IEC 61850 interface configuration for
VAMP products and WIMO

This application note applies to Vamp 50, Vamp 200, Vamp 300 series
and WIMO

1 Overview

This document applies to VAMP protection relays, which have a so called “native” IEC
61850 interface. This is available starting from software version 10.10.

The IEC 61850 protocol is available with the optional inbuilt Ethernet port. The IEC 61850
protocol can be used to read / write static data from the relay or to receive events and to
receive / send GOOSE messages to other relays.

The IEC 61850 server interface supports the following features:

- Configurable data model: selection of logical nodes corresponding to active application
  functions
- Configurable pre-defined data sets
- Dynamic data sets created by clients
- Reporting function with buffered and unbuffered Report Control Blocks
- Control model: direct with normal security and with enhanced security, SBO with
  normal and with enhanced security
- Horizontal communication with GOOSE: configurable GOOSE publisher data sets,
  configurable filters for GOOSE subscriber inputs, GOOSE inputs available in the
  application logic and output matrix

The inbuilt Ethernet is available as a communication option. Consult the manuals of the
individual devices for more information.

2 Configuration

The configuration of the IEC 61850 protocol is done with VAMPSET. VAMPSET can be
connected to the relay either via serial interface to the front panel connector or via the
Ethernet network. The version of VAMPSET that is needed will vary depending on the
version of the device firmware (for instance, firmware version 10.108 requires VAMPSET
version 2.2.85 or higher). Furthermore, an ICD (IED Capability Description) file can be generated with VAMPSET.

2.1 Setting the main parameters IP Address, TCP port, and Network Mask

The configuration is started by setting the appropriate values for the IP address (IP address of the VAMP device), NetMask (Network Mask) and Gateway (IP address of the gateway).

Please note that the IP address and network mask must be correctly set in reference to the client system in order to get the communication to work properly. When adding a device to an existing network, please consult with a network administrator to obtain proper IP addresses that you are allowed to use.

Also note that the devices do not support DHCP, in contrast to PC’s, which are able to obtain different IP addresses each time they are connected to a network. This may cause trouble if the communication is tested in an office network. The use of a separate test network is recommended.

Next, the IEC 61850 protocol is activated selecting “IEC-61850” as the Ethernet port protocol for one of the two instances of TCP ports available, see Figure 2.1, where the IEC-61850 protocol has been set as the port protocol for the first instance of TCP ports. The IP port for protocol selection is by default set to 102, and does generally not need to be changed.
1. A change of protocols on any port, serial port or TCP port instance, will require a reboot of the device.

2. If a VAMP device equipped with dual Ethernet ports is configured, a menu showing settings for RSTP (Rapid Spanning Tree Protocol) will also be visible in the PROTOCOL CONFIGURATION menu in VAMPSET. See figure 2.3 for a screenshot of these settings. The RSTP is described further in a different Application Note (ANCOM.EN013).

Two useful commands for troubleshooting can be found in the CommandPrompt (Microsoft Windows OS), `ipconfig` and `ping`.

The `ipconfig` command shows the current address and network mask of your PC. The `ping` command can be used to verify if the LAN connection is working properly. A successful ping response indicates that a physical connection between the client and the server (in this case the PC and the VAMP device). Furthermore, it proves that the TCP/IP-address and network mask setting is accepted. See figure below for an example.
Once the IEC 61850 protocol has been activated, the IEC 61850 Main Config will become selectable in the group list in VAMPSET (the list to the left in the VAMPSET window). See figure 2.4 for a screenshot of this menu selected. The first part of the “IEC 61850 main config” - menu contains some 61850 parameters, which normally do not need to be changed.

The IED Name parameter is a unique identifier and must be set differently for each device connected to the same network.
Figure 2.2: The “IEC 61850 main config” menu (see following text for explanations of the different fields).
Explanations for the fields presented in “IEC 61850 main config”:

- **Port** = TCP/IP port number to be used, 102 is the default.
- **Edition** = IEC 61850 standard edition to be used (1 or 2), Edition 1 is the default (feature available in firmware versions 10.123 and newer)

- **Check upper addresses** = No/Yes – No is the default. Defines whether the following 5 address parameters of the protocol layers above TCP/IP (AP ID,…) should be checked or not during the IEC 61850 connection establishing procedure. Needed only in special cases.

- **IED Name** = IED Name to be used as part of the 61850 addressing of the data.
- **AP Name = Access Point Name**, a name used to refer to the communication interface of this device in SCL-file.

- **Delete dynamic datasets** = this selection can be used to delete all dynamic datasets, which may have been created by client tools and stored in the relay’s memory.

- **Remove not valid LNs** = this selection can be used to remove from the data maps such Logical Nodes which are not pertinent for this VAMP type.

- **Instantiated RCBs** = “No” (the default): there are 8 separately defined BRCBs and 8 separately defined URCBs in the ICD file. “Yes”: the report control blocks are instantiated from single BRCB and URCB definitions given in the ICD file.

- **ResvTms included in BRCBs** = specifies whether “ResvTms”-attribute is included in the BRCBs or not (this is actually an extension from Tissue 453 and Edition 2 and should be set to “No” if the client system does not support this).

- **Control mode for object nodes** = selects the control model to be used with the controllable Objects.

- **SDO allowed in DS** = “Yes”: the “Structured Data Objects”, e.g. A.phsA, are allowed in pre-defined datasets DS1, DS2, DS3. “No”: the “Structured Data Objects” are not allowed in pre-defined datasets. Should be set to “No” if the client system is able to handle only complete 3-phase data types like A, PhV, PPV.

- **Type of BCR** = 32/64/128BIT, length of binary counters.

- **Type of SBO** = VisStr64/VisStr65, can be used to select the length of visible strings.

- **Size of array** = Number of elements in the arrays used to transfer the harmonics.

- **Dataset 1** and **Dataset 2** and **Dataset 3** can be used to include LLN0 and LPHD in predefined datasets DS1, DS2, DS3.

### 2.2 Selecting the Logical Nodes and Datasets for event reporting

The Logical Nodes (LN) to be visible via the IEC 61850 interface can be selected in “IEC 61850 data map (1)”… “IEC 61850 data map (n)”, see Figure 2.3 and Figure 2.4.
The data maps contain the IEC 61850 names of the functions of the device. Data maps are edited as follows:

- Set the “In use” field of the needed logical nodes to “Yes”
- Select to which pre-defined Dataset the data from the given function are assigned (e.g. for reporting purpose): set “Dataset x” to “Yes”
- Edit the “Description” field of the selected function if needed (this description will be visible in the IEC 61850 data model – in d attribute of NamPlt data in the LN).

**NOTICE**

1. If there is no special reason to use many datasets, use only dataset 1.
2. The data maps may contain Logical Nodes, which are not functional in the device which is being configured. Consult the manual of the device to see what functions are really operational in the relay type being configured.
3. Logical nodes may appear or hide in the data maps of VAMP relays which can be set to different protection modes (motor, generator, feeder). Due to this, it is recommended to set the relay to required protection function before configuring the IEC-61850 protocol.
Datasets are assigned to Report Control Blocks in the “IEC 61850 BRCB configuration” and “IEC 61850 URCB configuration” menus. A VAMP device has 3 predefined data sets DS1…DS3, these can be assigned to one or more of the eight buffered report control blocks BRCB 1…BRCB 8 and to one or more of the eight unbuffered report control blocks URCB 1…URCB 8.

The configurations menus of buffered and unbuffered report control blocks are shown in Figure 2.6.

Some clients may create their own so called dynamic data sets and assign these to report control blocks. Both persistent and non-persistent dynamic data sets are supported. However, these can only be viewed with VAMPSET, not created. IEC 61850 client tool software is needed for creating these. The “dynamic datasets” menu is shown in Figure 2.5.

1. The clients (e.g. the RTU) reserve one or more RCBs to subscribe for reports (events from the relay functions). The relay sends reports to those clients who have done subscriptions to RCBs.
2. The maximum number of simultaneous client connections is 8 (from firmware version 10.96 onward. Before this, the limit was three clients).

![Report Control Block configuration](image)

**Figure 2.6: Report Control Block configuration. Left: buffered. Right: unbuffered.**

### 2.3 Measurement config settings

The Deadband values, Deadband integration time and Unit multipliers used by the IEC 61850 protocol can be configured in the “IEC 61850 Measurement Config” in VAMPSET. See Figure 2.7 for screenshots of the configurable items.
There are two variants of the deadband calculation: absolute deadband and integrated deadband. To select absolute deadband, set the Deadband integration time to zero.

Set the deadband values with caution – too small values may cause unnecessary overhead in the data transfer.

A short example: if the Current I deadband value is set to 5 A, and the Integration time set to 0 (absolute deadband), the change condition will be satisfied when the value changes more than 5 A from the previously reported value. If, on the other hand, the Integration time is set to 1, the change condition will be satisfied for instance, if the signal value changes more than 1 A from the previously reported value and remains as such for five seconds.

### 2.4 Generic events

It is also possible to configure so called Generic events, which can be done in the table shown in Figure 2.10. This provides means to map any application events of the relay to maximum 8 indication data objects of the EvtGGIO183 logical node of the IEC 61850 interface. The status of the indication data object will be determined by ON and OFF events set for the corresponding index in the table.
IEC 61850 generic events

<table>
<thead>
<tr>
<th>Index</th>
<th>Off event channel</th>
<th>Off event code</th>
<th>Off event channel</th>
<th>Off event code</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
<td>69</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
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</tr>
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<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>8</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Figure 2.8: Generic events menu.

Figure 2.8 also features an example, where the status of Virtual Input 1 is mapped to the generic events table. The channel and code correspond to the SPA bus representation of events, which is defined in a separate document, “Modbus Profibus SPA Bus Events”. If the value of Virtual Input 1 is changed, then the value stored in the IEC 61850 address EvtGGIO183.Ind1.stVal will indicate the current value of Virtual Input 1.

**NOTICE**

If only an “ON event” is defined for an indication then the transition to OFF state is generated automatically after reporting the ON state (momentary ON state). And the same applies if only an “OFF event” is defined for an indication (momentary OFF state).

2.5 Configuration of the GOOSE communication

The working principle of the GOOSE communication is described in figure 2.3.1.

One-bit binary signals can be sent/received as GOOSE data. One device can send a maximum of two GOOSE data packets containing 8 bits of data, thus the maximum number of data points that can be sent from one device is 16 bits. Goose control block 1 (GCB1) and Goose control block 2 (GCB2) are used to control the sending of these two 8-bit GOOSE data packets.
GOOSE data is multi-casted to the Ethernet network. The multicast MAC Address, Application ID and Configuration Revision are the main parameters when routing the information from one relay to the other.

**NOTICE**

The MAC Address used in GOOSE communication is independent from the MAC Addresses of the devices in the Ethernet network!

One device can receive a maximum of 64 bits of GOOSE data. These can be utilized in the device internal logic and output matrix – these are named as GOOSE NI1…GOOSE NI64.

The main parameters of the GOOSE communication are available via “GOOSE configuration” menu (see Figure 2.10).

**NOTICE**

Extensions in GOOSE communication starting from firmware version 10.116

- the maximums number of data points that can be sent from one device is 2 x 16 signals.
- also analog values (IL1, IL2, IL3, UL1, UL2, UL3, Io1, IoCalc, P, Q, S, P.F) can be sent in GOOSE messages
- changes of analog values are checked by IEC-61805 server with cycle of 500ms and are subject to deadband calculation, so the minimum cycle of receiving new values of analog signals is 500ms.

**NOTICE**

Extensions in GOOSE communication starting from firmware version 10.125

- also states of objects 1..8 can be sent in GOOSE messages
- specific bits from received bit string (i.e. objects status or quality) or integer can be selected as input for binary NIs
IEC 61850 interface configuration

Figure 2.10: GOOSE main configuration menu.

Explanations for the fields presented in “GOOSE configuration”:

- **Max retransmission timeout** = GOOSE background sending cycle
- **Fixed length GOOSE** = No/Yes: disable/enable sending the GOOSE messages in flexible or fixed format (fixed length is a feature defined by Edition 2).
- **Enable** = Yes / No: Enable/disable the publishing of data defined by GCB 1 (data points group in 1)
- **GOOSE ID** = a textual string used to describe this GOOSE data packet, this may be used in the receiving end to identify the correct message
- **Configuration Revision** = a number describing the GOOSE configuration revision (if this is changed then the revision number must be aligned also in the receiving end to make the connection work again)
- **Need Commissioning** = No/Yes: a flag which can be used to indicate that some change has been done in the configuration and a new commissioning is needed.
When the VAMP device receives a message with this flag set, the data is not delivered to the logics or matrix but the status is shown in the subscriber view.

- **Test mode** = No: normal operation. Yes: Test mode. When the VAMP device receives a message with this flag set, the data is not delivered to the logics or matrix but the status is shown in the subscriber view.

- **MAC Address** = the MAC Address (01-0C-CD-01-00-00…01-0C-CD-01-01-FF) to be used as destination address for the GOOSE message.

- **VLAN priority** = a priority number, which may be used (in the Ethernet switches) to give higher priority to the GOOSE messages.

- **VLAN ID** = if Virtual LAN is used to deliver this GOOSE message, VLAN ID can be used to identify the correct Virtual LAN.

- **Application ID** = a number which is used to identify this GOOSE message source, this is used in the receiving end to identify the correct message.

- **Enable** = No/Yes, disable/enable the GOOSE subscriber (receiver) functionality.

- **MACAddress** = the MAC destination address which is valid for the incoming GOOSE messages.

- **Min supervision time** = minimum timeout for indicating invalid status of GOOSE Network Inputs due to no incoming GOOSE messages (exceeded supervision time or time allowed to live from the last GOOSE message, whichever is greater).

- **GOOSE ID 1…5** = List of GOOSE IDs which can be used to check incoming GOOSE messages (in addition to checking MAC address, Application ID and Configuration Revision).

**NOTICE**

1. Use different “Application ID” in different relays, because this is the main identification criteria when receiving GOOSE data in the VAMP relays. Also use different “Application ID” for GCB1 and GCB2.

2. VAMP devices can receive GOOSE data only with one defined MAC Destination Address (Subscriber configuration).

3. The VLAN ID and Application ID are given as hexadecimal values in this menu.
The data values to be sent are selected in the GOOSE mapping tables “GOOSE GCB1: DATA POINTS” and “GOOSE GCB2: DATA POINTS” (see Figure 2.11).

![Figure 2.11: GOOSE Control Block configuration menu.](image)

**NOTICE**

All the lines in the GOOSE GCB data point lists must indicate OK, otherwise no data is sent. See Figure 2.11.

The bit values to be received as GOOSE data are defined in the “GOOSE Subscriber: DATA POINTS” menu. See Figure 2.12.

![Figure 2.12: GOOSE Subscriber data points (see explanations in the text below).](image)

Explanations to “GOOSE Subscriber: DATA POINTS”:
- **NI** = index of GOOSE Network Input for the received GOOSE data point (can be binary or analog). Binary NIs can be used as inputs for the user-defined logic blocks or as control inputs in the other functions of the relay (e.g. the output matrix). Analog NIs (Virtual Analog Inputs) can be used as coupling in programmable stages.
- **App ID** = Application ID of the incoming GOOSE message
- **Conf Rev** = Configuration Revision of the incoming GOOSE message
- **Data index** = Index of the data element in the incoming GOOSE message
- **Bit index** = Index of the bit inside received value to be taken as value for binary NI (in this way for example particular bit from 2bit encoded object position can be taken)
- Matching GOID = if the “GOOSE ID” of the incoming message is to be checked, then this column defines the number of the GOOSE ID from the list of GOOSE IDs defined in “GOOSE main configuration menu”
- Value = data value received in the GOOSE data packet
- VAI unit = unit of the incoming analogue data
- Status = status of the GOOSE data NO DATA / OLD etc…
- Supervision group = number of the group which is used to indicate possible communication problems

**NOTICE**

All devices sending GOOSE data to VAMP relays must use different “Application ID”, because this is the main criteria when receiving data in the VAMP relays. If this is not possible due to publisher configuration capabilities validation can be also made by using GOOSE ID strings.

VAMP devices accept following data types as a source of binary signals: BOOLEAN and starting from firmware version 10.125: BITSTRING (for example object position or quality), INTEGER and UNSIGNED INTEGER. Reception of data of not supported type will cause that corresponding NI will get “BAD TYPE” status and will be invalid. Setting bit index out of range (for example 2 for 2 bit long bit string or 32 for integer) will also cause that corresponding NI will get “BAD TYPE” status.

VAMP devices accept following data types as a source of analog signals: FLOAT, INTEGER and UNSIGNED INTEGER. Reception of data of not supported type will cause that corresponding NI will get “BAD TYPE” status and its value will be set to 0. Internally analog signals are stored as scaled integer values with accuracy of 0.01. Due to that reason received integer value of 100 will be seen as value 1.00. In contrary received floating point value if 100.0 will be seen as value 100.00.

### 2.6 Creating ICD files with VAMPSET

An IED Capability Description (ICD) file defines complete capability of an IED. This file needs to be supplied by each manufacturer to make the complete system configuration. The file contains a single IED section, an optional communication section and an optional substation part which denotes the physical entities corresponding to the IED.

#### 2.6.1 Creating an ICD file online

In order to create the IEC61850 description file, connect the device with VAMPSET and select “Communication” → “Get ICD File”. From the ICD file generation options you can select whether the RCB names in the file contain indexes or not (selection of “RCB names with indexes” means that in the ICD file each RCB name will include an explicit two digit
index, otherwise this index is assumed to be added by the client when referencing the RCB). The need for indexed or non-indexed report control block names in the ICD file depends on the client system – in most cases the indexes are not required in the ICD file and will be added by the client system.

You can also enable some features of the 61850 Edition 2 – normally you can skip these. However, to be able to set up GOOSE data exchange using system configuration tool (like e.g. VAMP SCD Editor), in SCL Generation Options it is recommended to check Edition 2: Not configured GOOSE network inputs. In this way the ICD file will inform the system configuration tool about the GOOSE Subscriber capability of the relay.

After the selection of wanted features, press OK. The ICD file is generated and you will be prompted to choose a directory and name for saving the ICD file.

Figure 2.13: Creating an ICD file with VAMPSET.

2.6.2 Creating an ICD file offline

ICD files can also be created with VAMPSET offline, without opened connection to the device. This is, however, possible for firmware versions for which the resource files are available in VAMPSET tool (from 10.93 version onwards). The resource file is located in VAMPSET tool folder “ICD”.

2.7 Creating an IID file with VAMPSET

An Instantiated IED Description (IID) file defines the configuration for one IED for a substation project and is used as data exchange format from the IED configurator to the system configurator. This file contains only the data for the particular IED being configured: one IED section, the communication section with the IED’s communication parameters, the IED’s data type templates and optionally, a substation section with the binding of functions (LNodes) to a single line diagram.
An IID file is created by connecting Vampset to a device and selecting “Communication”→ “Get IID file”. This will show the same prompt as when creating an ICD file (Figure 2.13).

From the IID generation options you can select whether the RCB names in the file contain indexes or not (selection of “RCB names with indexes” means that in the ICD file each RCB name will include an explicit two digit index, otherwise this index is assumed to be added by the client when referencing the RCB). The need for indexed or non-indexed report control block names in the ICD file depends on the client system – in most cases the indexes are not required in the ICD file and will be added by the client system.

You can also enable some features of the 61850 Edition 2 – normally you can skip these. However, to be able to set up GOOSE data exchange using system configuration tool (like e.g. VAMP SCD Editor), in SCL Generation Options it is recommended to check Edition 2: Not configured GOOSE network inputs. In this way the ICD file will inform the system configuration tool about the remaining un-configured GOOSE Network Inputs in the relay (otherwise only the configured NIs will be listed in the IID file).

After selection of wanted features, press OK. The IID file is generated and you will be prompted to select a directory in which to save the IID file.

3 Configuring a device with SCD file

The configuration of the IEC 61850 interface in VAMP devices can be updated according to a system setup defined in an SCD file. SCD files are created with the system configuration tool used, such as VAMP SCD Editor or some similar tool.

To configure a VAMP device using an SCD file, connect Vampset to the device and select “Communication” → “Configure using SDC file”. This will bring up a file browsing window. In this window, navigate to the SCD file intended to be used, select it and press “Open”.

After reading the SCD file with Vampset, the following parameters will be updated in the device (if they have values set in the SCD file or the default values are implied by the SCD file):

1. Relay IP Address information
   i. IP address
   ii. Network mask
   iii. Gateway address
2. Network time protocol server address (NTP address)
3. IEC 61850 protocol stack addresses
   i. AP ID
   ii. AE Qualifier
iii. P selector
iv. S selector
v. T selector

4. IED name

5. Buffered and unbuffered report control block configuration parameters
   i. Dataset name
   ii. Report ID
   iii. Integrity period
   iv. Buffering time
   v. Triggering options
   vi. Optional fields

6. GOOSE publisher parameters
   i. GOOSE ID
   ii. Configuration revision
   iii. Application ID
   iv. MAC Address (destination)
   v. VLAN priority
   vi. VLAN ID

7. GOOSE subscriber parameters
   i. MAC Address
   ii. For all network inputs: AppID, Configuration Revision, Data index and \textit{In use} flag
   iii. For binary network inputs additionally Bit index

The configuration of GOOSE subscriber parameters can be rejected if the configuration of network inputs is inconsistent, for instance:

   i. IED publisher data are sent using different MAC destination addresses (only one address is allowed in VAMP)

**NOTICE**

Please remember that configuration parameters provided by SCD files overwrite the current values in the device. For instance, in the case of GOOSE subscribers, the network inputs are defined according to the SCD file, and the previous setup is cleared.