

# **hohner**

Elektrotechnik Werne

## **User Manual**

Absolute Encoder



**EtherCAT** 

Your partner for standard and special designs  
- precise, reliable and fast -



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Warning

*This symbol warns the user of potential danger. Nonobservance may lead to personal injury or death and/or damage to property.*



Attention

*This symbol warns the user of potential device failure. Nonobservance may lead to the complete failure of the device or other devices connected.*



Note

*This symbol calls attention to important notes.*

## Security advice



Warning

*This product must not be used in applications, where safety of persons depend on the correct device function.*

*This product is not a safety device according to EC machinery directive.*

## Notes

These operating instructions refer to proper and intended use of this product. They must be read and observed by all persons making use of this product. This product is only able to fulfill the tasks for which it is designed if it is used in accordance with specifications of Hohner Automazione srl

The warrantee offered by Hohner Automazione srl for this product is null and void if the product is not used in accordance with the specifications of Hohner Automazione srl.

Changes to the devices or components and the use of defective or incomplete devices or components are not permitted. Repairs to devices or components may only be performed by Hohner Automazione srl or authorized work shops. These work shops are responsible for acquiring the latest technical information about Hohner Automazione srl devices and components. Repair tasks made on the product that are not performed by Hohner Automazione srl are not subject to influence on the part of Hohner Automazione srl Our liability is thus limited to repair tasks that are performed by Hohner Automazione srl.

The preceding information does not change information regarding warrantee and liability in the terms and conditions of sale and delivery of Hohner Automazione srl

This device contains sub-assemblies that are electrostatically sensitive. Only qualified specialists may open the device to perform maintenance and repair tasks. Touching the components without protection involves the risk of dangerous electrostatic discharge, and must be avoided. Destruction of basic components caused by an electrostatic discharge voids the warrantee!

Subject to technical modifications.



## **1 Introduction**

This manual explains how to install and configure the Absolute Rotary Encoder with EtherCAT<sup>®</sup> interface applicable for military and industrial applications with EtherCAT<sup>®</sup> protocol. The products are compliant with standard DS406 (encoder device profile) and Ethernet ETHERCAT<sup>®</sup> Communication Profile Specification CiA DS 301 V1.1.0.

### **1.1 General Definitions**

In the following chapters general definitions are described.

### **1.2 Intended Use**

The absolute rotary encoder measures the physical measure and angle and revolutions and converts this into a digital position value transmitted via the EtherCAT<sup>®</sup> bus according to the EtherCAT<sup>®</sup> communication profile (CiA DS301) to other field devices. The encoder shall be connected to an EtherCAT<sup>®</sup> network according to (CiA DS301) and shall only be used for this purpose. The sensor can be used in applications like positioning tasks or length measurements. General applications could be like cranes, construction machines, lifts, packing machines etc.

### **1.3 Interface**

This device provides one EtherCAT<sup>®</sup> interface with incoming and outgoing port to support a daisy chain cable structure. It supports the profile Specification CiA DS 301 V1.1.0.

### **1.4 Maintenance**

For this device is no maintenance required.

### **1.5 Intended Time of Usage**

Refer to the data sheet of the Absolute Rotary Encoder.

### **1.6 Measurement Principle**

This absolute rotary encoder family uses a highly integrated Opto-ASIC, providing a resolution up to 16 bits (65,536 steps) per revolution. In case of multiturn rotary encoders, the measuring range is extended by additional mechanically geared code disks to as many as 16,384 ( $2^{14}$ ) revolutions. These encoders are fully capable of operating in rugged industrial environments.

### **1.7 Ethernet**

The current developments in the field of Industrial Ethernet are based on the vision of an integrated access to all data of a company through a uniform communication system. In higher levels of enterprise communication Ethernet is the main medium of data transfers. Together with other IT technologies it is internationally standardized. In the long run automation engineers will benefit from the rapid technological progress in the mass markets of IT and web technologies.

Ethernet technically provides a system with higher data transfer rates than common field bus systems. TCP/IP and UDP are using a statistical access method to access the medium thereby prohibiting determined response times. Many developments are intensely done on additional real time mechanisms, e.g. EtherCAT<sup>®</sup>.

EtherCAT<sup>®</sup>'s key functional principle lies in how its nodes process Ethernet frames.

Each node reads the data addressed to it and writes its data back to the frame all while the frame is moving downstream. This leads to improved bandwidth utilization (one frame per cycle is often sufficient for communication) while also eliminating the need for switches or hubs.

The unique way EtherCAT<sup>®</sup> process frames makes it the fastest Industrial Ethernet technology. No other technology can top EtherCAT<sup>®</sup>'s bandwidth utilization or the corresponding performance.

In addition to its speed, an EtherCAT® network is able to support up to 65,535 devices without placing restrictions on their topology, such as line, bus, tree, star topology- or any combination thereof. Fast Ethernet Physics allows two devices to be up to 100 m (330 ft.) apart, and greater distances are possible with the use of fiber optics. EtherCAT® also has additional features that offer further topological flexibility, such as Hot Connect and Hot Swap for devices, and added redundancy through a ring topology.

EtherCAT® is suitable for both, centralized and decentralized system architectures. It can support master/slave, master/master, and slave/slave communication as well as incorporate subordinate field buses. At the factory-level, the EtherCAT® Automation Protocol has communication covered - all with the existing infrastructure.

When compared to a classic field bus system, EtherCAT® is the obvious choice: node addresses can be set automatically, there is no need for network tuning, and onboard diagnostics with fault localization make pinpointing errors a snap. Despite these advanced features, EtherCAT® is also easier to use than Industrial Ethernet. There are no switches to configure, and no complicated handling of MAC or IP addresses is required.

EtherCAT® also supports common internet technologies without jeopardizing the network's real-time capability. Its "Ethernet over EtherCAT®" protocol transports FTP, http, TCP/IP and Co.

Other functions (offset values, resolution, etc) can be configured. The absolute rotary encoder corresponds to the class 1 encoder profile (DS 406 in which the characteristics of encoder with CANopen interface are defined).

Further information is available at:

EtherCAT Technology Group

**<http://www.ethercat.org>**

You will find a detailed network description in the following chapters.

## 2 Hardware Set-Up and Ethernet Connection

### 2.1 Network Topology

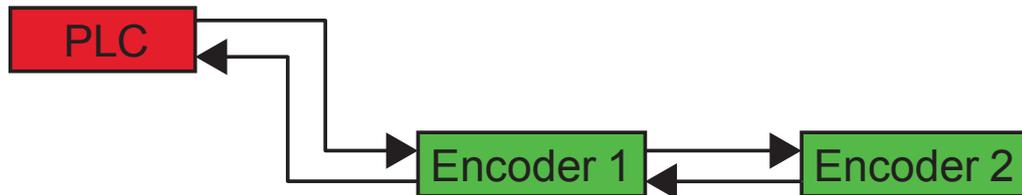


Fig. 2.1: Network topology. Shown is a line topology as an example.

The line structure can be built up like known from standard field bus systems e.g. CANopen. The device can be connected to other devices by usage of "straight" or "crossover" network cable, because the PHY of the device is capable to realize auto crossover. You need at least a cable of category Cat5e to obtain a data transfer rate up to 100 Mbit. To increase noise immunity only cables with foil and copper netting shield should be used (S/UTP), twisted pair, AWG26.

The symbolized structure, above shows a line cabling structure.

Each device can be electrically connected with a maximum cable length of 100 m.

These requirements are specified in EtherCAT<sup>®</sup> specification. For more details refer to the web site: <http://www.ethercat.org>

### 3 Installation

#### 3.1 Electrical connection

The rotary encoder is connected by a 4 pin M12 connector for the power supply and two 4 pin, D-coded M12 connector for Ethernet.

##### Connector EtherCAT®

4 pin female, D-coded

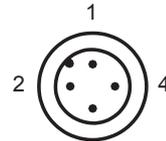
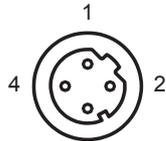
Pin Number	Signal
1	Tx+
2	Rx+
3	Tx-
4	Rx-

##### Connector power supply

4 pin male, A-coded

Pin Number	Signal
1	US (10 - 30 V DC)
2	n.c.
3	GND (0 V)
4	n.c.

Sketch as seen on the encoder



#### 3.2 Ethernet cables

##### 3.2.1 RJ45 – M12 crossed

Signal	RJ45 Pin	M12 Pin	Signal
Tx+	3	2	Rx+
Tx-	6	4	Rx-
Rx+	1	1	Tx+
Rx-	2	3	Tx-

##### 3.2.2 RJ45 – M12 straight

Signal	RJ45 Pin	M12 Pin	Signal
Tx+	3	1	Tx+
Tx-	6	3	Tx-
Rx+	1	2	Rx+
Rx-	2	4	Rx-

##### 3.2.3 M12 - M12 crossed

Signal	M12 Pin	M12 Pin	Signal
Tx+	1	2	Rx+
Tx-	3	4	Rx-
Rx+	2	1	Tx+
Rx-	4	3	Tx-

## 4 Diagnostic LEDs

On the backside of the connection cap the encoder provides several diagnostic LEDs. For each port there is a functional combined LED for link status and activity named "Link/Act".

Additionally there are two LEDs to indicate the network status for EtherCAT® named "Error" and "Run".



Fig. 4.1: Rear view onto diagnostic LEDs

The meaning of the LED indication is specified in the following tables.

### 4.1 Ports LEDs Function

LED	Color	Status	Description
Link/Act IN	green	on	LINK is active for HUB port 1
		blinking	Activity on HUB port 1
Link/ActOUT	green	on	LINK is active for HUB port 2
		blinking	Activity on HUB port 2

### 4.2 EtherCAT® LEDs Function

LED	Color	Status	Description
Error	red	off	no error
		blinking	invalid configuration
		single flash	local error
		double flash	Process data watchdog timeout/EtherCAT watchdog timeout
		flickering	booting error
		on	application failure
Run	green	off	initialization
		blinking	Pre-Operational
		single flash	Safe-Operational
		flickering	initialization or Bootstrap
		on	Operational

## 5 Network configuration



### **Device damage**

*A dismantling of the connection cap at the rear end of the encoder is not permitted!*

*All configurations can be directly executed without opening of the housing.*



### 5.1 Installation to Network

1. Turn off the power supply for your machine.
2. Connect the Ethernet CAT5 cable with D-coded M12 connector from the PLC or the last device to the ECAT IN-Port.
3. If necessary install additional devices to the ECAT OUT-Port.
4. Connect the A-coded M12 connector for the power supply.
5. Turn on the power supply of the PLC and the devices.

## 6 Project Integration

This integration description is an example related to Beckhoff control units with TwinCAT®. In general the user can integrate the encoder in any project tool or hardware set up using an EtherCAT® network.



Note

*TwinCAT® needs a special network card with INTEL-Chip. For further information see <http://www.beckhoff.com>.*



Note

*Start TwinCAT® mit administration rights.*

### 6.1 ESI File

An ESI file describes the properties and functions of the device like timings and configurable device parameters. By using the ESI file an easy and abstract integration of an EtherCAT® device in a project tool is realized. To configure the device detailed EtherCAT® knowledge is not required. An actual ESI file can be downloaded from the Hohner Automazione srl website:

**[www.hohner.it](http://www.hohner.it)**

The format of the ESI file is XML and is similar to an EDS file used in the CANopen world.

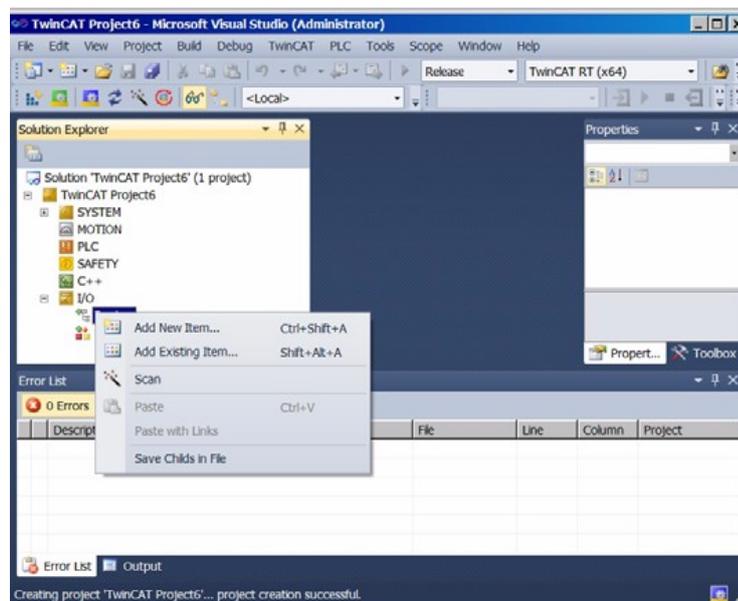
### 6.2 Configuration using TwinCAT® 3

#### 6.2.1 ESI file Import

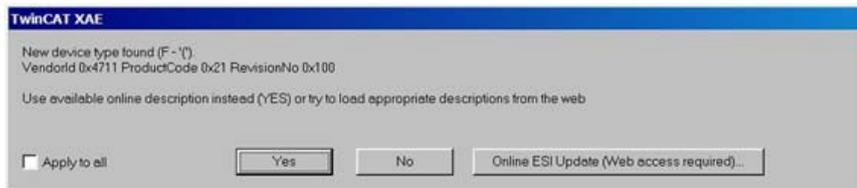
Copy the ESI file in the following directory: ...\\TwinCAT\\3.1\\Config\\Io\\EtherCAT

#### 6.2.2 Create Project

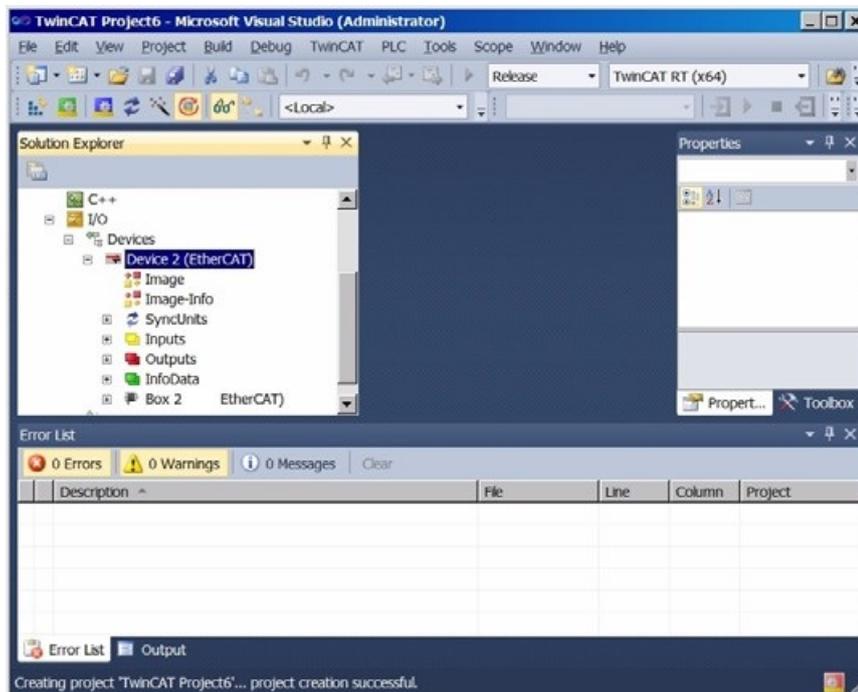
Add New Item under Devices



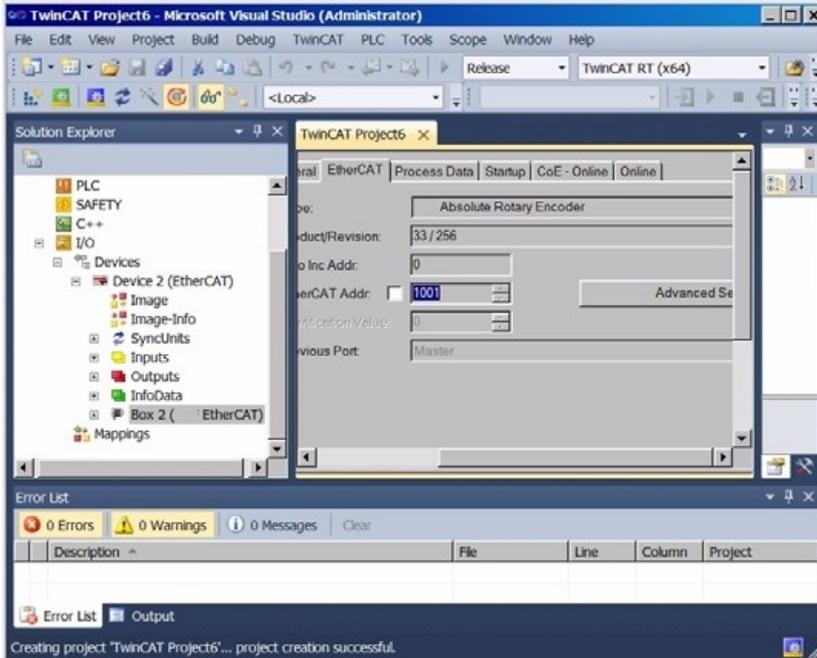
If ESI-File was not installed you get the following message:



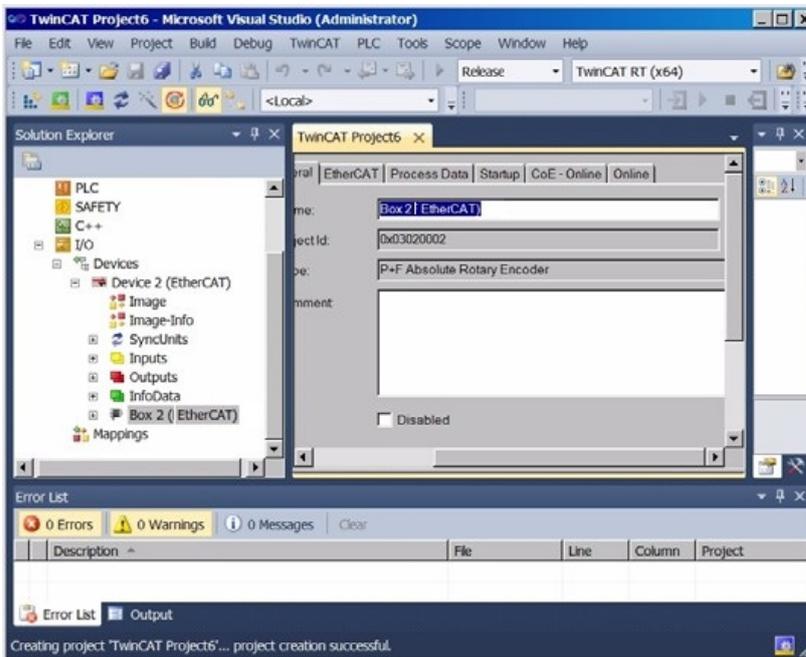
The encoder is available under the EtherCAT® Device (network card) as Box under InfoData (see encoder icon).



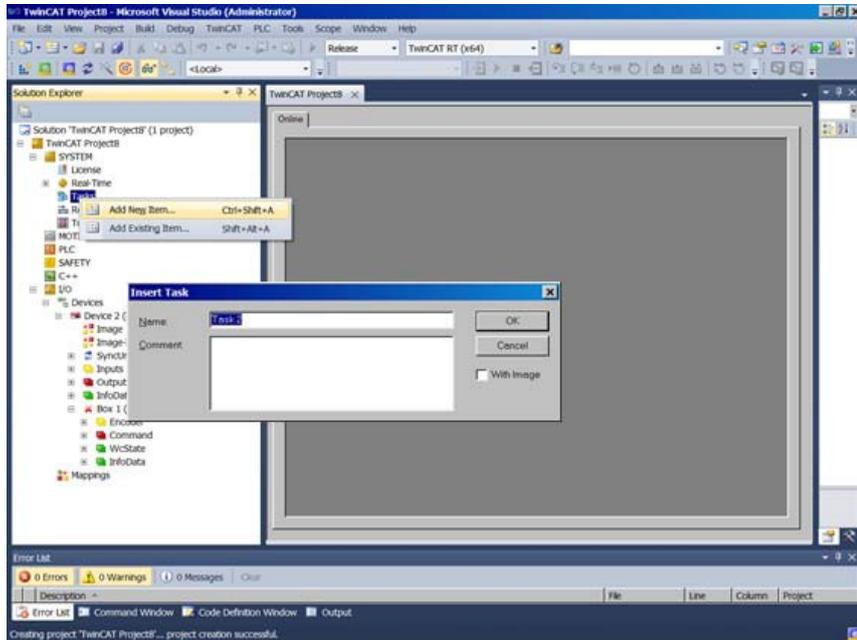
Under the tabs is it possible to set the various configurations.



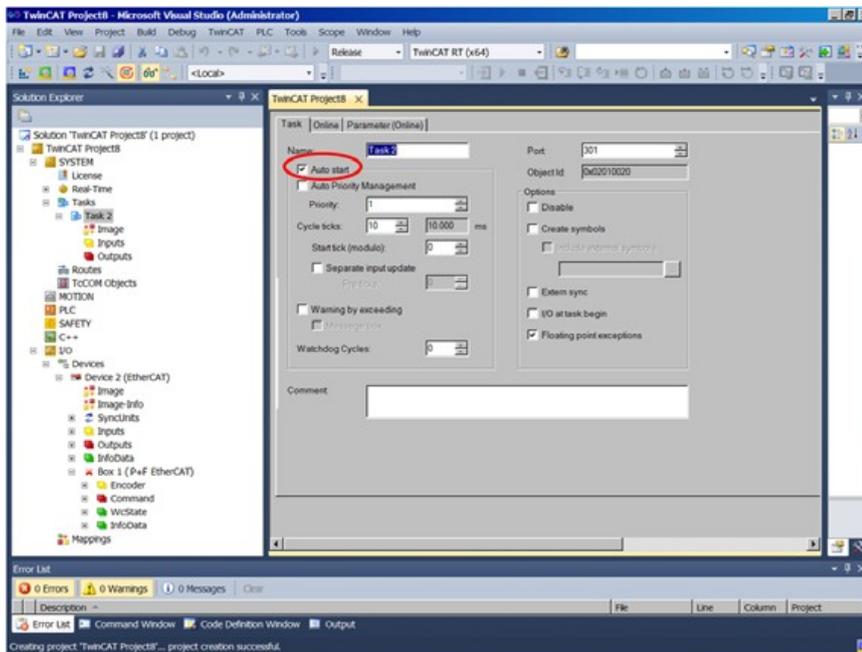
Change the device to an explicit name.



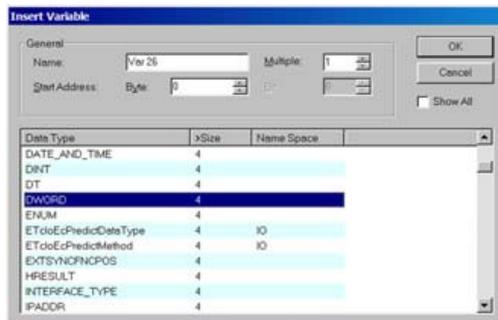
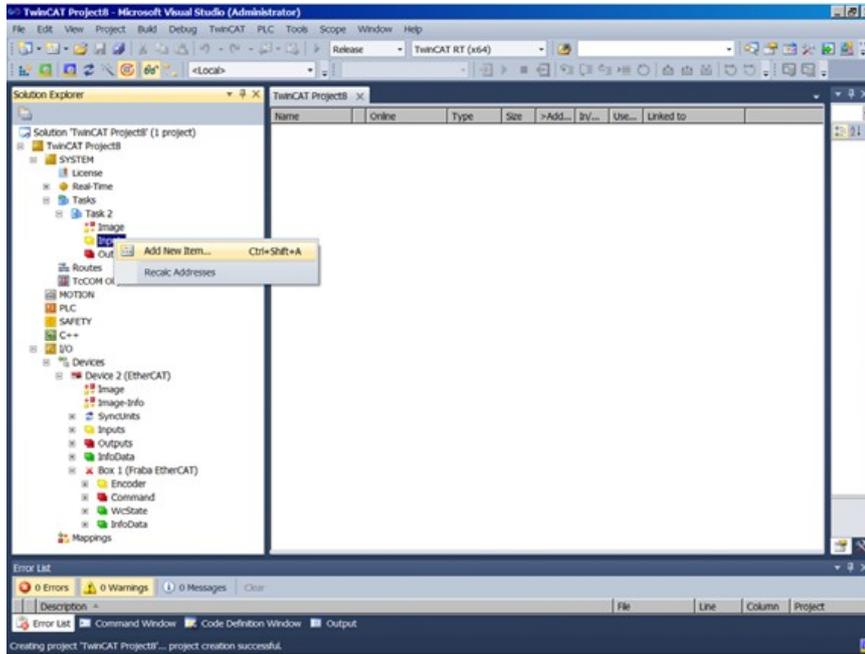
If no external EtherCAT<sup>®</sup>-Master is in use (only Notebook as Master) then an additional task is necessary.



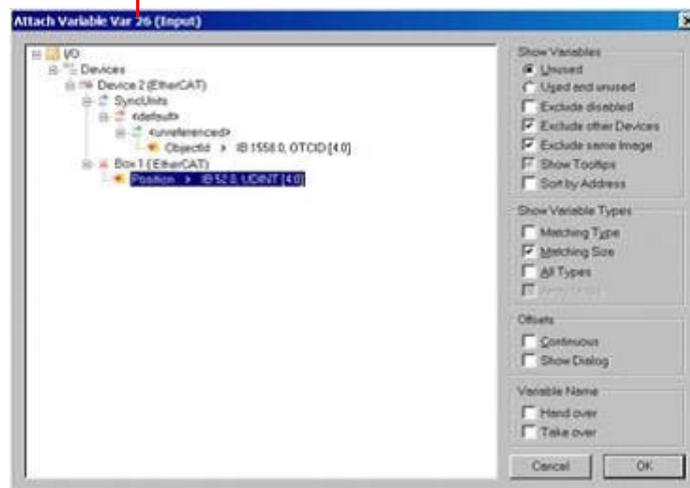
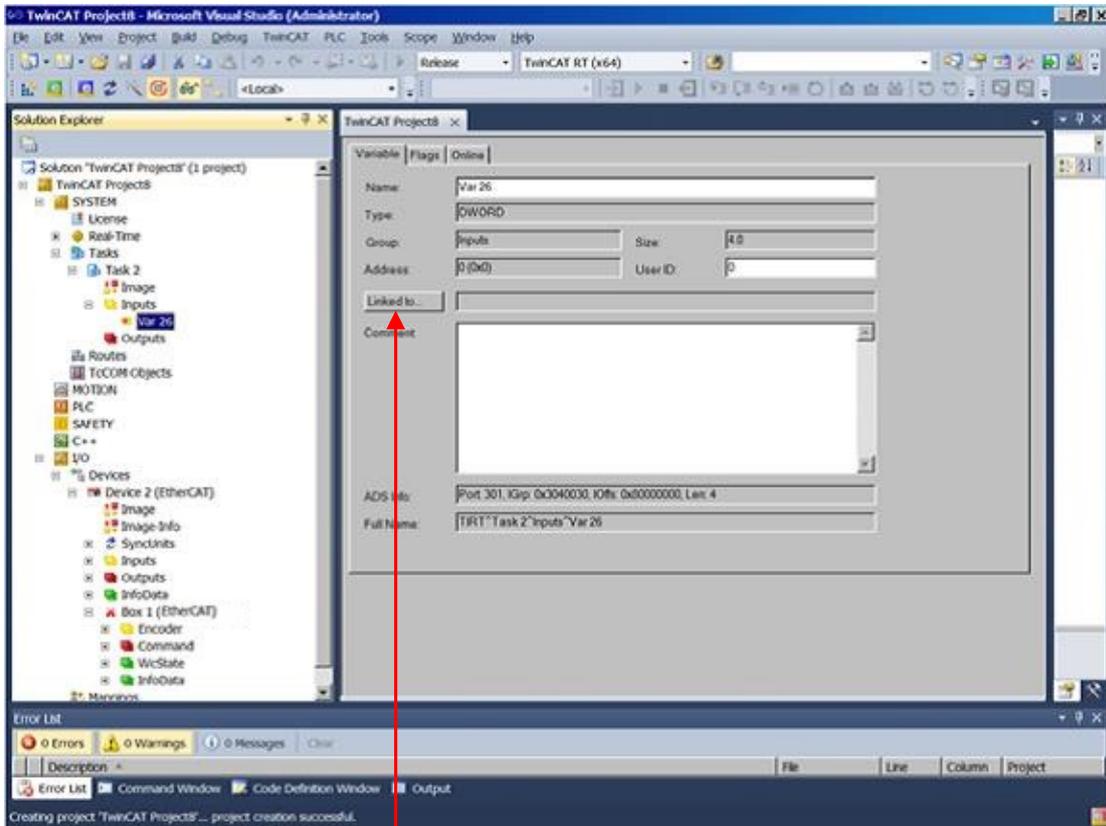
Activate Auto start.

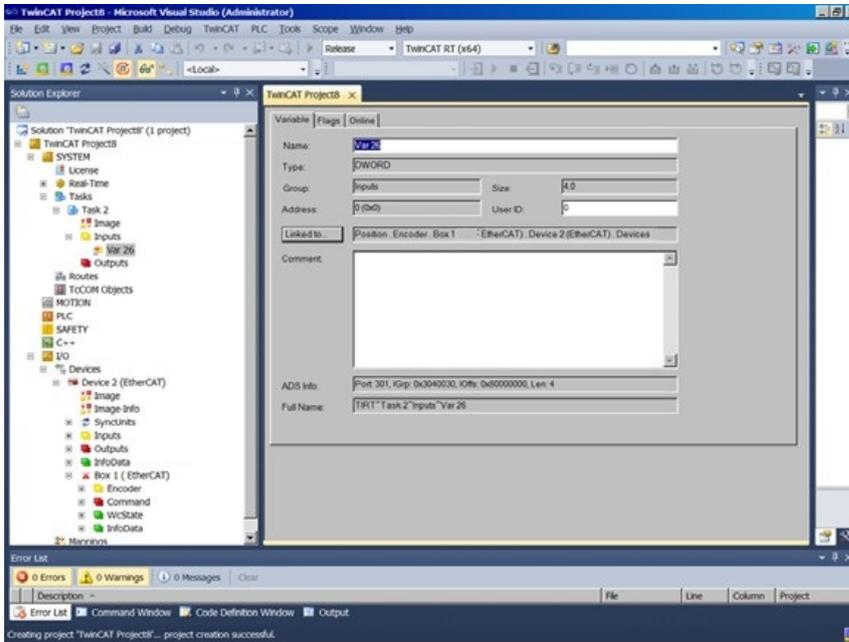


Add New Item under Input and set the attributes.



Attach the necessary variable



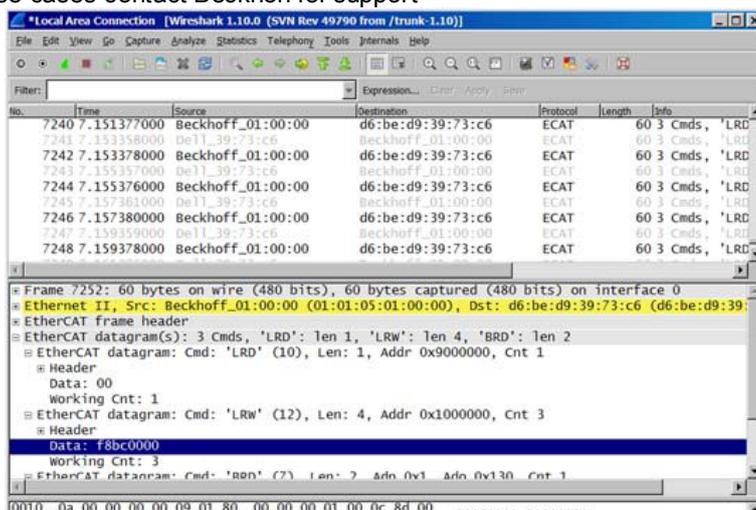


### 6.3 Diagnostic

If problems occur it is possible to conduct diagnosis with standard Ethernet tools like Wireshark (<http://www.wireshark.org>). It is one tool of many available on the market which can be used, because EtherCAT<sup>®</sup> is using standard Ethernet frames. With this tool an interpretation of Ethernet frames according to EtherCAT<sup>®</sup> is possible. Just the right filter "ECAT" has to be selected and the user has a powerful tool. In case of problems it is recommended to log a trace for own analysis.

Anyhow our experience is, that this tool has also restrictions at very low EtherCAT<sup>®</sup> cycles and that you cannot trust time stamps and the order of logged telegrams.

In those cases contact Beckhoff for support



## 7 Encoder Profile

The CANopen Device profiles have been overtaken for the EtherCAT<sup>®</sup> protocol to minimize integration effort for the customer. This means for encoders, that device parameters are corresponding to the profile DS406. In the following table the supported parameters are listed:

Object	Description	Data Type	Access Type
6000h	Operating Parameters	Unsigned 16	r / w
6001h	Measuring units per revolution	Unsigned 32	r / w
6002h	Total measuring range in measuring units	Unsigned 32	r / w
6003h	Preset value	Unsigned 32	r / w
6004h	Position Value	Unsigned 32	r-map
6500h	Operating status	Unsigned 16	r
6501h	Singletum resolution	Unsigned 32	r
6502h	Number of distinguishable revolutions (Multitum resolution)	Unsigned 32	r
6507h	Profile and Software Version	Unsigned 32	r
6509h	Offset Value	Integer 32	r
650Bh	Serial Number (fits to Identity Object 1018h)	Unsigned 32	r

### Object 6000h: Operating parameters

This object indicates the functions for code sequence, commissioning diagnostic control and scaling function control.

Subindex	Description	Data Type	Default Value	Access Type
0h	Operating Parameters	Unsigned 16	4h	r / w

Code sequence: The code sequence defines, whether increasing or decreasing position values are output, in case the encoder shaft rotates clockwise or counter clockwise as seen from the point of view of the shaft.

Scaling function control: With the scaling function the encoder numerical value is converted in software to change the physical resolution of the encoder. The measuring units per revolution (object 6001h) and total measuring range in measuring units (object 6002h) are the scaling parameters. The scaling function bit is set in the operating parameters. If the scaling function bit is set to zero, the scaling function is disabled.

Bit structure for the operating parameters:

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Use	MS	MS	MS	MS	R	R	R	R	R	R	R	R	MD	SFC	CD	CS

Table description:

- MS: Manufacturer Specific Function (not available)
- R: Reserved for future use
- MD: Measuring direction (not available)
- SFC: Scaling function (0 = disable, 1 = enable)
- CD: Commissioning diagnostic control (not available)
- CS: Code sequence (0 = CW, 1 = CCW)

### Object 6001h: Measuring units per revolution

This object indicates the measuring units per revolution.

Subindex	Description	Data Type	Default Value	Access Type
0h	Measuring units per revolution	Unsigned 32	see name plate	r / w



Note

*The ESI file has as default value 2000h. This value has to be adapted in the project tool to the specific encoder value. Please refer to the type shield for the type key and data sheet.*

### Object 6002h: Total measuring range in measuring units

This object shall indicate the number of distinguishable steps over the total measuring range.

Subindex	Description	Data Type	Default Value	Access Type
0h	Total measuring units	Unsigned 32	see name plate	r / w



Note

*The ESI file has as default value 1000h. This value has to be adapted in the project tool to the specific encoder value. Please refer to the type shield for the type key and data sheet.*

### Object 6003h: Preset value

This object indicates the preset value for the output position value. The encoder output position can be set to a desired value: Preset value.

Subindex	Description	Data Type	Default Value	Access Type
0h	Preset value	Unsigned 32	-	r / w

### Object 6004h: Position value

This object contains the process value of the encoder.

Subindex	Description	Data Type	Default Value	Access Type
0h	Process value	Unsigned 32	-	r-map

### Object 6500h: Operating status

This object provides the operating status of the encoder. It provides information on encoder internal programmed parameters.

Subindex	Description	Data Type	Default Value	Access Type
0h	Operating status	Unsigned 16	4h	r

### Object 6501h: Singleturn resolution

The object contains the physical measuring steps per revolution of the absolute rotary encoder. The value written into object 6001h must not exceed the value defined here.

Subindex	Description	Data Type	Default Value	Access Type
0h	Singleturn resolution	Unsigned 32	see name plate	r

### Object 6502h: Number of distinguishable revolutions

This object contains the number of revolutions of the absolute rotary encoder. The value written in object 6002h must not exceed the value of object 6501h multiplied by the value of Object 6502h (Object 6002h <= Object 6501h \* Object 6502h).

Subindex	Description	Data Type	Default Value	Access Type
0h	Number of revolutions	Unsigned 16	see name plate	r

### Object 6507h: Profile and software version

This object provides the implemented encoder device profile version and the software version.

Subindex	Description	Data Type	Default Value	Access Type
0h	Profile and software version	Unsigned 32	xyy0302h	r

The value splits up into the profile version part and the Software version part. Each part splits up in upper version and lower version.

MSB		LSB	
Software version xx.yy		Profile version 3.2	
Upper software version	Lower software version	Upper profile version	Lower profile version
xx	yy	03h	02h

### Object 6509h: Offset value

This object contains the offset value. It is calculated as the difference between the physical position and the indicated process value. This calculation is influenced by the preset function.

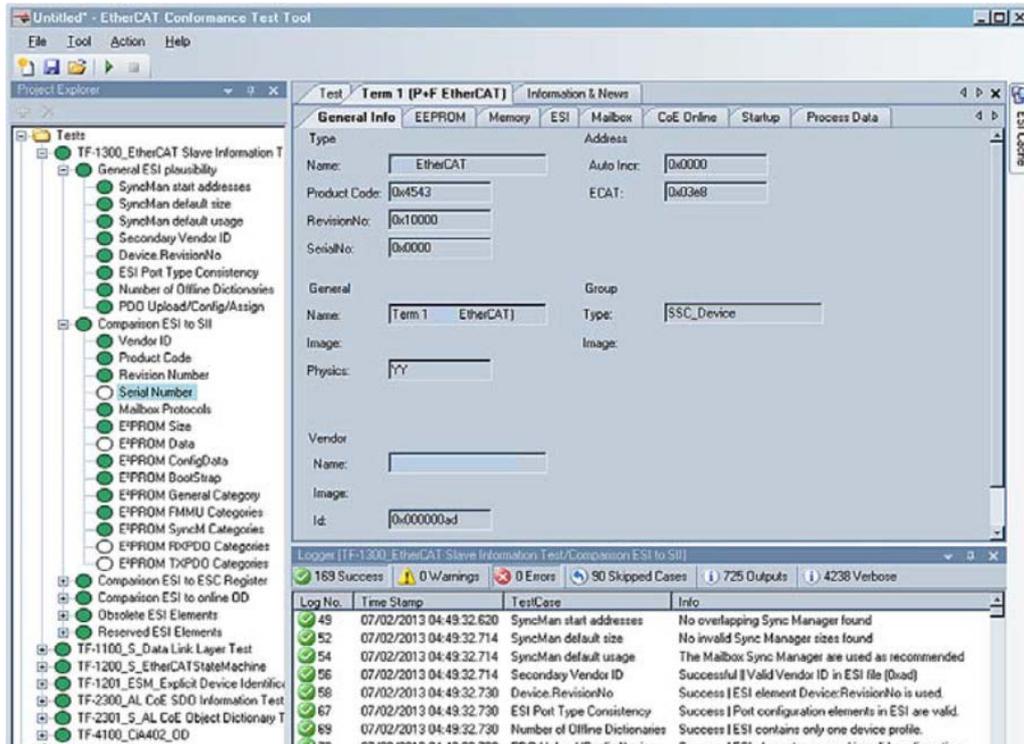
Subindex	Description	Data Type	Default Value	Access Type
0h	Offset value	Integer 32	-	r

### Object 650Bh: Serial number

This object contains the serial number of the device. The serial number is identical with the value in object 1018h subindex 4h.

Subindex	Description	Data Type	Default Value	Access Type
0h	Serial number	Unsigned 32	see name plate	r

## 8 Conformance Test



### 9 Glossary

<b>Terms</b>	<b>Description</b>
10 Base T	Transmission line with 10 Mbit data transmission rate
100 Base T	Transmission line with 100 Mbit data transmission rate
APV	Absolute Position Value.
ASCII	American Standard Code for Information Interchange ASCII describes as code the correlation from digital integers to a normal font described character.
Batch file	Script program for MS-DOS
Baud rate	Transmission speed formulated in number of bits per second. Bus nodeDevice that cansend and/or receive or amplify data by means of the bus.
Binary	Numeric system with value 0 or 1. Byte 8-bit unit of data = 1 byte.
CAN	Controller Area Network or CAN multiplexing network.
CANopen	Application layer of an industrial network based on the CAN bus. CAT5 Terminations for transmission rates up to 100 Mbit.
CCW	Counter-clockwise
CiA	CAN In Automation, organization of manufacturers and users of devices that operate on the CANbus.
CoE	CANopen over EtherCAT®
CRC	The cyclic redundancy check is a method from the information technology to control a checksum for data, to reduce errors by the transmission.
CW	Clockwise
DC	Distributed Clocks
EEPROM	Electrically Erasable Programmable Read-only Memory
EMC	Electromagnetic compatibility, there are rules to verifying devices.
ESC	EtherCAT® Slave Controller
ESI	EtherCAT® Slave Information, electronic data sheet based on XML
ETG	EtherCAT® Technology Group
EtherCAT®	EtherCAT® is registered trademark and patented technology, licensed by Beckhoff AutomationGmbH, Germany
Ethernet	Ethernet is a computer network technology based on frames.
FAQ	Frequently Asked Questions
Fast Ethernet	Transmission technology with 100 Mbit transmission rate.
Flash	Internal memory, saved data will be available after power down.
IP-Protokoll	The Internet Protocol is widespread in computer networks. It is the implementation of the internet layer of the TCP/IP-model.
Mbit	Transmission rate or baud rate, million bits per second
OSI-Modell	The Open System Interconnection reference model is a open layer model for the organisation of a communication.
PCV	Process Value
PDO	Communication object, with a high priority for sending process data.
PLC	Programmable Logic Controller
PV	Preset Value:Configuration value
r	Read Only: Parameter that is only accessible in read mode.
r-map	Read Only MAPable:Parameter that can be polled by the PDO.
r / w	Read / Write: Parameter that can be accessed in read or write mode.
SDO	Communication object, with a low priority for messaging (configuration, error handling, diagnostics). Slave Bus node that sends data at the request of the master.The encoders are always slaves.
TCP	The Transmission Control Protocol is a connection orientated transmission protocol in a network.
TwinCAT®	Configuration tool for Beckhoff controllers
w	Write Only: Parameter that is only accessible in write mode.



# **hohner**

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