Baumer

Sensor Solutions • Motion Control • Vision Technologies • Process Instrumentation

Manual

Absolute Encoder with EtherCAT (with bus cover)

Firmware version 3.01 and up

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Content

**TwinCAT is a trademark of the company BECKHOFF Industrie Elektronik

1 Introduction

1.1 Product classification

Shaft encoders

Product	Product-Code	Product Name	Product family
GBAMW	0x0F	GBAMW_H	multivo*Plus* - Singleturn
GBMMW	0x0E	GBMMW_H	multivo*Plus* - Multiturn
GBLMW	0x0E	GBMMW_H	multivo*Plus* - Multiturn
GCAMW	0x0D	GCAMW_H	magtivo® - Singleturn
GCMMW	0x0C	GCMMW_H	magtivo® - Multiturn
GXAMW	0x0B	GXAMW_H	multivo® - Singleturn
GXMMW	0x0A	GXMMW_H	multivo® - Multiturn
GXLMW	0x0A	GXMMW_H	multivo® - Multiturn

End shaft encoders

Product	Product-Code	Product Name	Product family
GBAMS	0x0F	GBAMW_H	multivo*Plus* - Singleturn
GBMMS	0x0E	GBMMW_H	multivo*Plus* - Multiturn
GBLMS	0x0E	GBMMW_H	multivo*Plus* - Multiturn
GCAMS	0x0D	GCAMW_H	magtivo® - Singleturn
GCMMS	0x0C	GCMMW_H	magtivo® - Multiturn
GXAMS	0x0B	GXAMW_H	multivo® - Singleturn
GXMMS	0x0A	GXMMW_H	multivo® - Multiturn
GXLMS	0x0A	GXMMW_H	multivo® - Multiturn

Note:
For the above mentioned products there are 2 XML files available:

BAUMER IVO GxxMW_H encoder.xml (10 Byte PDO)
BAUMER IVO FAST GxxMW_H encoder.xml (4 Byte PDO)

See also chapter „PDO (Process Data Object)“.

2 Safety and operating instructions

Supplementary information
- This manual is intended as supplement to already existing documentation (catalogues, data sheet and mounting instructions).
- The manual must be read carefully prior to initial commissioning of the equipment.

Intended purpose of the equipment
- The encoder is a precision measurement device. It is used to determine angular positions and revolutions and to prepare and supply measured values in the form of electrical output signals for control systems. The encoder must not be used for any other purpose.

Commissioning
- Encoders may only be installed and mounted by suitably qualified experts.
- Observe the operating instructions of the machine manufacturer.

Safety remarks
- Prior to commissioning of the equipment, check all electrical connections.
- If installation, electrical connections or any other work performed at the encoder or at the equipment is not correctly executed, this can result in encoder malfunction or failure.
- Steps must be taken to exclude any risk of personal injury, damage to facility or operating appliances as a result of encoder failure or malfunction by providing suitable safety precautions.
- The encoder must not be operated beyond the specified limits (see further documentation).

Failure to comply with the safety remarks can result in malfunctions, personal injury or material damage!

Transport and storage
- Only ever transport or store encoders in their original packaging.
- Never drop encoders or expose them to major vibrations.

Mounting
- Avoid impacts or shocks on housing and shaft.
- Avoid any twist or torsion on housing.
- Do not open the encoder or proceed any mechanical modifications.

Shaft, ball bearings, glass disc or electronic components might be damaged. In this case, safe and reliable operation is no longer guaranteed.

Electrical commissioning
- Do not proceed any electrical modifications at the encoder.
- Do not proceed any wiring work while encoder is under power supply.
- Never plug or unplug connector while encoder is 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. In case of earth loop problems, earth at least on one side.

Failure to observe these instructions can result in malfunctions, material damage or personal injury!

3 Product families

The structure of the product family is modular. Depending on what is required of 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 sampling system used.

Bus cover
The bus cover contains the entire electronic circuitry for measured value processing and the Ethernet communication.

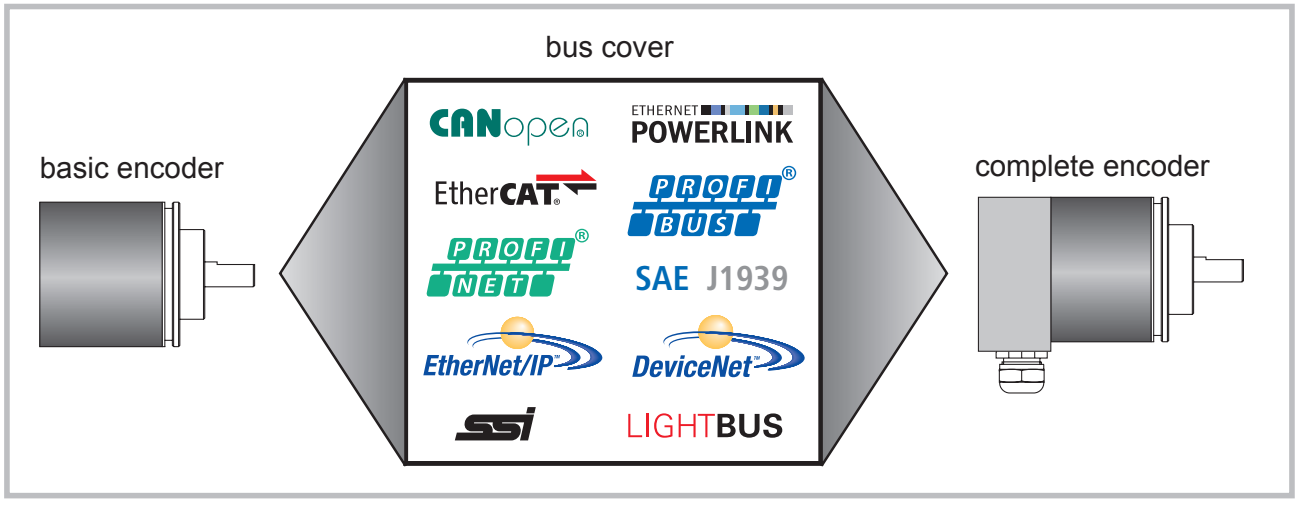
magtivo®
has a resolution of 1024 steps per revolution with 10 bit, features a magnetic sampling system and is suitable for operation in extreme ambient conditions.

multivo®
has a resolution of 8192 steps per revolution with 13 bit, features an optical/magnetic sampling system and is suitable for standard applications.

activo®/multivo*Plus*
features a 18 bit resolution of 262144 steps per turn, applies an optical/magnetic sensing method with integrated analogue/digital conversion and is intended for ultra-precise sensing applications.

The basic encoder comprises a singleturn and a multiturn encoder. The multiturn encoder features a 16 bit resolution respectively 65536 turns, or a 14 bit resolution corresponding to 16384 turns (multivo*Plus)*. The bus covers differ by their integrated bus interface.
Available bus interfaces: CANopen, DeviceNet, EtherCAT, Ethernet/IP, LIGHTBUS (fiber-optic), Profibus-DP, Profinet, Powerlink, SAE J1939, SSI.
Except for encoders with fiber-optic interface, all encoders enable parameterization by bus interface.

Functional principle:



4 Encoder operating parameters

Significance of operating parameters

Product	Product family	Resolution per turn			Number of turns			Measuring range		
		Decimal	Hex	Bit	Decimal	Hex	Bit	Decimal	Hex	Bit
GCAMW(S)	magtivo®	4096	1000	12	1	1	0	4096	1000	12
GCMMW(S)	magtivo®	4096	1000	12	65536	10000	16	268435456	10000000	28
GDAMW(S)	activo®	262144	40000	18	1	1	0	262144	40000	18
GDMMW(S)	activo®	262144	40000	18	16384	4000	14	4294967296	100000000	32
GXAMW(S)	multivo®	8192	2000	13	1	1	0	8192	2000	13
GXMMW(S)	multivo®	8192	2000	13	65536	10000	16	536870912	20000000	29
GBAMW(S)	multivo*Plus*	262144	40000	18	1	1	0	262144	40000	18
GBMMW(S)	multivo*Plus*	262144	40000	18	16384	4000	14	4294967296	100000000	32

These are ROM default parameters upon delivery.

Firmware version (0x100A) V4.00 provides a scaling function for customer-specific parameterization of resolution, total measuring range, direction of rotation and preset. Refer also to chapter SDO, object 0x6000.

5 Encoder data

5.1 CoE (CANopen over EtherCAT)

Since there are many device and application profiles for a large variety of CANopen applications these may also be applied at EtherCAT slaves.
The EtherCAT encoder is implementing a part of the DS406 encoder device profile.
Explanations and description of implemented Service Data Objects in chapter SDO.

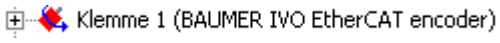
5.2 PDO (Process Data Object)

With XML file **BAUMER IVO GxxMW_H encoder.xml**

The encoder will transmit following PDO (input data) as process data:

Value	Data Type	Significance
Position value	UDINT	Actual absolute encoder position value. For value range please refer to chapter „Encoder operating parameters“
Warnings	UINT	Warnings Bit 2^2 = 1: Battery warning, Lithium cell voltage is not sufficient
System Time	UDINT	Actual system time, resolution in ns

Device identification in the TwinCAT system environment as „BAUMER IVO EtherCAT encoder“.



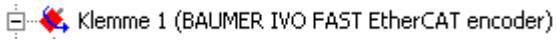
Linking the position value with the high resolution system time enables the master to calculate for example speed respectively acceleration. Thus any jitter occurring in the communication system will not have any impact.

With XML file **BAUMER IVO FAST GxxMW_H encoder.xml**

PDO (Process Data Object)
The encoder will transmit following PDO (input data) as process data:

Value	Data type	Significance
Position Value	UDINT	Actual absolute encoder position value. For value range please refer to chapter „Encoder operating parameters“

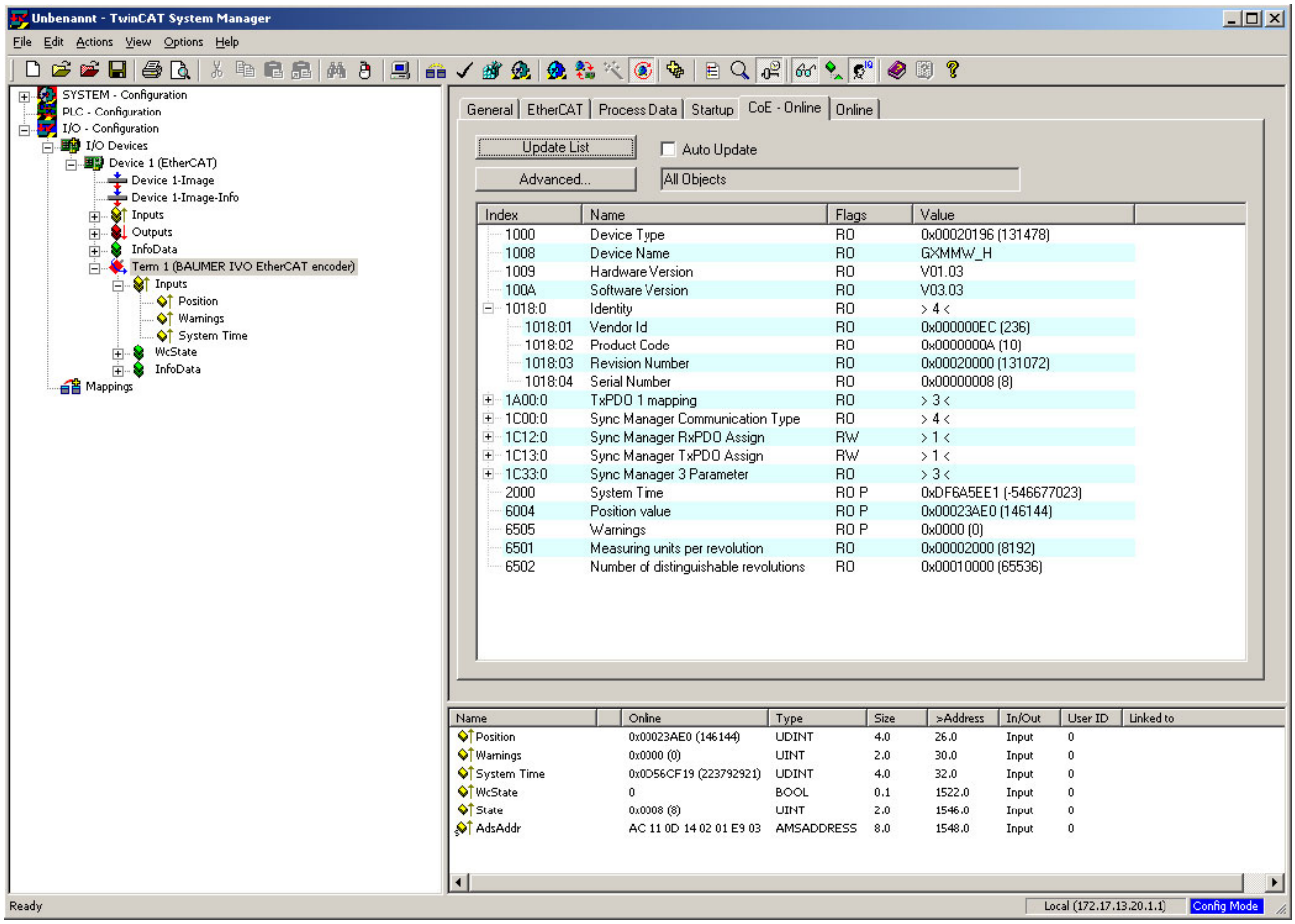
Device identification in the TwinCAT system environment as „BAUMER IVO FAST EtherCAT encoder“.



Shorter clock cycles (up to 125 µs) are possible.

5.3 SDO (Service Data Object)

Under TwinCAT there is access to the SDO objects under **CoE - Online**.



Please consider that every CoE access (mailbox communication) will shortly interrupt generation of encoder input data for the time of mailbox communication. With short cycle times in Distributed Clocks Mode this may imply that not in every Sync cycle a new position is detected.

Object list Detailed explanations on the most important SDO objects

Object 0x1000 Device Type

SubIndex	0
Data type	Unsigned 32
Access	ReadOnly
Default	Multiturn: 0x00020196 Singleturn: 0x00010196h
EEPROM	No
Significance	Information on device profile and device type
Values	

Object 0x1008 Device Name

SubIndex	0
Data type	VISIBLE_STRING
Access	ReadOnly
Default	According to connected basic encoder "GXMMW_H","GXAMW_H","GCMMW_H ","GCAMW_H ", "GDMMW_H","GDAMW_H",“GBMMW_H ","GBAMW_H "
EEPROM	No
Significance	Device name in ASCII
Values	

Object 0x1009 Hardware Version

SubIndex	0
Data type	VISIBLE_STRING
Access	ReadOnly
Default	
EEPROM	No
Significance	Hardware version in ASCII
Values	

Object 0x100A Manufacturer Software Version

SubIndex	0
Data type	VISIBLE_STRING
Access	ReadOnly
Default	
EEPROM	No
Significance	Software version in ASCII
Values	

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 0.

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

Object 0x1011 RESTORE Application Parameter

Object 0x1011 restores ROM default in device-specific objects (0x6000..0x6FFF) both in RAM and EEPROM. To prevent any inadvertent restore, the signature „**load**“ must be written in object 0x1011 Subindex 0.

Signature	MSB			LSB
ISO 8859 character	**d**	**a**	**o**	**l**
hex	**0x64**	**0x61**	**0x6F**	**0x6C**

Object 0x1018 Identity Object

SubIndex	0
Data type	Unsigned 8
Access	ReadOnly
Default	4
EEPROM	No
Significance	Maximum supported subindex
Values	4 = Maximum supported subIndex

SubIndex	1
Data type	Unsigned 32
Access	ReadOnly
Default	Ech
EEPROM	No
Significance	VendorID for Baumer IVO GmbH & Co. assigned by CiA
Values	0xEC (in the Internet under www.can-cia.de)

SubIndex	2
Data type	Unsigned 32
Access	ReadOnly
Default	0x0A → GXMMW_H ; 0x0B → GXAMW_H 0x0C → GCMMW_H ; 0x0D → GCAMW_H 0x0E → GBMMW_H, GDMMW_H ; 0x0F → GBAMW_H, GDAMW_H
EEPROM	No
Significance	Product Code
Values	

SubIndex	3
Data type	Unsigned 32
Access	ReadOnly
Default	
EEPROM	No
Significance	Revision no.
Values	

SubIndex	4
Data type	Unsigned 32
Access	ReadOnly
Default	
EEPROM	No
Significance	Serial no.
Values	

Object 0x1A00 TxPDO1 Mapping

SubIndex	0
Data type	Unsigned 8
Access	ReadOnly
Default	
EEPROM	No
Significance	Maximum supported subindex
Values	3

SubIndex	1
Data type	Unsigned 32
Access	ReadOnly
Default	
EEPROM	No
Significance	Position value
Values	0x6004

SubIndex	2
Data type	Unsigned 16
Access	ReadOnly
Default	
EEPROM	No
Significance	Warnings
Values	0x6505

SubIndex	3
Data type	Unsigned 32
Access	ReadOnly
Default	
EEPROM	No
Significance	System time
Values	0x2000

Device-specific objects

Object 0x6000 Operating parameters

SubIndex	0
Data type	Unsigned 16
Access	ReadWrite
Default	0 , scaling OFF, CW
EEPROM	Yes
Significance	Operating parameters
Values	Bit 0: direction of rotation 0 CW 1 CCW Entries ≠ default values are only effective with enabled scaling function (0x6000). Bit 2: scaling function ON/OFF **(firmware version V4.00 and up)** 0 scaling disabled. Encoder provides raw data (less offset). 1 scaling enabled. Encoder provides position values under consideration of scaling factor and offset ². Example: Value 0x0004 -> scaling on, CW

² Firmware version (0x100A) V4.00 and up provide here an optional scaling function, otherwise customer-specific parameterization as resolution, total measuring range, direction of rotation and preset are not effective.

Above parameters are first saved volatile in the encoder RAM. If required, non-volatile saving in EEPROM is by utilizing object SAVE Application parameter (0x1010).
Please note that with enabled scaling the input data (TxPDO) are generated considerably more slowly since the encoder requires additional processing time for scaling calculations. In other words, the programmed PLC cycle times for encoder readout have to be correspondingly prolonged.

Guide values:

Device	Input data 4/10 byte PDO	Cycle time with scaling OFF	Cycle time with scaling ON	Cycle time in mode Distributed Clocks with scaling OFF	Cycle time in mode Distributed Clocks with scaling ON
GXMMW_H	4	111µs	407µs	125µs	500µs
GXMMW_H	10	197µs	492µs	250µs	1000µs

Object 0x6001 Measuring units per revolution

SubIndex	0
Data type	Unsigned 32
Access	ReadWrite
Default	0x2000 = 8192 = 13bit → GXxMW_H 0x1000 = 4096 = 12bit → GCxMW_H 0x40000 = 262144 = 18bit → GBxMW_H, GDxMW_H
EEPROM	Yes
Significance	Optional number of steps per revolution.
Values	1..n.. max. number of steps per revolution (0x6501) Entries ≠ default values are only effective with enabled scaling function (0x6000).

In general, when writing on this object any previously saved offset (0x6509) will be cleared (value = 0).

Object 0x6002 Total measuring range

SubIndex	0
Data type	Unsigned 32
Access	ReadWrite
Default	0x20000000 = 536870912 = 29bit → GXMMW_H 0x2000 = 8192 = 13bit → GXAMW_H 0x10000000 = 268435456= 28bit → GCMMW_H 0x1000 = 4096 = 12bit → GCAMW_H 0x80000000 = 2147483648 = 31bit ² → GBMMW_H, GDMMW_H 0x40000 = 262144 = 18bit → GBAMW_H, GDAMW_H
EEPROM	Yes
Significance	Total measuring range in steps optionally programmable. Consequence : Number of revolutions = total measuring range / resolution The maximum resolution (0x6502) must not be exceeded since otherwise the selected total resolution range is too wide and will be rejected.
Values	1..n.. max. total measuring range in steps (0x 6502) Entries ≠ default values are only effective with enabled scaling function (0x6000).

² with disabled scaling 32 bit
In general, when writing on this object any previously saved offset (0x6509) will be cleared (value = 0).

Important for multiturn encoder operation:
If the programmed number of revolutions is a value ≠ 2^n (1, 2, 4,...65536), re-programming after having crossed the encoder zero point in powerless state is required.

Object 0x6003 Preset value

SubIndex	0
DatenTyp	Unsigned 32
Zugriff	ReadWrite
Default	0
EEPROM	Yes
Beschreibung	Optionally programmable position value. In this operation an offset value is calculated and saved in object 0x6509.
Werte	0..actual total measuring range (0x6002) -1 Entries ≠ default values are only effective with enabled scaling function (0x6000).

Object 0x6004 Position value

SubIndex	0
Data type	Unsigned 32
Access	ReadOnly
Default	
EEPROM	No
Significance	Value of actual position in steps
Values	0..actual total measuring range (0x6002) -1

Object 0x6501 Max. measuring units per revolution (max. resolution in steps)

SubIndex	0
Data type	Unsigned 32
Access	ReadOnly
Default	0x2000 = 8192 = 13bit → GXxMW_H 0x1000 = 4096 = 12bit → GCxMW_H 0x40000 = 262144 = 18bit → GBxMW_H, GDxMW_H
EEPROM	No
Significance	Maximum singleturn resolution in steps
Values	

Object 0x6502 Number of distinguishable revolutions

SubIndex	0
Data type	Unsigned 32
Access	ReadOnly
Default	0x10000 = 65536= 16bit → GXMMW_H 0x10000 = 65536= 16bit → GCMMW_H 0x2000 = 8192 = 13bit ² → GBMMW_H, GDMMW_H
EEPROM	No
Significance	Maximum number of revolutions
Values	With singleturn encoders =0, otherwise according to basic encoder

² with disabled scaling 14 bit

Object 0x6505 Warnings)

SubIndex	0
Data type	Unsigned 16
Access	ReadOnly
Default	0
EEPROM	No
Significance	Warnings
Values	Multiturn encoder Bit 2 : 0 → Lithium battery OK 1 → Lithium battery NOK

Object 0x6509 Offset

SubIndex	0
Data type	Unsigned 32
Access	ReadOnly
Default	0
EEPROM	Yes
Significance	Value is calculated upon writing on object Preset (0x 6003)
Values	

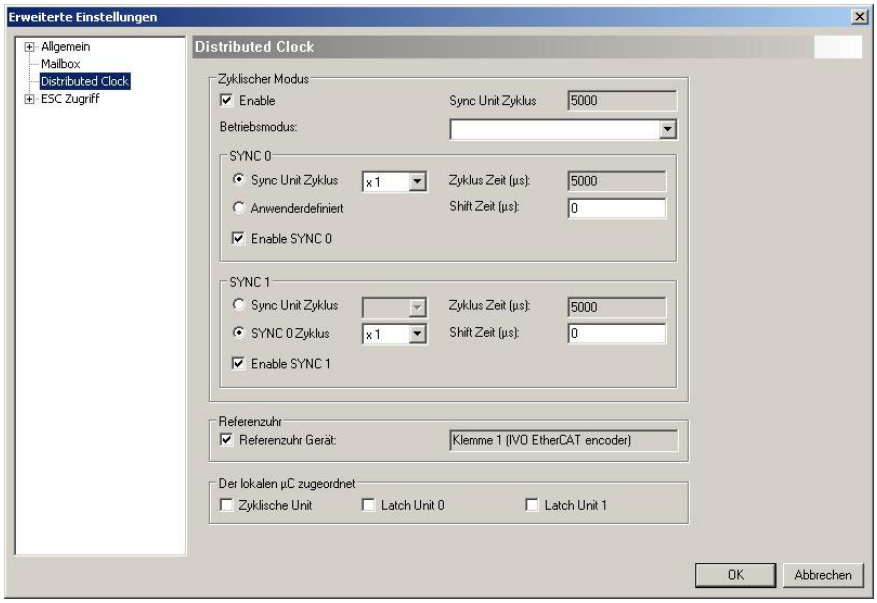
5.4 Free Run Mode (default)

Encoder generates process data in a cyclic asynchronous manner.

5.5 Distributed Clocks Mode

Distributed clocks mode enables exactly the same time with all bus users.
The encoder can be utilized and configurated as reference clock for synchronisation purposes of both other users and master. Thus a high-precision time base is available throughout the network.
The encoder generates process data synchronously to a Sync Signal .

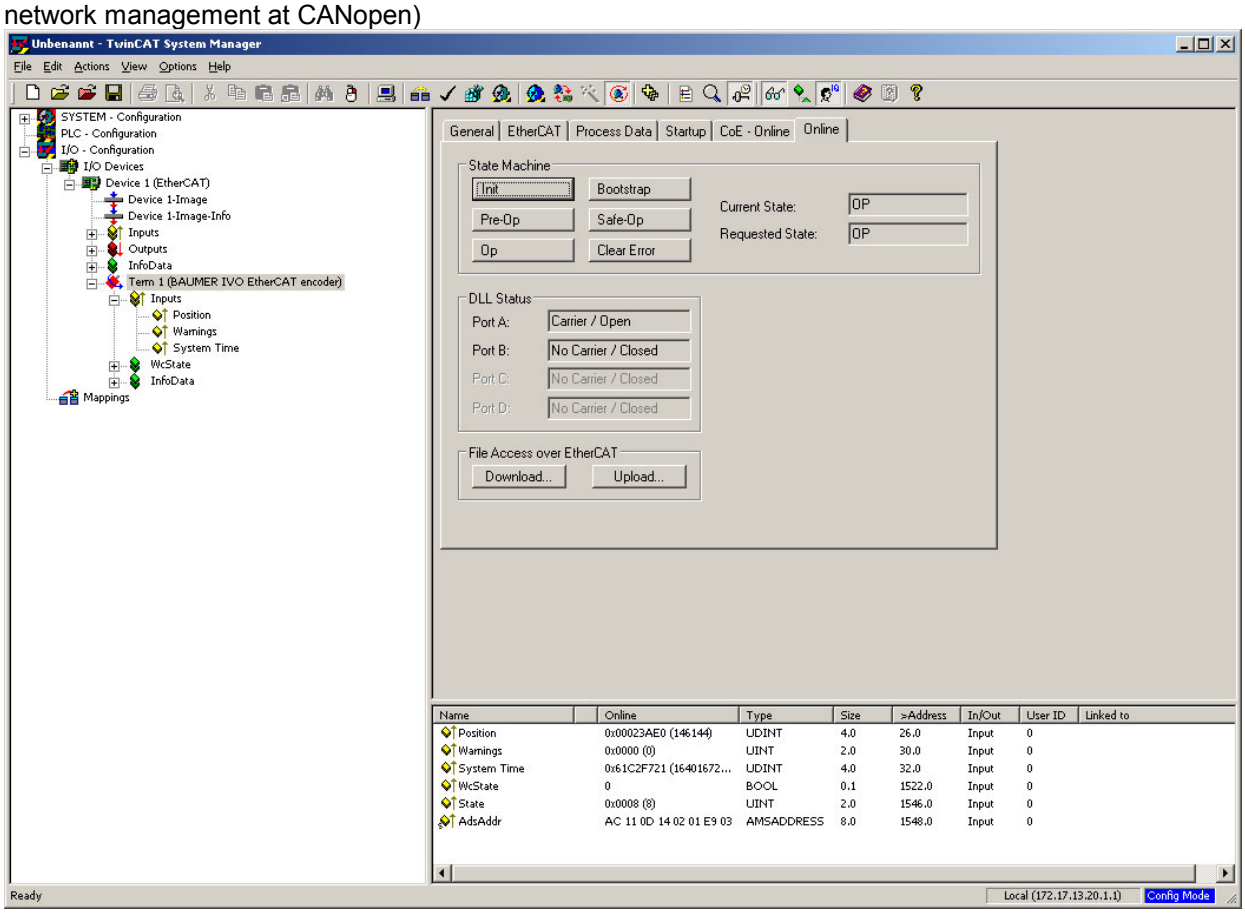
5.5.1 Activation Distributed Clocks under TwinCAT



Afterwards E/A devices reload (F4) is mandatory

5.6 Network management

The encoder state machine can be switched over by **online** in the TwinCAT system manager (similar to network management at CANopen)



6 Terminal assignment and commissioning

6.1 Mechanical mounting

Shaft encoders

- Mount encoder housing by help of the mounting holes and three screws (square flange: 4 screws) provided at 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 equalize any shifts due to temperature as well as mechanical tolerances. Observe the maximum permitted axial or radial shaft load. For appropriate couplings please refer to accessories.
- Tighten the mounting screws firmly.

End shaft encoders

- Mounting by clamping ring
  Open clamping ring completely before mounting the encoder.
  Slide encoder onto the drive shaft and tighten the clamping ring firmly.
- Adjusting element with rubber buffer
  Slide encoder onto the drive shaft and insert cylindrical pin into adjusting element (with rubber buffer) provided by customer.
- Spring washer
  Spring washer assembly at the encoder housing is by inserting the screws into the mounting holes. Slide encoder onto the drive shaft and assemble spring washer at the contact surface.

6.2 Electrical connection

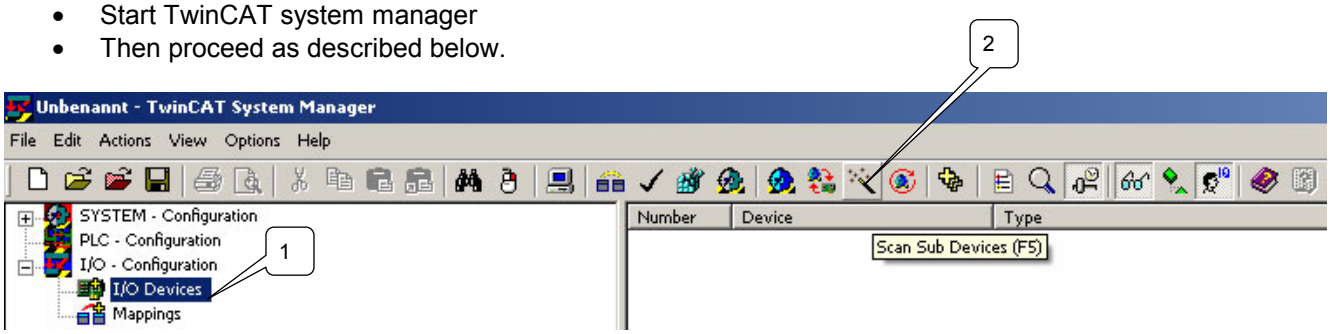
Only ever store and transport bus cover in the ESD bag. Bus cover must fully rest against the housing and be firmly screwed in place.
For e-connection of the bus cover please proceed as follows:

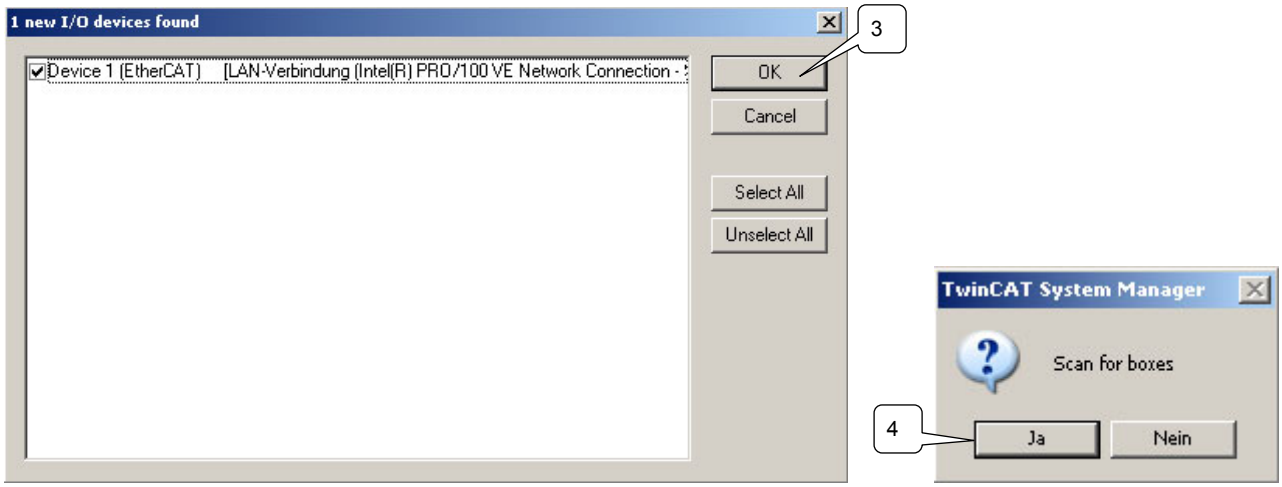
- Release fixing screws of the bus cover
- Carefully loosen the bus cover and lift it off in axial direction.
- Carefully plug bus cover onto the D-SUB connector of the basic encoder. Slide it over the seal by avoiding any cocking. The bus cover must fully rest on the basic encoder.
- Tighten the fixing screws firmly and equally.

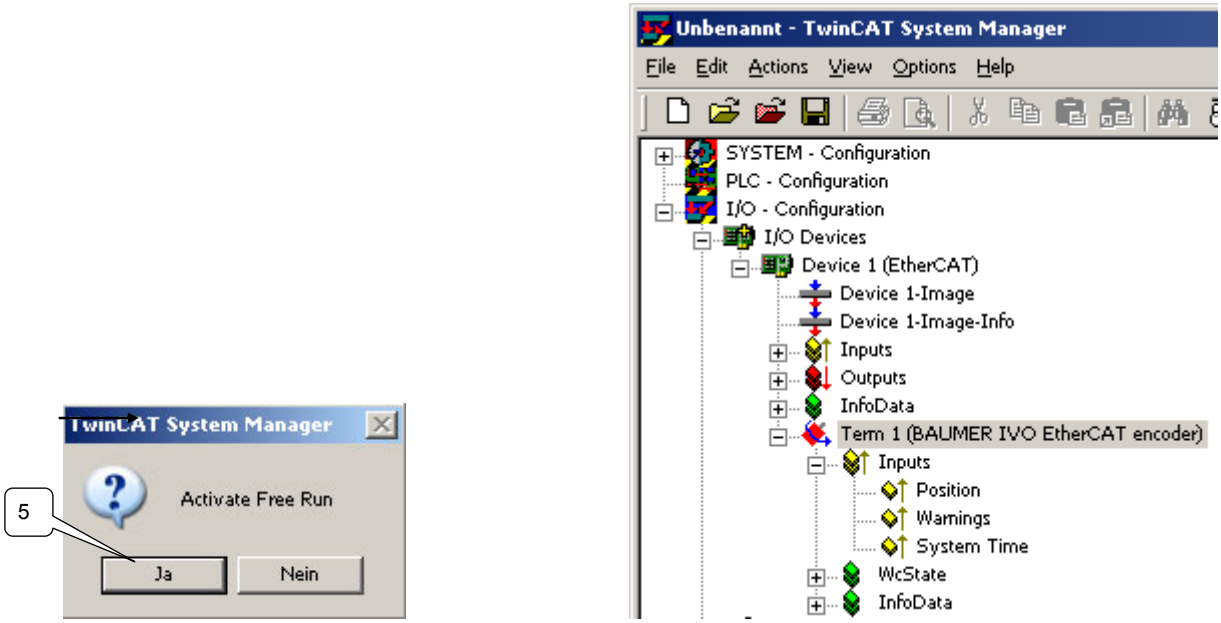
Encoder housing and bus cover are only ideally connected if the bus cover mounting surface is fully resting on the basic encoder (positive locking).

6.2.1 Initialising under TwinCAT system manager

- The included XML file must be copied into the respective directory: ..\TwinCAT\Io\EtherCAT
- Start TwinCAT system manager
- Then proceed as described below.

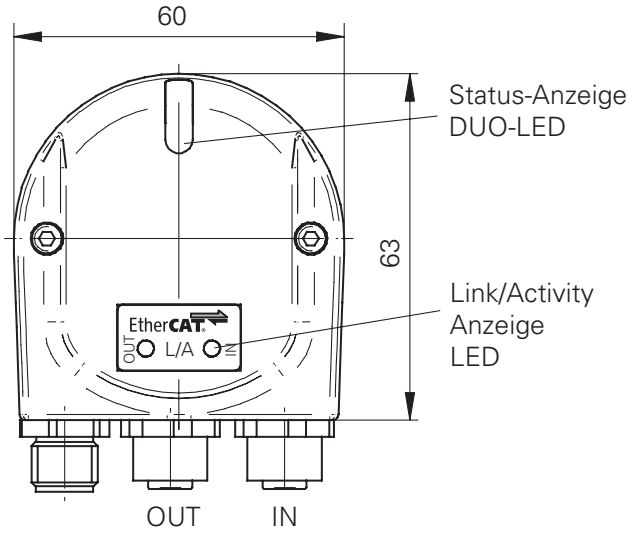


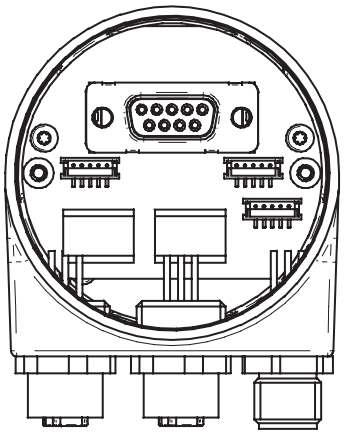




Now EtherCAT devices should respond as shown above!

6.2.2 Terminal assignment





1 x M12 connector (male)
A-coded

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

2 x M12 connector (female)
D-coded

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

6.3 Display elements

6.3.1 State indicator

The bus cover provides a DUO LED (green/red) operating in line with EtherCAT Indicator Specification V0.91.

DUO-LED green RUN State

RUN State	Status	Description	Category
Off	INIT	The device is in state INIT	Mandatory
Blinking	PRE-OPERATIONAL	The device is in state PRE-OPERATIONAL	Mandatory
Single Flash	SAFE-OPERATIONAL	The device is in state SAFE-OPERATIONAL	Mandatory
On	OPERATIONAL	The device is in state OPERATIONAL	Mandatory
Flickering	INITIALISATION or BOOTSTRAP	The device is booting and has not yet entered the INIT state, or:The device is in state BOOTSTRAP.Firmware download operation in progress	Optional
Double Flash	Reserved	Reserved for future use	reserved
Triple Flash	Reserved	Reserved for future use	reserved
Quadruple	Reserved	Reserved for future use	reserved

DUO-LED red ERR State

ERR State	Error	Description	Example	Category
Off	No error	The EtherCAT communication of the device is in working condition		Mandatory
Flickering	Booting Error Booting	Error was detected. INIT state reached, but Parameter "Change" in the AL status register is set to 0x01:change error	Checksum Error in Flash Memory.	Optional
Blinking	Invalid Configuration	General Configuration Error	State change commanded by master is impossible due to register or object settings.	Mandatory
Single Flash	Unsolicited State Change	Slave device application has changed the EtherCAT state autonomously: Parameter "Change" in the AL status register is set to 0x01:change/error.	Synchronisation Error, device enters Safe-Operational automatically.	Mandatory
Double Flash	Application Watchdog Timeout	An application watchdog timeout has occurred.	Sync Manager Watchdog timeout	Mandatory
Triple Flash	Reserved	Reserved for future use		Reserved
Quadruple Flash	Reserved	Reserved for future use		Reserved
On	PDI Watchdog Timeout	A PDI Watchdog timeout has occurred	Application controller is not responding any more	Optional

6.3.2 Link/Activity indicator

One LED each for input and output.

Link	Activity	State of Link/Activity indicator
Yes	No	On
Yes	Yes	Flickering
No	Not applicable	Off

Note: All LED´s are “off“ if the encoder is under power supply but not yet connected to Ethernet.