

## IEC61850 - Ethernet-based substation communication protocol

### Relay testing - Application note

The standard IEC 61850 describes the communication of devices in substations. GOOSE messages describe binary status signals over the substation network and are also used for relays tripping. For relay testing in IEC 61850 substations it is necessary to access to these data. This new feature is performed by ISA Automatic relay test set DRTS-6 and the new software TDMS rev. 5.01.

By means of a dedicated software module, ISA DRTS-6 can expand his testing capabilities by handling IEC61850 messages. One such message coming from a device connected to the substation network (such a relay) is also called Goose.

The IEC61850 Interface option for DRTS-6 is required for relay testing with Ethernet-based substation communication protocol. The IEC61850 Interface is mounted directly on the front panel of the DRTS-6. It is possible to upgrade old DRTS-6 units.

### TDMS 5.01 Software upgrade.

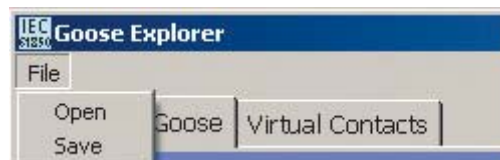
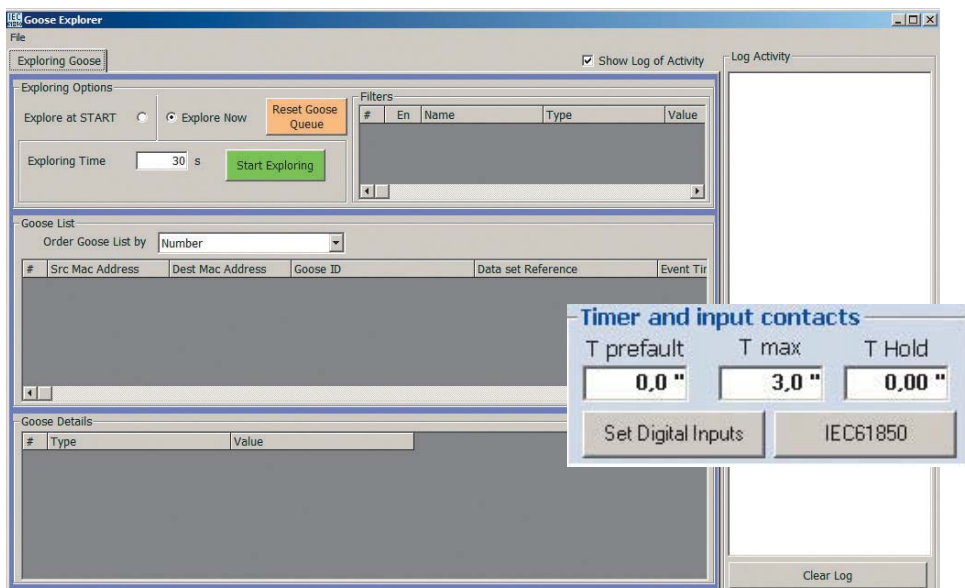
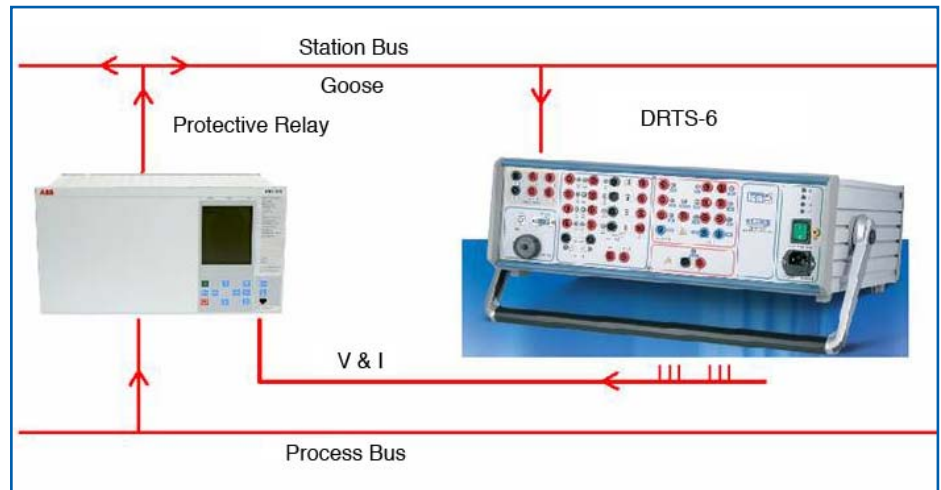
To control the IEC61850 board press the relative button in the Timer and Input Contacts frame of the Test Page of Distance 21.

When the button is pressed the window Goose Explorer is opened.

By means of the Goose Explorer it is possible to explore the IEC61850 messages on the network. The window shows a File menu, a main area divided in two pages (Exploring Goose and Virtual Contacts) and an optional side that shows the Activity Log.

### File Menu

A simple and basic menu is provided in order to handle the data that is captured by the Goose Explorer window.



- Open: opens a database file (.gse extension) containing the result of a session of exploring of the IEC61850 network
- Save: saves a database file (.gse extension) containing the result of a session of exploring of the IEC61850 network

**Main Area**

As it can be seen, the main Area is divided in two main pages:

- **Exploring Goose**

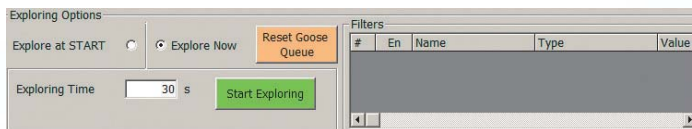
This page controls the Exploring Options, displays the Goose List and the Goose details and also handles the Filters

- **Virtual Contacts**

This page displays and sets the Virtual Contacts.

**Exploring Goose**

The first action to perform in order to use effectively the Goose Explorer is to catch the messages on the network. To this extent there are two Exploring options: **Explore at START** and **Explore Now**



It is possible to Reset the Goose queue with the relative button. This will clear the IEC61850 board from any previous goose still pending. Press this button when required, but when the Exploring session is closed.

**Explore Now**

When the Explore now option is selected it is possible to execute the exploring by pressing the **Start Exploring** button. Choose appropriately the **Exploring time** by setting the relative box.

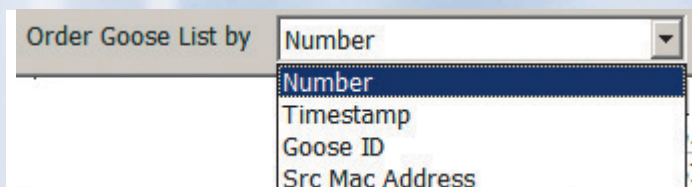
Upon pressing the button, the IEC61850 board mounted in the ISA Instrument starts to capture the messages and these are immediately displayed in the **Goose list** frame.

#	Src Mac Address	Dest Mac Address	Goose ID	Data set Reference	Event Timestamp
1	00-80-82-59-1C-34	01-0C-CD-01-00-02	ABB_REL670LD0/LIN09G09G_ZM1_TRIPS	ABB_REL670LD0/LIN09ZM1_TRIPS	2007-10-02 15.58.27.938
2	00-80-82-59-1C-34	01-0C-CD-01-00-03	ABB_REL670LD0/LIN09G09G_ZM2_STARTS	ABB_REL670LD0/LIN09ZM2_STARTS	2007-10-02 16.00.35.954
3	00-80-82-59-1C-34	01-0C-CD-01-00-03	ABB_REL670LD0/LIN09G09G_ZM2_STARTS	ABB_REL670LD0/LIN09ZM2_STARTS	2007-10-02 16.00.35.954
4	00-80-82-59-1C-34	01-0C-CD-01-00-03	ABB_REL670LD0/LIN09G09G_ZM2_STARTS	ABB_REL670LD0/LIN09ZM2_STARTS	2007-10-02 16.00.35.954
5	00-80-82-59-1C-34	01-0C-CD-01-00-03	ABB_REL670LD0/LIN09G09G_ZM2_STARTS	ABB_REL670LD0/LIN09ZM2_STARTS	2007-10-02 16.00.36.977
6	00-80-82-59-1C-34	01-0C-CD-01-00-04	ABB_REL670LD0/LIN09G09G_ZM2_TRIP	ABB_REL670LD0/LIN09ZM2_TRIP	2007-10-02 16.00.36.977
7	00-80-82-59-1C-34	01-0C-CD-01-00-01	ABB_REL670LD0/LIN09G09G_TRIP	ABB_REL670LD0/LIN09TRIPS	2007-10-02 16.01.47.938

The Start Exploring button turns Red and its caption is changed into Stop Exploring. The exploring can thus be stopped at any moment by pressing the button.

The grid displays for each Goose:

- Source Mac Address: physical address of the generator of the message
- Destination Mac Address: physical address of the destination of the message
- Goose ID: Identifier of the Message
- Data Set Reference: Identifier of the type of message created by the IED
- Event TimeStamp: Universal Time that identifies the Goose Data in this grid can be ordered in various ways included in the **Order Goose List by** menu.



You can select this menu at any time, even during the download of gooses. It is possible to Order data according to

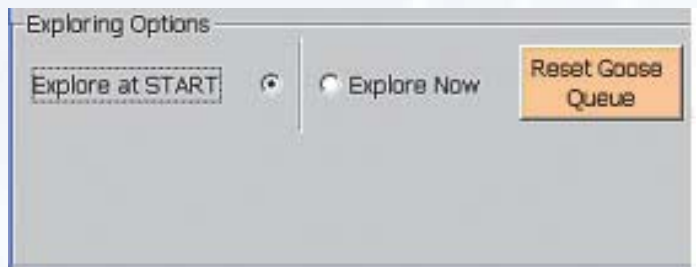
- Number: the actual sequence in which the goose has been captured. (not necessarily they are received by Time Stamp)
- Time Stamp: the UTCtime identifier of the goose
- Goose ID
- Source Mac Address

By selecting a row of the Goose List, it is possible to see the details of the Data Structure handled by the selected DataSet Reference. The **Goose Details** grid is loaded accordingly.

#	Type	Value
1	BOOLEAN	Vero
2	BOOLEAN	Vero
3	BOOLEAN	Falso
4	BOOLEAN	Falso

**Explore at START**

When the Explore at Start option is selected, it is not possible to Start the exploring in this window. The Exploring will be automatically performed during the execution of a Shot type test.



This means that at the execution of the Shot, the software will:

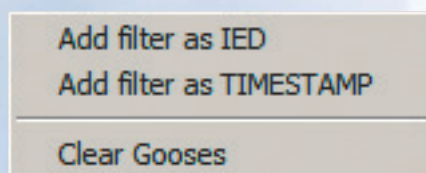
- open an exploring session appropriately just prior to the test start
- execute the shot test until the relay trips as normal
- close the exploring session
- get the IEC61850 messages that have been generated and display them in the Exploring Goose window
- display the results of the Shot in the main window of the software.

**Filters**

The amount of messages that can travel on a IEC61850 network can be burdening due to the amount of objects connected to it. In order to select a portion of the messages, especially only the meaningful once, related to the device undergoing the test, it is possible to set Filters.

Once a number of messages have been received, typically through an Explore now session, it is possible to select only those that match a selection.

In particular, by selecting one message from the Goose List and by right-clicking with the mouse, a menu is opened:



Relating to Filters, it is possible

- add filter as **IED**: extracts the IED of the selected Goose and use it as a Filter, in order to capture only the messages with that same DataSet Reference

#	En	Name	Type	Value
1			FILTER IED	ABB_REL670LD0/LLN0\$ZM1_TRIPS

The filter cannot be changed. A name can be given to the filter by selecting the Name column and writing an appropriate name. Click on the En column in order to Enable the Filter.

- add filter as **TIMESTAMP**: extracts the timestamp of the selected Goose and use it as a basis for a Filter. The Time can be edited.

#	En	Name	Type	Value
1			FILTER IED	ABB_REL670LD0/LLN0\$ZM1_TRIPS
2			FILTER TIMESTAMP	2007-10-02 16.00.35,954

The filter can be changed: click on the Value column and a box appears in order to edit the time of the filter.

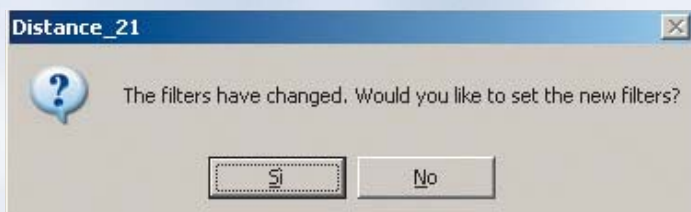
**FILTER TIMESTAMP**

This will represent the minimum time after which messages will be sensed and captured by the IEC61850 board. Any message with UTCtime prior to the Filter time will be discarded.

A name can be given to the filter by selecting the Name column and writing an appropriate name. Click on the En column in order to Enable the Filter.

It is possible to set up to 8 filters, although only one at a time can be enabled.

At the start of an Exploring session, if the filters have been changed, a message box will appear to let the user choose whether to use the new filters or leave the previous filter condition.



### Virtual Contacts

Once the user has performed an Exploring of the messages, be it with or without Filters, it is possible to set Virtual contacts. As the name describes, this is not a physical contact of the ISA Instrument, but is a 'virtual' contact or a condition that becomes true for a device on the network. This condition is verified by means of the occurrence of a very specific goose.

After selecting a goose from the Goose List in the Exploring Goose page, the Goose details frame is loaded with the details of the selected Dataset data structure. Each of the parameters in this data structure can be set in order to define a virtual contact.

Right-click with the mouse on a parameter and a menu appears.

#	Type	Value
1	BOOLEAN	Falso
2	BOOLEAN	Falso
3	BOOLEAN	Falso
4	BOOLEAN	Falso

Set virtual contact

It is possible to set the parameter as a basis for a virtual contact. By choosing the menu item, a new virtual contact will be added to the Virtual Contacts page. It is possible to add up to 8 virtual contacts.

#	Name	DatasetRef	Type	Condition	Value	Time
1	VC1	ABB_REL670LD0/LLN0\$ZM1_TRIP	BOOLEAN	Equal to	Falso	0
2	VC2	ABB_REL670LD0/LLN0\$ZM1_TRIP	BOOLEAN	Equal to	Ver0	0
3	VC3	ABB_REL670LD0/LLN0\$ZM1_TRIP	BOOLEAN	Equal to	Falso	0
4	VC4	ABB_REL670LD0/LLN0\$ZM1_TRIP	BOOLEAN	Not Equal to	Falso	0
5	VC5	ABB_REL670LD0/LLN0\$ZM1_TRIP	BOOLEAN	Not Equal to	Falso	0
6	VC6	ABB_REL670LD0/LLN0\$ZM1_TRIP	BOOLEAN	Equal to	Ver0	0
7	VC7	ABB_REL670LD0/LLN0\$ZM1_TRIP	BOOLEAN	Not Equal to	Falso	0
8	VC8	ABB_REL670LD0/LLN0\$ZM2_STAR	BOOLEAN	Equal to	Ver0	0

#	Name	AND #1	AND #2	AND #3	AND #4	OR #1
1	VC1					
2	VC2					
3	VC3					
4	VC4					
5	VC5					
6	VC6					
7	VC7					
8	VC8					

A virtual contact is identified by a

- Name: it can be given by the user by editing the relative box in the grid. The same name will appear in the lower frame that represent the Trip condition for the Virtual contact.
- Dataset Reference: it represents the exact goose that serves as the basis for the virtual contact. The same device can and does produce more than one Goose ID, so in order to set the virtual contact it is not enough to define the Goose ID, but the selection has to be made on the Dataset Reference.
- Type: it can be Boolean, BitString, Unsigned, Signed, Float or UTCTime.
- Condition: depending on the type of the data it can be: Equal to, Less than, Greater than or Not Equal to. It is set by default to Equal to, but it can be changed according to the data type. Select the appropriate condition form the menu that appears when clicking on the condition column.
- Value: together with the condition field, it defines the actual condition of the Virtual Contact. In case of data type Boolean, it can only assume value True or False.

- Time: represents the actual 'trip time' of the virtual contact, or the time interpreted from the goose that the device produces when the condition is verified. It cannot be modified, it is automatically set by the software when a test is performed and a virtual contact has tripped.

In the situation here pictured, the test will trip, apart from the Trip contact conditions set in the main page of the software in this conditions:

- trip of virtual contacts 1 and 2
- trip of virtual contacts 3 and 4
- trip of virtual contacts 5 6 and 8
- trip of the only contact 7

In the lower part of the page, it is possible to set the Virtual Contacts trip conditions.

#	Name	AND #1	AND #2	AND #3	AND #4	OR #1
1	VC1	✓				
2	VC2	✓				
3	VC3		✓			
4	VC4		✓			
5	VC5			✓		
6	VC6			✓		
7	VC7					✓
8	VC8			✓		