostics (16 bytes)	3	4.1.5	24
	Reserved	4	-	-
	Activate lower limit switch	5	4.1.7	24
	Activate upper limit switch	6	4.1.8	25
	Activate octet 27 – 39	7	4.1.6	24
27 ... 30	Lower limit switch		4.1.7	24
31 ... 34	Upper limit switch		4.1.8	25
35 ... 38	Physical impulses		4.1.9	25
39	Reserved	0	-	-
	Encoder type (Single-/Multiturn)	1	4.1.10	26
	Reserved	2	-	-
	Reserved	3	-	-
	Velocity time base	4	4.1.11	26
		5		
	Reserved	6	-	-
	Reserved	7	-	-

4.1.1 Activating octet 26

The functionality in the commissioning mode is prepared using octet 26. The detailed procedure is described under 4.2. This bit is automatically activated by selecting FRABA 2.1 or FRABA 2.2. However, it is only important when „manually“ parameterizing.

Octet 9 Bit 6	Octet 26
0	switched out
1	switched in

Further, for Versions FRABA 2.1 and FRABA 2.2, bit 7 in octet 26 must be set. (Refer to 4.1.6.)

4.1.2 Desired measuring units

The parameter, desired measuring units per xxx („xxx“, refer to 4.1.3) is used to program the angular encoder, so that a required number of steps can be realized, either referred to one revolution, the complete measuring range, or any sub-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 per xxx			

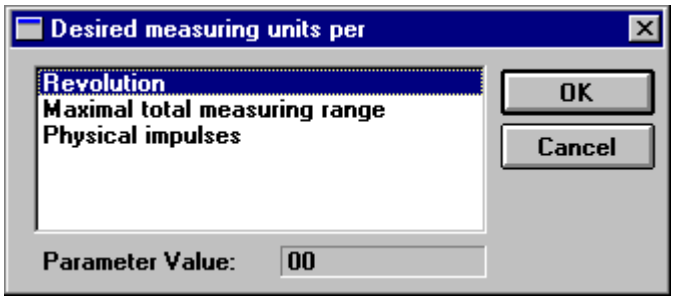
Bits 0 and 1 in octet 26 are used to define the reference for the value entered here (refer to 4.1.3). When selecting „per revolution“, in addition, the value saved in octet 14 - 17 is used (also refer to 3.1.6) and is used to set shorter periods than 4096 revolutions.
If a value greater than the basic resolution of the angular encoder is selected as resolution per revolution, the output code is no longer a single-step code. Thus, it should be observed that the required resolution does not exceed the angular encoder resolution, specified by the hardware (4096 steps per revolution for 12 bit encoders and 8192 steps per revolution for 13 bit encoders).

4.1.3 Desired measuring units reference

Here a decision is made to the reference for the 'Desired measuring units' (=resolution) entered in octet 10-13, i.e. either

- required number of steps per revolution
- required number of steps per 4096 revolutions (= total maximum resolution)
- required number of steps per the number of Physical impulses saved in octet 35 - 39 (also refer to 4.1.9). 'Physical impulses' means: The numerical value as the encoder internally reads from the coding disc. This is always 4096 steps per revolution (8192 steps for the 13 bit version).

For example, the selection field in COM Profibus looks like this:



Gear factors can be freely set using the later option. Whereby it should be noted, that if the resolution is higher than the physical one, the single-step functionality is lost.

For the case that the resolution per revolution is selected, the total resolution, saved in octets 14 - 17 are used. **Always refer to the comments under 3.1.6.**

Reference	Octet 26 Bit 0	Octet 26 Bit 1
per revolution	0	0
per maximum total measuring range	1	0
per physical impulses (=steps specified in octet 35-38)	0	1

4.1.4 Activating the commissioning mode

Bit 2 in octet 26 represents a switch for the commissioning mode. This switch is, for example, available in the selection menu for COM Profibus.
The commissioning mode is a special status in the DDLM_Data_Exchange mode. If it is activated (this can be identified when the green LED in the unit flashes), then other parameters, besides the preset value, can be transferred to the angular encoder. These are then saved so that they are not lost when the power goes down (non-volatile). A gear

factor can be determined by directly moving the system (for details, refer to 4.2). The system is ready to operate in this status. If all of the parameters have been optimized, then the determined quantities should be directly entered in the DDLM_Set_Prm mode (the bus is run-up again with a configuration), and the commissioning mode disabled.

Bit 2 Octet 26	Inbetriebnahmemodus
0	Ausgeschaltet
1	Eingeschaltet

4.1.5 Shorter diagnostics

For some Profibus masters it is important that the full number of diagnostic bytes are **not** output, as this could otherwise cause problems. This is the case for older masters. Please refer to the documentation of the master board for the number of possible diagnostic bytes. For the FRABA absolute value encoders, it is possible to reduce the number of diagnostic bytes, output from the angular encoder, to 16.

Octet 26 Bit 3	Diagnostics
0	Standard = 57 bytes
1	Reduced = 16 sytes

4.1.6 Activating octet 27- 39

Octets 27- 39 are activated with bit 7 in octet 26. This bit is automatically activated by selecting version FRABA 2.1 or FRABA 2.2. This bit should only be taken into account if the parameters are directly entered as hexadecimal values.

Bit 7	Octet 27 - 39
0	switched out
1	switched in

4.1.7 Lower limit switch

A total of two positions can be programmed. When these two positions are fallen below or exceeded, the absolute value encoder sets bit 27 to „1“ in the 32 bit process actual value; within the range it is zero.

Both limit switch values may not exceed the value set for parameter ‘Total measuring range’.
The lower limit switch is switched-in using bit 5 in octet 26. The position value for the Lower limit switch is saved in octets 27 to 30:

Octet	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 (In units, as the encoder outputs them after parameterization)			

4.1.8 Upper limit switch

A total of two positions can be programmed. When these positions are fallen below or exceeded, the absolute value encoder sets bit 27 to one in the 32 bit process actual value; within the range it is zero. Both limit switch values may not exceed the value set for parameter 'Total measuring range'. The Upper limit switch is activated using bit 6 in octet 26 and the position value for the upper limit switch is saved in octets 31 to 34:

Octet	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 (In units, as the encoder outputs them after parameterization)			

4.1.9 Physical impulses

The „Physical impulses" function is activated with bit 0 and 1 in byte 26 (refer to 4.1.3, Page 23). These „physical impulses" are used to freely set a gear factor. The number of steps which should be output for a specified partial measuring range are entered (namely the „Physical impulses").
The value for the „Physical impulses" is saved in octets 35 to 38:

Octet	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}

4.1.10 Angular encoder type

The angular encoder type is specified in bit 1 of octet 39. Generally, this bit is automatically set when the appropriate class is selected.

Angular encoder type	Bit 1
Singleturn	0
Multiturn	1

4.1.11 Velocity time base

The velocity output units can be selected using bits 4 and 5 in octet 39.

In the case of the steps/1000 ms unit, an average is made over 200 ms, and the value multiplied by 5.

Velocity time base	Bit 4	Bit 5
Steps / 1000 ms	0	0
Steps / 100 ms	1	0
Steps / 10 ms	0	1
RPM (Revolutions per minute)	1	1

4.2 Normal operation and commissioning mode

Two different conditions of the DDLM_Data_Exchange mode are available with the versions FRABA 2.1 and FRABA 2.2. Especially the teach-in technique in the commissioning mode allows gear factors to be simply determined directly in the system. In this case, the system is brought to the start of the range to be traversed (e.g. a distance of 4 m), and then the teach-in routine is started (refer to 4.2.3). Now, for example, the range is traversed manually. With the teach-in stop routine (refer to 4.2.4), the user enters how many steps he wishes to have along this particular path (e.g. 4000 steps, each step would then correspond to 1 mm). The encoder internally calculates the new gear factor and automatically sets it. It is saved so that it is not lost during power outages (non-volatile). The device then provides the total resolution. This should be noted, and later, when the system is finally commissioned, set using a new configuration and it then recommended to operate the encoder in the normal operating mode (refer to 4.1.4).

Note

The recommended sequence when using the start-up mode is to first set the direction of rotation and then possibly use teach-in and then finally, to set the preset, as the preset is changed by the first procedures mentioned.

The data are transferred, in normal operation, according to the schematic below. The velocity is only output in version FRABA 2.2.

ID	F1 hex				D0 hex	
Significance	Status + position actual 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}

The master sends 4 bytes to the angular encoder.
The 4 bytes have the following significance:

Significance	Preset value + status			
	Status + (2^{24})	2^{23} - 2^{16}	2^{15} - 2^{8}	2^{7} - 2^{0}

The status bits have the following significance:

Bit 25	Ready 0 = angular encoder is not ready 1 = angular encoder is ready
Bit 26	Mode 0 = commissioning mode 1= normal mode
Bit 27	Software limit switch 0 = lower limit switch ≤ process actual value ≤ upper limit switch 1 = process actual value ≤ lower software limit switch or process actual value ≥ upper software limit switch
Bit 28	Code sequence Bit 28 = 0 : Direction of rotation, clockwise (when viewing the shaft) Bit 28 = 1 : Direction of rotation, counter-clockwise (when viewing the shaft)

4.2.1 Preset value

The preset value is set, analog to the method described in 3.2.2. For version FRABA 2.1 and FRABA 2.2, the preset value can be set both in the commissioning mode as well as in the normal mode.

4.2.2 Setting the counting direction

The direction in which the angular encoder counts up can be changed on-line during the commissioning mode. The master can changeover the direction of rotation set in the angular encoder, using bit 28. The angular encoder itself outputs the selected direction to the master in this bit. If it is zero, then the encoder counts up in the clockwise direction of rotation (when viewing the shaft). If it is one, it counts up in the counter-clockwise direction of rotation.

M = Master		Status bits							Data bits																							
S = Slave	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
M -> S		0	0	0	1	0	0	0	The selected direction of rotation is changed over from 0 to 1 or from 1 to 0 using bit 28																								
S -> M		0	0	0	0/1	0/1	0	1	The encoder now acknowledges the newly selected direction of rotation in bit 0 and bit 28																							0/1
M -> S		0	0	0	0	0	0	0	Changeover is completed by setting bit 28 to zero																							
S -> M		0	0	0	0/1	0/1	0	1	The process actual value is now output again																							

Note

The preset value (refer to 3.2.2) must be set again after this function.

4.2.3 Teach-in START

Start the measurement in order to determine the gear factor, which is required so that the angular encoder outputs a number of steps, specified by the user when the system traverses through a specific distance. Later, with the teach-in STOP procedure (refer to 4.2.4), the user enters the required number after the distance has actually been traversed (e.g. in manual operation).
This function allows the gear to be automatically calculated. The measuring path may not exceed 2047 revolutions.

M = Master	function	Status bits							Data bits																							
S = Slave	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
M -> S		0	1	0	0	0	0	0	The teach-in mode is activated by setting bit 30																							
S -> M		0	1	0	0/1	0/1	0	1	Acknowledging by setting bit 30 to 1																							
M -> S		0	0	0	0	0	0	0	Reset																							
S -> M		0	1	0	0/1	0/1	0	1	Non-calculated process actual value (gear factor = 1, no preset active)																							

Note

The gear factor is internally set to 1, and the zero offset is deleted.

4.2.4 Teach-In STOP

The path difference calculation is started and displayed using this function. The calculation can only be realized, if the teach-in START procedure (refer to 4.2.3) was first executed. When entering the required number of steps, it should be observed that the physical resolution is not exceeded (e.g. entering 3000 steps for a quarter of a revolution). Positive and negative directions of rotation are automatically taken into account, and also if the zero is exceeded.

The „calculated total resolution“ value output, should be noted, and later, if the system is re-configured for final normal operation, set. After this procedure, the new gear factor is saved in the encoder so that it is not lost during power outages (non-volatile).

Note:

The preset value (refer to 3.2.2) must be set again after this function.

M = Master	function	Status bits							Data bits																							
S = Slave	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
M -> S		0	0	1	0	0	0	0	Number of steps which the encoder should output is now sent to the encoder																								
S -> M		0	1	1	0/1	0/1	0	1	Transfer of the total measuring range for the new gear factor (this should be noted!)																								
M -> S		0	0	0	0	0	0	0	Resetting																								
S -> M		0	0	0	0/1	0/1	0	1	The process actual value, calculated with the new gear factor, is output																								

In order that the encoder can be subsequently replaced without having to repeat the teach-in procedure, the total resolution, determined by the encoder, should be transferred into the Profibus master. This is realized by entering the total resolution in the „Desired Measuring units“ field (refer to 4.1.2), and then the „Desired measuring units per“ switch should be set to „Maximal total measuring range“ (refer to 4.1.3). The commissioning mode should then be switched-out (refer to 4.1.4). The encoder then operates in the normal mode.

Note

It should be observed, that for this new configuration, the direction of rotation is correctly entered. If this was changed in the commissioning mode (refer to 4.2.2), then the direction of rotation must be set in the same way when the configuring operation is repeated.

5 Diagnostic messages

Numerous diagnostic data are provided in EN 50170, the Profibus Standard. The widest range of values can be interrogated via the bus. The diagnostic data, supported by the FRABA encoder, will now be described.

5.1 Overview

When requested by the master, by using DDLM_Slave_Diag, a series of data is transferred. There are 57 pieces of diagnostics data. Exception: Shorter diagnostics (refer to 4.1.5). The diagnostics data are output according to the encoder profile [1)] rules.

Diagnostics function	Data type	Diagnostics – octet number	Encoder 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
PTO identification number	Octet	5, 6	1
Extended diagnostics 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
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
Parameterized resolution per revolution	Unsigned 32	40 - 43	2
Parameterized total resolution	Unsigned 32	44 - 47	2
Serial number	ASCII String	48 - 57	2

[1] Profibus Profile for Encoders, PNO Order No. 3.062

5.2 Supported diagnostics messages

The implemented diagnostics messages are described in more detail below. The messages which are not supported, are either not relevant for FRABA absolute value encoders, or have not been implemented.

5.2.1 Extended diagnostics header

The length of the extended diagnostic bytes, including diagnostics header, is contained in diagnostics byte 7. The format of the length value is written in hexadecimal code.

Bit	7	6	5 - 0
Data	0	0	xxh
			Länge der Diagnosebytes

5.2.2 Memory error

Bit 4 in diagnostics byte 8 is used to display whether a memory error has occurred. Memory errors means in this case, that the angular encoder EEPROM no longer functions correctly and the preset value is no longer saved so that it is kept during power outages (non-volatile data save).

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

5.2.3 Operating status

The operating parameters which are set can be interrogated using diagnostics byte 9.

Bit	Definition	= 0	= 1
0	Direction of rotation	CW	CCW
1	Class 2 functionality [1)]	Off	On
2	Diagnostic routine	Off	On
3	Scaling function	Off	On

[1] Class 2 functionality disabled means that the angular encoder is in the operating status, Class 1. Also refer to 3.1.2.

5.2.4 Encoder type

The angular encoder version can be interrogated using diagnostics byte 10. The code is saved in the hexadecimal notation.

Code	Definition
00 h	Single-turn angular encoder
01h	Multi-turn angular encoder

5.2.5 Single-turn resolution

The physical resolution per revolution of the angular encoder can be interrogated via diagnostic bytes 11-14. The value is saved in the binary code.

5.2.6 Number of revolutions

The physical number of revolutions of the angular encoder, can be interrogated using diagnostic bytes 15 and 16. The value is saved in binary code. The two standard values are 1 for singleturn and/or 4096 for multiturn.

5.2.7 Operating time alarm

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

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

5.2.8 Profile version

The profile version of the angular encoder is saved in diagnostic bytes 24 and 25.

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

5.2.9 Software version

The software version of the angular encoder is saved in diagnostic 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

5.2.10 Operating time

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

5.2.11 Zero offset

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

5.2.12 Parameterized resolution per revolution

The parameterized resolution per revolution is saved in diagnostic bytes 40 to 43. This value is only valid, if the gearbox factor was calculated in the parameter mask using the setting „Resolution per revolution“ (refer to 4.1.3).

5.2.13 Parameterized total measuring range

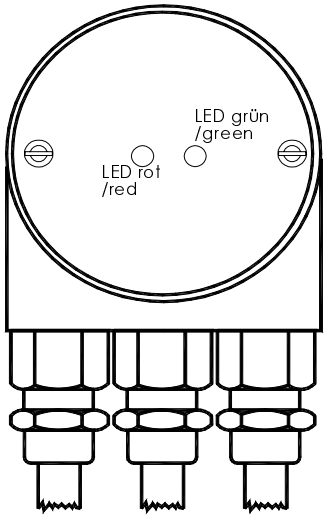
The parameterized and calculated total resolution can be read-out of diagnostic bytes 44 - 47.

5.2.14 Serial number

Diagnostic 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).

5.3 Alarm messages using the LEDs in the connection cap

The connection cap has two LEDs, which optically represent the status of the bus at the angular encoder. This red LED is used to display errors and the green LED is used to display the status of the angular encoder. Each LED can have one of three conditions: dark, bright, flashing. From the nine combination possibilities, six are used to display a special condition.



The connection cap from outside

Overview of the various conditions, displayed using the LEDs

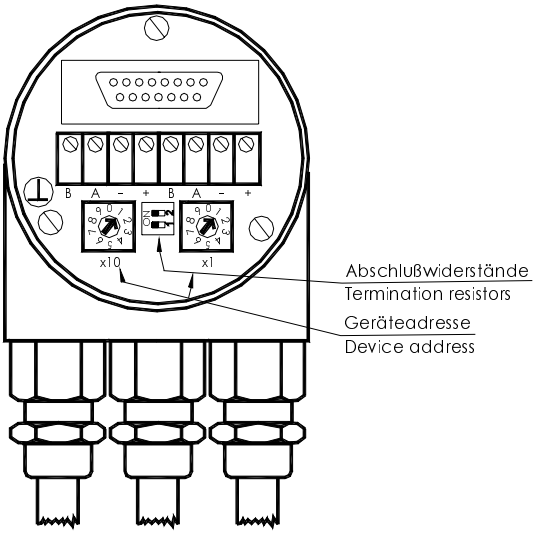
Lfd.Nr.	Rote LED	grüne LED	Statusmeldung / Mögliche Ursache
1	Dark	Dark	Power supply missing
2	Bright	Bright	Encoder ready, but has not received any configuration data after power on
3	Bright	Flashing	Parameterizing- or configuring error, i.e. the encoder receives configuring- or parameterizing data with the incorrect length or inconsistent data (for example, the total resolution has been set too high)
4	Flashing	Bright	Encoder ready, but is not addressed from the master (for example an incorrect address was addressed)
5	Bright	Dark	Encoder doesn't 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	Dark	Flashing	Commissioning mode in the Data Exchange mode

6 Installation

6.1 Settings in the connection cap

6.1.1 Node address

The node (station) address is simple to set using the rotary switch under the connecting cover.



Permissible addresses lie between 0 and 99, whereby each one must be unique in the complete system. The user can simply remove the connecting cover for installation purposes by releasing two screws on the angular encoder.

6.1.2 Bus termination

The terminating resistors must be switched-in, if the encoder is used as an end device. The terminating resistors are set using the double dip switches in the connecting cover.

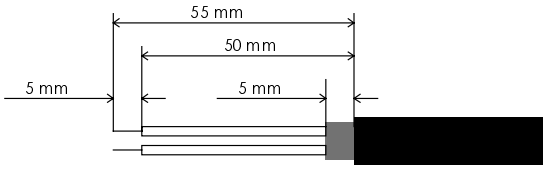
Note

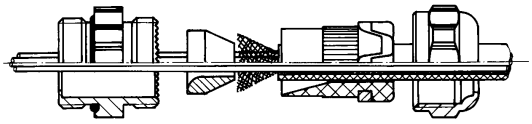
The bus has only been correctly terminated, if the encoder is mounted to the connecting cover. If the encoder has to be replaced in operation, then we recommend that a separate, active bus termination is used.

The angular encoder can be commissioned after the address has been set per hardware and the cable terminating resistor has been switched-in if required.

6.2 Connecting-up the connection cap

The pressure screw, insert and taper sleeve must be removed from the cable gland. Approximately 55 mm of the bus cable sheath must be removed and approximately 50 mm of the braided screen. Approximately 5 mm insulation must be removed from the individual conductors.
The pressure screw and insert are then threaded onto the cable. The taper sleeve is pushed under the screen as shown in the drawing. The complete assembly is then inserted in the cable gland and the pressure screw tightened.





6.3 Connecting the screen

To achieve the highest possible noise immunity the data transmission between different components goes over screened cable. The screen should be connected to ground on both ends of the cable. In certain cases a compensation current might flow over the screen. Therefore a potential compensation wire is recommended.

6.4 Instructions to mechanically install and electrically connect the angular encoder

The following points should be observed:

- Do not drop the angular encoder or subject it to excessive vibration. The encoder is a precision device.
- Do not open the angular encoder housing (this does not mean that you cannot remove the connection cap). If the device is opened and closed again, then it can be damaged and dirt may enter the unit.
- The angular encoder shaft must be connected to the shaft to be measured through a suitable coupling. This coupling is used to dampen vibrations and imbalance on the encoder shaft and also avoid inadmissible high forces. Suitable couplings are available from FRABA.
- Although FRABA absolute value encoders are rugged, when used in tough ambient conditions, they should be protected against damage using suitable protective measures. Care should be taken that they are not installed so that they can be used as handles or even 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 angular encoder at a considerable distance away or completely separated from power cables with their associated noise. Completely screen 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 and fault connections can result in severe personnel injury and material damage.

7 Angular encoder and the COM Profibus

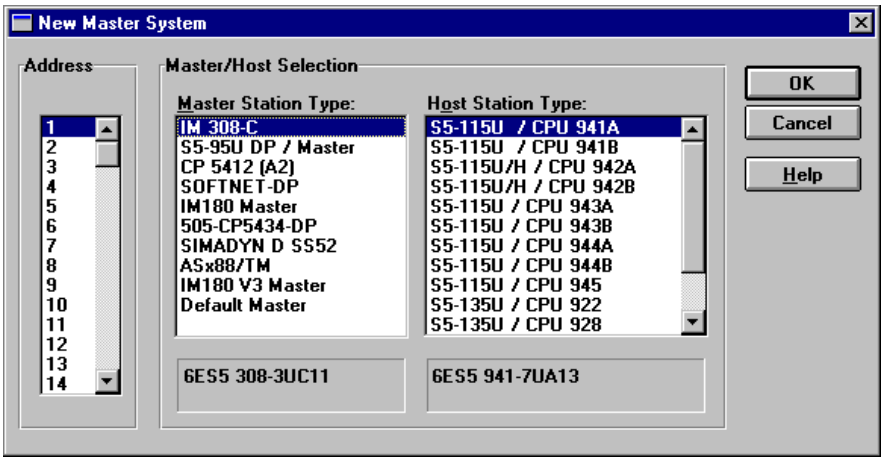
The Profibus-DP master commissioning is illustrated using as an example, the IM 308 C interface board with the COM Profibus software package. If you have questions regarding other project tools, please contact that manufacturer.

7.1 Reading-in the GSD files

COM Profibus can be started after the GSD file has been copied into the directory ...*GSD* and the bitmap into the directory ..*Bitmap*. The type files are first read-in by selecting the menu item “Read-in GSD files” under the menu “File”. A signal is not output to indicate that the GSD files were successfully read-in.

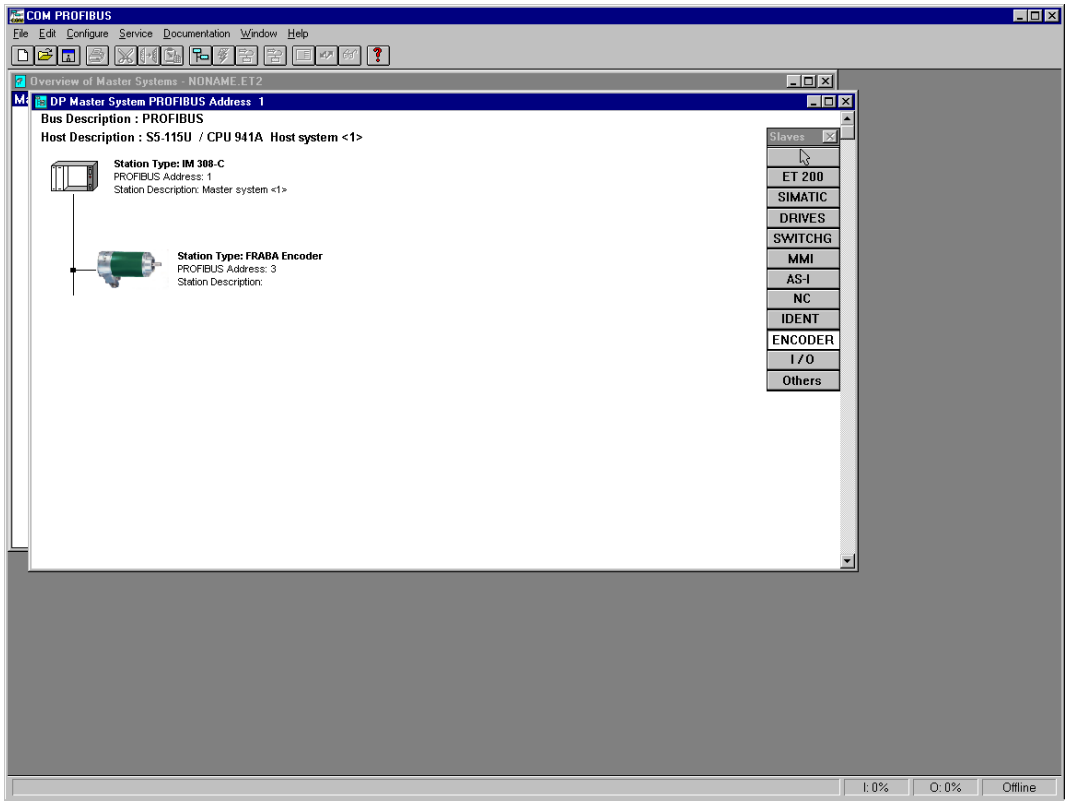
7.2 Configuring the master system

An existing configuration file can be loaded under the menu item “Open” in the “File” menu or a new configuration file generated with the “New” menu item. After this, a master system with the previously defined station number can be selected from the overview.

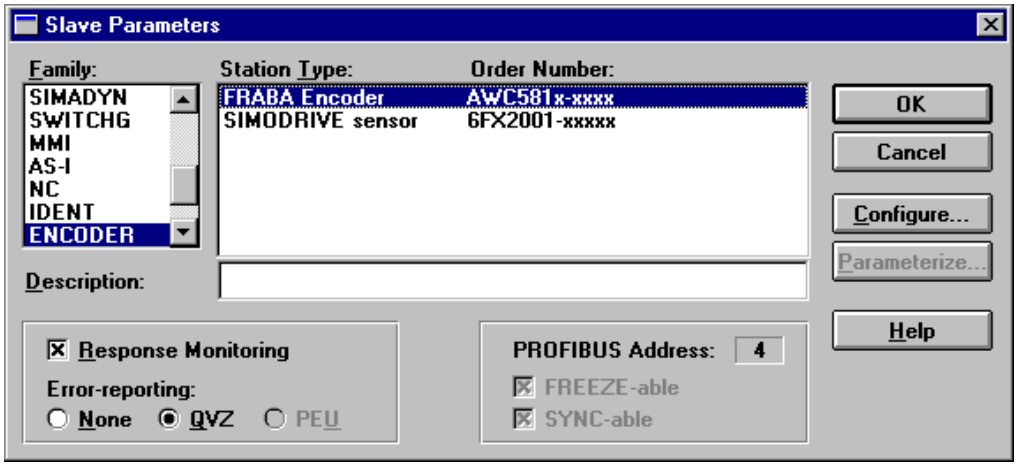


7.3 Selecting and parameterizing the DP slave

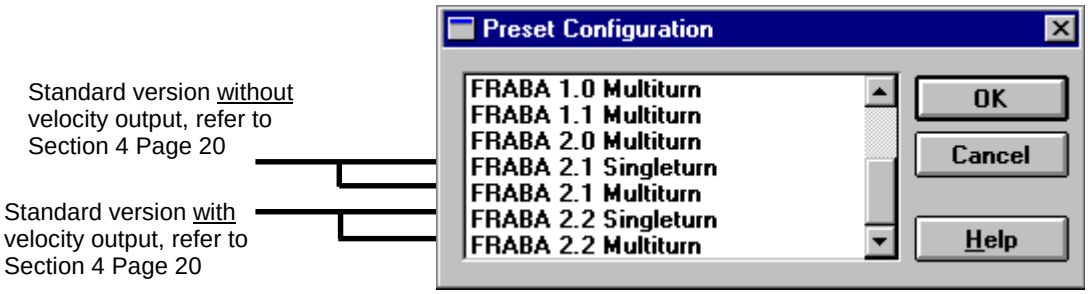
After the GSD files have been read-in, the “Encoder” button is displayed. After clicking-on the button using the mouse, the encoder is attached to the master and the address entered.



The menu, in which the station type is selected, is then displayed. The FRABA encoder should then be selected.



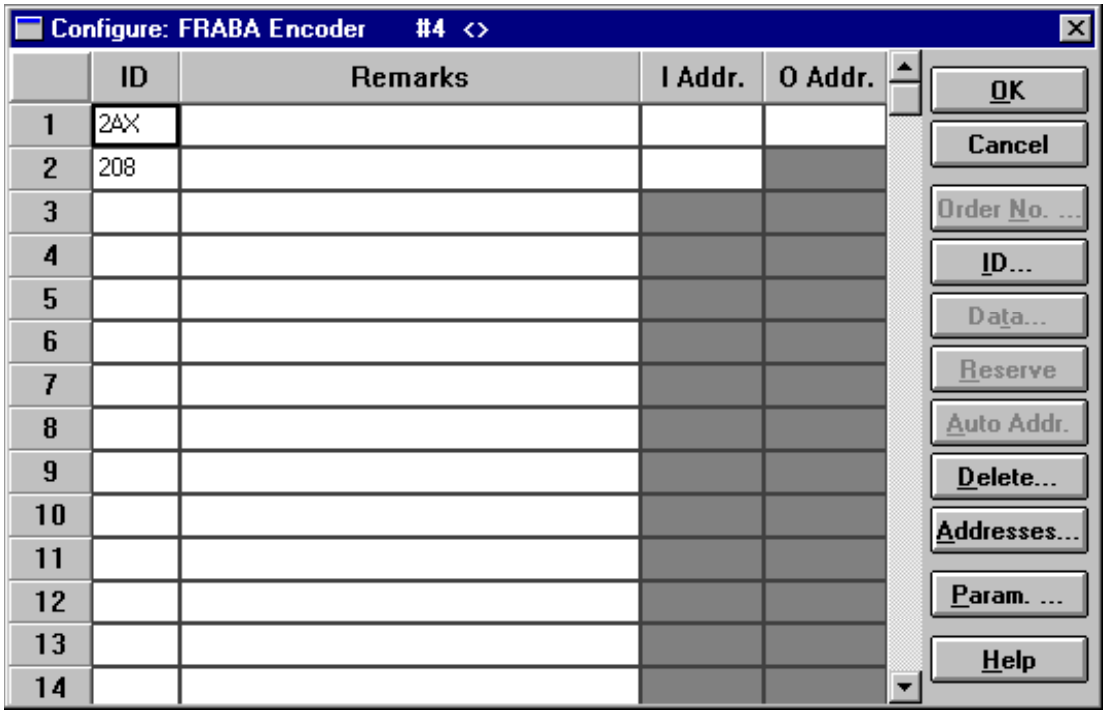
If you now click-on “Configure”, then the menu window is displayed, in which the profile can be selected:



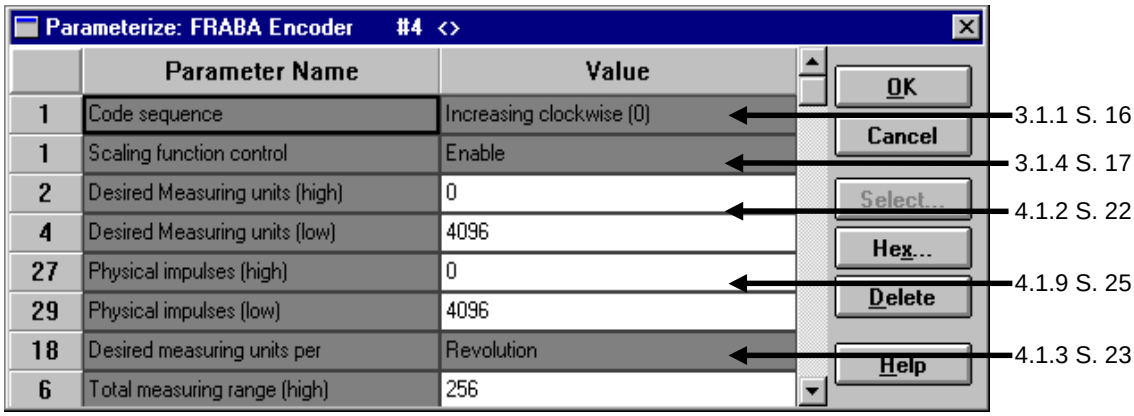
Also refer to Section 2for the various versions.

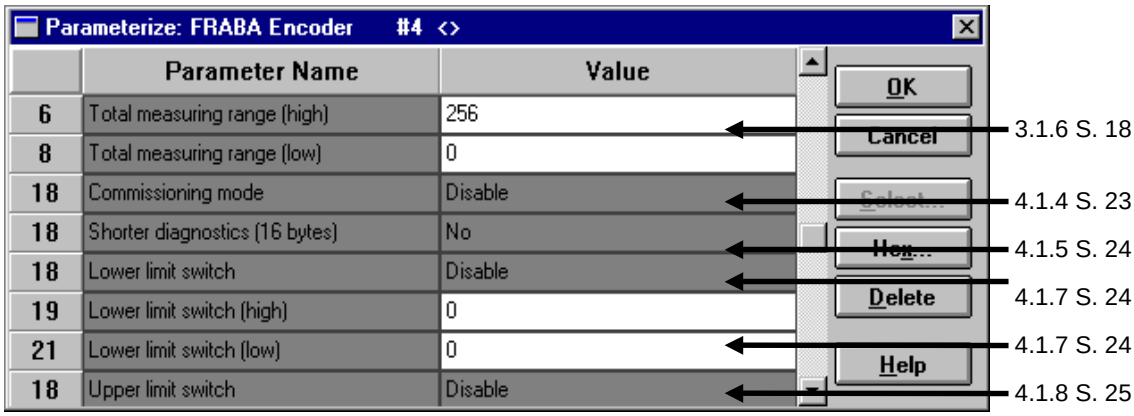
The following window now appears. Click on the “Parameterize” button.

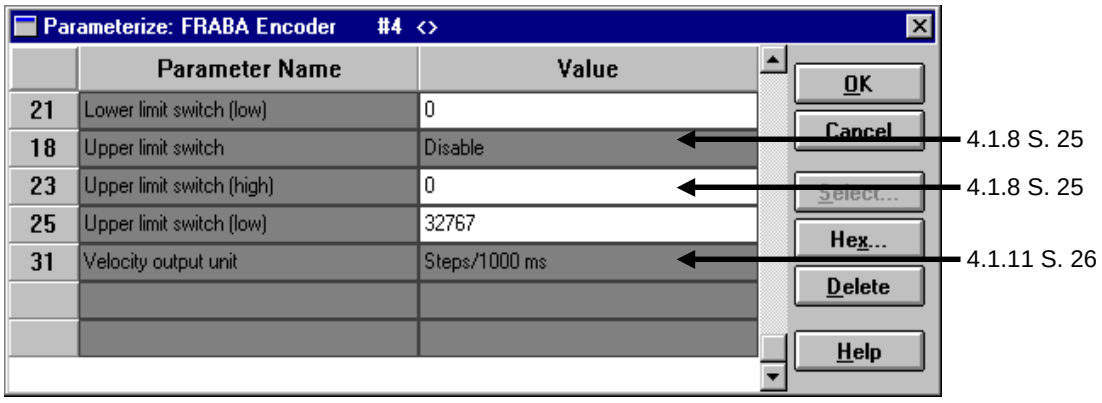
Refer to the COM Profibus and control documentation for the significance of “Identification” and “Input- and output address”.



You can now enter the parameters for the angular encoder. If several possibilities are offered in the fields to the right, an additional window opens by double clicking. On the other hand, numerical values are directly entered. Version FRABA 2.2 was selected in the example illustrated here:





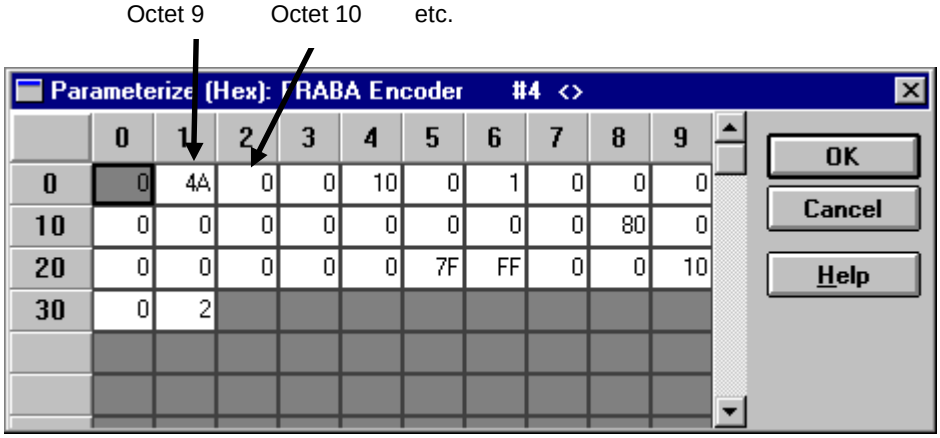


As a result of the COM Profibus software, the complete resolution is sub-divided between LOW and HIGH words, i.e. the required total resolution of up to 24 bits is sub-divided into bits 0 - 15 (LOW word) and bits 16 - 31 (HIGH word). .

Here is an example:

Decimal	Hexadecimal		Hexadecimal	Decimal
129600	00 01 FA 40	High word	00 01	1
		Low word	FA 40	64064

Decimal value 1 is now entered in the high field and decimal value 64 064 in the low field. The data can also be directly entered in the hexadecimal format. However, this is extremely tedious, and should be done, taking into account the COM Profibus documentation.



8 Technical data

8.1 Electrical data

General design	According to DIN VDE 0160 Protective Class III, degree of pollution 2, overvoltage Category II
Power supply voltage	10 - 30 V DC
Power drain	max. 3.5 Watt
EMC	Noise emission according to EN 50081-2 Noise immunity according to EN 50082-2
Bus connection	Electrically isolated through opto couplers
Interface	Line driver according to RS 485
Baud rates	12 MBaud, 6 MBaud, 3 MBaud, 1.5 MBaud, 500 kBaud, 187.5 kBaud, 93.75 kBaud, 19.2 kBaud, 9.6 kBaud
Resolution	4096 steps/revolution (optional 8192 steps/revolution)
Number of revolutions	1 or 4096
Scale accuracy	± ½ LSB
Step frequency	max. 100 kHz
Code type	Binary
Lifetime (electr.)	> 10^5 h
Addressing	Using rotary switches in the connection cap

Note
The absolute angular encoder may only be operated with extra low safety voltage!

8.2 Mechanical data

Housing	Aluminum	
Flange	Synchro (Y)	Synchro (Z), Clamp (F)
Shaft diameter	6 mm	10 mm
Shaft length	10 mm	20 mm
Shaft loading	axial 20 N, radial 110 N	
Friction torque	≤ 5 Ncm	
Rotor moment of inertia	≈ 50 gcm^2	
Lifetime	> 10^5 h at 1000 RPM	
Speed	6000 RPM (continuous operation); 10000 RPM (briefly)	
Shock immunity (IEC 68-2-27)	≤ 200 m/s^2 (12 ms)	
Vibration immunity (IEC 68-2-6)	≤ 100 m/s^2 (10 Hz ... 1000 Hz)	
Connection	connection cap with T-coupler functionality	
Operating temperature	0° ... + 70° C	
Storage temperature	-40° ... + 85° C	
Relative air humidity	98% (without moisture condensation)	
Degree of protection (EN 60529)	housing	shaft
	IP 65	IP 65*
Weight (incl. connection cap)	Single-Turn Multi-Turn	approx. 500 g approx. 700 g

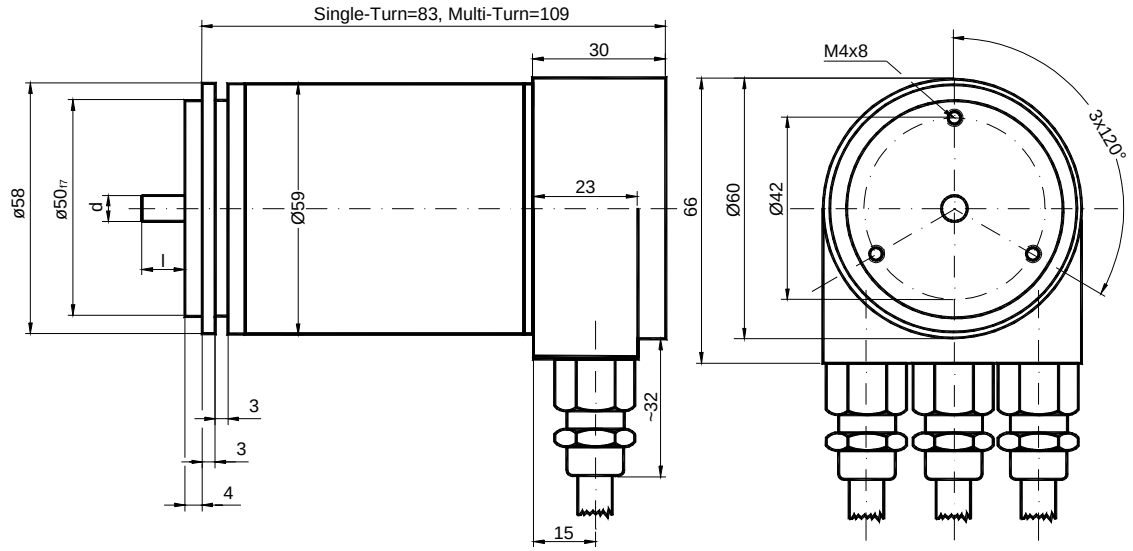
(*) bis 0,5 bar

8.3 Dimension drawings

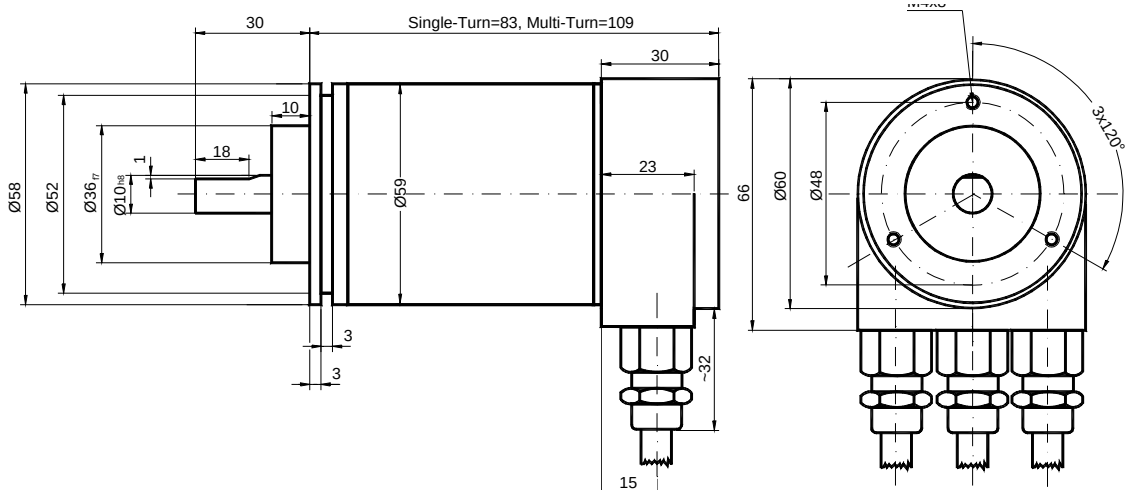
Synchro Flange (Y, Z)

The only difference between the Y and Z Flange is the shaft size (refer to the table besides).

	d / mm	l / mm
Y-Flange	6_{f6}	10
Z-Flange	10_{h8}	20



Clamp Flange (F)



9 Attachment

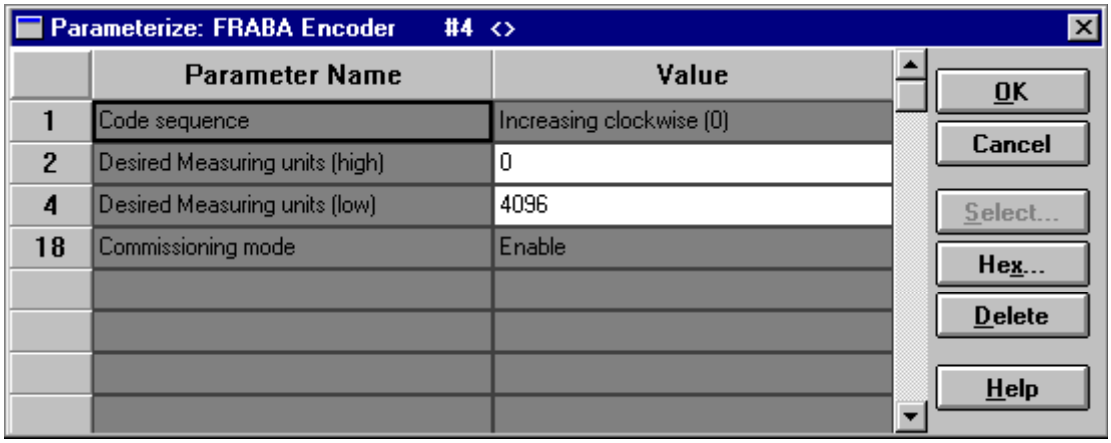
9.1 Conversion table, decimal - binary - hexadecimal

0	00000000	00	64	01000000	40	128	10000000	80	192	11000000	C0
1	00000001	01	65	01000001	41	129	10000001	81	193	11000001	C1
2	00000010	02	66	01000010	42	130	10000010	82	194	11000010	C2
3	00000011	03	67	01000011	43	131	10000011	83	195	11000011	C3
4	00000100	04	68	01000100	44	132	10000100	84	196	11000100	C4
5	00000101	05	69	01000101	45	133	10000101	85	197	11000101	C5
6	00000110	06	70	01000110	46	134	10000110	86	198	11000110	C6
7	00000111	07	71	01000111	47	135	10000111	87	199	11000111	C7
8	00001000	08	72	01001000	48	136	10001000	88	200	11001000	C8
9	00001001	09	73	01001001	49	137	10001001	89	201	11001001	C9
10	00001010	0A	74	01001010	4A	138	10001010	8A	202	11001010	CA
11	00001011	0B	75	01001011	4B	139	10001011	8B	203	11001011	CB
12	00001100	0C	76	01001100	4C	140	10001100	8C	204	11001100	CC
13	00001101	0D	77	01001101	4D	141	10001101	8D	205	11001101	CD
14	00001110	0E	78	01001110	4E	142	10001110	8E	206	11001110	CE
15	00001111	0F	79	01001111	4F	143	10001111	8F	207	11001111	CF
16	00010000	10	80	01010000	50	144	10010000	90	208	11010000	D0
17	00010001	11	81	01010001	51	145	10010001	91	209	11010001	D1
18	00010010	12	82	01010010	52	146	10010010	92	210	11010010	D2
19	00010011	13	83	01010011	53	147	10010011	93	211	11010011	D3
20	00010100	14	84	01010100	54	148	10010100	94	212	11010100	D4
21	00010101	15	85	01010101	55	149	10010101	95	213	11010101	D5
22	00010110	16	86	01010110	56	150	10010110	96	214	11010110	D6
23	00010111	17	87	01010111	57	151	10010111	97	215	11010111	D7
24	00011000	18	88	01011000	58	152	10011000	98	216	11011000	D8
25	00011001	19	89	01011001	59	153	10011001	99	217	11011001	D9
26	00011010	1A	90	01011010	5A	154	10011010	9A	218	11011010	DA
27	00011011	1B	91	01011011	5B	155	10011011	9B	219	11011011	DB
28	00011100	1C	92	01011100	5C	156	10011100	9C	220	11011100	DC
29	00011101	1D	93	01011101	5D	157	10011101	9D	221	11011101	DD
30	00011110	1E	94	01011110	5E	158	10011110	9E	222	11011110	DE
31	00011111	1F	95	01011111	5F	159	10011111	9F	223	11011111	DF
32	00100000	20	96	01100000	60	160	10100000	A0	224	11100000	E0
33	00100001	21	97	01100001	61	161	10100001	A1	225	11100001	E1
34	00100010	22	98	01100010	62	162	10100010	A2	226	11100010	E2
35	00100011	23	99	01100011	63	163	10100011	A3	227	11100011	E3
36	00100100	24	100	01100100	64	164	10100100	A4	228	11100100	E4
37	00100101	25	101	01100101	65	165	10100101	A5	229	11100101	E5
38	00100110	26	102	01100110	66	166	10100110	A6	230	11100110	E6
39	00100111	27	103	01100111	67	167	10100111	A7	231	11100111	E7
40	00101000	28	104	01101000	68	168	10101000	A8	232	11101000	E8
41	00101001	29	105	01101001	69	169	10101001	A9	233	11101001	E9
42	00101010	2A	106	01101010	6A	170	10101010	AA	234	11101010	EA
43	00101011	2B	107	01101011	6B	171	10101011	AB	235	11101011	EB
44	00101100	2C	108	01101100	6C	172	10101100	AC	236	11101100	EC
45	00101101	2D	109	01101101	6D	173	10101101	AD	237	11101101	ED
46	00101110	2E	110	01101110	6E	174	10101110	AE	238	11101110	EE
47	00101111	2F	111	01101111	6F	175	10101111	AF	239	11101111	EF
48	00110000	30	112	01110000	70	176	10110000	B0	240	11110000	F0
49	00110001	31	113	01110001	71	177	10110001	B1	241	11110001	F1
50	00110010	32	114	01110010	72	178	10110010	B2	242	11110010	F2
51	00110011	33	115	01110011	73	179	10110011	B3	243	11110011	F3
52	00110100	34	116	01110100	74	180	10110100	B4	244	11110100	F4
53	00110101	35	117	01110101	75	181	10110101	B5	245	11110101	F5
54	00110110	36	118	01110110	76	182	10110110	B6	246	11110110	F6
55	00110111	37	119	01110111	77	183	10110111	B7	247	11110111	F7
56	00111000	38	120	01111000	78	184	10111000	B8	248	11111000	F8
57	00111001	39	121	01111001	79	185	10111001	B9	249	11111001	F9
58	00111010	3A	122	01111010	7A	186	10111010	BA	250	11111010	FA
59	00111011	3B	123	01111011	7B	187	10111011	BB	251	11111011	FB
60	00111100	3C	124	01111100	7C	188	10111100	BC	252	11111100	FC
61	00111101	3D	125	01111101	7D	189	10111101	BD	253	11111101	FD
62	00111110	3E	126	01111110	7E	190	10111110	BE	254	11111110	FE
63	00111111	3F	127	01111111	7F	191	10111111	BF	255	11111111	FF

9.2 Special encoder profile-versions

9.2.1 Version FRABA 2.0 Multiturn

This version differs from the Version 2.2 only by the fact that there are fewer selection fields displayed in the COM Profibus mask:



9.2.2 Version FRABA 1.1 Multiturn

This is an older version. Previously, it was unofficially designated as a so-called Class „3“. In Edition 1.03 of this Manual, it is listed under Number 6. It behaves just like Class 2, but in addition outputs the velocity. It is still available, if a user does not wish to make any changes; however, it should no longer be used for new systems.

9.2.3 Version FRABA 1.0 Multiturn

Corresponds to Number 5 in the 1.03 Edition of this Manual. Position value and velocity outputs are available without the possibility of making a preset. This should no longer be used.

9.2.4 Version Class 2 Multiturn ‘DX-Version’

Old version with a reduced number of diagnostics data. Should only be used with older encoders with „DX“ in the type key.

9.3 Instructions and experience made with special bus nodes / software

Experience gained by users with specific bus nodes and software packages is now provided in the following text. The problems which have occurred are essentially independent of the FRABA absolute value encoders. However this information can be extremely useful and we wish to make it available to all users. However, FRABA cannot accept any liability for the correctness of the information and the tips which are given. FRABA is very grateful for you feedback if you have made experiences of this kind. In that way we can communicate them to other users. Thank you!

Power connected, the angular encoder does not log-on

Problem:
The PLC and the master interface group have been powered-up, the bus is active, but the installed encoder does not log-on.

Removing the fault:
Power-down the PLC. Remove the connecting cover of the encoder. Check the encoder addressing. Re-mount the connecting cover. Power-up. Also refer to „Alarm messages using the LEDs in the connection cap“ on page 33.
.

Occasional faulty encoder values

Problem:
When transferring the encoder values, faults can occasionally occur. The bus can also go into a fault condition.

Removing the fault:
Check that the terminating resistors in the last bus node are switched-in. If the last node is an encoder, then the terminating resistors in the connection cap must be switched-in.
Check the screen connection in the connection cap.

Reproducible steps for a special encoder position

Problem:
At a specific position, the encoder jumps to a value which is not plausible and is generally extremely high. The phenomena can be reproduced.

Removing the fault:
The *Total resolution* (total measuring units range) has been selected too high with respect to the *Number of steps per revolution*. This means that zero crossovers occur at the incorrect position, and, in conjunction with a set preset value, non-plausible values are displayed. Also refer to 3.1.6.

Master interface IM 308 B: The bus goes into a fault condition at each run-up

Problem:
The bus immediately goes into a fault condition at each power-on.

Removing the fault:
First check whether the terminating resistors for the last bus node are switched-in, and the addressing is correct.
If everything is correct, then the reason can be in the limited range of the diagnostic bytes. The encoder provides 57 diagnostic bytes. However, the IM 308 B can only process 32 bytes. This results in bus errors. The encoder can be operated as Class 1 encoder on the bus, as in this case, only 10 diagnostic bytes are transferred. However, if the programming capability is required, the abbreviated diagnostics can be switched-in for Version 2.1 and Version 2.2. (Refer to 4.1.5).

Sporadic encoder steps

Problem:
The encoder position values sporadically jump, and cannot be directly reproduced, e.g. by actually moving the encoder in the system or manually moving the shaft. Further, the step generally only occurs for one machine cycle of the PLC control.
Further, the bus does not go into a fault condition.
Cause: The PLC control accesses data on the Profibus Master IM 308C. The encoder does not control PLC data accesses to the IM308 C. The user must ensure that his programming is correct!

Removing the fault:
1. Always read-out the encoder values in the following sequence:
   a) Most significant address
   b) Least significant address
2. Devices, addressed in the Q range must be read-out from the highest address to the lowest address in order to guarantee data consistency.
3. When using a multi-processor control, which accesses a Profibus master, the semaphore interlocking must be activated.

Type files

Several older software packages (e.g. COMET 200 or Windows COM V 2.0) cannot process any GSD files. For these cases, please use the type files. Please contact you software vendor for details.

Master interface IM 308 B: How can the encoder be programmed?

Problem:
The COM-ET-200 software does not support the WINDOWS version. Can the encoder still be programmed?

Removing the fault:
Normally, the encoder cannot be simply programmed using this software, as it is necessary to be extremely knowledgeable about the individual bits in the parameter octet. We do not recommend such a programming procedure. We recommend that the IM 308 C is used as the IM 308 B will also be shortly discontinued.

Calling the diagnostic functions

Problem:
How does one access the diagnostics information?

Removing the fault:
The diagnostic functions can be called-up via the DDLM_Slave_Diag. They are also transferred each time the master board runs-up. It is not possible to call-up the information in the Data_Exchange mode.

Allen-Bradley 1785 PFB/B Profibus Master and Mitsubishi A1SJ 71PB92D Profibus Master

Problem:
When the class 2 functionality is switched on the encoder does not go on-line. Class 1, however does not cause any problems

Removing the fault:
These masters can process a maximum of 32 diagnostics bytes. The problem is solved by switching on the reduced diagnostics. Refer to Section 4.1.5 on page 24.

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Softing -PROFIboard

Problem:
When the class 2 functionality is switched on the values from the encoder are only updated once, when the encoder is switched on. Class 1, however does not cause any problems.

Removing the fault:
In the memory-configuration of the DP master the parameter for the maximum number of diagnostics data per slave is set to 32 (default). This must be set to a number bigger than 57. As an alternative the number of diagnostics data can be reduced. Refer to Section 4.1.5 on page 24.

9.4 Type designation / ordering code

Description	Type Key									
Absolute rotary encoder	**AWC**	**58**	. . -	. . . . -	.	B	A1	DP		3PG
Diameter in mm										
Steps per revolution	4096		**12**							
	8192		13							
No. of revolutions	1			**1**						
	4096			**4096**						
Flange	Clamp Flange (shaft = 10 mm ∅)				**F**					
	Synchro Flange (shaft = 6 mm ∅)				**Y**					
	Synchro Flange (shaft = 10 mm ∅)				Z					
Code	Binary					**B**				
Version							**A1**			
Interface	Profibus DP							**DP**		
Options	Without								**0**	
	Shaft sealing (not possible for Z-Flange)								W	
	Stainless steel configuration (Flange, housing, cap)								Q	
Connection	Connection Cap *									**3PG**

* The connection cap must be ordered separately: AH 58-A1DP-3PG and is necessary for the operation of the encoder.

Further models on request.

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V