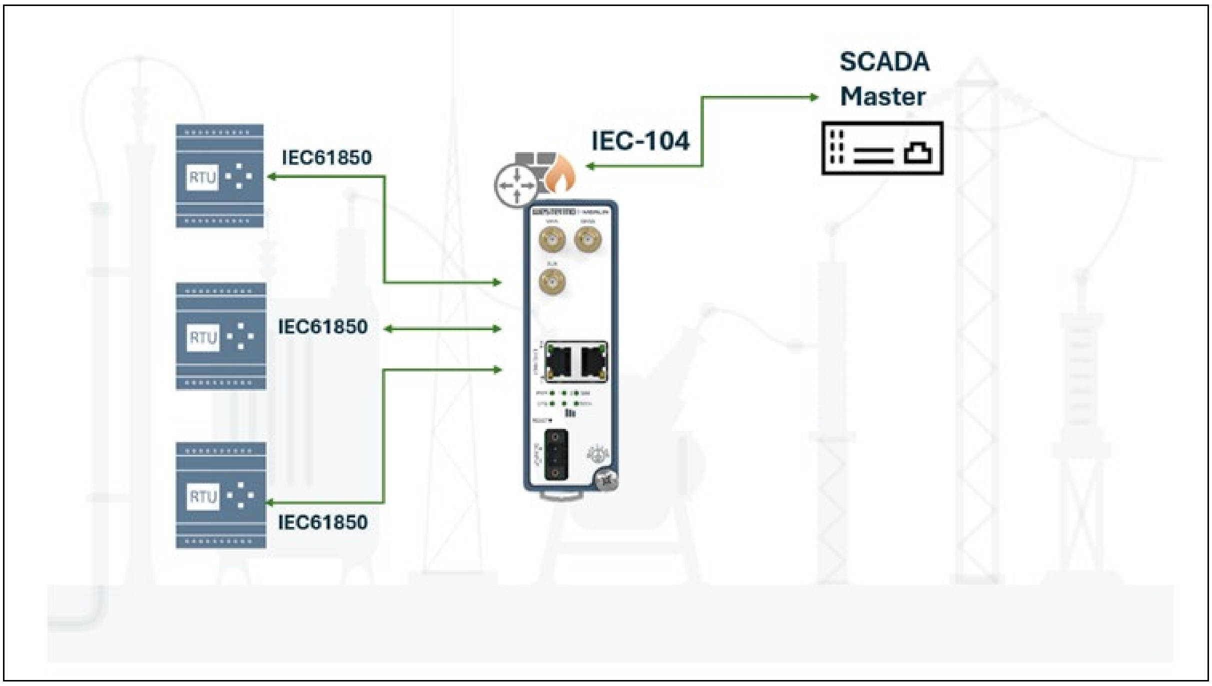
Merlin SCADA Protocol Conversion

Conversion scenario: IEC61850 to IEC104

AN-003-WIE



Hardware Models	Merlin Series
Revision	1.01
Approval status	Approved
Date:	06 June 2025
Brief description	Merlin SCADA Protocol Conversion Scenario: IEC61850 to IEC104

1 Overview

This application note demonstrates how to set up the IECD application for selected protocol conversion. It details the steps required to configure an IEC61850 to IEC104 protocol conversion scenario. IECD is a SCADA protocol conversion application.

1.1 Firmware information

Firmware version: SXL-25.04.66.000-Beta or newer.

1.2 Assumptions

This application note shows the Merlin 4407 router and assumes the router has a factory default configuration. Instructions can be applied to other routers in the Merlin Series.

1.3 Corrections

Requests for corrections or amendments to this application note are welcome and should be addressed to support.ie@westermo.com

Requests for new application notes can be sent to the same address.

2 Configuring an IECD application

Browse to the IECD configuration page via the WebUI and follow the steps below.

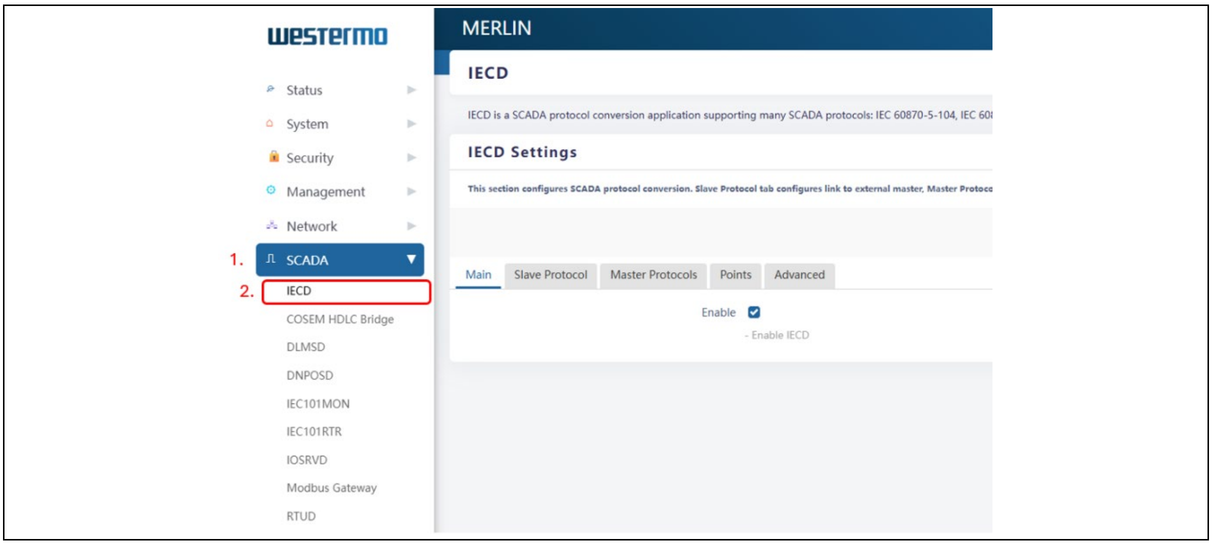


Figure 1: Main Settings

1. In the left-hand menu, click **SCADA**.
2. Select **IECD**.

Note: in the IECD application, communication with local controlled devices such as RTU is referred to as the Master protocol, while communication with the external controller, Main SCADA Master, is referred to as the Server/Slave protocol.

3 Setting up the scenario

To set up a conversion scenario, you must configure the server (slave) protocol, master protocol, and at least one data point.

Follow the configuration tabs from left to right.

Enable the application in the Main tab and then configure the other tabs as described in the following sections.

Remember to always click **SAVE & Apply** after completing each of the tabs.

The SAVE & APPLY button is always at the bottom of the page.

4 Configuring server protocol (IEC104)

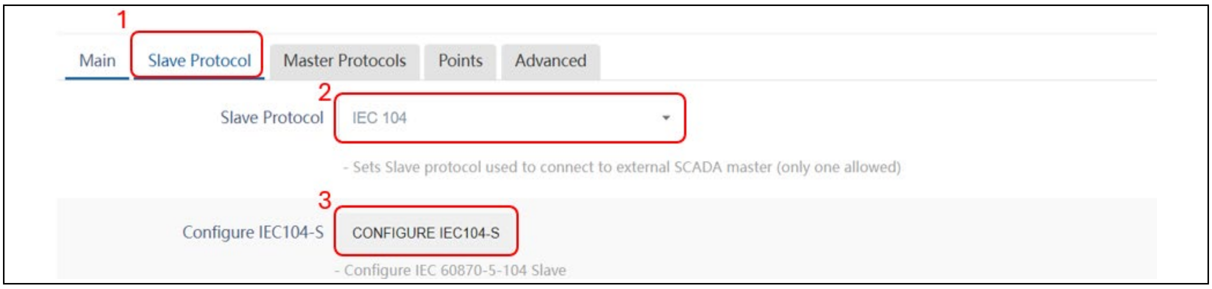


Figure 2:Slave Protocol tab in IEC104 Server Settings

1. Click **Slave Protocol**.
2. Select **IEC104** as the Server protocol.
3. Click **CONFIGURE IEC104-S**.

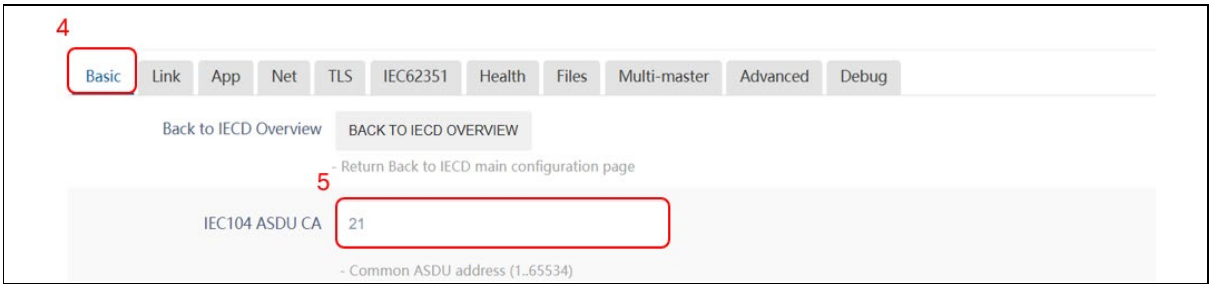


Figure 3:Basic tab in IEC104 Server Settings

4. Click **Basic**.
5. Set the IEC104 ASDU CA number.

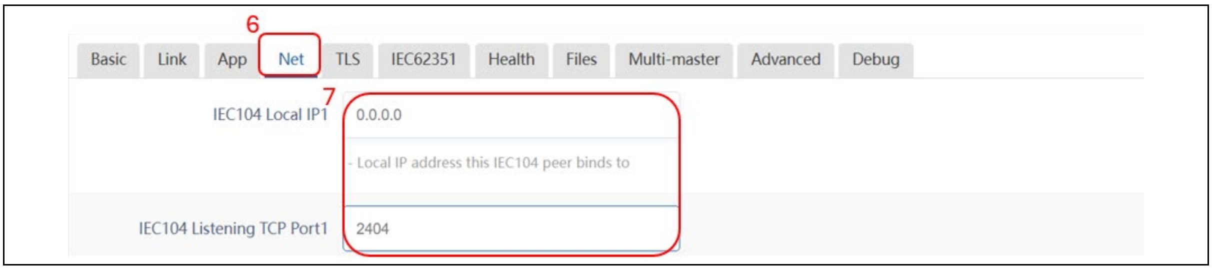


Figure 4: Net tab in IEC104 Server Settings

6. Click **Net**.
7. Set the **Local IP** and **Port** for the IEC104 server.

5 Configuring a master protocol

For this scenario (IEC61850-IEC1040), there are two configuration methods available: fully automated via SCL file upload (such as .SCD) or manual method.

Note 1: the IECD application supports up to 32 clients (32 connections with local servers) and 2048 data points in total.

Note 2: automated configuration via SCL file upload is only supported for an IEC104 scenario. To configure different scenarios, e.g. IEC61850 to DNP3, you must perform a manual configuration.

5.1 Uploading an SCL file

An SCL file can be uploaded via the WebUI interface within the Mater Protocols section. The upload will automatically trigger the autoconfiguration feature. The SCL files must include all necessary parameters for establishing IEC6850 communication. The parser will process the file and populate the parameter values automatically, thereby eliminating the need for manual user configuration. Once the SCL file configuration method is selected, users are unable to make change via the WebUI; modifications must be made in the SCL file and reuploaded.

Note: data points will be created automatically, and there is no additional configuration steps required once this method has been selected.

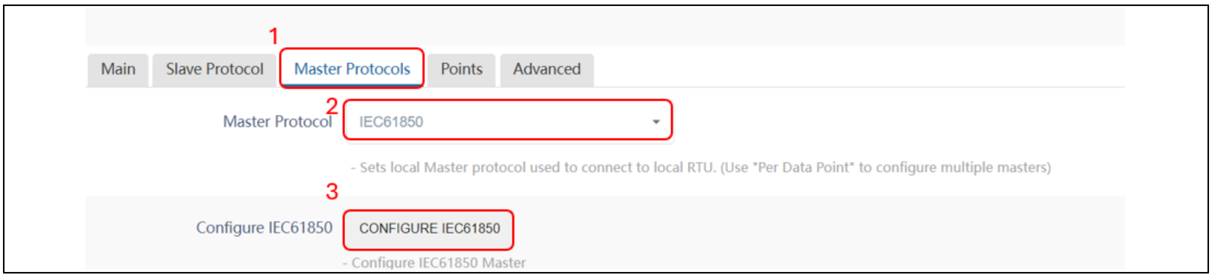


Figure 5: Master Protocol tab

1. Navigate to IECD Settings and click **Master Protocols**.
2. Set **IEC61850** as the master protocol.

3. Click **CONFIGURE IEC61850**.

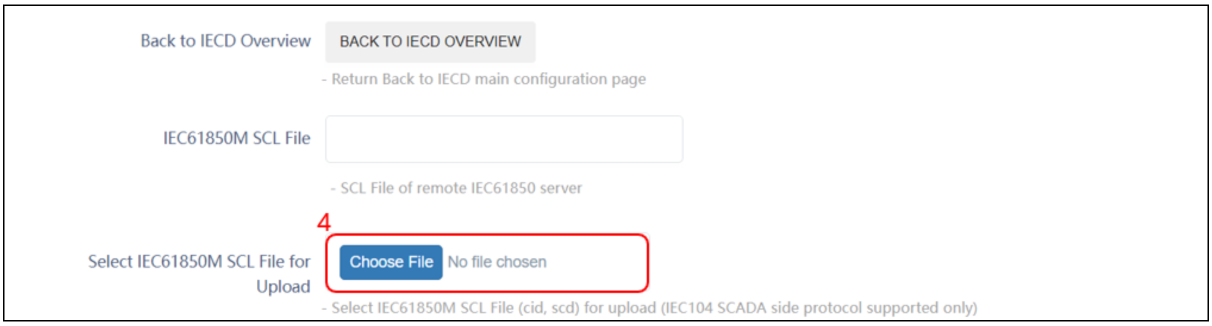


Figure 6: IEC61850 Settings

4. Click **Choose File** and select the SCL file to upload. Supported files are CID, ICD, and IID.

Note: you can switch to manual configuration after a successful autoconfiguration/SCL parsing step, by removing the content of IEC61850M SCL file parameter (the file path).

5. Scroll to the bottom of the page and click **SAVE & APPLY**.

After a successful file upload, a list of newly configured client connections will be presented in the same Master Protocols configuration window. Users will be capable of viewing individual client settings parsed from the SCL file.

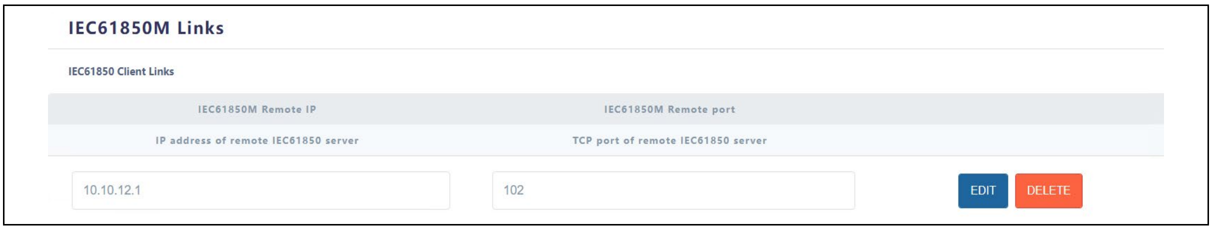


Figure 7: IEC61850 Client List

5.2 Manually configuring IEC61850

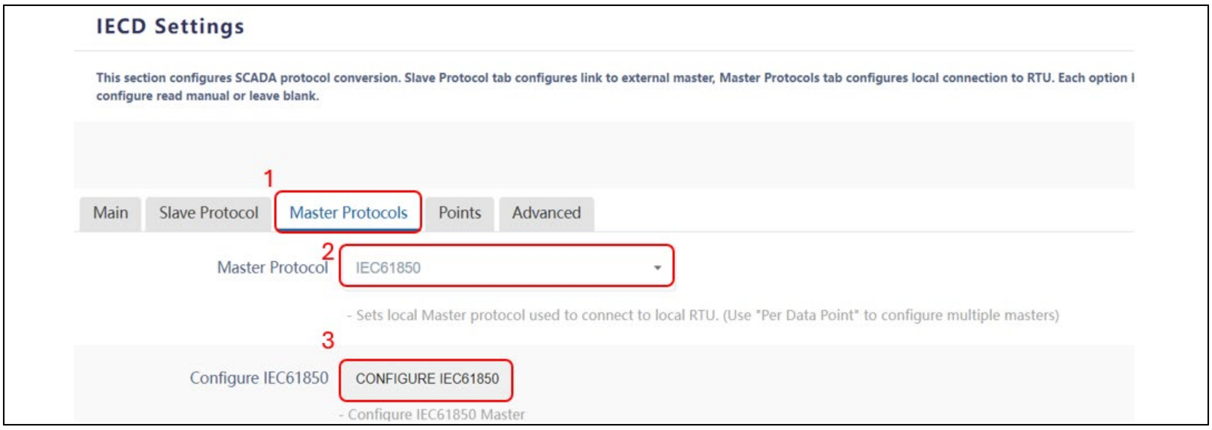


Figure 8: Master Protocols tab in IEC61850 Master Settings

1. Navigate to IECD Settings and click **Master Protocols**.
2. Set **IEC61850** as the master protocol.

3. Click **CONFIGURE IEC61850**.

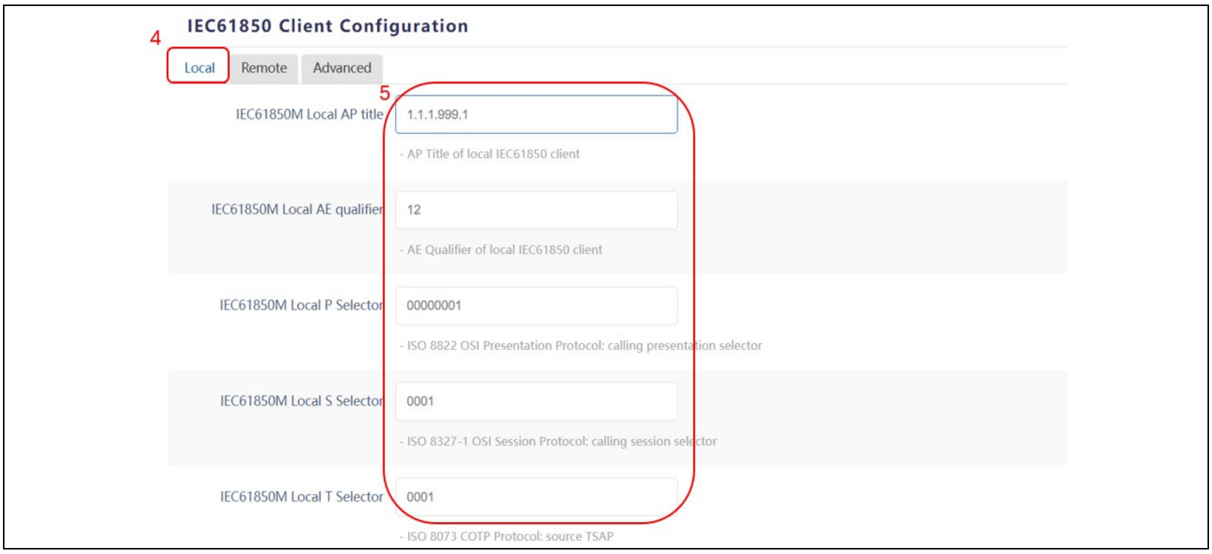


Figure 9: Local tab in IEC61850 Master Settings

4. Click **Local** to configure local parameters.
5. Set the communication parameters for the local IEC61850 Master. Default values are shown in the above screenshot.

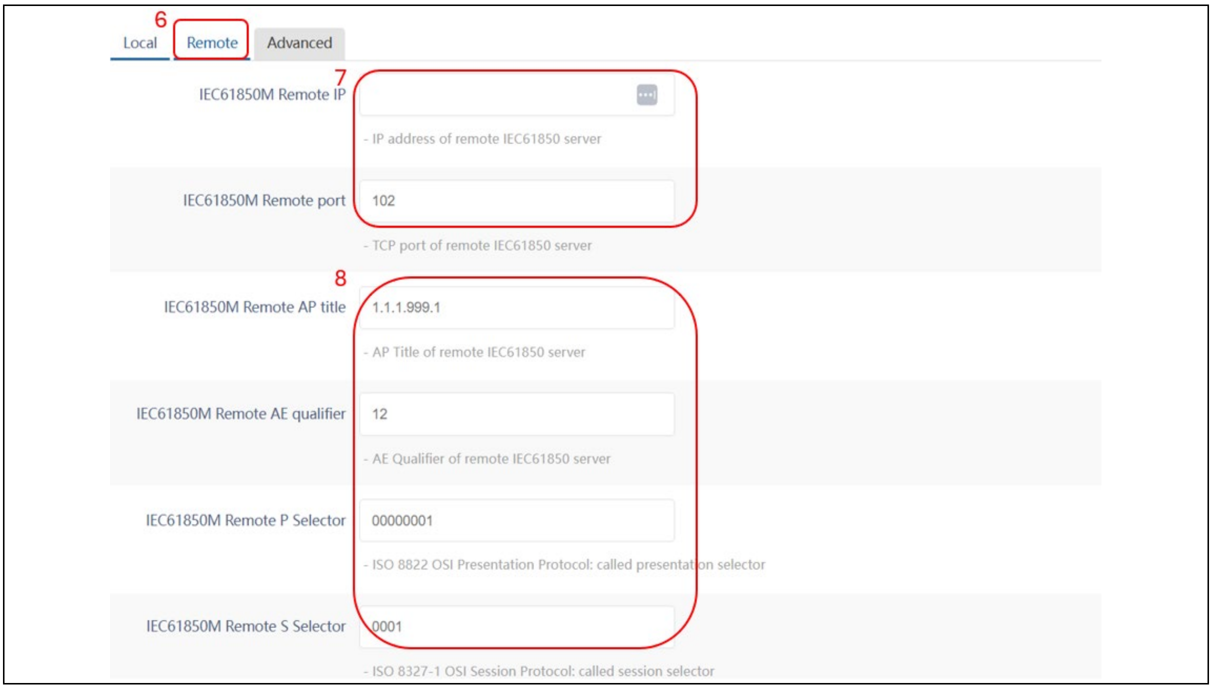


Figure 10: Remote tab in IEC61850 Master Settings

6. Click **Remote**.
7. Specify the **Remote IP** and **Port** of the IEC61859 RTU.
8. Specify the communication parameters of the remote IEC61850 RTU. Make sure that the local and remote (on RTU) communication parameters match.

Figure 11:The SAVE & APPLY button on IEC61850 Master Settings

Scroll to the bottom of the page and click **SAVE & APPLY**.

6 Configuring points (data points)

Data points are essential for protocol conversion, requiring users to develop a data addressing/type map to facilitate the conversion between two distinct protocols. Each data point represents an individual value, such as mapping a Modbus Holding register to an IEC104 Measured Value. The configuration of data points adheres to the same principles as configuring communication interfaces, necessitating appropriate values for both the slave and Master sides.

Note: the IEC104 and IEC61850 protocols utilize a command points concept. In this solution, configurations are divided into two distinct files: one for monitoring direction (Data Point) and another for control direction (Command Point). Other protocols consolidate configuration into a single file, where mapping is configured using only data points.

6.1 Points configuration – manual

Navigate to the main IECD page.

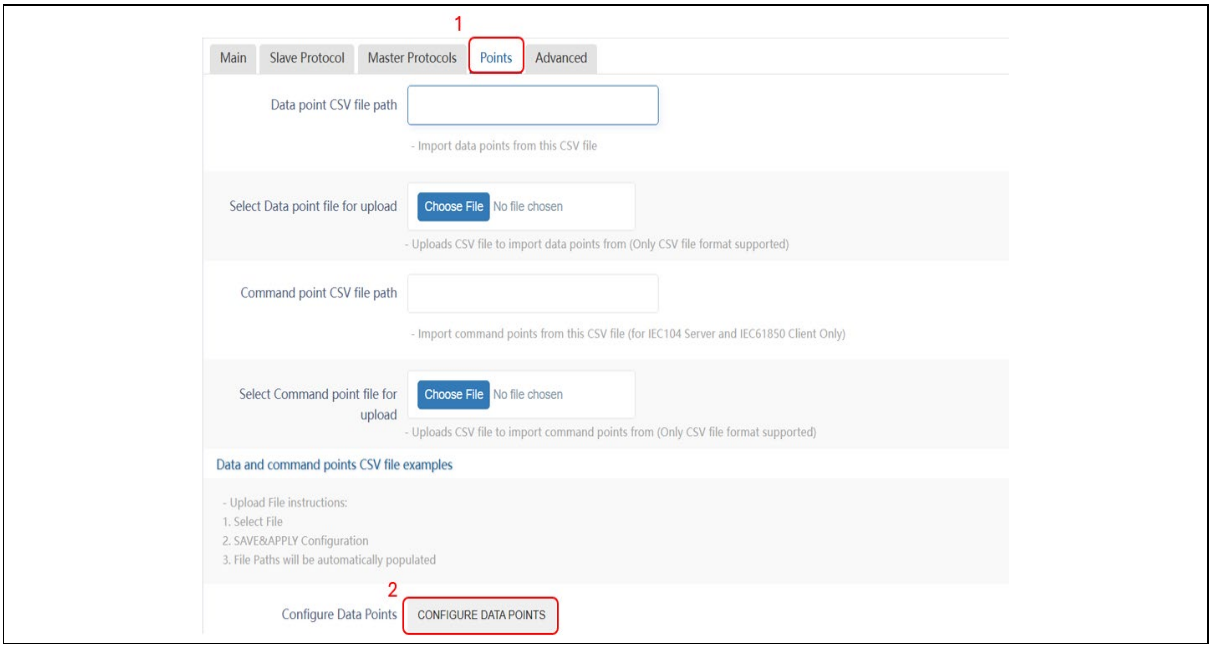


Figure 12:Points tab in data point configuration

1. Click **Points**.
2. Click **CONFIGURE DATA POINTS**.

Figure 13:Data point configuration

3. Click **ADD** to create a point.
4. Click **EDIT** to configure the added point.

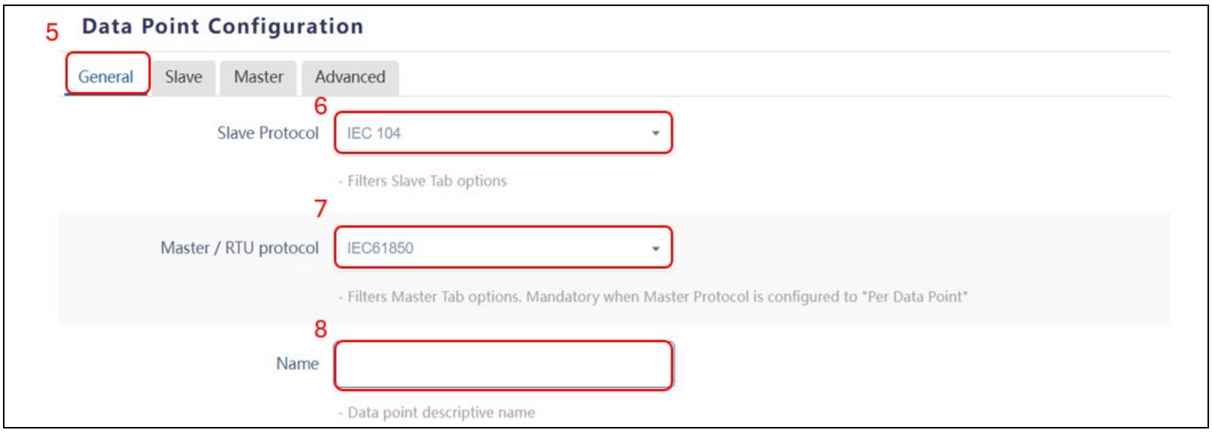


Figure 14:Data point configuration

5. On the Data Point Configuration page, click **GENERAL**.
6. Set the Slave Protocol as **IEC104**.
7. Set the Master/RTU protocol as **IEC61850**.
8. Assign a name to the data point (optional).

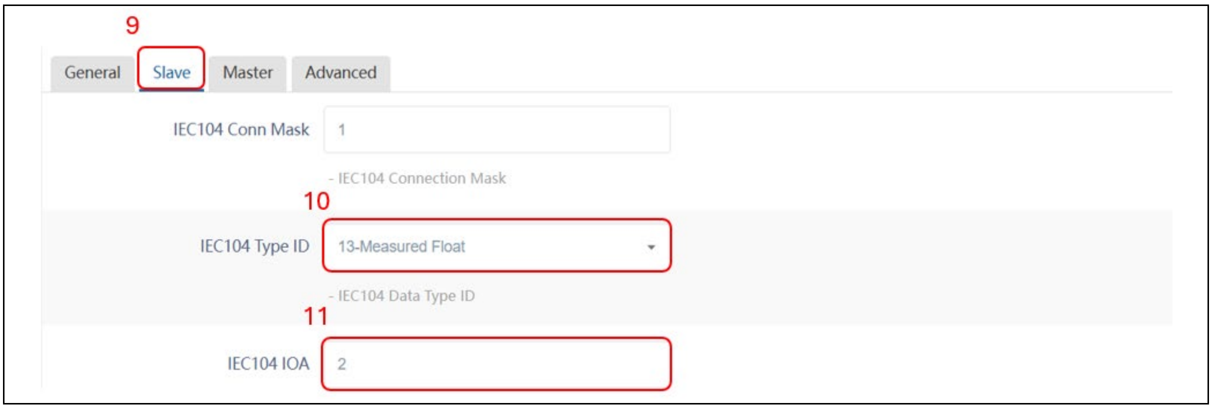


Figure 15:Data point configuration

9. Click **Slave**.
10. Set the **IEC104 Type ID**.

11. Set the **IEC104 IOA**. (Information Object Address – this will be visible to external master).

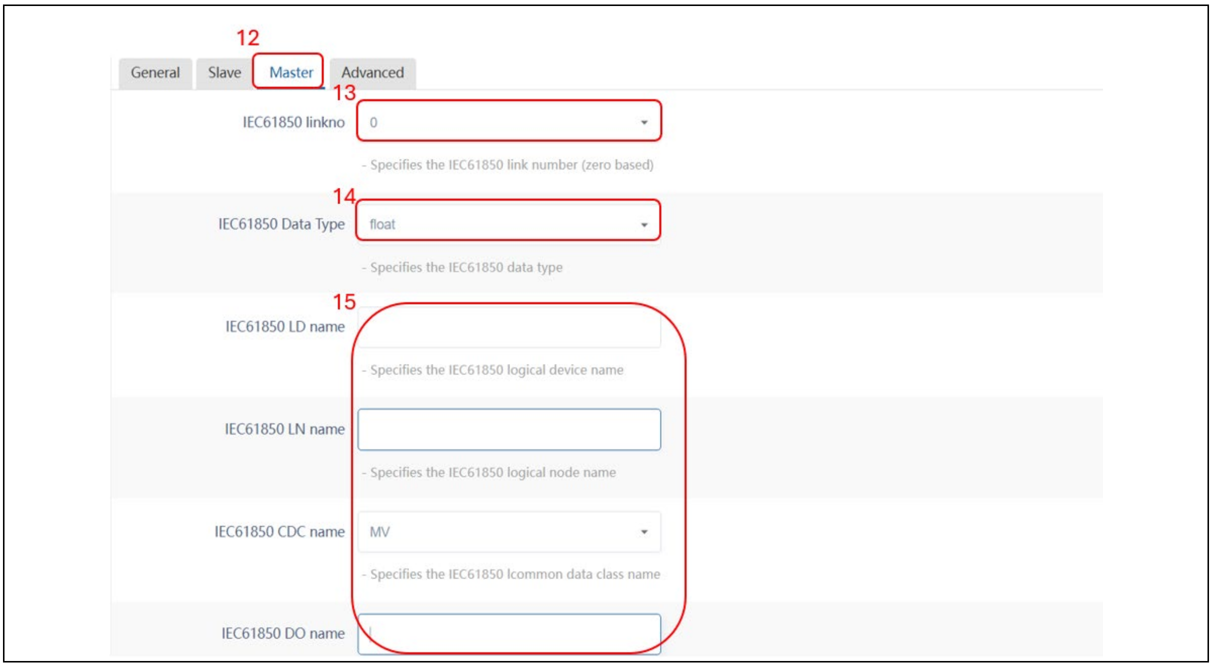


Figure 16:Data point configuration

12. Click **Master**.
13. Set **IEC61850 link number**. (e.g. 0 for first client zero-based order)
14. Set **IEC61850 Data Type** (CDC)
15. Set the names for Logical Devices (**LD**), nodes (**LN**), common data class (**CDC**), and data object (**DO**) name.

Note: the same configuration principles apply when configuring Command Points.

6.2 Points configuration – CSV file

Data/command points can be configured via CSV file upload. The CSV file shall include all required options in its header and their corresponding values in subsequent rows. Further instructions are available on the page via 'Data and command points CSV file examples' link, highlighted in Figure 17 below.

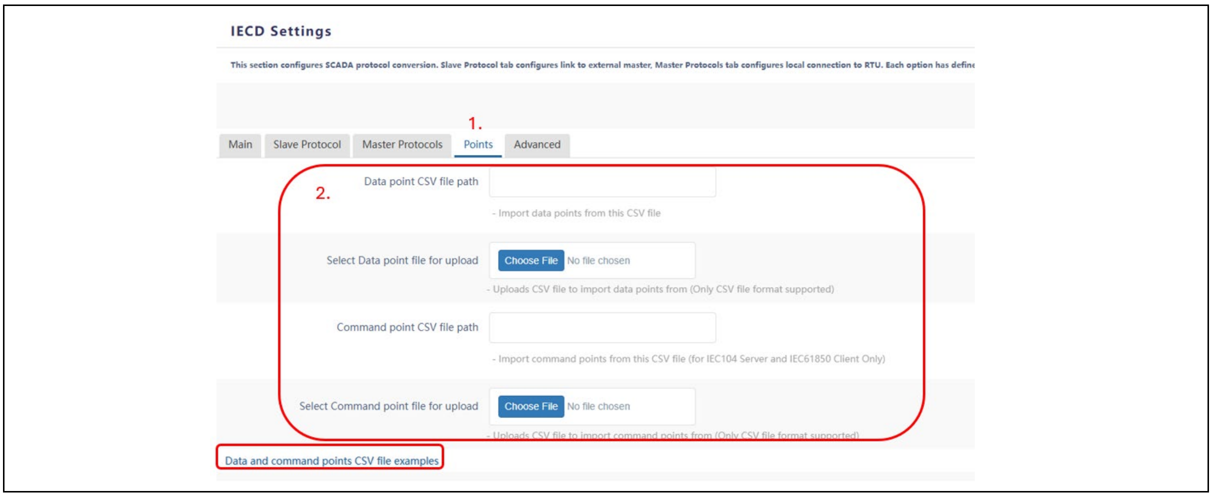


Figure 17: Points tab on data point configuration

16. On the IECD Settings page, click **Points**.
17. Click **Choose File** and select the CSV file.

name	rtu_proto	iec104_ioa	iec61850m_linkno	iec61850m_value_type	iec61850m_ld_name	iec61850m_node_name	iec61850m_cdc_name	iec61850m_do	iec104_type_id
Point1_SPCO	iec61850	3000	0	bool	IED_1LDevice1	GGIO3	SPC	SPCO	1

Figure 18: CSV file format

7 Troubleshooting

7.1 IECD status via the WebUI

Basic troubleshooting such as verifying connections quality, values, mapping or addressing can be accessed via the dedicated IECD status page.

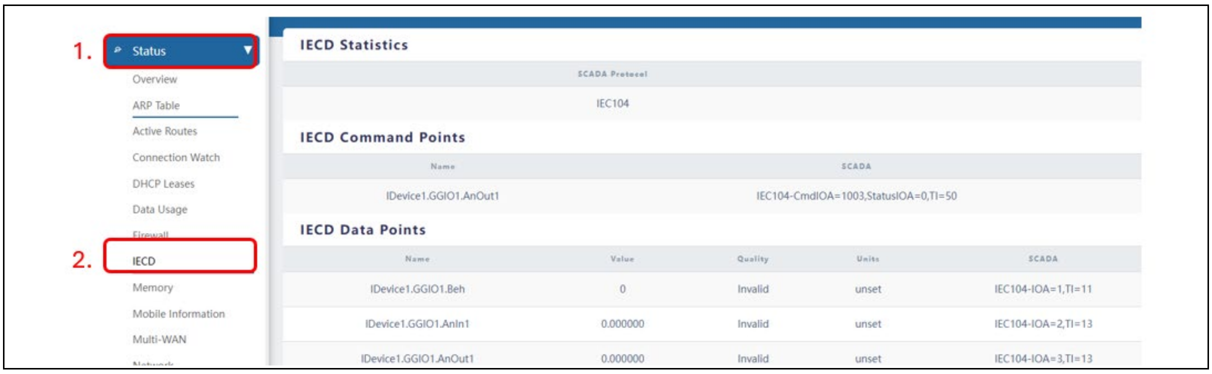


Figure 19:IECD status WebUI

1. On the main page, click **Status**.
2. Click **IECD**.

7.2 IECD status via CLI

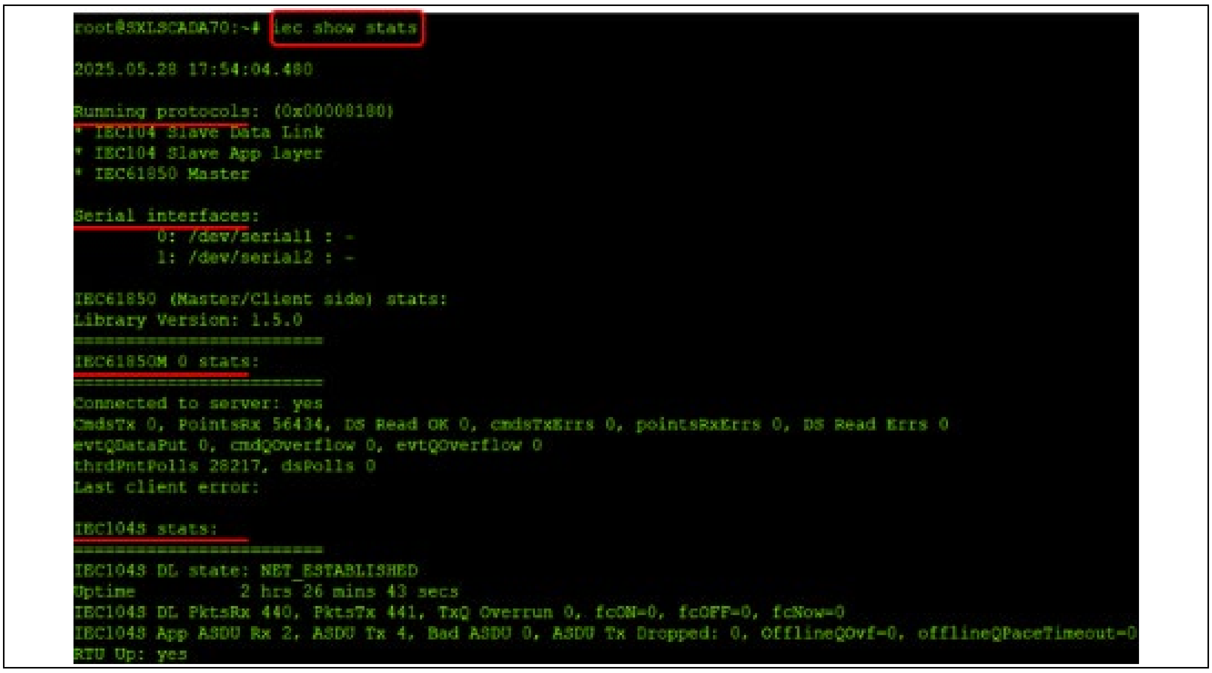


Figure 20: IECD status CLI output

1. To check the IECD status using CLI, connect to the router via SSH and enter the command `iec show stats`.
2. This will display the running protocols, serial interface in use, server and master protocol statistics such as the number of transmitted and received frames, and more. This information serves as a starting point for basic troubleshooting.

7.3 Configuring main debug level

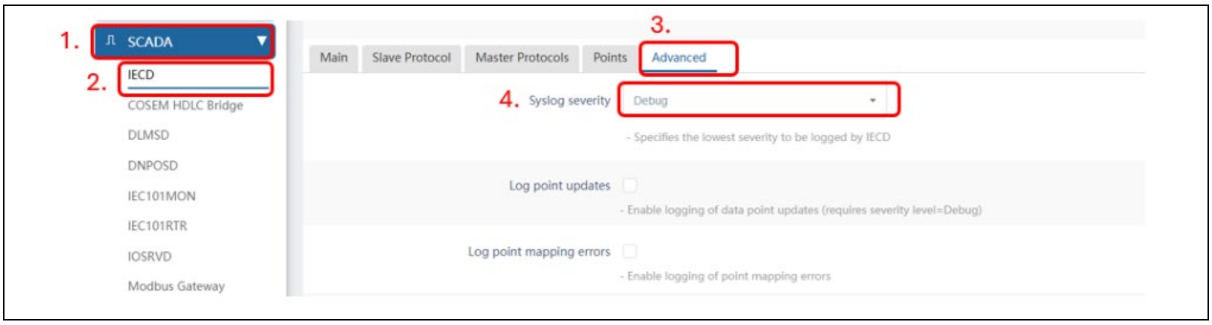


Figure 21: Enabling IECD logs

1. Click **SCADA**.
2. Click **IECD**.
3. Click **Advanced**.
4. From the Syslog severity drop-down menu, set the Syslog severity to **Debug**.
5. To save the configuration and restart the IECD application, scroll to the bottom of the page and click **SAVE & APPLY**.

7.4 Enabling debug per protocol – IEC104 (Server)

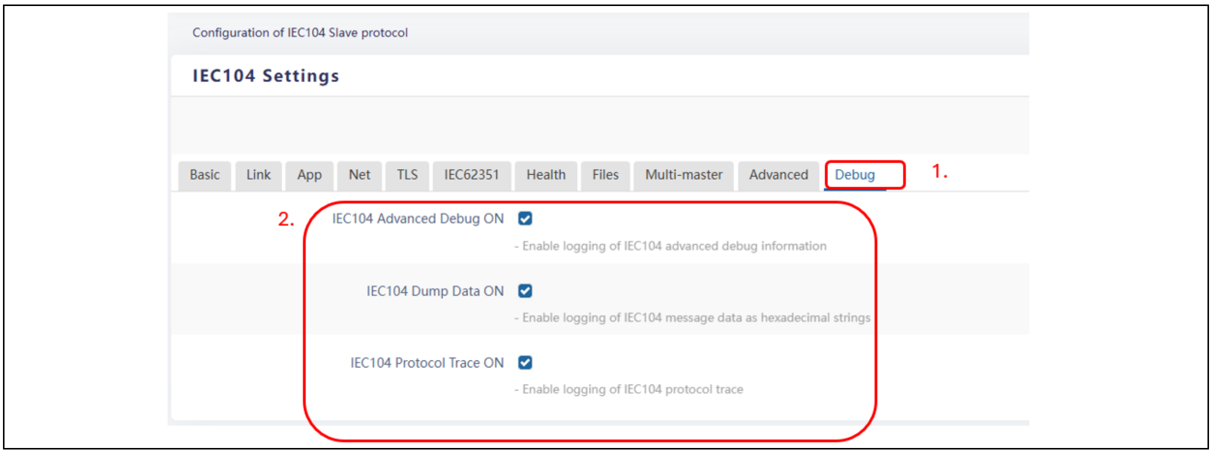


Figure 22:Enabling server protocol logs

Via the WebUI, access IEC Slave settings.

Click **Slave Protoco**l and then **CONFIGURE IEC104-S**.

1. Click Debug.
2. To enable additional logging:
    a. IEC104 Advanced Debug ON – enables printing of all IEC104 exchanges.
    b. IEC104 Dump Data ON – enables printing for all messages in HEX.
    c. IEC104 Protocol Trace ON – enables printing for all protocol processing.
3. To save the configuration and restart the IECD application, scroll to the bottom of the page and click **SAVE & APPLY**.

7.5 Enabling debug per protocol – IEC61850 (Master)

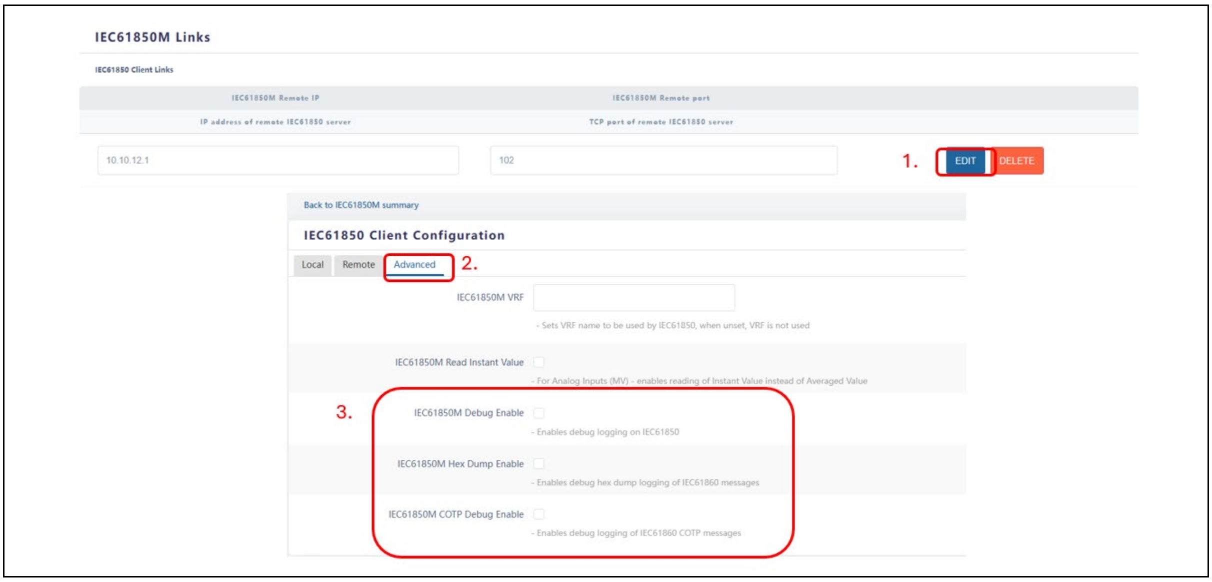


Figure 23: Enabling master protocol logs

Via the WebUI, access IEC61850 Master settings.

Click **Master Protocol** and then **CONFIGURE IEC61850**. Debug settings are available per client connection.

1. Identify a client in IEC61850 Client Links list and click **Edit** in the top right-hand side. This action will open a new IEC61850 Client Configuration window.)
2. In the client configuration window, click Advanced.
3. To enable additional logging:
    a. IEC61850M Debug Enable – enables printing of additional debug for MMS.
    b. IEC61850M Hex Dump Enable – enable printing for all messages in HEX.
    c. IEC61850 COTP Debug Enable – enables printing COTP protocol messages.
4. To save the configuration and restart the IECD application, scroll to the bottom of the page and click **SAVE & APPLY**.

7.6 Accessing logs using WebUI

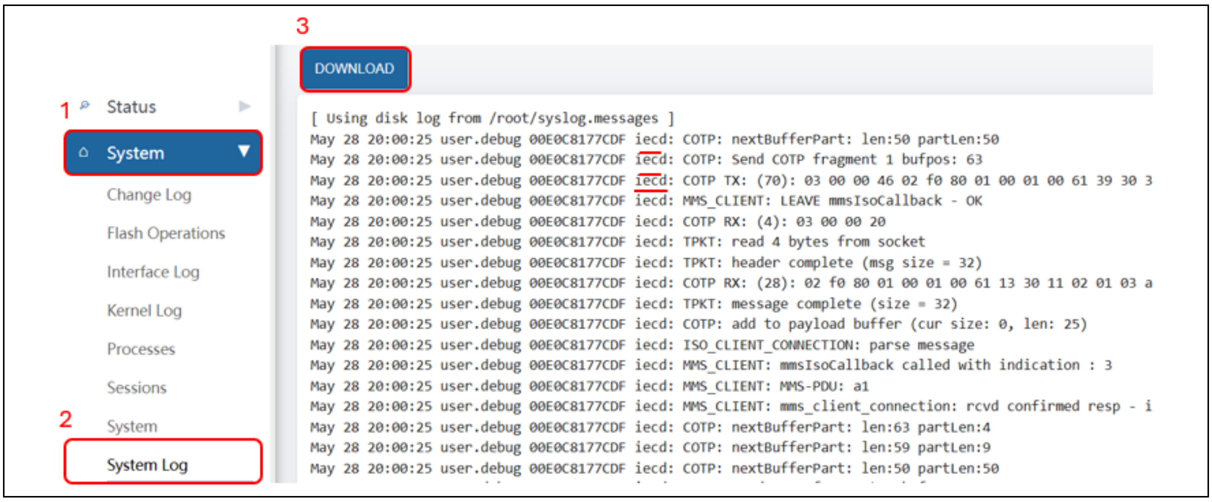


Figure 24: Enabling system logs

1. To check the logs, in the left-hand menu, click **System**.
2. Click **System Log** and search for logs related to IECD. These logs will have the name **iecd**.
3. To download the logs, click **Download**.

7.7 Accessing logs via CLI

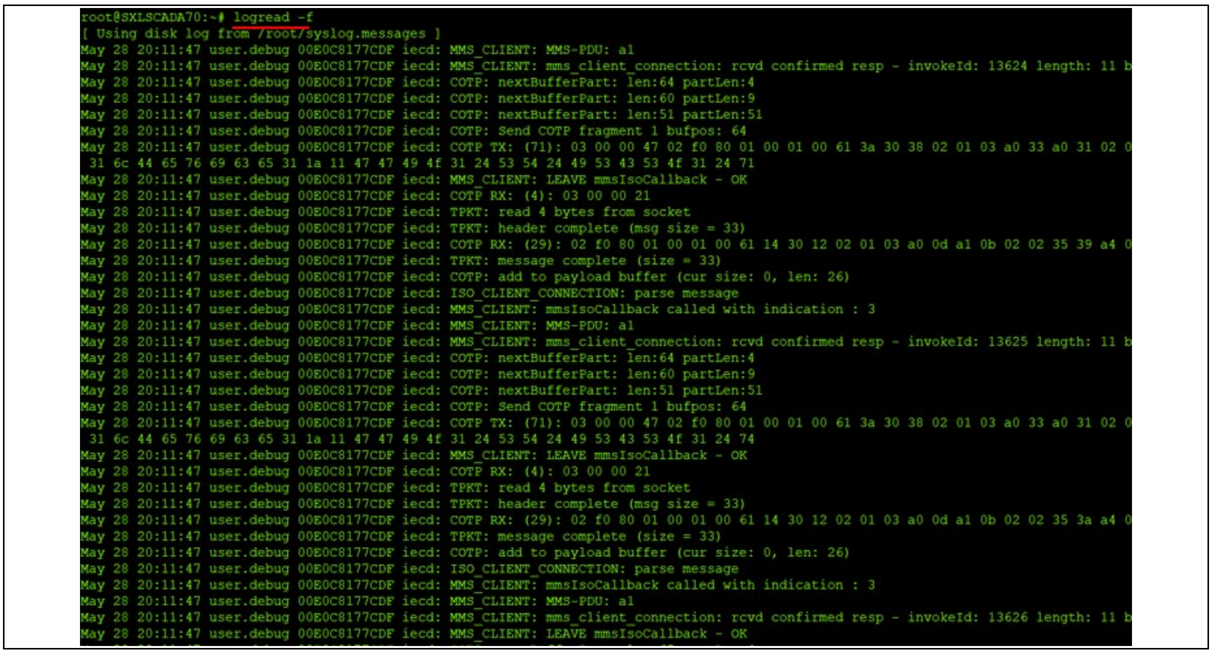


Figure 25: Enabling CLI logs output

1. To check the IECD logs using the CLI, connect via SSH and enter the command `logread -f`.
2. Logs related to the server and master protocols will be displayed.

Note: users can download the log file, as `syslog.messages` in the root directory, via WinSCP.

7.8 Table of supported CDC types

The table below shows the supported data types. For requests or enquiries, email support.ie@westermo.com.

CDCs defined in IEC61850-7-3: 2003 (61850-80-1)	
IEC61850 CDC (Common Data Class)	**IEC104 ASDU type**
SPS (Single Point Status)	monitor direction (status): TI<30> as event TI<1> as part of GI
SPC (Controllable Single Point)	monitor direction (status): TI<30> as event TI<1> as part of GI control direction (command)
SPG (Single point setting) (NOT SUPPORTED)	control direction (status): TI<31> as event TI<3> as part of GI

DPS (Double point status)	monitor direction (status): TI<31> as event TI<3> as part of GI
DPC (Controllable double point)	monitor direction (status): TI<31> as event TI<3< as part of GI control direction
INS (Integer status)	Monitor direction (status) TI<35> event TI<11> as part of GI
STV (Status value) (NOT SUPPORTED)	Mapped via CDC INS Interger status