Smart encoders & actuators

User's guide

EM58 PT
HS58 PT
HM58 PT

second series

PROFINET®

This is a phase-out product, it is still in production, but not recommended for new applications. We recommend using the new EXM58-EXO58 encoder.

Suitable for the following models:

- EM58, EM58S PT
- EMC58, EMC59, EMC60 PT
- HS58, HS58S PT
- HSC58, HSC59, HSC60 PT
- HM58, HM58S PT
- HMC58, HMC59, HMC60 PT

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Typographic and iconographic conventions

In this guide, to make it easier to understand and read the text the following typographic and iconographic conventions are used:

- parameters and objects of both Lika device and interface are coloured in **GREEN**;
- alarms are coloured in **RED**;
- states are coloured in **FUCSIA**.

When scrolling through the text some icons can be found on the side of the page: they are expressly designed to highlight the parts of the text which are of great interest and significance for the user. Sometimes they are used to warn against dangers or potential sources of danger arising from the use of the device. You are advised to follow strictly the instructions given in this guide in order to guarantee the safety of the user and ensure the performance of the device. In this guide the following symbols are used:

	This icon, followed by the word **WARNING**, is meant to highlight the parts of the text where information of great significance for the user can be found: user must pay the greatest attention to them! Instructions must be followed strictly in order to guarantee the safety of the user and a correct use of the device. Failure to heed a warning or comply with instructions could lead to personal injury and/or damage to the unit or other equipment.
	This icon, followed by the word **NOTE**, is meant to highlight the parts of the text where important notes needful for a correct and reliable use of the device can be found. User must pay attention to them! Failure to comply with instructions could cause the equipment to be set wrongly: hence a faulty and improper working of the device could be the consequence.
	This icon is meant to highlight the parts of the text where suggestions useful for making it easier to set the device and optimize performance and reliability can be found. Sometimes this symbol is followed by the word **EXAMPLE** when instructions for setting parameters are accompanied by examples to clarify the explanation.

Preliminary information

This guide is designed to provide the most complete information the operator needs to correctly and safely install and operate the following encoders **equipped with Profinet interface**:

EMxxx-13-14-PT2-...	**(DAP 1 : multiturn encoder 13 +14 bits)**
HSxxx-18-00-PT2-...	**(DAP 2 : singleturn encoder 18 bits)**
HMxxx-16-14-PT2-...	**(DAP 3 : multiturn encoder 16 +14 bits)**

To make it easier to read the text, this guide can be divided into some main sections.
In the first section (from chapter 1 to chapter 4) general information concerning the safety, the mechanical installation and the electrical connection.
In the second section (chapter 5) information on how to install and configure the encoder in TIA Portal development environment as well as tips for setting up and running properly and efficiently the unit are provided.
In the third section (from chapter 6 to chapter 12) both general and specific information is given on the Profinet interface. In this section the interface features and the parameters implemented in the unit are fully described.
In the last section (from chapter 13 to chapter 15) some examples of programming and advanced maintenance information are explained.

Lika Electronic Profinet encoder documentation is complete with some **example projects** provided free of charge. These programs are designed to make your own project planning, programming, communication and diagnostics with the TIA V15 development environment user-friendly and reliable. You can find them in the **Lika TIA V15 CPU1500 Profinet example project.zip** compressed file contained in the **SW EM58_HS58_HM58_XAC77_XAC81 PT.zip** file.

WARNING
If the encoder is used as a **TO Technology Object**, please refer to the "5.7 TO Technology Objects" section on page 62.

Glossary of Profinet terms

PROFINET IO, like many other networking systems, has a set of unique terminology. Table below contains a few of the technical terms used in this guide to describe the PROFINET IO interface. Sometimes they also refer more specifically to the S7 programming environment. They are listed in alphabetical order.

Acyclic Communications	Unscheduled, on demand communications. Diagnostic messages from an IO Supervisor to an IO Device are Acyclic. Refer to page 93.
AP	Application Process - The application process running in the device. PROFINET supports a default Application Processes and additional profile specific application processes.
API	The value of the API (Application Process Identifier) parameter specifies the application that is processing the IO data. PROFINET standard IEC 61158 assigns profiles to certain APIs (PROFIdrive, PROFIslave) which are defined by the PROFINET User Organization. The standard API is 0.
Application class	An application class specifies a number of mandatory functions and addition optional functions to be supported by an IO device. The Profinet encoders can be configured as CLASS 3 and CLASS 4 PROFINET IO devices according to the encoder profile. Refer to page 77.
AR	Application Relation - The relationship between a PROFINET IO Controller and an IO device. A PROFINET IO device can support more than one Application Relationship.
Automation system	Programmable logic controller for the open-loop and closed-loop control of process chains in process and production engineering. The automation system consists of different components and integrated system functions depending on the automation task.
Bus	A bus is a communication medium connecting several nodes. Data can be transferred via serial or parallel circuits, that is, via electrical conductors or fiber optic.
Channel	A single IO point. A Channel can be discrete or analog.
Consumer Status	The Status an IO device provides to an IO Controller for the data it consumes from IO Controller.
CPU	Central Processing Unit – Central module of an automation system with a control and arithmetic unit, memory, operating system and interface for programming device.
CR	Communication Relationship - A virtual communication channel within an AR.
Cyclic Communications	Scheduled, repetitive communications. IO data and alarm transfers are cyclic.

Data block	In contrast to code blocks, data blocks (DB) do not contain Step 7 statements. They are used to save data, i.e. variable data which are processed by the user program. Global data blocks serve to accommodate user data which can be used by all other blocks.
DCP	Discovery Control Protocol - A communications protocol with PROFINET IO that allows an IO Controller or Supervisor to find every PROFINET IO device on a subnet.
Determinism	Determinism means that a system responds in a predictable (deterministic) manner.
Device name	Before an IO device can be addressed by an IO controller, it must have a device name. In PROFINET, this method was selected because it is simpler to work with names than with complex IP addresses. Refer to page 30.
Encoder Profile	The PROFINET profile for Encoders is intended to define a standard application interface for encoders. The profile is a supplement to the PROFIdrive profile, so it is mandatory to read the PROFIdrive profile before implementing the encoder profile.
Function	Functions (FC) are code blocks which can be programmed by the user. A FC does not have a "memory". Temporary variables as well as parameters transferred to the function when the latter is called are saved in a L stack. They are lost following processing of the FC.
Function block	Function blocks (FB) are code blocks with a "memory" which are programmed by the user. They have an assigned instance data block (instance DB) as memory. Parameters transferred to a FB as well as the static variables are saved in this data block. An FB contains a program which is always executed when the FB is called by another code block. Function blocks facilitate the programming of frequently repeated, complex functions.
Frame ID	The two-byte field in the Ethernet frame which defines the type of PROFINET IO message.
GSD	The properties of a PROFINET device are described in a GSD file (General Station Description) that contains all the information required for configuration. In PROFINET IO, the GSD file is in XML format. The structure of the GSD file conforms to ISO 15734, which is the world-wide standard for device descriptions. Refer to page 45.
GSDML	General Station Description Markup Language – The file containing the XML description of the PROFINET IO device. Refer to page 45.
IO Controller	Device used to address the connected IO devices. This means that the IO controller exchanges input and output signals with assigned field devices. The IO controller is often the controller on which the automation program runs. Refer to page 75.
IO Device	A decentralized field device that is assigned to one of the IO

	controllers (e.g. remote IO, encoders, valve terminals, frequency converters, switches, etc.). Refer to page 75.
IO Parameter Server	An IO Parameter Server is a server station, usually a PC, for loading and saving the configuration data (records) of IO Devices.
IO Supervisor	Programming device, PC or HMI device used for commissioning and diagnostics of IO Controllers and IO Devices. Refer to page 75.
IP address	The IP address is the name of the unit in a network using the Internet protocol. Refer to page 30.
IRT	Synchronized transmission procedure for the cyclic exchange of IRT data between PROFINET devices. A reserved bandwidth within the send clock is available for the IRT IO data. The reserved bandwidth ensures that the IRT data can be transmitted at reserved, synchronized intervals whilst remaining uninfluenced even by other greater network loads (e.g. TCP/IP communication or additional real time communication). The "high flexibility" enables simple planning and expansion of the system. A topological configuration is not required. Refer to page 103.
MAC address	The MAC address is an identifier unique worldwide consisting of two parts: the first 3 bytes are the manufacturer ID and are provided by IEE standard authority; the last three bytes represent a consecutive number of the manufacturer. Refer to page 30.
Module	Modules are user defined components that plug into slots. Modules can be real or virtual.
NRT	Non Real Time - The non Real Time PROFINET IO Channel. Configuration and diagnostic messages are transferred over the NRT Channel.
Organization block	A range of organization blocks (OB) are designed to execute the user program. OBs are the interface interface between the user program and the operating system of a CPU. They permit event-controlled processing of special program components within the user program. The order in which the user program is executed is defined in the organization blocks.
Profile	Profiles define application-specific functionality to ensure the openness of PROFIBUS and PROFINET is utilized consistently. PI Profiles can cover simple devices such as encoders by defining how signals are used and how they are physically connected. However, profiles are increasingly covered more complex systems or requirements. Profiles such as PROFIdrive and PROFIsafe deliver active functionality as well. An advanced profile covering active power management for end devices like lasers and robots is now under development with the aim of bringing significant reductions in energy consumption for the automotive industry. Profiles guarantee

	quicker system design and they support faster device interchange, promoting competition amongst vendors, increased choice for users and full interoperability.
Provider Status	The Status an IO device provides to an IO Controller with the data transferred to the Controller.
Proxy	A device which maps non PROFINET IO data to PROFInet.
Real-time	Real-time means that a system processes external events within a defined time. If the reaction of a system is predictable, one speaks of a deterministic system. The general requirements for real-time are therefore: deterministic response and defined response time. Refer to page 103.
RT	Real Time - The Real Time PROFINET IO Channel. I/O and Alarm Data are transferred over the RT Channel. Refer to page 103.
Slot	A group of one or more Subslots. Slots can be real or virtual.
Standard signal	The encoder profile defines a series of standard signals which are used to configure the IO data. Refer to page 82.
Submodule	A component of a module that is plugged into a subslot. A submodule is real or virtual.
Subslot	A group of one or more channels. Subslots can be real or virtual.
Sync domain	All PROFINET devices that are to be synchronized via PROFINET IO with IRT must belong to a sync domain. The sync domain consists of precisely one sync master and at least one sync slave. IO controllers and switches can hold the role of a sync master or sync slave. Other IO devices support only the role as sync slave.
System function	System functions (SFC) are integral functions in the operating system of a S7 CPU. In addition, SFCs are frequently called implicitly by SFBs. SFCs can be called by the user program like normal functions. SFCs are used to implement a number of important system functions for Profinet IO.
System function block	System function blocks (SFB) are integral functions in the operating system of a S7 CPU. SFBs can be called by the user program like normal function blocks. SFBs are used to implement a number of important system functions for Profinet IO.
TCP/IP	The Ethernet system is designed solely to carry data. It is comparable to a highway as a system for transporting goods and passengers. The data is actually transported by protocols. This is comparable to cars and commercial vehicles transporting passengers and goods on the highway. Tasks handled by the basic Transmission Control Protocol (TCP) and Internet Protocol (IP) (abbreviated to TCP/IP): 1. The sender splits the data into a sequence of packets. 2. The packets are transported over the Ethernet to the correct recipient.

	3. The recipient reassembles the data packets in the correct order. 4. Faulty packets are sent again until the recipient acknowledges that they have been transferred successfully.
Telegram	A telegram is a rigidly defined bit stream carrying data. A telegram specifies the data length and the type of data which is sent to and from the IO controller. The encoder profile can support the Standard Telegrams 81, 82, 83 and 84. Refer to page 80.
Topology	Network structure. Commonly used structures: • Line topology; • Ring topology; • Star topology; • Tree topology.
Transmission rate	Data transfer rate (in bps).
User program	The user program contains all instructions, declarations and data for signal processing required to control a plant or a process. It is assigned to a programmable module (for example CPU) and can be structured in smaller units (blocks).

List of abbreviations

Table below contains a list of abbreviations (in alphabetical order) which may be used in this guide to describe the PROFINET IO interface. Sometimes they also refer more specifically to the S7 programming environment.

AR	Application Relation
API	Application Process Identifier
C-LS	Controller's Sign-Of-Life
CR	Communication Relation
DB	Data block
DO	Drive Object
DO-LS	Driver Object Sign-Of-Life
DU	Drive Unit
EO	Encoder Object
EU	Encoder Unit
FB	Function block
FC	Function
I&M	Identification & Maintenance
IRT	Isochronous Real Time Ethernet
IRT Flex	IRT "High Flexibility"
IRT Top	IRT "High Performance"
GSDML	General Station Description Markup Language
IO	Input/Output
IP	Internet Protocol
LLDP	Link Layer Discovery Protocol
LS	Sign-Of-Life
MAC	Media Access Control
MAP	Module Access Point
MLS	Master Sign-Of-Life
OB	Organization block
PAP	Parameter Access Point
PI	PROFIBUS and PROFINET International
RT	Real Time Ethernet

SFB	System function block
SFC	System function
TCP	Transmission Control Protocol
$\mathbf{T_{MAPC}}$	Master Application Cycle Time

References

1- Profile encoder. Technical Specification for PROFIBUS and PROFINET related to PROFIdrive Version 4.1 December 2008 Order No: 3.162

2- Profile Drive Technology PROFIdrive. Technical Specification for PROFIBUS and PROFINET Version 4.1 May 2006 Order No: 3.172

3- Profile Guidelines Part 1: Identification & Maintenance Functions. Guideline for PROFIBUS and PROFINET Version 1.2 October 2009 Order No: 3.502

4- Profibus Guidelines: Profibus Interconnection Technology Version V1.4 Order No: 2.142

5- Profinet Guidelines: Profinet Cabling and Interconnection Version V1.8 Order No: 2.252

1 Safety summary

1.1 Safety

- Always adhere to the professional safety and accident prevention regulations applicable to your country during device installation and operation;
- installation and maintenance operations have to be carried out by qualified personnel only, with power supply disconnected and stationary mechanical parts;
- device must be used only for the purpose appropriate to its design: use for purposes other than those for which it has been designed could result in serious personal and/or the environment damage;
- high current, voltage and moving mechanical parts can cause serious or fatal injury;
- warning ! Do not use in explosive or flammable areas;
- failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the equipment;
- Lika Electronic assumes no liability for the customer's failure to comply with these requirements.

1.2 Electrical safety

- Turn OFF the power supply before connecting the device;
- connect according to the explanation in the "Electrical connections" section on page 28;
- in compliance with 2014/30/EU norm on electromagnetic compatibility, the following precautions must be taken:
  - before handling and installing the equipment, discharge electrical charge from your body and tools which may come in touch with the device;
  - power supply must be stabilized without noise; install EMC filters on device power supply if needed;
  - always use shielded cables (twisted pair cables whenever possible);
  - avoid cables runs longer than necessary;
  - avoid running the signal cable near high voltage power cables;
  - mount the device as far as possible from any capacitive or inductive noise source; shield the device from noise source if needed;
  - to guarantee a correct working of the device, avoid using strong magnets on or near by the unit;
  - minimize noise by connecting the shield and/or the connector housing and/or the frame to ground. Make sure that ground is not affected by

noise. The connection point to ground can be situated both on the device side and on user's side. The best solution to minimize the interference must be carried out by the user. Provide the ground connection as close as possible to the encoder. We suggest using the ground point provided in the cap, use one TCEI M3 x 4 cylindrical head screw with two tooth lock washers.

1.3 Mechanical safety

- Install the device following strictly the information in the "Mechanical installation" section on page 23;
- mechanical installation has to be carried out with stationary mechanical parts;
- do not disassemble the unit;
- do not tool the unit or its shaft;
- delicate electronic equipment: handle with care; do not subject the device and the shaft to knocks or shocks;
- respect the environmental characteristics of the product;
- unit with solid shaft: in order to guarantee maximum reliability over time of mechanical parts, we recommend a flexible coupling to be installed to connect the encoder and user's shaft; make sure the misalignment tolerances of the flexible coupling are respected;
- unit with hollow shaft: the encoder can be mounted directly on a shaft whose diameter has to respect the technical characteristics specified in the purchase order and clamped by means of the collar and, when requested, the anti-rotation pin.

2 Identification

Device can be identified through the **order code**, the **serial number** and the **MAC address** printed on the label applied to its body. Information is listed in the delivery document too. Please always quote the order code, the serial number and the MAC address when reaching Lika Electronic for purchasing spare parts or needing assistance. For any information on the technical characteristics of the product refer to the technical catalogue.

Warning: encoders having order code ending with "/Sxxx" may have mechanical and electrical characteristics different from standard and be supplied with additional documentation for special connections (Technical info).

3 Mechanical installation

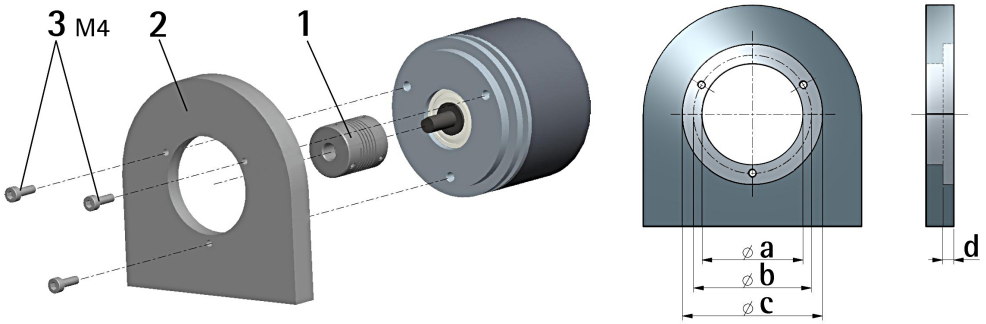
WARNING
Installation and maintenance operations have to be carried out by qualified personnel only, with power supply disconnected. Shaft and mechanical components must be in stop.

For any information on the mechanical data and the electrical characteristics of the encoder please refer to the technical catalogue.
Values are expressed in millimetres (mm).

3.1 Solid shaft encoders

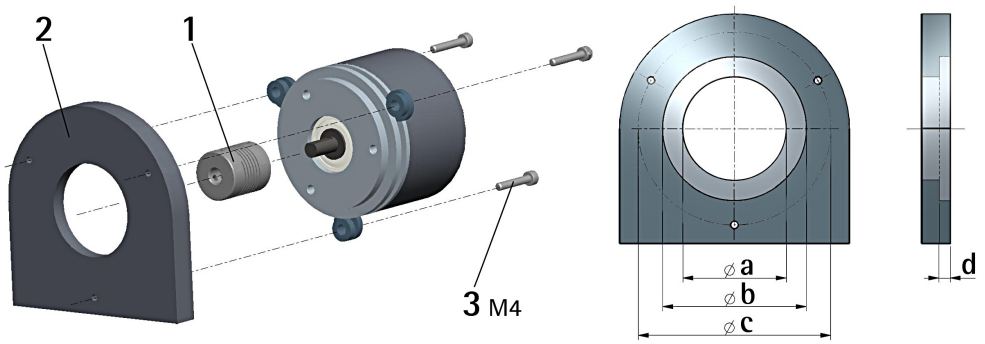
- Mount the flexible coupling **1** on the encoder shaft;
- fix the encoder to the flange **2** (or to the mounting bell) by means of the screws **3**;
- secure the flange **2** to the support (or the mounting bell to the motor);
- mount the flexible coupling **1** on the motor shaft;
- make sure the alignment tolerances of the flexible coupling **1** are respected.

3.1.1 Customary installation



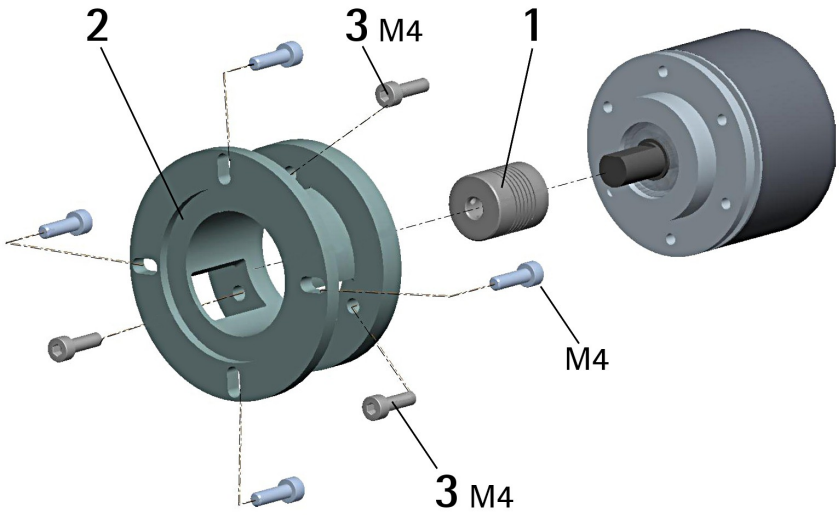
	a [mm]	b [mm]	c [mm]	d [mm]
EM58, HS58, HM58	-	42	50 F7	4
EM58S, HS58S, HM58S	36 H7	48	-	-

3.1.2 Installation using fixing clamps (code LKM-386)



	a [mm]	b [mm]	c [mm]	d [mm]
EM58, HS58, HM58	-	50 F7	67	4
EM58S, HS58S, HM58S	36 H7	-	67	-

3.1.3 Installation using a mounting bell (code PF4256)

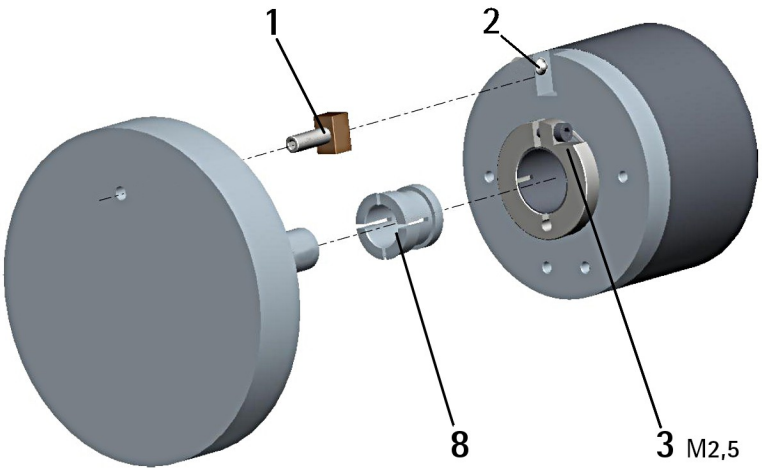


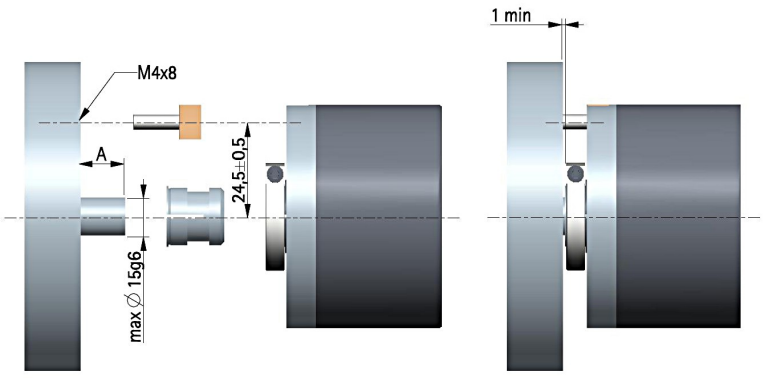
NOTE
In order to guarantee reliability over time of the encoder mechanical parts, we recommend a flexible coupling to be installed between the encoder and the motor shaft. Make sure the misalignment tolerances of the flexible coupling are respected.

3.2 Hollow shaft encoders

3.2.1 EMC58, HxC58

- Fasten the anti-rotation pin **1** to the rear of the motor (secure it using a locknut);
- mount the encoder on the motor shaft using the reducing sleeve **8** (if supplied). Avoid forcing the encoder shaft;
- insert the anti-rotation pin **1** into the slot on the flange of the encoder; this secures it in place by grub screw **2**, preset at Lika;
- fix the collar **3** to the encoder shaft (apply threadlocker to screw **3**).

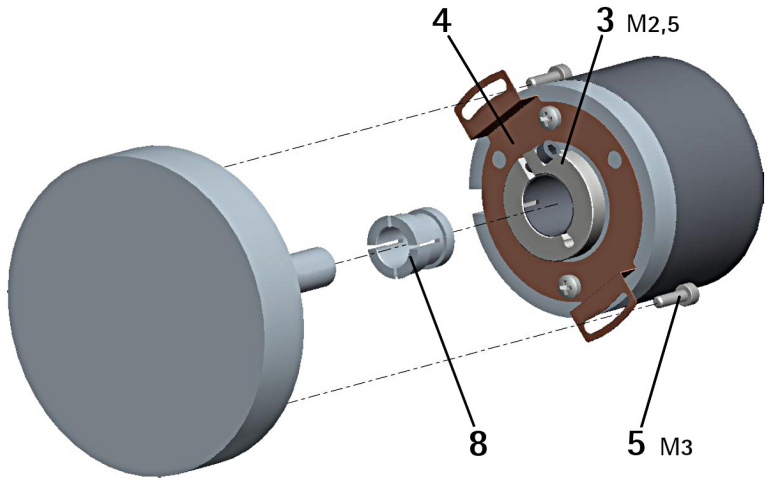


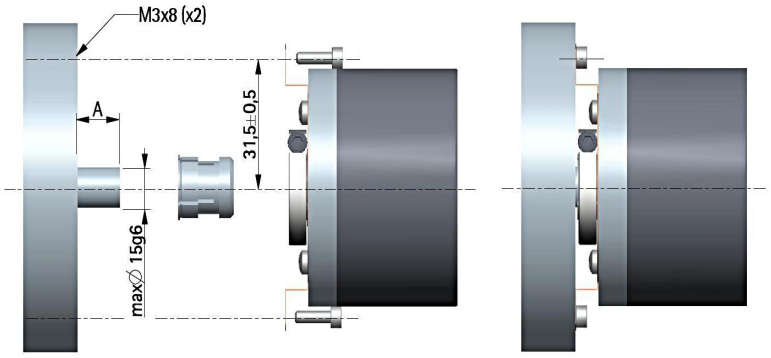


A = min. 8 mm, max. 18 mm

3.2.2 EMC59, HxC59

- Mount the encoder on the motor shaft using the reducing sleeve **8** (if supplied). Avoid forcing the encoder shaft;
- fasten the fixing plate **4** to the rear of the motor using two M3 cylindrical head screws **5**;
- fix the collar **3** to the encoder shaft (apply threadlocker to screw **3**).

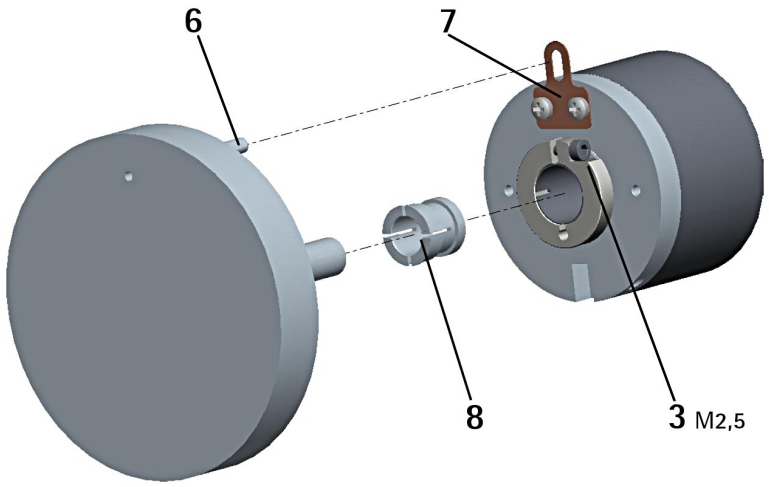


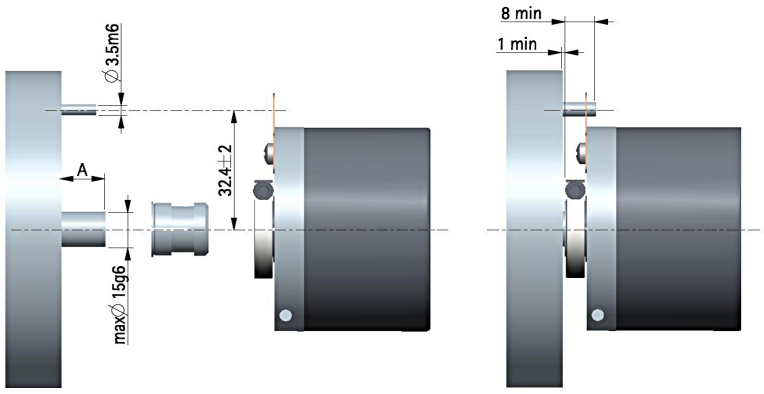


A = min. 8 mm, max. 18 mm

3.2.3 EMC60, HxC60

- Fix the tempered pin **6** to the rear of the motor;
- mount the encoder on the motor shaft using the reducing sleeve **8** (if supplied). Avoid forcing the encoder shaft;
- make sure the anti-rotation pin **6** is inserted properly into the fixing plate **7**;
- fix the collar **3** to the encoder shaft (apply threadlocker to screw **3**).





A = min. 8 mm, max. 18 mm

NOTE
You are strongly advised not to carry out any mechanical operations (drilling, milling, etc.) on the encoder shaft. This could cause serious damages to the internal parts and an immediate warranty loss. Please contact our technical personnel for the complete availability of "custom made" shafts.

4 Electrical connections

WARNING

Power supply must be turned off before performing any electrical connection!
Installation, electrical connection and maintenance operations must be carried out by qualified personnel only, with power supply disconnected. Mechanical components must be in stop.
Do not remove the connection cap of the encoder. Damage may be caused to internal components.

No user serviceable parts inside the connection cap!

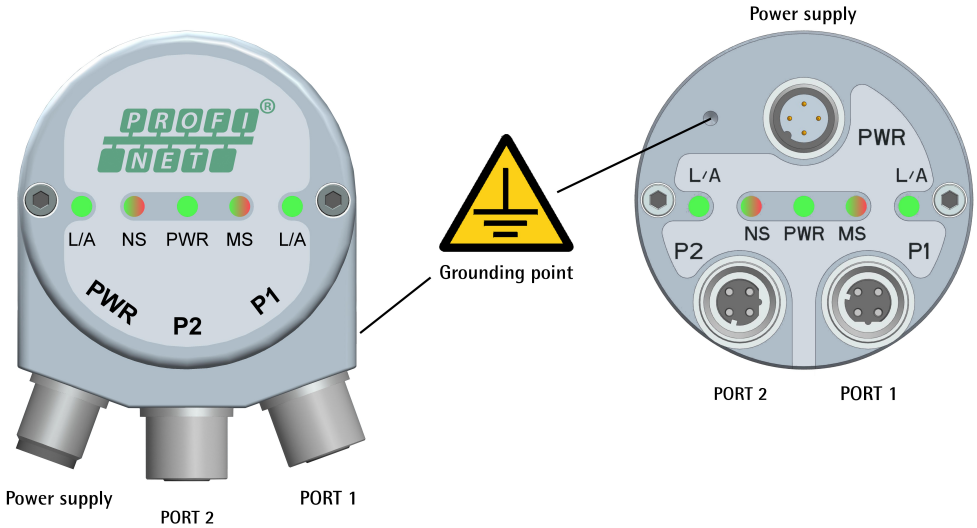
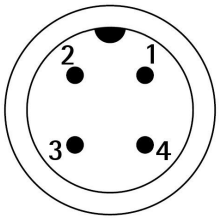


Figure 1 - Connectors and diagnostic LEDs

4.1 PWR Power supply connector (Figure 1)

M12 4-pin male connector with A coding is used for power supply.

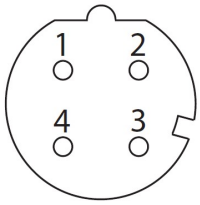


Description	Pin
+10Vdc +30Vdc	1
n.c.	2
0Vdc	3
n.c.	4

n.c. = not connected

4.2 P1 Port 1 and P2 Port 2 connectors (Figure 1)

Two M12 4-pin female connectors with D coding are used for Ethernet connection through port 1 and port 2.



Description	Pin
Tx Data +	1
Rx Data +	2
Tx Data -	3
Rx Data -	4

The ports are equal and interchangeable - if only one connection is required, either port can be used. The Ethernet interface supports 100 Mbit/s, full-duplex operation.

4.3 Network configuration: cables, hubs, switches - Recommendations

PROFINET is based on a 100 Mbps, full-duplex Ethernet network. Faster communication is also possible on all transmission sections (e.g., between switches, PC systems, or camera systems).
Using Ethernet several topologies of connection are supported by Profinet networks: line, tree, daisy-chain, star, ... Furthermore Profinet networks can be configured in almost any topology in the same structure.
The connection of PROFINET IO field devices occurs exclusively with switches as network components. Switches typically integrated in the field device are used for this (with 2 ports assigned). PROFINET-suitable switches must support "autonegotiation" (negotiating of transmission parameters) and "autocrossover" (autonomous crossing of send and receive lines).

Cables and connectors comply with the Profinet specifications. The cabling guide defines for all Conformance Classes a 2-pair cable according to IEC 61784-5- 3.
Standard Profinet cables commercially available can be used.
The maximum segment length for electrical data transmission with copper cables between two nodes (field devices or switches) is 100 m. The copper cables are designed uniformly in AWG 22. The installation guide defines different cable types, whose range has been optimally adapted to general requirements for industry. Sufficient system reserves allow industry-compatible installation with no limitation on transmission distance.
The PROFINET cables conform to the cable types used in industry:

- PROFINET Type A: Standard permanently routed cable, no movement after installation
- PROFINET Type B: Standard flexible cable, occasional movement or vibration
- PROFINET Type C: Special applications: for example, highly-flexible, constant movement (trailing cable or torsion)

For complete information please refer to IEC 61918, IEC 61784-5-13 and IEC 61076-2-101.
To increase noise immunity only S/FTP or SF/FTP cables must be used (CAT-5).
The maximum cable length (100 meters) predefined by Ethernet 100Base-TX must be compulsorily fulfilled.
Regarding wiring and EMC measures, the IEC 61918 and IEC 61784-5-13 must be considered.

For a complete list of the available cordsets and connection kits please refer to the product datasheet ("Accessories" list).

4.4 Line termination

Profinet network needs no line termination because the line is terminated automatically; in fact every Slave is able to detect the presence of the downstream Slaves.

4.5 MAC address and IP address

The unit can be identified in the network through the **MAC address** and the **IP address**. MAC address has to be intended as a permanent and globally unique identifier assigned to the unit for communication on the physical layer; while the IP address is the name of the unit in a network using the Internet protocol. MAC address is 6-byte long and cannot be modified. It consists of two parts,

numbers are expressed in hexadecimal notation: the first three bytes are used to identify the manufacturer (OUI, namely Organizationally Unique Identifier), while the last three bytes are the specific identifier of the unit. The MAC address can be found on the label applied to the encoder. The IP address (and the subnet mask) must be assigned by the user to each interface of the unit to be connected in the network. For additional information on the MAC address refer to the "5.4 Mac address" section on page 45. For additional information on the IP address refer to the "5.5.8 Setting the device name and the IP address" section on page 54.

4.6 Ground connection (Figure 1)

To minimize noise connect properly the shield and/or the connector housing and/or the frame to ground. Connect properly the cable shield to ground on user's side. Lika's EC- pre-assembled cables are fitted with shield connection to the connector ring nut in order to allow grounding through the body of the device. Lika's E- connectors have a plastic gland, thus grounding is not possible. If metal connectors are used, connect the cable shield properly as recommended by the manufacturer. Anyway make sure that ground is not affected by noise. It is recommended to provide the ground connection as close as possible to the device. We suggest using the ground point provided in the cap (see Figure 1, use 1 TCEI M3 x 4 cylindrical head screw with two tooth lock washers).

4.7 Diagnostic LEDs (Figure 1)

Five LEDs located in the cap of the encoder (see Figure 1) are meant to show visually the operating or fault status of the encoder and the Profinet interface. The meaning of each LED is explained in the following tables.

L/A Link/Activity LED for port 2 P2 (green)

It shows the state and the activity of the physical link (port 2 P2).

L/A LED	Description	Meaning
OFF	No link	Link not active, no activity on port 2 P2
ON green	Link	Port 2 P2 link active, no activity
FLICKERING green	Activity	Port 2 P2 link active, activity on port 2 P2

NS Network Status LED (green / red)

It shows the current state of the network.

NS LED	Description	Meaning
OFF	Offline	• The device is switched OFF • No connection with IO controller established
ON green	Online (RUN)	• Connection with IO controller established • IO controller in RUN state
FLASHING green once	Online (STOP)	• Connection with IO controller established • IO controller in STOP state or IO data is wrong • IRT synchronization not carried out
BLINKING green	Blink	Used by engineering tools to identify the node in the network
ON red	Fatal event	A mayor internal error has occurred (this indication is combined with the red MS Module Status LED)
FLASHING red once	Station name error	Name of the node not set
FLASHING red twice	IP address error	IP address of the node not set
FLASHING red three times	Configuration error	Expected identification differs from real identification

PWR Power LED (green)

It shows the power supply state.

PWR LED	Description	Meaning
OFF	Power OFF	The encoder power supply is switched OFF.
ON	Power ON	The encoder power supply is switched ON.

MS Module Status LED (green / red)

It shows the state of the Profinet device.

MS LED	Description	Meaning
OFF	Not initialized	The power supply is switched OFF or the device is in SETUP or NW_INIT state (see on page 34)
ON green	Normal operation	The device has shifted from the NW_INIT state (see on page 34)
FLASHING green once	Diagnostic event(s)	Diagnostic event(s) active
ON red	Exception error	The device is in EXCEPTION state (see on page 34)
	Fatal event	A major internal error has occurred (this indication is combined with the red NS Network Status LED)
Alternating red / green	Firmware update	Do NOT power off the encoder. Switching the encoder off during this phase could cause permanent damage

L/A Link/Activity LED for port 1 P1 (green)

It shows the state and the activity of the physical link (port 1 P1).

LED	Description	Meaning
OFF	No link	Link not active, no activity on port 1 P1
ON green	Link	Port 1 P1 link active, no activity
FLICKERING green	Activity	Port 1 P1 link active, activity on port 1 P1

While the encoder is performing its power up testing, the NS network status indicator and the MS module status indicator shall perform a test sequence.

4.8 States

Here follows the list of the available states.

SETUP state

The setup of the device is in progress. The encoder may not send commands to the application in this state. If setup is successful, the module will shift to the NW_INIT state; or, in case of failure, it will shift to the EXCEPTION state.

NW_INIT state

The device is currently performing network-related initialization tasks. Telegrams now contains Process Data (if such data is mapped), however the network Process Data channel is not active yet. If the process is successful, the module will shift to the WAIT_PROCESS state; or, in case of failure or if a serious error occurs (i.e. any error which prevents the system from proceeding), it will shift to the EXCEPTION state.

WAIT_PROCESS state

The network Process Data channel is temporarily inactive. The system will consider the Read Process Data as not valid.

IDLE state

The network interface is idle. The Read Process Data may be either updated or static (unchanged).

PROCESS_ACTIVE state

The network Process Data channel is active and error free. Perform normal data handling.

ERROR state

There is at least one serious network error. The Read Process Data shall be regarded as not valid. Write Process Data could still be forwarded to the Master, so the application must keep this data updated.

EXCEPTION state

The module has ceased all network participation due to an error. This state is unrecoverable, i.e. the system must be restarted in order to be able to exchange network data.

5 Getting started

5.1 Quick start information

The following instructions allow the operator to quickly and safely set up the device in a standard operational mode.
For complete and detailed information please read the mentioned pages thoroughly.

- Mechanically install the device, see on page 23 ff;
- execute the electrical and network connections, see on page 28 ff;
- switch on the +10Vdc +30Vdc power supply;
- install the GSDML file, see on page 47 ff;
- insert the Lika module and type of telegram in the PROFINET-IO system, see on page 49 ff;
- set the device name, see on page 54 ff;
- set the IP address and the subnet mask to the node, see on page 54 ff; the default address set by Lika is **0.0.0.0**;
- to set the parameters, enter the **Module parameters** page, see on page 52; in this page it is possible, for example, to set the singleturn resolution or the total resolution, to enable the scaling function or to change the counting direction; after entering new values, you must download the parameters to the device; the complete list of the default parameters is available on page 141;
- to enable the scaling function, change the counting direction and execute the preset, the **Class 4 functionality** parameter must be enabled (="1"), see on page 95.

NOTE
It is possible to configure the parameters also by entering the web server via browser (see the "14 Integrated web server" section on page 124): in the **Set Encoder Registers** page (see on page 129), the operator can either enter the desired value or set it through the drop-down box in the input field under the **WRITE** column; then he has to press the button between the boxes to confirm. The value that is currently set can be found in the box on the right under the **READ** column.
Please note that at each power on of the PLC all parameters set in the project are downloaded to the encoder, thus any previous setting is overwritten. For a definitive setting please use TIA PORTAL and the **Module parameters** page.

5.1.1 Setting the resolution and the scaling function

- If you want to use the physical resolution of the encoder, please check that the **Scaling function control** parameter is disabled (="0"), see on page 96; this parameter is active only if the **Class 4 functionality** parameter is enabled (="1"), see on page 95;
- on the contrary, if you need a custom resolution, you must enable the scaling function by setting the **Scaling function control** parameter to ="1" first and then set the required resolution values:
  - open the **Module parameters** page and set the singleturn resolution next to the **Measuring units / Revolution** parameter, see on page 52 and on page 98;
  - open the **Module parameters** page and set the total resolution next to the **Total measuring range** parameter, see on page 52 and on page 99.

NOTE
It is possible to enable the scaling function and set a custom resolution also by entering the web server via browser (see the "14 Integrated web server" section on page 124): in the **Set Encoder Registers** page (see on page 129), the operator can either enter the desired value or set it through the drop-down box in the input field under the **WRITE** column; then he has to press the button between the boxes to confirm. The value that is currently set can be found in the box on the right under the **READ** column.
Please note that at each power on of the PLC all parameters set in the project are downloaded to the encoder, thus any previous setting is overwritten. For a definitive setting please use TIA PORTAL and the **Module parameters** page.

5.1.2 Reading the position

- To read the value of the absolute position use the Standard Telegram 81, see the **Telegram 0x51** table available in the project example provided by Lika, see on page 80; see also the **G1_XIST1** parameter on page 84 and the **G1_XIST2** parameter on page 85).

NOTE
It is possible to read the current position of the encoder also by entering the web server via browser (see the "14 Integrated web server" section on page 124): in the **Encoder position and speed** page (see on page 126), the current position of the encoder is displayed. For example, it is "11562" in Figure 55.

5.1.3 Setting and executing the preset

- To set and execute the preset proceed as follows:
  - check that the **Control by PLC** bit 10 of the **STW2_ENC** control word is ="1", see on page 87;
  - check that the **Class 4 functionality** parameter is enabled (="1"), see on page 95;
  - check that the **G1_XIST1 Preset control** parameter is enabled (="0"), see on page 95;
  - set the preset value by means of Telegram 860 and **G1_XIST1_PRESET_VALUE** signal, see on page 85;
  - execute the preset by forcing high the **Request set/shift of home position** bit 12 in the **G1_STW** control word, see on page 89;
  - the encoder replies by forcing high the **Set/shift of home position executed** bit 12 in the **G1_ZSW** status word, see on page 91;
  - the Master must set back to 0 the **Request set/shift of home position** bit 12 in the **G1_STW** control word, see on page 89;
  - the **Set/shift of home position executed** bit 12 in the **G1_ZSW** status word is set back to 0, see on page 91; see the diagram on page 120.

Setting and activating the preset via TIA PORTAL and the example project

Documentation is complete with the **EM_HMS_PT_V15 example project** and the **Preset encoder Profinet Lika.mp4 explanation video** provided free of charge. The project is designed to help you set and execute the preset with the TIA PORTAL V15 development environment easily. You can find it in the **Lika TIA V15 CPU1500 Profinet example project.zip** compressed file contained in the **SW EM58_HS58_HM58_XAC77_XAC81 PT.zip** file.

- To set and activate the preset via TIA PORTAL development environment we suggest getting the followings:
  - EM_HMS_PT_V15.ap15 example project (see Lika TIA V15 CPU1500 Profinet example project\RT\EM_HMS_PT_V15);
  - Preset encoder Profinet Lika.mp4 explanation video.

- Then proceed as follows:
  1. start the EM_HMS_PT_V15.ap15 example project;
  2. in the Project Tree on the left select the **Watch and force tables** where the **Telegram 81** and the **Telegram 860** items are found;
  3. select the **Telegram 81** watch table and then press the **Monitor all** button in the toolbar; if the online connection to the controller is not already established, the system goes online;
  4. select the **Telegram 860** watch table and then press the **Monitor all** button in the toolbar;
  5. in the **Telegram 860** watch table you can set a desired Preset value; to do this select the **Telegram 860** watch table in the project tree, the **Telegram 860** watch table will be displayed;
  6. under the section **CONTROLLER => DEVICE** select the **G1_XIST_PRESET_B** function, enter the desired value in the field under the **Monitor value** column ("0" in the video); then right-click on the field and press the **Modify** and **Modify now** commands in the drop-down box that appears;
  7. now you must activate the Preset value you have set;
  8. select the **Telegram 81** watch table in the project tree, the **Telegram 81** watch table will be displayed;
  9. under the section **CONTROLLER => DEVICE** select the **G1_STW.12** function, right-click on the line and then press the **Modify** and **Modify to 1** commands in the drop-down box that appears;
  10. check that under the section **DEVICE => CONTROLLER** the **G1_XIST1** function is set to the preset value ("0" in the video);
  11. again select the **G1_STW.12** function, right-click on the line and then press the **Modify** and **Modify to 0** commands in the drop-down box that appears.

NOTE

It is possible to set and activate the preset value also by entering the web server via browser (see the "14 Integrated web server" section on page 124): in the **Set Encoder Preset** page (see on page 131), the operator can enter the desired Preset value and activate it. For complete information refer to page 131.

5.2 Configuring the encoder with Siemens TIA PORTAL V15

In this manual some screenshots are shown to explain how to install and configure the encoder in a supervisor. In the specific example the development environment is TIA PORTAL V15 with SIEMENS PLC CPU 1500. Therefore, the installation of the GSDML file, the assignment of the IP address and the device name, the configuration of the encoder in the network, topology, diagnostics, etc. will always refer to the aforementioned development tools. If you need to install the encoder using a different configuration tool, please follow carefully the instructions given in the documentation provided by the manufacturer.

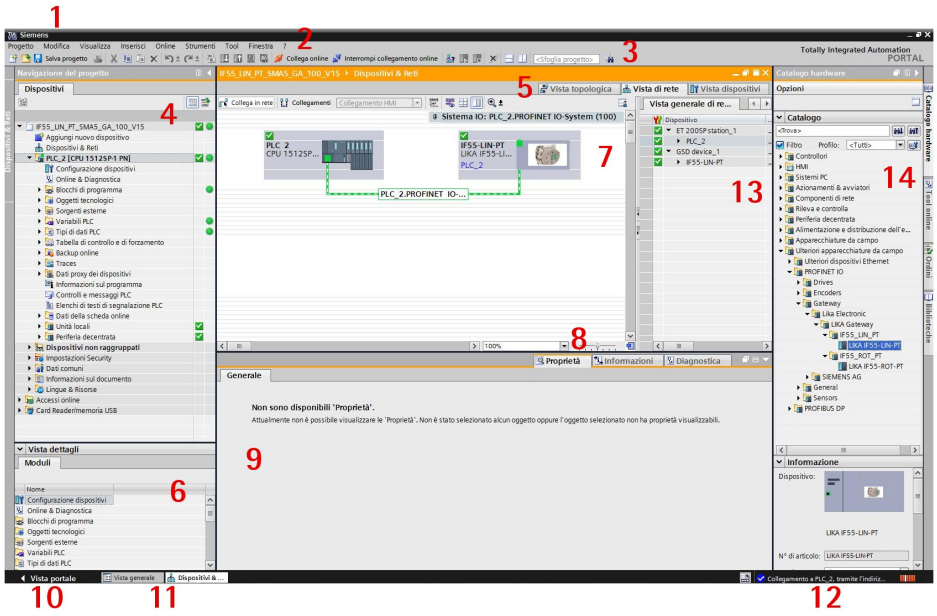
Documentation is complete with an **example project** provided free of charge. This program is designed to make your own project planning, programming, communication and diagnostics with the TIA PORTAL V15 development environment user-friendly and reliable. You can find it in the **Lika TIA V15 CPU1500 Profinet example project.zip** compressed file contained in the **SW EM58_HS58_HM58_XAC77_XAC81 PT.zip** file.

WARNING
If the encoder is used as a **TO Technology Object**, please refer to the "5.7 TO Technology Objects" section on page 62. Please see the **example project** available in the **Lika TIA V15 CPU1500 Profinet example project.zip** compressed file.

5.2.1 About TIA Portal

TIA Portal stands for Totally Integrated Automation Portal. It is an integrated engineering framework for controllers, HMI and drives. It integrates several SIMATIC products into a single software in order to increase productivity and efficiency.
TIA portal can be used to configure both the PLC and the visualization in an homogeneous system. Data is saved in a single project. Tools for programming (STEP 7) and displaying (WinCC) are not distinct programs, but editors of a system that has access to and uses a common database. One single user interface is used to enter all functions used for displaying and programming.

5.2.2 Project overview



1. **Title bar**: the name of the project is displayed in the title bar.
2. **Menu bar**: the menu bar contains all the commands that you require for your work.
3. **Toolbar**: the toolbar provides you with buttons for commands you will use frequently. This gives you faster access to these commands.
4. **Project Tree**: using the Project Tree features gives you access to all components and project data. You can perform the following tasks in the Project Tree:
    - add new components
    - edit existing components
    - scan and modify the properties of existing components
5. **Changeover switches**: they allow the user to switch among the three working areas of the **Hardware and network editor**: Topology view, Network view and Device view. See point 7 for more information.
6. **Details view**: it shows certain content of the selected object in the **Overview Window** or in the **Project Tree**. This might include text lists or tags. The content of the folders is not shown, however. To display the content of the folders, use the **Project Tree** or the **Inspector Window**.
7. **Graphic Area** of the **Hardware and network editor**. The **Hardware and network editor** opens when you double-click on the **Devices and Networks** entry in the **Project Tree**. The **Hardware and network editor** is the integrated development environment for configuring, networking and assigning parameters to devices and modules. It provides maximum support for the realization of the automation

project. This pane is the graphic area where the current configuration of the installed devices with information on the topology and the network can be found. The **Hardware and network editor** provides you with three views of your project. You can switch between these three views at any time depending on whether you want to produce and edit individual devices and modules, entire networks and device configurations or the topological structure of your project.
See the **Changeover switches**, point 5: **Device view** for parametrisation and configuration of the individual devices, it allows to configure and assign both device and module parameters, see on page 43; **Network view** for graphical connections between devices, it allows to configure and assign device parameters and to network the devices with one another, see on page 43; and **Topology view** for current interconnection of Profinet devices, it allows to display and configure the Ethernet topology as well as to identify and minimize differences between the desired and actual topology, see on page 44. In the Figure above the SIEMENS PLC CPU 1512SP-1 PN is the Master device and is connected to a Lika's IF55 LIN PT gateway, i.e. the Slave device, through the PLC_2.PROFINET IO-... connection.

8. **Overview Navigation**, it allows to quickly scroll through the objects available in the **Work Area** by pressing the left button of the mouse.
9. **Inspector window**: additional information on an object selected or on actions executed are displayed in the **Inspector window**, the available properties and parameters shown for the object selected can be edited in the Inspector window using the **Properties** tab.
10. It allows to enter the **Portal view**. The Portal view provides you with a task-oriented view of the tools.
11. **Editor bar**: it displays the open editors. If you have opened a lot of editors, they are shown grouped together. You can use the Editor bar to change quickly between the open elements.
12. **Status bar with progress display**. In the status bar, you will find the progress display for processes that are currently running in the background. This also includes a progress bar that shows the progress graphically. Hover the mouse pointer over the progress bar to display a tooltip providing additional information on the active background process. You can cancel the background processes by clicking the button next to the progress bar. If no background processes are currently running, the status bar displays the last generated alarm.
13. **Table Area** of the **Hardware and network editor**: it offers a general overview of the characteristics of the Device (when **Device view** is selected), of the Network (when **Network view** is selected) and of the Topology (when **Topology view** is selected).

14. **Task Cards**: depending on the edited or selected object, task cards are available, they allow you to perform additional actions. These actions include:
    - selecting objects from a library or from the hardware catalog
    - searching for and replacing objects in the project
    - dragging predefined objects to the work area

    The task cards available can be found in a bar on the right-hand side of the screen. You can collapse and reopen them at any time. Which task cards are available depends on the products installed. More complex task cards are divided into panes that you can also collapse and reopen.
    The **Hardware catalog** can be selected in the **Task Cards**; it allows to install the available components just dragging and dropping them onto the **Work Area**. Customarily the field devices that have been integrated into the TIA Portal via GSDML files are listed under **Other field devices > Profinet IO**.

5.2.3 Device view

Press the **Device view** changeover switch in the **Hardware and network editor** to enter the **Device view**.
The configuration of devices and assigning of addresses etc. is performed in the **Device view**. All devices are represented in a photo-realistic way.

- Buffering of configured hardware modules and reuse with module clipboard
- When zoomed to at least 200%, I/Os are displayed with the symbolic names / addresses
- Automatic readout of available hardware with hardware detect
- Full text search in the Hardware catalogue
- Option of filtering the Hardware catalogue to show modules that can currently be used
- All parameters and configuration data are displayed on a hierarchical and context-sensitive basis

5.2.4 Network view

Press the **Network view** changeover switch in the **Hardware and network editor** to enter the **Network view**.
The **Network view** enables the configuration of plant communication. The communication links between individual stations are displayed here graphically and very clearly.

- Combined view of all network resources and network components
- Fully graphical configuration of the individual stations

- Resources are networked by linking communication interfaces using drag & drop
- Multiple controllers, peripherals, HMI devices, SCADA stations, PC stations and drives possible in a single project
- Procedure for integrating AS-i devices identical to PROFIBUS/PROFINET
- Zoom and page navigation
- Copying/pasting entire stations, incl. configuration, or individual hardware modules

A subnet (PLC_2.PROFINET IO) is added to the operator panel. Click the subnet (PLC_2.PROFINET IO) to apply the network settings. Specify the required network settings under **Properties > Network Settings** in the **Properties** area (see point 9 on page 41). Make sure that you use the same settings throughout the entire network.

5.2.5 Topology view

Press the **Topology view** changeover switch in the **Hardware and network editor** to enter the **Topology view**.
Decentralised peripherals on Profinet are configured in the Network view. The controllers and the decentralised peripherals assigned to them can be shown graphically. During ongoing operation, however, it is not possible to see which ports are actually connected and communicating with each other.
Yet this is precisely what is often important for diagnostics. For Profinet networks, the **Topology view** enables this information to be displayed quickly and easily. An offline/online comparison identifies the communicating ports. By detecting, presenting and monitoring the physical connections between devices on Profinet, the administrator can easily monitor and maintain even complex networks.

5.3 Network and communication settings

The **MAC address** of the device is reported in the label applied to the device enclosure. See the following section.
The IP address and the subnet mask as well as the Profinet device name must be assigned by the user to each interface of the unit to be connected in the network. By default, before delivery the device name of the encoder is set to a **blank string** and its IP address is set to **0.0.0.0**. See on page 53.

5.4 Mac address

The MAC address is an identifier unique worldwide.
The MAC-ID consists of two parts: the first 3 bytes are the manufacturer ID and are provided by IEE standard authority; the last three bytes represent a consecutive number of the manufacturer.

NOTE
The MAC address is always printed on the encoder label for commissioning purposes.

The MAC address has the following structure:

Bit value 47 ... 24			Bit value 23 ... 0		
X	X	X	X	X	X
Company code (OUI)			Consecutive number		

5.5 Installing the encoder under TIA PORTAL environment

5.5.1 Description of the GSDML file

The functionality of a PROFINET IO device is always described in a GSDML file. This file contains all data that are relevant for engineering as well as for data exchange with the IO device.
PROFINET IO devices can be described using XML-based GSD. The description language of the GSD file, i.e. GSDML (General Station Description Markup Language) is based on international standards. As the name suggests, the GSD file is a language-independent XML file (Extensible Markup Language).

Profinet encoders from Lika Electronic are supplied with their own GSDML file **GSDML-V2.35-LIKA-0239-ROTACOD-PT-V1-XXXXXXXX.XML** where XXXXXXXX is the release date of the file in a 8-digit format encompassing information about year (4 digits), month (2 digits) and day (2 digits): **20200512** is the first GSDML file released by Lika Electronic for Profinet encoders. Enter Lika's web site **www.lika.biz** to get the GSDML file.
The XML file has to be installed in the Profinet Controller.

Version structure of GSDML files

The GSDML file structure is in compliance with the ISO 15745 "Open Systems Application Integration Framework" and is oriented on the defined profile of a field device via the following model:

GSDML-	V2.35-	LIKA-0239-	ROTACOD-PT-V1	20200512	.xml
GSD data identification	Version of GSDML scheme	Manufacturer	Name of device	Version number, format: yyyymmdd	File extension

- The version of the GSDML model used defines which scope of language a GSD file uses.
- The version date is updated, if, for example, an error is cleared or a function extended.

WARNING

Please always comply with the specifications indicated in the following table:

GSDML file version	Encoder HW version	Encoder SW version	User's guide version
20200512	5.2	1.0, 1.1, 1.2, 1.3, 1.4	1.0, 1.1, 1.2, 1.3, 1.4
20230213	5.2	1.4	1.4, 1.5

5.5.2 Installing the GSDML file

In the menu bar of the main window, press **Options** and then **Manage general station description files (GSD)** command.

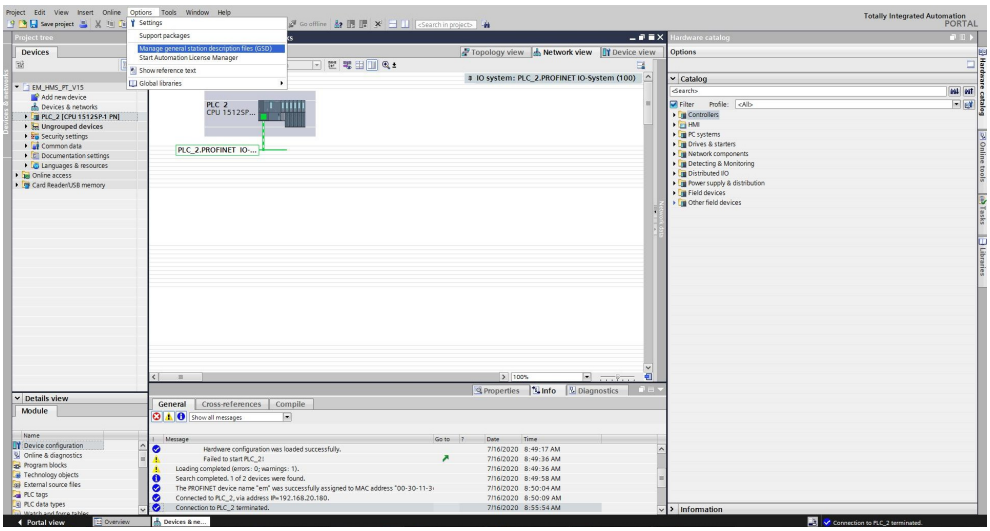


Figure 2 - Installing the GSDML file

The **Manage general station description files** dialog box will appear. Press the **Source path** button to choose the folder where the GSDML file is located. Please make sure that the bitmap file representing the encoder is located in the same folder as the GSDML file. Select the GSDML file specific to the device you need to install and press the **Install** button to install it.

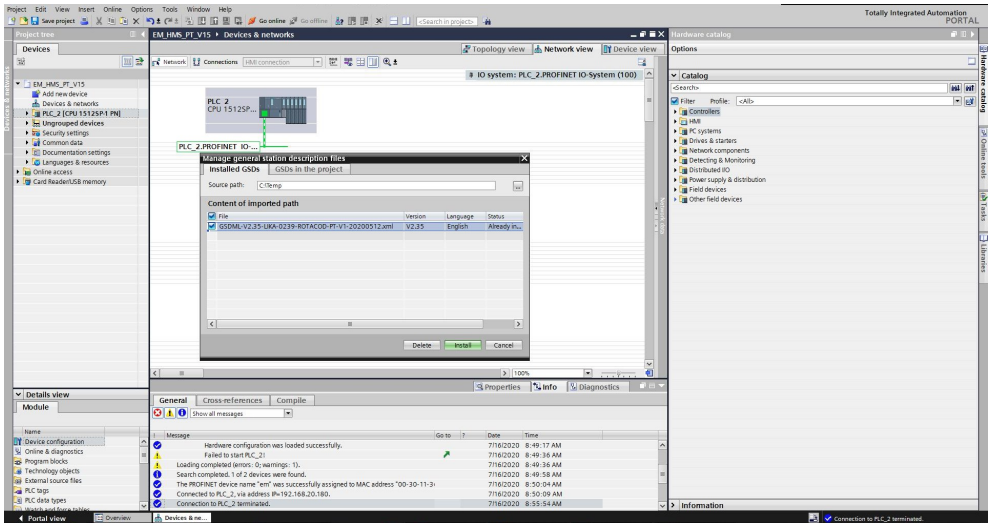


Figure 3 - Selecting the GSDML file

Now scroll through the directory tree in the **Hardware Catalog** pane of the main window (task cards) and select the path **Catalog \ Other Field devices \ PROFINET IO \ Encoders \ Lika Electronic**: the **LIKA ROTACOD** family can be found inside the folder.

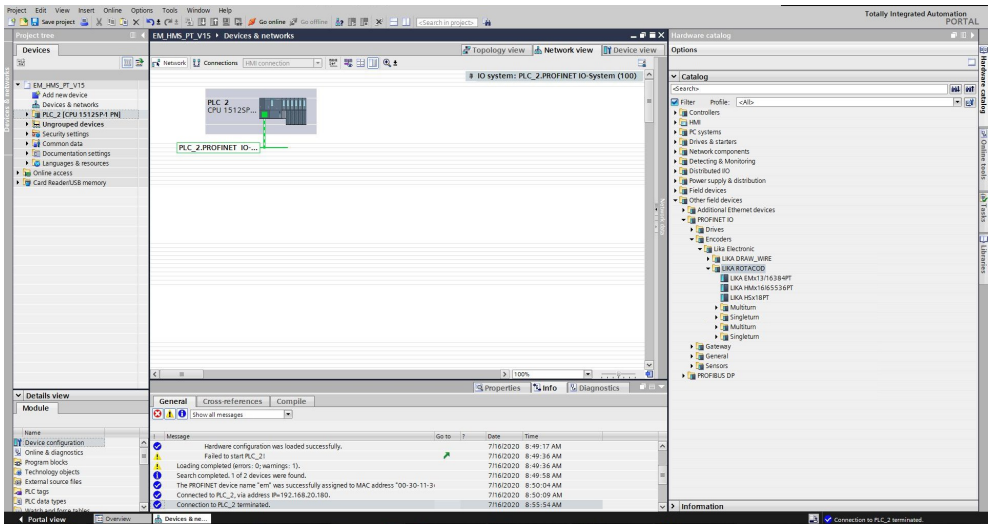


Figure 4 - Scrolling through Profinet families and categories

5.5.3 Adding a node to the project

Now we need to install the module of the desired model. For instance, we want to configure the EMx-13-14-PT2-... model.
In the right pane open the **Hardware catalog** task card to display the field devices integrated into TIA Portal via the Profinet file (GSDML file); select the LIKA ROTACOD directory; drag the required module LIKA EMx13/16384PT to the **Network view** and drop it next to the PLC module. Then assign the module to the network.

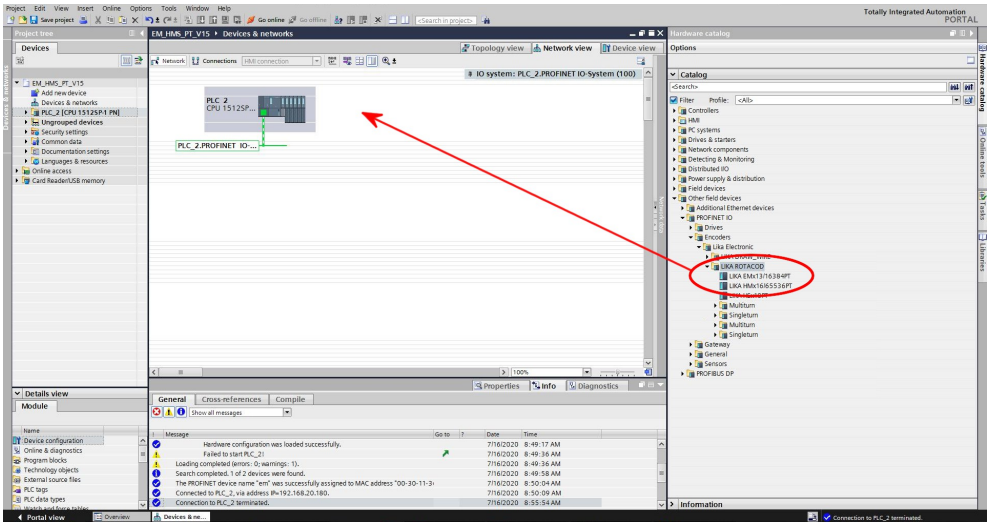


Figure 5 - Adding a node to the project

5.5.4 Establishing the bus connection

As soon as the device has been inserted into the project, the bus connection with the PLC can be established in the **Network view**.
The "**Not assigned**" information message appears in the picture of the node: it warns that the connection between the PLC and the Slave device is not established yet. Right-click on the message and select, through the **Select IO controller** drop-down box, the PLC the node has to be connected to. When doing so, make sure that you are in the **Network** function mode in the **Network view**.

After configuring the networking, the device is connected to the PLC via the Profinet network.

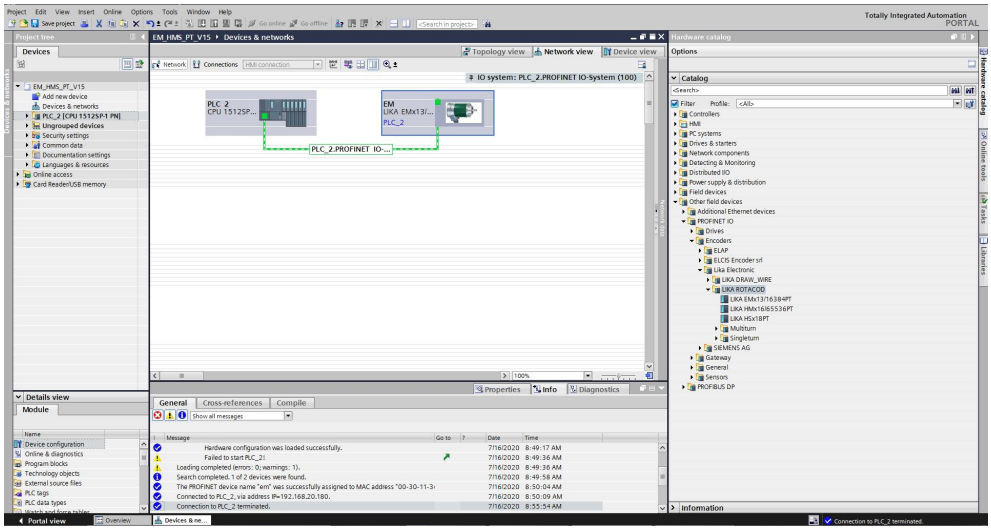


Figure 6 - Establishing the bus connection

5.5.5. Inserting the telegrams

You are not required to insert the telegrams, as they are installed automatically. Press the **Device view** changeover switch to enter the **Device overview** working area and display the installed telegrams. Two types of telegrams with different characteristics are available: Standard Telegram 81 and Telegram 860. For detailed information on the Telegrams refer to the "7.1 Telegrams" section on page 80.

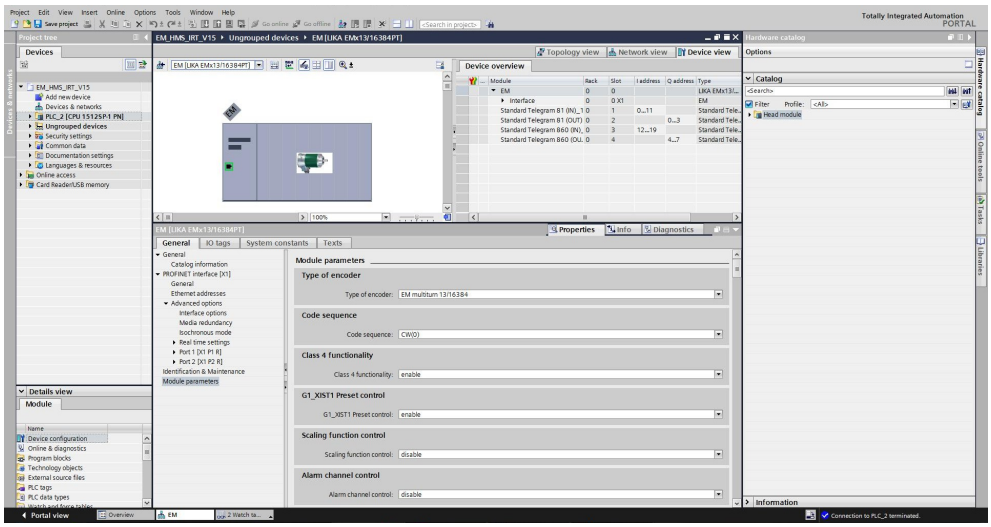


Figure 7 - Telegrams and module parameters

5.5.6 Module parameters

Press the **Device view** changeover switch in the **Hardware and network editor** to enter the **Device view** working area, then select the device you need to configure in the drop-down box on the top left of the graphic area. Select the **Module Access Point** field in **Device view**. In the **Properties** inspector window, **General** tab, press the **Module parameters** menu option to see and set the encoder's parameters if required.
The parameters listed in this page are sent at each switching on.
You can change the value of each parameter in the edit field. The new value will be transmitted to the Device at switching on.
You can change the value of the module parameters also while the device is operational in the Cyclic Data Exchange mode via the Watch table. Please note that the value however will be overwritten at switching on by the value set in the **Module parameters** tabbed page.

For a comprehensive description of the parameters and how to set them properly refer to the specific explanation in the "Encoder parameters" section on page 93.

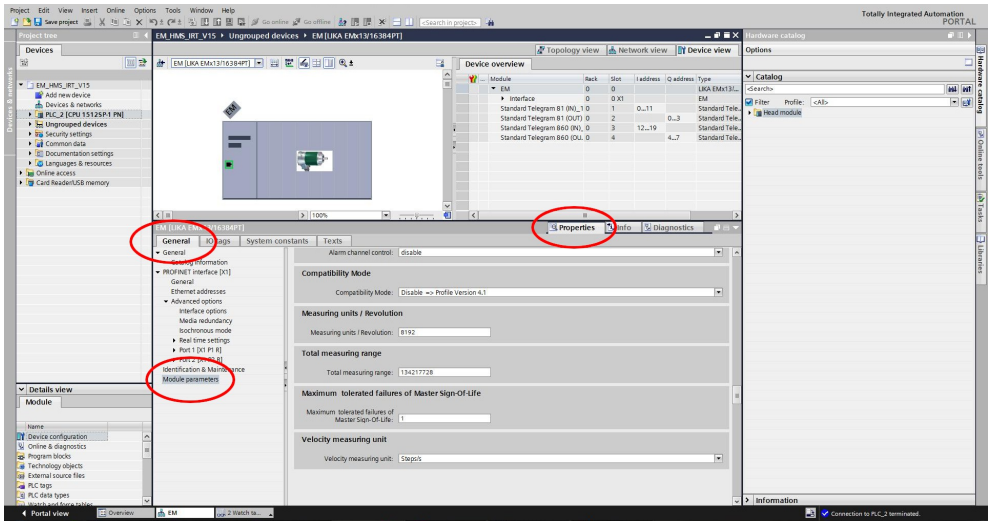


Figure 8 - Module parameters

5.5.7 Device name and IP address at delivery

In a Profinet network it is mandatory that each IO device is provided with its own Device name and IP address. By default, before delivery the device name of the encoder is set to a **blank string** and its IP address is set to **0.0.0.0**.

Before the PROFINET IO controller can address a PROFINET IO device, a name has to be assigned to the PROFINET IO device. PROFINET uses this method because names are easier to use and recall than complex IP addresses. Devices on an Ethernet subnet must have unique names.

NOTE
An IO Device does not have a device name when delivered. By default, the device name of Lika's Profinet encoders is set to a **blank string**.

The device names must satisfy DNS (Domain Name System) conventions:

- Names are limited to a total of 127 characters (letters, numbers, dashes or dots).
- Any component part (that is, a character string between two dots) of the device name may only be up to 63 characters long.
- Names cannot contain any special character such as umlauts, parentheses, underscores, forward or backward slashes, empty spaces, etc. The dash is the only special character allowed.
- Names must neither start nor end with the minus "-" sign.

5.5.8 Setting the device name and the IP address

As stated, to completely establish the connection, you have to assign the IP address and the Profinet device name to the Slave device. To do so, enter the **Device view** working area, select the device you need to configure in the drop-down box on the top left of the graphic area, right-click on the image of the module and select the **Properties** command from the shortcut menu (or the **Assign device name** command as an alternative).

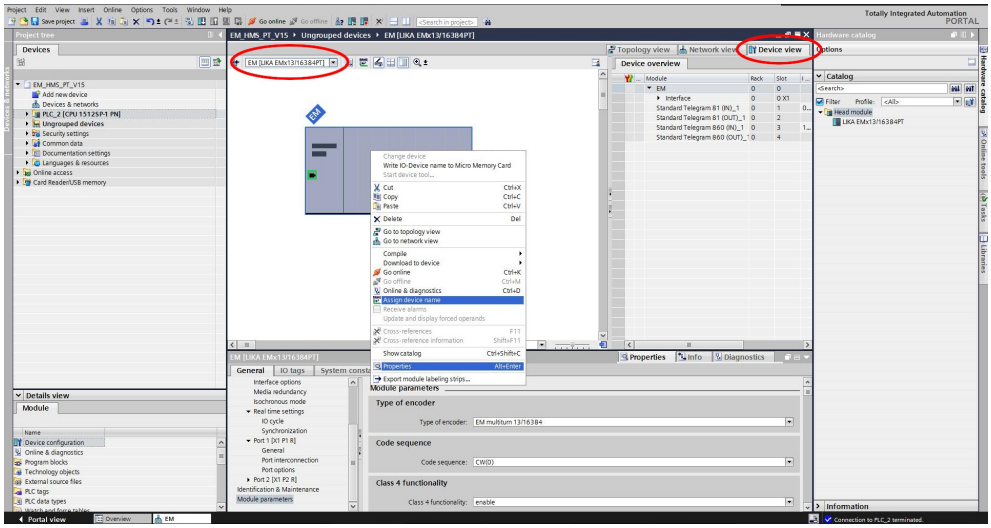


Figure 9 - Setting the device name and IP address

In the **Properties** inspector window, **General** tab, you can now use the **Ethernet addresses** menu option to set the Ethernet address (IP address, subnet mask, ...) and assign the Profinet name of the Device.

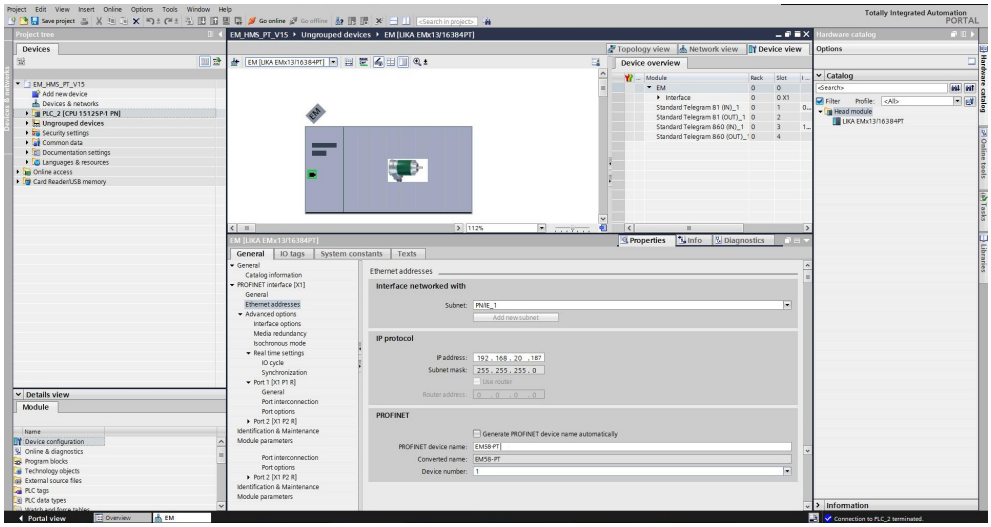
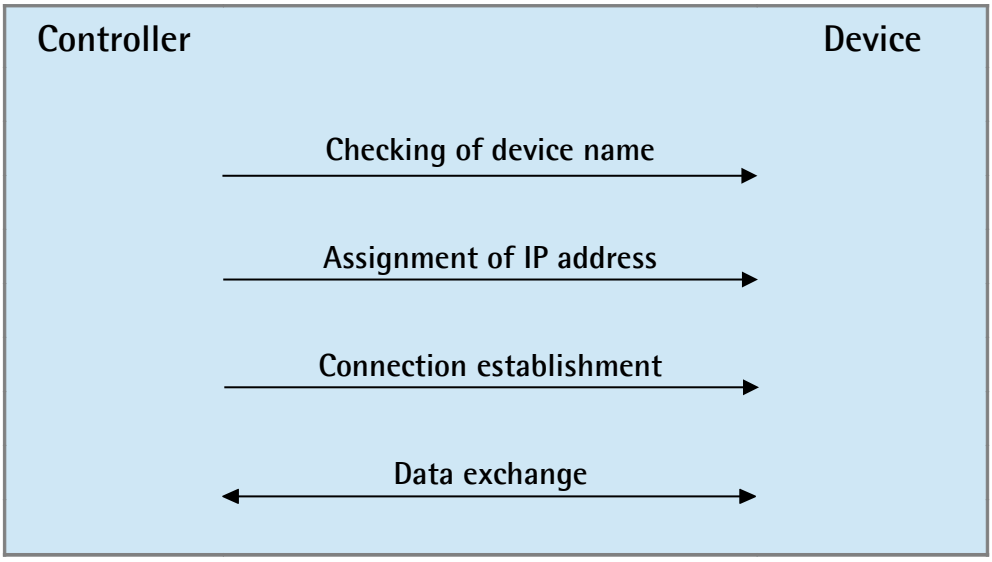
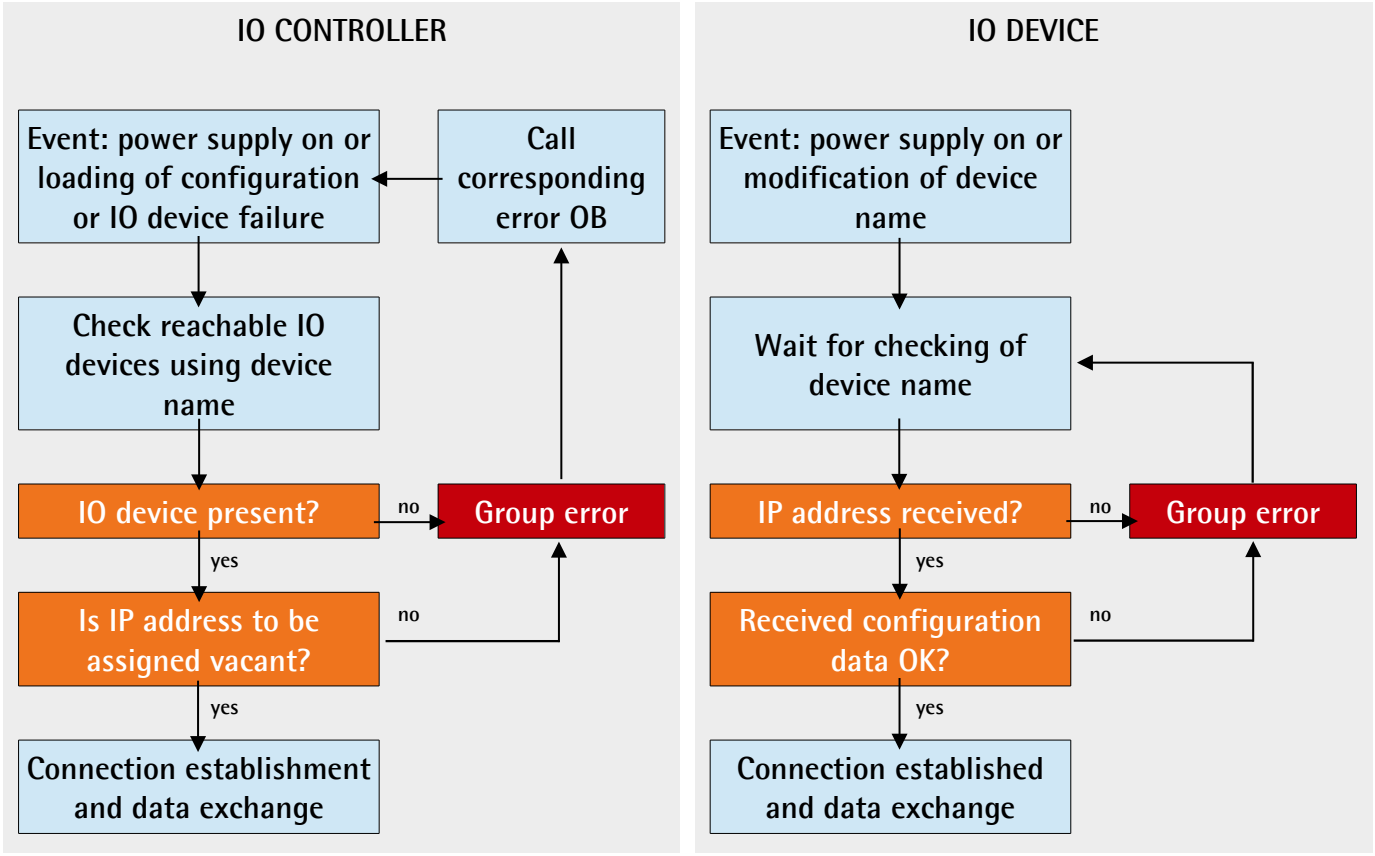


Figure 10 - Setting the device name and IP address

Steps for system start-up



Start-up response



5.5.9 Compiling and transferring the project

After setting you must compile and then transfer the project to the device.

5.5.10 Establishing an online connection (Online mode)

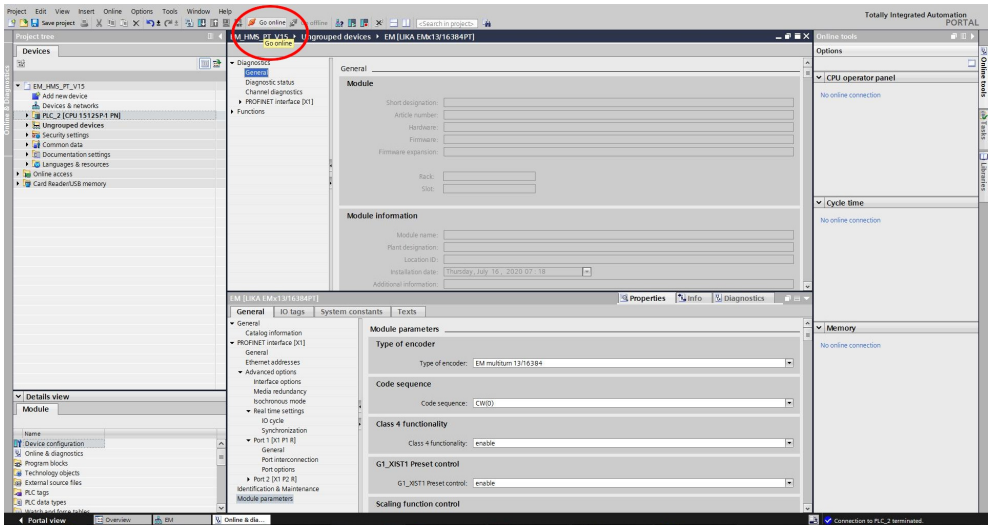


Figure 11 - Establishing an online connection

In online mode, there is an online connection between the PLC and one or more devices. An online connection between the PLC and the device is required, for example, for the following tasks:

- Using the Control Table
- Testing user programs
- Displaying and changing the operating mode of the device
- Displaying module information
- Comparing blocks
- Hardware diagnostics

Before you can establish an online connection, the PLC and the device must be physically or remotely connected.
After establishing a connection, you can use the **Online and Diagnostics view** or the **Online tools** task card to access the data on the device. The current online status of a device is indicated by an icon to the right of the device in the **Project Tree**.

To establish an online connection between the PLC (Profinet Controller) and the device (Profinet Device) proceed as follows.

- In the **Project Tree** (see point 4 in the "5.2.2 Project overview" section on page 41) mark the folder of the PLC that is configured as the Controller.
- Select the **Go online** command in the **Online** menu bar to establish an online connection to the PLC (Controller) and to the device (Device).
- If the device has already been connected online, the online connection is automatically established using the previously specified connection path.
- If there was no previous connection, the **Go online** dialog opens.
- Select the connection path:
  - select the type of interface;
  - select the interface of the PLC;
  - select the interface or the subnet for the connection.
- Click the **START SEARCH** button. Devices which can be reached by the set connection path are displayed in the **Compatible devices in target subnet**. The connection line in the graphic is displayed as solid.
- Select the device in the **Compatible devices in target subnet table** and confirm the selection with **Go online**. The online connection to the selected target device is established.

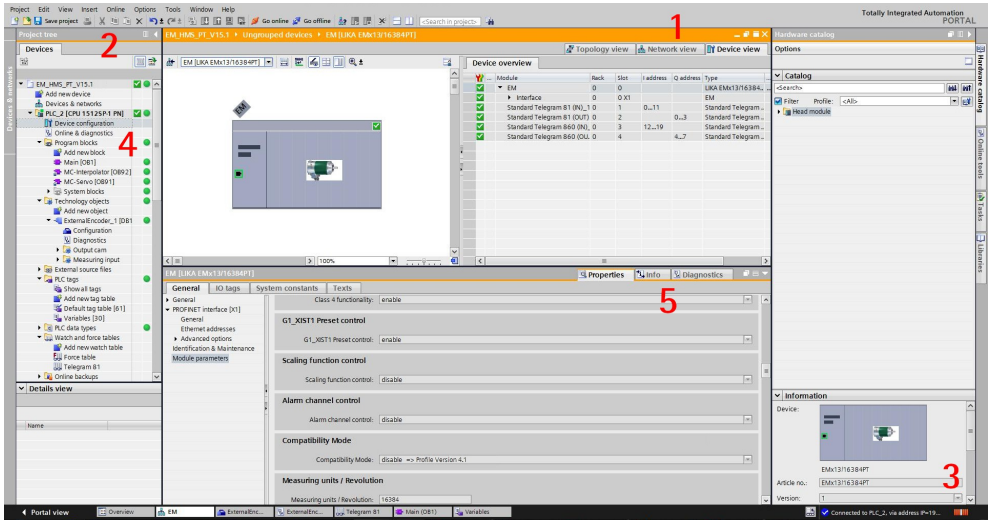


Figure 12 - Online connection established

After the online connection has been established successfully, the user interface changes (see the Figure above).

1. The title bar of the active window gets an orange background as soon as at least one of the devices currently displayed in the editor has been successfully connected online. If one or more devices are unavailable, a symbol for a broken connection appears in the title bar of the editor.

2. Now the title bars of inactive windows for the relevant station have an orange line below them.
3. An orange, pulsing bar appears at the right-hand edge of the status bar. If the connection has been established but it is not working properly, an icon for an interrupted connection is displayed instead of the bar. You will find more information on the error in **Diagnostics** in the **Inspector window**.
4. Operating mode symbols or diagnostics symbols for the stations connected online and their underlying objects are shown in the **Project Tree**. A comparison of the online and offline status is also made automatically. Differences between online and offline objects are also displayed in the form of symbols.
5. The **Diagnostics > Device information** area is brought to the foreground in the **Inspector window**.

5.5.11 Closing an online connection

To close the existing online connection, follow these steps.

1. Select the device for which you want to disconnect the online connection in the **Project Tree**.
2. Select the **Go offline** command in the **Online** menu bar. The online connection is disconnected.

5.5.12 Diagnostics

Configuration of the diagnostics is integrated in the system in a user-friendly way and activated with just one click. When new hardware components are introduced, the diagnostic information is updated automatically via the engineering system (HWCN). System diagnostics outputs all relevant information on existing errors in the system. This information is packaged automatically in messages containing the following elements:

- Module
- Message text
- Message status

To access the diagnostics function please proceed as follows.

1. Right-click on the module to process.
2. Select the **Online & diagnostics** command from the shortcut menu.
3. If there is no online connection established, click the **Connect online** button in the **Diagnostics** entry.
4. The diagnostic status of the module will be displayed in the **Diagnostic status** group in the **Diagnostics** folder in the **Online and diagnostics view** of the module to be diagnosed.

The following status information is displayed in the **Diagnostic status** area:

- Status of the module as viewed by the CPU, for example:
  - Module available and OK.
  - Module defective.
    If the module experiences a fault and you have enabled the diagnostic error interrupt during configuration, the "Module defective" status is displayed.
  - Module configured, but not available.
    Example: Diagnostics data is not available because the current online configuration differs from the offline configuration.
- Detected differences between the configured and the inserted module. Provided it can be ascertained, the article number will be displayed for the set and actual type.

The scope of the displayed information depends on the selected module.

5.6 Resetting the parameters to the default factory values

Default values are provided to each parameter of the device and are preset at the factory by Lika Electronic engineers. The first time you install the encoder, it will operate using the default values. They allow the operator to run the IO device for standard and safe operation. They are plainly not optimized for specific application yet they provide maximum performance for most systems. To suit the specific application requirements it may be advisable and even necessary to enter new parameters instead of the factory default settings.
There could be exceptional circumstances where it would be necessary for you to restore the default values of the settable parameters. When this is the case, you have to use the **Reset** command.

NOTE
When you restore the default values, please always consider that:

- the encoder parameters will be restored to the default values;

- the encoder offset will be reset;
- the Device Name will be lost and replaced with a blank string;
- the IP address will be set to 0.0.0.0;
- the parameters associated with the IP range will be set to 0.

WARNING
The execution of this command causes all the values which have been set previously next to each parameter to be overwritten!

NOTE
The complete list of machine data and relevant default parameters preset by Lika Electronic engineers is available on page 141.

When you need to restore the default values proceed as follows.
Enter the **Device view** working area, select the device you need to configure in the drop-down box on the top left of the graphic area, right-click on the image of the module and select the **Online & diagnostics** command from the shortcut menu (or double-click the **Online & diagnostics** command in the project tree). Confirm your request in the dialog box that appears.

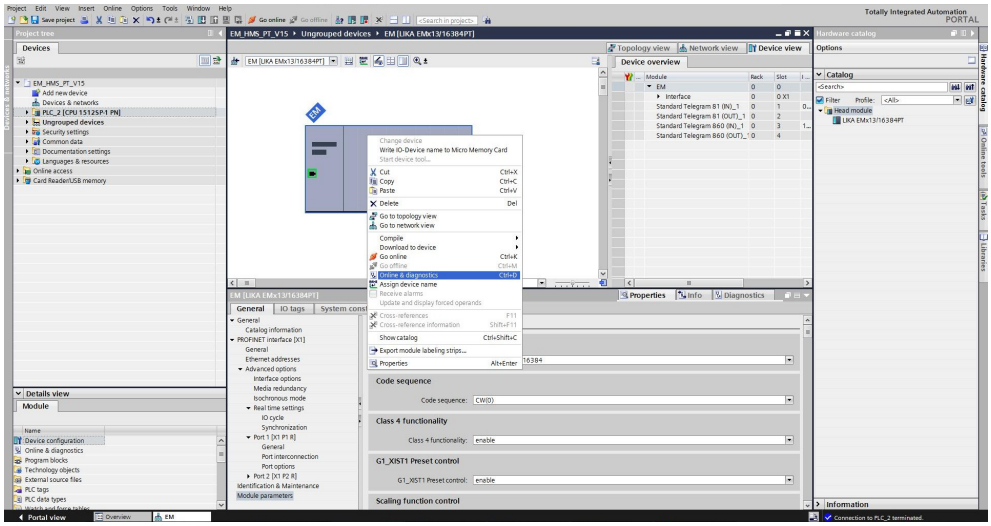


Figure 13 - Restoring default values

To get started with the diagnostic functions you must go online. To do this you must press the **Go online** command in the **Online** menu bar (see also the "5.5.10 Establishing an online connection (Online mode)" section on page 56).

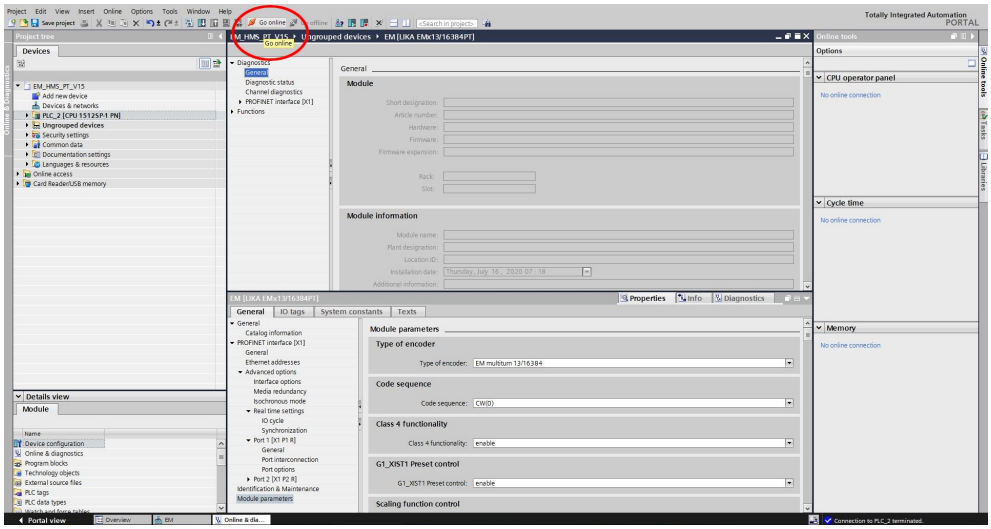


Figure 14 - Going online

The **Diagnostics** working area window contains information about the encoder, statuses, events, etc.
Under **Functions** press **Reset to factory settings**.

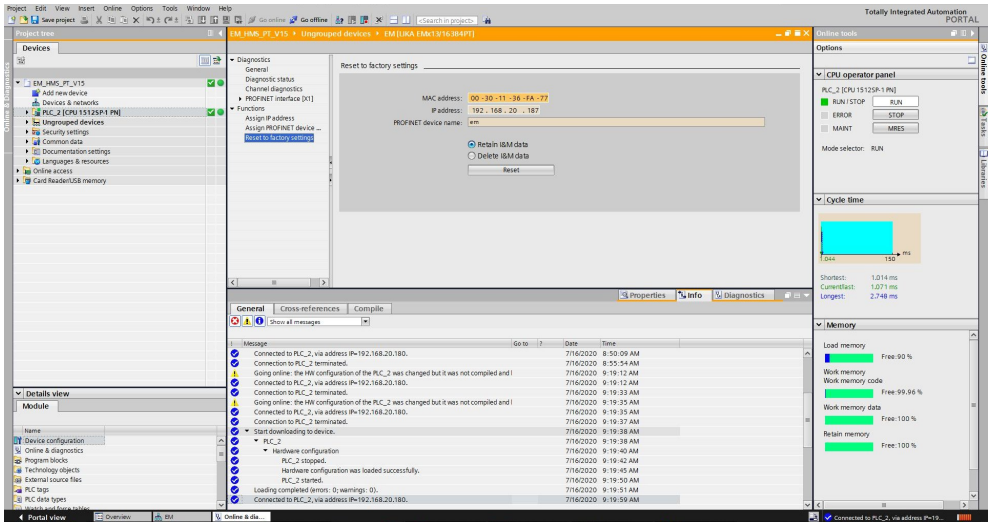


Figure 15 - Reset to factory settings

Enter the MAC address of the encoder you need to reset (it is written on the encoder label) and then press the **Reset** button to confirm.

When the operation is carried out, you will find the value 0.0.0.0 under the **IP address** item and three dashes under the **PROFINET device name** item, they are followed by the message "No device name assigned".

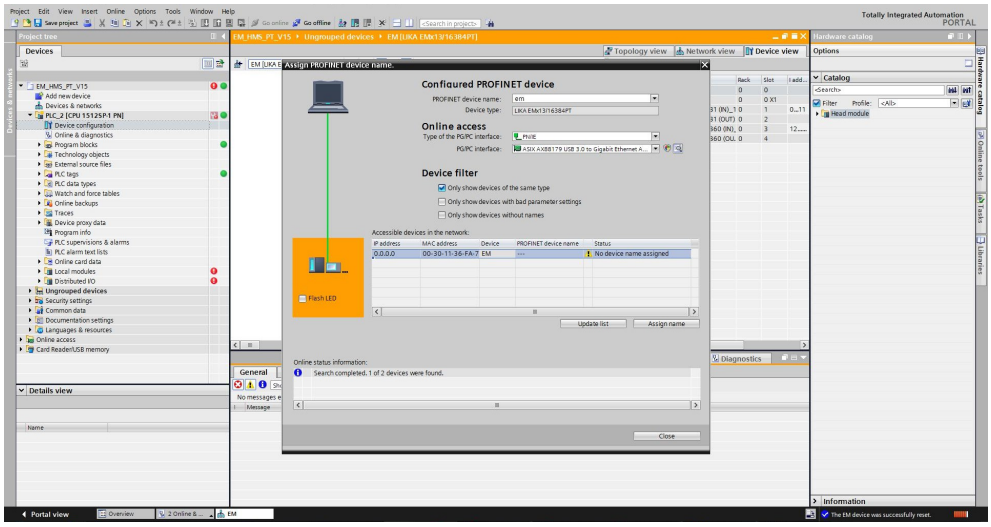


Figure 16 - Encoder reset

5.7 TO Technology Objects

In order to be able to facilitate the use of technological functions that can be used with a SIMATIC controller, what is known as **Technology Objects** have been introduced in the programming environment of SIMATIC. Within these technology objects, the available functions are encapsulated and provided to the creator of the user program for easy access and the easy use in the programming environment.
In particular these technology objects are used in the "motion control" area to simplify the control and handling of axes and additional motion control functionalities and to support the user in the creation of a user program with motion control functionalities.

NOTE
When the encoder is installed as a TO Technology Object, with IRT Isochronous-Real-Time communication (see on page 103) the cycle time must be greater than or equal to 2 ms.

5.7.1 Properties of a technology object (TO)

A technology object (TO) for motion control in the SIMATIC has the following properties:

- The technology object represents a software object in the controller.
- The technology object represents the mechanical components.
- The technology object encapsulates the technological functionality.
- The technology object allows a uniform setting and configuration.
- The technology object ensures a simple connection of the drives and encoders as well as the distributed I/O.
- The technology object encapsulates the mechanical configuration, the monitoring and limitations of the drive and the mechanic that is connected to it.
- The technology object is addressed via PLCopen motion control instructions from the user program.

This guarantees a simple and standardized use of the motion control functionalities in the SIMATIC.

5.7.2 Installing the encoder as a technology object (TO)

First of all, if the encoder has to be used as a TO Technology Object, please set the Compatibility Mode parameter to 0 = Enable = Compatible with Encoder Profile V3.1.

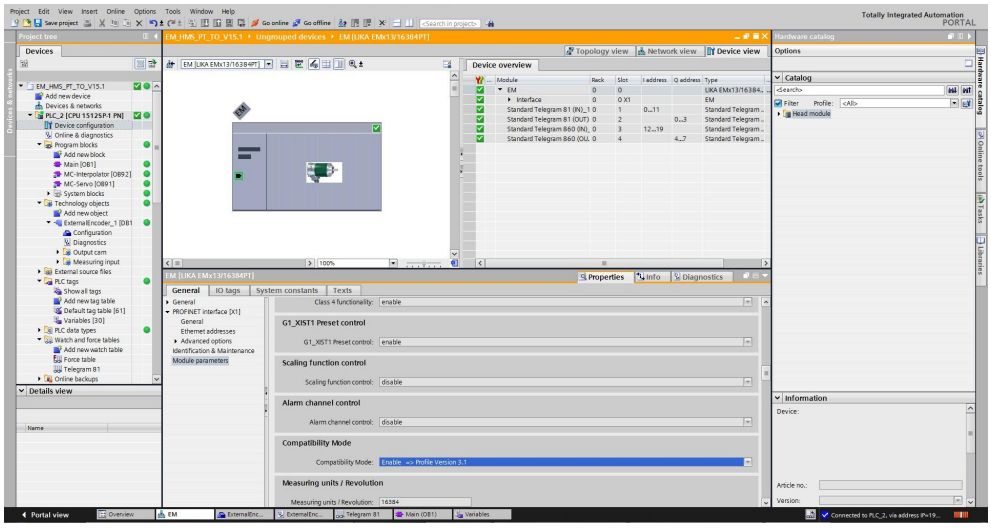


Figure 17 - Checking the Compatibility Mode parameter setting

When you need to add a new technology object, click **Add new object** under the **Technology objects** item in the project tree: the **Add new object** dialog box will be displayed.

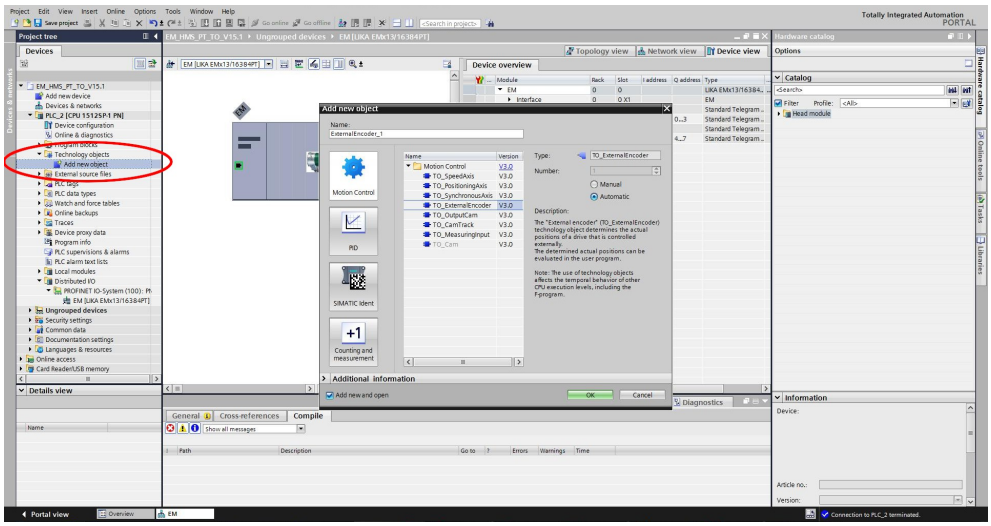


Figure 18 - Adding a new technology object

In the **Add new object** dialog box, select the entry **TO_ExternalEncoder** under the **Motion Control** list. Press **OK** to confirm.

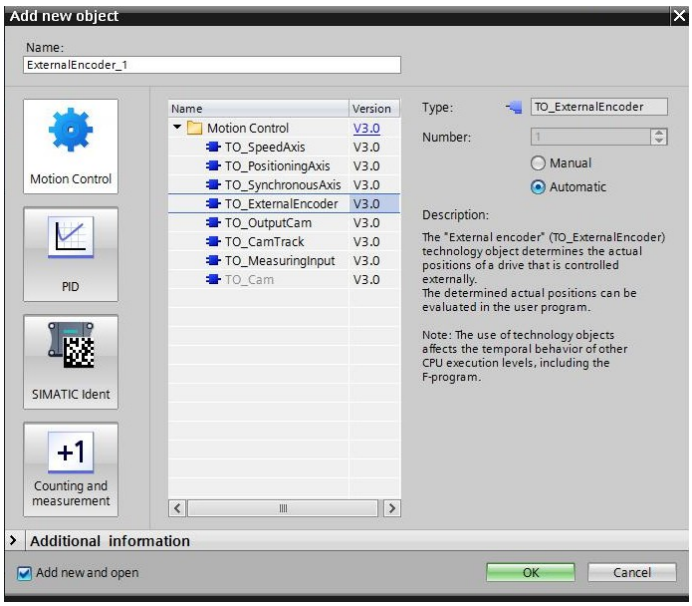


Figure 19 - Adding External Encoder technology object

Under **Basic parameters** in the **Function view** working area set the available items according to the technical features of the encoder to be connected.
Please note that when a new object is successfully added, the object node is added to the Project tree and the configuration for this newly added device is opened.

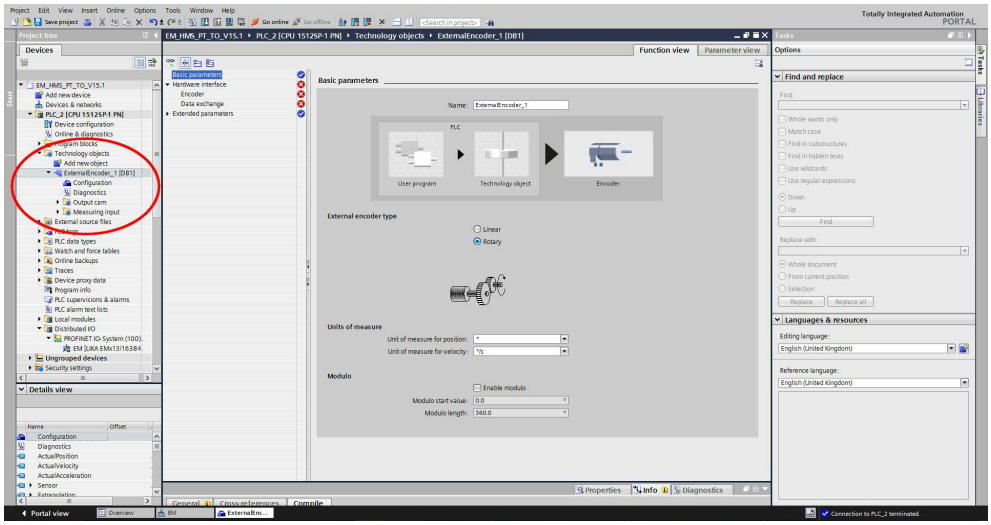


Figure 20 - Setting the TO basic parameters

Under **Hardware interface** set both the **Encoder** parameters and the **Data exchange** parameters. Select the telegrams to be used and set the singleturn resolution and the number of revolutions. In the example an EM58-13-14-PT2-... encoder is to be connected as TO.

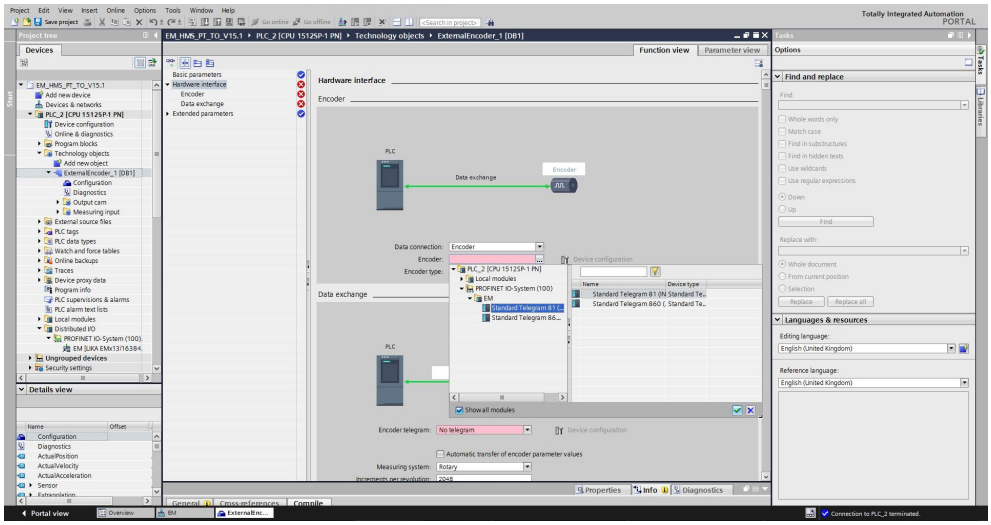


Figure 21 - Setting the TO hardware interface

As soon as the parameters are set, some green ticks will appear in the lateral bar to indicate the proper configuration.

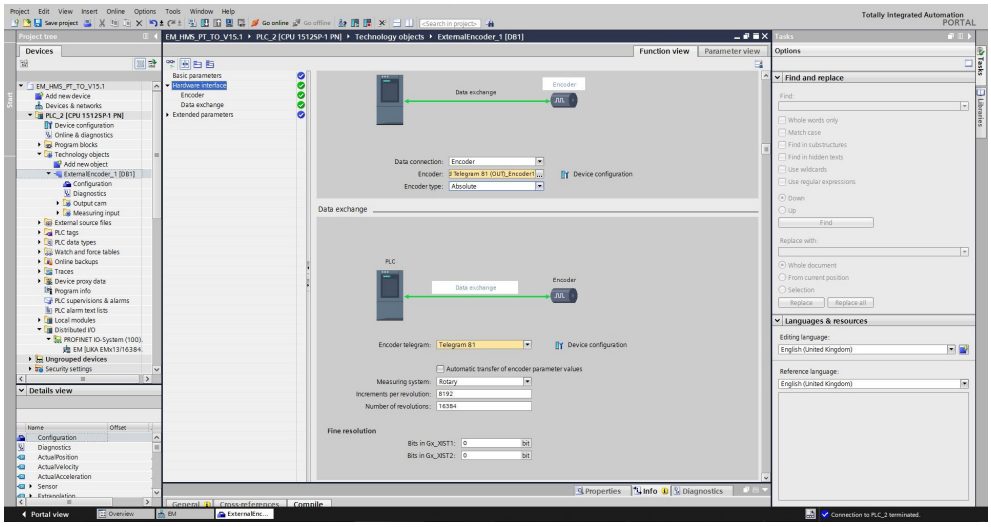


Figure 22 - TO configured

The page will appear as in the following detailed views:

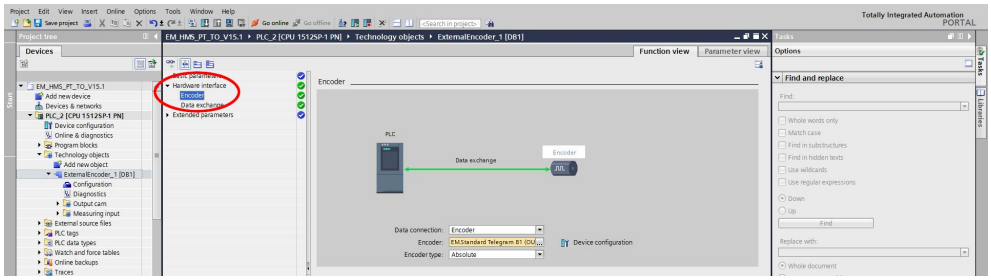


Figure 23 - TO encoder pane

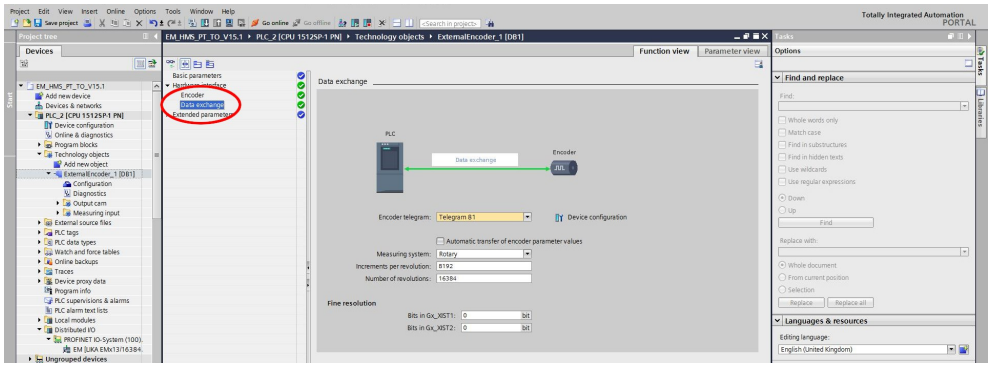


Figure 24 - TO data exchange pane

5.7.3 Using TO V5.0 with active Enable modulo option

WARNING

Please read carefully the following important information about using the TO V5.0 with TIA Portal V16 when the **Enable Modulo** option is selected.

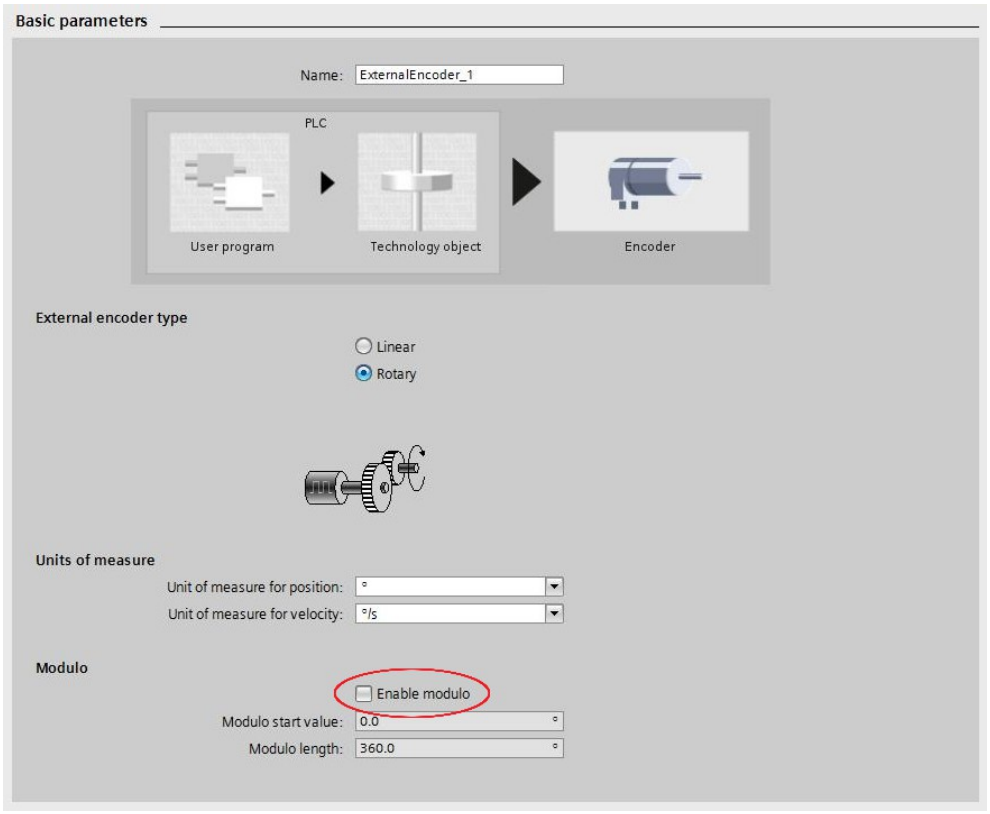


Figure 25 - TO Enable modulo option

The latest TIA Portal V16 development environment has added, among other features, the new TO Technology Object V5.0 and the **BehaviorGx_XIST1** parameter.

The **BehaviorGx_XIST1** parameter is used to set whether the encoder raw value is supplied by the encoder to Gx_XIST1 as an incremental count value with 32 bit data width (**BehaviorGx_XIST1** = 1) or according to the resolution of the encoder (**BehaviorGx_XIST1** = 0).

When the **Enable Modulo** option is selected, to avoid any miscount when the encoder crosses the physical zero point (for instance, in the EM5813/16384 encoder with 27 bit resolution, an error would occur when the count changes from 134,217,727 to 0 or backward from 0 to 134,217,727), the **BehaviorGx_XIST1** parameter must be set to 0.

To set the parameter proceed as follows.

1. Right-click on the TO and then press the **Open DB editor** command in the drop-down menu that appears.

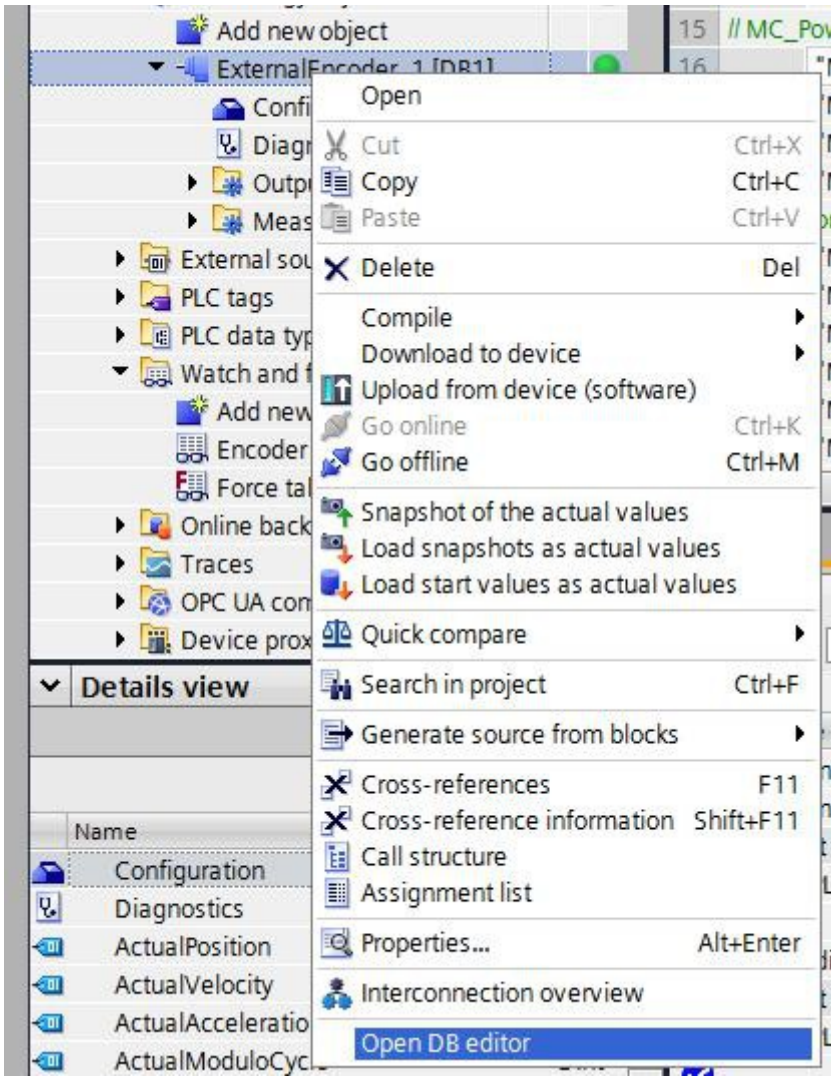


Figure 26 - TO Open DB editor command

2. Select the **BehaviorGx_XIST1** parameter in the TODB page that opens. To reach the parameter see under STATIC → SENSOR → PARAMETER.

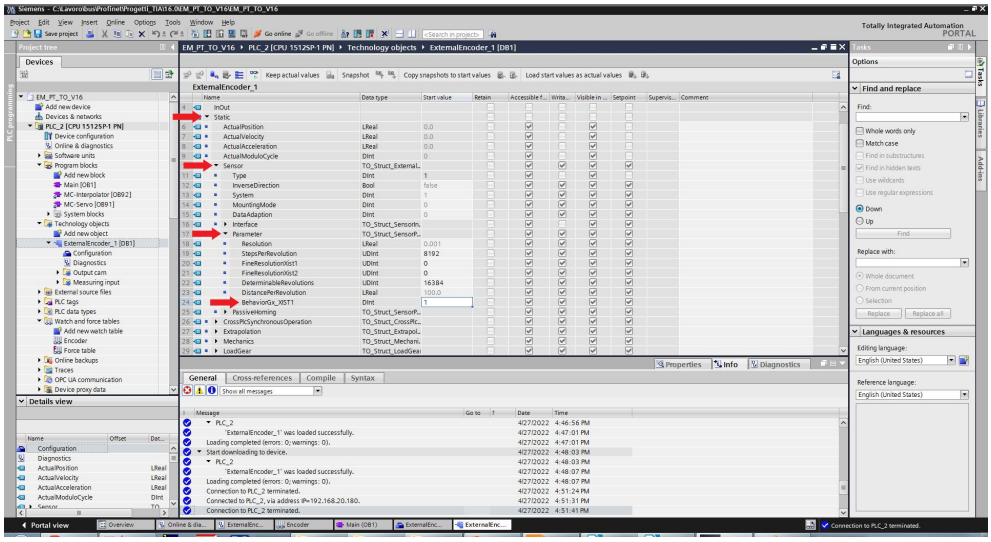


Figure 27 - TO TODB page

3. Check the value in the **BehaviorGx_XIST1** parameter. If it is set to 1, change it to 0.

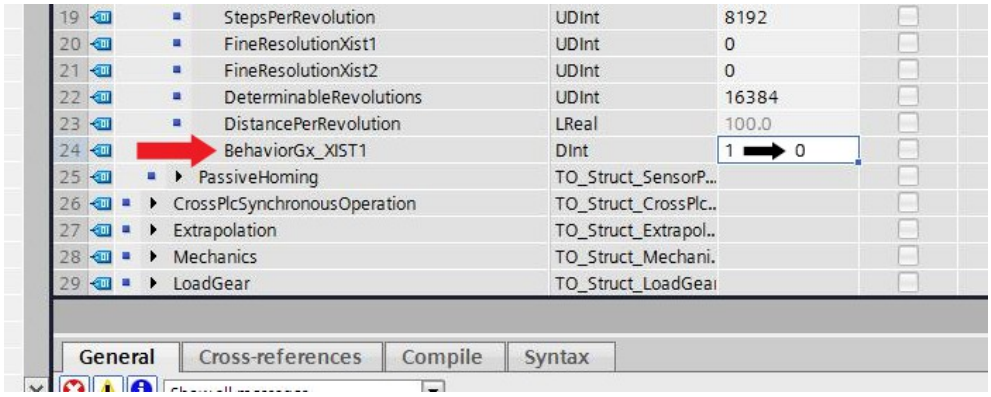


Figure 28 - Setting the BehaviorGx_XIST1 parameter

4. Finally download the project to the CPU by pressing the **Download to device** button in the toolbar; or by pressing the **Online** button in the toolbar and the **Download to device** command in the drop-down menu that appears. The TO has to be selected.

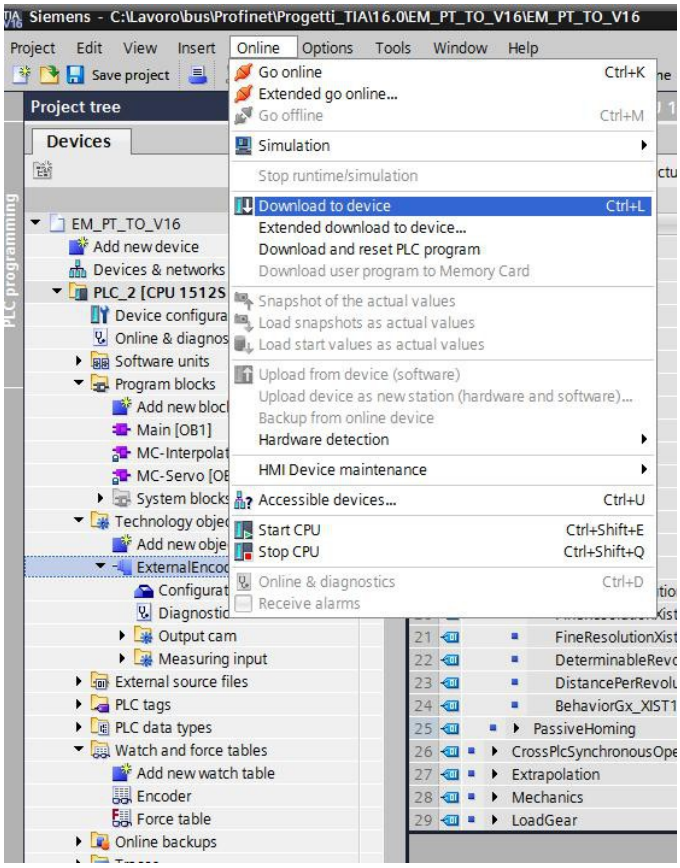
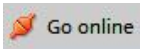


Figure 29 - TO Downloading the project

NOTE

As an alternative you can set the TO to V3.0 or to V4.0. In the TO versions prior to V5.0 the **BehaviorGx_XIST1** parameter is not present and only the data width of the encoder as set in the TO is evaluated.

5.7.4 Downloading the project and going online

After the project has been successfully completed, the controller can be selected and the created program downloaded. To do this press the **Download to device** button in the toolbar. After download is carried out, you can go online by pressing the **Go online** button 

in the toolbar.
Once the online connection to the controller is established, you can enter the diagnostic functions. To do this select the Technology Object and then the **Diagnostics** item in the Project tree.
The **Status and error bits** pane will be displayed.

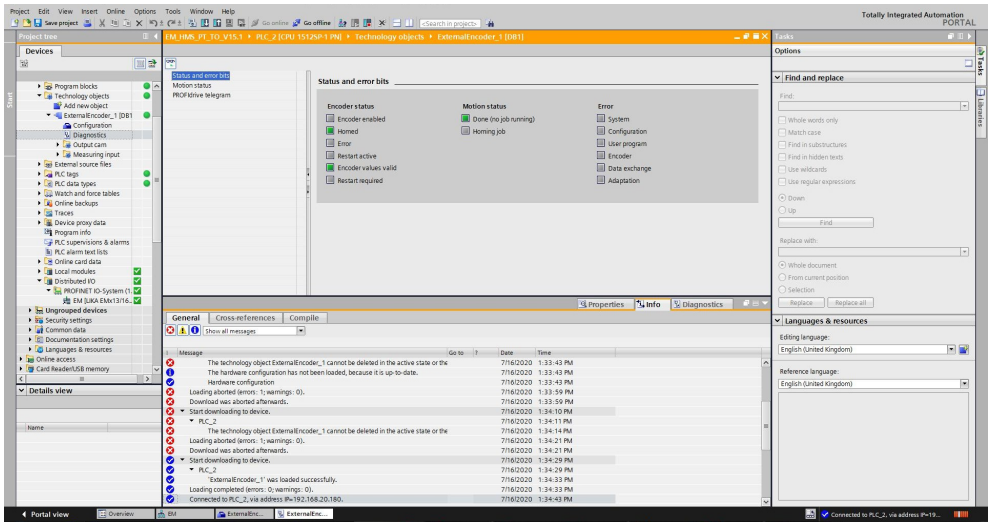


Figure 30 - TO status and error bits pane

5.7.5 Enabling the encoder

Please note that the encoder is disabled now: it must be enabled.

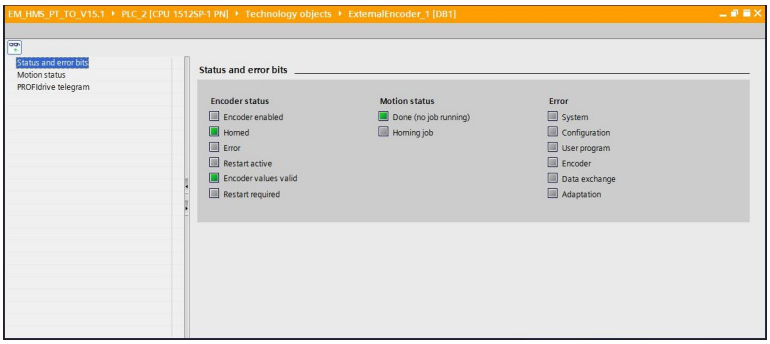


Figure 31 - TO encoder disabled

To enable the encoder select the **Watch and force tables** and then the **Telegram 81** item in the Project tree. The **Telegram 81** watch table will be displayed.

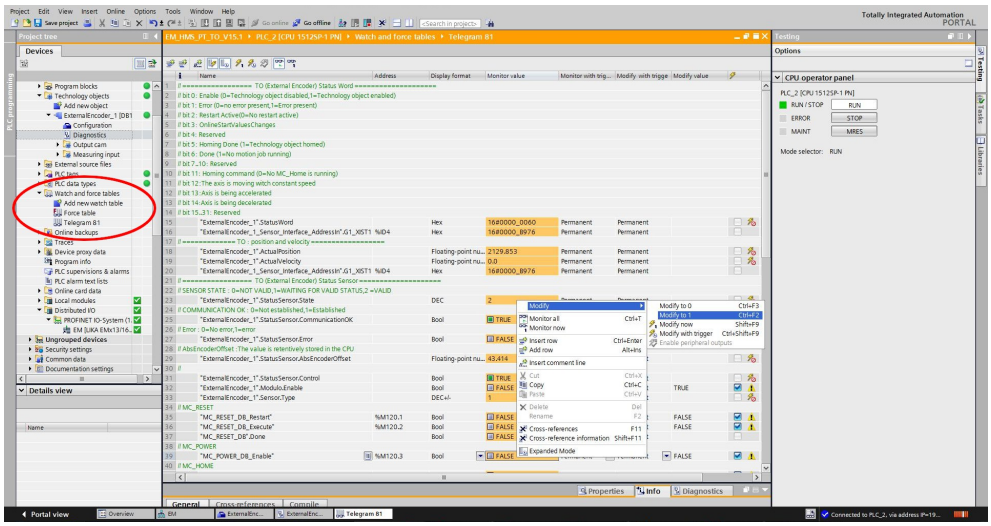


Figure 32 - TO Watch and force tables

Under the section **TO (External Encoder) Status Sensor \ MC_POWER** select the **MC_POWER_DB_Enable** function, right-click on the item in the **Monitor value** column and then press **Modify** and **Modify to 1** commands in the drop-down box that appears.

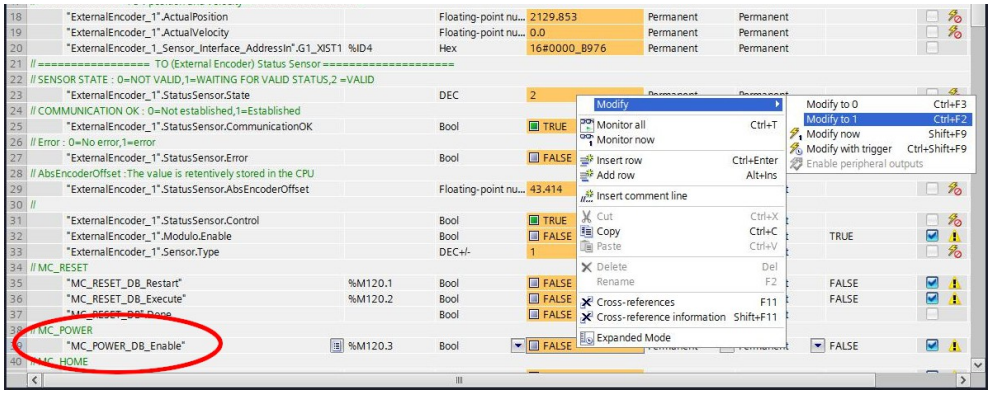


Figure 33 - TO enabling the encoder

In the **Status and error bits** pane check that the encoder is enabled now.

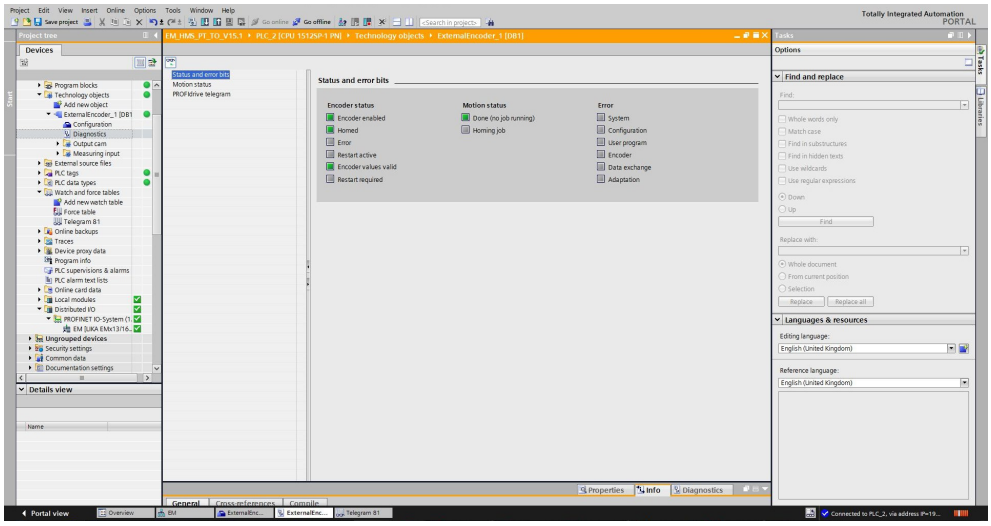


Figure 34 - TO encoder enabled

5.7.6 Setting and activating the preset value

NOTE
We suggest activating the preset value when the encoder is in stop.

Preset function is meant to assign a desired value to a known physical position of the system. The chosen physical position will get the value set next to this index and all the previous and following mechanical positions will get a value according to it.

Open the **Watch and force tables** and select the **Telegram 81** item in the Project tree. The **Telegram 81** watch table will be displayed.
Please check the current position of the encoder, see the **ExternalEncoder_1.ActualPosition** under the section **TO position and velocity**. It is "2129.853" currently.
To set the preset value select the **MC_HOME_DB.Position** function under the section **TO (External Encoder) Status Sensor \ MC_HOME** and set a desired value in the **Monitor value** field (for example, "50" in Figure 35). Press **ENTER** to confirm. Then select the **MC_HOME_DB_Execute** function and right-click in the **Monitor value** column. Then press **Modify** and **Modify to 1** commands in the drop-down box that appears. Finally deactivate back the function by using the commands **Modify** and **Modify to 0**.

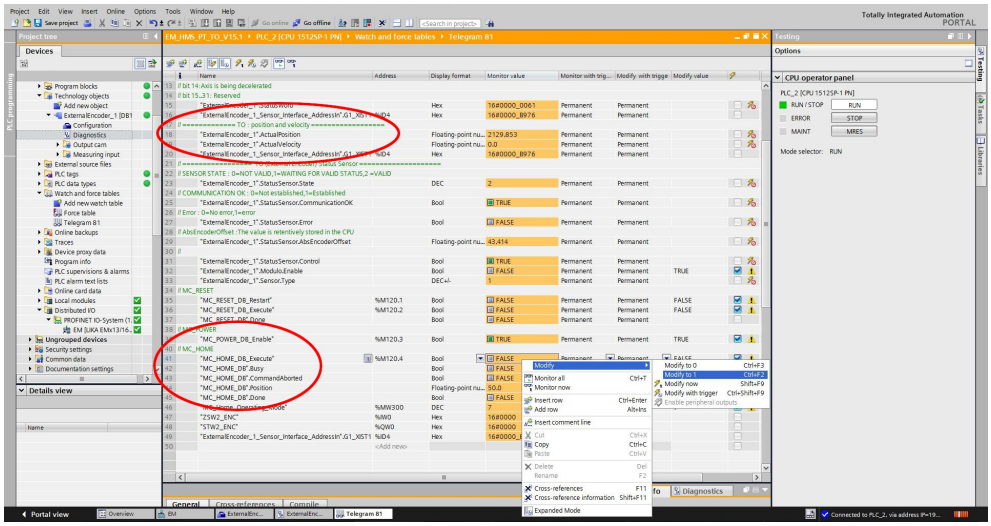


Figure 35 - TO setting and activating the preset

Now check again the current position of the encoder, see the **ExternalEncoder_1.ActualPosition** under the section **TO position and velocity**. It is "50.000" currently.

6 Profinet interface

6.1 A brief introduction to Profinet

PROFINET IO is the open industrial network devised for automation applications and built on the Ethernet application layer (TCP/IP and IT standards). For PROFINET IO the layers 1 through 7a of the ISO/OSI (Open Systems Interconnection) reference model are exclusively based on internationally proven standards. The functionality of PROFINET is defined in layer 7b. PROFINET IO complies with IEEE802.3 Ethernet Standard and follows the standards IEC 61158 and IEC61784, so it is 100% Ethernet compatible.
Its technology development and standardization are entrusted to Profibus & Profinet International (PI), the international umbrella organization including members of more than 1400 companies (**www.profibus.com**).

PROFINET IO is expressly developed to connect controllers (named IO controllers, equivalent to Profibus DP Masters), peripheral devices (named IO devices, similar to Profibus DP Slaves) and programming devices / PCs (named IO supervisors) with Ethernet Real Time (RT) and Isochronous Real Time (IRT) communication all the way. Real Time channel is used for time-critical process data and allows to meet the real-time requirements of the automation engineering (cycle times < 500 µs, jitter < 1 µs); while IRT is suitable for sophisticated motion control and high performance applications in factory automation and permits cycle times lower than 250 µs with less than 1 µs jitter. The standard TCP/IP channel is used for parametrization, configuration and acyclic read/write operations.
A PROFINET IO system requires at least one IO Controller and one IO Device. The most frequent network topologies can be implemented and even mixed together including Star, Line, Tree and Ring structures by means of copper or fiber-optic cables. The number of devices (each one fitted with its own MAC address, IP address and device name) which can be connected in the PROFINET network is virtually unlimited. The transmission rate is 100Mbit/s with full duplex communication (Fast Ethernet).
PROFINET IO Devices are configured using a configuration tool which acts as the IO Supervisor. The IO Supervisor uses a GSD (General Station Description) file based on XML language, thus it is called GSDML file, see on page 45.

6.2 Profinet encoders from Lika Electronic

PROFINET encoders from Lika Electronic fulfil the requirements of the Application Classes 3 and 4, thus they are intended for clock-synchronous (isochronous) real-time applications with cyclic and synchronous data transmission. Anyway they can also be used in applications without clock

synchronization. For detailed information on the application classes refer to the "6.3 Application Class definition" section on page 77.

PROFINET encoders supports the telegrams 81 and 860. Further information can be found in the "7.1 Telegrams" section on page 80.

The IO data is transferred to and from the Encoder Object (EO, see the "6.4 Encoder Object model" section on page 78) via the Cyclic Data Exchange Service. The EO comprises the following mandatory functionalities:

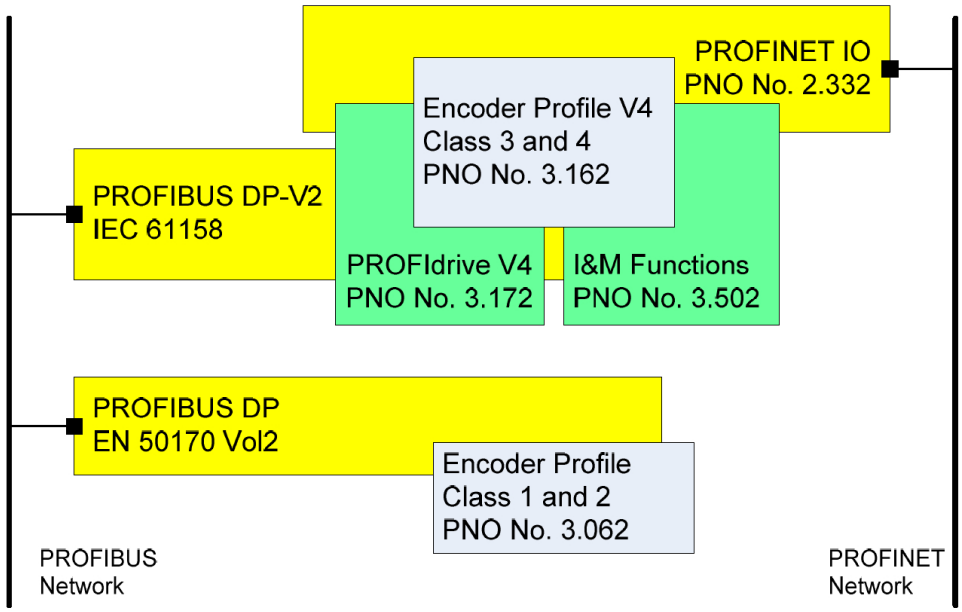
- parameters;
- measuring task (i.e. position value, velocity value, ...);
- IO data (cyclical transmission of control and actual values);
- support for Alarm Mechanism.

Among the parameters available in the Profinet encoders from Lika Electronic: code sequence, scaling function, preset (Class 4 functionalities), position readout, offset value, velocity value, velocity measuring unit, acyclic Error Data communication and diagnostic information.

PROFINET at a glance

Number of stations	Setting the IP-Address	Setting the baud rate	Transmission rate	Cable length	Cable
Virtually unlimited	Software / automatic via DCP	-	100 Mbit/s full duplex	Up to 100 m / 330 ft	M12 D-coded Profinet connectors

6.2.1 Overview of the encoder profiles



6.3 Application Class definition

The encoder supports two application classes: **Class 3** and **Class 4**. A number of mandatory functions are specified for each application class, in addition all optional functions must be recognized by the encoder and handled so that the controller is able to determine whether an optional function is supported.

NOTE
There is no relation between the Encoder application classes and the application classes defined in the PROFIdrive profile.

6.3.1 Application Class 3

Encoder with base mode parameter access and limited parametrization of the encoder functionality. Isochronous mode is not supported.

6.3.2 Application Class 4

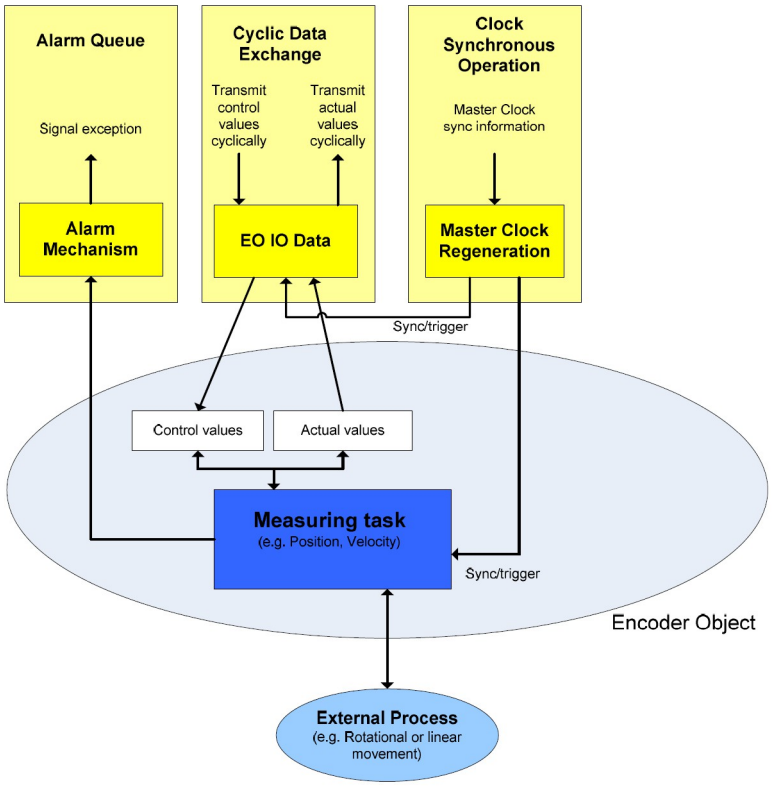
Encoder with scaling, preset, isochronous mode and base mode parameter access. A Class 4 configured encoder fully supports all functionalities.

Lika Electronic encoders fulfil the requirements of CLASS 4

6.4 Encoder Object model

The Figure shows the general Encoder Object (EO) architecture. Central element of the EO is the Measuring Task where the measurements are made and the results are calculated. The properties of the EO is represented and controlled by parameters. The parameters are administered in the Parameter Data Base. For periodic transportation of control values to the EO and actual values from the EO, the Cyclic Data Exchange service is used. Exception situations out of the Measuring Task and the General State Machine may be signalled by the Alarm Mechanism to the controlling device.
The EO shall comprise as minimum mandatory functionality:

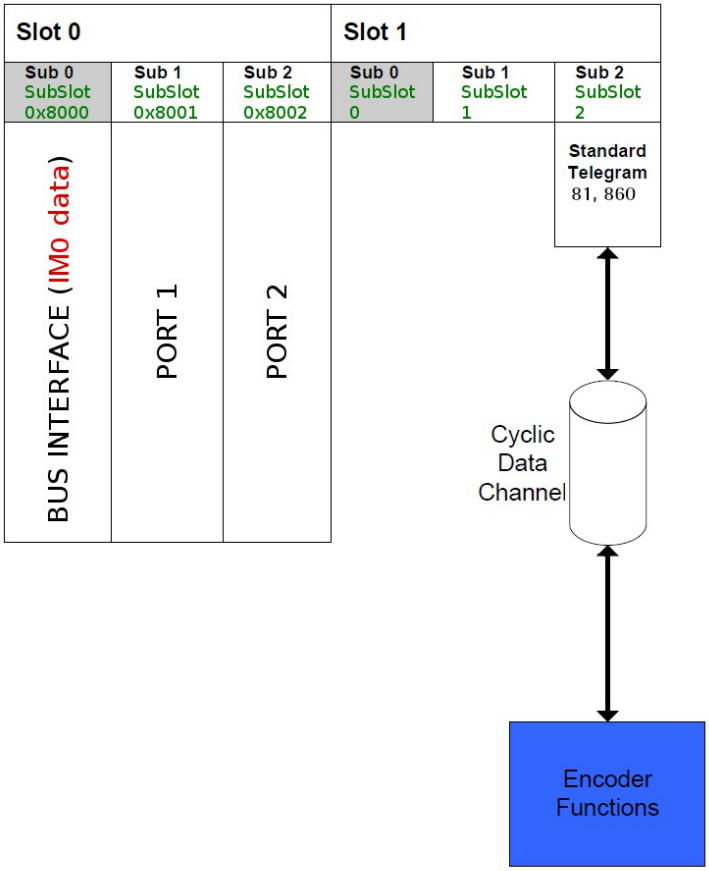
- Parameters;
- Measuring Task;
- IO Data (control value, actual value);
- Support for Alarm Mechanism;
- Optional functionality;
- Clock Synchronous operation.



6.5 Encoder object architecture

The Figure shows the general architecture and the mapping of the Encoder Object (EO) architectural elements to Communication Objects of the Peripheral Device for PROFINET IO. General with PROFINET IO the EO is mapped exactly to one Module/Slot. Slot 0 is exclusively reserved for Device representative purpose and therefore shall not used for any Encoder module. Valid Slot numbers for Encoder Objects are from 1 to 0x7FFF. Every EO contains at least the mandatory Module Access Point (MAP) which is mapped to a dedicated EO representative Submodule. This MAP Submodule contains at least the mandatory Parameter Access Point (PAP) which is mapped to a dedicated Record Data Object. Via the EO representative Submodule (MAP) and the specified Record Data Object the access to the EO parameter manager is possible. The EO parameter manager has access to the EO local Parameter Data Base. In addition to the mandatory MAP submodule, the EO may contain additional submodules which may be used to:

- represent communication end points for IO Data (cyclic data channel) and also to structure the IO Data in data blocks (telegrams, signals).
- represent physical or logical Subobjects of the EO.



7 PROFINET IO data description

7.1 Telegrams

A telegram is a rigidly defined bit stream carrying data. In each telegram the data length and the type of data which is sent to and from the IO controller is specified. PROFINET interface devices communicate and stay in sync by sending telegrams each other. The encoder supports two types of telegrams: Standard Telegram 81 and manufacturer-specific Telegram 860. They are described hereafter. Standard signals are fully described in the "Cyclic Data Exchange – Std signals" section on page 82.

7.1.1 Standard Telegram 81

The Standard Telegram 81 is the default telegram. It uses 4 bytes to output data from the IO controller to the encoder and 12 bytes to input data from the encoder to the IO controller.

Output data CONTROLLER => DEVICE

	2 bytes	2 bytes
IO Data	1	2
Set point	**STW2_ENC**	**G1_STW**

Input data DEVICE => CONTROLLER

	2 bytes	2 bytes	4 bytes		4 bytes	
IO Data	1	2	3	4	5	6
Actual value	**ZSW2_ENC**	**G1_ZSW**	**G1_XIST1**		**G1_XIST2**	

7.1.2 Telegram 860

The Telegram 860 is a manufacturer-specific encoder telegram.
It offers the following functionality:

- 32 bit current position value;
- 32 bit current velocity value;
- using cyclic data, in the **G1_XIST1_PRESET_VALUE** signal a preset value can be entered for the position (it must be executed by forcing high and then low the **Request set/shift of home position** bit 12 in the **G1_STW** control word, see on page 89).

The Telegram 860 uses 4 bytes to output data from the IO controller to the encoder and 8 bytes to input data from the encoder to the IO controller.

Output data CONTROLLER => DEVICE

	4 bytes	
IO Data	1	2
Set point	**G1_XIST1_PRESET_VALUE**	

NOTE
Bit 31 is ignored.

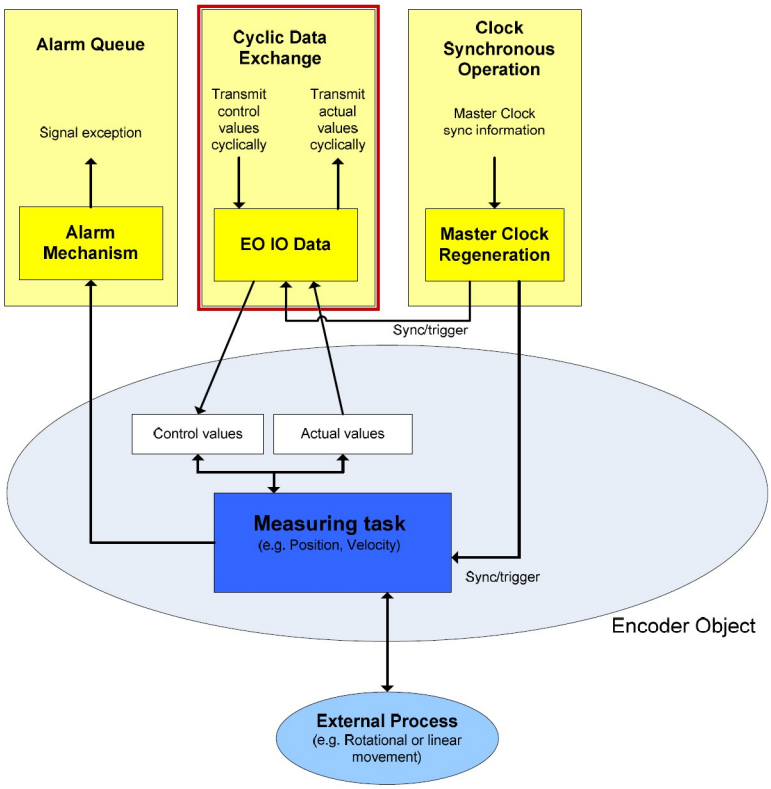
Input data DEVICE => CONTROLLER

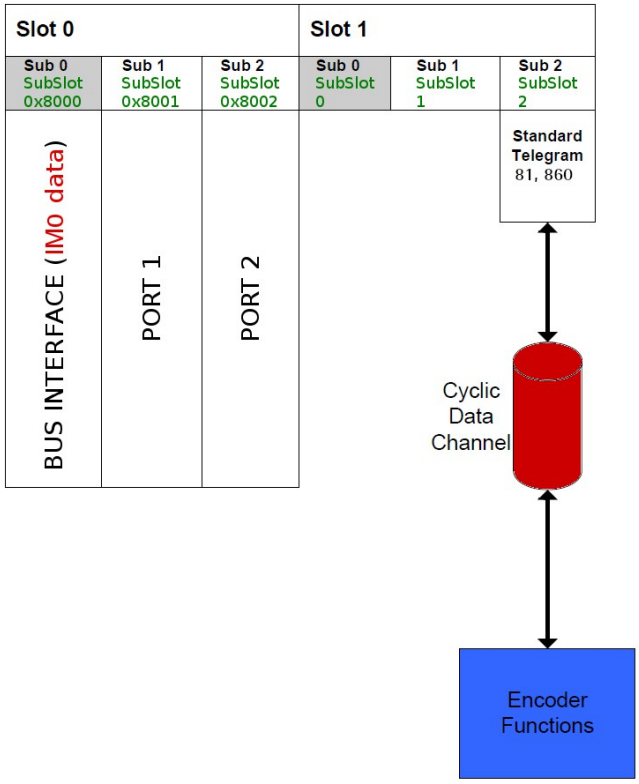
	4 bytes		4 bytes	
IO Data	1	2	3	4
Actual value	**G1_XIST1**		**NIST_B**	

8 Cyclic Data Exchange – Std signals

IO data is transferred via the Cyclic Data Exchange. A series of standard signals is defined to configure the IO data. In the following table the standard signals are summarily described.

Significance	Abbreviation	Length (bits)	Data type	Page
Sensor 1 current position value 1	**G1_XIST1**	32	Unsigned	84
Sensor 1 current position value 2	**G1_XIST2**	32	Unsigned	85
Sensor 1 preset value	**G1_XIST1_PRESET_VALUE**	32	Unsigned	85
Encoder Control word 2	**STW2_ENC**	16	Unsigned	86
Encoder Status word 2	**ZSW2_ENC**	16	Unsigned	87
Sensor 1 Control word	**G1_STW**	16	Unsigned	88
Sensor 1 Status word	**G1_ZSW**	16	Unsigned	91
Speed current value B	**NIST_B**	32	Signed	92


Alarm Queue
Signal exception
Alarm Mechanism
Cyclic Data Exchange
Transmit control values cyclically
Transmit actual values cyclically
EO IO Data
Clock Synchronous Operation
Master Clock sync information
Master Clock Regeneration
Sync/trigger
Control values
Actual values
Measuring task
(e.g. Position, Velocity)
Sync/trigger
Encoder Object
External Process
(e.g. Rotational or linear movement)


Slot 0
Slot 1
Sub 0 SubSlot 0x8000
Sub 1 SubSlot 0x8001
Sub 2 SubSlot 0x8002
Sub 0 SubSlot 0
Sub 1 SubSlot 1
Sub 2 SubSlot 2
BUS INTERFACE (IM0 data)
PORT 1
PORT 2
Standard Telegram 81, 860
Cyclic Data Channel
Encoder Functions

8.1 List of the available standard signals

G1_XIST1

[Unsigned, 32 bits]
It is defined as Sensor 1 current position value 1. This signal is the current (real) absolute position of the encoder expressed in binary notation.

Format definition:

- all values are represented in binary notation;
- the recommended default shift factor is zero (right aligned value) for both **G1_XIST1** and **G1_XIST2**;
- the settings in the encoder parameter data affect the position value in both **G1_XIST1** and **G1_XIST2**.

EXAMPLE
Here follows a format example.
25-bit absolute multiturn encoder, 13-bit singleturn resolution (8,192 counts per revolution), 12-bit multiturn resolution (4,096 revolutions)

M	= Multiturn value, number of revolutions
S	= Singleturn value, number of counts per revolution

MSB LSB

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
							M	M	M	M	M	M	M	M	M	M	M	M	S	S	S	S	S	S	S	S	S	S	S	S	S

Absolute position value in **G1_XIST1**

MSB LSB

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
							M	M	M	M	M	M	M	M	M	M	M	M	S	S	S	S	S	S	S	S	S	S	S	S	S

Absolute position value in **G1_XIST2**

G1_XIST2

[Unsigned, 32 bits]
It is defined as Sensor 1 current position value 2. By default this signal is the current (real) absolute position of the encoder expressed in binary notation yet it has a different meaning if an error is active.

If no error is active:
this signal informs about the current position value of the encoder, provided that the bit **Request absolute value cyclically** (bit 13 of control word **G1_STW**) is set to 1; otherwise this value is 0.

If an error is active:
this signal informs about the active error. For the complete list of the error codes refer to the "8.2 Error codes in G1_XIST2" section on page 92.

Format definition:

- all values are represented in binary notation;
- the recommended default shift factor is zero (right aligned value) for both **G1_XIST1** and **G1_XIST2**;
- the settings in the encoder parameter data affect the position value in both **G1_XIST1** and **G1_XIST2**;
- **G1_XIST2** displays the error telegram instead of the position value if an error occurs.

For the format example see **G1_XIST1** above.

G1_XIST1_PRESET_VALUE

[Unsigned, 32 bits]
Using the **G1_XIST1_PRESET_VALUE** signal, the user can enter a preset value for the encoder via the cyclic data telegram 860 (see on page 80), and activate it by forcing high and then low the **Request set/shift of home position** bit 12 in the **G1_STW** control word, see on page 89.
Preset function is meant to assign a desired value to a known physical position of the system. The chosen physical position will get the value set next to this index and all the previous and following mechanical positions will get a value according to it.
The structure of the **G1_XIST1_PRESET_VALUE** signal is shown below.

NOTE
We suggest activating the preset value when the encoder is in stop.

MSB LSB

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
N	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P

P = preset value (30 bits) for **G1_XIST1** in the format/resolution of **G1_XIST1**.
The preset value must be less than or equal to **Total measuring range** - 1.
N = not used

STW2_ENC

[Unsigned, 16 bits]
It is defined as Encoder control word 2. Control word **STW2_ENC** includes the **Control by PLC** mechanisms from PROFIdrive STW1 and the **Controller Sign-Of-Life** mechanism from PROFIdrive STW2.

Bit	Meaning
0 ... 6	Reserved
7	Not used
8 & 9	Reserved
10	**Control by PLC**
11	Reserved
12 ... 15	**Controller Sign-Of-Life**

Control by PLC
Bit 10
If the **Compatibility Mode** is enabled (see on page 97), then the bit 10 **Control by PLC** is ignored. In this case the control word **G1_STW** and the setpoint are always checked.

If the **Compatibility Mode** is disabled (see on page 97), then the bit 10 **Control by PLC** is checked. So the control word **G1_STW** and the setpoint are checked only if the bit **Control by PLC** is set.

Bit	Value	Significance	Comment
10	1	Control from PLC	Control via interface, EO IO Data is processed.
	0	No control from PLC	EO IO Data not valid, except Sign-Of-Life.

Controller Sign-Of-Life
Bits 12 ... 15

For more information on the control word **STW2_ENC** please refer to the PROFIdrive Technical Specification document.

ZSW2_ENC
[Unsigned, 16 bits]
It is defined as Encoder status word 2. The encoder status word 2 **ZSW2_ENC** includes the Control by PLC mechanism from PROFIdrive ZSW1 and the Slave Sign-Of-Life mechanism from PROFIdrive ZSW2.

Bit	Meaning
0 ... 2	Reserved
3	Not used
4 ... 8	Reserved
9	**Control requested**
10 & 11	Reserved
12 ... 15	**Encoder Sign-Of-Life**

Control requested
Bit 9

Bit	Value	Significance	Comment
9	1	Control Requested	The automation system is requested to assume control.
	0	No Control requested	Control by the automation system is not possible, only possible at the device or by another interface.

Encoder Sign-Of-Life
Bits 12 ... 15

For more information on the status word 2 **ZSW2_ENC** please refer to the PROFIdrive Technical Specification document.

G1_STW

[Unsigned, 16 bits]
It is defined as Sensor 1 control word. This control word controls the functionality of major encoder functions.

Bit	Meaning
0 ... 7	Not used
8 ... 10	Reserved
11	**Home position mode**
12	**Request set/shift of home position**
13	**Request absolute value cyclically**
14	**Activate parking sensor**
15	**Acknowledging a sensor error**

NOTE
If the **Activate parking sensor** is activated (bit 14 = 1) the encoder is still on bus with the slave Sign-Of-Life active and the encoder error and diagnostics switched off.

Home position mode
Bit 11

Request set/shift of home position
Bit 12

The preset function is controlled by bits 11 and 12 in this Sensor 1 control word **G1_STW** and acknowledged by the bit 12 **Set/shift of home position executed** in the sensor status word **G1_ZSW**. The preset value is 0 by default and can be set by using the Telegram 860 and **G1_XIST1_PRESET_VALUE** (see on page 85). The preset function has an absolute and a relative operating mode selectable by means of the bit 11 **Home position mode** in this Sensor 1 control word **G1_STW** (0 = absolute; 1 = relative). Bit 11 and bit 12 in the Sensor 1 control word **G1_STW** control the preset function as described in the table below.

Bit 12	Bit 11	Action
0	X	**Normal operating mode.** The encoder will make no change in the output value.
1	0	**Preset mode absolute** The encoder reads the current position value and calculates an internal offset value from the preset value **G1_XIST1_PRESET_VALUE** and the read position value. The position value is then shifted with the calculated offset value to get the current position value equal to the preset value. The encoder acknowledges the preset by setting the bit 12 **Set/shift of home position executed** in the sensor status word **G1_ZSW**. Now the bit 12 **Request set/shift of home position** in the sensor 1 control word **G1_STW** can be set to zero by the Master. The encoder will end the preset cycle by clearing the bit 12 **Set/shift of home position executed** in the sensor status word **G1_ZSW**. The new internal offset value is securely stored in case of voltage breakdown and uploaded again at each power on.
1	1	**Preset mode relative (offset)** The encoder uses the preset value **G1_XIST1_PRESET_VALUE** as a relative offset value. In this mode the current position value is shifted by the value deriving from the preset value. **EXAMPLE** A preset value "1000" is intended to shift the current position value by 1000 steps in the positive counting direction. So a "real" position value of "5000" will have the value "6000" after the

		relative shifting sequence. The encoder will set the bit 12 **Set/shift of home position executed** in the sensor status word **G1_ZSW** to acknowledge the execution of the shifting. The bit 12 **Request set/shift of home position** in the sensor control word **G1_STW** can now be set to zero by the Master. The encoder will end the preset cycle by clearing the bit 12 **Set/shift of home position executed** in the sensor status word **G1_ZSW**. The internal offset value will be shifted according to the transferred preset value. The new offset value is securely stored in case of voltage breakdown and uploaded again at each power on.

The Preset command automatically saves the calculated internal offset values.

NOTE
Refer also to **G1_XIST1 Preset control** on page 95; and to the "13.2 Preset diagram" section on page 120.

Request absolute value cyclically
Bit 13

Bit	Significance	Comment
13	=1 : **Request absolute value cyclically**	Request of additional cyclic transmission of the current absolute position in **G1_XIST2**.

Activate parking sensor
Bit 14

Bit	Significance	Comment
14	=1 : **Activate parking sensor**	Request to stop monitoring the measuring system and the current value measurements in the drive. This makes it possible to disconnect the encoder from the line without needing to change the drive configuration or causing a fault. In this case all current errors of the encoder are cleared. The

		parking of the encoder while the drive is running is not allowed and will result in a sensor interface error (error code 0x03 in **G1_XIST2**).

See also "13.3 Parking sensor diagram" on page 121.

Acknowledging a sensor error
Bit 15

Bit	Significance	Comment
15	=1 : **Acknowledging a sensor error**	Request to acknowledge a sensor error (bit 15 **Sensor error** of **G1_ZSW**).

G1_ZSW

[Unsigned, 16 bits]
It is defined as Sensor 1 status word. This status word defines the states, acknowledgements and error messages of the encoder and its main functions.

Bit	Meaning
0 ... 9	Not used
10	Reserved
11	**Requirements of error acknowledge detected**
12	**Set/shift of home position executed**
13	**Transmit absolute value cyclically**
14	**Parking sensor active**
15	**Sensor error**

NOTE
If the bit 13 **Transmit absolute value cyclically** or the bit 15 **Sensor error** are not set, there is no valid value or error code transferred in **G1_XIST2**.

NOTE
The bit 13 **Transmit absolute value cyclically** and the bit 15 **Sensor error** cannot be set at the same time as they are used to indicate either a valid position value transmission (bit 13) or the error code transmission (bit 15) in **G1_XIST2**.

NIST_B

[Signed, 32 bits]
It is defined as current velocity value B.
Velocity value is calculated every 100 ms.
Refer also to the **Velocity measuring unit** parameter on page 100.

8.2 Error codes in G1_XIST2

Error codes are sent in **G1_XIST2** if an error occurs. For information about **G1_XIST2** refer to page 85.

G1_XIST2	Meaning	Explanation
0x0F02	Master's sign of life fault	The number of permissible failures of the Master's sign of life was exceeded.
0x0F04	Synchronization fault	The number of permissible failures for the bus cycle was exceeded.
0x1001	Memory error	Error while writing on or reading the internal non volatile memory.
0x1002	Parametrization error	User parameter data assignment error. Example: **Measuring units / Revolution** and **Total measuring range** not compatible.

9 Encoder parameters

9.1 User parameter data

User parameter data listed in the table below is sent to the encoder in the start-up phase.

Parameter	Index	Data Type	Default	Comment
Type of encoder	516	BitArea	0 (EM58-13-14-...) 1 (HS58-18-00-...) 2 (HM58-16-14-...)	Default is according to model
Code sequence	517	Bit	0 (CW)	
Class 4 functionality	518	Bit	1 (enabled)	
G1_XIST1 Preset control	519	Bit	0 (enabled)	
Scaling function control	520	Bit	0 (disabled)	
Alarm channel control	521	Bit	0 (disabled)	Only supported in Compatibility Mode
Compatibility Mode	522	Bit	1 (disabled = profile version V4.1)	
Measuring units / Revolution	523	Unsigned32	8192 (EM58-13-14-...) 262144 (HS58-18-00-...) 65536 (HM58-16-14-...)	Default is according to model
Total measuring range	524	Unsigned32	134217728 (EM58-13-14-...) 262144 (HS58-18-00-...) 1073741824 (HM58-16-14-...)	Default is according to model
Maximum tolerated failures of Master Sign-Of-Life	525	Unsigned8	1	Only supported in Compatibility Mode
Velocity measuring unit	526	BitArea	0 (Steps/s)	

NOTE
Default values are highlighted in **bold** in the following tables.

Type of encoder

[Index 516]

The index contains information about the type of encoder. The default value is according to the specific model.

Attribute	Meaning	Value
EM multiturn 13-14	Installed encoder: EM58, EM58S, EMC58, EMC59, EMC60, resolution: 13 x 14 bits	**0**
HS singleturn 18-00	Installed encoder: HS58, HS58S, HSC58, HSC59, HSC60, resolution: 18 bits	**1**
HM multiturn 16-14	Installed encoder: HM58, HM58S, HMC58, HMC59, HMC60, resolution: 16 x 14 bits	**2**

Default = 0 (min. = 0, max. = 2)

Code sequence

[Index 517]

Code sequence sets whether the absolute position value output by the encoder increases (count up information) when the encoder shaft rotates clockwise (0 = CW) or counter-clockwise (1 = CCW). CW and CCW rotations are viewed from the shaft end. This parameter is processed only if **Class 4 functionality** is enabled.

Attribute	Meaning	Value
CW	Absolute position value increasing (count up information) when the shaft rotates clockwise (viewed from shaft end)	**0**
CCW	Absolute position value increasing (count up information) when the shaft rotates counter-clockwise (viewed from shaft end)	1

Default = 0 = CW (min. = 0, max. = 1)

WARNING

Changing this value causes also the position calculated by the controller to be necessarily affected. Therefore it is mandatory to execute a new preset after setting this parameter.

Class 4 functionality

[Index 518]

For any information on the implemented Application Classes refer to the "6.3 Application Class definition" section on page 77.

If it is enabled, **Code sequence**, **G1_XIST1 Preset control** and **Scaling function control** affect the position value in **G1_XIST1** and **G1_XIST2**. However the preset will not affect the position value in **G1_XIST1** if the parameter **G1_XIST1 Preset control** is disabled; it will always affect **G1_XIST2** instead.

Attribute	Meaning	Value
Disable	**Code sequence**, **G1_XIST1 Preset control** and **Scaling function control** disabled	0
Enable	**Code sequence**, **G1_XIST1 Preset control** and **Scaling function control** enabled	**1**

Default = 1 = enable (min. = 0, max. = 1)

G1_XIST1 Preset control

[Index 519]

This parameter is available only if **Class 4 functionality** is enabled.

This parameter controls the effect of a preset on the **G1_XIST1** current value. When it is enabled, Preset will affect the position value in **G1_XIST1**.

Attribute	Meaning	Value
Enable	**G1_XIST1** is affected by a Preset command	**0**
Disable	Preset does not affect **G1_XIST1**	1

Default = 0 = enable (min. = 0, max. = 1)

WARNING

G1_XIST1 Preset control is disabled by setting the value 1.

NOTE

There is no functionality of this parameter if the **Class 4 functionality** parameter is disabled.

Scaling function control

[Index 520]

This parameter enables / disables the Scaling function. When this parameter is disabled, the device uses the **hardware** singleturn and multiturn resolutions; when it is enabled, the device uses the resolutions set next to the parameters **Measuring units / Revolution** and **Total measuring range**. Refer also to the "Scaling function parameters" section on page 98.

Attribute	Meaning	Value
Disable	Scaling function disabled	**0**
Enable	Scaling function enabled	1

Default = 0 = disable (min. = 0, max. = 1)

NOTE

There is no functionality of this parameter if the **Class 4 functionality** parameter is disabled.

Alarm channel control

[Index 521]

This parameter enables / disables the encoder specific Alarm channel transferred as Channel Related Diagnosis. This functionality is used to limit the amount of data sent in isochronous mode.

If the value is zero (0 = default value), only the communication related alarms are sent via the alarm channel. If the value is one (1), also the encoder specific faults and warnings are sent via the alarm channel.

Attribute	Meaning	Value
Disable	No profile specific diagnosis	**0**
Enable	Profile specific diagnosis	1

Default = 0 = disable (min. = 0, max. = 1)

NOTE

This parameter is only supported in compatibility mode (see **Compatibility Mode** on page 97).

Compatibility Mode

[Index 522]

This parameter defines whether the encoder has to run in a mode compatible with Version 3.1 of the Encoder Profile. See the table below for an overview of the functions affected when the compatibility mode is enabled.

Attribute	Meaning	Value
Enable	Compatibility with Encoder Profile V3.1	0
Disable	No backward compatibility, compatible with Encoder Profile V4.1	**1**

Default = 1 = disable (min. = 0, max. = 1)

Function	Compatibility mode Enabled (=0)	Compatibility mode Disabled (=1)
Control by PLC (STW2_ENC)	Ignored. The control word **G1_STW** and setpoint values are always valid. **Control requested (ZSW2_ENC)** is not supported and is set to 0	Supported
User parameter **Maximum tolerated failures of Master Sign-Of-Life**	Supported	Not supported. One Sign-Of-Life failure tolerated.
User parameter **Alarm channel control**	Supported	Not supported. The application alarm channel is active and controlled by a PROFIdrive parameter

WARNING

If the encoder is used as a TO Technology Object (see the "5.7 TO Technology Objects" section on page 62), **Compatibility Mode** parameter must be set to 0 = Enable = Compatible with Encoder Profile V3.1.

Scaling function parameters

Using the scaling function parameters the absolute position value of the encoder is converted by the software in order to customize the resolution of the encoder according to needs. The scaling parameters will only be activated if the parameters **Class 4 functionality** and **Scaling function control** are enabled.
The permissible range for the scaling parameters is limited by the hardware resolution of the encoder.

EXAMPLE
In a 27-bit encoder having a singleturn resolution of 13 bits (8,192 cpr) and a number of revolutions of 14 bits (16,384 revolutions), the permissible value for the **Measuring units / Revolution** is between 2^0 and 2^{13} (2^{13} = 8,192) while the permissible value for the **Total measuring range** is between 2 and 2^{27} (2^{27} = 2^{13} * 2^{14} = 134,217,728).

Measuring units / Revolution

[Index 523]
It is used to program a user specific resolution per each revolution (singleturn resolution). Allowed values are less than or equal to the hardware counts per revolution (physical singleturn resolution). We suggest setting values that are a power of 2 (1, 2, 4, ... 2048, 4096, ...). See the parameter **Total measuring range** below.

Default =	8192 (min. = 1, max. = 8,192)	for EM58 series
	262144 (min. = 1, max. = 262,144)	for HS58 series
	65536 (min. = 1, max. = 65,536)	for HM58 series

NOTE
There is no functionality of this parameter if the **Scaling function control** parameter is disabled.

EXAMPLE
The HS58-18-00-PT2-... singleturn encoder has a singleturn resolution of 18 bits (262,144 cpr); the permissible value for the **Measuring units / Revolution** will be between 2^0 and 2^{18} (2^{18} = 262,144).

NOTE
When you change the value next to this parameter, then you are required to enter a new preset.

Total measuring range

[Index 524]
This parameter sets the number of distinguishable steps over the total measuring range. Allowed values are less than or equal to the total hardware resolution value (physical multiturn resolution = number of physical counts per revolution + number of physical revolutions).

We recommend the **Number of revolutions** to be set to a power of 2.
The set **Number of revolutions** results from the following calculation:

$$\text{Number of revolutions} = \frac{\text{Total measuring range}}{\text{Measuring units / Revolution}}$$

Setting the **Number of revolutions** to a value which is a power of 2 is meant to avoid problems when using the device in endless operations requiring the physical zero to be overstepped. If you set the **Number of revolutions** which is not a power of 2, a so-called "Red Zone" is generated before the physical zero. For more detailed information refer to the 9.2 "Red Zone" section on page 101).

Default =	134217728 (min. = 1, max. = 134,217,728)	for EM58 series
	262144 (min. = 1, max. = 262,144)	for HS58 series
	1073741824 (min. = 1, max. = 1,073,741,824)	for HM58 series

NOTE
There is no functionality of this parameter if the **Scaling function control** parameter is disabled.

EXAMPLE
The HM58-16-14-PT2-... encoder has a singleturn resolution of 16 bits (65,536 cpr) and a multiturn resolution of 14 bits (16,384 revolutions). The permissible value for the **Measuring units / Revolution** will be between 2^0 and 2^{16} (2^{16} = 65,536) while the permissible value for the **Total measuring range** will be between 2 and 2^{30} ($2^{30} = 2^{16} * 2^{14}$ = 1,073,741,824).

NOTE
When you change the value next to this parameter, then you are required to enter a new preset.

Maximum tolerated failures of Master Sign-Of-Life

[Index 525]
This parameter sets the number of allowed failures of the Master's sign of life. The default value is one (1).
Default = 1 (min. = 1, max. = 255)

NOTE
This parameter is only supported in compatibility mode (see Compatibility Mode on page 97).

Velocity measuring unit

[Index 526]
This parameter defines the engineering unit of the velocity value used to configure the signal **NIST_B**. Standard telegram 81 has no velocity information included and the encoder does not use the velocity measuring unit information in this case. Telegram 860 include velocity output (**NIST_B**) and need a declaration of the velocity measuring unit.

Parameter	Meaning	Value
Velocity measuring unit	Definition of the engineering unit for the encoder velocity output value	See table below

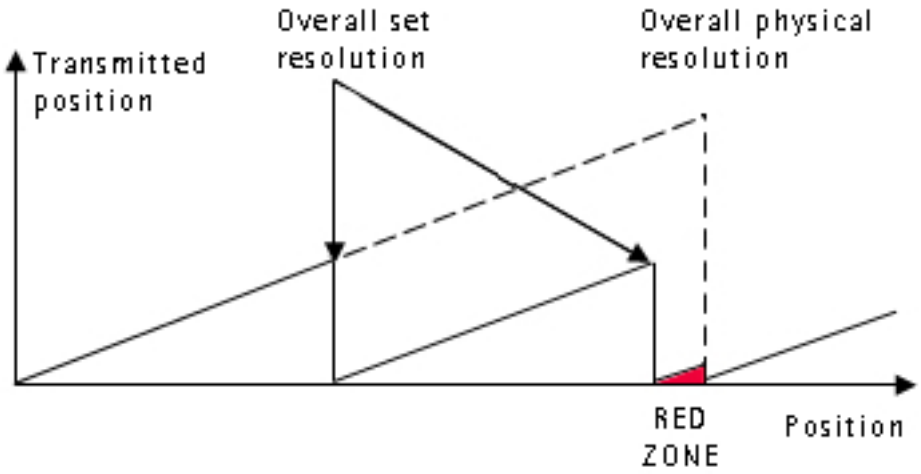
Velocity measuring units	Value
Steps / s	**0**
Steps / 100 ms	1
Steps / 10 ms	2
RPM	3

Default = 0= Step/s (min. = 0, max. = 3)

NOTE
Please note that the velocity value is always calculated every 100 ms.

9.2 "Red Zone"

The so-called "Red Zone" problem occurs when the **Number of revolutions** (i.e. the **Total measuring range** / **Measuring units / Revolution**) is not a power of 2.
When this problem arises, the device must operate within the "red zone" for a certain number of positions. The size of the "red zone" is variable. To calculate it we must subtract the overall set resolution from the overall physical resolution of the device as many times as until the difference is less than the overall set resolution. When the encoder crosses the limit of the last value in the overall physical resolution, a counting error occurs, i.e. a jump in the position count. The problem is represented graphically in the following Figure.



EXAMPLE
HM58-16-14-PT2-... multiturn encoder

Physical resolution:
- Singleturn physical resolution = 65,536 counts/rev. = 16 bits (2^{16})
- Multiturn physical resolution = 16,384 revolutions = 14 bits (2^{14})
- Overall physical resolution = 1,073,741,824 = 30 bits (2^{30})

Set values:
- **Measuring units / Revolution** = 65,536 = 2^{16}
- **Total measuring range** = 442,236,928 = it is NOT a power of 2

It results from this:

- **Number of revolutions** = 6,748 = it is NOT a power of 2

This can be proved easily:

$$\frac{\textbf{Overall physical resolution}}{\textbf{Overall set resolution}} = \frac{1{,}073{,}741{,}824}{442{,}236{,}928} = 2.427...$$

It follows that for 189,267,968 positions (1,073,741,824 – 442,236,928 * 2 = 189,267,968), i.e. for 11,552 revolutions, the encoder will work within the limits of the so-called "red zone". After position 189,267,968 (i.e. at the end of the "red zone") a position error (namely, a "jump" in the position count) would happen as the following position would be "0". See the Figure in the previous page.

NOTE

Make attention using the values sent by the encoder while working within the limits of the "Red Zone". When the encoder changes from normal status to "Red Zone" status (and vice versa) a jump of position occurs.

10 Real time class communication

Within PROFINET IO, process data and alarms are always transmitted in real time. Real-Time for PROFINET (RT) is based on the definitions of IEEE and IEC for high-performance data exchange of I/O data. RT communication constitutes the basis for data exchange in PROFINET IO.

Real-time data are handled with higher priority compared to TCP(UDP)/IP data. This method of data exchange allows bus cycle times in the range of a few hundred milliseconds to be achieved.

Isochronous data exchange with PROFINET is defined in the Isochronous-Real-Time (IRT) concept. IRT communication is always clock synchronized and only possible within an IRT domain. Isochronous real-time communication differs from real-time communication mainly in its isochronous behaviour: the start of a bus cycle can deviate by a maximum of 1 µs (jitter is less then 1 µs). IRT is required in motion control applications (positioning operations), for example. This communication is required, for example, for high-accuracy closed-loop control tasks.

10.1 Real-time classes in PROFINET IO

To enable enhanced scaling of communication options and, thus, also of determinism in PROFINET IO, real-time classes have been defined for data exchange. From the user perspective, these classes involve unsynchronized and synchronized communication.
PROFINET IO differentiates the following classes for RT communication.
They differ not in terms of performance but in determinism.

10.2 Real-Time class 2 (RT2) – Not synchronized

In real-time class 2, frames are transmitted via unsynchronized communication (anysochronous communication).
To activate the real-time class 2 both the IO controller and the IO device must be set exactly the same as "Not synchronized".

10.3 Real-Time class 3 (IRT_TOP) (RT3)

Isochronous data exchange with PROFINET is defined in the Isochronous-Real-Time (IRT) concept. IRT communication is always clock synchronized and only possible within an IRT domain. Isochronous real-time communication differs

from real-time communication mainly in its isochronous behaviour: the start of a bus cycle can deviate by a maximum of 1 µs (jitter is less then 1 µs).
This communication is required, for example, for high-accuracy closed-loop control tasks.
Only industrial IRT switches can be used.
Typical cycle time 1 ms or less. When the encoder is installed as a TO Technology Object (see on page 62), the cycle time must be greater than or equal to 2 ms.
All network components must support PROFINET IRT frame priority processing.
Position values are captured with an accuracy of +/- 1 µs or better, with respect to the highly accurate bus clock.

10.3.1 Setting an isochronous communication

To activate the real-time class 3 both the IO controller and the IO device must be configured. To do this proceed as follows.

1. Enter the Network view: the bus connection between the encoder and the PLC is established.

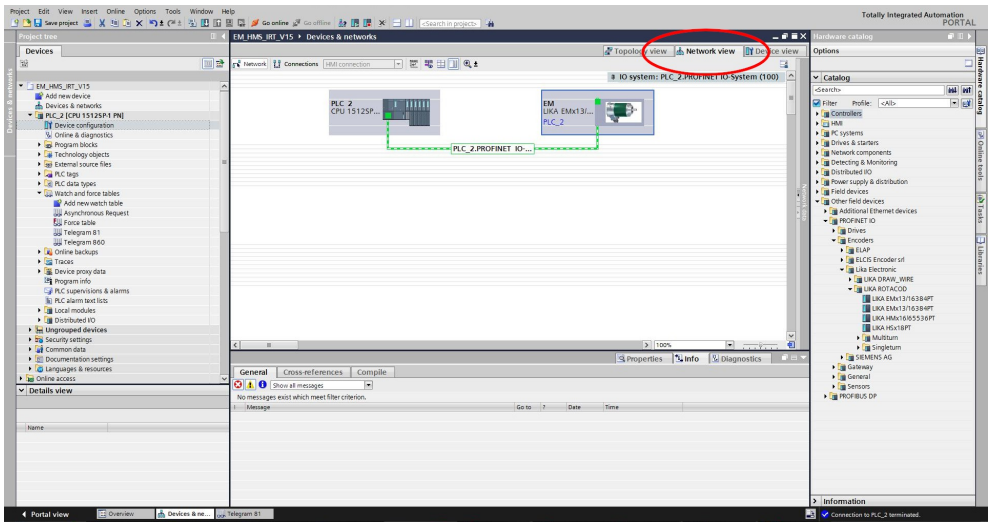


Figure 36 - Encoder inserted in the Network view

2. Now enter the Topology view and connect the PROFINET interface of the encoder to the PROFINET interface of the CPU, i.e. interconnect the corresponding ports of the PROFINET interfaces of the devices.

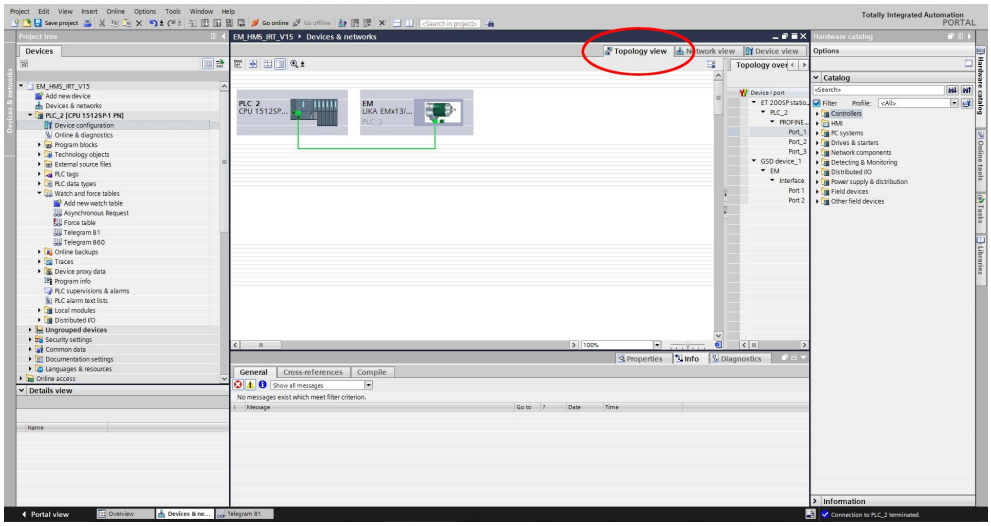


Figure 37 - Setting the Topology

3. Select the encoder and change to the Device view; then, in the properties of the encoder, navigate via **General** > **PROFINET interface** > **Advanced options** > **Isochronous mode** and display the **Isochronous mode** area.

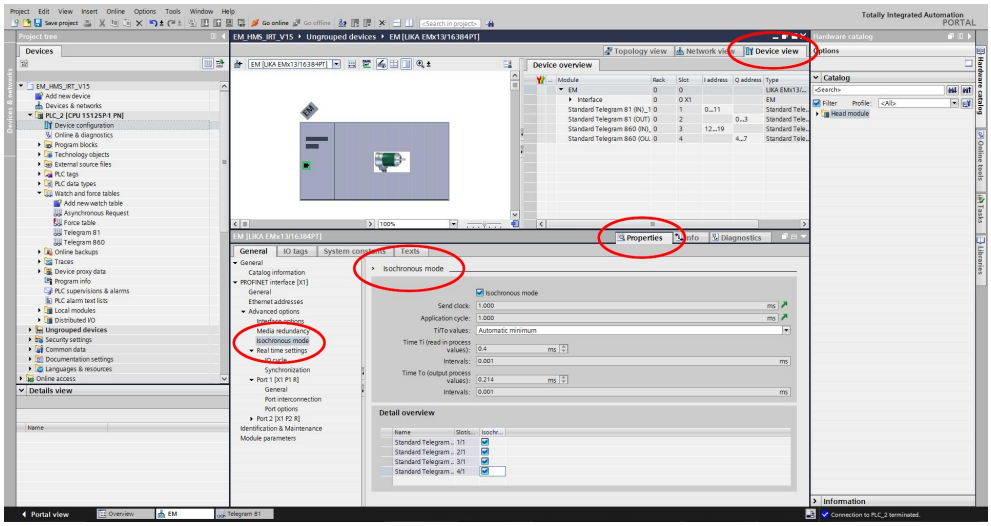


Figure 38 - Isochronous area

4. Select the **Isochronous mode** option in the **Isochronous mode** area. In the **Detail overview** area, you see all modules of the configuration you can operate isochronously. Select the **Isochronous mode** option for all telegrams.

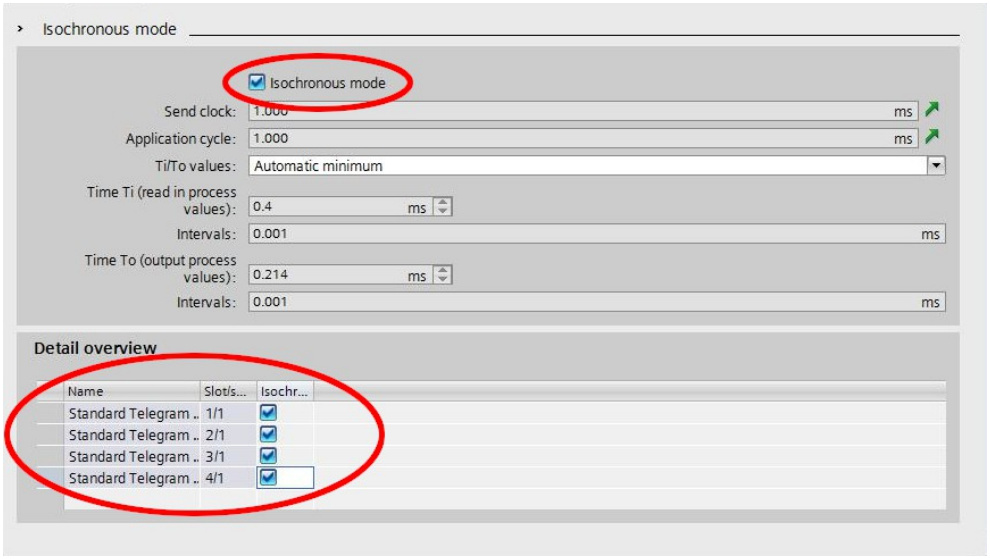


Figure 39 - Setting the Isochronous mode

5. Select each I/O module in the Device view. Navigate to the **I/O addresses** area in the Inspector window and set each Telegram as shown in the Figures hereafter. You use the properties of the I/O addresses of the corresponding I/O module to:
   - set isochronous mode for the module;
   - assign the inputs and outputs of the module to a process image partition and an isochronous mode interrupt OB.

   Set **Synchronous Cycle** under **Organization block** and **PIP 1** under **Process image**.

NOTE
For more information on PIPs (Process Image Partitions) refer to the "10.5 PIP (Process Image Partition)" section on page 109.

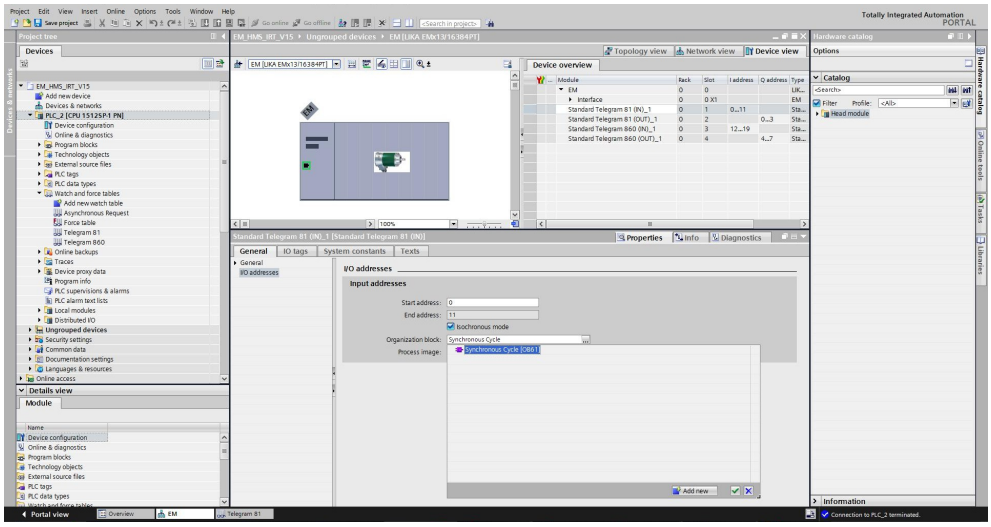


Figure 40 - Telegram 81 IN

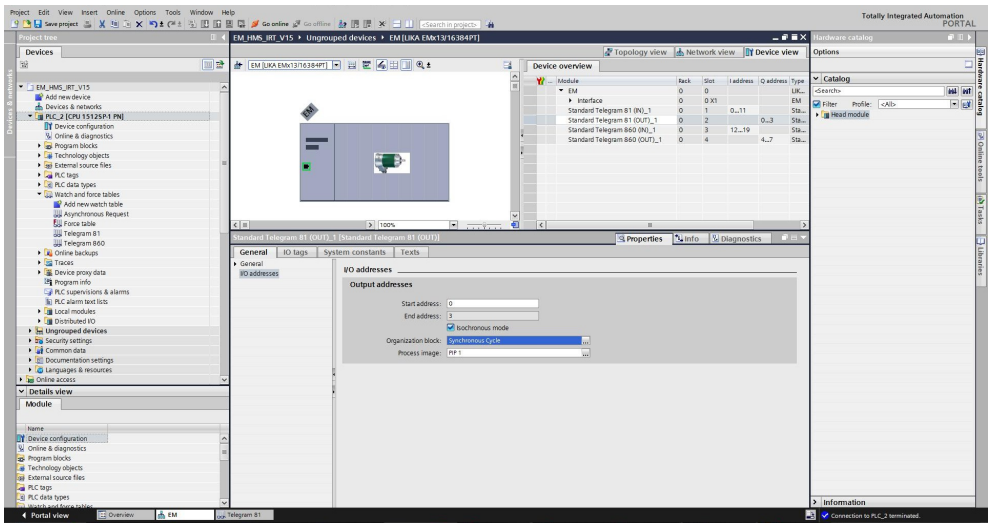


Figure 41 - Telegram 81 OUT

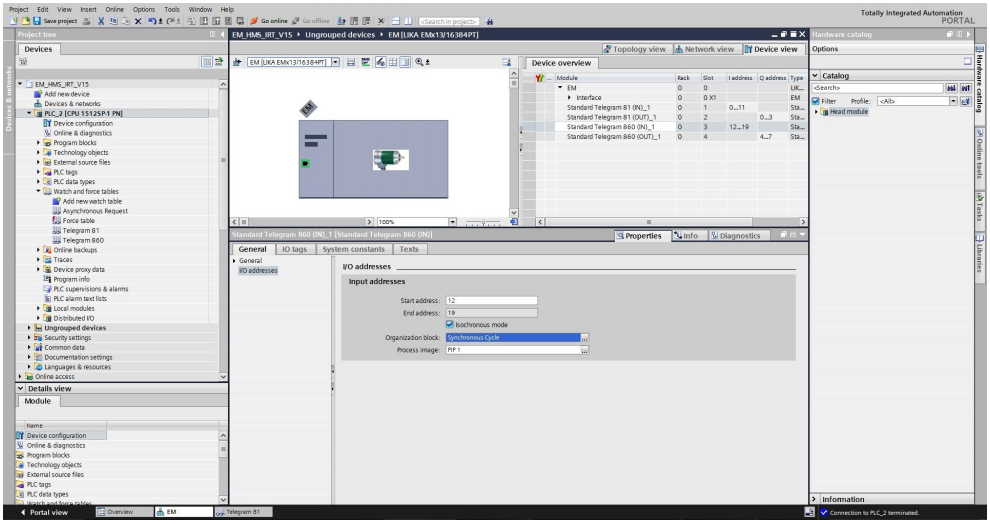


Figure 42 - Telegram 860 IN

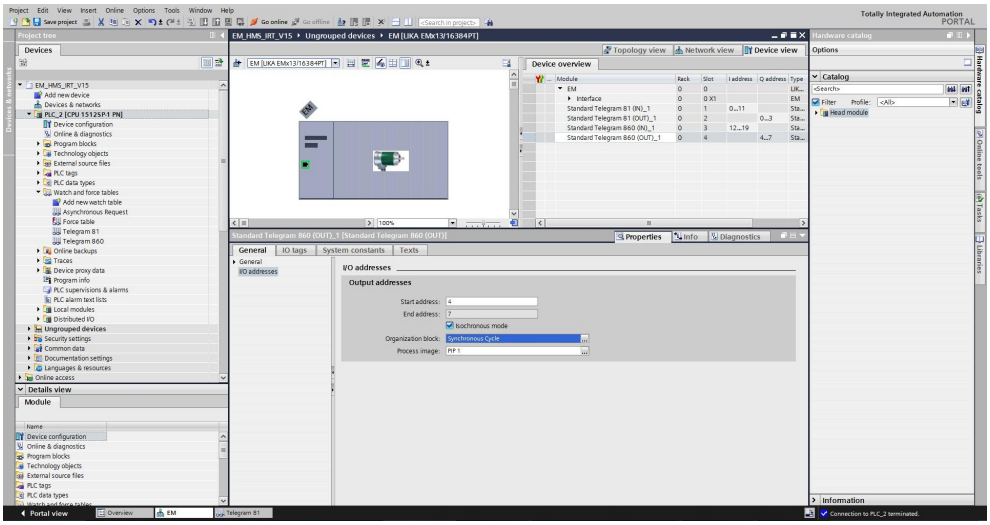


Figure 43 - Telegram 860 OUT

6. Finally transfer your project.

10.4 OB61

WARNING
Use of OBs requires both in-depth skills and specific expertise in TIA PORTAL programming environment. For detailed information please consult the TIA PORTAL Programmer's handbook and documentation.

Organization blocks (OBs) form the interface between the CPU operating system and the user program. The order in which the user program is executed is defined in the organization blocks.

The synchronization with the user program is maintained through the clocked interrupt OB61. OB61 is a synchronous cycle interrupt; in other words it is an isochronous event that is called with the start of every PROFINET cycle. It is synchronous with the Profinet send clock.

10.5 PIP (Process Image Partition)

WARNING
Use of PIPs requires both in-depth skills and specific expertise in TIA PORTAL programming environment. For detailed information please consult the TI PORTAL Programmer's handbook and documentation.

10.5.1 Consistency

PIPs (Process Image Partitions) are used to update the distributed IO device synchronously with the constant bus cycle time clock.
Compared with direct access to the input/output modules, the main advantage of accessing the process image is that the CPU has a consistent image of the process signals for the duration of one program cycle. If a signal state on an input module changes while the program is being executed, the signal state in the process image is retained until the process image is updated again in the next cycle. The process of repeatedly scanning an input signal within a user program ensures that consistent input information is always available. You define process image partition with TIA PORTAL when you assign addresses (which input/output addresses of the modules are listed in which process-image partition). The process image partition is updated by the user with SFCs.

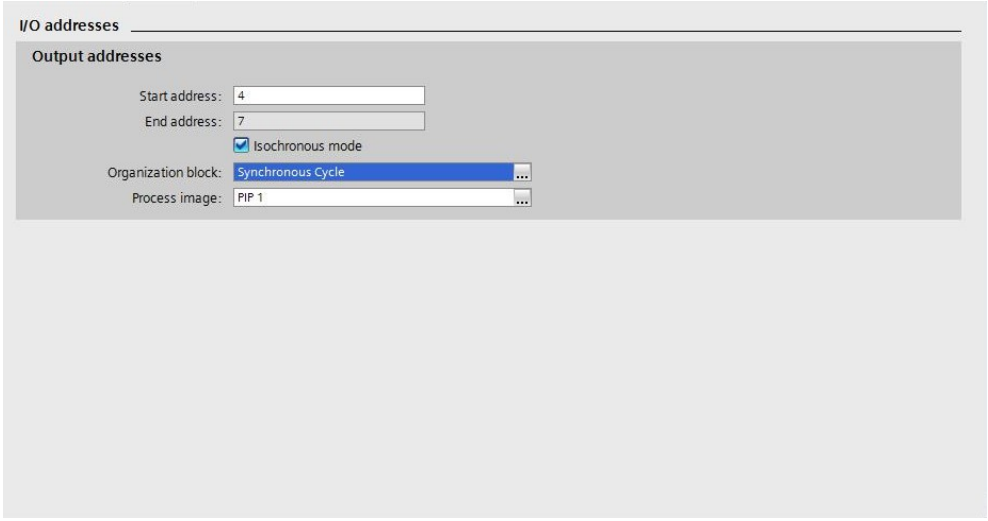


Figure 44 - Process Image Partition

11 Encoder replacement using LLDP

LLDP (Link Layer Discovery Protocol) is a Layer 2 protocol that is used to detect the closest neighbours in the network. It enables a device to send information about itself and to save information received from neighbouring devices, i.e. it provides the option of communicating data between neighbouring devices (e.g. device name, port, MAC address). This information allows a network management system to determine the network topology. The protocol is formally referred to by the IEEE as *Station and Media Access Control Connectivity Discovery* specified in standards document IEEE 802.1AB.
Among the main uses, LLDP allows to replace a device of the Profinet network.
The partner ports before and behind the replaced device save the relevant information so that no additional configuration is necessary. The flag **Support device replacement without exchangeable medium** must be activated in the Controller.

When you need to activate / deactivate the **Support device replacement without exchangeable medium** function in the IO controller, proceed as follows:

1. In the Device or Network view of TIA Portal select the PROFINET interface of the corresponding IO controller. The properties of the PROFINET interface are displayed in the inspector window.
2. In the **Properties** of the PROFINET interface, under **Advanced options** > **Interface options** enable **Support device replacement without exchangeable medium**.

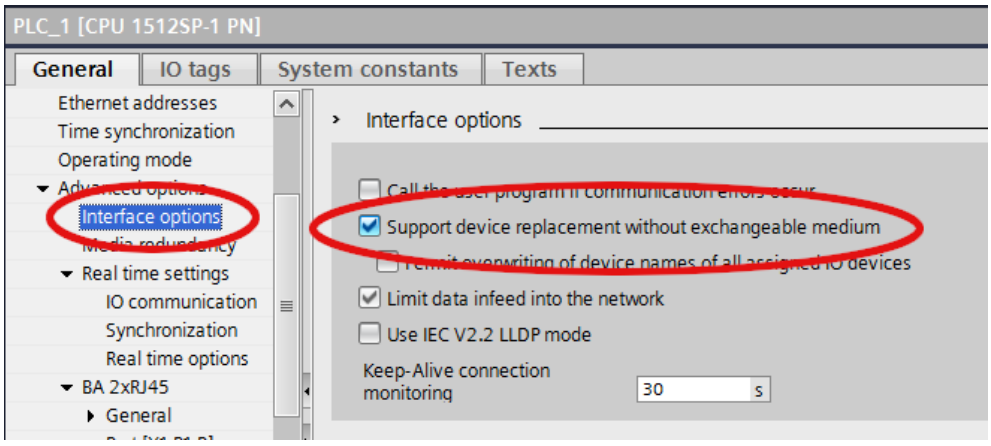


Figure 45 - Link Layer Discovery Protocol (LLDP)

NOTE

When you replace a device, make sure that the PROFINET cable is then inserted into the correct port as it is configured in TIA Portal. Otherwise, the system will not run.

12 Media Redundancy Protocol (MRP)

MRP (Media Redundancy Protocol) is a redundancy protocol supported by all Profinet capable devices that will allow a network to be configured in a ring topology. It is standardized by the International Electrotechnical Commission as IEC 62439-2. It is suitable to most Industrial Ethernet applications. Since Profinet is an open standard, this means that MRP is a manufacturer independent protocol and can be used to form a ring with devices from different manufacturers (so long as all devices are fully IEC 62439-2 compliant).

It allows rings of Ethernet devices to overcome any single failure with recovery time much faster than achievable with Spanning Tree Protocol. In other words, it allows to prevent interruptions in an automation machine caused by a defect of a cable or a device. In an MRP ring, the ring manager is named **Media Redundancy Manager** (**MRM**), while ring clients are named **Media Redundancy Clients** (**MRCs**). Any MRC is connected to the MRM via two ways of communication. During normal work status (network without failure in the ring) the telegrams will only be sent via one way of communication; the second way of communication will be blocked by the MRM. If a failure in the ring occurs (for instance because of a cable break), the second way of communication will be opened by the MRM.

Requirements are:

- all devices in the ring support MRP;
- you have complied with the rules for topology.

For complete information on the MRP please refer to the documentation provided by Siemens.

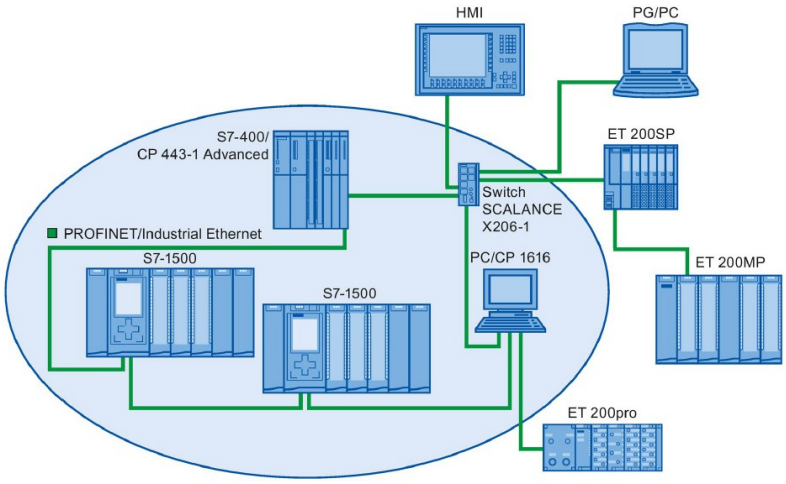


Figure 46 - Example of a ring topology with the MRP media redundancy protocol

12.1 Setting MRP roles

Within an MRP ring, each device must be assigned a role. One device will be the MRP Manager (MRM) and will be responsible for sending out test frames to detect for a network failure and for blocking network traffic on one port (except for the test frames) to prevent a network loop. The other devices must be assigned a Client role (MRC) so they know how to handle the test frames.

So let's set our PLC as the manager.
Go to the **Device view** for the PLC and look at the properties of the network interface. Under **Advanced Options**, look for **Media redundancy**. Here you can select the role for the device: set the **Manager (Auto)** option in the **Media redundancy role** drop-down menu.

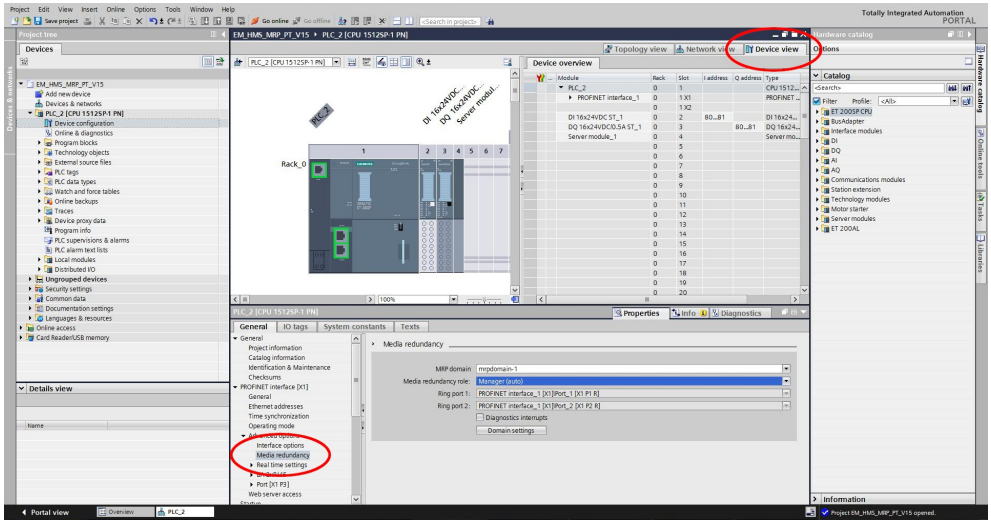


Figure 47 - Setting the PLC as the MRM

We do the same for the encoder: it must be set as a client.
Go to the **Device view** for the encoder and look at the properties of the network interface. Under **Advanced Options**, look for **Media redundancy**. Here you can select the role for the encoder: set the **Client** option in the **Media redundancy role** drop-down menu.

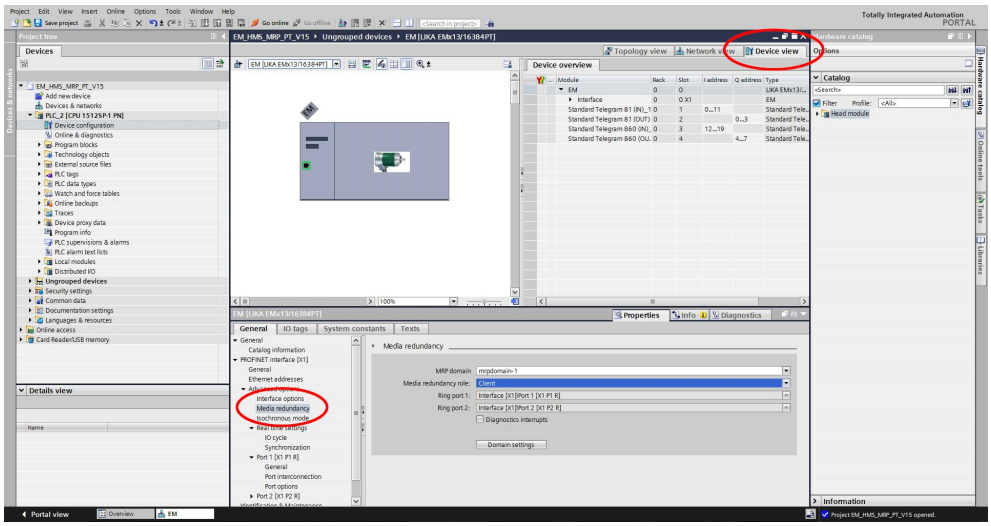


Figure 48 - Setting the encoder as the MRC

12.2 Configuring the network topology

To configure the network topology proceed as follows.
Navigate to the **Topology view** tab of the **Devices and Networks** view.
Configure the topology to create a ring by connecting the ports, for instance as shown in the Figure. Of course you must comply with the rules for topology as required by your own network. For detailed information please refer to specific documentation.

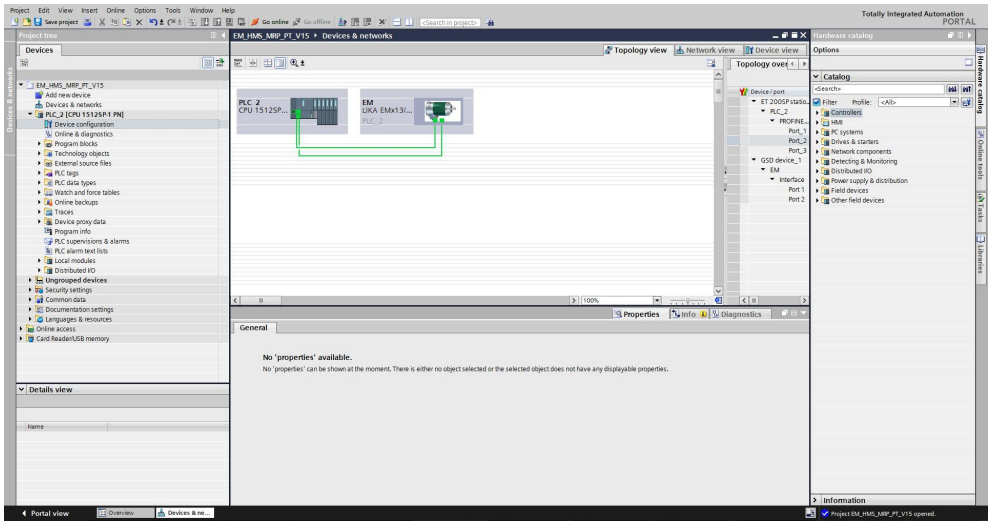


Figure 49 - Configuring the network topology

12.3 Interconnecting the ports in the Inspector window

To interconnect the ports, follow these steps:

1. In the **Device view** tab or **Network view** tab, select the PROFINET device or PROFINET interface.
2. In the **Table Area** of the **Hardware and network editor** select the port which you want to configure (Port 1 and Port 2).
3. In the Inspector window, navigate to the **Properties** tab and select **Port interconnection** in the navigation area.
4. In the **Local port** section, you can find the settings at the local port.
5. In the **Partner port** area, select the drop-down list for **Partner port** in order to display the available partner ports and make a selection.

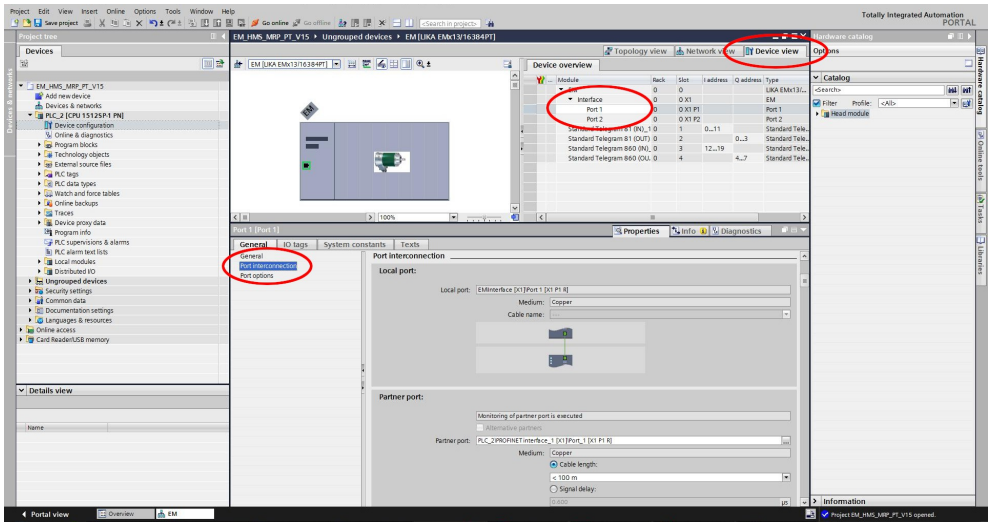


Figure 50 - Interconnecting port 1

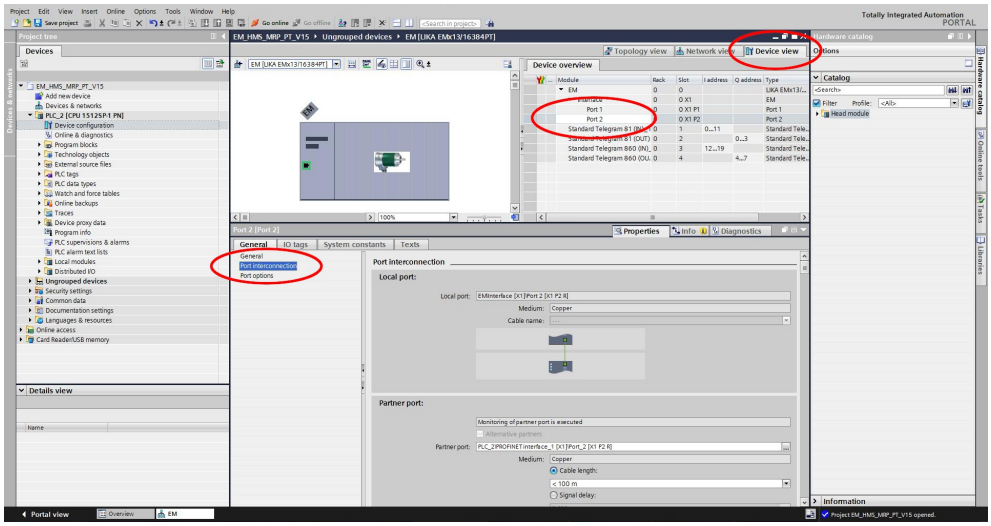


Figure 51 - Interconnecting port 2

13 Encoder state machine

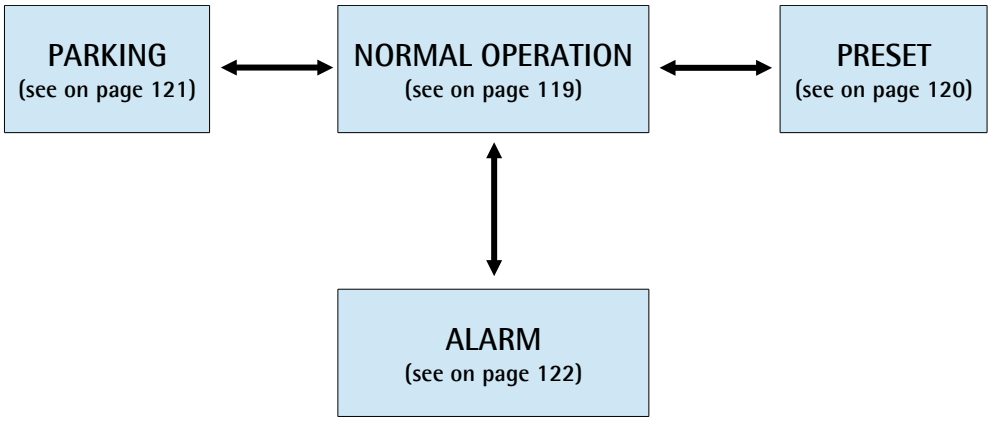
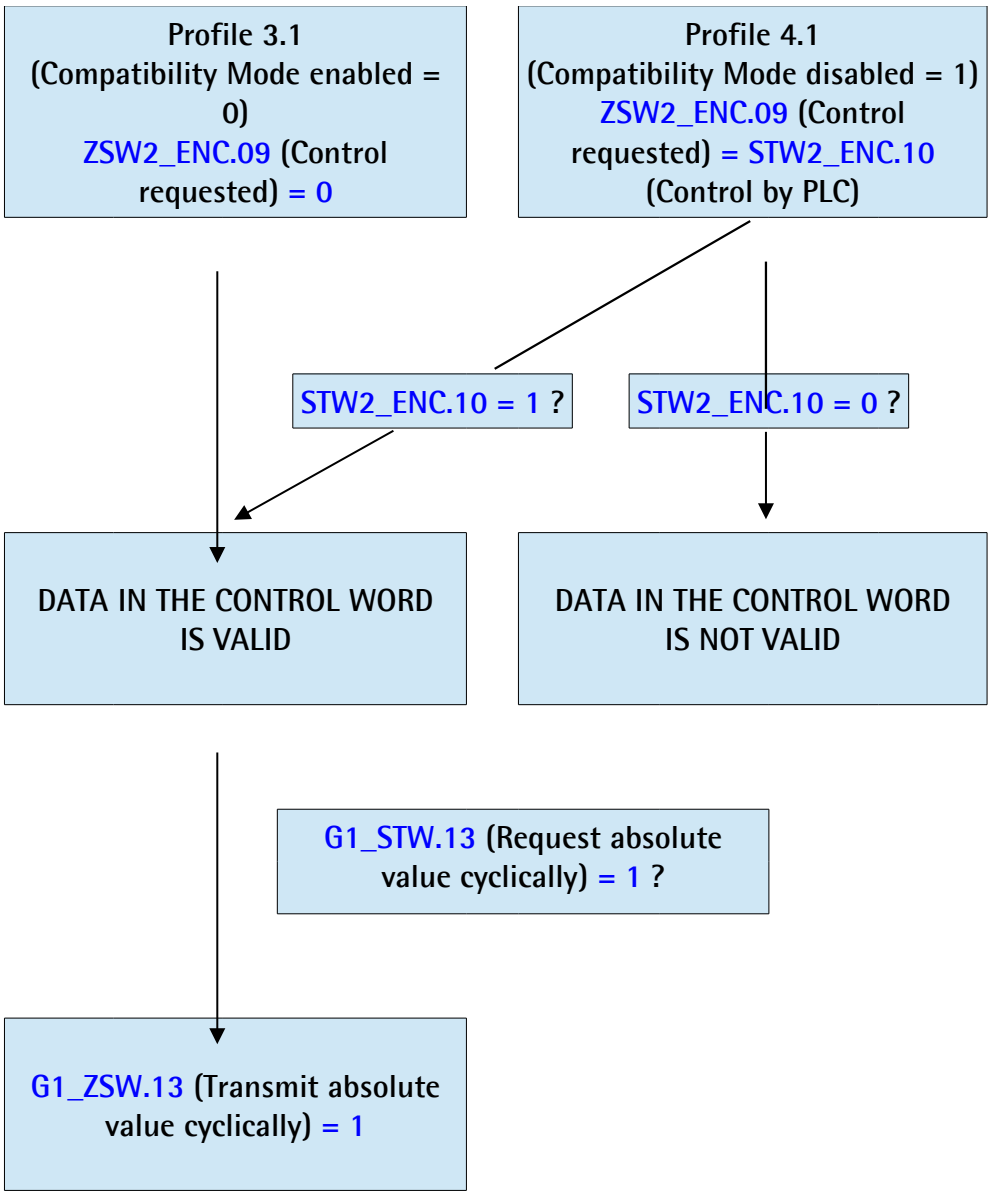
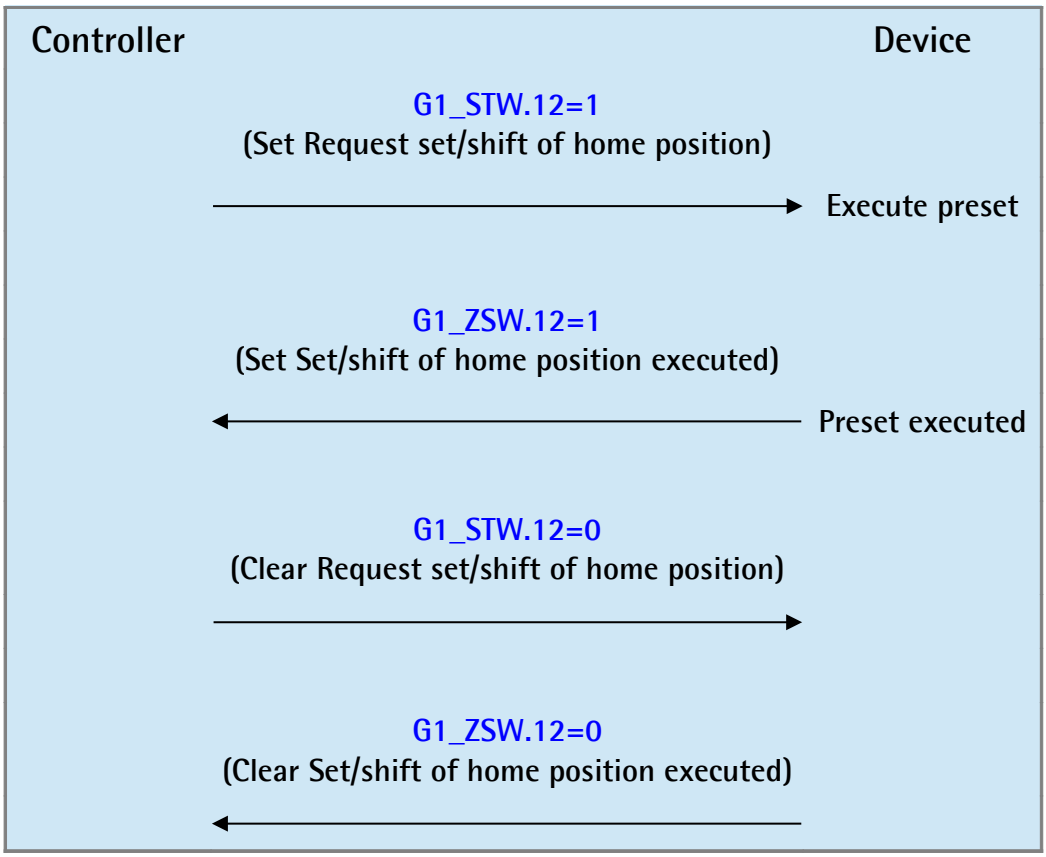


Figure 52 - Encoder state machine

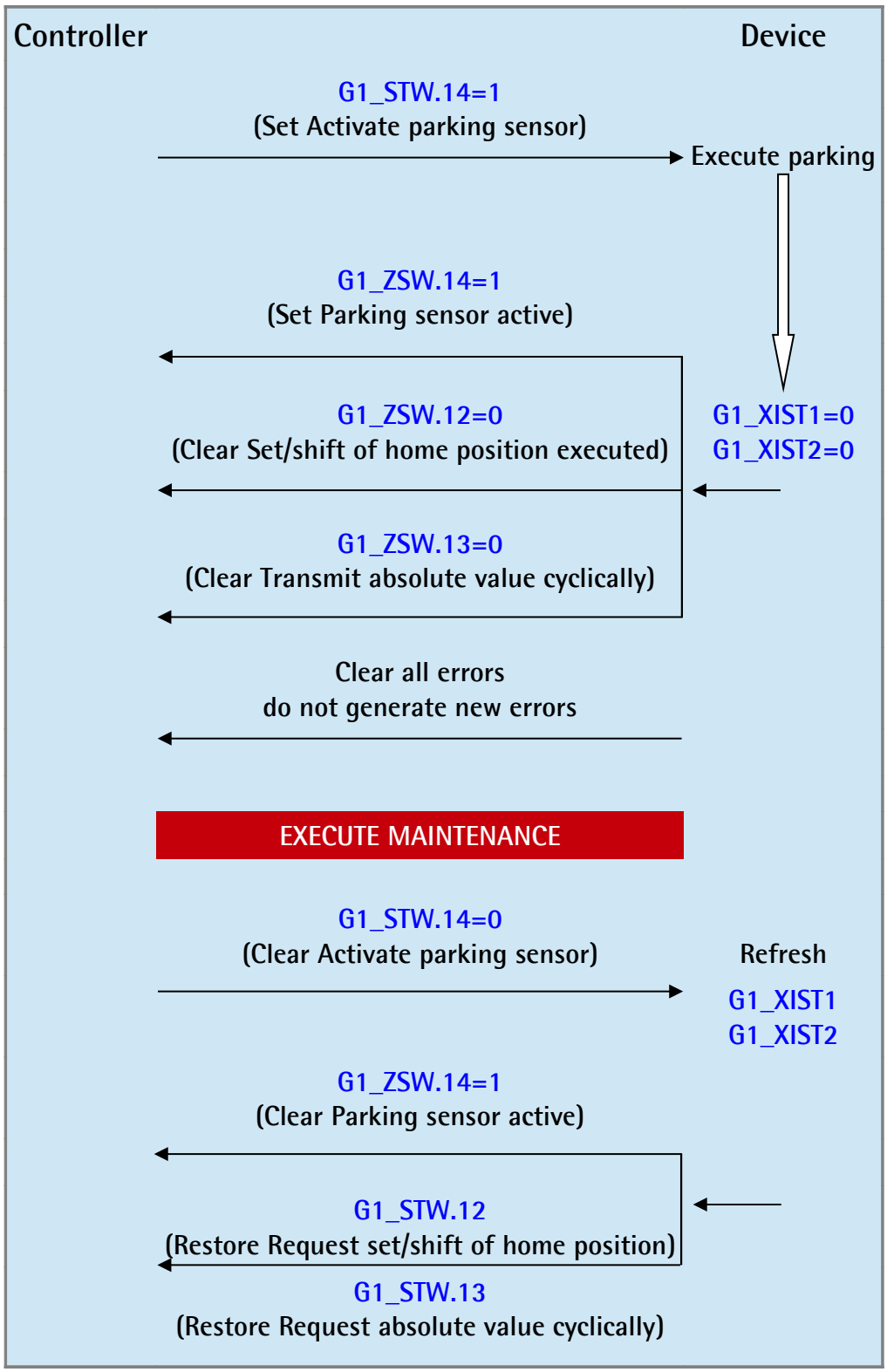
13.1 Normal operation diagram



13.2 Preset diagram

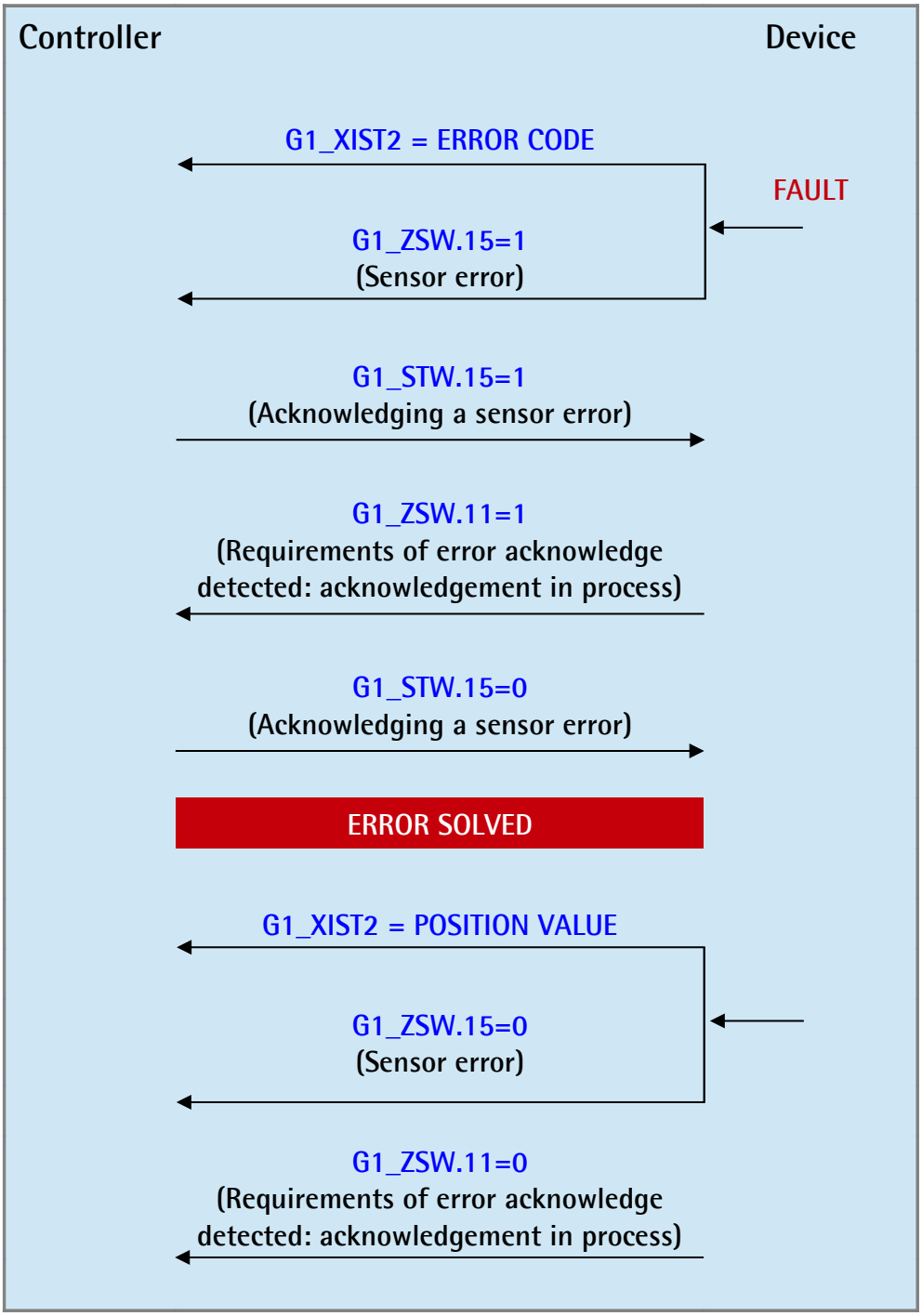


13.3 Parking sensor diagram

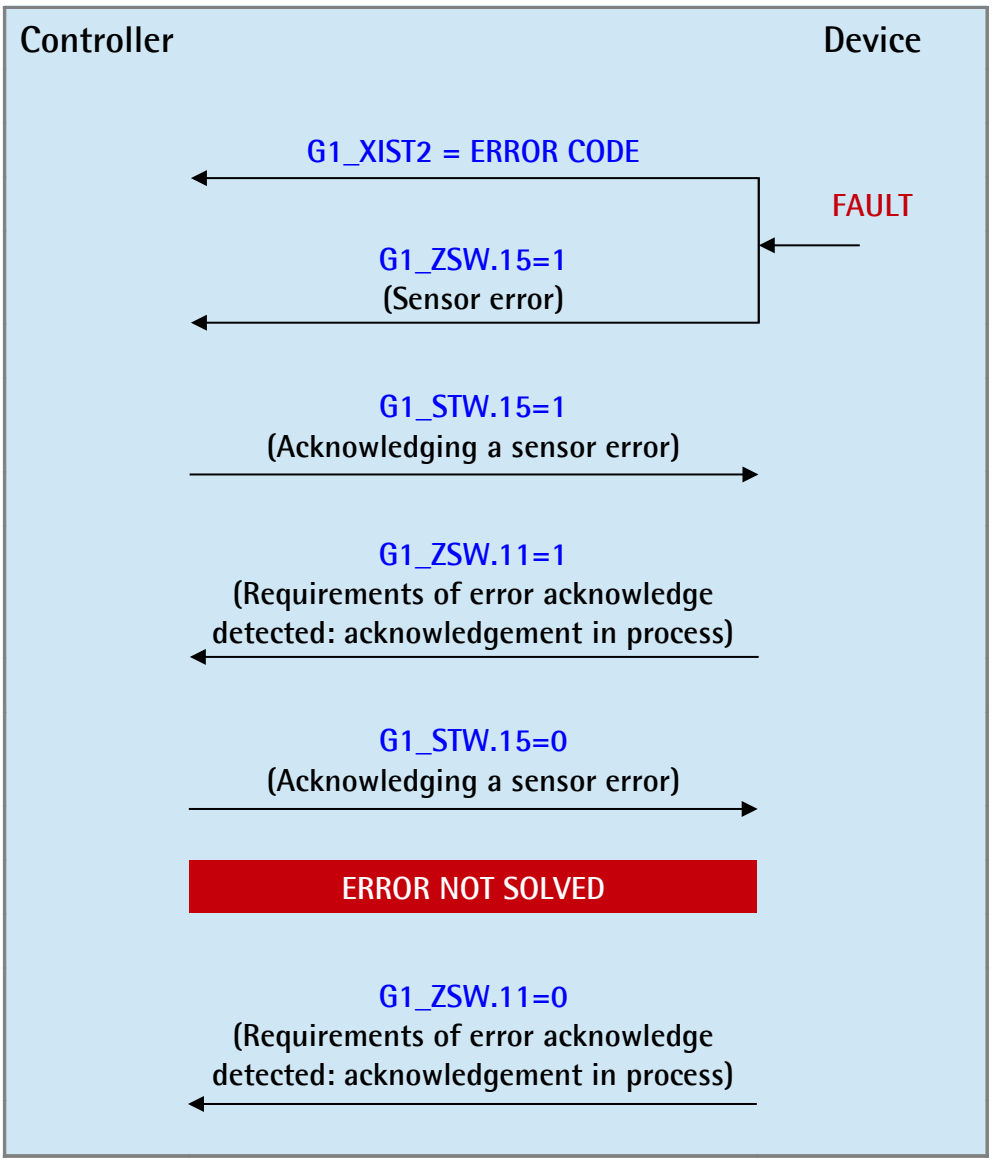


13.4 Error diagram

13.4.1 Acknowledgement of acknowledgeable sensor error



13.4.2 Acknowledgement of not acknowledgeable sensor error



14 Integrated web server

Profinet encoders from Lika Electronic integrate a web server. This web-based user interface is designed to offer helpful functions and deliver complete information on the device that can be accessed through the Internet.
In particular it allows:

- to display the current position and speed values;
- to display and check the currently set parameters;
- to set the parameters.

The web server can be accessed from any PC running a web browser. Since its only requirement is a HTTP connection between the web browser and the web server running on the device, it is perfectly fitted also for remote access scenarios.

Before opening the Profinet encoder web server please ascertain that the following requirements are fully satisfied:

- the encoder is connected to the network;
- the encoder has valid device name and IP address;
- the PC is connected to the network;
- a web browser (Internet Explorer, Mozilla Firefox, Google Chrome, Opera, ...) is installed in the PC or in the device used for connection.

NOTE
This web server has been tested and verified using the following web browsers:

- Internet Explorer IE11 version 11.1593.14393.0
- Mozilla Firefox version 55.0.3
- Google Chrome version 60.0.3112.113
- Opera version 47.0.2631.80

NOTE
Please note that the snapshot look may vary depending on the used web browser. The following snapshots have been taken from Google Chrome.

14.1 Web server Home page

To open the Profinet encoder web server proceed as follows:

1. type the IP address of the encoder you want to connect to (in the example: 192.168.20.1) in the address bar of your web browser and confirm by pressing **ENTER**;

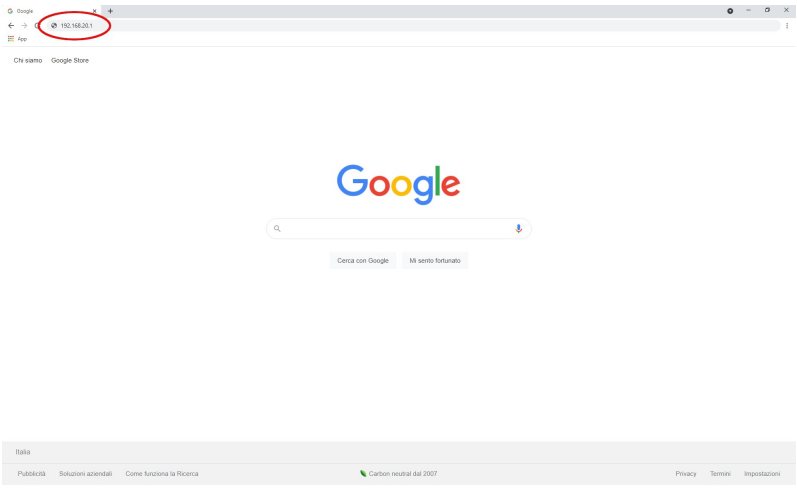


Figure 53 - Opening the web server

2. as soon as the connection is established, the web server **Home** page will appear on the screen;

Figure 54 - Web server Home page

In the **Home** page some commands are available in the menu bar.
Press on the **Lika logo** to enter Lika's web site (www.lika.biz).

Press the **Documentation** command to enter the Profinet encoder technical documentation page available on Lika's web site (https://www.lika.it/eng/products/rotary-encoders/absolute/ethernet/) where specific technical information and documentation concerning the Profinet encoder can be found.

Furthermore some commands are available in the left navigation bar. All the pages except the **Firmware upgrade** page are freely accessible through the commands in the bar. The **Firmware upgrade** page requires a password.
These commands allow to enter specific pages where information and diagnostics on the connected encoder as well as useful functions can be achieved.
They are described in the following sections.

14.2 Encoder position and speed

Press the **Encoder Position-Speed** command in the left navigation bar of the Web server **Home** page to enter the page where the current encoder position and the current encoder speed are displayed.

Figure 55 - Encoder position and speed page

The current encoder position is expressed in counts. For any information refer to the G1_XIST1 signal on page 84.
The current speed is expressed according to the setting next the Velocity measuring unit parameter on page 100 (by default it is expressed in counts per second). For any information refer to the NIST_B signal on page 92.

NOTE
The current encoder position and speed values are real-time processed and continuously updated (every 200 msec. on the screen).

Press the **Homepage** command to move back to the Web server **Home** page.

14.2.1 Specific notes on using Internet Explorer

The following options must be set properly on Internet Explorer in order to get the **Encoder position and speed** page to be continuously updated.

- Open the **Settings** menu;
- open the **Internet Options** property sheet;
- in the **General** tabbed page, press the **Setting** button available in the **History Browsing** section;
- under **Check for newer versions of stored pages**, click **Every time I visit the webpage**;
- press the **OK** button to confirm whenever requested.

14.3 Encoder information (Profinet parameters)

Press the **Encoder Information** command in the left navigation bar of the Web server **Home** page to enter the **Encoder Information** page. In this page the complete list of the available Profinet parameters is displayed. Parameters are specific to each DAP. Indexes are expressed in hexadecimal notation, values are expressed in either decimal notation or string format. The MAC address of the connected encoder is shown under the name of the page.

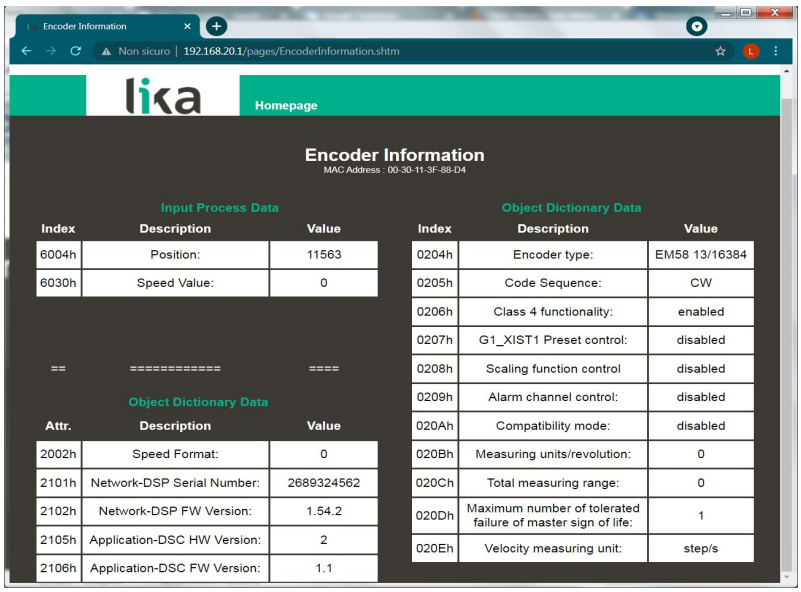


Figure 56 - Encoder Information page

For a complete description of the available encoder parameters please refer to the "Encoder parameters" section on page 93.

NOTE

Please note that the values shown in the **Encoder Information** page are "frozen" in the moment when the page is displayed. To update the values you must refresh the web page.

NOTE

The parameters in the **Encoder Information** page cannot be changed. To change the set values please enter the **Set Registers** page (see on page 129).

Press the **Homepage** command to move back to the Web server **Home** page.

14.4 Setting the parameters

Press the **Set Registers** command in the left navigation bar of the Web server **Home** page to enter the **Set Encoder Registers** page. In this page the Profinet encoder parameters are displayed and their value can be changed. Parameters are specific to each DAP.
For complete information on the encoder parameters please refer to the "Encoder parameters" section on page 93.

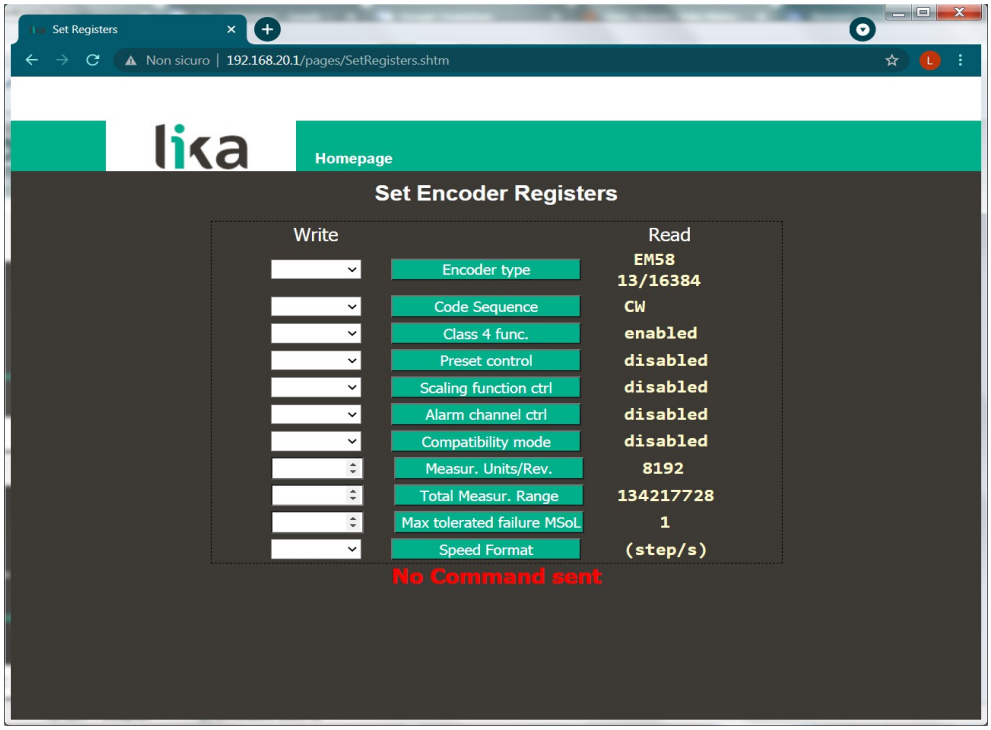


Figure 57 - Set Encoder Registers page

A soon as you press the **Set Registers** command a warning message (**Are you sure you want to change Registers Values?**) appears on the screen: it warns the operator about the awkwardness of the operation, thus he is required to confirm the procedure before continuing.
Press the **OK** button to proceed, otherwise press the **EXIT** button to abort the procedure. The **Set Registers cancelled!** message will appear on the screen. Press the **OK** button to move back to the Web server **Home** page.

If you confirm the procedure, the **Set Encoder Registers** page will appear on the screen.

The values that are currently set in the encoder are displayed in the **READ** column.

To change any value enter a suitable value in the **WRITE** column next to the desired parameter and then press the button between the boxes to confirm. The values have to be set either in decimal notation or by using the drop-down menu (when available).
For complete information on the available parameters please refer to the "Encoder parameters" section on page 93.

EXAMPLE
The Code sequence parameter is currently set to "**CW**" (see the **READ** box in the first line of the Figure 57 above). To change the set value enter a suitable value in the corresponding **WRITE** box of the same line through the drop-down menu and then press the **CODE SEQUENCE** button to confirm.

EXAMPLE
The Measuring units / Revolution parameter is currently set to "**8192**" (see the **READ** box in the third last line of the Figure 57 above). To change the set value enter a suitable value in the corresponding **WRITE** box of the same line and then press the **MEASUR. UNITS/REV.** button to confirm.

NOTE
Please note that, after pressing the button between the boxes, the set value is instantly saved in a permanent way in the parameter.

NOTE
At each confirmation of the set parameters, a message will appear under the buttons (see the No Command sent message). It informs whether the operation has been accomplished properly or an error occurred (for example Command was set correctly if everything went well; or Command Error! if something went wrong).

NOTE
Please note that at each power on of the PLC all parameters set in the project are downloaded to the encoder, thus any previous setting is overwritten. For a definitive setting please use TIA PORTAL and the **Module parameters** page.

Press the **Homepage** command to move back to the Web server **Home** page.

14.5 Setting and activating the preset

Press the **Set Preset Value** command in the left navigation bar of the Web server **Home** page to enter the **Set Encoder Preset** page and set/activate a Preset value. If you need to set the preset occasionally, we suggest using the web server. For complete information on the preset function please refer to the **G1_XIST1_PRESET_VALUE** signal on page 85.

To set and execute the preset via web server proceed as follows:

- press the **Set preset** command in the left navigation bar of the Web server **Home** page and enter the **Set Encoder Preset** page;
- as soon as you press the **Set Preset Value** command a warning message (**Are you sure you want to change Preset Value?**) appears on the screen: it warns the operator about the awkwardness of the operation, thus he is required to confirm the procedure before continuing;
- press the **OK** button to proceed;
- otherwise press the **EXIT** button to abort the procedure. The **Set Preset cancelled!** message will appear on the screen. Press the **OK** button to move back to the Web server **Home** page;
- if you confirm the procedure, the **Set Encoder Preset** page will appear on the screen;

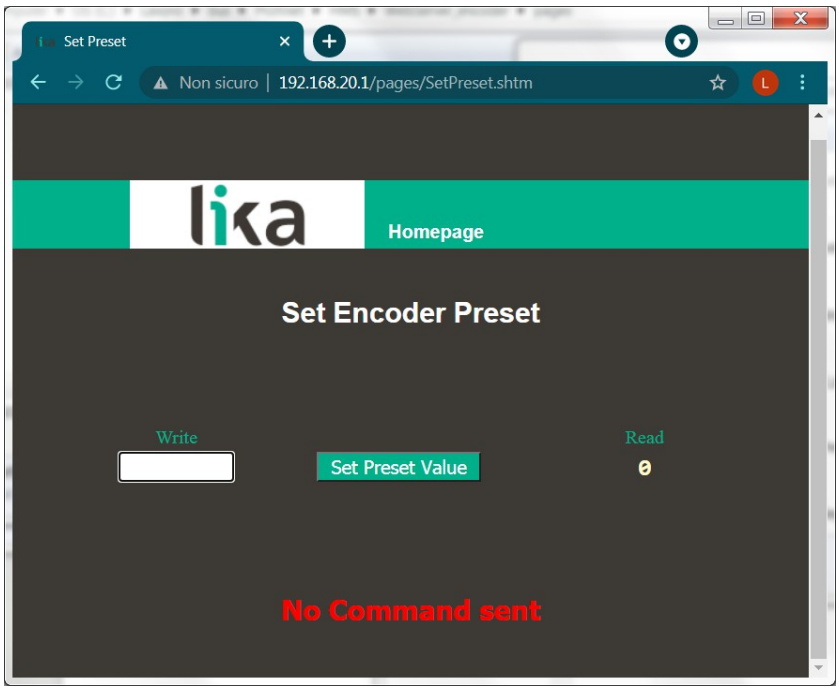


Figure 58 - Set Encoder Preset page

- the Preset value that is currently set in the encoder (see the **G1_XIST1_PRESET_VALUE** signal on page 85) will be displayed in the **READ** box;
- to change the Preset enter a suitable value in the **WRITE** box and then press the **Set Preset Value** button to confirm. The value has to be set in decimal notation. The preset value is set and activated at the same time.

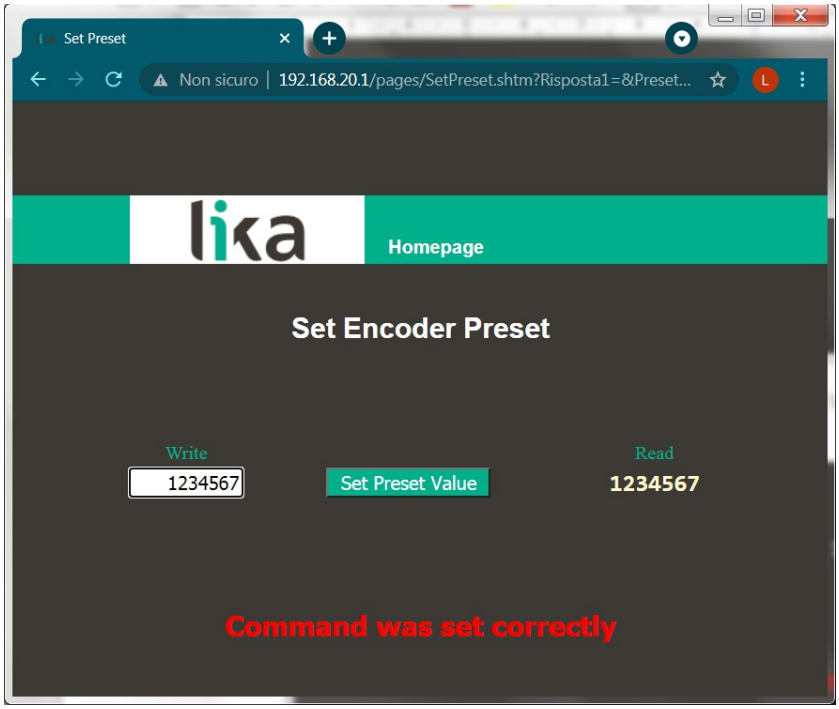


Figure 59 - Setting the preset value

WARNING

The preset value is set and activated for the position of the encoder in the moment when the preset value is transmitted. It is activated as soon as the value is confirmed by pressing the **Set Preset Value** button. We suggest activating the preset value when the encoder is in stop.

NOTE

At each confirmation / activation of the Preset setting, a message will appear under the button (see **No Command sent** message, see Figure 58). It informs whether the operation has been accomplished properly or an error occurred (for example **Command was set correctly** if everything went well, see Figure 59; or **Command Error!** if something went wrong).

Press the **Homepage** command to move back to the Web server **Home** page.

14.6 Firmware upgrade

Press the **Upgrade Firmware** command in the left navigation bar of the Web server **Home** page to enter the **Firmware Upgrade** page. Please note that this is a password protected page, thus a password is requested to access the page.

WARNING
Firmware upgrading process has to be accomplished by skilled and competent personnel. It is mandatory to perform the upgrade according to the instructions provided in this section.
Before installation always ascertain that the firmware program is compatible with the hardware and software of the device. Furthermore never turn off power during flash upgrade. In case of flash upgrade error, the program is lost irreversibly (there is not a bootloader) and the device must be sent back to Lika Electronic for restoring.

This operation allows to upgrade the unit firmware by downloading upgrading data to the flash memory.
Firmware is a software program which controls the functions and operation of a device; the firmware program, sometimes referred to as "user program", is stored in the flash memory integrated inside the unit. These encoders are designed so that the firmware can be easily updated by the user himself. This allows Lika Electronic to make new improved firmware programs available during the lifetime of the product.
Typical reasons for the release of new firmware programs are the necessity to make corrections, improve and even add new functionalities to the device.
The firmware upgrading program consists of a single file having .BIN extension. It is released by Lika Electronic Technical Assistance & After Sale Service.

If the latest firmware version is already installed in the unit, you do not need to proceed with any new firmware installation. The firmware version currently installed can be read next to the **Application-DSC FW Version** item in the **Encoder Information** page after connection to the web server (see on page 128).

NOTE
If you are not confident that you can perform the update successfully please contact Lika Electronic Technical Assistance & After Sale Service.

Before proceeding with the firmware upgrade please ascertain that the following requirements are fully satisfied:

- the encoder is connected to the Ethernet network;
- the encoder has valid device name and IP address;
- the PC is connected both to the network and the IO controller;
- a web browser (Internet Explorer, Mozilla Firefox, Google Chrome, Opera, ...) is installed in the PC or device used for connection;
- you have the SW_ETH_REVX_Y.EXE executable file;
- you have the .BIN file for firmware upgrade.

To upgrade the firmware program please proceed as follows:

1. press the **Upgrade Firmware** command in the left navigation bar of the Web server **Home** page to enter the **Firmware Upgrade** page;
2. as soon as you press the **Upgrade Firmware** command a warning message (**Are you sure you want to update the flash?**) appears on the screen: it warns the operator about the awkwardness of the operation, thus he is required to confirm the procedure before continuing;
3. press the **OK** button to proceed, otherwise press the **EXIT** button to abort the procedure. The **Firmware upgrade cancelled!** message will appear on the screen. Press the **OK** button to move back to the Web server **Home** page;
4. if you confirm the procedure, the **Firmware Upgrade** page will appear on the screen: the operator is requested to submit a password before starting the firmware upgrade procedure;

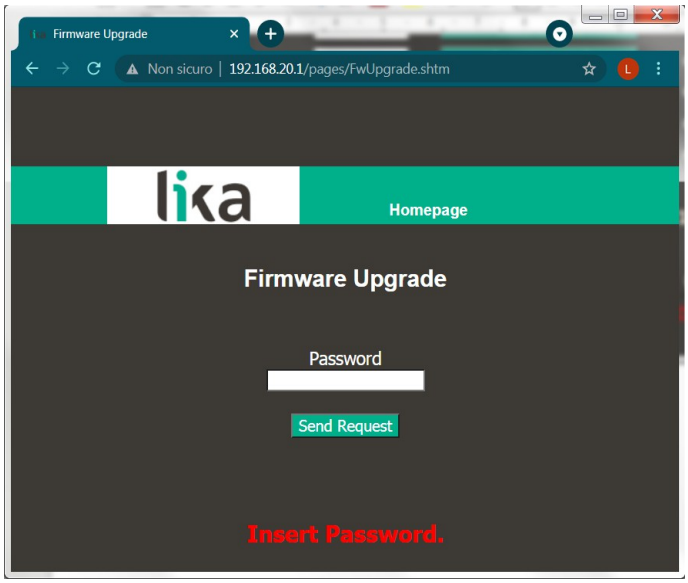


Figure 60 - Firmware Upgrade page

5. in the **Password** text box type the password **LIKA** (all uppercase letters) and then press the **Send Request** button;

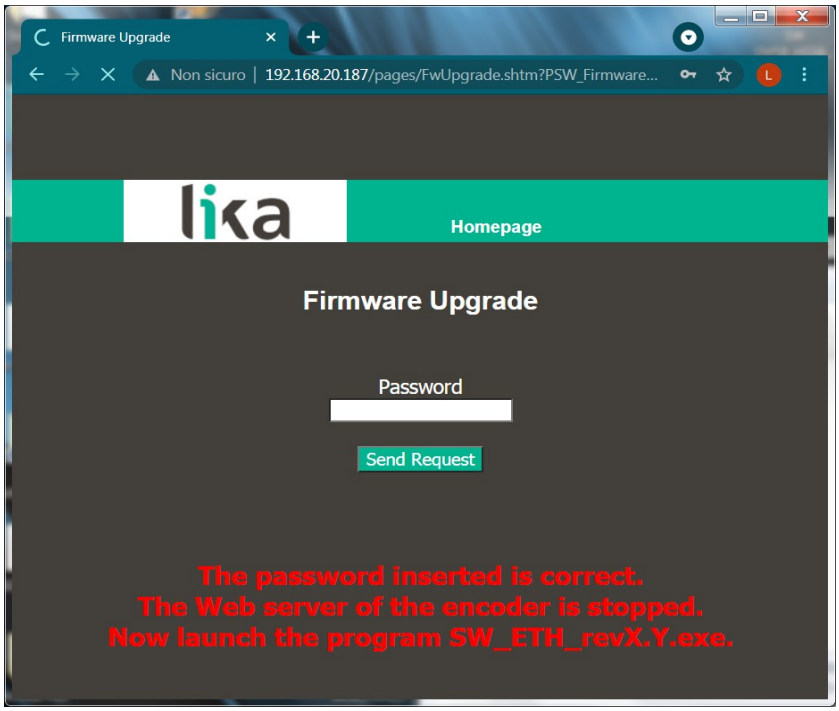


Figure 61 - Firmware Upgrade page

6. if the password you typed is wrong, the following warning message will appear on the screen: THE PASSWORD INSERTED IS INCORRECT. PLEASE RETRY!. Please retype the correct password and confirm;
7. if the password you typed is correct, the following message will appear on the screen: **THE PASSWORD INSERTED IS CORRECT. THE WEB SERVER OF THE ENCODER IS STOPPED. NOW LAUNCH THE PROGRAM SW_ETH_REVX_Y.EXE**;
8. the encoder is now ready to accept the firmware program: the web server is stopped and the communication with the encoder through the web browser is interrupted; if you need to exit the procedure and restore the communication you must switch the encoder off and then on again;
9. now you must launch the SW_ETH_REVX_Y.EXE executable file provided by Lika Electronic to continue with the procedure; X and Y indicate the version of the firmware upgrading program: REV1_0 is the version 1.0;

10. launch the SW_ETH_REVX_Y.EXE executable file; the following page will appear:

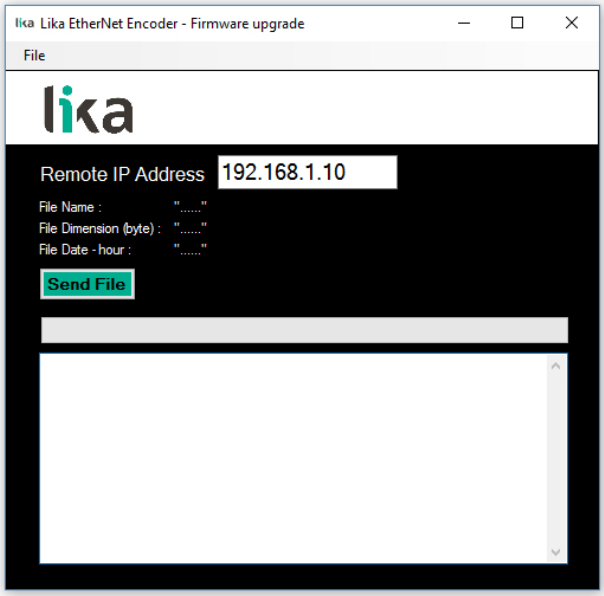


Figure 62 - Firmware upgrade executable file

11. type the IP address of the encoder in the **Remote IP Address** box;
12. press the **FILE** command and then the **OPEN** command in the menu bar; once you press the **OPEN** command the **OPEN** dialog box appears on the screen: open the folder where the firmware upgrading .BIN file released by Lika Electronic is located, select the file and confirm. Hx in the file name shows the hardware version of the PCB; Sx shows the software version of the firmware upgrading file.

WARNING

Please pay attention to install the BIN file that perfectly matches the series of the encoder to be updated.

EM58_HMS_PT_Hx_Sx.bin	for EM58 series
HS58_HMS_PT_Hx_Sx.bin	for HS58 series
HM58_HMS_PT_Hx_Sx.bin	for HM58 series

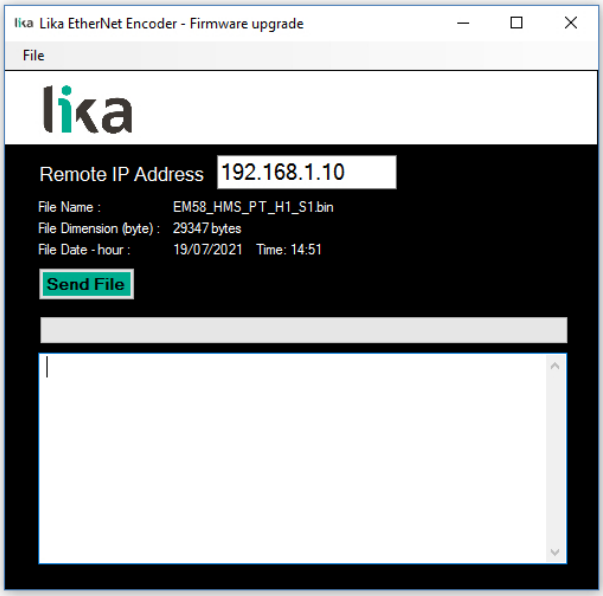


Figure 63 - Selecting the firmware upgrade .BIN file

13. some properties of the selected file are shown next to the relevant labels in the page: **File Name**, **File Dimension (byte)**, **File Date – hour**. Please check the file properties and ascertain that you are installing the correct upgrade file;

WARNING
Before installation always ascertain that the firmware program is compatible with the hardware and software of the device.
Never turn the power supply off during the flash upgrade operation.

14. press the **Send File** button to start the firmware upgrade process;

15. a download progress bar as well as additional information are shown in the page while upgrading the firmware;

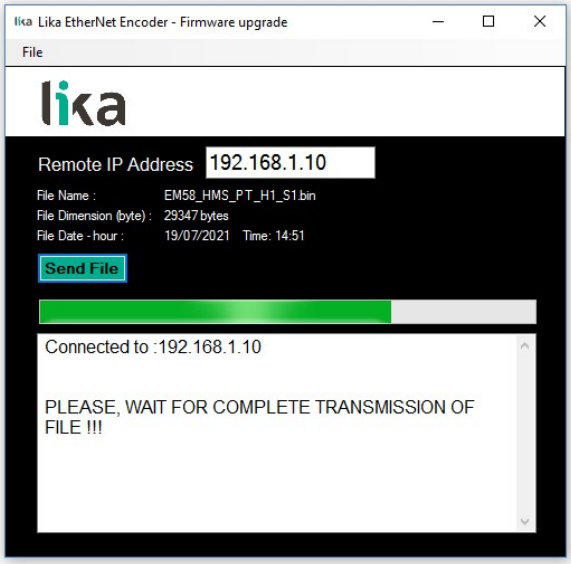


Figure 64 - Updating the firmware

16. as soon as the operation is carried out successfully, the **FILE SENT CORRECTLY** message appears on the screen;

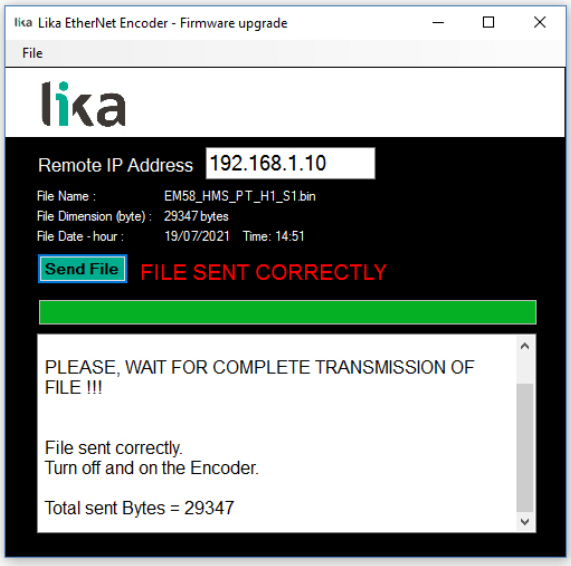


Figure 65 - Firmware upgrade process accomplished

17. now you are required to turn the encoder power supply off and then on. Close the program;
18. turn the encoder power supply off and then on to complete the operation.

NOTE
While downloading the firmware upgrading program, unexpected conditions may arise which could lead to a failure of the installation process. When such a matter occurs, the download process cannot be carried out successfully and thus the operation is aborted; error messages are displayed. In case of flash upgrade error, please switch the encoder off and then on again and retry the operation.

Press the **Homepage** command to move back to the Web server **Home** page.

15 Default parameters list

Parameters list	Default value		
Type of encoder	0 = EM58 series 1 = HS58 series 2 = HM58 series		
Code sequence	0		
Class 4 functionality	1		
G1_XIST1 Preset control	0		
Scaling function control	0		
Alarm channel control	0		
Compatibility Mode	1		
Measuring units / Revolution	8192 = EM58 series 262144 = HS58 series 65536 = HM58 series		
Total measuring range	134217728 = EM58 series 262144 = HS58 series 1073741824 = HM58 series		
Maximum tolerated failures of Master Sign-Of-Life	1		
Velocity measuring unit	0		

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Document release	Release date	Description	HW	SW	GSDML file version
1.0	06.08.2020	First issue	5.2	1.0	20200512
1.1	18.06.2021	Signals information updated, web server added	5.2	1.1	20200512
1.2	22.07.2021	"Electrical connections" section updated, "Getting started" section updated, web server updated (firmware upgrade, preset function, ...)	5.2	1.2	20200512
1.3	02.11.2021	Information about cycle time with TO and IRT connection added, first issue in Italian (04.03.2022)	5.2	1.3, 1.4	20200512
1.4	02.05.2022	Information about TO V5.0 in TIA Portal 16 added	5.2	1.4	20200512
1.5	18.09.2023	New order codes, phase-out product information	5.2	1.4	20230213

This device is to be supplied by a Class 2 Circuit or Low-Voltage Limited Energy or Energy Source not exceeding 30 Vdc. Refer to the order code for supply voltage rate.
Ce dispositif doit être alimenté par un circuit de Classe 2 ou à très basse tension ou bien en appliquant une tension maxi de 30Vcc. Voir le code de commande pour la tension d'alimentation.

Dispose separately

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