Smart encoders & actuators

User's guide

IF55 LIN MT

MODBUS TCP/IP

- SSI to MODBUS TCP/IP converter
- Suitable for SSI linear encoders
- Accepts MSB & LSB Aligned protocols up to 30 bits
- M12 connectors
- In compliance with “Application Protocol Specification V1.1b3”

Suitable for the following models:

- IF55 LIN MT

General Contents

General contents

Subject index

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 both of the device and the 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 and exhaustive information the operator needs to correctly and safely install and operate the **SSI to MODBUS TCP/IP gateways of the IF55 series**.

IF55 series gateways allow the **integration of SSI encoders**, both rotary and linear, **into conventional fieldbuses or industrial Ethernet networks**.
The present manual is specifically designed to describe the SSI to MODBUS TCP/IP IF55 model for linear encoders (order code IF55 LIN MT). For information on the SSI to MODBUS TCP/IP IF55 model for rotary encoders (order code IF55 ROT MT) refer to the specific documentation.
For information on the gateways designed for the integration of other fieldbus encoders (SSI to Profinet: order codes IF55 ROT PT and IF55 LIN PT; SSI to EtherNet/IP: order codes IF55 ROT EP and IF55 LIN EP; SSI to EtherCAT: order codes IF55 ROT EC and IF55 LIN EC; SSI to Profibus: order codes IF55 ROT PB and IF55 LIN PB; and SSI to CANopen: order codes IF55 ROT CB and IF55 LIN CB), refer to the specific documentation.

Please note that the present manual does not prescind from the user's guide of the SSI encoder the gateway has to be connected to. Please read carefully the encoder's documentation before installing, connecting and operating the measuring system.
For detailed technical specifications please refer also to the product datasheet.

To make it easier to read the text, this guide can be divided into two main sections.
In the first section general information concerning the safety, the mechanical installation and the electrical connection as well as tips for setting up and running properly and efficiently the unit are provided.
While in the second section, entitled **MODBUS TCP/IP Interface**, both general and specific information is given on the MODBUS interface. In this section the interface features and the registers implemented in the unit are fully described.

Glossary of MODBUS TCP/IP terms

MODBUS TCP/IP, 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 MODBUS TCP/IP interface. They are listed in alphabetical order.

ADU	Application Data Unit, it is the data frame of the MODBUS protocol. It takes the form of a 7 byte header (MBAP Header: transaction identifier + protocol identifier + length field + unit identifier), and the Protocol Data Unit (PDU: function code + data). The MODBUS TCP/IP ADU is inserted into the data field of a standard TCP frame and sent via TCP on registered port 502, which is specifically reserved for MODBUS applications. Thus, this packet is encapsulated by the data frames imposed by the TCP/IP stack of protocols (TCP/IP/MAC) before being transmitted onto the network. Refer to page 37.
Application Process	The Application Process is the task on the Application Layer.
Application protocol	MODBUS is an application protocol or messaging structure that defines rules for organizing and interpreting data independent of the data transmission medium. TCP/IP only guarantees that application messages are transferred between the devices over the Ethernet Local-Area Network (LAN), it does not guaranty that the devices actually understand or interoperate with one another. For MODBUS TCP/IP, this capability is provided by the application layer protocol MODBUS.
Broadcast address	An IP address with a host portion that is all ones.
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.
Client	A Client is any network device that sends data requests to servers. MODBUS TCP/IP follows the Client/Server model. MODBUS Masters are referred to as Clients, while MODBUS Slaves are Servers.
Data encoding	MODBUS uses a 'big-Endian' representation for addresses and data items. This means that when a numerical quantity larger than a single byte is transmitted, the most significant byte is sent first. Refer to page 37.
Determinism	It is the ability of the communication protocol to guaranty that a message is sent or received in a finite and predictable amount of time.
Deterministic Communication	It describes a communication process whose timing behaviour can be predicted exactly. I.e. the time when a message reaches

	the recipient is predictable.
DHCP	DHCP (Dynamic Host Configuration Protocol) is a standardized network protocol used on Internet Protocol (IP) networks for dynamically distributing network configuration parameters, such as IP addresses for interfaces and services. A DHCP server assigns dynamic IP addresses at startup, and the addresses might change over time. DHCP servers on the network acknowledge the request by offering the client an IP address. The client acknowledges the first offer it receives, and the DHCP server in turn tells the client that it has succeeded in leasing the IP address for a specified amount of time.
DNS	DNS (Domain Name System) is a hierarchical distributed naming system for computers, services, or any resource connected to the Internet or a private network. DNS is a host name resolution service that you can use to determine the IP address of a computer from its host name. This lets users work with host names, such as www.example.com, rather than an IP address, such as 192.168.5.102 or 192.168.12.68.
Encapsulation	The term "encapsulation" refers to the action of packing (embedding) the MODBUS message into the TCP container, the IP container, and the MAC container.
Exception code	Code to be returned by Slaves in the event of problems. All exceptions are signalled by adding 0x80 to the function code of the request. Refer to page 81.
Exception response	MODBUS operates according to the common client/server (Master/Slave) model: the Client (Master) sends a request telegram (service request) to the Server (Slave), and the Server replies with a response telegram. If the Server cannot process a request, it will instead return a error function code (exception response) that is the original function code plus 80H (i.e. with its most significant bit set to 1). Refer to pages 39 and 81.
Function code	MODBUS is a request/reply protocol and offers services specified by function codes. The function code is sent from a Client to the Server and indicates which kind of action the Server must perform. MODBUS function codes are elements of MODBUS request/reply PDUs. The function code field of a MODBUS data unit is coded in one byte. Valid codes are in the range of 1 ... 255 decimal (the range 128 – 255 is reserved and used for exception responses). Function code "0" is not valid. Lika encoders only implement public function codes. Refer to page 40.
Holding register	In the MODBUS data model, a Holding register is the output data. A Holding register has a 16-bit quantity, is alterable by an application program, and allows either read-write or read-only access. Refer to page 53.
Host	A computer or other device on a TCP/IP network.

IEEE 1588	This standard defines a protocol enabling synchronisation of clocks in distributed networked devices (e.g. connected via Ethernet).
Input register	In the MODBUS data model, an Input register is the input data. An Input register has a 16-bit quantity, is provided by an I/O system, and allows read-only access. Refer to page 77.
Internet	The global collection of networks that are connected together and share a common range of IP addresses.
InterNIC	The organization responsible for administration of IP addresses on the Internet.
IP	The network protocol used for sending network packets over a TCP/IP network or the Internet.
IP Address	The IP Address is a 32-bit number that uniquely identifies a host (computer or other device, such as a printer or router) on a TCP/IP network. IP addresses are normally expressed in dotted-decimal format, with four numbers separated by periods, such as 192.168.123.132. An IP address has two parts. The first part of an IP address is used as a network address, the last part as a host address. If you take the example 192.168.123.132 and divide it into these two parts you get the following: 192.168.123. = Network; .132 = Host. Or: 192.168.123.0 = network address; 0.0.0.132 = host address. Refer to page 27.
Isochronous	Pertains to processes that require timing coordination to be successful. Isochronous data transfer ensures that data flows continuously and at a steady rate in close timing with the ability of connected devices.
Legacy Ethernet	Ethernet as standardised in IEEE 802.3 (non-deterministic operation in non-time-critical environments).
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 27.
Master	A Master is any network device that sends data requests to Slaves.
MBAP Header	The MBAP header (MODBUS Application Header) is a 7-byte header added to the start of the message and is used on TCP/IP to identify the MODBUS Application Data Unit. It has the following data: • Transaction Identifier: 2 bytes set by the Client to uniquely identify each request. These bytes are echoed by the Server since its responses may not be received in the same order as the requests. • Protocol Identifier: 2 bytes set by the Client, always = 00 00 • Length: 2 bytes identifying the number of bytes in the

	message to follow. • Unit Identifier: 1 byte set by the Client and echoed by the Server for identification of a remote slave connected on a serial line or on other buses. Refer to page 37.
Media Access Control (MAC)	One of the sub-layers of the Data Link Layer that controls who gets access to the medium to send a message.
Message	The MODBUS messaging service provides a Client/Server communication between devices connected on the Ethernet TCP/IP network. The Client / Server model is based on four types of messages: • MODBUS Request • MODBUS Confirmation • MODBUS Indication • MODBUS Response The MODBUS messaging services are used for information exchange.
MODBUS Confirmation	A MODBUS Confirmation is the Response Message received on the Client side.
MODBUS Indication	A MODBUS Indication is the Request message received on the Server side.
MODBUS Request	A MODBUS Request is the message sent on the network by the Client to initiate a transaction. Refer to page 39.
MODBUS Response	A MODBUS Response is the Response message sent by the Server. Refer to page 39.
Network	Network is a group of computers on a single physical network segment; otherwise it is an IP network address range that is allocated by a system administrator.
Network address	An IP address with a host portion that is all zeros.
Octet	An 8-bit number, 4 of which comprise a 32-bit IP address. They have a range of 00000000-11111111 that correspond to the decimal values 0- 255.
Packet	A unit of data passed over a TCP/IP network or wide area network.
PDU	The Protocol Data Unit (PDU) is the MODBUS function code and data field in their original form. It is packed together with the MBAP Header to form the Application Data Unit (ADU). The MODBUS protocol defines three PDUs. They are: • MODBUS Request PDU, mb_req_pdu • MODBUS Response PDU, mb_rsp_pdu • MODBUS Exception Response PDU, mb_excep_rsp_pdu Refer to page 39.
Port	It is an address that is used locally at the transport layer (on one node) and identifies the source and destination of the

	packet inside the same node. Port numbers are divided between well-known port numbers (0-1023), registered user port numbers (1024-49151) and private-dynamic port numbers (49152-65535). For TCP, port number 0 is reserved and cannot be used. Ports allow TCP/IP to multiplex and demultiplex a sequence if IP datagrams that need to go to many different (simultaneous) application processes. MODBUS TCP/IP uses well-known port 502 to listen and receive MODBUS messages over Ethernet.
Read Holding Registers (03, 0003hex)	This function code is used to READ the contents of a contiguous block of holding registers in a remote device; in other words, it allows to read the values set ina group of work parameters placed in order. Refer to page 41.
Read Input Register (04, 0004hex)	This function code is used to READ from 1 to 125 contiguous input registers in a remote device; in other words, it allows to read some result values and state / alarm messages in a remote device. Refer to page 43.
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.
Register	MODBUS functions operate on memory registers to configure, monitor, and control device I/O. Refer to page 53.
Router	A device that passes network traffic between different IP networks.
Server	A Server is any program that awaits data requests to be sent to it. Servers do no initiate contacts with Clients, but only respond to them. MODBUS TCP/IP follows the Client/Server model. MODBUS Masters are referred to as clients, while MODBUS Slaves are servers.
Service request	It is the MODBUS Request, i.e. the message sent on the network by the Client to initiate a transaction.
Slave	A Slave is any program that awaits data requests to be sent to it. Slaves do no initiate contacts with Masters, but only respond to them.
Subnet Mask	A 32-bit number used to distinguish the network and host portions of an IP address. In other terms, it is used by the TCP/IP protocol to determine whether a host is on the local subnet or on a remote network.
Subnet or Subnetwork	A smaller network created by dividing a larger network into equal parts.
TCP/IP	Used broadly, the set of protocols, standards and utilities commonly used on the Internet and large networks. 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.
Topology	Network structure. Commonly used structures: • Line topology; • Ring topology; • Star topology; • Tree topology. Refer to page 26.
Transmission rate	Data transfer rate (in bps). Refer to page 26.
Wide area network (WAN)	A large network that is a collection of smaller networks separated by routers. The Internet is an example of a very large WAN.
Write Multiple Registers (16, 0010hex)	This function code is used to WRITE a block of contiguous registers (1 to 123 registers) in a remote device. Refer to page 47.
Write Single Register (06, 0006hex)	This function code is used to WRITE a single holding register in a remote device. Refer to page 45.

List of abbreviations

Table below contains a list of abbreviations (in alphabetical order) which may be used in this guide to describe the MODBUS TCP/IP interface.

ADU	Application Data Unit
HDLC	High level Data Link Control
HMI	Human Machine Interface
I/O	Input/Output
IETF	Internet Engineering Task Force
IP	Internet Protocol
MAC	Media Access Control
MB	MODBUS Protocol
MBAP	MODBUS Application Protocol
MBAP header	MODBUS Application Header
PDU	Protocol Data Unit
PLC	Programmable Logic Controller
TCP	Transmission Control Protocol

References

[1] MODBUS Application Protocol Specification, Version V1.1b3

[2] MODBUS messaging on TCP/IP implementation guide, Version V1.0b

[3] RFC 791, Internet Protocol, Sep81 DARPA

[4] RFC 1122 Requirements for Internet Hosts -- Communication Layers

[5] IEC 61918 Industrial communication networks – Installation of communication networks in industrial premises

[6] IEC 61784-5-13 Industrial communication networks – Profiles – Part 5-13: Installation of fieldbuses – Installation profiles for CPF 13

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 power supply before connecting the device;
- connect according to explanation in the "4 - Electrical connections" section on page 23;
- in compliance with the 2014/30/EU norm on electromagnetic compatibility, following precautions must be taken:

  - before handling and installing, 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 6 cylindrical head screw with two tooth lock washers.

1.3 Mechanical safety

- Install the device following strictly the information in the "3 - Mounting instructions" section on page 20;
- mechanical installation has to be carried out with stationary mechanical parts;
- do not disassemble the encoder;
- do not tool the encoder 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 declared by manufacturer.

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: devices 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 Mounting instructions

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

For any information on the mechanical data and the electrical characteristics of the encoder please refer to the technical catalogue.

3.1 Overall dimensions

(values are expressed in mm)

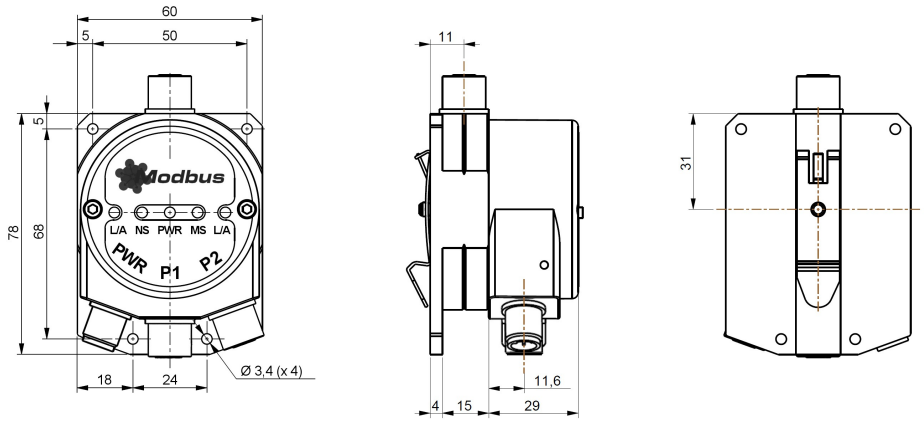


Figure 1 - Overall dimensions

3.2 Installation on panel (Figure 1)

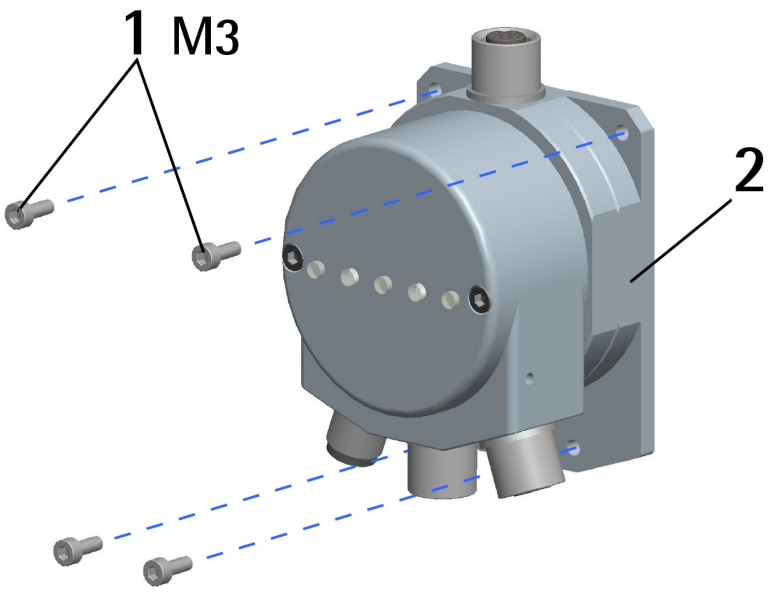


Figure 2 - Installation on panel

The unit is designed for installation on the even surface of a panel.
The back flange **2** is fitted with four holes for inserting the fixing screws **1**. Tighten the four fixing screws **1** until the unit is properly fastened to the support. Use **four M3 8 mm min. long cylinder head screws**. The recommended tightening torque is **1.1 Nm**.

3.3 Installation with DIN rail clip (Figure 2)

The unit can be installed on DIN profiles inside a rack. A clip **3** for direct fitting on DIN TS35 rails is supplied for free. It has to be fixed on the back of the flange **2** by means of the provided screw **4**.

WARNING
To mount the clip **3** you need to remove the cap **5** and drill a hole **A** in the back flange **2**. Delicate electronic circuits and wirings are located inside the cap **5**. Thus this operation has to be accomplished by skilled personnel only. Please pay careful attention and observe great precaution when carrying out this operation.

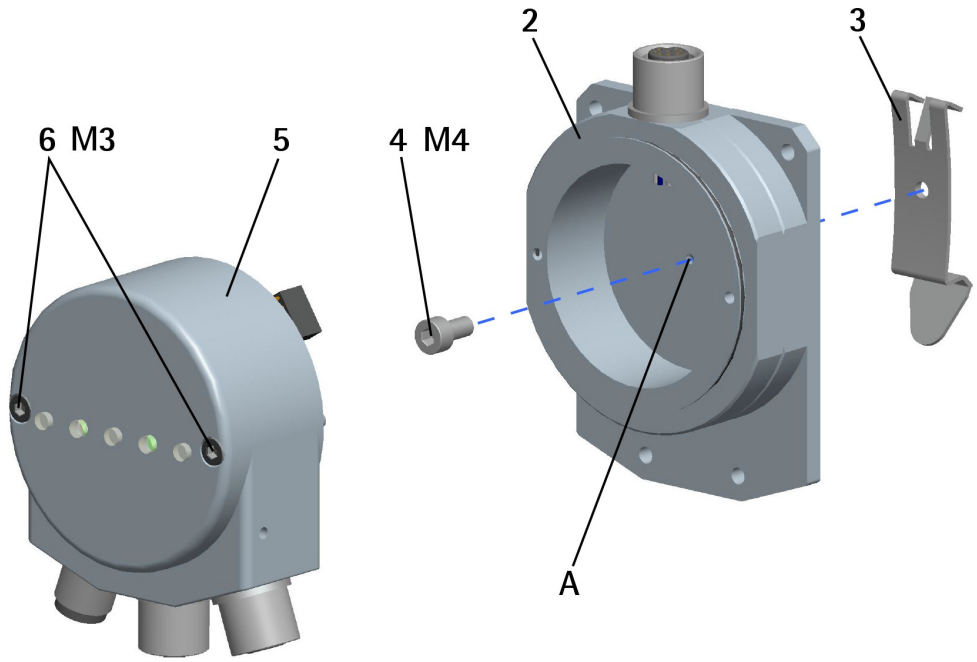


Figure 3 - Installation with DIN rail clip

- Loosen the two screws **6** that fasten the cap **5** to the back flange **2**;

WARNING
Please note that, for graphical clarity, we show the cap **5** completely removed from the back flange **2**. Actually the parts cannot be fully separated because of the internal wirings.

- open the cap **5** and separate it from the flange **2** as much as possible; please pay attention to the internal wirings;
- drill a 4.5 mm diameter hole **A** in the flange **2**; use the notch in the inside of the flange **2** to guide the drill bit;

WARNING
Carefully remove the scrap material after drilling.

- mount the clip **3** on the back of the flange **2** and fix it by means of the provided M4 x 8 screw **4**; it has to be screwed on the inner side of the flange **2**;
- replace the cap **5** and fix it by means of the screws **6**.

4 Electrical connections

WARNING
Power supply must be turned off before performing any electrical connection!

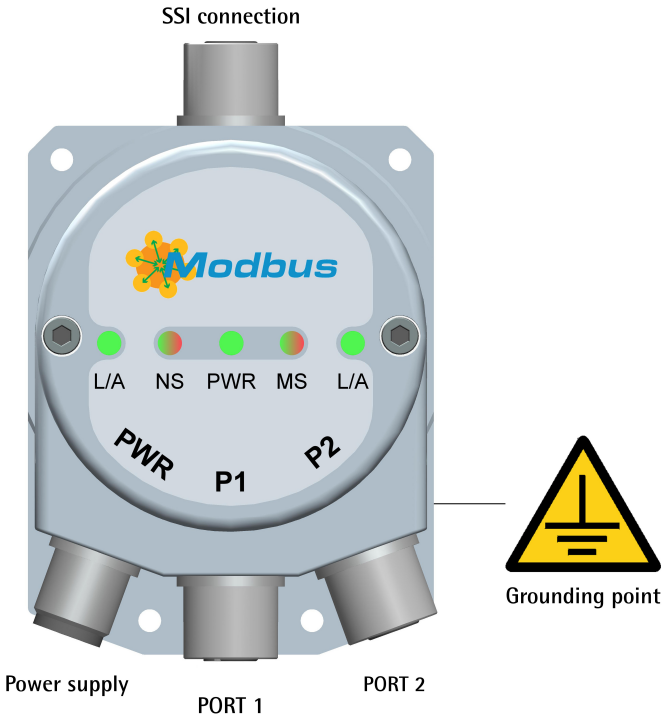


Figure 4 - Connectors and diagnostic LEDs

4.1 Connection cap of the converter

WARNING
Do not remove or mount the connection cap with power supply switched ON. Damage may be caused to internal components.

The DIP switch meant to reset the network configuration parameters of the converter to the factory values (default values) is located inside the connection cap. Thus you must remove the connection cap to access it.

NOTE
Be careful not to damage the internal components when you perform this operation.

To remove the connection cap loosen the two screws **1**. Please be careful with the internal connector.
Always replace the connection cap at the end of the operation. Take care in re-connecting the internal connector. Tighten the screws **1** using a tightening torque of approx. 2.5 Nm.

WARNING
You are required to check that the converter back flange and the connection cap are at the same potential before replacing the connection cap!

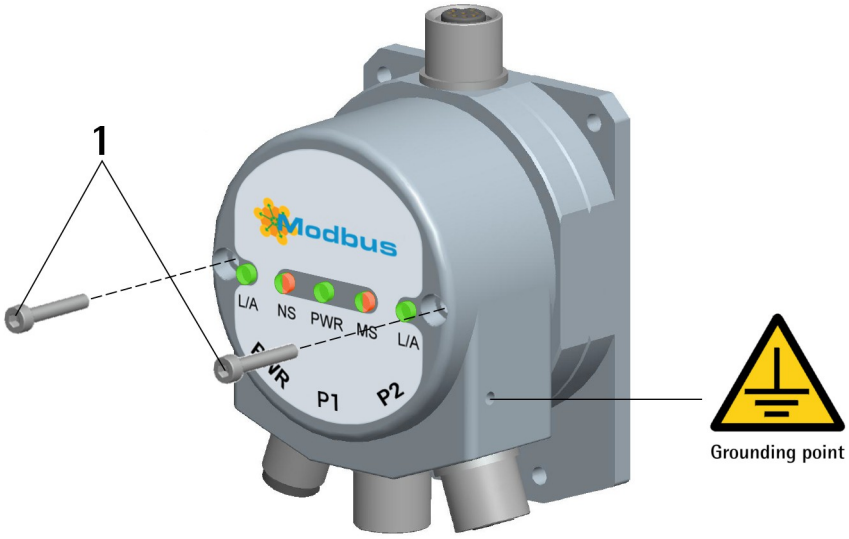
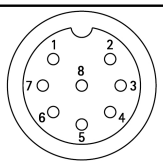


Figure 5 - Removing the connection cap

4.2 SSI connection (Figure 4)

The connection cap is fitted with one M12 8-pin female connector to network the IF55 gateway and the SSI encoder.

M12 8-pin	SSI connection
(frontal side)	 A coding female

Pin	Description
1	0Vdc power supply
2	+10Vdc +30Vdc power supply
3	Clock IN +

4	Clock IN -
5	Data OUT +
6	Data OUT -
7 and 8	not connected

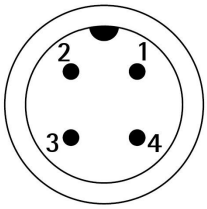
WARNING
The max. length of the SSI cable must not exceed 2 m / 78.7".

4.3 Power supply and MODBUS TCP/IP interface connectors (Figure 4)

The connection cap is fitted with three M12 4-pin connectors with pin-out in compliance with the Ethernet standard. Therefore you can use standard Ethernet cables commercially available, for more information see later.

4.3.1 PWR Power supply connector (Figure 4)

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

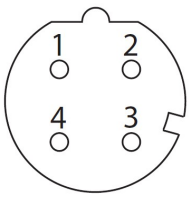


Description	Pin
+10Vdc +30Vdc	1
n.c.	2
0Vdc	3
n.c.	4

n.c. = not connected

4.3.2 P1 Port 1 and P2 Port 2 connectors (Figure 4)

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 Ethernet interface supports 10/100 Mbit/s, full/half-duplex/full duplex operation.

P1 PORT 1 and P2 PORT 2 M12 connectors have pin-out in compliance with the Ethernet standard. Therefore you can use standard Ethernet cables commercially available, for more information see later.
P1 PORT 1 and P2 PORT 2 connectors are interchangeable.

4.4 Network configuration: topologies, cables, hubs, switches - Recommendations

Using Ethernet several topologies of connection are supported by MODBUS TCP/IP networks: line, tree, daisy-chain, star, ... Furthermore MODBUS TCP/IP networks can be configured in almost any topology in the same structure.
The connection of the encoder can be made directly with a network card or indirectly with a switch, hub or company network.
Cables and connectors comply with the IEEE 802.3 Ethernet specifications.
If you use a direct connection to a computer/controller without network components in between, you need to use a standard, "straight" network cable (not a crossover cable).
You need at least a CAT-5 cable (category 5) to get a data transfer rate up to 100 Mbit/s. If there is a network component in the network which does not provide fast Ethernet, the encoder will automatically switch down to 10 Mbit/s.
Standard Ethernet cables commercially available can be used.
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.

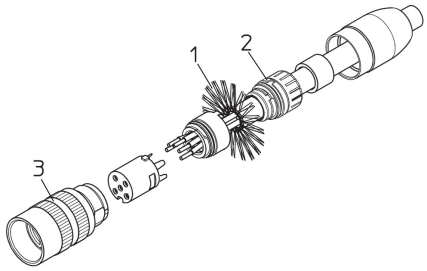
For a complete list of the available cordsets and connection kits please refer to the product datasheet ("Accessories" list).

4.5 Ground connection

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 4, use 1 TCEI M3 x 6 cylindrical head screw with two tooth lock washers).

4.6 Connection of the shield

Disentangle and shorten the shielding **1** and then bend it over the part **2**; finally place the ring nut **3** of the connector. Be sure that the shielding **1** is in tight contact with the ring nut **3**.



4.7 MAC address and IP address

The unit can be identified in the network through the **MAC address** and the **IP address**.

The MAC address is an identifier unique worldwide and 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. The 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) and are provided by IEE standard authority; while the last three bytes represent a consecutive number of the manufacturer and are the specific identifier of the unit. The MAC address can be found for commissioning purposes on the label applied to the converter and is displayed in the Converter Information page of the web server.

The MAC address has the following structure:

Bit value 47 ... 24			**Bit value 23 ... 0**		
10	B9	FE	X	X	X
Company code (OUI)			**Consecutive number**		

The IP address must be assigned by the user to each interface of the unit to be connected in the network, the default IP address assigned by Lika Electronic is 192.168.1.10, while the default subnet mask is 255.255.255.0.

To set the network configuration parameters refer to the next section.

4.8 Setting the IP address and the network configuration parameters

WARNING
Only competent technicians, who are properly trained, have adequate experience and are familiar with computer architecture, network design and operating systems should configure the network communication parameters.
The inappropriate setting of the network parameters results in an incorrect operation of the system.

WARNING
The MODBUS TCP/IP address and communication parameters can be set only via software.

The following table summarises the default IP address and the network configuration parameters.

IP Parameter	Value
IP address	192.168.1.10
Subnet mask	255.255.255.0
Default Gateway	0.0.0.0

To configure the network and set specific communication parameters, the operator must enter the **Network IP Configuration** page of the Web server.
Any change is valid in the range: 0.0.0.0 ... 255.255.255.255 in compliance with the Internet Protocol rules.
For any information on the **Network IP Configuration** page refer to the "8.8 Network configuration" section on page 102.

NOTE
If for any reason you must restore the factory values (default values) of the network configuration parameters you must access the DIP A dip switch located inside the connection cap. For complete information please refer to the "4.10 DIP A: Resetting the network configuration parameters to the factory values" section on page 30.

4.9 Diagnostic LEDs (Figure 4)

Five LEDs located in the cap of the converter (see the Figure 4) are meant to show visually the operating or fault status of the device and the MODBUS interface. The meaning of each LED is explained in the following tables.

LED	Description
L/A Link/Activity LED for port 1 P1 (green)	It shows the state and the activity of the physical link (port 1 P1).
OFF	Neither link active nor activity
ON	Port 1 P1 link active, no activity.
BLINKING	Activity on port 1 P1.

LED	Description
NS Network State Error LED (green / red)	It shows the current state of the network.
OFF	No IP address detected or fault status.
ON green	One MODBUS message at least has been received.
FLASHING green	The converter is waiting for the first MODBUS message to be received.
ON red	IP address conflict detected or FATAL ERROR.
FLASHING red	Connection timeout, no MODBUS message has been received within the set timeout time (see the **Watchdog timeout [82]** register on page 54).

LED	Description
PWR Power LED (green)	It shows the power supply state.
OFF	The converter power supply is switched OFF.
ON	The converter power supply is switched ON.

LED	Description
MS Module Status LED (green / red)	It shows the state of the MODBUS TCP/IP device.
OFF	The device power supply is switched OFF.
ON green	The device is in normal operational state.
ON red	Major fault, FATAL ERROR.
FLASHING red	Minor fault.

LED	Description
L/A Link/Activity LED for port 2 P2 (green)	It shows the state and the activity of the physical link (port 2 P2).
BLINKING	Activity on port 2 P2.
ON	Port 2 P2 link active, no activity.

NOTE
If both the NS Network Status LED and the MS Module Status LED are red, a fatal error has occurred.

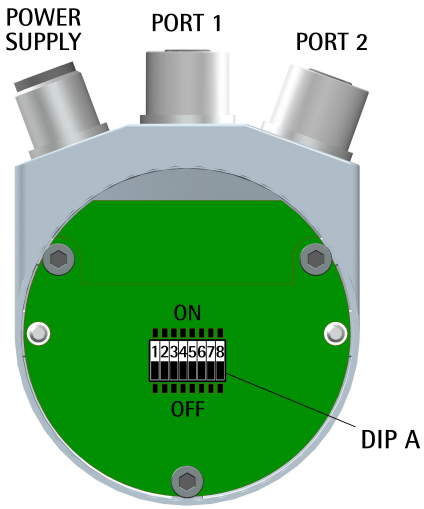
NOTE
At switching on, the device carries out a hardware test to check the LEDs operation.
Both NS Network Status and MS Module Status LEDs light up.

4.10 DIP A: Resetting the network configuration parameters to the factory values

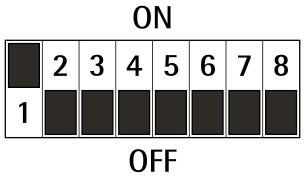
WARNING
To access the DIP A dip switch meant to reset the network configuration parameters to the factory values (default values) you must remove the connection cap. For any information on removing the connection cap please refer to the "4.1 Connection cap of the converter" section on page 23.

If for any reason you must restore the factory values (default values) of the network configuration parameters (IP address, Subnet mask, DHCP), access the DIP A dip switch proceeding as follows:

WARNING
Please pay the utmost attention to the internal wirings and connections while the cap is open.



- Turn the power supply off;
- remove the connection cap as explained in the "4.1 Connection cap of the converter" section on page 23;
- set the hardware switch 1 to ON;



- reconnect the cap, then turn the power supply on and wait for the initialization process to be completed;
- turn the power supply off;
- remove the connection cap again and set the hardware switch 1 to OFF again;
- replace the connection cap as explained in the following "4.1 Connection cap of the converter" section on page 23;
- turn the power supply on to restore the normal converter operation.

The following table summarises the IP address and the network configuration parameters after reset.

IP Parameter	Value
IP address	192.168.1.10
Subnet mask	255.255.255.0
DHCP	OFF

5 Quick reference

5.1 Getting started

The following instructions are provided to allow the operator to set up the device for standard operation in a quick and safe mode.

- Mechanically install the device, see on page 20;
- execute the electrical connections, see on page 23;
- if required, set the communication parameters to allow the unit to access the MODBUS TCP/IP network, see the "4.8 Setting the IP address and the network configuration parameters" section on page 28; the default network configuration parameters are as follows:

IP Parameter	Value
IP address	192.168.1.10
Subnet mask	255.255.255.0
Default Gateway	0.0.0.0

- switch on the +10Vdc +30Vdc power supply;
- set the characteristics of the connected SSI encoder:
  - set the number of SSI clocks next to the **No of SSI clocks** parameter in the **Encoder Settings [141-142]** registers;
  - set the output code used by the SSI encoder to arrange the output information next to the **SSI output code** parameter in the **Encoder Settings [141-142]** registers;
  - set the protocol used by the SSI encoder to arrange the absolute information next to the **SSI protocol** parameter in the **Encoder Settings [141-142]** registers;
  - set the physical resolution of the SSI encoder next to the **Measure of a pulse nm [143-144]** registers; the **Position step setting nm [103-104]** and **Measuring step nm [113-114]** registers are automatically set accordingly;
  - set the max. number of information the SSI encoder can output for the max. measuring range next to the **Max No of Information** parameter in the **Encoder Settings [141-142]** registers; the **Total measuring range [101-102]** registers are automatically set according to the value in the **Max No of Information** parameter; the user can set a custom measuring range;
- if you need to use the physical resolution of the unit, please check that the **Scaling function** item is disabled (the bit 0 in the **Operating parameters [109-110]** registers = 0; see on page 63); the encoder will use the **Max No of Information** parameter in the **Encoder Settings [141-142]** registers and the **Measure of a pulse nm [143-144]** registers value to arrange the absolute position information;

- otherwise if you need a specific resolution, please enable the **Scaling function** item (the bit 0 in the Operating parameters [109-110] registers = 1; see on page 63);
- then set the the resolution you need for your application next to the Position step setting nm [103-104] registers, see on page 57;
- now you can set a custom measuring range next to the Total measuring range [101-102] registers, see on page 55;
- now, if you need you can set a Preset value next to the Preset value [105-106] registers and then activate it by executing the **Perform counting preset** command available in the Control Word [111-112] registers, see on page 61;
- save the new setting values (use the **Save parameters** command available in the Control Word [111-112] registers, see on page 65).

NOTE
Please consider that if the **Bypass mode** parameter in the Encoder Settings [141-142] registers (see on page 74) is set to "1" = enabled, the scaling function -even if enabled- is ignored.

NOTE
MODBUS TCP/IP protocol does not require any configuration file.

5.2 Examples

EXAMPLE 1
We need to connect an **SMA5-GA-50** linear encoder.

The main features of the linear encoder are:
Resolution: **0.05 mm** (-50-, see the order code in the product datasheet).
Max. measuring length: **5,050 mm** (see the "Mechanical Specifications" in the product datasheet).
Output code: **Gray code** (-GA-, see the order code in the product datasheet).
SSI protocol: **25-bit "LSB Right Aligned" protocol** (see the User's manual).

Encoder Settings [141-142]
SSI protocol = 0h (= 25-bit "LSB Right Aligned" protocol)
SSI output code = 1h (= Gray code)
Max No of Information = 11h (= Max. measuring length/Resolution = 5,050/0.05 = 101,000 ≈ 2^{17} = 17 bits)
No of SSI clocks = 19h (= 25 dec)
Measure of a pulse nm [143-144] = C350h (0.05 mm resolution = 50,000 nm resolution)
Position step setting nm [103-104] = C350h (0.05 mm resolution = 50,000 nm resolution)

Total measuring range [101-102] = 0002 0000h (= 5,050/0.05 = 101,000 information; default and max. value 2^{17} = 131,072 dec = 0002 0000h) as a default

If you want to use the physical resolution:
Scaling function in the **Operating parameters [109-110]** registers = 0

If you need a custom resolution:
Scaling function in the **Operating parameters [109-110]** registers = 1
Position step setting nm [103-104] ≥ **Measure of a pulse nm [143-144]**

Total measuring range [101-102] ≤ 0002 0000h (= 5,050/0.05 = 101,000 information; max. value 2^{17} = 131,072 dec = 0002 0000h); the user can set a custom measuring range

If you set a 0 preset along the path, when the encoder moves back and cross the zero, the value immediately after 0 will be $2^{\text{Max No of Information}}$-1, i.e. 131,071 (assuming that **Total measuring range [101-102]** = 131,072).

...	131,069	131,070	131,071	0	1	2	...

EXAMPLE 2
We need to connect an **SMAX-BG-100** linear encoder.

The main features of the linear encoder are:
Resolution: **0.1 mm** (-100-, see the order code in the product datasheet).
Max. measuring length: **600 mm** (see the "Mechanical Specifications" in the product datasheet).
Output code: **Binary code** (-BG-, see the order code in the product datasheet).
SSI protocol: **13-bit "MSB Left Aligned" protocol** (see the User's manual).

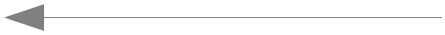
Encoder Settings [141-142]
SSI protocol = 1h (= "MSB Left Aligned" protocol)
SSI output code = 0h (= Binary code)
Max No of Information = 0Dh (= Max. measuring length/Resolution = 600/0.1 = 6,000 ≈ 2^{13} = 13 bits)
No of SSI clocks = 0Dh (= 13 dec), according to **Max No of Information**
Measure of a pulse nm [143-144] = 0001 86A0h (0.1 mm resolution = 100,000 nm resolution)
Position step setting nm [103-104] = 0001 86A0h (0.1 mm resolution = 100,000 nm resolution)
Total measuring range [101-102] = 0000 2000h (= 600/0.1 = 6,000 information; default and max. value 2^{13} = 8,192 dec = 0000 2000h) as a default;

If you want to use the physical resolution:
Scaling function in the **Operating parameters [109-110]** registers = 0

If you need a custom resolution:
Scaling function in the **Operating parameters [109-110]** registers = 1
Position step setting nm [103-104] ≥ **Measure of a pulse nm [143-144]**

Total measuring range [101-102] ≤ 0000 2000h (= 600/0.1 = 6,000 information; max. value 2^{13} = 8,192 dec = 0000 2000h); the user can set a custom measuring range

If you set a 0 preset along the path, when the encoder moves back and cross the zero, the value immediately after 0 will be $2^{\text{Max No of Information}}$-1, i.e. 8,191 (assuming that **Total measuring range [101-102]** = 8,192).



...	8,189	8,190	8,191	0	1	2	...

6 MODBUS® TCP/IP interface

Lika's MODBUS TCP/IP converters are Slave (Server) devices and implement the MODBUS application protocol (level 7 of OSI model) and the "MODBUS messaging on TCP/IP" protocol (Ethernet: levels 1 & 2 of OSI model; TCP/IP: levels 3 & 4 of OSI model).
For any further information or omitted specifications please refer to "MODBUS Application Protocol Specification, Version V1.1b3" and "MODBUS messaging on TCP/IP implementation guide, Version V1.0b" available at www.modbus.org.

6.1 MODBUS protocol principles

MODBUS is an application layer messaging protocol, positioned at level 7 of the OSI model, which provides Client/Server communication between devices connected on different types of buses or networks. In particular, the MODBUS TCP/IP messaging service provides a Client/Server communication between devices connected on an Ethernet TCP/IP network.
The Modbus protocol was developed in 1979 by Modicon, for industrial automation systems and Modicon programmable controllers. It has since become an industry standard method for the transfer of discrete/analogue I/O information and register data between industrial control and monitoring devices.

MODBUS devices communicate using a Master-Slave (Client-Server) technique in which only one device (the Master/Client) can initiate transactions (called queries). The other devices (Slaves/Servers) respond by supplying the requested data to the Master, or by taking the action requested in the query. A Slave is any peripheral device (I/O transducer, valve, network drive, or other measuring device) which processes information and sends its output to the Master using MODBUS.
Masters can address individual Slaves, or can initiate a broadcast message to all Slaves. Slaves return a response to all queries addressed to them individually, but do not respond to broadcast queries. Slaves do not initiate messages on their own, they only respond to queries from the Master.

MODBUS TCP/IP (also MODBUS-TCP) is simply the MODBUS RTU protocol with a TCP interface that runs on Ethernet.
The MODBUS messaging structure is the application protocol that defines the rules for organizing and interpreting the data independent of the data transmission medium.
TCP/IP refers to the Transmission Control Protocol and Internet Protocol, which provides the transmission medium for MODBUS TCP/IP messaging.

Among the significant advantages of MODBUS TCP/IP are:

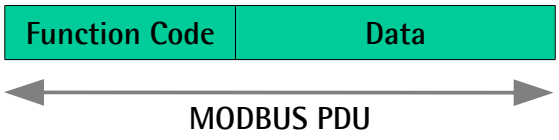
- MODBUS TCP/IP simply takes the MODBUS instruction set and wraps TCP/IP around it;

- it supports standard Ethernet and does not require dedicated Masters or chipsets; standard PC Ethernet cards and PCs can be used to communicate in any Ethernet network;
- it does not require any configuration file;
- it does not need any specific software thanks to the possibility of integrating a web server: it 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 and check the currently set parameters;
  - to set the network communication parameters;
  - to set the device work parameters;
  - to upgrade the firmware;
  - to monitor the device and access some advanced maintenance functions.

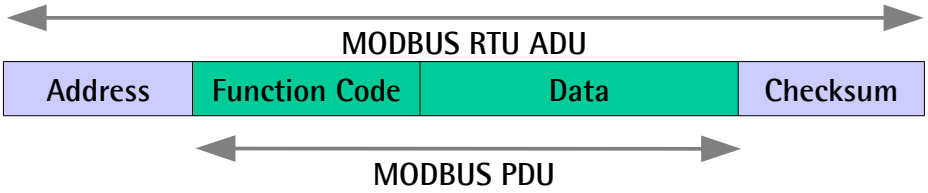
  The web server can be accessed from any PC running a web browser.

6.2 General MODBUS frame description

The MODBUS application protocol defines a simple **Protocol Data Unit (PDU)** independent of the underlying communication layers:



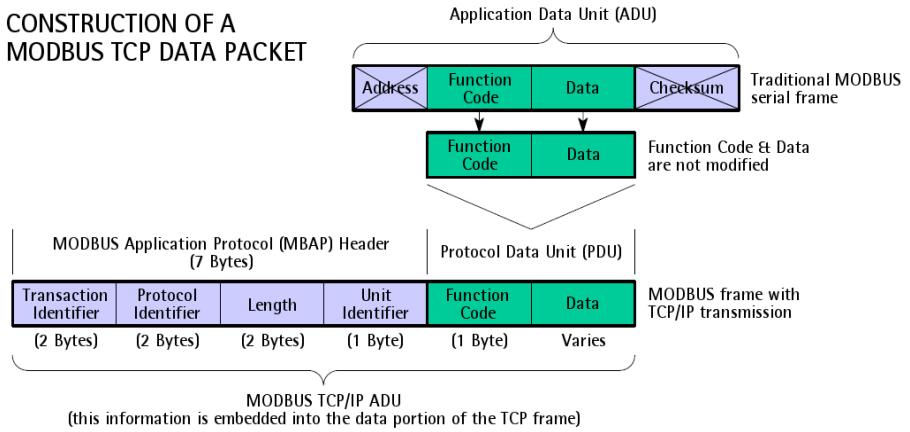
The mapping of MODBUS protocol on a specific bus or network introduces some additional fields on the **Application Data Unit (ADU)**. The Client that initiates a MODBUS transaction builds the MODBUS Application Data Unit, and then adds fields in order to build the appropriate communication ADU. The function code indicates to the Server which kind of action to perform.



6.3 MODBUS on TCP/IP Application Data Unit

MODBUS TCP/IP uses TCP/IP and Ethernet to carry the data of the MODBUS message structure between compatible devices. That is, MODBUS TCP/IP combines a physical network (Ethernet) with a networking standard (TCP/IP), and a standard method of representing data (MODBUS as the application

protocol). Essentially, the MODBUS TCP/IP message is simply a MODBUS communication encapsulated in an Ethernet TCP/IP wrapper.
In practice, MODBUS TCP embeds a standard MODBUS data frame into a TCP frame, without the MODBUS RTU address and checksum, as shown in the following diagram.



As you can see, the Protocol Data Unit is integrated in its original form.
The MODBUS TCP/IP Application Data Unit (ADU) takes the form of a 7-byte header (MBAP Header -MODBUS Application Protocol Header: Transaction Identifier + Protocol Identifier + Length field + Unit Identifier), and the protocol data unit (MODBUS PDU: Function Code + Data).

- **MBAP HEADER** (MODBUS Application Protocol Header). A dedicated header is used on TCP/IP to identify the MODBUS Application Data Unit. The MBAP Header contains the following fields:
  - **Transaction Identifier**: it is 2-byte long and is used for transaction pairing, i.e. for identification of a MODBUS Request / Response transaction. It is initialized by the Client, the Server copies in the response the Transaction Identifier received with the request.
  - **Protocol Identifier**: it is 2-byte long and is used for intra-system multiplexing. The MODBUS protocol is identified by the value 0. It is initialized by the Client, the Server copies in the response the Protocol Identifier received with the request.
  - **Length**: it is 2-byte long and is a byte count of the following fields, including the Unit Identifier, the Function Code and the Data field. It is initialized by the Client in the request, and it is initialized by the Server in the response.
  - **Unit Identifier**: it is 1-byte long and is used for intra-system routing purpose. It is typically used to communicate to a MODBUS+ or a MODBUS serial line Slave through a gateway between an Ethernet TCP/IP network and a MODBUS serial line. This field is set by the MODBUS Client in the request and must be returned with the same value in the response by the Server. In a typical MODBUS TCP/IP Server application, the Unit Identifier is set to 00 hex or FF hex.

- **FUNCTION CODE**: the function code indicates to the Server what kind of action to perform. The function code is followed by a **DATA** field that contains request and response parameters. All MODBUS request and responses are designed in such a way that the recipient can verify that a message is finished. For function codes where the MODBUS PDU has a fixed length, the function code alone is enough. For function codes carrying a variable amount of data in the request or in the response, the data field includes a byte count. For any further information on the implemented function codes refer to the "6.5 Function codes" section on page 40.
- **DATA**: the **DATA** field of messages contains the bytes for additional information and transmission specifications that the Server uses to take the action defined by the **FUNCTION CODE**. This can include items such as discrete and register addresses, the quantity of items to be handled, and the count of actual data bytes in the field. The structure of the **DATA** field depends on each **FUNCTION CODE** (refer to the "6.5 Function codes" section on page 40).

The complete MODBUS TCP/IP Application Data Unit is embedded into the data field of a standard TCP frame and sent via TCP to **registered port 502**, which is specifically reserved for MODBUS applications. MODBUS TCP/IP Clients and Servers listen and receive MODBUS data via port 502.

NOTE
MODBUS uses a 'big-Endian' representation for addresses and data items. This means that when a numerical quantity larger than a single byte is transmitted, the most significant byte (MSB) is sent first. So for example:

Register size	value	
16–bit	1234hex	the first byte sent is 12hex, then 34hex

6.4 MODBUS PDUs

The MODBUS protocol defines three PDUs. They are:

- **MODBUS Request PDU**;
- **MODBUS Response PDU**;
- **MODBUS Exception Response PDU**.

The **MODBUS Request PDU** is defined as {function_code, request_data}, where:
function_code = MODBUS function code [1 byte];
request_data = this field is function code dependent and usually contains information such as variable references, variable counts, data offsets, sub-function, etc. [n bytes].

The **MODBUS Response PDU** is defined as {function_code, response_data}, where:
function_code = MODBUS function code [1 byte];
response_data = this field is function code dependent and usually contains information such as variable references, variable counts, data offsets, sub-function, etc. [n bytes].

The **MODBUS Exception Response PDU** is defined as {exception-function_code, exception_code}, where:
exception-function_code = MODBUS function code + 0080 hex [1 byte];
exception_code = MODBUS Exception code, refer to the table "MODBUS Exception Codes" in the section 7 of the document "MODBUS Application Protocol Specification V1.1b", [1 byte].

The size of the MODBUS PDU is limited by the size constraint inherited from the first MODBUS implementation on Serial Line network (max. RS485 ADU = 256 bytes).
Therefore:
MODBUS **PDU for serial line communication** = 256 - Server address (1 byte) - CRC (2 bytes) = 253 bytes.
Consequently:
RS232 / RS485 **ADU** = 253 bytes + Server address (1 byte) + CRC (2 bytes) = **256 bytes**.
TCP MODBUS **ADU** = 253 bytes + MBAP (7 bytes) = **260 bytes**.

6.5 Function codes

As previously stated, the function code indicates to the Server what kind of action to perform.
The function code field of a MODBUS Protocol Data Unit is coded in one byte. Valid codes are in the range of 1 ... 255 decimal (the range 128 ... 255 is reserved and used for Exception Responses). When a message is sent from a Client to a Server device the function code field tells the Server what kind of action to perform. Function code "0" is not valid.
There are three categories of MODBUS function codes, they are:

- **public function codes**;
- **user-defined function codes**;
- **reserved function codes**.

Public function codes are in the range 1 ... 64, 73 ... 99 and 111 ... 127; they are well defined function codes, validated by the MODBUS-IDA.org community and publicly documented; furthermore they are guaranteed to be unique.
Ranges of function codes from 65 to 72 and from 100 to 110 are **user-defined function codes**: user can select and implement a function code that is not supported by the specification, it is clear that there is no guarantee that the use of the selected function code will be unique.
Reserved function codes are not available for public use.

6.5.1 Implemented function codes

Lika MODBUS TCP/IP devices only implement public function codes, they are described hereafter.

03 Read Holding Registers

FC = 03 (0003 hex) ro

This function code is used to READ the contents of a contiguous block of Holding Registers (4X Reference Addresses) in a remote device; in other words, it allows to read the values set in a group of work parameters placed in order. The Request PDU specifies the starting register address and the number of registers. In the PDU registers are addressed starting at zero. Therefore registers numbered 1-16 are addressed as 0-15.

The register data in the response message is packed as two bytes per register, with the binary contents right justified within each byte. For each register, the first byte contains the high order bits (msb) and the second contains the low order bits (lsb).

For the complete list of the holding registers accessible using the **03 Read Holding Registers** function code please refer to the "7.1.1 Holding Register parameters" section on page 53.

Request PDU

Function code	1 byte	**0003 hex**
Starting address	2 bytes	0000 hex to FFFF hex
Quantity of registers	2 bytes	1 to 125 (007D hex)

Response PDU

Function code	1 byte	**0003 hex**
Byte count	1 byte	2 x **N***
Register value	**N*** x 2 bytes	

*N = Quantity of registers

Exception Response PDU

Error code	1 byte	**0083 hex (=0003 hex + 0080 hex)**
Exception code	1 byte	01 or 02 or 03 or 04

Here is an example of a request to read the **Preset value [105-106]** registers (address 104-105).

Request	
Field name	(Hex)
Function	**03**
Starting address Hi	**00**
Starting address Lo	**68**
No. of registers Hi	**00**
No. of registers Lo	**02**

Response	
Field name	(Hex)
Function	**03**
Byte count	**04**
Register 105 value Hi	**00**
Register 105 value Lo	**00**
Register 106 value Hi	**05**
Register 106 value Lo	**DC**

As you can see in the table, the **Preset value [105-106]** registers (address 104-105) contain the value 00 00 hex and 05 DC hex, i.e. 1500 in decimal notation.

The MODBUS TCP/IP ADU needed for the request to read the **Preset value [105-106]** registers (address 104-105) is as follows:

MBAP Header + Request PDU (in hexadecimal notation)

[00][01][00][00][00][06][00][03][00][68][00][02]
where:
[00][01] = Transaction Identifier
[00][00] = Protocol Identifier
[00][06] = Length
[00] = Unit Identifier
[03] = **03 Read Holding Registers** function code
[00][68] = starting address (**Preset value [105-106]** registers, address 104-105)
[00][02] = number of requested registers

The MODBUS TCP/IP ADU needed to send back the values of the **Preset value [105-106]** registers (address 104-105) is as follows:

MBAP Header + Response PDU (in hexadecimal notation)
[00][01][00][00][00][07][00][03][04][00][00][05][DC]
where:
[00][01] = Transaction Identifier
[00][00] = Protocol Identifier
[00][07] = Length
[00] = Unit Identifier
[03] = **03 Read Holding Registers** function code

[04] = number of bytes (2 bytes for each register)
[00][00] = value of register 105, 00 00 hex = 0 dec
[05][DC] = value of register 106, 05 DC hex = 1500 dec

04 Read Input Registers

FC = 04 (0004 hex)

This function code is used to READ from 1 to 125 contiguous Input Registers (3X Reference Addresses) in a remote device; in other words, it allows to read some results values and state / alarm messages in a remote device. The Request PDU specifies the starting register address and the number of registers. In the PDU registers are addressed starting at zero. Therefore input registers numbered 1-16 are addressed as 0-15.
The register data in the response message are packed as two bytes per register, with the binary contents right justified within each byte. For each register, the first byte contains the high order bits (msb) and the second contains the low order bits (lsb).
For the complete list of the input registers accessible using the **04 Read Input Registers** function code please refer to the "7.1.2 Input Register parameters" section on page 77.

Request PDU

Function code	1 byte	**0004 hex**
Starting address	2 bytes	0000 hex to FFFF hex
Quantity of Input Registers	2 bytes	0000 hex to 007D hex

Response PDU

Function code	1 byte	**0004 hex**
Byte count	1 byte	2 x **N***
Input register value	**N*** x 2 bytes	

*N = Quantity of registers

Exception Response PDU

Error code	1 byte	**0084 hex (=0004 hex + 0080 hex)**
Exception code	1 byte	01 or 02 or 03 or 04

Here is an example of a request to read the **Current position [1-2]** registers (address 0-1).

Request	
Field name	(Hex)
Function	**04**
Starting address Hi	**00**
Starting address Lo	**00**
Quantity of Input Reg. Hi	**00**
Quantity of Input Reg. Lo	**02**

Response	
Field name	(Hex)
Function	**04**
Byte count	**04**
Register 1 value Hi	**00**
Register 1 value Lo	**00**
Register 2 value Hi	**2F**
Register 2 value Lo	**F0**

As you can see in the table, the **Current position [1-2]** registers (address 0-1) contain the values 00 00 hex and 2F F0 hex, i.e. 12272 in decimal notation.

The MODBUS TCP/IP ADU needed for the request to read the **Current position [1-2]** registers (address 0-1) is as follows:

MBAP Header + Request PDU (in hexadecimal notation)
[00][01][00][00][00][06][00][04][00][00][00][02]
where:
[00][01] = Transaction Identifier
[00][00] = Protocol Identifier
[00][06] = Length
[00] = Unit Identifier
[04] = **04 Read Input Registers** function code
[00][00] = starting address (**Current position [1-2]** registers, address 0-1)
[00][02] = number of requested registers

The MODBUS TCP/IP ADU needed to send back the value of the **Current position [1-2]** registers (address 0-1) is as follows:

MBAP Header + Response PDU (in hexadecimal notation)
[00][01][00][00][00][07][00][04][04][00][00][2F][F0]
where:
[00][01] = Transaction Identifier
[00][00] = Protocol Identifier
[00][07] = Length
[00] = Unit Identifier
[04] = **04 Read Input Registers** function code
[04] = number of bytes (2 bytes for each register)
[00][00] = value of register 1, 00 00 hex = 0 dec

[2F][F0] = value of register 2, 2F F0 hex = 12272 dec

06 Write Single Register

FC = 06 (0006 hex)

This function code is used to WRITE a single Holding Register (4X Reference Addresses) in a remote device. The Request PDU specifies the address of the register to be written. Registers are addressed starting at zero. Therefore register numbered 1 is addressed as 0.
The normal response is an echo of the request, returned after the register contents have been written.
For the complete list of the holding registers accessible using the **06 Write Single Register** function code please refer to the "7.1.1 Holding Register parameters" section on page 53.

Request PDU

Function code	1 byte	**0006 hex**
Register address	2 bytes	0000 hex to FFFF hex
Register value	2 bytes	0000 hex to FFFF hex

Response PDU

Function code	1 byte	**0006 hex**
Register address	2 bytes	0000 hex to FFFF hex
Register value	2 bytes	0000 hex to FFFF hex

Exception Response PDU

Error code	1 byte	**0086 hex (=0006 hex + 0080 hex)**
Exception code	1 byte	01 or 02 or 03 or 04

Here is an example of a request to write in the **Watchdog timeout [82]** register (address 81): you want to enable the Watchdog function and set the timeout to 10 ms.

Request	
Field name	(Hex)
Function	**06**
Register address Hi	**00**
Register address Lo	**51**
Register value Hi	**00**
Register value Lo	**0A**

Response	
Field name	(Hex)
Function	**06**
Register address Hi	**00**
Register address Lo	**51**
Register value Hi	**00**
Register value Lo	**0A**

As you can see in the table, the value 00 0A hex (10 dec) is set in the **Watchdog timeout [82]** register (address 81): the Watchdog function is enabled and the timeout is set to 10 ms.

The MODBUS TCP/IP ADU needed for the request to write the value 00 0A hex in the **Watchdog timeout [82]** register (address 81) is as follows:

MBAP Header + Request PDU (in hexadecimal notation)
[00][01][00][00][00][06][00][06][00][51][00][0A]
where:
[00][01] = Transaction Identifier
[00][00] = Protocol Identifier
[00][06] = Length
[00] = Unit Identifier
[06] = **06 Write Single Register** function code
[00][51] = address of the **Watchdog timeout [82]** register, 51 hex = 81 dec
[00][0A] = value to be set in the register

The MODBUS TCP/IP ADU needed to send back a response following the request to write the value 00 0A hex in the **Watchdog timeout [82]** register (address 81) is as follows:

MBAP Header + Response PDU (in hexadecimal notation)
[00][01][00][00][00][06][00][06][00][51][00][0A]
where:
[00][01] = Transaction Identifier
[00][00] = Protocol Identifier
[00][06] = Length
[00] = Unit Identifier
[06] = **06 Write Single Register** function code
[00][51] = address of the **Watchdog timeout [82]** register, 51 hex = 81 dec

[00][0A] = value set in the register

16 Write Multiple Registers

FC = 16 (0010 hex)

This function code is used to WRITE a block of contiguous Holding Registers (4X Reference Addresses, 1 to 123 registers) in a remote device.
The values to be written are specified in the request data field. Data is packed as two bytes per register.
The normal response returns the function code, starting address and quantity of written registers.
For the complete list of the holding registers accessible using the **16 Write Multiple Registers** function code please refer to the "7.1.1 Holding Register parameters" section on page 53.

Request PDU

Function code	1 byte	**0010 hex**
Starting address	2 bytes	0000 hex to FFFF hex
Quantity of registers	2 bytes	0001 hex to 007B hex
Byte count	1 byte	2 x **N***
Registers value	**N*** x 2 bytes	value

*N = Quantity of registers

Response PDU

Function code	1 byte	**0010 hex**
Starting address	2 bytes	0000 hex to FFFF hex
Quantity of registers	2 bytes	1 to 123 (007B hex)

Exception Response PDU

Error code	1 byte	**0090 hex (= 0010 hex + 0080 hex)**
Exception code	1 byte	01 or 02 or 03 or 04

Here is an example of a request to write the value 00 00 17 70 hex (=6,000 dec) next to the **Total measuring range [101-102]** registers (address 100-101) and the value 00 00 27 10 hex (=10,000 dec) next to the **Position step setting nm [103-104]** registers (address 102-103).

Request	
Field name	(Hex)
Function	**10**
Starting address Hi	**00**
Starting address Lo	**64**
Quantity of registers Hi	**00**
Quantity of registers Lo	**04**
Byte count	**08**
Register 101 value Hi	**00**
Register 101 value Lo	**00**
Register 102 value Hi	**17**
Register 102 value Lo	**70**
Register 103 value Hi	**00**
Register 103 value Lo	**00**
Register 104 value Hi	**27**
Register 104 value Lo	**10**

Response	
Field name	(Hex)
Function	**10**
Starting address Hi	**00**
Starting address Lo	**64**
Quantity of registers Hi	**00**
Quantity of registers Lo	**04**

As you can see in the table, the values 00 00 hex and 17 70 hex, i.e. 6,000 in decimal notation, are set in the **Total measuring range [101-102]** registers at address 100-101; while the values 00 00 hex and 27 10 hex, i.e. 10,000 in decimal notation, are set in the **Position step setting nm [103-104]** registers at the address 102-103. Thus the encoder will be programmed to run a 6000-count long travel and use a 10,000 nm = 0.01 mm resolution.

The MODBUS TCP/IP ADU needed for the request to write the value 6,000 dec next to the **Total measuring range [101-102]** registers (address 100-101) and the value 10,000 dec next to the **Position step setting nm [103-104]** registers (address 102-103) is as follows:

MBAP Header + Request PDU (in hexadecimal notation)
[00][01][00][00][00][0F][00][10][00][64][00][04][08][00][00][17][70][00][00][27][10]
where:
[00][01] = Transaction Identifier

[00][00] = Protocol Identifier
[00][0F] = Length
[00] = Unit Identifier
[10] = **16 Write Multiple Registers** function code
[00][64] = starting address (**Total measuring range [101-102]** registers, address 100-101)
[00][04] = number of requested registers
[08] = number of bytes (2 bytes for each register)
[00][00] = value to be set in the register 101, 00 00 hex
[17][70] = value to be set in the register 102, 17 70 hex (00 00 17 70 hex = 6000 dec)
[00][00] = value to be set in the register 103, 00 00 hex
[27][10] = value to be set in the register 104, 27 10 hex (00 00 27 10 hex = 10,000 dec)

The MODBUS TCP/IP ADU needed to send back a response following the request to write the value 6,000 next to the **Total measuring range [101-102]** registers (address 100-101) and the value 10,000 next to the **Position step setting nm [103-104]** registers (address 102-103) is as follows:

MBAP Header + Response PDU (in hexadecimal notation)
[00][01][00][00][00][06][00][10][00][64][00][04]
where:
[00][01] = Transaction Identifier
[00][00] = Protocol Identifier
[00][06] = Length
[00] = Unit Identifier
[10] = **16 Write Multiple Registers** function code
[00][64] = starting address (**Total measuring range [101-102]** registers, address 100-101)
[00][04] = number of written registers

Here is an example of a request to write in the **Operating parameters [109-110]** registers (address 108-109): we need to set the scaling function (bit 0 **Scaling function** = 1) and the count up information with clockwise rotation of the encoder shaft (bit 1 **Code sequence** = 0).

Request	
Field name	(Hex)
Function	**10**
Starting address Hi	**00**
Starting address Lo	**6C**
Quantity of registers Hi	**00**
Quantity of registers Lo	**02**
Byte count	**04**
Register 109 value Hi	**00**
Register 109 value Lo	**00**
Register 110 value Hi	**00**
Register 110 value Lo	**01**

Response	
Field name	(Hex)
Function	**10**
Starting address Hi	**00**
Starting address Lo	**6C**
Quantity of registers Hi	**00**
Quantity of registers Lo	**02**

As you can see in the table, the value 00 00 00 01 hex, i.e. 0000 0000 0000 0000 0000 0000 0000 0001 in binary notation, is set in the **Operating parameters [109-110]** registers (address 108-109): the bit 0 **Scaling function** = 1; the bit 1 **Code sequence** = 0; the remaining bits are not used, therefore their value is 0.

The MODBUS TCP/IP ADU needed for the request to set the scaling function (bit 0 **Scaling function** = 1) and the count up information with clockwise rotation of the encoder shaft (bit 1 **Code sequence** = 0) in the **Operating parameters [109-110]** registers (address 108-109) is as follows:

MBAP Header + Request PDU (in hexadecimal notation)
[00][01][00][00][00][0B][00][10][00][6C][00][02][04][00][00][00][01]
where:
[00][01] = Transaction Identifier
[00][00] = Protocol Identifier
[00][0B] = Length
[00] = Unit Identifier
[10] = **16 Write Multiple Registers** function code
[00][6C] = starting address (**Operating parameters [109-110]** registers, address 108-109)
[00][02] = number of requested registers

[04] = number of bytes (2 bytes for each register)
[00][00] = value to be set in the register 109, 00 00 hex
[00][01] = value to be set in the register 110, 00 01 hex

The MODBUS TCP/IP ADU needed to send back a response following the request to set the scaling function (bit 0 **Scaling function** = 1) and the count up information with clockwise rotation of the encoder shaft (bit 1 **Code sequence** = 0) in the **Operating parameters [109-110]** registers (address 108-109) is as follows:

MBAP Header + Response PDU (in hexadecimal notation)
[00][01][00][00][00][06][00][10][00][6C][00][02]
where:
[00][01] = Transaction Identifier
[00][00] = Protocol Identifier
[00][06] = Length
[00] = Unit Identifier
[10] = **16 Write Multiple Registers** function code
[00][6C] = starting address (**Operating parameters [109-110]** registers, address 108-109)
[00][02] = number of written registers

WARNING
For safety reasons, while the encoder is on, a continuous data exchange between the Master and the Slave has to be planned in order to be sure that the communication is always active; this is intended to prevent danger situations from arising in case of failures in the communication network.
For this purpose the Watchdog function is implemented and can be enabled. The Watchdog function is a safety timer that uses a time-out to detect loop or deadlock conditions. For instance, should the communication be cut off while a command is still active and running, the Watchdog safety system immediately takes action and commands an alarm to be triggered.
The **Watchdog timeout [82]** register is used to disable/enable the Watchdog function and further to set the timeout value expressed in milliseconds. Setting the register to 0 causes the Watchdog function to be disabled. Any value greater than 0 enables the Watchdog function and sets the Watchdog timeout. When the Watchdog function is enabled, if the device does not receive a message from the Server within the set time, the system forces the encoder to exit the network participation and shift to the **EXCEPTION** state. Furthermore the NS Network State Error LED starts flashing red.

6.6 Encoder states

The table below describes the states the encoder can enter during operation in the MODBUS TCP/IP network.

Encoder state	Description
WAIT_PROCESS	Waiting for MODBUS requests. The encoder shifts to the PROCESS_ACTIVE state as soon as a MODBUS request is received.
ERROR	An IP address conflict has been detected in the MODBUS network. The NS Network State Error LED lights up red (see on page 29).
PROCESS_ACTIVE	The encoder shifts to the WAIT_PROCESS state if no requests are received within the preset time.
EXCEPTION	A Watchdog timeout has occurred, any MODBUS requests will be ignored. The NS Network State Error LED starts flashing red (see on page 29).

7 Programming parameters

7.1 Parameters available

Hereafter the parameters available for the MODBUS encoders are listed and described as follows:

Parameter name [Register number]
[register address, data type, attribute]

- The register number and address are expressed in decimal notation.
- Attribute:
  ro = read only access
  rw = read and write access

The MODBUS registers are 16-bit long; while all the encoder parameters -except the **Watchdog timeout [82]** parameter- are 2-register long, i.e. 32-bit long (independently of their size, whether they are 32-bit long or 16-bit long).

word	MSW			LSW		
bit	31	...	16	15	...	0
	msb		lsb	msb		lsb

7.1.1 Holding Register parameters

Holding registers (**Machine data** parameters) are 4X Reference Registers and accessible for both writing and reading; to read the value set in the parameter use the **03 Read Holding Registers** function code (reading of multiple registers); to write a value in the parameter use the **06 Write Single Register** function code (writing of a single register) or the **16 Write Multiple Registers** (writing of multiple registers); for any further information on the implemented function codes refer to the "6.5.1 Implemented function codes" section on page 41.

NOTE
Always save the new values after setting in order to store them in the non-volatile memory permanently. Use the **Save parameters** function available in the **Control Word [111-112]** registers, see on page 65.
Should the power supply be turned off all data that has not been saved previously will be lost!

Watchdog timeout [82]

[81, Unsigned16, rw]

For safety reasons, while the encoder is on, a continuous data exchange between the Master and the Slave has to be planned in order to be sure that the communication is always active; this is intended to prevent danger situations from arising in case of failures in the communication network.

For this purpose the Watchdog function is implemented and can be enabled. The Watchdog function is a safety timer that uses a time-out to detect loop or deadlock conditions. For instance, should the communication be cut off while a command is still active and running, the Watchdog safety system immediately takes action and commands an alarm to be triggered.

This register is used to disable/enable the Watchdog function and further to set the timeout value expressed in milliseconds. Setting the register to 0 causes the Watchdog function to be disabled. Any value greater than 0 enables the Watchdog function and sets the Watchdog timeout. When the Watchdog function is enabled, if the device does not receive a message from the Server within the set time, the system forces the encoder to exit the network participation and shift to the EXCEPTION state. Furthermore the NS Network State Error LED starts flashing red.

Default = 0 (min. = 0, max. = 65535)

NOTE

As soon as the Watchdog function is enabled (**Watchdog timeout [82]** > 0), one MODBUS command at least must be sent in order to activate the timeout.

NOTE

The **Watchdog timeout [82]** value is immediately saved in the memory as soon as it is set; thus you are not required to save it by means of the the **Save parameters** function.

Current position [95-96]

[94-95, Unsigned32, ro]

The **Current position [1-2]** input registers are also available as holding registers at the address 94-95 and accessible by using the **03 Read Holding Registers** function code. For any information refer to page 77.

Speed value [97-98]

[96-97, Signed32, ro]

The **Speed value [3-4]** input registers are also available as holding registers at the address 96-97 and accessible by using the **03 Read Holding Registers** function code. For any information refer to page 78.

Status word [99-100]

[98-99, Unsigned16, ro]

The **Status word [5-6]** input registers are also available as holding registers at the address 98-99 and accessible by using the **03 Read Holding Registers** function code. For any information refer to page 78.

Total measuring range [101-102]

[100-101, Unsigned32, rw]

WARNING

These registers are active only if the bit 0 **Scaling function** in the **Operating parameters [109-110]** registers is set to "=1"; otherwise they are ignored and the system uses the physical values (see the **Max No of Information** parameter in the **Encoder Settings [141-142]** registers and the **Measure of a pulse nm [143-144]** registers) to calculate the position information. As soon as the user confirms the value in the **Max No of Information** parameter of the **Encoder Settings [141-142]** registers, the program automatically sets the default value of the **Total measuring range [101-102]** registers accordingly.

If the **Scaling function** is disabled (the bit 0 in the **Operating parameters [109-110]** registers is set to "=0"), then **Total measuring range [101-102]** = $2^{\text{Max No of Information}}$.

Furthermore, if the **Bypass mode** parameter in the **Encoder Settings [141-142]** registers (see on page 74) is set to "1" = enabled, the scaling function -even if enabled- and these **Total measuring range [101-102]** registers are ignored.

It sets the length of the travel the encoder has to measure. The value is expressed in number of information (counts).

It can be either the number of information for the max. measuring length (for instance, if the application needs the whole path); or the number of information for just a part of the scale if the application only uses a section of the scale. Thus this value must be less than or equal to the number of information resulting from the scale max. measuring length ($2^{\text{Max No of Information}}$).

We suggest setting a value that is a power of 2 submultiple of the maximum measuring range (**Max No of Information**) not to cause a counting error, i.e. a jump in the position count when the sensor crosses the physical zero point (see the WARNING below).

Default = $2^{\text{Max No of Information}}$

Min. value = 0000 0002h

Max. value = $2^{\text{Max No of Information}}$

EXAMPLE

We need to connect the following linear encoder: **SMA5-GA-50**.
As you can see in the product datasheet, "50" in the order code means a **0.05 mm** resolution. Let's say the mechanical travel of our application is the max. measuring length the SMA5 linear encoder is allowed to run on the MTA5 scale, i.e. **5,050 mm**. Thus the max. number of information is **101,000 ≈ 17 bits** (for the complete explanation refer to the **Max No of Information** parameter). After having set the **Max No of Information** parameter, the system automatically sets the value 0002 0000h = 131,072 = 2^{17} in these registers. If you need a custom measuring range, you need to enable the **Scaling function** and then set a value less than 2^{17} = 131,072 here.
If you set a preset along the path, when the encoder moves back and cross the zero, the value immediately after 0 will be $2^{\text{Max No of Information}}$ - 1, i.e. 131,071.

...	131,069	131,070	131,071	0	1	2	...

EXAMPLE

We need to connect the following linear encoder: **SMAX-BG-100**.
As you can see in the product datasheet, "100" in the order code means a **0.1 mm** resolution. Let's say the mechanical travel of our application is the max. measuring length the SMAX linear encoder is allowed to run on the MTAX scale, i.e. **600 mm**. Thus the max. number of information is **6,000 ≈ 13 bits** (for the complete explanation refer to the **Max No of Information** parameter). After having set the **Max No of Information** parameter, the system automatically sets the value 0000 2000h = 8,192 = 2^{13}. If you need a custom measuring range, you need to enable the **Scaling function** and then set a value less than 2^{13} = 8,192 here.
If you set a preset along the path, when the encoder moves back and cross the zero, the value immediately after 0 will be $2^{\text{Max No of Information}}$-1, i.e. 8,191.

...	8,189	8,190	8,191	0	1	2	...

EXAMPLE

We need to connect an **SMA5-GA-50**, its physical resolution is **0.05 mm**. Let's say the mechanical travel of our application is **1000 mm**. Thus the max. number of information is **20,000 ≈ 15 bits** (for the complete explanation refer to the **Max No of Information** parameter). Thus you must enable the **Scaling function** parameter and set the value 0000 4E20h in this parameter (instead of the default value 0002 0000h).

In this way you will obtain several 20,000 information sections following each other all along the whole measuring length. The position information will be from 0 to 19,999; then again from 0 to 19,999 and so on.

...	19997	19998	19999	0	1	2	...	19997	19998	19999	0	1	2	...

← max measuring length →

WARNING

When you enable the scaling function (**Scaling function** = 1), a counting error, i.e. a jump in the position count, may occur if the following conditions arise:

- a physical zero setting has been performed in the linear sensor;
- the **Position step setting nm [103-104]** registers value is not a multiple of the physical resolution as set next to the **Measure of a pulse nm [143-144]** registers;
- the measuring range (**Total measuring range [101-102]** registers) is not a power of 2 submultiple of the maximum measuring range.

If the above described conditions arise, a counting error may occur when the sensor crosses the physical zero point.
If the scaling function is disabled (**Scaling function** = 0), the transmitted position values are always consistent.
If the scaling function is enabled (**Scaling function** = 1) yet no physical zero setting has been performed in the linear sensor, the transmitted position values are always consistent.
If the scaling function is enabled (**Scaling function** = 1), the **Position step setting nm [103-104]** registers value is a multiple of the physical resolution and the measuring range (**Total measuring range [101-102]** registers) is a power of 2 submultiple of the maximum measuring range, the transmitted position values are consistent, regardless of the physical zero setting.

WARNING

When you change the value next to **Total measuring range [101-102]** registers, then you must check the value in the **Preset value [105-106]** registers and perform the preset operation.

Position step setting nm [103-104]

[102-103, Unsigned32, rw]

WARNING

These registers are active only if the bit 0 **Scaling function** in the **Operating parameters [109-110]** registers is set to "=1"; otherwise they are ignored and the system uses the physical values (see the **Max No of Information** parameter

in the Encoder Settings [141-142] registers and the Measure of a pulse nm [143-144] registers) to calculate the position information. As soon as the user confirms the value in the Measure of a pulse nm [143-144] registers, the program automatically sets the default value of the Position step setting nm [103-104] registers accordingly.
If the **Scaling function** is disabled (the bit 0 in the Operating parameters [109-110] registers is set to "=0"), then Position step setting nm [103-104] = Measure of a pulse nm [143-144].
Furthermore, if the **Bypass mode** parameter in the Encoder Settings [141-142] registers (see on page 74) is set to "1" = enabled, the scaling function -even if enabled- and these Position step setting nm [103-104] registers are ignored.

These registers are used to set a custom resolution (otherwise referred to as measuring step) expressed in nanometres [nm].
The resolution can be defined as the smallest change in the underlying quantity that produces a response in the measurement, the response being the information that is provided to output (count).
The custom resolution value must be greater than or equal to the physical resolution of the connected encoder.
We suggest setting a value that is a multiple of the physical resolution as set next to the Measure of a pulse nm [143-144] registers not to cause a counting error, i.e. a jump in the position count when the sensor crosses the physical zero point (see the WARNING below).
Default = according to Measure of a pulse nm [143-144]
Min. value = 0000 0001h
Max. value = 000F 4240h

EXAMPLE
We need to connect the following linear encoder: **SMA5-GA-50**.
As you can see in the product datasheet, "50" in the order code means a **0.05 mm** resolution = 50,000 nanometres resolution. As soon as the user confirms the value in the Measure of a pulse nm [143-144] registers, the system automatically sets the default value of the Position step setting nm [103-104] registers accordingly (0000 C350h). If needed, after enabling the **Scaling function** parameter the user is allowed to set a custom resolution: it must be greater than or equal to 0000 C350h.

EXAMPLE
We need to connect the following linear encoder: **SMAX-BG-100**.
As you can see in the product datasheet, "100" in the order code means a **0.1 mm** resolution = 100,000 nanometres resolution. As soon as the user confirms the value in the Measure of a pulse nm [143-144] registers, the system automatically sets the default value of the Position step setting nm [103-104] registers accordingly (0001 86A0h). If needed, after enabling the **Scaling**

function parameter the user is allowed to set a custom resolution: it must be greater than or equal to 0001 86A0h.

WARNING

When you enable the scaling function (**Scaling function** = 1), a counting error, i.e. a jump in the position count, may occur if the following conditions arise:

- a physical zero setting has been performed in the linear sensor;
- the **Position step setting nm [103-104]** registers value is not a multiple of the physical resolution as set next to the **Measure of a pulse nm [143-144]** registers;
- the measuring range (**Total measuring range [101-102]** registers) is not a power of 2 submultiple of the maximum measuring range.

If the above described conditions arise, a counting error may occur when the sensor crosses the physical zero point.
If the scaling function is disabled (**Scaling function** = 0), the transmitted position values are always consistent.
If the scaling function is enabled (**Scaling function** = 1) yet no physical zero setting has been performed in the linear sensor, the transmitted position values are always consistent.
If the scaling function is enabled (**Scaling function** = 1), the **Position step setting nm [103-104]** registers value is a multiple of the physical resolution and the measuring range is a power of 2 submultiple of the maximum measuring range, the transmitted position values are consistent, regardless of the physical zero setting.

NOTE

If you have set and activated the preset, when you change the value next to the **Position step setting nm [103-104]** registers, then you must check the value in the **Preset value [105-106]** registers and perform the homing operation.

EXAMPLE

The main and default features of the **SMAX-BG-100** linear encoder are as follows:

- **Default resolution** = 0.1 mm = 100,000 nm
- **MTAX max. measuring length** = 600 mm
- **Max. number of information** = 6,000 (13 bits)

As stated, the max. number of information provided to output is calculated as follows:

$$\text{Number of information} = \frac{\text{Max. measuring length}}{\text{Resolution}}$$

Thus, in a default configuration the number of information is:

$$\textbf{Number of information} = \frac{\textbf{Max. measuring length}}{\textbf{Resolution}} = \frac{600}{0.1} = \textbf{6,000}$$

Let's assume that you need **2,000 information** to be provided to output for the max. measuring length. It follows that you need to calculate and then set a custom resolution.

The resolution value results from the following calculation:

$$\textbf{Resolution} = \frac{\textbf{Max. measuring length}}{\textbf{Number of information}}$$

Thus, in the example the resolution will be:

$$\textbf{Resolution} = \frac{\textbf{Max. measuring length}}{\textbf{Number of information}} = \frac{600}{2,000} = \textbf{0.3}$$

As the value next to the **Position step setting nm [103-104]** registers has to be expressed in nanometres, then you have to enter the value **300,000**.
The complete programming sequence will be:

1. Enable the **Scaling function**: **Operating parameters [109-110]**, bit 0 = 1
2. Set the custom resolution: **Position step setting nm [103-104]** = 0004 93E0 hex (300,000 dec)
3. Save the set parameters (**Save parameters** bit 9 in the **Control Word [111-112]** registers; see on page 65)

NOTE
Please note that, if you set a preset along the path, when the encoder moves back and cross the zero, the value immediately after 0 will be 1,999 as shown below.

...	1,996	1,997	1,998	1,999	0	1	2	3	4	...

Preset value [105-106]

[104-105, Unsigned32, rw]

These registers allow to set the encoder position to a Preset value. The Preset function is meant to assign a desired value to a physical position of the encoder shaft. The chosen physical position will get the value set next to these registers and all the previous and following positions will get a value according to it. This function is useful, for example, when the zero position of the encoder and the zero position of the axis need to match. The preset value will be set for the position of the encoder in the moment when the **Perform counting preset** command available in the Control Word [111-112] registers is sent. We suggest activating the preset value when the encoder is in stop.

Default = 0 (min. = 0, max. = $2^{\text{Max No of Information}}$-1 *)

* See the note below.

EXAMPLE

Let's take a look at the following example to better understand the preset function and the meaning and use of the related registers and commands: Preset value [105-106], Offset value [125-126] and **Perform counting preset**.

The encoder position which is transmitted results from the following calculation:

Transmitted value = **read position** (it does not matter whether the position is physical or scaled) + Preset value [105-106] - Offset value [125-126].

If you never set the Preset value [105-106] and you never performed the preset setting (**Perform counting preset** command in the Control Word [111-112]), then the transmitted value and the read position are necessarily the same as Preset value [105-106] = 0 and Offset value [125-126] = 0.

When you set the Preset value [105-106] and then execute the **Perform counting preset** command, the system saves the current encoder position in the Offset value [125-126] registers. It follows that the transmitted value and the Preset value [105-106] are the same as **read position** - Offset value [125-126] = 0; in other words, the value set next to the Preset value [105-106] registers is paired with the current position of the encoder as you wish.

For example, let's assume that the value "50" is set next to the Preset value [105-106] registers and you execute the **Perform counting preset** command when the encoder position is "1000". In other words, you want to receive the value "50" when the encoder reaches the position "1000".

We will obtain the following:

Transmitted value = **read position** (="1000") + Preset value [105-106] (="50") - Offset value [125-126] (="1000") = **50**.

The following transmitted value will be:

Transmitted value = **read position** (="1001") + Preset value [105-106] (="50") - Offset value [125-126] (="1000") = **51**.

And so on.

NOTE

- If the **Scaling function** is disabled (the bit 0 in the **Operating parameters [109-110]** registers = 0), then the **Preset value [105-106]** must be less than or equal to $2^{\text{Max No of Information}}$-1, for instance **Max No of Information** = 13 bits; $2^{13} - 1 = 8{,}192$.
- If the **Scaling function** is enabled (the bit 0 in the **Operating parameters [109-110]** registers = 1), then the **Preset value [105-106]** must be less than or equal to **Total measuring range [101-102]** - 1.

NOTE

Please consider that if the **Bypass mode** parameter in the **Encoder Settings [141-142]** attribute (see on page 74) is set to "1" = enabled, the preset function -even if set and activated- is ignored. If the user sets a preset while the "Bypass mode" is enabled, the operation is not carried out.

WARNING

Check the value in the **Preset value [105-106]** registers and perform the preset operation if necessary (the bit 11 **Perform counting preset** in the **Control Word [111-112]** registers = 1) every time you set a new **Code sequence** or enable the **Scaling function** or change the scaled values (**Total measuring range [101-102]** and / or **Position step setting nm [103-104]** registers).

Speed format [107-108]

[106-107, Unsigned16, rw]

These registers define the engineering unit for the velocity value (see the **Speed value [3-4]** registers on page 78).

0 = counts/s: counts per second;

1 = mm/sec: millimetres per second.

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

Operating parameters [109-110]

[108-109, Unsigned16, rw]

Bit	Function	bit = 0	bit = 1
0	**Scaling function**	**disabled**	enabled
1	**Code sequence**	**Standard**	Reversed
2 ... 31	not used		

Default values are highlighted in bold

Default = 0000 0000 hex (min. = 0000 0000 hex, max. = 0000 0003 hex)

Byte 0
Scaling function

bit 0

If this function is disabled (the bit 0 **Scaling function** = 0), the devices uses the physical resolution to arrange the absolute position value (see the **Max No of Information** parameter in the Encoder Settings [141-142] registers and the Measure of a pulse nm [143-144] registers); if this function is enabled (the bit 0 **Scaling function** = 1), the device uses the custom resolution set next to the Total measuring range [101-102] and Position step setting nm [103-104] registers.

NOTE
To know whether the **Scaling function** is currently enabled, you can read the bit 0 **Scaling function** of the Status word [5-6] input registers, see on page 79.

NOTE
Please consider that if the **Bypass mode** parameter in the Encoder Settings [141-142] attribute (see on page 74) is set to "1" = enabled, the preset function -even if set and activated- is ignored. If the user sets a preset while the "Bypass mode" is enabled, the operation is not carried out.

WARNING
When you enable the scaling function (**Scaling function** = 1), a counting error, i.e. a jump in the position count, may occur if the following conditions arise:

- a physical zero setting has been performed in the linear sensor;
- the Position step setting nm [103-104] registers value is not a multiple of the physical resolution as set next to the Measure of a pulse nm [143-144] registers;
- the measuring range (Total measuring range [101-102] registers) is not a power of 2 submultiple of the maximum measuring range.

If the above described conditions arise, a counting error may occur when the sensor crosses the physical zero point.
If the scaling function is disabled (**Scaling function** = 0), the transmitted position values are always consistent.
If the scaling function is enabled (**Scaling function** = 1) yet no physical zero setting has been performed in the linear

sensor, the transmitted position values are always consistent.
If the scaling function is enabled (**Scaling function** = 1), the **Position step setting nm [103-104]** registers value is a multiple of the physical resolution and the measuring range is a power of 2 submultiple of the maximum measuring range, the transmitted position values are consistent, regardless of the physical zero setting.

WARNING
Every time you enable/disable the scaling function and/or change the scaling values (see the **Total measuring range [101-102]** and **Position step setting nm [103-104]** registers), then you are required to set a new preset value (see the **Preset value [105-106]** registers) and finally save the new parameters (see the **Save parameters** function).

Code sequence
bit 1

It defines whether the count is increasing (count up information) when the linear encoder moves in the standard direction (it is indicated in the encoder's manual) or when the encoder moves in reverse of the standard direction. If the bit 1 **Code sequence** = 0, the absolute position value **increases** when the encoder moves in the standard direction; on the contrary, if the bit 1 **Code sequence** = 1, the absolute position value **increases** when the encoder moves in reverse of the standard direction. For any information on the standard and inverted counting direction please refer to the specific manual of the encoder.

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 (see the **Preset value [105-106]** registers) and save the parameters after setting this item.

NOTE
To know whether the **Code sequence** is currently enabled, you can read the bit 1 **Code sequence** of the **Status word [5-6]** input registers, see on page 79.

NOTE
Please consider that if the **Bypass mode** parameter in the Encoder Settings [141-142] registers (see on page 74) is set to "1" = enabled, the preset function -even if set and activated- is ignored. If the user sets a preset while the "Bypass mode" is enabled, the operation is not carried out.

bits 2 ... 7 Not used.

Bytes 1 ... 3 Not used.

Control Word [111-112]

[110-111, Unsigned16, rw]
This variable contains the commands to be sent in real time to the Slave in order to manage it.

Bit	Function	bit = 0	bit = 1
0 ... 8	**not used**		
9	**Save parameters**		
10	**Restore default parameters**		
11	**Perform counting preset**		
12 ... 31	not used		

Byte 0 Not used.

Byte 1

bit 8 Not used.

Save parameters
bit 9 This function allows to save all parameters on non-volatile memory. Data is saved on non-volatile memory at each rising edge of the bit; in other words, data save is performed each time this bit is switched from logic level low ("0") to logic level high ("1"). Then the bit must be switched back to logic level low ("0") to make the function available again.

NOTE
Always save the new values after setting in order to store them in the non-volatile memory permanently.
Should the power supply be turned off all data that has not been saved previously will be lost!

Restore default parameters

bit 10

This function allows the operator to restore all parameters to default values (default values are set at the factory by Lika Electronic engineers to allow the operator to run the device for standard operation in a safe mode). This function can be useful, for instance, to restore the factory values in case the encoder is set incorrectly and you are not able to resume the proper operation.
Default parameters are restored at each rising edge of the bit; in other words, the default parameters uploading operation is performed each time this bit is switched from logic level low ("0") to logic level high ("1"). Then the bit must be switched back to logic level low ("0") to make the function available again. The complete list of machine data and relevant default parameters preset by Lika Electronic engineers is available on page 111.

WARNING
The execution of this command causes all parameters which have been set previously to be overwritten!

Perform counting preset

bit 11

This command is used to activate a preset value in the encoder. As soon as the command is sent, the position value which is transmitted for the current encoder position is the one set next to the **Preset value [105-106]** registers and all the previous and following positions will get a value according to it. The operation is performed at each rising edge of the bit, i.e. each time this bit is switched from logic level low ("0") to logic level high ("1"). Then the bit must be switched back to logic level low ("0") to make the function available again. When the command is sent, the current encoder position is saved temporarily in the **Offset value [125-126]** registers. For any further information on the preset function and the meaning and use of the related registers and commands **Preset value [105-106]**, **Offset value [125-126]** and **Perform counting preset** refer to page 61.

WARNING
To save permanently the current encoder position in the **Offset value [125-126]** registers, please execute the **Save parameters** command. Should the power supply be turned off without saving data, the **Offset value [125-126]** that has not been saved will be lost!

bits 12 ... 15

Not used.

Bytes 2 and 3 Not used.

NOTE
Always save the new values after setting in order to store them in the non-volatile memory permanently. Use the **Save parameters** function, see on page 65.
Should the power supply be turned off all data that has not been saved previously will be lost!

Measuring step nm [113-114]

[112-113, Unsigned32, ro]
These registers are intended to show the physical resolution of the connected encoder expressed in nanometres [nm]. The physical resolution must be set next to the **Measure of a pulse nm [143-144]** registers. As soon as the user confirms the value in the **Measure of a pulse nm [143-144]** registers, the program automatically sets the value in these registers accordingly. If you want to set a custom resolution see the **Position step setting nm [103-104]** registers.
Default = according to **Measure of a pulse nm [143-144]**

Supported alarms [115-116]

[114-115, Unsigned16, ro]

Bit	Function	bit = 0	bit = 1
0 ... 11	**not used**		
12	**Machine data not valid**	Alarm not supported	Alarm supported
13	**Setting data not valid**	Alarm not supported	Alarm supported
14	**Flash memory error**	Alarm not supported	Alarm supported
15 ... 31	not used		

These registers contain the information on the alarms supported by the device. The available alarm messages are described in the **Alarm registers [119-120]** item.

The supported alarms are listed here afterwards:

Byte 0 Not used.

Byte 1

bits 8 ... 11 Not used.

Machine data not valid
bit 12

Setting data not valid
bit 13

Flash memory error
bit 14

bit 15 Not used.

Bytes 2 and 3 Not used.

Default = 0000 7000h (= 00000 0000 0000 0000 0111 0000 0000 0000 = alarms at bits 12, 13 and 14 of the **Alarm registers [119-120]** item are supported).

Supported warnings [117-118]

[116-117, Unsigned16, ro]
These registers contain the information on the warnings supported by the device. No warnings are supported in this device.
Default = 0

Alarm registers [119-120]

[118-119, Unsigned16, ro]

Bit	Function	bit = 0	bit = 1
0 ... 11	**not used**		
12	**Machine data not valid**	Alarm not active	Alarm active
13	**Setting data not valid**	Alarm not active	Alarm active
14	**Flash memory error**	Alarm not active	Alarm active
15 ... 31	not used		

These registers are meant to show the alarms currently active in the device. An alarm will be set if a malfunction in the encoder could lead to incorrect position value. If an alarm occurs, the according bit is set to logical high (1) until the alarm is cleared and the encoder is able to provide an accurate position value.
The available alarm messages are described here afterwards.

Byte 0 Not used.

Byte 1

bits 8 ... 11 Not used.

Machine data not valid

bit 12 One or more parameters are not valid, set proper values to restore normal work condition. See the list of the wrong parameters in the **Wrong parameters list [123-124]** registers.

Setting data not valid

bit 13 This alarm message is currently disabled in this firmware version.

Flash memory error

bit 14 Flash memory internal error, it cannot be restored (bad checksum error, etc.). The flash memory contains corrupted data; or maybe the flash memory is damaged.

bit 15 Not used.

Bytes 2 and 3 Not used.

NOTE

Please note that should the alarm be caused by wrong parameter values (see **Machine data not valid** and **Wrong parameters list [123-124]** registers), normal work status can be restored only after having set proper values. The **Flash memory error** alarm cannot be reset.

Warnings register [121-122]

[120-121, Unsigned16, ro]

This variable is meant to show the warnings currently active in the device. No warnings are supported in this encoder.

Wrong parameters list [123-124]

[122-123, Unsigned16, ro]

The operator has entered invalid data and the **Machine data not valid** alarm has been triggered. This variable is meant to show (bit value = HIGH) the list of the wrong parameters, according to the following table.

Please note that the normal work status can be restored only after having set proper values.

Bit	Function	bit = 0	bit = 1
0	Total resolution error	Alarm not active	Alarm active
1	Pulse setting error	Alarm not active	Alarm active

2	Preset value error	Alarm not active	Alarm active
3	Offset value error	Alarm not active	Alarm active
4	Encoder settings error		
5	Measure of a pulse error		
6 ... 31	not used		

Byte 0

Total resolution error

bit 0 — Wrong data has been set next to the **Total measuring range [101-102]** registers. Set proper values to restore the normal work condition.

Pulse setting error

bit 1 — Wrong data has been set next to the **Position step setting nm [103-104]** registers. Set proper values to restore the normal work condition.

Preset value error

bit 2 — Wrong data has been set next to the **Preset value [105-106]** registers. Set proper values to restore the normal work condition.

Offset value error

bit 3 — Wrong data has been saved on the **Offset value [125-126]** registers. Save proper values to restore the normal work condition.

Encoder settings error

bit 4 — Wrong data has been saved on the **Encoder Settings [141-142]** registers. Save proper values to restore the normal work condition.

Measure of a pulse error

bit 5 — Wrong data has been saved on the **Measure of a pulse nm [143-144]** registers. Save proper values to restore the normal work condition.

bits 6 and 7 — Not used.

Bytes 1 ... 3 **Not used.**

Offset value [125-126]

[124-125, Signed32, ro]

As soon as you send the **Perform counting preset** command (see the bit 11 in the **Control Word [111-112]** registers), the current position of the encoder is recorded in these registers. The offset value is then used in the preset function in order to calculate the encoder position value to be transmitted. To zero set the value in these registers you must upload the factory default values (see the bit 10, **Restore default parameters** command, in the **Control Word [111-112]** registers on page 66).

For any further information on the preset function and the meaning and use of the related registers and commands **Preset value [105-106]**, **Offset value [125-126]** and **Perform counting preset** refer to page 61.

Default = 0

DSC Firmware Version [127-128]

[126-127, Unsigned32, ro]

These registers are meant to show the firmware version of the DSC (Digital Signal Controller).

The meaning of the 32 bits in the registers is as follows:

Word	MS Word			LS Word		
bit	31	...	16	15	...	0
	msb		lsb	msb		Lsb
	Major version			Minor version		

For example, the value 0001 0001 hex in hexadecimal notation corresponds to the binary representation 0000 0000 0000 0001 0000 0000 0000 0001 and has to be interpreted as: firmware version 1.1.

PCB Hardware Version [129-130]

[128-129, Unsigned32, ro]

These registers are meant to show the hardware version of the PCB (Printed Circuit Board).

The meaning of the 32 bits in the registers is as follows:

Word	MS Word			LS Word		
bit	31	...	16	15	...	0
	msb		lsb	msb		Lsb
	Major version			Minor version		

For example, the value 0001 0001 hex in hexadecimal notation corresponds to the binary representation 0000 0000 0000 0001 0000 0000 0000 0001 and has to be interpreted as: hardware version 1.1.

Serial Number [133-134]

[132-133, Unsigned32, ro]
These registers contain the serial number of the converter assigned by the manufacturer. It can be read in the label applied to the device enclosure.
The meaning of the 32 bits in the registers is as follows:

Bit	31 ... 24	23 ... 16	15 ... 0
	YoP	WoP	Serial number

YoP: year of production.
Wop: week of production.
Serial number: serial number in ascending order.

Default = Device dependent

Network DSC Firmware Version [137-138]

[136-137, Unsigned32, ro]
These registers are meant to show the firmware version of the Network DSC (Digital Signal Controller).
Default = Device dependent

Network DSC Serial Number [139-140]

[138-139, Unsigned32, ro]
These registers contain the serial number of the Network DSC (Digital Signal Controller).
Default = Device dependent

Encoder Settings [141-142]

[140-141, Unsigned16, rw]
These registers contain information about the connected SSI encoder. Default values are highlighted in bold in the table.

Bit	Function	bit = 0	bit = 1
0	**SSI protocol**	**LSB Right Aligned protocol**	MSB Left Aligned protocol
1 ... 3	not used		
4	**SSI output code**	Binary code	**Gray code**
5 and 6	not used		
7	**Bypass mode**	**Disabled**	Enabled
8 ... 15	**Max No of Information**	**19**	
16 ... 23	**No of SSI clocks**	**25**	
24 ... 31	not used		

Default: 0019 1310h = 0000 0000 0001 1001 0001 0011 0001 0000_2 (min. value 0000 0100h, max. value 0000 2011h)

SSI protocol

It sets the SSI protocol used by the SSI encoder to arrange the absolute position information. The SSI protocol can be the "LSB Right Aligned" protocol (bit 0 = 0) or the "MSB Left Aligned" protocol (bit 0 = 1). For any information on the SSI protocol please refer to the "User's manual" of the connected encoder.
Default = 0h
Min. value = 0h "LSB Right Aligned" protocol
max. value = 1h "MSB Left Aligned" protocol

EXAMPLE

We need to connect the following linear encoder: **SMA5-GA-50**.
SMA5 encoder uses the 25-bit "LSB Right Aligned" protocol to arrange the absolute position information. Thus you have to set the value 0h in this entry. For further information refer to the encoder's "User's manual".

EXAMPLE

We need to connect the following linear encoder: **SMAX-BG-100**.
"BG" in the order code means that "MSB Left Aligned" protocol and Binary code are used to arrange the absolute position information. Thus you have to set the value 1h in this entry. For further information refer to the encoder's "User's manual".

SSI output code

It sets the output code used by the SSI encoder to output the absolute position information. The output code can be "Binary" (bit 4 = 0) or "Gray" (bit 4 = 1). For any information on the output code please refer to the "User's manual" of the connected encoder.
Default = 1h
Min. value = 0h Binary code
Max. value = 1h Gray code

EXAMPLE

We need to connect the following linear encoder: **SMA5-GA-50**.
SMA5 encoder uses the Gray code to output the absolute position information. Thus you have to set the value 1h = Gray in this entry. For further information refer to the encoder's "User's manual".

EXAMPLE
We need to connect the following linear encoder: **SMAX-BG-100**.
"BG" in the order code means that "MSB Left Aligned" protocol and Binary code are used to arrange the absolute position information. Thus you have to set the value 0h = Binary in this entry. For further information refer to the encoder's "User's manual".

Bypass mode

If the bit 7 = 0h, the "Bypass mode" is disabled, that is: the position value (refer to the **Current position [1-2]** registers on page 77) read by the encoder can be processed according to needs, so the user can scale the value, set a preset and change the counting direction.
If the bit 7 = 1h, the "Bypass mode" is enabled, that is: the information from the encoder is transmitted "as it is" and not processed in any way. The preset, scaling and counting direction functions -even if set and enabled- are ignored and the **Max No of Information** parameter in the **Encoder Settings [141-142]** registers and **Measure of a pulse nm [143-144]** registers are used to calculate the position information. If, for example, the user sets a preset while the "Bypass mode" is enabled, the value is accepted, but not activated. As soon as the "Bypass mode" is disabled, the preset, scaling and counting direction functions -if set and enabled- become active and the **Current position [1-2]** will be accordingly.
Default = 0h
Min. value = 0h disabled
Max. value = 1h enabled

Max No of Information

It sets the max. number of information (expressed in bits) the SSI encoder can output for the max. measuring length, i.e. the total physical resolution. The value depends on the encoder resolution and the max. measuring length. As soon as you confirm the value, the system automatically sets the default value of the **Total measuring range [101-102]** registers accordingly. For any information on the max. number of information please refer to the "User's manual" of the connected encoder.
Default = 13h
Min. value = 01h
Max. value = 1Eh

EXAMPLE
We need to connect the following linear encoder: **SMA5-GA-50**. Its resolution is **0.05 mm** (see the order code).
The max. measuring length of the the SMA5 linear encoder on the MTA5 scale is **5,050 mm**.

The max. number of information the encoder can output results from the following calculation:

$$\text{Max. No of Information} = \frac{\text{Max. measuring range}}{\text{Resolution}}$$

$$\text{Max. No of Information} = \frac{5{,}050}{0.05} = \mathbf{101{,}000}$$

Now you have to "round up" the result to the next highest power of 2, that is: 131,072 = 2^{17}. Thus the number of bits is "17". The value to set in this entry is 11h.

EXAMPLE

We need to connect the following linear encoder: **SMAX-BG-100**. Its resolution is **0.1 mm** (see the order code).
The max. measuring length of the SMAX linear encoder on the MTAX scale is **600 mm**.
The max. number of information the encoder can output results from the following calculation:

$$\text{Max. No of Information} = \frac{\text{Max. measuring range}}{\text{Resolution}}$$

$$\text{Max. No of Information} = \frac{600}{0.1} = \mathbf{6{,}000}$$

Now you have to "round up" the result to the next highest power of 2, that is: 8,192 = 2^{13}. Thus the number of bits is "13". The value to set in this entry is 0Dh.

No of SSI clocks

It sets the number of SSI clocks required by the SSI encoder to send the complete data word. The number of clocks depends on the max. number of information and the type of SSI protocol. For any information on the SSI clocks required please refer to the "User's manual" of the connected encoder.
Default = 19h
Min. value = 01h
Max. value = 20h

EXAMPLE

We need to connect the following linear encoder: **SMA5-GA-50**.
SMA5 encoder always requires 25 clocks (the length of the word is always 25 bits, regardless of the max. number of information to provide). Thus you have to

set 19h in this entry. For further information refer to the encoder's "User's manual".

EXAMPLE
We need to connect the following linear encoder: **SMAX-BG-100**.
The number of clocks depends on the max. number of information (see the example in the following parameter). Let's say the max. number of information is 6,000, thus it requires 13 clocks. You have to set 0Dh in this entry. For further information refer to the encoder's "User's manual".

Measure of a pulse nm [143-144]

[142-143, Unsigned16, rw]
It sets the physical resolution of the linear encoder expressed in nanometres (nm). The value has to be comprised between 1 and 1 000 000 (1 mm). Usually the physical resolution can be read in the order code (see the product datasheet). As soon as the user confirms the value, the system automatically sets the default value of the **Position step setting nm [103-104]** registers and the **Measuring step nm [113-114]** registers accordingly.
Default = 0000 2710h (min. value 0000 0001h, max. value 3FFF FFFFh)

EXAMPLE
We need to connect the following linear encoder: **SMA5-GA-50**.
As you can see in the product datasheet, "50" in the order code means a 0.05 mm resolution = 50,000 nm resolution. Thus you have to set the value 0000 C350h here. For further information refer also to the "User's manual".

EXAMPLE
We need to connect the following linear encoder: **SMAX-BG-100**.
As you can see in the product datasheet, "100" in the order code means a 0.1 mm resolution = 100,000 nm resolution. Thus you have to set the value 0001 86A0h here. For further information refer also to the "User's manual".

7.1.2 Input Register parameters

Input Registers are 3X Reference Registers and accessible for reading only; to read the value set in an input register parameter use the **04 Read Input Registers** function code (reading of multiple input registers); for any further information on the implemented function codes refer to the "6.5.1 Implemented function codes" section on page 41.

Current position [1-2]

[000-001, Unsigned32, ro]
These registers are meant to show the current position of the device in the moment in which the request is sent. The output value is scaled according to the set scaling parameters, see **Scaling function** on page 63.
The **Current position [1-2]** input registers are also available as holding registers at the address 94-95 and accessible by using the **03 Read Holding Registers** function code. For any information refer to page 54.

NOTE
Please consider that if the **Bypass mode** parameter in the **Encoder Settings [141-142]** registers (see on page 74) is set to "0" = disabled, the position value read by the encoder can be processed according to needs, so the user can scale the value, set a preset and change the counting direction. On the contrary, if the **Bypass mode** parameter is set to "1" = enabled, the information from the encoder is transmitted "as it is" and not processed in any way. The preset, scaling and counting direction functions -even if set and enabled- are ignored and the **Max No of Information** parameter in the **Encoder Settings [141-142]** registers and the **Measure of a pulse nm [143-144]** registers are used to calculate the position information. If, for example, the user sets a preset while the "Bypass mode" is enabled, the value is accepted, but not activated. As soon as the "Bypass mode" is disabled, the preset, scaling and counting direction functions -if set and enabled- become active and the **Current position [1-2]** will be accordingly.

To convert the read position value into nanometres [nm] (and into micrometres or millimetres or any other engineering unit afterwards) you must multiply the read position by the value set next to the **Measuring step nm [113-114]** registers (if the bit 0 **Code sequence** in the **Operating parameters [109-110]** registers is disabled = 0); otherwise you must multiply the read position by the value set next to the **Position step setting nm [103-104]** registers (if the bit 0 **Code sequence** in the **Operating parameters [109-110]** registers is enabled = 1).

EXAMPLE
We have the following linear encoder: **SMA5-GA-50**.
Code sequence = 0
Measuring step nm [113-114] = 0000 C350h = 50,000 nm = 0.05 mm
Current position [1-2] = 0001 1005h = 69,637 dec
Position = **Current position [1-2]** * **Measuring step nm [113-114]** = 0001 1005h * 0000 C350h = CF88 D090h = 3,481,850,000 nm
3,481,850,000 nm = 3,481,850 µm = 3,481.85 mm

EXAMPLE
We have the following linear encoder: **SMA5-GA-50**.
Code sequence = 1
Position step setting nm [103-104] = 0001 86A0h = 100,000 nm = 0.1 mm
Current position [1-2] = 0000 1760h = 5,984 dec
Position = **Current position [1-2]** * **Position step setting nm [103-104]** = 0000 1760h * 0001 86A0h = 23AA DC00h = 598,400,000 nm
598,400,000 nm = 598,400 µm = 598.4 mm

Speed value [3-4]

[002-003, Signed32, ro]
This attribute shows the current output speed value detected by the encoder and calculated every 100 ms.
The value can be expressed in either information per second or millimetres per second according to the setting next the **Speed format [107-108]** registers on page 62.
The **Speed value [3-4]** input registers are also available as holding registers at the address 96-97 and accessible by using the **03 Read Holding Registers** function code. For any information refer to page 54.

Status word [5-6]

[004-005, Unsigned16, ro]
These registers contain the information about the current state of the device. The eight bits of the Byte 0 show the values currently set in the **Operating parameters [109-110]** registers; while the eight bits of the Byte 1 are used to signal if any alarm is active. Bytes 2 and 3 are not used.
Structure of the **Status word [5-6]** registers:

Word	MS Word			LS Word		
bit	31	...	16	15	...	0
	msb		lsb	msb		Lsb

Byte 0

Scaling function

bit 0 — It shows whether the scaling function (see the bit 0 **Scaling function** of the **Operating parameters [109-110]** registers) is currently disabled or enabled. If the value is "=0" the scaling function is disabled (i.e. the system uses the physical values –**Max No of Information** parameter in the **Encoder Settings [141-142]** registers and the **Measure of a pulse nm [143-144]** registers- to calculate the position information); if the value is "=1" the scaling function is enabled (i.e. the system uses the custom resolution values –**Total measuring range [101-102]** and **Position step setting nm [103-104]**- to calculate the position information). To disable / enable the scaling function you must set the bit 0 **Scaling function** of the **Operating parameters [109-110]** registers to 0 / 1. For any further information on setting and using the scaling function refer to the **Scaling function** parameter on page 63.

Code sequence

bit 1 — It shows whether the code sequence (see the bit 1 **Code sequence** of the **Operating parameters [109-110]** registers) is currently set to "standard" or "reversed". If the bit is "=0" the output encoder position value has been set to increase (count up information) when the encoder moves in the standard direction; if the bit is "=1" the output encoder position value has been set to increase when the encoder moves in reverse of the standard direction. To set the code sequence to either "standard" or "reverse" you must set the bit 1 **Code sequence** of the **Operating parameters [109-110]** registers to 0 / 1. For any further information on setting and using the counting direction function refer to the **Code sequence** parameter on page 64.

bits 2 ... 7 — Not used.

Byte 1

Alarm

bit 8 — If the value is "=1" an alarm has occurred, see details in the **Alarm registers [119-120]** variable on page 68.

bits 9 ... 15 — Not used.

Bytes 2 and 3 Not used.

NOTE

The **Status word [5-6]** input registers are also available as holding registers at the address 98-99 and accessible by using the **03 Read Holding Registers** function code. For any information refer to page 55.

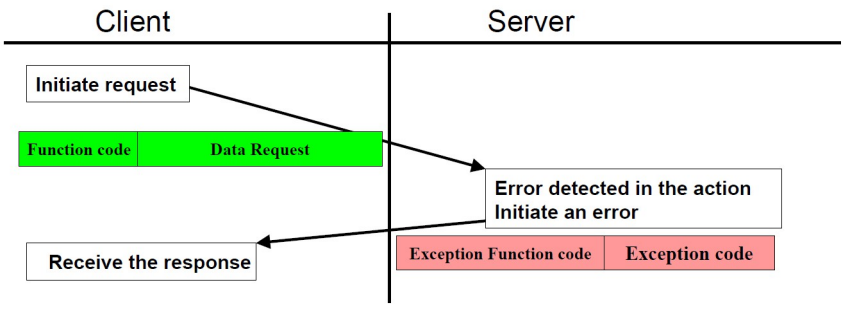
7.2 Exception response and codes

When a Client device sends a request to a Server device it expects a normal response. One of four possible events can occur from the Master's query.

- If the Server device receives the request without a communication error and can handle the query normally, it returns a normal response.
- If the Server does not receive the request due to a communication error, no response is returned. The client program will eventually process a timeout condition for the request.
- If the Server receives the request, but detects a communication error, no response is returned. The Client program will eventually process a timeout condition for the request.
- If the Server receives the request without a communication error, but cannot handle it (for example, if the request is to read a non-existent output or register), the Server will return an **exception response** informing the Client about the nature of the error.

The exception response message has two fields that differentiate it from a normal response:

FUNCTION CODE FIELD: in a normal response, the Server echoes the function code of the original request in the function code field of the response. All function codes have a most significant bit (msb) of 0 (their values are all below 80 hexadecimal). In an exception response, the Server sets the msb of the function code to 1. This makes the function code value in an exception response exactly 80 hexadecimal higher than the value would be for a normal response. With the function code's msb set, the client's application program can recognize the exception response and can examine the data field for the exception code.
DATA FIELD: in a normal response, the Server may return data or statistics in the data field (any information that was requested in the request). In an exception code, the Server returns an exception code in the data field. This defines the Server condition that caused the exception.



NOTE
Please note that here follows the list the exception codes indicated by MODBUS but not necessarily supported by the manufacturer.

MODBUS Exception codes		
Code	**Name**	**Meaning**
01	ILLEGAL FUNCTION	The function code received in the query is not an allowable action for the server. This may be because the function code is only applicable to newer devices, and was not implemented in the unit selected. It could also indicate that the server is in the wrong state to process a request of this type, for example because it is not configured and is being asked to return register values.
02	ILLEGAL DATA ADDRESS	The data address received in the query is not an allowable address for the server. More specifically, the combination of reference number and transfer length is invalid. For a controller with 100 registers, the PDU addresses the first register as 0, and the last one as 99. If a request is submitted with a starting register address of 96 and a quantity of registers of 4, then this request will successfully operate (address-wise at least) on registers 96, 97, 98, 99. If a request is submitted with a starting register address of 96 and a quantity of registers of 5, then this request will fail with Exception Code 0x02 "Illegal Data Address" since it attempts to operate on registers 96, 97, 98, 99 and 100, and there is no register with address 100.
03	ILLEGAL DATA VALUE	A value contained in the query data field is not an allowable value for server. This indicates a fault in the structure of the remainder of a complex request, such as that the implied length is incorrect. It specifically does NOT mean that a data item submitted for storage in a register has a value outside the expectation of the application program, since the MODBUS protocol is unaware of the significance of any particular value of any particular register.
04	SERVER DEVICE FAILURE	An unrecoverable error occurred while the server was attempting to perform the requested action.
05	ACKNOWLEDGE	Specialized use in conjunction with programming commands. The server has accepted the request and is processing it, but a long duration of time will be required to do so. This response is returned to prevent a timeout error from occurring in the client. The client can next issue a Poll Program Complete message to determine if processing is completed.
06	SERVER DEVICE BUSY	Specialized use in conjunction with programming commands. The server is engaged

		in processing a long-duration program command. The client should retransmit the message later when the server is free.
08	MEMORY PARITY ERROR	Specialized use in conjunction with function codes 20 and 21 and reference type 6, to indicate that the extended file area failed to pass a consistency check. The server attempted to read record file, but detected a parity error in the memory. The client can retry the request, but service may be required on the server device.
0A	GATEWAY PATH UNAVAILABLE	Specialized use in conjunction with gateways, indicates that the gateway was unable to allocate an internal communication path from the input port to the output port for processing the request. Usually means that the gateway is misconfigured or overloaded.
0B	GATEWAY TARGET DEVICE FAILED TO RESPOND	Specialized use in conjunction with gateways, indicates that no response was obtained from the target device. Usually means that the device is not present on the network.

For any information on the available exception codes and their meaning refer to the "MODBUS Exception Responses" section on page 47 of the "MODBUS Application Protocol Specification V1.1b3" document.

8 Integrated web server

8.1 Integrated web server – Preliminary information

MODBUS TCP/IP 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 and check the currently set parameters;
- to set the network communication parameters;
- to set some parameters such as the preset and the code sequence;
- to upgrade the firmware;
- to monitor the encoder and access some advanced maintenance functions.

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 MODBUS TCP/IP encoder web server please ascertain that the following requirements are fully satisfied:

- the encoder is connected to the network;
- the encoder has valid 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 65.0.2
- Google Chrome version 72.0.3626.121
- 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 Mozilla Firefox Quantum.

8.2 Web server Home page

To open the MODBUS TCP/IP encoder web server proceed as follows:

1. type the IP address of the encoder you want to connect to (in the example: 192.168.1.10, this is the default IP address set at Lika, see on page 28) in the address bar of your web browser and confirm by pressing **ENTER**;

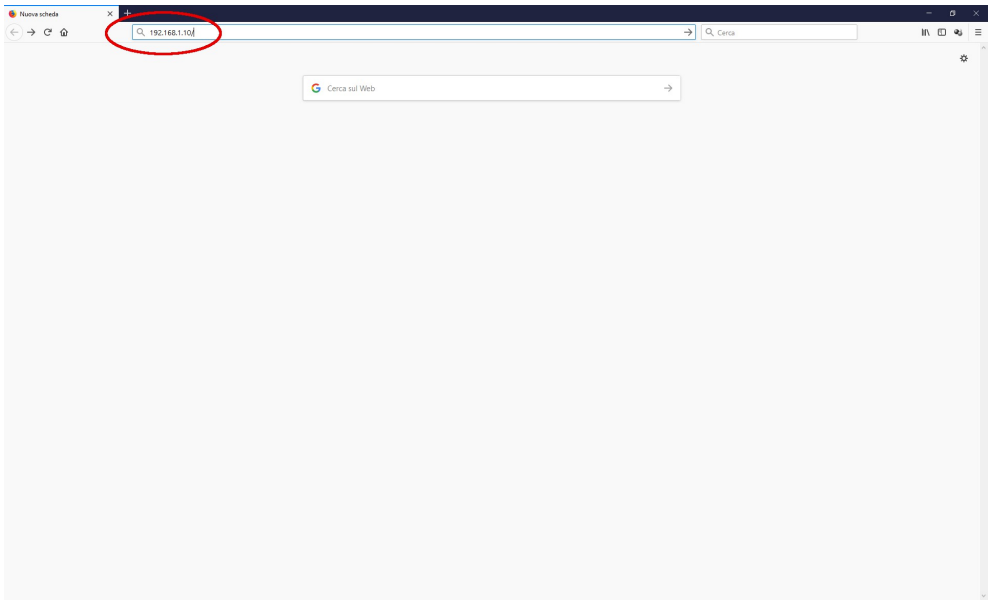


Figure 6 - Opening the web server

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

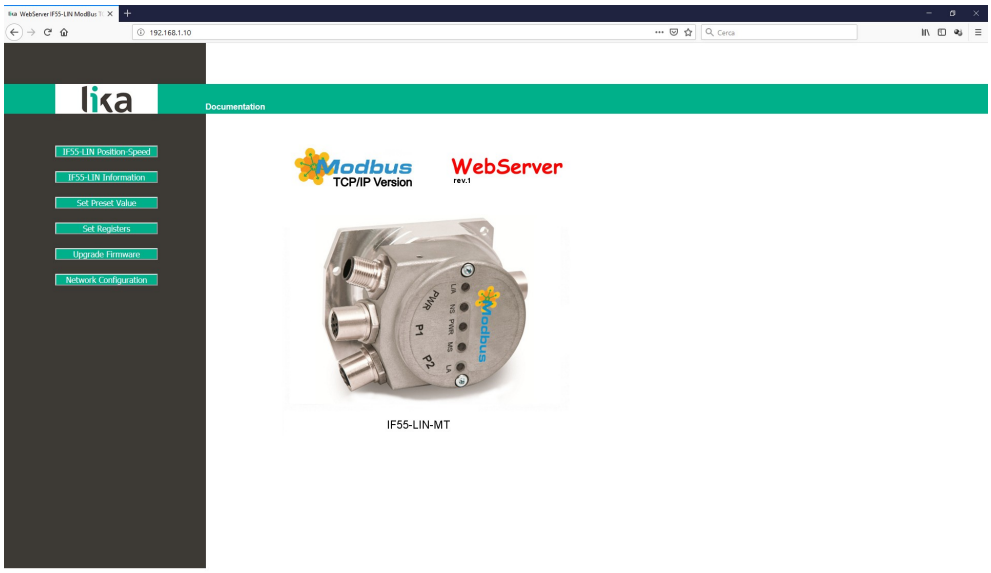


Figure 7 - Web server Home page

Some commands are available in the menu bar of the **Home** page.

Press on the **Lika logo** to enter Lika's web site (www.lika.biz).

Press the **Documentation** command to enter the MODBUS TCP/IP encoder technical documentation page available on Lika's web site (http://www.lika.it/eng/prodotti.php?id_cat=267&id_fam=270&id_sfam=544) where specific technical information and documentation concerning the MODBUS TCP/IP encoder can be found.

Furthermore some commands are available in the left navigation bar. All the pages that can be entered through the commands in the bar are freely accessible except the **Upgrade firmware** page that is protected and requires a password to allow access.
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.

8.3 Encoder position and speed

Press the **IF55-LIN 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.

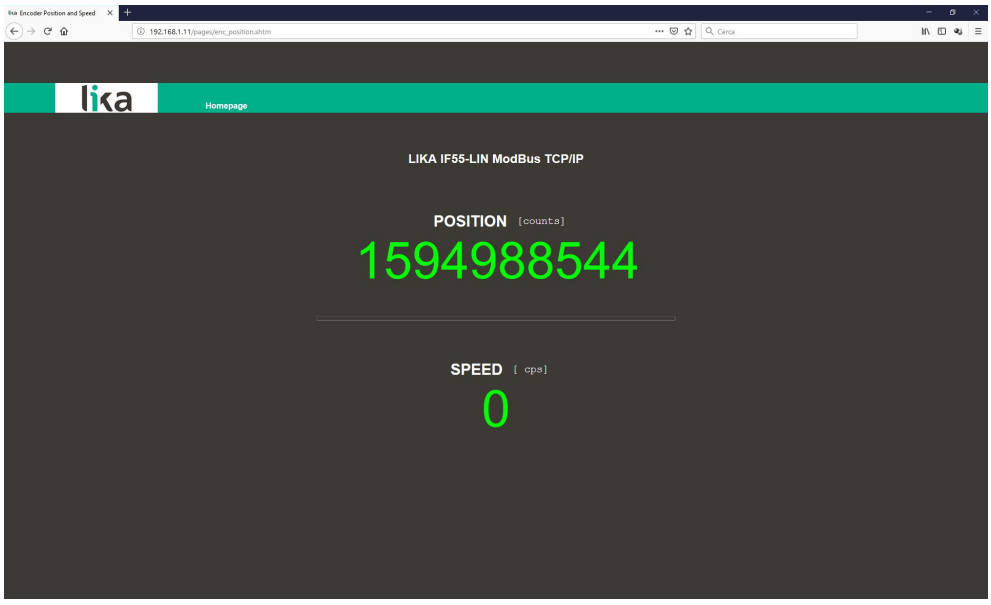


Figure 8 - Encoder position and speed page

The current encoder position is expressed in counts. For any information refer to the Current position [1-2] registers on page 77.

The current encoder speed is expressed according to the setting next the **Speed format [107-108]** registers on page 62 (counts per second or millimetres per second).

NOTE
The current encoder position is real-time processed and continuously updated (every 200 msec.).

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

8.3.1 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.

8.4 Converter information (MODBUS registers)

Press the **IF55-LIN Information** command in the left navigation bar of the Web server **Home** page to enter the **IF55-LIN-MT Information** page. In this page the complete list of the available MODBUS registers is displayed. Addresses are expressed in decimal notation, values are expressed in either hexadecimal or decimal notation. The MAC address of the connected converter is shown under the page name.

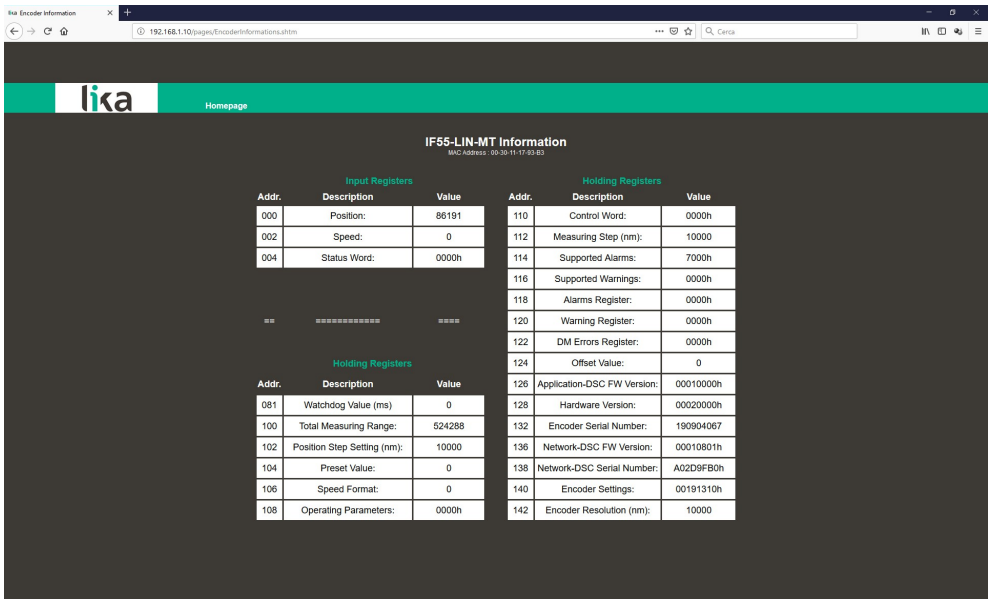


Figure 9 - IF55-LIN-MT Information page

The registers listed under the **Input registers** section are process data and read-only access values. For a complete description of the Input registers please refer to the "7.1.2 Input Register parameters" section on page 77.
The registers listed under the **Holding registers** section are the encoder configuration parameters; they can be either read-write or read-only access parameters. For a complete description of the Holding registers please refer to the "7.1.1 Holding Register parameters" section on page 53.

NOTE
The parameters are made up of two 16-bit registers (except the **Watchdog Value (ms)** which is a single 16-bit register, see the Watchdog timeout [82] register on page 54). For such reason only the start address appears under the **ADDR.** column. To read -for instance- the **114 Supported Alarms** item, you must read the register at the address 114 (MSWord) and the register at the address 115 (LSWord).

NOTE

Please note that the values shown in the **IF55-LIN-MT Information** page are "frozen" in the moment when the page is displayed. To update the values you must refresh the web page.

NOTE

The registers in the **IF55-LIN-MT Information** page cannot be changed even though they are read-write access registers. To change the set values please enter the **Set Registers** page (see on page 91).

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

8.5 Setting the Preset value

Press the **Set Preset Value** command in the left navigation bar of the Web server **Home** page to enter the **Set IF55-LIN-MT Preset** page and set/activate a Preset value. For complete information on the preset function please refer to the Preset value [105-106] registers on page 61.

A 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.

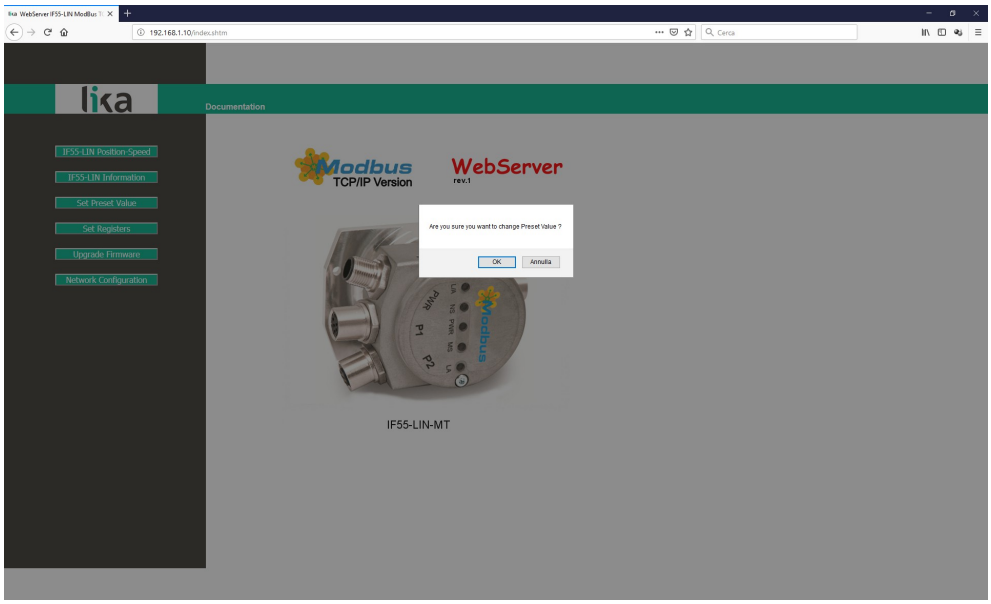


Figure 10 - Entering the Set IF55-LIN-MT Preset page

Press the **OK** button to proceed, otherwise press the **EXIT** button to exit 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.

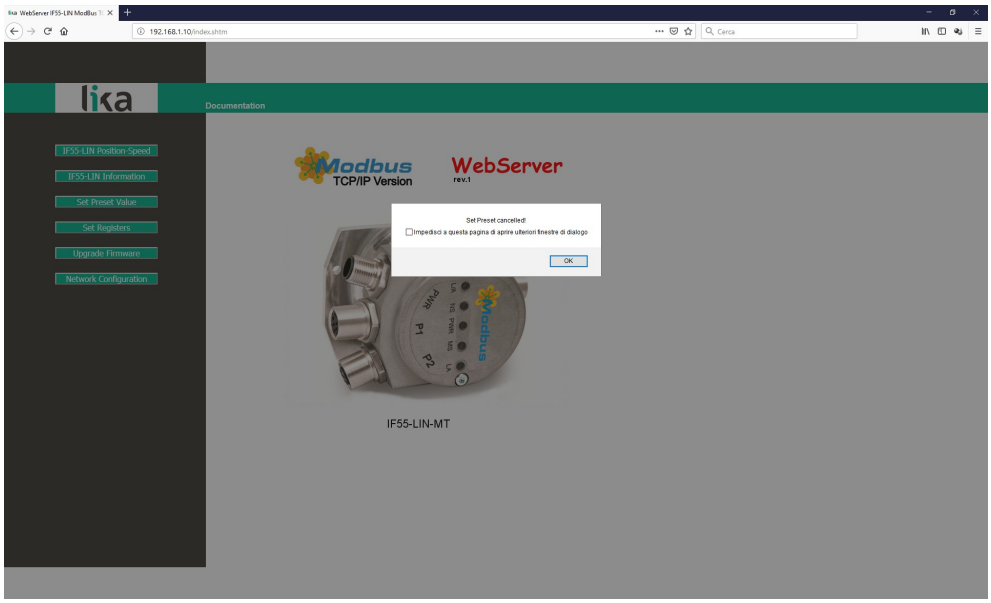


Figure 11 - Preset operation cancelled

If you confirm the procedure, the **Set IF55-LIN-MT Preset** page will appear on the screen:

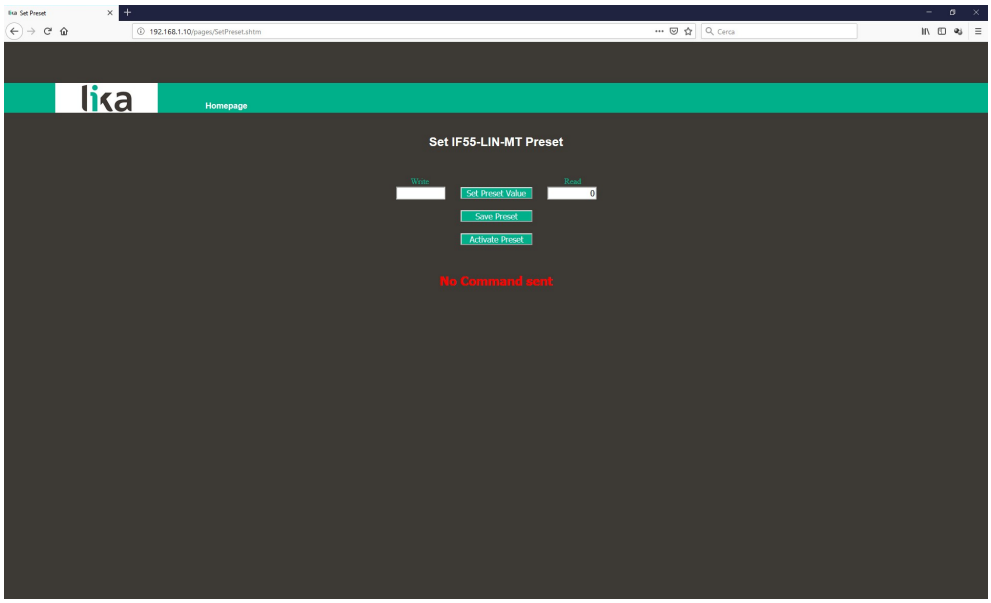


Figure 12 - Set IF55-LIN-MT Preset page

The Preset value that is currently set in the encoder (see the Preset value [105-106] registers on page 61) 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.

NOTE
Please note that the Preset value is now saved temporarily in the **Preset value [105-106]** registers. To save permanently the set Preset value in the **Preset value [105-106]** registers, please press the **Save Preset** button. Should the power supply be turned off without saving data, the Preset value that has not been saved on the Flash EEProm will be lost! For more information refer to the **Save parameters** command in the **Control Word [111-112]** registers on page 65.

After saving the Preset value, you must activate it (see the **Perform counting preset** command in the **Control Word [111-112]** registers on page 66).
Press the **Activate Preset** button to activate the preset value. The Preset value will be set for the position of the encoder in the moment when the **Activate Preset** button is pressed. We suggest activating the preset value when the encoder is in stop.

NOTE
At each confirmation of the Preset setting and activation, a message will appears in the **No Command sent** line. 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).

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

8.6 Setting the registers

Press the **Set Registers** command in the left navigation bar of the Web server **Home** page to enter the **Set IF55-LIN-MT Registers** page. In this page the read-write access MODBUS registers are displayed and their value can be changed.
For complete information on the available holding registers please refer to the "7.1.1 Holding Register parameters" section on page 53.

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.

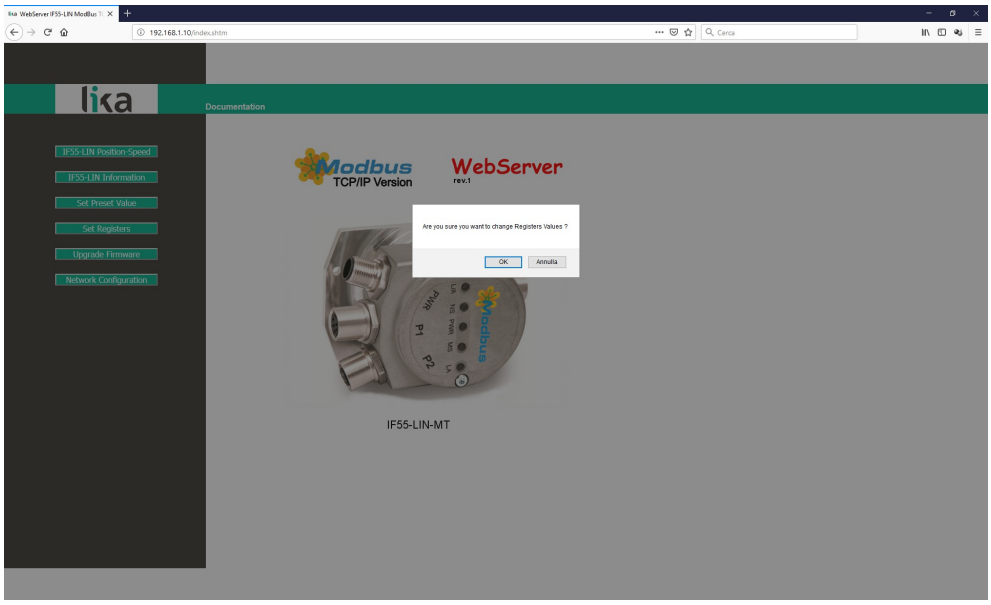


Figure 13 - Entering the Set IF55-LIN-MT Registers page

Press the **OK** button to proceed, otherwise press the **EXIT** button to exit 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.

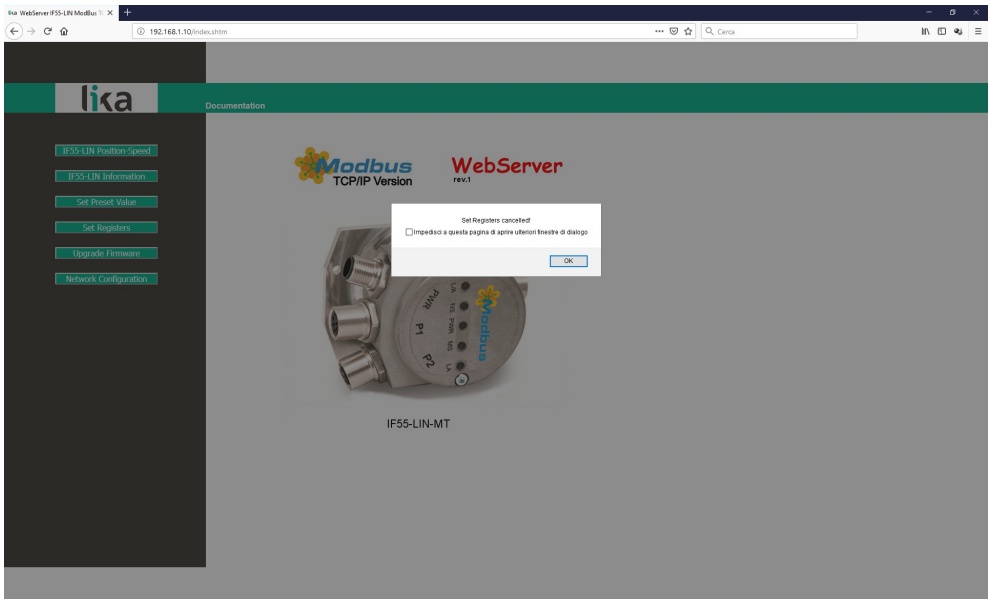


Figure 14 - Register setting operation cancelled

If you confirm the procedure, the **Set IF55-LIN-MT Registers** page will appear on the screen:

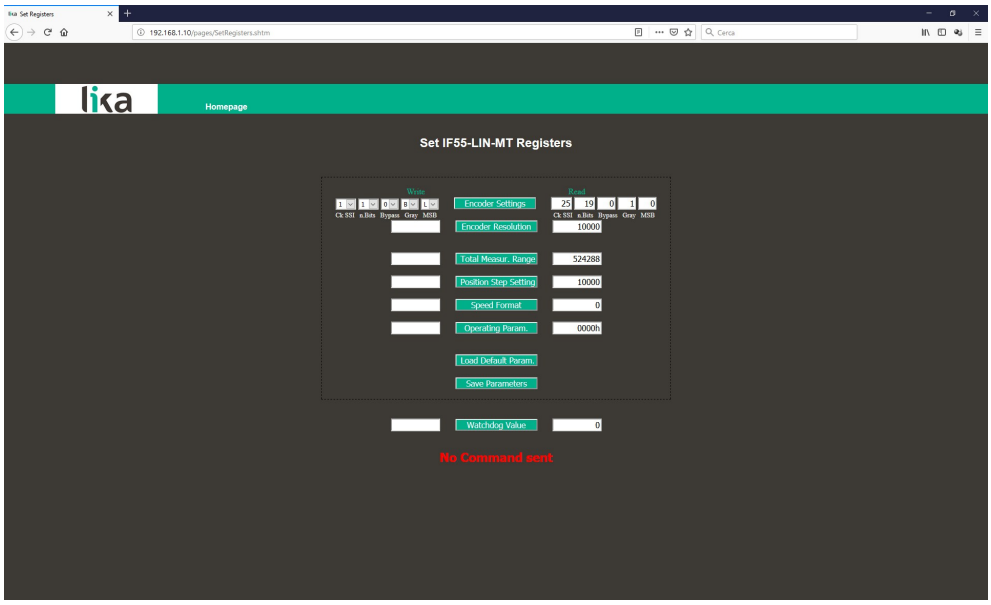


Figure 15 - Set IF55-LIN-MT Registers page

The values that are currently set in the converter are displayed in the **READ** box.

To change any value enter a suitable value in the **WRITE** box 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 box (when available).
For complete information on the available registers please refer to the "7.1.1 Holding Register parameters" section on page 53.

NOTE
Please note that, after pressing the button between the boxes, the set value is saved temporarily in the registers. To save it permanently, please press the **Save Parameters** button. Should the power supply be turned off without saving data, the values that have not been saved on the Flash EEProm will be lost! For more information refer to the **Save parameters** command in the **Control Word [111-112]** registers on page 65.

NOTE
The **Watchdog Value** parameter only is saved automatically after setting.

Press the **Load Default Param.** button to restore all parameters to default values. Default values are set at the factory by Lika Electronic engineers to allow

the operator to run the device for standard operation in a safe mode. This function can be useful, for instance, to restore the factory values in case the encoder is set incorrectly and you are not able to resume the proper operation. For more information refer to the **Restore default parameters** command in the Control Word [111-112] registers on page 66.

WARNING
The execution of this command causes all parameters which have been set previously to be overwritten!

NOTE
At each confirmation of the set registers, a message will appears in the **No Command sent** line. 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).

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

8.7 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 the power supply during the flash upgrade operation.

This operation allows to upgrade the unit firmware by downloading upgrading data to the flash memory.
The firmware is a software program which controls the functions and the 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 **Firmware Version** parameter in the **IF55-LIN-MT Information** page after connection to the web server (see on page 88; see also the **DSC Firmware Version [127-128]** registers on page 71).

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 converter is connected to the network;
- the converter has valid 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_MB_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.

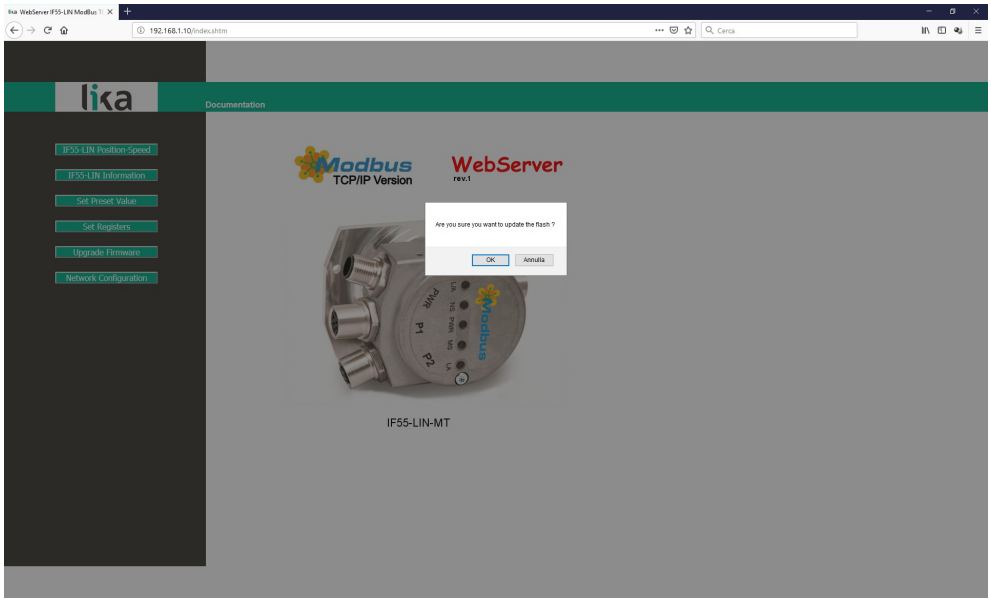


Figure 16 - Entering the Upgrade Firmware page

3. Press the **OK** button to proceed, otherwise press the **EXIT** button to exit 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.

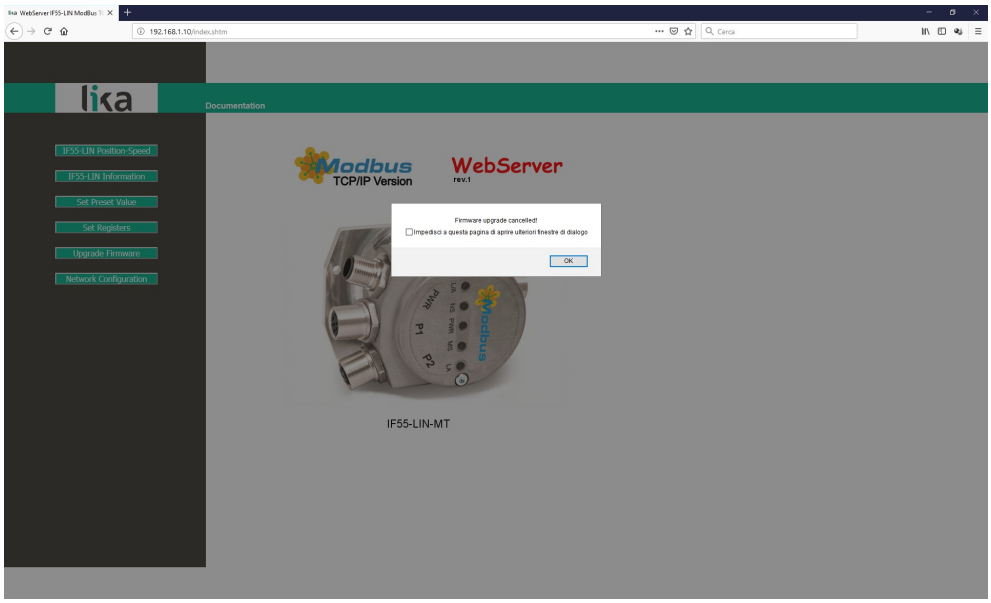


Figure 17 - Firmware upgrade operation cancelled

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

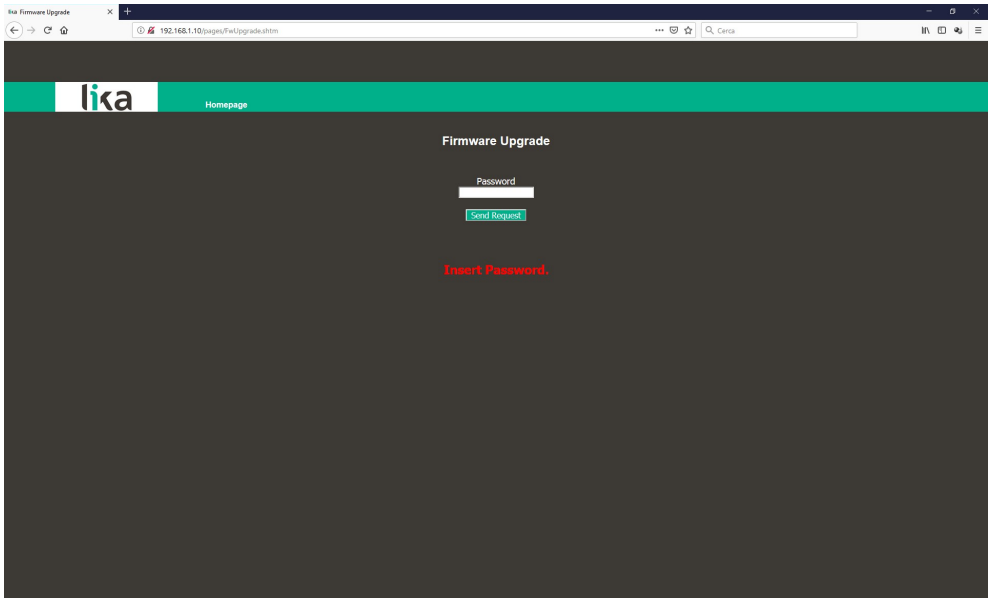


Figure 18 - Firmware Upgrade page

6. If the password you typed is incorrect, the following warning message will appear on the screen: **THE PASSWORD INSERTED IS INCORRECT. PLEASE RETRY!**. Please retype the 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**.

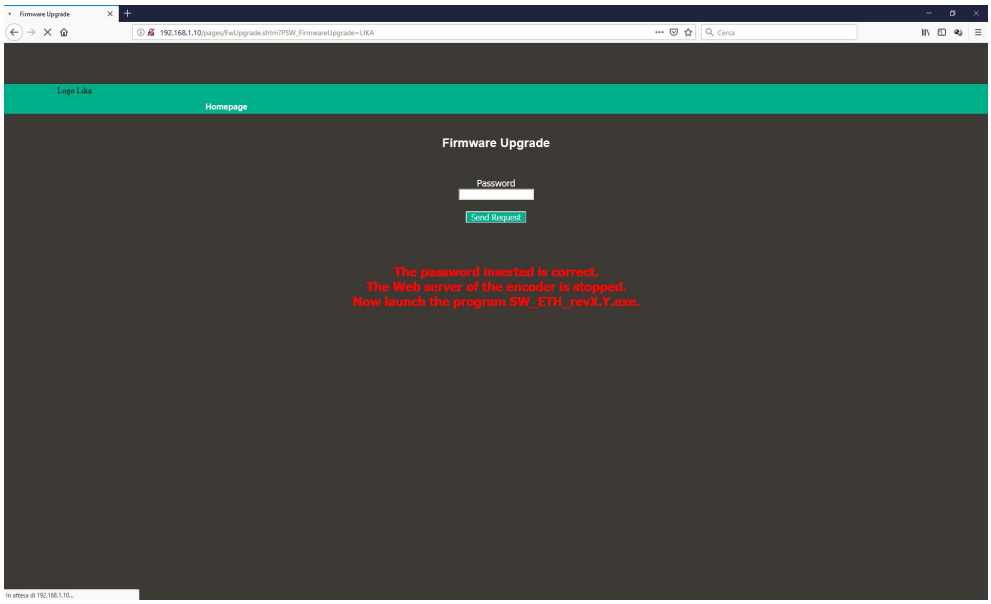


Figure 19 - Firmware Upgrade page – Correct password

8. The converter is in Bootloader work mode and ready to accept the firmware program: the web server is stopped and the communication with the converter through the web browser is interrupted; if you need to exit the procedure and restore the communication you must switch the converter off and then on again.
9. Now you must launch the SW_ETH_REVX_Y.EXE executable file 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 provided by Lika Electronic; the following page will appear:

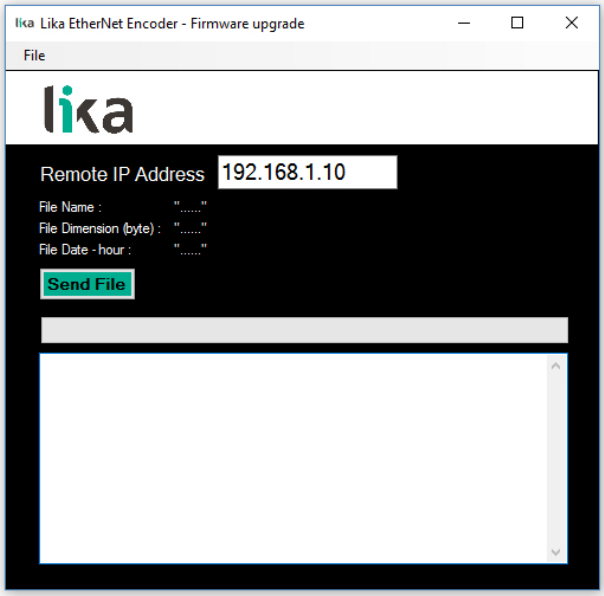


Figure 20 - Firmware upgrade executable file

11. Type the converter IP address in the **Remote IP Address** box. The default IP address set by Lika Electronic is 192.168.1.10.
12. Press the **FILE** command and then the **OPEN** command in the menu bar; once you press the **OPEN** command the **OPEN** dialogue 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 device to be updated.
IF55_LIN_MT_Hx_Sx.bin for IF55 series for linear encoders

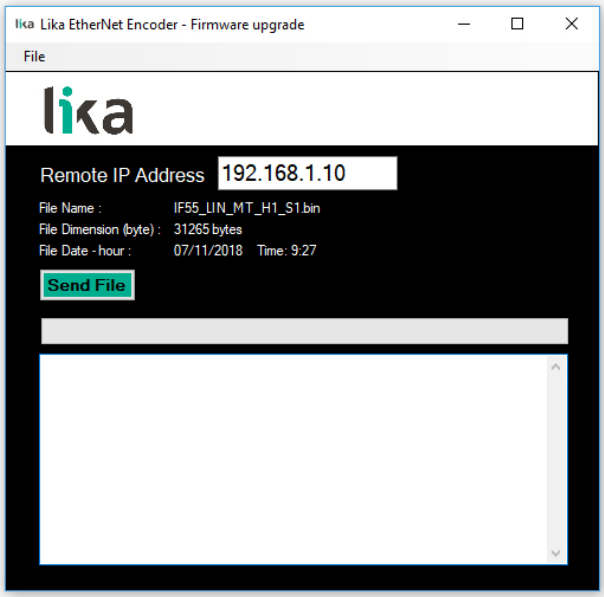


Figure 21 - Selecting the firmware upgrade .BIN file

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 off the power supply during the flash upgrade operation.

14. Press the **Send File** button to start the firmware upgrade process.
15. A download progress bar and additional information are shown in the page while upgrading the firmware.

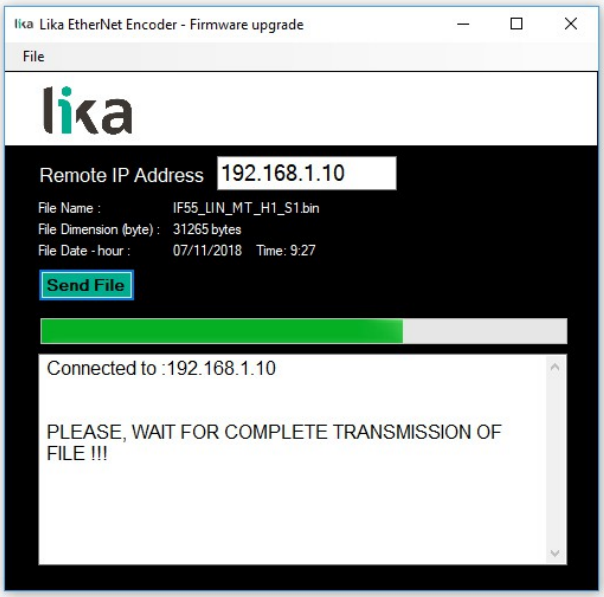


Figure 22 - Updating the firmware

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

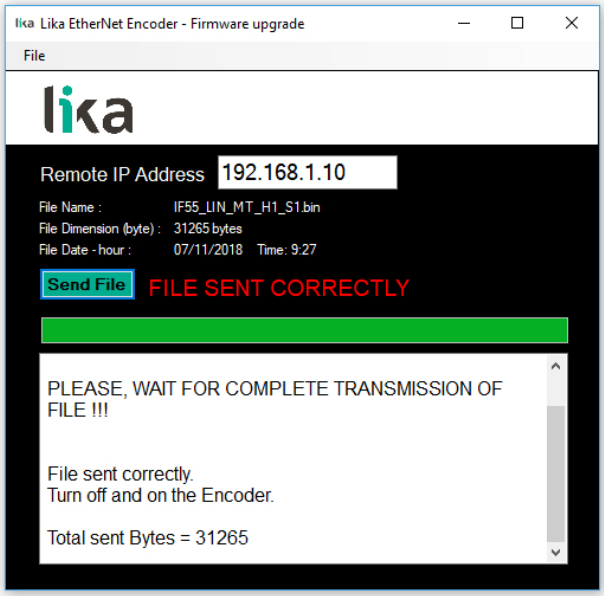


Figure 23 - Firmware upgrade process accomplished

17. Now you are required to turn the converter power supply off and then on. Close the program.
18. Turn the converter 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 off and then on again the encoder and retry the operation.

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

8.8 Network configuration

Press the **Network Configuration** command in the left navigation bar of the Web server **Home** page to enter the **Network IP Configuration** page. This page allows the operator to configure the TCP/IP properties, that is how the encoder communicates with other devices in the network.
For further information on the network communication parameters please refer to the "4.8 Setting the IP address and the network configuration parameters" section on page 28.

WARNING
The network configuration has to be accomplished by skilled and competent personnel.

A soon as you press the **Network Configuration** command a warning message (**Are you sure you want to change Network Parameters?**) appears on the screen: it warns the operator about the awkwardness of the operation, thus he is required to confirm the procedure before continuing.

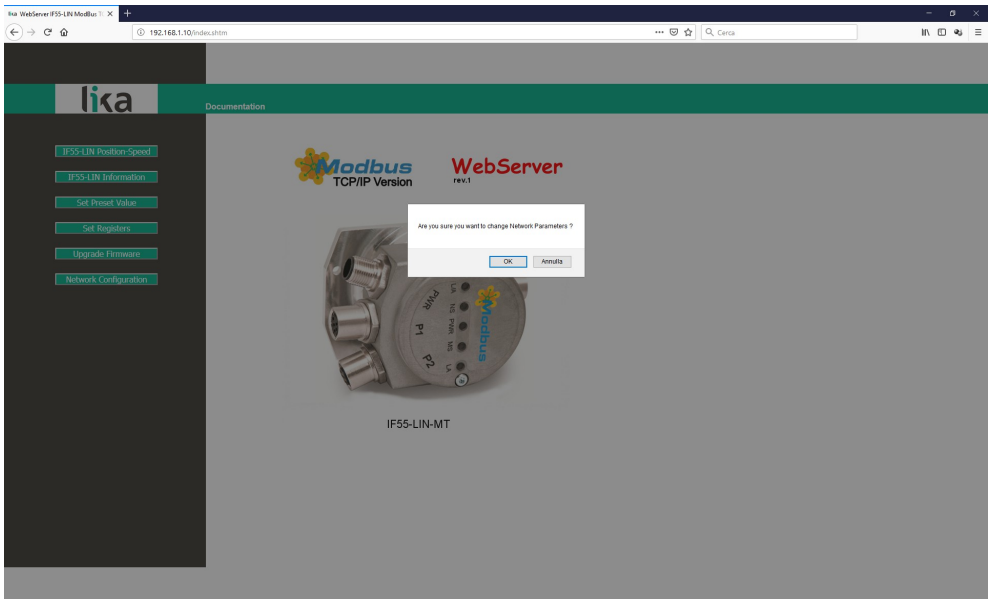


Figure 24 - Entering the Network Configuration page

Press the **OK** button to proceed, otherwise press the **EXIT** button to abort the procedure. The **Set Network parameters cancelled!** message will appear on the screen. Press the **OK** button to move back to the Web server **Home** page.

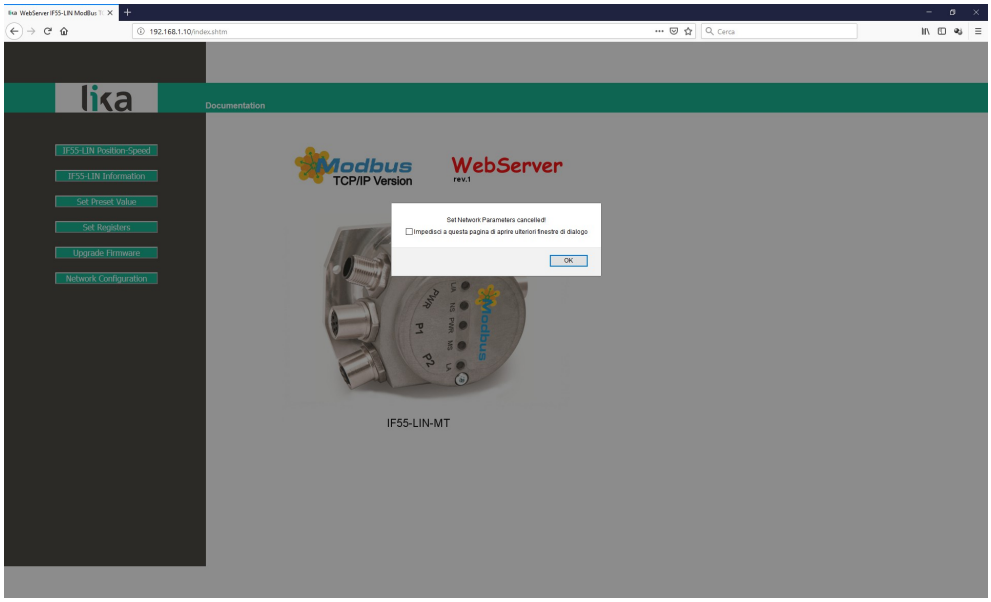


Figure 25 - Network configuration aborted

If you confirm the procedure, the **Network Configuration** page will appear on the screen:

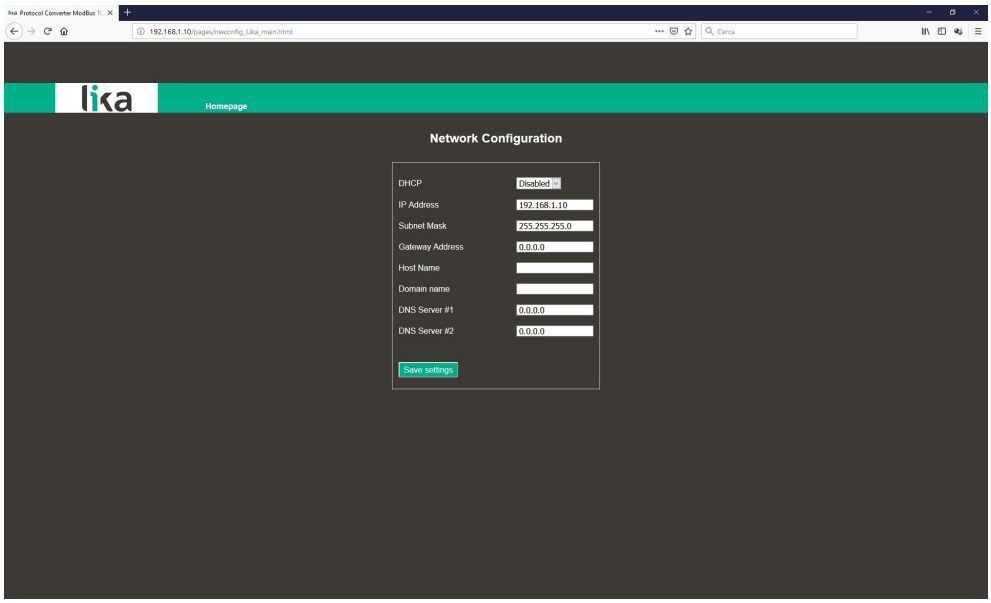


Figure 26 - Network Configuration page

WARNING
Only competent technicians, who are properly trained, have adequate experience and are familiar with computer architecture, network design and operating systems should configure the network communication parameters.
The inappropriate setting of the network parameters results in an incorrect operation of the system.

In this page it is possible to set the parameters that affect the proper communication of the converter in the TCP/IP network: IP address, Subnet mask, DHCP, DNS, etc.

The following table summarises the default IP address and the network configuration parameters.

IP Parameter	Value
IP address	192.168.1.10
Subnet mask	255.255.255.0
Default Gateway	0.0.0.0

To save the set values permanently, please press the **Save Settings** button. Should the power supply be turned off without saving data, the values that have not been saved on the Flash EEProm will be lost!

WARNING

After any setting please note down the configuration values to have access to the converter and the Web server pages in the future. If for any reason you are not able to communicate with the converter and enter the Web server pages you must restore the factory values (default values) of the network configuration parameters. To do this you must access the DIP A dip switch located inside the connection cap. For complete information please refer to the "4.10 DIP A: Resetting the network configuration parameters to the factory values" section on page 30.

WARNING

If you enable the DHCP network protocol (DHCP = ENABLED), then the following default parameters are set for the converter:
IP ADDRESS = 0.0.0.0
SUBNET MASK = 0.0.0.0
Please check that these settings are allowed by the DHCP server and they are valid address values.

NOTE

If for any reason you must restore the factory values (default values) of the network configuration parameters you must access the DIP A dip switch located inside the connection cap. For complete information please refer to the "4.10 DIP A: Resetting the network configuration parameters to the factory values" section on page 30.

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

9 Programming examples

Hereafter are some examples of both reading and writing parameters. All values are expressed in hexadecimal notation. For any information on the MODBUS TCP/IP ADU (MBAP Header + PDU) refer to the "6.3 MODBUS on TCP/IP Application Data Unit" section on page 37.

9.1 Using the 03 Read Holding Registers function code

EXAMPLE 1
Request to read the **Preset value [105-106]** registers (address 104-105).

MBAP Header + Request PDU (in hexadecimal notation)

[00][01][00][00][00][06][00][03][00][68][00][02]
where:
[00][01] = Transaction Identifier
[00][00] = Protocol Identifier
[00][06] = Length
[00] = Unit Identifier
[03] = **03 Read Holding Registers** function code
[00][68] = starting address (**Preset value [105-106]** registers, address 104-105)
[00][02] = number of requested registers

MBAP Header + Response PDU (in hexadecimal notation)
[00][01][00][00][00][07][00][03][04][00][00][05][DC]
where:
[00][01] = Transaction Identifier
[00][00] = Protocol Identifier
[00][07] = Length
[00] = Unit Identifier
[03] = **03 Read Holding Registers** function code
[04] = number of bytes (2 bytes for each register)
[00][00] = value of register 105, 00 00 hex = 0 dec
[05][DC] = value of register 106, 05 DC hex = 1500 dec

The **Preset value [105-106]** registers (address 104-105) contain the value 00 00 hex and 05 DC hex, i.e. 1500 in decimal notation; in other words the value set in the **Preset value [105-106]** registers is 1500 dec.

9.2 Using the 04 Read Input Registers function code

EXAMPLE 1
Request to read the **Current position [1-2]** registers (address 0-1).

MBAP Header + Request PDU (in hexadecimal notation)
[00][01][00][00][00][06][00][04][00][00][00][02]
where:
[00][01] = Transaction Identifier
[00][00] = Protocol Identifier
[00][06] = Length
[00] = Unit Identifier
[04] = **04 Read Input Registers** function code
[00][00] = starting address (**Current position [1-2]** registers, address 0-1)
[00][02] = number of requested registers

MBAP Header + Response PDU (in hexadecimal notation)
[00][01][00][00][00][07][00][04][04][00][00][2F][F0]
where:
[00][01] = Transaction Identifier
[00][00] = Protocol Identifier
[00][07] = Length
[00] = Unit Identifier
[04] = **04 Read Input Registers** function code
[04] = number of bytes (2 bytes for each register)
[00][00] = value of register 1, 00 00 hex = 0 dec
[2F][F0] = value of register 2, 2F F0 hex = 12272 dec

The **Current position [1-2]** registers (address 0-1) contain the value 00 00 2F F0 hex, i.e. 12272 in decimal notation.

9.3 Using the 06 Write Single Register function code

EXAMPLE 1
Request to write in the **Watchdog timeout [82]** register (address 81): you want to enable the Watchdog function and set the timeout to 10 ms.

MBAP Header + Request PDU (in hexadecimal notation)
[00][01][00][00][00][06][00][06][00][51][00][0A]
where:
[00][01] = Transaction Identifier
[00][00] = Protocol Identifier
[00][06] = Length
[00] = Unit Identifier
[06] = **06 Write Single Register** function code
[00][51] = address of the **Watchdog timeout [82]** register, 51 hex = 81 dec
[00][0A] = value to be set in the register

MBAP Header + Response PDU (in hexadecimal notation)
[00][01][00][00][00][06][00][06][00][51][00][0A]
where:
[00][01] = Transaction Identifier
[00][00] = Protocol Identifier
[00][06] = Length
[00] = Unit Identifier
[06] = **06 Write Single Register** function code
[00][51] = address of the **Watchdog timeout [82]** register, 51 hex = 81 dec
[00][0A] = value set in the register

The value 00 0A hex (10 dec) is set is set in the **Watchdog timeout [82]** register (address 81): the Watchdog function is enabled and the timeout is set to 10 ms.

9.4 Using the 16 Write Multiple Registers function code

EXAMPLE 1

Request to write the value 00 00 17 70 hex (=6000 dec) next to the **Total measuring range [101-102]** registers (address 100-101) and the value 00 00 27 10 hex (= 10000 dec) next to the **Position step setting nm [103-104]** registers (address 102-103).

MBAP Header + Request PDU (in hexadecimal notation)
[00][01][00][00][00][0F][00][10][00][64][00][04][08][00][00][17][70][00][00][27][10]
where:
[00][01] = Transaction Identifier
[00][00] = Protocol Identifier
[00][0F] = Length
[00] = Unit Identifier
[10] = **16 Write Multiple Registers** function code
[00][64] = starting address (**Total measuring range [101-102]** registers, address 100-101)
[00][04] = number of requested registers
[08] = number of bytes (2 bytes for each register)
[00][00] = value to be set in the register 101, 00 00 hex
[17][70] = value to be set in the register 102, 17 70 hex (00 00 17 70 hex = 6000 dec)
[00][00] = value to be set in the register 103, 00 00 hex
[27][10] = value to be set in the register 104, 27 10 hex (00 00 27 10 hex = 10000 dec)

MBAP Header + Response PDU (in hexadecimal notation)
[00][01][00][00][00][06][00][10][00][64][00][04]
where:
[00][01] = Transaction Identifier
[00][00] = Protocol Identifier
[00][06] = Length
[00] = Unit Identifier
[10] = **16 Write Multiple Registers** function code
[00][64] = starting address (**Total measuring range [101-102]** registers, address 100-101)
[00][04] = number of written registers

The values 00 00 hex and 17 70 hex, i.e. 6000 in decimal notation, are set in the **Total measuring range [101-102]** registers at address 100-101; while the values 00 00 hex and 27 10 hex, i.e. 10000 in decimal notation, are set in the **Position step setting nm [103-104]** registers at address 102-103. Thus the

encoder will be programmed to run a 6000-count long travel and use a 10000 nm = 0.01 mm resolution.

EXAMPLE 2

Request to write in the **Operating parameters [109-110]** registers (address 108-109): we need to set the scaling function (bit 0 **Scaling function** = 1) and the count up information with clockwise rotation of the encoder shaft (bit 1 **Code sequence** = 0). The value to set is 00 00 00 01 hex (= 0000 0000 0000 0000 0000 0000 0000 0001 in binary notation: the bit 0 **Scaling function** = 1; the bit 1 **Code sequence** = 0; the remaining bits are not used, therefore their value is 0).

MBAP Header + Request PDU (in hexadecimal notation)
[00][01][00][00][00][0B][00][10][00][6C][00][02][04][00][00][00][01]
where:
[00][01] = Transaction Identifier
[00][00] = Protocol Identifier
[00][0B] = Length
[00] = Unit Identifier
[10] = **16 Write Multiple Registers** function code
[00][6C] = starting address (**Operating parameters [109-110]** registers, address 108-109)
[00][02] = number of requested registers
[04] = number of bytes (2 bytes for each register)
[00][00] = value to be set in the register 109, 00 00 hex
[00][01] = value to be set in the register 110, 00 01 hex

MBAP Header + Response PDU (in hexadecimal notation)
[00][01][00][00][00][06][00][10][00][6C][00][02]
where:
[00][01] = Transaction Identifier
[00][00] = Protocol Identifier
[00][06] = Length
[00] = Unit Identifier
[10] = **16 Write Multiple Registers** function code
[00][6C] = starting address (**Operating parameters [109-110]** registers, address 108-109)
[00][02] = number of written registers

The value 00 00 00 01 hex, i.e. 0000 0000 0000 0000 0000 0000 0000 0001 in binary notation is set in the **Operating parameters [109-110]** registers (address 108-109): the bit 0 **Scaling function** = 1; the bit 1 **Code sequence** = 0; the remaining bits are not used, therefore their value is 0.

10 Default parameters list

Default values are expressed in decimal notation, unless otherwise indicated.

Parameters list	Default values		
Watchdog timeout [82]	0		
Total measuring range [101-102]	524288		
Position step setting nm [103-104]	10000		
Preset value [105-106]	0		
Speed format [107-108]	0 = cps		
Operating parameters [109-110]	0000 0000 hex		
	bit 0 Scaling function = 0		
	bit 1 Code sequence = 0		
Control Word [111-112]	0		
Measuring step nm [113-114]	10000		
Supported alarms [115-116]	0000 7000 hex		
Supported warnings [117-118]	0		
Encoder Settings [141-142]	bit 0 SSI protocol = 0		
	bit 4 SSI output code = 1		
	bit 7 Bypass mode = 0		
	bits 8 .. 15 Max No of Information = 19		
	bits 16 ... 23 No of SSI clocks = 25		
Measure of a pulse nm [143-144]	10000		

Document release	Release date	Description	HW	SW	Interface
1.0	12.03.2019	First issue	1.0	1.0	-

Dispose separately

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