IEC 61850 Client Library

User Manual

https://support.industry.siemens.com/cs/ww/en/view/Entry ID

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1 Security

1.1 Security Concept

A direct connection of the devices to the internet has to be avoided. In order to protect plants, systems, machines and networks against cyber threats, it is necessary to implement – and continuously maintain – a holistic, state-of-the-art industrial security concept. Siemens' products and solutions constitute one element of such a concept. For more information about industrial security, please visit https://www.siemens.com/industrialsecurity

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1.2 Qualified Personnel

The product/system described in this documentation may be operated only by personnel qualified for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

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1.4 Prevention of Misconfiguration

A misconfiguration of configured tags or the hardware properties can lead to malfunctions, including:

- Hardware not reachable
- Redundancy doesn't work
- Sporadic data loss
- Permanent data loss

To reduce this risk, a detailed signal loop test is highly recommended during commissioning.

1.5 Disclaimer

We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

This library fulfils the functionality, described in this document. Older releases of this document are invalid. Functionality, which is not described or explicit marked as ‘not supported’, is not supported by this product or software release.

It is possible that superior products (like PCS 7 or STEP7) provide a system standard functionality (like SFC). If this functionality isn’t handled inside this document, the system behavior of this library can differ from the superior system.

For more information about this topic, please contact function.blocks.industry@siemens.com.

1.6 System Hardening

To increase the security of the plant, we recommend a system hardening of this system and all other systems. Due to a large variety of needs/requirements, it is not possible to suggest a concrete hardening strategy.

For this device, please refer to “PCS 7 compendium f” and consider this with responsible and qualified personnel of your plant. System hardening requires a deep knowledge about the guidelines, environment and needs on site. Therefore, system hardening isn’t covered by the service agreement. Please note that a wrong hardening configuration can impact the functionality.

1.7 Integrity of Delivery

Please ensure the integrity of the delivered components. To ensure the integrity, we seal the packaging of hardware components and the storage volumes with the following seal:

Figure 1-1 Valid seals

Invalid seals can be identified by:

- The corners are damaged from the removal and replacement of the seal.
- A removed seal leaves a pattern on the underground.
  If the seal is placed again, that pattern is missing in the background.
- The seal was cut.

Figure 1-2 Invalid seals

NOTICE	**Please ensure that all components contain a valid seal.** If the seals are missing or broken, do not connect the device or data volume. In this case, please contact us.

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1.8 Updates

Depending on the update cause (feature extensions, bug fixing, closing security issues, ...), the installation of the update should be considered. The availability of security updates should be checked permanently to ensure a proper and secure operation.

If a valid Service Agreement exists, the update can be requested on our hotline.

1.9 Personal Data Disclaimer

Siemens observes the principles of data protection, in particular the principle of data minimization (privacy by design). For this reason, the product only processes / stores technical functional data (e.g., time stamps) and no personal data. If the user links this data with other data (e.g., shift plans) or stores personal data on the same medium (e.g., hard disk) and thus establishes a personal reference, the user must ensure compliance with data protection regulations.

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2 System Requirements and Use Conditions

2.1 Software

TIA Portal V18

IEC 61850 device engineering tool

IEC Browser

Most parts of this manual are also valid for TIA V13, V13.1, V14, V15, V15.1, V16, V17. For more information, please contact function.blocks.industry@siemens.com.

2.2 Library

The mainline of this library is for the usage with CPU S7 1500. Depending on the project environment, following versions can be requested:

- S7 300: Lib_TIA_v1x_IEC61850_Client_300_CP
  Using the library with an additional CP module
- S7 300: Lib_TIA_v1x_IEC61850_Client_300_TCON
  Using the library with the CPUs PN-IO port
- S7 400: Lib_TIA_v1x_IEC61850_Client_400

For more information, please contact function.blocks.industry@siemens.com.

2.3 Hardware

The following Hardware is supported with the IEC 61850 block library.

- S7-1500 - Advanced Controller (e.g.: 1511, 1513,1515, 1516, 1517, 1518)
- S7-1500 - Software Controller (e.g.: 1505SP, 1507S, 1508S)
- S7-1500 - Distributed Controller (e.g.: 1510SP, 1512SP)
- S7-1500 - Redundant Controller (e.g.: 1513R, 1515R, 1517H)

Application examples for S7-1511 and S7-1517H are in scope of delivery. Configuration at other controllers might differ from the example projects.

2.4 Maximum number of instances per S7 400 CPU

Because the S7 CPU handles the IEC 61850 protocol, the IEC61850_COM/ IEC61850_RCOM block consumes a lot of scan time and memory. (The CP module only handles the deeper Layers ISO on TCP and TCP.)
Therefore, the IEC 61850 library is limited to up to 8 connections per CPU.

2.5 General performance restrictions

The maximum number of IEC 61850 tags, which can be handled by the library, depends on the used CPU and the number of connected IEC 61850 server devices. To calculate the maximum number, we provide an excel sheet you can download on our IEC 61850 product webpage:

https://support.industry.siemens.com/cs/document/109779276/power-control-integration-services-calculation-sheet-for-pcs-7-and-tia-portal?dti=0&lc=en-DE

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2.6 Redundancy limitation

If the library is used in a redundant system, the cases in which a redundancy switch over or a return to redundancy occur should be considered.

- In case of a redundancy switch over, the IEC61850_RCOM block reconnects automatically. The reconnection duration depends on function block settings and the cyclic interval but will be at least 10 seconds.
- Since the IEC 61850 connection technically behaves like a standard S7 connection, the connection is reinitialized after a redundancy return and should only be performed with the necessary safety precautions.

NOTE In order to use the blocks, a license for each plant/project is required.

Additional functionality can be implemented on request.

2.7 Service Agreement

A 5-year service agreement (MLFB: 9LA11106PC102CA0) is mandatory for this library. This service agreement covers questions about general topics, system handling and troubleshooting via phone or email. This service agreement provides library updates for new versions of TIA Portal. The license of the library and the service agreement are bound to one plant.

Without a valid service agreement, no free of charge support or updates are possible. If support via email or phone is required, an extended support package has to be ordered if the service contract is run out.

A template of the service agreement document can be found in the appendix.

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3 Installation

3.1 Requirements

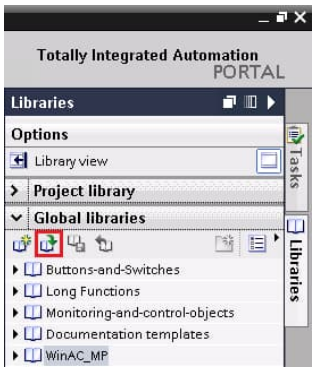
This version of IEC 61850 Client Library requires TIA V17. The usage of this library with CFC Addon is not supported.

3.2 TIA Portal – Open global library

The IEC 61850 Client library is a global TIA Portal library with the file name Lib_TIA_v17_IEC61850_Client_1500.al17.

The library has to be opened in the project view of TIA Portal. Open the library with the option “Open as read-only” in the open file dialog.

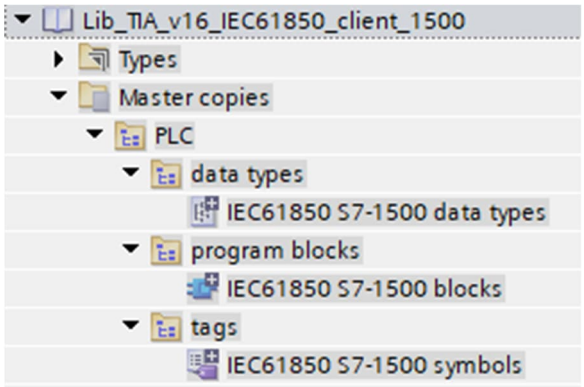
Figure 3-1 Open library



After the library was opened, you can find all objects for using the library in the directory “Master copies”. This directory contains:

- The IEC 61850 data types
- The IEC 61850 symbols
- The IEC 61850 program blocks

Figure 3-2 Library structure



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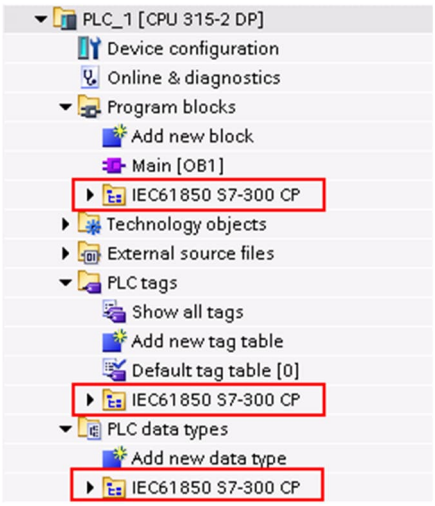
Copy the PLC elements from the library to your PLC object in the project which should use the IEC 61850 communication.

- IEC 61850 symbols → PLC tags
- IEC 61850 data types → PLC data types
- IEC 61850 program blocks → Program blocks

Figure 3-3 PLC



Compile all your program blocks (Software / Rebuild all blocks).

After the compile action is finished, the following system blocks should be added to your PLC.

Table 3-1 System blocks

BLOCK NO	NAME	PLC-Type
FB 700	Program_Alarm	S7-1500
FB 1030	TSEND_C	S7-1500
FB 1031	TRCV_C	S7-1500
FC 108	RH_GetPrimaryID	S7-1500 R/H

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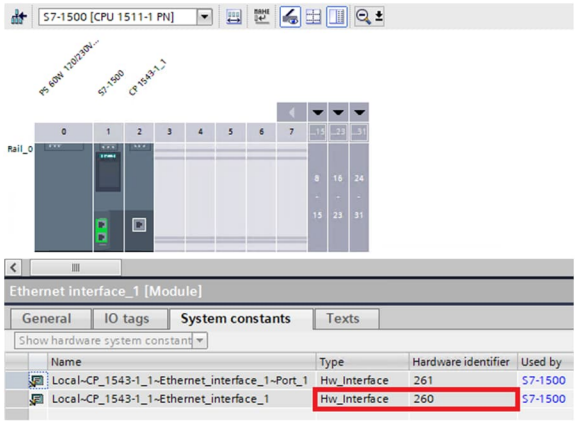
3.3 Hardware Identifier

Like mentioned in the introduction, the IEC 61850 client library can be used with various S7-1500 PLCs. As there are different PLC types available, depending on the product used, some points must be considered. Even before programming starts, the network interface to be used must be defined. As not every ethernet interface is suitable for IEC 61850 communication, the next chapter contains information about which ports can be used and how to identify the required hardware identification IDs.

3.3.1 S7-1500 Advanced Controller

In case of an S7-1500 Advanced Controller (e.g., S7-1511-1 PN), the internal PN-Interface as well as the ethernet interface of an external CP can be used for IEC 61850 communication. To get the correct hardware identifier, please select the desired port and switch to “System constants”. The hardware identifier of the superior ethernet interface must be used for IEC communication, so make a note of this number for programming which is explained in chapter 3.4.

Figure 3-4



3.3.2 S7-1500 Software Controller

In case of an S7-1500 Software Controller (e.g., S7-1505SP), the internal PN-Interface can be used for IEC 61850 communication. The ethernet interface, which is used for the Windows environment, cannot be used for IEC 61850 communication with this library. To get the correct hardware identifier, please select the desired port and switch to “System constants”. The hardware identifier of the superior ethernet interface must be used for IEC communication, so make a note of this number for programming which is explained in chapter 3.4

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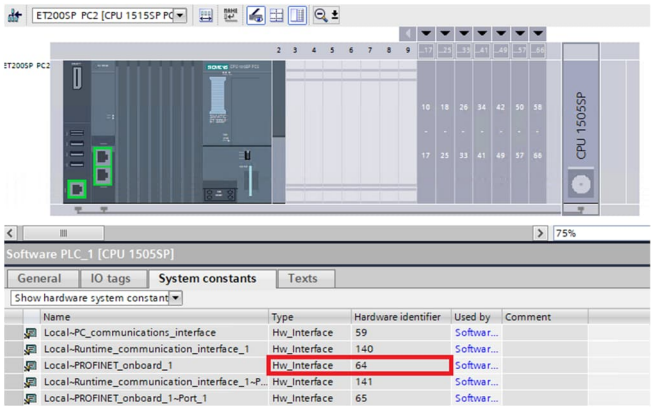
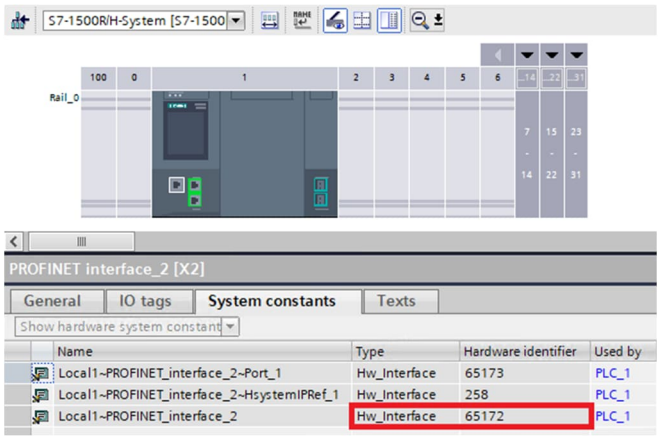
Figure 3-5



3.3.3 S7-1500 R/H Controller

In case of an S7-1500 R/H Controller (e.g., S7-1517H-3 PN) the internal PN-Interfaces can be used for IEC 61850 communication. To get the correct hardware identifier, please select the desired port and switch to “System constants”. The hardware identifier of the superior ethernet interface must be used for IEC communication, so make a note of these numbers at **both** PLCs for programming which is explained in chapter 3.4.

Figure 3-6



3.4 TIA Portal – Engineering

An extensive function- and performance test was performed with up to eight IEDs. The performance (reaction time and manageable number of signals) depends on the CPU performance and engineering.

Theoretical memory consumption, CPU load and cycle time can be calculated by a Excel sheet, that can be requested from function.blocks.industry@siemens.com.

The PCIS product portfolio also provides a more powerful and more flexible product for larger data amount or more demanding requirements. The mentioned product is the “PCIS Station Controller for TIA”. This product is an IEC 61850/60870 (Server/Client, Master/Slave) communication device, based on CPU1515 (ET200SP with Soft-PLC). It can be used as communication gateway, data concentrator or via internal Soft-PLC as a stand-alone device between IEC 61850/60870 and WinCC. For further information, please contact function.blocks.industry@siemens.com.

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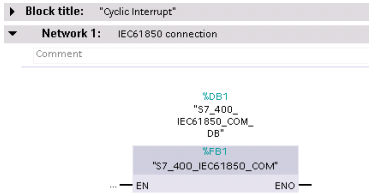
3.4.1 Setup IEC 61850 communication

- Add a new cyclic organization block (e.g., OB35) to your PLC
- Add a new start up organization block (e.g., OB100) to your PLC
- Add a new Function Block (FB) to your PLC.
- Open the organization blocks in editor, drag the new FB into a network and add the instance data block to your program.

Figure 3-7 Cyclic OB – Call FB



- Open the function block in the editor.
- Select the function block “IEC61850_COM” underneath the IEC 61850 group directory in your PLC and drag it to a network in your function block. One block is required for each IEDs.
- Add the instance data block to your program. The IEC61850_COM block’s inputs and outputs are explained in detail in chapter 5.1.
- Configure the block inputs for communication with the IED:

IP_ADDR

Set the IED IP-Address of the IED at the input IP_ADDR.

CON_ID

Specify a unique connection ID at the input CON_ID for every IEC61850_COM block, starting at “1”.

Interface_ID

Enter the Interface_ID identified in chapter 0.

MODE:

Here you can choose the mode for the cyclically reading of tags. It is important to choose the correct mode for your application.

- Mode “1” – DATASET
- Mode “2” – LIST

For initial test purposes the LIST Mode should be used, as it is the easiest way to set up an IEC 61850 connection. However, if your device supports DataSets, we recommend using DATASET mode for productive operation, because it is the fastest way for communication.

NOTE For more information see block description at chapter **Fehler! Verweisquelle konnte nicht gefunden werden.** and application example 4.2.

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Reporting

If your IEC 61850 device supports Reporting, enter the DataSet address for reporting, containing the list of Report values, in the input **RP_DSADDR**. (e.g., “CTRL/LLN0$$DataSet2”). Only the complete address is allowed.

NOTE For more information see block description at chapter **Fehler! Verweisquelle konnte nicht gefunden werden.** and application example 4.2.

IED_NAME

Configure the Input IED_NAME with the IEC 61850 device name. (Please note, all addresses and names are case sensitive).

SAMPLE_T

Set the cycle time of the OB which calls the communication block to SAMPLE_T. This input should never be 0.0. It’s used for TIMOUT calculation. (e.g., 100 ms Cycle time means SAMPLE_T = 0.1).

EN_MSG

To enable WinCC messaging, set **EN_MSG** to 1.

STRT_COM

Set the **STRT_COM** input to “OFF” until the engineering work is done; to start communication, set it to “ON”.

Please follow up by adding at least one RD_XXX block. This procedure is explained in chapter **Fehler! Verweisquelle konnte nicht gefunden werden. Fehler! Verweisquelle konnte nicht gefunden werden.**.

3.4.2 Configure Tag blocks

The IEC 61850 Client library is designed for a very flexible use. On one hand, there is the IEC61850_COM block which handles the IEC 61850 protocol block and management functionality. On the other hand, there are several blocks which can be connected to the IEC61850_COM block, called tag blocks. Each of the tag blocks represents one value in a special data format (e.g., INT, REAL, BOOL).

NOTE At least one IEC_RD_XXX block has to be connected to the IEC61850_COM block.

Currently, the library supports the following tag blocks which read IEC 61850 tags cyclically:

- IEC_RD_BO (BOOL)
- IEC_ALARM (BOOL with timestamp)
- IEC_RD_BS (BITSTRING)
- IEC_RD_IN (INT)
- IEC_RD_RL (REAL)

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The following tag blocks read values on change with the IEC 61850 reporting mechanism

- IEC_REPORT (BOOL on change with timestamp)

Switches can be controlled with:

- IEC_CTRL (uses IEC 61850 control mechanism)

Additionally, tags can be written (e.g., substitution values) with the following blocks

- IEC_WR_BO (BOOL)
- IEC_WR_BS (BITSTRING)
- IEC_WR_IN (INT)
- IEC_WR_RL (REAL)

3.4.3 Engineer Tag blocks

Add e.g., one IEC_RD_IN block. Set R0_CONNECT to the data block value IEC61850_COM_DB.CONNECT.

NOTE For the following tag blocks always use the same order of R0_CONNECT.

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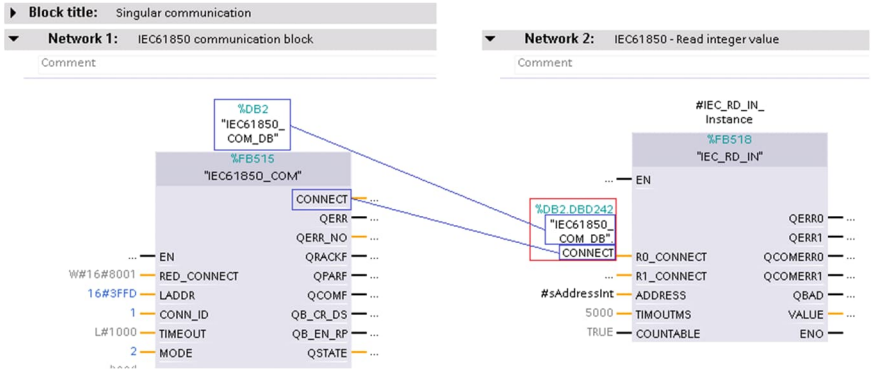
Figure 3-8 Set R0_Connect to DB value “CONNECT”



Enter the IEC 61850 address string on input “ADDRESS”.

NOTE Please note you have to replace “$” with “$$”.

NOTE These IEC 61850 address strings can also be generated and copied via the StatCon configuration tool. For further information see chapter 3.5.

Simple tag blocks

- IEC_RD_BS (BITSTRING),
- IEC_RD_IN (INT),
- IEC_RD_RL (REAL)
- IEC_RD_BO (BOOL)

The full path including the object attribute has to be entered, starting with the IEC 61850 domain name.

E.g., ‘CTRL/LLN0$$ST$$Loc$$stVal’ (for a BOOL tag block).

Complex tag blocks

- IEC_ALARM (BOOL with timestamp),
- IEC_REPORT (BOOL on change with timestamp)
- IEC_CTRL (uses IEC 61850 control mechanism)

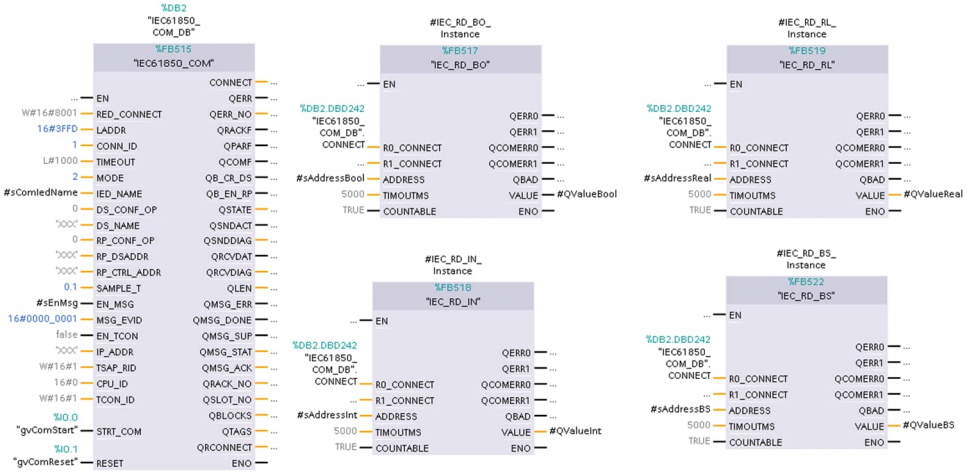
NOTE Only the path to the object name itself has to be entered, e.g., ‘CTRL/LLN0$$ST$$Loc’ (for a REPORT tag block).

NOTE In Case of IEC_CTRL, the path excluding Oper/SBO object has to be set up: e.g., ‘CTRL/LLN0$$CO$$LEDRs’.

Interface

		Name	Data type	Offset	Default value
1		Input			
2		Output			
3		QValueBool	Bool	...	false
4		QValueInt	DInt	...	0
5		QValueReal	Real	...	0.0
6		QValueBS	DWord	...	16#0
7		<Add new>			
8		InOut			
9		Static			
10		sComledName	String[24]	...	'IED_0002'
11		sEnMsg	Bool	...	true
12		IEC_RD_IN_Instance	"IEC_RD_IN"	...	
13		IEC_RD_BO_Instance	"IEC_RD_BO"	...	
14		IEC_RD_RL_Instance	"IEC_RD_RL"	...	
15		IEC_RD_BS_Instance	"IEC_RD_BS"	...	
16		sAddressBool	String[52]	...	'CTRL/LLN0$$ST$$LEDRs$$stVal'
17		sAddressInt	String[52]	...	'CTRL/LLN0$$ST$$LEDRs$$origin$$orCat'
18		sAddressReal	String[52]	...	'MEAS/MMTR1$$CF$$SupWh$$pulsQty'
19		sAddressBS	String[52]	...	'CTRL/LLN0$$ST$$LEDRs$$q'

Figure 3-9 Example: Tag block configuration



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WinCC messages

The tag blocks IEC_ALARM (BOOL with timestamp) and IEC_REPORT (BOOL on change with timestamp) can be configured to generate messages in WinCC. The message texts can be specified as described in the following:

- Open the PLC alarms in editor
- If you are using a single instance DB for your IEC_ALARM or IEC_REPORT block, you can change the default text of the subalarm entries of MSG_EVID of the block. These text entries are used for each single instance DB of this block.
- If you are using a multi instance DB for your IEC_ALARM or IEC_REPORT block, no default alarm texts will be used. You have to declare the alarm texts for each multi instance DB.
- After changing the message texts, the AS program and the HMI should be compiled. The compiled AS program has to be downloaded to the CPU.

NOTE At least one cyclically read tag block (IEC_RD_XXX) has to be engineered to establish the communication to an IEC 61850 device.

NOTE A maximum up to 80 cyclically read tag blocks can be configured. The maximum size of connected blocks is 250. The more blocks are engineered, the more CPU scan time is needed. Detailed performance information can be found in Chapter 2.

3.4.4 Setup redundant IEC 61850 communication

The setup of redundant IEC 61850 connections is basically the same as a single connection as described in chapter 3.4.1.

Please follow the instructions of the singular connection but use the IEC61850_RCOM block instead of the IEC61850_COM and add the additional configuration at the input parameters:

RECON_TIMEOUT

Configure a suitable value for the input RECON_TIMEOUT. For 100 ms cycle time, at least 10 seconds should be used. If the cyclic communication is not reached, the timeout value must be increased.

INTERFACE_ID2

Add a second INTERFACE_ID at the input INTERFACE_ID2 as mentioned in chapter 0.

RP_CTRL_ADDR2

In case of DATASET mode and reporting mechanism, an additional report control block is required. Set an IEC 61850 path to report control block at the input RP_CTRL_ADDR2, which is different than the RP_CTRL_ADDR1.

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3.5 Configuring IEC 61850 addresses via StatCon

The delivery of the IEC 61850 Client Basic Library also contains the StatCon configuration tool. This tool can be used to configure the correct IEC 61850 addresses on the tag blocks in your TIA Portal program.

3.5.1 Copy and paste IEC 61850 addresses

This chapter explains how addresses can be copied from StatCon to your blocks in the TIA Portal program. For further information about working with the configuration tool, please refer to the separated StatCon manual.

The first step is to add a new “IEC 61850 Client Basic Library” Station device and a new “External device” in StatCon.

After this, you have to assign the ICD file of your IEC device to the external device. If the settings of the external device were applied, the data structure of your IEC device will be generated.

Drag the Data Objects of the IEC device you want to configure to the tag table of the “IEC 61850 Client Basic Library” Station device. In the tag table, a new entry is added, which contains the IEC 61850 address of your Data Object with the correct object separators, as required on tag blocks of the IEC 61850 library in TIA Portal.

Figure 3-10 Drag Data Object to tag table

Using the checkbox in the table column “Alarm/Report”, you can select if the address is used on a tag block or on an alarm or report block. If you want to use the address on an alarm or report block, activate the checkbox. Afterwards, the address does not contain the address part of the IEC 61850 Data Attribute name anymore.

Figure 3-11 Address for a tag block

	Server	IED Name	IEC61850 path	Equipme...	Variable type	Alarm / Report
	Siprotec	IED_0002	CTRL/LLN0$$ST$$Loc$$stVal		Boolean	☐

Figure 3-12 Address for alarm or report block

	Server	IED Name	IEC61850 path	Equipme...	Variable type	Alarm / Report
	Siprotec	IED_0002	CTRL/LLN0$$ST$$Loc		Boolean	☑

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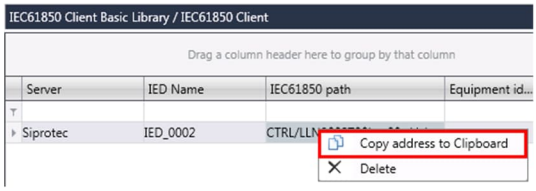
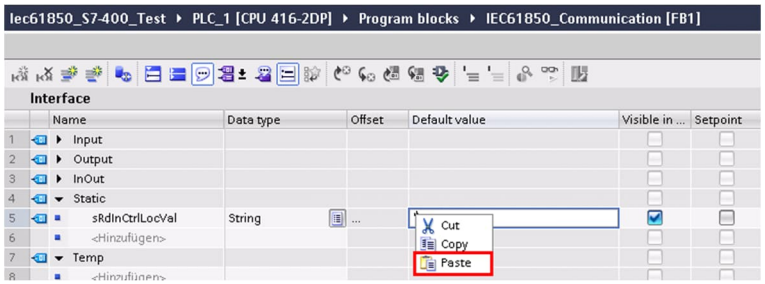
To copy the IEC 61850 address, open the context of the corresponding tag by a right click on your mouse and select the context entry “Copy address to clipboard”.

Figure 3-13 Copy address from StatCon tag



After this, switch to your TIA Portal program block and paste the address value.

Figure 3-14 Paste address to TIA Portal program block



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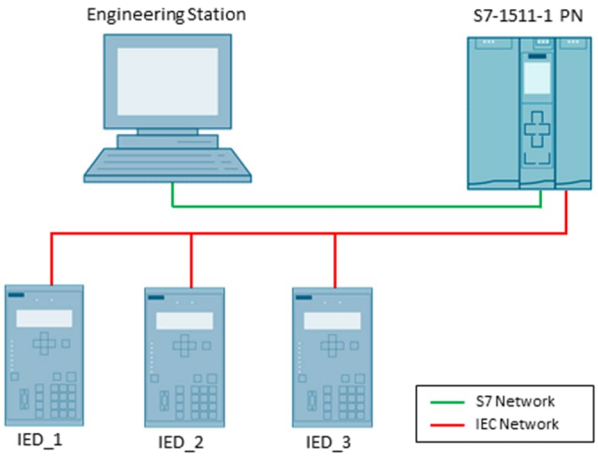
4 Application Examples

In the following two examples, different possible configuration options are shown and explained step by step. The example projects are part of the scope of delivery and should show possibilities how the library can be used correctly.

4.1 S7-1500 Advanced PLC

The first example shows the engineering basics of the IEC 61850 client library used to connect three identical SIPROTEC4 protection relays to a S7-1500 Advanced controller with a CP-Modul.

Figure 4-1 Example 1 - Architecture



Because we want to keep the configuration as simple as possible, we will perform a small configuration with a couple of common values including BOOL, FLOAT, INTEGER which are exchanged cyclical, every 400 ms with the IED. Furthermore, we will engineer a control function as it is usually used for switches.

4.1.1 Hardware configuration

The first step is to configure the hardware configuration for the used PLC as usual in TIA Portal – in this example an S7-1511 advanced controller with an external CP. As we want to use the CPs ethernet port for IEC 61850 communication, we need to note the corresponding Hw_Interface ID. In this case it is “260” as marked in the following picture.

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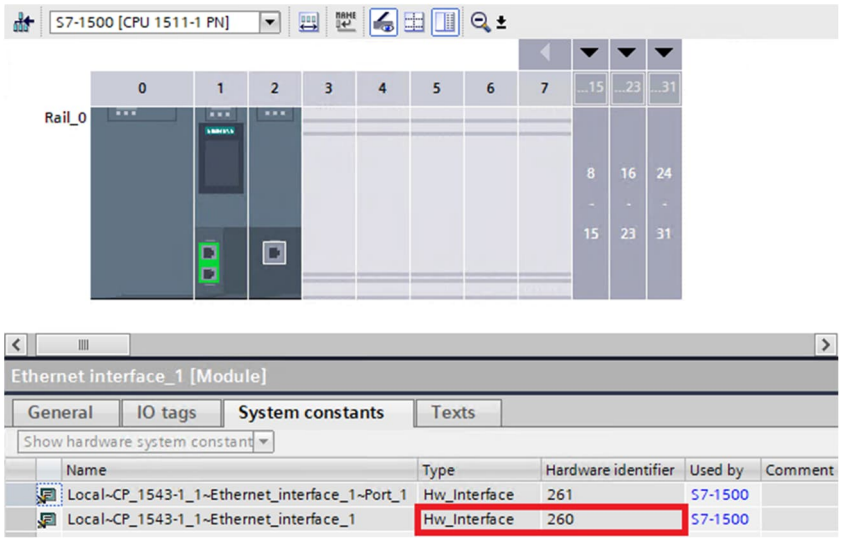
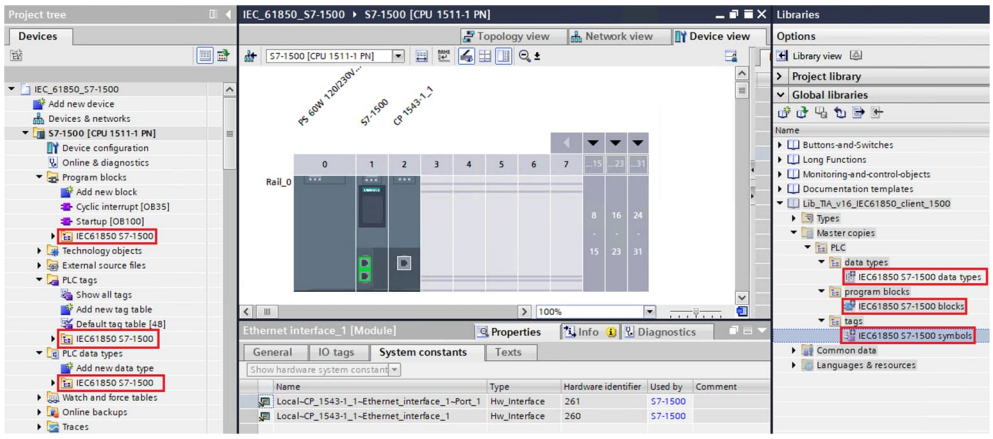
Figure 4-2 HW Interface ID / Singular PLC



4.1.2 Engineering

After the hardware configuration is done, drag & drop the master copies of the IEC 61850 client library to the corresponding folders at the PLC.

Figure 4-3 Master copies S7-1500



Create a startup OB (e.g., OB100) and a cyclic OB (e.g., OB35, 100 ms) which calls a FB named “IED_0001”. For one complete data exchange cycle, four PLC cycles are needed. In the FB “IED_0001” one IEC61850_COM block must be inserted. Before we can start the configuration of the target values, the general connection properties need to be set correctly as described in chapter 3.4.1.

The following Inputs must be set in this example:

Table 4-1

Input	Value	Comment
IP_ADDR	140.80.161.101	IP Address of IED
CON_ID	1	1st Connection
Interface_ID	260	As identified before
MODE	2	Only cyclic data exchange
IED_NAME	IED_0001	IED name from SCD/ICD File

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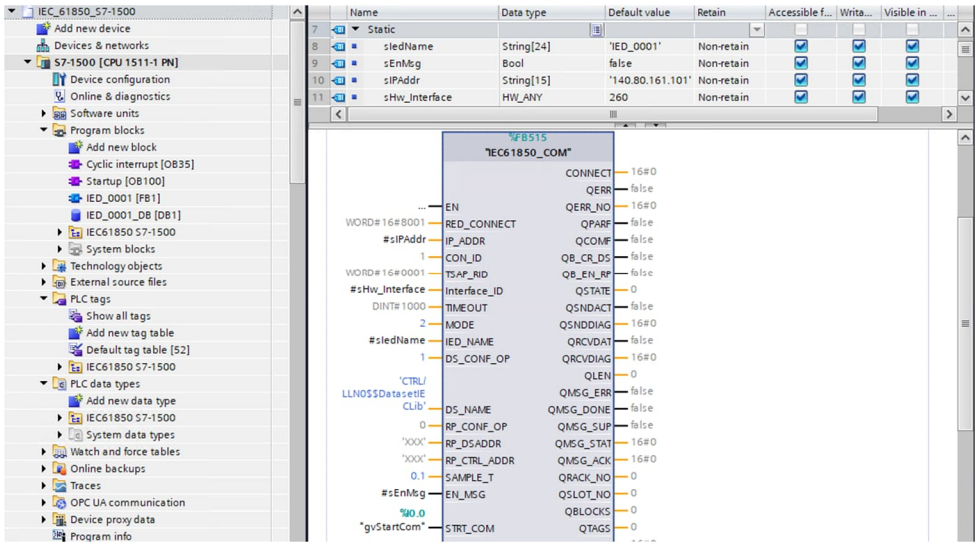
Input	Value	Comment
DS_CONF_OP	1	Dynamic Dataset supported
DS_NAME	CTRL/LLN0$$DatasetIECLib	Name for Dyn-Dataset
SAMPLE_TIME	0.1	Cycle time in seconds
EN_MSG	0	No alarming
START_COM	Bool PLC Tag “gvStartCom”	To start communication
RESET	Bool PLC Tag “gvResetCom”	To reset communication

Figure 4-4 IEC61850_COM configuration



After the configuration of the IEC61850_COM block is completed, the required tag blocks for the IED can be engineered. At least one “Read”-Tag is mandatory. In this sample application, five sample values are engineered to show the engineering principles:

- Boolean
- Integer
- Float
- Bool with timestamp
- Control-Structure

Create static string variables for each corresponding IEC path of the target values and instance dbs for the tag blocks as shown in picture **Fehler! Verweisquelle konnte nicht gefunden werden.**”. At this point it is important to consider the right IEC path for each block type. While all IEC_RD_XX-blocks need total IEC paths e.g., ‘CTRL/LLN0$$ST$$Loc$$stVal’ the IEC_ALARM and the IEC_CONTROL block needs the whole structure path, e.g., ‘CTRL/Q0CSWI1$$CO$$Pos’ without absolute target value.

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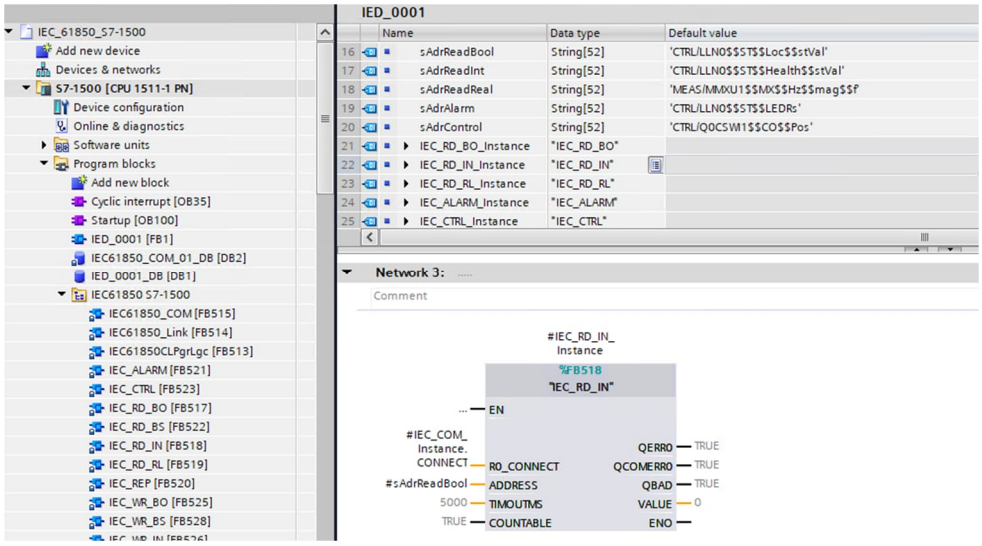
Figure 4-5 IEC tag configuration



The next step is to connect the R0_CONNECT input to the CONNECT output of the IEC61850_COM block and the ADDRESS input with the matching static string containing the IEC 61850 path.

Finally, we need to create two more PLC tags to use the IEC_CTRL block. Connect one Boolean PLC tag named “ctrlValue” with the input CTRLVAL and another Boolean PLC tag named “ctrlTrigger” to the CTRL input.

At last, copy the IED_0001 block twice and rename it for the other two IEDs. If all IEDs are the same, just the IP address, IED name and the CON_ID input must be modified individually.

When the engineering is completed, the program can be loaded to the PLC for testing purposes. The IEC 61850 communication can be started by modifying the START_COM input of the IEC61850_COM block.

After a few seconds, the QSTATE output is expected to show “12”, which means cyclic communication is in progress – the engineered tag blogs should now show the correct values of the IEDs – it’s recommended to compare the online values with a suitable tool, e.g., “IEC Browser”.

4.1.3 Conclusion

Congratulations, the first IEC 61850 communication to the S7-1500 PLC is finished. Even if the communication is running fine, you should consider some points before putting the PLC to productive use.

As the cyclic IEC 61850 communication leads to a high consumption of resources, this kind of communication is only suitable for a small amount of IEDs depending of the required update interval, the number of tags, the used PLC model and of course the other task of the PLC.

As a more powerful PLC is not always a possible solution, you should take the second application sample into account, where the “Report” mechanism for data exchange of the IEC 61850 protocol is being used. This has big advantages regarding the performance compared to the cyclic data exchange (also called “Polling”).

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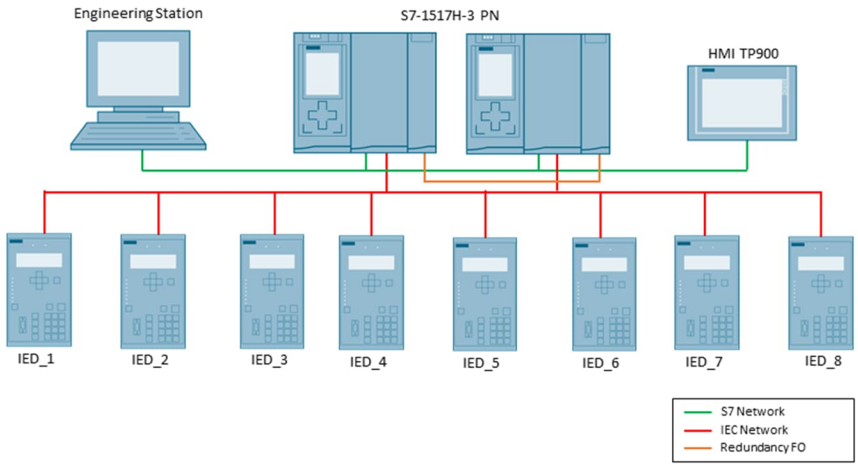
4.2 S7-1500H Redundant PLC

The second example shows a more complex automation system including a redundant S7-1500 PLC, several connected IEDs and an HMI panel. To reduce the communication load for the PLC to a minimum, report mechanism is being used for data exchange.

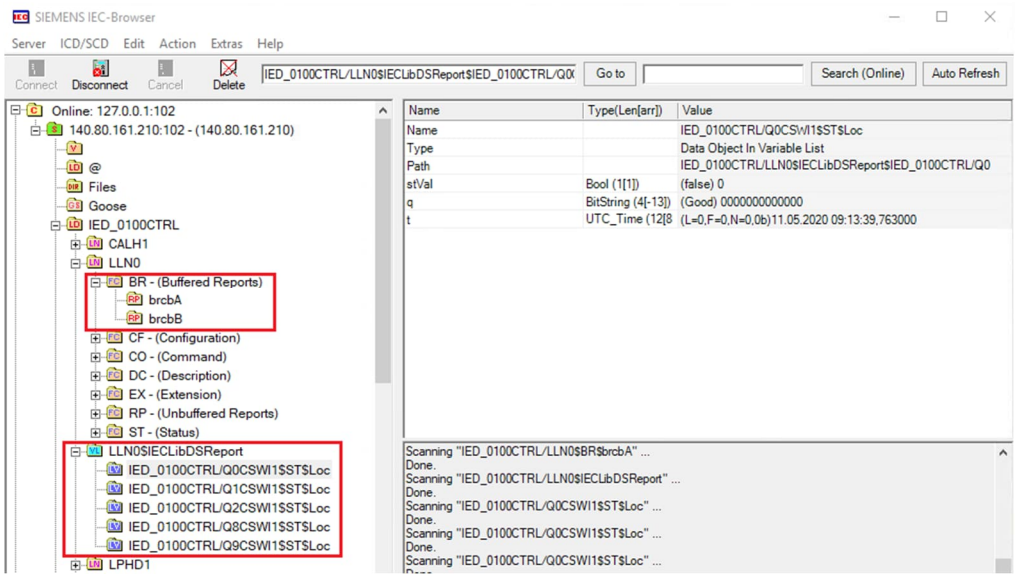
Figure 4-6 Example 2 - Architecture



4.2.1 Preconditions

To use the report mechanism for data exchange, it is required that the IEDs have a preconfigured static dataset which contains all tags that shall be reported to the client. Additionally, two buffered report control blocks are necessary as shown in Figure 4-6. Usually, a separate engineering tool is required to configure the IED, e.g., for SIPROTEC devices you need to use the DIGSI software.

Figure 4-7 Static DataSets & BRCBs



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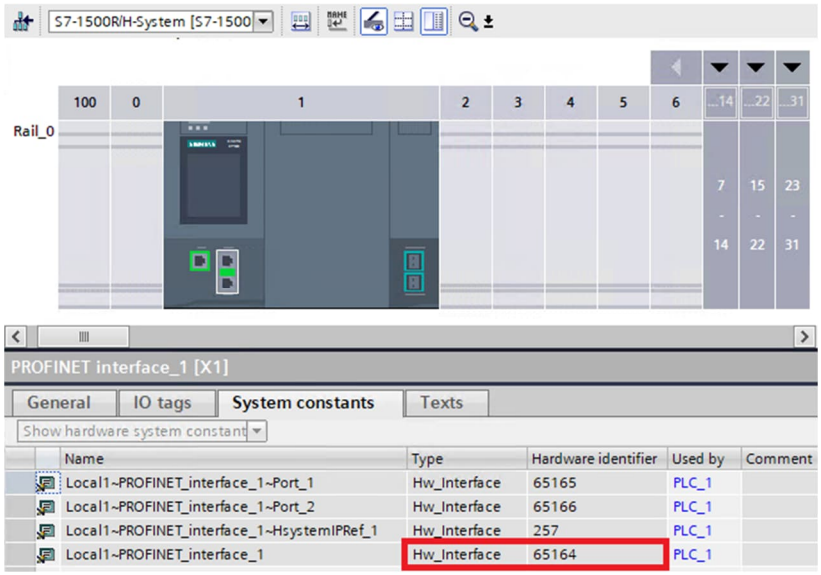
4.2.2 Hardware configuration

The first step is to configure the hardware configuration for the used PLC as usual in the TIA Portal – in this example an S7-1517H redundant controller. As we want to use both of the PLCs for IEC 61850 communication, we need to note the corresponding Hw_Interface IDs. In this case, it is “65164” as marked in the following picture for the first PLC and “65364” for the second PLC. Configure the HMI panel for alarming of the S7-1517H PLCs.

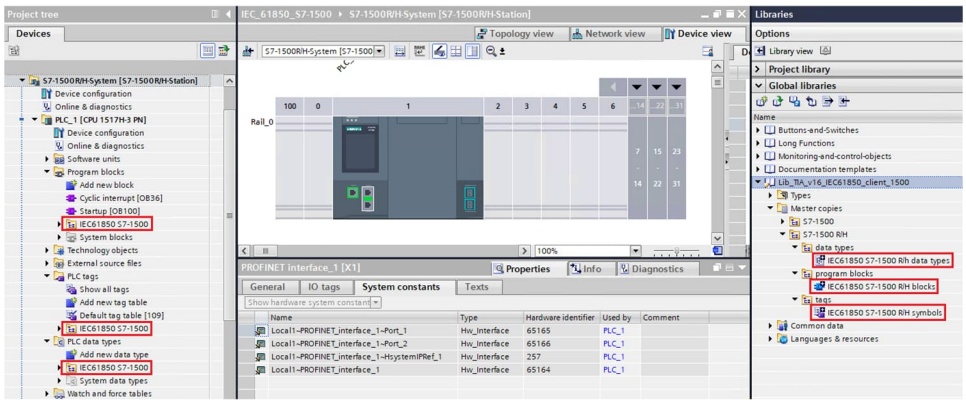
Figure 4-8 HW Interface ID / Redundant PLC



4.2.3 Engineering

After the hardware configuration is done, drag & drop the master copies of the IEC 61850 client library to the corresponding folders at the PLC.

Figure 4-9 Master copies S7-1500 R/H



Create a startup OB (e.g., OB100) and a cyclic OB (e.g., OB36, 50 ms), which calls a FB named “IED_0100”. For one complete data exchange cycle, four PLC cycles are needed. In the FB “IED_0100” one IEC61850_**RCOM** block must be inserted. Before we can start the configuration of the target values, the general connection properties need to be set correctly as described in chapter 3.4.4.

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The following inputs must be set in this example:

Table 4-2

Input	Value	Comment
IP_ADDR	140.80.161.211	IP Address of IED
CON_ID	1	1st Connection
INTERFACE_ID1	65164	As identified before
INTERFACE_ID2	65364	As identified before
RECON_TIMEOUT	T#15s	Reconnect delay 15s
MODE	1	Dataset mode
IED_NAME	IED_0101	IED name from SCD/ICD File
DS_CONF_OP	1	Dynamic Dataset supported
DS_NAME	CTRL/LLN0$$DatasetIECLib	Name for Dyn-Dataset
RP_CONF_OP	1	
RP_DSADDR	CTRL/LLN0$$DatasetReport	
RP_CTRL_ADDR1	CTRL/LLN0$$BR$$brcbA01	
RP_CTRL_ADDR2	CTRL/LLN0$$BR$$brcbB01	
SAMPLE_TIME	0.05	Cycle time in seconds
EN_MSG	1	Alarming enabled
START_COM	Bool PLC Tag “gvStartCom”	To start communication
RESET	Bool PLC Tag “gvResetCom”	To reset communication

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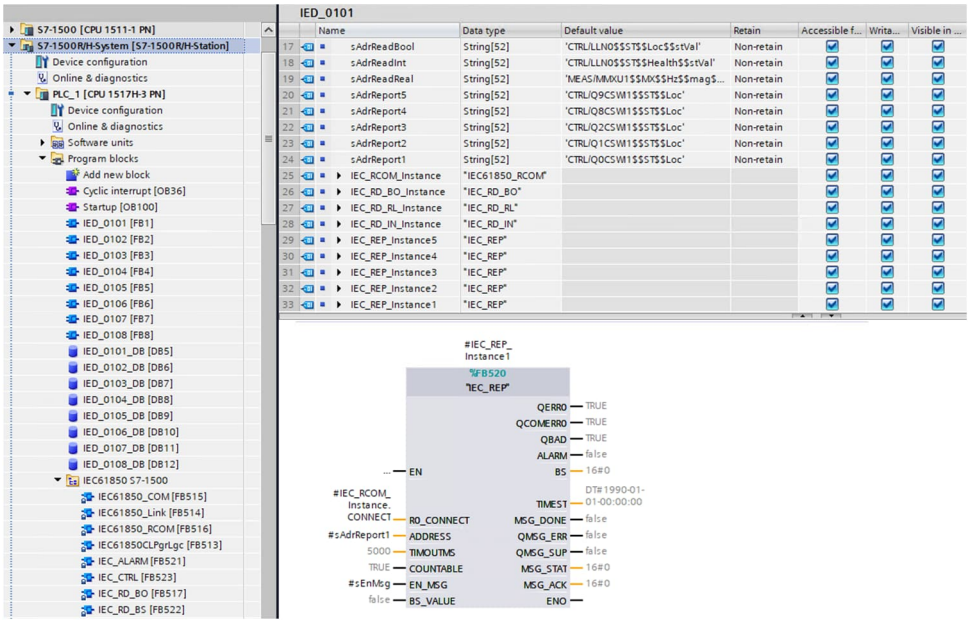
After the configuration of the IEC61850_RCOM block is completed, the required tag blocks for the IED can be engineered. At least one “Read”-Tag is mandatory. In this sample application, several sample values are engineered to show the engineering principles:

- Boolean
- Integer
- Float
- 5x Boolean Report

Create static string variables for each corresponding IEC path of the target values, and instance dbs for the tag blocks as shown in Figure 4-10. At this point, it is important to consider the right IEC path for each block type. While all IEC_RD_XX-blocks need total IEC paths e.g., ‘CTRL/LLN0$$ST$$Loc$$stVal’ the IEC_REP block needs the whole structure path, e.g., ‘CTRL/Q0CSWI1$$ST$$Loc’ without an absolute target value.

Figure 4-10 IEC Report configuration



The next step is to connect the R0_CONNECT input to the CONNECT output of the IEC61850_COM block, and the ADDRESS input with the matching static string containing the IEC 61850 path.

At last, copy the IED_0101 block seven times and rename it for the other IEDs. If all IEDs are the same, just the IP address, IED name and the CON_ID input must be modified individually.

When the engineering is completed, the program can be loaded to the PLC for testing purposes. The IEC 61850 communication can be started by modifying the START_COM input of the IEC61850_COM block.

After a few seconds, the QSTATE output is expected to show “12”, which means cyclic communication is in progress – the engineered tag blogs should now show the correct values of the IEDs and the HMI will show the alarms in case of a signal change at the report blocks – it’s recommended to compare the online values with a suitable tool, e.g., “IEC Browser”.

4.2.4 Conclusion

In this application example, the principles of using the IEC 61850 Client Library with reporting mechanism was explained, which is highly recommended to keep the PLC load on a reasonable level.

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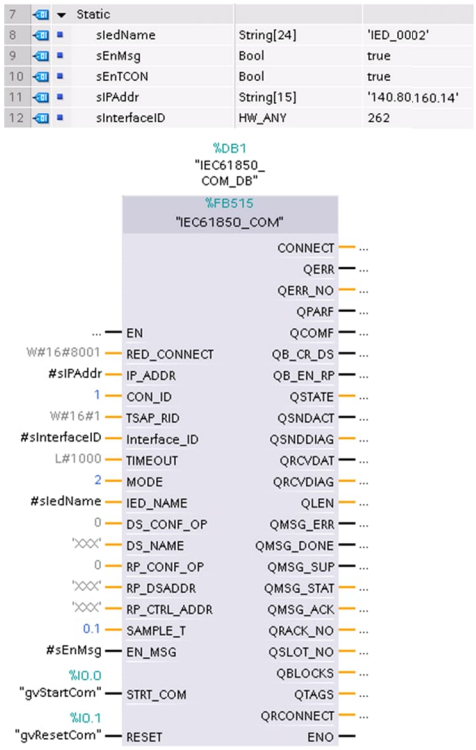
5 Block description

5.1 IEC61850_COM

5.1.1 Block screenshot

Figure 5-1 IEC61850_COM block S7-1500



5.1.2 Block description

IEC61850_COM block handles the IEC 61850 protocol. It manages all connected tag blocks. It recognizes cyclic read tags, creates read requests and dispatches the values to the connected blocks. Furthermore, reports are dispatched to the dedicated blocks.

In the following, the most important inputs and outputs will be explained in detail.

RED_CONNECT

Do not change the default value of this input (default value 16#8001). This input is just necessary for H-systems and these systems will not be supported by TIA Portal.

CON_ID

CONN_ID specify the used connection between the PLC or CP and the IEC 61850 device. Every IEC61850_COM or IEC61850_RCOM block must have a unique CON_ID.

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MODE

Mode input configures the way the IEC61850_COM block requests the cyclically read values:

- **DEBUG_MODE (0)** means, the IEC_61850_COM block is running in debug mode. It sends a read request for every tag, which should be read cyclically and evaluates its response. In that mode, it can be verified if an IEC 61850 tag address is not set up correctly. (QBAD = TRUE).

NOTE This mode is for debugging only.

NOTE This mode does not support IEC_CTRL, IEC_REPORT. Although the tag blocks can be connected to the IEC61850_COM block, they will not work properly.

- **DATASET (1)** stands for DataSet mode. This means that at the beginning a list (DataSet) is created in the IEC 61850 device. When running in ZYKLCOM, all variables are read with requesting the list name. Not all devices support the services to create a DataSet dynamically over the IEC 61850 protocol but allow configuring a DataSet with an Engineering Tool.
- **LIST (2)** mode reads all the connected tags within one request. Therefore, a list of tags containing all addresses is read cyclically. This mode is very scan time consuming. It should only be used for devices which don't support DataSets.

  Maybe the TIMEOUT variable has to be increased. This is indicated if the IEC61850_COM block reaches the "ZYKLCOM" state but does not keep it stable.

The following configurations are possible:

Table 5-1 DATASET configuration

Input name	DataSet supported		No DataSets
	Dynamic DataSets	Static DataSets	Device does not support DataSets, use LIST mode.
	Device allows dynamic creation of DataSets.	DataSets can only be created with engineering tool.	
MODE	1 = DataSet	1 = DataSet	2 = List
DS_CONF_OP	1 = Supported	0 = Not Supported	0 = Not Supported
DS_NAME	DataSet name of your choice. Will be created in device automatically by the library. e.g.,"CTRL/LLN0$$DataSet1".	Enter the DataSet name, which was previously configured with the external engineering tool, e.g., „CTRL/LLN0$$DataSet1"	-

NOTE It is recommended to set MODE to DATASET, due to the fact it is the fastest way to poll tags cyclically. If your IEC 61850 device does not support datasets, use LIST mode.

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NOTE DEBUG mode should only be used to detect address configuration faults.

NOTE LIST mode as well as DATASET mode require a RESET for engineering changes (add, delete blocks, address change).

Please see also table DATASET configuration at chapter 3.4.1.

IED_NAME

The IED name has to be set with this input (IED: Intelligent Electronic Device). The IED name is a string and is set up with your engineering tool. (E.g., IED_001).

It can be read out with the IEC 61850 browser tool.

DS_CONF_OP

DS_CONF_OP stands for DataSet Configuration Operations. These can either be supported or not supported. (Dynamic create, delete DataSets). Check your device description to see if these operations are supported.

DS_NAME

The DataSet name is a string to identify your DataSet to cyclically read tags. The DataSet is placed in the IEC 61850 device VMD area (entering only the DataSet name like “DS1” or in the Device Domain/Item area, like “CTRL/LLN0$$DS1”).

NOTE The configured tag blocks have to be engineered in the same order as in the DataSet. DataSet entries must not contain objects, but only attributes, except for ALARM tags.

RP_CONF_OP

RP_CONF_OP stands for Reporting Configuration Operation. If the IEC 61850 device supports subscribing and unsubscribing reports, select “SUPPORTED”, otherwise select “NOT_SPTED”.

If subscribing to reports is selected, the IEC61850_COM block enables the buffered reporting for all tags included in the DataSet specified with RP_DSADDR (whole address) with the trigger “on change”. Therefore, a free Report Control block address which contains the RP_DSADDR in entry DataSet has to be specified in RP_CTRL_ADDR.

If RP_CONF_OP is set to “SUPPORTED”, each installed report block (IEC_REP) will be initialized during communication startup with the values of the connected IEC 61850-Server device. After initialization, report values will only be changed if a report is triggered through a connected IEC 61850-Server device.

RP_DSADDR

Specify the DataSet containing the tags for reporting. The whole DataSet address has to be configured. E.g., ‘CTRL/LLN0$$DataSet1'.

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NOTE It is recommended to **not** configure the same DataSet you have configured on input DS_NAME for cyclically reading the tag blocks (e.g., IEC_RD_BO, IEC_RD_IN…). For reporting functionality, you have to create a separate DataSet within your IEC 61850 server device with the related IEC 61850 device engineering tool.

Further enter the Report Control block address (e.g., “CTRL/LLNO$$BR$$brcbA01”) at the input RP_CTRL_ADDR.

RP_CTRL_ADDR

Specify a free Report Control block address to enable reporting. Normally, the corresponding Report Control blocks reside in the same tree part as the Report DataSet. E.g., 'CTRL/LLN0$$BR$$brcbA01'.

IP_ADDR

Enter the IEC 61850 server IP address (protection relay) when using T-communication.

TSAP_RID

Enter the IEC 61850 server TSAP number (default no: 0001 when using T-communication.

Interface_ID

Hardware identifier of the local interface. Find this ID in the properties of your communication module.

SAMPLE_T

Use SAMPLE_T to write the block OB cycle time in ms/100. This input should never be 0.0. It is used for TIMOUT calculation.

EN_MSG

Enables WinCC messaging if set to “1”.

STRT_COM

OFF deactivates the communication via IEC 61850. ON starts the communication again.

RESET

Reset deactivates the IEC 61850 communication, sets all internal variables to INIT value and re-organizes the internal block list. It has to be executed, if for example a tag block is removed or added, or an address has changed.

CONNECT

CONNECT output has to be connected with the tag block R0/1_CONNECT input. (Singular mode: connect only R0_CONNECT, redundant mode: connect R0_CONNECT, when IEC61850_COM is connected with CP Rack 0, otherwise connect R1_CONNECT.)

QERR

QERR is set to “1” if any errors occur.

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QERR_NO

QERR_NO delivers detailed error information. (Not yet supported.)

QRACKF

QRACKF is set to “1” if a RACK failure occurs.

QPARF

QPARF is set to “1” if the plausibility check of connection parameters LADDR and CONN_ID failed.

QCOMF

QCOMF is set to “1” if the IEC 61850 communication is not in state “ZYKLCOM”. Communication error.

QB_CR_DS

If QB_CR_DS is set to “1”, the DataSet with the name specified in DS_NAME could not be created.

QB_EN_RP

If QB_EN_RP is set to “1”, writing the Report configuration failed. Reporting could not be enabled.

NOTE If QB_EN_RP is set to “1”, all connected IEC_REPORT blocks will not work properly.

QSTATE

IEC 61850_COM is mainly organized with a state machine. QSTATE shows the current state. If communication to the IEC 61850 device is established correctly, the function block is running in state “ZYKLCOM” after initialization.

The following table lists the possible states:

Table 5-2 IEC61850_COM QSTATE output

QSTATE	PROG_STATE	Description
0	'INIT'	Initialization state to get parameter
1	'CONREQ'	Send initiate request
2	'CONRES'	Receive initiate response
3	'CONERROR'	Connection error (please see table on next page)
4	'CDSEXREQ'	Send Request to check existence of DataSet
5	'CDSEXRES'	Receive Response for DataSet existence request
6	'CDSCRREQ'	Create DataSet request
7	'CDSCRRES'	Create Dataset response
8	'CDSDLREQ'	Delete DataSet request
9	'CDSDLRES'	Delete DataSet response
10	'CINFOREQ'	Write ReportCtrlblock request
11	'CINFORES'	Write ReportCtrlblock response
12	'ZYKLCOM'	Cyclic communication state.
13	'CONCLREQ'	Conclude Request

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QSTATE	PROG_STATE	Description
14	'CONCLRES'	Conclude Response
15	'FINREQ'	Release Request
16	'FINRES'	Release Response
17	'ABORT'	Abort received

5.1.3 Called blocks

Table 5-3 IEC61850_COM called blocks

Declaration/Block number	Declaration/Block name
FB511	MMS_BuildReq
FB512	MMS_ParseResp
FB513	IEC61850CLPgrLgc
FB514	IEC61850_Link
FB529	MMS_ParseDSAddr
FB531	MMS_Strin_IP_Konv
FB63	TSEND
FB64	TRCV
FB65	TCON
FB66	TDISCON
UDT10	BST_BOOL_SHORT
UDT11	BST_INT_SHORT
UDT12	BST_REAL_SHORT
UDT13	BST_CTRL_SHORT
UDT14	IEC61850_Params
UDT16	BSt_BSTR_SHORT
UDT65	TCON_PAR
UDT7	BST_SHORT
UDT8	LINK_INFO
FC21	LEN
SFC20	BLKMOV
SFC49	LGC_GADR
SFC6	RD_SINFO

5.1.4 I/O description

Depending on the used library, not all inputs and outputs in the list will still be required. These inputs and outputs wouldn’t exist on the block.

NOTE These inputs and outputs are marked in the list with the extension (opt.).

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Table 5-4 IEC61850 I/O description

I/O	I/O Name	Type	I/O Default	Comment
I	RED_CONNECT	WORD	16#8001	Connection to IEC61850_RED block
I	CON_ID	INT	0	connection ID
I	TIMEOUT	DINT	1000	Timeout in milliseconds
I	MODE	INT	0	Debug mode (0) / DATASET (1) / LIST (2)
I	IED_NAME	STRING	XXX	IEC 61850 IED name
I	DS_CONF_OP	INT	0	DataSet Configuration Operation SUPPORTED / NOT SUPPORTED
I	DS_NAME	STRING	XXX	IEC 61850 Dataset name
I	RP_CON_OP(opt.)	INT	0	Report Configuration Operation SUPPORTED / NOT SUPPORTED
I	RP_DSADDR(opt.)	STRING	XXX	DataSet address used for Reporting
I	RP_CTRL_ADDR(opt.)	STRING	XXX	DataSet Control block address
I	MSG_EVID(opt.)	DWORD	2	Alarm_8P message ID // depreciated
I	SAMPLE_T	REAL		Sample time input (system input)
I	EN_MSG(opt.)	BOOL	0	1 = enable alarm
I	MSG_EVID(opt.)	BOOL	0	System input for Alarming
I	IP_ADDR(opt.)	STRING	0	IEC 61850 device IP address
I	TSAP_RID(opt.)	WORD	0	TSAP remote ID for T-communication
I	CPU_ID(opt.)	BYTE	0	Select correct CPU/CP for T-communication
I	TCON_ID(opt.)	WORD	0	Use unique number for T-communication instance
IO	STRT_COM	BOOL	0	1 = start communication
IO	RESET	BOOL	0	1 = reset function block
O	CONNECT	BOOL	1	Connection to input R_CONNECT of READ_IEC blocks
O	QERR	BOOL	0	General error
O	QERR_NO	WORD	0	Error number – not yet supported
O	QRACKF	BOOL	0	1 = Rack failure (power fault, CPU error, …)
O	QPARF	BOOL	0	1 = Parameter assignment error module
O	QCOMF	BOOL	0	1 = Communication error, Communication not running in ZYKLCOM.
O	QB_CR_DS	BOOL	1	Create DataSet failed
O	QB_EN_RP(opt.)	BOOL	1	Subscribing Report failed
O	QSTATE	INT	0	Internal state

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I/O	I/O Name	Type	I/O Default	Comment
O	QSNDACT	BOOL	0	1 = data sent
O	QSNDDIAG	WORD	0	Detailed send status
O	QRCVDAT	BOOL	0	1 = data received
O	QRCVDIAG	WORD	0	Detailed receive status
O	QLEN	INT	0	Length of received data
O	QMSG_ERR(opt.)	BOOL	0	1 = Message Error
O	QMSG_SUP(opt.)	BOOL	0	1 = Message suppression active
O	MSG_STAT(opt.)	WORD	0	ALARM_8P: STATUS Output
O	MSG_ACK(opt.)	WORD	0	ALARM_8P: ACKNOWLEDGE Output
O	QRACK_NO	INT	0	CP Rack-Number
O	QSLOT_NO	INT	0	CP Slot-Number
O	QBLOCKS	INT	0	Number of connected blocks
O	QTAGS	INT	0	Number of connected tags
O	QRCONNECT	WORD	16#00	Red. Communication output

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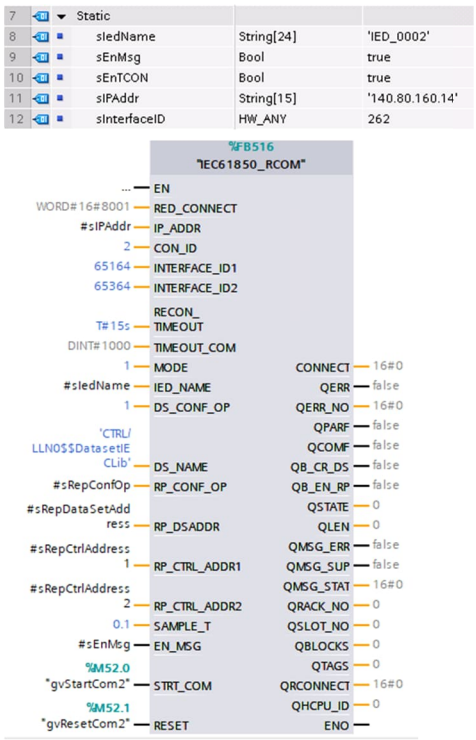
5.2 IEC61850_RCOM

5.2.1 Block screenshot

Figure 5-2 IEC61850_RCOM block S7-1500



5.2.2 Block description

IEC61850_RCOM block handles the IEC 61850 protocol. It manages all connected tag blocks and redundancy. It recognizes cyclic read tags, creates read requests and dispatches the values to the connected blocks. Furthermore, reports are dispatched to the dedicated blocks.

In the following, the most important inputs and outputs will be explained in detail.

RECON_TIMEOUT

The input RECON_TIMEOUT defines the time period after a connection reset will be performed in case of a connection interrupt. The shorter the duration is parameterized, the shorter the reconnection time will be after a redundancy switch over. If the parameterized duration is too short, no connection to the IED can be established.

RP_CTRL_ADDR1/2

RP_CTRL_ADDR1/2 specify a free Report Control block address to enable reporting. Normally, the corresponding Report Control blocks reside in the same tree part as the Report DataSet. E.g., 'CTRL/LLN0$$BR$$brcbA01'.

NOTE In case of DATASET mode and reporting mechanism, an additional report control block is required. Set an IEC 61850 path to report control block at input RP_CTRL_ADDR2 which is different to RP_CTRL_ADDR1.

Interface_ID1/2

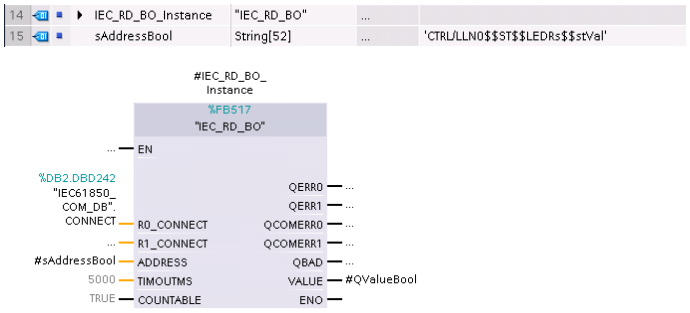
Hardware identifier of the local interface. Find those ID for both redundant PLCs in the properties of your communication module.

Input/Output description is equal to IEC61850_COM Block description. Please see chapter 5.1.

5.3 IEC_RD_BO (BOOL tag)

5.3.1 Block screenshot

Figure 5-3 IEC_RD_BO



5.3.2 Block description

IEC_RD_BO reads one Boolean tag cyclically.

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R0/1_CONNECT

R0_CONNECT input has to be connected to the IEC61850_COM block CONNECT output.

ADDRESS

The address for the tag has to be configured with the input ADDRESS. The address has to be entered as an IEC 61850 address string including the IEC 61850 objects attribute name.

NOTE The additional character “$” has to be replaced with “$$” in STEP 7

NOTE The IEC 61850 address strings can also be generated and copied via the StatCon configuration tool.

The function block outputs can be connected with other SIMATIC S7 blocks.

Example for an address: “CTRL/LLN0$$ST$$LEDRs$$stVal”.

TIMOUTMS

TIMOUTMS specifies the time in ms after the quality output QBAD changes to true, if there is no actualization of the value.

QERR0

QERR0 is set, if the connection to the IEC61850_COM block cannot be found or is faulty.

QCOMERR0

QCOMERR0 is set if the IEC 61850 communication handled by the IEC61850_COM is not working properly. IEC61850_COM: QSTATE != ZYKLCOM.

QBAD

QBAD is set if the value is not valid anymore.

Possible reasons are:

- No connection to any IEC61850_COM block
- No IEC 61850 communication running
- Address string not set properly; value was not updated for time TIMOUTMS

VALUE

VALUE represents the actual BOOL value addressed through IEC61850_COM IED_NAME and IEC_RD_BO ADDRESS string.

5.3.3 Called blocks

Table 5-5 IEC_RD_BO called blocks

Declaration/Block number	Declaration/Block name
UDT3	BST_BOOL
UDT8	LINK_INFO

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Declaration/Block number	Declaration/Block name
FC10	LEN
FC21	LEN
SFC64	TIME_TCK

5.3.4 I/O description

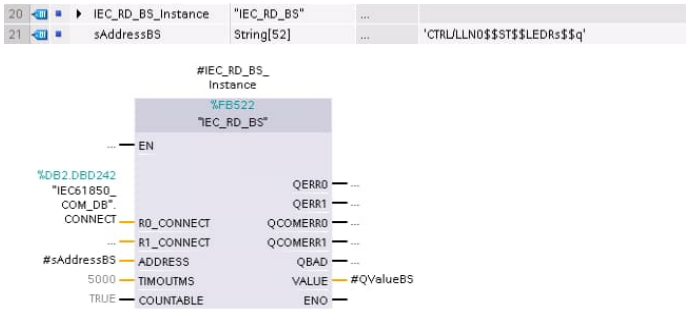
Table 5-6 IEC_RD_BO I/O description

I/O	I/O Name	Type	I/O Default	Comment
I	R0_CONNECT	ANY(Struct)		Connection to IEC61850_COM block DB
I	ADDRESS	STRING[52]		IEC 61850 tag address
I	TIMEOUTS	INT	5000	Timeout in ms
I	COUNTABLE	BOOL	1	Internal value
O	QERR0	BOOL	1	1 = Connection to IEC61850_COM block 0 faulty
O	QCOMERR0	BOOL	1	Communication IEC61850_COM block 0 not ok
O	QBAD	BOOL	1	0 = Data valid
O	VALUE	BOOL	0	Addressed value as BOOL

5.4 IEC_RD_BS (BITSTRING tag)

5.4.1 Block screenshot

Figure 5-4 IEC_RD_BS



5.4.2 Block description

IEC_RD_BS reads one Bitstring tag cyclically. The Bitstring length is limited to 4 Bytes. Bitstrings with a length bigger than 4 bytes cannot be parsed.

Input/Output description is equal to IEC_RD_BO Block description. Please see chapter 5.3.2.

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5.4.3 Called blocks

Table 5-7 IEC_RD_BS called blocks

Declaration/Block number	Declaration/Block name
UDT15	BST_BSTR
UDT8	LINK_INFO
FC10	EQ_STRING
FC21	LEN
SFC20	BLKMOV
SFC64	TIME_TCK

5.4.4 I/O description

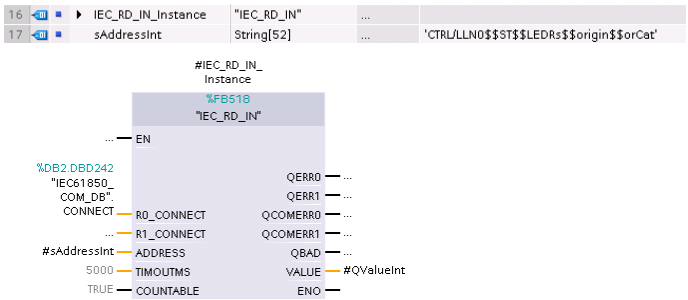
Table 5-8 IEC_RD_BS I/O description

I/O	I/O Name	Type	I/O Default	Comment
I	R0_CONNECT	ANY(Struct)		Connection to IEC61850_COM block DB
I	ADDRESS	STRING[52]		IEC 61850 tag address
I	TIMEOUTS	INT	5000	Timeout in ms
I	COUNTABLE	BOOL	1	Internal value
O	QERR0	BOOL	1	1 = Connection to IEC61850_COM block 0 faulty
O	QCOMERR0	BOOL	1	Communication IEC61850_COM block 0 not ok
O	QBAD	BOOL	1	0 = Data valid
O	VALUE	DWORD	0	Addressed value as BITSTRING

5.5 IEC_RD_IN (INTEGER tag)

5.5.1 Block screenshot

Figure 5-5 IEC_RD_IN



5.5.2 Block description

IEC_RD_IN reads one DINT tag cyclically. The Integer size is 32 bit (4byte).

Input/Output description is equal to the IEC_RD_BO Block description. Please see chapter 5.3.2.

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5.5.3 Called blocks

Table 5-9 IEC_RD_IN called blocks

Declaration/Block number	Declaration/Block name
UDT4	BST_INT
UDT8	LINK_INFO
FC10	EQ_STRING
FC21	LEN
SFC20	BLKMOV
SFC64	TIME_TCK

5.5.4 I/O description

Table 5-10 IEC_RD_IN I/O description

I/O	I/O Name	Type	I/O Default	Comment
I	R0_CONNECT	ANY(Struct)		Connection to IEC61850_COM block DB
I	ADDRESS	STRING[52]		IEC 61850 tag address
I	TIMEOUTS	INT	5000	Timeout in ms
I	COUNTABLE	BOOL	1	Internal value
O	QERR0	BOOL	1	1 = Connection to IEC61850_COM block 0 faulty
O	QCOMERR0	BOOL	1	Communication IEC61850_COM block 0 not ok
O	QBAD	BOOL	1	0 = Data valid
O	VALUE	DINT	0	Addressed value as Integer (DINT)

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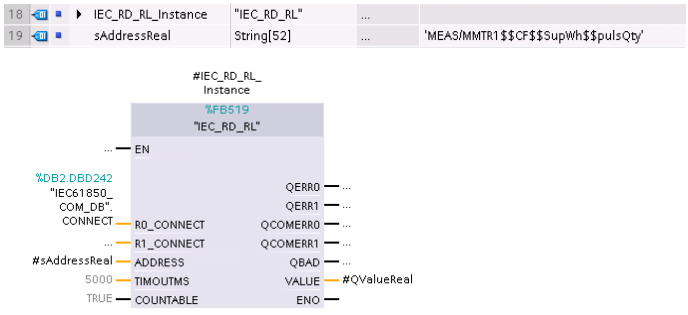
5.6 IEC_RD_RL (REAL tag)

5.6.1 Block screenshot

Figure 5-6 IEC_RD_RL



5.6.2 Block description

IEC_RD_RL reads one REAL tag cyclically. The Floating point value size is 32 bit (4byte).

Input/Output description is equal to IEC_RD_BO Block description. Please see chapter 5.3.2.

5.6.3 Called blocks

Table 5-11 IEC_RD_RL called blocks

Declaration/Block number	Declaration/Block name
UDT5	BST_REAL
UDT8	LINK_INFO
FC10	EQ_STRING
FC21	LEN
SFC20	BLKMOV
SFC64	TIME_TCK

5.6.4 I/O description

Table 5-12 IEC_RD_RL I/O description

I/O	I/O Name	Type	I/O Default	Comment
I	R0_CONNECT	ANY(Struct)		Connection to IEC61850_COM block DB
I	ADDRESS	STRING[52]		IEC 61850 tag address
I	TIMEOUTS	INT	5000	Timeout in ms
I	COUNTABLE	BOOL	1	Internal value
O	QERR0	BOOL	1	1 = Connection to IEC61850_COM block 0 faulty
O	QCOMERR0	BOOL	1	Communication IEC61850_COM block 0 not ok
O	QBAD	BOOL	1	0 = Data valid
O	VALUE	REAL	0	Addressed value as Floating point value (REAL)

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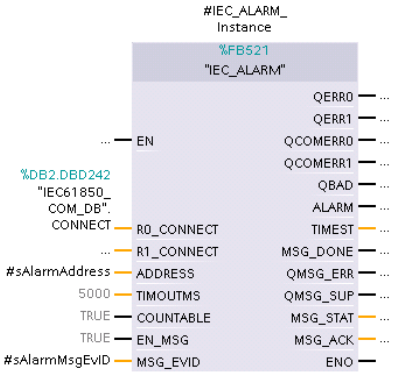
5.7 IEC_ALARM (BOOL tag with timestamp)

5.7.1 Block screenshot

Figure 5-7 IEC_ALARM



5.7.2 Block description

IEC_ALARM reads one BOOL value cyclically with its timestamp, which is updated if the variable changes.

NOTE This block is not supported by S7-300 CPUs.

NOTE The IEC 61850 address strings can also be generated and copied via the StatCon configuration tool. Example for an address: “CTRL/LLN0$$ST$$LEDRs”

NOTE The address has to be set without the IEC 61850 object’s attribute name, only the IEC 61850 object name has to be set.

EN_MSG

EN_MSG enables Alarming in WinCC. Special messages can be specified.

Further Input/Output description is equal to the IEC_RD_BO Block description. Please see chapter 5.3.2.

5.7.3 Called blocks

Table 5-13 IEC_ALARM called blocks

Declaration/Block number	Declaration/Block name
FB530	UTCcalc
SFB35	ALARM_8P
UDT3	BST_BOOL
UDT8	LINK_INFO
FC10	EQ_STRING
FC21	LEN
SFC20	BLKMOV
SFC64	TIME_TCK

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5.7.4 I/O description

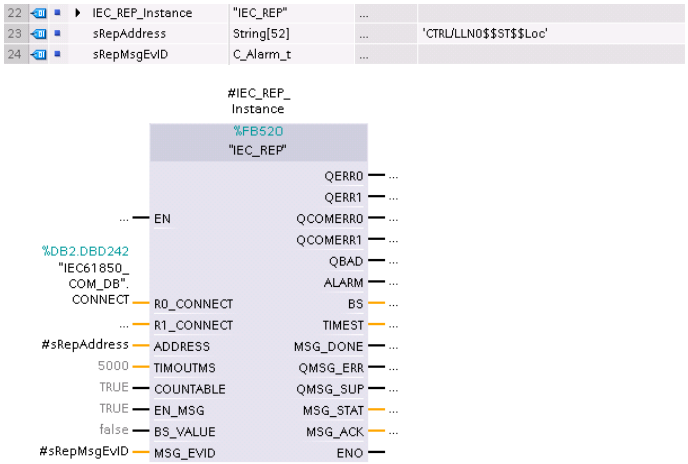
Table 5-14 IEC_ALARM I/O description

I/O	I/O Name	Type	I/O Default	Comment
I	R0_CONNECT	ANY(Struct)		Connection to IEC61850_COM block DB
I	ADDRESS	BOOL	1	IEC 61850 tag address
I	TIMEOUTS	INT	5000	Timeout in milliseconds
I	COUNTABLE	BOOL	1	Internal value
I	EN_MSG			1 = enable alarming in WinCC
I	MSG_EVID	DWORD		Alarm_8 message ID
O	QERR0	BOOL	1	1 = Connection to IEC61850_COM block 0 faulty
O	QCOMERR0	BOOL	1	Communication IEC61850_COM block 0 not ok
O	QBAD	BOOL	1	0 = Data valid
O	ALARM	REAL	0	Alarm value (BOOL)
O	TIMEST	DT		Time Stamp of Value
O	MSG_DONE	BOOL	0	1 = ALARM_8 DONE
O	QMSG_ERR	BOOL	0	1 = ALARM_8 Error
O	QMSG_SUP	BOOL	0	1 = Message suppression active
O	MSG_STAT	WORD	0	ALARM_8P: STATUS Output
O	MSG_ACK	WORD	0	ALARM_8P: STATUS Output

5.8 IEC_REP (Report – BOOL tag with timestamp)

5.8.1 Block screenshot

Figure 5-8 IEC_REP



5.8.2 Block description

IEC_REP reads one BOOL value asynchronous via IEC 61850 Report mechanism with its timestamp.

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To use this Report block, the IEC 61850 device has to support the IEC 61850 service Report. Furthermore, a DataSet containing the tag (addressed with IEC_REP) has to exist in the device. The DataSet name and its address for Reporting have to be set in IEC61850_COM: RP_DSADDR. Furthermore, enabling Reporting has to be executed successfully. IEC61850_COM: QB_EN_RP has to be “0” after initialization.

ADDRESS

The address has to be set without the IEC 61850 object’s attribute name, only the IEC 61850 object name has to be set.

NOTE The IEC 61850 address strings can also be generated and copied via the StatCon configuration tool. Example for an address: “CTRL/LLN0$$ST$$LEDRs”

EN_MSG

EN_MSG enables Alarming in WinCC. Special messages can be specified.

Further Input/Output description is equal to IEC_RD_BO Block description. Please see chapter 5.3.2.

NOTE When adding two IEC_REP tag blocks with the same address, only the first IEC_REP tag will be updated. The library allows no duplicate IEC_REP blocks.

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5.8.3 Alarming

There two different messages being triggered, depending on the value data type (BOOL or BITSTRING). For both messages, the timestamps of the IEC 61850 report event (e.g., switch change time in IEC 61850 server device) are delivered to WinCC.

Table 5-15

Message no.	Block parameters	Default message text	Message class	Message no.
1	ALARM	Report Alarm Message 1	ALARM – high	1

5.8.4 Called blocks

Table 5-16 IEC_REP called blocks

Declaration/Block number	Declaration/Block name
UDT18	BST_REP
UDT8	LINK_INFO
FC10	EQ_STRING
FC21	LEN
SFC20	BLKMOV
SFC64	TIME_TCK

5.8.5 I/O description

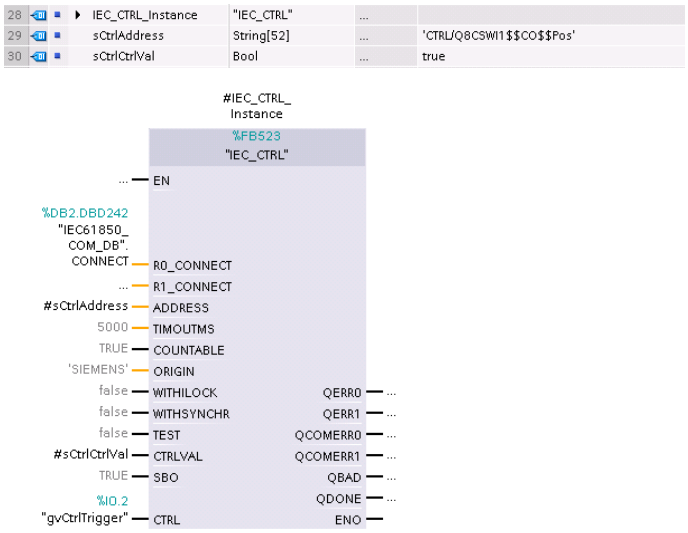
Table 5-17 IEC_REP I/O description

I/O	I/O Name	Type	I/O Default	Comment
I	R0_CONNECT	ANY(Struct)		Connection to IEC61850_COM block DB
I	ADDRESS	BOOL	1	IEC 61850 tag address
I	TIMEOUTS	INT	5000	Timeout in milliseconds
I	COUNTABLE	BOOL	1	Internal value
I	EN_MSG	BOOL	1	1 = enable alarming in WinCC
I	BS_VALUE	BOOL	0	1 = value with BITRSTING type
I	MSG_EVID	DWORD		Alarm_8 message ID
O	QERR0	BOOL	1	1 = Connection to IEC61850_COM block 0 faulty
O	QCOMERR0	BOOL	1	Communication IEC61850_COM block 0 not ok
O	QBAD	BOOL	1	0 = Data valid
O	ALARM	REAL	0	Alarm value (BOOL)
O	TIMEST	DT		Time Stamp of Value
O	MSG_DONE	BOOL	0	1 = ALARM_8 DONE
O	QMSG_ERR	BOOL	0	1 = ALARM_8 Error
O	QMSG_SUP	BOOL	0	1 = Message suppression active
O	MSG_STAT	WORD	0	ALARM_8P: STATUS Output
O	MSG_ACK	WORD	0	ALARM_8P: STATUS Output

5.9 IEC_CTRL

5.9.1 Block screenshot

Figure 5-9 IEC_CTRL



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5.9.2 Block description

IEC_CTRL controls an IEC 61850 device switch using the **IEC 61850 Control Service**. If CTRL is set to “1”, a Control command is executed with the Control value CTRLVAL.

ADDRESS

The address has to be set without the IEC 61850 object’s attribute name, only the IEC 61850 object name has to be set. Addresses for Control objects contain the function constraint “CO”.

NOTE The IEC 61850 address strings can also be generated and copied via the StatCon configuration tool. Example for an address: “CTRL/LLN0$$**CO**$$LEDRs”

ORIGIN

Specify the command source (Actor). This string cannot be empty. Default value is “SIEMENS”.

WITHILOC

If WITHILOC is set before executing control command, an Interlock check is done in the device.

WITHSYNC

If WITHSYNC is set before executing control command, a Synchro check is done in the device.

TEST

If TEST is set, the switch command is only for testing, real switching is not executed.

CTRLVAL

Specifies the Command value: “0” stands for close, “1” represents open.

SBO

Specifies if “Select before Operate” should be used. If “Select before Operate” is selected, a “Select” telegram is sent to the IEC 61850 device first and after acknowledging, a second “Operate” telegram is sent to control the switch. If SBO is disabled, only an “Operate” telegram is sent to the device.

QBAD

If the DONE bit is not raised up for time TIMOUT, QBAD gets “1”, else QBAD equals “0”.

DONE

If the switch execution was successful, the DONE bit is raised up.

Further Input/Output description is equal to IEC_RD_BO Block description. Please see chapter 5.3.2.

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5.9.3 Called blocks

Table 5-18 IEC_CTRL called blocks

Declaration/Block number	Declaration/Block name
UDT6	BST_CTRL
UDT8	LINK_INFO
FC10	EQ_STRING
FC21	LEN
SFC20	BLKMOV
SFC64	TIME_TCK

5.9.4 I/O description

Table 5-19 IEC_CTRL I/O description

I/O	I/O Name	Type	I/O Default	Comment
I	R0_CONNECT	ANY(Struct)		Connection to IEC61850_COM block DB
I	ADDRESS	BOOL	1	IEC 61850 tag address
I	TIMEOUTS	INT	5000	Timeout in milliseconds
I	COUNTABLE	BOOL	1	Internal value
I	ORIGIN	STRING[52]		Actor name, control source
I	WITHILOCK			1 = enables Interlock check
I	WITHSYNCHR			1 = enables Synchro check
I	TEST			Only test switch control command
I	CTRLVAL			Switch command 1: open 0: close
I	SBO			1: Select before operate 0: only operate
IO	CTRL	BOOL		Control command trigger, is reset automatically
O	QERR0	BOOL	1	1 = Connection to IEC61850_COM block 0 faulty
O	QCOMERR0	BOOL	1	Communication IEC61850_COM block 0 not ok
O	QBAD	BOOL	1	0: QDONE raised up after CTRL = 1 1: QDONE did not raise up after CTRL = 1
O	QDONE	REAL	0	Switch operation executed successfully

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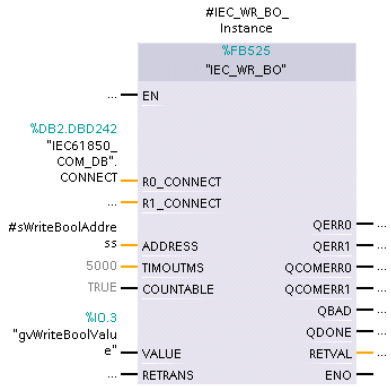
5.10 IEC_WR_BO

5.10.1 Block screenshot

Figure 5-10 IEC_WR_BO



5.10.2 Block description

With the IEC_WR_BO block a Boolean variable can be written to an IEC 61850 Server Device. This block can be used for example to write substitution values.

R0/1_CONNECT

R0_CONNECT input has to be connected to the IEC61850_COM block CONNECT output.

ADDRESS

The address for the tag has to be configured with the input ADDRESS. The address has to be entered as an IEC 61850 address string including the IEC 61850 object's attribute name.

NOTE The additional character "$" has to be replaced with "$$" in STEP 7

NOTE The IEC 61850 address strings can also be generated and copied via the StatCon configuration tool. Example for an address: "CTRL/LLN0$$ST$$LEDRs$$stVal".

TIMOUTMS

TIMOUTMS specifies the time in ms after the output QBAD changes to true, if the IEC 61850 device does not respond with a positive acknowledge in between.

VALUE

Represents the Boolean value which should be written to the IEC 61850 device. Write is performed on value change.

RETRANS

If RETRANS is set to "TRUE", the current value will be retransmitted. Input resets automatically to "FALSE".

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QERR0

QERR0 is set if the connection to the IEC61850_COM block cannot be found or is faulty.

QCOMERR0

QCOMERR0 is set if the IEC 61850 communication the IEC61850_COM handles is not working properly. IEC61850_COM: QSTATE != ZYKLCOM.

QBAD

QBAD is set if the value is not valid anymore.

Possible reasons are:

- No connection to any IEC61850_COM block
- No IEC 61850 communication running
- Address string not set properly, value was not written successfully in between specified timeout
- Access rights: no permission for writing value / value cannot be overwritten

DONE

Done will be set to TRUE, after transmission of value

RETVAL

RETVAL shows the IEC 61850 Write return value.

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5.10.3 Called blocks

Table 5-20 IEC_WR_BO called blocks

Declaration/Block number	Declaration/Block name
UDT3	BST_BOOL
UDT8	LINK_INFO
FC10	EQ_STRING
FC21	LEN
SFC20	BLKMOV
SFC64	TIME_TCK

5.10.4 I/O description

Table 5-21 IEC_WR_BO I/O description

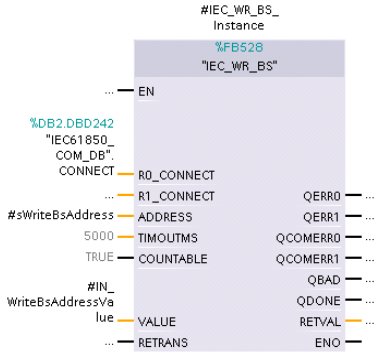
I/O	I/O Name	Type	I/O Default	Comment
I	R0_CONNECT	ANY(Struct)		Connection to IEC61850_COM block DB
I	ADDRESS	STRING[52]		IEC 61850 tag address
I	TIMEOUTS	INT	5000	Timeout in ms
I	COUNTABLE	BOOL	1	Internal value
I	VALUE	BOOL	1	Tag value to be written in device
I	RETRANS	BOOL	1	Retransmission of value

I/O	I/O Name	Type	I/O Default	Comment
O	QERR0	BOOL	1	1 = Connection to IEC61850_COM block 0 faulty
O	QCOMERR0	BOOL	1	Communication IEC61850_COM block 0 not ok
O	QBAD	BOOL	1	0 = Data valid
O	QDONE	BOOL	0	Addressed value as BITSTRING
O	RETVAL	BYTE	0	Return code

5.11 IEC_WR_BS

5.11.1 Block screenshot

Figure 5-11 IEC_WR_BS



5.11.2 Block description

With the IEC_WR_BS block a Bitstring variable can be written in an IEC 61850 Server Device. This block can be used for example to write substitution values.

Input/Output description is equal to the IEC_WR_BO Block description. Please see chapter 5.10.2.

5.11.3 Called blocks

Table 5-22 IEC_WR_BS called blocks

Declaration/Block number	Declaration/Block name
UDT15	BST_BITSTRING
UDT8	LINK_INFO
FC10	EQ_STRING
FC21	LEN
SFC20	BLKMOV
SFC64	TIME_TCK

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5.11.4 I/O description

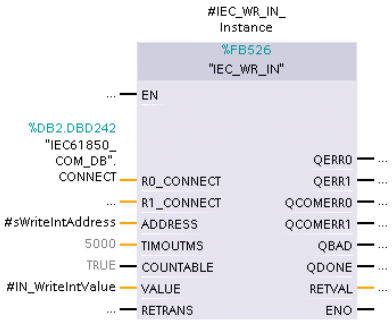
Table 5-23 IEC_WR_BS I/O description

I/O	I/O Name	Type	I/O Default	Comment
I	R0_CONNECT	ANY(Struct)		Connection to IEC61850_COM block DB
I	ADDRESS	STRING[52]		IEC 61850 tag address
I	TIMEOUTS	INT	5000	Timeout in ms
I	COUNTABLE	BOOL	1	Internal value
I	VALUE	DWORD	1	Tag value to be written in device
I	RETRANS	BOOL	1	Retransmission of value
O	QERR0	BOOL	1	1 = Connection to IEC61850_COM block 0 faulty
O	QCOMERR0	BOOL	1	Communication IEC61850_COM block 0 not ok
O	QBAD	BOOL	1	0 = Data valid
O	QDONE	BOOL	0	Addressed value as BITSTRING
O	RETVAL	BYTE	0	Return code

5.12 IEC_WR_IN

5.12.1 Block screenshot

Figure 5-12 IEC_WR_IN



5.12.2 Block description

With the IEC_WR_IN block, an Integer variable can be written in an IEC 61850 Server Device. This block can be used for example to write substitution values.

Input/Output description is equal to IEC_WR_BO Block description. Please see chapter 5.10.2.

5.12.3 Called blocks

Table 5-24 IEC_WR_IN called blocks

Declaration/Block number	Declaration/Block name
UDT4	BST_INT
UDT8	LINK_INFO
FC10	EQ_STRING

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Declaration/Block number	Declaration/Block name
FC21	LEN
SFC20	BLKMOV
SFC64	TIME_TCK

5.12.4 I/O description

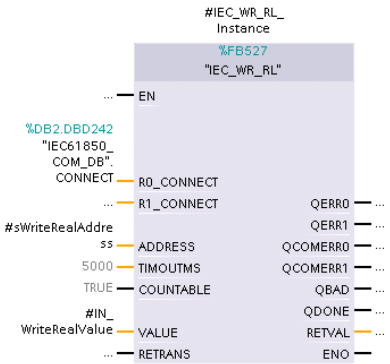
Table 5-25 IEC_WR_IN I/O description

I/O	I/O Name	Type	I/O Default	Comment
I	R0_CONNECT	ANY(Struct)		Connection to IEC61850_COM block DB
I	ADDRESS	STRING[52]		IEC 61850 tag address
I	TIMEOUTS	INT	5000	Timeout in ms
I	COUNTABLE	BOOL	1	Internal value
I	VALUE	DINT	1	Tag value to be written in device
I	RETRANS	BOOL	1	Retransmission of value
O	QERR0	BOOL	1	1 = Connection to IEC61850_COM block 0 faulty
O	QCOMERR0	BOOL	1	Communication IEC61850_COM block 0 not ok
O	QBAD	BOOL	1	0 = Data valid
O	QDONE	BOOL	0	Addressed value as BITSTRING
O	RETVAL	BYTE	0	Return code

5.13 IEC_WR_RL

5.13.1 Block screenshot

Figure 5-13 IEC_WR_RL



5.13.2 Block description

With the IEC_WR_RL block, a Real variable can be written in an IEC 61850 Server Device. This block can be used for example to write substitution values.

Input/Output description is equal to IEC_WR_BO Block description. Please see chapter 5.10.2.

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5.13.3 Called blocks

Table 5-26 IEC_WR_RL called blocks

Declaration/Block number	Declaration/Block name
UDT5	BST_INT
UDT8	LINK_INFO
FC10	EQ_STRING
FC21	LEN
SFC20	BLKMOV
SFC64	TIME_TCK

5.13.4 I/O description

Table 5-27 IEC_WR_RL I/O description

I/O	I/O Name	Type	I/O Default	Comment
I	R0_CONNECT	ANY(Struct)		Connection to IEC61850_COM block DB
I	ADDRESS	STRING[52]		IEC 61850 tag address
I	TIMEOUTS	INT	5000	Timeout in ms
I	COUNTABLE	BOOL	1	Internal value
I	VALUE	REAL	1	Tag value to be written in device
I	RETRANS	BOOL	1	Retransmission of value
O	QERR0	BOOL	1	1 = Connection to IEC61850_COM block 0 faulty
O	QCOMERR0	BOOL	1	Communication IEC61850_COM block 0 not ok
O	QBAD	BOOL	1	0 = Data valid
O	QDONE	BOOL	0	Addressed value as BITSTRING
O	RETVAL	BYTE	0	Return code

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6 Troubleshooting

Table 6-1 Troubleshooting IEC 61850 communication

No	Problem	Possible Reason	Solution
1.	IEC61850_COM does not get into QSTATE “ZYKLCOM”	MODE: DATASET, some of the tag addresses are not valid	Change mode into LIST, to see which tags keep QBAD = “TRUE”. Check tag addresses with the IEC 61850 browser tool.
		MODE: DATASET, DataSet modifications are not supported with IEC 61850 device	Either check if static DataSet can be used. Set DS_CONF_OP to “FALSE” and ensure your tag block sequence is the same as your tag order in the existing DataSet. Another possibility is to use “LIST” mode instead of DATASET mode.
		TIMEOUT or SAMPLE_T are not set properly	Check the TIMEOUT value. It’s the time the block waits for a successful response to its requests. It should be at minimum 1000 ms. Running in LIST mode it should be at minimum 2000 ms. Check SAMPLE_T. It should represent the current scan time / 100.
		IEC61850 _COM block is placed in more than one cyclic OBs	Ensure the IEC61850_COM block is placed only in one OB (e.g., OB35).
2.	IEC_RD_XX tag QBAD = 1	Invalid IEC 61850 address string	Check the address of your tag with the IEC 61850 browser. Remember that in Step 7, the additional sign “$” has to be replaced with “$$”. Further keep in mind, for IEC_ALARM, IEC_REPORT and IEC_CTRL only the address including the IEC 61850 object name has to be set. For all others the IEC 61850 attribute has to be added to the address.
		IEC 61850 Communication is not established	Check the IEC61850_COM block, if running in QSTATE = “ZYKLCOM”. If not, check its parameters.
		IEC61850_COM IED_NAME does not equal IEC 61850 device name	Check IED name of IEC 61850 device.
3.	IEC61850_COM QBLOCKS and QTAGS output does not fit to tag configuration	No RESET executed	Changes to the tag configuration, like address change, adding tag blocks, removing tag blocks are taken over with executing a RESET. Execute a RESET.

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No	Problem	Possible Reason	Solution
4.	PLC Scan time exceeded	Tag blocks are not executed in the optimal OB	To get a better performance of the PLC system, the tag blocks can be put in a lower numbered OB (e.g., OB34, OB33, OB32) with bigger scan times (e.g., 200 ms, 500 ms, 1 s). With this method you can optimize your PLC system.
5.	Reporting does not work, no WinCC messages	WinCC settings are not correct	Please check, if your OS is updated and works with your PLC program. Check if all connections to the PLC are established and working. IEC_REP block should update the timestamp after the report was generated. (Compare IEC_REP timestamp with tag timestamp get by IEC 61850 browser).
		RP_EN_QB is set to “1”	Something failed enabling Reporting with the Report Control block. Check if your RP_DS_ADDR0/1 match with DataSet address get by IEC 61850 browser.
		Reporting was not activated with DIGSI System Configurator (using a SIPROTEC)	Please follow up the procedure described in Appendix A.1.1 Report configuration with DIGSI if using a SIPROTEC device. If using a different device, follow up the manual instructions to add a Report application.
6.	“ZYKLCOM” state is reached, but IEC61850_COM block does not keep this state; communication gets instable.	IEC61850_COM TIMEOUT to small	Increase TIMEOUT value.

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7 Appendix

7.1 Service Agreement

Figure 7-1 – Service Agreement (1)

1. General

This letter was machine-generated and is valid without signature.

Unless this Agreement contains contrary or more specialized provisions, our General Terms and Conditions for Consulting Services (Germany) shall apply in their current version. Please understand that for processing reasons we must reject orders placed by you that refer to your own purchasing conditions.

Your Agreement Number is: **JJJJMM_ordernumber**

The contract period starts from the delivery date of the *IEC 61850 MMS Client AS Library* software package.

The term of the Agreement is 5 years.

The mentioned agreement number is also considered as license number for the delivered software package.

2. Scope of service

During the contract period, we grant you the full software maintenance service to the delivered software package to ensure serviceability.

That includes:

- troubleshooting
- updates / patches
- migrations of the software to higher versions of the target system within the PCS 7 or TIA Portal product line and providing the corresponding updates for the software package on request.

Technical functional extensions for the software package are excluded and not part of this service agreement.

In addition, you will receive technical support to functional themes and integration of the software components during the duration of this service agreement.

Our central technical support organization is supporting in terms of

- general technical questions
- system handling
- troubleshooting
- updates / patches

for all delivered components of the system.

Support is offered by phone or email.

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Figure 7-2 – Service Agreement (2)

Support processing is limited to 2h per support request. There is no limitation in terms of amount of cases. In cases were the processing exceeds the 2h limitation it is possible to request extended support. Information´s to our extended support you will receive by our technical support on request.

Our technical support organization is located at

Siemens AG
DI CS PA PFM
Siemensallee 84
76187 Karlsruhe, Deutschland
Phone: +49 (0)721 595 7522
Email: function.blocks.industry@siemens.com
Availability: Monday–Friday
except for national and regional holidays in Germany:
8 a.m. to 5 p.m. CET/CEST
Languages: German and English

For fast and efficient case handling, please have your PCIS service agreement number available.

3. Spare Parts / Software Updates

Software updates which are part of this agreement, can be requested via our technical support.

Technical functional extensions of the software are excluded and not part of this service agreement but can be requested by our technical support.

The delivery time of software updates is appr. 8 weeks after the problem has been evaluated by our technical support and / or our sub-suppliers.

4. Product sheet

Description	Version

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7.2 Service and support

Industry Online Support

Do you have any questions or need assistance?

Siemens Industry Online Support offers round the clock access to our entire service and support know-how and portfolio.

The Industry Online Support is the central address for information about our products, solutions and services.

Product information, manuals, downloads, FAQs, application examples and videos – all information is accessible with just a few mouse clicks:

support.industry.siemens.com

Technical Support

The Technical Support of Siemens Industry provides you fast and competent support regarding all technical queries with numerous tailor-made offers – ranging from basic support to individual support contracts.

Please send queries to Technical Support via Web form:

siemens.com/SupportRequest

SITRAIN – Digital Industry Academy

We support you with our globally available training courses for industry with practical experience, innovative learning methods and a concept that's tailored to the customer's specific needs.

For more information on our offered trainings and courses, as well as their locations and dates, refer to our web page:

siemens.com/sitrain

Service offer

Our range of services includes the following:

- Plant data services
- Spare parts services
- Repair services
- On-site and maintenance services
- Retrofitting and modernization services
- Service programs and contracts

You can find detailed information on our range of services in the service catalog web page:

support.industry.siemens.com/cs/sc

Industry Online Support app

You will receive optimum support wherever you are with the "Siemens Industry Online Support" app. The app is available for iOS and Android:

support.industry.siemens.com/cs/ww/en/sc/2067

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7.3 Industry Mall

The Siemens Industry Mall is the platform on which the entire siemens Industry product portfolio is accessible. From the selection of products to the order and the delivery tracking, the Industry Mall enables the complete purchasing processing – directly and independently of time and location:
mall.industry.siemens.com

7.4 Related literature

Table 7-1

	Topic
\1\	Siemens Industry Online Support https://support.industry.siemens.com
\2\	Download page of this entry https://support.industry.siemens.com/cs/ww/en/view/Entry ID
\3\	

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