

# VAMP RELAYS

IEC 61850 interface

Configuration instructions

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# 1. Introduction

## 1.1. Overview

The purpose of this document is to present all steps of configuring IEC 61850 communication in VAMP relays, starting from the factory default configuration status and ending with the substation system configuration.

Two configuration tool programs are provided by VAMP Ltd. to accomplish this process:

- VAMPSET – a relay setting tool,
- VAMP SCD Editor – a tool program designed for creating and editing SCD files for the purpose of building IEC 61850 communication network configurations.

Communication interface setup in VAMP relay can be later verified with the following testing tools:

- VAMP 61850 Simple Tester (IEC 61850 client)
- INFO TECH 61850 Avenue (IEC 61850 client and GOOSE testing programs)

All listed tool programs can be run on PC with Microsoft® Windows 2000/XP/Vista operating system.

This guide assumes that the user is familiar with the basic concepts of IEC 61850 data modeling and communication. A short overview of IEC 61850 standard is provided in Appendix A.

## 1.2. Abbreviations

The following abbreviations are used throughout this help:

CID	Configured IED Description
DS	Data Set
GCB	GOOSE Control Block
GOOSE	Generic Object Oriented Substation Events
ICD	IED Capability Description
IED	Intelligent Electronic Device (usually a relay or controller, IEC61850 server)
IID	Instantiated IED Description
LD	Logical Device
LN	Logical Node
NI	Network Input
RCB	Report Control Block (BRCB – buffered, URCB – unbuffered)
SCD	Substation Configuration Description
SCL	Substation Configuration description Language

## 1.3. Configuration process steps

Configuration process consists of the following Steps and tasks:

### Step 1: Collecting latest versions of VAMP configuration tools and testing tools

1. Obtain and install the correct version of VAMPSET tool for the used version of VAMP relay firmware.
2. Obtain and install VAMP SCD Editor tool for system configuration description.
3. Obtain and install VAMP 61850 Simple Tester tool for checking the communication with configured VAMP relay.
4. Optionally, obtain and install an advanced communication testing tool, e.g. INFO TECH 61850 Avenue.

**Step 2: Relay initial setup – performed with VAMPSET tool**

1. Setup of the relay application (selecting active functions and active I/O, unmasking events, building application logic, matrix setup).
2. Selection of IEC 61850 protocol on the Ethernet port of the relay.
3. Selection of IEC 61850 logical nodes to the interface data model in correspondence with active relay functions, with assignment of LN data to data sets.
4. Setup of deadband values for supervision of analog data changes in the relay.
5. Preliminary configuration of GOOSE publisher with assignment of LN data to data sets used by GCB.
6. Generation of ICD file for the relay – a description of IEC 61850 interface capabilities in SCL (without known network address in the future system and without defining data exchange with other relays of the future system).

Already after accomplishing Step 2 the relay can be delivered to system engineer to proceed with system installation and configuration as described in Step 4. However, note that such a relay is still unable to communicate in the IEC 61850 network (missing network address) and its configuration cannot be yet verified using the recommended testing tools.

Before proceeding to Step 4, additional IEC 61850 parameters can be still pre-configured with VAMPSET tool as described in the tasks of Step 3. Note that to be able to perform the configuration tasks of Step 3 certain information about the relay position in the system, about the required way of data reporting by the relay, and about fast data exchange with other relays must be known by the relay engineer.

### Step 3: Advanced relay configuration – performed with VAMPSET tool

1. Setup of the relay network address and IED name in the IEC 61850 system.
2. Setup of Report Control Blocks parameters (assigned data set, report identifier, integrity period, buffering time, report triggering options, option fields of reports) for these BRCBs and URCBs that will be used in the system.
3. Setup of GOOSE publishing parameters (maximum retransmission timeout and parameters of 2 GOOSE Control Blocks, GCB1 and GCB2).
4. Assignment of data to data sets for transmitting into the network by GCB1 and GCB2.
5. Setup of GOOSE Subscriber general parameters (enabling and defining the accepted MAC address of incoming GOOSE data messages).
6. Mapping of selected data from incoming GOOSE messages into Network Inputs (elements of the relay application logic).
7. Generation of IID file for the relay – a description of IEC 61850 interface capabilities of a configured network device.

After accomplishing Step 3 the relay is already pre-configured for a specific network role in the IEC 61850 system (assigned network address, defined data flow parameters). The defined configuration can be verified using the listed tools. The relay shall be able to act as an IEC 61850 server device and respond to IEC 61850 client requests. It should also be able to transmit GOOSE messages in accordance with the setup of GCBs and to receive GOOSE messages from the network in accordance with the GOOSE Subscriber setup.

This prepared configuration may, however, require further adjustments in Step 4, when the complete system is defined including all devices and all dependencies between the devices can be verified.

#### **Step 4: IEC 61850 system configuration building – performed with VAMP SCD Editor tool**

1. Starting the system configuration description with creating a new substation. Communication section shall contain at least one Subnetwork. Optionally, more Subnetworks can be added to the system.
2. Adding time server device to the selected Subnetwork – this will be the source of time synchronization for the clocks of IEDs.
3. Adding IEDs to the system configuration description: for each added relay device its ICD (or IID) file shall be imported, with assigning a unique IED name to the device, and with placing the device on the chosen Subnetwork. An imported ICD file can be either a template ICD file produced in Step 2 or a pre-configured ICD/IID file produced in Step 3. In case of the template ICD file, several parameters values must be still set in the system configuration description. In case of the pre-configured ICD/IID file, several parameter values will be imported into the system configuration description but must be verified for compliance with system requirements.
4. For each added IED, its unique network address must be checked / set in the chosen Subnetwork section in accordance with system addressing scheme.
5. For an IED including GCB, its network address for publishing must be checked / set for each GCB in accordance with system addressing scheme.
6. For an IED including RCB, the parameters of RCB must be checked / set in accordance with system requirements (they can also be left unchanged to be dynamically set by clients).
7. For an IED including GCB, the parameters of GCB must be checked / set in accordance with system requirements (they cannot be dynamically set by clients).
8. For an IED including Inputs (GOOSE Subscriber function), the binding between chosen Network Inputs and published data of other IEDs must be set in accordance with system requirements for horizontal communication. NI configurations imported from ICD file will be also verified.
9. The system configuration description shall be verified for correctness using the tool command.
10. After accomplishing all IED parameter setup, generation of SCD file containing system configuration description in SCL.
11. Optional generation of IID files for selected IEDs.

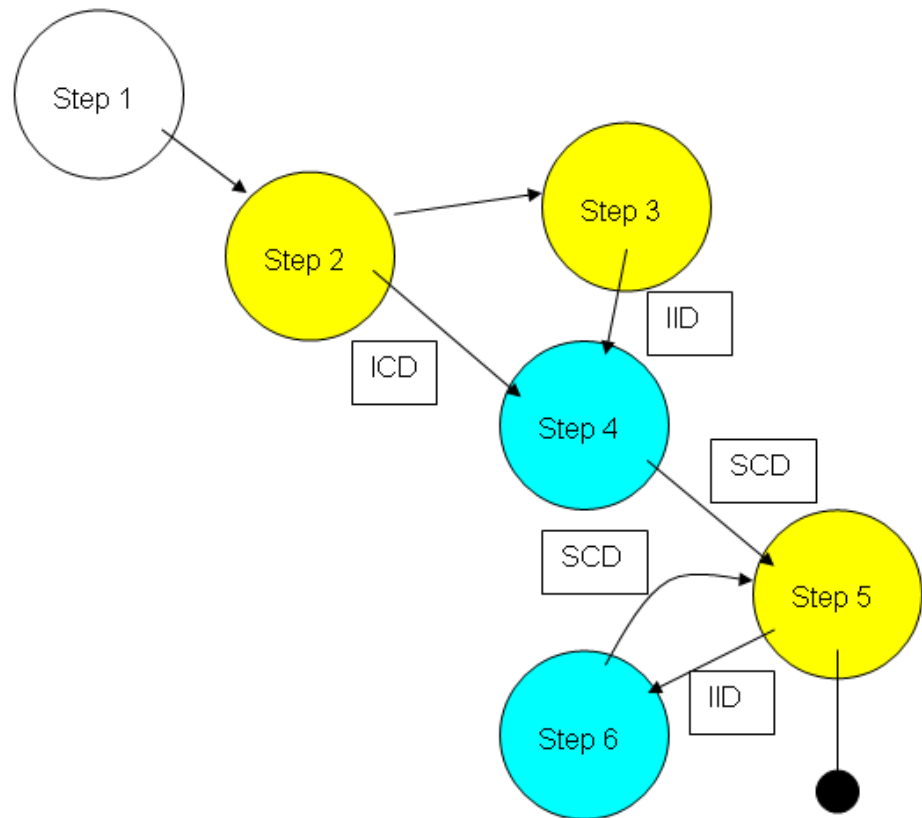
The produced SCD file is then required to adjust the configuration of each VAMP relay device dedicated to the defined system. This is done in the tasks of Step 5.

#### **Step 5: IEC 61850 configuration adjustment in each system relay – performed with VAMPSET**

1. Configuring with SCD file – the imported SCD file (or IID file) is used to update the IEC 61850 configuration parameters of the relay. At this moment the relay configuration shall be compliant with the system configuration.
2. Check Enable flags of GOOSE Publishers and GOOSE Subscriber.
3. Review the signal matrices and application logic of the relay – check how GOOSE Network Inputs signals shall be used.
4. Optionally, an IID file can be generated with VAMPSET to document the present configuration.
5. In case some requirements have been altered or added to the system, the configuration process can continue with another iteration. The relay configuration can be further modified with VAMPSET, ending with the generation of a new IID file to be used in the new run of SCD Editor as described in the tasks of Step 6.

#### **Step 6: IEC 61850 system configuration revisions – performed with VAMP SCD Editor**

1. Updating the previously created system configuration description with the revised IED configuration – by IED update, importing the revised IID file and altering the parameters respectively. This operation is combined with verification of provided parameter values.
2. In case some system requirements have been altered or added to the system, the configuration process can continue with further changes in the system configuration description (changed parameter values, new devices etc.)
3. The system configuration description shall be verified for correctness using the tool command.
4. After accomplishing all IED parameter setup, generation of SCD file containing system configuration description in SCL.
5. Optional generation of IID files for selected IEDs.
6. Repetition of Step 5 to adjust the relay configurations in accordance with the present system configuration description. Note that there may be several iterations of Step 5 and Step 6.



The figure above presents the sequence of configuration steps with possible iterations of Step 5 and Step 6.

In further chapters the tasks of Steps 2 – 6 will be described in detail.

## 2. Step 2: Relay initial setup – performed with VAMPSET

Connect the configuration PC with VAMP relay using VAMPSET cable (or using Ethernet) and run VAMPSET tool application. Establish the connection with the relay and download its complete configuration to the tool program. From now the configuration tasks can be started.

Remember that after entering new parameter values you should enforce VAMPSET to write changes to the device by the pressing the proper button in the program menu. Some parameter changes may require rebooting of the device, after which the configuration process can proceed.

### 2.1. Setup of the relay application

For each VAMP relay there has to be a list of required application functions specified in accordance with customer requirements. These functions (including protection stages, measurements and calculations, physical and logical I/O) shall be activated and configured in the relay using VAMPSET tool. It is very important to enable application events generated by these functions as the IEC61850 server interface in the relay monitors the status of application functions by collecting generated change events. Please remember to check that:

1. active stages of protection functions have enabled both start and trip on/off events,
2. start and trip on/off events for programmable protection functions are enabled,
3. monitored and controlled objects have defined signals which determine their state, and that all events related to 4 object states are enabled,
4. change events of physical Digital Inputs, Logical Outputs, Virtual Inputs and Virtual Outputs are enabled.

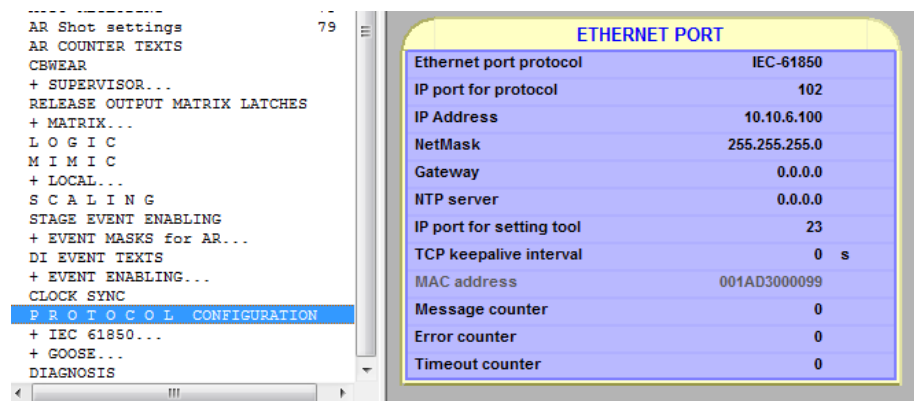
Measurement values will be periodically scanned by the IEC61850 server interface to detect value changes.

Signal matrix operations (signal transfer and signal blocking) and application logics shall be also defined. Remember that also data received from the network (from incoming GOOSE messages) and mapped to Network Inputs 1..64 together with Error status (failure of GOOSE Subscriber) can be used as input signals in the application matrices and in the application logic. Network Inputs will represent signals from other devices, to be processed by the relay application. VAMP relay may also

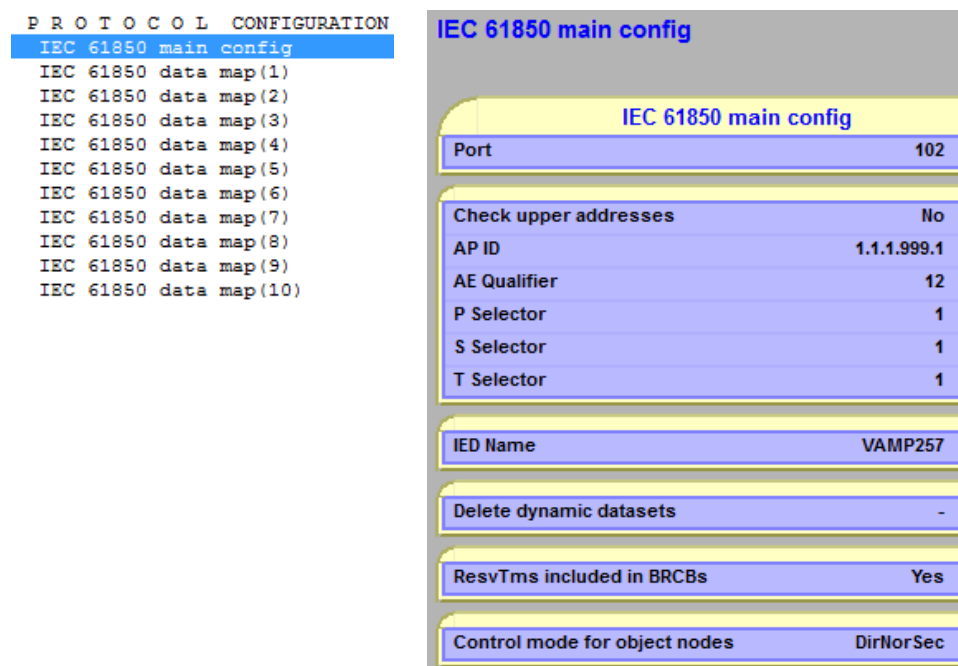
be required to transmit some selected signals to the network. This part of the configuration can normally be left for the tasks of the later Step 5, when system requirements on horizontal communication are settled.

## 2.2. Selection of IEC 61850 protocol on the Ethernet port of the relay

In **PROTOCOL CONFIGURATION** view, in the **ETHERNET PORT** section the Ethernet port protocol shall be set to IEC-61850. Further parameters of this section (own IP address information and NTP server address) may be left with default values if the target values are not yet available at this step of the configuration process.



**IEC 61850 main config** view displays additional addressing parameters of the IEC 61850 server.



The default port number in this standard is **102**. The following parameters define the settings of upper layers, above IP. First, it should be deducted from system requirements whether these parameter values must always be checked by the server interface whenever there comes a connection request, or whether these parameter values may be ignored and the connection is settled only based on IP address of the request. The flag **Check upper addresses** is by default set to **No**. Default values of the next five parameters (**AP ID, AE Qualifier, P Selector, S Selector, T Selector**) are those typically used in IEC61850 server devices.

**IED Name** parameter has a default value **TEMPLATE**. It should be finally set to a unique device name in the system but this assignment can also be left for the task of Step 4.

**Delete dynamic datasets** control flag allows clearing the definitions of persistent dynamic data sets created by IEC 61850 clients during some previous communication sessions. The relay with factory default settings should have no dynamic data sets in its configuration. Otherwise, if the device is reconfigured from some previous setup, those old dynamic data sets can be erased from nonvolatile memory by selecting value **DELETE** for this control flag.

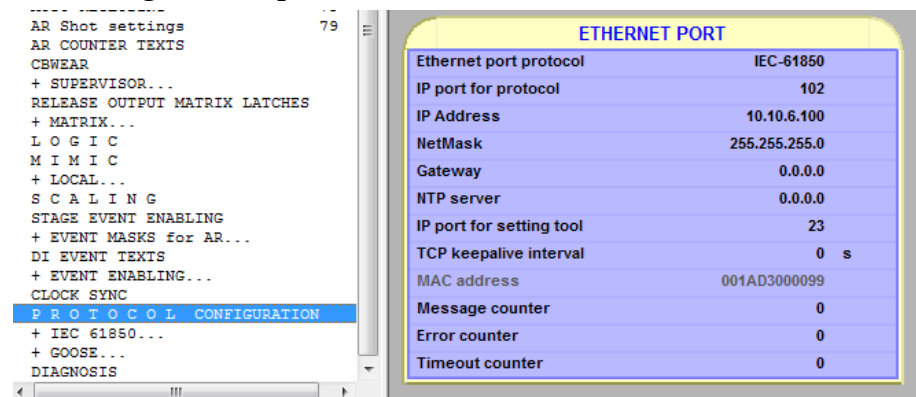
**RsrvTms included in BRCBs** flag informs whether BRCB structures include an attribute **ResvTms** added in Edition 2 of the IEC61850 standard. For compliance with Edition 1 of the standard, the flag value should be set to **No**.

**Control mode for object nodes** parameter defines which control model will be used in CSWI LNs representing control objects of VAMP relay. The same control model will be applied to Objects 1 .. 6 (Objects 7 .. 8 provide only status information and their control model is always set to status only). The possible parameter values are:

- **DirNorSec** (direct with normal security, one step control procedure, no activation termination message),
- **DirEnhSec** (direct with enhanced security, one step control procedure, activation termination message upon completion of the procedure or time-out, before activation termination no further control command can be executed on a given object),
- **SBONorSec** (select before operate with normal security, two step control procedure, possible cancel after select, no activation termination message),
- **SBOEnhSec** (select before operate with enhanced security, two step control procedure, possible cancel after select, activation termination message upon completion of the procedure or time-out, before activation termination no further control command can be executed on a given object).

## 2.3. Selection of IEC 61850 protocol on the Ethernet port of the relay

In **PROTOCOL CONFIGURATION** view, in the **ETHERNET PORT** section the Ethernet port protocol shall be set to IEC-61850. Further parameters of this section (own IP address information and NTP server address) may be left with default values if the target values are not yet available at this step of the configuration process.



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**IED Name** parameter has a default value **TEMPLATE**. It should be finally set to a unique device name in the system but this assignment can also be left for the task of Step 4.

**Delete dynamic datasets** control flag allows clearing the definitions of persistent dynamic data sets created by IEC 61850 clients during some previous communication sessions. The relay with factory default settings should have no dynamic data sets in its configuration. Otherwise, if the device is reconfigured from some previous setup, those old dynamic data sets can be erased from nonvolatile memory by selecting value **DELETE** for this control flag.

**RsrvTms included in BRCBs** flag informs whether BRCB structures include an attribute added in Edition 2 of the

IEC61850 standard. For compliance with Edition 1 of the standard, the flag value should be set to **No**.

```

P R O T O C O L   C O N F I G U R A T I O N
IEC 61850 main config
IEC 61850 data map(1)
IEC 61850 data map(2)
IEC 61850 data map(3)
IEC 61850 data map(4)
IEC 61850 data map(5)
IEC 61850 data map(6)
IEC 61850 data map(7)
IEC 61850 data map(8)
IEC 61850 data map(9)
IEC 61850 data map(10)
    
```

IEC 61850 main config	
IEC 61850 main config	
Port	102
Check upper addresses	No
AP ID	1.1.1.999.1
AE Qualifier	12
P Selector	1
S Selector	1
T Selector	1
IED Name	TEMPLATE
Delete dynamic datasets	-
RsrvTms included in BRCBs	No

## 2.4. Selection of IEC 61850 logical nodes to the interface data model

Application functions of VAMP relay as well as physical and logical I/O signals are mapped into corresponding data models of the IEC61850 standard.

For each stage of protection function there is a corresponding instance of logical node (P group) which includes the status of start and trip signals. Some protection related functions might have several data mapped into individual LNs, e.g. events of auto-reclose function. Measurement values produced by the relay application are also represented by logical nodes (M group), with semantic based grouping – e.g. phase current values for all 3 phases are represented by one LN with 3 data attribute branches. Each of the Digital Inputs, Logical Inputs, Virtual Inputs and Virtual Outputs has its own LN (GGIO) in the IEC61850 data model.

There are 10 views of **IEC61850 data map** (firmware version as of December 2009) on which you can choose which active functions of VAMP relay should have their data accessible via IEC61850 server interface. Description column in these views gives the native function name. LN column provided the LN object name.

```

P R O T O C O L   C O N F I G U R A T I O N
IEC 61850 main config
IEC 61850 data map(1)
IEC 61850 data map(2)
IEC 61850 data map(3)
IEC 61850 data map(4)
IEC 61850 data map(5)
IEC 61850 data map(6)
IEC 61850 data map(7)
IEC 61850 data map(8)
IEC 61850 data map(9)
IEC 61850 data map(10)
IEC 61850 deadband configuration
IEC 61850 BRCB configuration
IEC 61850 URCB configuration
+ GOOSE...
    
```

You can choose the subset of active relay functions – only those are important for SCADA monitoring and control. For an active function that should have data accessible via IEC61850 server interface set the In use column with Yes value.

IEC 61850 data map(6)

IEC 61850 data map						
Index	LN	Description	Dataset 1	Dataset 2	Dataset 3	In use
150	Obj6CSWI6	Object 6	No	No	Yes	No
151	Obj7CSWI7	Object 7	No	No	Yes	No
152	Obj8CSWI8	Object 8	No	No	Yes	No
153	OC1PTOC1	I>	Yes	No	No	<input type="checkbox"/>
154	OC2PTOC2	I>>	Yes	No	No	<input type="checkbox"/>
155	OC3PTOC3	I>>>	Yes	No	No	<input checked="" type="checkbox"/>
156	OFUF1PTOF1	f><	Yes	No	No	No
157	OFUF2PTOF2	f>><<	Yes	No	No	No
158	OV1PTOV3	U>	Yes	No	No	No
159	OV2PTOV4	U>>	Yes	No	No	No
160	OV3PTOV5	U>>>	Yes	No	No	No
161	PhRevPTOC16	I2>>	Yes	No	No	No
162	PQSpdMMXU19	P,Q,S,PF demand	No	Yes	No	No

All other functions should have **In use** column set to **No** value.

For functions with **In use** flag set, their data attributes can be assigned to any of the 3 pre-defined data sets (named DS1, DS2 and DS3). By such assignment these data can be reported to client systems using Report Control Blocks supervising the data sets. To assign LN data to a pre-defined data set select **Yes** value in the respective column of that data set. Only process data of LNs will be assigned to pre-defined data sets. These are the data with ST (status) and MX (measurement) functional constraint, for example start and trip states of protection LNs (ST) and all measured values of measurement LNs (MX). A member of the data set will be a structure composed of process data value, quality and timestamp attributes. Some LNs provide more than 1 member to the selected data set (e.g. a protection LN provides 2 members – start and trip, current measurement LN provides 3 members – currents for 3 phases). Keep in mind that any of the 3 pre-defined data sets may include not more than 150 members.

Index	LN	Description	Dataset 1	Dataset 2	Dataset 3	In use
150	Obj6CSWI6	Object 6	No	No	Yes	No
151	Obj7CSWI7	Object 7	No	No	Yes	No
152	Obj8CSWI8	Object 8	No	No	Yes	No
153	OC1PTOC1	I>	Yes		No	Yes
154	OC2PTOC2	I>>	Yes	No	No	No
155	OC3PTOC3	I>>>	Yes	Yes	No	No
156	OFUF1PTOF1	f<	Yes	No	No	No
157	OFUF2PTOF2	f<<<	Yes	No	No	No
158	OV1PTOV3	U>	Yes	No	No	No
159	OV2PTOV4	U>>	Yes	No	No	No
160	OV3PTOV5	U>>>	Yes	No	No	No

Typically, all data required by some client are collected into one data set. Then only one RCB is needed by per client to perform data reporting.

Remember that the setup of IEC61850 data map has to be carefully specified – missing LNs will disable SCADA system to see certain parts of the process while obsolete LNs will deliver constant 0 values.

By default the pre-configured data sets are assigned to RCBs: DS1 is assigned to BRCB1 and URCB1, DS2 is assigned to BRCB2 and URCB2, DS3 is assigned to BRCB3 and URCB3. If some data set will be left empty as a result of configuring **IEC61850 data map**, the appropriate data set assignment in RCBs will be null.

Note that by default there is only one Logical Device in the data model of VAMP relay. All LNs will be placed under this LD.

## 2.5. Setup of deadband values for supervision of analog data

For monitoring changes of measurements in the relay application functions the IEC61850 interface program relies on deadband calculation.

In **IEC61850 deadband configuration** view there is a deadband parameter for each measured quantity. Value 0 is interpreted as any change being of importance. Set the deadband parameters with caution – too small values may cause unnecessary overhead in the data transfer.

Deadband calculation algorithm has two variants: absolute deadband and integrated deadband. To apply absolute deadband set the **Deadband integration time** parameter to 0 seconds, otherwise choose the required integration time.

For example, with setting **Current I** deadband value to 5 A and **Integration time** set to 0, the change condition will be satisfied when the signal value changes of more than 5 A from the previously reported value. With setting **Current I** deadband value to 5 A and **Integration time** set to 1, the change condition

will be satisfied when the signal value changes of e.g. more than 1 A from the previously reported value and remains such for 5 seconds.

Deadband values		
Energy	0.100	MWh
Reactive energy	0.100	Mvarh
Frequency f	0.005	Hz
Current I	5	A
Residual current I <sub>o</sub>	0.10	A
Active power	5	kW
Reactive power	5	kvar
Apparent power	5	kVA
Power factor	0.05	
Current THD	5.0	%
Voltage THD	5.0	%
Voltage U	200	V
Residual voltage U <sub>o</sub>	5.0	%
External AI1	1.0	C
External AI2	1.0	C
External AI3	1.0	C
External AI4	1.0	C
External AI5	1.0	C
External AI6	1.0	C
External AI7	1.0	C
External AI8	1.0	C
External AI9	1.0	C
External AI10	1.0	C
External AI11	1.0	C
External AI12	1.0	C
External AI13	1.0	C
External AI14	1.0	C
External AI15	1.0	C
External AI16	1.0	C
Deadband integration time		
Integration time	1	s

## 2.6. Preliminary configuration of GOOSE

Usually at this step of the system configuration there may be very limited knowledge about the data flow among different devices.

Initially, there may be nothing to set / change in the **GOOSE configuration** view unless we have already received system parameters.

If you already know that the configured relay should act in the system as GOOSE Subscriber then in **GOOSE configuration** view, in **Subscriber configuration** the **Enable** flag should be set to Yes.

VALID PROTECTION STAGES	
+ PRO...	
COLD LOAD/INRUSH	
+ OVERCURRENT STAGE...	
+ DIRECTIONAL O/C STAGE...	
+ REVERSE POWER STAGE...	
UNDER CURRENT STAGE I<	37
UNBALANCE STAGE I2>	46
THERMAL OVERLOAD STAGE T>	49
+ EARTH-FAULT STAGE...	
+ DIRECTIONAL E/F...	
TRANSIENT INTERMITTENT E/F	67NI
+ OVERVOLTAGE STAGE...	
+ UNDERVOLTAGE STAGE...	
+ ZERO SEQ. VOLTAGE STAGE...	
+ FREQUENCY STAGE...	
+ UNDERFREQUENCY STAGE...	
FREQUENCY STAGE df/dt	81R
+ PROGRAMMABLE STAGE...	
CB FAILURE PROTECTION	50BF
+ ARC...	
2nd HARMONIC O/C STAGE If2>	51F2
O B J E C T S	
AUTO RECLOSING	79
AR Shot settings	79
AR COUNTER TEXTS	
CBWEAR	
+ SUPERVISOR...	
RELEASE OUTPUT MATRIX LATCHES	
+ MATRIX...	
L O G I C	
M I M I C	
+ LOCAL...	
S C A L I N G	
STAGE EVENT ENABLING	
+ EVENT MASKS for AR...	
DI EVENT TEXTS	
+ EVENT ENABLING...	
CLOCK SYNC	
P R O T O C O L CONFIGURATION	
+ IEC 61850...	
<b>GOOSE configuration</b>	
GOOSE GCB1: DATA POINTS	
GOOSE GCB2: DATA POINTS	
GOOSE Subscriber: DATA POINTS	

Publisher parameters	
Max retransmission timeout	20 s

Publisher configuration GCB 1	
Enable	No
GOOSE ID	VAMP
Configuration Revision *	1
Needs Commissioning	No
Test mode	No
MAC Address	01-0C-CD-01-00-00
VLAN Priority	4
VLAN ID	0
Application ID *	1
* Important for VAMP subscriber	

Publisher configuration GCB 2	
Enable	No
GOOSE ID	VAMP
Configuration Revision *	1
Needs Commissioning	No
Test mode	No
MAC Address	01-0C-CD-01-00-00
VLAN Priority	4
VLAN ID	0
Application ID *	1
* Important for VAMP subscriber	

Subscriber configuration	
Enable	No
MAC Address	01-0C-CD-01-00-00

Based on the list of active application functions and their mapping to IEC61850 LNs it is possible to select information that VAMP relay can transmit to the network as GOOSE Publisher, using GCB1 and GCB2 objects. Data set DSG1 provides a list of data transmitted by GCB1 and DSG2 – a list of data transmitted by GCB2. Each of these data sets may include up to 8 members, and only binary signals from active LNs can be assigned. DSG1 and DSG2 will be typically transmitted to different destinations, thus they are configured independently.

In the view **GOOSE GCB1: DATA POINTS** the drop down menu shows the binary data available for assignment to the data set related to GCB1.

**GOOSE GCB1: DATA POINTS**

**DSG1 data configuration**

Index	IEC-61850 Variable	Signal	Status
0	VO1GGIO97.Ind.stVal(ST)	VO1	OK
1	VO2GGIO98.Ind.stVal(ST)	VO2	OK
2	VO3GGIO99.Ind.stVal(ST)	VO3	OK
3	VO4GGIO100.Ind.stVal(ST)	VO4	OK
4	VO5GGIO101.Ind.stVal(ST)	VO5	OK
5	VO6GGIO102.Ind.stVal(ST)		OK
6	None		OK
7	None		OK

A dropdown menu is open over the empty Signal cell for Index 5, showing a list of signals: VO1, VO2, VO3, VO4, VO5, and VO6. VO6 is currently selected and highlighted in blue.

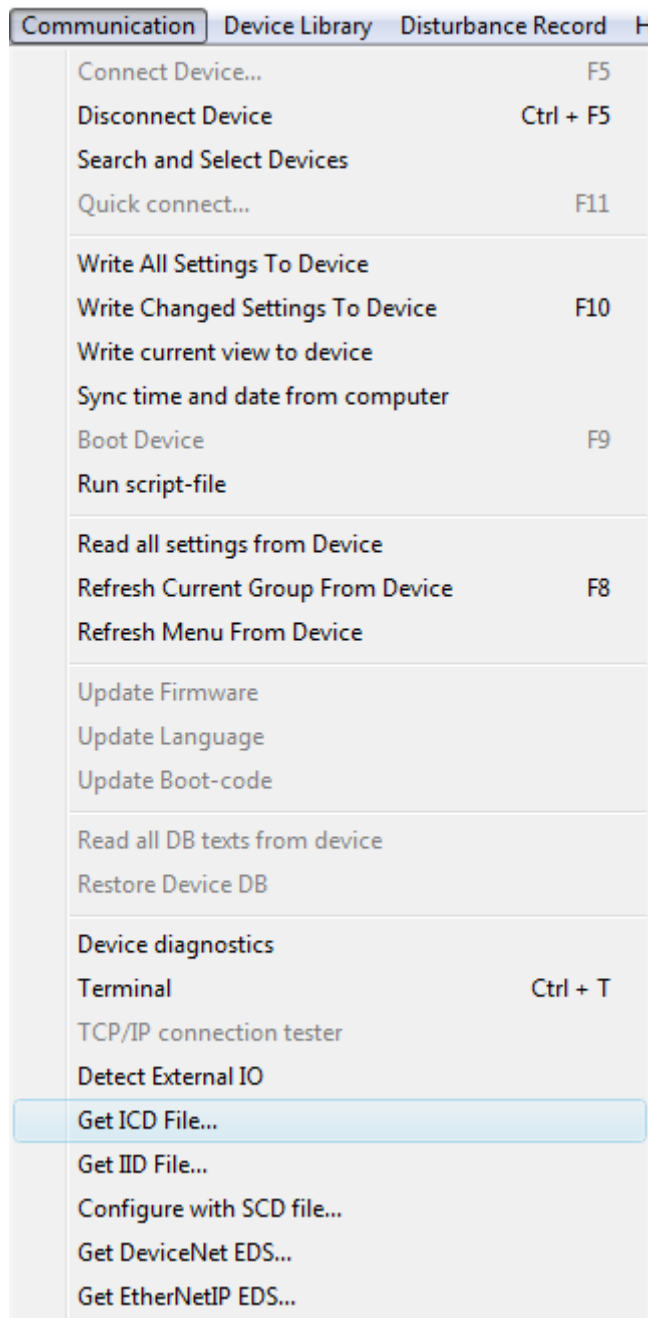
In a similar way the view **GOOSE GCB2: DATA POINTS** allows to configure the data set DSG2 related to GCB2.

The relay checks availability of all signals assigned to DSG1 and DSG2 and confirms this by **OK** value in **Status** column. If some required signal is not available, its **Status** will be set to **Not in use**, and it must be due to the fact that its LN is not marked as **In use** in the **IEC61850 data map**. After revising the IEC61850 data map, the configuration of DSG1 and DSG2 can be continued.

The setup of **GOOSE Subscriber: DATA POINTS** can be now left untouched.

## 2.7. Generation of ICD file for the relay

The tasks described above define the data model of the IEC61850 server in VAMP relay. Following this the IED Capability Description file (ICD) can be generated using **Get ICD file...** command from **Communication** menu of VAMPSET tool. ICD file describes which IEC61850 services are supported by the server in the relay, LD and LNs included in the data model, all pre-configured data sets with their names and lists of members, 3 default BRCBs and 3 default URCBs, and 2 default GCBs. The produced ICD file shall be saved under a given name in the proper file directory to be used in further step of the configuration process.



The device description provided in ICD file is not yet complete to be used for network communication: the device does not yet have a unique IED Name and IP address (is not yet instantiated for the network). Also RCBs, GCBs and GOOSE Subscriber are not configured.

## 3. Step 3: Advanced relay configuration – performed with VAMPSET

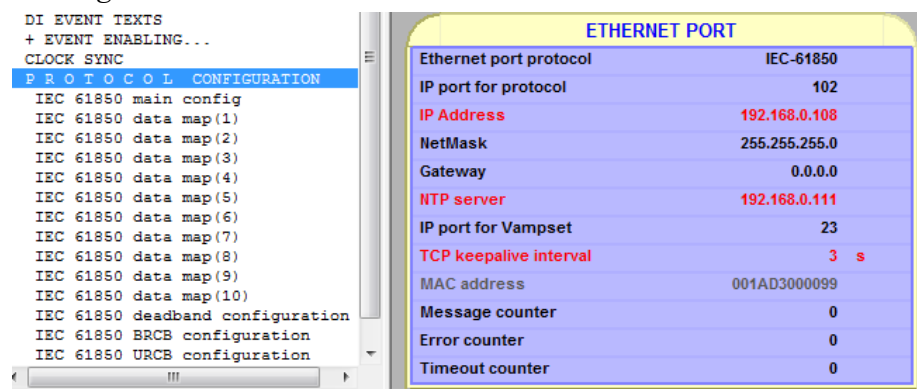
This is an optional continuation of VAMP relay configuration performed if the system related information is already available. Otherwise, Step 3 should be omitted, with direct transition to Step 4.

### 3.1. Setup of the relay network address and IED name

In **PROTOCOL CONFIGURATION** view, in the **ETHERNET PORT** section set **IP Address** of the relay to be used in the target system. Remember to configure also the **NetMask** address. **Gateway** address can most likely be discarded if the relay should communicate only within the local substation network.

In IEC61850 systems all IEDs shall have their clocks synchronized with the common time source. The IP address of this time server shall be configured by **NTP server** parameter.

For supervising the TCP connection with client devices the relay should use “keep alive” messages. Set the **TCP keepalive interval** parameter to the required number of seconds. It is strongly recommended to set this parameter, as the client device may be not prepared for sending TCP keep alive messages.



In the **IEC 61850 main config** view additional addressing parameters of the IEC 61850 server shall be configured. The default port number in this standard is **102**. The following parameters define the settings of upper layers, above IP. First, Find in the system requirements whether these parameter

values must always be checked by the server interface whenever there comes a connection request, or whether these parameter values may be ignored and the connection is settled only based on IP address of the request. In the first case set the flag **Check upper addresses** to **Yes**. Then set the values the next five parameters (**AP ID**, **AE Qualifier**, **P Selector**, **S Selector**, **T Selector**) as required in the system specification.

P R O T O C O L   C O N F I G U R A T I O N	
IEC 61850 main config	IEC 61850 main config
IEC 61850 data map(1)	
IEC 61850 data map(2)	
IEC 61850 data map(3)	
IEC 61850 data map(4)	
IEC 61850 data map(5)	
IEC 61850 data map(6)	
IEC 61850 data map(7)	
IEC 61850 data map(8)	
IEC 61850 data map(9)	
IEC 61850 data map(10)	

IEC 61850 main config	
Port	102
Check upper addresses	Yes
AP ID	1.1.1.999.1
AE Qualifier	12
P Selector	1
S Selector	1
T Selector	1
IED Name	VAMP257
Delete dynamic datasets	-
ResvTms included in BRCBs	No
Control mode for object nodes	SBOEnhSec

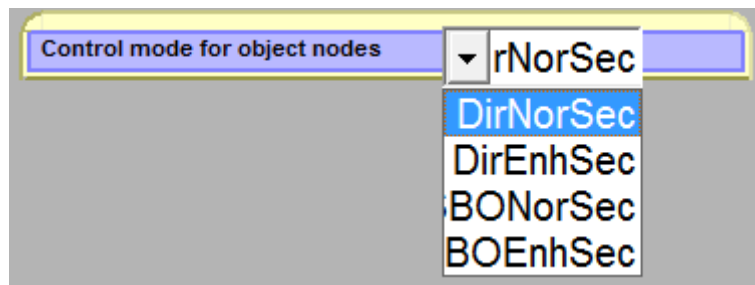
**IED Name** parameter has a default value **TEMPLATE**. It should be set to a unique device name in the system, e.g. **VAMP1**.

**Delete dynamic datasets** control flag allows clearing the definitions of persistent dynamic data sets created by IEC 61850 clients during some previous communication sessions. The relay with factory default settings should have no dynamic data sets in its configuration. Otherwise, if the device is reconfigured from some previous setup, those old dynamic data sets can be erased from nonvolatile memory by selecting value **DELETE** for this control flag.

**RsrvTms included in BRCBs** flag informs whether BRCB structures include an attribute added in Edition 2 of the IEC61850 standard. For compliance with Edition 1 of the standard, the flag value should be set to No. Otherwise, leave the value Yes.

**Control mode for object nodes** parameter defines which IEC61850 control model will be used in CSWI LNs representing control objects of VAMP relay. The same control model will be applied to Objects 1 .. 6 (Objects 7 .. 8 provide only status information and their control model is always set to status only). The possible parameter values are:

- DirNorSec (direct with normal security, one step control procedure, no activation termination message),
- DirEnhSec (direct with enhanced security, one step control procedure, activation termination message upon completion of the procedure or time-out, before activation termination no further control command can be executed on a given object),
- SBONorSec (select before operate with normal security, two step control procedure, possible cancel after select, no activation termination message),
- SBOEnhSec (select before operate with enhanced security, two step control procedure, possible cancel after select, activation termination message upon completion of the procedure or time-out, before activation termination no further control command can be executed on a given object).



Carefully check which control model is chosen in the system specification before setting this parameter. Direct with normal security is the simplest model, but a more advanced procedure might be required.

Remember that in VAMP relays the control model for the objects cannot be changed in runtime using IEC61850 communication services.

## 3.2. Setup of Report Control Blocks parameters

Configuration of Report Control Block parameters prepares RCB objects to perform data reporting to subscribing client devices. In VAMP relays there are 3 BRCB objects and 3 URCB objects available for clients. The main difference between BRCB and URCB is that Buffered Report Control Block collects and buffer data reports also during the period when there is no active subscription from a client device. Thus, BRCBs are typically dedicated to provide data reports to such clients as SCADA systems or gateways to Network Control Centers. URCBs are typically used by such clients as additional

operation work stations, test stations, devices temporarily connected to the network.

Configuration of BRCBs shall be set in **IEC 61850 BRCB configuration** view. Supervised **Dataset** name can be selected from the drop down menu including all predefined data sets with contents configured along with IEC C61850 data map. Note that in the drop down list of the reconfigured relay there may also appear names of dynamic data sets, if those were previously created by clients and stored in nonvolatile memory of the relay. Next parameter, read-only, will show the full data set name including the LNN under which the selected data set is located. Next, configure **Report ID**, which will be used by client to recognize the source of received reports. This can be text string, it should be unique per client. A default value is a data reference name of RCB in the device. **Integrity Period** parameter defines the cycle of sending integrity reports with current values of all members of the supervised data set. If this parameter is set to 0, integrity reports will not be sent. Remember that this cycle is configured in ms units, thus the reasonable value to be set is at least on the level of tens of thousands (i.e. tens of seconds). **Buffering Time** parameter specifies the maximum time of suspending report transmission after the first report entry has been collected. This allows combining multiple entries into a single report message and avoiding too frequent transmissions. Typically this parameter value is set to hundreds of ms.

```

P R O T O C O L   C O N F I G U R A T I O N
IEC 61850 main config
IEC 61850 data map(1)
IEC 61850 data map(2)
IEC 61850 data map(3)
IEC 61850 data map(4)
IEC 61850 data map(5)
IEC 61850 data map(6)
IEC 61850 data map(7)
IEC 61850 data map(8)
IEC 61850 data map(9)
IEC 61850 data map(10)
IEC 61850 deadband configurati
IEC 61850 BRCB configuration
IEC 61850 URCB configuration
+ GOOSE...
DIAGNOSIS
    
```

**IEC 61850 BRCB configuration**

**BRCB 1**

<b>Dataset</b>	DS2
Name of selected Dataset	LLNO.DS1
<b>Report ID</b>	SCADA1
<b>Integrity Period</b>	30000 ms
<b>Buffering Time</b>	40 ms
Triggering Options	
- Data Change	Yes
- Quality Change	Yes
- Data Update	Yes
- Integrity	Yes
- General Interrogation	Yes
Optional Fields	
- Sequence Number	Yes
- Report Time Stamp	Yes
- Reason For Inclusion	Yes
- Dataset Name	No
- Data Reference	No
- Buffer Overflow	Yes
- Entry ID	Yes
- Configuration Revision	Yes



Triggering Options parameter flags define the reasons when the data reports shall be produced by the relay: in case of **Data Change** – value change (e.g. CB position change, trip status change, current value change), in case of **Quality Change** – when quality attribute changes its state (e.g. due to physical input failure, sensor failure), in case of **Data Update** – when new data values are computed by certain relay application functions (e.g. harmonic component values calculated cyclically), **Integrity** – with configured period, **General Interrogation** – upon client's request. **Optional Fields** in RCB configuration define which information shall be included in the data report. Note that **Buffer Overflow and Entry ID** fields can be present only in the report produced by BRCB, not by URCB. Configuration of URCBs shall be set in IEC 61850 URCB configuration view.

### 3.3. Setup of GOOSE publishing parameters

VAMP relay supports 2 GOOSE Publisher functions represented by 2 GOOSE Control Blocks. In **GOOSE configuration** view the parameters of GCB1 and GCB2 can be set.

Max retransmission timeout parameter defines the final cycle of transmitting GOOSE messages by GCB when no data changes occur. This can be called GOOSE keep alive cycle and it is common for GCB1 and GCB2. No retransmission within this time allows GOOSE Subscribers assume GOOSE Publisher failure. You can select the preferred parameter value from the drop down list.

**Enable** flag set to **Yes** allows to activate GCB and start GOOSE message transmission immediately after the IEC61850 interface is initialized. When set to **No**, GCB has to be enabled in run time by some client performing write operation on this GCB attribute.

GOOSE ID parameter is a text string used as source identifier in transmitted GOOSE messages. Remember that VAMP relays as GOOSE Subscribers do not use this parameter for filtering the incoming messages. However, it may be required by other subscribers.

Instead, VAMP relay as GOOSE Subscriber relies on **Application ID** parameter – a number that can also be used as source identifier in GOOSE messages.

**Configuration Revision** parameter provides the version number of the data set related to GCB. It should be updated after each reconfiguration of the data set contents.

**Needs Commissioning and Test mode** flags can be set to **Yes** only when running system tests and verifying the configuration. Otherwise, their values should be set to **No**. (Remember that if a GOOSE message with one of those fields set is received by VAMP relay, data values from this message will update Network Inputs only – but changed values will not be propagated to application matrices and application.

```

P R O T O C O L  C O N F I G U R A T I O N
+ I E C 6 1 8 5 0 . . .
GOOSE configuration
GOOSE GCB1: DATA POINTS
GOOSE GCB2: DATA POINTS
GOOSE Subscriber: DATA POINTS
DIAGNOSIS
    
```

**GOOSE configuration**

Publisher parameters	
Max retransmission timeout	40 s
Publisher configuration GCB 1	
Enable	Yes
GOOSE ID	VAMP1
Configuration Revision *	1
Needs Commissioning	No
Test mode	No
MAC Address	01-0C-CD-01-00-11
VLAN Priority	4
VLAN ID	0
Application ID *	3
* Important for VAMP subscriber	

**MAC Address** parameter defines Ethernet multicast address as a destination of GOOSE messages transmitted by GCB. Remember that VAMP relay as GOOSE Subscriber can accept only one such address of GOOSE messages to be processed. Therefore, all GOOSE Publishers transmitting data to VAMP relay must have the same MAC Address value set in their GCB configurations. The allowed value range for this multicast MAC Address parameter is 01-0C-CD-01-00-00 .. 01-0C-CD-01-FF-FF.

**VLAN Priority and VLAN ID** parameters shall be set in accordance with system specification. VLAN switches allow to build subnetworks in the system and limit the message flow. **VLAN ID** must be then set the same value in GCB and in the switch ports for the relays receiving these GOOSE messages.

## 3.4. Setup of data sets for GOOSE Publishers

In the view **GOOSE GCB1: DATA POINTS** the drop down menu shows the binary data available for assignment to the data set related to GCB1. In a similar way the view **GOOSE GCB2: DATA POINTS** allows to configure the data set DSG2 related to GCB2.

The relay checks availability of all signals assigned to DSG1 and DSG2 and confirms this by **OK** value in **Status** column. If some required signal is not available, its **Status** will be set to **Not in use**, and it must be due to the fact that its LN is not marked as **In use** in the **IEC61850 data map**. After revising the **IEC61850 data map**, the configuration of DSG1 and DSG2 can be continued.

**GOOSE GCB1: DATA POINTS**

**DSG1 data configuration**

Index	IEC-61850 Variable	Signal	Status
0	VO1GGIO97.Ind.stVal(ST)	VO1	OK
1	VO2GGIO98.Ind.stVal(ST)	VO2	OK
2	VO3GGIO99.Ind.stVal(ST)	VO3	OK
3	VO4GGIO100.Ind.stVal(ST)	VO4	OK
4	VO5GGIO101.Ind.stVal(ST)	VO5	OK
5	VO6GGIO102.Ind.stVal(ST)	▼	OK
6	None	VO1 ▲	OK
7	None	VO2	OK
		VO3	
		VO4	
		VO5	
		VO6 ▼	

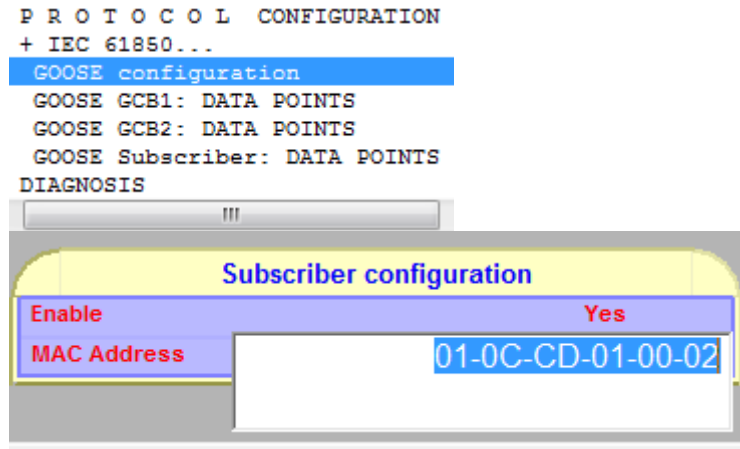
Remember that GOOSE Publishers in VAMP relays can only transmit binary signal values (Boolean type, value only, no quality and time stamp).

## 3.5. Setup of GOOSE Subscriber general parameters

If the configured relay should act in the system as GOOSE Subscriber then in **GOOSE configuration** view, in Subscriber configuration the **Enable flag should be set to Yes**.

It is also needed to configure the destination **MAC Address** of the incoming GOOSE messages. Remember that VAMP relay can accept GOOSE messages with only one configured address, thus all GOOSE Publishers providing data to this GOOSE

Subscriber must use the same destination address. Copy this destination address to **MAC Address** parameter.



Note that despite of using only one common MAC address in all GOOSE Publishers delivering data to GOOSE Subscriber in VAMP relay, you can still distinguish the source of publisher data by properly setting another GOOSE Publisher parameter, **Application ID (APPID)**, to different, publisher specific values.

## 3.6. Mapping of data from incoming GOOSE messages into Network Inputs

VAMP relay enables to configure up to 64 Network Inputs named NI1 .. NI64. Each of NIs is binary signal that may receive its value from the incoming GOOSE messages. Network Input can provide this value to the relay application (matrices and logic). In this way the signal transfer between different relays can be established in the IEC61850 network.

Remember that GOOSE Publishers and GOOSE Subscribers in VAMP relays can only process binary signals (Boolean type, value only, no quality and time stamp). It does not mean that other GOOSE Publishers must send only binary data in GOOSE messages. GOOSE messages may contain data of other types, but only binary data from them can be mapped to VAMP Network Inputs.

Selected Network Input to be used for providing network data to VAMP relay application shall be at first configured by setting its **In use** flag to **Yes**. Further configuration parameters define GOOSE message filtering to obtain the required data value for the NI. **App ID** parameter of NI corresponds to Application ID parameter of GCB transmitting these GOOSE messages. **Conf Rev** parameter of NI corresponds to Configuration Revision parameter of GCB transmitting these GOOSE messages. **Data index** parameter represents the

position of the data to be written into NI in the list of data values provided in the incoming GOOSE messages. The list index value is counted from 0 (and ending with 7 for messages from GOOSE Publishers in VAMP relays; the number of valid positions may be different in other relays).

**GOOSE Subscriber: DATA POINTS**

GOOSE Network Inputs Error 0

**Subscriber data configuration**

NI	App ID	Conf Rev	Data index	Value	Status	In use
1	1	1	0	0	NO DATA	Yes
2	2	1	0	0	NO DATA	Yes
3	1	2	2	0	NO DATA	Yes
4	1	2	3	0	NO DATA	No
5	1	1	4	0	NO DATA	Yes
6	1	1	5	0	NO DATA	No
7	1	1	6	0	NO DATA	No
8	1	1	7	0	NO DATA	No
9	1	1	8	0	NO DATA	No
10	1	1	9	0	NO DATA	No
11	1	1	10	0	NO DATA	No

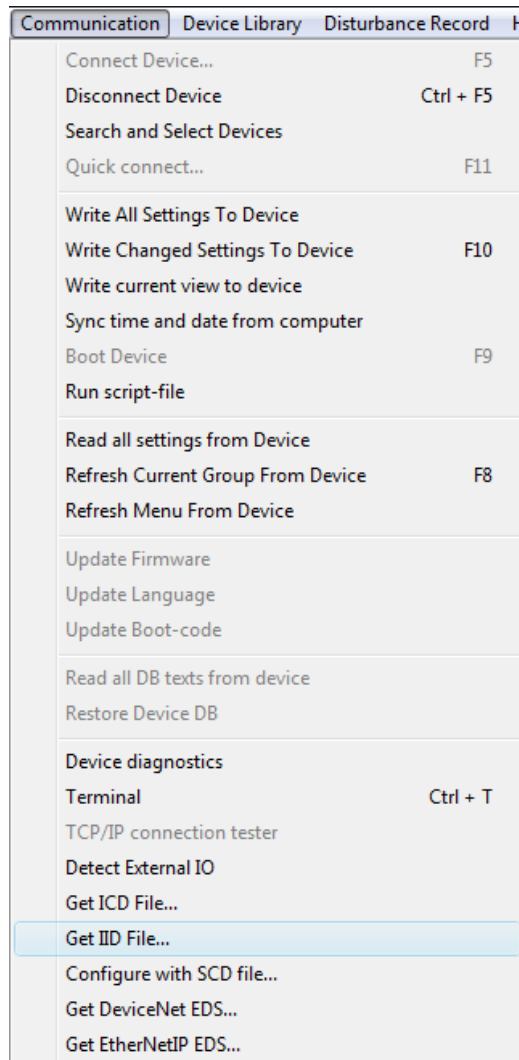
Note that this configuration task is not simple and requires detailed information on already configured GCBs in other relays.

Remember that in run time you can use this VAMPSET view to monitor GOOSE Subscriber performance. **GOOSE Network Inputs Error** tells whether there is some problem in the Subscriber configuration (if non-zero). In the NI table you can see incoming **Value** of NI and **Status**: OK (in case of correct performance), OLD (if Time-to-live is exceeded for the received data), BAD TYPE (in case unmatching type – the publisher delivers other data than Boolean).

After this setup you can define how the Network Inputs updated by GOOSE messages shall be used in VAMP relay application. You can configure **OUTPUT MATRIX**, **BLOCK MATRIX**, **AUTO-RECLOSING MATRIX** and **OBJECT BLOCK MATRIX** by specifying how GOOSE NI signals should operate on other signals or functions. You can also use GOOSE NI signals in the defined **LOGIC** of VAMP application. This is described in section 5.3.

### 3.7. Generation of IID file for the relay

The tasks described above create an instantiated and testable configuration of the IEC61850 server in VAMP relay. Therefore, instead of generating an ICD file (IED Capability Description) it is more appropriate to generate an IID file (Instantiated IED Description). This can be done using **Get IID file...** command from **Communication** menu of VAMPSET tool. The produced IID file shall be saved under a given name in the proper file directory to be used in the next step of the configuration process. Compared to ICD file, the IID file includes an assigned IED name, configured network addresses in Communication section, parameters of BRCBs, URCBs, GCBs, semi-reference information in Inputs section.



After accomplishing Step 3 the relay is already pre-configured for a specific network role in the IEC 61850 system (assigned network address, defined data flow parameters). The defined configuration can be verified using the listed testing tools (VAMP 61850 Simple Tester, INFO TECH 61850 Avenue). The relay shall be able to act as an IEC 61850 server device and respond to IEC 61850 client requests. It should also be able to transmit GOOSE messages in accordance with the setup of GCBs and to receive GOOSE messages from the network in accordance GOOSE Subscriber setup. This prepared configuration may, however, require further adjustments in Step 4, when the complete system is defined including all devices and all dependencies between the devices can be verified.

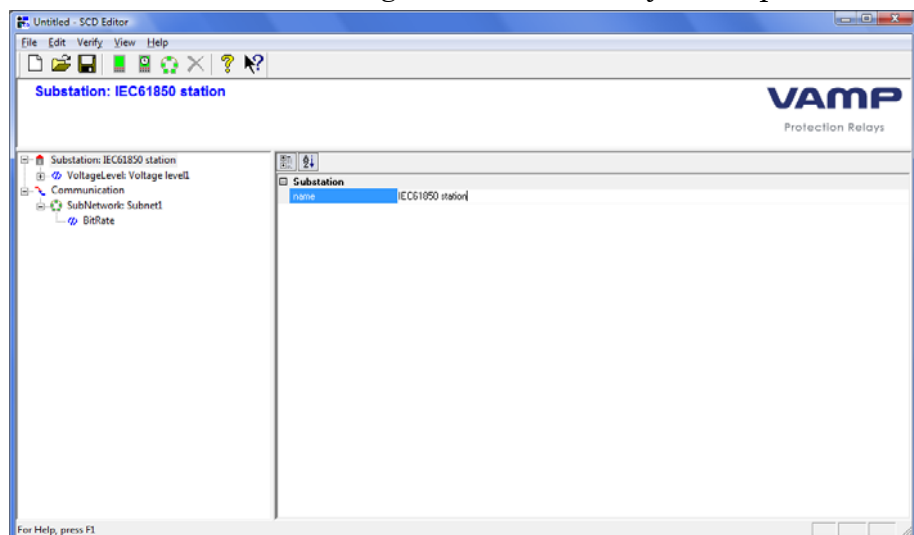
## 4. Step 4: IEC 61850 system configuration building – performed with VAMP SCD Editor

Start VAMP SCD Editor tool. You may be building a new substation system configuration description from scratch or updating some previously defined configuration (adding new devices, changing some parameters etc). In the first case, upon starting the tool will begin an new substation structure. In the second case you need to have an SCD file describing this configuration and must read this file into the SCD Editor using **Open** command from **File** menu.

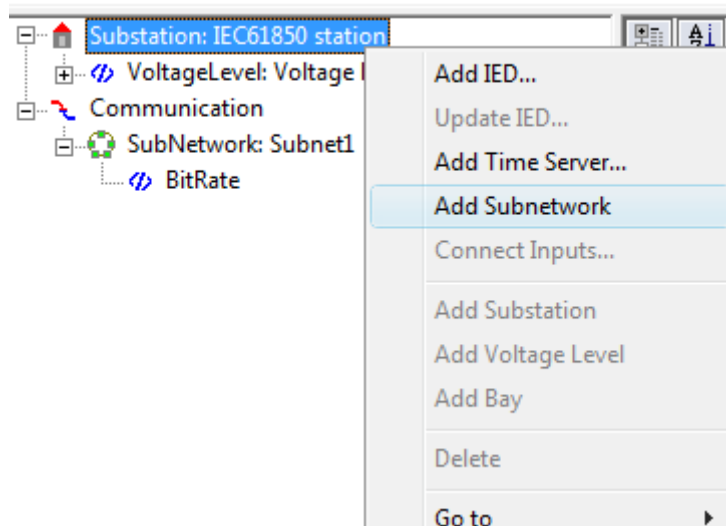
While building the substation system configuration description you may always save the temporary result in a file using **Save** or **Save as** command from **File** menu.

### 4.1. Starting the system configuration description with new substation

Initially, the tool creates an empty **Substation** structure with only one **Subnetwork** and without any devices. You can edit the substation name according to the received system specification.



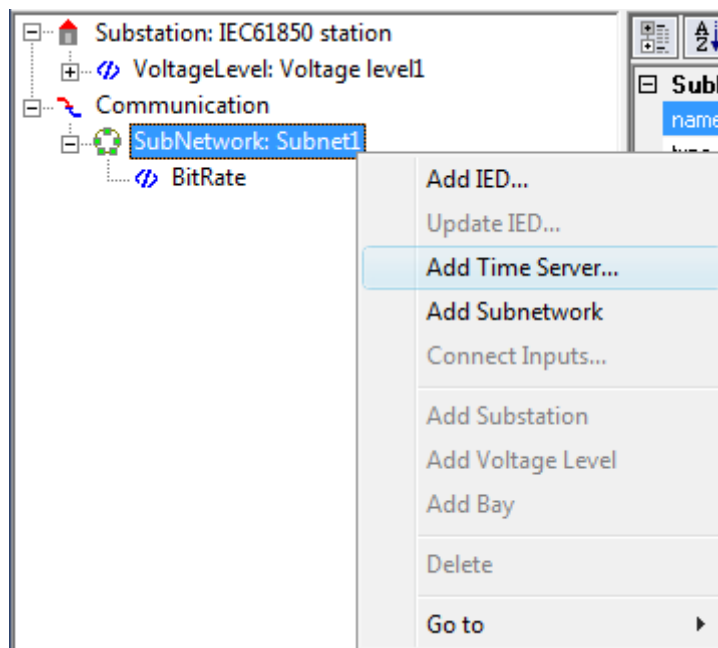
In accordance with the system specification you can add more subnetworks if required, using **Add Subnetwork** command from **Edit** menu or from the context menu of **Substation**.



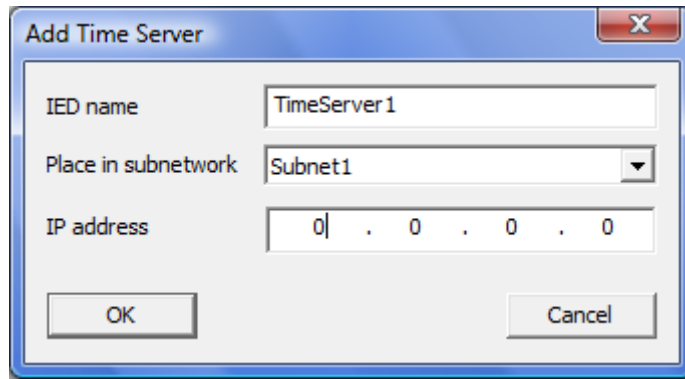
Subnetwork names can be set in accordance with system requirements. Another settable parameter of **Subnetwork** is **BitRate** – IEC61850 requires at least 100 Mbps.

## 4.2. Adding time server device to the selected Subnetwork

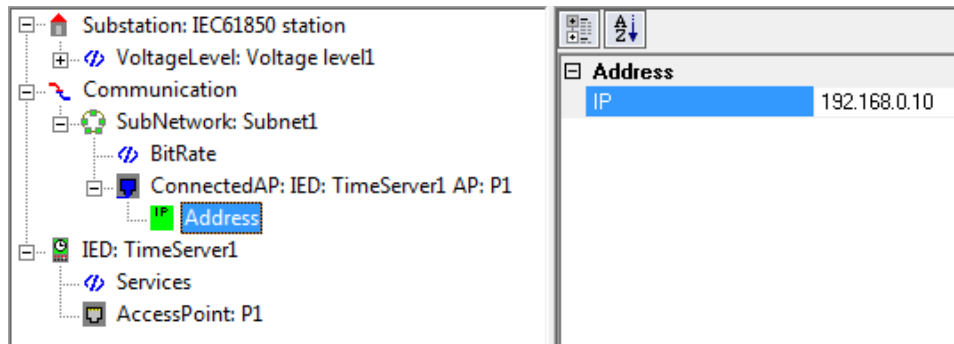
IEC61850 system requires time synchronization source for the clocks of IEDs. This is a device called time server, supporting NTP protocol. **Time Server** can be added to **Subnetwork** using **Add Time Server** command from the context menu of selected **Subnetwork**.



**Time Server** must be assigned to selected **Subnetwork** and must be given a unique IP address within this **Subnetwork**.

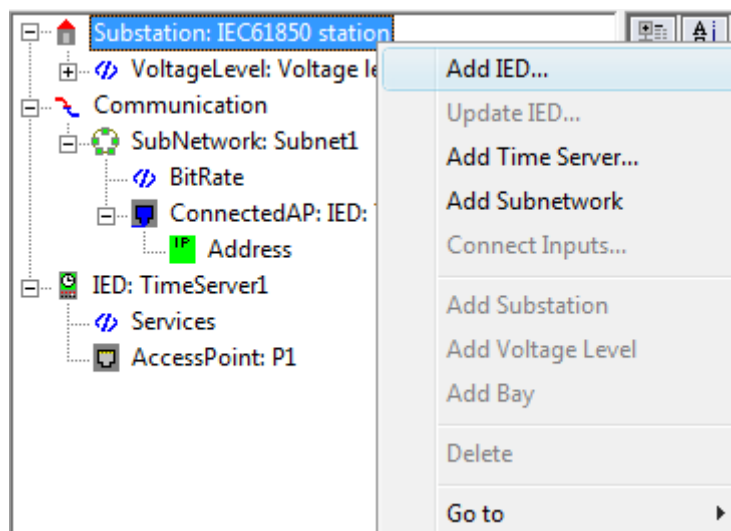


Added **Time Server** will be visible in the system structure – among **Substation** devices and in **Communication** section among **Connected AP** (Access Points).



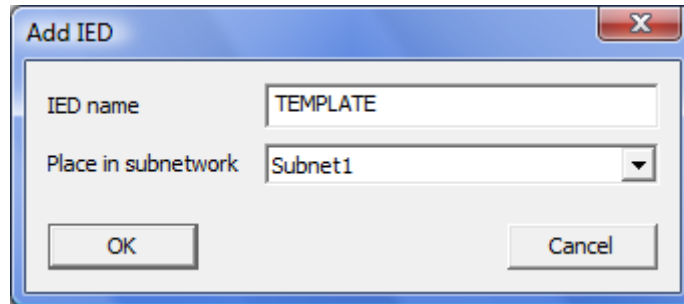
## 4.3. Adding IED to the system

An **IED** can be added to **Substation** using **Add IED** command from the context menu of **Substation**.

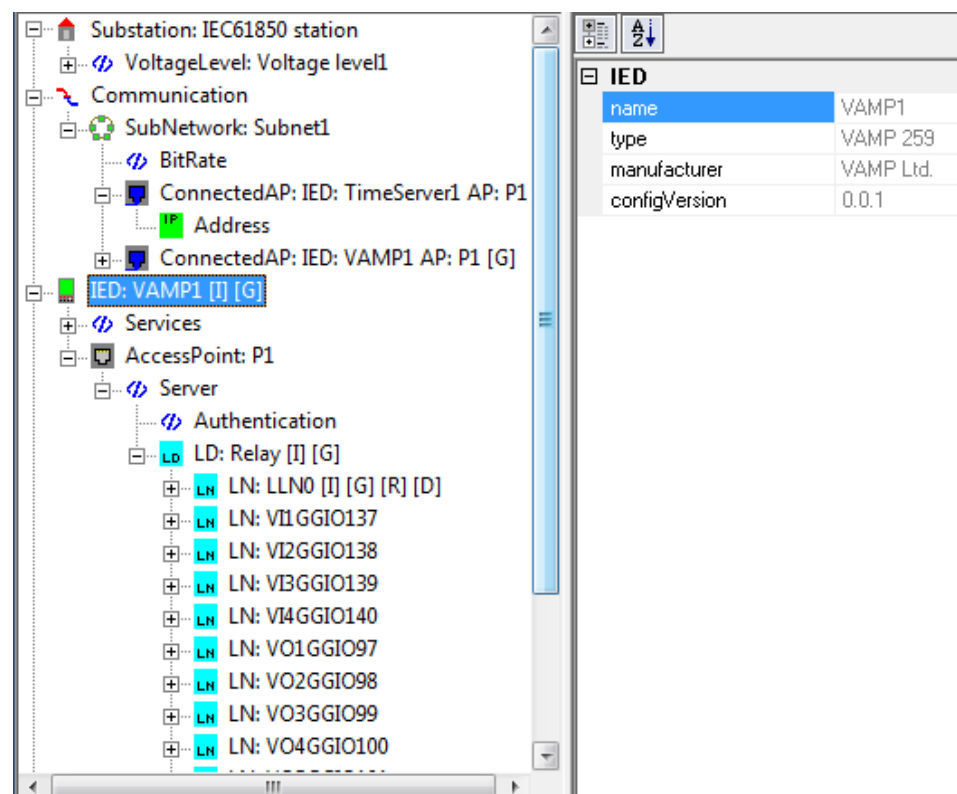


After invoking this command you must first select an ICD (or IID) file describing the device. SCD Editor will then require to

choose an **IED name** for this device (it must be unique within Substation) and for assigning this device to one of the available **Subnetworks**. A default IED name for ICD files, TEMPLATE, must be changed, for example to VAMP1. SCD Editor will check whether this name is unique in the system and if not, a new name will be requested.



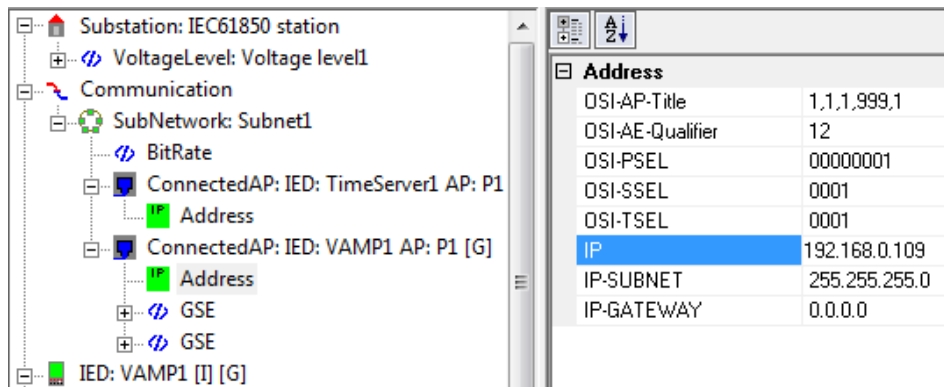
Added IED structure can be examined. IEDs **Connected AP** shall also appear in **Communication** section, under a chosen **Subnetwork**.



In case of importing a template ICD file, several parameters values must be still set in the system configuration description. In case of importing a pre-configured IID file, the set parameter values will be imported into the system configuration description but must be verified for compliance with system requirements.

## 4.4. Setting IED network address

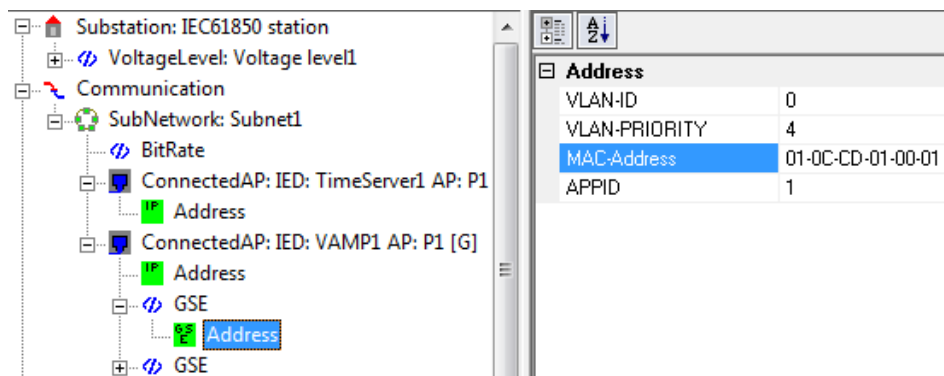
Each added **IED** must get a unique network address. This address should be checked / set in the **Address** parameters of IED's **ConnectedAP** in the chosen **Subnetwork**.



Note that **Address** parameters group includes the device IP address and also upper layers settings.

## 4.5. Setting GCB publishing address

If an added IED contains GOOSE Control Blocks (GCB), their publishing addresses should also be set. These Address parameters can also be found in IED's **ConnectedAP** in the chosen **Subnetwork**, under GSE branch representing GCB.



**MAC-Address** (destination, usually multicast) and **APPID** (identifier for message filtering) are the most important parameters for GOOSE publishing. Remember that GOOSE Subscriber function in VAMP relays accepts only one value of MAC-Address of incoming GOOSE messages. Therefore, it may be required that all GCBs in the devices will use the same MAC-Address value and the transmitted messages can be distinguished by APPID values.

Check also in the system specification what VLAN settings should be used.

## 4.6. Setting RCB parameters

If an added IED contains Report Control Blocks (RCB), their attribute values should also be reviewed and configured. You can browse the **IED** structure and locate **RCBs** in the LN branches marked with **[R]**.

The screenshot displays the configuration tree on the left and the parameter details on the right.

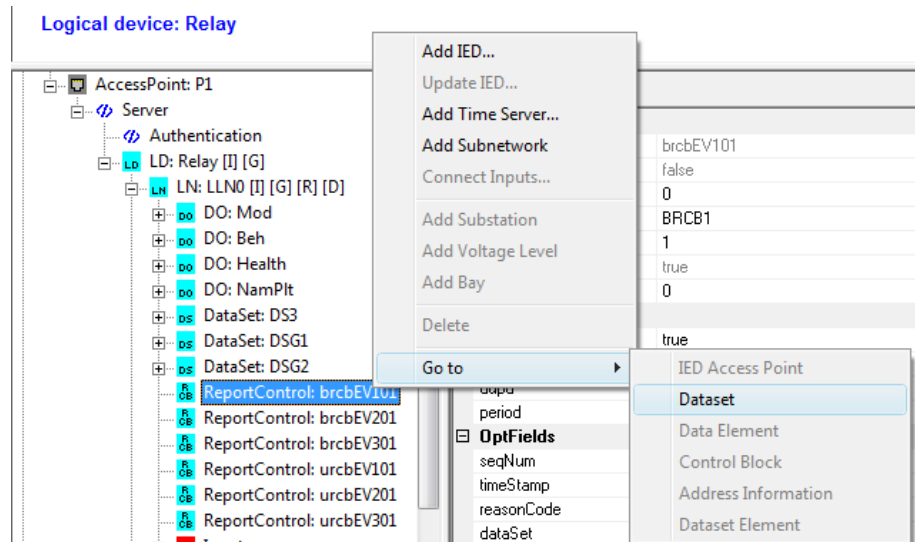
**Configuration Tree (Left):**

- IED: VAMP1 [I] [G]
  - Services
  - AccessPoint: P1
    - Server
      - Authentication
        - LD: Relay [I] [G]
          - LN: LLN0 [I] [G] [R] [D]
            - DO: Mod
            - DO: Beh
            - DO: Health
            - DO: NamPlt
            - DataSet: DS3
            - DataSet: DSG1
            - DataSet: DSG2
            - ReportControl: brcbEV101 (highlighted)
            - ReportControl: brcbEV201
            - ReportControl: brcbEV301
            - ReportControl: urcbEV101
            - ReportControl: urcbEV201
            - ReportControl: urcbEV301
            - Inputs
              - GSEControl: gcb1
              - GSEControl: gcb2

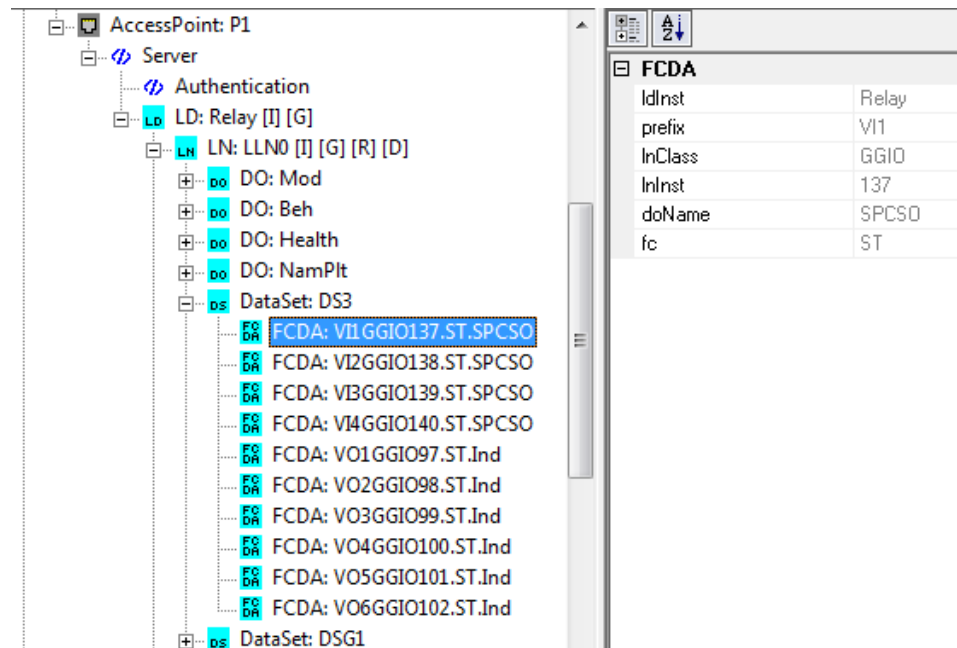
**ReportControl Parameters (Right):**

ReportControl	
name	brcbEV101
indexed	false
intgPd	0
rptID	BRCB1
confRev	1
buffered	true
bufTime	0
TrgOps	
dchg	true
qchg	true
dupd	true
period	true
OptFields	
seqNum	true
timeStamp	true
reasonCode	true
dataSet	true
dataRef	true
bufDvfl	true
entryID	true
configRef	true
RptEnabled	

The data set assigned to a chosen **RCB** can be reviewed by invoking **Go to ... and Dataset** command from the context menu. If an RCB has no assigned data set, there will be no context switch to data set description.



Note that SCD Editor tool does not allow to change the definitions of data sets. If the reviewed data set is missing some data or contains obsolete data, it will be required to make the next iteration of configuring the relay’s **IEC61850 data map** using VAMPSET tool and then providing a new IID file to SCD Editor.

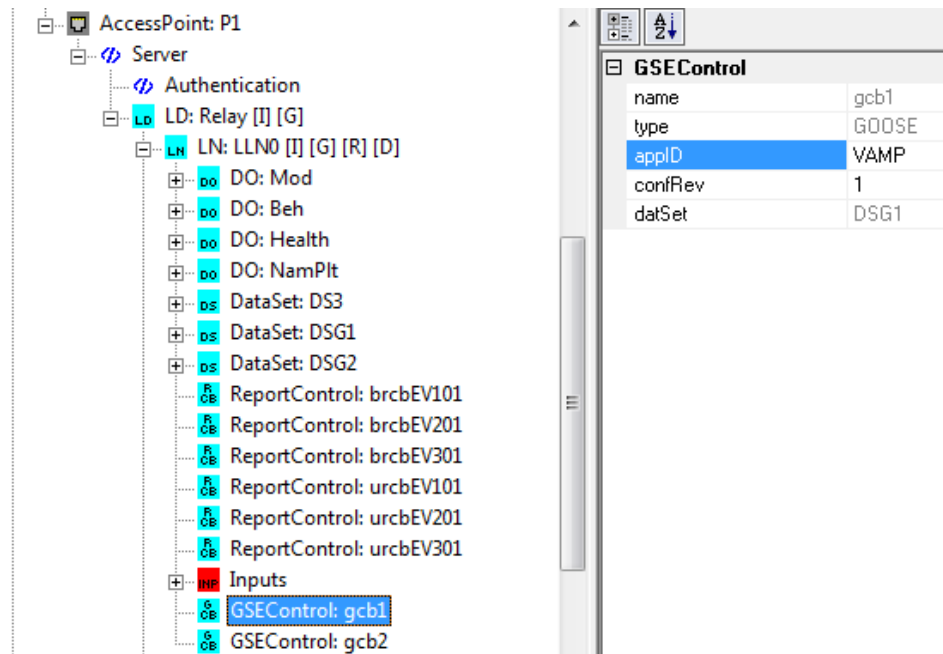


The system requirements may also assume that RCB parameters are not configured and will be dynamically set by clients subscribing for reports.

## 4.7. Setting GCB parameters

If an added IED contains GOOSE Control Blocks (GCB), their attribute values should also be reviewed and configured. You can browse the **IED** structure and locate **GCBs** in the **LLN0** branch marked with **[G]**.

Only **appID** and **confRev** attributes of GCB can be configured with SCD Editor.

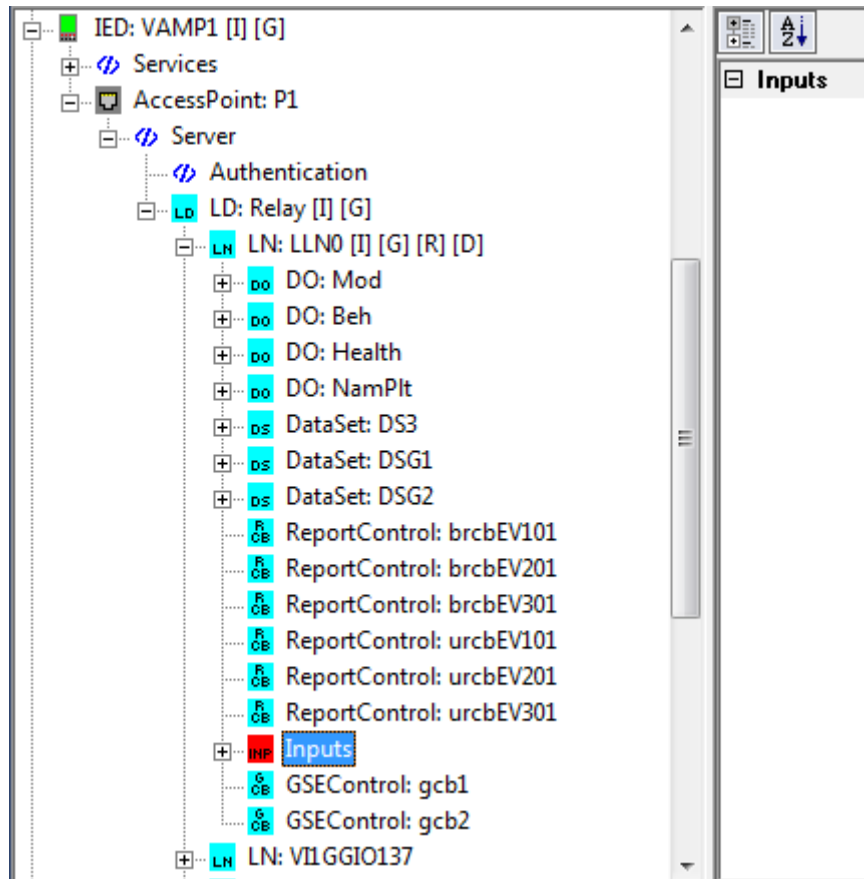


The data set assigned to a chosen **GCB** can be reviewed by invoking **Go to ... and Dataset** command from the context menu.

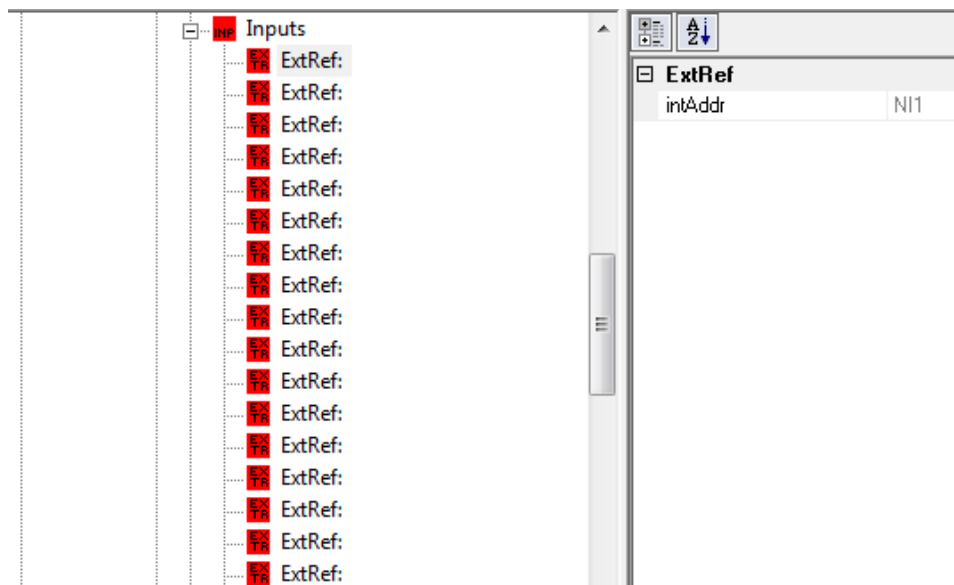
## 4.8. Binding between GOOSE Subscriber and GOOSE Publishers

For an IED including Inputs (GOOSE Subscriber function), the binding between chosen Network Inputs and published data of other IEDs must be set in accordance with system requirements for horizontal communication.

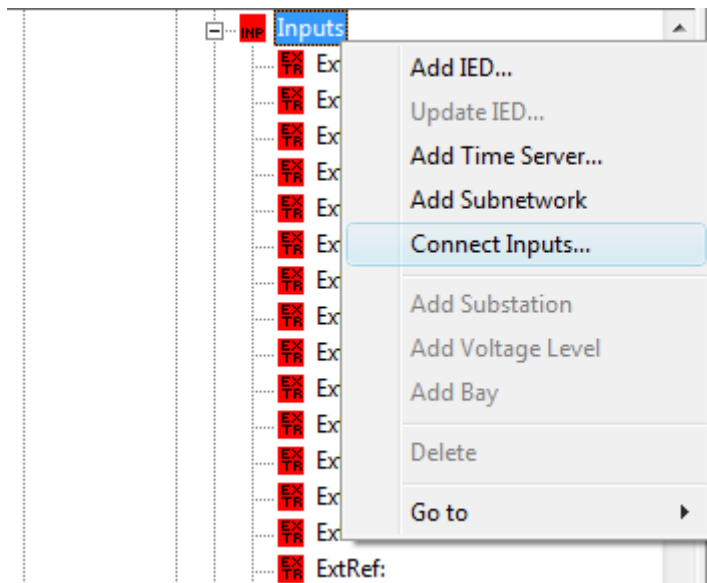
An **IED** with GOOSE Subscriber function must contain a mark **[I]** in the **LLN0** and **Inputs** section under **LLN0** logical node.



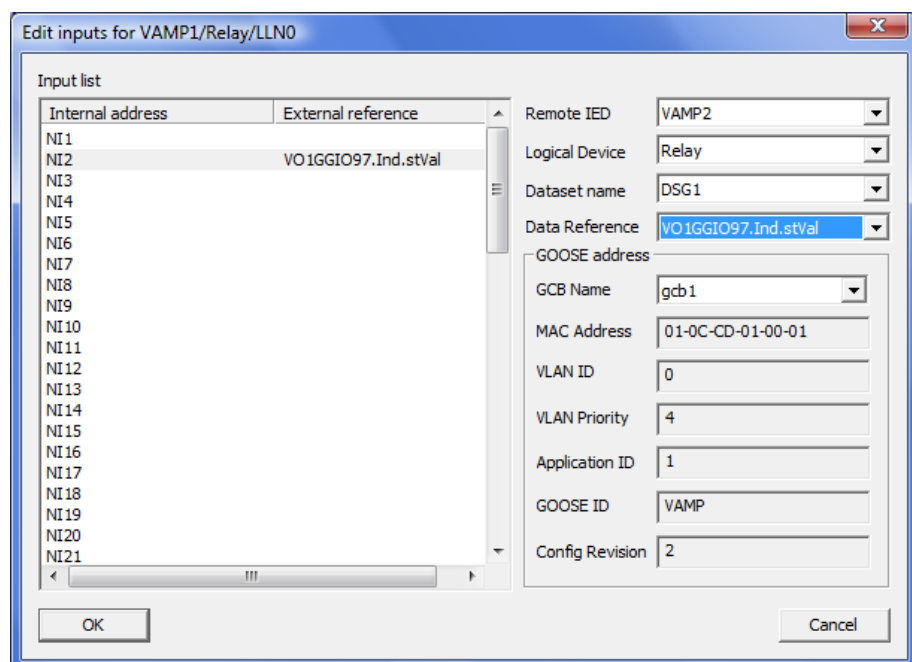
Inputs section may be initially unconfigured, with no data from other IEDs assigned as External References (**ExtRef**) to Network Inputs of this IED. Initially, **ExtRef** may include only one read-only attribute **intAddr** telling to which NI this External Reference applies.



The binding can be configured by invoking **Connect Inputs** command from the context menu.



In the view of editing the bindings between Network Inputs of the chosen IED and the data published by GCBs of other devices, first select a **Network Input** from the **Input list**. Then, for the given **NI** choose the data to be received: using dropdown menu select the **Remote IED** (publisher), its **LD**, **Data set name** and **Data reference**. GOOSE publisher information will be automatically provided in accordance with selected data. The dropdown menu includes only IEDs capable of transmitting GOOSE messages, with data belonging to data sets assigned to GCBs. The selected **External reference** will then appear next to **NI**.

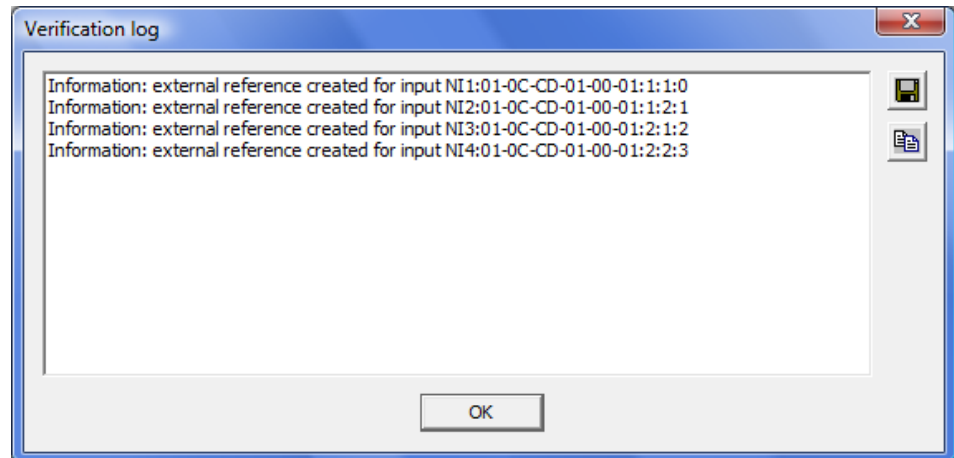


Press **OK** button after completing the task.

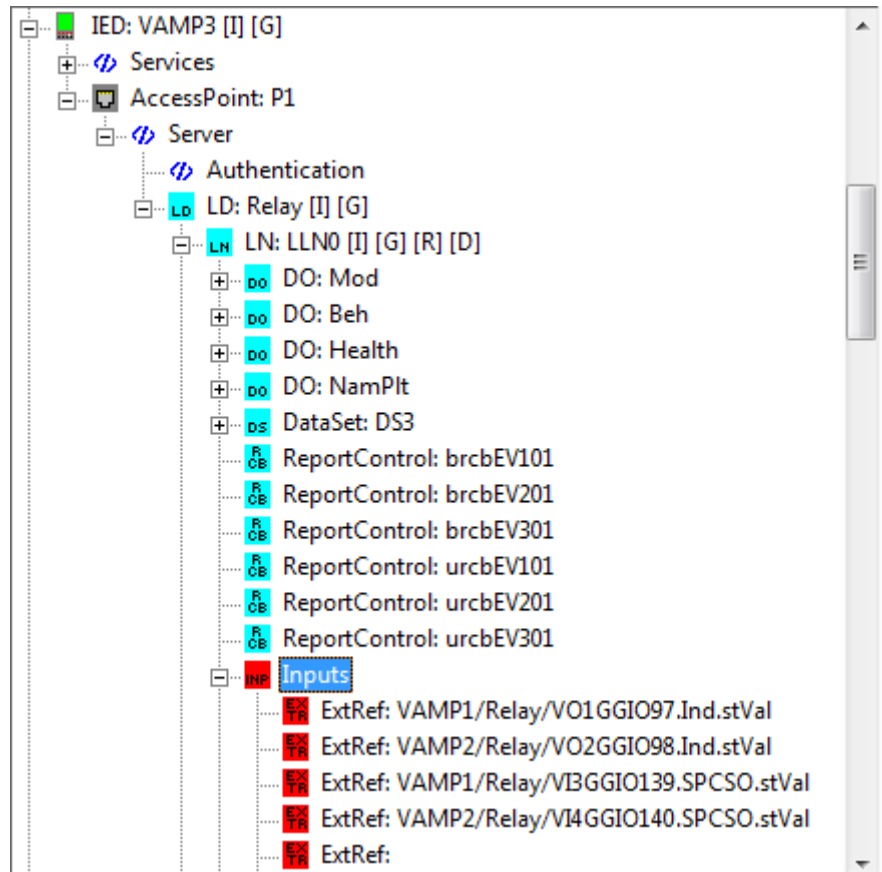
The configured bindings can be reviewed by examining **Inputs** section. No parameter editing is possible on this view. To make change in the **External Reference** definition, the **Connect Inputs** command must be invoked again.



If an IED description is imported to SCD Editor by an IID file including some Network Inputs configuration, these GOOSE Subscriber parameters will be verified by SCD Editor. Upon this verification External Reference information will be created only for these Network Inputs for which the source of incoming data can be resolved.



The resolved External References can be reviewed by examining Inputs section of this IED. Unresolved configurations of Network Inputs will be cleared.

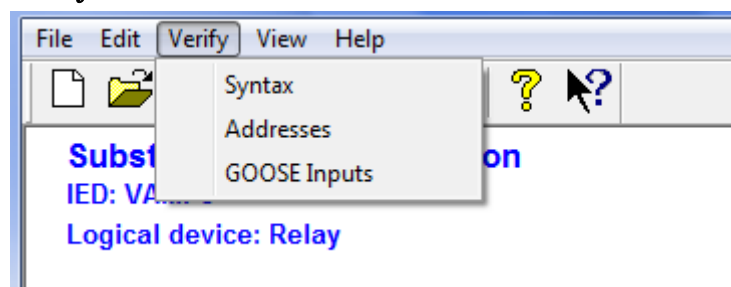


Remember that the binding between GOOSE Subscribers and GOOSE Publishers in the relays may be tedious and error prone process. Therefore, a verified specification of the required horizontal data flow should be prepared before starting this task.

## 4.9. SCD verification

SCD Editor tool allows to verify the created system configuration description for correctness. It is possible to check the formal syntax of an SCD document (essential when using documents produced with other tools), the network addresses assigned, and the configuration of GOOSE Inputs (correctness of binding GOOSE Subscribers with GOOSE Publishers).

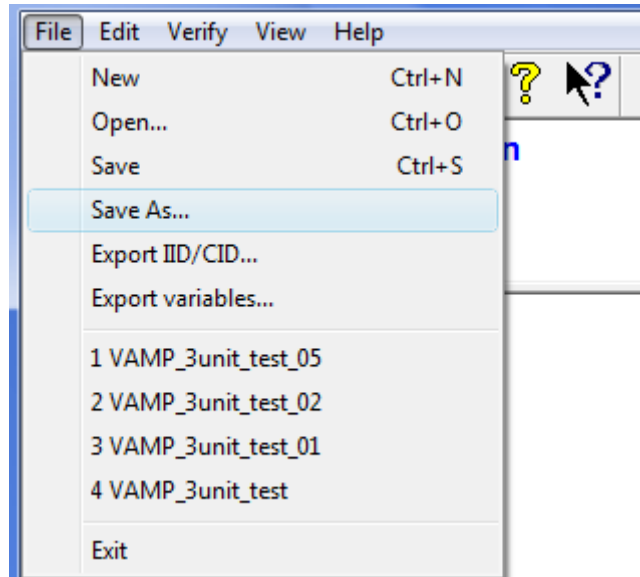
To invoke those verifications choose a proper command from **Verify** menu.



In case of finding errors, the modifications of the SCD document shall be still continued.

## 4.10. SCD file generation

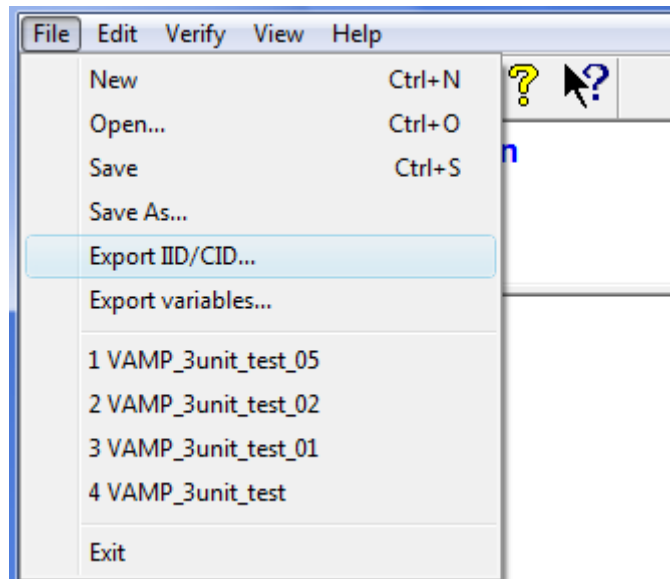
Upon completion (or partial completion) of defining the system configuration, you should save the created description in a file using Save or Save as command from File menu.



This file, with SCD extension of the name, is an SCL based description of the IEC61850 communication system. SCD file can be then directly used to update the configuration of the relays in accordance with the system configuration. This file may be also needed to configure client devices.

## 4.11. IID file generation

Upon completion (or partial completion) of defining the system configuration, besides SCD file which describes the whole IEC61850 system, you can also produce IID / CID files which are extracted parts of SCD describing a particular device. To do this invoke **Export IID/CID** command from File menu.



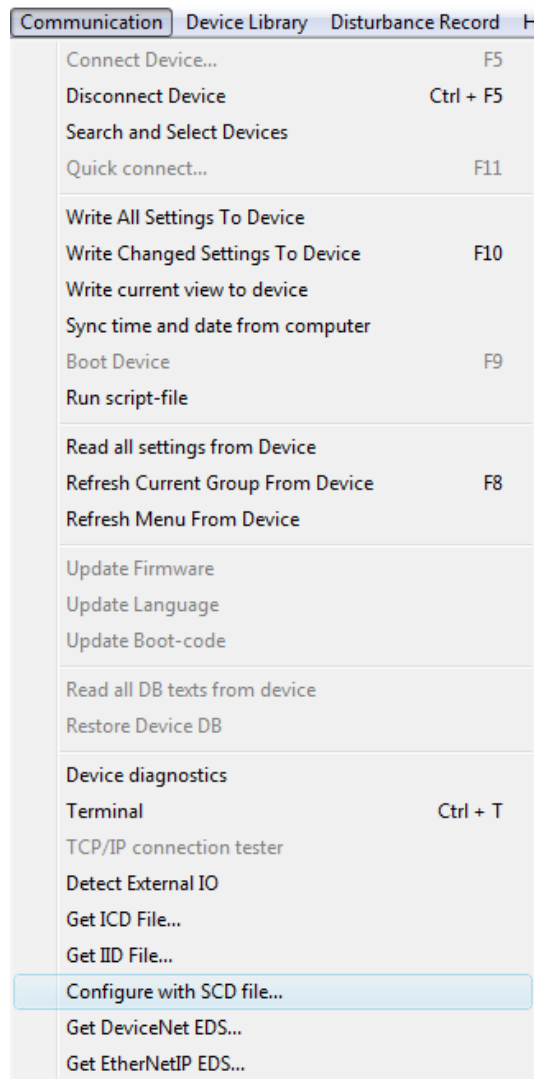
IID or CID file can also be used to update the configuration of the relay in accordance with the system description.

## 5. Step 5: IEC 61850 configuration adjustment in each system relay – performed with VAMPSET

### 5.1. Relay configuration update with SCD file

The SCD file created with VAMP SCD Editor tool (or its sections related to a particular device – exported IID file) shall be now used to update the IEC 61850 interface parameter in VAMP relay.

When having VAMPSET tool connected to the relay, with downloaded present configuration, invoke **Configure with SCD file ...** command from **Communication** menu of VAMPSET.



Open the SCD file produced with SCD Editor, select an IED name and let VAMPSET tool update the relay configuration by choosing option **Write Changed Settings To Device** from **Communication** menu. In case of a problem with parsing the delivered configuration file VAMPSET will display an error message. With SCD file positively verified with SCD Editor tool, an error situation should not occur.

At this point the relay configuration shall be compliant with the created system configuration description.

## 5.2. Checking Enable flags for GOOSE

If the configured relay should act in the system as GOOSE Subscriber, check in **GOOSE configuration** view, in **Subscriber configuration** section that the **Enable** flag is set to Yes. Otherwise, this flag should be set to No.

This procedure in VAMPSET has been changed to update this flag automatically when at least one NI is configured.

If the configured relay should act in the system as GOOSE Publisher and its GCBs should be enabled immediately after the relay start-up, check in **GOOSE configuration** view, in **Publisher configuration GCB1** section and in **Publisher configuration GCB2** section that the Enable flags are set to Yes. Otherwise, these flags should be set to No.

### 5.3. Review / update of Network Inputs processing

Network Inputs of GOOSE Subscriber are now configured to receive data from other devices. Now review the application configuration and check how GOOSE NI signals are processed in the matrices and in the logic.

GOOSE NI signals can be used to trigger relay outputs, to block protection functions, to initiate auto-reclose operations, to block controlled objects. They can also be used in building application logic schemes. Note that this task is going beyond the communication engineering and good knowledge of protection applications on the relay level and on the system level is required.

RELEASE OUTPUT MATRIX LATCHES

OUTPUT MATRIX

BLOCK MATRIX

AUTO-RECLOSING MATRIX

OBJECT BLOCK MATRIX

LOGIC

**OUTPUT MATRIX**

	T1	T2	T3	T4	A1	A2	A3	A4	A5	B0	AI	Tr	LA	LB	LC	DR	VO1	VO2	VO3	VO4	VO5	VO6	
GOOSE N1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input 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"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
GOOSE N2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
GOOSE N3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
GOOSE N4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
GOOSE N5	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
GOOSE N6	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
GOOSE N7	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
GOOSE N8	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
GOOSE N9	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
GOOSE N10	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**BLOCK MATRIX**

	I>	I<>	I<>>	Ig>	Ig<>	Ig<>>	Ig<>>>	I2>	I2<>	I2<>>	I2<>>>	I2<>>>>	U<>	U<>>	U<>>>	U<>>>>	U<>>>>>	U<>>>>>>	U<>>>>>>>	U<>>>>>>>>	U<>>>>>>>>>
GOOSE N1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
GOOSE N2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
GOOSE N3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
GOOSE N4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
GOOSE N5	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
GOOSE N6	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
GOOSE N7	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
GOOSE N8	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
GOOSE N9	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
GOOSE N10	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Besides GOOSE Network Inputs there is still another signal, **Error status**, which informs about GOOSE Subscriber failure

(no data received from the network). This signal can also be applied in matrices and in the logic to prevent some actions derived from valid state of Network Inputs.

## 5.4. IID file generation

Optionally, an IID file documenting the present relay configuration can be now generated with VAMPSET.

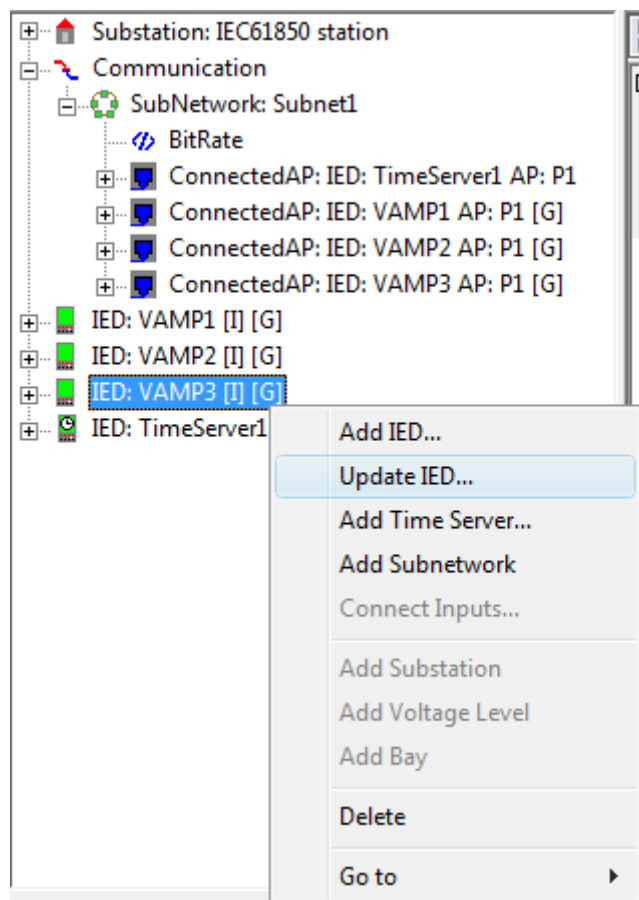
## 5.5. Further modifications

In case some requirements have been altered or added to the system, the configuration process can continue with another iteration. The relay configuration can be further modified with VAMPSET as described in Step 2 (changes in IEC 61850 data map) and Step 3 (changes in RCBs configuration and in GOOSE configuration). This will end up with the generation of a new IID file to be used in the new run of SCD Editor as described in the tasks of Step 6.

## 6. Step 6: IEC 61850 system configuration revisions – performed with VAMP SCD Editor

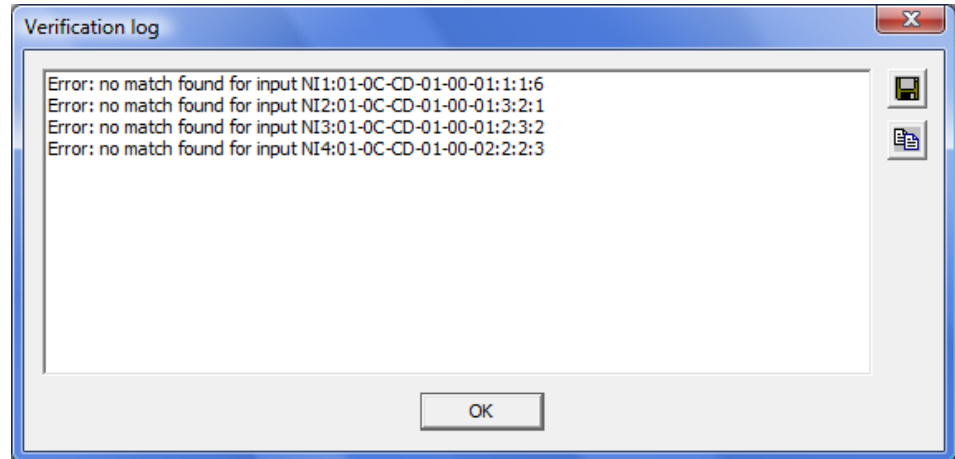
### 6.1. IED update in SCD

After some changes have been introduced into VAMP relay configuration and its new description is available in the IID file generated with VAMPSET in Step 5, the substation system configuration description shall be updated accordingly. SCD Editor tool should be started again, with opening the previously saved SCD file – using **Open** command of **File** menu. On the displayed **Substation** structure locate the **IED** with updated configuration, select it and invoke **Update IED** command from the context menu.



Now you need select the IID file produced in Step 5 to be imported by SCD Editor. The new configuration information

will be replacing the former description of the IED. The tool will verify the contents of IID file, trying to resolve External References for all configured Network Inputs. In case some NIs are not properly configured in the IID file, SCD Editor will display an error message, presenting the received setup of those NIs (MAC-address, APPID, ConfRev, Data Index). This error report can be save into a file or copied to the clipboard.



**Network Inputs** with erroneous setup will have cleared **External References** and need to be configured again using SCD Editor.

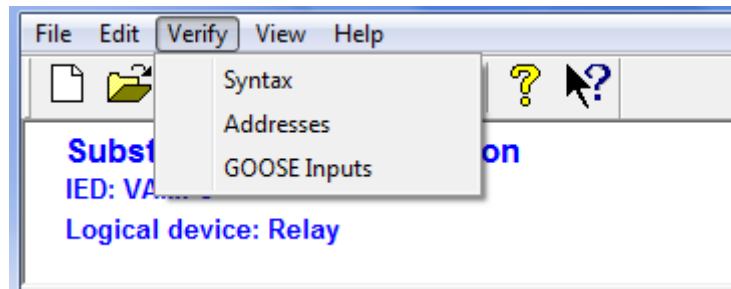
## 6.2. Further modifications

Besides the changes implied by updated IED configurations, it may also happen that some system requirements have been altered or new requirements have been added. The configuration process can then continue with adding new Subnetworks, new IED, modifying some parameter values, configuring GOOSE bindings etc. These tasks can be performed in the similar way as already described in Step 4.

## 6.3. SCD verification

When all modifications of the substation system configuration description are completed the correctness of the revised SCD document shall be verified again by checking its formal syntax, consistence of assigned network addresses and correctness of GOOSE bindings.

For a complete verification each of the commands from Verify menu should be invoked.



In case of finding errors, the modifications of the SCD document shall be still continued.

## 6.4. SCD file generation

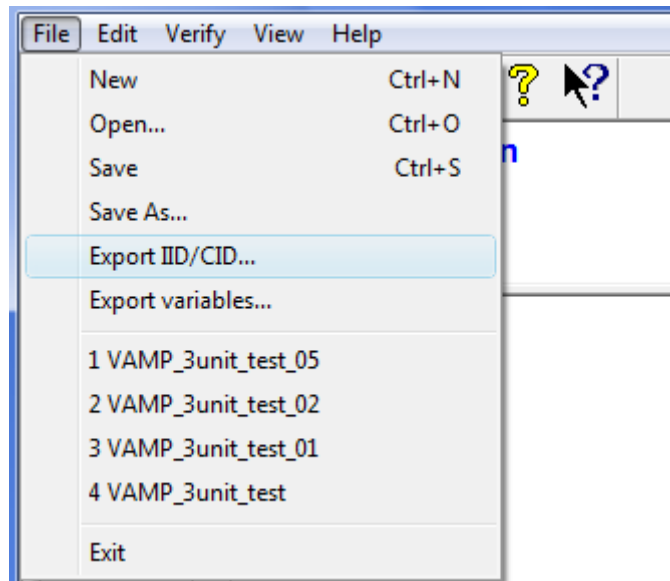
When the SCD document is completed and its verification result is positive, the created substation system configuration should be saved in a file using Save or Save as command from File menu.

SCD file can be then directly used to update the configuration of the relays in accordance with the latest system configuration. This file may be also required to configure the client devices communicating with IEDs.

Note that there is an additional command **Export variables** in File menu, allowing to produce a name list of IEC61850 data objects and data sets from all IEDs included in the system. This nonstandard document in ASCII text format may be also supportive in configuring some client systems for data exchange with IEDs.

## 6.5. IID file generation

You can also produce IID / CID files which are extracted parts of SCD describing a particular device. To do this invoke Export IID/CID command from File menu.



IID or CID file can also be used to update the configuration of the relay in accordance with the latest system configuration.

## 6.6. Repetition of Step 5

With the recently produced SCD or IID files return to Step 5 to adjust each relay configuration in accordance with the latest system configuration description.

Note that there may be several iterations of Step 5 and Step 6.



We reserve the right to changes without prior notice

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