Schneider Electric

Tutorial 1:

Configuring GOOSE in MiCOM S1 Studio

by Jason Wong and Michael Janiga

Schneider Electric

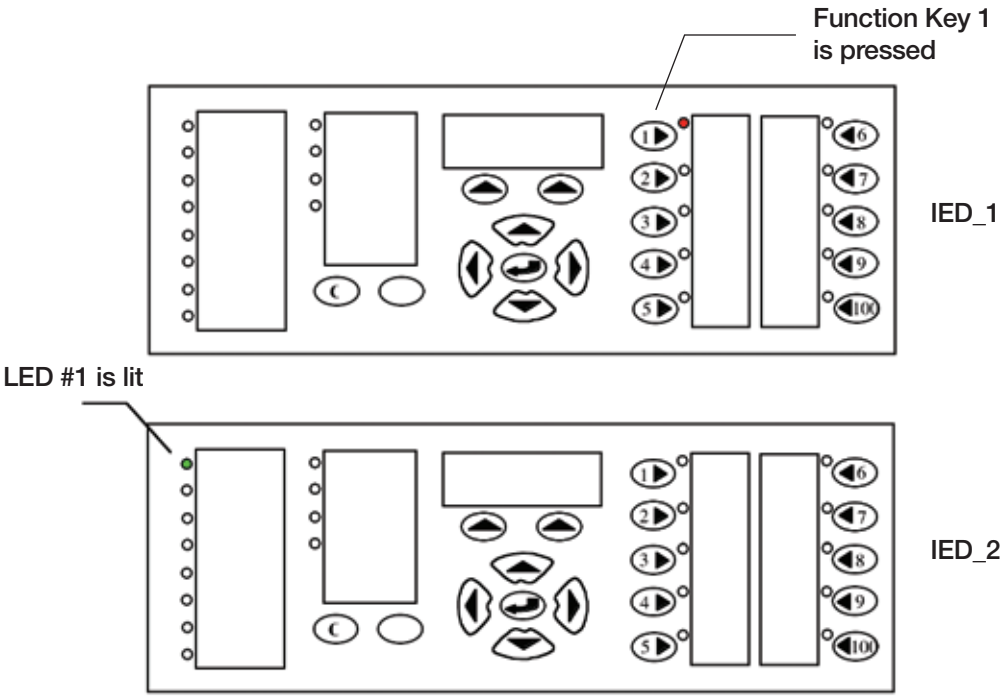
1. Requirements

- Two (2) MiCOM Px4x IEDs with Version 2 implementation of IEC 61850
- Two (2) Cat 5E Ethernet cable
- An Ethernet switch 10/100 Mbps
- MiCOM S1 Studio V3.5.1
- The correct data models for both Px40 IEDs that will be used
- One (1) RS-232 cable
- (Optional) Instead of using an Ethernet switch you can use a direct connection between two relays using a crossover Cat 5E Ethernet cable

> **NOTE:** You must ensure that you have the proper MiCOM S1 Studio data-models installed otherwise you will not be able to create new Setting, PSL or MCL files as required later on in this tutorial.

2. Setting up basic GOOSE messaging between two relays

The objective is to illustrate the configuration of basic GOOSE messaging on two Px4x series IEDs. Once the configuration is complete pressing **Function Key 1** on one IED will send a GOOSE signal to the second relay and illuminate LED #1 on that relay. Also, pressing **Function Key 1** on the second IED will send a GOOSE signal to the first IED and illuminate LED #1 on that IED. In other words, we will setup **IED_1** to publish a GOOSE message which is linked to the state of its **Function Key 1.** Also, we will setup **IED_1** to subscribe to the GOOSE message that is published by IED_2 and have that message turn on or off **IED_1**'s LED #1.



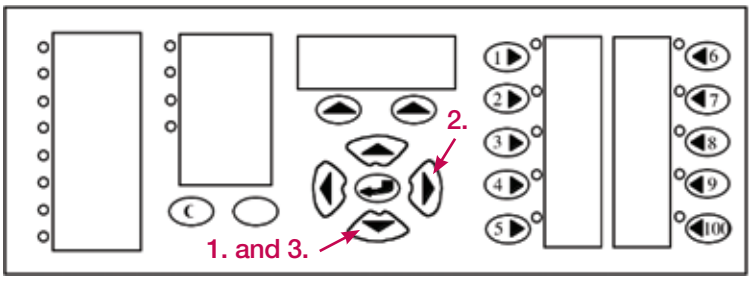
2.1 Setup Physical Connections

1. Apply power to the auxiliary power supply inputs of the IEDs.
2. Connect a Cat 5E cable from each IED to the switch and apply power to the switch.
3. Connect a serial cable from your PC to **IED_1** and configure the appropriate COM port that is being used so that it is compatible with the IED front port parameters. For details refer to the P54x User Guide – Getting Started.

2.2 Confirm IEC 61850 version

Confirm that both IEDs are using Version 2 of IEC 61850 protocol as this tutorial only applies to the Version 2 implementation.

1. Using the front panel HMI, push the down arrow key to list the menu items.



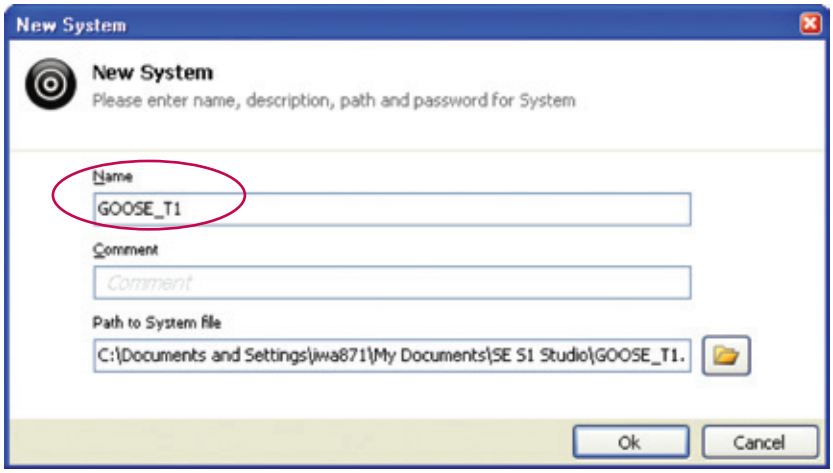
2. Push the right arrow key repeatedly to scroll to the menu item **IED CONFIGURATOR**.
3. Push the down arrow key until the menu item **GoEna** appears.
4. Confirm the settings range is a string of eight 0's and/or 1's. This indicates the IED is using Version 2 of IEC 61850 protocol.
5. If the settings range is shown as **Disabled/Enabled** then the relay is using the Version 1 implementation and this tutorial is not applicable for this IED.

2.3 Setup a System in S1 Studio

In MiCOM S1 Studio, a System provides a root node in the Studio Explorer from which all subsequent nodes are created. You may add substations, bays, voltage levels and devices to the system. After defining a system, you can use the **QuickConnect** command in the toolbar to add IEDs to the system.

1. Open MiCOM S1 Studio and create a new system.

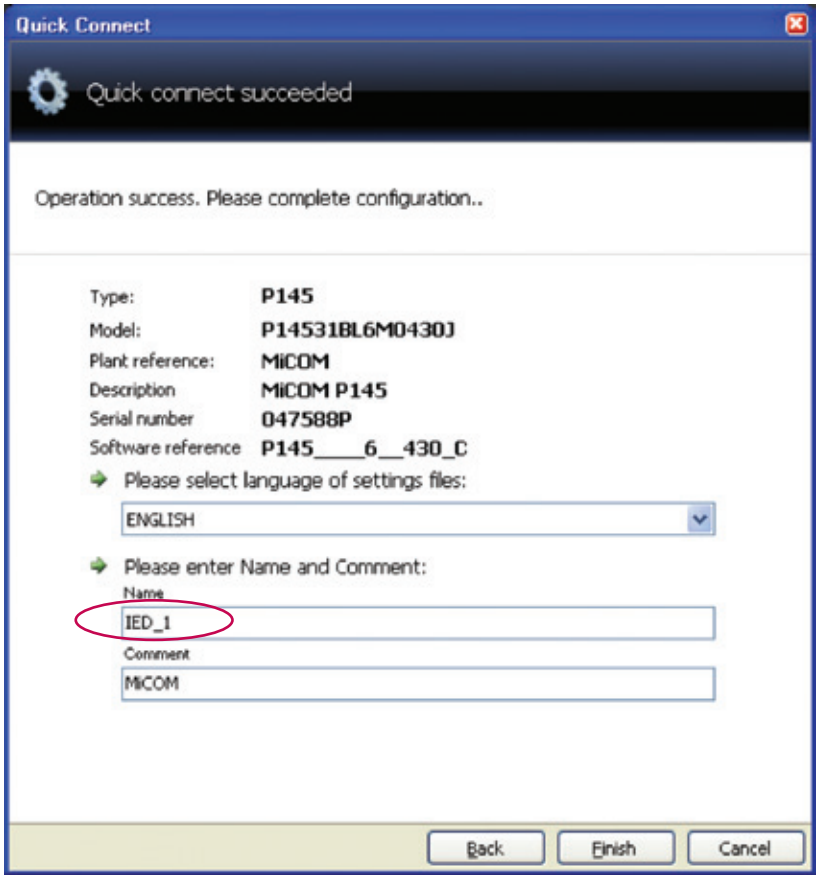
2. Name the system **GOOSE_T1.**

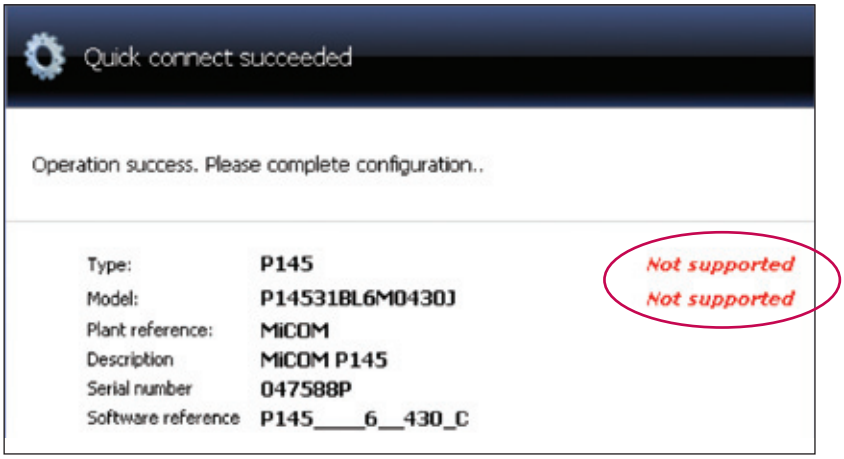


2.3.1 Create a System with Devices

1. Ensure serial cable is connected to front port of **IED_1**.
2. In the main menu bar of MiCOM S1 Studio, click on the **Quick Connect** command.
3. The **Quick Connect/Type** window will appear. Click **Px40 Series.**
4. The **Quick Connect/Port selection** window will appear. Click **Front port.**
5. The **Quick Connect/Connection Parameters** window will appear. Click **Finish.**

6. A new window will appear showing the Type, Model, Serial number and Software reference of the relay. Under the **Name** field change the value to **IED_1** and then click on the **Finish** command button.

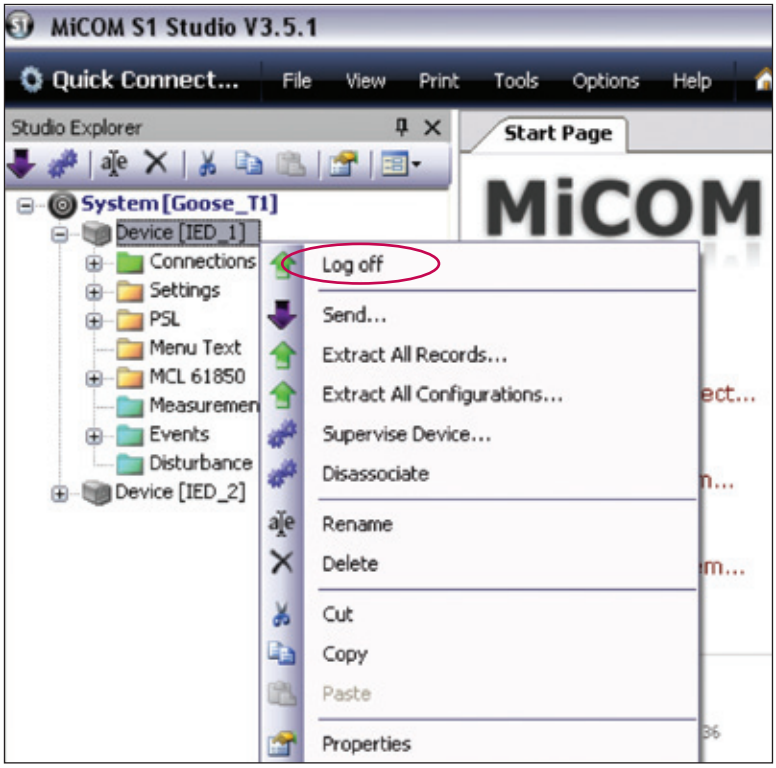




> **NOTE:** If the text **Not supported** appears beside the **Type** and **Model** fields in the **Quick connect succeeded** window then you must exit MiCOM S1 Studio and download the data model for the specific IED software version using the **Data Model Manager** utility. Otherwise you will not be able to create new Setting, PSL and MCL files which are required in the upcoming steps. After you have done so, open **0** in MiCOM S1 Studio and repeat Section 2.3.1 of this tutorial.

7. After this, the IED and its associated folders will be populated under the **System [GOOSE_T1]** in **Studio Explorer.**

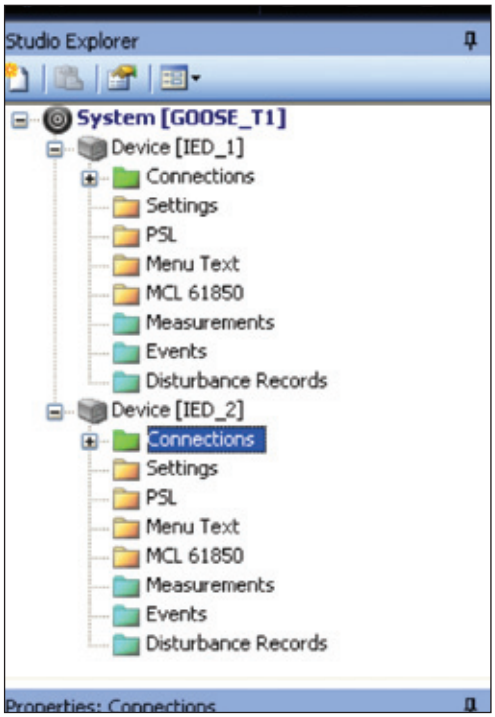
8. Right click on the newly added device and from the dropdown menu select **Log off.**



9. Disconnect the serial cable from the front port of **IED_1** and connect the serial cable to the front port of **IED_2.**
10. Add **IED_2** to **System [GOOSE_T1]** in the **Studio Explorer** area in S1 Studio by repeating Steps 1 to 8. However, be sure to enter **IED_2** under the **Name** field of the **Quick Connect/Quick connect succeeded** window in Step 6.

> **NOTE:** The folders listed under each device are used to hold one or more configuration files. Template files are used to create the initial configuration settings according to data models stored in S1 Studio's database. These default configuration files can be modified for the specific application and then transferred to the IED. Configuration files can also be read from an IED and saved in S1 Studio's database.

11. After adding **IED_1** and **IED_2,** the Studio Explorer should look similar to below.

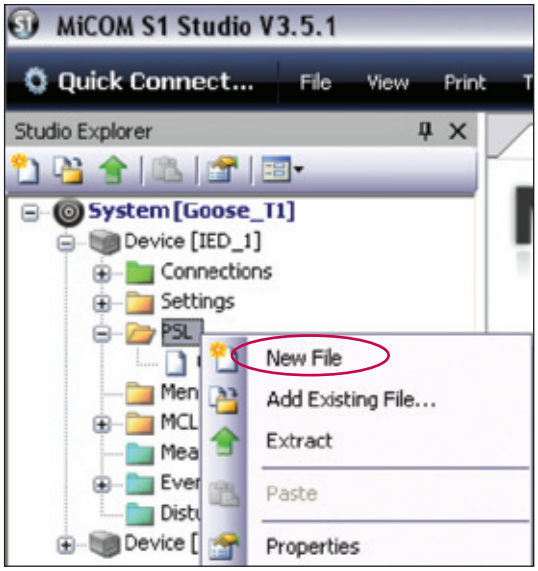


2.4 Configure Programmable Scheme Logic

Configure the logic for each IED so that:

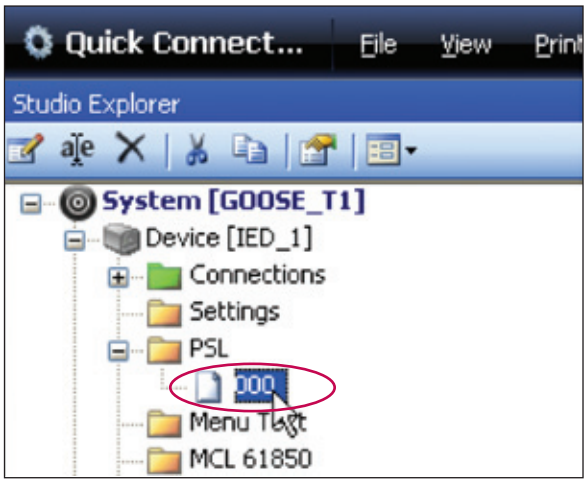
- when **Function Key 1** is pressed, the red LED associated with **Function Key 1** is lit and **Virtual Output 1** is asserted
- when **Virtual Output 1** is asserted, the green LED #1 is lit

1. Under **Studio Explorer** right click on **System [GOOSE_T1] > Device [IED_1] > PSL** and then left click **New File.**

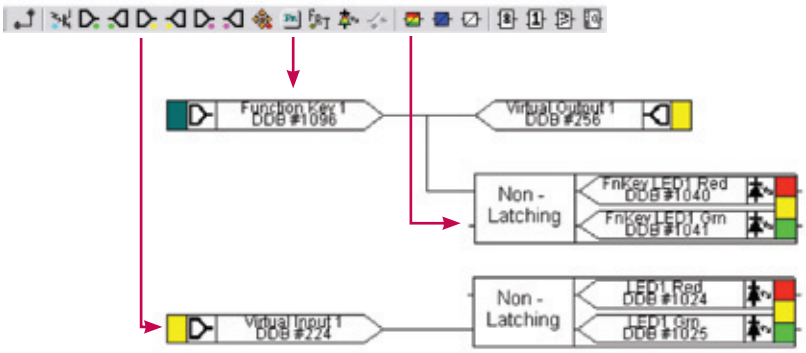


> **NOTE:** This programming is done offline and the serial cable does not need to be connected to any relay. Linking the **Virtual Output 1** to the **Virtual Output 2** of the other IED will be completed later in the tutorial.

2. Double Click on the document icon **000** to open the **000.psl** file in the PSL editor.



3. Use the **CTRL + A** technique to select all and press the delete key to clear all the elements in the default **000.psl** file created.
4. Using the PSL Editor Toolbar, build the logic as shown here.



5. Save the logic scheme in the **000.psl** file for **IED_1** and exit the PSL editor program.
6. Repeat Steps 1 to 5 for **IED_2.**

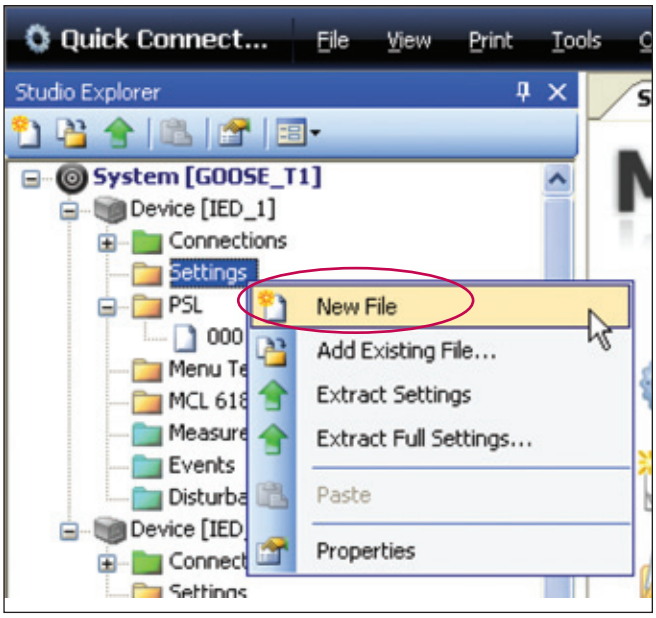
2.5 Configure the IED Settings

You will need to make some changes to the default settings files for both IEDs in order to change the behavior of the function keys and enable the GOOSE control blocks.

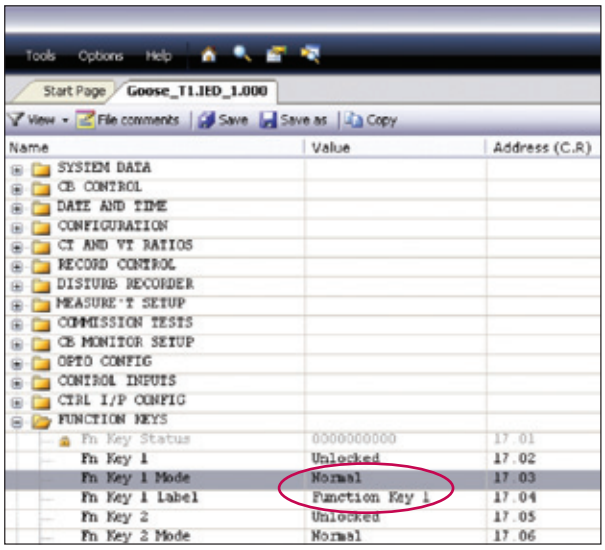
2.5.1 Modify Behavior of Function Keys

For **IED_1** confirm that **Function Key 1** is in **Normal** mode, which means **Function Key 1** element is logically high only when the key is pressed and logically low otherwise. Function Keys can also be set to Toggled mode which latches the key state and is not desired for this tutorial.

1. To create a new settings file, in **Studio Explorer** right click on **System [GOOSE_T1] > Device [IED_1] > Settings** and then left click **New File.**



2. Double Click on the document icon **"000"** to open the **000.set** settings file.
3. Verify that the **Value** field for element **FUNCTION KEYS > Fn Key 1 Mode** is set to **Normal.** If the **Value** field is set to **Toggled** then change the setting to **Normal.**



4. Repeat steps 1 to 3 in this section for **IED_2.**

> **NOTE:** If you receive an error indicating that the operation has failed then S1 Studio is missing the Data Model for that IED which you are trying to work with. In this case you must close MiCOM S1 Studio and download the appropriate Data Model using **Data Model Manager.**

2.5.2 Enable the GOOSE Control Block

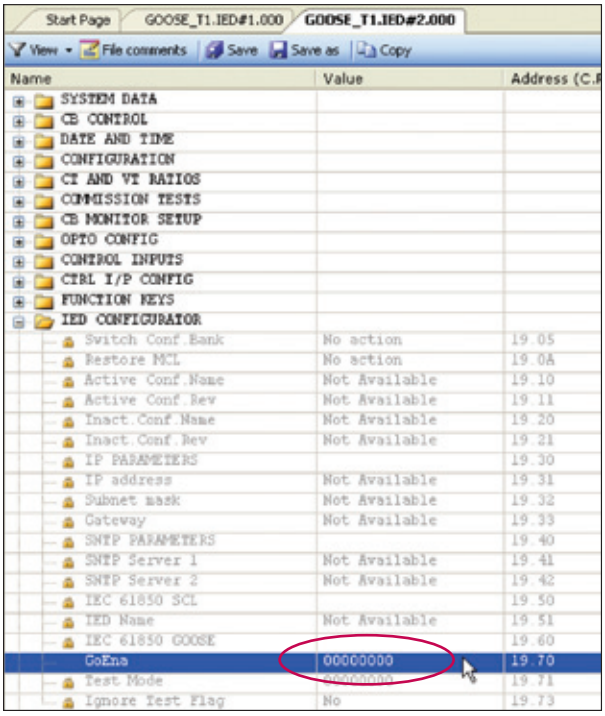
The GOOSE control block specifies the parameters for publishing a Dataset over the Ethernet LAN. In the Version 2 implementation of IEC 61850 we can link Datasets to a maximum of eight different GOOSE control blocks. At least one GOOSE control block within the IED must be enabled for GOOSE messages to work. If the other GOOSE blocks are not being used, it is best practice to leave them disabled.

For this tutorial, we will ensure GOOSE control block **gcb01** is enabled by checking the bit position corresponding to **gcb01** is set to 1.

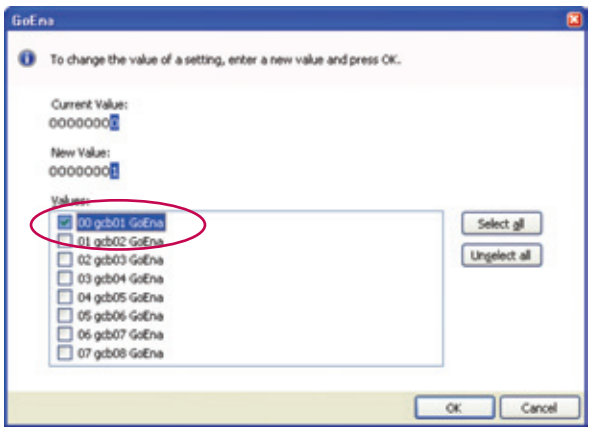
Depending on the relay, the GOOSE Control Block may need to be configured via S1 Studio or the Front Panel.

2.5.3 Option 1: Configuration Via S1 Studio

1. Open the settings file for **IED_1** and find setting **IED CONFIGURATOR -> GoEna.**

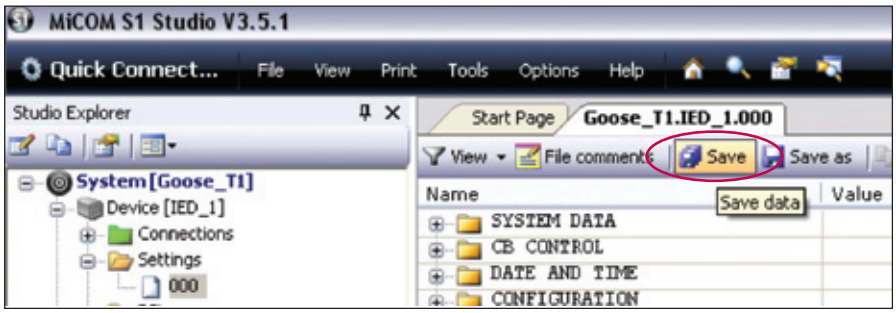


2. Double click the value field to open the **GoEna** settings window and enable **gcb01 GoEna** by checking off the corresponding box.



> **NOTE:** If **IED Configurator** is not shown in the default settings file for the IED then the GoEna parameter must be set differently. Skip down to the instructions on enabling via the front panel.

3. Click **OK** and save the changes to the **000.set** file

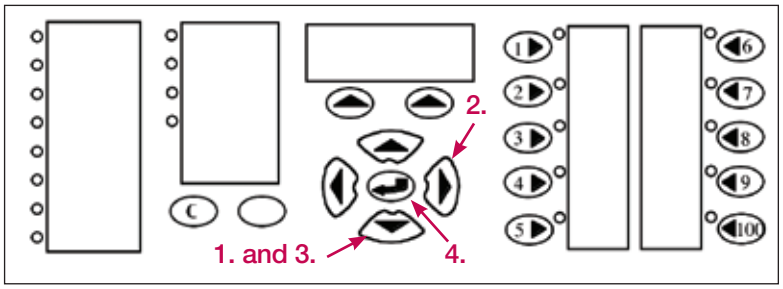


4. Repeat all steps in Section 2.5 for **IED_2** starting with the behavior of the Function Keys

2.5.4 Option 2: Configuration Via Front Panel

If the **IED CONFIGURATOR** settings group is not available in the settings file for a particular IED data model it will be necessary to enable the **gcb01 GoEna** element via the IED front panel HMI.

1. Using the front panel HMI, push the down arrow key to list the menu items.



2. Push the right arrow key repeatedly to scroll to the menu item **IED CONFIGURATOR.**
3. Push the down arrow key until the menu item **GoEna** appears.
4. Push the middle arrow key to change the settings string.
5. Use the directional arrow keys to select and set **gcb01** to 1.
6. Push the middle arrow key to confirm the change.
7. Repeat all steps in Section 2.5 for **IED_2** starting with the behavior of the Function Keys

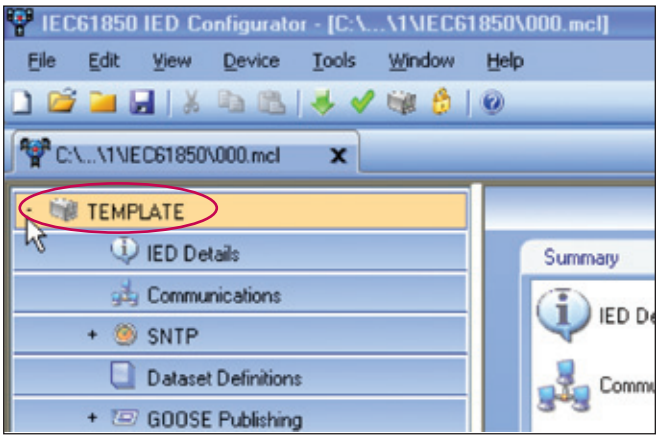
2.6 Configure IEC 61850 GOOSE Messages

Configure the MCL file for both IEDs such that GOOSE messages linked to the **Virtual Output 1** element of each IED are published over the LAN. There are a few major steps that need to be completed in order to configure IEC 61850 GOOSE messages:

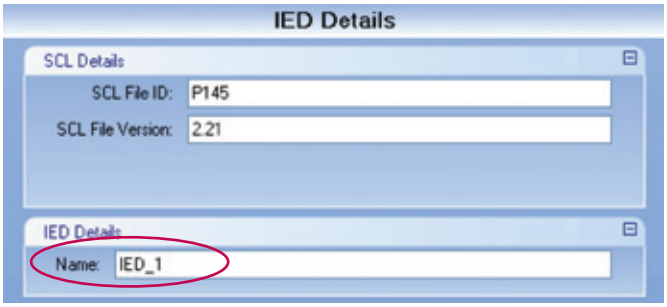
- Create a new MCL File
- Configure Communications
- Create Dataset Definitions
- Configure GOOSE Publishing
- Configure GOOSE Subscribing

2.6.1 Create and Edit New MCL File

1. Create a new MCL file under **Device [IED_1] > MCL 61850** in **Studio Explorer** and then open the file **000.MCL** file.
2. The **IEC61850 IED Configurator** window will open. On the left hand side of the explorer window, click the '+' symbol to expand the **TEMPLATE** tree.

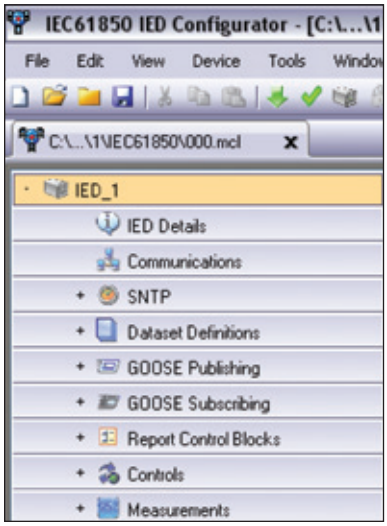


3. In the top toolbar menu, click the  icon in order to enter the **Manual Editing Mode.** This will unlock all the fields in **IEC 61850 IED Configurator** and allow the file to be edited.
4. Click on **IED Details** to display the **IED Details** window on the right hand side. In the **Name** field enter **IED_1.**



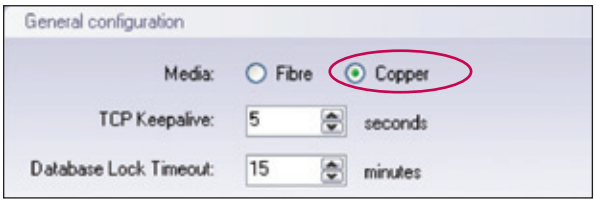
2.6.2 Configure the Communication settings

1. Click on **IED_1 > Communications** in order to view the communication settings on the main window.



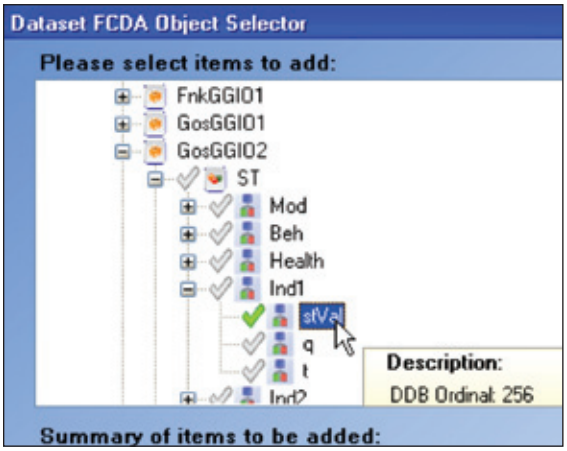
> **NOTE:** If you receive an error indicating that the operation has failed then your S1 Studio database does not have the Data Model for the specific IED model you are working with. You must close MiCOM S1 Studio and download the appropriate Data Model using **Data Model Manager.**

2. In the **Address configuration** section enter the following parameters:
   IP Address: 192.168.1.10 (192.168.1.20 for IED_2)
   SubNet Mask: 255.255.255.0
   Gateway Address: 0.0.0.0
3. Under **General configuration > Media > select Copper**

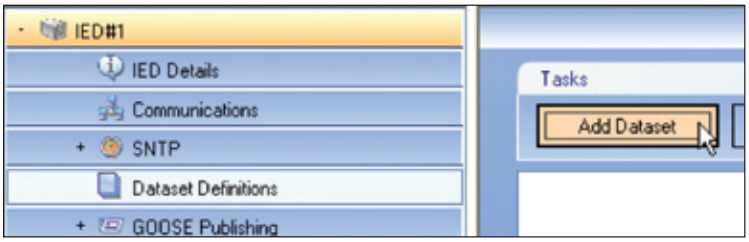


2.6.3 Create Dataset Definitions

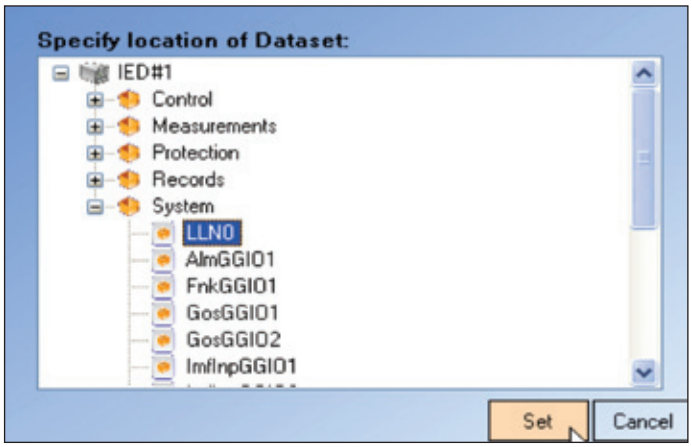
Create a dataset by specifying it's location within the IED and then select which data object will be contained within the dataset. For our purposes we will add the **System/GosGGIO2.ST.Ind1.stVal** to the dataset and store that dataset in the **System\LLN0\Dataset1** location of the IED data model. This particular data object represents a GOOSE output signal which is mapped internally to the **Virtual Output 1** element of Px40 series relays. We can confirm this is the case by hovering the curser over the data object and noting the DDB reference number is the same as the DDB number of **Virtual Output 1.**



1. Select **IED_1 > Dataset Definitions** and then click the **Add Dataset** command in the main window.



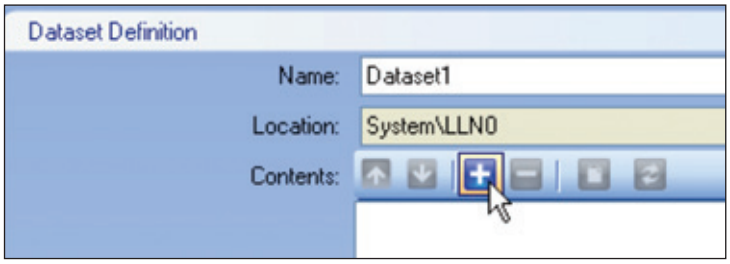
2. Specify the location the dataset by selecting **IED_1 > System > LLN0** and then clicking the **Set** command.



3. To select a specific data object click on the **Add item** button in the **Dataset Definition** window.

4. Specify the **GOOSE Output 1 Signal** status value data object and click the **Set** command so that it is included in the Dataset Definition. Do this by expanding the **IED_1/GosGGIO2/SystemGosGGIO2.ST.Ind1.stVal** tree and highlight the checkmark as shown in the next figure. Then click the **Add** command.

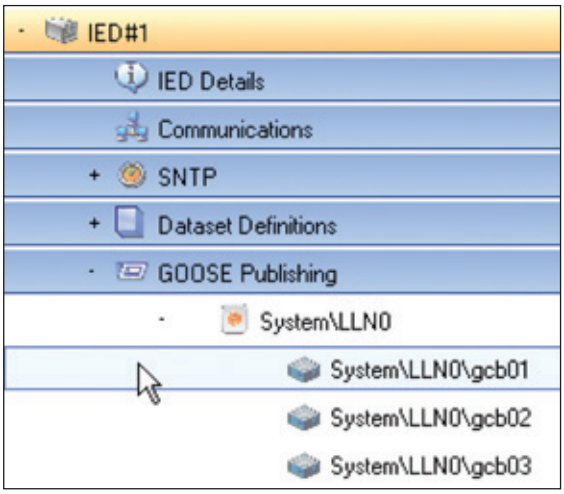
5. Check the **Dataset Definitions** window **System\LLN0\Dataset 1** to confirm that the **System/GosGGIO2.ST.Ind1.stVal** data object has been successfully defined as part of the dataset.



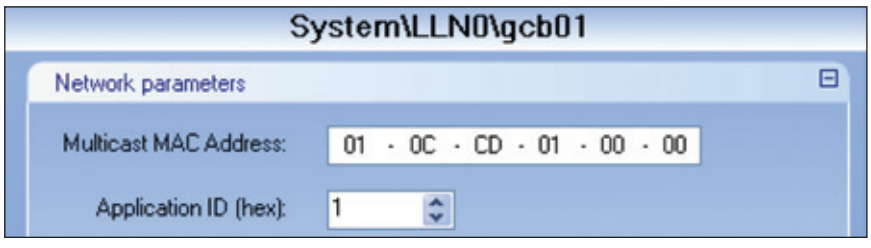
2.6.4 Configure GOOSE Publishing

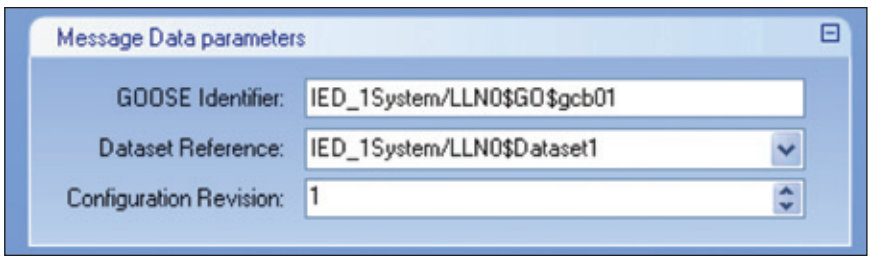
Configure GOOSE Publishing by linking, the dataset that was created in the previous step, to GOOSE control block **gcb01.**

1. Expand the tree in the explorer window and select **System\LLN0\gcb01.**



2. Set the **Application ID (hex)** field to 1 and set the **Dataset Reference** to **IED_1System/LLN0$Dataset1** by selecting it from the dropdown menu of the field.

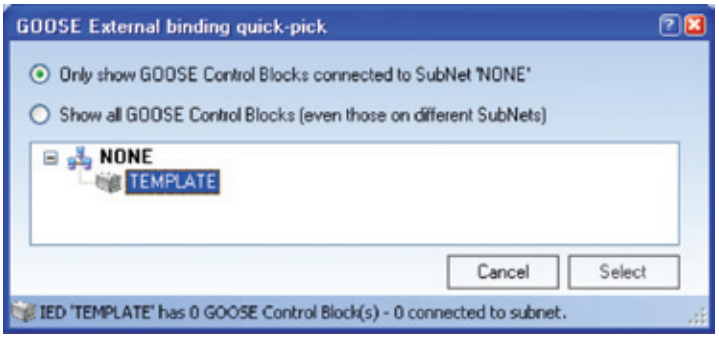




3. Save the MCL file and close the IEC61850 IED Configurator.
4. Repeat all the steps in Sections 2.6.1 to 2.6.4 while replacing all references to **IED_1** with **IED_2.** When configuring the Communication settings use the IP Address: 192.168.1.20. Dataset definition will continue to be associated with **GosGGIO2**. And **Virtual Output 1** will still be published over the LAN.

2.6.5 Configure GOOSE Subscribing

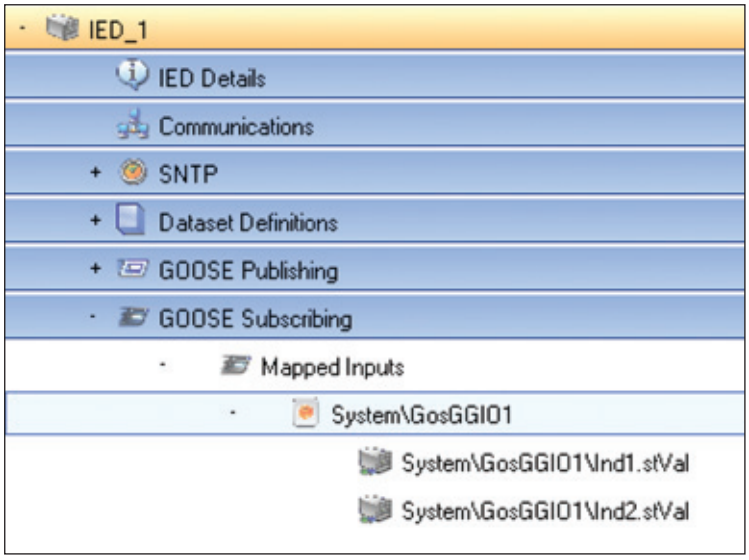
The final part in the configuration of the MCL file is to subscribe to the GOOSE message published by the other IED. The following message will appear if an IED attempts to subscribe to another IED's GOOSE message that does not exist or has not been configured.



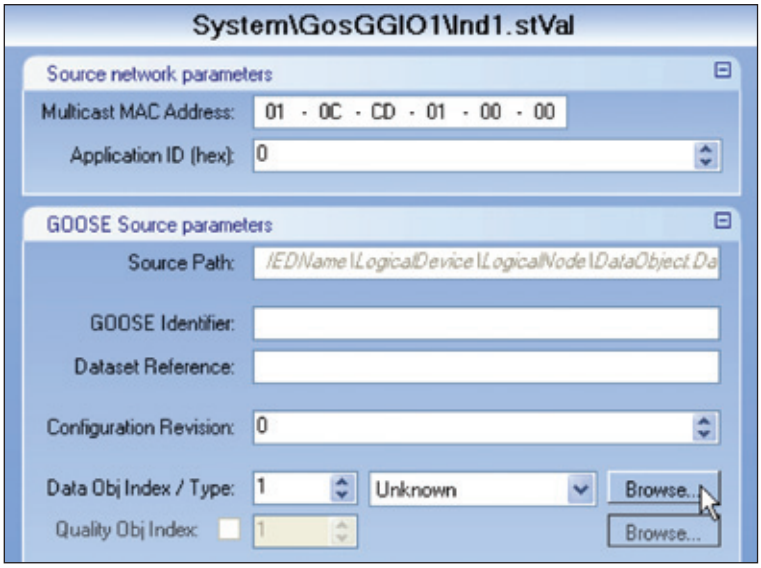
This occurs because a GOOSE message must be published before it can be subscribed. That is why both IED's Goose Publishing was configured before the GOOSE Subscribing.

Configure the MCL file for each IED such that one IED subscribes to the GOOSE messages published by the other IED. The end result will have the subscribed GOOSE message linked to the IED's **Virtual Input 1.**

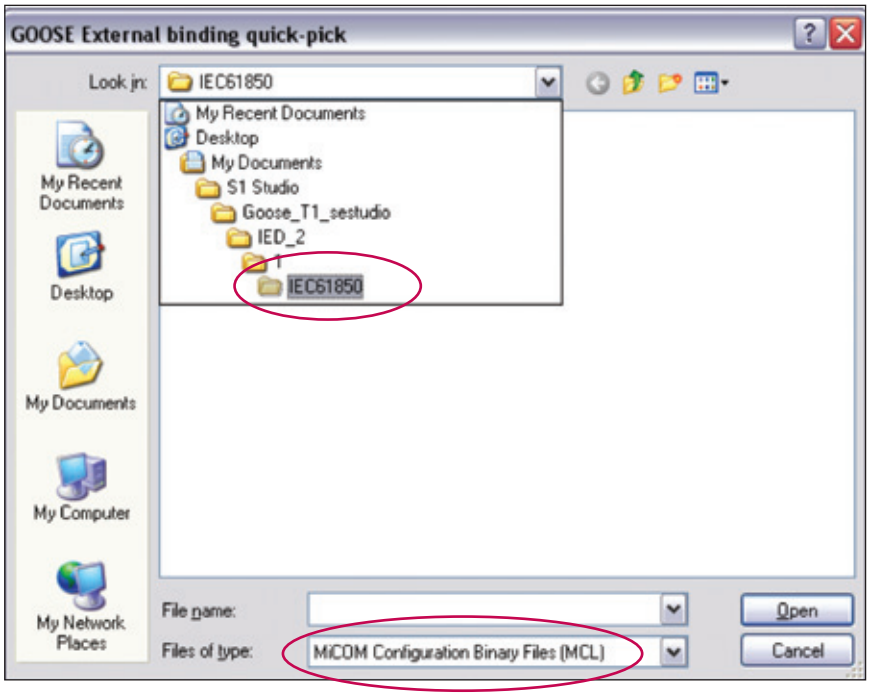
1. Open the MCL file for **IED_1** in the IED Configurator.
2. Expand the **GOOSE Subscribing** node in the tree explorer menu and select the **System\GosGGIO1\Ind1.stVal** data object. This data object is mapped directly to the **Virtual Input 1** element used in our PSL logic for **IED_1.**



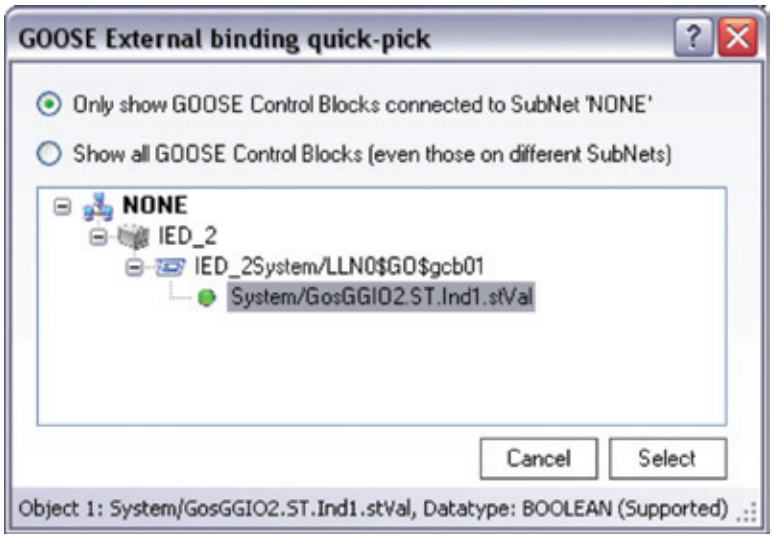
3. Click the **Browse** command under **GOOSE Source parameters** section of the **System\GosGGIO1\Ind1.stVal** main window.



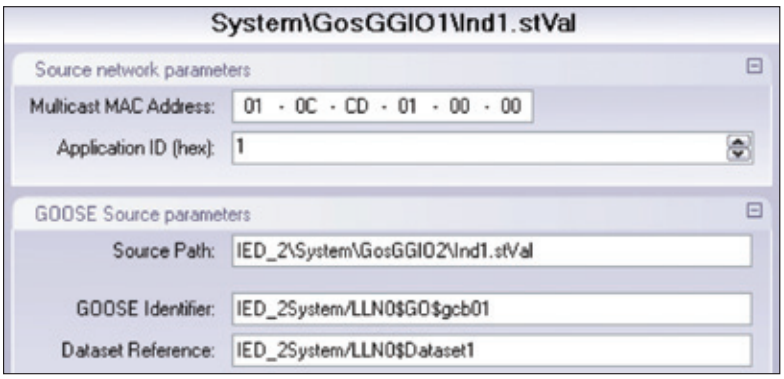
4. Locate and select the IEC 61850 folder which contains the 000.mcl file for **IED_2** and select **MiCOM Configuration Binary Files (MCL)** in the **Files of type** drop-down menu. Double click on the **000.mcl** file.



5. The **GOOSE External binding quick–pick** window will appear. Expand the tree and highlight the **System/GosGGIO2.ST.Ind1.stVal** data object.



6. Then click the **Select** command.
7. Confirm all the required GOOSE Source parameters are filled in so that **System\GosGGIO1\Ind1.stVal** data object of **IED_1** is subscribed to the **IED_2\System\GosGGIO2\Ind1.stVal** data object.

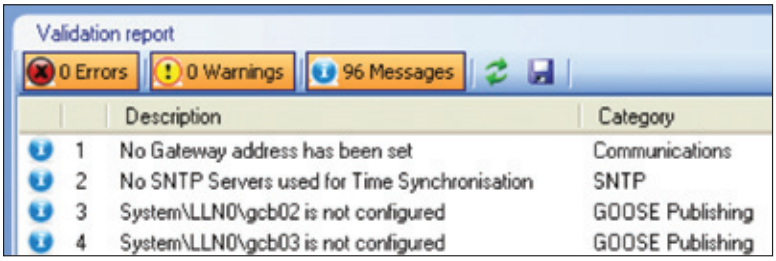


8. Save the **000.mcl** file for **IED_1** and close the MCL configuration window.
9. Repeat Steps 1 to 8 while replacing all references for **IED_1** with **IED_2** and vice versa.

2.6.6 Validate the MCL Configuration File

Validate the MCL configuration files for **IED_1** and **IED_2** to ensure that the configurations are free of errors.

1. With the MCL file for **IED_1** open in the **IEC61850 IED Configurator** click the **Validate Configuration** icon . The **Validation report** should display no errors or warnings.

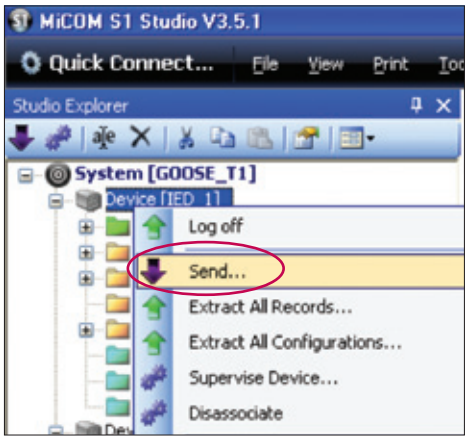


2. Open the MCL file for **IED_2** and validate the configuration as in the previous step.

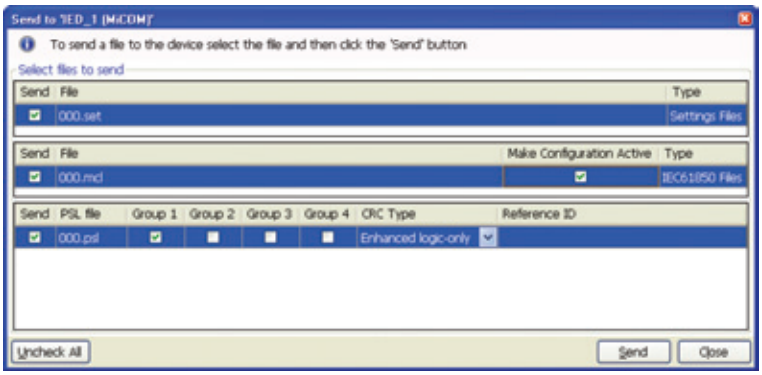
2.6.7 Upload Config Files and Test Functionality

Upload the Settings, PSL and MCL 61850 files from MiCOM S1 Studio to **IED_1.**

1. Ensure that the RS-232 serial cable is connected from the PC to **IED_1.**
2. Right click **Device [IED_1]** in the Studio Explorer and select Send in the drop down menu.



3. Select the boxes as shown in the next figure and click the **Send** command.



4. Once all the settings are transferred to **IED_1** you will see the following window which indicates a successful transfer of the files to the device.

5. Verify that the MCL configuration files were successfully uploaded to **IED_1** by using the front panel HMI of the relay navigate to **IED CONFIGURATOR -> IED Name** and confirm that the name **IED_1** is displayed.
6. Repeat Steps 1 to 5 while replacing all references for **IED_1** with **IED_2.**
7. Verify that pressing **Function Key 1** on **IED_1** activates LED #1 on **IED_2.**
8. Verify that pressing **Function Key 1** on **IED_2** activates LED #1 on **IED_1.**

> **Note:** For some IED models the device needs to be rebooted by cycling power to the relay in order for the configuration to be activated.

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