

Manual

Absolute Encoder with Ether**CAT**[®] (with bus cover)

Firmware version 3.01 and up

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**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 <i>Plus</i> - Singleturn
GBMMW	0x0E	GBMMW_H	multivo <i>Plus</i> - Multiturn
GCAMW	0x0D	GCAMW_H	magtivo® - Singleturn
GCMMW	0x0C	GCMMW_H	magtivo® - Multiturn
GDAMW	0x0F	GDAMW_H	activo® - Singleturn
GDMMW	0x0E	GDMMW_H	activo® - Multiturn
GXAMW	0x0B	GXAMW_H	multivo® - Singleturn
GXMMW	0x0A	GXMMW_H	multivo® - Multiturn

End shaft encoders

Product	Product-Code	Product Name	Product family
GBAMS	0x0F	GBAMW_H	multivo <i>Plus</i> - Singleturn
GBMMS	0x0E	GBMMW_H	multivo <i>Plus</i> - Multiturn
GCAMS	0x0D	GCAMW_H	magtivo® - Singleturn
GCMMS	0x0C	GCMMW_H	magtivo® - Multiturn
GDAMS	0x0F	GDAMW_H	activo® - Singleturn
GDMMS	0x0E	GDMMW_H	activo® - Multiturn
GXAMS	0x0B	GXAMW_H	multivo® - Singleturn
GXMMS	0x0A	GXMMW_H	multivo® - Multiturn

Note:

For the abovementioned 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.
- Never provide rigid connections between encoder shaft and drive shaft.
- 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.

multivoPlus / activo®

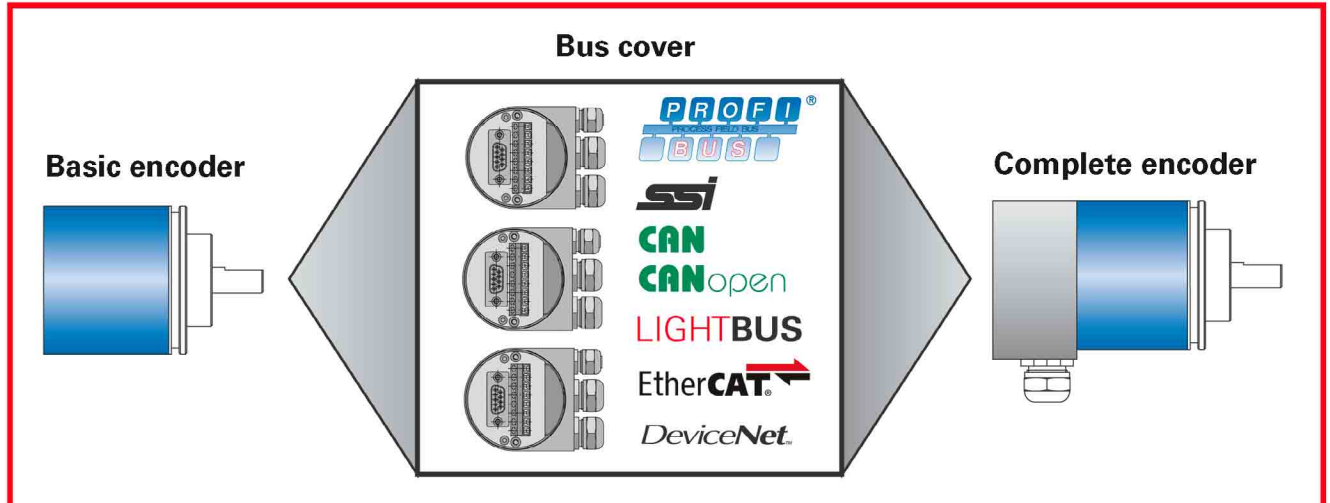
has a resolution of 262144 steps per revolution with 18 bit, features an optical/magnetic sampling system with integrated analogue/digital conversion and is suitable for high-precision measurements.

The basic encoders are subdivided once again into a singleturn and a multiturn encoder. The multiturn encoder is capable of a resolution of up to 16 bit or 65536 revolutions, or 14 bit corresponding to 16384 revolutions (*multivoPlus*). The bus covers are differentiated by the respective bus interfaces.

Available interfaces are Profibus-DP, CAN, CANopen and DeviceNet, LIGHTBUS, EtherCAT and SSI.

All encoders except LIGHTBUS and EtherCAT are programmable by bus interface.

Functional principle: magtivo® / multivo® / activo® / multivoPlus for shaft or hollow shaft respectively



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
GCMW(S)	magtivo®	4096	1000	12	65536	10000	16	268435456	10000000	28
GDAMW(S)	activo®	262144	40000	18	1	1	0	262144	40000	18
GDMW(S)	activo®	262144	40000	18	16384	4000	14	4294967296	100000000	32
GXAMW(S)	multivo®	8192	2000	13	1	1	0	8192	2000	13
GXMW(S)	multivo®	8192	2000	13	65536	10000	16	536870912	20000000	29
GBAMW(S)	multivoPlus	262144	40000	18	1	1	0	262144	40000	18
GBMW(S)	multivoPlus	262144	40000	18	16384	4000	14	4294967296	100000000	32

These parameters are permanent and do not allow alteration by programming (any scaling can efficiently be realized by PC-operated master).

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.


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 ⁰ = 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“.

 Klemme 1 (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“.

 Klemme 1 (BAUMER IVO FAST EtherCAT encoder)

Accelerated clock times ($\leq 125 \mu\text{s}$) are possible.

5.3 SDO (Service Data Object)

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

The screenshot shows the TwinCAT System Manager interface. On the left, a tree view shows the configuration hierarchy: SYSTEM - Configuration, PLC - Configuration, I/O - Configuration, I/O Devices, Device 1 (EtherCAT), Device 1-Image, Device 1-Image-Info, Inputs, Outputs, InfoData, Term 1 (BAUMER IVO EtherCAT encoder), Inputs, Position, Warnings, System Time, WcState, InfoData, and Mappings. The main window displays the 'CoE - Online' tab, showing a list of SDO objects with columns for Index, Name, Flags, and Value. Below this, a table provides more details for selected objects.

Index	Name	Flags	Value
1000	Device Type	RO	0x00020196 (131478)
1008	Device Name	RO	Gx3MMW_H
1009	Hardware Version	RO	V01.03
100A	Software Version	RO	V03.03
1018:0	Identity	RO	> 4 <
1018:01	Vendor Id	RO	0x000000EC (236)
1018:02	Product Code	RO	0x0000000A (10)
1018:03	Revision Number	RO	0x00020000 (131072)
1018:04	Serial Number	RO	0x00000008 (8)
1A00:0	TxPDD 1 mapping	RO	> 3 <
1C00:0	Sync Manager Communication Type	RO	> 4 <
1C12:0	Sync Manager RxPDD Assign	RW	> 1 <
1C13:0	Sync Manager TxPDD Assign	RW	> 1 <
1C33:0	Sync Manager 3 Parameter	RO	> 3 <
2000	System Time	RO P	0xDFA5EE1 (-546677023)
6004	Position value	RO P	0x00023AE0 (146144)
6505	Warnings	RO P	0x0000 (0)
6501	Measuring units per revolution	RO	0x00002000 (8192)
6502	Number of distinguishable revolutions	RO	0x00010000 (65536)

Name	Online	Type	Size	=>Address	In/Out	User ID	Linked to
Position	0x00023AE0 (146144)	UDINT	4.0	26.0	Input	0	
Warnings	0x0000 (0)	UINT	2.0	30.0	Input	0	
System Time	0x0D56CF19 (223792921)	UDINT	4.0	32.0	Input	0	
WcState	0	BOOL	0.1	1522.0	Input	0	
State	0x0008 (8)	UINT	2.0	1546.0	Input	0	
AdsAddr	AC 11 0D 14 02 01 E9 03	AMSADDRESS	8.0	1548.0	Input	0	

5.4 Free Run Mode (default)

Asynchronous cyclic transmission of encoder process data.

5.5 Distributed Clocks Mode

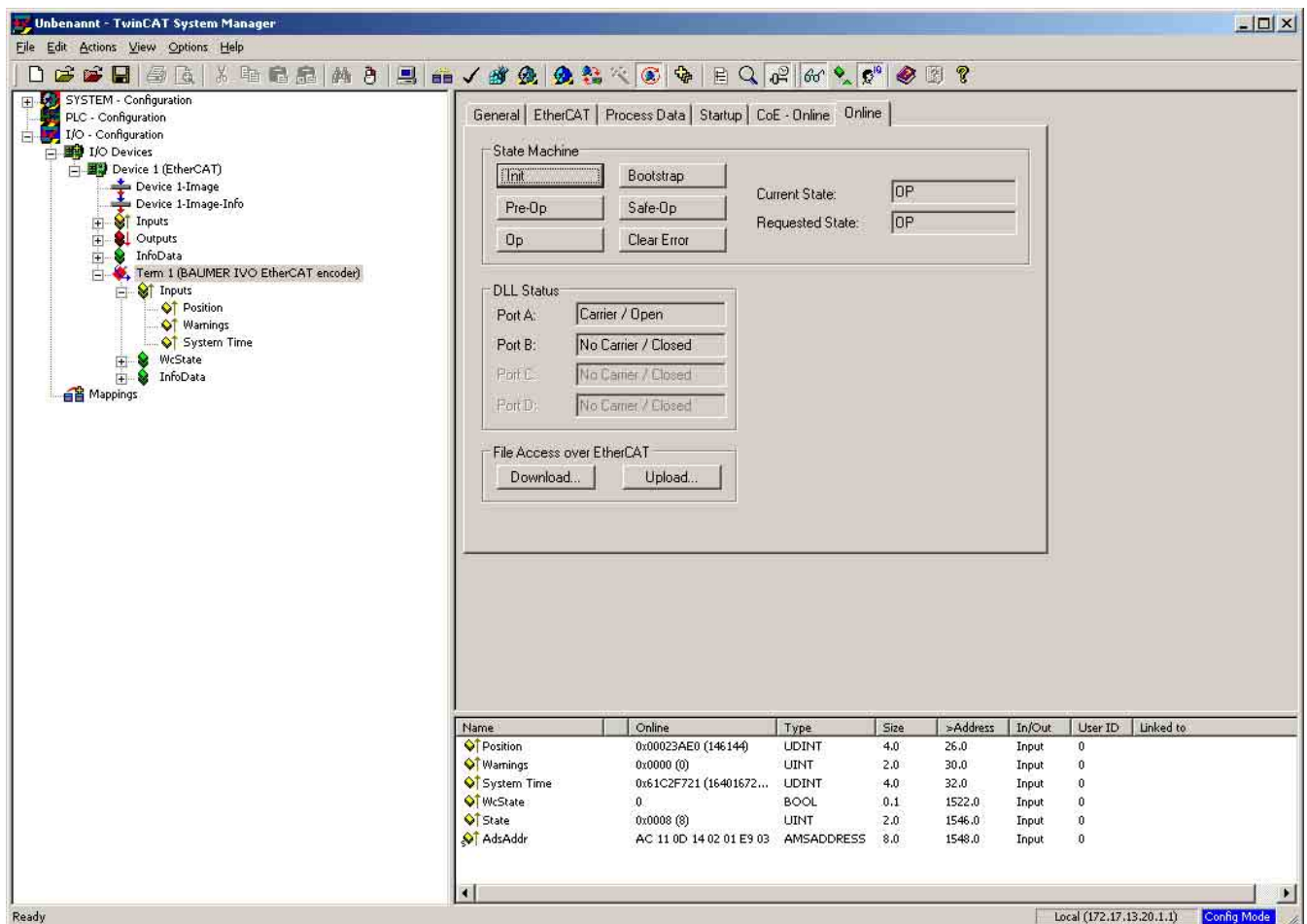
Distributed clocks mode enables exactly the same time with all bus users.

The encoder can be utilized and configured as reference clock for synchronisation purposes of both other users and master. Thus a high-precision time base is available throughout the network.

Encoder transmits process data synchronously to sync signal.

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
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.

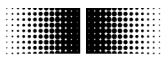
6.2 Electrical connection

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:

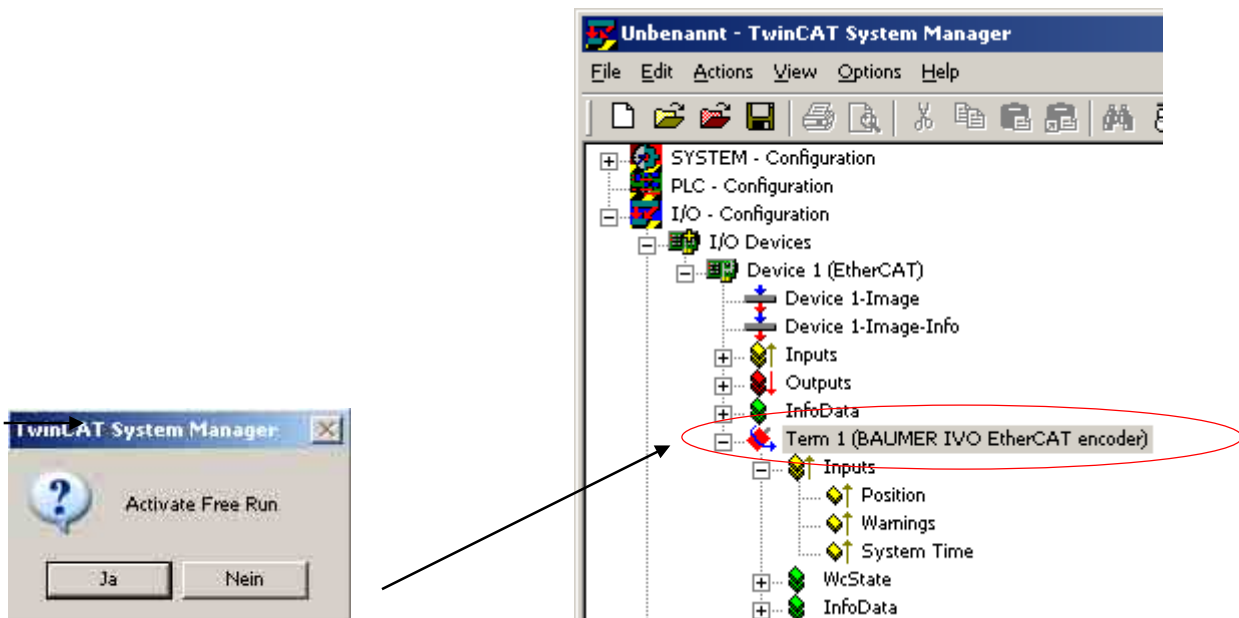
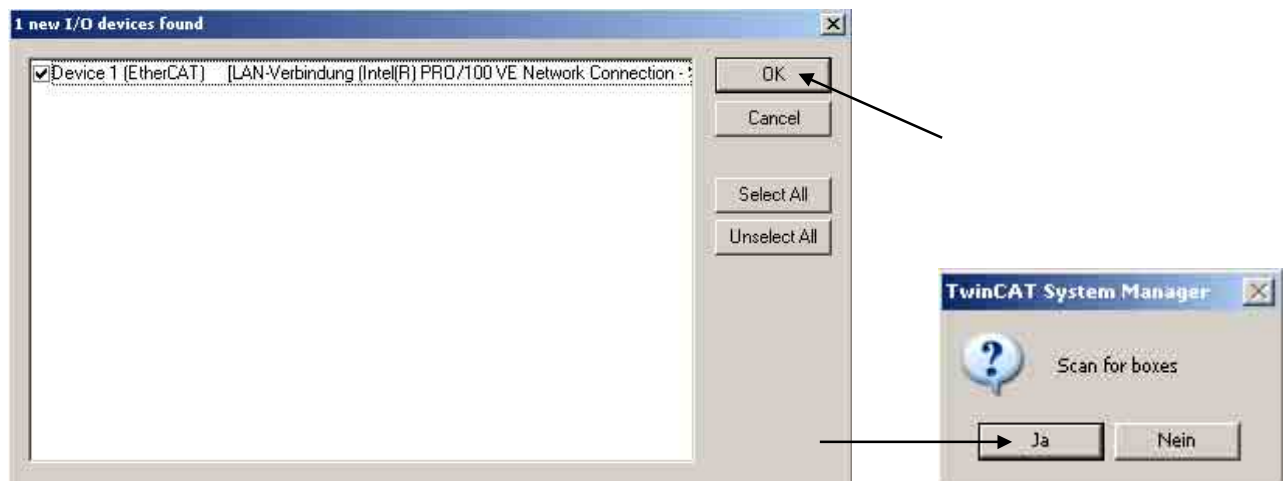
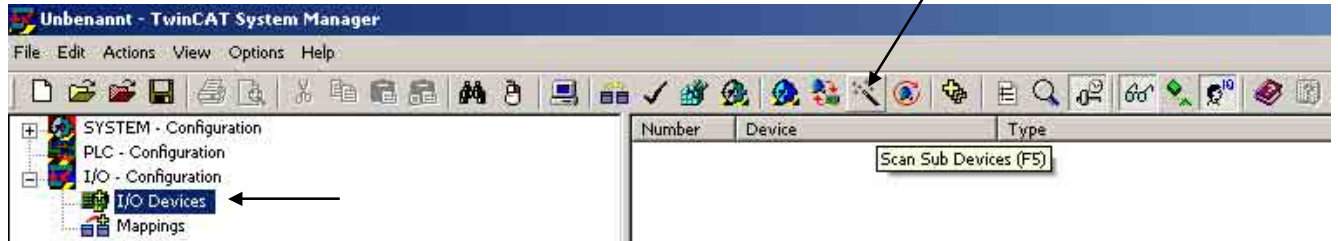
- Release fixing screws of the bus cover
- Carefully loosen the bus cover and lift it off in axial direction.
- Carefully plug bus cover onto the D-SUB connector of the basic encoder. Slide it over the seal by avoiding any cocking. The bus cover must fully rest on the basic encoder.
- Tighten the fixing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

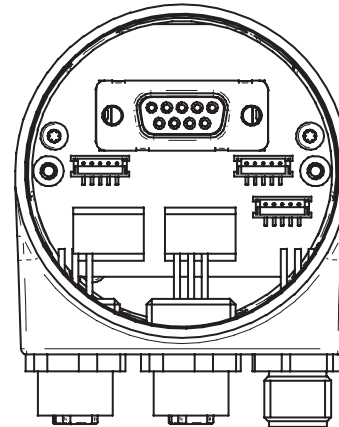
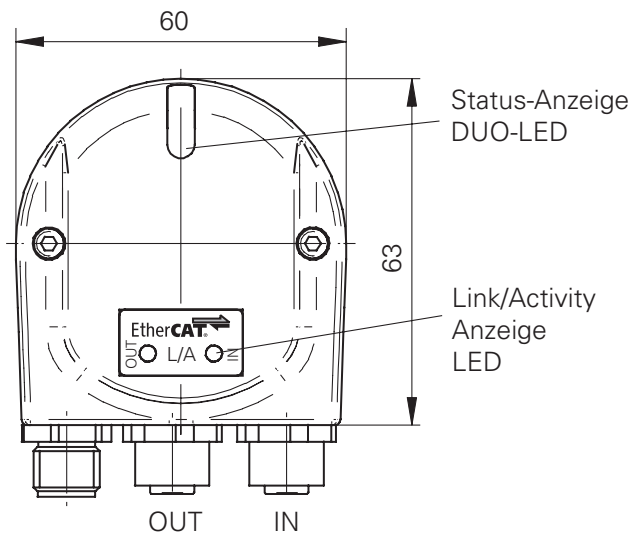


6.2.1 Initialising under TwinCAT system manager

- 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.