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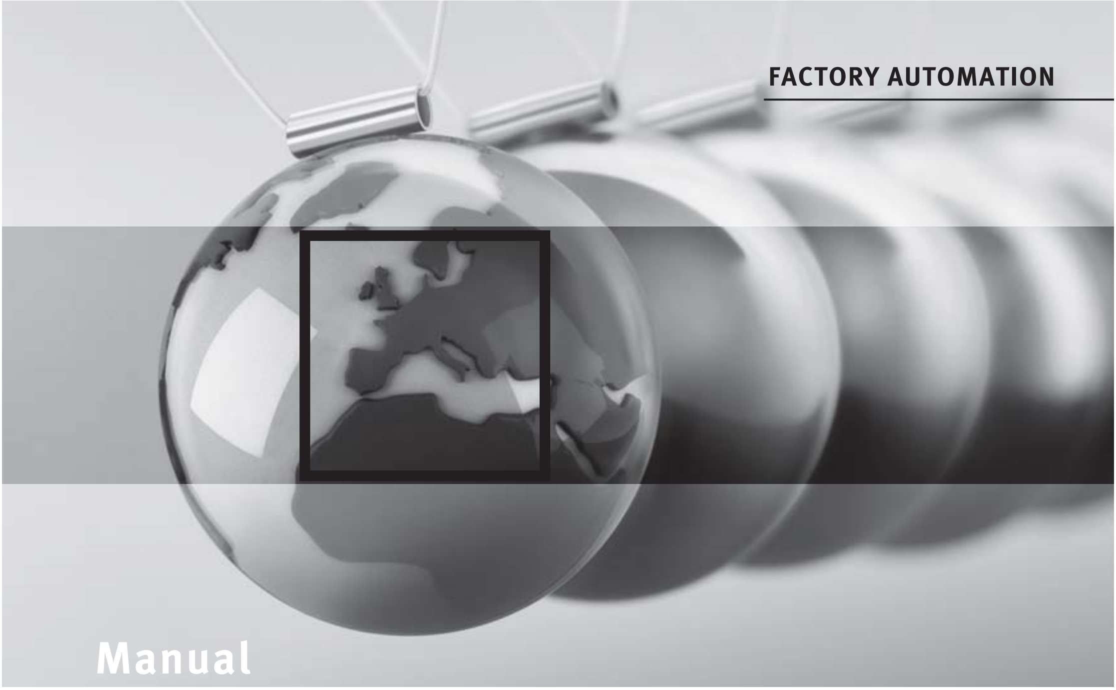

Manual

Absolute Rotary Encoder for DeviceNet

DeviceNet™

CE

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Part. No. xxxxxx / DOCT-2610 / 14th November 2011

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Used symbols

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 Pepperl+Fuchs.

The warrantee offered by Pepperl+Fuchs for this product is null and void if the product is not used in accordance with the specifications of Pepperl+Fuchs.

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The preceding information does not change information regarding warrantee and liability in the terms and conditions of sale and delivery of Pepperl+Fuchs.

Subject to technical modifications.

Pepperl+Fuchs GmbH in D-68301 Mannheim maintains a quality assurance system certified according to ISO 9001.

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1 Introduction

Absolute rotary encoders provide a definite value for every possible position. All these values are reflected on one or more code discs. The beams of infrared LEDs are sent through code discs and detected by Opto-Arrays. The output signals are electronically amplified and the resulting value is transferred to the interface.

The absolute rotary encoder has a maximum resolution of 65536 steps per revolution (16 Bit). The Multi-Turn version can detect up to 16384 revolutions (14 Bit). Therefore the largest resulting resolution is 30 Bit = 1.073.741.824 steps. The standard Single-Turn version has 12 Bit, the standard Multi-Turn version 24 Bit.

The integrated CAN-Bus interface of the absolute rotary encoder supports all of the DeviceNet func-tions. The following modes can be programmed and enabled or disabled:

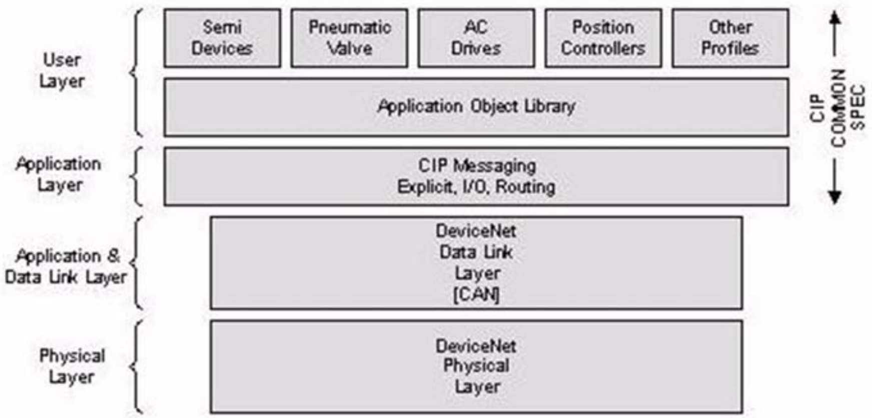
- Polled Mode

The protocol supports the programming of the following additional functions:

- Code sequence (Complement)
- Resolution per revolution
- Total resolution
- Preset value
- Baudrate
- MAC-ID

The general use of absolute rotary encoders with DeviceNet interface is guaranteed.

1. 1 Control and Information Protocol (CIP)



The DeviceNet specification defines the Application Layer and the Physical Layer. The Data Link layer is based on the CAN-specification. For the optimal industrial control will be defined two different messaging types. I/O messaging (Implicit Messaging) and explicit messaging.With Implicit Messaging becoming I/O data exchanged in realtime and with Explicit Messaging becoming data exchanged to configure a device.

CIP (Common Industrial Protocol) make for the user available four essential functions:

- Unique control service
- Unique communication service
- Unique allocation of messaging
- Common knowledge base

1. 2 Object modell

DeviceNet describes all data and functions of a device considering as object model. By means of that object-oriented description a device can be defined complete with single objects. A object is defined across the centralization by associated attributes (e.g. processdata), his functions (read- or write access of a single attribute) as well as by the defined behaviour.

DeviceNet distinction is drawn between three different objects:

- Communication object
  Define the exchange messages over DeviceNet and becoming designated as Connection Ob-jects. (DeviceNet Object, Message Router Object, Connection Object, Acknowledge Handler Object)
- System objects
  Define common DeviceNet-specific data and functions. (Identity Object, Parameter Object)
- Applications-specific objects
  Define device-specific data and functions. (Application Object, Assembly Object)

2 Data Transmission

The data transmission in the DeviceNet network is realised by message telegrams. Basically, these telegrams can be divided into the CAN-ID and 8 following bytes as shown in the table below:

CAN-ID	Message Header	Message Body
11 Bit	1 Byte	7 Byte

2. 1 The Object Dictionary

Instance Attribute of the Position Sensor Objects

Class Code:66_{hex}:Definition of the CAN-ID

Attribute ID	Access	Name	Data Type	Description
1 hex	Get	Number of Attributes	USINT	Number of supported Attributes
2 hex	Get	Attribute	Array of USINT	List of supported Attribute
96 hex	Get	Position value	DINT	current position
92 hex	Get / Set	Code sequence	Boolean	Controls the code sequence clockwise or counterclockwise
93 hex	Get / Set	resolution per revolution	INT	resolution for one revolution
94 hex	Get / Set	total resolution	DINT	total measurable resolution
95 hex	Get / Set	preset value	DINT	setting a defined position value

Get / Set: read, write

2. 2 Definition of the CAN-ID

DeviceNet is based on the standard CAN-protocol and used a 11Bit (2048 specifiable messages) messages identifier. For the identification of a device in a DeviceNet network are 6Bit enough because a network belongs 64 nodes. That nodes will be call MAC-ID. The CAN-Identifier consists of the Message Group, Message ID and the MAC-ID of the device.

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By our absolute rotary encoder it is a matter of a Group 2 Messages. In the table below a user can see the importance CAN-IDs for a certain communication type.

10	9	8	7	6	5	4	3	2	1	0	Identity Usage	Hex Range
0	Group 1 Message ID				Source MAC ID						GROUP 1 Message	000-3ff
0	1	1	0	1	Source MAC ID						Slave's I/O Change of State or Cyclic Message	
0	1	1	1	1	Source MAC ID						Slave's I/O Poll Response or Change of State/Cyclic Acknowledge Message	
1	0	MAC ID						Group 2 Message ID			GROUP 2 Messages	400 - 5ff
1	0	Destination MAC ID						0	1	0	Master's Change of State or Cyclic Acknowledge Message	
1	0	Source MAC ID						0	1	1	Slave's Explicit/Unconnected Response Messages	
1	0	Destination MAC ID						1	0	0	Master's Explicit Request Message	
1	0	Destination MAC ID						1	0	1	Master's I/O Poll Command/Change of State/Cyclic Message	
1	0	Destination MAC ID						1	1	0	Group 2 Only Unconnected Explicit Request Message (reserved)	
1	0	Destination MAC ID						1	1	1	Duplicate MAC ID Check Messages	

3 Programmable Parameters

3. 1 Encoder parameters

3.1.1 Operating Parameter

The operating parameter can be used to select the code sequence.

Attribute ID	Default value	Value range	Data Type
92 hex	1 hex	0 hex - 1hex	Boolean

The parameter code sequence (complement) defines the counting direction of the process value **as seen on the shaft** whether clockwise or counter clockwise. The counting direction is defined in the attribute 0b hex:

Bit 0	Direction of Rotation	Output code
1	CW	up
0	CCW	down

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3.1.2 Resolution per revolution

The parameter resolution per revolution is used to program the encoder to set a desired number of steps per revolution. Each value between 1 and the maximum (see type shield) can be realised

Attribute ID	Default value	Value range	Data Type
93 hex	(*)	0hex - 2000hex	Unsigned Integer16

(*) see type shield, Maximum resolution:

13/25 Bit Encoder: 2,000 hex (8192)

When the value is set larger than 8192 for a 13/25 Bit encoder, the process value of the encoder will not be single stepped and values will be skipped while rotating the shaft. So, it is recommended, to keep the measuring steps per revolution below 8192 measuring steps.

3.1.3 Total resolution

This value is used to program the desired number of measuring steps over the total measuring range. This value must not exceed the total resolution of the encoder with 25 bit = 33,554,432 steps. Please note the value written on the type shield.

Attribute ID	Default value	Value range	Data Type
94 hex	(*)	0h - 2,000,000h	Unsigned Integer 32

(*) see type shield

Maximum total resolution

25 Bit Encoder: 2,000,000 hex

Attention:

The following formula letters will be used:

PGA Physical total resolution of the encoder (see type shield)

PAU Physical resolution per revolution (see type shield)

GA Total resolution (customer parameter)

AU Resolution per revolution (customer parameter)

If the desired resolution per revolution is less than the physical resolution per revolution of the encoder, then the total resolution must be entered as follows:

Total resolution

GA = PGA * AU / PAU, if AU < PAU

Example:Customer requirement: AU = 2048,

Encoder type shield: PGA = 24 bit, PAU = 12 bit

GA = 16777216 * 2048 / 4096

GA = 8388608

If the total resolution of the encoder is less than the physical total resolution, the parameter total resolution must be a multiple of the physical total resolution:

- k = PGA / GA
- k = integer

3.1.4 Preset value

The preset value is the desired position value, which should be reached at a certain physical position of the axis. The position value of the encoder is set to the desired process value by the parameter preset. The preset value must not exceed the parameter total measuring units.

Attribute ID	Default value	Value range	Data Type
95 hex	0 hex	0hex - total measuring range	Unsigned Integer 32

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4 Operating Mode

4. 1 Polled Mode

Note

Only the Polled mode is allowed for the operation of this sensor!
Change of State or Cyclic Mode is not supported!

For switching the polled mode on the following telegrams are needed. Further it is assumed in the following example a master MAC ID of 0A hex and a slave MAC ID of 03 hex.

4.1.1 Allocate Master / Slave Connection Set

Allocate Polling

Byte Offset	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Frag [0]	XID	MAC ID					
1	R/R [0]	Service [4B]						
	Class ID [ ]							
	Instance ID [01]							
	Allocation Choice [03]							
	0	0	Allocator MAC ID					

Definition CAN ID

10	9	8	7	6	5	4	3	2	1	0	Identity Usage	Hex Range
1	**0**	**Destination MAC ID**						**1**	**1**	**0**	**Group 2 Only Unconnected Explicit Request Message (reserved)**	

Example:

CAN-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5
41E	0A	4B	03	01	03	0A

Setting the Expected_packet_rate of the Explicit Message Connection on 0:

Definition CAN-ID

10	9	8	7	6	5	4	3	2	1	0	Identity Usage	Hex Range
1	**0**	**Destination MAC ID**						**1**	**0**	**0**	**Master´s Explicit Request Message**	

Example:

CAN-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6
41C	0A	10	05	01	09	00	00

Setting the Expected_packet_rate of the Polling Connection on 0:n:

Example:

CAN-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6
41C	0A	10	05	02	09	00	00

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4.1.2 Release Master / Slave Connection Set

Release Polling

Byte Offset	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Frag [0]	XID	MAC ID					
1	R/R [0]	Service [4C]						
	Class ID []							
	Instance ID [01]							
	Release Choice [03]							

Example:

CAN-ID	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4
41E	0A	4C	03	01	03

5 Transmission of the actual position

The process value is transmitted according to the following table.

For the encoder just the transmission mode "Polling" is allowed!

CAN-ID	process value			
11 Bit	Byte 0	Byte 1	Byte 2	Byte 3
	2^7 to 2^0	2^{15} to 2^8	2^{23} to 2^{16}	2^{31} to 2^{24}

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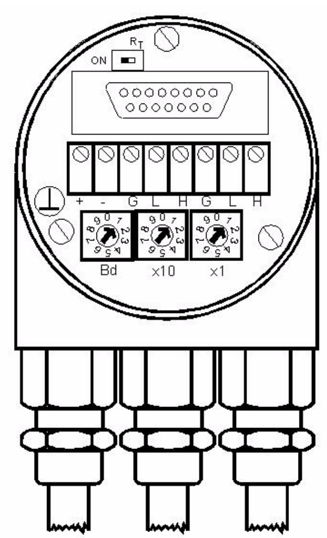
6 Installation

6. 1 Electrical connection

The rotary encoder is connected by three cables. The power supply is achieved with a two-wire connection cable through one PG 9. Each one of the twisted-pair and shielded bus lines are guided in and out through two PG 9 on the right side (as seen on clamps).

There is a resistor provided in the connection cap, which must be used as a line termination on the last device.

Resistor:



The setting of the node number is achieved by 2 turn-switches in the connection cap. Possible addresses lie between 0 and 63 whereby every address can only be used once. 2 LEDs on the backside of the connection cap show the operating status of the encoder.

Clamp	Description
⊥	Ground
+	24 V Supply voltage
-	0 V Supply voltage
CG	CAN Ground
CL	CAN Low
CH	CAN High
CG	CAN Ground
CL	CAN Low
CH	CAN High

DeviceNet Devices BCD coded rotary switches	
x1 x10	Device adress 0...63 Setting CAN-node number
xBd	Setting of the baud-rate

6. 2 Setting of the baudrate

Baudrate in kBit/s	BCD coded rotary switches
125	0
250	1
500	2
125	3
reserved	4...9

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7 Power On

7. 1 Operating Mode

After power on the absolute rotary encoder sends two times its MAC-ID telegram onto the bus.

7. 2 Programming

If some parameters should not be modified you can skip over this chapter.

The following numbers are given in hexadecimal format. In the examples, the CAN ID and MAC-ID are 0A (hex) and for the slave 03 (hex).

The changeable values are written in an italics.

7.2.1 Operating Parameter

Master to absolute rotary encoder: Set-Parameter

CAN ID	MAC ID	Service Code	Class ID	Instance ID	Attribute ID	Data		
	Byte 0	Byte1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
41C	*0A*	10	66	01	92	X	-	-

X: 1 hex for CW (Default), 0 hex for CCW

Absolute Rotary Encoder to Master: Confirmation

CAN ID	MAC ID	Service Code
	Byte 0	Byte 1
41B	*0A*	90

7.2.2 Resolution per revolution

Master to Absolute Rotary Encoder: Set-Parameter

CAN ID	MAC ID	Service Code	Class ID	Instance ID	Attribute ID	Data		
	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
41C	*0A*	10	66	01	93	X	*X*	-

X: desired resolution per revolution

Absolute rotary encoder to master: Confirmation

CAN ID	MAC ID	Service Code
	Byte0	Byte1
41B	0A	90

7.2.3 Total resolution

A fragmented transmission is needed, when the total resolution must be sent to the encoder.

So here are more messages necessary.

Master to Absolute Rotary Encoder: Set-Parameter

CAN ID	MAC ID	Fragment	Service Code	Class ID	Instance ID	Attribute ID		
	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
41C	*8A*	00	10	66	01	94	X	X

Absolute Rotary Encoder to Master: Confirmation

CAN ID	MAC ID		
	Byte0	Byte 1	Byte 2
41B	8A	C0	00

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Master to Absolute Rotary Encoder: Set-Parameter

CAN ID	MAC ID	Fragment						
	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
41C	8A	81	X	X	-	-	-	-

X: desired total resolution

Absolute Rotary Encoder to Master: Confirmation

CAN ID	MAC ID		
	Byte0	Byte 1	Byte 2
41B	8A	C1	00

Absolute Rotary Encoder to Master: Confirmation

CAN ID	MAC ID	Service Code
	Byte0	Byte1
41B	0A	90

7.2.4 Preset Value

Master to Absolute Rotary Encoder: Set-Parameter

CAN ID	MAC ID	Fragment	Service Code	Class ID	Instance ID	Attribute ID		
	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
41C	8A	00	10	66	01	95	X	X

X: desired preset value

Absolute Rotary Encoder to Master Confirmation

CAN ID	MAC ID		
	Byte0	Byte 1	Byte 2
41B	8A	C0	00

Master to Absolute Rotary Encoder: Set-Parameter

CAN ID	MAC ID	Fragment						
	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
41C	8A	81	X	X	-	-	-	-

X: desired preset value

Absolute Rotary Encoder to Master Confirmation

CAN ID	MAC ID		
	Byte0	Byte 1	Byte 2
41B	8A	C1	00

Absolute Rotary Encoder to Master: Confirmation

CAN ID	MAC ID	Service Code
	Byte0	Byte1
41B	0A	90

8 RsNetworx

8. 1 EDS Wizard

The EDS File contains information about device specific parameters as well as possible operating modes of the encoder. With this file you have a data sheet in an electronic format, which can be used to configure the device in the network, for example with RsNetworx from Rockwell.

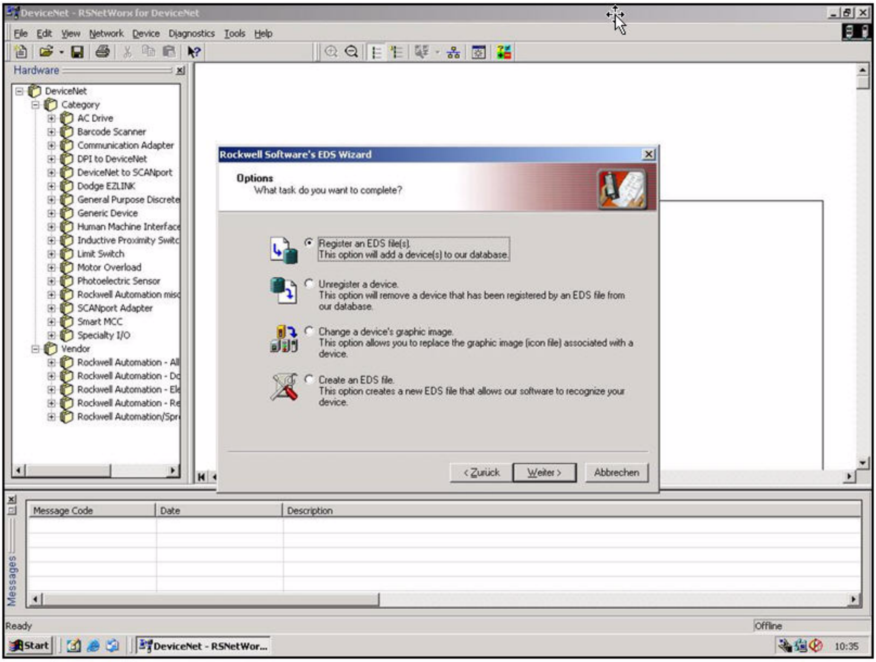

Fig.8.1: EDS Wizard

To install the EDS file the EDS Wizard has to be started, that can be done in the menu *Tools/ EDS Wizard*. If the EDS Wizard is activated successfully the *Register an EDS File(s)* has to be chosen and after that the button *weiter*. In the next step the *Register a directory of EDS files* has to be chosen and with Browse the path of the EDS file(s). That is indicated in figure 8.2.

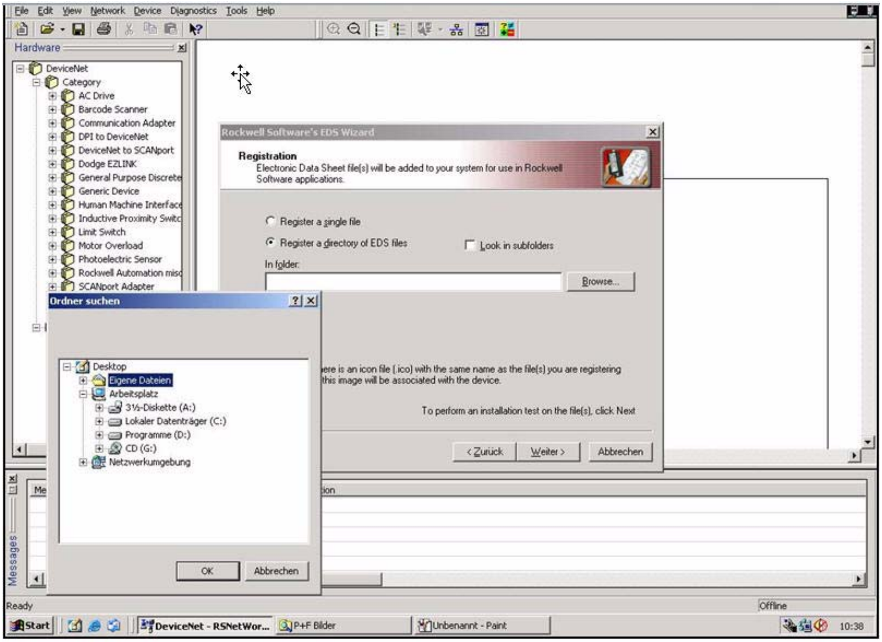

Fig.8.2: EDS Wizard

The Wizard finds all EDS files that are discarded in the choosing path and operates a test to check the EDS files on errors. In the next step (see figure 8.3) pictures can be selected for the using nodes. With the button *weiter* the installation can be continued and finished.

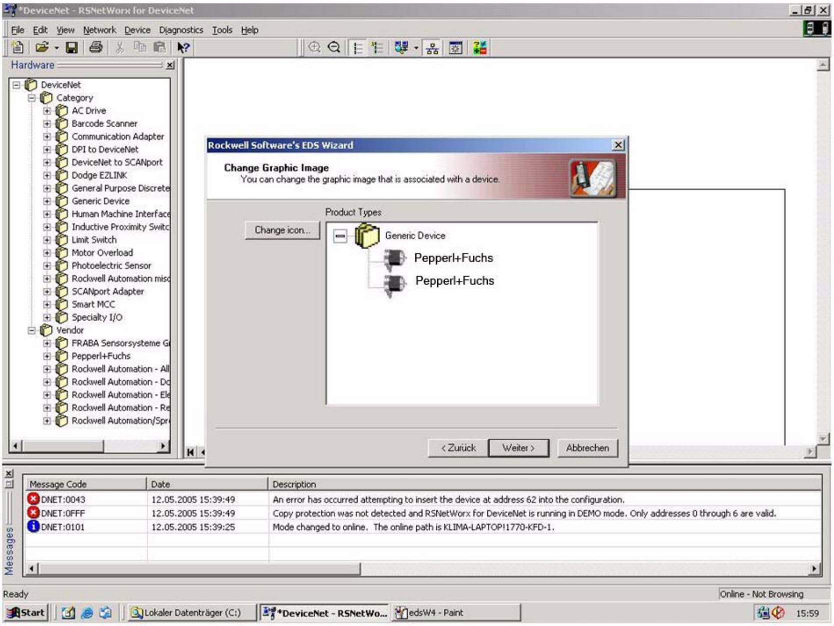

Fig.8.3: EDS Wizard

8. 2 Driver Configuration

After a successful installing of the EDS file the next step is to choose the suitable driver. With *Start/Programme/Rockwell Software/RSLinx* in the menu the programm RSLinx can be started. With this programm the suitable driver can be chosen. For this example the driver typ 1770-KFD is being used. In the next step the window *Configure Drivers* in the menu *Communications/ Configure Drivers* has to be started. In the drop down Menü *Available Driver Types* the driver typ 1770-KFD has to be chosen and confirmed with the button Add New. (See figure 8.4)

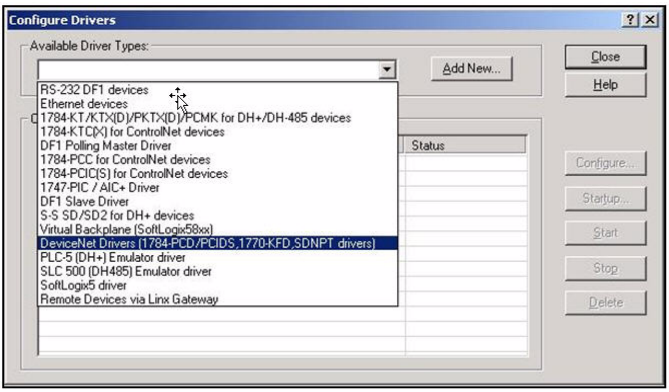

Fig.8.4: Configure Drivers

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If the suitable driver is chosen it can be configured in the window Driver Configuration. In this step the correct baudrate has to be registered (figure 8.5). In the next step a requested name can be registered.

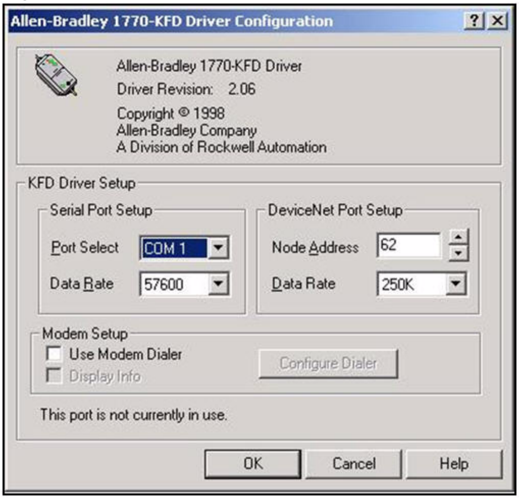

Fig.8.5: Driver Configuration

8. 3 Network Connection

This chapter will explain how to switch a network online and how to parametrise a encoder. In the menu *Network/ Online* the window *Browse for network* will be opened. If the driver *1770-KFD* has been choosen, this is explained in chapter 6.2, the network is online. After that RsNetworx searches in the network for connecting nodes. That is also being showed in figure 8.6.

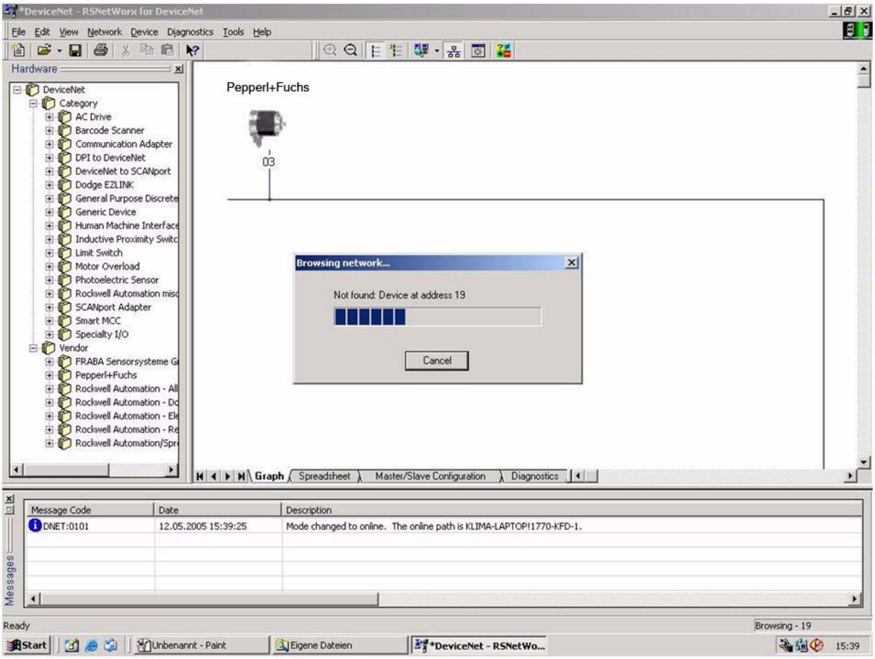

Fig.8.6: Browsing Network

To cofigure the encoder the configuration win-dow in the menu *Device/Properties* has to be opened. By pushing *Parameters* an upload of the encoder parameter is realized.

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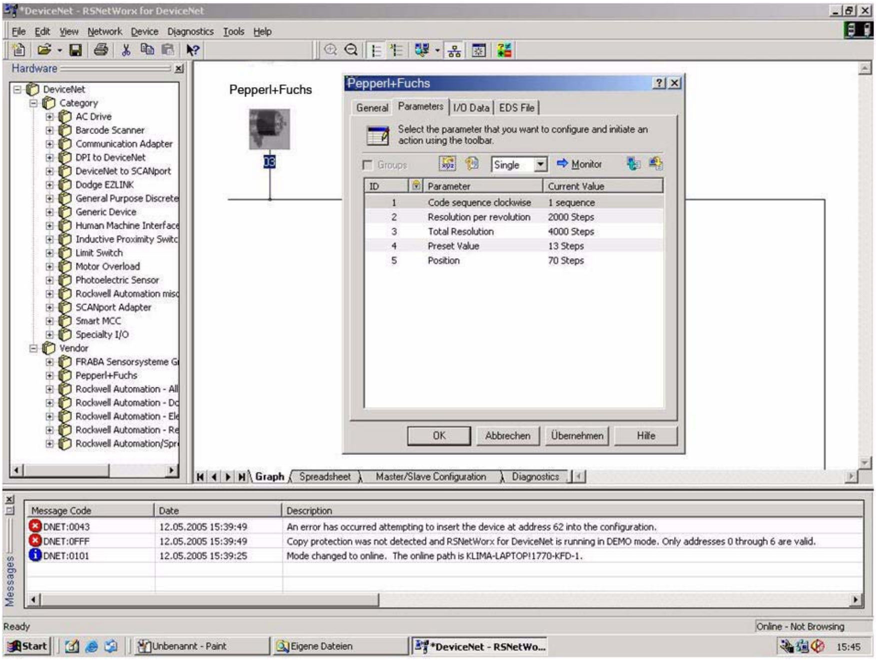

Fig.8.7: Upload Parameters

After a successful upload of the parameters a download of the configured parameters can be realized with the yellow arrow that is showing down and is placed at the top right in the configuration window. An upload can be realized with the arrow beside the download arrow which is showing up. To show the position value the button *Monitor* has to be pushed.

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