Manual

Absolute encoder with POWERLINK interface (Bus cover)

Software version 1.0.1 or higher

08.17· 174.02.065/8
Subject to technical and design modifications.
Errors and omissions excepted.

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Content

Annex

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At any time we should be pleased receiving your comments and proposals for further improvement of the present document.

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Change history

Version	Change / Description
V1.00	-
V1.01	Revision – especially due to new functionality of firmware 1.5.0 or higher
	• Section 1.2 Product allocation and xdd files
	- Product code for product GXAMx corrected
	- Product codes and xdd files for firmware 1.5.x added
	• Section 5.1Minimum cycle time 250 µs
	• Section 5.2 Ethernet Specification
	- Delay internal hub corrected (400 ns)
	- Max. Response Time corrected (10 µs)
	• Section 5.3Timing behaviour description modified / corrected
	• Section 5.4 Power consumption removed –
	Specification to be found in respective product information
	• Section 6 Process data – Speed added
	• Section 7 Service data
	- Revised description
	- Example for scaling function added
V1.02	• Section 5.4 Physical resolution – correction of the resolution
	• Section 7.1 Communication parameters – note: extended save command

1 Introduction

1.1 Scope of delivery

Please check the delivery upon completeness prior to commissioning.
Depending on encoder configuration and part number delivery is including:
Basic encoder, bus cover with describing file and manual (also available as download)

1.2 Product allocation and xdd files

1.2.1 Firmware version 1.3.x or lower

Product mechanics Solid / End shaft / Kit	Product Code / Name		xdd-file	Description
BMMV / BMMH / BMMK	16h	BMMx	5F_POWERLINK_Rotary_Encoder_BMMx_MT.xdd	MT, *MAGRES*
BMSV / BMSH / BMSK	17h	BMSx	5F_POWERLINK_Rotary_Encoder_BMSx_ST.xdd	ST, *MAGRES*
GBMMW / GBMMS / -	0Fh	GBMMx	5F_POWERLINK_Rotary_Encoder_GBMMx_MT.xdd	MT, Optical, 18 Bit ST
GBAMW / GBAMS / -	0Eh	GBAMx	5F_POWERLINK_Rotary_Encoder_GBAMx_ST.xdd	ST, Optical, 18 Bit ST
GXMMW / GXMMS / -	0Dh	GXMMx	5F_POWERLINK_Rotary_Encoder_GXMMx_MT.xdd	MT, Optical, 13 Bit ST
GXAMW / GXAMS / -	0Ch	GXAMx	5F_POWERLINK_Rotary_Encoder_GXAMx_ST.xdd	ST, Optical, 13 Bit ST

1.2.2 Firmware version 1.5.x or higher

Product mechanics Solid / End shaft / Kit	Product Code / Name		xdd-file	Description
BMMV / BMMH / BMMK	16h	BMMx	Baumer_EPL_Encoder_BMMx_244.xdd	MT, *MAGRES*
BMSV / BMSH / BMSK	17h	BMSx	Baumer_EPL_Encoder_BMSx_244.xdd	ST, *MAGRES*
GBMMW / GBMMS / -	0Fh	GBMMx	Baumer_EPL_Encoder_GBMMx_5EA4.xdd	MT, Optical, 18 Bit ST
GBAMW / GBAMS / -	0Eh	GBAMx	Baumer_EPL_Encoder_GBAMx_5EA4.xdd	ST, Optical, 18 Bit ST
GXMMW / GXMMS / -	0Dh	GXMMx	Baumer_EPL_Encoder_GXMMx_5EA4.xdd	MT, Optical, 13 Bit ST
GXAMW / GXAMS / -	0Ch	GXAMx	Baumer_EPL_Encoder_GXAMx_5EA4.xdd	ST, Optical, 13 Bit ST

Explanation:

MT	Multiturn encoder
ST	Singleturn encoder
MAGRES	Extremely robust encoder with magnetic sensing principle
18 Bit ST	High resolution encoder – up to 18 bit physical singleturn resolution, i.e. 2^{18} steps / revolution
13 Bit ST	Max. 13 bit physical singleturn resolution, i.e. 2^{13} steps / revolution

2 Safety and operating instructions

Intended use

- The encoder is a precision measuring device that is used to record positions. It provides measuring values as electronic output signals for the subsequently connected device. It must not be used for any other purpose. Unless this product is specially labeled, it may not be used for operation in potentially explosive environments.
- Make sure by appropriate safety measures, that in case of error or failure of the encoder, no danger to persons or damage to the system or operating facilities occurs.

Personnel qualification

- Installation and assembly of this product may be performed only by a person qualified in electronics and precision mechanics.

Maintenance

- The encoder is maintenance-free and must not be opened up nor mechanically or electronically modified. Opening up the encoder can lead to injury.

Disposal

- The encoder contains electronic components. At its disposal, local environmental guidelines must be followed.

Mounting

- Solid shaft: Do not connect encoder shaft and drive shaft rigidly. Connect drive and encoder shaft with a suitable coupling.
- Hollow shaft: Open clamping ring completely before mounting the encoder. Foreign objects must be kept at a sufficient distance from the stator coupling. The stator coupling is not allowed to have any contact to the encoder or the machine except at the mounting points.

Electrical commissioning

- Do not proceed any electrical modifications at the encoder.
- Do not proceed any wiring work while encoder is live.
- Do not remove or plug on connector whilst under power supply.
- Ensure that the entire system is installed in line with EMC/EMI requirements. Operating environment and wiring have an impact on the electromagnetic compatibility of the encoder. Install encoder and supply cables separately or far away from sources with high emitted interference (frequency converters, contactors, etc.).
- When working with consumers with high emitted interference provide separate encoder supply voltage.
- Completely shield encoder housing and connecting cables.
- Connect encoder to protective earth (PE) using shielded cables. The braided shield must be connected to the cable gland or connector. Ideally, aim at dual connection to protective earth (PE), i.e. housing by mechanical assembly and cable shield by the downstream devices.

Supplementary information

- The present manual is intended as a supplement to already existing documentation (e.g. catalogues, data sheets or mounting instructions).

3 Bus cover – functional principle

The product family architecture is modular. Depending on what is required from the encoder, the basic encoder and bus covers can be combined at will with the selected bus system.
The basic encoders differ in terms of accuracy, ambient conditions and the utilized sensing principle.

Bus cover
The bus cover accommodates the entire electronics for measured value processing and for Ethernet communication.

The bus covers differ by the respectively integrated bus interface.
Available bus interfaces: CANopen®, DeviceNet, EtherCAT, Ethernet/IP, Profibus-DP, Profinet, Powerlink, Power over EtherCAT, SAE J1939, SSI.
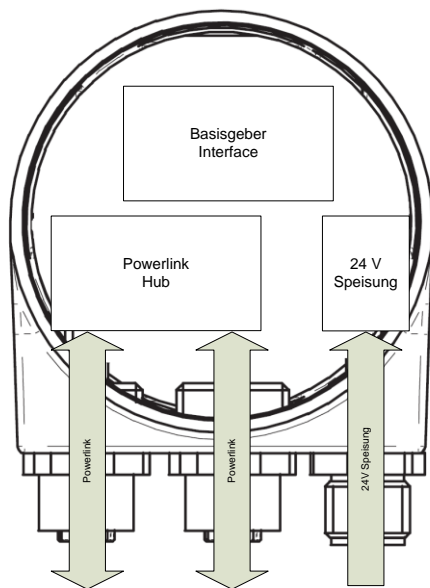All encoders enable parameterization by bus interface.

Functional principle:
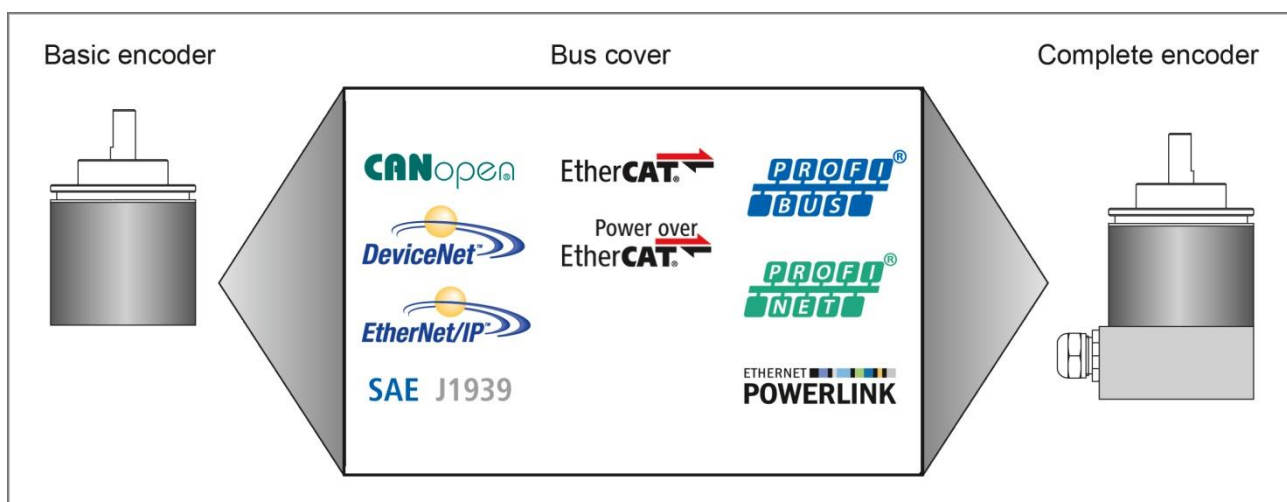
4 Overview

4.1 General

The bus cover which is the communication link between the Powerlink network and the basic encoder supports encoder profile 406 and Powerlink specification V2.0.

4.2 Daisy Chain

The Powerlink Hub integrated in the bus cover enables formation of a Daisy Chain.
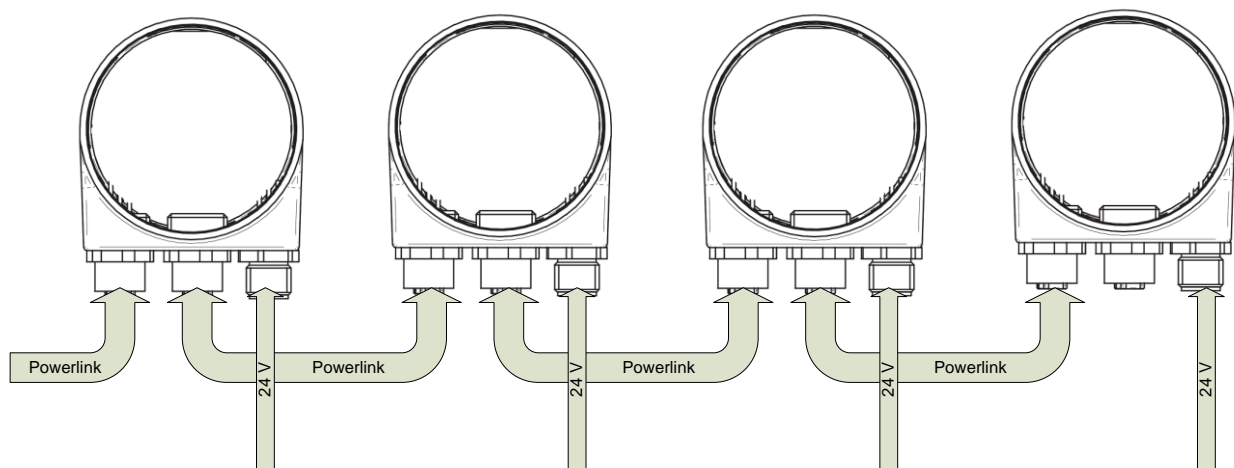
4.3 Auto-Negotiation

Ethernet interface supports the Auto-Negotiation functionality. Whether a straight or crossed Ethernet line does not matter, direct connection to the control without any Ethernet hubs is also feasible using any optional cable.

5 Technical specifications

5.1 Powerlink specifications

The bus cover complies with following specifications:

Powerlink version	2.0
CANopen profile	CiA 406 (encoders)
Minimum cycle time:	250µs

5.2 Ethernet specifications

MTU	300 Bytes
Delay internal Hub (Daisy Chain)	400ns/Node
Max. Response Time	2 µs (incl. hub delay)
Transmission rate	100 MBit/s semi-duplex
Ethernet outputs	2 outputs: M12 D-coded (Auto-Negation)

5.3 Timing behavior

The following table describes the delay and jitter between the Start of Cycle (SoC) and acquisition of a new position value.

Product	Delay typical	Jitter		
BMSx (ST):	11,34µs	+- 7,6µs	(= 7,5µs	+/- 68ns)
BMMx (MT):	13,84µs	+- 10,1µs	(= 10µs	+/- 68ns)
GXAMx (ST):	5,00µs	+- 0,6µs	(= 0,54µs	+/- 68ns)
GXMMx (MT):	5,00µs	+- 0,6µs	(= 0,54µs	+/- 68ns)
GBAMx (ST):	7,20µs	+-1,3µs	(= 1,2µs	+/- 68ns)
GBMMx (MT):	7,20µs	+-1,3µs	(= 1,2µs	+/- 68ns)

5.4 Physical resolution for each product

The following table describes the non-scaled physical resolution dependent on the used basic encoder.

Encoder	Product Name	ST Resolution		MT Resolution		Total Resolution	
BMS ST	BMSx	4000h	12 bit	-		4000h	12 bit
BMM MT	BMMx	4000h	12 bit	4 0000h	18bit	1 0000 0000h	30 bit
GXAM ST	GXAMx	2000h	13 bit	-		2000h	13 bit
GXMM MT	GXMMx	2000h	13 bit	1 0000h	16bit	2000 0000h	29 bit
GBAM ST	GBAMx	4 0000h	18 bit	-		4 0000h	18 bit
GBMM MT	GBMMx	4 0000h	18 bit	4000h	14bit	1 0000 0000h	32 bit

6 Process data

6.1 General

The bus cover supports PDO-static mapping only. PDO data are identical to the position in Object 6004h.
Firmware version 1.5.0 or higher:
In addition to the position value the speed value in counts / second is transmitted within the PDO (object 6030h)

6.2 PDO validity

The PDO's position data is ever the value picked up by the SoC in the last cycle.
Delay time and Jitter between SoC and position acquisition are specified in section 5.3.
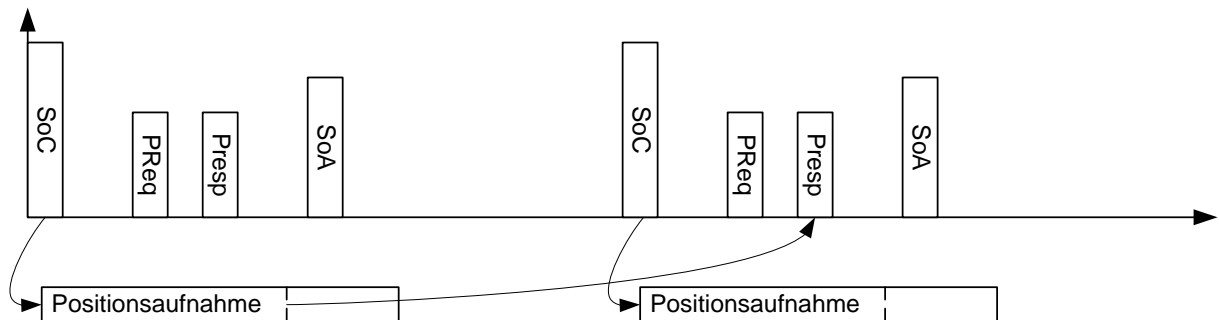
7 Service Data

The following table shows the most user-relevant objects. Section 7.1 describes all relevant objects for configuring the communication behavior. Section 0 describes relevant objects for configuring all encoder specific features.

Format
U/I	= Unsigned/Integer
No.	= Number of bits
ARR	= Array
REC	= Record
STR	= String
BOOL	= Boolean

Access
ro	= read only
wo	= write only
rw	= read write
const	= read only, value is constant

Default   default after first initialization

7.1 Communication parameters

Object Subindex	Name	Format	Access	Default	Description
1000h	NMT_DeviceType_U32	U32	const	Multiturn encoder: 0002'0196h Singleturn encoder: 0001'0196h	**Device type** Byte 0..1: Profile nr. = 196h = 406 Byte 2..3: Encoder type Type =1: Absolute Singleturn Type =2: Absolute Multiturn
1010h	NMT_StoreParam_REC				**Storing parameters (see footer 3)** Writing the ASCII value „save" into the respective subindex activates the save procedure.
00h	NumberOfEntries	U8	const	4	Largest subindex
01h	AllParam_U32	U32	rw		Save all parameters
02h	CommunicationParam_U32	U32	rw		Save communication parameters
03h	ApplicationParam_U32	U32	rw		Save application parameters
1011h	NMT_RestoreDefParam_REC				**Load factory configuration** Writing the ASCII value "load" (=6C6F6164h) within the respective subindex activates the restore procedure.
00h	NumberOfEntries	U8	const	3	Largest subindex
01h	AllParam_U32	U32	rw		Load all parameters
02h	CommunicationParam_U32	U32	rw		Load communication parameters
03h	ApplicationParam_U32	U32	rw		Load application parameters
04h	ManufacturingParam_U32	U32	rw		Load manufacturer parameters
1018h	NMT_IdentityObject_REC				**General product information**
00h	NumberOfEntries	U8	const	3	Largest subindex
01h	VendorID	U32	const	5Fh	Vendor ID from EPSG
02h	ProductCode	U32	const	See section 1.2	Number for product identification
03h	RevisionNumber	U32	const		Product revision number
04h	SerialNumber	U32	const		Unique consecutive serial number
1800h	PDO_TxCommParam_0h_REC				**PDO Communication parameter**
00h	NumberOfEntries	U8	const	3	Largest subindex
01h	NodeID_U8	U8	rw	0	Node ID
02h	MappingVersion_U8	U8	ro	0	Static mapping only
1A00h	PDO_TxMappParam_0h_AU64				**PDO Mapping parameter**
00h	NumberOfEntries	U8	const	1	Largest subindex
01h	ObjectMapping 1	U64	ro	0020'0000'0000'6004h	Static mapping with position value (object 6004) transmitted in PDO
02h	ObjectMapping 2	U64	ro	0020'0000'0000'6030h	(FW 1.5.0 and higher: position and speed transmitted)
1F82h	NMT_FeatureFlags_U32	U32	const	0000'0607h	**Supported features** Isochronous SDO by UDP/IP SDO by ASnd Multiplexed Access, NodeID setup by SW
1F83h	NMT_EPLVersion_U8	U8	const	20h	**Powerlink Communication profile** Currently used version
1F93h	NMT_EPLNodeID_REC				**Definition of Node ID**
00h	NumberOfEntries	U8	const	3	Largest subindex
01h	NodeID_U8	U8	ro	1	Currently active Node ID
02h	NodeIDByHW_BOOL	BOOL	ro	Default: FALSE Range: FALSE/TRUE	0: NodeID defined by Software; Both HW switches set to 0 (s. section 8.5) 1: NodeID defined by HW Switch
03h	SWNodeID_U8[1,2]	U8	rw	Default: 1 Range: 1..240, 253, 254	SW NodeID; Address is applied after power off/on

[1] Values are saved using object 1010h subindex 01h „save all parameters" (please note that a noncyclic command can´t be processed for one second during the saving process).

[2] Values are saved using object 1010h subindex 02h „save communication parameters" (please note that a noncyclic command can´t be processed for one second during the saving process).

[3] Object 0x1010 SAVE Application Parameter

Object 0x1010 is utilized to save device-specific objects (0x6000..0x6FFF) out of RAM into non-volatile memory (EEPROM). To prevent inadvertent saving operations the signature „**save**" must be written into object 0x1010 Subindex 3h.

Signature	MSB			LSB	
ISO 8859	**e**	**v**	**a**	**s**	character
	0x65	**0x76**	**0x61**	**0x73**	hex
	1702257011				dez

7.2 Application Parameters

Object Subindex	Name	Format / Access	Default	Description
6000h	Operating Parameters[1,3]	U16 / rw	0004h	bit 0: Rotation CCW bit 2: Scaling function active
6001h	Measuring Units per Revolution[1,3]	U32 / rw	Default: 1000h Range: BMS: 0...FFFF'FFFFh GXAM: 0...FFFF'FFFFh GBAM: 0...FFFF'FFFFh BMM: 0...4000h GXMM: 0...1'0000h GBMM: 0...4'0000h	Singleturn resolution in steps / revolution <u>Note:</u> The value may exceed the encoder's physical resolution (see section 1.2). However the code sequence in that case does not show every single step. The value 0 represents a resolution of 32 bit (1'0000'0000h). -- <u>ATTENTION (relevant for FW version 1.3.x or lower):</u> Changing this parameter will also affect the total measuring range (object 6002h)! The value must be limited to the following criteria: The multiplication of 6502h (number of revolutions) and 6001h (steps/revolution) may not exceed the value 2^{32}! <u>Formulas:</u> 2^{32} <=6001h x 6502h 6002h = 6001h x 6502h Meas.range = ST resolution x Num. of revolutions --
6002h	Total Measuring Range in Measuring Units[1,3]	U32 / rw	<u>Default:</u> BMS: 1000h GXAM: 1000h GBAM: 1000h BMM: 4000'0000h GXMM: 0100'000h GBMM: 0200'0000h Range: BMS: 1...FFFF'FFFFh GXAM: 1...FFFF'FFFFh GBAM: 1…FFFF'FFFFh BMM: [6001h] x 4'0000h GXMM: [6001h] x 1'0000h GBMM: [6001h] x 4000h	Total Measuring Range in steps Together with object 6001h (Measuring Units per Revolution) this parameter defines the max. number of distinguishable revolutions. <u>Note:</u> Value 0 represents 2^32 (= 1'0000'0000h) -- <u>ATTENTION (only relevant for FW version 1.3.x or lower):</u> Changing this parameter will affect the value of 6001h (Measuring Units per Revolution)! The value of 6002h must be an integer multiple of 6502h. <u>Formula:</u> 6002h = 6001h x 6502h Meas.range = ST resolution x Num. of revolutions -- FW version 1.5.x or higher: The total measuring range is freely configurable – independent from the Singleturn resolution (6001h). <u>ATTENTION:</u> The number of distinguishable revolutions (= 6002h / 6001h) may exceed the physical number of distinguishable revolutions (see section 1.2 – object 6502h). However, in that case the device works as a quasi-Multiturn encoder. I.e. the actual position value is not available after power off/on. The new value is calculated according to the physical number of distinguishable revolutions. --
6003h	Preset Value	U32 / rw	0	Actual position is set to the preset value! <u>ATTENTION:</u> The preset function changes the actual position value! This can cause unexpected motion which could result in personal injury and damage to the product or equipment. Steps should be taken to ensure the shaft is stationary and will remain so.
6004h	Position Value	U32 / ro		Actual position
6500h	Operating Status	U16 / ro	0004h	According to object 6000h.
6501h	Single-Turn Resolution / Measuring Step	U32 / ro		Currently used Singleturn resolution; According to 6001h

6502h	Number of distinguishable Revolutions	U32 / ro	BMS: 1 GXAM: 1 GBAM: 1 BMM: 4'0000h (18bit) GXMM: 1'0000h (16bit) GBMM: 4000h (14bit)	Number of physically distinguishable revolutions This parameter is different for respective basic encoders (see section 5.4) and not configurable! ATTENTION: Format and meaning differs from encoder profile DS406!
6503h	Alarms	U16 / ro	0000h	The following alarms are evaluated: bit0: Position alarm
6504h	Supported Alarms	U16 / ro	0001h	The following alarms are supported: bit0: Position alarm
6505h	Warnings	U16 / ro	0000h	The following warnings are evaluated: bit4: Battery charge
6506h	Supported Warnings	U16 / ro	0010h	The following warnings are supported: bit4: Battery charge
6507h	Profile and Software Version	U32 / ro		Byte 3-2: Software version Byte 1-0: Profile version (406)
6508h	Operating Time	U32 / ro	FFFF'FFFFh	Not supported
6509h	Offset Value[1,3]	I32 / ro	0000'0000h	Offset value in steps(non-scaled)
650Bh	Serial Number	U32 / ro		Serial number
FW version 1.5.0 or higher:				
2020h	Speed[1,3] Sample Rate	U8 / rw	Default 0 Range: 0…255	Update rate of speed calculation in multiples of the Powerlink cycle time
2021h	Speed[1,3] Averaging time	U8 / rw	Default 1 Range: 0…255	Averaging time of speed calculation in number of samples (e.g. value 10 means averaging over 10 samples)
6030h	Speed Value	I32 / ro		Speed value in counts per second (cps)

[1] Values are saved using object 1010h subindex 01h „save all parameters" (please note that a noncyclic command can´t be processed for one second during the saving process).

[3] Values are saved using object 1010h subindex 03h „save application parameters"

Examples for using the scaling function:

Product: GXMMW

Physical resolution (see section 5.4): 13/16 bit ST/MT (i.e. 8192 steps/rev., 65536 revolutions)

Example 1: Common scaling with resolution within the physical resolution of the encoder
- Desired Singleturn resolution: 3600 steps / revolution (0,1° per step)
- Desired number of revolutions: Max. possible number
- Configuration:
  6001h: 3600 steps / revolution
  6002h: 235929600 steps (= 3600 steps / revolution x 65536 revolutions)

Example 2: Scaling of Singleturn resolution and number of revolutions higher than physical resolution:
- Desired Singleturn resolution: 16384 steps / revolution
- Desired number of revolutions: 100000 revolutions
- Configuration:
  6001h: 16384 steps / revolution
  6002h: 1638400000 steps (=16384 steps / revolution x 100000 revolutions)

ATTENTION:
- ⇨ Every second step is measured (output values: 0,2,4,6…)!
- ⇨ The position value will change after power off/on if the actual position exceeds the number of physically distinguishable revolutions (here: 65536 revolutions)!

8 Terminal assignment and commissioning

8.1 Mechanical mounting
Solid shaft encoders
- Mount the encoder with the help of the mounting holes and three screws (square flange: 4 screws) provided at the encoder flange. Observe thread diameter and depth.
- There is an alternative mounting option in any angular position by eccentric fixings, see under accessories.
- Connect drive shaft and encoder shaft by using an appropriate coupling. The shaft ends must not touch each other. The coupling must compensate temperature and mechanical backlash. Observe the maximum permitted axial or radial shaft load. For appropriate couplings please refer to accessories.
- Tighten the mounting screws firmly.

Hollow shaft encoders
- Mounting by clamping ring: Prior to mounting the encoder open the clamping ring completely. Attach encoder to the drive shaft and tighten the clamping ring firmly.
- Mounting by adjusting element with rubber buffer: Attach the encoder to the drive shaft and insert the cylindrical pin into the adjusting element with rubber buffer (provided by customer)
- Spring washer: Fasten the spring washer at the mounting holes of the encoder housing using screws. Attach the encoder to the drive shaft and fix the spring washer to the contact surface.

8.2 Electrical connection
Ever store and transport the bus cover in the ESD bag only. The bus cover must fully rest against the housing and be firmly screwed together.
For electrical connection remove the bus cover as follows:
- Release the fastening screws of the bus cover
- Carefully loosen the bus cover and lift off in an axial direction
- Carefully plug bus cover onto the D-SUB connector of the basic encoder. Slide it over the seal by avoiding any cocking. The bus cover must fully rest on the basic encoder.
- Tighten the fixing screws firmly and equally.

An optimum connection of encoder housing and bus cover will be only provided if the bus cover mounting surface is fully resting on the basic encoder (positive locking).

8.3 Terminal assignment

Voltage supply
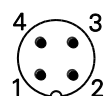
1 x connector M12 (male)
A-coded

Pin	Assignment	Core colour
1	UB (10...30 VDC)	brown
2	N.C.	white
3	GND	blue
4	N.C.	black

Powerlink (data line)

2 x connector M12 (female)
D-coded

Pin	Assignment	Core colour
1	TxD+	yellow
2	RxD+	white
3	TxD-	orange
4	RxD-	blue

8.4 Display elements

Status LED
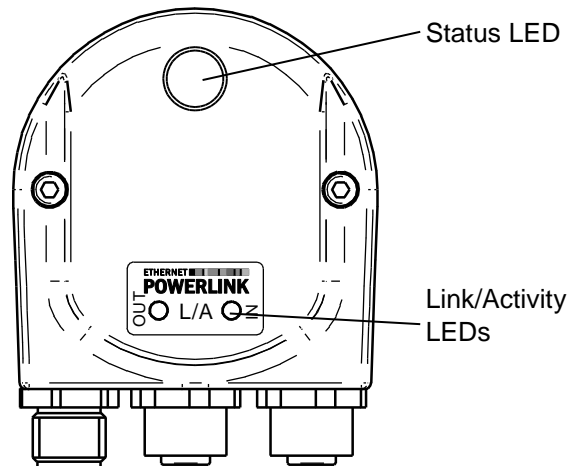
Link/Activity
LEDs

8.4.1 Link/Activity LEDs

The Link/Activity LEDs indicate the Ethernet interface activity.

Status	Meaning
off	No Ethernet link (unplugged)
on	Ethernet link available
flickering	Ethernet activity

8.4.2 Status DUO LED

The DUO LED (red/green) indicates the bus cover activity.

Green LED

Status	Meaning
off	Bus cover off or booting not yet finished
flickering	Status Pre-Operational
on	Status Operational
Single flash	-
Double flash	In reset status
Triple flash	Status aborted or inactive
Quadruple flash	Status Basic Ethernet

Red LED

Status	Meaning
off	No error
on	-

8.5   Setting the Node ID

Setting the Node ID is possible either by software or by hardware switches. If their position is 0, the software configuration will apply.
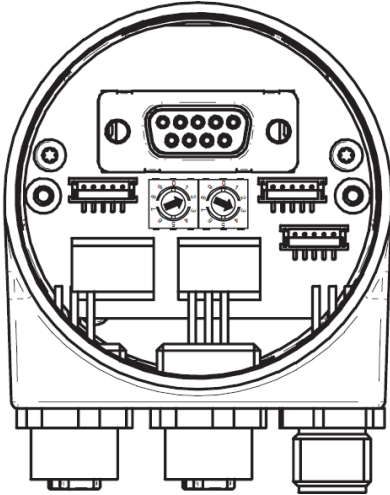
Example for Node ID 23:
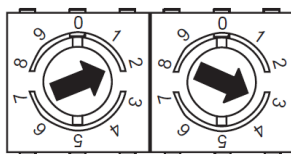
Annex

A.   Commissioning using B & R Automation Studio
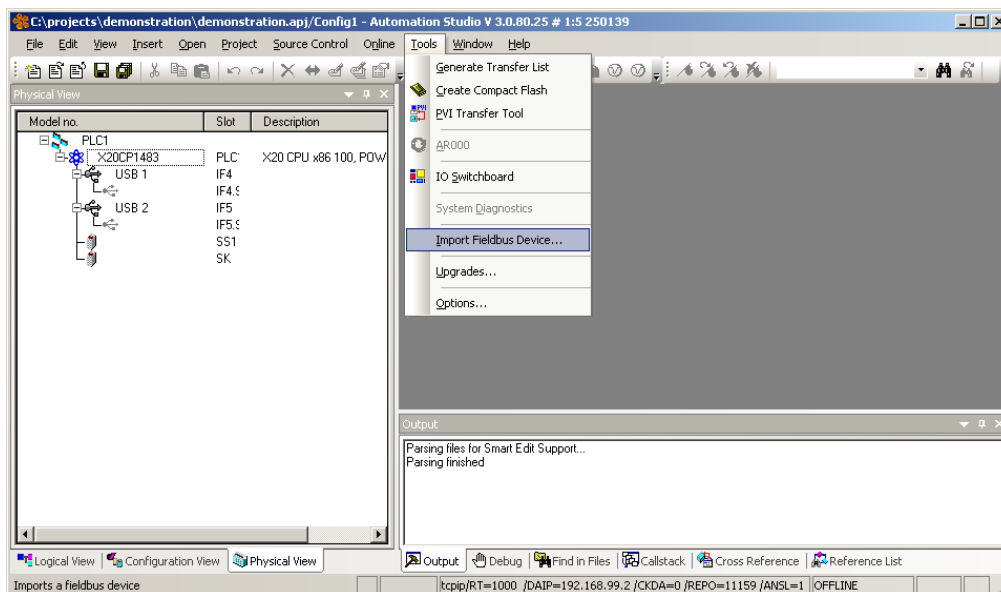
A.1   General

The fieldbus integrator within the Automation Studio eases integration of Ethernet Powerlink encoders.
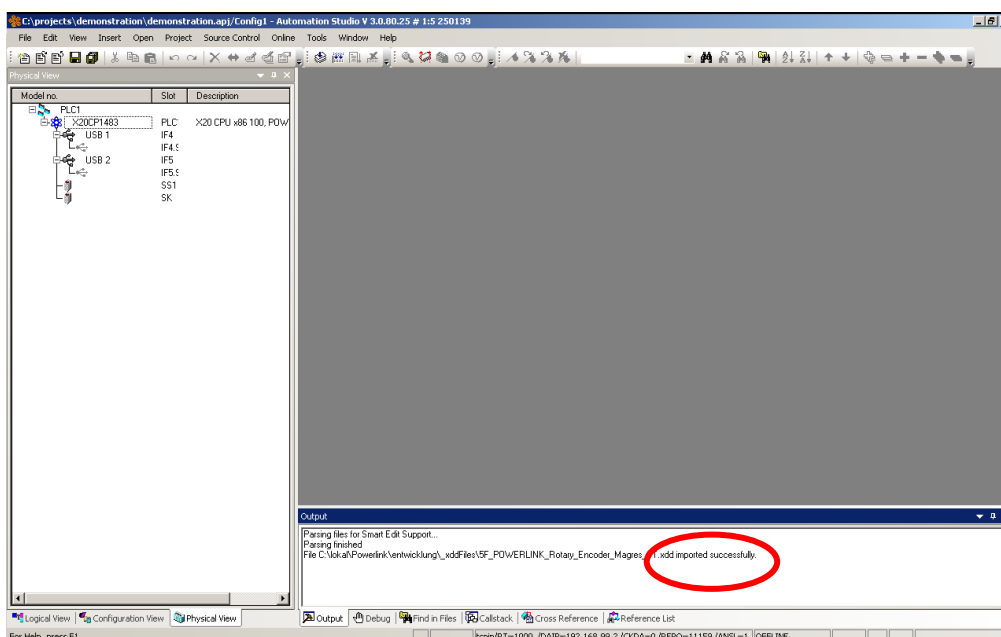
A.2   Prerequisites

- Set-up project with HW supporting Powerlink V2
- Automation Studio Version 3 and later

A.3   Step by step

1) Importing the xdd file using menu Tools->Import Fieldbus Device

2) Example: Import file 5F_POWERLINK_Rotary_Encoder_Magres_ST.xdd
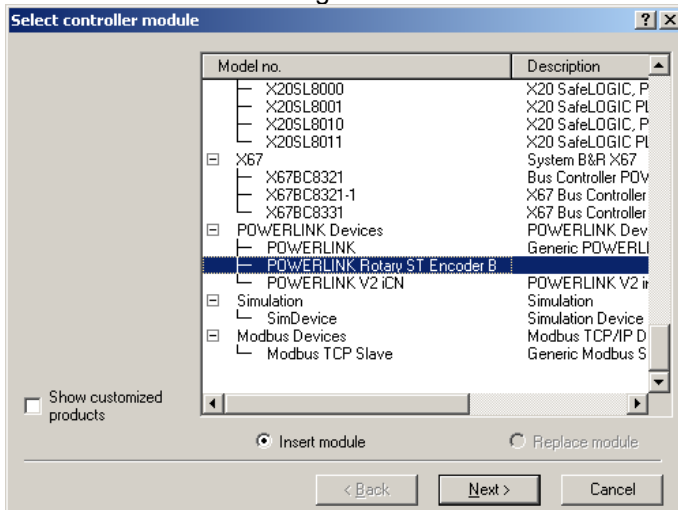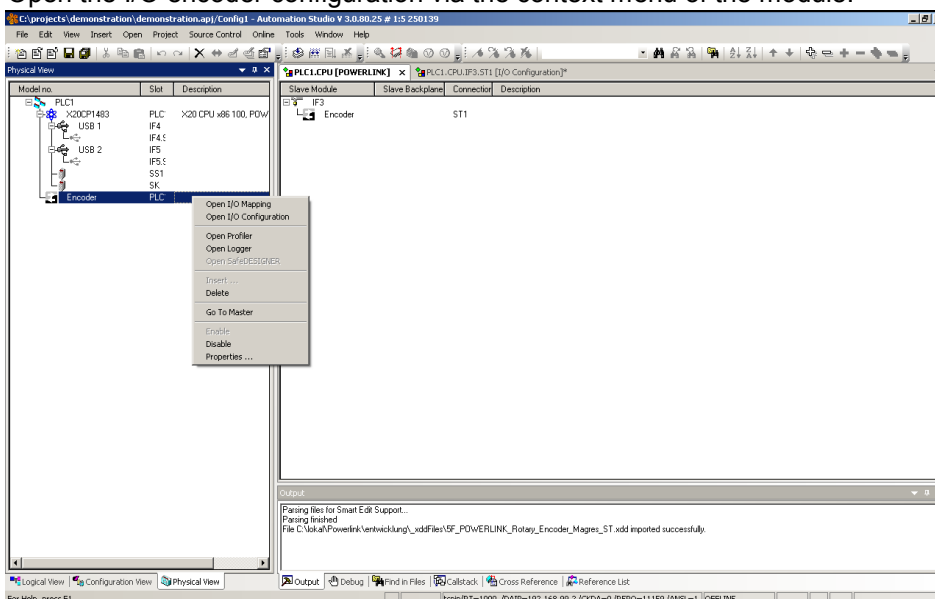3) Verify whether the xdd file has been properly imported

4) Follow menu path Open->Powerlink to have the Powerlink devices on screen
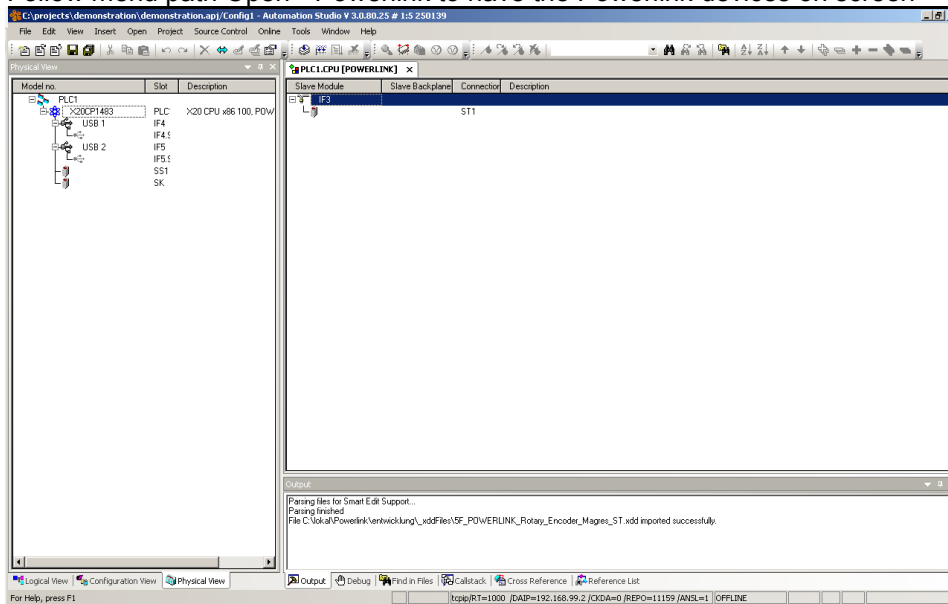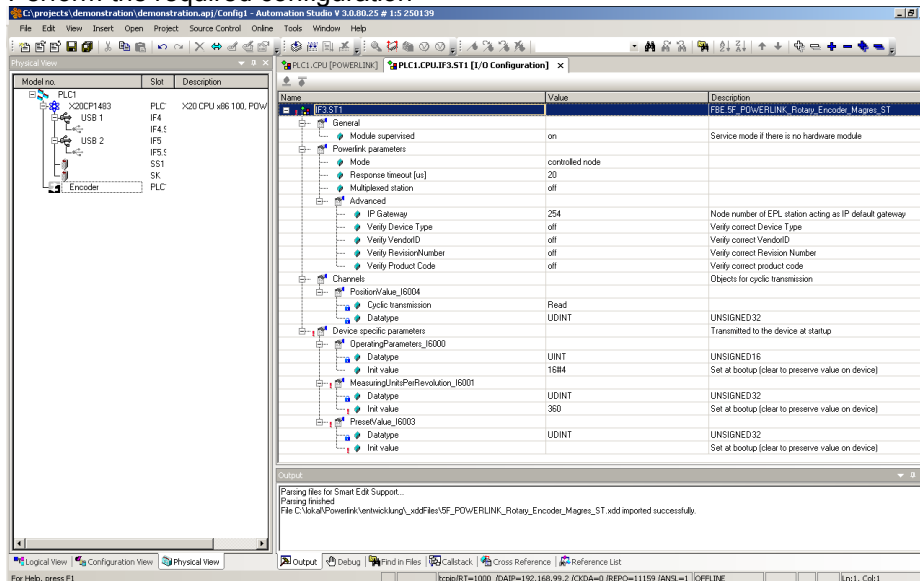

5) Add Baumer encoder using menu Insert->Module

6) Define the Node ID. Enter optional module name.
7) Open the I/O encoder configuration via the context menu of the module.

8) Perform the required configuration

The encoder has been embedded.

A hardware project in running mode allows for current status and position readout in monitor mode in encoder I/O mapping.