# IEC 61850 Driver for Tridium Niagara

User Guide

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# Contents

**1 Introduction** **3**

**2 Requirements** **4**

**3 Quick Start** **4**

**4 IEC 61850 Networks** **5**

**5 IEC 61850 Devices** **7**

**6 IEC 61850 Points** **8**

6.1 IEC 61850 Hierarchical Naming Structure . . . . . 8

6.1.1 Complete Object Reference Format . . . . . 9

6.1.2 Practical Examples . . . . . 9

6.1.3 More Reference Examples . . . . . 9

6.2 IEC 61850 Data Model . . . . . 9

6.2.1 Logical Devices (LD) . . . . . 9

6.2.2 Logical Nodes (LN) . . . . . 10

6.2.3 Data Objects (DO) . . . . . 10

6.2.4 Data Attributes (DA) . . . . . 10

6.2.5 Functional Constraints (FC) . . . . . 10

6.3 Point Representation in Niagara . . . . . 10

6.4 Niagara Point Types . . . . . 11

6.5 Point Discovery Process . . . . . 12

6.6 Point Update Logic . . . . . 12

6.6.1 Data Reading . . . . . 12

**7 Troubleshooting** **13**

7.1 Common Issues . . . . . 13

**8 FAQ** **13**

8.1 Can the driver control IEC 61850 devices? . . . . . 13

8.2 What is the difference between IEC 61850 and IEC 60870? . . . . . 14

8.3 What is the maximum number of points supported? . . . . . 14

8.4 Can I adjust polling rates for individual points? . . . . . 14

8.5 What data types are supported? . . . . . 14

8.6 Does the driver support time synchronization? . . . . . 14

8.7 Can the driver work with IEC 61850 Edition 1 and Edition 2 devices? . . . . . 14

8.8 Can Niagara and other SCADA systems connect to the same IEC 61850 server? . . . . . 14
8.9 Does the driver support GOOSE or SMV messages? . . . . . 15
8.10 How does performance compare to other protocols? . . . . . 15
8.11 What happens if the server connection is lost? . . . . . 15
8.12 Can I use custom port numbers? . . . . . 15
8.13 How do I know if my IED is compatible? . . . . . 15

# 1 Introduction

IEC 61850[1] is an international standard for communication protocols used in electrical substations. The standard defines object-oriented data models and services for substation automation systems, including protection relays, intelligent electronic devices (IEDs), and monitoring equipment. IEC 61850 is extensively deployed in:

- **Electrical Substations** - Protection, control, and monitoring systems
- **Power System Automation** - Smart grid applications, distribution automation
- **Renewable Energy Systems** - Wind farms, solar plants, energy storage
- **Industrial Power Systems** - Manufacturing plants, process control

The protocol provides object-oriented data modeling and MMS (Manufacturing Message Specification) communication services. Key features include:

- **MMS Communication** - TCP/IP port 102 for reliable network transport
- **Object-Oriented Data Model** - Hierarchical structure with Logical Devices, Logical Nodes, and Data Objects
- **Automatic Model Discovery** - Complete device model discovery for automatic point creation
- **Polling-Based Data Access** - Configurable polling rates for real-time data monitoring
- **Standard Data Types** - Support for boolean, numeric, string, and timestamp values

IEC 61850 Driver for Tridium Niagara acts as a **client** and connects to IEC 61850 **servers** such as protection relays, intelligent electronic devices (IEDs), and substation gateways. The driver automatically discovers the device data model and provides seamless integration with Niagara's point management system.

**Note:** This driver implements **read-only** functionality for monitoring applications. It does not support control commands or configuration changes to ensure safe operation in critical infrastructure environments.

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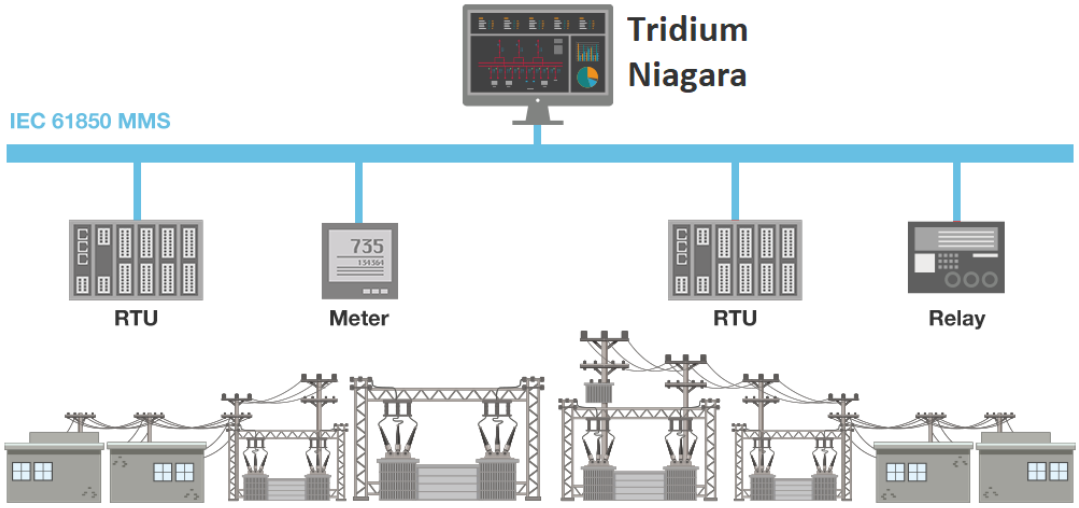


**Figure 1:** IEC 61850 Protocol Architecture

## 2 Requirements

- Niagara-powered device with software v4.8 or later, such as JACE, Supervisor, or any OEM version
- IEC 61850 driver module and license
- IEC 61850 devices with **MMS** (IEC 61850-8-1) communication capability
- IP address of the target IEC 61850 server/IED
- Network connectivity on TCP port 102 (standard IEC 61850 MMS port)

## 3 Quick Start

1. Copy iec61850-rt.jar module to Niagara /modules folder and restart the software.
    a. If the driver is hosted on PC: restart Supervisor / Workbench station.
    b. If the driver is hosted on JACE: import the module with all dependencies and restart it.
2. Ensure network connectivity to IEC 61850 server on TCP port 102.
3. Add **Iec61850 Network** to the station.
4. Enter license code in **License** property under **Iec61850 Network**.
5. Add **Iec61850 Device** under the network.
6. Configure device **Address** with the server's **Ip Address** and **Port** (normally 102).

7. **Discover** points in the device's **Points** extension.
8. Add discovered points to the station for monitoring.
9. Verify data reading by checking point **Out** values in real-time.

# 4 IEC 61850 Networks

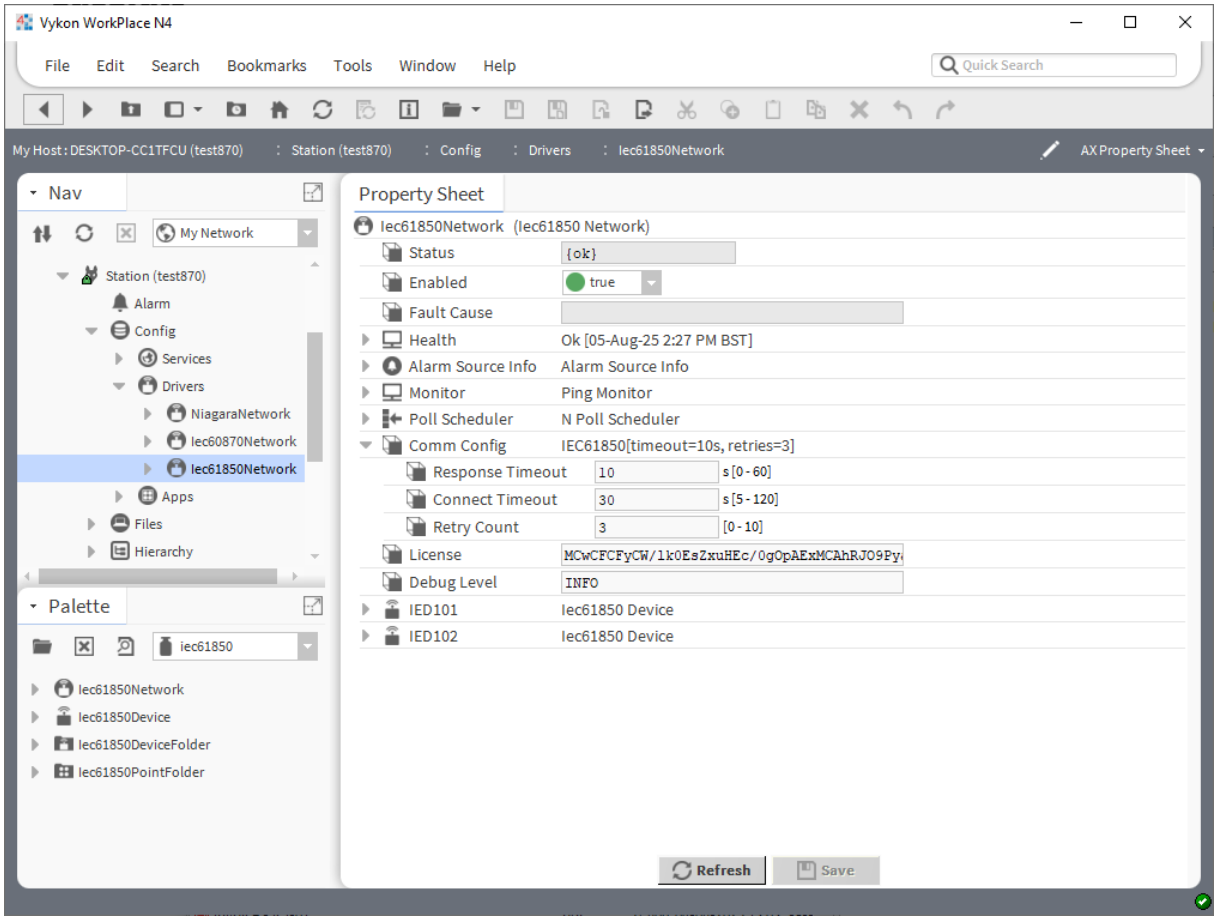


**Figure 2:** IEC 61850 network properties

**Iec61850 Network** contains standard Niagara network properties plus IEC 61850-specific configuration:

- **License** – the code that allows the driver to run on your host.
- **Comm Config** – communication parameters for the IEC 61850 MMS protocol:
  - **Response Timeout** – time to wait for MMS responses (default 10s, range 0-60s).
  - **Connect Timeout** – time to wait for connection establishment (default 30s, range 5-120s).

  - **Retry Count** – number of retries for failed operations (default 3, range 0-10).

- **Poll Scheduler** – polling rates for periodic data reading operations:
  - **Fast**: 10 seconds (high-priority data points)
  - **Normal**: 30 seconds (standard operation)
  - **Slow**: 120 seconds (slow-changing values)

Users should not usually adjust these parameters, as the defaults are optimized for most applications. However, advanced users can tune them based on network characteristics and server requirements.

In IEC 61850 data is read through polling, so the poll scheduler settings determine how frequently point values are updated. For basic deployments, only **License** value needs to be configured.

After network properties are configured, devices can be added to discover and monitor IEC 61850 data points.

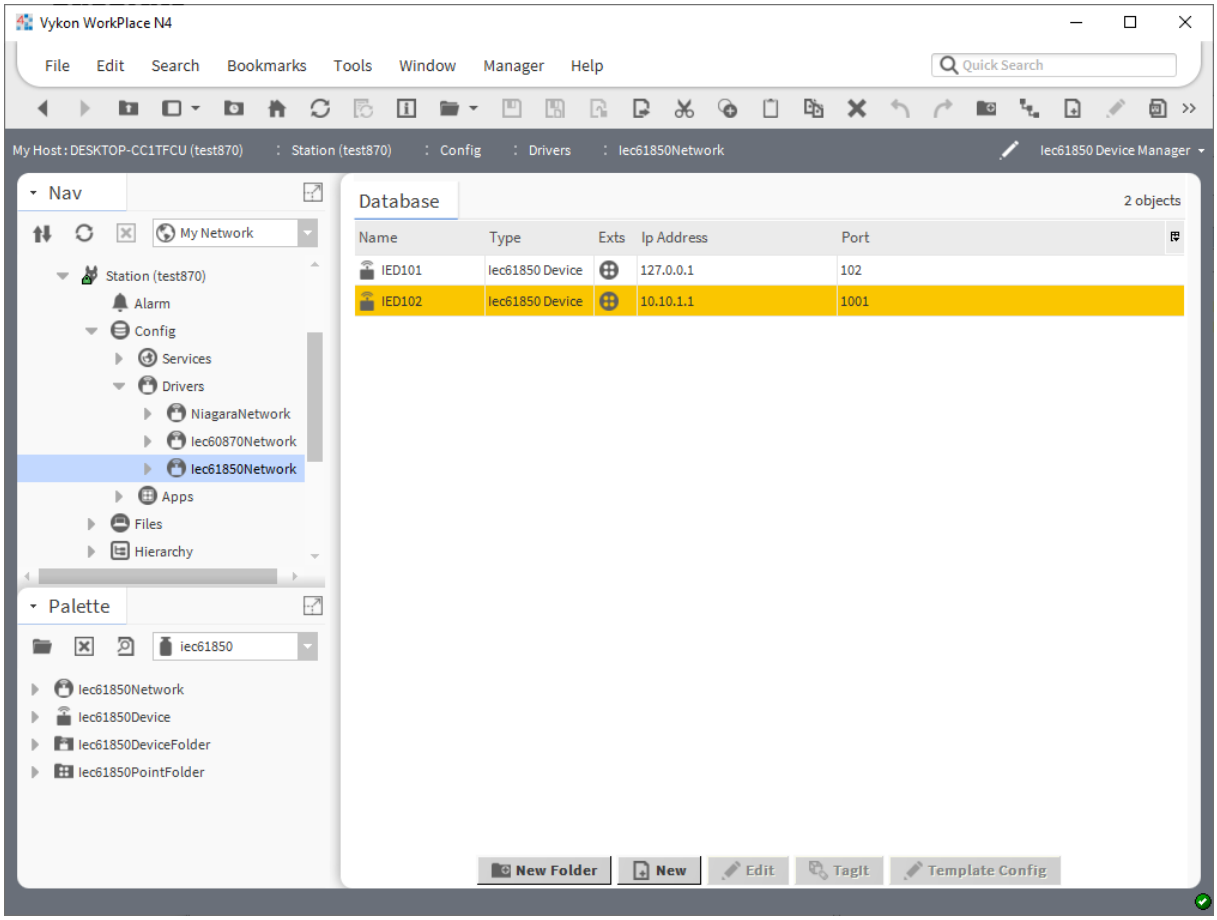


**Figure 3:** IEC 61850 device manager

# 5 IEC 61850 Devices

Each **Iec61850 Device** represents one IEC 61850 server (IED) identified by its network address:

- **Ip Address** – IP address of the IEC 61850 server/IED.
- **Port** – TCP port number (default 102).

The address must match the server configuration.

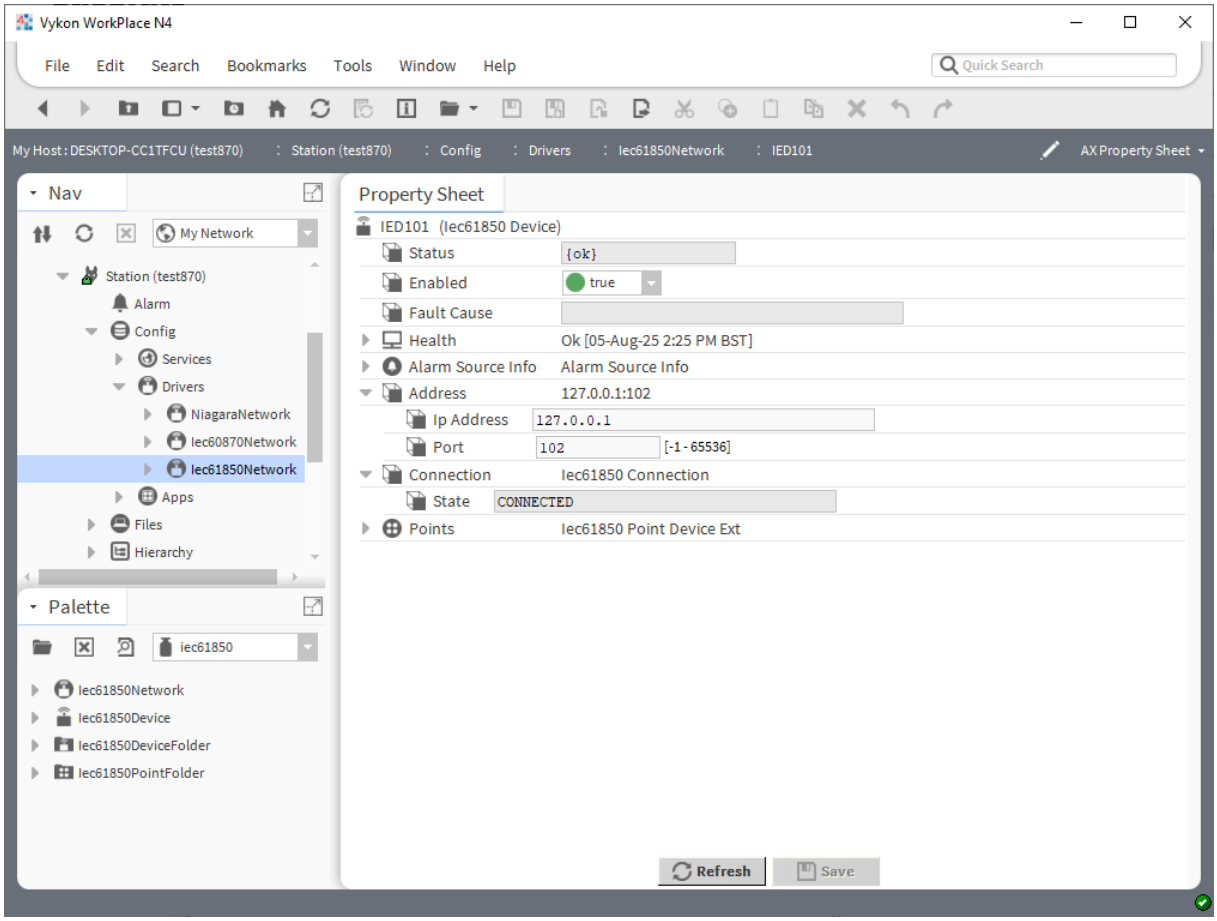


**Figure 4:** IEC 61850 device properties

**Connection Process:**

1. TCP connection established to server on port 102
2. **MMS Association** handshake with server
3. **Model Discovery** using directory services to get complete device structure
4. **Point Creation** based on discovered data attributes
5. **Data Reading** using MMS Read services for subscribed points

# 6 IEC 61850 Points

IEC 61850 data points are based on the standard's hierarchical data model and are uniquely identified by their **object reference**.

## 6.1 IEC 61850 Hierarchical Naming Structure

The IEC 61850 naming follows a strict hierarchical structure that represents the logical organization of substation equipment:

```
IED (Physical Intelligent Electronic Device)
│
├── Logical Device (LD) - "PROT" (Protection Functions)
│   │
│   ├── Logical Node (LN) - "XCBR1" (Circuit Breaker #1)
│   │   │
│   │   ├── Data Object (DO) - "Pos" (Position)
│   │   │   │
│   │   │   ├── Data Attribute (DA) - "stVal" (Status Value)
│   │   │   ├── Data Attribute (DA) - "q" (Quality)
│   │   │   └── Data Attribute (DA) - "t" (Timestamp)
│   │   │
│   │   └── Data Object (DO) - "OpCnt" (Operation Counter)
│   │       │
│   │       ├── Data Attribute (DA) - "stVal" (Counter Value)
│   │       └── Data Attribute (DA) - "q" (Quality)
│   │
│   └── Logical Node (LN) - "MMXU1" (Measurement Unit #1)
│       │
│       └── Data Object (DO) - "A" (Current)
│           │
│           ├── Data Attribute (DA) - "phsA.cVal.mag.f" (Ph A Value)
│           └── Data Attribute (DA) - "q" (Quality)
│
└── Logical Device (LD) - "MEAS" (Measurement Functions)
    └── [Additional Logical Nodes...]
```

#### 6.1.1 Complete Object Reference Format

Each point is addressed using the complete path with functional constraint:

**Reference**: `LogicalDevice/LogicalNode.DataObject.DataAttribute`

#### 6.1.2 Practical Examples

| Component | Example | Description |
|---|---|---|
| **Logical Device** | PROT | Protection functions group |
| **Logical Node** | XCBR1 | First circuit breaker |
| **Functional Constraint** | ST | Status information |
| **Data Object** | Pos | Position indication |
| **Data Attribute** | stVal | Status value |

#### 6.1.3 More Reference Examples

- `PROT/XCBR1.Pos.stVal` - Circuit breaker position (open/closed)
- `MEAS/MMXU1.A.phsA.cVal.mag.f` - Phase A current magnitude
- `PROT/PTOC1.Str.general` - Overcurrent protection start signal
- `CTRL/GGIO1.Ind1.stVal` - Generic input #1 status
- `INFO/LLN0.NamPlt.vendor` - Device nameplate vendor information

This hierarchical structure allows for systematic organization of thousands of data points in complex substation devices while maintaining clear logical relationships between related data.

### 6.2 IEC 61850 Data Model

The IEC 61850 data model is organized hierarchically to represent the logical structure of substation equipment:

#### 6.2.1 Logical Devices (LD)

Represent major equipment or functions within an IED, such as protection, control, or measurement functions.

#### 6.2.2 Logical Nodes (LN)

Represent specific functions within a Logical Device. Common types include:

- **XCBR**: Circuit Breaker - Position, operation counters, and health status
- **MMXU**: Measurement Unit - Voltage, current, power, and frequency measurements
- **PTOC**: Overcurrent Protection - Settings, pickup status, and trip decisions
- **GGIO**: Generic Process I/O - General-purpose inputs and outputs
- **LLN0**: Logical Node Zero - Device identification and status information

#### 6.2.3 Data Objects (DO)

Represent specific data items within a Logical Node, such as measurements, status points, or settings.

#### 6.2.4 Data Attributes (DA)

Individual values within Data Objects, such as magnitude (mag), status value (stVal), or quality (q).

#### 6.2.5 Functional Constraints (FC)

Define the purpose and behavior of data:

- **ST**: Status Information - Real-time status and position data
- **MX**: Measured Values - Analog measurements and calculated values
- **CF**: Configuration - Device configuration parameters and settings
- **DC**: Description - Device and data object descriptions
- **SP**: Setpoint - Control setpoints and parameters
- **SG**: Setting Groups - Protection setting group information
- **CO**: Control - Control operations and commands

### 6.3 Point Representation in Niagara

Each discovered **Data Attribute** can be mapped to a Niagara point. Points are addressed using the full IEC 61850 object reference and functional constraint. In addition to the standard **Out** property showing real-time values, each point contains configuration properties:

- **Reference** – the complete IEC 61850 object reference path (using / and . separators).

- **FC** – the Functional Constraint type (ST, MX, CF, DC, etc.) configured separately.
- **Poll Frequency** – polling rate for this specific point.

**Data Types** are automatically converted from IEC 61850 basic data types to appropriate Niagara point types during discovery.

**Note**: The functional constraint (FC) is configured separately from the reference path. The reference uses standard "/" for Logical Device/Node separation and "." for Data Object/Attribute separation.

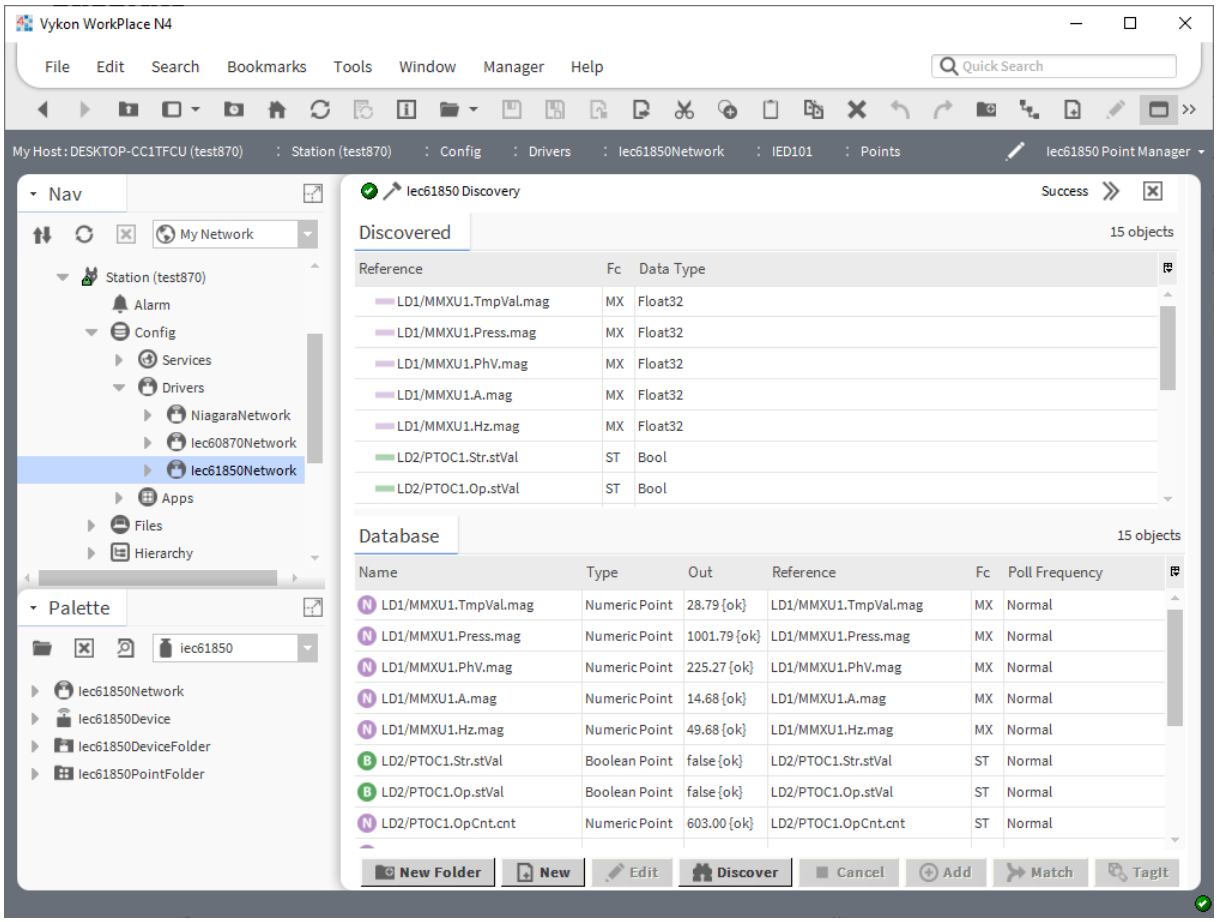


**Figure 5:** IEC 61850 points

## 6.4 Niagara Point Types

The driver maps IEC 61850 data types to appropriate Niagara point types:

| IEC 61850 Type | Description | Niagara Type | Use Case |
|---|---|---|---|
| BOOLEAN | Binary values | Boolean Point | Switch positions, alarm states |
| INT8/INT16/INT32/INT64 | Integer values | Numeric Point | Counters, enumerations |
| FLOAT32 / FLOAT64 | Floating point | Numeric Point | Measurements, calculated values |
| VISIBLE_STRING | ASCII text strings | String Point | Device names, descriptions |
| TIMESTAMP | Date/time values | String Point | Event timestamps |
| BIT_STRING | Binary bits | String Point | Status bit arrays |
| OCTET_STRING | Binary data | String Point | Raw binary data |

## 6.5 Point Discovery Process

IEC 61850 points are discovered automatically through the **GetNameList** MMS service. The **Iec61850 Point Manager** displays discovered points organized by their logical structure.

**Automatic Discovery Sequence:**

1. Driver connects to IEC 61850 server using MMS protocol
2. Driver gets the complete device model hierarchy
3. Driver recursively traverses the model to find readable data attributes
4. Each data attribute becomes a discoverable point with reference path and functional constraint
5. Point entries are automatically created in the discovered pane with proper data type mapping

## 6.6 Point Update Logic

The driver reads point values on-demand using direct MMS Read services. Unlike spontaneous protocols, IEC 61850 typically uses polling-based data access.

### 6.6.1 Data Reading

Point values are updated through:

- **Polling-based reading**: Active points are read according to poll scheduler settings (Fast: 10s, Normal: 30s, Slow: 120s)
- **Individual MMS Read**: Each point reads its value using the attribute reference and functional constraint
- **Cached model access**: Device model is cached after initial retrieval to minimize network traffic

# 7 Troubleshooting

## 7.1 Common Issues

**Connection Problems:**

- Verify network connectivity: `ping <server_ip>` and `telnet <server_ip> 102`
- Check firewall allows TCP port 102
- Confirm license is valid and not expired
- Increase **Connect Timeout** for slow networks

**No Points Discovered:**

- Verify device model contains readable data attributes
- Check server supports MMS services
- Confirm IED has proper Logical Node structure configured

**Data Reading Issues:**

- Verify point **Reference** path is correct
- Check **Functional Constraint** matches server configuration
- Adjust **Poll Frequency** for network performance

# 8 FAQ

## 8.1 Can the driver control IEC 61850 devices?

No, this driver is read-only for safety in critical infrastructure environments. It supports monitoring only.

### 8.2 What is the difference between IEC 61850 and IEC 60870?

IEC 61850 uses object-oriented data models with hierarchical naming, while IEC 60870 uses simple address-based point identification. IEC 61850 is designed specifically for substation automation with standardized logical nodes.

### 8.3 What is the maximum number of points supported?

Point limits depend on license type. Contact vendor for specific requirements.

### 8.4 Can I adjust polling rates for individual points?

Yes, each point has a Poll Frequency property that can be set to fast (10s), normal (30s), or slow (120s) independently.

### 8.5 What data types are supported?

The driver supports boolean, integer, floating-point, string, timestamp, and bit string data types with automatic conversion to appropriate Niagara point types.

### 8.6 Does the driver support time synchronization?

No, the current version focuses on data monitoring only. Time synchronization services are not implemented.

### 8.7 Can the driver work with IEC 61850 Edition 1 and Edition 2 devices?

Yes, the driver supports standard MMS services that are compatible with both Edition 1 and Edition 2 implementations.

### 8.8 Can Niagara and other SCADA systems connect to the same IEC 61850 server?

This depends on the server implementation. Many modern IEDs support multiple concurrent client connections.

### 8.9 Does the driver support GOOSE or SMV messages?

No, this driver implements MMS-based client-server communication only. GOOSE and Sampled Values are not supported in this implementation.

### 8.10 How does performance compare to other protocols?

IEC 61850 MMS provides reliable polling-based communication suitable for SCADA monitoring. Performance depends on poll frequency settings (10-120 seconds).

### 8.11 What happens if the server connection is lost?

The driver will automatically attempt to reconnect and re-establish data reading. Point values will show as down until connection is restored.

### 8.12 Can I use custom port numbers?

Yes, configure the port in device settings. Standard port 102 is recommended for compliance.

### 8.13 How do I know if my IED is compatible?

The IED must support standard IEC 61850 MMS services. Most standard IEC 61850 MMS implementations should work.