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Energy Automation Application Notes – Australia

IEC61850 GOOSE isolation features with SIPROTEC relays

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Unrestricted

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Forewords

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Our sincere wishes,

Siemens Australia Energy Automation team

Version	Date	Prepared by	Approved by	Details
01	16/10/2014	Frankie Lu	Damien Ravinet	First draft
02	16/09/2015	Damien Ravinet	Frankie Lu	Add sip 5 Test and OpBlock details

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1 Introduction

The IEC 61850 standard has been defined in cooperation with manufacturers and users to create a uniform, future-proof basis for the protection, communication and control of substations. Especially with the release of Edition 2 which provided further testing features.

The isolation of IEC 61850 GOOSE messages has always been an interesting topic for IEC 61850 IEDs testing applications. In this application note, some of the GOOSE isolation features will be demonstrated for SIEMENS SIPROTEC 4/Compact and SIPROTEC 5 protection IEDs.

In this application note, we will look at these isolation features only from the IED's perspective on the station bus (applies for inter bay level IEDs only, station level IEDs not discussed). IEC 61850 testing features from the station controller and process bus perspective is not included in the particular application note.

Should you have additional questions or queries please feel free to contact our Australian local service and support Hotline.

2 IEC 61850 GOOSE technology

Generic Object Oriented Substation Event (GOOSE) is defined under the Generic Substation Event (GSE) model within the IEC61850 standard. The Generic Substation Event (GSE) model enables fast and reliable data exchange for the substation protection and automation system. Generic Object Oriented Substation Event (GOOSE) is a control class which supports the exchange of a wide range of common data defined by the IEC61850 standard organized by a data-set.

Generic Object Oriented Substation Event (GOOSE) uses the ISO/IEC 8802-3 frame as a vehicle to transmit and receive Ethernet frames/messages between the peers on the station bus.

In a simplified way, there are three levels of GOOSE structure that can be isolated for testing purposes:

- Intelligent Electronic Device (IED) level (Layer 1 of OSI reference model)

Each IED whether a subscriber or a publisher is lowest level of the communication interface with a network address, i.e, physical link.

- GOOSE frame/message level (Layer 2 of OSI reference model)

Each IED can have a number of different GOOSE control blocks which each defines a collection of information (data-set) to be exchanged at the Ethernet frame level.

- GOOSE signal level (payload of GOOSE Ethernet Frame, encapsulated in the layer 2 frame)

Each GOOSE control blocks defines a collection of defined signals to be included in a data-set. A signal consists of data objects (DO) that feature various data attributes (DA).

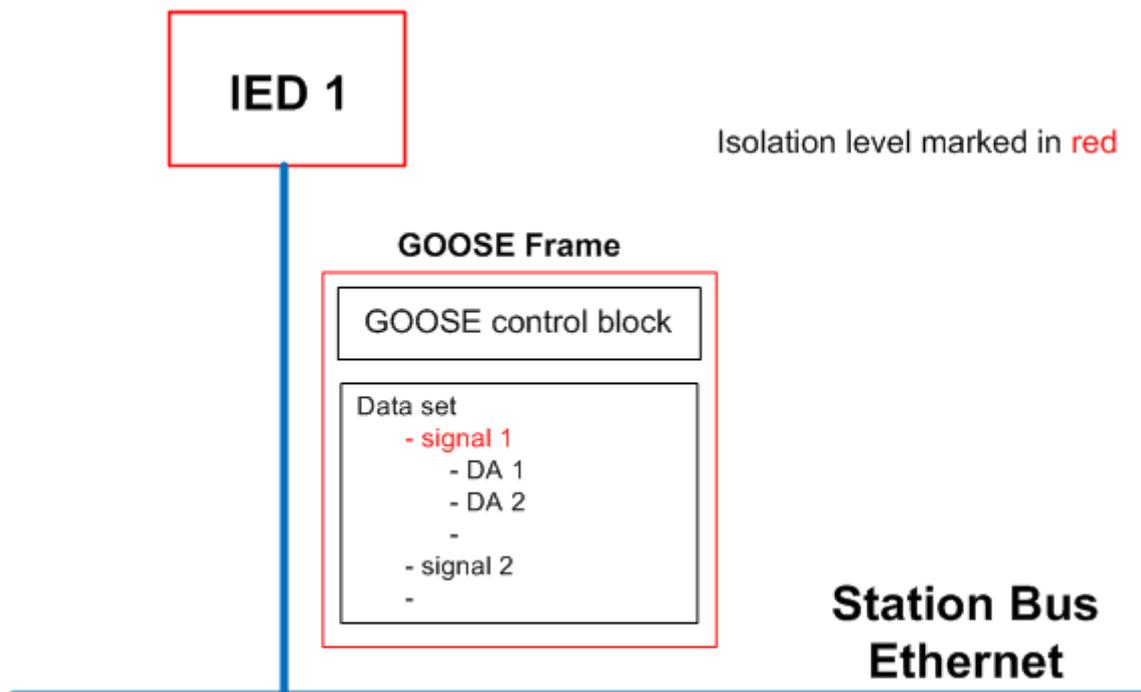


Figure 1

3 IEC 61850 Conformance

The IEC61850 standard defines a wide range of services, data models. The IEC 61850-10 defines the conformance to the IEC 61850 standard testing of a particular device. It is the manufacture's responsibility to provide the following documentation:

PIXIT

Protocol implementation extra information for testing

PICS

Protocol Implementation Conformance Statement

TICS

Technical Issues Conformance Statement

MICS

Model Implementation Conformance Statement

These documentations declare to what extent an IED complies with the services and data models defined by the standard. For example, does a device support the "Test" bit in its status value quality bits.

Such information for SIPROTEC devices can be accessed via our Australia service and support website: <http://www.siemens.com.au/energyautomation> or please feel free to contact our Australia service and support hotline.

4 GOOSE isolation features with SIPROTEC devices (Publisher)

4.1 GOOSE isolation at the IED level – device built-in signal

For SIPTOREC 5, there is an device internal signal ">GOOSE Stop" as shown in Figure 2 which is implemented with all SIPROTEC 5 devices that can be used for stopping all publishing GOOSE. You can switch off these publishing GOOSE messages from the device in the information routing by routing the ">GOOSE Stop" signal to a binary input or a function key.

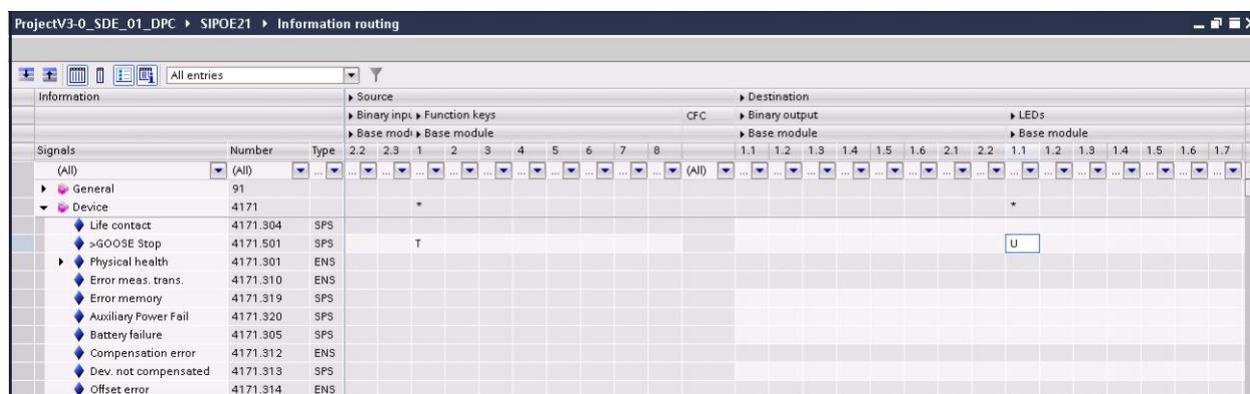


Figure 2

For SIPROTEC 4 and Compact, such a "GOOSE-Stop" signal as shown in Figure 3 is also available with SIPROTEC 4 and SIPROTEC Compact devices equipped with version 4.2 and higher of the communication module firmware, this also apply to any protection firmware released after July 2012.

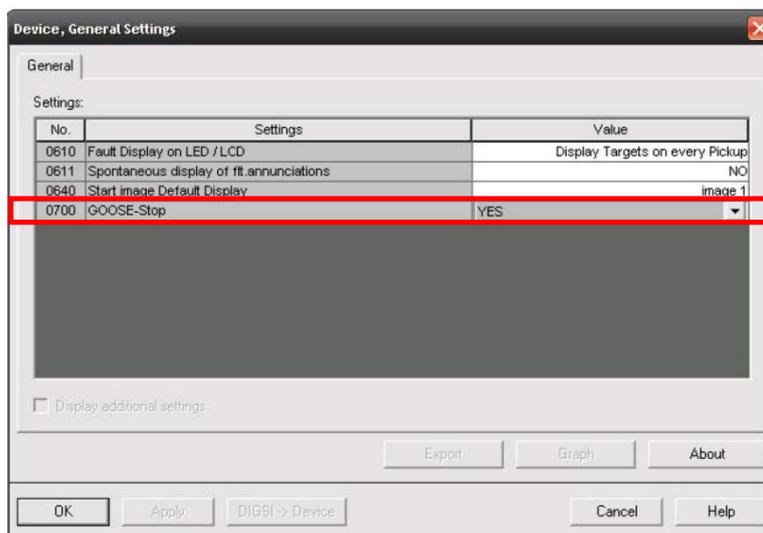


Figure 3

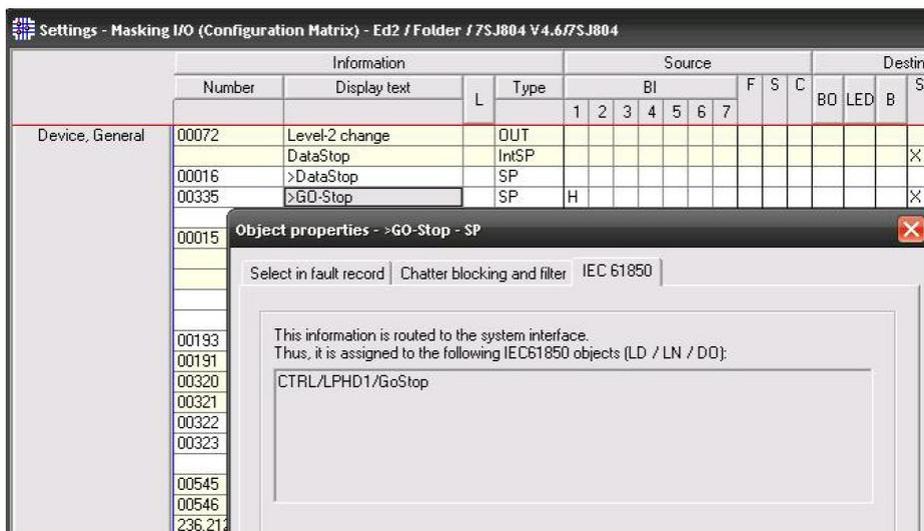
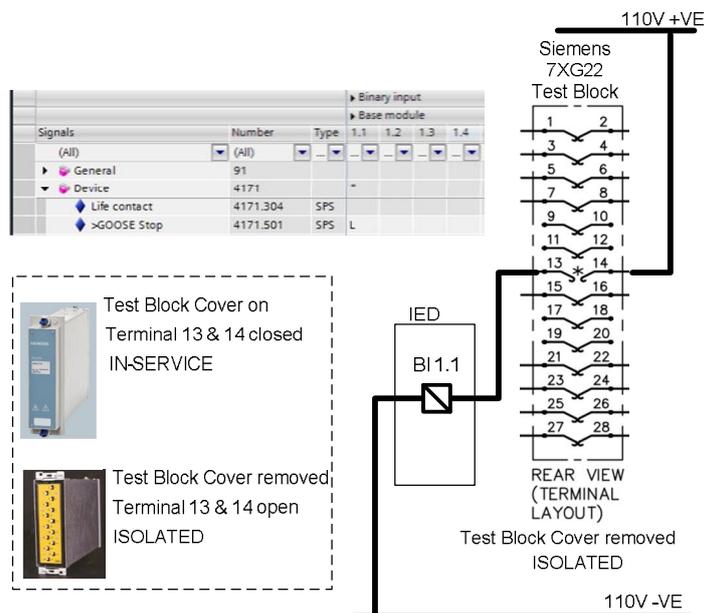


Figure 4

Below figure 5 shows possible application with test block and the use of the Goose Stop function.



Note: Image extracted from Siemens DIGSI software and 7XG22 test block documentation [7]

Figure 5

4.2 GOOSE isolation at the IED level – device test mode.

Each IEC 61850 signal has various attributes which can be understood as the properties of the signal. There are a range of possibilities to utilize these properties. In this application

note, we will demonstrate Individual IEC 61850 signals can be isolated utilizing the quality data attribute "Test" designed into SIPROTEC devices.

For SIPROTEC 4, SIPROTEC Compact and SIPROTEC 5, once the device is set to test mode, whether from the device HMI, from the engineering software DIGSI, even a function key or a binary input, all signals will have it's the quality data attribute "Test" bit set to "True".

In the following example, Figure 6 is shown for steps to set SIPROTEC 4 with a large LCD to "Test" mode via the HMI display.

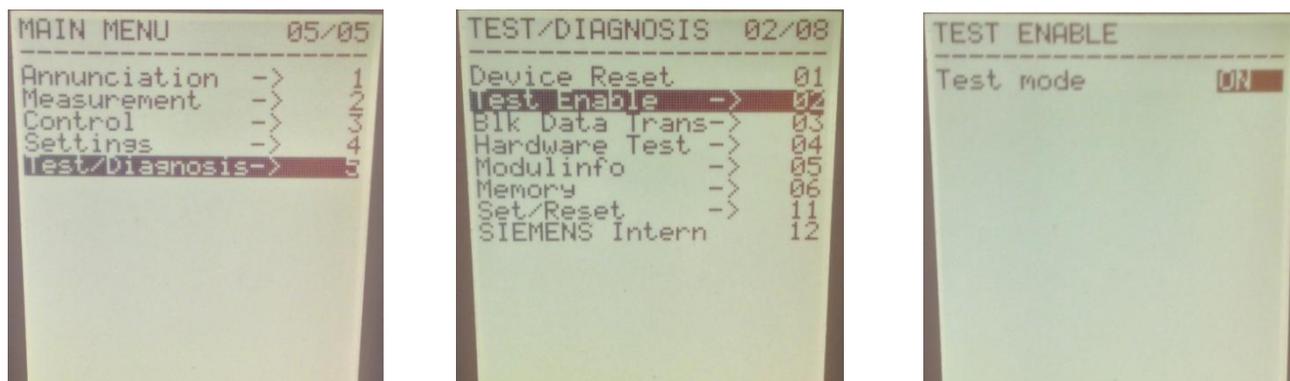


Figure 6

In the following example, Figure 7 is shown for steps to set SIPROTEC 5 with a large LCD to "Test" mode via the HMI.

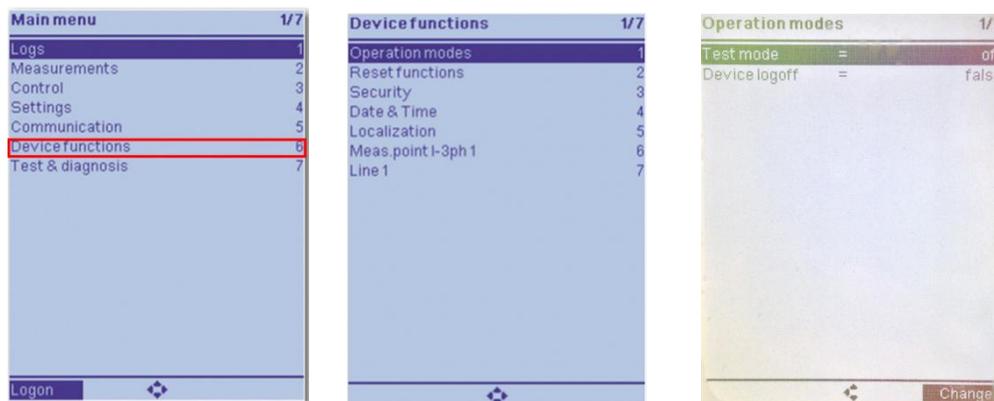


Figure 7

In the following example, Figure 8 is shown for setting an online SIPROTEC 5 device to "Test" mode via the engineering software DIGSI 5.

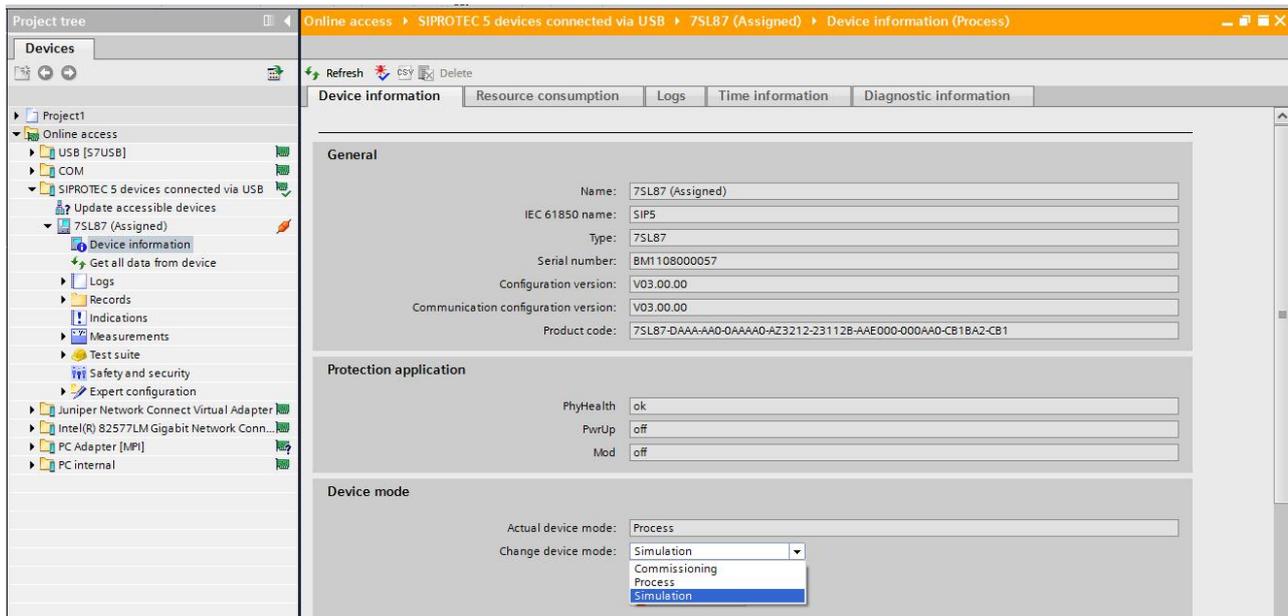


Figure 8

Below Figure 9 shows all quality data attributes are false ("0") when the device is in normal operation/process mode.

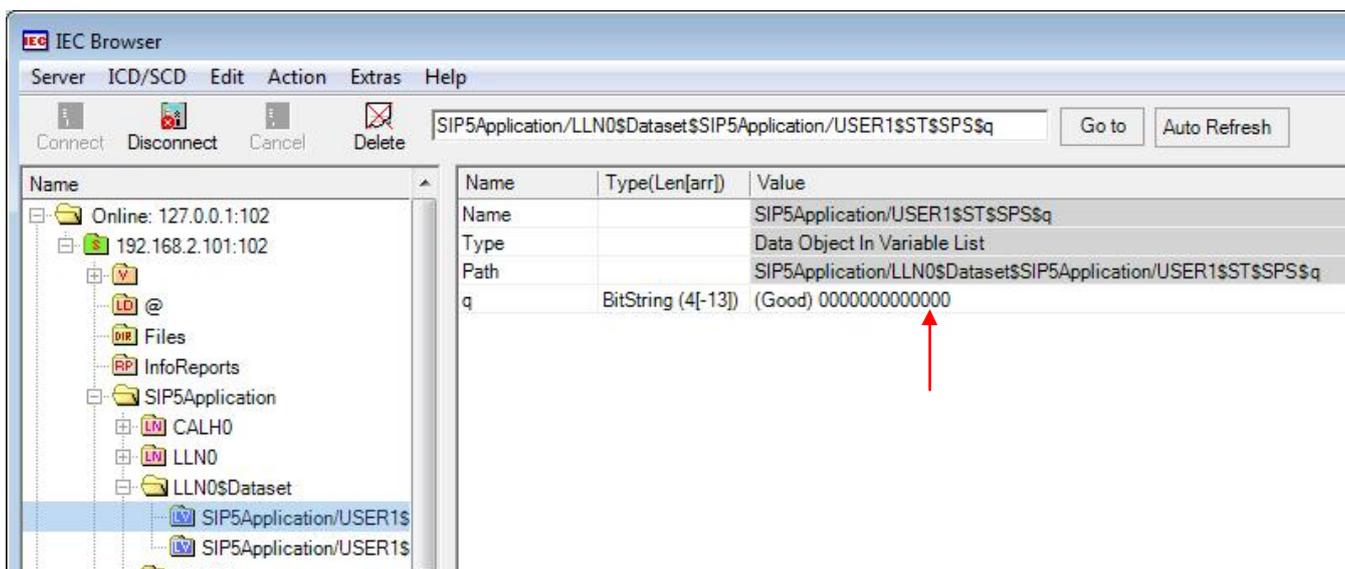


Figure 9

Below Figure 10 shows the "Test" bit quality data attributes is set to true ("1") when the device is set to test mode.

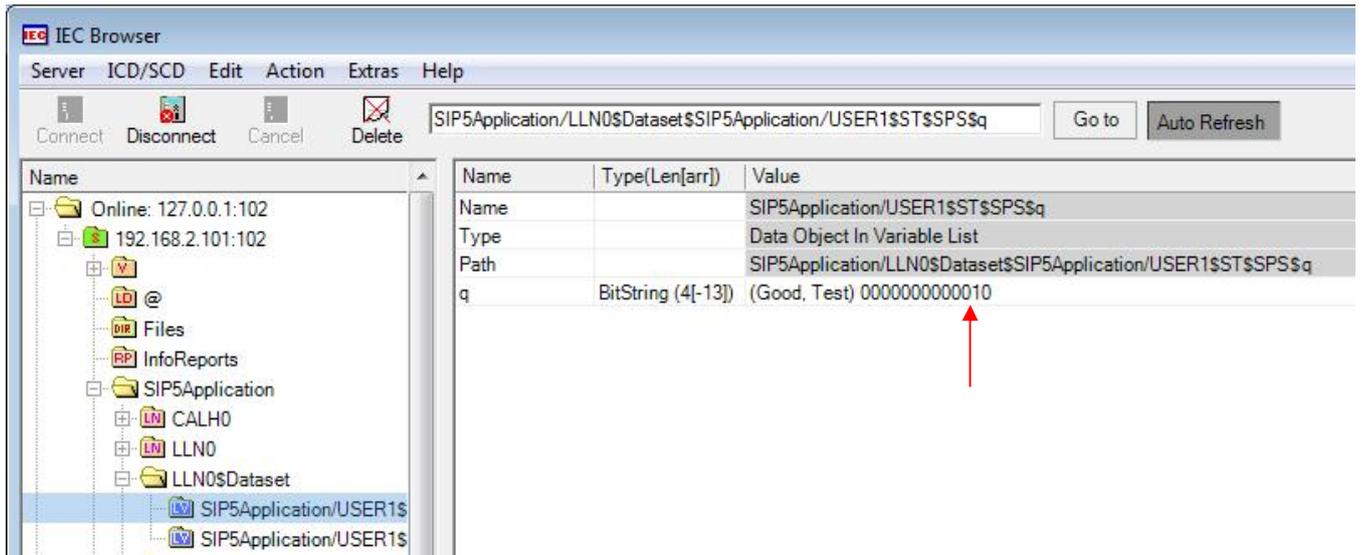


Figure 10

At the subscriber side, the subscribers can decode this “Test” bit so to choose how to react, whether it will action on it or discard the GOOSE signal. This allows for the isolation of individual GOOSE signals when test is being conducted. The possibility of SIPROTEC devices recognizing the quality data attribute “Test” bit will be discussed later in this document. Please refer to figure 11 for a demonstration of the application use utilizing test mode.

Name	Type(Len[arr])	Value
Name		SIP5Application/USER1\$ST\$SPSS\$q
Type		Data Object In Variable List
Path		SIP5Application/LLN0\$Dataset\$SIP5Application/
q	BitString (4[-13])	(Good) 0000000000000

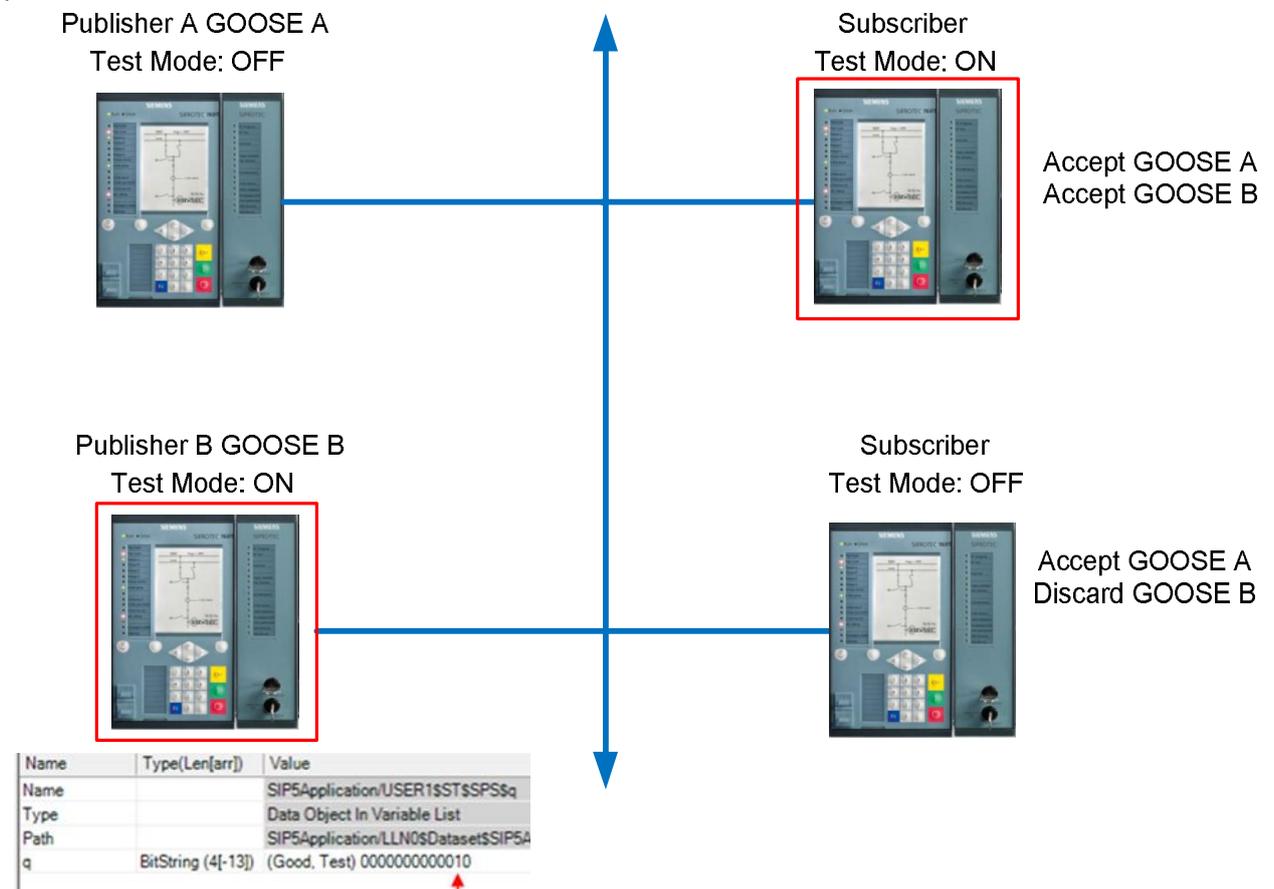


Figure 11

Commissioning note:

If the type quality shown "Questionable" and "Old data", there is a possibility that the publishing GOOSE signal is configured but there is no internal signal is assigned to this GOOSE signal for driving it.

SPCS09\$stVal	Bool (1 1)	(false) 0
SPCS09\$stq	BitString (4 -13)	(Questionable, Old data) 1100000100000
SPCS09\$st	UTC_Time (12 8	(L=0,F=1,N=1,10b)07.11.2013 23:10:28.536133

Please Note that Siprotec5 in test mode, the Binary outputs are not operated, however it is possible to activate binary outputs via menu:

Settings->General-> test Support->Operate Binary outputs under test

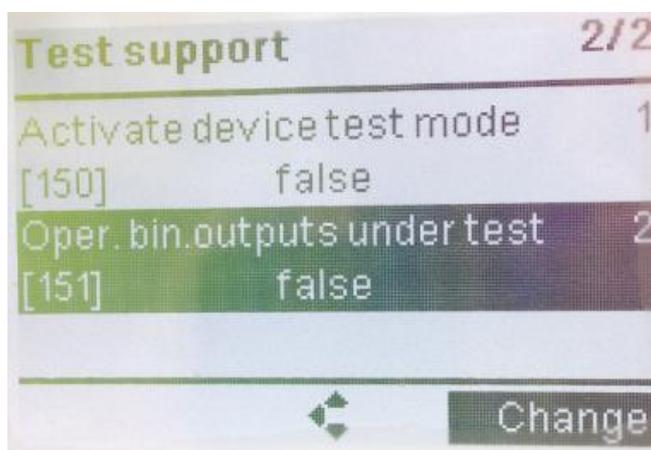


Figure 12

4.3 GOOSE isolation at the GOOSE frame/dataset level

A GOOSE message is controlled by a GOOSE control block. It is located in the LLNO of the logical device. All relevant information for the GOOSE frame/dataset can be found there.

The variable "GoEna" in the GOOSE Control block is needed to switch off individual GOOSE frames/datasets. The variable "GoEna" controls the transmission of the GOOSE frame/dataset. If a client sets this variable from 1 to 0, the device stops the transmission this GOOSE frame/dataset and the signals or objects it contains. The subscribers of GOOSE frames/datasets will check whether an interruption of data reception is detected. An object that is not received is set to the value Invalid or its state can be updated manually at the subscriber.

With the purchase of DIGSI software, a Siemens testing tool IEC Brower will be provided free of charge. IEC Brower is a Window OS application which acts as an IEC 61850 Client that supports various IEC 61850 services including GetDataValues and SetDataValues. Please note, all IEC 61850 features and services with Siemens devices is compatible with any IEC 61850 compliant devices. In other words, the following demonstrations can be done using any IEC 61850 compliant client.

With the use of IEC Brower you can isolate the GOOSE frame/dataset by disabling “GoEna”.

Name	Type(Len[arr])	Value
Name		Control_DataSet1
Type		Data Object
Path		IEDSJ64gCTRL/LLN0\$GO\$Control_DataSet1
TypeID		3
	{ (0[11])	
GoEna	Bool (1[1])	0
GoID	VisString (66[-65)	0
DatSet	VisString (69[-65)	IEDSJ64gCTRL/LLN0\$DataSet1
ConfRev	UInteger (4[4])	2
NdsCom	Bool (2[1])	0
DstAddress	{ (0[4])	
DstAddress\$Addr	OctetStr (6[6])	010ccd010004
DstAddress\$PRIORITY	UInteger (2[1])	4
DstAddress\$VID	UInteger (2[2])	0
DstAddress\$APPID	UInteger (2[2])	0
DstAddress	} (2[4])	
	} (0[11])	

Figure 13

If a device transmits several GOOSE frames/datasets, then you must set all “GoEna” variables to 0 to switch off the GOOSE frames/datasets completely.

The GOOSE frames/datasets are switched on by setting the value of the variable “GoEna” to 1.

For testing purposes, you can use the IEC 61850 Browser, as it displays and can set GOOSE control blocks and variables.

The “GoEna” variable is supported for SIPROTEC 5, SIPROTEC 4 and SIPROTEC Compact IEDs.

5 GOOSE isolation features with SIPROTEC devices (Subscriber)

5.1 GOOSE isolation at the GOOSE frame/dataset level

All GOOSE frames have a test field within the GOOSE header. SIPROTEC devices as subscribers will discard the GOOSE frame if the test field is true. This test field is not set at the IED level but SIPROTEC IEDs have the capability to interpret.

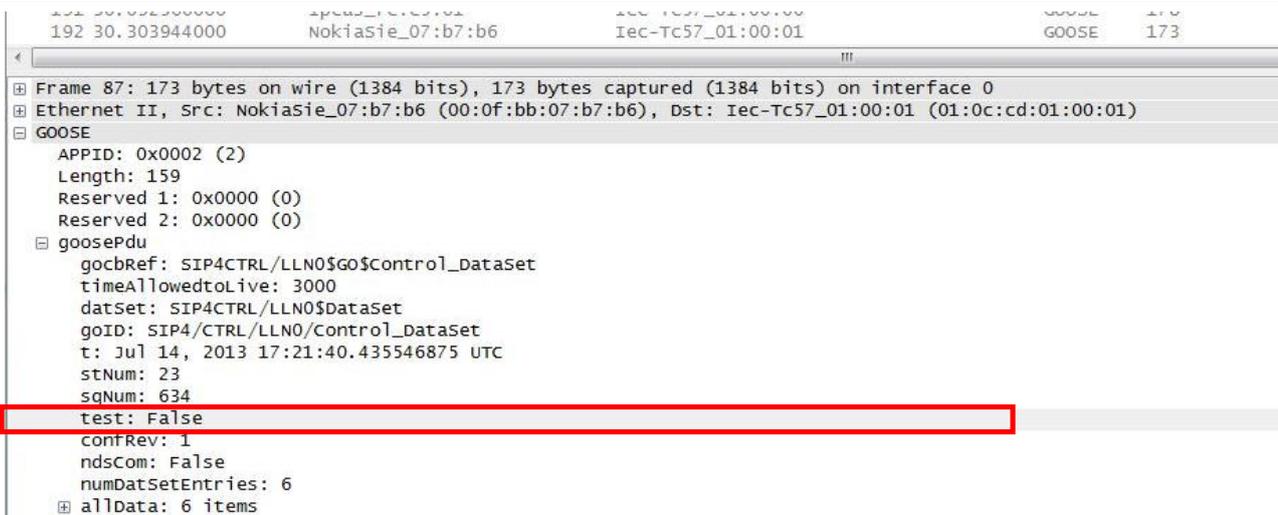
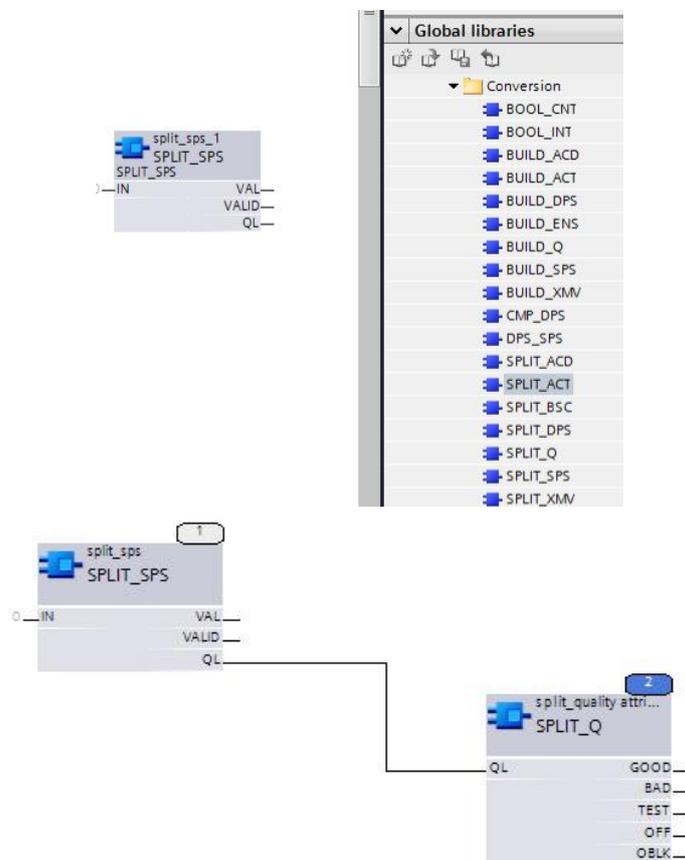


Figure 14

5.2 GOOSE isolation at the GOOSE Signal level

As mentioned in section 4.2, there are a lot of options to set a device in test mode. All published signals will have their "Test" bit as part of the signal quality attributes set to "True".

For SIPROTEC 5, by using the conversion CFC (Continuously Function Chart; SIPROTEC relay PLC blocks) the "Test" bit and other quality attributes (bad Q, opBlock) can be decoded, isolated, alarmed depends on the user's preference.

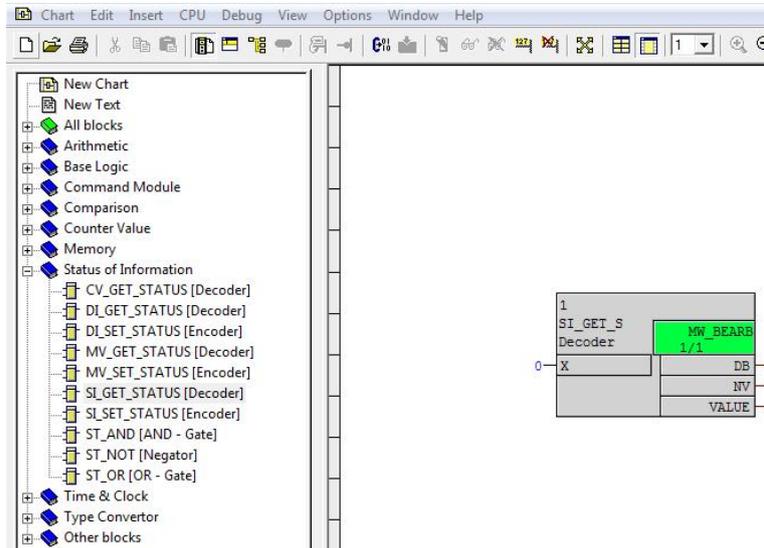


Note: currently "Good, Bad, OBLK" is functional, the rest are scheduled in end of 2015

Figure 15

There are similar logic blocks available for SIPROTEC 4 and Compact devices to discard/isolate/alarm individual test or bad quality signal at the subscriber side, this applies to single point, double point as well as measurement values.

DIGSI 4 CFC splitting signals (Value, Quality):



The SI_GET_STATUS block decodes the status of a single point indication (e. g. external single-point indication). The outputs provide two pieces of information, the value and the associated status.

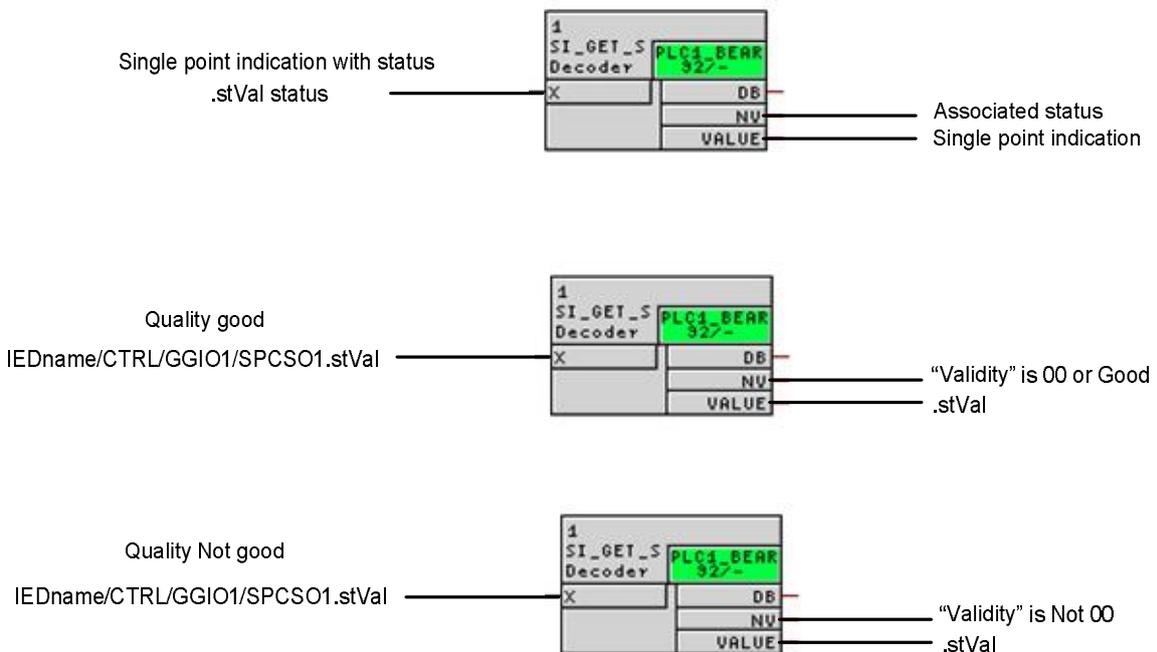


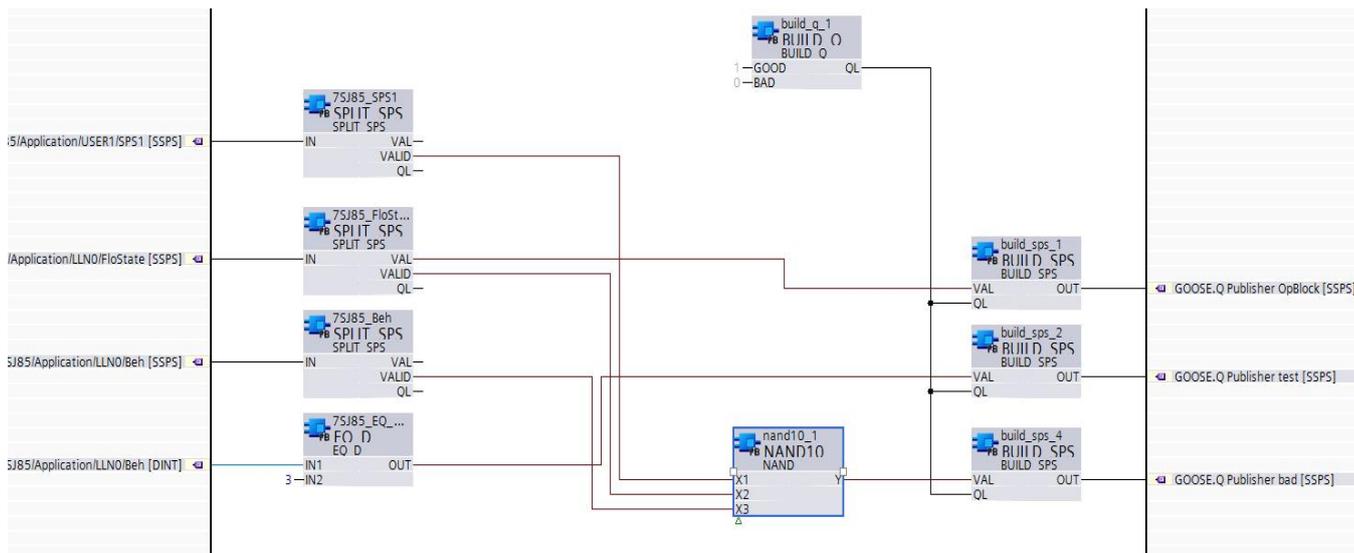
Figure 16

5.3 Publisher GOOSE status in Subscriber

The flexibility of DIGSI 5 software also allows you to monitor the status of the publisher GOOSE in the subscriber.

In the below example, the publisher (7SJ85) test status is monitored via Beh (in test mode Beh=3). FloState is monitoring the "Device Logoff" status (OpBlock or Operator Block).

Also the quality of these GOOSE are monitored via "valid" output of the CFC block, this will raise "Publisher bad Quality" alarm (Q=Bad Quality). Publisher bad quality can then be sent to the substation controller/HMI or triggers a LED on the IED.



Note from DIGSI 5 help manual:

Quality Attribute Validity

If only an invalid data is received in the case of CFC input data, all CFC output data are also set to invalid, provided they come from blocks without explicit quality processing. The quality is not processed sequentially from block to block, but the output data are set lump sum. An exception is the CFC output data that originate from function blocks with explicit quality processing. For this reason, in the above example the good quality needs to rebuild for CFC output signals.

5.4 Publisher Device Logoff GOOSE status (OpBlock)

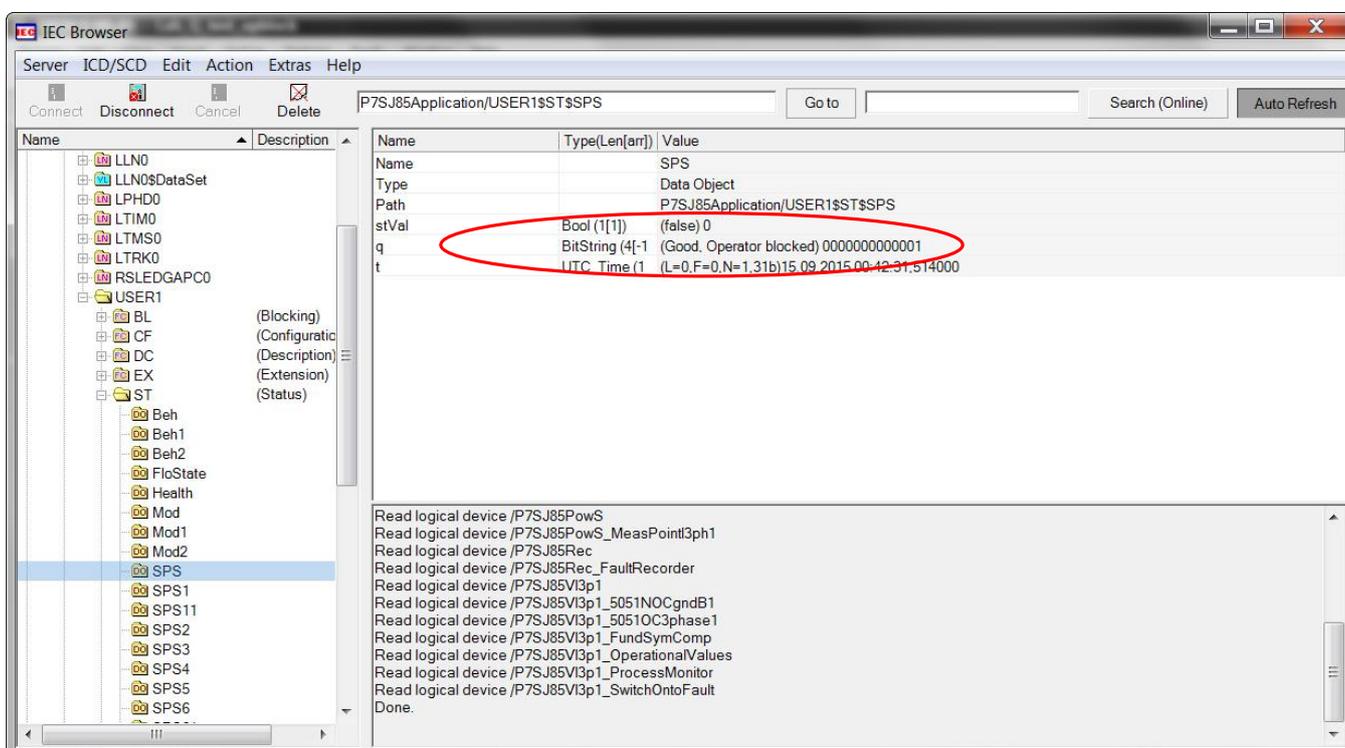
In some case, an IED may need to be removed/isolated from the network for maintenance purpose. In some cases, that the subscribers of the isolated IED may still need the isolated IED to publish GOOSE signals which are the inputs to its logics.

This means that there need to be a specific mode for the publishing device to inform all subscribers that they should ignore the invalidity of these GOOSEs.

Device Logoff can be enabled/disabled from "Menu->Device Functions->Operation modes" via the device menu.



When the Device Logoff mode is true, GOOSE will be published with Operator blocked Quality status.



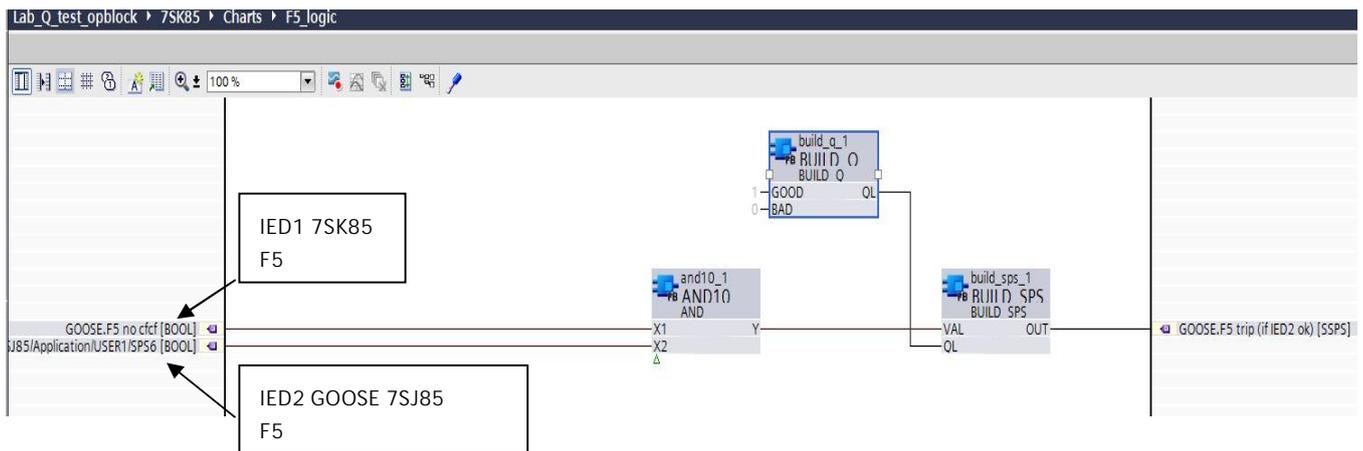
Device Logoff example:

IED1: 7SK85 - GOOSE Publisher, to be switched off.

IED2: 7SJ85 - GOOSE Subscriber, logics require a valid signal from IED2.

In this example, a CFC logic is configured in IED1.

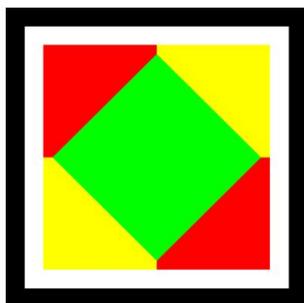
If Function key F5 ("F5") is ON in IED1 AND Function key F5 ("USER1/SPS6") in IED2; IED1 will trip ("GOOSE.F5 trip").



In the situation where IED2 need to be removed from the network, but IED1 need to have the particular signal from IED1 for the logic to work as part of the operation requirement. As soon as the IED 2 is powered off, Quality status of the GOOSE from IED2 will be invalid. However, by switching IED2 to Device logoff mode ("True") before switching off IED2. As long as F5 in IED2 is ON before switching the mode (this will be the last "Good status" for the subscribers), F5 trip logic in IED1 will still operate as required.

Appendix 1 Siemens IEC 61850 testing tools

- GOOSE Inspector (Dongle licensed) – GOOSE Monitoring tool
http://www.ib-boeser.de/dl/demo_en.htm



GOOSE Inspector

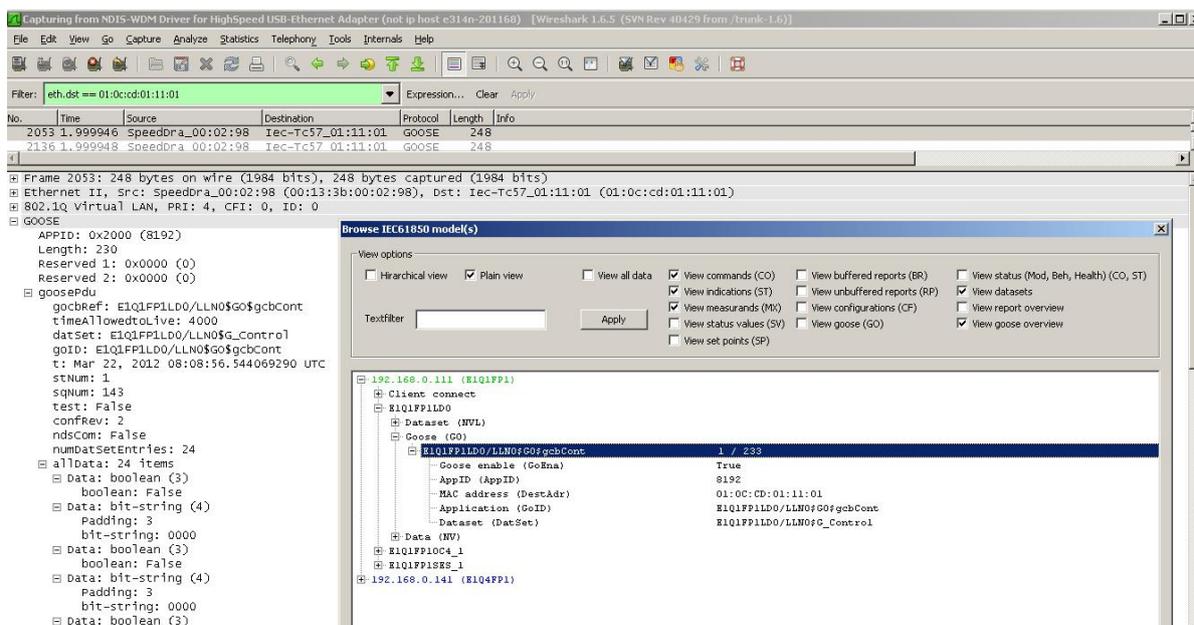
© 2012 Berthold Boeser Engineering Consultants

- IECBrowser (Free with DIGSI purchase) – IEC61850 Client for testing purposes



IEC Browser

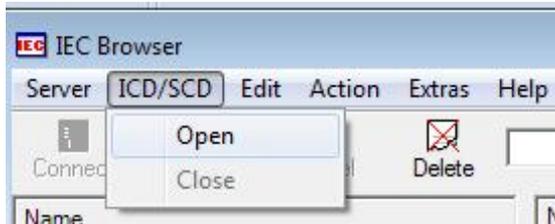
- SICAM Protocol test system (Dongle licensed) – IEC61850 server simulator, for example to simulate GOOSE of IEDS not available yet.



Appendix 2 IEC Brower quick guide

Offline mode:

IEC Brower can be used as an IEC 61850 structured viewer for ICDs and SCDs.



Online mode:

IEC Brower can be used as simple temporary client to:

- Connect to a IEC61850 server
- Read DataObjects
- Start Unbuffered Reporting
- Stop Unbuffered Reporting
- Create and Delete a DataSet
- Get Files
- Disconnect from the server

Supported IEC61850/MMS Services

Object	Service	IEC61850 SCSM Service	MMS Service
Connection	Connect	Associate	initiate
	Disconnect	Release	Conclude
Data	Read	GetDataValues	Read
	Write	SetDataValues	Write
	Informationreport	Informationreport	Informationreport
Dataset	define Variable List	CreateDataset	DefineNamedVariableList
	delete Variable List	DeleteDataset	DeleteNamedVariableList
	Variable List	GetDatasetDirectory	GetNameList
File	Directory	GetFileDirectory	FileDirectory
	Get File	GetFile	FileRead
	Delete File	DeleteFile	FileDelete

To connect to a server, click "Connect" and type in the server IP address:

