

61850 Avenue 2.1

Substation Communication Tool

User guide

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INFO TECH sp.j.

- ❑ Experts in the field of communication solutions for power automation and industrial automation.
- ❑ Renowned supplier of protocol software libraries and tools for communication testing and device simulation.
- ❑ As of May 2022, the licensed INFO TECH software is the basis for implementing IEC 61850 interfaces in the products of 50 companies and institutions from 15 countries of Europe, Asia and North America.
- ❑ INFO TECH offers also:
 - **Hands-on trainings** on IEC 61850 communication,
 - **Conformance testing** of the IEC 61850 interfaces,
 - **Audits and diagnostics of systems** using IEC 61850 communication.

Product from the renowned supplier of communication software libraries and testing tools for automation systems

Other known products from this area:

- ❑ **IEC 61850 Software Library (source code)**
- ❑ **61850 CCC** – IEC 61850 client DLL for PC/MS Windows
- ❑ **61850 SCC** – IEC 61850 server DLL for PC/MS Windows
- ❑ **61850 SCL Runner** – simulator of IEC 61850 server devices based on their description in SCL files
- ❑ **61850 GOOSE System Viewer** – visualization and monitoring of GOOSE communication based on SCD file
- ❑ **ProTester** – simulation tools for master and slave stations of protocols operating on serial and TCP/IP based networks (DNP3, IEC-104, IEC-101, IEC-103, Modbus, SPA-bus)
- ❑ **ProtAn** – protocol analyzer for serial asynchronous communication (RS-232, RS-485)
- ❑ **ProtAn for Ethernet** – protocol analyzer for Ethernet networks

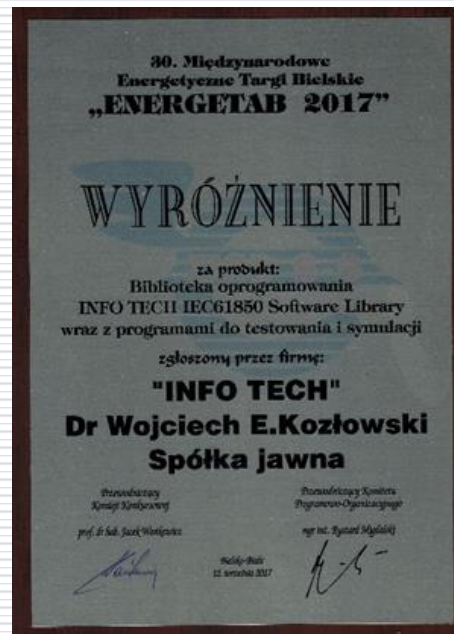
61850 Avenue toolset

- ❑ **61850 Avenue**: set of tool programs for testing IEC 61850 communication, developed with the use of **INFO TECH IEC61850 Software Library**
- ❑ First tool of the package - **61850 Avenue client tool**: beta version supplied to selected customers already in January 2007
- ❑ First official release: May 2007 (together with **61850 Relay Simulator**)
- ❑ **GOOSE toolset**: added in January 2008
- ❑ **Sampled Values toolset**: added in December 2011
- ❑ **File Transfer toolset**: added in February 2012
- ❑ **61850 Avenue 2.0**: released in April 2013
 - Added support of **Edition 2.0**
 - Added message logging
 - Added Process Data View
- ❑ **Update of IEC 61850 client GUI**: version **2.1** released in April 2018
- ❑ **Routable GOOSE and Routable SV** options added in September 2019
- ❑ Support of **Edition 2.1** in the release of January 2021
- ❑ **Secure client-server communication (TLS and ACSE)** added in May 2022
- ❑ Added **cyclic data polling** to Process Data View: added in February 2023

The name **61850 Avenue** was adopted to the whole toolset package.

Awarded product

- INFO TECH IEC61850 Software Library (source code) together with the testing and simulation toolsets (61850 Avenue and 61850 SCL Runner) – was honored with a prestigious award – **Honorable Commendation of the International Power Industry Fair ENERGETAB 2017**



Wide applicability of the toolset

- Suitable for:
 - testing devices and systems with IEC 61850 communication,
 - commissioning of IEC 61850 based systems,
 - development projects implementing IEC 61850 communication,
 - verification of product conformance with the IEC 61850 standard,
 - practical learning of the IEC 61850 standard.
- Truly easy to learn and apply ...
- All programs include the **context help function** invocable with **F1** key.

61850 Avenue

Your safe and easy road to learn and use the IEC 61850 standard.

Welcome!



Installation procedure

Supported platforms:

PC running

MS Windows

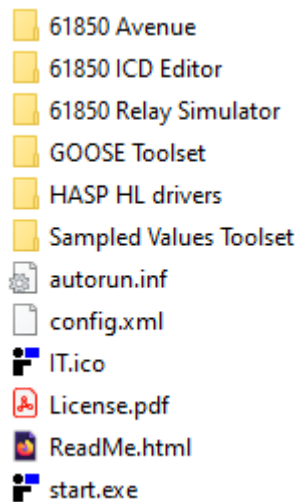
7, 8, 10 and 11.



To install the software

From the supplied CD: possible start in autorun mode.

Alternatively: invoke the program **start.exe** from the installation package directory

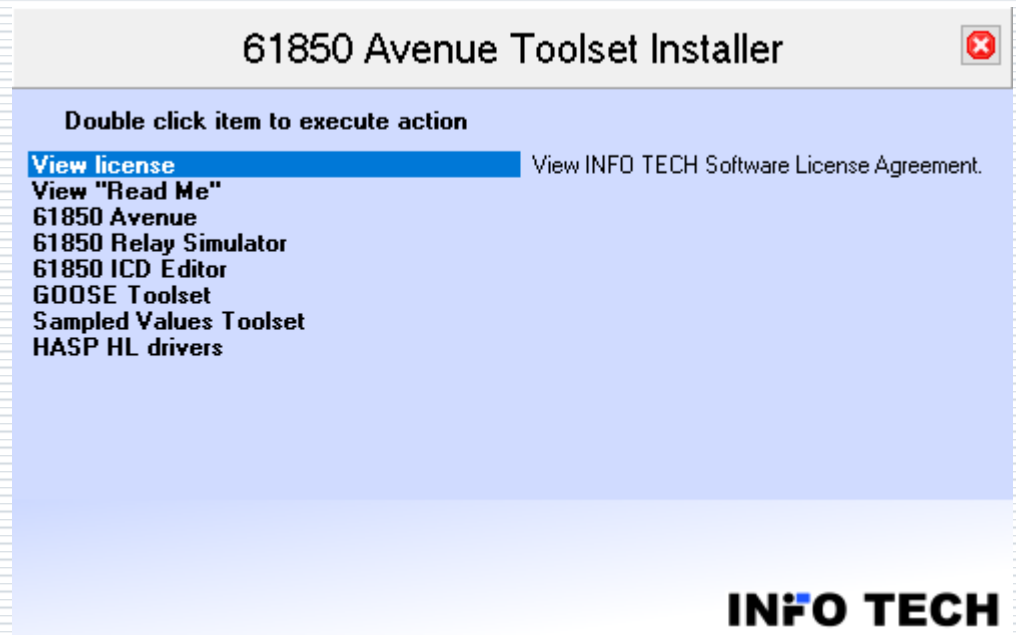


License

- **Before installing the software please learn and accept the licensing terms described in the paper note attached to the CD and/or in the file License.pdf**
- Please acknowledge the following notice concerning the USB license key:
 - The supplied license key represents the value you have purchased. Please take care of it and protect it from losing or damaging like any other object of value. Please understand that we cannot replace lost, corrupted or physically damaged keys.

Installation steps

- After starting the installation program the following list of documents, applications and drivers will be displayed – it is possible to install only selected tool programs and omit those which will not be used.
- At first, read the license agreement.



Third party components

- **HASP HL drivers** – to manage the USB license key
- **WinPcap 4.1.3** used by Relay Simulator, GOOSE toolset, SV toolset (alternatively, it is possible to use Win10Pcap or Npcap if already installed)

IEC 61850 client tool (**61850 Avenue**)



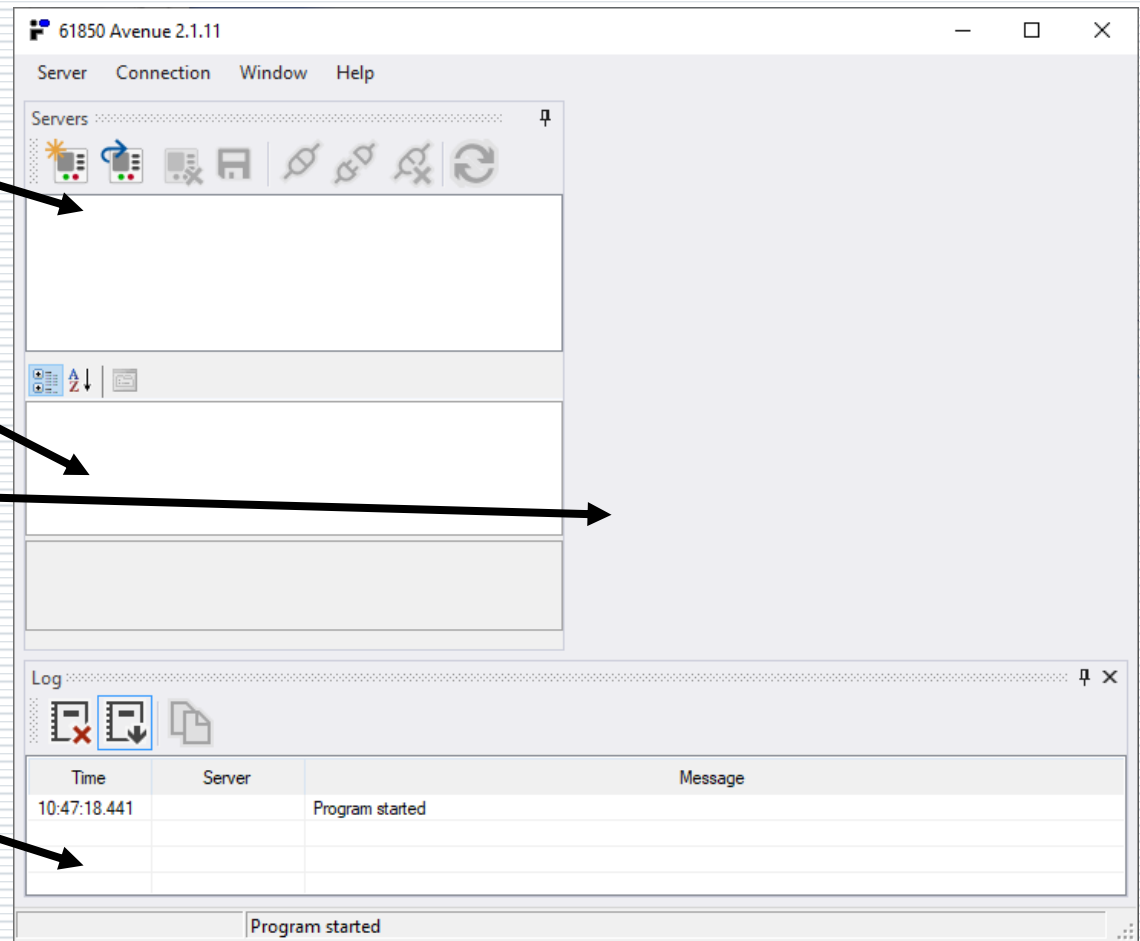
Initial view after the first start-up of 61850 Avenue client

Servers – window with the list of server devices to communicate with.

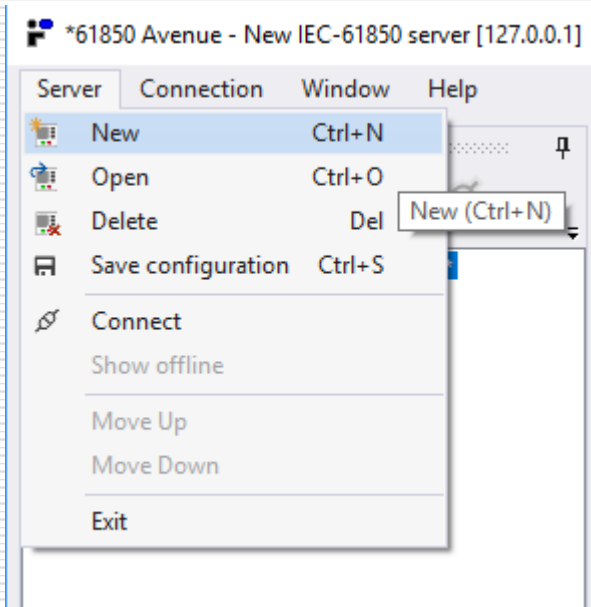
Properties – window with the list of connection parameters of the selected server (connection parameters can be saved in the configuration file).

Main operation view – for folders with server data models.

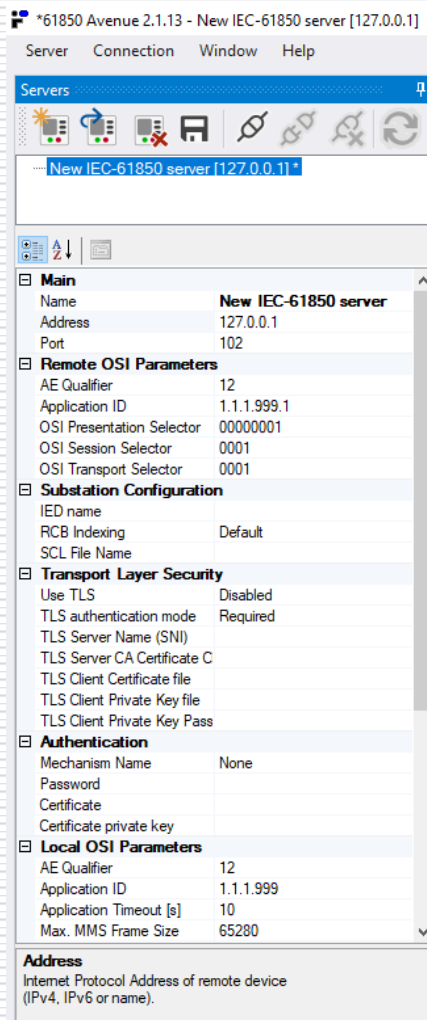
Log view – chronological view of operations (commands, responses and events) occurring during the interactions with server devices.



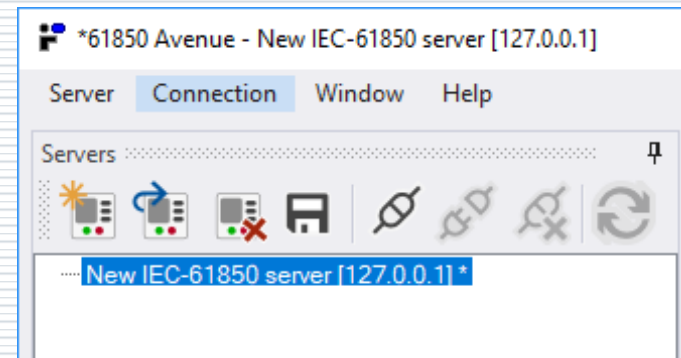
Connection to a new server device with data model browsing



From **Server** menu select **New** command to define a new server device.



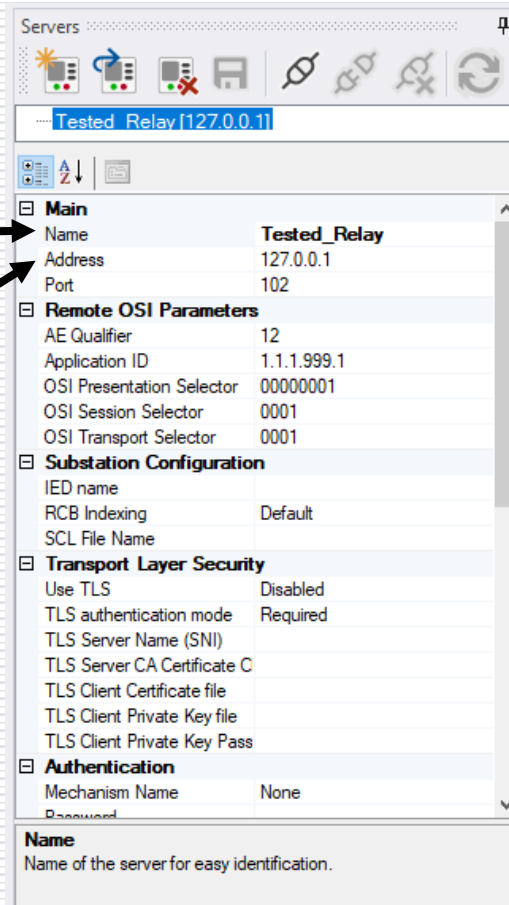
A new server IED with the name **New IEC-61850 server** and IP address **[127.0.0.1]** will appear in **Properties** window.



* **after** the name of the IED server device means **unsaved configuration**.

Assigning target name and IP address to a new server device for browsing

In **Servers** window write the target device name in place of default **New** **IEC-61850 server** and the target IP address in place of **127.0.0.1**.



Now the client-server connection can be established: in **Server** window from context menu of the selected device invoke the command **Connect**

Secure communication using TLS (encryption)

For using TLS to connect to the server, set the **Use TLS** parameter to **Enabled**. This parameter is part of the **Transport Layer Security** section of the Server Communication Profile.

Enabling TLS changes automatically communication port to default for TLS (3782). Disabling TLS returns the default port to 102.

Other TLS configurable parameters:

TLS authentication mode – selection between **Required** authentication using TLS CA certificate or **Optional**.

TLS Server Name (SNI) – TLS Server Name Indication.

TLS CA certificates files – file with a chain of certificates used to verify the certificate of the server to which the client connects.

TLS own certificates files – client's certificate file.

TLS private key – client's private key file.

TLS private keyphrase – the password used to decrypt the client's private key.

The screenshot shows the configuration for a server profile named 'Secure IEC-61850 server' with address '127.0.0.1' and port '3782'. The 'Transport Layer Security' section is expanded and highlighted with a blue box. The parameters in this section are:

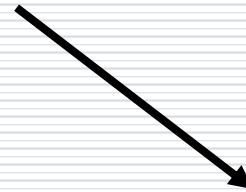
Parameter	Value
Use TLS	Enabled
TLS authentication mode	Required
TLS Server Name (SNI)	
TLS Server CA Certificate Chain	D:\certificates\ca.pem
TLS Client Certificate file	D:\certificates\client.pem
TLS Client Private Key file	D:\certificates\client.key
TLS Client Private Key Passphrase	

Below this section, the 'Authentication' and 'Local OSI Parameters' sections are also visible, showing various protocol-related settings.

Secure communication using ACSE (authentication)

Use of ACSE for authentication:

- select mechanism based on certificates,
- provide certificate of the client,
- provide private key of the client.



The screenshot shows the 'Servers' configuration window for a 'Secure IEC-61850 server [127.0.0.11]'. The 'Authentication' section is highlighted with a blue box. The configuration details are as follows:

Main	
Name	Secure IEC-61850 server
Address	127.0.0.1
Port	102

Remote OSI Parameters	
AE Qualifier	12
Application ID	1.1.1.999.1
OSI Presentation Selector	00000001
OSI Session Selector	0001
OSI Transport Selector	0001

Substation Configuration	
Transport Layer Security	
Authentication	
Mechanism Name	1.0.62351.4.3.1 (Certificate)
Password	
Certificate	D:\certificates\client.pem
Certificate private key	D:\certificates\client.key

Local OSI Parameters	
AE Qualifier	12
Application ID	1.1.1.999
Application Timeout [s]	10
Max. MMS Frame Size	65280
Max. MMS Services Called	1
Max. MMS Services Calling	1
OSI Presentation Selector	00000001
OSI Session Selector	0001
OSI Session Timeout [ms]	2000

Mechanism Name
Authentication mechanism name as object identifier. It can be selected among 'None' or '2.2.3.1 (Password)' values

Server device data model displayed after connecting and browsing

Fast exploration of the server device data model.

The screenshot displays the '61850 Avenue 2.1.10 - Tested_Relay [127.0.0.1]' window. The 'Servers' panel shows the selected server. The Properties panel displays the following data:

Main	
Name	Tested_Relay
Address	127.0.0.1
Port	102

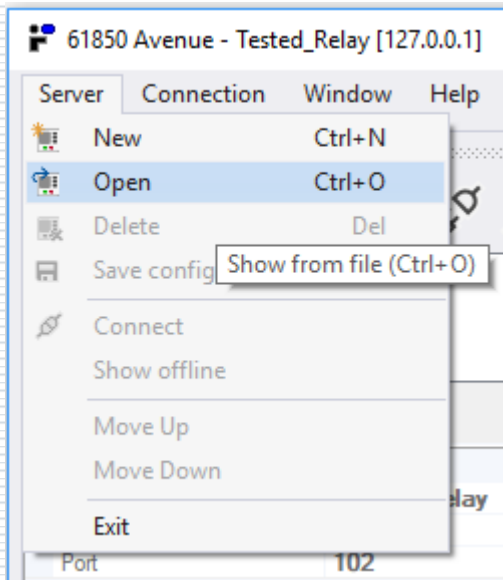
Remote OSI Parameters	
AE Qualifier	12
Application ID	1.1.1.999.1
OSI Presentation Selector	00000001
OSI Session Selector	0001
OSI Transport Selector	0001

Substation Configuration	
IED name	
RCB Indexing	Default
SCL File Name	

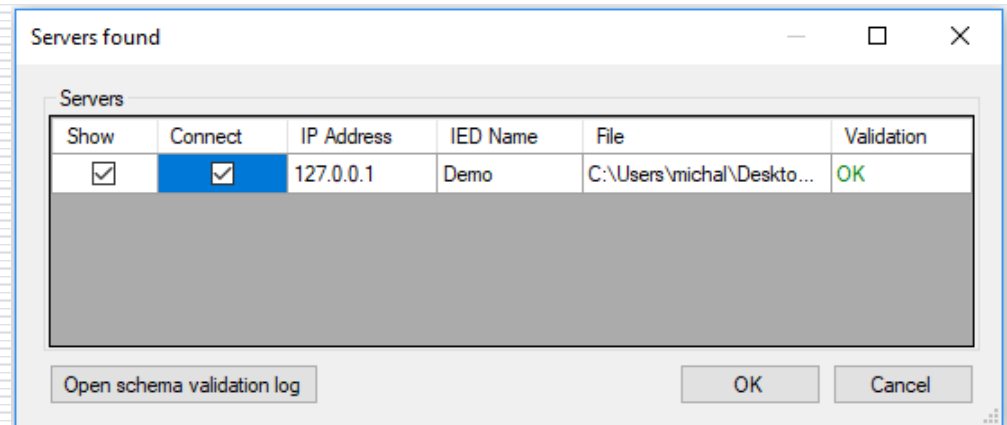
The tree view on the right shows the following structure:

- @ Association
 - LD DemoMeasurement
 - LN LLN0
 - LN LPHD1
 - LN I3pMHAI1
 - LN I3pMMXU1
 - LN U3pMMXU2
 - LD DemoProtCtrl
 - LN LLN0
 - LN LPHD1
 - LN DIGGIO1
 - LN I3GtPTOC1
 - LN I3GtPTRC1
 - LN Obj1CSWI1
 - LN Obj1XCBR1
 - LN Obj2XSWI1
 - LN Obj3CSWI2
 - LN Obj3XCBR2

Connection to a new server device using its SCL description file



Invoke **Open** command and select an SCL file describing the server device.



After selecting the file set check boxes:

- **Show** - to display the server preview (offline mode),
- **Connect** - to automatically connect to the server.

Explanation of Show and Connect options

After selecting the **Connect** option, the client will be automatically connected to the server.

When the **Show** option is checked, the device data model will appear in the **Main** operation view.

The screenshot displays the software interface for connecting to a server. The title bar reads "61850 Avenue 2.1.10 - Demo [127.0.0.1]". The menu bar includes "Server", "Connection", "Window", and "Help".

The "Servers" panel on the left shows a tree view with "Demo [127.0.0.1]" selected and highlighted in blue. Below this, the "Main" operation view is shown as a table with the following data:

Main	
Name	Demo
Address	127.0.0.1
Port	102
Remote OSI Parameters	
AE Qualifier	12
Application ID	1.1.1.999.1
OSI Presentation Selector	00000001
OSI Session Selector	0001
OSI Transport Selector	0001
Substation Configuration	
IED name	
RCB Indexing	Default
SCI File Name	

On the right side, a detailed tree view of the device data model is visible under the "Demo [127.0.0.1]" window. The tree structure is as follows:

- @ Association
 - LD DemoMeasurement
 - LN LLN0
 - LN LPHD1
 - LN I3pMHAI1
 - LN I3pMMXU1
 - LN U3pMMXU2
 - LD DemoProtCtrl
 - LN LLN0
 - LN LPHD1
 - LN DIGGIO1
 - LN I3GtPTOC1
 - LN I3GtPTRC1
 - LN Obj1CSWI1
 - LN Obj1XCBR1
 - LN Obj2XSWI1
 - LN Obj3CSWI2
 - LN Obj3XCBR2

Connection establishing after importing SCL file

Click **Connect** icon to connect with the device in the network

The screenshot shows the software interface for connecting to a device. The main workspace displays a tree view of the device's configuration, including a table of elements:

Name	FC	Value
DemoProtCtrl/Ob...	ST	{stVal=1
DemoProtCtrl/Ob...	ST	{stVal=1
DemoProtCtrl/LL...	ST	{stVal=f
DemoProtCtrl/I3...	ST	{stVal=c
DemoProtCtrl/I3...	ST	{general
DemoProtCtrl/I3...	ST	{general
DemoProtCtrl/I3...	ST	{general
DemoProtCtrl/Ob...	ST	{stVal=1
DemoProtCtrl/Ob...	ST	{stVal=1

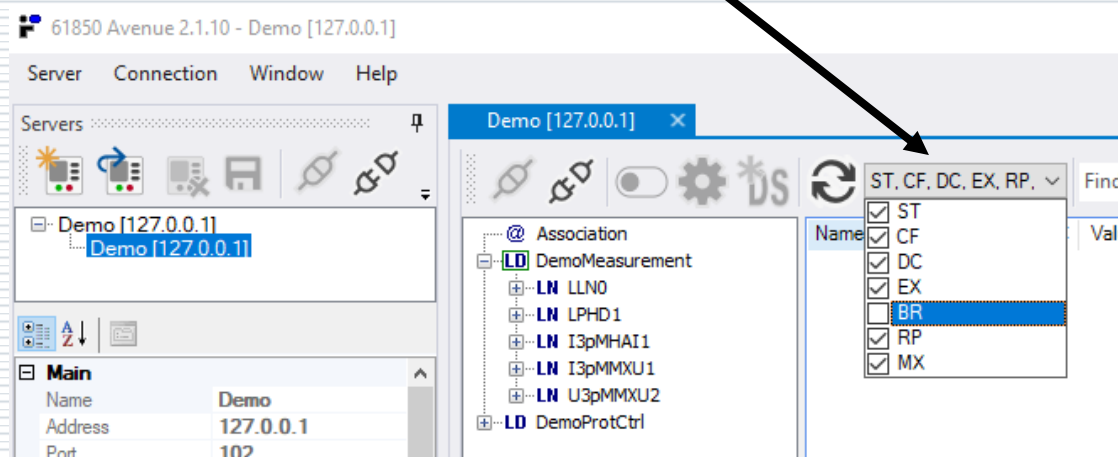
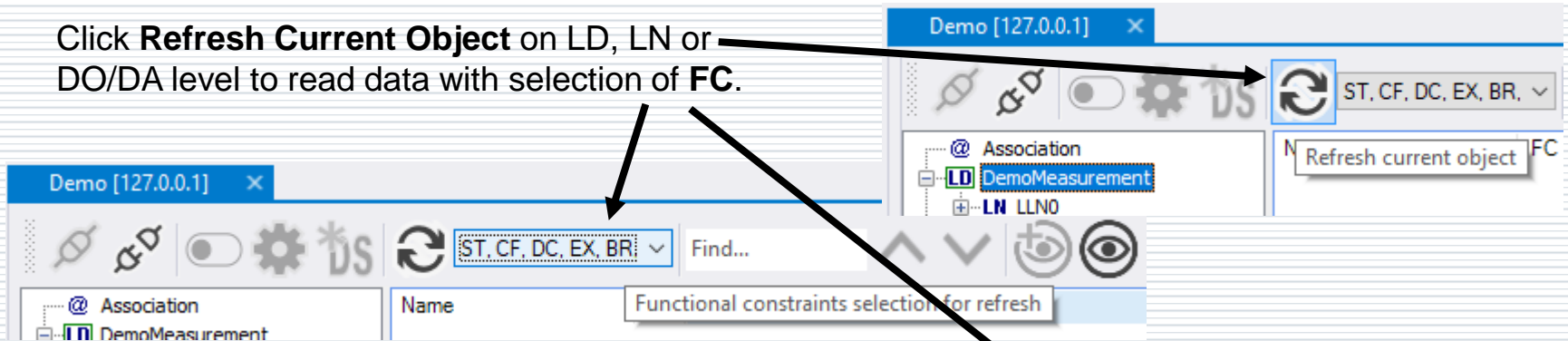
The connection window shows a 'Connect' icon and a 'Demo [127.0.0.1]' window. The main workspace shows a tree view of the device's configuration, including a table of elements:

Name	FC	Value
DemoProtCtrl/Ob...	ST	{stVal=1
DemoProtCtrl/Ob...	ST	{stVal=1
DemoProtCtrl/LL...	ST	{stVal=f
DemoProtCtrl/I3...	ST	{stVal=c
DemoProtCtrl/I3...	ST	{general
DemoProtCtrl/I3...	ST	{general
DemoProtCtrl/I3...	ST	{general
DemoProtCtrl/Ob...	ST	{stVal=1
DemoProtCtrl/Ob...	ST	{stVal=1

Off-line model browsing possible.

Refresh Current Object on LD, LN or DO/DA

Click **Refresh Current Object** on LD, LN or DO/DA level to read data with selection of **FC**.

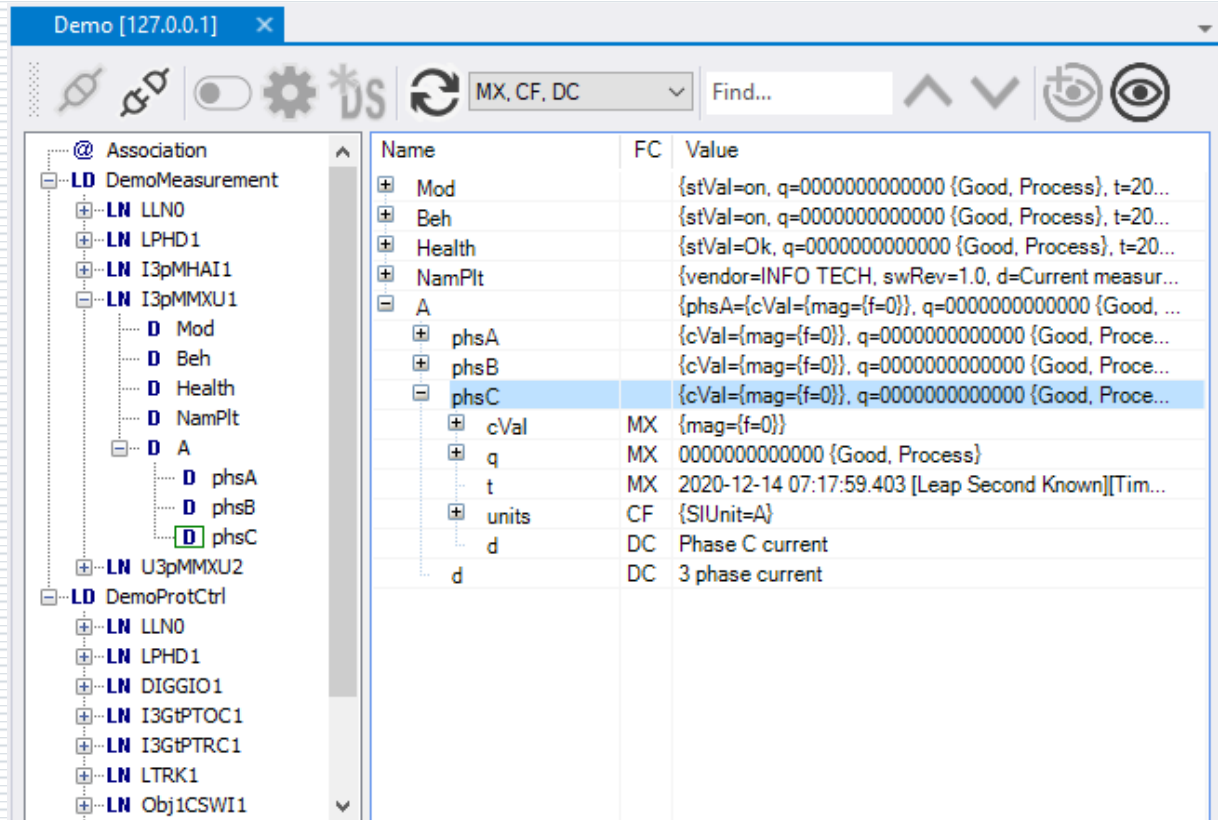


Data model view

True data model as defined in IEC 61850-7.

No confusion with MMS Named Variable space.

The tool can maintain connections to multiple server devices.



The screenshot displays a software interface for viewing a data model. The window title is "Demo [127.0.0.1]". The interface includes a toolbar with various icons and a search bar. The main area is divided into two panes:

- Left Pane (Tree View):** Shows a hierarchical structure of data points. The selected path is: Association > DemoMeasurement > LN I3pMMXU1 > D A > phsC.
- Right Pane (Table View):** Displays a table of data points with columns for Name, FC, and Value.

Name	FC	Value
Mod		{stVal=on, q=0000000000000000 {Good, Process}, t=20...
Beh		{stVal=on, q=0000000000000000 {Good, Process}, t=20...
Health		{stVal=Dk, q=0000000000000000 {Good, Process}, t=20...
NamPlt		{vendor=INFO TECH, swRev=1.0, d=Current measur...
A		{phsA={cVal={mag={f=0}}, q=0000000000000000 {Good, ...
phsA		{cVal={mag={f=0}}, q=0000000000000000 {Good, Proce...
phsB		{cVal={mag={f=0}}, q=0000000000000000 {Good, Proce...
phsC		{cVal={mag={f=0}}, q=0000000000000000 {Good, Proce...
cVal	MX	{mag={f=0}}
q	MX	0000000000000000 {Good, Process}
t	MX	2020-12-14 07:17:59.403 [Leap Second Known][Tim...
units	CF	{SIUnit=A}
d	DC	Phase C current
d	DC	3 phase current

Possible simultaneous connections with multiple servers

In **Main operation view** the tabs of server devices can be arranged as preferred by the tool user.

The screenshot displays a software interface with multiple tabs for server connections. The tabs include '61850 Avenue 2.1.10 - Demo [127.0.0.1]', 'Demo [127.0.0.1]', 'RegrTestEd2 [192.168.11.158]', and 'RegrTestEd2 [192.168.11.158]'. The interface shows a tree view of server components, including 'Association', 'DemoMeasurement', 'LLNO', 'LPHD1', 'I3pMHAI1', 'I3pMMXU1', 'Mod', 'Beh', 'Health', 'NamPlt', 'A', 'phsA', 'phsB', 'phsC', 'U3pMMXU2', 'DemoProtCtrl', 'LLNO', 'LPHD1', 'DIGGIO1', and 'I3GtPTOC1'. A table on the right lists these components with columns for 'Name' and 'FC'. The interface also includes various configuration panels, such as 'Note OSI Parameters' and 'Sport Layer Security', with fields for 'Sequence Number', 'Data Set', 'Buffer Overflow', 'Configuration Revision', 'Entry Identifier', and 'Data Reference'.

Reporting function in IEC 61850

Reporting services as defined in IEC 61850-7-2.

Reporting configuration can be invoked from the context menu of a chosen rcb or using the program icon.

The screenshot displays the software interface for configuring reporting services. On the left, a tree view shows the project structure under 'Demo [127.0.0.1]'. A context menu is open over the 'RP' (Reporting Control Block) element, with the 'Parameters...' option selected. On the right, a table lists the parameters for the selected RCB.

Name	FC	Value
RptID	BR	
RptEna	BR	false
DatSet	BR	DemoMeasurement/LLN0.DS1_Measurement
ConfRev	BR	1
OptFlds	BR	0111111111 {sequence-number, report-time-stam...
BurTm	BR	1000
SqNum	BR	0
TrgOps	BR	011111 {data-change, quality-change, data-update...
	BR	0
	BR	false
	BR	false
	BR	0000000000000001
	BR	2020-12-14 07:17:59.655

Configuration of the reporting function

BR / RP: dedicated windows for review and modification of reporting parameters of BRCB / URCB.

The screenshot shows a configuration window titled "Demo [127.0.0.1]: DemoProtCtrl/LLN0.brcb01". The window contains the following fields and options:

- Report Identifier: (empty text box)
- Data Set Reference: DemoMeasurement/LLN0.DS2_All (dropdown menu)
- Configuration Revision: 2 (text box)
- Integrity Period [ms]: 0 (text box)
- Buffer Time [ms]: 1000 (text box)
- Entry Identifier: 0000000000000000 (text box)
- Sequence Number: 0 (text box)
- Time Of Entry: 1984-01-01 00:00:00.000 (text box)
- Reservation Time [s]: (empty text box)
- Optional Fields (checkboxes):
 - Sequence Number (checked)
 - Report Time Stamp (checked)
 - Reason For Inclusion (checked)
 - Data Set Name (checked)
 - Data Reference (checked)
 - Buffer Overflow (checked)
 - Entry Identifier (checked)
 - Configuration Revision (checked)
- Trigger Options (checkboxes):
 - Data Change (dchg) (checked)
 - Quality Change (qchg) (checked)
 - Data Update (dupd) (checked)
 - Integrity (checked)
 - General Interrogation (checked)

Buttons at the bottom: Apply, Enable, GI, Refresh, Close.

Selection of dataset for reporting

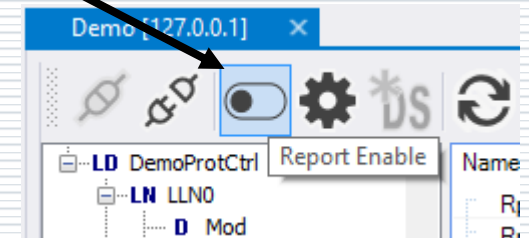
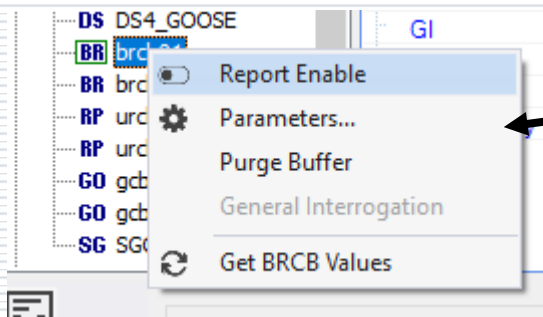
Selection from dropdown list of all datasets present in the device.

The list results from the imported or explored device data model and includes also dynamically created datasets.

The screenshot shows a configuration window for a device named 'Demo [127.0.0.1]: DemoProtCtrl/LLN0.brcb01'. The 'Data Set Reference' dropdown menu is open, displaying a list of datasets. The selected dataset is 'DemoProtCtrl/LLN0.DS1_Disconnector'. Other datasets in the list include 'DemoMeasurement/LLN0.DS1_Measurement', 'DemoMeasurement/LLN0.DS2_All', 'DemoProtCtrl/LLN0.DS2_Protection', 'DemoProtCtrl/LLN0.DS3_GOOSE', and 'DemoProtCtrl/LLN0.DS4_GOOSE'. The window also features fields for 'Report Identifier', 'Configuration Revision', 'Buffer Time [ms]', 'Sequence Number', and 'Reservation Time [s]'. There are sections for 'Optional Fields' and 'Trigger Options' with various checkboxes. The 'Optional Fields' section includes checkboxes for 'Sequence Number', 'Report Time Stamp', 'Reason For Inclusion', 'Data Set Name', 'Data Reference', 'Buffer Overflow', 'Entry Identifier', and 'Configuration Revision'. The 'Trigger Options' section includes checkboxes for 'Data Change (dchg)', 'Quality Change (qchg)', 'Data Update (dupd)', 'Integrity', and 'General Interrogation'. At the bottom of the window, there are buttons for 'Apply', 'Enable', 'GI', 'Refresh', and 'Close'.

Activation of the reporting function and reports viewing

Report control block (BRCB or URCB) can be enabled by invoking **Report Enable** command from the context menu or using the program icon.



#	Report ID	Reason code
0	DemoProtCtrl/LLNO\$BR\$brcb01	dchg
1	DemoProtCtrl/LLNO\$BR\$brcb01	dchg
2	DemoProtCtrl/LLNO\$BR\$brcb01	dchg
3	DemoProtCtrl/LLNO\$BR\$brcb01	dchg
4	DemoProtCtrl/LLNO\$BR\$brcb01	dchg
5	DemoProtCtrl/LLNO\$BR\$brcb01	dchg

Sequence Number:	0	Data Set:	DemoProtCtrl/LLNO\$DS1_Disconnector	
<input checked="" type="checkbox"/> Buffer Overflow	Configuration Revision:	1	ID:	DemoProtCtrl/LLNO\$BR\$brcb01
Entry Identifier:	0000000000000001	Time of Entry:	2020-05-06 11:25:06.645	
Data Reference		FC	Value	
DemoProtCtrl/Obj2XSW1.Pos		ST	Reason code: dchg	
stVal		ST	01 {off}	
q		ST	0000000000000000 {Good, Process}	
t		ST	2020-05-06 11:25:06.628 [Leap S...	

Incoming reports are displayed in a traceable list. A selected report content can be easily viewed.

List of reports

All incoming reports are collected into a list and presented with the following information:

- # - report number in the list,
- Report ID** – report identifier,
- Received** – reception timestamp,
- SN** – report sequence number set by the reporting server (other formats in case of segmented reports: SN.s - where s is a segment number, SN.sF - where s is a segment number and F indicates the last segment),
- Data Set** – reference name of the dataset used for reporting,
- Details off/on** – show/hide the details of the selected report.

The screenshot shows a software interface with two main panels. The top panel displays a tree view of a device structure on the left and a table of report details on the right. The bottom panel shows a table of reports and a detailed view of a selected report.

Report List Table:

#	Report ID	SN	BOvf	Data Set
19	DemoMeasurement/LLN0\$BR\$brcb01	25	false	DemoMeasurement/LLN0.DS1_Measureme
20	DemoMeasurement/LLN0\$BR\$brcb02	21	false	DemoMeasurement/LLN0.DS2_All
21	DemoMeasurement/LLN0\$BR\$brcb01	26	false	DemoMeasurement/LLN0.DS1_Measureme
22	DemoMeasurement/LLN0\$BR\$brcb02	22	false	DemoMeasurement/LLN0.DS2_All
23	DemoMeasurement/LLN0\$BR\$brcb01	27	false	DemoMeasurement/LLN0.DS1_Measureme
24	DemoMeasurement/LLN0\$BR\$brcb01	28	false	DemoMeasurement/LLN0.DS1_Measureme
25	DemoMeasurement/LLN0\$BR\$brcb02	23	false	DemoMeasurement/LLN0.DS2_All
26	DemoMeasurement/LLN0\$BR\$brcb02	24	false	DemoMeasurement/LLN0.DS2_All
27	DemoProtCtrl/LLN0\$BR\$brcb02	10	false	DemoProtCtrl/LLN0.DS2_Protection
28	DemoMeasurement/LLN0\$BR\$brcb01	29	false	DemoMeasurement/LLN0.DS1_Measureme
29	DemoMeasurement/LLN0\$BR\$brcb02	25	false	DemoMeasurement/LLN0.DS2_All
30	DemoProtCtrl/LLN0\$BR\$brcb02	11	false	DemoProtCtrl/LLN0.DS2_Protection

Detailed View of Selected Report:

Name	FC	Value
DemoMeasur...	MX	{phsA={cVal={mag={f=0}}, q=0000000000000000 (Good, Process), t=2023-02-27 09:47:56.925 [Leap Second K...
DemoMeasur...	MX	{phsA={cVal={mag={f=0}}, q=0000000000000000 (Good, Process), t=2023-02-27 09:47:56.925 [Leap Second K...
DemoProtCtrl/Ob...	ST	{stVal=01 (off), q=0000000000000000 (Good, Process), t=2023-02-27 09:47:56.922 [Leap Second Known][Tim...
stVal	ST	01 (off)
q	ST	0000000000000000 (Good, Process)
t	ST	2023-02-27 09:47:56.922 [Leap Second Known][Time Accuracy = 10 bits]
DemoProtCtrl/Ob...	ST	{stVal=10 (on), q=0000000000000000 (Good, Process), t=2023-02-27 09:44:50.940 [Leap Second Known][Tim...
stVal	ST	10 (on)
q	ST	0000000000000000 (Good, Process)
t	ST	2023-02-27 09:44:50.940 [Leap Second Known][Time Accuracy = 10 bits]
stSeld	ST	false

Report Details Panel:

Sequence Number: 29 Data Set: DemoMeasurement/LLN0.DS1_Me...
 Buffer Overflow Configuration Revision: 1 ID: DemoMeasurmen
 Entry Identifier: 00000000000000001E Time of Entry: 2023-02-27 09:47:!!

Data Reference Table:

Data Reference	FC	Value
DemoMeasurement/13pMHAI1.HA	MX	Reason code: DataUp...
phsAHar		{0={cVal={mag={f=0}}...
cVal	MX	{cVal={mag={f=0}}, q...
mag	MX	{f=0}
f	MX	0
q	MX	0000000000000000 (Goo...
t	MX	2023-02-27 09:47:56...
1		{cVal={mag={f=0}}, q...
2		{cVal={mag={f=0}}, q...

List of reports

Detailed view of selected report

Report detailed content viewing

For each report from the list its detailed content can be examined. The following information is presented:

Sequence Number – report sequence number set by the server,

Data Set – reference name of the dataset,

ID – report identifier,

Buffer Overflow – indication of buffer overflow occurrence (for reports from BRCB only),

Configuration Revision – version of RCB configuration,

Time of Entry – time of report generation (report time stamp – equal to Time of Entry for BRCB),

Entry Identifier – report identifier (for reports from BRCB only),

and the **view of reported data** including:

- reference name of reported data (**Data Reference**) with functional constraint (**FC**),
- reason (**Reason Code**) of including data in the report,
- names and values of data components.

Data Reference	FC	Value
DemoProtCtrl/Obj1CSW1.Pos	ST	Reason code: DataChange
stVal	ST	10 {on}
position	ST	on
q	ST	00000000000000 {Good, Process}
Validity	ST	Good
Overflow	ST	false
OutOfRange	ST	false
BadReference	ST	false
Oscillatory	ST	false
Failure	ST	false
OldData	ST	false
Inconsistent	ST	false
Inaccurate	ST	false
Source	ST	Process
Test	ST	false
OperatorBlocked	ST	false
t	ST	2023-02-27 09:51:38.210 [Leap Second Known][Time Accur...
DemoProtCtrl/I3GtPTOC1.Str	ST	Reason code: DataChange
general	ST	true
dirGeneral	ST	both
q	ST	00000000000000 {Good, Process}
t	ST	2023-02-27 09:51:38.242 [Leap Second Known][Time Accur...
DemoProtCtrl/Obj1XCBR1.Pos	ST	Reason code: DataChange
stVal	ST	10 {on}
position	ST	on
q	ST	00000000000000 {Good, Process}
Validity	ST	Good
Overflow	ST	false
OutOfRange	ST	false
BadReference	ST	false
Oscillatory	ST	false
Failure	ST	false
OldData	ST	false

Data model view updates by reports

Data values received in reports update also the view of the data model. The name and value of each updated data is emphasized using **blue font**. The same visualization is applied to updates obtained upon read requests.

The screenshot shows a software interface with a tree view on the left and a table on the right. The tree view shows a hierarchy of data points under 'Demo [127.0.0.1]'. The table on the right has columns for Name, FC, and Value. The 'Str' row is highlighted in blue, and its value is also in blue font.

Name	FC	Value
Mod		{stVal=on, q=0000000000000000 {Good, Process}, t=2020-12-14 07:17:59.403 [Leap Second Known][Time Accuracy = 10 bits], ctl...
Beh		{stVal=on, q=0000000000000000 {Good, Process}, t=2020-12-14 07:17:59.404 [Leap Second Known][Time Accuracy = 10 bits]}
Health		{stVal=Ok, q=0000000000000000 {Good, Process}, t=2020-12-14 07:17:59.404 [Leap Second Known][Time Accuracy = 10 bits]}
NamPlt		{vendor=INFO TECH, swRev=1.0, d=Overcurrent protection I>}
Str		{general=false, dirGeneral=both, q=0000000000000000 {Good, Process}, t=2020-12-14 07:17:59.403 [Leap Second Known][Time ...
general	ST	false
dirGeneral	ST	both
q	ST	0000000000000000 {Good, Process}
t	ST	2020-12-14 07:17:59.403 [Leap Second Known][Time Accuracy = 10 bits]
Op		{general=false, q=0000000000000000 {Good, Process}, t=2020-12-14 07:17:59.403 [Leap Second Known][Time Accuracy = 10 bits]}
TmACrv		{setCharact=Multiline 1}
StrVal		{setMag={f=50}, units={SIUnit=A}}

Control services in IEC 61850

The image displays two screenshots of the IEC 61850 software interface. The left screenshot shows a tree view of the data model with a context menu open over the 'Pos' object. The menu options are 'Control...', 'Get Data Values', and 'Set Data Values'. The right screenshot shows the same tree view with a 'Control...' button highlighted in the toolbar. A table of data model properties is visible in the center of the left screenshot.

Name	FC	Value
Mod		{stVal=on, q=00000000}
Beh		{stVal=on, q=00000000}
Health		{stVal=Ok, q=00000000}
NamPlt		{vendor=INFO TECH
Loc		{stVal=false, q=00000000}
OpCntRs		{stVal=0, q=01000000}
Pos		{stVal=10 {on}, q=00000000}
stVal	ST	10 {on}
q	ST	0000000000000000 {Good}
t	ST	2020-05-06 07:09:32.
Oper	CO	{ctlVal=false, origin=
ctlModel	CF	direct-with-enhanced

Services as defined in IEC 61850-7-2.

Control services can be invoked in the context menu of the data model or using the program icon.

Control models and control command parameters

Control command window **CO** shows:

- present status of an object to be controlled,
- parameters of control command,
- buttons for control procedure steps in accordance with assigned control model,
- log of the control procedure performance with client requests, server responses and reports with control results.

Demo [127.0.0.1]: DemoProtCtrl/Obj1CSWI1.Pos

Status Information

Value: 01 {off} Control Number: []

Quality: 00000000000000 {Good, Process}

Time Stamp: 2018-03-26 13:14:14.016 [Leap Second Known][Time Accuracy = 10 bits]

Originator

Category: [] Id: []

Control

Value: on (true) Control Number: 0

Time

Time Stamp: 2018-03-26 15:14:21 [] Use Current Time

Originator

Category: remote-control Id: COA80862 HEX []

Test
 Check
 Synchrocheck
 Interlock Check

Select With Value Select Operate Cancel Refresh Close

Log

Time	Service	Message
------	---------	---------

Control commands in test mode

The tool user should be aware of consequences of sending control commands to devices.

When a server device is intentionally switched to TEST or TEST-BLOCKED mode, it is possible to set **Test** flag for control commands and perform control operation as specified for this mode.

Demo [127.0.0.1]: DemoProtCtrl/Obj1CSWI1.Pos

Status Information

Value: 01 {off} Control Number:

Quality: 00000000000000 {Good, Process}

Time Stamp: 2018-03-26 13:14:14.016 [Leap Second Known][Time Accuracy = 10 bits]

Originator

Category: Id:

Control

Value: on {true} Control Number: 0

Time

Time Stamp: 2018-03-26 15:14:21 Use Current Time

Originator

Category: remote-control Id: COA80862 HEX

Test

Check

Synchrocheck

Interlock Check

Select With Value Select Operate Cancel Refresh Close

Log

Time	Service	Message
------	---------	---------

Tracing control commands performance

If the new controlled object position is reported, the status information will be updated in the **CO** window and in the data model view.

Command execution and its result are easy to trace in the log.

Demo [127.0.0.1]: DemoProtCtrl/Obj1CSWI1.Pos

Status Information

Value: 01 {off} Control Number: []

Quality: 000000000000 {Good, Process}

Time Stamp: 2018-03-26 13:14:14.016 [Leap Second Known][Time Accuracy = 10 bits]

Originator

Category: [] Id: []

Control

Value: on (true) Control Number: 0

Time

Time Stamp: 2018-03-26 15:14:21 [] Use Current Time []

Originator

Category: remote-control Id: COA80862 HEX []

Test []
Check []
Synchrocheck []
Interlock Check []

Select With Value Select Operate Cancel Refresh Close

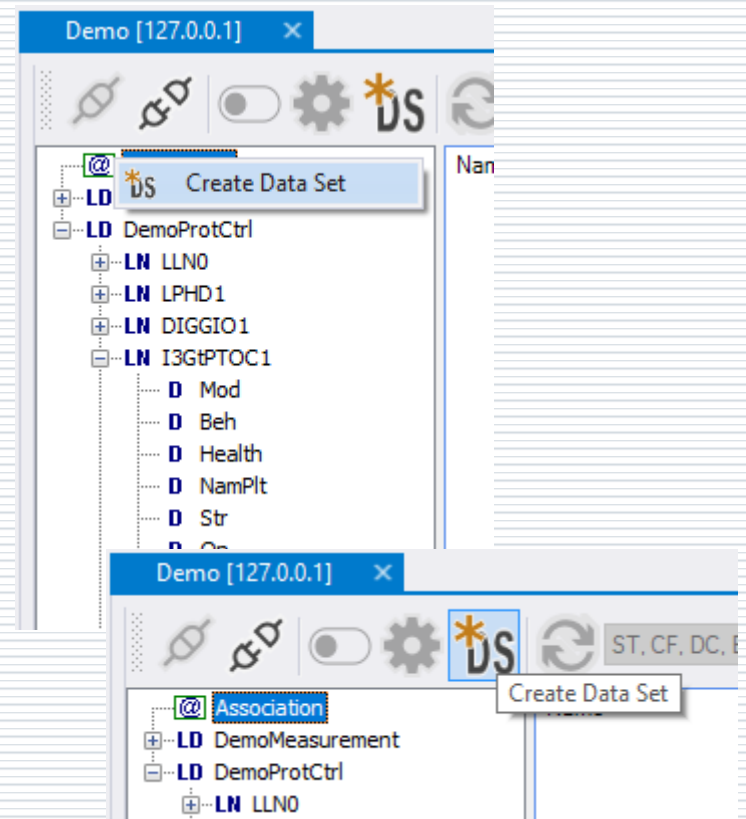
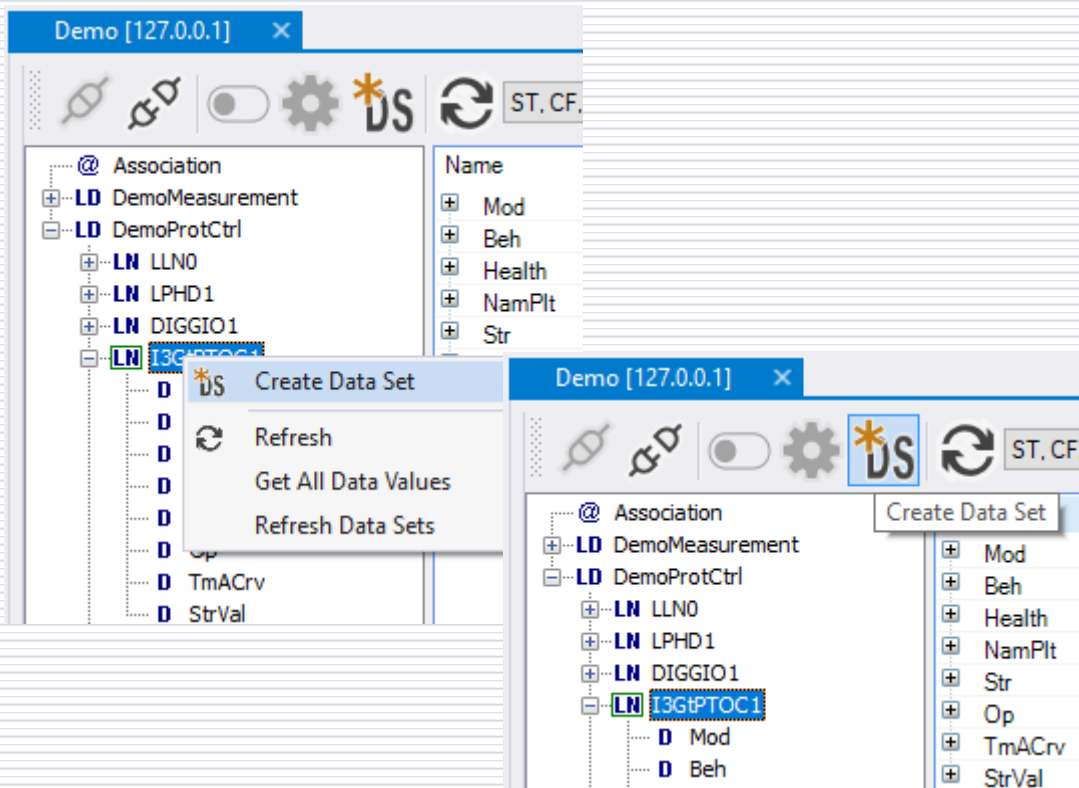
Log

Time	Service	Message
03:15:35.393	Operate	Request (ctlValue.true)
03:15:35.426	Operate	Response positive
03:15:35.427	Command Tem.	Positive (ctlValue.true)

Creating dynamic data sets

Persistent – created in LN context

Non-persistent – created in Association context



Steps of defining a new dataset

Upon invoking **Create Data Set** command a dedicated window pops up to enable dataset definition. The created dataset can be given a name and its elements can be selected from the data model by the command from context menu or by drag-and-drop operation.

The screenshot shows the 'Create data set' dialog box with the following fields and tables:

Data Set Reference

Scope: DemoProtCtrl/I3GtPTOC1
Name: NewDataSet

Data Set Members

Name	FC
DemoProtCtrl/I3GtPTOC1.Str	ST
DemoProtCtrl/I3GtPTOC1.Op	ST
DemoProtCtrl/I3GtPTRC1.Tr	ST

The background shows the data model tree with the 'Str' element selected. A context menu is open over the 'Str' element, showing the 'Add to Data Set' option. The 'Create' button in the dialog box is highlighted with a red arrow.

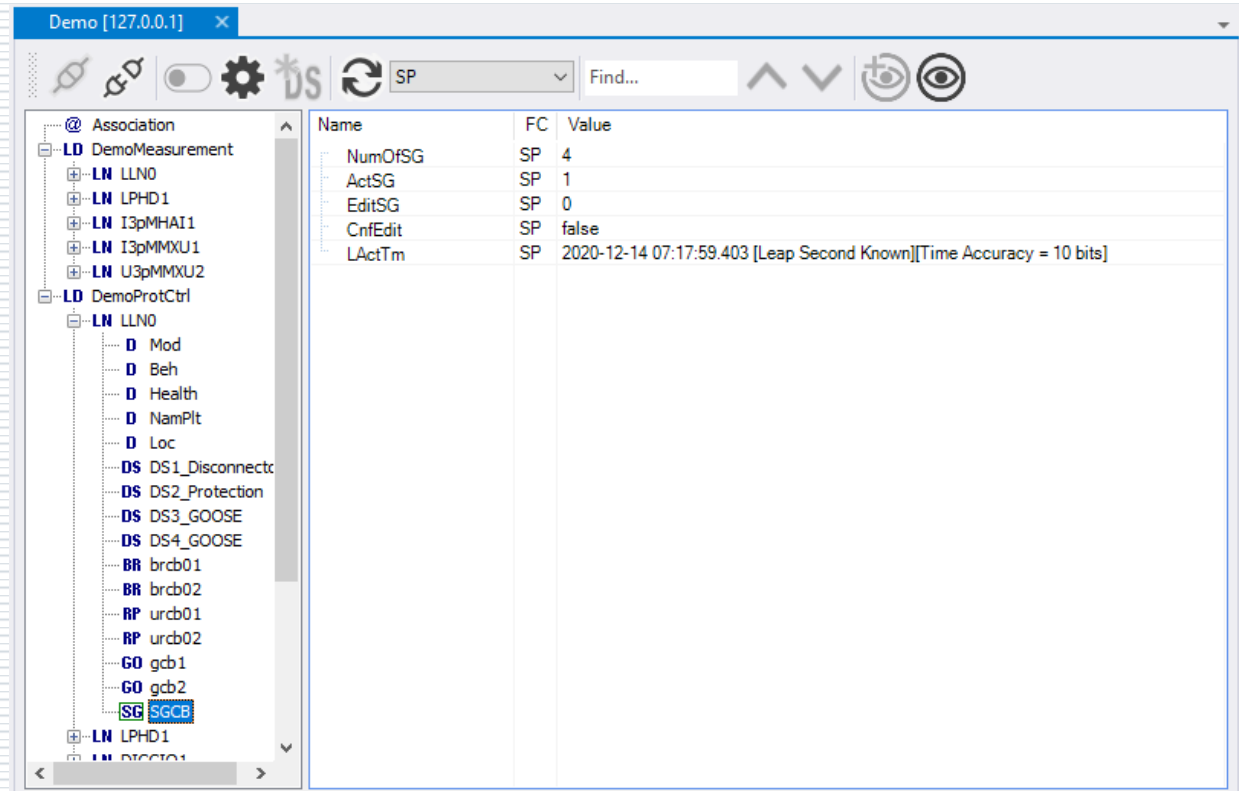
When the list of elements is complete press **Create** button – a command will be sent to the server device.

Activation and edition of Setting Groups

The data model of a server device implementing setting groups includes a Setting Group Control Block object (**SGCB**), placed always in LLN0 logical node.

SGCB attributes:

- NumOfSG – how many setting groups are included in the logical device (LD),
- ActSG – which setting group (number) is currently in use,
- EditSG – which setting group is currently available for editing values.



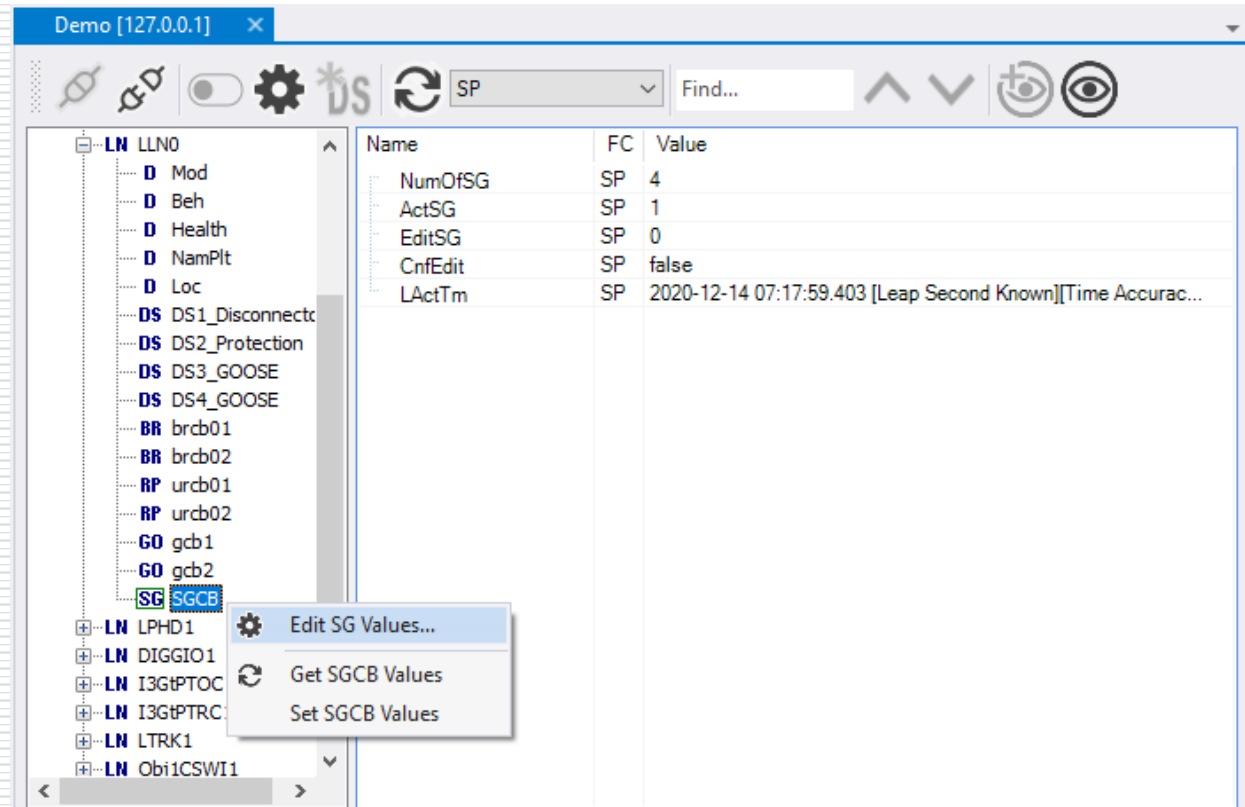
The screenshot shows a software interface with a tree view on the left and a table on the right. The tree view shows a hierarchy of objects: Association, LD DemoMeasurement, LN LLN0, LN LPHD1, LN I3pMHAI1, LN I3pMMXU1, LN U3pMMXU2, LD DemoProtCtrl, LN LLN0, D Mod, D Beh, D Health, D NamPlt, D Loc, DS DS1_Disconnect, DS DS2_Protection, DS DS3_GOOSE, DS DS4_GOOSE, BR brcb01, BR brcb02, RP urcb01, RP urcb02, GO gcb1, GO gcb2, SG SGCB, LN LPHD1, LN DSCIO1. The SGCB object is highlighted. The table on the right shows the attributes of the SGCB:

Name	FC	Value
NumOfSG	SP	4
ActSG	SP	1
EditSG	SP	0
CnfEdit	SP	false
LActTm	SP	2020-12-14 07:17:59.403 [Leap Second Known][Time Accuracy = 10 bits]

Operations on SGCB

SGCB context menu allows to read all attribute values and to write attributes ActSG, EditSG, CnfSG, ResvTms. A new value should be set in **Value** field of the attribute and confirmed with a proper command.

But a more user-friendly option to configure SGCB and edit settings is to invoke **Edit SG Values** command.



The screenshot shows a software interface with a tree view on the left and a table of SGCB values on the right. The tree view shows a hierarchy of objects, with 'LN LLN0' expanded to show various attributes. The 'SG SGCB' object is selected, and a context menu is open over it, showing three options: 'Edit SG Values...', 'Get SGCB Values', and 'Set SGCB Values'. The 'Edit SG Values...' option is highlighted.

Name	FC	Value
NumOfSG	SP	4
ActSG	SP	1
EditSG	SP	0
CnfEdit	SP	false
LActTm	SP	2020-12-14 07:17:59.403 [Leap Second Known][Time Accurac...

Setting Group Control window

Upon invoking **EditSGValues** command a dedicated **Setting Group Control** window pops up to enable all operations on SGCB as well as editing of values of the selected setting group.

The screenshot shows the 'Setting Group Control' window for 'DemoProtCtrl/LLN0.SG...'. The window is divided into several sections:

- Tree View:** A hierarchical tree on the left showing the device structure. The selected path is 'LD DemoProtCtrl' > 'LN LLN0' > 'SG SGCB'.
- Table:** A table in the center-right lists setting parameters with their functional class (FC) and current value.

Name	FC	Value
NumOfSG	SP	4
ActSG	SP	1
EditSG	SP	0
CnfEdit	SP	false
LActTm	SP	2020-...

- Control Panel:** A panel on the right contains controls for the active setting group, including a dropdown for 'Active Group' (set to '#1'), 'Last Activation Time' (2020-05-06 11:23:34.537 [I]), 'Edit Group' (set to 'none'), and 'Reservation Time [s]' (n/a). It also features 'Confirm Editing' and 'Refresh SGCB' buttons.
- Settings Table:** A table at the bottom right shows the current values for specific settings.

Setting Name	tive Bufl	Edit Buffer
I3GtPTOC1.TmACrv.setCharact	none	n/a
I3GtPTOC1.StrVal.setMag f	0	n/a

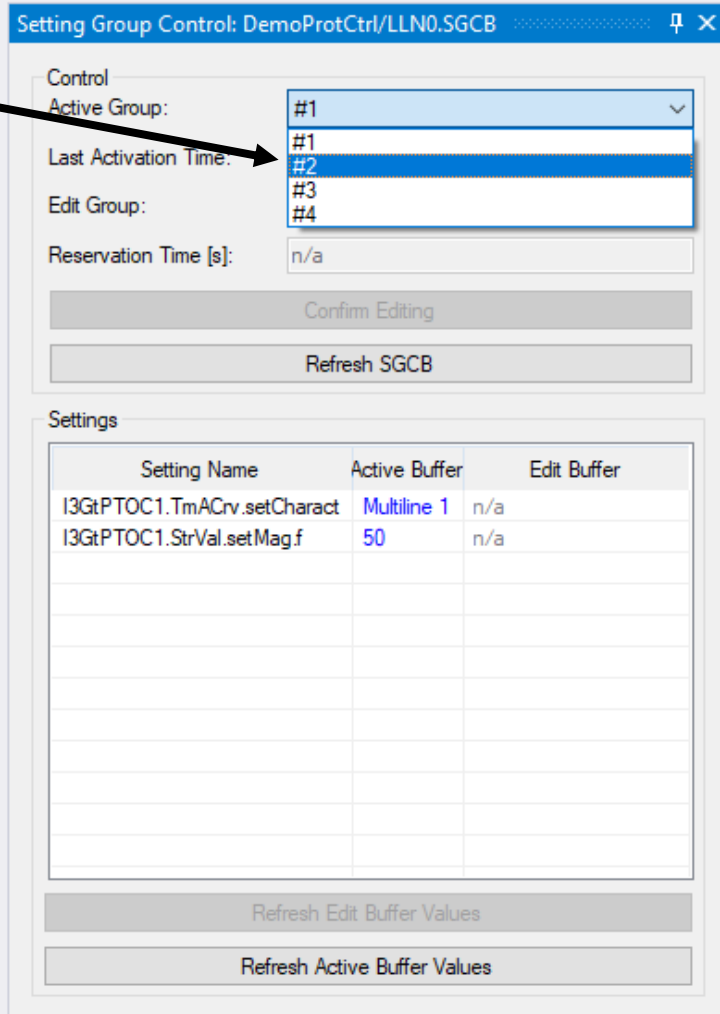
- Bottom Panel:** Includes fields for 'Sequence Number', 'Data Set', 'Entry Identifier', and a 'Report ID' field with a list of reports.

Change of the active setting group

Selection of an active setting group is made from the drop-down list with assigned numbers of all groups implemented in the device.

After changing the active setting group the device should set a new value of **Last Activation Time**.

Setting values from the active group are presented in the list below (**Active** column informs that these are the attributes of FC=SG) – there is no need to search this information in the data model.



Setting Group Control: DemoProtCtrl/LLN0.SGCB

Control
Active Group: #1
Last Activation Time: #2
Edit Group: #3, #4
Reservation Time [s]: n/a

Confirm Editing
Refresh SGCB

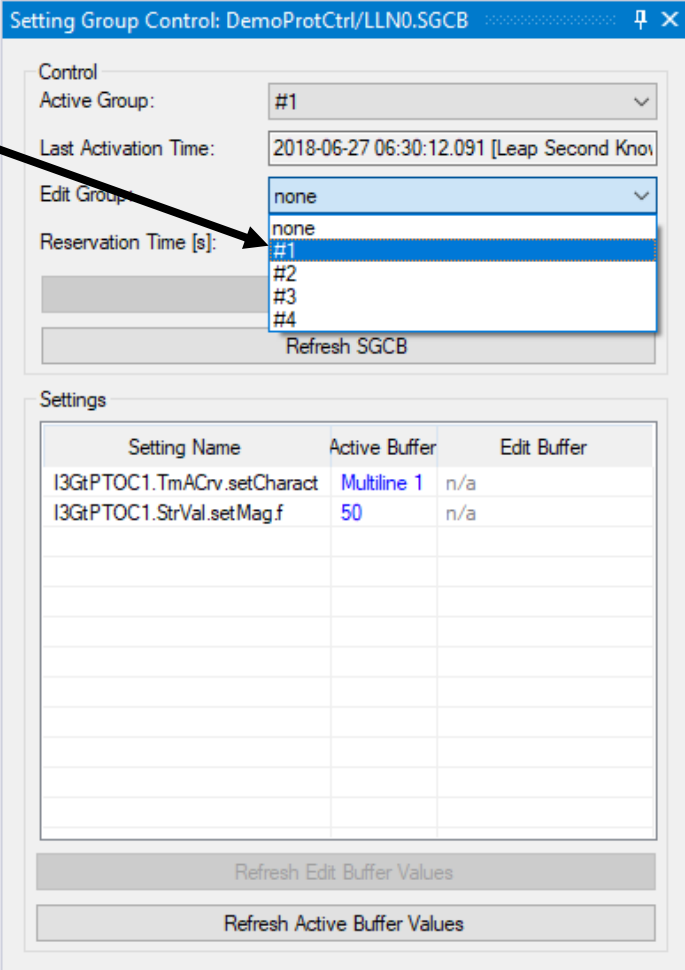
Settings

Setting Name	Active Buffer	Edit Buffer
I3GtPTOC1.TmACrv.setCharact	Multiline 1	n/a
I3GtPTOC1.StrVal.setMag.f	50	n/a

Refresh Edit Buffer Values
Refresh Active Buffer Values

Selection of the setting group for editing

Selection of the setting group for editing is made from the drop-down list with assigned numbers of all groups implemented in the device.
(none – denotes that none of the setting groups shall be available for editing).



Setting Group Control: DemoProtCtrl/LLN0.SGCB

Control

Active Group: #1

Last Activation Time: 2018-06-27 06:30:12.091 [Leap Second Know]

Edit Group: none

Reservation Time [s]:

- none
- #1
- #2
- #3
- #4

Refresh SGCB

Settings

Setting Name	Active Buffer	Edit Buffer
I3GtPTOC1.TmACrv.setCharact	Multiline 1	n/a
I3GtPTOC1.StrVal.setMag.f	50	n/a

Refresh Edit Buffer Values

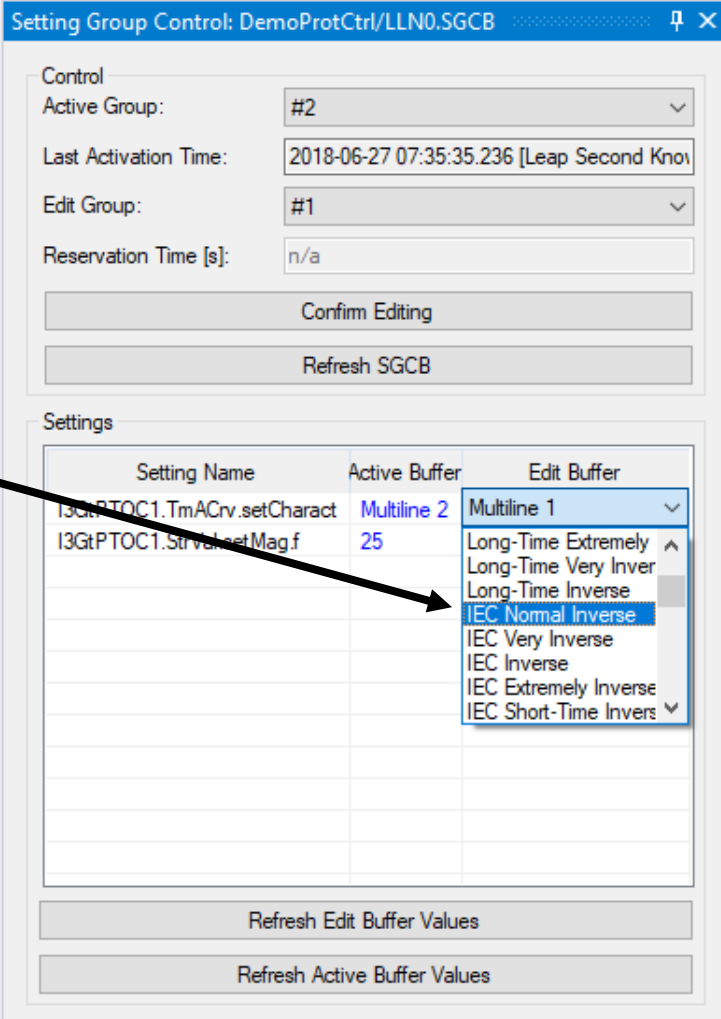
Refresh Active Buffer Values

Change of setting values in the group selected for editing

Setting values from the group selected for editing are presented in the list below (**Edit Buffer** column shows attributes of FC=SE) – there is no need to search this information in the data model.

For settings of enum type a new value can be selected from a drop-down list.

New values are checked for being accepted by the server device.



The screenshot shows a software interface titled "Setting Group Control: DemoProtCtrl/LLN0.SGCB". It features several control fields and a table of settings.

Control fields include:

- Active Group: #2
- Last Activation Time: 2018-06-27 07:35:35.236 [Leap Second Know]
- Edit Group: #1
- Reservation Time [s]: n/a

Buttons include "Confirm Editing" and "Refresh SGCB".

The "Settings" table has the following columns: Setting Name, Active Buffer, and Edit Buffer.

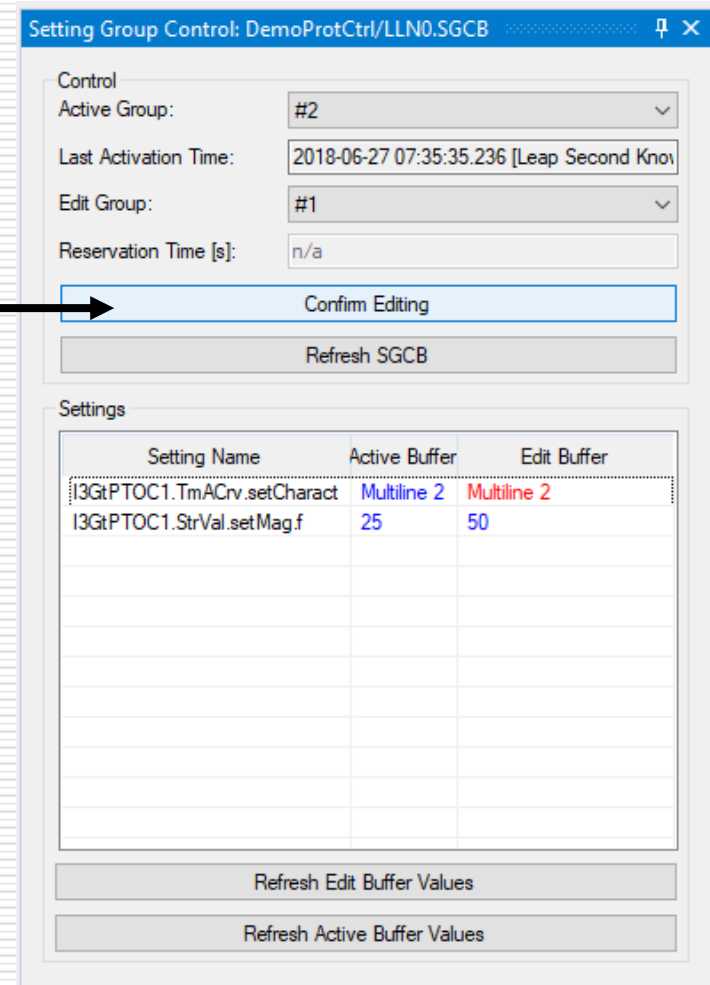
Setting Name	Active Buffer	Edit Buffer
I3GtPTOC1.TmACrv.setCharact	Multiline 2	Multiline 1
I3GtPTOC1.StrVal.setMag.f	25	Long-Time Extremely
		Long-Time Very Inver
		Long-Time Inverse
		IEC Normal Inverse
		IEC Very Inverse
		IEC Inverse
		IEC Extremely Inverse
		IEC Short-Time Invers

A dropdown menu is open for the "Edit Buffer" column of the first row, showing options: Multiline 1, Long-Time Extremely, Long-Time Very Inver, Long-Time Inverse, IEC Normal Inverse, IEC Very Inverse, IEC Inverse, IEC Extremely Inverse, and IEC Short-Time Invers.

Buttons at the bottom include "Refresh Edit Buffer Values" and "Refresh Active Buffer Values".

Confirmation of new setting values from the edited group

Newly introduced setting values are temporarily memorized in the server device (if correct), but their assignment to the group selected for editing must be still confirmed by pressing the command button **Confirm Editing**. Only after that the edited setting group will acquire the new values.



The screenshot shows a window titled "Setting Group Control: DemoProtCtrl/LLN0.SGCB". It contains several fields and buttons:

- Control section:
 - Active Group: #2
 - Last Activation Time: 2018-06-27 07:35:35.236 [Leap Second Know]
 - Edit Group: #1
 - Reservation Time [s]: n/a
- Buttons:
 - Confirm Editing (highlighted with a blue border and an arrow pointing to it from the text on the left)
 - Refresh SGCB
- Settings table:

Setting Name	Active Buffer	Edit Buffer
I3GtPTOC1.TmACrv.setCharact	Multiline 2	Multiline 2
I3GtPTOC1.StrVal.setMag.f	25	50
- Bottom buttons:
 - Refresh Edit Buffer Values
 - Refresh Active Buffer Values

Log view

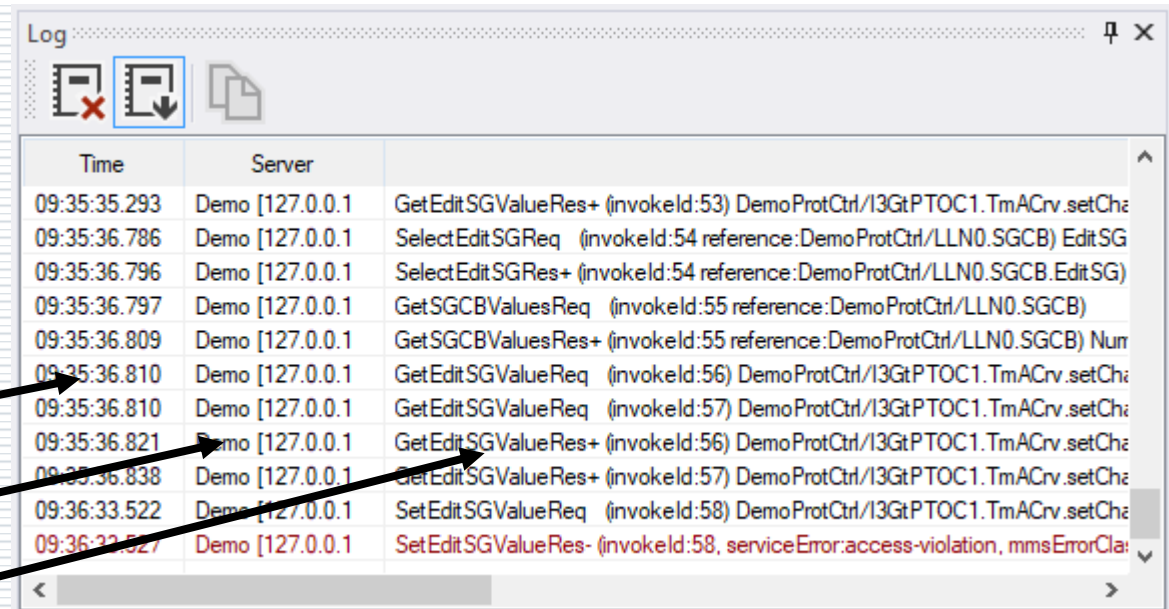
The tool provides a chronological view of operations (commands, responses and events) occurring during the interactions with server devices.

Each message in the log is described by:

Time – timestamp of the occurrence,

Server – device concerned,

Message – description of the operation.



Time	Server	Message
09:35:35.293	Demo [127.0.0.1	GetEditSGValueRes+ (invokeld:53) DemoProtCtrl/13GtPTOC1.TmACrv.setCha
09:35:36.786	Demo [127.0.0.1	SelectEditSGReq (invokeld:54 reference:DemoProtCtrl/LLN0.SGCB) EditSG
09:35:36.796	Demo [127.0.0.1	SelectEditSGRes+ (invokeld:54 reference:DemoProtCtrl/LLN0.SGCB.EditSG)
09:35:36.797	Demo [127.0.0.1	GetSGCBValuesReq (invokeld:55 reference:DemoProtCtrl/LLN0.SGCB)
09:35:36.809	Demo [127.0.0.1	GetSGCBValuesRes+ (invokeld:55 reference:DemoProtCtrl/LLN0.SGCB) Numr
09:35:36.810	Demo [127.0.0.1	GetEditSGValueReq (invokeld:56) DemoProtCtrl/13GtPTOC1.TmACrv.setCha
09:35:36.810	Demo [127.0.0.1	GetEditSGValueReq (invokeld:57) DemoProtCtrl/13GtPTOC1.TmACrv.setCha
09:35:36.821	Demo [127.0.0.1	GetEditSGValueRes+ (invokeld:56) DemoProtCtrl/13GtPTOC1.TmACrv.setCha
09:35:36.838	Demo [127.0.0.1	GetEditSGValueRes+ (invokeld:57) DemoProtCtrl/13GtPTOC1.TmACrv.setCha
09:36:33.522	Demo [127.0.0.1	SetEditSGValueReq (invokeld:58) DemoProtCtrl/13GtPTOC1.TmACrv.setCha
09:36:33.527	Demo [127.0.0.1	SetEditSGValueRes- (invokeld:58, serviceError:access-violation, mmsErrorCla

Finding objects

The search function allows users to enter any string of characters, and then search for matching objects in the data model. The function will highlight all objects in the model with names containing the search text.

The user can start searching for objects using the keyboard shortcut **Ctrl + F**.

The top screenshot shows a search for 'br' in the 'Demo [127.0.0.1]' window. The search results table is as follows:

Name	FC	Value
RptID	BR	
RptEna	BR	false

The middle screenshot shows a search for 'br' in the 'Demo [127.0.0.1]' window. The search results table is as follows:


Name	FC	Value
RptID	BR	
RptEna	BR	false
DatSet	BR	DemoMeasurement/LLNO.DS2_All
ConfRev	BR	1
OptFlds	BR	0111111111 {sequence-number, report-time-stamp, reason-fo...}
BufTm	BR	1000
SqNum	BR	0
TrgOps	BR	011111 {data-change, quality-change, data-update, integrity, g...}
IntgPd	BR	0
CP	BR	false


The bottom screenshot shows the search menu with 'Find...' selected. The search results table is as follows:

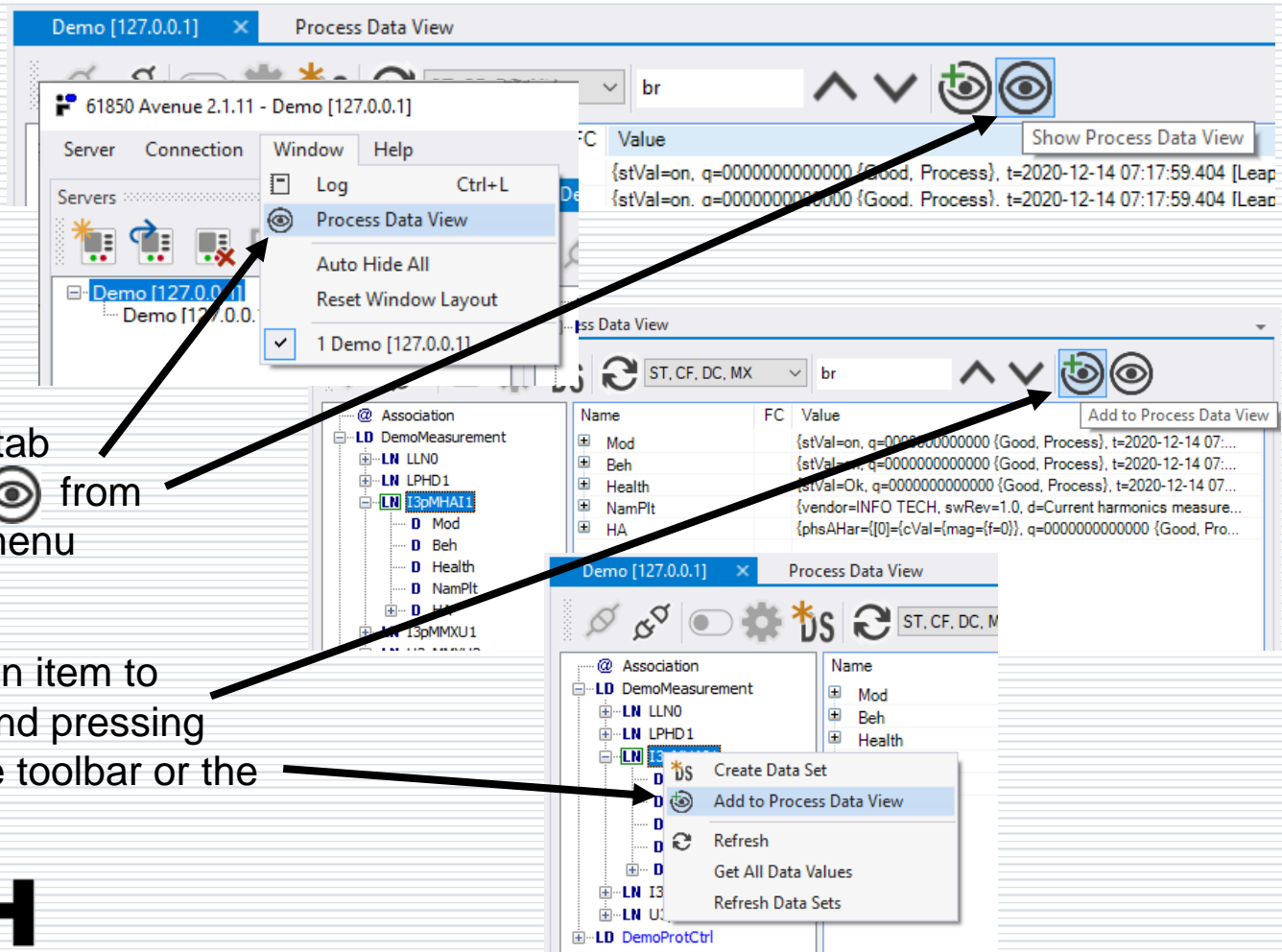
Name	FC	Value
DemoMeasurement		
DemoProtCtrl		

Process Data View - adding objects

Process Data View (PDV) is a common view to monitor selected items from different IEDs.


PDV is a separate tab opened by button  from the toolbar or the menu *Window*


The user can add an item to PDV by selecting and pressing button  from the toolbar or the context menu.





Process Data View (PDV) - toolbar

PDV toolbar is composed of the following elements:

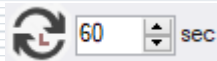
Confirming update of all items by button 

Removing item(s) from PDV by button 

Refreshing selected items by button 

Copying selection by button 


Data polling settings



The user can configure PDV presentation scope (right click on the table header) by showing / hiding columns of specific data attributes.

Location	Function	Object name	Value	Quality	Timestamp	FC	Reference
DemoMeasurement	I3pMHAI1	HA.phsBHar(14)	0	000000000000 {Good, Process}	1970-01-01 00:00:...	MX	DemoMeasurement/I3pMHAI1.HA.phsBHar(...)
DemoMeasurement	I3pMHAI1	HA.phsBHar(15)	0	000000000000 {Good, Process}	1970-01-01 00:00:...	MX	DemoMeasurement/I3pMHAI1.HA.phsBHar(...)
DemoMeasurement	I3pMHAI1	HA.phsChar(0)	0	000000000000 {Good, Process}	1970-01-01 00:00:...	MX	DemoMeasurement/I3pMHAI1.HA.phsChar(...)
DemoMeasurement	I3pMHAI1	HA.phsChar(1)	0	000000000000 {Good, Process}	1970-01-01 00:00:...	MX	DemoMeasurement/I3pMHAI1.HA.phsChar(...)
DemoMeasurement	I3pMHAI1	HA.phsChar(2)	0	000000000000 {Good, Process}	1970-01-01 00:00:...	MX	DemoMeasurement/I3pMHAI1.HA.phsChar(...)
DemoMeasurement	I3pMHAI1	HA.phsChar(3)	0	000000000000 {Good, Process}	1970-01-01 00:00:...	MX	DemoMeasurement/I3pMHAI1.HA.phsChar(...)
DemoMeasurement	I3pMHAI1	HA.phsChar(4)	0	000000000000 {Good, Process}	1970-01-01 00:00:...	MX	DemoMeasurement/I3pMHAI1.HA.phsChar(...)
DemoMeasurement	I3pMHAI1	HA.phsChar(5)	0	000000000000 {Good, Process}	1970-01-01 00:00:...	MX	DemoMeasurement/I3pMHAI1.HA.phsChar(...)
DemoMeasurement	I3pMHAI1	HA.phsChar(6)	0	000000000000 {Good, Process}	1970-01-01 00:00:...	MX	DemoMeasurement/I3pMHAI1.HA.phsChar(...)
DemoMeasurement	I3pMHAI1	HA.phsChar(7)	0	000000000000 {Good, Process}	1970-01-01 00:00:...	MX	DemoMeasurement/I3pMHAI1.HA.phsChar(...)
DemoMeasurement	I3pMHAI1	HA.phsChar(8)	0	000000000000 {Good, Process}	1970-01-01 00:00:...	MX	DemoMeasurement/I3pMHAI1.HA.phsChar(...)
DemoMeasurement	I3pMHAI1	HA.phsChar(9)	0	000000000000 {Good, Process}	1970-01-01 00:00:...	MX	DemoMeasurement/I3pMHAI1.HA.phsChar(...)
DemoMeasurement	I3pMHAI1	HA.phsChar(10)	0	000000000000 {Good, Process}	1970-01-01 00:00:...	MX	DemoMeasurement/I3pMHAI1.HA.phsChar(...)
DemoMeasurement	I3pMHAI1	HA.phsChar(11)	0	000000000000 {Good, Process}	1970-01-01 00:00:...	MX	DemoMeasurement/I3pMHAI1.HA.phsChar(...)
DemoMeasurement	I3pMHAI1	HA.phsChar(12)	0	000000000000 {Good, Process}	1970-01-01 00:00:...	MX	DemoMeasurement/I3pMHAI1.HA.phsChar(...)
DemoMeasurement	I3pMHAI1	HA.phsChar(13)	0	000000000000 {Good, Process}	1970-01-01 00:00:...	MX	DemoMeasurement/I3pMHAI1.HA.phsChar(...)
DemoMeasurement	I3pMHAI1	HA.phsChar(14)	0	000000000000 {Good, Process}	1970-01-01 00:00:...	MX	DemoMeasurement/I3pMHAI1.HA.phsChar(...)
DemoMeasurement	I3pMHAI1	HA.phsChar(15)	0	000000000000 {Good, Process}	1970-01-01 00:00:...	MX	DemoMeasurement/I3pMHAI1.HA.phsChar(...)
DemoMeasurement	I3pMMXU1	Mod - Mode	on	000000000000 {Good, Process}	2023-03-06 11:54:...	ST	DemoMeasurement/I3pMMXU1.Mod.stVal
DemoMeasurement	I3pMMXU1	Beh - Behaviour	on	000000000000 {Good, Process}	2023-03-06 11:54:...	ST	DemoMeasurement/I3pMMXU1.Beh.stVal
DemoMeasurement	I3pMMXU1	Health - Health	Ok	000000000000 {Good, Process}	2023-03-06 11:54:...	ST	DemoMeasurement/I3pMMXU1.Health.stVal
DemoMeasurement	I3pMMXU1	A.phsA - Phase A current	0 A	000000000000 {Good, Process}	2023-03-06 11:54:...	MX	DemoMeasurement/I3pMMXU1.A.phsA.cVal...
DemoMeasurement	I3pMMXU1	A.phsB - Phase B current	0 A				B.cVal...
DemoMeasurement	I3pMMXU1	A.phsC - Phase C current	0 A				C.cVal...
DemoMeasurement	LPHD1	PhyHealth - OK	Ok				.stVal
DemoMeasurement	LPHD1	Proxy - Indicates if this LN is a proxy	false				al
DemoMeasurement	U3pMMXU2	Mod - Mode	on				stVal
DemoMeasurement	U3pMMXU2	Beh - Behaviour	on				stVal
DemoMeasurement	U3pMMXU2	Health - Health	Ok				h.stVal
DemoMeasurement	U3pMMXU2	PhV.phsA - Phase A voltage	15000 V				phsA.cv...
DemoMeasurement	U3pMMXU2	PhV.phsB - Phase B voltage	15000 V				phsB.cv...
DemoMeasurement	U3pMMXU2	PhV.phsC - Phase C voltage	15000 V				phsC.cv...
DemoMeasurement	I3pMHAI1	HA.phsAHar.[0]	0				
DemoMeasurement	I3pMHAI1	HA.phsAHar.[1]	100				
DemoMeasurement	I3pMHAI1	HA.phsAHar.[2]	0				
DemoMeasurement	I3pMHAI1	HA.phsAHar.[3]	0				
DemoMeasurement	I3pMHAI1	HA.phsAHar.[4]	0				
DemoMeasurement	I3pMHAI1	HA.phsAHar.[5]	0				
DemoMeasurement	I3pMHAI1	HA.phsAHar.[6]	0				
DemoMeasurement	I3pMHAI1	HA.phsAHar.[7]	0				
DemoMeasurement	I3pMHAI1	HA.phsAHar.[8]	0				

Process Data View (PDV) – data polling

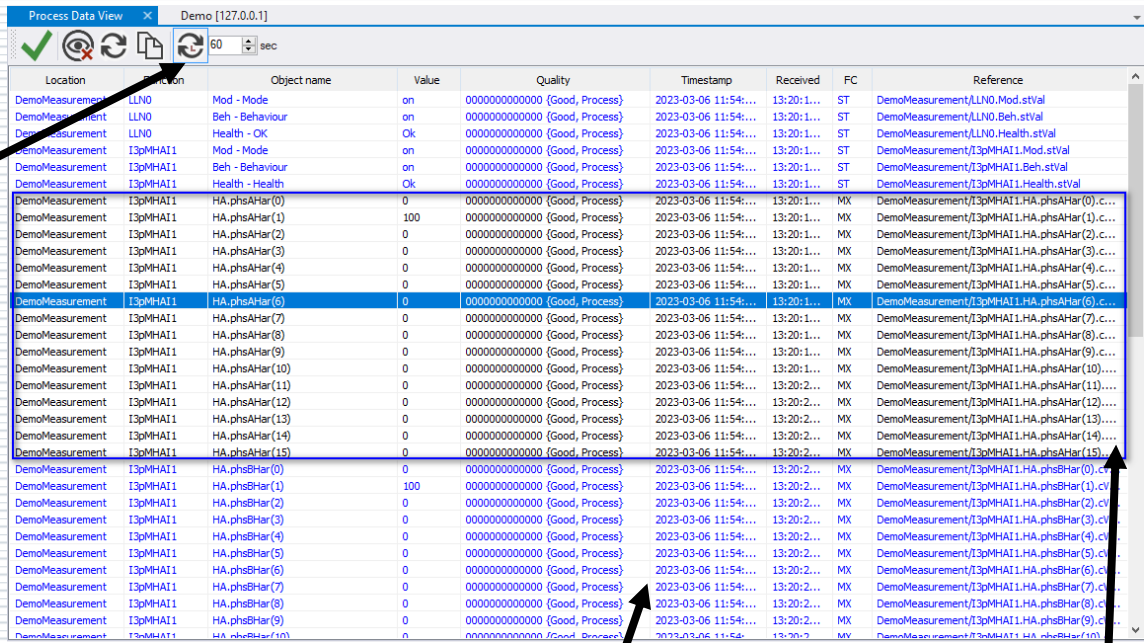
After adding items to PDV, the user can enable (or disable) cyclic data polling by clicking 

Enabled data polling.

The configurable parameters for cyclic polling of PDV items are:

- Polling cycle sec (default value is 60 seconds).
- Number of items in one request. Configurable in the Options view (Help -> Options):

PDV items count limit per poll:



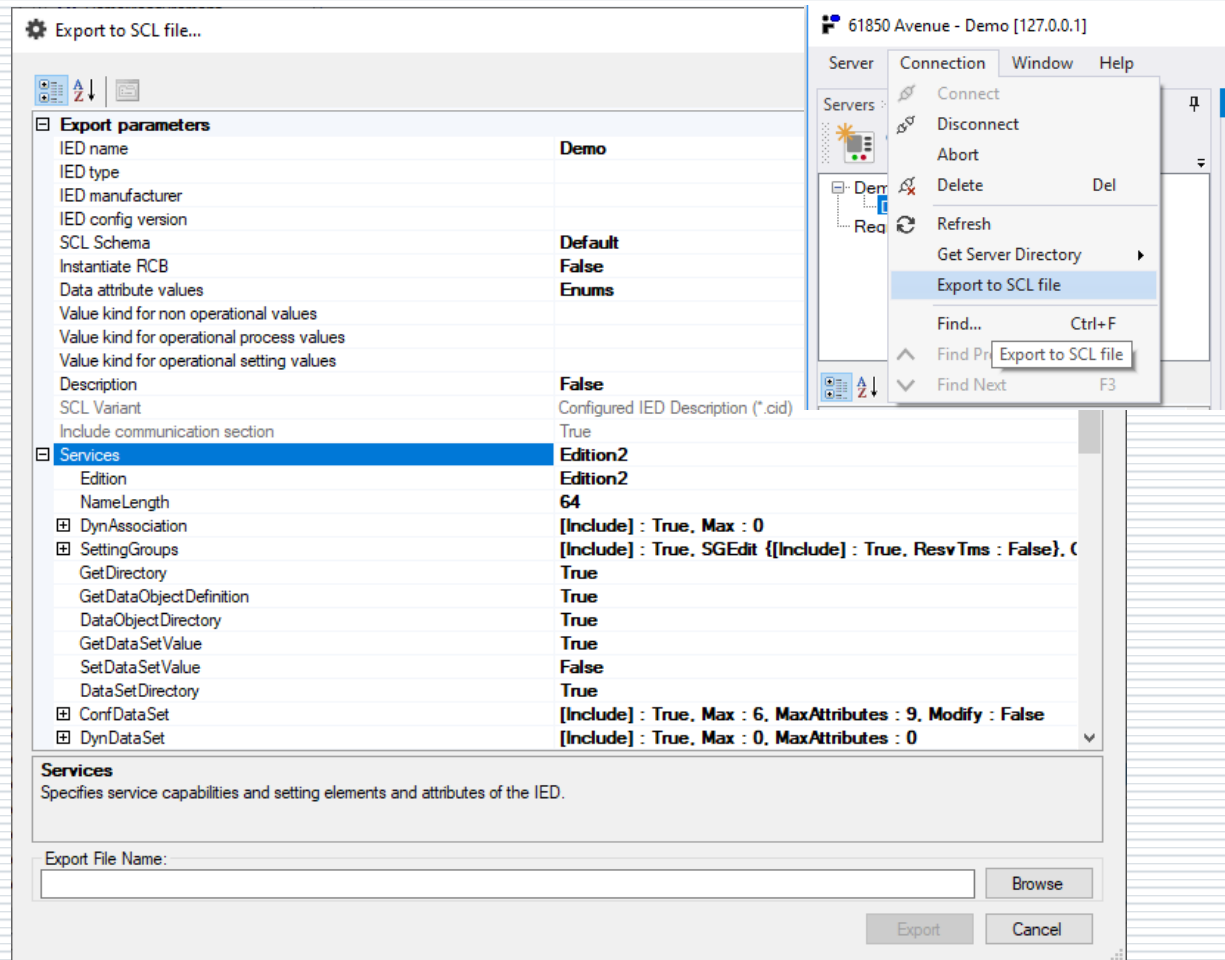
Location	Object name	Value	Quality	Timestamp	Received	FC	Reference
DemoMeasurement.LLN0	Mod - Mode	on	000000000000 (Good, Process)	2023-03-06 11:54:...	13:20:1...	ST	DemoMeasurement.LLN0.Mod.stVal
DemoMeasurement.LLN0	Beh - Behaviour	on	000000000000 (Good, Process)	2023-03-06 11:54:...	13:20:1...	ST	DemoMeasurement.LLN0.Beh.stVal
DemoMeasurement.LLN0	Health - OK	OK	000000000000 (Good, Process)	2023-03-06 11:54:...	13:20:1...	ST	DemoMeasurement.LLN0.Health.stVal
DemoMeasurement.I3pMHA11	Mod - Mode	on	000000000000 (Good, Process)	2023-03-06 11:54:...	13:20:1...	ST	DemoMeasurement.I3pMHA11.Mod.stVal
DemoMeasurement.I3pMHA11	Beh - Behaviour	on	000000000000 (Good, Process)	2023-03-06 11:54:...	13:20:1...	ST	DemoMeasurement.I3pMHA11.Beh.stVal
DemoMeasurement.I3pMHA11	Health - Health	OK	000000000000 (Good, Process)	2023-03-06 11:54:...	13:20:1...	ST	DemoMeasurement.I3pMHA11.Health.stVal
DemoMeasurement.I3pMHA11	HA.phsAHar(0)	0	000000000000 (Good, Process)	2023-03-06 11:54:...	13:20:1...	MX	DemoMeasurement.I3pMHA11.HA.phsAHar(0).c...
DemoMeasurement.I3pMHA11	HA.phsAHar(1)	100	000000000000 (Good, Process)	2023-03-06 11:54:...	13:20:1...	MX	DemoMeasurement.I3pMHA11.HA.phsAHar(1).c...
DemoMeasurement.I3pMHA11	HA.phsAHar(2)	0	000000000000 (Good, Process)	2023-03-06 11:54:...	13:20:1...	MX	DemoMeasurement.I3pMHA11.HA.phsAHar(2).c...
DemoMeasurement.I3pMHA11	HA.phsAHar(3)	0	000000000000 (Good, Process)	2023-03-06 11:54:...	13:20:1...	MX	DemoMeasurement.I3pMHA11.HA.phsAHar(3).c...
DemoMeasurement.I3pMHA11	HA.phsAHar(4)	0	000000000000 (Good, Process)	2023-03-06 11:54:...	13:20:1...	MX	DemoMeasurement.I3pMHA11.HA.phsAHar(4).c...
DemoMeasurement.I3pMHA11	HA.phsAHar(5)	0	000000000000 (Good, Process)	2023-03-06 11:54:...	13:20:1...	MX	DemoMeasurement.I3pMHA11.HA.phsAHar(5).c...
DemoMeasurement.I3pMHA11	HA.phsAHar(6)	0	000000000000 (Good, Process)	2023-03-06 11:54:...	13:20:1...	MX	DemoMeasurement.I3pMHA11.HA.phsAHar(6).c...
DemoMeasurement.I3pMHA11	HA.phsAHar(7)	0	000000000000 (Good, Process)	2023-03-06 11:54:...	13:20:1...	MX	DemoMeasurement.I3pMHA11.HA.phsAHar(7).c...
DemoMeasurement.I3pMHA11	HA.phsAHar(8)	0	000000000000 (Good, Process)	2023-03-06 11:54:...	13:20:1...	MX	DemoMeasurement.I3pMHA11.HA.phsAHar(8).c...
DemoMeasurement.I3pMHA11	HA.phsAHar(9)	0	000000000000 (Good, Process)	2023-03-06 11:54:...	13:20:1...	MX	DemoMeasurement.I3pMHA11.HA.phsAHar(9).c...
DemoMeasurement.I3pMHA11	HA.phsAHar(10)	0	000000000000 (Good, Process)	2023-03-06 11:54:...	13:20:1...	MX	DemoMeasurement.I3pMHA11.HA.phsAHar(10).c...
DemoMeasurement.I3pMHA11	HA.phsAHar(11)	0	000000000000 (Good, Process)	2023-03-06 11:54:...	13:20:2...	MX	DemoMeasurement.I3pMHA11.HA.phsAHar(11).c...
DemoMeasurement.I3pMHA11	HA.phsAHar(12)	0	000000000000 (Good, Process)	2023-03-06 11:54:...	13:20:2...	MX	DemoMeasurement.I3pMHA11.HA.phsAHar(12).c...
DemoMeasurement.I3pMHA11	HA.phsAHar(13)	0	000000000000 (Good, Process)	2023-03-06 11:54:...	13:20:2...	MX	DemoMeasurement.I3pMHA11.HA.phsAHar(13).c...
DemoMeasurement.I3pMHA11	HA.phsAHar(14)	0	000000000000 (Good, Process)	2023-03-06 11:54:...	13:20:2...	MX	DemoMeasurement.I3pMHA11.HA.phsAHar(14).c...
DemoMeasurement.I3pMHA11	HA.phsAHar(15)	0	000000000000 (Good, Process)	2023-03-06 11:54:...	13:20:2...	MX	DemoMeasurement.I3pMHA11.HA.phsAHar(15).c...
DemoMeasurement.I3pMHA11	HA.phsBHar(0)	0	000000000000 (Good, Process)	2023-03-06 11:54:...	13:20:2...	MX	DemoMeasurement.I3pMHA11.HA.phsBHar(0).c...
DemoMeasurement.I3pMHA11	HA.phsBHar(1)	100	000000000000 (Good, Process)	2023-03-06 11:54:...	13:20:2...	MX	DemoMeasurement.I3pMHA11.HA.phsBHar(1).c...
DemoMeasurement.I3pMHA11	HA.phsBHar(2)	0	000000000000 (Good, Process)	2023-03-06 11:54:...	13:20:2...	MX	DemoMeasurement.I3pMHA11.HA.phsBHar(2).c...
DemoMeasurement.I3pMHA11	HA.phsBHar(3)	0	000000000000 (Good, Process)	2023-03-06 11:54:...	13:20:2...	MX	DemoMeasurement.I3pMHA11.HA.phsBHar(3).c...
DemoMeasurement.I3pMHA11	HA.phsBHar(4)	0	000000000000 (Good, Process)	2023-03-06 11:54:...	13:20:2...	MX	DemoMeasurement.I3pMHA11.HA.phsBHar(4).c...
DemoMeasurement.I3pMHA11	HA.phsBHar(5)	0	000000000000 (Good, Process)	2023-03-06 11:54:...	13:20:2...	MX	DemoMeasurement.I3pMHA11.HA.phsBHar(5).c...
DemoMeasurement.I3pMHA11	HA.phsBHar(6)	0	000000000000 (Good, Process)	2023-03-06 11:54:...	13:20:2...	MX	DemoMeasurement.I3pMHA11.HA.phsBHar(6).c...
DemoMeasurement.I3pMHA11	HA.phsBHar(7)	0	000000000000 (Good, Process)	2023-03-06 11:54:...	13:20:2...	MX	DemoMeasurement.I3pMHA11.HA.phsBHar(7).c...
DemoMeasurement.I3pMHA11	HA.phsBHar(8)	0	000000000000 (Good, Process)	2023-03-06 11:54:...	13:20:2...	MX	DemoMeasurement.I3pMHA11.HA.phsBHar(8).c...
DemoMeasurement.I3pMHA11	HA.phsBHar(9)	0	000000000000 (Good, Process)	2023-03-06 11:54:...	13:20:2...	MX	DemoMeasurement.I3pMHA11.HA.phsBHar(9).c...
DemoMeasurement.I3pMHA11	HA.phsBHar(10)	0	000000000000 (Good, Process)	2023-03-06 11:54:...	13:20:2...	MX	DemoMeasurement.I3pMHA11.HA.phsBHar(10).c...

The PDV items highlighted with blue font are the ones that have been refreshed but not yet viewed by the user. After viewing by the user, the refreshed item is set back to the default black font.

Generation of ICD/CID file

Possible for a selected server device with explored data model. By invoking **Export to SCL file...** command.

The user can adjust the produced SCL file in the dialog of parameter selection.



What else can be found in 61850 Avenue toolset ...

- IEC 61850 Relay Simulator
- GOOSE testing toolset
- Sampled Values testing toolset
- File transfer testing toolset
- IEC 61850 ICD Editor



61850 Relay Simulator

Feeder bay model with circuit breaker and disconnecter.

Simple overcurrent protection relay with IEC61850 server interface (representative classes of LNs, fixed data model).

An excellent tool to help comprehending how a protection relay is seen in the IEC 61850 communication network.

Very easy to use for testing operations of the IEC 61850 client end.



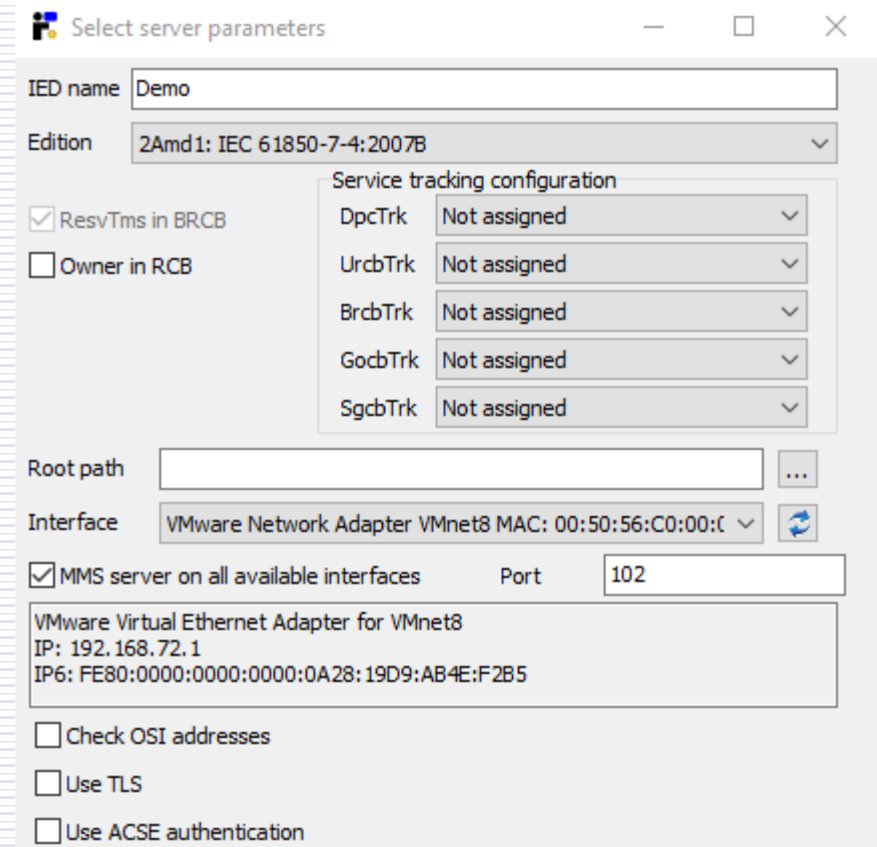
IEC 61850 Relay: Setup in the start view - edition

Standard edition to be applied can be selected by the user (1, 2 or 2.1).

Other connection parameters:

- Optional RCB attributes can be included.
- Service tracking configuration can be added.
- OSI addresses can be optionally checked.
- MMS communication on port 102 or optionally secure communication using TLS on port 3782 and optionally ACSE authentication.

Connection on the selected interface or on all interfaces can be accepted.



Select server parameters

IED name: Demo

Edition: 2Amd1: IEC 61850-7-4:2007B

ResvTms in BRCB

Owner in RCB

Service tracking configuration

DpcTrk	Not assigned
UrcbTrk	Not assigned
BrcbTrk	Not assigned
GocbTrk	Not assigned
SgcbTrk	Not assigned

Root path: [Empty]

Interface: VMware Network Adapter VMnet8 MAC: 00:50:56:C0:00:C...

MMS server on all available interfaces Port: 102

VMware Virtual Ethernet Adapter for VMnet8
IP: 192.168.72.1
IP6: FE80:0000:0000:0000:0A28:19D9:AB4E:F2B5

Check OSI addresses

Use TLS







Use ACSE authentication

IEC 61850 Relay: Setup in the start view – TLS & ACSE

When using TLS and ACSE:

- the port number must be set to 3782,
- the certificate and private key of the server must be provided,
- the certificate of Certificate Authority, Certificate Revocation List and the certificate of the client must be provided,
- optionally, the allowed IP addresses of the client can be defined.

The screenshot shows a configuration dialog box with the following elements:

- MMS server on all available interfaces Port:
- VMware Virtual Ethernet Adapter for VMnet8
IP: 192.168.72.1
IP6: FE80:0000:0000:0000:0A28:19D9:AB4E:F2B5
- Check OSI addresses
- Use TLS
- Use ACSE authentication
- Server cybersecurity configuration:
 - Certificate: 
 - Private key: 
- Client cybersecurity configuration:
 - CA file: 
 - CRL file: 
 - Certificate: 
 - Allowed IPs: 
-

IEC 61850 Relay: Outgoing feeder bay simulator

Feeder bay model with circuit breaker and disconnecter.

Simple overcurrent protection relay with IEC61850 server interface (representative classes of LNs, fixed data model).

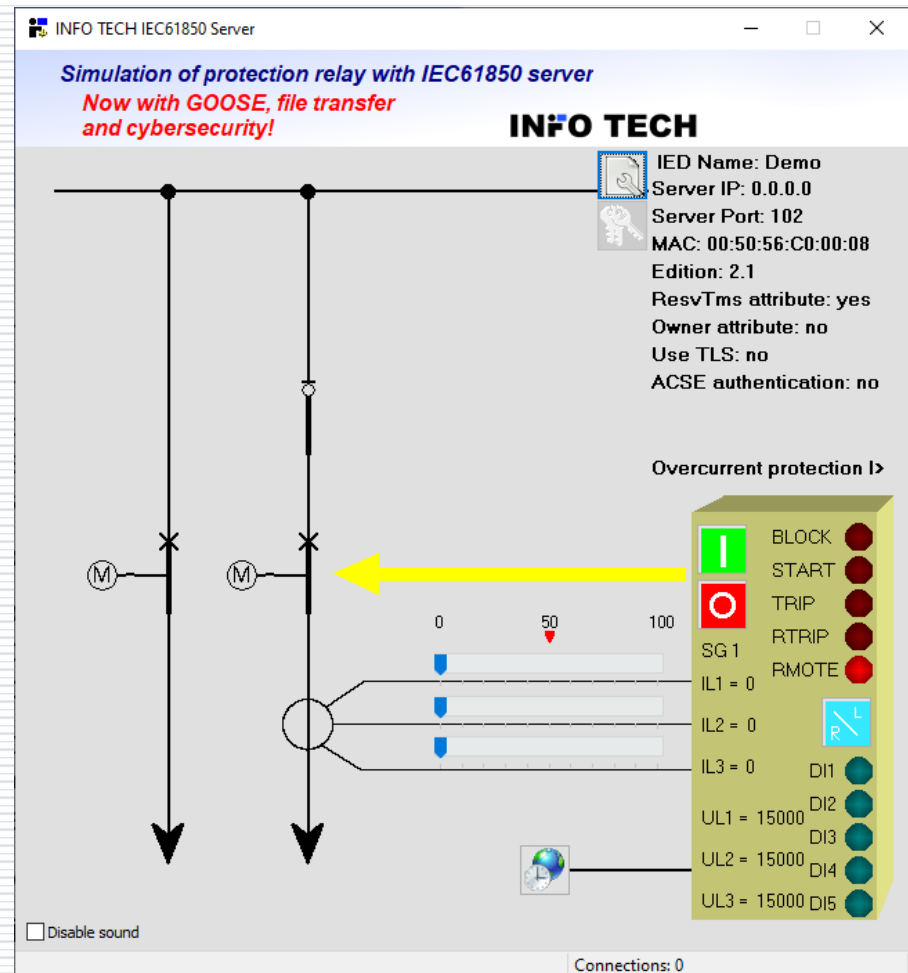
Local and remote monitoring.

Local and remote control (DO-es control model) with hardwired interlocking.

Additional line with circuit breaker for demonstration of an alternative control model (SBO-es).

Simulation of CB motor failure.

Client of time server.



IEC 61850 Relay: options for Ed.1, Ed.2 and Ed.2.1

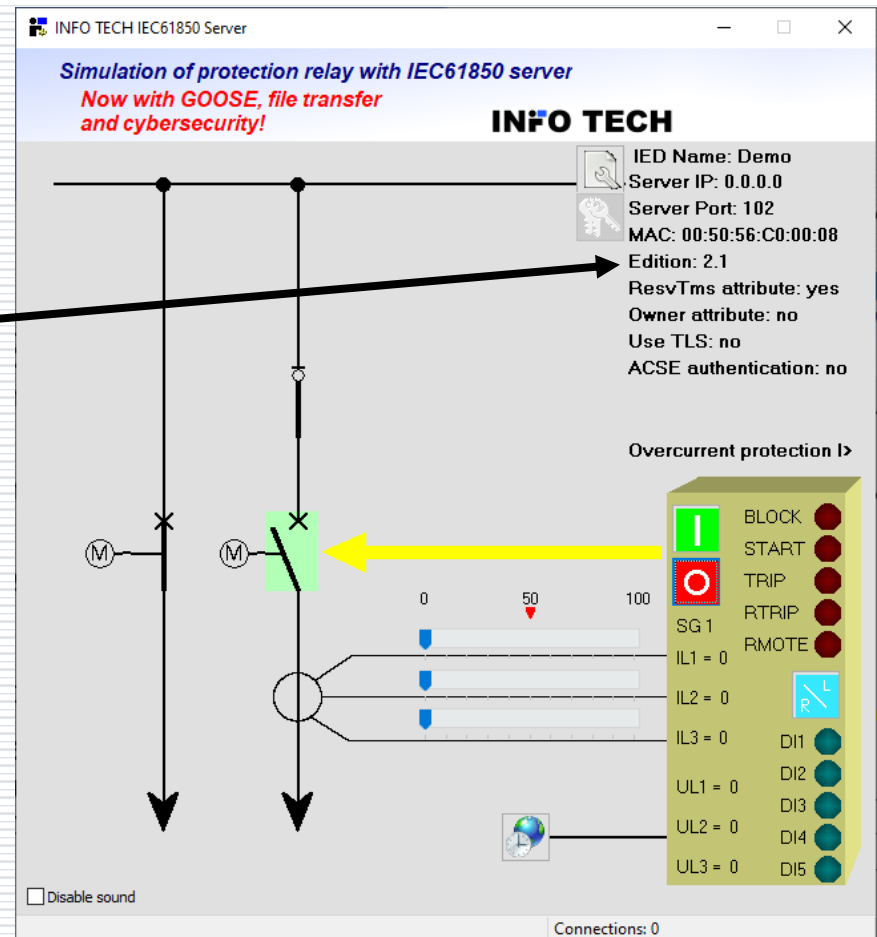
Three options of the simulator program execution are available:

- Conformant with IEC 61850 Ed.1
- Conformant with IEC 61850 Ed.2
- Conformant with IEC 61850 Ed.2.1

(with different ICD files).

Note:

Remember that on the same PC you can run only one instance of the simulator program at a time.

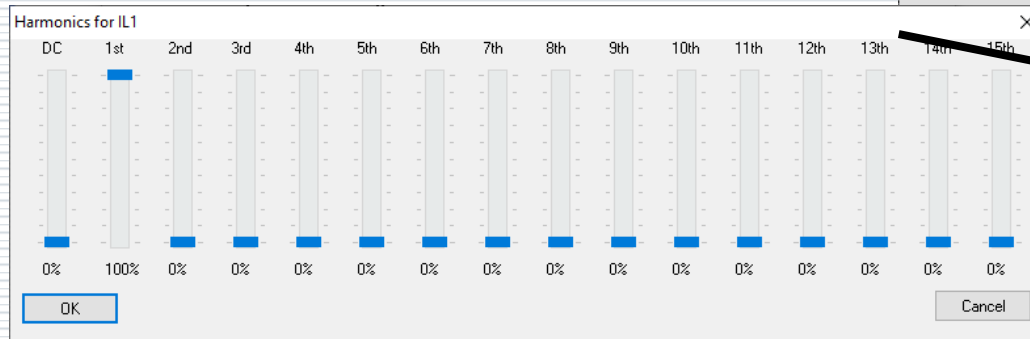


IEC 61850 Relay: simulation of analog signals

Current level can be driven for each phase (manually or by formula, e.g. time dependent) – menu on its scroll bar.

Possibility to simulate harmonic distortion – click on signal name.

Overcurrent protection with inverse time characteristics.



INFO TECH IEC61850 Server

Simulation of protection relay with IEC61850 server
Now with GOOSE, file transfer and cybersecurity!

INFO TECH

IED Name: Demo
Server IP: 0.0.0.0
Server Port: 102
MAC: 00:50:56:C0:00:08
Edition: 2.1
ResvTms attribute: yes
Owner attribute: no
Use TLS: no
ACSE authentication: no

Overcurrent protection I>

- BLOCK
- START
- TRIP
- RTRIP
- SG 1
- RMOTE
- IL1 = 48
- IL2 = 49
- IL3 = 49
- UL1 = 13560
- UL2 = 13530
- UL3 = 13530
- DI1
- DI2
- DI3
- DI4
- DI5

Connections: 0

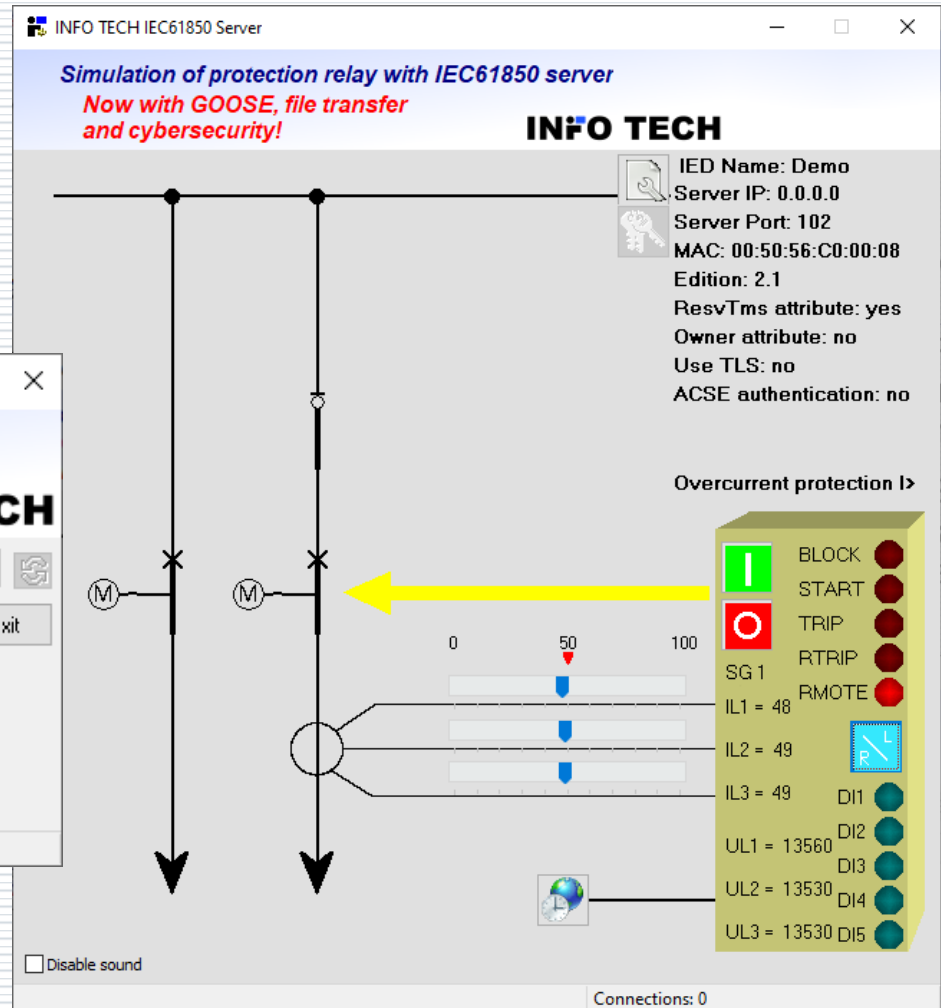
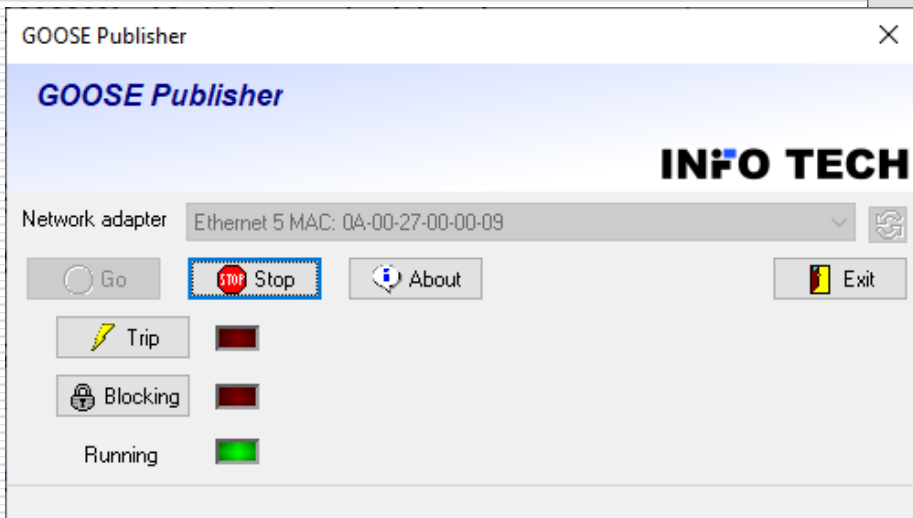
Disable sound

The screenshot shows a simulation interface for an IEC 61850 relay. It features a main window with a title bar and a menu bar. The main area displays a simulation diagram with a motor (M) and a circuit breaker. A yellow arrow points to a current value of 50 on a scale from 0 to 100. A dialog box titled 'Edit automatic formula' is open, showing 'IL1 = 49'. Another dialog box titled 'Harmonics for IL1' is also open, showing a bar chart with the 1st harmonic at 100% and all other harmonics at 0%. The interface includes a status bar at the bottom with 'Connections: 0' and a 'Disable sound' checkbox.

IEC 61850 Relay: GOOSE communication

GOOSE Publisher function (in a separate program): publishing status changes.

GOOSE Subscriber function: enables **remote tripping** and **remote protection blocking** from another application.



IEC 61850 Relay: Export of configuration files

Export of ICD file.

If TLS and/or ACSE used:
Export of secrets (file with
certificates and keys)

GOOSE Toolset



GOOSE toolset: GOOSE Sender – configurable publisher

The program operating as GOOSE Publisher with configurable transmission parameters of GOOSE messages, including the possibility of creating a dataset with data values driven manually by the user or by calculation formulas.

Press **GO** button to start publishing and **STOP** button to terminate.

Note: The program by default sets the GOOSE message **Simulation** bit (Ed.2) / **Test** bit (Ed.1) to TRUE to avoid unwanted consequences of transmitting GOOSE messages. It is the user's responsibility to change this bit value.

Idx	Type	Value	Formula	Data reference
0	BOOL	FALSE		
1	STRUCT	5 element(s)		
1.0	BOOL	FALSE		
1.1	QUALITY	00000000000000		
1.2	TIME	2023-03-08 08:18:49.749		
2	INT	0		

Remember to select the correct Ethernet adapter from the list of **Network adapter** parameter.

GOOSE Sender – data values defined by formulas

if	Conditional result: if argument 1 evaluates to true (is not 0) result is equal to argument 2 otherwise result is equal to argument 3
intpower	IntPower raises argument 1 to the power specified by argument 2 (both arguments are treated as integers)
ln	Natural logarithm ($\ln(e) = 1$) of the argument
log10	Logarithm of base 10 of the argument
logN	Logarithm base N of X
max	Maximum of 2 arguments
min	Minimum of 2 arguments
pi	The ratio of a circle's circumference to its diameter. Pi is approximated as 3.1415926535897932385
pow	Power raises argument 1 (base) to power given by argument 2 (exponent). For fractional exponents or exponents greater than 2147483647, base must be greater than 0
radtodeg	Converts angles measured in radians to degrees
randG	Produces random numbers with Gaussian distribution parametrized by argument 2 (standard deviation) about the argument 1 (mean).
random	Produces random number within the range $0 \leq X < 1$
round	Rounds a real-type value to an integer-type value
sin	Sine of the argument
sinh	Hyperbolic sine of the argument
sq	Square of the argument
sqrt	Square root of the argument
tan	Tangent of X
tanh	Hyperbolic tangent of X
trunc	Truncates a real-type value to an integer-type value (value of X rounded toward zero)

Symbol	Explanation
!	Factorial i.e. !5 gives $1*2*3*4*5 = 120$
%	Percentage i.e. 10% gives 0.1
-	Negate i.e. -10 gives -10 and --10 gives 10
+	Positive value i.e. +10 gives 10
^	Power i.e. 3^2 gives 9
*	Multiplication i.e. $2*2$ gives 4
/	Division i.e. $4/2$ gives 2
div	Integer division (result and operands are treated as integers)
mod	Remainder i.e. $3 \bmod 2$ gives 1 (result and operands are treated as integers)
+	Sum i.e. $2+2$ gives 4
-	Subtract i.e. $4-2$ gives 2
-	Subtract i.e. $4-2$ gives 2
-	Subtract i.e. $4-2$ gives 2
<	Less than i.e. $3 < 2$ gives 0 (false)
<=	Less than or equal to i.e. $1 \leq 2$ gives 1 (true)
>=	Greater than or equal to i.e. $4 \geq 2$ gives 1 (true)
>	Greater than i.e. $4 > 2$ gives 2
=	Equal to i.e. $4 = 2$ gives 0 (false)
<>	Not equal to i.e. $4 \neq 2$ gives 1 (true)
not	Logical negation i.e. not 0 gives 1 and not 1 gives 0
or	Bitwise or i.e. 1 or 4 gives 5
and	Bitwise and i.e. 3 and 6 gives 2
xor	Bitwise xor i.e. $7 \text{ xor } 5$ gives 2

When defining formulas for calculating data values and their changes it is possible to use various operators, functions and variable T representing time counter (in seconds) from the publisher function start, e.g.:

- T mod 2 - sequence false, true, false ... (1 s interval)
- $30+10*\sin(2*T)$ - sin wave with average value 30
- if(T mod 2, 10, -10) - square wave -10,10,-10 ...

GOOSE Sender – configuration based on imported SCL file

It is possible to configure GOOSE Publisher function by the definition of GoCB object included in the imported SCL file. Transmission parameters and the dataset will be configured as specified in the chosen control block of the selected device.

The screenshot shows the 'GOOSE Sender' application window. The 'Import' menu is open, and the 'GOOSE' configuration panel is active. The 'Network adapter' is set to 'Ethernet 5 MAC: 0A-00-27-00-00-09'. The 'GOOSE' configuration includes fields for Edition (1), App ID (2), Fixed (FALSE), DSRef (LLN0\$DS4), CBRRef (LLN0\$gcb1), GID (G2), Time (2023-03-08 08:02:55.610), TTL (4000), StNum (1), SqNum (113), CfgRev (1), NComm (FALSE), and Test (TRUE). The 'Data items' table is also visible, showing a list of GOOSE streams.

Idx	Type	Value	Formula	Data reference				
1	Demo	Not routable	01-0C-CD-01-00-00	0001	1	G1	DemoProtCtrl/LLN0\$GO\$acb1	DemoProtCtrl/DIGGIO1.Ind1.stVal [ST]
2	Demo	Not routable	01-0C-CD-01-00-01	0002	1	G2	DemoProtCtrl/LLN0\$GO\$acb2	DemoProtCtrl/DIGGIO1.Ind2.stVal [ST]
								DemoProtCtrl/DIGGIO1.Ind3.stVal [ST]
								DemoProtCtrl/DIGGIO1.Ind4.stVal [ST]
								DemoProtCtrl/DIGGIO1.Ind5.stVal [ST]

GOOSE Sender – simulation of another device

In this way the program can simulate the transmission performed by another device. It allows to test how GOOSE messages will be received and processed by devices with GOOSE Subscriber function.

In case of such a configuration the dataset description table will also include Data reference information with names of dataset elements.

The screenshot shows the GOOSE Sender application window. The interface includes a menu bar (File, Edit, Transmission, Help), a toolbar with icons for GO, STOP, and various network symbols, and a network adapter selection dropdown (Ethernet 5 MAC: 0A-00-27-00-00-09). The configuration is divided into several sections:

- Ethernet:** Source (0A:00:27:00:00:09), Destination (01:0C:CD:01:00:01), and buttons for Own and M-cast.
- VLAN:** Priority (4), CFI (Eth), ID (0), and a checked VLAN header checkbox.
- IP:** Address (239.1.1.35) and Class of traffic (32).
- GOOSE:** Edition (1), App ID (2), Fixed (FALSE), DSRef (DemoProtCtrl/LLN0\$DS4_GOOSE), CBRef (DemoProtCtrl/LLN0\$GO\$gb2), GID (G2), Time (2023-03-08 08:02:55.610), TTL (4000), StNum (1), SqNum (113), CfgRev (1), NComm (FALSE), and Test (TRUE).

Below the configuration is a **Data items** table:

Idx	Type	Value	Formula	Data reference
0	BOOL	FALSE		DemoProtCtrl/DIGGIO1.Ind1.stVal [ST]
1	BOOL	FALSE		DemoProtCtrl/DIGGIO1.Ind2.stVal [ST]
2	BOOL	FALSE		DemoProtCtrl/DIGGIO1.Ind3.stVal [ST]
3	BOOL	FALSE		DemoProtCtrl/DIGGIO1.Ind4.stVal [ST]
4	BOOL	FALSE		DemoProtCtrl/DIGGIO1.Ind5.stVal [ST]

GOOSE Sender – dataset elements of both simple and structured types

The created or imported configuration of GOOSE Publisher function may include dataset containing elements of simple or structured types – both options are supported.

The screenshot displays the GOOSE Sender application window. The interface includes a menu bar (File, Edit, Transmission, Help), a toolbar with various icons, and a network adapter selection dropdown set to 'Ethernet 5 MAC: 0A-00-27-00-00-09'. The configuration is divided into several sections:

- Type:** Not routable
- Ethernet:** Source (0A:00:27:00:00:09), Destination (01:0C:CD:01:00:20), M-cast checkbox, VLAN header checked, Priority (4), CFI (Eth), ID (0).
- IP:** Address (239.1.1.35), M-cast checkbox, Class of traffic (32).
- GOOSE:** Edition (1), App ID (20), Fixed (FALSE), DSRRef (EM20TCPLD0/LLN0\$DS3_Goose), CBRRef (EM20TCPLD0/LLN0\$G0\$gcb1), GID (EM20), Time (2023-03-08 08:02:55.610), TTL (4000), SNum (1), SqNum (113), CigRev (20), NComm (FALSE), Test (TRUE).

Below the configuration is a table titled 'Data items' with the following structure:

Idx	Type	Value	Formula	Data reference
0	STRUCT	3 element(s)		EM20TCPLD0/GOOSE01GGIO65.Ind [ST]
0.0	BOOL	FALSE		EM20TCPLD0/GOOSE01GGIO65.Ind.stVal [ST]
0.1	QUALITY	0000000000000		EM20TCPLD0/GOOSE01GGIO65.Ind.q [ST]
0.2	TIME	2023-03-08 09:17:08.328		EM20TCPLD0/GOOSE01GGIO65.Ind.t [ST]
1	STRUCT	3 element(s)		EM20TCPLD0/GOOSE02GGIO66.Ind [ST]
1.0	BOOL	TRUE		EM20TCPLD0/GOOSE02GGIO66.Ind.stVal [ST]
1.1	QUALITY	0000000000000		EM20TCPLD0/GOOSE02GGIO66.Ind.q [ST]
1.2	TIME	2023-03-08 09:17:08.329		EM20TCPLD0/GOOSE02GGIO66.Ind.t [ST]
2	STRUCT	3 element(s)		EM20TCPLD0/GOOSE03GGIO67.Ind [ST]
2.0	BOOL	TRUE		EM20TCPLD0/GOOSE03GGIO67.Ind.stVal [ST]
2.1	QUALITY	0000000000000		EM20TCPLD0/GOOSE03GGIO67.Ind.q [ST]
2.2	TIME	2023-03-08 09:17:08.330		EM20TCPLD0/GOOSE03GGIO67.Ind.t [ST]
3	STRUCT	3 element(s)		EM20TCPLD0/GOOSE04GGIO68.Ind [ST]
3.0	BOOL	TRUE		EM20TCPLD0/GOOSE04GGIO68.Ind.stVal [ST]
3.1	QUALITY	0000000000000		EM20TCPLD0/GOOSE04GGIO68.Ind.q [ST]
3.2	TIME	2023-03-08 09:17:08.331		EM20TCPLD0/GOOSE04GGIO68.Ind.t [ST]
4	STRUCT	3 element(s)		EM20TCPLD0/GOOSE05GGIO69.Ind [ST]

GOOSE toolset: GOOSE Receiver – configurable subscriber

Configurable GOOSE Subscriber function: reception parameters can be set manually or from the message stream detected in the network and subscribed.

Press **GO** button to start the message reception and **STOP** button to terminate.

Idx	Type	Value	Data reference
0	BOOL	FALSE	
1	BOOL	FALSE	
2	BOOL	FALSE	
3	BOOL	FALSE	
4	BOOL	FALSE	

GOOSE Receiver – monitoring the selected message stream

The selected GOOSE message stream can be monitored to test the performance of transmitting device (e.g. detect data changes, interruptions of transmissions, etc.).

Viewing message streams present in the networks allows also to recognize configuration errors, e.g. the same APPID or GOOSE ID values set to different publishers.

Idx	Type	Value	Data reference
0	BOOL	FALSE	DemoProtCtrl/DIGGIO1.Ind1.stVal [ST]
1	INT	0	DemoProtCtrl/DIGGIO1.Ind2.stVal [ST]
2	FLOAT	1.65699994	DemoProtCtrl/DIGGIO1.Ind3.stVal [ST]
3	BOOL	FALSE	DemoProtCtrl/DIGGIO1.Ind4.stVal [ST]
4	BOOL	FALSE	DemoProtCtrl/DIGGIO1.Ind5.stVal [ST]

A sequence of received GOOSE messages can be traced in the invoked **Parser** window.

GOOSE Receiver – detecting errors in configuration of message streams

The view of GOOSE message streams indicates conflicts in the system configuration:

Error: streams of different publishers have the same parameter values of Destination MAC, App ID and GOOSE ID

Warning: streams of different publishers have the same parameter values of Destination MAC and App ID.

Available GOOSE streams

Idx	Type	Source MAC	Destination MAC	IP	App ID	Config Rev	GOOSE ID	GCB ref	Messages	TEST	NDSKOM
1	Not routable	98:29:A6:87:3...	01:0C:CD:01:0...	N/A	0002	1	G2	DemoProtCtrl/...	80	TRUE	FALSE
2	Not routable	98:29:A6:87:3...	01:0C:CD:01:0...	N/A	0001	1	G1	DemoProtCtrl/...	11	TRUE	f
3	Not routable	98:29:A6:87:3...	01:0C:CD:01:0...	N/A	0002	1	G2	DemoProtCtrl/...	13	TRUE	f
4	Not routable	98:29:A6:87:3...	01:0C:CD:01:0...	N/A	0002	1	G3	DemoProtCtrl/...	12	TRUE	f

Subscribe Clear Close

Streams with conflicts are marked with colored background:

Red – error, **Dark red** – error and conflict with the stream selected for monitoring, **Yellow** – warning, **Dark yellow** – warning and conflict with the stream selected for monitoring, No color – no conflict.

GOOSE Receiver – configuration from imported SCL file

GOOSE Subscriber function can be also configured by the definition of GoCB object included in the imported SCL file. In this way it is possible to test message transmissions from each of the publishers present in the described system.

The screenshot shows the 'GOOSE Receiver' application window. The 'Import' menu is open, and the 'Available GOOSE streams' dialog is displayed. The dialog contains a table of stream definitions and a list of dataset elements.

Idx	IED	Type	Dest...	App ID	Con...	GOOSE ID	GCB Reference
1	Demo	Not routable	01-0C...	0001	1	G1	DemoProtCtrl/LLN0\$GO\$qcb1
2	Demo	Not routable	01-0C...	0002	1	G2	DemoProtCtrl/LLN0\$GO\$qcb2

Dataset elements:

- DemoProtCtrl/DIGGIO1.Ind1.stVal [ST]
- DemoProtCtrl/DIGGIO1.Ind2.stVal [ST]
- DemoProtCtrl/DIGGIO1.Ind3.stVal [ST]
- DemoProtCtrl/DIGGIO1.Ind4.stVal [ST]
- DemoProtCtrl/DIGGIO1.Ind5.stVal [ST]

The 'GOOSE Receiver' main window shows the following configuration:

- Network adapter: Ethernet MAC: 98-29-A6-87-39-76
- GOOSE App ID: 2, StNum: 2, TTL: 4000, SqNum: 137, DSRef: DemoProtCtrl/LLN0\$DS4_GOOSE, CfgRev: 1, CBRef: DemoProtCtrl/LLN0\$GO\$qcb2, NComm: FALSE, GID: G2, Test: TRUE, Time: 2020-06-05 12:26:52.849
- Ethernet Source: 98:29:A6:87:39:76, Destination: 01:0C:CD:01:00:01
- VLAN: VLAN header, Priority: 4, CFI: Eth, ID: 0
- IP Address: 239.1.1.35

GOOSE Receiver – dataset elements of both simple and structured types

GOOSE Subscriber function supports reception of messages with dataset containing elements of simple or structured types.

The screenshot shows the GOOSE Receiver software interface. The main window is titled "GOOSE Receiver" and has a menu bar with "File", "Transmission", "Data", and "Help". Below the menu bar are several icons: a folder, a green "GO" button, a grey "STOP" button, a magnifying glass, a network card icon, and a power button. The "Network adapter" is set to "Ethernet MAC: 98-29-A6-87-39-76".

The configuration is divided into several sections:

- Type:** Not routable
- Ethernet:** Source: 98 : 29 : A6 : 87 : 39 : 76 (Own), Destination: 01 : 0C : CD : 01 : 00 : 01 (M-cast)
- VLAN:** Priority: 4, CFI: Eth, ID: 0 (H), VLAN header
- IP:** Address: 239 . 1 . 1 . 35 (M-cast)
- GOOSE:** App ID: 2 (H), TTL: 4000, DSRef: DemoProtCtrl/LLN0\$DS4_GOOSE, CBRef: DemoProtCtrl/LLN0\$GO\$gcb2, StNum: 2, SqNum: 137, CfgRev: 1, NComm: FALSE, GID: G2, Test: TRUE, Time: 2020-06-05 12:26:52.849, Status: [empty]

Below the configuration is a table titled "Data items":

Idx	Type	Value	Data reference
0	BOOL	FALSE	
1	INT	0	
2	FLOAT	1.6569999945	
3	BOOL	FALSE	
4	BOOL	FALSE	

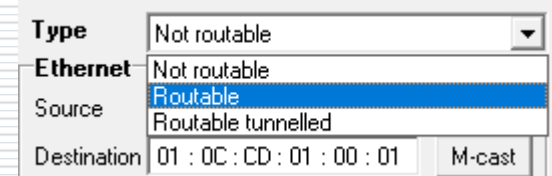
GOOSE Sender and GOOSE Receiver support also routable messages

The **Type** of packet to be sent or to be received can be configured:

Not routable – GOOSE message as Ethernet frame

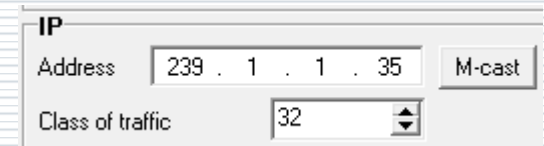
Routable – sent over IP between IEDs, data part of GOOSE frame routed using IP packets and UDP protocol, locally forwarded by receiving IED as Ethernet GOOSE frame

Routable tunneled – sent between routers of two subsystems, GOOSE frame routed using IP packets and UDP protocol, locally forwarded by router as Ethernet GOOSE frame



The screenshot shows a configuration window with the following fields:

Type	Not routable	
Ethernet	Not routable	
Source	Routable	
Destination	01 : 0C : CD : 01 : 00 : 01	M-cast



The screenshot shows an IP configuration window with the following fields:

IP		
Address	239 . 1 . 1 . 35	M-cast
Class of traffic	32	

For routable GOOSE the multicast destination IP address and class of traffic must be also configured.

Routable GOOSE: differences between types of routing

By using routable GOOSE (R-GOOSE) it is possible to transfer critical messages between different LANs of a wide area automation system.

An IP packet with **routable tunneled R-GOOSE** message contains an original destination MAC address and VLAN header – this information is then retained by the receiving router when forwarding R-GOOSE message as Ethernet GOOSE message to the local network.

An IP packet with **routable R-GOOSE** message comes without its original destination MAC address and VLAN header. This information will be set by the receiving router based on the internal setup before forwarding R-GOOSE message as Ethernet GOOSE message to the local network.

Sampled Values Toolset



SV toolset: SAV Sender – working area

Sender working area shows properties of the currently sent Sampled Values stream. This area is divided into several groups:

- Ethernet header** showing source and destination MAC address of the message
- VLAN header** showing VLAN part of the message (if present)
- Sampled Values header** used to set Sampled Values header part of the message
- Signal sampling properties** showing current sampling rate, network frequency, etc.
- Signal quality bits** allowing to set quality bits for each sampled signal
- Signal values** allowing to set amplitude and phase of each simulated signal

The screenshot shows the 'Sampled Values Sender' application window. The interface includes a menu bar (File, Transmission, Help), a toolbar with icons for folder, mail, GO, STOP, and a power button, and a 'Network adapter' dropdown menu set to 'Ethernet MAC: 98-29-A6-87-39-76'. The main area is divided into several sections: 'Type' (Not routable), 'Ethernet' (Source: 98:29:A6:87:39:76, Destination: 01:0C:CD:04:00:00), 'VLAN' (Priority: 4, VLAN header checked, CFI: Eth, ID: 0), 'IP' (Address: 239.1.1.35, Class of traffic: 32), 'Sampled Values Header' (App ID: 4000, Simulation: CPU, Config Rev: 1, SvID: INFOTECHMU01), 'Signal values' (Frequency: 50.00 Hz, Amplitude and Phase controls for signals I1, I2, I3, Io, U1, U2, U3, Uo), 'Sampled Values Quality' (a grid of checkboxes for various quality indicators), and 'Signal sampling' (Network: 50 Hz, Samples/Cycle: 80, Synchronized: No).

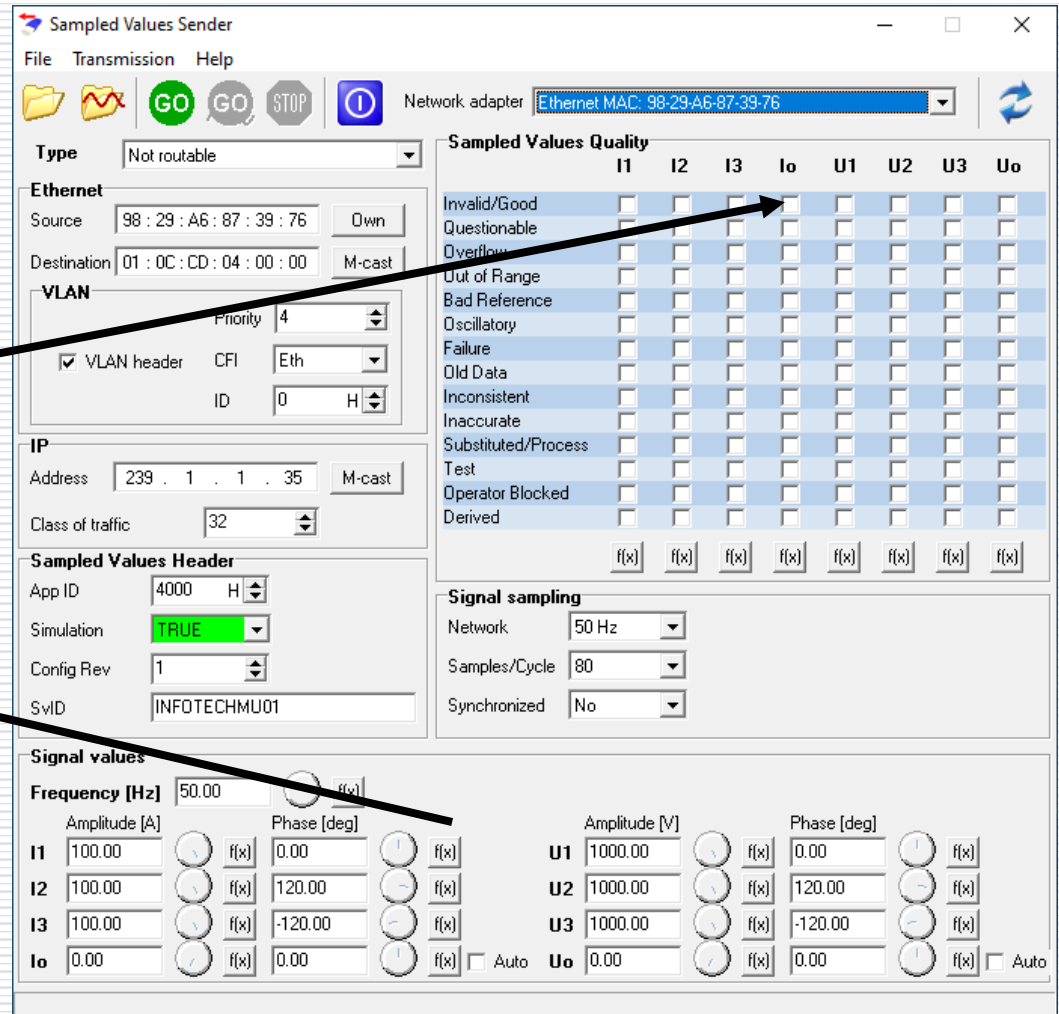
SV toolset: SAV Sender - simulator of Merging Unit

Configurable publisher of message stream with sampled values – Merging Unit simulator.

Define characteristics of sampled signals (amplitude, phase, frequency) manually or using calculation formulas. Simulate quality problems for the transmitted sampled values, if required.

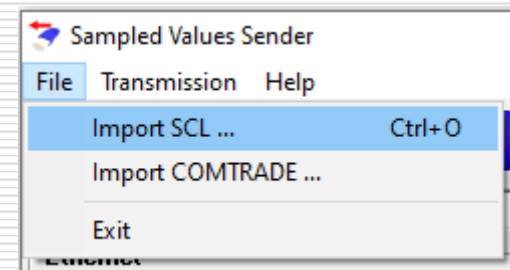


Press **GO** button to start publishing and **STOP** button to terminate.



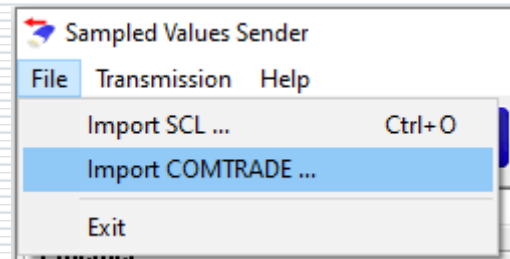
SV toolset: SAV Sender - configuration from files

The transmission parameters of a Merging Unit to be simulated can be configured using an imported SCL file with the defined MSVCB object.



The sampled signals waveforms can be configured using a recording from an imported COMTRADE.

In this case it is necessary to assign channels from the COMTRADE file to the signals transmitted by SAV Sender.



SV toolset: SAV Sender – COMTRADE channels selection

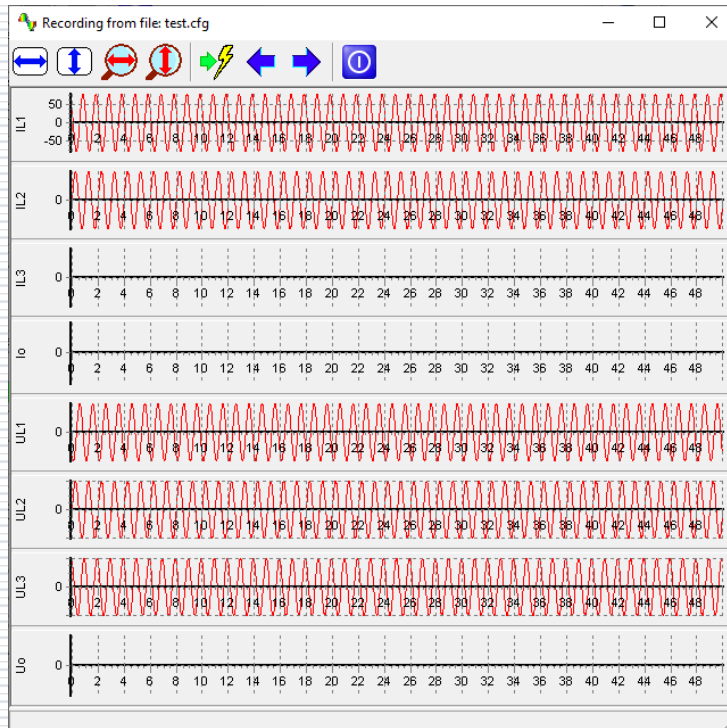
This window allows to select signals from an imported COMTRADE file and assign them to channels defined in the IEC 61850-9-2LE specification. Io and Uo signals can be artificially calculated from phase signals if needed (in such a case the DERIVED bit in quality attribute will be set for those signals). Not assigned channels will have values 0 and INVALID quality bit set.

It is possible to view selected signals by pressing **Preview** button. If the selection is acceptable, press **OK** button. Then invoke **Play COMTRADE** command from Transmission menu and the SAV stream will be sent to the network.

Signal	Channel in COMTRADE file
I1	IL1: L1 Current (A) [A]
I2	IL2: L2 Current (B) [A]
I3	IL3: L3 Current (C) [A]
Io	Not assigned <input type="checkbox"/> Calculate
U1	UL1: L1 Voltage (A) [V]
U2	UL2: L2 Voltage (B) [V]
U3	UL3: L3 Voltage (C) [V]
Uo	Not assigned <input type="checkbox"/> Calculate

SV toolset: SAV Sender – COMTRADE recording preview

Preview button from channels selection window allows visualize selected signals from the imported COMTRADE file.



Shortcuts available in the viewer's toolbox are shown below



Original width - command rescales plot to fit horizontally complete waveform



Original height - command rescales plot to fit vertically complete waveform



Magnify horizontally - command magnifies plot horizontally



Magnify vertically - command magnifies plot vertically



Go to trigger - command moves plot to make trigger point visible on the screen



Move left - command moves plot one step left



Move right - command moves plot one step right



Close - command closes viewer window

SV toolset: SAV Receiver - signal processing from received samples

Configurable sampled values subscriber: reception parameters can be set manually or defined using the selected SV message stream from the list of streams detected in the network.

Available SAV streams

Idx	Type	Source MAC	Destination ...	IP	App ID	Config Rev	SV ID	Mess...	Simul...
1	Not r...	98:29:A6:87...	01:0C:CD:0...	N/A	4000	1	INFOTECHM...	36448	FALSE

Press **GO** to start receiving and **STOP** to stop.

Subscribe Clear Close

Sampled Values Receiver

File Transmission Data Help

Start Stop Refresh adapters Detect streams

Network adapter Ethernet MAC: 98-29-A6-87-39-76

Communication status Status: OFF line Lost messages: 0 Clear

Sampled Values Quality

	I1	I2	I3	Io	U1	U2	U3	Uo
Invalid/Good	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Questionable	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Overflow	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Out of Range	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Bad Reference	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Oscillatory	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Failure	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Old Data	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Inconsistent	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Inaccurate	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Substituted/Process	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Test	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Operator Blocked	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Derived	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Sampled Values PDU

App ID 4000 H Config Rev 1 SV ID INFOTECHMU01 Samples/cycle 80 Sample Count 3499 APDUS 1 Synchronized No

Measurements

Nominal frequency 50 Hz Measured frequency [Hz]: 0.00 Resample to measured frequency Harmonics view

I1 Mag:0.00, Ang:0.00
I2 Mag:0.00, Ang:0.00
I3 Mag:0.00, Ang:0.00
Io Mag:0.00, Ang:0.00
U1 Mag:0.00, Ang:0.00
U2 Mag:0.00, Ang:0.00
U3 Mag:0.00, Ang:0.00
Uo Mag:0.00, Ang:0.00

SV toolset: SAV Receiver – computation of signal characteristics

Signal characteristics are computed in real-time based on the incoming sampled values message stream.

The computation may (optionally) apply resampling in case of detecting a deviation of the actual signal frequency from the nominal signal frequency specific for power systems.

	I1	I2	I3	Io	U1	U2	U3	Uo
Invalid/Good	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Questionable	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Overflow	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Out of Range	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Bad Reference	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Oscillatory	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Failure	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Old Data	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Inconsistent	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Inaccurate	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Substituted/Process	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Test	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Operator Blocked	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Derived	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

SV toolset: SAV Receiver - tracing SV message stream

SV messages are displayed in Parser window.

The screenshot displays the SAV Receiver application interface. A 'Parser window' is open, showing two received SV messages. The first message is from Ethernet Dst MAC:01-0C-CD-04-00-00 Src MAC:98-29-A6-87-39-76, received at 2020.06.05 15:15:30.647931. The second message is from the same source, received at 2020.06.05 15:15:30.647931. Both messages contain the same data: Frequency 50.00, I1: Amp: 77.00 Phase -86.00 Quality [Good.Process], I2: Amp: 86.00 Phase 120.00 Quality [Good.Process], I3: Amp: 0.00 Phase -99.00 Quality [Good.Process], Io: Amp: 63.00 Phase 126.00 Quality [Good.Process], U1: Amp: 930.00 Phase 0.00 Quality [Good.Process], U2: Amp: 1000.00 Phase 120.00 Quality [Good.Process], U3: Amp: 1000.00 Phase -120.00 Quality [Good.Process], and Uo: Amp: 0.00 Phase -99.00 Quality [Good.Process].

The main application window shows the 'Communication status' section with 'Status: No data' and 'Lost messages: 14440'. Below this is a 'Sampled Values Quality' table:

	I1	I2	I3	Io	U1	U2	U3	Uo
Invalid/Good	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Questionable	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Overflow	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Out of Range	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Bad Reference	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Oscillatory	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Failure	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Old Data	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Inconsistent	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Inaccurate	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Substituted/Process	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Test	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Operator Blocked	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Derived	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

At the bottom, the 'Measured frequency [Hz]' is 0.00, and the 'Resample to measured frequency' checkbox is checked. A 'Harmonics view' section shows a circular plot with axes at 0, 90, 180, and 270 degrees. The plot shows a single data point at the center (0,0) for all channels: I1, I2, I3, Io, U1, U2, U3, and Uo.

SAV Receiver – detecting errors in configuration of message stream

The view of SAV Receiver message streams indicates conflicts in the system configuration:

Stream viewer can also detect possible conflicts in process bus network. Application is using following rule to mark streams:

Error state: two streams with different source MAC and the same Destination MAC, App ID and SV ID

Warning state: two streams with different source MAC and the same Destination MAC and App ID

Idx	Type	Source MAC	Destination MAC	IP	App ID	Config Rev	SV ID	Mess...	Simul...
1	Not r...	98:29:A6:87:39:76	01:0C:CD:04:00:00	N/A	4000	1	INFOTECHMU01	112482	FALSE
2	Not r...	98:29:A6:87:39:78	01:0C:CD:04:00:00	N/A	4001	1	INFOTECHMU01	99310	FALSE
3	Not r...	98:29:A6:87:39:79	01:0C:CD:04:00:00	N/A	4001	1	INFOTECHMU01	9459	FALSE
4	Not r...	98:29:A6:87:39:79	01:0C:CD:04:00:00	N/A	4001	1	INFOTECHMU012	32183	FALSE

Buttons:

Streams with conflicts are marked with colored background:

Red – error, **Yellow** – warning, No color – no conflict, **Lime** - conflict warning with selected stream, **Aqua** - conflict error with selected stream

SAV Receiver – importing streams definitions from SCL

Definitions of data sent over the network can be imported from standard SCL files. The program can use System Configuration Description files (SCD files) describing the whole substation system or files of selected IEDs like for example Configured IED Description (CID file). Selecting an appropriate stream and clicking at **Use** button will start reception of the stream according to its parameters defined in SCL file.

Available SAV streams

Idx	Type	Source MAC	Destination MAC	IP	App ID	Config Rev	SV ID	Mess...	Simul...
1	Not r...	98:29:A6:87:39:76	01:0C:CD:04:00:00	N/A	4000	1	INFOTECHMU01	52667	FALSE

Subscribe Clear Close

SAV Receiver – recording samples in COMTRADE file

Received sequence of sampled values can be also recorded and saved in a COMTRADE format file (manual trigger or determined by condition formula).

The screenshot displays the SAV Receiver software interface, which is used for recording and analyzing sampled values. It consists of several main components:

- Recorder:** A window for configuring recording parameters. It includes fields for Duration [ms] (set to 1000), Pretrigger time [%] (set to 50), and a Trigger condition field. Below these are eight recording slots, each with a State (Done, Waiting, Empty), a Trigger time, and a Progress bar. Each slot has Save, Clear, and View buttons.
- Sampled Values Receiver:** The main application window. It shows the network adapter (Ethernet MAC: 98-29-A6-87-39-76) and communication status (Status: OFF line, Lost messages: 1461760). It features a Sampled Values Quality table and a Measured frequency section (50.00 Hz) with a Resample to measured frequency checkbox. The interface also includes a Manual trigger button and a Close button.
- Phasor Diagrams:** Two circular phasor diagrams are shown at the bottom. The left diagram shows a single phasor at 270 degrees. The right diagram shows four phasors: U1 (blue, 90 degrees), U2 (red, 0 degrees), U3 (green, 120 degrees), and Uo (purple, 162 degrees).

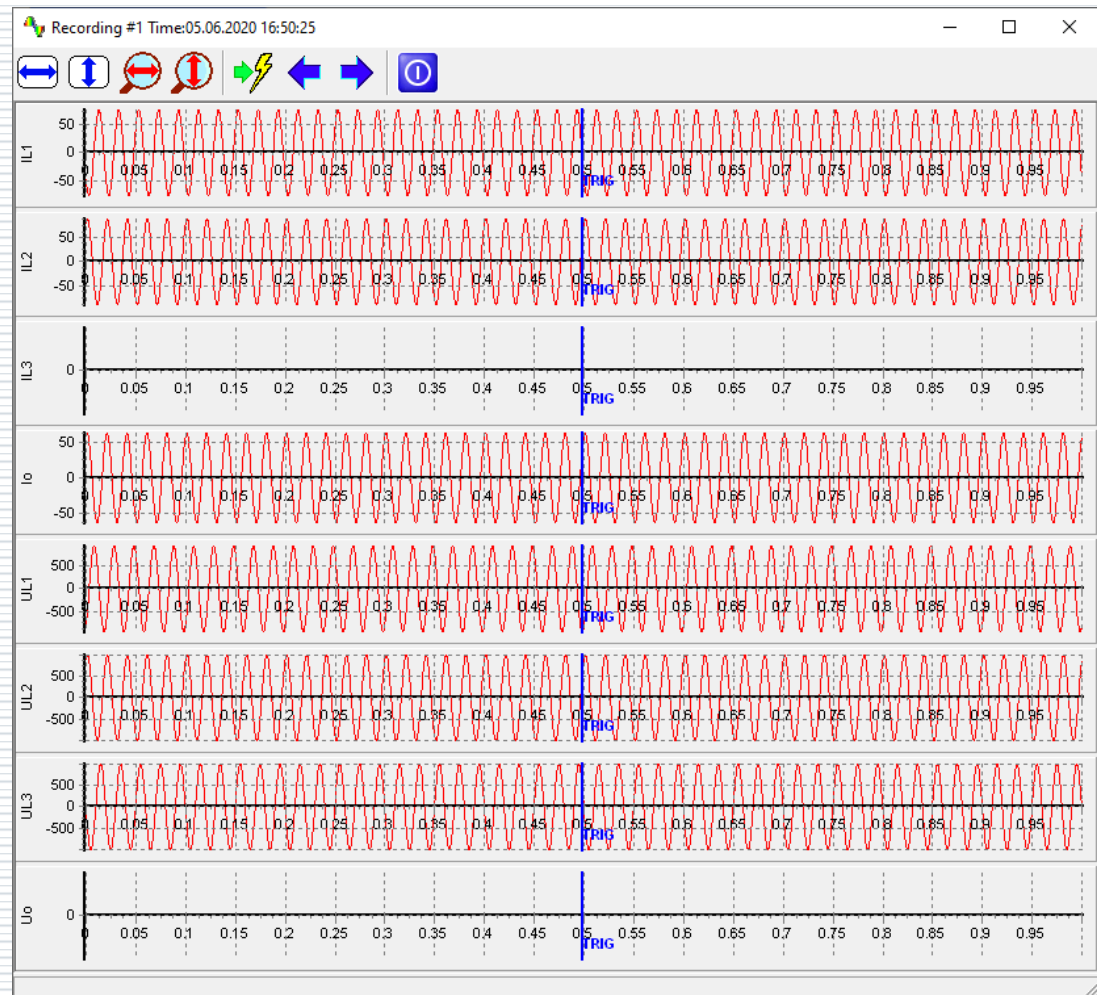
	I1	I2	I3	Io	U1	U2	U3	Uo
Invalid/Good	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Questionable	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Overflow	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Out of Range	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Bad Reference	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Oscillatory	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Failure	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Old Data	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Inconsistent	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Inaccurate	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Substituted/Process	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Test	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Operator Blocked	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Derived	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

I1	Mag:77.00, Ang:-86.00
I2	Mag:86.00, Ang:120.00
I3	Mag:0.00, Ang:162.00
Io	Mag:63.00, Ang:126.00
U1	Mag:930.00, Ang:0.00
U2	Mag:1000.00, Ang:120.00
U3	Mag:1000.00, Ang:-120.00
Uo	Mag:0.00, Ang:162.00

SV toolset: SAV Receiver

– viewing recorded COMTRADE file

View button in **Recorder** window allows to examine the waveforms of the signals received and recorded.



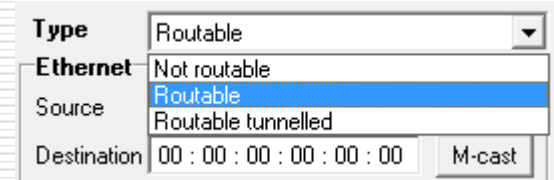
SAV Sender and SAV Receiver support also routable messages

The **Type** of packet to be sent or to be received can be configured:

Not routable – SV message as Ethernet frame

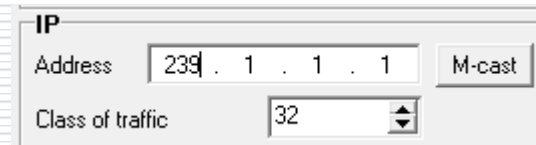
Routable – sent over IP between IEDs, data part of SV frame routed using IP packets and UDP protocol, locally forwarded by receiving IED as Ethernet SV frame

Routable tunneled – sent between routers of two subsystems, SV frame routed using IP packets and UDP protocol, locally forwarded by router as Ethernet SV frame



A screenshot of a configuration window with the following fields:

- Type**: A dropdown menu with "Routable" selected.
- Ethernet**: A dropdown menu with "Not routable", "Routable" (highlighted in blue), and "Routable tunneled" options.
- Source**: A text field.
- Destination**: A text field containing "00 : 00 : 00 : 00 : 00 : 00" and an "M-cast" button.



A screenshot of an IP configuration window with the following fields:

- IP**: A section header.
- Address**: A text field containing "239 . 1 . 1 . 1" and an "M-cast" button.
- Class of traffic**: A dropdown menu with "32" selected.

For routable GOOSE the multicast destination IP address and class of traffic must be also configured.

File Transfer Tool



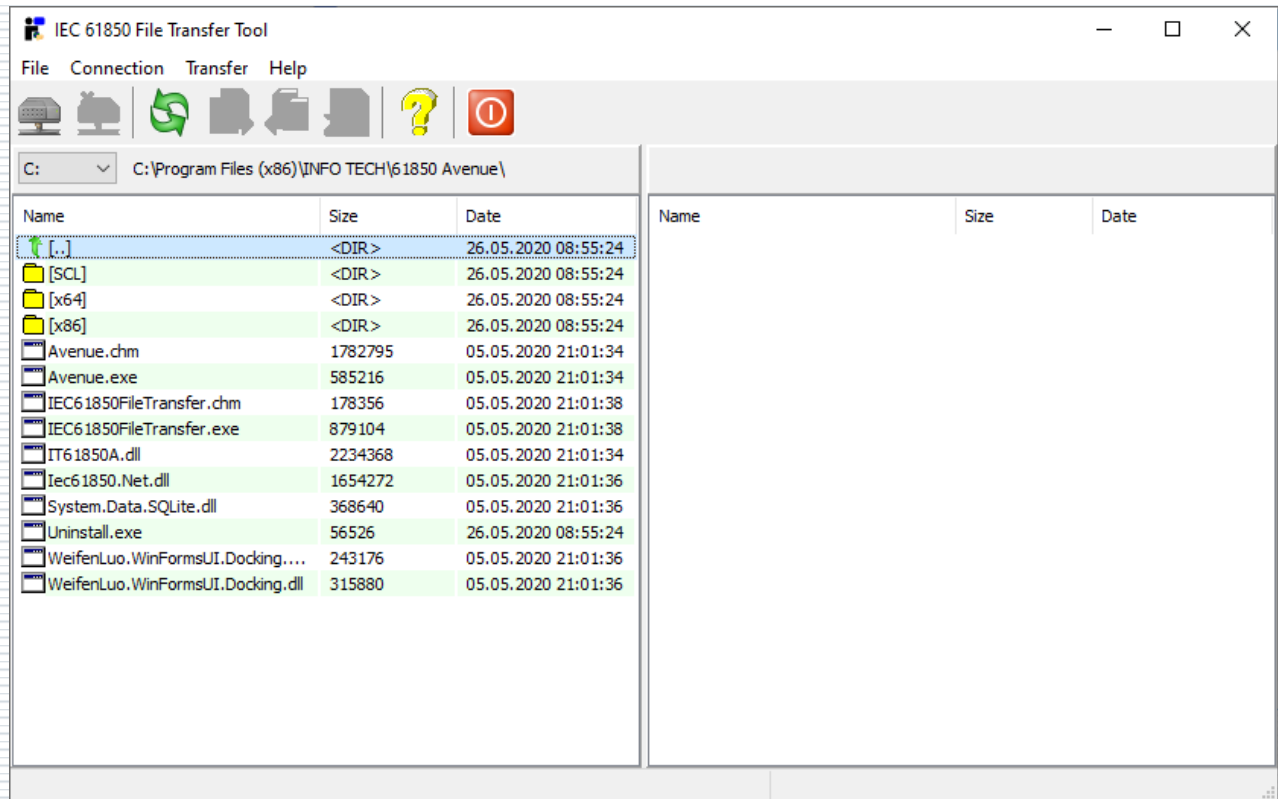
File Transfer Tool – to test access to files in server devices

Initial view:

Left side: selected directory of the file system on PC.

Right side: file system of the server device.

The program operated as MMS protocol client using file services.

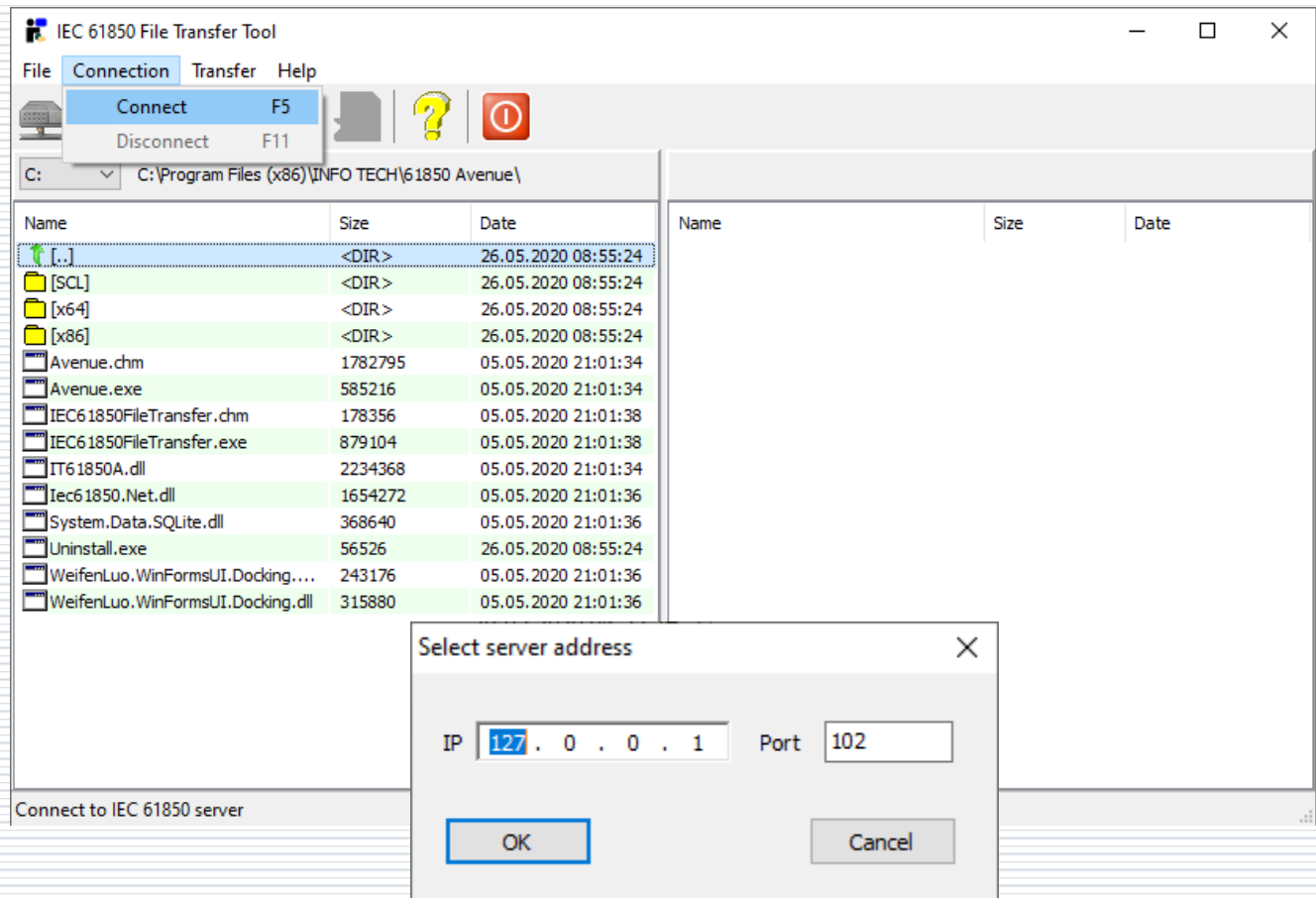


File Transfer Tool – connection to server device as a file server

From **Connection** menu select **Connect** command.

Next, enter an IP address of the server device to connect to.

Port number 102 is default for MMS which is used for file transfer.



File Transfer Tool – view of the file system in the server device

Note:

IEC 61850 Edition 1 allows server devices to present their file system as hierarchical with subdirectories.

IEC 61850 Edition 2 requires server devices to present a flat file system (as specified in MMS protocol) and then the names of subdirectories (e.g. COMTRADE) shall be a part of the file name – as shown here.

The screenshot displays the IEC 61850 File Transfer Tool interface. The left pane shows a hierarchical file system view for the local path C:\Program Files (x86)\INFO TECH\61850 Avenue\, listing various files and subdirectories. The right pane shows a flat file system view for the remote path 127.0.0.1:102\, listing files with their sizes and dates. The file Demo_Ed2.icd is highlighted in red in the right pane.

Name	Size	Date
[.]	<DIR>	26.05.2020 08:55:24
[SCL]	<DIR>	26.05.2020 08:55:24
[x64]	<DIR>	26.05.2020 08:55:24
[x86]	<DIR>	26.05.2020 08:55:24
Avenue.chm	1782795	05.05.2020 21:01:34
Avenue.exe	585216	05.05.2020 21:01:34
IEC61850FileTransfer.chm	178356	05.05.2020 21:01:38
IEC61850FileTransfer.exe	879104	05.05.2020 21:01:38
IT61850A.dll	2234368	05.05.2020 21:01:34
Iec61850.Net.dll	1654272	05.05.2020 21:01:36
System.Data.SQLite.dll	368640	05.05.2020 21:01:36
Uninstall.exe	56526	26.05.2020 08:55:24
WeifenLuo.WinFormsUI.Docking....	243176	05.05.2020 21:01:36
WeifenLuo.WinFormsUI.Docking.dll	315880	05.05.2020 21:01:36

Name	Size	Date
Demo.icd	36744	2019-09-23 10:47:58
Demo_Ed2.icd	39318	2019-09-23 10:4...
GoosePub.exe	2668544	2020-03-18 13:48:14
I61850Srv.exe	7250432	2020-03-18 13:48:10
INFO TECH Software License Agr...	26880	2020-02-12 08:57:50
ITIconSrv.ico	26054	2019-06-28 13:01:32
License.txt	4021	2020-01-22 13:54:10
Readme.txt	342	2020-02-12 08:50:28
Uninstall.exe	41217	2020-04-21 07:54:51

File Transfer Tool – file transfer operations

The set of supported operations is determined when establishing connection with the server device.

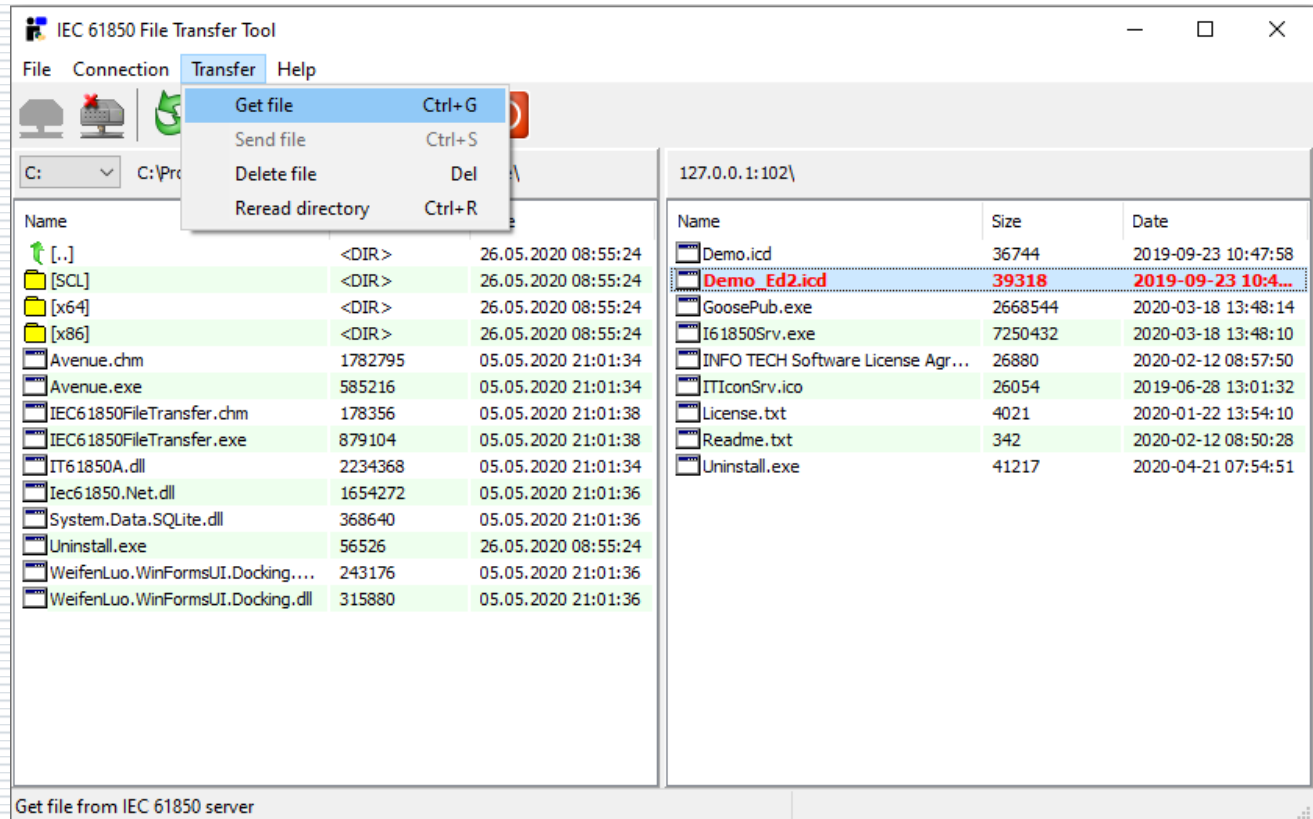
Possible operations in **Transfer** menu:

Get file – file reading from the server

Send file – file writing to the server

Delete file – file removal

Reread directory – refresh of the file list



61850 ICD Editor

A tool to create and modify SCL files.



61850 ICD Editor allows to build an ICD file of the server device

The screenshot displays the 61850 ICD Editor software interface. The main window shows a project tree on the left with a 'TEMPLATE' folder containing 'LD LDO', 'LN LLNO', 'DO Beh', 'DA stVal [ST]', 'DA q [ST]', 'DA t [ST]', 'LN LPHD1', 'DO PhyNam', 'DA vendor', 'DO PhyHealth', and 'DA stVal [ST]'. A toolbar at the top includes icons for file operations and adding LD, LN, CB, DS, and INP. Three dialog boxes are open: 'Create new Logical Device' (Name: LDO, Type: IEC 61850-7-4), 'Add new Logical Node' (Class: XCBR, LN name: TVBR), and 'Control Block Editor' (Control block type: Unbuffered Report CB, Name: Buffered Report CB). A 'Create new IED' dialog is also visible in the bottom left.

Add LD

Add LN with selection of optional DO and DA

Add RCB, GCB, SGCB, SVCB with attributes settings

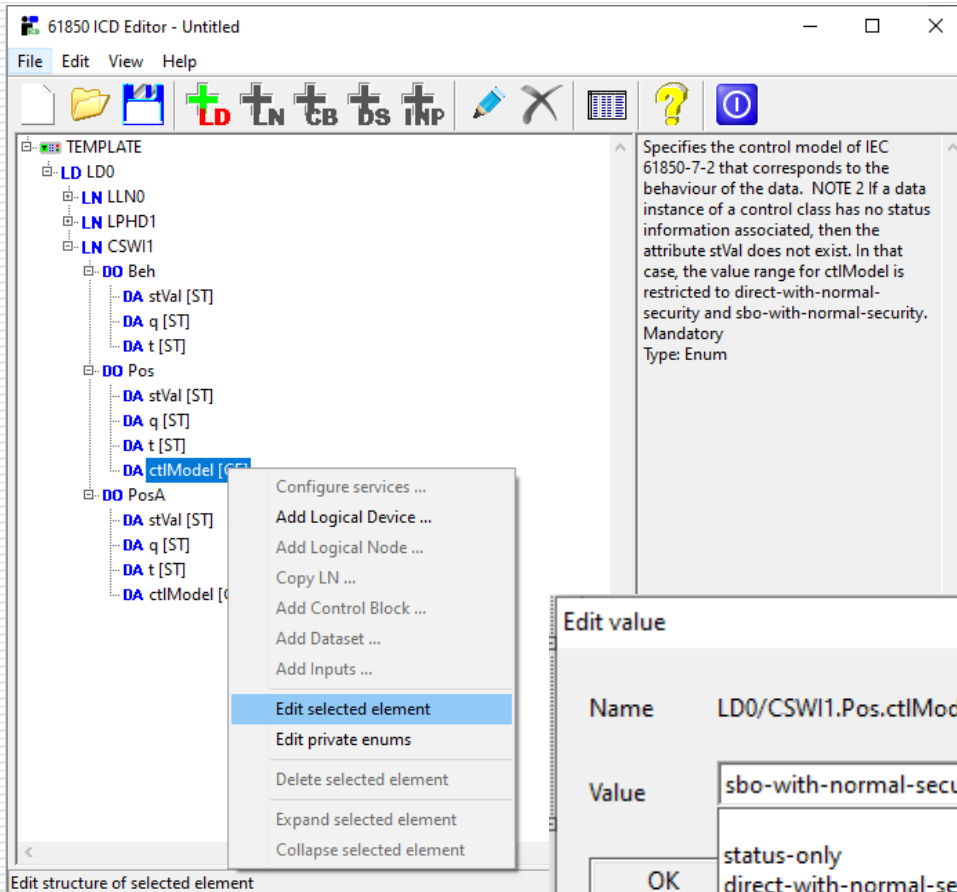
From scratch (new IED, new LD, new LN) or by modification of an existing file.

61850 ICD Editor - editing data model

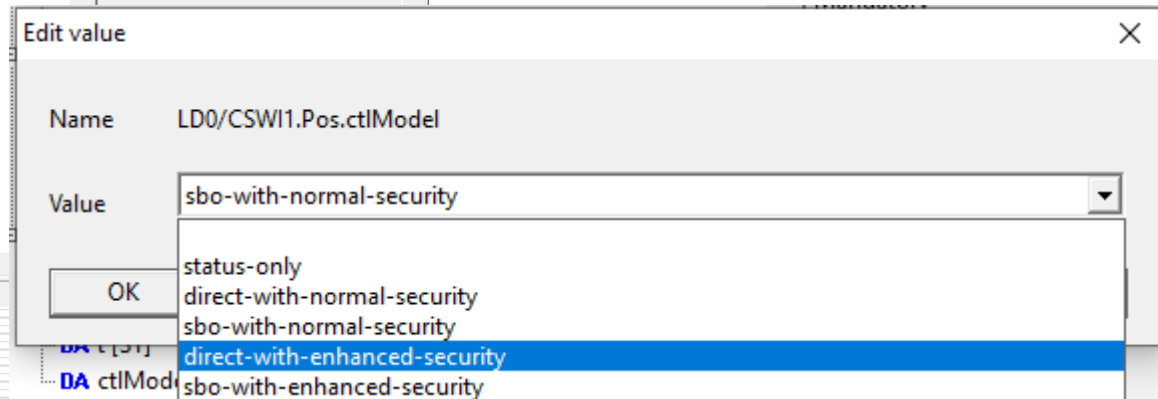
The screenshot displays the 61850 ICD Editor interface. On the left, a tree view shows the project structure under 'TEMPLATE', including 'LD LDO', 'LN LLN0', 'LN LPHD1', and 'LN CSWI1'. A context menu is open over 'LN CSWI1', listing options such as 'Configure services ...', 'Add Logical Device ...', 'Add Logical Node ...', 'Copy LN ...', 'Add Control Block ...', 'Add Dataset ...', 'Add Inputs ...', 'Edit selected element' (highlighted), 'Edit private enums', 'Delete selected element', 'Expand selected element', and 'Collapse selected element'. The 'Logical Node editor' window is open, showing the 'Definition' as 'IEC 61850-7-4', 'LN class' as 'CSWI', 'Prefix' as an empty field, 'LN name' as 'CSWI1', and 'LN namespace' as an empty field. The 'Instance' is set to '1'. A descriptive text box states: 'This LN class shall be used to control all switching conditions above process level. CSWI shall subscribe the data POWCap ('point-on-wave switching capability') from XCBBR if applicable. If a switching command (for example Select-before-Operate) arrives and point-on-wave switching capability' is supported by the breaker, the command shall be passed to CPOW. OpOpn and OpCls shall be used if no real time services are available between CSWI and XCBBR (see GSE in IEC 61850-7-2)'. Below this, a list of data elements is shown, with 'DA [C] sboTimeout [CF]' selected. A description for 'sboTimeout' is provided: 'Specifies the timeout according to the control model of IEC 61850-7-2 that corresponds to the behaviour of the data. The value shall be in ms. Conditional: Element is mandatory if declared control model supports 'sbo-with-normal-security' or 'sbo-with-enhanced-security' Type: INT32U'. The 'OK' and 'Cancel' buttons are visible at the bottom of the editor window.

Any added LN can be later modified by adding/deleting optional DOs and DAs.

61850 ICD Editor - presetting DA values



Data attribute values can be preset if needed. Standard defined enums are supported.



61850 ICD Editor - LNs with DOs containing array types

The screenshot displays two windows from the 61850 ICD Editor. The 'Logical Node editor' window on the left shows the definition for LN class 'MHAI', with a prefix of 'New' and an instance of '1'. The LN name is 'NewMHAI1'. A description states: 'Harmonics or interharmonics. This logical node is used for calculation of harmonics or interharmonics in a three-phase system.' A list of DOs is visible, with 'DO [M] phsAHar' selected. A context menu is open over this DO, and the 'Change array size' option is highlighted. A dialog box titled 'New array size for HA.phsAHar' is also open, showing a 'New size' of 32. The '61850 ICD Editor - Untitled' window on the right shows a tree structure of logical nodes. The 'LN NewMHAI1' node is expanded, showing its DOs: 'Beh', 'HA', and 'phsAHar <32>'. The 'phsAHar' DO is further expanded to show its array elements: 'IX [0]', 'cVal [MX]', 'mag', 'f', 'q [MX]', and 't [MX]'. A black arrow points from the 'Change array size' option in the context menu to the '32' in the dialog box.

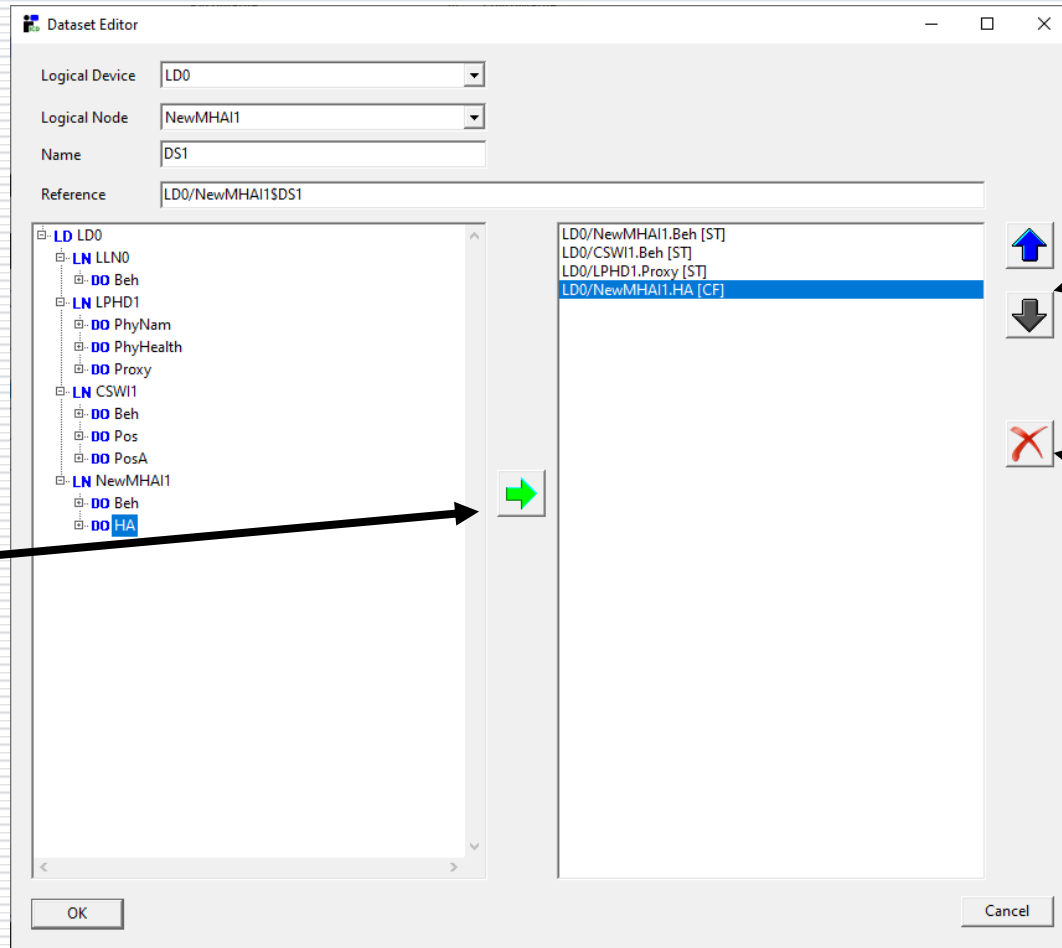
Array size can be set (default is 32).

61850 ICD Editor - Dataset creation by selection of elements from the data model

Any defined dataset can be later re-edited if needed.

Button for adding a selected element of data model to dataset.

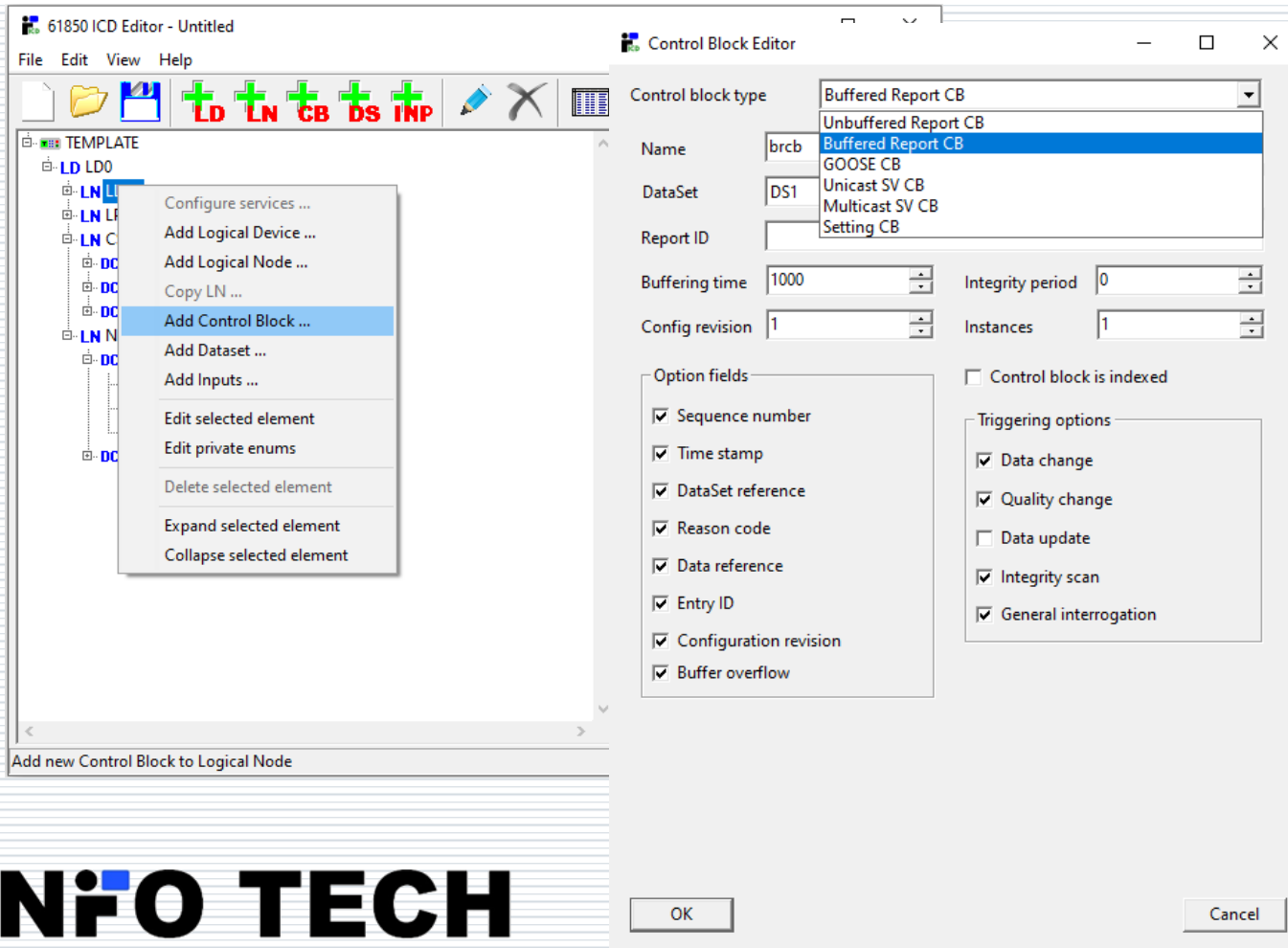
Note that in Ed.2.1 also indexed data can be elements of datasets.



Buttons for changing order of elements in dataset.

Button for removing element of dataset.

61850 ICD Editor - control blocks



URCB, BRCB, GoCB, USVCB, MSVCB and SGCB can be added to the data model and initially preset.

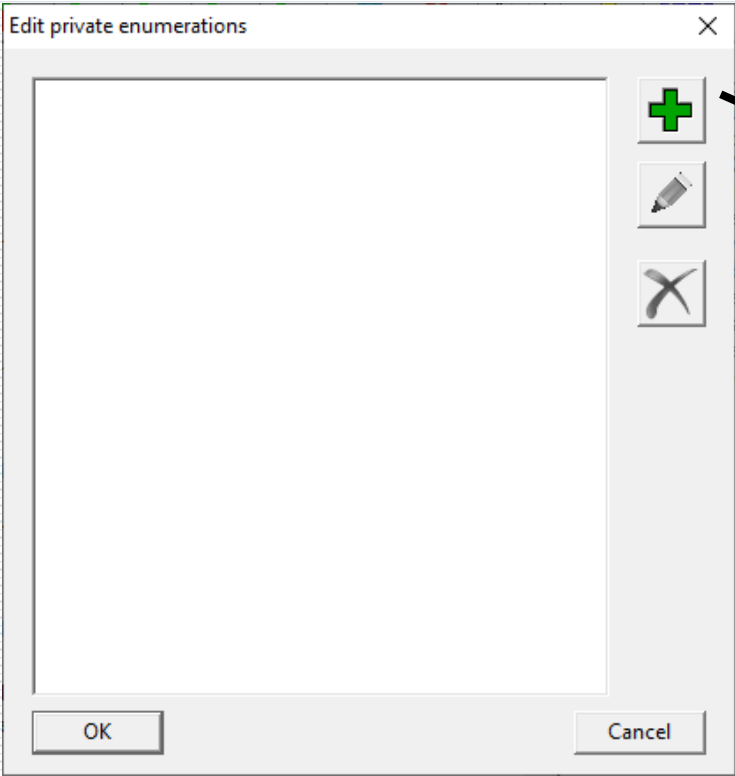
Any defined control block can be later re-edited if needed.

61850 ICD Editor - private Logical Nodes

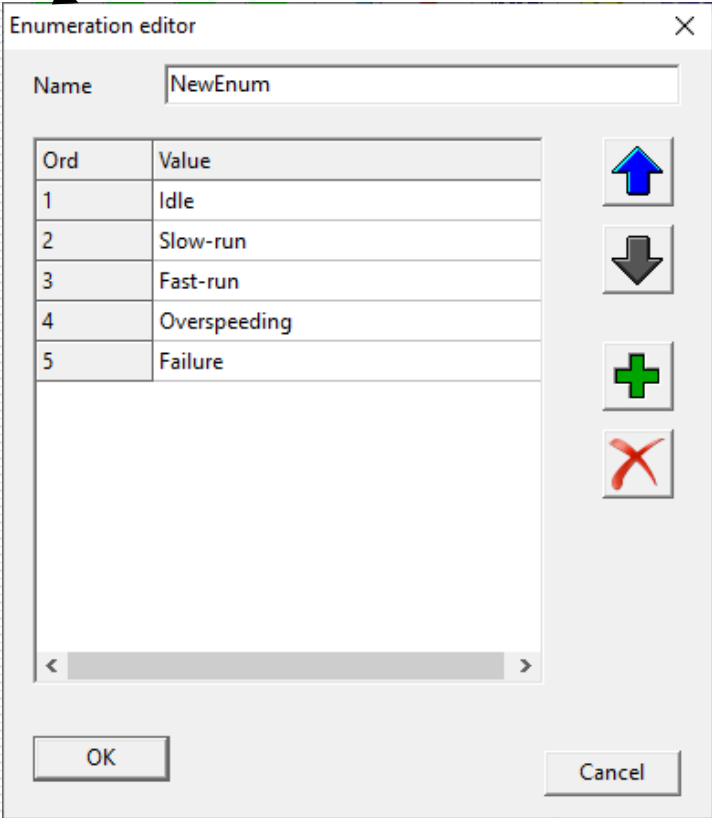
The screenshot displays the 'Logical Node editor' interface. The main window shows the 'Definition' set to 'IEC 61850-7-4' and 'LN class' set to 'CSWI'. A tree view on the left lists various Logical Nodes (LN) and Data Objects (DO). A context menu is open over the 'DO [M] TmASt' entry, with 'Add DO from other LN' selected. Two dialog boxes are overlaid on the main window. The 'Add DO from other LN' dialog shows 'Definition' as 'IEC 61850-7-4', 'LN class' as 'PTOC', and 'DO name' as 'TmASt'. The 'Add private data object' dialog shows 'DO name' as 'MyDO', 'DO type' as 'ACD', and 'Data namespace' as 'MyNameSpace'. The text area in this dialog contains 'Directional protection activation information (ACD)'. A descriptive text block for the LN class is also visible, explaining its use for switching control.

Private LN class and instance can be defined with the use of DOs from other LN classes or using defined private DOs.

61850 ICD Editor – private enums



Definition of private enum type:
Continuous range of integer values
with assigned user-defined names.



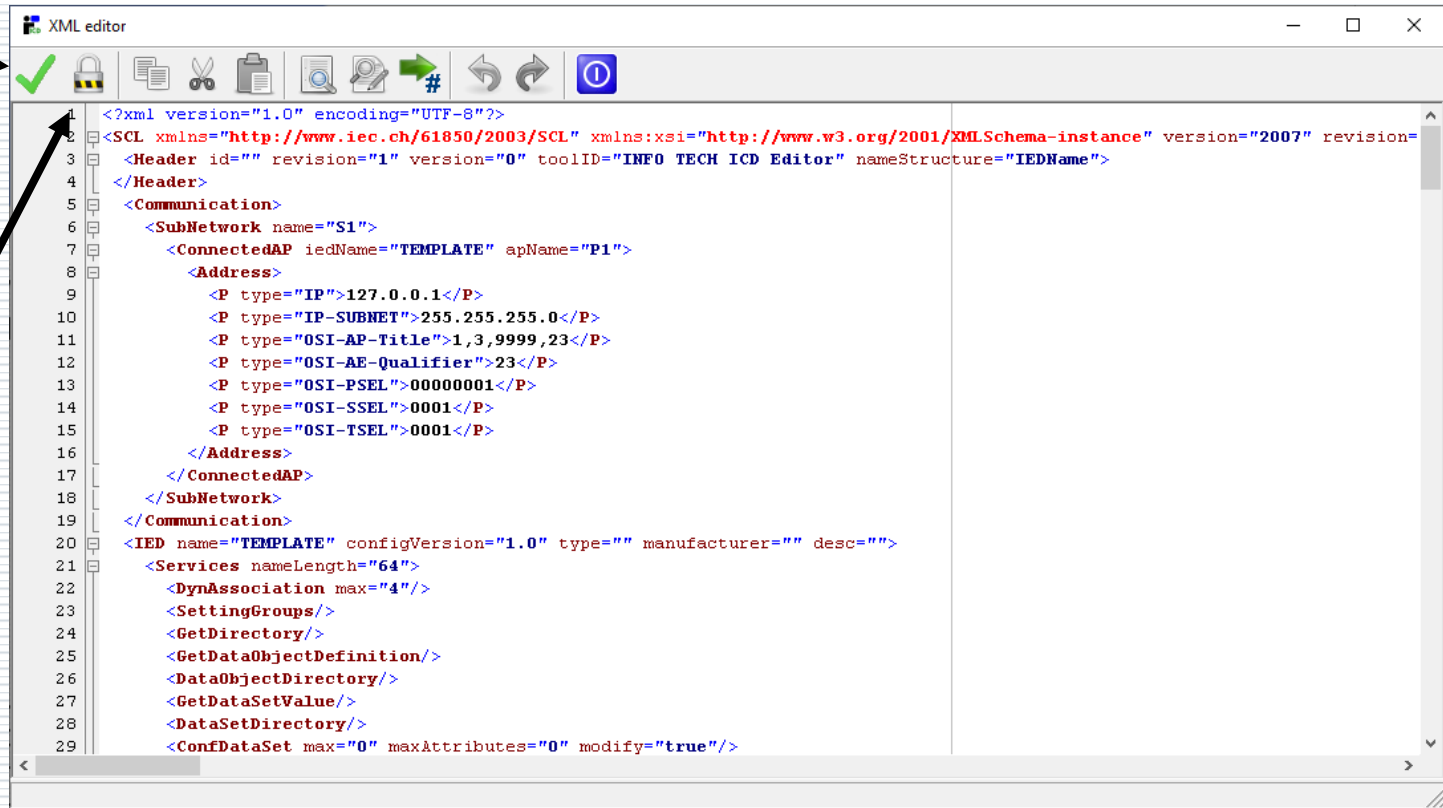
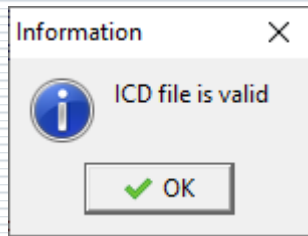
61850 ICD Editor - data model parameters setup

The screenshot shows the 61850 ICD Editor interface. A context menu is open over the 'LD' (Logical Device) node in the tree view, with 'Configure services ...' selected. The 'Edit server services' dialog box is open, displaying a list of services and their parameters. The 'MaxAttributes' parameter for the 'DynDataSet' service is highlighted and set to 30.

Service	Parameter	Value
ClientServices	(TClientServicesEd2_1)	
	Available	<input checked="" type="checkbox"/> (True)
CommProt	(TCommProt)	
	Available	<input checked="" type="checkbox"/> (True)
ConfDataSet	(TServiceForConfDataSet)	
	Available	<input checked="" type="checkbox"/> (True)
ConfLdName	(TServiceYesNo)	
	Available	<input checked="" type="checkbox"/> (True)
ConfLNs	(TConfLNs)	
	Available	<input checked="" type="checkbox"/> (True)
ConfLogControl	(TServiceWithMaxNonZero)	
	Max	4
ConfReportControl	(TServiceConfReportControlEd2_1)	
	Available	<input checked="" type="checkbox"/> (True)
ConfSigRef	(TServiceWithMaxNonZero)	
	Max	10
DataObjectDirectory	(TServiceYesNo)	
	Available	<input checked="" type="checkbox"/> (True)
DataSetDirectory	(TServiceYesNo)	
	Available	<input checked="" type="checkbox"/> (True)
DynAssociation	(TServiceWithOptionalMax)	
	Available	<input checked="" type="checkbox"/> (True)
DynDataSet	(TServiceWithMaxAndMaxAttributes)	
	max	30
FileHandling	(TServiceYesNo)	
	Available	<input checked="" type="checkbox"/> (True)
GetCBValues	(TServiceYesNo)	
	Available	<input checked="" type="checkbox"/> (True)
GetDataObjectDefinition	(TServiceYesNo)	
	Available	<input checked="" type="checkbox"/> (True)
GetDataSetValue	(TServiceYesNo)	
	Available	<input checked="" type="checkbox"/> (True)
GetDirectory	(TServiceYesNo)	
	Available	<input checked="" type="checkbox"/> (True)
GOOSE	(TServiceWithMax)	
	Available	<input checked="" type="checkbox"/> (True)

61850 ICD Editor - XML Editor and ICD file validation

Validation check button



Unlock/lock button for manual editing.

Possible applications of 61850 ICD Editor program

- ❑ Creation and modification of ICD/CID file for the device under configuration.
- ❑ Processing of an ICD file into a CID file (addresses, datasets, parameters of control blocks).
- ❑ Creation and modification of ICD/CID file to be used for server device simulation (e.g. with the use of INFO TECH 61850 SCL Runner tool).
- ❑ Modification of ICD/CID file for the IEC 61850 client program (e.g. 61850 Avenue client), for example to enable execution of negative test cases on the server device.

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