KRP absolute multiturn rotary encoder with Ethernet/IP interface

Relevant data sheet KRP 13386

SUPREME SENSORING

TWK

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EtherNet/IP™

User manual

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1. Safety instructions

1.1 Scope

This user manual is valid exclusively for the following rotary encoders with Ethernet/IP interface:
- KRPxx-xxxxxxxR4096C1xP01

1.2 Documentation

The following documents must be observed:

- The owner's system-specific operating instructions
- This user manual
- Data sheet number KRP13386
- The connection assignment enclosed with the device
- Assembly instructions TZY10206 enclosed with the device

1.3 Proper use

The TWK-ELEKTRONIK GmbH absolute encoders and linear transducers are used to register angular or linear positions and make their measured value available in the form of an electrical output signal. As part of a system, they have to be connected to the downstream electronics and must only be used for this purpose.

1.4 Commissioning

• The relevant device may only be set up and operated in combination with this and the documentation specified under point 1.2.

• Protect the device against mechanical damage during installation and operation.

• Device commissioning and operation may only be undertaken by a specialist electrician.

• Do not operate the device outside of the limit values specified in the data sheet.

• Check all electrical connections before commissioning the system.

2. General information

The KRP absolute multiturn rotary encoders are designed for direct connection to the Industrial Ethernet System Ethernet/IP. The Ethernet/IP interface is integrated according to the following specifications:

Volume 1: Common Industrial Protocol (CIP™) and
Volume 2: Ethernet/IP Adaptation of CIP

The specifications can be obtained from the DeviceNet/Ethernet IP user organisation ODVA (www.odva.org).

Depending on configuration, the KRP delivers a 24- or 25-bit position value and also a 16-bit wide velocity signal in the unit of steps/gate time via I/O messaging. Explicit messaging offers access to the rotary encoder parameters on the Position Sensor Object.

3. Installation

3.1 General information

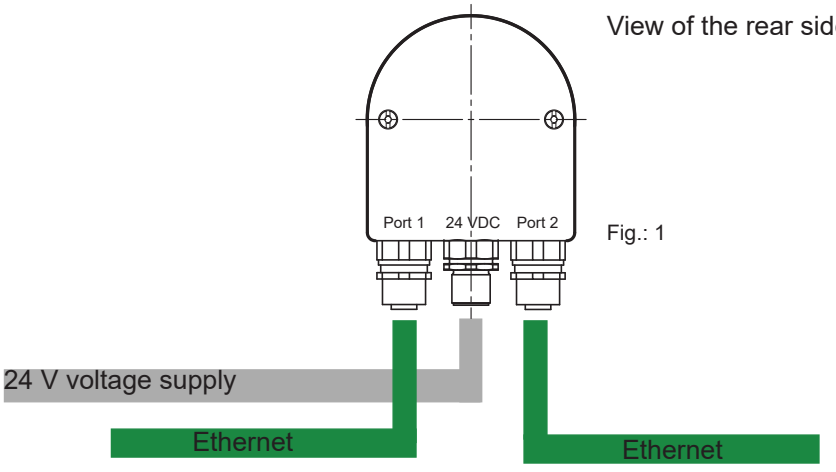
- On installation, note the data on the physical layer according to Volume 2: Ethernet/IP Adaptation of CIP
- Hubs are not permissible.
- The cable length between two subscribers may be max. 100 m.
- The TWK rotary encoder KRP is equipped with an integrated switch. This not only enables tree and star topologies but also the linear topology.
- The setting of addresses, the baud rate or terminating resistors on the device is not necessary.

3.2 Electrical connection

The " ...MP01" type rotary encoders have separate connectors for the supply and the Ethernet system. Port 1 or port 2 is optionally available for the Ethernet connection. Due to the integrated switch, it is irrelevant which port is used.

Connection	Designation	Connector type
Ethernet	Port 1	MM12x4 D-coded socket
Ethernet	Port 2	M12x4 D-coded socket
Voltage supply	Power	MM12x4 A-coded pins

Refer to data sheet No. 13386 for connector assignment and ordering information.



View of the rear side of the KRP

Fig.: 1

3.3 Setting the address

In the case of Ethernet/IP subscribers, an IP address has to be assigned to each subscriber for integration into the network. In the KRP, this is carried out using software via a BOOTP or DHCP server in the network; this is normally enclosed by the control system manufacturer.

After switching on, the KRP outputs BOOTP messages, which the BOOTP server records. It responds to the query with the subscriber IP address stored for this MAC address.

Proceed as follows to assign the IP address with the BOOTP/DHCP server from Rockwell Automation:

- With the supply voltage switched off, connect your rotary encoder to the network in which the BOOTP server is also located.
- Start the server.
- Switch on the voltage to the rotary encoder.
- The rotary encoder then transmits BOOTP messages (see Fig. 2).

Installation

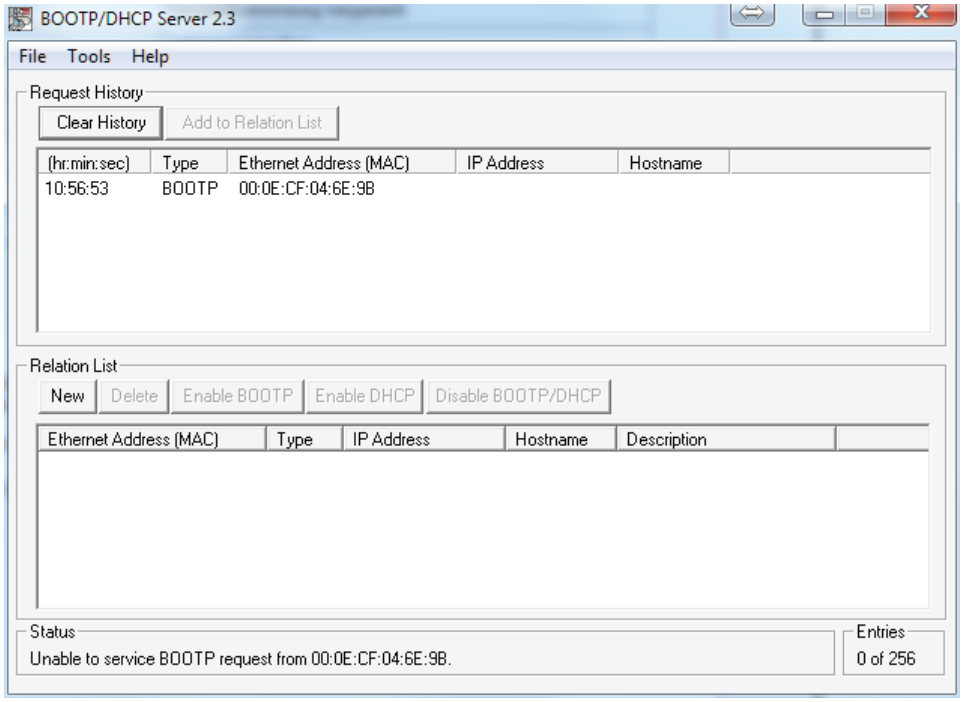


Fig.: 2

• Mark the line with your encoder's MAC address and click onto **Add to Relation List**.

• Enter the desired IP address of the encoder.

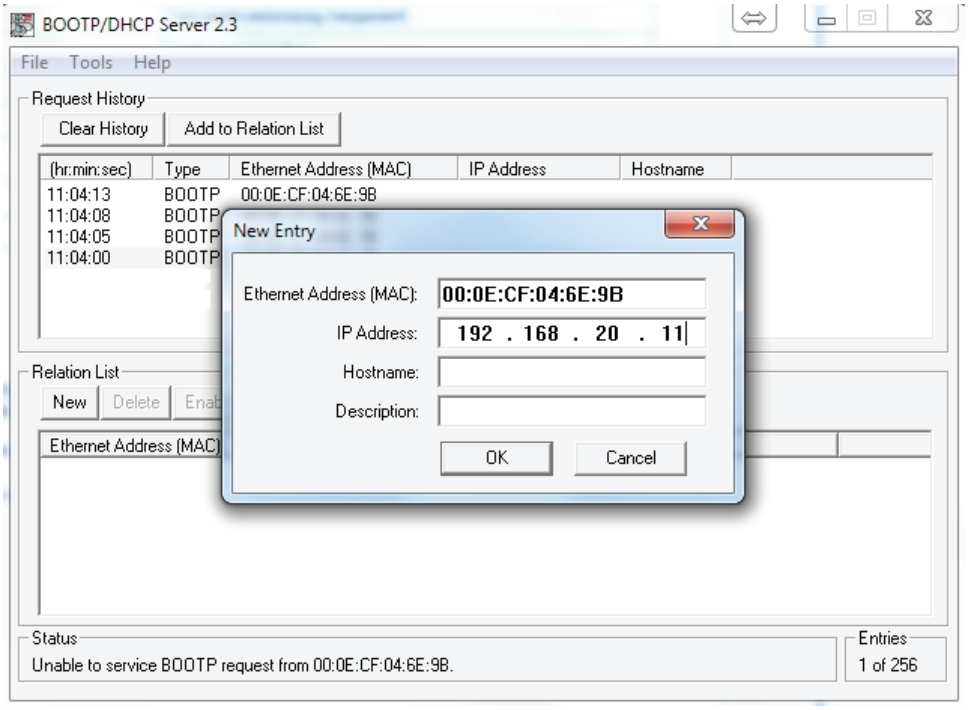


Fig.: 3

- The encoder is then informed of its IP address in the next BOOTP query.

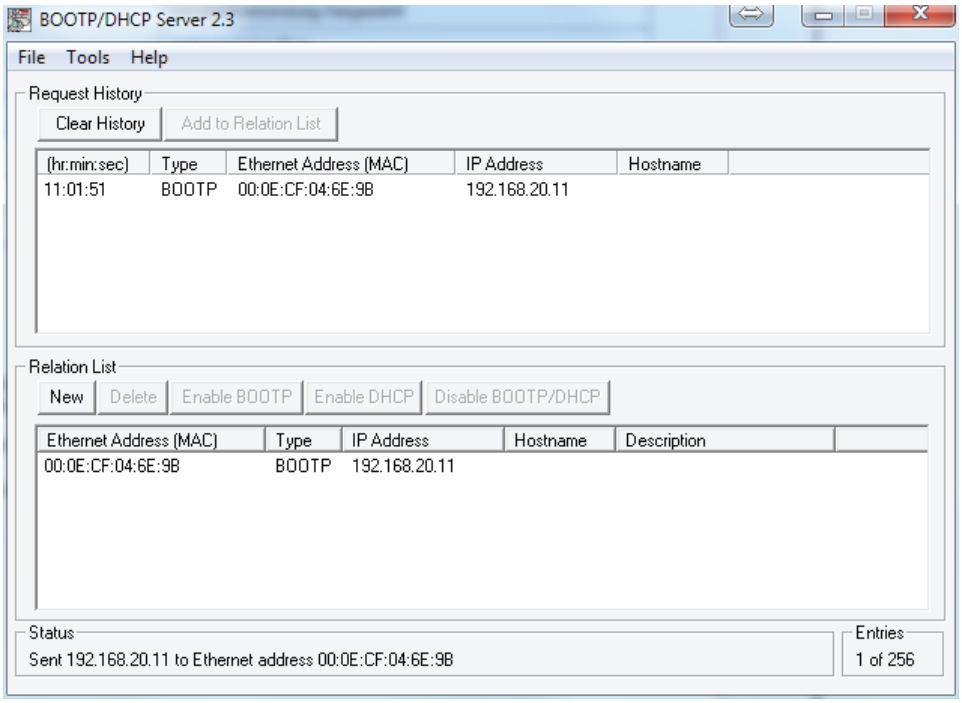


Fig.: 4

- Then save your settings.
- If you now mark the encoder in the lower window and click onto **Disable BOOTP/DHCP**, no further new BOOTP queries are transmitted after the voltage is next switched off/on and the encoder retains its last IP address. Otherwise, a BOOTP server must always be active in the network to supply the encoder with the IP address each time the supply voltage is switched on.
- A BOOTP that has been switched off can be switched on again using the **Relation List**.

3.4 Status LEDs

Six LEDs are housed in the rotary encoder's connecting cap. These have the following meaning:

Link 1/2	Active 1/2	Status1/2	Description
Green	Yellow	Green/red	
On			Network connection established
	Flashing		Connection establishment
	On		Connection established
		Green	Data exchange, device in operation and OK
		Fast green flashing	No IP address available
		Green slow flashing	IP address available but no connection to an Ethernet/IP master
		Red flashing	Impermissible parameter or preset value
		Red	Device error

3.5 Project planning

A device description file (EDS file) is available in the Internet under www.twk.de for integrating the rotary encoder into a project planning tool.

File name of the EDS file: TWK_KRP_xx12.eds

Project planning using the example of Logix Designer is explained in the following chapter.

4. Project planning with the Logix Designer

This chapter explains the procedure for integrating the TWK KRP rotary encoder into the Ethernet/IP network of a Compact/Control Logix control system. The documentation is based on Logix Designer Version 21.03.

4.1 Prerequisites

You have created a project (here, KRP_Test) in accordance with your control system structure, including Ethernet network.

(Shown here using the example of a CompactLogix 1769)

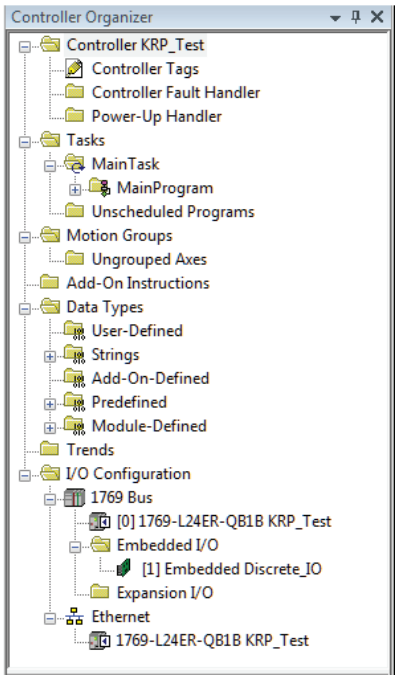


Fig.: 5

4.2 Installation of the EDS file

- Under Tools, select **EDS Hardware Installation Tool**.
- In the dialogue that then appears, select **Register an EDS file(s)** and select the downloaded file (see Figure 3).
- By confirming the subsequent dialogues with **Next**, you finally install the EDS file in the Logix Designer.

Note: the EDS file is available for downloading under www.twk.de.

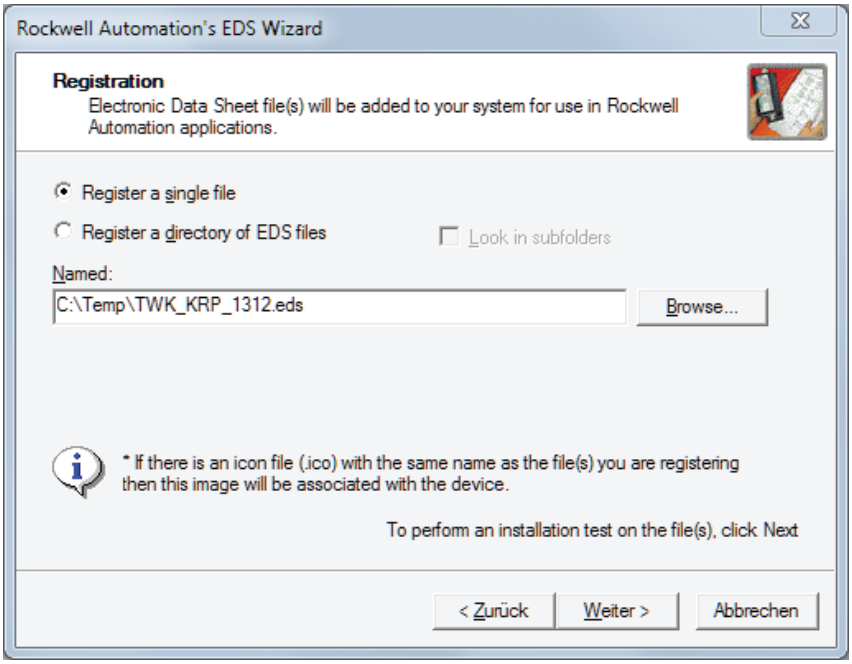


Fig.: 6

4.3 Installing the rotary encoder

Right-clicking onto the Ethernet system and selecting **New Module** takes you to the device catalogue (Fig. 8)

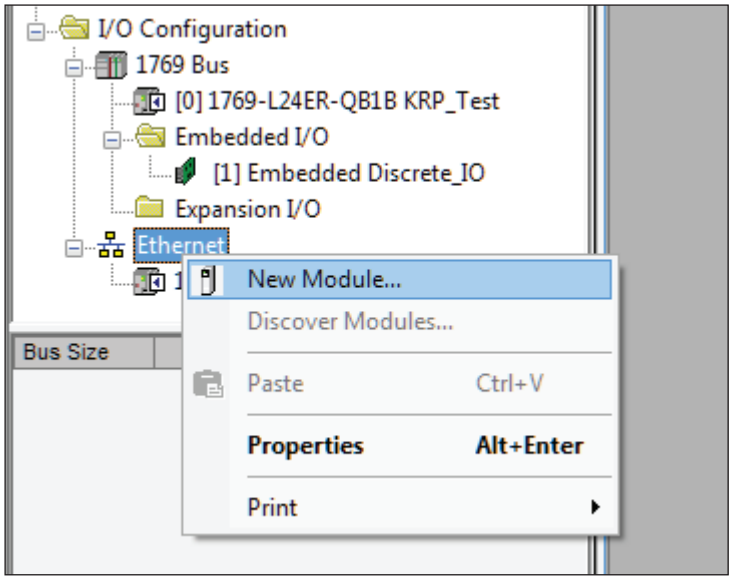


Fig.: 7

In the right window, select TWK-Elektronik GmbH. The KRP rotary encoder installed using the EDS file is then shown in the bottom section. Mark this and click onto **Create**.

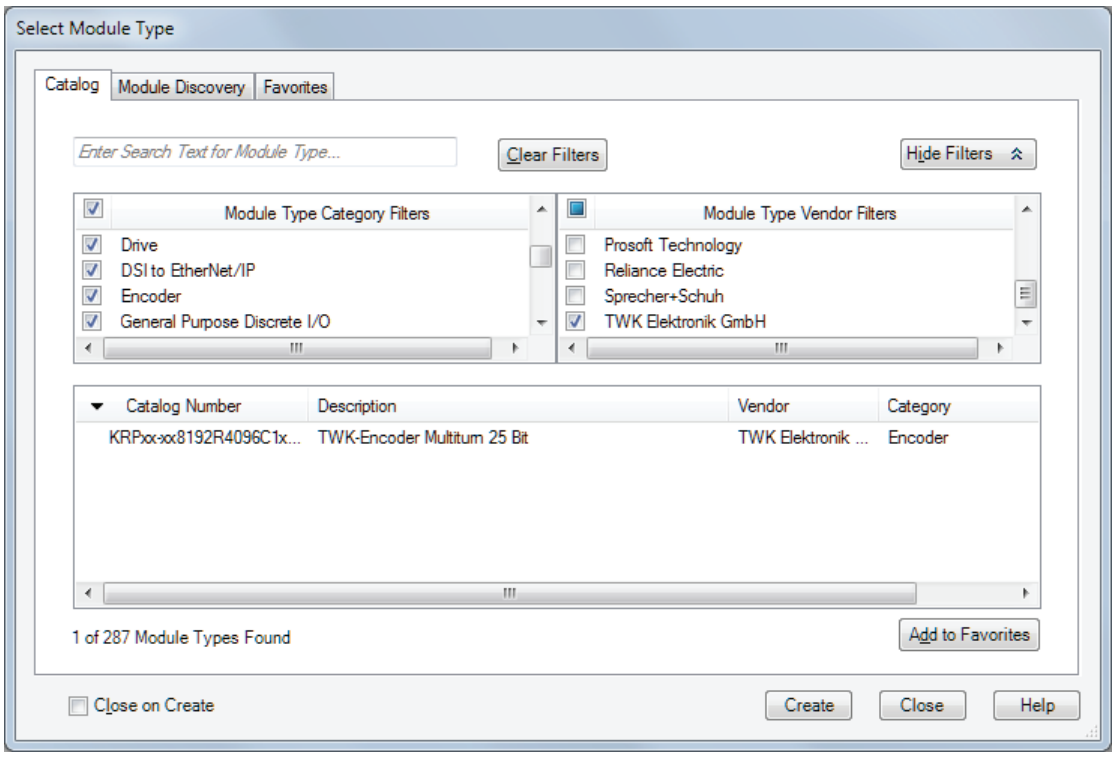


Fig.: 8

This then opens the KRP properties dialogue (Fig. 9).

4.4 Configuring the rotary encoder

Assign a device name and the IP address here, and specify the I/O configuration under **Module Definition** (Fig. 10). The KRP's transmission cycle can be defined in the Connection tab.

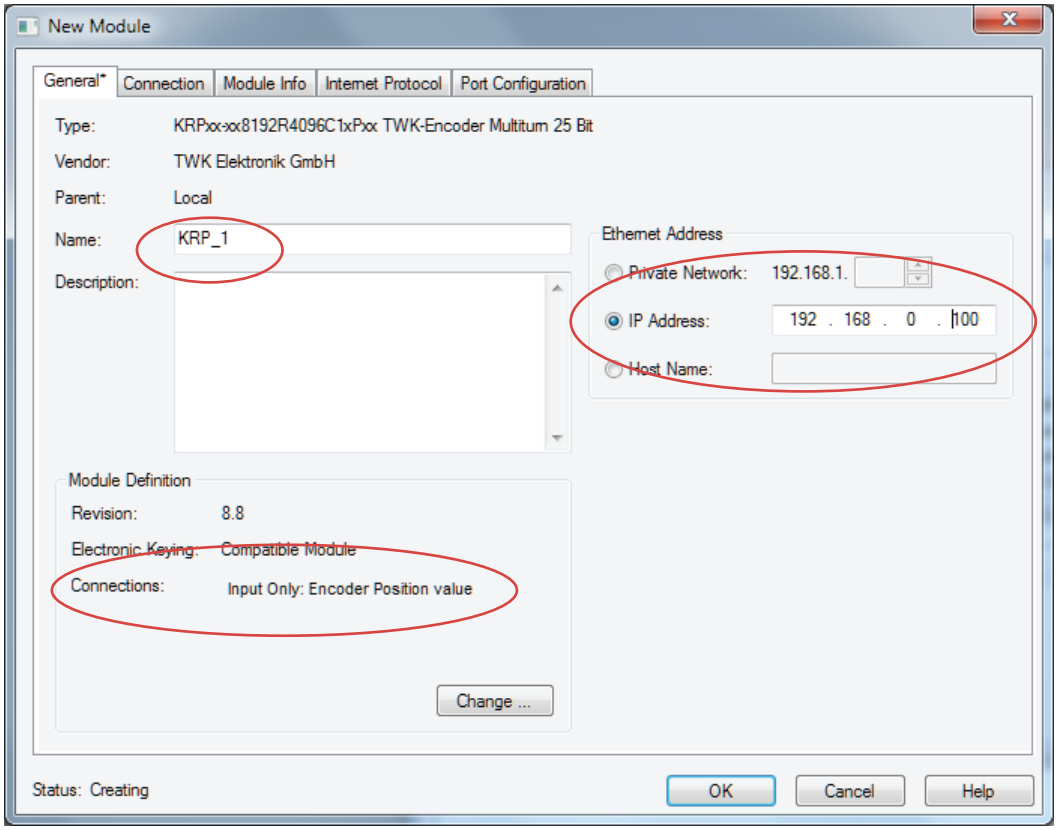


Fig.: 9

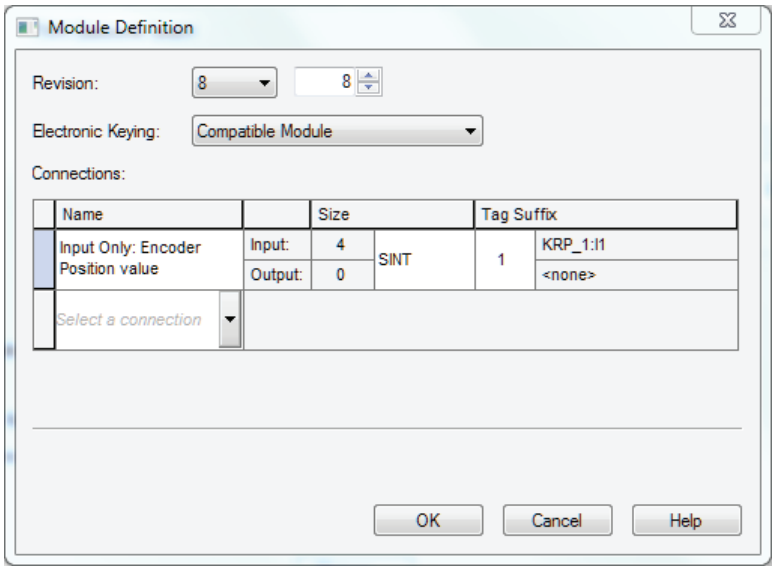


Fig.: 10

The following configurations are available (data formats, see Chapter 5):

Configuration	Data
Encoder position value	4-byte position value
Encoder position value + velocity	4-byte position value + 4-byte velocity value

The KRP is now in the Ethernet network and, after downloading the project to the control system, can already be operated in its basic setting. The next chapter shows you how to change the encoder's scaling.

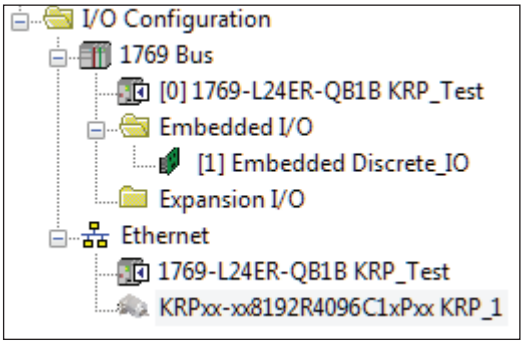


Fig.: 11

4.5 Parameterising the rotary encoder

The Ethernet/IP rotary encoder is parameterised via the **connect path** during control system start-up. In this process, the configuration and parameters are transferred and stored in the rotary encoder. This is carried out each time a connection is established between the control system and rotary encoder so that the set parameters can also be transferred to the new rotary encoder after the device has been exchanged. The parameters transmitted during connection establishment to the rotary encoder can be changed in the **Controller Tags**.

Controller Tags - KRP_Test(controller)

Scope: KRP_Test Show: All Tags

Name	Value	Force Mask	Style	Data Type
KRP_1:C	{...}	{...}		_0197:KRPxx_xx...
KRP_1:C.Direction_Counting_Toggle	0		Decimal	BOOL
KRP_1:C.Scaling_Function_Control	0		Decimal	BOOL
KRP_1:C.Measuring_Unit_Per_Span	8192		Decimal	DINT
KRP_1:C.Total_Measuring_Range_in_Measuri...	33554432		Decimal	DINT
KRP_1:C.Velocity_Format	7940		Decimal	INT
KRP_1:I1	{...}	{...}		_0197:KRPxx_xx...
Local:1:C	{...}	{...}		AB:Embedded_Di...
Local:1:I	{...}	{...}		AB:Embedded_Di...
Local:1:O	{...}	{...}		AB:Embedded_Di...

Fig.: 12

Save the project and transfer the changed parameters by downloading the project to the control system.

The parameters of a connected rotary encoder can also be changed online using a Class Instance Editor, e.g. with **RSNetWorx**. The description of all parameters is contained in Chapter 6.

4.6 Setting the preset (reference value)

It is possible to set a reference value to align a machine position value with the absolute position of the rotary encoder. On setting the reference value, an offset is generated and stored in the encoder, where it is protected against zero voltage.

The reference value is set by writing the Preset Value parameter in the Position Sensor Object.

This can be carried out e.g. via RSNetworx (see Fig. 13) or from the application programme (as of Fig. 14).

Via RSNetWorx:

- Establish a connection to the network
- Right-clicking onto the rotary encoder calls the Class Instance Editor
- The **Set Attribute Single** service now offers access to the Position Sensor Object's Attribute Preset Value. A reference value of 100 (64 $_{hex}$ is set here, for example.

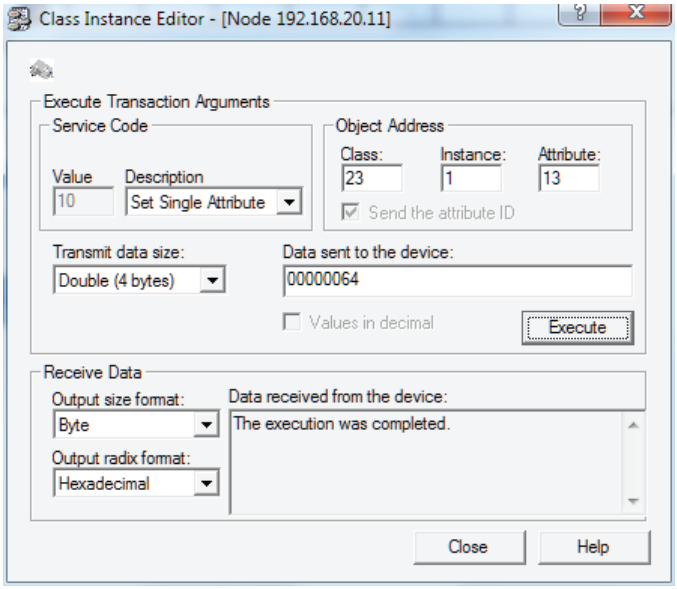


Fig.: 13

Via the user programme:

- Create a new **Controller Tag** with the data type **Message**

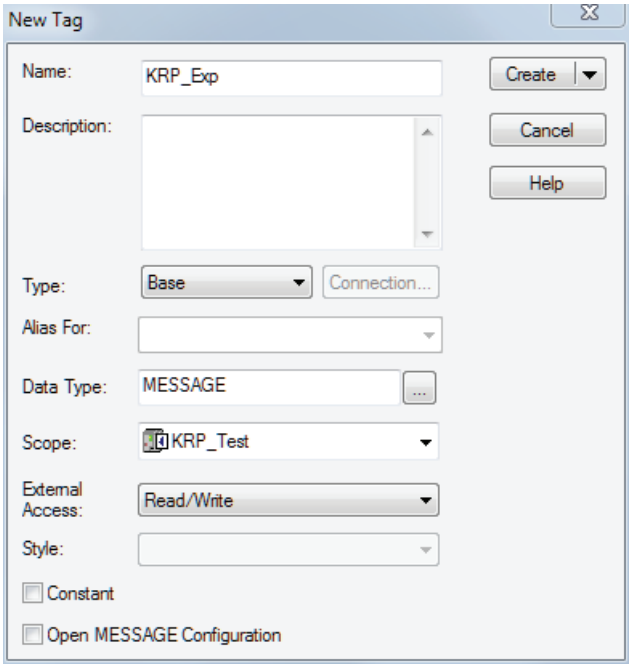


Fig.: 14

Project planning with the Logix Designer

- Insert a new message into your programme and select the previously created Controller Tag under **Message Control**

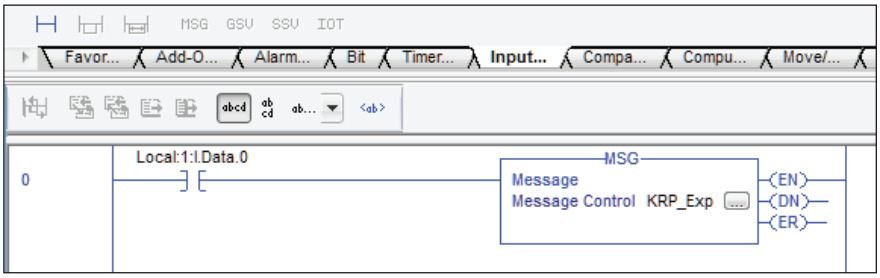


Fig.: 15

- Call the **Configuration dialogue** and configure the explicit message for writing the preset value

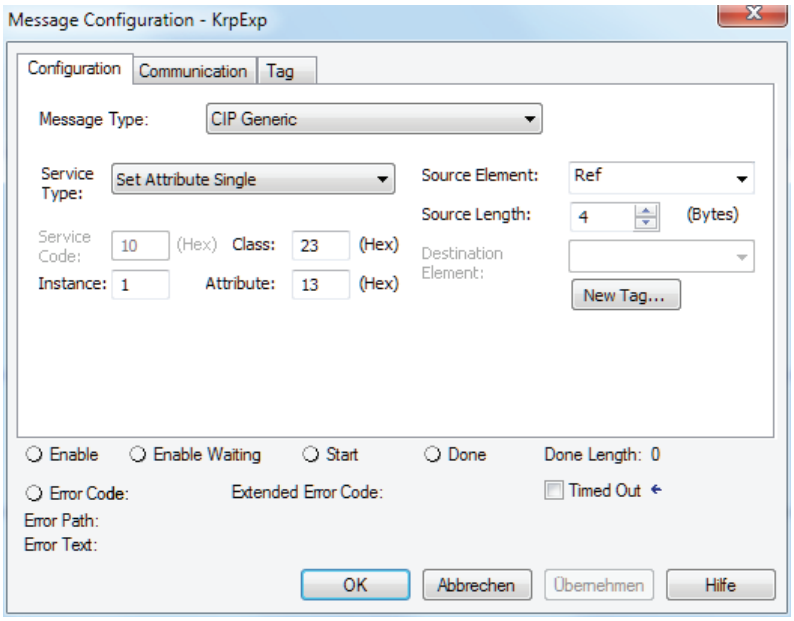


Fig.: 16

- Now, the rotary encoder merely has to be selected as the communication partner in the **Communication** tab.

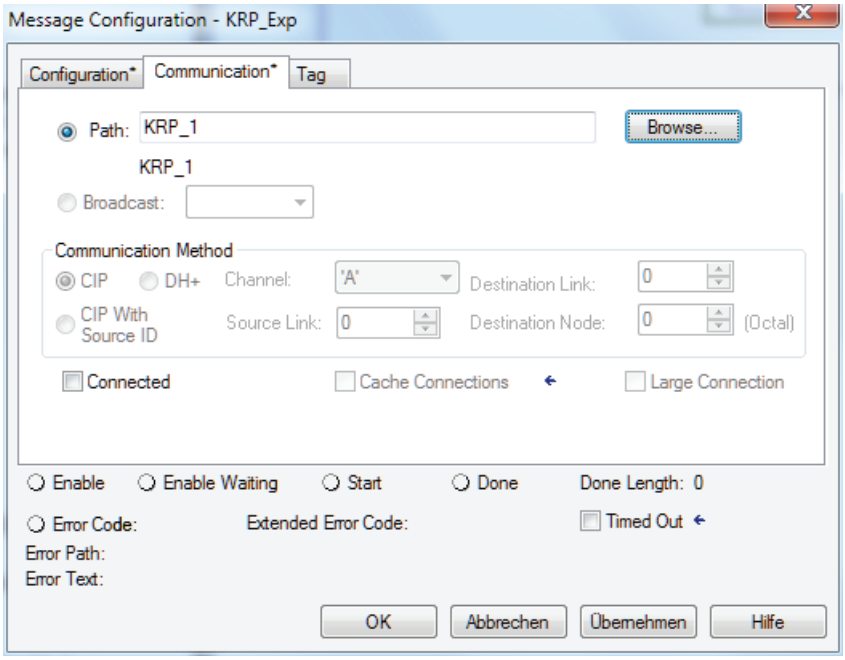


Fig.: 17

5. Data format of I/O data

5.1 Overview

5.1.1 Input data: device -> controller

"Encoder position value" configuration:

Byte 1	Byte 2	Byte 3	Byte 4
LSB	Position data		MSB

"Encoder position value + velocity" configuration:

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
LSB	Position data		MSB	LSB	Velocity		MSB

5.1.2 Output data: controller -> device

- None -

5.2 Position data

The position value in steps is output as a 32-bit unsigned integer value in Intel format (Little-Endian). The position value's resolution is set in the factory to 8192 steps / revolution. It can be changed via parameterisation.

Byte 4								Byte 3								Byte 2								Byte 1							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	Position value 25 Bit *1																								

5.3 Velocity

The velocity value is determined using cyclically read-in position data. The dimension is steps per gate time. The gate time (time span of position change recording) can be changed via parameterisation.

Byte 8								Byte 7								Byte 6								Byte 5							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Velocity																															

The velocity is output as a 16-bit signed integer value in Intel format (Little-Endian). The following applies to the prefix:

Positive with	ascending position value
Negative with	descending position value

The velocity measurement resolution is not dependent on the resolution set for the position value (resolution parameter); it is always based on a resolution of 8192 steps per revolution. (See Chapter 6).

6. Parameterisation

The rotary encoder is parameterised via the acyclical Explicit Messaging services or on establishment of the connection during start-up.

Attention: Never change the parameterisation whilst a system or machine is in operation!

6.1 Rotary encoder parameters

The object responsible for the rotary encoder parameters is the "Position Sensor Object" with the class code 23. The parameters are accessed using this object's functions (services) "Get Attribute Single" and "Set Attribute Single".

6.1.1 Attributes of the Position Sensor Object

Class code: 23_{hex}

Attribute ID (hex)	Access	Parameter name	Data type	Value range (dec)	Default (dec)	Description
01	Get	Number of Attributes	USINT		17	Number of supported attributes
02	Get	Attribute List	Array of USINT			List of supported attributes
0A	Get	Position Value Signed	DINT	0 - 33.554.432		Current position value (signed)
0B	Get	Position Sensor Type	UINT		2	Absolute multiturn rotary encoder
0C	Set	Direction Counting Toggle	BOOL	0: clockwise (cw) 1: counter clock-wise (ccw)	clockwise	Ascending values on rotation clockwise (cw) or counter clockwise (ccw). (When looking towards the shaft)
0E	Set	Scaling Function Control	BOOL	0: aus 1: ein	ein	Switches position value scaling through preset, resolution and total number of steps off/on
10	Set	Measuring Units per Span	UDINT	1 - 8192	8192	Resolution per revolution in steps. To change it, the parameter "Sca-ling function" must be set to "On"
11	Set	Total Measuring Range in Measuring Units	UDINT	1 - 33.554.432	33.554.432	Total number of steps in steps. To change it, the parameter "Scaling function" must be set to "On"
13	Set	Preset Value	DINT	0 - (total number of steps - 1)	0	Preset value in steps. To change it, the parameter "Scaling function" must be set to "On"
18	Get	Velocity Value	DINT			Current velocity in the format of attribute 19_{hex}
19	Set	Velocity Format	ENG UINT	$1F04_{hex}$ - $F07_{hex}$, $1F0F_{hex}$	$1F04_{hex}$	$1F04_{hex}$ = steps per second $1F05_{hex}$ = steps per millisecond $1F06_{hex}$ = steps per microsecond $1F07_{hex}$ = steps per minute $1F0F_{hex}$ = revolutions per min.
29	Get	Operating Status	BYTE		0	Shows the set operating mode (bit 1 = scaling, bit 2 = counting direction)

Parameterisation

Attribute ID (hex)	Access	Parameter name	Data type	Value range (dec)	Default (dec)	Description
2A	Get	Physical Resolution Span	UDINT	8192	8192	Physical (maximum) resolution in steps
2B	Get	Number of Spans	UINT	8192	8192	Physical (maximum) number of revolutions
33	Get	Offset Value	DINT	0 - (total number of steps -1)	0	Value by which the position value has been shifted by setting the preset
65	Set	Endless Shaft	DINT	0, 1, 2	2	0 = off, 1 = on, 2 = auto
66	Set	Velocity Filter	DINT	0, 1, 2	1	0 = fine, 1 = medium, 2 = coarse

* The values in brackets represent the rotary encoders with 25-bit total number of steps (KRPxx-xx8192R4096C1xPxx).

6.1.2 Position Sensor Object services

Service code (hex)	Service name	Description
05	Reset	Rotary encoder "warm start".
0E	Get_Attribute_Single	Service for reading out an attribute
10	Set_Attribute_Single	Service for writing an attribute

7. Scope of delivery

The scope of delivery includes:
- Rotary encoder with Ethernet/IP interface
- Connection assignment TY XXXXX (depending on device variant)

The following can be found in the Internet under www.twk.de:
- The relevant data sheet
- This manual
- EDS file

Annex A: Rotary encoder terms

Parameter	Explanation
Resolution - steps/360°	The resolution specifies the number of steps per revolution (360°).
Measuring range	The measuring range specifies the maximum number of revolutions. The revolutions must be specified in powers of 2^n.
Total number of steps	The total number of steps arises as follows: total number of steps = resolution x measuring
Code path	The code path specifies the direction of rotation in which the encoder's output code ascends. Depending on the direction of rotation, a distinction is made between: CW - clockwise direction of rotation CCW - counter clockwise direction of rotation (when looking towards the shaft)
Reference value/preset	The reference value is the value which appears as the encoder's actual position value according to the preset function. It lies in the value range from 0 to total number of steps -1.