Your Global Automation Partner

TURCK

Encoders with EtherNet/IP Interface

Instructions for Use

Contents

1 Document

This is the English translation of the original manual in German language.

Publisher	Turck Inc. 3000 Campus Drive USA-MN 55441 Minneapolis Phone: (+ 1) (763) 553 7300 Fax: (+ 1) (763) 553 0708 Email: turckusa@turck.com Website: www.turck.us
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Text sources
ODVA CIP Specification Vol 1, Ed 3.32
ODVA EtherNet/IP Specification Vol 2, Ed 1.30

Image sources
Screenshots from Studio 5000 Logix Designer V34
EtherNet/IP ODVA Technology Overview Series CIP on EtherNet Technology

Code sources
- none -

Legal Notices

2 General Information

Please read this document carefully before working with the product, mounting it or starting it up

2.1 Target Group

The device may only be planned, mounted, commissioned and serviced by persons having the following qualifications and fulfilling the following conditions:

- Technical training.
- Briefing in the relevant safety guidelines.
- Constant access to this documentation.

2.2 Symbols used / Classification of the Warnings and Safety instructions

DANGER	**Classification:** This symbol, together with the signal word **DANGER**, warns against immediately imminent threat to life and health of persons. The non-compliance with this safety instruction will lead to death or severe adverse health effects.
WARNING	**Classification:** This symbol, together with the signal word **WARNING**, warns against a potential danger to life and health of persons. The non-compliance with this safety instruction may lead to death or severe adverse health effects.
CAUTION	**Classification:** This symbol, together with the signal word **CAUTION**, warns against a potential danger for the health of persons. The non-compliance with this safety instruction may lead to slight or minor adverse health effects.
ATTENTION	**Classification:** The non-compliance with the **ATTENTION** note may lead to material damage.
NOTICE	**Classification:** Additional information relating to the operation of the product, and hints and recommendations for efficient and trouble-free operation.

2.3 Transport / Storage

Check the delivery immediately upon receipt for possible transport damages. If you do not mount the device immediately, store it preferably in its transport package.

The device must be stored at a dry and dust-free location, in compliance with the technical data, see chapter Technical Data [6].

3 Product Description

3.1 Technical Data

NOTICE	**Technical Data** All technical data, as well as the mechanical and electrical characteristics, are specified in the data sheets of the corresponding device variant, for special versions in the.corresponding quotation / customer drawing of the product.
NOTICE	**Observe the configuration** The performance characteristics and the mechanical design of the product depend on the selected configuration (according to order code).

3.1.1 Technical Data RM105_106 RS107_108

Singleturn technology		Optical
Multiturn technology		Battery-buffered, electronic counter, flash technology
Singleturn resolution (MUR)		
	Maximum	19 bit
	default	18 bit
Multiturn resolution (NDR)		
	Maximum	24 bit
	default	12 bit
Total resolution (TMR)		
	Maximum	43 bit
	default	30 bit
Scaling		Supports USF Supports gear factor
Accuracy		± 0,0137° (over the whole temperature range)

Mechanical Characteristics for the RM105_106 RS107_108 Encoders

Maximum rotational speed	
IP67 (for short periods– 10 min)	9000 min^{-1}
IP67 (continuous operation)	6000 min^{-1}
Starting torque (at 20 °C)	
IP67	< 0,01 Nm
Mass moment of inertia	
Shaft version	3,0 x 10^{-6} kg·m^2
Hollow shaft version	6,0 x 10^{-6} kg·m^2
Permissible shaft load	
radial	80 N
axial	40 N
Protection level (acc. to EN 60529)	
Housing side	IP67
Shaft side	IP65 (optional IP67)
Working temperature range	-40°C ... +80°C [-40°F ... +176°F
Materials	
Shaft/hollow shaft	Stainless steel
Flange	Aluminum
Housing	Aluminum(over the whole temperature range)
Shock resistance (acc. to EN 60068-2-27)	2500 m/s^2, 6 ms
Vibration resistance (acc. to EN 60068-2-6)	100 m/s^2, 55 ... 2000 Hz

Electrical Characteristics for the RM105_106 RS107_108 Encoders

Supply voltage	10 ... 30 V DC
Maximum current consumption	250 mA
Supply voltage reverse polarity protection	Yes

3.2 Supported Standards and Protocols

The EtherNet/IP standards and features implemented in the device are listed below:

3.2.1 RM105_106 RS107_108 Standards & Features

The devices are provided with three LEDs for displaying communication bus and device signal.

- CIP Version v3.32
- EtherNet/IP Version v1.30
- LLDP
- BOOTP
- DHCP

EtherNet/IP Features

- DLR (Device Level Ring) possible
- QoS (Quality of Service) possible
- ACD (Address Conflict Detection)
- Multicast and Unicast ability
- Connection to up to 5 controllers

General Information on EtherNet/IP

EtherNet/IP Conformance Tested	Version CT-19, August 2022
EtherNet/IP Specification	Vol 2, Ed 1.30
CIP Specification	Vol 1, Ed 3.32
CIP Position Sensor Object	rev. 2 (Class Code: 0x23)

Implemented Objects (CIP Objects)

- Identify Object
- Message Router
- Assembly Object
- Connection Manager
- Position Sensor Object
- QoS Object
- Port Object
- TCP/IP Interface Object
- EtherNet/IP

3.3 Interface Description EtherNet/IP

The real time EtherNet for industrial automation applications allows simultaneous Internet and enterprise connectivity for Industry 4.0 and Industrial IoT applications.

3.3.1 EtherNet/IP Communication Network

EtherNet/IP is an application layer that organizes data transmission between transmitters and receivers in the industrial network. All data is grouped in objects. Every EtherNet/IP field device (EtherNet-IP “Adapter”) manages a collection of objects. An object corresponds to a collection of related data. There are two types of objects: Necessary objects and application objects. Necessary objects must be implemented in every EtherNet/IP field device for the network communication. These include among others: Identity object, connection object, EtherNet/IP object and TCP object. For example, the identity object contains the vendor ID, the product name and the serial number of the device. The TCP/IP object contains among others the TCP/IP address, the net mask and the gateway address.
If for example several TCP/IP access addresses are used, there will be several TCP/IP objects. If there are several objects of a class, they are called instances. Instances of the same object of a class each have the same attributes and properties.
The data in the respective objects are called attributes.
Accessing to a determined attribute requires the object number, the instance number and the attribute number.
For example, the encoder has a single “Position Sensor object“ (object number 0x23, instance number 1) with the attributes Position, Velocity, Acceleration, etc. The compilation of the objects forms the data infrastructure for the network.

3.3.2 EtherNet/IP and CIP

The object-oriented Common Industrial Protocol (CIP), issued by the Open DeviceNet Vendor Association (ODVA), distinguishes between “implicit” I/O messages and “explicit” question/answer telegrams for configuration and data acquisition.
Explicit messages read or write a specific object, attribute, and instance through the router and return a response with corresponding data.
Implicite messages are defined by the manufacturer. Data from various objects is collected in an assembly in the device and transmitted to the network in bundled form. Incoming messages are also sent to the assembly in the device and distributed to the objects from there.
While explicit messages are embedded in TCP frames, data for real-time applications are sent via UDP. Switches that form the center of a star-shaped network topology prevent data collisions of the devices connected via point-to-point connection.
EtherNet/IP can be used to implement various network topologies: including star topology or line topology with standard EtherNet devices or a Device Level Ring (DLR) with EtherNet/IP devices specially parameterized for this purpose.
EtherNet/IP typically achieves “soft” real-time with cycle times of approximately 10 milliseconds.

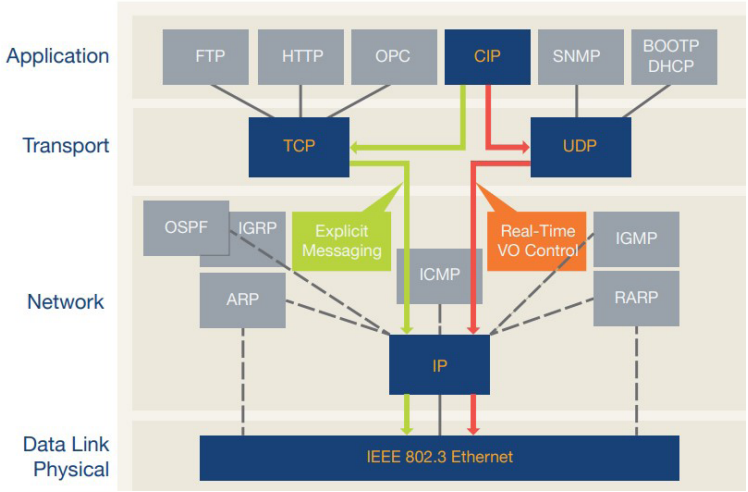


Fig. 1: Quelle: EtherNet/IP ODVA Technology Overview Series CIP on EtherNet Technology

3.3.3 Parameterizing

The network integration requires the EDS files of the field devices to be configured. EDS files are simple text files in the ASCII format. They describe how the field device can be used in the EtherNet/IP network and the available objects, attributes and services. EDS files contain all data relevant for engineering and data exchange with the device. The minimum requirement is an information about the identity to allow network tools to recognize the device.

3.3.4 Addressing

Field devices for EtherNet/IP networks support DHCP (Dynamic Host Configuration Protocol) and BOOTP for the allocation of the IP address.

3.3.5 Non-Volatile Memory

The EtherNet/IP encoder offers the advantage of a non-volatile memory (FRAM) for all saved non-constant internal and external parameters, application and configuration data, which remain preserved after a power off/power on cycle of the encoder.
Thanks to the implementation of the non-volatile memory as FRAM, this encoder has the advantage of allowing the user to reconfigure it (e.g. preset value) or to modify its configuration (e.g. IP address configuration, encoder configuration, etc.) as often as necessary.

4 Installation

NOTICE	**Observe the operation manual** Installation instructions can be found in the relevant operation manual.

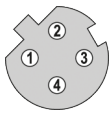
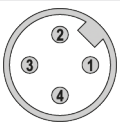
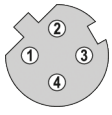
4.1 Electrical Installation

4.1.1 General Information for the Connection

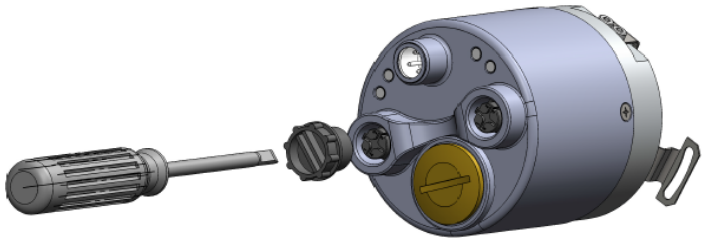
ATTENTION	**Destruction of the device** Before connecting or disconnecting the signal cable, always disconnect the power supply and secure it against switching on again.
NOTICE	**General safety instructions** Make sure that the entire system is in a de-energized state during electrical installation.
NOTICE	**No open cable wires:** Connect all required cable wires/connectors before commissioning. Insulate individually all unused ends of the output signals to avoid short-circuits. ▪ Electrostatic discharges at the contacts of the connector or at the cable ends could damage or destroy the device. Take appropriate precautionary measures.
NOTICE	**Traction relief** Always mount all cables with traction relief.
NOTICE	**Use shielded data lines** Use exclusively shielded data lines to comply with the EMC interference immunity requirements in force for interference emissions and external interference.

4.1.2 Terminal Assignment

The encoder has three connectors, two of them are the two Ethernet ports.
In this documentation, these ports are designated as Ethernet IN/OUT ports.
The central connector is the power supply of the encoder. The power supply connector is an A-coded M12 plug.
Both Ethernet connectors are D-coded M12 sockets. The assignment of the signals to the pins is described in the table below

3x M12, 4-pole					**Connector**
	Link 1 - Ethernet Port IN / OUT				 Female, D-coded
Signal	TxD+	RxD+	TxD-	RxD-	
Pin	1	2	3	4	
	Voltage supply				 Male, A-coded
Signal	+ V	-	0 V	-	
Pin	1	2	3	4	
	Link 2 - Ethernet Port IN / OUT				 Female, D-coded
Signal	TxD+	RxD+	TxD-	RxD-	
Pin	1	2	3	4	

The two external encoder connectors “PORT 1” and “PORT 2” are used for the Ethernet communication. One of the two ports is sufficient for a star structure. Both ports are required for a line or ring structure. In principle, the data ports are equivalent and can be chosen freely.



NOTICE	**M12 connector cover** Both Ethernet ports are provided with a plastic cap. If only one of both ports is to be used, the cap of the other port must be tightened at a torque of 1 Nm [0.74 ft-lb] to ensure the IP protection level.

Signal assignment of an M12 to RJ45 cable

M12 to RJ45 direct

Signal	M12 Pin	RJ45 Pin
TxD+	1	1
TxD-	3	2
RxD+	2	3
RxD-	4	6

4.1.2.1 Information for EMC-Compliant Installation

Requirements for cables

a) Use exclusively shielded twisted-pair cables to connect the device.
b) Comply with the maximum permissible connection cables length.

EMC acc. to EN 61326-1	Criterion A The device operates trouble-free, user data transmission proceeds without disturbance, internally stored data and configurations remain preserved.	Criterion B During a failure, a disturbed transmission of the user data is allowed, internally stored data and configurations remain preserved.
Interference immunity	Is achieved with a shielded line.	Is achieved with an unshielded line.
	Class A Industrial environment The device has a radiation according to Class A.	Class B Living area The device has a radiation according to Class B.
Radiation	Is achieved with an unshielded line.	Is achieved with a shielded line.

NOTICE	**Grounding of the encoder housing** The cable shield is connected internally to the encoder housing. When using a stator coupling for installation, make sure that this coupling is sufficiently conductive. Otherwise, the housing should be directly connected to a protective earth. • For this purpose, also provide alternative measures, as described in chapter Information for EMC-Compliant Installation [11].

Shielding and Equipotential Bonding

a) Apply the cable shield on a large contact area - ideally 360°. Use e. g. a shield terminal to this purpose.

b) Pay attention to proper cable shield fastening.

c) Preferably connect the shield on both sides with low impedance to the protective earth (PE), e.g.on the device and/or on the evaluation unit. In the event of potential differences, the shield must only be applied on one side.

d) If shielding is not possible, appropriate filtering measures must be taken.

e) Make sure that no short-time overvoltages can occur on the signal and power supply lines when the protective earth is connected to the shield on one side only.

f) For the large-area connection of the cable shield, use the shield terminal provided to this purpose. It can easily be mounted on the top-hat rail.

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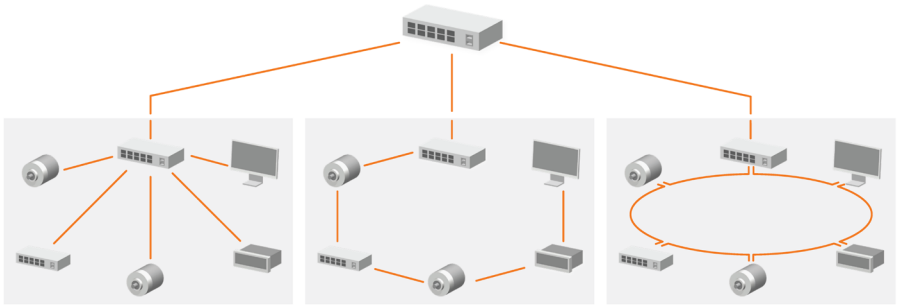
Order code	RA-ST-3_12MM	RA-ST-7_18MM
Material	Spring steel, galvanized	
Shield diameter	3.0 … 12.0 mm	7.0 … 18.0 mm

Turck offers a wide range of connection cables in various versions and lengths,
see www.Turck.us

4.1.3 Network topologies

Network topologies result from the functional requirements imposed on the respective network. However, network planners must also consider aspects such as management, performance, spatial environment, safety, maintenance and savings potential. Thus, the network topology is in practice always a compromise resulting from very different considerations.
Basically, any network topology can be achieved with Industrial Ethernet. There are essentially three patterns used to arrange devices in a network: the star, the line and the ring. Each of these three basic physical topologies in turn includes the smallest topology possible: the point-to-point topology between two participants.

- The star topology includes point-to-point connections between a central network participant and all others, which are arranged in star with respect to it. The transmission medium runs point-to-point between them, resulting in a star structure.
- In the line topology, all participants are interconnected by means of a common transmission medium. This medium is called bus, so this topology is also called bus topology.
- In the ring topology ("Device Level Ring"), the devices are wired in a ring structure. The two network ports of the devices are connected to the respective neighboring devices on both sides. The first and the last device in the ring are connected each with one of their ports to the ring master.



The basic logical topologies can be assigned to these three basic patterns.

- In the star topology, every connection between the central network participant and another participant consists in two lines - one to send, one to receive. The sent signal of a network participant is sent via the central network participant to all others.
- In the line topology, the data sent by a network participant is broadcast over the whole transmission medium. Thus, when a network participant is sending, no other participant can send without leading to data collision.
- In the ring topology, a network participant is only allowed to send when he receives the transmission authorization (token) circulating in the ring. Data prepared for sending is added to the token and transmitted in the ring from participant to participant until the target participant receives it.

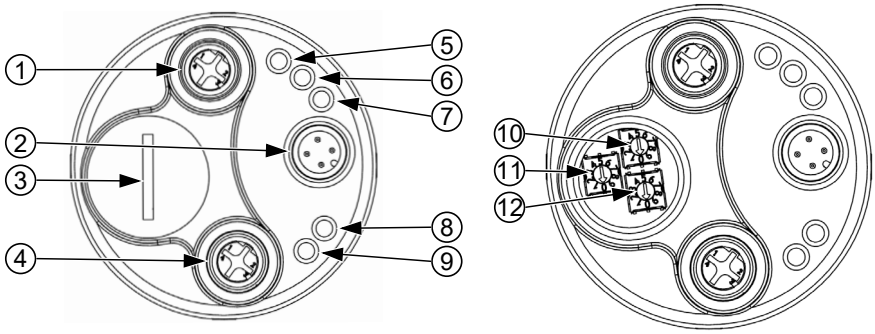
NOTICE	**Topology and line length** Independently of the chosen topology, the length of the line between the single devices shall in no case exceed 100 m. In the event of line lengths exceeding 100 m, the single devices must be coupled through suitable switches.

5 Commissioning and Operation

⚠ DANGER	**Risk of injury due to rotating shafts** Hair and loose clothing can be caught by rotating shafts. ▪ Prepare all work as follows: ⇨ Switch the operating voltage off and stop the drive shaft. ⇨ Cover the drive shaft if the operating voltage cannot be switched off.

5.1 Overview of the Connectors and LEDs

The encoder has five LEDs (No. 5 – 9).



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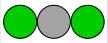
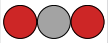
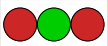
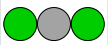
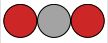
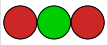
1	Ethernet Port – Link 2	5	Link 2	9	Link 1
2	Supply voltage	6	NET - Network	10	Switch: x100
3	Cover screw	7	MOD - Module	11	Switch: x10
4	Ethernet Port – Link 1	8	ENC – Encoder	12	Switch: x1

Display	LED	Description
LINK 1		The LINK 1 LED lights up green when the Ethernet connection is available and flashes yellow during data exchange. The LED is off in all other cases.
LINK 2		The LINK 2 LED lights up green when the Ethernet connection is available and flashes yellow during data exchange. The LED is off in all other cases.
NET		The NET LED displays the current status of the network. The (all) statuses are listed in the NET LED table.
MOD		The MOD LED displays the current status of the system. The (all) statuses are listed in the MOD LED table.
ENC		The ENC LED displays the current status of the encoder. The (all) statuses are listed in the ENC LED table.

NET LED

Display	LED	Description	Measures
Off		No power supply / IP address.	Check the voltage and the polarity.
On		Connected; the connected device has an IP address and a CIP connection.	n/a
Flashing		No connection; the device has an IP address, but no CIP connection.	Establish the connection / Check the network connection.
On		Error IP address already allocated to another device.	Correct the IP address conflict.
Flashing		Warning; connection timeout (recoverable error). Erased by resetting or by a new connection.	Restore the connection.
Flashing		Self-test when switching on.	n/a

MOD LED

Display	LED	Description	Measures
Off		No power supply.	Check the voltage and the polarity.
On		Device ready for operation.	n/a
Flashing		Standby / idle.	n/a
On		Error; device not ready (unrecoverable error).	Check the alarms (attribute 44).
Flashing		Warning; device still in operation (recoverable error).	Check the warnings (attribute 47).
Flashing		Self-test when switching on.	n/a

ENC LED

Display	LED	Description	Measure
Off		No power supply.	Check the voltage and the polarity.
On		Device ready for operation.	
On		Manufacturer-specific warning; device still in operation (recoverable error).	Check the warnings (attribute 47).
Flashing		Manufacturer-specific warning; device not ready (unrecoverable error).	Check the alarms (attribute 44).

5.1.1 Encoder Rotary Switches

The three rotary switches of the encoder (switch x1, x10, x100) form a three-digit decimal number with the units, the tens and the hundreds.

The switch positions are only taken over when switching on the power supply. The switches should be set only when the power supply is switched off. Modifying the switch positions during operation is not provided for. In this case, the encoder detects the changes and switches over to an error condition.
300, 555, 800 are so-called transient switch positions, the encoder does not switch to normal operation mode when they are set.
The rotary switches always have priority. If e.g. a static IP address is set, changes via the TCP/IP object with “Object State Conflict” are rejected.

Switch position	Meaning
000	Address assignment per DHCP.
1 to 254	Use the static IP address (standard: 192.168.1.x, subnet mask: 255.255.255.0), the last digit "x" of the IP address is defined by the rotary switches.
300	Explicit Protection mode OFF, see chapter Implicit Protection Mode and Explicit Protection Mode [41].
555	Encoder reset to factory setting, see chapter Resetting the Encoder [17].
800	Explicit Protection mode ON, see chapter Implicit Protection Mode and Explicit Protection Mode [41].
other positions	Reserved, not to be used!

5.2 Quick Start Guide

5.2.1 Default Settings

5.2.1.1 Encoder Factory Settings

The Address Conflict Detection (ACD) is enabled.
In delivery condition, the rotary switches are set to 000 (DHCP address allocation).

5.2.1.2 Setting the IP Address With the Rotary Switches

A fixed IP address can also be allocated using the address selector switches on the device in case the address allocation via DHCP is not desired.

a) Disconnect the encoder from the power supply.

b) Unscrew the cover screw on the encoder, see chapter Overview of the Connectors and LEDs [14].

c) Turn the rotary switches to the desired position, see chapter Encoder Rotary Switches [15].

d) Re-start the encoder.

⇨ After the new start, the encoder can communicate using the address set.

Attribute ID:	Attribute name	Default value	Remark
12	Direction Counting Toggle	0	Increasing clockwise.
14	Scaling Function Control	1	ON
16	Measuring Units per Span (MUR)	262,144 (18 bits)	
17	Total Measuring Range (TMR)	1,073,741,824 (30 bits) (multiturn encoders) 262,144 (18 bits) (singleturn encoders)	
19	Preset Value	0	
22	Position Low Limit	0	
23	Position High Limit	1,073,741,823 (multiturn encoders) 262,143 (singleturn encoders)	
25	Velocity Format	0x1F0F	Revolutions per minute.
26	Velocity Resolution	1	Currently not used.
27	Minimum Velocity Setpoint	-9000	
28	Maximum Velocity Setpoint	9000	
30	Acceleration Format	0x0812	Revolutions per second^2.
31	Acceleration Resolution	1	Currently not used.
32	Minimum Acceleration Set-point	-6366	
33	Maximum Acceleration Set-point	6366	
100	Gear Factor	0	OFF
101	Gear Factor, Numerator	4096	
102	Gear Factor, Denominator	1	
110	Velocity Filter Integration Time	20	
112	Acceleration Filter Integration Time	20	

Also refer to

Encoder Factory Settings [16]

5.2.1.3 Resetting the Encoder

There are two ways to reset the encoder to the factory settings.

With the Rotary Switches

Resetting the encoder to the factory settings with the rotary switches corresponds to a type 1 reset.

a) Disconnect the encoder from the power supply.
b) Set the rotary switches to 555.
c) Connect the encoder to the power supply.
d) Wait for approximately 5 seconds.
e) Disconnect the encoder from the power supply.
f) Set the rotary switches to the position desired for operation, e.g. 000.
g) Connect the encoder to the power supply.
⇨ The encoder is now reset.

With the Identity Object

To reset the encoder with the Identity object, the “Reset” service (Service Code 0x05) must be carried out with Parameter “1”, see chapter EtherNet/IP Services of the Position Sensor Object [29].
There are two encoder reset types, which differ in behavior:

Reset Type 0

To reset the encoder with the Identity object, the “Reset” service (Service Code 0x05) must be written with Parameter “0”.
The encoder behaves as if the power supply had been switched off and on again (“power cycle”).

Reset Type 1

The saved encoder configuration is set back to the “factory” delivery condition and saved (necessary objects and application objects). Then, the switching off and on of the power supply is simulated or carried out.

5.2.2 Configuration

NOTICE	**Position jumps after configuration changes** Please note that a configuration change (e.g. a change of one or several of the Position Sensor object attributes No. 12, 14, 16, 17, 100, 101, 102 and others) lead to a sudden change of the position sent by the encoder. We recommend to carry out again the preset function after configuration changes.

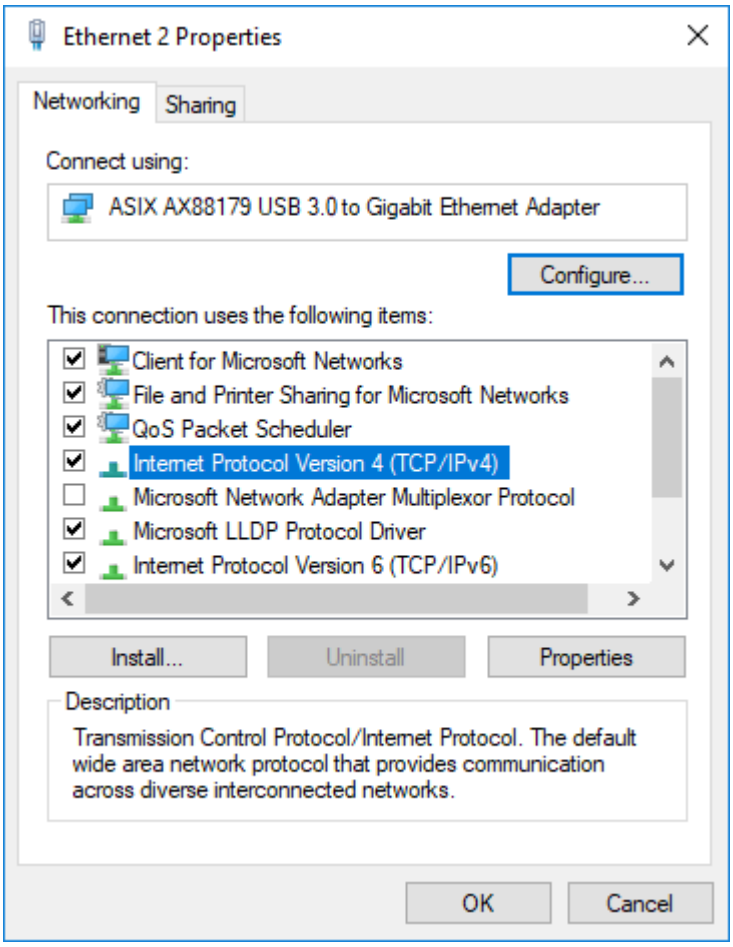
5.2.2.1 Integrating the Encoder in the Logix Designer

In order to use the encoder to its full extent, it must be integrated in the Studio 5000 Logix Designer software and in your control network.

a) Set the IP address and the subnet mask of the computer Logix Designer is running on.

b) Under Windows, call the menu “Control panel / Network and Sharing Center“.

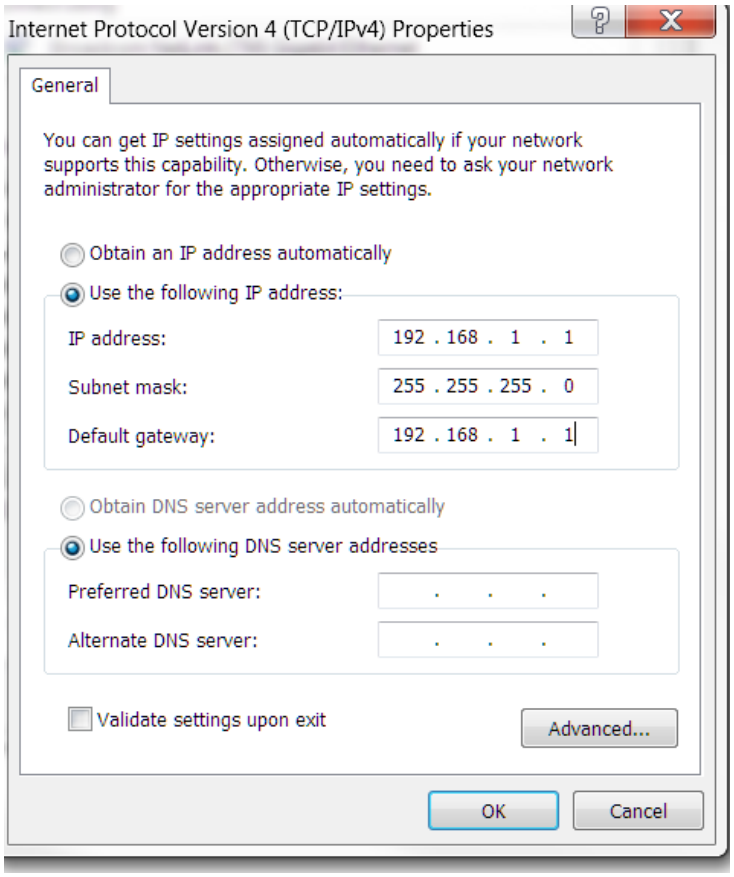
c) Open the menu “Properties” of the used network interface.



IMG-ID: 9007199572874379

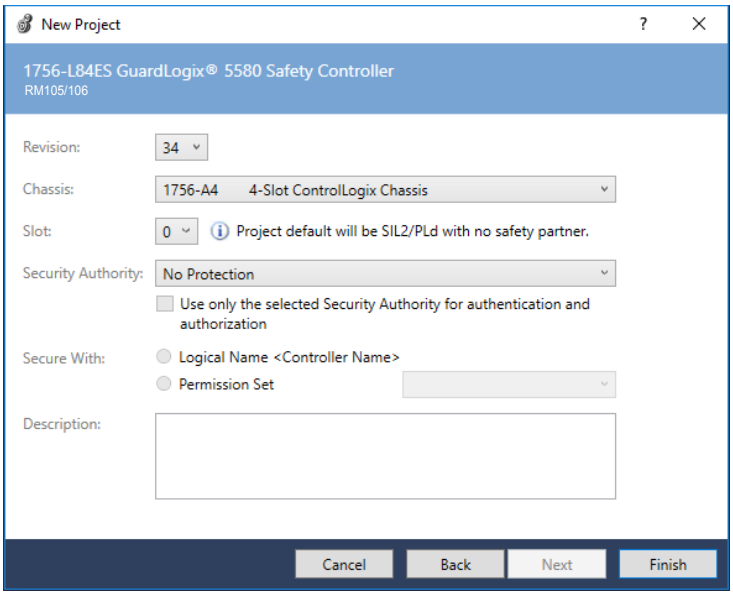
d) Select “Internet Protocol Version 4“ and click on “Properties”.

e) Input the following exemplary values: IP address: 192.168.1.111, subnet mask 255.255.255.0.



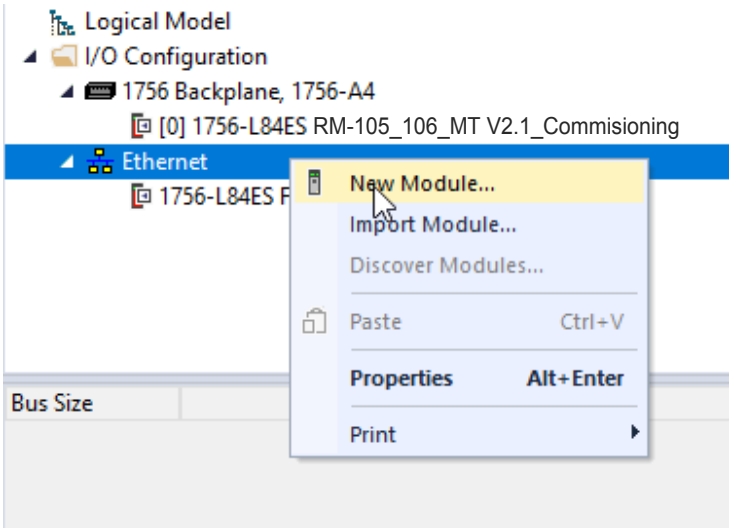
IMG-ID: 9007199572876299

f) Start the Logix Designer software and create a new project. A controller with switch and backplane is already configured in the following project example.



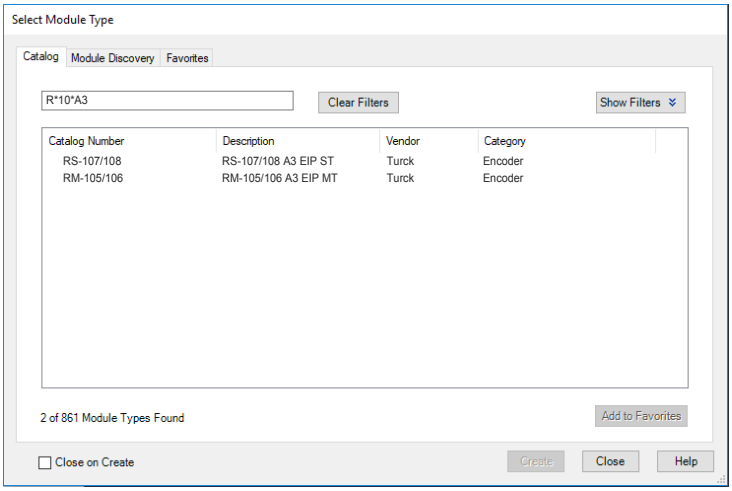
IMG-ID: 318137227

g) Below the “Ethernet” node, select the menu item “New Module”.



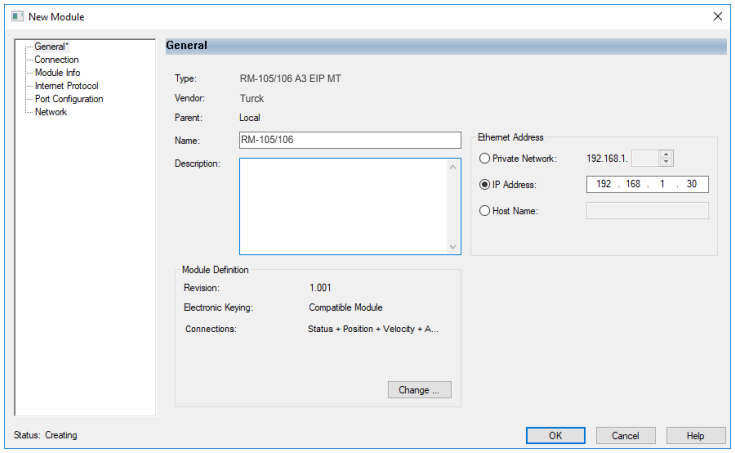
IMG-ID: 318139147

h) Select the suitable Turck encoder.



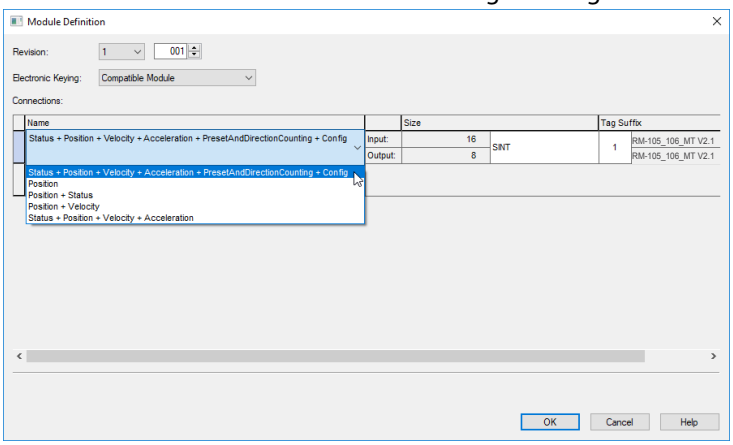
IMG-ID: 318141067

i) Input the desired name of the new encoder (here: RM-105_106_MT V2.1_Encoder) and its IP address (here: 192.168.1.30).



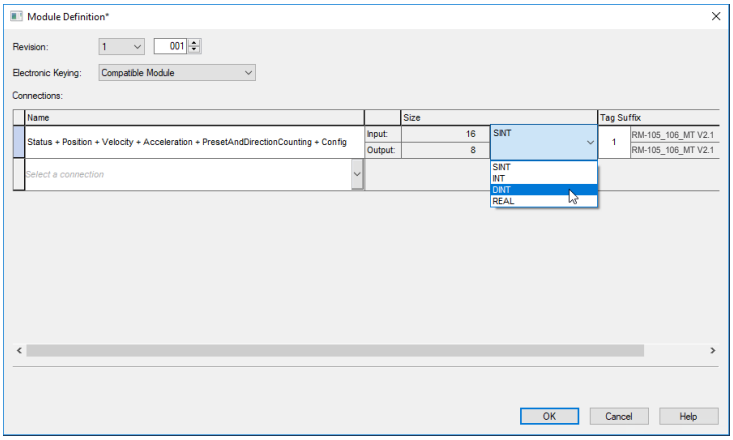
IMG-ID: 318142987

j) Select the desired connection. For this example, use the connection “Status + Position + Velocity + Acceleration + PresetAndDirectionCounting + Config”.



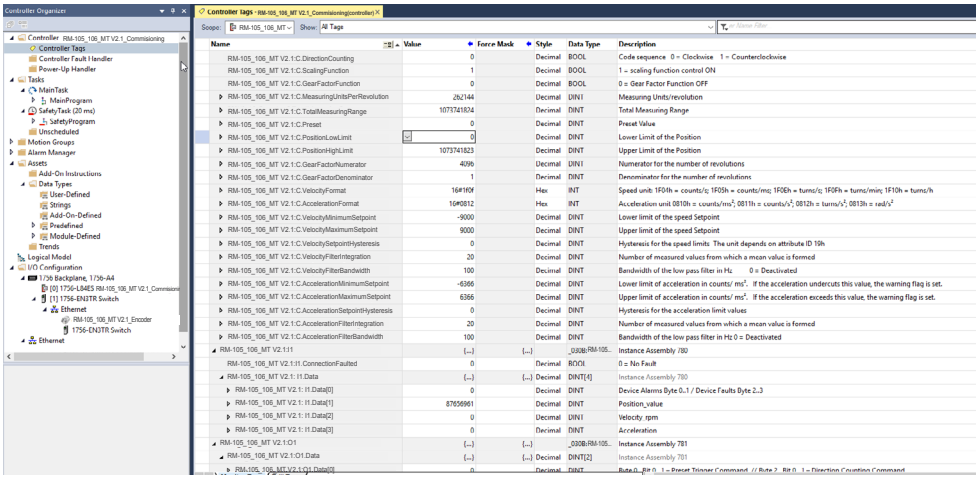
IMG-ID: 318144907

k) Select data length DINT.



IMG-ID: 318146827

⇨ You can now change the configuration values of the encoder under “Controller Tags / RM-105_106_MT V2.1:C.“.



IMG-ID: 318148747

⇨ The integration of the encoder in your Logix Designer project is now completed.
The description texts of the configuration values that can be seen in the screenshots have been input manually by the user.

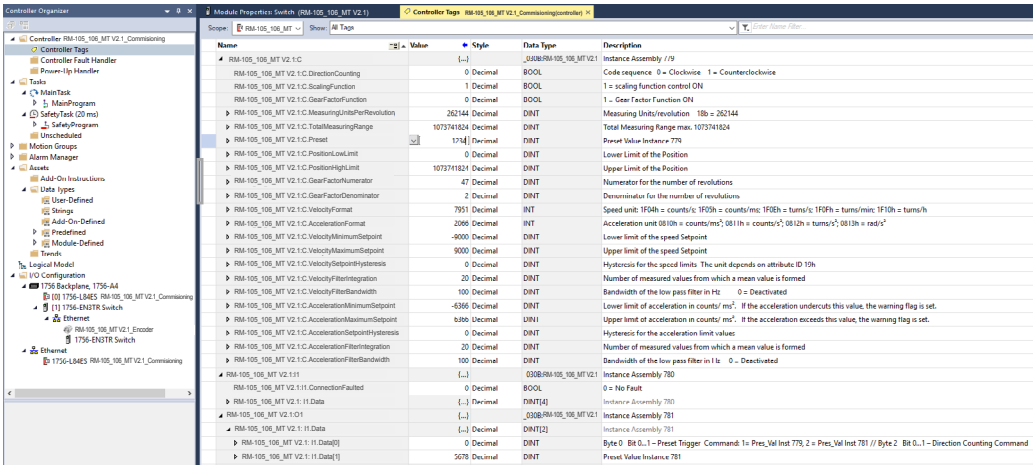
5.2.2.2 Setting the Preset

In the standard factory configuration, attribute 12 (“Direction Counting”) has the value 0 (“Clockwise”).
In this case, the position value increases for clockwise shaft rotation (looking at the shaft from the flange side).
If attribute 12 has the value 1 (“Counterclockwise”), the counting direction is reversed. The position value then decreases accordingly for clockwise shaft rotation.
The following alternative possibilities are available to configure the preset value and the direction of rotation.

Setting the Preset Value Using the Configuration Assembly

For this variant, the PLC transmits the desired preset value once when establishing the connection from the PLC to the encoder via Configuration assembly No. 779.

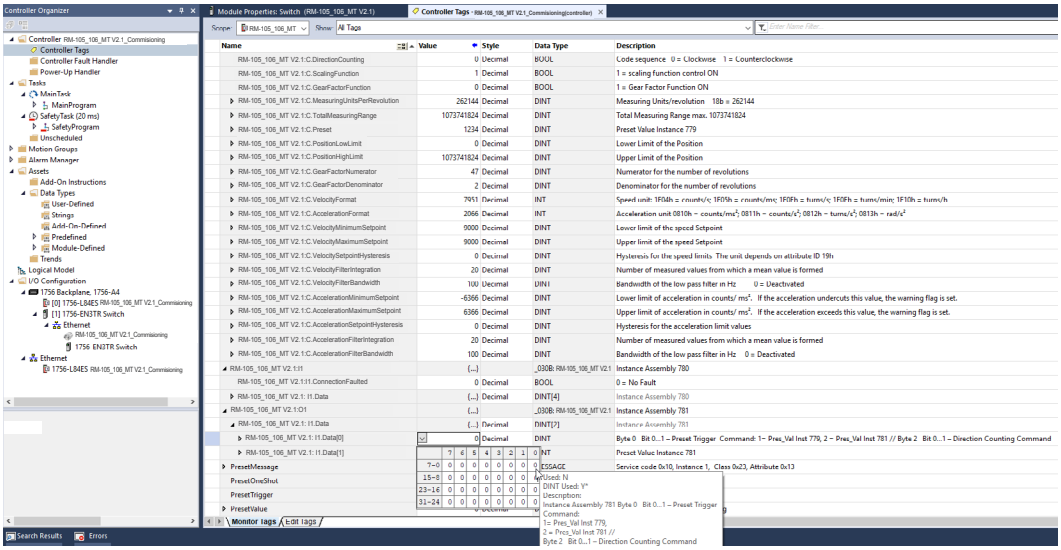
a) For this purpose, input the desired preset value in bytes 12-15 of Configuration assembly No. 779 before establishing the connection between the PLC and the encoder.



IMG-ID: 318308747

b) Then let the PLC establish the connection to the encoder.

c) Set the “Preset Trigger Command“ bits in byte 0 of Output assembly No. 781 first to 0.



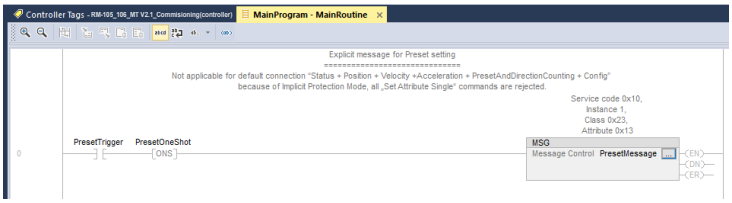
IMG-ID: 318310667

d) Then set the “Preset Trigger Command“ bits to 1 (designated in the EDS file as “SetPresetValueFromConfigurationAssembly”).

⇨ Modifying the value triggers the setting of the preset value. The “Preset Trigger Command“ bits can then be set to 0 again.

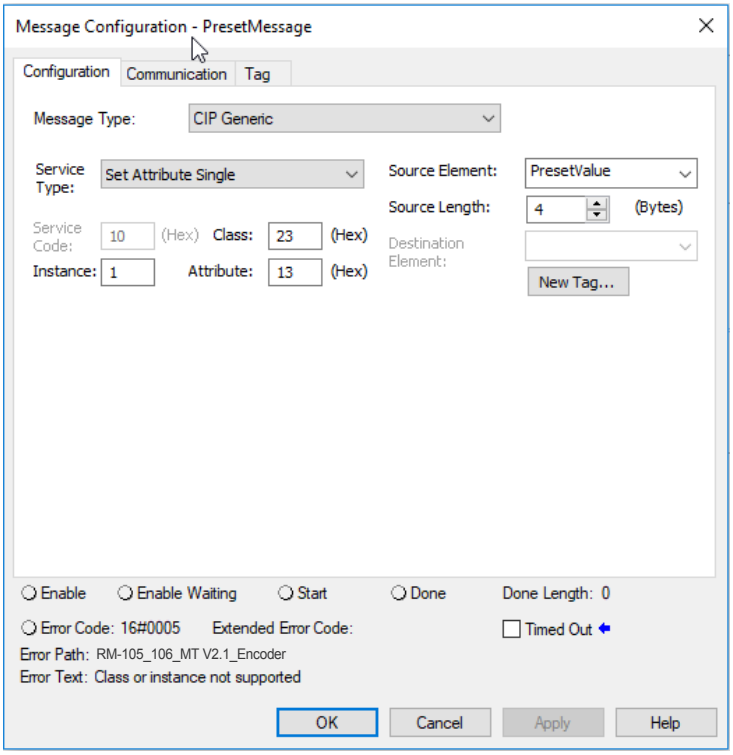
Setting the Preset Value Using Explicit Messaging

To set the preset by explicit messaging, appropriately insert an MSG command in connection with an ONS command in your PLC program (as described in the following illustrations).



IMG-ID: 319207307

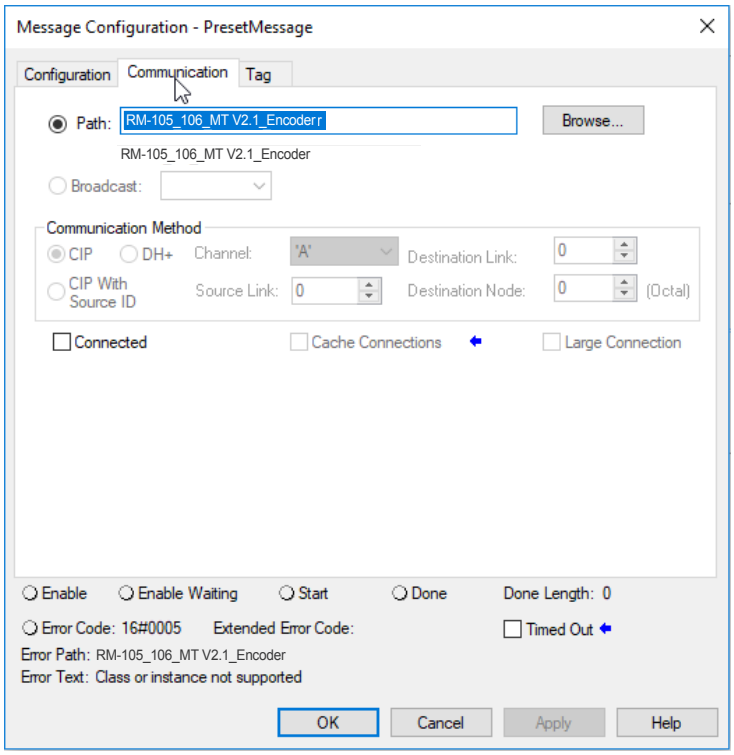
a) Press the button with the three points to open the configuration dialog of the MSG block.



IMG-ID: 319209227

Carry out the following settings in tab Configuration:

b) Service Type: Set Attribute
c) Instance: 1 (since only one device is connected to the controller)
d) Class: 23 (Hex) (Position Sensor Object)
e) Attribute: 13 (Hex) (Preset Value)
f) Source Element: PresetValue
g) Source Length: 4



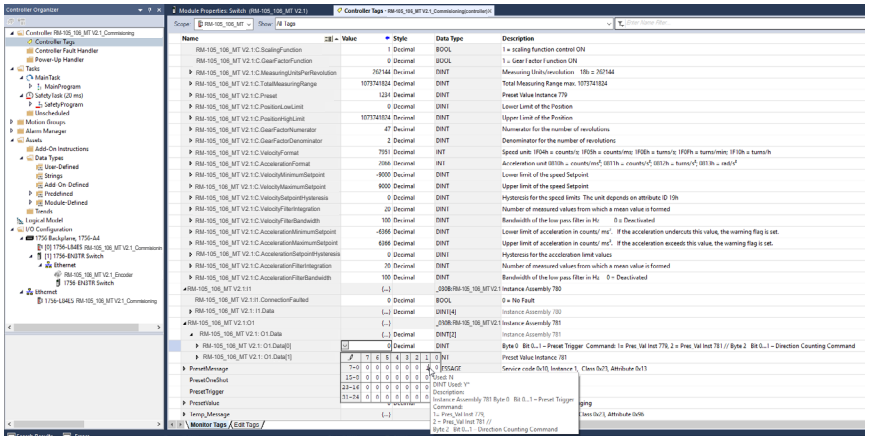
IMG-ID: 319211147

Carry out the following settings in tab Configuration:

h) Click on button Browse beside field Path to select the connected encoder.

Setting the Preset Value Using the Output Assembly

To set the preset value with Output assembly No. 781, select the connection called “Status + Position + Velocity + Acceleration + PresetAndDirectionCounting + Config” in the “Module Definition” dialog of Logix Designer when integrating the encoder.



IMG-ID: 318312587

For this variant, the PLC transmits the desired preset value via Configuration assembly No. 781 when the connection from the PLC to the encoder is already established.

a) Set the “Preset Trigger Command“ bits in byte 0 of Output assembly No. 781 first to 0.

b) Then let the PLC establish the connection to the encoder.

c) Input the desired preset value in bytes 4-7 of Output assembly No. 781.

d) Then set the “Preset Trigger Command“ bits to 2 (designated in the EDS file as “SetPresetValueFromOutputAssembly”).

⇨ Modifying the value triggers the setting of the preset value. The “Preset Trigger Command“ bits must then be set to 0 again.

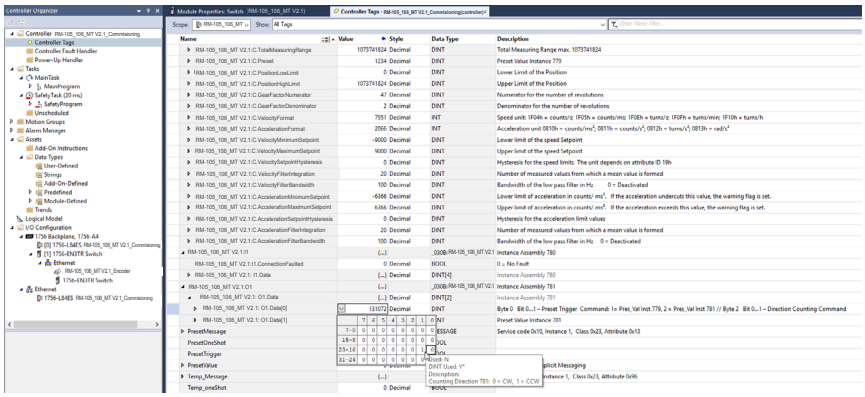
5.2.2.3 Setting the Direction of Rotation

Standard factory setting

In the standard factory configuration, attribute 12 (“Direction Counting”) has the value 0 (“Clockwise”).
In this case, the position value increases for clockwise shaft rotation (looking at the shaft from the flange side).
If attribute 12 has the value 1 (“Counterclockwise”), the counting direction is reversed. The position value then decreases accordingly for clockwise shaft rotation.
The following alternative possibilities are available to configure the preset value and the direction of rotation.

Setting the Direction of Rotation Using the Output Assembly

To set the direction of rotation with Output assembly No. 781, select the connection called “Status + Position + Velocity + Acceleration + PresetAndDirectionCounting + Config” in the “Module Definition” dialog of Logix Designer when integrating the encoder.



IMG-ID: 318314507

For this variant, the PLC transmits the desired direction of rotation setting via Output assembly No. 781 when the connection from the PLC to the encoder is already established.

a) Set the “Direction Counting Trigger“ bits in byte 2 of Output assembly No. 781 first to 0.

b) Then let the PLC establish the connection to the encoder.

⇨ Set the “Direction Counting Trigger“ bits to value 1 to set the direction of rotation to “Clockwise” (CW) (designated as “SetDirectionToCW” in the EDS file).

⇨ Set the “Direction Counting Trigger“ bits to value 2 to set the direction of rotation to “Counterclockwise” (CCW) (designated as “SetDirectionToCCW” in the EDS file).

⇨ Changing the value of the “Direction Counting Trigger“ bits leads to the change of the direction of rotation. The “Direction Counting Trigger“ bits can then be set to 0 again.

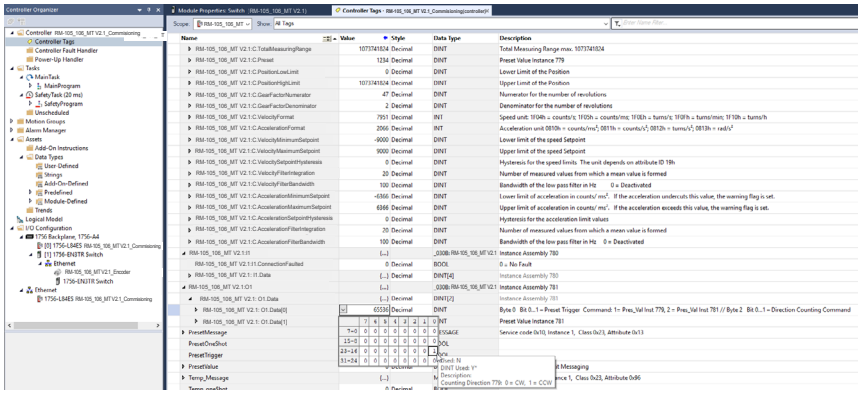
Setting the Direction of Rotation Using Explicit Messaging

NOTICE	**The Implicit Protection mode prevents attribute changes via explicit messaging Write Access.** Note that the encoder switches to Implicit Protection mode when establishing the communication “Status + Position + Velocity+ Acceleration + PresetAndDirectionCounting + Config” between the PLC and the encoder (see chapter Implicit Protection Mode and Explicit Protection Mode [41]) and thus rejects all “Set Attribute Single“ accesses.

The direction of rotation can be set with a “Set Attribute Single“ access to Position Sensor object attribute 12. The encoder changes the direction of rotation as soon as the “Set Attribute Single” access is completed.

Setting the Direction of Rotation Using the Configuration Assembly

To set the direction of rotation with Configuration assembly No. 779, select the connection called “Status + Position + Velocity + Acceleration + PresetAndDirectionCounting + Config” in the “Module Definition” dialog of Logix Designer when integrating the encoder.



IMG-ID: 318316427

For this variant, the desired direction of rotation is transmitted when establishing the connection from the PLC to the encoder via Configuration Assembly No. 779.

a) Enter the direction of rotation in bit 0 of byte 0 of Configuration Assembly No. 779 (designated in the EDS File as “DirectionCounting”).

Meaning:
Value 0 = “Clockwise” (CW)
Value 1 = “Counterclockwise” (CCW)

5.3 Protocol Features CIP

The data (configuration-/parameterizing data, measured values, output data) of the EtherNet/IP encoder are organized in parameters (more precisely, in the attributes of the Position Sensor object with attribute numbers and attribute names).
Every attribute has a data type with a different length, e.g. WORD or DINT, the EDS file describes the attributes.
These attributes are summarized in a meaningful way for the assemblies defined in the encoder. The EDS file also describes these assemblies.
Some connections are assigned to these assemblies (predefined and designated in the EDS file). The user can select connections in Logix Designer for data transfer from and to the encoder.
Logix Designer saves all data (configuration, measured values, output data) on the basis of tags in the memory of the PLC.
Encoder attributes ---> Encoder Assemblies ---> Encoder connections ---> Data in the tags of Logix Designer.

5.4 Configuration Parameters Description

5.4.1 EtherNet/IP Services of the Position Sensor Object

The encoder supports the following services for the Position Sensor object (class code: 0x23 = 35):

Service code	Service name	Implemented for class (instance = 0)	Implemented for instance = 1	Description of the service
0x05	Reset	Yes	No	Resets all parameter values to the factory setting and saves them in the non-volatile memory. Carries out a reset of the encoder. Reset Service Parameter Byte = 0: emulates as closely as possible the switch-off and switch-on cycle. Reset Service Parameter Byte = 1: resets the encoder as closely as possible to the factory configuration and then emulates as closely as possible the switch-off and switch-on cycle. Resets the IP configuration and the encoder parameters to the factory setting. After this operation, it may be necessary to set a preset value, see chapter Setting the Preset [23].
0x0E	Get Attribute Single	Yes	Yes	Returns the content of the attribute.
0x10	Set Attribute Single	Yes	Yes	Modifies the value of the attribute.

5.4.2 Configuration Assemblies

The meaning of the attribute number can be found in chapter “Class Attributes EtherNet / CIP Position Sensor Object”.
The encoder supports the following assembly instance for the transfer of the configuration:

Assembly instance no.	Byte	Designation	Attribute no.
779	0	Configuration Parameter LSB Bit 0 – Direction Counting Bit 1 – Scaling Function Bit 2 – Gear Factor Bit 3…7 – reserved, always 0	12, 14, 100
	1	reserved, always 0	-
	2	reserved, always 0	-
	3	reserved, always 0	-
	4	Measuring Units Per Revolution LSB	16
	5	Measuring Units Per Revolution	
	6	Measuring Units Per Revolution	
	7	Measuring Units Per Revolution MSB	
	8	Total Measuring Range LSB	17
	9	Total Measuring Range	
	10	Total Measuring Range	
	11	Total Measuring Range MSB	
	12	Preset LSB	19
	13	Preset	
	14	Preset	
	15	Preset MSB	
	16	Position Low Limit LSB	22
	17	Position Low Limit	
	18	Position Low Limit	
	19	Position Low Limit MSB	
	20	Position High Limit LSB	23
	21	Position High Limit	
	22	Position High Limit	
	23	Position High Limit MSB	
	24	Gear Factor, Numerator LSB	101
	25	Gear Factor, Numerator	
	26	Gear Factor, Numerator	
	27	Gear Factor, Numerator MSB	
	28	Gear Factor, Denominator LSB	102
	29	Gear Factor, Denominator	
	30	Gear Factor, Denominator	
	31	Gear Factor, Denominator MSB	
	32	Velocity Unit LSB	25
	33	Velocity MSB	
	34	Acceleration Unit LSB	30
	35	Acceleration Unit MSB	
	36	Velocity Minimum Setpoint LSB	27
	37	Velocity Minimum Setpoint	
	38	Velocity Minimum Setpoint	
	39	Velocity Minimum Setpoint MSB	

Assembly instance no.	Byte	Designation	Attribute no.
	40	Velocity Maximum Setpoint LSB	28
	41	Velocity Maximum Setpoint	
	42	Velocity Maximum Setpoint	
	43	Velocity Maximum Setpoint MSB	
	44	Velocity Setpoint Hysteresis LSB	114
	45	Velocity Setpoint Hysteresis	
	46	Velocity Setpoint Hysteresis	
	47	Velocity Setpoint Hysteresis MSB	
	48	Velocity Filter Integration LSB	110
	49	Velocity Filter Integration	
	50	Velocity Filter Integration	
	51	Velocity Filter Integration MSB	
	52	Velocity Filter Bandwidth LSB	111
	53	Velocity Filter Bandwidth	
	54	Velocity Filter Bandwidth	
	55	Velocity Filter Bandwidth MSB	
	56	Acceleration Minimum Setpoint LSB	32
	57	Acceleration Minimum Setpoint	
	58	Acceleration Minimum Setpoint	
	59	Acceleration Minimum Setpoint MSB	
	60	Acceleration Maximum Setpoint LSB	33
	61	Acceleration Maximum Setpoint	
	62	Acceleration Maximum Setpoint	
	63	Acceleration Maximum Setpoint MSB	
	64	Acceleration Setpoint Hysteresis LSB	115
	65	Acceleration Setpoint Hysteresis	
	66	Acceleration Setpoint Hysteresis	
	67	Acceleration Setpoint Hysteresis MSB	
	68	Acceleration Filter Integration LSB	112
	69	Acceleration Filter Integration	
	70	Acceleration Filter Integration	
	71	Acceleration Filter Integration MSB	
	72	Acceleration Filter Bandwidth LSB	113
	73	Acceleration Filter Bandwidth	
	74	Acceleration Filter Bandwidth	
	75	Acceleration Filter Bandwidth MSB	

5.4.3 EtherNet/IP Attributes

5.4.3.1 Standardized Attributes

The encoder supports the following attributes of the Position Sensor object (class: 0x23, instance: 1) for the configuration and for the transmission of process data:
A subset of the attributes is contained in the assemblies and can be read or written cyclically through an I/O “implicit message” connection. Other less frequently used attributes can only be read or written through “explicit message”.

Attribute ID	Access	Name	Description	Data type	Min…Max value (default)	Remark
3	Get	Position Value Unsigned	Current position value	UDINT	-	
11	Get	Position Sensor Type	0x0001 = Singleturn 0x0002 = Multiturn	UINT	-	

Attribute ID	Access	Name	Description	Data type	Min…Max value (default)	Remark
12	Set	Direction Counting	Code sequence 0 = clockwise 1 = counterclockwise	BOOL	(0)	
14	Set	Scaling Function Control	Scaling 0 = Off 1 = On	BOOL	(1)	When On, USF is on. When Off, USF is disabled, raw position output (18 bits ST / 12 bitsMT).
15	Set	Position Format	Position measurement format 0x1001 = counts	ENGUNIT	0x1001 … 0x1001	Always counts.
16	Set	Measuring Units Per Revolution	Number of measuring units per revolution (MUR)	UDINT	0x00000001 … 0x00080000 (0x00040000)	
17	Set	Total Measuring Range	Number of measuring units over the whole measuring range (TMR)	UDINT	0x00000004 … 0x40000000 (0x40000000)	Number of distinguishable revolutions (NDR) = TMR / attribute16. The Logix Designer EDS handling limits the data type to DINT at the maximum.
18	Set	Position Measuring Increment	Minimum resolution (always 1)	UDINT	0x00000001 … 0x00000001	
19	Set	Preset Value	Preset value	DINT	0x00000000 attribute 17 - 1 (0x00000000)	
21	Get	Position State Register	Indicates whether the range defined by attributes 22 and 23 is undershot / exceeded. Bit 0 = outside of the range Bit 1 = above the range Bit 2 = below the range Bit 3 … 7 = reserved	Byte	(0x00)	
22	Set	Position Low Limit	Lower limit value for the position	DINT	0x00000000 Attribut 17 - 1 (0x00000000)	Attribute 22≤ attribute 23 Attribute 23 must be ≤ attribute 17(TMR), otherwise configuration error.
23	Set	Position High Limit	Upper limit value for the position	DINT	0x00000000 attribute 17 - 1 (0x3FFFFFFF)	
24	Get	Velocity Value	Current velocity The format is defined by attributes25 and 26.	DINT	-	

Attribute ID	Access	Name	Description	Data type	Min…Max value (default)	Remark
25	Set	Velocity Format	Velocity unit 0x1F04 = counts/s 0x1F05 = counts/ms 0x1F0E = revolutions/s 0x1F0F = revolutions/min 0x1F10 = revolutions/h	ENGUNIT	(0x1F04)	If the unit counts/s^2 or counts/ms^2 is selected, the measured value in the attribute always relates to a fixed number of 52,4288 counts per revolution (19 bits), independently of the Scaling Function Control or Gear Factor settings.
26	Set	Velocity Resolution	Minimum resolution of the velocity measurement.	UDINT	0x00000001 … 0x00000001	
27	Set	Minimum Velocity Setpoint	Lower limit for the velocity in counts/s. If the velocity becomes lower than this value, the warning flag (attribute 47) is set.	DINT	-78,643,200 … 78,643,200 (-39,321,600)	(attribute 27 + attribute 114) ≤ attribute 28.
28	Set	Maximum Velocity Setpoint	Upper limit for the velocity in counts/s. If the velocity exceeds this value, the warning flag (attribute 47) is set.	DINT	-78,643,200 … 78,643,200 (39,321,600)	
29	Get	Acceleration Value	Current acceleration The format is defined by attributes 30 and 31.	DINT	-	
30	Set	Acceleration Format	Acceleration unit 0x0810 = counts/ms^2 0x0811 = counts/s^2 0x0812 = revolutions/s^2 0x1503 = rad/s^2	ENGUNIT	(0x0811)	If the unit counts/s^2 or counts/ms^2 is selected, the measured value in the attribute always relates to a fixed number of 52,4288 counts per revolution (19 bits), independently of the Scaling Function Control or Gear Factor settings.
31	Set	Acceleration Resolution	Minimum resolution of theacceleration measurement.	UDINT	0x00000001 … 0x00000001	
32	Set	Minimum Acceleration Setpoint	Lower limit for the acceleration in counts/s^2. If the acceleration becomes lower than this value, the warning flag (attribute 47) is set.	DINT	-2,147,483,647… 2,147,483,647 (-1,668,860,536)	(attribute 32 + attribute 115) ≤ attribute 33.

Attribute ID	Access	Name	Description	Data type	Min…Max value (default)	Remark
33	Set	Maximum Acceleration Setpoint	Upper limit for the acceleration in counts/ s^2. If the acceleration exceeds this value, the warning flag (attribute 47) is set.	DINT	-2,147,483,647… 2,147,483,647 (1,668,860,536)	
44	Get	Alarms	Bit field with flags for the alarms (see chapter Position SensorAlarms [39]).	WORD	-	-
45	Get	Supported Alarms	Bit field of the supported alarms.	WORD	-	
46	Get	Alarm Flag	0 = No alarm 1 = Alarm active.	BOOL	-	Logical OR of all alarm bits.
47	Get	Warnings	Bit field with flags for the warnings (see chapter Position Sensor Warnings [39]).	WORD	-	
48	Get	Supported Warnings	Bit field of the supported warnings.	WORD	-	
49	Get	Warning Flag	0 = No warnings 1 = Warning active.	BOOL	-	Logical OR of all warning bits.
51	Get	Offset Value	Offset value calculated when initializing the preset function.	DINT	-	

5.4.3.2 Manufacturer-Specific Attributes

Attribute ID	Access	Name	Description	Data type	Min…Max value (default)	Remark
100	Set	Gear Factor	Enables the gear factor function 0 = Gear factor function off 1 = Gear factor function on.	BOOL	(0)	Overwrites the setting of the scaling function when set to 1.
101	Set	Gear Factor, Numerator	Count for the gear factor	UDINT	1 … 16.777.216 (4.096)	
102	Set	Gear Factor, Denominator	Denominator for the gear factor	UDINT	1 … 131.072 (1)	
110	Set	Velocity	Number of measured values used to form the average speed value.	UDINT	0 … 128 (1)	Filter for the moving average.
111	Set	Velocity Filter Bandwitdth	Bandwidth of the low-passfilter in Hz.0 = disabled	UDINT	0 … 500 (100)	First-order low-pass filter.

Attribute ID	Access	Name	Description	Data type	Min…Max value (default)	Remark
112	Set	Acceleration Filter Integration Time	Number of measured valuesused to form the average acceleration value.	UDINT	0 … 128 (1)	Filter for the moving average.
113	Set	Acceleration Filter Bandwidth	Bandwidth of the low-pass-filter in Hz. 0 = disabled	UDINT	0 … 500 (100)	First-order low-pass filter.
114	Set	Velocity Setpoint Hysteresis	Hysteresis for the speed limits (attributes 27 and 28).	UDINT	0 … 78.643.200 (0)	The unit depends on attribute 25.
115	Set	Acceleration Setpoint Hysteresis	Hysteresis for the acceleration limits (attributes 32 and 33).	UDINT	0 … 2.147.483.647 (0)	The unit depends on attribute 30.
130	Get	Device Alarms	Bit field of the device alarms.	WORD	-	See chapter Device Alarms [40].
131	Get	Device Faults	Bit field of the device faults.	WORD	-	See chapter Device Faults [40].
150	Get	Temperature Value	Current temperature in °C with ±5 °C accuracy.	INT	-	
151	Get	Battery Voltage	Current battery voltage in mV.	UINT	-	
152	Get	Power Supply Voltage	Current power supply voltagein mV.	UINT	-	

5.4.3.3 Scaling Parameters

The encoder offers a choice between three options to calculate the position, which are described in the following sections.
The value range of the position values for all options described here is 0 to 1,073,741,823 (corresponds to 30 bits).

Position calculation without scaling function

The unscaled position calculation is active when attribute 14 (Scaling Function Control) = 0 and attribute 100 (Gear Factor) = 0.

Position Sensor object Attribute No.	Position Sensor object Attribute name	Attribute value used in the position calculation
12	Direction Counting Toggle	yes
16	MUR	no
17	TMR	no
19	Preset	yes
101	Numerator	no
102	Denominator	no

The encoder forms the position value as follows:

Bits 0–17	Bits 18-29
18 bits singleturn position	12 bits multiturn position

Description of the position calculation:

The position value increases by the amount of 262,144 units for the rotation of the shaft of 360 angle degrees in counting direction.
The position value decreases by the amount of 262,144 units for the rotation of the shaft of 360 angle degrees against the counting direction. When Direction Counting Toggle = 1 is set, the counting direction is reversed.
When exceeding the value 1,073,741,823, the next value is 0, and when undershooting the value 0, the next value is 1,073,741,823 (1,073,741,823 is the maximum value representable with 30 bits).

Position Calculation With Scaling Function

The position calculation with scaling function is active when attribute 14 (Scaling Function Control) = 1 and attribute 100 (Gear Factor) = 0.

Position Sensor object Attribute No.	Position Sensor object Attribute name	Attribute value used in the position calculation
12	Direction Counting Toggle	yes
16	MUR	yes
17	TMR	yes
19	Preset	yes
101	Numerator	no
102	Denominator	no

Description of the position calculation:
The position value increases [or decreases, if attribute 12 = 1] by the amount of MUR units for a full revolution of the shaft in counting direction.
When exceeding the value TMR-1, the next value is 0, and when undershooting the value 0, the next value is TMR-1.

Position Calculation With Gear Factor

The position calculation with gear factor is active when attribute 100 (Gear Factor) = 1.
When attribute 100 (Gear Factor) = 1, the value of attribute 14 (Scaling Function) is ignored.
When attribute 100 is not 0, it thus overrides attribute 14.
The following restrictions apply to the configuration values and to the configuration process:

- When the gear factor function is enabled (thus attribute 100 = 1), the following condition must be met:
TMR (Attr. 17) ≤ (numerator (attr. 101) / denominator (attr. 102)) * 524288 (phys. total resolution)

Position Sensor object Attribute No.	Position Sensor object Attribute name	Attribute value used in the position calculation
12	Direction Counting Toggle	yes
16	MUR	no
17	TMR	yes
19	Preset	yes
101	Numerator	yes
102	Denominator	yes

Description of the position calculation:
The position value increases [or decreases, if attribute 12 = 1] by the amount of TMR units when the axis is rotated by the fraction numerator / denominator of a full revolution in the counting direction.
When undershooting the value 0, the next value is TMR -1 and when exceeding the value TMR -1, the next value is 0.

5.5 Process Data Description

5.5.1 Process Data Description

Process data can be read either via the “Position Sensor object” using explicit message or via the Assembly object of the encoder.
The assemblies contain selected (fixed) process data. Part of the process data is only contained in the assemblies, other process data is only contained in the “Position Sensor object”.
The following assembly instances are implemented. They contain the process data for cyclic data transmission according to the tables below.
The meaning of the attribute numbers can be found in chapter EtherNet/IP Attributes [31].

5.5.1.1 Supported connections

The sensor supports the following connections, which are described in the EDS File :

Connection name	Configuration assembly no.	Producing assembly no.	Consuming assembly no.
Status + Position + Velocity + Acceleration + PresetAndDirectionCounting + Config	779	780	781
Position	not used	1	not used
Position + Status	not used	2	not used
Position + Velocity	not used	3	not used
Status + Position + Velocity + Acceleration	not used	780	not used

5.5.1.2 Input Assemblies

Assembly instance no.	Byte	Designation	Attribute no.
1	0	Position LSB	3
	1	Position	
	2	Position	
	3	Position MSB	
2	0	Position LSB	3
	1	Position	
	2	Position	
	3	Position MSB	
	4	Warning and Alarm Flags	49 / 46
3	0	Position LSB	3
	1	Position	
	2	Position	
	3	Position MSB	
	4	Velocity LSB	24
	5	Velocity	
	6	Velocity	
	7	Velocity MSB	
780	0	Device Alarms LSB	130
	1	Device Alarms MSB	
	2	Device Faults LSB	131
	3	Device Faults MSB	
	4	Position LSB	3
	5	Position	
	6	Position	
	7	Position MSB	
	8	Velocity LSB	24
	9	Velocity	
	10	Velocity	
	11	Velocity MSB	
	12	Acceleration LSB	29
	13	Acceleration	
	14	Acceleration	
	15	Acceleration MSB	

5.5.1.3 Output Assemblies

Assembly instance no.	Byte	Designation	Attribute no.
781	0	Preset Trigger Bit 0…1 – Preset Trigger Command Bit 2…7 – reserved, always 0	-
	1	reserved, always 0	-
	2	Direction Counting Trigger Bit 0…1 – Direction Counting Command Bit 2…7 – reserved, always 0	-
	3	reserved, always 0	-
	4	Preset LSB	-
	5	Preset	-
	6	Preset	-
	7	Preset MSB	-

5.5.1.4 Value Table of the Preset Trigger Command Bits

Value	Description
0	Initial value, must be transmitted at least one at the beginning.
1	Trigger: Carry out the preset with the value written previously in bytes no. 12-15 of Configuration assembly no. 779.
2	Trigger: Carry out the preset with the value written previously in bytes no. 4-7 of Output assembly no. 781.
3	reserved

5.5.1.5 Value Table of the Direction Counting Command Bits

Value	Description
0	Initial value, must be transmitted at least one at the beginning.
1	Trigger: Set the direction of rotation to CW (Clockwise). The encoder automatically sets attribute 12 ("Direction Counting") to the value 0 ("Clockwise").
2	Trigger: Set the direction of rotation to CCW (Counterclockwise). The encoder automatically sets attribute 12 ("Direction Counting") to the value 1 ("Counterclockwise").
3	reserved

5.5.2 Position Sensor Warnings

Bit	Description of the bits of Position Sensor attribute 47
0	The maximum velocity has been exceeded.
4	Battery charge low.
6	The speed is lower than the lower limit value configured with attribute 27.
7	The speed exceeds the upper limit value configured with attribute 28.
8	The acceleration is lower than the lower limit value configured with attribute 32.
9	The acceleration exceeds the upper limit value configured with attribute 33.
10	The position is outside of the range configured with attributes 22 and 23.

5.5.3 Position Sensor Alarms

Bit	Description of the bits of Position Sensor attribute 44
0	Position error.
1	Diagnostic fault / Error during the self-test.

5.5.4 Device Alarms

Description of the bits of Position Sensor attribute 130.
These bits indicate minor faults.

Bit	Description	Is reset when corrected	Notice
0	The speed is lower than the lower limit value configured with attribute 27.	Yes	
1	The speed exceeds the upper limit value configured with attribute 28.	Yes	
2	The acceleration is lower than the lower limit value configured with attribute 32.	Yes	
3	The acceleration exceeds the upper limit value configured with attribute 33.	Yes	
4	The position is below the range configured with attribute 22.	Yes	
5	The position is above the range configured with attribute 23.	Yes	ENC LED flashes red.
8	Battery charge level low (≤ 3.0 V DC).	No	Typical voltage 3.6 V DC.
9	Device status conflict (rotary switches)	Yes	e.g. position of rotary switches 000 (DHCP) vs. manually assigned IP address via Engineering Tool.

5.5.5 Device Faults

Description of the bits of Position Sensor attribute 131.
These bits indicate major faults.

Bit	Description	Is reset when corrected	Notice
0	Device temperature outside of the permissible range.	Yes	< -40°C or > 100°C [< -40°F or > 212°F]
1	Maximum velocity exceeded.	Yes	> 9000 min^{-1} and hyst. -1 %
2	Supply voltage outside of the allowable range.	Yes	< 9 V DC or > 31 V DC
8	Battery charge level critical.	No	≤ 2.7 V DC Replace the device.
9	Sensor error.	No	Replace the device.
10	Memory error.	No	Replace the device.
11	General internal fault.	No	Replace the device.

5.6 Implicit Protection Mode and Explicit Protection Mode

Implicit Protection mode and Explicit Protection mode are safety enhancements, which are activated automatically by the encoder when establishing certain connections or which can be activated by the user by means of rotary switches.

Automatic Activation and Deactivation of the Implicit Protection Mode

The Implicit Protection mode is activated automatically on the device as soon as a CIP Class 1 [Cyclic I/O] connection is established with the device. This mode is deactivated on the device as soon as the connection is ended.

Protective Functions in Implicit Protection Mode and Explicit Protection Mode

Both in Implicit Protection mode and in Explicit Protection mode, the device rejects the following configuration changes:

- Changes of the Ethernet configuration settings, e.g. the port speed.
- Changes of IP settings such as e.g. IP address, mask and DHCP mode.
- Device firmware update.
- Disabling or repeated enabling of external product ports.
- Execution of remote resets (resets triggered via the network).

Implicit Protection Mode: Enhanced Protection When the Exclusive Owner Connection is Active.

When the Exclusive Owner connection named “Status + Position + Velocity + Acceleration + PresetAndDirectionCounting + Config” (read / write connection) defined in the EDS File is established, the device rejects, in addition to the protective functions mentioned above, also the following:

- Changing any attribute of the Position Sensor object.

This feature protects the device from simultaneous configuration changes in two different ways (via Output assembly No. 781 and via write access on the attributes of the Position Sensor object).

Overview Table of the Protective Functions of the Protection Modes

The following table gives a detailed description of the protective functions:
Protection mode (attribute 19 in the Identity object)

<table>
<tr><th></th><th colspan="2">Implicit
(bit 0 = 1)</th><th>Explicit
(bit 3 = 1)</th></tr>
<tr><td>Switching on:</td><td colspan="2">An “Implicit Message“ I/O connection is active between the PLC and the sensor</td><td rowspan="2">Rotary switches: 800</td></tr>
<tr><td>Other "Implicit Message" I/O connection active</td><td>Connection "Status + Position +Velocity + Acceleration + PresetAndDirectionCounting + Config" active</td></tr>
<tr><td>Switching off:</td><td colspan="2">End the connection</td><td>Rotary switches: 300 / 555</td></tr>
<tr><td>Functions:</td><td colspan="3"></td></tr>
<tr><td>Reset</td><td colspan="2">no</td><td>no</td></tr>
<tr><td>Change Ethernet settings</td><td colspan="2">no</td><td>no</td></tr>
<tr><td>FW update</td><td colspan="2">yes</td><td>yes</td></tr>
<tr><td>Read attributes</td><td colspan="2">yes</td><td>yes</td></tr>
<tr><td>Write attributes</td><td>yes</td><td>no</td><td>no</td></tr>
</table>

Activating the Explicit Protection Mode

Proceed as follows to activate the Explicit Protection mode:

a) Switch the power supply of the encoder off.

b) Set the rotary switches to position 800.

c) Switch the power supply on and wait until the module status display flashes red, the network status display goes out and the status displays go out.

d) Switch the power supply off.

e) Set the rotary switches for normal operation.

f) Switch the power supply on.

⇨ The device is now in Explicit Protection mode.

Deactivating the Explicit Protection Mode

Proceed as follows to deactivate the Explicit Protection mode:

a) Switch the power supply of the encoder off.

b) Set the rotary switches to position 300.

c) Switch the power supply on and wait until the module status display flashes red, the network status display goes out and the status displays go out.

d) Switch the power supply off.

e) Set the rotary switches for normal operation.

f) Switch the power supply on.

⇨ The device is no longer in Explicit Protection mode.

5.7 Features Description

5.7.1 Address Conflict Detection (ACD) Feature

As a standard, the “ACD” feature (Address Conflict Detection) of EtherNet/IP is activated. If this function is not required, it can be deactivated. Object 0xF5 (TCP/IP) instance 1, attribute 11 allows reading information about address conflicts. To switch ACD off, write the value 0 in object 0xF5 (TCP/IP), instance 1, attribute 10. This can slightly accelerate the start-up of the device. Details can be found in the CIP / EtherNet/IP specification, see also chapter Overview of the Connectors and LEDs [14].

5.7.2 Device Level Ring (DLR)-Feature

The “Device Level Ring“ feature can be switched on when setting up a device ring for protection against breakage of a single EtherNet network cable, see chapter Network topologies [12]. All devices connected to the ring must imperatively have two EtherNet ports.

a) In window “Properties” of the PLC or in the network interface of Logix Designer, open tab “Network”.

b) Set the PLC e.g. as ring supervisor and set the network topology to “Ring”.

⇨ The encoder now supports a ring topology.

6 Annex

6.1 Scaling

The usability of the measured values output by the measuring system essentially depends on their scaling. Scaling the measured values presupposes that mathematical operations must be carried out, which, depending on the device type, are integrally or only partly supported. There are basically 3 different scaling types:

1. Binary scaling = Scaling function
2. Non-binary scaling = Universal Scaling function
3. Scaling by means of the gear factor = Gear Factor

6.2 Subnet mask in conjunction with the IP address

Each IP address can be subdivided into a network address and a host address. The subnet mask determines at which place this separation takes place. This basically determines the maximum possible number of host addresses and network addresses. The host addresses can be compared with the participants in an Ethernet network.
There are basically 3 address classes A, B and C.

Class A:

16,777,214 hosts per network
Subnet mask: 255.0.0.0
Maximum address range network address: 127.255.255.255

IP address 1st octet	IP address 2nd octet	IP address 3rd octet	IP address 3rd octet
1.	0.	0.	0.

Class B:

65,534 hosts per network
Subnet mask: 255.255.0.0
Maximum address range network address: 191.255.255.255

IP address 1st octet	IP address 2nd octet	IP address 3rd octet	IP address 4th octet
128.	**1.**	0.	0.

Class C:

254 hosts per network
Subnet mask: 255.255.255.0
Maximum address range network address: 223.255.255.255

IP address 1st octet	IP address 2nd octet	IP address 3rd octet	IP address 4th octet
192.	**0.**	**1.**	0.

The standard subnet mask is 255.255.255.0, thus allowing 254 network participants.

6.3 Decimal / Hexadecimal conversion table

Dec	Hex	Dec	Hex	Dec	Hex	Dec	Hex	Dec	Hex
0	*0x0*	51	*0x33*	102	*0x66*	153	*0x99*	204	*0xCC*
1	*0x1*	52	*0x34*	103	*0x67*	154	*0x9A*	205	*0xCD*
2	*0x2*	53	*0x35*	104	*0x68*	155	*0x9B*	206	*0xCE*
3	*0x3*	54	*0x36*	105	*0x69*	156	*0x9C*	207	*0xCF*
4	*0x4*	55	*0x37*	106	*0x6A*	157	*0x9D*	208	*0xD0*
5	*0x5*	56	*0x38*	107	*0x6B*	158	*0x9E*	209	*0xD1*
6	*0x6*	57	*0x39*	108	*0x6C*	159	*0x9F*	210	*0xD2*
7	*0x7*	58	*0x3A*	109	*0x6D*	160	*0xA0*	211	*0xD3*
8	*0x8*	59	*0x3B*	110	*0x6E*	161	*0xA1*	212	*0xD4*
9	*0x9*	60	*0x3C*	111	*0x6F*	162	*0xA2*	213	*0xD5*
10	*0xA*	61	*0x3D*	112	*0x70*	163	*0xA3*	214	*0xD6*
11	*0xB*	62	*0x3E*	113	*0x71*	164	*0xA4*	215	*0xD7*
12	*0xC*	63	*0x3F*	114	*0x72*	165	*0xA5*	216	*0xD8*
13	*0xD*	64	*0x40*	115	*0x73*	166	*0xA6*	217	*0xD9*
14	*0xE*	65	*0x41*	116	*0x74*	167	*0xA7*	218	*0xDA*
15	*0xF*	66	*0x42*	117	*0x75*	168	*0xA8*	219	*0xDB*
16	*0x10*	67	*0x43*	118	*0x76*	169	*0xA9*	220	*0xDC*
17	*0x11*	68	*0x44*	119	*0x77*	170	*0xAA*	221	*0xDD*
18	*0x12*	69	*0x45*	120	*0x78*	171	*0xAB*	222	*0xDE*
19	*0x13*	70	*0x46*	121	*0x79*	172	*0xAC*	223	*0xDF*
20	*0x14*	71	*0x47*	122	*0x7A*	173	*0xAD*	224	*0xE0*
21	*0x15*	72	*0x48*	123	*0x7B*	174	*0xAE*	225	*0xE1*
22	*0x16*	73	*0x49*	124	*0x7C*	175	*0xAF*	226	*0xE2*
23	*0x17*	74	*0x4A*	125	*0x7D*	176	*0xB0*	227	*0xE3*
24	*0x18*	75	*0x4B*	126	*0x7E*	177	*0xB1*	228	*0xE4*
25	*0x19*	76	*0x4C*	127	*0x7F*	178	*0xB2*	229	*0xE5*
26	*0x1A*	77	*0x4D*	128	*0x80*	179	*0xB3*	230	*0xE6*
27	*0x1B*	78	*0x4E*	129	*0x81*	180	*0xB4*	231	*0xE7*
28	*0x1C*	79	*0x4F*	130	*0x82*	181	*0xB5*	232	*0xE8*
29	*0x1D*	80	*0x50*	131	*0x83*	182	*0xB6*	233	*0xE9*
30	*0x1E*	81	*0x51*	132	*0x84*	183	*0xB7*	234	*0xEA*

Dec	Hex	Dec	Hex	Dec	Hex	Dec	Hex	Dec	Hex
31	*0x1F*	82	*0x52*	133	*0x85*	184	*0xB8*	235	*0xEB*
32	*0x20*	83	*0x53*	134	*0x86*	185	*0xB9*	236	*0xEC*
33	*0x21*	84	*0x54*	135	*0x87*	186	*0xBA*	237	*0xED*
34	*0x22*	85	*0x55*	136	*0x88*	187	*0xBB*	238	*0xEE*
35	*0x23*	86	*0x56*	137	*0x89*	188	*0xBC*	239	*0xEF*
36	*0x24*	87	*0x57*	138	*0x8A*	189	*0xBD*	240	*0xF0*
37	*0x25*	88	*0x58*	139	*0x8B*	190	*0xBE*	241	*0xF1*
38	*0x26*	89	*0x59*	140	*0x8C*	191	*0xBF*	242	*0xF2*
39	*0x27*	90	*0x5A*	141	*0x8D*	192	*0xC0*	243	*0xF3*
40	*0x28*	91	*0x5B*	142	*0x8E*	193	*0xC1*	244	*0xF4*
41	*0x29*	92	*0x5C*	143	*0x8F*	194	*0xC2*	245	*0xF5*
42	*0x2A*	93	*0x5D*	144	*0x90*	195	*0xC3*	246	*0xF6*
43	*0x2B*	94	*0x5E*	145	*0x91*	196	*0xC4*	247	*0xF7*
44	*0x2C*	95	*0x5F*	146	*0x92*	197	*0xC5*	248	*0xF8*
45	*0x2D*	96	*0x60*	147	*0x93*	198	*0xC6*	249	*0xF9*
46	*0x2E*	97	*0x61*	148	*0x94*	199	*0xC7*	250	*0xFA*
47	*0x2F*	98	*0x62*	149	*0x95*	200	*0xC8*	251	*0xFB*
48	*0x30*	99	*0x63*	150	*0x96*	201	*0xC9*	252	*0xFC*
49	*0x31*	100	*0x64*	151	*0x97*	202	*0xCA*	253	*0xFD*
50	*0x32*	101	*0x65*	152	*0x98*	203	*0xCB*	254	*0xFE*
								255	*0xFF*

6.4 Conversion table Data types

Data type	Figure type	Length in bits	Length in bytes
BOOL	Binary	1	-
BYTE	Binary	8	1
WORD	Binary	16	2
DWORD	Binary	32	4
LWORD	Binary	64	8
SINT	Integer	8	1
INT	Integer	16	2
DINT	Integer	32	4
UINT	Integer	32	4
LINT	Integer	64	8
REAL	Floating point number	32	4
LREAL	Floating point number	64	8

7 Contact

You want to get in touch with us:

Technical advice

Turck Inc.
3000 Campus Drive
USA-MN 55441 Minneapolis
Phone: (+ 1) (763) 553 7300
Fax: (+ 1) (763) 553 0708
Email: turckusa@turck.com
Website: www.turck.us

Repair service / RMA-Form

For warranty and/or repairs, please contact Turck, Inc.

Turck Inc.
3000 Campus Drive
USA-MN 55441 Minneapolis
Phone: (+ 1) (763) 553 7300
Fax: (+ 1) (763) 553 0708
Email: turckusa@turck.com
Website: www.turck.us

Glossary

ACD

Address Conflict Detection

ASCII

American Standard Code for Information Interchange. 7-bit coding

BOOL

Data type. A BOOL (or Boolean) represents a truth value that may be either true or false.

BOOTP

Bootstrap Protocol

CCW

counterclockwise. Related to the direction of rotation. The position value increases for counterclockwise shaft rotation (looking at the shaft from the flange side).

CIP

Common Industrial Protocol

CW

clockwise. Related to the direction of rotation. The position value increases for clockwise shaft rotation (looking at the shaft from the flange side).

Default

English for standard, generally used as default value. Factory-preset value of a changeable configuration value.

DHCP

Dynamic Host Configuration Protocol

DINT

Data type. An operand of the data type DINT (double integer) has a length of 32 bits and is made of two components: a sign and a numerical value in two's complement.

DLR

Device Level Ring

DWORD

Data type. A DWORD consists of two WORDs, each consisting of 2 bytes, each of them consisting of 8 bits.

EDS File

EDS (Electronic Data Sheet). An EDS file corresponding to the device is provided by the manufacturer. It contains accurate machine-readable information about the device and its communication. EDS files contain among others descriptions of the device (name, product code, manufacturer ID) and its communication. It contains the available objects, attributes, assemblies, parameters and connections with descriptions, precise definitions of the data types and data lengths. An EDS file greatly simplifies the integration of a device in a PLC system.

EMC

Electromagnetic compatibility

FRAM

Abbreviation: Ferroelectric Random Access Memory, non-volatile memory, in which the save and erase operations are carried out by changing the polarization in a ferroelectric layer.

INT

Data type. Integer. An integer is generally made of 16 bits.

LED

Light Emitting Diode. Semiconductor component that emits light.

LLDP

Link Layer Discovery Protocol. Protocol defining the network topology.

LSB

engl. Least Significant Bit

LWORD

Data type. Long WORD consisting of two DWORDs.

MSB

engl: Most Significant Bit

MSG command

MSG current path command (“Message”) as described in the Logix Designer manual.

MUR

Measuring Units per Revolution

ODVA

Open DeviceNet Vendor Association: the ODVA is an organization for the development of standards and a member association counting world leader companies in industrial automation among its members. The ODVA defines and publishes the documentation relating to the CIP and EtherNet/IP standards.

ONS command

ONS current path command (“One Shot”) as described in the Studio 5000 Logix Designer software manual.

PE

Abbreviation: Protective Earth, cable for safety protection against electric shocks (protective earth conductor).

PLC

Programmable Logic Controller

QoS

Quality of Service

RMA

Return Material Authorization, authorization to return material, e.g. in the case of complaints.

SINT

Data type. Short integer. An operand of the data type SINT (short INT) has a length of 8 bits and is made of two components: a sign and a numerical value.

TCP/IP

TCP/IP means “Transmission Control Protocol/Internet Protocol” and allows devices connected to the Internet to communicate with each other via networks

TMR

Total Measuring Range

UDP

Abbreviation: User Datagram Protocol is a minimal, connectionless network protocol, that belongs to the transport layer of the Internet protocols family.

UINT

Data type. An operand of the data type UINT (Unsigned INT) has a length of 16 bits and contains numerical values without sign.

USF

Universal Scaling Function, a non-binary scaling function (without overflow error)

WORD

Data type. A WORD includes 2 bytes, each of them including 8 bits.

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