USER MANUAL

MULTIPROTOCOL "KEY" GATEWAYS SERIES

IEC 61850 - MODBUS RTU&TCP GATEWAYS

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Document revisions

DATE	REVISION	NOTES	AUTHOR
16/09/2024	0	First revision	MM
24/02/2025	1	Added led chapter Added modbus registers info chapter	MM
27/05/2025	2	Added new functions from firmware rev 111	MM

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1. DESCRIPTION

The Z-KEY-I, R-KEY-LT-I, Z-KEY-2ETH-I products allow to convert data coming from the Modbus serial bus or Modbus TCP-IP Ethernet into the IEC61850 protocol or vice versa.

1.1. IEC61850 PROTOCOL

IEC 61850 is a standard for the design of automation systems for electrical substations. It is part of the International Electrotechnical Commission.
The data model defined in IEC 61850 is supported, for example, by the MMS protocol.

PROTOCOL	
Type of protocol	IEC 61850 server ICD edition 1.0 MMS (manufacture message specification) protocol supported Report Control Block buffered/unbuffered supported Encrypted connection with certificates supported Goose and SMV protocols not supported TLS 1.2 connection, X.509 certificate management

MEMORY	
Memory size of variables	max 50 IEC variables

1.2. FEATURES OF THE “KEY” SERIES COMMUNICATION PORTS

PRODUCT	*ETHERNET PORTS*	*SERIAL PORT # 1 RS232/RS485 CONFIGURABLE*	*RS485 SERIAL PORT # 2*	*ISOLATED SERIAL PORTS*
Z-KEY-I	1	1	1	Yes, both ports
R-KEY-LT-I	1	1	NO	NO
Z-KEY-2ETH-I	2	1	1	Yes, both ports

2. DEVICE HARDWARE REVISION

With a view to continuous improvement, Seneca updates and makes the hardware of its devices increasingly more sophisticated. It is possible to know the hardware revision of a product via the label on the side of the device.
An example of an R-KEY-LT product label is the following:

The label also shows the firmware revision present in the device (in this case 2.0.1.0) at the time of sale.
To improve performance or extend functionality, Seneca recommends updating the firmware to the latest available version (see the section dedicated to the product on www.seneca.it).

3. FLEX TECHNOLOGY FOR PROTOCOL CHANGE

Starting from the hardware revision indicated in the following table, the KEY series devices include Flex technology.

GATEWAY	FLEX TECHNOLOGY SUPPORTED BY HARDWARE REVISION
Z-KEY	"G00"
R-KEY-LT	"E00"
Z-KEY-2ETH	"C00"

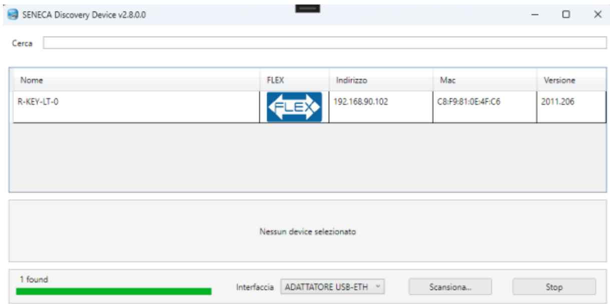
Flex allows you to change the combination of industrial communication protocols supported by the gateways at will from a list of available ones, the development is continuously updated, for a complete list refer to the page: https://www.seneca.it/flex/

Some examples of supported protocols are:

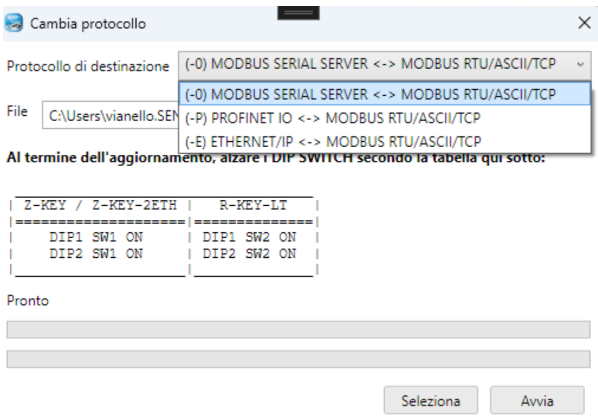
The gateway then becomes "universal" and compatible with Siemens or Rockwell or Schneider systems etc. without the need to purchase different hardware.

3.1. CHANGING PROTOCOLS WITH THE SENECA DISCOVERY DEVICE SOFTWARE

From revision 2.8 the Seneca Discovery Device software identifies the devices that support the “Flex” technology:



For example, in the case in the figure it is possible to press the “Change Protocol” button and select the destination protocol from those in the list:



At the end of the operation, bring (only at the first power-on) the dip switches 1 and 2 to “ON” to force the device to default (see also the chapter “RESETTING THE DEVICE TO ITS FACTORY CONFIGURATION”).

Always refer to the user manual of the communication protocol installed in the device by downloading it from the Seneca website.

4. *LED MEANING*

The devices are equipped with LEDs whose meaning is as follows:

4.1. Z-KEY-I (IEC61850) MODEL LED

LED	*STATUS*
PWR	***Steady on***: device powered and IP address set ***Flashing***: IP address not yet set ***Off***: device not powered
COM	Not used
TX1	***Flashing:*** data transmission on serial port #1 ***Off:*** no transmission on serial port #1
RX1	***Flashing:*** data reception on serial port #1 ***Steady on:*** check wiring on serial port #1 ***Off:*** no reception on serial port #1
TX2	***Flashing:*** data transmission on serial port #2 ***Off:*** no transmission on serial port #2
RX2	***Flashing:*** data reception on serial port #2 ***Steady on:*** check wiring on serial port #2 ***Off:*** no reception on serial port #2
ETH ACT (GREEN)	***Flashing:*** presence of data on ethernet port ***Steady on:*** ethernet port connected but no data present ***Off:*** check wiring of the ethernet port
ETH LNK (YELLOW)	***Steady on:*** ethernet cable connected ***Off:*** check the wiring of the ethernet port

4.2. R-KEY-LT-I (IEC61850) MODEL LED

LED	***STATUS***
PWR	***Steady on***: device powered and IP address set ***Flashing***: IP address not yet set ***Off***: device not powered
COM	Not used
TX	***Flashing:*** data transmission on serial port ***Off:*** no transmission on serial port
RX	***Flashing:*** data reception on serial port ***Steady on:*** check wiring on serial port ***Off:*** no reception on serial port
ETH ACT (GREEN)	***Flashing:*** presence of data on ethernet port ***Steady on:*** ethernet port connected but no data present ***Off:*** check wiring of the ethernet port
ETH LNK (YELLOW)	***Steady on:*** ethernet cable connected ***Off:*** check the wiring of the ethernet port

4.3. Z-KEY-2ETH-I (IEC61850) MODEL LED

LED	***STATUS***
PWR	***Steady on***: device powered and IP address set ***Flashing***: IP address not yet set ***Off***: device not powered
COM	Not used
TX1	***Flashing:*** data transmission on serial port #1 ***Off:*** no transmission on serial port #1
RX1	***Flashing:*** data reception on serial port #1 ***Steady on:*** check wiring on serial port #1 ***Off:*** no reception on serial port #1
TX2	***Flashing:*** data transmission on serial port #2 ***Off:*** no transmission on serial port #2
RX2	***Flashing:*** data reception on serial port #2 ***Steady on:*** check wiring on serial port #2 ***Off:*** no reception on serial port #2
ET1	***Flashing:*** presence of data on ethernet port #1 ***Steady on:*** ethernet port #1 connected but no data present ***Off:*** check wiring of ethernet port #1
ET2	***Flashing:*** presence of data on ethernet port #2 ***Steady on:*** ethernet port #2 connected but no data present ***Off:*** check wiring of ethernet port #2

5. ETHERNET PORT

The factory configuration of the Ethernet port is:

STATIC IP: 192.168.90.101
SUBNET MASK: 255.255.255.0
GATEWAY: 192.168.90.1

Multiple devices must not be inserted on the same network with the same static IP.

⚠ ATTENTION!

DO NOT CONNECT 2 OR MORE FACTORY-CONFIGURED DEVICES ON THE SAME NETWORK, OR THE DEVICE WILL NOT WORK
(CONFLICT OF IP ADDRESSES 192.168.90.101)

6. FIRMWARE UPDATE

In order to improve, add or optimize the functions of the product, Seneca releases firmware updates on the device section on the www.seneca.it website

The firmware update is performed using Seneca tools or the webserver.

⚠ ATTENTION!

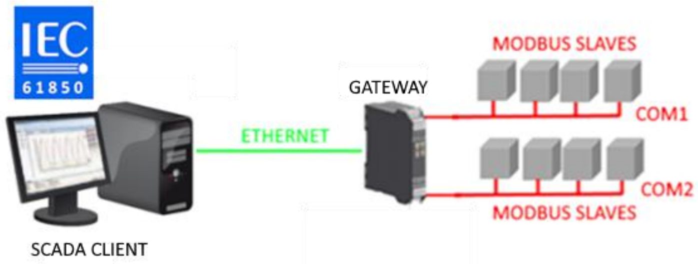
NOT TO DAMAGE THE DEVICE DO NOT REMOVE THE POWER SUPPLY DURING THE FIRMWARE UPDATE OPERATION.

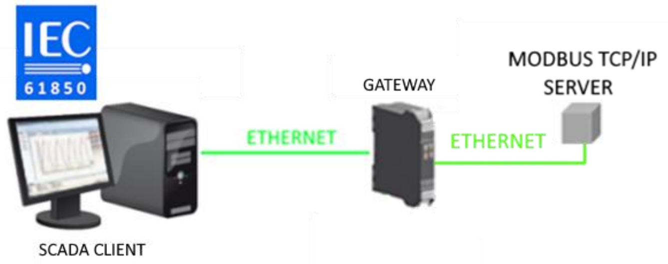
7. OPERATING MODE

The Gateway allows you to operate in the following mode:
GATEWAY IEC 61850 SERVER / MODBUS RTU/TCP MASTER

7.1. GATEWAY IEC 61850 SERVER / MODBUS MASTER

This operating mode allows to connect an IEC 61850 SCADA client with Modbus RTU/ASCII Slave and/or remote TCP Server I/O devices





The Gateway, on the field side, works as a Modbus master / Modbus Client device and on the other side as an IEC 61850 server via Ethernet.
The Modbus requests (read or write commands) are configured in the gateway device and an ICD file is automatically generated according to the IEC 61850 standard.
Once this file is imported into the SCADA (it is also possible to search for the node) all the configured IO will be accessible without any other configuration.

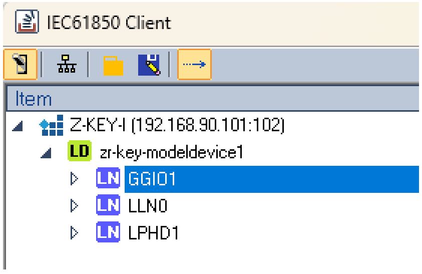
In addition to the serial devices, it is also possible to connect up to 3 remote Modbus TCP-IP servers.

8. *IEC61850 IMPLEMENTATION ON THE "KEY" SERIES GATEWAYS*

Given the complexity of the IEC61850 protocol, the "KEY" series gateways implement an IEC61850 server with some simplified features that we list:

8.1. Basic SCL structure

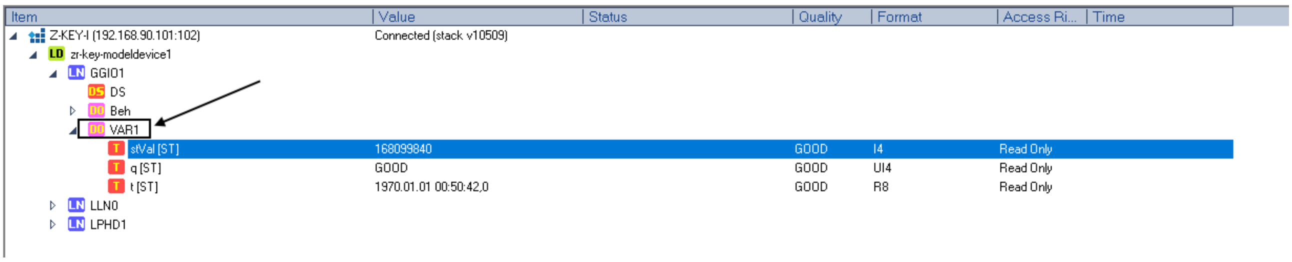
The basic SCL structure is constant and is represented by 3 logical nodes:



GGIO1 represents the logical Node Generic IO 1, here all the variables coming from the Modbus buses will be present.
LLN0 represents the logical node zero. Contains the data relating to the Intelligent Electronic Device (IED family KEY)
LPHD1 represents the physical logic node 1. Contains information relating to the physical device.

8.2. Modbus variables

When variables are added (reads from the Modbus protocol) these will always be added to the logic node GGIO1. For example, for the "VAR1" variable we have:



8.3. DataSet

For the Report Data Blocks it is necessary to define one or more sets of variables, this is done through the definition of the datasets.
Datasets can be used across different Report Control Blocks.

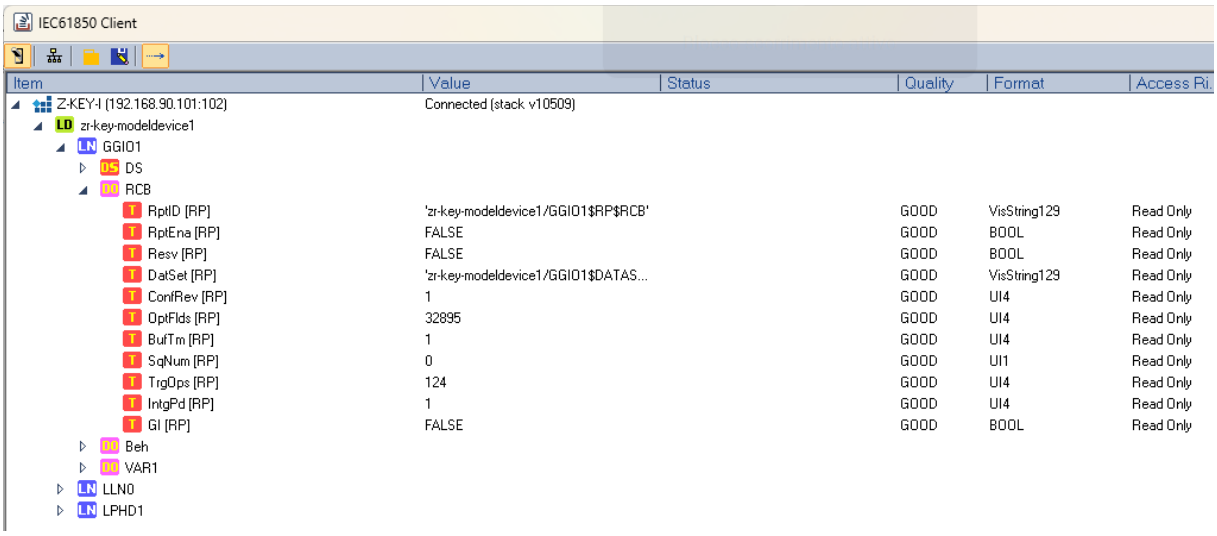
8.4. Report Control Block (RCB) unbuffered/buffered in the SCL structure

The IEC 61850 standard defines a reporting mechanism that uses spontaneous data transmission from the server to the client. This aims to minimize the network load.
The generation and transmission of the report are controlled by the report control blocks.
A report control block is defined by its attributes, such as the assigned dataset, trigger options and optional fields. The dataset is sent directly from the server to the client in case the configured event has occurred.
The KEY series gateways support both buffered and unbuffered RCBs.

In unbuffered RCBs the data is transmitted as defined by the chosen trigger options. In case of a connection loss the data is not stored. Transmission resumes once the connection is re-established but information that may have been transmitted during the connection loss will be lost. These RCBs are ideal for managing alarms.

In buffered RCBs, however, in the event of a connection interruption, the data is stored in a circular buffer. As soon as the connection is re-established, the buffered information is transmitted in chronological order.
These RCBs are ideal for managing measurements.

When Report Data Blocks are defined they can be associated with GGIO1 or LLN0:



9. GATEWAY CONFIGURATION

9.1. GATEWAY CONFIGURATION WITH THE WEBSERVER FOR THE "COPADATA IEC61850 CLIENT™" CLIENT

The COPADATA "IEC61850 Client" software will be used as IEC 61850 client for Windows.
For more information on the client software, refer to:

https://www.copadata.com

The purpose is to configure the gateway so that it can read a register coming from the serial modbus RTU protocol from a 61850 client.

We configure the Gateway via the webserver, first we activate the webserver (by default the device is in IEC61850 mode), we hold down the side button until the device restarts.
At this point the PWR LED starts to flash to indicate the operating mode as a webserver for the configuration.
The default address of the webserver is:

http://192.168.90.101

user: admin
password: admin

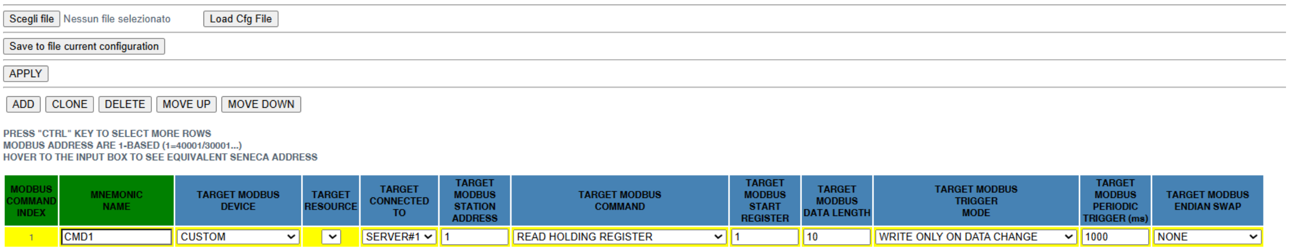
First, let's configure the Ethernet and serial parameters:

	CURRENT	UPDATED
DHCP	Disabled	Disabled
STATIC IP	192.168.90.101	192.168.90.101
STATIC IP MASK	255.255.255.0	255.255.255.0
STATIC GATEWAY	192.168.90.1	192.168.90.1
TCP/IP PORT	502	502
TCP/IP TIMEOUT [ms]	512	512
PORT#1 MODBUS PROTOCOL	RTU	RTU
PORT#2 MODBUS PROTOCOL	RTU	RTU
PORT#1 BAUDRATE	38400	38400
PORT#1 DATA BITS	8	8
PORT#1 PARITY	None	None
PORT#1 STOP BITS	1	1
PORT#1 TIMEOUT [ms]	500	500
PORT#1 WRITING RETRIES	3	3
PORT#2 BAUDRATE	38400	38400
PORT#2 DATA BITS	8	8
PORT#2 PARITY	None	None
PORT#2 STOP BITS	1	1
PORT#2 TIMEOUT [ms]	500	500
PORT#2 WRITING RETRIES	3	3
WEB SERVER PORT	80	80
WEB SERVER AUTHENTICATION USER NAME	admin	admin
WEB SERVER AUTHENTICATION USER PASSWORD	admin	admin
IP CHANGE FROM DISCOVERY	Enabled	Enabled
TLS	Disabled	Disabled
MODBUS TCP-IP CLIENT	ENABLED	ENABLED
MODBUS TCP-IP SERVER#1	ENABLED	ENABLED
SERVER#1 TCP/IP PORT	502	502
SERVER#1 TCP/IP ADDRESS	192.168.90.81	192.168.90.81
MODBUS TCP-IP SERVER#2	DISABLED	DISABLED
SERVER#2 TCP/IP PORT	502	502
SERVER#2 TCP/IP ADDRESS		
MODBUS TCP-IP SERVER#3	DISABLED	DISABLED
SERVER#3 TCP/IP PORT	502	502
SERVER#3 TCP/IP ADDRESS		
MODBUS TCP-IP CLIENT TIMEOUT [ms]	5000	5000
MODBUS TCP-IP CLIENT WRITING ATTEMPTS	3	3
SERVER AFTER FAIL DELAY [s]	60	60
STOP MODBUS READING WHEN NO IEC61850 CONNECTION	Disabled	Disabled
SYNC CLOCK WITH TIME INTERNET	ENABLED	ENABLED
NTP SERVER 1 ADDRESS	193.204.114.232	193.204.114.232
NTP SERVER 2 ADDRESS	0.0.0.0	0.0.0.0
GMT	0	0
IEC MODEL NAME	zr-key-model	zr-key-model
IEC DEVICE NAME	device1	device1
IEC61850 SERVER TCP/IP PORT	102	102

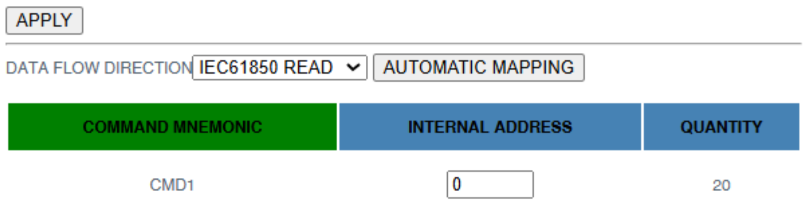
N.B. the protocol requires the use of UTC time to send the timestamp, we therefore recommend setting an NTP server and GMT = 0.
The date/time after a reboot will be synchronized by the NTP server, it is therefore necessary that the device has the ability to access the server.
IEC MODEL NAME and IEC DEVICE NAME are important in order to configure the IED and the logical device.

Now let's create the Modbus master requests (commands).
Let's enter the Setup Modbus Commands/Tags page:

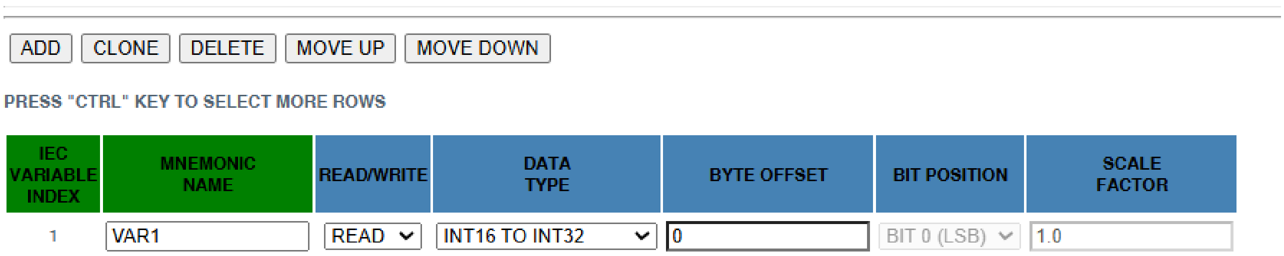
Let's read 10 holding registers from 40001 and 40010 (offset 0 and 9) from the device with station address 1, press the "APPLY" button.



Now the read bytes are updated in the internal memory of the gateway, let's go to the I/O Mapping page:



At this point we define an IEC variable associated with the first 2 bytes acquired from Modbus:



N.B. mnemonic name represents the Data Object with which the variable will be exposed in the 61850 protocol.
The 2 byte Modbus conversion must be brought to 32 bits since the 16-bit data type does not exist. Scaling is only available in the case of Float data type. It is also possible to discretize the single bit of the word in the boolean data type.
Three data types are managed:
INS (32-bit integer)
SPS (Boolean)
MV(32-BIT FLOAT)

We confirm with APPLY.
If we go to the “Status” section we will find the first 20 bytes in memory with the values read from Modbus and the IEC variable we have defined (linked to the first 2 bytes):

GET ALL TAG AS CSV FILE

START IEC

GET ICD FILE

DATA FLOW DIRECTION IEC61850 READ
START ADDRESS (HEX) 00
LENGTH 64
FORMAT HEX

INTERNAL ADDRESS	0x00	0x01	0x02	0x03	0x04	0x05	0x06	0x07	0x08	0x09	0x0A	0x0B	0x0C	0x0D	0x0E	0x0F
00	45	3F	45	3F	45	3F	45	3F	45	3F	45	3F	45	3F	45	3F
10	45	3F	45	3F	00	00	00	00	00	00	00	00	00	00	00	00
20	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
30	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00

IEC VARIABLE INDEX	MNEMONIC NAME	READ/WRITE	DATA TYPE	VALUE
1	VAR1	READ	INT16 TO INT32	17727

Let's now define a Dataset and then an associated Report Control Block.
Let's start by defining a Data Set from the “SETUP IEC DATASET” section.
Let's create a Dataset on the logical node LLN0 and select GGIO1.VAR1[ST] to add the variable VAR1 and the subattributes:

	CURRENT	UPDATED
CONNECTED TO LOGICAL NODE	GGIO1	LLN0
MNEMONIC NAME		DATASET
GGIO1.VAR1 [ST]	☑	
GGIO1.VAR1.stVal [ST]	☐	
GGIO1.VAR1.q [ST]	☐	
GGIO1.VAR1.t [ST]	☐	

APPLY

Let's press "APPLY" and the Dataset is created:

ADD | MODIFY | DELETE | MOVE UP | MOVE DOWN

IEC DATASET INDEX	MNEMONIC NAME	FCDAs
1	DATASET	LLN0.VAR1 [ST]

Let's now go to the "SETUP IEC REPORT CONTROL BLOCK" section and press the ADD button:

	CURRENT	UPDATED
CONNECTED TO LOGICAL NODE	GGIO1	LLN0
MNEMONIC NAME		RCB
REPORT ID		rpt_name
BUFFERED		YES
DATA SET		DATASET
CONFIGURATION REVISION	1	1
BUFFER TIME	0	1000
INTEGRITY PERIOD	600000	600000
TRIGGER OPTIONS : DATA CHANGE	YES	☑
TRIGGER OPTIONS : QUALITY CHANGE	YES	☑
TRIGGER OPTIONS : DATA UPDATE	YES	☑
TRIGGER OPTIONS : PERIOD	YES	☑
TRIGGER OPTIONS : GENERAL INTERROGATION	YES	☑
OPTIONAL FIELDS : SEQUENCE NUMBER	YES	☑
OPTIONAL FIELDS : TIME STAMP	YES	☑
OPTIONAL FIELDS : REASON FOR INCLUSION	YES	☑
OPTIONAL FIELDS : DATA SET NAME	YES	☑
OPTIONAL FIELDS : DATA ATTRIBUTE REFERENCE	YES	☑
OPTIONAL FIELDS : BUFFER OVERFLOW	YES	☑
OPTIONAL FIELDS : ENTRY ID	YES	☑
OPTIONAL FIELDS : CONFIGURATION REVISION	YES	☑

APPLY

We have selected the logical Node where we defined the Dataset, we define it buffered with a buffer time of 1000 ms.

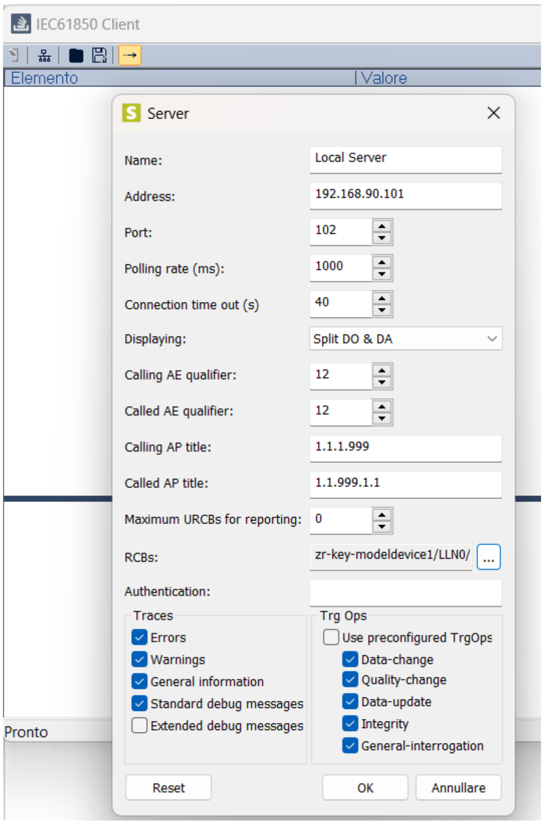
Let's confirm with “APPLY” and we obtain our buffered Report Control Block:

ADD | MODIFY | DELETE | MOVE UP | MOVE DOWN

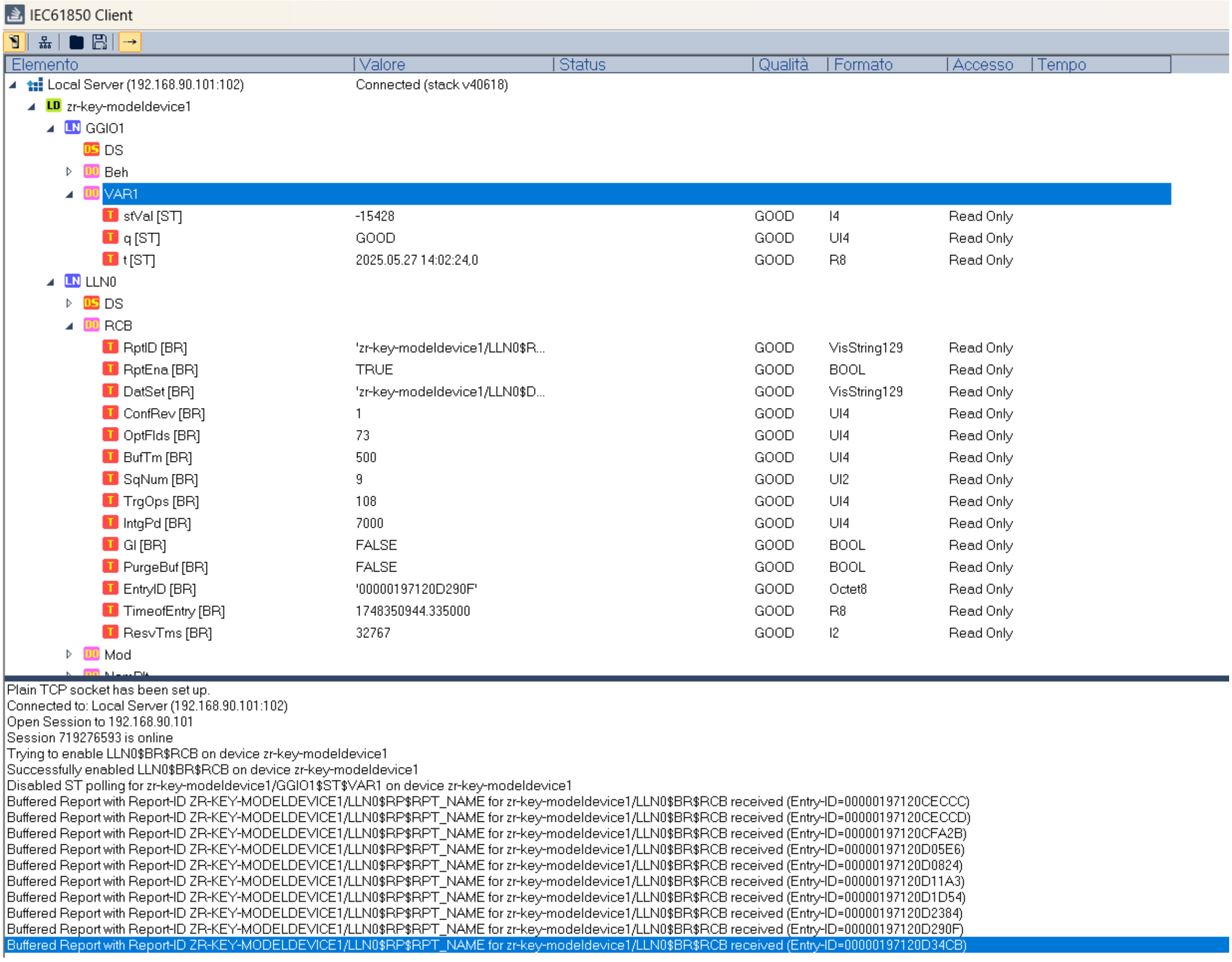
IEC RCB INDEX	MNEMONIC NAME	DATASET	REPORT ID	BUFFERED
1	RCB	DATASET	zr-key-modeldevice1/LLN0RPrpt_name	YES

Let's now go back to the “STATUS” section and press the “Start IEC” button, at this point the device restarts in IEC61850 mode (the webserver is disabled), the operation could also be obtained by holding down the side button.

Now let's open the 61850 client and set up the connection to our KEY-I and import the RCB:



Let's start the client and note both the IEC variable (VAR1) and the RCB:


IEC61850 Client
Elemento | Valore | Status | Qualità | Formato | Accesso | Tempo
Local Server (192.168.90.101:102) Connected (stack v40618)
zr-key-modeldevice1
GGIO1
DS
Beh
VAR1
stVal [ST] -15428 GOOD I4 Read Only
q [ST] GOOD GOOD UI4 Read Only
t [ST] 2025.05.27 14:02:24,0 GOOD R8 Read Only
LLN0
DS
RCB
RptID [BR] 'zr-key-modeldevice1/LLN0$R... GOOD VisString129 Read Only
RptEna [BR] TRUE GOOD BOOL Read Only
DatSet [BR] 'zr-key-modeldevice1/LLN0$D... GOOD VisString129 Read Only
ConfRev [BR] 1 GOOD UI4 Read Only
OptFlds [BR] 73 GOOD UI4 Read Only
BufTm [BR] 500 GOOD UI4 Read Only
SqNum [BR] 9 GOOD UI2 Read Only
TrgOps [BR] 108 GOOD UI4 Read Only
IntgPd [BR] 7000 GOOD UI4 Read Only
GI [BR] FALSE GOOD BOOL Read Only
PurgeBuf [BR] FALSE GOOD BOOL Read Only
EntryID [BR] '00000197120D290F' GOOD Octet8 Read Only
TimeofEntry [BR] 1748350944.335000 GOOD R8 Read Only
ResvTms [BR] 32767 GOOD I2 Read Only
Mod
Plain TCP socket has been set up.
Connected to: Local Server (192.168.90.101:102)
Open Session to 192.168.90.101
Session 719276593 is online
Trying to enable LLN0BRRCB on device zr-key-modeldevice1
Successfully enabled LLN0BRRCB on device zr-key-modeldevice1
Disabled ST polling for zr-key-modeldevice1/GGIO1STVAR1 on device zr-key-modeldevice1
Buffered Report with Report-ID ZR-KEY-MODELDEVICE1/LLN0RPRPT_NAME for zr-key-modeldevice1/LLN0BRRCB received (Entry-ID=00000197120CECCC)
Buffered Report with Report-ID ZR-KEY-MODELDEVICE1/LLN0RPRPT_NAME for zr-key-modeldevice1/LLN0BRRCB received (Entry-ID=00000197120CECCD)
Buffered Report with Report-ID ZR-KEY-MODELDEVICE1/LLN0RPRPT_NAME for zr-key-modeldevice1/LLN0BRRCB received (Entry-ID=00000197120CFA2B)
Buffered Report with Report-ID ZR-KEY-MODELDEVICE1/LLN0RPRPT_NAME for zr-key-modeldevice1/LLN0BRRCB received (Entry-ID=00000197120D05E6)
Buffered Report with Report-ID ZR-KEY-MODELDEVICE1/LLN0RPRPT_NAME for zr-key-modeldevice1/LLN0BRRCB received (Entry-ID=00000197120D0824)
Buffered Report with Report-ID ZR-KEY-MODELDEVICE1/LLN0RPRPT_NAME for zr-key-modeldevice1/LLN0BRRCB received (Entry-ID=00000197120D11A3)
Buffered Report with Report-ID ZR-KEY-MODELDEVICE1/LLN0RPRPT_NAME for zr-key-modeldevice1/LLN0BRRCB received (Entry-ID=00000197120D1D54)
Buffered Report with Report-ID ZR-KEY-MODELDEVICE1/LLN0RPRPT_NAME for zr-key-modeldevice1/LLN0BRRCB received (Entry-ID=00000197120D2384)
Buffered Report with Report-ID ZR-KEY-MODELDEVICE1/LLN0RPRPT_NAME for zr-key-modeldevice1/LLN0BRRCB received (Entry-ID=00000197120D290F)
Buffered Report with Report-ID ZR-KEY-MODELDEVICE1/LLN0RPRPT_NAME for zr-key-modeldevice1/LLN0BRRCB received (Entry-ID=00000197120D34CB)

10. GATEWAY WEBSERVERS

10.1. WEBSERVER DEI GATEWAY "-I"

10.1.1. WEBSERVER MODE AND IEC61850 MODE

The device is normally in Webserver mode.

To access the internal webserver, you must put the device in Webserver mode by pressing the button following the procedure:

10.1.2. MANUAL PROCEDURE FOR SWITCHING FROM IEC61850 MODE TO WEBSERVER MODE AND VICE VERSA

To force webserver mode:

1) Turn on the device
2) Keep the PS1 button pressed until all LEDs turn off
3) Release the button
4) The device restarts and the "PWR" led flash slowly to indicate webserver mode

To force IEC 61850 mode:

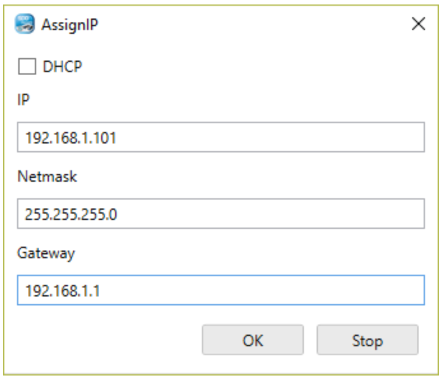
1) Turn on the device
2) Keep the PS1 button pressed until all LEDs turn off
3) Release the button
   The device restarts and the "PWR" led flash slowly to indicate IEC 61850 mode

10.1.3. STEP BY STEP GUIDE FOR THE FIRST ACCESS TO THE WEBSERVER

STEP 1: POWER THE DEVICE AND CONNECT THE ETHERNET PORT, PUT THE DEVICE IN WEBSERVER MODE

SENECA DISCOVERY DEVICE SOFTWARE STEP 2

If you need to change the IP address of the device (default 192.168.90.101), launch the Seneca Discovery Device software and perform the SCAN, select the device and press the "Assign IP" button, set a configuration compatible with your PC, for example:



Confirm with OK. Now the device can be reached via Ethernet from your PC.

STEP 3 ACCESS TO THE CONFIGURATION WEBSERVER

ENTER your access credentials:
user: admin
password: admin

⚠ ATTENTION!

THE WEB BROWSERS WHICH HAVE BEEN TESTED FOR COMPATIBILITY WITH THE DEVICE WEBSERVER ARE:
MOZILLA FIREFOX AND GOOGLE CHROME.
THEREFORE, THE OPERATION WITH OTHER BROWSERS IS NOT GUARANTEED

10.1.4. WEBSERVER DEVICE CONFIGURATION

For further information on the access to the webserver of a new device, please refer to chapter 10.1.3.

⚠ ATTENTION!
THE WEB BROWSERS WHICH HAVE BEEN TESTED FOR COMPATIBILITY WITH THE DEVICE WEBSERVER ARE:
MOZILLA FIREFOX AND GOOGLE CHROME.
THEREFORE, THE OPERATION WITH OTHER BROWSERS IS NOT GUARANTEED

⚠ ATTENTION!
AFTER THE FIRST ACCESS CHANGE USER NAME AND PASSWORD IN ORDER TO PREVENT ACCESS TO THE DEVICE TO UNAUTHORIZED PEOPLE.

⚠ ATTENTION!
IF THE PARAMETERS TO ACCESS THE WEBSERVER HAVE BEEN LOST, TO ACCESS IT, IT IS NECESSARY TO GO THROUGH THE PROCEDURE TO RESET THE FACTORY-SET CONFIGURATION

10.1.4.1. WEBSERVER SECTIONS

The Webserver is divided into pages (sections) representing the various gateway functions:

Status
It is the section that displays the values of Modbus requests in real time.

Setup
This is the section that allows the basic configuration of the device, it also allows you to export or import a configuration.

Setup Modbus Commands / Tags
It is the section that allows you to add/modify the Modbus commands of the Modbus devices connected to the gateway.

I/O Mapping
This is the section that allows you to remap the bytes relating to the data coming from the Modbus protocol.

Setup IEC Variables
This is the section that allows you to create IEC variables starting from the acquisitions of Modbus commands.

Setup IEC Dataset
This is the section that allows you to create datasets to be used in Report Control Blocks.

Setup IEC Report Control Block
This is the section that allows you to create Report Control Blocks.

Firmware Update
This is the section that allows you to update the device firmware.

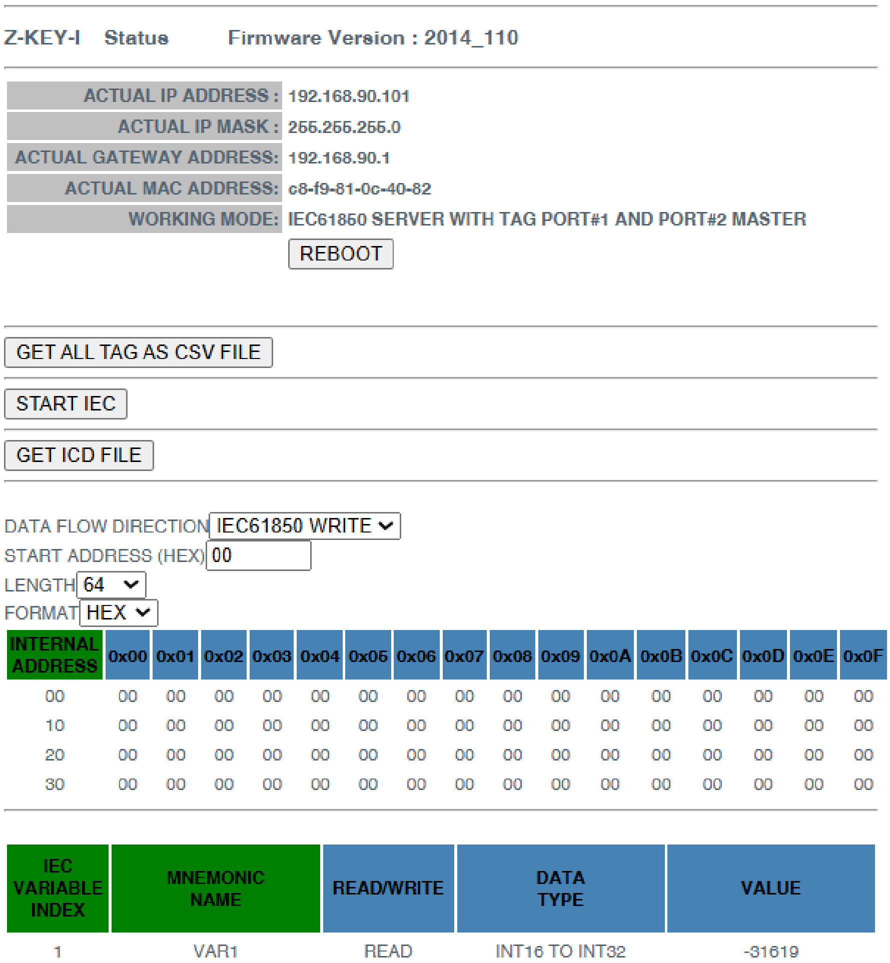
Certificate Setup
This is the section that allows you to manage X509 certificates

Serial Traffic Monitor
It allows to analyse the ModBUS frames of the serials.

UTC Time Setup
This allows you to set the device date/time

10.1.4.2. "STATUS" SECTION

The Status section displays the status of the values acquired from modbus in the memory:



Z-KEY-I Status Firmware Version : 2014_110

ACTUAL IP ADDRESS :	192.168.90.101
ACTUAL IP MASK :	255.255.255.0
ACTUAL GATEWAY ADDRESS:	192.168.90.1
ACTUAL MAC ADDRESS:	c8-f9-81-0c-40-82
WORKING MODE:	IEC61850 SERVER WITH TAG PORT#1 AND PORT#2 MASTER

REBOOT

GET ALL TAG AS CSV FILE

START IEC

GET ICD FILE

DATA FLOW DIRECTION IEC61850 WRITE
START ADDRESS (HEX) 00
LENGTH 64
FORMAT HEX

INTERNAL ADDRESS	0x00	0x01	0x02	0x03	0x04	0x05	0x06	0x07	0x08	0x09	0x0A	0x0B	0x0C	0x0D	0x0E	0x0F
00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
10	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
20	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
30	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00

IEC VARIABLE INDEX	MNEMONIC NAME	READ/WRITE	DATA TYPE	VALUE
1	VAR1	READ	INT16 TO INT32	-31619

There are two types of memories: that of the read-only variables and that of the write-only variables (supported according to ICD standard edition 1,0).

GET ICD FILE allows you to export the configuration to be imported into an IEC61850 client that supports the ICD format.

10.1.4.3. "SETUP" SECTION

DHCP (ETH) (default: Disabled)
Sets the DHCP client to get an IP address automatically.

STATIC IP (default: 192.168.90.101)
Sets the device static address. Careful not to enter devices with the same IP address into the same network.

STATIC IP MASK (default: 255.255.255.0)
Sets the mask for the IP network.

STATIC GATEWAY (default: 192.168.90.1)
Sets the gateway address.

TCP-IP PORT (default: 502)
Sets the communication port for the Modbus TCP-IP client protocol.

TCP-IP TIMEOUT [ms] (default 512 ms)
Sets the waiting time for a request to be considered in timeout.

PORT #1 MODBUS PROTOCOL (default RTU)
Sets the protocol on the serial between Modbus RTU or Modbus ASCII

PORT #2 MODBUS PROTOCOL (default RTU)
Sets the protocol on the serial between Modbus RTU or Modbus ASCII

PORT #1 BAUDRATE (default: 38400 baud)
Selects the communication speed of the COM #1 serial port

PORT #1 DATA BITS (default: 38400 baud)
Selects the communication speed of the COM #1 serial port

PORT #1 PARITY (default: None)
Sets the parity for the COM #1 serial communication port.

PORT #1 STOP BIT (default: 1)
Sets the number of stop bits for the COM #1 serial communication port.

PORT #1 TIMEOUT [ms]
Sets the wait time before defining fail.

PORT #1 WRITING RETRIES (default: 3)

Selects the number of writing attempts to be made on a serial slave before returning an error.

PORT #1 MAX READ NUM

Sets the maximum number of simultaneous serial reading ModBUS registers, the firmware will use this value to optimize the ModBUS readings.

PORT #1 MAX WRITE NUM

Sets the maximum number of simultaneous writing ModBUS registers of the serial, the firmware will use this value to optimize the ModBUS writings.

PORT #2 BAUDRATE (default: 38400 baud) (only for Z-KEY-I and Z-KEY-2ETH-I)

Selects the communication speed of the COM #2 serial port

PORT #2 DATA BITS (default: 38400 baud) (only for Z-KEY-I and Z-KEY-2ETH-I)

Selects the communication speed of the COM #2 serial port

PORT #2 PARITY (default: None) (only for Z-KEY-I and Z-KEY-2ETH-I)

Sets the parity for the COM #2 serial communication port.

PORT #2 STOP BIT (default: 1) (only for Z-KEY-I and Z-KEY-2ETH-I)

Sets the number of stop bits for the COM #2 serial communication port.

PORT# 2 TIMEOUT [ms] (only for Z-KEY-I and Z-KEY-2ETH-I)

Sets the wait time before defining fail.

PORT #2 WRITING RETRIES (default: 3) (only for Z-KEY-I and Z-KEY-2ETH-I)

Selects the number of writing attempts to be made on a serial slave before returning an error.

PORT #2 MAX READ NUM (only for Z-KEY-I and Z-KEY-2ETH-I)

Sets the maximum number of simultaneous reading ModBUS registers of the remote TCP-IP Modbus server, the firmware will use this value to optimize the ModBUS readings.

PORT #2 MAX WRITE NUM (only for Z-KEY-I and Z-KEY-2ETH-I)

Sets the maximum number of simultaneous writing ModBUS registers of the serial, the firmware will use this value to optimize the ModBUS writings.

WEB SERVER AUTHENTICATION USER NAME (default: admin)

Sets the username to access the webserver.

WEB SERVER PASSWORD (default: admin)

Sets the password to access the webserver and to read/write the configuration (if enabled).

WEB SERVER PORT (default: 80)
Sets the communication port for the web server.

IP CHANGE FROM DISCOVERY (default: Enabled)
Selects whether or not the device accepts the IP address change from the Seneca Discovery Device software.

TLS (default: Disabled)
Enables or disables cryptographic protocols via TLS.

MODBUS TCP-IP CLIENT
Enables or not the TCP-IP client Modbus

MODBUS TCP-IP SERVER#1…3 PORT
Sets the port for the max 3 remote TCP-IP Modbus servers

MODBUS TCP-IP SERVER#1…3 ADDRESS
Sets the IP address for the max 3 remote TCP-IP Modbus servers

MODBUS TCP-IP CLIENT TIMEOUT [ms]
Sets the timeout for remote TCP-IP Modbus servers

MODBUS TCP-IP CLIENT WRITING ATTEMPTS
Selects the number of writing attempts to be made on a remote TCP-IP Modbus server before returning an error and activating the quarantine.

MODBUS TCP-IP CLIENT MAX READ NUM
Sets the maximum number of simultaneous reading ModBUS registers of the remote TCP-IP Modbus server, the firmware will use this value to optimize the ModBUS readings.

MODBUS TCP-IP CLIENT MAX WRITE NUM
Sets the maximum number of simultaneous writing ModBUS registers of the remote TCP-IP Modbus server, the firmware will use this value to optimize the ModBUS writings.

SERVER AFTER FAIL DELAY
Sets the number of quarantine seconds after a tag has been declared in fail (i.e. these tags are no longer considered) before being interrogated again.

STOP MODBUS READING WHEN NO IEC61850 CONNECTION
If active, it allows to stop the modbus communication when the communication with the IEC61850 client is lost. This allows to trigger any timeouts present in the modbus slave/server devices.
SYNC CLOCK WITH TIME INTERNET

Allows you to enable date/time updating via connection to NTP servers (RFC 5905).

⚠ ***ATTENTION!***

AT EACH RESTART THE DEVICE MUST BE ABLE TO RETRIEVE THE DATE/TIME FROM AN NTP SERVER OTHERWISE THIS WILL BE SET TO 1/1/1970 0:00

NTP SERVER 1 ADDRESS
This is the IP address of the first NTP server (for example 193.204.114.232 for INRIM's NTP)

NTP SERVER 2 ADDRESS
This is the IP address of the second NTP server (in case the first one does not respond)

GMT
Sets the offset from Greenwich Mean Time (for example for Italy GMT=+1 when daylight saving time is not in effect)

IEC MODEL NAME
Sets the model name for the IEC protocol

IEC DEVICE NAME
Sets the device name for the IEC protocol

IEC61850 SERVER TCP/IP PORT
Sets the TCP-IP communication port of the IEC61850 protocol

In addition, a configuration can be exported / imported via the webserver.

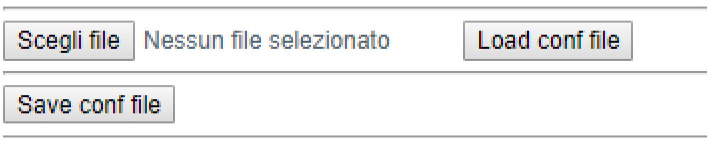
10.1.4.3.1. SAVING A CONFIGURATION ON A FILE

A configuration that includes:

CONFIGURATION
TAGS/COMMANDS

It can be saved to a file this way:

Go to the Setup section and select the file to save, press the "Save config" button



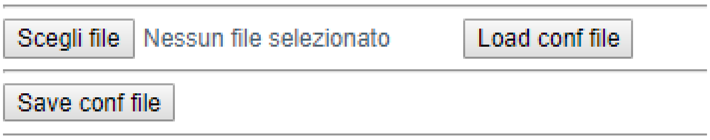
10.1.4.3.2. IMPORTING A CONFIGURATION FROM A FILE

A configuration that includes:

CONFIGURATION
TAGS/COMMANDS

It can be imported from a file this way:

Go to the Setup section and select the file to load, press the "Load config" button



10.1.4.4. “SETUP COMMANDS/TAGS” SECTION

In this section you can add, edit or delete a Modbus command.

Using the ADD button you can add a new command.
Using the CLONE button it is possible to clone a command.
Using the DEL button it is possible to delete an existing command.

MNEMONIC NAME
It is the identifying name of the command

TARGET MODBUS DEVICE
It represents the Seneca Modbus device selected from those available in the database.
In the case of a non-Seneca device or for advanced configurations, select CUSTOM.

TARGET RESOURCE
It represents the Seneca device variable you want to add.

TARGET CONNECTED TO
It selects the serial to be used for Modbus serial communication for the specified TAG.

TARGET MODBUS STATION ADDRESS
It selects the station address to use for the command.

TARGET MODBUS START REGISTER
It represents the starting Modbus address of the command (in the case of a Seneca device it is filled in automatically).

TARGET MODBUS REQUEST TYPE

It represents the type of Modbus command to use (Read Holding Register, Coil etc.).
In the case of a Seneca device it is filled in automatically.

TARGET REGISTER DATA LENGTH

Allows you to set how many Modbus registers are required in the command.

TARGET MODBUS WRITE PERIODIC TRIGGER [ms]

Represents the time interval of execution of the command

ENDIAN SWAP

Allows you to swap a register read by Modbus, i.e.:
NONE: no swap
BYTE: shifts the high byte with low byte (for example Modbus reading 0xAABB will be converted to 0xBBAA)
WORD: In the case of a data type greater than a Modbus register (e.g. single precision Floating Point registers) it allows you to set which word (register) to use as the most significant part, for example:
Register 1 = 0xAABB
Register 2 = 0xCCDD
will become a single value 0xAABBCCDD if the parameter is NONE, otherwise 0xCCDDAABB if this parameter is active
BYTE AND WORD: as in the previous case but there will also be a byte swap, for example:
Register 1 = 0xAABB
Register 2 = 0xCCDD
Will become 0xDDCCBBAA

10.1.4.5. "I/O MAPPING" SECTION

Allows you to move the contents of the bytes of the read and write buffers.

10.1.4.1. “SETUP IEC VARIABLES” SECTION

Allows you to define an IEC variable from the read or write buffer

MNEMONIC NAME

This is the name of the variable that will appear in the IEC61850 client

READ/WRITE

Selects whether the variable should be created from the read or write buffer

DATA TYPE

Represents the data type of the variable, the device can also convert the data type on the IEC61850 protocol:
BIT (SPS)-> 1 bit buffer size
INT16 TO INT32 (INS) -> 2 byte buffer size (converted to 4 bytes in the IEC61850 protocol)
UINT16 TO INT32 (INS) -> 2 byte buffer size (converted to 4 bytes in the IEC61850 protocol)
INT32 (INS) -> 4 byte buffer size
INT16 TO FLOAT32 (MV)-> 2 byte buffer size (converted to 4 bytes in the IEC61850 protocol)
UINT16 TO FLOAT32 (MV)-> 2 byte buffer size (converted to 4 bytes in the IEC61850 protocol)
INT32 TO FLOAT32 (MV)-> 4 byte buffer size
FLOAT 32 (MV)-> 4 byte buffer size

BYTE OFFSET

Represents the starting byte of the read or write buffer variable. The amount of bytes to use is defined by the data type

SCALE FACTOR

It is the floating point coefficient that multiplies the Modbus value (for example, if you set 0.1, the Modbus reading of 10 will be converted to 1 on IEC61850).

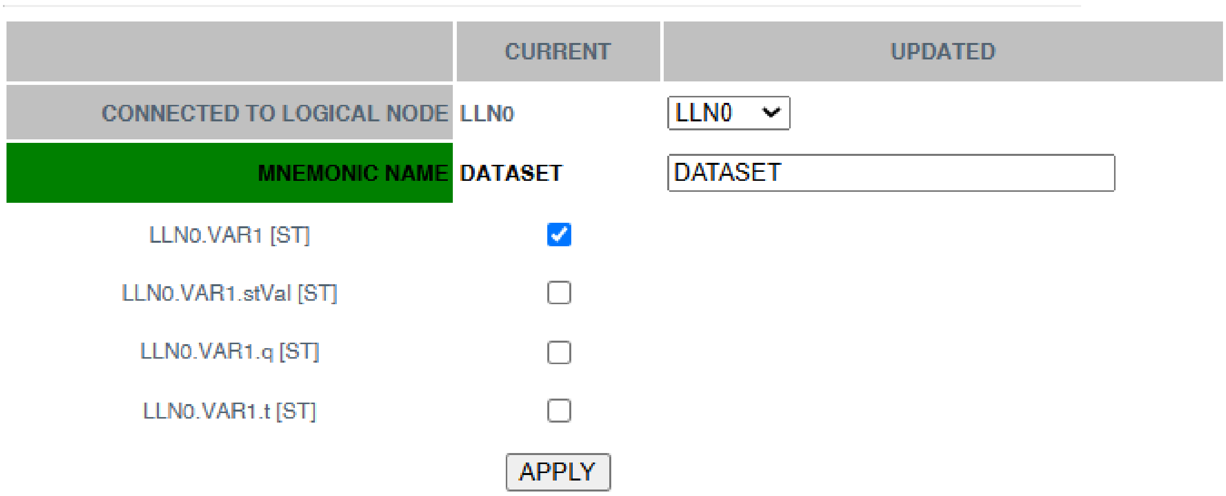
10.1.4.1. "SETUP IEC DATASET" SECTION

Allows you to set datasets by selecting the variables to enter.

CONNECTED TO LOGICAL NODE
Represents the logical node to which the Dataset is connected

MNEMONIC NAME
Represents the name of the Dataset

Then select the variables to associate:



10.1.4.2. "SETUP IEC REPORT CONTROL BLOCK" SECTION

Allows you to set the configuration of the Report Control Blocks and of the relevant Dataset.

CONNECTED TO LOGICAL NODE
Specifies the Logical Node (LN) to which the RCB is associated.
Typical values: LLN0 (Logical Node zero, the root node of the device instance).

MNEMONIC NAME
Mnemonic name of the RCB block, used as an identifying reference.
Example: RCB

REPORT ID
Unique identifier of the submitted report, used by the client to distinguish report sources.
Example: rpt_name

BUFFERED
Indicates whether the report is buffered (YES) or unbuffered (NO).
Buffered: Reports are temporarily stored if the client is unavailable.
Unbuffered: Reports are sent only if the client is connected.

DATA SET
Selection of the DataSet containing the references to the data that will be included in the reports.
Values: Default list of available DataSets.

CONFIGURATION REVISION
Revision number of the report configuration. Increased each time the dataset content changes.
Purpose: Ensure that clients and servers are in sync.

BUFFER TIME (ms)
Minimum delay between two successive reports, even if multiple events occur.
Unit: milliseconds.
Example: 1000 (1 second)

INTEGRITY PERIOD (ms)
Integrity period: forced sending of the report even if there are no changes.
Unit: milliseconds.
Example: 600000 (10 minutes)

Trigger Options
They determine the conditions that cause a report to be sent:
DATA CHANGE: the report is sent when the value of a data changes.
QUALITY CHANGE: the report is sent if the quality changes (e.g. 'good', 'invalid').
DATA UPDATE: The report is sent when the data is updated, even if it does not change.
PERIOD: report sent periodically, according to the Integrity Period.
GENERAL INTERROGATION: allows the client to request immediate sending of a report.

Optional Fields
These are optional fields included in the reports, useful for improving traceability and diagnostics:
SEQUENCE NUMBER: report progressive number.
TIME STAMP: time and date of the event or update.
REASON FOR INCLUSION: reason for the report trigger (e.g. data change, GI...).
DATA SET NAME: name of the included DataSet.
DATA ATTRIBUTE REFERENCE: complete data references (e.g. LD0/MMXU1.Vol.instMag.i).
BUFFER OVERFLOW: indicates whether data was lost due to buffer overflow.
ENTRY ID: unique identifier of the event within the buffer.
CONFIGURATION REVISION: version of the configuration used at the time of the report.

	CURRENT	UPDATED
CONNECTED TO LOGICAL NODE	LLN0	LLN0
MNEMONIC NAME	RCB	RCB
REPORT ID	rpt_name	rpt_name
BUFFERED	YES	YES
DATA SET		DATASET
CONFIGURATION REVISION	1	1
BUFFER TIME	1000	1000
INTEGRITY PERIOD	600000	600000
TRIGGER OPTIONS : DATA CHANGE	YES	☑
TRIGGER OPTIONS : QUALITY CHANGE	YES	☑
TRIGGER OPTIONS : DATA UPDATE	YES	☑
TRIGGER OPTIONS : PERIOD	YES	☑
TRIGGER OPTIONS : GENERAL INTERROGATION	YES	☑
OPTIONAL FIELDS : SEQUENCE NUMBER	YES	☑
OPTIONAL FIELDS : TIME STAMP	YES	☑
OPTIONAL FIELDS : REASON FOR INCLUSION	YES	☑
OPTIONAL FIELDS : DATA SET NAME	YES	☑
OPTIONAL FIELDS : DATA ATTRIBUTE REFERENCE	YES	☑
OPTIONAL FIELDS : BUFFER OVERFLOW	YES	☑
OPTIONAL FIELDS : ENTRY ID	YES	☑
OPTIONAL FIELDS : CONFIGURATION REVISION	YES	☑

APPLY

10.1.4.1. "FIRMWARE UPDATE" SECTION

In order to improve, add, optimize the functions of the product, Seneca releases firmware updates on the device section on the www.seneca.it website

⚠ ATTENTION!

NOT TO DAMAGE THE DEVICE DO NOT REMOVE THE POWER SUPPLY DURING THE FIRMWARE UPDATE OPERATION.

10.1.4.1. "CERTIFICATE SETUP" SECTION

This section allows you to send or delete a certificate and/or the private key of the device.
Up to 5 certificates are supported for clients.
The used format is PEM.

10.1.4.2. SERIAL “SERIAL TRAFFIC MONITOR”

Allows you to view the serial packets that are in transit.

10.1.4.1. LOCAL TIME SETUP

This allows you to set the date/time manually.

⚠ ***ATTENTION!***
IF AN NTP SERVER IS NOT SET, THE DEVICE WILL HAVE THE DATE/TIME 1/1/1970 0:00 WHEN IT RESTARTS

11. SUPPORTED MODBUS COMMUNICATION PROTOCOLS

The Modbus communication protocols supported are:

- Modbus RTU/ASCII master (from #1 and #2 serial ports)
- Modbus RTU/ASCII slave (from #1 and #2 serial ports)
- Modbus TCP-IP Client (from the Ethernet port) up to 3 remote TCP-IP Modbus Servers

For more information on these protocols, see the website:
http://www.modbus.org/specs.php.

11.1. SUPPORTED MODBUS FUNCTION CODES

The following Modbus functions are supported:

- Read Coils (function 1)
- Read Discrete Inputs (function 2)
- Read Holding Registers (function 3)
- Read Input Registers (function 4)
- Write Single Coil (function 5)
- Write Single Register (function 6)
- Write multiple Coils (function 15)
- Write Multiple Registers (function 16)

ATTENTION!
All 32-bit variables are contained in 2 consecutive Modbus registers
All 64-bit variables are contained in 4 consecutive Modbus registers

12. RESETTING THE DEVICE TO ITS FACTORY CONFIGURATION

The factory configuration resets all parameters to default.

To reset the device to the factory configuration it is necessary to follow the procedure below:

Z-KEY-I / Z-KEY-2ETH-I:

1) Remove power from the device
2) Turn dip switches 1 and 2 to ON
3) Power up the device and wait at least 10 seconds
4) Remove power from the device
5) Turn dip switches 1 and 2 to OFF
6) At the next restart the device will have loaded the factory configuration

R-KEY-LT-I:

1) Remove power from the device
2) Set dip switches 1 and 2 of SW2 to ON
3) Power up the device and wait at least 10 seconds
4) Remove power from the device
5) Turn 2 SW2 dip switches to OFF.
6) At the next restart the device will have loaded the factory configuration

13. INFORMATION ABOUT MODBUS REGISTERS

The following abbreviations are used in the following chapter:

MS	Most Significant
LS	Least Significant
MSBIT	Most Significant Bit
LSBIT	Least Significant Bit
MMSW	"Most" Most Significant Word (16bit)
MSW	Most Significant Word (16bit)
LSW	Least Significant Word (16bit)
LLSW	"Least" Least Significant Word (16bit)
RO	Read Only
RW*	Read-Write: REGISTERS CONTAINED IN FLASH MEMORY: WRITABLE ABOUT 10,000 TIMES MAXIMUM
RW**	Read-Write: REGISTERS THAT CAN BE WRITTEN ONLY AFTER WRITING THE COMMAND "ENABLE WRITE CUSTOM ENERGIES = 49616"
UNSIGNED 16 BIT	Unsigned integer register that can assume values from 0 to 65535
SIGNED 16 BIT	Signed integer register that can take values from -32768 to +32767
UNSIGNED 32 BIT	Unsigned integer register that can assume values from 0 to 4294967296
SIGNED 32 BIT	Signed integer register that can take values from -2147483648 to 2147483647
UNSIGNED 64 BIT	Unsigned integer register that can assume values from 0 to 18446744073709551615
SIGNED 64 BIT	Signed integer register that can assume values from -2^63 to 2^63-1
FLOAT 32 BIT	32-bit, single-precision floating-point register (IEEE 754) https://en.wikipedia.org/wiki/IEEE_754
BIT	Boolean register, which can take the values 0 (false) or 1 (true)

13.1. NUMBERING OF "0-BASED" OR "1-BASED" MODBUS ADDRESSES

According to the Modbus standard the Holding Registers are addressable from 0 to 65535, there are 2 different conventions for numbering the addresses: "0-BASED" and "1-BASED".
For greater clarity, Seneca shows its register tables in both conventions.

⚠ ATTENTION!

carefully read the documentation of the Modbus Master DEVICE
IN ORDER to understand which of the TWO conventions the manufacturer has decided to use.
SENECA USES THE "1 BASED" CONVENTION FOR ITS PRODUCTS

13.2. NUMBERING OF MODBUS ADDRESSES WITH "0-BASED" CONVENTION

The numbering is:

HOLDING REGISTER MODBUS ADDRESS (OFFSET)	*MEANING*
0	FIRST REGISTER
1	SECOND REGISTER
2	THIRD REGISTER
3	FOURTH REGISTER
4	FIFTH REGISTER

Therefore, the first register is at address 0.
In the following tables, this convention is indicated with ***"ADDRESS OFFSET".***

13.3. NUMBERING OF MODBUS ADDRESSES WITH "1 BASED" CONVENTION (STANDARD)

The numbering is that established by the Modbus consortium and is of the type:

HOLDING REGISTER MODBUS ADDRESS 4x	*MEANING*
40001	FIRST REGISTER
40002	SECOND REGISTER
40003	THIRD REGISTER
40004	FOURTH REGISTER
40005	FIFTH REGISTER

This convention is indicated with ***"ADDRESS 4x"*** since a 40000 is added to the address so that the first Modbus register is 40001.
A further convention is also possible where the number 4 is omitted in front of the register address:

HOLDING MODBUS ADDRESS WITHOUT 4x	*MEANING*
1	FIRST REGISTER
2	SECOND REGISTER
3	THIRD REGISTER
4	FOURTH REGISTER
5	FIFTH REGISTER

13.4. BIT CONVENTION WITHIN A MODBUS HOLDING REGISTER

A Modbus Holding Register consists of 16 bits with the following convention:

BIT 15	BIT 14	BIT 13	BIT 12	BIT 11	BIT 10	BIT 9	BIT 8	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0

For instance, if the value of the register in decimal is
12300
the value 12300 in hexadecimal is:
0x300C

the hexadecimal 0x300C in binary value is:
11 0000 0000 1100

So, using the above convention, we get:

BIT 15	BIT 14	BIT 13	BIT 12	BIT 11	BIT 10	BIT 9	BIT 8	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
0	0	1	1	0	0	0	0	0	0	0	0	1	1	0	0

13.5. MSB and LSB BYTE CONVENTION WITHIN A MODBUS HOLDING REGISTER

A Modbus Holding Register consists of 16 bits with the following convention:

BIT 15	BIT 14	BIT 13	BIT 12	BIT 11	BIT 10	BIT 9	BIT 8	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0

LSB Byte (Least Significant Byte) defines the 8 bits ranging from Bit 0 to Bit 7 included, we define MSB Byte (Most Significant Byte) the 8 bits ranging from Bit 8 to Bit 15 inclusive:

BIT 15	BIT 14	BIT 13	BIT 12	BIT 11	BIT 10	BIT 9	BIT 8	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
BYTE MSB								BYTE LSB							

13.6. REPRESENTATION OF A 32-BIT VALUE IN TWO CONSECUTIVE MODBUS HOLDING REGISTERS

The representation of a 32-bit value in the Modbus Holding Registers is made using 2 consecutive Holding Registers (a Holding Register is a 16-bit register). To obtain the 32-bit value it is therefore necessary to read two consecutive registers:
For example, if register 40064 contains the 16 most significant bits (MSW) while register 40065 contains the least significant 16 bits (LSW), the 32-bit value is obtained by composing the 2 registers:

BIT 15	BIT 14	BIT 13	BIT 12	BIT 11	BIT 10	BIT 9	BIT 8	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
40064 MOST SIGNIFICANT WORD															

BIT 15	BIT 14	BIT 13	BIT 12	BIT 11	BIT 10	BIT 9	BIT 8	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
40065 LEAST SIGNIFICANT WORD															

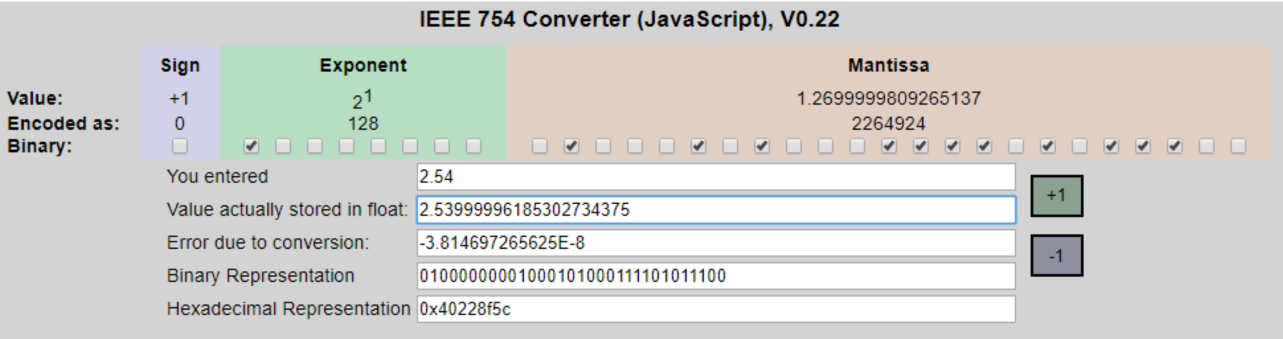
$$Value_{32bit} = Register_{LSW} + (Register_{MSW} * 65536)$$

In the reading registers it is possible to swap the most significant word with the least significant word, therefore it is possible to obtain 40064 as LSW and 40065 as MSW.

13.7. TYPE OF 32-BIT FLOATING POINT DATA (IEEE 754)

The IEEE 754 standard (https://en.wikipedia.org/wiki/IEEE_754) defines the format for representing floating point numbers.
As already mentioned, since it is a 32-bit data type, its representation occupies two 16-bit holding registers.
To obtain a binary/hexadecimal conversion of a floating point value it is possible to refer to an online converter at this address:

http://www.h-schmidt.net/FloatConverter/IEEE754.html



Using the last representation the value 2.54 is represented at 32 bits as:

0x4022 8F5C

Since we have 16-bit registers available, the value must be divided into MSW and LSW:

0x4022 (16418 decimal) are the 16 most significant bits (MSW) while 0x8F5C (36700 decimal) are the 16 least significant bits (LSW).