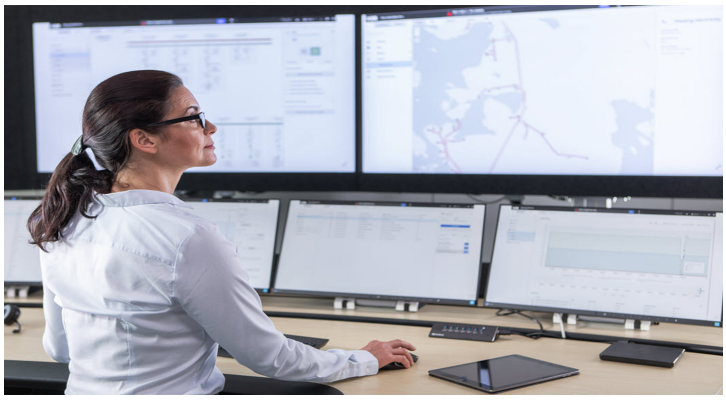
GRID AUTOMATION PRODUCTS

MicroSCADA X SYS600 10.2

IEC 61850 Master Protocol (OPC)



Document ID: 1MRK 511 495-UEN
Issued: March 2021
Revision: A
Product version: 10.2

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Section 1 About this manual

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1.2 General

This manual provides thorough information on the IEC 61850 Master Protocol (OPC) (later in this manual IEC 61850 OPC Server) and the central concepts related to it. It also contains instructions on how to configure IEC 61850 OPC Server related objects and peroform basic operation procedures.

Information in this user’s guide is intended for application engineers who need to configure the IEC 61850 OPC Server.

As a prerequisite, the user should understand the basic principles and the IEC 61850 technology and standard.

This user's guide is divided into following sections:

1.2.1 Introduction

This section gives an overview of the IEC 61850 OPC Server and its features.

1.2.2 Configuration

This section contains an overview of configuration. Instructions are given on how to configure IEC 61850 OPC Server related objects and the model of a substation or system.

1.2.3 Operation

This section gives instructions on how to monitor and control the condition of connections in the IEC 61850 network.

1.2.4 Technical reference

This section describes the IEC 61850 data modeling. This section also contains attributes and a list of status codes.

1.3 Document conventions

The following conventions are used for the presentation of material:

- The words in the names of screen elements (for example, the title in the title bar of a window, the label for a field of a dialog box) are initially capitalized.
- Capital letters are used for the name of a keyboard key if it is labeled on the keyboard. For example, the ENTER key.
- Lowercase letters are used for the name of a keyboard key that is not labeled on the keyboard. For example, the space bar and the comma key.
- Press CTRL+C indicates that the CTRL key must be held down while pressing the C key (to copy a selected object in this case).
- Press ESC E C indicates that each key is pressed and released in sequence (to copy a selected object in this case).
- The names of push and toggle buttons are boldfaced. For example, click **OK**.
- The names of menus and menu items are boldfaced. For example, the **File** menu.
    - The following convention is used for menu operations: **MenuName > MenuItem > CascadedMenuItem**. For example: select **File > New > Type**.
    - **Start** menu always refers to the **Start** menu on the Windows taskbar.
- System prompts/messages and user responses/input are shown in the Courier font. For example, if an entered value is out of range, the following message is displayed:

Entered value is not valid. The value must be 0 to 30.

- If the string MIF349 needs to be entered in a field, it is shown as follows in the procedure: MIF349
- Variables are shown using lowercase letters:

sequence name

1.4 Use of symbols

This publication includes warning, caution and information symbols where appropriate to point out safety-related or other important information. It also includes tips to point out useful hints to the reader. The corresponding symbols should be interpreted as follows:

Warning icon indicates the presence of a hazard which could result in personal injury.

Caution icon indicates important information or a warning related to the concept discussed in the text. It might indicate the presence of a hazard, which could result in corruption of software or damage to equipment/property.

Information icon alerts the reader to relevant factors and conditions.

Tip icon indicates advice on, for example, how to design a project or how to use a certain function.

Although warning hazards are related to personal injury, and caution hazards are associated with equipment or property damage, it should be understood that operation of damaged equipment could, under certain operational conditions, result in degraded process performance leading to personal injury or death. Therefore, comply fully with all warnings and caution notices.

1.5 Terminology

The following is a list of terms associated with the IEC 61850 OPC Server that the user should be familiar with. The list contains terms that are unique to ABB or have a usage or definition that is different from standard industry usage.

Term	Description
Alarm	An abnormal state of a condition.
Alarms and Events; AE	An OPC service for providing information about alarms and events to OPC clients.
Data Access; DA	An OPC service for providing information about process data to OPC clients.
Data Object; DO	Part of a logical node object representing specific information, e.g., status or measurement. From an object-oriented point of view a data object is an instance of a class data object. DOs are normally used as transaction objects; i.e., they are data structures.
Data Set	The data set is the content basis for reporting and logging. The data set contains references to the data and data attribute values.
Device	A physical device that behaves as its own communication node in the network, e.g. protection relay.
Event	Change of process data or an OPC internal value. Normally, an event consists of value, quality and timestamp.
Intelligent Electronic Device	A physical IEC 61850 device that behaves as its own communication node in the IEC 61850 protocol.
Logical Device; LD	Representation of a group of functions. Each function is defined as a logical node. A physical device consists of one or several LDs.
Table continues on next page	

Term	Description
Logical Node; LN	The smallest part of a function that exchanges data. A LN is an object defined by its data and methods.
LON	A communication protocol developed by Echelon.
LON Application Guideline for substation automation; LAG	A proprietary method of ABB on top of the standard LON protocol.
OPC	Series of standard specifications aiming at open connectivity in industrial automation and the enterprise systems that support industry.
OPC item	Representation of a connection to the data source within the OPC server. An OPC item is identified by a string <object path>:<property name>. Associated with each OPC item are Value, Quality and Time Stamp.
Property	Named data item.
Report Control Block	The report control block controls the reporting processes for event data as they occur. The reporting process continues as long as the communication is available.
SPA	ABB proprietary communication protocol used in substation automation.
SPA device	Protection and/or Control Product supporting the SPA protocol version 2.5 or earlier.
System Configuration description Language; SCL	XML-based description language for configurations of electrical substation IEDs. Defined in IEC 61850 standard.

1.6 Abbreviations

The following is a list of abbreviations associated with the IEC 61850 OPC Server that the user should be familiar with. See also Section 1.5.

Abbreviation	Description
AE	Alarms and Events
ASDU	Application Service Data Unit
BRCB	Buffered Report Control Block
CDC	Common Data Class
CET	Communication Engineering Tool
DA	Data Access
DMCD	Data Message Code Definition
DO	Data Object
GW	Gateway, component connecting two communication networks together
HMI	Human Machine Interface
IEC	International Electrotechnical Commission
IED	Intelligent Electronic Device
LAG	LON Application Guideline for substation automation
LAN	Local Area Network
LD	Logical Device
LMK	LonMark interoperable device communicating in LonWorks network. In this document the term is used for devices that do not support the ABB LON/LAG communication.
LN	Logical Node
LSG	LON SPA Gateway
Table continues on next page	

Abbreviation	Description
NCC	Network Control Center
NV	Network Variable
OLE	Object Linking and Embedding
OPC	OLE for Process Control
P&C	Protection & Control
RTS	Request To Send
SA	Substation Automation
SAB600	Station Automation Builder 600
SCL	System Configuration description Language
SLD	Single Line Diagram
SNTP	Simple Network Time Protocol
SOAP	Simple Object Access Protocol
RCB	Report Control Block
URCB	Unbuffered Report Control Block
XML	eXtended Markup Language

1.7 Related documents

Name of the manual	Document ID
SYS600 10.2 System Configuration	1MRK 511 481-UEN
SYS600 10.2 IEC 61850 System Design	1MRK 511 475-UEN

1.8 Document history

Revision	Version number	Date	History
A	10.2	31.03.2021	New document for SYS600 10.2

Section 2 Introduction

2.1 Product overview

The IEC 61850 OPC Server enables OPC clients to access process data from IEC 61850 devices.

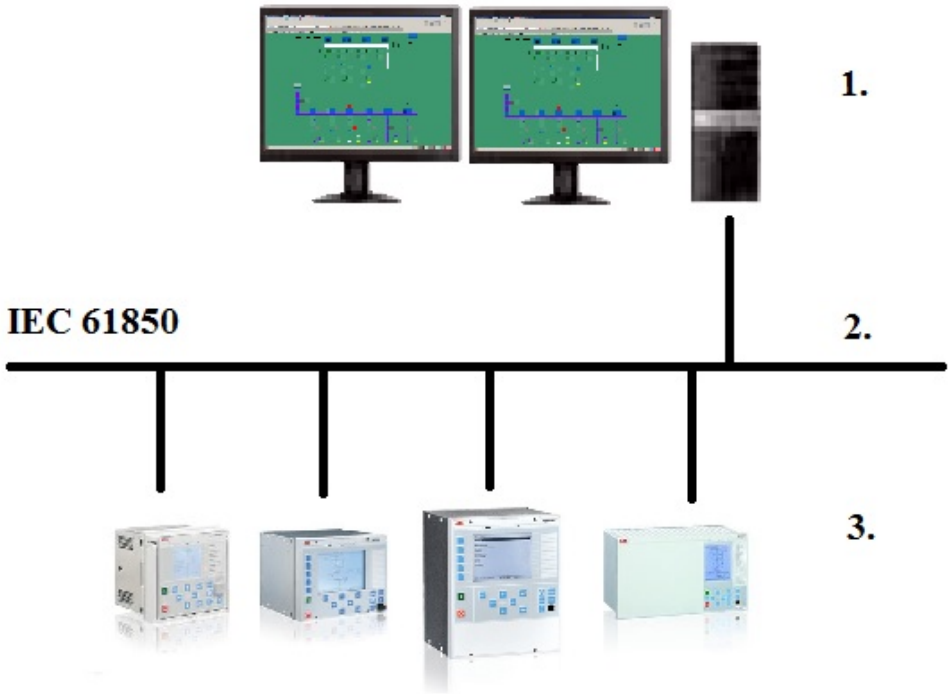

Figure 1: IEC 61850 OPC Server system overview

(1.) MicroSCADA X SYS600 with IEC 61850 OPC Server and Communication Engineering Tool (CET)

(2.) IEC 61850 network

(3.) Protection and control devices communicating through IEC 61850 protocol

The IEC 61850 OPC server is a part of the MicroSCADA X system (see Figure 1).

To create a common data interface between the OPC server and client, the process data is modeled using the IEC 61850 protocol. The IEC 61850 protocol is a set of specifications, which details layered substation communication architecture. The International Standard IEC 61850 has been prepared by IEC technical committee 57: Power system control and associated communications.

The IEC 61850 specifies usage of Manufacturing Message Specification (MMS, ISO 9506) over TCP/IP as communication between the IEC 61850 server and client (device/IEC 61850 OPC Server).

After the IEC 61850 OPC Server and other required components have been installed, the user can build and configure hierarchically structured models of a substation or a system for the IEC 61850 OPC Server using a Communication Engineering Tool (CET) configuration files and device.

The configuration data is stored in SCL (XML based) format. After the IEC 61850 OPC Server has been launched, it reads the configuration file and establishes communication with the IEC 61850 devices through the IEC 61850 protocol stack.

Configured IEC 61850 devices and their data are then exposed to OPC clients through an OPC Data Access (DA) server and device reported changes in data with DA subscription are reported to OPC clients.

2.2 IEC 61850 OPC Server features

The IEC 61850 OPC Server supports the following features:

- OPC Data Access v. 1.0/2.0
- OPC Alarms and Events specifications v. 1.10
- IEC 61850 data modeling
- IEC 61850 command services.
- IEC 61850 buffered and unbuffered reporting services
- IEC 61850 File Transfer
- IEC 61850 data objects:
  - SPS, DPS, INS, ENS, ACT, ACD, SEC, BCR, MV, CMV, SAV, WYE, DEL, SEQ, SPC, DPC, INC, ENC, BSC, ISC, APC, BAC, SPG, ING, ENG, ASG, CURVE, DPL, LPL, RSS, VSS, ORG, TSG, CUG, VSG, CST, CTS, BTS, UTS, LTS, OTS, GTS, MTS, NTS, STS
- System supervision:
  - IEC 61850 device communication
  - DuoDriver diagnostics
- Automatic Disturbance Recording upload using IEC 61850 file transfer or FTP
- SPA TCP
- SPA Parameter access (configured with Parameter Filtering Tool)
- Time synchronization:
  - The IEC 61850 OPC Server can act as an SNTP client and server for time synchronization. When the IEC 61850 OPC Server is configured for receiving time synchronization, it updates the operating system time of the PC.
- Multiple instance support

Section 3 Configuration

3.1 Overview of configuration

This section is a guide to the configuration tasks required before using the IEC 61850 OPC Server. For information on the IEC 61850 data modeling, refer to the respective standards and specifications.

Start CET to open and name a project.

The configuration work can be divided into two separate tasks:

1. Building an object tree
2. Configuring object properties

Build an object tree by adding objects to the object tree. Refer to Section 3.2.1.

When configuring OPC servers the following characters cannot be used in object names: \ ` ' ' #.

Table 1 describes the possible objects shown in the object tree. After the necessary objects have been added to the object tree in the Communication structure, they should be configured. Refer to Section 3.3.1.

Table 1: IEC 61850 OPC Server related objects

Object	Description
IEC 61850 OPC Server	Object representing the IEC 61850 OPC Server
Event Definitions	Object representing event definitions for IEC 61850 OPC Server diagnostics
IEC 61850 Subnetwork	Object representing a physical subnetwork. IEC 61850 OPC Server supports max. 16 subnetworks.
IEC 61850 Device (IEC 61850 IED)	Object representing a physical IEC 61850 protection and control device.
Attributes	Predefined object that contains items for controlling or retrieving status information for the parent object. The parent object can be the Server, a Subnetwork or a Device object.
Logical Device (LD)	Object representing a group of functions. Each function is defined as a logical node. A physical device consists of one or several LDs.
Logical Node (LN)	An object defined by its data and methods. LN is the smallest part of a function that exchanges data.
Data Object (DO)	A data object is an instance of one of the IEC 61850 Common Data Classes, for example single point status, measured value etc. Depending on the class, each data object has a set of attributes for monitoring and controlling the object, for instance value, quality and control.
Data Set (DS)	The data set is the content basis for reporting and logging. The data set contains references to the data and data attribute values.
Report Control Block (RCB)	The report control block controls the reporting process for event data as they occur. The reporting process continues as long as the communication is available.

3.2 Building object tree

3.2.1 General about building object tree

Before using the IEC 61850 OPC Server, the user needs to build and configure an object tree in CET to define the Communication structure.

Figure 2 is an example of how the object tree may look like after it has been built. The example represents the IEC 61850 OPC Server object and its child objects, such as subnetworks, devices and data objects. Indentation is used to indicate the parent-child relationship between the objects.

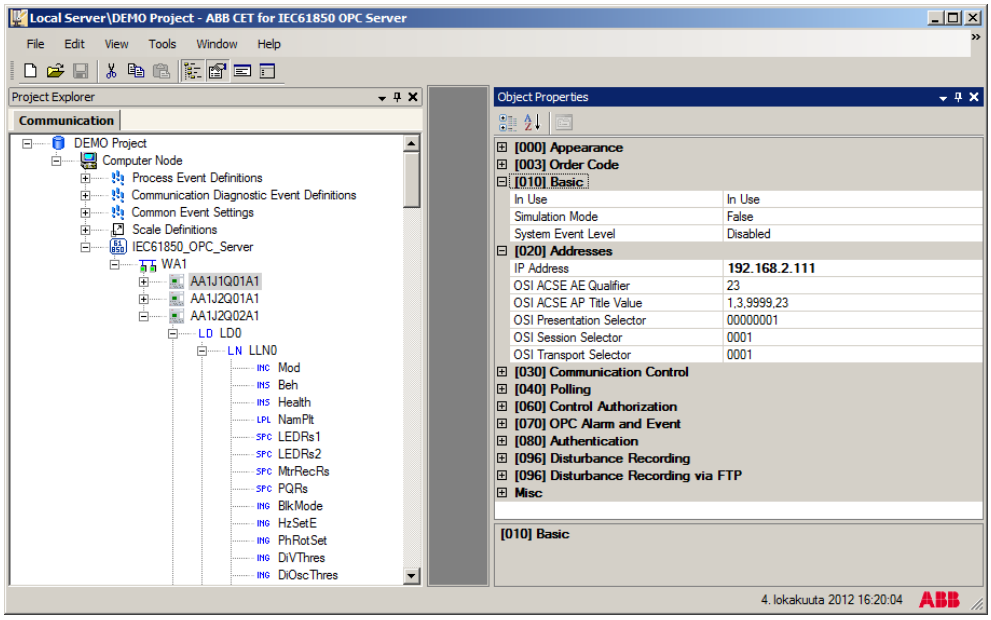

Figure 2: Example view of the Communication Engineering Tool

Add the objects in the following order:

1. Computer Node (MicroSCADA X computer)
2. IEC 61850 OPC Server
3. IEC 61850 Subnetwork
4. IEC 61850 Device (IEC 61850 IED)
5. Import devices configurations

3.2.2 Adding Computer Node object

To add a Computer Node object:

1. To start building the object tree, add a Computer Node object to the Communication structure by selecting the project name.
2. Right-click the project name and select **New/Communication/Computer Node**.

Continue building the object tree in the same way until all the necessary objects have been added to the current project (right-click the object and select **New/Communication/...**).

3.2.3 Adding IEC 61850 OPC Server object

After the Computer Node object has been successfully added, building the object tree can be continued by adding an IEC 61850 OPC Server object.

To add an IEC 61850 OPC Server object:

1. Select the Computer Node object in the Communication structure.
2. Right-click the Computer Node object.
3. Add an IEC 61850 OPC Server object.

By using the SCL Import function, it is possible to import configurations of an entire server or individual devices without having to insert them manually.

To open the SCL Import function:

1. Click the desired object.
2. Select **Tools/SCL Import**.

The user can import the whole communication structure under IEC 61850 OPC Server with new configurations from an existing file. This is done by using the SCL import function. Right-click the IEC 61850 OPC Server and select **SCL Import** from the shortcut menu. The possible file extensions for the import files are .scd, .sed or .xml.

To import a new configuration file:

1. Click **Select File**.
2. Browse for a new configuration file from the appearing dialog.
3. Select the file and click **Open**.
4. Select the OPC Server (or Subnetwork) to import from the drop-down list and click **Next**.
5. Select the import options. Click **Import**.

The new preconfigured objects appear in the object tree. If the configuration file is very large, the import may take time. To import a configuration file for a different OPC Server, close SCL Import, right-click the OPC Server, select **SCL Import** again, and repeat the steps above.

The following import options are available:

- **Filter DOs that don’t belong to DataSet**: This option limits the amount of data objects being imported to CET Project Explorer. If a data object does not belong to any data set, it is not imported. Some IEDs can provide huge amounts of data that is not reported, that is, not spontaneously updated. It does not filter data objects from the configuration of the IEC 61850 OPC Server. Import performance is enhanced by checking this option.
- **Overwrite existing descriptions**: This option overwrites all existing descriptions on objects affected by the import operation. Select this option only if it is certain that the importable file contains better descriptions than the current configuration.
- **Import protocol configuration (sAddr)**: Imports the protocol-specific information. If this option is selected, both the object tree and protocol configuration are done. If this is not selected, only the object tree structure is created.
- **Overwrite limit settings**: This option imports limit settings for IEC 61850 OPC Server limit supervision from IED configuration.
- **Check Report Control Blocks for Client Identity**: This option checks the imported IED configurations for reporting dedications. IEDs with no report control blocks dedicated for this OPC server are not imported. It uses the OPC Server name and the property Report Control Identity and compares them to all IED report control block client dedications. Import performance is enhanced by checking this option.
- **Check configuration revisions**: This option checks the imported IED configurations for revision changes. IEDs with no revision change are not imported. It compares the current

project revision attributes to imported configuration file revision information. Import performance is enhanced by checking this option.
- **Create Only IED Objects**: This option limits the Project Explorer to show imported elements down to IED level. Import performance is enhanced by checking this option.

3.2.4 Adding IEC 61850 Subnetwork objects

After the server object has been successfully added, building the object tree can be continued by adding IEC 61850 subnetwork objects.

To add an IEC 61850 subnetwork object:

1. Select an IEC 61850 OPC Server object.
2. Right-click the IEC 61850 OPC Server object.
3. Add an IEC 61850 subnetwork object.
4. Rename the new object if necessary.

3.2.5 Adding IEC 61850 IED objects

After adding a subnetwork, device objects can be added.

To add a device object:

1. Select a Subnetwork object.
2. Add an IEC 61850 Device (IEC 61850 IED) object.
3. Rename the new object. The names of the devices within an IEC 61850 network have to be unique.

With the SCL import function new objects can be imported with configurations from an existing file. Right-click the device and select **SCL Import** from the shortcut menu. The possible file extensions of the imported files are .icd, .cid, .scd, .iid, .sed or .xml.

To import a new configuration file:

1. Click **Select File**.
2. Browse for a new configuration file from the dialog box.
3. Select the file and click **Open**.
4. Select the IED and Accesspoint to import from the drop-down lists and click **Next**.
5. Click **Import**.

The new preconfigured objects appear in the object tree. If the configuration file is large, the import may take time. To import a configuration file for a different device, close SCL Import, right-click the device, select **SCL Import** again and repeat the steps above.

3.3 Configuring objects

3.3.1 Configuring object properties

After the objects have been added, the object properties need to be configured.

To configure an object:

1. Select an object in the object tree of the Communication structure.
   The object properties now appear in the **Object Properties** window, see Figure 3. The selected object is on the left and the available properties on the right.
2. Select a property to configure. Depending on the property value type, configuring is done either by:

- selecting a predefined value from a drop-down combo box, or
- entering a text string or a numerical value in a text field.

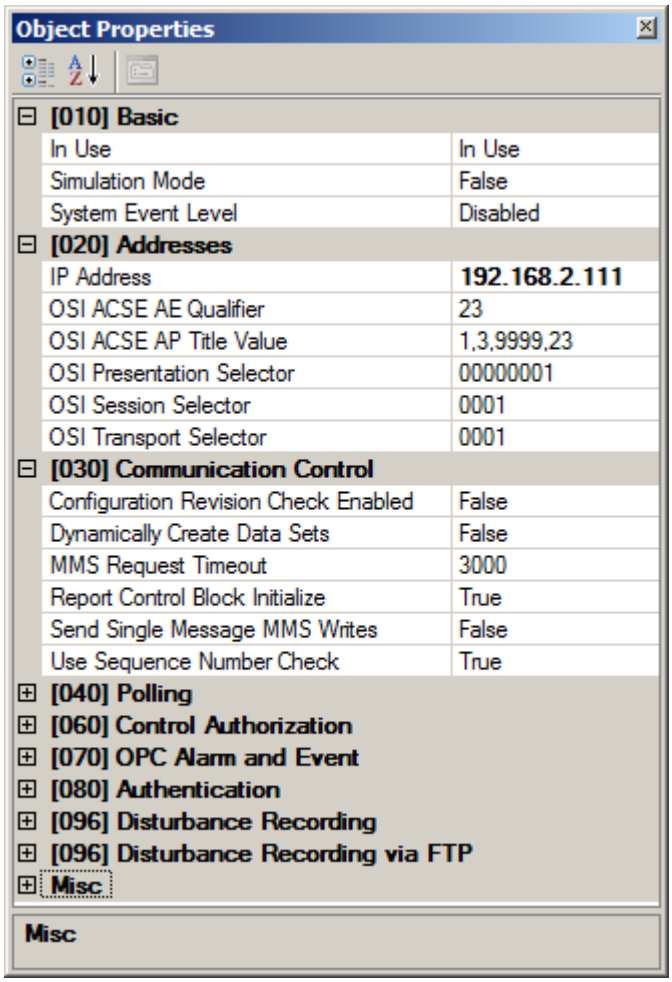

Figure 3: Example of object properties, IED Object Properties

The available properties for different objects are listed in the following subsections.

3.3.2 Configuring IEC 61850 OPC Server properties

Table 2 lists the configurable IEC 61850 OPC Server properties and their value ranges. The actual configuration by using CET is performed as described in Section 3.3.1.

Table 2: IEC 61850 OPC Server properties

Name	Value or Value range/ Default	Description
Basic		
AE Prog ID		Prog ID for OPC Alarm and Event Server (Automatically generated by management function)
DA Prog ID		Prog ID for OPC Data Access Server
SNTP Client		
1. Address for SNTP Server		IP address or node name for SNTP Server (Primary)

Table continues on next page

Name	Value or Value range/ Default	Description
1. Port Number	(1..65535) Default: 123	TCP/IP port number
1. Synchronization Interval	(0..3600) Default: 15	Time synchronization interval in seconds. If value is 0, no time synchronization will be done.
2. Address for SNTP Server		IP address or node name for SNTP Server
2. Port Number	(1...65535) Default: 123	TCP/IP port number
2. Synchronization Interval	(0..3600) Default: 15	Time synchronization interval in seconds. If value is 0, no time synchronization will be done.
3. Address for SNTP Server		IP address or node name for SNTP Server
3. Port Number	(1...65535) Default: 123	TCP/IP port number
3. Synchronization Interval	(0..3600) Default: 15	Time synchronization interval in seconds. If value is 0, no time synchronization will be done.
4. Address for SNTP Server		IP address or node name for SNTP Server
4. Port Number	(1...65535) Default: 123	TCP/IP port number
4. Synchronization Interval	(0..3600) Default: 15	Time synchronization interval in seconds. If value is 0, no time synchronization will be done.
Enable Time Synchronization Client	True False Default: False	Controls if time synchronization client is initially in use or not.
SNTP Server		
Enable Time Synchronization Server	True False Default: False	Controls if time synchronization server is initially in use or not.
Port Number For Time Synchronization Server	(1...65535) Default: 123	TCP/IP port number for the time synchronization server.
Communication Control		
Report Control Identity	Free string Default: Client1	Report Control Identity specifies, which report control block instance is used by the OPC Server. The value must match with the Report Client attribute under the Report Enabled attribute of the report control block to be used. To enable the IEC 61850 OPC Server to use the specific RCBs and therefore receive spontaneous events, the Report Control Identity field must match with one of the ReportClients under the Report Enabled object on devices RCB configuration. This dedicates a specific report control block instance from the device to be used by the IEC 61850 OPC Server. If the fields do not match, the configured report control block is discarded.

Table continues on next page

Name	Value or Value range/ Default	Description
Server Originator Category	Control operation issued from an operator using a client located at station level Control operation issued from an unknown location Control operation from a remote operator outside the substation (for example network control center) Default: Control operation issued from an operator using a client located at station level	Specifies the default originator category that is used for changing values and IEC 61850 control services. This can be overridden by OPC client for DPC control.
Server Originator Identification	Free string (max length 64 characters). For numeric values hex code can be used (starting with "0x", for example, 0xABB). Default: ABB	Specifies the default originator identification that is used for IEC 61850 control services.
System Event Level	Disabled Level 1 (main operation and errors) Level 2 (time synchronization errors) Level 3 (time synchronization done) Level 4 (reported local updates from devices) Level 5 (reported unconfigured updates from devices) Default: Disabled	Level of system event that is sent from the OPC Server. The number of events sent is cumulative, higher level also contains lower level events. System event level configuration at the OPC Server level overrides definitions at the subnetwork and device levels.

3.3.3 Configuring IEC 61850 Subnetwork properties

The IEC 61850 Subnetwork properties that can be configured and value ranges for them can be found in Table 3. The actual configuration by using CET is performed as described in Section 3.3.1.

Table 3: IEC 61850 Subnetwork properties

Name	Value or Value range/ Default	Description
Basic		
In Use	In Use Not In Use Default: In Use	Controls whether the device communication is initially in use or not.
Communication Port		
Communication port	ETH0 ETH1 Default: ETH0	LAN port used by the IEC 61850 protocol. Not used.
IP Address	127.0.0.1	IP Address for communication channel. Dotted decimal to be used. Not used.
Communication Control		
System Event Level	Disabled Level 1 (main operation and errors) Level 2 (time synchronization errors) Level 3 (time synchronization done) Level 4 (reported local updates from devices) Level 5 (reported unconfigured updates from devices) Default: Disabled	Level of system event that is sent from the OPC Server. The number of events sent is cumulative, higher level also contains lower level events. System event level configuration at the OPC Server level overrides definitions at the subnetwork and device levels.
TCP/IP Keepalive Time-out	(1..3600) Default: 15	TCP/IP Keepalive time-out in seconds.

3.3.4 Configuring IEC 61850 Device properties

Table 4 lists the configurable properties for IEC 61850 devices and value ranges for these properties. The actual configuration by using CET is performed as described in Section 3.3.1.

Each IEC 61850 node of the system must have a unique subnet or node address.

Table 4: IEC 61850 Device properties

Name	Value or Value range/ Default	Description
Basic		
In Use	In use Not in use Default: In use	Controls if the device communication is initially in use or not.
Simulation Mode	True False Default: False	Defines if the device is in simulation mode.
System Event Level	Level0=Disabled Level1=Level 1 (main operation, error replies, errors) Level2=Level 2 (information reports, OK replies, RCB initializing) Level3=Level 3 (sent requests (connect, read, write), transparent SPA messages) Level4=Level 4 (reported local updates) Level5=Level 5 (reported unconfigured updates)	Level of system events (OPC AE events) can be viewed with CET Diagnostic AE client for OPC Server or with an OPC AE client. The number of events sent is cumulative: higher level also contains lower level events. System event level configuration at subnetwork overrides definitions at device level. The same or higher event level must be set for Subnetwork as for IED. System events can be used for debugging and event flow monitoring. See: Table 3. Event level can be changed during the run time by using the Diagnostic events level attribute, see Section 5.3.4.
Addresses		
IP Address	127.0.0.1	IP address for communication in dotted decimal format.
OSI ACSE AE Qualifier	23	OSI ACSE AE Qualifier as defined in IEC 61850-8-1.
OSI ACSE AP Title Value	1,3,9999,23	OSI ACSE AP Title Value as defined in IEC 61850-8-1.
OSI Presentation Selector	00000001	OSI Presentation Selector as defined in IEC 61850-8-1.
OSI Session Selector	0001	OSI Session Selector as defined in IEC 61850-8-1.
OSI Transport Selector	0001	OSI Transport Selector as defined in IEC 61850-8-1.
Communication Control		
Configuration Revision Check Enabled	True False Default: False	If enabled, checks configuration revisions from all logical devices (LDx.LLN0.NamPlt.configRev). If the configuration revisions do not match between the configuration and the IED, communication to the IED is not established.
Dynamically Create Data Sets	True False Default: False	Specifies whether data sets and reporting are initialized dynamically.

Table continues on next page

Name	Value or Value range/ Default	Description
Enable EntryID Check	True False Default: False	*Obsolete!* Enable reporting EntryID check. Report EntryIDs are used as sequence numbers for buffered reporting. A gab in sequence numbers causes a restart of reporting starting from lost sequence number.
MMS Keepalive Timeout	0 - 3600 0: disabled 4: minimum Default: 60	MMS keepalive timeout in seconds. Configures the interval for sendig MMS Status request to IED when communication is silent.
MMS Request Timeout	0 - 65535 0 = disabled Default: 3000	Specifies the timeout for MMS Request in milliseconds. If the value is 0, it is not in use.
Report Control Block Initialize	True False Default: True	Initializes report control blocks and enables reporting.
Send Single Message MMS Writes	True False Default: False	Specifies if MMS Write contains only one message at the time.
Use 32 Bit Entry ID	True False Default: False	*Obsolete!* Enables or disables usage of 32 bit EntryIDs for information report sequence. The IEC 61850 standard defines 64 bit EntryID, but for example, the SPA-ZC 40x uses 32 bit EntryID.
Use Sequence Number Check	True False Default: True	Enables or disables sequence number checking information reports for the IEC 61850 OPC server.
Polling		
Polling Timeout	(0 - 3600) 0: disabled Default: 0	Polling Timeout in seconds. If the device does not support reporting, ST and MX attributes can be polled with this interval.
Control Authorization		
Disable Interlockcheck for All Controls	True False Default: False	Disables interlockcheck condition check for all select and operate controls.
Disable Syncrocheck for All Controls	True False Default: False	Disables synchrocheck condition check for all select and operate controls.
OPC Alarm and Event		
Device Connection Status Class	Default: Device Connection Status	Device Connection Status Class definition used with current device.
Discard Old Buffered Events	True False Default: False	Disables requesting of all buffered events from IED buffers. Enabling this prevents requesting of all available old events from IED BRCB buffers with setting EntryID to zero. Disabling this may cause unnecessary event duplicates on startup and during reporting synchronization failure. Enabling this may cause loss of events.
Authentication		
Is Authentication Disabled	True False Default: True	Specifies whether Authentication is used.
Is Password used	True False Default: False	Specifies whether authentication password is used.
Password	Default: None	Password used for authentication.
Disturbance Recording		

Table continues on next page

Name	Value or Value range/ Default	Description
Disturbance Recorder Delete Recordings	True False Default: False	Specifies whether DRs are deleted from the IED after upload.
Disturbance Recorder Enabled	True False Default: False	Specifies whether DR upload is enabled.
Disturbance Recorder Event Trigger Enabled	True False Default: False	Enable triggering of disturbance upload through event. When enabled, a disturbance recording upload process is executed when a triggering event is received.
Disturbance Recorder Event Trigger Source		OPC path of event triggering the disturbance recording upload. Requires a boolean event 'true' with value change to trigger upload. If empty LD \RDRE\RcdMade\stVal and LD\RDRE\ERcdStored \stVal items are searched and used if found. Format LD\LN\DO\Attr (for example DR\RDRE1\ERcdStored \stVal).
Disturbance Recorder Local Directory		Specifies the folder where all disturbance recordings will be stored in the running computer. If left empty, C:\COMTRADE\IEDName will be used.
Disturbance Recorder Maximum Total File Size	0 - 2147483647 0: no limit Default: 0	Specifies maximum size for folder where uploaded DRs are locally stored for this IED.
Disturbance Recorder Polling Period	0 – 2147483647 0: disabled Default: 120	DR polling period in seconds.
Disturbance Recorder Remote Directory		Specifies the folder where all disturbance recordings will be stored in this IED.
Disturbance Recording via FTP		
Disturbance Recorder FTP Password		Password to be used with DR uploads using FTP.
Disturbance Recorder FTP User Name		User name to be used with DR uploads using FTP.
Disturbance Recordings Read Via FTP	True (FTP) False (MMS/IEC 61850) Default: False	Specifies whether DRs are read using FTP or IEC 61850 file transfer services.

3.3.5 Configuring Logical Device properties

The logical devices are already configured when they are imported with IEC 61850 devices.

Table 5: Logical Device properties

Name	Value or Value range/ Default	Description
Transparent SPA		
SPA Address	(0..999) Default: 0	The SPA address of the device connected via TCP/IP. Setting a value >0 enables the built-in TCP/SPA client, which can be used through the Transparent SPA attribute. See Section 5.3.4.
SPA TCP Port	(1..65535) Default: 7001	SPA TCP Port
SPA TCP Timeout	(1..65535) Default: 3	SPA TCP Timeout in seconds

3.3.6 Configuring report control blocks

An instance of a report control block (RCB) is configured to be taken in to use by the IEC 61850 OPC Server by setting the IED Name property of a ReportClient instance of the RCB to match the OPC servers Report Control Identity property.

A RCB controls spontaneous event reporting, and the client can modify report sending behavior by setting RCB attributes. **Buffered Report Control Blocks** (BRCB) and **Unbuffered Report Control Blocks** (URCB) are supported.

For BRCB, events issue immediate sending of reports or buffer the events for transmission so that data values are not lost due to transport flow control constraints or loss of connection. For URCB, events issue immediate sending of reports on a best effort basis. If no association exists or if the transport data flow is not fast enough to support it, events may be lost.

To allow multiple clients to receive the same data values, multiple instances of the report control classes need to be available. **Report Enabled** and **Report Client** definitions are used to specify RCB instances to clients. **Report Enabled max** shows the maximum number of available RCB instances, and **Report Client** dedicates an instance to a client (see Report Control Identity in Table 2). All configured RCBs without IEC 61850 OPC Server specified instances are discarded. See Table 6.

The order of Report Clients specifies the used RCB instance and the RCB name. IEC 61850 OPC Server builds the RCB instance name to type RCBName<xx>. Each RCB instance takes on values from 01 to 99 as <xx>. For example, the first Report Client uses RCBName01. The RCB instance indexed naming convention can be disabled by setting the RCB Indexed property to false.

It is important to dedicate specific instances of the IED Report Control Blocks for specific IEC 61850 clients. Multiple IEC 61850 clients cannot enable reporting from a single RCB instance and will cause communication failures.

Table 6: IEC 61850 OPC Server RCB dedication and naming conventions

Report Control Identity	RCB Name	Indexed	Report Enabled element	Report Enabled max	Report Clients	Used RCB
Client1	rcbDemo	true	yes	2	Client1 Client2	rcbDemo01
Client1	rcbDemo	false	yes	3	Client1 Client2 Client3	rcbDemo
Client1	rcbDemo	true	yes	5	GW1 GW2 HMI1 HMI2 Client1	rcbDemo05
Client1	rcbDemo	true/false	no	-	-	-
Client1	rcbDemo	true/false	yes	3	Client4 Client5 Client6	-
Client1	rcbDemo	true/false	yes	5	-	-
Client1	rcbDemo	true/false	yes	0	-	-
Client1	rcbDemo	true/false	yes	0	Client1 Client2	-

The control attribute values are received from the imported device configuration. Some values can be overridden with the IEC 61850 OPC Server configuration.

- Buffer Time
  Controls the time interval in milliseconds when the BRCB buffers the events for inclusion into a single report. Overridable.
- Buffered
  Controls RCB to buffered (true) or unbuffered (false). Must be true for BRCB.
- Configuration Revision
  Represents the number of times that the configuration of the RCB has changed.
- Data Set
  Specifies the data set being monitored and what values are reported.
- Integrity period
  If this is set to integrity (>0), it indicates the period in milliseconds used for generating an integrity report. An integrity report reports the values of all members of the related data set. Overridable.
- Report ID
  Report identifier is the BRCB's client-specified report identifier. Report identifier generates the report.
- Option Fields
  Client specified optional fields to be included in the report issued by BRCB. This attribute defines the optional header fields' subset of the report that are included in the report. Refer to the IEC 61850-7-2 and IEC 61850-8-1 standards. The IEC 61850 OPC Server uses a default value for option fields to receive the necessary information for event updates and event flow control (cannot be overridden): BRCB (Sequence Number, Reason Code, Buffer Overflow, Entry ID, Time of Entry), URCB (Sequence Number, Reason Code). Overridable.
- Trigger Options
  Specifies the trigger conditions which BRCB monitors. The following values are defined: Data Change(dchg), Quality Change(qchg), Data Update(dupd), Period.

Buffer time and Integrity period are overridable. Option fields are also overridable, except the default values that the IEC 61850 OPC Server uses to receive the necessary information for event updates and event flow control.

Section 4 Operation

4.1 Updating IEC 61850 OPC Server configuration

Once the IEC 61850 configuration in CET is ready the configuration needs to be updated to be taken in to use in the IEC 61850 OPC Server. To update IEC 61850 OPC Server configuration:

1. Right-click the Computer Node and select **Management**
2. Click **Update configuration** to update the configuration.
3. Click **Reload configuration** to restart the IEC 61850 OPC Server with the new configuration. This is required if the IEC 61850 OPC Servers are already running.
4. Close the Management pane.

The configuration is now updated and the IEC 61850 OPC Server is ready to be started.

4.2 IEC 61850 OPC Server diagnostics

Once the IEC 61850 OPC Server has been configured, its runtime status can be diagnosed with the Online Diagnostics function in CET. Select **Tools/Online Diagnostics** or select and right-click the IEC 61850 Server object and select **Online Diagnostics** from the shortcut menu, see Figure 4.

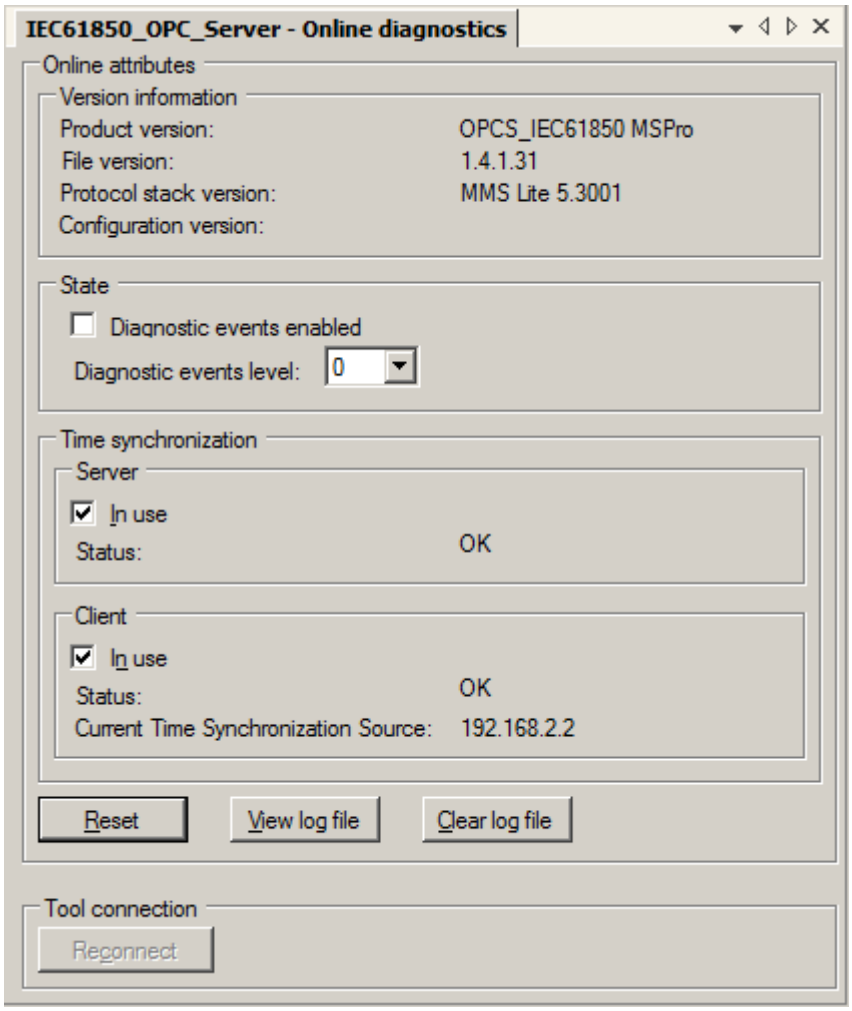

Figure 4: IEC 61850 OPC Server Online Diagnostics

The following diagnostics are available:

- enable or disable diagnostic events
- enable or disable the SNTP server
- enable or disable the SNTP client
- reset (restart the OPC server)
- view the event log file
- clear the log file
- reconnect the online diagnostics

4.3 IEC 61850 subnetwork diagnostics

The IEC 61850 subnetwork activity can be monitored with the Online Diagnostics function.

It is also possible to take a subnetwork into use or out of use.

To monitor and control IEC 61850 subnetwork activity:

1. Select a subnetwork to monitor in the object tree of CET.
2. Right-click the channel.
3. Select **Online Diagnostics**.

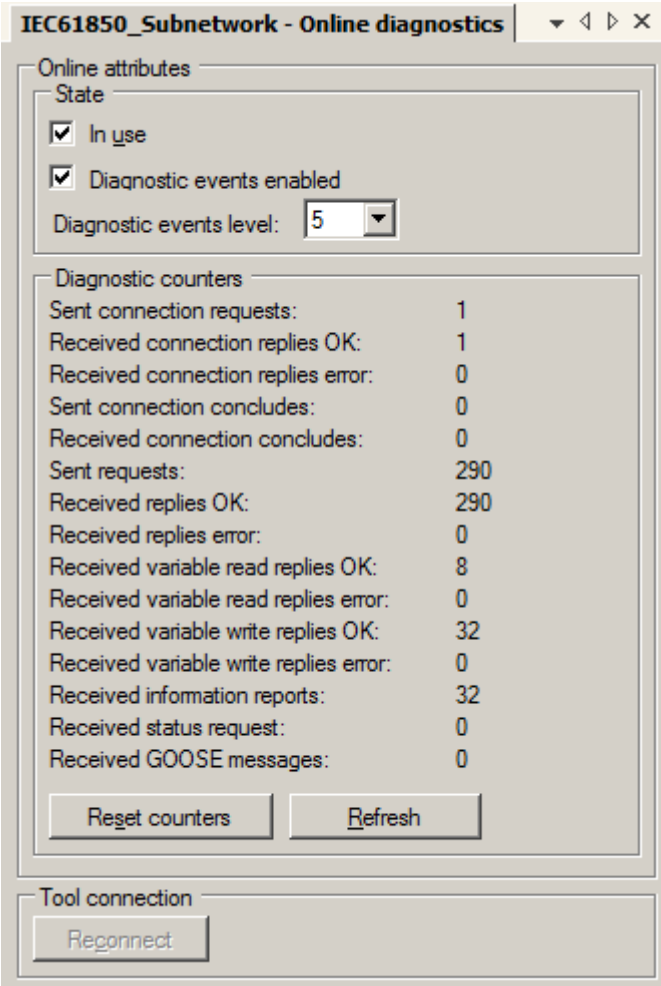

Figure 5: IEC 61850 subnetwork Online Diagnostics

Subnetwork activity and the available properties can be monitored in the Diagnostic counters field, see Figure 5. To reset Diagnostic counters, click **Reset counters**.

An IEC 61850 subnetwork can be taken into use by selecting the **In Use** check box. Clearing the check box takes the subnetwork out of use. To update the diagnostic counters click **Refresh**.

4.4 IEC 61850 device diagnostics

The IEC 61850 device communication can be monitored with the Online Diagnostics function.

To monitor and control IEC 61850 device communication:

1. Select a device to monitor in the object tree of CET.
2. Right-click the device.
3. Select **Online Diagnostics**.

The device status can be monitored in the **Status information** field. The Diagnostic counters field provides information on device activity. To reset diagnostic counters, click **Reset counters**. To update the diagnostic counters click **Refresh**.

An IEC 61850 device can be taken into use by selecting the **In Use** check box. Clearing the check box takes the device out of use.

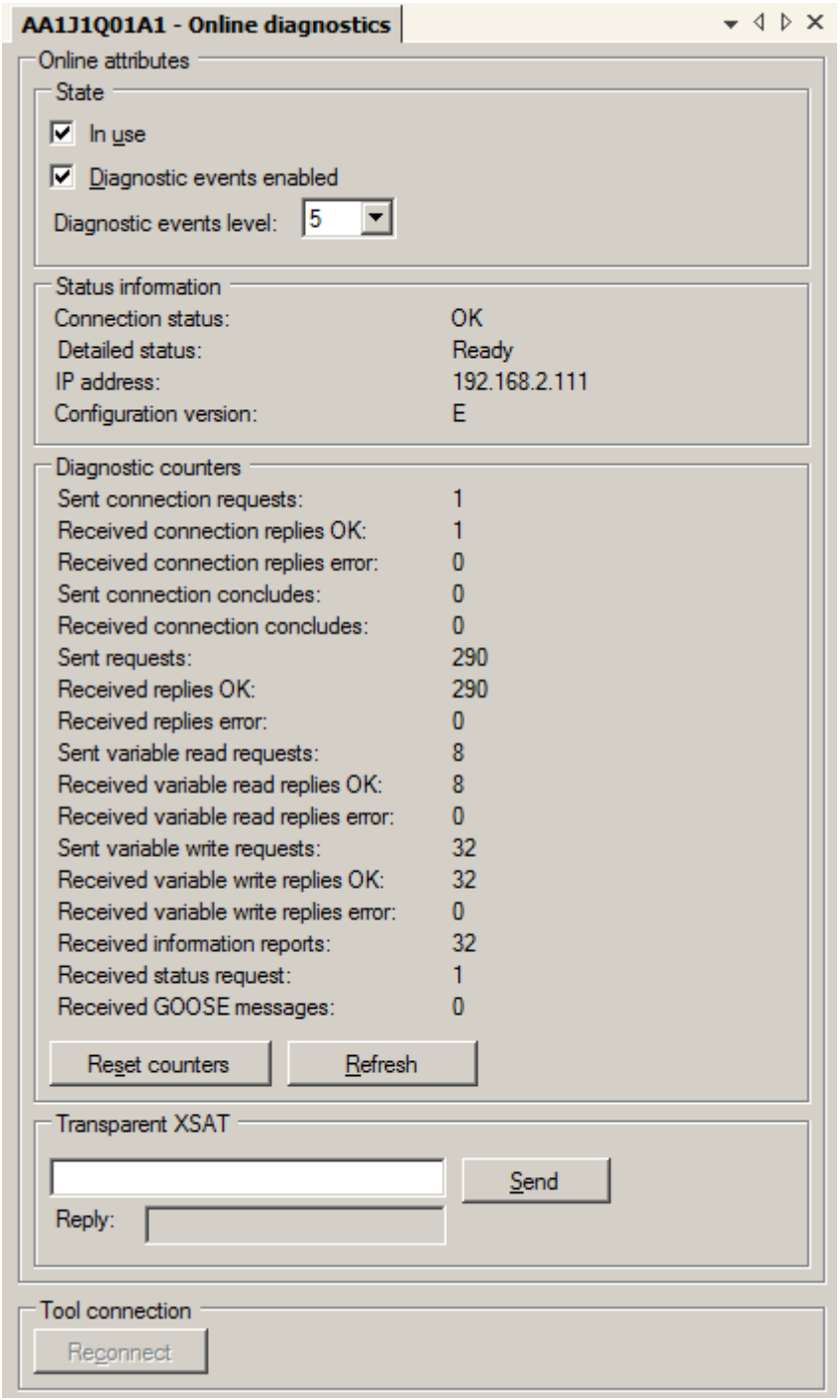

Figure 6: IEC 61850 Device Online Diagnostics

4.5 IEC 61850 data object diagnostics

The IEC 61850 data object diagnostics can be monitored with the Online Diagnostics function.

To monitor and control IEC 61850 data object communication:

1. Select a data object to monitor in the object tree.
2. Right-click the device.
3. Select **Online Diagnostics**.

In the **Status information** field, the user can monitor and set attribute values and use control services. The **Diagnostic counters** field provides information on device activity.

4.6 IEC 61850 report control block diagnostics

The IEC 61850 report control blocks can be monitored with the Online Diagnostics function.

To monitor and control IEC 61850 report control blocks:

1. Select a RCB to monitor in the object tree.
2. Right-click the RCB.
3. Select **Online Diagnostics**.

In addition to the IEC 61850 standard RCB attributes, non-standard OPC items **Object status** and **Last error** have been added to every RCB in the OPC Server for diagnostics. They are available for all connected OPC clients for reporting diagnostics.

4.6.1 Object status

This integer value (VT_I4) shows the current state of the RCB.

Values
13 = starting initialization
12 = reading RCB access attributes (data type)
11 = reading RCB values
10 = reading dataset
9 = deleting dataset
8 = reading dataset item access attributes (data types)
7 = enabling RCB
6 = configuring RCB attributes
5 = synchronizing reporting sequence
4 = checking reporting sequence synchronization
3 = purging RCB buffer
2 = enabling RCB reporting
1 = requesting general interrogation
0 = ready, reporting ok
< 0 = error

4.6.2 Last error

This integer value (VT_I4) shows the last error encountered while handling information reports to this RCB. All but value 18 (sequence number duplicate) indicate lost events.

Values
0 = ok
1 = no report to parse
2 = report data missing (data field that should be in report is missing)
3 = reporting not initialized
Table continues on next page

Values
4-16 = report field parsing error
17 = sequence number jump
18 = sequence number duplicate (no event loss)
19 = buffer overflow
20 = report value item missing (reported value field is for an item which is not configured on OPC namespace)
21 = value update (updating OPC item value failed)
22 = dataset changed (the reported dataset has changed, reporting is reinitialized)
23 = confrev changed (the RCB configuration revision has changed, reporting is reinitialized)
24 = dataset mismatch (dataset mismatch between configuration and IED)

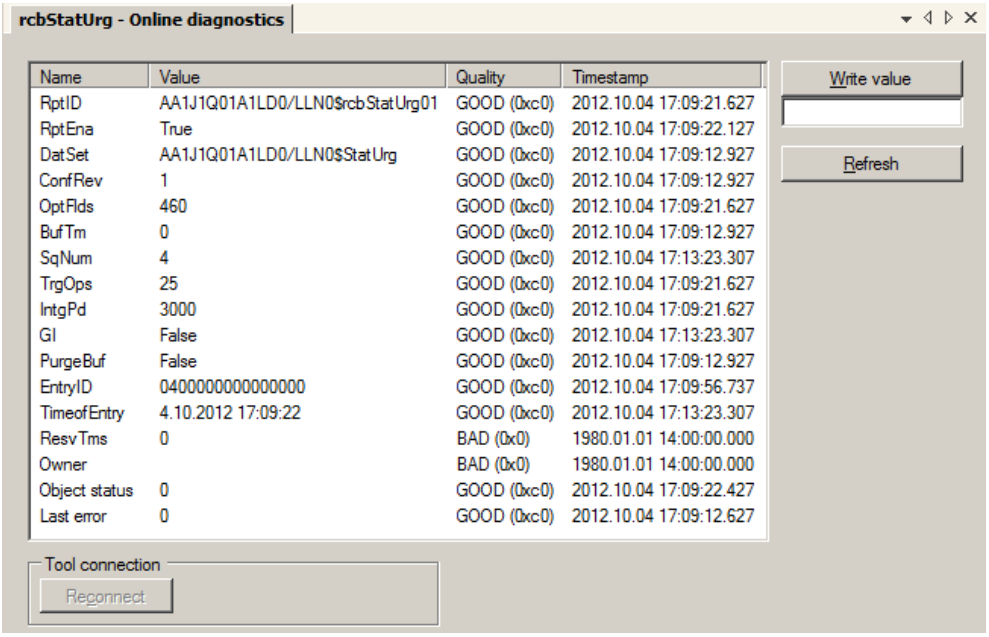

Figure 7: IEC 61850 Report Control Block Online Diagnostics

4.7 Advanced diagnostics

For diagnostics purposes the IEC 61850 OPC Server runtime behavior can be observed via diagnostic OPC AE events. The diagnostic events can be monitored using the Diagnostic AE Client function of CET, see Figure 8.

To receive events from communication with a certain IED, diagnostic events must be enabled for this device. This is done by controlling the System Event Levels of the OPC server, subnetwork and IED. To enable diagnostic AE events the System Event Level needs to be enabled for the monitored IED, the IEDs subnetwork and the OPC server. The System Event Level of OPC server overrides subnetwork level and subnetwork overrides the IED level. System Event Level can be set offline by setting the System Event Level property of the object to other than Disabled. It can also be set online via Online diagnostic tools for the object. The Diagnostic events enabled checkbox is used to enable/disable system events and Diagnostic events level controls the filtering level.

To view diagnostic events:

1. Right-click the IEC 61850 OPC Server.
2. Select **Diagnostic AE client**.

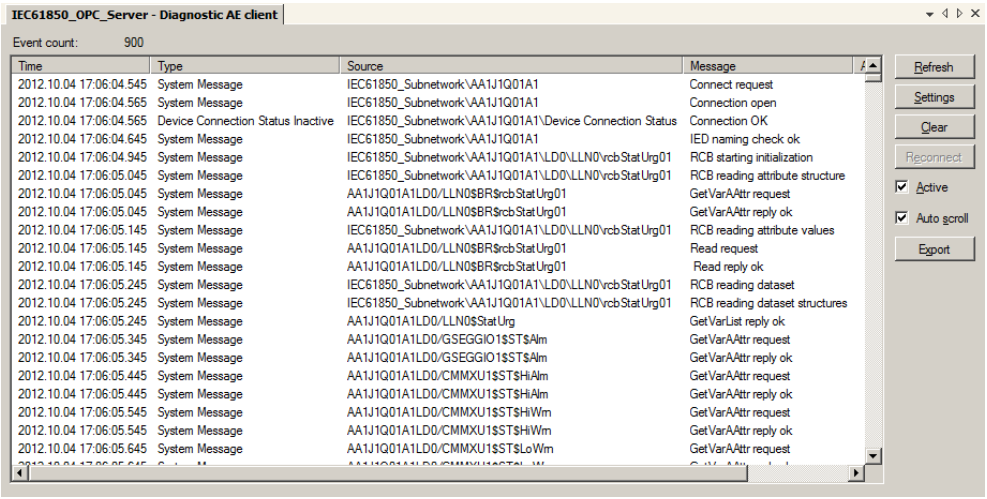

Figure 8: IEC 61850 OPC Server Diagnostics AE client

Section 5 Technical reference

5.1 About this section

This document describes how IEC 61850 data objects according to IEC 61850-7-3 are mapped to OPC nodes and item tags.

In general this is done by using an OPC node to represent an IEC 61850 object, and OPC item tags to represent the attributes of the object. Most objects are single-level (i.e. use only one node) but some are hierarchical and use several nodes.

This section provides reference information about the following issues:

- IEC 61850 data object modeling
- IEC 61850 OPC Server data object modeling
- Attributes
- Status codes

5.2 IEC 61850 OPC server data object modeling

5.2.1 Common data attribute types

The relationship between IEC 61850 data models and the IEC 61850 OPC Server is described in this section.

For each data class, there is a table giving a detailed description about the relation between the OPC data and the IEC 61850 data object attributes and services. The tables also describe how the data is presented on the OPC Server name space.

5.2.2 IEC 61850 quality

The table below defines the mapping of quality in MMS (IEC 61850 7-3). Only 13 bits (LSB) in quality are valid.

Table 7: IEC 61850 quality

Name	Type	Value/Value range	M/O/C	Bit
validity	2bit	good (0) | invalid (1) | reserved (2) | questionable (3)	M	0-1
overflow	1bit	FALSE (0) | TRUE (1)	M	2
outOfRange	1bit	FALSE (0) | TRUE (1)	M	3
badReference	1bit	FALSE (0) | TRUE (1)	M	4
oscillatory	1bit	FALSE (0) | TRUE (1)	M	5
failure	1bit	FALSE (0) | TRUE (1)	M	6
oldData	1bit	FALSE (0) | TRUE (1)	M	7
inconsistent	1bit	FALSE (0) | TRUE (1)	M	8
inaccurate	1bit	FALSE (0) | TRUE (1)	M	9

Table continues on next page

Name	Type	Value/Value range	M/O/C	Bit
source	1bit	process (0) | substituted (1)	M	10
test	1bit	FALSE (0) | TRUE (1)	M	11
operatorBlocked	1bit	FALSE (0) | TRUE (1)	M	12

5.2.3 Mapping quality value to OPC

The value of validity is presented as the value of the quality attribute and the other values are presented as OPC properties of the quality in the OPC namespace.

Table 8: Mapping quality value to OPC

Name	Type	Value/ Value range	M/O/C	OPC Data Type
Validity		good (0) | invalid (1) | reserved (2) | questionable (3)	M	VT_I4
DetailQuality		DetailedQuality	M	VT_I4
Source		process (0) | substituted (1)	M	VT_I4
Test		FALSE (0) | TRUE (1)	M	VT_BOOL
OperatorBlocked		FALSE (0) | TRUE (1)	M	VT_BOOL

5.2.4 Mapping of DetailedQuality

The value of DetailQuality is mapped to a DetailedQuality bitmap.

Table 9: Mapping of DetailedQuality

Name	Type	Value/ Value range	M/O/C	Bit
overflow	1bit	FALSE (0) | TRUE (1)	M	0
outOfRange	1bit	FALSE (0) | TRUE (1)	M	1
badReference	1bit	FALSE (0) | TRUE (1)	M	2
oscillatory	1bit	FALSE (0) | TRUE (1)	M	3
failure	1bit	FALSE (0) | TRUE (1)	M	4
oldData	1bit	FALSE (0) | TRUE (1)	M	5
inconsistent	1bit	FALSE (0) | TRUE (1)	M	6
inaccurate	1bit	FALSE (0) | TRUE (1)	M	7

Example:

DetailQuality = 1d = 00000001b > overflow = true

DetailQuality = 16d = 00010000b > failure = true

5.2.5 Analogue value (AnalogueValue)

Analogue values are always presented as 32 bit float values (VT_R4) so that the .f and .i extensions are discarded from the attribute names to simplify the OPC namespace. If a device only supports integer values, the value is converted to a floating point presentation of the value according to its configuration and the following formula, refer to Section 5.2.6.

$f \times 10^{units.multiplier} = (i \times scaleFactor) + offset$

Table 10: Analogue value (AnalogueValue)

Name	Type	Value/ Value range	M/O/C	OPC Data Type
i	INT32	integer value	Not Used	Not Used
f	FLOAT32	floating point value	Not Used	Not Used

Example:

MV: mag.f (VT_R4) & mag.i (VT_I4) > mag (VT_R4)

5.2.6 Configuration of analogue value (ScaledValueConfig)

The table below defines the mapping of configuration of analogue value (ScaledValueConfig).

Table 11: Configuration of analogue value (ScaledValueConfig)

Name	Type	Value/ Value range	M/O/C	OPC Data Type
scaleFactor	FLOAT32	floating point value	M	VT_R4
offset	FLOAT32	floating point value	M	VT_R4

5.2.7 Range configuration (RangeConfig)

The table below defines the mapping of range configuration (RangeConfig).

Table 12: Range configuration (RangeConfig)

Name	Type	Value/ Value range	M/O/C	OPC Data Type
hhLim	AnalogueValue	floating point value	M	VT_R4
hLim	AnalogueValue	floating point value	M	VT_R4
lLim	AnalogueValue	floating point value	M	VT_R4
llLim	AnalogueValue	floating point value	M	VT_R4
min	AnalogueValue	floating point value	M	VT_R4
max	AnalogueValue	floating point value	M	VT_R4

hhLim, hLim, lLim, llLim: These attributes are configuration parameters used in the context with the range attribute.

min: The min (minimum) attribute represents the minimum process measurement for which values of i or f are considered within process limits.

max: The max (maximum) attribute represents the maximum process measurement for which values of i or f are considered within process limits.

5.2.8 Step position with transient indication (ValWithTrans)

The table below defines the mapping of Step position with transient indication (ValWithTrans).

Table 13: Step position with transient indication (ValWithTrans)

Name	Type	Value/ Value range	M/O/C	OPC Data Type
posVal	INT8	-64 ... 63	M	VT_I4
transInd	BOOLEAN	TRUE | FALSE	M	VT_BOOL

5.2.9 Pulse configuration (PulseConfig)

The table below defines the mapping of pulse configuration (PulseConfig).

Table 14: Pulse configuration (PulseConfig)

Name	Type	Value/ Value range	M/O/C	OPC Data Type
cmdQual	ENUMERATED	pulse(0) | persistent(1)	M	VT_I4
onDur	INT32U		M	VT_I4
offDur	INT32U		M	VT_I4
numPls	INT32U		M	VT_I4

5.2.10 Originator

The table below defines the mapping of originator (Originator).

Table 15: Originator

Name	Type	Value/ Value range	M/O/C	OPC Data Type
orCat	ENUMERATED	not-supported(0) | bay-control(1) | station-control(2) | remote-control(3) | automatic-bay(4) | automatic-station(5) | automatic-remote(6) | maintenance(7) | process(8)	M	VT_I4
orident	OCTET STRING64	TRUE | FALSE	M	VT_BSTR

5.2.11 Unit

The table below defines the mapping of unit (Unit).

Table 16: Unit

Name	Type	Value/ Value range	M/O/C	OPC Data Type
SIUnit	ENUMERATED		M	VT_I4
multiplier	ENUMERATED		O	VT_I4

5.2.12 Vector

The table below defines the mapping of vector (Vector).

Table 17: Vector

Name	Type	Value/ Value range	M/O/C	OPC Data Type
mag	AnalogueValue	floating point value	M	VT_R4
ang	AnalogueValue	floating point value	O	VT_R4

5.2.13 TimeStamp

The timestamp OPC attributes are presented as OPC type VT_DATE. It is implemented using an 8-byte floating-point number. Days are represented by whole number increments starting with 30 December 1899, midnight as time zero. Hour values are expressed as the absolute value of the fractional part of the number.

5.2.14 AbbCommandBitmask

The table below defines the mapping of AbbCommandBitmask. This ABB specific control value is a bitmask value of a command to a device. This value is applicable to ABB extension control attributes.

Table 18: AbbCommandBitmask

Name	Type	Value/ Value range	M/O/C	OPC Data Type
NormalControl	1bit	FALSE (0) | TRUE (1)	M	0
InterlockOverride	1bit	FALSE (0) | TRUE (1)	M	1
SynchrocheckOverride	1bit	FALSE (0) | TRUE (1)	M	2
TestCommand	1bit	FALSE (0) | TRUE (1)	M	3
Originator	4bit	not-supported(0) | bay-control(1) | station-control(2) | remote-control(3) | automatic-bay(4) | automatic-station(5) | automatic-remote(6) | maintenance(7) | process(8)	M	4-7
ControlValue	nbit		M	8-31

NormalControl: True = normal operation, false = inverse operation (e.g. On > Off).

InterlockOverride: True = interlockcheck > false

SynchrocheckOverride: True = syncrocheck > false

TestCommand: True = test command

Originator: Command originator (= Originator.orCat)

5.2.15 Common data class specifications for status information

5.2.15.1 Single point status (SPS)

The table below defines the common data class of single point status.

Table 19: Single point status (SPS)

Name	Type	FC	Value/ Value range	M/O	OPC Data Type
stVal	BOOLEAN	ST	TRUE | FALSE	M	VT_BOOL
q	Quality	ST		M	VT_I4
t	TimeStamp	ST		M	VT_DATE
subEna	BOOLEAN	SV		O	VT_BOOL
subVal	BOOLEAN	SV	TRUE | FALSE	O	VT_BOOL
subQ	Quality	SV		O	VT_I4
subID	VISIBLE STRING64	SV		O	VT_BSTR
d	VISIBLE STRING64	DC	Text	O	VT_BSTR
dU	UNICODE STRING255	DC		O	VT_BSTR

Table continues on next page

Name	Type	FC	Value/ Value range	M/O	OPC Data Type
cdcNs	VISIBLE STRING255	EX		O	VT_BSTR
cdcName	VISIBLE STRING255	EX		O	VT_BSTR
dataNs	VISIBLE STRING255	EX		O	VT_BSTR

5.2.15.2 Double point status (DPS)

The table below defines the common data class of double point status.

Table 20: Double point status (DPS)

Name	Type	FC	Value/ Value range	M/O	OPC Data Type
stVal	CODED ENUM	ST	intermediate-state (0) | off (1) | on (2) | bad-state (3)	M	VT_I4
q	Quality	ST		M	VT_I4
t	TimeStamp	ST		M	VT_DATE
subEna	BOOLEAN	SV		O	VT_BOOL
subVal	CODED ENUM	SV	intermediate-state (0) | off (1) | on (2) | bad-state (3)	O	VT_I4
subQ	Quality	SV		O	VT_I4
subID	VISIBLE STRING64	SV		O	VT_BSTR
d	VISIBLE STRING255	DC	Text	O	VT_BSTR
dU	UNICODE STRING255	DC		O	VT_BSTR
cdcNs	VISIBLE STRING255	EX		O	VT_BSTR
cdcName	VISIBLE STRING255	EX		O	VT_BSTR
dataNs	VISIBLE STRING255	EX		O	VT_BSTR

5.2.15.3 Integer status (INS)

The table below defines the common data class of integer status.

Table 21: Integer status (INS)

Name	Type	FC	Value/ Value range	M/O	OPC Data Type
stVal	INT32	ST		M	VT_I4
q	Quality	ST		M	VT_I4
t	TimeStamp	ST		M	VT_DATE
subEna	BOOLEAN	SV		O	VT_BOOL
subVal	INT32	SV		O	VT_I4
subQ	Quality	SV		O	VT_I4
subID	VISIBLE STRING64	SV		O	VT_BSTR
d	VISIBLE STRING255	DC		O	VT_BSTR
dU	UNICODE STRING255	DC		O	VT_BSTR
cdcNs	VISIBLE STRING255	EX		O	VT_BSTR
cdcName	VISIBLE STRING255	EX		O	VT_BSTR
dataNs	VISIBLE STRING255	EX		O	VT_BSTR

5.2.15.4 Protection activation information (ACT)

The table below defines the common data class of protection activation information.

Table 22: Protection activation information (ACT)

Name	Type	FC	Value/ Value range	M/O	OPC Data Type
general	BOOLEAN	ST		M	VT_BOOL
phsA	BOOLEAN	ST		O	VT_BOOL
phsB	BOOLEAN	ST		O	VT_BOOL
phsC	BOOLEAN	ST		O	VT_BOOL
neut	BOOLEAN	ST		O	VT_BOOL
q	Quality	ST		M	VT_I4
t	TimeStamp	ST		M	VT_DATE
operTm	TimeStamp	CF		O	VT_DATE
d	VISIBLE STRING255	DC	Text	O	VT_BSTR
dU	UNICODE STRING255	DC		O	VT_BSTR
cdcNs	VISIBLE STRING255	EX		O	VT_BSTR
cdcName	VISIBLE STRING255	EX		O	VT_BSTR
dataNs	VISIBLE STRING255	EX		O	VT_BSTR

5.2.15.5 Directional protection activation information (ACD)

The table below defines the common data class of directional protection activation information.

Table 23: Directional protection activation information (ACD)

Name	Type	FC	Value/ Value range	M/O	OPC Data Type
general	BOOLEAN	ST		M	VT_BOOL
dirGeneral	ENUMERATED	ST	unknown (3) | forward (1) | backward (2)	M	
phsA	BOOLEAN	ST		O	VT_BOOL
dirPhsA	ENUMERATED	ST	unknown (3) | forward (1) | backward (2)	O	
phsB	BOOLEAN	ST		O	VT_BOOL
dirPhsB	ENUMERATED	ST	unknown (3) | forward (1) | backward (2)	O	
phsC	BOOLEAN	ST		O	VT_BOOL
dirPhsC	ENUMERATED	ST	unknown (3) | forward (1) | backward (2)	O	
neut	BOOLEAN	ST		O	VT_BOOL
dirNeut	ENUMERATED	ST	unknown (3) | forward (1) | backward (2)	O	
q	Quality	ST		M	VT_I4
t	TimeStamp	ST		M	VT_DATE
d	VISIBLE STRING255	DC	Text	O	VT_BSTR
dU	UNICODE STRING255	DC		O	VT_BSTR

Table continues on next page

Name	Type	FC	Value/ Value range	M/O	OPC Data Type
cdcNs	VISIBLE STRING255	EX		O	VT_BSTR
cdcName	VISIBLE STRING255	EX		O	VT_BSTR
dataNs	VISIBLE STRING255	EX		O	VT_BSTR

5.2.15.6 Security violation counter (SEC)

The table below defines the common data class of security violation counting.

Table 24: Security violation counting (SEC)

Name	Type	FC	Value/ Value range	M/O	OPC Data Type
cnt	INT32U	ST		M	VT_I4
sev	ENUMERATED	ST	unknown (0) | critical (1) | major (2) | minor (3) | warning (4)	M	VT_I4
t	TimeStamp	ST		M	VT_DATE
addr	OCTET STRING64	ST		O	VT_BSTR
addInfo	VISIBLE STRING64	ST		O	VT_BSTR
d	VISIBLE STRING255	DC	Text	O	VT_BSTR
dU	UNICODE STRING255	DC		O	VT_BSTR
cdcNs	VISIBLE STRING255	EX		O	VT_BSTR
cdcName	VISIBLE STRING255	EX		O	VT_BSTR
dataNs	VISIBLE STRING255	EX		O	VT_BSTR

5.2.15.7 Binary counter reading (BCR)

The table below defines the common data class of binary counter reading.

Table 25: Binary counter reading (BCR)

Name	Type	FC	Value/ Value range	M/O	OPC Data Type
actVal	INT128	ST		M	VT_I4
frVal	INT128	ST		O[a]	VT_I4
frTm	TimeStamp	ST		O[a]	VT_DATE
q	Quality	ST		M	VT_I4
t	TimeStamp	ST		M	VT_DATE
units	Unit	CF		O	VT_R4
pulsQty	FLOAT32	CF		M	VT_BOOL
frEna	BOOLEAN	CF		O [a]	VT_DATE
strTm	TimeStamp	CF		O [a]	VT_I4
frPd	INT32	CF		O[a]	VT_BOOL
frRds	BOOLEAN	CF		O [a]	VT_BSTR
d	VISIBLE STRING255	DC	Text	O	VT_BSTR
dU	UNICODE STRING255	DC		O	VT_BSTR

Table continues on next page

Name	Type	FC	Value/ Value range	M/O	OPC Data Type
cdcNs	VISIBLE STRING255	EX		O	VT_BSTR
cdcName	VISIBLE STRING255	EX		O	VT_BSTR
dataNs	VISIBLE STRING255	EX		O	VT_BSTR

a. All or none of these items must be present.

5.2.16 Common data class specifications for measured information

5.2.16.1 Measured value (MV)

The table below defines the common data class of measured value.

Table 26: Measured value (MV)

Name	Type	FC	Value/ Value range	M/O	OPC Data Type
instMag	AnalogueValue	MX		O	VT_R4
mag	AnalogueValue	MX		M	VT_R4
range	ENUMERATED	MX	normal (0) | high (1) | low (2) | high-high (3) | low-low (4) | ...	O	VT_I4
q	Quality	MX		M	VT_I4
t	TimeStamp	MX		M	VT_DATE
subEna	BOOLEAN	SV		O	VT_BOOL
subVal	AnalogueValue	SV		O	VT_R4
subQ	Quality	SV		O	VT_I4
subID	VISIBLE STRING64	SV		O	VT_BSTR
units	Unit	CF		O	
db	INT32U	CF	0...100 000	O	VT_I4
zeroDb	INT32U	CF	0...100 000	O	VT_I4
sVC	ScaledValueConfig	CF		O	
rangeC	RangeConfig	CF		O	
smpRate	INT32U	CF		O	VT_I4
d	VISIBLE STRING255	DC	Text	O	VT_BSTR
dU	UNICODE STRING255	DC		O	VT_BSTR
cdcNs	VISIBLE STRING255	EX		O	VT_BSTR
cdcName	VISIBLE STRING255	EX		O	VT_BSTR
dataNs	VISIBLE STRING255	EX		O	VT_BSTR

5.2.16.2 Complex measured value (CMV)

The table below defines the common data class of measured value.

Table 27: Complex measured value (CMV)

Name	Type	FC	Value/ Value range	M/O	OPC Data Type
instCVal	Vector	MX		O	
cVal	Vector	MX		M	
range	ENUMERATED	MX	normal (0) | high (1) | low (2) | high-high (3) | low-low (4) | ...	O	VT_I4
q	Quality	MX		M	VT_I4
t	TimeStamp	MX		M	VT_DATE
subEna	BOOLEAN	SV		O	VT_BOOL
subVal	Vector	SV		O	
subQ	Quality	SV		O	VT_I4
subID	VISIBLE STRING64	SV		O	VT_BSTR
units	Unit	CF		O	
db	INT32U	CF	0...100 000	O	VT_I4
zeroDb	INT32U	CF	0...100 000	O	VT_I4
rangeC	RangeConfig	CF		O	
magSVC	ScaledValueConfig			O	
angSVC	ScaledValueConfig			O	
angRef	ENUMERATED	CF	V | A | other ...	O	VT_I4
smpRate	INT32U	CF		O	VT_I4
d	VISIBLE STRING255	DC	Text	O	VT_BSTR
dU	UNICODE STRING255	DC		O	VT_BSTR
cdcNs	VISIBLE STRING255	EX		O	VT_BSTR
cdcName	VISIBLE STRING255	EX		O	VT_BSTR
dataNs	VISIBLE STRING255	EX		O	VT_BSTR

5.2.16.3 Sampled value (SAV)

The table below defines the common data class of sampled value.

Table 28: Sampled value (SAV)

Name	Type	FC	Value/ Value range	M/O	OPC Data Type
instMag	AnalogueValue	MX		M	VT_R4
q	Quality	MX		M	VT_I4
t	TimeStamp	MX		M	VT_DATE
units	Unit	CF		O	
sVC	ScaledValueConfig	CF		O	
min	AnalogueValue	CF		O	VT_R4
max	AnalogueValue	CF		O	VT_R4
d	VISIBLE STRING255	DC	Text	O	VT_BSTR
dU	UNICODE STRING255	DC		O	VT_BSTR
Table continues on next page					

Name	Type	FC	Value/ Value range	M/O	OPC Data Type
cdcNs	VISIBLE STRING255	EX		O	VT_BSTR
cdcName	VISIBLE STRING255	EX		O	VT_BSTR
dataNs	VISIBLE STRING255	EX		O	VT_BSTR

5.2.16.4 WYE

The table below defines the common data class of WYE. This class is a collection of simultaneous measurements of values in a three-phase system that represents phase to ground values.

Table 29: WYE

Name	Type	FC	Value/ Value range	M/O	OPC Data Type
phsA	CMV	MX		O[a]	
phsB	CMV	MX		O[a]	
phsC	CMV	MX		O[a]	
neut	CMV	MX		O[a]	
net	CMV	MX		O[a]	
res	CMV	MX		O[a]	
angRef	ENUMERATEDe	CF	Va (0) | Vb (1) | Vc (2) | Aa (3) | Ab (4) | Ac (5) | Vab (6) | Vbc (7) | Vca (8) | Vother (9) | Aother (10)	O	VT_I4
d	VISIBLE STRING255	DC	Text	O	VT_BSTR
dU	UNICODE STRING255	DC		O	VT_BSTR
cdcNs	VISIBLE STRING255	EX		O	VT_BSTR
cdcName	VISIBLE STRING255	EX		O	VT_BSTR
dataNs	VISIBLE STRING255	EX		O	VT_BSTR

a. One or more of these items (1 - 6) must be present.

5.2.16.5 Delta (DEL)

The table below defines the common data class of delta. This class is a collection of measurements of values in a three-phase system that represents phase-to-phase values.

Table 30: Delta (DEL)

Name	Type	FC	Value/ Value range	M/O	OPC Data Type
phsAB	CMV	MX		O [a]	
phsBC	CMV	MX		O [a]	
phsCA	CMV	MX		O [a]	
angRef	ENUMERATED	CF	Va (0) | Vb (1) | Vc (2) | Aa (3) | Ab (4) | Ac (5) | Vab (6) | Vbc (7) | Vca (8) | Vother (9) | Aother (10)	O	VT_I4
d	VISIBLE STRING255	DC	Text	O	VT_BSTR
dU	UNICODE STRING255	DC		O	VT_BSTR

Table continues on next page

Name	Type	FC	Value/ Value range	M/O	OPC Data Type
cdcNs	VISIBLE STRING255	EX		O	VT_BSTR
cdcName	VISIBLE STRING255	EX		O	VT_BSTR
dataNs	VISIBLE STRING255	EX		O	VT_BSTR

a. One or more of these groups (1 - 3) must be present.

5.2.16.6 Sequence (SEQ)

The table below defines the common data class of sequence.

Table 31: Sequence (SEQ)

Name	Type	FC	Value/ Value range	M/O	OPC Data Type
c1	CMV	MX		O [a]	
c2	CMV	MX		O [a]	
c3	CMV	MX		O [a]	
seqT	ENUMERATED	CF	pos-neg-zero (0) | dir-quad-zero (1)	O	VT_I4
phsRef	ENUMERATED	CF	A (0) | B (1) | C (2) | ...		VT_I4
d	VISIBLE STRING255	DC	Text	O	VT_BSTR
dU	UNICODE STRING255	DC		O	VT_BSTR
cdcNs	VISIBLE STRING255	EX		O	VT_BSTR
cdcName	VISIBLE STRING255	EX		O	VT_BSTR
dataNs	VISIBLE STRING255	EX		O	VT_BSTR

a. One or more of these groups (1 - 3) must be present.

5.2.17 Common data class specifications for controllable status information

An indication of command termination message from IED is available for all control data objects using enhanced security control model. Indication for success or failure response can be seen from cmdTermination OPC item in the data object.

5.2.17.1 Controllable single point (SPC)

The table below defines the common data class of controllable single point.

Table 32: Controllable single point (SPC)

Name	Type	FC	Value/ Value range	M/O	OPC Data Type
lastApplError	ApplicationErrorCode		Refer to Section 5.2.22		VT_I4
ctlVal	BOOLEAN	CO	off (FALSE) | on (TRUE)	M	VT_BOOL
operTm	TimeStamp	CO		O	VT_DATE
origin	Originator	CO, ST			
ctlNum	INT8U	CO, ST	0..255	O	VT_I4

Table continues on next page

Name	Type	FC	Value/ Value range	M/O	OPC Data Type
stVal	BOOLEAN	ST	FALSE | TRUE	M	VT_BOOL
q	Quality	ST		M	VT_I4
t	TimeStamp	ST		M	VT_DATE
stSeld	BOOLEAN	ST	FALSE | TRUE	O	VT_BOOL
subEna	BOOLEAN	SV		O	VT_BOOL
subVal	BOOLEAN	SV	FALSE | TRUE	O	VT_BOOL
subQ	Quality	SV		O	VT_I4
subID	VISIBLE STRIN64	SV		O	VT_BSTR
pulseConfig	PulseConfig	CF		O	
ctlModel	ENUMERATED	CF	Status-only (0) | direct-with-normal-security (1) | sbo-with-normal-security (2) | direct-with-enhanced-security (3) | sbo-with-enhanced-security (4)	M	VT_I4
sboTimeout	INT32U	CF		O	VT_I4
sboClass	ENUMERATED	CF	operate-once (0) | operate-many (1)	O	VT_I4
d	VISIBLE STRING255	DC	Text	O	VT_BSTR
dU	UNICODE STRING255	DC		O	VT_BSTR
cdcNs	VISIBLE STRING255	EX		O	VT_BSTR
cdcName	VISIBLE STRING255	EX		O	VT_BSTR
dataNs	VISIBLE STRING255	EX		O	VT_BSTR

Mapping of controls
Direct Control with Normal Security:

- ctlVal: MMS Write.request to Oper structure with value.

SBO with Normal Security:

- ctlVal: MMS Write.request to ctlVal with value. IEC 61850 OPC Server will do the select before operate.

Direct Control with Enhanced Security:

- ctlVal: MMS Write.request to Oper structure with value.

SBO with Enhanced Security:

- ctlVal: MMS Write.request to ctlVal with value. IEC 61850 OPC Server will do the select before operate.

5.2.17.2 Controllable double point (DPC)

The table below defines the common data class of controllable double point.

Table 33: Controllable double point (DPC)

Name	Type	FC	Value/ Value range	M/O	OPC Data Type
ctlSelOn	AbbCommandBitmask			M	VT_I4
ctlSelOff	AbbCommandBitmask			M	VT_I4
ctlOperOn	AbbCommandBitmask			M	VT_I4
ctlOperOff	AbbCommandBitmask			M	VT_I4
ctlCan	AbbCommandBitmask			M	VT_I4
ctlOper	AbbCommandBitmask			M	VT_I4
lastApplError	ApplicationErrorCode		Refer to Section 5.2.22		VT_I4
ctlVal	BOOLEAN	CO	off (FALSE) | on (TRUE)	M	VT_BOOL
operTm	TimeStamp	CO		O	VT_DATE
origin	Originator	CO, ST		O	
ctlNum	INT8U	CO, ST	0..255	O	VT_I4
stVal	CODED ENUM	ST	intermediate-state (0) | off (1) | on (2) | bad-state (3)	M	VT_I4
q	Quality	ST		M	VT_I4
t	TimeStamp	ST		M	VT_DATE
stSeld	BOOLEAN	ST	FALSE | TRUE	O	VT_BOOL
subEna	BOOLEAN	SV		O	VT_BOOL
subVal	CPT	SV	intermediate-state (0) | off (1) | on (2) | bad-state (3)	O	VT_I4
subQ	Quality	SV		O	VT_I4
subID	VISIBLE STRING64	SV		O	VT_BSTR
pulseConfig	PulseConfig	CF		O	
ctlModel	ENUMERATED	CF	Status-only (0) | direct-with-normal-security (1) | sbo-with-normal-security (2) | direct-with-enhanced-security (3) | sbo-with-enhanced-security (4)	M	VT_I4
sboTimeout	INT32U	CF		O	VT_I4
sboClass	ENUMERATED	CF	operate-once (0) | operate-many (1)	O	VT_I4
d	VISIBLE STRING255	DC	Text	O	VT_BSTR
dU	UNICODE STRING255	DC		O	VT_BSTR
cdcNs	VISIBLE STRING255	EX		O	VT_BSTR
cdcName	VISIBLE STRING255	EX		O	VT_BSTR
dataNs	VISIBLE STRING255	EX		O	VT_BSTR

ctlOperOn: This attribute determines the control activity operation in direction On/Close.

ctlOperOff: This attribute determines the control activity operation in direction Off/Open.

ctlSelOn: This attribute determines the selection with direction On/Close.

ctlSelOff; This attribute determines the selection with direction Off/Open.

ctlCan: This attribute determines the cancellation of the selection

ctlOper: This attribute determines the selection with direction (direction taken from previous select). Only applicable for controls with SBO.

Mapping of controls
Direct Control with Normal Security:

- ctlSelOn: (not used)
- ctlSelOff: (not used)
- ctlOperOn: MS Write.request to Oper structure with value ON.
- ctlOperOff: MMS Write.request to Oper structure with value OFF.
- ctlCan: (not used)
- ctlOper: (not used)

The ctlSelOn, ctlSelOff, ctlCan, selCause, cmdTermCause, stSeld and the bits in ControlValues are not applicable.

SBO with Normal Security:

- ctlSelOn: MMS Read.request to SBO structure (to perform select).
- ctlSelOff: MMS Read.request to SBO structure (to perform select).
- ctlOperOn: MMS Write.request to Oper structure with value ON (to operate).
- ctlOperOff: MMS Write.request to Oper structure with value OFF (to operate).
- ctlCan: MMS Write.request ro Cancel structure
- ctlOper: MMS Write.request to Oper structure with value ON/OFF according to previous direction of select.

Direct Control with Enhanced Security:

- ctlSelOn: (not used)
- ctlSelOff: (not used)
- ctlOperOn: MMS Write.request to Oper structure with value ON.
- ctlOperOff: MMS Write.request to Oper structure with value OFF.
- ctlCan: MMS Write.request ro Cancel structure
- ctlOper: (not used)

SBO with Enhanced Security:

- ctlSelOn: MMS Read.request to SBOw structure.
- ctlSelOff: MMS Read.request to SBOw structure.
- ctlOperOn: MMS Write.request to Oper structure with value ON.
- ctlOperOff: MMS Write.request to Oper structure with value OFF.
- ctlCan: MMS Write.request ro Cancel structure
- ctlOper: MMS Write.request to Oper structure with value ON/OFF according to previous direction of select.

5.2.17.3 Controllable integer status (INC)

The table below defines the common data class of controllable integer status.

Table 34: Controllable integer status (INC)

Name	Type	FC	Value/ Value range	M/O	OPC Data Type
lastApplError	ApplicationErrorCode		Refer to Section 5.2.22		VT_I4
ctlVal	INT32	CO		M	VT_I4
operTm	TimeStamp	CO		O	VT_DATE
orCat	ENUMERATED			O	VT_I4
orIdent	OCTET STRING64			O	VT_BSTR
Table continues on next page					

Name	Type	FC	Value/ Value range	M/O	OPC Data Type
ctlNum	INT8U	CO, ST	0..255	O	VT_I4
stVal	INT32	ST		M	VT_I4
q	Quality	ST		M	VT_I4
t	TimeStamp	ST		M	VT_DATE
stSeld	BOOLEAN	ST	FALSE | TRUE	O	VT_BOOL
subEna	BOOLEAN	SV		O	VT_BOOL
subVal	INT32	SV		O	VT_I4
subQ	Quality	SV		O	VT_I4
subID	VISIBLE STRING64	SV	Text	O	VT_BSTR
ctlModel	ENUMERATED	CF	Status-only (0) | direct-with-normal-security (1) | sbo-with-normal-security (2) | direct-with-enhanced-security (3) | sbo-with-enhanced-security (4)	M	VT_I4
sboTimeout	INT32U	CF		O	VT_I4
sboClass	ENUMERATED	CF	operate-once (0) | operate-many (1)	O	VT_I4
minVal	INT32	CF		O	VT_I4
maxVal	INT32	CF		O	VT_I4
stepSize	INT32U	CF	1 ... (maxVal - minVal)	O	VT_I4
d	VISIBLE STRING255	DC	Text	O	VT_BSTR
dU	UNICODE STRING255	DC		O	VT_BSTR
cdcNs	VISIBLE STRING255	EX		O	VT_BSTR
cdcName	VISIBLE STRING255	EX		O	VT_BSTR
dataNs	VISIBLE STRING255	EX		O	VT_BSTR

Mapping of controls
Direct Control with Normal Security:

- ctlVal: MMS Write.request to Oper structure with value.

SBO with Normal Security:

- ctlVal: MMS Write.request to Oper structure with value. IEC 61850 OPC Server will do the select before operate.

Direct Control with Enhanced Security:

- ctlVal: MMS Write.request to Oper structure with value.

SBO with Enhanced Security:

- ctlVal: MMS Write.request to Oper structure with value. IEC 61850 OPC Server will do the select before operate.

5.2.17.4 Binary controlled step position information (BSC)

The table below defines the common data class of binary controlled step position information.

Table 35: Binary controlled step position information (BSC)

Name	Type	FC	Value/ Value range	M/O	OPC Data Type
lastApplError	ApplicationErro rCode		Refer to Section 5.2.22		VT_I4
ctlVal	ENUMERATED		stop (0) | lower (1) | higher (2) | reserved (3)	M	VT_I4
operTm	TimeStamp	CO		O	VT_DATE
orCat	ENUMERATED		not-supported | bay-control | station-control | remote-control | automatic-bay | automatic-station | automatic-remote | maintenance | process	O	VT_I4
orIdent	OCTET STRING64				VT_BSTR
ctlNum	INT8U	CO, ST	0..255	O	VT_I4
valWTr.posVal	INT8	ST		M	VT_I4
valWTr.transInd	BOOLEAN	ST		M	VT_BOOL
q	Quality	ST		M	VT_I4
t	TimeStamp	ST		M	VT_DATE
stSeld	BOOLEAN	ST	FALSE | TRUE	M	VT_I4
q	Quality	ST		O	VT_BOOL
t	TimeStamp	ST		M	VT_DATE
stSeld	BOOLEAN	ST	FALSE | TRUE	O	VT_BOOL
subEna	BOOLEAN	SV		O	VT_BOOL
subVal	INT32	SV		O	VT_I4
subQ	Quality	SV		O	VT_I4
subID	VISIBLE STRING64	SV	Text	O	VT_BSTR
				O	
ctlModel	ENUMERATED	CF	Status-only (0) | direct-withnormal- security (1) | sbo-withnormal- security (2) | direct-withenhanced- security (3) | sbo-withenhanced-security (4)	M	VT_I4
sboTimeout	INT32U	CF		O	VT_I4
sboClass	ENUMERATED	CF	operate-once (0) | operate-many (1)	O	VT_I4
minVal	INT8	CF		O	VT_I4
maxVal	INT8	CF		O	VT_I4
stepSize	INT8	CF	1 ... (maxVal - minVal)	O	VT_I4
d	VISIBLE STRING255	DC	Text	O	VT_BSTR
dU	UNICODE STRING255	DC		O	VT_BSTR
cdcNs	VISIBLE STRING255	EX		O	VT_BSTR
cdcName	VISIBLE STRING255	EX		O	VT_BSTR
dataNs	VISIBLE STRING255	EX		O	VT_BSTR

Mapping of controls

Direct Control with Normal Security:

- ctlVal: MMS Write.request to Oper structure with value.

SBO with Normal Security:

- ctlVal: MMS Write.request to Oper structure with value.
  IEC 61850 OPC Server will do the select before operate.

Direct Control with Enhanced Security:

- ctlVal: MMS Write.request to Oper structure with value.

SBO with Enhanced Security:

- ctlVal: MMS Write.request to Oper structure with value.
  IEC 61850 OPC Server will do the select before operate.

5.2.17.5 Integer controlled step position information (ISC)

The table below defines the common data class of integer controlled step position information.

Table 36: Integer controlled step position information (ISC)

Name	Type	FC	Value/ Value range	M/O	OPC Data Type
lastApplError	ApplicationErrorCode		Refer to Section 5.2.22		VT_I4
ctlVal	INT8	CO	-64 ... 63	M	VT_I4
operTm	TimeStamp	CO		O	VT_DATE
orCat	ENUMERATED		not-supported | bay-control | station-control | remote-control | automatic-bay | automatic-station | automatic-remote | maintenance | process	O	VT_I4
orIdent	OCTET STRING64			O	VT_BSTR
ctlNum	INT8U	CO, ST	0..255	O	VT_I4
valWTr.posVal	INT8	ST		M	VT_I4
valWTr.transInd	BOOLEAN	ST		M	VT_BOOL
q	Quality	ST		M	VT_I4
t	TimeStamp	ST		M	VT_DATE
stSeld	BOOLEAN	ST	FALSE | TRUE	O	VT_BOOL
				O	
subEna	BOOLEAN	SV		O	VT_BOOL
subVal	INT32	SV		O	VT_I4
subQ	Quality	SV		O	VT_I4
subID	VisibleString	SV	Text	O	VT_BSTR
				O	
ctlModel	ENUMERATED	CF	Status-only (0) | direct-with-normal-security (1) | sbo-with-normal-security (2) | direct-with-enhanced-security (3) | sbo-with-enhanced-security (4)	M	VT_I4

Table continues on next page

Name	Type	FC	Value/ Value range	M/O	OPC Data Type
sboTimeout	INT32U	CF		O	VT_I4
sboClass	ENUMERATED	CF	operate-once (0) | operate-many (1)	O	VT_I4
minVal	INT8	CF		O	VT_I4
maxVal	INT8	CF		O	VT_14
stepSize	INT8	CF	1 ... (maxVal - minVal)	O	VT_14
d	VISIBLE STRING255	DC	Text	O	VT_BSTR
dU	UNICODE STRING255	DC		O	VT_BSTR
cdcNs	VISIBLE STRING255	EX		O	VT_BSTR
cdcName	VISIBLE STRING255	EX		O	VT_BSTR
dataNs	VISIBLE STRING255	EX		O	VT_BSTR

Mapping of controls
Direct Control with Normal Security:

- ctlVal: MMS Write.request to Oper structure with value.

SBO with Normal Security:

- ctlVal: MMS Write.request to Oper structure with value.
  IEC 61850 OPC Server will do the select before operate.

Direct Control with Enhanced Security:

- ctlVal: MMS Write.request to Oper structure with value.

SBO with Enhanced Security:

- ctlVal: MMS Write.request to Oper structure with value.
  IEC 61850 OPC Server will do the select before operate.

5.2.18 Common data class specifications for controllable analogue information

5.2.18.1 Analogue set point (APC)

The table below defines the common data class of analogue set point.

Table 37: Analogue set point (APC)

Name	Type	FC	Value/ Value range	M/O	OPC Data Type
lastApplError	ApplicationErrorCode		Refer to Section 5.2.22		VT_I4
setMag	AnalogueValue	SP, MX		M	VT_R4
origin	Originator	SP, MX		O	
operTm	TimeStamp	SP		O	VT_DATE
q	Quality	ST		M	VT_I4
t	TimeStamp	ST		M	VT_DATE
ctlModel	ENUMERATED	CF	direct-with-normal-security (1)	M	VT_I4
Table continues on next page					

Name	Type	FC	Value/ Value range	M/O	OPC Data Type
units	Unit	CF		O	
sVC	ScaledValueConfig	CF		O	
minVal	AnalogueValue	CF		O	VT_R4
maxVal	AnalogueValue	CF		O	VT_R4
stepSize	AnalogueValue	CF	1 ... (maxVal-minVal)	O	VT_R4
d	VISIBLE STRING255	DC	Text	O	VT_BSTR
dU	UNICODE STRING255	DC		O	VT_BSTR
cdcNs	VISIBLE STRING255	EX		O	VT_BSTR
cdcName	VISIBLE STRING255	EX		O	VT_BSTR
dataNs	VISIBLE STRING255	EX		O	VT_BSTR

Mapping of controls
Direct Control with Normal Security:

- setMag: MMS Write.request to Oper structure with value.

SBO with Normal Security:

- setMag: MMS Write.request to Oper structure with value. IEC 61850 OPC Server will do the select before operate.

Direct Control with Enhanced Security:

- setMag: MMS Write.request to Oper structure with value.

SBO with Enhanced Security:

- setMag: MMS Write.request to Oper structure with value. IEC 61850 OPC Server will do the select before operate.

5.2.19 Common data class specifications for status settings

5.2.19.1 Single point setting (SPG)

The table below defines the common data class of single point setting.

Table 38: Single point setting (SPG)

Name	Type	FC	Value/ Value range	M/O	OPC Data Type
setVal	BOOLEAN	SP	off (FALSE) | on (TRUE)	M	VT_BOOL
d	VISIBLE STRING255	DC	Text	O	VT_BSTR
dU	UNICODE STRING255	DC		O	VT_BSTR
cdcNs	VISIBLE STRING255	EX		O	VT_BSTR
cdcName	VISIBLE STRING255	EX		O	VT_BSTR
dataNs	VISIBLE STRING255	EX		O	VT_BSTR

5.2.19.2 Integer status setting (ING)

The table below defines the common data class of integer status setting.

Table 39: Integer status setting (ING)

Name	Type	FC	Value/ Value range	M/O	OPC Data Type
setVal	INT32	SP		M	VT_I4
minVal	INT32	CF		O	VT_I4
maxVal	INT32	CF		O	VT_I4
stepSize	INT32	CF	1 ... (maxVal - minVal)	O	VT_I4
d	VISIBLE STRING255	DC	Text	O	VT_BSTR
dU	UNICODE STRING255	DC		O	VT_BSTR
cdcNs	VISIBLE STRING255	EX		O	VT_BSTR
cdcName	VISIBLE STRING255	EX		O	VT_BSTR
dataNs	VISIBLE STRING255	EX		O	VT_BSTR

5.2.20 Common data class specifications for analogue settings

5.2.20.1 Analogue setting (ASG)

The table below defines the common data class of analogue setting.

Table 40: Analogue setting (ASG)

Name	Type	FC	Value/ Value range	M/O	OPC Data Type
setMag	AnalogueValue	SP		M	VT_I4
units	Unit	CF		O	
sVC	ScaledValueConfig	CF		O	
minVal	AnalogueValue	CF		O	VT_I4
maxVal	AnalogueValue	CF		O	VT_I4
stepSize	AnalogueValue	CF	1 ... (maxVal - minVal)	O	VT_I4
d	VISIBLE STRING255	DC	Text	O	VT_BSTR
dU	UNICODE STRING255	DC		O	VT_BSTR
cdcNs	VISIBLE STRING255	EX		O	VT_BSTR
cdcName	VISIBLE STRING255	EX		O	VT_BSTR
dataNs	VISIBLE STRING255	EX		O	VT_BSTR

5.2.20.2 Setting curve (CURVE)

The table below defines the common data class of setting curve.

Table 41: Setting curve (CURVE)

Name	Type	FC	Value/ Value range	M/O	OPC Data Type
setCharact	ENUMERATED	SP		M	VT_I4
setParA	FLOAT32	SP		O	VT_R4
setParB	FLOAT32	SP		O	VT_R4
setParC	FLOAT32	SP		O	VT_R4
setParD	FLOAT32	SP		O	VT_R4
Table continues on next page					

Name	Type	FC	Value/ Value range	M/O	OPC Data Type
setParE	FLOAT32	SP		O	VT_R4
setParF	FLOAT32	SP		O	VT_R4
d	VISIBLE STRING255	DC	Text	O	VT_BSTR
dU	UNICODE STRING255	DC		O	VT_BSTR
cdcNs	VISIBLE STRING255	EX		O	VT_BSTR
cdcName	VISIBLE STRING255	EX		O	VT_BSTR
dataNs	VISIBLE STRING255	EX		O	VT_BSTR

5.2.21 Common data class specifications for description information

5.2.21.1 Device name plate (DPL)

The table below defines the common data class of device name plate. Data of this common data class is used to identify entities like primary equipment or physical devices.

Table 42: Device name plate (DPL)

Name	Type	FC	Value/ Value range	M/O	OPC Data Type
vendor	VISIBLE STRING255	DC		M	VT_BSTR
hwRev	VISIBLE STRING255	DC		O	VT_BSTR
swRev	VISIBLE STRING255	DC		O	VT_BSTR
serNum	VISIBLE STRING255	DC		O	VT_BSTR
model	VISIBLE STRING255	DC		O	VT_BSTR
location	VISIBLE STRING255	DC		O	VT_BSTR
cdcNs	VISIBLE STRING255	EX		O	VT_BSTR
cdcName	VISIBLE STRING255	EX			VT_BSTR
dataNs	VISIBLE STRING255	EX		O	VT_BSTR

5.2.21.2 Logical node name plate (LPL)

The table below defines the common data class of logical node name plate. Data of this common data class is used to identify logical nodes.

Table 43: Logical node name plate (LPL)

Name	Type	FC	Value/ Value range	M/O	OPC Data Type
vendor	VISIBLE STRING255	DC		M	VT_BSTR
hwRev	VISIBLE STRING255	DC		M	VT_BSTR
d	VISIBLE STRING255	DC	Text	M	VT_BSTR
dU	UNICODE STRING255	DC		O	VT_BSTR
configRev	VISIBLE STRING255	DC		O	VT_BSTR
ldNs	VISIBLE STRING255	EX	will be included only in LLN0	O	VT_BSTR
lnNs	VISIBLE STRING255	EX		O	VT_BSTR
cdcNs	VISIBLE STRING255	EX		O	VT_BSTR
cdcName	VISIBLE STRING255	EX		O	VT_BSTR
dataNs	VISIBLE STRING255	EX		O	VT_BSTR

5.2.22 Application error codes

Command Error codes of lastApplError attribute. The attribute is valid only for command data classes and its value represents the status of the last command. It is updated when the command responses are received from the devices.

The lastAppleError attribute is updated only when the IED responds to a failed command with the last application error. The value is not cleared or updated after a successful command.

The status code is received by adding the additional status code to main status code.

Example1: 3 = Select failed

Example2: 10 = Blocked by interlocking

Example3: 2000 = Timeout Test Not OK

Table 44: Main status codes

0	OK
1000	Unknown
2000	Timeout test not ok
3000	Operator test not ok

Table 45: Additional status codes

0	Unknown
1	Not supported
2	Blocked by switching hierarchy
3	Select failed
4	Invalid position
5	Position reached
6	Parameter change in execution
7	Step limit
8	Blocked by mode
9	Blocked by process
10	Blocked by interlocking
11	Blocked by synchrocheck
12	Command already in execution
13	Blocked by health
14	1 of n control
15	Abortion by cancel
16	Time limit over
17	Abortion by trip
18	Object not selected

5.3 Attributes

5.3.1 General about attributes

In addition to attributes for process data (indications and commands), the OPC Server also provides some attributes for controlling the devices and retrieving status information from them. These attributes are available for the OPC access client.

5.3.2 Server attributes

Table 46: Server attributes

Name	Value or Value range/ Default	Description
Protocol stack version	Version information	Data type: Text Access: Read-only The version information of the Protocol Stack
Configuration version	Version information	Data type: Text Access: Read-only The version information of the current configuration file.
Reset	By writing 1 the server is reset. By writing 2 the log file is cleared. Other values are currently ignored.	Data type: Integer Access: No limitations Makes it possible for clients to reset the OPC server. A reset means that the server disconnects all clients and reloads the configuration file. When the last client is disconnected the server usually shuts down. The server does not shut down if it was not started by the COM runtime or if it is running as a Windows service. In that case the configuration file is not reloaded.
File version	Version information	Data type: Text Access: Read-only The file version number of the OPC server/client .exe file.
Product version	Version information	Data type: Text Access: Read-only The version (revision) of the package that the server/client belongs to.

Timesync client	Value or Value range/ Default	Description
In use	0 = Not in use 1 = In use Default: 1	Data type: Integer Access: No limitations Status of the integrated SNTP client time synchronization routine. Value is 0 when not in use and 1 when in use. By writing 0 the client is started and by writing 1 it is stopped. The client can be started only if configuration parameters are given in a configuration file.
Timesync status	False = Not synchronized True = Synchronized OK	Data type: Boolean Access: Read-only Status of the integrated SNTP client time synchronization routine. Value is false when synchronization is not received and true when synchronization received and local time set OK.

Timesync server	Value or Value range/ Default	Description
In use	0 = Not in use 1 = In use Default: 1	Data type: Integer Access: No limitations Status of the integrated SNTP servers time synchronization routine. Value is 0 when not in use and 1 when in use. By writing 0 the client is started and by writing 1 it is stopped.
Timesync status	False = Failure True = OK	Status of the integrated SNTP servers time synchronization routine. Value is false when operation fails and true when operating OK.

5.3.3 IEC 61850 line attributes

Table 47: IEC 61850 line attributes

Name	Value or Value range/ Default	Description
In use	0 = Not in use, the line communication is stopped 1 = In use Default: 1	Data type: Integer Access: No limitations The state of the line whether it is in use or not. When a line is not in use, no data can be transmitted on it, and no data is received from it. When a line is stopped by setting the in use attribute to 0, all data transmission on the line ceases and all open connections to the devices will be closed. Single devices in use attribute may be set to 1 and this operation also takes the line in use. Now only the one device is in use. If the line's in use is set to 1, the rest of the devices are taken in use. The in use attribute has no affect on devices in simulation mode.
Object status	89 = Initialize error 90 = Not connected 91 = Initializing 100 = Ready 101 = Suspended (=Not in use) 102 = Simulated	Data type: Integer Access: Read-only Indicates the operating status of the device
Diagnostic events enabled	False = Diagnostic events disabled True = Diagnostic events enabled	Data type: Boolean Access: No limitations Enables/disables diagnostic events
Diagnostic events level	0 = Disabled 1 = Level1 (main operation and errors) 2 = Level2 (+ time synchronization error) 3 = Level3 (+ time synchronization done) 4 = Level4 5 = Level5	Data Type: Integer Access: No limitations Sets the maximum level for events coming from devices. Limits the lower level events to pass through. See also System Event level shown in .
Diagnostic counters:		
Sent connection request		Data type: Integer Access: No limitations Connect requests sent to devices
Received connection replies ok		Data type: Integer Access: No limitations Successful connect replies from devices
Received connection replies error		Data type: Integer Access: No limitations Failed connect replies from devices

Table continues on next page

Name	Value or Value range/ Default	Description
Sent connection concludes		Data type: Integer Access: No limitations Connections closed by IEC 61850 OPC server
Received connection concludes		Data type: Integer Access: No limitations Received connection concludes
Received connection aborts		Data type: Integer Access: No limitations Connections refused and aborted by devices
Received rejects		Data type: Integer Access: No limitations Request rejected by devices (usually if device could not decode the request or they do not support the used service)
Sent requests		Data type: Integer Access: No limitations Request sent to devices
Received replies ok		Data type: Integer Access: No limitations Successful requests to devices (received success responses)
Received replies error		Data type: Integer Access: No limitations Failed requests to devices (received error responses)
Received variable read replies ok		Data type: Integer Access: No limitations Variable read success responses from devices
Received variable read replies error		Data type: Integer Access: No limitations Variable read failure responses from devices
Received variable write replies ok		Data type: Integer Access: No limitations Variable write success responses from devices
Received variable write replies error		Data type: Integer Access: No limitations Variable read failure responses from devices
Received information reports		Data type: Integer Access: No limitations Information reports received from devices
Received status requests		Data type: Integer Access: No limitations Unsolicited status requests received from devices

5.3.4 IEC 61850 device attributes

Table 48: IEC 61850 device attributes

Name	Value or Value range/ Default	Description
In use	0 = Out of use 1 = In use Default: 1	Data type: Integer Access: No limitations The operational status of the device whether it is in use or out of use. Taking the device out of use with this attribute stops all data communication with the device and closes the connection. All operations that would result in a data exchange are disabled. Setting the value in use to 1 takes the device back in use and re-establishes connection to the physical device. The device itself is not affected by the attribute, only protocol stack's image of the device. The attribute in use has no effect on devices in simulation mode.
Object status	78 = Connection failure, authentication required 79 = Connection failure, authentication failed 84 = Buffer overflow error, purging RCB buffer 85 = Reporting initialization error, reinitializing 86 = Dataset create error 87 = Configuration error 88 = Configuration version error (device suspended) 89 = Error (not specified) 90 = Device not connected 91 = Initializing 92 = Initializing rcb (after error in reporting init or information report flow) 93 = Reinitialize (after reconnection if init done) 94 = Init (checking configuration version) 95 = Init (creating dataset) 96 = Init (checking rcb) 97 = Init (reading dataset) 98 = Init (enabling reporting) 99 = Init (rcb init ready) 100 = Ready 101 = Suspended (not in use) 102 = Device simulated	Data type: Integer Access: Read-only Indicates the operating status of the device Data type: Integer Access: Read-only Indicates the operating status of the device
Device connection status	False = Device connection suspended True = Device connection OK	Data type: Boolean Access: Read-only Indicates the status of the device connection.
Diagnostic events enabled	False = Diagnostic events disabled True = Diagnostic events enabled	Data type: Boolean Access: No limitations Enables/disables diagnostic events

Table continues on next page

Name	Value or Value range/ Default	Description
Diagnostic events level	0 = Disabled 1 = Level1 (main operation, error replies, errors) 2 = Level2 (+ Information Reports, OK replies, RCB init) 3 = Level3 (+ sent requests (connect,read,write), transparent SPA messages) 4 = Level4 (+ reported local updates) 5 = Level5 (+ reported unconfigured updates)	Data Type: Integer Access: No limitations Sets diagnostics event level See also System Event Level shown in IEC Device Properties.
IP address	0.0.0.0 - 255.255.255.255	Data type: Text Access: Read-only (configuration) IP address of the physical device
Configuration version	Version information	Data type: Text Access: Read-only The version information of the current configuration for this device.
Transparent XSAT		See Section 5.3.5.
Events		See Section 5.3.6.
Diagnostic counters:		
Sent connection requests		Data type: Integer Access: No limitation Connection requests sent to device
Received connection replies OK		Data type: Integer Access: No limitation Success connection replies received from device (connection accepted)
Received connection replies error		Data type: Integer Access: No limitation Failure connection replies received from device (connection refused).
Sent connection concludes		Data type: Integer Access: No limitation Connection to the device closed by IEC 61850 OPC Server.
Received connection concludes		Data type: Integer Access: No limitation Connections closed by device.
Sent requests		Data type: Integer Access: No limitation Additional requests (variable list, access attributes) sent to device
Received replies ok		Data type: Integer Access: No limitation Success replies to additional requests from device.
Received replies error		Data type: Integer Access: No limitation Failure replies to additional requests from device
Sent variable read requests		Data type: Integer Access: No limitation Variable read requests sent to device
Received variable read replies ok		Data type: Integer Access: No limitation Success replies to variable reads from device

Table continues on next page

Name	Value or Value range/ Default	Description
Received variable read replies error		Data type: Integer Access: No limitation Failure replies to variable reads from device
Sent variable write requests		Data type: Integer Access: No limitation Variable write requests sent to device
Received variable write replies ok		Data type: Integer Access: No limitation Success replies to variable write from device
Received variable write replies error		Data type: Integer Access: No limitation Failure replies to variable write from device
Received information reports		Data type: Integer Access: No limitation Information reports received from device
Received status replies		Data type: Integer Access: No limitation Successful replies to Status requests received from device

5.3.5 Transparent XSAT

The Transparent XSAT attribute can be used to read and write IEC 61850 attributes, which are not configured to the OPC namespace of the IEC 61850 OPC Server. For example, the transparent XSAT attribute can be used to set group control. The Transparent XSAT attribute is used through an OPC client. The attribute uses the OPC data type BSTR, which is a variant of the VT_BSTR data type.

The Transparent XSAT attribute passes the IEC 61850 servers and their attributes outside the IEC 61850 OPC servers namespace on request. The IEC 61850 OPC server does not check the outgoing attributes. Therefore the IEC 61850 OPC clients that are using the Transparent XSAT attribute know what attributes they are accessing. The Transparent XSAT attribute only supports read and write requests.

The Transparent XSAT attribute uses synchronic data access in the IEC 61850 OPC server. When an IEC 61850 OPC client writes a request, the IEC 61850 OPC server parses and sends the request to the IEC 61850 server.

The Transparent XSAT attribute returns and releases the request after it has received a reply from the IEC 61850 server. The reply is written into the Transparent XSAT attribute as an XSAT string.

5.3.5.1 XSAT Read Request

Attribute Data Type Unknown
The data type of the attribute is not known because it is not included in the IEC 61850 OPC Server configuration (SCL). The Transparent XSAT attribute requests the required data type before reading the data from an IEC 61850 server.

If the Transparent XSAT attribute receives a success message, the data type is saved. If the Transparent XSAT attribute receives an error message, an XSAT error string is sent to the IEC 61850 OPC client.

The IEC 61850 OPC server request the data type with a ReadVariableData service and the results are written in the Transparent XSAT attribute as an XSAT string. The XSAT string contains success and error messages.

Attribute Data Type Known
The data type of the attribute is known from a previous request or the attribute is included in the IEC 61850 OPC Server configuration (SCL). The IEC 61850 OPC server directly uses a ReadVariableData service to complete the request. The reply message is written into the Transparent XSAT attribute as an XSAT string. The XSAT string contains success and error messages.

5.3.5.2 XSAT Write Request

Attribute Data Type Unknown
The data type of the attribute is not known because it is not included in the IEC 61850 OPC Server configuration (SCL). The Transparent XSAT attribute requests the required data type before writing the data to an IEC 61850 server.

If the Transparent XSAT attribute receives a success message, the data type is saved. If the Transparent XSAT attribute receives an error message, an XSAT error string is sent to the IEC 61850 OPC client.

The IEC 61850 OPC server requests the data type with a WriteVariableData service and the results are written into the Transparent XSAT attribute as an XSAT string. The XSAT string contains success and error messages.

Attribute Data Type Known
The data type of the attribute is known from a previous request or the attribute is included in the IEC 61850 OPC Server configuration (SCL). The IEC 61850 OPC server directly uses a WriteVariableData service to complete the request. The reply message is written into the Transparent XSAT attribute as an XSAT string. The XSAT string contains success and error messages.'

5.3.5.3 XSAT Formats

- XSAT Read Request

  ```
  GetDataValue&result={name|noname}&LDInst=””&FunConstr=””&LNName=””
  [&DORef=””&Attr=””]]
  ```

- XSAT Write Request

  ```
  SetDataValue&LDInst=””&FunConstr=””&LNName=””[&DORef=””[&Attr=””]]&v=””
  ```

- XSAT Read Reply

  ```
  Success with names (result=name):

  <?xml version="1.0"?>
  <!DOCTYPE XSAT SYSTEM "xsat-004.dtd">
  <XSAT>
  <Response>
  <DO>
    <LDInst>…</LDInst>
    <LNName>…</LNName>
    <DORef>…</DORef>
    <At>
    <n>…</n>
    <v>…</v>
    <FunConstr>…</FunConstr>
    </At>
    …
    </DO>
    …
  </Response> </XSAT>
  ```

```
Success without names (result=noname):

<?xml version="1.0"?><!DOCTYPE XSAT SYSTEM "xsat-004.dtd">
<XSAT>
<Response>
<Values>
  <v>…</v>
  …
</Values>
</Response>
</XSAT>


Failure:

<?xml version=\"1.0\"?>
<!DOCTYPE XSAT SYSTEM \"xsat-004.dtd\">
<XSAT>
<Response>
<Result>failure</Result>
</Response>
</XSAT>
```

- XSAT Write Reply
  Success

```
<?xml version=\"1.0\"?><!DOCTYPE XSAT SYSTEM \"xsat-004.dtd\">
<XSAT>
<Response>
<Result>ok</Result>
</Response>
</XSAT>
```

  Failure

```
<?xml version=\"1.0\"?><!DOCTYPE XSAT SYSTEM \"xsat-004.dtd\">
<XSAT>
<Response>
<Result>failure</Result>
</Response>
</XSAT>
```

- EXAMPLE 1 (Read request + success reply)
  IEC 61850 Path:

```
LD1$PTOC1$ST
```

  Request:

```
GetDataValue&result=name&LDInst=LD1&LNName=PTOC1&FunConstr=ST
```

  Reply OK:

```
<?xml version="1.0"?>
<!DOCTYPE XSAT SYSTEM "xsat-004.dtd">
<XSAT>
<Response>
<DO><LDInst>LD1</LDInst><LNName>PTOC1</LNName><DORef>Str</DORef>
  <At><n>general</n><v>False</v><FunConstr>ST</FunConstr></At>
  <At><n>t</n><v>1.1.1970</v><FunConstr>ST</FunConstr></At>
  <At><n>q</n><v>12288</v><FunConstr>ST</FunConstr></At>
</DO>
<DO><LDInst>LD1</LDInst><LNName>PTOC1</LNName><DORef>Op</DORef>
  <At><n>general</n><v>False</v><FunConstr>ST</FunConstr></At>
  <At><n>t</n><v>1.1.1970</v><FunConstr>ST</FunConstr></At>
  <At><n>q</n><v>68</v><FunConstr>ST</FunConstr></At>
</DO>
</Response>
</XSAT>
```

- EXAMPLE 2 (Write request + failure reply)

IEC 61850 Path:

```
LD1$LLN0$BR$brcbStatUrg02&RptEna
```

Request:

```
SetDataValue&LDInst=LD1&LNName=LLN0&DORef=brcbStatUrg02&Attr=RptEna&Fun
Constr=BR&v=False
```

Reply OK:

```
<?xml version="1.0"?>
<!DOCTYPE XSAT SYSTEM "xsat-004.dtd">
<XSAT>
<Response>
<Result>failure</Result>
</Response>
</XSAT>
```

5.3.6 Events

The Events attribute is used to obtain IEC 61850 event data in the string data format. Events provides event data for all supported data objects in a single OPC item for each IED. Data for Events must be received in a single IEC 61850 information report. When the information report is received, the data is parsed from the report and combined into a single SCIL LIST formatted text string presentation. The string is updated to the Events attribute. Events supports event generation for the following CDCs: CST, CTS, BTS, UTS, LTS, OTS, GTS, MTS, NTS, STS. The attribute uses the OPC data type VT_BSTR. See SYS600 IEC 61850 System Design manual for details which CDCs are supported by the Power Process library.

There is no need for configuration. When an information report is received with data for the supported CDCs, the data is made available in Events. Duplicates of the latest received events for each data object are discarded. Events with the GI trigger option are discarded.

5.3.6.1 Events Format

EVENT SCIL LIST format:

LIST[([cdc = value [,attribute = value]*])]

The LIST format starts with the attribute 'cdc' with a string value according to IEC 61850 to identify the CDC of the event data. It is followed by the reported CDC attributes with values. 'attribute' is the name of the CDC attribute.

5.3.6.2 Events Data Value Formats

The IEC 61850 data type values are converted to a SCIL representation as defined below.

BOOLEAN is a string value TRUE or FALSE.

The FLOAT value delimiter is '.'.

PACKED LIST is presented as VECTOR of binary values. See examples for check, optFlds and trgOps.

OCTET STRING is presented as a string value in the hexadecimal representation. See examples for orIdent and entryID.

CTS structured attribute origin (Originator) is presented as VECTOR as defined below.

Originator
Originator = VECTOR(orCat,orIdent), where

orCat = INTEGER

orIdent = string in hexadecimal representation

TIMESTAMP(Full date time UTC with quality) is presented as VECTOR as defined below.

UtcTimestamp
UtcTimestamp =
VECTOR(SecondsSinceEpoch,MicroSeconds,ClockFailure,ClockNotSynchronized), where

SecondsSinceEpoch = seconds of timestamp from 1970-01-01 00:00:00 UTC

MicroSeconds = microseconds of timestamp

ClockFailure = BOOLEAN

ClockNotSynchronized = BOOLEAN

EntryTime(Full date time GMT without quality) is presented as UtcTimeStamp where

ClockFailure = FALSE

ClockNotSynchronized = FALSE

CDC = the CTS T-attribute is renamed as cT (control time).

5.3.6.3 Examples

- EXAMPLE 1
  The event data for control service tracking (CDC = CTS) data is defined below.

```
LIST(
cdc="CTS",
Check=VECTOR(1,1),
cT=VECTOR(1460104702,689000,FALSE,FALSE),
ctlNum=1,
ctlVal=TRUE,
errorCode=5,
objRef="AA1D1Q01A1CTRL/SCSWI1.Pos",
operTm=VECTOR(1457357647,232561,TRUE,TRUE),
origin=VECTOR(2,"414242"),
originatorID="c0a802b8",
respAddCause=2,
serviceType=44,
t=VECTOR(1460104692,652620,TRUE,TRUE),
Test=FALSE)
```

- EXAMPLE 2
  The event data for buffered report tracking service (CDC = BTS) data is defined below.

```
LIST(
cdc="BTS",
objRef="AA1D1Q02A1LD0/LLN0.rcbMeasFlt01",
serviceType=24,
errorCode=0,
originatorID="c0a8021d",
t=VECTOR(1461936548,53000,FALSE,FALSE),
rptID="AA1D1Q02A1LD0/LLN0$rcbMeasFlt01",
rptEna=TRUE,
datSet="AA1D1Q02A1LD0/LLN0$MeasFlt",
confRev=1,
optFlds=VECTOR(0,1,1,0,0,0,1,1,0,0),
bufTm=100,
sqNum=0,
trgOps=VECTOR(0,1,1,0,0,1),
```

```
intgPd=3000,
gi=FALSE,
purgeBuf=FALSE,
entryID="0200000000000000",
timeOfEntry=VECTOR(1461934452,592999,FALSE,FALSE),
owner="c0a8021d")
```

- EXAMPLE 3
  The event data for common tracking service (CDC = CST) data is defined below.

```
LIST(
cdc="CST",
objRef="Associate (initiate) received from 192.168.2.2",
serviceType=1,
errorCode=0,
originatorID="c0a80202",
t=VECTOR(1461935509,998000,FALSE,FALSE))
```

5.3.7 IEC 61850 logical device attributes

Table 49: IEC 61850 logical device attributes

Name	Value or Value range/ Default	Description
Transparent SPA	The contents of a valid SPA request	Data type: Text Access: No limitations Makes it possible to communicate with SPA unit by sending SPA message and reading the reply as text in SPA format from this item. The communication is passed through a TCP/SPA tunnel, where this attribute acts as an independent TCP/SPA client and is connected to a TCP/SPA server. The TCP/SPA server is then responsible for forwarding the SPA messages to and from the SPA devices. The SPA/TCP client handles its own communication separately from other communication. No checks are done on command or reply contents, they are simply passed on. This parameter is available only by configuration. This attribute must be enabled by setting the Transparent SPA Address, see Table 5. For example: SPA address = 1 SPA command RF must we written in format RF: and sent in format 1RF:. The reply is received in format >1D:REF543 :.

5.3.8 DuoDriver diagnostics

The local machine DuoDriver diagnostics status data is available through the IEC 61850 OPC Server, if DuoDriver is installed on the computer running the OPC Server. DuoDriver offers driver level management and diagnostics interface (API). The OPC Server uses the API to obtain the diagnostics and offers data through its OPC interface.

The IEC 61850 OPC Server requires no configuration. On startup it checks that DuoDriver is installed and creates the OPC items for DuoDriver diagnostics for all instances of DuoDriver. The configured DuoDriver instance name and NIC name are used in the IEC 61850 OPC Server namespace to identify the DuoDriver diagnostics.

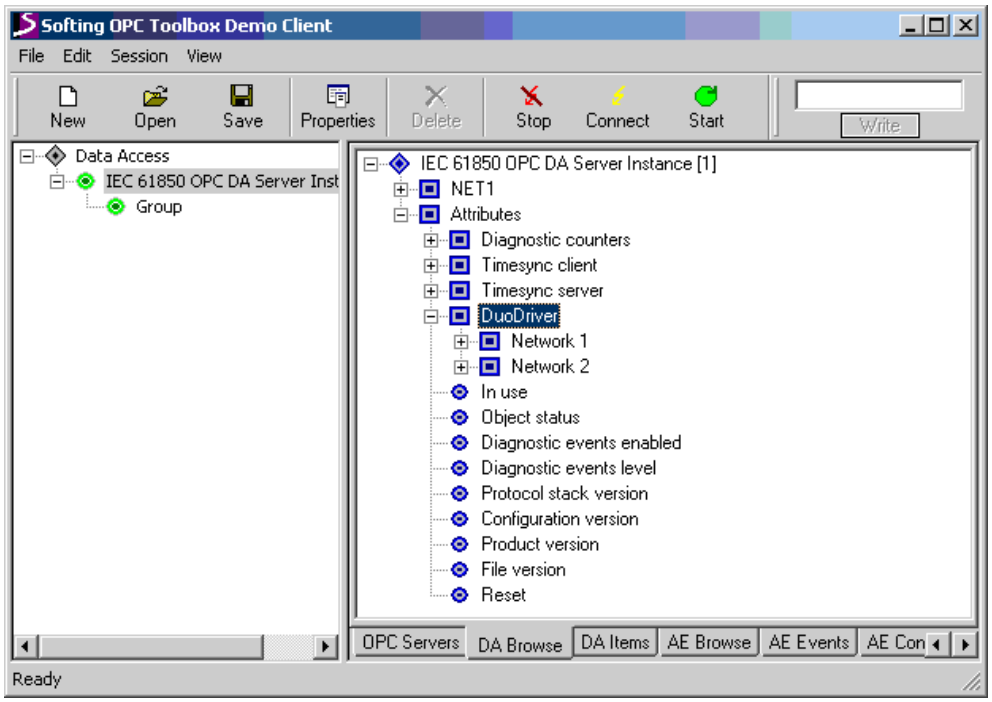

Figure 9: DuoDriver local diagnostics: 2 instances

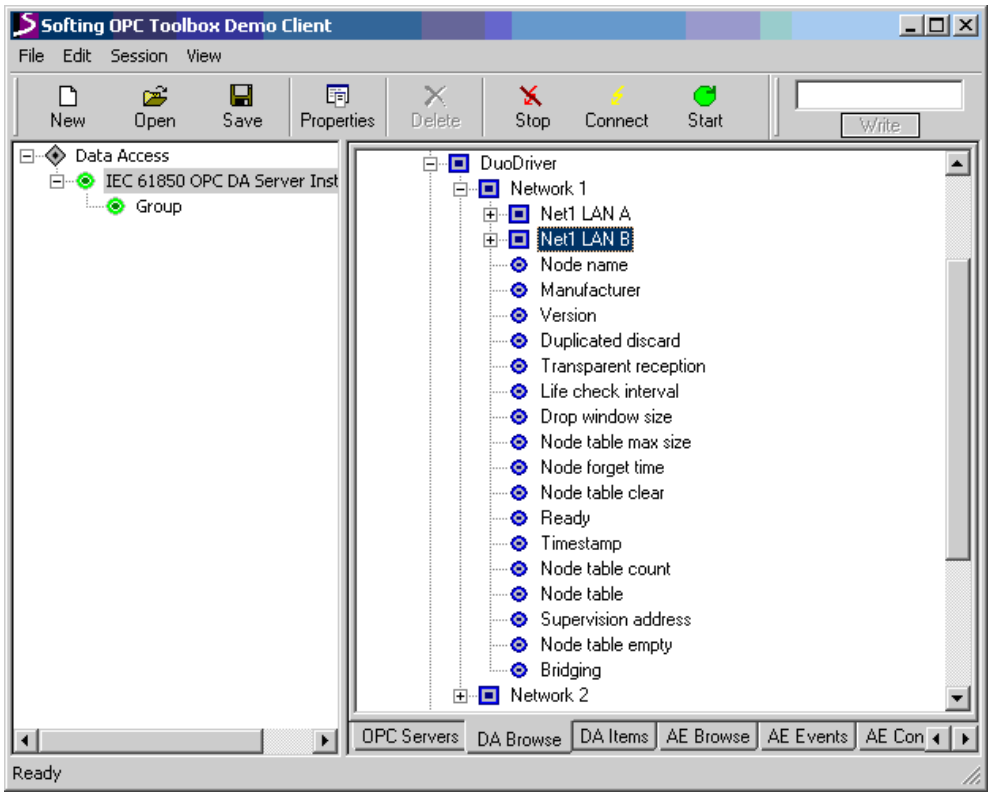

Figure 10: DuoDriver local diagnostics: instance diagnostics

The Working status of all DuoDriver interfaces (NICs) is polled once every 5 seconds from the driver. All other diagnostics must be explicitly read by an OPC client to be updated.

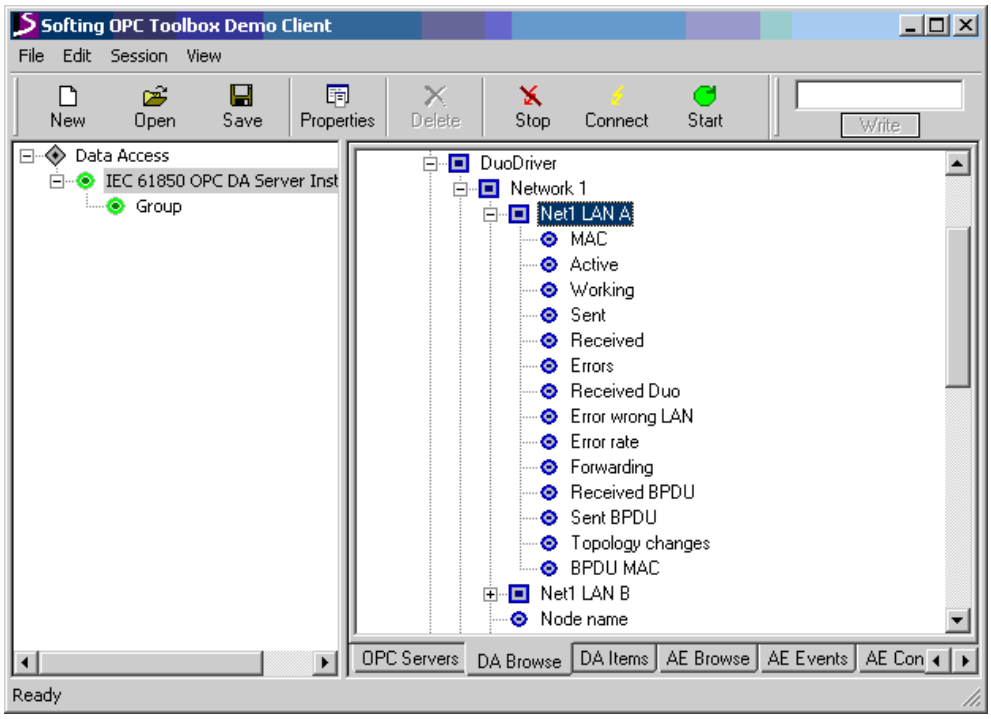

Figure 11: DuoDriver local diagnostics: interface diagnostics

5.4 IEC 61850 File transfer

5.4.1 General about IEC 61850 File Transfer

This section defines how the IEC 61850 file transfer services between the IEC 61850 OPC Server and the IEC 61850 devices are used through OPC DA. Since it is not possible to pass files through OPC, the IEC 61850 OPC Server is used as a file storage. The received and sent files are stored locally in the computer running the OPC server.

File transfer services are controlled by an OPC DA client through the OPC attributes under the IED\Attributes\File transfer node. For more information about the file transfer attributes, refer to Section 5.4.2.

The supported file transfer services are GetFile, SetFile, DeleteFile, GetFileAttributes, GetFileAttributesEx, RenameFile and Cancel. For more information about the file transfer services, refer to Section 5.4.3.

Make sure that the devices support the file transfer services.

5.4.2 File Transfer attributes

Table 50: File transfer attributes

Name	Value or Value range/ Default	Description
Remote file name		Data type: Text Access: No limitations File name of the remote file.
Remote file directory		Data type: Text Access: No limitations File directory of the remote directory.
Local file name		Data type: Text Access: No limitations File name of the local file.
Local file directory		Data type: Text Access: No limitations File directory of the local directory.
File size in bytes		Data type: Text Access: No limitations The size of the remote file is received in bytes.
Received bytes		Data type: Integer Access: No limitations The size of the current remote file is received in bytes. The IEC 61850 file transfer receives the file part by part in maximum sized MMS messages. This attribute shows the size of the file that has been received. The value increases as the file transfer continues.
Status	1000 - 10000 For more information about valid status values, refer to Section 5.4.4.	Data type: Integer Access: Read-only Status of the currently requested or last completed service.
Output		Data type: Text Access: Read-only The GetFileAttributeValues and GetFileAttributeValuesEx services print the output of the requested file structure to this attribute. For more information about the output format, refer to Section 5.4.3.
Control file reception	0 = Cancel 1 = GetFile 2 = GetFileAttributeValues 3 = GetFileAttributeValuesEx 4 = RenameFile 5 = SetFile 6 = DeleteFile	Data type: Text Access: Write-only This attribute controls the file transfer services. For more information about control codes for specific services, refer to Section 5.4.3.

5.4.3 File Transfer services

The file transfer services are controlled through the OPC DA attributes, see Table 50. To initiate a service, first the required parameters are written to respective OPC attributes and then the service is started by writing the service control code to the file transfer control attribute.

The file transfer control attribute uses synchronous data access for OPC. When an OPC client writes a service request, the corresponding IEC 61850 file transfer service on the device is called. When the service is finished or an error occurs, the OPC request is released.

The status of the latest service is available in the Status attribute. After a service is started, the status changes to the specific service status code. If the service is completed successfully, the status code is set to Ready (see Table 50). For more information about service failure status codes, refer to Table 53 and Table 54. Only one service can be called at a time.

5.4.3.1 GetFile

The user can copy a specified file from a remote device to the local file storage with the GetFile service. Through IEC 61850, this is done in three phases. First, the remote file is opened, then read, and finally closed. Remote file parameters identify the remote file. During this operation, the Status, Received bytes and File size in bytes attributes are updated as the file is moved (in max MMS message size parts). The copied file is renamed and placed into the local file storage according to local file parameters.

Required parameters:	Remote file name Remote file directory Local file name Local file directory
Control code:	1
Service status codes:	1100 1120 1140
Failure status codes:	91xx
The remote file name:	Remote file directory + Remote file name
The local file name:	Local file directory + Local file name

5.4.3.2 GetFileAttributeValues

The GetFileAttributeValues service obtains the name of a file or a group of files in the remote file storage. Received file attributes are printed to the Output attribute. This service prints only file names.

Required parameters:	Remote file name Remote file directory
Control code:	2
Service status codes:	1200
Failure status codes:	92xx

The remote file or directory name: Remote file directory + Remote file name

To request file attributes for a remote directory, set parameter Remote file name to empty. Space and tabulator are accepted as empty parameter.

Output
The format of the result string is printed to the Output attribute in the following format:

```
filename1{, filename2{, ...}}
```

Example:

```
70010106.cfg, 70010106.dat, 70010106.inf
```

5.4.3.3 GetFileAttributeValuesEx

The GetFileAttributeValuesEx service obtains the name and attributes of a file or group of files in the remote file storage. Received file attributes are printed to the Output attribute. This service prints the file names, file sizes and last modification dates if they are available.

Required parameters	Remote file name Remote file directory
Control code	3
Service status codes	1300
Failure status codes	93xx

The remote file or directory name: Remote file directory + Remote file name

To request file attributes for a remote directory, set the parameter Remote file name to empty. Space and tabulator are accepted as an empty parameter.

Output
The format of the result string is printed to the Output attribute in a following format:

```
filename1 [size{;d.m.Y H:M:S}]{, filename2 [size{;d.m.Y H:M:S}]{, ...}}
```

filename	= string
size	= bytes
d	= Day of month as decimal number (01 - 31)
m	= Month as decimal number (01 - 12)
Y	= Year with century, as decimal number
H	Hour in 24-hour format (00 - 23)
M	= Minute as decimal number (00 - 59)
S	= Second as decimal number (00 - 59)

Example:

```
70010106.cfg [922;02.01.1980 01:57:00], 70010106.dat [66600;02.01.1980
01:57:00], 70010106.inf [84;02.01.1980 01:57:00]
```

5.4.3.4 RenameFile

A file can be renamed or moved in the remote file storage with the RenameFile service.

Required parameters	Remote file name Remote file directory Local file name Local file directory
Control code	4
Service status codes	1400
Failure status codes	94xx
The remote file name to be renamed	Remote file directory + Remote file name
The new name for the remote file	Local file directory + Local file name

5.4.3.5 SetFile

The SetFile service initiates the remote device to obtain a file from the local file storage to the remote file storage. The service triggers an IEC 61850 device to call the IEC 61850 clients GetFile service and during this, the IEC 61850 client acts as a file server. During this operation, the Status, Received bytes and File size in bytes attributes are updated as the file is moved (in max MMS message size parts). The local file parameters identify the local file and the copied file is placed to the remote file storage according to remote file parameters.

Required parameters	Remote file name Remote file directory Local file name Local file directory
Control code	5
Service status codes	1500 1520 1540 1560
Failure status codes	94xx
The remote file name	Remote file directory + Remote file name
The local file name	Local file directory + Local file name

5.4.3.6 DeleteFile

The DeleteFile service is used to delete a file from the remote file storage.

Required parameters:	Remote file name Remote file directory
Control code:	6
Service status codes:	1600
Failure status codes:	96xx
The remote file name:	Remote file directory + Remote file name

5.4.3.7 Cancel

The Cancel service is used to cancel a service currently in use. The Cancel service sets the status to Ready and clears for the following attribute values: File size in bytes, Received bytes and Status.

Control code: 0

5.4.4 File Transfer service codes

Status codes can be read from the Status attribute. The status indicates the current service status and the service result.

Table 51: Service control codes

0	Cancel
1	GetFile
2	GetFileAttributeValues
3	GetFileAttributeValuesEx
Table continues on next page	

4	RenameFile
5	SetFile
6	DeleteFile

In the service status codes, the first number indicates success (1) or failure (9), and the second number indicates the currently requested service (0 - 6). If a local service is requested in multiple parts for the remote device, the third number indicates the currently called remote service (1 - 3). The fourth number gives a detailed failure code (0 - 3).

Example:

9601 = parameters error, remote file delete error

9123 = remote service error, remote file read error

Table 52: Success

1000	Ready
1100	Opening remote file
1120	Reading remote file
1140	Closing remote file
1200	Requesting remote directory file details
1300	Requesting remote directory file details
1400	Renaming remote file
1500	Requesting remote device to obtain local file
1520	Remote device requested to open local file
1540	Remote device requested to read local file
1560	Remote device requested to close local file
1600	Deleting remote file
1000	Service done

The failure status code indicates a failure in the requested service. The failure status code can also include a more detailed error code indicating the failure type, which can be a local or a remote failure.

Table 53: Failure

9000	Unspecified error
9100	Remote file open error
9120	Remote file read error
9140	Remote file close error
9200	Remote directory details error
9300	Remote directory details error
9400	Remote file rename error
9500	Error in remote obtaining local file
9520	Error in remote opening local file
Table continues on next page	

9540	Error in remote reading local file
9560	Error in remote closing local file
9600	Remote file delete error

Table 54: Failure details

0	No error details
1	Service parameters error (user error) Reason: required name attribute is empty Recovery: check the attribute values and try again
2	Local service error (IEC 61850 OPC Server internal error) Reason: not connected, too much network traffic, etc. Recovery: check connection and try again
3	Remote service error (remote device error) Reason: remote device is not supporting service, wrong parameters, no such file, connection failed, etc. Recovery: check remote device services support, check parameters (file names), check connection and try again

5.5 ACSI conformance statement

5.5.1 General about ACSI conformance statement

This section defines the compliance to IEC 61850 in terms of service, modeling and engineering interfaces and gives detailed explanation of the IEC 61850 capabilities of a product. ACSI conformance statement describes the abstract services interfaces, which are normally mapped to a certain SCSM (Specific communication service mapping) and therefore indirectly stated in PICS (Protocol Implementation Conformance Statement).

5.5.2 ACSI basic conformance statement

Table 55: ACSI basic conformance statement

		Client/ Subscriber	Server/ Publisher	Value/ Comments
	Client-Server roles			
B11	Server side (of TWO-PARTY-APPLICATION-ASSOCIATION)	-	a	
B12	Client side of (TWO-PARTY-APPLICATION-ASSOCIATION)	a	-	Supported
	SCSMs supported			
B21	SCSM: IEC 6185-8-1 used			Supported
B22	SCSM: IEC 6185-9-1 used			Not supported
B23	SCSM: IEC 6185-9-2 used			Not supported
B24	SCSM: other			
	Generic substation event model (GSE)			
B31	Publisher side	-	O	
B32	Subscriber side	O	-	Not supported

Table continues on next page

		Client/ Subscriber	Server/ Publisher	Value/ Comments
	Transmission of sampled value model (SVC)			
B41	Publisher side	-	O	
B42	Subscriber side	O	-	Not supported

a. Will be M if support for LOGICAL DEVICE model has been declared.

5.5.3 ACSI models conformance statement

Table 56: ACSI models conformance statement

		Client/ Subscriber	Server/ Publisher	Value/ Comments
	Server (If B1 side supported)			
M1	Logical device	a	a	Supported
M2	Logical node	b	b	Supported
M3	Data	c	c	Supported
M4	Data set	d	d	Supported
M5	Substitution	O	O	Supported
M6	Setting group control	O	O	Supported (through Transparent XSAT)
	Reporting			
M7	Buffered report control	O	O	Supported
M7-1	sequence-number			
M7-2	report-time-stamp			
M7-3	reason-for-inclusion			
M7-4	data-set-name			
M7-5	data-reference			
M7-6	buffer-overflow			
M7-7	EntryID			
M7-8	BufTim			
M7-9	IntgPd			
M7-10	GI			
M8	Unbuffered report control	M	M	Supported
M8-1	sequence-number			
M8-2	report-time-stamp			
M8-3	reason-for-inclusion			
M8-4	data-set-name			
M8-5	data-reference			
M8-6	BufTim			
M8-7	IntgPd			
	Logging	O	O	Not supported

Table continues on next page

		Client/ Subscriber	Server/ Publisher	Value/ Comments
M9	Log control	O	O	Supported (through Transparent XSAT)
M9-1	IntgPd			
M10	Log	O	O	Not supported
M11	Control	M	M	Supported
	GSE (if B31/B32 is supported)			
	GOOSE	O	O	Not supported
M12-1	EntryID			
M12-2	DataRefInc			
M13	GSSE	O	O	Not supported
	SVC (if 41/42 is supported)			
M14	Multicast SVC	O	O	Not supported
M15	Unicast SVC	O	O	Not supported
M16	Time	M	M	Supported (Time source with required accuracy will be available)
M17	File transfer	O	O	Supported

a. is M, if support for LOGICAL NODE model has been declared.

b. is M, if support for DATA model has been declared.

c. is M, if support for DATA SET, Substitution, Report, Log Control, or Time model has been declared.

d. is M, if support for Report, GSE, or SMV models have been declared.

5.5.4 ACSI service conformance statement

The ACSI service conformance statement is as defined in Table 57 (depending on the statements in Table 55).

Table 57: ACSI service conformance statement

		AA: TP/MC	Client (C)	Server (S)	Comments
	Server				
S1	ServerDirectory	TP		M	
	Application Association				
S2	Associate		M	M	Supported
S3	Abort		M	M	Supported
S4	Release		M	M	Supported
	Logical device				
S5	LogicalDeviceDirectory	TP	M	M	Supported
	Logical node				
S6	LogicalNodeDirectory	TP	M	M	Supported
Table continues on next page					

		AA: TP/MC	Client (C)	Server (S)	Comments
S7	GetAllDataValues	TP	O	M	Not supported
	Data				
S8	GetDataValues	TP	M	M	Supported
S9	SetDataValues	TP	O	O	Supported
S10	GetDataDirectory	TP	O	M	Supported
S11	GetDataDefinition	v	O	M	Supported
	Data set				
S12	GetDataSetValues	TP	O	M	Supported
S13	SetDataSetValues	TP	O	O	Not supported
S14	CreateDataSet	TP	O	O	Supported
S15	DeleteDataSet	TP	O	O	Not supported
S16	GetDataSetDirectory	TP	O	O	Supported
	Substitution				
S17	SetDataValues	TP	M	M	Supported
	Setting up control				
S18	SelectActiveSG	TP	O	O	Supported (through Transparent XSAT)
S19	SelectEditSG	TP	O	O	Supported (through Transparent XSAT)
S20	SetSGValues	TP	O	O	Supported (through Transparent XSAT)
S21	ConfirmEditSGValues	TP	O	O	Supported (through Transparent XSAT)
S22	GetSGValues	TP	O	O	Supported (through Transparent XSAT)
S23	GetSGCBValues	TP	O	O	Supported (through Transparent XSAT)
	Reporting				
	Buffered report control block (BRCB)				
S24	Report	TP	a	a	Supported
S24-1	data-change (dchg)				
S24-2	qchg-change (qchg)				
S24-3	data-update (dupd)				
S25	GetBRCBValues	TP	a	a	Supported

Table continues on next page

		AA: TP/MC	Client (C)	Server (S)	Comments
S26	SetBRCBValues	TP	a	a	Supported
	Unbuffered report control block (URBC)				
S27	Report	TP	a	a	Supported
S27-1	data-change (dchg)				
S27-2	qchg-change (qchg)				
S27-3	data-update (dupd)				
S28	GetURCBValues	TP	a	a	Supported
S29	SetURCBValues	TP	a	a	Supported
	Logging				
	Log control block				
S30	GetLCBValues	TP		M	Supported (through Transparent XSAT)
S31	SetLCBValues	TP		M	Supported (through Transparent XSAT)
	Log				
S32	QueryLogByTime	TP	b	M	Not supported
S33	QueryLogByEntry	TP	b	M	Not supported
S34	GetLogStatusValues	TP		M	Supported (through Transparent XSAT)
	Generic substation event model (GSE)				
	GOOSE-CONTROL-BLOCK				
S35	SendGOOSEMessage	MC	c	c	Not supported
S36	GetReference	TP	O	d	Not supported
S37	GetGOOSEElementNumber	TP	O	d	Not supported
S38	GetGoCBValues	TP	O	O	Supported (through Transparent XSAT)
S39	SetGoCBValues	TP	O	O	Supported (through Transparent XSAT)
S40	SendGSSEMessage	MC	c	c	Not supported
S41	GetReference	TP	O	d	Not supported
S42	GetGSSEElementNumber	TP	O	d	Not supported

Table continues on next page

		AA: TP/MC	Client (C)	Server (S)	Comments
S43	GetGsCBValues	TP	O	O	Supported (through Transparent XSAT)
S44	SetGsCBValues	TP	O	O	Supported (through Transparent XSAT)
	Transmission of sampled value model (SVC)				
	Multicast SVC				
S45	SendMSVMessage	MC	e	e	Not supported
S46	GetMSVCBValues	TP	O	O	Supported (through Transparent XSAT)
S47	SetMSVCBValues	TP	O	O	Supported (through Transparent XSAT)
	Unicast SVC				
S48	SendUSVMessage	TP	e	e	Not supported
S49	GetUSVCBValues	TP	O	O	Supported (through Transparent XSAT)
S50	SetUSVCBValues	TP	O	O	Supported (through Transparent XSAT)
	Control				
S51	Select		M	M	Supported
S52	SelectWithValue	TP	M	M	Supported
S53	Cancel	TP	O	M	Supported
S54	Operate	TP	M	M	Supported
S55	Command-Termination	TP	M	M	Supported
S56	TimeActivated-Operate	TP	O	O	Not supported
	File transfer				
S57	GetFile	TP	O	M	Supported
S58	SetFile	TP	O	O	Supported
S59	DeleteFile	TP	O	O	Supported
S60	GetFileAttributeValues	TP	O	M	Supported
	Time				
T1	Time resolution of internal clock				(nearest negative power of 2 in seconds)
T2	Time accuracy of internal clock			T0	

Table continues on next page

		AA: TP/MC	Client (C)	Server (S)	Comments
				T1	
				T2	
				T3	
				T4	
				T5	
T3	supported TimeStamp resolution			(nearest negative power of 2 in seconds)	

a. Declares support for at least one (BRCB or URCB).

b. Declares support for at least one (QueryLogByTime or QueryLogByEntry).

c. Declares support for at least one (SendGOOSEMessage or SendGSSEMessage).

d. Declares support, if TP association is available.

e. Declares support for at least one (SendMSVMessage or SendUSVMessage).

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Hitachi ABB Power Grids
Grid Automation Products
PL 688
65101 Vaasa, Finland

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